Homogeneous Calorimeter ($PbWO_4$) as e^- detector

Possible technologies for far-backward detectors

- Data are present at every bunch crossing (rates in $\mathcal{O}(100)$ MHz), demand on rad hardness
- Relatively small channel count because of small size ($\mathcal{O}(10)$ cm) for individual components

Trackers

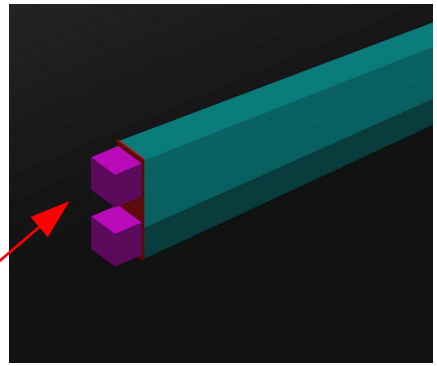
- Multiple particles from the same bunch crossing
- Small pixel pitch for track separation
- MAPS or AC-LGAD for sensors
- Suitable ASIC for timing capability (Timepix4)

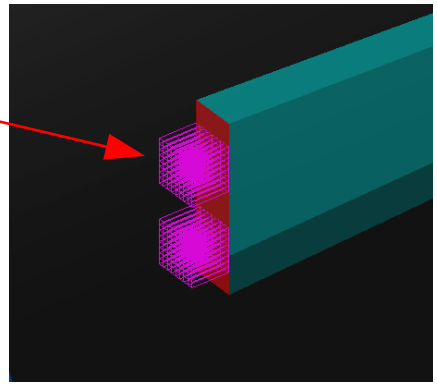
Calorimeters

- Performance stability over the run
- Most of the e^+ and e^- are incident at the edge of the module
- Homogeneous bars of $PbWO_4$
- Sampling W/ScFi, quartz fibers or W-Si
- Readout by fast PMTs or SiPM

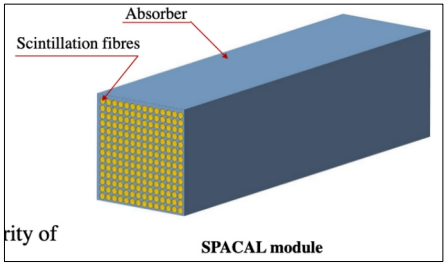
- Good timing and short integration time is needed to identify each bunch crossing
- Large data rates and volumes in DAQ, also should provide online machine performance

Jaroslav Adam (CTU Prague) Far-Backward WG July 26, 2022 13 / 17



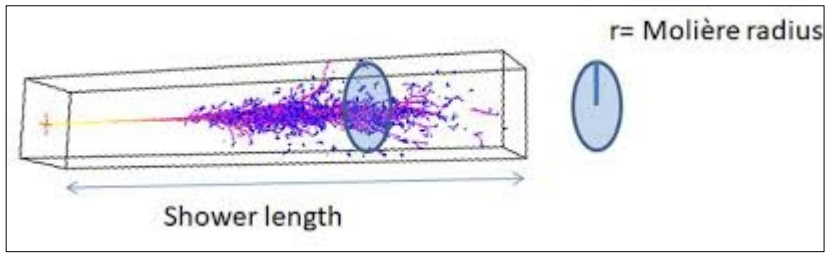


- 8 x 8 Matrix
- Each 17 x 2.5 x 2.5 (cm^3)

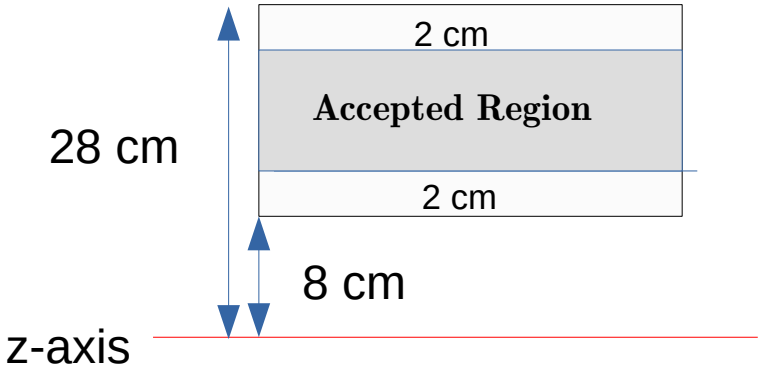


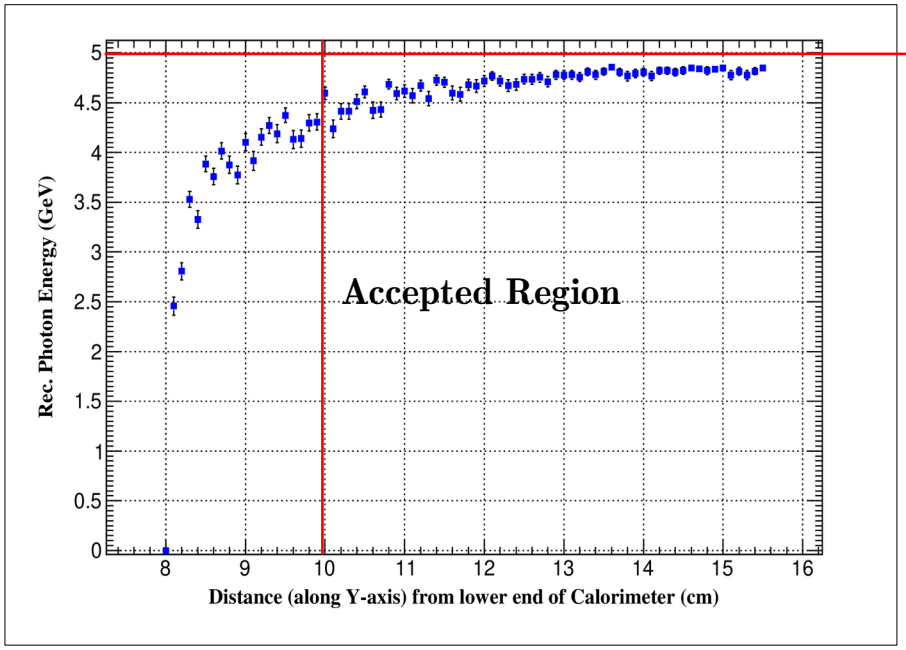
Aranya Giri & Dhevan Gangadharan

Cuts for measuring the energy in Calorimeter



Molière radius is the radius of a cylinder containing on average 90% of the EM shower's energy deposition. For $PbWO_4$ it is around 2 cm.

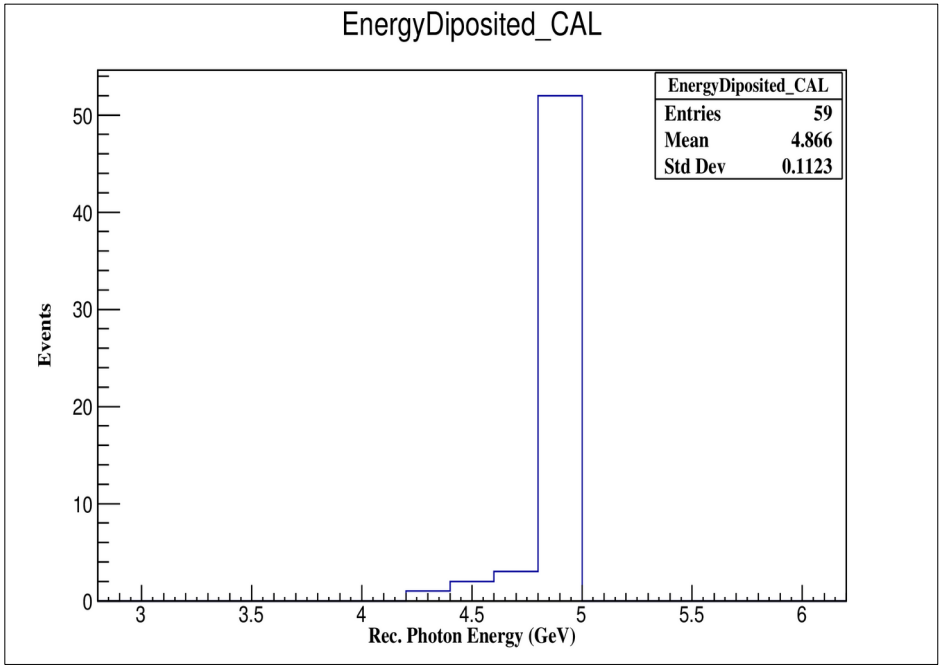




Generated γ Energy

- Same cut from the upper end of Calorimeter

Reconstructing γ Energy from Calorimeter



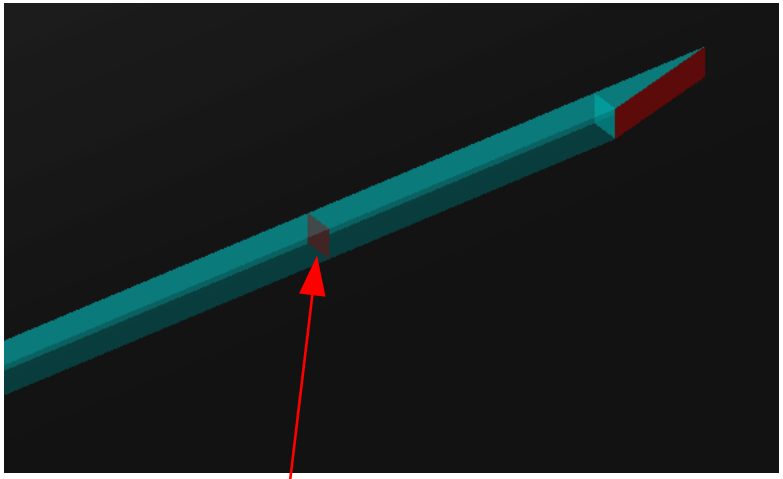
- 25000 γ generated at 5 GeV
- $E_{\gamma} = E_{e-} + E_{e+}$
- $E_{\gamma} = 4.866 \pm 0.015$ GeV

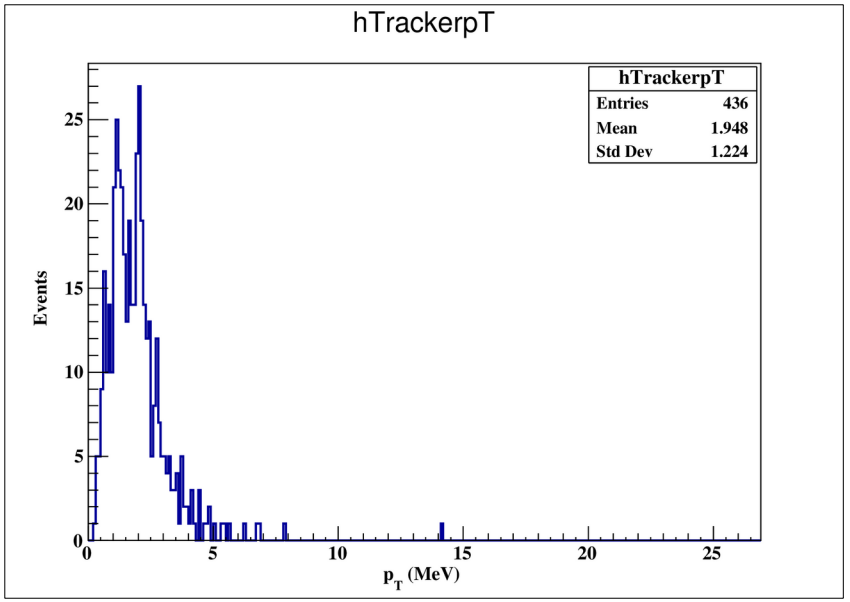
Reconstructing γ Energy from 1st Tracking Plane

$$E_{e-} = p_T \, L \, / \, y_{up}$$

$$E_{e+} = p_T \, L \, / \, y_{down}$$

Only valid when the pair produced e^- 's p_T is very low !



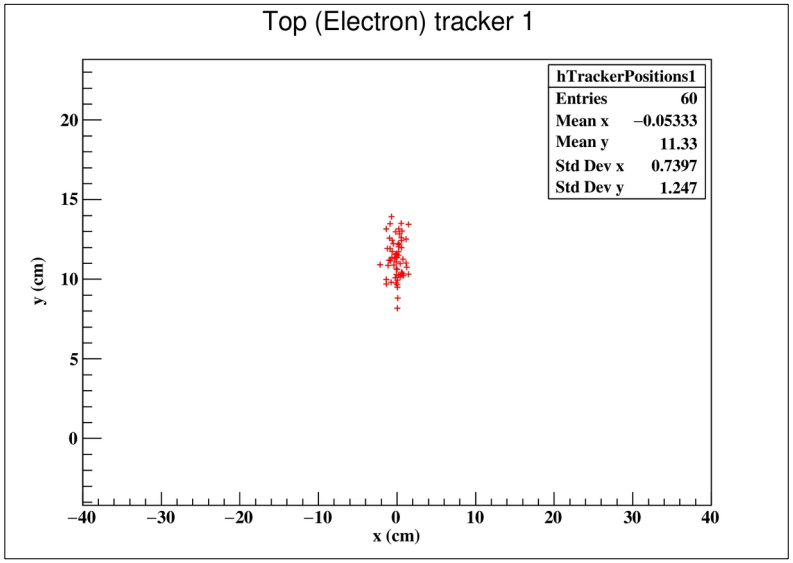


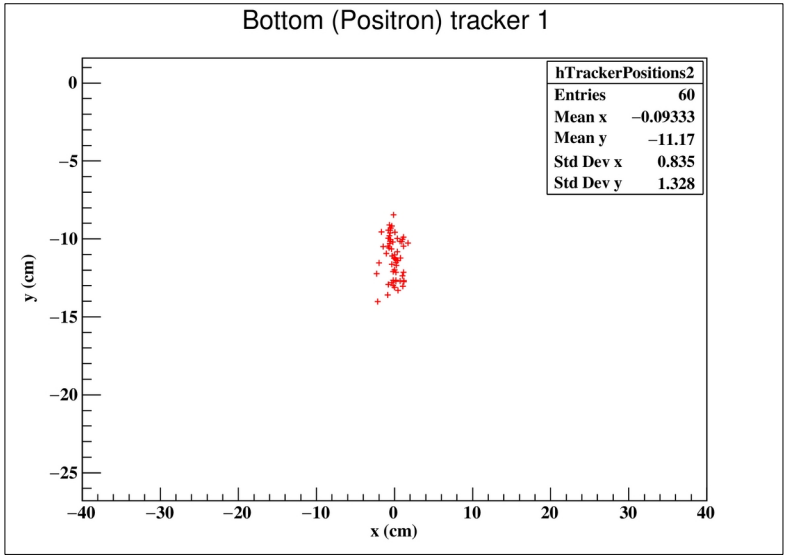
- Exit Window thickness is 0.5 mm.
- A Virtual Plane (0.1 mm) to determine p_T

- P_T of pair produced e^-/e^+ , In the order of 2 MeV

Note : p_T is before the B and pT after B

Reconstructing γ Energy from 1st Tracking Plane





$$P_T = 0.303\ B\ dL$$

- $P_T = 0.303 * 0.37 * 0.6$ GeV
- $L = 404.73$ cm
- $Y_{up} = 11.33 \pm 0.16$ cm
- $Y_{down} = 11.17 \pm 0.17$ cm

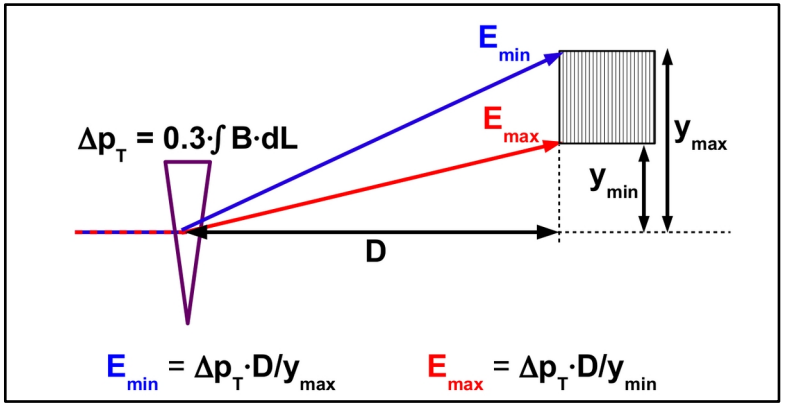
$$E_{e-} = 2.40 \pm 0.03 \text{ GeV}$$

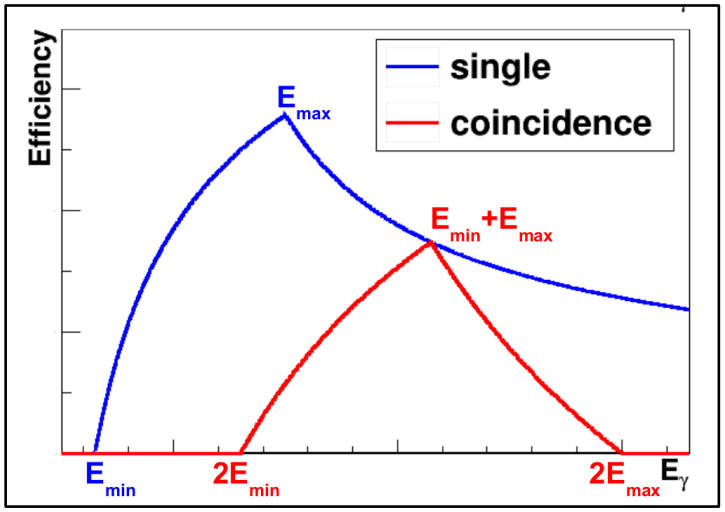
$$E_{e+} = 2.44 \pm 0.04 \text{ GeV}$$

$$E_{\gamma} = 4.84 \pm 0.07 \text{ GeV}$$

The spectrometer system for measuring ZEUS luminosity at HERA

Acceptance of the Calorimeter



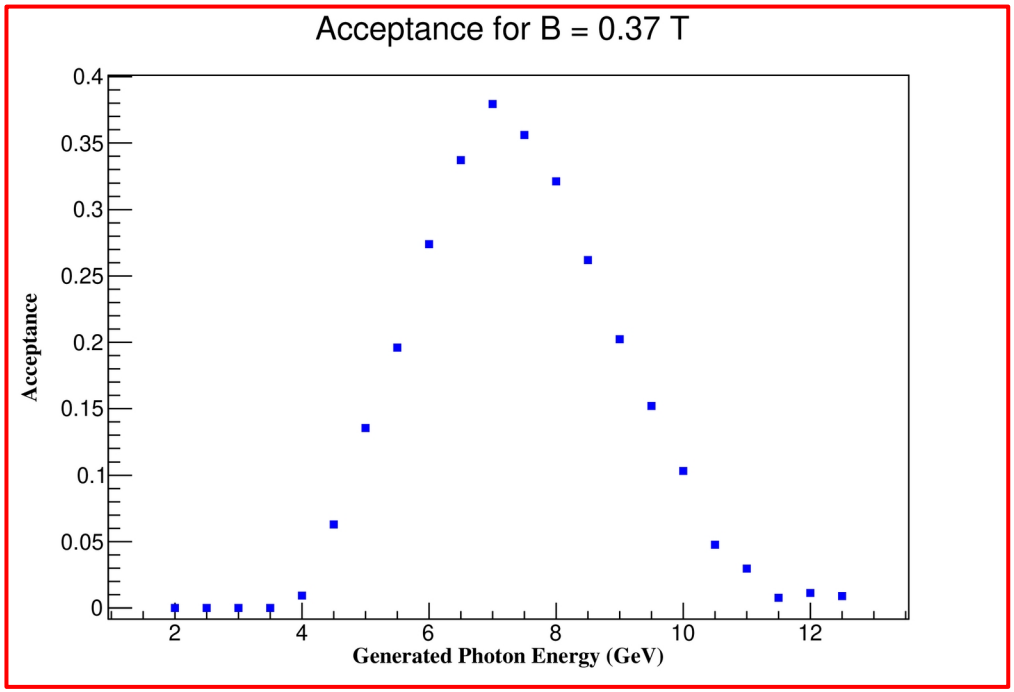


Theoretical Values at 0.37 T

(Considering cut on calorimeter)

- $E_{max} = 5.45$ GeV
- $E_{min} = 2.09$ GeV
- $2E_{max} = 10.9$ GeV
- $2E_{min} = 4.19$ GeV
- $E_{min} + E_{max} = 7.54$ GeV

Acceptance of the Calorimeter



- **Only considered pair converted photons.**
- **Same cut of 2 cm in the Calorimeter**

Next Steps

- **Currently attending the DD4Hep software tutorials.**
- **Building the luminosity detector in the new platform**