

爱因斯坦探针 (EP) 科学讨论会
2023北京香山会议



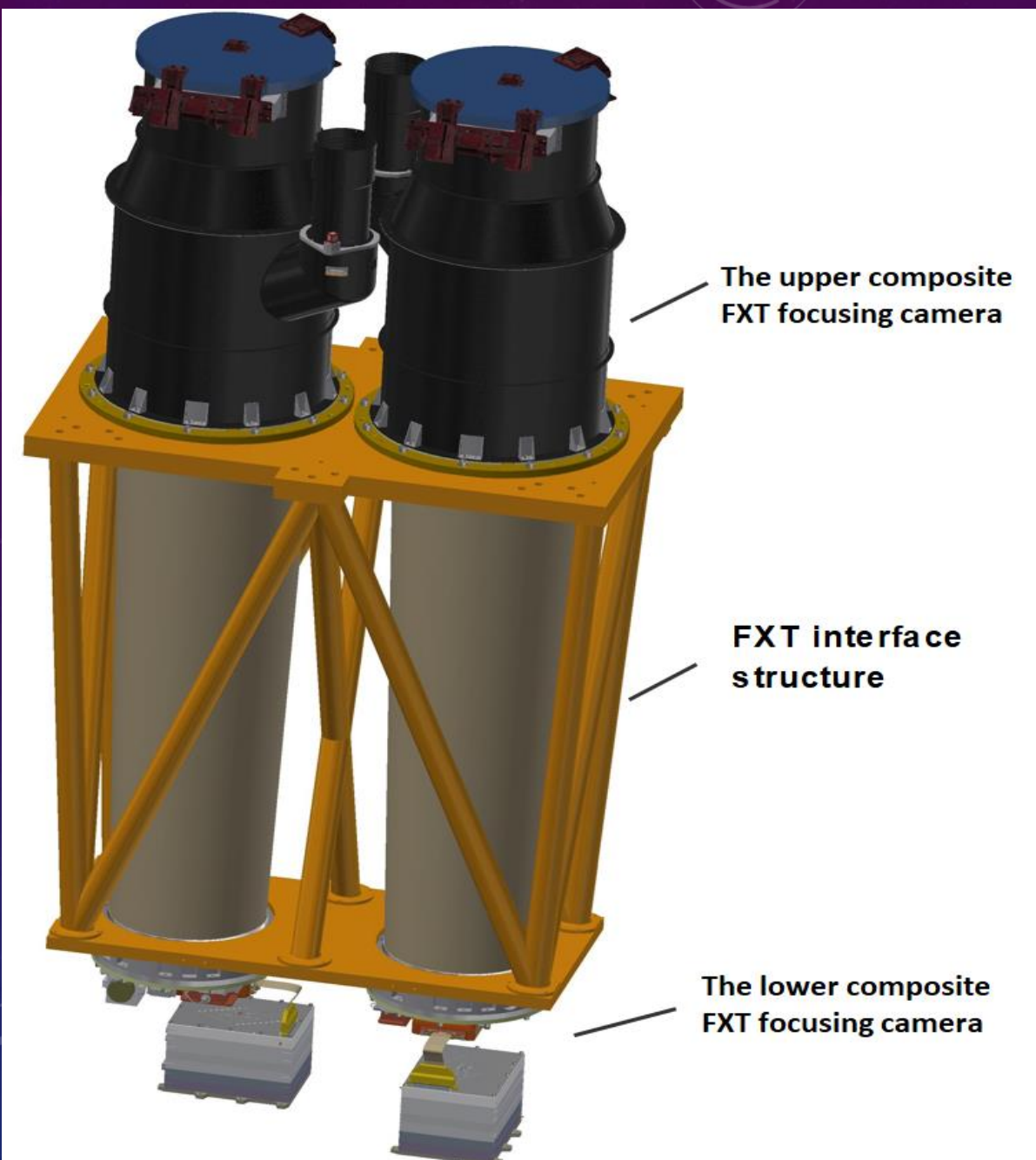
EP/FXT仪器及性能

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20230606



爱因斯坦探针卫星



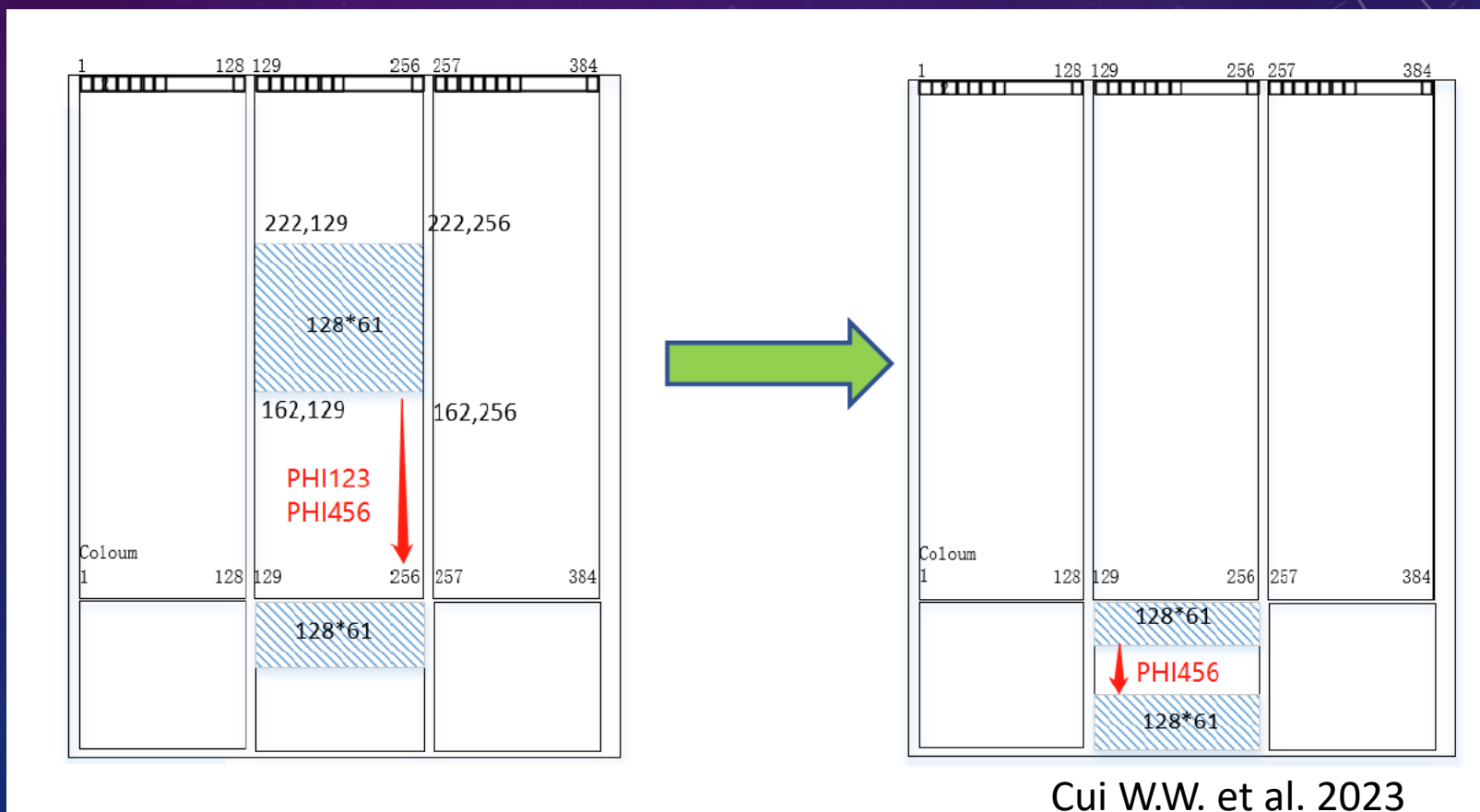
名称	基本要求	期望指标
视场	直径 $\geq 38'$	$1^\circ \times 1^\circ$
源流强上限	-	成像模式: $\geq 200\text{mCrab}$ 非成像模式: $\geq 5\text{Crab}$
有效面积	$\geq 100\text{cm}^2 @ 1.25\text{ keV}$, 在轴	$\geq 600\text{cm}^2 @ 1.25\text{ keV}$, 在轴
角分辨率	$\leq 2'$ HPD	$\leq 30''$; HPD
能量分辨率	$\text{FWHM} \leq 170\text{ eV} @ 1.25\text{ keV}$ (Mg特征线测试)	$\text{FWHM} \leq 120\text{ eV} @ 1.25\text{ keV}$ (Mg特征线测试)
探测能段	0.5–8.0 keV	0.3–10.0 keV
源定位精度	优于20" (探测器坐标系) 测量条件: 90%置信度, 观测时间100秒, 焦斑 内光子数大于200	优于4" (探测器坐标系) 测量条件: 68% 置信 度

FXT特点

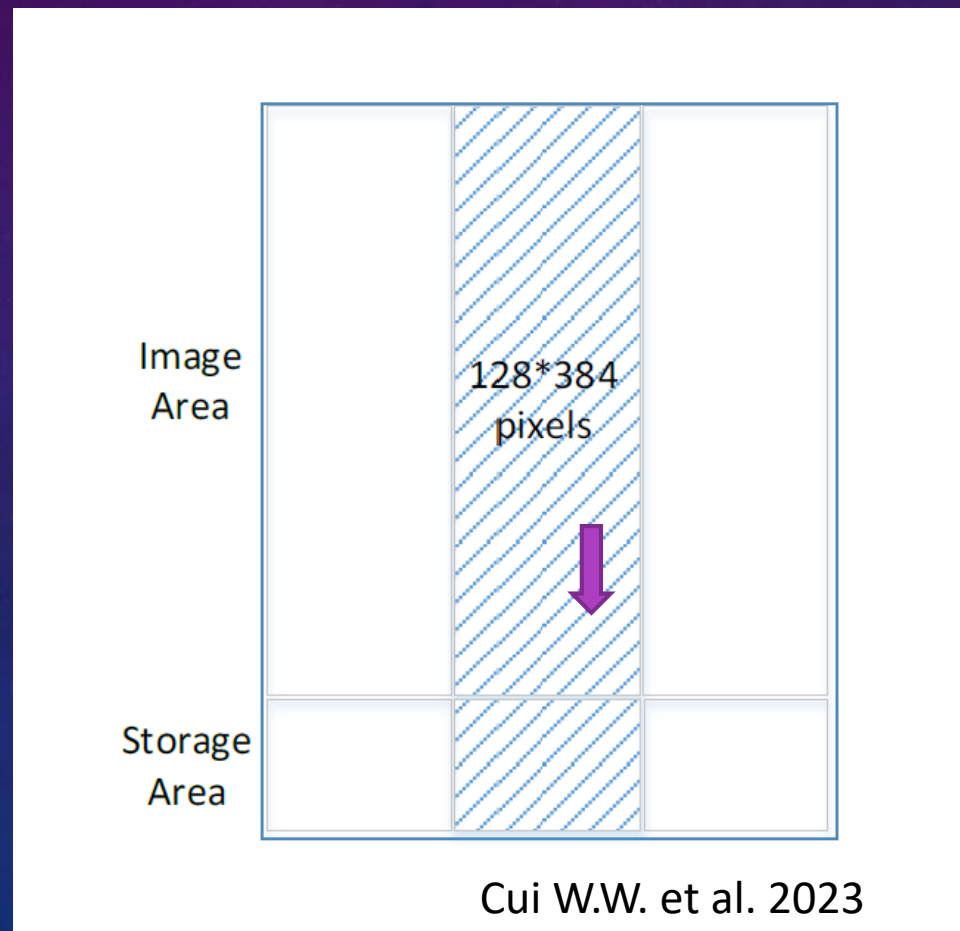
- **迅捷**：触发后3-5分钟到位；北斗、VHF快速数据通讯
- **灵敏**：有效面积大、视场大、定位好、能量分辨好
- **智能**：在轨自动数据处理，自动切换观测模式，自主发出触发信号

科学观测模式：开窗模式

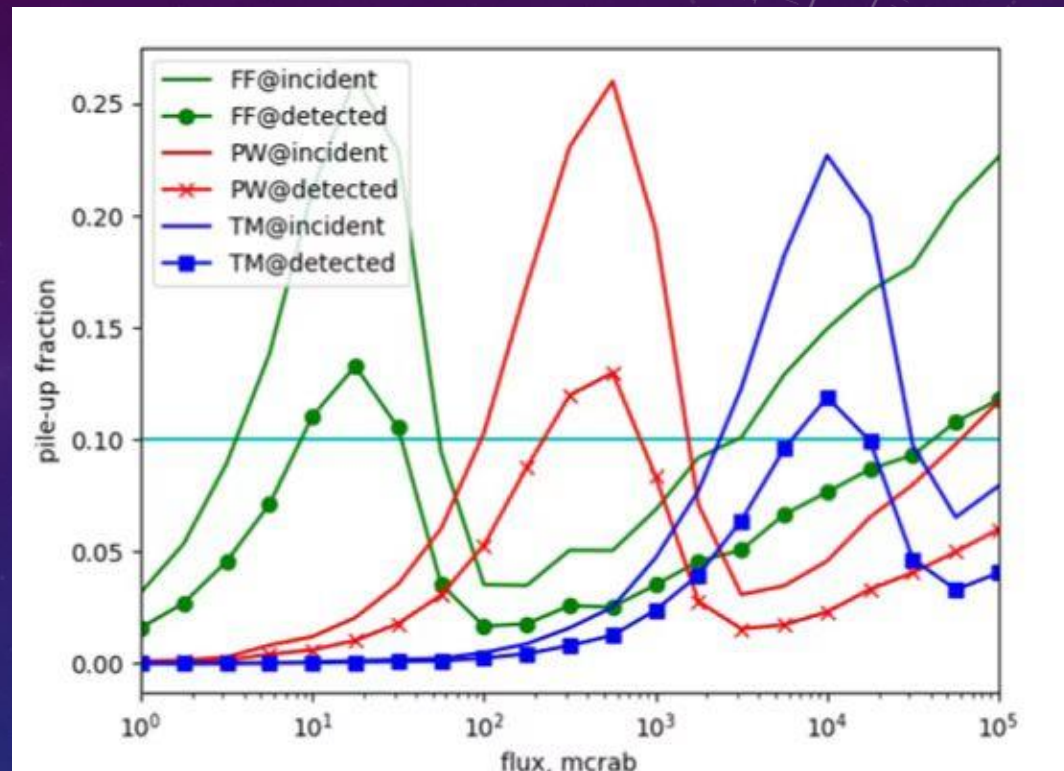
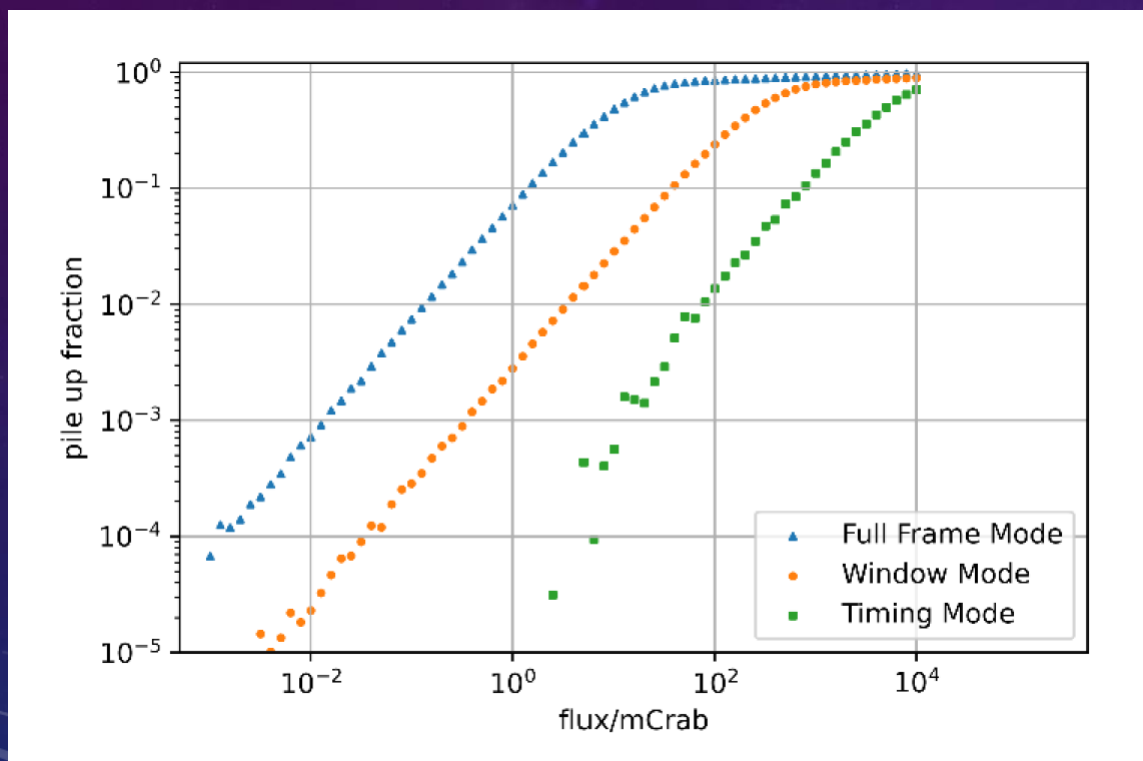
- 帧频: 500 帧/秒



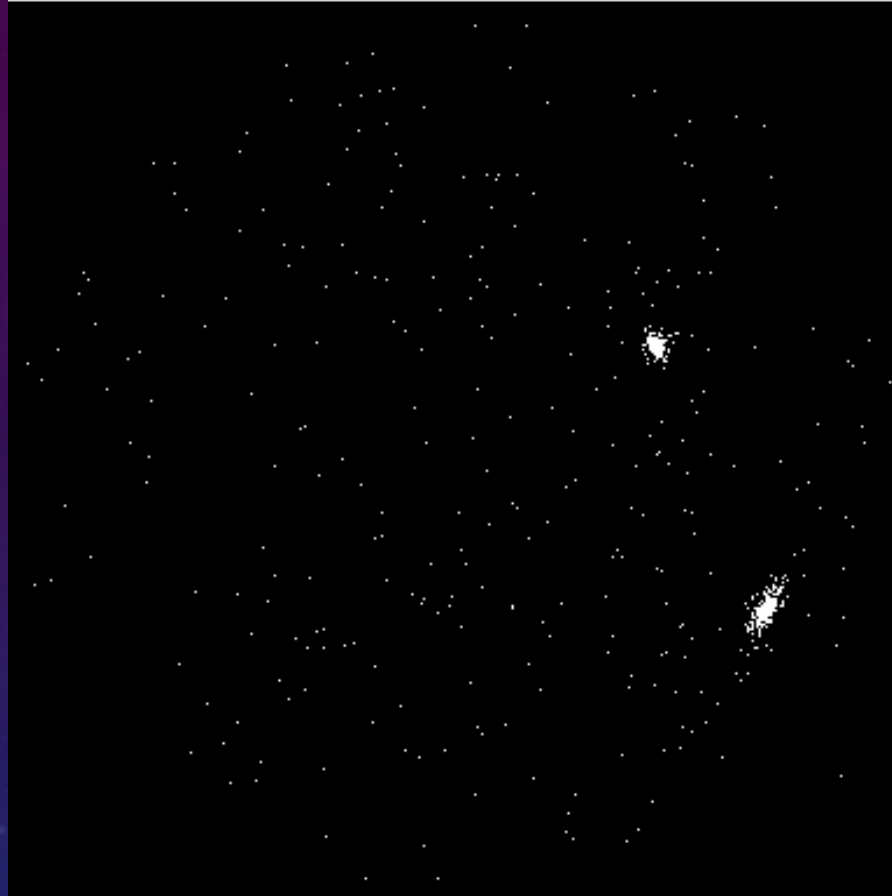
科学观测模式：时变模式



堆积



探测到有效事例的堆积率模拟



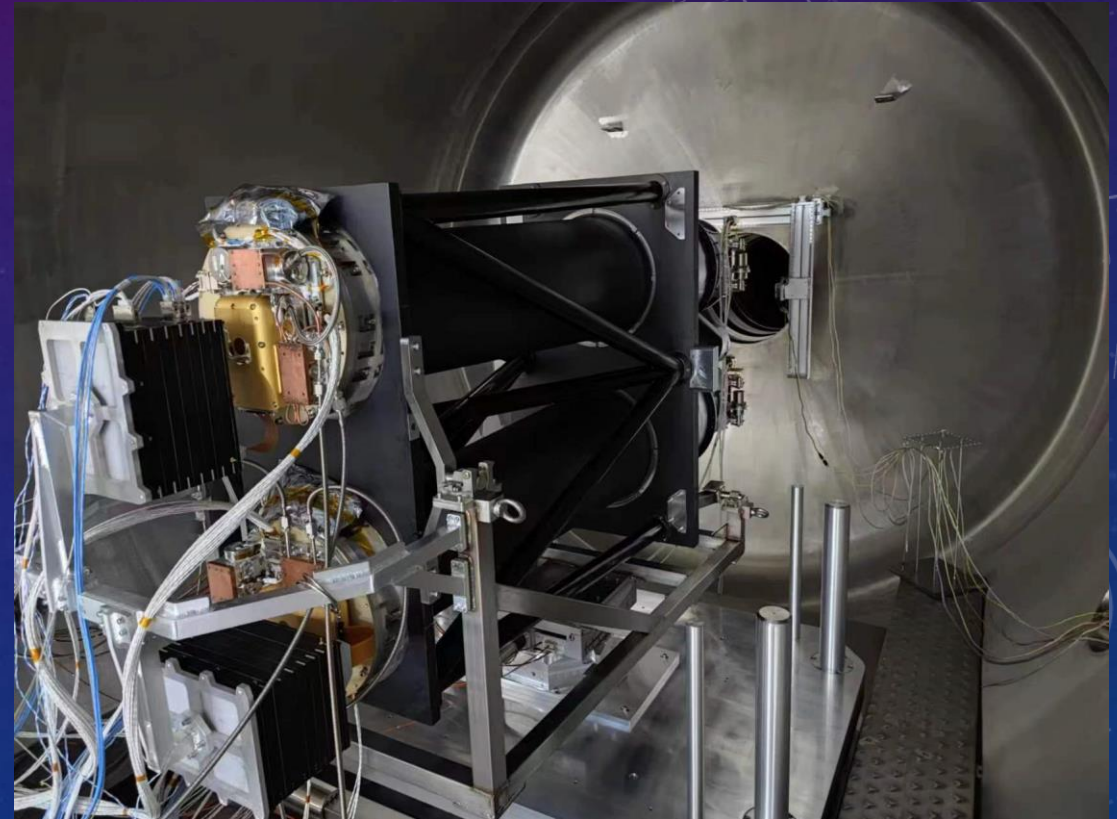
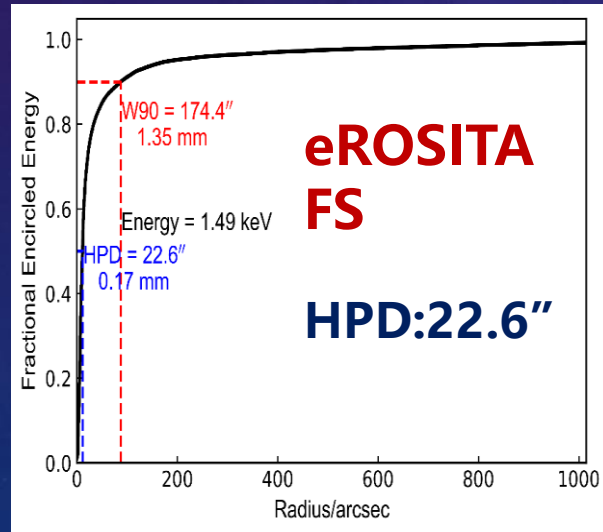
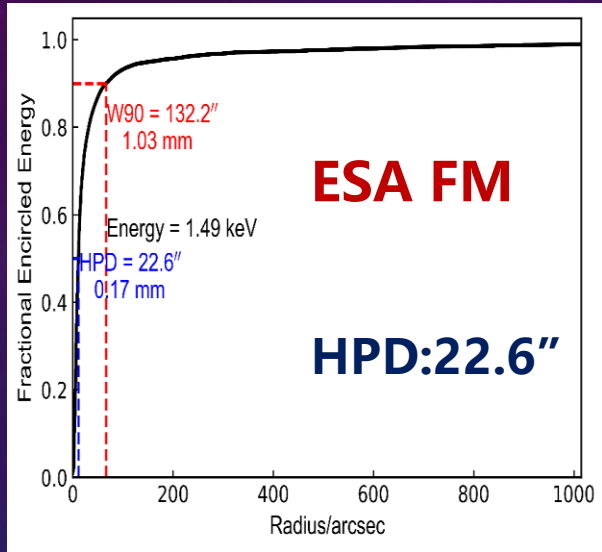
5分钟观测灵敏度 (5σ) :

- 距轴0.1度, $5.8\text{E-}13 \text{ erg/s/cm}^2$
- 距轴0.3度, $9.2\text{E-}13 \text{ erg/s/cm}^2$
- 距轴0.4度, $1.2\text{E-}12 \text{ erg/s/cm}^2$

COMPLETE THE CALIBRATION OF MA IN 2022

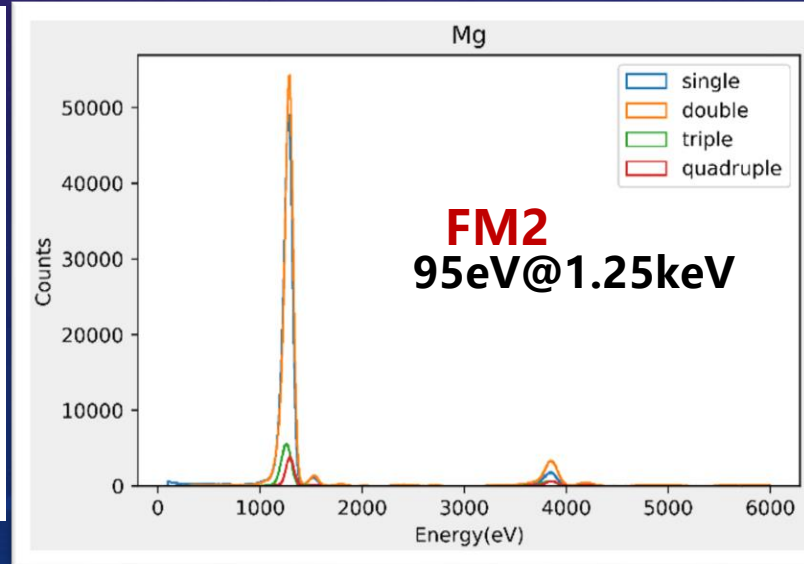
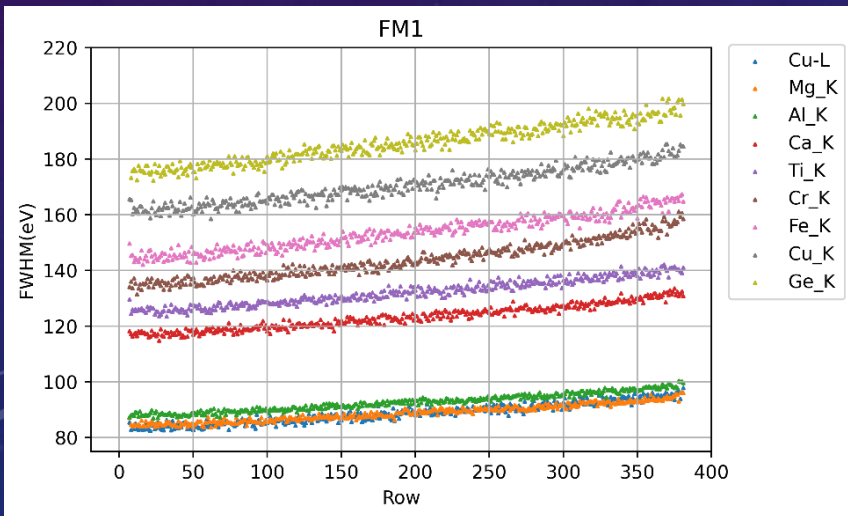
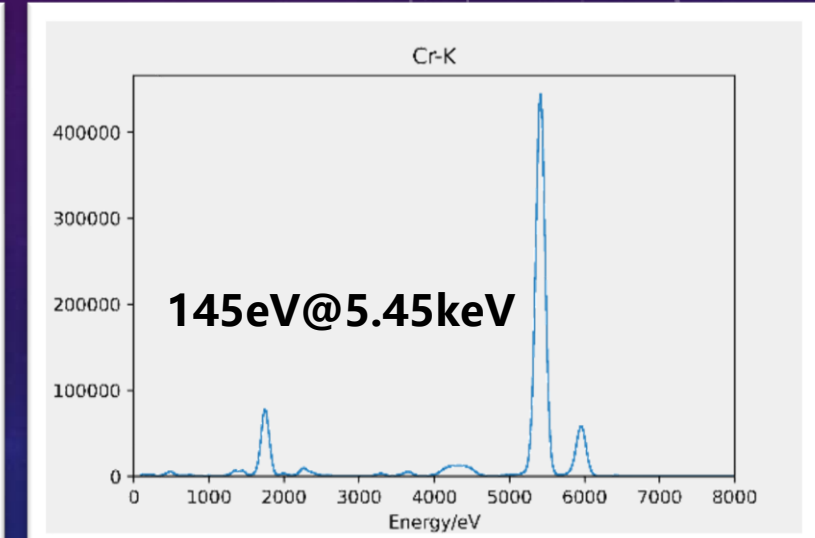
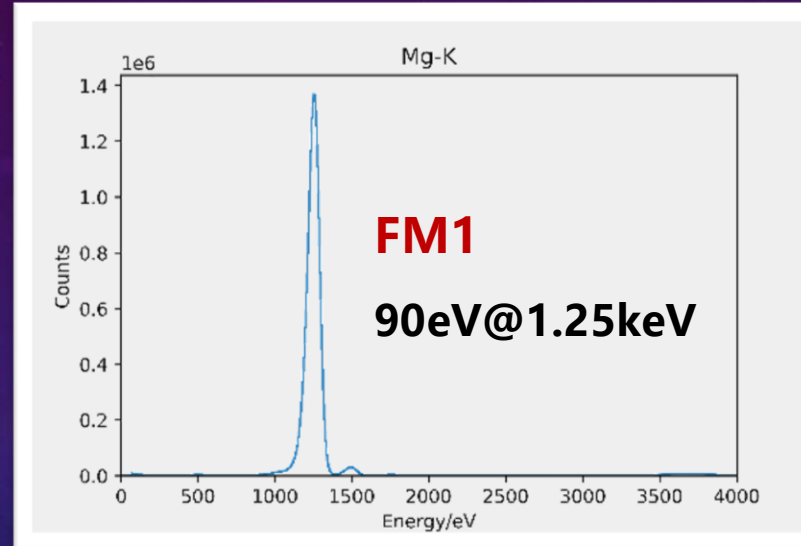
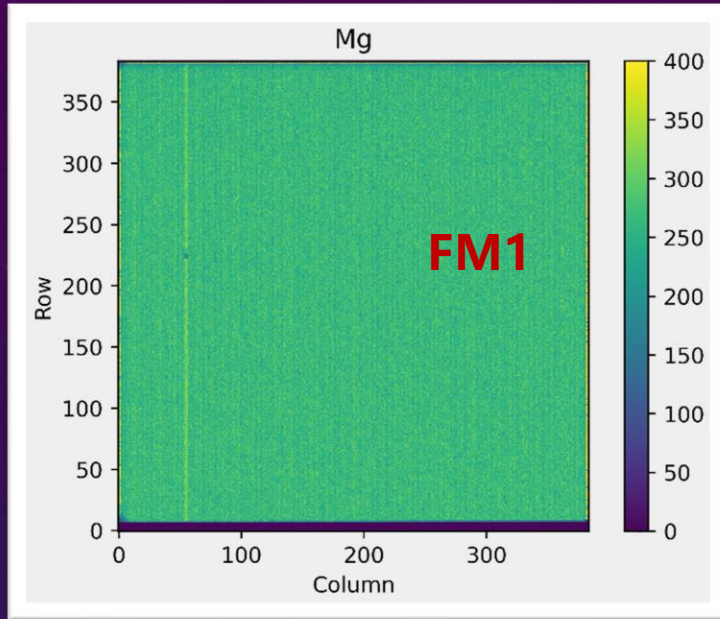
➤ ESA FM and eROSITA FS MA calibration

Angular resolution and effective area are basically consistent with those measured in MPE



CALIBRATION OF PNCCD

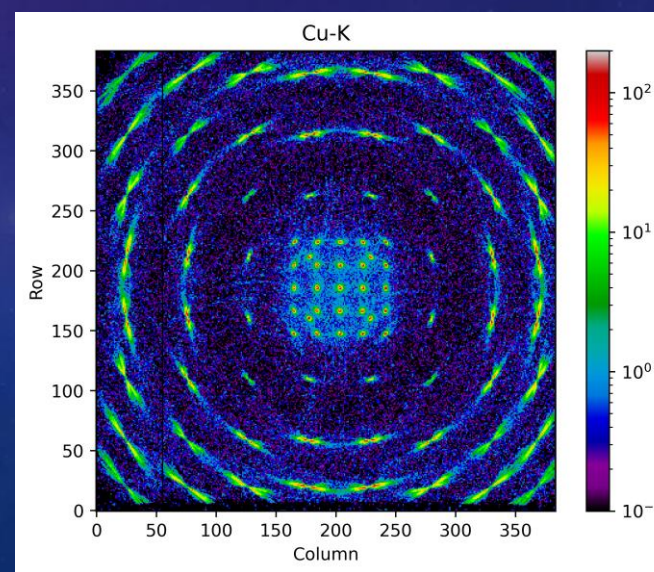
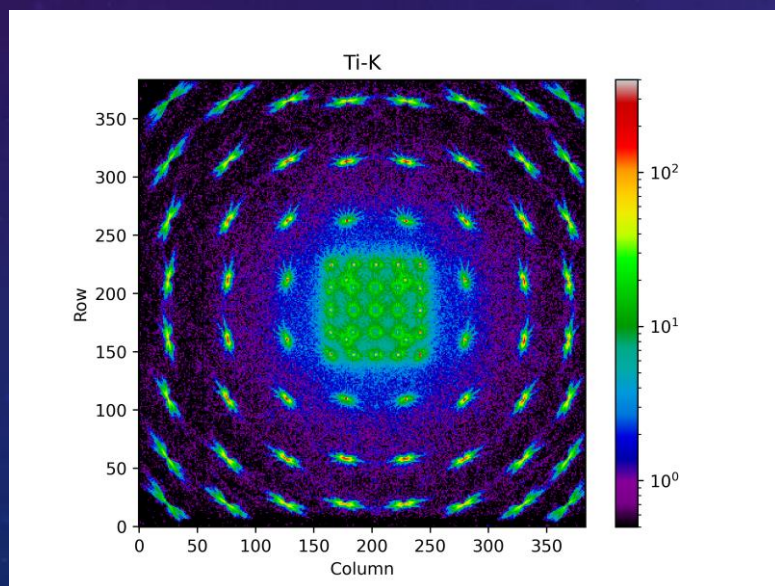
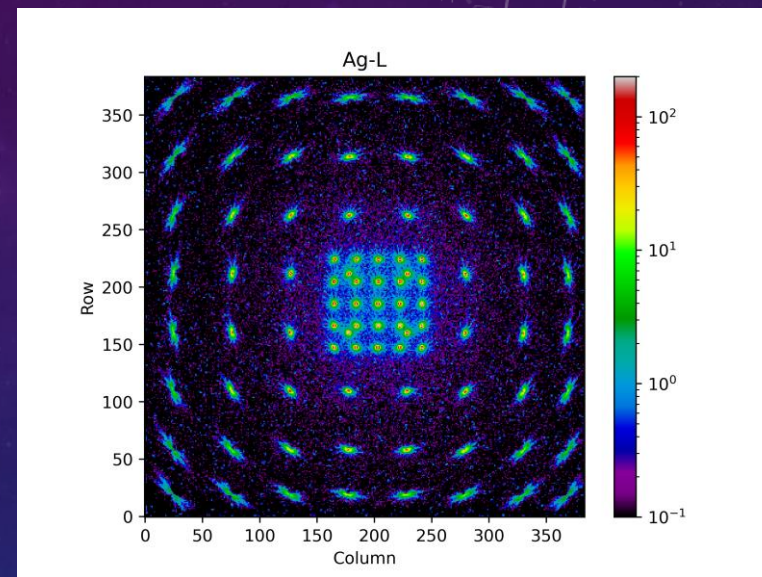
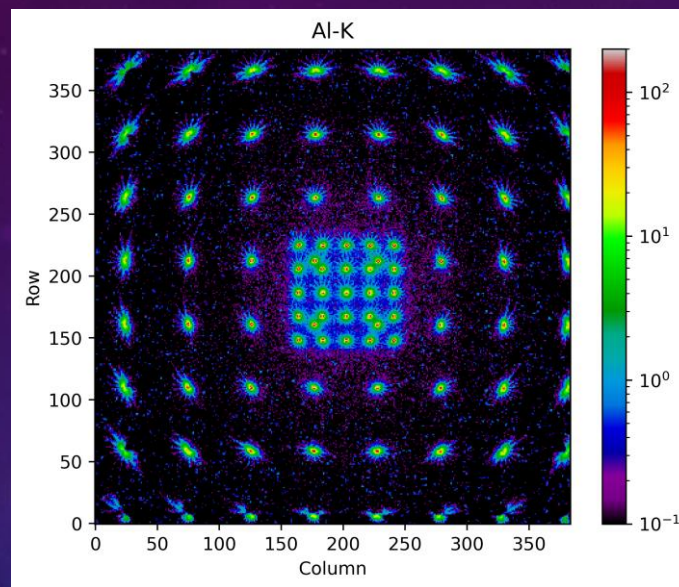
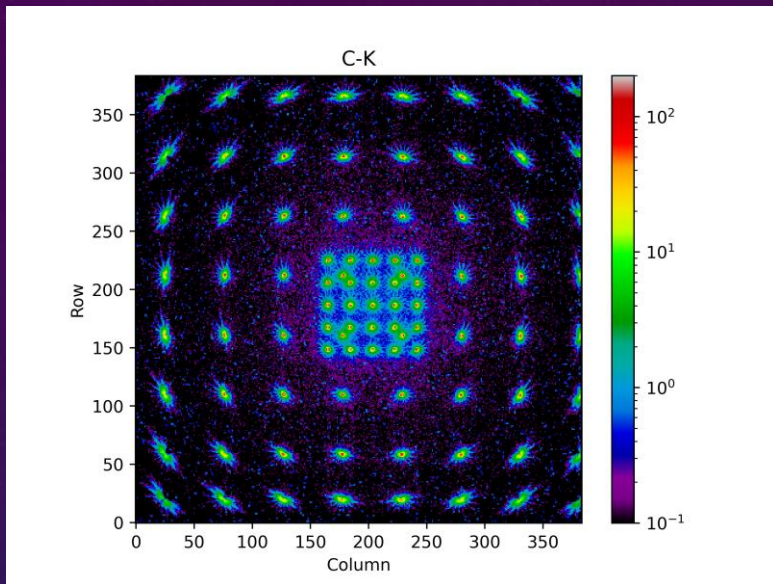
Energy resolution of pnCCD FM1 、 FM2



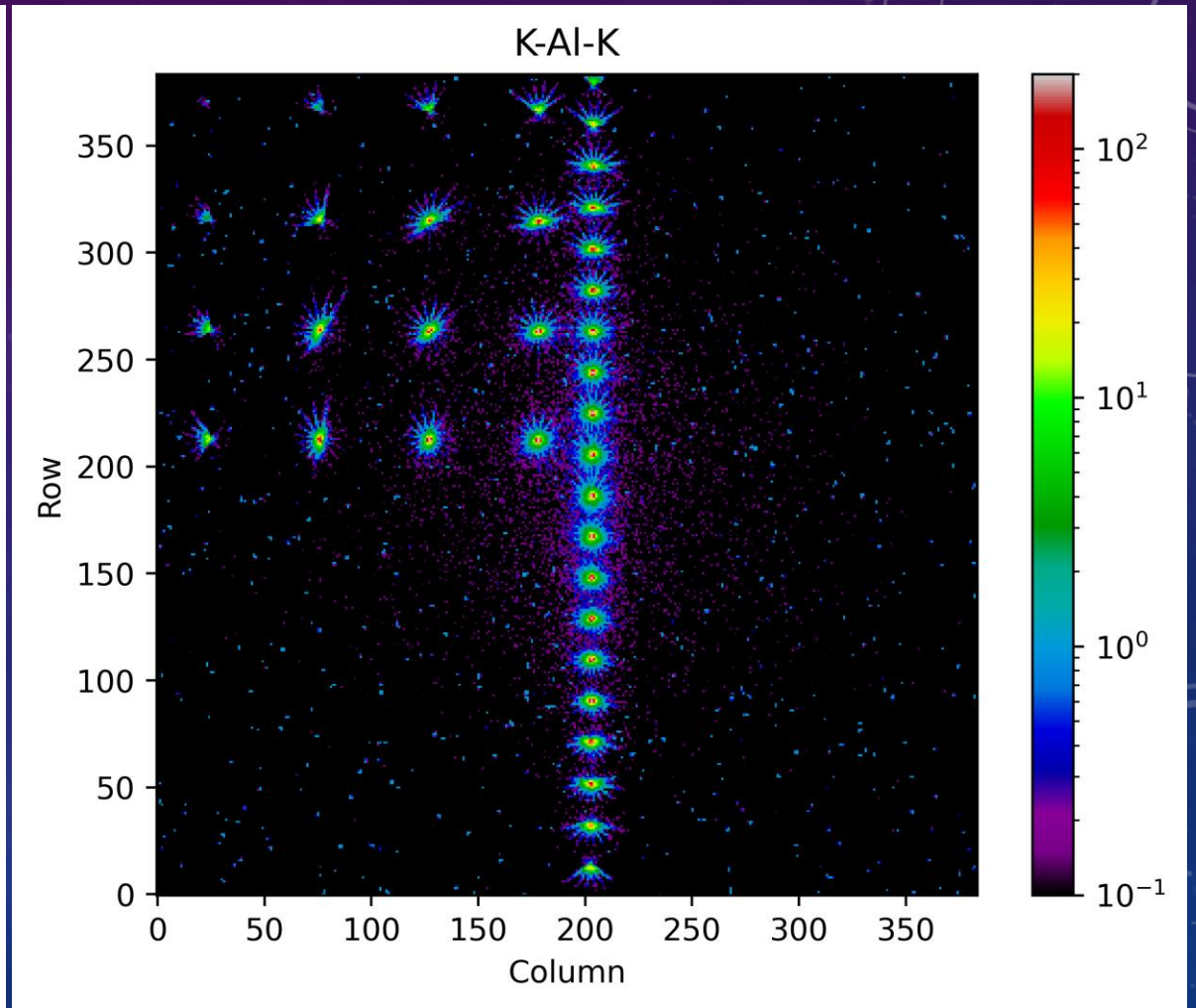
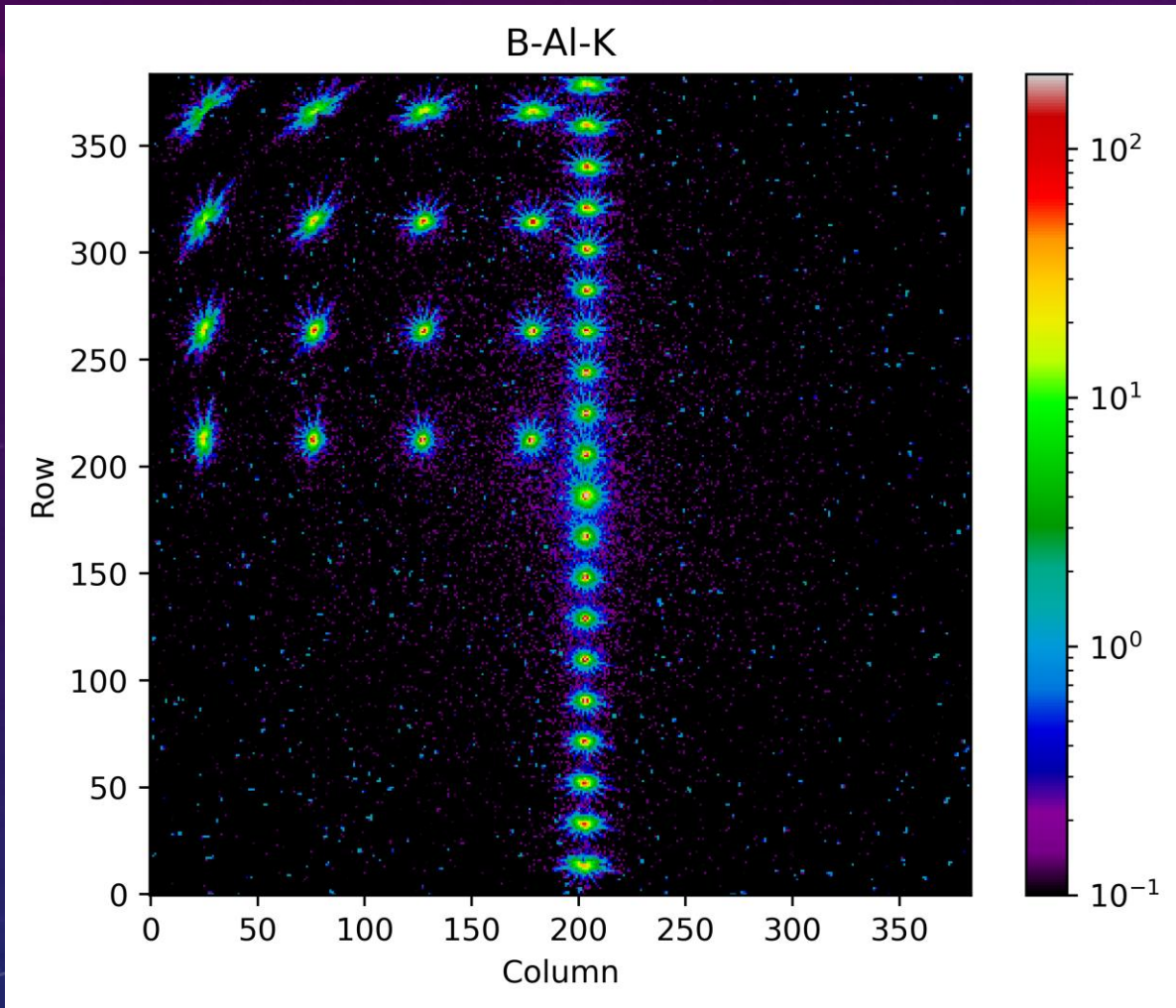
有效面积标定

Energy keV	FXT A 全透射 cm ²	FXT B 薄膜 cm ²
C-K: 0.28	134.4	61.8
O-K: 0.53	263.1	177.0
Cu-L: 0.93	325.3	288.4
Mg-K: 1.25	323.3	329.8
Al-K: 1.49	324.8	346.3
Ag-L: 2.98	86.2	86.4
Ti-K: 4.51	71.5	74.1
Fe-K: 6.4	33.8	37.6
Cu-K: 8.04	18.9	20.5

PSF CALIBRATION



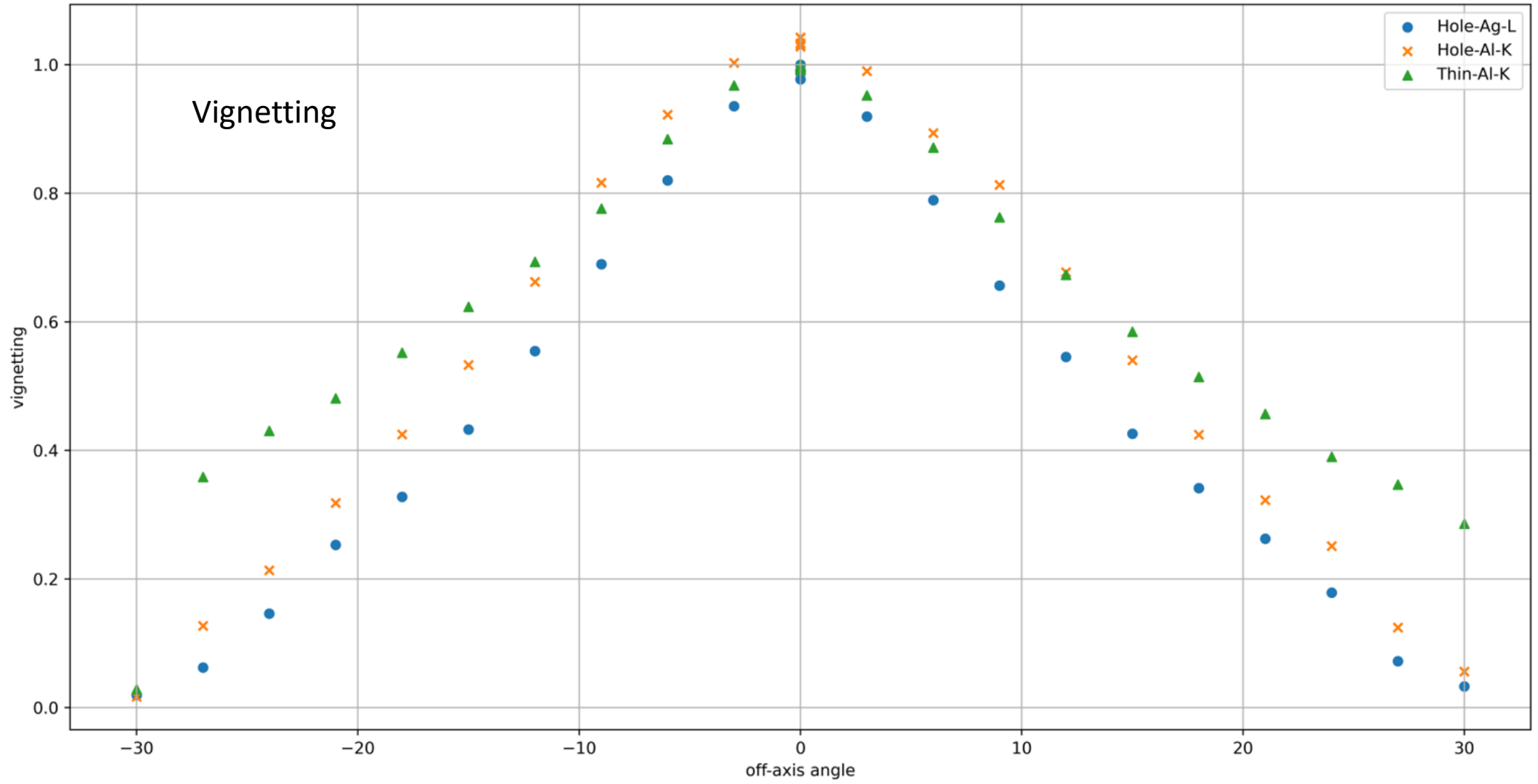
VIGNETTING:



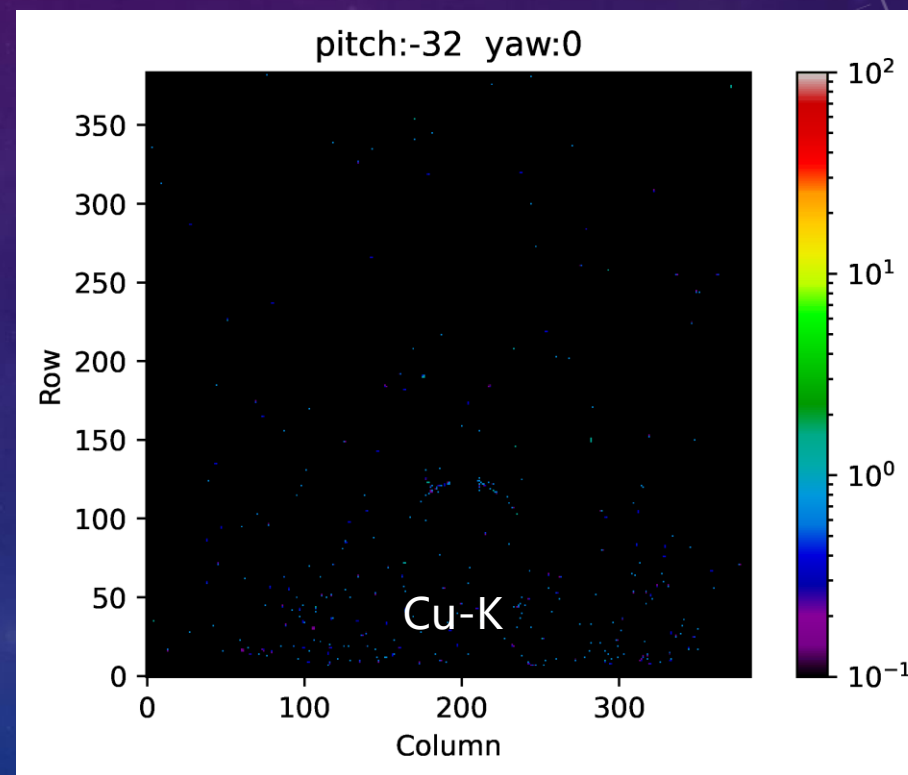
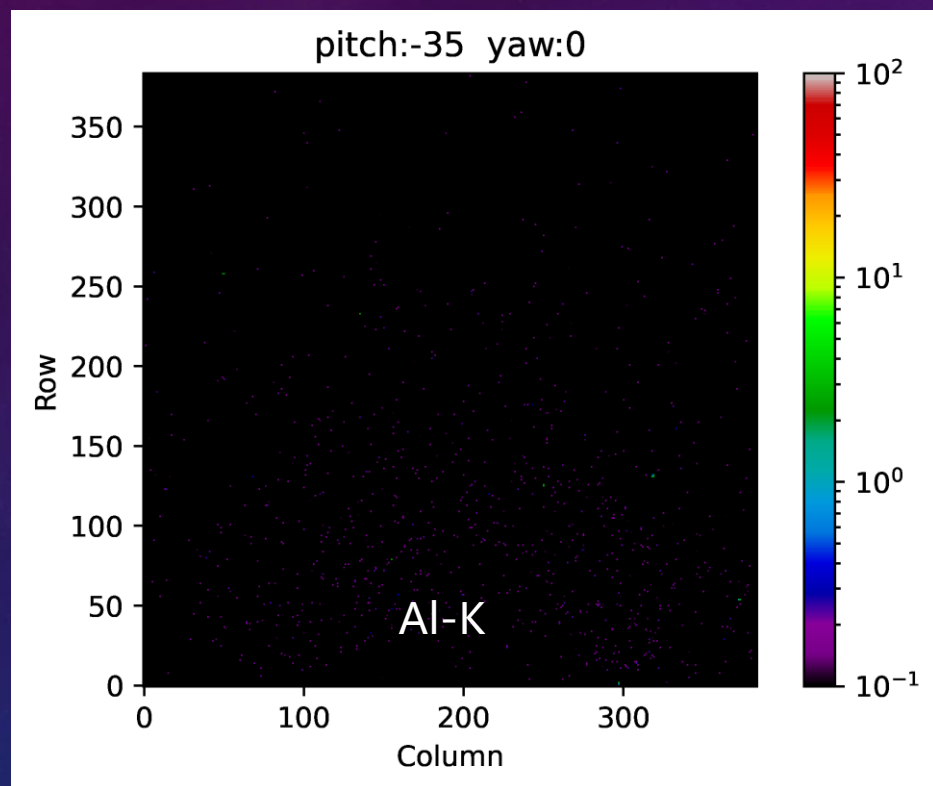
Thin filter: PSF & vignetting

Hole position: PSF & vignetting

Vignetting

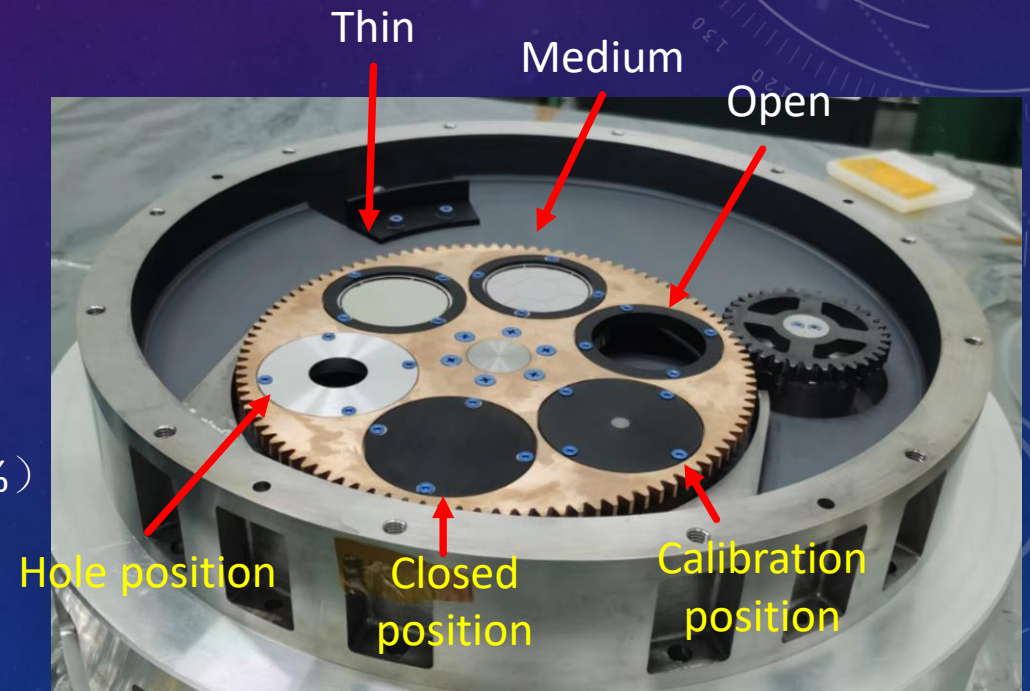


FOV



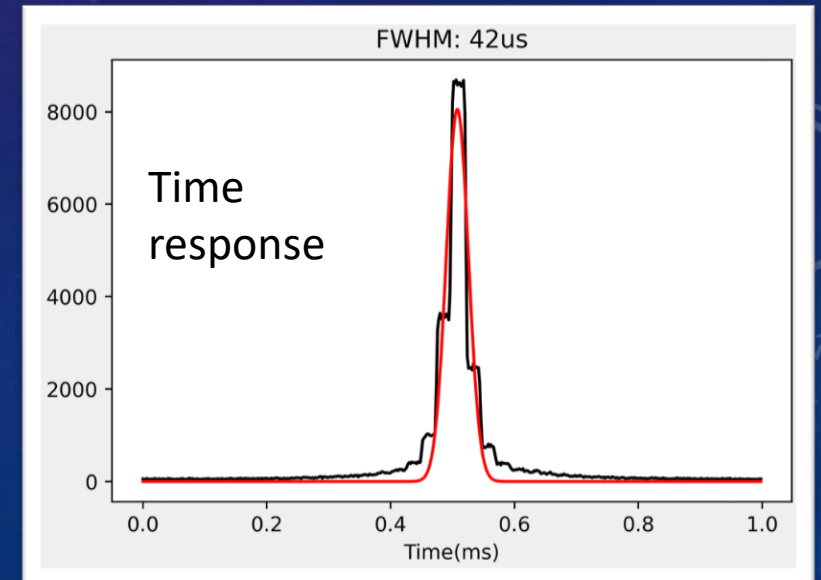
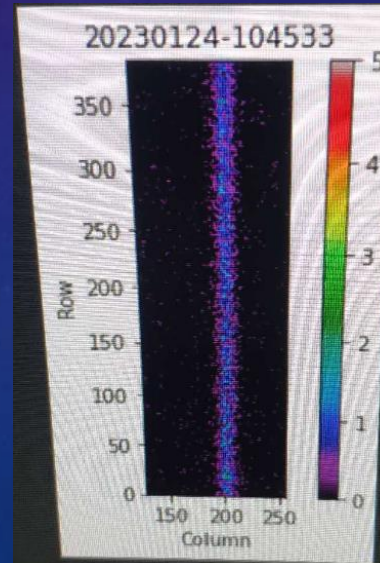
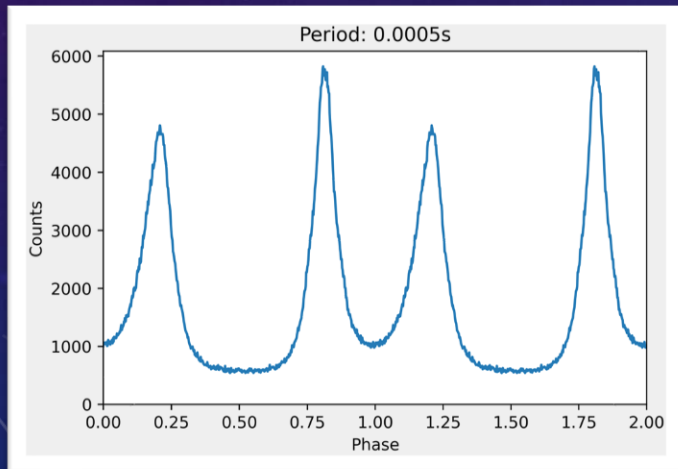
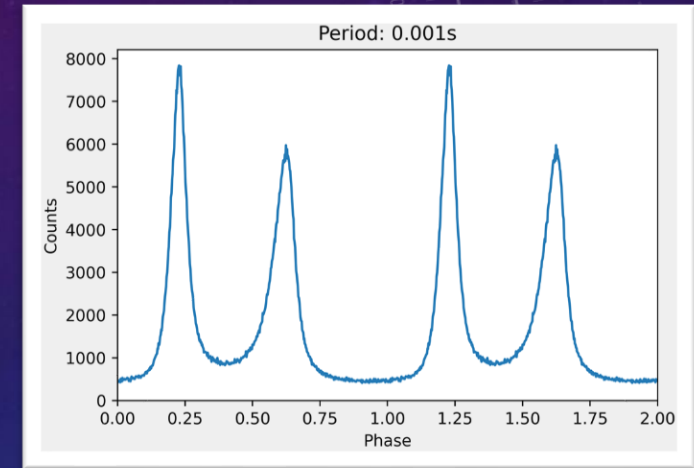
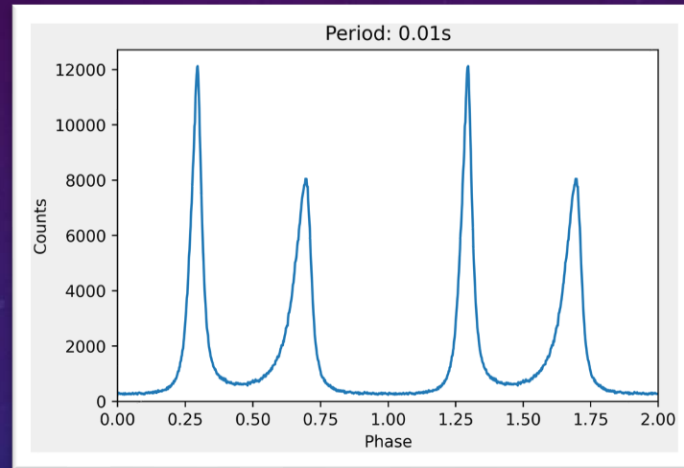
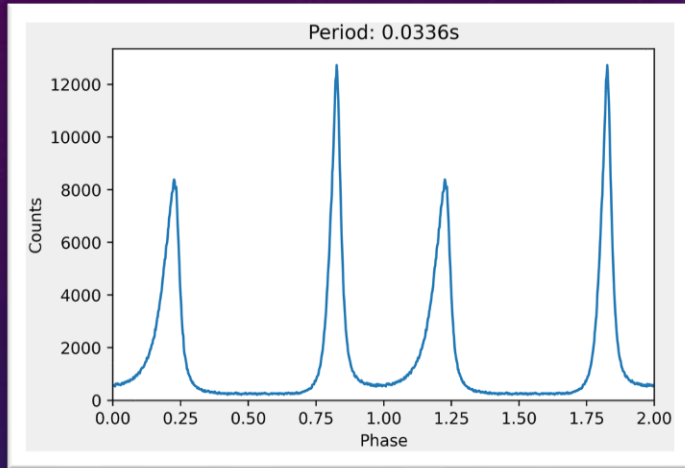
TRANSMITTANCE OF OPTICAL-BLOCKING FILTER

- For C-K (0.277 keV)
- Thin filter (80 nm Al+200 nm PI): 40.6% (theoretical: 46.2%)
- Hole position: 43.5% (theoretical: 46.2%)
- Medium filter (200 nm Al+400 nm PI) : 16.9% (theoretical: 15.1%)

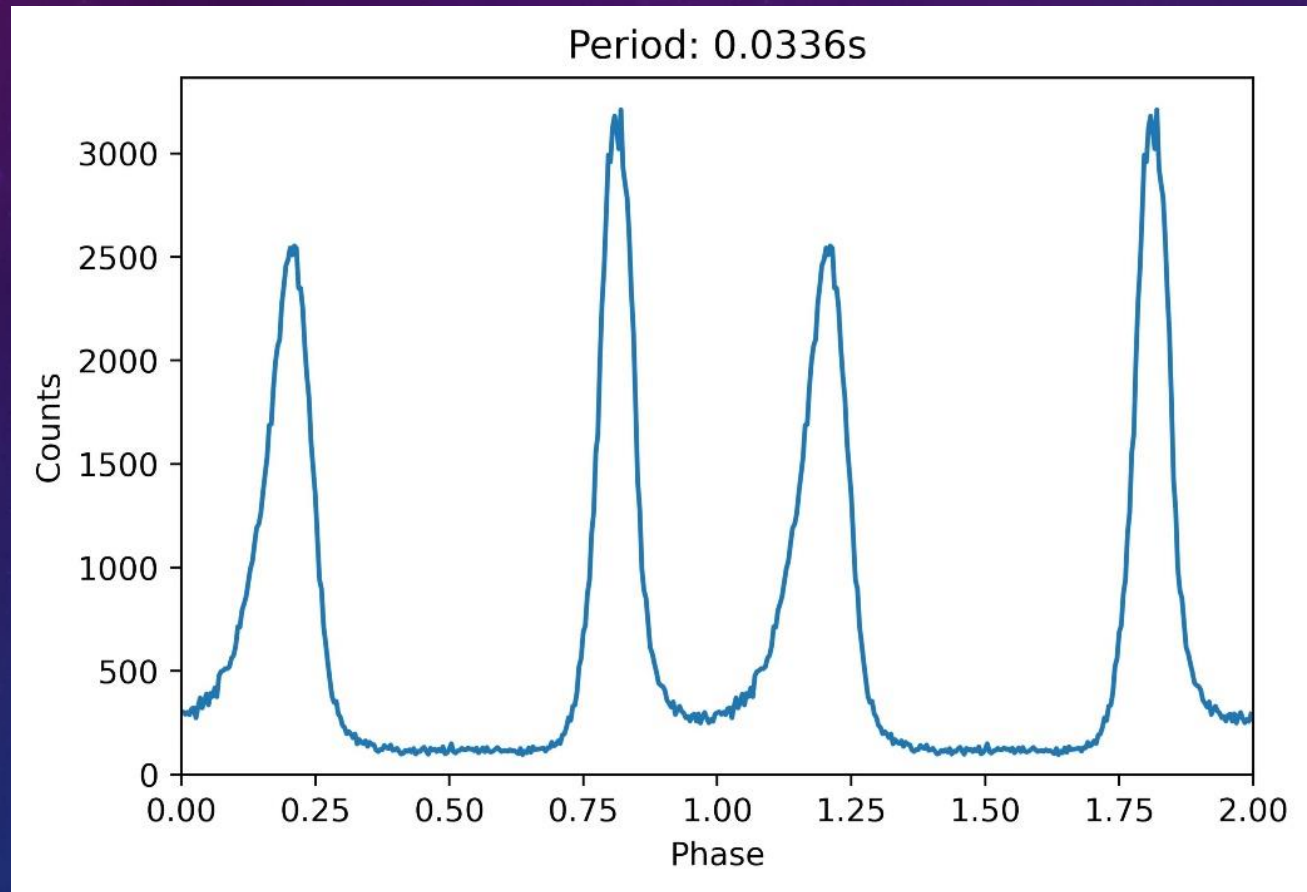


FXT filter wheel

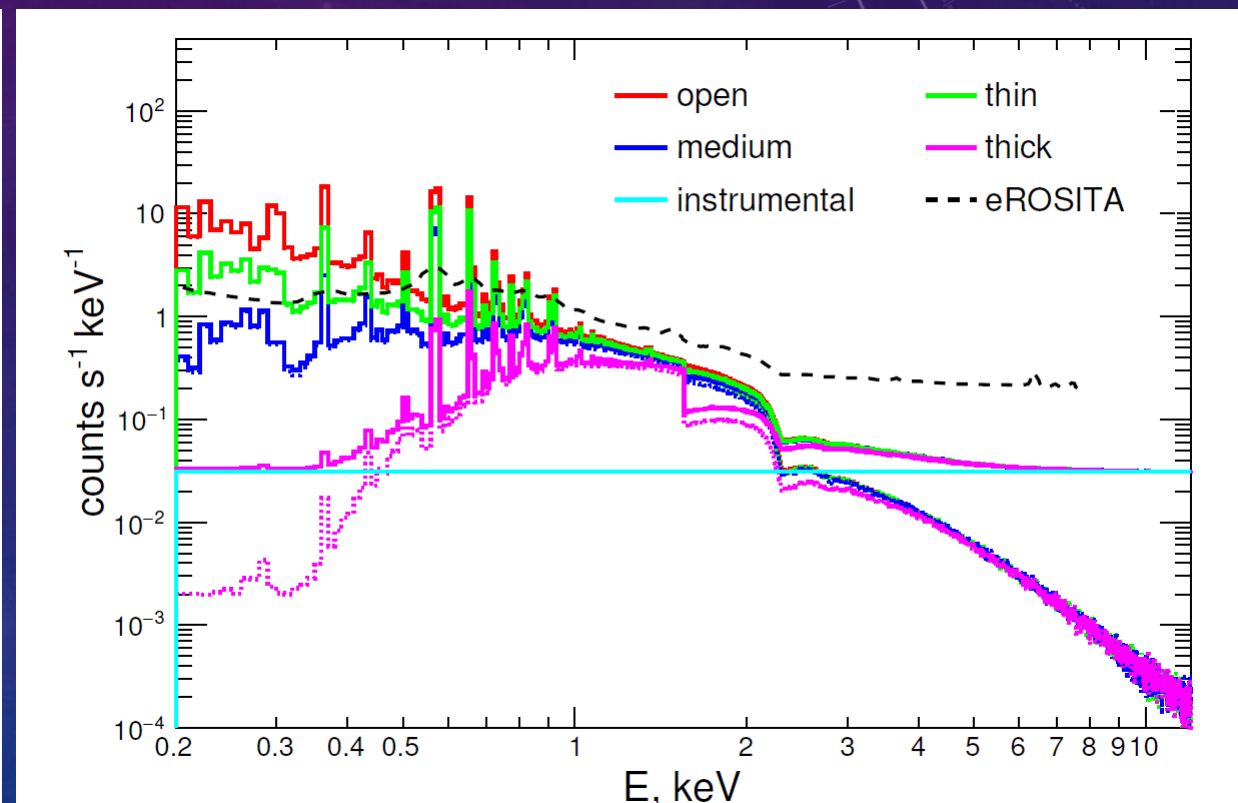
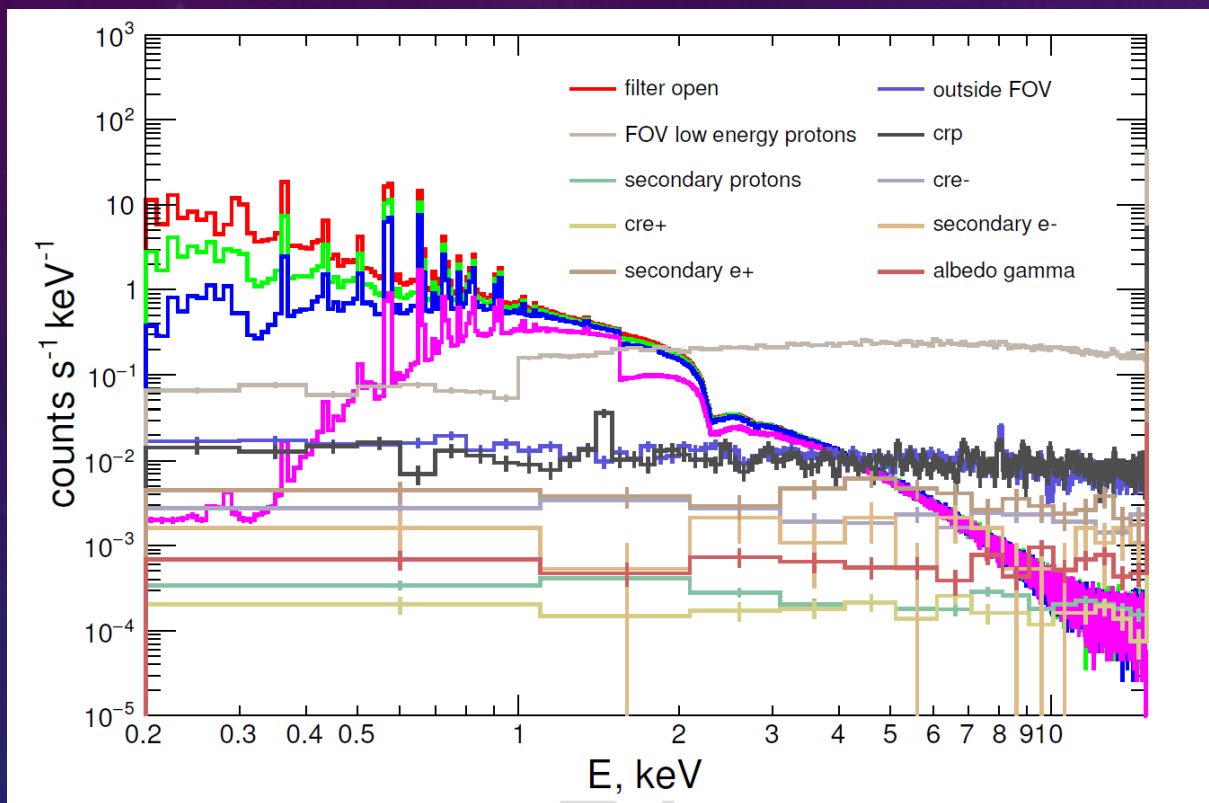
CRAB-LIKE PROFILE TEST OF DIFFERENT PERIOD IN TIMING MODE



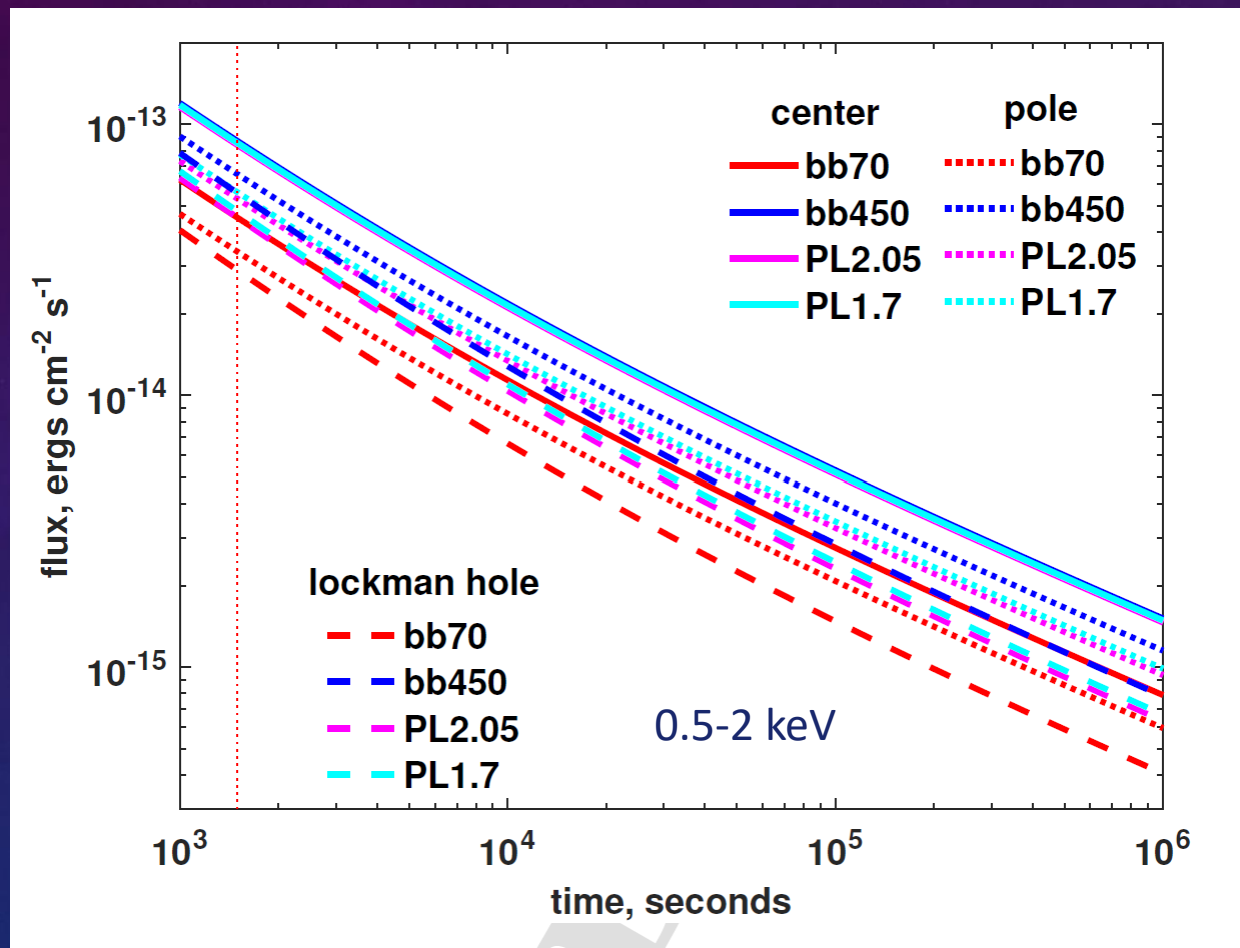
CRAB-LIKE PROFILE TEST IN PARTIAL-WINDOW MODE



背景模拟



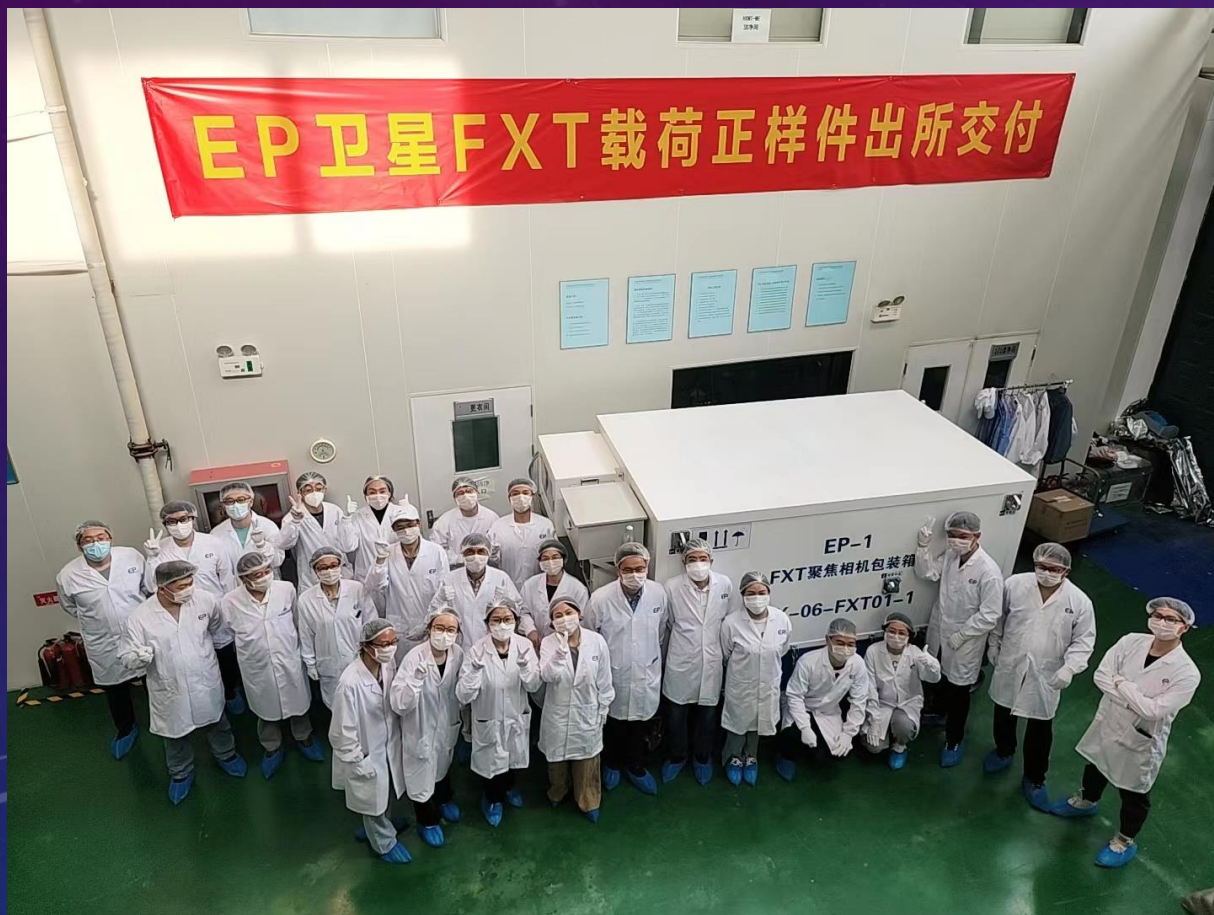
FXT灵敏度



FXT技术难点

- **力**：聚焦镜的力学适应性
- **热**：聚焦镜： $20\pm 1^{\circ}\text{C}$ ；pnCCD： $-90\pm 0.5^{\circ}\text{C}$
- **光**：HPD：22.6"
- **机**：滤光转轮，翻转机构；脉冲管制冷机
- **电**：探测器机箱，电控箱，制冷机控制器，运动机构控制器，温控仪
- **防污染**：分子污染 $8\text{E}-7 \text{ g}/\text{cm}^2$ ；颗粒物污染 900 ppm
- **防病毒**：三年疫情

总结与展望



- FXT迅捷、灵敏、智能，将在EP科学研究中发挥重要作用
- 按日计划加班完成正样测试标定和AIT
- FXT正样已完成装星，力保2023年底发射！

谢谢！