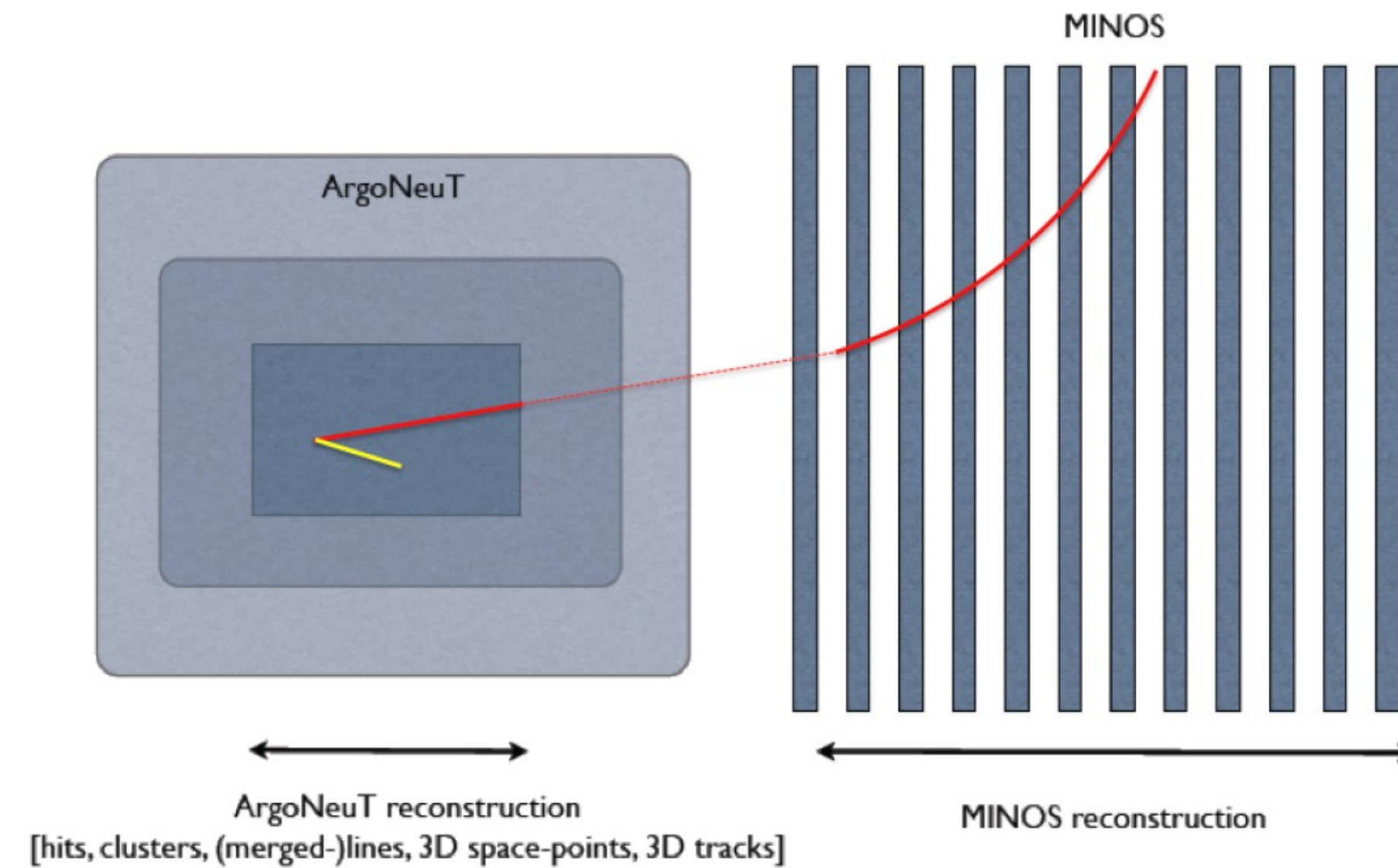
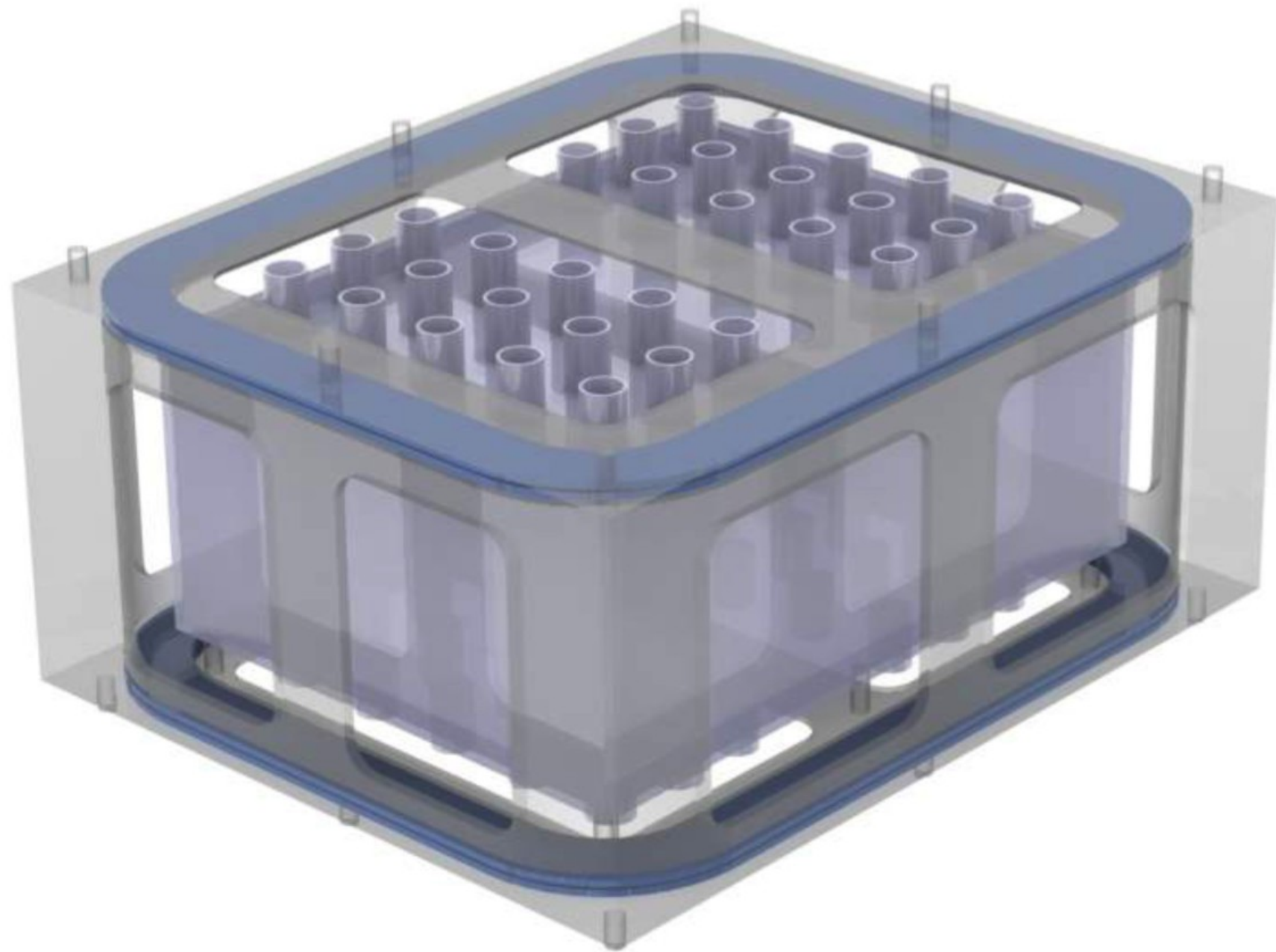


LArTPC DUNE Near Detector

C. Amsler, J. Asaadi, M. Auger, A. Ereditato, *S. Lockwitz*, D. Lorca, D. Goldi, R. Hanni, U. Kose, I. Kreslo, M. Luthi, P. Lutz, J. Raaf, C. Rudolph Von Rohr, *J. Sinclair*, M. Weber, J. Sinclair, S. Tufanli

LArTPC Design Concepts

Option A:
Magnetized
Modular LArTPC
Within superconducting Helmholtz coil



Option B:
Hybrid detector
Modular LArTPC
Upstream of spectrometer

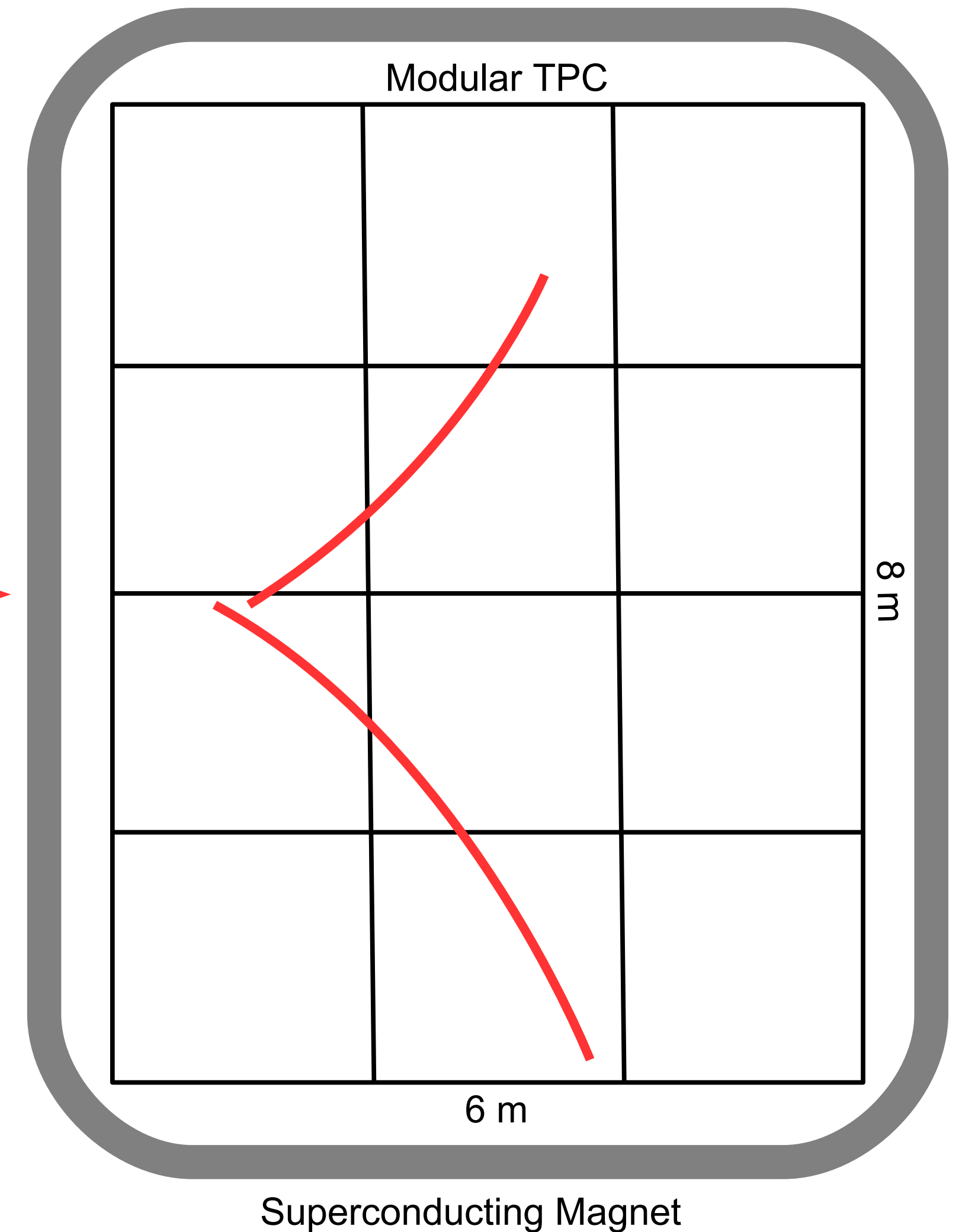
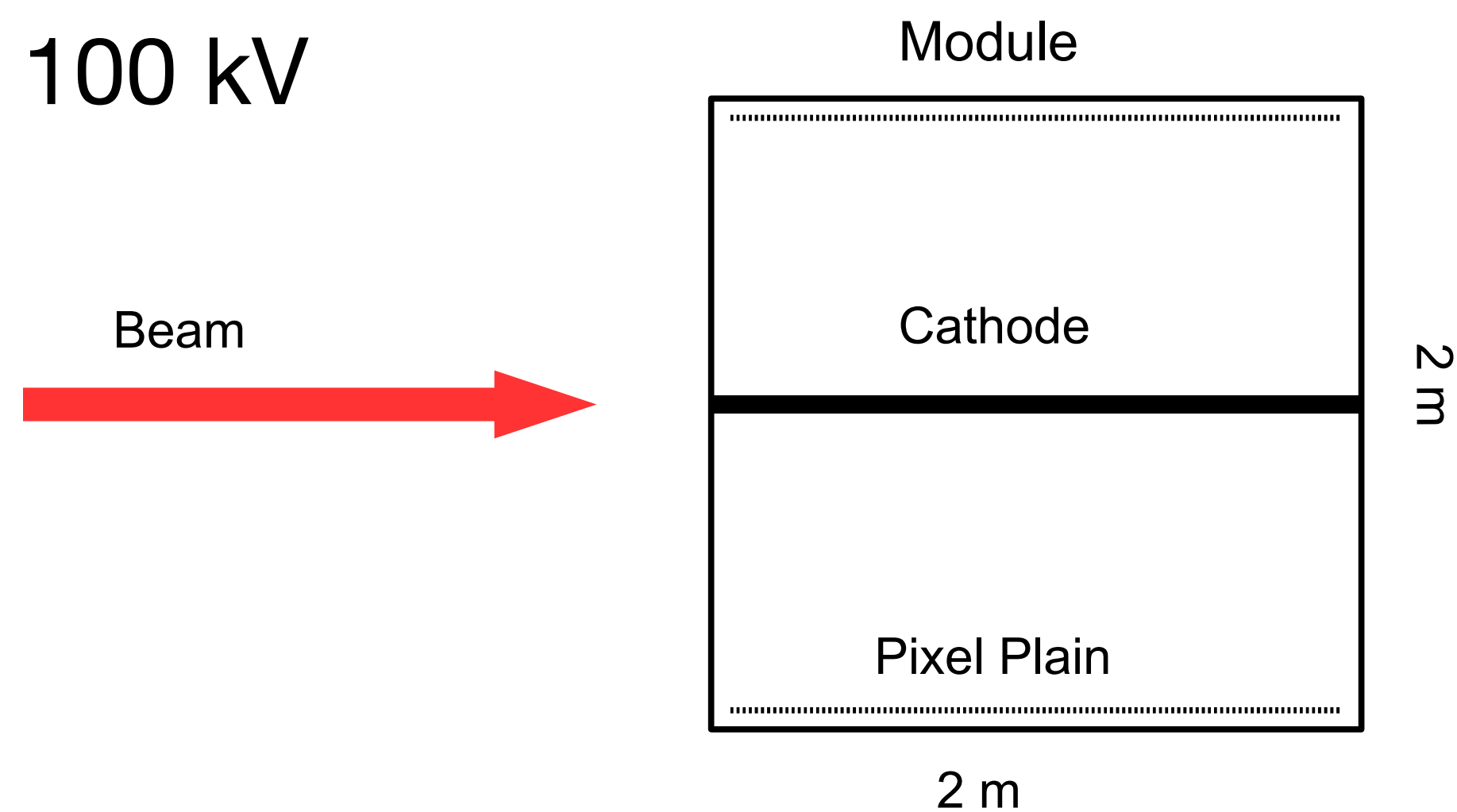
Magnetized Modular LArTPC

Modular TPC total 6 m x 8 m x 3 m
- ~ 200 t

Module 2 m x 2 m x 3 m.
- 1 m drift length

B-field 1T

E-Field 100 kV



Why Magnetize a TPC?

Neutrino/antineutrino analysis – ID $e^{+/-}$ & $\mu^{+/-}$

Momentum measurement less dependent on containment

Shorter drift-times - Less stringent purity, less pileup & lower voltage

Light contained - Less optical pileup, accurate trigger & veto

Pixel readout - Live 3D reconstruction, reduced reconstruction ambiguity & more intelligent trigger

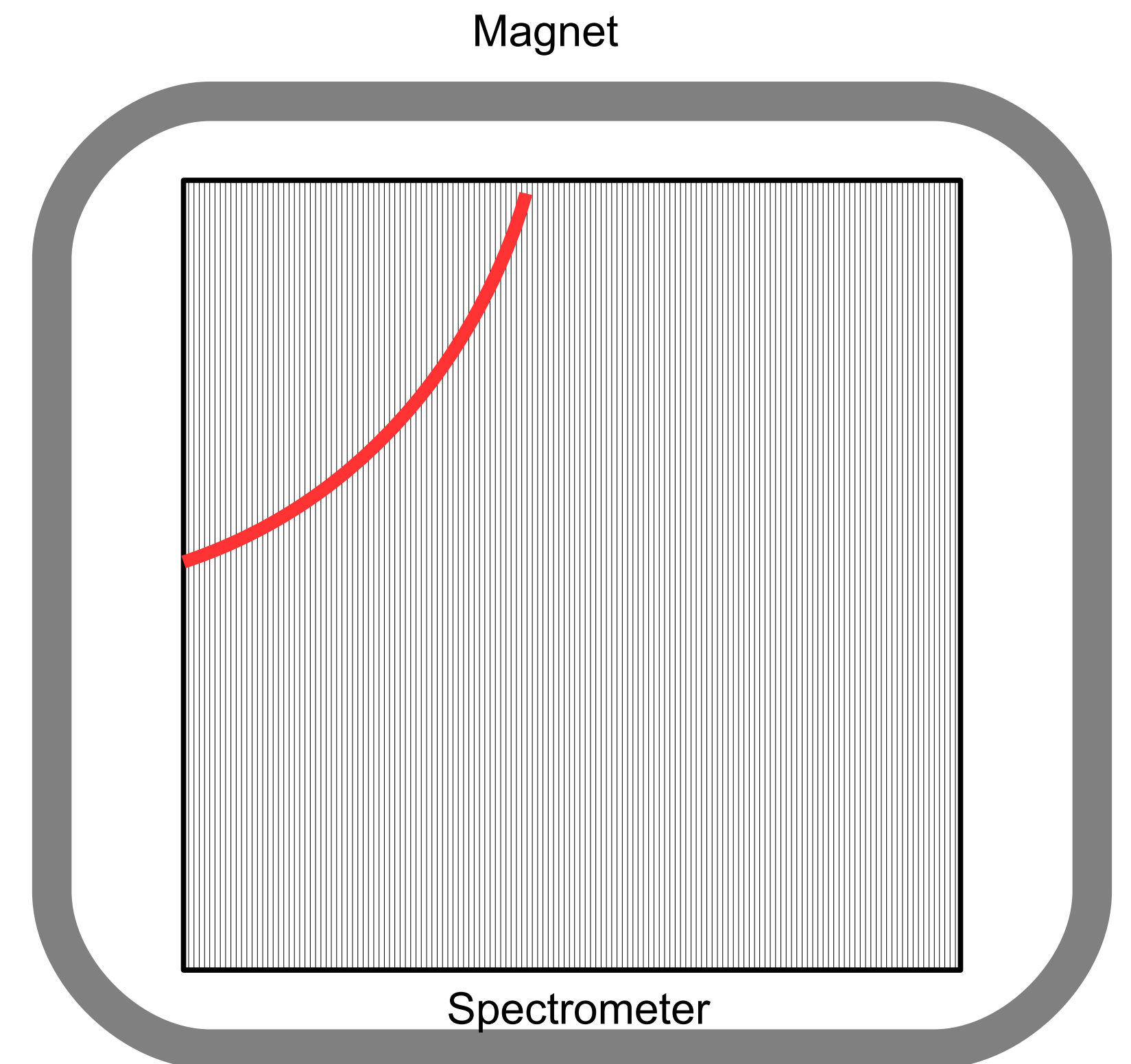
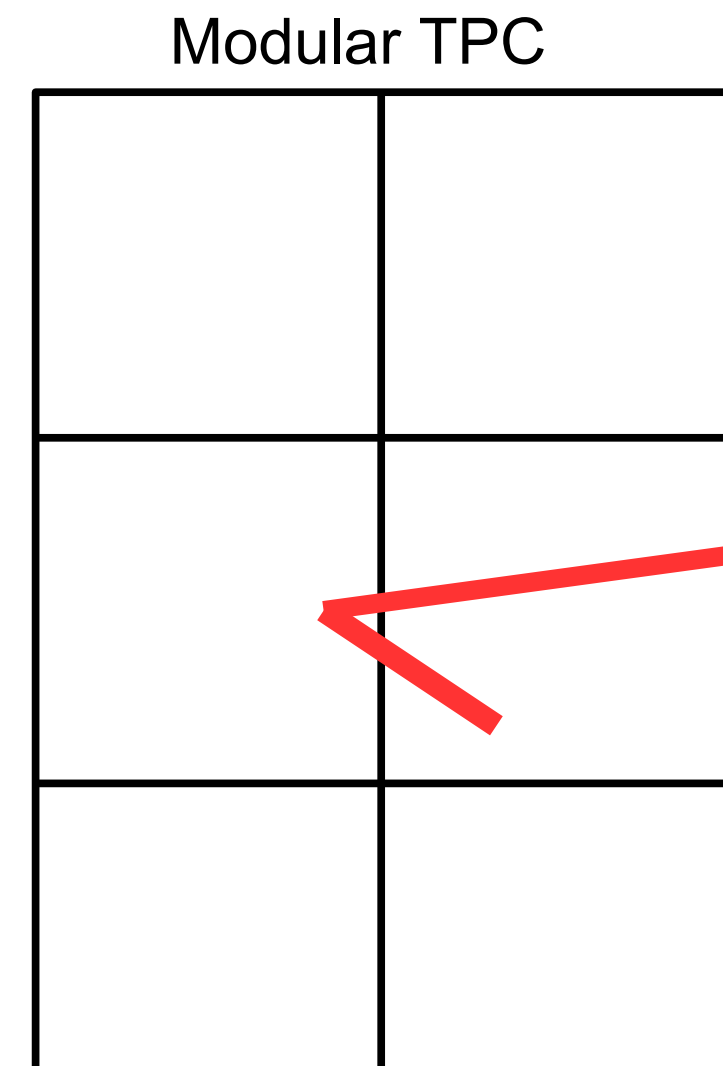
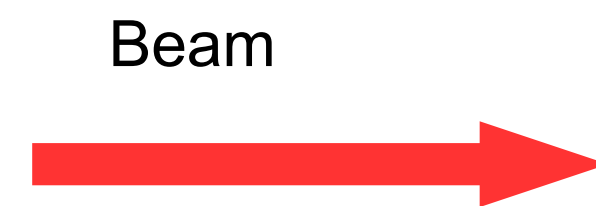
Run constantly - No need for low rate & upgrade sans down-time

Non-Magnetized LArTPC

Hybrid detector.

Modular LArTPC upstream of spectrometer.

With only a 4 m long LArTPC, ~100t is achievable



Simulation Tasks

Need a magnet geometry for simulation of background events

Define geometries for both options & Incorporate into LArSoft

Apply a magnetic field (option A)

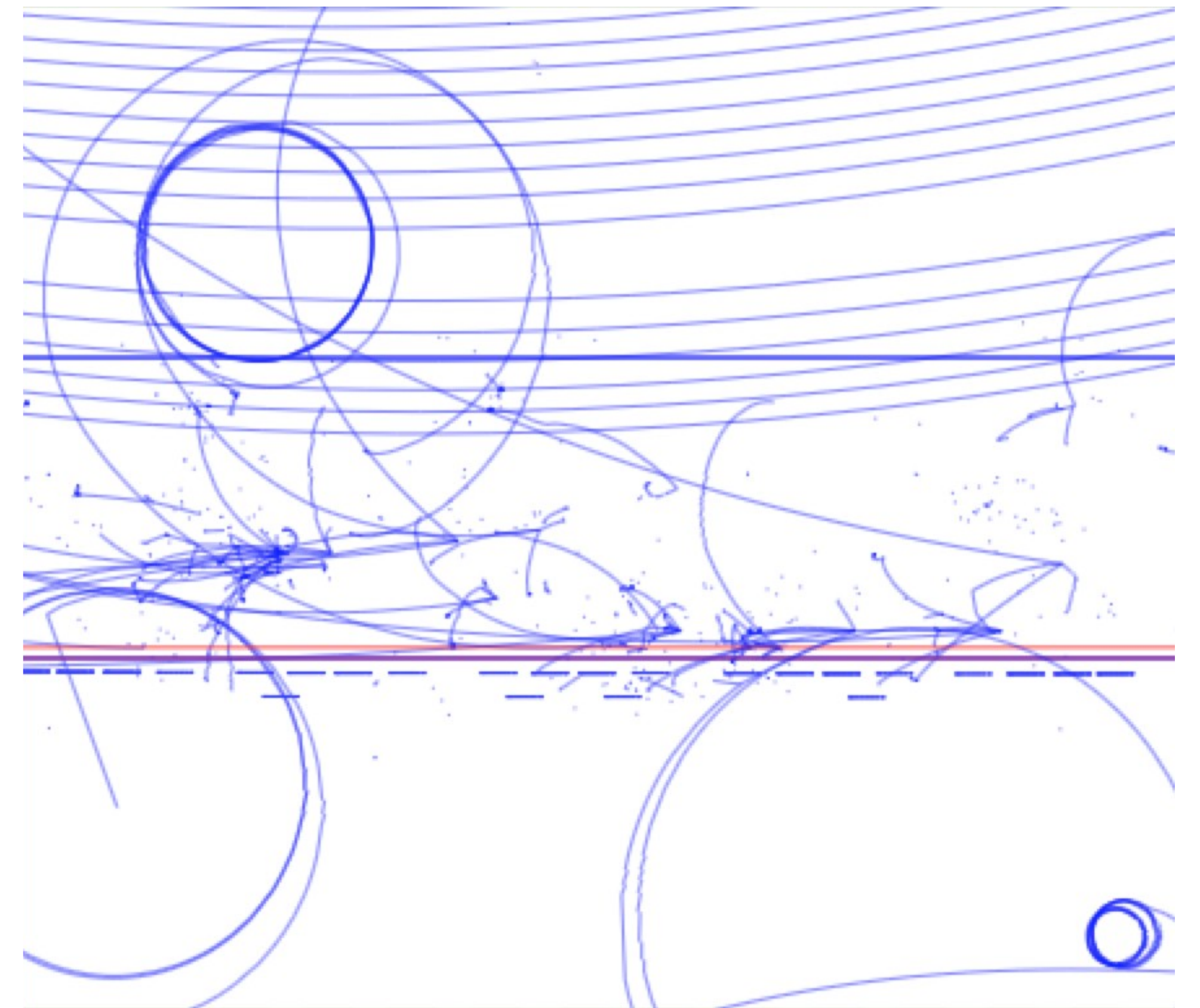
Study containment (showers contained vs. energy?)

Can e^{\pm} showers visually be differentiated

Temporarily use existing wire reconstruction

Evaluate effect of multiple scattering on momentum resolution

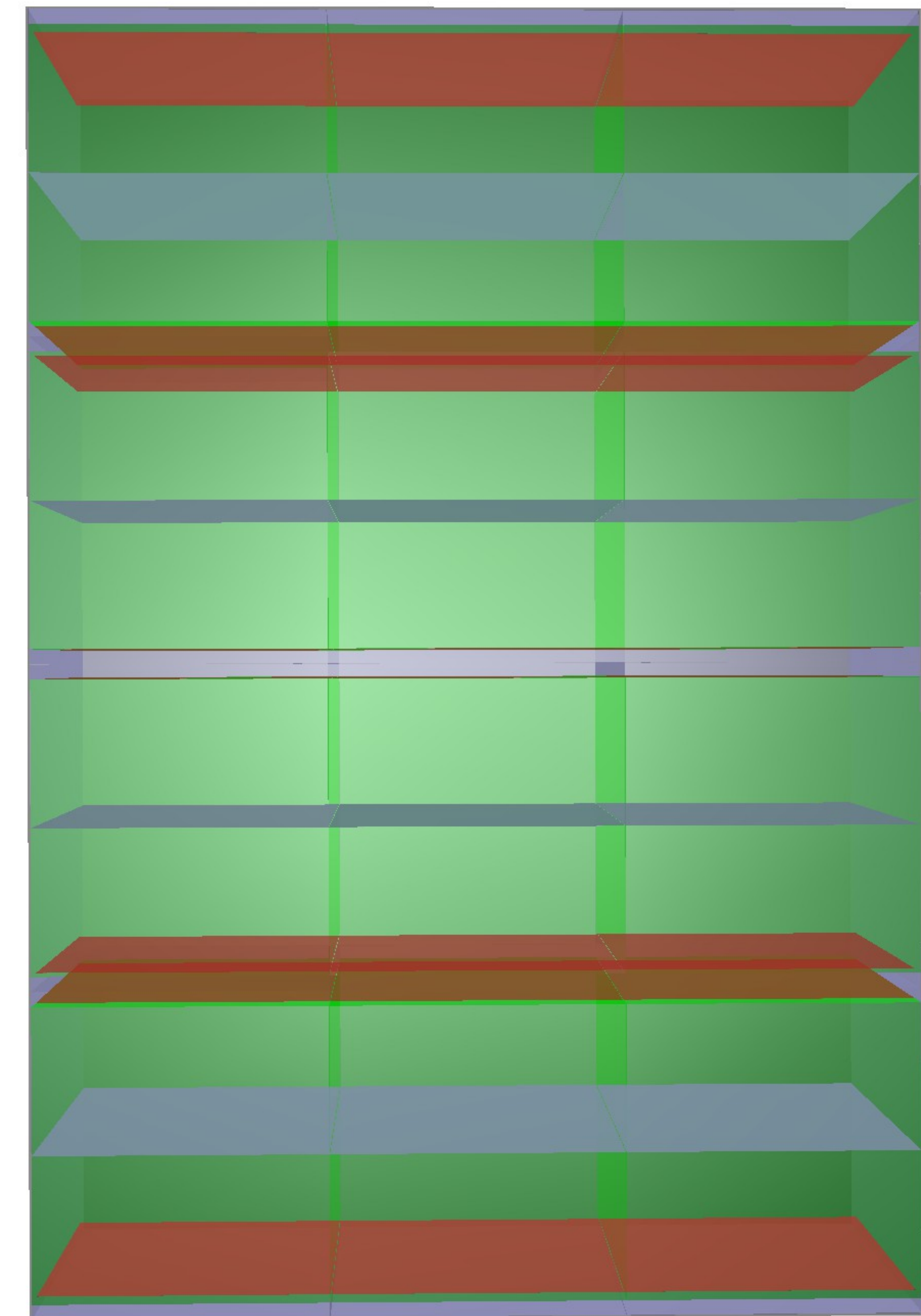
Energy & angular resolution studies with particle gun



Magnetized MicroBooNE

Plans for the Analysis Run Throughs

- **For the May meeting:**
 - Use a new volume corresponding to the ArgonCube geometry (no spectrometer)
 - Use cheated reconstruction again
 - Attempt to get E_{reco} from the event objects, but PID from truth
 - In parallel, perform studies to inform the downselect between LArTPC or a LArTPC+Spectrometer
 - Magnetic field: can we distinguish e^{\pm} ?
 - Modular design: effect of gaps? Improvements with light detection?
 - Converge on something justifiable
- **For the August meeting:**
 - Generate events in a mature geometry (perhaps a B field)
 - Cheat tracks and showers
 - But use intelligent smearing based on studies*
 - Vertexing*
 - Attempt real PID*
- **For the last meeting:**
 - Improve the * above
 - Account for issues that impact LAr differently than the other technologies (field uniformity, build up of events)



Generated by T. Alion

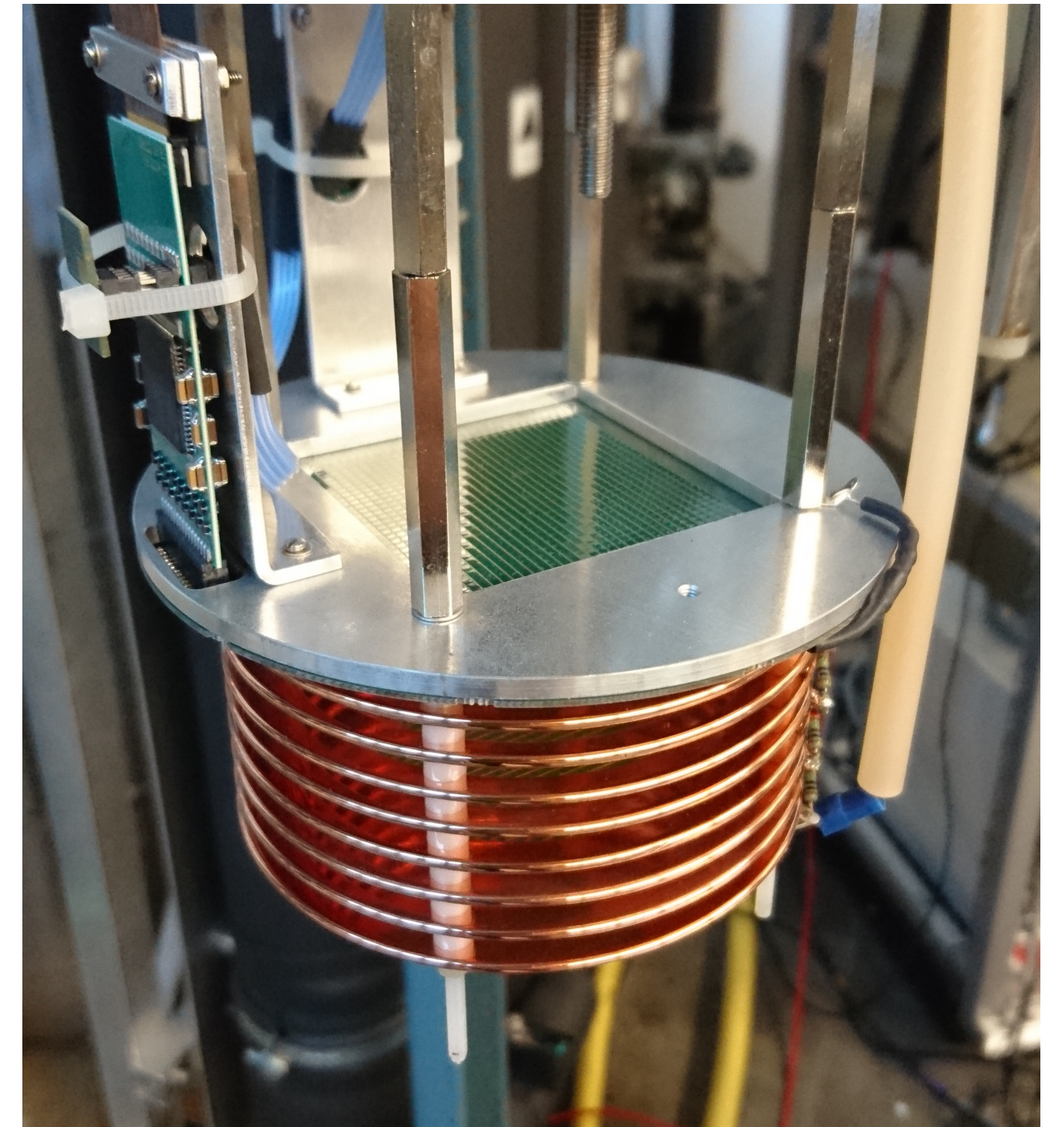
GDML of modular TPC (6 m X 8 m)

Hardware Tasks

Modular TPC needs to be demonstrated. ArgonCube under construction, first TPC tests summer 2016

Magnetized TPC with superconducting Helmholtz coil. Existing TPC to be modified, summer 2016

To determine expected resolution, pixels readout needs testing in LAr with comparable drift length to ND. TPC under construction, first results expected May 2016



Summary

We are moving from the MicroBooNE geo, to ArgonCube's modular technology to the DUNE near detector.

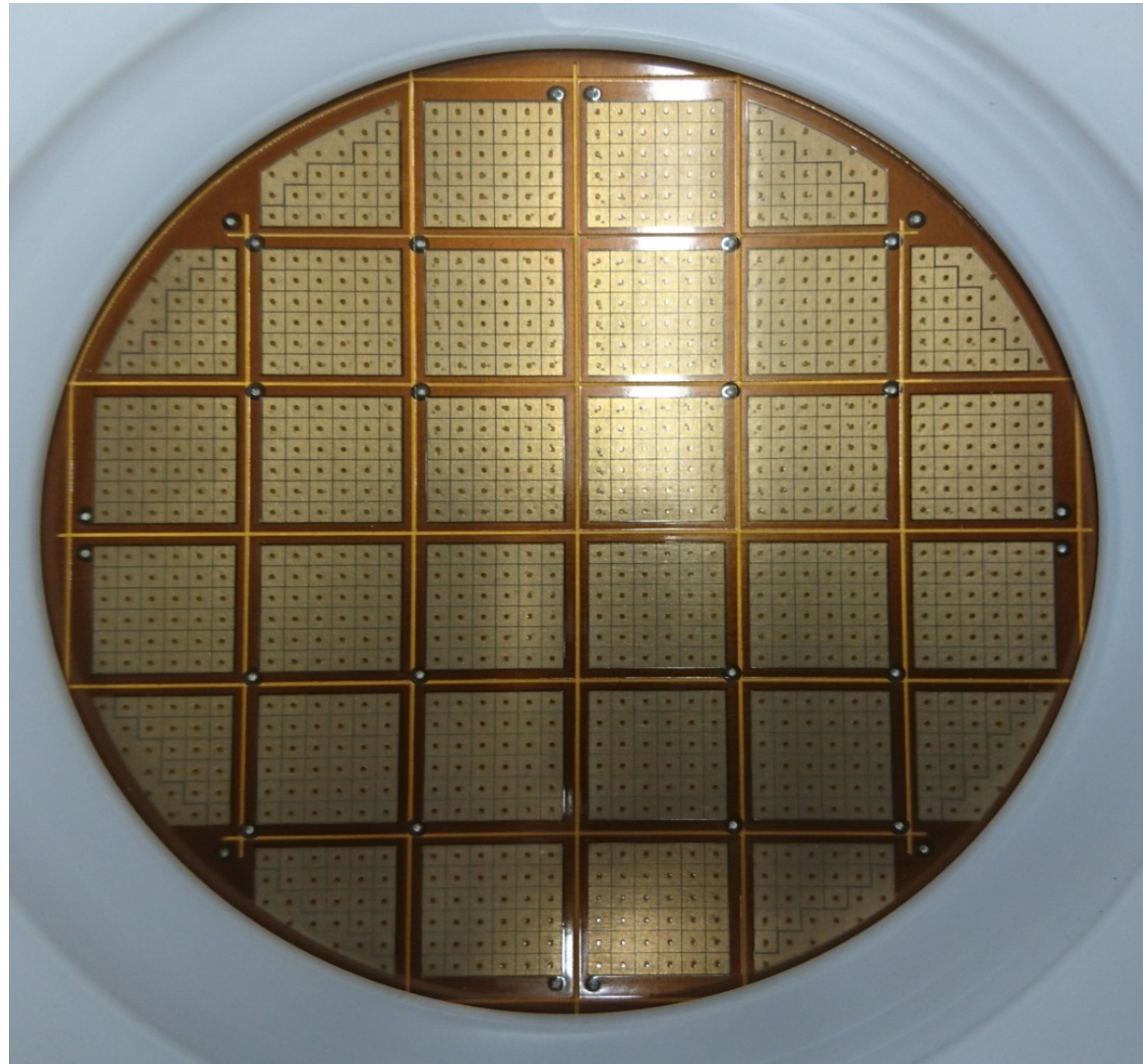
This allows simulation workload to be shared across collaborations.

Simulation is proceeding within the framework of ArgonCube, working in parallel with R&D for optimal design.

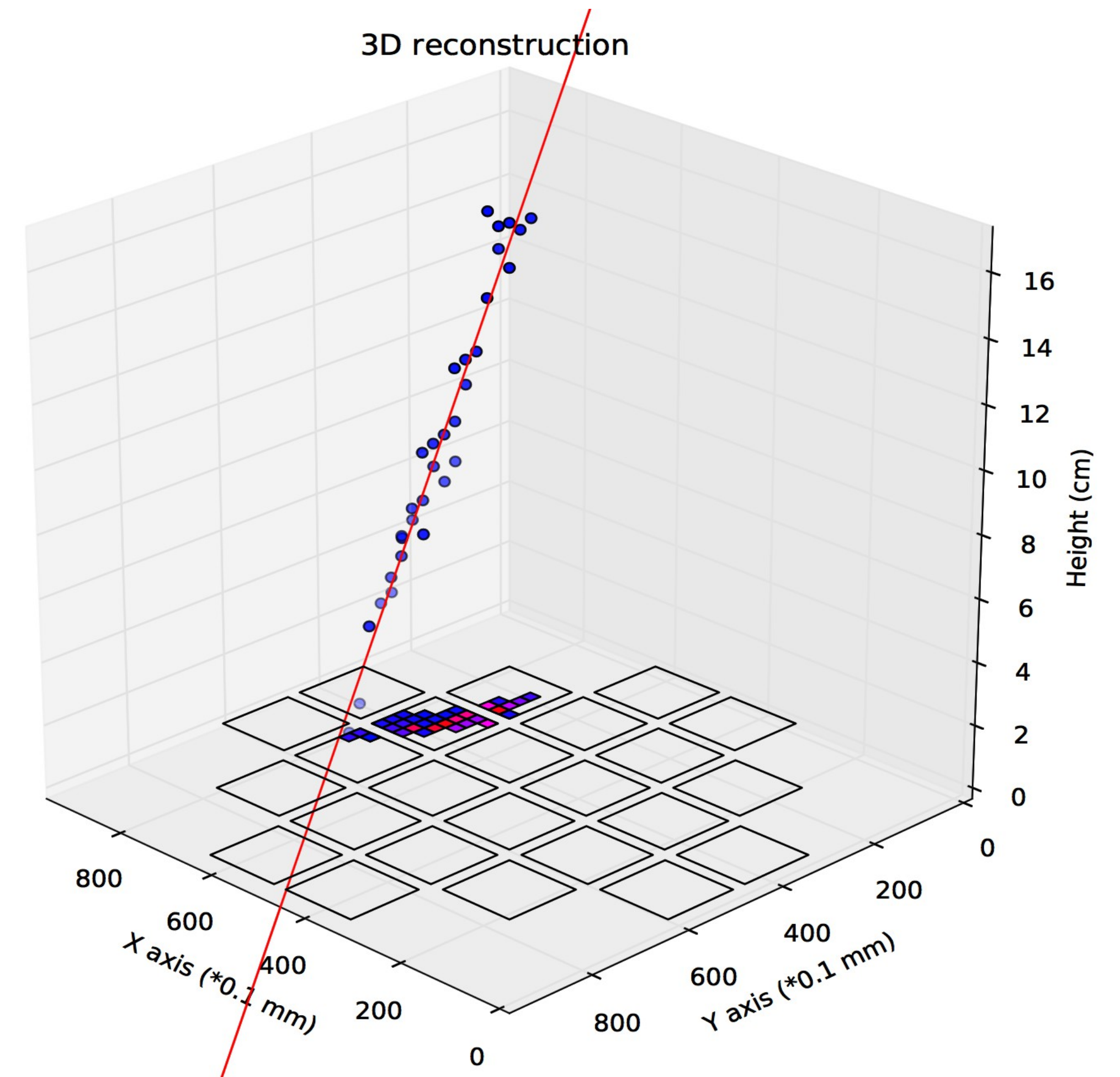
Two options are considered: Option A, a magnetized LArTPC of order 200 t. Option B, a standalone LArTPC of order 100 t. Both potentially complementary to other technologies.

Backup Slides

Pixel Readout – Live 3D Reconstruction



100 mm

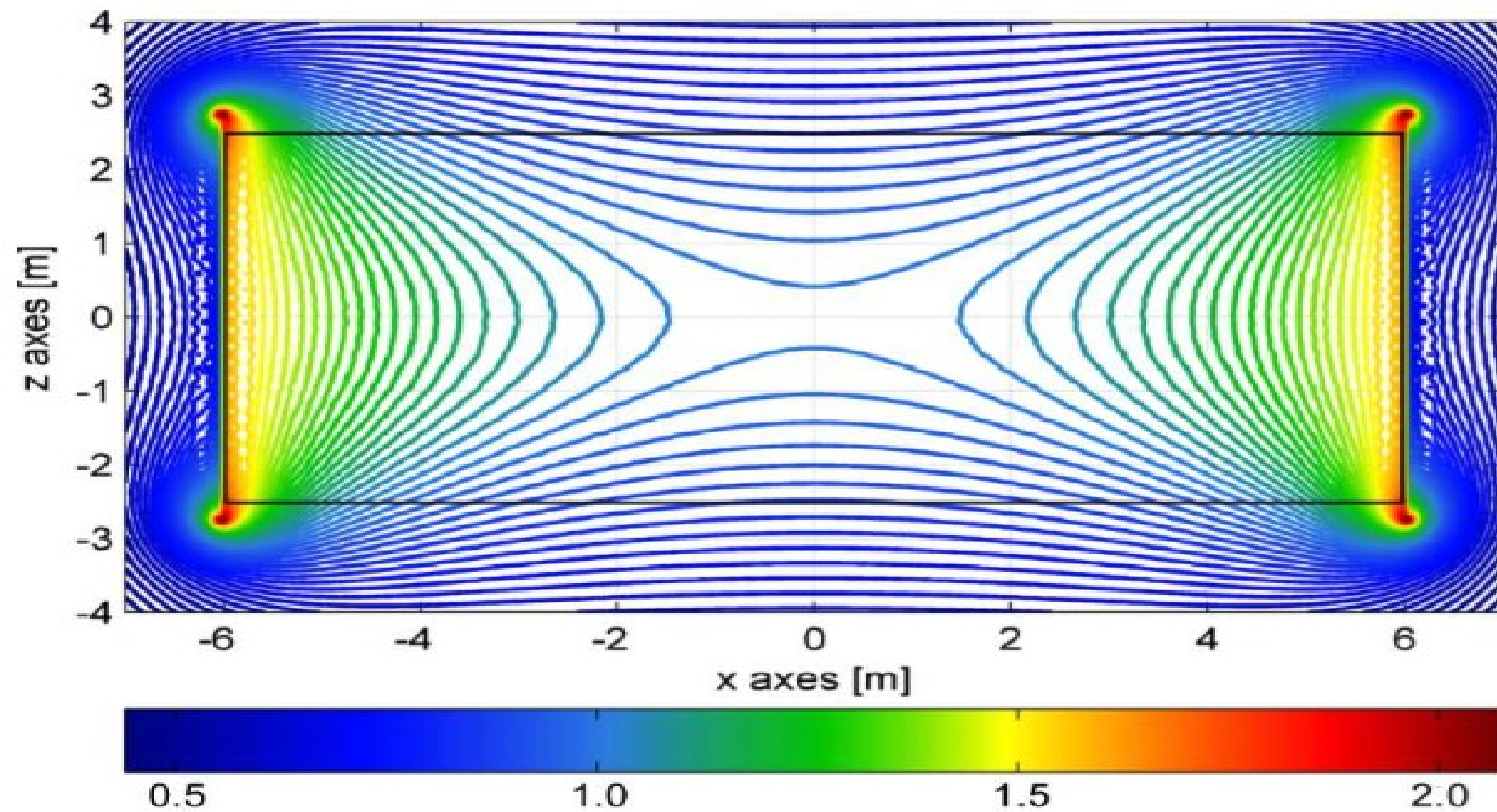


M. Auger, Bern

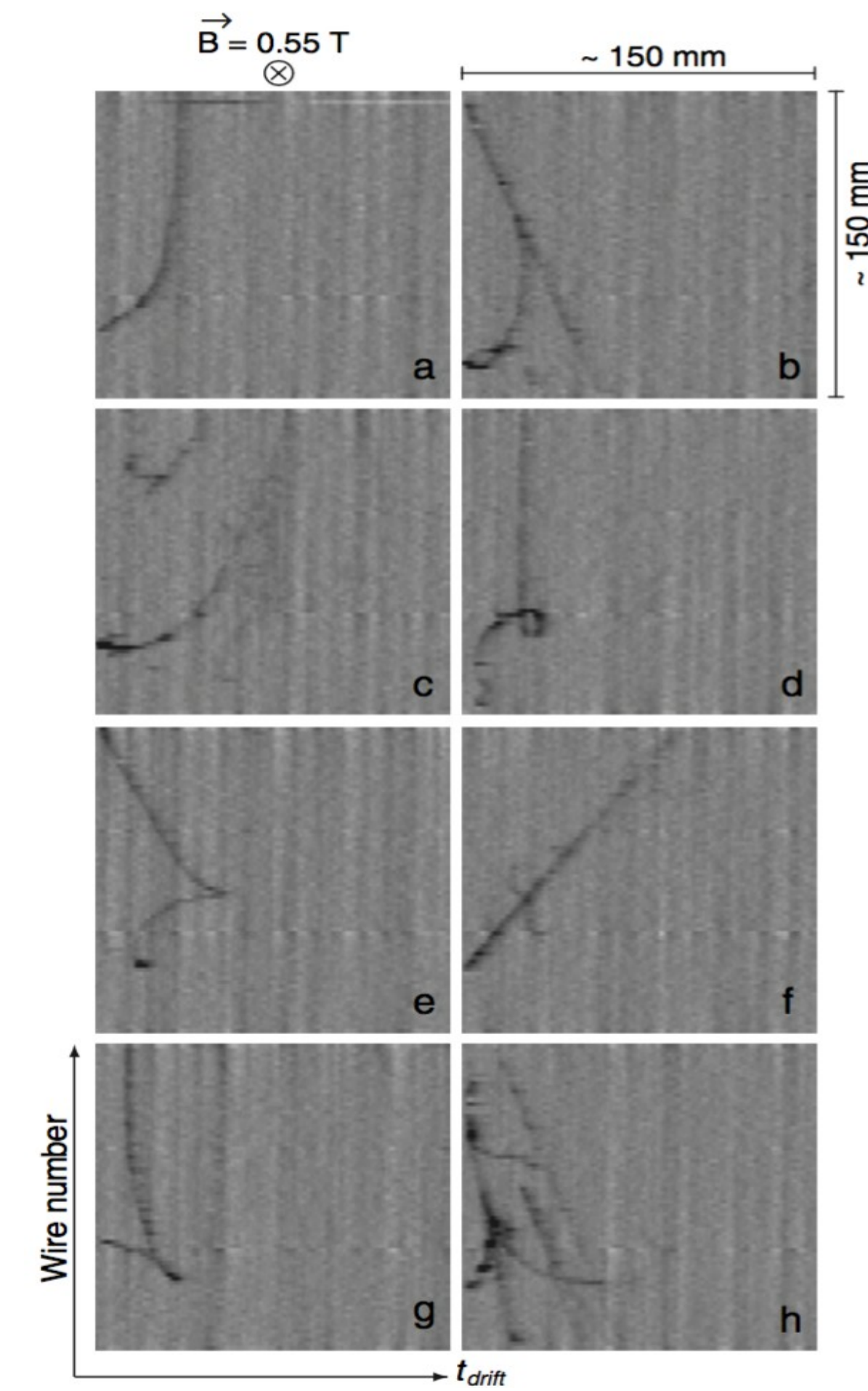
Magnetized TPCs aren't so crazy

Recent engineering studies for 150 t LArTPC at 1 T.

Demonstrated operation, successful PID

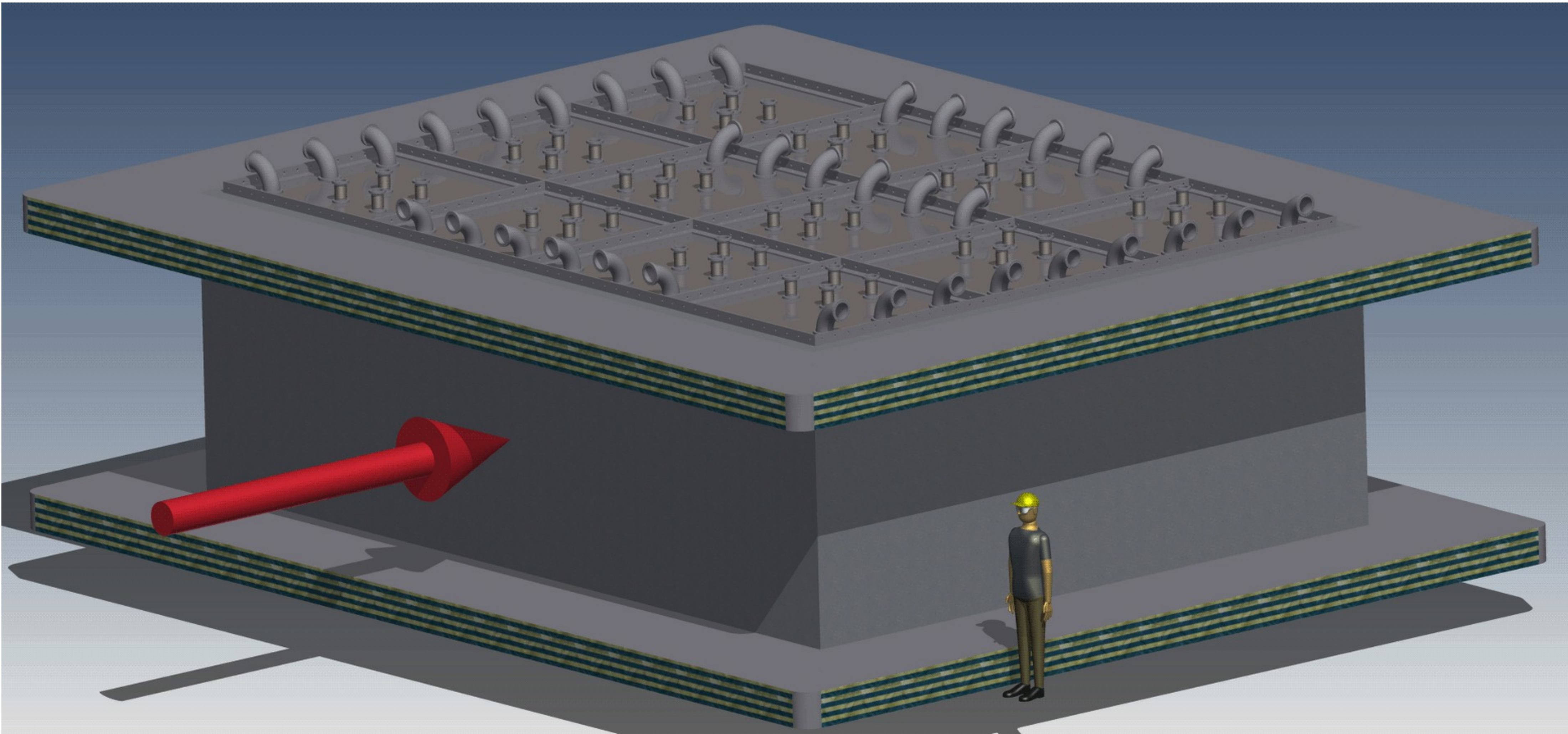


B-field [T] in the xz-plane of the solenoid model. Detector volume indicated with black rectangle. L.Y. van Dijk 2014



Real events collected with the LAr TPC in a B-field of 0.55 T. A. Badertscher, et al. 2005

Magnetized Modular LArTPC



Recommended Reading

L.Y. van Dijk - *“Design Optimization of a new Superconducting Magnet System for a LAr Neutrino Detector”*. CERN 2014

D. B. Cline & K. Lee - *“Possible Study of Rare Decays of Muons and Kaons and a Neutrino Near Detector with a Liquid Argon “ICARUS”-like Detector”*. UCLA 2011

A. Badertscher, et al. - *“Test of a Liquid Argon TPC in a magnetic field and investigation of high temperature superconductors in liquid argon and nitrogen”*. ETH 2010

A. Badertscher, et al. - *“First operation of a liquid-argon TPC embedded in a magnetic field”*. ETH 2005

Simulation Tasks

Maintain one version for a large submission job and output trees

- »Right now, this is the uB model

- »Will update in large steps

Longer term: incorporate the ArgonCube modules and evaluate the effect of dead-space between modules

Thoughts on Readout:

Pixels result in less ambiguity, and more intelligent trigger.

- »But, existing reconstruction uses wires, maybe beyond the scope of this TF to work pixel readout into the reconstruction chain.

We are currently in discussion with the other groups on what is needed/desired for the Task Force study