E320 data analysis meeting

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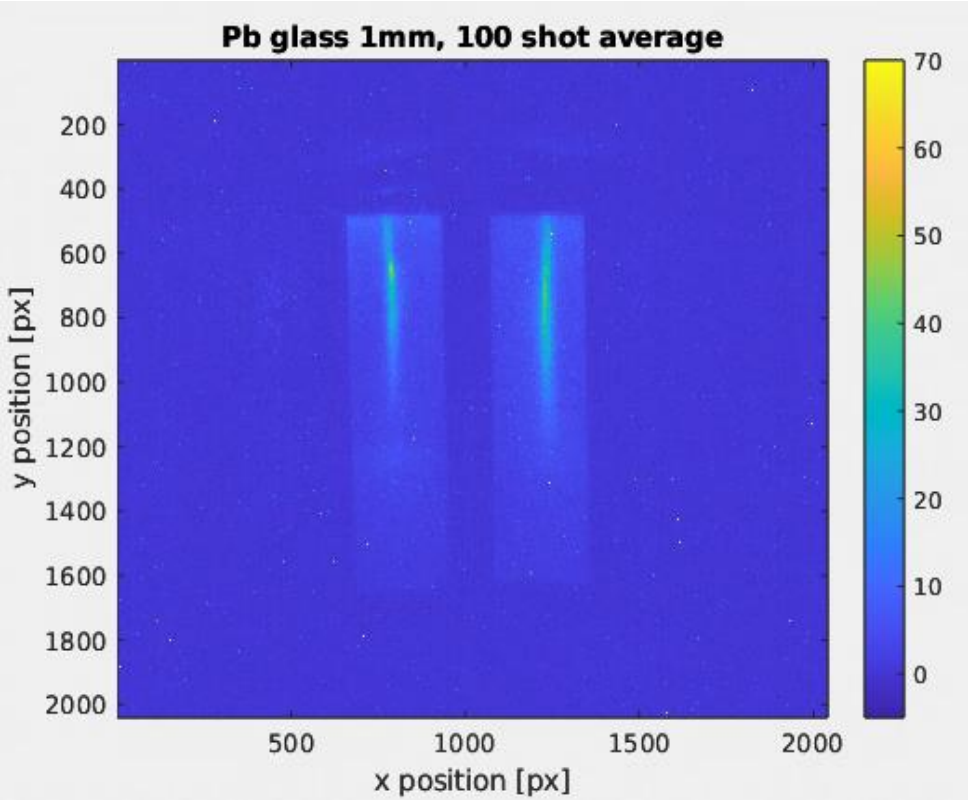
9/24/24

Overview

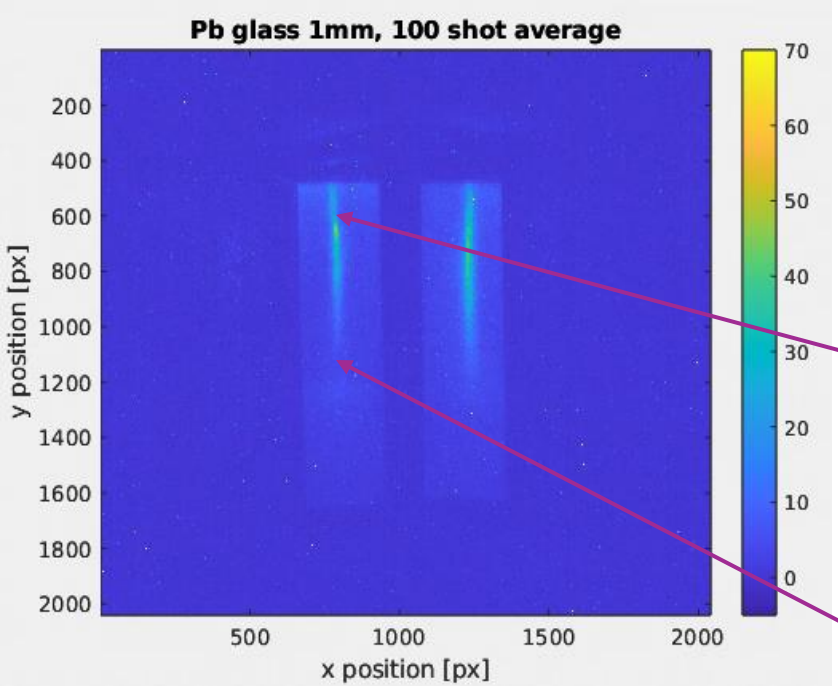
- Analyzed LYSO screen images taken during May 2024 E320 run
- Subtracted the average of 100 background images taken at the end
- Subtracted a polyfit on the left/right sides of the LYSO screen
- Calibrated the conversion from y axis to y axis in mm and to energy in GeV
- Converted counts/pixel to counts/mm and to counts/GeV
- Calibrated count to positron number with GEANT4 simulations

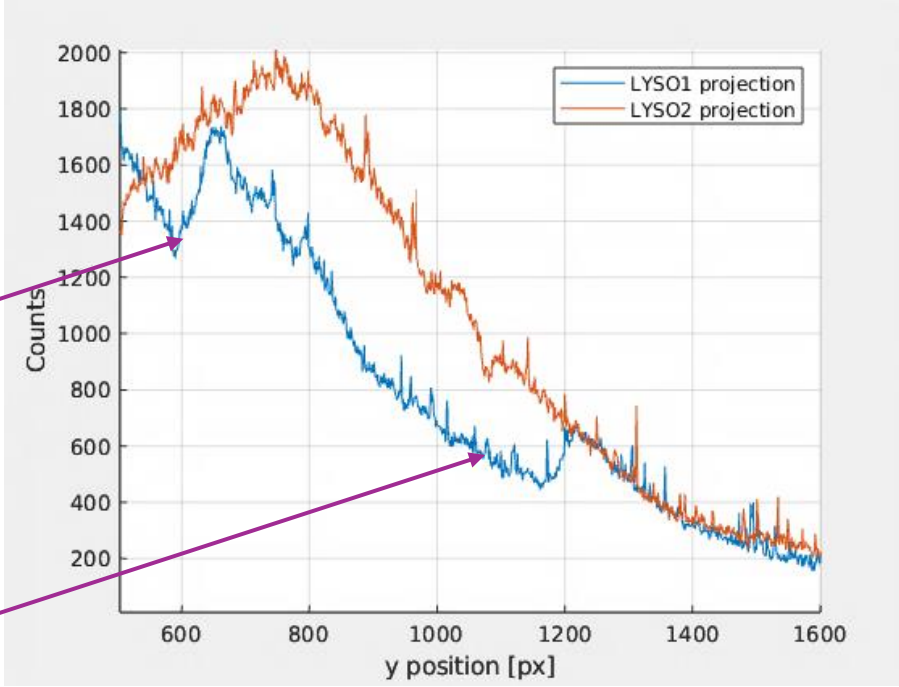


dipole = 24 GeV, quads = 6 GeV

LYSO1 defect

Positrons appear to be consistently under-detected on certain pixels of LYSO1 – only LYSO2 is used for the rest of the analysis,





Outline

Section 1: Positron signal

- Experiment
- Simulation
- Calibration

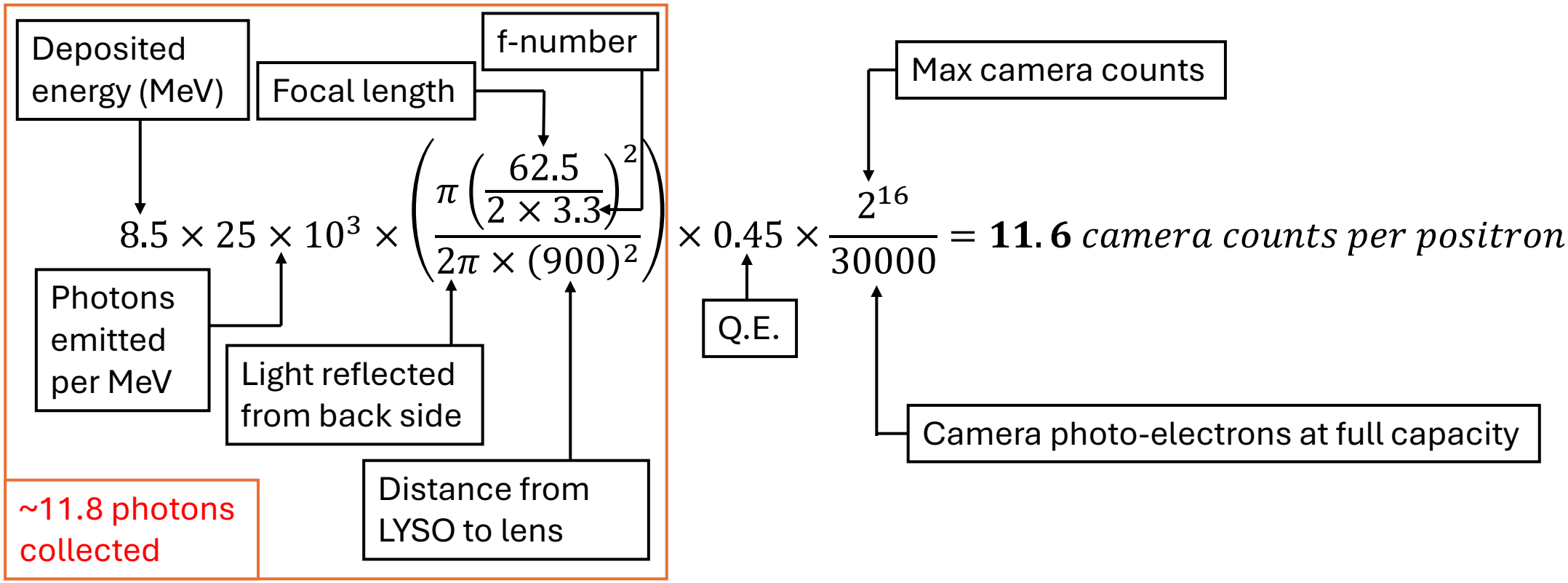
Section 2: Background subtraction

- Constant background
- Screen-induced background
- Shot averaging

Section 1: Positron signal

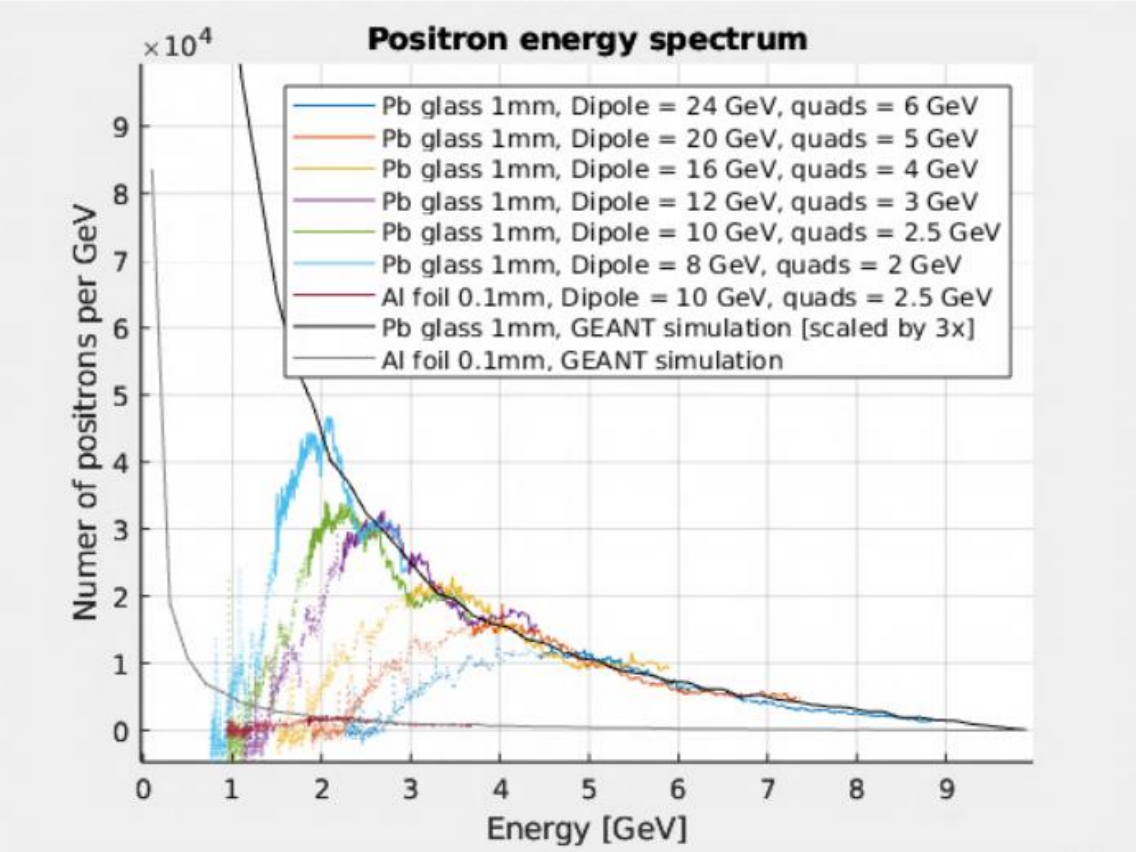
Positron count to camera count estimation

Assume positron deposits 8.5 MeV on second LYSO screen (Felipe's simulation) w/ 2x2x4 mm^3 pixel. Calibration factor :



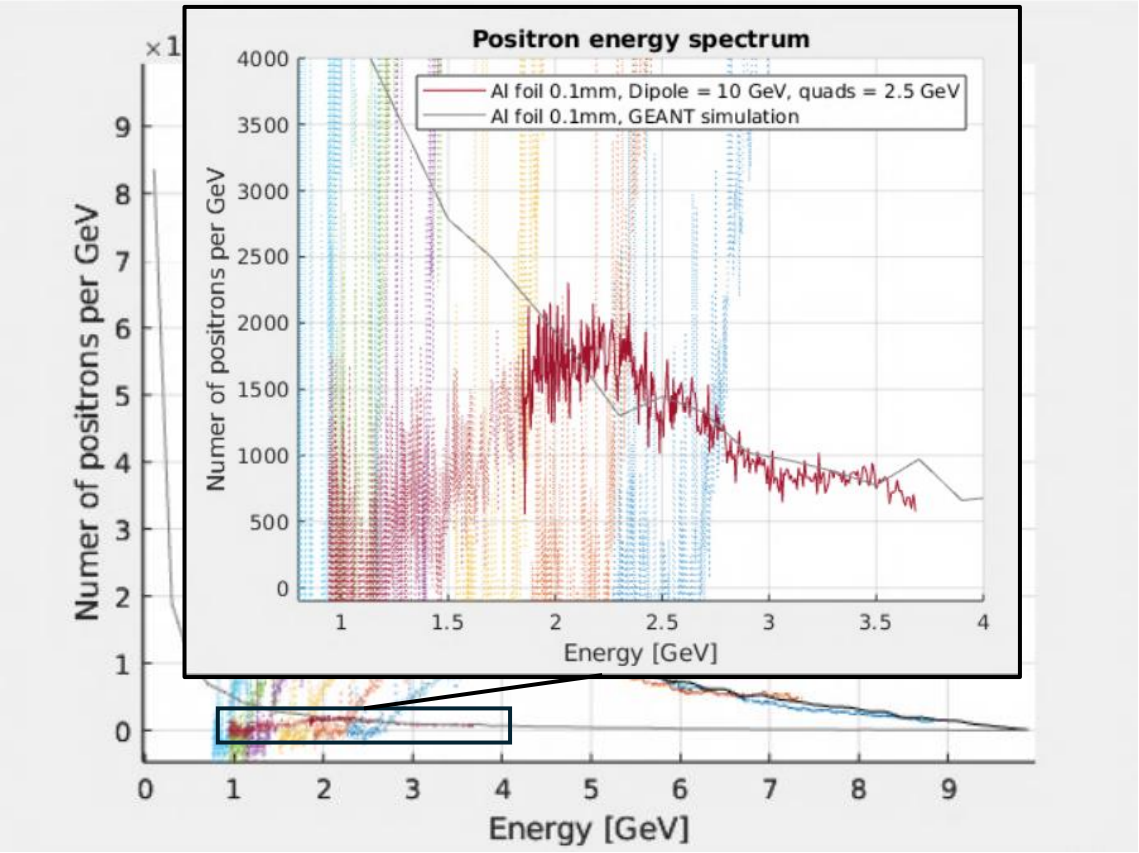
Experiment vs Robert's GEANT4 simulation

- Positron spectrum for 1mm lead glass and 0.1mm Al foil compared to simulation
- Dotted lines represent approximate vertical cutoff for dipole exit window
- Good match for general shape
- Pb glass simulation result scaled linearly



Experiment vs Robert's GEANT4 simulation

- Positron spectrum for 1mm lead glass and 0.1mm Al foil compared to simulation
- Dotted lines represent approximate vertical cutoff for dipole exit window
- Good match for general shape
- Al foil data calibrated with simulation in 2.5 GeV to 3.5 GeV range: **14** counts per positron

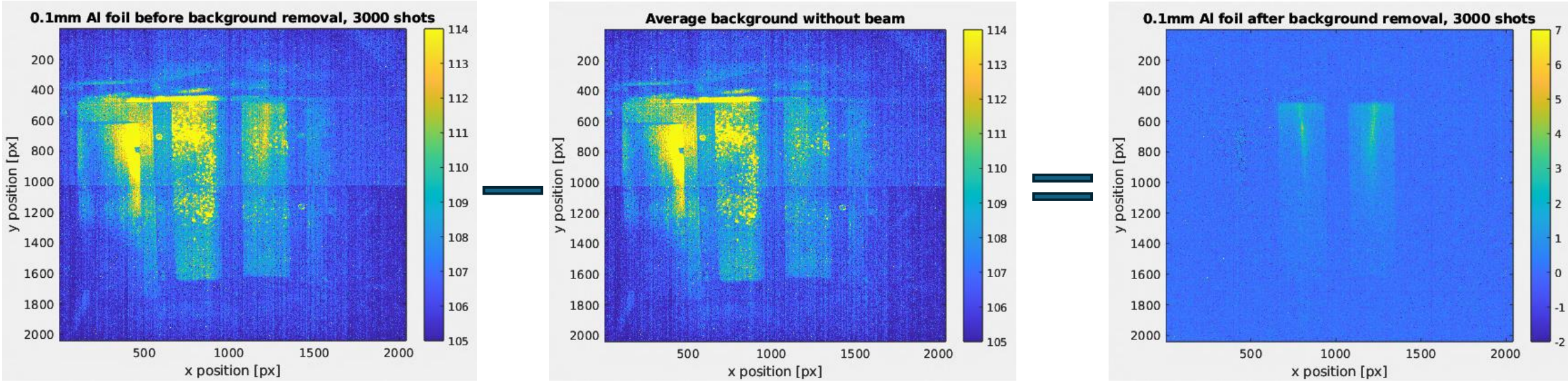


Section 2: Background subtraction

Background subtraction

Three kinds of background:

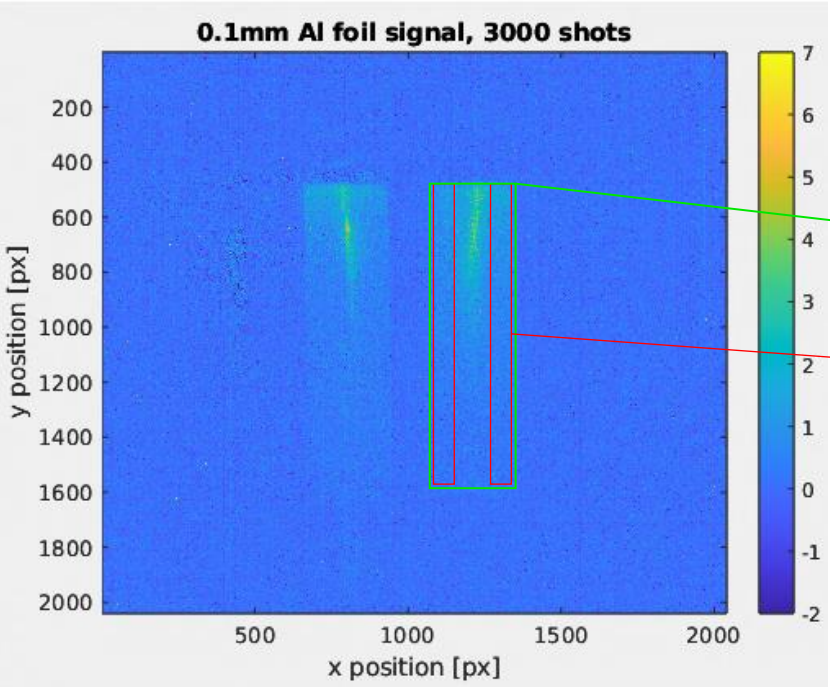
1. Constant background: subtract image recorded without beam (includes camera offset of 107 counts)

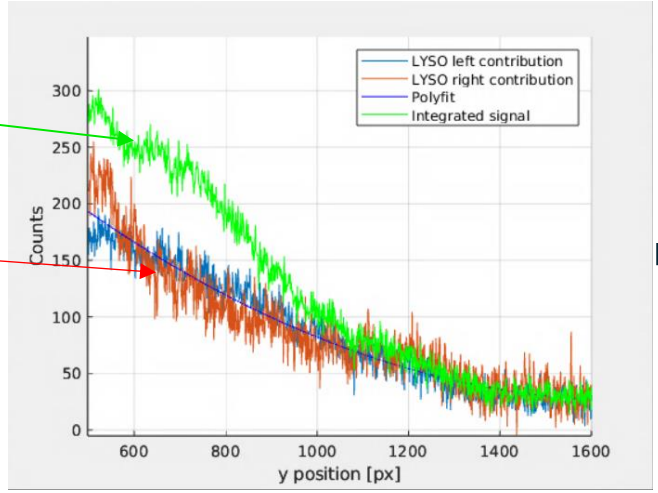


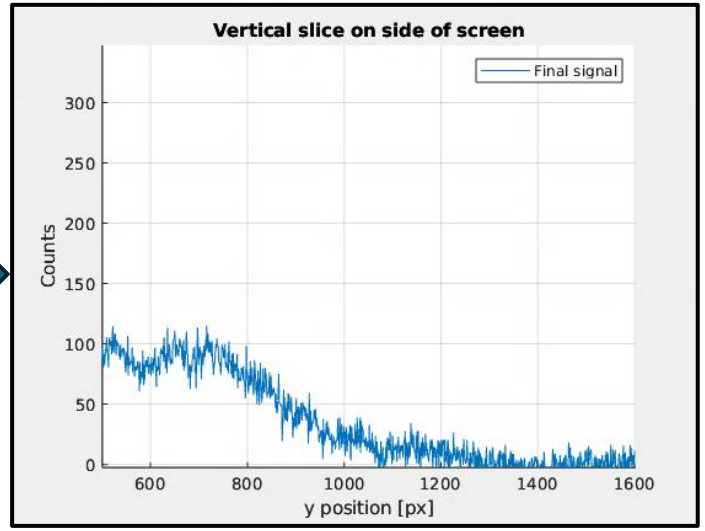
Background subtraction

Three kinds of background:

2. LYSO Screen background (while beam is present): polynomial fit section of screen where there is no signal, then subtract from signal



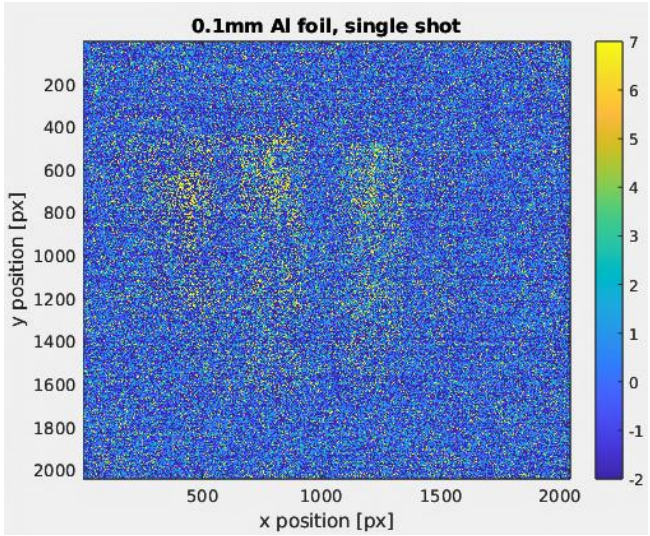


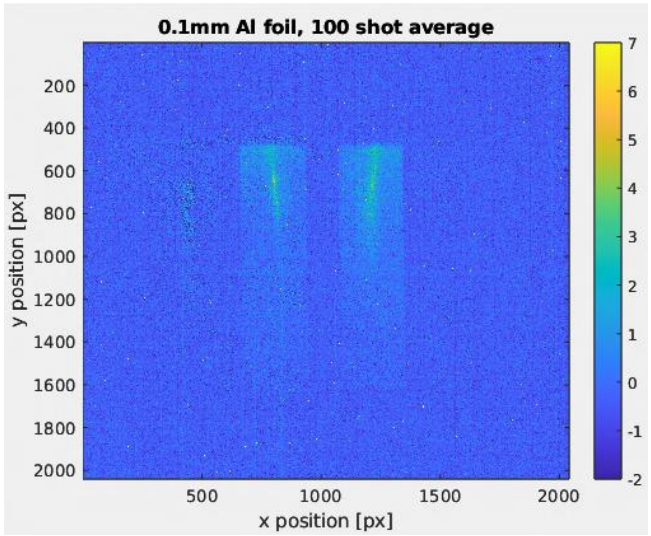


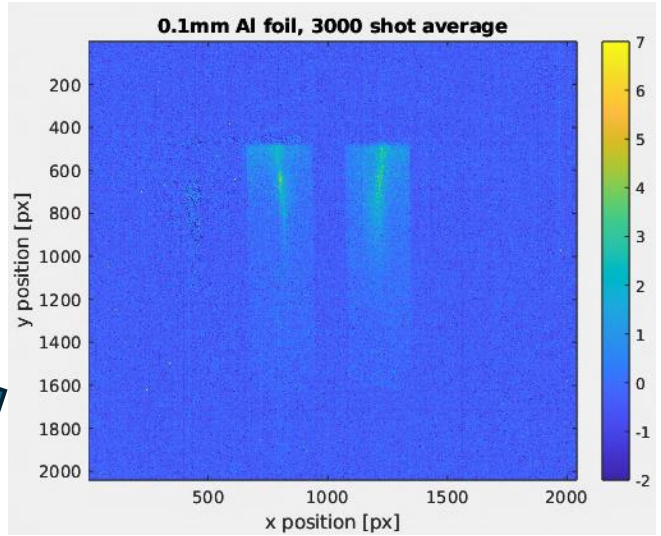
Background subtraction

Three kinds of background:

3. Random noise: reduce by averaging over shots

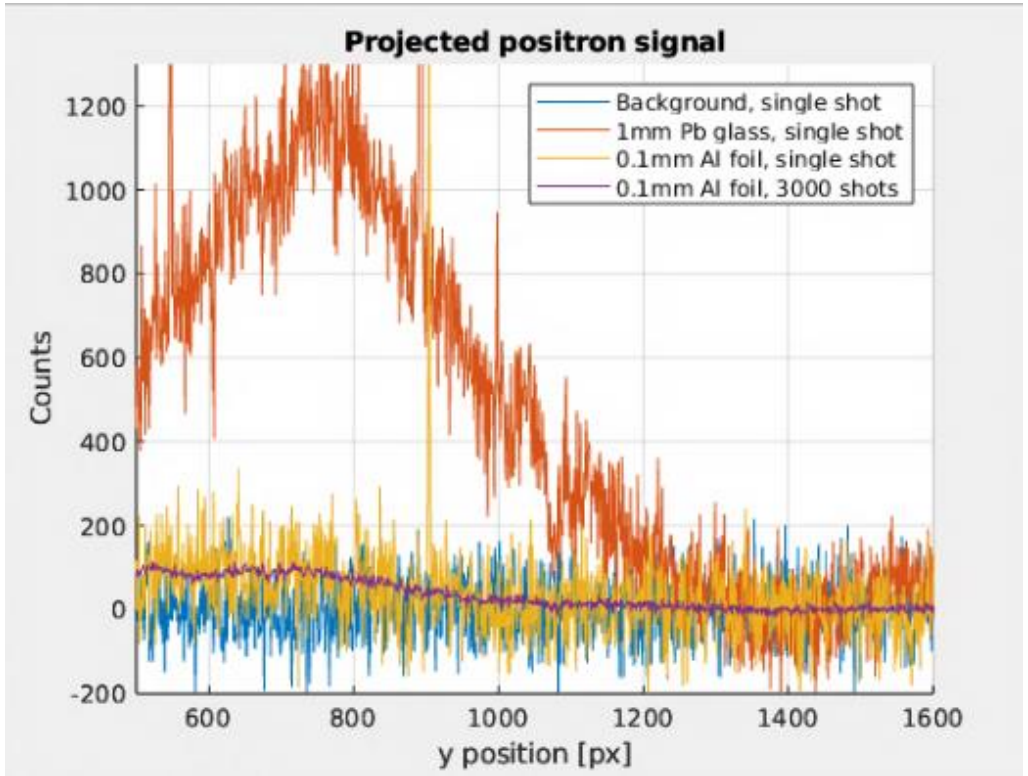


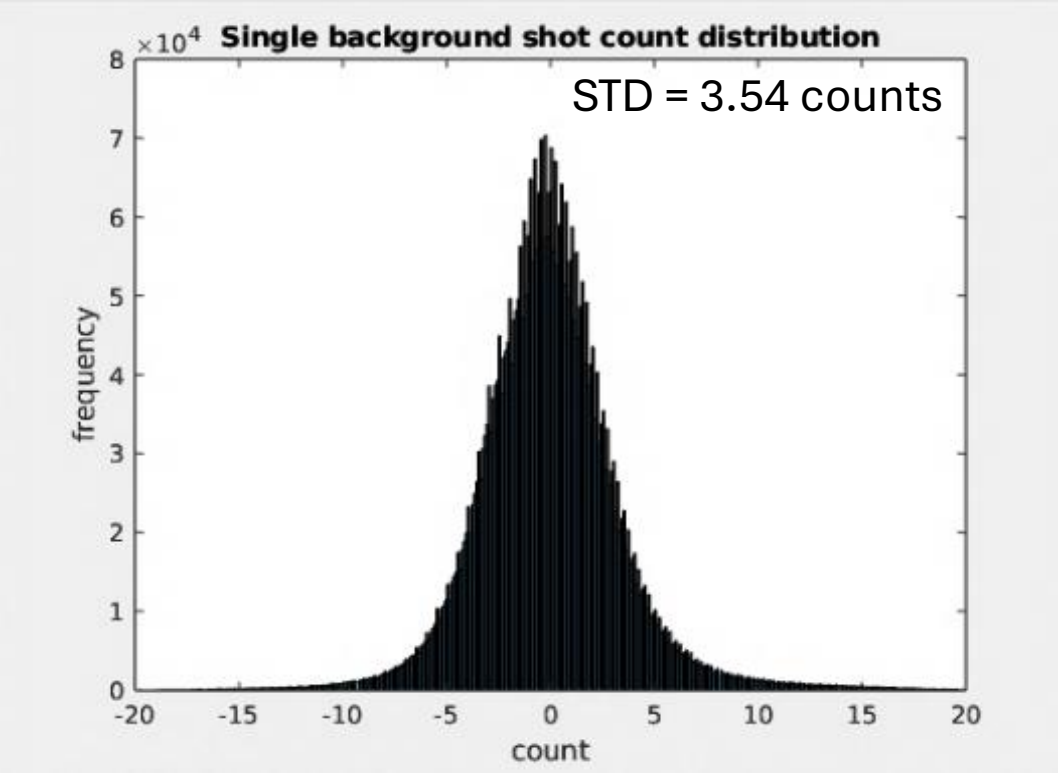




Background subtraction

Aluminum foil signal is faintly visible even with a single shot after all other background subtractions

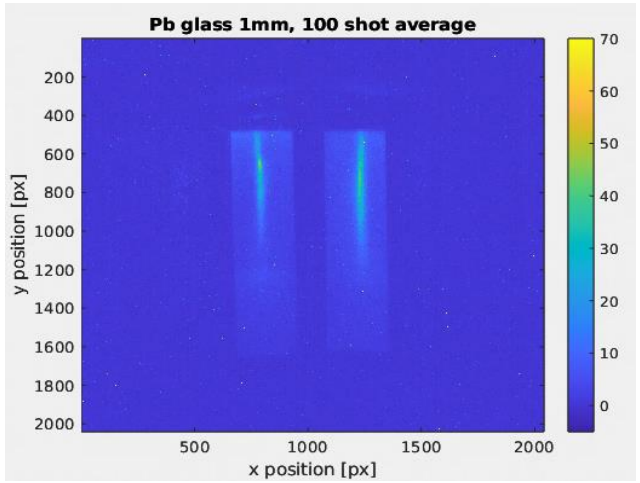




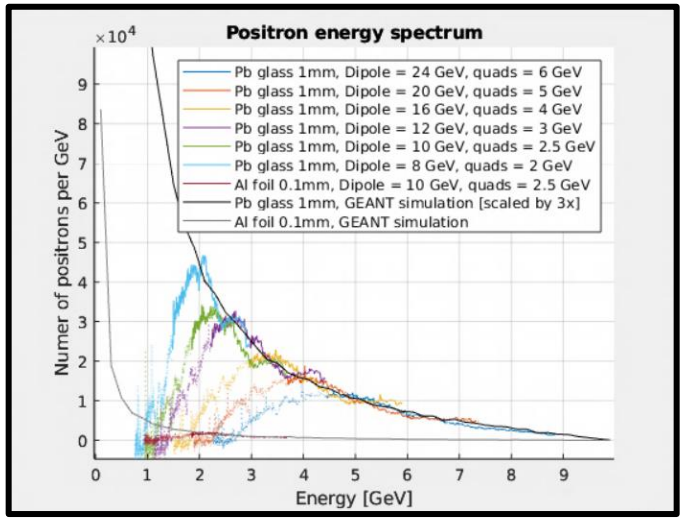
Summary

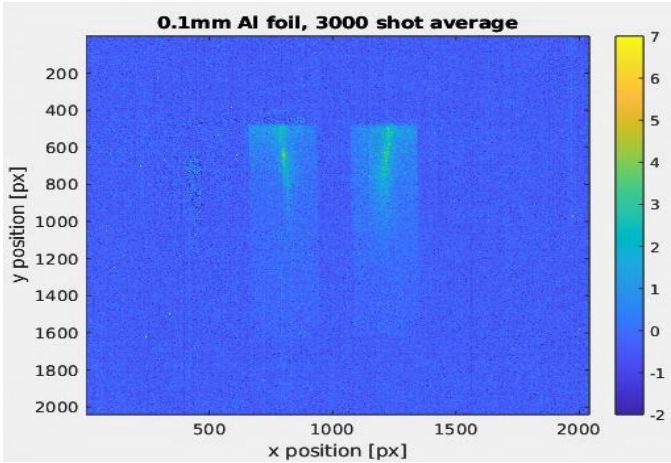
May 2024 setup sensitivity:

- Estimate:11.6 counts per positron
- Experimental Calibration: 14 counts per positron



dipole = 24 GeV, quads = 6 GeV





dipole = 10 GeV, quads = 2.5 GeV

Thank you

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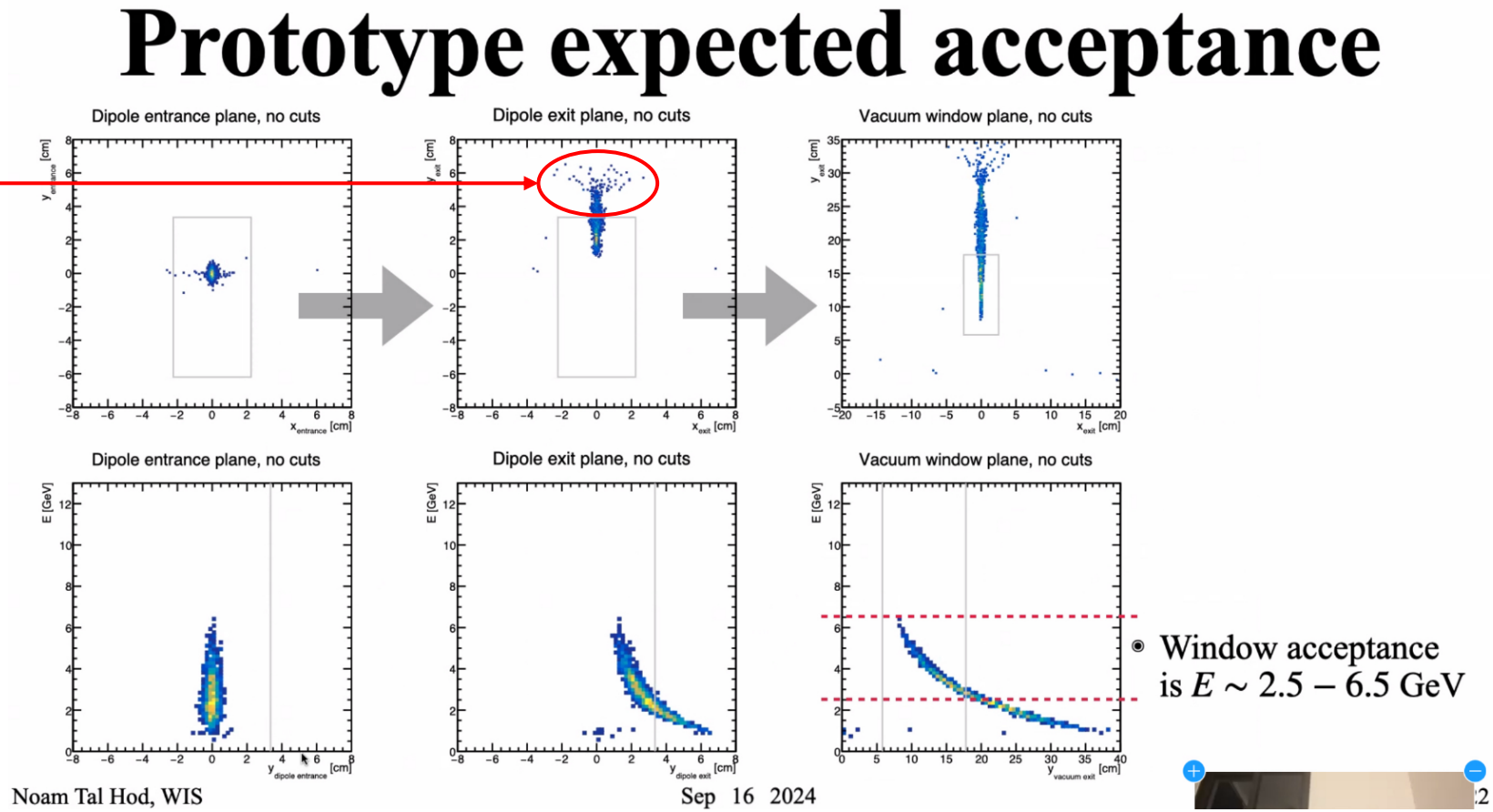
Backup

Vertical cutoffs

Some positrons are blocked by the top of the dipole exit plane window



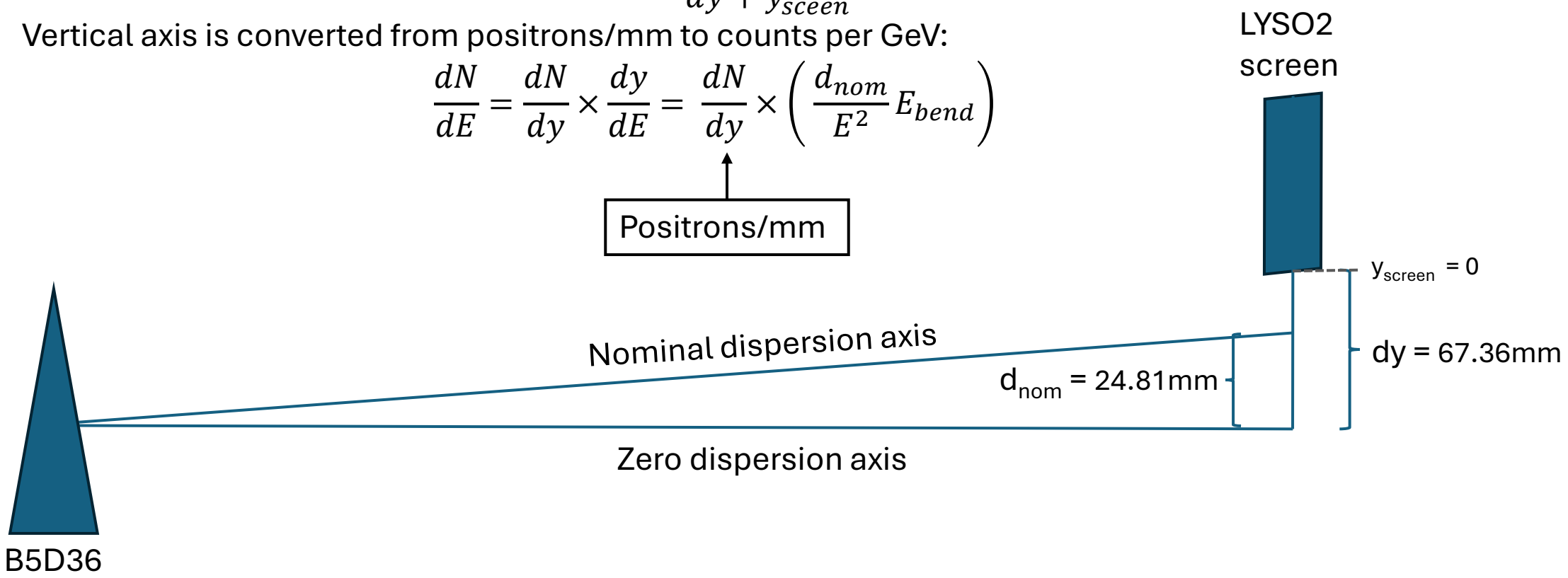
Energy calibration

- Horizontal axis is converted from px to mm, then from mm to GeV:

$$E(y_{screen}) = \frac{d_{nom}}{dy + y_{sceen}} E_{bend}$$

- Vertical axis is converted from positrons/mm to counts per GeV:

$$\frac{dN}{dE} = \frac{dN}{dy} \times \frac{dy}{dE} = \frac{dN}{dy} \times \left(\frac{d_{nom}}{E^2} E_{bend} \right)$$



Sensitivity to energy calibration

- Experimental calibration value = 14 counts/positron
- Assuming dy is accurate to +/- 1cm and d_{nom} is accurate to +/- 7%, we get that the calibration value is accurate to +/- 2 counts/positron
- Final result: **14 +/- 2 counts/positrons**

Screen-induced backgrounds