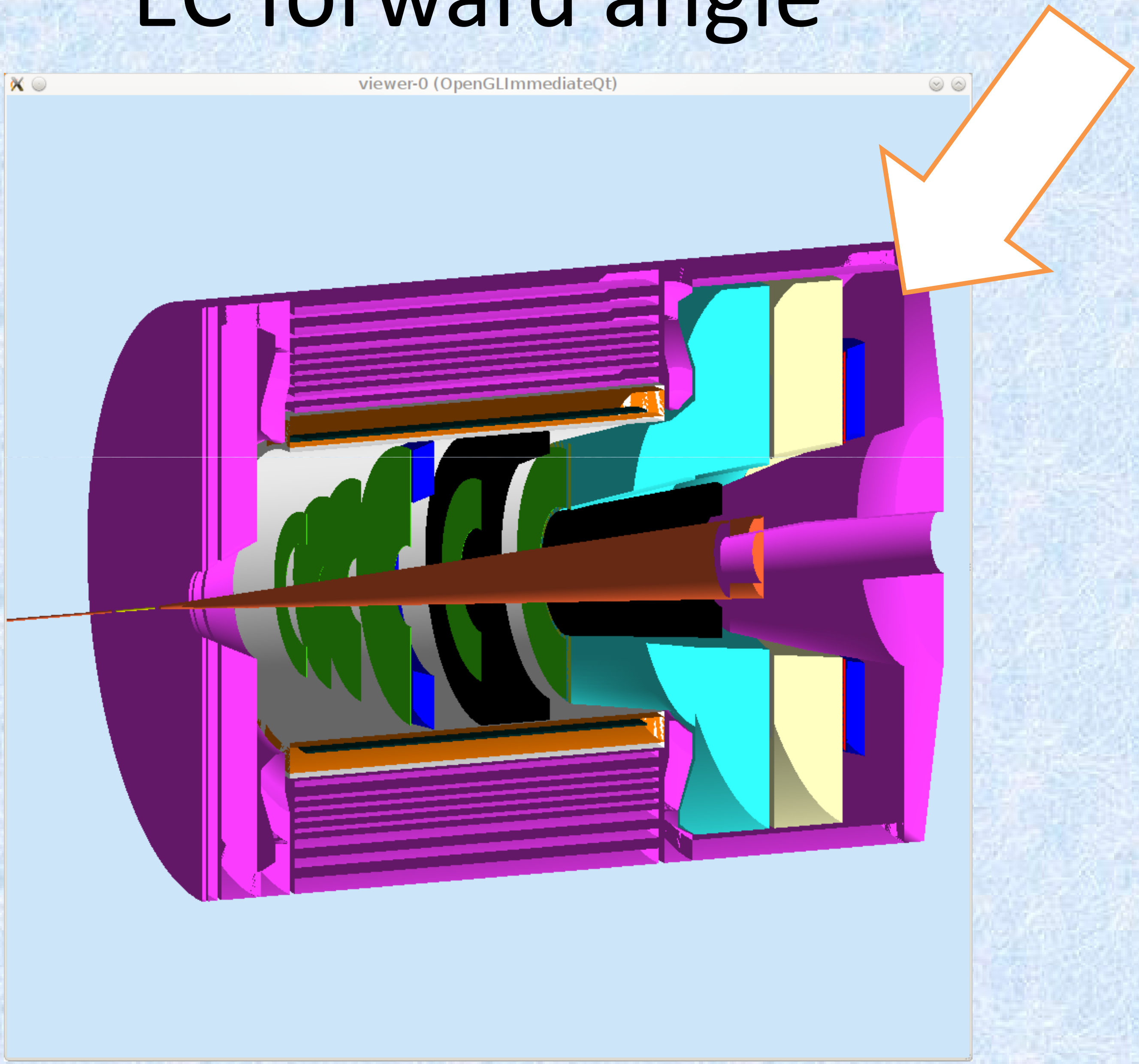
EC Forward Angle

Zhiwen Zhao

UVa

2011/03/25

EC forward angle



Requirement

- PVDIS rate 2000GeV/cm2/s, 60krad/year
- SIDIS rate 500GeV/cm2/s, 15krad/year
- Resultion $\frac{\sigma E}{E} = \frac{3\%}{\sqrt{E}} \oplus 2\%$ $\frac{\sigma E}{E} = \frac{10\%}{\sqrt{E}} \oplus 1\%$

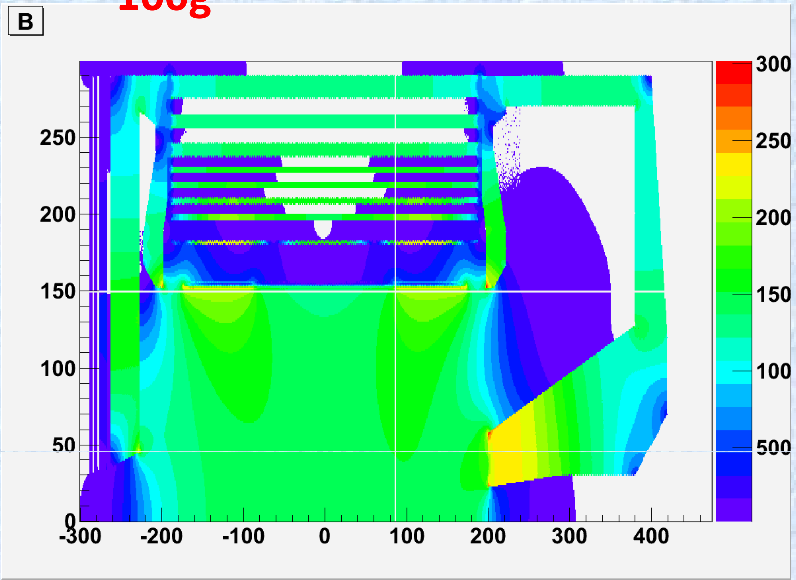
- Pion rejection 200:1 at E > 3.5 GeV, 100:1 at E > 1.0 GeV
- Fast time response, provide a trigger
- Good position resolution for tracking

The Menu

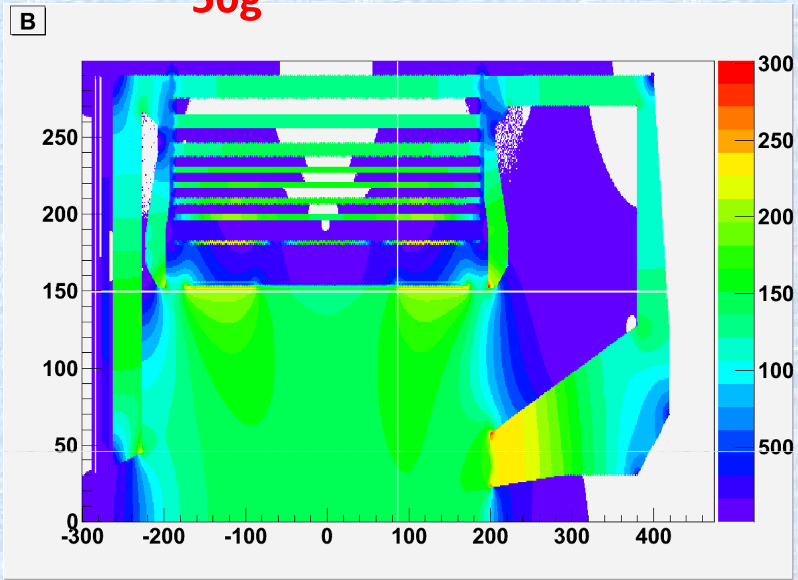
- Lead glass (can’t hold such radiation)
- **Shashlyk**
- **SciFI**

BaBar field

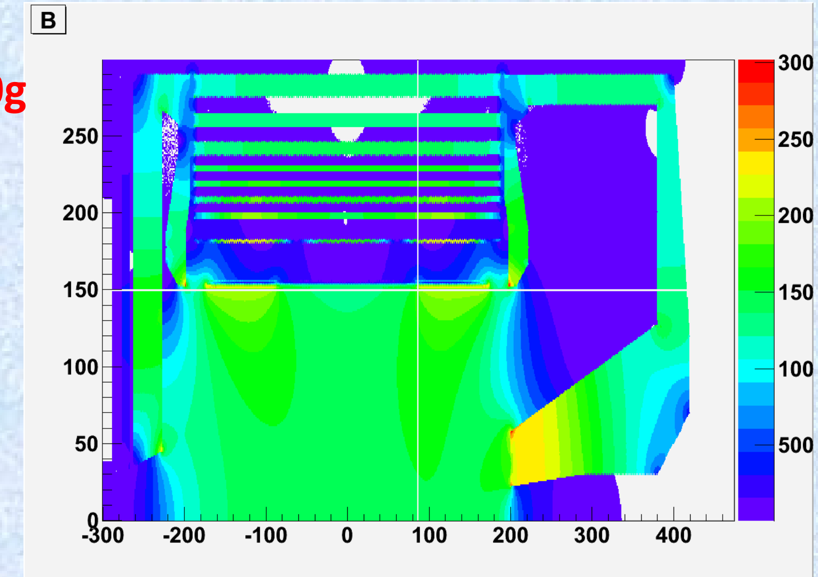
100g



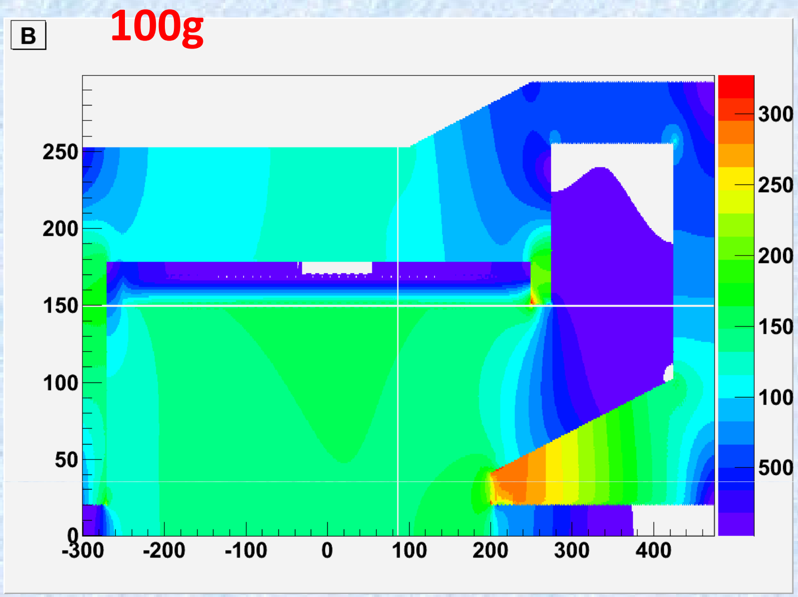
50g



20g



CDF field


B
100g
250
200
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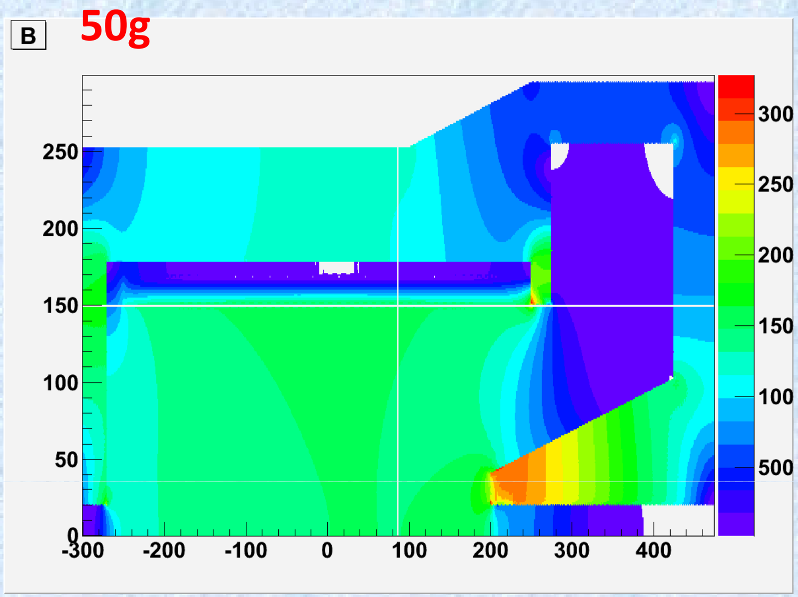
500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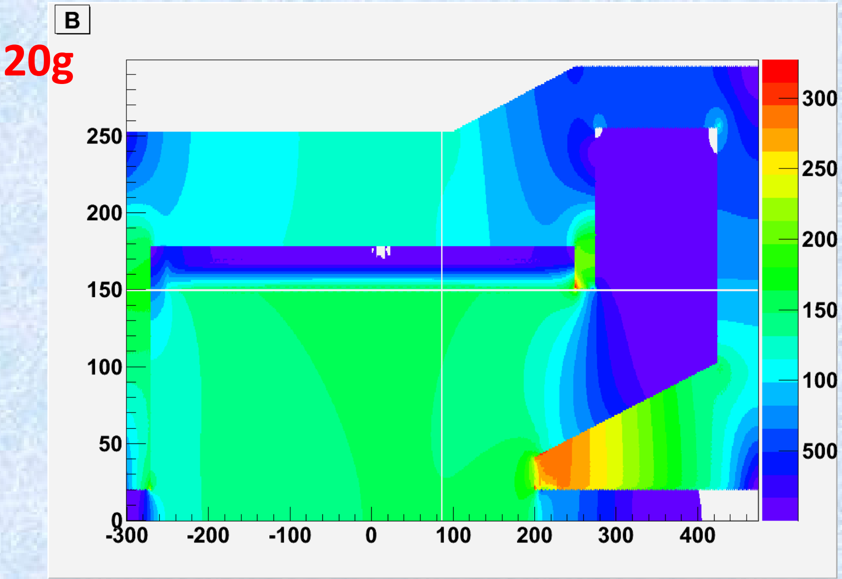
B
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400
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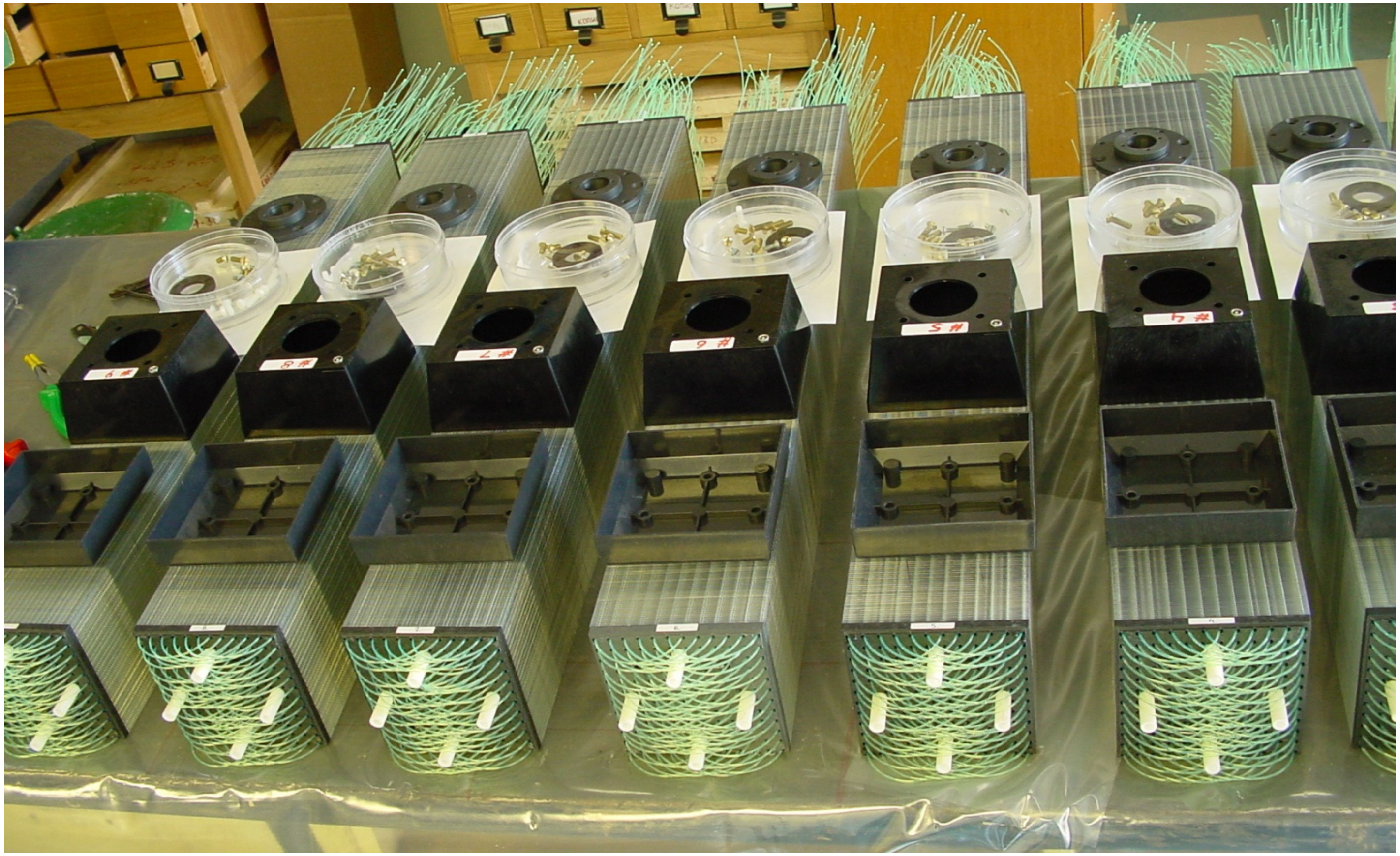
250
200
150
100
500

Shashlyk prototype module parameters

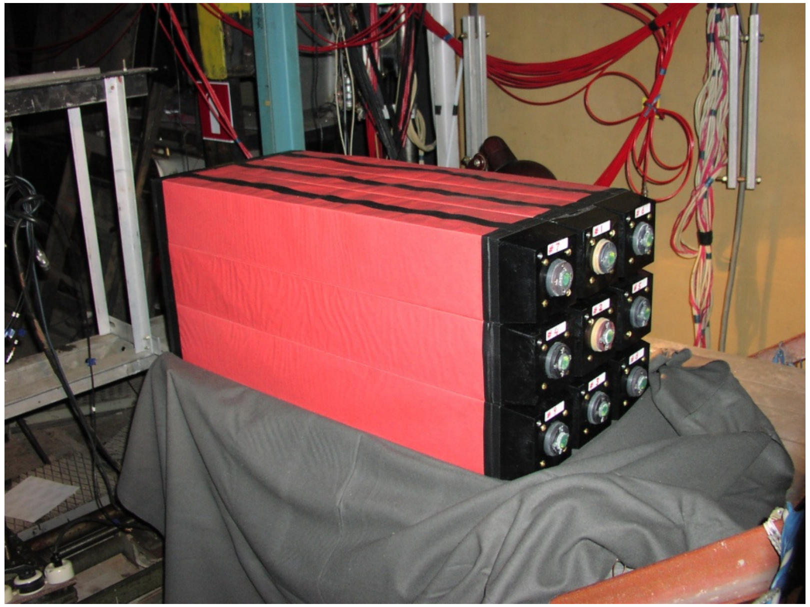
9 modules assembled in matrix 3x3

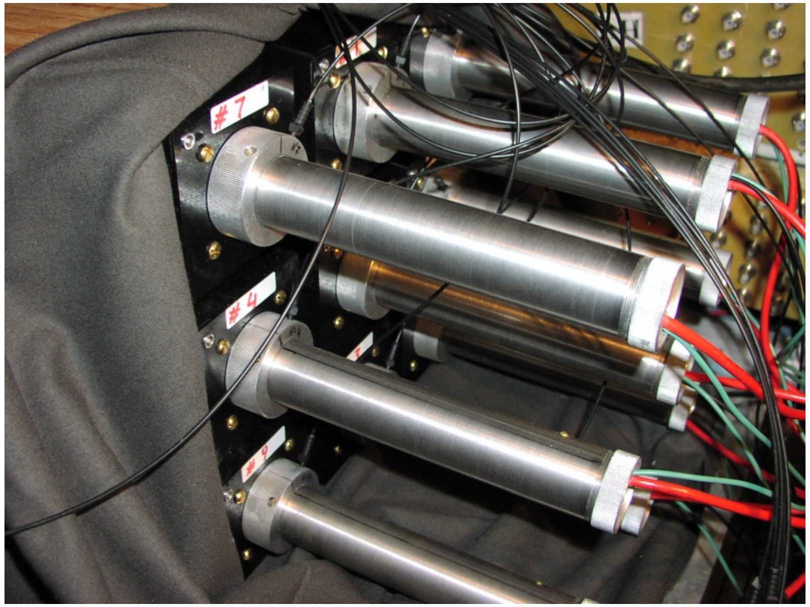
- 380 layers of 0.3-mm lead and 1.5-mm scintillator, total length 680 mm
- Transverse size 110x110 mm^2
- Effective Moliere radius: R_M=59 mm
- Effective radiation length: X_0=34 mm
- Total radiation length: $20X_0$
- Light collection: 144 (12×12) fibers BCF-91A (∅1.2 mm)
- PMT Hamamtsu R5800 as photodetectors

Shashlyk modules production



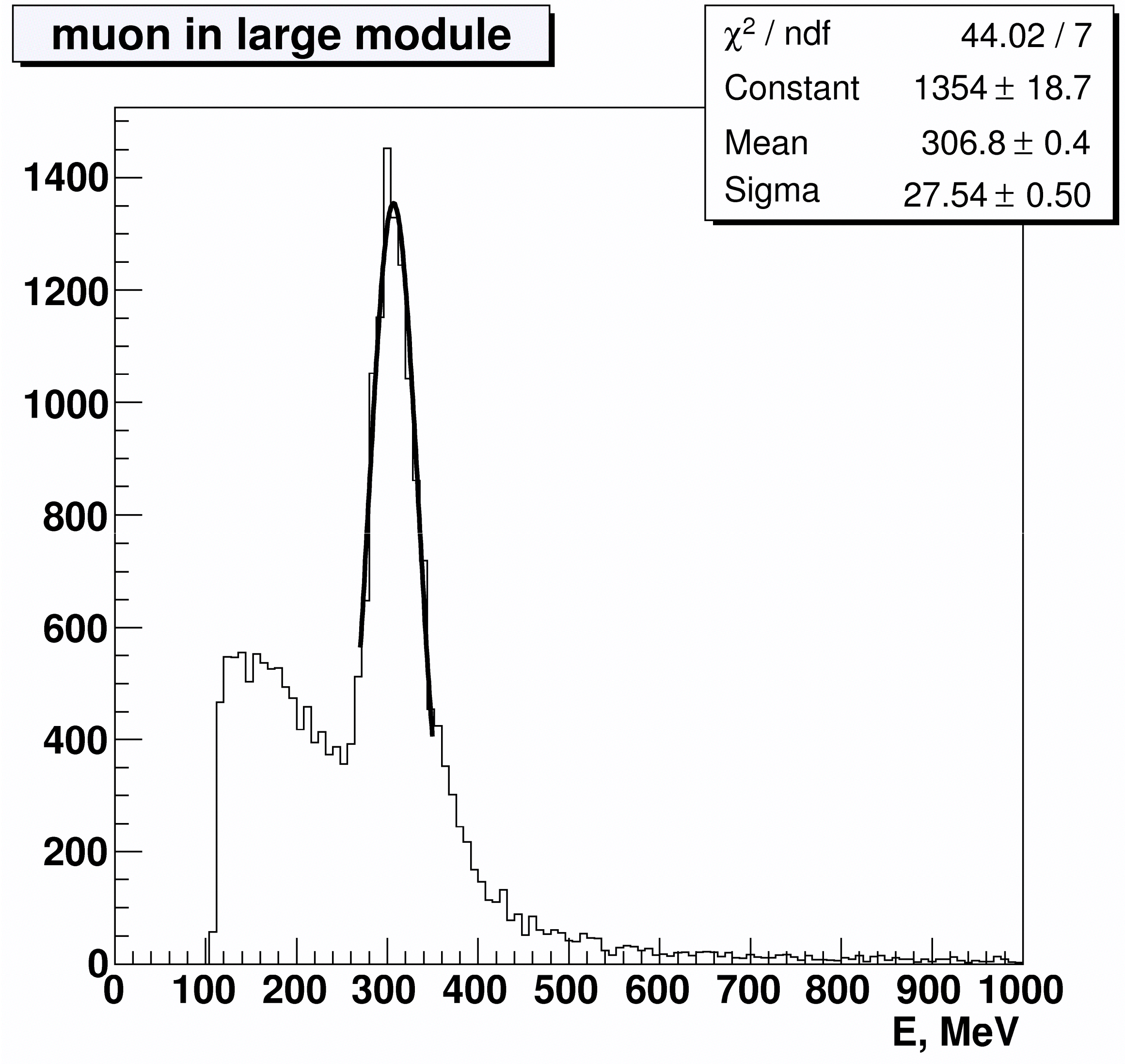
Shashlyk prototype pictures



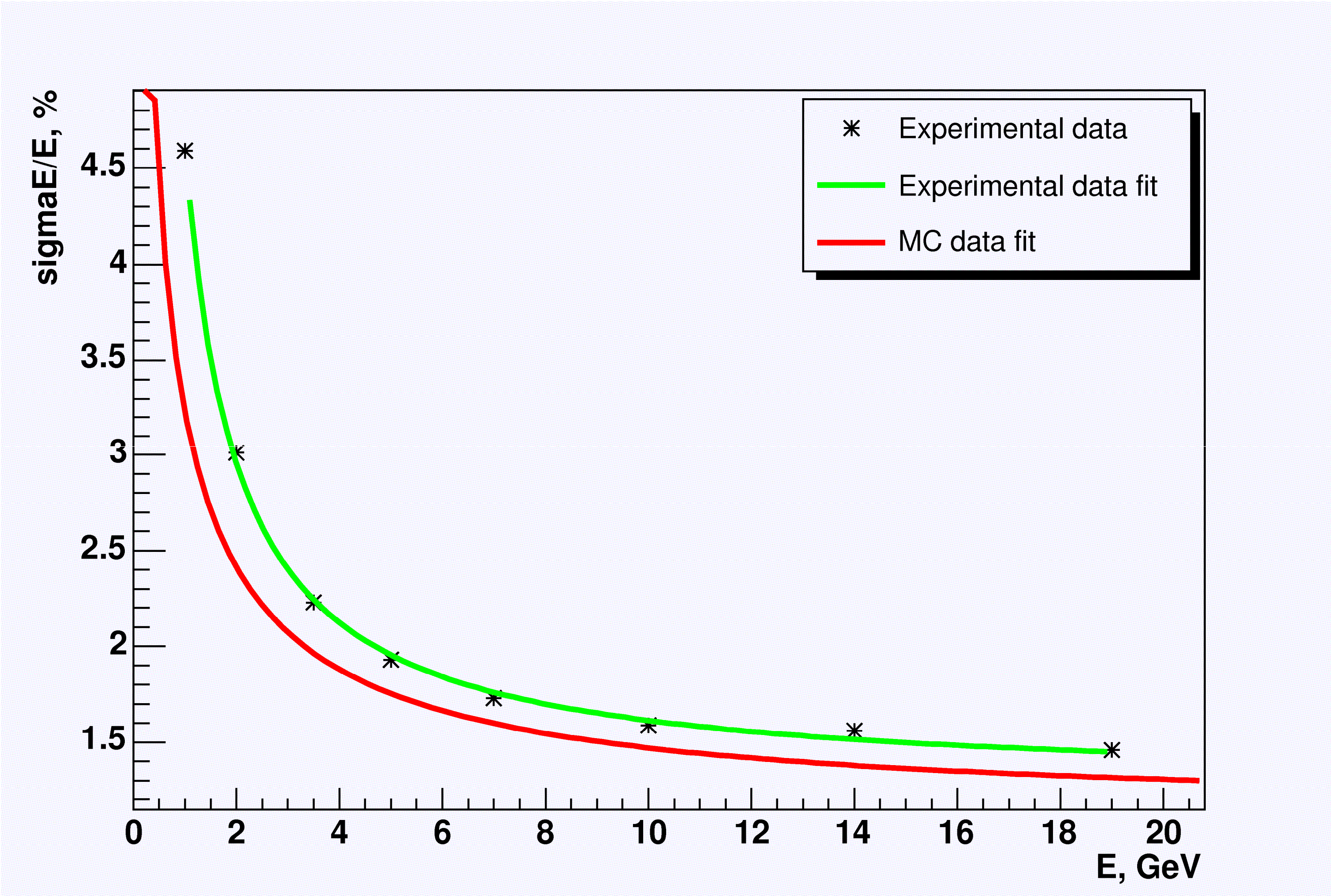


3x3 matrix of shashlyk modules and PMT attached to the modules

Minimum ionizing particle peak



Energy Resolution dependence on energy



Energy Resolution parameterization

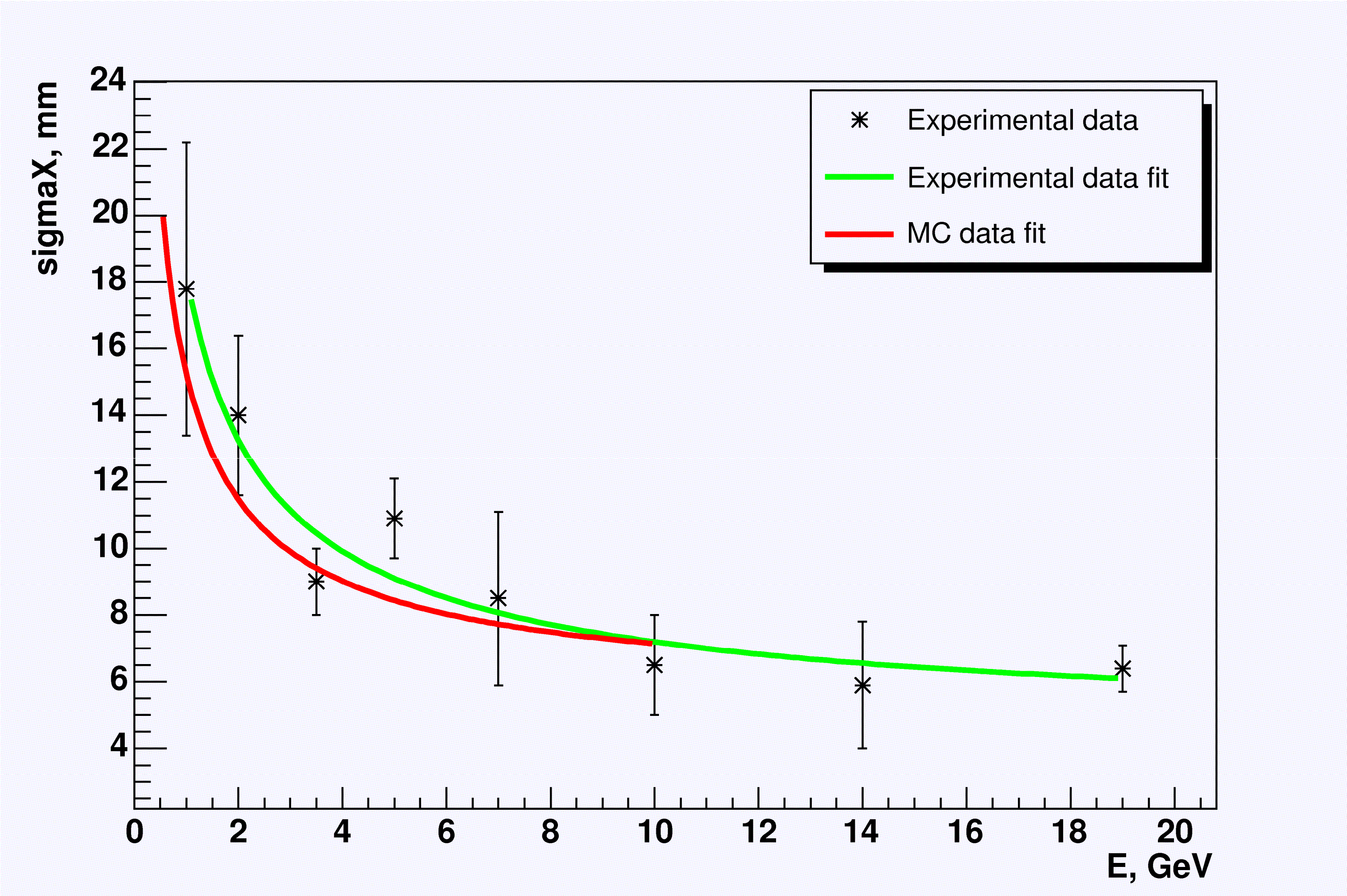
$$\sigma_E / E = a/E \oplus b/\sqrt{E} \oplus c\ [\%],\ E \text{ in GeV}$$

Experiment data fit:	MC data fit:
$a = 3.5 \pm 0.3$	$a = 0.0$
$b = 2.8 \pm 0.2$	$b = 3.0 \pm 0.3$
$c = 1.3 \pm 0.04$	$c = 1.1 \pm 0.7$

Good agreement with MC without noise term.

Good agreement with previous studies of similar sampling modules at lower energies (2.9%/ $\sqrt{E}$ at 220-370 MeV: *Test beam study of the KOPIO shashlyk calorimeter prototype,* G.Atoian, S.Dhawan,V.Issakov et al. *CALOR-2004 Proceedings*)

Position resolution (center) dependence on energy



Position resolution parameterization

$$\sigma_x = a/\sqrt{E} \oplus b \text{ [mm], E in GeV}$$

Experiment data fit:

$a = 17.6 \pm 0.9$

$b = 4.6 \pm 0.9$

MC data fit:

$a = 14.2 \pm 0.6$

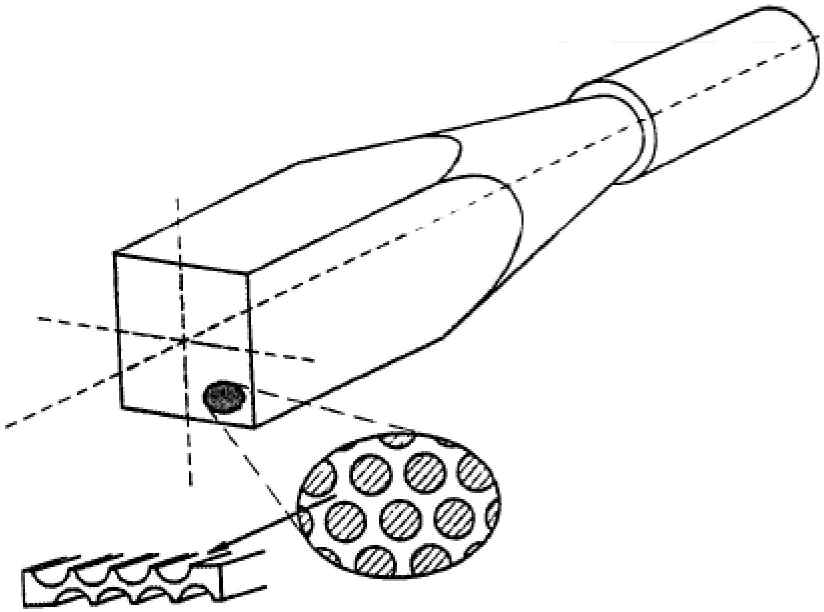
$b = 5.5 \pm 0.9$

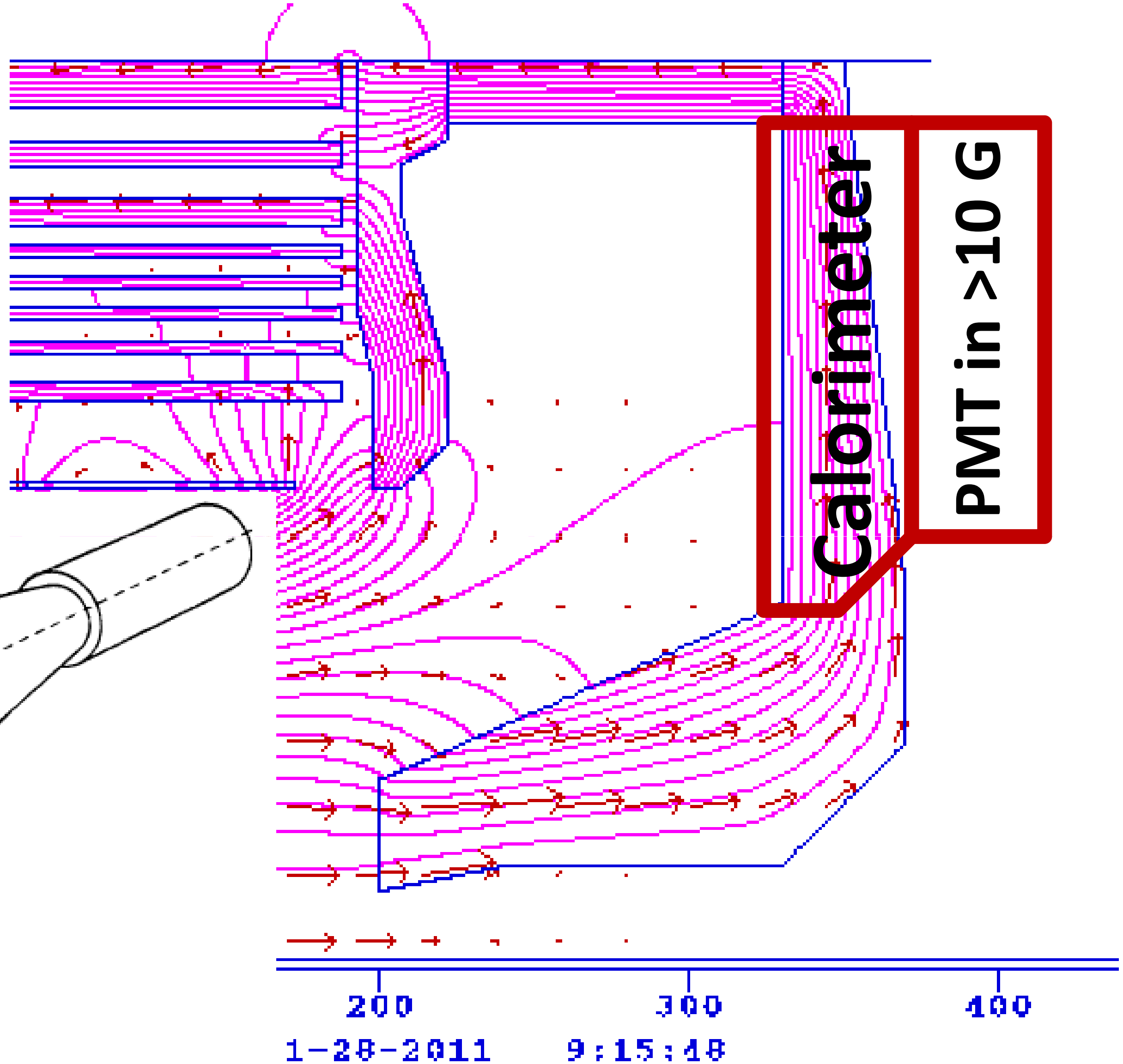
Worst case – resolution at the module center.

Resolution near the module edge is 3 times better

Calorimeter in Solenoid Flux Return

- How to get the light from the calorimeter to a photosensitive detector?
  - APD's
  - Light Guides out of field region
  - **Use flux return for calorimeter**





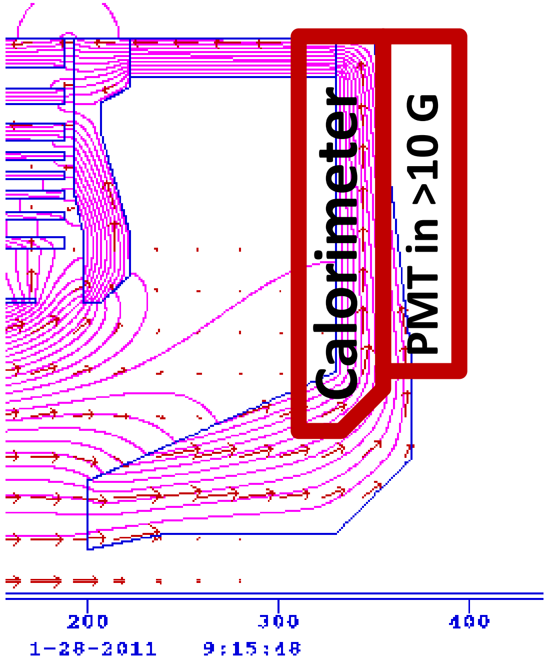
Calorimeter in Solenoid Flux Return

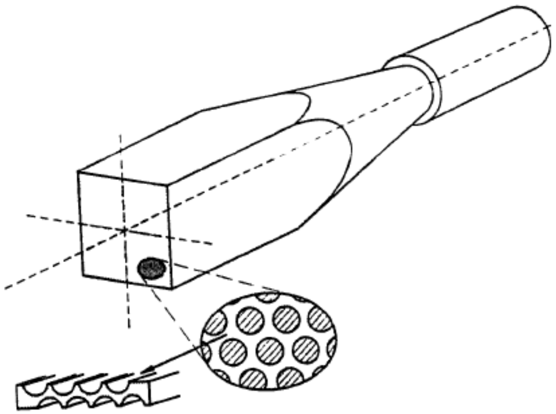
Open Questions:

- What does magnetic field do the shower?
  - My guess is that charged particles in the EM shower will curl up causing the shower to become shorter and wider
- How does magnetic field affect resolution in Energy and in space? Is this a strong function of field strength or direction?
- What resolution do we need? [Pb:SciFi at ~1:1 gives 4.5%/sqrt(E)]
- Is Iron dense enough?
- How does the fiber affect the Magnetic flux return?
  - My guess is that we use and “effective” μ which is about half that of Fe.

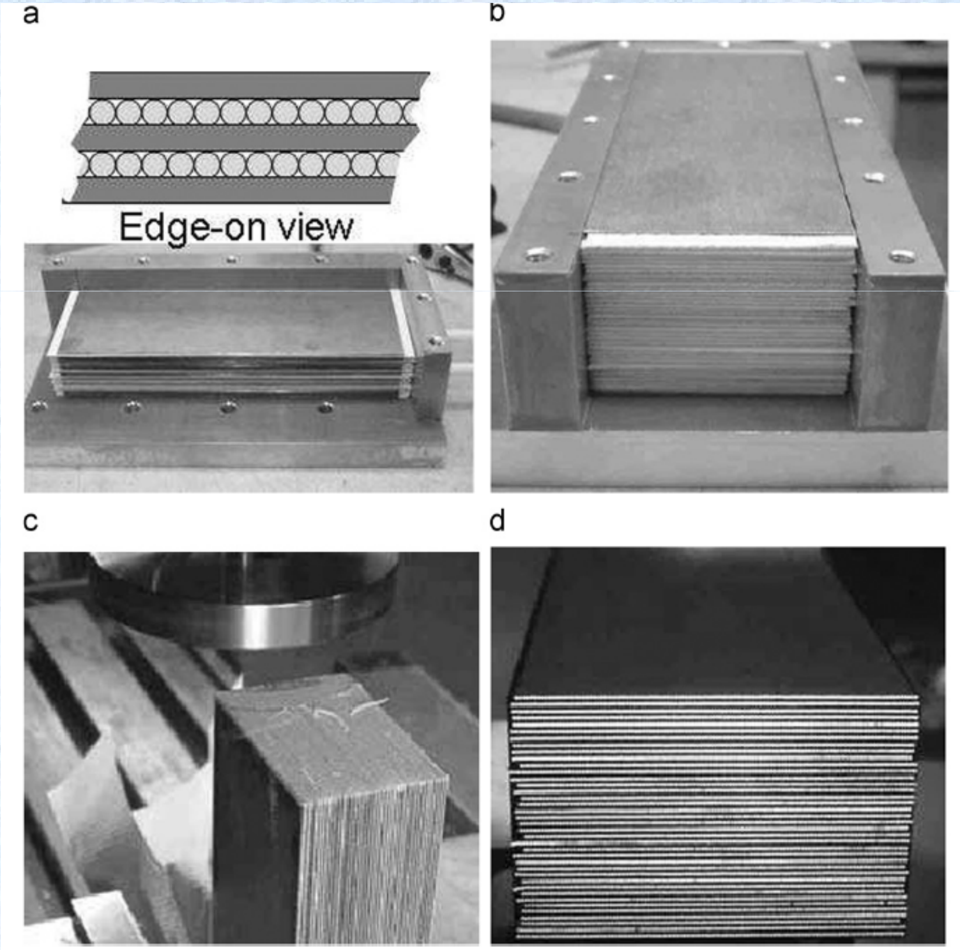
Require detailed MC; Have contacted D. Hertzog about simulations.

- How do we cost this?
  - D Hertzog—driving cost is amount of fiber—Fe less dense than Pb thus need more fiber.

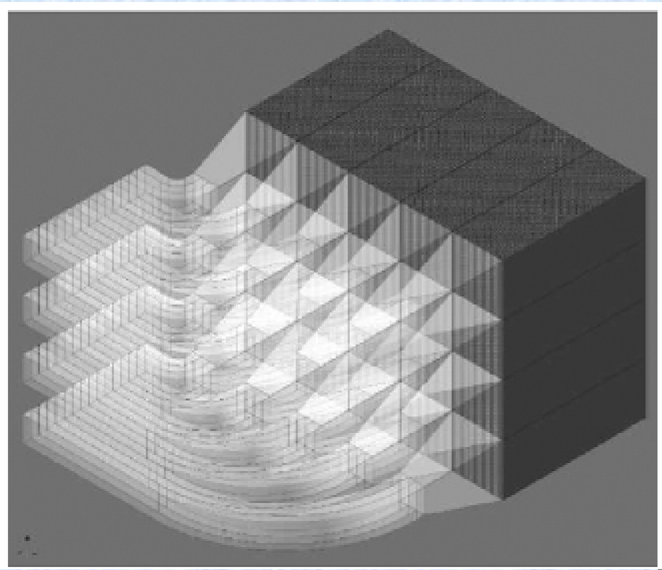




Mixture of radiation material and scintillator fiber(glue)

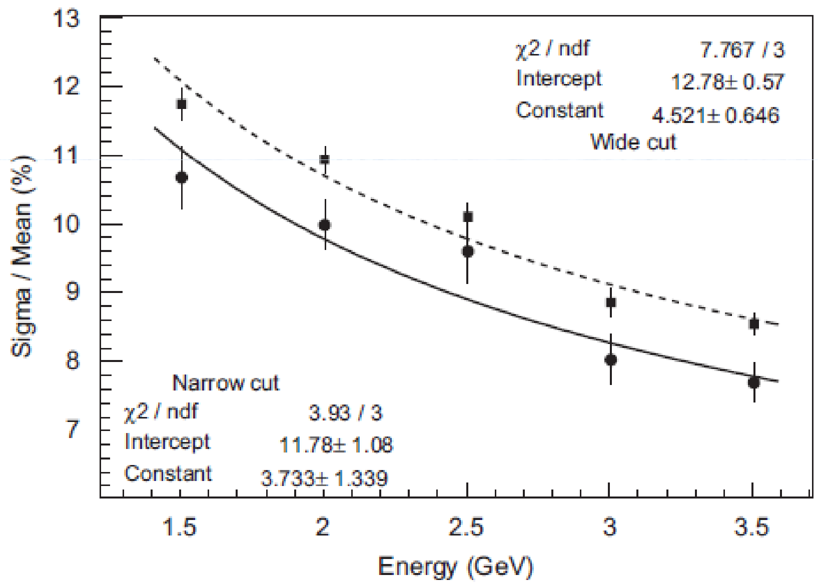


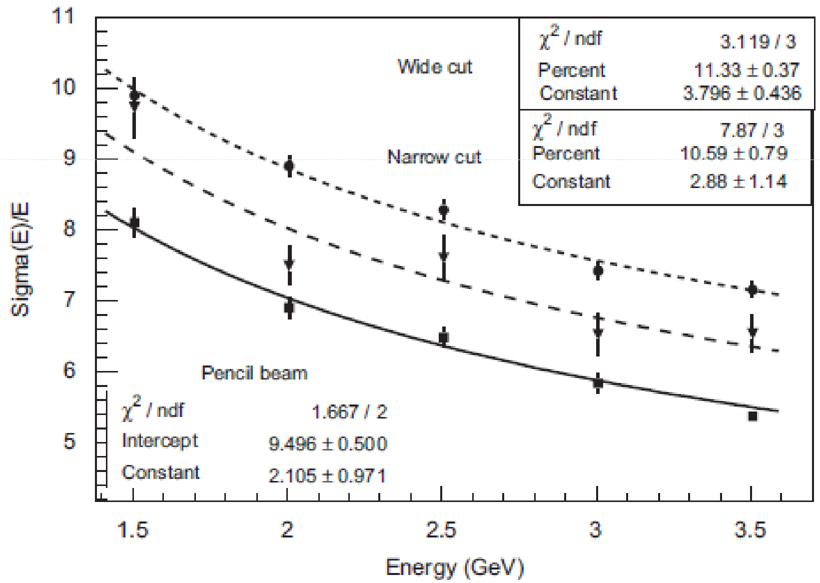
g-2 W/SciFi prototype



g-2 prototype test run

Data | Simulation

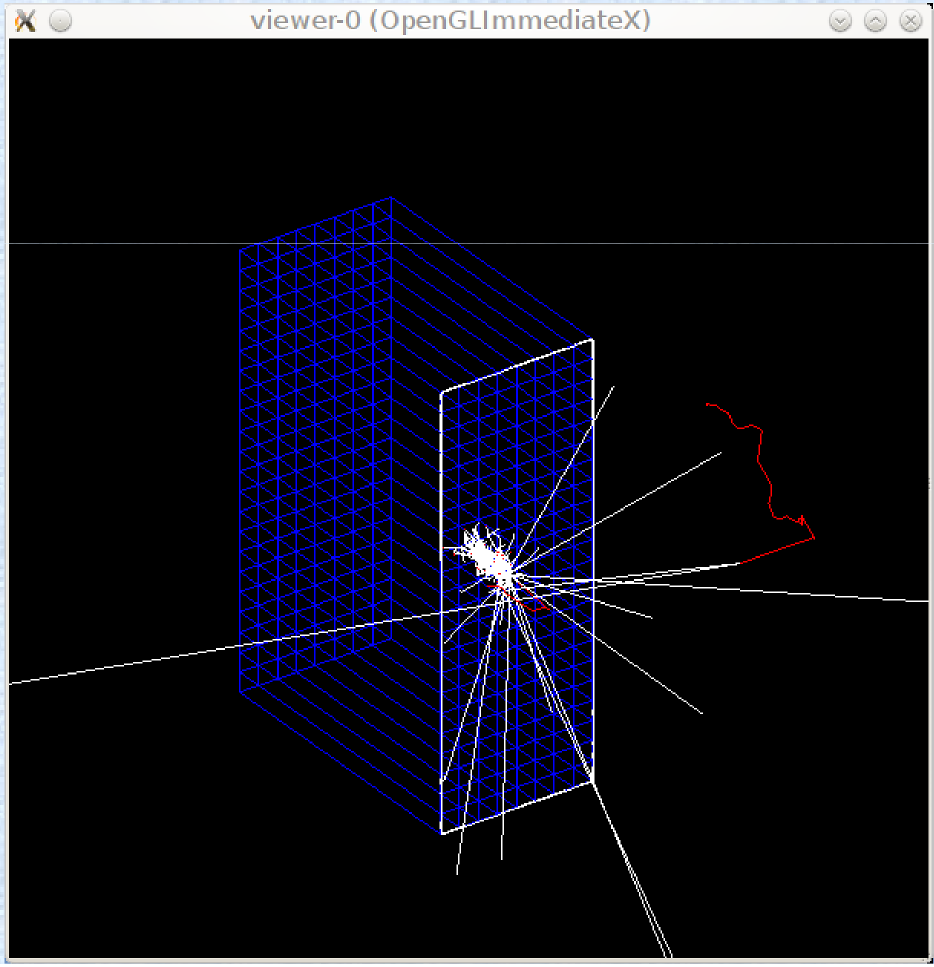




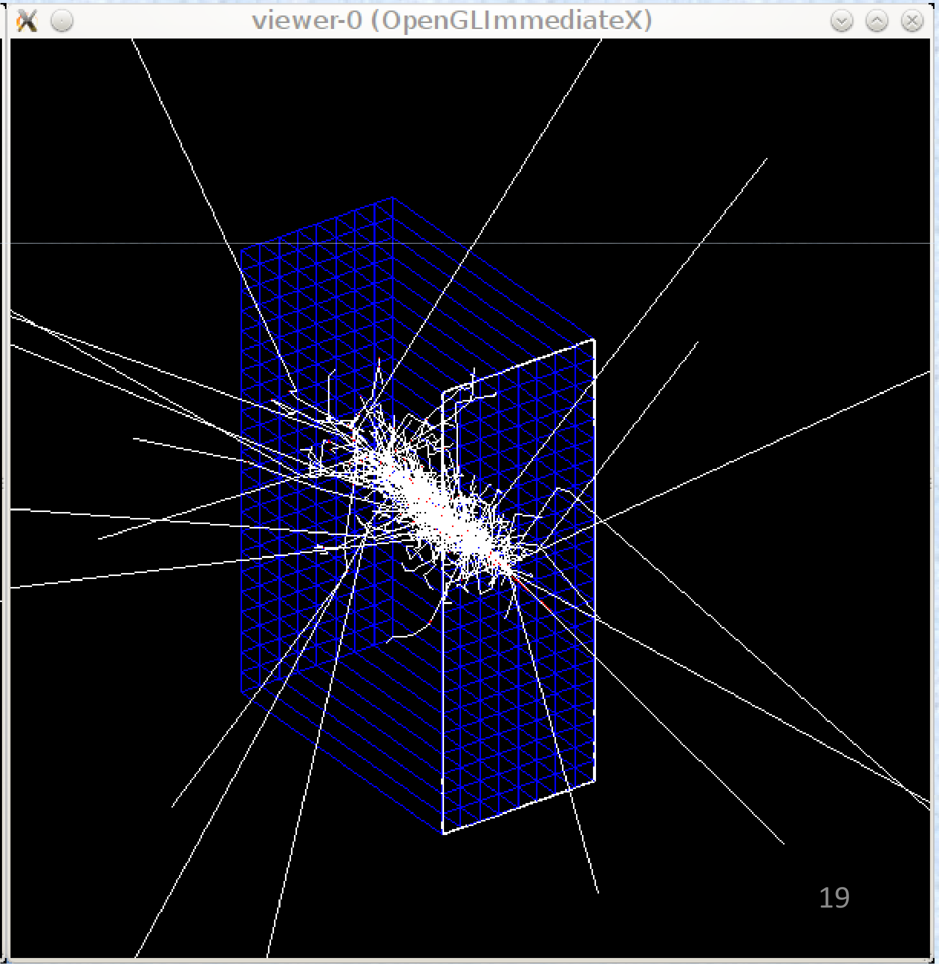
Test module simulation

- 90cm(height)x32cm(width)x60cm(depth),
- material:(fiber+flue)=1:1,
- fiber along Z, layer along Y, optional 2T field along Y

W/SciFi

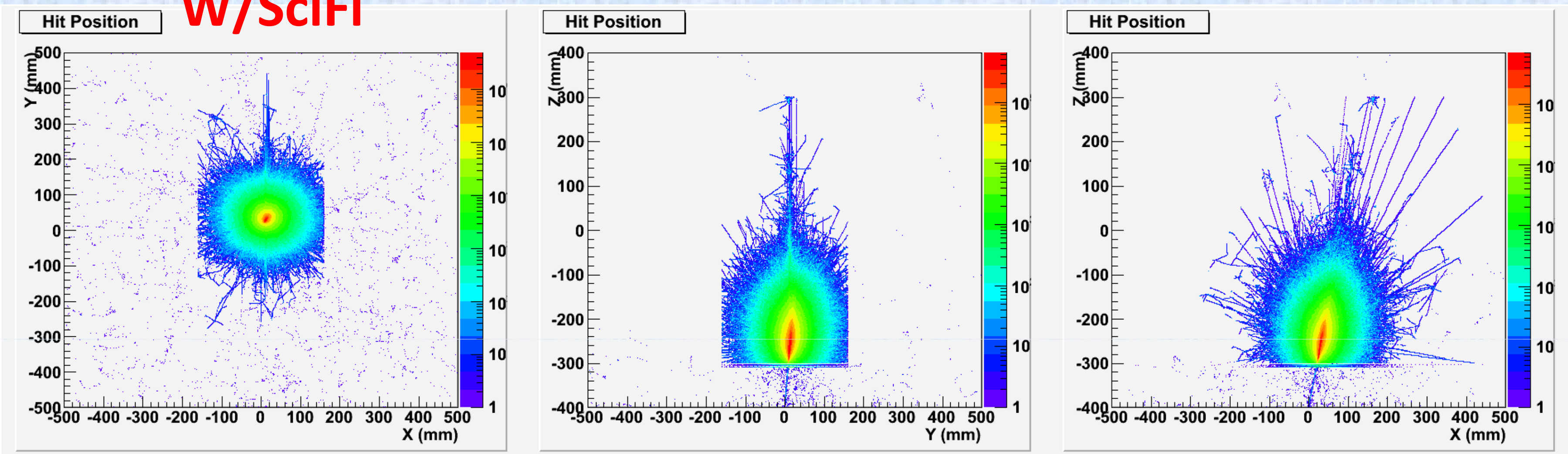


Fe/SciFi

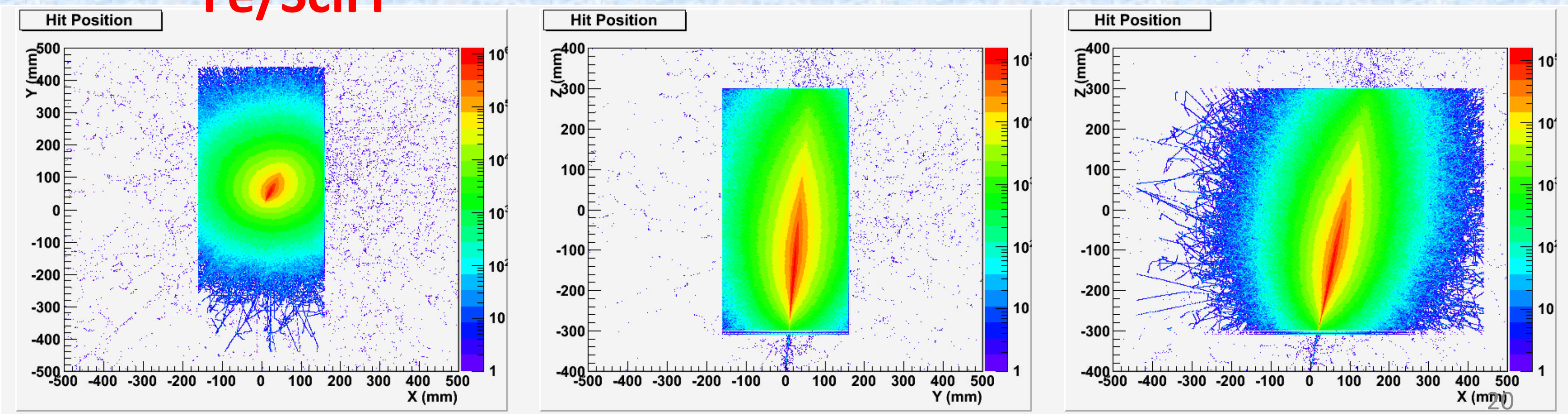


Test module simulation hit distribution (No Field)

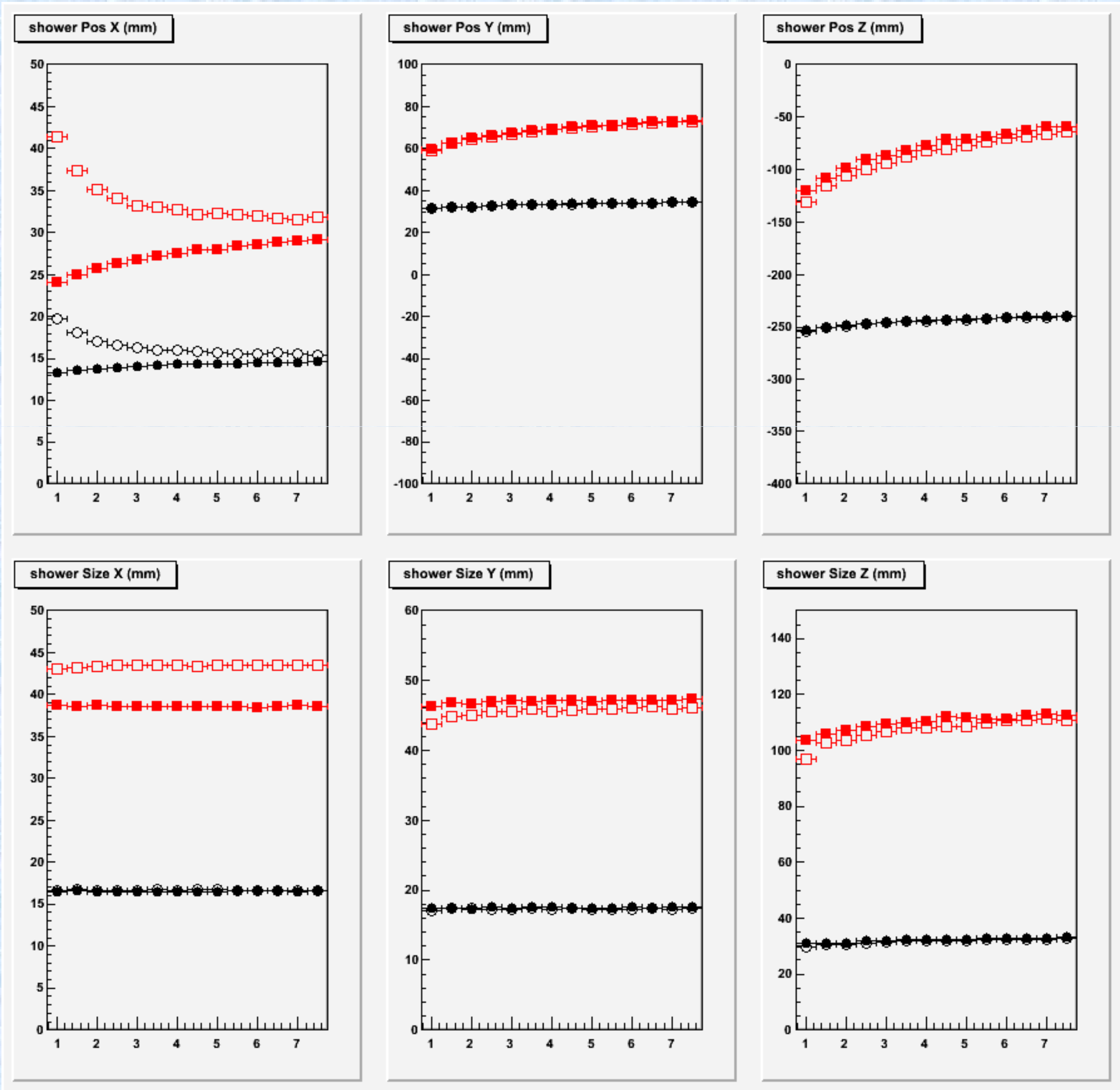
W/SciFi



Fe/SciFi



Test module simulation shower position and size



W_NoField (Solid)

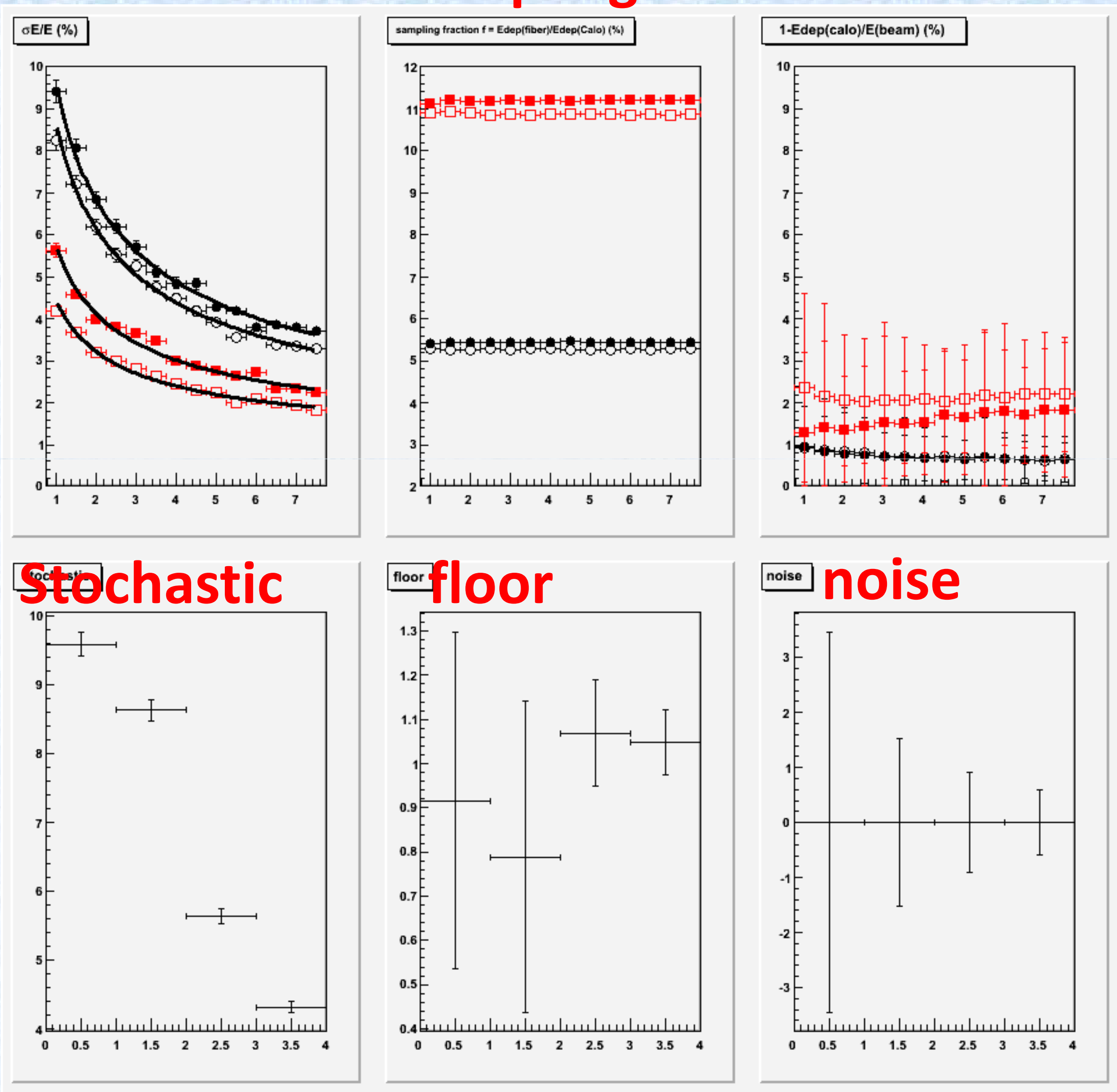
W_YesField (Empty)

Fe_NoField (Solid)

Fe_YesField (Empty)

Test module simulation

resolution **Sampling fraction** **loss**



W_NoField (Solid)

W_YesField (Empty)

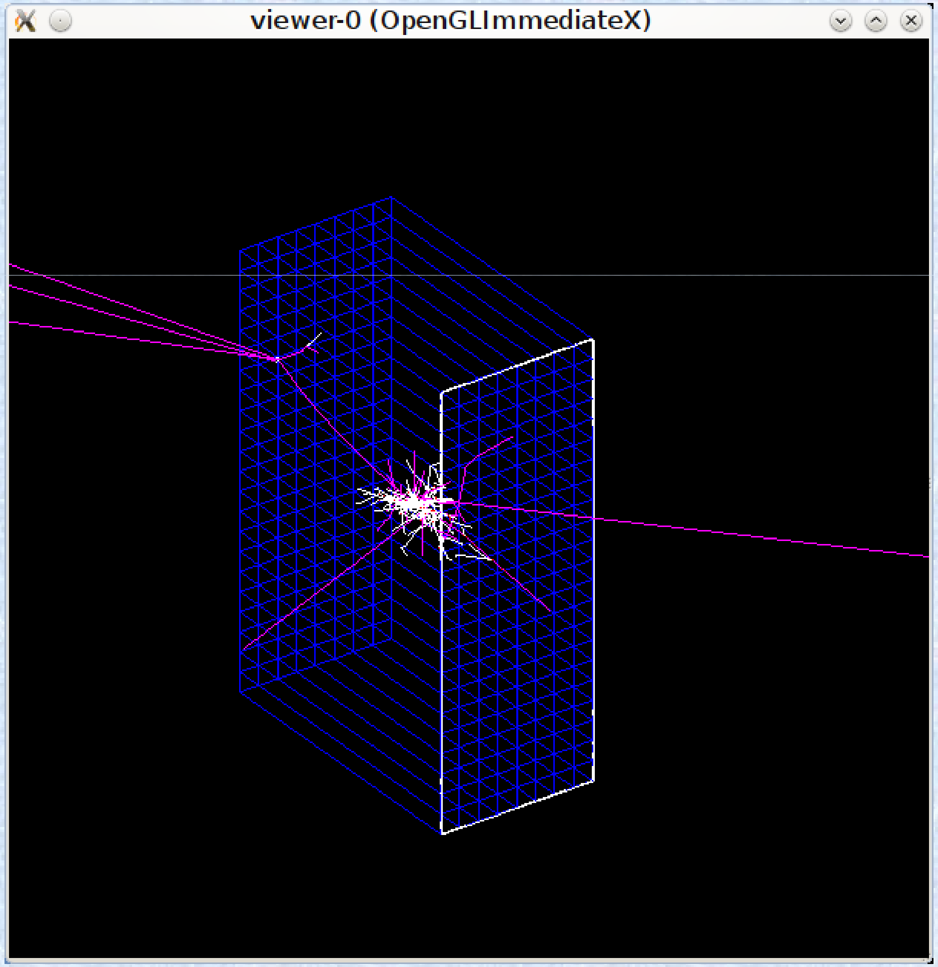
Fe_NoField (Solid)

Fe_YesField (Empty)

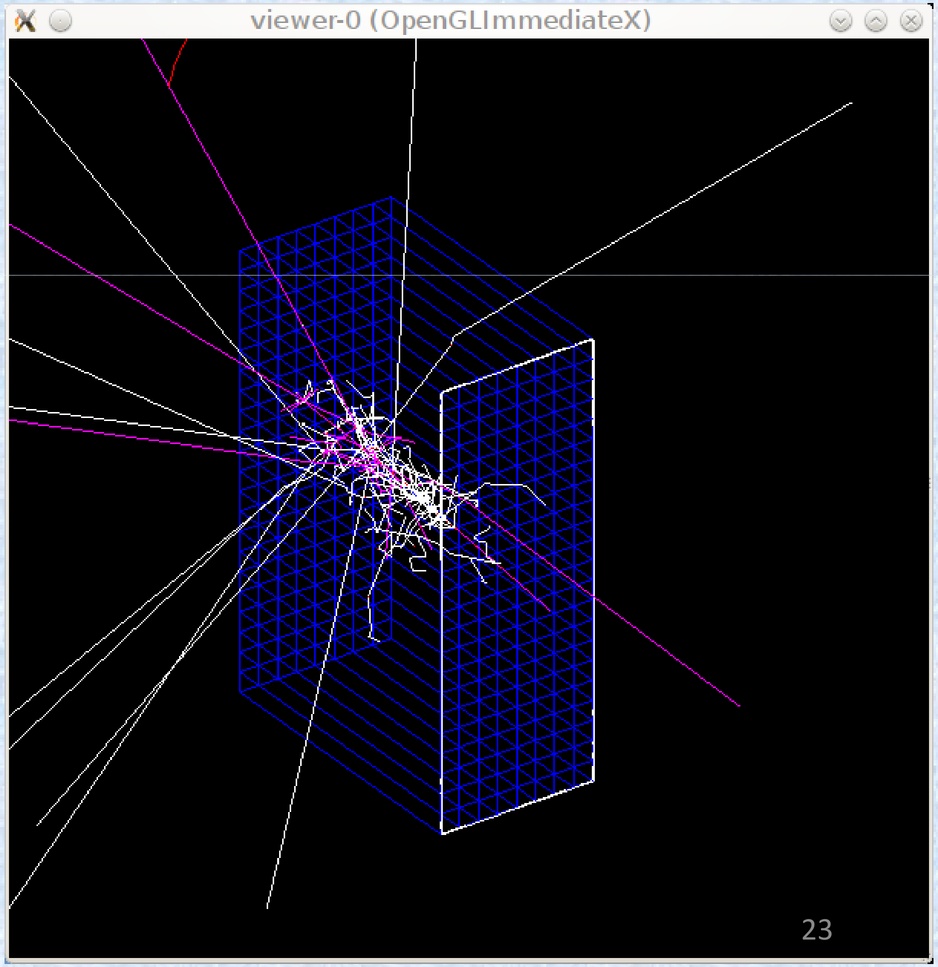
$$\frac{\sigma E}{E} = \frac{a\%}{\sqrt{E}} \oplus b\% \oplus \frac{c\%}{E}$$

Test module simulation
pion response

W/SciFi

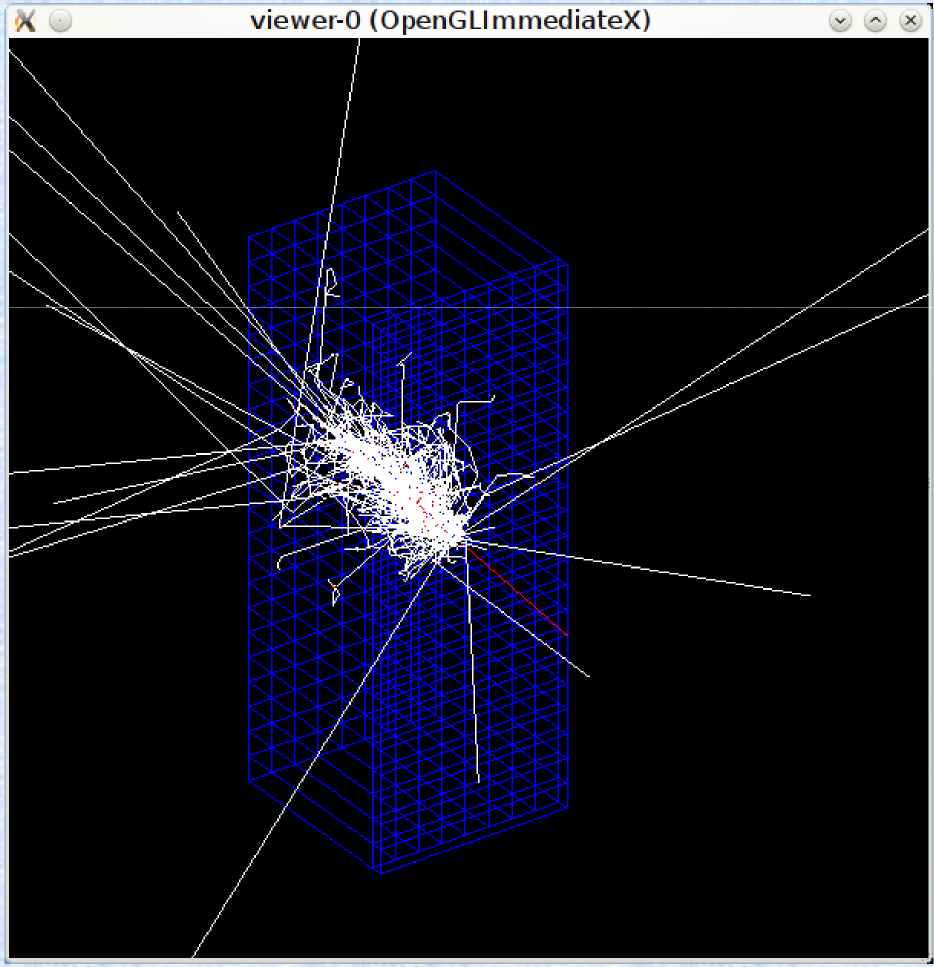


Fe/SciFi

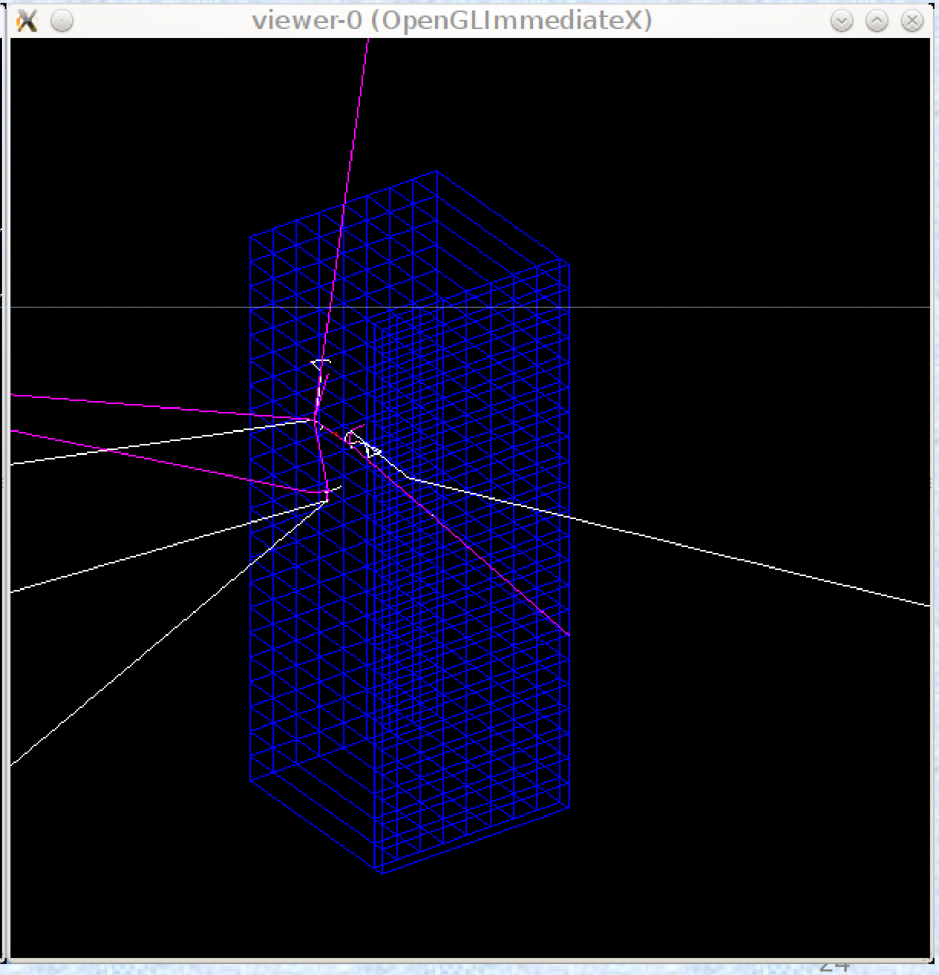


Test module simulation add 4cm W preshower

Fe/SciFi, electron



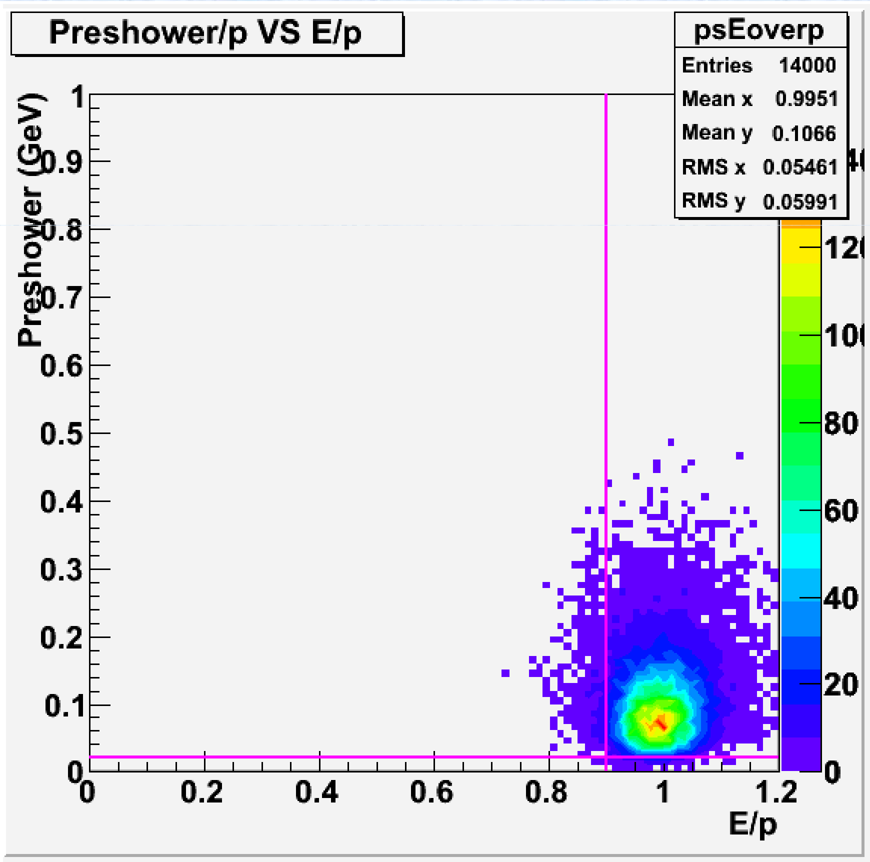
Fe/SciFi, pion

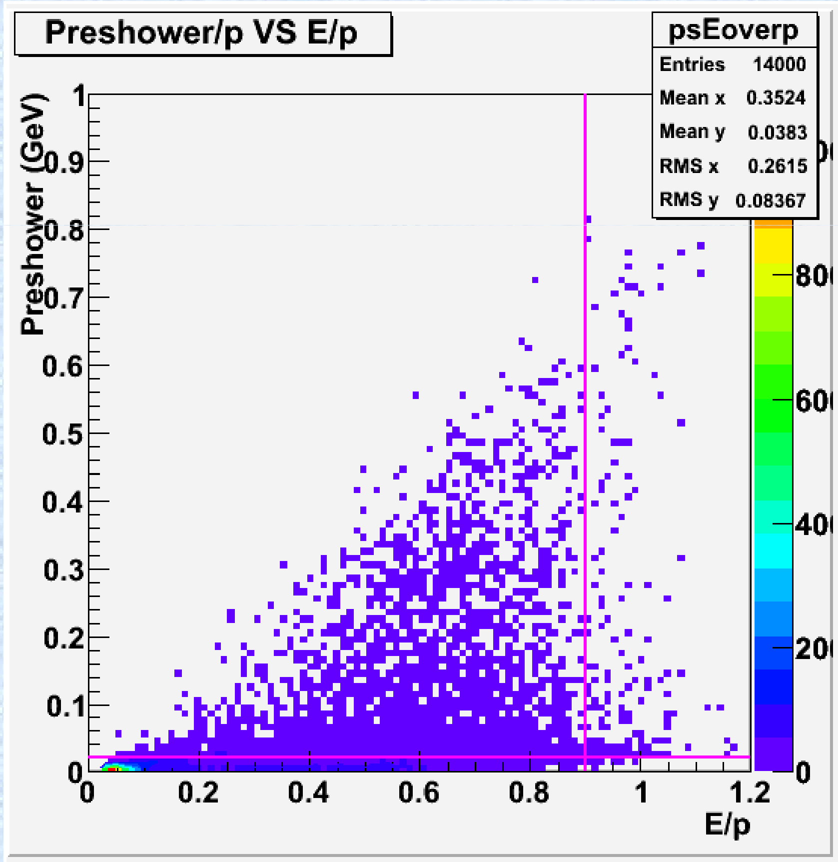


Test module simulation add 4cm W preshower

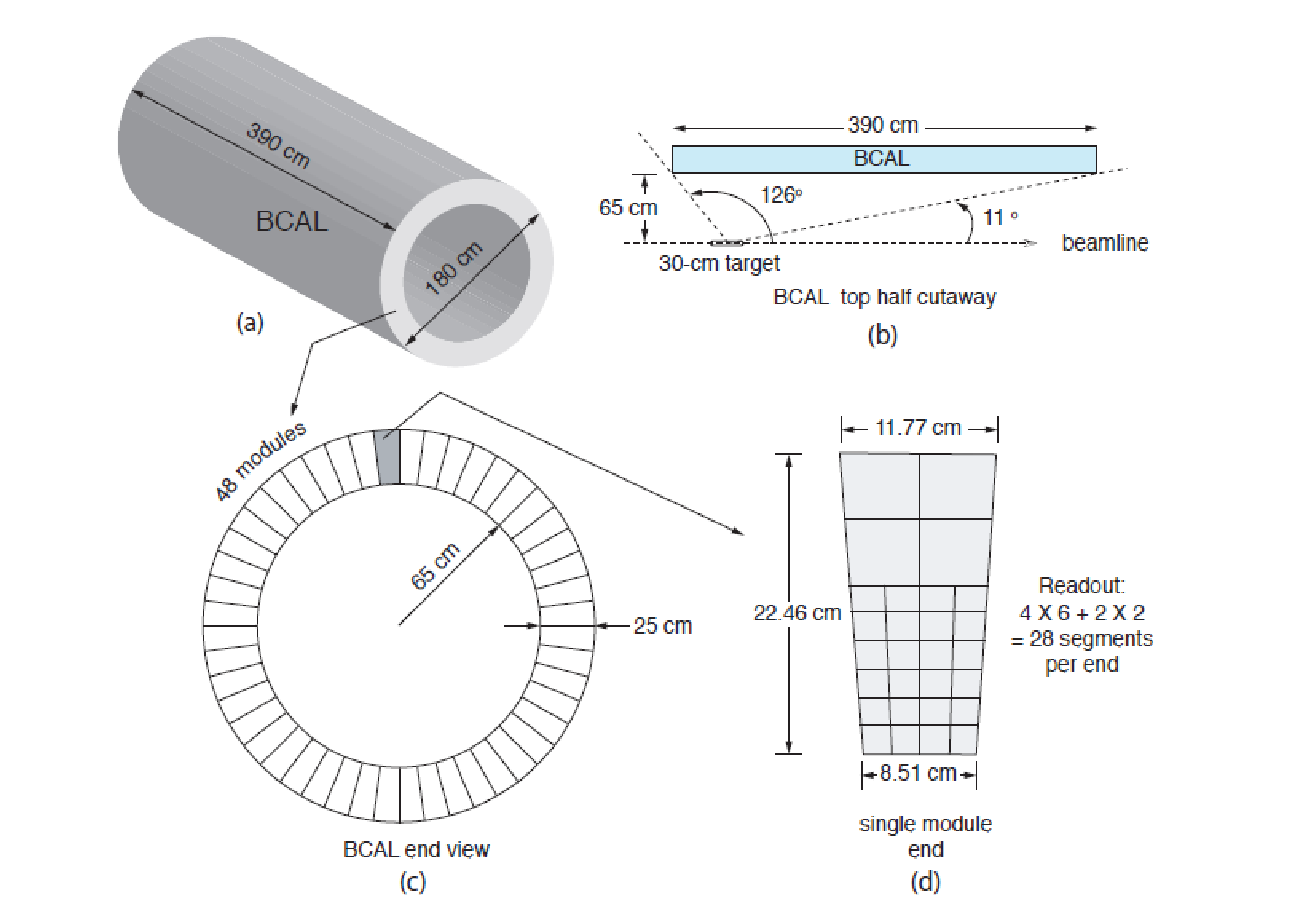
electron eff 95%

pion rejection 50:1





HallD Pb/SciFi BCAL
optimazed for photon detection



Summary

- Shashlyk need more study.
- Fe/SciFi seems a promising candidate.

  Still need more study, particular emerging side about how to implement it into endcup.
- Some expertise can be used within Jlab.