



Photon Tagged Beamline at the DESY II Test Beam Facility

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7th Beam Telescopes and Testbeams Workshop, January 2019

Outline

- Motivation
- Simulation
- Testbeam
- Results
- Summary

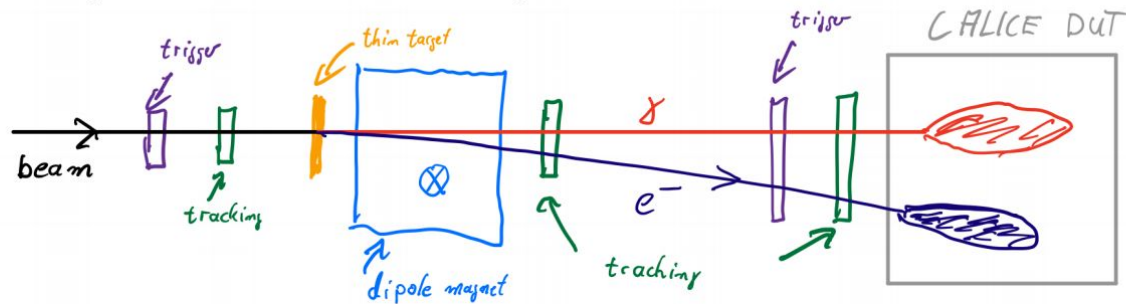
Motivation

Investigate feasibility of photon tagging in the DESY II test beam areas:

- Requested by users
- Useful for calorimeter tests
- Summer student project provides proof of concept
- Informs what rates we can get for different photon energies

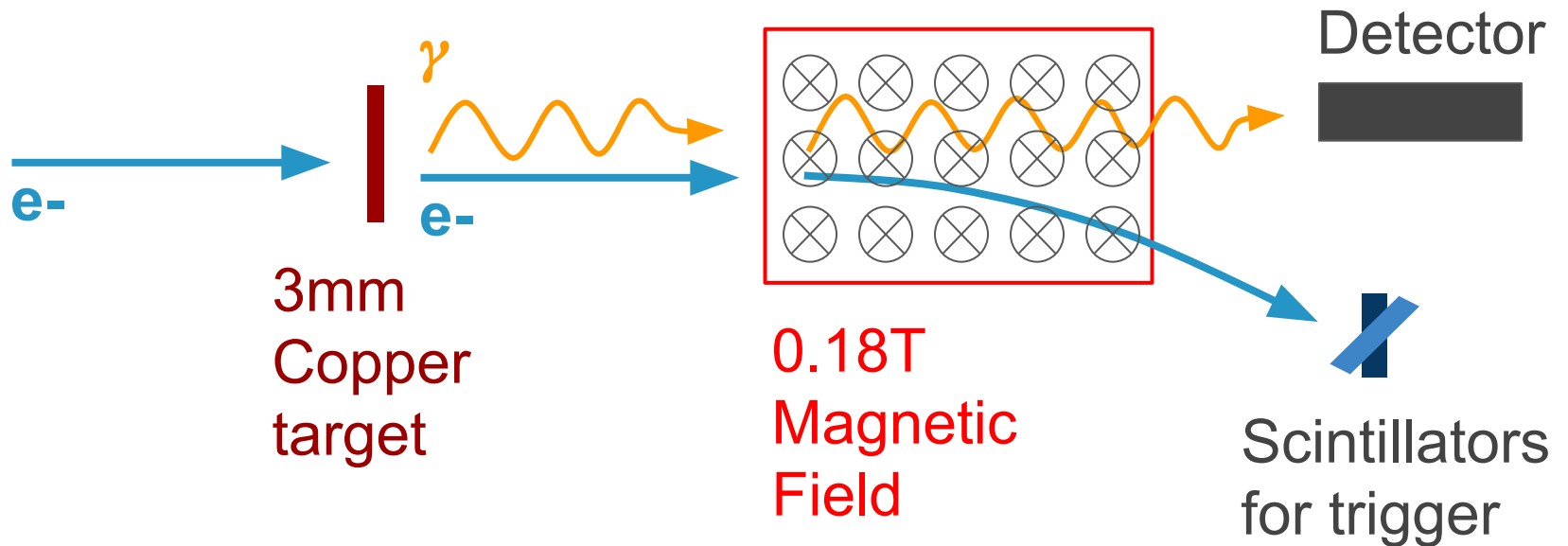
DESY Test Beam Users Workshop '17

- Desirable extensions of instrumentation / infrastructure:
 - strip telescope to cover larger areas
 - precise calorimeter for absolute beam energy calibration
 - fast reference timing device
 - pairs of electron + γ - for example created with a thin target followed by a magnet to separate the two with variable separation



Photon Tagging

- 5 GeV electron beam in TB21
- Install 3mm copper target in test beam area to create bremsstrahlung photons
- Big Red Magnet fans out electrons by momentum
- Lead-glass detector measures energy of photons
- Pair of scintillators trigger Lead-glass detector

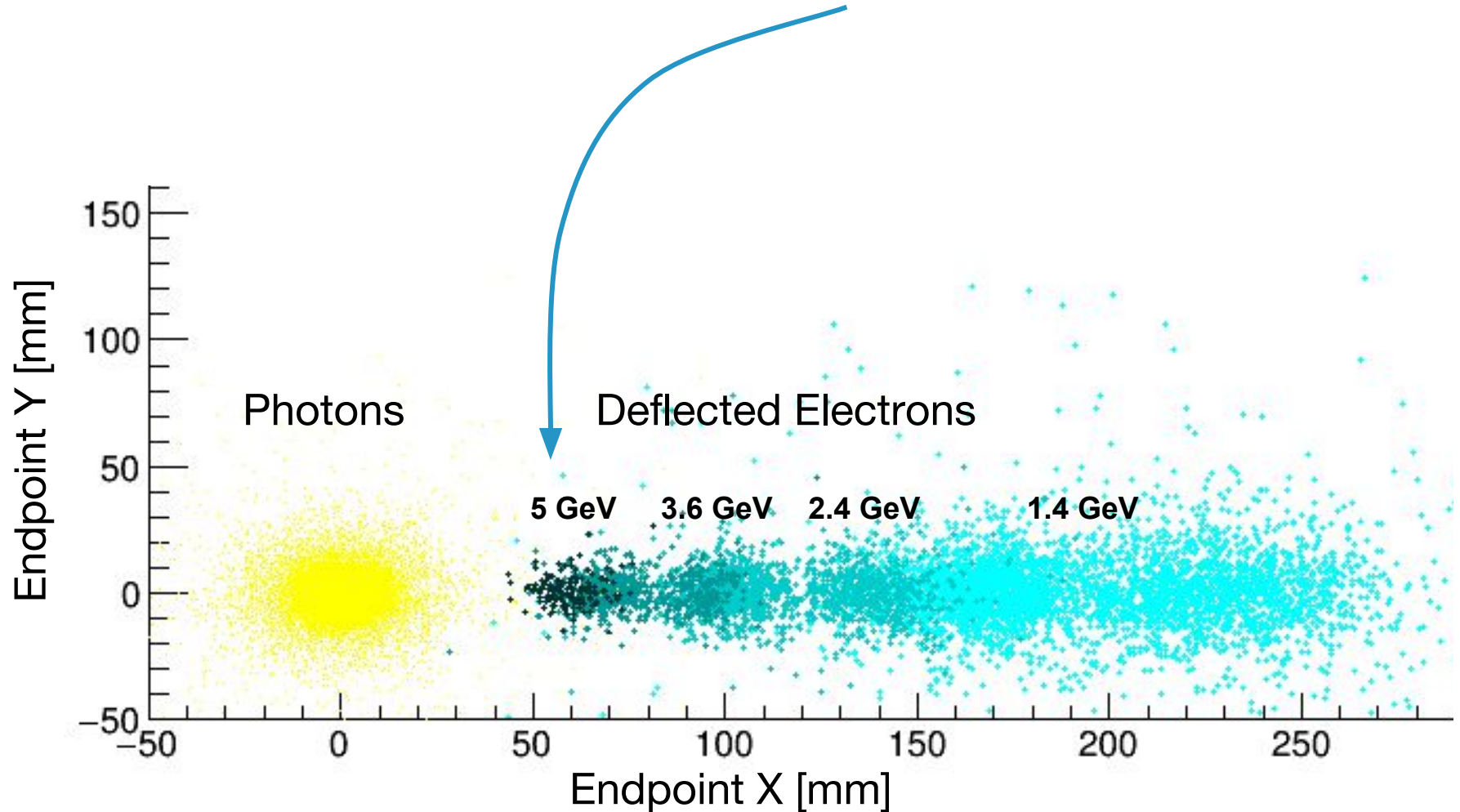


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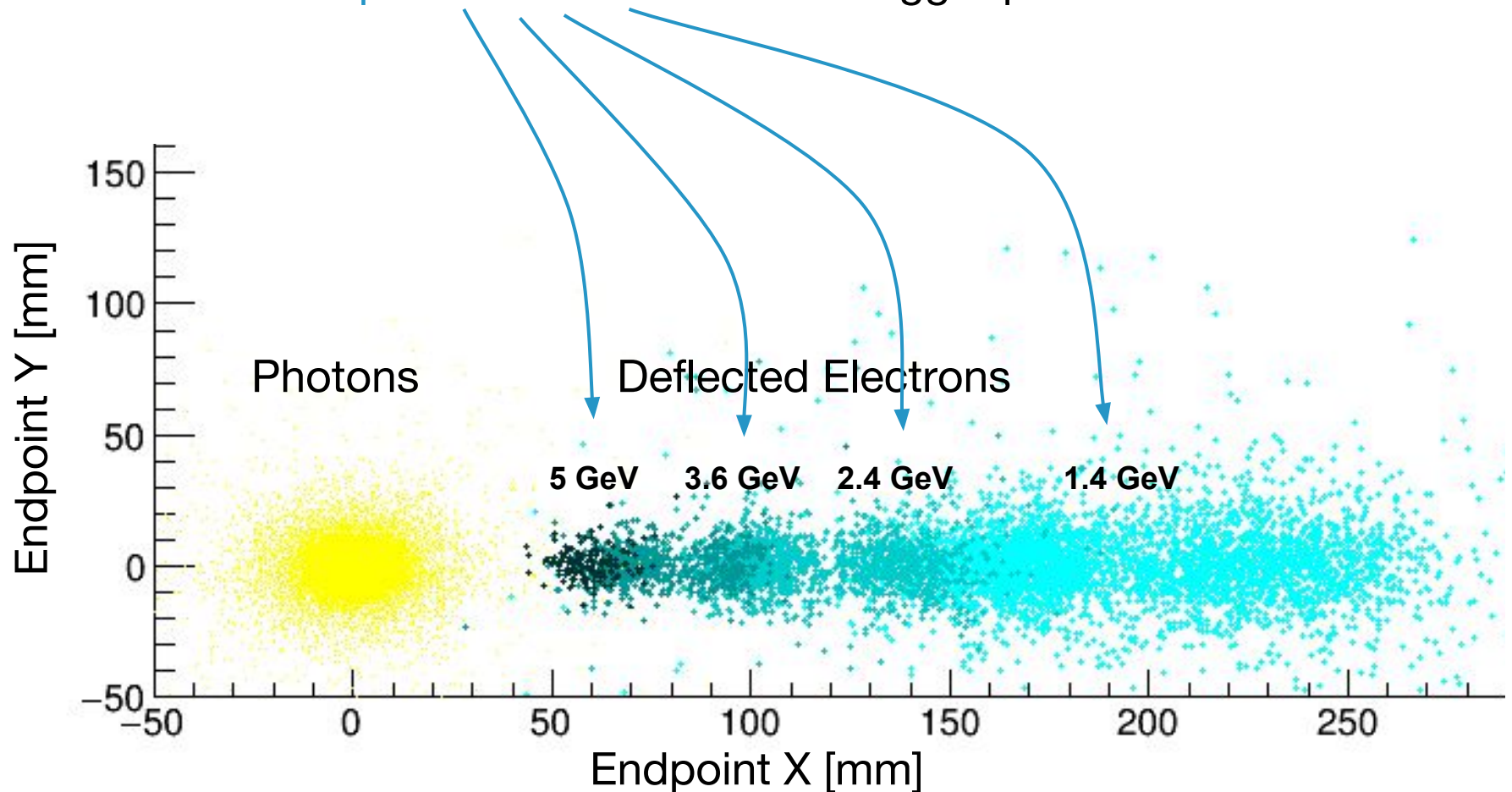
Simulation

- SLIC (Geant4 based simulation tool for linear colliders)
- Useful info for test beam plan:
 - Electrons won't be measured in photon detector area (deflected 5cm)



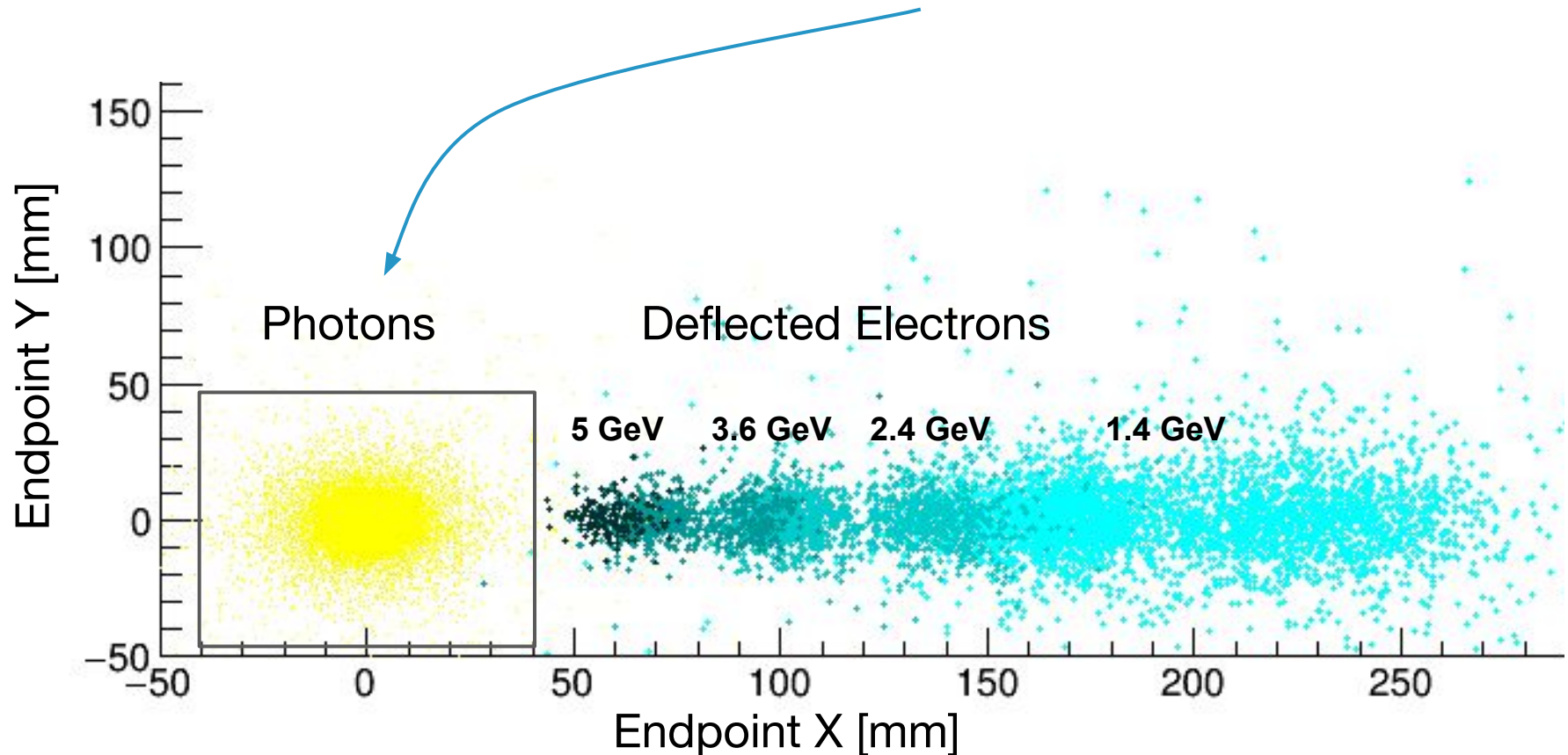
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 - **Deflection positions** found for each trigger position



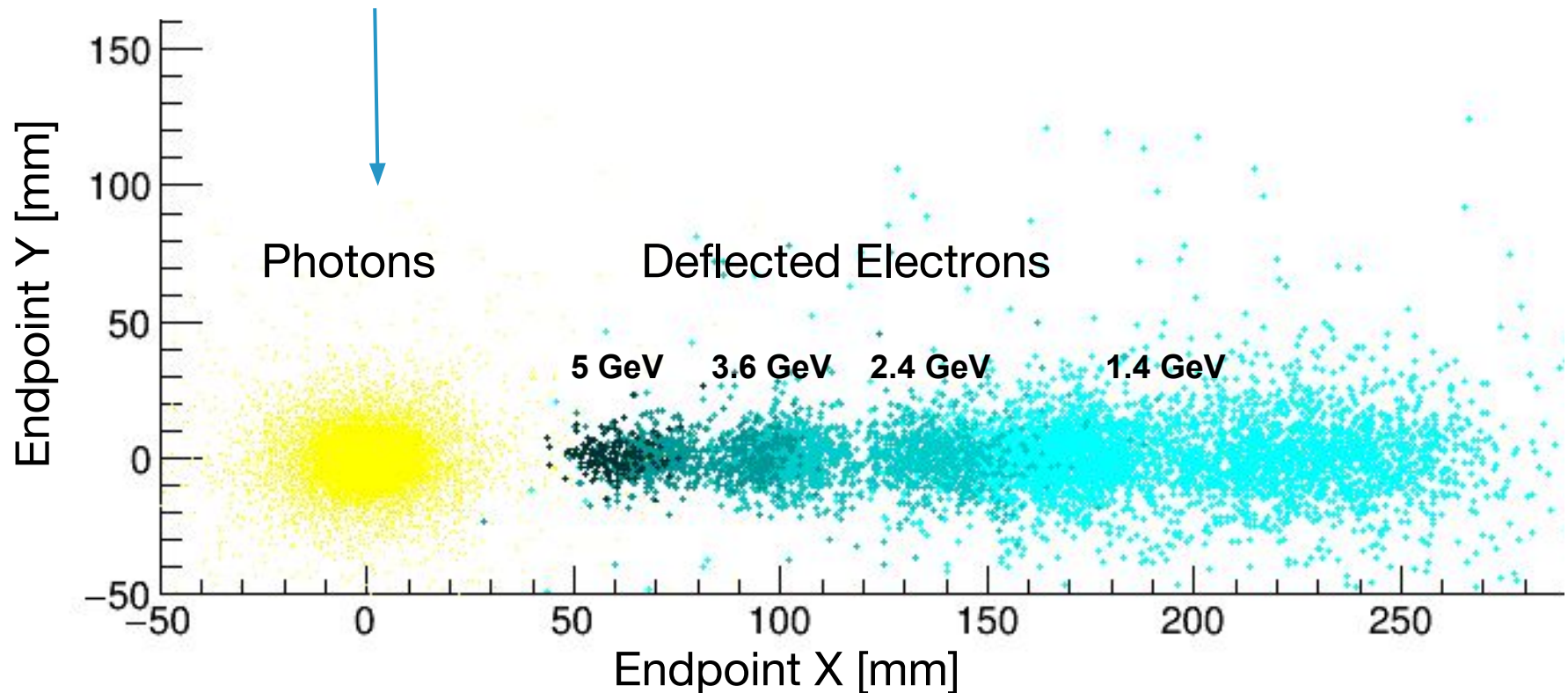
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 - Bremsstrahlung photon distribution contained within lead glass area



Simulation

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- Useful info for test beam plan:
 - Electrons won't be measured in photon detector area (deflected 5cm)
 - Deflection positions found for each trigger position
 - Bremsstrahlung photon distribution contained within lead glass area
 - Synchrotron photons found in lead-glass area



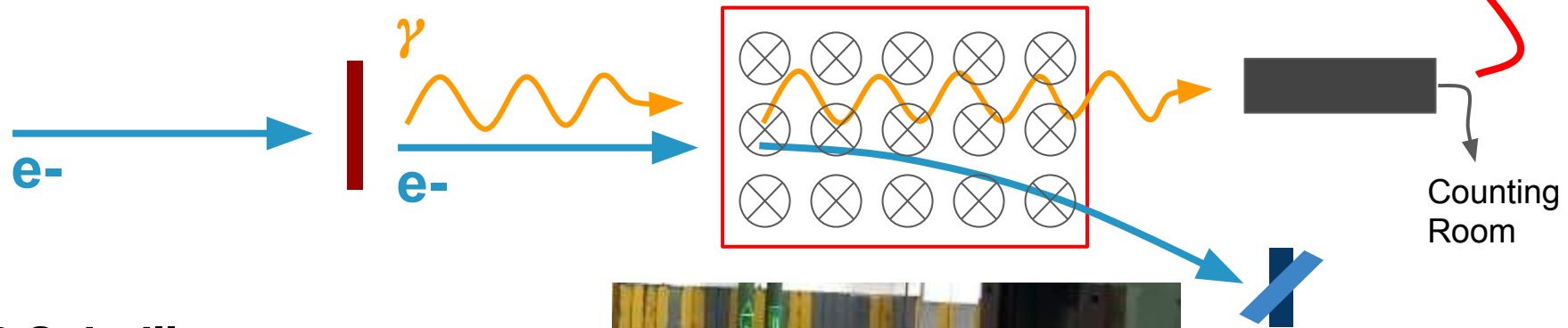
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Detector Setup

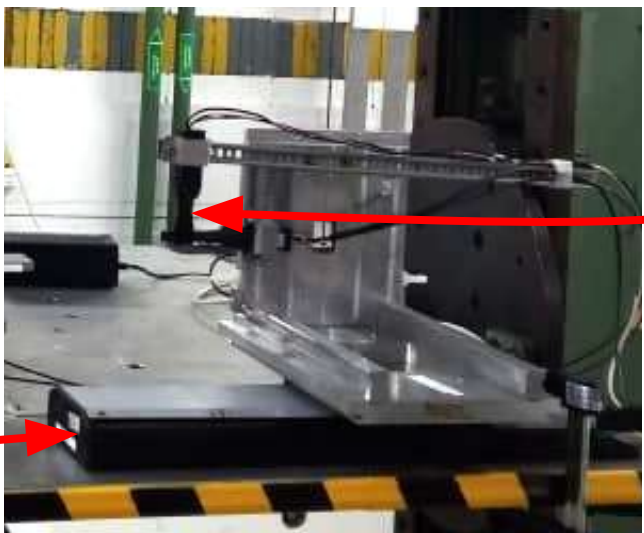
Lead-Glass Detector

- Used for energy measurements
- Pulse shape proportional to incident energy



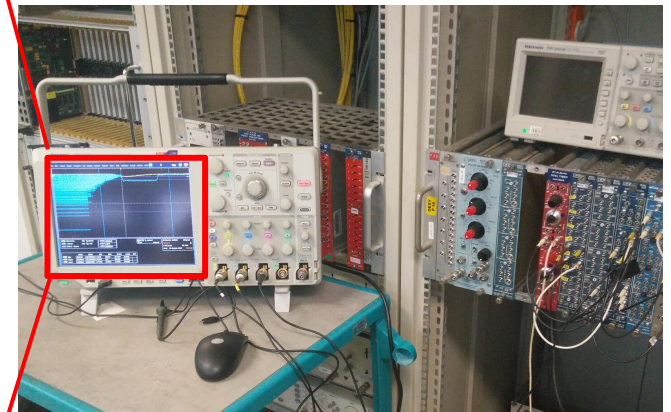
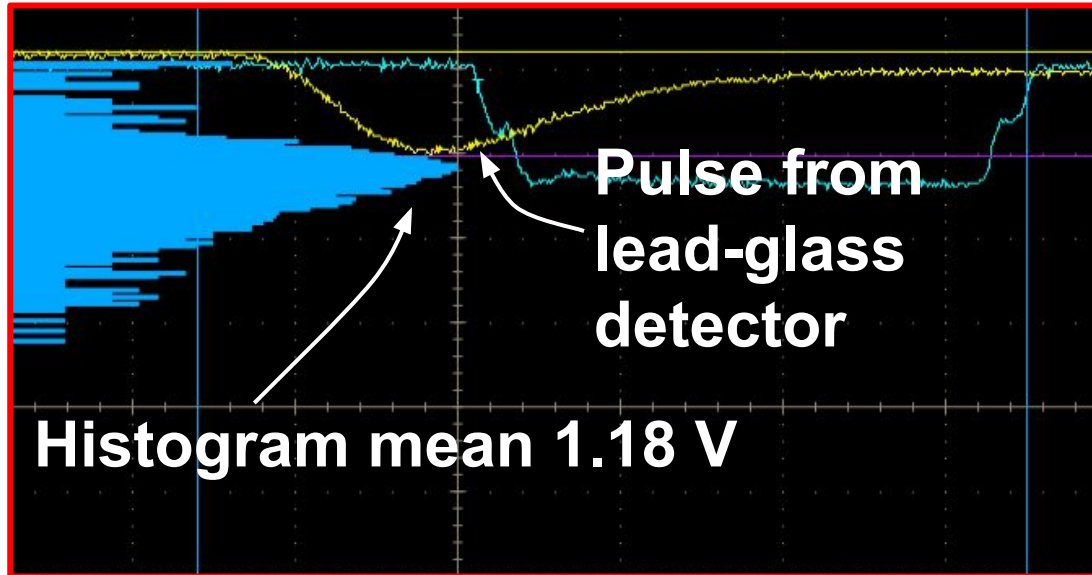
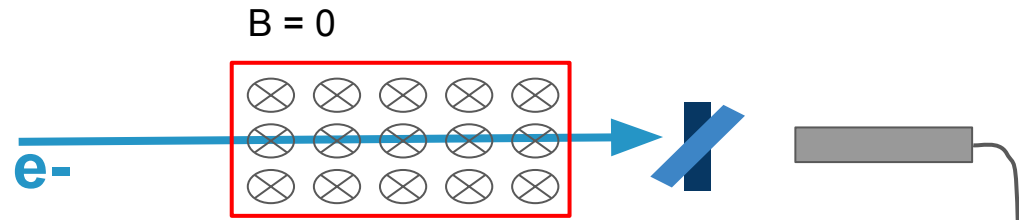
2 Scintillators

- 1cm x 2cm arranged in cross
- Trigger for lead-glass
- Moveable remotely via horizontal stage

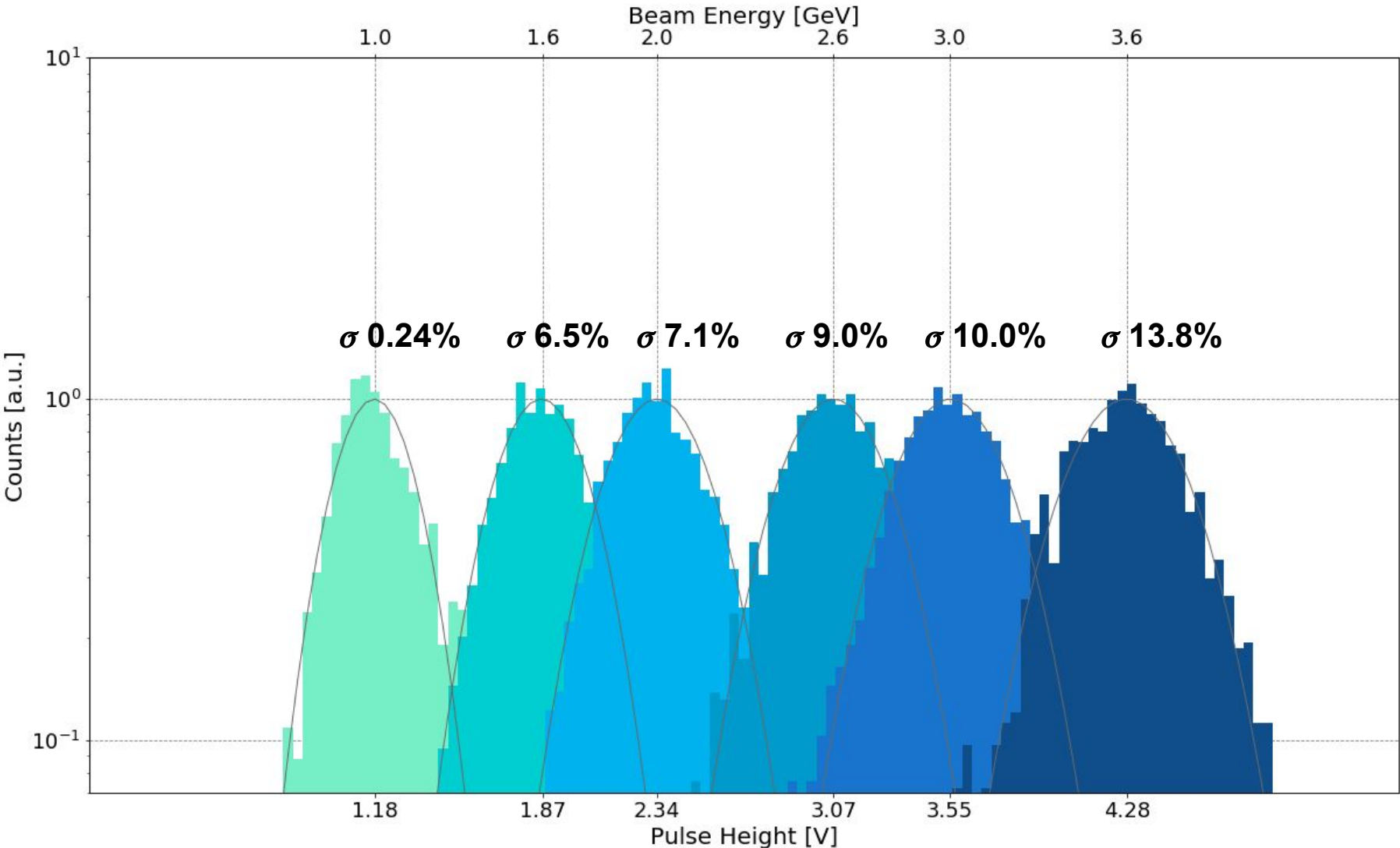


Calibrate energy to pulse height

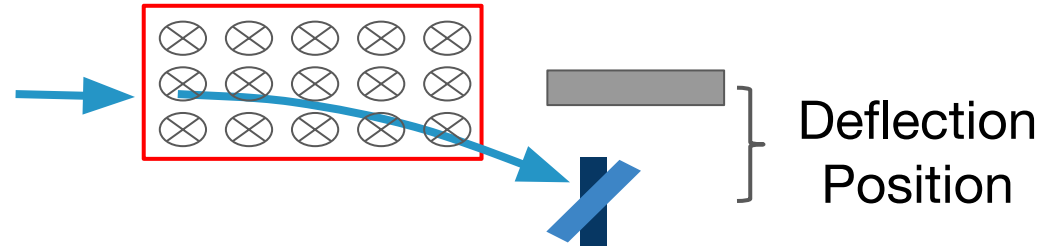
- Magnet off
- Vary electron momentum
- Measure lead-glass pulse height on scope
- Record histogram ~30k events



Detector calibration with electrons



Deflection Position

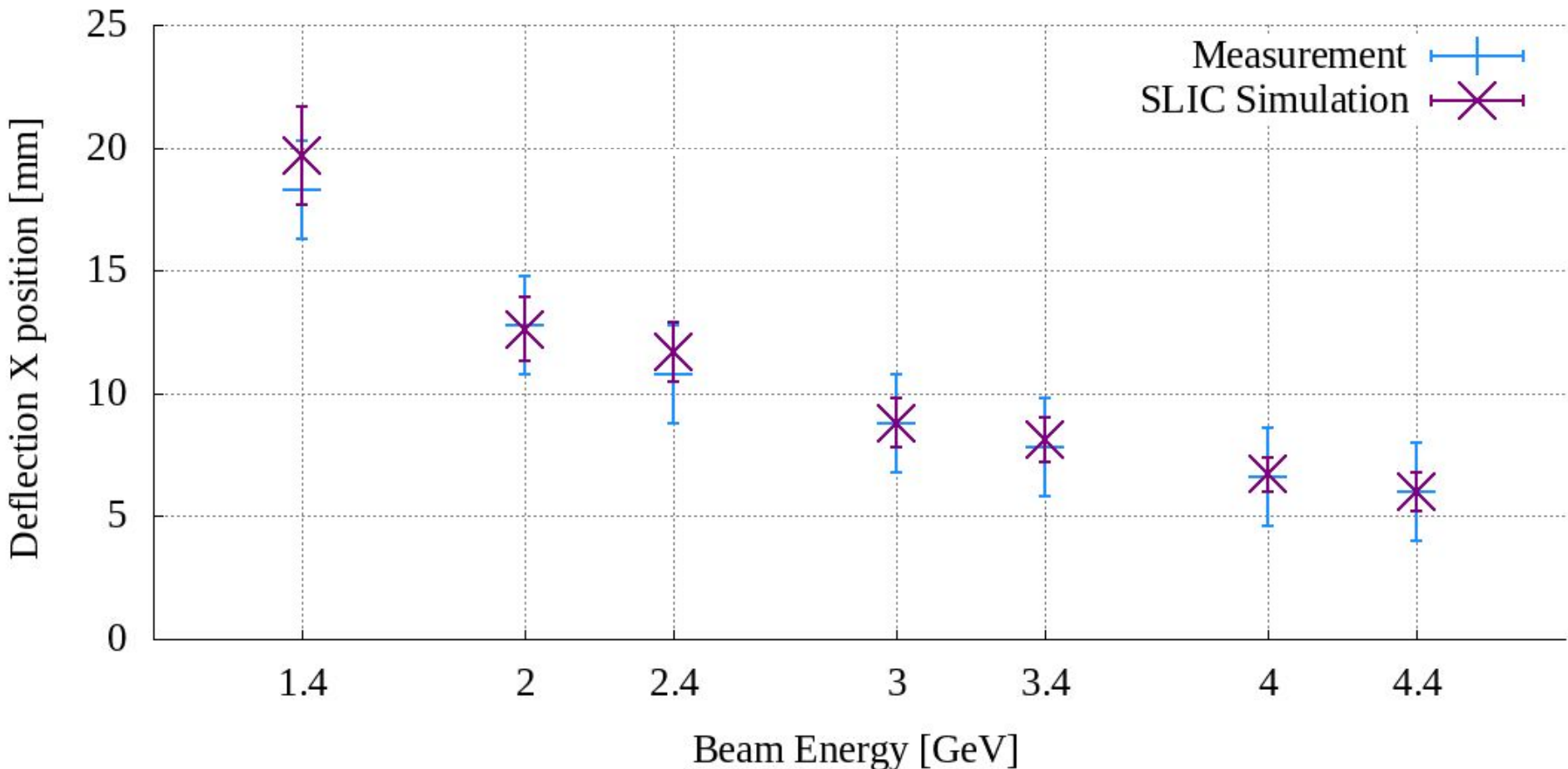
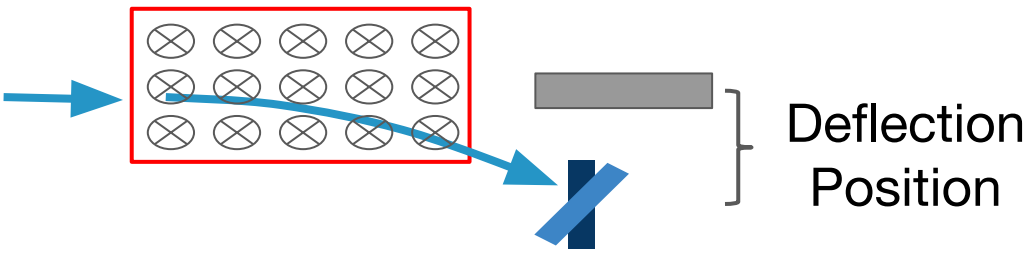


- Vary electron momentum
- Magnetic field applied
- Measure deflection position:
 - Simulation guides first measurement position
 - Count rate measured in mm increments around first position
 - Highest count rate: deflection position

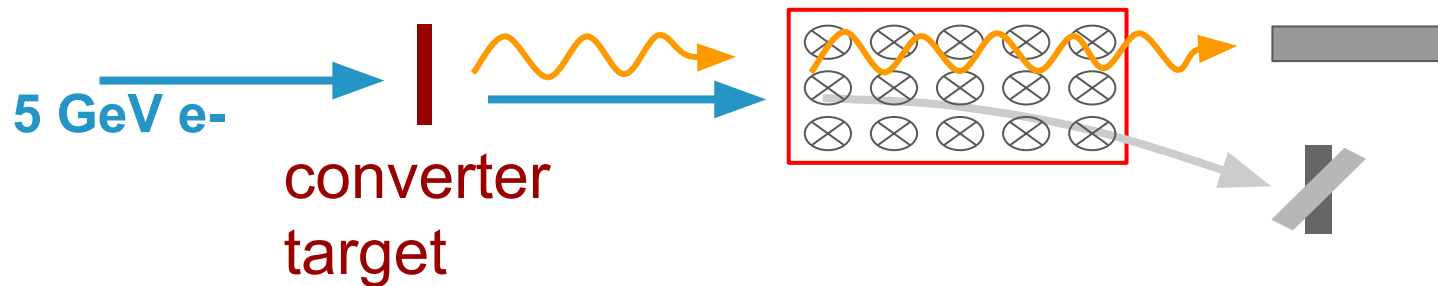


Moveable Stage

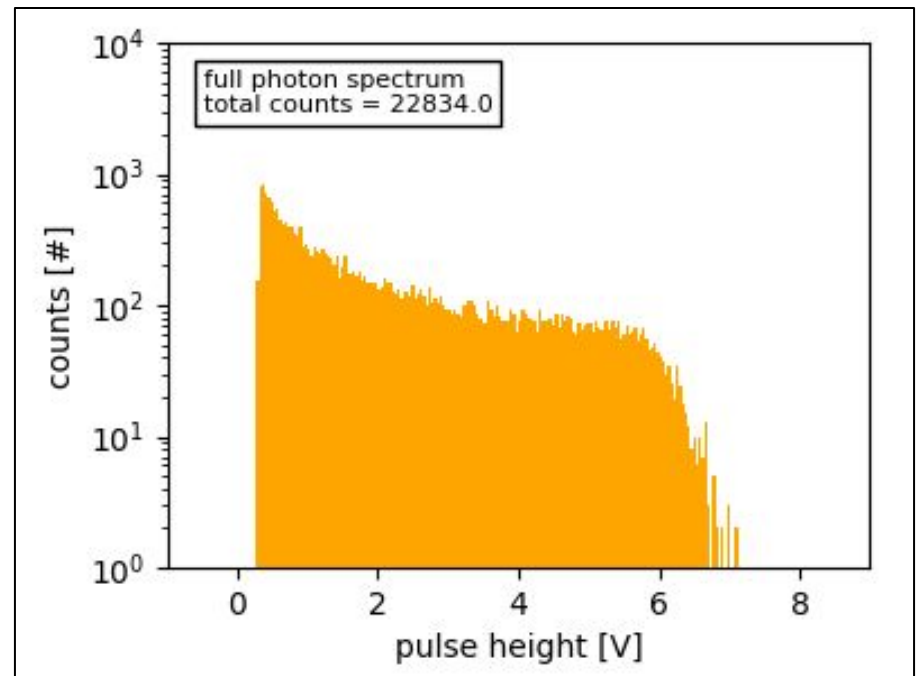
Deflection Position



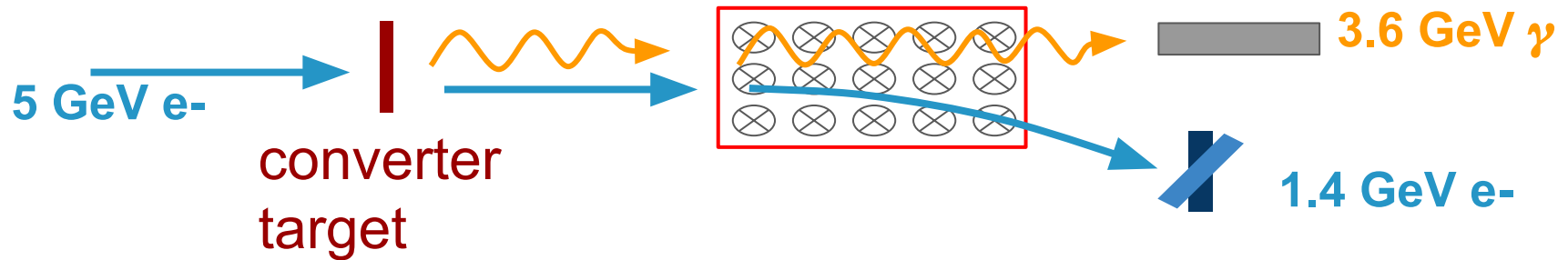
Photon Energy Measurements



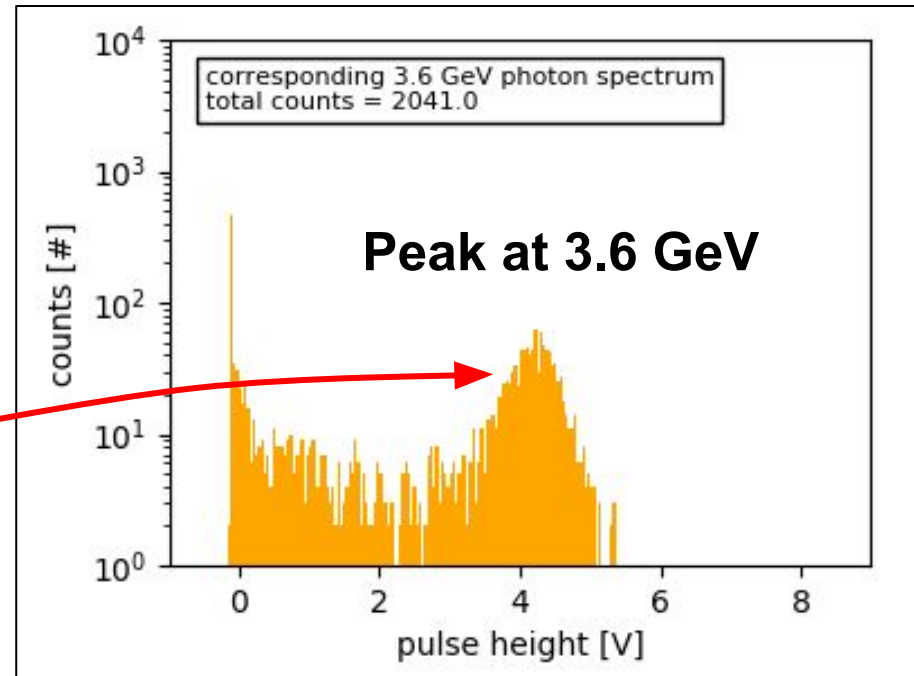
- 5 GeV electron momentum
- Trigger on photons arriving at lead glass: Bremsstrahlung spectrum



Photon Energy Measurements



- 5 GeV electron momentum
- Trigger on electron momentum (via scintillator position)
- Measure corresponding photon energy



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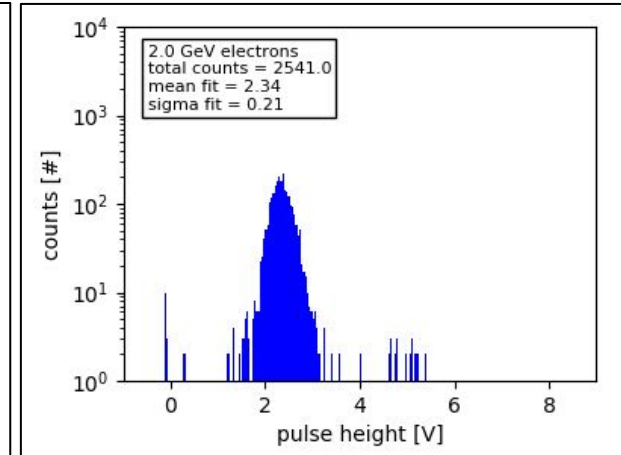
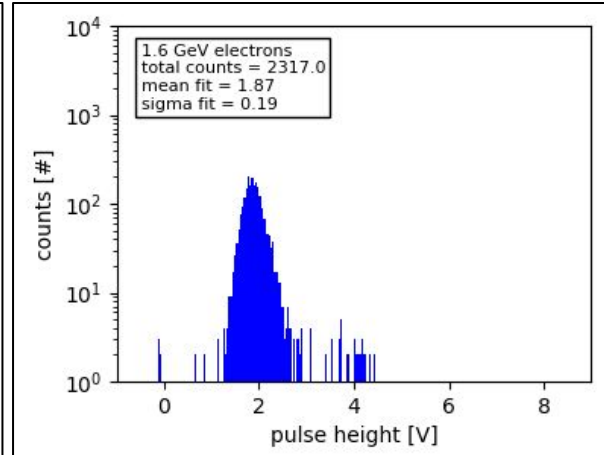
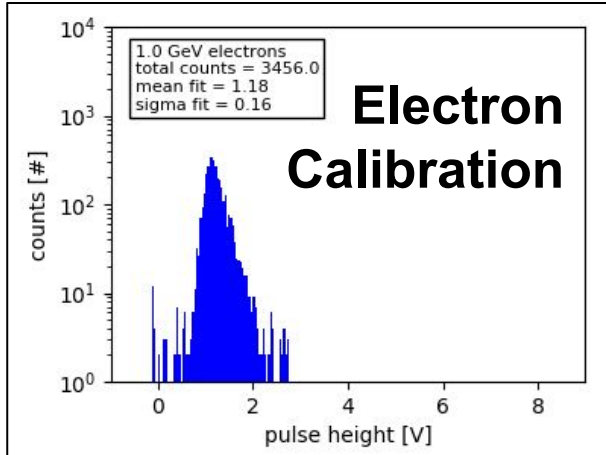
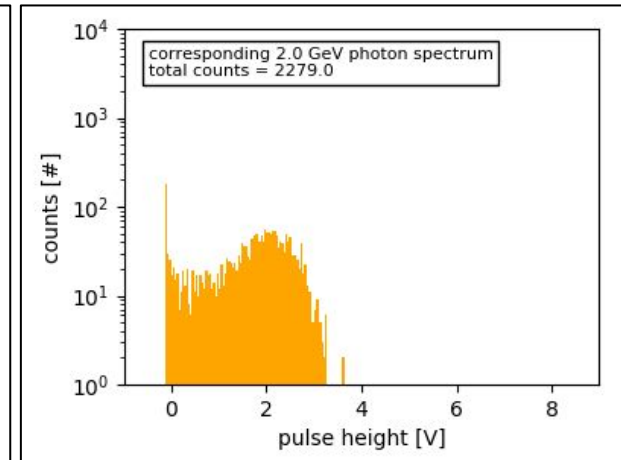
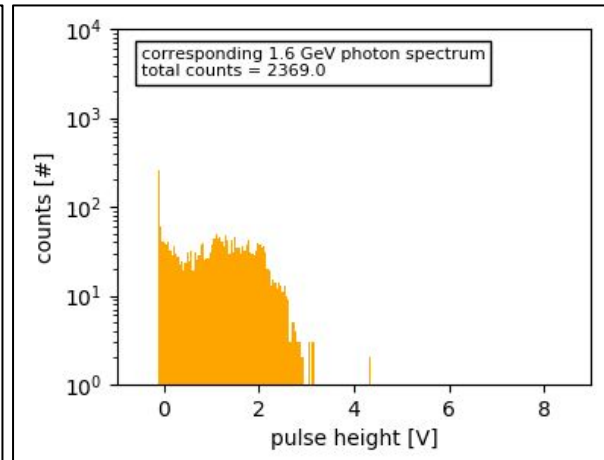
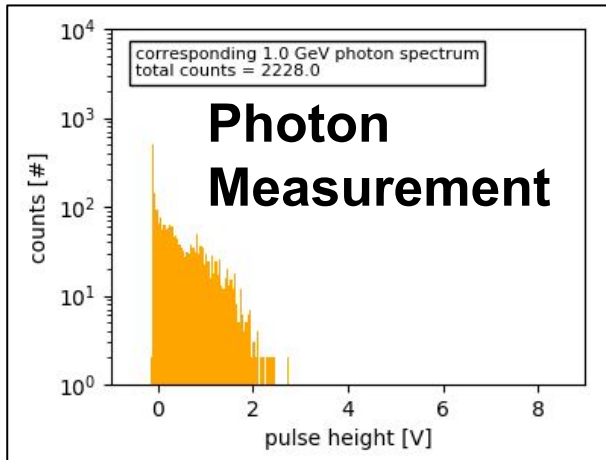
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Photon Energy Results

1.0 GeV

1.6 GeV

2.0 GeV

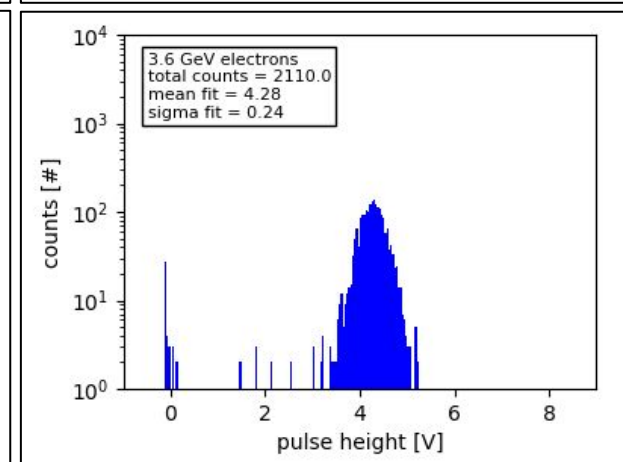
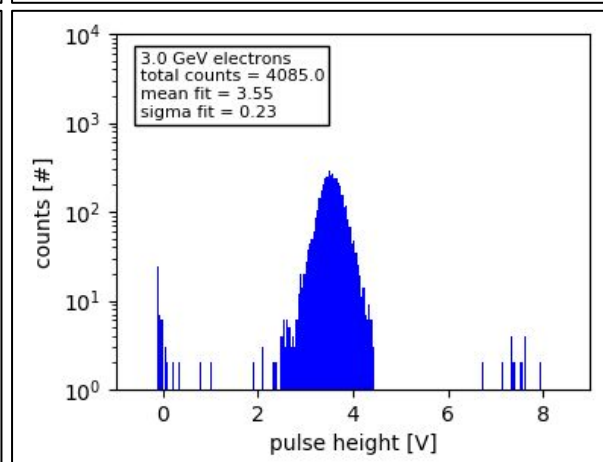
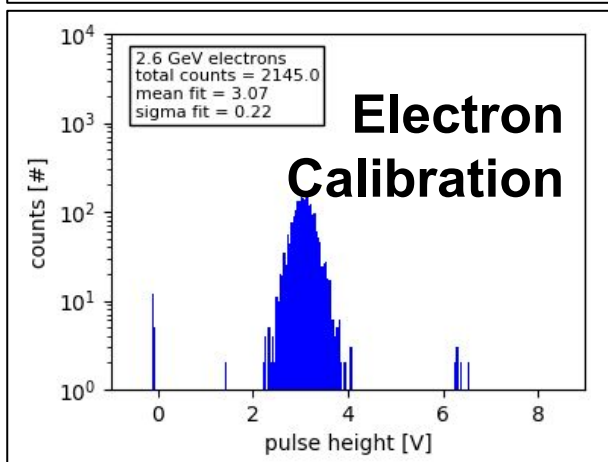
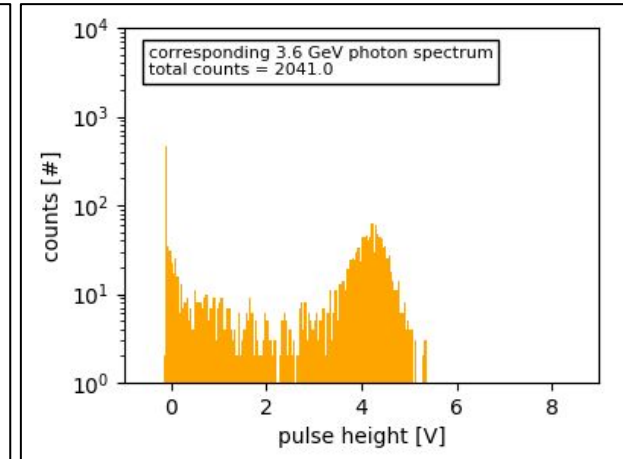
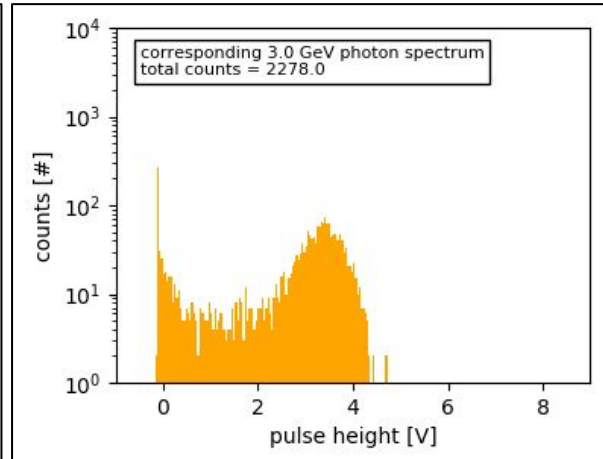
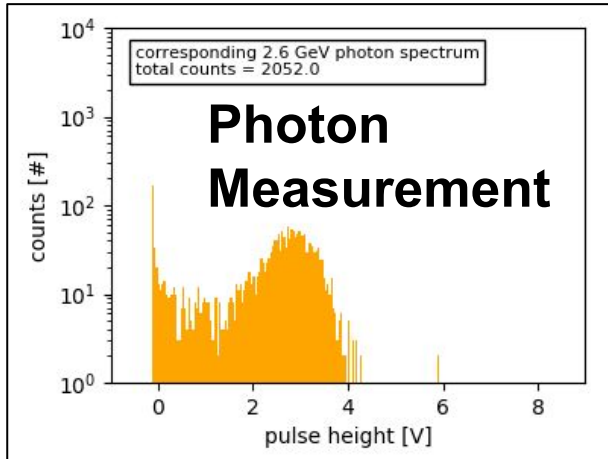


Photon Energy Results

2.6 GeV

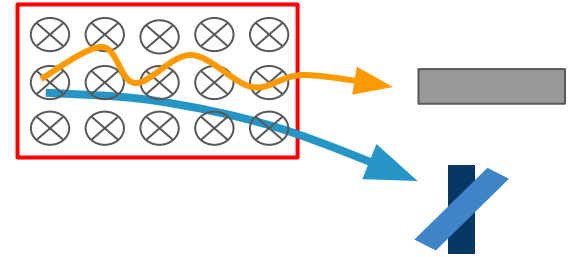
3.0 GeV

3.6 GeV

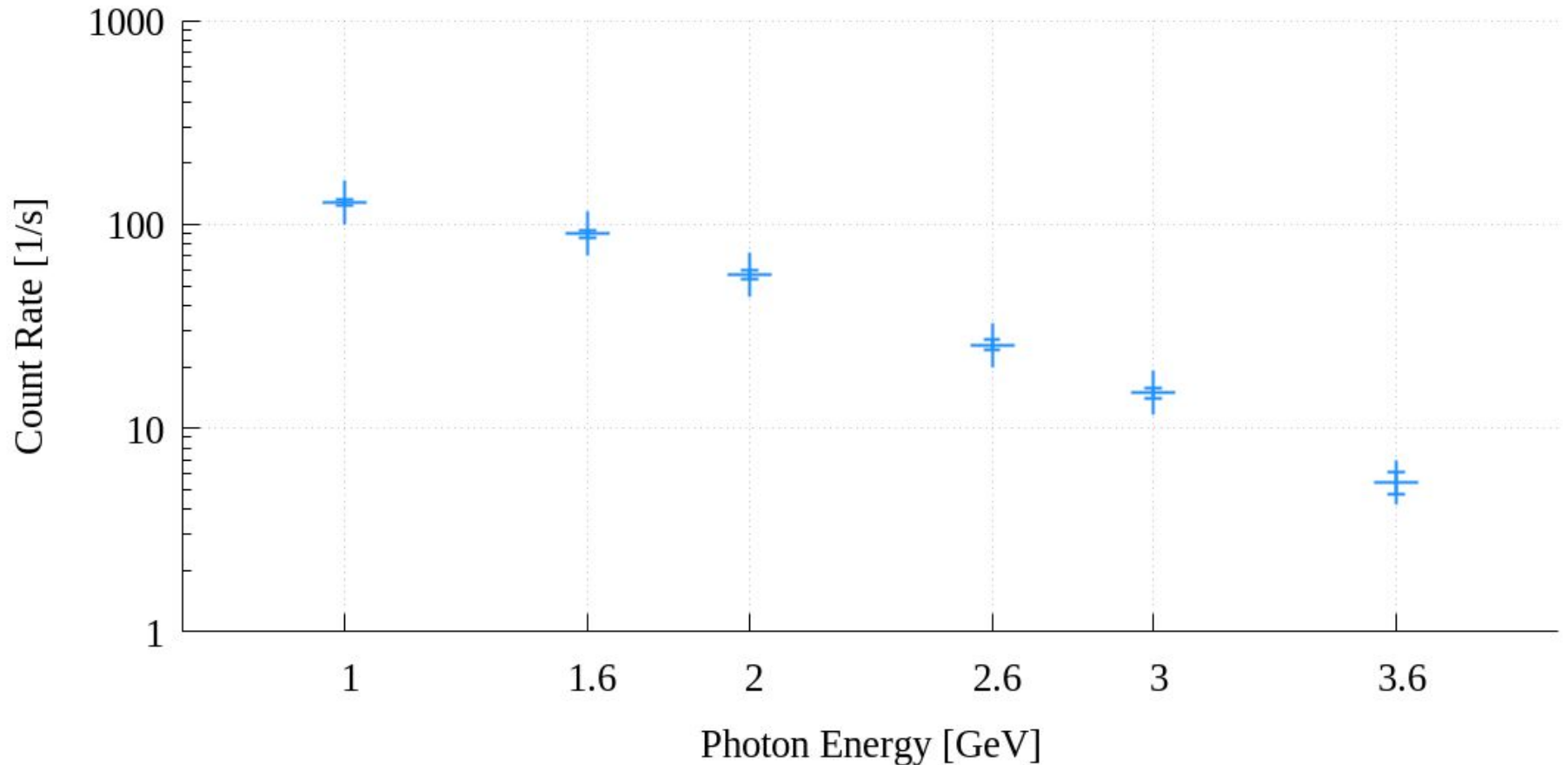


Photon Rate Results

**Count rate: coincidence signal
between scintillators + lead-glass**

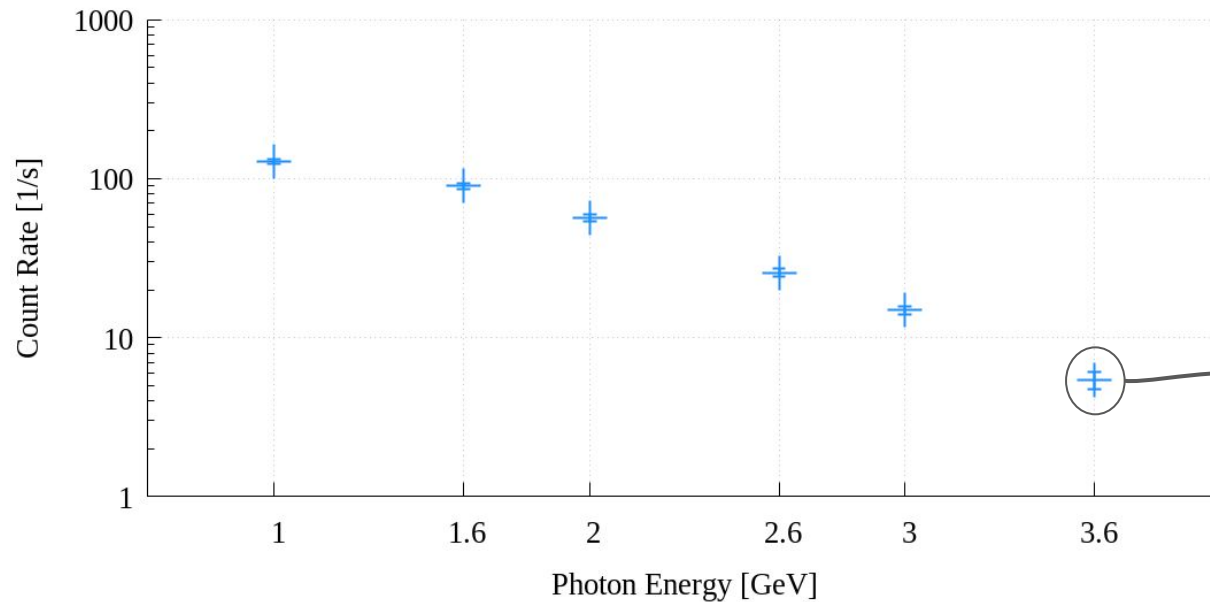


Photon production rate 3mm Copper Target



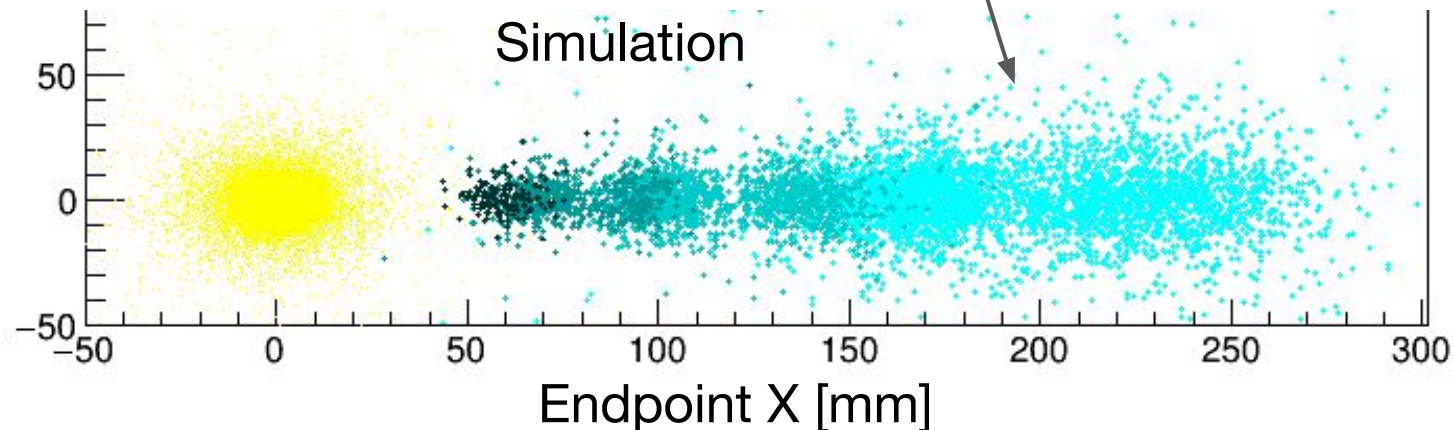
Photon Rate Results

Photon production rate 3mm Copper Target



1.4 GeV electrons

- Wide distribution: multiple scattering
- Triggering on 1x2 cm slice



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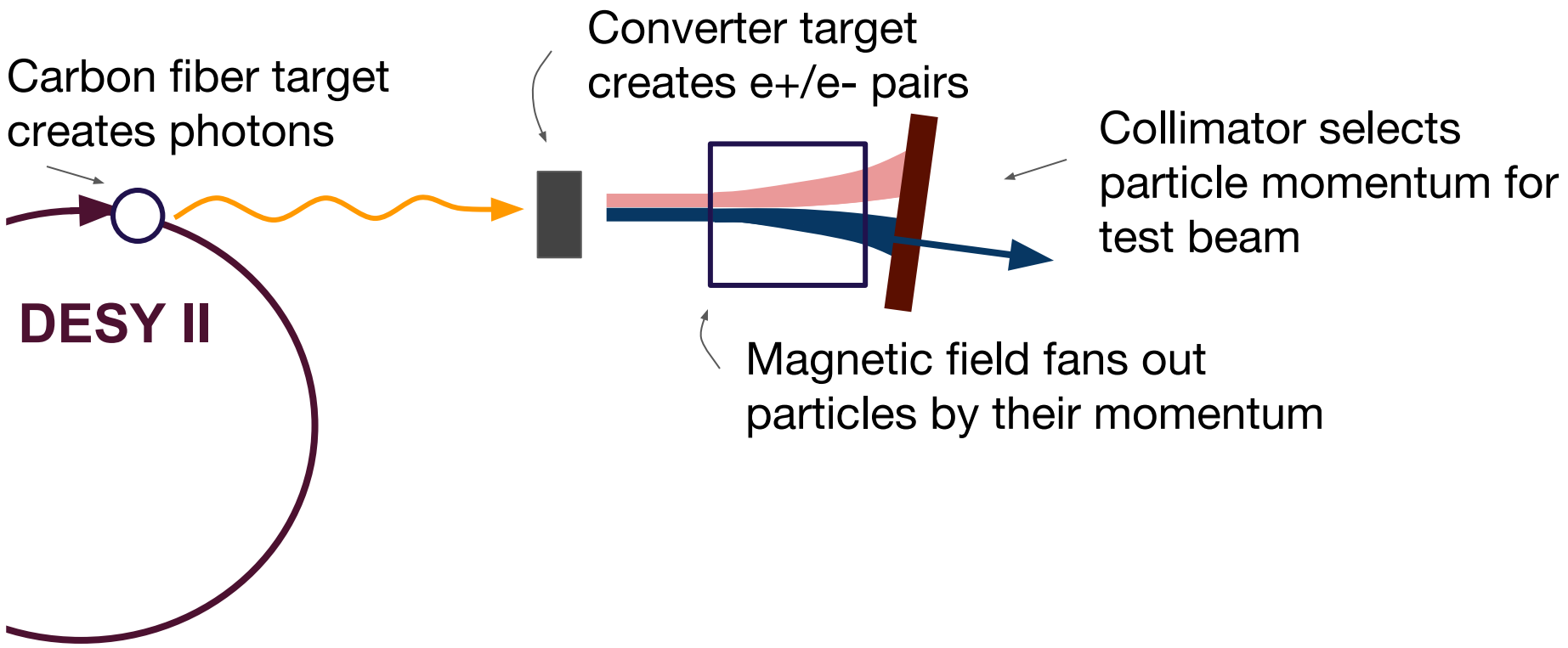
- 1st photon tagging experiment done in DESY II test beam facility
- Proof of concept for measuring photon energies with oscilloscope pulse height
- Rates of photon production for this setup order of 10 --100 Hz

To Look Into

- Background of low energy particles
- Triggering on low energy electrons affected by multiple scattering

Bonus Slides

DESY II Test Beam



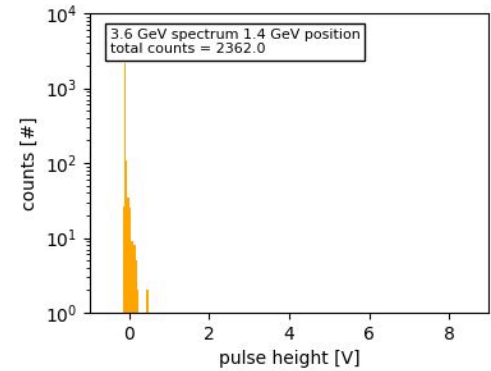
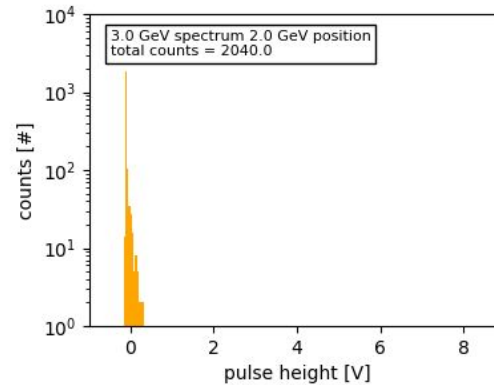
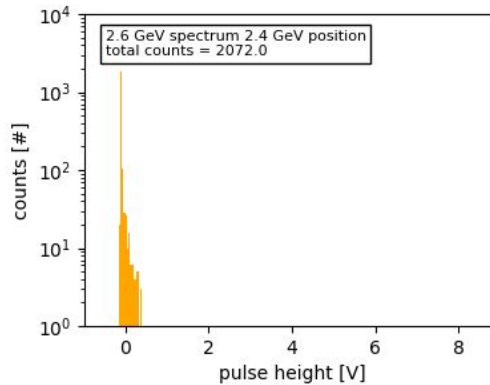
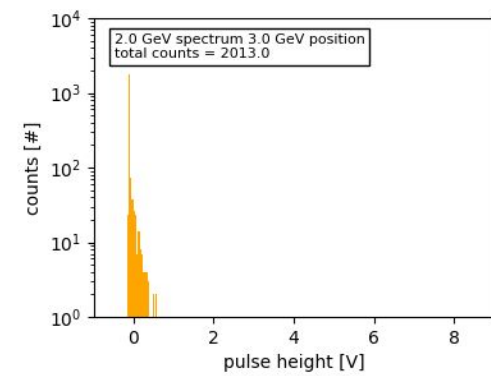
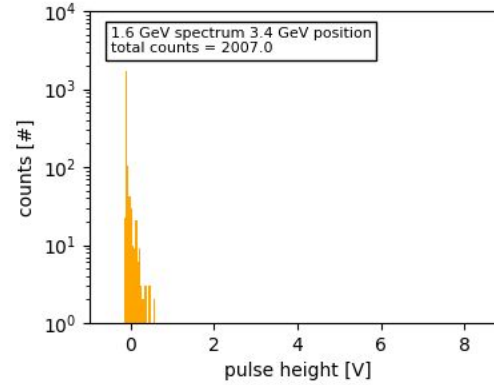
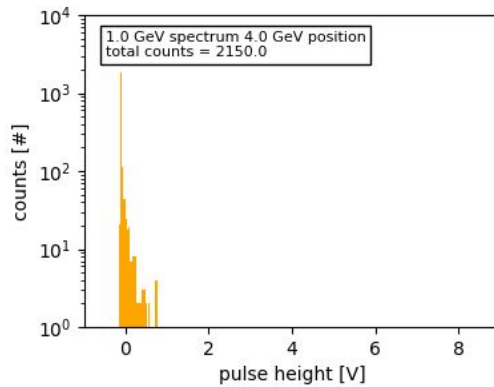
DESY II Circumference: ~292 m

Synchrotron photons

No converter

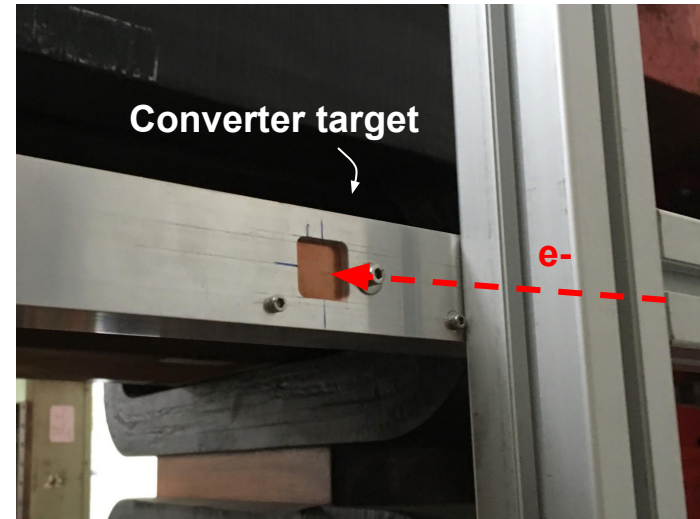
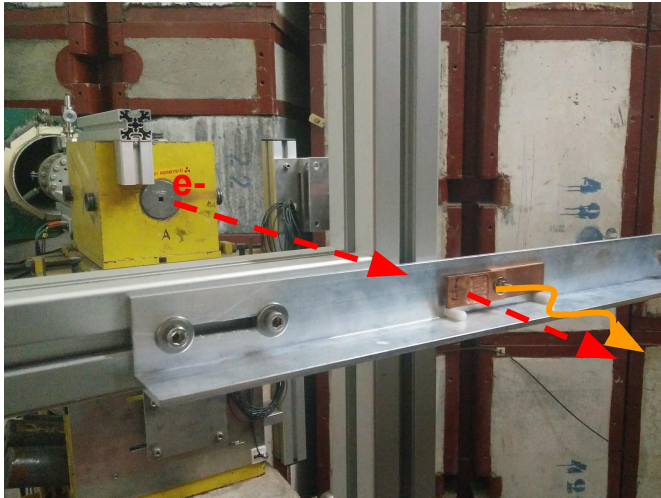
Magnet on

Vary electron energy



Converter Target

3mm copper target between collimator and magnetic field



Electron calibration pulse integral

