PXIE Overview: Goal, Status, Strategy

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for all of those who have been working on PXIE

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The Goals: stable and consistent

Project X

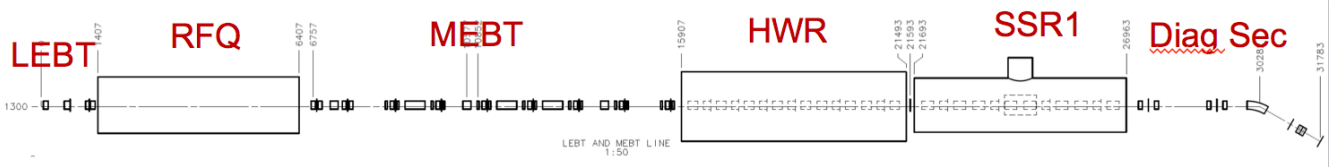
Front-End R&D Program (as proposed in Oct 2011)

- We are building an integrated systems test of the first ~30 MeV of Project X.
  - Validate the concept for the Project X front end, thereby minimizing the primary technical risk element within the Reference Design.
  - Demonstrate wideband chopper; low-β acceleration
  - Operate at full design parameters
- Integrated systems test goals:
  - 1 mA average current with 80% chopping of beam delivered from RFQ
  - Efficient acceleration with minimal emittance dilution through ~30 MeV
- Collaboration between Fermilab, ANL, LBNL, SLAC, SNS, India
- ***Beam through β=0.1 , 0.2 CM at ~30 MeV with nearly final parameters (1 mA cw, 5 mA peak, arbitrary bunch chopping)***

The Hardware Layout

Project X

Project X Injector Experiment: PXIE



~ 40 m long

Dump

- CW H- source delivering 5 mA at 30 keV
- LEBT with beam pre-chopping
- CW RFQ operating at 162.5 MHz and delivering 5 mA at 2.1 MeV
- MEBT with integrated wide-band chopper and beam absorbers capable of generating arbitrary bunch patterns at 162.5 MHz, and disposing of 4 mA average beam current
- Low beta superconducting cryomodules: 1 mA to ~25 MeV
- Beam dump capable of accommodating 2 mA at 25 MeV (50 kW) for extended periods.
- Associated beam diagnostics, utilities and shielding

PIP-II vs Project X

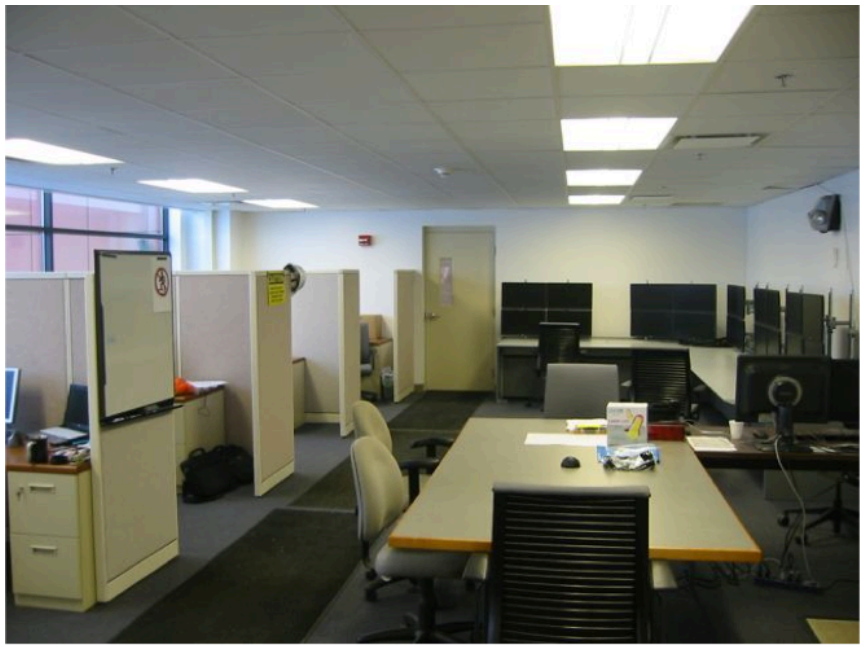
- PIP-II as specified still points towards CW operation
  - 800 MeV superconducting pulsed linac, extendible to support >2 MW operations to LBNE and upgradable to continuous wave (CW) operations
- Primary challenges from the CW capability:
  - a CW RFQ
  - bunch by bunch chopper in the MEBT
    - flexibility in pulse train for experiments
  - warm to cold transition near the MEBT dump
  - low β, high power SRF acceleration
- operation of SRF in both pulsed and CW modes

The Current Focus: being ready for the RFQ

- Anticipate RFQ delivery in February 2015
  - Goal to be prepared operate RFQ when it arrives
  - Building the LEBT and support infrastructure
  - Ion Source/LEBT : minimal beam characterization
    - know the input beam to RFQ!
  - Diagnostics and equipment downstream to characterize
- Goal in FY15: to characterize the RFQ beam

Infrastructure: Well underway

- Water, power, and other utilities
- Cave and shielding blocks
- Shielding assessment for operation
- Network and controls
- Control Room at CMTF
- Ready for a working accelerator!

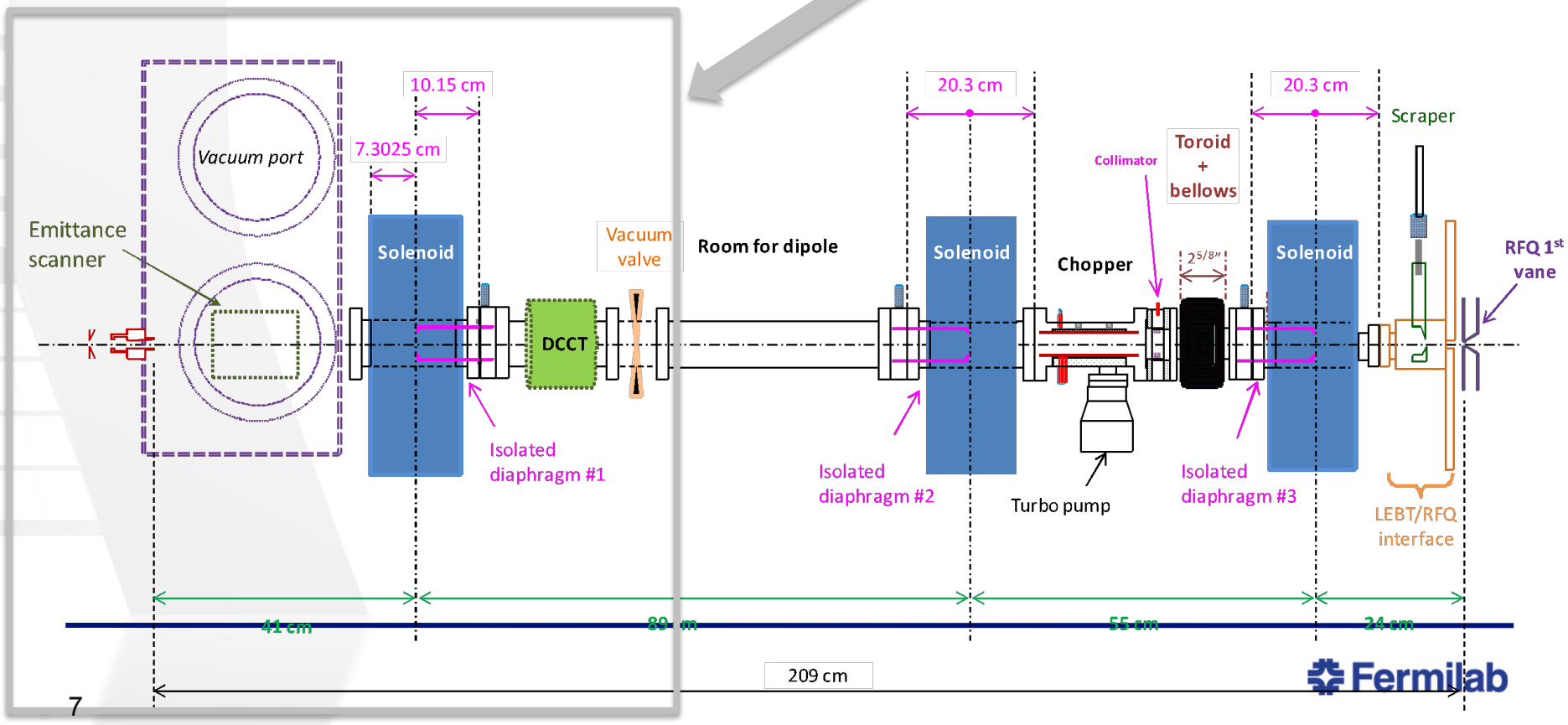


Ion Source & LEBT

- Specifications:
  - 30 keV
  - Emittance: < 0.25 mm mrad RMS
  - 5-10 mA beam current

Have these elements installed as of 2 June

Lionel Prost will fill in the details next



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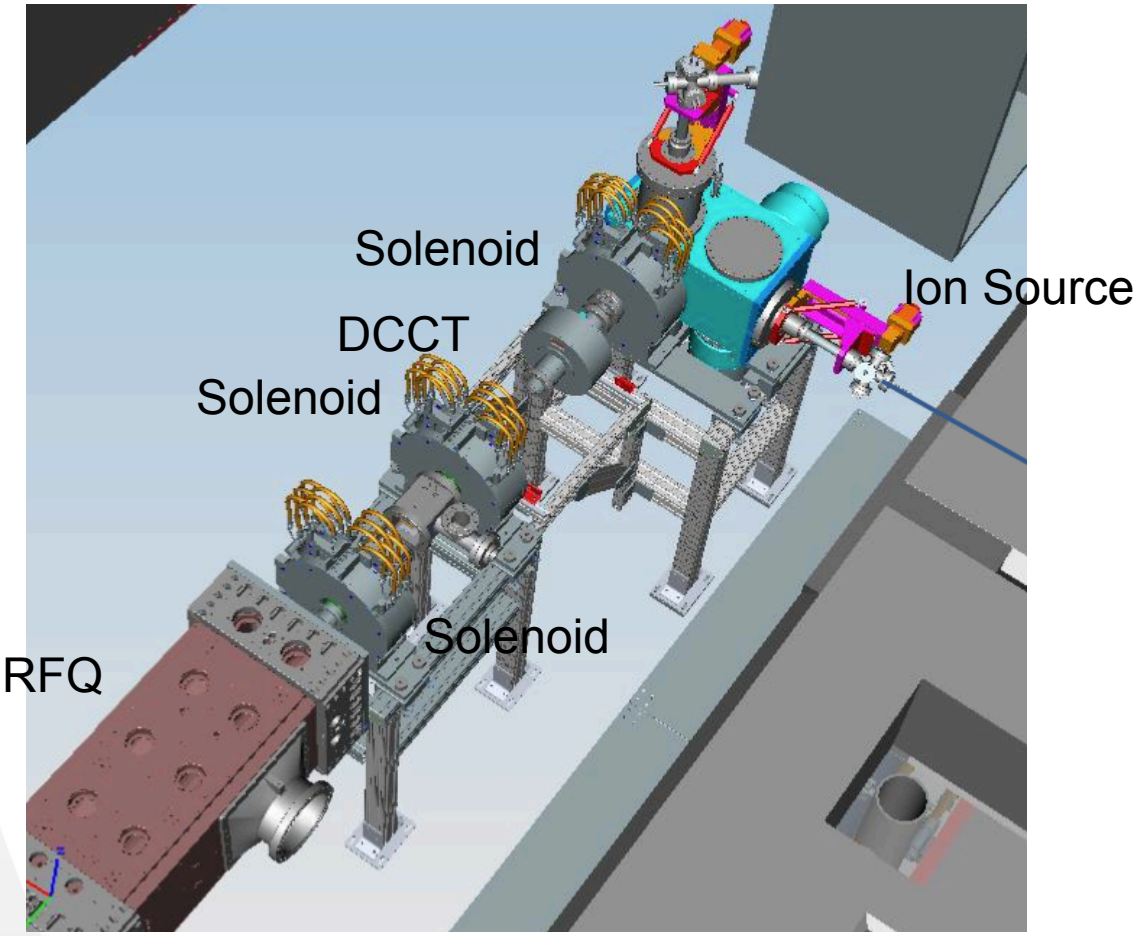
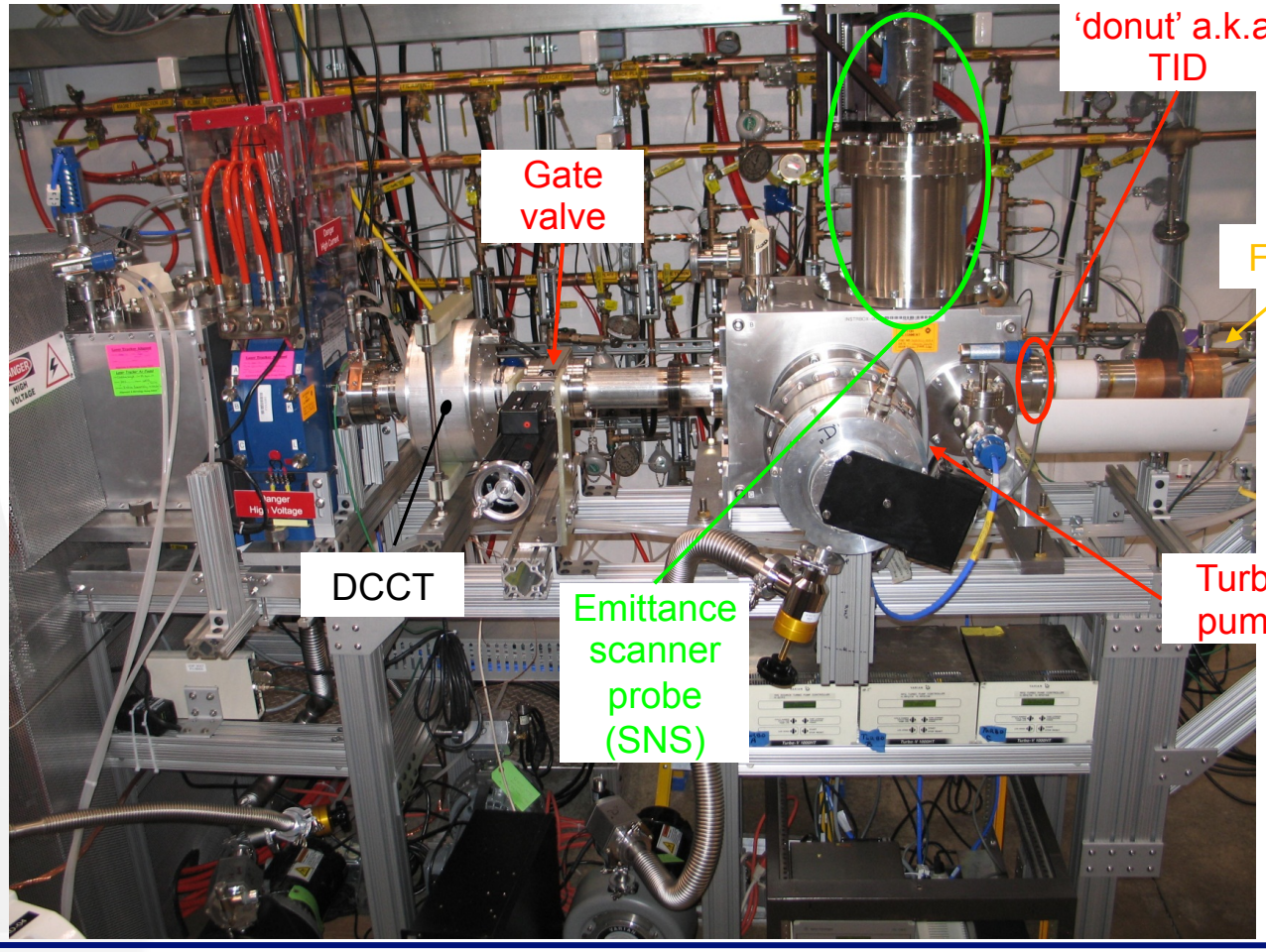
Ion Source & LEBT 3D Model



Current setup at CMTF



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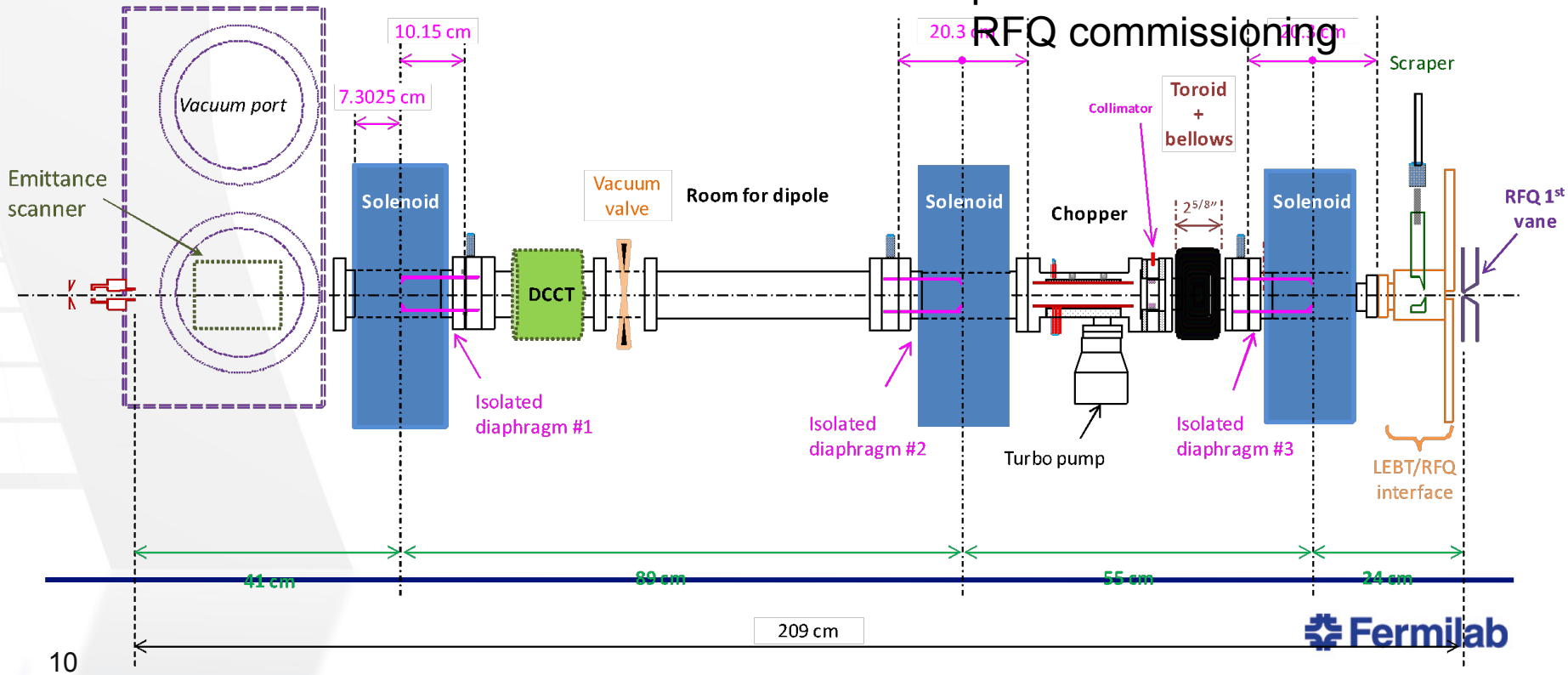
The entire line on track for RFQ installation

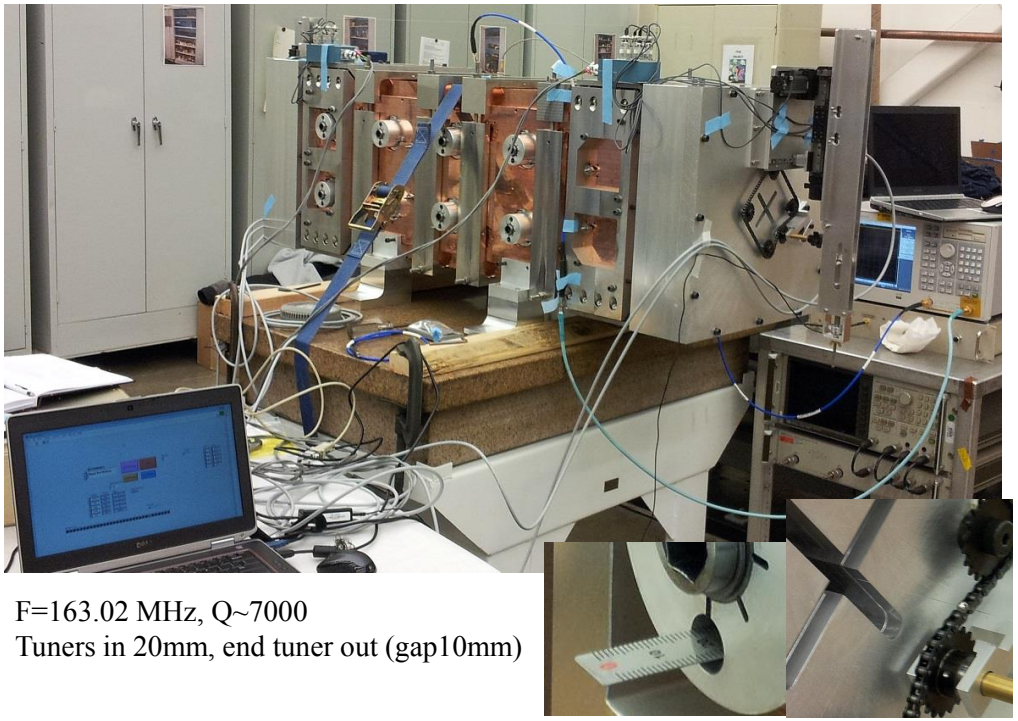
Need to demonstrate pulsed mode for RFQ commissioning



RFQ

- LBNL making good progress:
  - bead pull measurement on 2nd section
  - getting ready to go out for brazing
  - delivery anticipated in spring 2015
- Derun will fill in on more details

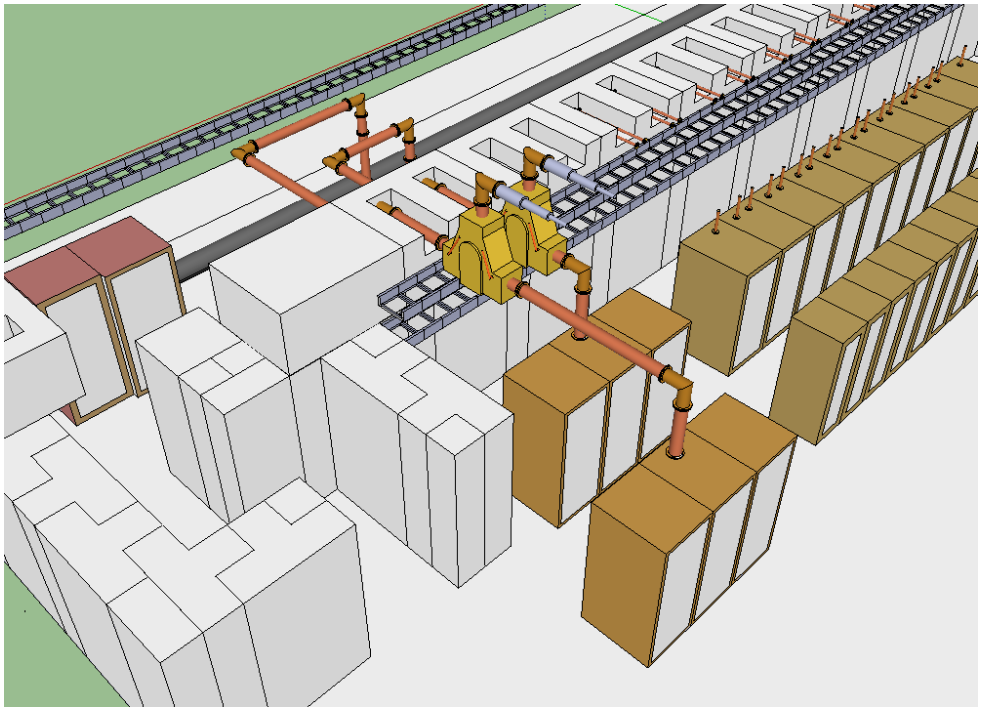
Bead-pull setup on RFQ Section #2



F=163.02 MHz, Q~7000
Tuners in 20mm, end tuner out (gap10mm)

RFQ Power Sources

- Amplifiers and Circulators are at CMTF!
  - Customs delay of a month
- Detailed Testing Plan: DocDB 1293
  - Amp and directional couplers to a fixed load
    - Full power test to measure the amplifer performance with respect to specifications
  - Circulators
  - Testing to start ~ late June
  - Should be ready for coupler tests in the fall



Ralph Pasquinelli

RFQ Power Sources

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Ralph Pasquinelli

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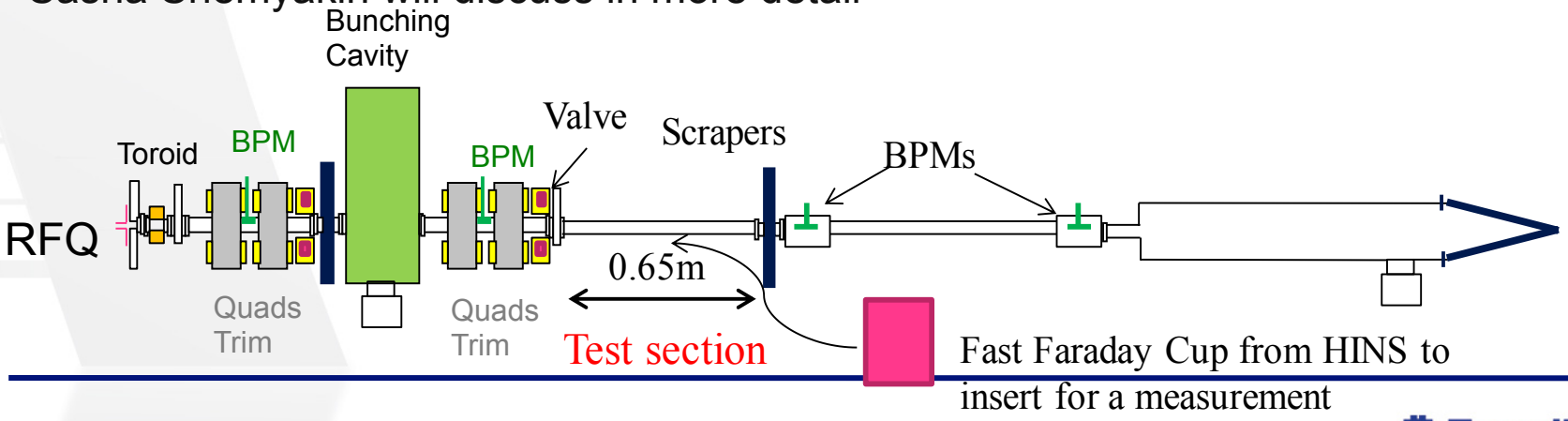
MEBT

- FY15 goal: to characterize the beam coming out of the RFQ
  - Energy (±1%)
  - Longitudinal emittance: estimation with Faraday Cup (from SNS)
  - Transverse emittance: estimation with quadrupole scan (quads and trims fabricated by our collaborators at BARC)
  - test high average power operation mode
    - either high current pulsed or low current CW
  - prepare for more detailed measurements in 2016
  - Making the best use of our resources
    - no dedicated diagnostics
    - use only those that are part of final MEBT

MEBT in FY15

- driven by resource limitations, doing work that is directly related to RFQ beam characterization
- RF commissioning of RFQ 10 kW (average) power
- Estimation of beam emittances and energy
- Hardware
  - 4 quad, 2 correctors fabricated at BARC – being prepared for shipping now!
  - 1 bunching cavity (FY14)
  - BPMs prototyped in FY14
- Test Section: available for diagnostic tests, absorber tests, specific measurements (e.g., Faraday cup)
- Sasha Shemyakin will discuss in more detail



SRF Systems

- SC cryomodules operating at 2 K
  - Solenoidal focusing
  - Warm gap between cryomodules
  - Fast vacuum valves at both sides of the cryomodules
- 2 Systems: 1 CM apiece for PXIE
  - Half Wave Resonator (β_G=0.11) at 162.5 MHz
  - SSR1 (β_G=0.22) at 325 MHz

SRF Systems

- HWR Cryomodule: β_G=0.11
  - 2.1 MeV -> 11 MeV
  - 8 cavities, 8 SC solenoids (x,y correctors) and 8 BPMs
  - Argonne design
    - Prototype cavities and couplers have been fabricated
  - Peter Ostroumov will discuss in more detail

Prototype cavities Dec 2013

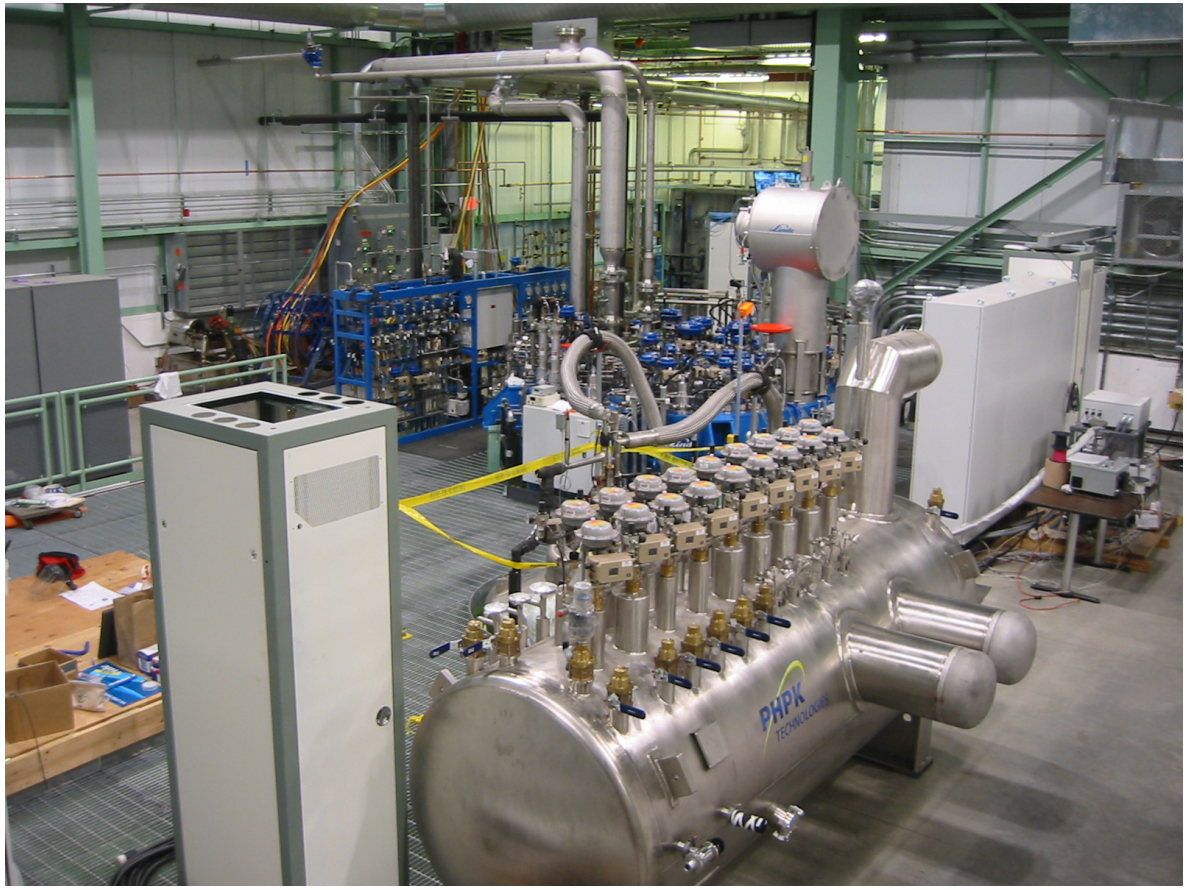
SRF Systems

- SSR1 Cryomodule: (β_G=0.22)
  - 11 MeV -> 25 MeV
  - 8 cavities, 4 SC solenoids (x,y correctors) and 4 BPMs
  - Have production cavities
  - Test bed
    - to learn how to compensate Lorentz Force Detuning for pulsed operation in PIP-II

S1H-NR-105
The first production SSR1

Cryogenic Plant

- Superfluid cryoplant is fully operational
- Cryomodule Test Stand ready - Q1 FY16 (LCLS-II)
- PXIE cryogenic system is in design phase



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Summary

- Short Term Goal: ready for RFQ spring 2015
  - Infrastructure being put in place
  - Ion Source and LEBT installation ongoing
  - RF Power amplifiers and couplers will be in place
  - MEBT hardware to characterize RFQ being prepared
  - working with available funding to keep these on schedule
- Long Term Goals
  - 2016: Beam delivered to the end of MEBT with nearly final parameters (2.1 MeV, 1 mA CW, 80% arbitrary chopping)
  - 2018: 1-mA CW beam 25 MeV beam delivered to the dump