Neutron studies within Edelweiss - Lyon/Saclay groups - Update
IDM 2004

Gilles Gerbier for EDELWEISS collab.

- Edelweiss data: neutron evts?
- Comparison GEANT321 FLUKA
- Benchmarks for comparison
  - neutron primary production
Edelweiss data
background E>30 keV, Q<0.5
Incomplete charge collection events

- Total: $E > 30$ kEV $Q > 0.5 = 28$ evts, last 42 kg.d
  - Upperband: 11
  - In recoil zone: 5
  - Lower band: 12
- If homogeneous filling of incomplete charge collection evts: expect about 25% (recoil zone surface/total) of total in recoil zone ie: 7
- Observed 5 => no evidence for significant other contribution (neutron)
Neutrons

• 1 double recoil interaction seen
  – 1 Coincidence recoil recoil evt in bolo1 – bolo2
  – 90 % CL interval (poisson) : 0.051-4.73 evts
  – Probability of double evt ~ 10 %
  – => Expected single at 90 % CL ~ 0.5 - 47 evts !!!

• Expected rate from rock neutrons
  – Rate of neutron > 1 MeV in LSM is 1.6 $10^{-6}$ n/cm²/s
  – Propagation with GEANT3/MCNP gave following compatible expectations :
    • Rate > 10 keV = 0.05 evts/kg/d
    • Rate > 30 keV = 0.014 evts/kg/d
  – => expected in 62 kg.d : 3 evts with E >10 keV : 1 evt>30keV
“Recommendations” from Third TECNOmSIQ meeting, Paris 24/01/03

Benchmarks for code comparison

- Compare n production + spectrum with FLUKA (Vitaly) and Geant 321 (Lyon) for a "cubic volume" : section 20mx20m, length d

12 different cases:
- d = 200 g/cm²
- Material: Aluminium
  - = 500 Lead
  - = 1000 (Carbon, CH2)

Monoenergetic muon beam of on face A: E = 100, 300 GeV
Vacuum after d and an energy threshold for neutrons crossing face B: 100 keV

- Neutron recoil spectrum in a large volume comparable to LVD experiment with Geant321
Correction in photonuclear cross section in GEANT321 – Martine Stern IPNL

- X section integrated from $\nu = 10$ MeV

- However: no photo production of neutron in secondary shower!!! But try to compare…
Fluka – Vitaly K.

Geant 3 – Martine S.
Study of features of primary interaction: energy/mult. in scintillator

100,000 muons crossing 240 cm of scintillator <=> 200 g/cm²
Study of features of primary interaction: energy/mult. in lead

100,000 muons crossing 18 cm of lead

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<thead>
<tr>
<th>ID</th>
<th>Entries</th>
<th>Mean</th>
<th>RMS</th>
<th>UDFLW</th>
<th>OVFLW</th>
<th>ALLCHAN</th>
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mult and energy (GeV) primary neutrons in Pb, 20 GeV muons
```

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mult and energy (GeV) primary neutrons in Pb, 300 GeV muons
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## Summary

<table>
<thead>
<tr>
<th>Primary production in scintillator</th>
<th>n/mu/g/cm²</th>
<th>Mean multiplicity (&gt;= 1)</th>
<th>Mean energy</th>
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</thead>
<tbody>
<tr>
<td>20 GeV Analyt calc</td>
<td>0.7 $10^{-5}$ 0.87</td>
<td>2.1</td>
<td>65 MeV</td>
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<tr>
<td>300 GeV Analyt calc</td>
<td>1.6 $10^{-5}$ 1.8</td>
<td>2.2</td>
<td>117 MeV</td>
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</table>

<table>
<thead>
<tr>
<th>Primary production in lead</th>
<th>n/mu/g/cm²</th>
<th>Mean multiplicity (&gt;= 1)</th>
<th>Mean energy</th>
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<tbody>
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<td>20 GeV</td>
<td>10 $10^{-5}$</td>
<td>13</td>
<td>14 MeV</td>
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<tr>
<td>300 GeV</td>
<td>20 $10^{-5}$</td>
<td>16</td>
<td>24 MeV</td>
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</tbody>
</table>

[Delorme et al 1995]
What next?

- Go to GEANT4?
- Get reliability in
  - Production, including other, $\pi, \gamma$: FLUKA/GEANT4/exp
  - Propagation + simulation in detector: GEANT4/MCNP
- Reestimate neutron rate, recoil rate, E spectra multiplicity for EDW 2
  - From muons in shield
  - From muons in rock