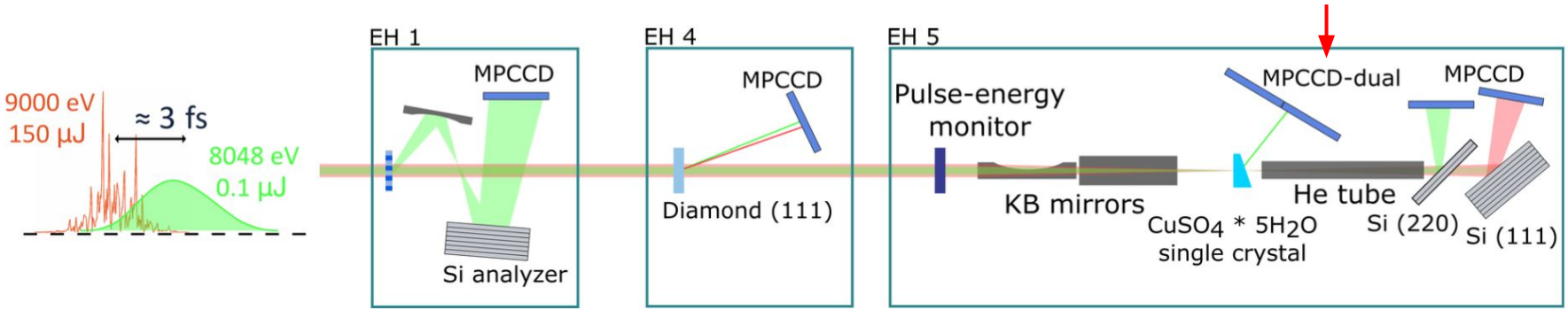
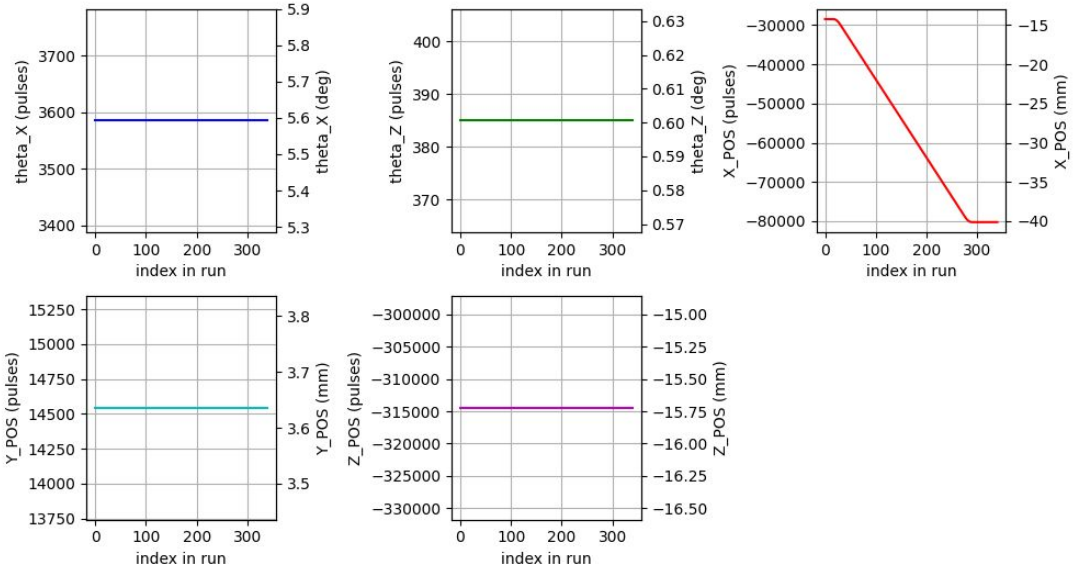
Pulse-Resolved Fluorescence Reconstruction

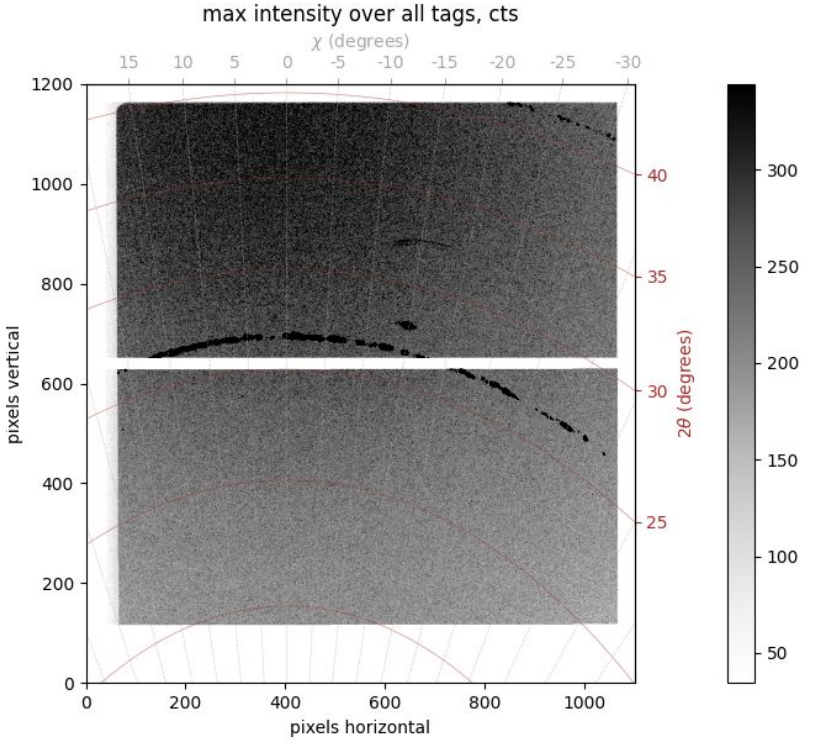
Liu Tianchi, FS-TUX

Experimental set-up



Run overview

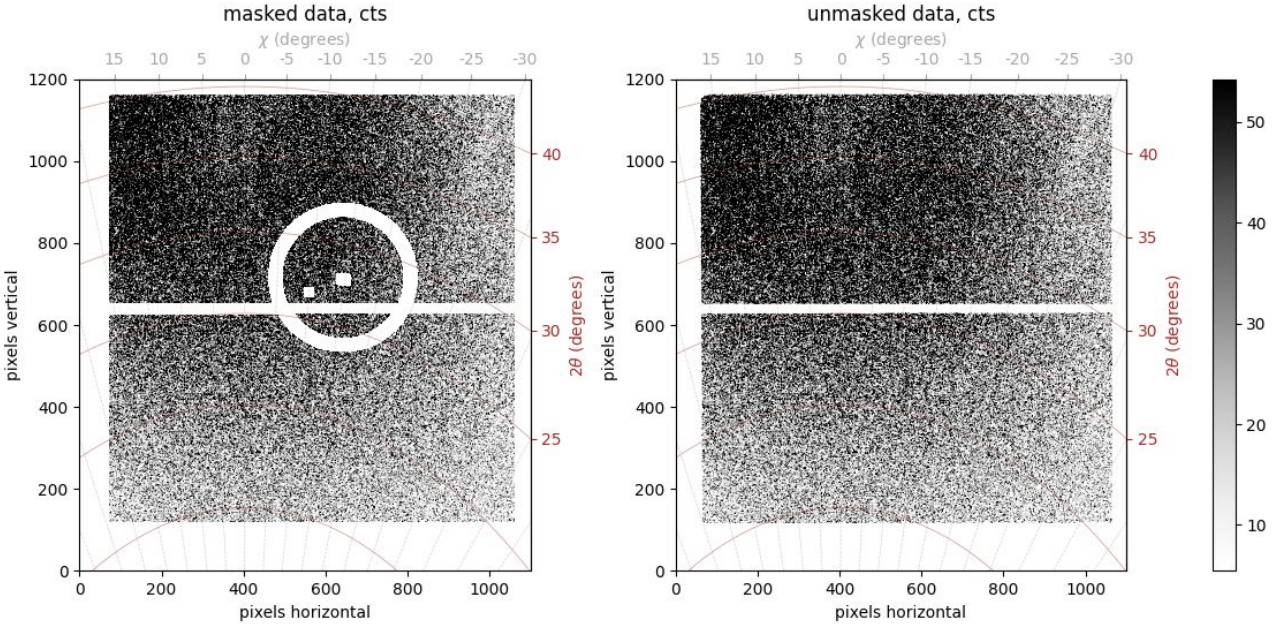




Outlines

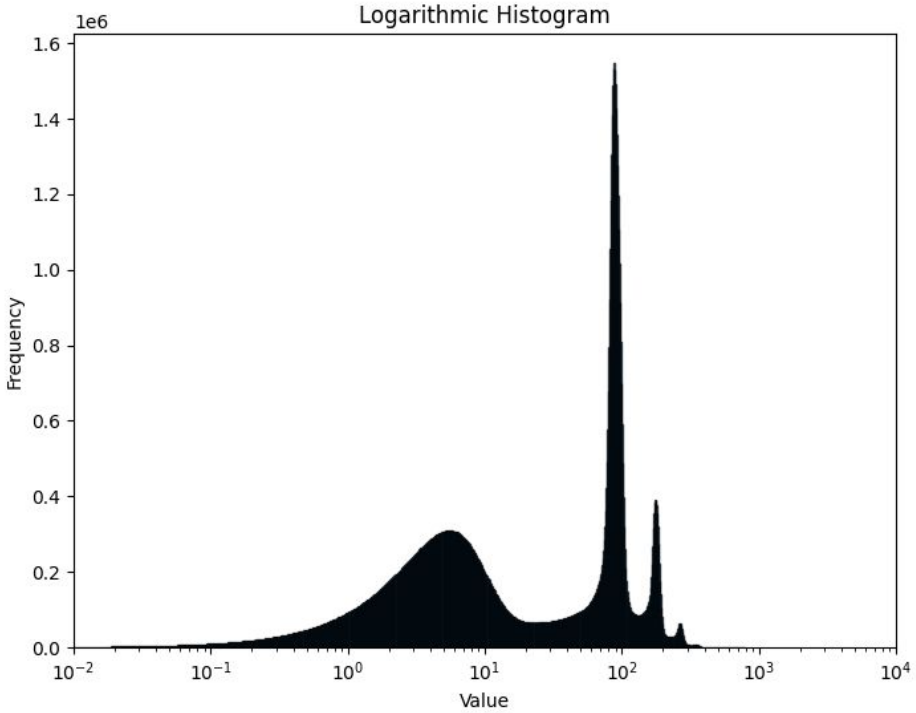
- Preliminary data processing
  - masking
  - discretisation
- Fluorescence background reconstruction
  - absorption
  - detector efficiency
  - solid angle
  - poisson fit and correction
- Check on homogeneity
  - slope
  - standard deviation
- Parameter optimisation (CuSO4 and BN thickness)
- Fluorescence yield

Masking



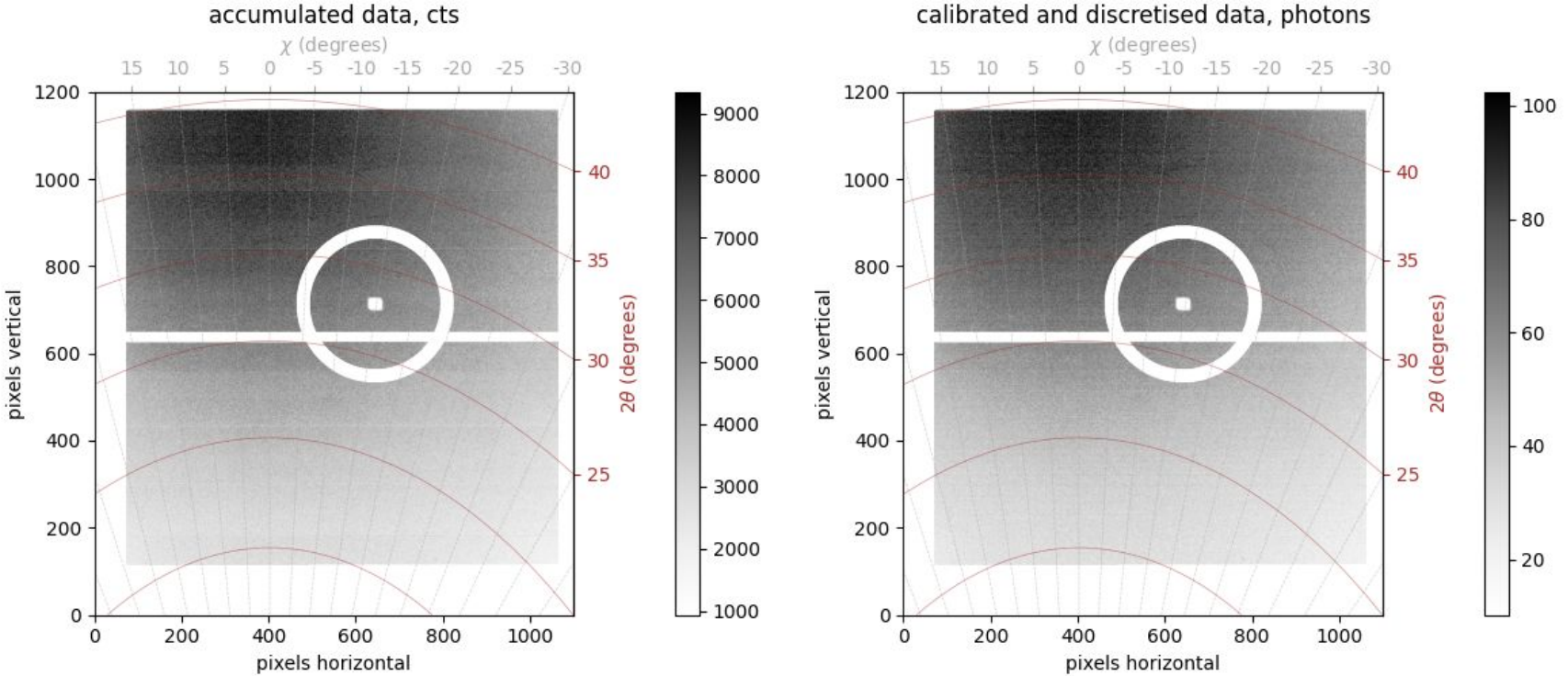
- threshold: 28
- extension: 10
- tag 6

Discretisation & Calibration

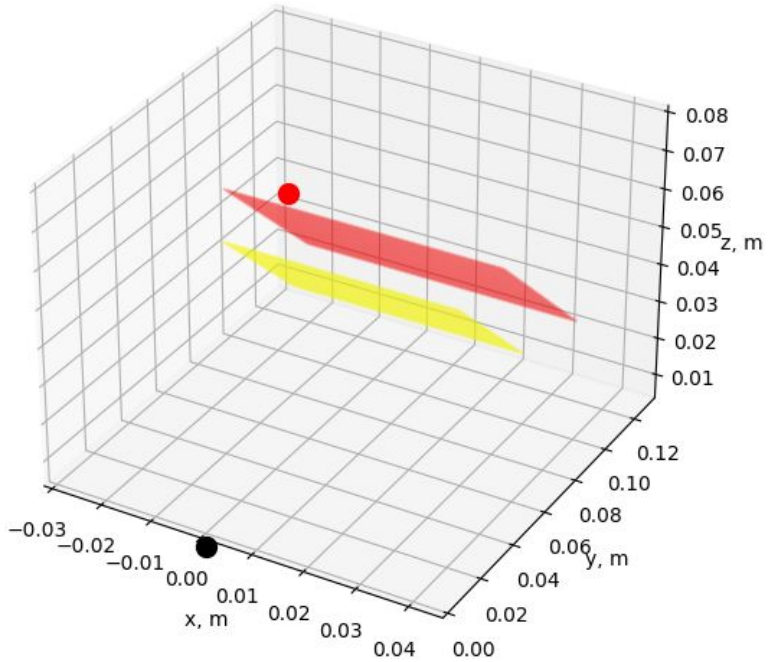


- sample data logarithmic histogram
- maximum number of photons

Discretisation & Calibration



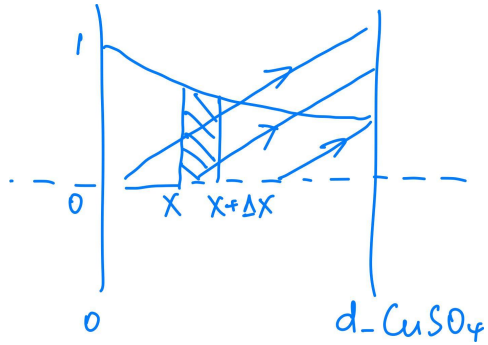
Geometry set-up



Line source absorption

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

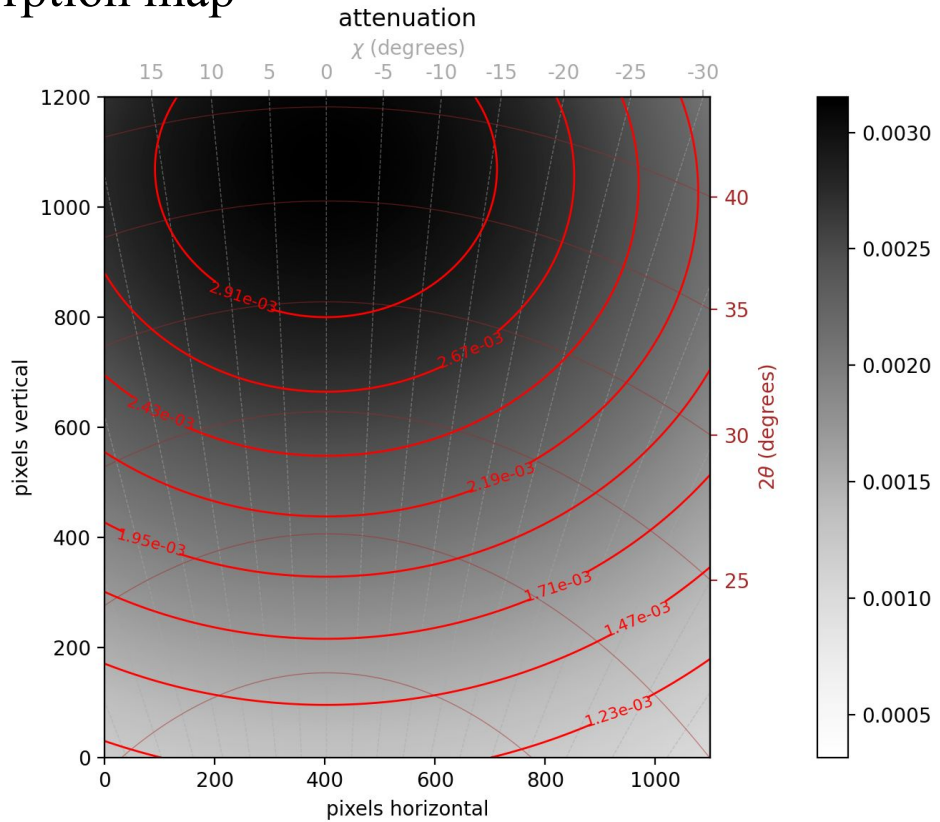
factor of attenuation when leaving CuSO4: $\exp\left(-\frac{d_{\mathrm{CuSO_4}} - x}{d_{8048} \cdot \cos(\theta)}\right)$



integration and normalisation:

$$\frac{\int_0^{d_{\mathrm{CuSO_4}}} \frac{\exp\left(-\frac{x}{d_{9000}}\right) \cdot \exp\left(-\frac{d_{\mathrm{CuSO_4}} - x}{d_{8048} \cdot \cos(\theta)}\right)}{d_{9000}} dx}{\int_0^{d_{\mathrm{CuSO_4}}} \frac{\exp\left(-\frac{x}{d_{9000}}\right)}{d_{9000}} dx}$$

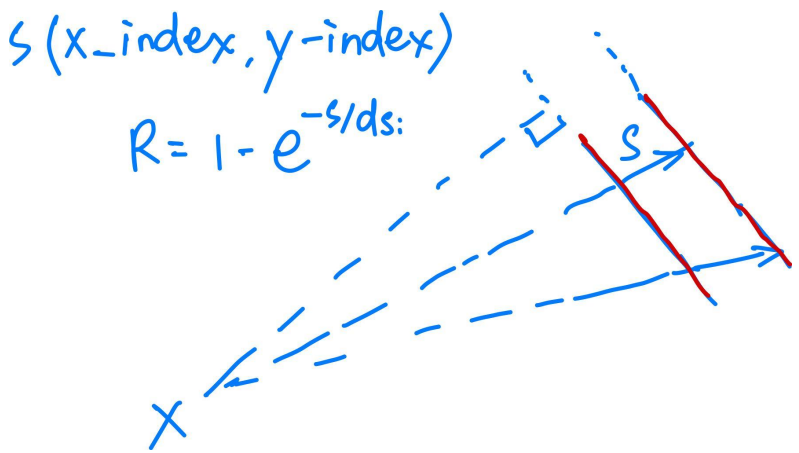
Absorption map

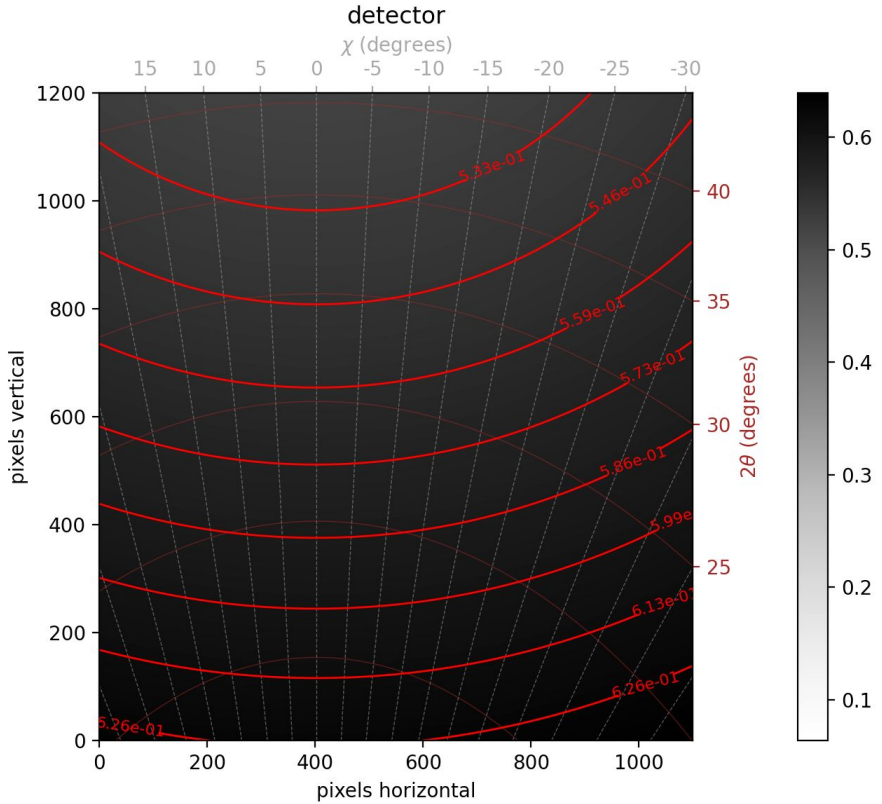


Attenuation lengths

- CuSO4.5H2O_8048: 142.61um
- CuSO4.5H2O_9000: 51.60 um
- BN_8048: 982 um
- air_8048: 0.3252 m
- Cu_8048: 22.29 um

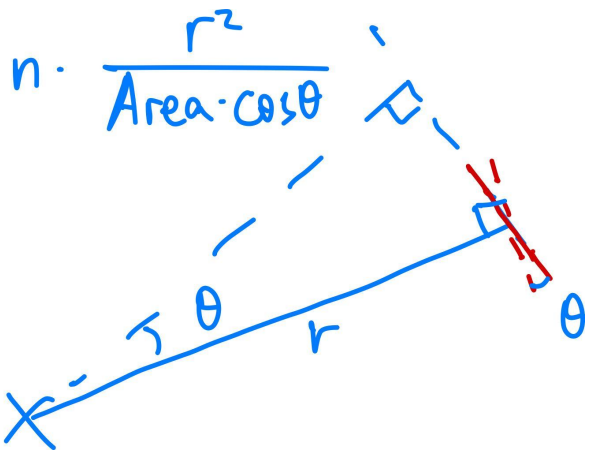
Detector map

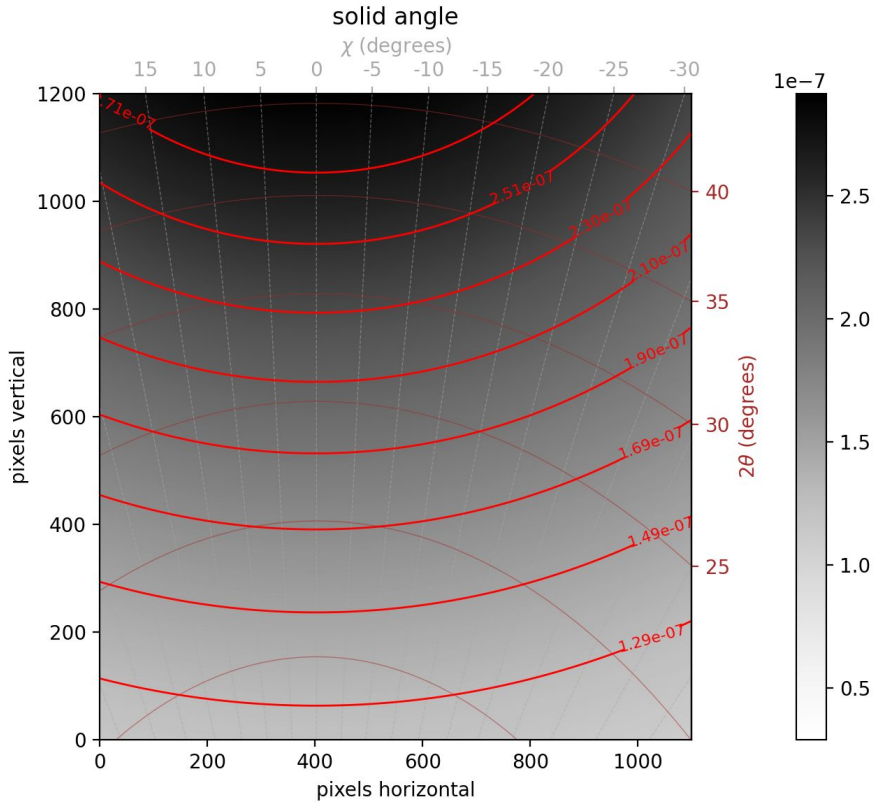




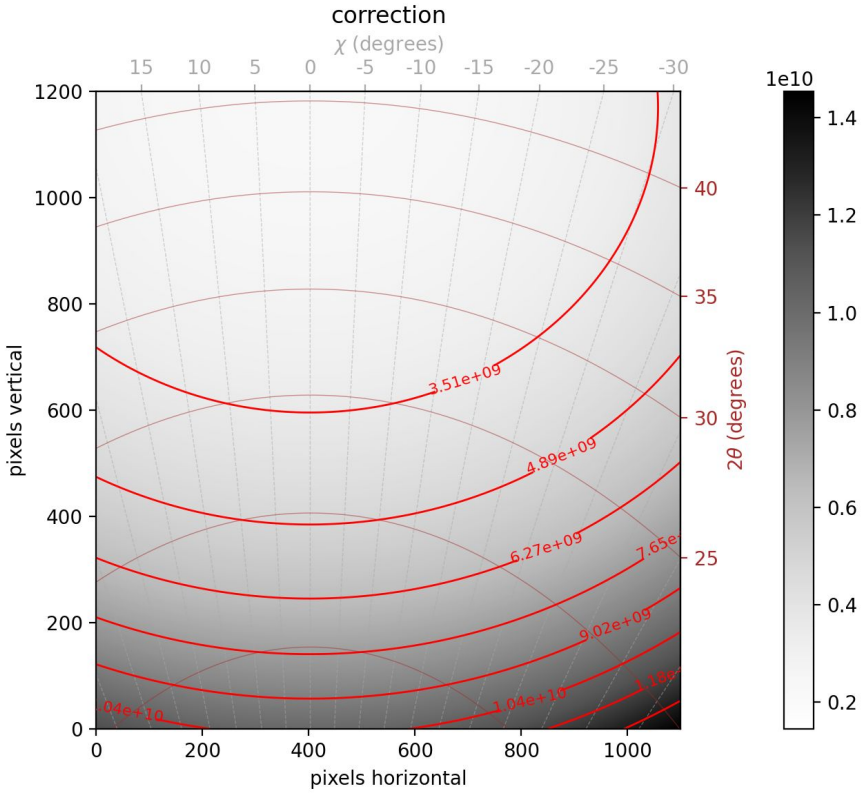
Solid angle map

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



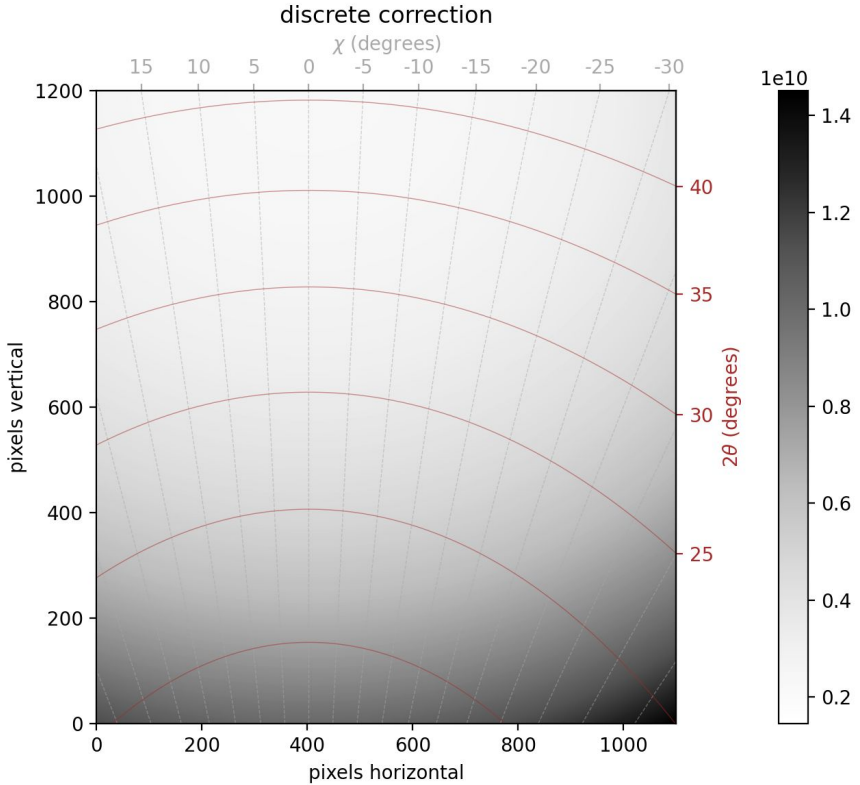


Overall correction



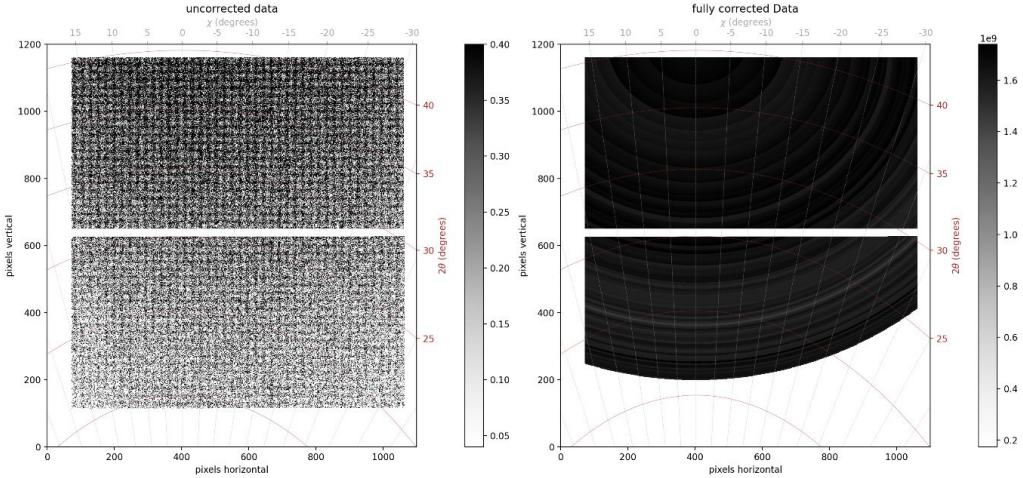
$$\text{correction} = \frac{1}{\text{absorption} \times \text{detector} \times \text{solid angle}}$$

Poisson fit and reconstruction

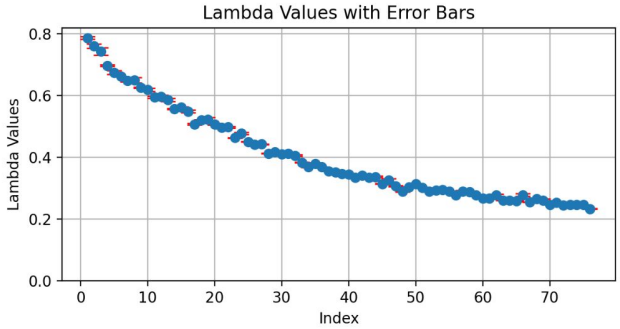


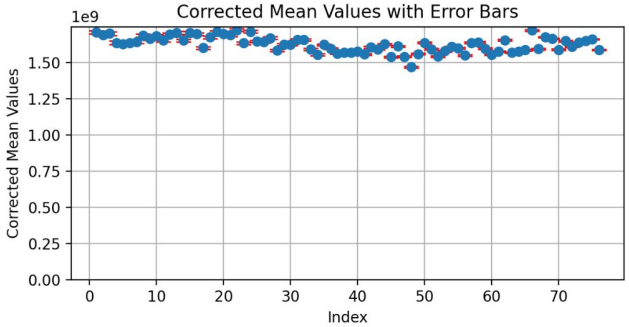
- divide the detector pixels into **200 regions** based on correction map
- each region can be seen as approximately homogeneous
- Poisson fit in each region
- use fitted lambda instead of pixel values
- perform correction

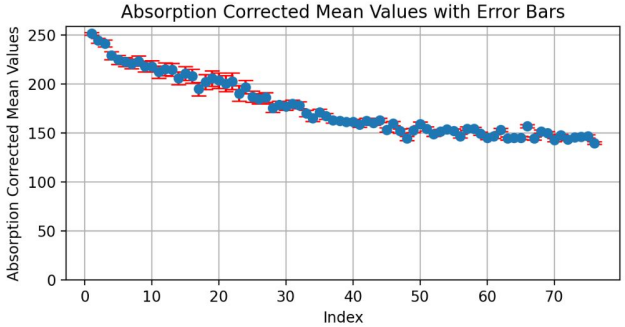
Reconstruction result - vmax=max, vmin=0.1*max



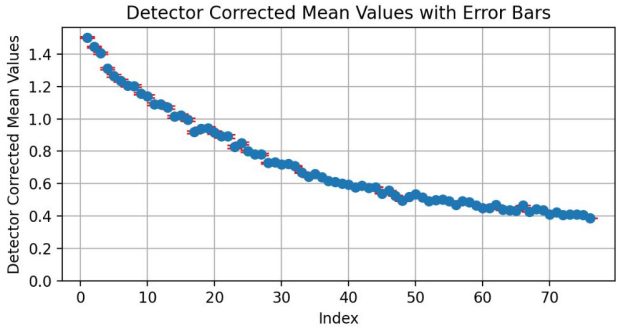
Check on homogeneity

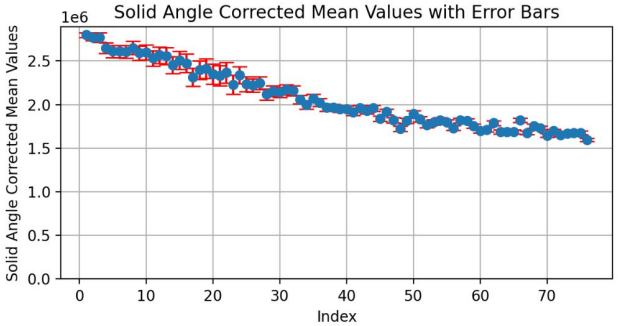




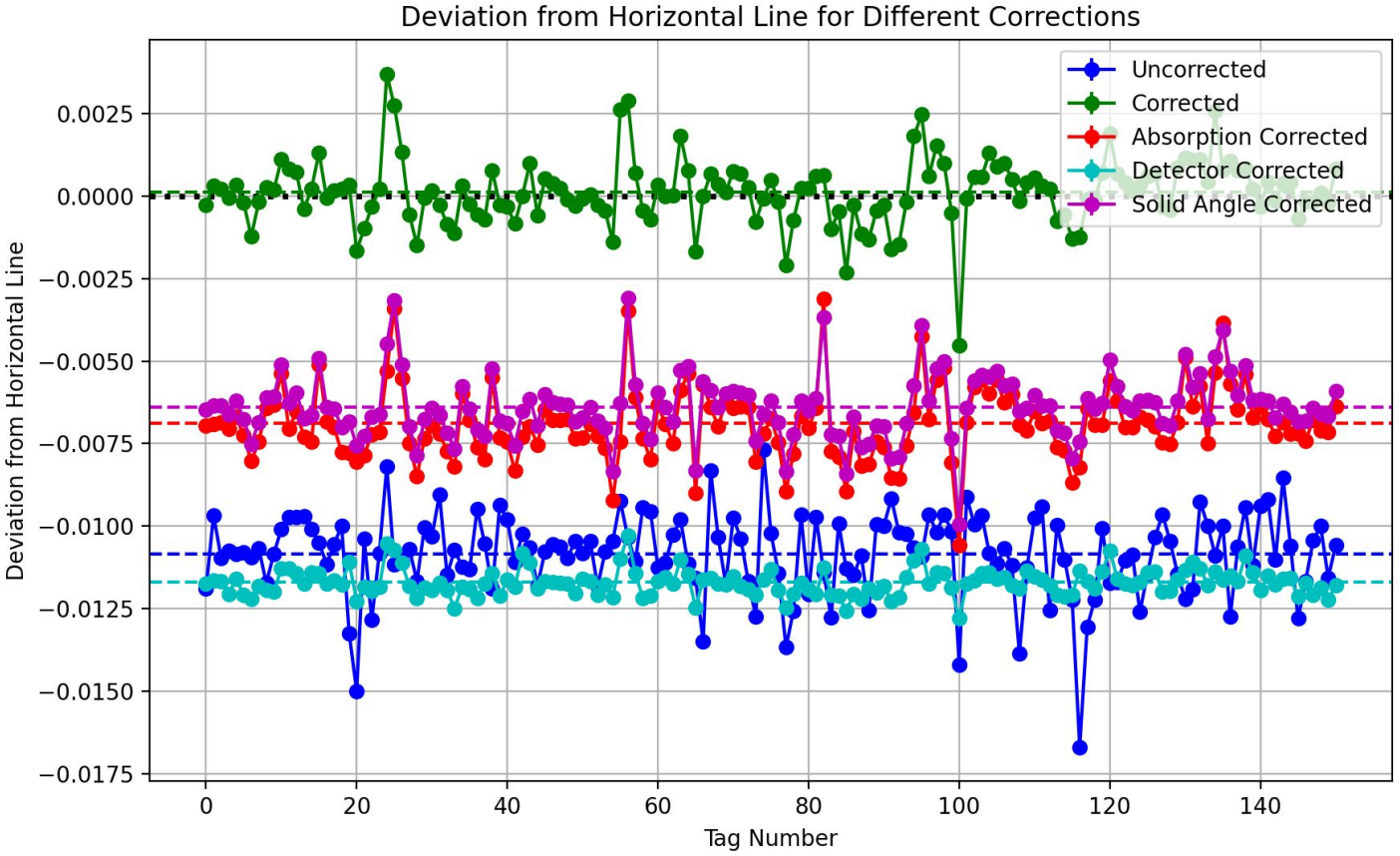


- tag 0

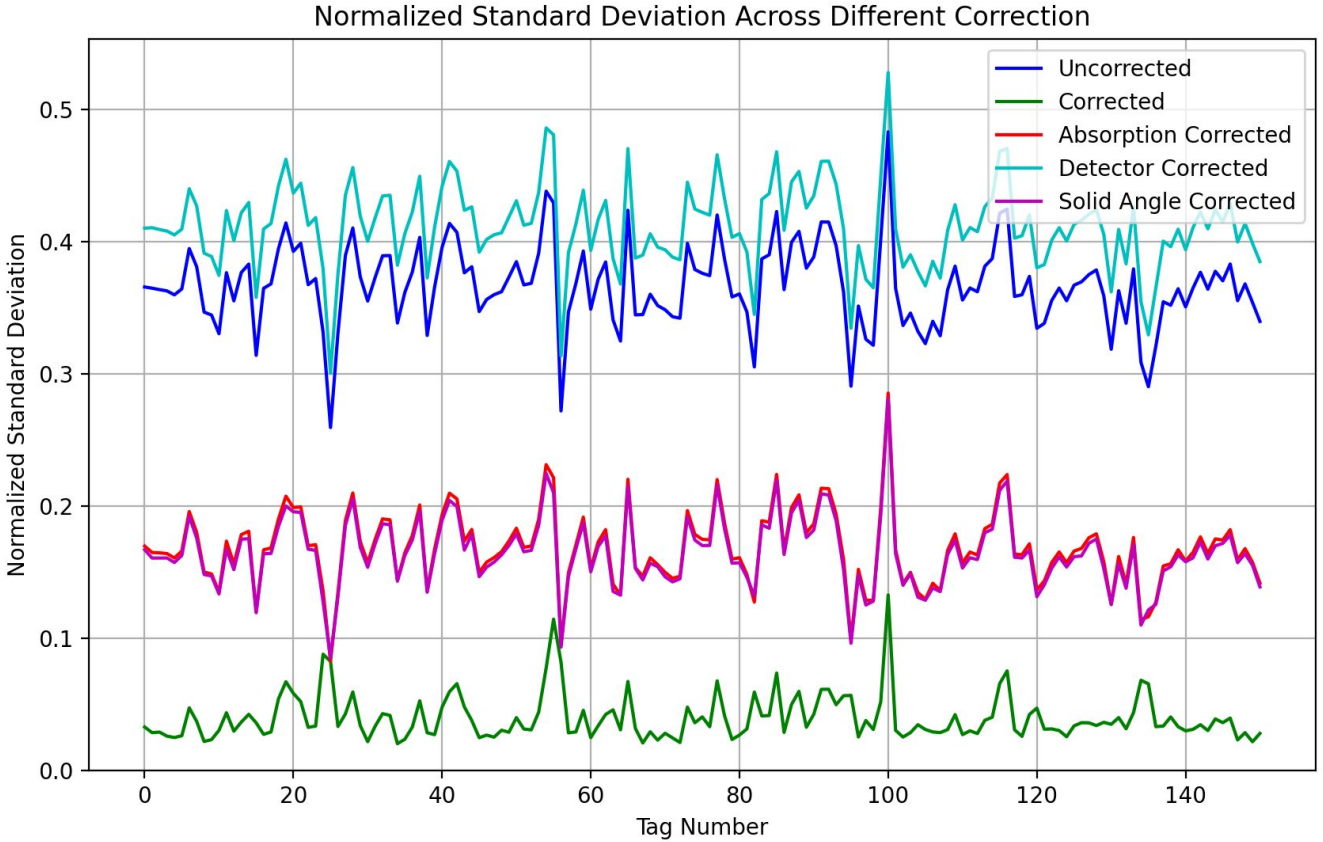




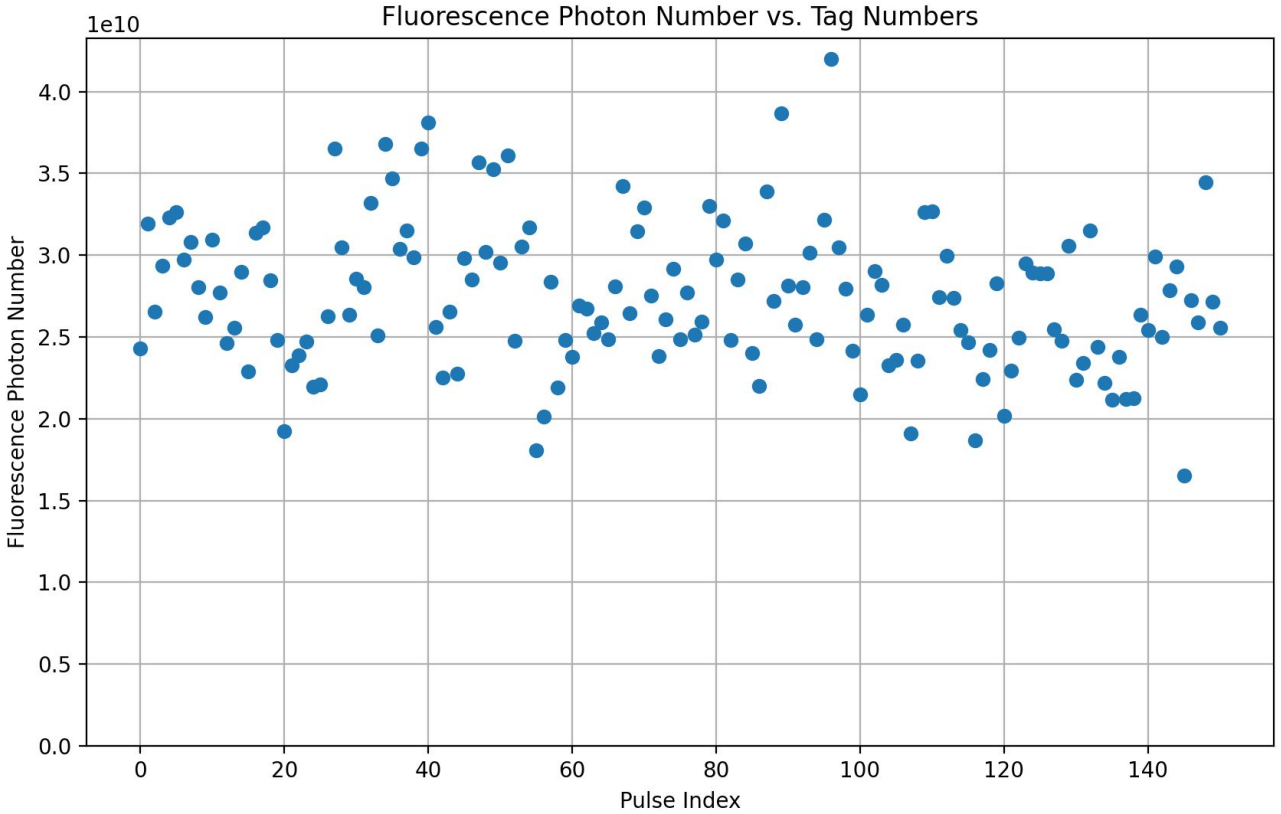
Check on homogeneity



Check on homogeneity

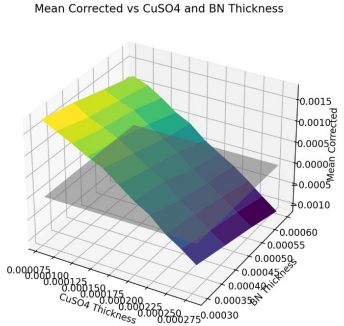


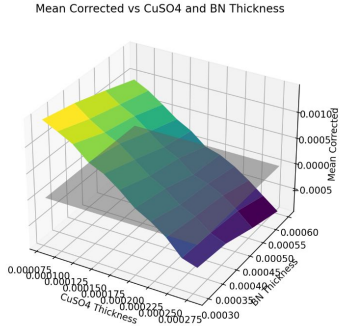
Fluorescence photon number

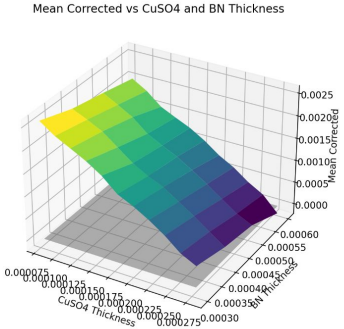


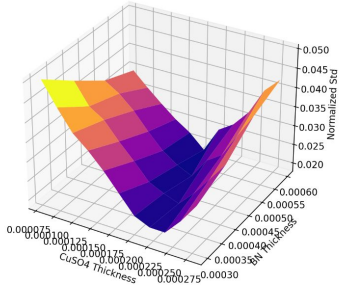
$$\sigma_{\mathrm{Cu}} = 2.986 \times 10^{-6}$$
$$\sigma_{\mathrm{H}} = 6.331 \times 10^{-13}$$
$$\sigma_{\mathrm{S}} = 3.505 \times 10^{-7}$$
$$\sigma_{\mathrm{O}} = 1.977 \times 10^{-8}$$
$$\mathrm{ratio} = 0.84964$$

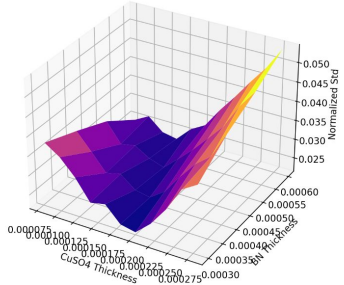
Parameter scan

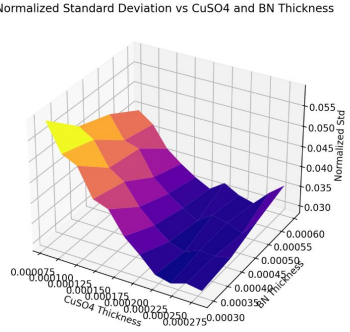


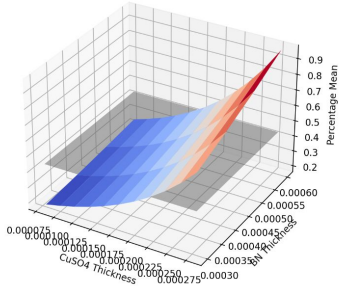


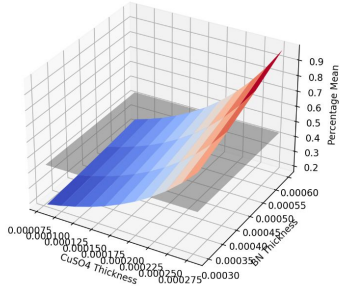


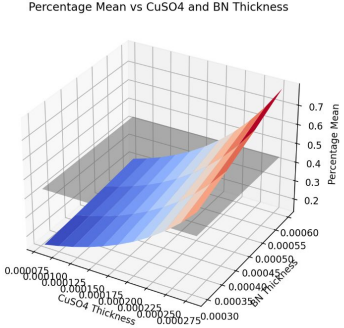




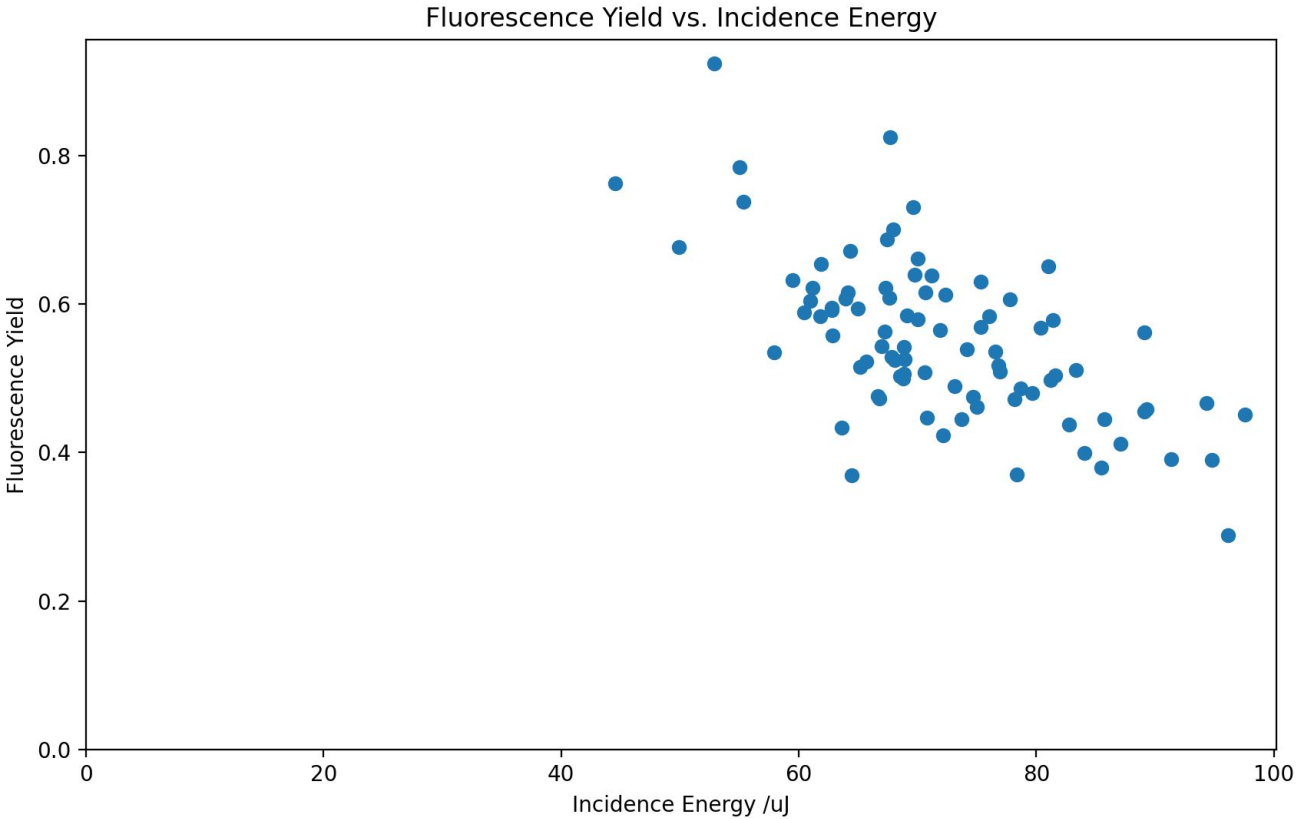






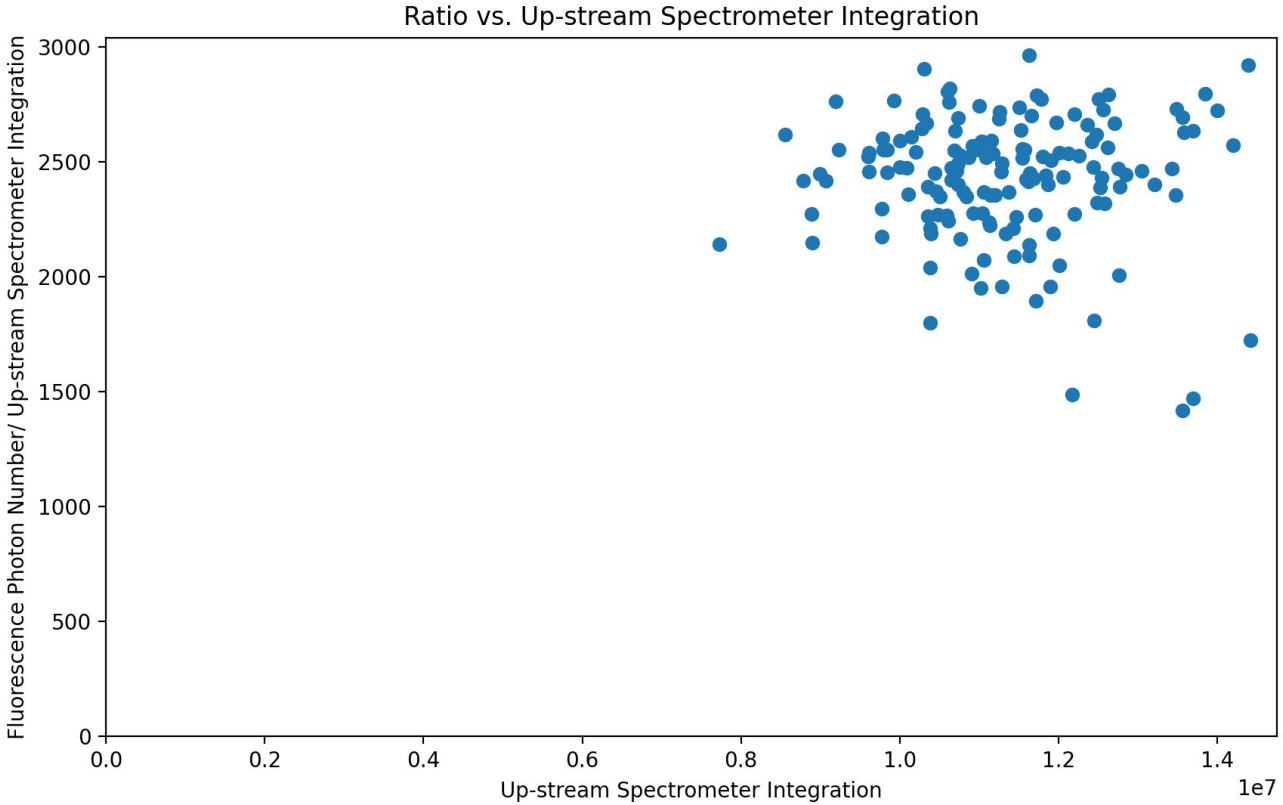


Fluorescence yield



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

Fluorescence yield



- no correlation
- smaller fluctuation
- needs to calibrate

Thank you for listening