



302.4 Q1/Q3 Cryo-Assembly Fabrication Progress

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PMG meeting – March 16th, 2021



Progress report

- Although last update on PMG was in June, I will update from CD3 approval - few Highlights that has been achieved since June
- Will include:
 - 302.4.01 Magnets Vertical Test at BNL
 - 302.4.02 Cold Mass Assembly Fabrication
 - 302.4.03 Cryo-Assemblies Fabrication
 - 302.4.04 Cryo-assemblies Horizontal Test

302.4.01 Magnets Vertical Test at BNL

After the successful completion of the MQXFA04 test, the following tasks had to be accomplished before the next test:

- Work on main LHe refrigerator CTI4000 to replace leaking Phase 1 Heat Exchanger (LN₂).
- Development and manufacture of centering fixture and bumpers for warm bore tube to minimize motion and provide protection for magnet during test.



302.4.01 Magnets Vertical Test at BNL

Work on main LHe refrigerator CTI4000 to replace leaking Phase 1 Heat Exchanger (LN₂).

- Old heat exchanger removed.
- New heat exchanger was 1" wider than original.
- Plumbing around heat exchanger had to be cut out and new piping welded in place to create extra space for bigger heat exchanger.
- Welding job was complex due to tightness of piping and difficulty of navigating within cramped and confined space.
- Welding of pipes and Heat Exchanger finished by mid-Dec.
- During pressure test, one aluminum weld was found to be leaking and difficult to repair due to tight location and the non-availability of welders for an extensive period of time. Welder out on medical for a month.
- Leaking weld finally repaired by mid-Feb.
- Test start of MQXFA05 (in Test Dewar since 24-Dec) delayed due to this.
- Cooldown of magnet started 27-Feb.

302.4.01 Magnets Vertical Test at BNL

- In analysis of the delays in the cryogenics work, there was a significant impact due to lost days due to COVID quarantines
- There were several quarantines and illnesses in Magnet Division, Facilities & Operations, and Collider Accelerator Department that had an impact on AUP and cryo-plant maintenance.
- During this time period, due to COVID19 issues:
 - Lost all four electrical techs for 2 weeks.
 - Lost cryogenics technician for 2 weeks.
 - Lost engineer for month.
 - Lost mechanical technician for 2 weeks.

302.4.01 Magnets Vertical Test at BNL

Other updates:

- Installation of two new valves to protect new Phase 1 heat exchanger. Done
- Repair of CTI4000 inline purifier. Done
- Assembly of second top plate and test fixture has been accelerated. In progress.
- Test of MQXFA05 was already at 1.9 K.
 - Contamination stopped the test
 - Purification and identifying the source of the contamination is in progress
- A BCR on the impact of the test delay has been successfully reviewed by the AUP change control board.

302.4.01 Magnets Vertical Test at BNL

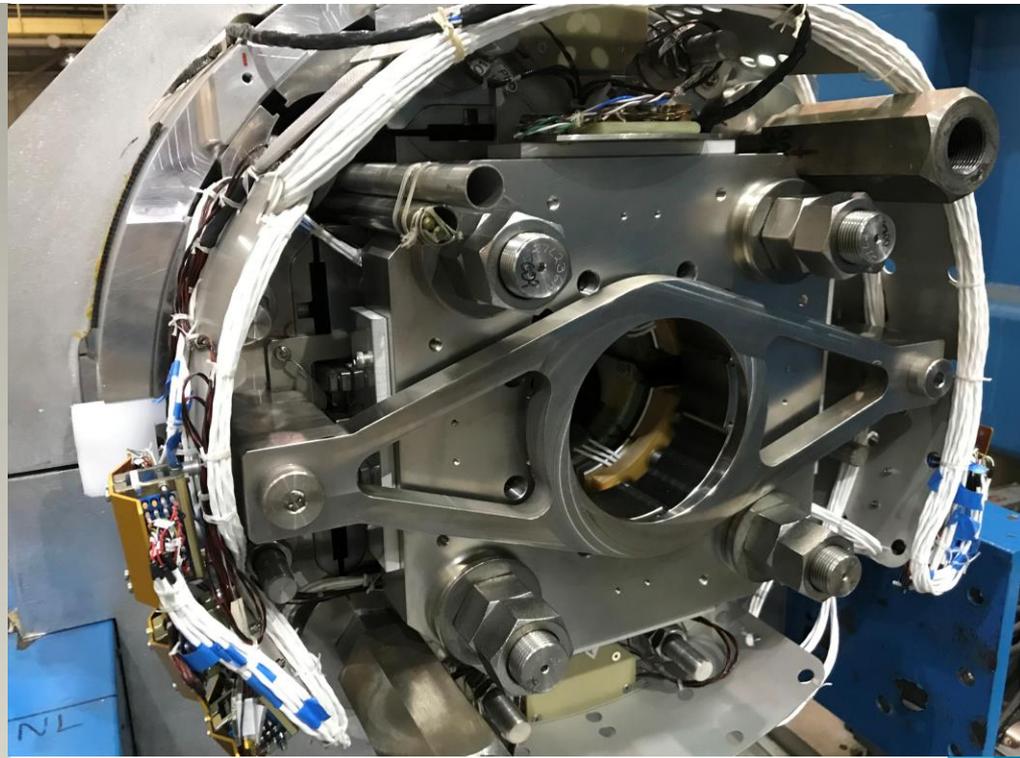
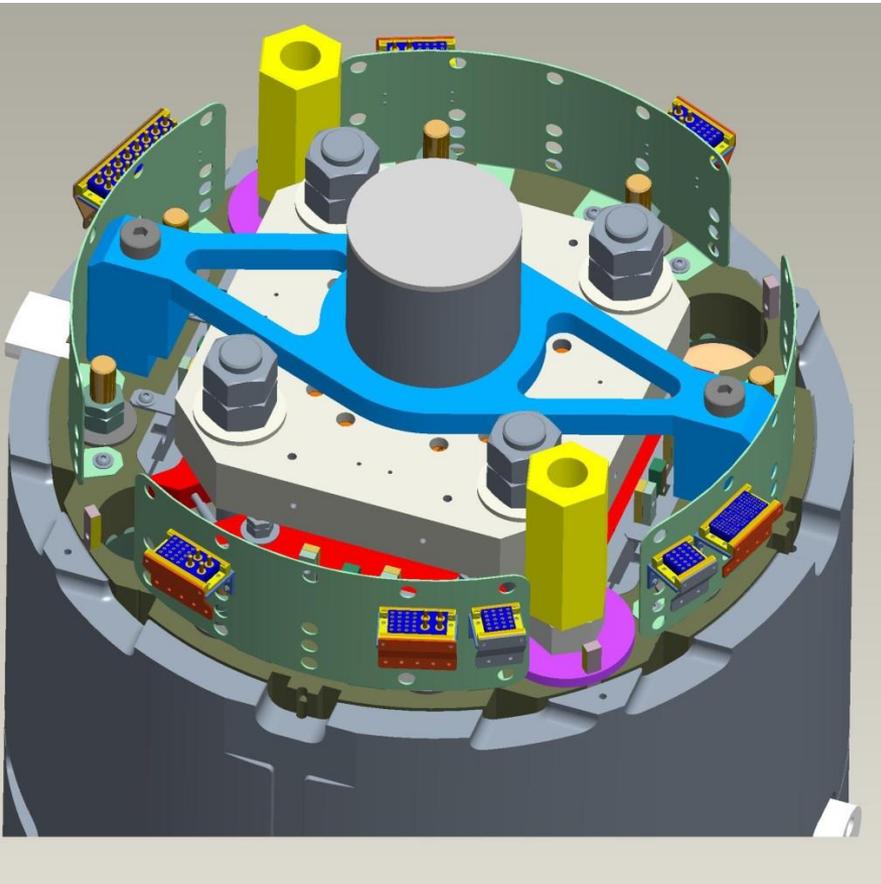
Installation of protective bumpers on WBT.
Used for first time on MQXFA05.



302.4.01 Magnets Vertical Test at BNL

Design, manufacture, and installation of WBT centering fixture.

Being used for first time on MQXFA05.

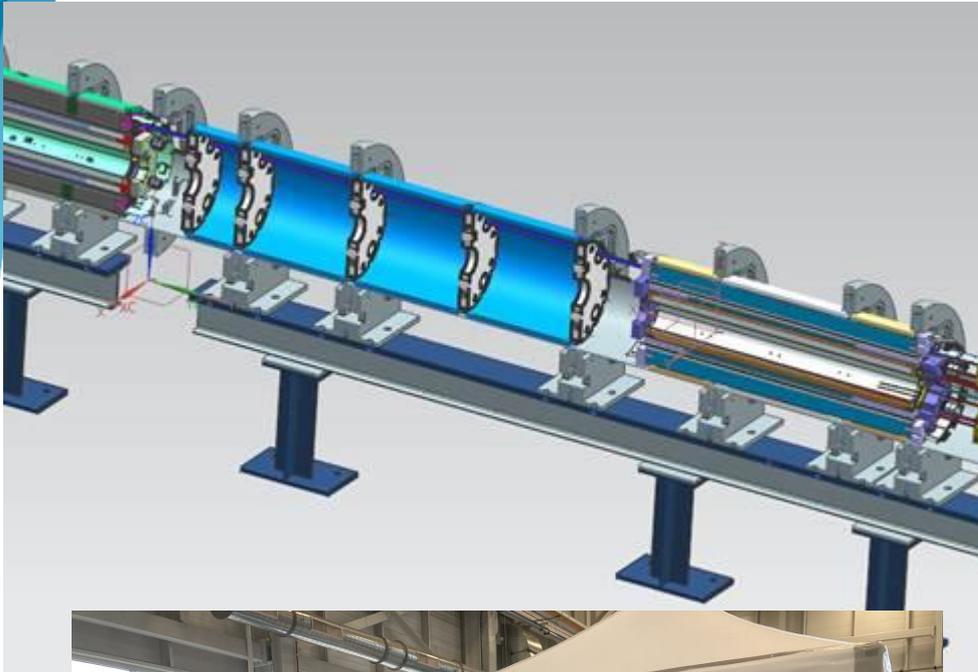


302.4.01 Magnets Vertical Test at BNL

- Work on second top plate/test fixture in progress – expected to be completed within a month – ready for MQXFA06
 - Mains and CLIQ gas-cooled leads are installed.
 - Lambda plate and hanging hardware are installed.
 - Wiring to connectors are done.
 - Still to be done:
 - Potting of connectors (**mostly done**)
 - Wiring boards (**resistor installation done**).
 - Leads and instrumentation wiring through lambda plate and potting.



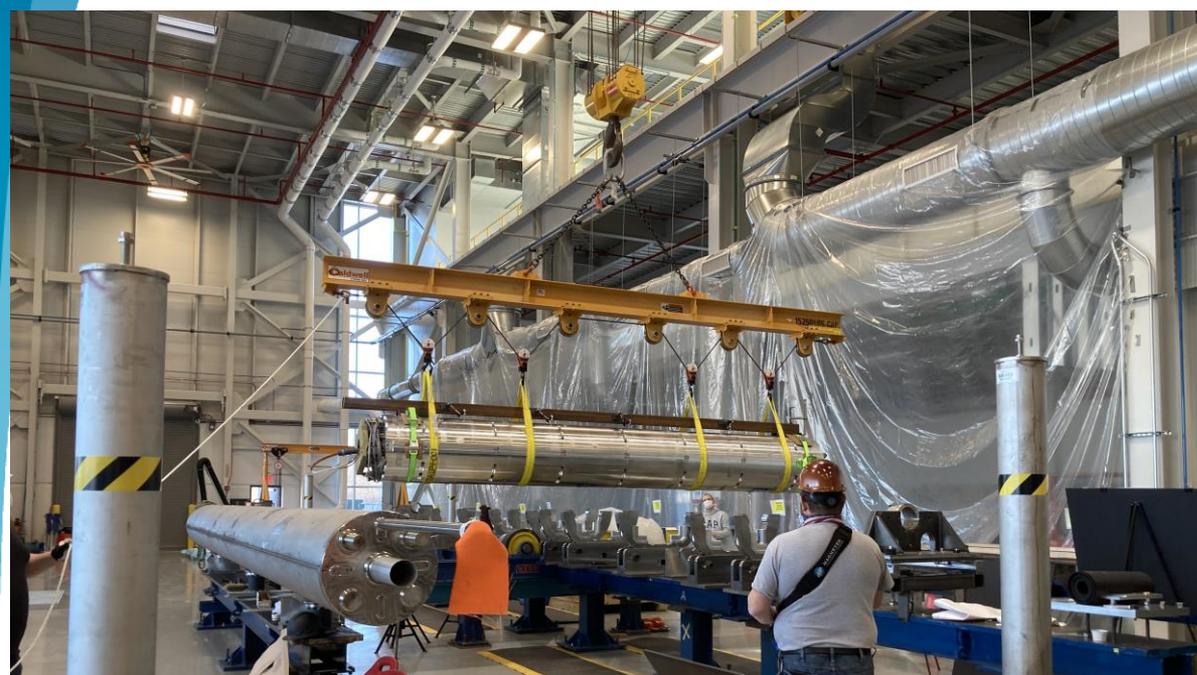
302.4.02 Cold Mass Assembly Fabrication



Practice Cold mass has been completed and Cold mass traveler has been updated – lesson learned incorporated: Alignment station clamps need to be re-aligned prior to using them; Welding sequence is important; Saddle positioning and welding process and survey steps were refined based on the experience etc.

We are still using it to test-fixtures for leak checking and for a weld repair exercise

302.4.02 Cold Mass Assembly Fabrication



Even lift – no deflection
Measured with dial
indicators less than $33\ \mu\text{m}$
Requirement is $\leq 250\ \mu\text{m}$

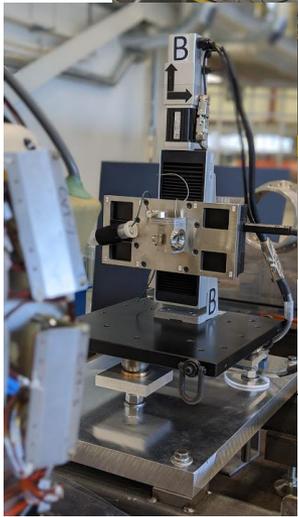


302.4.02 Cold Mass Assembly Fabrication



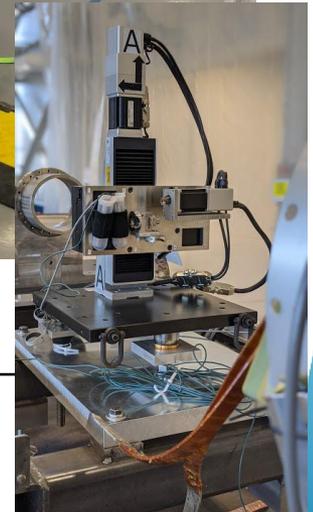
302.4.02 Cold Mass Assembly Fabrication

First results of MQXFA03 – MQXFA04 alignment measurements with Single Stretched Wire in ICBA



11.023 m

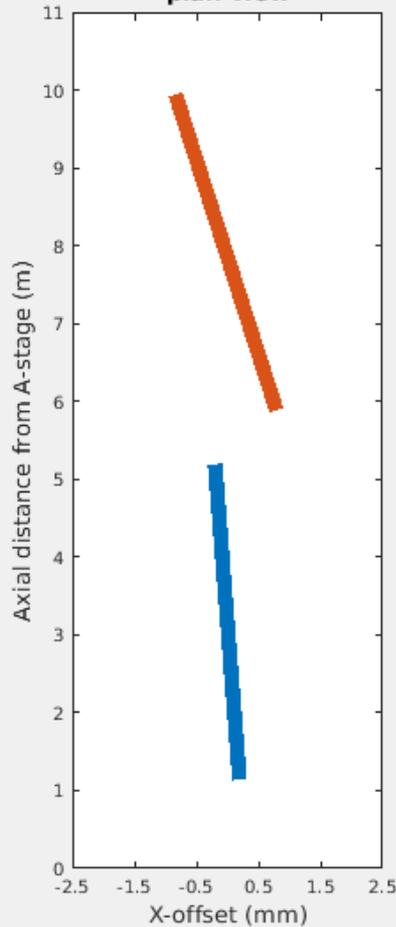
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302.4.02 Cold Mass Assembly Fabrication

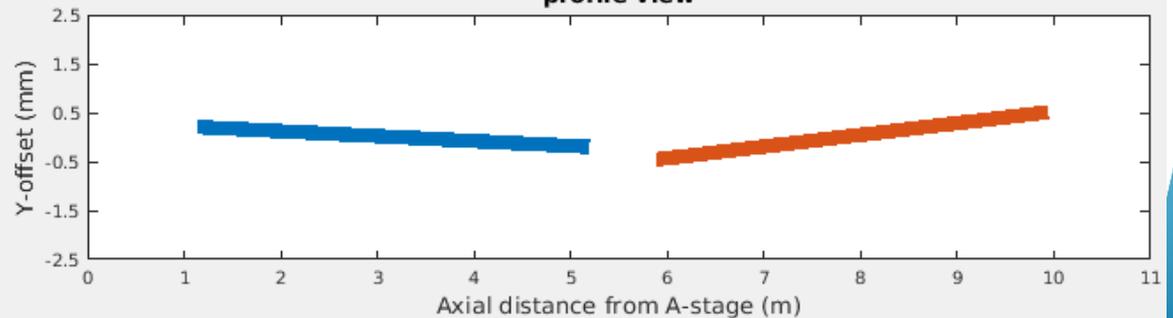
MQXFA03-MQXFA04 Alignment - After move to average axis
09Mar2021

**Horizontal Offsets
plan view**



MQXFA03 Lead End: X= 0.195, Y= 0.207 mm
MQXFA03 Interface End: X= -0.200, Y= -0.200 mm
MQXFA04 Interface End: X= 0.790, Y= -0.459 mm
MQXFA04 Lead End: X= -0.837, Y= 0.510 mm

**Vertical Offsets
profile view**



302.4.03 Cryo-Assembly Fabrication



Installation of the Cryostat tooling completed

Initial operation was completed using the practice cold mass

Several minor items were identified to be addressed

Commissioning of the tooling expected to be completed in late April

302.4.03 Cryo-Assembly Fabrication

- Shipment of first cryostat kit in late March
 - CLIQ/k-mod/IFS assemblies to be shipped separately
 - Everything else is ready to be shipped
 - Expected to leave port on March 26 (earliest available slot that the shipping company could secure) and to arrive on April 17th
 - We had several meeting with CERN and FNAL shipping to avoid duties. Critical is to treat as: *HTS Code 8543.90.8845: Particle accelerators; Parts; Other; Of particle accelerator*



302.4.04 Cryo-assemblies Horizontal Test

- Preparation for Production Tests
 - Cryo-assembly staging area will be prepared in IB1
 - Return End thermal shield fabrication in progress
 - Interconnect component assembly-fabrication in progress at MW9
 - Components for the cold mass piping extensions in procurement
- Process Controls
 - UPS installation in Stand 4 PLC cabinets is complete
 - Kinney Pump Room PLC update (Allen Bradley)
 - Update of the engineering notes and specification documents
 - Quench Line instrumentation
 - Software updates for the Production test
- Quench Protection and Monitoring
 - CERN HFU upgrade at Surya Electronics
 - High-voltage cable tray assembly in progress
 - Additional components required for the production AQD/DQD systems, PS control and current reading, etc. are in procurement
 - Simulation of the additional protection warm diodes for the horizontal cryo-assembly testing is complete

302.4.04 Cryo-assemblies Horizontal Test

Test Facility Upgrade

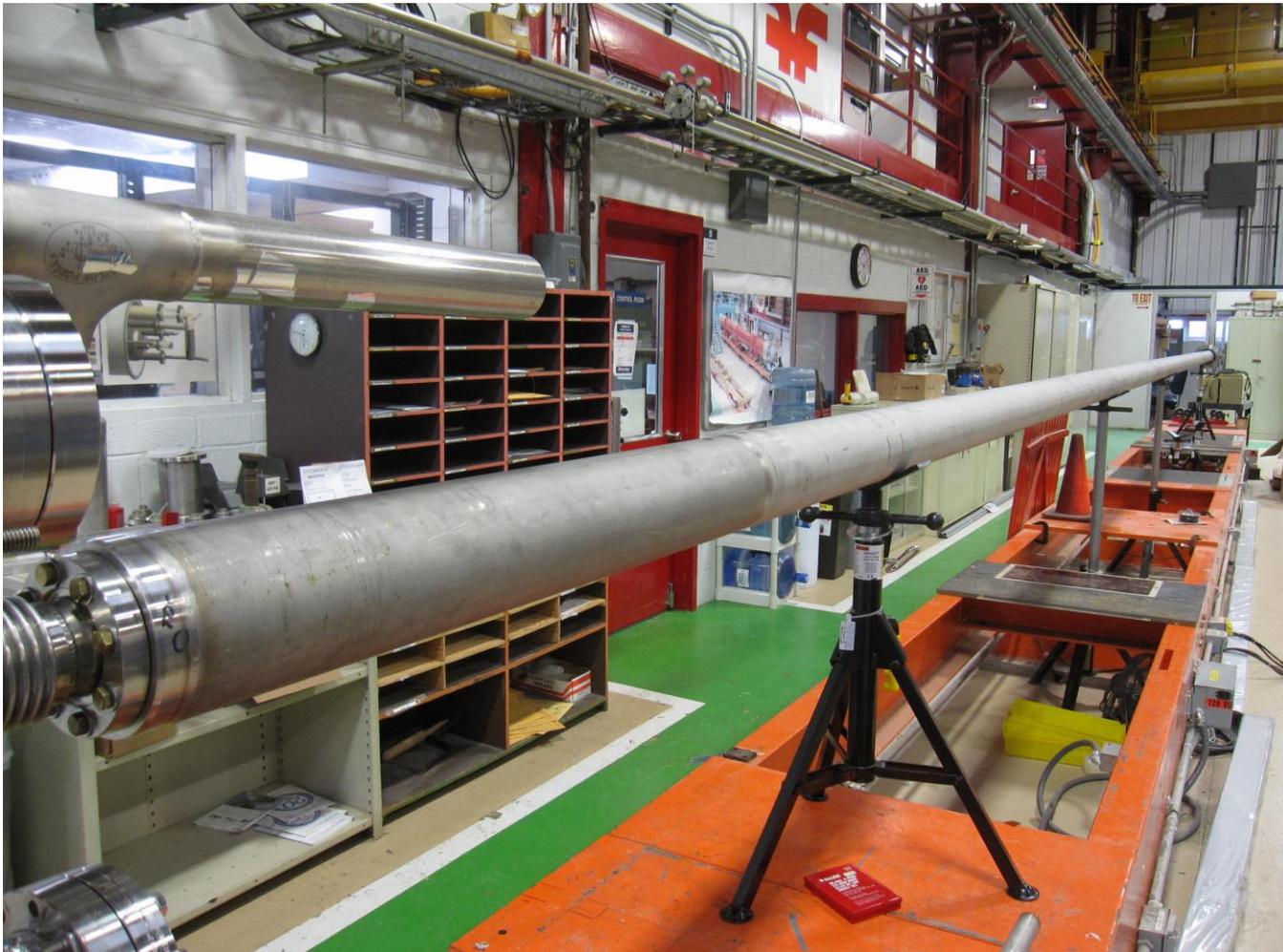
- Need to discuss/coordinate location of the stationary survey targets (brackets) in IB1 with the metrology group
- Pumping line heater installation is complete
- LCW re-work at Stand 4
- Quench Recovery Line

BCR203 – Test Stand 4 Restoration ATF FY21 Funding Issue: The overall cost impact is \$514k.

- Due to funding issues on the ATF B&R code at Fermilab in FY21, some elements of work that was agreed to be off-project – through the FNAL-AUP Memorandum of Agreement – cannot be supported by the Laboratory in FY21.

302.4.04 Cryo-assemblies Horizontal Test

- Warm finger (WF) assembly completed, and it is installed temporarily at Stand 4 for magnetic measurements



Rotating coil system

- Rotating coil system is verified with MQXFA short model and 15-T dipoles at Fermilab's Vertical Magnet Test Facility
- PCB measurement probes developed at Fermilab are also used at BNL and LBNL
- Old probe drive system has been refurbished and tested

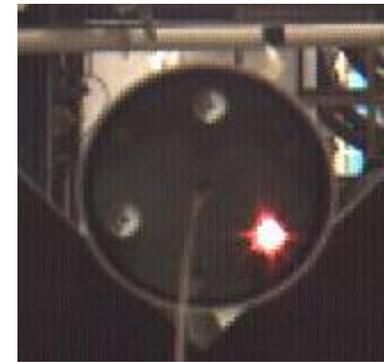


Precise magnetic measurements at Stand 4

- For accurate measurements of the local magnetic center and field angles we need to know the measurement probe location and orientation inside the magnet with high precision
- Laser tracker will follow and measure 3 targets (reflectors) on a probe
 - Dedicated software developed for finding and measurement of targets
 - More Tests will be performed at the Horizontal test facility

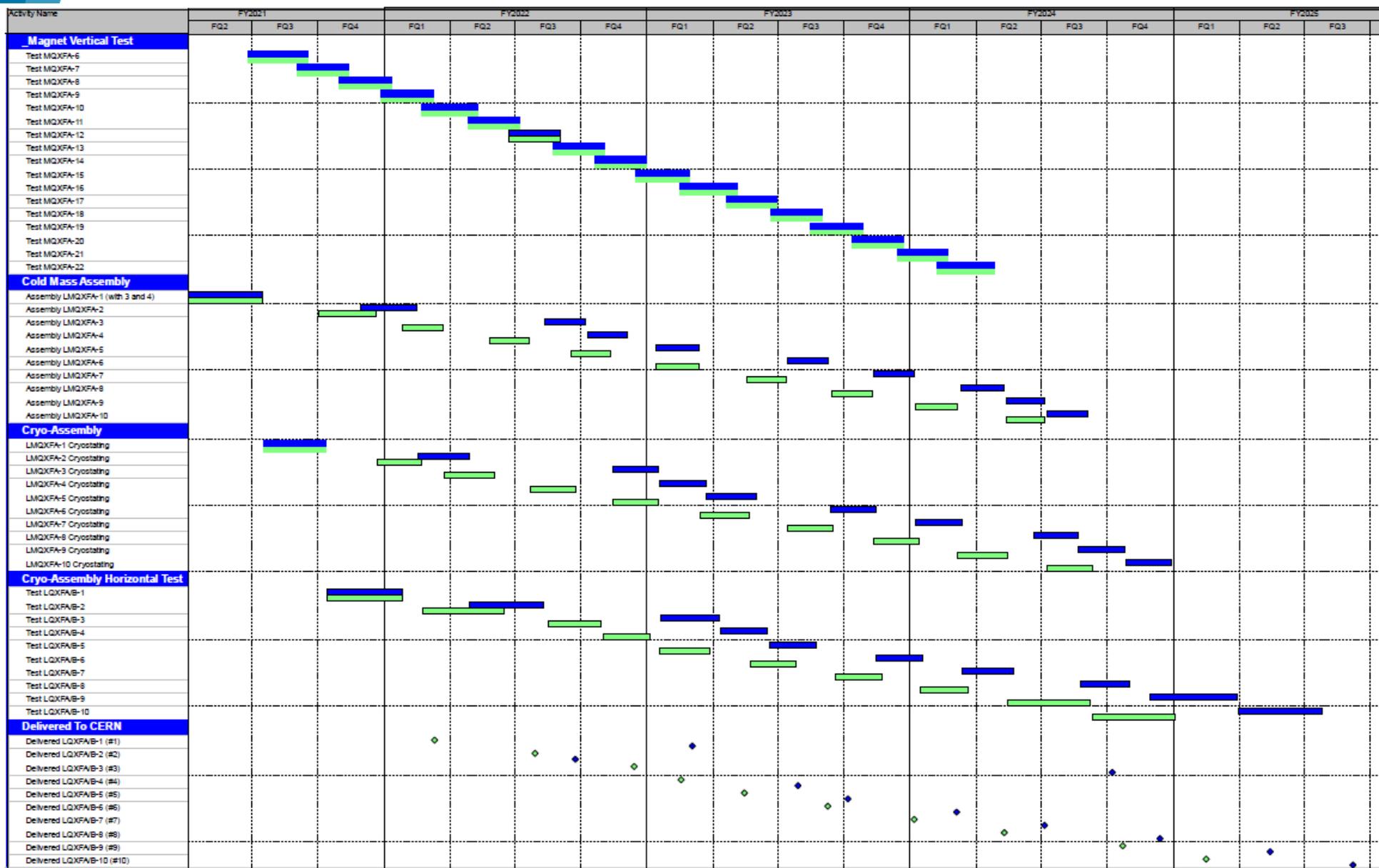
The screenshot displays the software interface for the laser tracker. On the left, there are control panels for IP Address (192.168.0.1), Laser Tracker Name and Settings, and Data File (ProbeShaft0m-12m.csv). The main window shows a 'Positioning System' with 'Get Targets' and 'Find.MeasureTargets' buttons. Below this is a 'Measurement History' table with columns for H Est, V Est, D Est, H Meas, V Meas, D Meas, Timestamp, and Label. The table contains several rows of data, all labeled as 'Duplicate'. On the right, there is an 'Overview Camera' view showing a probe with three red targets inside a warm bore tube. Below the camera view, there are fields for Target# (HbAngle, VbAngle, PixelX, PixelY) and buttons for 'Start Camera', 'Stop Camera', and 'Save Image'. A 'Save To File' button is also present.

H Est	V Est	D Est	H Meas	V Meas	D Meas	Timestamp	Label
35.319725	89.599193	10000.000000	0.000000	0.000000	0.000000	4/26/2019 4:53:59 PM	Duplicate
35.711099	90.183803	10000.000000	0.000000	0.000000	0.000000	4/26/2019 4:53:09 PM	Duplicate
35.833482	89.857860	10000.000000	0.000000	0.000000	0.000000	4/26/2019 4:53:19 PM	Duplicate
35.932483	89.591492	10000.000000	0.000000	0.000000	0.000000	4/26/2019 4:53:29 PM	Duplicate
36.266354	90.111058	10000.000000	0.000000	0.000000	0.000000	4/26/2019 4:53:39 PM	Duplicate
36.294121	90.116832	10000.000000	0.000000	0.000000	0.000000	4/26/2019 4:53:49 PM	Duplicate



Probe with 3 targets inside the warm bore tube

Current & Success Oriented Schedule



◆ Current Milestone ◆ Success Oriented Milestone