Cosmogenic beta-n backgrounds in Darkside20k with GEANT4

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Backgrounds by Cosmogenic activation of materials in Darkside20k with GEANT4

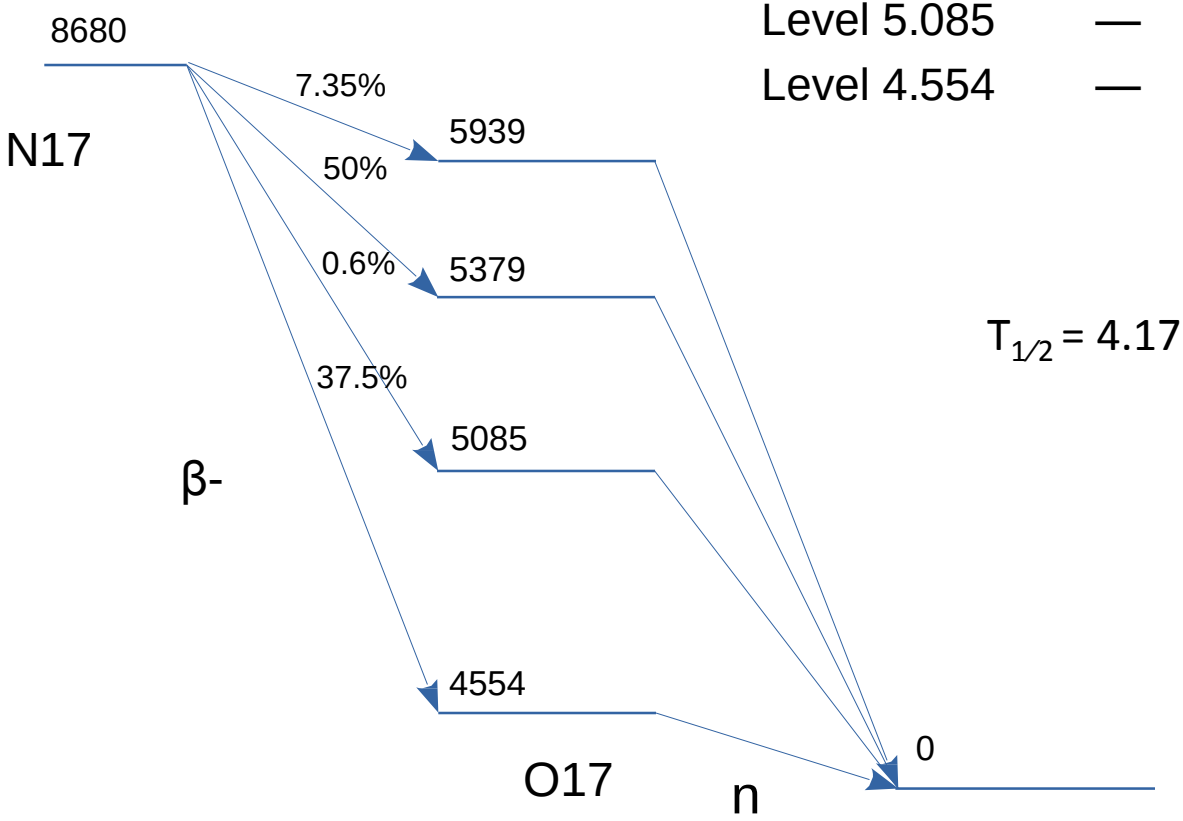
- Geant4.10.6 simulation of 10 years flux of muons and secondary's in Hall C (the cosmogenic flux was taken from Fluka simulation for DS-50), crossing the DS-20k.
- 50 beta-n decay isotopes are produced by cosmic muons and secondary's in DarkSide20k materials, according to GEANT4.10.6:

  39P, 38P, 37Si, 36Si, 36Al, 35Al, 34Al, 33Al, 32Al, 31Al, 34Mg, 33 Mg, 32Mg, 31Mg, 30Mg, 33Na, 32Na, 31Na, 30Na, 29Na, 28Na, 27Na, 29Ne, 28Ne, 27Ne, 26Ne, 25F, 24F, 23F, 22F, 24O, 23O, 22O, 20N, 19N, 18N, 17N, 20C, 19C, 18C, 17C, 16C, 15B, 14B, 13B, 14Be, 12Be, 11Li, 9Li, 8He.

- NEUTRON YIELDS from cosmogenic activation for DS-20k construction materials (Acrylic, Gd-loaded Acrylic, Titanium vessel) are much less, than NEUTRON YIELDS from alpha-n reactions, except for argon.

- NEUTRON YIELDS from cosmogenic activation in Argon are rather high (5.1 beta-neutron decay/year/50 ton) and can be cutted by MUON VETO and other WIMP-search criterias. The simplest one way is to tag the time of muon, crossing the TPC volume and Neutron Veto volume and afterwards to search for coincidences muon – beta – neutron.

β-,n decay of N17



Energy levels	—	neutron energy,	electron energy :
Level 5.939	—	E_n = 1690 keV	$E_{e-,max}$ = 2741 keV
Level 5.379	—	E_n = 1163 keV	$E_{e-,max}$ = 3301 keV
Level 5.085	—	E_n = 886 keV	$E_{e-,max}$ = 3595 keV
Level 4.554	—	E_n = 520 keV	$E_{e-,max}$ = 4126 keV

$T_{1/2}$ = 4.173 s

Beta-n isotopes in Liquid Argon Volumes (in 10 years)

Argon Volume	Total Beta-n Isotopes Yield	Total Neutron Yield	Total Neutron Yield after 5 s Muon Veto	Number of WIMP-like events after the rejection criteria (background in ROI 200 ton*year)
TPC UAr	347	51	9.6	$7.4\ 10^{-5}$
Neutron Veto UAr	591	95	16.1	$< 16.4\ 10^{-5}$
Cryostate AAr	3970	610	No 5 s muon veto	$1.4\ 10^{-5}$
Total Argon Volume in Darkside20k	4908	756	-	$< 2.6\ 10^{-4}$

Conclusion

- *Background from cosmogenics beta-n isotopes can be reduced to $< 2.6 * 10^{-4}$ events for 200 tonn*year exposure in the case of tagging muons, crossing the TPC and Neutron Veto Argon volumes (time stamp for energy release E > 15 MeV).*

- *This background can be studied using the triple coincedences (muon-beta-neutron).*

- *Further studies should be done on the rejection of beta-n isotopes background produced in Neutron Veto argon (possibility of Neutron Veto electronics to tag the muon, crossing the Neutron Veto; Marco Rescigno proposes to provide the prompt window in Neutron Veto (+- 200 ns from the TPC triger to tag beta decays).*