

# Hall C Beamline Status

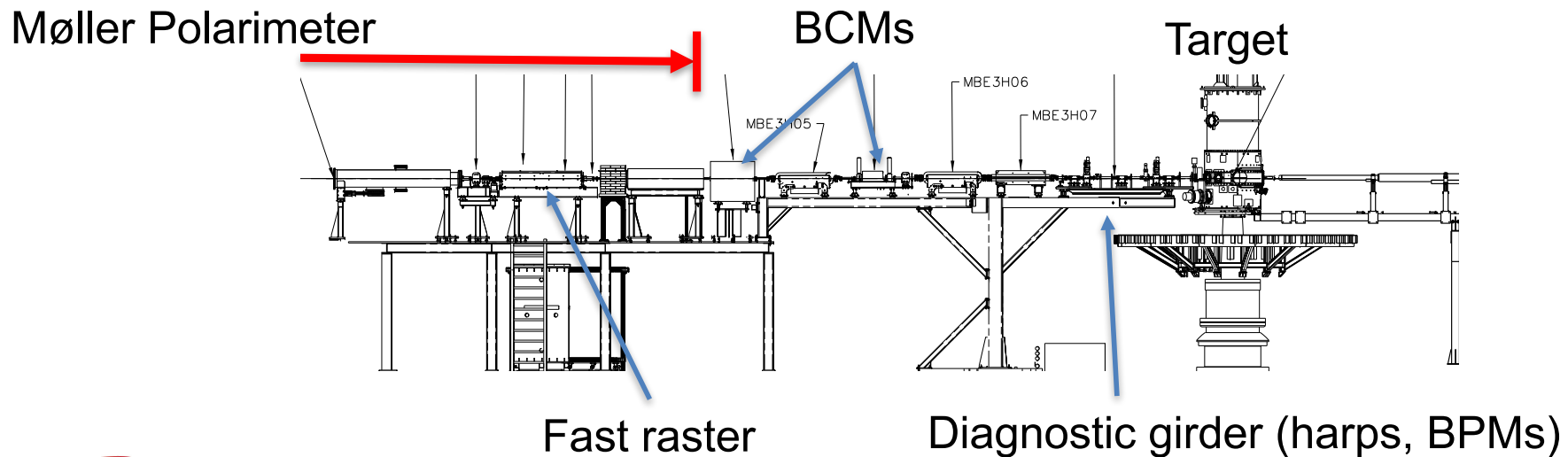
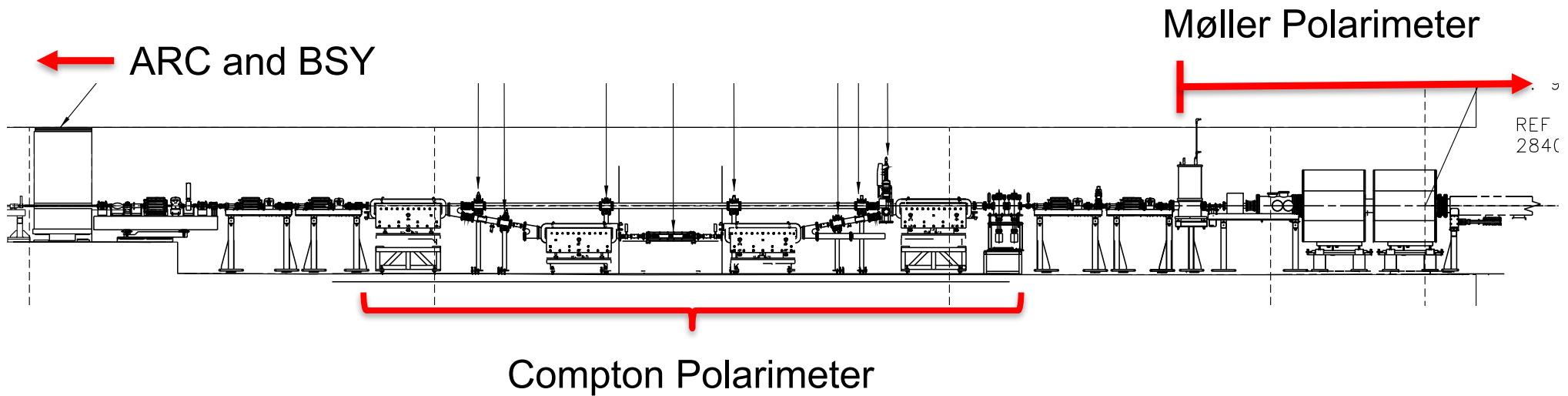
Dave Gaskell  
Hall C Users Meeting  
January 20, 2017

## *Outline*

1. Hall C 12 GeV Beamline Overview
2. Modifications: 6 GeV  $\rightarrow$  12 GeV
3. Beam test summary (May 2016)
4. Present status – remaining work



# Hall C Beamline - Layout



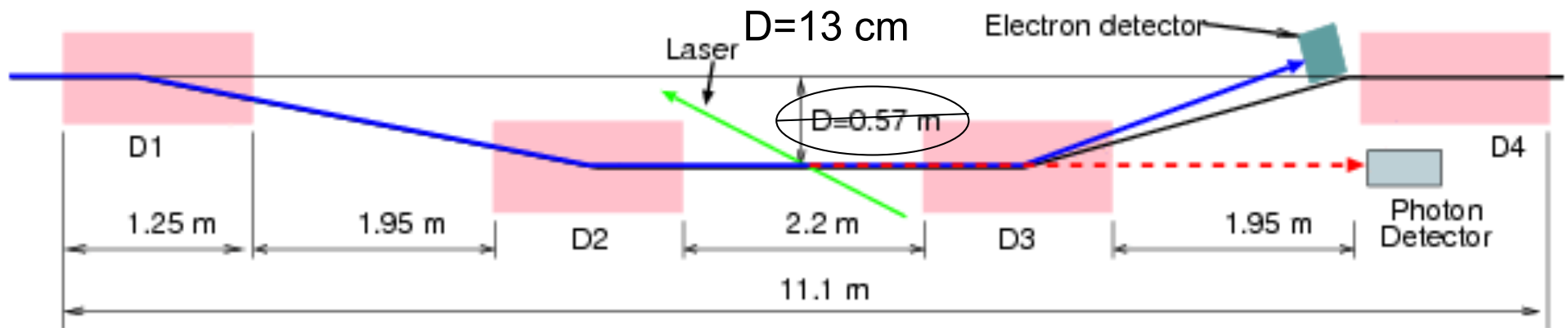


# Hall C Beamline: 6 GeV → 11 GeV

- Beamline modified prior to Q-Weak to accommodate new Compton polarimeter
  - Beamline designed with operation at 12 GeV in mind
- Modifications needed for transition from 6 GeV → 12 GeV
  - Modify Compton polarimeter for operation at 11 GeV
  - Small modifications to Møller collimators
  - Make beamline downstream of Møller ready for 11 GeV
- Additional work needed to maintain prior capabilities
  - Replace coils for large Møller quadrupoles
  - Update harp system (as was done in Hall A)
  - Complete repairs from 2012 Hall C flood
- In parallel, Hall C beam dump is undergoing upgrade (a la Hall A) → project driven by Accelerator Operations

# Compton Polarimeter Reconfiguration

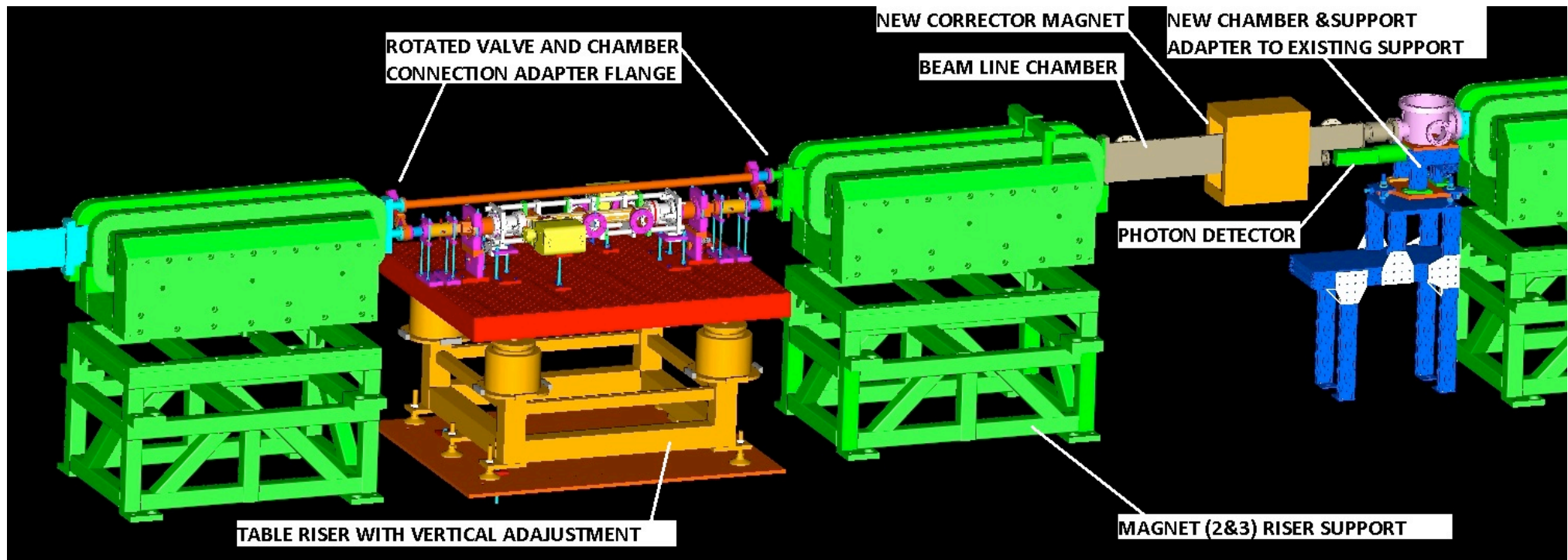
- Compton polarimeter dipole chicane was re-configured for 11 GeV operations
  - Qweak  $\rightarrow$  beam deflected 57 cm vertically
  - 11 GeV  $\rightarrow$  beam deflected 13 cm
- Dipoles 2 and 3 were raised
  - Impacts dipole stands, beam pipe, electron detector chamber



# Updated Compton design

Design: Paulo Medeiros

with a lot of input from Engineering and Ops (John Musson and Jay Benesch in particular)



## ***Compton chicane update complete***

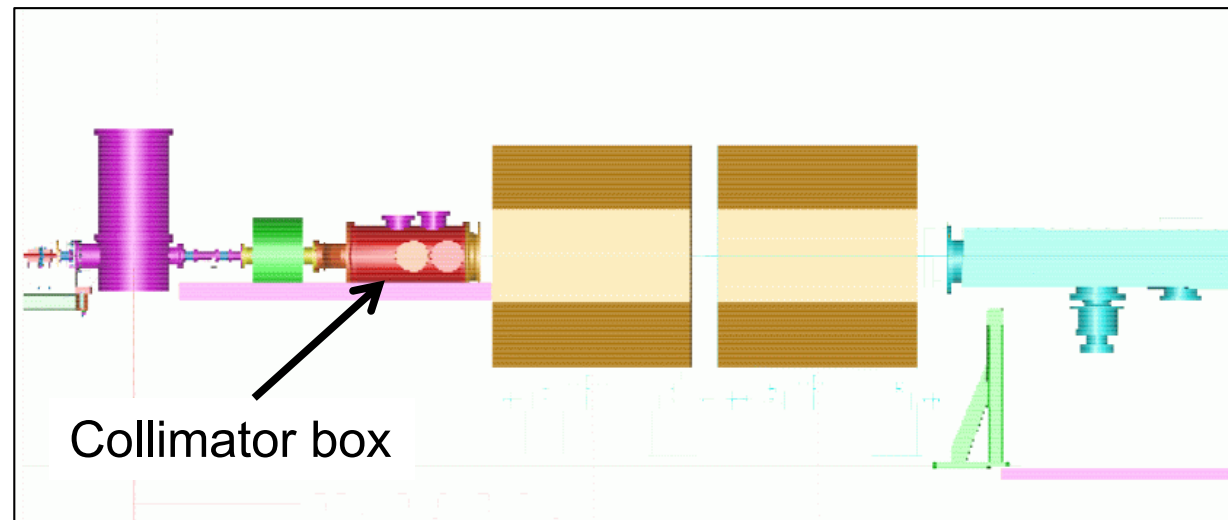
→ Laser system and photon detector not yet installed: not needed for first experiments

# Møller Polarimeter

*Note: Polarization measurements not needed for first experiments, but Møller quads needed for beamline optics*

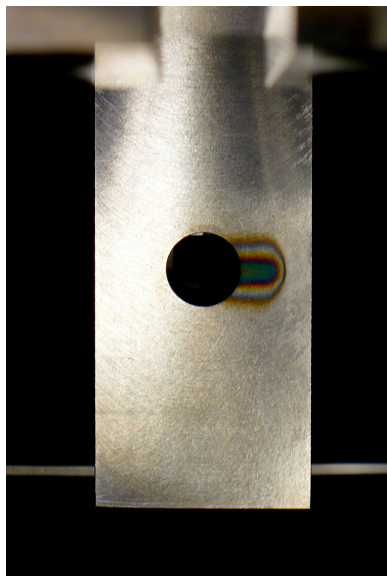
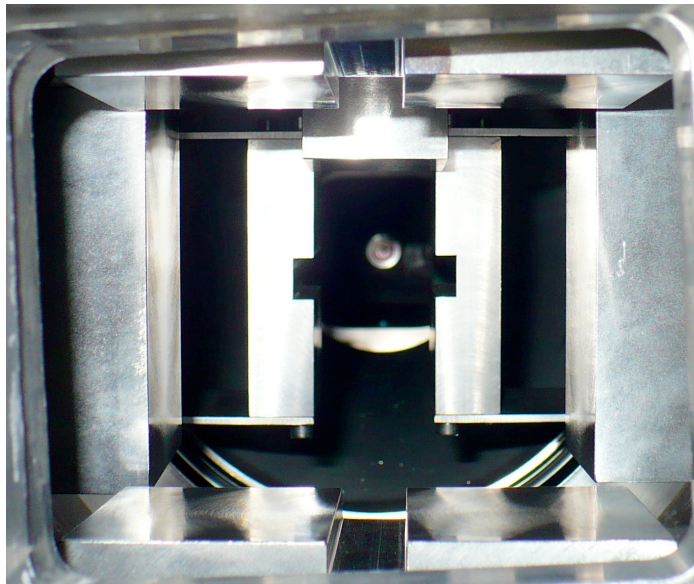
## Møller tasks

1. Replace large quad coils ✓  
→ New power supply required for Møller measurements at high energy
2. Modify moveable collimators (only needed for polarization measurements) ✓
3. Fix small quad (cooling water clog) ✓



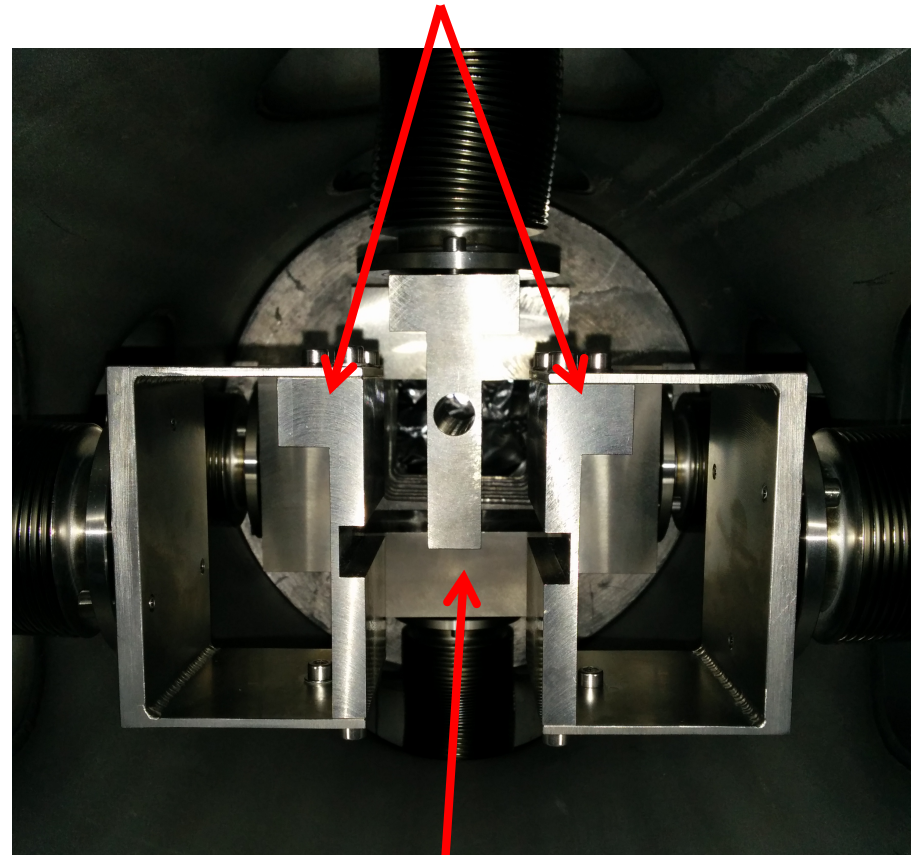
# Møller Collimators

Unmodified



Modified

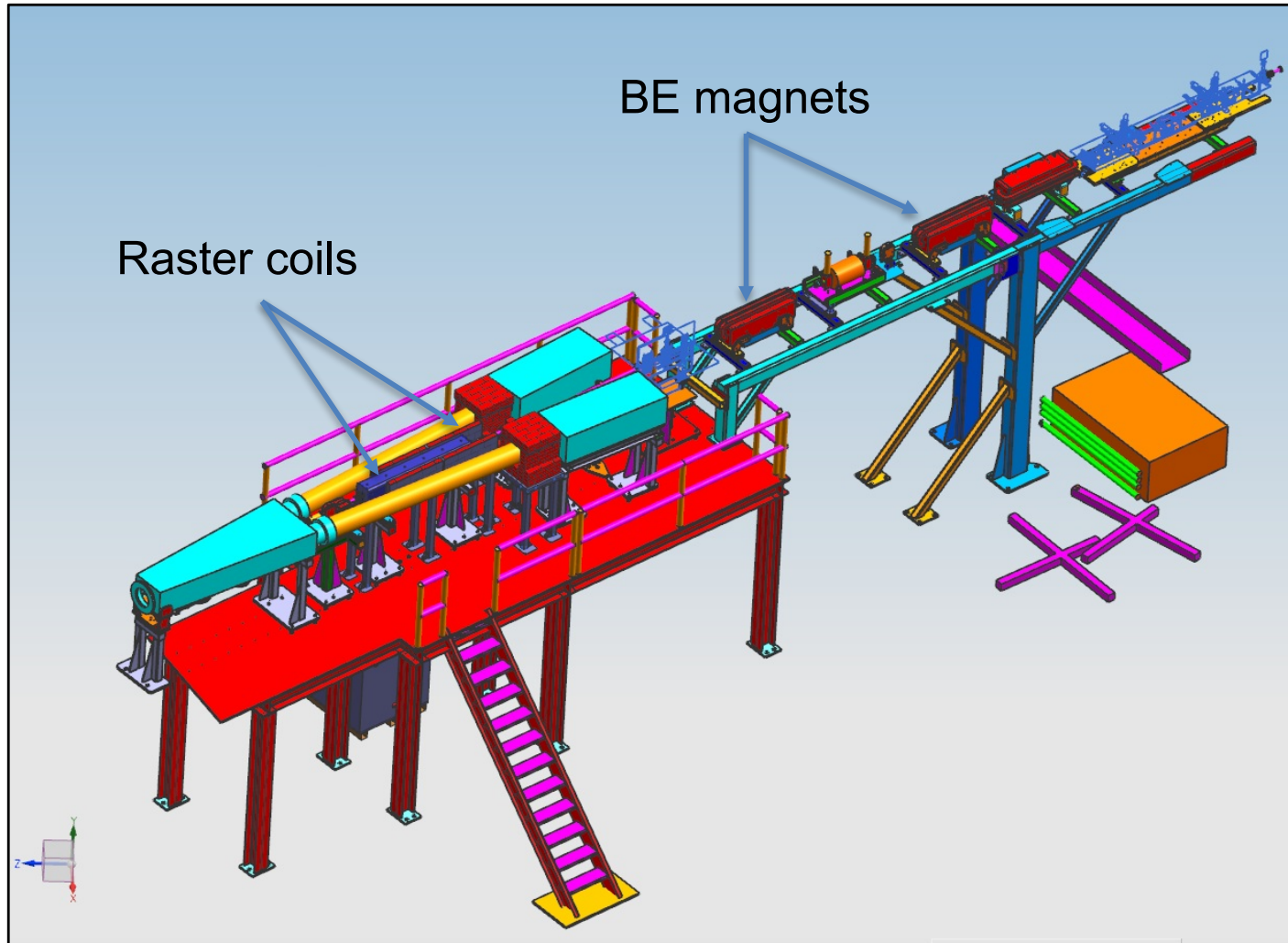
Collimators 6 and 7



Collimator 5



# Beamline: Møller to Target



## Main modifications

→ 1 meter dipoles (BE) required for 2 cm vertical beam shift

→ Additional pair of fast raster coils

Mechanical installation complete  
→ Some work on diagnostics, magnet power supplies remains

Figure courtesy Butch Dillon-Townes (Engineering)

# Beam Energy Measurement

Beam energy measured in Hall C using the arc dipoles as a spectrometer

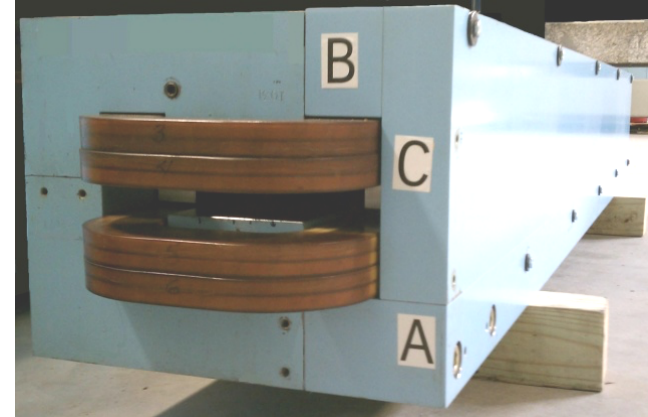
Accurate measurement requires

1. Knowledge of the beam trajectory through the arc
2.  $\int B \cdot dl$  of dipoles

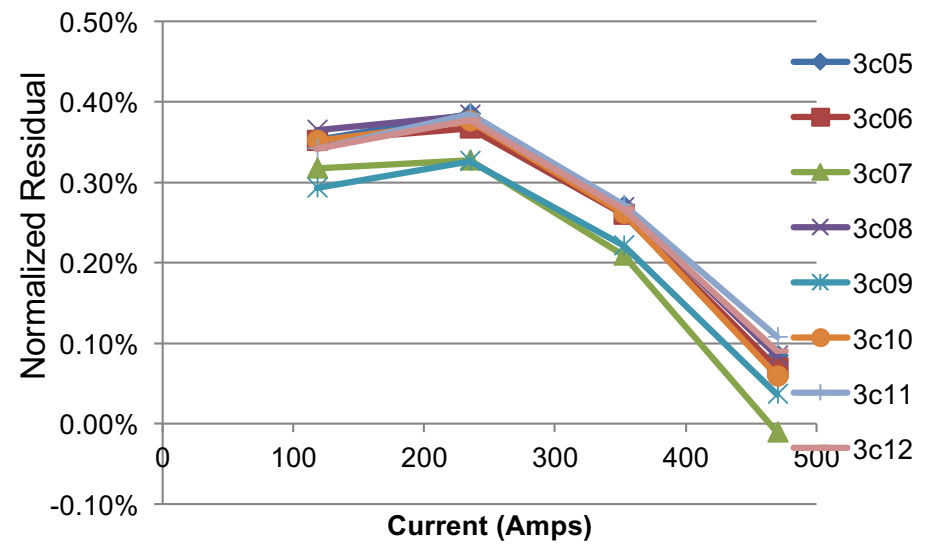
As part of the 12 GeV Upgrade, the 8 dipoles in the Hall C arc were converted from C-type to H-type

→ Modified dipoles were measured before re-installation

→ Arc energy measurement “calculator” will soon be updated



**Hall-C Arc Dipole**



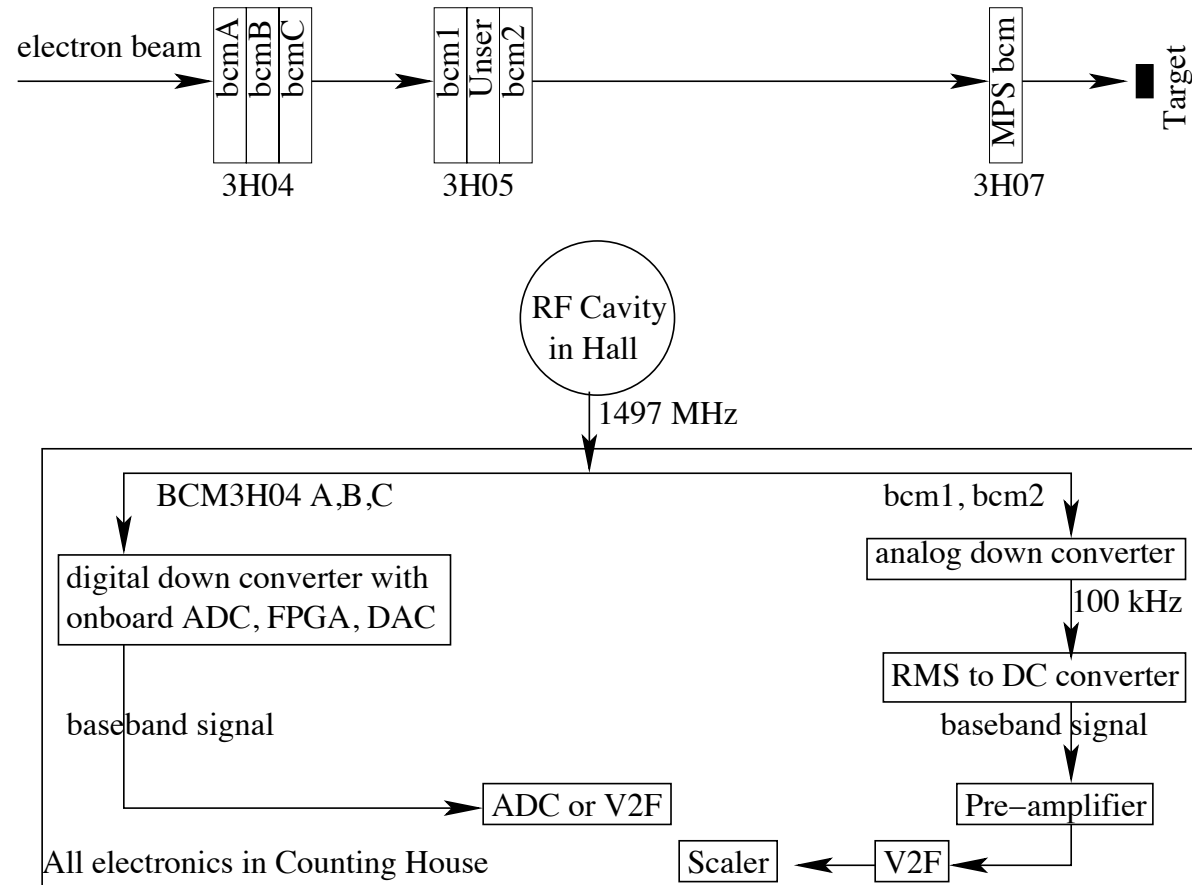
**ARC Dipole Field Measurements**

# Current Measurement

6 GeV era: Relied on pair of resonating cavities (relative) + Unser monitor (absolute calibration) for current measurement → Analog readout path  
→ Similar configuration in Hall A

During Q-Weak, added resonating cavity triplet with new, digital receivers

12 GeV Beamline will make use of both the Unser/cavity system and Q-Weak triplet  
→ No modifications required to either system





# Harp Upgrade

Harps provide precise beam size and position information

→ Required for beam energy measurement, BPM calibration, beam tuning, etc.

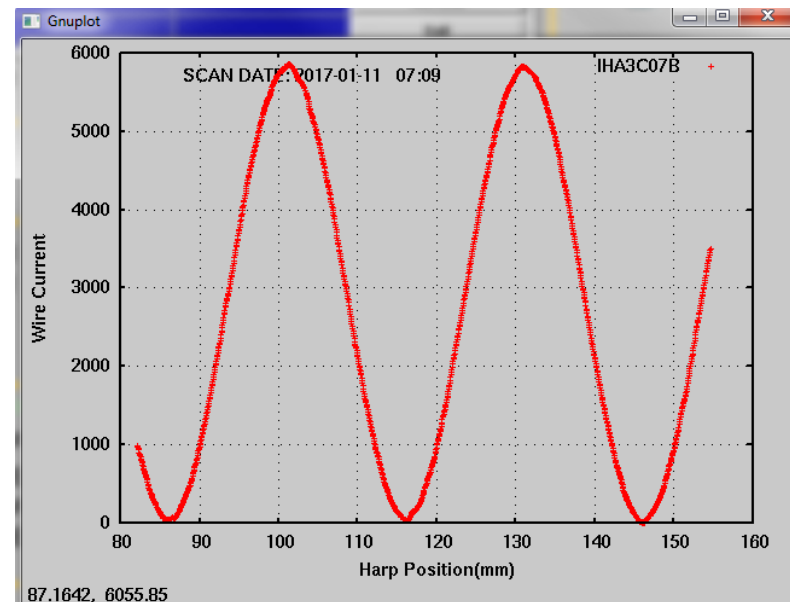
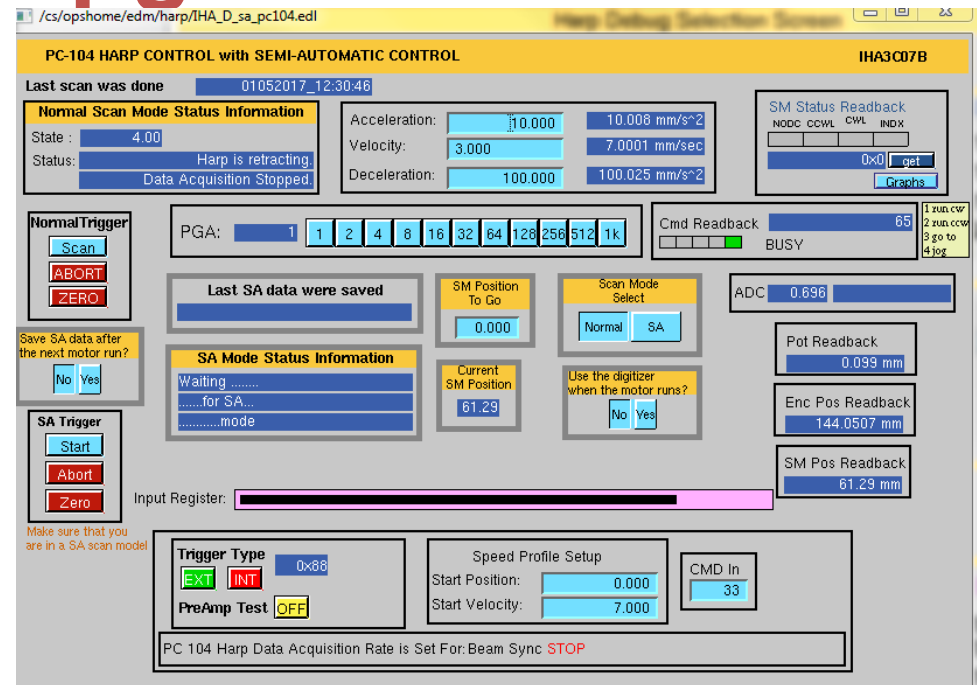
In 6 GeV era, system made use of CAMAC-based electronics/readout

→ No longer sustainable

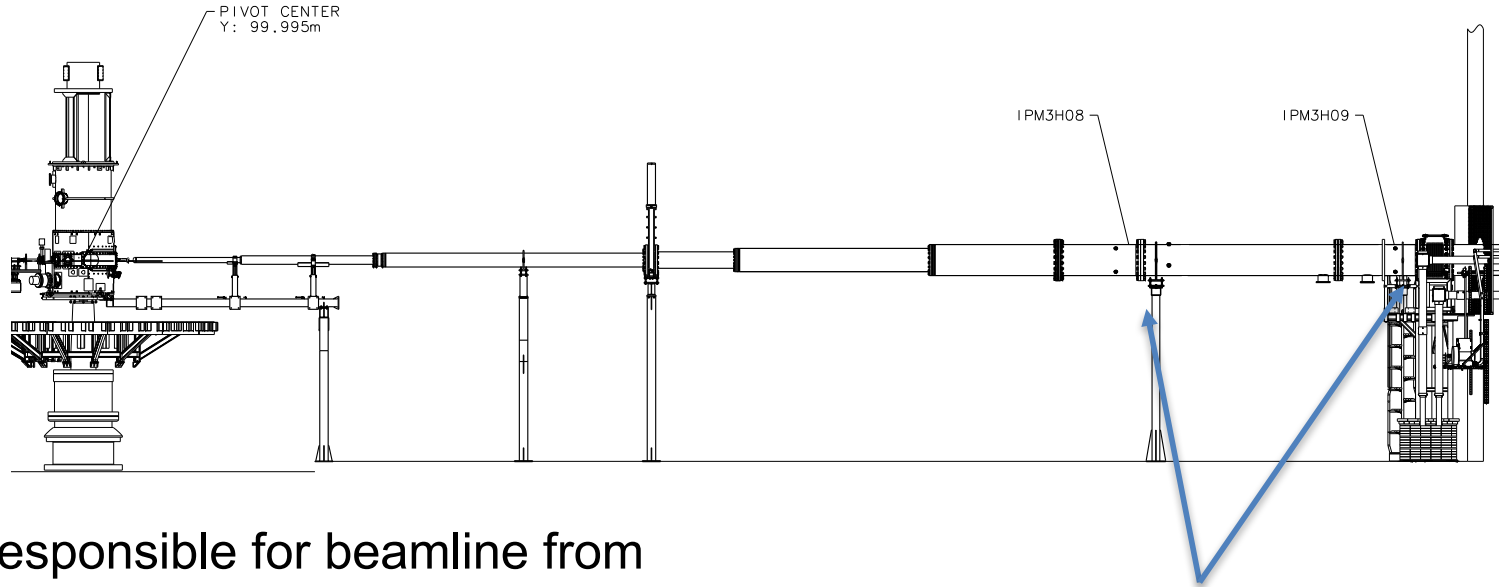
Hall C harps have been upgraded to PC104-based system

Required new electronics, cables, controls

→ Installation work complete – checks with test signals nearly complete



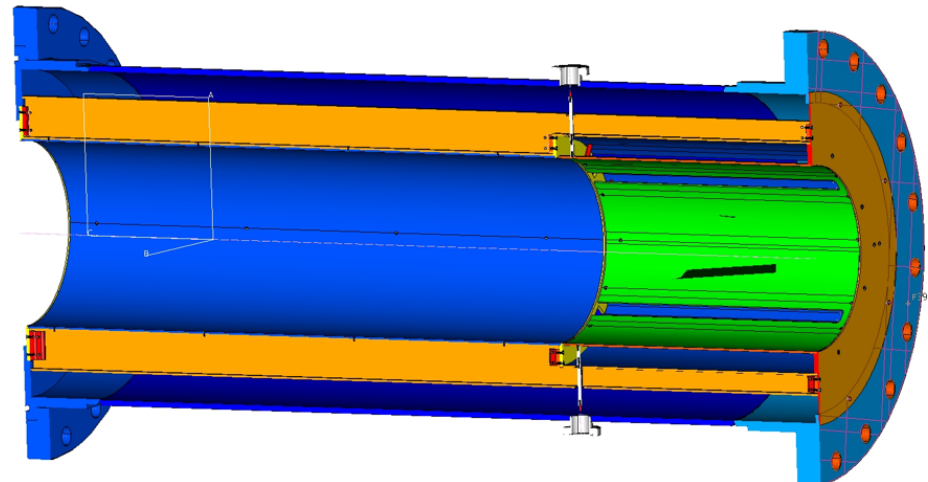
# Downstream Beamline



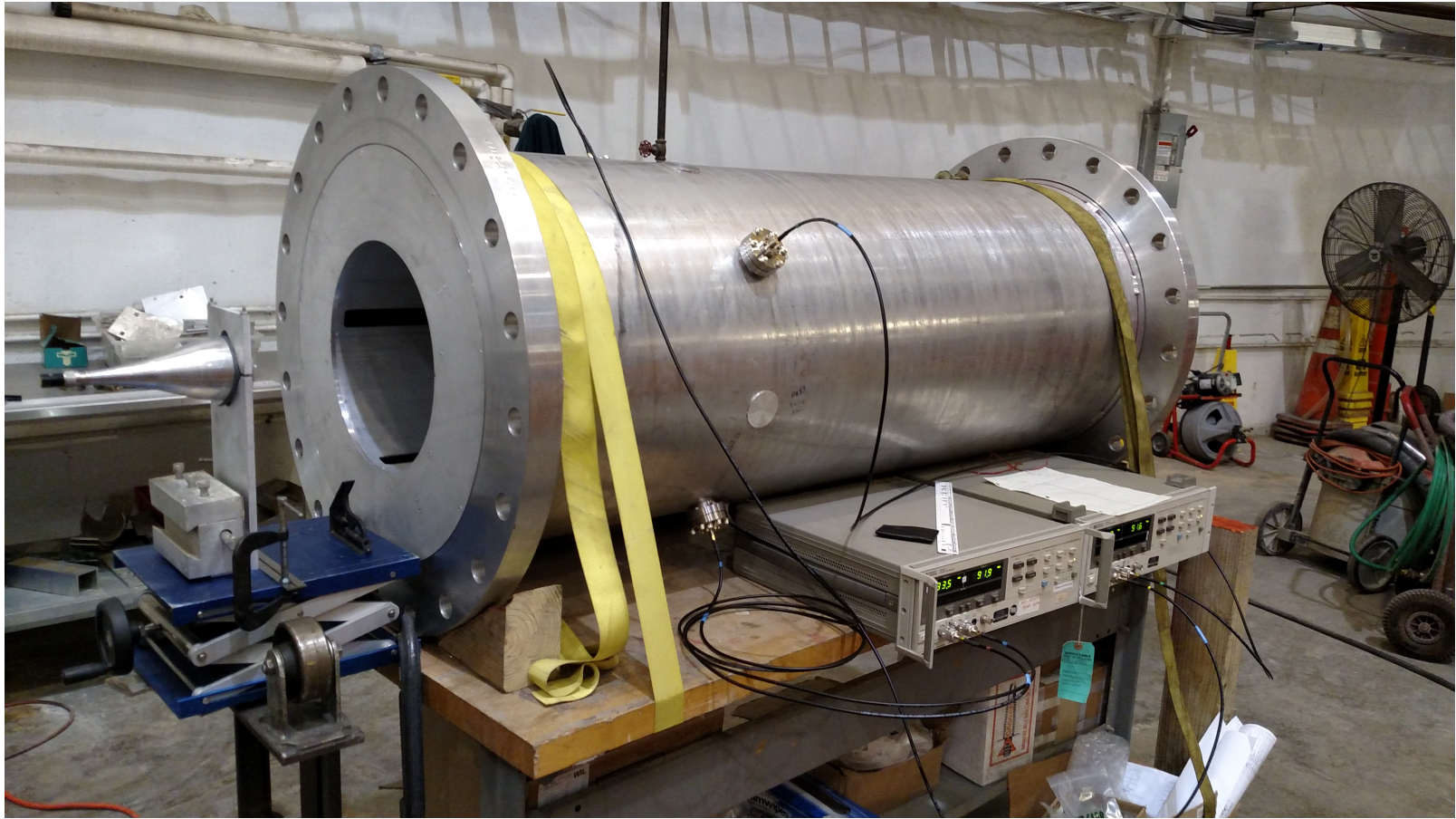
Hall C responsible for beamline from target → dump entrance

Novel component will be pair of so-called “Big BPMs” → monitor beam position/trajectory (non-invasively) on the way to the dump

Should be ready at start of commissioning (but not required)



# Big BPMs



Big BPMs have been assembled, leak checked, and preliminary checks done (John Musson, et al)

→ Performance consistent with expected ~few mm resolution

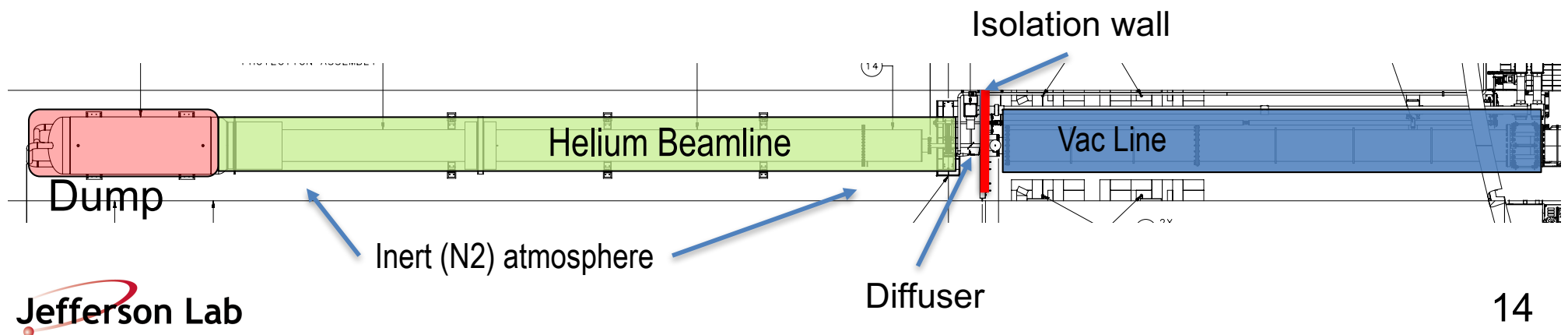
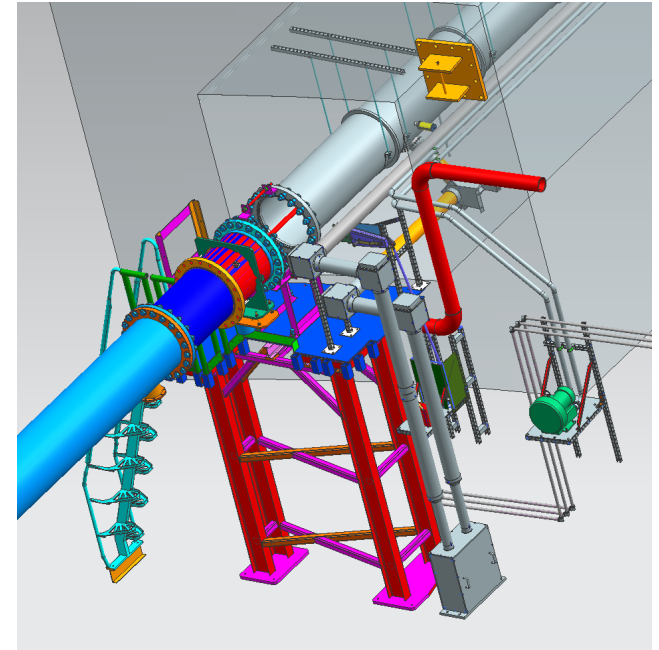
# Beam Dump Upgrade

Hall C beam dump upgrade required for operation at 12 GeV

- Inspection (visual and other) of dump entrance window
- Improved beam diffuser system needed to prevent damage to dump
- Improved beam diagnostics/viewers desired

Hall C beam dump upgrade based on Hall A design

- Project a collaboration of Accelerator Operations, RadCon, and Engineering

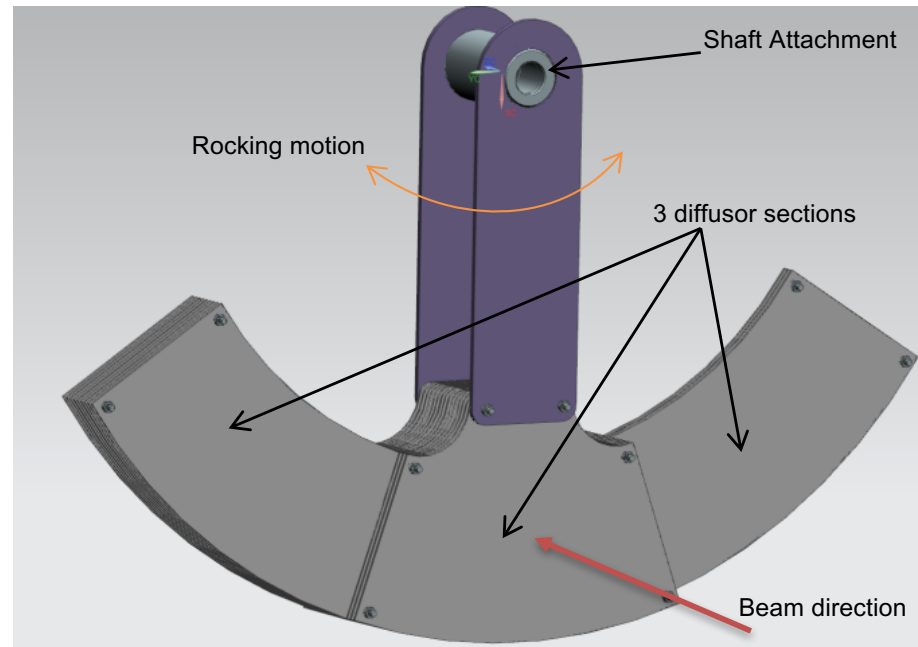


# Beam Dump Diffuser

Diffuser needed to increase beam size via multiple scattering before impinging on dump

6 GeV diffuser:  
Fixed, water cooled beryllium

12 GeV diffuser:  
Aluminum “vanes”, different sections depending on beam energy  
→ Slow rocking motion to spread out heat deposition on vanes



Diffuser position must be adjusted “by hand” depending on beam energy



# Beam Dump Upgrade Status



Dump window as found



Dump window after cleaning

- Dump window inspected and cleaned – structurally sound, no need to replace
- Old dump tunnel infrastructure removed, tunnel cleaned
- New dump tunnel infrastructure installed (helium pipe, vacuum pipe, diffuser, viewers)
- Installation work nearly 100% complete – some checks on viewers, gas system remains
- Plan to improve access to diffuser “crank” under investigation – any potential changes will not be implemented before KPP run

# May Beam Test

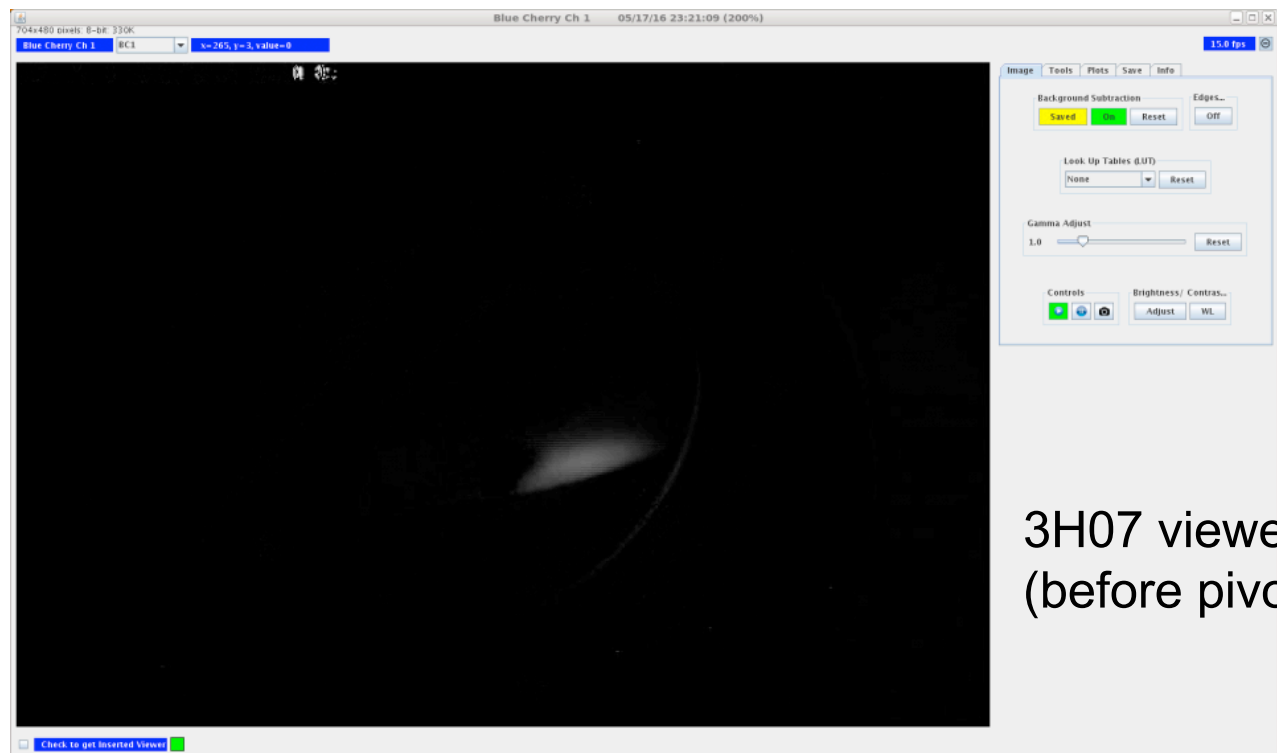
Test conducted in May to verify operation of the bulk of the systems required for beam delivery to Hall C

Checked:

1. PSS System
2. Beam delivery magnet functionality  
→ some time spent on polarity checks
3. Fast raster
4. Some diagnostics (BPMs, viewers, 2 harps)

→ BCMs, many harps not available at that time

Pulsed beam: Swing shift, Tuesday, May 17



3H07 viewer  
(before pivot)

# Beamline Work Remaining

- Since May, 2016, effort has been ongoing to complete systems needed for high current, CW beam for Physics
- Beamline nearly 100% ready
- Hall/beamline to-do list
  - Complete beam dump upgrade → largely done, some small jobs remain
  - Finish installation of downstream beamline (pivot to hall exit)
  - BCM hookups, "Big BPMs"
  - SSG: BLMs and Ion chambers, test readout and system
  - Finalize fast raster setup
  - Final alignment of any remaining beamline elements
  - Complete installation of new power supply for large Møller quads (polarity switch)

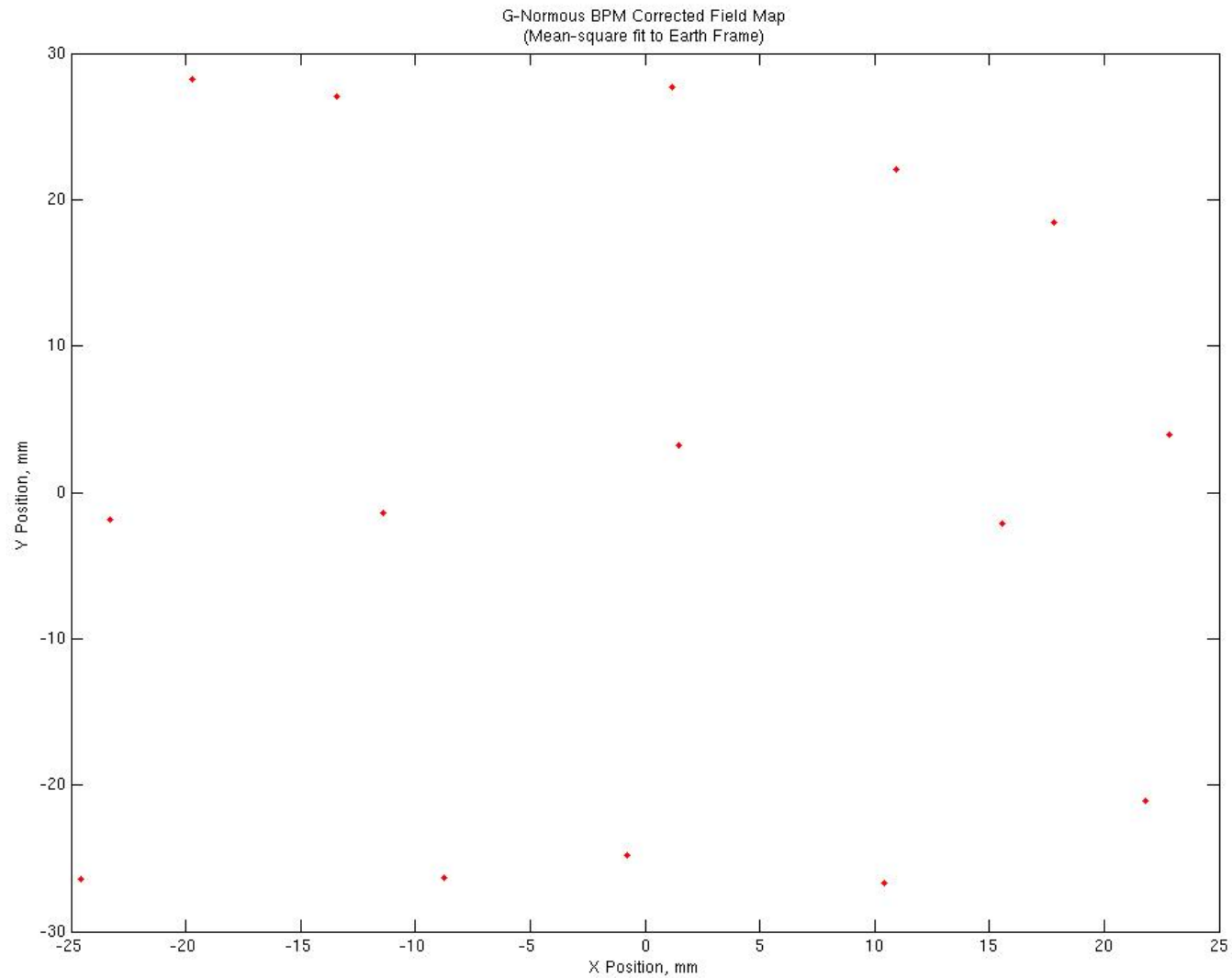


# Summary

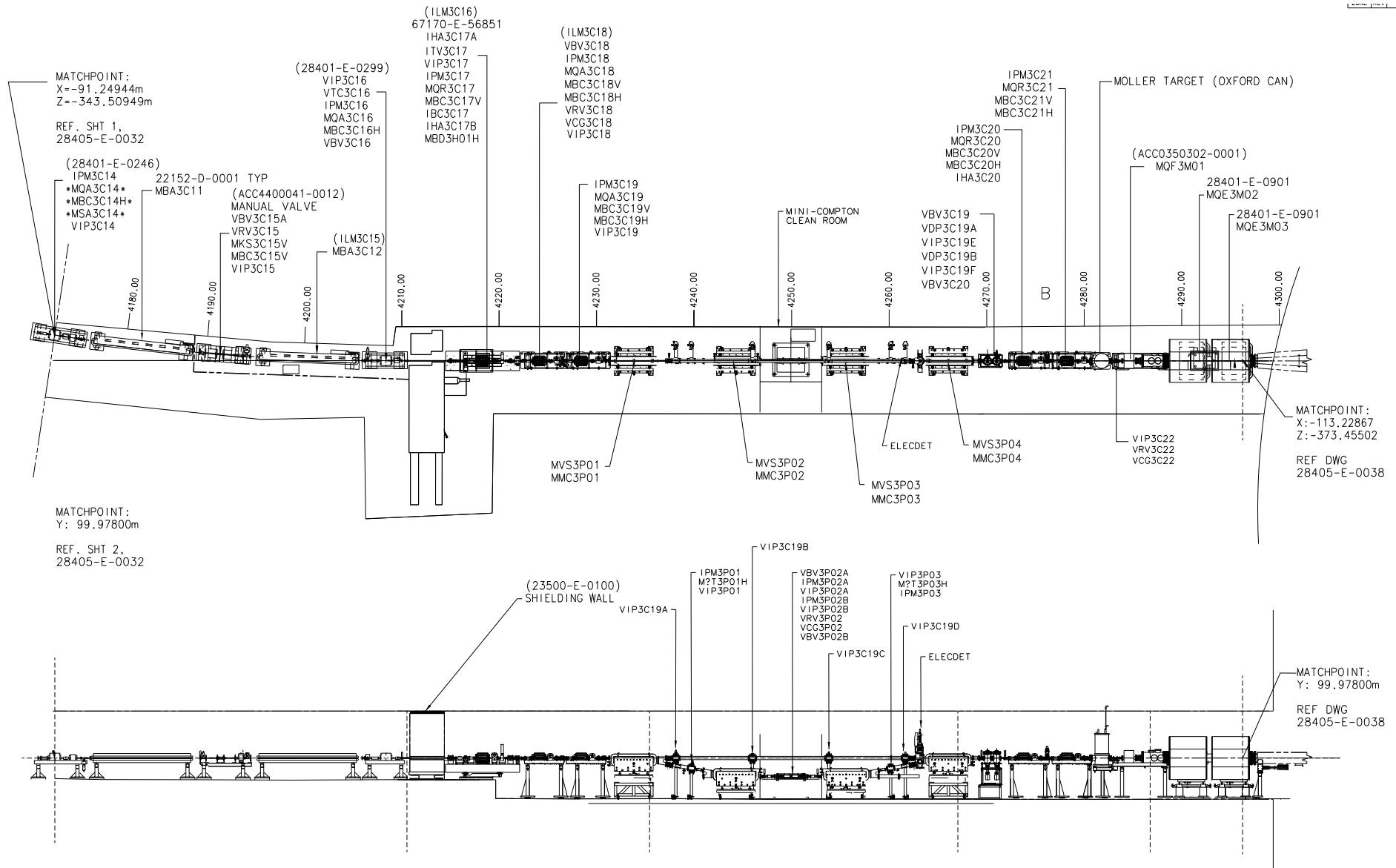
- Hall C beamline upgrade for 11 GeV operations nearly complete
  - Will be ready for scheduled beam in February
- Tune beam successfully delivered in May, 2016 – very useful for checking out beamline magnets, identifying elements that needed attention
- Hall C polarimeters also upgraded for 11 GeV operations → not needed for first 1+ years of experiments
  - Compton laser and photon detector not yet installed
  - Moller polarimeter could be checked out if opportunity arises
- Hall C beam dump upgrade nearing completion
  - Similar to Hall A (small modifications)

# EXTRA

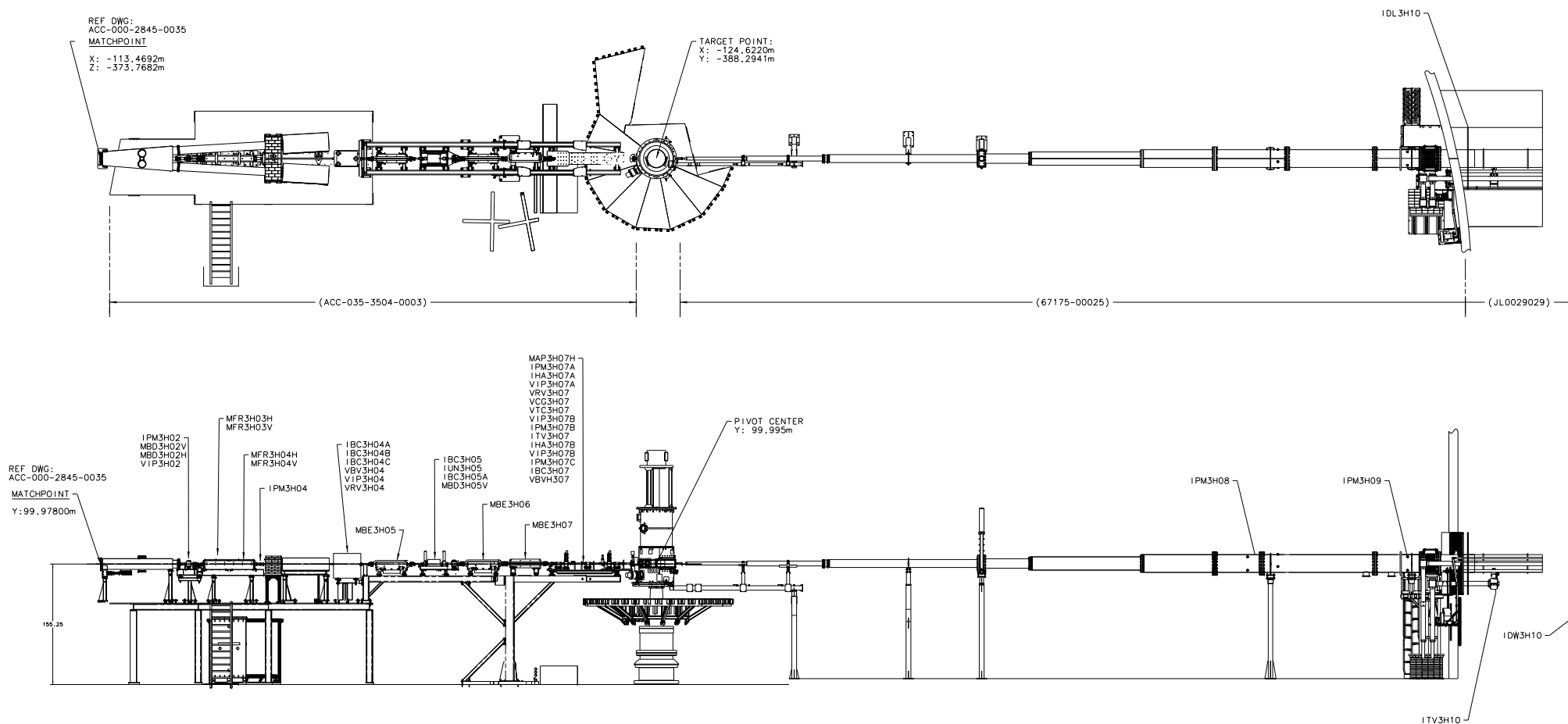
# Big BPM Response



# Hall C Songsheet – Green wall to Hall

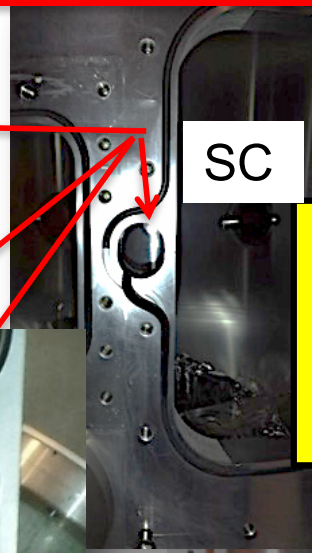


# Hall C Songsheet - Hall

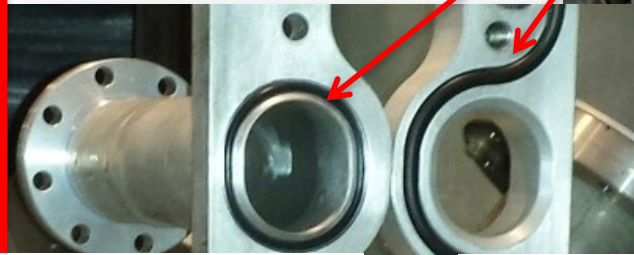


# Scattering Chamber

Old design: ALARA issue with 3 o-rings close to beam axis. Thick Al makes bkg.



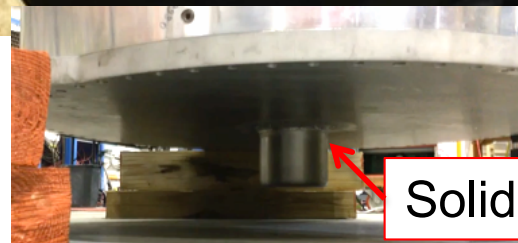
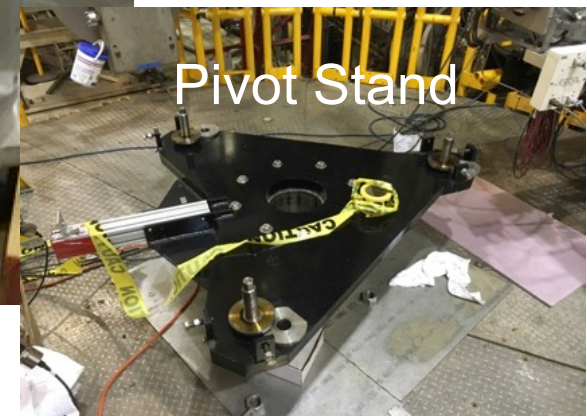
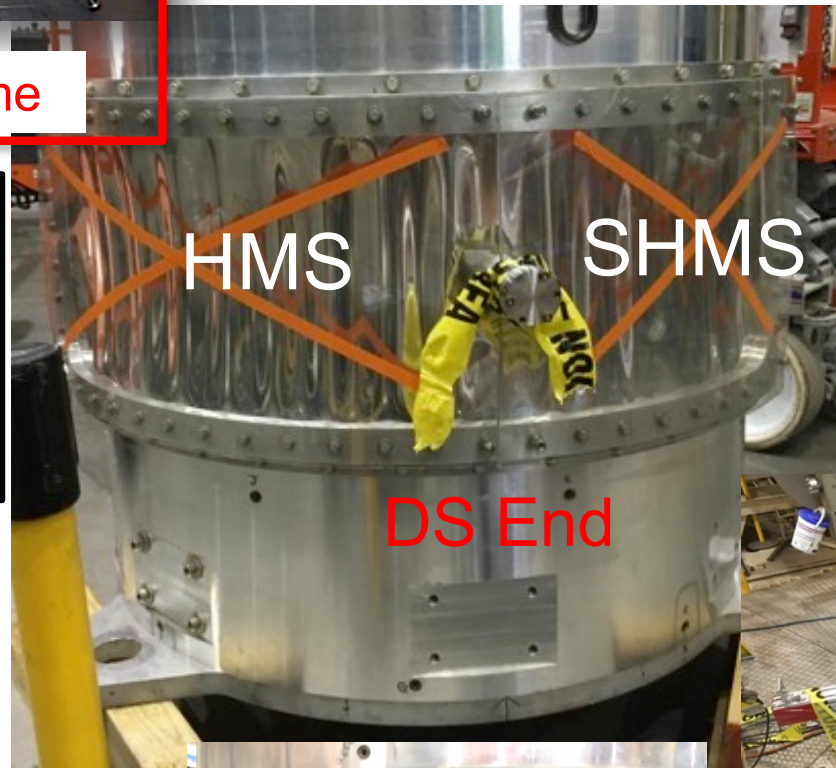
SC **Ready**, on floor of Hall C.  
✓ Leak-checked:  
 $\text{Few} \times 10^{-8} \text{ atm-cc/s}$   
@ a few milliTorr.



SHMS Frame

HMS Frame

New design: No bkg or ALARA issue. Beampipe flanged directly to a single 0.020" window shared by both HMS & SHMS.



Solid Tgt Extension underneath