Compton Polarimetry

for

Future Linear Colliders

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Polarimetry at Future Linear Colliders

* Upstream polarimeter to measure the undisturbed beam before collisions.

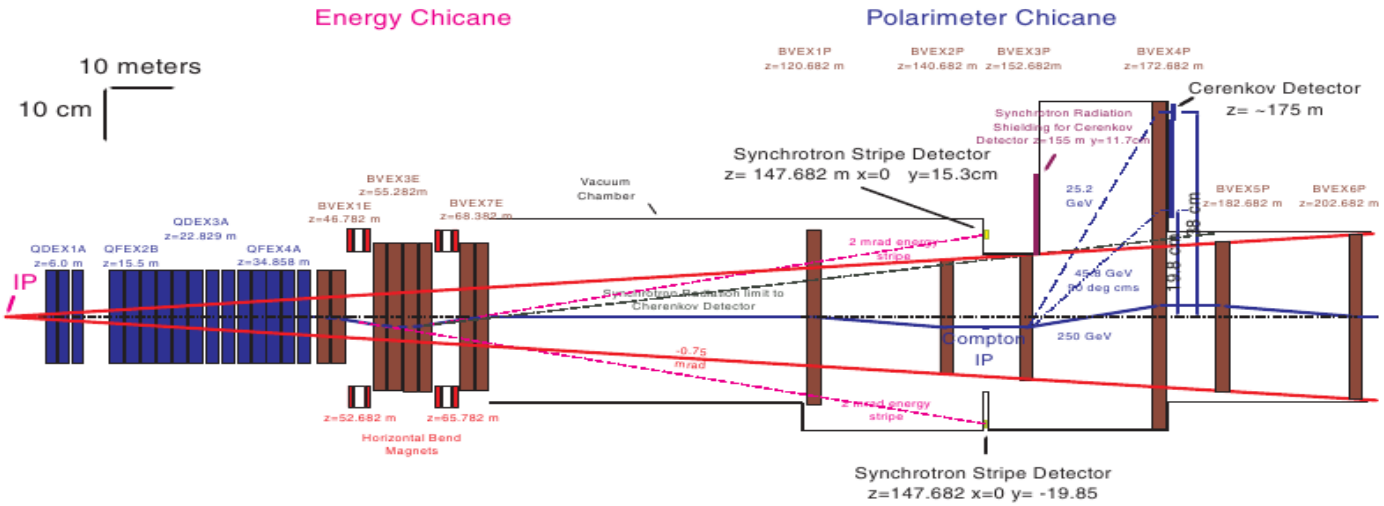
* SM asymmetries

* Compton polarimetry

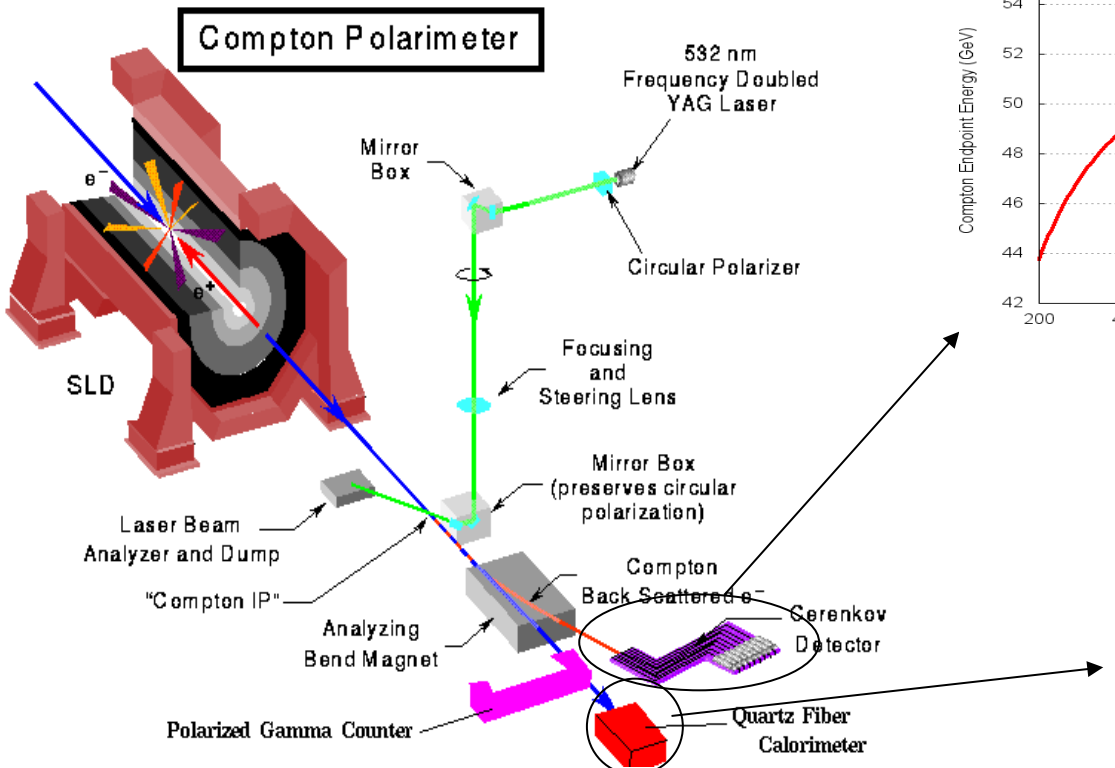
  - Necessary to obtain a sub-1% (~0.25%) polarization accuracy.

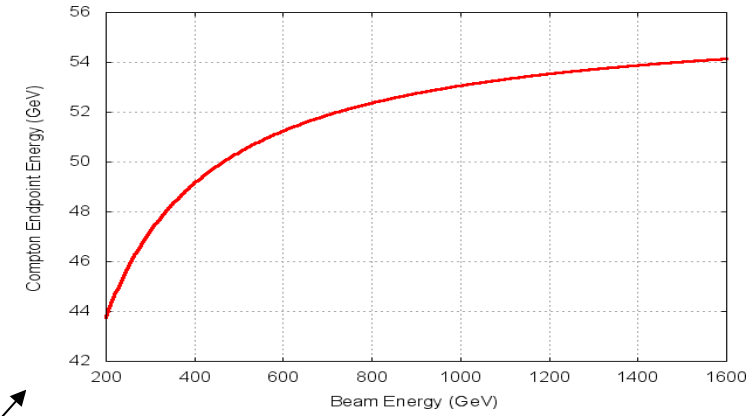
  - Accurately measure depolarization effects.

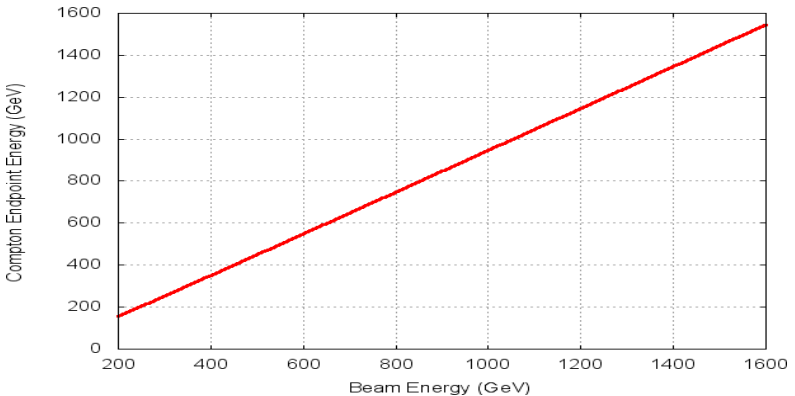
Compton Polarimetry Baseline



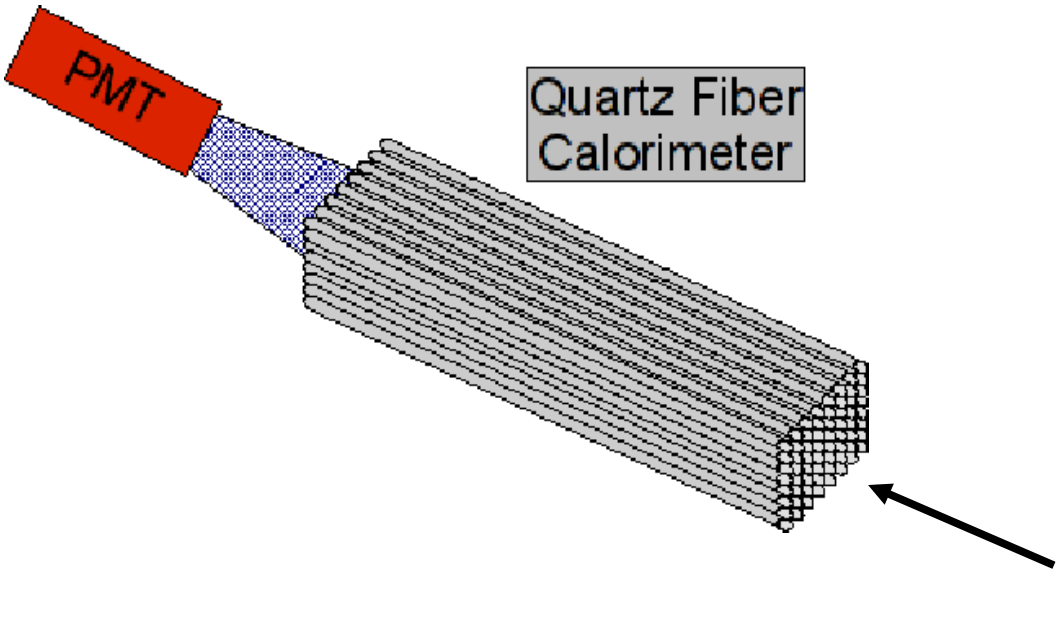
ILC RDR

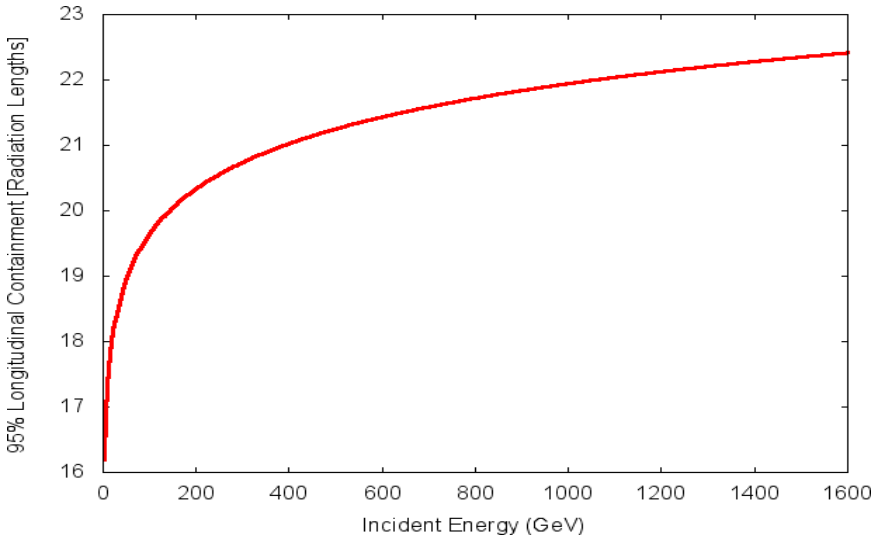






Quartz Fiber Calorimeter

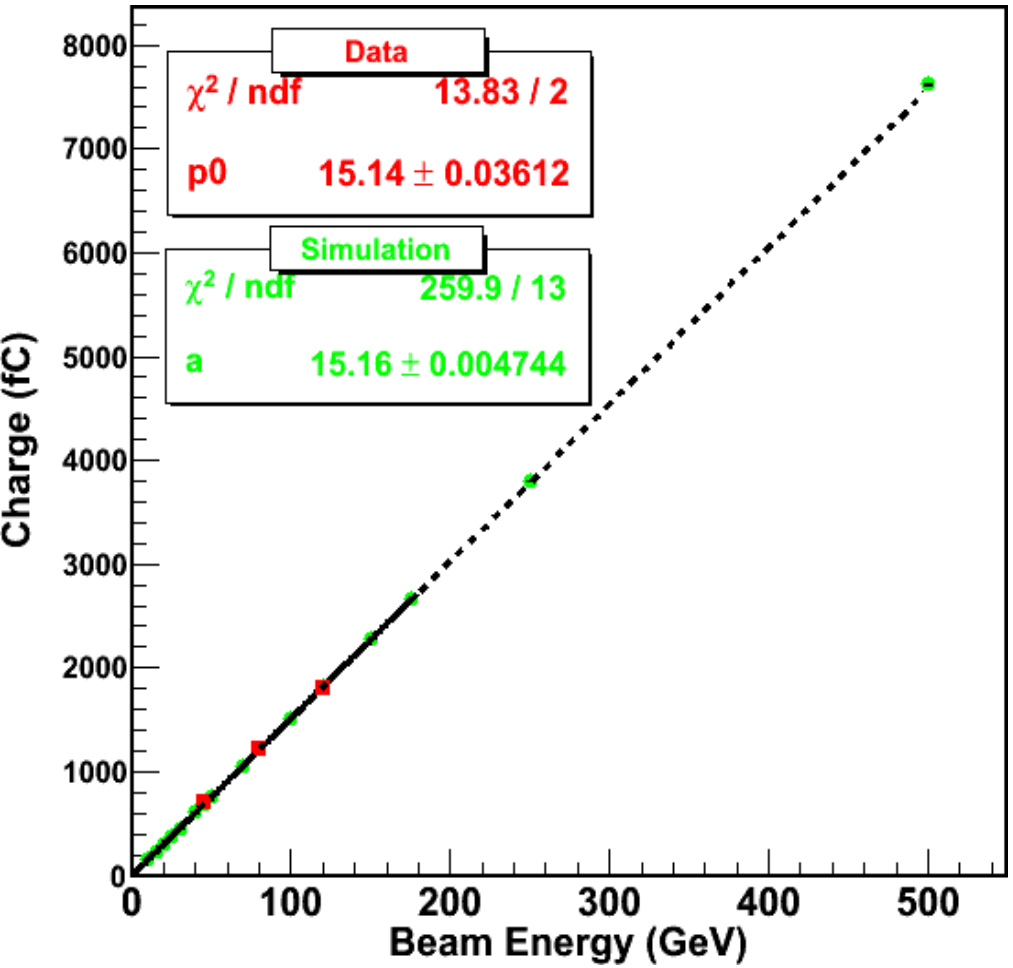


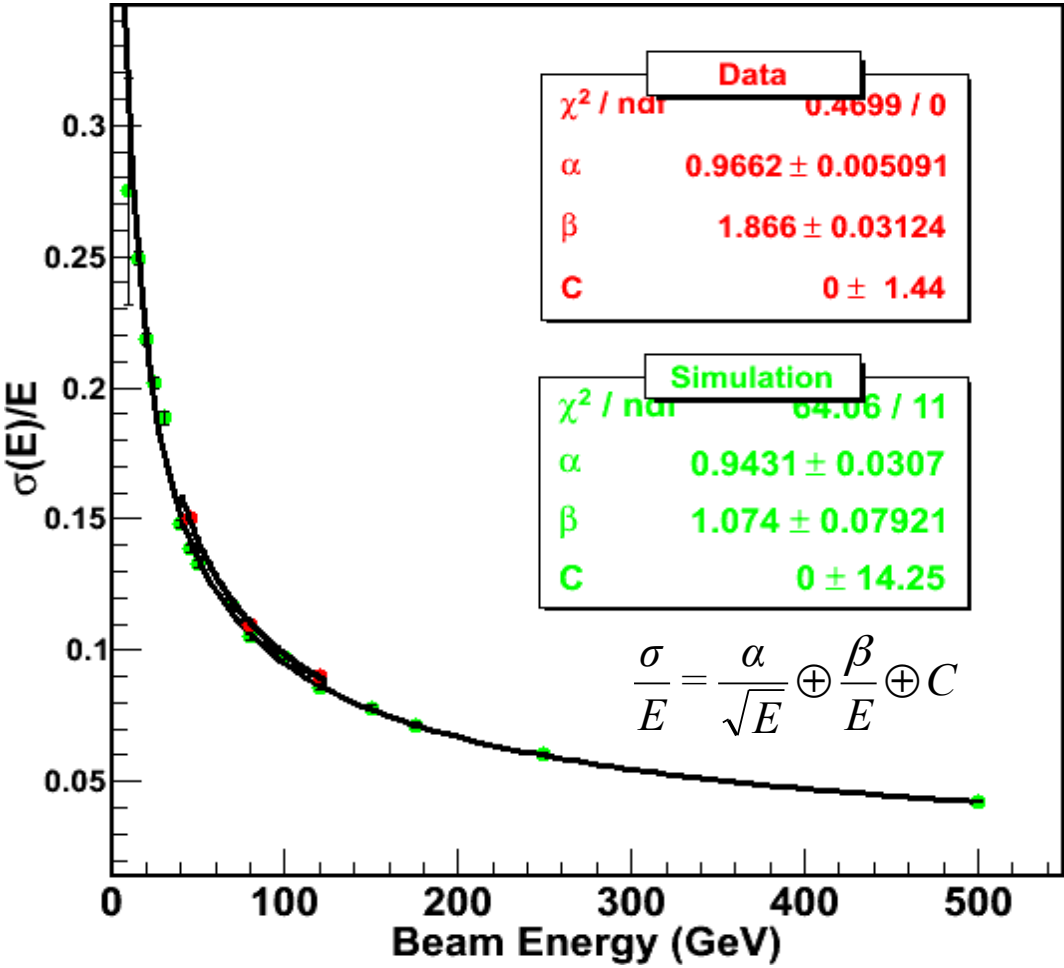


- Iron rods of 6 mm diameter, 45 cm length (~25X_0).
- Quartz fibers in between the rods (0.3 mm core diameter).
- 20 cm x 20 cm lateral size.
- Single readout of the bundled fibers.

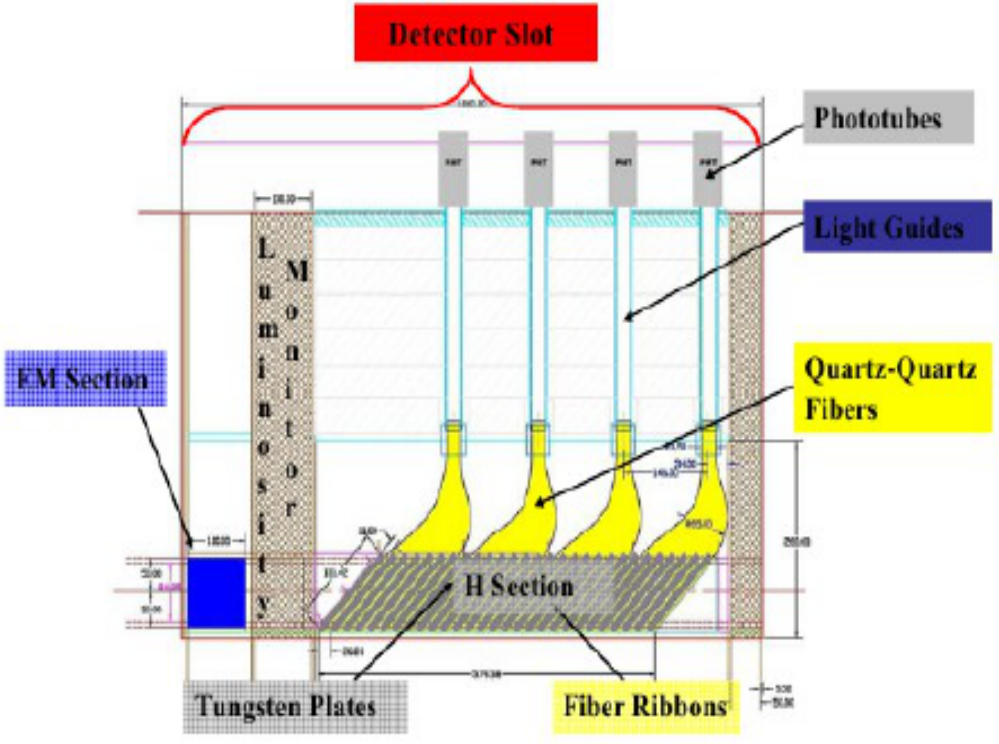
Tested with 45, 80 and 120 GeV/c electron beams.

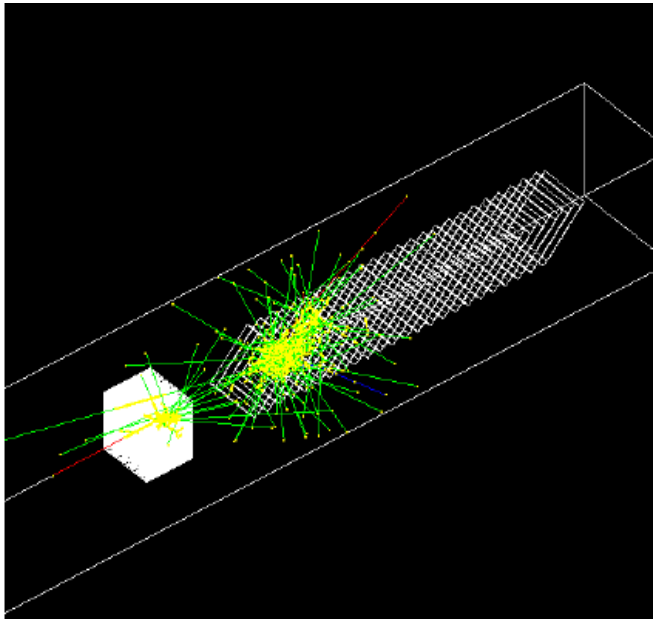
Quartz Fiber Calorimeter





Quartz Fiber Calorimeter Alternative – CMS ZDC





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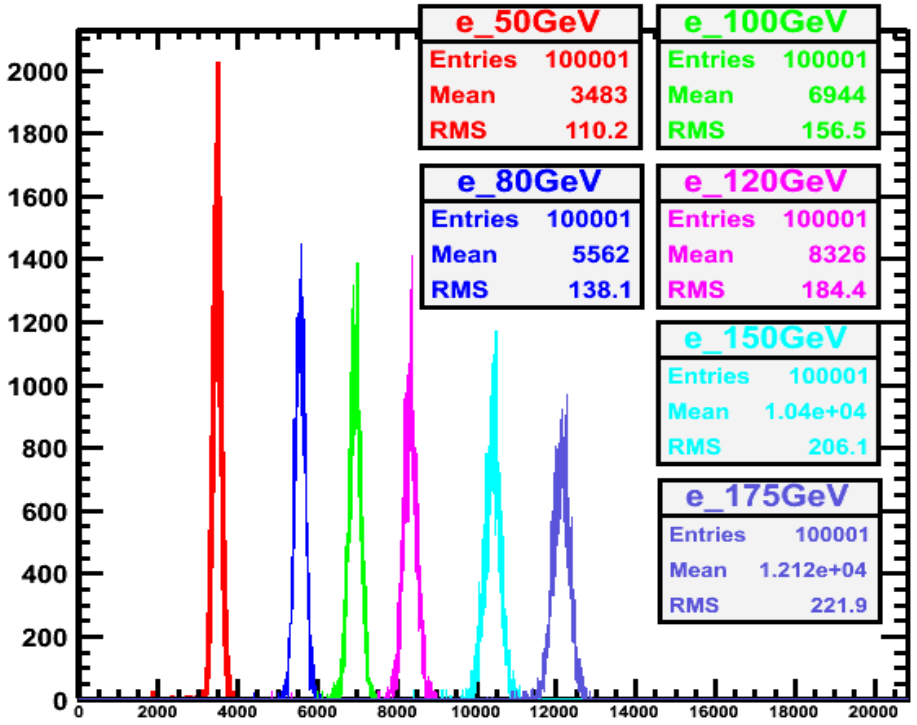
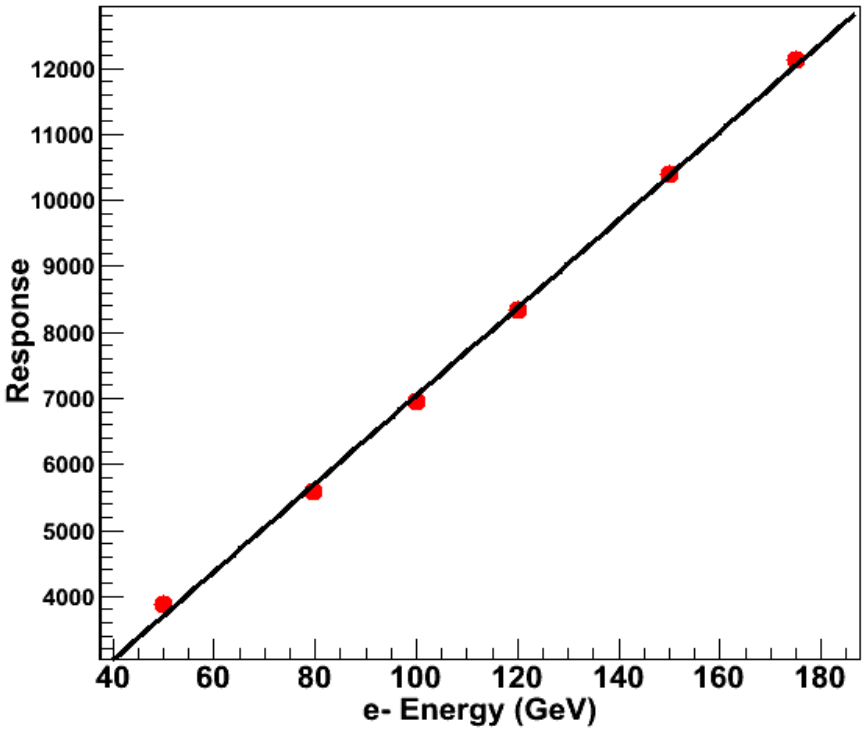
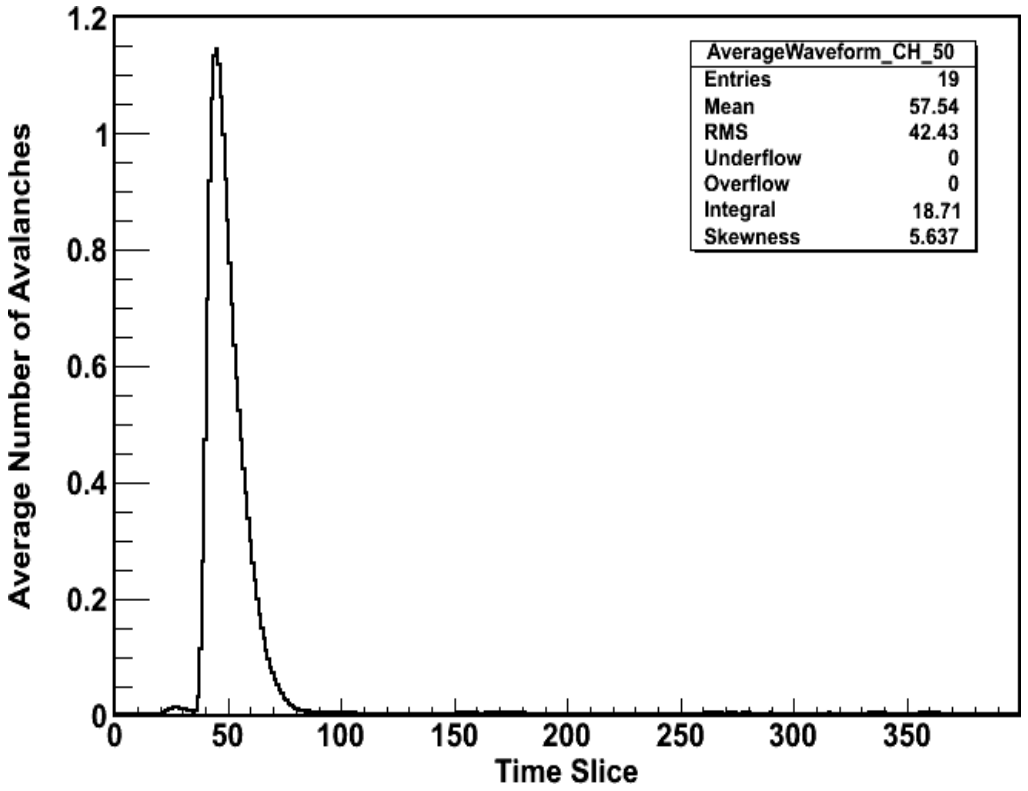




Čerenkov Detector

We have shown in TIPP2011 that the Čerenkov light produced in PbF_2 crystals can be read out by SiPMs directly coupled to the crystal.



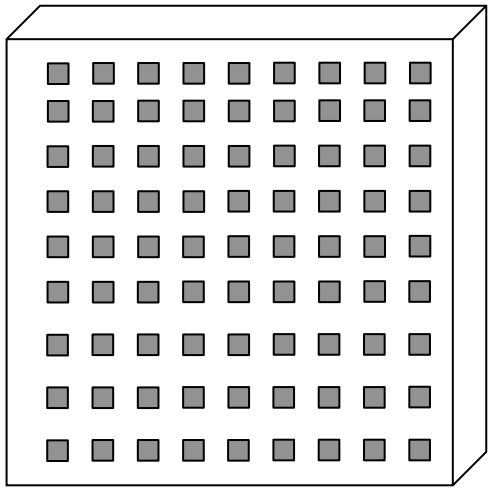
2 cm x 2 cm x 5 cm PbF_2

3 mm Hamamatsu SiPM

http://indico.cern.ch/contributionDisplay.py?contribId=225&confId=102998

B. Bilki et. al., Total Absorption Dual Readout Calorimetry R&D, Physics Procedia 37, 309 - 316 (2012).

Čerenkov Detector
First Approach



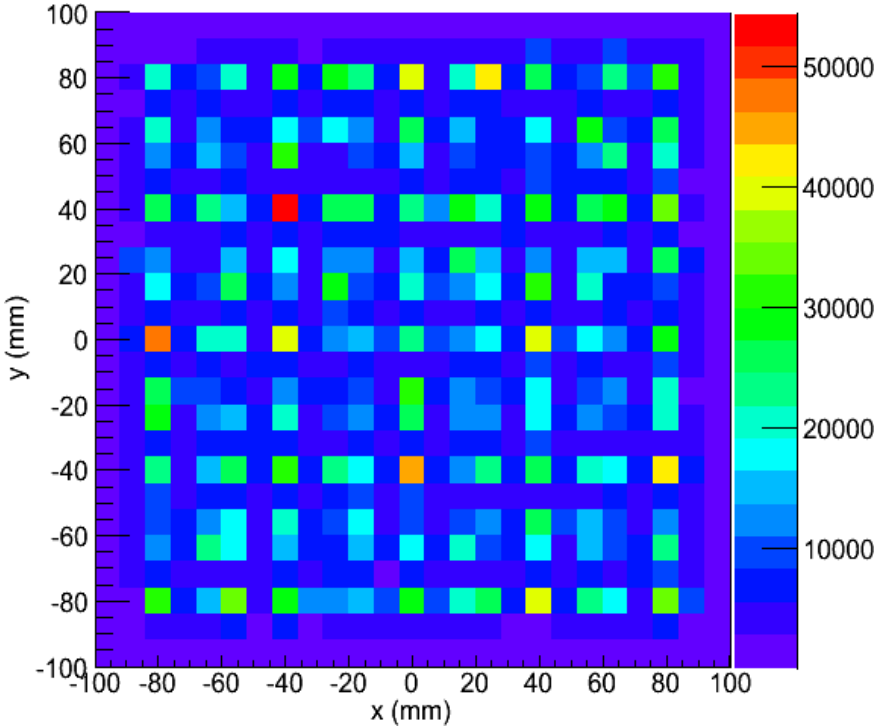
20 cm x 20 cm x 1 cm PbF_2

n=1.78 → Čerenkov angle ~ 57°

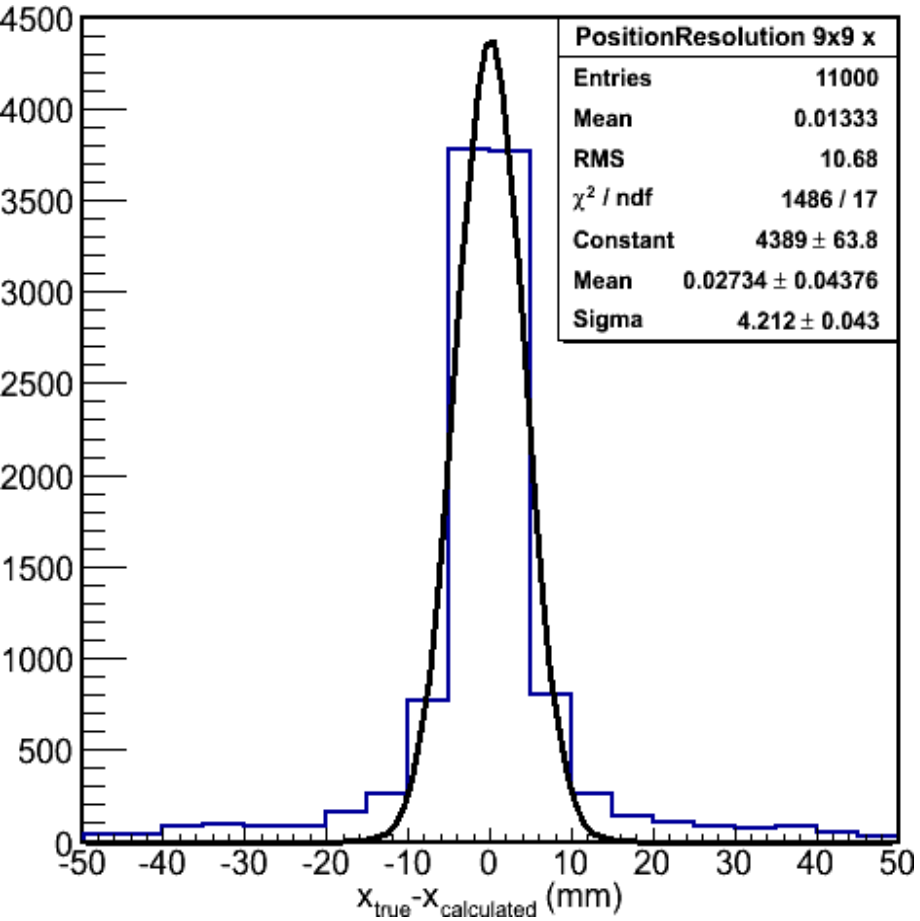
2 cm SiPM seperation

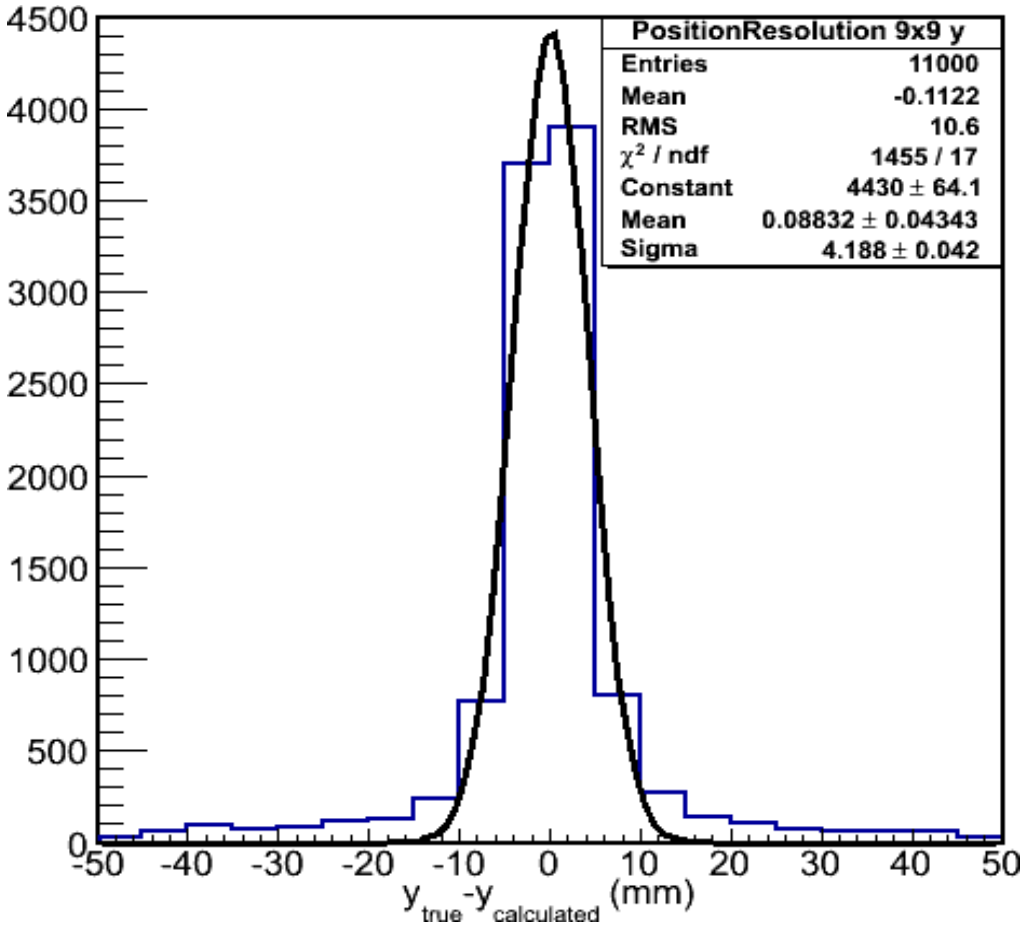
SiPM response ↔ number of photons

50 GeV e^- beam ~ Compton edge @ 500 GeV



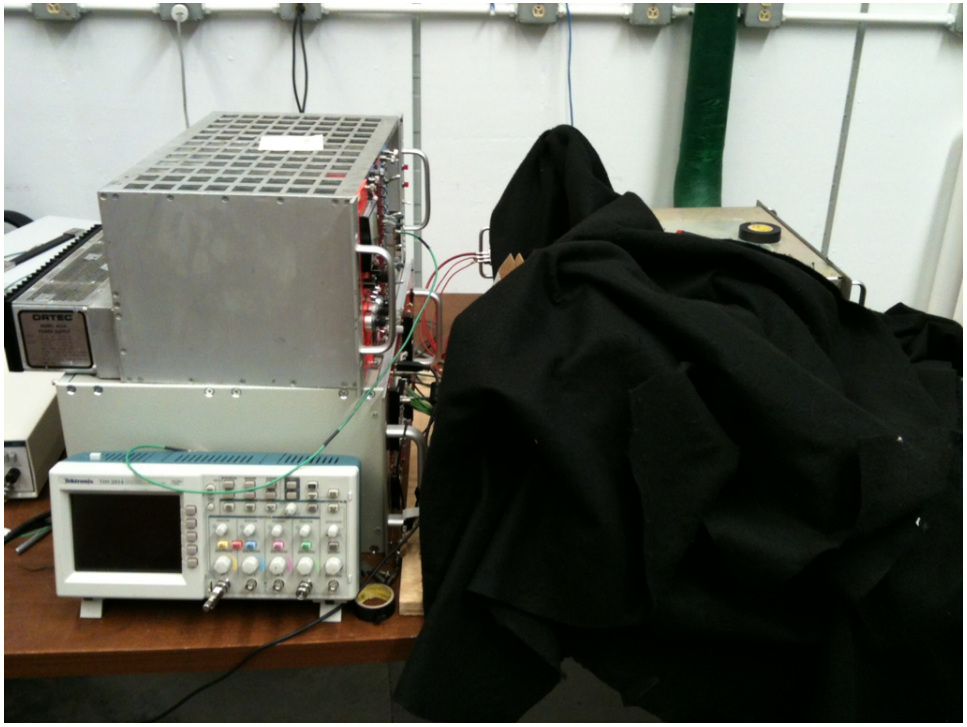
Čerenkov Detector
First Approach

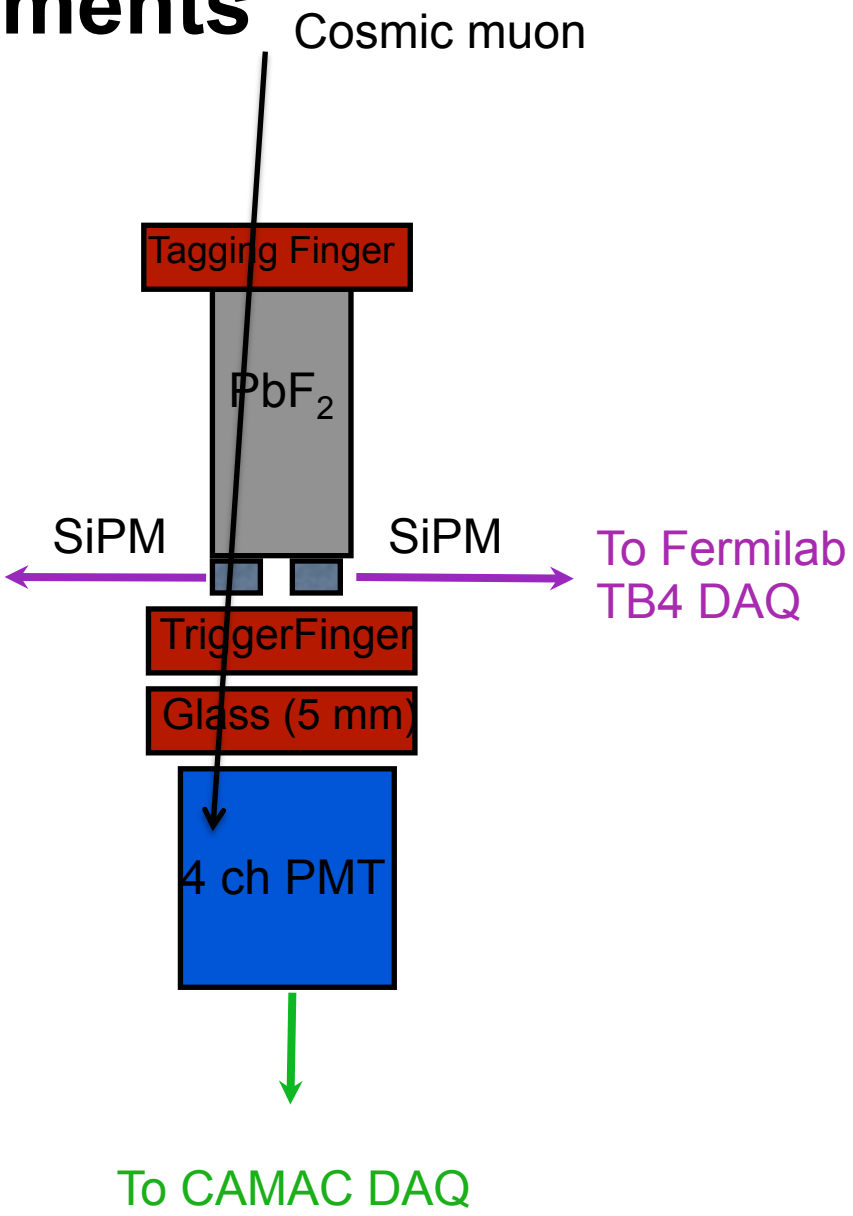




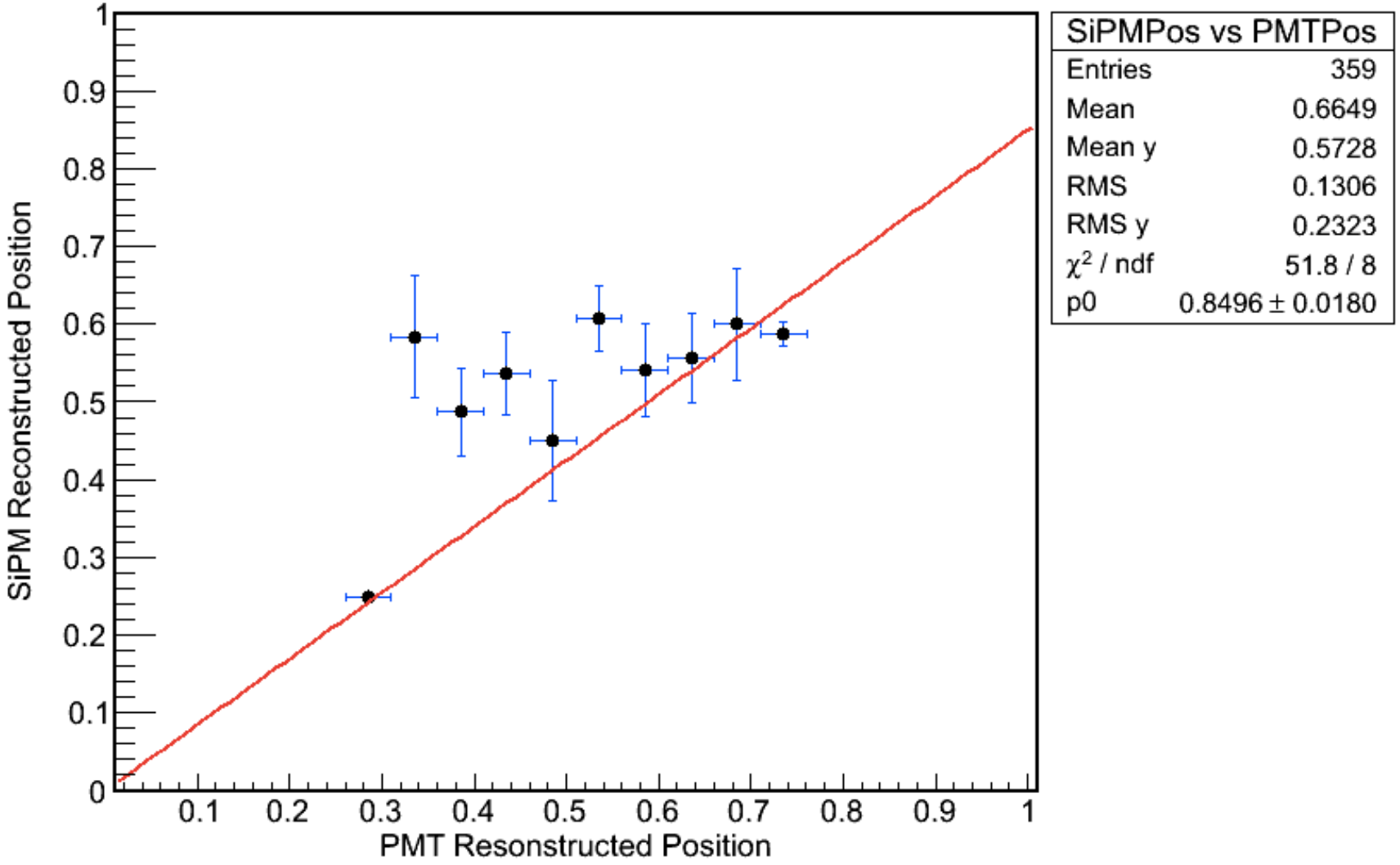
Čerenkov Detector
Further Experiments

Test station at University Of Iowa





Čerenkov Detector
Further Experiments



PMT Position = $((PMT_0+PMT_1)x0.25 + (PMT_2+PMT_3)x0.75)/(PMT_0+PMT_1+PMT_2+PMT_3)$
SiPM Position = $(SiPM_0 \times 0.25 + SiPM_1x0.75)/(SiPM_0+SiPM_1)$

Summary

• We have a working quartz fiber calorimeter that has desired properties in the energy range we are interested in.

• Other design options are available (well understood, operational, sufficiently well simulated)

• A novel approach for Čerenkov detector (needs further investigation – CERN test beam in two weeks)

• Might have other applications in beam monitoring