FLUKA
Current Status and Plans

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Monte Carlo Simulation

- **Enrico Fermi** is to credit for first using similar approach, *hand cranked* though and not published
- **John von Neumann** and **Stanislav Ulam** formulated, used and named the approach **Monte Carlo**.
- In **1946** this was all secret and classified and the work required a code name. J. von Neumann picked Monte Carlo because the uncle of S. Ulam would borrow and lose money in the Casino at Monaco.
- Los Alamos

  nuclear and particle physics: **neutron diffusion**

FLUKA today

Current release: **Fluka2011.2.6** (Nov.13 2011)

FLUKA is supported jointly by CERN and INFN

official website: http://www.fluka.org

- more than 2000 users world wide today
- FLUKA is available to the academic community free of charge

  the source code is available under a special license
  (published results only for standard version of FLUKA)
- FLUKA's predictions are based on (micro) physics models
  conserves energy
  very consistent approach across all different regimes

FLUKA Collaboration

The FLUKA international Collaboration

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FLUKA

Recently formed working groups within the collaboration – one topic:

electro-nuclear interactions

Alberto Fasso
moved from SLAC to JLAB
FLUKA course at JLAB, April 2012

Wish list

- low energy neutron interactions for C, O, Ar and …
- deuteron interactions

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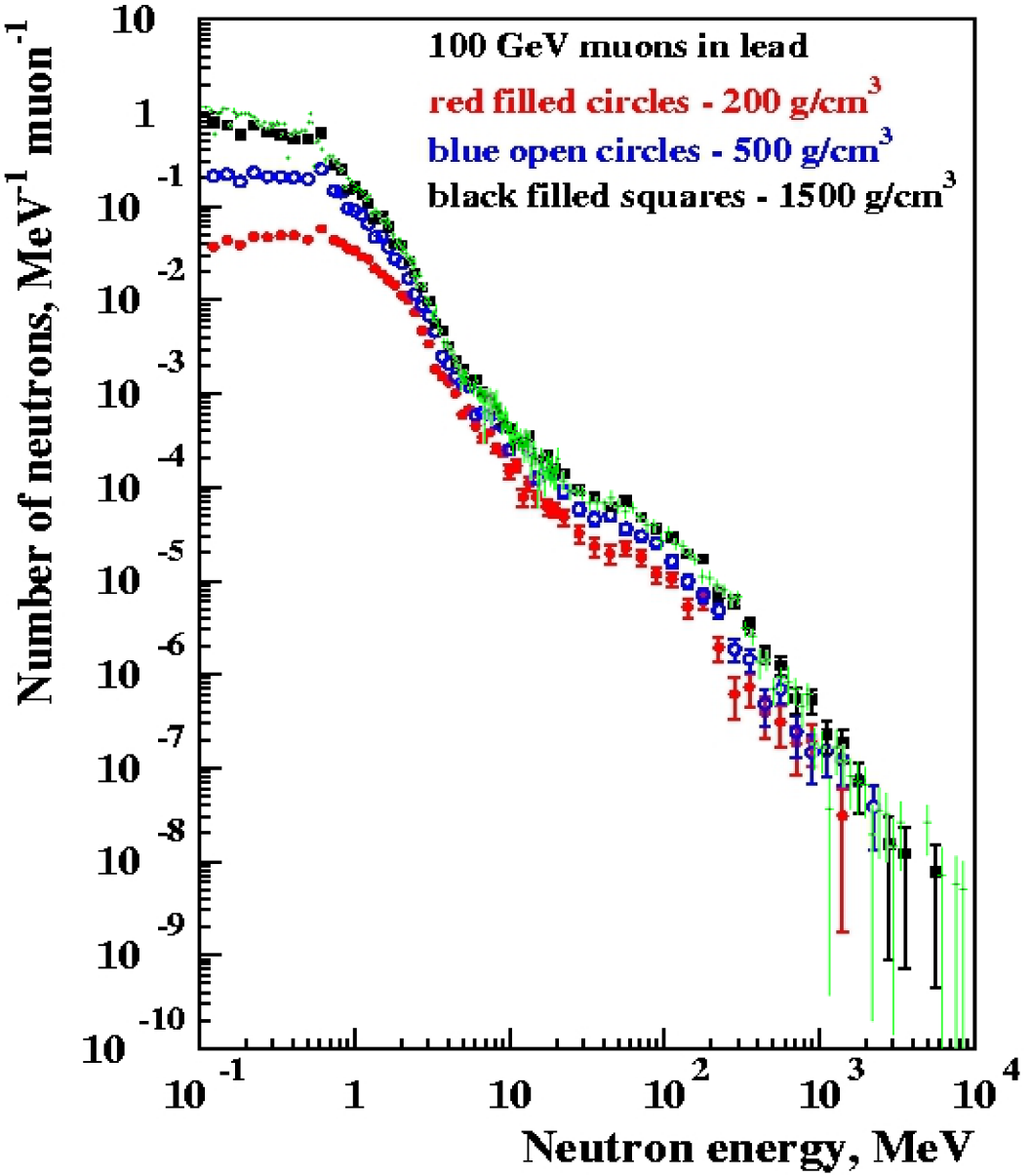
FLUKA - Geant4 comparision

See Anthony's presentation later

FLUKA is consistent with previous results from many years ago.

Original graph provided by Vitaly Kudryavtsev



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Neutron kinetic energy spectrum

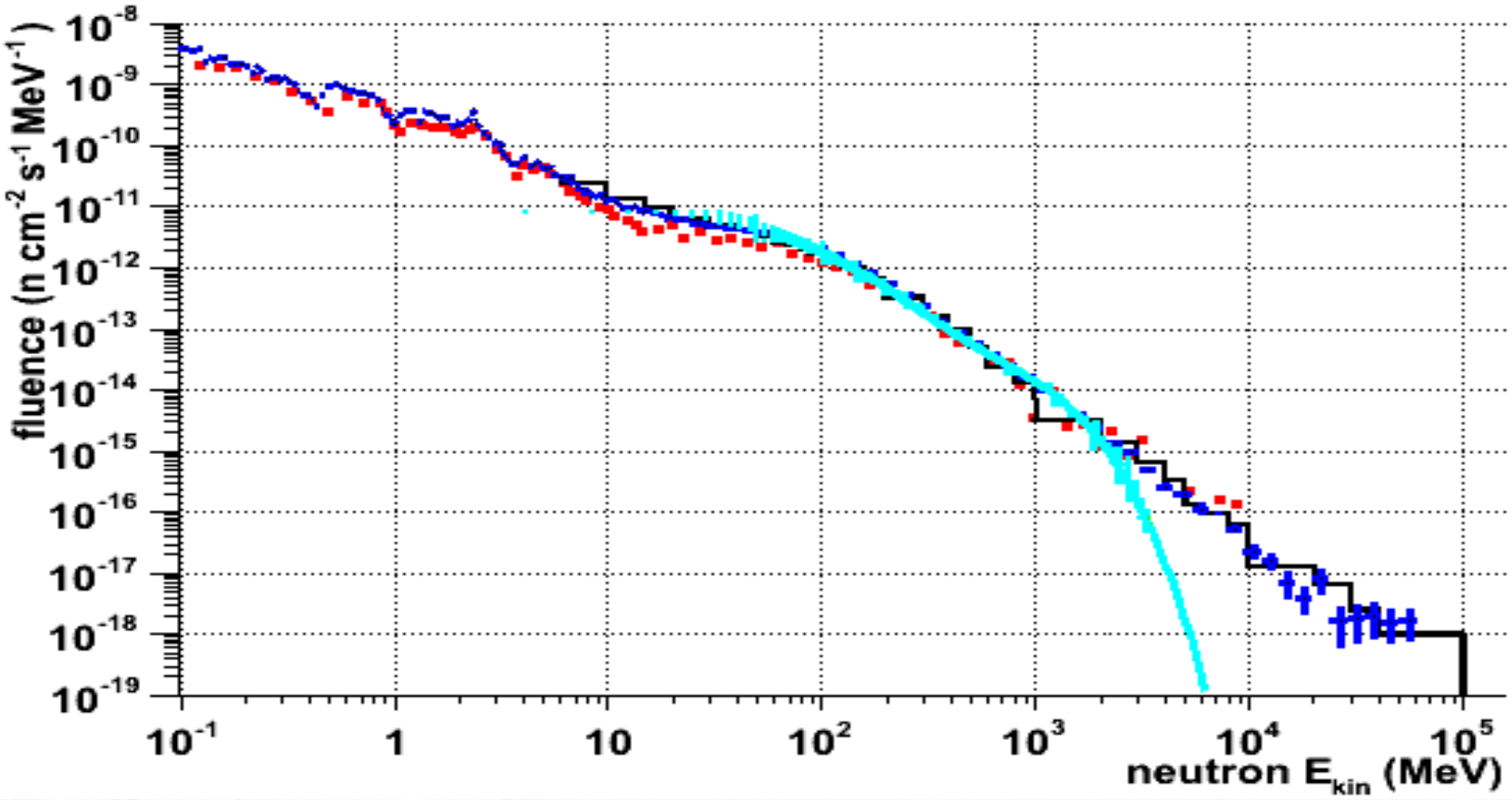
at rock cavern boundary (simple geometry: 6m^3 cavern centered in 20m^3 rock)

current result

H. Wulandari etal arXiv:hep-ex/0401032v1 21 Jan 2004 - FLUKA

A. Dementyev etal Gran Sasso note: INFN/AE-97/50, 22 Sep 1997 - Bezrukov and Bugaev + SHIELD

A. Hime and D.-M. Mei, parameterization × 1.3 arXiv:astro-ph/0512125 v2 6 Dec 2005 - FLUKA



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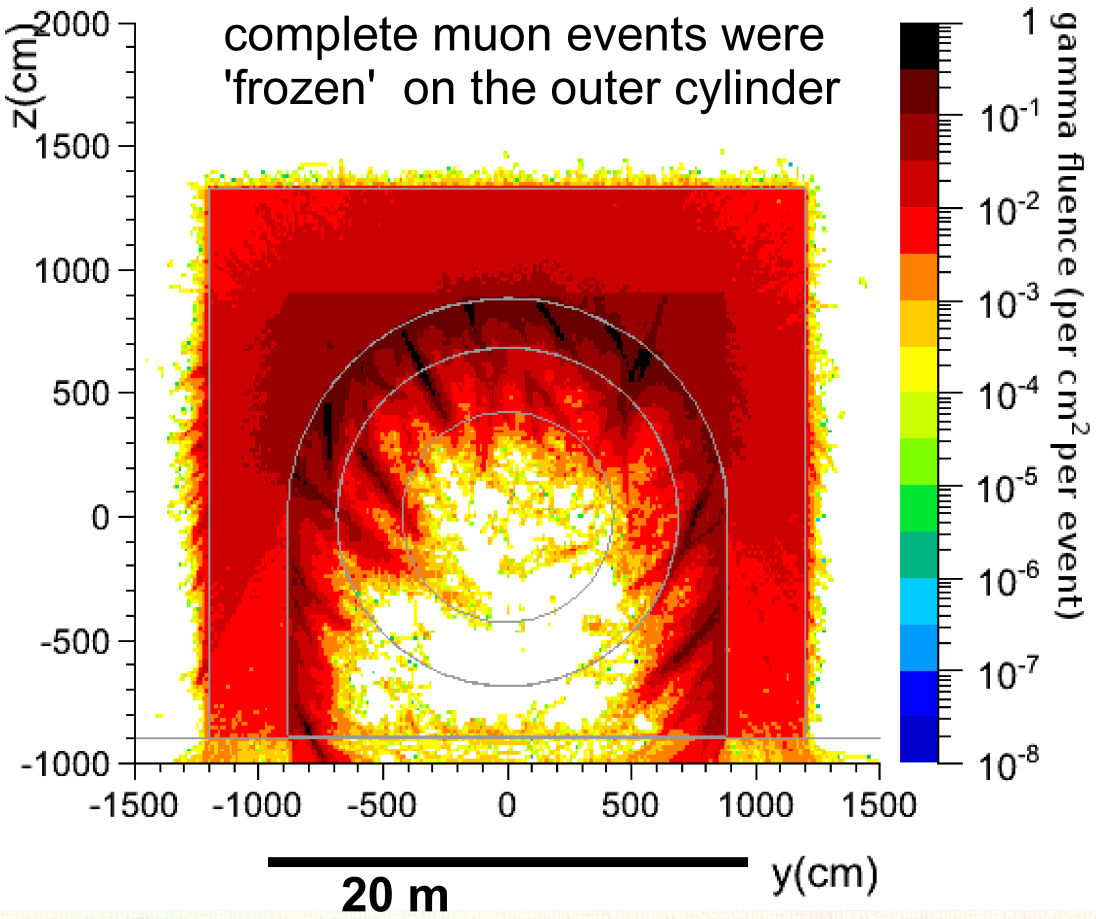
BOREXINO Solar Neutrino Experiment



On the left we show the muon induced gamma background present in BOREXINO as predicted by FLUKA
note the individual showers visibly penetrating the shielding

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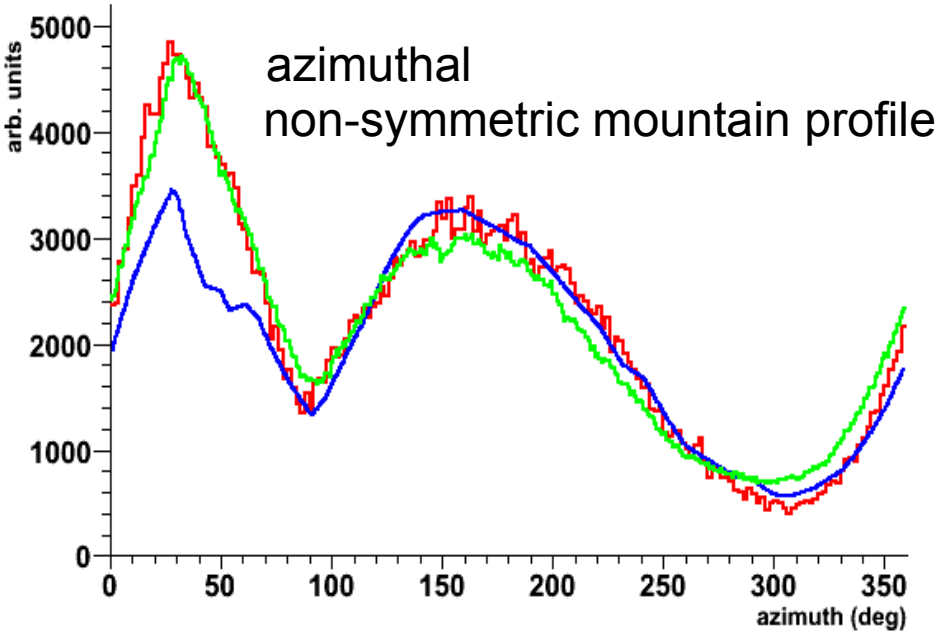
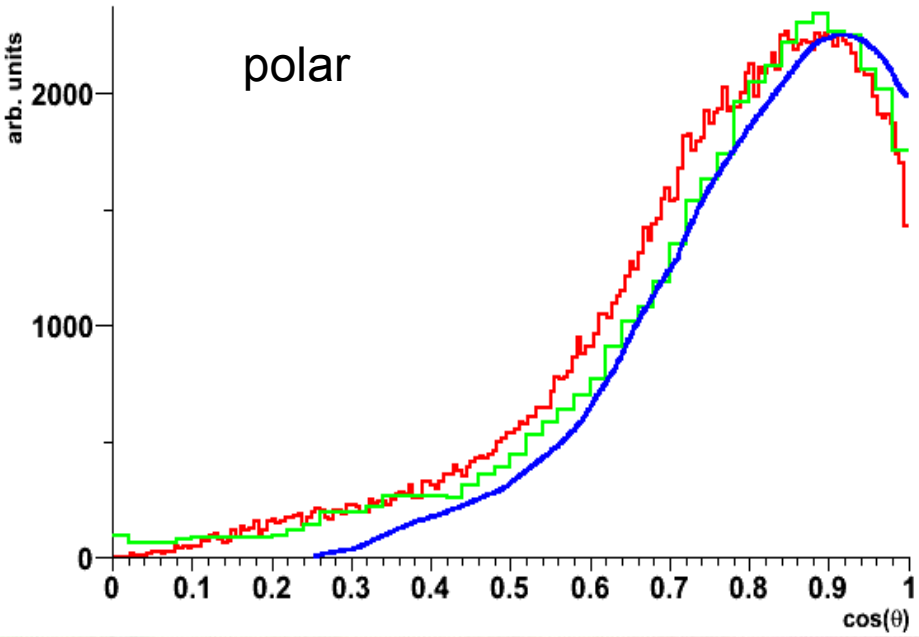
Muon angular distribution at Gran Sasso laboratory





- Borexino measurement in green

  arXiv:1101.3101v2 [physics.ins-det] 16 Feb 2011

- FLUKA predictions in red

  starting from cosmic rays in atmosphere

- MACRO measurement in blue

  Astrophysical Journal, 412:301-311,1993 July 20

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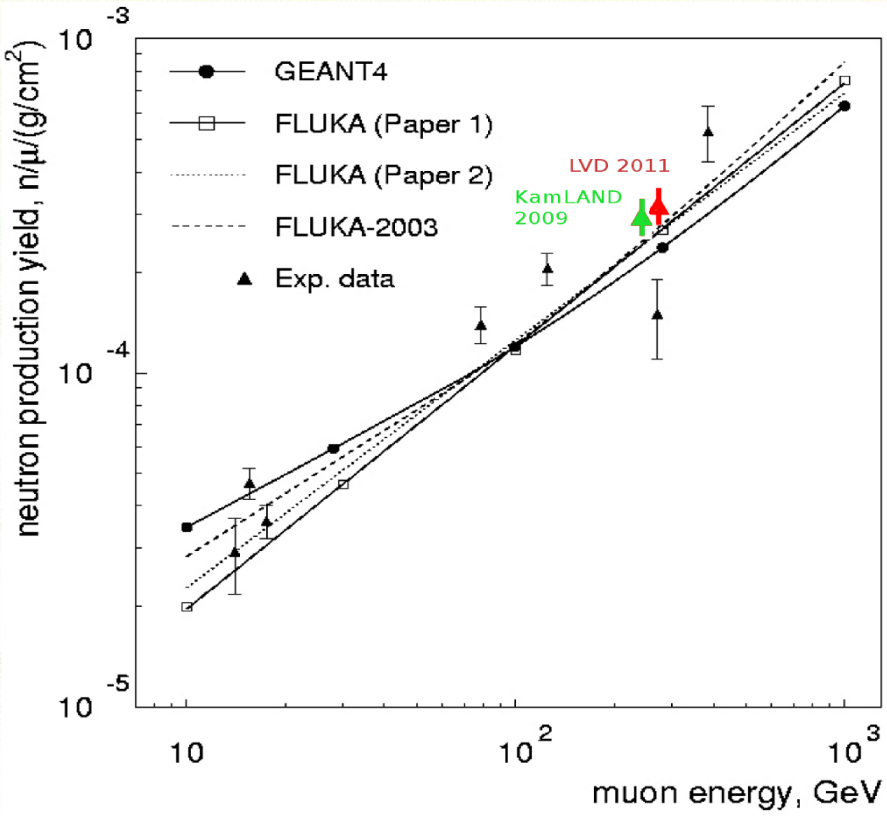
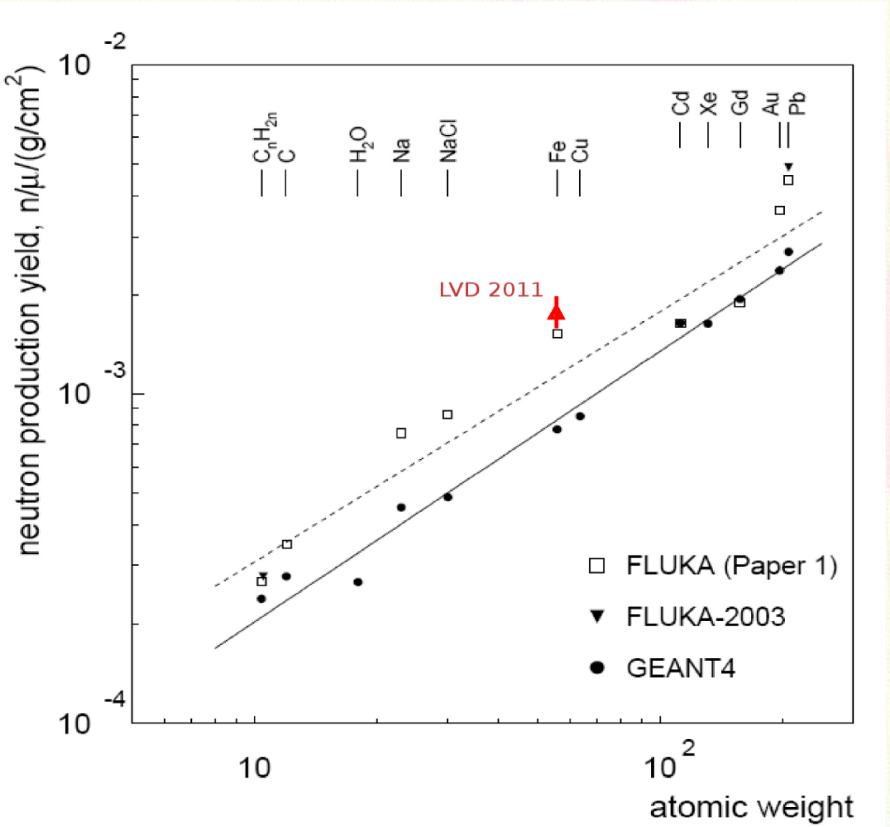
Neutron Yield

Taken from Marco Selvi's presentation given at the Berkeley meeting in April - updated LVD and KamLAND data points added.

(graphs from Araujo et al., NIM A 545 (2005) 398)

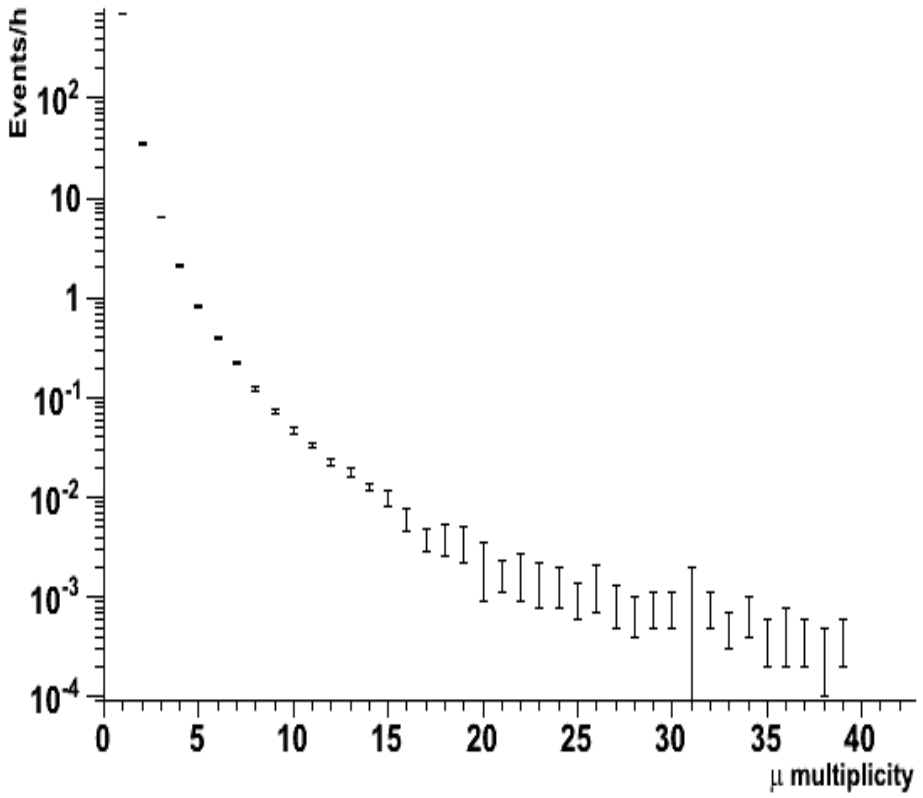


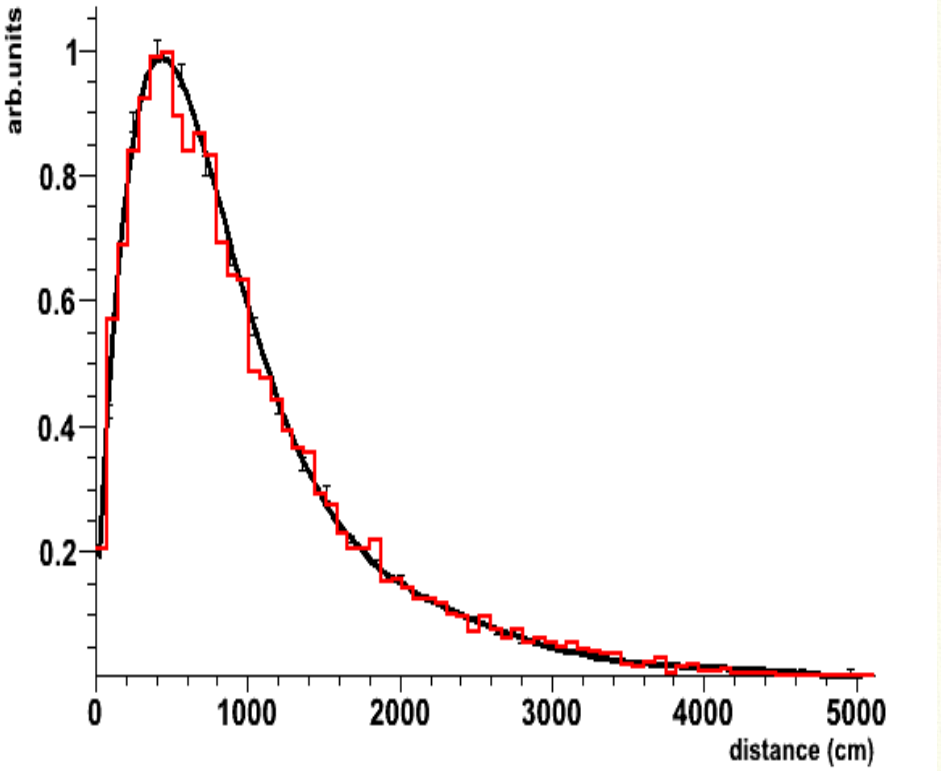


Muon Radiation Field

Detailed description is very important.

Information on muon bundles measured for LNGS by MACRO for example.





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Details to Consider

(currently ongoing work)

Muon Bundles

1.5% muon events with more than 1 muon in BOREXINO

12% of muons crossing inner vessel are from muon bundles

Single muon event mean energy 270 GeV

For multi-muon events the muon mean energy is 382 GeV rather

- mean energy of muons inside BOREXINO: 283 GeV

Energy loss of muons for rock cell in simulation

EVAPORATion and COALESCEnce

Creation of fragments from de-exitation of nuclei

lose 8% neutrons to light fragments

Deuterons ! They are lost to the counting

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A FLUKA Framework

We should consider spending all our resources on preparing the best ever description of full muon events at the cavern walls.

Besides seasonal changes in muon flux, this should be a very stable problem. Once solved, it can be used by experiments taking all relevant details into account. To the degree the experiment decides to do so.

In a naïve and save way, this can be as simple as an ASCII files with pid, x/y/z, cx/cy/cz, ek and age of all particles at the cavern walls per muon event.

Thank you

http://www.fluka.org