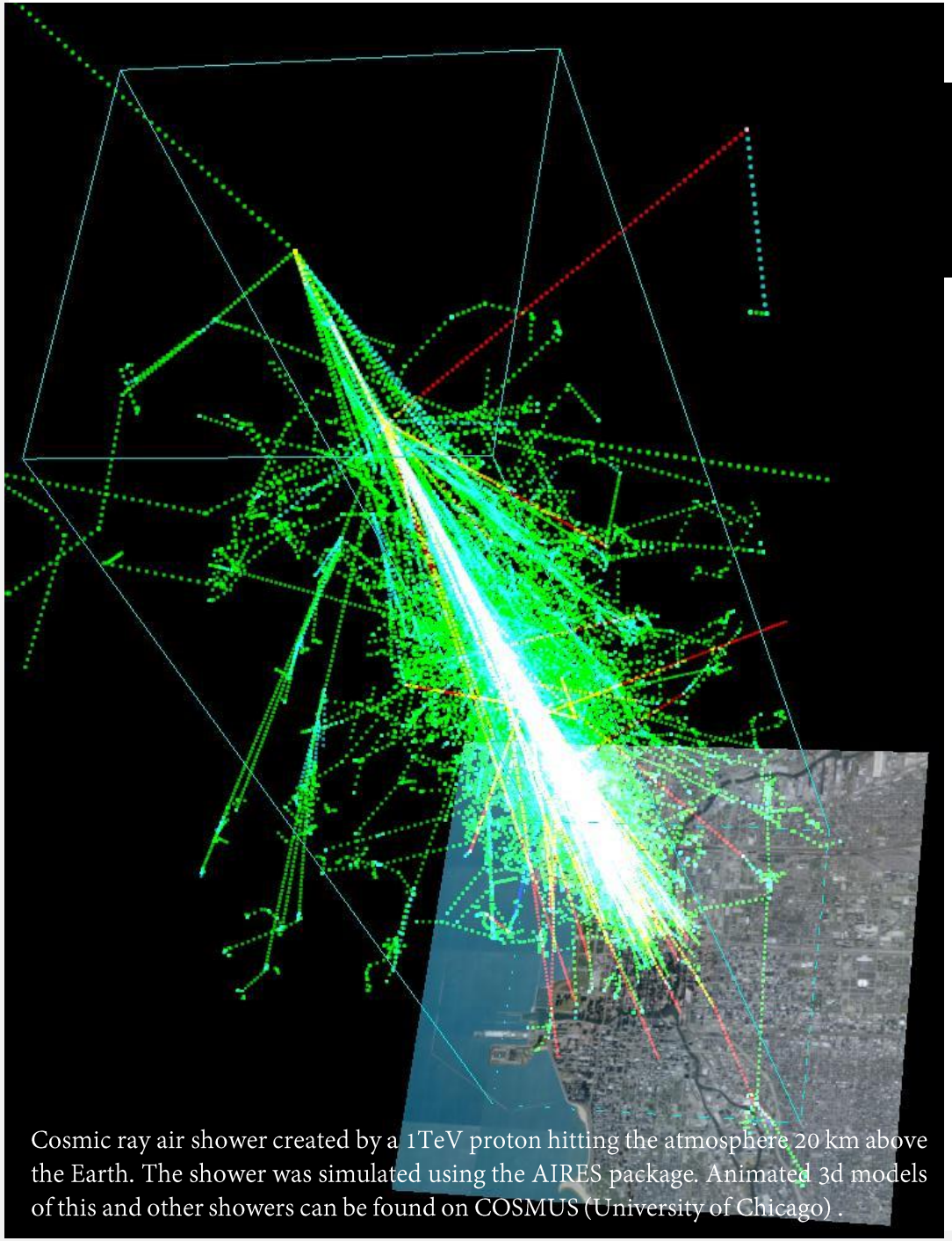
FLUKA simulation program

AUDCHARAPORN PAGWHAN

Astronomy, Chiang Mai University



Cosmic ray air shower created by a 1TeV proton hitting the atmosphere 20 km above the Earth. The shower was simulated using the AIRES package. Animated 3d models of this and other showers can be found on COSMUS (University of Chicago) .

Introduction

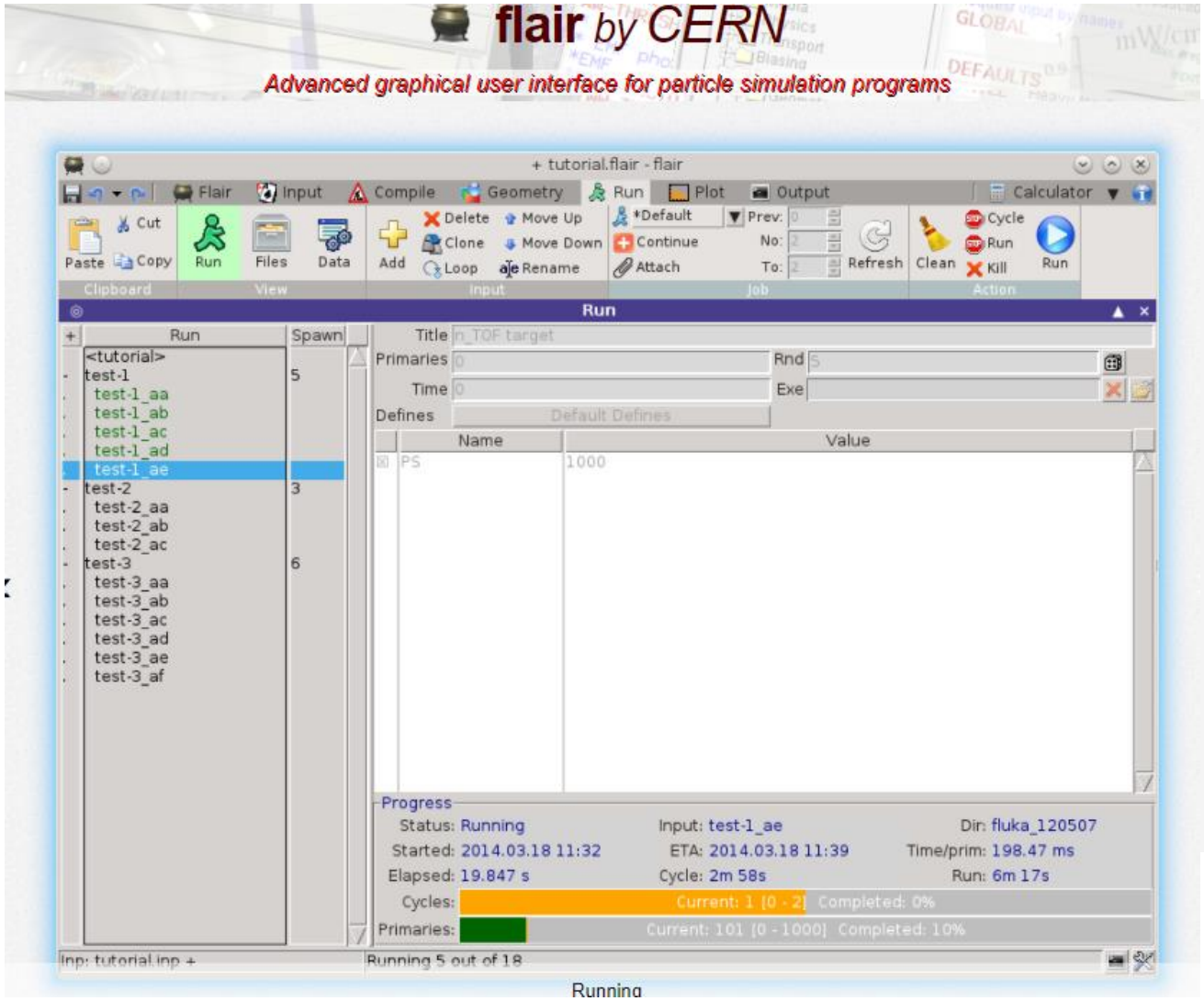
Cosmic Rays

- Cosmic rays are energetic particles or gamma rays from space
- Sources of cosmic rays (energetic particles)
  - inside the solar system → Solar Energetic Particles (SEPs)
  - outside the solar system → Galactic Cosmic Rays (GCRs)
- Primary cosmic rays contain 90% p^+, 9% α and 1% heavy nuclei
- Secondary particles (e^-, γ, μ^+, μ^-, n, …) was generated in the Earth's atmosphere

Neutron monitors

- Neutron monitors (NMs) detect atmospheric secondary particles (SPs) that reach the ground. Those SPs produced by the interaction of primary cosmic ray particles in the Earth's atmosphere.

FLUKA and flair



- Monte-Carlo method is a type of computer algorithm that is using random number to measure statistical properties.

FLUKA 2011-2c software

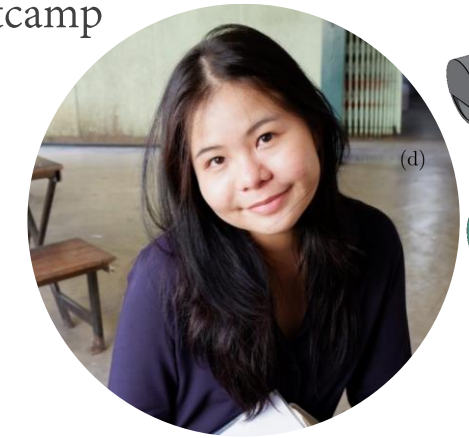
FLUKA 2020 software

Work timeline

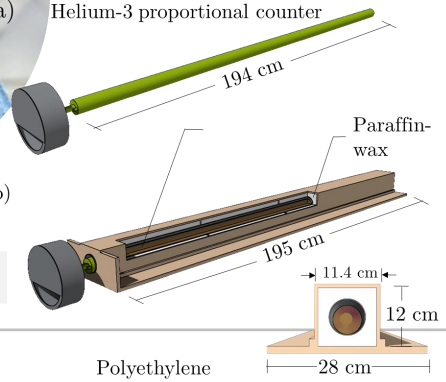
July – December 2020

July

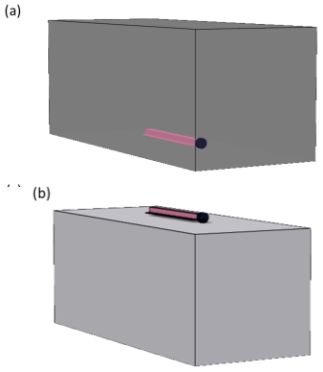
3rd NM-Bootcamp



October

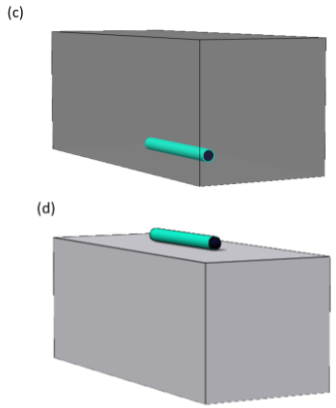


November

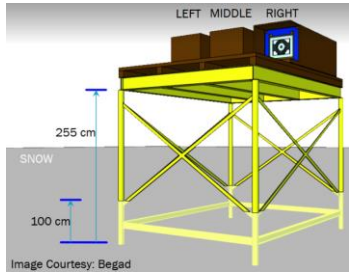


December

Post 3rd NM-Bootcamp



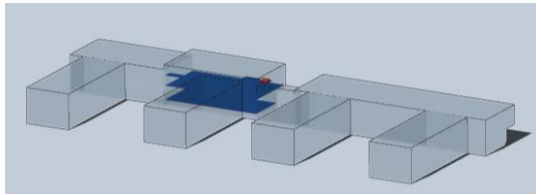
3NM64



Future 2021

Bare/3NM64

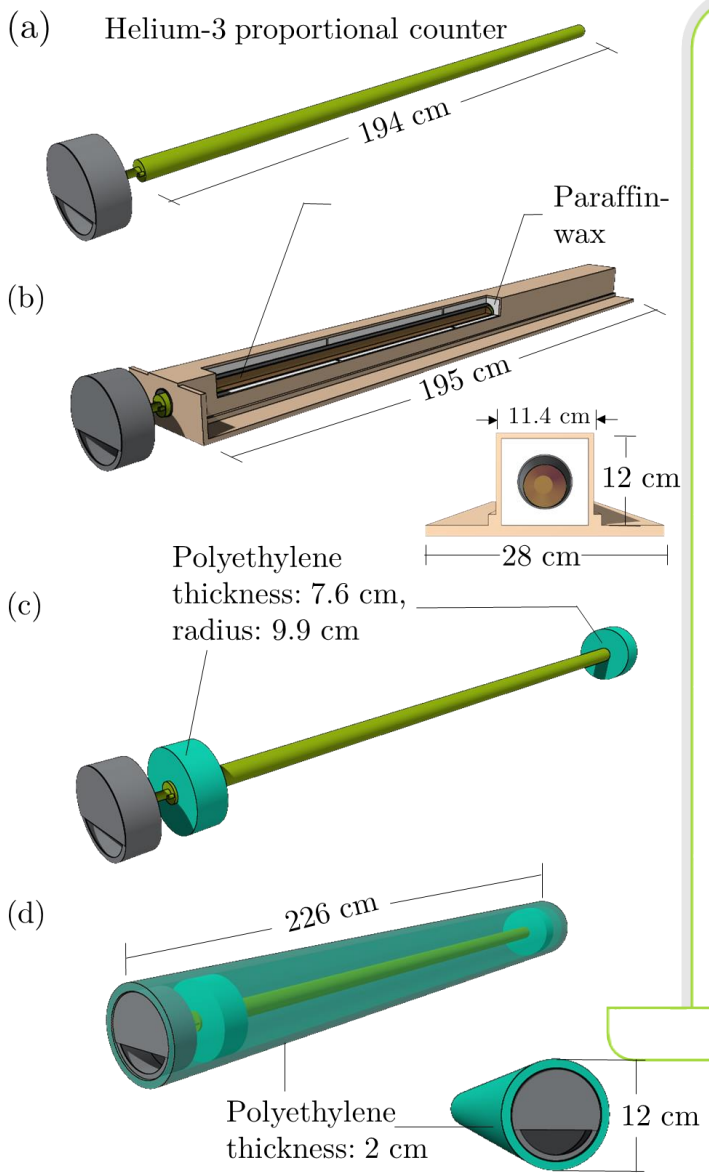
Bare at South Pole station

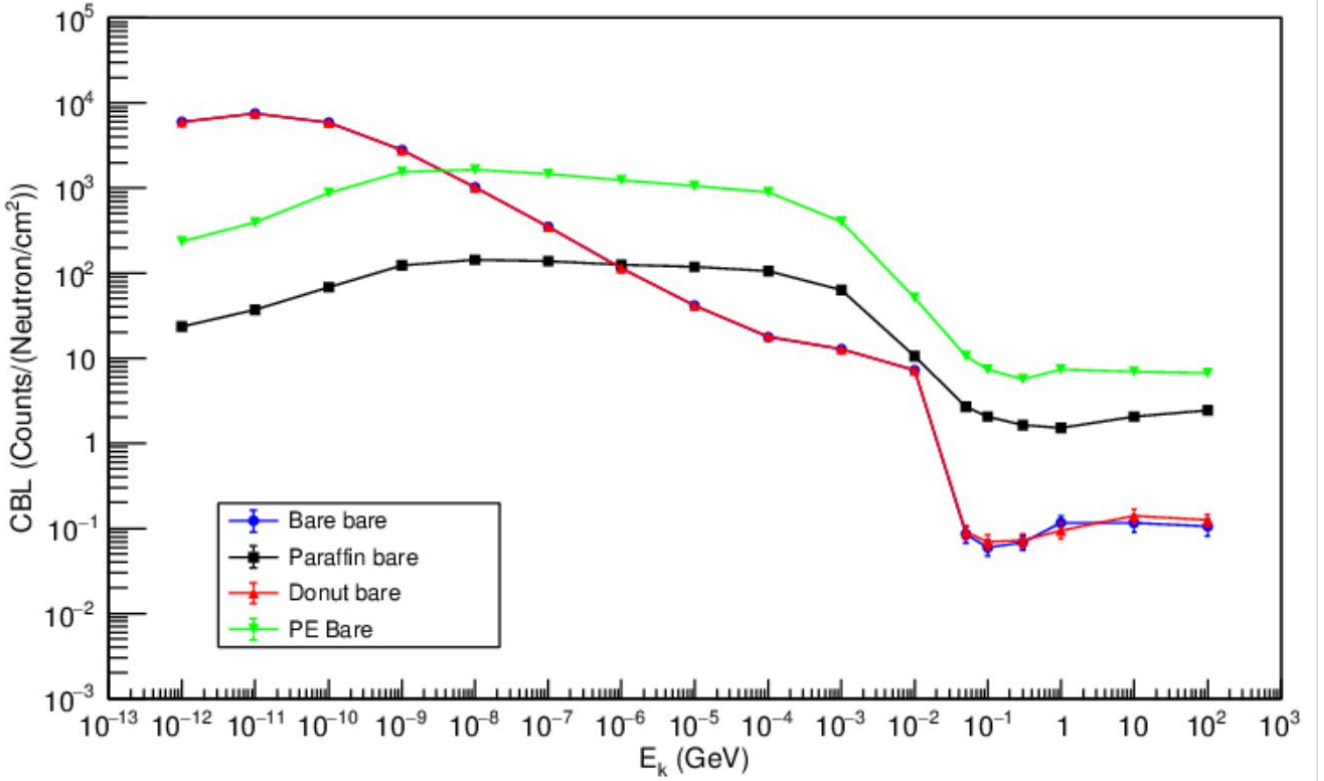


Process

Fixed the geometry and material in flair → Running FLUKA on CMU server → Finding the response function

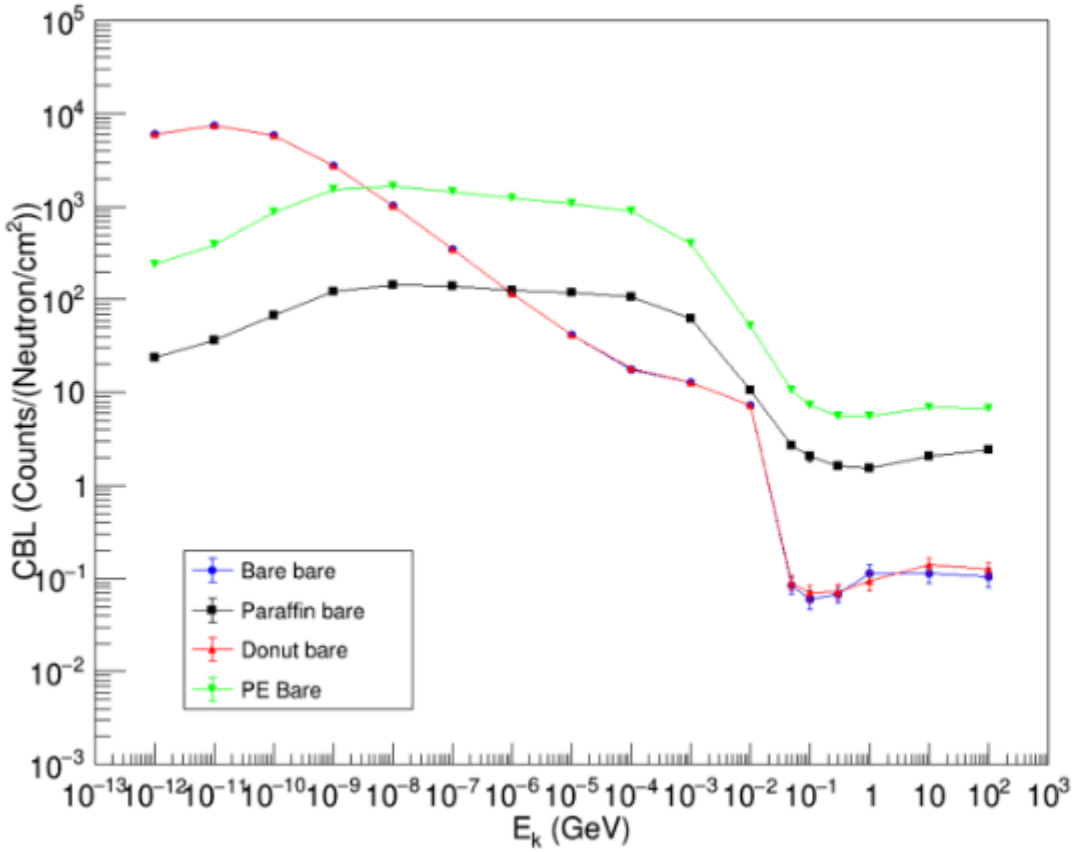
Response function of four different types of neutron monitor



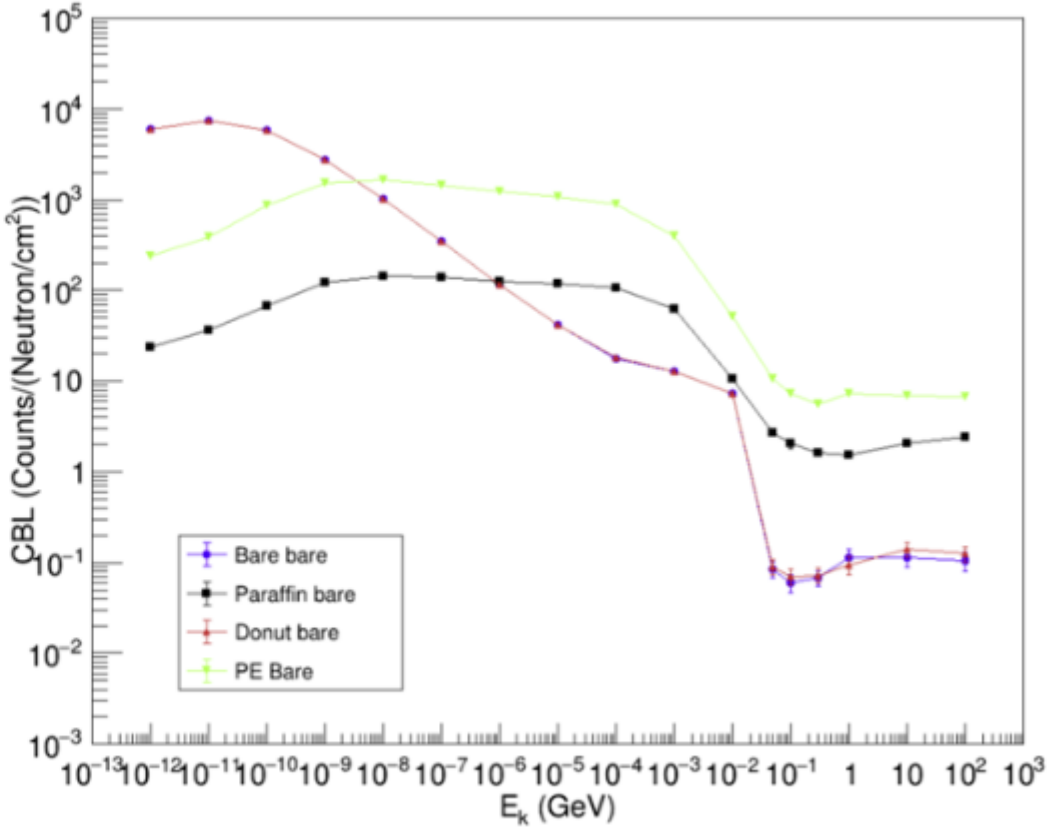


Response function of four different types of neutron monitor

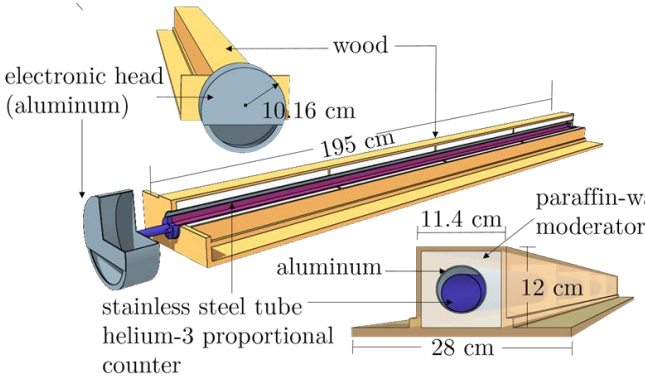
Dr. Kim's result

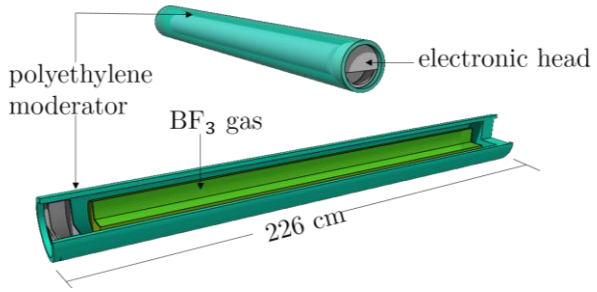


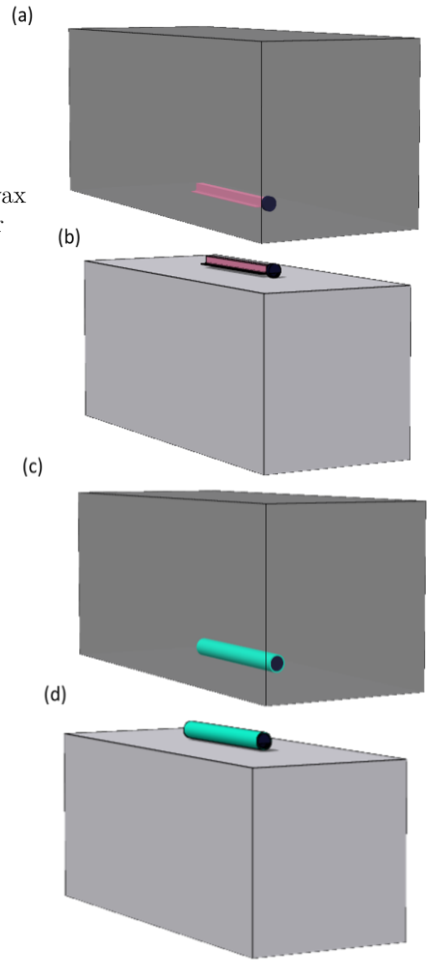
Ink's result

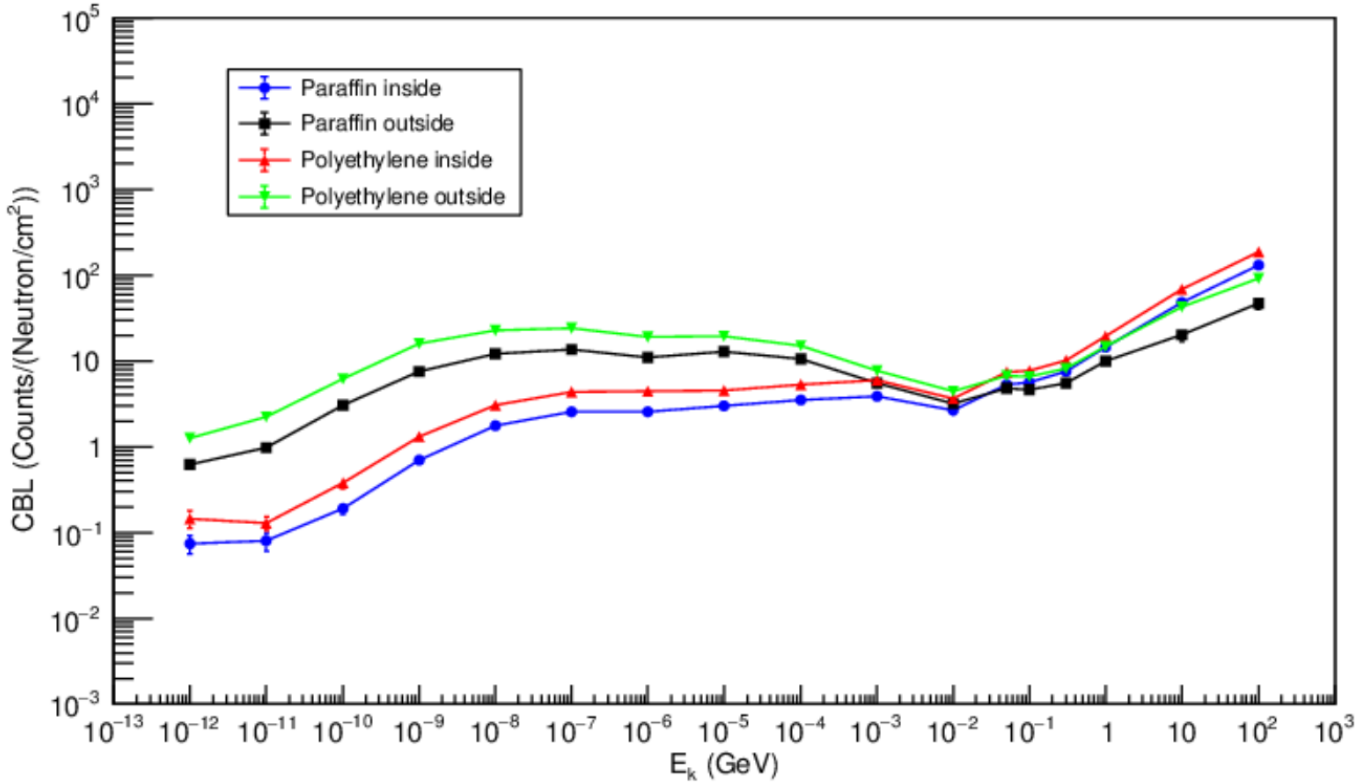


Response function of two different types of neutron monitor and surrounding

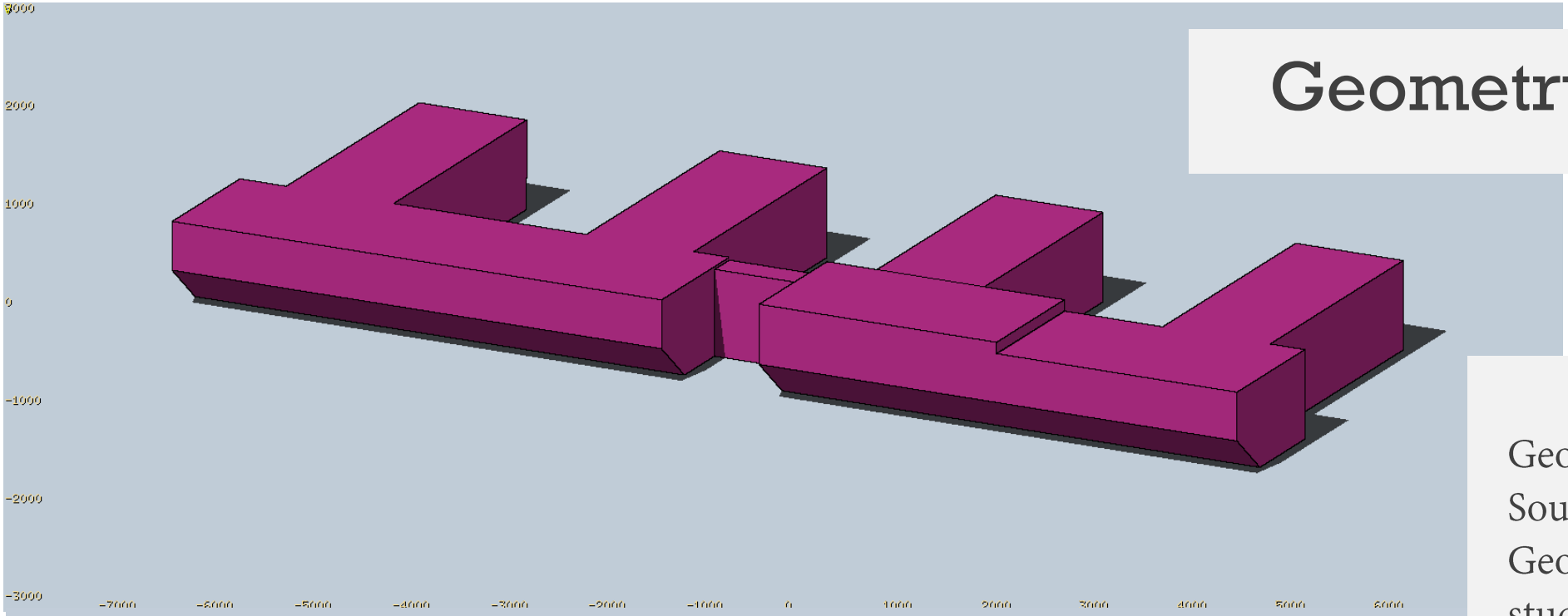


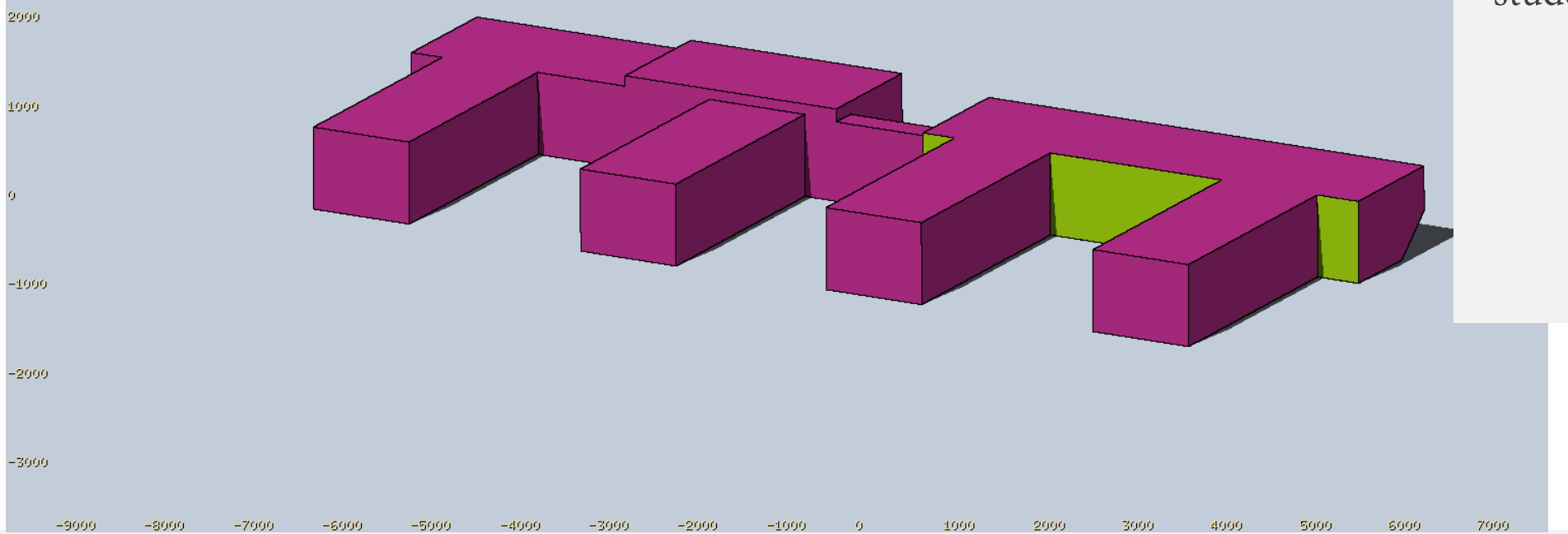






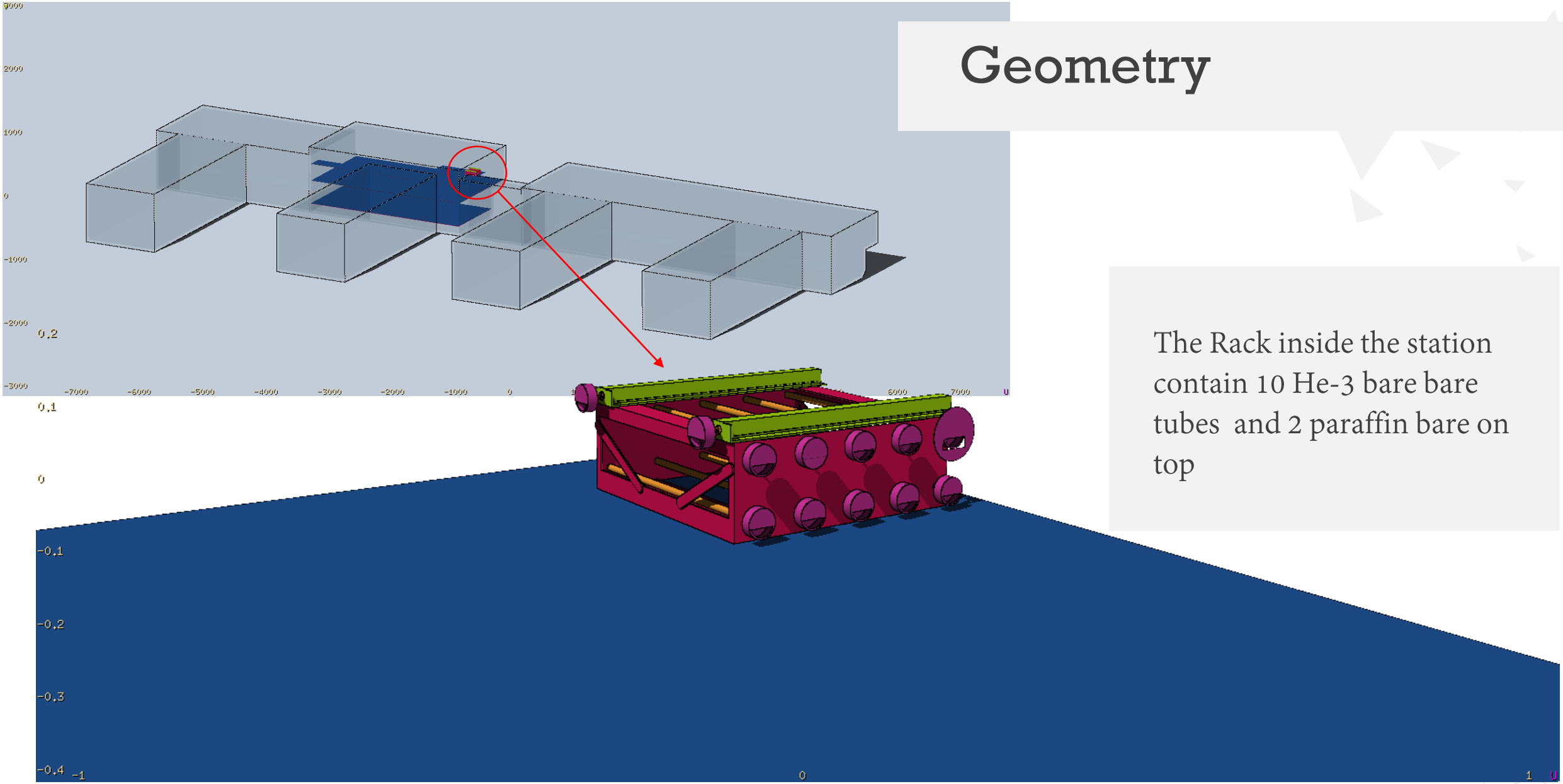
Geometry





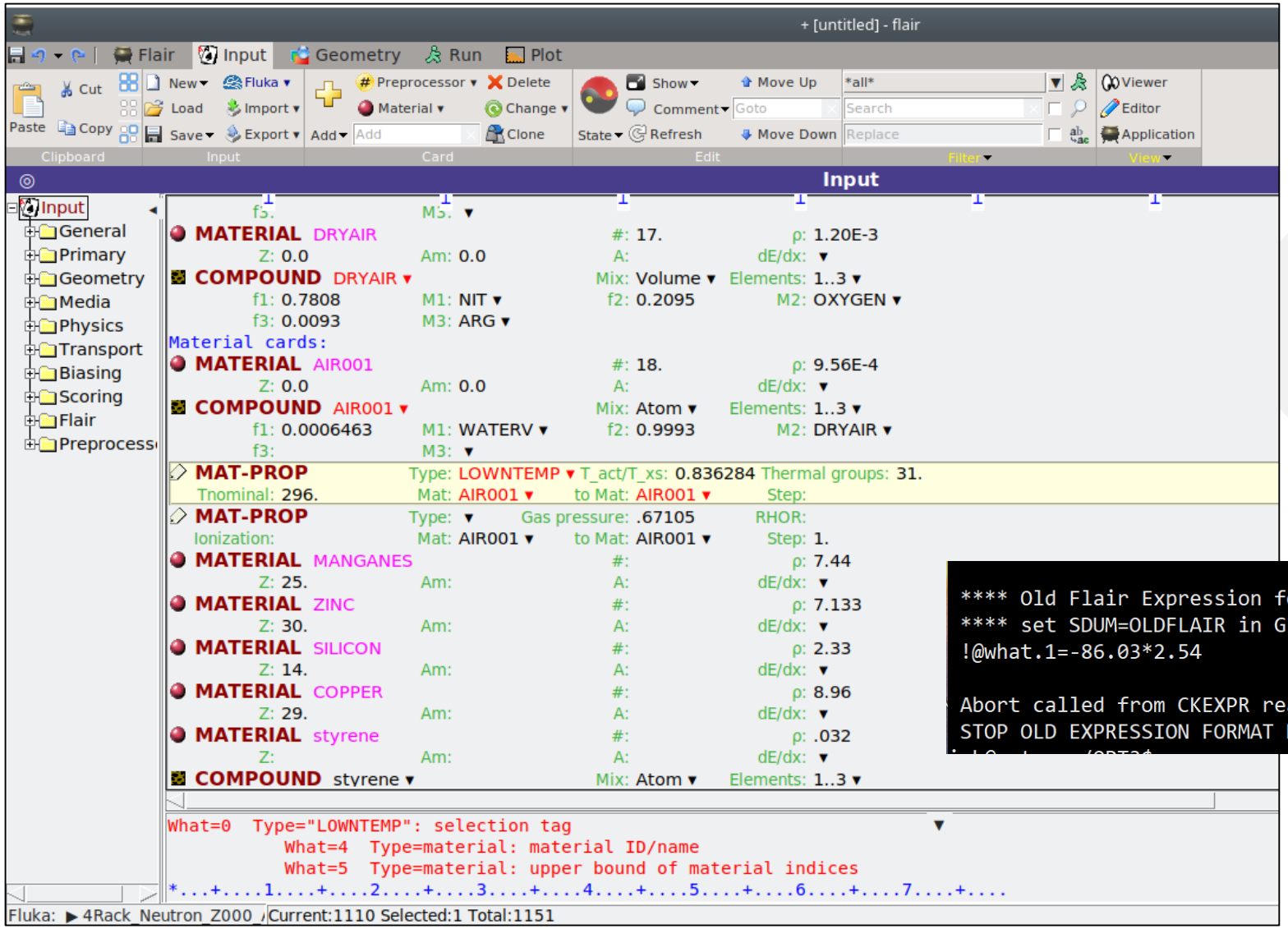
Geometry of Amundson-scott South Pole station
Geometry by Mitch American student at River-falls

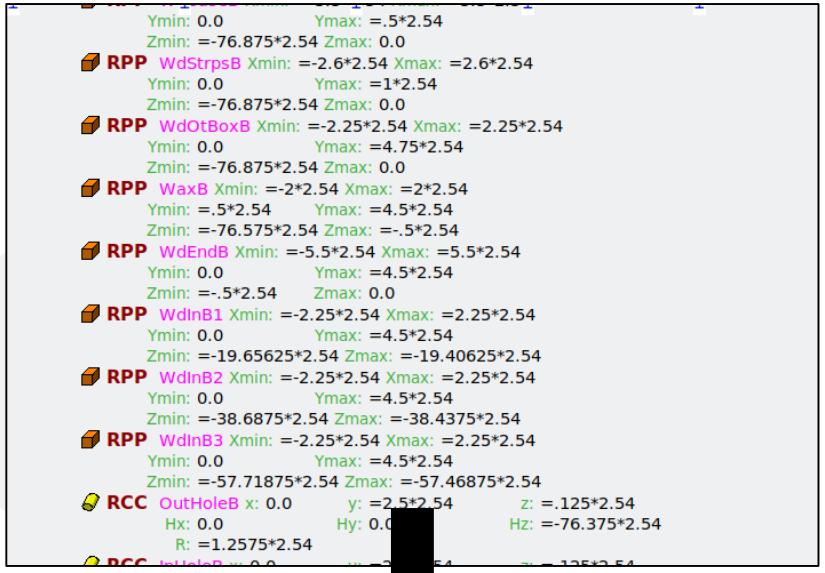
Geometry



The Rack inside the station contain 10 He-3 bare bare tubes and 2 paraffin bare on top

The Problems

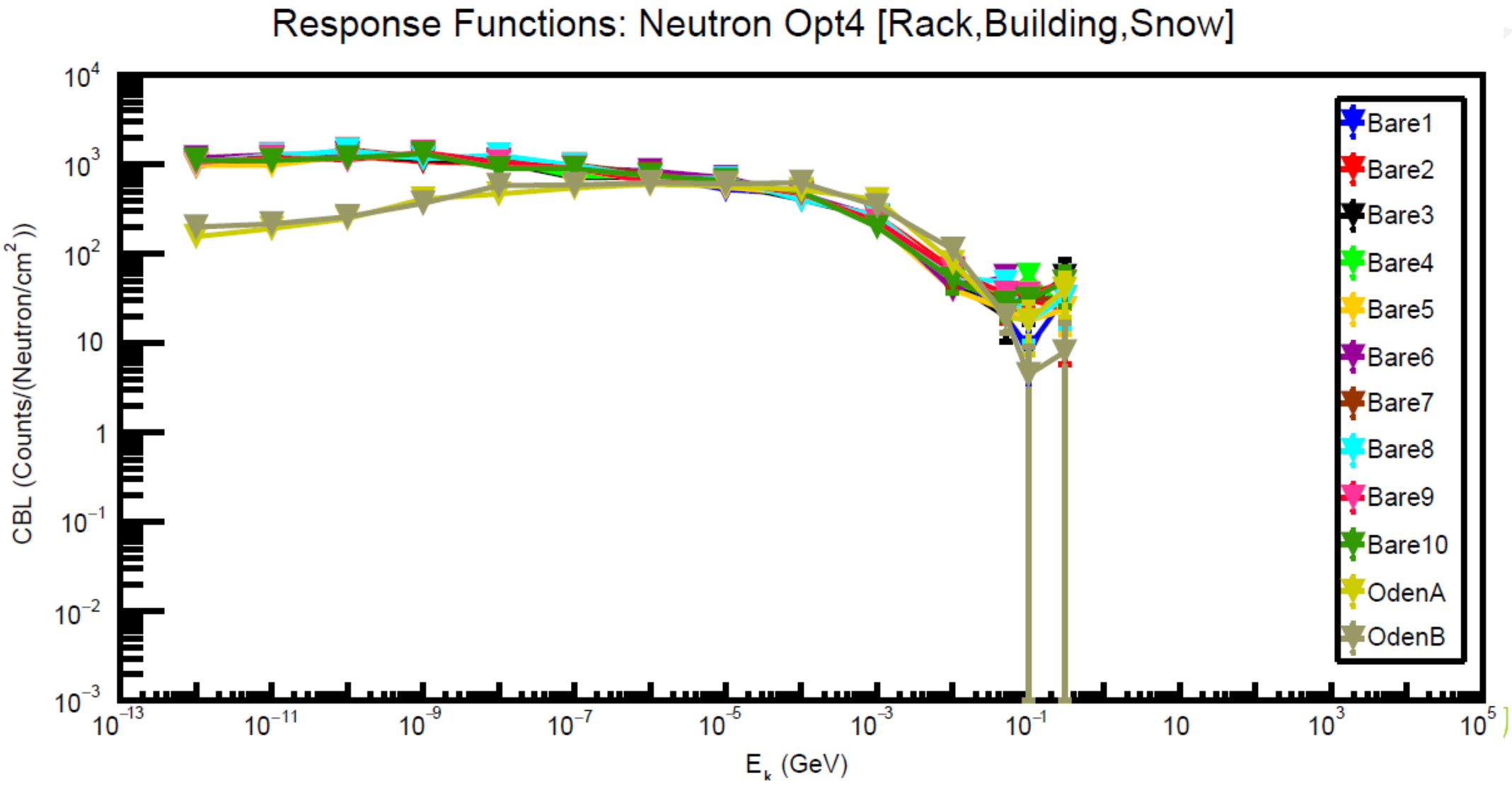


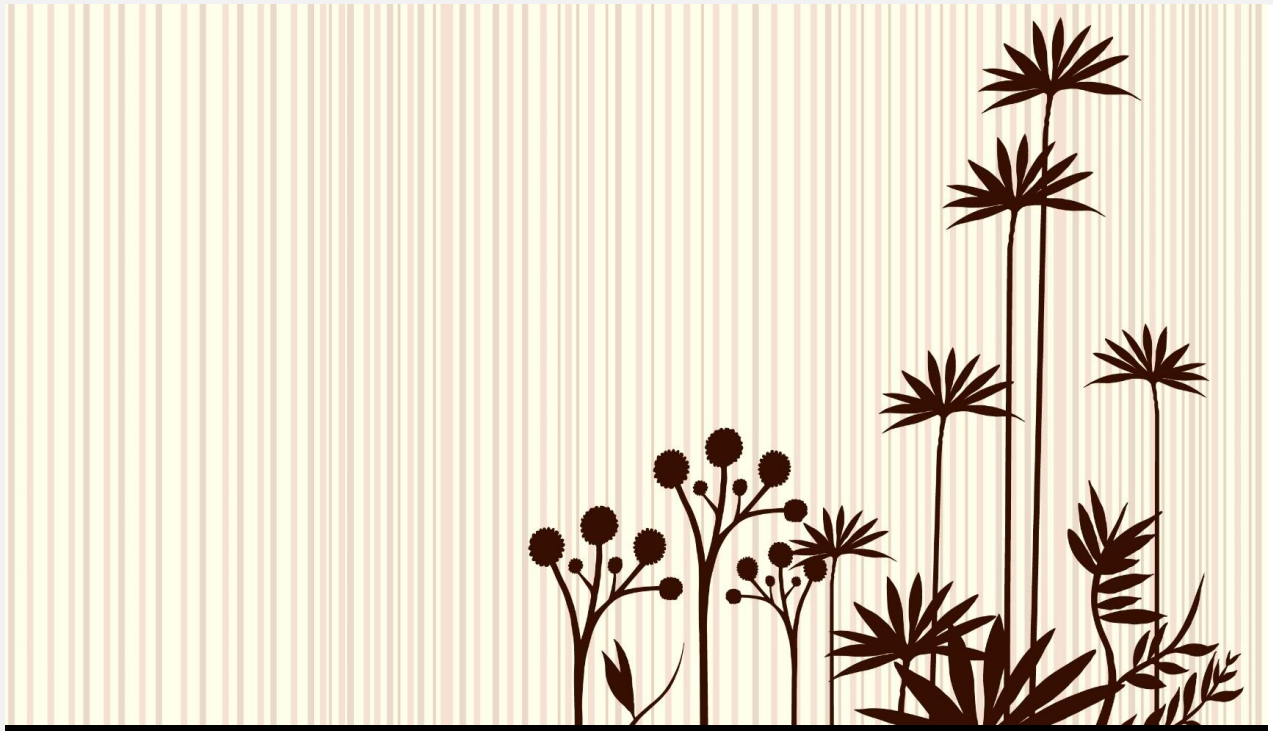



```
**** Old Flair Expression format no longer supported ****
**** set SDUM=OLDFLAIR in GLOBAL to temporarily allow them ****
!@what.1=-86.03*2.54

Abort called from CKEXPR reason OLD EXPRESSION FORMAT NO LONGER SUPPORTED Run stopped!
STOP OLD EXPRESSION FORMAT NO LONGER SUPPORTED
```

Results


Response Functions: Neutron Opt4 [Rack,Building,Snow]
CBL (Counts/(Neutron/cm^2))
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-13}
10^{-11}
10^{-9}
10^{-7}
10^{-5}
10^{-3}
10^{-1}
10
10^3
10^5
E_k (GeV)
Bare1
Bare2
Bare3
Bare4
Bare5
Bare6
Bare7
Bare8
Bare9
Bare10
OdenA
OdenB



Summary

Summary tagline or sub-headline

- We performed simulations of two different types of neutron monitor and surrounding.
- We found that particles of low energy penetrate to inside container lower than high energy particles as expected.
- We performed simulations of 10 bares neutron monitor and 2 oden monitors.
- We will do more simulations to reduce error bar at high energy particles.
- In future we will find ratio of bare/3NM64 when we have results of 3NM64 simulations.

Thank You

Audcharaporn Pagwhan
+66 86 188 1191
Audcharaporn_p@cmu.ac.th