Recent Progress on LArIAT

Jason St. John - University of Cincinnati - for the LArIAT collaboration

March 21st, 2013 - Liquid Argon TPC R&D Workshop - Fermilab

Liquid **Ar**gon TPC
in a Testbeam

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Scientific Goals

Phased program for comprehensive characterization of LArTPC performance for the range of energies relevant to upcoming experiments like MicroBooNE and LBNE

Phase-I: Modified ArgoNeuT detector

Single-track calibration (recombination/charge-to-energy calibration)
Experimental measurement of e/gamma separation
Optimization of particle ID methods
Development of criteria for charge-sign determination

Phase-II: Larger volume TPC (TBD)

Reconstruction of collective topologies (detected-to-incident energy calibration)
Characterization of EM and hadronic showers

Timeline

35-ton Phase-1 (purity run)

35-ton Phase-2 (LBNE-like TPC + cold electronics)

MicroBooNE construction & installation

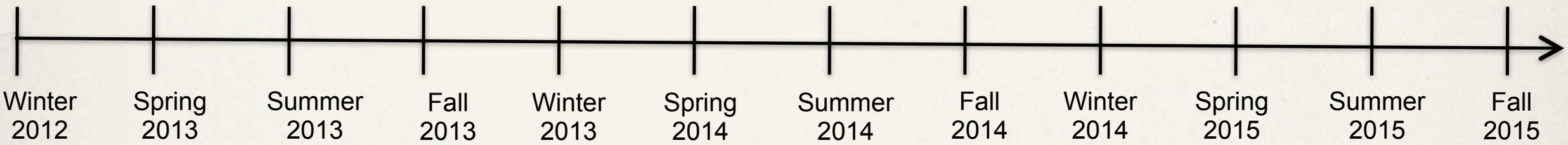
MicroBooNE

LArIAT Phase I

Install | Pilot run | Data-taking and analysis | Physics Run I | Physics Run II

LArIAT Phase II

design, construction, data-taking and analysis



LBNE milestone: CD-1 review

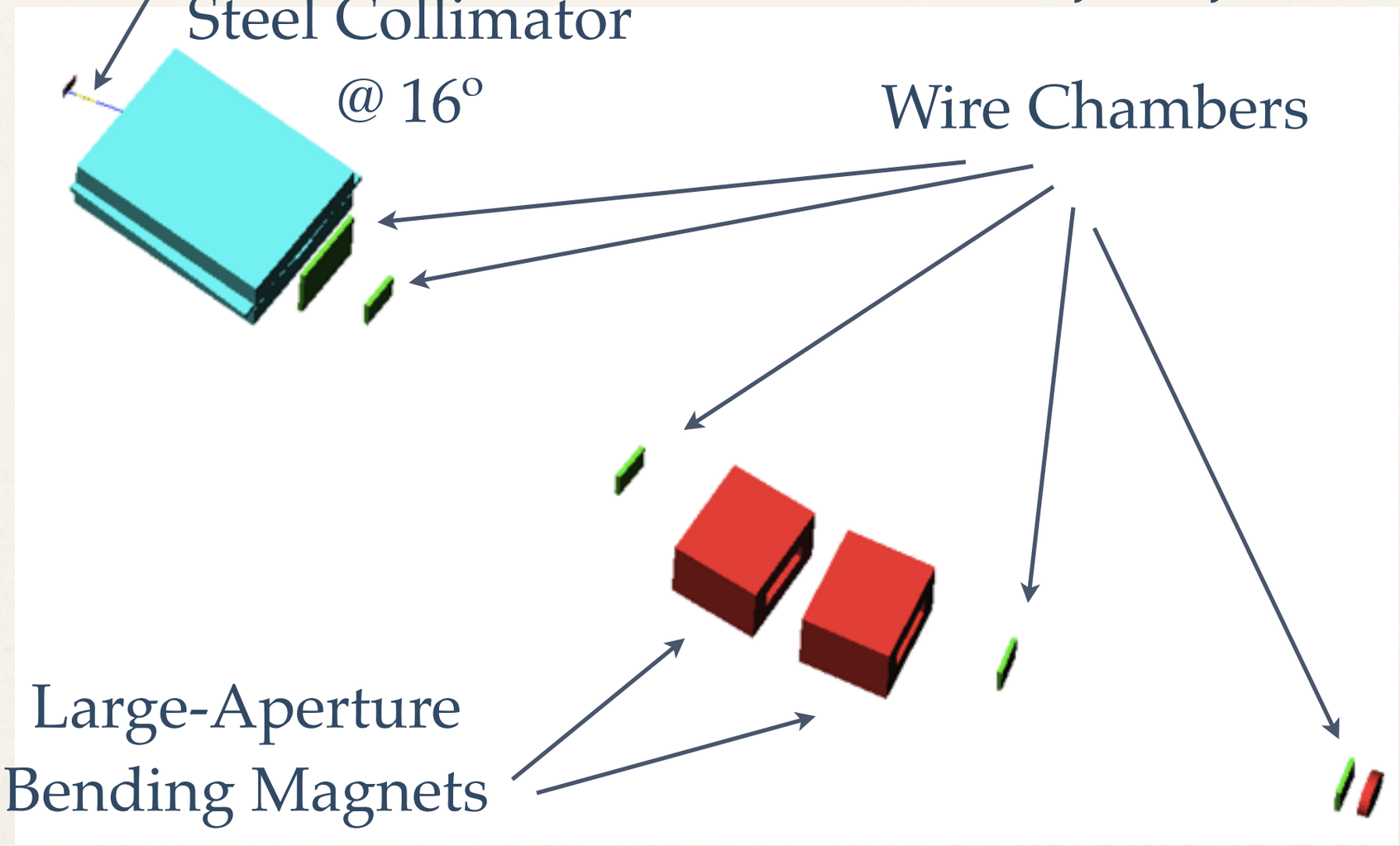
LBNE milestone: CD-2 approval (Spring 2016)

Recent Progress for Phase-1: From Beam to Data

- Beamline layout
- Triggering schemes
- Cryostat preparations
- PMT's and Light Yield
- Readout Electronics
- TPC simulation & Reconstruction

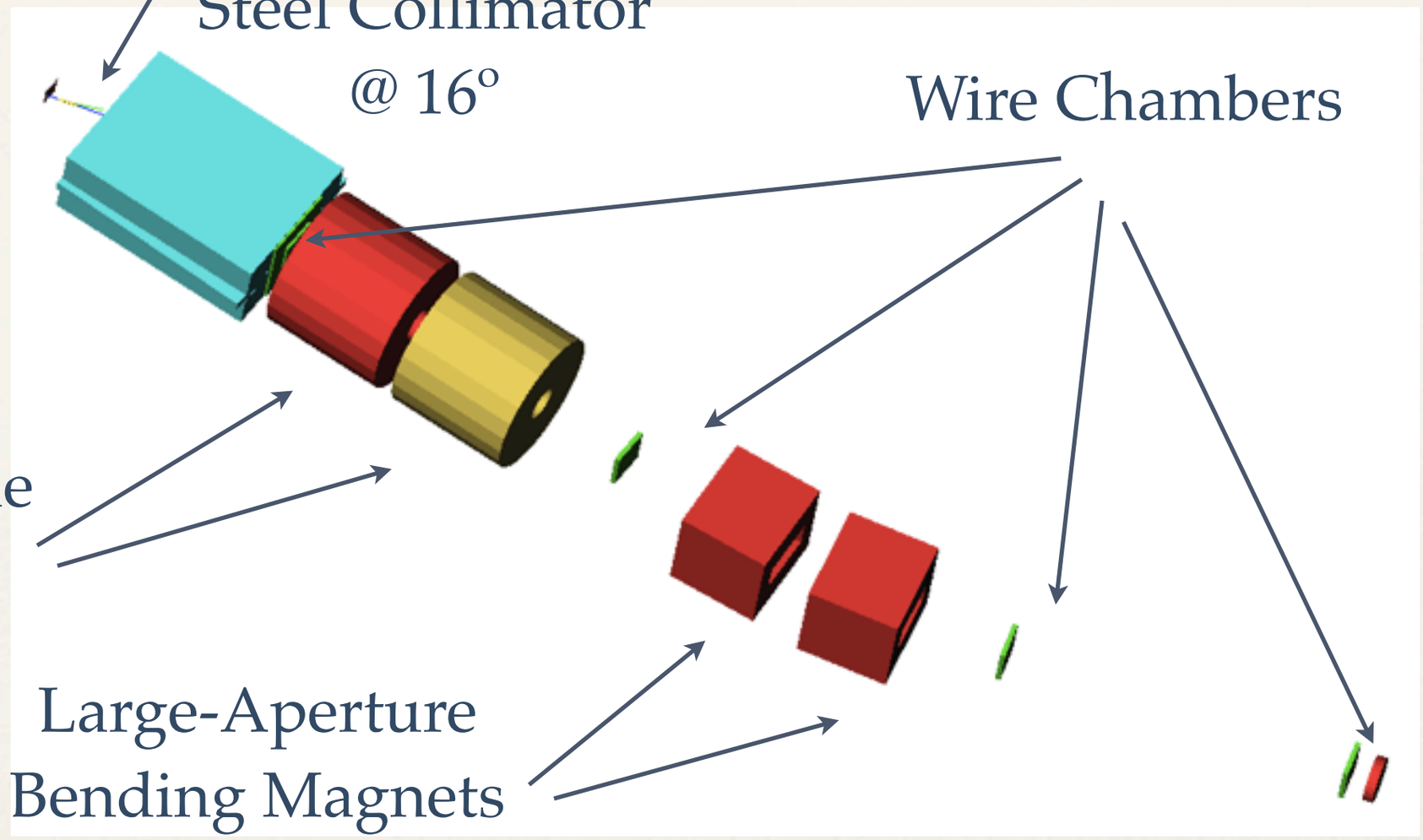
Beam Optics Layout

D. Jensen, FNAL
J. St. John, U. Cincinnati



Beam Optics Layout

J. St. John,
U. Cincinnati



Testbeam Triggering Progress

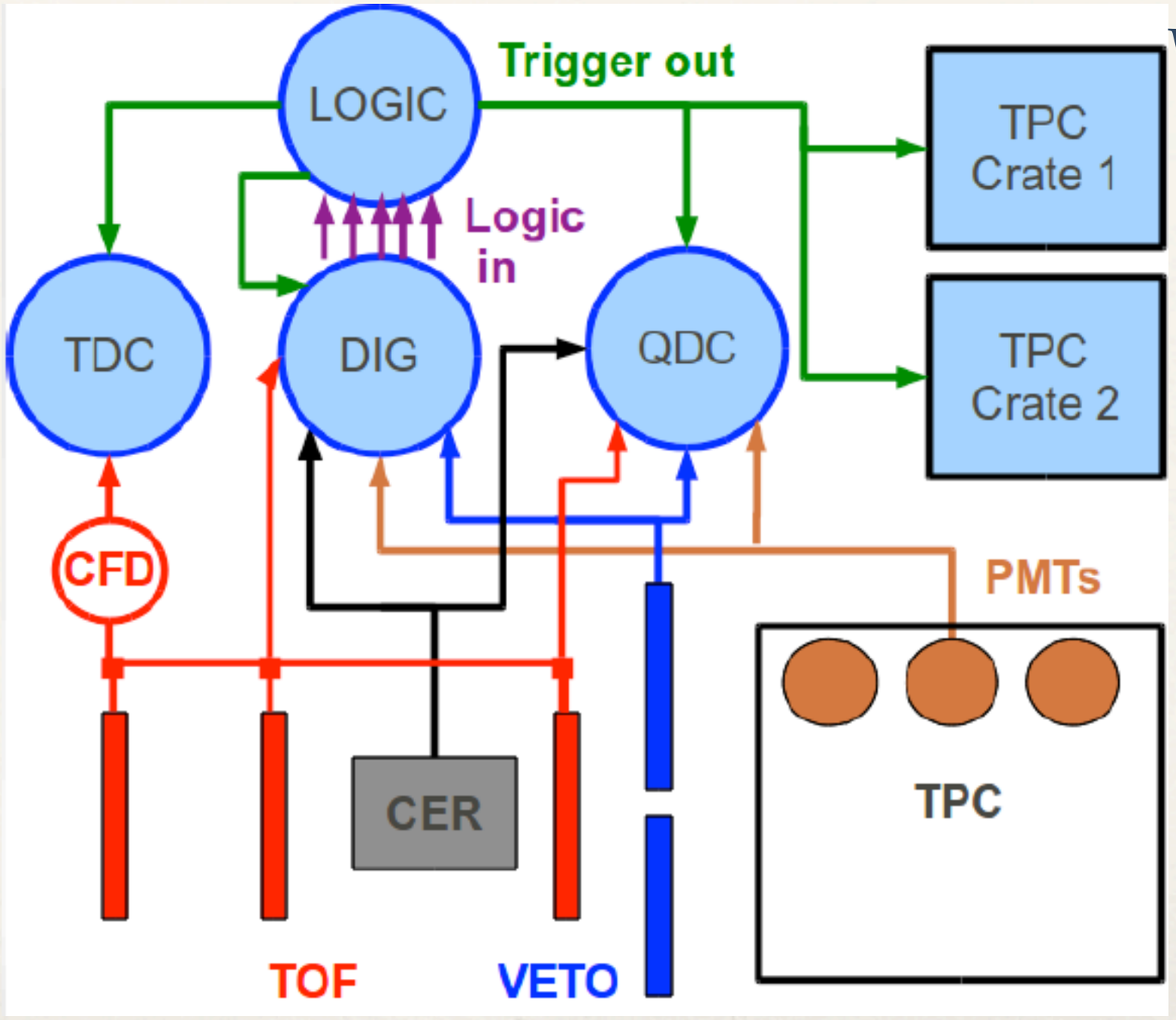
M. Kordosky,
William & Mary

Time of Flight

Cherenkov

Halo veto

PMTs



Testbeam Triggering Progress

Randy Johnson,
U. Cincinnati

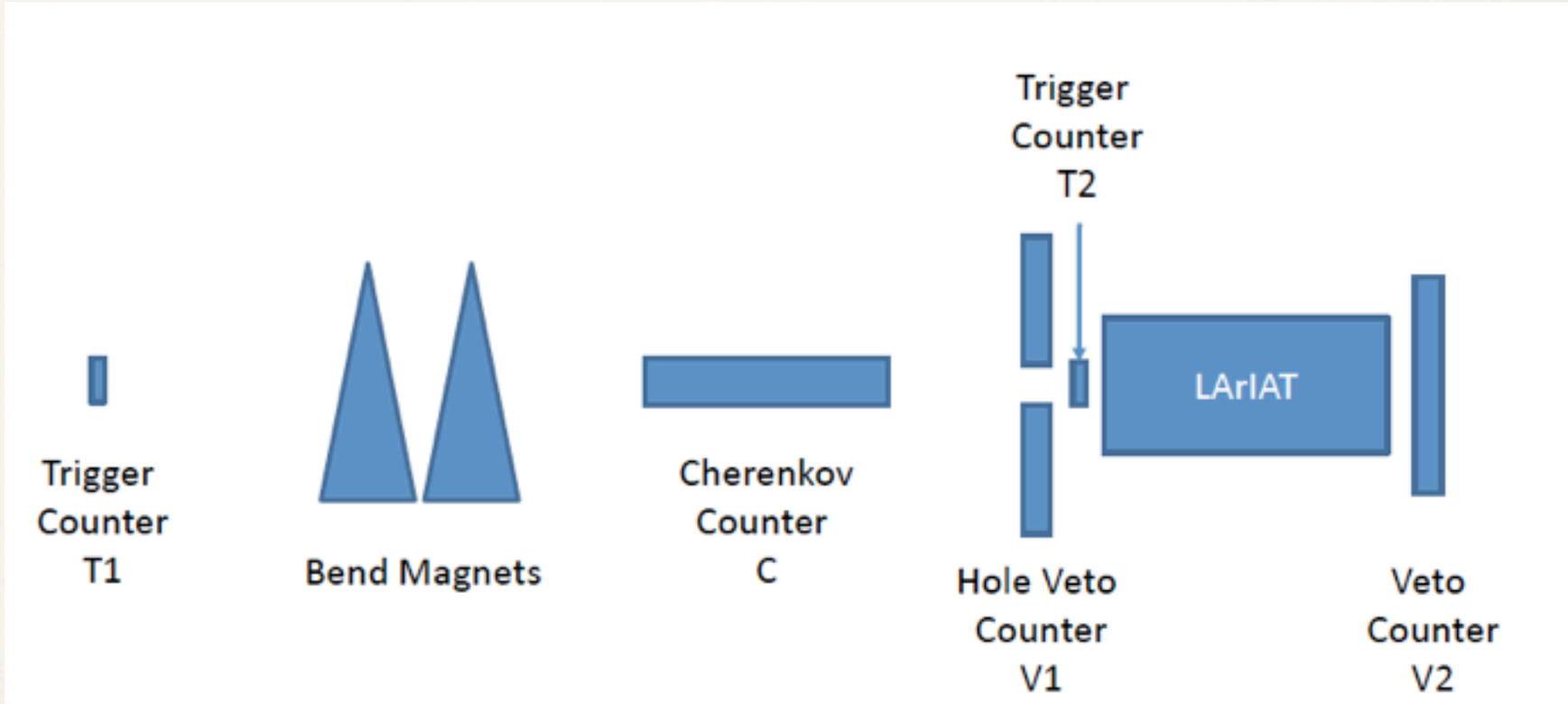
Time of Flight

Cherenkov

Halo veto

PMTs

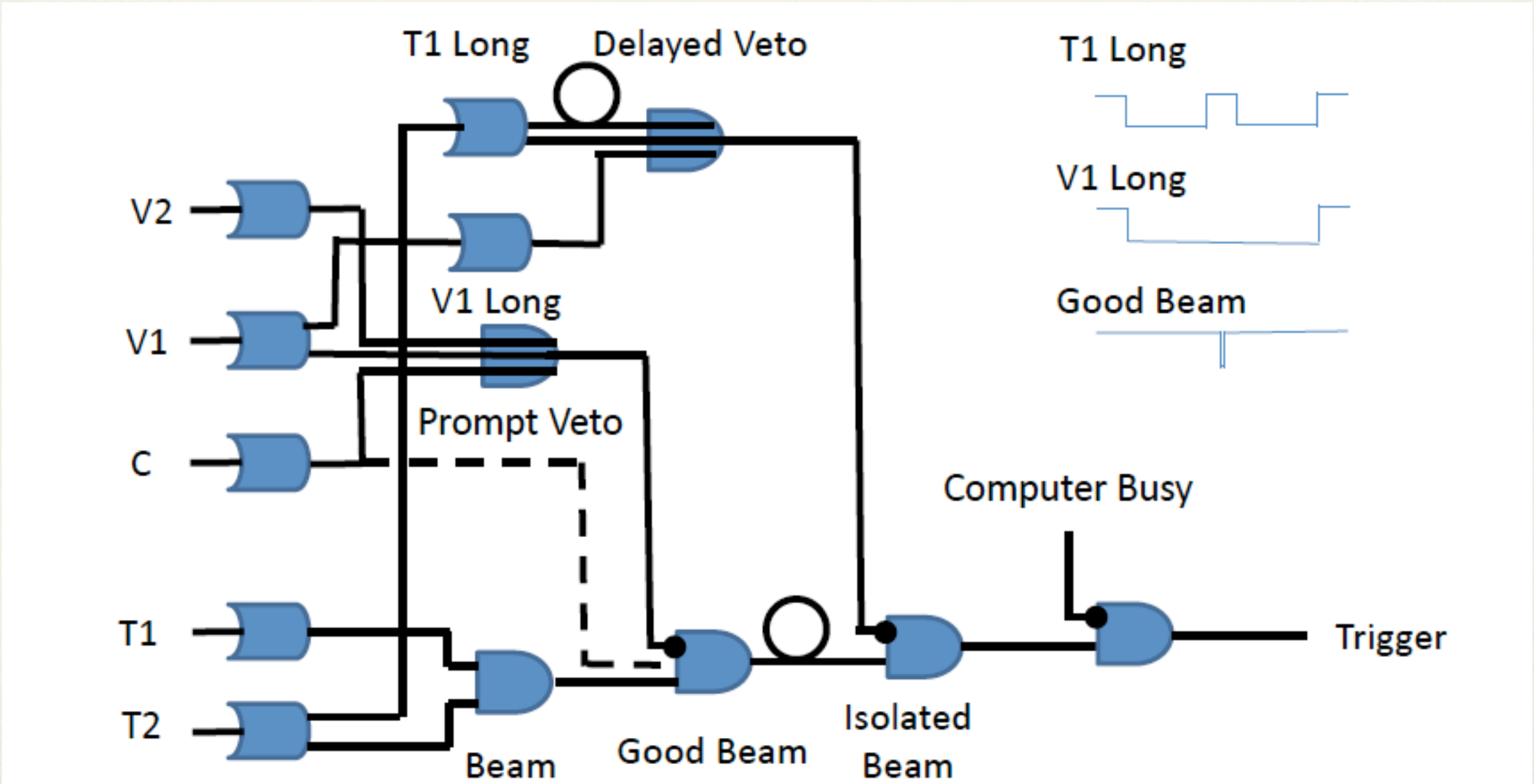
Punchthrough



Testbeam Triggering Progress

Randy Johnson,
U. Cincinnati

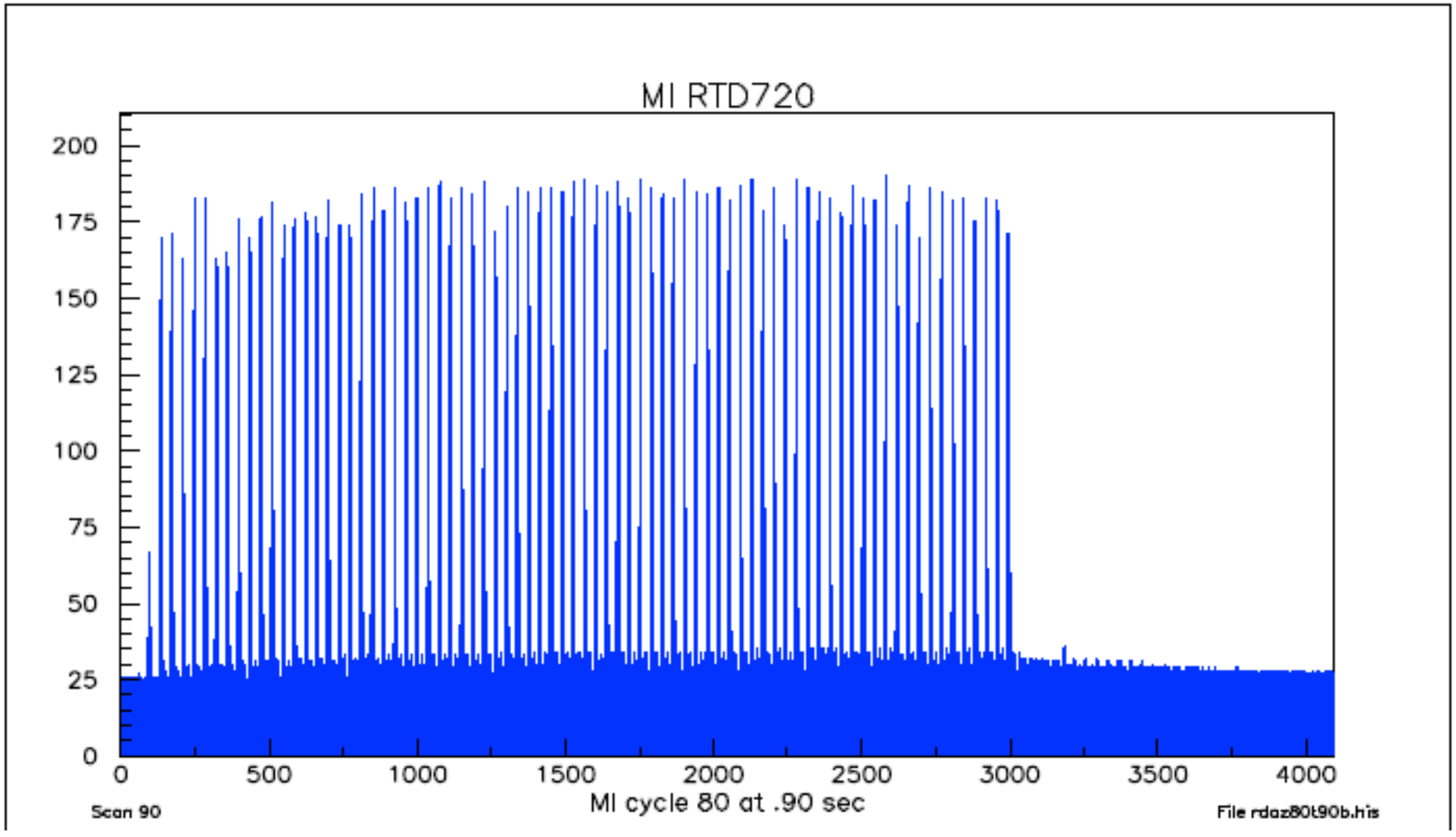
Beamspill, pileup, busy signal



Detailed Beam Spill Structure

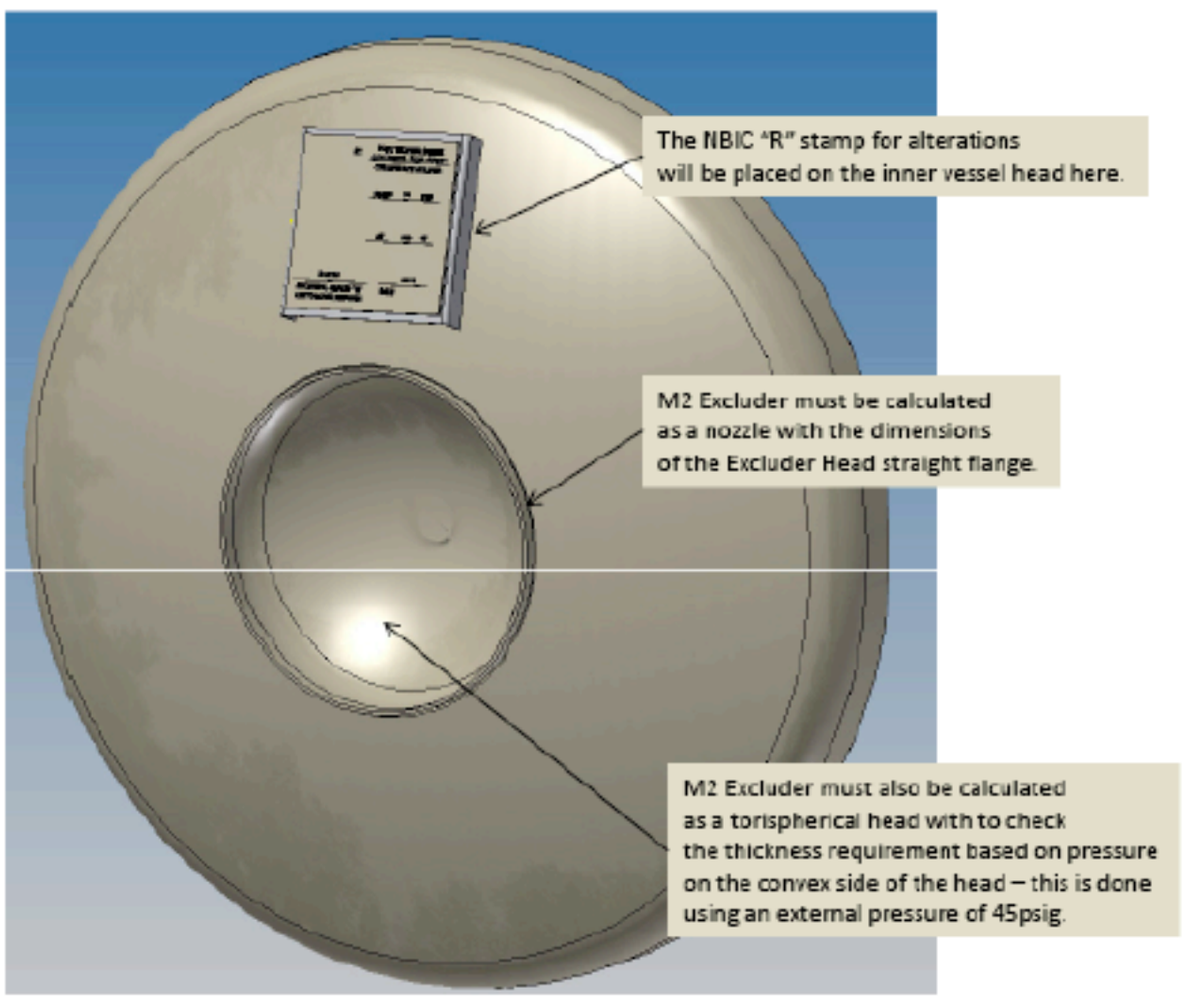
D. Jensen, FNAL

One Batch from the booster in the MI
data from the resistive wall monitor in the MI
this is a set of data during acceleration



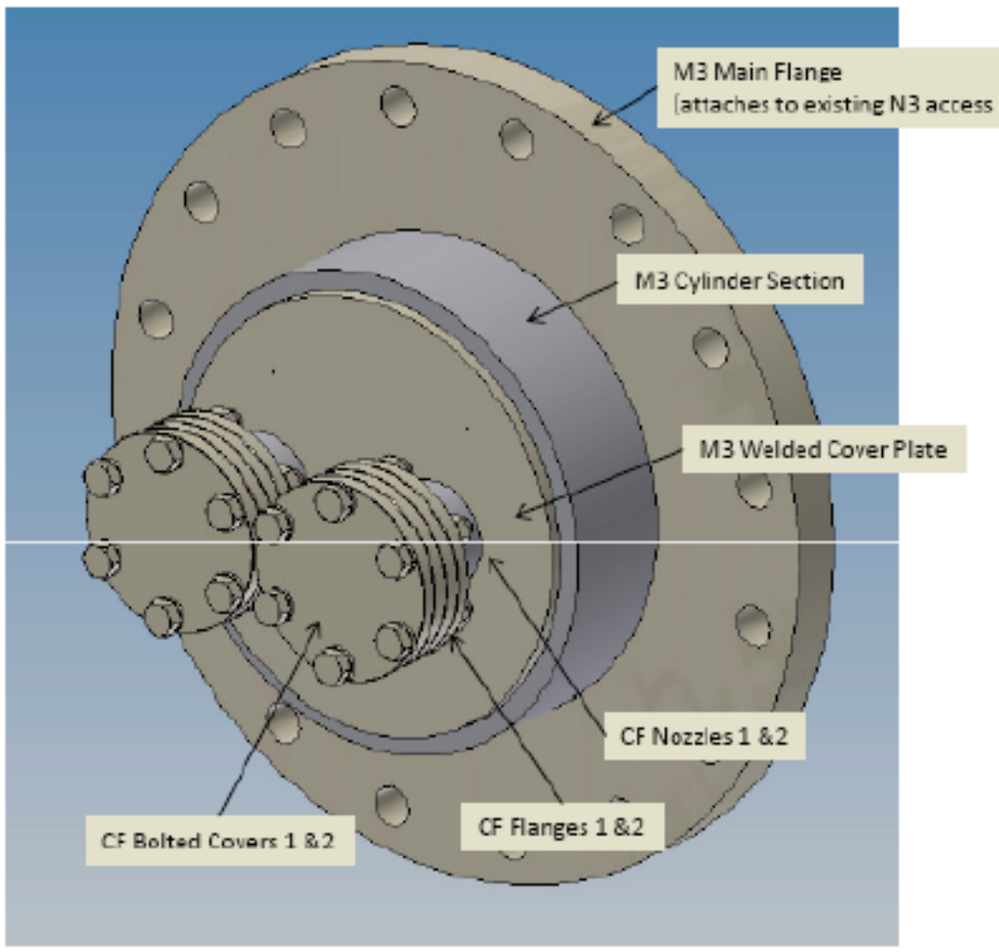
Cryostat Modifications

- Work being done at PHPK



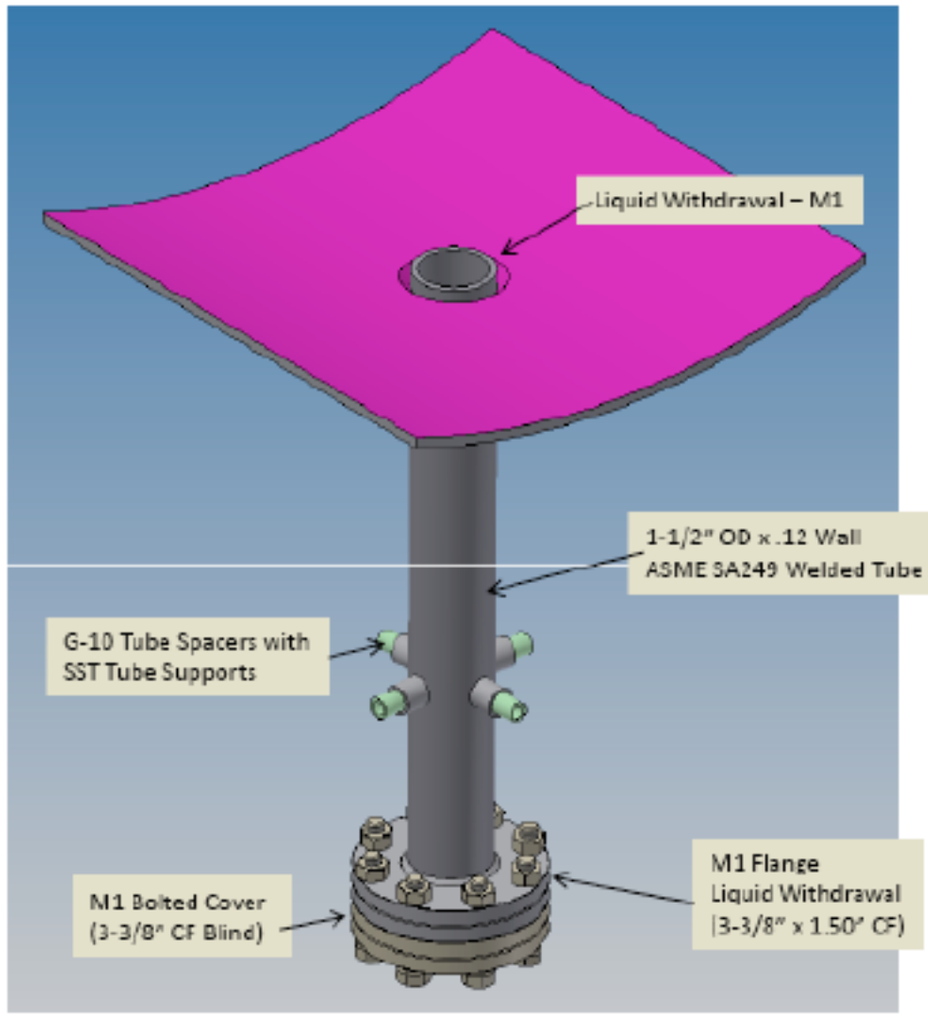
Cryostat Modifications

- Work being done at PHPK, continued.



MODIFICATION 03

Add removable instrument port

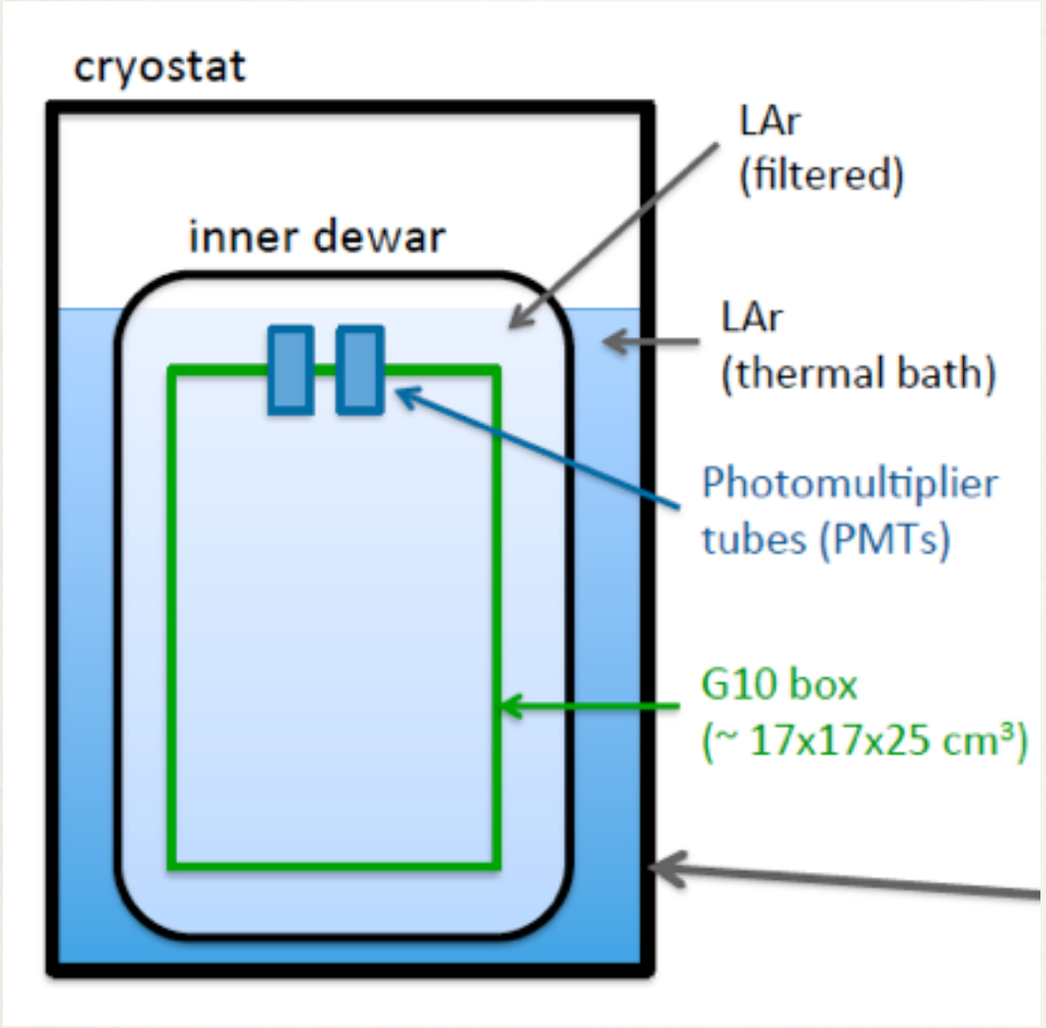


MODIFICATION 01

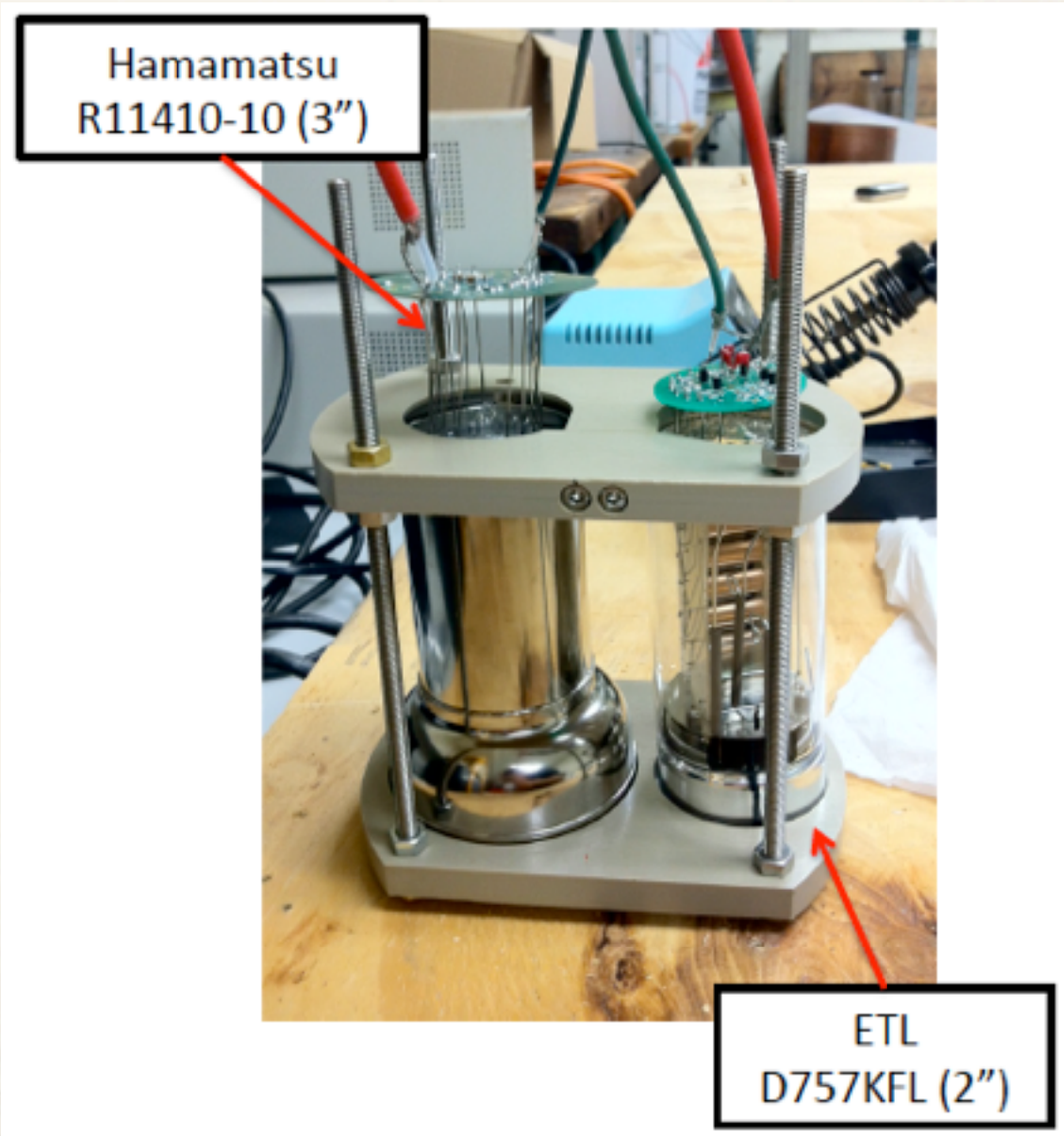
Add new 1-1/2" OD Nozzle for Liquid Withdrawal

Light Readout Tests

W. Foreman, D. Schmitz,
A. Szelc

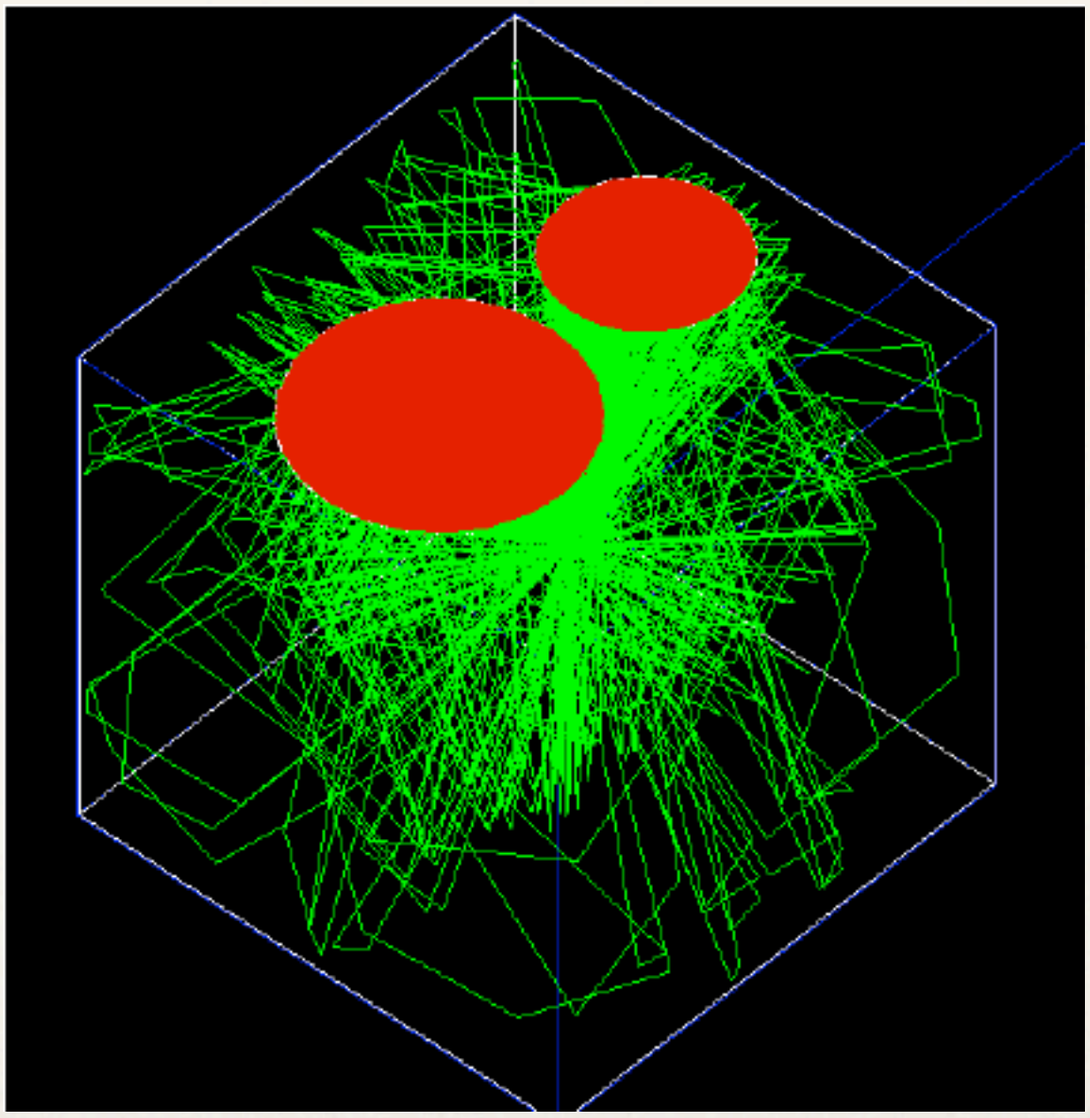


Regenerated Cu filter
Commissioned vacuum system



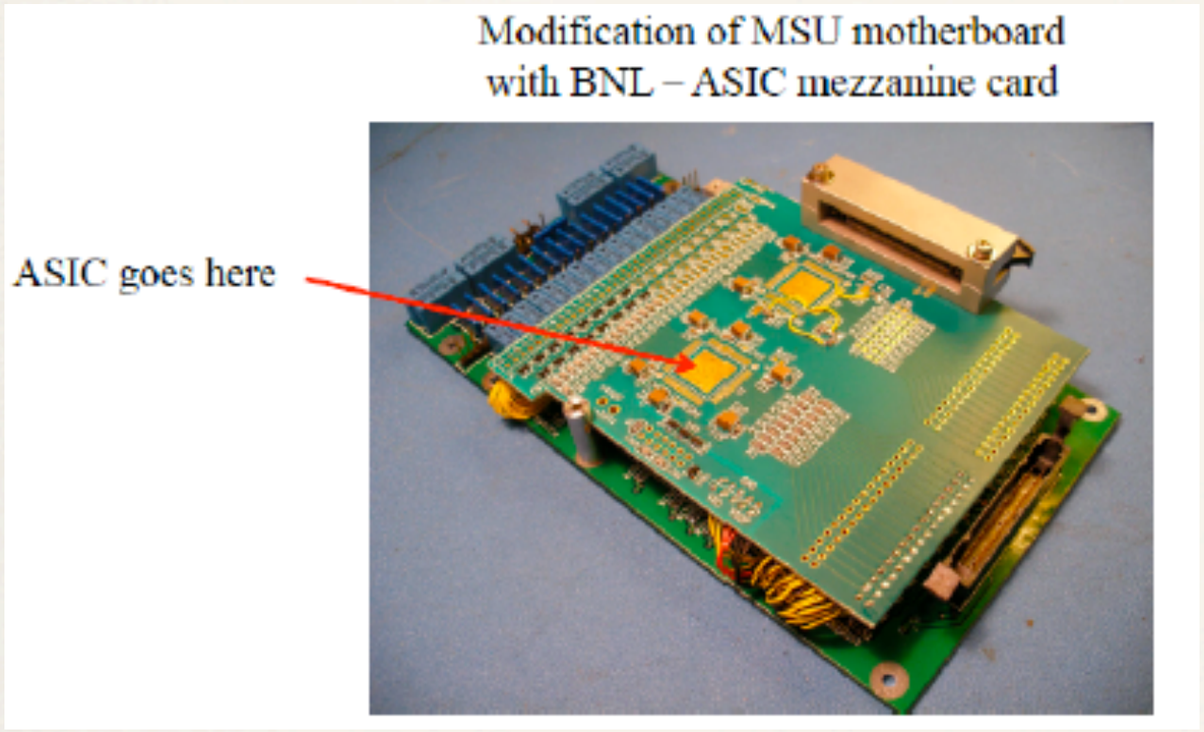
Optical Model

P. Kryczynski,
U. Chicago



Readout Electronics

C. Bromberg,MSU
M. Stancari, FNAL



Using proven, existing parts

Cost estimates and proposed work schedules generated and on the table

Argoneut Electronics:

- Warm &
- Accessible only by complete disassembly

Upgrade for LArIAT:

- Cold (great Signal/Noise)
- MicroBooNE ASIC (BNL) on a mezzanine

Readout Electronics & DAQ

Summarized at
LANL LAr Meeting
J. Raaf,
FNAL

DAQ rate must be increased by factor ≥5

Existing ArgoNeuT DAQ rate: ~1 Hz

Expected good-trigger rate at FTBF: ~5 Hz

(~20 particles/spill in 4 second spill once per minute)

Two planned improvements to reach up to 32x rate increase:

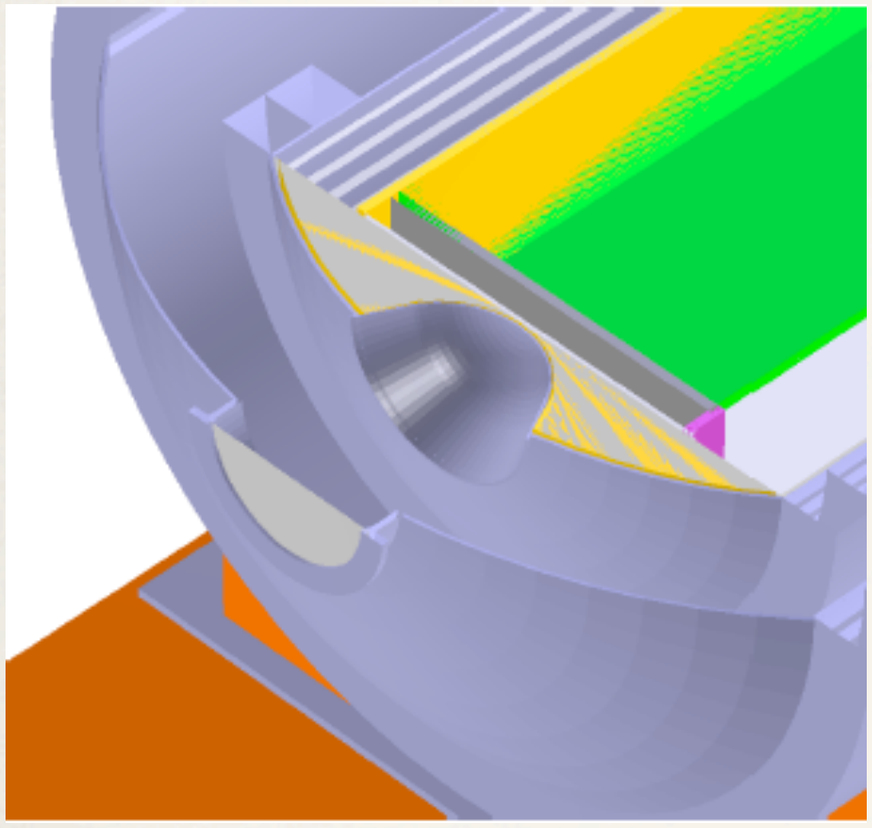
- ADF2 digitizer firmware upgrade for improved VME readout speed
- Replace "bit-3" PC-VME interface with Motorola SBCs (which we can get from CDF or D0)

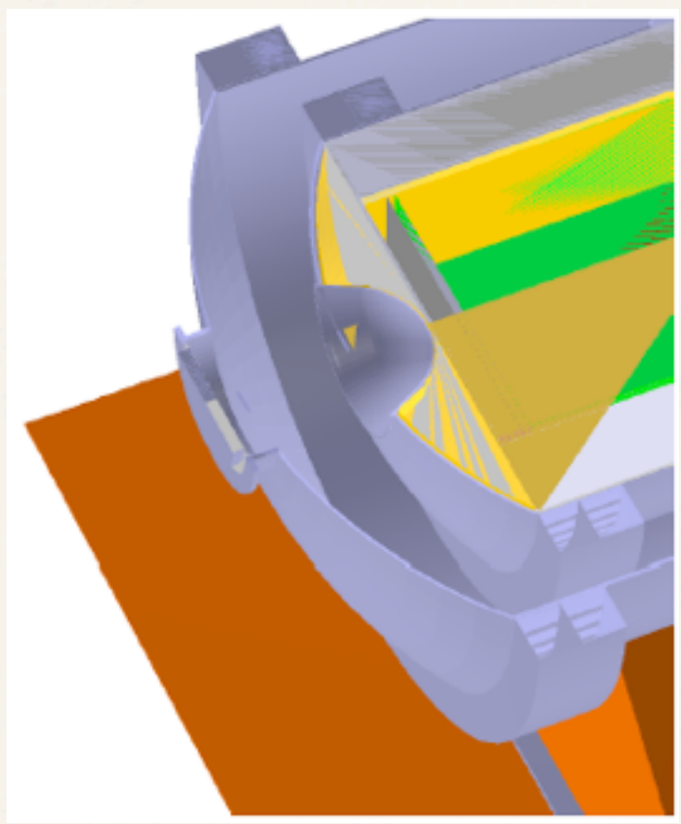
ArgoNeuT warm electronics can be used again, but we strongly prefer to instead upgrade to cold electronics (improved signal-to-noise)

Maybe not feasible with available FNAL funding...

Looking for external funds for this

Simulation & Reconstruction

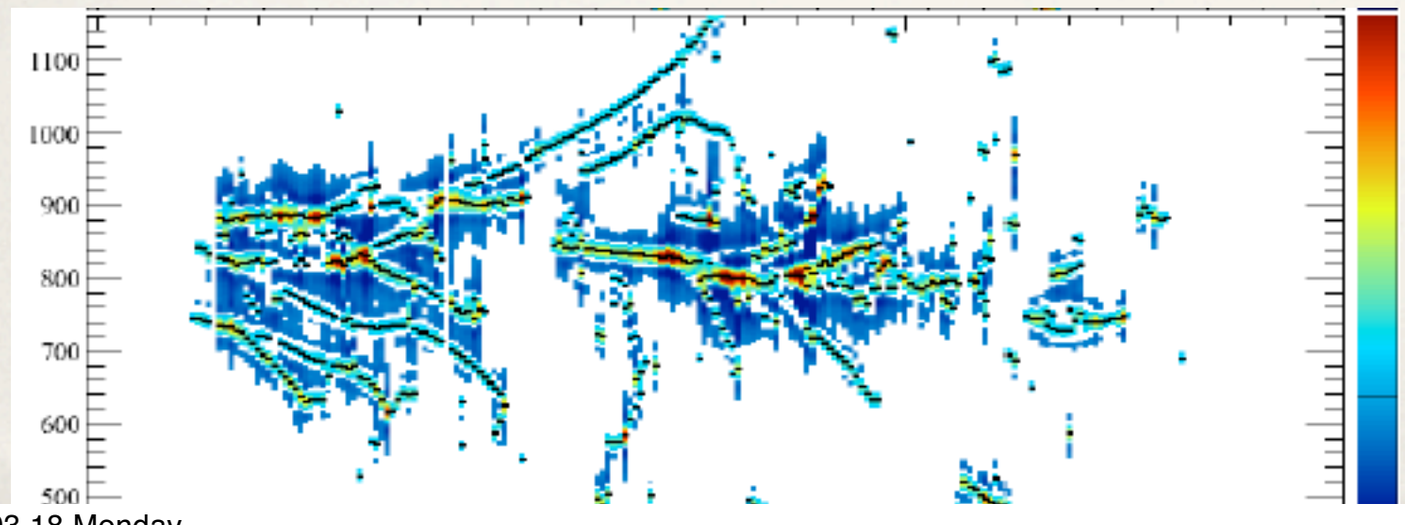




A. Szelc, Yale

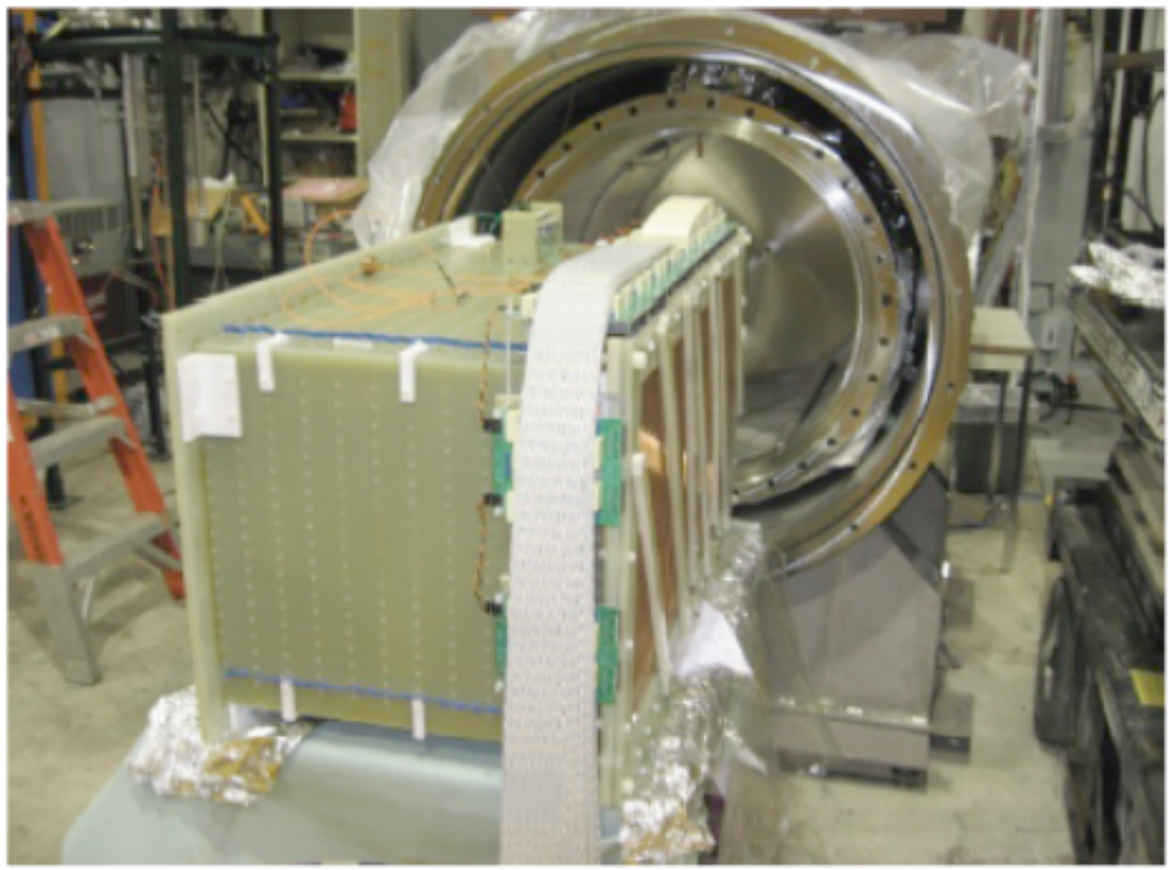
Modified geometry now in Geant

Possible shower-inducer for studying e/γ discrimination



Reconstruction simulation given realistic electronics noise

Thank You!



Summary

LArIAT scientific goals:

- Direct/experimental proof of e/γ separation in LArTPCs
- Detailed measurements of recombination factors
  p, K, π, μ PID and accurate calorimetry
- Direct measurement of energy resolutions
  for EM and hadronic showers
- Fine-tuning software for offline analysis

Phase-I effort is well underway

Working hard to be ready for beam startup (Summer 2013)

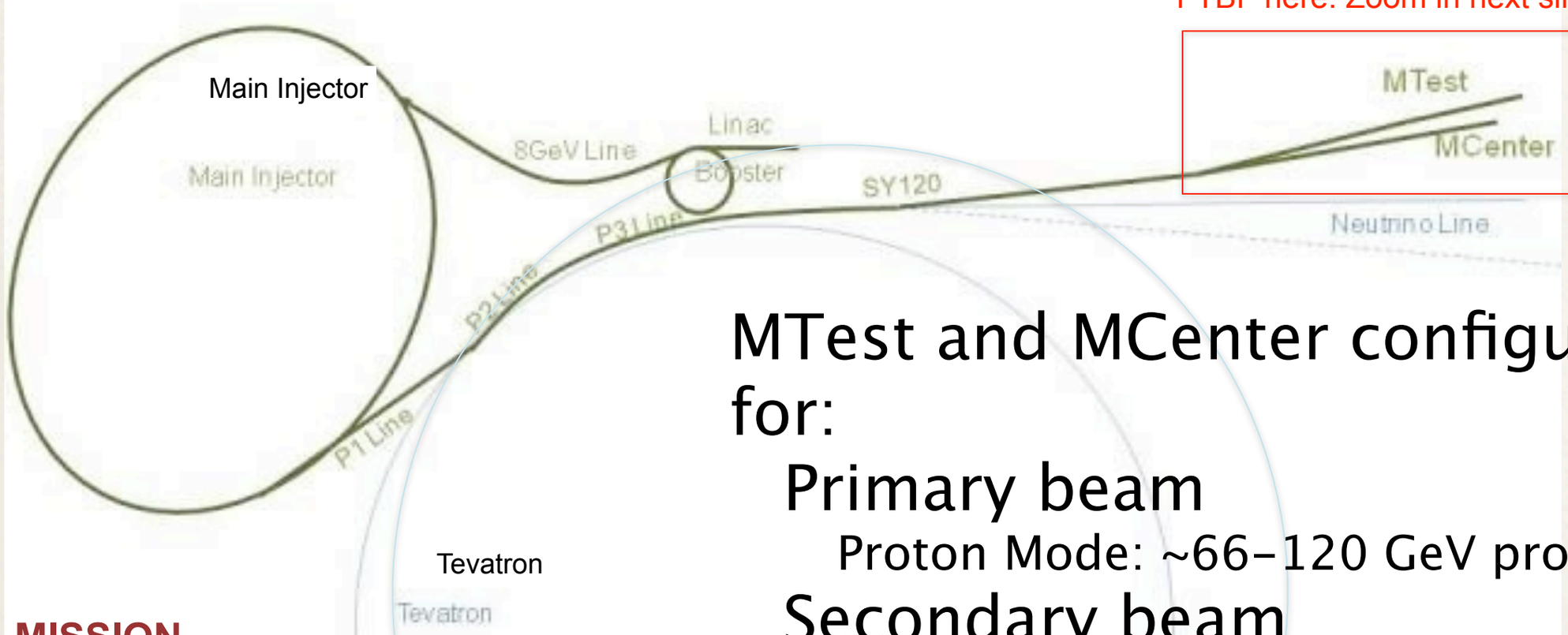
Phase-II simulation & planning has begun

Plenty of opportunities for new members to contribute!

Fermilab Test Beam Facility

http://www-ppd.fnal.gov/MTBF-w/

FTBF here. Zoom in next slide.



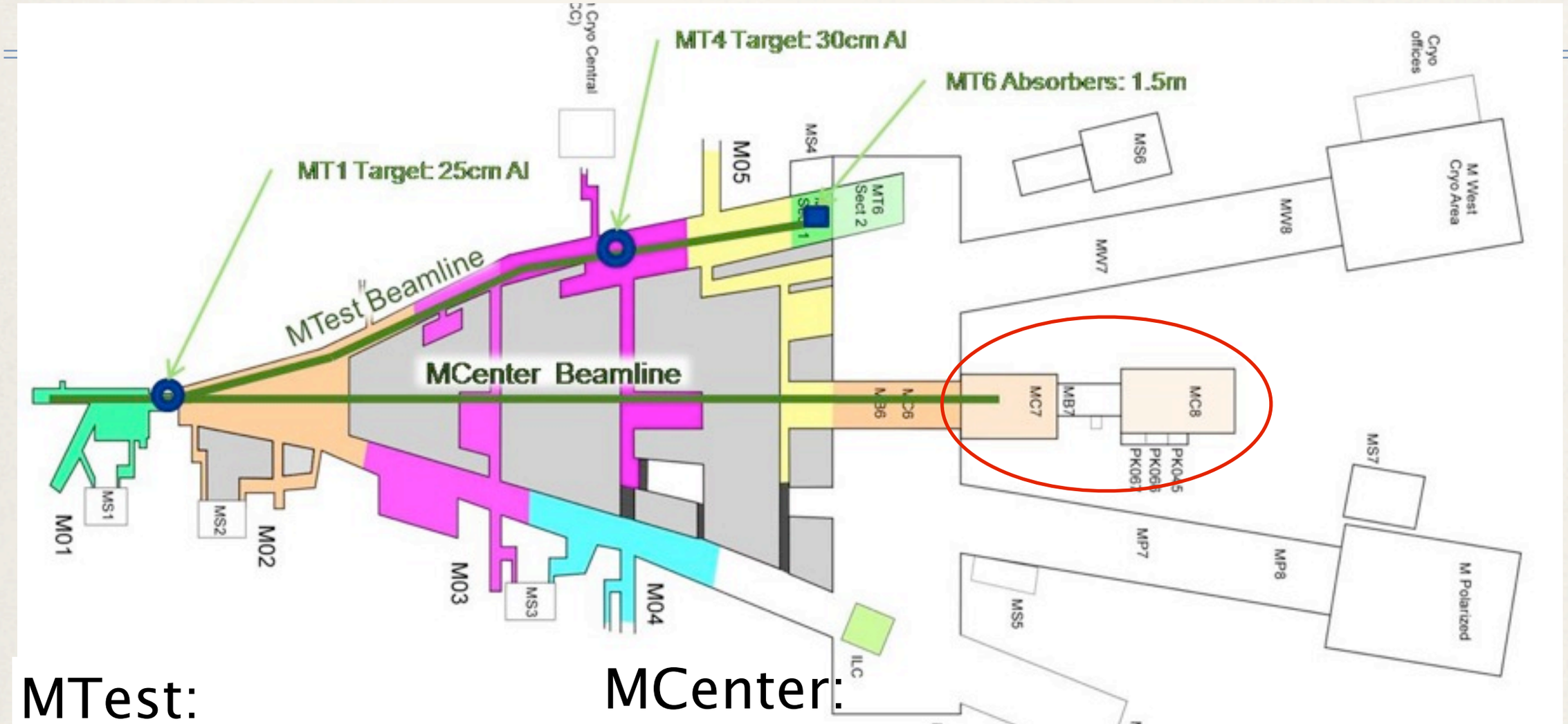
MISSION

The goal of the Fermilab Test Beam Program is to provide flexible, equal, and open access to test beams for all detector tests, with relatively low bureaucratic overhead and a guarantee of safety, coordination, and oversight.

MTest and MCenter configurable for:

- Primary beam
  - Proton Mode: ~66-120 GeV protons
- Secondary beam
  - Pion Mode: 8-66 GeV beam
  - Low Energy Pion Mode: 1-32 GeV beam
  - Muon Mode: Same energy range as above
- Tertiary beam
  - Low Energy Pion Mode: 200 MeV - 3 GeV

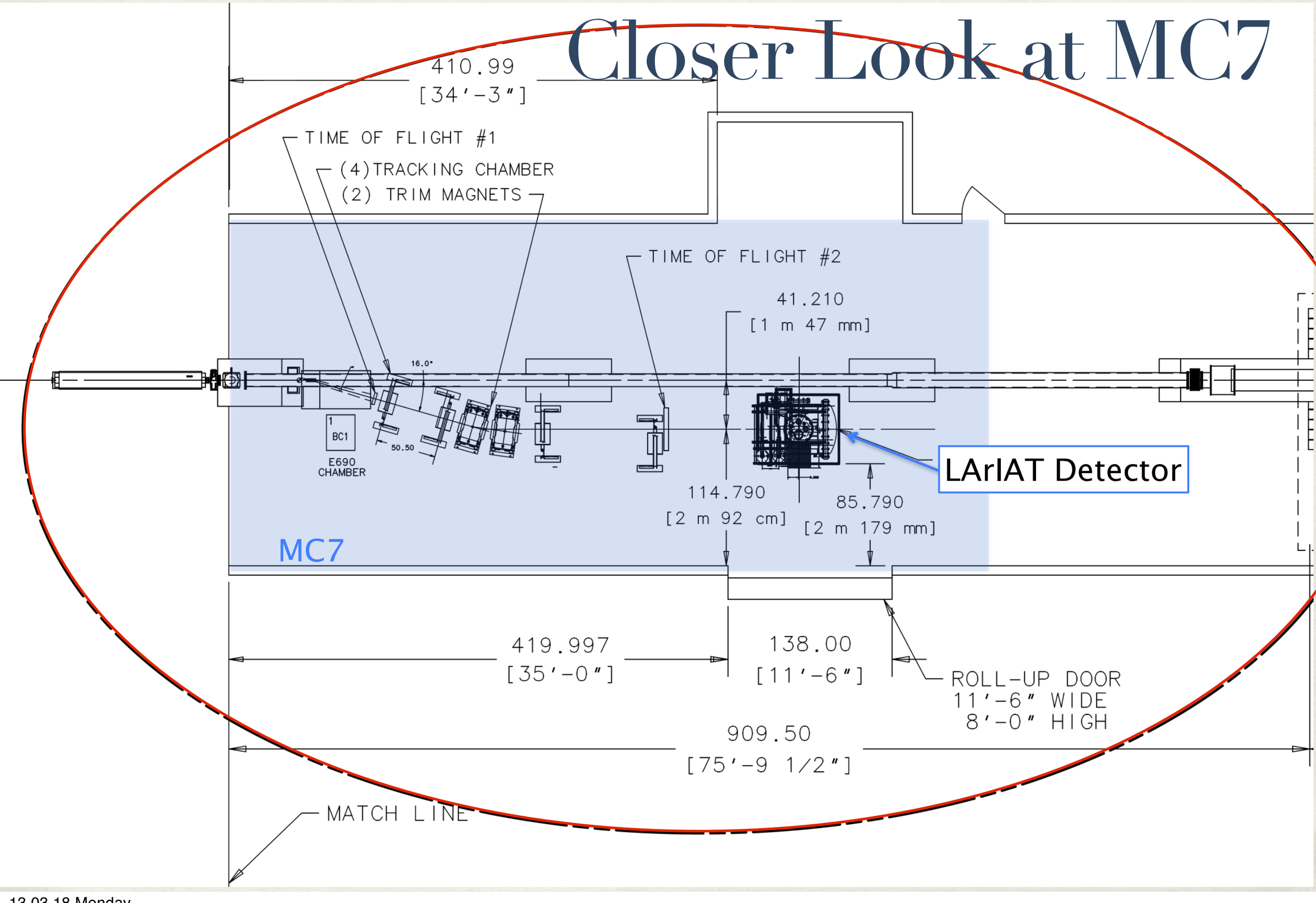
Closer Look at FTBF



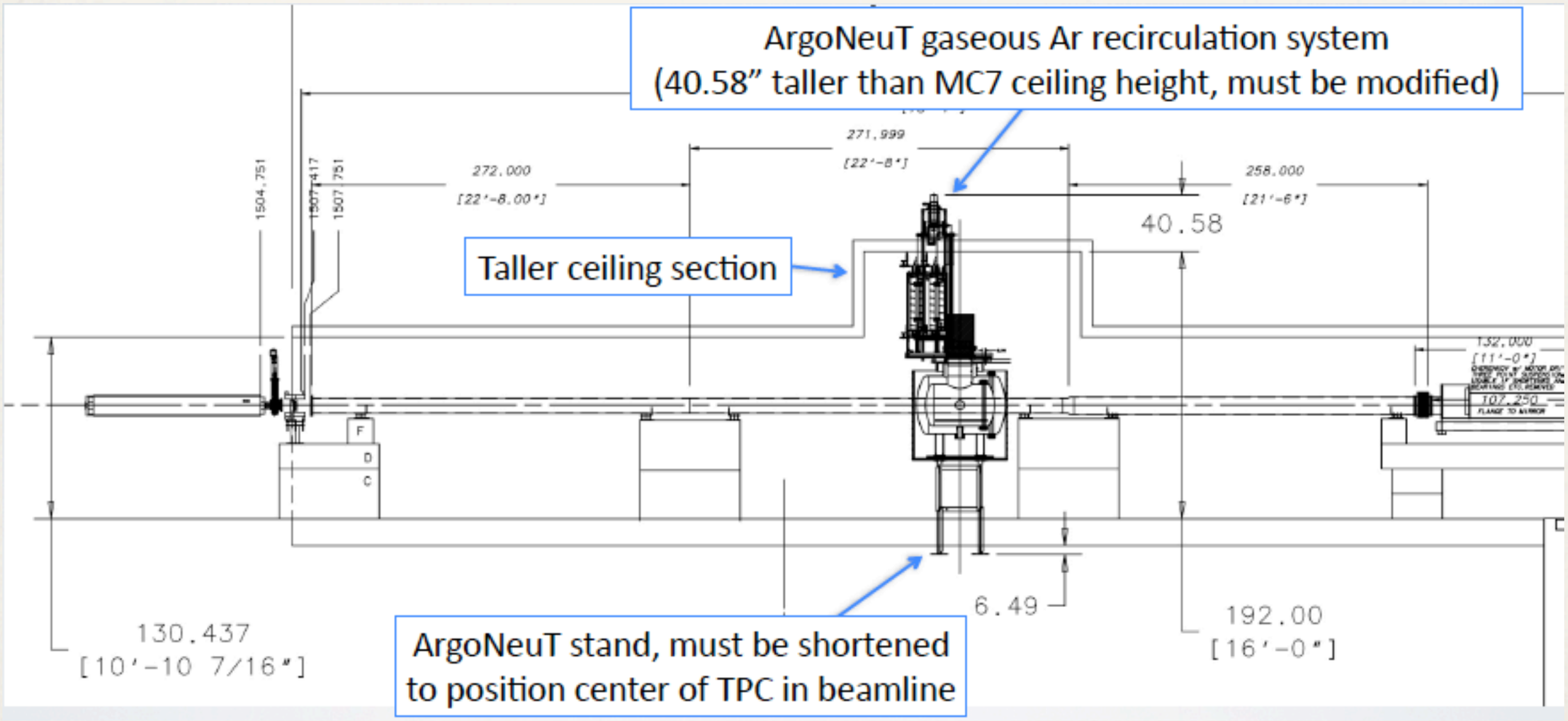
MTest:
Continue to use for short-term experiments (few weeks to months)

MCenter:
Create a facility for long-term LAr calibration and R&D with "generic" cryogenic plant in MC7/8 that will service upcoming experiments (LArIAT-I and -II) and any future LAr R&D in this beam.

Closer Look at MC7

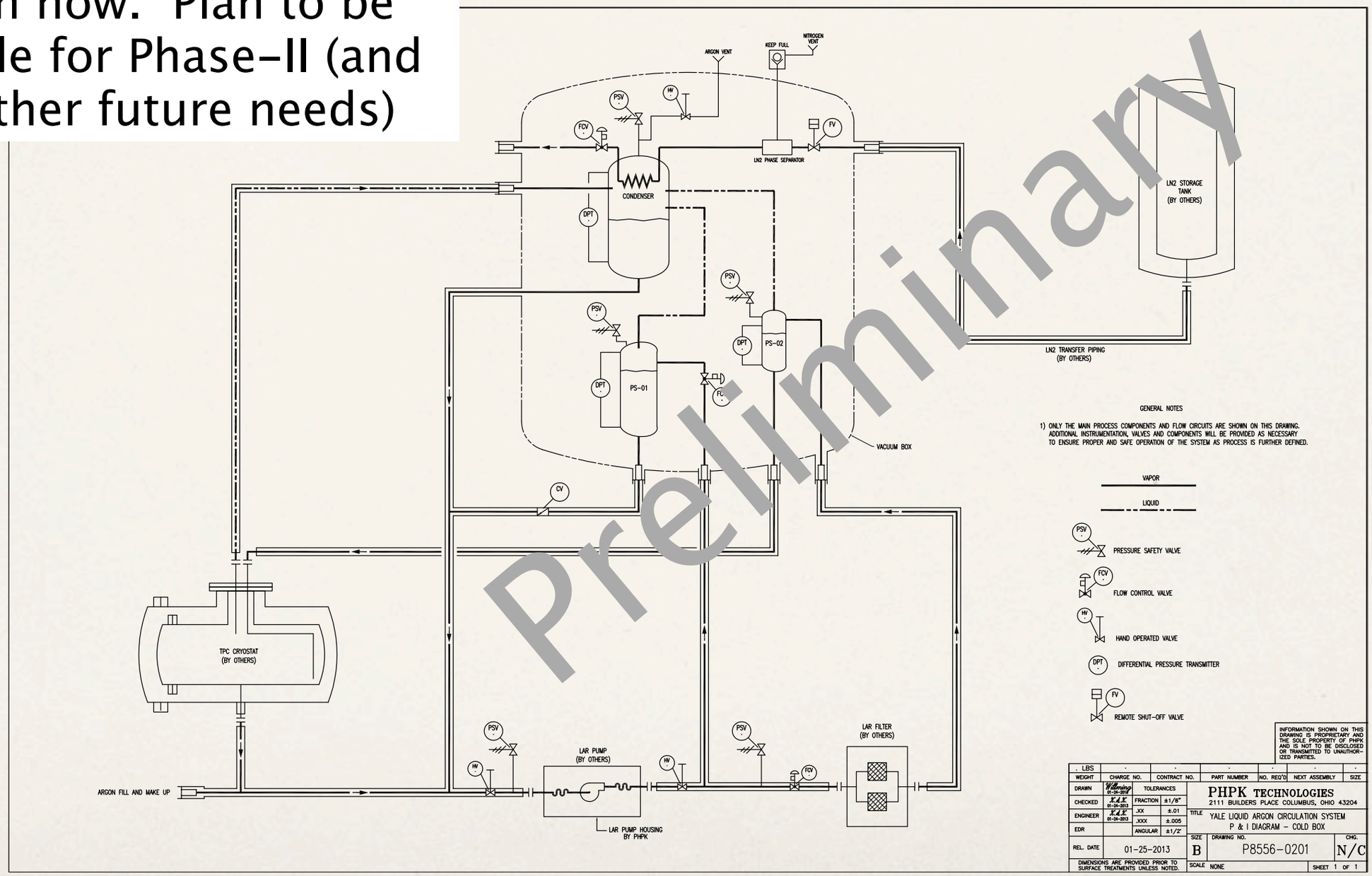


Argoneut at MC7



Cryogenics and LAr Purification

"Generic" purification system under discussion/ design now. Plan to be reusable for Phase-II (and any other future needs)



Target and Shielding

D. Jensen, FNAL