Exploring the Great Pyramid
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Background
For centuries, the pyramids at Giza have been the object of frequent speculation and study. L. Alvarez et. al in 1970 and the ScanPyramids collaboration in 2017 have very successfully implemented HEP detector technology to image the pyramid of Khafre and the Great Pyramid of Khufu, respectively. Numerous questions about Khufu’s structure remain, however. The EGP project aims to undertake a new study of this enigmatic monument’s interior by applying high-resolution tomographic imaging and reconstruction, which will permit a detailed understanding of internal variations in density and may offer insight regarding exactly how Egypt’s largest pyramid was built.

Cosmic-Ray Muon Tomography
When cosmic particles such as protons interact with Earth’s upper atmosphere, they produce muons; upon reaching the planet’s surface, many of these muons remain energetic enough to penetrate massive edifices like the Great Pyramid. By measuring the rate at which the muons reach the other side as a function of angle, we can obtain information about the pyramid’s internal structure. Repeating such measurements at several locations around the perimeter of the monument permits full 3D image reconstruction.

EGP Detector Proposal
We plan to field eight detectors, housed in 40-ft. steel shipping containers, and move these around the pyramid perimeter to observe events at a variety of angles. Each detector will consist of two planes of scintillator strips, embedded with wavelength-shifting fibers and read out by SiPMs (see below). Data collection will continue for a total of 1-2 years.

Conclusions and Future Work
Because it produces only small increases in energy deposition for increasing incident energy, inserting a Pb sheet in the space between detectors does not provide a viable means of determining muons’ incident momenta. Further simulation is needed to fully answer the question of detector resolution: next steps include varying the angle of the muon beam, refining the position & angular resolution algorithms, and adding a concrete block upstream of the detector to mimic the presence of the Great Pyramid.

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