Update on cross-media showers

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Objectives

- Show the flexibility of Corsika 8 for different experimental situations.
- Show that cross-media showers work by comparing to C7+Geant4
- Show with a simple example the possibility of medium specific radio propagators. If done, not with a general interface.

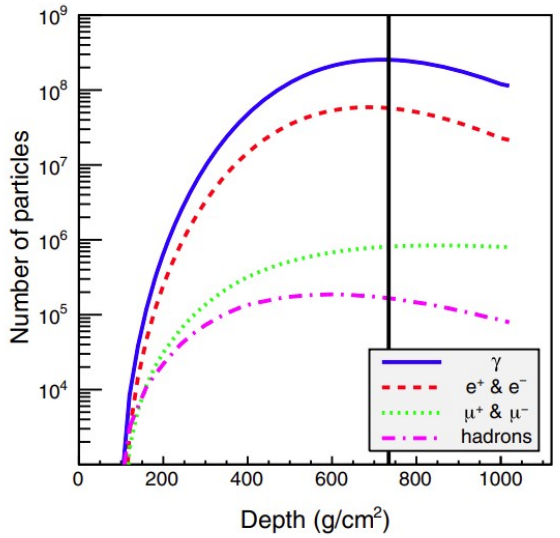
The comparison with C7+Geant4

- Study done by S. De Kockere ,K. D. de Vries ,N. van Eijndhoven and U. A. Latif. PhysRevD.106.043023
- C7 simulated the air shower and then the particles at ground were propagated in ice with Geant4.
- Ice medium density: $\rho(z) = 0.460 + 0.468 \cdot (1 - e^{0.02 \cdot z})$, $z \equiv$ ice depth
- Medium density implemented in slices of 1 cm of constant density.

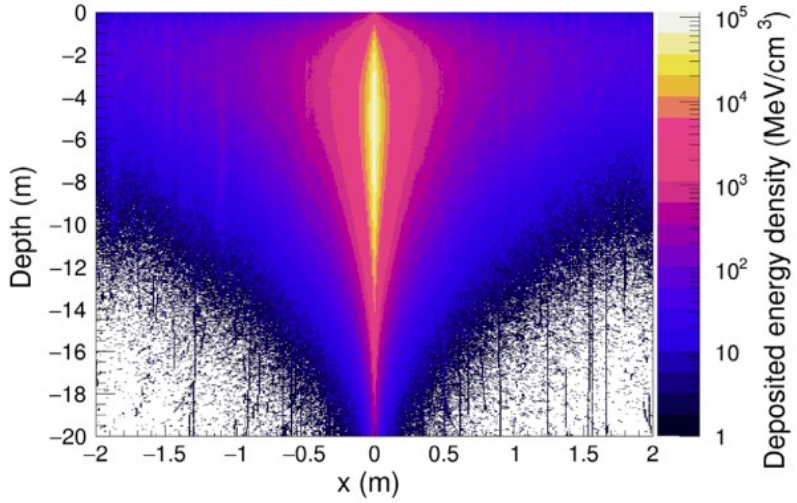
The comparison with C7+Geant4

- 100 PeV shower, cut-off length 1 mm ~ 0.1 MeV KE in top ice layer.

Longitudinal profile

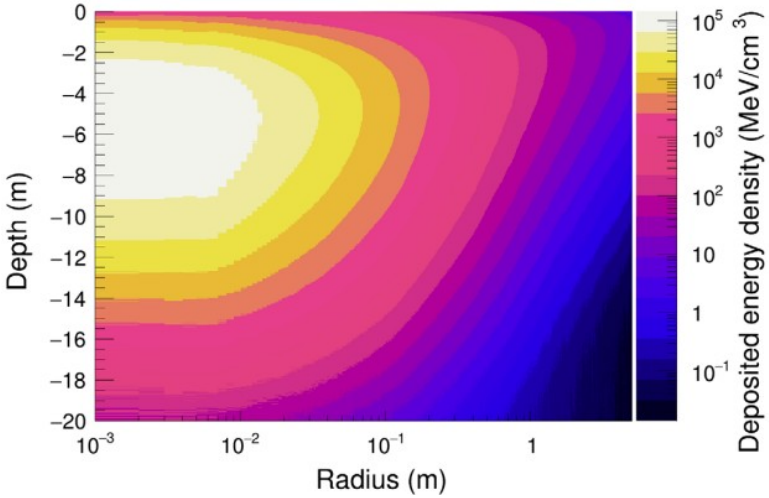


Energy deposit ice

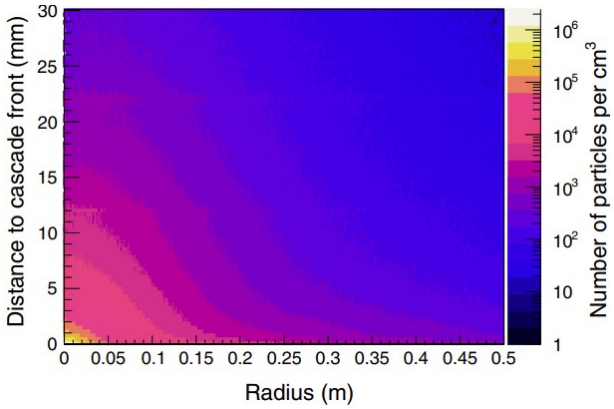


The comparison with C7+Geant4

Radial deposited energy density distribution in ice



Distance to shower front at 1034 g cm^{-2}



The ice medium in C8

- Implemented as a new class IceMedium.

- Elements needed to create a new medium:

  1.Density

  2.Length to Grammage

  3.Grammage to length

$$\rho(h) = 0.460 + 0.468 \cdot (1 - e^{-0.02 \cdot (h_{int} - h)})$$

$$\rho(h) = a_1 + a_2 \cdot (1 - e^{-b \cdot (h_{int} - h)})$$

$$\chi = \int_{h_1}^{h_2} \rho(h) \frac{dh}{\cos(\theta)} = (a_1 + a_2) l + \frac{a_2}{\cos(\theta) b} \cdot e^{-b \cdot (h_{int} - h_1)} \cdot (1 - e^{bl \cos(\theta)})$$

where l is the length of the step and θ is the angle of the track with $\hat{r}$.

The ice medium in C8

- In order to get length from grammage one should have $l = l(X)$
- It is not possible to get an analytical expression.
- If one asumes $bl\cos(\theta) < 1$ we can expand the last exponential to second order and get:

$$\chi \approx (a_1 + a_2)l + \frac{a_2}{\cos(\theta)b} \cdot e^{-b\cdot(h_{int}-h_1)} \cdot [bl\cos(\theta) - \frac{1}{2}b^2l^2\cos^2(\theta)]$$

$$\chi = cl + dl^2$$

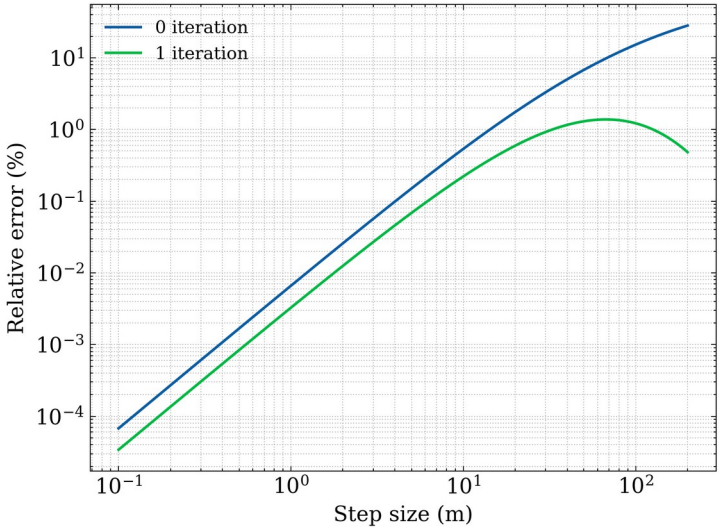
The ice medium in C8

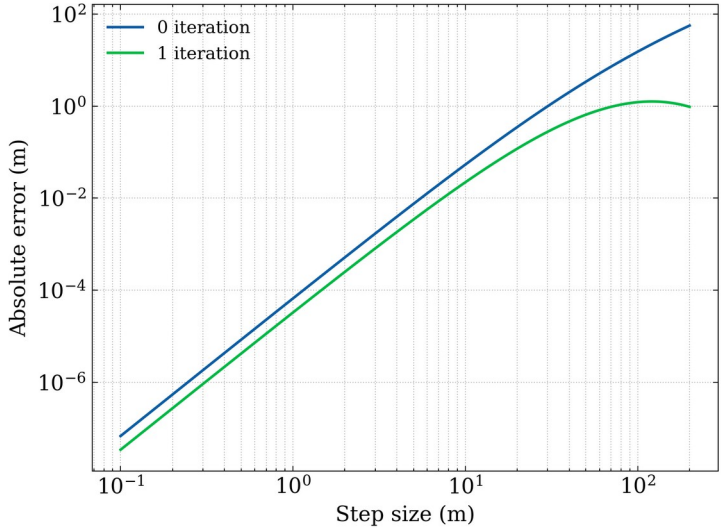
- Rad. Length ~ 37 g cm^{-2} so $bX_0 \approx 0.0161$
- For some muons the approximation could be not so good.
- The approximation could be iterated once to get a better result.
- For very long or deep tracks it is not a problem.

The ice medium in C8

- 1 iteration means doing $l_1 = X^{-1}(l_0)$ to get a better estimate.

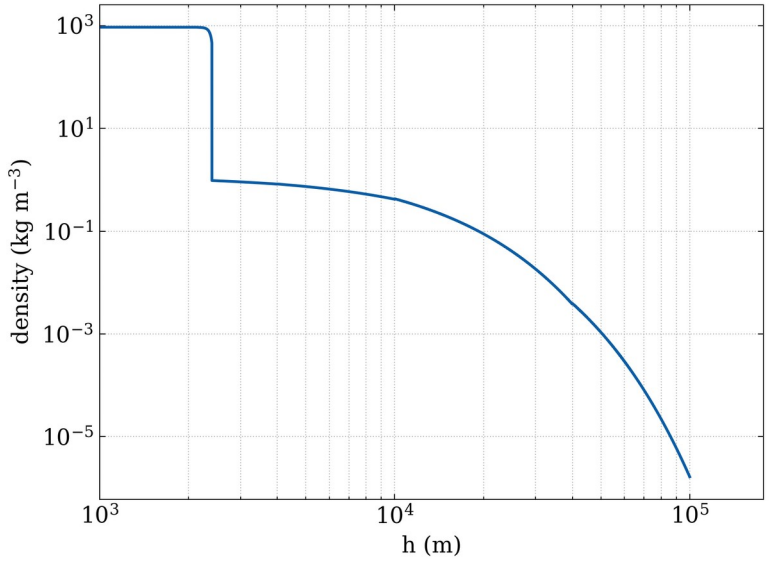
- For em particles the approximation seems fine.

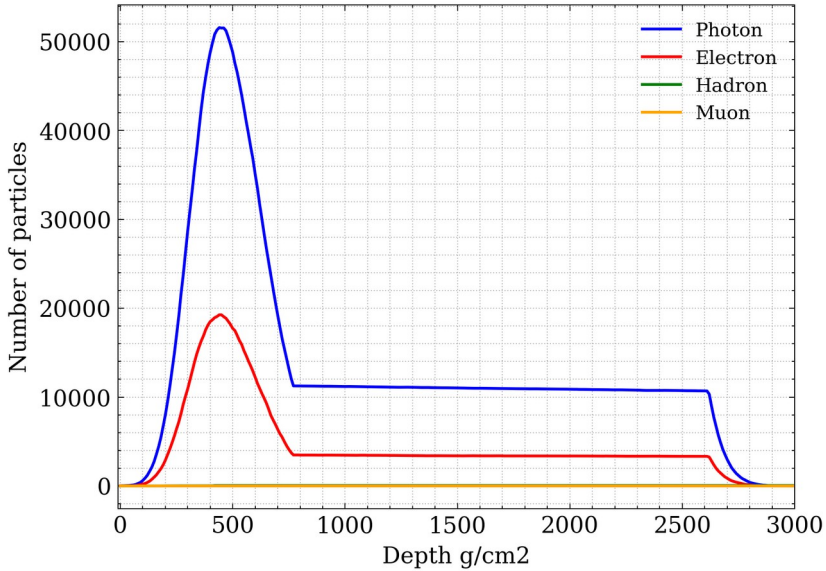




Some results

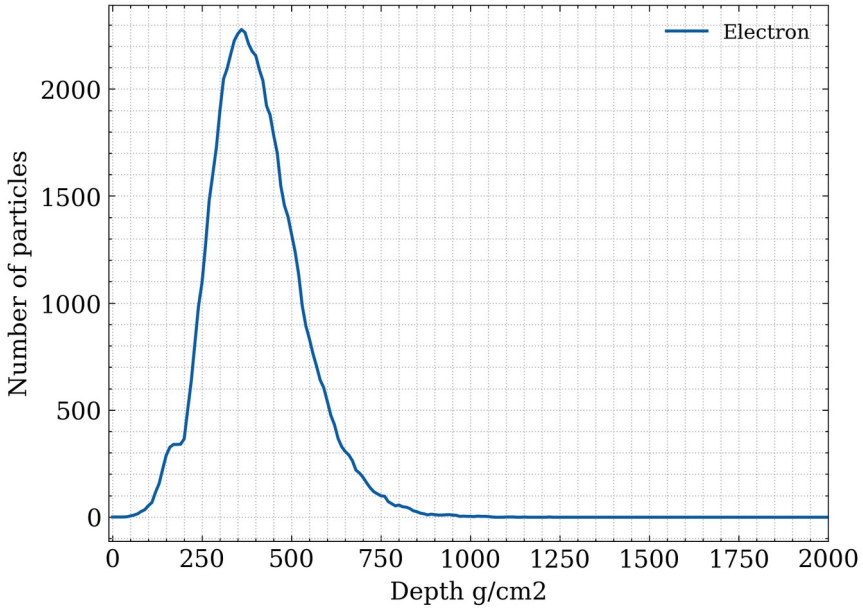
- Linsley atm. + ice sphere at h=2.4 km and inj. Alt. 112.75 km.
- 1 PeV with 1 GeV cuts, em shower.



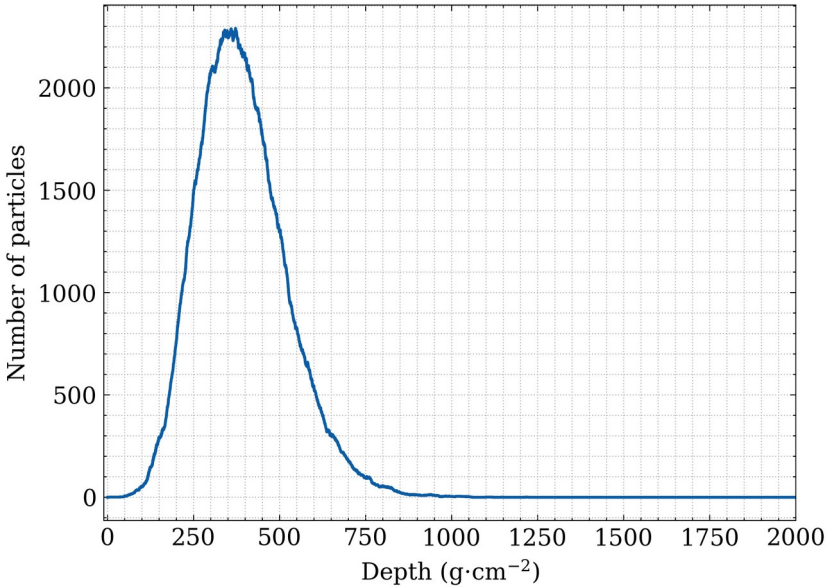


Some results

- Linsley atm. + ice sphere at h=3 km and inj. alt. 5 km.
- 100 TeV with 1 GeV cuts, em shower.



Corsika 8



My script from tracks.parquet

1cm binning