DS-20k (plan C): Simulation of neutrons from Hall C walls

Ludovico Luzzi (CIEMAT)

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Strategy

- **GOAL:** Estimate neutrons background from walls of the Hall C at LNGS

Simulation divided in 2 subsequent steps, to speed up simulation:

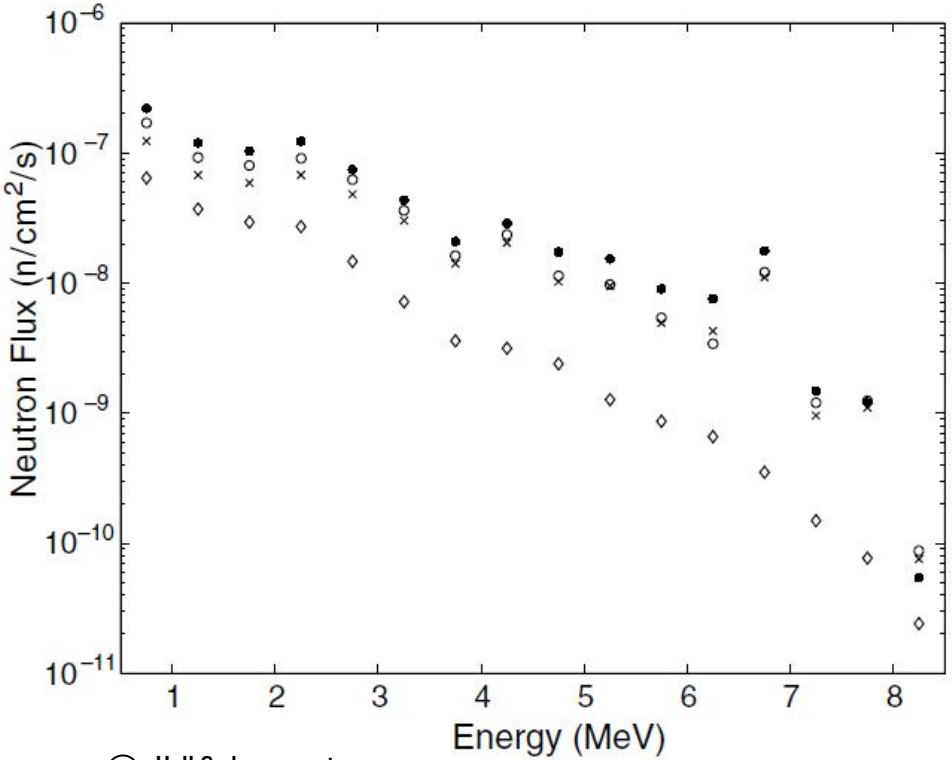
- **Step 1**:

1. Neutrons emitted with an external generator around the cryostat, 10.4 x 10.4 x 10.4 m cube
2. Isotropic emission from cube surface, directed inward
3. Initial energy follows a spectrum from MC simulations (https://doi.org/10.1016/j.astropartphys.2004.07.005)
4. Stop and tag neutrons reaching the vessel around TPC (save position, direction and kinetic energy)

- **Step 2**:

1. Propagate tagged neutrons in the whole geometry
2. Tag neutrons depositing energy in the TPC
3. Apply TPC and veto cuts

Neutron flux from simulations



◯ Hall C, dry concrete

- (alpha,n) + spontaneous fission
- Total flux = 2.75e-6 n/cm2/s (all inward)

- Time (10 y) = 3.15e8 s
- Surface = 6.48e6 cm2

Total neutrons after 10 y exposure = flux * time * surface = 5.6e9

https://doi.org/10.1016/j.astropartphys.2004.07.005

Analysis

First step:

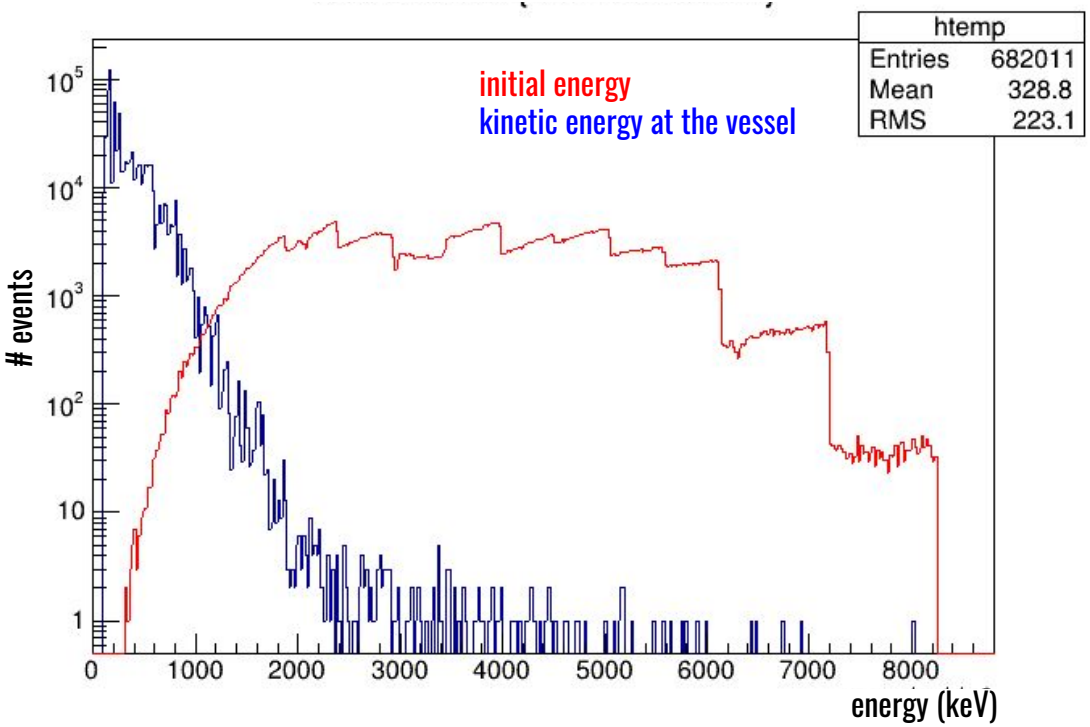
- Number of initial neutrons N = 5.6e9 (10 y)
- hitting the vessel n = 682011
- probability to hit the vessel = n/N = 1.21e-4 (to be compared to 8.7e-3 from the foam)

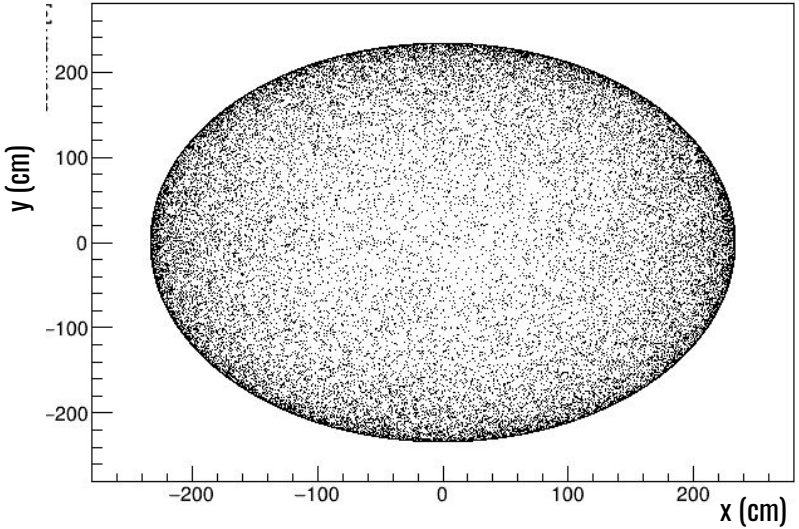
Second step:

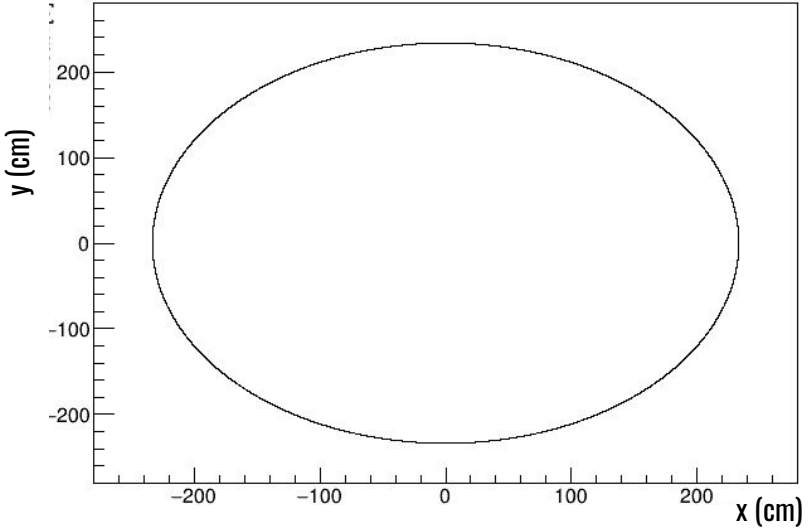
- To increase statistics each event at vessel is propagated 590 times:
  N1 = N * 590 = 3.3e12 initial neutrons equivalent (590 exposures)

- Events depositing energy in the TPC n1 = 127557222

- probability to deposit in the TPC = n1/N1 = 3.8e-5




y (cm)
x (cm)


y (cm)
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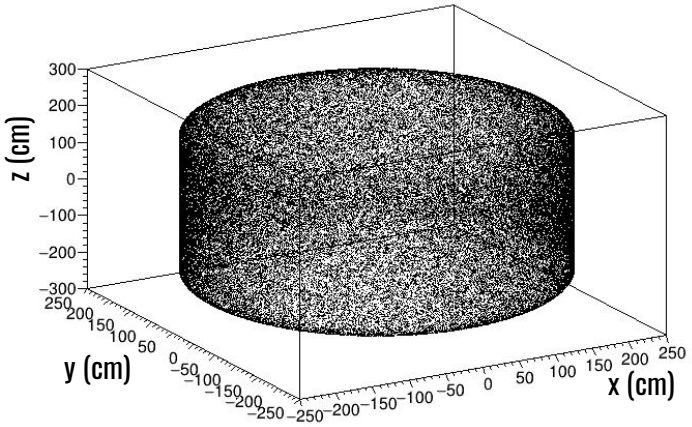
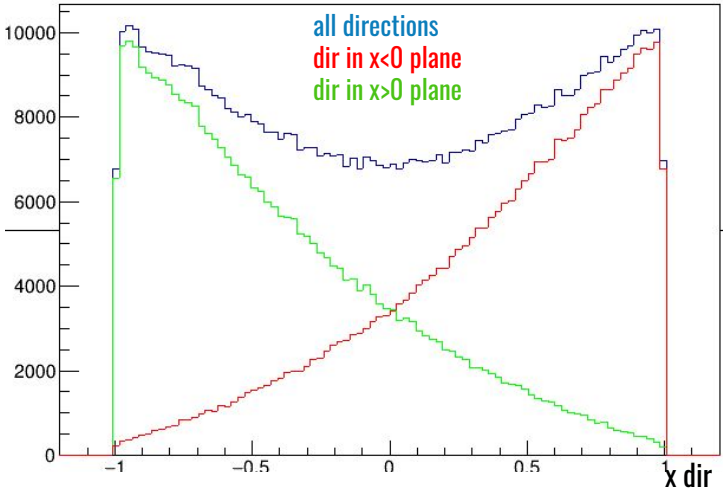

z (cm)
y (cm)
x (cm)


all directions
dir in x<0 plane
dir in x>0 plane
x dir

Analysis

CUTS:

1. just 1 cluster deposited in the TPC
2. in TPC fiducial volume (regular octagon with L = 120.5 cm, h = 200 cm)
3. NR-like
4. deposited energy in the TPC by a cluster in [30, 200] keV
5. deposited energy in the TPC by gamma rays < 50 keV
6. deposited energy in the TPC by inelastic recoil < 10 keV
7. energy deposited in the veto buffer < 200 keV

20 ± 4.5 neutrons after cuts

- n probability to survive in 590 exposures = 20/3.3e12 = 6.06e-12
- bkg = 20/590 = **0.034 neutrons / exposure**