MUON INDUCED BACKGROUND FOR DAMIC 1KG

Mariangela Settimo

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Preliminary

OUTLINE

Goal : study the muon induced background in the shielding for different overburdens (or depths of the underground lab as Snolab, Modane and GranSasso)

- Detector geometry used here not complete but only the shielding is taken into account

- Save the particle informations after the lead shielding: they can be reused to generate only the DAMIC-detector part later on (if needed)

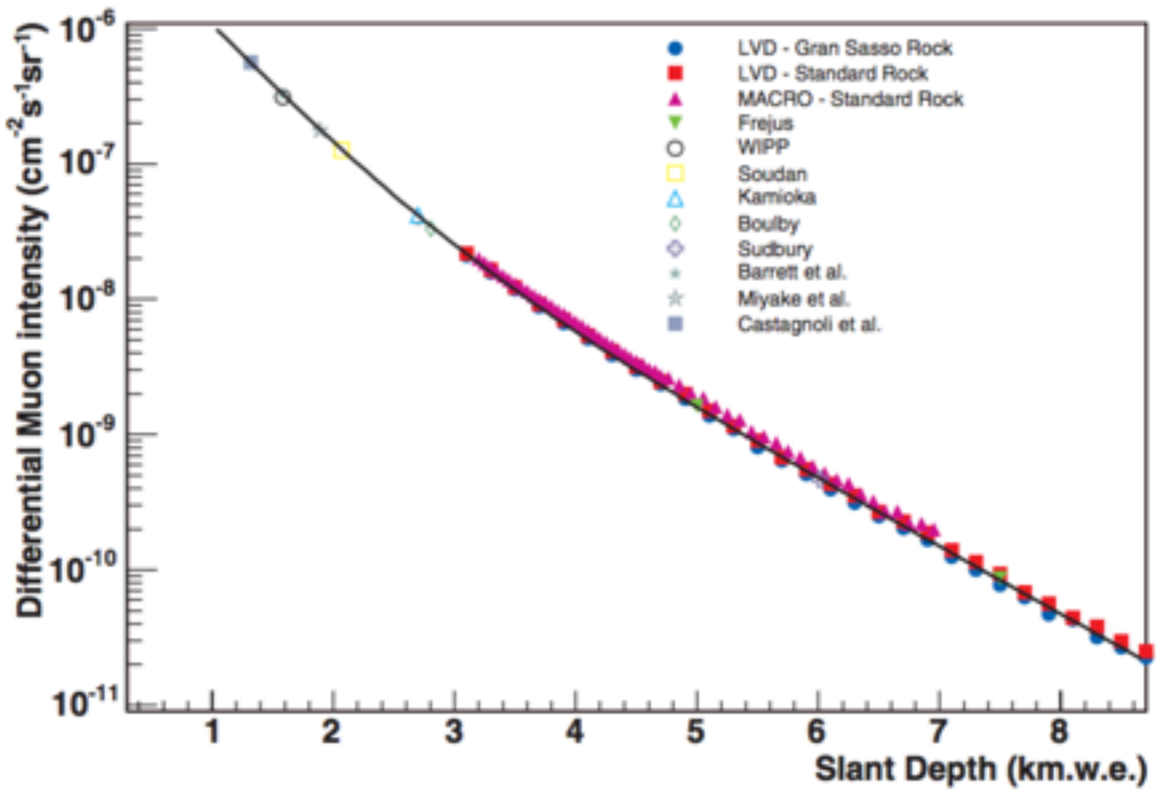
- Here only compare the total flux of secondaries and their energy distributions

MUON FLUX IN UNDERGROUND LABORATORY

Goal : study the muon induced background in the shielding for different overburdens (or depths of the underground lab as Snolab, Modane and GranSasso)

1. Muon flux and lab depth

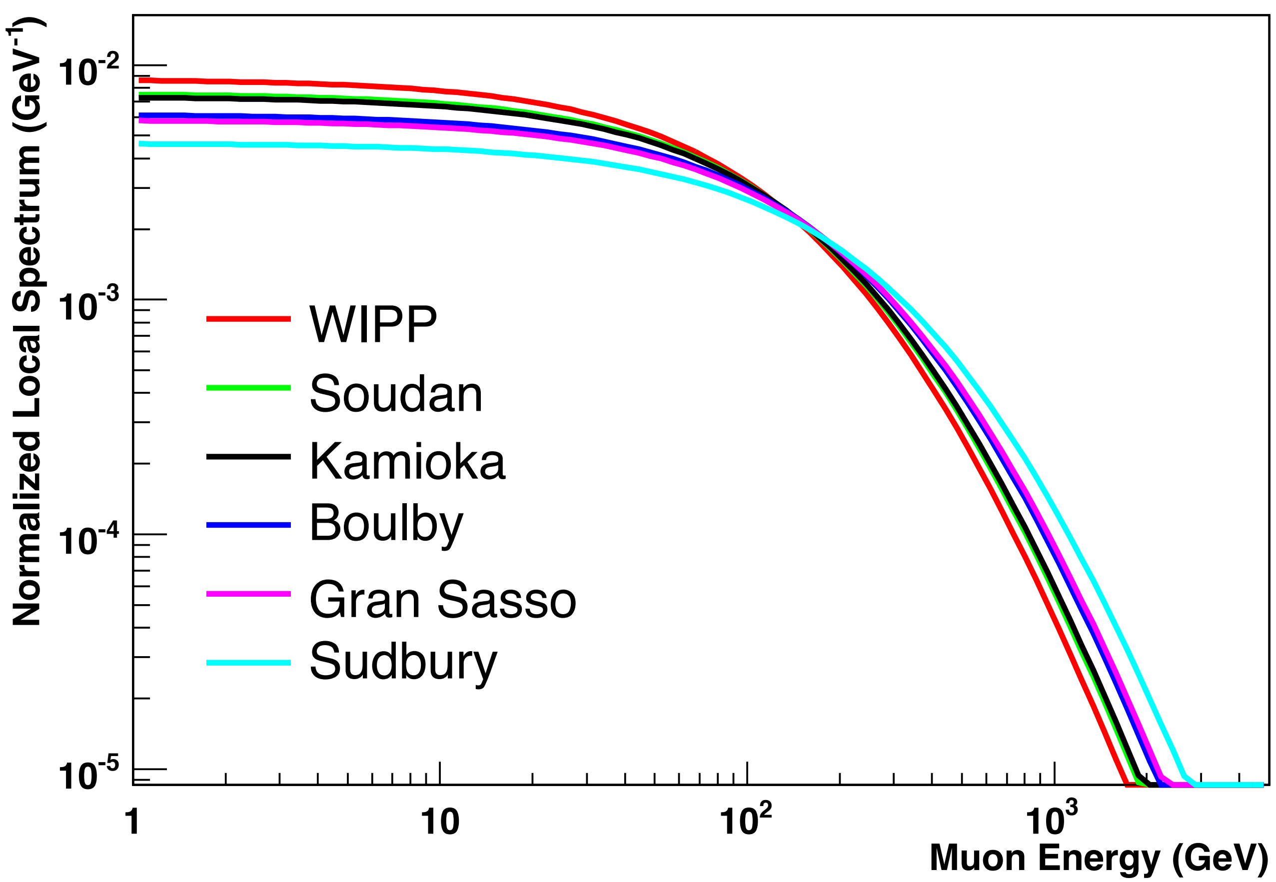
$$I(h) = (I_1 e^{(-h/\lambda_1)} + I_2 e^{(-h/\lambda_2)}), \qquad (1)$$



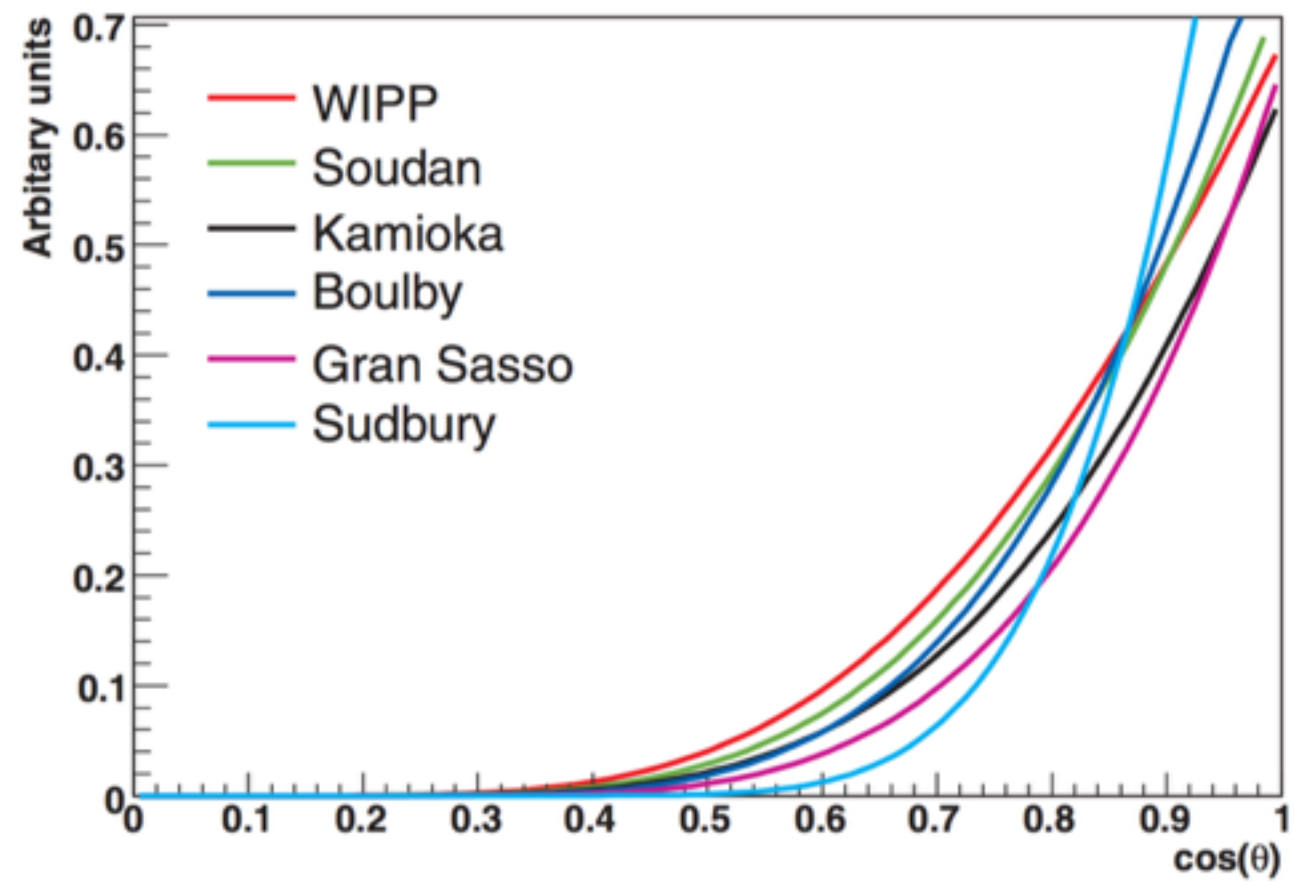
Site	Total flux $cm^{-2}sec^{-1}$	Depth km.w.e.
WIPP	$(4.77\pm0.09) \times 10^{-7}$ [6]	1.585 ± 0.011
Soudan	$(2.0\pm0.2) \times 10^{-7}$ [15]	1.95 ± 0.15
Kamioka	$(1.58\pm0.21) \times 10^{-7}$ [8]	$2.05\pm0.15^\dagger$
Boulby	$(4.09\pm0.15) \times 10^{-8}$ [9]	2.805 ± 0.015
Gran Sasso	$(2.58\pm0.3) \times 10^{-8}$[this work]	$3.1\pm0.2^\dagger$
	$(2.78\pm0.2) \times 10^{-8}$ [16]	$3.05\pm0.2^\dagger$
	$(3.22\pm0.2) \times 10^{-8}$ [17]	$2.96\pm0.2^\dagger$
Fréjus	$(5.47\pm0.1) \times 10^{-9}$ [14]	$4.15\pm0.2^\dagger$
	$(4.83\pm0.5) \times 10^{-9}$ [this work]	$4.2\pm0.2^\dagger$
Homestake	$(4.4\pm0.1 \times 10^{-9})$[this work]	4.3 ± 0.2
Sudbury	$(3.77\pm0.41) \times 10^{-10}$ [12]	6.011 ± 0.1

MUON FLUX IN UNDERGROUND LABORATORY

2. Muon Energy distribution

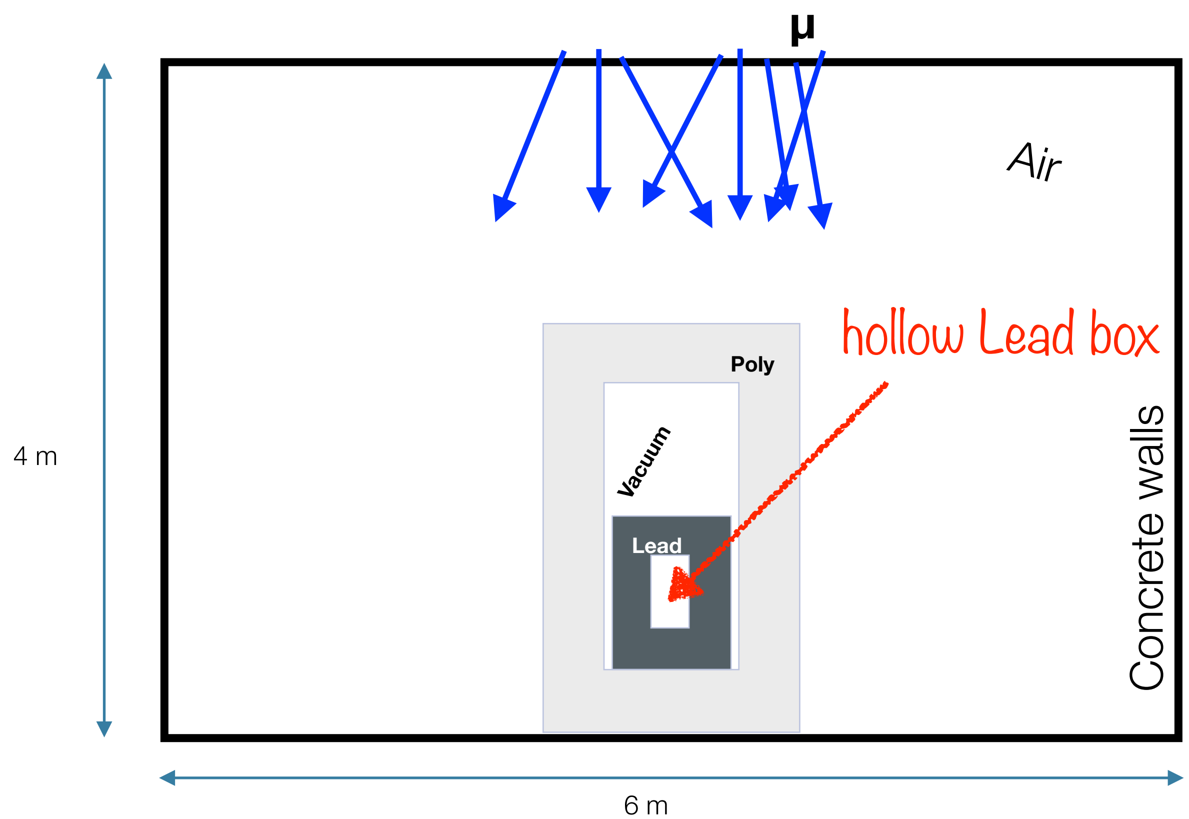


3. Angular distribution



mostly dependent on the overburden and on the <atomic weight> of the rock

A SIMPLIFIED GEANT4 SIMULATION



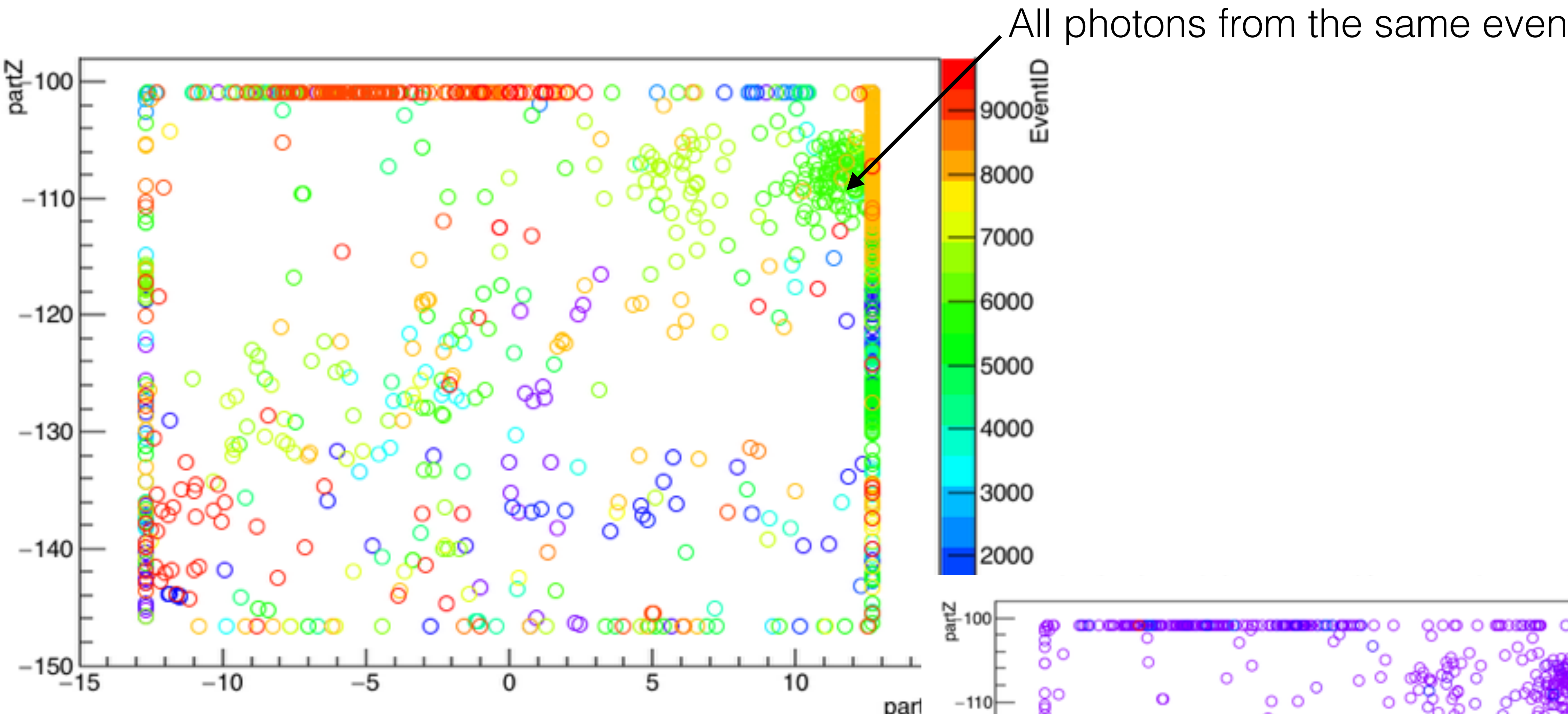
sketch of the Lab geometry
Lab walls 0.2 cm of concrete

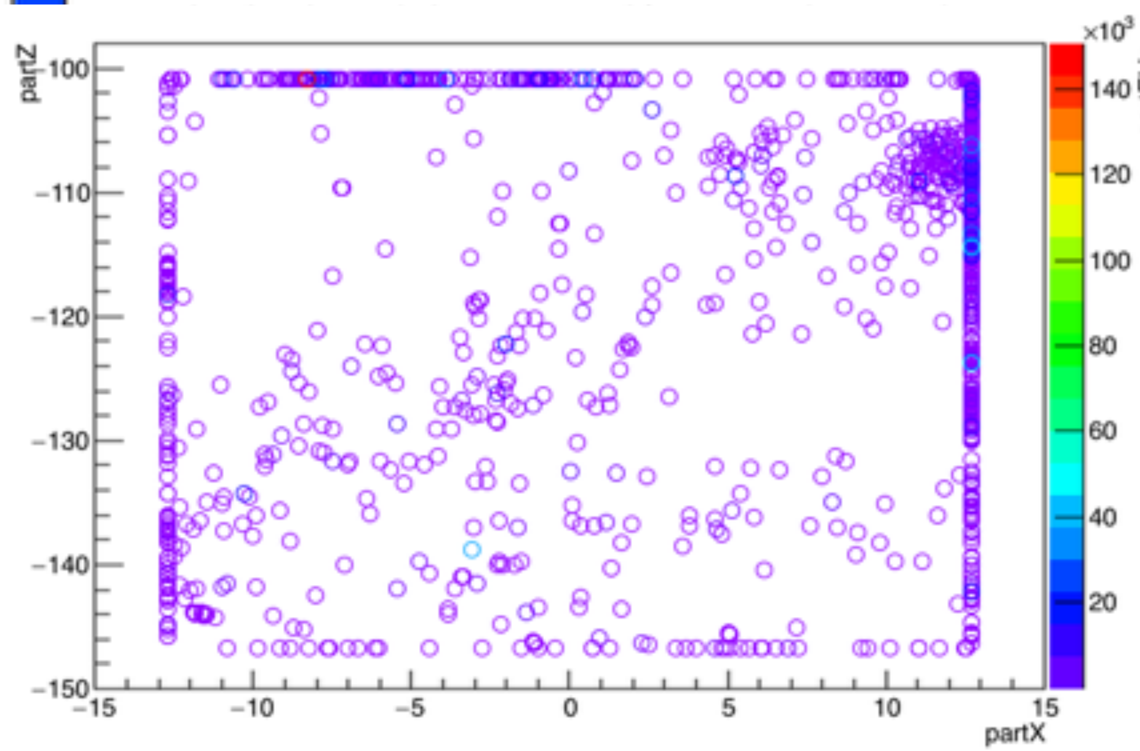
- 6 CCDs also included in the simulation to store the hits but the vessel geometry not included
- 10k events generated for each site (same random seed)

- physics list as in std underground DM applications (basically livermore + HP neutron)
- muons injected from the top (concrete) wall following their energy and angular distribution (specific for each site)
- "potential bkg" particles stopped (and its info registered) as it enters the hollow LeadBox
- absolute flux of "potential bkg" from normalization to muon intensity

$$\Phi_{bkg} = I_{\mu}(h)*N_{bkg}/N_{\mu,gen}$$

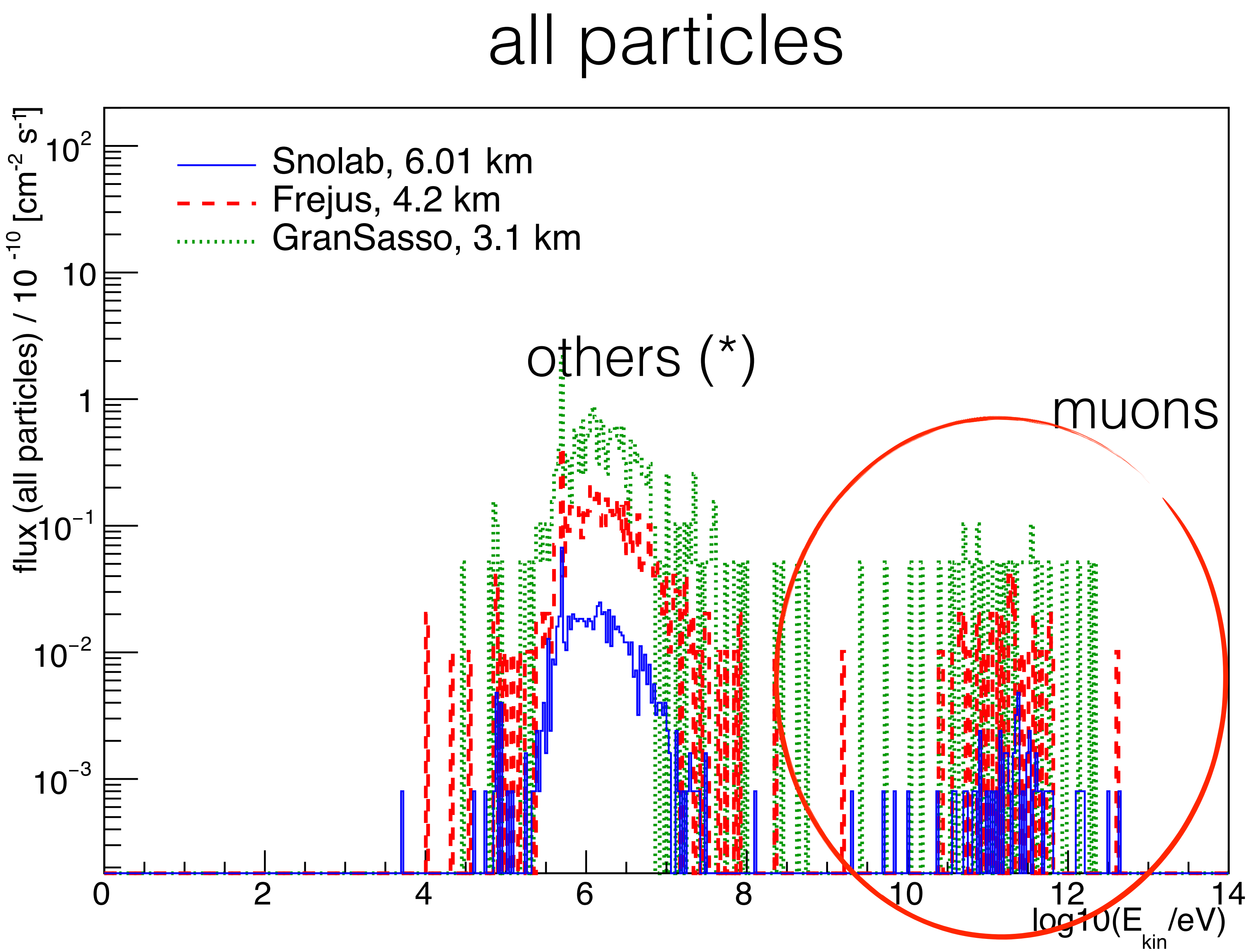
PRELIMINARY / QUICK RESULTS





ex. of particles in the hollow lead box

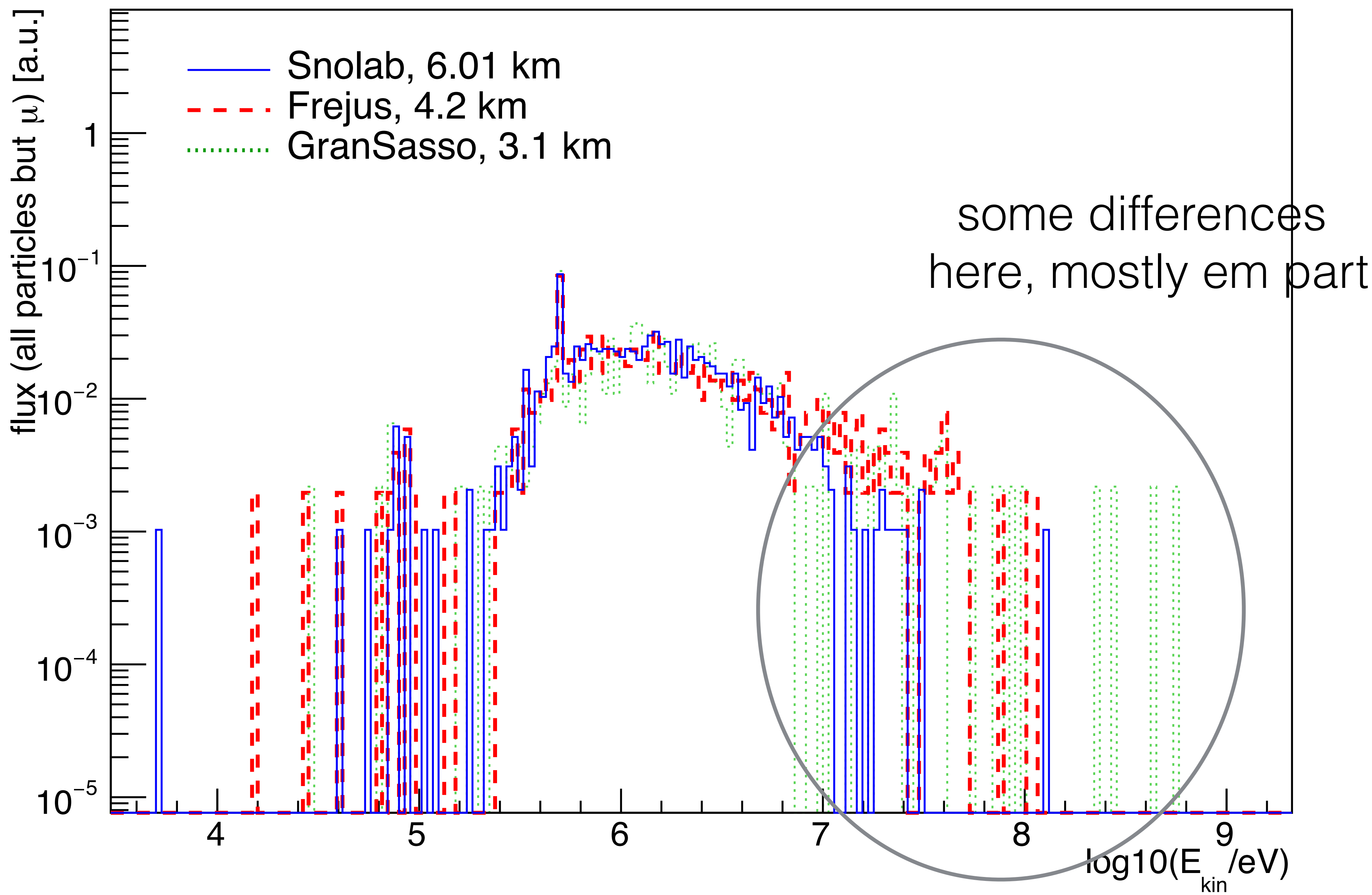
PRELIMINARY / QUICK RESULTS (II)



(*)no neutrons found over 5k events. more statistics needed

PRELIMINARY / QUICK RESULTS (II)

all particles but muons, (normalized histo)



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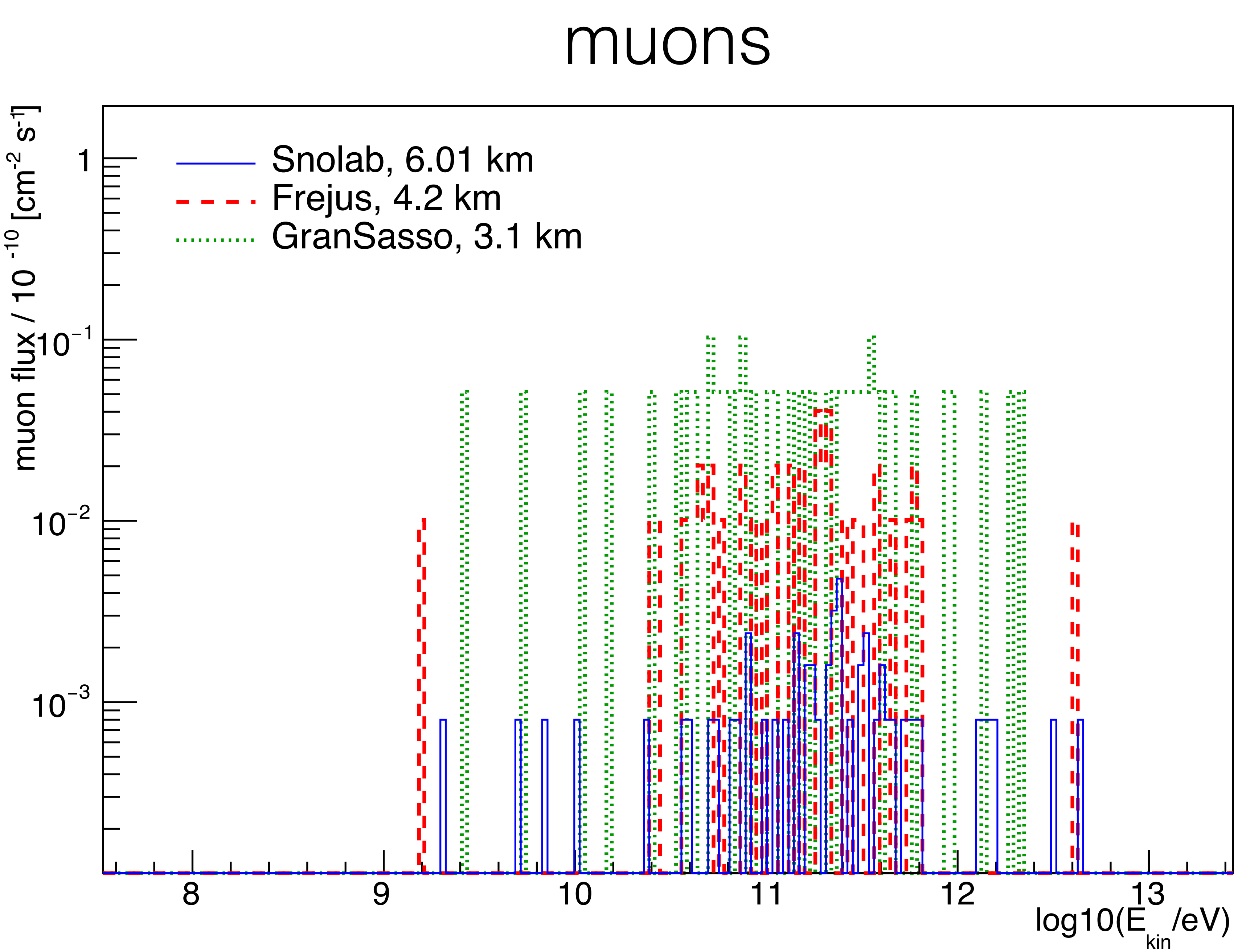

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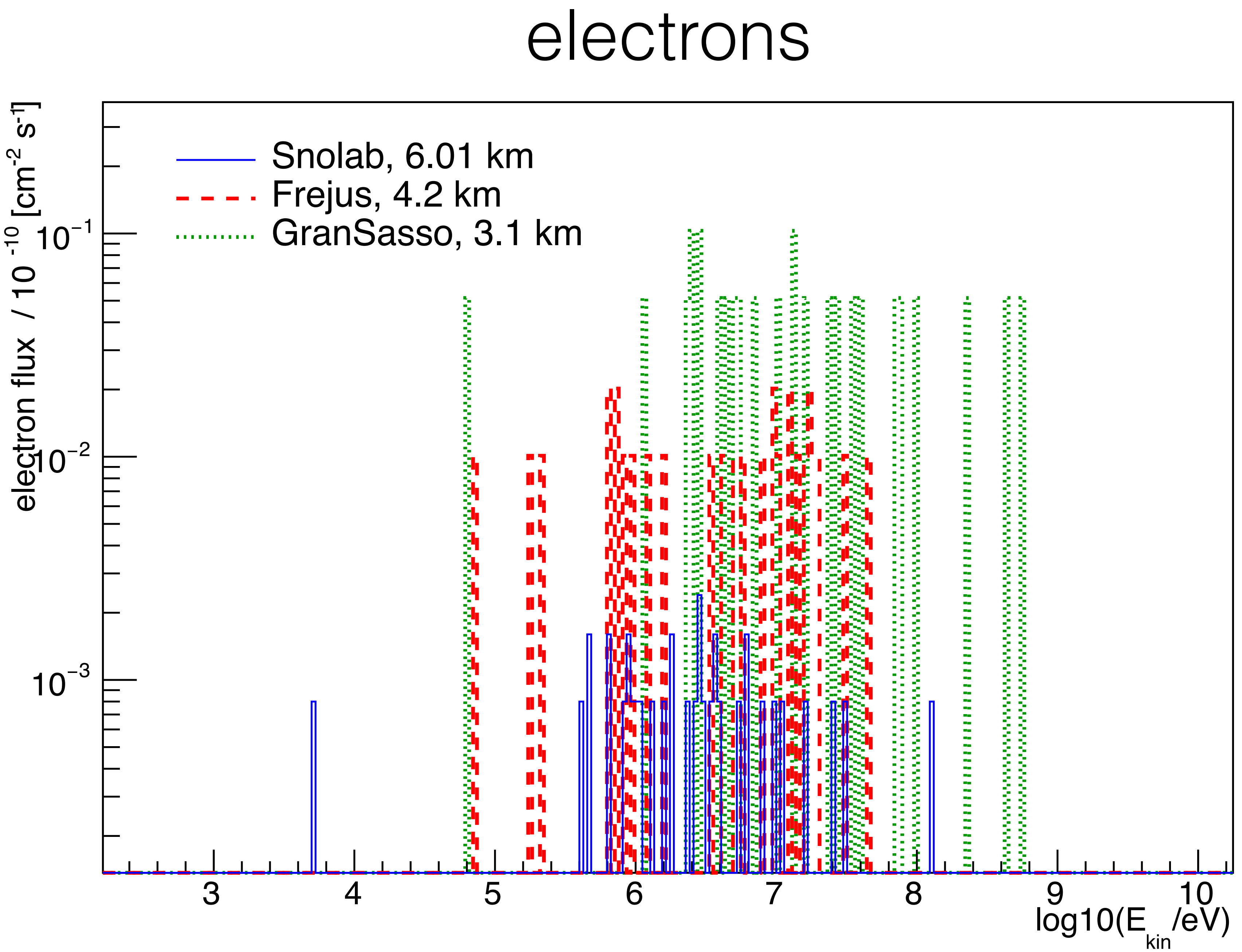

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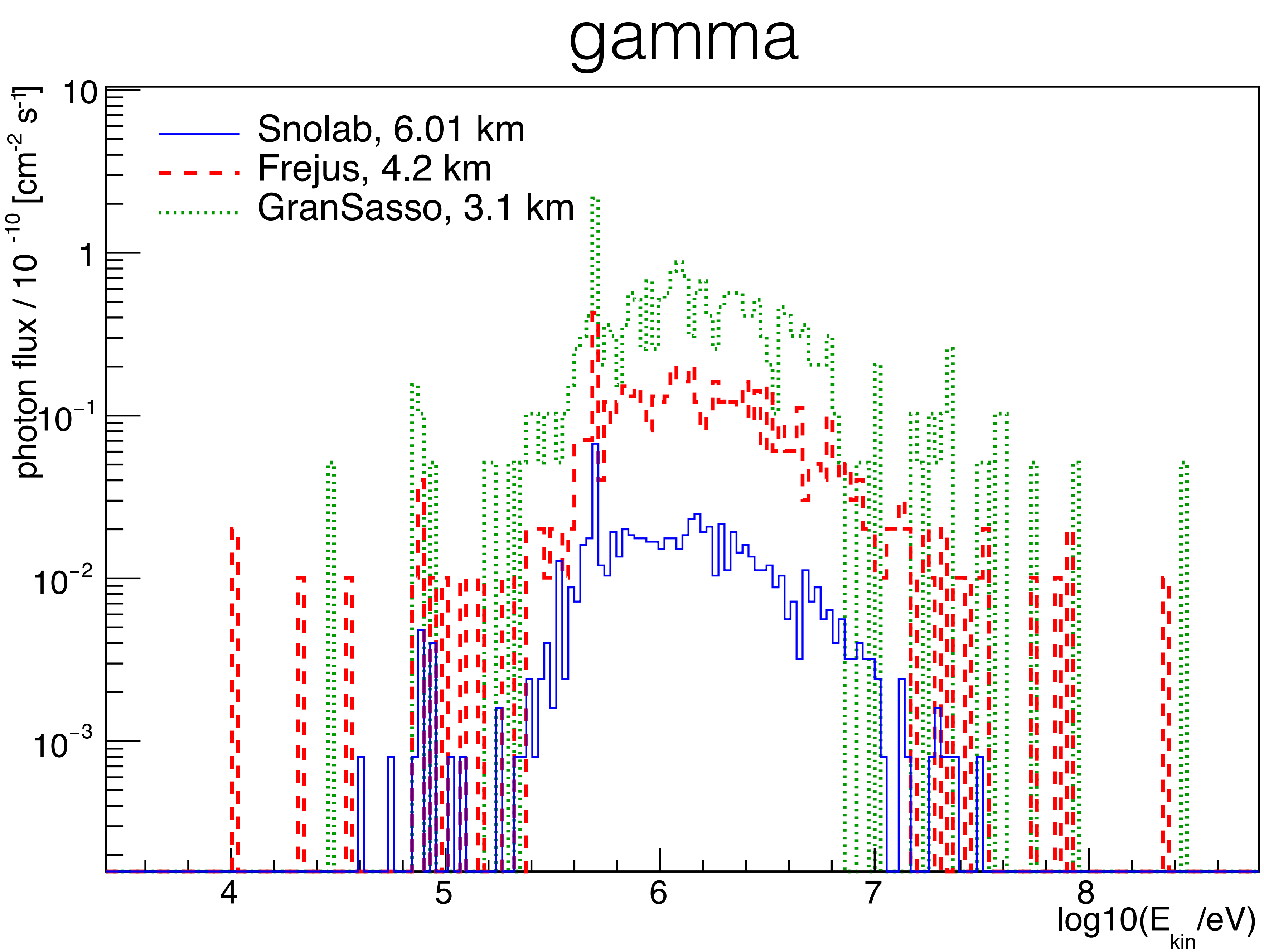

SOME COMMENTS/CONCERNS

- Change vacuum (in the hollow poly and lead box) with nitrogen?
- Larger statistics needed, too time consuming for a laptop (move to a cluster)
- Look at the hits in the CCDs. Simulations with the full detector are possible (I added the shielding, energy and angular distributions for muons in my local version of Joao(@LPNHE) code). However:
    - Few things to be fixed in Joao's code (for the geometry)
    - long time consumption and not optimal choice for DAMIC 1kg purposes (if we change geometry). Thus at least:
        - I would modify LPNHE code in order to store particle's info after lead (before vessel) to simulate different detector geometries if needed.

SOME COMMENTS (II)

- Interesting things to test
  - Add also neutron from the rock (to test if the Poly shielding is enough when changing site
    - energy and angular distribution (extrapolated from GS measurements) available —> easy to add to geant4 code (you can assume this done)

- “Parametrise” the rate of “potential bkg” (after lead) vs muon track length in the material to quickly extend this study to different shielding geometry/size?