Geant4.9.5 Muon Sím for Homestake 4850ft Level

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Muons Travel in Rock



- 1. Homestake rock sample.
- 2. Muons with fixed energy 1PeV and vertically downwards.
- Average depth 1Pev muon can reach is 6~7 km. So a casting area with radius of 10km on the surface is big enough for a full simulation. No earth curvature consideration needed.



Muon Tracking from Surface

• Surface Muon Flux(Gaisser formula):

$$\frac{dN_{\mu}}{dE_{\mu,0}} \approx \frac{0.14 \cdot E_{\mu,0}^{-2.7}}{\mathrm{cm}^{2} \mathrm{sr \ s \ GeV}} \times \left(\frac{1.0}{1 + \frac{1.1 \cdot E_{\mu,0} \cos(\theta)}{\epsilon_{\pi}}} + \frac{0.054}{1 + \frac{1.1E_{\mu,0} \cos(\theta)}{\epsilon_{K}}}\right)$$

 In this formula, the muon decay effect is neglected which make it slightly off from experimental data at low energy range. The rewrite formula[guan et. al.,

http://escholarship.org/uc/item/6jm8g76d]:

$$\frac{dI}{dE_{\mu}d\cos\theta} = 0.14 \left(\frac{E_{\mu}}{GeV} \left(1 + \frac{3.64GeV}{E_{\mu}[\cos\theta^*]^{1.29}}\right)\right)^{-2.7} \left[\frac{1}{1 + \frac{1.1E_{\mu}\cos\theta^*}{115GeV}} + \frac{0.054}{1 + \frac{1.1E_{\mu}\cos\theta^*}{850GeV}}\right]$$

Surface mountain profile



We need a circle area with radius of ~ 10km. So the rest of area is supplemented by satellite data from CGIAR (http://srtm.csi.cgiar.org/)

Muon Casting and Selection

- Surface position: uniformly distributed on a sheet 10km*10km(easier to calculate live time.) then compare the angle to the experimental hall to match the real position in the mountain profile.
- Energy and angle: get randomly from the modified Gaisser formula: energyTheta-> GetRandom2(E, cosTheta). For the 4850ft level, we take the energy range[1TeV, 1PeV]. The total flux for this energy range at surface is: 7.16e-3/m2/s.
- Only those muon direction can reach the detector (34m³, with extended tolerance of 6 meter) are selected for Geant4 tracking.

The Plans

- Full simulation of 4850ft with different rock density: 2.7g/cm3 and 2.93g/cm3 to see the effect of density to the results.
- Full simulation of 800ft level.
- Standard rock with flat surface. Try to get the general depth vs muon flux relation for all depth down to 12 km.w.e.

Preliminary Results



Muon Flux at 4850 (E>1GeV) 3.83e-05/m2/s ---G4.9.5 full sim

Angular Distribution

