Cosmogenic activation in DarkSide20k with GEANT4

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Experience from Borexino

Borexino colaboration, Cosmogenic Backgrounds in Borexino at 3800 m water-equivalent depth, Journal of Cosmology and Astroparticle Physics, Volume 2013, August 2013

- Production of isotopes in Hall C by muons in C_9H_{12} (psevdocumen) liquid scintillator

- the yields of a number of cosmogenic radioisotopes are measured for 12N, 12B, 8He, 9C, 9Li, 8B, 6He, 8Li, 11Be, 10C and 11C. All results are compared with Monte Carlo simulation predictions using the FLUKA and GEANT4 packages. General agreement between data and simulation is observed for the cosmogenic production yields with a few exceptions, the most prominent case being 11C yield for which both codes return about 50% lower values. The predicted μ-n distance profile and the neutron multiplicity distribution are found to be overall consistent with data.

Monte-Carlo and experimental yields for isotopes production in C9H12

	Geant**4** Model III	**G**eant**4** Model IV	**F**luka	**Borexino**	**KamLAND**
		— $\langle E_\mu \rangle$ = 283 ± 19 GeV —			$\langle E_\mu \rangle$ = 260 ± 8 GeV
Isotopes		Yield $[10^{-7}\,(\mu\,g/cm^2)^{-1}]$			
^{12}**N**	1.11 ± 0.13	3.0 ± 0.2	0.5 ± 0.2	< 1.1	1.8 ± 0.4
^{12}**B**	30.1 ± 0.7	29.7 ± 0.7	28.8 ± 1.9	56 ± 3	42.9 ± 3.3
^{8}**He**	< 0.04	0.18 ± 0.05	0.30 ± 0.15	< 1.5	0.7 ± 0.4
^{9}**Li**	0.6 ± 0.1	1.68 ± 0.16	3.1 ± 0.4	2.9 ± 0.3	2.2 ± 0.2
^{8}**B**	0.52 ± 0.09	1.44 ± 0.15	6.6 ± 0.6	14 ± 6	8.4 ± 2.4
^{6}**He**	18.5 ± 0.5	8.9 ± 0.4	17.3 ± 1.1	38 ± 15	not reported
^{8}**Li**	27.7 ± 0.7	7.8 ± 0.4	28.8 ± 1.0	7 ± 7	12.2 ± 2.6
^{9}**C**	0.16 ± 0.05	0.99 ± 0.13	0.91 ± 0.10	< 16	3.0 ± 1.2
^{11}**Be**	0.24 ± 0.06	0.45 ± 0.09	0.59 ± 0.12	< 7.0	1.1 ± 0.2
^{10}**C**	15.0 ± 0.5	41.1 ± 0.8	14.1 ± 0.7	18 ± 5	16.5 ± 1.9
^{11}**C**	315 ± 2	415 ± 3	467 ± 23	886 ± 115	866 ± 153
Neutrons		Yield $[10^{-4}\,(\mu\,g/cm^2)^{-1}]$			
	3.01 ± 0.05	2.99 ± 0.03	2.46 ± 0.12	3.10 ± 0.11	2.79 ± 0.31

First steps:

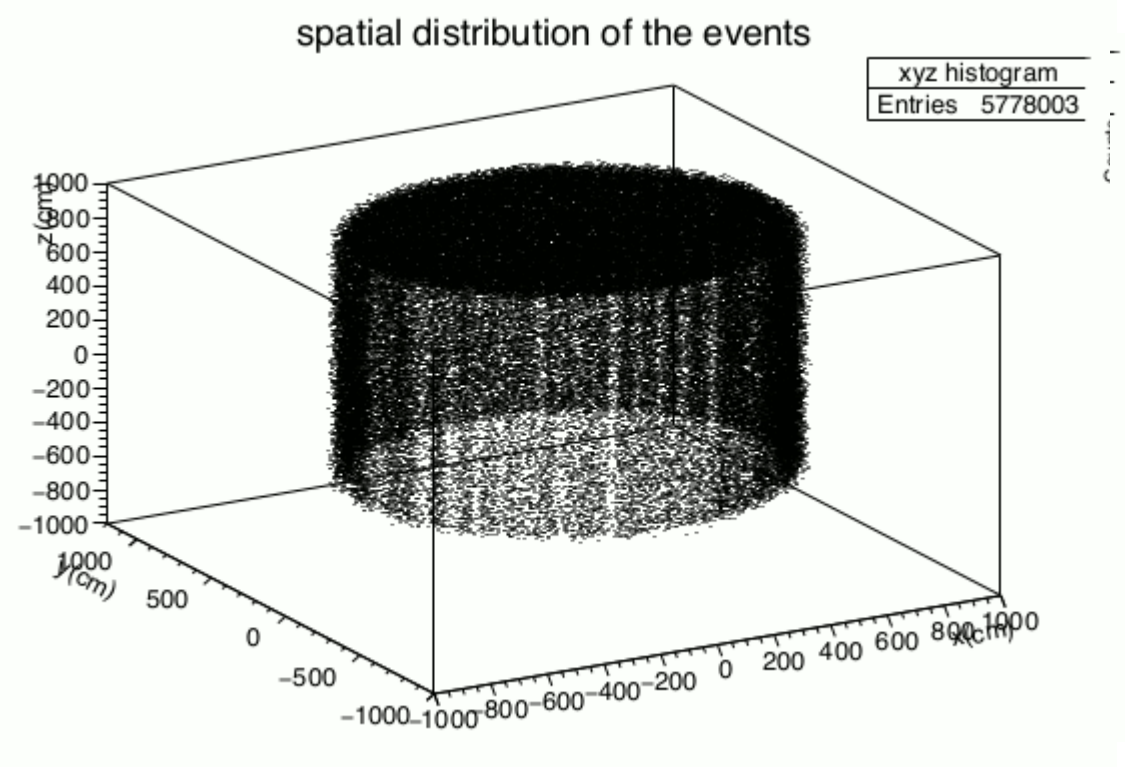
- production of isotopes in 30 ton of Ar with simple Darkside geometry by muons with 270 GeV energy vertical in the center of TPC
- Production of isotopes, using the flux from Fluka simulation (file from Darkside50 old simulation, see the next slide from Sagar presentation

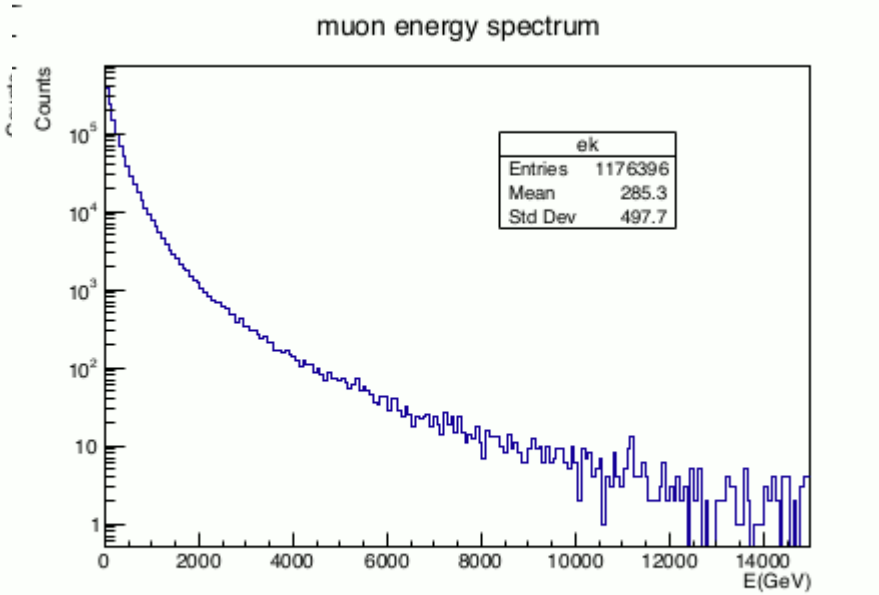
  - virtual cylinder of 7m radius and 14 m height (or propagated flux to cryostate dimensions)

Final step:

Full simulation with Darkside20k (Using the exact g4ds geometry)

- The outer cryostat geometry was obtained from CERN group responsible for construction of the ProtoDUNE cryostat at CERN.
- Cosmogenic events(muons and secondaries) with the information (event type, energy, age, position coordinates and direction cosines) stored in a virtual cylinder of 7m radius and 14 m height. (Results from earlier FLUKA simulation through the Gran Sasso Rock.)





Sample file (C_300), ~ 8 x 10^5 events (5.8 x 10^6 particles)

10^7 muons at cavern ~ 169 days (normalised with respect to Borexino's muon flux measurements)

Muon event rate at cavern ~ 3.4 x 10^{-4} s^{-1} m^{-2}