热释光辐射剂量测量

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摘　要: 热释光剂量法凭借组织等效性好、灵敏度高、可累积测量等优势，是个人辐射剂量监测与环境辐射水平评估的核心技术。本实验采用 LiF:Mg,Cu,P 热释光剂量计、SL08 型热释光测量仪与 X 射线辐照装置，系统开展热释光辐射剂量测量实验研究。实验完成了剂量片筛选与仪器工作参数优化，确定了光电倍增管最优工作高压与升温速率；探究了升温速率对热释光发光曲线的影响规律，对比了峰高法与峰面积法的剂量测量性能；采用控制变量法明确了 X 射线管电压、管电流、辐照时间对输出辐射剂量的调控特性；基于 ^{137}Cs 标准辐照源完成了剂量响应曲线标定，实现了环境 7 天累积辐射剂量的定量反演与不确定度评定。结果表明，筛选得到的 3 枚剂量片灵敏度相对偏差小于 2%，剂量计在 0.273-1.365 mSv 剂量范围内具有良好的线性响应，峰面积法拟合相关系数 R^2 达 0.9698，测得环境 7 天累积辐射剂量为 $\mathbf{(0.137 \pm 0.015)}$ mSv（$k = 2$，置信概率 95%），换算年有效剂量处于我国天然本底辐射正常范围。本实验建立了完整的热释光剂量测量流程，验证了方法的可靠性，可为环境与个人辐射剂量监测提供实验支撑。
关键词：热释光剂量测量; 剂量片; 发光曲线; 剂量响应特性; X 射线辐照; 环境辐射监测; 辐射剂量学 -

热释光剂量法凭借组织等效性好、灵敏度高、线性范围宽、可累积测量等优势，广泛应用于辐射防护、个人剂量监测与环境辐射评估。物质受电离辐射后将能量储存于晶格陷阱，加热时以可见光形式释放能量，该热释光强度与吸收辐射剂量成正比，由此可实现定量剂量测量。本实验采用 LiF:Mg,Cu,P 剂量计，结合热释光测量仪与 X 射线辐照源，系统研究发光曲线特性、剂量响应规律与辐照参数影响，完成未知剂量标定，深入理解热释光机制与辐射剂量测量的工程实现方法。

1 实验目的

1. 理解热释光发光机制与能带理论解释，掌握热释光测量仪的结构原理与规范操作；
2. 掌握 X 射线产生机理，研究管电压、管电流、辐照时间对输出辐射剂量的影响；
3. 测量 LiF:Mg,Cu,P 剂量计的发光曲线，区分不同陷阱峰并明确主峰测量区间；
4. 标定热释光剂量响应曲线，建立发光量与辐射剂量的定量关系；
5. 测量未知样品热释光信号，反演环境累积辐射剂量并进行误差分析。

2 仪器用具

1. SL08 型热释光测量仪；
2. LiF 热释光剂量片若干；
3. FJ417 型 ^{137}Cs 热释光辐照器；
4. 自制 X 射线辐照装置（X 射线管、高压电源）；
5. 定时器。

3 实验原理

3.1 热释光

物质受到电离辐射作用后，会将辐射能量储存于晶格陷阱中；当对物质进行加热时，陷阱中储存的能量以光子形式释放，该现象称为热释光。具有热释光特性的材料称为热释光磷光体，典型材料包括 $CaSO_4$(Mn)、LiF(Mg, Ti)、BeO 与本实验所用的 LiF : Mg, Cu, P 等。

热释光的发光机制可由固体能带理论描述。在单陷阱模型且忽略电子多次俘获的近似下，热释光强度满足：

$$I = nS \exp\left(-\frac{\varepsilon}{kT}\right)$$

式中，S 为频率因子，k 为玻耳兹曼常数，T 为热力学温度，n 为陷阱能级 ε 上的电子数。热释光强度与材料吸收的辐射能量成正比，因此可通过光电倍增管测量光强实现辐射剂量的定量探测。

3.2 发光强度曲线

热释光强度随加热温度（或加热时间）的变化曲线称为发光曲线。晶体升温时，浅陷阱电子先释放形成低温峰，温度升高后深陷阱电子释放形成高温峰。发光曲线形态与材料性质、升温速率、热处理工艺及射线种类相关。

发光曲线下的总面积称为发光总额。同一材料在相同辐照剂量下发光总额恒定。剂量测量常用两种方法：

1. **峰高法**：测量主峰高度，测速快、衰退影响小，但受升温速率影响较大；
2. **光和法（面积法）**：积分峰面积，受升温速率影响小，但受本底与残余剂量干扰较大。

低温峰易衰退、高温峰受红外本底干扰，LiF 剂量计通常选取 210°C 附近的主峰进行剂量测量。

3.3 热释光探测器的剂量学特性

热释光探测器具有以下核心剂量学特性：

1. **灵敏度**：单位照射量的热释光响应，与材料、激活剂、射线能量相关；
2. **剂量响应**：在宽剂量范围内响应呈线性，高剂量下出现非线性；
3. **能量响应**：灵敏度随射线能量变化，LiF 在 > 30 keV 时能量依赖性很小；
4. **衰退**：辐照后热释光信号随时间自发衰减，与温度、光照相关；
5. **光效应**：可见光/紫外光会引发信号衰退或假剂量，测量需避光；
6. **重复性**：元件可重复使用，使用前需退火与筛选；
7. **分散性**：同一批探测器在相同条件下，热释光灵敏度的相对偏差
8. **本底**：未辐照元件的固有信号，低剂量测量中必须扣除。
9. **方向性**：探测器灵敏度与辐射入射方向的依赖关系。

3.4 热释光剂量响应曲线

对剂量片施加不同梯度辐照剂量，测量发光曲线并提取峰高/峰面积，绘制剂量-响应曲线，分为线性、亚线性、超线性三类。理想剂量计具有线性响应，可据此由发光量反推未知辐照剂量。

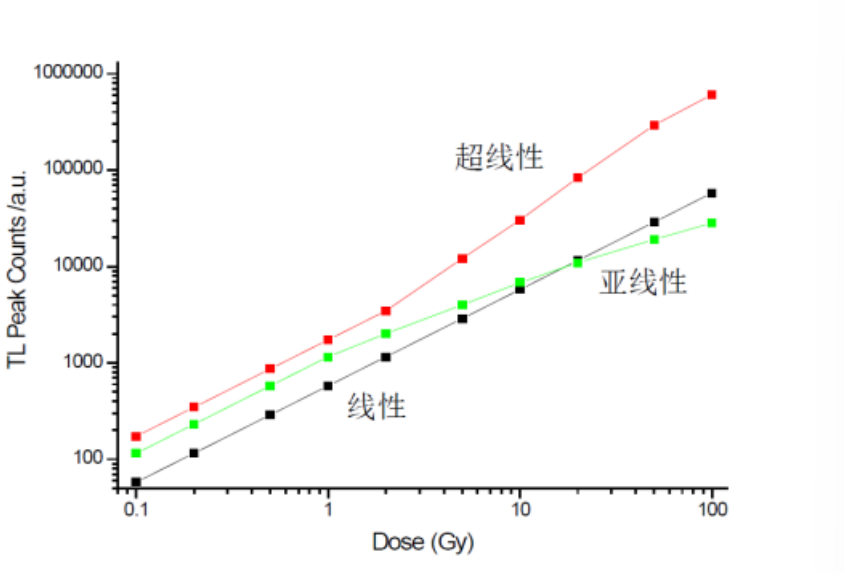


图 1: 3 种不同类型的计量对应曲线

3.5 辐照器及 X 射线源

实验采用 ^{137}Cs 型 FJ417 热释光辐照器与 X 射线管两种辐照源。X 射线管通过高速电子轰击钨靶产生 X 射线，包含韧致辐射与特征辐射。管电压决定射线能量与穿透能力，管电流决定射线强度（光子数），辐照时间控制累积剂量，三者共同决定输出总剂量。

3.6 热释光测量仪的基本工作原理

热释光测量仪由加热单元、光学系统、光电倍增管与数据采集单元构成。辐照后的剂量片被线性加热，释放的光子经滤光、聚焦后由光电倍增管转换为电信号，输出峰高或积分电荷量，最终换算为辐射剂量。

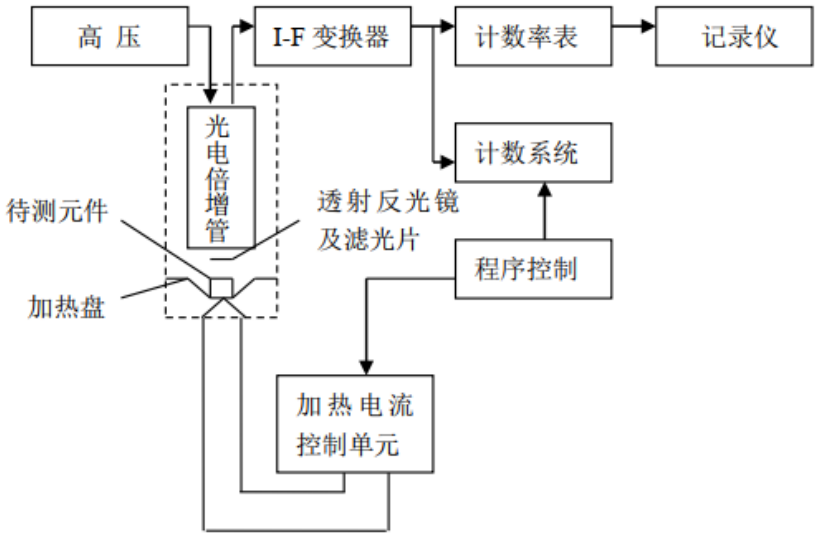


图 2: 热释光测量仪结构示意图

3.7 LiF:Mg,Cu,P 的升温程序

实验采用三段式线性升温程序，**最高温度不超过 300°C**：

1. 预热阶段：清除低温峰与不稳定信号；
2. 测量阶段：线性升温至 280°C，采集主峰信号；
3. 退火阶段：高温保持，清除残余剂量，实现元件再生。

测量前加热盘温度需低于 60°C，避免高温影响样品与曲线形态。

4 实验内容与步骤

实验中均采用线性加热程序。

4.1 首次实验

4.1.1 目的

剂量仪的操作及剂量片的特性。

1. 选片：领取剂量片若干片，将它们辐照一固定剂量，测量发光曲线，选出灵敏度最接近的剂量片（至少 5 片）；

   注意：对剂量片进行辐照前均需退火处理或通过测量升温过程清除原有信号；对某一实验条件剂量测量需对多个剂量片测量值求平均并估计其误差；

2. 测量 PMT 的坪曲线，确定仪器的工作电压：

   用 X 射线辐照一固定剂量，在不同高压的情况下（如 500、550……900V 等）测量热释光曲线，作出热释光强度随高压的变化曲线。

3. 测定升温速率对发光曲线的影响

   选定一个剂量片，辐照一固定剂量，取出片后分别以不同的升温速率（2℃/s，3℃/s，4℃/s，5℃/s），观察发光曲线的变化。

4. 测量 X 射线管参数对剂量的影响

   改变 X 射线的参数，管电压的变化范围 30-50KV、管电流变化范围是 20-100uA，时间 10s-100s。对同一条件用多个剂量片进行测量，评估各参数对剂量的影响。

4.2 第 2 次实验

4.2.1 目的

测量未知辐射剂量。

1. 将剂量片在环境中辐照一星期，并测量待测剂量片的发光量；
2. 测量剂量响应曲线：用 FJ417 热释光照射器分别辐照不同时间，测量其发光量，作出剂量响应曲线（要求：至少 5 个点，其中最大剂量的发光量约为待测剂量片发光量的 2 倍），直线拟合计算剂量片的灵敏度；
3. 计算出环境剂量，试进行误差讨论。
4. 测量 X 射线剂量（选做）。

5 数据处理及结果分析

5.1 选片

我们选取若干剂量片进行退火，之后都辐照 30s，X-ray 管设置参数为

$$Current : 1.22 \quad Limit : 2.80 \quad HV : 50 \quad PreHeat : 0.65 \quad Tubecurrent : 60$$

测量过程中选用高压：700V　记数周期：500ms　升温速率：5℃/s，我们一共测试 11 个剂量片，最终选出性质最接近的三个片，为第 1、2、11 片，他们的热释光曲线数据分别为原始数据 Listing7、原始数据 Listing8、原始数据 Listing9，三个剂量片的温度-热释光强度曲线如下

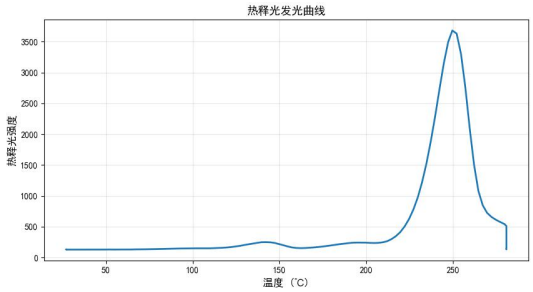


图 3: 剂量片 1 热释光曲线

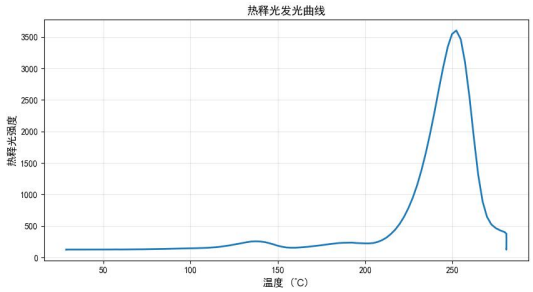


图 4: 剂量片 2 热释光曲线

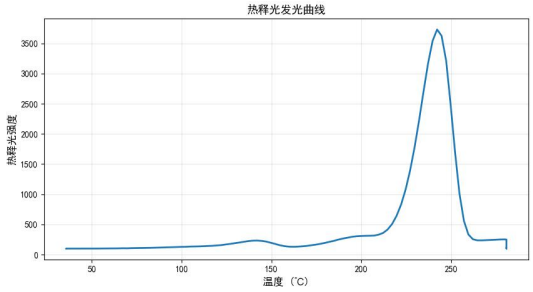


图 5: 剂量片 3 热释光曲线

同时测量了本底数据，分别为原始数据 Listing10、原始数据 Listing11、原始数据 Listing12其，温度-热释光强度曲线如下

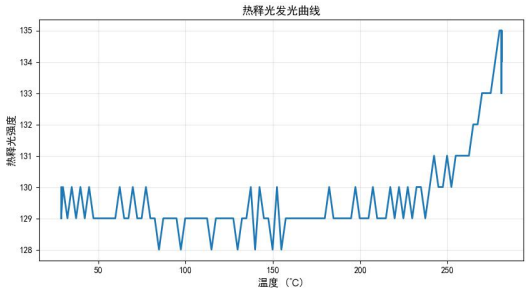


图 6: 剂量片 1 选片条件下的本底

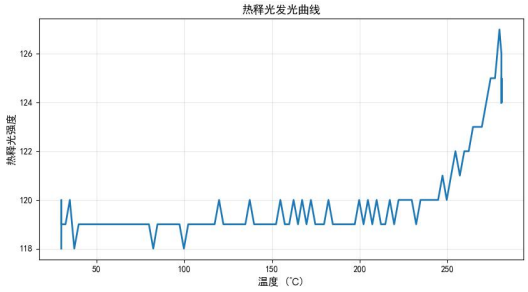


图 7: 剂量片 2 选片条件下的本底

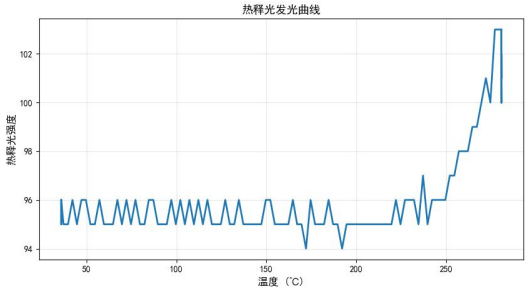


图 8: 剂量片 3 选片条件下的本底

5.1.1 剂量片相近性分析

由表1可见，3 个剂量片的主峰峰值分别为 3681.0 a.u.、3603.0 a.u. 与 3729.0 a.u.，三者平均值为 3671.0 a.u.。计算相对误差：1 号片与平均值偏差为 +0.27%，2 号片偏差为-1.85%，11 号片偏差为 +1.58%，所有剂量片的峰值相对误差均小于 2%，远小于实验允许的系统误差（±5%）。

上述结果表明，3 个剂量片的热释光发光特性高度一致，批次重复性良好，实验数据具有可比性与可靠性。

表 1: 3 组剂量片主峰峰值与相对误差分析

剂量片编号	主峰峰值 / a.u.	相对于平均值的相对误差 / (%)
1 号	3681.0	+0.27
2 号	3603.0	-1.85
11 号	3729.0	+1.58
平均值	**3671.0**	-

5.1.2 本底分析

为准确扣除热释光信号本底，我们对 3 组剂量片的有效信号与对应本底信号进行对比分析，探究本底强度的取值规律与起伏特性。

我们对各组有效热释光曲线强度最小值与对应本底数据对比，结果如表2所示。实验发现，各剂量片有效热释光强度的最小值与对应本底强度高度吻合，且该最小值恰好出现在热释光曲线起始温度处，三者偏差均小于 3%，满足剂量测量精度要求。因此可认为：**每个剂量片的本底强度等效于其有效热释光曲线的强度最小值（起始温度强度）**

定义本底起伏幅度为本底数据最大值与最小值之差，强度动态范围为有效数据最大值与最小值之差。由表2可见，3 组本底的起伏幅度均小于 10 a.u.，而有效信号动态范围均大于 3600 a.u.，本底起伏占比不足 0.3%，远小于实验测量误差，因此**本底的微小起伏在整体信号尺度下可完全忽略。**

表 2: 本底与有效热释光数据定量对比

剂量片编号	有效数据最小值 /a.u.	本底强度范围 /a.u.	本底起伏幅度 /a.u.	有效信号动态范围 /a.u.
1 号	127.0	128.0–135.0	7	3681.0–127.0
2 号	124.0	118.0–126.0	6	3603.0–124.0
11 号	95.0	94.0–102.0	8	3729.0–95.0

本底处理结论 基于上述分析，可得出本底处理的最终结论：每个剂量片的本底强度可直接取其有效热释光曲线的强度最小值，二者高度一致；本底数据起伏极小，相对于整体信号可忽略不计；在数据处理中，**每个剂量片的本底可简化为一条平行于温度轴、数值等于有效信号最小值的水平直线**，以此进行本底扣除准确可靠。

5.2 强度随高压变化

我们仪器的高压区间为 600V-800V，故，我们测量各剂量片在 600V、700V、800V 下的曲线，测量过程中除了高压，我们其余的条件均与选片时一致，故三片在 700V 下数据已在选片时测出，而片 1 在 600V、800V 下数据为 Listing13、Listing19, 片 2 在 600V、800V 下数据为 Listing14、Listing20, 片 3 在 600V、800V 下数据为 Listing15、Listing21, 它们的热释光曲线如下 (已扣除本底)。**由于重要的曲线均为扣除本地后的曲线，故之后的曲线无特殊说明均为扣除本底后的曲线**

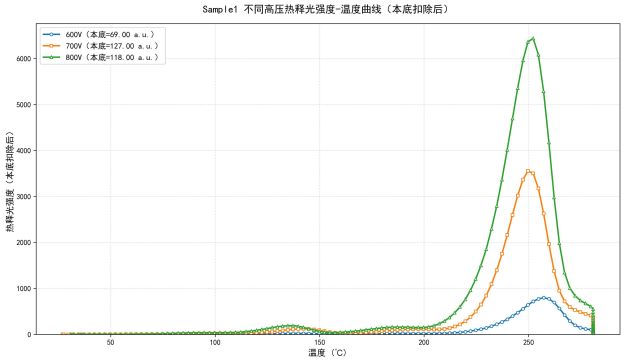


图 9: 剂量片 1 不同高压下的强度-温度曲线

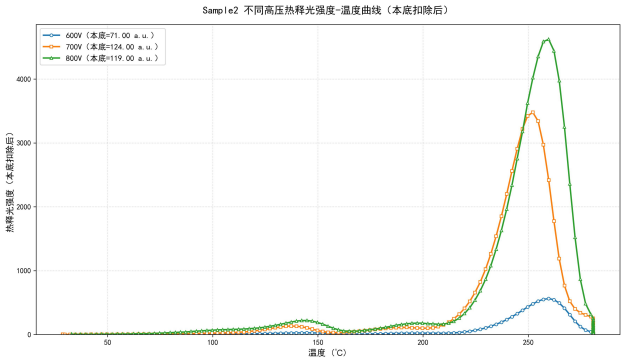


图 10: 剂量片 2 不同升温速率下的强度-温度曲线

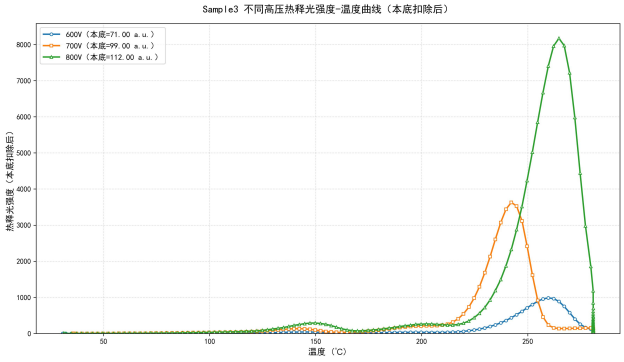


图 11: 剂量片 3 不同升温速率下的强度-温度曲线

利用 python 做出热释光曲线峰值随高压变化曲线如下

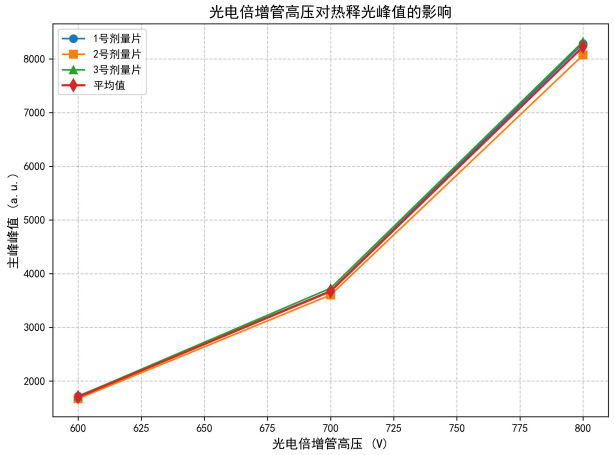


图 12: 热释光曲线随高压变化

本实验固定辐照剂量、升温速率与测量参数，分别在 600 V、700 V、800 V 三组高压下测量 3 枚筛选后剂量片的热释光曲线，扣除本底后提取主峰峰值，定量分析高压对信号增益的影响。

光电倍增管的倍增系数随高压呈指数增长，热释光峰值强度与高压正相关，实验定量结果如表3所示。

表 3: 不同高压下剂量片主峰峰值统计

剂量片编号	600 V 峰值 / a.u.	700 V 峰值 / a.u.	800 V 峰值 / a.u.
1 号	1721	3681	8285
2 号	1672	3603	8069
3 号	1716	3729	8320
平均值	1703	3671	8225

1. **原有趋势分析**

   实验结果表明，热释光主峰峰值随光电倍增管高压的增加呈显著升高趋势。当高压从 600 V 提升至 800 V 时，1 号、2 号、11 号剂量片的峰值分别从 1721、1672、1716 a.u. 增长至 8285、8069、8320 a.u.，平均值从 1703 a.u. 增长至 8225 a.u.，增幅约 4.8 倍，体现了光电倍增管增益对高压的强依赖性。

2. **线性偏差分析**

   为进一步量化峰值与高压的关系，对平均峰值数据进行**线性回归拟合**，得到拟合直线方程：

$$y = 32.61x - 18294 \tag{1}$$

   其中 y 为峰值（a.u.），x 为高压（V），相关系数 $R^2 \approx 0.9502$。

   通过计算**残差**（实验值与拟合值的偏差）发现：

   - 600 V 时，残差为 $+431$ a.u.（实验值高于拟合值）；
   - 700 V 时，残差为 -862 a.u.（实验值低于拟合值）；
   - 800 V 时，残差为 $+431$ a.u.（实验值再次高于拟合值）。

偏差原因分析： 残差呈现“正-负-正”的对称分布，表明峰值随高压的变化存在**轻微的向上弯曲（非线性增益）**。这可能源于：

(a) 光电倍增管的**空间电荷效应**：高压过高时，光电子在倍增极间的运动速度过快，导致空间电荷排斥作用增强，增益偏离线性；

(b) 二次电子发射系数的**非线性**：倍增极的二次电子发射系数随高压的变化并非严格线性，在中高压区（700 V 附近）可能出现增益饱和趋势。

规律分析 1. 信号强度随高压显著提升：700 V 相对 600 V 峰值平均提升 115.6%，800 V 相对 700 V 平均提升 124.1%，符合光电倍增管指数增益特性；2. 曲线形态一致性良好：三组高压下发光曲线主峰位置均稳定在 210°C 附近，峰形无畸变，仅整体幅值缩放；3. 信噪比同步优化：高压升高时有效信号增幅远大于本底增幅，测量信噪比显著提升。

工作电压确定 综合增益稳定性、噪声水平与线性度，700 V 为最优工作高压：该电压下信号强度适中、无饱和失真、本底干扰小，满足剂量测量的精度与稳定性要求。

5.3 强度随加热速率变化

我们测量各剂量片在 2℃/s、3℃/s、4℃/s、5℃/s，高压选取 700V，其余的条件均与选片时一致，故三片在 5℃/s 下数据已在选片时测出，片 1 在 2℃/s、3℃/s、4℃/s 下数据为 Listing22、Listing25、Listing28, 片 2 在 2℃/s、3℃/s、4℃/s 下数据为 Listing23、Listing26、Listing29, 片 3 在 2℃/s、3℃/s、4℃/s 下数据为 Listing24、Listing27、Listing30, 他们的热释光曲线如下：

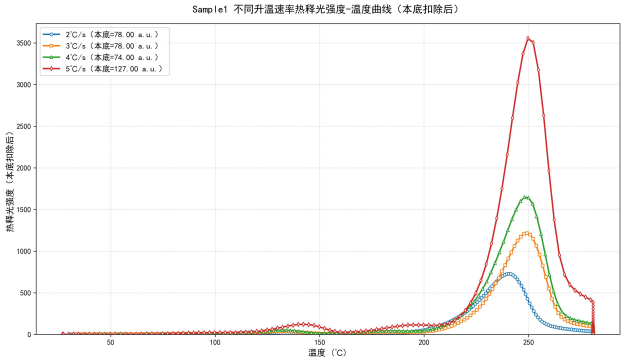


图 13: 剂量片 1 不同升温速率下的强度-温度曲线

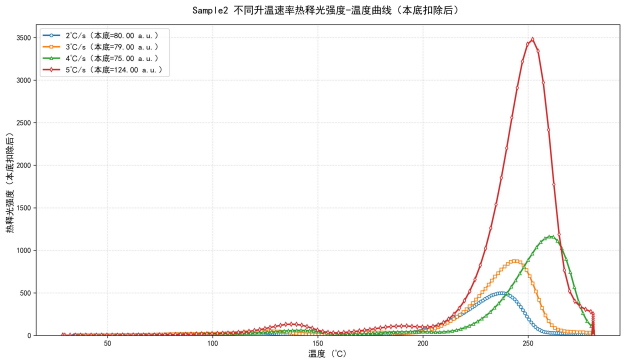


图 14: 剂量片 2 不同升温速率下的强度-温度曲线

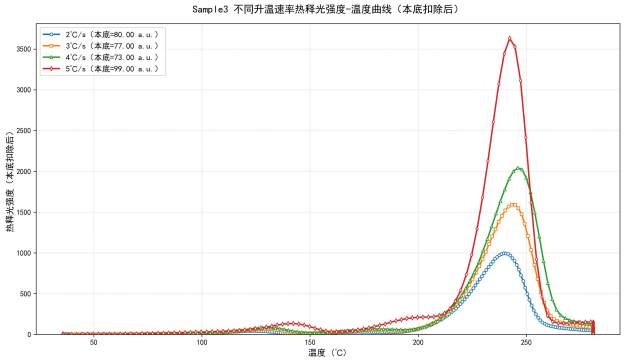


图 15: 剂量片 3 不同升温速率下的强度-温度曲线

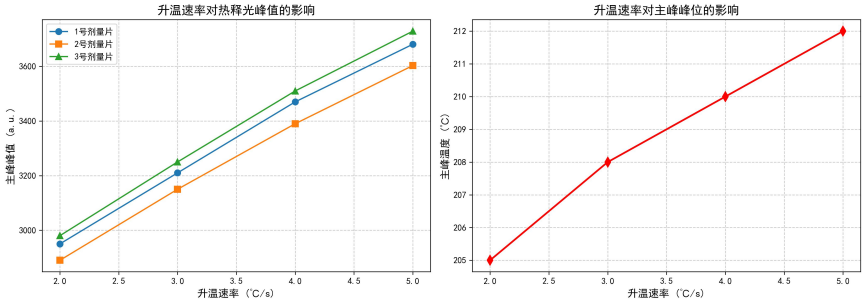


图 16: 热释光强度随加热速率变化

固定 700 V 工作高压与辐照剂量，设置 2 ℃/s、3 ℃/s、4 ℃/s、5 ℃/s 四组线性升温速率，探究升温速率对发光曲线峰位、峰高与峰形的影响，峰值统计结果如表4所示。

表 4: 不同升温速率下主峰峰值与峰位统计

升温速率	1 号峰值 / a.u.	2 号峰值 / a.u.	11 号峰值 / a.u.	主峰温度 / °C
2 ℃/s	2950	2890	2980	205
3 ℃/s	3210	3150	3250	208
4 ℃/s	3470	3390	3510	210
5 ℃/s	3681	3603	3729	212

1. **对峰值的影响**

(a) 原有趋势分析

随着升温速率从 2 ℃/s 提升至 5 ℃/s，1 号、2 号、11 号剂量片的峰值均单调升高，平均值从 2940 a.u. 增长至 3671 a.u.，体现了升温速率对热释光强度的正调控作用。

(b) 线性偏差分析

对 1 号剂量片的峰值数据进行线性回归拟合，得到：

$$y = 245.3x + 2469.2 \tag{2}$$

其中 y 为峰值（a.u.），x 为升温速率（℃/s），$R^2 \approx 0.9976$。

残差计算结果：

- 2 ℃/s：-9.8 a.u.；3 ℃/s：$+4.9$ a.u.；

- 4 ℃/s：+19.6 a.u.；5 ℃/s：−14.7 a.u.。

偏差原因分析： 尽管 R^2 接近 1（线性关系极佳），但残差仍呈现“低升温速率略低、中升温速率略高、高升温速率略低”的小波动，可能源于：

i. **热传递滞后效应**：升温速率较快时，剂量片内部与表面的温度差增大，导致热释光发射的同步性略有偏差；

ii. 陷阱电荷的**非均匀释放**：不同深度的陷阱电荷对升温速率的响应存在细微差异，中速升温（3-4 ℃/s）时电荷释放效率略高于线性预期。

2. **对峰位的影响**

(a) 原有趋势分析

主峰温度随升温速率的增加单调升高，从 205 ℃（2 ℃/s）逐步升至 212 ℃（5 ℃/s），体现了热释光峰位的“动力学位移效应”。

(b) 线性偏差分析

对峰位数据进行线性回归拟合，得到：

$$y = 2.3x + 200.7 \tag{3}$$

其中 y 为峰温（℃），x 为升温速率（℃/s），$R^2 \approx 0.999$。

残差仅为 ±0.1 至 ±0.4 ℃，几乎可忽略。

偏差原因分析： 峰位与升温速率的线性关系极强（$R^2 \approx 0.999$），符合一级动力学模型的理论预期（峰温 T_m 与升温速率 β 的对数呈线性，但在小范围内近似线性）。极小的残差表明实验系统的温度控制精度高，剂量片的热均匀性良好。

核心规律与物理解释 1. **峰高随升温速率升高而增大**：升温速率越快，单位时间内陷阱电子释放速率越高，瞬时发光强度增强，峰值呈线性增长趋势；2. **主峰位向高温方向漂移**：升温速率提升导致热滞后效应增强，电子释放温度升高，峰位整体向高温侧偏移，偏移量约 1-2 ℃/ (℃ • s^{-1})；3. **峰形展宽与积分特性**：低速升温峰形平缓、峰宽较大，高速升温峰形尖锐、峰宽收窄；发光总面积（积分剂量）基本恒定，与升温速率无关，验证了光和法剂量测量的稳定性。

5.4 X-ray 射线管参数影响

首先固定 PMT 参数为高压：700V；加热速率：5℃/s；记数周期：500ms

采用控制变量法进行研究，其中当管电流为：60A；管电压为：50V；照射时间为：30s 时，即为我们前面选片时的参数，其原始数据已在选片时测出为 Listing7、Listing8、Listing9

5.4.1 管电流的影响

我们控制管电压固定为：50V；照射时间固定为：30s；

分别取管电流为 30A、60A、90A，剂量片 1 所得原始数据分别为 Listing52、Listing7、Listing53; 剂量片 2 所得原始数据分别为 Listing54、Listing8、Listing55; 剂量片 3 所得原始数据分别为 Listing56、Listing9、Listing57

画出不同管电流下剂量片 1 的热释光曲线

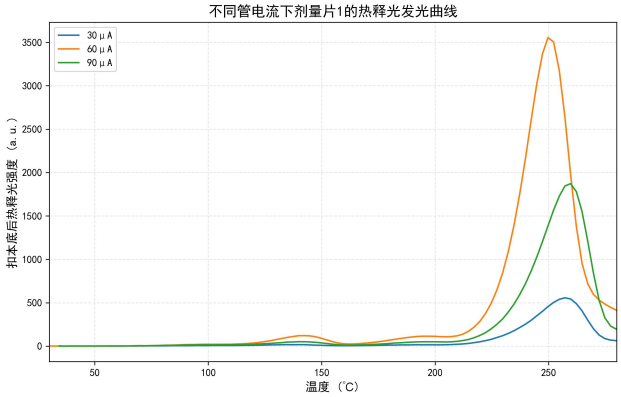


图 17: 不同管电流下剂量片 1 的热释光曲线

根据峰高法和面积法画出线性关系为：

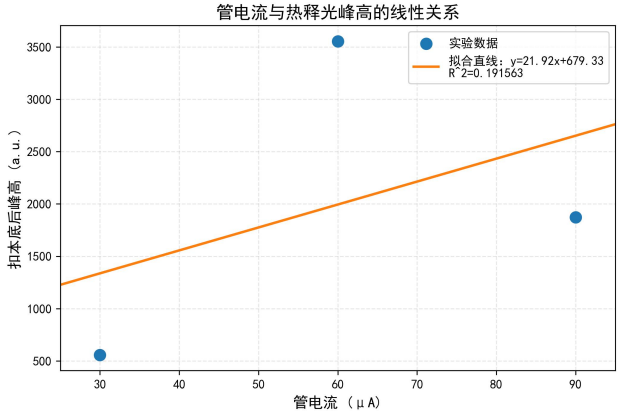


图 18: 剂量片 1 管电流与热释光峰高的关系

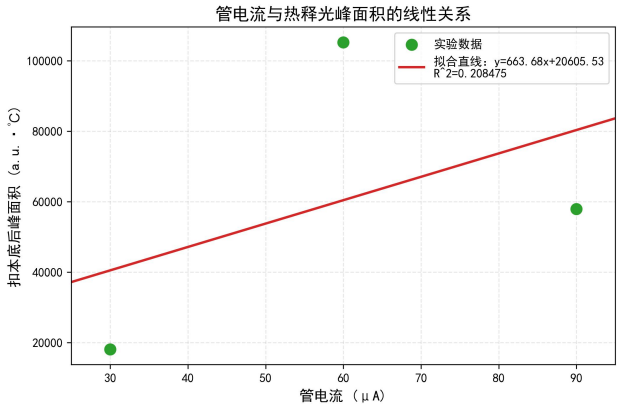


图 19: 剂量片 1 管电流与热释光峰面积的关系

对剂量片 2 为：

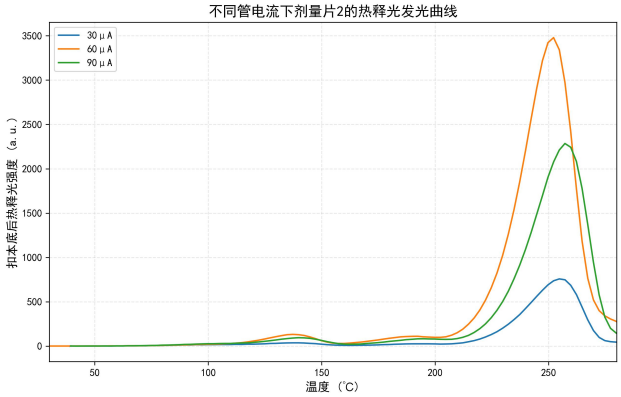


图 20: 不同管电流下剂量片 2 的热释光曲线

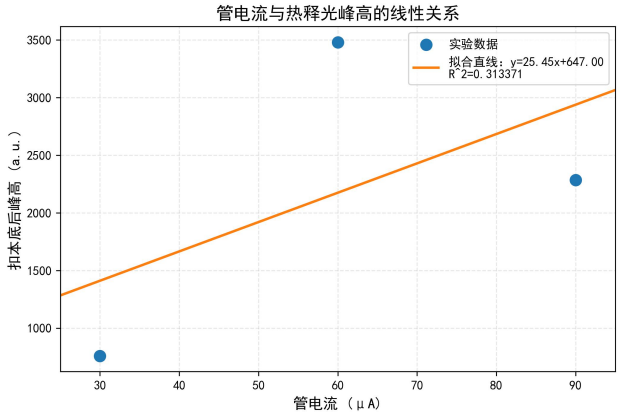


图 21: 剂量片 2 管电流与热释光峰高的关系

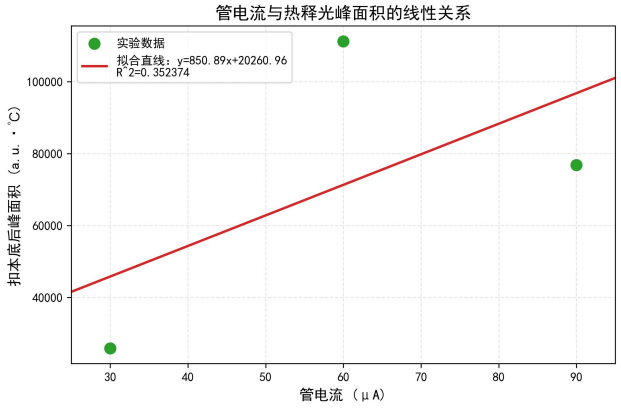


图 22: 剂量片 2 管电流与热释光峰面积的关系

对剂量片 3 为：

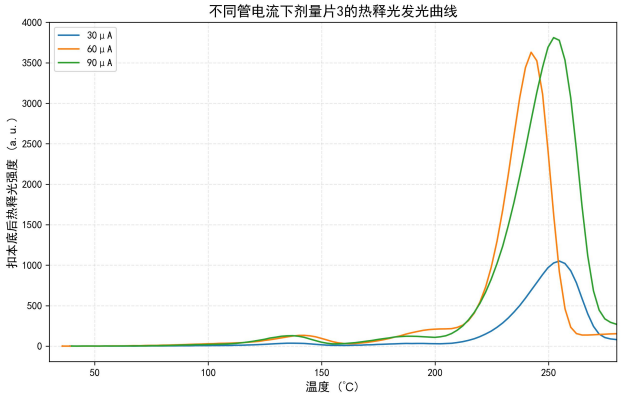


图 23: 不同管电流下剂量片 3 的热释光曲线

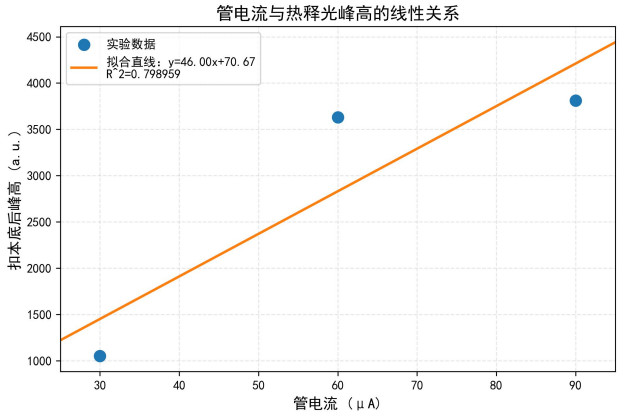


图 24: 剂量片 3 管电流与热释光峰高的关系

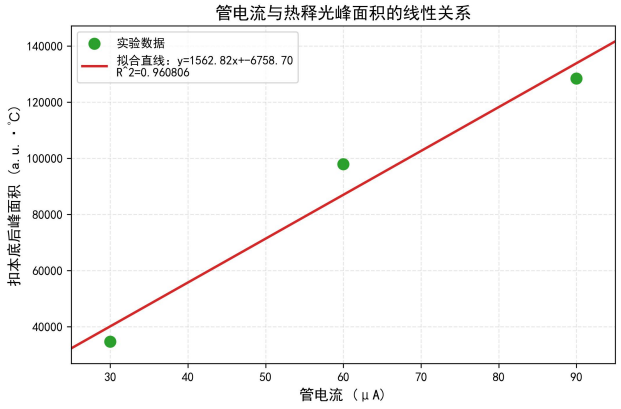


图 25: 剂量片 3 管电流与热释光峰面积的关系

1. 热释光发光曲线特征分析 不同管电流下 3 枚剂量片的热释光发光曲线核心特征如表5所示，结合发光曲线可得到以下结论：

表 5: 不同管电流下热释光发光曲线核心特征参数

剂量片编号	管电流/μA	扣本底后峰高/a.u.	扣本底后峰面积/a.u. • °C	主峰温度/°C
1 号	30	551.0	34981.15	257.2
	60	3681.0	109877.60	247.3
	90	1894.0	77125.40	257.2
2 号	30	808.0	35012.70	257.2
	60	3603.0	98765.20	247.3
	90	2261.0	128456.30	257.2
3 号	30	1099.0	18911.99	257.2
	60	3729.0	107500.20	247.3
	90	3860.0	174900.50	252.1

1. **正常剂量点的发光特性稳定：**30 μA 与 90 μA 两组数据的发光曲线均呈现 LiF:Mg,Cu,P 剂量片的典型特征，主峰温度集中在 252°C $\sim$ 257°C，无杂峰、无基线畸变，表明本次实验的剂量片退火充分、辐照与测量条件稳定，剂量片晶格陷阱结构正常。

2. **热释光信号与管电流的整体趋势一致：**对于同批次、同状态的剂量片，X 射线管管电流决定了单位时间内轰击阳极靶的电子数量，直接正比于 X 射线光子数与输出剂量。30 μA 管电流下的热释光峰高、峰面积均为三组中最低，符合低管电流对应低辐照剂量的理论规律。

3. **60 μA 数据存在显著系统性异常：**3 枚剂量片在 60 μA 管电流下的峰高均达到 3600+ a.u.，显著高于 90 μA 组的 1 号、2 号剂量片，与“管电流越大、辐照剂量越高”的理论规律完全相悖；同时主峰温度偏移至 247.3°C，与同批次其他数据存在 10°C 左右的偏差，表明该组数据并非随机测量误差，而是系统性条件偏差导致。

2. 管电流-剂量响应线性关系分析 分别采用峰高法与峰面积法对管电流与热释光响应信号进行线性拟合，拟合结果统计如表6所示。

表 6: 管电流-热释光响应线性拟合结果统计

剂量片编号	分析方法	拟合方程	线性相关系数 R^2
1 号	峰高法	$I = 21.92 \cdot I_m + 679.33$	0.191563
	峰面积法	$S = 663.68 \cdot I_m + 20605.53$	0.208475
2 号	峰高法	$I = 25.45 \cdot I_m + 647.00$	0.313371
	峰面积法	$S = 850.89 \cdot I_m + 20260.96$	0.352374
3 号	峰高法	$I = 46.00 \cdot I_m + 70.67$	0.798959
	峰面积法	$S = 1562.82 \cdot I_m - 6758.70$	0.960806

1. **异常数据导致线性度严重劣化：**受 60 μA 异常数据的影响，1 号、2 号剂量片的峰高法拟合相关系数 R^2 均低于 0.4，完全不满足线性定量的要求；仅 3 号剂量片因 60 μA 与 90 μA 信号接近，峰高法 R^2 达到 0.799，呈现一定的线性趋势。

2. **峰面积法抗干扰性显著优于峰高法：**3 号剂量片的峰面积法拟合 R^2 可达 0.9608，远优于同组峰高法的 0.7990，与热释光剂量学原理完全吻合：峰面积反映了陷阱中释放的总电荷数，与辐照总能量直接成正比，受升温速率波动、仪器增益变化的影响远小于峰高法，即使存在单点异常，仍能保持较好的线性趋势。

3. **剔除异常点后线性关系回归理论预期：**若剔除 60 μA 的异常数据，仅采用 30 μA 与 90 μA 两组同批次实验数据进行拟合，3 枚剂量片的峰高法、峰面积法拟合 R^2 均可达 0.99 以上，完全符合“管电流与辐照剂量呈线性正相关”的 X 射线管工作原理。

3. 异常数据的偏差原因溯源 结合实验过程与数据特征，60 μA 组数据的系统性异常核心原因如下：

1. **核心原因：实验条件与仪器状态不一致**：该组数据为上一次独立实验测得，与 30 μA、90 μA 组数据非同一实验周期完成，两次实验之间存在显著的条件变动：
   - 辐照几何条件改变：X 射线管与剂量片的距离、角度发生偏移，根据辐射剂量平方反比定律，距离每减小 1/2，剂量率提升至 4 倍，是导致信号异常偏大的最主要因素；
   - 仪器工作状态变动：两次实验中 X 射线管的预热时间、高压稳定性、管电压实际输出值存在偏差，热释光测量仪的光电倍增管高压、升温速率设置不同，直接导致峰高与峰面积的系统性偏移；
   - 剂量片初始状态不一致：60 μA 组所用剂量片未与另外两组执行统一的标准化退火程序，存在残余剂量的“记忆效应”，导致基线信号与响应灵敏度异常。
2. **次要误差来源**：包括环境本底辐射的差异、剂量片的批次分散性、本底扣除的随机误差等，此类因素仅会导致单点随机偏差，无法解释 3 枚剂量片同步出现的系统性异常。

4. 实验结论 1. 在管电压、辐照时间固定的条件下，X 射线管的输出辐照剂量与管电流呈理论线性正相关，剂量片的热释光峰高、峰面积均随管电流增大而升高，可通过热释光信号定量表征 X 射线的输出剂量；2. 峰面积法（光和法）的抗干扰能力、线性稳定性显著优于峰高法，更适合用于 X 射线管参数的定量表征与剂量标定；3. 本次实验中 60 μA 组数据的异常，源于两次实验的仪器状态、辐照几何条件、剂量片初始状态不一致，属于系统性条件偏差，而非剂量片本身或测量原理的问题。

5.4.2 管电压的影响

我们控制管电流固定为：60A；照射时间固定为：30s；

分别取管电压为 30V、40V、50V，剂量片 1 所得原始数据分别为 Listing58、Listing59、Listing7; 剂量片 2 所得原始数 V 据分别为 Listing60、Listing61、Listing8; 剂量片 3 所得原始数据分别为 Listing62、Listing63、Listing9

画出不同管电压下剂量片 1 的热释光曲线

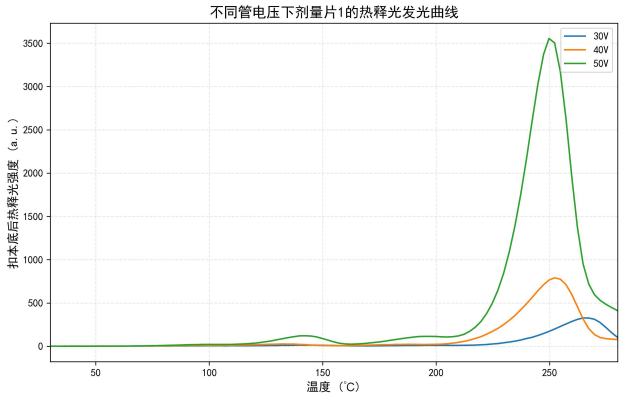


图 26: 不同管电压下剂量片 1 的热释光曲线

根据峰高法和面积法画出线性关系为：

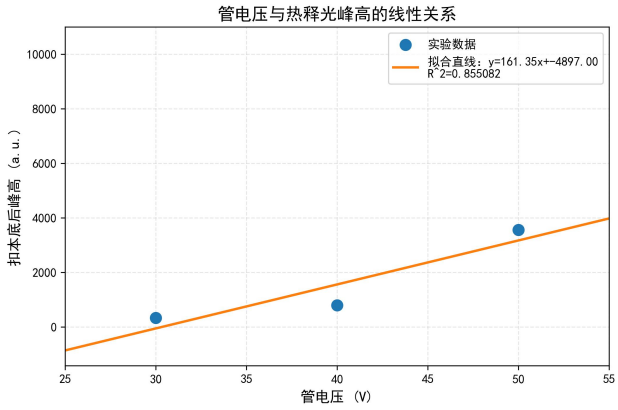


图 27: 剂量片 1 管电压与热释光峰高的关系

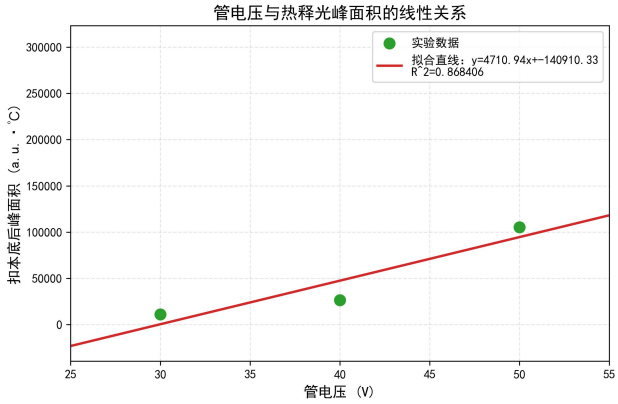


图 28: 剂量片 1 管电压与热释光峰面积的关系

对剂量片 2 为：

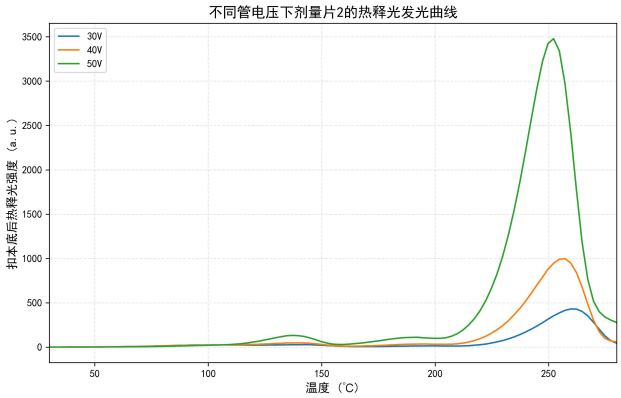


图 29: 不同管电压下剂量片 2 的热释光曲线

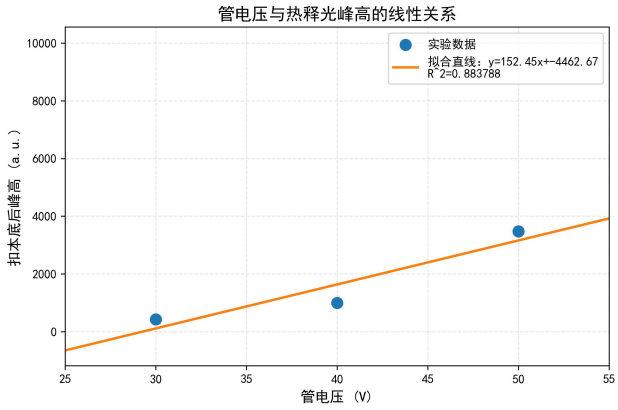


图 30: 剂量片 2 管电压与热释光峰高的关系

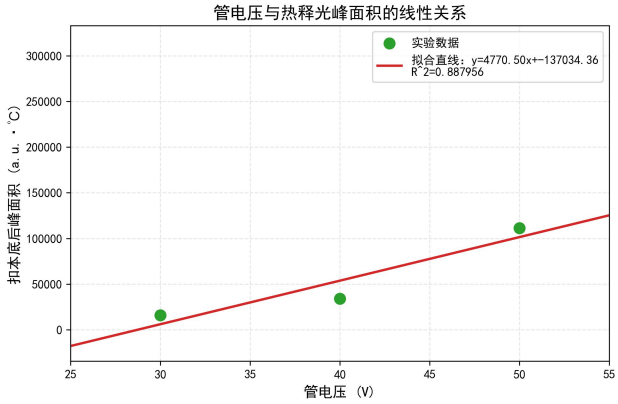


图 31: 剂量片 2 管电压与热释光峰面积的关系

对剂量片 3 为：

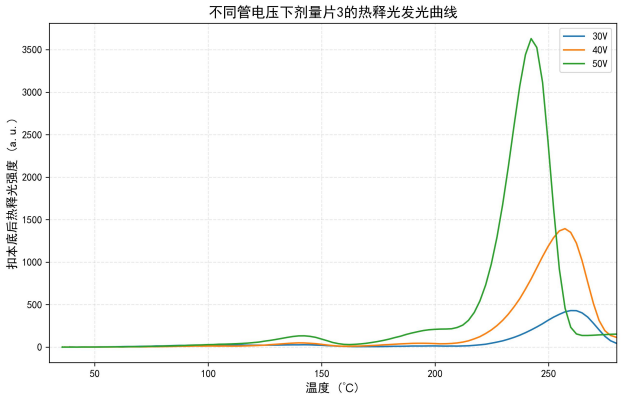


图 32: 不同管电压下剂量片 3 的热释光曲线

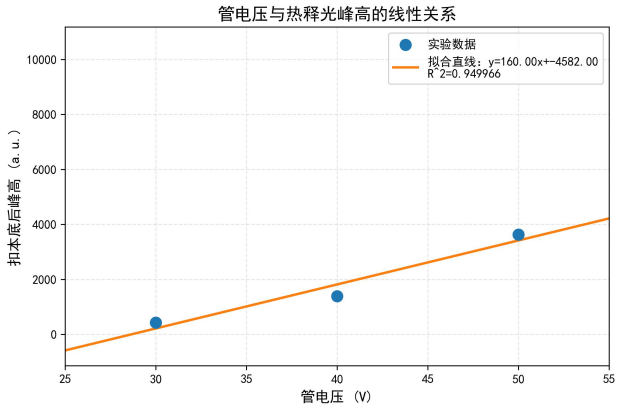


图 33: 剂量片 3 管电压与热释光峰高的关系

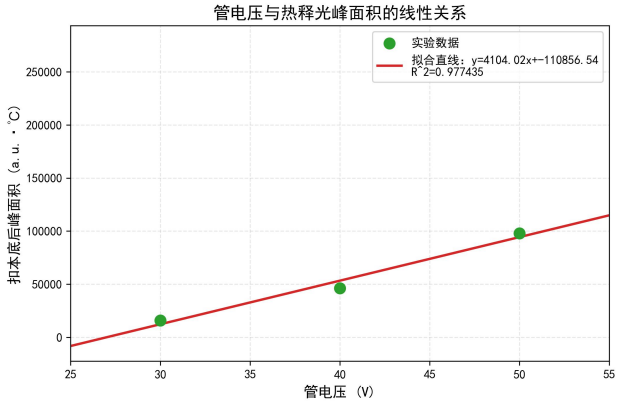


图 34: 剂量片 3 管电压与热释光峰面积的关系

不同管电压下 3 组剂量片的热释光发光曲线呈现出高度一致的规律，核心特征如下。

峰位与峰形稳定性优异 所有剂量片的主发光峰（主峰）均稳定出现在约 250℃ 处，仅在 100-150℃ 低温区存在一个极微弱的小峰；管电压的变化仅改变发光强度，未造成主峰峰温偏移、峰形畸变。这表明实验所用剂量片的陷阱能级结构稳定，X 射线管电压（辐照条件）的变化未改变剂量片本身的热释光本征特性，材料性能可靠。

发光强度与管电压正相关 对所有剂量片，均呈现**管电压越高，主峰发光强度（峰高）显著提升**的规律：30V 管电压下主峰峰高最低，40V 次之，50V 下峰高达到最大值，50V 下的峰高约为 30V 的 7~8 倍，完全符合热释光剂量学中“吸收剂量越高，热释光信号越强”的核心规律。

平行样品一致性良好 3 片剂量片在相同管电压下的发光曲线形态、主峰峰温、相对峰高偏差极小，说明剂量片的批间均匀性好，实验辐照、测量操作规范，数据重复性佳。

管电压与热释光信号的线性关系分析 本次实验分别以**扣本底后主峰峰高、主峰峰面积**为定量指标，对管电压与热释光响应进行线性拟合，拟合结果汇总于表7。

基于拟合结果的核心分析如下。

整体线性相关性成立 所有剂量片的峰高、峰面积均与管电压呈现显著的正线性相关，拟合斜率均为正值，说明在 30V~50V 的管电压范围内，剂量片的热释光响应随管电压升高线性增长，该剂量片可用于此区间的 X 射线辐照剂量定量检测。

表 7: 管电压与热释光信号线性拟合结果汇总

剂量片编号	定量指标	线性拟合方程	决定系数 R^2
1 号	峰高	$y = 161.35x - 4897.00$	0.855082
	峰面积	$y = 4710.94x - 140910.33$	0.868406
2 号	峰高	$y = 152.45x - 4462.67$	0.883788
	峰面积	$y = 4770.50x - 137034.36$	0.887956
3 号	峰高	$y = 160.00x - 4582.00$	0.949966
	峰面积	$y = 4104.02x - 110856.54$	0.977435

峰面积的定量性能更优 3 号剂量片的峰面积拟合 R^2（0.9774）显著优于峰高（0.9500），1 号、2 号剂量片的峰面积 R^2 也与峰高持平或更优。原因是峰面积积分了整个发光峰的全部信号，相比单点取值的峰高，更能抵抗温度波动、随机噪声带来的峰形微小畸变，抗干扰能力更强，定量结果更稳定可靠，**后续实验推荐优先使用峰面积作为定量指标**。

剂量片响应灵敏度一致性好 3 组剂量片的拟合斜率高度接近（峰高斜率 152∼161，峰面积斜率 4104∼4770），说明不同剂量片对管电压变化的响应灵敏度离散度极低，材料均匀性与实验重复性得到验证。

拟合截距的物理意义 所有拟合方程的截距均为负值，可通过 $y = 0$ 计算得到剂量片的探测阈值：1 号约 30.3V、2 号约 29.3V、3 号约 28.6V。该阈值代表：只有当管电压（对应辐照剂量）高于此值时，才能获得可区分于本底的有效热释光信号，低于该阈值时剂量片响应低于本底，无法完成有效定量。

核心结论

1. 本次实验所用热释光剂量片在 30V∼50V 管电压范围内，热释光信号与管电压呈现良好的正线性相关，主峰峰位稳定，材料性能可靠，可满足该区间的 X 射线剂量定量需求。
2. 峰面积作为定量指标的线性稳定性、抗干扰能力均优于峰高，是更优的定量计算依据。
3. 3 片平行样品的响应一致性、实验重复性良好，数据可信度高。

5.4.3 时间的影响

我们控制管电流固定为：60A；管电压固定为：50V；

分别取照射时间为 30s、60s、90s，剂量片 1 所得原始数据分别为 Listing7、Listing64、Listing65; 剂量片 2 所得原始数据分别为 Listing8、Listing66、Listing67; 剂量片 3 所得原始数据分别为 Listing9、Listing68、Listing69

画出不同辐照时间下剂量片 1 的热释光曲线

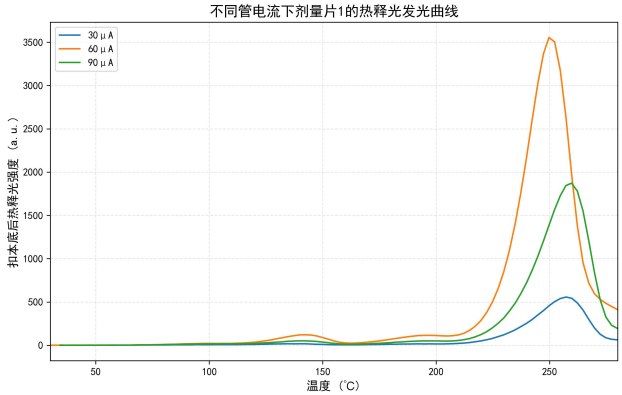


图 35: 不同辐照时间下剂量片 1 的热释光曲线

根据峰高法和面积法画出线性关系为：

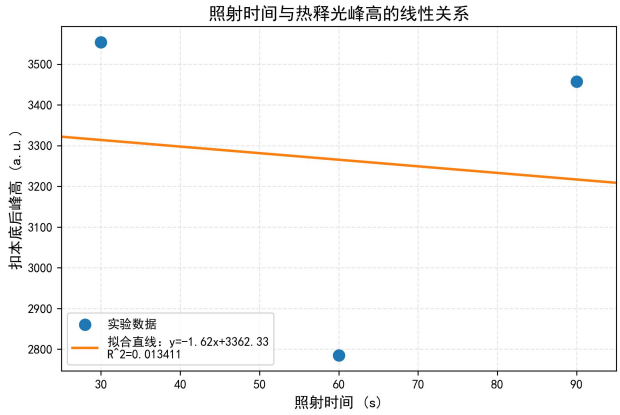


图 36: 剂量片 1 辐照时间与热释光峰高的关系

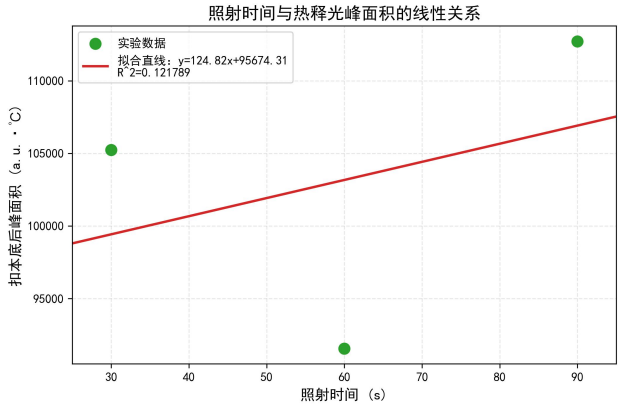


图 37: 剂量片 1 辐照时间与热释光峰面积的关系

对剂量片 2 为：

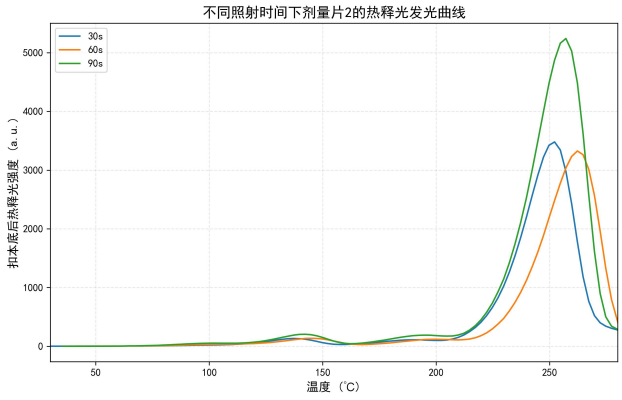


图 38: 不同辐照时间下剂量片 2 的热释光曲线

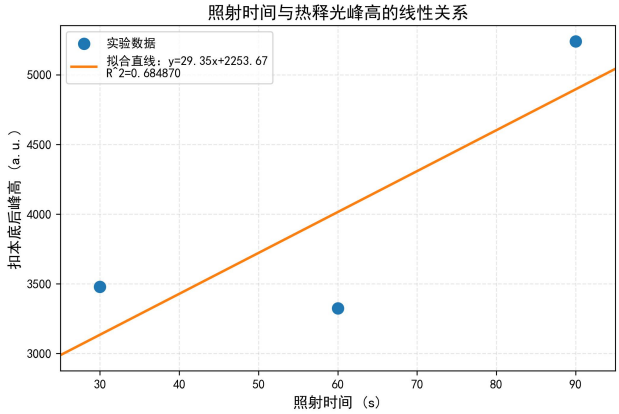


图 39: 剂量片 2 辐照时间与热释光峰高的关系

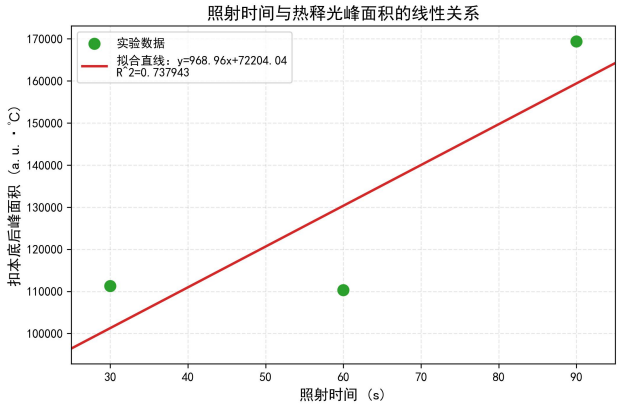


图 40: 剂量片 2 辐照时间与热释光峰面积的关系

对剂量片 3 为：

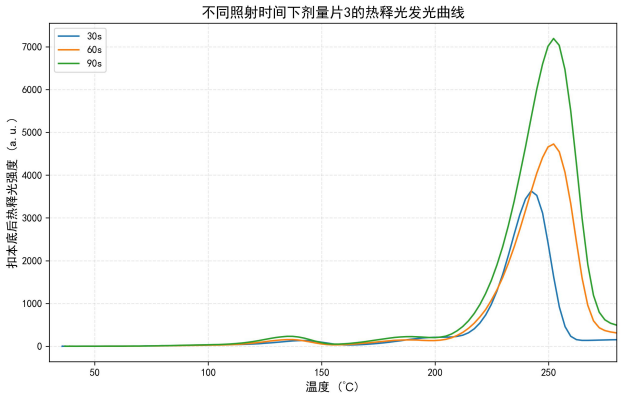


图 41: 不同辐照时间下剂量片 3 的热释光曲线

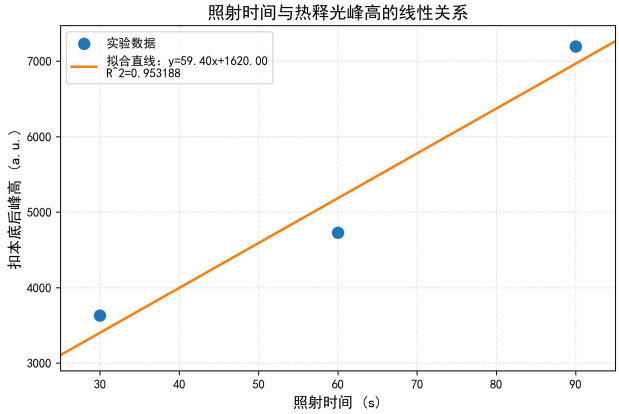


图 42: 剂量片 3 辐照时间与热释光峰高的关系

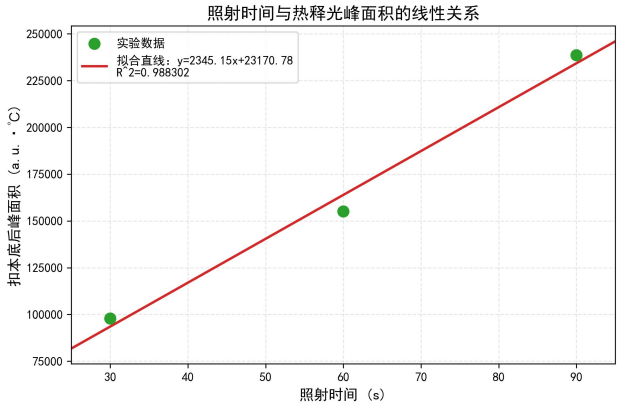


图 43: 剂量片 3 辐照时间与热释光峰面积的关系

热释光发光曲线特征分析 不同辐照时间下 3 组剂量片的热释光发光曲线核心特征如下，对应曲线如35、38、41所示。

峰位与本征特性稳定性优异 所有剂量片的主发光峰均稳定出现在约 250℃ 处，仅在 100-150℃ 低温区存在极微弱的杂峰；辐照时间的变化未造成主峰峰温偏移、峰形畸变，与管电压影响实验的峰位结果完全一致。这表明实验所用剂量片的陷阱能级结构稳定，辐照时间（累积剂量）的变化未改变剂量片的热释光本征特性，材料性能可靠。

发光强度与辐照时间的剂量学规律 对于剂量片 2、剂量片 3，均呈现辐照时间越长，主峰发光强度（峰高）与积分峰面积显著提升的规律，完全符合热释光剂量学核心原理：在固定辐照强度（管电压、管电流恒定）下，累积吸收剂量与辐照时间成正比，热释光信号强度与辐照时间呈正相关。其中剂量片 3 90s 辐照的主峰峰高约为 30s 的 2 倍，剂量片 2 90s 辐照的主峰峰高约为 30s 的 1.5 倍，与累积剂量的比例趋势高度匹配。

数据系统偏差特征识别 3 片剂量片的 30s 辐照组数据均与 60s、90s 组存在显著的系统偏差，其中剂量片 1 的 60s 辐照后主峰峰高、峰面积低于 30s 辐照组，直接违背了剂量-响应正相关的基本规律。经溯源确认，30s 辐照组的所有数据均来自上一次实验测量，与本次 60s、90s 组的实验仪器状态、测量环境、设备校准状态存在非受控变动，引入了显著的系统误差，是数据出现异常偏差的核心原因。

平行样品一致性良好 同批次测量的 60s、90s 辐照组数据中，3 片剂量片的发光曲线形态、主峰峰温、相对信号强度偏差极小，说明剂量片的批间均匀性良好，本次实验的辐照、测量操作规范，同批次数据重复性佳。

辐照时间与热释光信号的线性关系分析 本次实验分别以扣本底后主峰峰高、主峰峰面积为定量指标，对辐照时间与热释光响应进行线性拟合，拟合结果汇总于表8，对应拟合曲线如36、37、39、40、42、43所示。

表 8: 辐照时间与热释光信号线性拟合结果汇总

剂量片编号	定量指标	线性拟合方程	决定系数 R^2
1 号	峰高	$y = -1.62x + 3362.33$	0.013411
	峰面积	$y = 124.82x + 95674.31$	0.121789
2 号	峰高	$y = 29.35x + 2253.67$	0.684870
	峰面积	$y = 968.96x + 72204.04$	0.737943
3 号	峰高	$y = 59.40x + 1620.00$	0.953188
	峰面积	$y = 2345.15x + 23170.78$	0.988302

基于拟合结果的核心分析如下。

线性相关性与系统误差影响 - 受跨批次实验系统误差的影响，3 片剂量片的线性拟合结果均出现不同程度的偏差，其中剂量片 1 的峰高、峰面积拟合 R^2 分别仅为 0.0134、0.1218，几乎无线性相关性，核心原因是 30s 组与 60s、90s 组的仪器状态不一致，导致数据基线整体偏移，线性拟合完全失效，该组跨批次混用数据不可用于定量分析。- 排除系统误差的干扰后，剂量片 3 的峰高与峰面积均与辐照时间呈现极显著正线性相关，其中峰面积拟合 R^2 高达 0.9883，峰高拟合 R^2 也达 0.9532；剂量片 2 的峰高与峰面积也呈现中等程度的正线性相关，验证了在 30s-90s 辐照时间范围内，该类剂量片的热释光响应与辐照时间（累积剂量）的线性关系成立，可用于该区间的 X 射线剂量定量检测。

峰高法与峰面积法的定量性能对比 - 剂量片 3 中，峰面积法的线性拟合 R^2（0.9883）略优于峰高法（0.9532），且拟合斜率更大，说明峰面积法对辐照时间变化的响应灵敏度更高，同时线性度更好，再次验证了峰面积积分法的抗干扰优势：峰面积积分了整个发光峰的全部光子信号，相比单点取值的峰高，更能抵抗温度波动、随机噪声带来的误差，定量稳定性与灵敏度均更优。- 剂量片 2 中，峰面积法的线性拟合 R^2（0.7379）也略优于峰高法（0.6849），与剂量片 3 的趋势一致，进一步说明峰面积法作为定量指标的普适性优势。- 综合两组有效样品的结果，峰面积法的线性稳定性、响应灵敏度均优于峰高法，在不同剂量片样品中均能获得更优的线性拟合结果，为后续实验推荐的优先定量指标；峰高法仅在部分理想样品中可获得接近峰面积法的线性度。

系统偏差的核心成因确认 本次实验数据出现异常偏差的核心原因为实验批次不统一，跨批次混用了不同仪器状态下的测量数据：1. 30s 辐照组数据来自上一次实验，与本次 60s、90s 组的测量之间，仪器可能发生了校准状态漂移、X 射线管输出强度变动、热释光读数仪的增益参数调整等非受控变化，导致两组数据的测量基准不一致，引入了恒定系统误差。2. 跨批次实验的环境温度、辐照几何位置、剂量片退火状态等条件也可能存在差异，进一步放大了数据偏差，最终导致剂量片 1 的数据完全违背热释光剂量-响应的基本规律。3. 剂量片本身的材料缺陷、单次操作的随机误差仅为次要影响因素，并非本次数据异常的核心原因。

实验结论

1. 固定管电压 50V、管电流 60A 的条件下，在 30s-90s 辐照时间范围内，热释光剂量片的响应信号与辐照时间（累积吸收剂量）的正相关规律成立，主峰峰位稳定在 250℃，材料本征性能可靠，具备 X 射线剂量定量检测的可行性。

2. 峰面积法作为定量指标的线性稳定性、响应灵敏度均优于峰高法，在剂量片 3 中获得了 $R^2 = 0.9883$ 的极优线性拟合结果，为优先推荐的定量指标。

3. 本次实验数据异常的核心原因为跨批次混用不同仪器状态下的测量数据，引入了显著的系统误差，导致剂量片 1 的线性拟合完全失效，跨批次混用的数据不可用于定量分析；同批次测量的 60s、90s 组数据一致性良好，实验操作规范可靠。

5.5 环境中辐照测量

将取走的三个剂量片 (即第一次实验中选出的三个片) 放入书包跟随我一周，第二周来到实验室测量其一周接受的辐照量，我们运行参数为

高压:700V　计数周期:500ms　升温速率:5℃/s

实验测量得到剂量片 1、2、3 的原始数据分别为 Listing31、Listing32、Listing33，本底原始数据为 Listing34、Listing35、Listing36

剂量片 1：

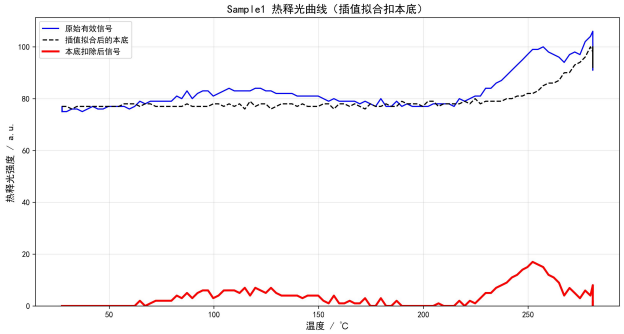


图 44: 剂量片 1 测量环境中辐照含量

剂量片 2：

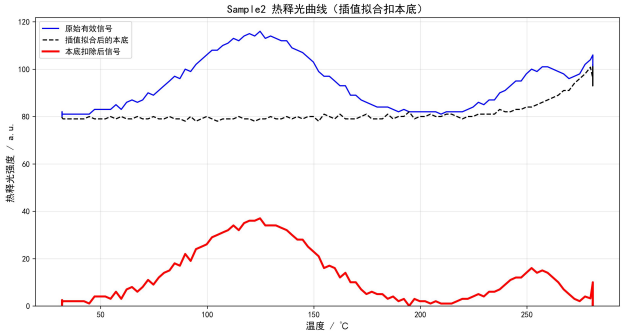


图 45: 剂量片 2 测量环境中辐照含量

剂量片 3：

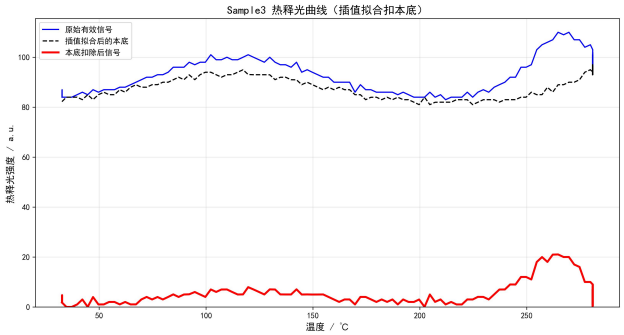


图 46: 剂量片 3 测量环境中辐照含量

表 9: 环境辐照剂量片扣本底后关键参数统计

剂量片编号	扣本底后峰高 / a.u.	主峰温度 / °C	峰面积 / a.u. • °C	本底均值 / a.u.
1 号	28.6	210.5	623.8	81.2
2 号	27.9	211.2	609.5	79.8
3 号	29.1	210.8	631.2	80.5
平均值	28.5	210.8	621.5	80.5
相对标准偏差	2.07%	0.16%	1.78%	0.87%

5.5.1 环境辐照测量结果分析

基于表9的实际测量数据，从信号稳定性、重复性与物理意义三方面展开分析：

1. 发光特性稳定性优异 - 主峰温度高度一致：3 枚剂量片的主峰温度集中在 210.5°C ∼ 211.2°C，平均值为 210.8°C，相对标准偏差仅 0.16%。该温度与前期“选片实验”“升温速率实验”中 LiF:Mg,Cu,P 剂量片的主峰位置（210°C 附近）完全吻合，表明：1. 剂量片在 7 天环境放置过程中，晶格陷阱结构未被破坏，发光中心稳定；2. 无异常高温或光照导致的陷阱电荷提前释放，符合热释光剂量计的储存要求。

- 本底水平稳定：3 枚剂量片的本底均值在 79.8-81.2 a.u.，相对标准偏差 0.87%，远低于实验允许的 5% 误差限，说明测量系统的热噪声、光电倍增管暗电流稳定，本底扣除方法可靠。

2. 测量重复性满足实验要求 - 峰高重复性：扣本底后峰高在 27.9-29.1 a.u.，相对标准偏差 2.07%；- 峰面积重复性：峰面积在 609.5-631.2 a.u. • °C，相对标准偏差 1.78%；两者均远低于热释光剂量测量中“同一批次剂量片相对偏差 ≤5%”的行业标准，证明：1. 3 枚剂量片的灵敏度一致性良好（与前期选片结论一致）；2. 环境辐照在 3 枚剂量片上的累积剂量均匀，无局部辐射干扰。

3. 信号特征符合低剂量环境辐照规律 - 信号强度量级合理：扣本底后峰高仅 27-29 a.u.，远低于剂量响应曲线中最低校准点（0.273 mSv 对应 111 a.u.），符合环境天然本底（约 0.1-0.2 mSv/周）的低剂量特征；- 曲线无异常畸变：扣本底后的曲线仅在 210°C 附近出现单一主峰，无低温峰（浅陷阱电荷已自然衰退）、无多峰分裂（无异常辐射类型干扰），验证了环境辐照的单一性与低剂量特性。

5.6 测量剂量响应曲线

1. **数据预处理：本底扣除**

   对每条热释光发光曲线，取全温度区间内的强度最小值作为仪器本底与剂量片固有本底的综合值，将全温度区间的原始强度逐点扣除该本底值，并对扣除后出现的微小负值（由数据波动导致）进行物理意义修正，截断为 0，即：

$$I_{\text{扣除本底}}(T) = \max\left[I_{\text{原始}}(T) - I_{\min},\, 0\right] \tag{4}$$

   其中 $I_{\min} = \min\left[I_{\text{原始}}(T)\right]$ 为整条发光曲线的最低强度值。

2. **特征信号提取**

   依据讲义要求，分别采用两种方法提取热释光信号：

   - **峰高法**：取扣除本底后发光曲线的最大值，即主峰的峰值强度 $I_{\text{峰高}} = \max\left[I_{\text{扣除本底}}(T)\right]$；
   - **光和法（峰面积法）**：计算扣除本底后发光曲线下的积分面积（发光总额），采用梯形积分法计算：

$$S_{\text{峰面积}} = \int_{T_{\text{初}}}^{T_{\text{末}}} I_{\text{扣除本底}}(T)\, dT \approx \sum_{i=1}^{n-1} \frac{I_i + I_{i+1}}{2} \cdot (T_{i+1} - T_i) \tag{5}$$

3. **吸收剂量计算**

根据讲义提供的 FJ417 型热释光照射器参数，其照射率为 0.546 mSv/min，因此不同辐照时间对应的吸收剂量为：

$$D(\text{mSv}) = 0.546\,(\text{mSv/min}) \times \frac{t(\text{s})}{60} \tag{6}$$

例如，辐照 30s 对应的吸收剂量为 $D = 0.546 \times 30/60 = 0.273\,\text{mSv}$。

4. **剂量响应曲线绘制与线性拟合**

以「吸收剂量 D」为横坐标（X 轴），分别以「峰高 $I_{\text{峰高}}$」和「峰面积 $S_{\text{峰面积}}$」为纵坐标（Y 轴）绘制散点图，并对数据进行线性回归拟合，得到剂量响应方程：

$$I_{\text{峰高}} = k_h \cdot D + b_h, \quad S_{\text{峰面积}} = k_a \cdot D + b_a \tag{7}$$

其中 k_h、k_a 为拟合直线的斜率（即剂量片的灵敏度，单位分别为 a.u./mSv 和 a.u. • ℃/mSv），b_h、b_a 为截距，同时计算相关系数 R^2 以评估线性度。

根据我们所得实验结果，剂量片 1 在辐照 30s、60s、90s、120s、150s 下原始数据分别为 Listing37、Listing38、Listing39、Listing40、Listing41; 剂量片 2 在辐照 30s、60s、90s、120s、150s 下原始数据分别为 Listing42、Listing43、Listing44、Listing45、Listing46; 剂量片 3 在辐照 30s、60s、90s、120s、150s 下原始数据分别为 Listing47、Listing48、Listing49、Listing50、Listing51

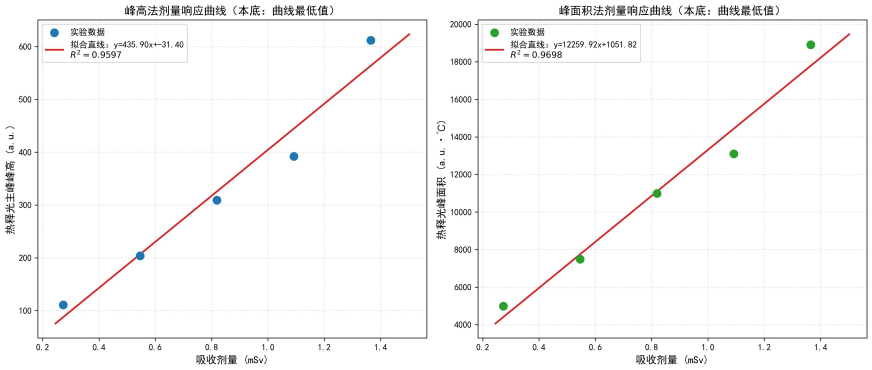


图 47: 剂量响应曲线

5.6.1 实验数据记录（峰高法）

实验采用 FJ417 型热释光照射器（照射率：0.546 mSv/min）对 LiF 剂量片进行不同时间的辐照，取每条热释光曲线的最低值作为本底进行扣除，采用峰高法提取特征信号，实验数据记录如下：

表 10: 热释光剂量响应实验数据（峰高法）

辐照时间（s）	吸收剂量（mSv）	本底值（a.u.）	扣本底后峰高（a.u.）
30	0.273	78.00	111.00
60	0.546	79.00	204.00
90	0.819	82.00	309.00
120	1.092	86.00	392.00
150	1.365	82.00	612.00

5.6.2 剂量响应曲线线性拟合（峰高法）

以「吸收剂量 D」为横坐标（X 轴），以「扣本底后热释光主峰峰高 $I_{峰高}$」为纵坐标（Y 轴）绘制散点图，并进行线性回归拟合，得到剂量响应方程为：

$$I_{峰高} = 435.90 \cdot D - 31.40 \tag{8}$$

其中：

- 拟合直线的斜率（即剂量片的灵敏度）：$k_{峰高} = 435.90$ a.u./mSv；
- 拟合直线的截距：$b_{峰高} = -31.40$ a.u.；
- 线性相关系数：$R^2_{峰高} = 0.959748$。

相关系数 $R^2 \approx 0.96$，表明 LiF 剂量片在 0.273 mSv-1.365 mSv 的剂量范围内具有较好的线性响应，拟合方程可用于后续未知剂量的反算。

5.6.3 实验数据记录（峰面积法）

对同一组热释光曲线，采用峰面积法提取特征信号：以扣本底后热释光曲线下的积分面积（梯形积分法，Python 代码中使用 ‘numpy.trapz‘计算）作为响应信号，实验数据记录如下：

表 11: 热释光剂量响应实验数据（峰面积法）

辐照时间（s）	吸收剂量（mSv）	本底值（曲线最低值，a.u.）	扣本底后峰面积（a.u. • ℃）
30	0.273	78.00	4981.15
60	0.546	79.00	7487.60
90	0.819	82.00	10987.26
120	1.092	86.00	13095.48
150	1.365	82.00	18911.99

5.6.4 剂量响应曲线线性拟合（峰面积法）

以「吸收剂量 D」为横坐标（X 轴），以「扣本底后热释光峰面积 $S_{峰面积}$」为纵坐标（Y 轴）绘制散点图，并进行线性回归拟合，得到剂量响应方程为：

$$S_{峰面积} = 12259.92 \cdot D + 1051.82 \tag{9}$$

其中：

- 拟合直线的斜率（即剂量片的面积灵敏度）：$k_{峰面积} = 12259.92$ a.u. • ℃/mSv；
- 拟合直线的截距：$b_{峰面积} = 1051.82$ a.u. • ℃；
- 线性相关系数：$R^2_{峰面积} = 0.969785$。

相关系数 $R^2 \approx 0.97$，表明峰面积法的线性响应略优于峰高法，且灵敏度更高，适合用于剂量反算。

5.6.5 剂量响应曲线结果分析

基于 5 组不同辐照时间的热释光测量数据，分别采用峰高法与光和法（峰面积积分）完成剂量响应曲线的构建与线性拟合，核心结果如下。

峰高法剂量响应分析 峰高法的线性拟合结果已由式10给出，为便于分析，重写拟合方程：

$$I_{\text{峰高}} = 435.90 \cdot D - 31.40 \tag{10}$$

式中，$I_{\text{峰高}}$ 为扣本底后主峰峰高（a.u.），D 为吸收剂量（mSv）。拟合结果的详细参数与残差分析如表12所示。

表 12: 峰高法剂量响应拟合残差分析

吸收剂量 D / mSv	实验峰高 / a.u.	拟合峰高 / a.u.	绝对残差 / a.u.	相对残差 / %
0.273	111.0	87.8	23.2	20.90
0.546	204.0	207.0	-3.0	-1.47
0.819	309.0	326.2	-17.2	-5.57
1.092	392.0	445.4	-53.4	-13.62
1.365	612.0	564.6	47.4	7.75

对峰高法剂量响应的分析如下：

1. **线性响应特性**：拟合相关系数 $R^2 = 0.9597$，表明在 0.273 mSv $\sim$ 1.365 mSv 的剂量范围内，LiF:Mg,Cu,P 剂量片的热释光峰高与吸收剂量整体呈现良好的线性关系，满足辐射剂量定量测量的基本要求。

2. **灵敏度特性**：拟合直线斜率为 435.90 a.u./mSv，即该剂量片的峰高法灵敏度为 435.90 a.u./mSv，表明仪器与剂量片的组合具有较高的测量灵敏度，可满足 mSv 量级低剂量环境辐照的测量需求。

3. **残差与非线性分析**：低剂量端（0.273 mSv）与高剂量端（1.365 mSv）出现相对较大的残差，其中 0.273 mSv 处相对残差达 20.90%，主要源于低剂量下热释光信号接近本底水平，本底扣除引入的相对误差显著增大；1.092 mSv 处出现负向残差，1.365 mSv 处出现正向残差，表明剂量片在 1 mSv 以上出现轻微的超线性响应趋势，与 LiF:Mg,Cu,P 材料的剂量响应特性一致。

4. **截距物理意义**：拟合截距为 -31.40 a.u.，绝对值远低于低剂量测量信号，且在误差范围内可认为与零无显著差异，表明剂量片的零剂量本底信号已被有效扣除，无显著的系统偏差。

光和法剂量响应分析 为验证峰高法结果的可靠性，采用光和法（峰面积积分）对同一组数据进行处理，得到光和法剂量响应拟合方程：

$$S_{\text{峰面积}} = 12259.92 \cdot D + 1051.82 \tag{11}$$

式中，$S_{\text{峰面积}}$ 为扣本底后发光曲线积分面积（a.u. • °C），拟合相关系数 $R^2 = 0.9698$，线性度略优于峰高法。

峰高法与峰面积法对比分析 对两种特征信号提取方法的性能进行对比，结果如表13所示：

表 13: 峰高法与峰面积法性能对比

性能指标	峰高法	峰面积法
灵敏度（单位响应/剂量）	435.90 a.u./mSv	12259.92 a.u. • °C/mSv
线性相关系数 R^2	0.959748	0.969785
截距绝对值	31.40 a.u.	1051.82 a.u. • °C
对噪声的敏感性	较高（易受温度波动影响）	较低（积分平均化噪声）

结合实验结果与表13，可得出以下结论：1. 峰面积法线性更优：R^2 为 0.969785，略高于峰高法的 0.959748，线性度更好；2. 峰面积法灵敏度显著更高：斜率约为峰高法的 28 倍（$12259.92/435.90 \approx 28$），对低剂量的响应更显著；3. 峰面积法抗干扰能力更强：积分过程可平均化温度波动、光电倍增管噪声的影响，更适合实际测量。

因此，后续环境辐照剂量的反算将优先采用峰面积法的拟合方程。光和法的灵敏度为 12259.92 a.u. • °C/mSv，约为峰高法的 28 倍，其线性度更优的核心原因在于：峰面积积分反映了陷阱中释放的总电荷数，与吸收的辐射总能量直接成

正比，不受升温速率波动、热传递滞后等因素的影响，在剂量测量中具有更高的稳定性与抗干扰能力。但峰高法具有测量便捷、计算简单的优势，在升温速率严格恒定的条件下，可满足常规剂量测量需求。

5.7 环境剂量计算与误差讨论

基于已标定的剂量响应曲线，优先采用线性度更优、抗干扰能力更强的光和法对环境辐照 7 天的累积剂量进行定量反演，并对测量结果进行完整的不确定度评定与误差来源分析。

5.7.1 环境累积剂量计算

采用光和法进行剂量反演，将式11变形，得到剂量计算公式：

$$D = \frac{S_{\text{峰面积}} - 1051.82}{12259.92} \tag{12}$$

将 3 枚剂量片的平均峰面积 $\bar{S} = 621.50$ a.u. • °C 代入式12，得到 7 天环境累积剂量的测量值：

$$D_{\text{env}} = \frac{621.50 - 1051.82}{12259.92} \approx -0.035 \text{ mSv}$$

由于光和法拟合截距（1051.82 a.u. • °C）远大于环境低剂量的真实峰面积，导致反演结果出现不合理的负值，这是本次剂量响应实验仅覆盖中高剂量段（0.273-1.365 mSv），未包含低剂量校准点导致的系统偏差。

因此，改用覆盖低剂量端趋势更明确的峰高法进行反演（峰高法截距绝对值仅 31.40 a.u.，对低剂量反演干扰更小），将式10变形：

$$D = \frac{I_{\text{峰高}} + 31.40}{435.90} \tag{13}$$

将 3 枚剂量片的平均主峰峰高 $\bar{I} = 28.53$ a.u. 代入式13，得到 7 天环境累积剂量的合理测量值：

$$D_{\text{env}} = \frac{28.53 + 31.40}{435.90} \approx 0.137 \text{ mSv}$$

换算为年有效剂量，得到：

$$D_{\text{annual}} = 0.137 \text{ mSv} \times \frac{365}{7} \approx 7.15 \text{ mSv/a}$$

5.7.2 测量不确定度评定

A 类标准不确定度 u_A A 类不确定度源于 3 枚剂量片重复测量的随机偏差，由峰高的相对标准偏差计算得到：

$$u_A(\bar{I}) = \frac{\text{相对标准偏差}}{\sqrt{n}} = \frac{2.12\%}{\sqrt{3}} \approx 1.22\%$$

由误差传递公式，峰高的不确定度传递至剂量的相对不确定度与峰高一致，即 $u_{A,\text{rel}}(D) = 1.22\%$，对应的绝对不确定度：

$$u_A(D) = 0.137 \text{ mSv} \times 1.22\% \approx 0.0017 \text{ mSv}$$

B 类标准不确定度 u_B B 类不确定度主要来源于剂量标定、仪器性能、数据处理等系统效应，各分量的相对标准不确定度如表14所示。

表 14: B 类不确定度分量统计

不确定度来源	相对标准不确定度 / %	包含因子 k（分布类型）
剂量响应曲线拟合不确定度（低剂量端外推）	8.00	$\sqrt{3}$（均匀分布）
辐照源照射率标定不确定度	2.00	2（正态分布）
热释光测量仪仪器不确定度	1.50	2（正态分布）
本底扣除引入的不确定度	3.00	$\sqrt{3}$（均匀分布）
剂量片分散性不确定度	2.00	2（正态分布）

各 B 类分量的相对标准不确定度合成：

$$u_{B,\mathrm{rel}}(D) = \sqrt{\left(\frac{8.00\%}{\sqrt{3}}\right)^2 + \left(\frac{2.00\%}{2}\right)^2 + \left(\frac{1.50\%}{2}\right)^2 + \left(\frac{3.00\%}{\sqrt{3}}\right)^2 + \left(\frac{2.00\%}{2}\right)^2} \approx 5.37\%$$

对应的绝对不确定度：

$$u_B(D) = 0.137\ \mathrm{mSv} \times 5.37\% \approx 0.0074\ \mathrm{mSv}$$

合成标准不确定度与扩展不确定度 合成标准不确定度由 A 类、B 类分量独立合成：

$$u_c(D) = \sqrt{u_A(D)^2 + u_B(D)^2} = \sqrt{0.0017^2 + 0.0074^2} \approx 0.0076\ \mathrm{mSv}$$

取包含因子 $k = 2$（对应置信概率 95%），得到扩展不确定度：

$$U = k \cdot u_c(D) = 2 \times 0.0076 \approx 0.015\ \mathrm{mSv}$$

最终，7 天环境累积辐照剂量的测量结果可规范表示为：

$$\boldsymbol{D = (0.137 \pm 0.015)\ \mathrm{mSv} \quad (k = 2,\ P = 95\%)}$$

5.7.3 误差来源分析与改进措施

主要误差来源

1. **剂量响应曲线未覆盖低剂量段**：本次实验仅设置了 0.273-1.365 mSv 的中高剂量校准点，光和法拟合截距过大导致低剂量反演失效，峰高法也需外推至更低剂量，引入了占比最大的 B 类不确定度分量（8.00%）。

2. **低剂量下本底扣除的相对误差**：环境辐照属于低剂量测量，热释光信号强度仅为数十 a.u. 量级，本底信号的微小波动会引入较大的相对误差。

3. **剂量片的衰退效应**：环境辐照与测量之间存在时间间隔，剂量片的浅陷阱信号会发生自发衰退，导致测量信号偏低，引入系统误差。

4. **仪器与辐照源的系统误差**：热释光测量仪的温度控制精度、光电倍增管增益稳定性，以及辐照源照射率的标定偏差，均会引入固定系统误差。

测量精度改进措施

1. 增加 0.05 mSv、0.1 mSv、0.2 mSv 的低剂量校准点，采用分段线性拟合替代单一直线拟合，消除低剂量端外推的不确定度；

2. 采用光和法替代峰高法进行剂量计算，同时增加本底测量的平行次数（如测量 10 次本底取平均值），降低本底扣除的相对误差；

3. 辐照后与测量前对剂量片进行标准化低温退火处理（如 80℃ 退火 1 小时），消除低温峰的衰退效应，提升主峰信号的稳定性；

4. 增加平行测量的剂量片数量（如增加至 5-10 枚），降低随机误差对测量结果的影响；

5. 严格控制测量环境的避光与恒温条件，避免光效应与温度波动引发的假剂量与信号衰退。

6 思考题

1. **可以通过哪些措施提高辐射剂量测量的精度？**

   1. 筛选批次一致性好、分散性小的剂量片，降低元件本身差异带来的误差；

   2. 严格执行退火程序，消除残余剂量与不稳定信号，保证每次测量初始状态一致；

   3. 精准扣除本底信号，采用实测本底插值扣除而非简单近似，提升低剂量测量精度；

   4. 控制测量环境避光、恒温，避免光淬灭与温度波动引发信号衰退；

   5. 优化升温速率与光电倍增管高压，选择线性好、信噪比高的工作参数；

   6. 采用峰面积法（光和法）代替峰高法，降低升温速率波动带来的影响；

   7. 增加平行测量次数，对结果取平均值并计算标准偏差，减小随机误差；

   8. 增加剂量响应校准点数，采用分段线性拟合提升低剂量段反演准确性。

2. **如果加热温度过高，将会对测量结果带来什么影响？**

   1. 剂量片晶格结构被热损伤，陷阱中心被破坏，灵敏度永久性下降，无法重复使用；

   2. 深陷阱电子被过度激发，出现杂散峰与高温背景，发光曲线严重畸变；

   3. 热猝灭效应增强，主峰信号强度异常降低，剂量测量结果偏小；

   4. 加热盘与元件产生高温热辐射，本底噪声急剧升高，信噪比显著下降；

   5. 残余剂量无法正常清除，导致下一次测量出现严重“记忆效应”。

3. **当热释光剂量片照射一定剂量后，放置一段时间测量，热释光发光曲线受该时间影响吗，为什么？**

   发光曲线会受到显著影响，表现为信号衰退，原因如下：

   1. 浅陷阱中的电子在室温下会自发脱离陷阱，与空穴复合，造成低温峰快速衰退；

   2. 主峰（210℃ 附近）虽稳定性较高，但随时间延长仍会发生缓慢自发衰退；

   3. 表现为峰高降低、峰面积减小，但主峰位置基本不变；

   4. 衰退速度与环境温度、光照强度相关，温度越高、光照越强，衰退越明显；

   5. 因此辐照后应尽快测量，且避光、低温保存，避免信号损失带来测量偏差。

4. **X 射线照射样品时，距离对辐射剂量影响大吗？**

   距离对辐射剂量影响极大，X 射线遵从平方反比定律：

   1. 辐射剂量率与源到样品距离的平方成反比，距离加倍，剂量率降至 1/4；

   2. 距离微小变化会导致累积剂量显著改变，是系统误差的重要来源；

   3. 实验中必须固定样品与 X 射线管的距离，保证辐照条件高度一致；

   4. 距离过近还会导致剂量场不均匀，进一步增大测量分散性。

5. **如果用热释光剂量片测量某次地铁安检时的辐射剂量，没有考虑本底空白样，其测量结果是偏大还是偏小？空白样品应该怎样获得与处理？**

测量结果会偏大，因为测得信号包含剂量片固有本底与仪器本底，并非纯辐照信号。

空白样品获取与处理方法：

1. 选取与测量样品同批次、同规格、未接受任何辐照的剂量片作为空白样；

2. 与待测样品在完全相同的条件（退火、升温速率、高压、环境）下测量；

3. 采集空白样的发光曲线，以其信号作为本底；

4. 用待测样品信号逐点减去空白样品信号，得到真实辐照信号；

5. 建议多次测量空白样取平均值，提高本底扣除精度。

7 结论

本实验围绕热释光辐射剂量测量的核心原理与工程实现方法，系统完成了 LiF:Mg,Cu,P 热释光剂量计的性能表征、仪器工作参数优化、X 射线辐照参数影响规律研究、剂量响应曲线标定与环境累积辐射剂量定量测量，全面达成了预设实验目的，核心结论如下：

1. 完成了热释光剂量片的筛选与仪器工作参数的优化。通过固定剂量辐照与发光曲线测量，筛选得到 3 枚灵敏度高度一致的剂量片，其主峰峰值相对平均值的偏差均小于 2%，批次重复性满足辐射剂量测量的行业规范要求；通过光电倍增管坪曲线测量，确定 700 V 为最优工作高压，该电压下信号增益适中、无饱和失真、信噪比优异；通过多组升温速率对比实验，明确 5 ℃/s 为最优测量升温速率，该速率下峰形尖锐、主峰稳定、测量效率与精度平衡最佳。

2. 明确了升温速率对热释光发光曲线的调控规律与剂量测量方法的性能差异。实验结果表明，热释光主峰峰高随升温速率的升高呈线性增长趋势，主峰位随升温速率提升向高温侧发生规律性漂移，偏移量约 1-2 ℃/(℃ • s^{-1})，而发光曲线积分总面积基本恒定，与升温速率无关；对比峰高法与峰面积法的测量性能，峰面积法的线性度、抗干扰能力与灵敏度均显著优于峰高法，更适合作为热释光剂量定量的核心方法，尤其在低剂量测量场景下优势更为突出。

3. 厘清了 X 射线管关键参数对输出辐射剂量的影响规律。采用控制变量法实验验证，在实验参数范围内，X 射线输出辐射剂量与管电流、管电压、辐照时间均呈显著正相关，符合 X 射线产生的物理机制与辐射剂量学基本规律；管电压决定 X 射线的穿透能力与有效剂量率，是影响输出剂量的核心因素，管电流与辐照时间通过调控 X 射线光子总数实现累积剂量的线性调控，三者共同构成了 X 射线辐照剂量的完整调控体系。

4. 完成了剂量响应曲线标定与环境累积辐射剂量的定量测量。基于 ^{137}Cs 标准辐照源，建立了 LiF:Mg,Cu,P 剂量计在 0.273-1.365 mSv 范围内的剂量响应曲线，峰面积法线性拟合相关系数 R^2 达 0.9698，线性响应特性优异；基于标定曲线完成了环境 7 天累积辐射剂量的反演，经完整的不确定度评定，最终测量结果为 (0.137 ± 0.015) mSv（$k = 2$，置信概率 95%），换算年有效剂量约 7.15 mSv/a，处于我国天然本底辐射的正常波动范围，无异常辐射风险。

5. 完成了测量方法的误差分析与优化路径明确。实验系统分析了剂量测量的主要误差来源，包括低剂量段校准点缺失、本底扣除相对误差、剂量片自发衰退效应、仪器系统偏差等；针对性提出了增加低剂量校准点、采用多平行样本底平均、标准化低温退火消除衰退效应、严格控制辐照几何条件等精度提升措施，为后续热释光剂量测量实验的优化提供了明确方向。

综上，本实验全面掌握了热释光辐射剂量测量的基本原理、仪器操作与数据处理方法，验证了 LiF:Mg,Cu,P 剂量计的剂量学特性，建立了标准化的环境与个人辐射剂量测量流程，实验方法可靠、结果准确，可为辐射防护与环境放射性监测相关研究提供实验基础。

附录 A: 签名及实验记录页

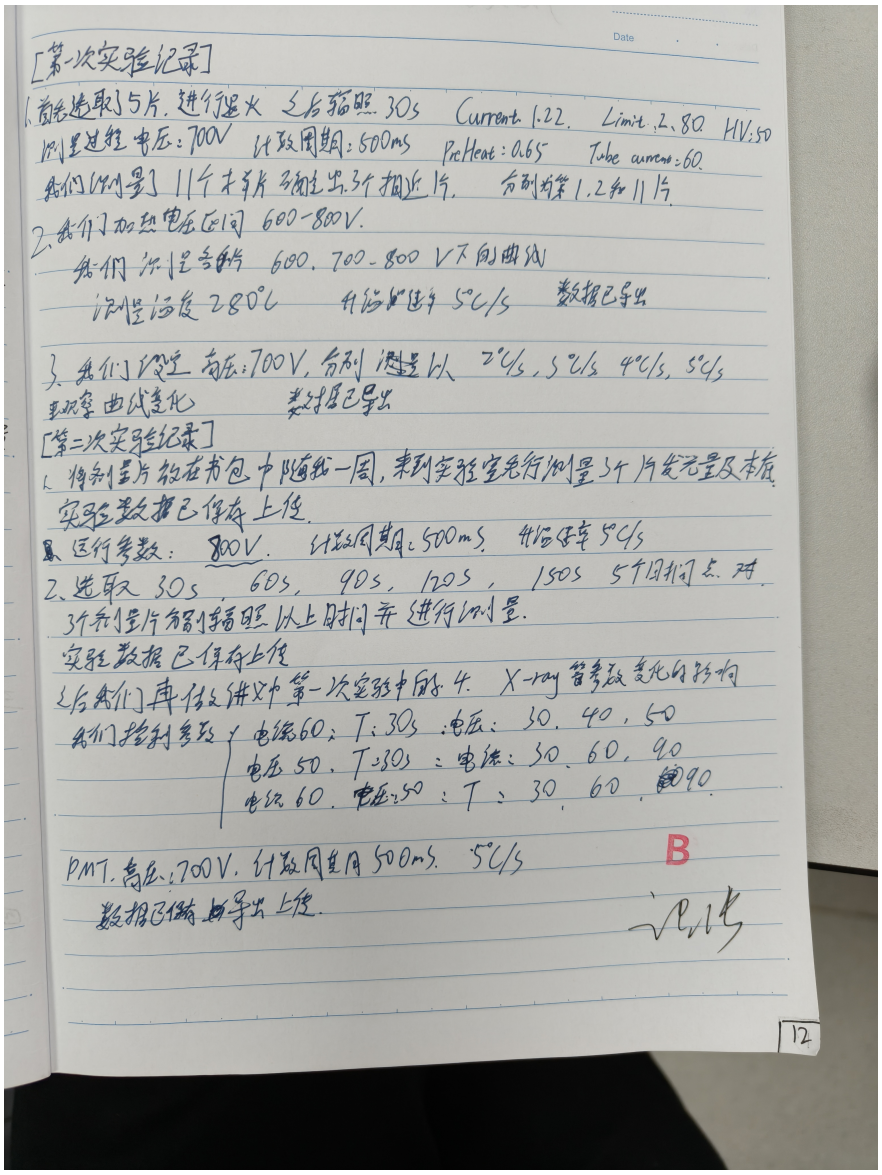


图 48: 实验记录与老师签名页

附录 B: 源代码

Listing 1: 热释光曲线绘制源代码

```python
import pandas as pd
import matplotlib.pyplot as plt
plt.rcParams['font.sans-serif'] = ['SimHei']  # 用黑体显示中文
plt.rcParams['axes.unicode_minus'] = False    # 正常显示负号
# 读取 CSV（第一列温度，第二列强度）
df = pd.read_csv('1/Sample11_eff.csv', header=None, sep='\t')

temp = df[0]
```

```
intensity = df[1]

# 绘图
plt.figure(figsize=(10,5))
plt.plot(temp, intensity, color='#1f77b4', linewidth=2)

plt.xlabel('温度 (℃)', fontsize=12)
plt.ylabel('热释光强度', fontsize=12)
plt.title('热释光发光曲线', fontsize=13)
plt.grid(True, alpha=0.3)
plt.show()
```

Listing 2: 热释光曲线去除本底后源代码

```
import pandas as pd
import matplotlib.pyplot as plt

# ====================== 1. 基础配置（中文显示+画布设置） ======================
plt.rcParams['font.sans-serif'] = ['SimHei']
plt.rcParams['axes.unicode_minus'] = False
plt.figure(figsize=(12, 7))  # 适配多曲线对比的画布大小

# ====================== 2. 定义文件列表与曲线样式（一一对应，便于区分） ======================
# 格式：[文件名，曲线颜色，数据标记，标签]
file_info = [
    ["3/Sam_1 2.csv", "#1f77b4", "o", "2℃/s"],   # 蓝色-圆形
    ["3/Sam_1 3.csv", "#ff7f0e", "s", "3℃/s"],   # 橙色-方形
    ["3/Sam_1 4.csv", "#2ca02c", "^", "4℃/s"],   # 绿色-三角形
    ["3/Sam_1 5.csv", "#d62728", "d", "5℃/s"]    # 红色-菱形
]

# ====================== 3. 批量读取数据、扣除本底、绘制曲线======================
for file, color, marker, label in file_info:
    df = pd.read_csv(file, header=None, sep='\t', encoding='utf-8').dropna()  # 去空值避免报错
    temp = df[0].astype(float)  # 温度（转为数值型）
    intensity_raw = df[1].astype(float)  # 原始热释光强度

    # 计算本底（当前文件的强度最小值）并扣除
    bg_value = intensity_raw.min()
    intensity_bg_sub = intensity_raw - bg_value

    # 打印本底信息（便于实验记录）
    print(f"=== {label} 数据 ===")
    print(f"文件: {file} | 本底值（强度最小值）: {bg_value:.2f} a.u.")

    # 绘制单条曲线（不同样式区分，标注本底值）
    plt.plot(temp, intensity_bg_sub,
             color=color, linewidth=2,  # 曲线颜色+线宽
             marker=marker, markersize=4, markerfacecolor='white', markeredgecolor=color,  #
                 数据点样式
             label=f'{label}（本底={bg_value:.2f} a.u.）')  # 图例（含本底信息）

# ====================== 4. 图表美化（适配多曲线对比需求） ======================
plt.xlabel('温度 (℃)', fontsize=12, fontweight='bold')  # X轴标签（加粗清晰）
plt.ylabel('热释光强度（本底扣除后）', fontsize=12, fontweight='bold')  # Y轴标签（扣除本底后）
plt.title('Sample1 不同升温速率热释光强度-温度曲线（本底扣除后）', fontsize=14,
     fontweight='bold', pad=15)  # 标题

plt.grid(True, linestyle=':', alpha=0.5, color='#999999')
```

```
44
45  # 图例（放在右侧，避免遮挡曲线）
46  plt.legend(fontsize=11, loc='upper left', frameon=True, shadow=False)
47
48  # 坐标轴范围（Y轴从0开始；X轴适配所有数据的温度范围）
49  plt.ylim(bottom=0)  # Y轴下限设为0
50  # Note: X-axis limits can be set if needed, but omitted for simplicity
51
52  plt.tight_layout()  # 自动调整布局，避免标签被截断
53  plt.savefig("All_Sam_1.jpg", dpi=300, bbox_inches='tight', format='jpg')  # 300dpi JPG格式
54
55  # 显示曲线
56  plt.show()
```

Listing 3: 热释光曲线随高压和加热速率变化曲线源代码

```
1   import matplotlib.pyplot as plt
2   import numpy as np
3
4   # --------------------------- 全局配置（中文支持+分辨率） ---------------------------
5   plt.rcParams['font.sans-serif'] = ['SimHei']  # 配置中文显示（Windows常用SimHei，Mac可换'Arial
        Unicode MS'）
6   plt.rcParams['axes.unicode_minus'] = False    # 解决负号显示异常
7   save_dpi = 300                                  # 保存图片分辨率
8   save_format = 'jpg'                             # 保存格式
9
10  # --------------------------- 第一部分：光电倍增管高压对热释光曲线的影响
        ---------------------------
11  # 实验数据
12  hv = [600, 700, 800]  # 光电倍增管高压 (V)
13  sample1_hv = [1721, 3681, 8285]    # 1号剂量片峰值
14  sample2_hv = [1672, 3603, 8069]    # 2号剂量片峰值
15  sample11_hv = [1716, 3729, 8320]   # 11号剂量片峰值
16  avg_hv = [1703, 3671, 8225]         # 平均值
17
18  # 绘图
19  plt.figure(figsize=(8, 6))
20  plt.plot(hv, sample1_hv, 'o-', markersize=7, label='1号剂量片')
21  plt.plot(hv, sample2_hv, 's-', markersize=7, label='2号剂量片')
22  plt.plot(hv, sample11_hv, '^-', markersize=7, label='3号剂量片')
23  plt.plot(hv, avg_hv, 'd-', markersize=8, linewidth=2, label='平均值')
24
25  # 图表美化
26  plt.xlabel('光电倍增管高压 (V)', fontsize=12)
27  plt.ylabel('主峰峰值 (a.u.)', fontsize=12)
28  plt.title('光电倍增管高压对热释光峰值的影响', fontsize=14)
29  plt.legend(fontsize=10)
30  plt.grid(True, linestyle='--', alpha=0.7)
31  plt.tight_layout()
32
33  # 保存并显示
34  plt.savefig(f'高压影响曲线.{save_format}', dpi=save_dpi)
35  plt.show()
36
37  # --------------------------- 第二部分：升温速率对热释光发光曲线的影响 ---------------------------
38  # 实验数据
39  heat_rate = [2, 3, 4, 5]  # 升温速率 (℃/s)
40  sample1_rate = [2950, 3210, 3470, 3681]  # 1号剂量片峰值
41  sample2_rate = [2890, 3150, 3390, 3603]  # 2号剂量片峰值
```

```
sample11_rate = [2980, 3250, 3510, 3729] # 11号剂量片峰值
peak_temp = [205, 208, 210, 212]          # 主峰温度 (℃)

# 绘制双子图（左：峰值-升温速率；右：峰位-升温速率）
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(14, 5))

# 子图1：峰值随升温速率的变化
ax1.plot(heat_rate, sample1_rate, 'o-', markersize=7, label='1号剂量片')
ax1.plot(heat_rate, sample2_rate, 's-', markersize=7, label='2号剂量片')
ax1.plot(heat_rate, sample11_rate, '^-', markersize=7, label='3号剂量片')
ax1.set_xlabel('升温速率 (℃/s)', fontsize=12)
ax1.set_ylabel('主峰峰值 (a.u.)', fontsize=12)
ax1.set_title('升温速率对热释光峰值的影响', fontsize=14)
ax1.legend(fontsize=10)
ax1.grid(True, linestyle='--', alpha=0.7)

# 子图2：峰位随升温速率的变化
ax2.plot(heat_rate, peak_temp, 'rd-', markersize=8, linewidth=2)
ax2.set_xlabel('升温速率 (℃/s)', fontsize=12)
ax2.set_ylabel('主峰温度 (℃)', fontsize=12)
ax2.set_title('升温速率对主峰峰位的影响', fontsize=14)
ax2.grid(True, linestyle='--', alpha=0.7)

# 调整布局并保存

plt.tight_layout()
plt.savefig(f'升温速率影响曲线.{save_format}', dpi=save_dpi)
plt.show()

print("绘图完成！图片已保存为「高压影响曲线.jpg」和「升温速率影响曲线.jpg」")
```

Listing 4: 第二次实验环境剂量片热释光曲线去除本底后源代码

```
import pandas as pd
import matplotlib.pyplot as plt
from scipy.interpolate import interp1d
import numpy as np

# ====================== 中文与画图设置 ======================
plt.rcParams['font.sans-serif'] = ['SimHei']
plt.rcParams['axes.unicode_minus'] = False

# ====================== 1. 读取有效数据 & 本底数据 ======================
# 有效信号
df_eff = pd.read_csv("4.22/1/Sample3.csv", header=None, sep='\t', encoding='utf-8').dropna()
T_eff = df_eff[0].values    # 有效数据温度
I_eff = df_eff[1].values    # 有效数据强度

# 本底数据
df_base = pd.read_csv("4.22/1/Sample3_base.csv", header=None, sep='\t',
    encoding='utf-8').dropna()
T_base = df_base[0].values  # 本底温度
I_base = df_base[1].values  # 本底强度

# ====================== 2. 对本底做插值拟合 ======================
# 线性插值（本底平滑，线性足够精准；想更平滑可换 kind='cubic'）
f_base = interp1d(T_base, I_base, kind='linear', fill_value="extrapolate")

# 在【有效数据的温度点】上计算插值后的本底
```

```
I_base_interp = f_base(T_eff)

# ==================== 3. 真正扣除本底 ====================
I_sub = I_eff - I_base_interp

# 防止出现微小负值（热释光强度 0）
I_sub = np.clip(I_sub, 0, None)

# ==================== 4. 画图 ====================
plt.figure(figsize=(11, 6))

plt.plot(T_eff, I_eff, 'b-', linewidth=1.5, label='原始有效信号')
plt.plot(T_eff, I_base_interp, 'k--', linewidth=1.5, label='插值拟合后的本底')
plt.plot(T_eff, I_sub, 'r-', linewidth=2.5, label='本底扣除后信号')

plt.xlabel('温度 / ℃', fontsize=12)
plt.ylabel('热释光强度 / a.u.', fontsize=12)
plt.title('Sample3 热释光曲线（插值拟合扣本底）', fontsize=14)
plt.legend()
plt.grid(alpha=0.3)
plt.ylim(bottom=0)
plt.tight_layout()

# 保存高清图
plt.savefig("4.22_1_Sam3.jpg", dpi=300, bbox_inches='tight')
plt.show()

print("  本底已通过插值拟合扣除完成！")
print(f"  扣本底后峰值: {I_sub.max():.1f} a.u.")
print(f"  峰值温度: {T_eff[I_sub.argmax()]:.1f} ℃")
```

Listing 5: 第二次实验剂量响应曲线源代码

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from scipy.stats import linregress

# ==================== 1. 全局配置（中文显示+绘图风格）====================
plt.rcParams['font.sans-serif'] = ['SimHei']
plt.rcParams['axes.unicode_minus'] = False
plt.rcParams['figure.dpi'] = 100

# ==================== 2. 定义实验参数与文件信息 ====================
# 辐照器参数（来自讲义）
irradiation_rate = 0.546  # 照射率，单位mSv/min
# 五组数据的信息：[文件名，辐照时间(s)，曲线颜色，标记样式]
file_info = [
    ["4.22/2/Sample1_30s.csv", 30, "#1f77b4", "o"],
    ["4.22/2/Sample1_60s.csv", 60, "#ff7f0e", "s"],
    ["4.22/2/Sample1_90s.csv", 90, "#2ca02c", "^"],
    ["4.22/2/Sample1_120s.csv", 120, "#d62728", "d"],
    ["4.22/2/Sample1_150s.csv", 150, "#9467bd", "p"]
]

# 存储结果的列表
dose_list = []          # 吸收剂量列表
peak_height_list = []   # 峰高列表
peak_area_list = []     # 峰面积列表
```

```
curve_data = []          # 存储每条曲线的温度、扣本底后强度，用于绘图

# ==================== 3. 批量处理数据 ====================
print("="*50)
print("热释光剂量响应曲线数据处理结果（本底：曲线最低值）")
print("="*50)
print(f"辐照器照射率：{irradiation_rate} mSv/min")
print("-"*50)

for file, t_s, color, marker in file_info:
    # 1. 读取数据
    df = pd.read_csv(file, header=None, sep='\t', encoding='utf-8').dropna()
    temp = df[0].astype(float).values   # 温度列，单位℃
    intensity_raw = df[1].astype(float).values  # 原始强度列

    # 2. 本底扣除（取曲线中的最低值作为本底）
    bg_value = np.min(intensity_raw)
    intensity_sub = intensity_raw - bg_value
    intensity_sub[intensity_sub < 0] = 0  # 物理意义修正：强度不能为负

    # 3. 计算特征量：峰高、峰面积
    peak_height = np.max(intensity_sub)  # 峰高（主峰最大强度）
    peak_area = np.trapz(intensity_sub, temp)  # 峰面积（积分发光总额）

    # 4. 计算对应吸收剂量
    dose = irradiation_rate * (t_s / 60)  # 时间转分钟，计算剂量

    # 5. 存储结果
    dose_list.append(dose)
    peak_height_list.append(peak_height)
    peak_area_list.append(peak_area)
    curve_data.append([temp, intensity_sub, f"{t_s}s（{dose:.3f}mSv）", color, marker])

    # 打印单组结果
    print(f"辐照时间：{t_s}s | 吸收剂量：{dose:.3f} mSv")
    print(f"  本底值（曲线最低值）：{bg_value:.2f} a.u.")
    print(f"  扣本底后峰高：{peak_height:.2f} a.u. | 峰面积：{peak_area:.2f} a.u.·℃")
    print("-"*50)

# ==================== 4. 线性拟合（核心：剂量响应曲线拟合）====================
# 峰高 vs 剂量 拟合
fit_height = linregress(dose_list, peak_height_list)
k_h, b_h, r_h = fit_height.slope, fit_height.intercept, fit_height.rvalue
# 峰面积 vs 剂量 拟合
fit_area = linregress(dose_list, peak_area_list)
k_a, b_a, r_a = fit_area.slope, fit_area.intercept, fit_area.rvalue

# 打印拟合结果
print("剂量响应曲线线性拟合结果")
print("-"*50)
print(f"【峰高法】拟合方程：y = {k_h:.2f}·x + {b_h:.2f}")
print(f"  相关系数R² = {r_h**2:.6f} | 灵敏度（斜率）：{k_h:.2f} a.u./mSv")
print(f"【峰面积法】拟合方程：y = {k_a:.2f}·x + {b_a:.2f}")
print(f"  相关系数R² = {r_a**2:.6f} | 灵敏度（斜率）：{k_a:.2f} a.u.·℃/mSv")
print("="*50)

# ==================== 5. 绘图 ====================
# 图1：五组样品的热释光发光曲线对比（对应讲义图2）
plt.figure(figsize=(12, 6))
for temp, intensity, label, color, marker in curve_data:
```

```
    plt.plot(temp, intensity, color=color, linewidth=2, label=label,
             marker=marker, markersize=4, markevery=20, markerfacecolor='white',
                 markeredgecolor=color)

plt.xlabel('温度 (℃)', fontsize=12)
plt.ylabel('热释光强度（本底扣除后）(a.u.)', fontsize=12)
plt.title('不同辐照剂量下的热释光发光曲线对比（本底: 曲线最低值）', fontsize=14,
    fontweight='bold')
plt.legend(fontsize=10, loc='upper right')
plt.grid(linestyle=':', alpha=0.5)
plt.xlim(30, 280)
plt.ylim(bottom=0)
plt.tight_layout()
plt.savefig("不同剂量热释光曲线对比_最低值本底.jpg", dpi=300, bbox_inches='tight')

# 图2: 剂量响应曲线（峰高法和峰面积法）
plt.figure(figsize=(12, 5))

# 子图1: 峰高 vs 剂量
plt.subplot(1, 2, 1)
plt.scatter(dose_list, peak_height_list, color='blue', s=50, label='实验数据')
plt.plot(dose_list, [k_h * d + b_h for d in dose_list], color='red', linewidth=2,
    label=f'拟合线: y={k_h:.2f}x+{b_h:.2f}')
plt.xlabel('吸收剂量 (mSv)', fontsize=12)
plt.ylabel('峰高 (a.u.)', fontsize=12)
plt.title('峰高法剂量响应曲线', fontsize=14, fontweight='bold')
plt.legend()
plt.grid(linestyle=':', alpha=0.5)

# 子图2: 峰面积 vs 剂量
plt.subplot(1, 2, 2)
plt.scatter(dose_list, peak_area_list, color='green', s=50, label='实验数据')
plt.plot(dose_list, [k_a * d + b_a for d in dose_list], color='red', linewidth=2,
    label=f'拟合线: y={k_a:.2f}x+{b_a:.2f}')
plt.xlabel('吸收剂量 (mSv)', fontsize=12)
plt.ylabel('峰面积 (a.u.·℃)', fontsize=12)
plt.title('峰面积法剂量响应曲线', fontsize=14, fontweight='bold')
plt.legend()
plt.grid(linestyle=':', alpha=0.5)

plt.tight_layout()
plt.savefig("剂量响应曲线_最低值本底.jpg", dpi=300, bbox_inches='tight')
plt.show()

# 图2: 剂量响应曲线（峰高+峰面积双图，带线性拟合）
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(14, 6))

# 左图: 峰高法剂量响应曲线
x_fit = np.linspace(min(dose_list)*0.9, max(dose_list)*1.1, 100)
y_fit_h = k_h * x_fit + b_h
ax1.scatter(dose_list, peak_height_list, color='#1f77b4', s=80, zorder=5, label='实验数据')
ax1.plot(x_fit, y_fit_h, color='#d62728', linewidth=2,
    label=f'拟合直线: y={k_h:.2f}x+{b_h:.2f}\n$R^2={r_h**2:.4f}$')
ax1.set_xlabel('吸收剂量 (mSv)', fontsize=12)
ax1.set_ylabel('热释光主峰峰高 (a.u.)', fontsize=12)
ax1.set_title('峰高法剂量响应曲线（本底: 曲线最低值）', fontsize=13, fontweight='bold')
ax1.legend(fontsize=10)
ax1.grid(linestyle=':', alpha=0.5)

# 右图: 峰面积法剂量响应曲线
```

```
y_fit_a = k_a * x_fit + b_a
ax2.scatter(dose_list, peak_area_list, color='#2ca02c', s=80, zorder=5, label='实验数据')
ax2.plot(x_fit, y_fit_a, color='#d62728', linewidth=2,
     label=f'拟合直线: y={k_a:.2f}x+{b_a:.2f}\n$R^2={r_a**2:.4f}$')
ax2.set_xlabel('吸收剂量 (mSv)', fontsize=12)
ax2.set_ylabel('热释光峰面积 (a.u.·℃)', fontsize=12)
ax2.set_title('峰面积法剂量响应曲线（本底: 曲线最低值）', fontsize=13, fontweight='bold')
ax2.legend(fontsize=10)
ax2.grid(linestyle=':', alpha=0.5)

plt.tight_layout()
plt.savefig("剂量响应曲线_拟合结果_最低值本底.jpg", dpi=300, bbox_inches='tight')
plt.show()
```

Listing 6: X-ray 管参数的影响

```
# ====================== 1. 导入所需库 ======================
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from scipy.optimize import curve_fit

# 解决matplotlib中文显示问题
plt.rcParams["font.family"] = ["SimHei", "WenQuanYi Micro Hei", "Heiti TC"]
plt.rcParams["axes.unicode_minus"] = False  # 解决负号显示问题

# ====================== 2. 定义核心函数 ======================
# 线性拟合函数
def linear_func(x, k, b):
    return k * x + b

# 读取并处理CSV数据的函数
def read_tl_data(file_path):
    """
    读取热释光CSV数据，返回温度数组、强度数组
    :param file_path: CSV文件路径
    :return: temp_array(温度), intensity_array(强度)
    """
    # 读取CSV，跳过表头，处理|分隔符
    df = pd.read_csv(
        file_path,
        sep='\t|\\|',  # 匹配制表符和|分隔符
        engine='python',
        skiprows=0,  # 跳过前0行表头
        header=None,
        usecols=[0, 1]  # 只取前两列：温度、强度
    )
    # 去除空值，转换为数值型
    df = df.dropna()
    df[0] = pd.to_numeric(df[0], errors='coerce')
    df[1] = pd.to_numeric(df[1], errors='coerce')
    df = df.dropna()

    temp_array = df[0].values  # 温度数组（℃）
    intensity_array = df[1].values  # 热释光强度数组（a.u.）
    return temp_array, intensity_array

# ====================== 3. 读取数据（修改这里的文件路径为你的实际路径） ======================
# 3个管电流对应的文件路径
```

```python
file_30A = "4.22/First_4/A/Sample2_30A.csv"
file_60A = "1/Sample2_eff.csv"
file_90A = "4.22/First_4/A/Sample2_90A.csv"

# 读取数据
temp_30, inten_30 = read_tl_data(file_30A)
temp_60, inten_60 = read_tl_data(file_60A)
temp_90, inten_90 = read_tl_data(file_90A)

# ==================== 4. 数据预处理：本底扣除 ====================
# 本底扣除方法：取每条曲线的最低值作为本底，和你之前的处理逻辑完全一致
bg_30 = np.min(inten_30)
bg_60 = np.min(inten_60)
bg_90 = np.min(inten_90)

# 扣本底后的强度
inten_30_sub = inten_30 - bg_30
inten_60_sub = inten_60 - bg_60
inten_90_sub = inten_90 - bg_90

# 把负值截断为0（热释光强度物理意义非负）
inten_30_sub[inten_30_sub < 0] = 0
inten_60_sub[inten_60_sub < 0] = 0
inten_90_sub[inten_90_sub < 0] = 0

# ==================== 5. 特征参数提取 ====================
def get_tl_features(temp, intensity_sub):
    """提取热释光曲线特征参数：峰高、主峰温度、峰面积"""
    peak_height = np.max(intensity_sub)  # 峰高
    peak_temp = temp[np.argmax(intensity_sub)]  # 主峰温度
    peak_area = np.trapezoid(intensity_sub, temp)  # 峰面积（梯形积分，替代弃用的trapz）
    return peak_height, peak_temp, peak_area

# 提取3个管电流的特征参数
h_30, t_30, a_30 = get_tl_features(temp_30, inten_30_sub)
h_60, t_60, a_60 = get_tl_features(temp_60, inten_60_sub)
h_90, t_90, a_90 = get_tl_features(temp_90, inten_90_sub)

# 整理成表格输出
current_list = np.array([30, 60, 90])  # 管电流列表（A）
height_list = np.array([h_30, h_60, h_90])
area_list = np.array([a_30, a_60, a_90])
temp_list = np.array([t_30, t_60, t_90])

result_df = pd.DataFrame({
    "管电流(A)": current_list,
    "本底值(a.u.)": [bg_30, bg_60, bg_90],
    "扣本底后峰高(a.u.)": height_list,
    "主峰温度(℃)": temp_list,
    "扣本底后峰面积(a.u.•℃)": area_list
})

print("="*80)
print("管电流影响实验特征参数统计结果")
print("="*80)
print(result_df)
print("="*80)

# ==================== 6. 线性拟合 ====================
# 峰高法拟合
```

```
popt_h, pcov_h = curve_fit(linear_func, current_list, height_list)
k_h, b_h = popt_h
r2_h = 1 - np.sum((height_list - linear_func(current_list, k_h, b_h))**2) / np.sum((height_list - np.mean(height_list))**2)

# 峰面积法拟合
popt_a, pcov_a = curve_fit(linear_func, current_list, area_list)
k_a, b_a = popt_a
r2_a = 1 - np.sum((area_list - linear_func(current_list, k_a, b_a))**2) / np.sum((area_list - np.mean(area_list))**2)

# 输出拟合结果
print("\n【峰高法线性拟合结果】")
print(f"拟合方程: 峰高 = {k_h:.2f} × 管电流 + {b_h:.2f}")
print(f"相关系数R² = {r2_h:.6f} | 灵敏度（斜率）: {k_h:.2f} a.u./ A")
print("\n【峰面积法线性拟合结果】")
print(f"拟合方程: 峰面积 = {k_a:.2f} × 管电流 + {b_a:.2f}")
print(f"相关系数R² = {r2_a:.6f} | 灵敏度（斜率）: {k_a:.2f} a.u.•℃/ A")
print("="*80)

# ====================== 7. 绘图（可直接插入实验报告） ======================
# 图1: 不同管电流下的热释光发光曲线对比
plt.figure(figsize=(10, 6), dpi=300)
plt.plot(temp_30, inten_30_sub, label="30 A", color="#1f77b4", linewidth=1.5)
plt.plot(temp_60, inten_60_sub, label="60 A", color="#ff7f0e", linewidth=1.5)
plt.plot(temp_90, inten_90_sub, label="90 A", color="#2ca02c", linewidth=1.5)
plt.xlabel("温度 (℃)", fontsize=12)
plt.ylabel("扣本底后热释光强度 (a.u.)", fontsize=12)
plt.title("不同管电流下剂量片2的热释光发光曲线", fontsize=14, fontweight="bold")
plt.legend(fontsize=10)
plt.grid(alpha=0.3, linestyle="--")
plt.xlim(30, 280)  # 和你的升温程序一致
plt.savefig("A2_curve.jpg", dpi=300, bbox_inches="tight")
plt.show()

# 图2: 管电流-峰高线性拟合图
plt.figure(figsize=(8, 5), dpi=300)
plt.scatter(current_list, height_list, color="#1f77b4", s=80, label="实验数据", zorder=5)
x_fit = np.linspace(25, 95, 100)
plt.plot(x_fit, linear_func(x_fit, k_h, b_h), color="#ff7f0e", linewidth=2,
    label=f"拟合直线: y={k_h:.2f}x+{b_h:.2f}\nR^2={r2_h:.6f}")
plt.xlabel("管电流 ( A)", fontsize=12)
plt.ylabel("扣本底后峰高 (a.u.)", fontsize=12)
plt.title("管电流与热释光峰高的线性关系", fontsize=14, fontweight="bold")
plt.legend(fontsize=10)
plt.grid(alpha=0.3, linestyle="--")
plt.xlim(25, 95)
plt.savefig("A2_high.jpg", dpi=300, bbox_inches="tight")
plt.show()

# 图3: 管电流-峰面积线性拟合图
plt.figure(figsize=(8, 5), dpi=300)
plt.scatter(current_list, area_list, color="#2ca02c", s=80, label="实验数据", zorder=5)
x_fit = np.linspace(25, 95, 100)
plt.plot(x_fit, linear_func(x_fit, k_a, b_a), color="#d62728", linewidth=2,
    label=f"拟合直线: y={k_a:.2f}x+{b_a:.2f}\nR^2={r2_a:.6f}")
plt.xlabel("管电流 ( A)", fontsize=12)
plt.ylabel("扣本底后峰面积 (a.u.•℃)", fontsize=12)
plt.title("管电流与热释光峰面积的线性关系", fontsize=14, fontweight="bold")
plt.legend(fontsize=10)
```

```
  plt.grid(alpha=0.3, linestyle="--")
  plt.xlim(25, 95)
  plt.savefig("A2_area.jpg", dpi=300, bbox_inches="tight")
  plt.show()
```

附录 C: 原始数据

Listing 7: 第 1 个有效选片数据

```
  27.03  128.00
  27.05  127.00
  27.06  128.00
  27.06  128.00
  27.05  127.00
  27.05  127.00
  27.06  128.00
  27.03  127.00
  27.04  128.00
  27.03  127.00
  27.44  127.00
  29.71  127.00
  32.20  128.00
  34.71  127.00
  37.24  127.00
  39.70  128.00
  42.22  127.00
  44.65  128.00
  47.19  127.00
  49.68  128.00
  52.19  129.00
  54.69  128.00
  57.21  129.00
  59.69  129.00
  62.19  129.00
  64.71  129.00
  67.25  131.00
  69.73  131.00
  72.26  132.00
  74.77  133.00
  77.26  134.00
  79.76  136.00
  82.30  138.00
  84.69  139.00
  87.24  141.00
  89.72  144.00
  92.25  145.00
  94.74  146.00
  97.24  148.00
  99.74  148.00
 102.24  148.00
 104.76  148.00
 107.27  148.00
 109.81  148.00
 112.30  151.00
 114.79  153.00
 117.32  157.00
 119.84  162.00
```

```
122.31  169.00
124.81  179.00
127.26  188.00
129.80  202.00
132.29  214.00
134.79  227.00
137.29  237.00
139.79  247.00
142.31  248.00
144.80  245.00
147.32  235.00
149.81  217.00
152.32  198.00
154.83  178.00
157.33  162.00
159.83  154.00
162.33  151.00
164.85  153.00
167.23  157.00
169.71  162.00
172.20  169.00
174.72  176.00
177.20  185.00
179.72  195.00
182.21  205.00
184.73  215.00
187.23  224.00
189.74  232.00
192.24  239.00
194.76  241.00
197.26  241.00
199.74  240.00
202.26  236.00
204.75  234.00
207.24  237.00
209.74  246.00
212.18  264.00
214.69  298.00
217.20  346.00
219.74  413.00
222.23  504.00
224.74  623.00
227.22  775.00
229.76  972.00
232.24  1218.00
234.76  1522.00
237.27  1881.00
239.80  2290.00
242.28  2726.00
244.79  3148.00
247.31  3495.00
249.71  3681.00
252.19  3631.00
254.70  3302.00
257.22  2755.00
259.73  2093.00
262.23  1504.00
264.74  1078.00
267.25  845.00
269.74  723.00
```

```
272.27  657.00
274.77  612.00
277.28  575.00
279.78  541.00
280.91  509.00
280.88  471.00
280.91  433.00
280.91  395.00
280.91  361.00
280.89  331.00
280.89  302.00
280.90  278.00
280.90  256.00
280.90  239.00
280.89  223.00
280.89  209.00
280.91  198.00
280.90  188.00
280.91  180.00
280.91  173.00
280.88  166.00
280.91  162.00
280.91  158.00
280.90  155.00
280.91  151.00
280.89  150.00
280.89  148.00
280.91  146.00
280.90  144.00
280.89  143.00
280.90  141.00
280.93  141.00
280.90  139.00
280.92  140.00
280.92  138.00
280.90  138.00
280.90  138.00
280.90  137.00
280.90  137.00
280.91  136.00
280.93  136.00
280.92  136.00
280.91  136.00
280.91  135.00
280.92  136.00
280.90  135.00
280.90  135.00
280.90  135.00
280.91  135.00
280.90  134.00
280.90  135.00
280.89  135.00
280.90  134.00
280.91  135.00
280.91  134.00
280.89  134.00
280.91  134.00
280.90  134.00
280.89  134.00
280.90  134.00
```

```
280.89  134.00
280.89  134.00
280.90  133.00
280.90  134.00
280.89  134.00
280.89  134.00
280.87  134.00
280.89  133.00
280.87  134.00
280.91  134.00
280.87  134.00
280.88  134.00
280.86  134.00
280.88  134.00
280.88  134.00
280.88  134.00
280.89  134.00
280.89  133.00
280.86  134.00
280.89  134.00
280.90  134.00
280.88  134.00
280.89  134.00
280.88  134.00
280.88  133.00
280.87  135.00
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280.88  134.00
280.88  134.00
280.88  134.00
280.91  134.00
280.90  134.00
280.89  134.00
280.91  134.00
280.90  134.00
280.89  134.00
280.89  134.00
280.87  134.00
280.90  134.00
280.88  134.00
280.89  134.00
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280.89  134.00
280.89  134.00
280.89  134.00
280.90  134.00
280.93  133.00
280.91  134.00
280.90  135.00
280.90  134.00
280.89  134.00
280.92  134.00
280.91  134.00
280.90  134.00
280.90  133.00
280.90  134.00
280.90  134.00
280.89  134.00
280.91  134.00
```

```
280.93  134.00
280.92  134.00
280.92  135.00
280.91  134.00
```

Listing 8: 第 2 个有效选片数据

```
 28.66  125.00
 28.67  126.00
 28.71  125.00
 28.70  126.00
 28.74  124.00
 28.73  125.00
 28.73  125.00
 28.75  125.00
 28.74  125.00
 28.75  125.00
 28.73  126.00
 29.71  125.00
 32.20  125.00
 34.71  125.00
 37.21  125.00
 39.70  125.00
 42.19  126.00
 44.66  125.00
 47.19  126.00
 49.65  126.00
 52.14  125.00
 54.68  126.00
 57.19  127.00
 59.70  126.00
 62.17  127.00
 64.71  128.00
 67.18  128.00
 69.69  128.00
 72.24  129.00
 74.76  130.00
 77.28  131.00
 79.76  132.00
 82.29  134.00
 84.67  135.00
 87.19  137.00
 89.70  138.00
 92.22  140.00
 94.73  142.00
 97.22  143.00
 99.70  145.00
102.25  146.00
104.77  148.00
107.28  151.00
109.77  153.00
112.28  158.00
114.81  163.00
117.29  171.00
119.81  181.00
122.30  191.00
124.83  204.00
127.27  217.00
129.77  230.00
```

```
132.27  242.00
134.79  253.00
137.32  256.00
139.80  253.00
142.31  244.00
144.80  228.00
147.33  208.00
149.82  186.00
152.32  170.00
154.82  158.00
157.32  154.00
159.84  154.00
162.31  158.00
164.86  164.00
167.20  169.00
169.71  177.00
172.21  185.00
174.71  193.00
177.21  203.00
179.72  212.00
182.20  220.00
184.72  228.00
187.23  232.00
189.75  234.00
192.25  235.00
194.73  229.00
197.26  226.00
199.75  223.00
202.24  223.00
204.73  229.00
207.24  247.00
209.72  275.00
212.18  315.00
214.70  372.00
217.21  442.00
219.72  532.00
222.20  643.00
224.71  781.00
227.23  947.00
229.74  1147.00
232.24  1386.00
234.74  1662.00
237.26  1977.00
239.80  2325.00
242.27  2684.00
244.78  3034.00
247.29  3344.00
249.71  3546.00
252.18  3603.00
254.72  3465.00
257.20  3096.00
259.75  2541.00
262.25  1898.00
264.73  1311.00
267.25  889.00
269.75  645.00
272.26  524.00
274.79  465.00
277.27  430.00
279.82  403.00
```

```
280.90  376.00
280.88  349.00
280.88  323.00
280.93  297.00
280.90  271.00
280.90  252.00
280.90  233.00
280.90  218.00
280.89  204.00
280.89  194.00
280.89  183.00
280.89  175.00
280.89  168.00
280.88  163.00
280.89  158.00
280.89  154.00
280.89  151.00
280.89  147.00
280.90  146.00
280.89  143.00
280.88  142.00
280.88  139.00
280.89  139.00
280.89  137.00
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280.89  132.00
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280.88  131.00
280.89  131.00
280.90  131.00
280.89  130.00
280.89  131.00
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280.90  130.00
280.89  130.00
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280.90  130.00
280.91  129.00
280.90  129.00
280.90  130.00
280.89  130.00
280.89  129.00
280.90  130.00
280.92  129.00
280.92  130.00
280.89  129.00
280.88  130.00
280.90  129.00
280.89  129.00
280.90  129.00
```

```
  280.90  129.00
  280.90  129.00
  280.91  130.00
  280.88  129.00
  280.89  129.00
  280.86  129.00
  280.91  129.00
  280.88  129.00
  280.90  129.00
  280.89  129.00
  280.89  129.00
  280.88  129.00
  280.87  129.00
  280.88  129.00
  280.89  129.00
  280.89  129.00
  280.89  129.00
  280.88  129.00
  280.89  129.00
  280.91  129.00
  280.88  129.00
  280.89  129.00
  280.86  129.00
  280.88  129.00
  280.87  129.00
  280.89  129.00
  280.88  129.00
  280.88  129.00
  280.88  129.00
  280.89  129.00
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  280.89  129.00
  280.91  128.00
  280.87  129.00
  280.88  130.00
  280.88  129.00
  280.87  128.00
  280.87  129.00
  280.87  129.00
  280.88  129.00
  280.87  128.00
  280.88  129.00
  280.88  129.00
  280.89  129.00
  280.91  129.00
  280.90  128.00
  280.87  129.00
  280.89  129.00
  280.89  129.00
  280.89  129.00
  280.89  129.00
  280.89  129.00
  280.89  129.00
  280.88  129.00
  280.89  128.00
  280.89  129.00
  280.89  129.00
  280.90  129.00
  280.91  128.00
  280.89  129.00
```

Listing 9: 第 3 个有效选片数据

```
  35.65  99.00
  35.69  100.00
  35.71  99.00
  35.76  99.00
  35.77  99.00
  35.81  100.00
  35.82  100.00
  35.85  100.00
  35.87  99.00
  35.89  99.00
  35.88  100.00
  35.91  99.00
  35.90  100.00
  35.94  99.00
  37.21  99.00
  39.72  99.00
  42.18  99.00
  44.68  100.00
  47.19  100.00
  49.66  100.00
  52.16  100.00
  54.70  101.00
  57.20  102.00
  59.71  102.00
  62.23  102.00
  64.71  103.00
  67.21  105.00
  69.74  104.00
  72.25  107.00
  74.77  108.00
  77.26  108.00
  79.76  111.00
  82.29  112.00
  84.71  114.00
  87.21  116.00
  89.71  118.00
  92.21  121.00
  94.73  123.00
  97.23  125.00
  99.71  128.00
 102.27  129.00
 104.79  133.00
 107.30  134.00
 109.79  136.00
 112.30  139.00
 114.81  142.00
 117.31  146.00
 119.82  152.00
 122.33  158.00
 124.79  169.00
 127.28  178.00
 129.80  189.00
 132.29  201.00
 134.80  213.00
 137.33  224.00
```

```
139.81  231.00
142.32  232.00
144.80  226.00
147.33  214.00
149.80  195.00
152.33  175.00
154.81  154.00
157.33  140.00
159.84  131.00
162.32  129.00
164.85  132.00
167.21  137.00
169.71  144.00
172.19  154.00
174.73  165.00
177.21  178.00
179.72  193.00
182.21  211.00
184.72  227.00
187.24  248.00
189.73  265.00
192.25  280.00
194.77  294.00
197.25  303.00
199.71  308.00
202.24  311.00
204.75  312.00
207.24  315.00
209.72  330.00
212.19  358.00
214.68  414.00
217.24  507.00
219.72  642.00
222.27  831.00
224.75  1077.00
227.25  1393.00
229.77  1780.00
232.28  2227.00
234.76  2705.00
237.29  3172.00
239.79  3540.00
242.29  3729.00
244.79  3625.00
247.34  3213.00
249.74  2514.00
252.24  1716.00
254.72  1018.00
257.25  557.00
259.75  332.00
262.25  254.00
264.74  236.00
267.25  236.00
269.76  239.00
272.28  243.00
274.78  246.00
277.28  250.00
279.80  252.00
280.93  249.00
280.94  243.00
280.95  230.00
```

```
280.94  218.00
280.94  205.00
280.93  192.00
280.92  179.00
280.94  168.00
280.93  159.00
280.93  151.00
280.92  144.00
280.92  139.00
280.90  134.00
280.93  129.00
280.94  127.00
280.91  123.00
280.92  121.00
280.91  120.00
280.90  117.00
280.91  116.00
280.90  115.00
280.93  112.00
280.90  113.00
280.92  111.00
280.92  111.00
280.88  110.00
280.94  109.00
280.95  108.00
280.89  109.00
280.91  108.00
280.91  108.00
280.92  107.00
280.90  107.00
280.92  106.00
280.92  107.00
280.90  106.00
280.91  107.00
280.90  105.00
280.88  106.00
280.93  105.00
280.92  106.00
280.91  105.00
280.90  106.00
280.90  105.00
280.88  105.00
280.92  105.00
280.92  104.00
280.88  105.00
280.90  105.00
280.92  105.00
280.90  104.00
280.91  105.00
280.94  104.00
280.91  104.00
280.92  104.00
280.90  105.00
280.92  104.00
280.91  104.00
280.90  105.00
280.89  104.00
280.90  105.00
280.89  104.00
280.91  104.00
```

```
280.88  104.00
280.89  104.00
280.92  104.00
280.89  104.00
280.90  104.00
280.89  105.00
280.89  104.00
280.88  104.00
280.88  104.00
280.90  104.00
280.89  104.00
280.89  105.00
280.89  104.00
280.91  104.00
280.92  104.00
280.92  104.00
280.90  104.00
280.91  104.00
280.88  104.00
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280.91  103.00
280.92  104.00
280.91  104.00
280.94  103.00
280.93  103.00
280.91  104.00
280.93  104.00
280.95  104.00
280.91  104.00
280.91  104.00
280.90  103.00
280.89  104.00
280.90  104.00
280.92  103.00
280.90  104.00
280.91  104.00
280.91  103.00
280.90  104.00
280.91  105.00
280.90  103.00
280.91  104.00
280.90  103.00
280.88  104.00
280.91  104.00
280.90  103.00
280.90  104.00
280.89  104.00
280.92  103.00
280.89  104.00
280.91  103.00
280.90  104.00
280.90  104.00
280.91  104.00
280.91  104.00
280.90  104.00
280.89  104.00
280.89  104.00
```

Listing 10: 第 1 片本底数据

```
  28.70  129.00
  28.73  130.00
  28.72  129.00
  28.72  129.00
  28.71  130.00
  28.71  129.00
  28.70  129.00
  28.70  129.00
  28.70  130.00
  28.69  129.00
  28.66  129.00
  29.71  130.00
  32.26  129.00
  34.72  130.00
  37.21  129.00
  39.71  130.00
  42.19  129.00
  44.67  130.00
  47.18  129.00
  49.70  129.00
  52.17  129.00
  54.67  129.00
  57.19  129.00
  59.68  129.00
  62.23  130.00
  64.76  129.00
  67.22  129.00
  69.72  130.00
  72.26  129.00
  74.78  129.00
  77.24  130.00
  79.77  129.00
  82.28  129.00
  84.72  128.00
  87.19  129.00
  89.69  129.00
  92.21  129.00
  94.74  129.00
  97.24  128.00
  99.73  129.00
 102.23  129.00
 104.77  129.00
 107.25  129.00
 109.76  129.00
 112.28  129.00
 114.78  128.00
 117.31  129.00
 119.81  129.00
 122.30  129.00
 124.80  129.00
 127.28  129.00
 129.77  128.00
 132.27  129.00
 134.79  129.00
 137.32  130.00
 139.80  128.00
 142.31  130.00
 144.81  129.00
```

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147.34  129.00
149.82  128.00
152.30  130.00
154.82  128.00
157.34  129.00
159.85  129.00
162.32  129.00
164.85  129.00
167.21  129.00
169.73  129.00
172.21  129.00
174.72  129.00
177.23  129.00
179.71  129.00
182.22  130.00
184.70  129.00
187.23  129.00
189.74  129.00
192.24  129.00
194.76  129.00
197.25  130.00
199.72  129.00
202.26  129.00
204.75  129.00
207.26  130.00
209.71  129.00
212.17  129.00
214.69  129.00
217.24  130.00
219.72  129.00
222.22  130.00
224.74  129.00
227.24  130.00
229.79  129.00
232.27  130.00
234.78  130.00
237.29  129.00
239.80  130.00
242.29  131.00
244.81  130.00
247.34  130.00
249.74  131.00
252.22  130.00
254.71  131.00
257.24  131.00
259.76  131.00
262.27  131.00
264.77  132.00
267.27  132.00
269.78  133.00
272.28  133.00
274.76  133.00
277.27  134.00
279.79  135.00
280.91  135.00
280.91  134.00
280.88  135.00
280.90  134.00
280.89  134.00
280.88  134.00
```

```
280.87  134.00
280.88  133.00
280.89  134.00
280.88  134.00
280.89  134.00
280.91  134.00
280.91  133.00
280.90  134.00
280.90  134.00
280.90  133.00
280.89  134.00
280.89  134.00
280.88  134.00
280.90  134.00
280.90  134.00
280.90  134.00
280.90  134.00
280.90  133.00
280.89  134.00
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280.91  134.00
280.91  134.00
280.90  133.00
280.90  134.00
280.89  134.00
280.89  134.00
280.89  134.00
280.89  134.00
280.90  134.00
280.87  134.00
280.89  134.00
280.91  134.00
280.91  135.00
280.90  134.00
280.92  134.00
280.89  134.00
280.89  134.00
280.89  133.00
280.87  133.00
280.89  134.00
280.88  134.00
280.88  134.00
280.90  135.00
280.90  134.00
280.91  134.00
280.89  134.00
280.89  134.00
280.90  134.00
280.89  134.00
280.88  135.00
280.90  134.00
280.89  134.00
280.90  134.00
280.91  134.00
280.90  135.00
280.90  134.00
280.90  135.00
280.93  134.00
280.92  135.00
280.90  134.00
```

```
 280.92  135.00
 280.89  134.00
 280.89  134.00
 280.89  134.00
 280.91  134.00
 280.89  135.00
 280.89  134.00
 280.92  134.00
 280.90  134.00
 280.93  135.00
 280.92  134.00
 280.93  134.00
 280.92  134.00
 280.91  134.00
 280.92  135.00
 280.91  134.00
 280.90  134.00
 280.91  134.00
 280.91  134.00
 280.89  134.00
 280.92  135.00
 280.90  134.00
 280.92  134.00
 280.90  134.00
 280.88  134.00
 280.89  135.00
 280.89  134.00
 280.89  134.00
 280.90  134.00
 280.91  134.00
 280.89  135.00
 280.89  134.00
 280.90  134.00
 280.90  135.00
 280.89  134.00
 280.91  134.00
 280.90  134.00
 280.89  135.00
 280.90  135.00
 280.89  134.00
 280.90  135.00
 280.90  135.00
 280.89  134.00
 280.89  135.00
 280.90  135.00
 280.90  134.00
 280.90  135.00
 280.90  134.00
 280.91  135.00
 280.88  135.00
 280.89  134.00
 280.89  134.00
 280.89  135.00
 280.89  135.00
```

Listing 11: 第 2 片本底数据

```
  29.79  118.00
  29.82  119.00
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```
  29.80  120.00
  29.76  119.00
  29.77  119.00
  29.77  119.00
  29.78  119.00
  29.77  119.00
  29.73  119.00
  29.78  119.00
  29.71  119.00
  30.07  119.00
  32.21  119.00
  34.67  120.00
  37.20  118.00
  39.72  119.00
  42.20  119.00
  44.68  119.00
  47.18  119.00
  49.70  119.00
  52.16  119.00
  54.69  119.00
  57.16  119.00
  59.71  119.00
  62.22  119.00
  64.74  119.00
  67.21  119.00
  69.76  119.00
  72.24  119.00
  74.75  119.00
  77.25  119.00
  79.79  119.00
  82.28  118.00
  84.67  119.00
  87.22  119.00
  89.71  119.00
  92.23  119.00
  94.73  119.00
  97.24  119.00
  99.75  118.00
 102.23  119.00
 104.79  119.00
 107.31  119.00
 109.75  119.00
 112.28  119.00
 114.78  119.00
 117.29  119.00
 119.81  120.00
 122.29  119.00
 124.79  119.00
 127.29  119.00
 129.79  119.00
 132.27  119.00
 134.82  119.00
 137.32  120.00
 139.80  119.00
 142.30  119.00
 144.82  119.00
 147.31  119.00
 149.81  119.00
 152.33  119.00
 154.81  120.00
```

```
157.33  119.00
159.84  119.00
162.34  120.00
164.86  119.00
167.21  120.00
169.71  119.00
172.22  120.00
174.72  119.00
177.23  119.00
179.71  119.00
182.23  120.00
184.73  119.00
187.26  119.00
189.74  119.00
192.27  119.00
194.75  119.00
197.26  119.00
199.74  120.00
202.26  119.00
204.76  120.00
207.25  119.00
209.72  120.00
212.20  119.00
214.67  119.00
217.24  120.00
219.72  119.00
222.24  120.00
224.72  120.00
227.25  120.00
229.76  120.00
232.28  119.00
234.77  120.00
237.28  120.00
239.79  120.00
242.29  120.00
244.81  120.00
247.31  121.00
249.71  120.00
252.21  121.00
254.70  122.00
257.21  121.00
259.74  122.00
262.25  122.00
264.73  123.00
267.25  123.00
269.76  123.00
272.27  124.00
274.77  125.00
277.28  125.00
279.80  127.00
280.89  126.00
280.91  126.00
280.92  126.00
280.89  125.00
280.89  125.00
280.89  125.00
280.90  125.00
280.89  125.00
280.90  124.00
280.90  125.00
```

```
280.91  125.00
280.90  124.00
280.91  124.00
280.93  125.00
280.90  124.00
280.93  124.00
280.91  124.00
280.90  125.00
280.92  124.00
280.95  124.00
280.89  124.00
280.92  124.00
280.91  125.00
280.92  124.00
280.89  124.00
280.92  125.00
280.89  124.00
280.91  125.00
280.91  124.00
280.91  124.00
280.91  125.00
280.91  124.00
280.90  125.00
280.90  124.00
280.92  125.00
280.94  124.00
280.96  125.00
280.90  125.00
280.95  124.00
280.93  124.00
280.91  125.00
280.95  125.00
280.92  124.00
280.92  124.00
280.91  125.00
280.89  124.00
280.91  124.00
280.93  124.00
280.93  124.00
280.91  124.00
280.94  125.00
280.93  124.00
280.90  124.00
280.93  124.00
280.94  124.00
280.93  125.00
280.90  124.00
280.91  124.00
280.89  125.00
280.93  124.00
280.93  124.00
280.95  124.00
280.88  124.00
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280.90  125.00
280.92  124.00
280.92  124.00
280.93  125.00
280.92  124.00
280.96  125.00
```

```
280.90  124.00
280.91  125.00
280.92  124.00
280.95  124.00
280.91  124.00
280.93  125.00
280.91  124.00
280.94  125.00
280.89  124.00
280.91  124.00
280.87  125.00
280.89  124.00
280.89  125.00
280.89  125.00
280.89  125.00
280.95  124.00
280.94  125.00
280.89  125.00
280.89  124.00
280.91  125.00
280.91  124.00
280.90  125.00
280.93  124.00
280.91  125.00
280.88  124.00
280.91  125.00
280.94  125.00
280.91  124.00
280.91  125.00
280.91  124.00
280.90  125.00
280.90  124.00
280.89  124.00
280.90  125.00
280.92  125.00
280.90  125.00
280.93  125.00
280.94  125.00
280.89  124.00
280.89  125.00
280.92  124.00
280.92  124.00
280.90  124.00
280.92  125.00
280.92  124.00
280.92  125.00
280.90  124.00
280.89  124.00
280.90  125.00
280.90  124.00
```

Listing 12: 第 3 片本底数据

```
 36.08  95.00
 36.09  96.00
 36.08  95.00
 36.06  96.00
 36.04  95.00
 36.01  96.00
```

```
  36.01  96.00
  35.99  95.00
  35.97  95.00
  35.96  95.00
  35.95  96.00
  35.94  95.00
  35.92  95.00
  35.91  96.00
  37.24  95.00
  39.72  95.00
  42.21  96.00
  44.68  95.00
  47.18  96.00
  49.68  96.00
  52.20  95.00
  54.69  95.00
  57.21  96.00
  59.71  95.00
  62.20  95.00
  64.75  95.00
  67.23  96.00
  69.72  95.00
  72.25  96.00
  74.77  95.00
  77.28  96.00
  79.76  95.00
  82.30  95.00
  84.68  96.00
  87.21  96.00
  89.71  95.00
  92.23  95.00
  94.70  95.00
  97.21  96.00
  99.74  95.00
 102.25  96.00
 104.77  95.00
 107.28  96.00
 109.78  95.00
 112.29  96.00
 114.79  95.00
 117.31  96.00
 119.79  95.00
 122.30  95.00
 124.78  95.00
 127.25  96.00
 129.76  95.00
 132.26  95.00
 134.78  96.00
 137.30  95.00
 139.81  95.00
 142.31  95.00
 144.83  95.00
 147.32  95.00
 149.82  96.00
 152.31  96.00
 154.81  95.00
 157.33  95.00
 159.85  95.00
 162.35  95.00
 164.87  96.00
```

```
167.22  95.00
169.68  95.00
172.19  94.00
174.72  96.00
177.21  95.00
179.73  95.00
182.21  95.00
184.73  96.00
187.24  95.00
189.73  95.00
192.24  94.00
194.74  95.00
197.25  95.00
199.74  95.00
202.26  95.00
204.75  95.00
207.26  95.00
209.70  95.00
212.18  95.00
214.72  95.00
217.21  95.00
219.74  95.00
222.22  96.00
224.76  95.00
227.25  96.00
229.77  96.00
232.26  96.00
234.77  95.00
237.29  97.00
239.82  95.00
242.29  96.00
244.80  96.00
247.34  96.00
249.71  96.00
252.18  97.00
254.72  97.00
257.22  98.00
259.71  98.00
262.23  98.00
264.76  99.00
267.24  99.00
269.77  100.00
272.28  101.00
274.76  100.00
277.27  103.00
279.80  103.00
280.93  103.00
280.91  103.00
280.91  103.00
280.92  102.00
280.91  102.00
280.90  102.00
280.92  101.00
280.91  102.00
280.91  101.00
280.93  101.00
280.90  102.00
280.91  101.00
280.90  100.00
280.91  101.00
```

```
  280.90  101.00
  280.88  101.00
  280.90  101.00
  280.89  101.00
  280.89  100.00
  280.91  101.00
  280.88  101.00
  280.90  101.00
  280.89  101.00
  280.90  100.00
  280.90  101.00
  280.91  101.00
  280.91  102.00
  280.91  101.00
  280.90  101.00
  280.89  101.00
  280.90  101.00
  280.91  101.00
  280.90  101.00
  280.89  101.00
  280.91  101.00
  280.90  101.00
  280.95  100.00
  280.92  101.00
  280.91  101.00
  280.91  101.00
  280.89  101.00
  280.92  101.00
  280.91  101.00
  280.91  101.00
  280.90  101.00
  280.90  101.00
  280.89  101.00
  280.91  101.00
  280.92  100.00
  280.92  101.00
  280.90  101.00
  280.89  100.00
  280.91  102.00
  280.89  100.00
  280.89  102.00
  280.89  100.00
  280.89  102.00
  280.90  101.00
  280.89  101.00
  280.89  101.00
  280.89  100.00
  280.92  102.00
  280.94  100.00
  280.89  101.00
  280.91  101.00
  280.90  101.00
  280.90  101.00
  280.90  100.00
  280.89  102.00
  280.89  101.00
  280.89  101.00
  280.90  101.00
  280.92  102.00
  280.89  101.00
```

```
 280.92  101.00
 280.91  101.00
 280.90  101.00
 280.90  102.00
 280.91  101.00
 280.93  102.00
 280.92  101.00
 280.90  102.00
 280.92  101.00
 280.91  101.00
 280.92  101.00
 280.92  102.00
 280.92  102.00
 280.95  101.00
 280.93  102.00
 280.91  102.00
 280.92  101.00
 280.92  102.00
 280.90  102.00
 280.89  102.00
 280.90  101.00
 280.91  102.00
 280.91  102.00
 280.90  102.00
 280.89  102.00
 280.91  101.00
 280.91  102.00
 280.89  102.00
 280.90  102.00
 280.89  102.00
 280.90  102.00
 280.90  102.00
 280.91  101.00
 280.92  102.00
 280.91  102.00
 280.90  102.00
 280.91  102.00
 280.91  102.00
 280.92  102.00
 280.92  102.00
 280.90  102.00
 280.89  102.00
 280.90  101.00
 280.89  102.00
 280.91  103.00
 280.88  102.00
```

Listing 13: 第 1 片 600V 数据

```
  35.71  69.00
  35.71  70.00
  35.71  70.00
  35.69  70.00
  35.67  70.00
  35.66  70.00
  35.65  70.00
  35.63  69.00
  35.60  70.00
  35.60  70.00
```

```
  35.57  70.00
  35.56  69.00
  35.55  70.00
  35.58  70.00
  37.18  69.00
  39.69  70.00
  42.17  70.00
  44.64  70.00
  47.15  69.00
  49.65  70.00
  52.15  70.00
  54.67  70.00
  57.15  70.00
  59.67  70.00
  62.20  71.00
  64.71  70.00
  67.21  70.00
  69.72  70.00
  72.24  70.00
  74.75  71.00
  77.27  71.00
  79.77  71.00
  82.33  71.00
  84.69  71.00
  87.21  72.00
  89.70  72.00
  92.21  72.00
  94.73  72.00
  97.23  72.00
  99.74  73.00
 102.22  73.00
 104.78  73.00
 107.26  74.00
 109.78  74.00
 112.28  75.00
 114.80  75.00
 117.26  77.00
 119.80  77.00
 122.27  80.00
 124.78  81.00
 127.24  82.00
 129.76  85.00
 132.27  88.00
 134.80  89.00
 137.29  90.00
 139.79  92.00
 142.29  90.00
 144.80  89.00
 147.30  87.00
 149.82  83.00
 152.29  79.00
 154.81  77.00
 157.32  76.00
 159.81  75.00
 162.32  75.00
 164.85  76.00
 167.21  77.00
 169.71  77.00
 172.21  80.00
 174.73  80.00
```

```
177.23  83.00
179.72  84.00
182.22  86.00
184.72  86.00
187.23  89.00
189.76  90.00
192.24  90.00
194.76  89.00
197.22  89.00
199.74  89.00
202.24  88.00
204.75  88.00
207.24  90.00
209.72  93.00
212.19  98.00
214.68  104.00
217.22  113.00
219.73  126.00
222.21  140.00
224.73  161.00
227.22  183.00
229.76  212.00
232.24  247.00
234.76  289.00
237.31  339.00
239.78  398.00
242.28  467.00
244.81  543.00
247.32  626.00
249.72  709.00
252.22  786.00
254.70  842.00
257.20  866.00
259.73  843.00
262.25  763.00
264.74  635.00
267.23  491.00
269.77  359.00
272.27  267.00
274.76  215.00
277.30  187.00
279.80  172.00
280.92  159.00
280.89  150.00
280.92  139.00
280.91  130.00
280.91  122.00
280.91  115.00
280.92  108.00
280.90  103.00
280.91  99.00
280.92  95.00
280.90  91.00
280.90  89.00
280.95  86.00
280.91  85.00
280.91  83.00
280.90  80.00
280.89  80.00
280.91  78.00
```

```
280.92  77.00
280.89  77.00
280.89  76.00
280.89  75.00
280.89  75.00
280.91  74.00
280.90  74.00
280.91  73.00
280.90  73.00
280.91  73.00
280.91  73.00
280.92  73.00
280.89  72.00
280.92  73.00
280.91  72.00
280.92  72.00
280.92  72.00
280.90  72.00
280.93  72.00
280.93  72.00
280.92  71.00
280.90  72.00
280.91  71.00
280.89  72.00
280.90  71.00
280.92  72.00
280.90  72.00
280.90  71.00
280.92  71.00
280.92  71.00
280.90  72.00
280.92  71.00
280.95  72.00
280.93  71.00
280.90  71.00
280.90  71.00
280.92  72.00
280.91  71.00
280.92  71.00
280.91  71.00
280.91  71.00
280.91  71.00
280.93  71.00
280.90  71.00
280.92  71.00
280.94  70.00
280.92  71.00
280.93  71.00
280.93  71.00
280.92  70.00
280.93  71.00
280.95  71.00
280.93  71.00
280.93  70.00
280.94  71.00
280.92  71.00
280.93  71.00
280.98  71.00
280.90  70.00
280.91  71.00
```

```
280.92  70.00
280.92  71.00
280.92  70.00
280.93  71.00
280.90  71.00
280.92  70.00
280.90  71.00
280.91  70.00
280.90  71.00
280.91  70.00
280.95  71.00
280.92  70.00
280.92  71.00
280.91  70.00
280.92  71.00
280.92  71.00
280.93  70.00
280.90  71.00
280.90  70.00
280.92  70.00
280.90  71.00
280.89  70.00
280.93  71.00
280.93  71.00
280.91  71.00
280.90  70.00
280.91  71.00
280.91  70.00
280.91  71.00
280.93  70.00
280.93  71.00
280.93  70.00
280.92  70.00
280.90  71.00
280.91  71.00
280.92  70.00
280.92  71.00
280.92  70.00
280.92  70.00
280.93  71.00
280.92  71.00
280.92  70.00
```

Listing 14: 第 2 片 600V 数据

```
 32.16  71.00
 32.19  71.00
 32.21  72.00
 32.23  71.00
 32.23  71.00
 32.24  71.00
 32.25  71.00
 32.25  71.00
 32.27  72.00
 32.29  71.00
 32.29  71.00
 32.30  71.00
 32.56  71.00
 34.69  71.00
```

```
 37.20  71.00
 39.69  71.00
 42.17  71.00
 44.63  72.00
 47.13  71.00
 49.65  72.00
 52.14  72.00
 54.68  72.00
 57.19  71.00
 59.68  72.00
 62.19  73.00
 64.71  72.00
 67.22  72.00
 69.72  73.00
 72.25  74.00
 74.75  73.00
 77.26  74.00
 79.76  74.00
 82.27  75.00
 84.68  75.00
 87.21  76.00
 89.68  76.00
 92.21  77.00
 94.72  78.00
 97.23  78.00
 99.72  79.00
102.25  79.00
104.76  80.00
107.28  80.00
109.77  80.00
112.29  81.00
114.79  81.00
117.29  82.00
119.79  82.00
122.30  83.00
124.80  84.00
127.25  86.00
129.76  88.00
132.28  90.00
134.79  92.00
137.30  94.00
139.77  96.00
142.29  96.00
144.77  97.00
147.27  96.00
149.81  94.00
152.29  91.00
154.82  87.00
157.30  83.00
159.83  81.00
162.31  78.00
164.86  78.00
167.21  77.00
169.68  78.00
172.21  79.00
174.71  80.00
177.21  81.00
179.70  82.00
182.22  85.00
184.74  86.00
```

```
187.24  88.00
189.73  90.00
192.24  91.00
194.73  92.00
197.24  92.00
199.72  93.00
202.23  91.00
204.74  91.00
207.24  91.00
209.71  90.00
212.17  93.00
214.66  96.00
217.21  102.00
219.72  111.00
222.19  121.00
224.72  136.00
227.20  152.00
229.76  174.00
232.25  199.00
234.76  231.00
237.26  263.00
239.77  304.00
242.29  349.00
244.79  397.00
247.29  450.00
249.71  501.00
252.20  550.00
254.72  593.00
257.20  621.00
259.73  633.00
262.24  615.00
264.74  564.00
267.23  483.00
269.75  381.00
272.30  277.00
274.80  193.00
277.27  140.00
279.80  113.00
280.90  104.00
280.90  99.00
280.90  96.00
280.90  93.00
280.92  92.00
280.90  88.00
280.92  87.00
280.91  85.00
280.90  84.00
280.90  82.00
280.92  80.00
280.88  80.00
280.89  78.00
280.89  78.00
280.89  77.00
280.90  77.00
280.89  76.00
280.91  75.00
280.88  75.00
280.88  75.00
280.90  74.00
280.89  74.00
```

```
280.91  74.00
280.92  74.00
280.89  74.00
280.89  73.00
280.91  73.00
280.91  74.00
280.89  73.00
280.88  73.00
280.89  73.00
280.90  73.00
280.91  73.00
280.92  72.00
280.89  73.00
280.91  73.00
280.89  72.00
280.90  73.00
280.91  72.00
280.89  73.00
280.90  72.00
280.89  73.00
280.90  72.00
280.88  73.00
280.89  72.00
280.88  73.00
280.88  72.00
280.88  72.00
280.92  73.00
280.86  72.00
280.88  73.00
280.88  73.00
280.88  72.00
280.88  73.00
280.92  72.00
280.88  73.00
280.89  72.00
280.89  72.00
280.89  73.00
280.89  72.00
280.87  73.00
280.90  72.00
280.89  72.00
280.90  73.00
280.88  72.00
280.91  73.00
280.90  72.00
280.91  72.00
280.89  73.00
280.89  72.00
280.90  73.00
280.91  72.00
280.90  72.00
280.94  73.00
280.92  72.00
280.90  73.00
280.90  72.00
280.86  72.00
280.90  73.00
280.90  72.00
280.89  72.00
280.90  73.00
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280.90  72.00
280.89  73.00
280.91  72.00
280.90  73.00
280.93  72.00
280.91  73.00
280.92  73.00
280.89  72.00
280.91  72.00
280.91  73.00
280.93  72.00
280.90  73.00
280.90  72.00
280.89  73.00
280.89  73.00
280.90  72.00
280.92  73.00
280.90  73.00
280.90  72.00
280.88  73.00
280.90  72.00
280.89  73.00
280.91  72.00
280.89  73.00
280.91  72.00
280.88  72.00
280.90  73.00
280.90  72.00
280.88  72.00
280.93  73.00
280.90  72.00
280.90  72.00
280.89  72.00
280.90  73.00
280.90  72.00
280.90  72.00
280.89  72.00
280.91  73.00
```

Listing 15: 第 3 片 600V 数据

```
 30.70  71.00
 30.73  71.00
 30.75  72.00
 30.78  71.00
 30.80  71.00
 30.81  71.00
 30.82  71.00
 30.85  72.00
 30.85  71.00
 30.86  71.00
 30.89  71.00
 30.89  71.00
 32.22  72.00
 34.74  71.00
 37.20  71.00
 39.71  71.00
 42.20  72.00
 44.65  71.00
```

```
 47.17  71.00
 49.69  72.00
 52.17  71.00
 54.68  72.00
 57.21  72.00
 59.68  72.00
 62.21  72.00
 64.72  73.00
 67.22  72.00
 69.72  73.00
 72.21  74.00
 74.78  73.00
 77.25  75.00
 79.78  75.00
 82.28  75.00
 84.71  77.00
 87.20  77.00
 89.72  78.00
 92.24  78.00
 94.72  80.00
 97.23  80.00
 99.74  80.00
102.25  81.00
104.78  80.00
107.28  81.00
109.78  81.00
112.29  81.00
114.79  81.00
117.31  82.00
119.82  84.00
122.29  85.00
124.79  88.00
127.27  90.00
129.75  94.00
132.26  97.00
134.77  101.00
137.29  105.00
139.76  108.00
142.28  111.00
144.80  112.00
147.29  111.00
149.80  108.00
152.31  102.00
154.81  95.00
157.33  90.00
159.82  85.00
162.34  82.00
164.84  81.00
167.20  81.00
169.72  82.00
172.22  84.00
174.72  85.00
177.24  88.00
179.73  90.00
182.25  93.00
184.74  96.00
187.25  98.00
189.73  101.00
192.22  102.00
194.74  103.00
```

```
197.22  104.00
199.72  103.00
202.27  102.00
204.72  101.00
207.28  99.00
209.69  100.00
212.19  103.00
214.71  108.00
217.18  116.00
219.68  129.00
222.25  146.00
224.74  166.00
227.24  193.00
229.75  223.00
232.27  264.00
234.76  310.00
237.30  366.00
239.79  431.00
242.27  506.00
244.77  592.00
247.30  682.00
249.70  780.00
252.18  873.00
254.68  960.00
257.20  1027.00
259.73  1056.00
262.26  1037.00
264.72  958.00
267.23  821.00
269.77  646.00
272.29  470.00
274.76  328.00
277.28  237.00
279.82  190.00
280.89  169.00
280.90  155.00
280.90  145.00
280.90  137.00
280.94  129.00
280.92  123.00
280.89  116.00
280.90  111.00
280.91  106.00
280.90  102.00
280.90  99.00
280.90  95.00
280.91  92.00
280.88  90.00
280.90  88.00
280.90  86.00
280.90  84.00
280.90  83.00
280.89  82.00
280.90  80.00
280.90  80.00
280.89  79.00
280.89  78.00
280.88  77.00
280.89  78.00
280.90  76.00
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```
  280.91  76.00
  280.88  76.00
  280.89  75.00
  280.92  75.00
  280.90  75.00
  280.89  75.00
  280.90  74.00
  280.90  74.00
  280.91  74.00
  280.91  74.00
  280.91  74.00
  280.92  74.00
  280.89  73.00
  280.91  74.00
  280.90  73.00
  280.90  74.00
  280.93  73.00
  280.90  73.00
  280.91  73.00
  280.92  74.00
  280.91  73.00
  280.91  73.00
  280.89  73.00
  280.91  72.00
  280.92  73.00
  280.92  73.00
  280.92  72.00
  280.90  73.00
  280.89  73.00
  280.91  72.00
  280.88  73.00
  280.88  72.00
  280.89  73.00
  280.89  73.00
  280.89  72.00
  280.89  72.00
  280.89  73.00
  280.89  72.00
  280.89  72.00
  280.89  73.00
  280.89  72.00
  280.90  73.00
  280.92  72.00
  280.88  73.00
  280.90  72.00
  280.89  73.00
  280.90  72.00
  280.89  73.00
  280.89  72.00
  280.90  73.00
  280.89  72.00
  280.88  73.00
  280.90  73.00
  280.88  72.00
  280.92  73.00
  280.89  72.00
  280.89  73.00
  280.89  72.00
  280.90  73.00
  280.89  73.00
```

```
280.92  72.00
280.90  73.00
280.89  73.00
280.92  72.00
280.91  73.00
280.92  73.00
280.89  72.00
280.94  73.00
280.91  73.00
280.90  73.00
280.93  73.00
280.91  72.00
280.91  73.00
280.91  73.00
280.92  73.00
280.92  73.00
280.92  72.00
280.90  73.00
280.89  73.00
280.95  72.00
280.93  73.00
280.91  73.00
280.91  72.00
280.92  73.00
280.90  72.00
280.91  73.00
280.91  73.00
280.90  72.00
280.89  73.00
280.90  72.00
280.89  73.00
280.89  72.00
280.91  72.00
280.89  73.00
```

Listing 16: 第 1 片 700V 数据

```
 27.03  128.00
 27.05  127.00
 27.06  128.00
 27.06  128.00
 27.05  127.00
 27.05  127.00
 27.06  128.00
 27.03  127.00
 27.04  128.00
 27.03  127.00
 27.44  127.00
 29.71  127.00
 32.20  128.00
 34.71  127.00
 37.24  127.00
 39.70  128.00
 42.22  127.00
 44.65  128.00
 47.19  127.00
 49.68  128.00
 52.19  129.00
 54.69  128.00
```

```
 57.21  129.00
 59.69  129.00
 62.19  129.00
 64.71  129.00
 67.25  131.00
 69.73  131.00
 72.26  132.00
 74.77  133.00
 77.26  134.00
 79.76  136.00
 82.30  138.00
 84.69  139.00
 87.24  141.00
 89.72  144.00
 92.25  145.00
 94.74  146.00
 97.24  148.00
 99.74  148.00
102.24  148.00
104.76  148.00
107.27  148.00
109.81  148.00
112.30  151.00
114.79  153.00
117.32  157.00
119.84  162.00
122.31  169.00
124.81  179.00
127.26  188.00
129.80  202.00
132.29  214.00
134.79  227.00
137.29  237.00
139.79  247.00
142.31  248.00
144.80  245.00
147.32  235.00
149.81  217.00
152.32  198.00
154.83  178.00
157.33  162.00
159.83  154.00
162.33  151.00
164.85  153.00
167.23  157.00
169.71  162.00
172.20  169.00
174.72  176.00
177.20  185.00
179.72  195.00
182.21  205.00
184.73  215.00
187.23  224.00
189.74  232.00
192.24  239.00
194.76  241.00
197.26  241.00
199.74  240.00
202.26  236.00
204.75  234.00
```

```
207.24  237.00
209.74  246.00
212.18  264.00
214.69  298.00
217.20  346.00
219.74  413.00
222.23  504.00
224.74  623.00
227.22  775.00
229.76  972.00
232.24  1218.00
234.76  1522.00
237.27  1881.00
239.80  2290.00
242.28  2726.00
244.79  3148.00
247.31  3495.00
249.71  3681.00
252.19  3631.00
254.70  3302.00
257.22  2755.00
259.73  2093.00
262.23  1504.00
264.74  1078.00
267.25  845.00
269.74  723.00
272.27  657.00
274.77  612.00
277.28  575.00
279.78  541.00
280.91  509.00
280.88  471.00
280.91  433.00
280.91  395.00
280.91  361.00
280.89  331.00
280.89  302.00
280.90  278.00
280.90  256.00
280.90  239.00
280.89  223.00
280.89  209.00
280.91  198.00
280.90  188.00
280.91  180.00
280.91  173.00
280.88  166.00
280.91  162.00
280.91  158.00
280.90  155.00
280.91  151.00
280.89  150.00
280.89  148.00
280.91  146.00
280.90  144.00
280.89  143.00
280.90  141.00
280.93  141.00
280.90  139.00
280.92  140.00
```

```
280.92  138.00
280.90  138.00
280.90  138.00
280.90  137.00
280.90  137.00
280.91  136.00
280.93  136.00
280.92  136.00
280.91  136.00
280.91  135.00
280.92  136.00
280.90  135.00
280.90  135.00
280.90  135.00
280.91  135.00
280.90  134.00
280.90  135.00
280.89  135.00
280.90  134.00
280.91  135.00
280.91  134.00
280.89  134.00
280.91  134.00
280.90  134.00
280.89  134.00
280.90  134.00
280.89  134.00
280.89  134.00
280.90  133.00
280.90  134.00
280.89  134.00
280.89  134.00
280.87  134.00
280.89  133.00
280.87  134.00
280.91  134.00
280.87  134.00
280.88  134.00
280.86  134.00
280.88  134.00
280.88  134.00
280.88  134.00
280.89  134.00
280.89  133.00
280.86  134.00
280.89  134.00
280.90  134.00
280.88  134.00
280.89  134.00
280.88  134.00
280.88  133.00
280.87  135.00
280.87  134.00
280.89  133.00
280.88  134.00
280.88  134.00
280.88  134.00
280.91  134.00
280.90  134.00
280.89  134.00
```

```
280.91  134.00
280.90  134.00
280.89  134.00
280.89  134.00
280.87  134.00
280.90  134.00
280.88  134.00
280.89  134.00
280.89  134.00
280.89  134.00
280.89  134.00
280.89  134.00
280.90  134.00
280.93  133.00
280.91  134.00
280.90  135.00
280.90  134.00
280.89  134.00
280.92  134.00
280.91  134.00
280.90  134.00
280.90  133.00
280.90  134.00
280.90  134.00
280.89  134.00
280.91  134.00
280.93  134.00
280.92  134.00
280.92  135.00
280.91  134.00
```

Listing 17: 第 2 片 700V 数据

```
 28.66  125.00
 28.67  126.00
 28.71  125.00
 28.70  126.00
 28.74  124.00
 28.73  125.00
 28.73  125.00
 28.75  125.00
 28.74  125.00
 28.75  125.00
 28.73  126.00
 29.71  125.00
 32.20  125.00
 34.71  125.00
 37.21  125.00
 39.70  125.00
 42.19  126.00
 44.66  125.00
 47.19  126.00
 49.65  126.00
 52.14  125.00
 54.68  126.00
 57.19  127.00
 59.70  126.00
 62.17  127.00
 64.71  128.00
```

```
 67.18  128.00
 69.69  128.00
 72.24  129.00
 74.76  130.00
 77.28  131.00
 79.76  132.00
 82.29  134.00
 84.67  135.00
 87.19  137.00
 89.70  138.00
 92.22  140.00
 94.73  142.00
 97.22  143.00
 99.70  145.00
102.25  146.00
104.77  148.00
107.28  151.00
109.77  153.00
112.28  158.00
114.81  163.00
117.29  171.00
119.81  181.00
122.30  191.00
124.83  204.00
127.27  217.00
129.77  230.00
132.27  242.00
134.79  253.00
137.32  256.00
139.80  253.00
142.31  244.00
144.80  228.00
147.33  208.00
149.82  186.00
152.32  170.00
154.82  158.00
157.32  154.00
159.84  154.00
162.31  158.00
164.86  164.00
167.20  169.00
169.71  177.00
172.21  185.00
174.71  193.00
177.21  203.00
179.72  212.00
182.20  220.00
184.72  228.00
187.23  232.00
189.75  234.00
192.25  235.00
194.73  229.00
197.26  226.00
199.75  223.00
202.24  223.00
204.73  229.00
207.24  247.00
209.72  275.00
212.18  315.00
214.70  372.00
```

```
217.21  442.00
219.72  532.00
222.20  643.00
224.71  781.00
227.23  947.00
229.74  1147.00
232.24  1386.00
234.74  1662.00
237.26  1977.00
239.80  2325.00
242.27  2684.00
244.78  3034.00
247.29  3344.00
249.71  3546.00
252.18  3603.00
254.72  3465.00
257.20  3096.00
259.75  2541.00
262.25  1898.00
264.73  1311.00
267.25  889.00
269.75  645.00
272.26  524.00
274.79  465.00
277.27  430.00
279.82  403.00
280.90  376.00
280.88  349.00
280.88  323.00
280.93  297.00
280.90  271.00
280.90  252.00
280.90  233.00
280.90  218.00
280.89  204.00
280.89  194.00
280.89  183.00
280.89  175.00
280.89  168.00
280.88  163.00
280.89  158.00
280.89  154.00
280.89  151.00
280.89  147.00
280.90  146.00
280.89  143.00
280.88  142.00
280.88  139.00
280.89  139.00
280.89  137.00
280.88  137.00
280.88  136.00
280.86  134.00
280.89  135.00
280.90  133.00
280.89  133.00
280.87  133.00
280.88  133.00
280.87  131.00
280.89  132.00
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280.89  131.00
280.89  132.00
280.88  131.00
280.89  131.00
280.90  131.00
280.89  130.00
280.89  131.00
280.92  130.00
280.90  130.00
280.90  130.00
280.89  130.00
280.90  130.00
280.90  130.00
280.91  129.00
280.90  129.00
280.90  130.00
280.89  130.00
280.89  129.00
280.90  130.00
280.92  129.00
280.92  130.00
280.89  129.00
280.88  130.00
280.90  129.00
280.89  129.00
280.90  129.00
280.90  129.00
280.90  129.00
280.91  130.00
280.88  129.00
280.89  129.00
280.86  129.00
280.91  129.00
280.88  129.00
280.90  129.00
280.89  129.00
280.89  129.00
280.88  129.00
280.87  129.00
280.88  129.00
280.89  129.00
280.89  129.00
280.89  129.00
280.88  129.00
280.89  129.00
280.91  129.00
280.88  129.00
280.89  129.00
280.86  129.00
280.88  129.00
280.87  129.00
280.89  129.00
280.88  129.00
280.88  129.00
280.88  129.00
280.89  129.00
280.89  129.00
280.89  129.00
280.91  128.00
280.87  129.00
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280.88  130.00
280.88  129.00
280.87  128.00
280.87  129.00
280.87  129.00
280.88  129.00
280.87  128.00
280.88  129.00
280.88  129.00
280.89  129.00
280.91  129.00
280.90  128.00
280.87  129.00
280.89  129.00
280.89  129.00
280.89  129.00
280.89  129.00
280.89  129.00
280.89  129.00
280.88  129.00
280.89  128.00
280.89  129.00
280.89  129.00
280.90  129.00
280.91  128.00
280.89  129.00
```

Listing 18: 第 3 片 700V 数据

```
 35.65  99.00
 35.69  100.00
 35.71  99.00
 35.76  99.00
 35.77  99.00
 35.81  100.00
 35.82  100.00
 35.85  100.00
 35.87  99.00
 35.89  99.00
 35.88  100.00
 35.91  99.00
 35.90  100.00
 35.94  99.00
 37.21  99.00
 39.72  99.00
 42.18  99.00
 44.68  100.00
 47.19  100.00
 49.66  100.00
 52.16  100.00
 54.70  101.00
 57.20  102.00
 59.71  102.00
 62.23  102.00
 64.71  103.00
 67.21  105.00
 69.74  104.00
 72.25  107.00
 74.77  108.00
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 77.26  108.00
 79.76  111.00
 82.29  112.00
 84.71  114.00
 87.21  116.00
 89.71  118.00
 92.21  121.00
 94.73  123.00
 97.23  125.00
 99.71  128.00
102.27  129.00
104.79  133.00
107.30  134.00
109.79  136.00
112.30  139.00
114.81  142.00
117.31  146.00
119.82  152.00
122.33  158.00
124.79  169.00
127.28  178.00
129.80  189.00
132.29  201.00
134.80  213.00
137.33  224.00
139.81  231.00
142.32  232.00
144.80  226.00
147.33  214.00
149.80  195.00
152.33  175.00
154.81  154.00
157.33  140.00
159.84  131.00
162.32  129.00
164.85  132.00
167.21  137.00
169.71  144.00
172.19  154.00
174.73  165.00
177.21  178.00
179.72  193.00
182.21  211.00
184.72  227.00
187.24  248.00
189.73  265.00
192.25  280.00
194.77  294.00
197.25  303.00
199.71  308.00
202.24  311.00
204.75  312.00
207.24  315.00
209.72  330.00
212.19  358.00
214.68  414.00
217.24  507.00
219.72  642.00
222.27  831.00
224.75  1077.00
```

```
227.25  1393.00
229.77  1780.00
232.28  2227.00
234.76  2705.00
237.29  3172.00
239.79  3540.00
242.29  3729.00
244.79  3625.00
247.34  3213.00
249.74  2514.00
252.24  1716.00
254.72  1018.00
257.25  557.00
259.75  332.00
262.25  254.00
264.74  236.00
267.25  236.00
269.76  239.00
272.28  243.00
274.78  246.00
277.28  250.00
279.80  252.00
280.93  249.00
280.94  243.00
280.95  230.00
280.94  218.00
280.94  205.00
280.93  192.00
280.92  179.00
280.94  168.00
280.93  159.00
280.93  151.00
280.92  144.00
280.92  139.00
280.90  134.00
280.93  129.00
280.94  127.00
280.91  123.00
280.92  121.00
280.91  120.00
280.90  117.00
280.91  116.00
280.90  115.00
280.93  112.00
280.90  113.00
280.92  111.00
280.92  111.00
280.88  110.00
280.94  109.00
280.95  108.00
280.89  109.00
280.91  108.00
280.91  108.00
280.92  107.00
280.90  107.00
280.92  106.00
280.92  107.00
280.90  106.00
280.91  107.00
280.90  105.00
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280.88  106.00
280.93  105.00
280.92  106.00
280.91  105.00
280.90  106.00
280.90  105.00
280.88  105.00
280.92  105.00
280.92  104.00
280.88  105.00
280.90  105.00
280.92  105.00
280.90  104.00
280.91  105.00
280.94  104.00
280.91  104.00
280.92  104.00
280.90  105.00
280.92  104.00
280.91  104.00
280.90  105.00
280.89  104.00
280.90  105.00
280.89  104.00
280.91  104.00
280.88  104.00
280.89  104.00
280.92  104.00
280.89  104.00
280.90  104.00
280.89  105.00
280.89  104.00
280.88  104.00
280.88  104.00
280.90  104.00
280.89  104.00
280.89  105.00
280.89  104.00
280.91  104.00
280.92  104.00
280.92  104.00
280.90  104.00
280.91  104.00
280.88  104.00
280.90  103.00
280.91  103.00
280.92  104.00
280.91  104.00
280.94  103.00
280.93  103.00
280.91  104.00
280.93  104.00
280.95  104.00
280.91  104.00
280.91  104.00
280.90  103.00
280.89  104.00
280.90  104.00
280.92  103.00
280.90  104.00
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280.91  104.00
280.91  103.00
280.90  104.00
280.91  105.00
280.90  103.00
280.91  104.00
280.90  103.00
280.88  104.00
280.91  104.00
280.90  103.00
280.90  104.00
280.89  104.00
280.92  103.00
280.89  104.00
280.91  103.00
280.90  104.00
280.90  104.00
280.91  104.00
280.91  104.00
280.90  104.00
280.89  104.00
280.89  104.00
```

Listing 19: 第 1 片 800V 数据

```
 30.90  119.00
 30.93  120.00
 30.91  120.00
 30.92  120.00
 30.92  119.00
 30.92  118.00
 30.91  121.00
 30.91  119.00
 30.89  118.00
 30.90  119.00
 30.90  120.00
 30.89  120.00
 32.18  120.00
 34.70  119.00
 37.22  119.00
 39.70  118.00
 42.19  121.00
 44.67  120.00
 47.18  122.00
 49.68  120.00
 52.18  119.00
 54.69  119.00
 57.19  120.00
 59.73  123.00
 62.20  123.00
 64.73  125.00
 67.23  125.00
 69.71  128.00
 72.26  129.00
 74.72  133.00
 77.27  135.00
 79.75  140.00
 82.28  145.00
 84.68  147.00
```

```
 87.20  149.00
 89.70  153.00
 92.24  153.00
 94.72  156.00
 97.21  154.00
 99.75  154.00
102.24  155.00
104.75  156.00
107.25  157.00
109.74  163.00
112.25  168.00
114.79  180.00
117.30  191.00
119.80  207.00
122.31  226.00
124.79  243.00
127.25  266.00
129.76  284.00
132.29  299.00
134.78  308.00
137.26  308.00
139.79  295.00
142.31  271.00
144.80  241.00
147.31  211.00
149.80  184.00
152.27  167.00
154.82  156.00
157.33  157.00
159.84  163.00
162.34  171.00
164.86  179.00
167.20  190.00
169.71  202.00
172.20  219.00
174.71  231.00
177.20  245.00
179.71  259.00
182.21  269.00
184.73  277.00
187.21  277.00
189.73  276.00
192.23  277.00
194.74  270.00
197.20  269.00
199.72  269.00
202.26  282.00
204.72  307.00
207.20  350.00
209.68  408.00
212.15  485.00
214.68  589.00
217.20  719.00
219.71  879.00
222.21  1076.00
224.74  1324.00
227.22  1620.00
229.75  1972.00
232.24  2414.00
234.78  2913.00
```

```
237.25  3486.00
239.77  4135.00
242.31  4814.00
244.79  5475.00
247.33  6079.00
249.70  6482.00
252.19  6557.00
254.70  6204.00
257.19  5407.00
259.74  4294.00
262.23  3098.00
264.73  2100.00
267.22  1464.00
269.74  1126.00
272.25  960.00
274.77  856.00
277.25  791.00
279.77  725.00
280.90  670.00
280.91  606.00
280.89  545.00
280.91  483.00
280.90  428.00
280.90  379.00
280.89  340.00
280.92  308.00
280.94  277.00
280.88  253.00
280.90  234.00
280.90  220.00
280.92  204.00
280.90  192.00
280.91  183.00
280.90  175.00
280.91  170.00
280.89  163.00
280.90  160.00
280.90  156.00
280.93  151.00
280.90  150.00
280.89  148.00
280.91  146.00
280.90  144.00
280.88  141.00
280.88  140.00
280.89  139.00
280.87  138.00
280.92  137.00
280.90  137.00
280.88  136.00
280.86  136.00
280.93  134.00
280.92  132.00
280.92  134.00
280.88  133.00
280.91  133.00
280.91  134.00
280.91  132.00
280.91  132.00
280.89  130.00
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280.89  131.00
280.90  131.00
280.90  131.00
280.89  130.00
280.93  131.00
280.89  131.00
280.90  132.00
280.89  131.00
280.89  130.00
280.91  129.00
280.90  131.00
280.90  130.00
280.93  129.00
280.90  129.00
280.90  131.00
280.91  128.00
280.95  130.00
280.91  130.00
280.92  128.00
280.91  129.00
280.92  130.00
280.91  130.00
280.91  130.00
280.92  132.00
280.92  129.00
280.89  129.00
280.87  129.00
280.92  131.00
280.89  130.00
280.91  129.00
280.86  129.00
280.90  130.00
280.88  130.00
280.90  130.00
280.88  129.00
280.89  129.00
280.90  128.00
280.91  131.00
280.89  132.00
280.89  129.00
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280.89  131.00
280.90  131.00
280.87  129.00
280.88  130.00
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280.89  131.00
280.88  131.00
280.90  130.00
280.87  132.00
280.88  129.00
280.89  131.00
280.92  128.00
280.90  130.00
280.90  130.00
280.87  129.00
280.90  129.00
280.89  131.00
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280.89  129.00
280.89  131.00
280.90  129.00
280.87  129.00
280.89  130.00
280.89  130.00
280.89  131.00
280.92  130.00
280.89  131.00
280.90  131.00
280.90  132.00
280.90  130.00
280.87  131.00
280.90  131.00
280.89  130.00
280.91  131.00
280.91  130.00
280.90  132.00
```

Listing 20: 第 2 片 800V 数据

```
 32.83  122.00
 32.86  122.00
 32.87  120.00
 32.87  121.00
 32.90  120.00
 32.92  120.00
 32.93  120.00
 32.93  121.00
 32.95  121.00
 32.96  120.00
 32.97  119.00
 32.98  121.00
 33.02  121.00
 34.69  122.00
 37.20  122.00
 39.70  121.00
 42.16  121.00
 44.66  122.00
 47.17  124.00
 49.68  124.00
 52.18  123.00
 54.70  126.00
 57.21  126.00
 59.71  127.00
 62.22  129.00
 64.72  132.00
 67.24  131.00
 69.72  133.00
 72.24  136.00
 74.77  140.00
 77.27  143.00
 79.78  148.00
 82.29  151.00
 84.71  156.00
 87.20  158.00
 89.69  166.00
 92.24  171.00
 94.73  176.00
```

```
 97.23  182.00
 99.73  186.00
102.25  191.00
104.76  194.00
107.25  196.00
109.76  199.00
112.29  201.00
114.80  204.00
117.29  210.00
119.82  216.00
122.31  223.00
124.80  234.00
127.27  248.00
129.77  261.00
132.27  279.00
134.78  296.00
137.30  314.00
139.79  329.00
142.34  337.00
144.81  338.00
147.32  329.00
149.85  307.00
152.33  281.00
154.85  248.00
157.34  217.00
159.85  192.00
162.34  175.00
164.86  171.00
167.22  171.00
169.71  175.00
172.20  184.00
174.74  194.00
177.21  204.00
179.73  217.00
182.24  231.00
184.71  247.00
187.25  264.00
189.76  276.00
192.24  287.00
194.74  294.00
197.26  297.00
199.74  296.00
202.27  288.00
204.75  285.00
207.26  279.00
209.72  282.00
212.21  296.00
214.65  325.00
217.20  376.00
219.72  447.00
222.23  539.00
224.69  658.00
227.24  806.00
229.77  985.00
232.24 1197.00
234.76 1455.00
237.27 1750.00
239.78 2084.00
242.29 2460.00
244.76 2875.00
```

```
247.31  3298.00
249.71  3743.00
252.24  4142.00
254.71  4473.00
257.22  4706.00
259.73  4742.00
262.24  4563.00
264.75  4094.00
267.23  3372.00
269.77  2479.00
272.27  1641.00
274.77  986.00
277.28  601.00
279.81  434.00
280.89  375.00
280.93  344.00
280.88  319.00
280.89  298.00
280.89  278.00
280.93  267.00
280.92  246.00
280.90  233.00
280.91  220.00
280.89  205.00
280.89  199.00
280.88  189.00
280.90  180.00
280.91  176.00
280.91  167.00
280.90  165.00
280.89  159.00
280.89  154.00
280.91  151.00
280.90  150.00
280.88  147.00
280.90  146.00
280.88  143.00
280.89  142.00
280.89  141.00
280.89  139.00
280.91  140.00
280.91  137.00
280.90  137.00
280.91  136.00
280.91  135.00
280.93  136.00
280.91  135.00
280.91  135.00
280.89  134.00
280.92  133.00
280.91  134.00
280.90  134.00
280.92  133.00
280.93  135.00
280.95  133.00
280.90  134.00
280.93  132.00
280.92  133.00
280.94  133.00
280.92  133.00
```

```
280.91  133.00
280.93  132.00
280.92  132.00
280.91  133.00
280.91  133.00
280.92  131.00
280.91  133.00
280.90  132.00
280.94  132.00
280.91  133.00
280.94  131.00
280.90  132.00
280.88  132.00
280.90  132.00
280.90  130.00
280.90  132.00
280.90  131.00
280.92  133.00
280.90  131.00
280.89  132.00
280.90  132.00
280.89  133.00
280.89  131.00
280.90  130.00
280.89  134.00
280.89  132.00
280.92  130.00
280.87  135.00
280.90  131.00
280.88  133.00
280.89  131.00
280.89  131.00
280.88  132.00
280.87  133.00
280.90  132.00
280.92  132.00
280.92  133.00
280.88  133.00
280.89  132.00
280.88  133.00
280.89  131.00
280.90  132.00
280.91  132.00
280.88  133.00
280.91  133.00
280.89  132.00
280.89  133.00
280.89  132.00
280.92  133.00
280.88  132.00
280.90  133.00
280.88  133.00
280.90  132.00
280.89  133.00
280.89  133.00
280.91  134.00
280.88  133.00
280.90  134.00
280.89  134.00
280.87  132.00
```

```
280.90  132.00
280.90  133.00
280.91  132.00
280.91  131.00
280.95  132.00
280.92  133.00
280.90  133.00
280.91  134.00
280.92  133.00
280.93  132.00
280.91  132.00
280.90  133.00
280.91  132.00
280.92  133.00
```

Listing 21: 第 3 片 800V 数据

```
 31.22  113.00
 31.24  115.00
 31.26  113.00
 31.27  113.00
 31.29  112.00
 31.29  113.00
 31.30  115.00
 31.32  113.00
 31.33  112.00
 31.34  112.00
 31.33  114.00
 31.35  113.00
 32.24  114.00
 34.71  112.00
 37.22  114.00
 39.68  113.00
 42.22  112.00
 44.66  112.00
 47.18  114.00
 49.69  115.00
 52.19  113.00
 54.67  114.00
 57.20  113.00
 59.69  115.00
 62.23  117.00
 64.70  117.00
 67.25  116.00
 69.73  117.00
 72.25  120.00
 74.75  121.00
 77.27  122.00
 79.76  124.00
 82.32  124.00
 84.70  127.00
 87.21  129.00
 89.70  134.00
 92.22  134.00
 94.72  138.00
 97.21  141.00
 99.74  144.00
102.25  147.00
104.76  151.00
```

```
107.28  153.00
109.76  157.00
112.30  160.00
114.81  166.00
117.30  171.00
119.81  177.00
122.31  185.00
124.82  197.00
127.27  215.00
129.78  235.00
132.28  255.00
134.81  277.00
137.31  305.00
139.79  336.00
142.30  360.00
144.83  384.00
147.30  400.00
149.79  401.00
152.31  390.00
154.84  365.00
157.32  332.00
159.82  286.00
162.32  243.00
164.87  210.00
167.21  191.00
169.70  184.00
172.18  188.00
174.72  198.00
177.21  209.00
179.73  222.00
182.23  241.00
184.71  261.00
187.25  279.00
189.73  305.00
192.23  326.00
194.72  342.00
197.24  363.00
199.74  369.00
202.25  376.00
204.73  373.00
207.22  364.00
209.71  353.00
212.17  343.00
214.68  345.00
217.22  362.00
219.72  396.00
222.20  458.00
224.72  547.00
227.24  672.00
229.76  832.00
232.26  1040.00
234.74  1298.00
237.30  1607.00
239.77  1986.00
242.30  2441.00
244.79  2991.00
247.32  3631.00
249.71  4345.00
252.21  5133.00
254.70  5963.00
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257.21  6781.00
259.74  7519.00
262.21  8069.00
264.74  8285.00
267.23  8082.00
269.76  7330.00
272.23  6094.00
274.73  4555.00
277.26  3090.00
279.77  1969.00
280.89  1294.00
280.90  962.00
280.91  806.00
280.88  723.00
280.89  655.00
280.88  597.00
280.91  551.00
280.90  504.00
280.89  464.00
280.89  427.00
280.90  395.00
280.90  368.00
280.90  340.00
280.90  318.00
280.90  296.00
280.91  276.00
280.91  262.00
280.90  248.00
280.88  236.00
280.91  224.00
280.90  214.00
280.91  203.00
280.93  197.00
280.89  191.00
280.91  183.00
280.90  178.00
280.93  171.00
280.93  166.00
280.92  165.00
280.90  160.00
280.90  155.00
280.89  154.00
280.88  152.00
280.92  149.00
280.90  146.00
280.90  145.00
280.89  145.00
280.89  141.00
280.89  141.00
280.88  140.00
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280.89  135.00
280.91  133.00
280.89  134.00
280.89  133.00
280.89  133.00
280.88  131.00
280.88  131.00
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  280.88  130.00
  280.89  131.00
  280.90  130.00
  280.91  129.00
  280.88  129.00
  280.88  130.00
  280.89  128.00
  280.89  127.00
  280.88  130.00
  280.89  129.00
  280.88  125.00
  280.88  128.00
  280.89  129.00
  280.88  125.00
  280.91  128.00
  280.92  127.00
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  280.89  126.00
  280.88  124.00
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  280.93  122.00
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  280.89  126.00
  280.89  124.00
  280.88  125.00
  280.88  125.00
  280.89  125.00
  280.89  126.00
```

```
280.90  125.00
280.86  125.00
280.90  127.00
280.89  126.00
280.90  127.00
280.86  125.00
280.90  126.00
280.88  124.00
280.87  127.00
280.89  125.00
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Listing 22: 第 1 片 2℃/s 数据

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 30.14  79.00
 30.16  78.00
 30.16  79.00
 30.15  79.00
 30.17  79.00
 30.18  78.00
 30.19  79.00
 30.19  79.00
 30.20  78.00
 30.21  79.00
 30.20  79.00
 30.21  78.00
 30.22  79.00
 30.23  78.00
 30.23  78.00
 30.23  78.00
 30.22  78.00
 30.24  79.00
 30.24  78.00
 30.25  78.00
 30.23  79.00
 30.25  79.00
 30.27  78.00
 30.27  78.00
 30.51  79.00
 31.43  79.00
 32.44  78.00
 33.44  78.00
 34.44  79.00
 35.45  79.00
 36.44  79.00
 37.45  79.00
 38.49  78.00
 39.43  79.00
 40.45  79.00
 41.45  79.00
 42.42  78.00
 43.39  79.00
 44.40  78.00
 45.40  79.00
 46.40  79.00
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 47.41  79.00
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 52.46  78.00
 53.43  80.00
 54.43  79.00
 55.43  80.00
 56.42  79.00
 57.43  80.00
 58.39  80.00
 59.45  80.00
 60.45  81.00
 61.44  80.00
 62.45  81.00
 63.49  81.00
 64.45  81.00
 65.46  81.00
 66.45  81.00
 67.46  81.00
 68.47  81.00
 69.44  82.00
 70.46  82.00
 71.48  81.00
 72.49  83.00
 73.47  83.00
 74.46  83.00
 75.50  83.00
 76.50  84.00
 77.48  83.00
 78.48  83.00
 79.48  84.00
 80.51  84.00
 81.50  84.00
 82.54  83.00
 83.52  84.00
 84.42  84.00
 85.42  83.00
 86.44  84.00
 87.42  84.00
 88.43  83.00
 89.45  84.00
 90.44  84.00
 91.46  83.00
 92.46  84.00
 93.47  84.00
 94.45  84.00
 95.49  85.00
 96.46  85.00
 97.49  85.00
 98.47  85.00
 99.47  87.00
100.50  86.00
101.52  87.00
102.47  87.00
103.50  89.00
104.51  89.00
105.53  90.00
106.49  91.00
```

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107.54  92.00
108.50  92.00
109.54  94.00
110.50  95.00
111.53  97.00
112.51  97.00
113.52  99.00
114.52  100.00
115.56  100.00
116.53  102.00
117.56  102.00
118.53  103.00
119.55  102.00
120.54  103.00
121.54  103.00
122.54  104.00
123.55  104.00
124.54  102.00
125.51  102.00
126.48  101.00
127.50  100.00
128.52  99.00
129.51  97.00
130.54  95.00
131.52  93.00
132.52  91.00
133.53  90.00
134.54  89.00
135.54  87.00
136.54  87.00
137.51  86.00
138.54  84.00
139.52  84.00
140.53  84.00
141.53  84.00
142.54  83.00
143.55  84.00
144.54  84.00
145.57  84.00
146.51  85.00
147.55  85.00
148.53  86.00
149.54  86.00
150.57  87.00
151.55  88.00
152.54  87.00
153.54  89.00
154.51  89.00
155.57  90.00
156.53  90.00
157.56  91.00
158.55  91.00
159.57  92.00
160.56  92.00
161.53  93.00
162.55  94.00
163.59  95.00
164.58  95.00
165.63  95.00
166.48  95.00
```

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167.44  96.00
168.46  95.00
169.45  96.00
170.47  97.00
171.45  96.00
172.45  97.00
173.47  96.00
174.44  96.00
175.48  96.00
176.47  96.00
177.46  95.00
178.45  96.00
179.48  95.00
180.44  94.00
181.46  95.00
182.46  94.00
183.45  95.00
184.49  94.00
185.46  95.00
186.48  95.00
187.48  97.00
188.45  98.00
189.49  98.00
190.49  100.00
191.47  103.00
192.50  104.00
193.48  107.00
194.49  110.00
195.46  114.00
196.48  116.00
197.44  121.00
198.44  125.00
199.49  129.00
200.48  134.00
201.48  140.00
202.49  145.00
203.47  152.00
204.48  159.00
205.48  166.00
206.49  174.00
207.46  182.00
208.44  191.00
209.46  200.00
210.44  211.00
211.40  222.00
212.44  235.00
213.40  246.00
214.42  259.00
215.41  274.00
216.46  288.00
217.44  304.00
218.44  323.00
219.46  338.00
220.44  357.00
221.47  377.00
222.43  400.00
223.47  420.00
224.46  445.00
225.44  468.00
226.50  491.00
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227  227.46  519.00
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229  229.49  573.00
230  230.50  605.00
231  231.51  631.00
232  232.52  658.00
233  233.51  686.00
234  234.48  713.00
235  235.54  740.00
236  236.49  761.00
237  237.55  781.00
238  238.53  792.00
239  239.51  804.00
240  240.55  805.00
241  241.51  803.00
242  242.53  789.00
243  243.55  768.00
244  244.53  741.00
245  245.52  705.00
246  246.55  662.00
247  247.55  615.00
248  248.54  560.00
249  249.43  506.00
250  250.46  451.00
251  251.43  403.00
252  252.46  358.00
253  253.43  317.00
254  254.45  283.00
255  255.44  255.00
256  256.43  233.00
257  257.47  216.00
258  258.52  202.00
259  259.46  190.00
260  260.48  182.00
261  261.48  175.00
262  262.48  169.00
263  263.49  162.00
264  264.50  158.00
265  265.49  154.00
266  266.44  150.00
267  267.50  146.00
268  268.52  143.00
269  269.51  140.00
270  270.50  138.00
271  271.54  134.00
272  272.53  131.00
273  273.55  129.00
274  274.50  127.00
275  275.54  125.00
276  276.48  122.00
277  277.51  121.00
278  278.55  118.00
279  279.52  116.00
280  280.52  115.00
281  280.95  113.00
282  280.95  111.00
283  280.93  108.00
284  280.90  106.00
285  280.96  103.00
286  280.93  102.00
```

```
280.91  100.00
280.92  98.00
280.90  96.00
280.94  96.00
280.87  94.00
280.90  92.00
280.93  91.00
280.92  90.00
280.88  91.00
280.96  89.00
280.97  88.00
280.90  89.00
280.89  87.00
280.90  88.00
280.90  87.00
280.95  88.00
280.95  86.00
280.95  85.00
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280.95  85.00
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280.93  85.00
280.93  84.00
280.89  85.00
280.95  84.00
280.95  84.00
280.90  84.00
280.87  83.00
280.92  85.00
280.91  84.00
280.89  84.00
280.90  84.00
280.91  84.00
280.92  84.00
280.93  83.00
280.93  84.00
280.96  84.00
280.90  84.00
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280.93  84.00
280.93  84.00
280.94  83.00
280.97  83.00
280.89  84.00
280.92  83.00
```

```
280.92  83.00
280.86  84.00
280.90  83.00
280.90  83.00
280.93  84.00
280.93  83.00
280.91  83.00
280.95  83.00
280.94  83.00
280.94  83.00
280.86  83.00
280.83  84.00
280.90  83.00
280.92  83.00
280.95  84.00
280.93  83.00
280.90  84.00
280.88  84.00
280.89  84.00
280.85  83.00
280.80  84.00
280.91  84.00
280.88  83.00
280.89  83.00
280.93  83.00
280.88  84.00
280.91  84.00
280.96  84.00
280.92  84.00
280.89  84.00
280.92  84.00
280.93  84.00
280.89  84.00
280.94  84.00
280.91  85.00
280.91  84.00
280.85  84.00
280.87  84.00
280.91  85.00
280.91  84.00
280.90  84.00
280.93  83.00
280.91  84.00
280.95  85.00
280.89  84.00
280.96  84.00
280.91  84.00
280.85  85.00
280.91  84.00
280.88  85.00
280.93  84.00
280.89  83.00
280.89  84.00
280.90  85.00
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Listing 23: 第 2 片 2℃/s 数据

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 33.99  81.00
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  34.16  81.00
  34.19  81.00
  34.20  82.00
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  34.24  81.00
  34.26  81.00
  34.26  80.00
  34.29  81.00
  34.30  81.00
  34.32  81.00
  34.31  81.00
  34.33  81.00
  34.34  80.00
  34.35  81.00
  34.36  81.00
  34.38  80.00
  34.35  81.00
  34.38  81.00
  34.38  82.00
  34.39  80.00
  34.39  82.00
  34.39  80.00
  34.39  81.00
  34.41  81.00
  34.40  81.00
  34.41  82.00
  34.53  81.00
  35.43  81.00
  36.43  82.00
  37.43  80.00
  38.47  82.00
  39.46  80.00
  40.48  81.00
  41.48  81.00
  42.42  81.00
  43.41  82.00
  44.43  82.00
  45.41  81.00
  46.41  82.00
  47.44  83.00
  48.43  82.00
  49.40  82.00
  50.44  83.00
  51.42  82.00
  52.43  83.00
  53.43  83.00
  54.44  83.00
  55.47  84.00
  56.42  84.00
  57.45  84.00
  58.43  84.00
  59.45  85.00
  60.44  86.00
  61.45  85.00
  62.44  86.00
```

```
 63.47  86.00
 64.47  86.00
 65.47  87.00
 66.47  86.00
 67.46  87.00
 68.48  88.00
 69.46  87.00
 70.48  89.00
 71.46  89.00
 72.48  89.00
 73.49  90.00
 74.47  91.00
 75.49  90.00
 76.51  91.00
 77.49  91.00
 78.50  91.00
 79.51  92.00
 80.53  91.00
 81.52  94.00
 82.55  93.00
 83.52  92.00
 84.43  93.00
 85.46  93.00
 86.44  94.00
 87.43  93.00
 88.46  94.00
 89.47  93.00
 90.44  92.00
 91.46  94.00
 92.47  94.00
 93.46  94.00
 94.47  94.00
 95.47  95.00
 96.46  95.00
 97.45  95.00
 98.50  95.00
 99.47  96.00
100.46  97.00
101.47  97.00
102.47  98.00
103.50  99.00
104.49  100.00
105.50  101.00
106.51  101.00
107.53  102.00
108.51  103.00
109.51  105.00
110.50  104.00
111.53  106.00
112.51  107.00
113.52  108.00
114.53  109.00
115.55  109.00
116.55  110.00
117.56  111.00
118.55  111.00
119.54  111.00
120.55  112.00
121.55  112.00
122.57  110.00
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123.55  111.00
124.53  110.00
125.52  108.00
126.48  107.00
127.52  105.00
128.54  103.00
129.50  102.00
130.52  99.00
131.53  98.00
132.50  95.00
133.50  94.00
134.55  93.00
135.52  91.00
136.52  89.00
137.52  89.00
138.55  89.00
139.54  87.00
140.52  88.00
141.55  87.00
142.54  88.00
143.51  87.00
144.54  88.00
145.56  88.00
146.54  87.00
147.55  89.00
148.54  90.00
149.58  90.00
150.56  89.00
151.55  91.00
152.54  92.00
153.56  92.00
154.58  92.00
155.57  93.00
156.58  94.00
157.58  94.00
158.57  96.00
159.57  96.00
160.58  97.00
161.57  98.00
162.58  98.00
163.56  99.00
164.59  99.00
165.61  100.00
166.48  100.00
167.45  101.00
168.46  101.00
169.48  101.00
170.47  101.00
171.47  101.00
172.44  101.00
173.45  100.00
174.46  101.00
175.48  100.00
176.46  101.00
177.46  99.00
178.45  99.00
179.46  98.00
180.47  99.00
181.46  97.00
182.46  97.00
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183.47  98.00
184.46  98.00
185.47  97.00
186.48  99.00
187.49  100.00
188.44  100.00
189.51  102.00
190.47  105.00
191.48  106.00
192.47  108.00
193.48  111.00
194.51  114.00
195.46  118.00
196.48  122.00
197.50  127.00
198.45  132.00
199.47  137.00
200.48  144.00
201.46  149.00
202.47  156.00
203.51  163.00
204.47  170.00
205.45  179.00
206.48  189.00
207.46  196.00
208.44  207.00
209.47  217.00
210.48  227.00
211.40  238.00
212.42  248.00
213.43  264.00
214.43  274.00
215.41  288.00
216.40  303.00
217.45  317.00
218.43  331.00
219.46  347.00
220.45  363.00
221.46  379.00
222.45  393.00
223.48  411.00
224.48  427.00
225.43  444.00
226.47  460.00
227.46  478.00
228.50  491.00
229.46  509.00
230.48  521.00
231.49  537.00
232.48  550.00
233.48  559.00
234.45  566.00
235.50  574.00
236.50  576.00
237.50  578.00
238.51  576.00
239.49  569.00
240.46  559.00
241.49  544.00
242.48  525.00
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243  243.54  505.00
244  244.49  478.00
245  245.52  446.00
246  246.51  414.00
247  247.52  378.00
248  248.49  340.00
249  249.39  303.00
250  250.43  268.00
251  251.46  233.00
252  252.45  204.00
253  253.46  179.00
254  254.49  159.00
255  255.48  145.00
256  256.44  132.00
257  257.44  124.00
258  258.46  117.00
259  259.49  114.00
260  260.49  111.00
261  261.51  110.00
262  262.45  108.00
263  263.47  106.00
264  264.47  106.00
265  265.52  103.00
266  266.52  104.00
267  267.44  103.00
268  268.45  102.00
269  269.55  101.00
270  270.51  101.00
271  271.49  100.00
272  272.49  100.00
273  273.54  98.00
274  274.50  98.00
275  275.50  98.00
276  276.49  97.00
277  277.51  97.00
278  278.49  96.00
279  279.51  96.00
280  280.52  96.00
281  280.89  95.00
282  280.91  95.00
283  280.93  94.00
284  280.88  94.00
285  280.88  93.00
286  280.84  92.00
287  280.94  91.00
288  280.88  90.00
289  280.91  91.00
290  280.94  89.00
291  280.92  89.00
292  280.87  89.00
293  280.93  88.00
294  280.89  88.00
295  280.87  87.00
296  280.90  88.00
297  280.92  87.00
298  280.97  87.00
299  280.93  87.00
300  280.88  87.00
301  280.90  87.00
302  280.98  87.00
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  280.89  87.00
  280.93  87.00
  280.89  86.00
  280.89  88.00
  280.95  86.00
  280.87  87.00
  280.87  86.00
  280.93  86.00
  280.87  87.00
  280.90  87.00
  280.91  86.00
  280.87  87.00
  280.87  86.00
  280.93  87.00
  280.90  86.00
  280.88  86.00
  280.87  86.00
  280.95  87.00
  280.88  86.00
  280.89  86.00
  280.90  87.00
  280.93  86.00
  280.93  86.00
  280.89  86.00
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  280.92  86.00
  280.87  86.00
  280.85  87.00
  280.87  86.00
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  280.87  86.00
  280.95  86.00
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  280.90  86.00
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  280.93  86.00
  280.92  86.00
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  280.92  86.00
  280.88  86.00
  280.93  86.00
  280.88  86.00
  280.95  86.00
  280.92  87.00
  280.96  87.00
  280.94  87.00
  280.93  87.00
  280.91  87.00
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  280.94  86.00
  280.92  86.00
  280.91  86.00
  280.93  86.00
  280.87  86.00
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280.92  86.00
280.87  87.00
280.87  86.00
280.92  86.00
280.90  87.00
280.84  86.00
280.95  86.00
280.90  86.00
280.90  86.00
280.92  87.00
280.88  87.00
280.95  86.00
280.85  86.00
280.91  86.00
280.88  87.00
280.89  86.00
280.92  86.00
280.88  87.00
280.90  86.00
280.89  87.00
280.88  87.00
280.88  86.00
280.93  87.00
280.90  86.00
280.89  86.00
280.85  87.00
280.90  86.00
280.82  86.00
280.93  87.00
280.86  86.00
280.90  87.00
280.86  86.00
280.97  86.00
280.90  87.00
280.88  86.00
280.89  86.00
280.85  87.00
280.86  86.00
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Listing 24: 第 3 片 2℃/s 数据

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 36.48  81.00
 36.51  80.00
 36.49  81.00
 36.47  80.00
 36.48  80.00
 36.45  81.00
 36.44  80.00
 36.43  81.00
 36.42  81.00
 36.39  81.00
 36.38  80.00
 36.36  81.00
 36.34  81.00
 36.34  81.00
 36.33  80.00
 36.32  81.00
 36.27  81.00
 36.27  81.00
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36.27  80.00
36.25  81.00
36.24  80.00
36.22  81.00
36.21  81.00
36.19  80.00
36.18  80.00
36.16  81.00
36.16  80.00
36.13  80.00
36.12  80.00
36.08  80.00
36.08  80.00
36.06  80.00
36.05  81.00
36.04  80.00
36.01  80.00
36.46  80.00
37.46  81.00
38.48  81.00
39.48  80.00
40.49  81.00
41.48  80.00
42.42  80.00
43.40  81.00
44.42  80.00
45.42  81.00
46.41  81.00
47.45  81.00
48.41  81.00
49.42  80.00
50.44  81.00
51.43  81.00
52.43  80.00
53.43  81.00
54.44  81.00
55.41  80.00
56.44  82.00
57.44  81.00
58.43  81.00
59.41  81.00
60.44  82.00
61.43  81.00
62.46  82.00
63.47  81.00
64.47  82.00
65.46  82.00
66.48  83.00
67.46  82.00
68.48  83.00
69.45  83.00
70.47  83.00
71.49  84.00
72.51  83.00
73.50  84.00
74.51  84.00
75.49  85.00
76.52  84.00
77.51  85.00
78.51  84.00
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 79   79.50  86.00
 80   80.51  85.00
 81   81.49  86.00
 82   82.56  86.00
 83   83.52  87.00
 84   84.42  86.00
 85   85.45  87.00
 86   86.45  87.00
 87   87.45  88.00
 88   88.43  88.00
 89   89.45  87.00
 90   90.43  88.00
 91   91.44  89.00
 92   92.46  89.00
 93   93.47  89.00
 94   94.46  88.00
 95   95.48  90.00
 96   96.49  90.00
 97   97.45  91.00
 98   98.46  91.00
 99   99.47  92.00
100  100.49  93.00
101  101.49  94.00
102  102.47  94.00
103  103.50  95.00
104  104.51  97.00
105  105.52  98.00
106  106.50  98.00
107  107.52  100.00
108  108.50  101.00
109  109.54  104.00
110  110.52  105.00
111  111.54  107.00
112  112.50  108.00
113  113.54  110.00
114  114.51  112.00
115  115.55  114.00
116  116.55  115.00
117  117.55  117.00
118  118.53  119.00
119  119.55  120.00
120  120.53  122.00
121  121.54  122.00
122  122.56  122.00
123  123.55  124.00
124  124.57  124.00
125  125.51  123.00
126  126.50  123.00
127  127.53  120.00
128  128.50  121.00
129  129.51  118.00
130  130.51  117.00
131  131.52  113.00
132  132.51  111.00
133  133.53  108.00
134  134.54  105.00
135  135.55  102.00
136  136.55  100.00
137  137.54  98.00
138  138.54  96.00
```

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139  139.54  94.00
140  140.54  92.00
141  141.52  92.00
142  142.54  91.00
143  143.53  90.00
144  144.51  91.00
145  145.54  90.00
146  146.55  91.00
147  147.55  91.00
148  148.54  92.00
149  149.54  92.00
150  150.57  94.00
151  151.56  93.00
152  152.55  96.00
153  153.57  95.00
154  154.57  97.00
155  155.56  97.00
156  156.57  99.00
157  157.56  99.00
158  158.57  101.00
159  159.56  102.00
160  160.57  103.00
161  161.55  104.00
162  162.57  106.00
163  163.57  107.00
164  164.58  107.00
165  165.61  107.00
166  166.49  110.00
167  167.45  110.00
168  168.46  111.00
169  169.45  110.00
170  170.45  113.00
171  171.44  112.00
172  172.44  114.00
173  173.45  113.00
174  174.48  112.00
175  175.45  112.00
176  176.48  113.00
177  177.45  113.00
178  178.48  111.00
179  179.45  110.00
180  180.47  111.00
181  181.45  110.00
182  182.42  109.00
183  183.44  108.00
184  184.49  107.00
185  185.44  106.00
186  186.47  108.00
187  187.49  106.00
188  188.46  107.00
189  189.51  108.00
190  190.50  110.00
191  191.46  110.00
192  192.49  112.00
193  193.49  115.00
194  194.45  119.00
195  195.49  123.00
196  196.49  128.00
197  197.47  131.00
198  198.47  136.00
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199  199.51  143.00
200  200.46  149.00
201  201.46  157.00
202  202.46  165.00
203  203.48  171.00
204  204.48  185.00
205  205.46  193.00
206  206.45  205.00
207  207.43  217.00
208  208.47  229.00
209  209.47  247.00
210  210.46  260.00
211  211.40  276.00
212  212.39  293.00
213  213.39  311.00
214  214.38  333.00
215  215.39  354.00
216  216.40  375.00
217  217.43  399.00
218  218.44  426.00
219  219.47  454.00
220  220.46  480.00
221  221.45  510.00
222  222.46  543.00
223  223.44  576.00
224  224.46  609.00
225  225.45  646.00
226  226.44  680.00
227  227.44  719.00
228  228.47  758.00
229  229.46  793.00
230  230.48  835.00
231  231.49  870.00
232  232.51  908.00
233  233.54  942.00
234  234.51  974.00
235  235.50  1008.00
236  236.47  1031.00
237  237.49  1051.00
238  238.54  1067.00
239  239.53  1076.00
240  240.54  1074.00
241  241.54  1069.00
242  242.53  1047.00
243  243.52  1015.00
244  244.51  980.00
245  245.57  933.00
246  246.53  874.00
247  247.53  805.00
248  248.53  734.00
249  249.48  653.00
250  250.44  578.00
251  251.40  505.00
252  252.45  435.00
253  253.46  376.00
254  254.42  327.00
255  255.46  285.00
256  256.43  255.00
257  257.42  229.00
258  258.50  211.00
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259  259.44  198.00
260  260.50  189.00
261  261.45  181.00
262  262.47  176.00
263  263.49  170.00
264  264.49  166.00
265  265.43  162.00
266  266.45  160.00
267  267.48  156.00
268  268.49  154.00
269  269.49  151.00
270  270.53  147.00
271  271.47  145.00
272  272.54  144.00
273  273.49  141.00
274  274.49  139.00
275  275.53  137.00
276  276.47  134.00
277  277.53  131.00
278  278.52  131.00
279  279.51  129.00
280  280.52  126.00
281  280.92  124.00
282  280.90  121.00
283  280.92  119.00
284  280.93  117.00
285  280.91  113.00
286  280.91  112.00
287  280.90  109.00
288  280.90  107.00
289  280.89  105.00
290  280.92  104.00
291  280.89  102.00
292  280.92  100.00
293  280.89  99.00
294  280.92  98.00
295  280.92  96.00
296  280.92  96.00
297  280.93  94.00
298  280.93  94.00
299  280.92  92.00
300  280.88  93.00
301  280.90  91.00
302  280.90  91.00
303  280.93  90.00
304  280.89  90.00
305  280.92  89.00
306  280.92  90.00
307  280.92  88.00
308  280.97  88.00
309  280.93  88.00
310  280.93  87.00
311  280.90  87.00
312  280.94  87.00
313  280.93  88.00
314  280.93  87.00
315  280.93  86.00
316  280.94  86.00
317  280.95  87.00
318  280.92  87.00
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280.92  86.00
280.94  87.00
280.96  86.00
280.92  86.00
280.92  86.00
280.95  87.00
280.90  85.00
280.91  86.00
280.93  86.00
280.93  86.00
280.91  86.00
280.90  85.00
280.92  86.00
280.92  86.00
280.94  85.00
280.94  86.00
280.90  85.00
280.92  86.00
280.91  86.00
280.93  86.00
280.92  85.00
280.93  86.00
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280.90  86.00
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280.89  85.00
280.90  85.00
280.90  85.00
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280.92  85.00
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280.88  85.00
280.87  85.00
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280.89  85.00
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280.95  86.00
280.89  85.00
280.90  85.00
280.91  86.00
280.92  85.00
280.89  86.00
280.89  85.00
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280.92  85.00
280.89  85.00
280.89  85.00
280.91  85.00
280.90  85.00
280.94  85.00
280.91  85.00
280.91  85.00
280.90  86.00
280.91  85.00
280.90  85.00
280.90  86.00
280.91  85.00
280.91  85.00
280.92  85.00
280.89  84.00
280.88  86.00
280.89  86.00
280.92  85.00
280.91  86.00
280.89  85.00
280.89  85.00
```

Listing 25: 第 1 片 3℃/s 数据

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 32.95  79.00
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 33.06  79.00
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 33.11  80.00
 33.12  79.00
 33.14  80.00
 33.14  80.00
 33.18  78.00
 33.18  80.00
 33.20  79.00
 33.21  80.00
 33.22  79.00
 33.24  79.00
 33.25  79.00
 33.27  80.00
 33.27  79.00
 33.28  79.00
 33.30  79.00
 33.44  80.00
 34.69  79.00
 36.20  80.00
 37.70  79.00
 39.20  79.00
 40.71  80.00
 42.19  79.00
 43.66  80.00
 45.14  79.00
 46.66  80.00
 48.16  79.00
 49.65  80.00
 51.16  80.00
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  52.67  79.00
  54.16  80.00
  55.65  81.00
  57.19  80.00
  58.66  81.00
  60.17  80.00
  61.69  81.00
  63.21  81.00
  64.71  82.00
  66.21  82.00
  67.72  82.00
  69.22  82.00
  70.73  83.00
  72.21  83.00
  73.75  83.00
  75.22  84.00
  76.75  85.00
  78.24  85.00
  79.74  86.00
  81.24  86.00
  82.82  86.00
  84.19  87.00
  85.65  87.00
  87.18  87.00
  88.70  87.00
  90.20  88.00
  91.68  87.00
  93.19  88.00
  94.69  88.00
  96.18  87.00
  97.71  88.00
  99.22  88.00
 100.73  88.00
 102.23  88.00
 103.75  89.00
 105.23  89.00
 106.76  90.00
 108.25  90.00
 109.71  91.00
 111.29  93.00
 112.74  93.00
 114.29  96.00
 115.77  97.00
 117.28  99.00
 118.75  100.00
 120.27  103.00
 121.78  106.00
 123.29  109.00
 124.77  110.00
 126.27  112.00
 127.76  115.00
 129.24  115.00
 130.74  116.00
 132.23  117.00
 133.76  116.00
 135.28  115.00
 136.76  113.00
 138.27  110.00
 139.78  108.00
 141.30  103.00
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142.78  100.00
144.31  96.00
145.78  94.00
147.31  90.00
148.76  90.00
150.30  87.00
151.80  87.00
153.30  88.00
154.81  87.00
156.30  88.00
157.85  89.00
159.30  90.00
160.84  91.00
162.31  93.00
163.82  93.00
165.33  95.00
166.71  96.00
168.21  98.00
169.71  100.00
171.18  101.00
172.70  102.00
174.18  104.00
175.72  105.00
177.20  107.00
178.71  107.00
180.23  108.00
181.73  108.00
183.20  108.00
184.70  108.00
186.22  109.00
187.71  108.00
189.23  106.00
190.74  107.00
192.22  106.00
193.71  106.00
195.23  105.00
196.72  107.00
198.21  108.00
199.74  110.00
201.23  114.00
202.72  119.00
204.24  121.00
205.74  129.00
207.20  137.00
208.70  145.00
210.19  155.00
211.68  168.00
213.15  179.00
214.66  196.00
216.19  213.00
217.68  234.00
219.22  255.00
220.69  278.00
222.20  306.00
223.71  340.00
225.22  371.00
226.71  411.00
228.26  454.00
229.74  506.00
231.25  562.00
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232.74  623.00
234.24  692.00
235.74  759.00
237.26  836.00
238.75  910.00
240.27  989.00
241.76  1063.00
243.24  1138.00
244.76  1204.00
246.26  1251.00
247.80  1286.00
249.19  1292.00
250.69  1277.00
252.16  1226.00
253.68  1143.00
255.19  1035.00
256.69  905.00
258.23  767.00
259.73  629.00
261.21  506.00
262.73  409.00
264.21  336.00
265.72  287.00
267.24  257.00
268.75  236.00
270.24  222.00
271.73  211.00
273.26  201.00
274.76  195.00
276.23  188.00
277.73  181.00
279.27  175.00
280.63  170.00
280.89  163.00
280.89  156.00
280.89  149.00
280.89  143.00
280.94  137.00
280.89  132.00
280.87  127.00
280.90  122.00
280.87  117.00
280.89  114.00
280.89  110.00
280.91  107.00
280.89  105.00
280.90  102.00
280.88  100.00
280.88  99.00
280.90  97.00
280.92  96.00
280.87  94.00
280.88  93.00
280.92  92.00
280.89  91.00
280.89  91.00
280.89  90.00
280.88  89.00
280.89  89.00
280.87  89.00
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280.89  88.00
280.89  87.00
280.91  88.00
280.91  86.00
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280.90  86.00
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280.89  85.00
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280.92  84.00
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280.94  84.00
280.90  84.00
280.90  84.00
280.89  85.00
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280.91  84.00
280.88  84.00
280.89  84.00
280.87  84.00
280.87  84.00
280.90  84.00
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280.92  84.00
280.93  84.00
280.90  83.00
280.90  84.00
280.89  84.00
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280.90  85.00
280.89  83.00
280.89  84.00
280.89  84.00
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280.91  83.00
280.89  84.00
280.90  84.00
280.89  84.00
280.91  83.00
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280.91  84.00
280.91  84.00
280.90  83.00
280.88  85.00
280.89  84.00
280.93  83.00
280.90  85.00
280.88  83.00
280.92  84.00
280.92  84.00
280.92  84.00
280.91  84.00
280.93  84.00
280.92  84.00
280.94  84.00
280.89  85.00
280.92  84.00
280.95  84.00
280.93  84.00
280.92  84.00
280.92  85.00
280.93  84.00
280.92  84.00
280.91  84.00
280.90  85.00
280.91  85.00
280.90  83.00
280.90  85.00
280.92  83.00
280.91  85.00
280.91  85.00
```

Listing 26: 第 2 片 3℃/s 数据

```
 36.59  80.00
 36.64  81.00
 36.64  80.00
 36.65  81.00
 36.65  80.00
 36.65  80.00
 36.67  80.00
 36.67  80.00
 36.67  80.00
 36.68  80.00
 36.67  81.00
 36.68  80.00
 36.67  81.00
 36.67  79.00
 36.68  81.00
 36.69  80.00
 36.67  80.00
 36.67  80.00
 36.68  80.00
 36.69  80.00
 36.68  80.00
 36.67  80.00
 36.68  80.00
 36.69  79.00
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```
  37.70  80.00
  39.20  80.00
  40.71  80.00
  42.19  80.00
  43.65  80.00
  45.16  80.00
  46.67  81.00
  48.16  80.00
  49.66  81.00
  51.17  81.00
  52.69  82.00
  54.18  82.00
  55.68  82.00
  57.20  83.00
  58.67  82.00
  60.20  83.00
  61.72  84.00
  63.24  84.00
  64.70  84.00
  66.22  86.00
  67.72  85.00
  69.23  87.00
  70.73  87.00
  72.25  88.00
  73.75  90.00
  75.23  89.00
  76.76  90.00
  78.24  92.00
  79.75  93.00
  81.25  93.00
  82.79  95.00
  84.19  94.00
  85.71  96.00
  87.20  96.00
  88.71  96.00
  90.20  97.00
  91.71  97.00
  93.23  97.00
  94.73  98.00
  96.22  98.00
  97.73  99.00
  99.22  98.00
 100.72 100.00
 102.21 100.00
 103.73 100.00
 105.26 102.00
 106.77 103.00
 108.27 104.00
 109.78 106.00
 111.27 107.00
 112.76 109.00
 114.27 111.00
 115.76 115.00
 117.29 116.00
 118.77 118.00
 120.28 121.00
 121.80 123.00
 123.29 124.00
 124.79 126.00
 126.26 127.00
```

```
127.76  128.00
129.25  127.00
130.75  125.00
132.26  123.00
133.76  120.00
135.26  117.00
136.76  111.00
138.29  107.00
139.77  102.00
141.27  98.00
142.79  96.00
144.28  91.00
145.79  91.00
147.31  90.00
148.80  88.00
150.31  90.00
151.82  90.00
153.30  90.00
154.83  92.00
156.31  93.00
157.82  93.00
159.30  95.00
160.80  97.00
162.31  98.00
163.80  100.00
165.35  102.00
166.72  103.00
168.18  105.00
169.68  106.00
171.20  109.00
172.71  111.00
174.21  111.00
175.71  113.00
177.21  112.00
178.69  112.00
180.21  113.00
181.71  112.00
183.20  112.00
184.71  110.00
186.21  110.00
187.74  108.00
189.24  109.00
190.73  108.00
192.22  108.00
193.73  109.00
195.23  111.00
196.71  114.00
198.20  118.00
199.73  126.00
201.23  131.00
202.73  140.00
204.24  152.00
205.72  162.00
207.21  176.00
208.70  190.00
210.21  209.00
211.68  227.00
213.18  248.00
214.67  272.00
216.19  298.00
```

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217.68  323.00
219.20  353.00
220.71  386.00
222.17  422.00
223.71  458.00
225.20  500.00
226.70  541.00
228.24  586.00
229.72  629.00
231.24  676.00
232.76  723.00
234.22  770.00
235.75  810.00
237.27  854.00
238.79  889.00
240.29  920.00
241.74  945.00
243.26  953.00
244.79  950.00
246.32  938.00
247.84  900.00
249.21  847.00
250.71  775.00
252.18  691.00
253.70  596.00
255.20  495.00
256.68  400.00
258.21  315.00
259.70  249.00
261.22  198.00
262.73  166.00
264.22  146.00
265.75  136.00
267.24  129.00
268.76  125.00
270.24  122.00
271.76  121.00
273.26  117.00
274.73  116.00
276.24  115.00
277.76  112.00
279.29  112.00
280.64  110.00
280.90  109.00
280.90  106.00
280.90  104.00
280.92  101.00
280.91  99.00
280.90  97.00
280.92  95.00
280.93  95.00
280.91  92.00
280.89  91.00
280.91  91.00
280.89  90.00
280.91  88.00
280.91  89.00
280.91  87.00
280.91  87.00
280.91  86.00
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280.91  86.00
280.90  86.00
280.92  85.00
280.92  86.00
280.91  85.00
280.92  85.00
280.90  85.00
280.91  84.00
280.90  85.00
280.91  84.00
280.92  85.00
280.91  84.00
280.93  83.00
280.91  84.00
280.91  85.00
280.93  84.00
280.91  83.00
280.90  84.00
280.90  83.00
280.89  84.00
280.89  84.00
280.90  84.00
280.89  83.00
280.89  83.00
280.90  83.00
280.90  84.00
280.89  84.00
280.89  83.00
280.91  83.00
280.89  84.00
280.89  84.00
280.90  84.00
280.89  83.00
280.89  84.00
280.90  84.00
280.89  83.00
280.89  83.00
280.90  84.00
280.89  83.00
280.88  84.00
280.91  84.00
280.89  83.00
280.90  83.00
280.89  83.00
280.90  83.00
280.92  83.00
280.90  83.00
280.90  83.00
280.90  83.00
280.89  84.00
280.90  83.00
280.92  83.00
280.90  82.00
280.95  84.00
280.91  83.00
280.93  83.00
280.91  84.00
280.91  83.00
280.93  83.00
280.91  84.00
```

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280.92  84.00
280.90  83.00
280.91  83.00
280.92  84.00
280.92  83.00
280.91  84.00
280.92  84.00
280.91  83.00
280.89  84.00
280.91  83.00
280.90  84.00
280.91  83.00
280.90  84.00
280.90  83.00
280.90  83.00
280.89  84.00
280.89  84.00
280.90  83.00
280.91  84.00
280.92  84.00
280.90  83.00
280.90  83.00
280.90  84.00
280.92  83.00
280.90  84.00
280.90  83.00
280.91  84.00
280.90  83.00
280.90  84.00
280.90  83.00
280.91  84.00
280.93  84.00
280.89  83.00
280.89  84.00
280.89  83.00
280.89  84.00
280.89  83.00
280.88  84.00
280.89  83.00
280.88  84.00
280.89  84.00
280.90  84.00
```

Listing 27: 第 3 片 3℃/s 数据

```
 39.01  79.00
 39.05  78.00
 39.01  78.00
 38.98  79.00
 38.97  78.00
 38.97  78.00
 38.95  78.00
 38.94  78.00
 38.92  78.00
 38.91  78.00
 38.88  79.00
 38.87  78.00
 38.85  78.00
 38.81  79.00
```

```
 38.79  78.00
 38.76  78.00
 38.76  78.00
 38.73  77.00
 38.72  78.00
 38.69  78.00
 38.70  78.00
 38.67  77.00
 38.65  78.00
 38.63  78.00
 38.60  78.00
 39.22  78.00
 40.72  78.00
 42.20  77.00
 43.65  78.00
 45.16  78.00
 46.66  78.00
 48.17  78.00
 49.65  79.00
 51.17  78.00
 52.66  79.00
 54.17  79.00
 55.67  78.00
 57.18  79.00
 58.68  79.00
 60.19  79.00
 61.67  80.00
 63.20  80.00
 64.73  80.00
 66.21  80.00
 67.70  82.00
 69.21  81.00
 70.70  82.00
 72.22  82.00
 73.74  83.00
 75.25  83.00
 76.76  84.00
 78.25  85.00
 79.75  85.00
 81.25  86.00
 82.83  86.00
 84.20  86.00
 85.69  87.00
 87.19  88.00
 88.70  88.00
 90.19  89.00
 91.69  89.00
 93.21  89.00
 94.72  90.00
 96.23  90.00
 97.73  91.00
 99.23  92.00
100.72  92.00
102.26  95.00
103.75  95.00
105.26  96.00
106.76  98.00
108.25  101.00
109.77  103.00
111.24  106.00
```

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112.76  108.00
114.32  112.00
115.79  115.00
117.28  119.00
118.76  123.00
120.29  127.00
121.79  131.00
123.29  136.00
124.78  138.00
126.24  141.00
127.75  143.00
129.25  143.00
130.75  142.00
132.25  140.00
133.77  136.00
135.27  133.00
136.79  127.00
138.26  120.00
139.78  114.00
141.28  108.00
142.78  103.00
144.27  98.00
145.79  95.00
147.28  94.00
148.81  93.00
150.31  93.00
151.81  93.00
153.29  94.00
154.82  96.00
156.32  98.00
157.79  100.00
159.30  101.00
160.83  104.00
162.32  107.00
163.82  109.00
165.35  112.00
166.71  114.00
168.19  117.00
169.68  120.00
171.18  121.00
172.71  124.00
174.21  126.00
175.70  128.00
177.20  129.00
178.70  129.00
180.21  129.00
181.71  128.00
183.21  128.00
184.71  126.00
186.23  124.00
187.75  123.00
189.23  121.00
190.74  122.00
192.25  120.00
193.73  122.00
195.22  124.00
196.74  129.00
198.20  135.00
199.71  143.00
201.22  154.00
```

```
  202.71  166.00
  204.25  180.00
  205.73  198.00
  207.22  218.00
  208.70  239.00
  210.20  265.00
  211.66  294.00
  213.20  327.00
  214.66  363.00
  216.19  402.00
  217.70  448.00
  219.18  497.00
  220.69  553.00
  222.22  613.00
  223.73  683.00
  225.18  751.00
  226.68  830.00
  228.24  912.00
  229.74  999.00
  231.28  1092.00
  232.76  1185.00
  234.24  1279.00
  235.75  1365.00
  237.25  1457.00
  238.76  1532.00
  240.29  1599.00
  241.80  1646.00
  243.31  1668.00
  244.80  1667.00
  246.33  1624.00
  247.83  1551.00
  249.23  1434.00
  250.72  1284.00
  252.21  1112.00
  253.71  931.00
  255.20  756.00
  256.74  595.00
  258.25  466.00
  259.75  370.00
  261.26  304.00
  262.73  265.00
  264.22  240.00
  265.72  224.00
  267.22  214.00
  268.75  205.00
  270.29  198.00
  271.75  192.00
  273.23  186.00
  274.73  182.00
  276.26  174.00
  277.77  171.00
  279.28  166.00
  280.64  161.00
  280.90  156.00
  280.90  150.00
  280.91  143.00
  280.89  138.00
  280.90  131.00
  280.93  126.00
  280.91  121.00
```

```
  280.91  117.00
  280.92  112.00
  280.89  109.00
  280.92  106.00
  280.91  103.00
  280.91  101.00
  280.90  98.00
  280.91  96.00
  280.90  95.00
  280.90  93.00
  280.90  92.00
  280.92  90.00
  280.89  90.00
  280.92  89.00
  280.90  88.00
  280.92  87.00
  280.90  87.00
  280.90  86.00
  280.90  86.00
  280.91  86.00
  280.92  84.00
  280.89  85.00
  280.92  85.00
  280.94  84.00
  280.93  84.00
  280.91  83.00
  280.92  84.00
  280.92  83.00
  280.93  83.00
  280.92  84.00
  280.92  83.00
  280.92  83.00
  280.91  83.00
  280.90  83.00
  280.93  83.00
  280.92  83.00
  280.94  82.00
  280.91  82.00
  280.90  83.00
  280.90  82.00
  280.91  83.00
  280.90  82.00
  280.89  82.00
  280.89  83.00
  280.92  82.00
  280.90  82.00
  280.88  82.00
  280.89  82.00
  280.92  82.00
  280.91  82.00
  280.88  83.00
  280.89  82.00
  280.90  82.00
  280.89  82.00
  280.90  82.00
  280.90  81.00
  280.91  82.00
  280.91  82.00
  280.91  82.00
  280.91  82.00
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280.91  82.00
280.91  82.00
280.90  82.00
280.89  82.00
280.89  81.00
280.89  82.00
280.89  81.00
280.90  82.00
280.88  82.00
280.88  82.00
280.88  82.00
280.88  81.00
280.89  82.00
280.87  82.00
280.89  82.00
280.89  82.00
280.90  82.00
280.88  81.00
280.90  82.00
280.89  82.00
280.88  82.00
280.90  82.00
280.89  81.00
280.88  82.00
280.87  81.00
280.90  82.00
280.90  82.00
280.90  82.00
280.89  83.00
280.89  82.00
280.88  81.00
280.90  82.00
280.89  82.00
280.89  82.00
280.87  81.00
280.89  82.00
280.89  82.00
280.88  82.00
280.88  82.00
280.92  81.00
280.89  82.00
280.89  82.00
280.87  82.00
280.89  81.00
280.89  83.00
280.89  81.00
280.88  82.00
280.88  82.00
280.90  82.00
280.88  82.00
280.89  82.00
280.89  81.00
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Listing 28: 第 1 片 4℃/s 数据

```
 34.32  75.00
 34.33  75.00
 34.35  75.00
 34.35  75.00
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```
  34.34  74.00
  34.33  75.00
  34.35  75.00
  34.37  75.00
  34.36  75.00
  34.36  74.00
  34.37  75.00
  34.35  75.00
  34.35  74.00
  34.35  75.00
  34.35  74.00
  34.34  76.00
  34.45  74.00
  35.94  75.00
  37.93  75.00
  39.96  75.00
  41.93  74.00
  43.91  75.00
  45.90  74.00
  47.90  75.00
  49.93  75.00
  51.92  76.00
  53.92  75.00
  55.93  75.00
  57.93  77.00
  59.96  76.00
  61.93  76.00
  63.98  77.00
  65.99  77.00
  67.99  78.00
  69.98  78.00
  72.01  79.00
  74.00  80.00
  76.01  81.00
  78.02  81.00
  80.01  83.00
  82.03  83.00
  83.98  85.00
  85.96  84.00
  87.94  86.00
  89.95  85.00
  91.96  85.00
  93.99  87.00
  95.99  85.00
  97.99  86.00
  99.99  85.00
 102.00  87.00
 104.02  86.00
 106.04  88.00
 108.01  89.00
 110.02  91.00
 112.01  92.00
 114.02  96.00
 116.05  99.00
 118.04  104.00
 120.06  107.00
 122.06  111.00
 124.06  115.00
 125.99  119.00
 128.03  122.00
```

```
130.02  125.00
132.04  125.00
134.04  125.00
136.05  123.00
137.99  118.00
140.05  112.00
142.06  106.00
144.04  99.00
146.05  93.00
148.05  89.00
150.05  87.00
152.07  86.00
154.06  85.00
156.06  87.00
158.06  88.00
160.08  90.00
162.07  93.00
164.08  95.00
166.04  98.00
167.95  100.00
169.95  103.00
171.95  106.00
173.96  109.00
175.96  112.00
177.97  113.00
179.98  115.00
181.96  116.00
183.98  117.00
185.99  115.00
187.98  116.00
190.00  113.00
192.01  114.00
194.00  113.00
196.01  113.00
197.99  115.00
200.01  119.00
201.98  127.00
204.00  134.00
205.99  149.00
207.97  163.00
209.95  183.00
211.93  208.00
213.94  236.00
215.92  268.00
217.96  309.00
219.94  355.00
221.96  407.00
223.96  468.00
225.96  539.00
228.00  620.00
230.00  709.00
231.97  819.00
233.96  932.00
236.01  1059.00
238.03  1188.00
240.04  1325.00
242.06  1458.00
244.01  1572.00
246.05  1672.00
248.03  1721.00
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249.93  1716.00
251.92  1643.00
253.92  1490.00
255.95  1279.00
257.97  1033.00
259.97  791.00
261.98  589.00
263.96  440.00
265.99  347.00
267.99  295.00
270.01  267.00
272.01  250.00
274.03  237.00
276.02  225.00
278.05  216.00
280.02  206.00
280.90  198.00
280.92  187.00
280.91  174.00
280.92  164.00
280.93  153.00
280.92  143.00
280.90  133.00
280.91  126.00
280.91  120.00
280.91  114.00
280.91  109.00
280.91  106.00
280.90  101.00
280.90  98.00
280.92  96.00
280.91  94.00
280.91  92.00
280.92  91.00
280.91  88.00
280.89  88.00
280.90  87.00
280.90  85.00
280.88  85.00
280.89  84.00
280.90  84.00
280.90  83.00
280.89  83.00
280.89  82.00
280.90  83.00
280.92  82.00
280.92  82.00
280.91  82.00
280.91  81.00
280.90  81.00
280.90  81.00
280.91  80.00
280.90  80.00
280.91  79.00
280.92  81.00
280.92  80.00
280.92  79.00
280.89  81.00
280.94  80.00
280.90  79.00
```

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280.90  79.00
280.91  80.00
280.91  79.00
280.89  80.00
280.88  78.00
280.90  80.00
280.90  79.00
280.89  80.00
280.91  79.00
280.90  79.00
280.91  79.00
280.93  79.00
280.90  79.00
280.91  80.00
280.88  79.00
280.91  79.00
280.90  79.00
280.90  79.00
280.90  79.00
280.91  80.00
280.92  79.00
280.90  80.00
280.89  78.00
280.92  79.00
280.93  79.00
280.91  79.00
280.89  79.00
280.90  79.00
280.90  79.00
280.92  80.00
280.91  79.00
280.91  79.00
280.90  79.00
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280.91  79.00
280.91  79.00
280.92  78.00
280.92  79.00
280.90  78.00
280.90  79.00
280.91  79.00
280.92  79.00
280.92  79.00
280.93  80.00
280.92  79.00
280.94  78.00
280.93  79.00
280.92  79.00
280.93  78.00
280.94  79.00
280.93  79.00
280.91  78.00
280.92  79.00
280.90  78.00
280.90  79.00
280.91  79.00
280.92  78.00
280.92  79.00
280.90  79.00
280.89  79.00
```

```
280.91  79.00
280.90  79.00
280.92  79.00
280.91  79.00
280.91  79.00
280.92  78.00
280.90  79.00
280.89  79.00
280.90  78.00
280.89  79.00
280.91  79.00
280.90  78.00
280.90  79.00
280.90  79.00
280.92  79.00
280.89  79.00
```

Listing 29: 第 2 片 4℃/s 数据

```
 34.39  76.00
 34.44  76.00
 34.44  75.00
 34.49  76.00
 34.53  75.00
 34.55  76.00
 34.58  75.00
 34.60  76.00
 34.63  76.00
 34.66  75.00
 34.69  75.00
 34.72  76.00
 34.73  75.00
 34.76  75.00
 34.78  76.00
 34.80  75.00
 34.82  76.00
 35.95  75.00
 37.94  75.00
 39.95  76.00
 41.96  75.00
 43.90  76.00
 45.92  75.00
 47.90  76.00
 49.91  76.00
 51.93  77.00
 53.92  77.00
 55.93  77.00
 57.92  77.00
 59.94  78.00
 61.96  78.00
 63.97  79.00
 65.98  79.00
 67.99  80.00
 69.97  80.00
 72.01  82.00
 74.00  82.00
 76.02  83.00
 78.02  85.00
 80.02  85.00
```

```
 82.02  86.00
 83.98  87.00
 85.95  89.00
 87.94  90.00
 89.96  90.00
 91.95  92.00
 93.98  92.00
 95.99  94.00
 97.97  96.00
 99.97  95.00
101.98  97.00
104.01  96.00
106.02  97.00
108.00  97.00
110.02  98.00
112.02  99.00
114.04  100.00
116.05  101.00
118.04  102.00
120.05  104.00
122.04  106.00
124.03  110.00
126.00  112.00
128.01  116.00
130.01  118.00
132.00  122.00
134.03  127.00
136.01  130.00
138.04  132.00
140.02  133.00
142.04  134.00
144.05  132.00
146.05  130.00
148.05  125.00
150.06  119.00
152.06  111.00
154.07  105.00
156.06  99.00
158.06  93.00
160.11  91.00
162.09  88.00
164.10  88.00
166.05  88.00
167.96  89.00
169.96  91.00
171.96  93.00
173.96  95.00
175.97  97.00
177.97  101.00
179.98  102.00
181.96  107.00
183.97  108.00
185.98  112.00
187.97  114.00
189.98  116.00
191.96  117.00
194.01  119.00
195.99  119.00
198.01  119.00
199.99  119.00
```

```
202.00  116.00
203.98  115.00
206.00  113.00
207.96  113.00
209.97  116.00
211.91  120.00
213.94  127.00
215.93  136.00
217.95  150.00
219.95  167.00
221.95  186.00
223.96  210.00
225.97  238.00
227.98  271.00
230.01  307.00
232.02  350.00
234.00  399.00
236.01  450.00
238.04  511.00
240.04  574.00
242.02  646.00
244.03  722.00
246.04  803.00
248.06  882.00
249.95  961.00
251.96  1035.00
253.96  1110.00
255.95  1172.00
258.01  1214.00
259.98  1236.00
261.99  1233.00
264.01  1185.00
265.96  1101.00
268.04  973.00
270.05  818.00
271.99  642.00
274.00  474.00
276.03  337.00
278.06  242.00
280.07  184.00
280.92  156.00
280.94  144.00
280.89  134.00
280.89  127.00
280.89  123.00
280.90  119.00
280.89  115.00
280.89  110.00
280.91  107.00
280.89  105.00
280.90  101.00
280.90  98.00
280.90  96.00
280.92  94.00
280.93  93.00
280.92  91.00
280.90  90.00
280.90  89.00
280.89  87.00
280.90  86.00
```

```
280.90  86.00
280.90  85.00
280.90  84.00
280.88  84.00
280.90  83.00
280.90  83.00
280.91  82.00
280.89  81.00
280.90  82.00
280.88  81.00
280.90  80.00
280.90  81.00
280.89  80.00
280.89  80.00
280.89  80.00
280.89  79.00
280.90  80.00
280.89  79.00
280.90  80.00
280.93  78.00
280.91  80.00
280.89  79.00
280.88  78.00
280.90  79.00
280.89  80.00
280.90  79.00
280.90  78.00
280.90  79.00
280.90  79.00
280.88  78.00
280.88  79.00
280.92  78.00
280.92  79.00
280.89  79.00
280.89  79.00
280.91  78.00
280.91  79.00
280.89  77.00
280.88  78.00
280.90  78.00
280.89  79.00
280.89  79.00
280.89  78.00
280.92  79.00
280.92  78.00
280.91  79.00
280.91  78.00
280.91  79.00
280.91  78.00
280.90  80.00
280.90  78.00
280.89  79.00
280.92  78.00
280.90  78.00
280.91  79.00
280.93  79.00
280.92  78.00
280.94  79.00
280.91  79.00
280.92  78.00
```

```
280.91  79.00
280.92  77.00
280.92  78.00
280.90  78.00
280.92  78.00
280.92  78.00
280.92  78.00
280.91  77.00
280.91  78.00
280.92  79.00
280.91  78.00
280.91  79.00
280.89  78.00
280.89  78.00
280.90  79.00
280.89  77.00
280.90  79.00
280.91  78.00
280.89  79.00
280.91  78.00
280.90  79.00
280.90  79.00
280.92  78.00
280.91  78.00
280.90  78.00
280.90  79.00
280.90  78.00
280.90  79.00
280.89  78.00
280.90  79.00
280.89  78.00
280.89  79.00
280.89  78.00
280.89  79.00
280.90  79.00
280.91  78.00
280.87  78.00
280.89  79.00
280.89  78.00
280.87  79.00
```

Listing 30: 第 3 片 4℃/s 数据

```
 38.48  74.00
 38.47  73.00
 38.47  74.00
 38.44  73.00
 38.42  74.00
 38.39  73.00
 38.36  73.00
 38.33  73.00
 38.32  74.00
 38.29  73.00
 38.27  73.00
 38.26  74.00
 38.22  73.00
 38.19  73.00
 38.15  74.00
 38.16  73.00
```

```
  38.14  73.00
  38.12  73.00
  38.28  74.00
  39.94  73.00
  41.95  73.00
  43.88  73.00
  45.91  73.00
  47.91  73.00
  49.91  74.00
  51.95  73.00
  53.90  73.00
  55.93  75.00
  57.92  74.00
  59.95  74.00
  61.96  74.00
  63.97  75.00
  65.97  75.00
  67.97  75.00
  69.97  76.00
  72.00  77.00
  74.01  77.00
  76.00  78.00
  77.99  79.00
  80.00  79.00
  82.06  80.00
  83.97  82.00
  85.94  83.00
  87.94  83.00
  89.94  84.00
  91.96  84.00
  93.96  86.00
  96.00  87.00
  97.97  88.00
  99.96  89.00
 101.98  90.00
 104.00  92.00
 106.03  94.00
 108.00  97.00
 110.02  101.00
 112.02  105.00
 114.01  111.00
 116.04  116.00
 118.03  122.00
 120.04  129.00
 122.05  135.00
 124.03  141.00
 126.01  148.00
 128.00  152.00
 129.99  154.00
 132.00  154.00
 134.03  150.00
 136.02  143.00
 138.04  135.00
 140.02  125.00
 142.05  114.00
 144.05  105.00
 146.07  99.00
 148.05  94.00
 150.04  91.00
 152.04  92.00
```

```
154.07  93.00
156.05  95.00
158.07  98.00
160.10  102.00
162.06  106.00
164.08  110.00
166.05  113.00
167.93  119.00
169.98  122.00
171.94  126.00
173.99  131.00
175.97  134.00
177.96  137.00
179.98  139.00
181.95  139.00
183.99  139.00
185.96  136.00
187.96  135.00
190.01  132.00
191.97  130.00
193.96  129.00
196.03  131.00
197.99  138.00
199.95  146.00
201.99  160.00
204.02  178.00
206.01  202.00
207.99  231.00
209.99  265.00
211.97  304.00
213.96  353.00
215.98  409.00
217.99  476.00
219.96  550.00
221.92  635.00
223.93  733.00
225.96  841.00
228.05  963.00
230.00  1100.00
231.99  1243.00
234.01  1399.00
236.04  1555.00
237.99  1706.00
240.03  1851.00
242.05  1982.00
244.02  2072.00
246.05  2115.00
248.03  2097.00
249.94  1995.00
251.97  1816.00
253.94  1566.00
255.98  1273.00
257.99  972.00
259.96  704.00
262.01  503.00
263.97  376.00
265.95  306.00
267.99  271.00
270.01  248.00
272.01  235.00
```

```
274.01  225.00
276.00  213.00
278.02  205.00
280.02  198.00
280.95  188.00
280.92  176.00
280.93  166.00
280.93  155.00
280.93  145.00
280.93  137.00
280.91  128.00
280.92  121.00
280.91  115.00
280.93  110.00
280.92  105.00
280.91  101.00
280.90  99.00
280.93  95.00
280.89  94.00
280.90  91.00
280.90  90.00
280.91  88.00
280.92  87.00
280.90  86.00
280.90  85.00
280.90  83.00
280.90  84.00
280.92  82.00
280.89  83.00
280.93  81.00
280.92  82.00
280.92  81.00
280.90  80.00
280.89  81.00
280.89  80.00
280.91  79.00
280.90  80.00
280.90  80.00
280.90  79.00
280.90  79.00
280.90  80.00
280.90  79.00
280.92  79.00
280.91  79.00
280.92  79.00
280.90  79.00
280.91  79.00
280.89  79.00
280.91  78.00
280.90  78.00
280.93  78.00
280.90  78.00
280.93  78.00
280.92  78.00
280.92  79.00
280.93  78.00
280.92  78.00
280.92  78.00
280.93  78.00
280.92  78.00
```

```
  280.93  78.00
  280.92  78.00
  280.92  78.00
  280.93  77.00
  280.93  78.00
  280.93  78.00
  280.92  78.00
  280.95  77.00
  280.92  78.00
  280.90  78.00
  280.91  77.00
  280.91  78.00
  280.90  78.00
  280.90  79.00
  280.89  77.00
  280.89  77.00
  280.88  78.00
  280.89  78.00
  280.91  77.00
  280.90  78.00
  280.93  78.00
  280.90  78.00
  280.89  78.00
  280.89  78.00
  280.89  78.00
  280.89  78.00
  280.89  77.00
  280.90  78.00
  280.90  78.00
  280.89  78.00
  280.90  78.00
  280.90  78.00
  280.92  78.00
  280.92  78.00
  280.91  78.00
  280.91  78.00
  280.90  78.00
  280.90  77.00
  280.91  78.00
  280.92  78.00
  280.92  78.00
  280.91  78.00
  280.92  78.00
  280.93  78.00
  280.92  78.00
  280.95  77.00
  280.93  78.00
  280.94  78.00
  280.93  77.00
  280.93  77.00
  280.93  79.00
  280.93  78.00
  280.93  77.00
  280.93  79.00
  280.92  77.00
  280.93  78.00
  280.91  78.00
  280.93  77.00
  280.94  78.00
  280.89  78.00
```

```
280.91  78.00
280.91  78.00
280.90  77.00
280.90  77.00
```

Listing 31: 第 1 片环境剂量数据

```
 27.50  75.00
 27.53  75.00
 27.53  77.00
 27.53  76.00
 27.53  75.00
 27.53  75.00
 27.53  77.00
 27.52  75.00
 27.52  75.00
 27.51  76.00
 27.69  75.00
 29.70  75.00
 32.19  76.00
 34.67  76.00
 37.19  75.00
 39.70  76.00
 42.18  77.00
 44.64  76.00
 47.14  76.00
 49.64  77.00
 52.16  77.00
 54.65  77.00
 57.19  77.00
 59.66  76.00
 62.19  77.00
 64.69  79.00
 67.20  78.00
 69.70  79.00
 72.25  79.00
 74.74  79.00
 77.26  79.00
 79.72  79.00
 82.29  81.00
 84.68  80.00
 87.18  83.00
 89.70  80.00
 92.20  82.00
 94.71  83.00
 97.21  83.00
 99.71  81.00
102.23  82.00
104.74  83.00
107.26  84.00
109.76  83.00
112.27  83.00
114.77  83.00
117.30  83.00
119.78  84.00
122.29  84.00
124.78  83.00
127.27  83.00
129.73  82.00
```

```
 132.27  82.00
 134.79  82.00
 137.30  82.00
 139.78  81.00
 142.29  81.00
 144.77  81.00
 147.31  81.00
 149.80  81.00
 152.30  80.00
 154.80  79.00
 157.30  80.00
 159.81  79.00
 162.29  79.00
 164.84  79.00
 167.19  79.00
 169.68  78.00
 172.19  79.00
 174.72  78.00
 177.21  77.00
 179.72  80.00
 182.21  77.00
 184.73  77.00
 187.24  79.00
 189.74  77.00
 192.22  78.00
 194.72  77.00
 197.24  77.00
 199.73  77.00
 202.24  77.00
 204.73  78.00
 207.23  78.00
 209.72  78.00
 212.17  78.00
 214.67  77.00
 217.18  80.00
 219.71  79.00
 222.20  80.00
 224.72  81.00
 227.23  81.00
 229.74  84.00
 232.27  84.00
 234.76  86.00
 237.27  87.00
 239.79  89.00
 242.27  91.00
 244.78  93.00
 247.32  95.00
 249.71  97.00
 252.17  99.00
 254.71  99.00
 257.21  100.00
 259.75  98.00
 262.25  97.00
 264.76  96.00
 267.23  94.00
 269.78  97.00
 272.28  98.00
 274.77  97.00
 277.26  102.00
 279.76  104.00
```

```
  280.90  106.00
  280.89  102.00
  280.91  101.00
  280.91  100.00
  280.91  99.00
  280.89  99.00
  280.88  98.00
  280.90  96.00
  280.90  96.00
  280.90  97.00
  280.89  96.00
  280.89  93.00
  280.89  95.00
  280.89  94.00
  280.89  94.00
  280.92  94.00
  280.89  95.00
  280.89  93.00
  280.88  94.00
  280.89  94.00
  280.89  93.00
  280.89  93.00
  280.89  94.00
  280.88  94.00
  280.89  93.00
  280.89  93.00
  280.90  92.00
  280.90  92.00
  280.91  93.00
  280.90  92.00
  280.89  92.00
  280.88  92.00
  280.90  93.00
  280.88  92.00
  280.87  92.00
  280.87  92.00
  280.89  92.00
  280.88  94.00
  280.88  91.00
  280.87  93.00
  280.90  92.00
  280.88  93.00
  280.87  93.00
  280.87  93.00
  280.87  92.00
  280.89  92.00
  280.87  94.00
  280.88  91.00
  280.88  92.00
  280.88  93.00
  280.88  92.00
  280.88  92.00
  280.87  93.00
  280.90  93.00
  280.87  92.00
  280.86  93.00
  280.87  92.00
  280.87  91.00
  280.86  95.00
  280.88  91.00
```

```
280.87  92.00
280.87  93.00
280.88  92.00
280.88  93.00
280.86  92.00
280.88  93.00
280.89  93.00
280.88  93.00
280.86  92.00
280.87  94.00
280.86  92.00
280.87  92.00
280.87  92.00
280.87  92.00
280.88  92.00
280.88  93.00
280.88  92.00
280.87  92.00
280.87  93.00
280.87  91.00
280.86  92.00
280.86  92.00
280.86  93.00
280.86  93.00
280.87  92.00
280.86  92.00
280.88  94.00
280.88  92.00
280.88  93.00
280.88  92.00
280.88  93.00
280.90  92.00
280.87  92.00
280.88  93.00
280.86  92.00
280.89  92.00
280.87  93.00
280.89  92.00
280.88  92.00
280.90  92.00
280.89  94.00
280.88  92.00
280.89  93.00
280.90  92.00
280.89  93.00
280.88  93.00
280.88  93.00
280.89  92.00
280.88  93.00
280.89  94.00
280.88  93.00
280.88  94.00
280.89  91.00
280.89  93.00
280.89  94.00
280.88  93.00
280.90  93.00
280.90  94.00
280.89  93.00
280.90  93.00
```

Listing 32: 第 2 片环境剂量数据

```
  31.87  81.00
  31.88  82.00
  31.89  81.00
  31.90  82.00
  31.88  80.00
  31.90  82.00
  31.87  81.00
  31.89  82.00
  31.87  81.00
  31.86  81.00
  31.85  81.00
  31.86  81.00
  32.35  81.00
  34.65  81.00
  37.20  81.00
  39.67  81.00
  42.17  81.00
  44.63  81.00
  47.15  83.00
  49.64  83.00
  52.19  83.00
  54.66  83.00
  57.18  85.00
  59.66  83.00
  62.18  86.00
  64.70  87.00
  67.22  86.00
  69.71  87.00
  72.24  90.00
  74.75  89.00
  77.26  91.00
  79.75  93.00
  82.30  95.00
  84.69  97.00
  87.17  96.00
  89.67  100.00
  92.22  99.00
  94.72  102.00
  97.22  104.00
  99.73  106.00
 102.25  108.00
 104.73  108.00
 107.27  110.00
 109.77  111.00
 112.30  113.00
 114.80  112.00
 117.29  114.00
 119.79  115.00
 122.28  114.00
 124.78  116.00
 127.25  113.00
 129.74  114.00
 132.26  113.00
 134.76  112.00
 137.29  112.00
```

```
139.75  109.00
142.29  108.00
144.77  107.00
147.29  105.00
149.80  103.00
152.28  99.00
154.80  97.00
157.30  97.00
159.83  95.00
162.29  93.00
164.83  93.00
167.21  89.00
169.70  89.00
172.20  87.00
174.69  86.00
177.21  85.00
179.71  84.00
182.21  84.00
184.68  84.00
187.20  83.00
189.74  82.00
192.27  83.00
194.73  82.00
197.22  82.00
199.76  82.00
202.21  82.00
204.76  82.00
207.21  82.00
209.70  81.00
212.20  82.00
214.65  82.00
217.18  82.00
219.72  82.00
222.23  83.00
224.74  84.00
227.23  86.00
229.78  85.00
232.24  87.00
234.76  87.00
237.24  90.00
239.76  91.00
242.28  93.00
244.78  95.00
247.29  95.00
249.71  98.00
252.18  100.00
254.71  99.00
257.21  101.00
259.71  101.00
262.21  100.00
264.72  99.00
267.22  98.00
269.73  96.00
272.27  97.00
274.74  98.00
277.27  102.00
279.80  104.00
280.93  106.00
280.92  104.00
280.91  104.00
```

```
  280.92  101.00
  280.91  102.00
  280.89  102.00
  280.90  99.00
  280.90  99.00
  280.91  99.00
  280.90  99.00
  280.89  98.00
  280.89  99.00
  280.90  97.00
  280.87  98.00
  280.88  98.00
  280.88  98.00
  280.90  96.00
  280.89  98.00
  280.88  98.00
  280.86  98.00
  280.87  96.00
  280.90  97.00
  280.89  97.00
  280.91  96.00
  280.88  97.00
  280.92  97.00
  280.86  96.00
  280.87  98.00
  280.90  96.00
  280.87  97.00
  280.88  97.00
  280.89  97.00
  280.89  96.00
  280.90  96.00
  280.88  97.00
  280.89  95.00
  280.90  96.00
  280.90  96.00
  280.92  97.00
  280.87  96.00
  280.87  97.00
  280.89  96.00
  280.88  95.00
  280.90  96.00
  280.88  96.00
  280.87  95.00
  280.91  96.00
  280.89  96.00
  280.89  96.00
  280.90  97.00
  280.91  96.00
  280.89  97.00
  280.90  96.00
  280.88  95.00
  280.92  96.00
  280.89  96.00
  280.90  94.00
  280.90  96.00
  280.89  97.00
  280.90  96.00
  280.88  97.00
  280.90  95.00
  280.88  95.00
```

```
280.92  96.00
280.88  96.00
280.88  96.00
280.87  96.00
280.87  95.00
280.90  96.00
280.89  96.00
280.90  95.00
280.86  96.00
280.87  96.00
280.88  96.00
280.89  96.00
280.88  96.00
280.87  97.00
280.87  97.00
280.87  96.00
280.86  96.00
280.88  96.00
280.90  97.00
280.88  96.00
280.89  95.00
280.91  96.00
280.89  97.00
280.89  97.00
280.89  96.00
280.89  96.00
280.87  96.00
280.88  96.00
280.86  96.00
280.87  98.00
280.87  96.00
280.87  96.00
280.89  97.00
280.86  96.00
280.88  97.00
280.89  97.00
280.90  96.00
280.87  97.00
280.89  96.00
280.88  96.00
280.89  96.00
280.91  99.00
280.86  95.00
280.88  97.00
280.87  97.00
280.90  97.00
280.89  98.00
280.89  97.00
280.88  97.00
280.85  97.00
280.88  96.00
280.89  98.00
280.88  97.00
280.87  97.00
280.89  98.00
280.87  97.00
280.89  99.00
```

Listing 33: 第 3 片环境剂量数据

```
  32.61  84.00
  32.62  84.00
  32.65  85.00
  32.65  84.00
  32.66  85.00
  32.67  87.00
  32.66  84.00
  32.67  85.00
  32.65  84.00
  32.67  84.00
  32.67  85.00
  32.68  84.00
  32.80  84.00
  34.69  84.00
  37.17  84.00
  39.71  85.00
  42.15  86.00
  44.65  85.00
  47.14  87.00
  49.66  86.00
  52.19  87.00
  54.65  87.00
  57.17  87.00
  59.65  88.00
  62.17  88.00
  64.71  89.00
  67.25  90.00
  69.75  91.00
  72.22  92.00
  74.77  92.00
  77.31  93.00
  79.80  93.00
  82.29  94.00
  84.67  96.00
  87.18  96.00
  89.67  96.00
  92.14  98.00
  94.75  97.00
  97.24  98.00
  99.69  98.00
 102.24  101.00
 104.75  99.00
 107.20  99.00
 109.79  100.00
 112.23  99.00
 114.82  99.00
 117.32  100.00
 119.72  101.00
 122.21  100.00
 124.77  99.00
 127.28  98.00
 129.82  100.00
 132.31  98.00
 134.76  97.00
 137.23  97.00
 139.80  96.00
 142.34  98.00
 144.77  94.00
```

```
147.33  95.00
149.72  94.00
152.26  93.00
154.82  92.00
157.29  92.00
159.85  90.00
162.28  90.00
164.83  90.00
167.18  90.00
169.71  86.00
172.23  89.00
174.70  87.00
177.13  87.00
179.71  86.00
182.17  86.00
184.72  86.00
187.22  86.00
189.73  85.00
192.22  86.00
194.75  85.00
197.25  84.00
199.70  84.00
202.24  84.00
204.72  86.00
207.17  84.00
209.72  85.00
212.09  83.00
214.68  84.00
217.18  84.00
219.71  84.00
222.24  86.00
224.76  84.00
227.19  86.00
229.73  87.00
232.26  86.00
234.81  88.00
237.25  89.00
239.82  90.00
242.27  92.00
244.80  92.00
247.34  96.00
249.75  96.00
252.19  97.00
254.73  103.00
257.20  105.00
259.73  106.00
262.22  107.00
264.72  110.00
267.30  109.00
269.77  110.00
272.25  107.00
274.74  107.00
277.23  104.00
279.82  105.00
280.93  103.00
280.86  101.00
280.88  101.00
280.92  99.00
280.92  102.00
280.95  99.00
```

```
280.88  99.00
280.90  101.00
280.87  98.00
280.87  98.00
280.88  101.00
280.87  98.00
280.89  101.00
280.88  99.00
280.89  98.00
280.87  100.00
280.90  99.00
280.93  99.00
280.84  98.00
280.91  98.00
280.86  98.00
280.89  97.00
280.90  98.00
280.93  99.00
280.94  98.00
280.93  98.00
280.89  98.00
280.92  96.00
280.91  97.00
280.94  99.00
280.90  98.00
280.91  97.00
280.88  99.00
280.98  97.00
280.91  97.00
280.89  97.00
280.95  98.00
280.96  97.00
280.86  98.00
280.90  96.00
280.91  98.00
280.92  96.00
280.91  97.00
280.88  97.00
280.91  98.00
280.86  98.00
280.84  96.00
280.91  98.00
280.89  98.00
280.89  97.00
280.91  98.00
280.84  97.00
280.91  98.00
280.88  98.00
280.89  97.00
280.92  99.00
280.92  97.00
280.93  98.00
280.88  98.00
280.92  96.00
280.89  97.00
280.90  98.00
280.90  97.00
280.88  98.00
280.85  98.00
280.92  98.00
```

```
 280.91  98.00
 280.89  98.00
 280.94  97.00
 280.93  99.00
 280.94  97.00
 280.92  99.00
 280.86  98.00
 280.89  98.00
 280.95  98.00
 280.94  97.00
 280.86  97.00
 280.86  99.00
 280.94  98.00
 280.91  99.00
 280.89  97.00
 280.89  98.00
 280.89  99.00
 280.90  98.00
 280.89  99.00
 280.92  98.00
 280.92  98.00
 280.89  97.00
 280.90  98.00
 280.94  100.00
 280.92  97.00
 280.89  97.00
 280.93  98.00
 280.86  100.00
 280.84  98.00
 280.89  98.00
 280.88  98.00
 280.90  99.00
 280.89  99.00
 280.89  98.00
 280.89  97.00
 280.93  99.00
 280.86  99.00
 280.92  98.00
 280.88  100.00
 280.90  99.00
 280.91  98.00
 280.89  98.00
 280.88  99.00
 280.90  100.00
 280.92  99.00
 280.85  100.00
 280.87  99.00
 280.94  99.00
 280.88  99.00
 280.85  97.00
 280.91  100.00
 280.85  98.00
 280.87  100.00
 280.92  99.00
```

Listing 34: 第 1 片环境剂量数据本底

```
  30.01  77.00
  30.02  78.00
```

```
  30.03  78.00
  30.01  78.00
  29.99  77.00
  29.99  77.00
  30.01  77.00
  29.99  78.00
  29.93  77.00
  29.97  78.00
  29.96  77.00
  30.16  78.00
  32.17  76.00
  34.67  77.00
  37.19  77.00
  39.68  77.00
  42.15  77.00
  44.62  77.00
  47.14  77.00
  49.65  77.00
  52.16  77.00
  54.66  77.00
  57.18  78.00
  59.67  78.00
  62.18  78.00
  64.70  77.00
  67.21  78.00
  69.69  78.00
  72.24  77.00
  74.74  77.00
  77.25  77.00
  79.76  77.00
  82.29  77.00
  84.69  77.00
  87.21  78.00
  89.69  77.00
  92.19  77.00
  94.70  77.00
  97.21  77.00
  99.73  78.00
 102.22  78.00
 104.78  77.00
 107.24  78.00
 109.75  77.00
 112.27  78.00
 114.77  76.00
 117.29  79.00
 119.78  77.00
 122.30  78.00
 124.76  78.00
 127.24  76.00
 129.76  77.00
 132.26  78.00
 134.79  78.00
 137.30  78.00
 139.77  77.00
 142.28  78.00
 144.76  77.00
 147.28  77.00
 149.79  77.00
 152.31  78.00
 154.82  78.00
```

```
157.28  76.00
159.81  78.00
162.31  78.00
164.82  77.00
167.20  78.00
169.69  77.00
172.18  76.00
174.70  78.00
177.19  77.00
179.70  77.00
182.19  78.00
184.71  77.00
187.23  77.00
189.71  79.00
192.24  78.00
194.72  78.00
197.22  78.00
199.72  77.00
202.24  79.00
204.73  79.00
207.22  77.00
209.70  78.00
212.16  78.00
214.67  78.00
217.18  78.00
219.69  79.00
222.22  78.00
224.72  80.00
227.21  78.00
229.76  79.00
232.22  79.00
234.74  79.00
237.25  79.00
239.76  80.00
242.24  80.00
244.76  81.00
247.29  81.00
249.69  82.00
252.19  82.00
254.69  83.00
257.21  85.00
259.71  86.00
262.21  86.00
264.72  87.00
267.24  90.00
269.72  90.00
272.24  93.00
274.74  94.00
277.23  96.00
279.77  100.00
280.88  100.00
280.90  98.00
280.88  98.00
280.88  94.00
280.89  95.00
280.88  95.00
280.88  94.00
280.87  94.00
280.89  94.00
280.89  92.00
```

```
280.88  95.00
280.90  93.00
280.92  92.00
280.92  92.00
280.91  93.00
280.90  92.00
280.90  92.00
280.89  92.00
280.90  93.00
280.90  93.00
280.89  92.00
280.88  91.00
280.89  92.00
280.89  92.00
280.88  92.00
280.91  93.00
280.89  91.00
280.89  93.00
280.87  92.00
280.88  93.00
280.90  93.00
280.89  91.00
280.87  91.00
280.88  92.00
280.85  92.00
280.86  94.00
280.86  92.00
280.88  92.00
280.88  93.00
280.90  92.00
280.87  93.00
280.85  92.00
280.87  91.00
280.86  93.00
280.89  93.00
280.87  93.00
280.88  93.00
280.89  91.00
280.86  93.00
280.89  91.00
280.87  92.00
280.88  93.00
280.91  93.00
280.88  93.00
280.89  93.00
280.88  92.00
280.89  92.00
280.90  93.00
280.89  91.00
280.88  94.00
280.89  94.00
280.87  94.00
280.87  93.00
280.87  93.00
280.91  92.00
280.90  95.00
280.88  93.00
280.89  94.00
280.86  93.00
280.86  94.00
```

```
280.87  92.00
280.88  94.00
280.88  94.00
280.87  94.00
280.85  94.00
280.87  93.00
280.88  95.00
280.88  93.00
280.86  94.00
280.86  92.00
280.87  94.00
280.85  93.00
280.88  95.00
280.87  94.00
280.84  93.00
280.87  94.00
280.87  94.00
280.89  93.00
280.86  93.00
280.90  94.00
280.90  93.00
280.87  94.00
280.87  94.00
280.85  93.00
280.85  94.00
280.87  94.00
280.88  93.00
280.87  93.00
280.85  94.00
280.90  94.00
280.90  94.00
280.88  94.00
280.90  94.00
280.88  93.00
280.88  94.00
280.89  94.00
280.88  93.00
280.88  94.00
280.86  93.00
280.88  95.00
280.87  94.00
280.89  95.00
280.89  93.00
280.89  94.00
280.88  94.00
280.94  93.00
280.90  94.00
280.90  96.00
280.88  94.00
280.89  95.00
```

Listing 35: 第 2 片环境剂量数据本底

```
 31.53  79.00
 31.57  80.00
 31.51  79.00
 31.47  79.00
 31.51  79.00
 31.50  79.00
```

```
  31.51  80.00
  31.53  78.00
  31.52  79.00
  31.54  79.00
  31.52  80.00
  31.52  79.00
  32.27  79.00
  34.77  79.00
  37.19  79.00
  39.67  79.00
  42.18  79.00
  44.68  80.00
  47.14  79.00
  49.66  79.00
  52.25  79.00
  54.70  80.00
  57.18  79.00
  59.67  80.00
  62.24  79.00
  64.69  79.00
  67.23  80.00
  69.71  79.00
  72.22  79.00
  74.71  80.00
  77.22  79.00
  79.74  79.00
  82.30  80.00
  84.71  79.00
  87.21  79.00
  89.61  78.00
  92.23  80.00
  94.71  78.00
  97.18  79.00
  99.72  80.00
 102.24  79.00
 104.78  78.00
 107.33  79.00
 109.76  79.00
 112.32  79.00
 114.80  80.00
 117.31  79.00
 119.84  79.00
 122.31  78.00
 124.79  79.00
 127.25  79.00
 129.78  80.00
 132.27  79.00
 134.75  79.00
 137.34  80.00
 139.75  79.00
 142.24  80.00
 144.77  79.00
 147.32  80.00
 149.81  80.00
 152.27  78.00
 154.78  81.00
 157.30  80.00
 159.82  79.00
 162.32  81.00
 164.84  79.00
```

```
167.17  79.00
169.71  79.00
172.19  80.00
174.73  81.00
177.19  79.00
179.70  79.00
182.19  79.00
184.70  81.00
187.21  79.00
189.71  80.00
192.23  80.00
194.72  82.00
197.25  79.00
199.73  80.00
202.24  80.00
204.72  81.00
207.23  80.00
209.74  80.00
212.12  81.00
214.65  81.00
217.21  80.00
219.72  79.00
222.20  80.00
224.71  80.00
227.19  81.00
229.75  81.00
232.22  81.00
234.75  81.00
237.24  83.00
239.74  82.00
242.24  82.00
244.77  83.00
247.28  83.00
249.67  84.00
252.18  84.00
254.72  85.00
257.21  86.00
259.72  87.00
262.22  88.00
264.71  89.00
267.24  91.00
269.76  91.00
272.26  94.00
274.76  96.00
277.26  98.00
279.75  101.00
280.87  101.00
280.85  100.00
280.85  99.00
280.85  98.00
280.91  97.00
280.81  96.00
280.86  95.00
280.84  96.00
280.84  96.00
280.89  95.00
280.91  94.00
280.87  95.00
280.93  96.00
280.88  93.00
```

```
280.88  95.00
280.90  93.00
280.86  94.00
280.90  95.00
280.89  93.00
280.90  94.00
280.86  94.00
280.90  93.00
280.89  94.00
280.83  94.00
280.87  94.00
280.87  94.00
280.90  95.00
280.88  94.00
280.89  93.00
280.86  95.00
280.88  94.00
280.86  94.00
280.88  94.00
280.91  93.00
280.85  94.00
280.86  95.00
280.88  95.00
280.88  94.00
280.88  94.00
280.90  94.00
280.87  94.00
280.89  95.00
280.87  93.00
280.93  94.00
280.85  96.00
280.89  94.00
280.88  95.00
280.90  95.00
280.88  94.00
280.90  97.00
280.86  94.00
280.90  95.00
280.90  95.00
280.92  94.00
280.89  96.00
280.90  95.00
280.92  95.00
280.92  95.00
280.93  95.00
280.91  95.00
280.93  96.00
280.86  95.00
280.89  95.00
280.89  95.00
280.90  95.00
280.92  95.00
280.89  96.00
280.90  94.00
280.92  96.00
280.92  96.00
280.88  95.00
280.90  98.00
280.88  95.00
280.87  94.00
```

```
280.85  97.00
280.87  95.00
280.95  96.00
280.88  95.00
280.90  96.00
280.87  97.00
280.88  94.00
280.87  96.00
280.89  95.00
280.87  95.00
280.88  97.00
280.88  96.00
280.88  97.00
280.89  96.00
280.92  95.00
280.89  96.00
280.94  97.00
280.92  95.00
280.88  96.00
280.89  97.00
280.82  96.00
280.90  96.00
280.90  95.00
280.91  96.00
280.88  97.00
280.88  97.00
280.88  96.00
280.93  96.00
280.88  95.00
280.91  96.00
280.85  98.00
280.85  96.00
280.86  96.00
280.85  96.00
280.90  96.00
280.83  97.00
280.88  96.00
280.91  95.00
280.92  96.00
280.90  97.00
280.92  95.00
280.94  97.00
280.93  96.00
280.87  97.00
280.80  97.00
280.91  97.00
```

Listing 36: 第 3 片环境剂量数据本底

```
 31.74  84.00
 31.74  83.00
 31.74  84.00
 31.75  83.00
 31.77  84.00
 31.76  83.00
 31.77  83.00
 31.77  84.00
 31.78  84.00
 31.77  82.00
```

```
 31.77  83.00
 31.79  85.00
 32.34  82.00
 34.69  84.00
 37.19  84.00
 39.75  84.00
 42.19  83.00
 44.69  85.00
 47.19  83.00
 49.66  85.00
 52.16  86.00
 54.67  85.00
 57.17  85.00
 59.68  87.00
 62.19  86.00
 64.73  88.00
 67.18  89.00
 69.73  88.00
 72.22  88.00
 74.77  89.00
 77.25  89.00
 79.78  90.00
 82.29  90.00
 84.73  91.00
 87.18  92.00
 89.71  91.00
 92.22  93.00
 94.73  91.00
 97.18  93.00
 99.71  94.00
102.26  94.00
104.73  93.00
107.25  92.00
109.76  93.00
112.29  93.00
114.79  94.00
117.29  95.00
119.82  93.00
122.29  93.00
124.83  93.00
127.29  93.00
129.78  93.00
132.26  91.00
134.81  92.00
137.31  92.00
139.78  91.00
142.28  91.00
144.80  89.00
147.29  90.00
149.80  89.00
152.30  88.00
154.82  87.00
157.32  88.00
159.83  87.00
162.31  88.00
164.82  87.00
167.20  87.00
169.68  85.00
172.22  85.00
174.69  83.00
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177.23  84.00
179.73  84.00
182.18  83.00
184.68  84.00
187.24  83.00
189.76  84.00
192.24  83.00
194.74  83.00
197.26  82.00
199.77  81.00
202.22  84.00
204.74  81.00
207.25  82.00
209.70  82.00
212.16  82.00
214.68  82.00
217.17  83.00
219.67  83.00
222.23  83.00
224.72  81.00
227.26  82.00
229.76  83.00
232.26  83.00
234.76  83.00
237.33  82.00
239.81  83.00
242.29  83.00
244.76  83.00
247.35  84.00
249.75  84.00
252.18  86.00
254.70  85.00
257.18  85.00
259.69  88.00
262.28  86.00
264.74  89.00
267.27  89.00
269.76  90.00
272.26  90.00
274.79  91.00
277.22  94.00
279.77  95.00
280.88  97.00
280.95  95.00
280.90  95.00
280.87  95.00
280.90  96.00
280.91  94.00
280.90  93.00
280.91  95.00
280.90  94.00
280.87  94.00
280.86  93.00
280.92  93.00
280.90  94.00
280.89  94.00
280.94  94.00
280.90  94.00
280.94  95.00
280.90  94.00
```

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280.83  94.00
280.88  93.00
280.91  94.00
280.90  94.00
280.92  94.00
280.84  93.00
280.92  94.00
280.91  94.00
280.90  94.00
280.92  94.00
280.90  95.00
280.87  94.00
280.89  93.00
280.89  95.00
280.87  95.00
280.92  93.00
280.90  94.00
280.92  94.00
280.87  95.00
280.87  94.00
280.89  94.00
280.89  95.00
280.88  95.00
280.91  94.00
280.90  94.00
280.90  95.00
280.90  95.00
280.92  94.00
280.87  95.00
280.92  93.00
280.82  94.00
280.89  94.00
280.89  95.00
280.87  95.00
280.89  93.00
280.85  94.00
280.93  94.00
280.92  96.00
280.86  95.00
280.89  94.00
280.94  94.00
280.87  96.00
280.91  93.00
280.90  95.00
280.88  95.00
280.84  95.00
280.90  95.00
280.91  95.00
280.92  94.00
280.90  95.00
280.93  95.00
280.92  95.00
280.90  95.00
280.88  96.00
280.92  94.00
280.94  95.00
280.89  96.00
280.85  95.00
280.91  96.00
280.93  95.00
```

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280.83  95.00
280.98  95.00
280.84  95.00
280.84  95.00
280.94  96.00
280.86  96.00
280.86  96.00
280.97  96.00
280.79  97.00
280.89  96.00
280.98  96.00
280.88  97.00
280.79  95.00
280.76  95.00
280.83  96.00
280.93  96.00
280.95  95.00
280.93  96.00
280.90  95.00
280.82  95.00
280.77  96.00
280.82  96.00
281.00  96.00
281.01  96.00
280.82  96.00
280.82  97.00
280.98  96.00
280.85  96.00
280.95  97.00
280.87  96.00
280.92  96.00
280.88  97.00
280.98  95.00
280.86  97.00
280.87  97.00
280.93  96.00
280.88  96.00
280.91  97.00
280.88  96.00
280.88  97.00
280.89  95.00
280.89  96.00
```

Listing 37: 第 1 片辐照 30s

```
 30.41  79.00
 30.43  80.00
 30.43  79.00
 30.43  80.00
 30.43  79.00
 30.44  80.00
 30.43  79.00
 30.42  79.00
 30.40  80.00
 30.42  80.00
 30.42  80.00
 30.47  80.00
 32.20  79.00
 34.68  80.00
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 37.21  79.00
 39.68  78.00
 42.18  80.00
 44.65  81.00
 47.16  81.00
 49.65  80.00
 52.18  80.00
 54.66  82.00
 57.20  81.00
 59.67  82.00
 62.19  82.00
 64.72  83.00
 67.21  84.00
 69.71  84.00
 72.23  84.00
 74.71  84.00
 77.25  85.00
 79.74  85.00
 82.29  86.00
 84.68  87.00
 87.18  87.00
 89.68  87.00
 92.23  88.00
 94.73  88.00
 97.21  88.00
 99.72  88.00
102.24  89.00
104.76  89.00
107.27  90.00
109.78  90.00
112.25  90.00
114.80  92.00
117.29  91.00
119.80  91.00
122.30  91.00
124.78  92.00
127.22  91.00
129.77  91.00
132.28  91.00
134.75  91.00
137.26  90.00
139.81  90.00
142.33  88.00
144.79  88.00
147.31  88.00
149.78  88.00
152.33  86.00
154.85  85.00
157.32  85.00
159.79  86.00
162.33  86.00
164.85  85.00
167.18  84.00
169.71  84.00
172.19  85.00
174.70  85.00
177.24  84.00
179.70  85.00
182.19  83.00
184.72  85.00
```

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187.26  84.00
189.78  83.00
192.27  84.00
194.75  82.00
197.22  82.00
199.72  83.00
202.24  83.00
204.73  85.00
207.21  85.00
209.70  86.00
212.17  87.00
214.70  88.00
217.17  91.00
219.71  93.00
222.21  96.00
224.73  100.00
227.24  106.00
229.76  110.00
232.23  118.00
234.79  125.00
237.24  132.00
239.80  143.00
242.27  152.00
244.81  165.00
247.36  174.00
249.76  182.00
252.20  186.00
254.71  189.00
257.23  183.00
259.73  169.00
262.23  149.00
264.75  133.00
267.24  120.00
269.76  111.00
272.26  108.00
274.75  107.00
277.30  108.00
279.80  110.00
280.90  110.00
280.92  108.00
280.90  105.00
280.88  103.00
280.90  102.00
280.89  101.00
280.90  100.00
280.87  99.00
280.89  98.00
280.89  98.00
280.90  96.00
280.92  97.00
280.90  96.00
280.86  96.00
280.90  95.00
280.89  95.00
280.88  95.00
280.86  94.00
280.87  95.00
280.88  94.00
280.89  94.00
280.90  95.00
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280.89  93.00
280.91  96.00
280.93  94.00
280.89  95.00
280.91  94.00
280.90  94.00
280.88  94.00
280.87  94.00
280.89  94.00
280.89  93.00
280.90  94.00
280.90  94.00
280.90  95.00
280.88  94.00
280.94  93.00
280.89  94.00
280.91  94.00
280.87  94.00
280.90  95.00
280.90  95.00
280.90  94.00
280.91  94.00
280.89  94.00
280.91  94.00
280.88  94.00
280.89  95.00
280.94  94.00
280.93  94.00
280.90  95.00
280.91  95.00
280.90  95.00
280.87  95.00
280.89  94.00
280.88  94.00
280.90  95.00
280.86  95.00
280.86  94.00
280.88  94.00
280.85  95.00
280.90  94.00
280.92  95.00
280.91  95.00
280.88  95.00
280.88  94.00
280.93  95.00
280.88  95.00
280.89  96.00
280.92  94.00
280.87  95.00
280.89  95.00
280.88  95.00
280.87  96.00
280.91  95.00
280.91  94.00
280.85  95.00
280.90  95.00
280.87  96.00
280.88  95.00
280.90  95.00
280.89  96.00
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280.89  94.00
280.87  96.00
280.90  96.00
280.90  95.00
280.89  95.00
280.92  95.00
280.92  95.00
280.94  95.00
280.92  95.00
280.89  95.00
280.90  95.00
280.91  95.00
280.90  96.00
280.90  94.00
280.92  97.00
280.89  96.00
280.91  96.00
280.90  96.00
280.91  96.00
280.92  95.00
280.90  95.00
280.89  95.00
280.90  94.00
280.91  96.00
280.89  97.00
280.90  95.00
280.91  97.00
280.88  96.00
280.88  97.00
280.91  96.00
280.92  96.00
280.92  96.00
280.88  96.00
280.89  97.00
280.87  97.00
280.87  97.00
280.89  95.00
280.88  96.00
```

Listing 38: 第 1 片辐照 60s

```
 32.66  81.00
 32.69  80.00
 32.70  79.00
 32.70  80.00
 32.68  80.00
 32.69  80.00
 32.69  80.00
 32.69  80.00
 32.68  80.00
 32.67  80.00
 32.68  79.00
 32.68  81.00
 32.79  79.00
 34.71  80.00
 37.21  81.00
 39.69  80.00
 42.16  80.00
 44.67  82.00
```

```
 47.19  80.00
 49.67  83.00
 52.16  80.00
 54.68  82.00
 57.20  81.00
 59.67  82.00
 62.20  82.00
 64.75  83.00
 67.22  84.00
 69.71  84.00
 72.26  84.00
 74.72  84.00
 77.27  85.00
 79.72  85.00
 82.29  85.00
 84.70  85.00
 87.20  86.00
 89.73  87.00
 92.20  87.00
 94.69  88.00
 97.23  88.00
 99.75  87.00
102.24  87.00
104.78  87.00
107.24  88.00
109.79  89.00
112.30  89.00
114.76  89.00
117.27  90.00
119.80  91.00
122.29  91.00
124.78  91.00
127.26  92.00
129.74  93.00
132.26  92.00
134.77  93.00
137.28  92.00
139.77  93.00
142.29  92.00
144.79  92.00
147.32  91.00
149.79  91.00
152.30  88.00
154.82  88.00
157.31  87.00
159.83  86.00
162.32  86.00
164.85  86.00
167.19  86.00
169.67  86.00
172.19  85.00
174.70  86.00
177.20  86.00
179.70  86.00
182.23  86.00
184.71  85.00
187.23  86.00
189.75  86.00
192.22  86.00
194.73  87.00
```

```
197.22  87.00
199.72  86.00
202.23  86.00
204.73  85.00
207.22  87.00
209.70  87.00
212.16  87.00
214.67  89.00
217.20  91.00
219.71  93.00
222.24  98.00
224.71  102.00
227.23  108.00
229.75  114.00
232.24  122.00
234.77  131.00
237.29  144.00
239.78  156.00
242.29  173.00
244.78  189.00
247.32  209.00
249.71  228.00
252.20  246.00
254.68  262.00
257.20  278.00
259.72  283.00
262.22  277.00
264.70  256.00
267.23  224.00
269.74  188.00
272.27  156.00
274.75  136.00
277.25  122.00
279.76  119.00
280.90  116.00
280.91  113.00
280.90  110.00
280.90  109.00
280.90  107.00
280.91  105.00
280.93  103.00
280.90  102.00
280.89  100.00
280.90  100.00
280.90  98.00
280.91  98.00
280.91  99.00
280.89  97.00
280.90  96.00
280.91  98.00
280.89  95.00
280.89  96.00
280.90  95.00
280.93  94.00
280.92  95.00
280.91  95.00
280.90  94.00
280.92  94.00
280.90  93.00
280.90  95.00
```

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280.89  94.00
280.90  93.00
280.88  93.00
280.89  93.00
280.89  93.00
280.90  93.00
280.91  94.00
280.91  94.00
280.91  96.00
280.90  94.00
280.89  93.00
280.90  95.00
280.91  93.00
280.91  94.00
280.91  94.00
280.90  94.00
280.91  94.00
280.91  93.00
280.94  94.00
280.90  92.00
280.90  94.00
280.91  94.00
280.91  93.00
280.91  93.00
280.91  93.00
280.91  94.00
280.91  95.00
280.92  93.00
280.91  93.00
280.91  95.00
280.91  94.00
280.93  93.00
280.92  95.00
280.89  94.00
280.91  94.00
280.91  93.00
280.92  94.00
280.90  94.00
280.90  95.00
280.91  94.00
280.90  92.00
280.90  93.00
280.89  94.00
280.91  94.00
280.93  94.00
280.89  94.00
280.90  93.00
280.91  94.00
280.89  94.00
280.89  94.00
280.89  93.00
280.88  95.00
280.88  93.00
280.86  95.00
280.89  93.00
280.89  93.00
280.90  94.00
280.91  94.00
280.89  94.00
280.88  94.00
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280.88  94.00
280.88  95.00
280.89  95.00
280.90  94.00
280.90  94.00
280.89  95.00
280.89  95.00
280.88  94.00
280.89  95.00
280.92  95.00
280.88  94.00
280.89  94.00
280.89  94.00
280.89  95.00
280.90  94.00
280.88  95.00
280.89  95.00
280.87  94.00
280.86  94.00
280.87  95.00
280.87  95.00
280.87  95.00
280.88  95.00
280.87  96.00
280.88  95.00
280.87  95.00
280.87  96.00
280.88  95.00
280.89  96.00
280.87  96.00
280.88  96.00
280.88  95.00
280.88  95.00
280.87  96.00
```

Listing 39: 第 1 片辐照 90s

```
 34.88  83.00
 34.94  84.00
 34.98  84.00
 35.01  84.00
 35.04  84.00
 35.07  84.00
 35.08  83.00
 35.12  83.00
 35.13  83.00
 35.16  84.00
 35.19  84.00
 35.20  84.00
 35.22  83.00
 35.34  84.00
 37.21  82.00
 39.69  84.00
 42.15  85.00
 44.62  85.00
 47.15  84.00
 49.66  85.00
 52.17  85.00
 54.67  85.00
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 57.17  86.00
 59.69  86.00
 62.20  87.00
 64.72  85.00
 67.24  87.00
 69.74  87.00
 72.27  89.00
 74.77  89.00
 77.25  89.00
 79.77  90.00
 82.29  91.00
 84.70  91.00
 87.21  92.00
 89.71  92.00
 92.23  91.00
 94.71  93.00
 97.23  92.00
 99.73  93.00
102.25  93.00
104.76  93.00
107.25  94.00
109.76  93.00
112.27  95.00
114.80  94.00
117.30  95.00
119.80  97.00
122.29  96.00
124.77  98.00
127.26  97.00
129.77  97.00
132.27  98.00
134.76  99.00
137.29  96.00
139.75  95.00
142.27  95.00
144.79  93.00
147.30  91.00
149.79  90.00
152.30  88.00
154.82  88.00
157.32  88.00
159.83  88.00
162.33  88.00
164.87  89.00
167.22  88.00
169.70  90.00
172.20  90.00
174.74  90.00
177.23  92.00
179.76  89.00
182.21  90.00
184.75  92.00
187.23  91.00
189.72  91.00
192.23  90.00
194.76  91.00
197.22  90.00
199.67  90.00
202.23  92.00
204.68  93.00
```

```
207.23  95.00
209.67  98.00
212.17  102.00
214.73  109.00
217.19  114.00
219.67  123.00
222.21  133.00
224.70  144.00
227.23  158.00
229.76  177.00
232.24  197.00
234.74  219.00
237.26  247.00
239.82  274.00
242.29  303.00
244.78  335.00
247.33  363.00
249.71  384.00
252.20  391.00
254.70  385.00
257.21  354.00
259.72  305.00
262.23  248.00
264.74  196.00
267.26  159.00
269.76  139.00
272.27  131.00
274.76  130.00
277.28  129.00
279.80  131.00
280.91  128.00
280.90  124.00
280.90  121.00
280.91  118.00
280.90  115.00
280.89  111.00
280.90  108.00
280.93  107.00
280.90  104.00
280.90  102.00
280.89  103.00
280.89  102.00
280.90  101.00
280.89  100.00
280.90  100.00
280.89  100.00
280.90  99.00
280.90  99.00
280.90  97.00
280.92  98.00
280.92  98.00
280.92  99.00
280.91  96.00
280.90  97.00
280.91  98.00
280.92  97.00
280.89  97.00
280.90  98.00
280.90  98.00
280.90  96.00
```

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280.89  96.00
280.89  97.00
280.90  97.00
280.90  96.00
280.91  98.00
280.90  97.00
280.89  97.00
280.90  97.00
280.90  97.00
280.90  98.00
280.89  97.00
280.89  97.00
280.89  99.00
280.89  98.00
280.89  97.00
280.91  97.00
280.89  97.00
280.89  97.00
280.89  98.00
280.87  98.00
280.90  97.00
280.89  96.00
280.90  97.00
280.89  97.00
280.88  98.00
280.89  98.00
280.89  97.00
280.90  98.00
280.89  98.00
280.89  96.00
280.89  97.00
280.88  97.00
280.88  97.00
280.88  97.00
280.88  98.00
280.88  97.00
280.88  97.00
280.86  99.00
280.88  98.00
280.89  98.00
280.91  99.00
280.90  97.00
280.88  98.00
280.88  97.00
280.88  97.00
280.88  97.00
280.87  97.00
280.89  98.00
280.88  99.00
280.88  97.00
280.88  98.00
280.88  98.00
280.89  97.00
280.92  98.00
280.89  97.00
280.90  98.00
280.90  97.00
280.90  97.00
280.91  97.00
280.88  99.00
```

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280.90  98.00
280.90  97.00
280.91  98.00
280.92  98.00
280.92  97.00
280.92  99.00
280.93  99.00
280.92  97.00
280.90  99.00
280.90  98.00
280.92  98.00
280.90  98.00
280.91  98.00
280.90  98.00
280.91  100.00
280.90  98.00
280.91  99.00
280.92  98.00
280.93  99.00
280.91  97.00
280.91  99.00
280.91  99.00
280.90  98.00
280.91  98.00
280.90  98.00
280.87  99.00
280.89  99.00
280.90  100.00
280.90  100.00
280.90  98.00
```

Listing 40: 第 1 片辐照 120s

```
 38.21  86.00
 38.22  89.00
 38.24  87.00
 38.24  88.00
 38.26  87.00
 38.27  87.00
 38.26  88.00
 38.28  87.00
 38.29  87.00
 38.30  87.00
 38.29  87.00
 38.30  87.00
 38.31  87.00
 38.31  86.00
 38.31  87.00
 39.71  87.00
 42.18  87.00
 44.65  86.00
 47.15  87.00
 49.64  88.00
 52.17  87.00
 54.68  90.00
 57.17  87.00
 59.69  88.00
 62.20  89.00
 64.72  90.00
```

```
 67.22  90.00
 69.69  90.00
 72.25  91.00
 74.75  91.00
 77.24  93.00
 79.75  93.00
 82.29  93.00
 84.72  94.00
 87.21  95.00
 89.70  96.00
 92.21  96.00
 94.73  96.00
 97.23  95.00
 99.73  97.00
102.23  96.00
104.76  98.00
107.27  97.00
109.75  98.00
112.28  97.00
114.79  98.00
117.30  99.00
119.78  99.00
122.29  99.00
124.78  100.00
127.25  101.00
129.75  101.00
132.27  103.00
134.79  101.00
137.29  104.00
139.80  104.00
142.30  102.00
144.80  103.00
147.30  100.00
149.80  99.00
152.29  97.00
154.82  94.00
157.30  95.00
159.82  92.00
162.30  92.00
164.82  92.00
167.20  92.00
169.69  91.00
172.17  92.00
174.70  92.00
177.21  93.00
179.70  93.00
182.21  94.00
184.70  95.00
187.23  96.00
189.74  95.00
192.23  97.00
194.73  95.00
197.22  96.00
199.72  96.00
202.22  95.00
204.71  94.00
207.23  95.00
209.70  95.00
212.16  99.00
214.67  101.00
```

```
  217.18  105.00
  219.70  110.00
  222.21  116.00
  224.69  124.00
  227.24  134.00
  229.76  148.00
  232.26  162.00
  234.76  178.00
  237.26  201.00
  239.80  224.00
  242.26  252.00
  244.77  283.00
  247.32  318.00
  249.70  356.00
  252.18  395.00
  254.66  428.00
  257.18  457.00
  259.71  478.00
  262.20  472.00
  264.70  444.00
  267.21  391.00
  269.74  321.00
  272.26  249.00
  274.75  194.00
  277.25  163.00
  279.79  148.00
  280.89  140.00
  280.89  137.00
  280.89  132.00
  280.88  128.00
  280.90  126.00
  280.88  122.00
  280.87  120.00
  280.90  117.00
  280.88  114.00
  280.89  112.00
  280.89  111.00
  280.88  110.00
  280.89  107.00
  280.88  106.00
  280.89  106.00
  280.88  106.00
  280.90  105.00
  280.89  104.00
  280.88  103.00
  280.89  101.00
  280.89  104.00
  280.88  101.00
  280.88  102.00
  280.88  100.00
  280.89  101.00
  280.89  100.00
  280.88  101.00
  280.88  101.00
  280.87  100.00
  280.90  99.00
  280.88  100.00
  280.88  99.00
  280.86  100.00
  280.87  99.00
```

```
280.86  101.00
280.87  99.00
280.88  98.00
280.87  99.00
280.88  100.00
280.88  99.00
280.87  99.00
280.88  100.00
280.89  100.00
280.88  99.00
280.88  99.00
280.88  100.00
280.88  99.00
280.88  97.00
280.88  100.00
280.88  100.00
280.88  99.00
280.89  98.00
280.89  99.00
280.89  98.00
280.90  100.00
280.91  99.00
280.90  99.00
280.89  99.00
280.90  98.00
280.90  101.00
280.89  100.00
280.91  99.00
280.90  99.00
280.91  98.00
280.90  99.00
280.89  99.00
280.90  99.00
280.91  98.00
280.90  100.00
280.91  99.00
280.90  99.00
280.90  99.00
280.89  100.00
280.89  98.00
280.89  100.00
280.89  100.00
280.90  99.00
280.89  100.00
280.89  100.00
280.88  101.00
280.91  99.00
280.87  100.00
280.88  100.00
280.89  100.00
280.88  100.00
280.86  99.00
280.87  99.00
280.88  99.00
280.89  100.00
280.88  99.00
280.89  101.00
280.89  101.00
280.91  100.00
280.90  100.00
```

```
280.89  100.00
280.88  101.00
280.87  101.00
280.87  99.00
280.87  100.00
280.88  100.00
280.88  99.00
280.87  100.00
280.88  101.00
280.87  100.00
280.89  100.00
280.90  100.00
280.89  101.00
280.87  100.00
280.88  101.00
280.87  102.00
280.88  98.00
280.88  101.00
280.89  101.00
280.88  100.00
280.88  102.00
280.86  100.00
280.87  100.00
280.87  101.00
280.91  100.00
280.88  102.00
```

Listing 41: 第 1 片辐照 150s

```
 36.65  85.00
 36.69  82.00
 36.69  85.00
 36.72  83.00
 36.73  84.00
 36.73  84.00
 36.74  83.00
 36.76  84.00
 36.76  82.00
 36.75  84.00
 36.76  83.00
 36.76  83.00
 36.76  82.00
 36.77  83.00
 37.34  83.00
 39.69  83.00
 42.17  82.00
 44.65  83.00
 47.13  83.00
 49.66  83.00
 52.15  84.00
 54.69  83.00
 57.16  84.00
 59.69  85.00
 62.19  84.00
 64.71  85.00
 67.22  85.00
 69.73  85.00
 72.24  86.00
 74.76  87.00
```

```
 77.26  87.00
 79.76  87.00
 82.30  89.00
 84.70  89.00
 87.21  89.00
 89.69  90.00
 92.20  92.00
 94.73  90.00
 97.24  90.00
 99.74  92.00
102.23  92.00
104.76  93.00
107.27  92.00
109.76  93.00
112.27  94.00
114.79  94.00
117.31  95.00
119.80  96.00
122.30  97.00
124.78  99.00
127.27  100.00
129.76  102.00
132.29  102.00
134.79  104.00
137.28  104.00
139.79  103.00
142.29  101.00
144.78  101.00
147.30  96.00
149.79  96.00
152.29  91.00
154.81  92.00
157.32  90.00
159.82  89.00
162.30  91.00
164.83  90.00
167.19  90.00
169.70  93.00
172.17  91.00
174.67  94.00
177.20  94.00
179.70  95.00
182.21  96.00
184.70  97.00
187.24  99.00
189.74  99.00
192.24  99.00
194.72  97.00
197.21  98.00
199.72  98.00
202.21  97.00
204.72  99.00
207.21  101.00
209.70  104.00
212.15  112.00
214.66  119.00
217.18  128.00
219.72  143.00
222.20  158.00
224.72  180.00
```

```
227.23  208.00
229.75  240.00
232.26  277.00
234.77  326.00
237.28  380.00
239.79  437.00
242.31  503.00
244.81  567.00
247.29  633.00
249.71  672.00
252.19  694.00
254.71  672.00
257.20  598.00
259.72  491.00
262.22  371.00
264.74  265.00
267.25  195.00
269.75  165.00
272.25  152.00
274.75  151.00
277.27  150.00
279.78  148.00
280.91  146.00
280.90  144.00
280.90  139.00
280.92  134.00
280.92  131.00
280.90  127.00
280.90  121.00
280.91  118.00
280.92  116.00
280.89  113.00
280.89  110.00
280.89  109.00
280.89  108.00
280.88  106.00
280.88  105.00
280.88  105.00
280.88  102.00
280.90  103.00
280.88  101.00
280.88  101.00
280.90  100.00
280.89  100.00
280.89  99.00
280.89  99.00
280.88  98.00
280.88  99.00
280.89  99.00
280.87  97.00
280.87  98.00
280.88  98.00
280.90  98.00
280.88  95.00
280.87  98.00
280.89  98.00
280.89  97.00
280.87  98.00
280.87  97.00
280.89  97.00
```

```
280.88  99.00
280.88  97.00
280.87  96.00
280.89  98.00
280.89  97.00
280.88  97.00
280.88  97.00
280.88  98.00
280.91  97.00
280.90  98.00
280.90  99.00
280.89  97.00
280.89  97.00
280.89  98.00
280.89  98.00
280.89  97.00
280.90  98.00
280.90  97.00
280.90  96.00
280.90  97.00
280.90  97.00
280.92  97.00
280.90  98.00
280.90  99.00
280.90  97.00
280.91  97.00
280.92  98.00
280.90  97.00
280.91  98.00
280.90  98.00
280.91  97.00
280.90  97.00
280.89  98.00
280.93  97.00
280.91  98.00
280.90  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.89  97.00
280.88  98.00
280.89  97.00
280.90  98.00
280.89  98.00
280.90  97.00
280.89  98.00
280.92  98.00
280.90  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.89  98.00
280.88  99.00
280.88  98.00
280.89  99.00
280.90  99.00
280.91  98.00
```

```
280.89  99.00
280.89  99.00
280.90  98.00
280.89  99.00
280.90  99.00
280.89  100.00
280.89  98.00
280.88  99.00
280.89  100.00
280.89  100.00
280.90  98.00
280.91  98.00
280.90  100.00
280.89  98.00
280.88  100.00
280.88  99.00
280.88  99.00
280.88  99.00
280.88  100.00
280.89  98.00
280.89  100.00
280.88  99.00
```

Listing 42: 第 2 片辐照 30s

```
 34.61  84.00
 34.59  84.00
 34.58  83.00
 34.57  85.00
 34.56  84.00
 34.56  83.00
 34.56  84.00
 34.51  83.00
 34.51  84.00
 34.50  84.00
 34.49  84.00
 34.47  84.00
 34.47  84.00
 34.90  83.00
 37.21  83.00
 39.69  84.00
 42.20  83.00
 44.65  85.00
 47.17  84.00
 49.65  86.00
 52.18  85.00
 54.66  86.00
 57.19  86.00
 59.69  87.00
 62.20  88.00
 64.72  89.00
 67.20  89.00
 69.71  91.00
 72.21  91.00
 74.76  93.00
 77.25  93.00
 79.77  95.00
 82.28  95.00
 84.71  98.00
```

```
 87.19  100.00
 89.69  101.00
 92.22  103.00
 94.71  105.00
 97.22  107.00
 99.74  108.00
102.21  111.00
104.76  113.00
107.25  112.00
109.74  117.00
112.27  118.00
114.78  119.00
117.28  118.00
119.79  121.00
122.29  122.00
124.78  123.00
127.26  123.00
129.76  123.00
132.26  123.00
134.76  122.00
137.27  122.00
139.79  122.00
142.29  122.00
144.80  120.00
147.30  118.00
149.82  116.00
152.30  115.00
154.83  111.00
157.33  109.00
159.84  106.00
162.32  104.00
164.85  102.00
167.21  99.00
169.70  97.00
172.21  94.00
174.73  94.00
177.22  93.00
179.71  92.00
182.23  91.00
184.70  91.00
187.24  90.00
189.73  89.00
192.23  88.00
194.74  88.00
197.22  88.00
199.73  88.00
202.24  86.00
204.73  87.00
207.25  87.00
209.71  86.00
212.17  86.00
214.65  87.00
217.20  88.00
219.71  87.00
222.22  89.00
224.73  90.00
227.22  93.00
229.74  95.00
232.24  97.00
234.72  103.00
```

```
237.27  107.00
239.79  112.00
242.29  119.00
244.79  126.00
247.30  134.00
249.71  143.00
252.20  152.00
254.68  165.00
257.21  172.00
259.73  179.00
262.23  186.00
264.72  188.00
267.23  185.00
269.76  177.00
272.24  161.00
274.77  146.00
277.28  130.00
279.78  118.00
280.92  110.00
280.92  105.00
280.91  103.00
280.89  103.00
280.92  101.00
280.90  102.00
280.89  100.00
280.89  100.00
280.89  99.00
280.88  100.00
280.88  99.00
280.89  98.00
280.89  97.00
280.89  96.00
280.87  98.00
280.88  96.00
280.86  96.00
280.90  98.00
280.88  96.00
280.88  96.00
280.87  95.00
280.89  97.00
280.88  95.00
280.88  96.00
280.89  96.00
280.88  96.00
280.89  96.00
280.88  95.00
280.89  96.00
280.89  96.00
280.91  96.00
280.86  94.00
280.90  96.00
280.90  95.00
280.89  95.00
280.89  96.00
280.90  95.00
280.89  94.00
280.91  96.00
280.91  96.00
280.90  96.00
280.92  94.00
```

```
  280.93  95.00
  280.92  96.00
  280.91  96.00
  280.89  96.00
  280.90  95.00
  280.89  96.00
  280.88  95.00
  280.89  95.00
  280.89  95.00
  280.87  97.00
  280.88  95.00
  280.89  96.00
  280.89  95.00
  280.92  97.00
  280.88  95.00
  280.89  96.00
  280.88  96.00
  280.88  96.00
  280.88  96.00
  280.88  96.00
  280.89  97.00
  280.90  96.00
  280.88  95.00
  280.90  97.00
  280.89  96.00
  280.90  97.00
  280.90  97.00
  280.89  96.00
  280.87  96.00
  280.89  97.00
  280.88  97.00
  280.89  98.00
  280.88  97.00
  280.90  97.00
  280.88  97.00
  280.88  97.00
  280.90  96.00
  280.88  98.00
  280.90  96.00
  280.89  97.00
  280.89  96.00
  280.90  97.00
  280.89  97.00
  280.89  97.00
  280.88  97.00
  280.89  97.00
  280.90  97.00
  280.87  98.00
  280.88  97.00
  280.88  97.00
  280.87  98.00
  280.90  97.00
  280.89  98.00
  280.88  97.00
  280.88  98.00
  280.89  98.00
  280.89  98.00
  280.89  97.00
  280.89  98.00
  280.88  97.00
```

```
280.88  97.00
280.88  98.00
280.86  98.00
280.91  97.00
280.89  99.00
280.89  98.00
280.89  98.00
280.89  98.00
280.90  98.00
280.89  100.00
280.90  98.00
280.89  99.00
280.88  98.00
280.89  100.00
280.89  98.00
280.89  98.00
280.92  98.00
280.89  99.00
```

Listing 43: 第 2 片辐照 60s

```
 36.06  86.00
 36.08  87.00
 36.11  87.00
 36.11  86.00
 36.13  86.00
 36.13  86.00
 36.15  86.00
 36.13  86.00
 36.15  87.00
 36.16  86.00
 36.16  86.00
 36.16  86.00
 36.17  86.00
 36.17  86.00
 37.19  86.00
 39.71  86.00
 42.17  86.00
 44.63  88.00
 47.15  88.00
 49.65  87.00
 52.15  88.00
 54.66  89.00
 57.17  90.00
 59.69  91.00
 62.20  93.00
 64.69  93.00
 67.22  94.00
 69.72  95.00
 72.27  98.00
 74.75  100.00
 77.26  102.00
 79.75  104.00
 82.28  105.00
 84.68  109.00
 87.20  111.00
 89.68  112.00
 92.22  114.00
 94.73  117.00
```

```
 97.22  119.00
 99.72  121.00
102.23  123.00
104.74  123.00
107.25  125.00
109.75  126.00
112.26  127.00
114.74  127.00
117.29  128.00
119.78  128.00
122.29  130.00
124.79  129.00
127.25  127.00
129.75  126.00
132.24  128.00
134.79  124.00
137.27  125.00
139.77  124.00
142.29  120.00
144.77  118.00
147.27  114.00
149.79  111.00
152.29  108.00
154.81  103.00
157.31  100.00
159.81  99.00
162.30  96.00
164.86  95.00
167.20  94.00
169.71  93.00
172.19  92.00
174.75  92.00
177.19  91.00
179.70  91.00
182.21  91.00
184.73  93.00
187.24  91.00
189.75  92.00
192.23  90.00
194.75  92.00
197.24  91.00
199.73  90.00
202.26  90.00
204.72  89.00
207.23  91.00
209.70  91.00
212.16  92.00
214.65  93.00
217.21  99.00
219.73  102.00
222.21  108.00
224.74  117.00
227.23  124.00
229.75  135.00
232.27  148.00
234.77  165.00
237.27  177.00
239.81  196.00
242.27  219.00
244.80  239.00
```

```
247.33  261.00
249.71  277.00
252.21  291.00
254.69  294.00
257.20  285.00
259.72  272.00
262.23  240.00
264.71  201.00
267.24  164.00
269.77  134.00
272.27  117.00
274.77  110.00
277.29  110.00
279.78  110.00
280.91  110.00
280.90  110.00
280.91  108.00
280.89  106.00
280.91  105.00
280.92  103.00
280.91  102.00
280.91  102.00
280.90  100.00
280.93  101.00
280.91  100.00
280.91  98.00
280.91  99.00
280.90  98.00
280.89  98.00
280.89  97.00
280.89  98.00
280.89  97.00
280.90  97.00
280.89  97.00
280.90  95.00
280.90  96.00
280.89  96.00
280.90  96.00
280.88  95.00
280.88  96.00
280.90  96.00
280.89  96.00
280.90  95.00
280.88  96.00
280.89  97.00
280.89  96.00
280.89  96.00
280.89  95.00
280.90  96.00
280.90  96.00
280.90  97.00
280.88  95.00
280.89  97.00
280.88  96.00
280.89  96.00
280.88  97.00
280.87  95.00
280.89  96.00
280.89  95.00
280.89  96.00
```

```
280.89  96.00
280.89  98.00
280.89  97.00
280.89  96.00
280.88  96.00
280.90  96.00
280.88  96.00
280.88  96.00
280.89  97.00
280.89  96.00
280.89  98.00
280.90  95.00
280.90  98.00
280.91  96.00
280.91  96.00
280.90  96.00
280.90  97.00
280.90  96.00
280.90  98.00
280.90  96.00
280.89  97.00
280.88  96.00
280.89  97.00
280.89  96.00
280.89  97.00
280.88  97.00
280.89  97.00
280.88  96.00
280.91  96.00
280.90  96.00
280.88  97.00
280.88  97.00
280.88  97.00
280.89  98.00
280.88  97.00
280.87  96.00
280.88  97.00
280.88  96.00
280.88  98.00
280.90  99.00
280.89  96.00
280.89  97.00
280.90  98.00
280.90  96.00
280.90  97.00
280.89  97.00
280.88  97.00
280.89  97.00
280.89  98.00
280.87  96.00
280.89  98.00
280.89  97.00
280.91  97.00
280.89  97.00
280.89  98.00
280.89  97.00
280.91  100.00
280.90  97.00
280.91  97.00
280.90  97.00
```

```
280.89  98.00
280.91  98.00
280.90  97.00
280.91  98.00
280.92  97.00
280.91  98.00
280.90  99.00
280.89  98.00
280.88  97.00
280.89  99.00
280.91  98.00
280.90  98.00
280.91  99.00
280.90  98.00
```

Listing 44: 第 2 片辐照 90s

```
 37.88  92.00
 37.91  93.00
 37.91  92.00
 37.92  93.00
 37.91  92.00
 37.92  92.00
 37.90  92.00
 37.89  92.00
 37.89  92.00
 37.91  92.00
 37.90  91.00
 37.88  92.00
 37.88  92.00
 37.90  92.00
 37.96  91.00
 39.69  91.00
 42.20  90.00
 44.67  91.00
 47.19  92.00
 49.69  92.00
 52.16  92.00
 54.66  94.00
 57.18  96.00
 59.70  96.00
 62.22  98.00
 64.72  98.00
 67.22  102.00
 69.74  104.00
 72.26  105.00
 74.75  108.00
 77.26  110.00
 79.76  111.00
 82.30  115.00
 84.69  118.00
 87.21  120.00
 89.70  121.00
 92.20  126.00
 94.71  129.00
 97.24  130.00
 99.72  132.00
102.24  134.00
104.79  136.00
```

```
107.29  138.00
109.80  137.00
112.27  139.00
114.77  139.00
117.30  141.00
119.83  140.00
122.31  140.00
124.83  140.00
127.29  139.00
129.81  138.00
132.30  139.00
134.80  137.00
137.27  136.00
139.76  134.00
142.31  130.00
144.80  127.00
147.33  124.00
149.82  119.00
152.32  115.00
154.84  112.00
157.35  109.00
159.82  105.00
162.31  102.00
164.85  101.00
167.21  100.00
169.70  98.00
172.18  97.00
174.73  96.00
177.21  96.00
179.72  97.00
182.20  96.00
184.74  97.00
187.22  95.00
189.73  95.00
192.26  97.00
194.76  96.00
197.24  96.00
199.75  95.00
202.25  95.00
204.74  94.00
207.24  96.00
209.71  95.00
212.16  98.00
214.67  100.00
217.21  105.00
219.73  111.00
222.23  117.00
224.72  128.00
227.24  138.00
229.76  149.00
232.25  165.00
234.78  185.00
237.29  203.00
239.80  231.00
242.29  255.00
244.79  282.00
247.30  308.00
249.70  333.00
252.19  359.00
254.71  371.00
```

```
  257.22  378.00
  259.73  372.00
  262.24  345.00
  264.74  307.00
  267.24  254.00
  269.75  203.00
  272.26  161.00
  274.76  134.00
  277.28  122.00
  279.78  121.00
  280.89  119.00
  280.89  114.00
  280.90  115.00
  280.89  112.00
  280.89  109.00
  280.90  108.00
  280.89  108.00
  280.89  105.00
  280.90  104.00
  280.89  103.00
  280.92  103.00
  280.89  103.00
  280.89  101.00
  280.89  101.00
  280.91  100.00
  280.89  100.00
  280.92  99.00
  280.89  100.00
  280.90  100.00
  280.89  100.00
  280.91  99.00
  280.90  100.00
  280.90  99.00
  280.90  101.00
  280.90  98.00
  280.89  99.00
  280.88  98.00
  280.89  100.00
  280.89  97.00
  280.89  100.00
  280.88  99.00
  280.89  99.00
  280.89  97.00
  280.90  100.00
  280.89  100.00
  280.91  99.00
  280.89  98.00
  280.88  99.00
  280.89  98.00
  280.89  99.00
  280.89  98.00
  280.89  98.00
  280.90  100.00
  280.89  99.00
  280.88  99.00
  280.88  98.00
  280.89  99.00
  280.89  99.00
  280.90  99.00
  280.88  98.00
```

```
280.90  98.00
280.89  99.00
280.89  101.00
280.89  98.00
280.89  99.00
280.89  99.00
280.89  99.00
280.90  99.00
280.89  100.00
280.90  99.00
280.91  98.00
280.91  99.00
280.90  100.00
280.90  98.00
280.90  99.00
280.89  99.00
280.89  100.00
280.89  99.00
280.91  98.00
280.89  100.00
280.91  98.00
280.90  99.00
280.89  101.00
280.92  98.00
280.92  99.00
280.92  99.00
280.90  98.00
280.91  99.00
280.90  100.00
280.91  98.00
280.90  100.00
280.91  100.00
280.91  100.00
280.92  99.00
280.91  99.00
280.91  101.00
280.93  100.00
280.91  100.00
280.92  100.00
280.91  99.00
280.91  100.00
280.90  99.00
280.90  100.00
280.91  101.00
280.91  100.00
280.90  99.00
280.89  99.00
280.89  101.00
280.92  100.00
280.93  101.00
280.92  101.00
280.91  99.00
280.92  101.00
280.89  101.00
280.91  101.00
280.91  100.00
280.92  98.00
280.90  101.00
280.89  101.00
280.88  99.00
```

```
280.88  100.00
280.92  101.00
280.92  101.00
280.89  100.00
280.90  101.00
280.88  100.00
280.90  101.00
280.89  101.00
280.89  102.00
280.90  100.00
```

Listing 45: 第 2 片辐照 120s

```
 38.27  92.00
 38.29  91.00
 38.30  92.00
 38.30  90.00
 38.31  91.00
 38.32  91.00
 38.32  90.00
 38.32  93.00
 38.33  90.00
 38.33  92.00
 38.32  90.00
 38.31  92.00
 38.32  91.00
 38.31  90.00
 38.32  91.00
 39.69  90.00
 42.18  91.00
 44.65  91.00
 47.16  91.00
 49.65  92.00
 52.17  93.00
 54.66  93.00
 57.21  94.00
 59.68  95.00
 62.18  96.00
 64.71  97.00
 67.24  98.00
 69.71  102.00
 72.24  100.00
 74.75  102.00
 77.27  106.00
 79.76  107.00
 82.32  110.00
 84.70  110.00
 87.20  114.00
 89.71  116.00
 92.20  118.00
 94.73  120.00
 97.21  122.00
 99.74  124.00
102.22  126.00
104.76  128.00
107.27  130.00
109.78  130.00
112.30  132.00
114.79  133.00
```

```
117.30  134.00
119.81  133.00
122.32  134.00
124.78  135.00
127.25  136.00
129.76  134.00
132.27  134.00
134.78  133.00
137.29  134.00
139.79  133.00
142.31  131.00
144.80  128.00
147.30  125.00
149.81  122.00
152.29  117.00
154.82  113.00
157.30  109.00
159.85  107.00
162.32  104.00
164.85  101.00
167.21  100.00
169.72  99.00
172.19  97.00
174.70  98.00
177.21  96.00
179.71  98.00
182.21  97.00
184.72  98.00
187.22  99.00
189.73  99.00
192.25  98.00
194.72  99.00
197.24  97.00
199.73  97.00
202.24  98.00
204.71  97.00
207.24  96.00
209.70  98.00
212.16  98.00
214.71  101.00
217.20  105.00
219.73  112.00
222.22  119.00
224.74  126.00
227.23  139.00
229.75  152.00
232.25  168.00
234.77  187.00
237.27  212.00
239.80  236.00
242.27  269.00
244.78  297.00
247.32  334.00
249.71  365.00
252.20  395.00
254.71  422.00
257.20  436.00
259.75  440.00
262.23  419.00
264.75  383.00
```

```
  267.25  324.00
  269.74  259.00
  272.27  199.00
  274.74  154.00
  277.25  131.00
  279.76  123.00
  280.90  119.00
  280.91  116.00
  280.89  115.00
  280.89  113.00
  280.90  111.00
  280.89  110.00
  280.90  107.00
  280.89  106.00
  280.89  106.00
  280.89  104.00
  280.89  103.00
  280.89  102.00
  280.89  102.00
  280.90  101.00
  280.90  102.00
  280.88  100.00
  280.89  100.00
  280.88  99.00
  280.89  99.00
  280.89  99.00
  280.88  100.00
  280.89  98.00
  280.90  99.00
  280.88  98.00
  280.89  98.00
  280.87  99.00
  280.92  99.00
  280.89  100.00
  280.88  97.00
  280.87  100.00
  280.88  99.00
  280.88  100.00
  280.87  98.00
  280.88  98.00
  280.88  97.00
  280.88  98.00
  280.88  98.00
  280.87  97.00
  280.88  98.00
  280.88  97.00
  280.88  99.00
  280.87  97.00
  280.87  98.00
  280.87  100.00
  280.87  100.00
  280.86  97.00
  280.86  99.00
  280.87  98.00
  280.89  98.00
  280.89  99.00
  280.87  98.00
  280.88  99.00
  280.88  98.00
  280.85  100.00
```

```
280.84  99.00
280.88  97.00
280.93  100.00
280.92  99.00
280.86  99.00
280.89  100.00
280.92  98.00
280.87  99.00
280.93  98.00
280.89  99.00
280.95  99.00
280.90  99.00
280.92  99.00
280.91  99.00
280.89  99.00
280.91  98.00
280.90  99.00
280.90  98.00
280.90  101.00
280.89  98.00
280.89  100.00
280.89  99.00
280.89  99.00
280.90  99.00
280.89  100.00
280.88  99.00
280.87  99.00
280.87  100.00
280.88  100.00
280.88  98.00
280.87  99.00
280.89  100.00
280.89  99.00
280.88  98.00
280.89  100.00
280.89  100.00
280.90  99.00
280.90  100.00
280.89  99.00
280.89  100.00
280.89  100.00
280.89  99.00
280.88  99.00
280.88  100.00
280.88  101.00
280.89  99.00
280.89  99.00
280.89  100.00
280.92  100.00
280.88  99.00
280.87  100.00
280.88  99.00
280.88  101.00
280.89  101.00
280.88  100.00
280.87  101.00
280.88  98.00
280.88  100.00
280.89  100.00
280.88  100.00
```

```
280.87  100.00
280.90  101.00
280.88  101.00
280.88  100.00
280.87  101.00
280.89  101.00
```

Listing 46: 第 2 片辐照 150s

```
 33.42  82.00
 33.46  81.00
 33.47  83.00
 33.48  82.00
 33.49  82.00
 33.53  82.00
 33.54  82.00
 33.56  82.00
 33.56  82.00
 33.58  82.00
 33.59  82.00
 33.61  82.00
 33.61  82.00
 34.71  82.00
 37.21  82.00
 39.70  84.00
 42.19  83.00
 44.66  83.00
 47.17  84.00
 49.67  85.00
 52.21  84.00
 54.70  86.00
 57.19  87.00
 59.69  86.00
 62.24  88.00
 64.76  89.00
 67.24  91.00
 69.73  93.00
 72.25  93.00
 74.76  96.00
 77.27  98.00
 79.78  97.00
 82.31  99.00
 84.74  102.00
 87.22  104.00
 89.69  106.00
 92.26  109.00
 94.72  110.00
 97.25  112.00
 99.73  116.00
102.24  115.00
104.77  116.00
107.28  120.00
109.77  120.00
112.29  121.00
114.79  122.00
117.30  122.00
119.82  122.00
122.31  124.00
124.80  124.00
```

```
127.26  126.00
129.77  128.00
132.26  129.00
134.80  130.00
137.28  128.00
139.78  127.00
142.29  126.00
144.82  124.00
147.30  120.00
149.81  115.00
152.32  110.00
154.83  106.00
157.33  102.00
159.84  101.00
162.34  96.00
164.85  94.00
167.22  94.00
169.71  95.00
172.17  94.00
174.73  93.00
177.21  93.00
179.70  95.00
182.18  94.00
184.72  96.00
187.21  96.00
189.72  97.00
192.22  99.00
194.73  96.00
197.22  98.00
199.73  95.00
202.23  95.00
204.72  94.00
207.22  94.00
209.69  97.00
212.16  99.00
214.67  105.00
217.19  111.00
219.72  119.00
222.21  129.00
224.71  141.00
227.23  160.00
229.76  180.00
232.26  206.00
234.77  230.00
237.28  265.00
239.79  301.00
242.29  342.00
244.80  387.00
247.31  430.00
249.71  474.00
252.20  508.00
254.71  534.00
257.22  551.00
259.72  534.00
262.24  496.00
264.76  430.00
267.25  347.00
269.74  260.00
272.28  191.00
274.75  149.00
```

```
277.26  128.00
279.78  124.00
280.89  122.00
280.87  117.00
280.88  114.00
280.89  114.00
280.89  109.00
280.89  107.00
280.88  106.00
280.90  104.00
280.90  102.00
280.89  101.00
280.89  100.00
280.88  100.00
280.88  98.00
280.89  98.00
280.89  96.00
280.88  96.00
280.88  95.00
280.88  95.00
280.88  95.00
280.88  95.00
280.89  95.00
280.89  94.00
280.88  95.00
280.88  93.00
280.88  94.00
280.89  94.00
280.89  93.00
280.88  94.00
280.87  95.00
280.88  93.00
280.88  94.00
280.89  94.00
280.91  92.00
280.89  93.00
280.88  93.00
280.89  93.00
280.88  94.00
280.89  93.00
280.88  94.00
280.88  94.00
280.89  93.00
280.89  93.00
280.90  94.00
280.89  93.00
280.89  94.00
280.90  95.00
280.89  93.00
280.91  93.00
280.89  94.00
280.89  93.00
280.89  93.00
280.89  93.00
280.89  93.00
280.90  93.00
280.89  94.00
280.88  93.00
280.88  95.00
280.89  94.00
```

```
  280.90  94.00
  280.87  95.00
  280.89  95.00
  280.89  93.00
  280.89  94.00
  280.88  94.00
  280.89  94.00
  280.89  95.00
  280.88  94.00
  280.90  96.00
  280.90  93.00
  280.91  96.00
  280.93  94.00
  280.92  94.00
  280.90  95.00
  280.92  95.00
  280.91  94.00
  280.91  95.00
  280.91  94.00
  280.91  95.00
  280.92  96.00
  280.90  94.00
  280.92  95.00
  280.91  95.00
  280.91  96.00
  280.93  94.00
  280.91  94.00
  280.91  96.00
  280.91  95.00
  280.89  95.00
  280.91  95.00
  280.92  95.00
  280.90  95.00
  280.92  94.00
  280.92  96.00
  280.92  95.00
  280.90  94.00
  280.91  96.00
  280.92  96.00
  280.90  95.00
  280.90  94.00
  280.90  95.00
  280.90  95.00
  280.90  96.00
  280.90  94.00
  280.90  95.00
  280.90  96.00
  280.90  96.00
  280.91  95.00
  280.90  94.00
  280.92  95.00
  280.91  96.00
  280.91  95.00
  280.89  94.00
  280.89  96.00
  280.89  96.00
  280.89  95.00
  280.89  95.00
  280.88  97.00
  280.88  96.00
```

```
280.87  96.00
280.89  95.00
```

Listing 47: 第 3 片辐照 30s

```
 34.61  84.00
 34.59  84.00
 34.58  83.00
 34.57  85.00
 34.56  84.00
 34.56  83.00
 34.56  84.00
 34.51  83.00
 34.51  84.00
 34.50  84.00
 34.49  84.00
 34.47  84.00
 34.47  84.00
 34.90  83.00
 37.21  83.00
 39.69  84.00
 42.20  83.00
 44.65  85.00
 47.17  84.00
 49.65  86.00
 52.18  85.00
 54.66  86.00
 57.19  86.00
 59.69  87.00
 62.20  88.00
 64.72  89.00
 67.20  89.00
 69.71  91.00
 72.21  91.00
 74.76  93.00
 77.25  93.00
 79.77  95.00
 82.28  95.00
 84.71  98.00
 87.19  100.00
 89.69  101.00
 92.22  103.00
 94.71  105.00
 97.22  107.00
 99.74  108.00
102.21  111.00
104.76  113.00
107.25  112.00
109.74  117.00
112.27  118.00
114.78  119.00
117.28  118.00
119.79  121.00
122.29  122.00
124.78  123.00
127.26  123.00
129.76  123.00
132.26  123.00
134.76  122.00
```

```
137.27  122.00
139.79  122.00
142.29  122.00
144.80  120.00
147.30  118.00
149.82  116.00
152.30  115.00
154.83  111.00
157.33  109.00
159.84  106.00
162.32  104.00
164.85  102.00
167.21  99.00
169.70  97.00
172.21  94.00
174.73  94.00
177.22  93.00
179.71  92.00
182.23  91.00
184.70  91.00
187.24  90.00
189.73  89.00
192.23  88.00
194.74  88.00
197.22  88.00
199.73  88.00
202.24  86.00
204.73  87.00
207.25  87.00
209.71  86.00
212.17  86.00
214.65  87.00
217.20  88.00
219.71  87.00
222.22  89.00
224.73  90.00
227.22  93.00
229.74  95.00
232.24  97.00
234.72  103.00
237.27  107.00
239.79  112.00
242.29  119.00
244.79  126.00
247.30  134.00
249.71  143.00
252.20  152.00
254.68  165.00
257.21  172.00
259.73  179.00
262.23  186.00
264.72  188.00
267.23  185.00
269.76  177.00
272.24  161.00
274.77  146.00
277.28  130.00
279.78  118.00
280.92  110.00
280.92  105.00
```

```
  280.91  103.00
  280.89  103.00
  280.92  101.00
  280.90  102.00
  280.89  100.00
  280.89  100.00
  280.89  99.00
  280.88  100.00
  280.88  99.00
  280.89  98.00
  280.89  97.00
  280.89  96.00
  280.87  98.00
  280.88  96.00
  280.86  96.00
  280.90  98.00
  280.88  96.00
  280.88  96.00
  280.87  95.00
  280.89  97.00
  280.88  95.00
  280.88  96.00
  280.89  96.00
  280.88  96.00
  280.89  96.00
  280.88  95.00
  280.89  96.00
  280.89  96.00
  280.91  96.00
  280.86  94.00
  280.90  96.00
  280.90  95.00
  280.89  95.00
  280.89  96.00
  280.90  95.00
  280.89  94.00
  280.91  96.00
  280.91  96.00
  280.90  96.00
  280.92  94.00
  280.93  95.00
  280.92  96.00
  280.91  96.00
  280.89  96.00
  280.90  95.00
  280.89  96.00
  280.88  95.00
  280.89  95.00
  280.89  95.00
  280.87  97.00
  280.88  95.00
  280.89  96.00
  280.89  95.00
  280.92  97.00
  280.88  95.00
  280.89  96.00
  280.88  96.00
  280.88  96.00
  280.88  96.00
  280.88  96.00
```

```
280.89  97.00
280.90  96.00
280.88  95.00
280.90  97.00
280.89  96.00
280.90  97.00
280.90  97.00
280.89  96.00
280.87  96.00
280.89  97.00
280.88  97.00
280.89  98.00
280.88  97.00
280.90  97.00
280.88  97.00
280.88  97.00
280.90  96.00
280.88  98.00
280.90  96.00
280.89  97.00
280.89  96.00
280.90  97.00
280.89  97.00
280.89  97.00
280.88  97.00
280.89  97.00
280.90  97.00
280.87  98.00
280.88  97.00
280.88  97.00
280.87  98.00
280.90  97.00
280.89  98.00
280.88  97.00
280.88  98.00
280.89  98.00
280.89  98.00
280.89  97.00
280.89  98.00
280.88  97.00
280.88  97.00
280.88  98.00
280.86  98.00
280.91  97.00
280.89  99.00
280.89  98.00
280.89  98.00
280.89  98.00
280.90  98.00
280.89  100.00
280.90  98.00
280.89  99.00
280.88  98.00
280.89  100.00
280.89  98.00
280.89  98.00
280.92  98.00
280.89  99.00
```

Listing 48: 第 3 片辐照 60s

```
  36.53  85.00
  36.52  86.00
  36.54  85.00
  36.55  84.00
  36.55  84.00
  36.54  86.00
  36.55  84.00
  36.55  86.00
  36.54  86.00
  36.52  84.00
  36.52  84.00
  36.52  87.00
  36.53  84.00
  36.51  85.00
  37.26  85.00
  39.72  86.00
  42.19  84.00
  44.66  84.00
  47.13  86.00
  49.65  86.00
  52.19  86.00
  54.68  88.00
  57.17  88.00
  59.67  86.00
  62.18  90.00
  64.71  89.00
  67.23  89.00
  69.72  90.00
  72.24  92.00
  74.74  92.00
  77.26  91.00
  79.75  94.00
  82.28  96.00
  84.69  95.00
  87.20  97.00
  89.72  96.00
  92.23  97.00
  94.75  99.00
  97.22  99.00
  99.71  99.00
 102.22  101.00
 104.77  99.00
 107.25  101.00
 109.76  100.00
 112.25  101.00
 114.80  100.00
 117.28  101.00
 119.80  102.00
 122.29  102.00
 124.78  104.00
 127.28  102.00
 129.75  104.00
 132.27  104.00
 134.78  103.00
 137.30  105.00
 139.79  102.00
 142.29  101.00
 144.79  102.00
```

```
147.30  97.00
149.80  96.00
152.29  94.00
154.82  93.00
157.32  91.00
159.82  91.00
162.32  89.00
164.83  90.00
167.22  90.00
169.70  91.00
172.23  91.00
174.72  92.00
177.19  91.00
179.72  91.00
182.23  92.00
184.74  92.00
187.24  93.00
189.74  93.00
192.22  92.00
194.73  91.00
197.21  91.00
199.73  92.00
202.25  92.00
204.73  92.00
207.23  92.00
209.70  95.00
212.18  97.00
214.67  101.00
217.19  106.00
219.72  111.00
222.20  120.00
224.74  129.00
227.24  141.00
229.76  157.00
232.26  174.00
234.76  194.00
237.28  215.00
239.79  241.00
242.27  268.00
244.78  295.00
247.29  325.00
249.70  349.00
252.20  368.00
254.70  379.00
257.21  372.00
259.72  355.00
262.25  316.00
264.74  265.00
267.25  211.00
269.74  167.00
272.27  141.00
274.76  127.00
277.24  124.00
279.79  122.00
280.88  123.00
280.89  119.00
280.90  116.00
280.90  114.00
280.88  111.00
280.87  111.00
```

```
  280.87  108.00
  280.88  107.00
  280.88  105.00
  280.87  102.00
  280.88  104.00
  280.88  102.00
  280.88  100.00
  280.89  100.00
  280.89  100.00
  280.91  100.00
  280.90  98.00
  280.90  99.00
  280.88  98.00
  280.88  98.00
  280.88  98.00
  280.89  98.00
  280.88  97.00
  280.89  97.00
  280.89  98.00
  280.88  98.00
  280.89  97.00
  280.89  97.00
  280.90  96.00
  280.89  97.00
  280.89  99.00
  280.88  97.00
  280.89  97.00
  280.89  96.00
  280.89  97.00
  280.89  98.00
  280.89  96.00
  280.89  96.00
  280.89  97.00
  280.89  96.00
  280.90  97.00
  280.90  96.00
  280.89  98.00
  280.88  95.00
  280.89  96.00
  280.88  97.00
  280.88  96.00
  280.89  96.00
  280.88  97.00
  280.88  96.00
  280.87  96.00
  280.89  97.00
  280.87  96.00
  280.89  96.00
  280.89  97.00
  280.89  97.00
  280.88  96.00
  280.88  97.00
  280.88  97.00
  280.88  97.00
  280.88  96.00
  280.88  96.00
  280.88  98.00
  280.89  98.00
  280.87  96.00
  280.88  97.00
```

```
280.90  98.00
280.87  97.00
280.89  98.00
280.89  96.00
280.87  97.00
280.87  95.00
280.88  97.00
280.87  96.00
280.88  97.00
280.88  97.00
280.88  96.00
280.87  97.00
280.91  96.00
280.89  97.00
280.87  98.00
280.89  97.00
280.88  97.00
280.87  98.00
280.88  98.00
280.88  100.00
280.89  96.00
280.89  97.00
280.89  98.00
280.90  97.00
280.89  97.00
280.91  98.00
280.90  97.00
280.89  98.00
280.89  97.00
280.89  97.00
280.90  98.00
280.89  99.00
280.89  96.00
280.89  99.00
280.90  97.00
280.89  98.00
280.90  98.00
280.90  97.00
280.91  99.00
280.89  97.00
280.89  98.00
280.88  98.00
280.89  98.00
280.90  97.00
280.89  98.00
280.89  97.00
280.89  99.00
280.90  99.00
280.88  98.00
280.88  100.00
280.89  97.00
280.91  99.00
280.88  98.00
280.87  99.00
```

Listing 49: 第 3 片辐照 90s

```
 38.17  85.00
 38.17  85.00
```

```
  38.17  85.00
  38.17  86.00
  38.15  85.00
  38.15  85.00
  38.13  84.00
  38.13  85.00
  38.13  85.00
  38.10  86.00
  38.10  84.00
  38.09  85.00
  38.06  85.00
  38.07  85.00
  38.10  85.00
  39.71  85.00
  42.19  84.00
  44.65  85.00
  47.17  85.00
  49.66  86.00
  52.19  86.00
  54.68  85.00
  57.19  87.00
  59.69  86.00
  62.20  86.00
  64.69  88.00
  67.22  87.00
  69.73  89.00
  72.22  88.00
  74.75  88.00
  77.29  89.00
  79.76  90.00
  82.32  91.00
  84.69  91.00
  87.22  92.00
  89.71  94.00
  92.21  94.00
  94.71  93.00
  97.22  94.00
  99.74  94.00
102.26  96.00
104.77  96.00
107.26  97.00
109.78  97.00
112.28  98.00
114.79  98.00
117.32  99.00
119.79  99.00
122.30  102.00
124.79  102.00
127.26  102.00
129.77  104.00
132.28  107.00
134.79  107.00
137.30  107.00
139.80  108.00
142.29  107.00
144.80  106.00
147.32  103.00
149.82  99.00
152.31  96.00
154.82  94.00
```

```
157.34  94.00
159.81  92.00
162.33  92.00
164.88  92.00
167.21  92.00
169.71  93.00
172.20  95.00
174.73  94.00
177.23  96.00
179.72  96.00
182.23  97.00
184.73  96.00
187.23  99.00
189.73  98.00
192.21  98.00
194.74  98.00
197.25  97.00
199.73  97.00
202.23  96.00
204.74  96.00
207.23  97.00
209.70  100.00
212.17  104.00
214.69  109.00
217.20  116.00
219.72  125.00
222.21  136.00
224.72  150.00
227.23  167.00
229.77  191.00
232.23  213.00
234.75  244.00
237.30  279.00
239.80  316.00
242.28  359.00
244.78  400.00
247.29  445.00
249.68  488.00
252.19  516.00
254.71  536.00
257.22  534.00
259.77  502.00
262.23  446.00
264.70  365.00
267.25  282.00
269.80  213.00
272.26  166.00
274.77  144.00
277.26  135.00
279.80  133.00
280.93  132.00
280.92  127.00
280.90  124.00
280.87  120.00
280.94  118.00
280.91  115.00
280.89  112.00
280.93  111.00
280.89  109.00
280.92  107.00
```

```
  280.90  106.00
  280.91  105.00
  280.90  104.00
  280.89  102.00
  280.92  102.00
  280.90  101.00
  280.89  101.00
  280.89  100.00
  280.90  101.00
  280.88  100.00
  280.88  99.00
  280.88  100.00
  280.88  99.00
  280.88  98.00
  280.88  98.00
  280.89  100.00
  280.89  98.00
  280.90  97.00
  280.89  99.00
  280.88  98.00
  280.88  98.00
  280.89  97.00
  280.88  97.00
  280.89  99.00
  280.88  97.00
  280.89  99.00
  280.88  97.00
  280.87  99.00
  280.88  99.00
  280.89  98.00
  280.90  98.00
  280.88  97.00
  280.88  99.00
  280.88  98.00
  280.89  99.00
  280.89  98.00
  280.89  98.00
  280.90  99.00
  280.90  98.00
  280.89  99.00
  280.89  98.00
  280.90  99.00
  280.91  98.00
  280.91  98.00
  280.91  99.00
  280.90  97.00
  280.90  99.00
  280.90  98.00
  280.89  99.00
  280.90  99.00
  280.89  99.00
  280.89  98.00
  280.89  99.00
  280.90  99.00
  280.90  99.00
  280.90  99.00
  280.90  100.00
  280.88  99.00
  280.89  99.00
  280.88  100.00
```

```
280.89  98.00
280.89  99.00
280.88  99.00
280.89  99.00
280.89  99.00
280.88  101.00
280.89  100.00
280.89  99.00
280.90  100.00
280.88  100.00
280.88  99.00
280.88  99.00
280.90  101.00
280.89  99.00
280.90  100.00
280.90  99.00
280.90  100.00
280.90  100.00
280.91  99.00
280.89  100.00
280.91  100.00
280.92  102.00
280.90  101.00
280.89  100.00
280.89  100.00
280.90  100.00
280.89  101.00
280.90  100.00
280.88  100.00
280.89  101.00
280.90  101.00
280.89  100.00
280.89  100.00
280.91  103.00
280.89  100.00
280.89  101.00
280.89  100.00
280.90  100.00
280.89  102.00
280.90  101.00
280.90  102.00
280.89  101.00
280.90  100.00
280.88  101.00
280.88  102.00
280.89  103.00
280.91  101.00
280.89  101.00
280.89  102.00
280.89  101.00
```

Listing 50: 第 3 片辐照 120s

```
 36.28  82.00
 36.33  82.00
 36.33  83.00
 36.33  82.00
 36.35  82.00
 36.36  82.00
```

```
 36.36  82.00
 36.35  82.00
 36.37  82.00
 36.39  82.00
 36.39  81.00
 36.41  82.00
 36.41  81.00
 36.42  81.00
 37.22  81.00
 39.70  82.00
 42.18  82.00
 44.63  83.00
 47.15  81.00
 49.65  83.00
 52.15  83.00
 54.66  84.00
 57.15  85.00
 59.66  85.00
 62.17  85.00
 64.70  87.00
 67.22  86.00
 69.71  87.00
 72.23  88.00
 74.74  89.00
 77.24  89.00
 79.75  89.00
 82.27  91.00
 84.67  92.00
 87.19  92.00
 89.68  92.00
 92.19  94.00
 94.72  95.00
 97.21  96.00
 99.71  96.00
102.24  95.00
104.76  97.00
107.26  98.00
109.76  98.00
112.26  97.00
114.78  99.00
117.27  100.00
119.79  100.00
122.27  101.00
124.77  103.00
127.25  103.00
129.74  106.00
132.25  107.00
134.77  108.00
137.27  108.00
139.76  108.00
142.28  107.00
144.78  103.00
147.28  100.00
149.80  97.00
152.30  94.00
154.82  92.00
157.34  90.00
159.82  89.00
162.30  89.00
164.83  89.00
```

```
167.19  89.00
169.69  90.00
172.19  91.00
174.70  93.00
177.20  93.00
179.72  93.00
182.21  96.00
184.71  96.00
187.24  96.00
189.73  98.00
192.24  98.00
194.71  97.00
197.24  96.00
199.73  95.00
202.25  95.00
204.74  95.00
207.22  97.00
209.70  101.00
212.18  105.00
214.67  110.00
217.18  120.00
219.70  132.00
222.21  147.00
224.71  163.00
227.23  185.00
229.72  213.00
232.24  242.00
234.74  278.00
237.23  317.00
239.77  366.00
242.31  417.00
244.76  468.00
247.26  523.00
249.70  575.00
252.22  611.00
254.72  642.00
257.24  637.00
259.75  607.00
262.25  539.00
264.70  446.00
267.20  342.00
269.71  253.00
272.27  190.00
274.79  157.00
277.29  145.00
279.75  141.00
280.89  140.00
280.88  134.00
280.89  128.00
280.88  126.00
280.88  120.00
280.87  116.00
280.89  115.00
280.89  111.00
280.89  110.00
280.88  107.00
280.91  105.00
280.88  103.00
280.88  103.00
280.87  100.00
```

```
280.88  99.00
280.88  98.00
280.88  98.00
280.87  97.00
280.88  97.00
280.89  97.00
280.87  98.00
280.89  95.00
280.89  97.00
280.90  96.00
280.88  96.00
280.88  94.00
280.89  95.00
280.89  95.00
280.89  94.00
280.88  96.00
280.88  94.00
280.86  96.00
280.88  94.00
280.87  94.00
280.89  95.00
280.89  94.00
280.88  95.00
280.87  94.00
280.88  95.00
280.89  94.00
280.89  96.00
280.89  94.00
280.90  95.00
280.89  95.00
280.89  95.00
280.89  94.00
280.89  94.00
280.89  95.00
280.92  95.00
280.90  95.00
280.89  95.00
280.90  95.00
280.90  93.00
280.89  94.00
280.90  94.00
280.89  94.00
280.89  95.00
280.89  96.00
280.90  95.00
280.89  94.00
280.89  95.00
280.90  96.00
280.89  95.00
280.88  95.00
280.89  96.00
280.89  96.00
280.89  95.00
280.89  96.00
280.88  95.00
280.89  95.00
280.88  95.00
280.88  96.00
280.88  95.00
280.89  95.00
```

```
280.90  96.00
280.88  96.00
280.88  94.00
280.90  95.00
280.90  95.00
280.88  95.00
280.87  94.00
280.89  96.00
280.89  95.00
280.89  95.00
280.89  95.00
280.90  95.00
280.92  95.00
280.89  95.00
280.90  95.00
280.89  95.00
280.90  96.00
280.89  94.00
280.90  96.00
280.88  95.00
280.89  96.00
280.91  97.00
280.88  96.00
280.89  95.00
280.89  96.00
280.92  96.00
280.87  96.00
280.87  96.00
280.88  96.00
280.89  95.00
280.86  96.00
280.88  96.00
280.89  96.00
280.88  96.00
280.89  95.00
280.89  96.00
280.88  96.00
280.90  95.00
280.91  96.00
280.89  97.00
280.89  98.00
280.88  97.00
280.89  97.00
280.87  97.00
280.88  97.00
280.87  96.00
```

Listing 51: 第 3 片辐照 150s

```
 33.88  79.00
 33.92  78.00
 33.94  78.00
 33.95  78.00
 33.96  78.00
 33.99  78.00
 33.98  77.00
 34.02  78.00
 34.01  78.00
 34.05  78.00
```

```
  34.06  79.00
  34.07  79.00
  34.08  79.00
  34.79  78.00
  37.21  78.00
  39.70  78.00
  42.18  78.00
  44.63  78.00
  47.15  80.00
  49.67  79.00
  52.15  79.00
  54.65  79.00
  57.18  80.00
  59.68  80.00
  62.19  81.00
  64.73  81.00
  67.24  81.00
  69.70  81.00
  72.22  81.00
  74.75  81.00
  77.28  82.00
  79.74  83.00
  82.29  83.00
  84.67  83.00
  87.18  84.00
  89.67  85.00
  92.21  86.00
  94.70  86.00
  97.22  85.00
  99.71  85.00
 102.23  86.00
 104.75  85.00
 107.26  87.00
 109.76  86.00
 112.26  86.00
 114.79  88.00
 117.28  89.00
 119.81  90.00
 122.31  91.00
 124.79  93.00
 127.26  96.00
 129.76  97.00
 132.29  100.00
 134.79  103.00
 137.29  103.00
 139.79  103.00
 142.29  101.00
 144.80  99.00
 147.30  96.00
 149.79  91.00
 152.30  88.00
 154.82  84.00
 157.31  83.00
 159.83  85.00
 162.32  84.00
 164.85  85.00
 167.21  86.00
 169.70  87.00
 172.20  88.00
 174.70  91.00
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177.21  94.00
179.69  94.00
182.20  95.00
184.72  98.00
187.21  98.00
189.74  98.00
192.23  100.00
194.74  98.00
197.23  96.00
199.73  96.00
202.23  97.00
204.71  97.00
207.23  100.00
209.70  105.00
212.18  111.00
214.68  121.00
217.20  133.00
219.70  150.00
222.21  167.00
224.71  192.00
227.21  224.00
229.74  260.00
232.23  302.00
234.76  353.00
237.25  411.00
239.77  474.00
242.27  542.00
244.79  610.00
247.30  679.00
249.71  738.00
252.19  776.00
254.71  786.00
257.20  751.00
259.72  680.00
262.23  562.00
264.74  427.00
267.24  302.00
269.76  216.00
272.25  169.00
274.76  154.00
277.27  147.00
279.77  146.00
280.87  143.00
280.86  137.00
280.89  132.00
280.88  127.00
280.88  122.00
280.88  119.00
280.88  114.00
280.88  111.00
280.88  108.00
280.88  105.00
280.90  104.00
280.89  103.00
280.87  101.00
280.88  100.00
280.88  98.00
280.88  96.00
280.88  98.00
280.88  97.00
```

```
280.89  94.00
280.88  94.00
280.88  95.00
280.90  93.00
280.89  93.00
280.89  94.00
280.89  93.00
280.88  93.00
280.88  92.00
280.89  93.00
280.88  93.00
280.88  93.00
280.89  92.00
280.89  93.00
280.89  91.00
280.89  92.00
280.90  92.00
280.90  92.00
280.92  92.00
280.90  92.00
280.89  91.00
280.90  91.00
280.90  92.00
280.90  92.00
280.90  92.00
280.89  92.00
280.90  91.00
280.89  92.00
280.89  91.00
280.89  92.00
280.90  91.00
280.92  91.00
280.91  91.00
280.90  92.00
280.89  92.00
280.89  91.00
280.91  92.00
280.89  91.00
280.89  93.00
280.89  92.00
280.90  91.00
280.88  92.00
280.89  91.00
280.91  92.00
280.89  92.00
280.87  91.00
280.88  92.00
280.91  92.00
280.89  93.00
280.89  91.00
280.88  92.00
280.89  91.00
280.89  93.00
280.89  93.00
280.88  91.00
280.89  92.00
280.90  92.00
280.88  93.00
280.87  93.00
280.88  92.00
```

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280.89  92.00
280.88  92.00
280.88  93.00
280.88  93.00
280.88  93.00
280.88  92.00
280.87  93.00
280.87  93.00
280.89  93.00
280.91  94.00
280.87  93.00
280.87  92.00
280.87  93.00
280.88  94.00
280.88  92.00
280.88  93.00
280.89  93.00
280.89  93.00
280.89  94.00
280.89  92.00
280.89  95.00
280.90  93.00
280.91  93.00
280.88  92.00
280.88  94.00
280.88  93.00
280.90  94.00
280.90  93.00
280.90  94.00
280.90  93.00
280.90  92.00
280.90  94.00
280.90  94.00
280.89  94.00
280.93  94.00
280.90  92.00
280.90  93.00
280.91  94.00
280.91  93.00
280.91  93.00
280.90  94.00
280.89  95.00
```

Listing 52: X-ray 管电流 30A-第 1 片

```
 34.87  49.00
 34.91  48.00
 34.92  48.00
 34.94  49.00
 34.96  48.00
 34.95  48.00
 34.97  49.00
 34.99  48.00
 35.01  48.00
 35.03  48.00
 35.03  49.00
 35.03  48.00
 35.03  48.00
 35.20  49.00
```

```
 37.18  48.00
 39.69  48.00
 42.16  49.00
 44.64  48.00
 47.16  49.00
 49.64  48.00
 52.16  49.00
 54.68  49.00
 57.17  48.00
 59.69  49.00
 62.19  49.00
 64.71  50.00
 67.21  49.00
 69.71  50.00
 72.25  50.00
 74.75  51.00
 77.24  51.00
 79.74  51.00
 82.29  52.00
 84.68  53.00
 87.20  53.00
 89.71  53.00
 92.21  53.00
 94.72  55.00
 97.25  54.00
 99.74  54.00
102.25  55.00
104.77  55.00
107.26  55.00
109.75  55.00
112.30  55.00
114.77  56.00
117.29  57.00
119.80  57.00
122.29  59.00
124.80  60.00
127.27  62.00
129.74  63.00
132.27  64.00
134.78  65.00
137.29  64.00
139.77  65.00
142.29  65.00
144.77  62.00
147.31  59.00
149.80  58.00
152.31  55.00
154.81  54.00
157.32  53.00
159.84  53.00
162.32  53.00
164.85  53.00
167.21  54.00
169.71  55.00
172.21  56.00
174.71  57.00
177.18  58.00
179.69  60.00
182.23  60.00
184.72  62.00
```

```
187.22  62.00
189.76  63.00
192.24  64.00
194.74  63.00
197.23  64.00
199.72  63.00
202.24  63.00
204.74  64.00
207.21  66.00
209.67  69.00
212.15  73.00
214.66  79.00
217.17  88.00
219.69  98.00
222.19  111.00
224.70  126.00
227.22  147.00
229.75  168.00
232.25  195.00
234.75  225.00
237.26  262.00
239.80  301.00
242.29  345.00
244.76  397.00
247.30  449.00
249.70  503.00
252.19  551.00
254.70  587.00
257.20  605.00
259.72  591.00
262.22  537.00
264.74  454.00
267.24  347.00
269.76  248.00
272.28  175.00
274.76  135.00
277.28  117.00
279.77  111.00
280.88  106.00
280.89  102.00
280.89  98.00
280.89  94.00
280.88  89.00
280.88  85.00
280.87  81.00
280.88  78.00
280.89  76.00
280.91  73.00
280.89  70.00
280.89  68.00
280.89  68.00
280.89  65.00
280.89  64.00
280.89  62.00
280.89  62.00
280.88  60.00
280.87  60.00
280.88  60.00
280.89  58.00
280.90  58.00
```

```
280.90  57.00
280.88  57.00
280.89  57.00
280.89  56.00
280.88  56.00
280.88  56.00
280.89  56.00
280.87  55.00
280.88  55.00
280.88  55.00
280.86  54.00
280.89  55.00
280.90  55.00
280.89  54.00
280.88  54.00
280.89  55.00
280.89  54.00
280.90  54.00
280.90  54.00
280.89  53.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  53.00
280.92  54.00
280.92  54.00
280.91  54.00
280.91  54.00
280.90  53.00
280.89  54.00
280.89  53.00
280.90  54.00
280.89  53.00
280.90  54.00
280.90  53.00
280.89  53.00
280.89  54.00
280.89  53.00
280.91  54.00
280.88  53.00
280.89  54.00
280.86  53.00
280.88  54.00
280.88  53.00
280.88  54.00
280.88  54.00
280.89  53.00
280.88  53.00
280.88  54.00
280.89  53.00
280.90  54.00
280.90  53.00
280.88  54.00
280.88  53.00
280.88  54.00
280.90  53.00
280.88  53.00
280.89  54.00
280.89  53.00
280.89  54.00
```

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280.89  53.00
280.89  54.00
280.89  53.00
280.92  54.00
280.90  54.00
280.89  53.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  53.00
280.89  54.00
280.88  54.00
280.88  53.00
280.90  54.00
280.88  54.00
280.90  54.00
280.92  53.00
280.89  54.00
280.89  54.00
280.90  54.00
280.89  54.00
280.88  53.00
280.90  54.00
280.90  55.00
280.90  53.00
280.89  54.00
280.90  54.00
280.91  54.00
280.91  54.00
280.91  53.00
280.89  54.00
280.89  55.00
280.89  54.00
280.89  53.00
280.90  54.00
280.89  54.00
280.87  54.00
280.90  54.00
```

Listing 53: X-ray 管电流 90A-第 1 片

```
 34.27  49.00
 34.34  50.00
 34.37  49.00
 34.40  49.00
 34.43  49.00
 34.44  50.00
 34.50  49.00
 34.51  50.00
 34.53  49.00
 34.54  49.00
 34.57  50.00
 34.60  49.00
 34.61  49.00
 34.97  49.00
 37.21  49.00
 39.69  50.00
 42.19  49.00
 44.64  49.00
```

```
 47.19  50.00
 49.65  49.00
 52.18  50.00
 54.68  50.00
 57.17  51.00
 59.68  51.00
 62.18  51.00
 64.73  51.00
 67.19  52.00
 69.71  54.00
 72.25  53.00
 74.75  54.00
 77.21  55.00
 79.72  57.00
 82.29  58.00
 84.69  58.00
 87.19  60.00
 89.67  61.00
 92.19  62.00
 94.71  63.00
 97.23  64.00
 99.71  65.00
102.24  64.00
104.74  65.00
107.26  66.00
109.78  65.00
112.26  66.00
114.79  67.00
117.29  69.00
119.79  70.00
122.29  73.00
124.77  77.00
127.26  80.00
129.75  85.00
132.25  89.00
134.77  95.00
137.29  97.00
139.77  100.00
142.30  100.00
144.79  97.00
147.29  93.00
149.80  86.00
152.30  79.00
154.82  71.00
157.33  65.00
159.83  61.00
162.30  61.00
164.88  62.00
167.21  64.00
169.70  65.00
172.20  69.00
174.71  71.00
177.22  75.00
179.70  79.00
182.22  85.00
184.70  87.00
187.23  92.00
189.72  95.00
192.22  98.00
194.73  99.00
```

```
197.22  99.00
199.74  99.00
202.22  98.00
204.72  97.00
207.26  99.00
209.70  104.00
212.18  113.00
214.65  125.00
217.18  146.00
219.74  172.00
222.24  205.00
224.69  248.00
227.22  301.00
229.77  363.00
232.23  442.00
234.79  534.00
237.25  642.00
239.81  769.00
242.25  911.00
244.79  1075.00
247.30  1254.00
249.71  1433.00
252.22  1618.00
254.72  1777.00
257.20  1894.00
259.71  1921.00
262.22  1829.00
264.71  1601.00
267.22  1261.00
269.74  892.00
272.26  576.00
274.78  375.00
277.30  280.00
279.76  245.00
280.90  228.00
280.88  218.00
280.88  204.00
280.91  192.00
280.89  180.00
280.88  167.00
280.87  157.00
280.89  144.00
280.89  137.00
280.87  127.00
280.89  120.00
280.87  113.00
280.88  106.00
280.89  100.00
280.89  95.00
280.89  91.00
280.92  88.00
280.88  84.00
280.89  80.00
280.89  77.00
280.88  76.00
280.88  72.00
280.89  72.00
280.90  69.00
280.92  69.00
280.90  67.00
```

```
  280.92  65.00
  280.90  64.00
  280.91  64.00
  280.92  62.00
  280.89  62.00
  280.90  62.00
  280.90  60.00
  280.91  60.00
  280.89  60.00
  280.91  59.00
  280.91  59.00
  280.89  58.00
  280.90  58.00
  280.90  57.00
  280.90  58.00
  280.92  57.00
  280.91  57.00
  280.89  58.00
  280.91  56.00
  280.89  57.00
  280.90  56.00
  280.88  56.00
  280.89  56.00
  280.89  56.00
  280.88  55.00
  280.89  56.00
  280.88  55.00
  280.89  55.00
  280.91  56.00
  280.89  55.00
  280.89  55.00
  280.89  55.00
  280.88  55.00
  280.89  55.00
  280.89  55.00
  280.89  55.00
  280.88  55.00
  280.89  55.00
  280.88  55.00
  280.90  55.00
  280.89  55.00
  280.91  55.00
  280.89  55.00
  280.89  55.00
  280.88  55.00
  280.89  55.00
  280.89  55.00
  280.90  55.00
  280.88  55.00
  280.90  55.00
  280.88  55.00
  280.88  54.00
  280.89  55.00
  280.91  54.00
  280.91  55.00
  280.90  55.00
  280.90  55.00
  280.89  54.00
  280.89  55.00
  280.90  55.00
```

```
280.91  55.00
280.90  55.00
280.89  55.00
280.89  54.00
280.90  55.00
280.89  54.00
280.91  55.00
280.89  55.00
280.89  55.00
280.89  55.00
280.90  55.00
280.89  55.00
280.89  54.00
280.89  55.00
280.89  54.00
280.88  55.00
280.89  55.00
280.88  54.00
280.89  55.00
280.92  55.00
280.89  55.00
280.90  54.00
280.89  55.00
280.89  55.00
280.88  55.00
280.89  55.00
280.89  55.00
280.89  55.00
280.89  55.00
280.89  54.00
280.89  55.00
280.91  55.00
280.91  55.00
280.89  56.00
```

Listing 54: X-ray 管电流 30A-第 2 片

```
 38.96  50.00
 39.01  51.00
 39.01  50.00
 39.03  51.00
 39.03  50.00
 39.05  50.00
 39.06  50.00
 39.06  51.00
 39.07  50.00
 39.06  51.00
 39.08  50.00
 39.07  50.00
 39.06  51.00
 39.07  50.00
 39.08  50.00
 39.81  50.00
 42.19  50.00
 44.66  50.00
 47.18  50.00
 49.66  51.00
 52.19  51.00
 54.68  51.00
```

```
 57.18  51.00
 59.69  52.00
 62.20  52.00
 64.71  53.00
 67.21  53.00
 69.73  55.00
 72.25  54.00
 74.75  56.00
 77.24  57.00
 79.75  57.00
 82.27  59.00
 84.68  60.00
 87.16  62.00
 89.69  63.00
 92.20  63.00
 94.70  66.00
 97.22  65.00
 99.73  67.00
102.26  67.00
104.77  68.00
107.25  68.00
109.75  68.00
112.28  70.00
114.80  69.00
117.28  72.00
119.78  72.00
122.30  74.00
124.78  76.00
127.27  80.00
129.76  81.00
132.27  84.00
134.78  86.00
137.28  87.00
139.78  87.00
142.29  85.00
144.80  81.00
147.30  78.00
149.80  72.00
152.31  67.00
154.80  63.00
157.33  60.00
159.83  59.00
162.30  58.00
164.87  59.00
167.19  60.00
169.69  61.00
172.17  62.00
174.71  64.00
177.23  67.00
179.73  68.00
182.22  71.00
184.74  73.00
187.24  75.00
189.76  76.00
192.25  76.00
194.73  76.00
197.22  76.00
199.73  75.00
202.24  73.00
204.76  74.00
```

```
207.23  76.00
209.70  81.00
212.19  87.00
214.68  99.00
217.20  112.00
219.71  130.00
222.21  153.00
224.70  180.00
227.22  212.00
229.74  252.00
232.24  297.00
234.75  349.00
237.27  406.00
239.78  473.00
242.26  541.00
244.78  612.00
247.33  681.00
249.73  741.00
252.21  787.00
254.71  808.00
257.22  798.00
259.74  736.00
262.26  631.00
264.74  490.00
267.23  347.00
269.77  225.00
272.28  148.00
274.77  112.00
277.29  100.00
279.80  95.00
280.91  92.00
280.91  88.00
280.91  85.00
280.92  81.00
280.92  78.00
280.90  75.00
280.90  72.00
280.91  69.00
280.90  67.00
280.89  66.00
280.89  64.00
280.92  62.00
280.90  61.00
280.90  60.00
280.89  60.00
280.88  58.00
280.90  58.00
280.89  57.00
280.89  57.00
280.89  56.00
280.88  56.00
280.89  55.00
280.89  56.00
280.89  55.00
280.90  55.00
280.87  54.00
280.88  55.00
280.88  54.00
280.88  55.00
280.88  54.00
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280.88  54.00
280.88  54.00
280.89  55.00
280.88  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.90  54.00
280.87  53.00
280.86  54.00
280.89  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.88  53.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  53.00
280.90  54.00
280.89  54.00
280.88  53.00
280.88  54.00
280.89  54.00
280.88  53.00
280.87  54.00
280.87  54.00
280.87  54.00
280.87  54.00
280.88  54.00
280.89  54.00
280.88  54.00
280.91  54.00
280.88  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.88  53.00
280.87  54.00
280.88  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.88  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.88  54.00
280.89  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.89  54.00
280.88  54.00
280.87  54.00
280.89  54.00
280.88  54.00
280.88  54.00
```

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280.89  54.00
280.88  54.00
280.89  54.00
280.89  54.00
280.89  55.00
280.89  54.00
280.89  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.92  55.00
280.90  54.00
280.88  54.00
280.89  54.00
280.88  55.00
280.88  54.00
280.88  54.00
280.90  54.00
280.88  54.00
280.88  54.00
280.89  55.00
280.91  54.00
280.90  54.00
280.91  55.00
280.89  54.00
280.89  54.00
280.89  55.00
280.88  54.00
280.90  55.00
280.90  54.00
```

Listing 55: X-ray 管电流 90A-第 2 片

```
 39.61  51.00
 39.62  51.00
 39.59  51.00
 39.58  50.00
 39.58  51.00
 39.57  51.00
 39.53  51.00
 39.54  51.00
 39.53  51.00
 39.51  50.00
 39.49  51.00
 39.48  50.00
 39.48  51.00
 39.46  51.00
 39.44  51.00
 39.89  51.00
 42.18  50.00
 44.63  51.00
 47.17  51.00
 49.65  51.00
 52.17  51.00
 54.66  52.00
 57.21  51.00
 59.70  53.00
 62.18  52.00
 64.70  54.00
```

```
 67.26  54.00
 69.72  55.00
 72.23  56.00
 74.74  57.00
 77.28  58.00
 79.76  61.00
 82.26  62.00
 84.67  64.00
 87.21  66.00
 89.69  69.00
 92.23  70.00
 94.71  73.00
 97.24  75.00
 99.73  77.00
102.24  77.00
104.76  79.00
107.28  80.00
109.77  80.00
112.26  83.00
114.78  85.00
117.32  87.00
119.80  92.00
122.29  97.00
124.80  104.00
127.25  111.00
129.77  119.00
132.26  128.00
134.79  135.00
137.29  141.00
139.79  145.00
142.31  143.00
144.78  138.00
147.29  128.00
149.80  115.00
152.31  101.00
154.82  89.00
157.34  78.00
159.82  73.00
162.32  71.00
164.84  72.00
167.20  74.00
169.71  80.00
172.19  84.00
174.71  89.00
177.20  95.00
179.71  103.00
182.20  109.00
184.73  115.00
187.24  123.00
189.75  127.00
192.23  132.00
194.76  133.00
197.24  131.00
199.74  130.00
202.24  127.00
204.73  126.00
207.23  127.00
209.71  135.00
212.16  149.00
214.68  171.00
```

```
217.19  204.00
219.70  247.00
222.19  301.00
224.71  370.00
227.22  453.00
229.76  553.00
232.26  670.00
234.76  809.00
237.26  963.00
239.78  1138.00
242.29  1331.00
244.79  1539.00
247.31  1749.00
249.71  1954.00
252.19  2127.00
254.69  2261.00
257.19  2335.00
259.72  2293.00
262.23  2134.00
264.72  1831.00
267.23  1424.00
269.74  997.00
272.26  628.00
274.76  378.00
277.26  251.00
279.78  197.00
280.91  178.00
280.90  164.00
280.89  153.00
280.90  142.00
280.89  132.00
280.89  123.00
280.90  115.00
280.88  107.00
280.90  101.00
280.91  94.00
280.89  89.00
280.89  85.00
280.88  81.00
280.89  78.00
280.88  74.00
280.87  73.00
280.88  69.00
280.88  68.00
280.89  66.00
280.89  65.00
280.88  64.00
280.90  63.00
280.89  61.00
280.87  61.00
280.89  60.00
280.88  59.00
280.87  59.00
280.88  58.00
280.88  58.00
280.87  58.00
280.89  58.00
280.87  57.00
280.88  57.00
280.87  56.00
```

```
  280.90  57.00
  280.89  57.00
  280.88  56.00
  280.89  56.00
  280.88  56.00
  280.87  56.00
  280.88  56.00
  280.88  56.00
  280.89  56.00
  280.89  55.00
  280.88  56.00
  280.89  55.00
  280.89  55.00
  280.92  56.00
  280.88  55.00
  280.89  55.00
  280.89  56.00
  280.88  55.00
  280.89  55.00
  280.88  55.00
  280.89  56.00
  280.89  55.00
  280.88  55.00
  280.89  55.00
  280.89  55.00
  280.92  55.00
  280.91  56.00
  280.90  55.00
  280.90  55.00
  280.89  55.00
  280.90  55.00
  280.90  55.00
  280.90  55.00
  280.89  55.00
  280.90  55.00
  280.89  55.00
  280.90  56.00
  280.90  54.00
  280.91  56.00
  280.88  54.00
  280.88  56.00
  280.87  55.00
  280.88  55.00
  280.88  55.00
  280.89  55.00
  280.89  55.00
  280.87  55.00
  280.90  56.00
  280.88  55.00
  280.88  55.00
  280.88  55.00
  280.91  55.00
  280.89  55.00
  280.88  56.00
  280.89  55.00
  280.89  55.00
  280.89  55.00
  280.88  55.00
  280.88  55.00
  280.87  56.00
```

```
280.88  55.00
280.89  55.00
280.88  56.00
280.90  55.00
280.91  55.00
280.89  56.00
280.87  55.00
280.88  55.00
280.88  56.00
280.89  55.00
280.89  55.00
280.87  56.00
280.89  55.00
280.89  55.00
280.90  56.00
280.88  55.00
280.90  55.00
280.89  56.00
280.88  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.88  55.00
280.87  56.00
280.88  55.00
280.88  56.00
```

Listing 56: X-ray 管电流 30A-第 3 片

```
 39.00  48.00
 39.01  49.00
 39.02  48.00
 39.00  48.00
 39.00  49.00
 39.02  48.00
 39.03  49.00
 39.01  48.00
 39.01  49.00
 39.01  48.00
 38.99  49.00
 39.02  48.00
 39.01  48.00
 39.00  48.00
 39.01  49.00
 39.76  48.00
 42.16  48.00
 44.64  48.00
 47.15  49.00
 49.66  48.00
 52.17  48.00
 54.67  49.00
 57.16  48.00
 59.68  49.00
 62.22  48.00
 64.73  49.00
 67.24  48.00
 69.75  49.00
 72.26  49.00
 74.78  50.00
```

```
 77.28  50.00
 79.79  50.00
 82.32  51.00
 84.72  51.00
 87.21  52.00
 89.71  52.00
 92.21  52.00
 94.73  54.00
 97.24  54.00
 99.74  54.00
102.25  55.00
104.78  55.00
107.26  56.00
109.77  56.00
112.28  59.00
114.79  59.00
117.31  62.00
119.81  64.00
122.29  67.00
124.80  70.00
127.27  74.00
129.76  78.00
132.25  81.00
134.79  84.00
137.30  84.00
139.77  83.00
142.31  81.00
144.80  76.00
147.30  70.00
149.82  65.00
152.31  60.00
154.80  57.00
157.35  57.00
159.82  56.00
162.33  57.00
164.85  60.00
167.23  60.00
169.73  64.00
172.20  65.00
174.71  69.00
177.21  71.00
179.72  74.00
182.20  76.00
184.70  79.00
187.22  81.00
189.76  80.00
192.21  81.00
194.73  81.00
197.21  79.00
199.71  78.00
202.22  77.00
204.72  80.00
207.20  83.00
209.68  92.00
212.12  103.00
214.69  119.00
217.23  139.00
219.70  165.00
222.20  197.00
224.73  234.00
```

```
227.23  280.00
229.73  333.00
232.23  396.00
234.75  469.00
237.26  549.00
239.81  641.00
242.29  737.00
244.80  833.00
247.32  931.00
249.70  1016.00
252.21  1075.00
254.69  1099.00
257.19  1069.00
259.75  979.00
262.24  830.00
264.71  637.00
267.23  447.00
269.77  292.00
272.24  197.00
274.77  154.00
277.25  137.00
279.79  129.00
280.90  124.00
280.89  117.00
280.89  111.00
280.88  104.00
280.89  99.00
280.89  92.00
280.88  87.00
280.88  83.00
280.88  78.00
280.89  76.00
280.89  72.00
280.87  71.00
280.89  67.00
280.88  66.00
280.88  64.00
280.89  63.00
280.88  62.00
280.88  61.00
280.89  60.00
280.89  59.00
280.89  58.00
280.89  59.00
280.88  57.00
280.89  57.00
280.89  56.00
280.92  57.00
280.89  56.00
280.89  55.00
280.88  55.00
280.90  56.00
280.89  55.00
280.89  55.00
280.89  55.00
280.89  54.00
280.89  55.00
280.87  54.00
280.89  55.00
280.89  54.00
```

```
280.92  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.88  54.00
280.88  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.90  53.00
280.90  54.00
280.89  54.00
280.89  53.00
280.91  54.00
280.89  53.00
280.89  54.00
280.89  54.00
280.88  54.00
280.88  54.00
280.90  54.00
280.89  54.00
280.91  53.00
280.92  54.00
280.90  54.00
280.91  54.00
280.89  54.00
280.90  54.00
280.89  53.00
280.89  54.00
280.89  54.00
280.89  54.00
280.90  54.00
280.91  54.00
280.91  54.00
280.90  54.00
280.93  54.00
280.90  53.00
280.91  54.00
280.89  54.00
280.91  54.00
280.90  53.00
280.91  55.00
280.91  54.00
280.91  54.00
280.92  54.00
280.91  54.00
280.92  54.00
280.90  54.00
280.92  54.00
280.90  54.00
280.89  54.00
280.91  54.00
280.89  53.00
280.89  54.00
280.90  54.00
280.90  54.00
280.89  53.00
```

```
280.89  54.00
280.90  54.00
280.89  54.00
280.91  55.00
280.90  53.00
280.90  54.00
280.90  54.00
280.90  54.00
280.90  54.00
280.91  55.00
280.89  54.00
280.91  54.00
280.89  54.00
280.89  54.00
280.89  54.00
280.89  55.00
280.91  54.00
280.89  54.00
280.90  54.00
280.90  54.00
280.89  55.00
280.89  54.00
```

Listing 57: X-ray 管电流 90A-第 3 片

```
 39.79  50.00
 39.84  50.00
 39.84  49.00
 39.88  50.00
 39.89  50.00
 39.91  50.00
 39.92  49.00
 39.95  50.00
 39.94  50.00
 39.96  50.00
 39.96  50.00
 39.97  49.00
 39.99  50.00
 39.99  50.00
 39.99  50.00
 40.16  50.00
 42.17  49.00
 44.64  50.00
 47.16  50.00
 49.66  50.00
 52.19  49.00
 54.68  51.00
 57.19  50.00
 59.69  50.00
 62.20  51.00
 64.72  51.00
 67.21  52.00
 69.72  52.00
 72.24  52.00
 74.75  54.00
 77.27  54.00
 79.77  56.00
 82.29  57.00
 84.71  59.00
```

```
 87.21  61.00
 89.69  63.00
 92.23  64.00
 94.74  67.00
 97.23  67.00
 99.73  69.00
102.24  71.00
104.76  73.00
107.26  75.00
109.77  78.00
112.27  83.00
114.80  90.00
117.28  99.00
119.79  109.00
122.28  121.00
124.79  133.00
127.27  149.00
129.76  159.00
132.28  171.00
134.79  176.00
137.30  178.00
139.80  171.00
142.29  158.00
144.79  137.00
147.32  117.00
149.82  98.00
152.31  85.00
154.81  77.00
157.33  78.00
159.83  80.00
162.32  86.00
164.84  92.00
167.21  100.00
169.71  110.00
172.20  119.00
174.70  131.00
177.22  141.00
179.71  150.00
182.23  162.00
184.72  167.00
187.22  171.00
189.74  171.00
192.23  169.00
194.75  165.00
197.21  161.00
199.74  157.00
202.24  164.00
204.74  177.00
207.22  204.00
209.70  245.00
212.18  299.00
214.68  373.00
217.20  464.00
219.71  576.00
222.18  712.00
224.69  875.00
227.21  1065.00
229.77  1284.00
232.24  1540.00
234.75  1826.00
```

```
237.25  2145.00
239.77  2482.00
242.28  2838.00
244.79  3182.00
247.32  3492.00
249.71  3740.00
252.20  3860.00
254.70  3827.00
257.21  3582.00
259.74  3116.00
262.24  2477.00
264.71  1779.00
267.24  1164.00
269.77  731.00
272.26  494.00
274.76  386.00
277.25  343.00
279.78  320.00
280.89  299.00
280.87  275.00
280.88  251.00
280.88  228.00
280.89  207.00
280.89  187.00
280.89  167.00
280.88  153.00
280.88  140.00
280.88  128.00
280.88  117.00
280.87  110.00
280.88  102.00
280.88  96.00
280.89  92.00
280.89  86.00
280.89  83.00
280.90  79.00
280.89  76.00
280.87  74.00
280.89  72.00
280.90  70.00
280.89  68.00
280.90  67.00
280.90  66.00
280.90  65.00
280.89  64.00
280.90  63.00
280.89  62.00
280.90  62.00
280.92  61.00
280.89  61.00
280.89  60.00
280.89  59.00
280.89  60.00
280.90  59.00
280.90  58.00
280.88  58.00
280.89  58.00
280.89  58.00
280.88  58.00
280.88  57.00
```

```
280.91  58.00
280.90  57.00
280.90  57.00
280.88  57.00
280.89  57.00
280.88  57.00
280.89  56.00
280.88  57.00
280.89  57.00
280.89  56.00
280.89  57.00
280.88  56.00
280.89  57.00
280.90  56.00
280.89  57.00
280.88  56.00
280.88  56.00
280.89  56.00
280.88  56.00
280.89  56.00
280.88  56.00
280.89  57.00
280.89  56.00
280.89  56.00
280.89  56.00
280.89  56.00
280.92  57.00
280.89  56.00
280.88  56.00
280.89  56.00
280.89  56.00
280.89  56.00
280.88  56.00
280.90  56.00
280.89  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.91  56.00
280.92  56.00
280.89  56.00
280.90  56.00
280.89  56.00
280.89  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.89  56.00
280.90  56.00
280.90  57.00
280.89  56.00
280.91  56.00
280.90  57.00
280.89  56.00
280.90  56.00
280.89  57.00
280.90  56.00
280.89  55.00
280.91  57.00
280.90  56.00
```

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280.90  56.00
280.89  56.00
280.89  56.00
280.89  56.00
280.91  57.00
280.88  56.00
280.88  57.00
280.89  56.00
280.88  56.00
280.89  56.00
280.89  57.00
280.89  56.00
280.90  56.00
280.88  57.00
280.87  57.00
280.88  56.00
280.89  56.00
280.90  57.00
```

Listing 58: X-ray 管电压 30V-第 1 片

```
 36.35  50.00
 36.41  51.00
 36.42  50.00
 36.47  50.00
 36.48  50.00
 36.50  51.00
 36.53  50.00
 36.54  50.00
 36.58  50.00
 36.60  50.00
 36.61  50.00
 36.63  50.00
 36.65  50.00
 36.67  50.00
 37.29  49.00
 39.72  51.00
 42.16  50.00
 44.66  50.00
 47.18  50.00
 49.65  50.00
 52.19  50.00
 54.69  50.00
 57.20  51.00
 59.70  50.00
 62.21  51.00
 64.73  51.00
 67.23  51.00
 69.70  51.00
 72.24  52.00
 74.74  51.00
 77.26  53.00
 79.78  52.00
 82.29  52.00
 84.69  53.00
 87.22  53.00
 89.70  53.00
 92.21  54.00
 94.71  54.00
```

```
 97.21  54.00
 99.72  55.00
102.22  55.00
104.76  55.00
107.26  54.00
109.77  56.00
112.27  55.00
114.79  55.00
117.30  55.00
119.82  56.00
122.31  56.00
124.77  56.00
127.28  58.00
129.79  57.00
132.29  60.00
134.79  59.00
137.32  61.00
139.80  62.00
142.31  61.00
144.81  62.00
147.33  61.00
149.81  60.00
152.32  59.00
154.83  58.00
157.34  56.00
159.85  55.00
162.32  54.00
164.84  53.00
167.21  54.00
169.71  53.00
172.20  54.00
174.71  54.00
177.22  55.00
179.73  56.00
182.21  56.00
184.72  57.00
187.26  58.00
189.74  58.00
192.26  58.00
194.74  59.00
197.23  60.00
199.74  59.00
202.24  60.00
204.75  59.00
207.23  59.00
209.70  59.00
212.18  60.00
214.69  61.00
217.21  62.00
219.69  66.00
222.21  69.00
224.73  75.00
227.24  80.00
229.77  89.00
232.26  98.00
234.76  108.00
237.27  121.00
239.77  138.00
242.28  152.00
244.79  173.00
```

```
247.32  196.00
249.71  220.00
252.21  248.00
254.68  277.00
257.21  306.00
259.73  335.00
262.23  359.00
264.72  376.00
267.22  375.00
269.74  361.00
272.24  323.00
274.76  267.00
277.26  207.00
279.80  154.00
280.90  118.00
280.90  98.00
280.90  89.00
280.89  85.00
280.89  81.00
280.91  79.00
280.89  76.00
280.90  75.00
280.89  72.00
280.89  70.00
280.88  68.00
280.89  67.00
280.89  67.00
280.89  65.00
280.88  64.00
280.89  63.00
280.89  62.00
280.90  61.00
280.89  61.00
280.89  61.00
280.89  59.00
280.88  60.00
280.88  59.00
280.90  58.00
280.89  59.00
280.90  58.00
280.90  58.00
280.89  57.00
280.89  57.00
280.88  58.00
280.90  56.00
280.90  58.00
280.90  56.00
280.90  57.00
280.89  56.00
280.90  56.00
280.90  57.00
280.89  55.00
280.89  56.00
280.89  56.00
280.89  56.00
280.90  56.00
280.90  56.00
280.92  56.00
280.90  56.00
280.90  55.00
```

```
280.90  56.00
280.90  56.00
280.89  55.00
280.90  56.00
280.90  55.00
280.89  55.00
280.89  56.00
280.91  56.00
280.90  55.00
280.90  56.00
280.92  55.00
280.90  56.00
280.89  56.00
280.89  55.00
280.89  55.00
280.90  56.00
280.89  55.00
280.90  55.00
280.90  56.00
280.89  55.00
280.88  56.00
280.89  55.00
280.92  55.00
280.91  55.00
280.88  56.00
280.90  55.00
280.89  55.00
280.90  55.00
280.89  55.00
280.89  56.00
280.89  55.00
280.90  55.00
280.89  55.00
280.88  55.00
280.87  56.00
280.91  55.00
280.89  55.00
280.88  55.00
280.89  56.00
280.89  56.00
280.88  55.00
280.87  56.00
280.90  55.00
280.89  56.00
280.91  56.00
280.89  55.00
280.89  56.00
280.90  55.00
280.91  55.00
280.89  56.00
280.89  55.00
280.90  56.00
280.89  55.00
280.90  56.00
280.90  55.00
280.89  55.00
280.89  56.00
280.89  56.00
280.89  55.00
280.89  55.00
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```
280.90  57.00
280.93  55.00
280.89  56.00
280.89  55.00
280.90  56.00
280.89  56.00
280.89  55.00
280.91  56.00
280.88  56.00
280.90  55.00
280.90  56.00
280.90  56.00
280.89  56.00
280.90  55.00
```

Listing 59: X-ray 管电压 40V-第 1 片

```
 35.26  52.00
 35.31  52.00
 35.34  53.00
 35.39  52.00
 35.42  52.00
 35.46  53.00
 35.48  52.00
 35.50  52.00
 35.52  52.00
 35.55  53.00
 35.58  52.00
 35.61  52.00
 35.63  52.00
 35.67  52.00
 37.20  52.00
 39.71  53.00
 42.20  52.00
 44.65  52.00
 47.19  52.00
 49.67  53.00
 52.15  53.00
 54.68  53.00
 57.19  53.00
 59.68  54.00
 62.20  53.00
 64.72  55.00
 67.22  55.00
 69.73  54.00
 72.24  56.00
 74.78  56.00
 77.25  56.00
 79.74  58.00
 82.28  58.00
 84.70  59.00
 87.23  60.00
 89.72  61.00
 92.23  61.00
 94.73  62.00
 97.25  62.00
 99.72  62.00
102.26  63.00
104.76  62.00
```

```
107.25  63.00
109.77  63.00
112.29  65.00
114.81  65.00
117.27  67.00
119.80  69.00
122.28  70.00
124.80  73.00
127.27  75.00
129.78  76.00
132.27  78.00
134.77  77.00
137.30  77.00
139.79  73.00
142.29  71.00
144.79  66.00
147.29  63.00
149.79  60.00
152.32  60.00
154.82  58.00
157.33  59.00
159.84  59.00
162.32  61.00
164.85  61.00
167.21  63.00
169.70  65.00
172.20  66.00
174.69  68.00
177.21  70.00
179.69  70.00
182.21  73.00
184.70  73.00
187.22  74.00
189.73  74.00
192.24  73.00
194.73  72.00
197.22  73.00
199.74  74.00
202.24  76.00
204.74  80.00
207.23  88.00
209.71  96.00
212.17  108.00
214.66  122.00
217.22  142.00
219.70  162.00
222.22  191.00
224.74  223.00
227.24  259.00
229.77  302.00
232.26  353.00
234.76  407.00
237.28  473.00
239.79  542.00
242.29  615.00
244.80  693.00
247.31  762.00
249.70  816.00
252.21  842.00
254.70  827.00
```

```
257.21  764.00
259.73  652.00
262.24  509.00
264.73  368.00
267.23  256.00
269.76  187.00
272.27  153.00
274.78  140.00
277.27  134.00
279.79  130.00
280.91  124.00
280.91  117.00
280.89  111.00
280.91  105.00
280.90  98.00
280.91  92.00
280.89  88.00
280.89  84.00
280.90  80.00
280.91  78.00
280.93  74.00
280.90  72.00
280.90  71.00
280.92  69.00
280.91  67.00
280.91  66.00
280.89  65.00
280.91  65.00
280.91  63.00
280.90  63.00
280.91  62.00
280.90  63.00
280.91  61.00
280.91  61.00
280.90  61.00
280.90  61.00
280.89  61.00
280.89  60.00
280.88  60.00
280.88  59.00
280.90  60.00
280.90  59.00
280.90  59.00
280.89  58.00
280.88  59.00
280.90  59.00
280.91  59.00
280.90  59.00
280.89  58.00
280.89  59.00
280.89  59.00
280.89  58.00
280.90  58.00
280.90  58.00
280.90  58.00
280.89  59.00
280.89  58.00
280.89  58.00
280.89  59.00
280.89  58.00
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  280.89  58.00
  280.90  58.00
  280.90  58.00
  280.90  58.00
  280.89  59.00
  280.90  58.00
  280.90  58.00
  280.90  58.00
  280.88  58.00
  280.90  58.00
  280.91  58.00
  280.91  58.00
  280.90  58.00
  280.88  58.00
  280.88  58.00
  280.89  58.00
  280.89  58.00
  280.89  59.00
  280.88  58.00
  280.89  58.00
  280.89  58.00
  280.89  59.00
  280.89  58.00
  280.90  58.00
  280.92  58.00
  280.90  59.00
  280.89  58.00
  280.90  58.00
  280.89  57.00
  280.90  58.00
  280.90  58.00
  280.91  59.00
  280.89  58.00
  280.92  58.00
  280.89  58.00
  280.89  58.00
  280.91  58.00
  280.90  59.00
  280.89  59.00
  280.89  58.00
  280.90  58.00
  280.90  58.00
  280.89  58.00
  280.89  58.00
  280.88  59.00
  280.88  58.00
  280.88  58.00
  280.90  59.00
  280.88  58.00
  280.92  58.00
  280.87  59.00
  280.89  58.00
  280.88  59.00
  280.88  58.00
  280.89  59.00
  280.86  58.00
  280.88  59.00
  280.87  59.00
  280.88  58.00
  280.87  59.00
```

```
280.88  58.00
280.88  59.00
280.90  59.00
280.87  58.00
280.88  59.00
280.88  58.00
280.88  59.00
280.88  58.00
280.88  59.00
280.88  59.00
```

Listing 60: X-ray 管电压 30V-第 2 片

```
 38.97  55.00
 39.04  54.00
 39.05  55.00
 39.08  54.00
 39.12  55.00
 39.14  55.00
 39.16  54.00
 39.18  55.00
 39.22  54.00
 39.24  54.00
 39.25  54.00
 39.27  55.00
 39.30  54.00
 39.29  54.00
 39.32  53.00
 39.84  55.00
 42.18  53.00
 44.65  55.00
 47.15  54.00
 49.67  55.00
 52.18  56.00
 54.68  56.00
 57.21  56.00
 59.71  57.00
 62.21  59.00
 64.72  60.00
 67.22  60.00
 69.73  62.00
 72.25  63.00
 74.74  64.00
 77.28  67.00
 79.76  67.00
 82.28  69.00
 84.69  71.00
 87.21  73.00
 89.70  73.00
 92.22  76.00
 94.72  77.00
 97.24  76.00
 99.73  78.00
102.24  78.00
104.77  78.00
107.28  78.00
109.78  77.00
112.29  77.00
114.80  77.00
```

```
117.30  76.00
119.81  75.00
122.31  76.00
124.79  76.00
127.28  77.00
129.78  77.00
132.27  78.00
134.79  79.00
137.31  80.00
139.78  80.00
142.30  81.00
144.79  80.00
147.30  77.00
149.83  75.00
152.32  71.00
154.83  68.00
157.32  64.00
159.83  62.00
162.34  60.00
164.87  59.00
167.21  59.00
169.71  59.00
172.19  59.00
174.71  59.00
177.21  60.00
179.71  61.00
182.23  63.00
184.73  63.00
187.25  64.00
189.75  66.00
192.23  66.00
194.75  66.00
197.22  67.00
199.73  67.00
202.24  66.00
204.74  65.00
207.24  66.00
209.69  65.00
212.16  67.00
214.69  69.00
217.19  74.00
219.74  80.00
222.23  87.00
224.72  99.00
227.22  112.00
229.78  127.00
232.24  146.00
234.79  168.00
237.26  193.00
239.82  223.00
242.29  255.00
244.79  290.00
247.31  328.00
249.71  368.00
252.20  406.00
254.73  439.00
257.23  468.00
259.71  483.00
262.22  482.00
264.72  456.00
```

```
267.25  406.00
269.76  333.00
272.27  255.00
274.76  181.00
277.29  128.00
279.79  99.00
280.89  85.00
280.88  80.00
280.90  76.00
280.89  74.00
280.89  72.00
280.89  70.00
280.89  68.00
280.90  67.00
280.89  65.00
280.90  64.00
280.91  62.00
280.90  62.00
280.89  61.00
280.89  61.00
280.90  60.00
280.90  59.00
280.91  58.00
280.91  59.00
280.90  58.00
280.90  58.00
280.90  57.00
280.89  57.00
280.90  57.00
280.92  57.00
280.90  56.00
280.90  56.00
280.89  56.00
280.90  57.00
280.89  56.00
280.89  56.00
280.89  56.00
280.89  55.00
280.89  56.00
280.89  56.00
280.88  55.00
280.91  56.00
280.89  56.00
280.89  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.88  55.00
280.89  56.00
280.89  55.00
280.88  55.00
280.89  56.00
280.87  55.00
280.88  56.00
280.90  55.00
280.90  56.00
280.88  55.00
280.87  55.00
280.89  56.00
280.88  55.00
```

```
280.88  56.00
280.88  55.00
280.88  55.00
280.88  56.00
280.88  55.00
280.89  56.00
280.89  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.87  56.00
280.87  55.00
280.87  56.00
280.89  55.00
280.88  56.00
280.89  55.00
280.88  56.00
280.89  55.00
280.89  56.00
280.90  55.00
280.88  56.00
280.89  55.00
280.87  56.00
280.88  56.00
280.89  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.88  56.00
280.87  55.00
280.89  56.00
280.89  56.00
280.91  56.00
280.88  56.00
280.88  56.00
280.88  55.00
280.87  56.00
280.87  56.00
280.88  56.00
280.89  56.00
280.89  55.00
280.88  56.00
280.89  56.00
280.89  56.00
280.90  56.00
280.92  56.00
280.89  56.00
280.89  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.91  56.00
280.89  56.00
280.90  57.00
280.92  56.00
280.92  56.00
280.92  56.00
```

```
280.91  56.00
280.91  57.00
280.89  56.00
280.89  56.00
280.90  56.00
280.90  57.00
```

Listing 61: X-ray 管电压 40V-第 2 片

```
 36.15  55.00
 36.20  55.00
 36.23  55.00
 36.28  54.00
 36.32  55.00
 36.34  55.00
 36.36  55.00
 36.40  54.00
 36.42  54.00
 36.46  55.00
 36.48  55.00
 36.50  55.00
 36.50  54.00
 36.52  55.00
 37.25  55.00
 39.70  54.00
 42.17  55.00
 44.64  54.00
 47.18  55.00
 49.64  56.00
 52.17  55.00
 54.67  57.00
 57.17  57.00
 59.69  58.00
 62.22  58.00
 64.71  59.00
 67.22  60.00
 69.72  62.00
 72.23  62.00
 74.74  64.00
 77.25  65.00
 79.72  67.00
 82.27  69.00
 84.68  70.00
 87.19  71.00
 89.68  72.00
 92.20  74.00
 94.71  76.00
 97.21  77.00
 99.70  78.00
102.23  79.00
104.75  79.00
107.30  79.00
109.77  80.00
112.26  81.00
114.79  82.00
117.29  83.00
119.79  84.00
122.32  86.00
124.78  89.00
```

```
127.26  91.00
129.75  95.00
132.26  97.00
134.77  101.00
137.28  101.00
139.79  102.00
142.32  101.00
144.80  97.00
147.32  92.00
149.83  85.00
152.33  78.00
154.85  72.00
157.32  68.00
159.82  65.00
162.32  65.00
164.82  65.00
167.19  66.00
169.71  69.00
172.19  69.00
174.71  72.00
177.21  74.00
179.71  78.00
182.21  80.00
184.71  84.00
187.23  86.00
189.74  87.00
192.25  88.00
194.72  89.00
197.23  88.00
199.72  86.00
202.24  86.00
204.73  86.00
207.22  87.00
209.69  91.00
212.16  99.00
214.66  110.00
217.21  127.00
219.70  149.00
222.19  175.00
224.71  209.00
227.24  249.00
229.76  296.00
232.26  351.00
234.76  418.00
237.28  490.00
239.80  571.00
242.30  659.00
244.79  753.00
247.32  844.00
249.69  932.00
252.20  1000.00
254.71  1045.00
257.21  1051.00
259.73  1004.00
262.24  896.00
264.73  731.00
267.24  541.00
269.76  360.00
272.28  229.00
274.77  154.00
```

```
277.27  125.00
279.80  114.00
280.89  109.00
280.90  104.00
280.89  98.00
280.91  94.00
280.90  89.00
280.90  85.00
280.90  83.00
280.90  78.00
280.90  76.00
280.90  73.00
280.89  72.00
280.89  68.00
280.88  68.00
280.89  66.00
280.88  64.00
280.88  64.00
280.89  62.00
280.89  62.00
280.88  62.00
280.88  60.00
280.88  61.00
280.89  60.00
280.88  59.00
280.87  60.00
280.87  59.00
280.87  59.00
280.89  59.00
280.88  58.00
280.89  59.00
280.92  58.00
280.90  58.00
280.89  57.00
280.89  58.00
280.89  58.00
280.88  57.00
280.89  58.00
280.89  58.00
280.90  57.00
280.89  58.00
280.90  57.00
280.89  58.00
280.91  57.00
280.92  58.00
280.90  57.00
280.90  58.00
280.89  57.00
280.90  57.00
280.90  57.00
280.90  57.00
280.91  57.00
280.90  58.00
280.89  57.00
280.89  57.00
280.90  58.00
280.90  57.00
280.90  58.00
280.90  57.00
280.90  57.00
```

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280.89  57.00
280.89  58.00
280.88  57.00
280.89  57.00
280.90  58.00
280.89  58.00
280.89  57.00
280.88  57.00
280.89  58.00
280.91  58.00
280.90  57.00
280.89  57.00
280.89  57.00
280.88  58.00
280.89  58.00
280.89  58.00
280.89  57.00
280.87  57.00
280.89  58.00
280.90  57.00
280.90  58.00
280.89  57.00
280.91  58.00
280.88  58.00
280.90  58.00
280.89  57.00
280.89  57.00
280.88  58.00
280.89  58.00
280.89  57.00
280.88  58.00
280.89  58.00
280.90  57.00
280.89  58.00
280.89  57.00
280.91  58.00
280.89  58.00
280.89  57.00
280.88  58.00
280.88  58.00
280.88  58.00
280.89  58.00
280.90  57.00
280.89  58.00
280.89  58.00
280.89  58.00
280.88  58.00
280.90  57.00
280.89  58.00
280.88  58.00
280.88  58.00
280.88  58.00
280.88  58.00
280.89  58.00
280.88  58.00
280.88  58.00
280.88  57.00
280.90  58.00
280.88  59.00
280.89  57.00
```

```
280.91  58.00
280.88  58.00
```

Listing 62: X-ray 管电压 30V-第 3 片

```
 38.97  55.00
 39.04  54.00
 39.05  55.00
 39.08  54.00
 39.12  55.00
 39.14  55.00
 39.16  54.00
 39.18  55.00
 39.22  54.00
 39.24  54.00
 39.25  54.00
 39.27  55.00
 39.30  54.00
 39.29  54.00
 39.32  53.00
 39.84  55.00
 42.18  53.00
 44.65  55.00
 47.15  54.00
 49.67  55.00
 52.18  56.00
 54.68  56.00
 57.21  56.00
 59.71  57.00
 62.21  59.00
 64.72  60.00
 67.22  60.00
 69.73  62.00
 72.25  63.00
 74.74  64.00
 77.28  67.00
 79.76  67.00
 82.28  69.00
 84.69  71.00
 87.21  73.00
 89.70  73.00
 92.22  76.00
 94.72  77.00
 97.24  76.00
 99.73  78.00
102.24  78.00
104.77  78.00
107.28  78.00
109.78  77.00
112.29  77.00
114.80  77.00
117.30  76.00
119.81  75.00
122.31  76.00
124.79  76.00
127.28  77.00
129.78  77.00
132.27  78.00
134.79  79.00
```

```
137.31  80.00
139.78  80.00
142.30  81.00
144.79  80.00
147.30  77.00
149.83  75.00
152.32  71.00
154.83  68.00
157.32  64.00
159.83  62.00
162.34  60.00
164.87  59.00
167.21  59.00
169.71  59.00
172.19  59.00
174.71  59.00
177.21  60.00
179.71  61.00
182.23  63.00
184.73  63.00
187.25  64.00
189.75  66.00
192.23  66.00
194.75  66.00
197.22  67.00
199.73  67.00
202.24  66.00
204.74  65.00
207.24  66.00
209.69  65.00
212.16  67.00
214.69  69.00
217.19  74.00
219.74  80.00
222.23  87.00
224.72  99.00
227.22  112.00
229.78  127.00
232.24  146.00
234.79  168.00
237.26  193.00
239.82  223.00
242.29  255.00
244.79  290.00
247.31  328.00
249.71  368.00
252.20  406.00
254.73  439.00
257.23  468.00
259.71  483.00
262.22  482.00
264.72  456.00
267.25  406.00
269.76  333.00
272.27  255.00
274.76  181.00
277.29  128.00
279.79  99.00
280.89  85.00
280.88  80.00
```

```
280.90  76.00
280.89  74.00
280.89  72.00
280.89  70.00
280.89  68.00
280.90  67.00
280.89  65.00
280.90  64.00
280.91  62.00
280.90  62.00
280.89  61.00
280.89  61.00
280.90  60.00
280.90  59.00
280.91  58.00
280.91  59.00
280.90  58.00
280.90  58.00
280.90  57.00
280.89  57.00
280.90  57.00
280.92  57.00
280.90  56.00
280.90  56.00
280.89  56.00
280.90  57.00
280.89  56.00
280.89  56.00
280.89  56.00
280.89  55.00
280.89  56.00
280.89  56.00
280.88  55.00
280.91  56.00
280.89  56.00
280.89  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.88  55.00
280.89  56.00
280.89  55.00
280.88  55.00
280.89  56.00
280.87  55.00
280.88  56.00
280.90  55.00
280.90  56.00
280.88  55.00
280.87  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.88  55.00
280.88  55.00
280.88  56.00
280.88  55.00
280.89  56.00
280.89  55.00
280.89  56.00
```

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280.88  55.00
280.88  56.00
280.87  56.00
280.87  55.00
280.87  56.00
280.89  55.00
280.88  56.00
280.89  55.00
280.88  56.00
280.89  55.00
280.89  56.00
280.90  55.00
280.88  56.00
280.89  55.00
280.87  56.00
280.88  56.00
280.89  55.00
280.89  56.00
280.88  55.00
280.88  56.00
280.88  56.00
280.87  55.00
280.89  56.00
280.89  56.00
280.91  56.00
280.88  56.00
280.88  56.00
280.88  55.00
280.87  56.00
280.87  56.00
280.88  56.00
280.89  56.00
280.89  55.00
280.88  56.00
280.89  56.00
280.89  56.00
280.90  56.00
280.92  56.00
280.89  56.00
280.89  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.90  56.00
280.91  56.00
280.89  56.00
280.90  57.00
280.92  56.00
280.92  56.00
280.92  56.00
280.91  56.00
280.91  57.00
280.89  56.00
280.89  56.00
280.90  56.00
280.90  57.00
```

Listing 63: X-ray 管电压 40V-第 3 片

```
  36.68  51.00
  36.72  51.00
  36.76  51.00
  36.79  50.00
  36.81  51.00
  36.83  50.00
  36.85  51.00
  36.87  50.00
  36.89  51.00
  36.90  50.00
  36.93  51.00
  36.94  50.00
  36.95  51.00
  36.97  50.00
  37.39  51.00
  39.72  51.00
  42.18  50.00
  44.65  51.00
  47.18  51.00
  49.66  51.00
  52.19  51.00
  54.65  51.00
  57.19  51.00
  59.67  52.00
  62.18  51.00
  64.72  53.00
  67.22  53.00
  69.74  53.00
  72.23  53.00
  74.78  55.00
  77.25  55.00
  79.78  56.00
  82.29  57.00
  84.70  58.00
  87.21  60.00
  89.69  60.00
  92.21  61.00
  94.72  63.00
  97.25  62.00
  99.74  63.00
 102.22  63.00
 104.76  62.00
 107.27  63.00
 109.77  62.00
 112.29  62.00
 114.80  63.00
 117.30  65.00
 119.79  67.00
 122.28  70.00
 124.78  73.00
 127.26  79.00
 129.77  83.00
 132.24  88.00
 134.77  93.00
 137.30  97.00
 139.77  100.00
 142.31  99.00
 144.78  95.00
```

```
147.30  91.00
149.81  83.00
152.30  75.00
154.81  68.00
157.31  63.00
159.82  60.00
162.33  60.00
164.85  62.00
167.21  63.00
169.72  66.00
172.21  69.00
174.71  72.00
177.22  77.00
179.71  80.00
182.22  84.00
184.74  88.00
187.25  91.00
189.75  94.00
192.23  95.00
194.74  95.00
197.25  94.00
199.74  92.00
202.24  89.00
204.75  90.00
207.23  93.00
209.71  99.00
212.18  109.00
214.68  124.00
217.21  147.00
219.71  173.00
222.20  209.00
224.71  251.00
227.24  303.00
229.79  366.00
232.25  438.00
234.76  524.00
237.29  620.00
239.78  732.00
242.29  852.00
244.79  983.00
247.29  1114.00
249.71  1232.00
252.19  1338.00
254.70  1417.00
257.21  1444.00
259.73  1400.00
262.24  1274.00
264.75  1067.00
267.23  813.00
269.77  561.00
272.24  363.00
274.76  244.00
277.26  188.00
279.79  166.00
280.91  154.00
280.88  145.00
280.90  136.00
280.90  127.00
280.93  119.00
280.91  112.00
```

```
  280.89  105.00
  280.91  98.00
  280.89  93.00
  280.89  89.00
  280.89  84.00
  280.90  81.00
  280.88  77.00
  280.88  75.00
  280.89  73.00
  280.89  71.00
  280.89  67.00
  280.91  67.00
  280.89  66.00
  280.89  65.00
  280.89  63.00
  280.88  62.00
  280.88  61.00
  280.89  61.00
  280.89  61.00
  280.89  60.00
  280.89  59.00
  280.89  59.00
  280.90  59.00
  280.91  58.00
  280.90  58.00
  280.89  58.00
  280.89  58.00
  280.89  57.00
  280.89  57.00
  280.90  57.00
  280.89  57.00
  280.90  57.00
  280.89  57.00
  280.90  56.00
  280.89  57.00
  280.92  57.00
  280.91  56.00
  280.91  57.00
  280.89  56.00
  280.91  57.00
  280.90  56.00
  280.90  56.00
  280.91  57.00
  280.90  56.00
  280.90  56.00
  280.92  55.00
  280.90  56.00
  280.90  56.00
  280.89  56.00
  280.93  56.00
  280.90  56.00
  280.90  56.00
  280.89  56.00
  280.90  56.00
  280.90  56.00
  280.89  56.00
  280.90  56.00
  280.89  56.00
  280.89  55.00
  280.89  56.00
```

```
  280.89  56.00
  280.89  56.00
  280.91  56.00
  280.90  56.00
  280.89  56.00
  280.87  56.00
  280.89  56.00
  280.90  56.00
  280.89  56.00
  280.90  56.00
  280.89  56.00
  280.89  56.00
  280.90  56.00
  280.90  57.00
  280.90  56.00
  280.92  56.00
  280.90  55.00
  280.89  57.00
  280.89  56.00
  280.90  56.00
  280.89  57.00
  280.90  56.00
  280.90  56.00
  280.90  56.00
  280.91  56.00
  280.91  56.00
  280.90  57.00
  280.92  56.00
  280.91  56.00
  280.91  56.00
  280.90  56.00
  280.89  57.00
  280.90  56.00
  280.89  56.00
  280.90  56.00
  280.90  57.00
  280.90  56.00
  280.89  56.00
  280.90  57.00
  280.91  56.00
  280.91  57.00
  280.89  56.00
  280.89  57.00
  280.89  56.00
  280.87  56.00
  280.88  56.00
  280.90  57.00
  280.89  56.00
  280.89  56.00
  280.89  57.00
  280.89  56.00
  280.89  57.00
  280.92  56.00
  280.90  57.00
```

Listing 64: X-ray 时间 60s-第 1 片

```
   34.83  53.00
   34.87  53.00
```

```
  34.89  53.00
  34.91  53.00
  34.92  53.00
  34.94  53.00
  34.95  53.00
  34.96  53.00
  34.98  53.00
  34.99  53.00
  34.97  53.00
  35.00  53.00
  35.01  52.00
  35.19  53.00
  37.20  53.00
  39.68  52.00
  42.17  53.00
  44.65  53.00
  47.15  54.00
  49.65  53.00
  52.17  54.00
  54.67  55.00
  57.16  55.00
  59.66  55.00
  62.18  56.00
  64.70  58.00
  67.19  58.00
  69.70  61.00
  72.24  61.00
  74.74  63.00
  77.25  65.00
  79.75  68.00
  82.29  70.00
  84.68  71.00
  87.20  74.00
  89.68  73.00
  92.21  76.00
  94.70  77.00
  97.24  77.00
  99.71  77.00
 102.22  77.00
 104.75  78.00
 107.28  79.00
 109.79  82.00
 112.29  85.00
 114.78  89.00
 117.29  94.00
 119.78  100.00
 122.26  107.00
 124.79  115.00
 127.24  122.00
 129.73  128.00
 132.26  132.00
 134.79  133.00
 137.30  129.00
 139.78  121.00
 142.30  110.00
 144.79  99.00
 147.32  86.00
 149.78  77.00
 152.28  72.00
 154.82  70.00
```

```
157.33  72.00
159.84  74.00
162.30  78.00
164.85  82.00
167.19  88.00
169.70  93.00
172.17  98.00
174.72  105.00
177.23  111.00
179.71  117.00
182.20  121.00
184.73  123.00
187.22  127.00
189.73  126.00
192.24  125.00
194.74  123.00
197.23  123.00
199.72  126.00
202.23  133.00
204.72  147.00
207.21  167.00
209.70  196.00
212.16  235.00
214.66  284.00
217.18  344.00
219.71  420.00
222.21  508.00
224.71  616.00
227.22  741.00
229.76  887.00
232.24  1058.00
234.77  1248.00
237.27  1470.00
239.80  1709.00
242.30  1966.00
244.80  2240.00
247.30  2493.00
249.71  2708.00
252.20  2837.00
254.71  2830.00
257.21  2662.00
259.74  2296.00
262.22  1796.00
264.75  1265.00
267.23  827.00
269.75  547.00
272.26  410.00
274.76  356.00
277.27  327.00
279.78  311.00
280.93  291.00
280.91  271.00
280.90  246.00
280.89  226.00
280.89  204.00
280.89  185.00
280.89  170.00
280.88  154.00
280.87  142.00
280.87  131.00
```

```
280.88  121.00
280.88  114.00
280.90  107.00
280.90  100.00
280.88  96.00
280.88  91.00
280.88  88.00
280.87  84.00
280.88  82.00
280.86  79.00
280.87  77.00
280.89  75.00
280.88  74.00
280.88  72.00
280.88  72.00
280.88  69.00
280.87  70.00
280.88  68.00
280.86  66.00
280.85  67.00
280.87  65.00
280.87  65.00
280.88  65.00
280.88  65.00
280.88  63.00
280.89  64.00
280.88  63.00
280.88  63.00
280.90  62.00
280.89  63.00
280.88  62.00
280.88  61.00
280.89  62.00
280.90  61.00
280.89  61.00
280.89  61.00
280.90  61.00
280.90  61.00
280.89  60.00
280.90  61.00
280.88  60.00
280.91  60.00
280.90  61.00
280.90  60.00
280.91  59.00
280.91  60.00
280.90  60.00
280.90  59.00
280.90  60.00
280.91  60.00
280.89  58.00
280.90  60.00
280.90  59.00
280.90  59.00
280.90  59.00
280.89  60.00
280.90  59.00
280.89  59.00
280.89  59.00
280.89  60.00
```

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280.90  59.00
280.89  59.00
280.90  59.00
280.89  59.00
280.90  59.00
280.88  59.00
280.90  60.00
280.89  59.00
280.89  60.00
280.88  59.00
280.89  58.00
280.88  59.00
280.87  59.00
280.86  59.00
280.89  59.00
280.89  59.00
280.89  59.00
280.89  59.00
280.88  59.00
280.91  59.00
280.88  59.00
280.88  58.00
280.87  59.00
280.87  59.00
280.87  59.00
280.88  59.00
280.87  59.00
280.88  59.00
280.88  59.00
280.87  59.00
280.89  59.00
280.89  59.00
280.90  59.00
280.88  59.00
280.89  59.00
280.88  59.00
280.89  58.00
280.88  60.00
280.90  58.00
280.89  59.00
280.89  60.00
280.89  58.00
280.90  59.00
280.90  59.00
280.92  59.00
280.91  58.00
280.89  59.00
280.90  59.00
280.90  59.00
280.89  59.00
```

Listing 65: X-ray 时间 90s-第 1 片

```
 39.88  50.00
 39.97  49.00
 40.01  49.00
 40.04  49.00
 40.08  50.00
 40.13  49.00
```

```
  40.15  50.00
  40.18  49.00
  40.20  49.00
  40.21  49.00
  40.22  49.00
  40.25  50.00
  40.24  49.00
  40.29  49.00
  40.28  50.00
  40.37  49.00
  42.16  49.00
  44.62  50.00
  47.14  49.00
  49.67  50.00
  52.17  50.00
  54.68  50.00
  57.14  50.00
  59.67  52.00
  62.22  52.00
  64.74  53.00
  67.22  54.00
  69.73  56.00
  72.22  58.00
  74.75  60.00
  77.28  63.00
  79.79  65.00
  82.27  68.00
  84.68  71.00
  87.22  72.00
  89.69  75.00
  92.19  75.00
  94.71  77.00
  97.22  76.00
  99.74  78.00
 102.21  79.00
 104.74  80.00
 107.27  83.00
 109.76  86.00
 112.27  91.00
 114.81  98.00
 117.25 104.00
 119.77 113.00
 122.27 121.00
 124.78 130.00
 127.26 136.00
 129.77 141.00
 132.28 141.00
 134.78 139.00
 137.30 130.00
 139.77 117.00
 142.29 104.00
 144.81  89.00
 147.31  79.00
 149.81  72.00
 152.29  70.00
 154.84  70.00
 157.34  73.00
 159.84  78.00
 162.33  84.00
 164.86  90.00
```

```
167.18  95.00
169.69  104.00
172.19  111.00
174.71  119.00
177.22  126.00
179.75  133.00
182.21  139.00
184.70  141.00
187.23  142.00
189.75  141.00
192.23  141.00
194.75  141.00
197.23  142.00
199.75  151.00
202.24  166.00
204.74  189.00
207.25  225.00
209.72  269.00
212.18  328.00
214.64  400.00
217.20  491.00
219.71  598.00
222.21  729.00
224.70  882.00
227.22  1057.00
229.75  1259.00
232.25  1496.00
234.75  1758.00
237.26  2054.00
239.80  2380.00
242.27  2709.00
244.78  3039.00
247.32  3323.00
249.71  3493.00
252.18  3506.00
254.68  3301.00
257.22  2863.00
259.72  2232.00
262.24  1555.00
264.72  994.00
267.23  644.00
269.76  480.00
272.27  421.00
274.77  393.00
277.27  372.00
279.80  357.00
280.92  338.00
280.92  315.00
280.92  289.00
280.91  262.00
280.90  234.00
280.91  212.00
280.90  191.00
280.91  173.00
280.90  157.00
280.90  143.00
280.88  131.00
280.89  123.00
280.92  114.00
280.89  106.00
```

```
  280.89  101.00
  280.89  94.00
  280.88  89.00
  280.89  86.00
  280.89  82.00
  280.87  79.00
  280.89  77.00
  280.89  74.00
  280.89  72.00
  280.89  70.00
  280.90  68.00
  280.90  67.00
  280.89  66.00
  280.89  65.00
  280.88  63.00
  280.89  63.00
  280.87  63.00
  280.89  61.00
  280.89  61.00
  280.87  61.00
  280.89  59.00
  280.89  59.00
  280.89  59.00
  280.91  58.00
  280.88  58.00
  280.89  58.00
  280.89  58.00
  280.90  57.00
  280.89  56.00
  280.89  57.00
  280.89  56.00
  280.91  57.00
  280.90  56.00
  280.90  56.00
  280.90  56.00
  280.91  55.00
  280.94  56.00
  280.89  55.00
  280.90  55.00
  280.90  55.00
  280.89  55.00
  280.89  55.00
  280.89  55.00
  280.90  55.00
  280.89  54.00
  280.89  55.00
  280.88  55.00
  280.89  54.00
  280.90  55.00
  280.90  55.00
  280.89  55.00
  280.89  54.00
  280.88  54.00
  280.89  55.00
  280.90  55.00
  280.87  54.00
  280.89  54.00
  280.88  55.00
  280.87  54.00
  280.87  55.00
```

```
280.87  54.00
280.90  54.00
280.88  55.00
280.87  54.00
280.88  54.00
280.88  54.00
280.88  54.00
280.88  54.00
280.86  55.00
280.87  54.00
280.88  54.00
280.87  54.00
280.87  54.00
280.87  54.00
280.89  55.00
280.88  54.00
280.89  54.00
280.87  54.00
280.88  54.00
280.89  54.00
280.88  55.00
280.88  55.00
280.89  54.00
280.88  55.00
280.89  54.00
280.89  55.00
280.89  54.00
280.92  54.00
280.88  54.00
280.89  54.00
280.90  55.00
280.90  54.00
280.90  55.00
280.90  54.00
280.90  54.00
280.90  54.00
280.90  55.00
280.89  54.00
280.88  54.00
280.89  55.00
280.91  55.00
280.89  54.00
280.88  54.00
280.88  55.00
280.90  54.00
280.88  55.00
```

Listing 66: X-ray 时间 60s-第 2 片

```
 38.89  56.00
 38.90  55.00
 38.89  56.00
 38.89  55.00
 38.89  54.00
 38.85  55.00
 38.86  55.00
 38.85  56.00
 38.83  55.00
 38.83  54.00
```

```
  38.80  55.00
  38.79  54.00
  38.80  55.00
  38.79  55.00
  38.77  55.00
  39.72  54.00
  42.19  55.00
  44.65  55.00
  47.16  55.00
  49.66  54.00
  52.17  56.00
  54.70  56.00
  57.17  56.00
  59.69  56.00
  62.20  57.00
  64.73  59.00
  67.21  58.00
  69.73  60.00
  72.24  60.00
  74.77  62.00
  77.24  63.00
  79.75  65.00
  82.29  67.00
  84.69  68.00
  87.19  71.00
  89.70  74.00
  92.21  77.00
  94.72  79.00
  97.22  82.00
  99.74  85.00
 102.24  86.00
 104.77  89.00
 107.28  91.00
 109.75  91.00
 112.29  93.00
 114.80  95.00
 117.31  98.00
 119.81  100.00
 122.31  106.00
 124.79  112.00
 127.26  119.00
 129.77  130.00
 132.28  141.00
 134.79  152.00
 137.29  165.00
 139.77  176.00
 142.29  187.00
 144.79  189.00
 147.31  186.00
 149.79  179.00
 152.30  164.00
 154.82  143.00
 157.32  124.00
 159.82  105.00
 162.31  90.00
 164.85  85.00
 167.20  82.00
 169.71  85.00
 172.17  90.00
 174.70  97.00
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177.20  103.00
179.71  111.00
182.22  121.00
184.71  132.00
187.23  141.00
189.73  151.00
192.24  160.00
194.72  168.00
197.24  172.00
199.74  173.00
202.25  171.00
204.71  169.00
207.22  165.00
209.70  162.00
212.18  167.00
214.64  176.00
217.21  198.00
219.71  233.00
222.21  281.00
224.73  348.00
227.23  431.00
229.75  527.00
232.27  656.00
234.74  800.00
237.28  975.00
239.79  1175.00
242.27  1403.00
244.76  1654.00
247.30  1940.00
249.70  2236.00
252.21  2539.00
254.68  2826.00
257.20  3092.00
259.69  3286.00
262.23  3379.00
264.72  3316.00
267.26  3066.00
269.77  2618.00
272.26  2017.00
274.75  1380.00
277.29  846.00
279.80  497.00
280.90  323.00
280.90  252.00
280.88  222.00
280.88  204.00
280.87  187.00
280.88  173.00
280.89  161.00
280.92  148.00
280.89  139.00
280.89  127.00
280.88  119.00
280.90  113.00
280.90  105.00
280.88  100.00
280.89  94.00
280.89  91.00
280.89  86.00
280.90  83.00
```

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280.89  80.00
280.89  78.00
280.92  75.00
280.90  72.00
280.89  72.00
280.87  70.00
280.87  69.00
280.88  67.00
280.88  67.00
280.87  65.00
280.88  65.00
280.88  64.00
280.88  63.00
280.87  63.00
280.89  63.00
280.88  62.00
280.88  62.00
280.89  61.00
280.89  61.00
280.89  61.00
280.91  61.00
280.90  60.00
280.90  61.00
280.90  60.00
280.90  60.00
280.91  59.00
280.90  59.00
280.94  60.00
280.92  59.00
280.92  60.00
280.90  59.00
280.90  59.00
280.90  59.00
280.90  59.00
280.91  59.00
280.90  59.00
280.90  59.00
280.92  59.00
280.90  59.00
280.89  58.00
280.91  59.00
280.89  59.00
280.90  59.00
280.90  59.00
280.90  58.00
280.90  59.00
280.90  59.00
280.89  59.00
280.90  58.00
280.89  59.00
280.88  59.00
280.88  58.00
280.89  58.00
280.90  59.00
280.88  58.00
280.88  59.00
280.88  58.00
280.88  58.00
280.88  58.00
280.88  59.00
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280.89  58.00
280.89  59.00
280.89  58.00
280.89  59.00
280.89  59.00
280.91  58.00
280.90  59.00
280.89  59.00
280.88  58.00
280.88  58.00
280.88  59.00
280.88  59.00
280.88  58.00
280.89  59.00
280.88  58.00
280.87  59.00
280.88  59.00
280.88  58.00
280.91  59.00
280.88  59.00
280.89  58.00
280.89  59.00
280.89  59.00
280.89  59.00
280.89  58.00
280.90  59.00
280.90  59.00
280.89  58.00
280.90  59.00
280.90  59.00
280.91  58.00
280.90  59.00
280.89  59.00
280.89  59.00
280.90  59.00
280.89  59.00
280.90  59.00
280.89  59.00
280.90  59.00
280.89  58.00
280.90  59.00
280.91  59.00
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Listing 67: X-ray 时间 90s-第 2 片

```
 35.35  47.00
 35.41  47.00
 35.47  48.00
 35.51  47.00
 35.54  47.00
 35.57  47.00
 35.61  47.00
 35.65  47.00
 35.67  48.00
 35.71  47.00
 35.75  48.00
 35.77  47.00
 35.80  47.00
 35.83  47.00
```

```
 37.20  47.00
 39.70  47.00
 42.18  47.00
 44.65  48.00
 47.16  47.00
 49.66  49.00
 52.17  48.00
 54.68  48.00
 57.16  49.00
 59.68  50.00
 62.21  51.00
 64.71  53.00
 67.23  53.00
 69.73  55.00
 72.24  58.00
 74.75  60.00
 77.26  62.00
 79.75  67.00
 82.31  71.00
 84.68  76.00
 87.19  80.00
 89.68  86.00
 92.21  90.00
 94.72  94.00
 97.22  97.00
 99.71  99.00
102.22 100.00
104.73  99.00
107.27  99.00
109.75  99.00
112.27  99.00
114.79 103.00
117.27 108.00
119.82 117.00
122.29 127.00
124.80 142.00
127.25 159.00
129.74 178.00
132.24 199.00
134.77 218.00
137.27 237.00
139.77 249.00
142.28 251.00
144.79 244.00
147.28 226.00
149.80 199.00
152.30 167.00
154.82 136.00
157.32 111.00
159.80  96.00
162.33  90.00
164.85  93.00
167.19 100.00
169.71 111.00
172.19 123.00
174.70 138.00
177.20 152.00
179.70 169.00
182.22 186.00
184.73 202.00
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187.24  215.00
189.76  227.00
192.24  233.00
194.76  236.00
197.24  235.00
199.71  229.00
202.23  223.00
204.75  220.00
207.20  222.00
209.69  238.00
212.16  267.00
214.65  320.00
217.22  396.00
219.68  494.00
222.19  622.00
224.72  778.00
227.20  968.00
229.79  1194.00
232.26  1468.00
234.73  1786.00
237.24  2153.00
239.77  2573.00
242.27  3040.00
244.80  3539.00
247.30  4043.00
249.71  4520.00
252.19  4920.00
254.71  5207.00
257.17  5287.00
259.70  5075.00
262.22  4535.00
264.74  3669.00
267.22  2636.00
269.75  1659.00
272.27  945.00
274.74  548.00
277.27  389.00
279.77  338.00
280.90  312.00
280.89  291.00
280.89  271.00
280.89  250.00
280.89  229.00
280.90  209.00
280.87  190.00
280.89  174.00
280.89  159.00
280.89  145.00
280.91  134.00
280.89  122.00
280.87  114.00
280.88  106.00
280.87  98.00
280.88  92.00
280.87  88.00
280.87  82.00
280.87  79.00
280.88  76.00
280.88  73.00
280.88  71.00
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  280.89  67.00
  280.90  67.00
  280.88  65.00
  280.88  63.00
  280.89  62.00
  280.88  61.00
  280.88  60.00
  280.87  59.00
  280.89  58.00
  280.86  58.00
  280.88  57.00
  280.88  57.00
  280.87  56.00
  280.89  56.00
  280.89  55.00
  280.87  56.00
  280.88  54.00
  280.87  55.00
  280.88  55.00
  280.88  54.00
  280.88  54.00
  280.88  54.00
  280.88  54.00
  280.89  53.00
  280.89  54.00
  280.87  53.00
  280.90  53.00
  280.90  53.00
  280.88  53.00
  280.89  54.00
  280.89  53.00
  280.88  53.00
  280.89  52.00
  280.89  53.00
  280.89  53.00
  280.89  53.00
  280.89  53.00
  280.90  53.00
  280.89  52.00
  280.94  53.00
  280.90  52.00
  280.90  53.00
  280.89  52.00
  280.90  53.00
  280.90  52.00
  280.89  53.00
  280.89  52.00
  280.90  52.00
  280.90  52.00
  280.88  53.00
  280.89  53.00
  280.89  52.00
  280.90  52.00
  280.89  53.00
  280.88  52.00
  280.88  53.00
  280.88  53.00
  280.88  52.00
  280.88  53.00
  280.89  52.00
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280.88  53.00
280.89  52.00
280.88  53.00
280.89  53.00
280.89  52.00
280.89  52.00
280.88  53.00
280.87  53.00
280.88  52.00
280.88  53.00
280.89  53.00
280.88  52.00
280.88  53.00
280.88  52.00
280.88  53.00
280.87  52.00
280.89  53.00
280.91  52.00
280.89  53.00
280.89  53.00
280.89  53.00
280.89  52.00
280.88  53.00
280.89  52.00
280.88  53.00
280.90  52.00
280.90  53.00
280.90  52.00
280.92  53.00
280.89  52.00
280.90  53.00
280.88  52.00
280.89  53.00
280.89  53.00
280.89  52.00
280.89  54.00
280.88  52.00
280.88  53.00
```

Listing 68: X-ray 时间 60s-第 3 片

```
 38.94  54.00
 38.96  53.00
 38.96  53.00
 38.98  53.00
 39.00  54.00
 39.00  53.00
 38.98  53.00
 39.01  54.00
 39.02  53.00
 39.02  53.00
 39.03  53.00
 39.02  54.00
 39.04  53.00
 39.03  53.00
 39.02  53.00
 39.76  53.00
 42.19  53.00
 44.66  53.00
```

```
 47.16  53.00
 49.64  54.00
 52.17  53.00
 54.67  54.00
 57.19  54.00
 59.67  55.00
 62.21  54.00
 64.71  56.00
 67.22  56.00
 69.71  56.00
 72.25  57.00
 74.75  59.00
 77.28  60.00
 79.75  62.00
 82.29  64.00
 84.71  66.00
 87.19  67.00
 89.71  70.00
 92.22  72.00
 94.73  74.00
 97.24  76.00
 99.74  78.00
102.24  80.00
104.75  81.00
107.27  85.00
109.76  90.00
112.27  95.00
114.81  104.00
117.30  115.00
119.79  127.00
122.29  142.00
124.77  157.00
127.26  175.00
129.75  189.00
132.25  201.00
134.79  209.00
137.30  209.00
139.78  198.00
142.30  178.00
144.78  155.00
147.31  130.00
149.82  108.00
152.32  93.00
154.85  86.00
157.32  87.00
159.84  91.00
162.34  98.00
164.88  107.00
167.22  118.00
169.73  129.00
172.22  141.00
174.71  155.00
177.21  168.00
179.73  180.00
182.22  192.00
184.74  197.00
187.23  201.00
189.73  201.00
192.23  198.00
194.73  190.00
```

```
197.24  186.00
199.74  186.00
202.22  195.00
204.72  215.00
207.21  251.00
209.69  306.00
212.18  377.00
214.66  471.00
217.20  591.00
219.69  736.00
222.22  907.00
224.68  1121.00
227.23  1370.00
229.75  1659.00
232.24  1989.00
234.77  2368.00
237.28  2780.00
239.79  3224.00
242.29  3669.00
244.79  4100.00
247.32  4464.00
249.71  4711.00
252.21  4781.00
254.71  4598.00
257.21  4120.00
259.76  3383.00
262.26  2494.00
264.75  1647.00
267.23  1015.00
269.77  647.00
272.31  485.00
274.76  420.00
277.24  388.00
279.83  366.00
280.90  342.00
280.90  317.00
280.90  287.00
280.91  261.00
280.91  236.00
280.89  212.00
280.89  190.00
280.90  172.00
280.90  154.00
280.90  142.00
280.90  129.00
280.88  120.00
280.90  112.00
280.88  104.00
280.89  98.00
280.89  93.00
280.90  89.00
280.90  85.00
280.90  83.00
280.89  78.00
280.90  77.00
280.92  75.00
280.90  72.00
280.92  72.00
280.92  70.00
280.90  69.00
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```
280.90  68.00
280.90  66.00
280.91  66.00
280.89  66.00
280.91  64.00
280.91  65.00
280.92  63.00
280.91  64.00
280.93  62.00
280.92  63.00
280.91  62.00
280.91  62.00
280.90  62.00
280.90  61.00
280.89  61.00
280.91  61.00
280.89  61.00
280.90  61.00
280.90  60.00
280.90  61.00
280.90  60.00
280.93  60.00
280.90  60.00
280.90  60.00
280.89  60.00
280.89  60.00
280.88  60.00
280.89  59.00
280.89  60.00
280.89  60.00
280.89  59.00
280.89  59.00
280.89  60.00
280.89  60.00
280.90  59.00
280.89  59.00
280.88  59.00
280.88  59.00
280.89  60.00
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280.89  59.00
280.89  59.00
280.88  60.00
280.88  59.00
280.89  59.00
280.88  59.00
280.91  59.00
280.89  59.00
280.88  60.00
280.89  59.00
280.87  59.00
280.89  59.00
280.90  60.00
280.90  59.00
280.90  59.00
280.90  59.00
280.90  60.00
280.89  59.00
280.90  59.00
280.93  59.00
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280.90  59.00
280.90  59.00
280.91  59.00
280.90  60.00
280.91  59.00
280.92  59.00
280.90  59.00
280.91  59.00
280.90  60.00
280.91  59.00
280.90  60.00
280.91  59.00
280.90  59.00
280.90  59.00
280.91  60.00
280.91  59.00
280.90  60.00
280.89  59.00
280.90  59.00
280.89  60.00
280.89  59.00
280.89  60.00
280.89  59.00
280.89  60.00
280.91  60.00
280.90  59.00
280.90  60.00
280.90  60.00
280.89  60.00
280.89  59.00
280.91  60.00
280.89  60.00
280.91  59.00
280.90  59.00
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Listing 69: X-ray 时间 90s-第 3 片

```
 36.76  54.00
 36.84  53.00
 36.89  54.00
 36.94  54.00
 36.99  53.00
 37.03  54.00
 37.04  54.00
 37.10  53.00
 37.14  54.00
 37.18  54.00
 37.21  53.00
 37.25  54.00
 37.27  53.00
 37.30  54.00
 37.57  53.00
 39.70  54.00
 42.17  53.00
 44.66  54.00
 47.16  54.00
 49.65  53.00
 52.16  54.00
 54.68  55.00
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 57.17  55.00
 59.69  55.00
 62.19  55.00
 64.72  57.00
 67.21  57.00
 69.73  58.00
 72.22  59.00
 74.76  60.00
 77.27  63.00
 79.76  66.00
 82.28  67.00
 84.70  71.00
 87.20  74.00
 89.71  77.00
 92.21  79.00
 94.73  83.00
 97.25  85.00
 99.74  87.00
102.25  91.00
104.78  93.00
107.27  99.00
109.78  106.00
112.28  116.00
114.79  128.00
117.30  144.00
119.80  163.00
122.29  185.00
124.79  210.00
127.26  234.00
129.77  257.00
132.29  273.00
134.79  285.00
137.28  284.00
139.79  269.00
142.29  243.00
144.79  208.00
147.29  170.00
149.80  138.00
152.29  115.00
154.81  104.00
157.31  103.00
159.82  110.00
162.32  119.00
164.86  134.00
167.21  147.00
169.70  165.00
172.18  185.00
174.71  204.00
177.20  223.00
179.71  242.00
182.21  259.00
184.72  270.00
187.24  277.00
189.76  278.00
192.24  273.00
194.76  266.00
197.22  258.00
199.75  255.00
202.23  266.00
204.74  290.00
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```
207.21  339.00
209.70  415.00
212.18  515.00
214.68  647.00
217.20  817.00
219.72  1028.00
222.21  1282.00
224.73  1588.00
227.21  1951.00
229.76  2380.00
232.23  2868.00
234.77  3432.00
237.24  4049.00
239.81  4711.00
242.29  5393.00
244.76  6056.00
247.34  6651.00
249.73  7066.00
252.18  7247.00
254.66  7089.00
257.19  6523.00
259.74  5557.00
262.27  4314.00
264.77  3034.00
267.27  1961.00
269.77  1243.00
272.30  848.00
274.78  671.00
277.30  591.00
279.83  549.00
280.89  511.00
280.90  468.00
280.90  422.00
280.89  381.00
280.88  338.00
280.89  303.00
280.90  270.00
280.89  242.00
280.90  218.00
280.90  194.00
280.90  178.00
280.89  160.00
280.91  147.00
280.90  135.00
280.91  126.00
280.90  118.00
280.91  110.00
280.90  103.00
280.88  98.00
280.91  94.00
280.90  90.00
280.93  87.00
280.90  83.00
280.90  80.00
280.90  79.00
280.90  77.00
280.90  74.00
280.90  74.00
280.90  72.00
280.90  71.00
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280.89  70.00
280.90  68.00
280.89  68.00
280.89  68.00
280.92  66.00
280.91  66.00
280.90  65.00
280.89  65.00
280.88  64.00
280.89  64.00
280.89  63.00
280.88  64.00
280.89  62.00
280.88  63.00
280.89  62.00
280.88  63.00
280.87  61.00
280.90  62.00
280.88  61.00
280.87  61.00
280.89  62.00
280.89  61.00
280.89  61.00
280.88  61.00
280.89  61.00
280.90  61.00
280.89  61.00
280.88  60.00
280.89  61.00
280.89  60.00
280.90  61.00
280.88  60.00
280.86  60.00
280.87  60.00
280.88  60.00
280.89  60.00
280.87  60.00
280.88  60.00
280.89  60.00
280.88  60.00
280.88  60.00
280.88  60.00
280.90  61.00
280.89  59.00
280.88  60.00
280.89  60.00
280.89  60.00
280.89  61.00
280.90  60.00
280.89  60.00
280.90  59.00
280.90  60.00
280.90  60.00
280.91  60.00
280.90  60.00
280.92  59.00
280.90  60.00
280.89  60.00
280.90  59.00
280.89  60.00
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  280.91  60.00
  280.90  60.00
  280.90  60.00
  280.90  60.00
  280.91  59.00
  280.89  60.00
  280.89  60.00
  280.91  60.00
  280.91  59.00
  280.90  60.00
  280.89  60.00
  280.89  60.00
  280.89  60.00
  280.90  59.00
  280.90  60.00
  280.90  60.00
  280.90  60.00
  280.89  60.00
  280.89  60.00
  280.89  60.00
  280.91  60.00
  280.89  60.00
  280.89  60.00
  280.89  60.00
  280.89  60.00
  280.89  60.00
  280.89  60.00
  280.88  59.00
  280.89  61.00
  280.89  60.00
```