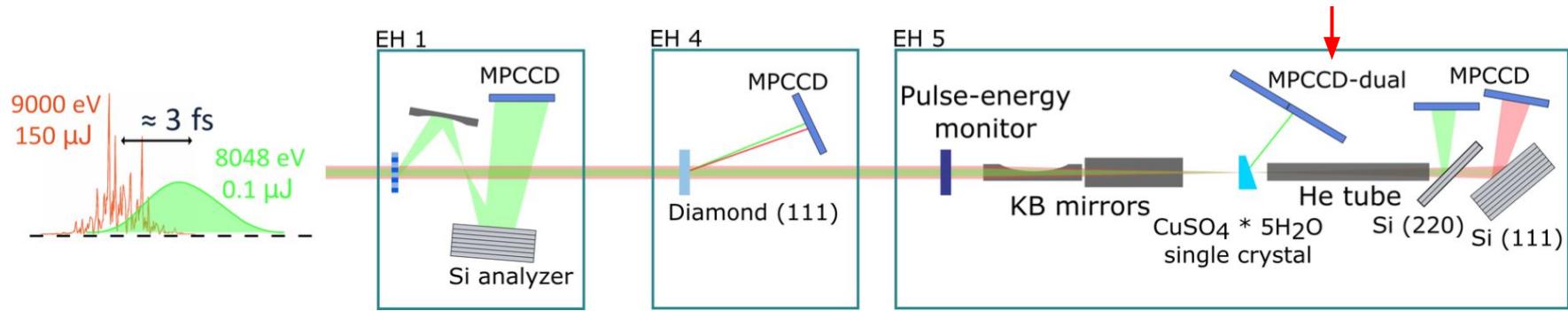


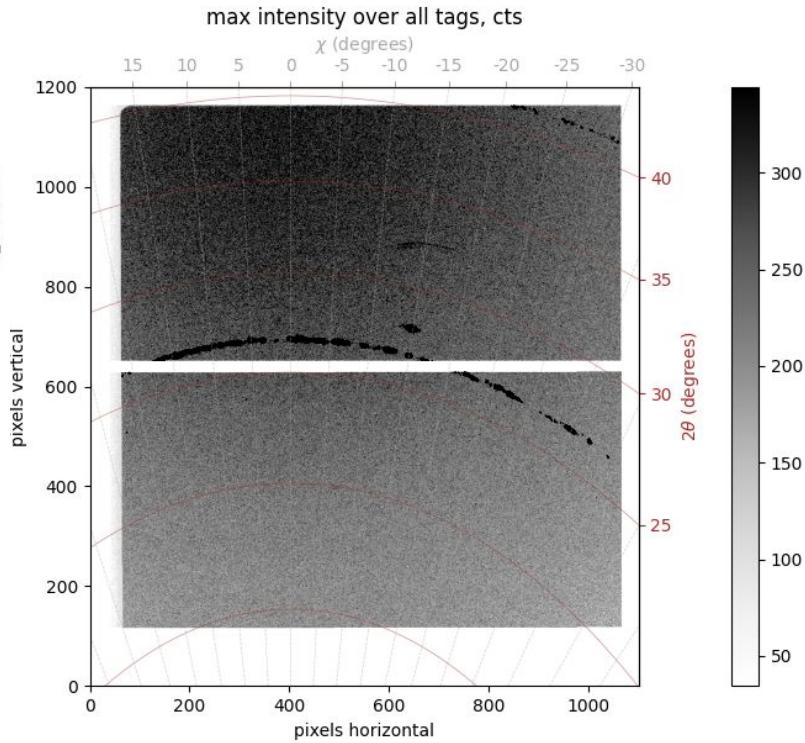
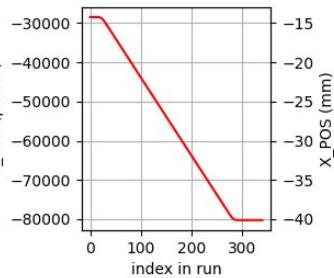
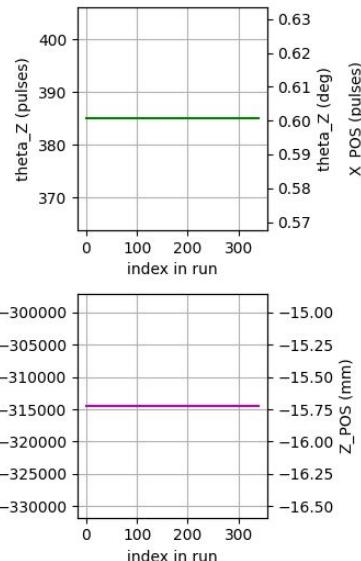
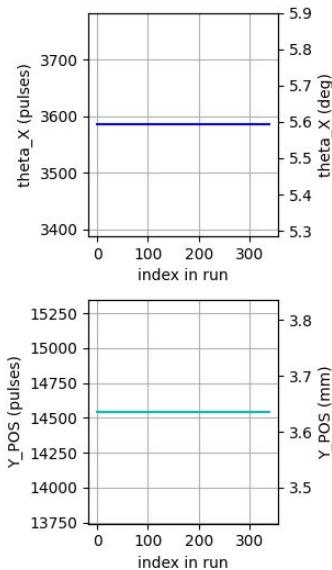
# Pulse-Resolved Fluorescence Reconstruction

Liu Tianchi, FS-TUX

# Experimental set-up



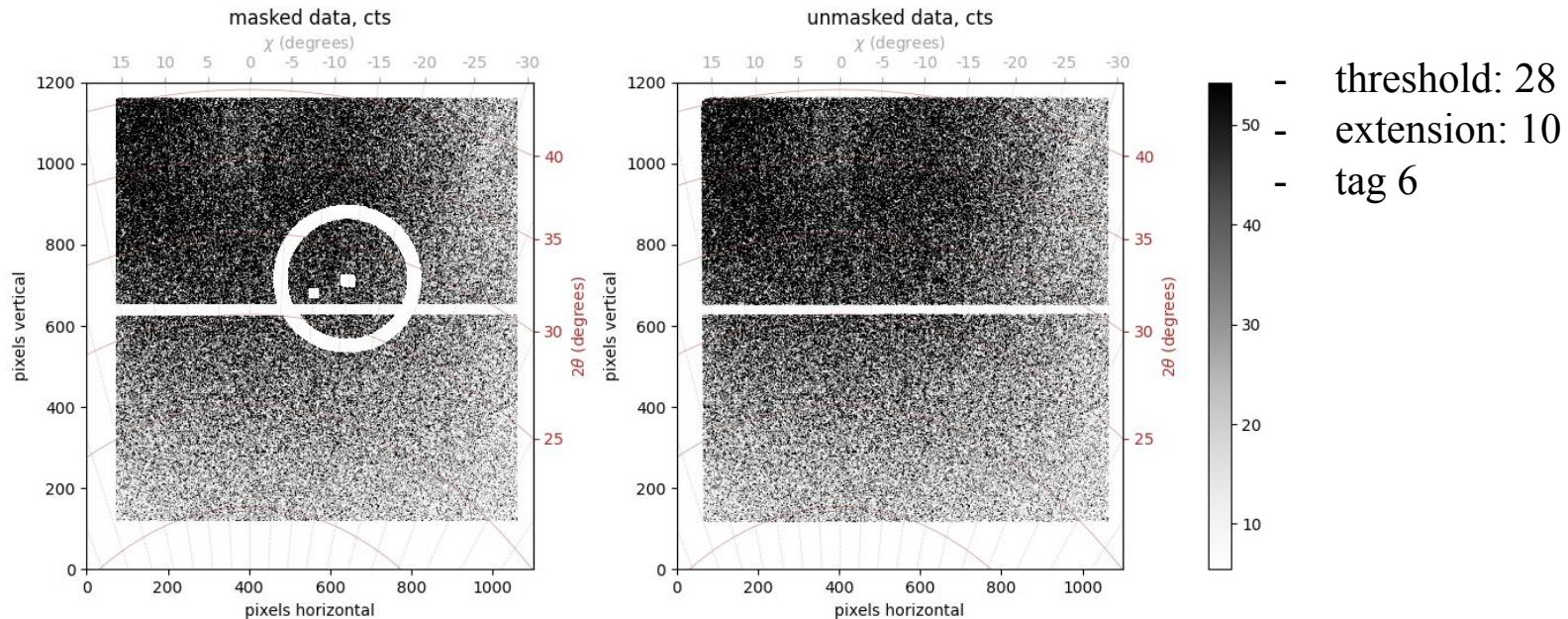
# Run overview



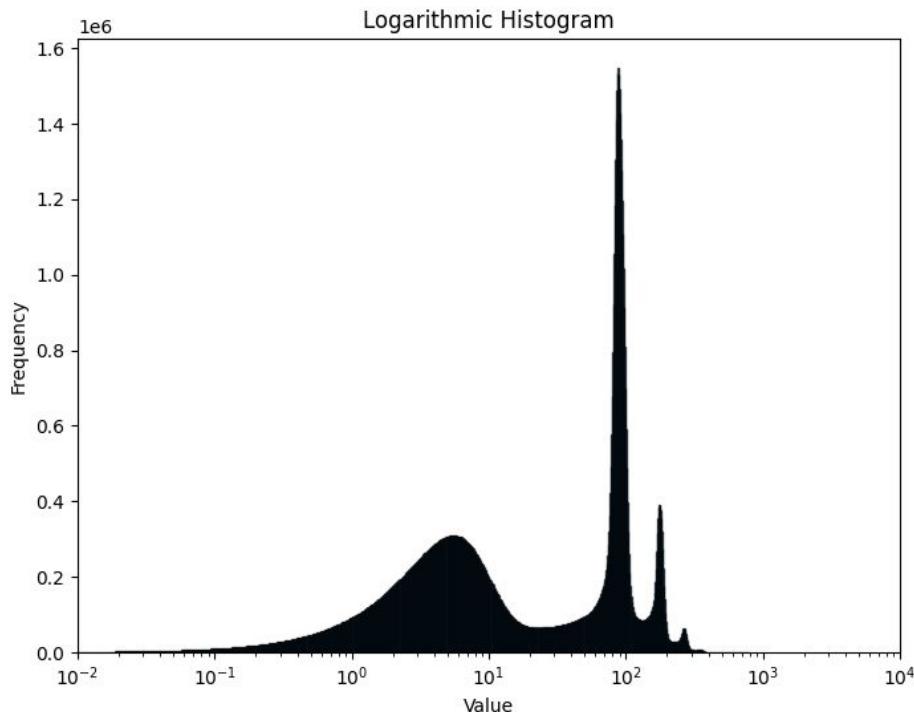
# Outlines

- Preliminary data processing
  - masking
  - discretisation
- Fluorescence background reconstruction
  - absorption
  - detector efficiency
  - solid angle
  - poisson fit and correction
- Check on homogeneity
  - slope
  - standard deviation
- Parameter optimisation (CuSO<sub>4</sub> and BN thickness)
- Fluorescence yield

# Masking

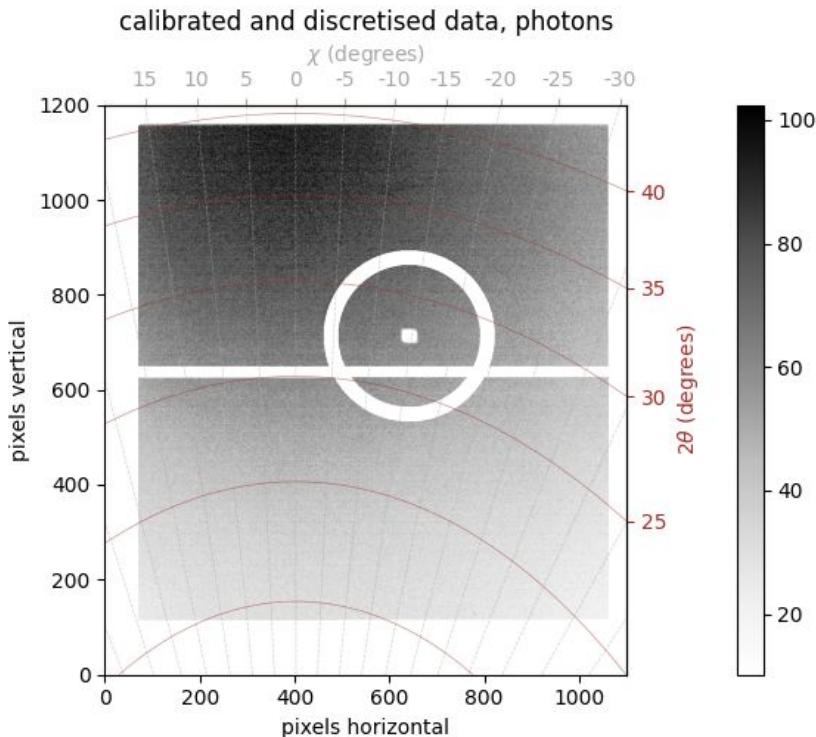
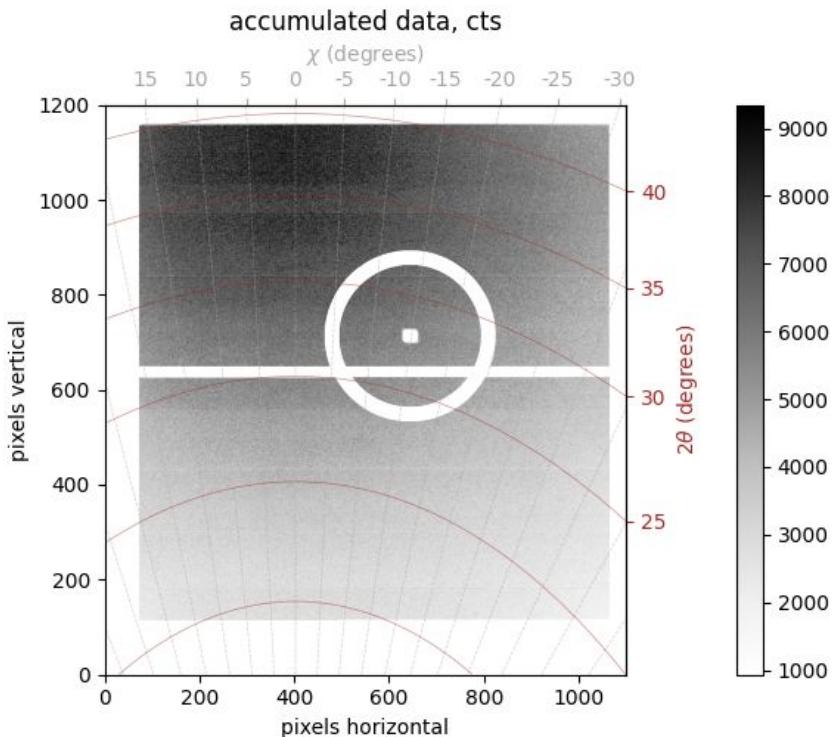


# Discretisation & Calibration

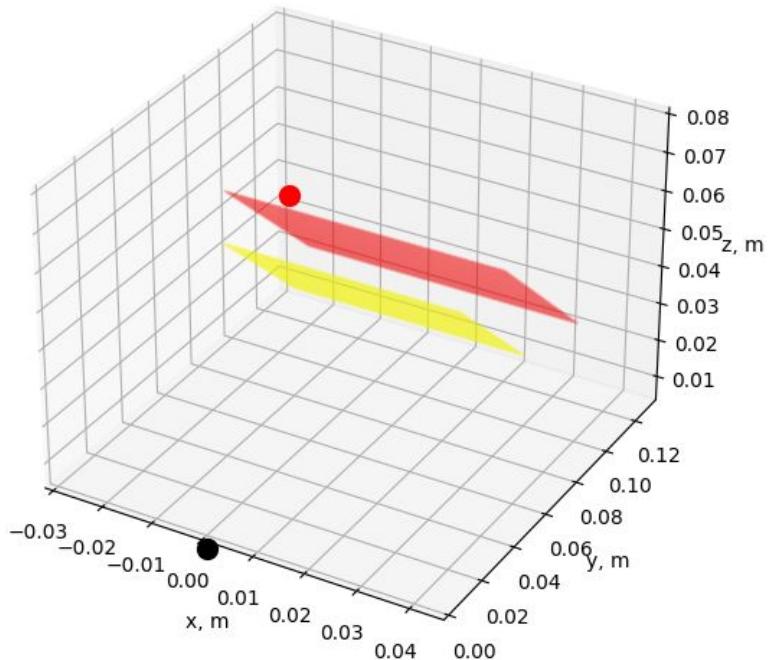


- sample data logarithmic histogram
- maximum number of photons

# Discretisation & Calibration



## Geometry set-up

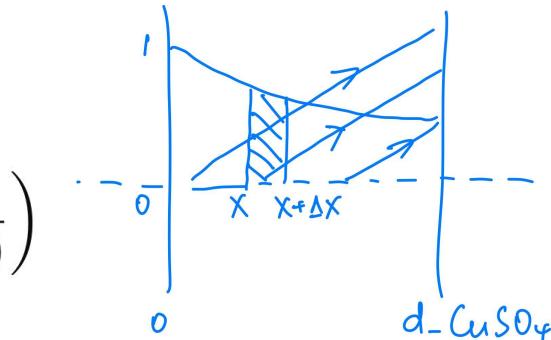


## Line source absorption

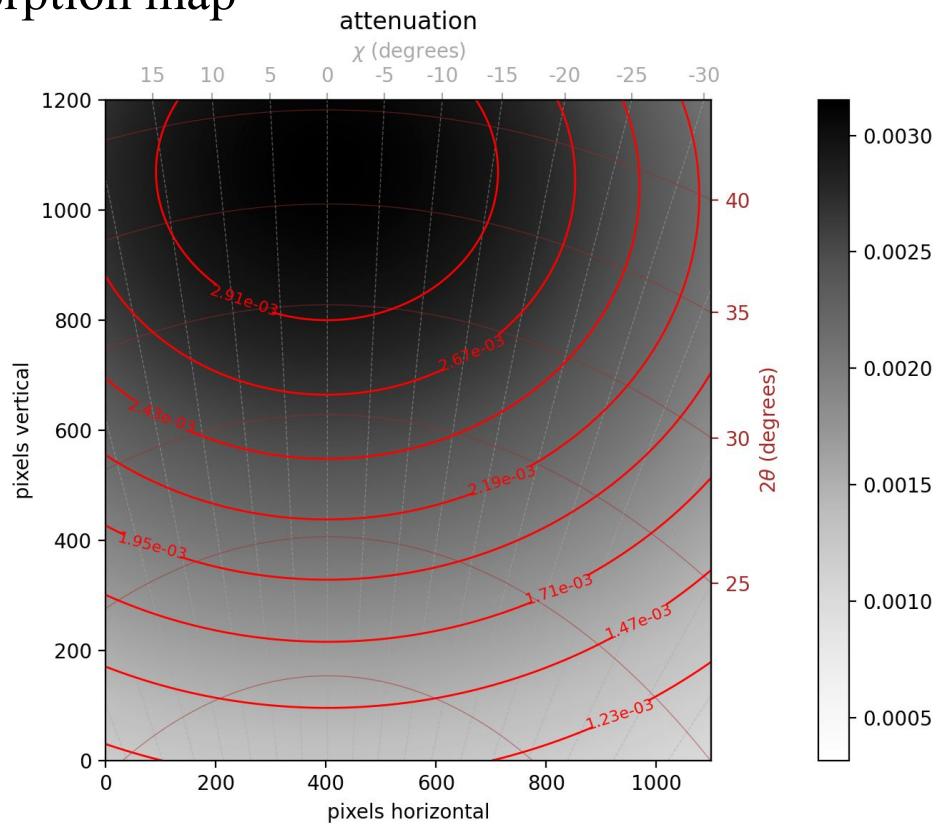
light interacted in delta x:  $e^{-\frac{x}{d_{9000}}} - e^{-\frac{x+\Delta x}{d_{9000}}} \approx -\frac{e^{-\frac{x}{d_{9000}}}}{d_{9000}} \cdot \Delta x$

factor of attenuation when leaving CuSO<sub>4</sub>:  $\exp\left(-\frac{d_{\text{CuSO}_4} - x}{d_{8048} \cdot \cos(\theta)}\right)$

integration and normalisation:  $\frac{\int_0^{d_{\text{CuSO}_4}} \frac{\exp\left(-\frac{x}{d_{9000}}\right) \cdot \exp\left(-\frac{d_{\text{CuSO}_4} - x}{d_{8048} \cdot \cos(\theta)}\right)}{d_{9000}} dx}{\int_0^{d_{\text{CuSO}_4}} \frac{\exp\left(-\frac{x}{d_{9000}}\right)}{d_{9000}} dx}$



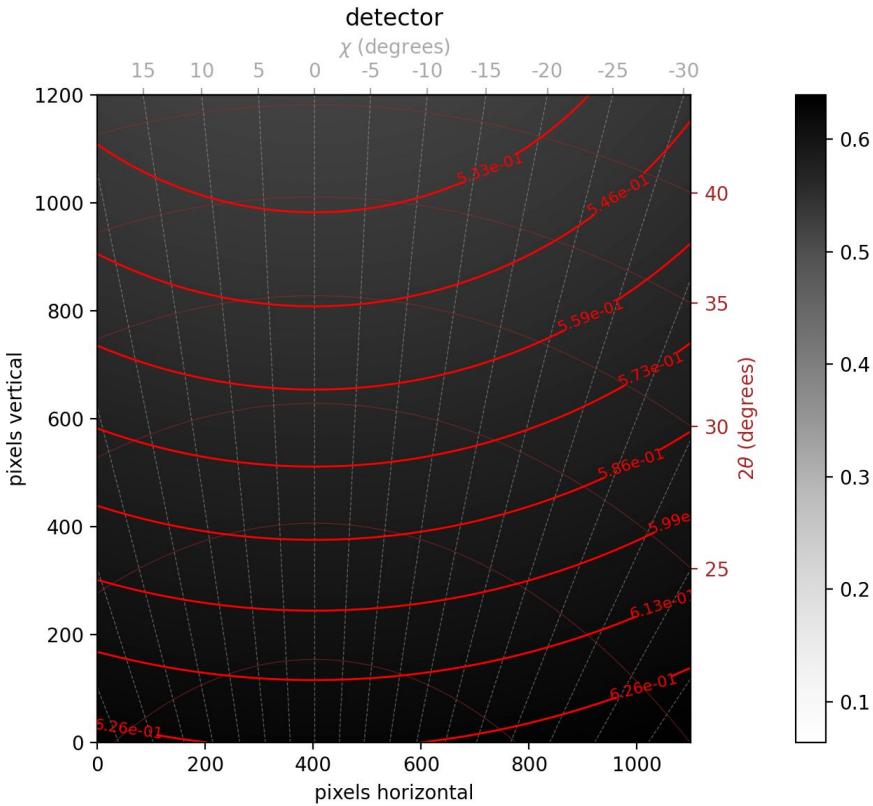
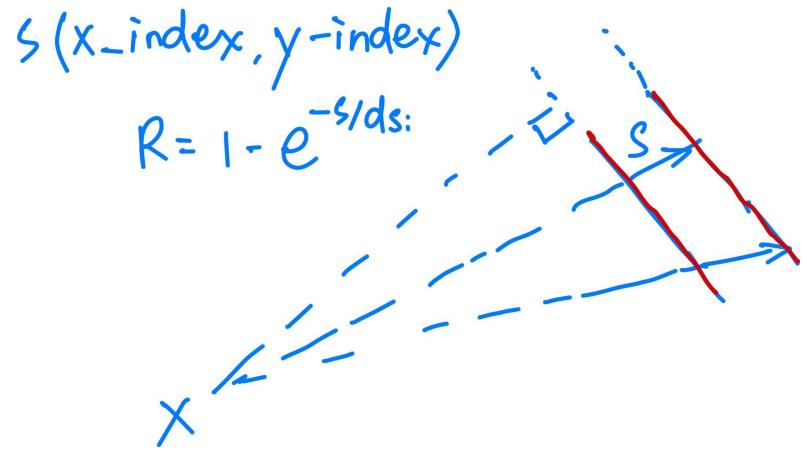
# Absorption map



## Attenuation lengths

- CuSO<sub>4</sub>.5H<sub>2</sub>O\_8048: 142.61 um
- CuSO<sub>4</sub>.5H<sub>2</sub>O\_9000: 51.60 um
- BN\_8048: 982 um
- air\_8048: 0.3252 m
- Cu\_8048: 22.29 um

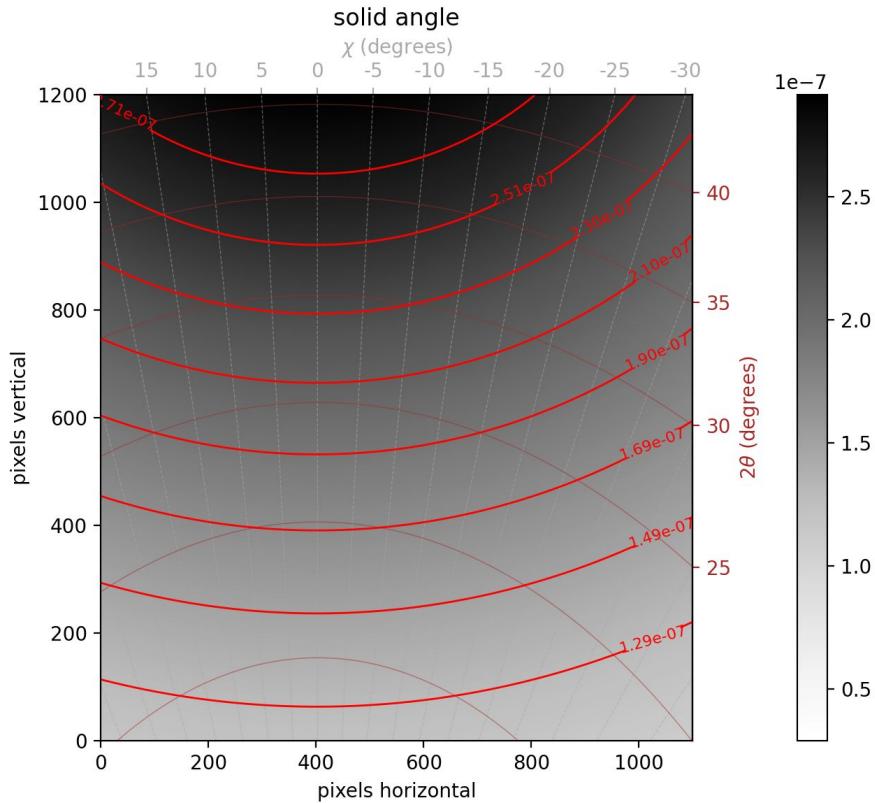
# Detector map



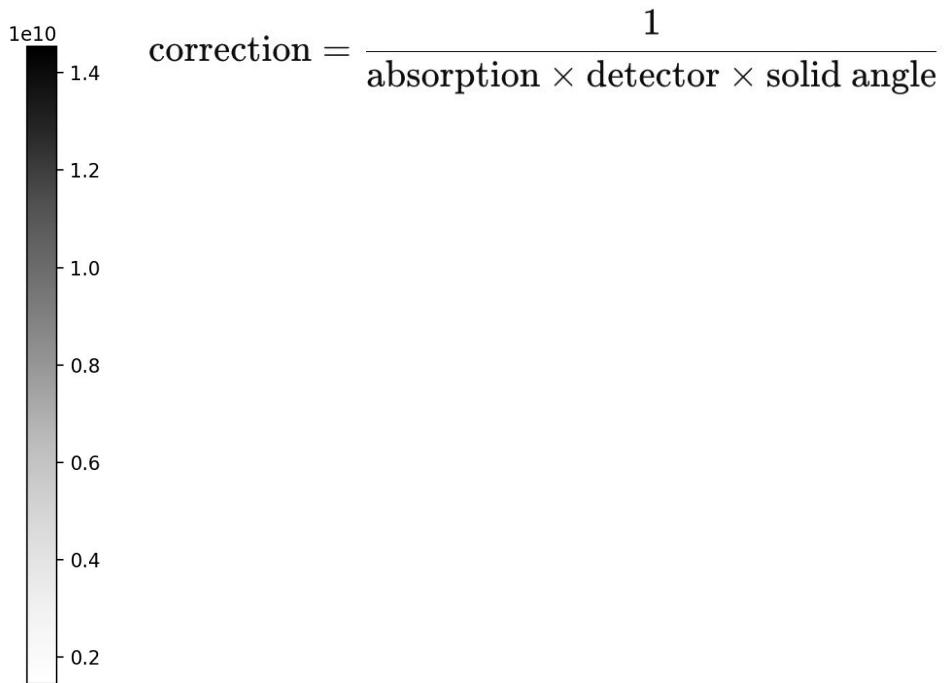
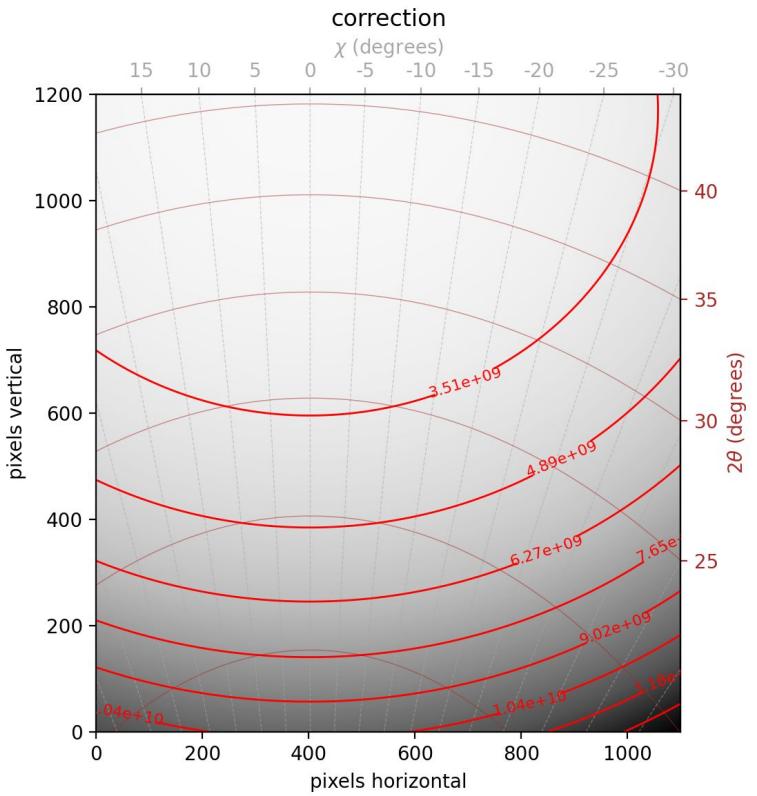
# Solid angle map

$$n' = n \cdot \frac{r^2}{\text{Area} \cdot \cos\theta}$$

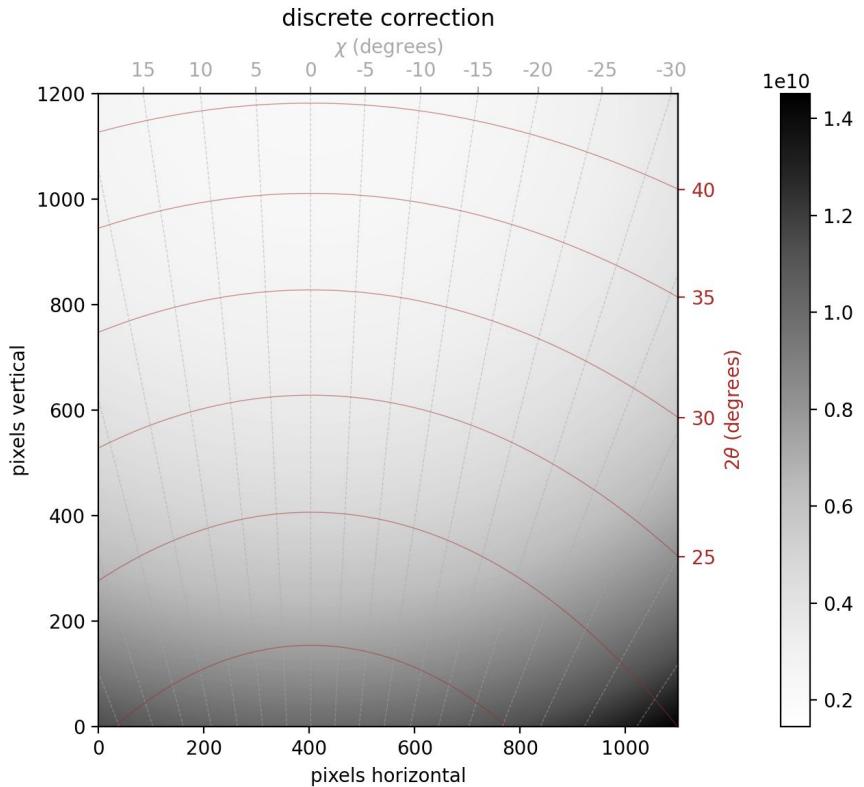
A hand-drawn diagram illustrating the calculation of solid angle. It shows a point X at the origin of a coordinate system. A blue line segment extends from X to a point on a sphere, labeled 'r'. At the end of this segment, two dashed blue arcs are drawn, each labeled with an angle 'θ'. A small blue square indicates the area element being considered. The formula  $n' = n \cdot \frac{r^2}{\text{Area} \cdot \cos\theta}$  is written above the diagram.



## Overall correction

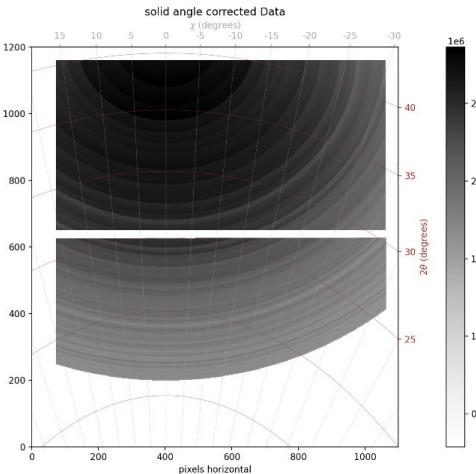
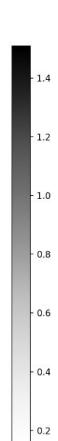
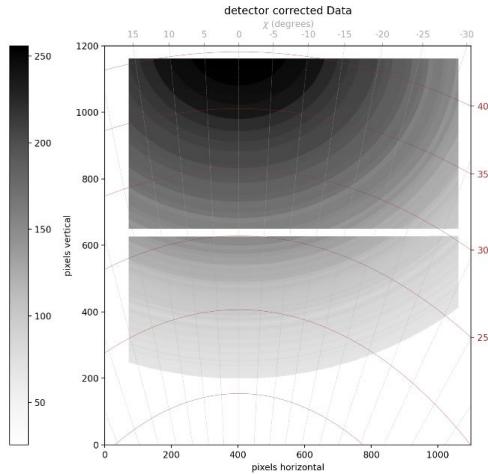
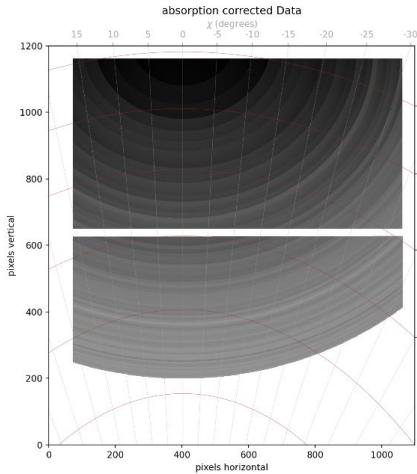
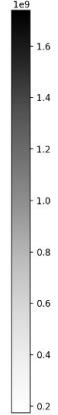
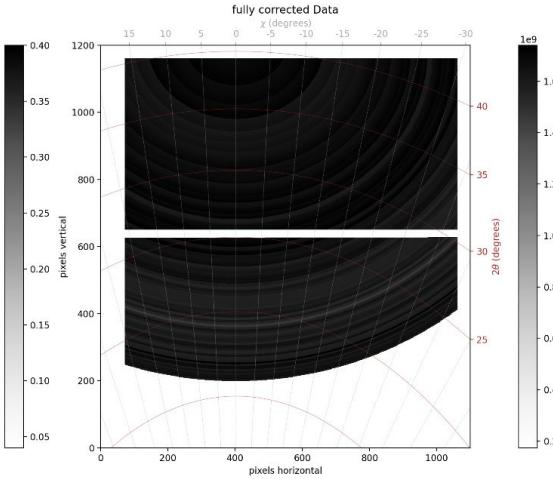
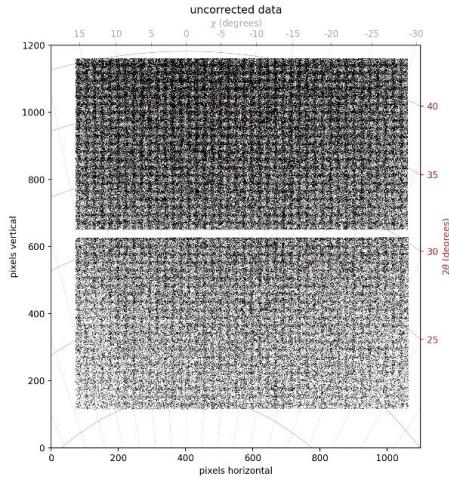


# Poisson fit and reconstruction

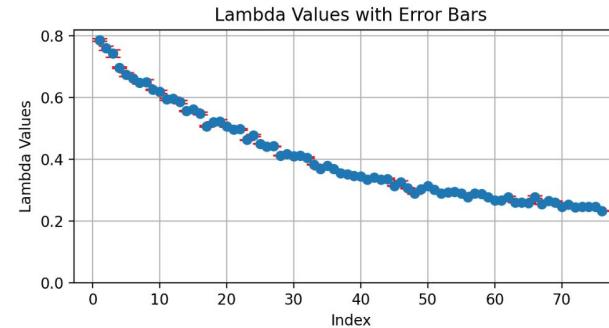
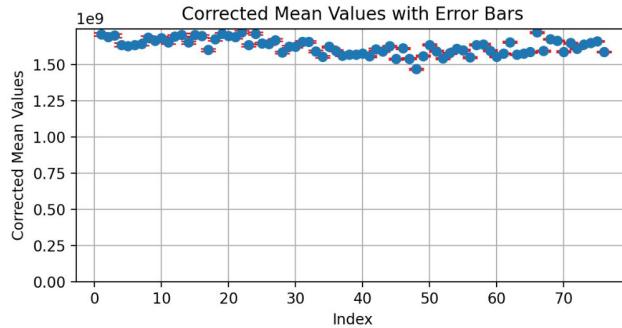


- divide the detector pixels into **200 regions** based on correction map
- each region can be seen as approximately homogeneous
- Poisson fit in each region
- use fitted lambda instead of pixel values
- perform correction

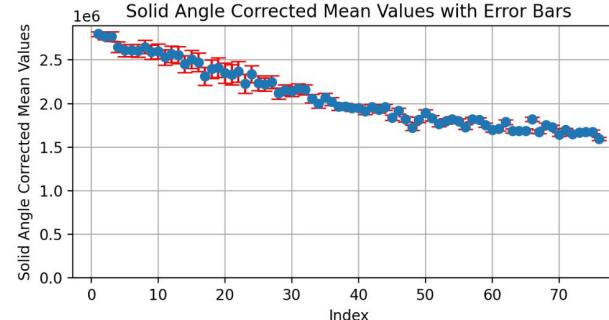
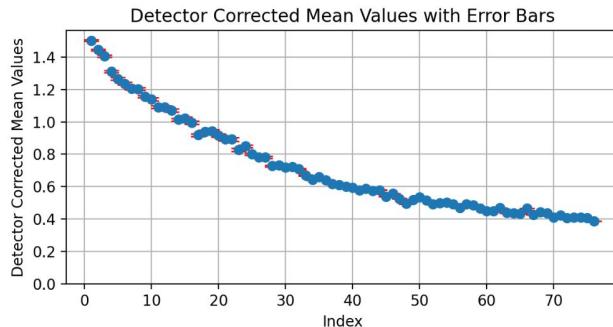
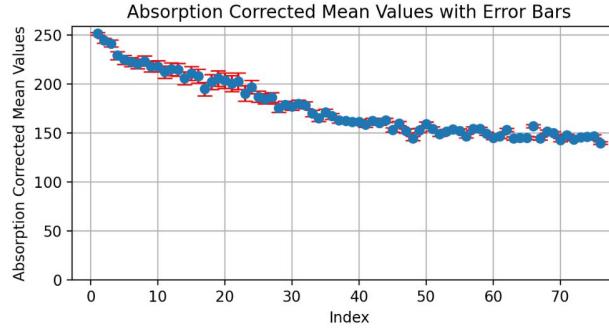
# Reconstruction result - vmax=max, vmin=0.1\*max



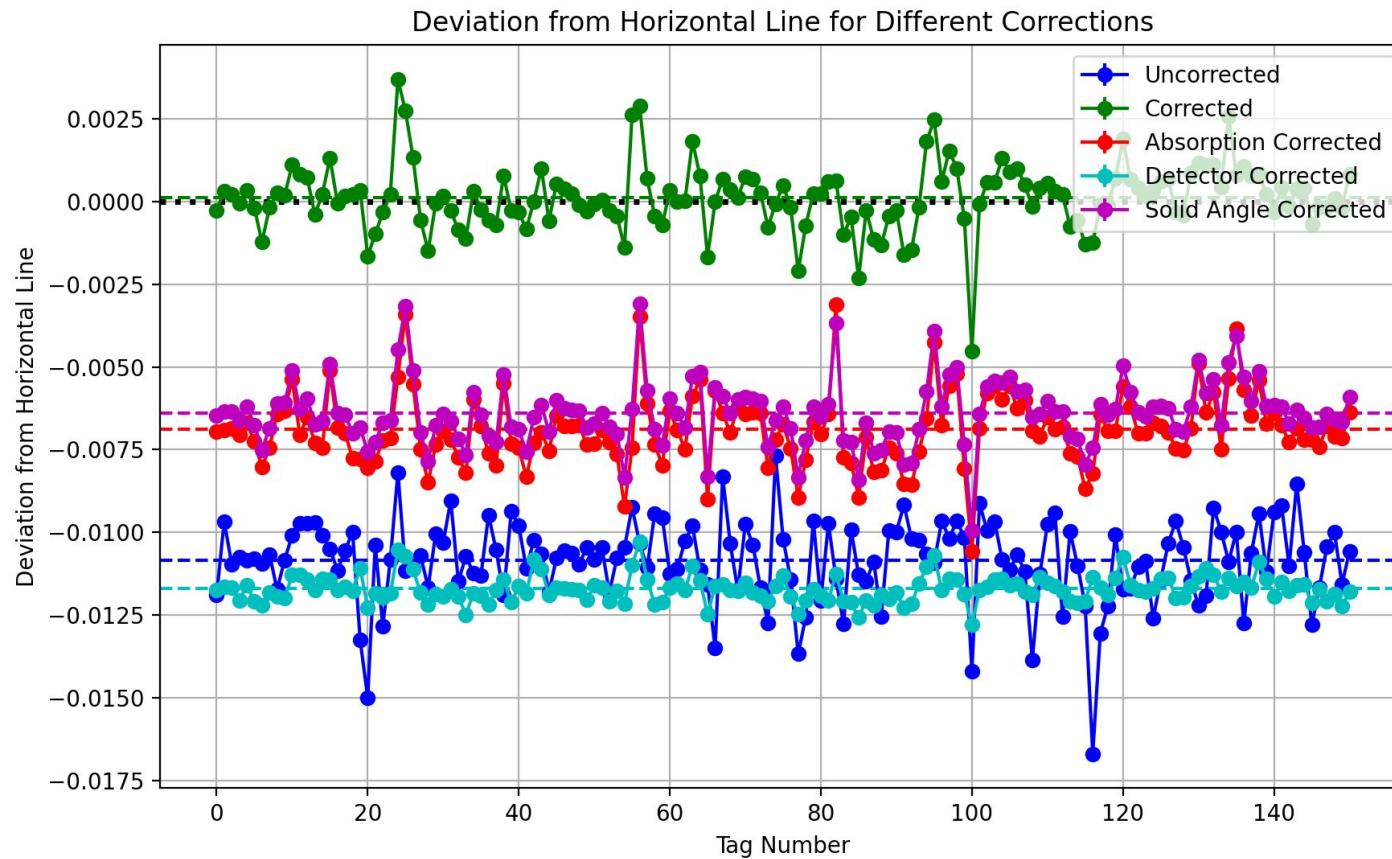
# Check on homogeneity



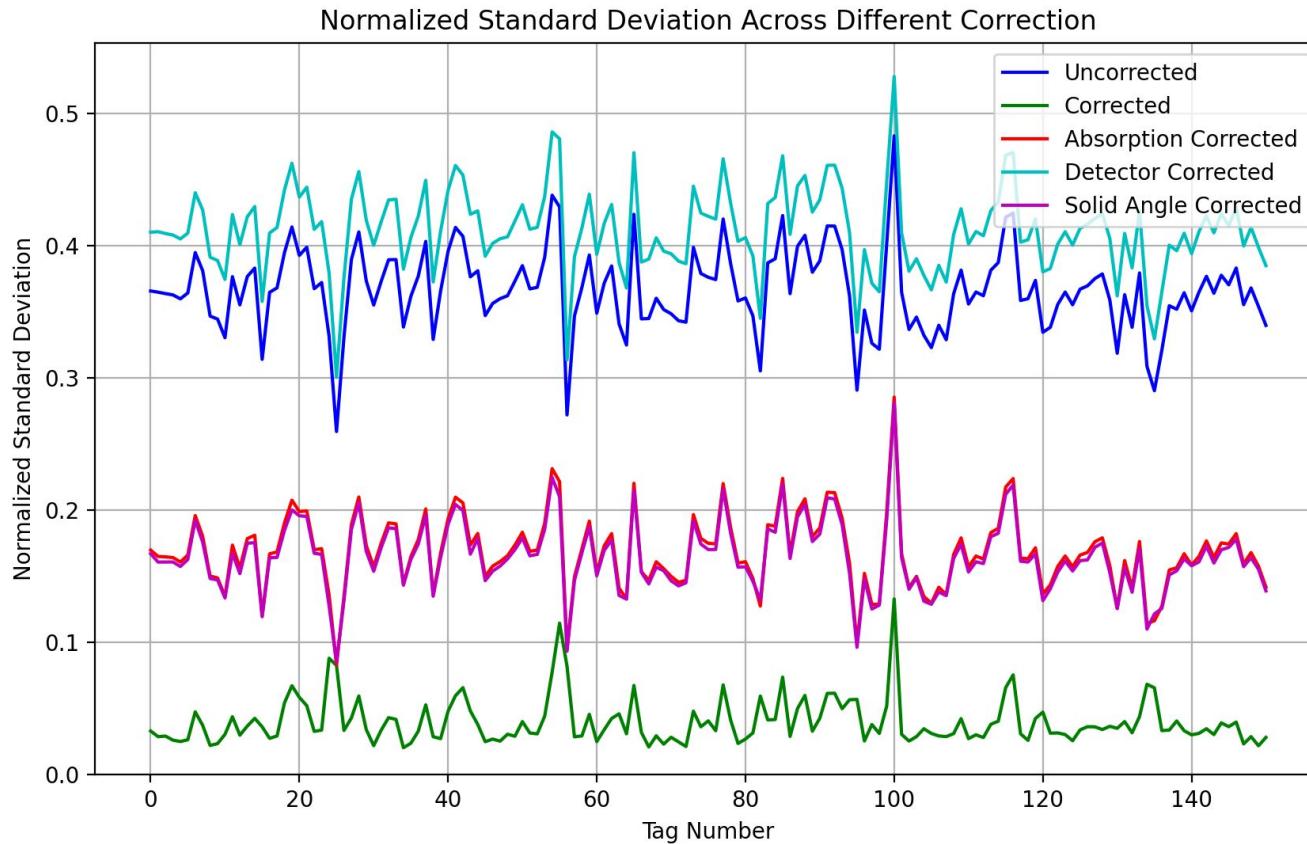
- tag 0



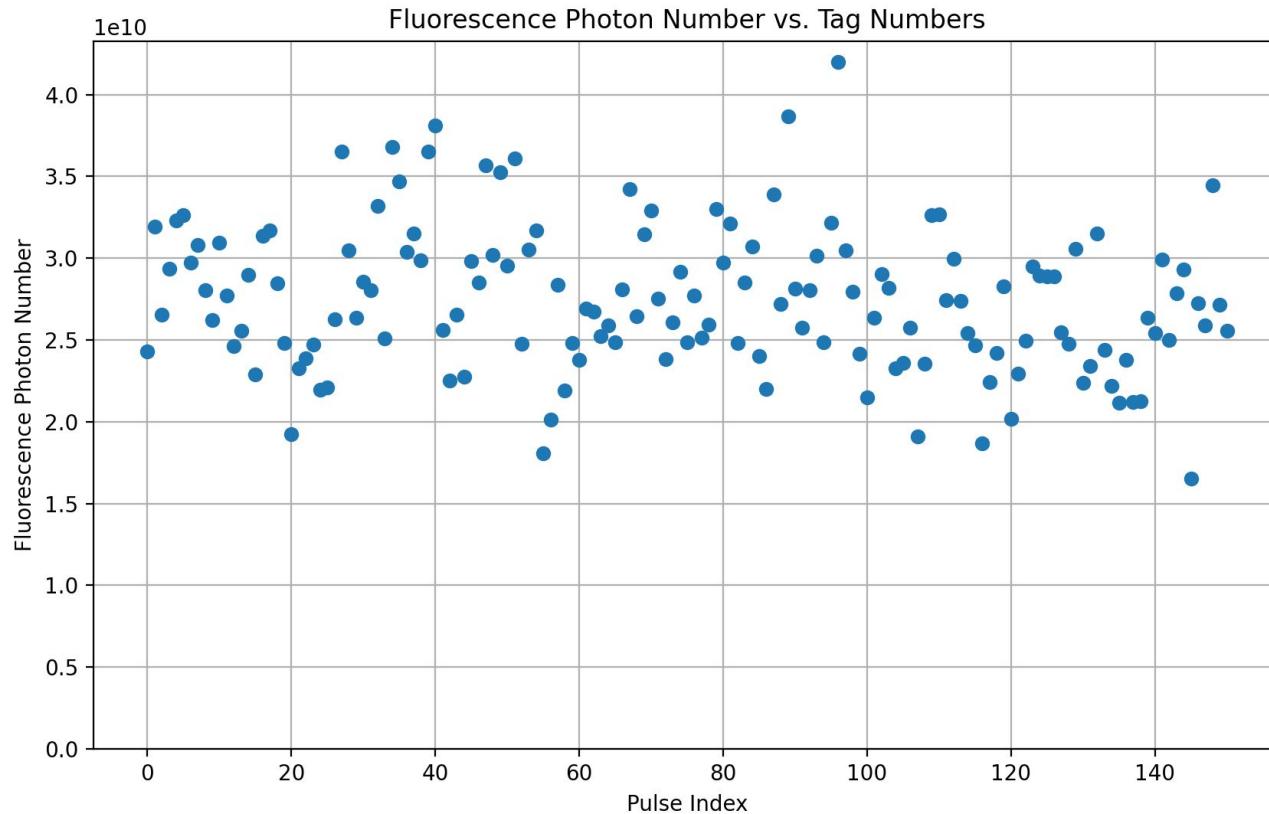
# Check on homogeneity



## Check on homogeneity



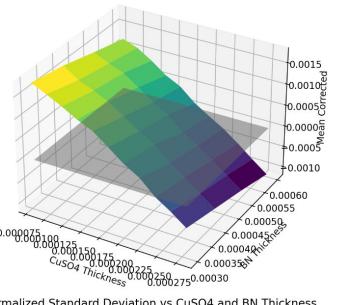
# Fluorescence photon number



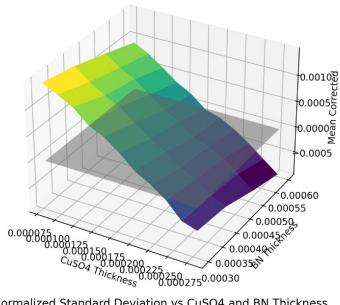
$$\begin{aligned}\sigma_{\text{Cu}} &= 2.986 \times 10^{-6} \\ \sigma_{\text{H}} &= 6.331 \times 10^{-13} \\ \sigma_{\text{S}} &= 3.505 \times 10^{-7} \\ \sigma_{\text{O}} &= 1.977 \times 10^{-8} \\ \text{ratio} &= 0.84964\end{aligned}$$

# Parameter scan

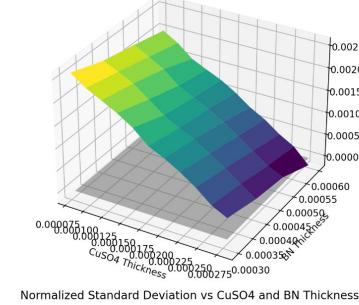
Mean Corrected vs CuSO<sub>4</sub> and BN Thickness



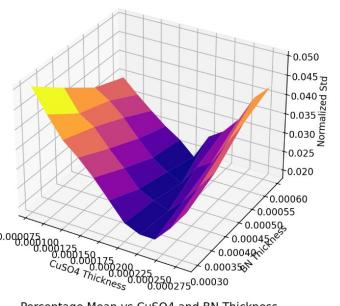
Mean Corrected vs CuSO<sub>4</sub> and BN Thickness



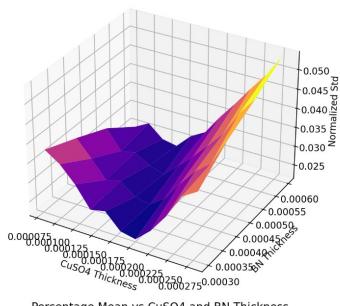
Mean Corrected vs CuSO<sub>4</sub> and BN Thickness



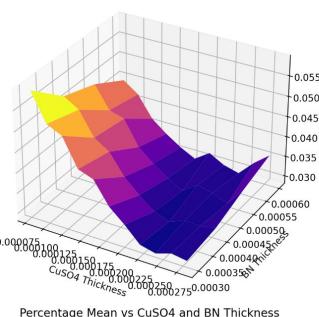
Normalized Standard Deviation vs CuSO<sub>4</sub> and BN Thickness



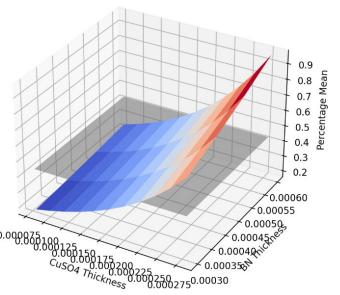
Normalized Standard Deviation vs CuSO<sub>4</sub> and BN Thickness



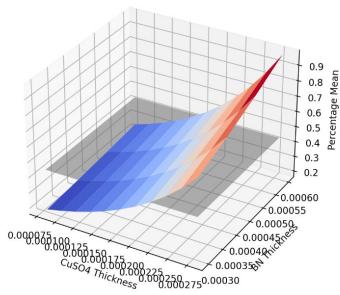
Normalized Standard Deviation vs CuSO<sub>4</sub> and BN Thickness



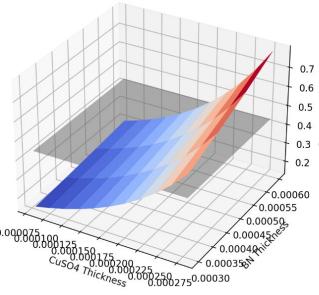
Percentage Mean vs CuSO<sub>4</sub> and BN Thickness



Percentage Mean vs CuSO<sub>4</sub> and BN Thickness

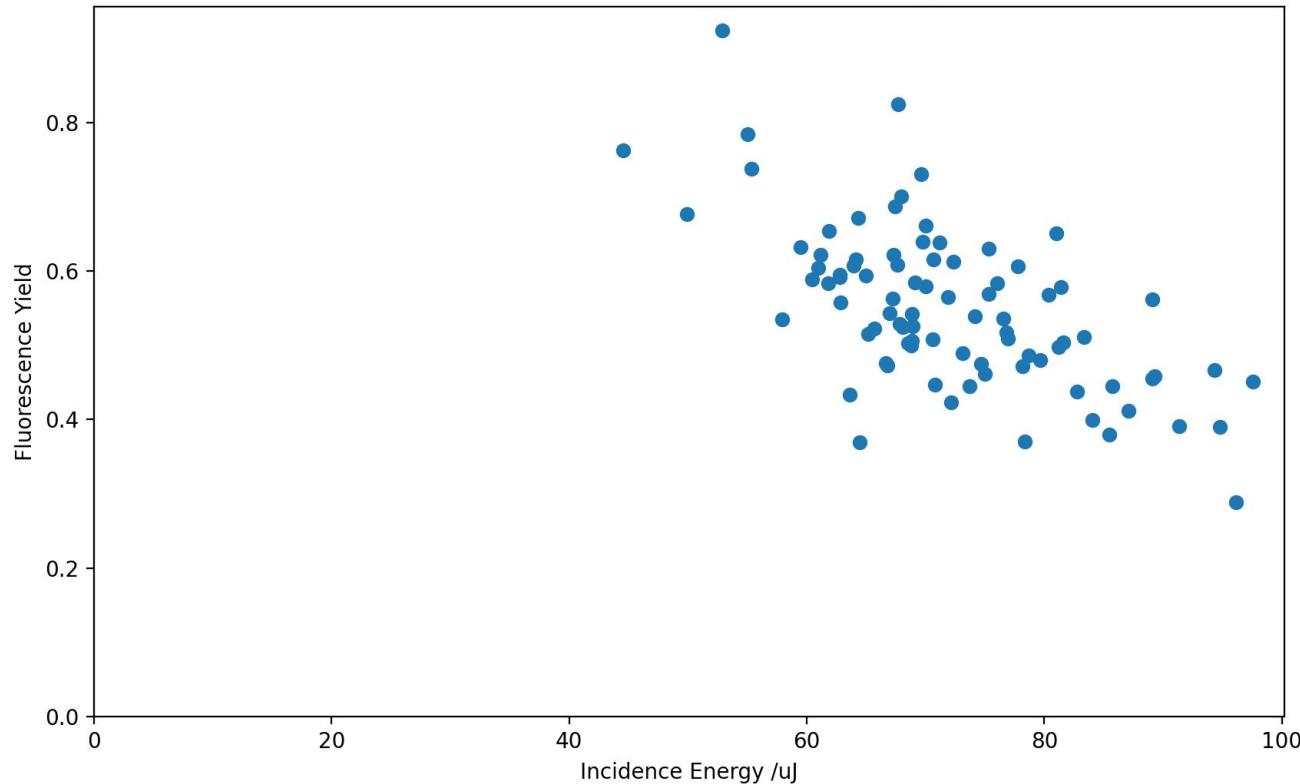


Percentage Mean vs CuSO<sub>4</sub> and BN Thickness



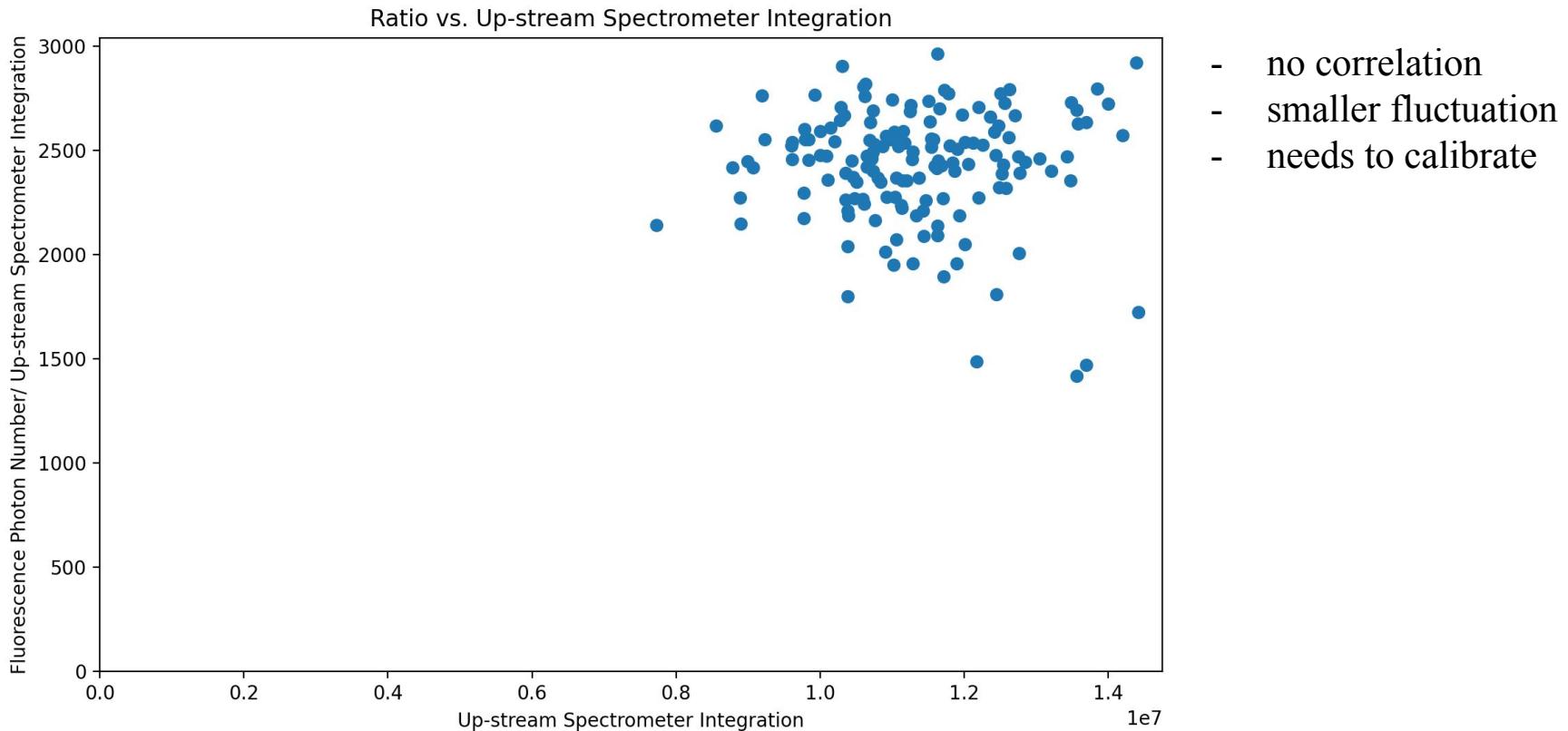
# Fluorescence yield

Fluorescence Yield vs. Incidence Energy



- unexpected correlation
- mean yield 0.55007
- huge fluctuation overshadowing non-linear effect

# Fluorescence yield



Thank you for listening