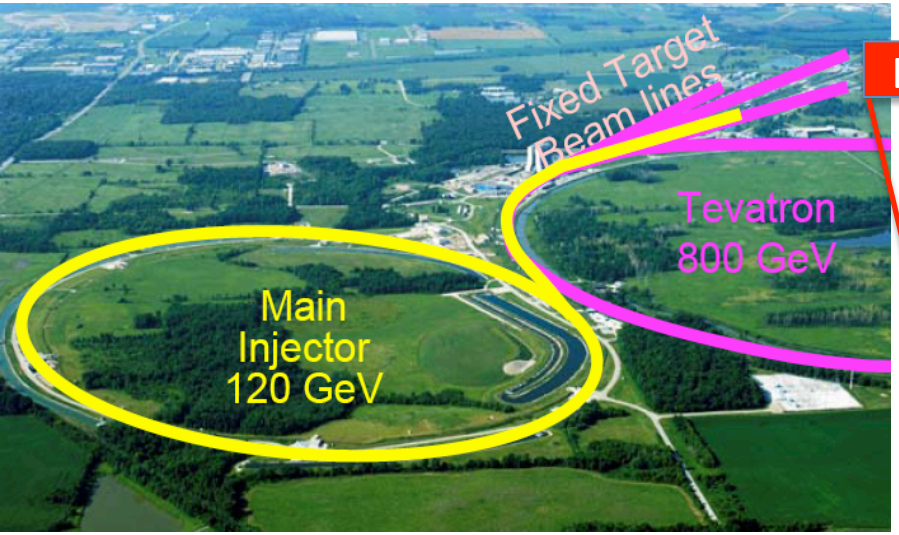
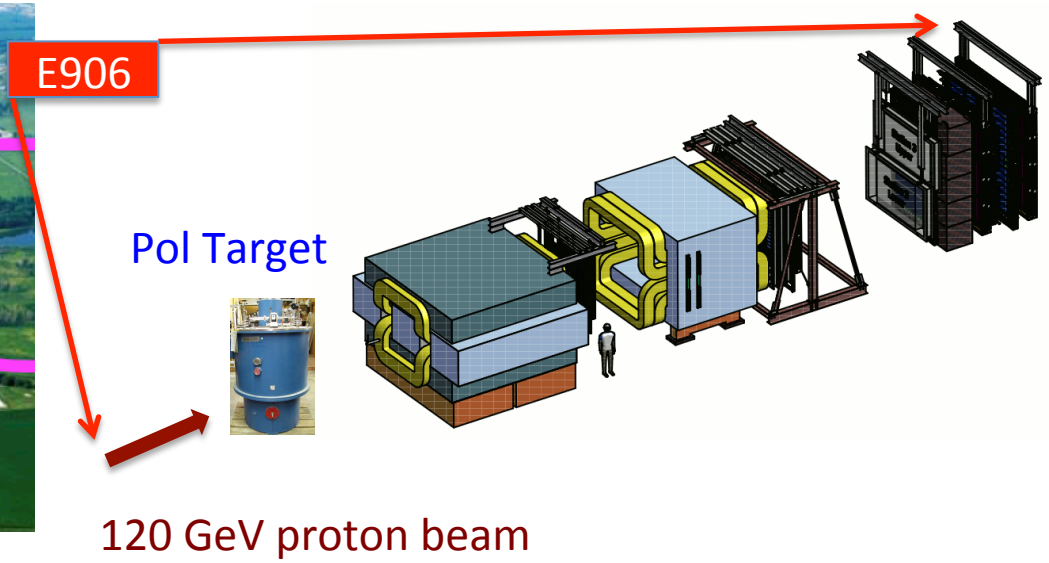
Transition from E906 to E1039

Ming Liu

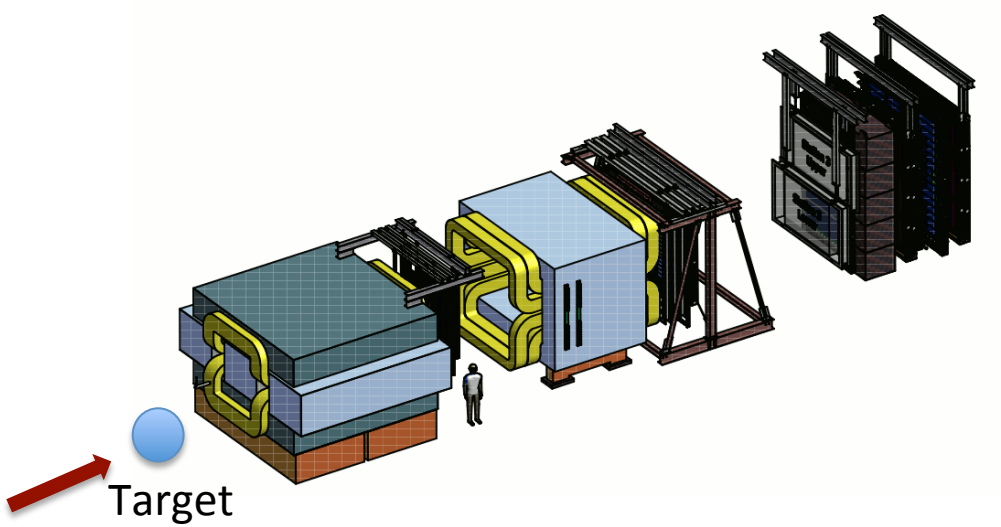
P-25





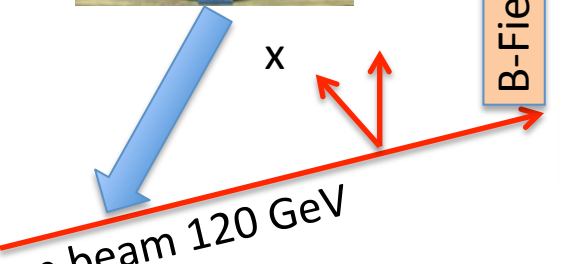
E906 vs E1039

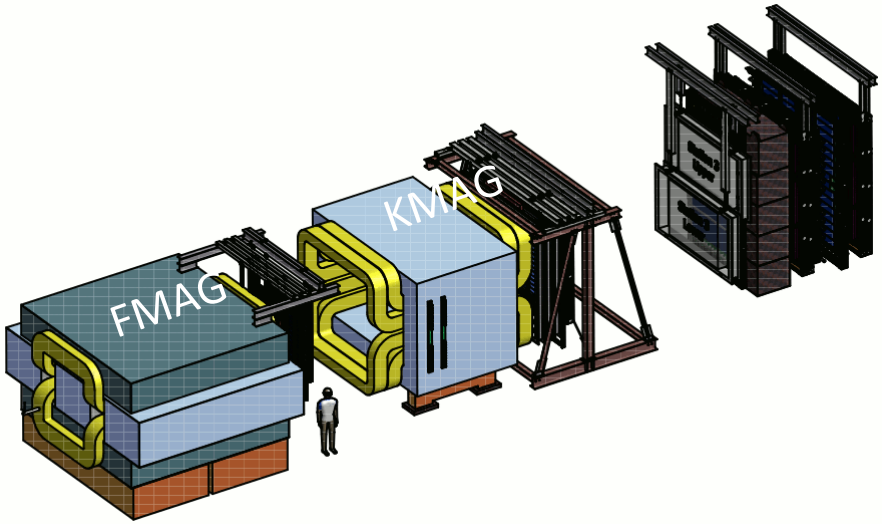
- Fixed target dimuon experiments for Drell-Yan and J/Psi productions in p+p and p+A
  - Common Forward Muon Spectrometers
  - Very different target systems



- E906 Targets: "simple"
  - 10~20% of nuclear interaction length, >5cm in diameter
  - LH_2 and LD_2, ~50cm long, operate at 20K
  - C, Fe and W
- E1039 polarized target:
  - NH3 operate at 1K, 5T B-field

From E906 to E1039: To Do List





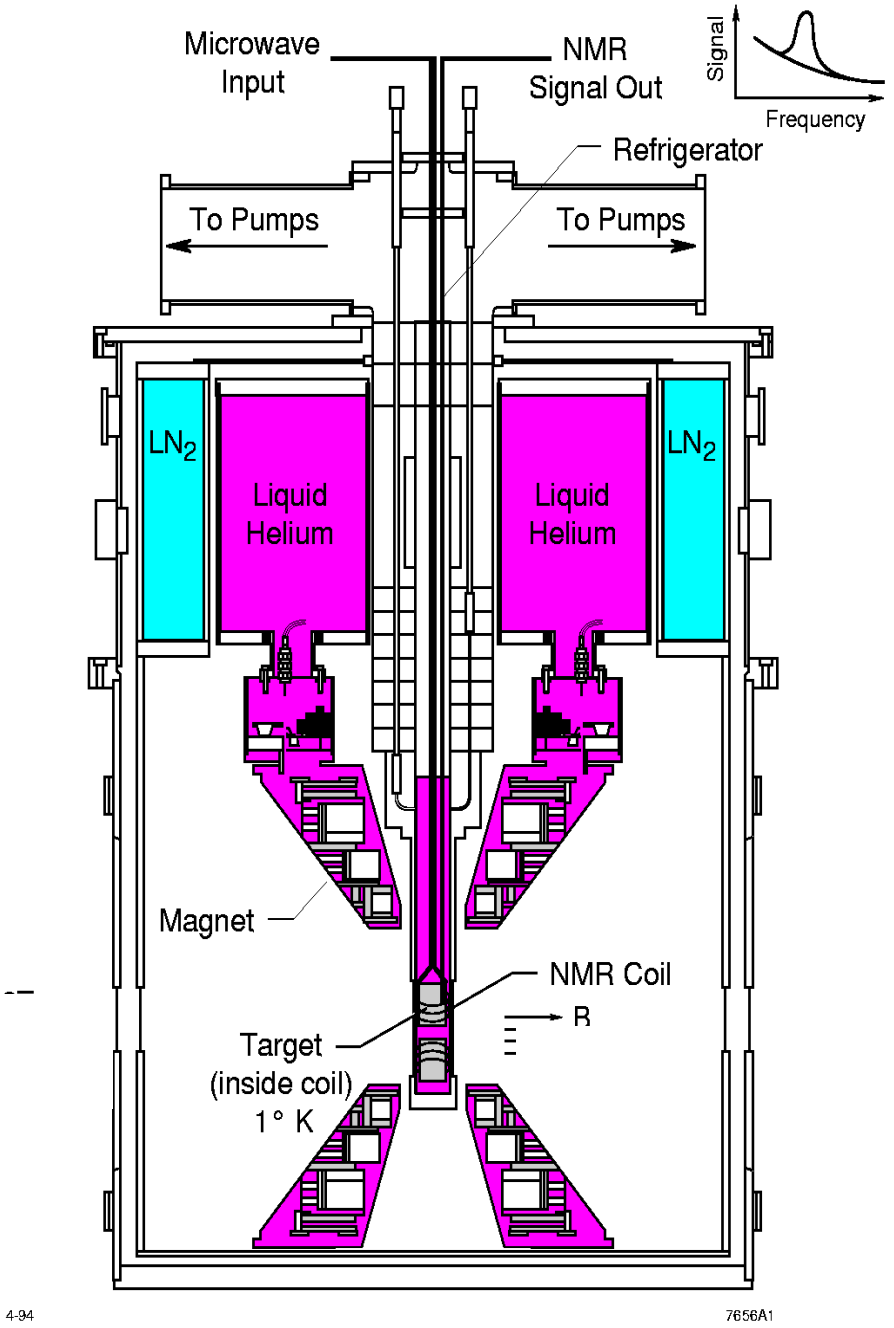
- Target
- Beam line
- DAQ
- Mechanical
- Cryogenics
- Electrical
- Cooling
- Shielding
- Safety Review

E906 Target Cave

E906 Targets: LH2, LD2, C, Fe, W

LANL High Density Polarized Proton (NH_3) Target

- Superconducting dipole magnet
  - Temperature ~ 1 K
  - Magnetic Field: 5 Tesla
  - 8cm long NH_3 target
- Proved capable of handling high luminosity
  - up to ~ 10^{35} (Hall C)
    ~ 10^{34} (Hall B)



Modifications to E906 Setup

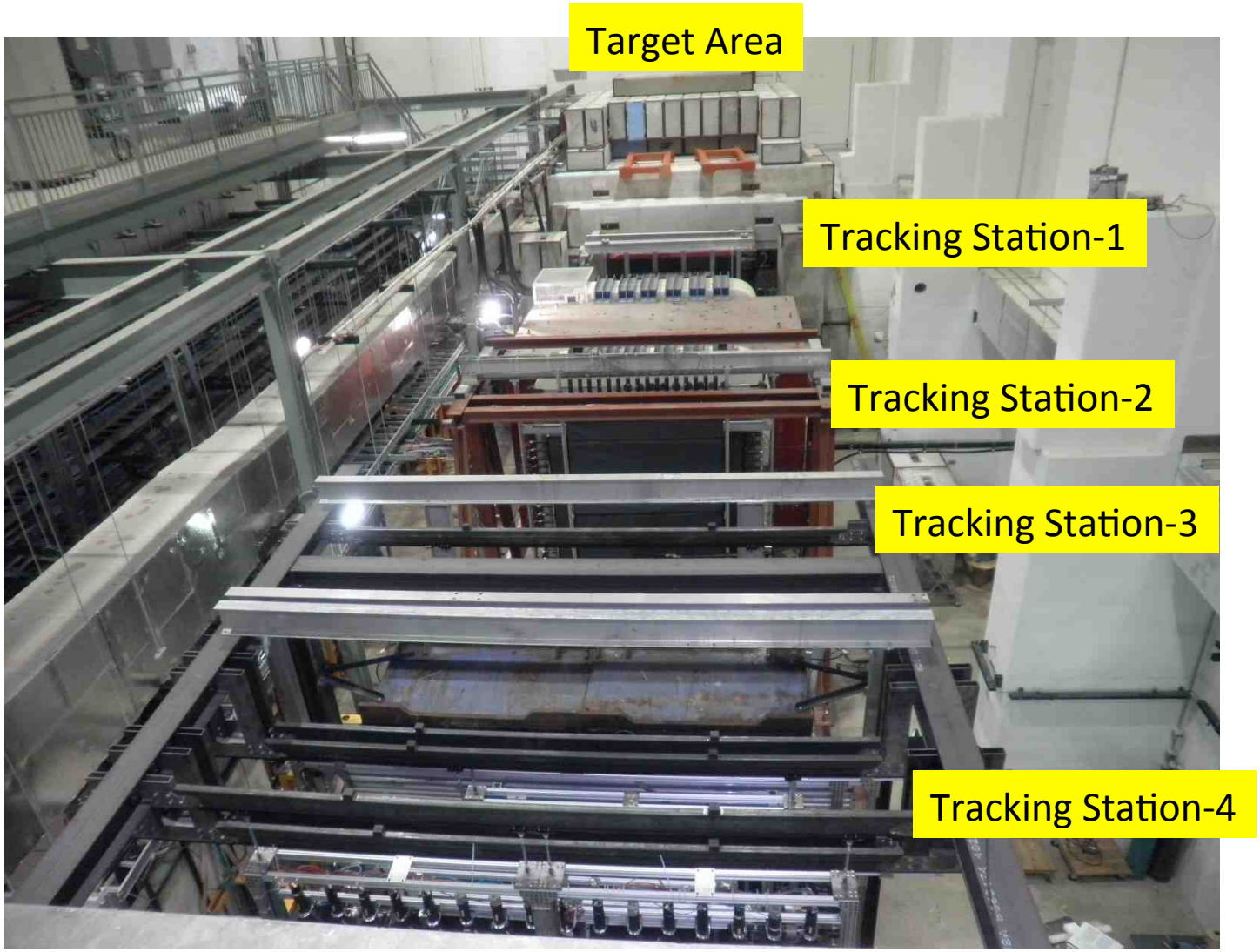
Target and Beam Control

- Some changes @IR
  - New space for operation, target change etc
  - New target stand (a platform)
  - Radiation shielding around the target area
- Target operation and maintenance
  - Service lines, Power, Cryogenic systems
  - NMR system, radiation shielding for electronics, network access
  - Space for target changes etc.
- Beam control
  - A new final focusing quadrupoles (Q3 near target)
  - Beam collimator, target magnet quench protection
  - Beam spot position/direction/size monitors
  - Beam position/direction stability
  - Luminosity monitors, Cerenkov, new telescopes
- Fermilab Engineering and Safety Review

DAQ and Spectrometers

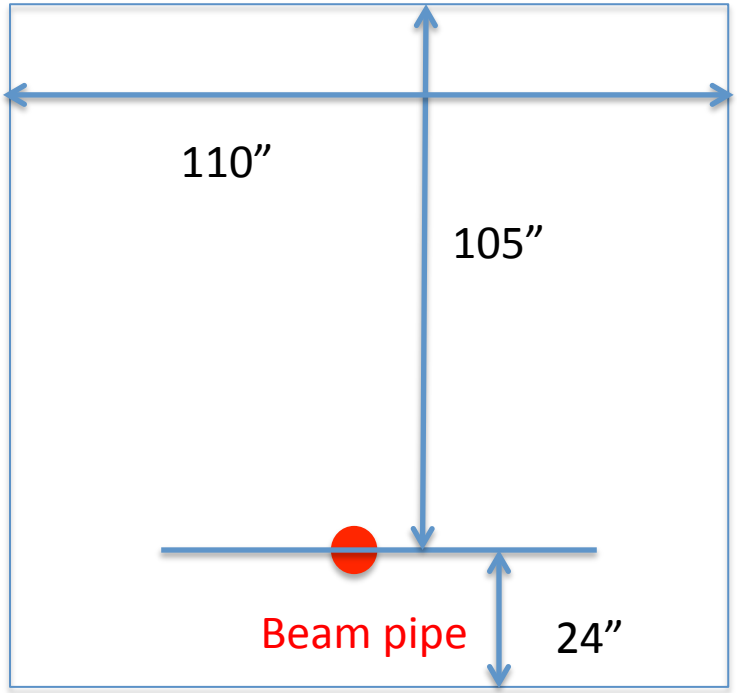
- Spectrometers
  - New switches to Reverse fields of FMag and KMag for spin asymmetry systematic control
- Triggers
  - A new trigger road map to optimize signal from target
- DAQ
  - Improve DAQ bandwidth
  - Slow control integration into DAQ
- Physics asymmetry systematic controls
  - Precision luminosity

The Experimental Hall: No Change



Target Area

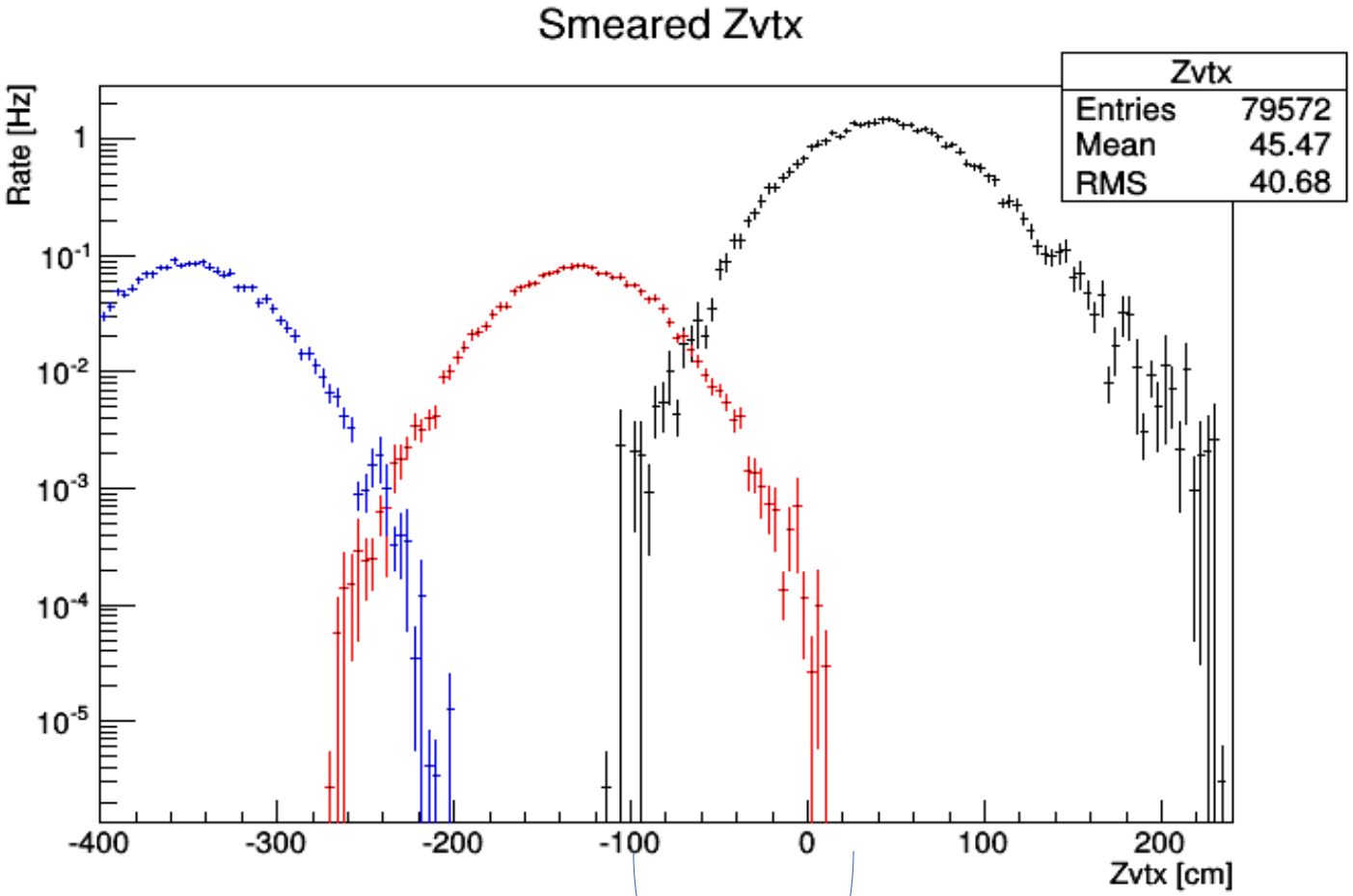
- Targets must be rad. shielded
- E906 target cave too small for Pol. Target
- Issues with target and beam dump separation
- Stability of beam on target



Current E906 Target Cave

Target and Beam Dump Event Separation

move the target upstream: Z=-3.5m



Beam on Target: 4-sigma coverage

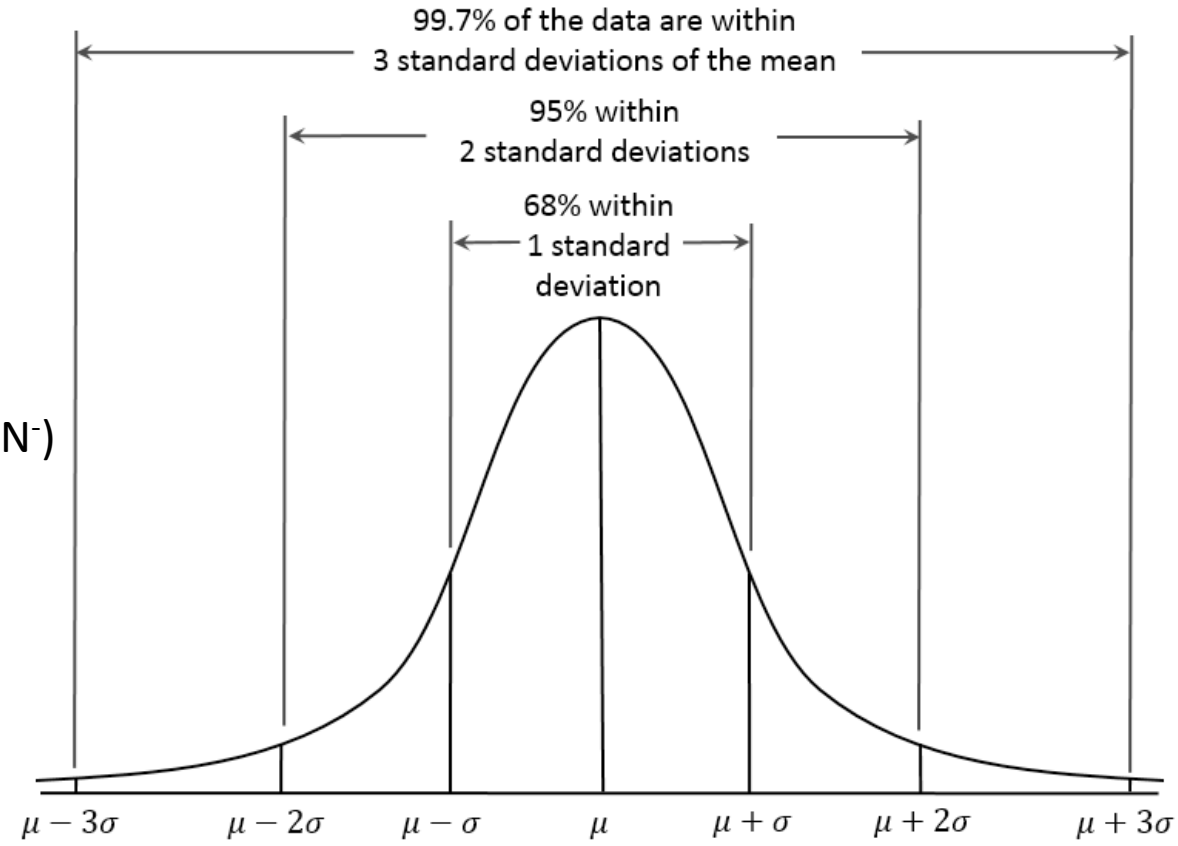
relative luminosity measurement better than 2×10^{-4}

Expected Raw Asymmetry:

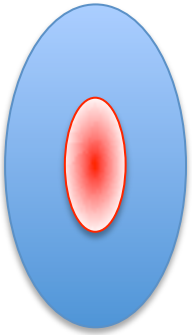
~ 1%/10~20 = 5×10^{-4}

Asymetry = $(N^+/R - N^-)/(N^+/R + N^-)$

R = spin-dependent
relative luminosity
dR <~ 2×10^{-4}



New Beam Collimator, Focusing Q3 and Target

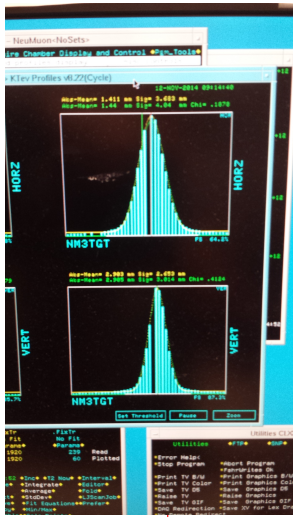


Target cross section: 18 x 28 mm^2

Beam cross section:
Need be well contained within
4 sigma, required by dR< 2x10^{-4}

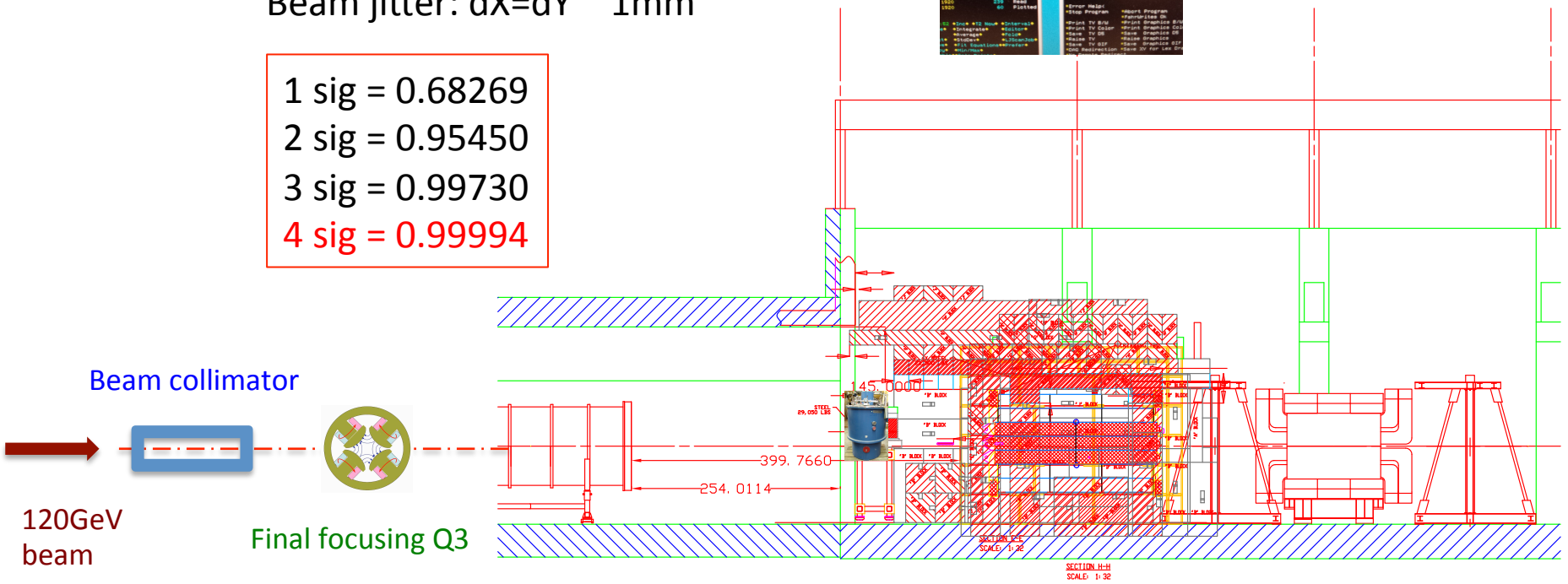
sigX = 18/2/4 = 2.2 mm
sigY = 28/2/4 = 3.5 mm
Beam jitter: dX=dY ~ 1mm

1 sig	0.68269
2 sig	0.95450
3 sig	0.99730
4 sig	0.99994



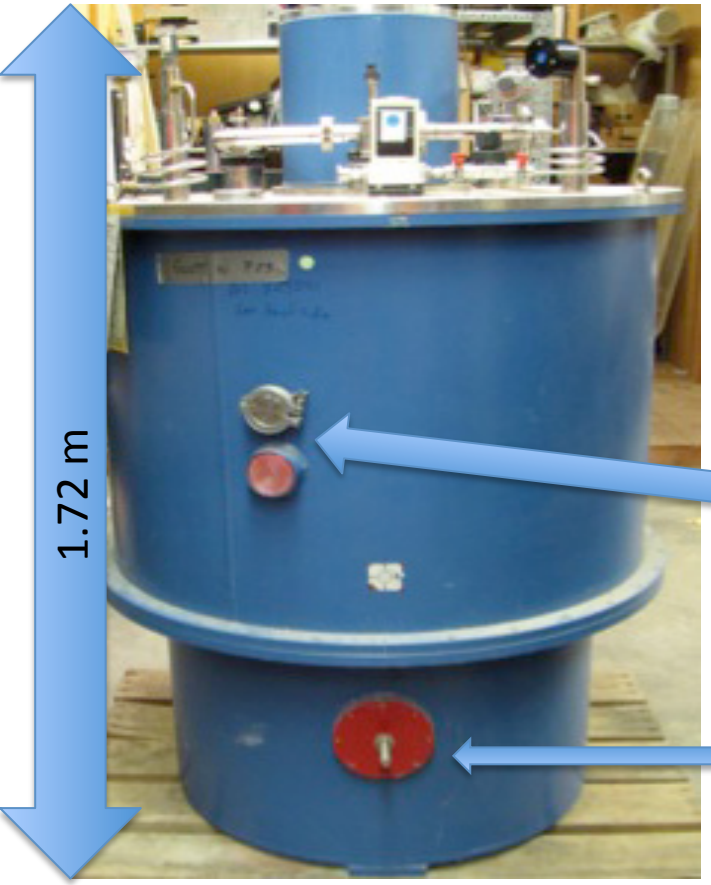
E906 beam profile:
SigX = 4.0mm
SigY = 3.0mm

$$f(x,\mu,\sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$



Target stick movement: 3.6m to ceiling (tight)

Polarized Target Operation



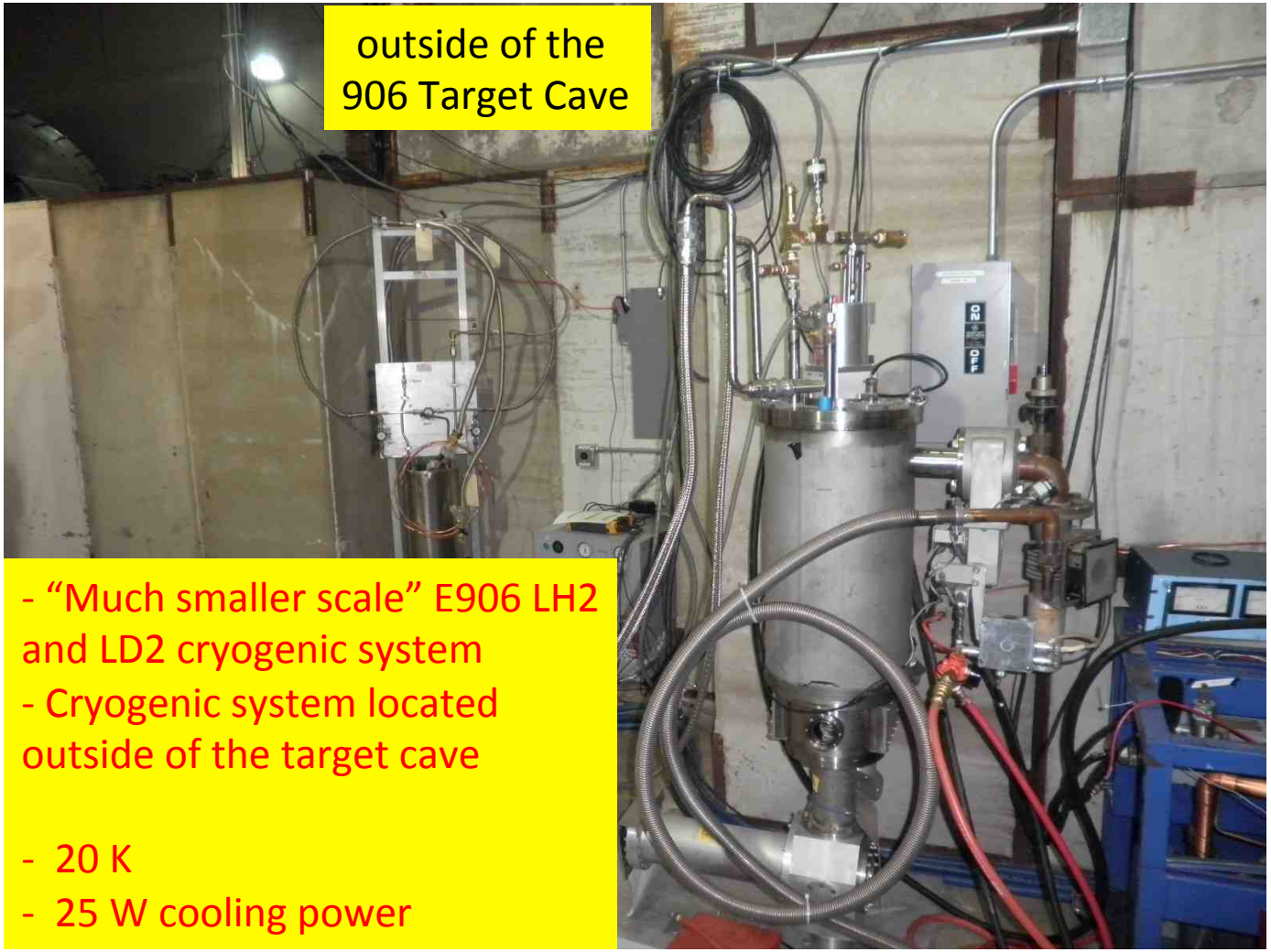
Mechanical issues:

- Need platform to work around for target insert changes, helium refill, Nitrogen refill
- Stand of target magnet
- Crane or Gantry to lift target, max 2000 lb
- New position -350 cm upstream of FMAG
- Pump connections for evaporation cooling
- Pump connection for separator
- Pump connection for main vacuum
- Placement of liquefier system

Beam entry (8' above ground)

Current E906 Target Cryogenic Service

Next to the E906 Target Cave



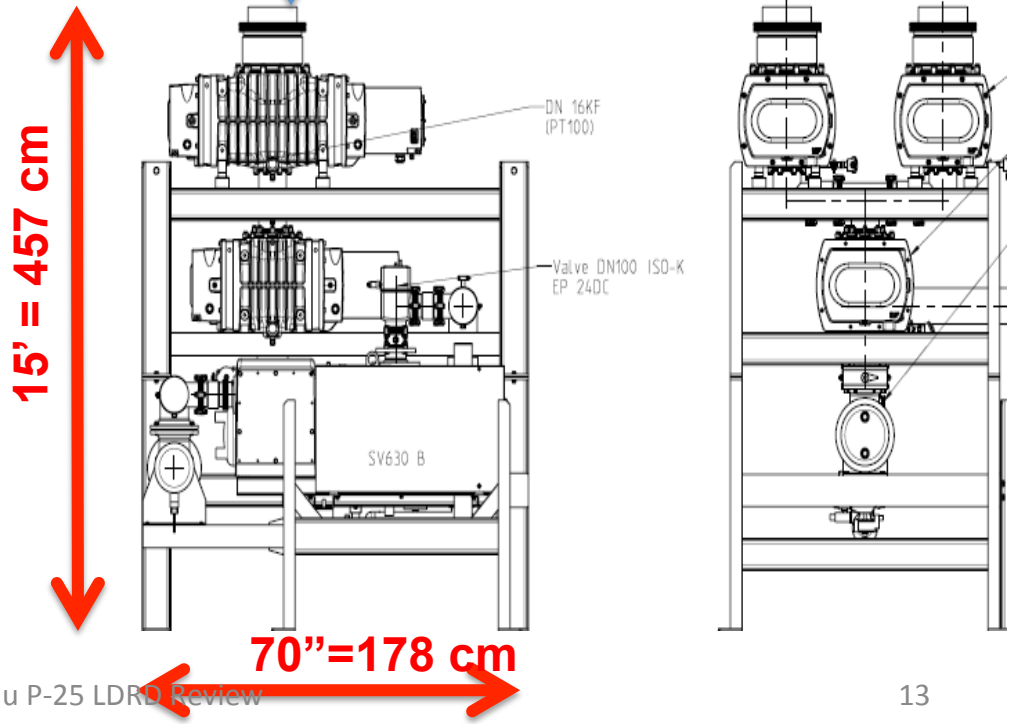
- "Much smaller scale" E906 LH2 and LD2 cryogenic system
- Cryogenic system located outside of the target cave

- 20 K
- 25 W cooling power

Root Pump, Microwave and Mechanical Support

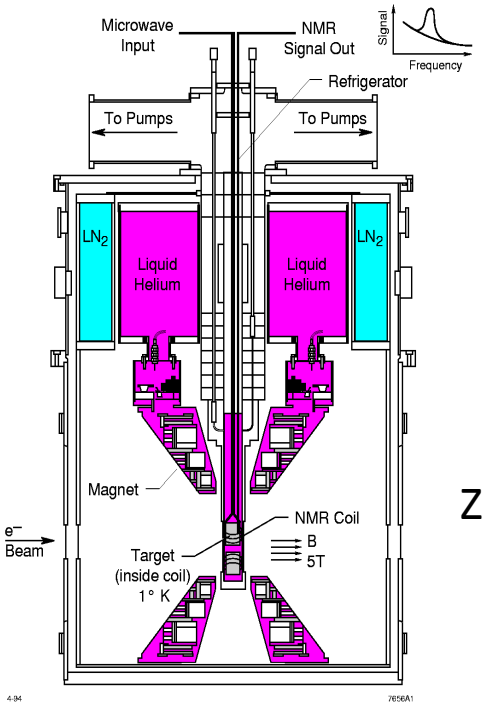
- Chiller for microwave
- Where to locate pump?
  - Cave or outside?
- Connect exhaust of magnet to pump

172cm

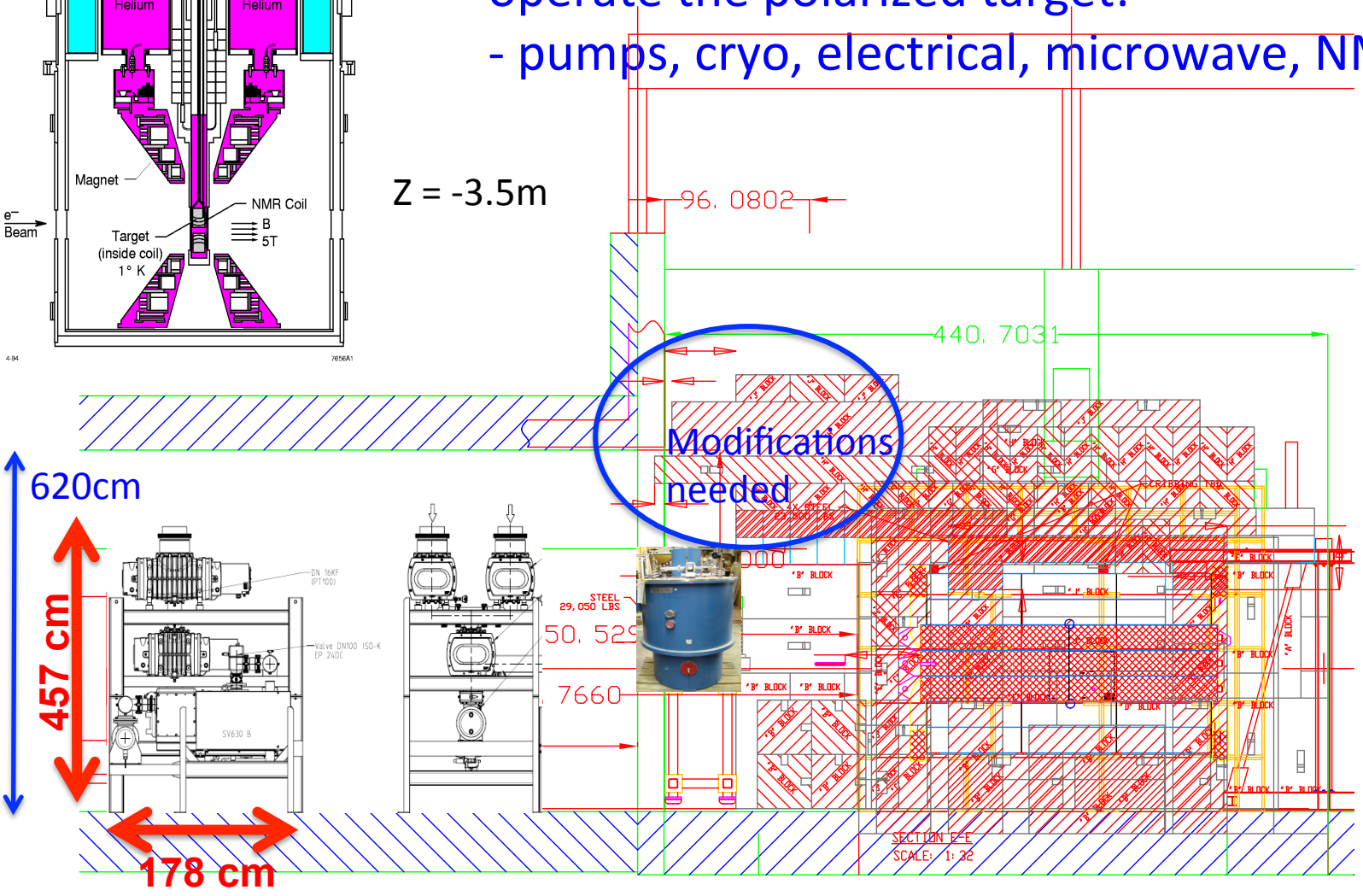


Conceptual Design of the New Polarized Target Area

- new services and modifications needed to operate the polarized target:
- pumps, cryo, electrical, microwave, NMR



Z = -3.5m



Shielding and Beam Line Work - work in progress

Radiation Shielding

- Cave/ceiling shielding for new target position
- Electronics around target
  - microwave tube
  - microwave power supply
  - NMR electronics
  - control electronics
  - Magnet power supply, controls
- Calculations for target activation
- Target area radiation monitoring

Beam line and spectrometer

- Beam size requires additional Quads
- Collimator upstream of target
- Beam position interlock, loss monitors
- Spin-sorted luminosity monitor of beam on target

More on Service Needs

Electrical, Water Cooling and Cryogenics

- Pump: 460V
- Fmag and kMAG magnets need field direction switches
- Network close to target
- regular 220 and 110 outlets

- 2.3 lt/min cooling H_2O
- ^4He and N_2 lines
- Pump lines
- Fermilab Tech support

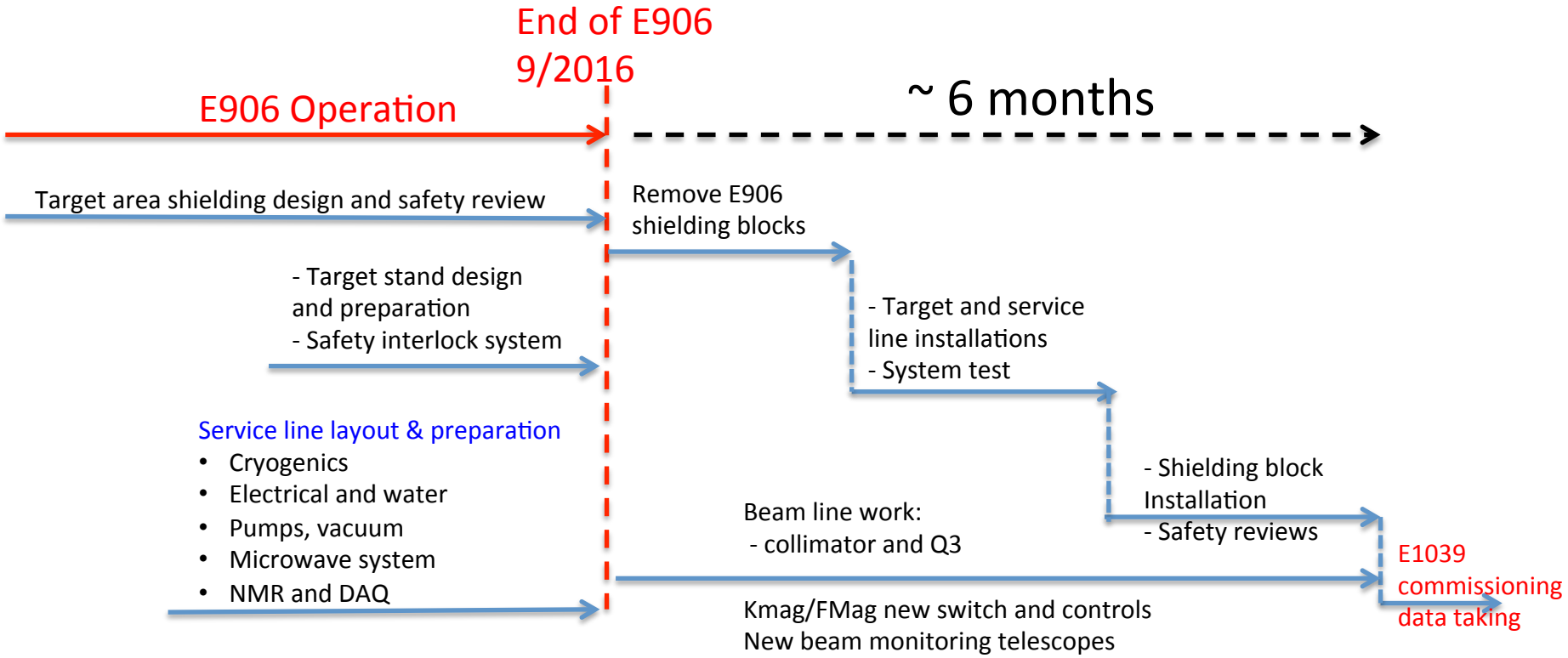
Safety and Monitoring

- Radiation monitor and safety interlock
- Oxygen deficiency monitor
- Quench lines to outside building
- Activation analysis for target

- Fermilab Engineering and Safety Reviews of cryogenic, electrical, vacuum, water cooling etc.

Schedule and Timeline

1. New target area and radiation shielding design and safety review
2. Cryogenics System design and installation
3. Beam line modifications
4. Beam on target monitoring telescopes



Summary

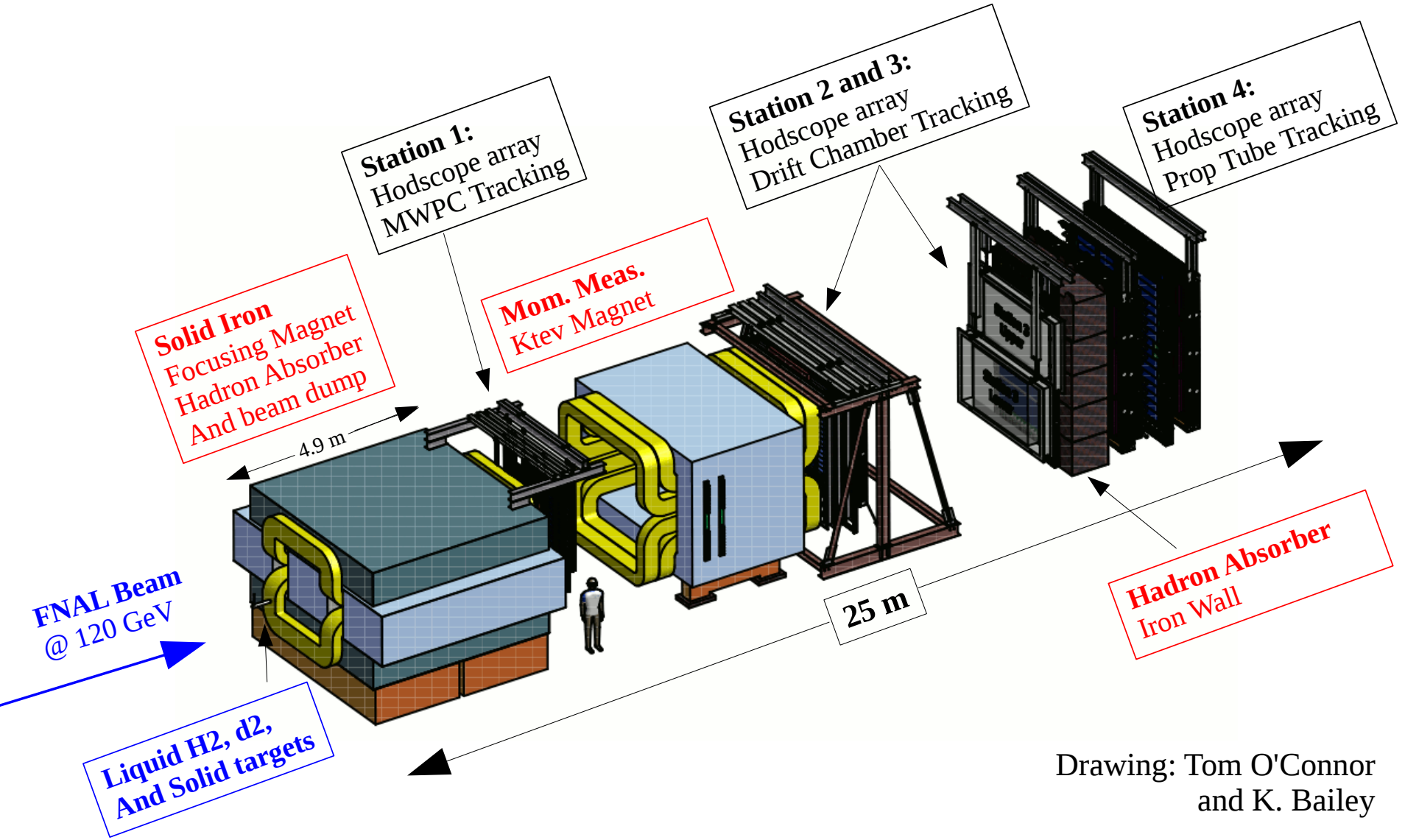
Target and Beam Control

- Some changes @IR
  - New space for operation, target change etc
  - New target stand (a platform)
  - Radiation shielding around the target area
- Target operation and maintenance
  - Service lines, Power, Cryogenic systems
  - NMR system, radiation shielding for electronics, network access
  - Space for target changes etc.
- Beam control
  - A new final focusing quadrupoles
  - Beam collimator, target magnet quench protection
  - Beam spot position/direction/size monitors
  - Beam position/direction stability
  - Luminosity monitors, Cerenkov, new telescopes
- Fermilab Engineering and Safety Review

DAQ and Spectrometers

- Spectrometers
  - New switches to Reverse fields of FMag and KMag for spin asymmetry systematic control
- Triggers
  - A new trigger road map to optimize signal from target
- DAQ
  - Improve DAQ bandwidth
  - Slow control integration into DAQ
- Physics asymmetry systematic controls
  - Precision luminosity

Current E906 Setup



Drawing: Tom O'Connor
and K. Bailey