EGP

Alan Bross

EGP?

- Just to bring everyone up to speed
- We applied to the Egyptian Supreme Council of Antiquities for a mission to study the Great Pyramid (Khufu).
- We were approved in 2018
- As you can see on the right, funding sources were undefined
- Goal now is to get enough of the simulation work completed to go out and secure funding to build and deploy the telescopes
- Probably will have to reapply to the Ministry
  - They wonder what happened to us

ARAB REPUBLIC OF EGYPT
Ministry of Antiquities
SUPREME COUNCIL OF ANTIQUITIES

SCA Foreign Mission Application Form

Please complete and submit to missions@moantiq.gov.eg

SECTION A: MISSION INFORMATION

Concession status:
New concession

Name of Mission:

"Exploring the Great Pyramid" - EGP

High-Resolution Muon Tomography of the Great Pyramid

Name and Nationality of Sponsoring Institution:

Fermi National Accelerator Laboratory, Batavia, IL 60510

(Please indicate the website address for further details concerning the institution's activities)

Name: **Fermi National Accelerator Laboratory:** Nationality: United States

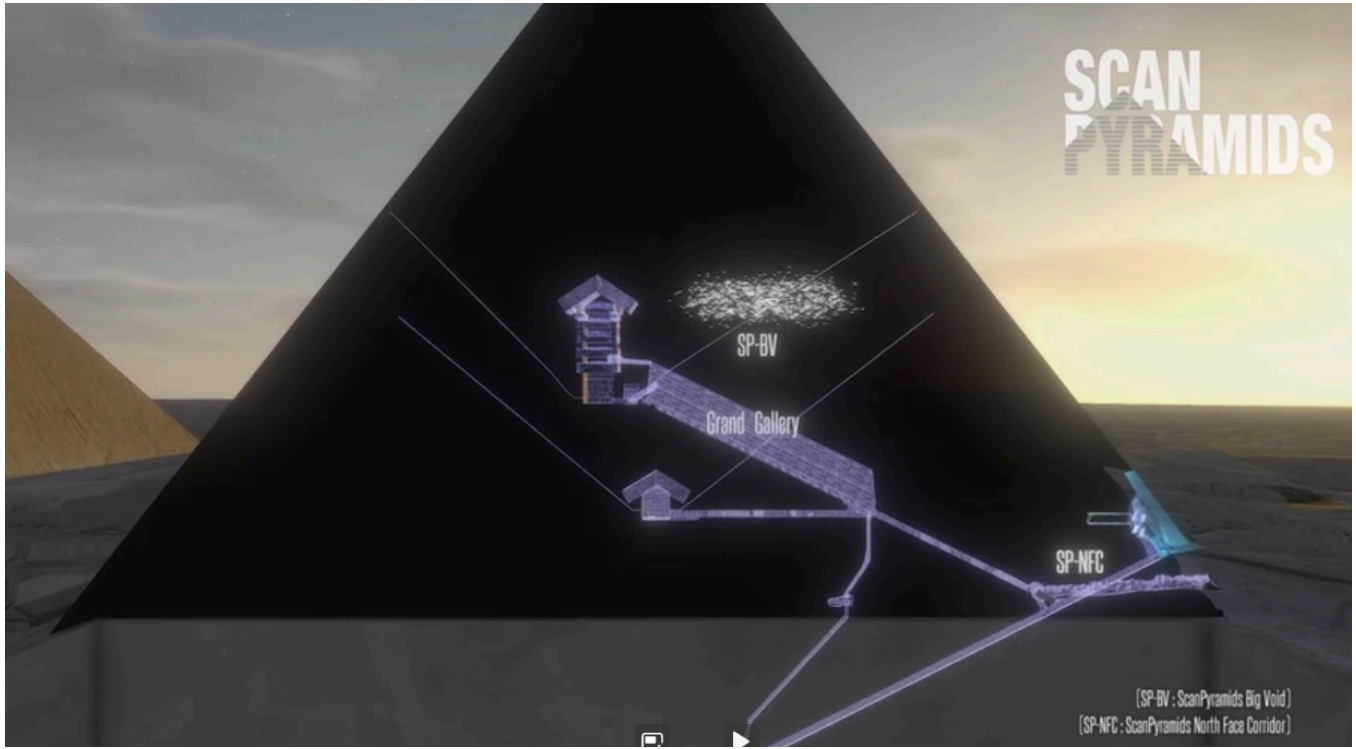
Website address: http://www.fnal.gov

Mission's Site: (Please include monuments if applicable): GIZA

Area: Giza Plateau
Monument(s): Great Pyramid of Khufu
Mission Director: Dr. Alan Bross
Mission Assistant Director:
Number of Mission Members:
Funding Source(s):

Fermilab

And the invitation for us to apply came because of this



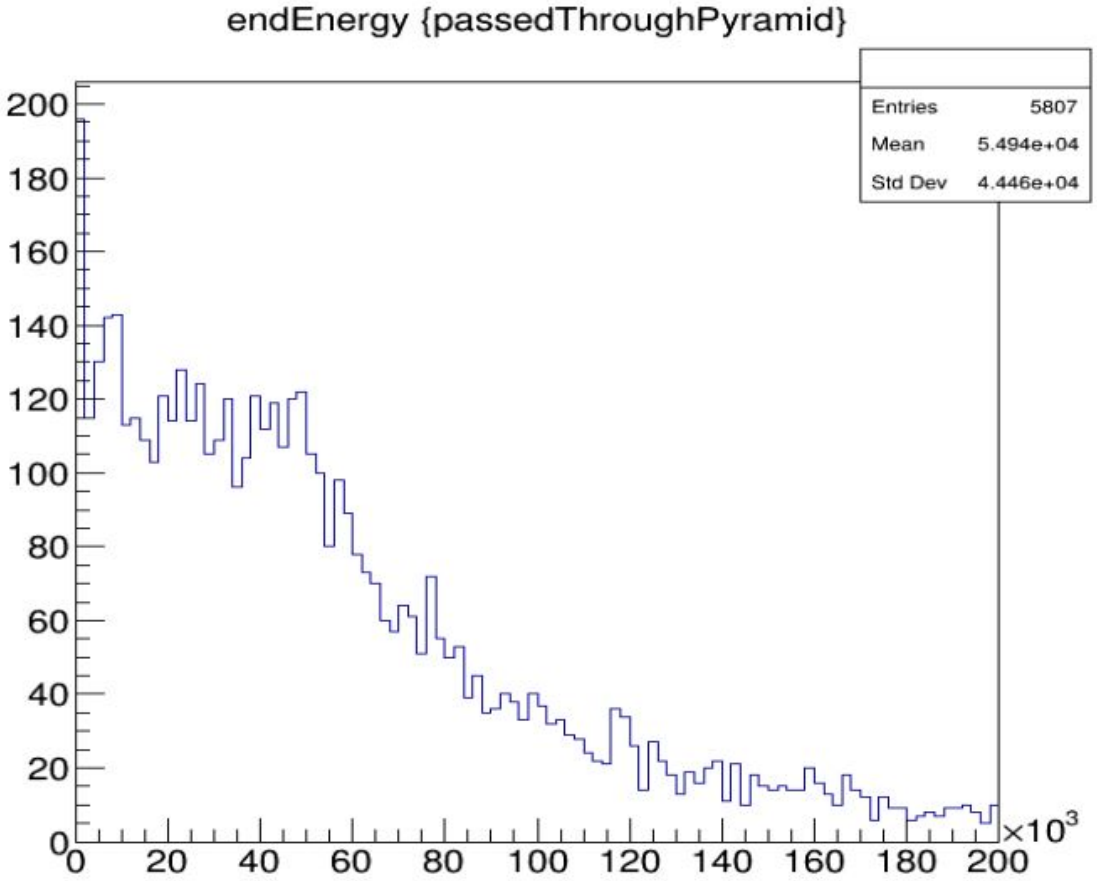
Simulation work

- Several components:
  - Build test model (solid pyramid with voids) and create database of cosmic-ray muons penetrating the structure
    - Ralf has already done a few iterations on this and one currently running
  - Create stand-alone muon Monte Carlo (MC) to study detector performance & optimize
  - Transform MC data into a format more easily applied to tomographic reconstruction/analysis and investigate reco capabilities
  - Run simulation on full Khufu model with known structure and with known structure plus “hypotheticals.”
    - Move to National Energy Research Scientific Computing Center (NERSC)
  - Apply tomographic reconstruction to final data set(s)

Stand-alone muon MC (some guidance)

- Muon gun
  - $0.1 < E_{\mu} < 200$ GeV to study detector performance
  - $40 < E_{\mu} < 400$ GeV to study pointing accuracy
  - Angular acceptance $\pm$ 60^{o}
    - Out to ~ 80^{o} if telescope at the extreme of its travel
- Cell geometry study
  - 1x2 cm reference? (Range of study - 1 x 2, 2 x 2, ?)
- Study (Assume the 2 XY planes are separated by 2m):
  - Point set resolution
  - Charge sharing between strips & clustering
  - dE/dx vs E
  - Pointing accuracy
    - With and without multiple coulomb scattering (50-100m concrete?)
    - Use mid-plane of pyramid as extrapolation point?

E_μ detected from Ralf's simulation



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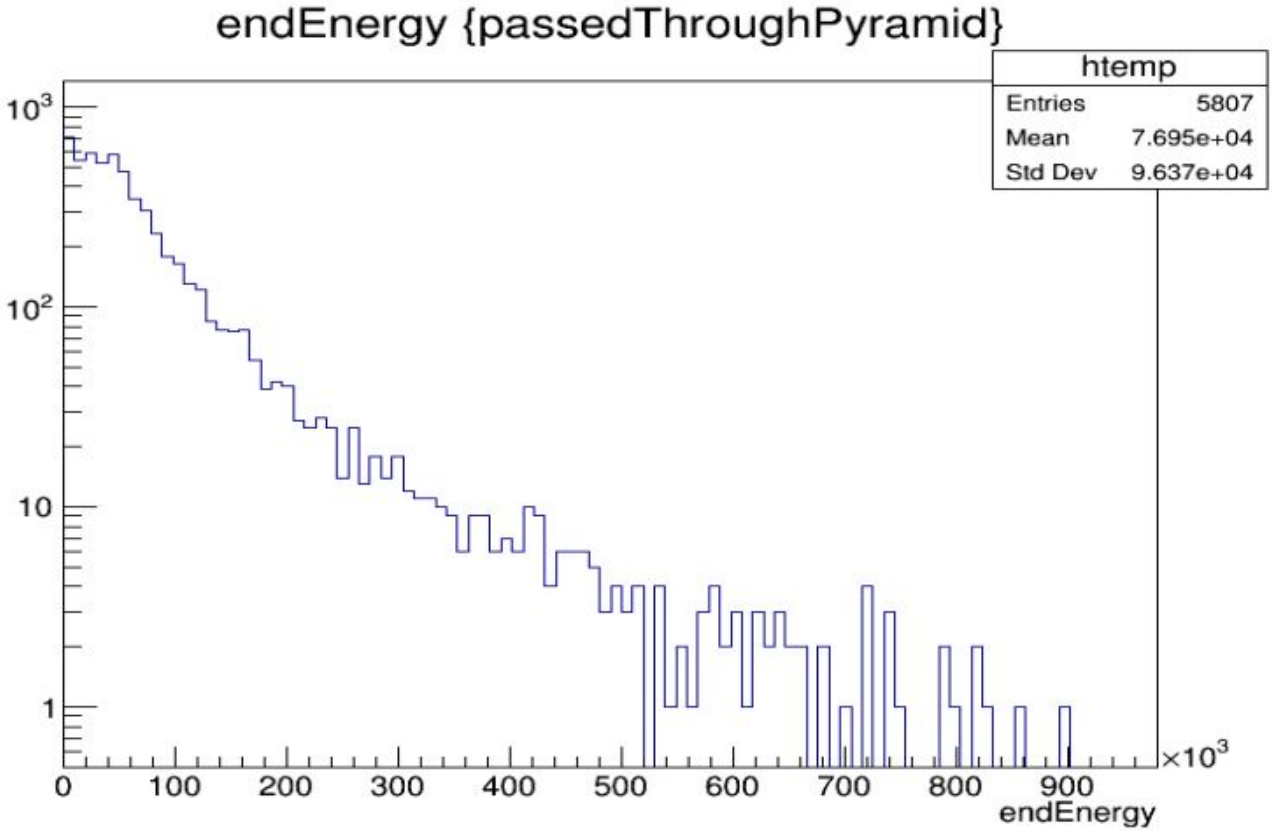
E_μ detected – full range



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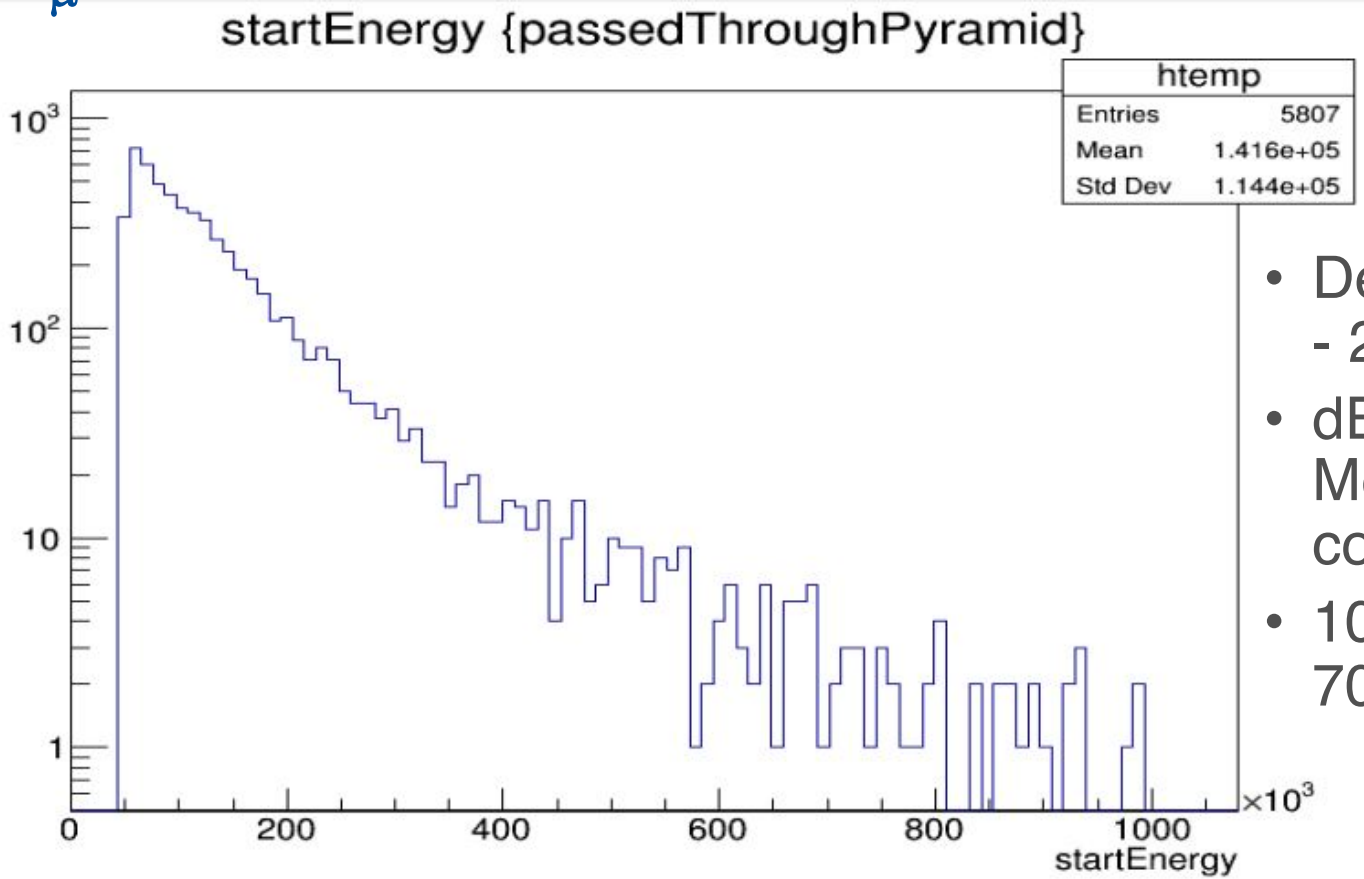
$E_{\mu}^{initial}$ of those detected



- Density of limestone - 2.7g/cm^3
- dE/dx $\simeq$ 1.7 MeV/g/cm^2 (using concrete for now)
- 100m of limestone $\simeq$ 70 GeV

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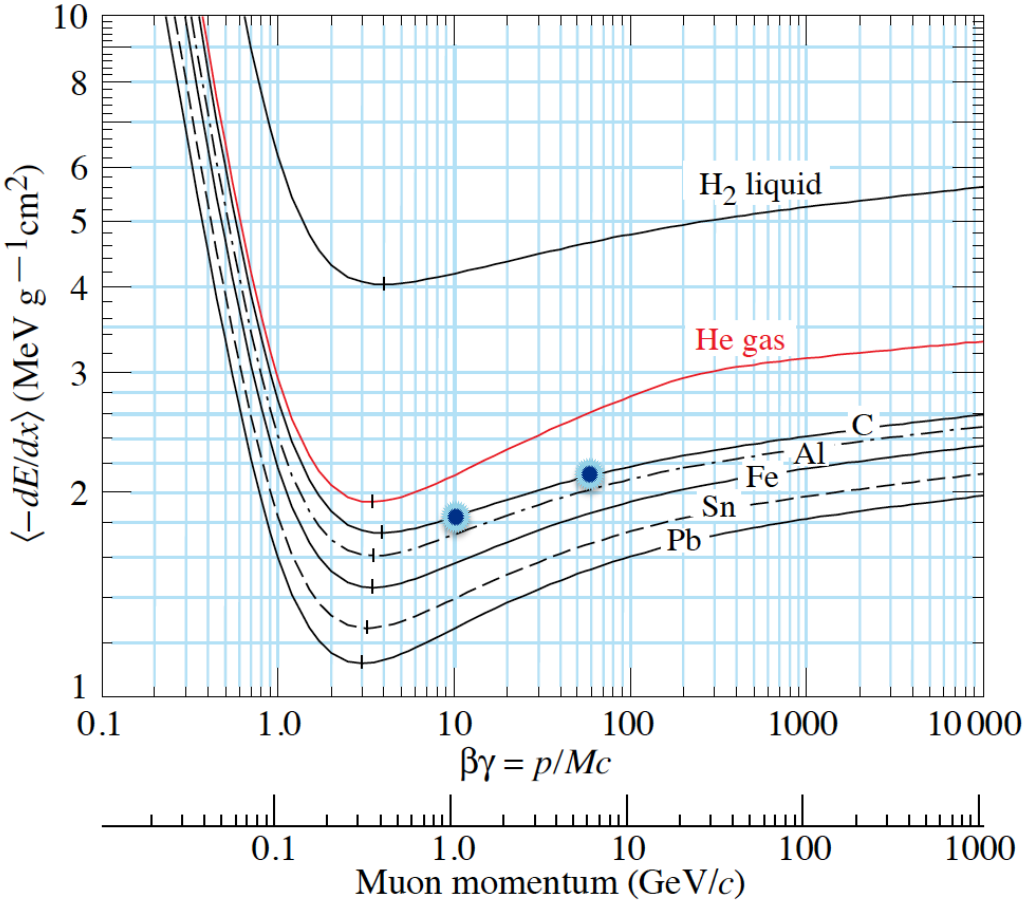
dE/dx



Rise≃2.1/1.8=1.17

Our dE/dx resolution ≃ 5%

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