Test Beam Prototype Simulation Studies of a Total Absorption DR Calorimeter

PROGRESS REPORT

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- University of Udine -

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Outline

In the following slides the simulation studies on the energy reconstruction of a single particle (either 10 GeV electron or 10 GeV pion) that undergoes inside a test beam prototype of a total absorption calorimeter with optical dual readout are reported.

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In this analysis, the test beam calorimeter prototype simulated has a truncated cone shape and it is made of scintillating glasses.

The attention is focused on the application of the DR Technique and the evaluation/correction of the quantity of the leaking energy to obtain a good energy resolution.

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3. Particle Beams → *"DRCalPrimaryGeneratorAction,, and "file.mac,,*

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Material Composition

Salt	% (by weight)
BaO	43.4%
SiO_2	42.5%
Li_2O	4.0%
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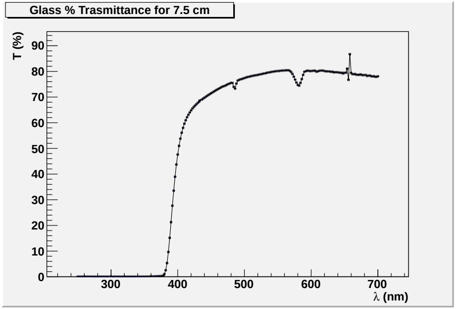
Material Proprieties

- density: 3.36 g/cm^3;
- radiation length: 4.25 cm;
- interaction length: 45.6 cm (for pions with 30-200 GeV energy)
- refraction index: n: 1.61 (TODO)
- Cherenkov emission angle θ_C: 51.6
- Scintillation decay time: 70 ns
- Cherenkov to scintillation signal: C/S=40/60
- Absorption length vs photon energy (next slide)
- TODO: Birks constant, "YIELDRATIO", "SCINTILLATIONYIELD", "SLOWCOMPONENT".

Absorption Length vs Photon Energy

Trasmittance: from experimental measurements ...



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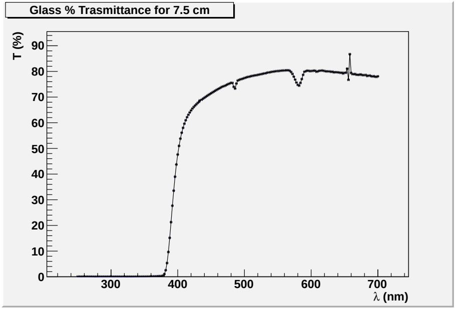

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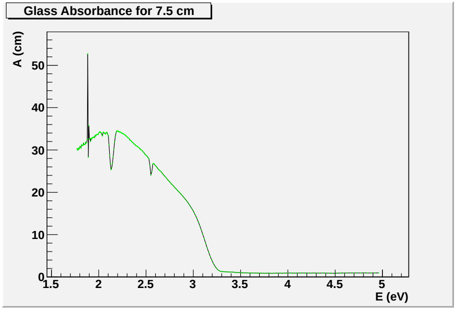
Absorption Lenght

$$A = -\frac{7.5}{\ln(T)} \qquad E = \frac{hc}{\lambda}$$



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The dimensions of the glasses are:

- 74 large glasses: 15 x 15 x 89 cm^3
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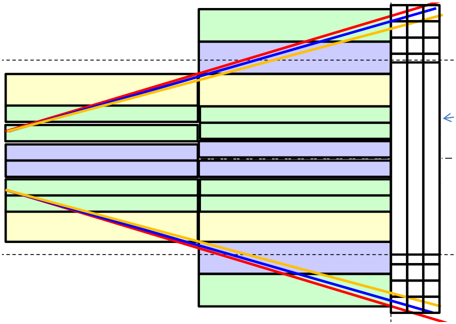

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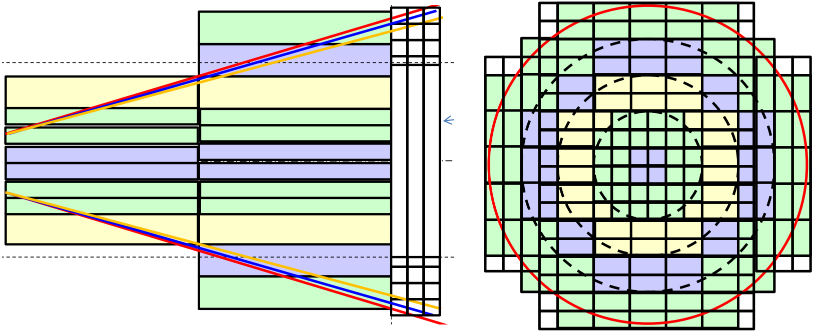

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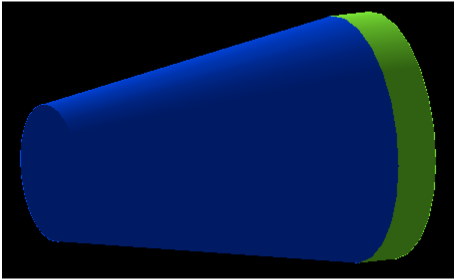
Actual Geometry on the Simulation

FOR NOW SIMPLIFIED GEOMETRY: Truncated Cone + Cylinder



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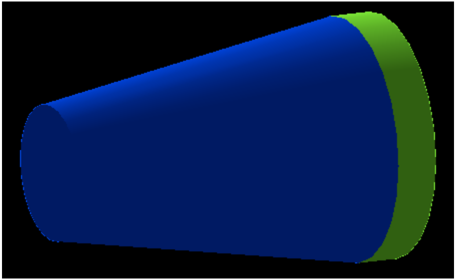

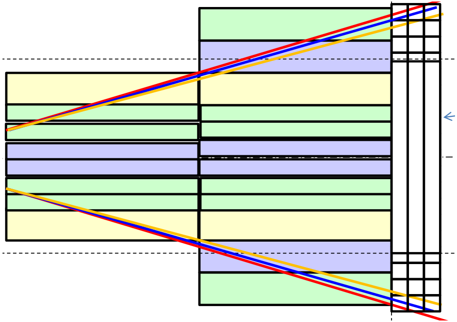

Truncated cone

- Rmin= 37.5 cm
- Rmax= 67.5 cm
- Length= 178 cm

Cylinder

- Radius= 67.5 cm
- Length= 22.5 cm

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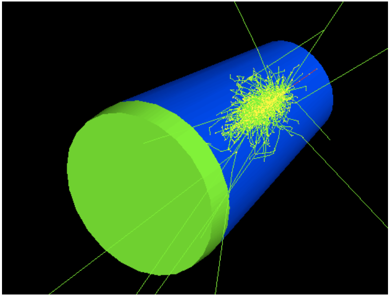

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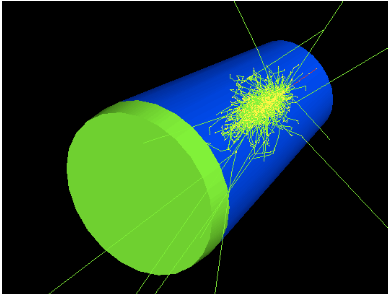

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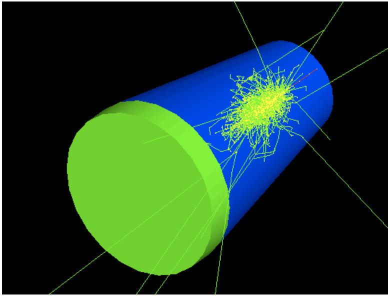

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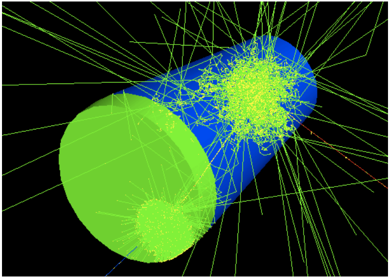

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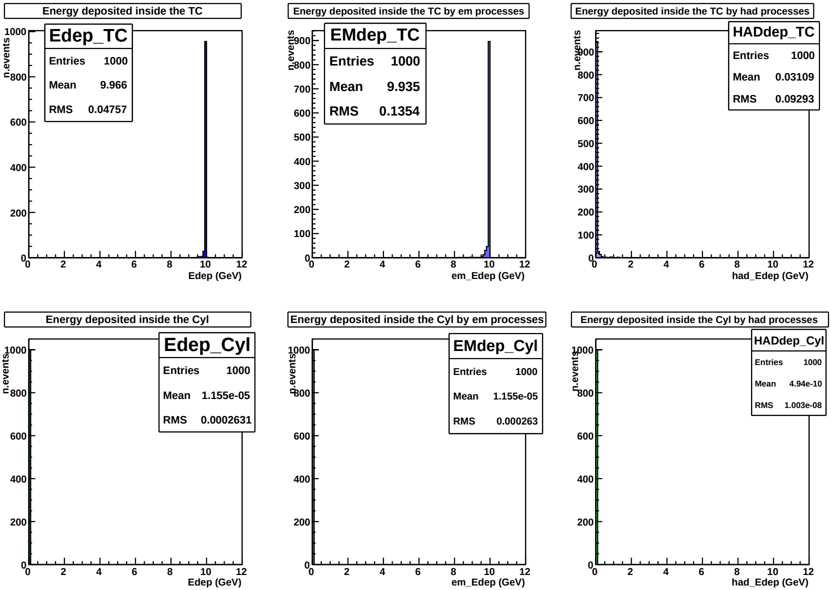
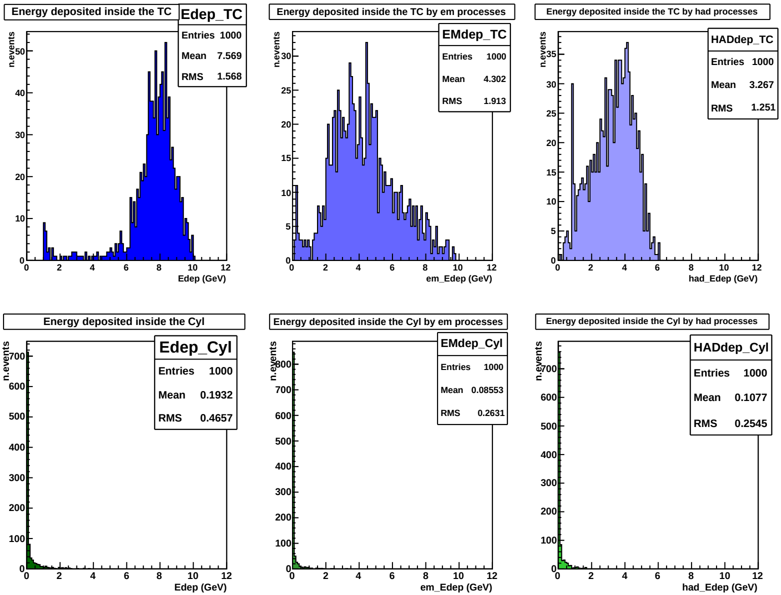


Energy Deposited by Pions



Longitudinal Leakage and DR Corrections

First the longitudinal leakage corrections for the hadronic energy (S) and the Čerenkov energy (C) are performed in the following way:

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Recipe for the Longitudinal Leakage Correction

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2. Find the correlation f by fitting the plot $\Rightarrow \frac{S_{TC}}{\langle S\rangle} = f(S_{Cyl})$;
3. The "no leakage" energy will be: $\widetilde{S} = \frac{S_{TC}}{f(S_{Cyl})}$
4. For Čerenkov energy just replace S with C.

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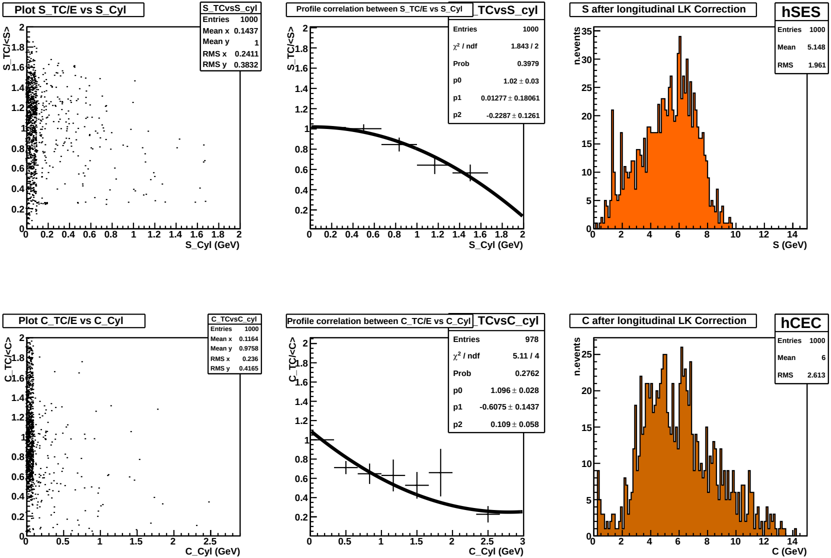
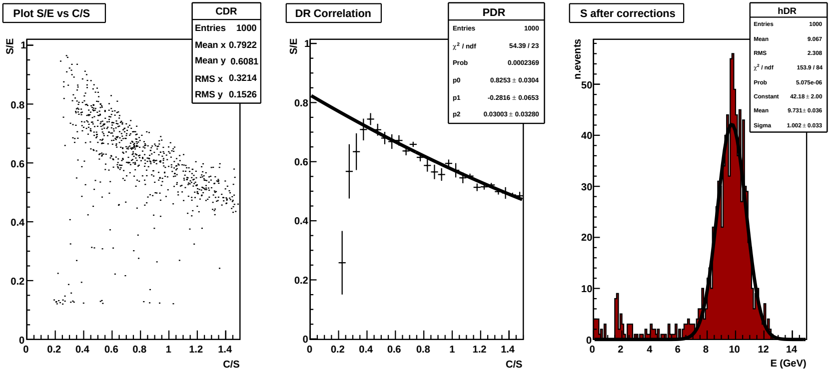
Recipe for the DR Correction

1. Make a plot of $\widetilde{S}/E$ vs $\frac{\widetilde{C}}{\widetilde{S}}$;
2. Find the correlation g by fitting the plot $\Rightarrow \widetilde{S}/E = g(\frac{\widetilde{C}}{\widetilde{S}})$;
3. The corrected energy will be: $\widetilde{E} = \frac{\widetilde{S}}{g(\frac{\widetilde{C}}{\widetilde{S}})}$

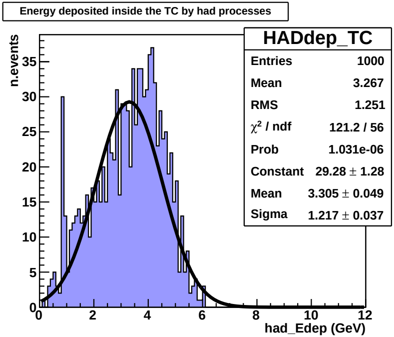
Example of Longitudinal Leakage Correction

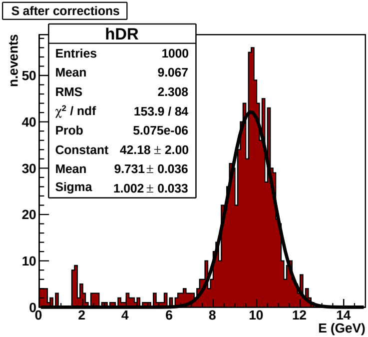


Example of DR Correction



S Before and After Correction





Conclusions and Comments

- The leaking energy needs to be studied thoroughly:
  - an idea for investigating longitudinal LK, lateral LK and back scattering is to include the TBP (blue TC) inside a "big" truncate cone made with an active material and to measure the energy deposited on it.
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  - the longitudinal correction has been investigated. Now the attention is focused on the correction for the lateral losses with the same mechanism.
- Future work: make a detailed simulation of the TBP (as the example shown before).