High Energy Light Isotope eXperiment

Presented by Nahee Park

HELIX Collaboration

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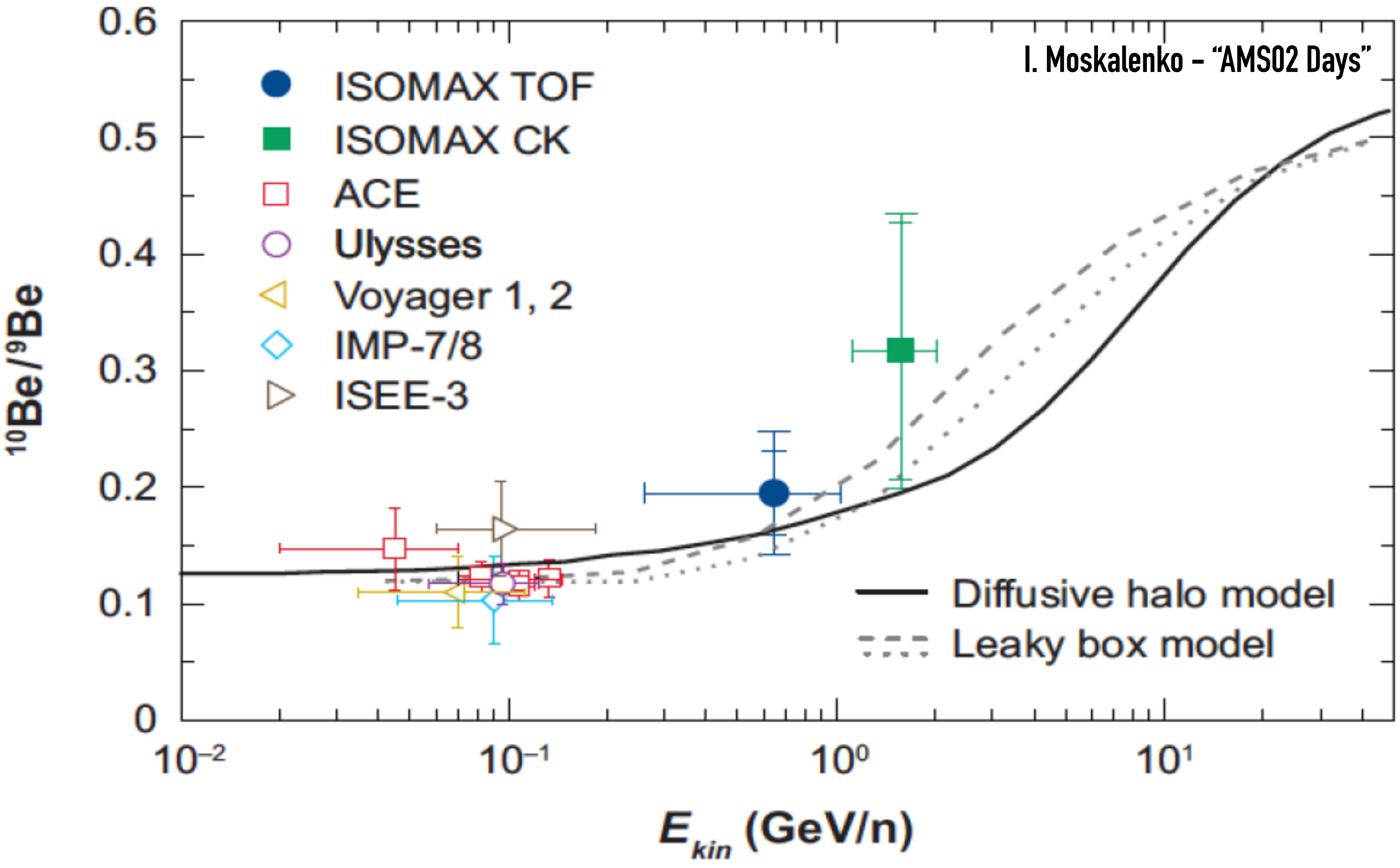
^{10}Be/^{9}Be measurements

^{10}Be : Unstable isotope with known half life of 1.4×10^{6} yr

- ^{10}Be/^{9}Be ratio provides strong constraints for the propagation models
- Challenging measurements



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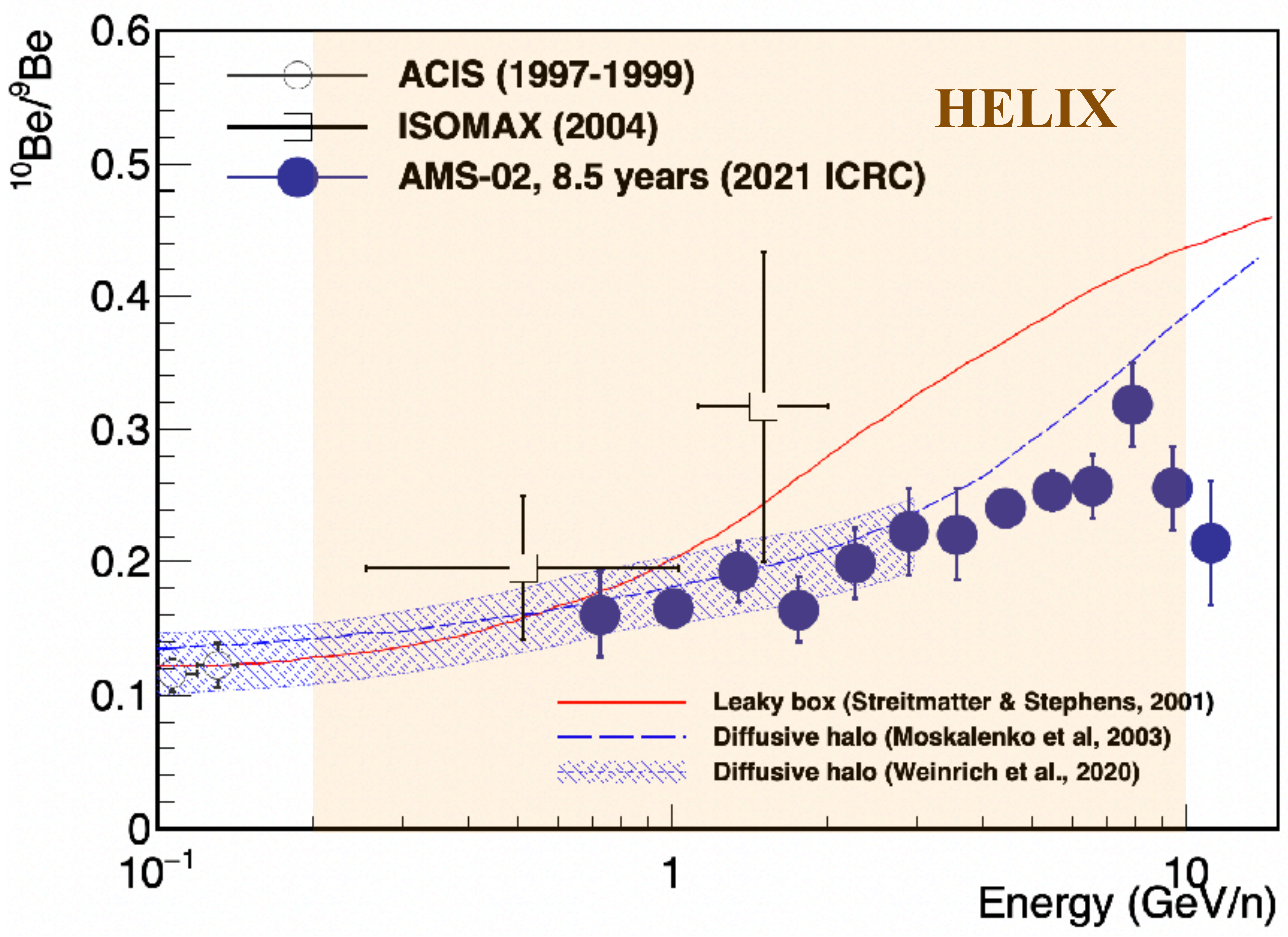
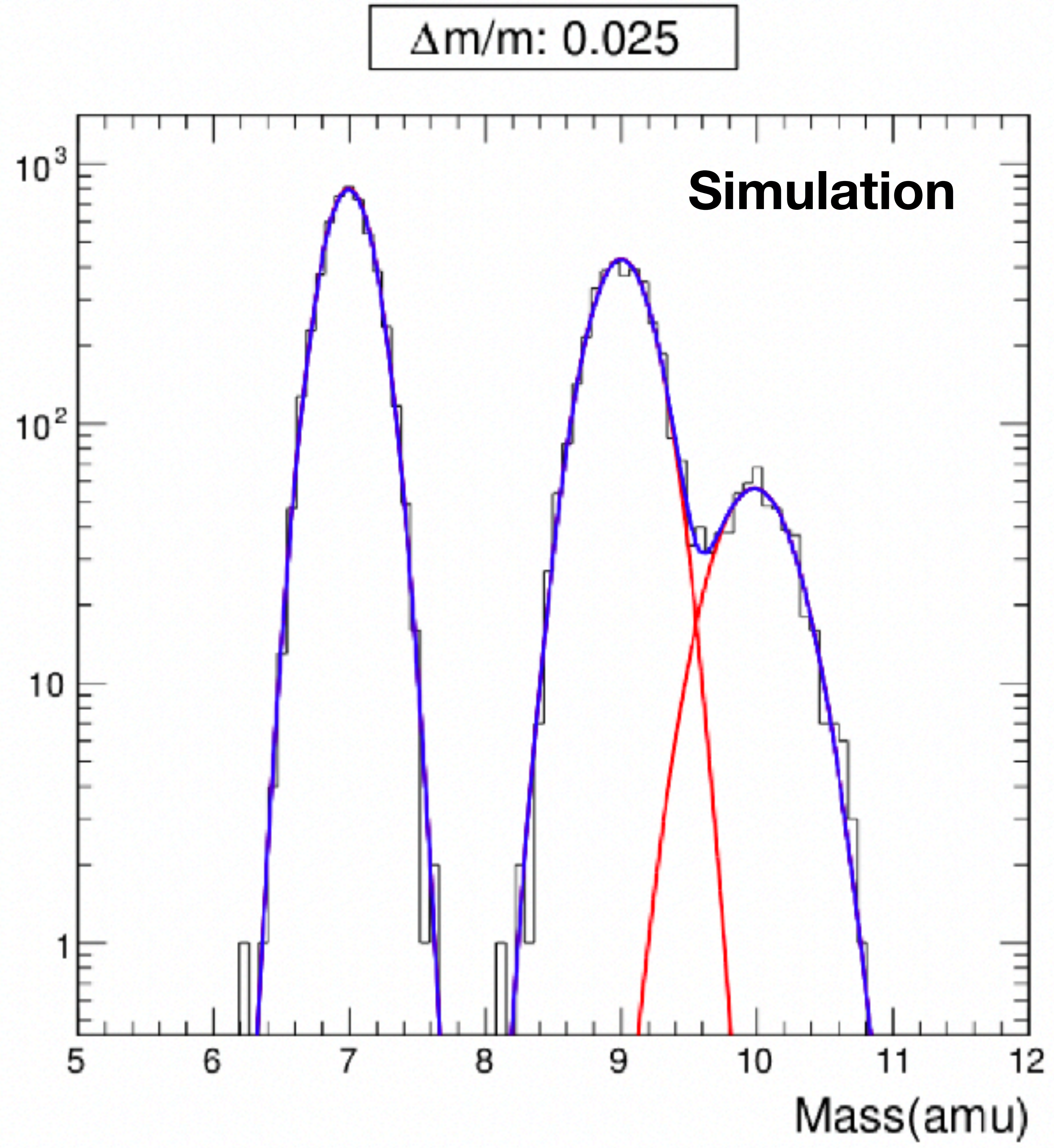
HELIX is designed to provide a precision measurement of ^{10}Be!

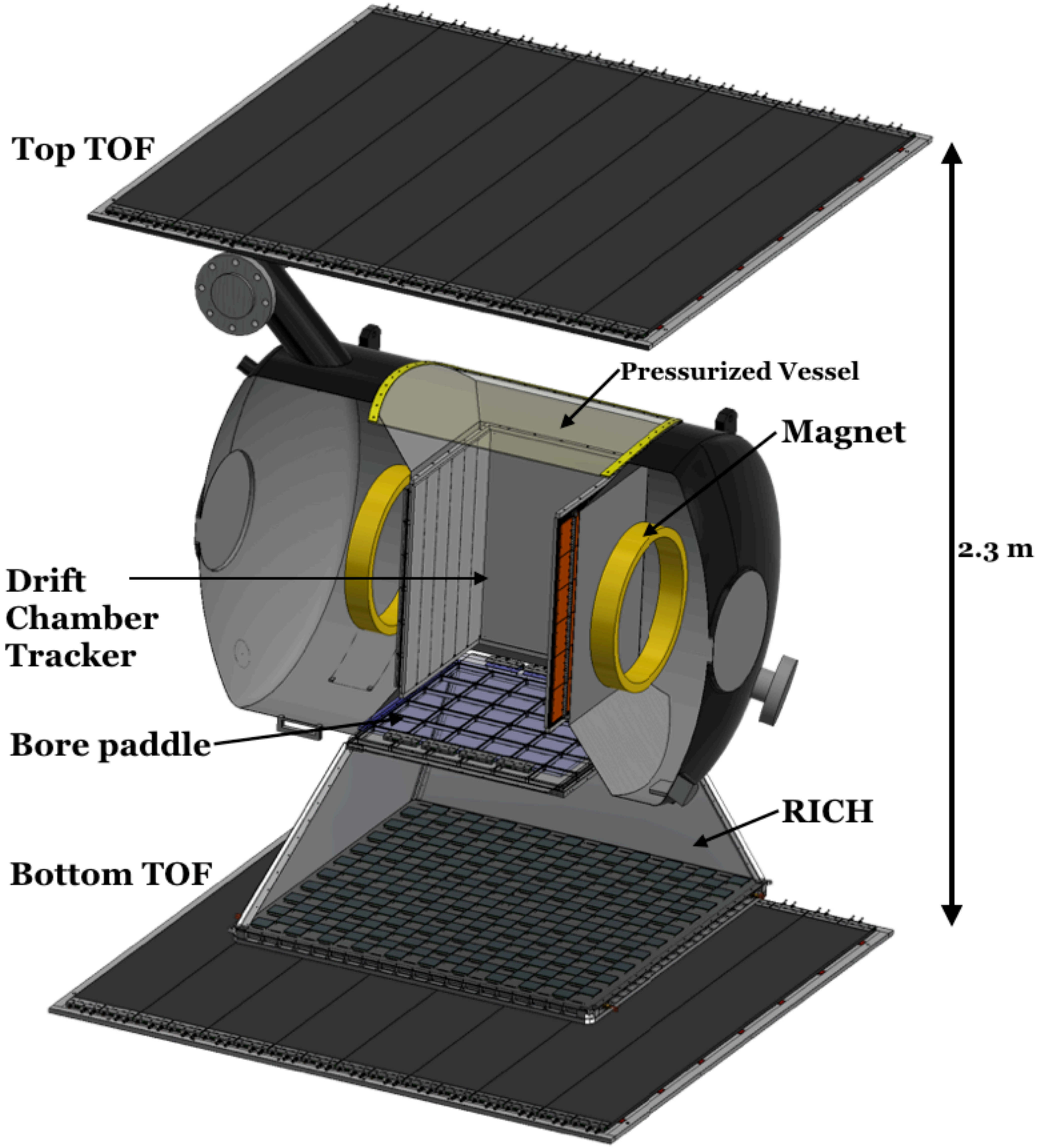




High Energy Light Isotope eXperiment

A new magnet spectrometer payload to measure $^{10}Be/^{9}Be$ isotope ratio up to 10 GeV/n

- Design considerations
  - -A mass resolution of few % up to 10 GeV/n
  - -Readout within a very strong magnetic field (Superconducting magnet used for HEAT balloon payloads, B field at the center ~ 1 T)
  - -All SiPM readout needs good thermal design



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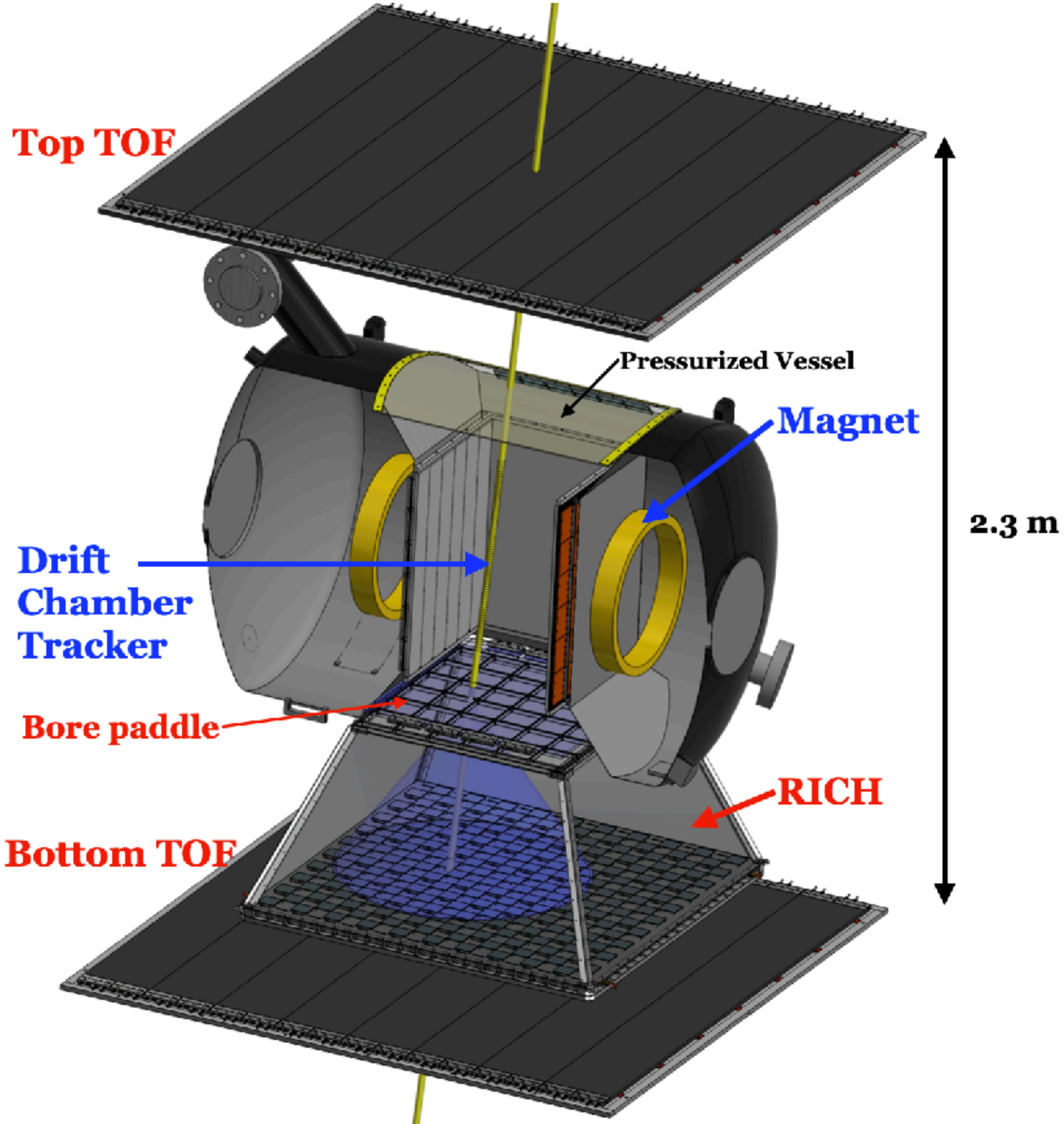
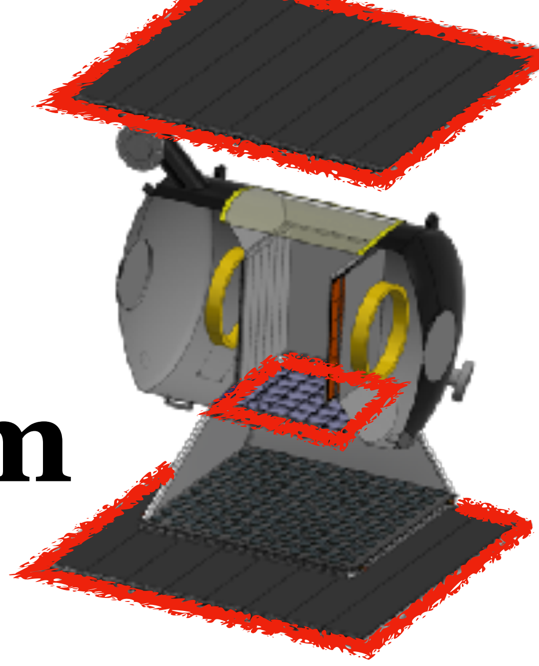
  - -All SiPM readout needs good thermal design
- Two stage approach to cover wider range of energy
  - -Stage 1 : covers up to ~ 3 GeV/n

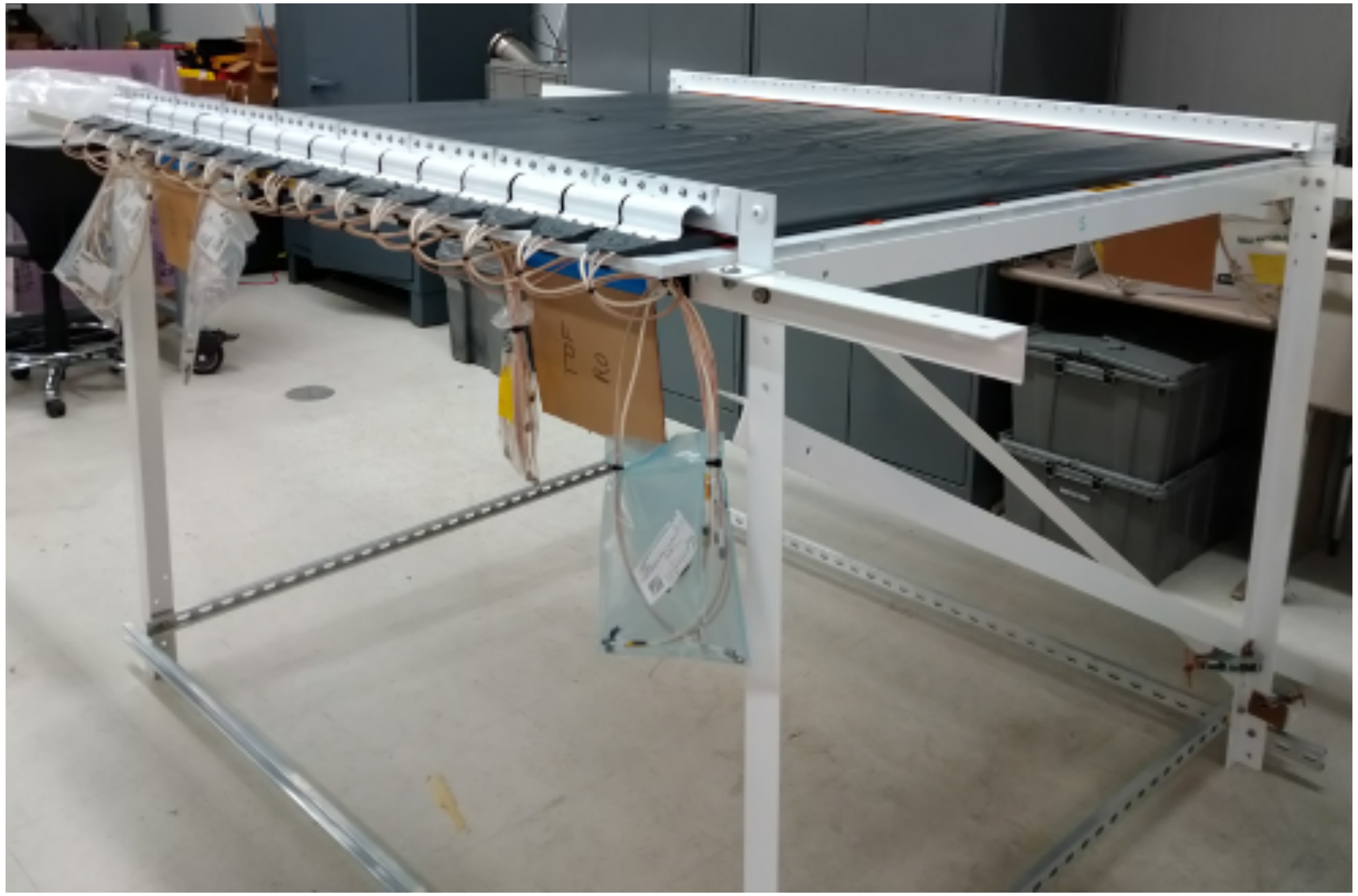


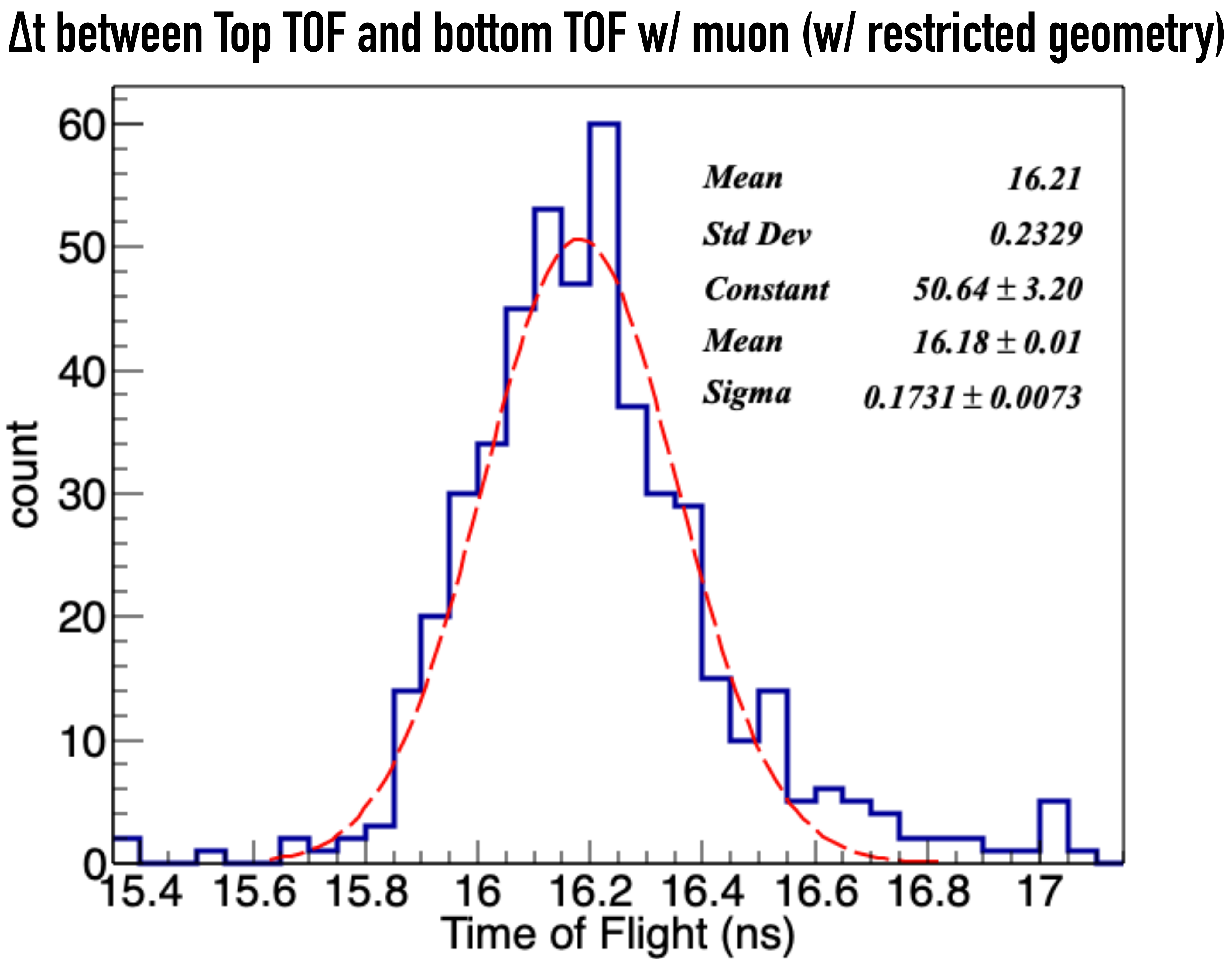
Time-Of-Flight



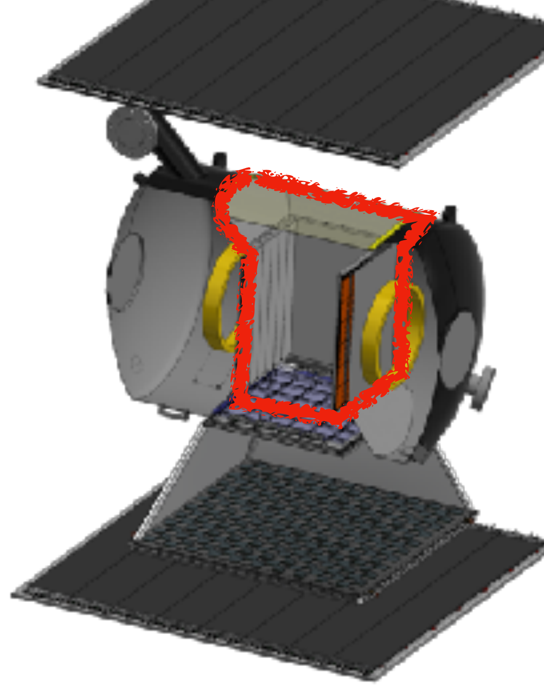
Three layers of 1 cm thickness fast plastic scintillator, 2.3m top to bottom

- Timing resolution of <50 ps for Z>3
  - -Each 20cm EJ200 scintillator paddle with each end read by 8 SiPMs
  - -TDC timing resolution better than 25 ps
- Preliminary analysis on the muon test shows a timing resolution better than 200 ps





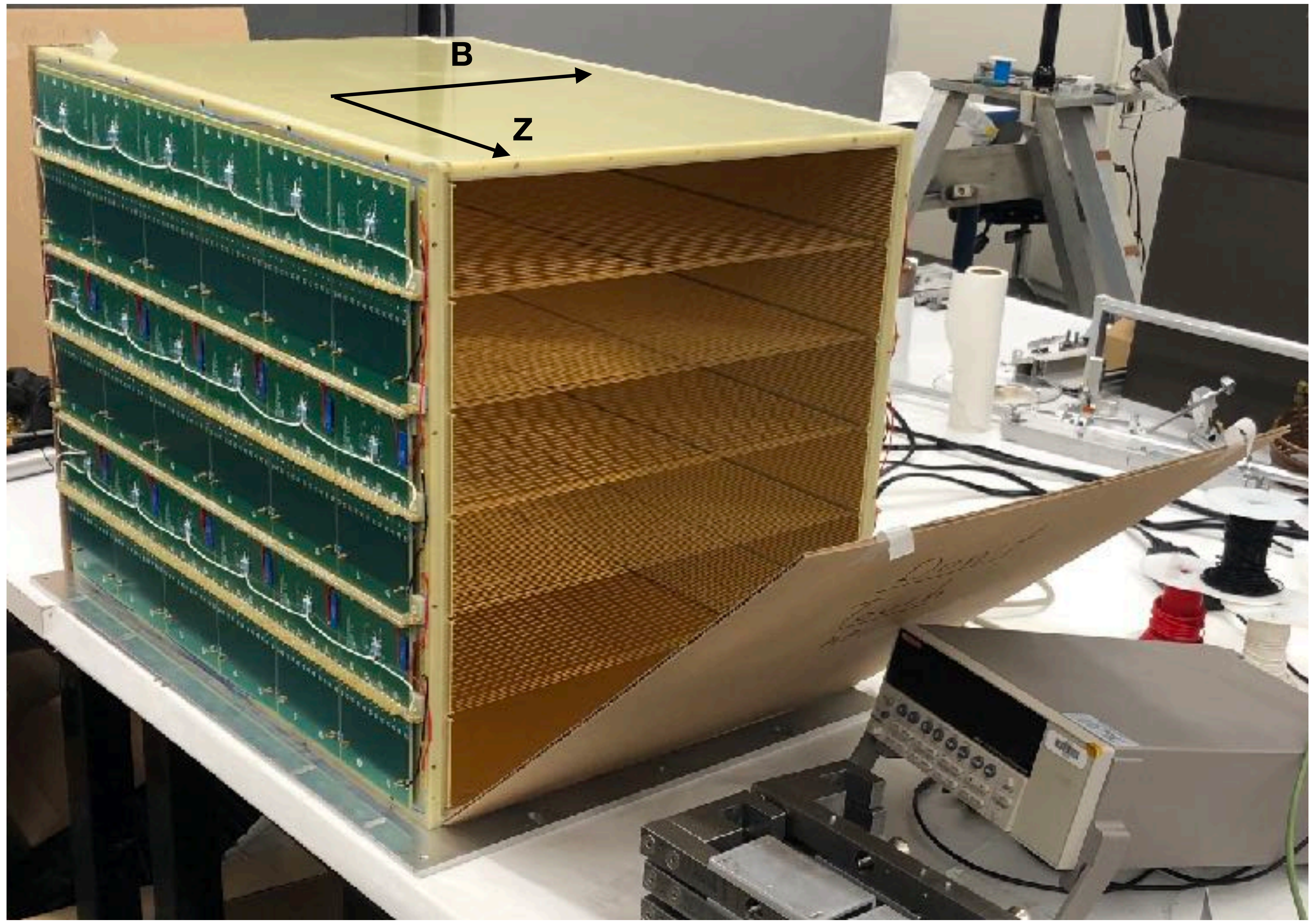
Drift Chamber Tracker

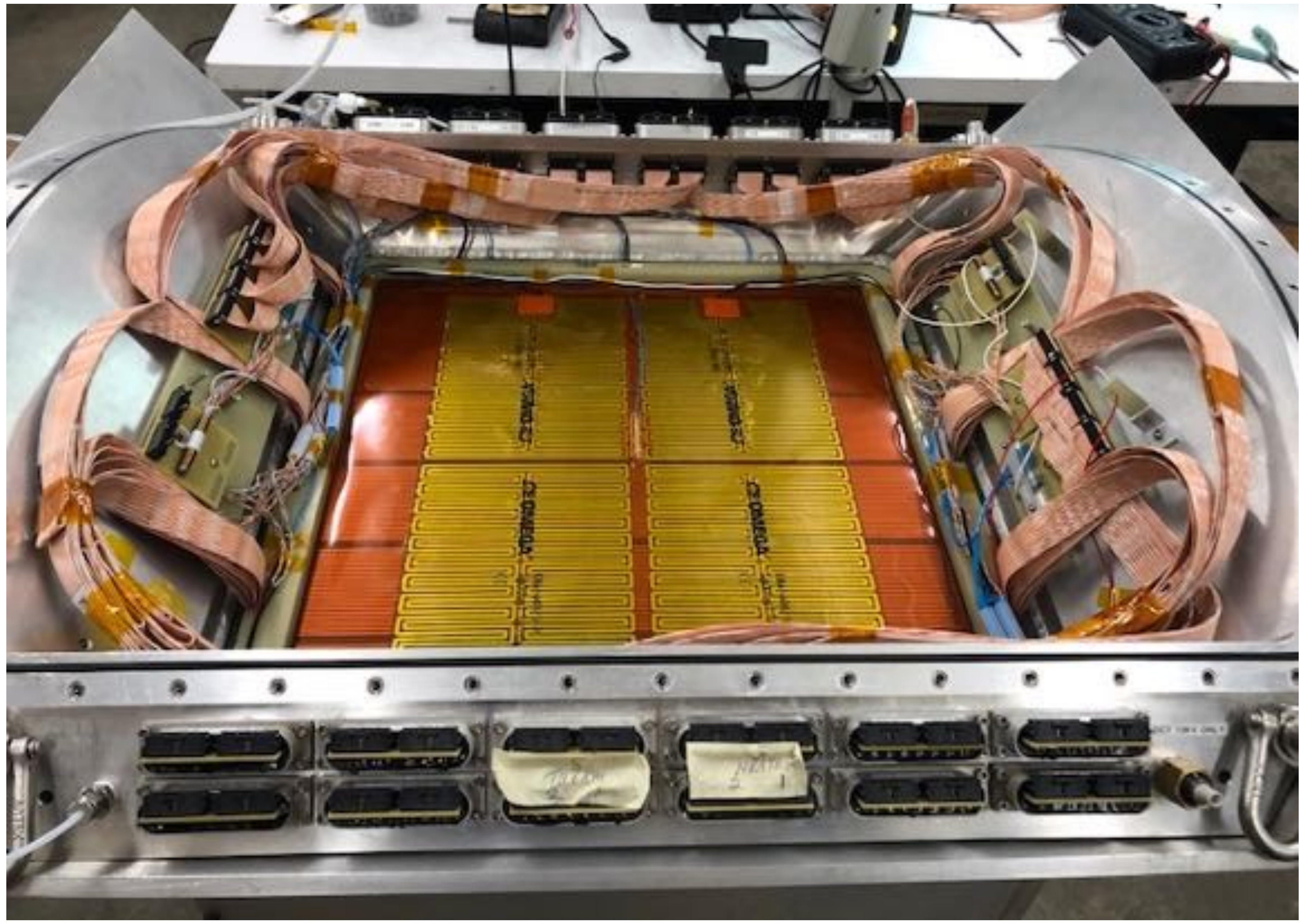


Multi-wire drift chamber with drift gas CO_2 + Ar

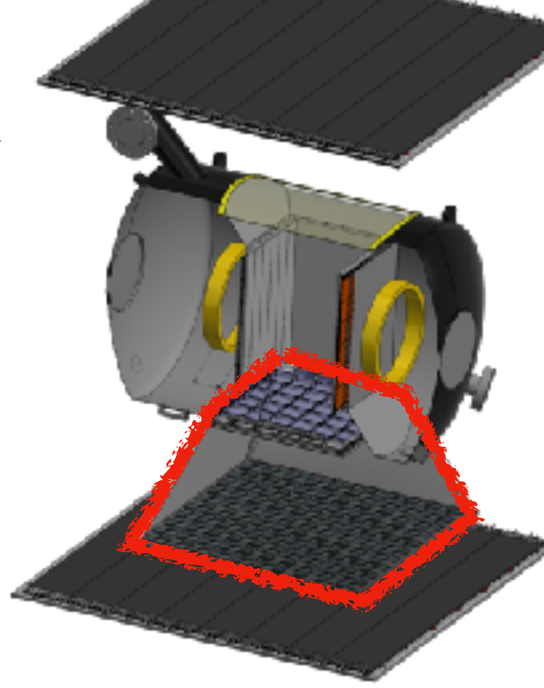
Poster

- Spatial resolution of 65 μm for Z>3
  - -72 sense layers, read out with 80 MHz sampling
- Installed in the bore of magnet within a thin pressure vessel
- Prototype measurements show a tracking resolution for muons to be consistent with reaching the design goal



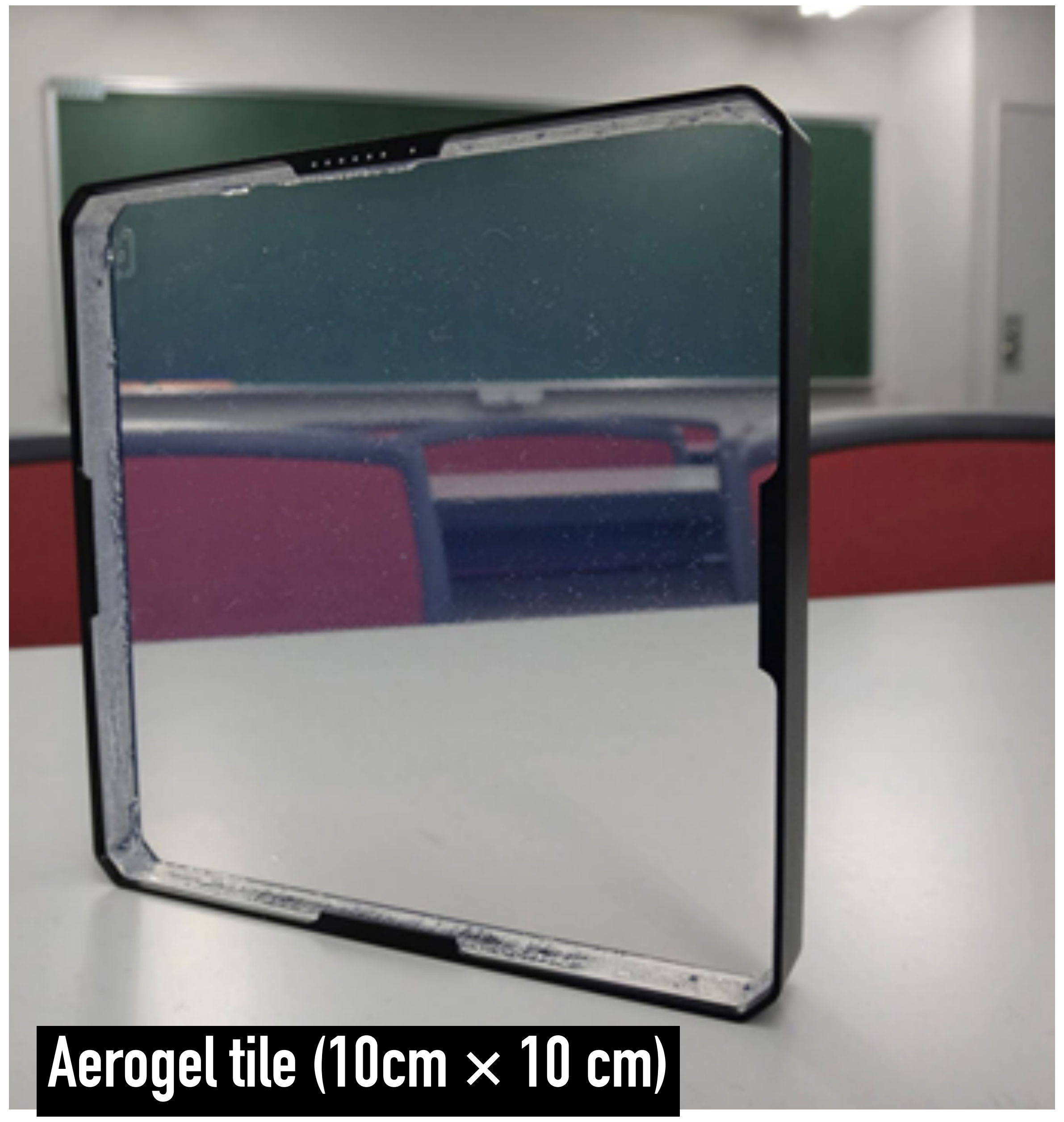


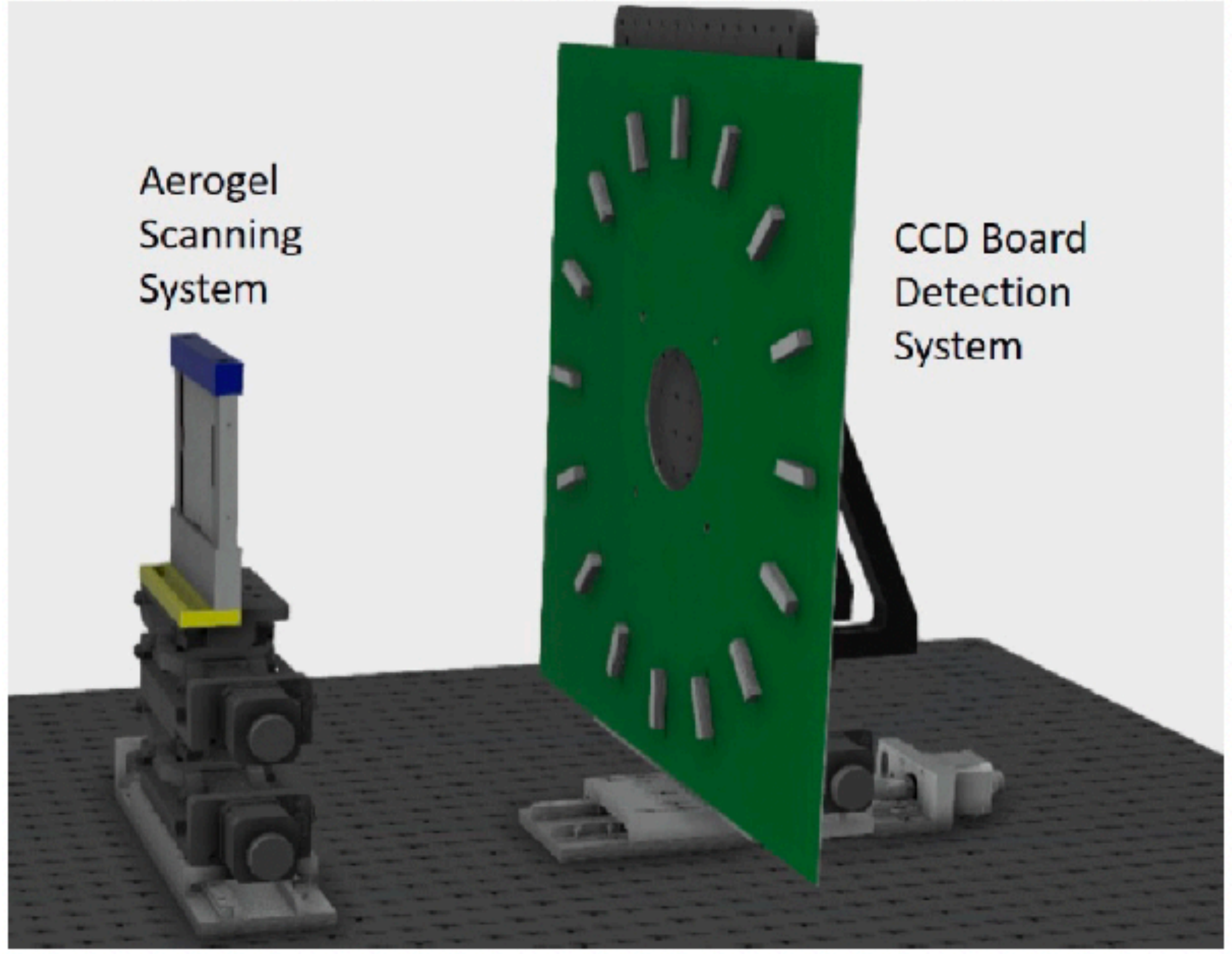
Ring Imaging Cherenkov Counter

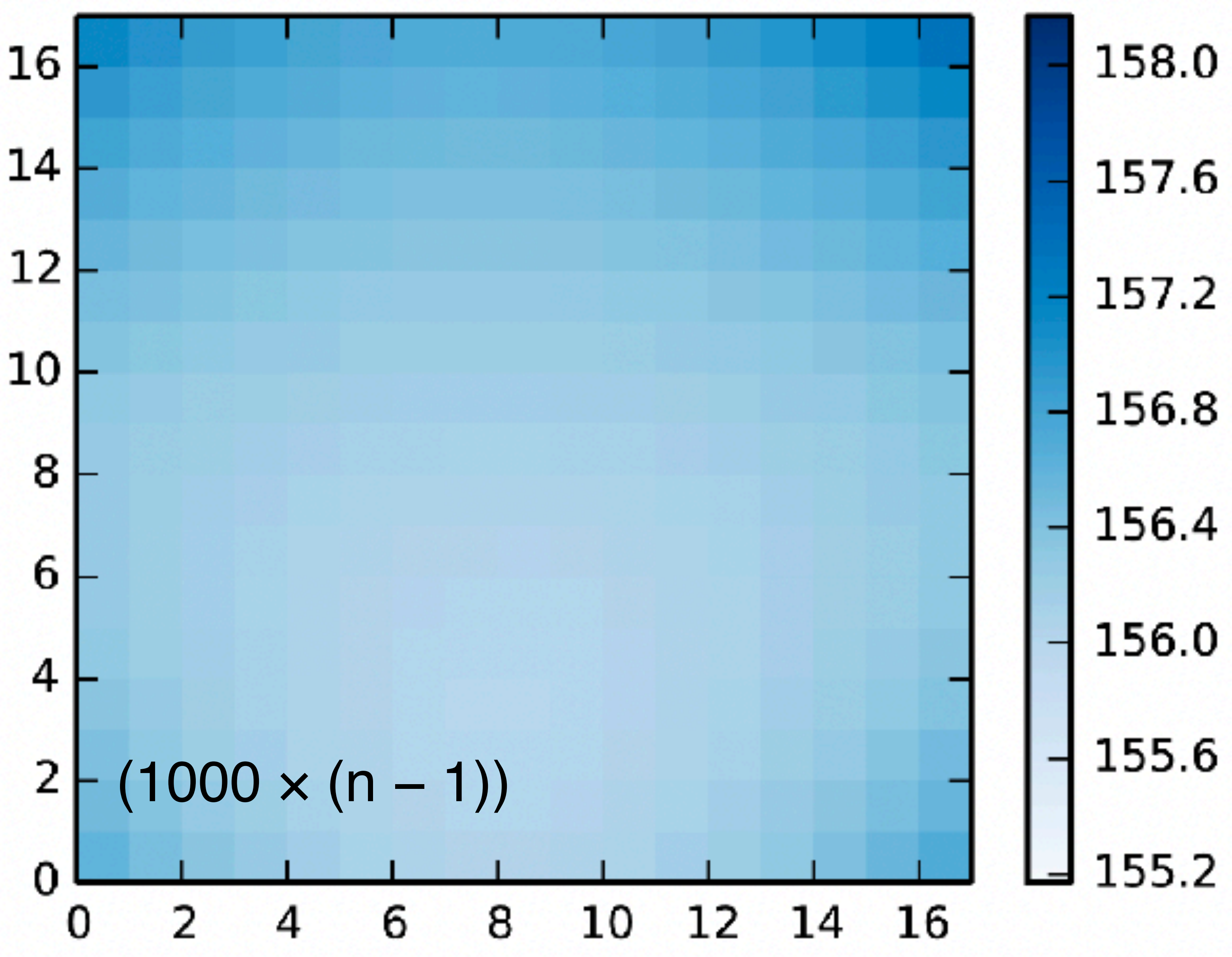


Proximity-focused RICH with SiPM readout

- Velocity resolution of $\Delta\beta/\beta \sim 1\times10^{-3}$ for Z>3 for E>1 GeV/n
  - -Main radiator : Highly transparent & hydrophobic high refractive index aerogel (n~1.15)
    - ✦Refractive index calibration w/ systematic error at 10^{-4} level for 51 tiles (paper in preparation)
      - ✦Thickness measured w/ CMM at TRIUMF
      - ✦Electron-beam calibration at 35 MeV electron linac at National Research Countil, Ottawa
      - ✦Interferometry measurements for thickness/refractive index measurements







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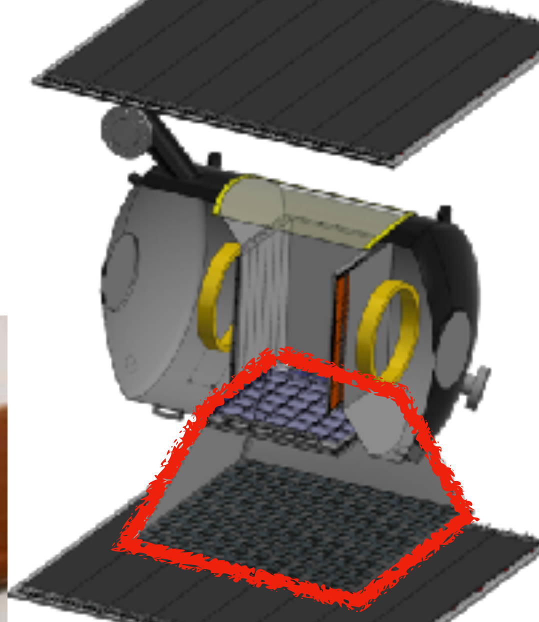
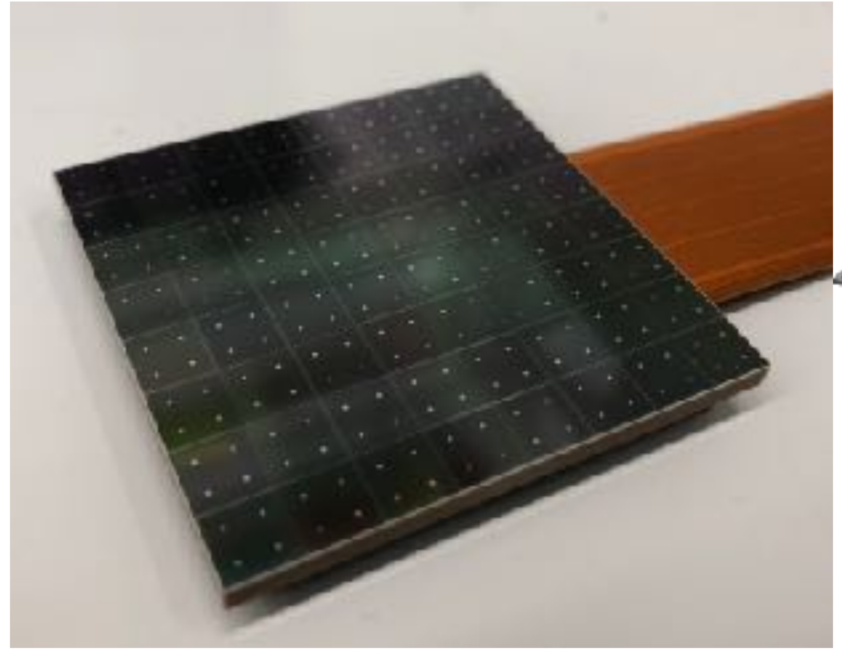
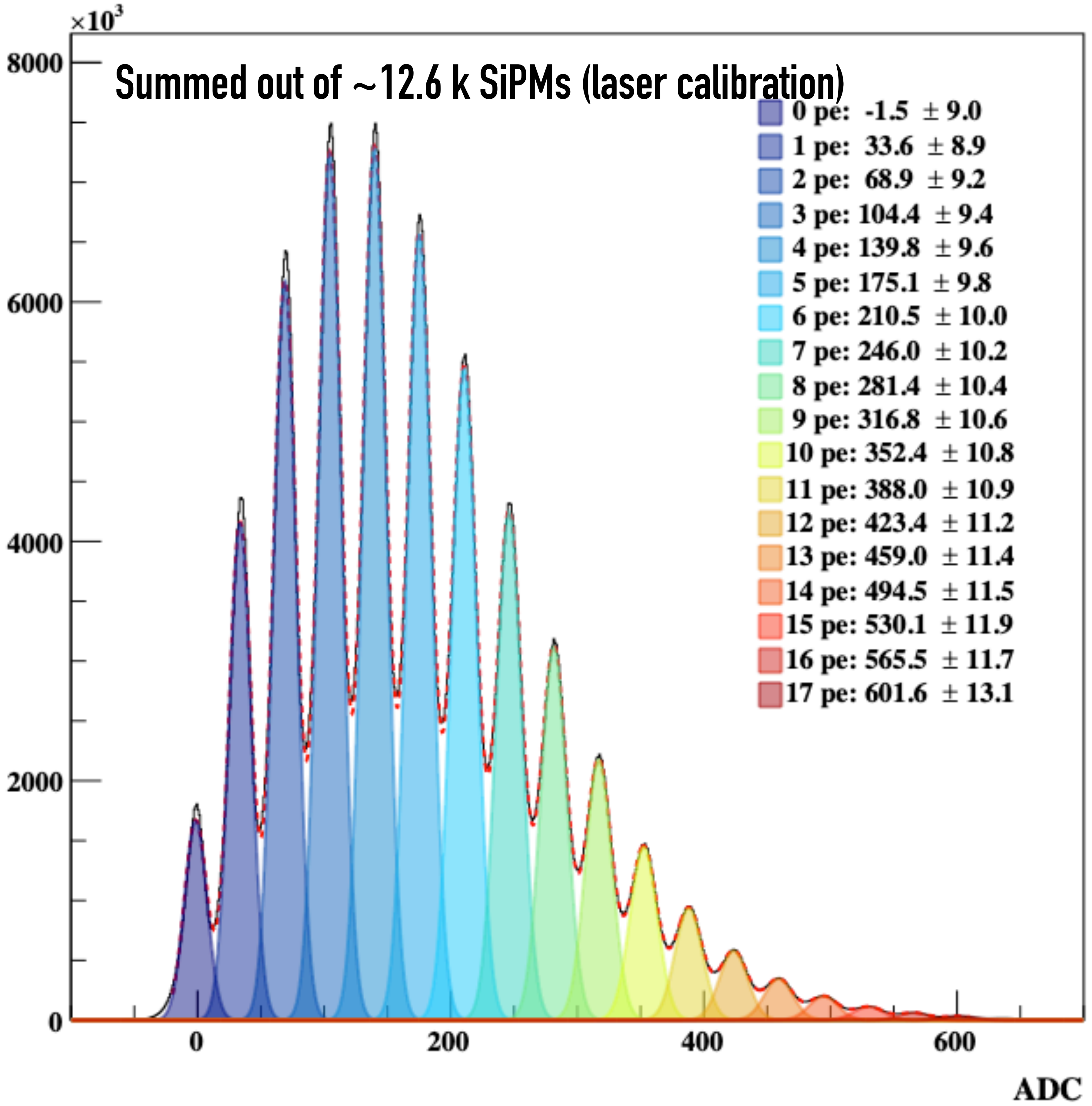




Proximity-focused RICH with SiPM readout

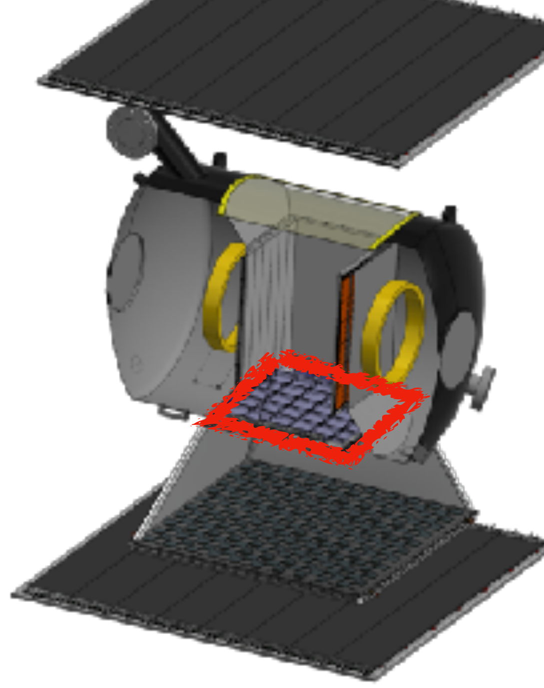
- Velocity resolution of $\Delta\beta/\beta \sim 1\times10^{-3}$ for Z>3 for E>1 GeV/n
  - Focal plane (1 m × 1 m) covered by 6 mm × 6mm SiPM array in checker board configuration: 12.8k channels!



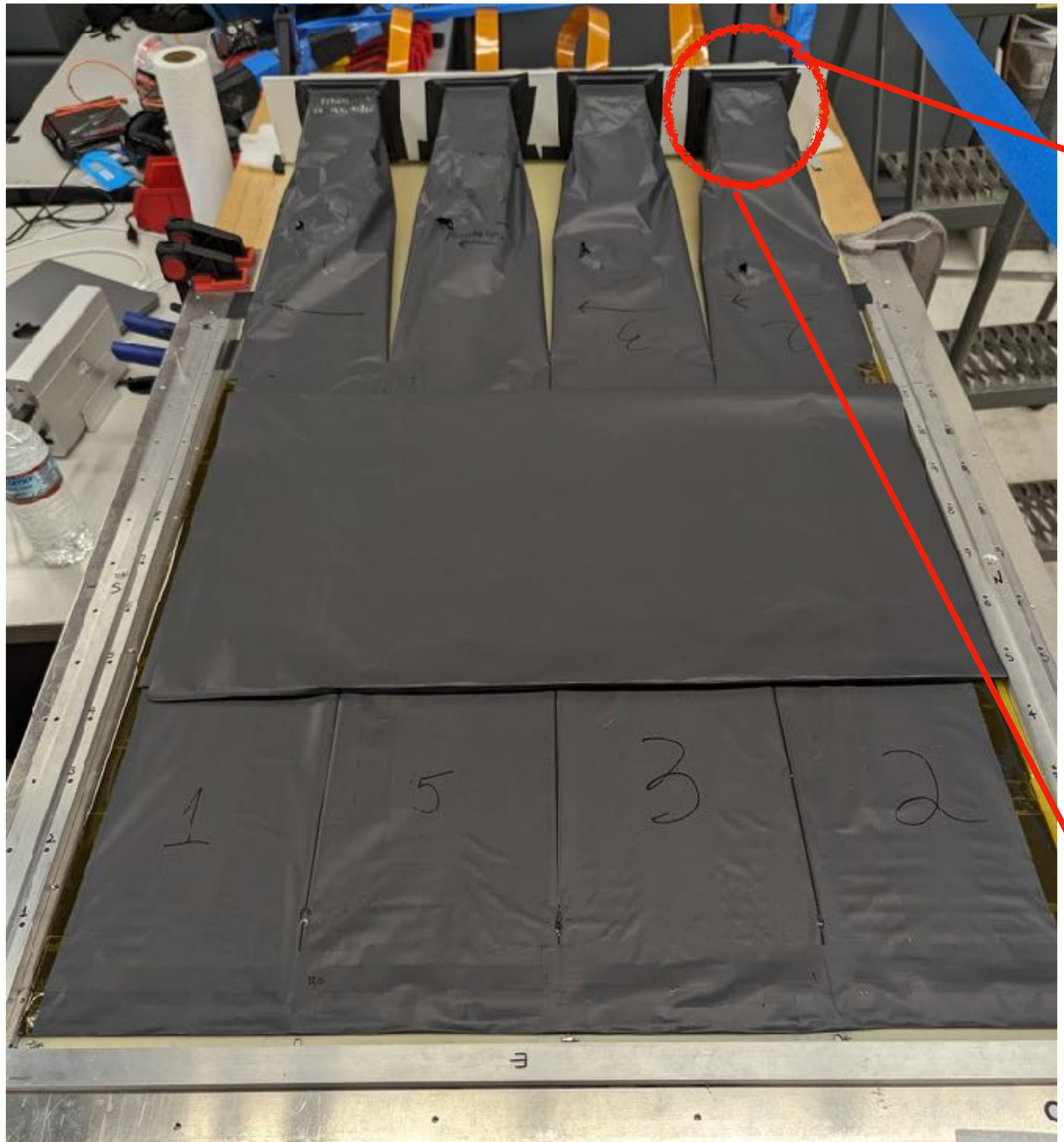
Hodoscope

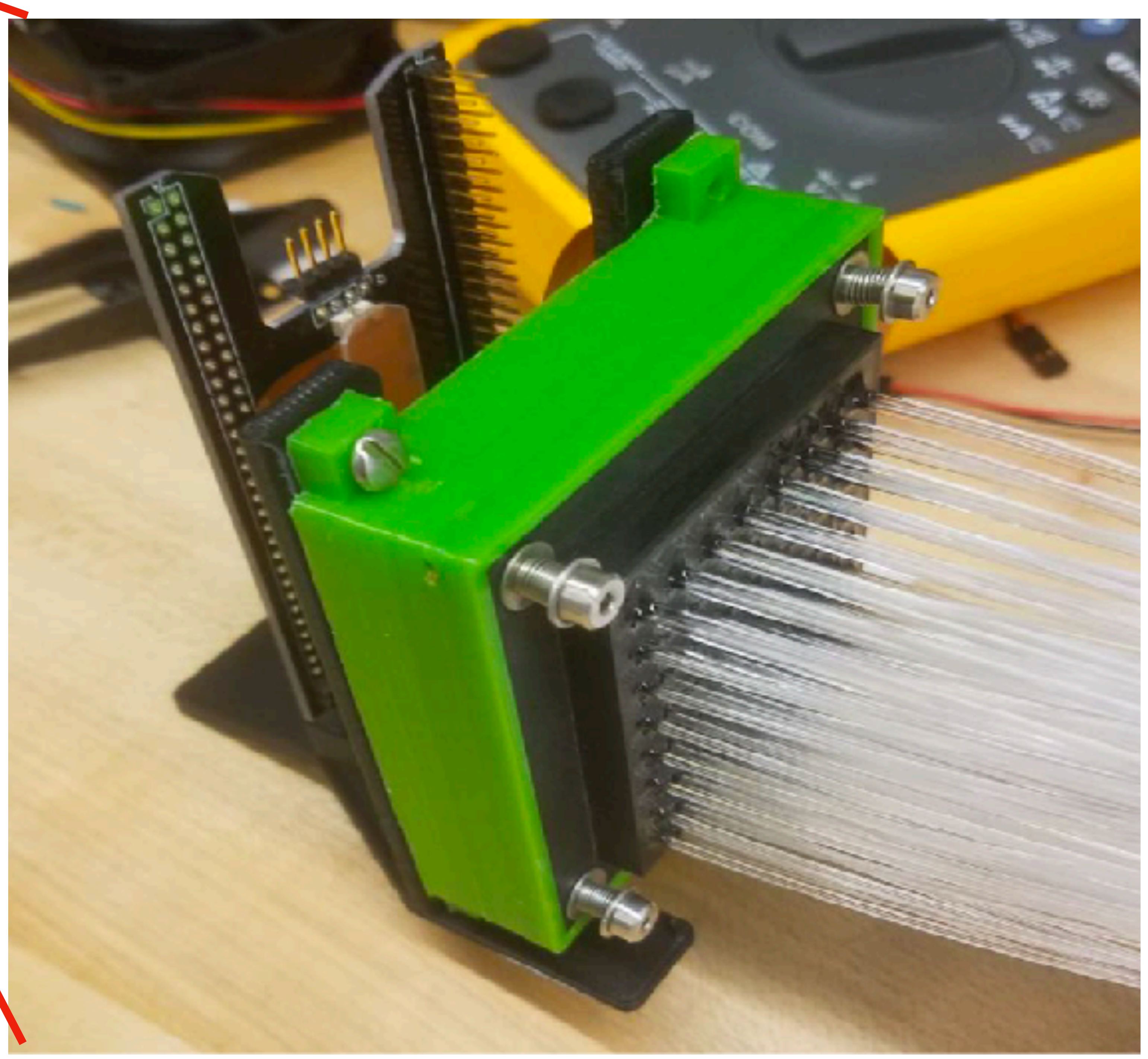
Non-bending plane position measurement

- 1 mm thickness scintillating fiber coupled to the RICH SiPM + readout
- Optical weaving to minimize the readout channel



Poster ID

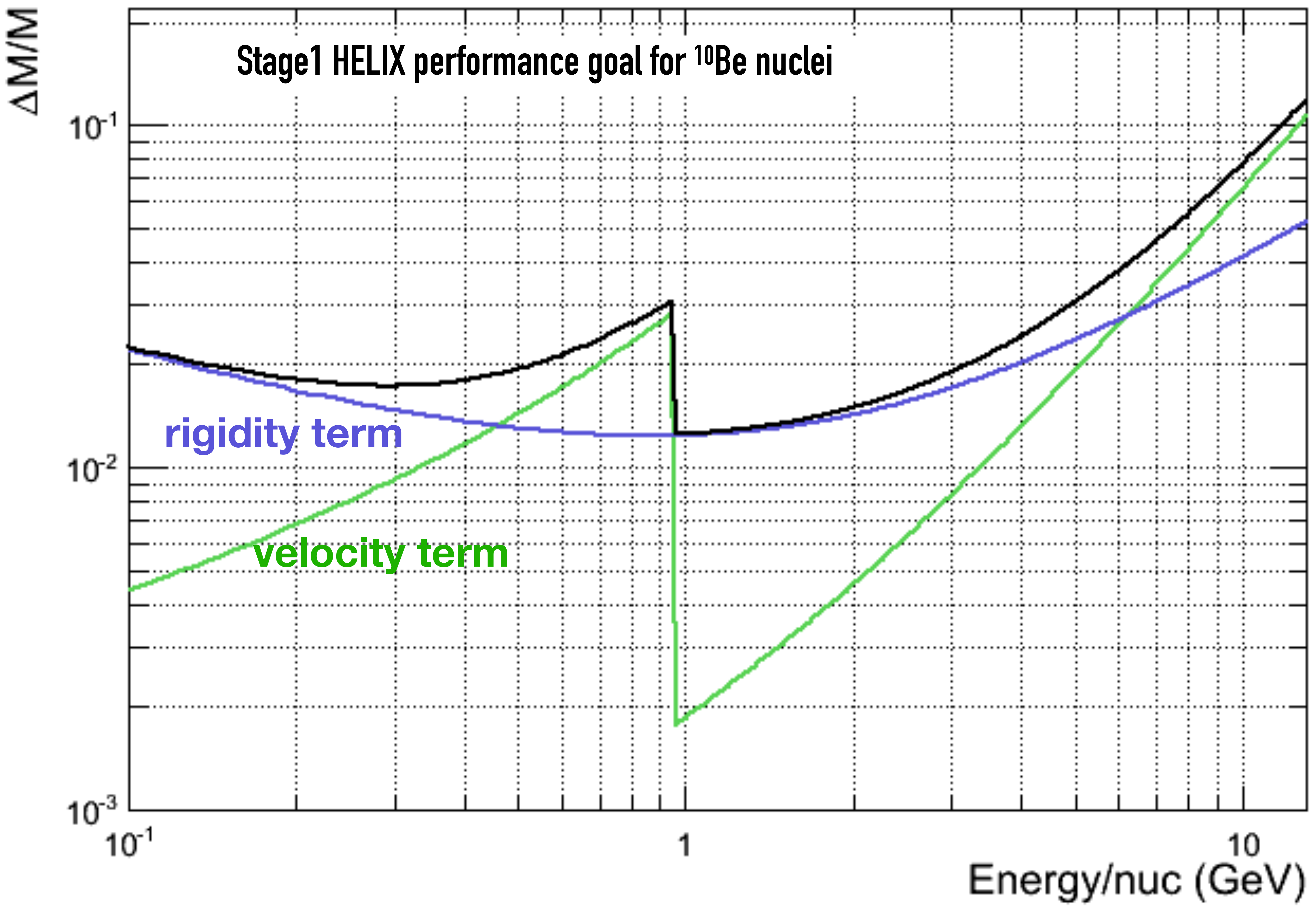




HELIX Stage1 Performance

^{10}Be/^{9}Be ratio up to ~3 GeV/n with Δm/m ~2.5%

- 7-14 day exposure with 0.1 m^{2}sr geometry factor
- Measure the charge of CR up to neon (Z=10)
- Mass resolution of few percentage for light isotopes up to 3 GeV/n



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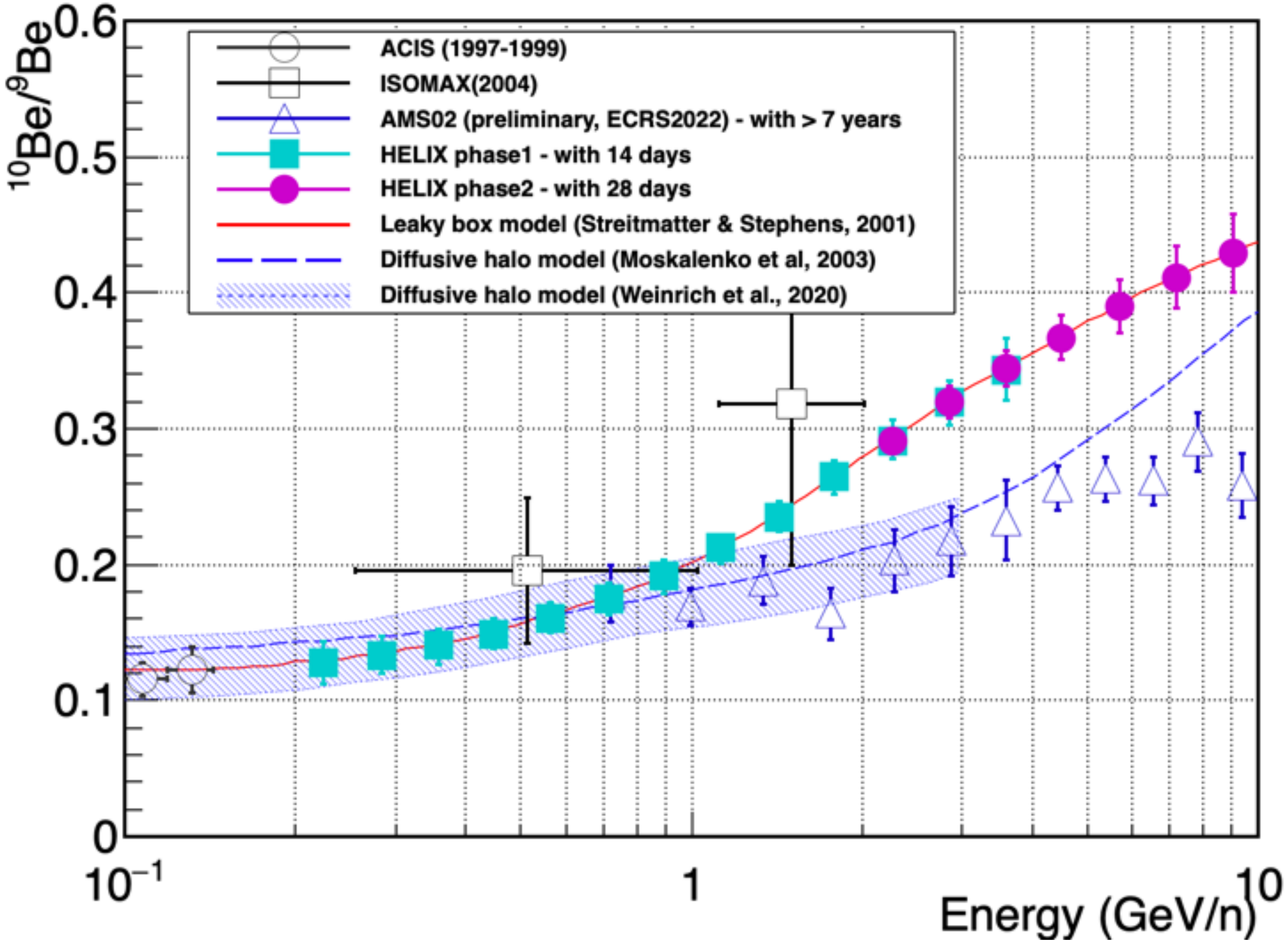
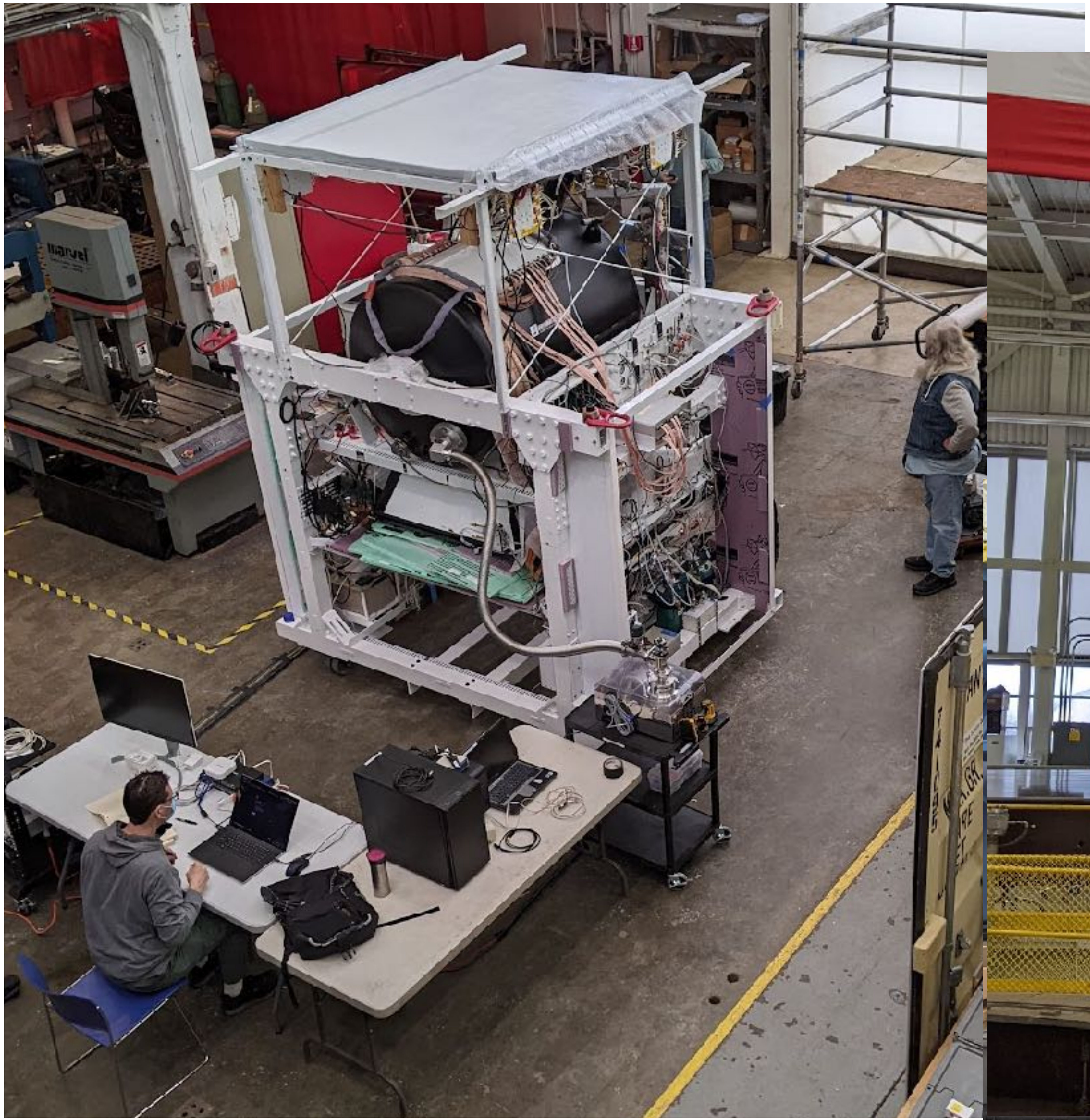
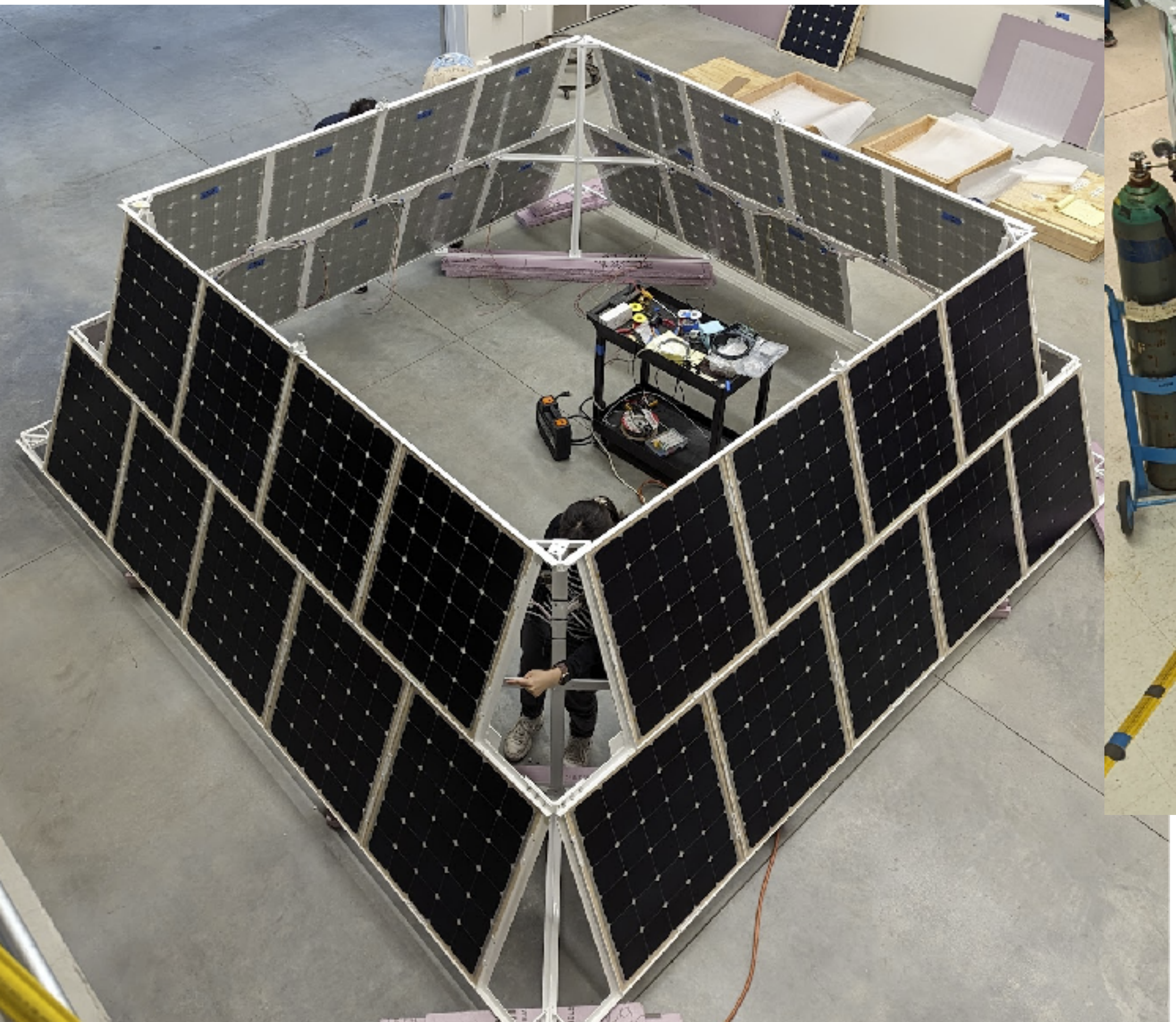


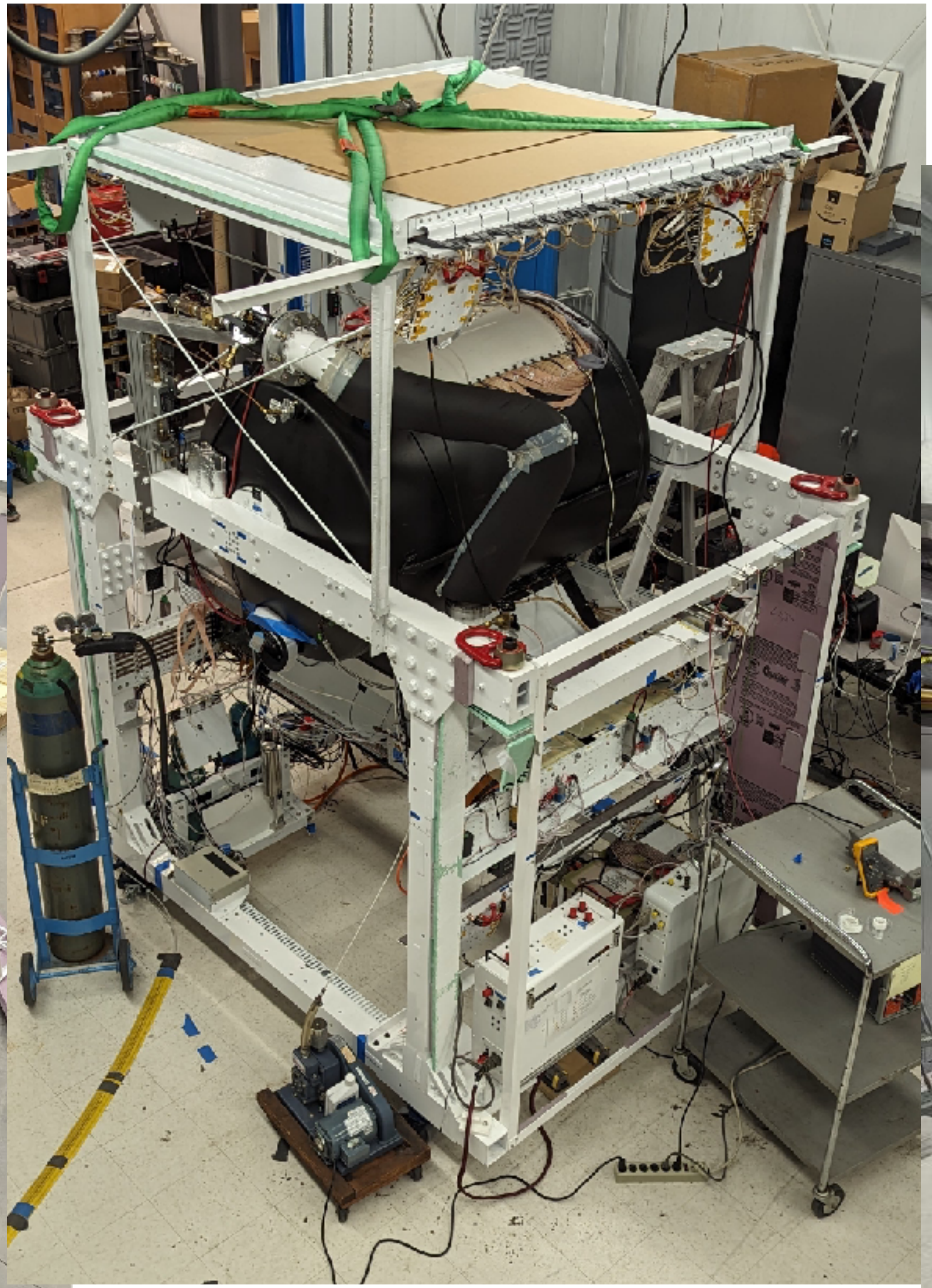
Tests and integrations

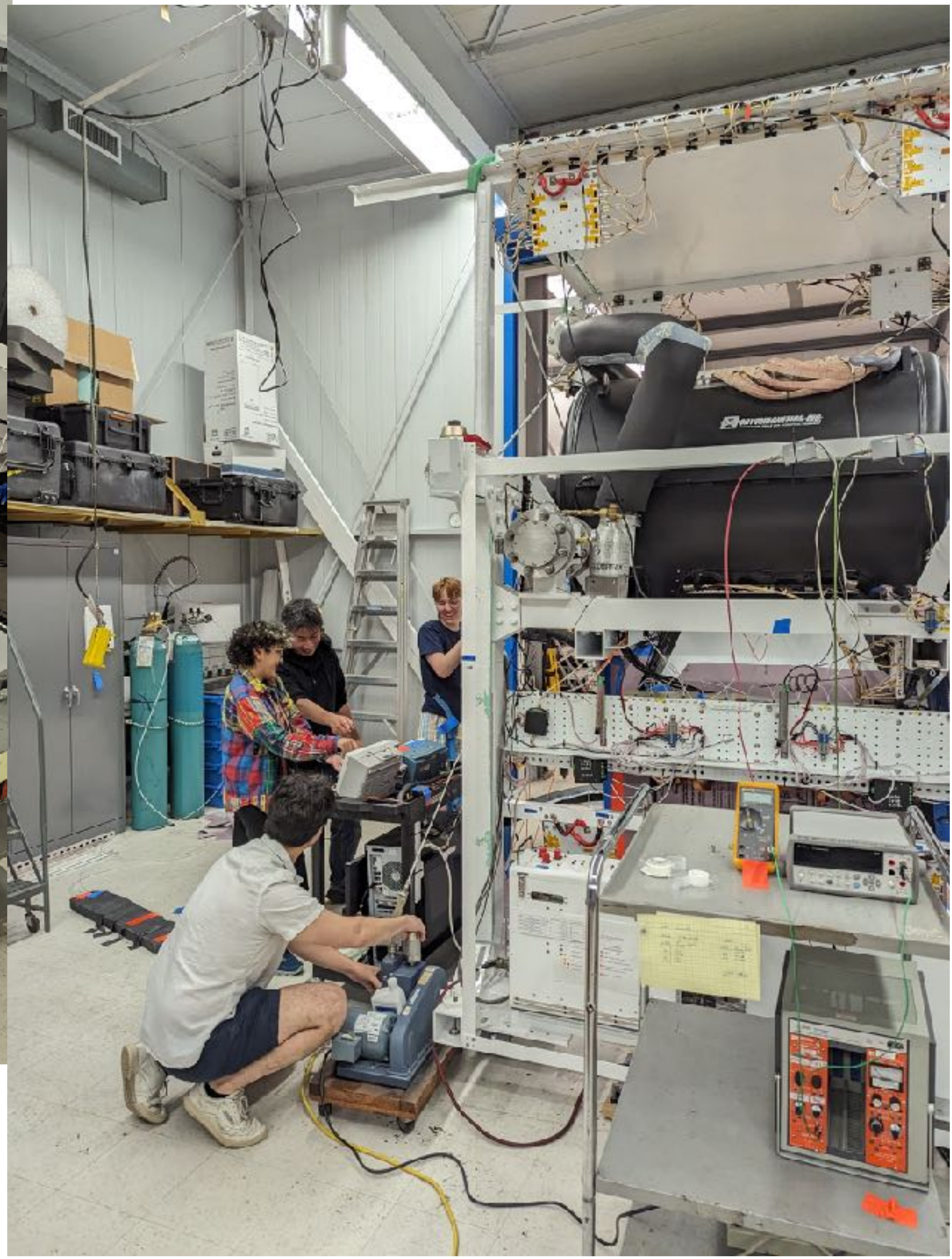
Successful thermal-vacuum test in 2022



Tests and integrations (2)







First Muon w/ full detector system!

Summary

HELIX will have a full integration test w/ muon in 2023, aiming to catch the earliest flight opportunity from 2024 summer at Kiruna

Recent discoveries of new features of CRs require better understanding of CR propagation. Measurement of propagation clock isotope, such as ^{10}Be can provide essential data.

HELIX is a magnet spectrometer designed to measure the light isotopes from proton up to neon (Z=10). The instrument is optimized to measure ^{10}Be from 0.2 GeV/n to beyond 3 GeV/n with a mass resolution $\lesssim$ 3%.

The production of flight hardware has finished, and its performance was tested. Integration and testing are underway.