Designing, Constructing and Testing Ring 6 for The MOLLER Experiment

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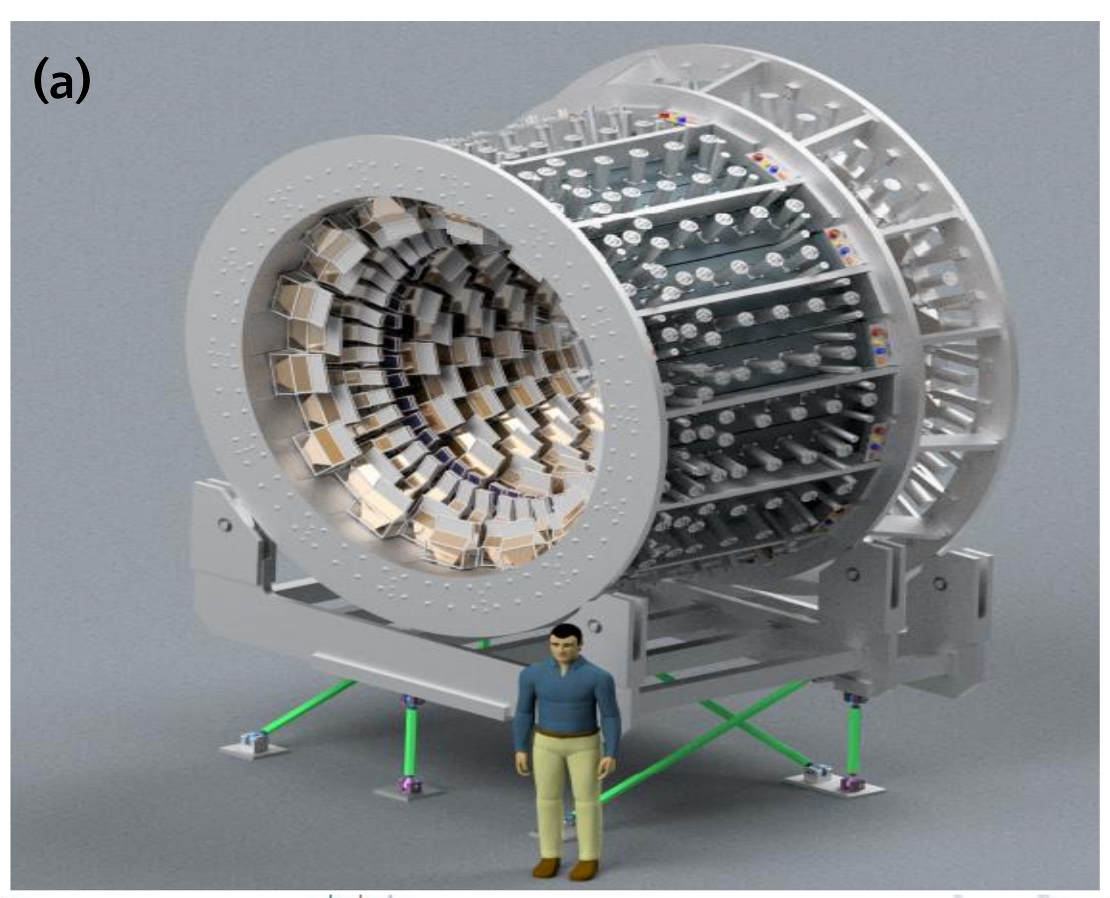
Introduction

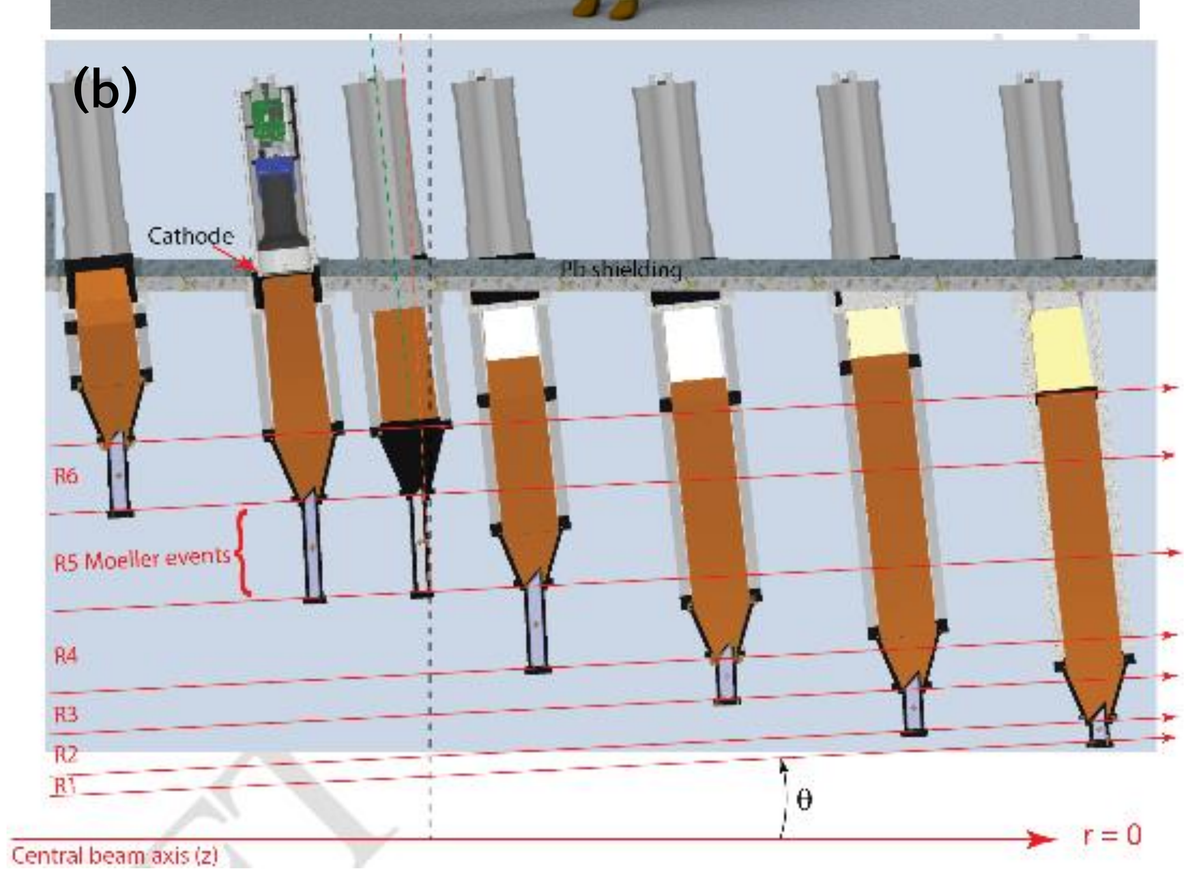
MOLLER seeks to measure the parity violating asymmetry of moller scattering

- Precision on the order of parts per billion
- Requires 10^{18} measured events due to $1/\sqrt{N}$ dependency

This is accomplished using 224 integrating Cherenkov detectors broken into 6 rings

- Relativistic electrons pass through radiation-hard fused-silica tiles, generating Cherenkov radiation
- This radiation provides a relative measurement of the scattered flux
- Integrating signal at a 100 GHz rate allows all events to be collected in 10^7 seconds (~116 days)





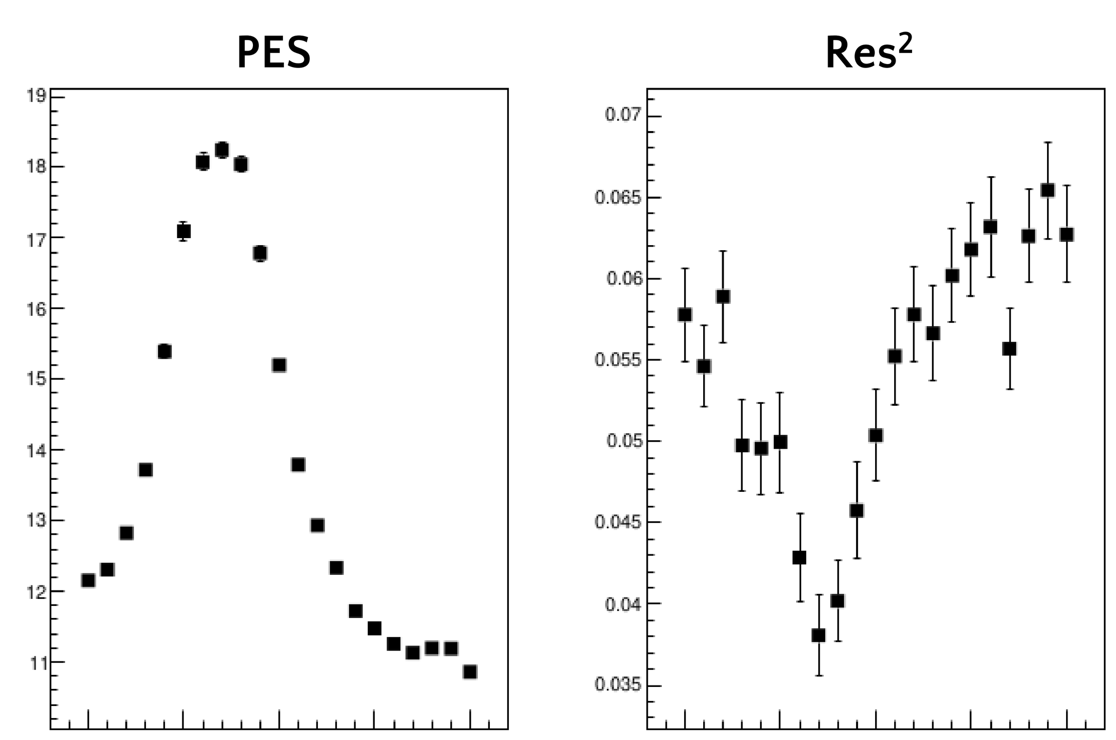
(a) Main detector and (b) segment of main detector

Design and construction

Each detector consists of a quartz tile, a light guide, and a photomultiplier tube (PMT)

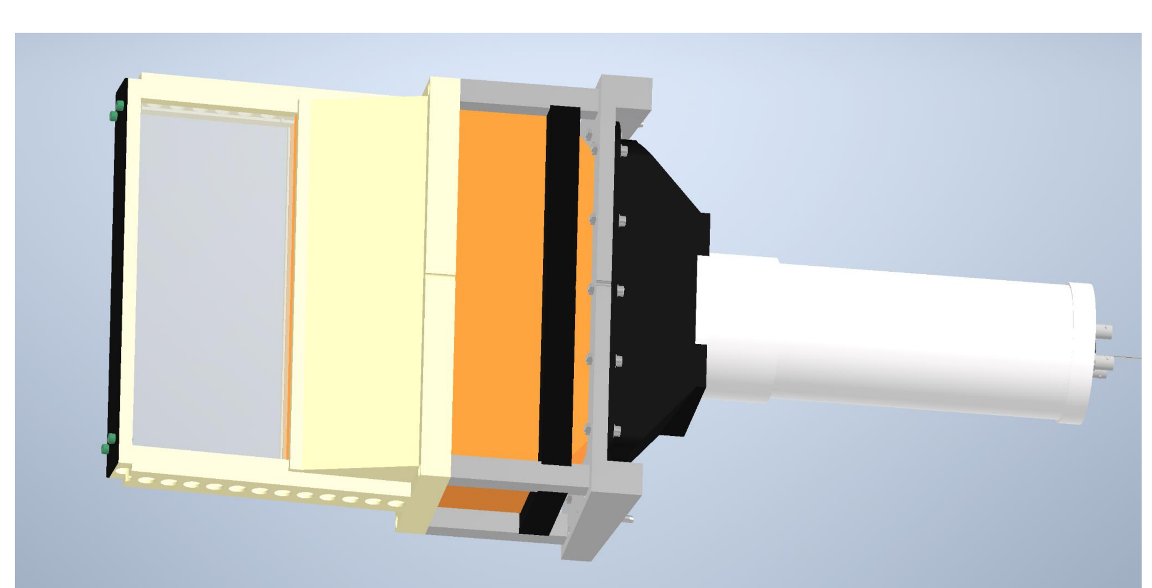
- Photons undergo total internal reflection in the quartz before exiting into the light guide
- Light Guide is made of flat reflective panels optimized to funnel Cherenkov radiation towards the PMT
- PMT converts photons into photoelectrons (PEs) to create a measurable signal we integrate over

Optical Monte Carlo simulations using Geant4 were used to design and optimize the geometry of the detectors



Varying the angle of a reflector plate, then measuring the PE yield and resolution

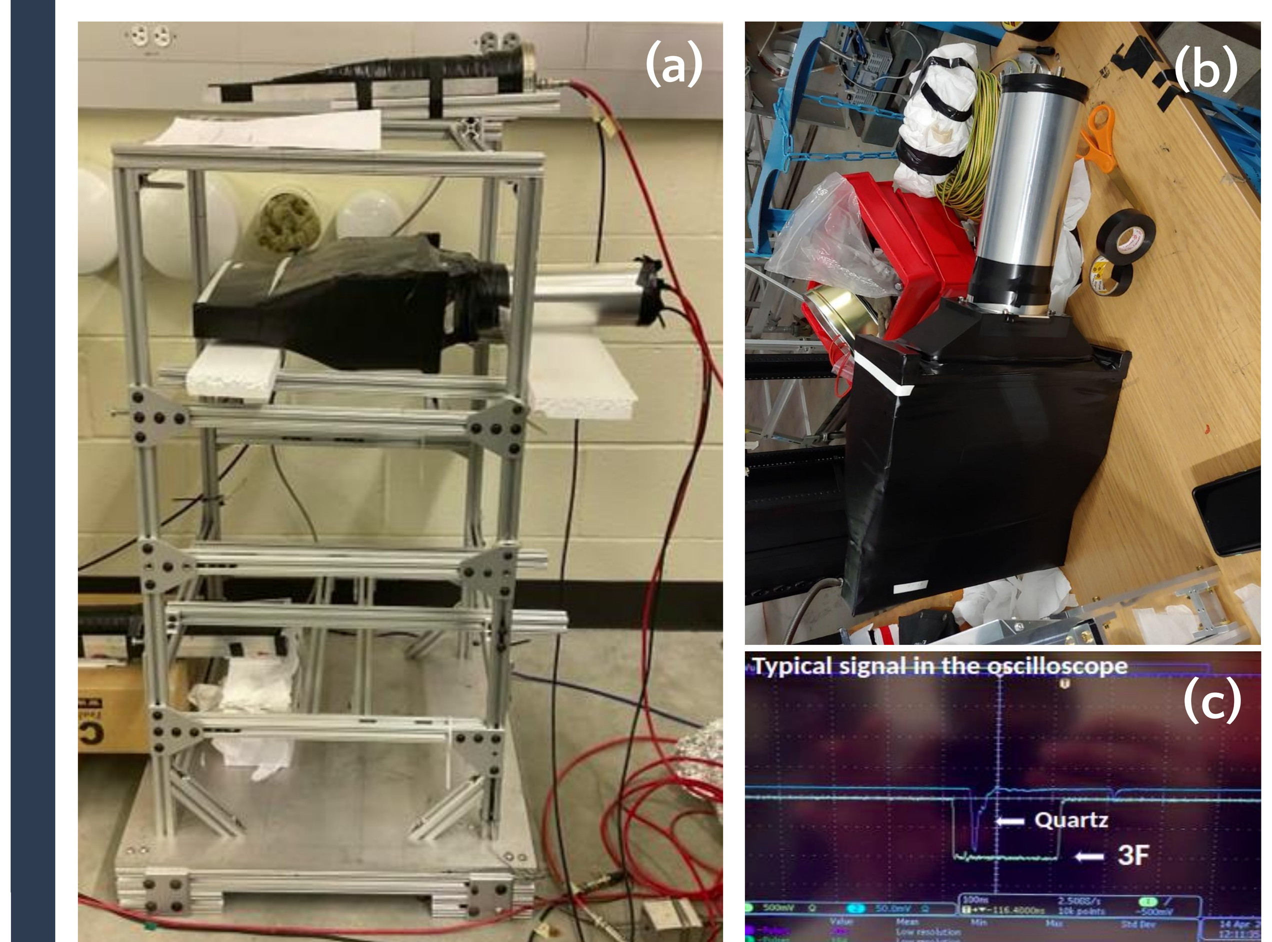
After determining an optimal geometry, CAD models and physical prototypes were created



CAD model of Ring 6

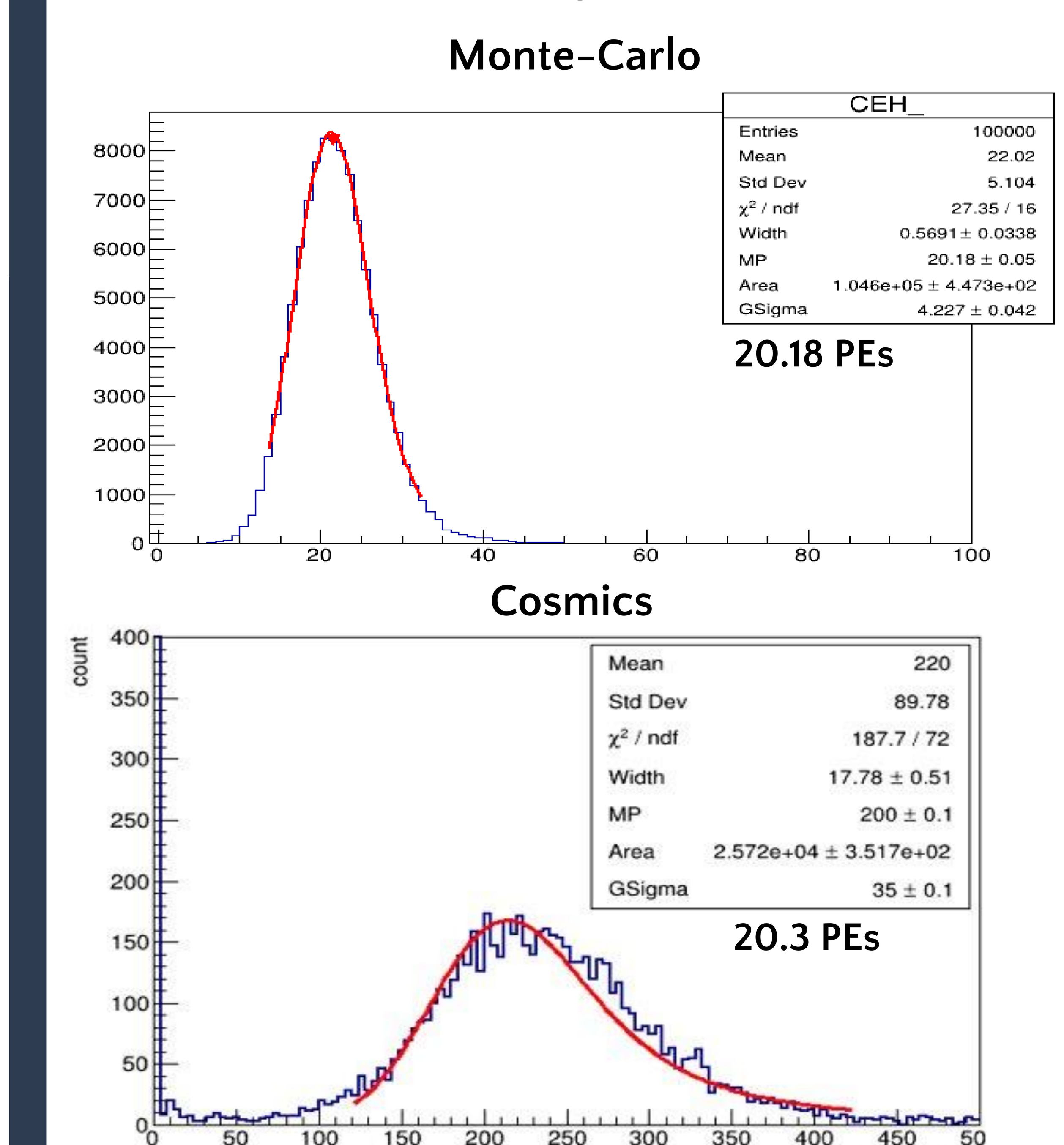
Testing and Data Analysis

To test performance locally, we analyzed cosmic muons that passed through the quartz



(a) Cosmic stand, (b) Physical prototype, and (c) Cosmic signal

Once satisfactory results were obtained, the detector was taken to the Mainz Microtron (MAMI) for benchmarking

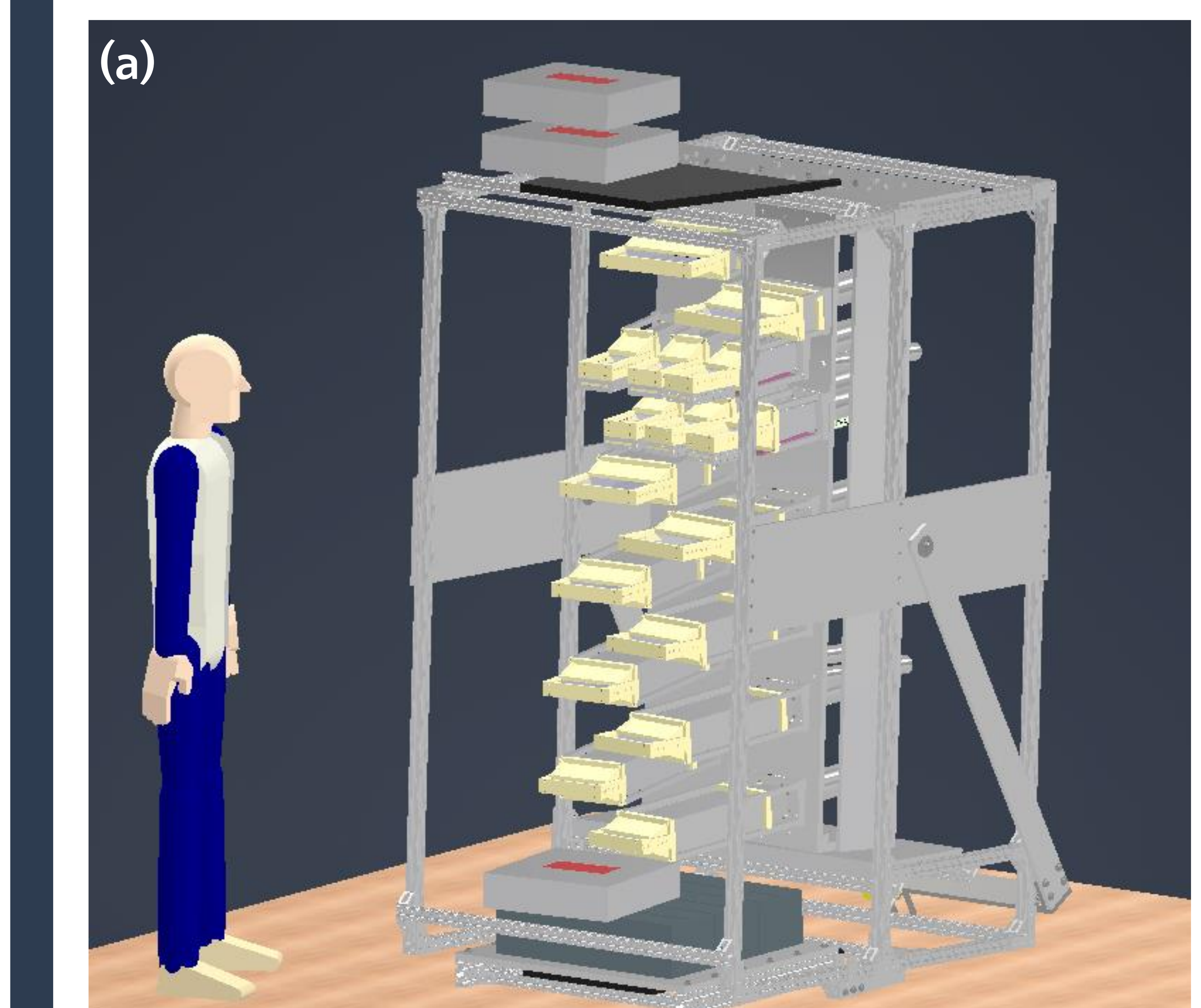


Comparison of Monte-Carlo vs. cosmic data

Going Forward

To further improve accuracy, we plan on implementing GEMs (Gas Electron Multipliers) to further constrain the angular acceptance of our cosmic stand

We are also assembling a full segment to test interference between the detectors



(a) New cosmic stand to be constructed in the following months

(b) Testing a detector at the Mainz Microtron

Acknowledgements

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