Magnet Measurements of the ALS-U Magnets

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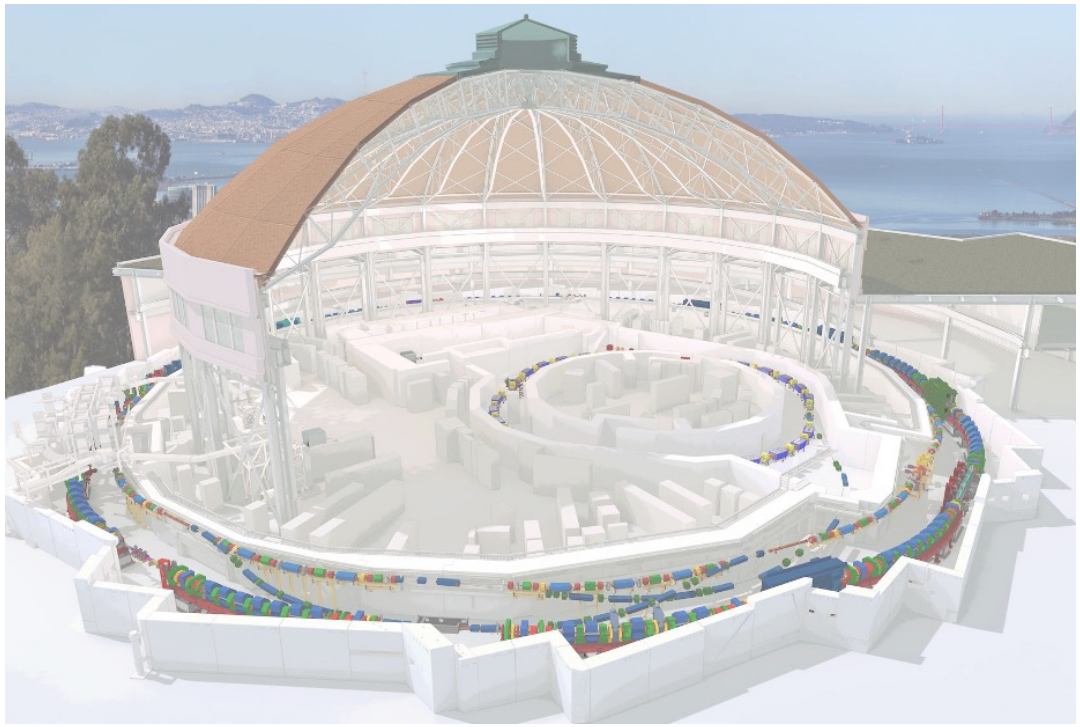
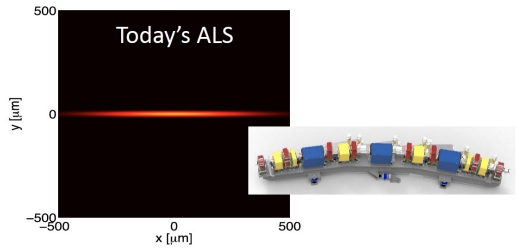
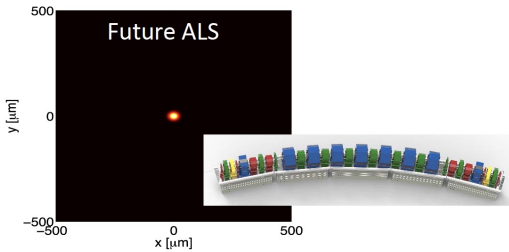
Contents

ALS-U, an upgrade of the accelerator systems at the ALS

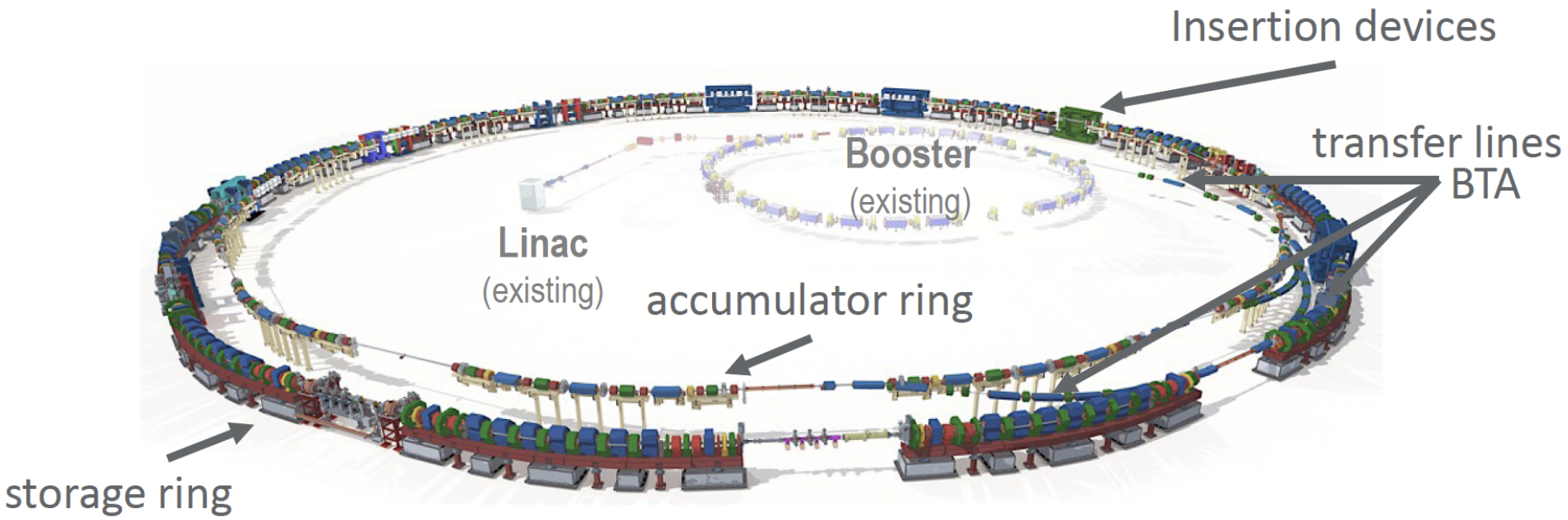
- The accelerator systems at the Advanced Lights Source (ALS) is going through a major upgrade to become the ALS-U.
- Today's triple bend achromat will be replaced by a nine bend achromat with reversed bends from offset quadrupoles.
- The nine bend achromat storage ring (SR) uses on-axis injection from a triple bend achromat accumulator ring (AR).



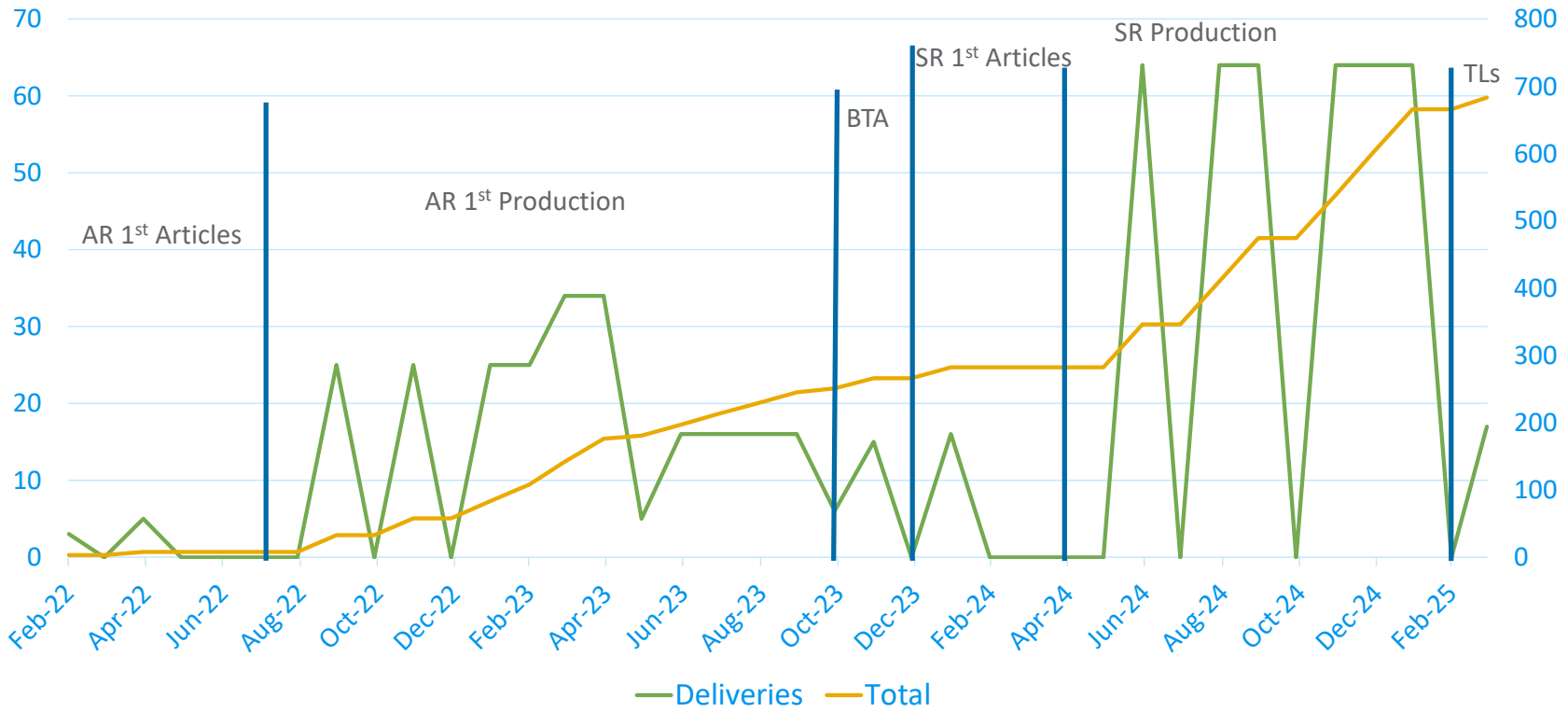




Accelerator replacements



Deliveries of 700 magnets over the coming three years



Scope of magnetic measurement work

- Develop the instrumentation and laboratory space for the magnetic measurements needed for the ALS-U project.
- Carry out magnetic measurements of the strength (transfer function), multipole contents, magnetic axis, and fiducialization on:
  - 100% of the prototype and first article magnets.
  - 25% of the Accumulator Ring Magnets (100% ABEND).
  - 100% of the Storage Ring magnets.
  - 100% of the BTA, ATS, and STA magnets.
- In addition to magnetic measurements, QA inspections and mechanical reassembly tests will be carried out in the same laboratory space.

Magnetic Measurement Facility

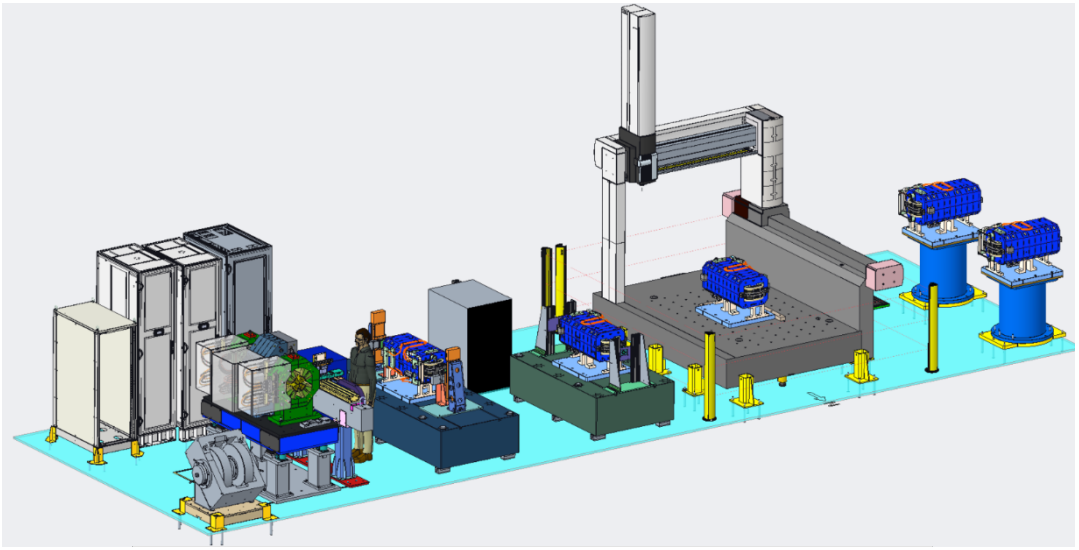
- It has been challenging to find a sufficiently large and suitable area at LBNL for the Magnetic Measurement Facility MMF
- The MMF is in building 15 high bay during first half of project for prototype measurements, and AR and BTA magnets
- The MMF will be moved to building 77 room 161 for remaining part and measurements on SR, and ATS and STA magnets
- The temperature controlled UMF (77-0108A) may be used for parts of the measurements on the ppm based HBEND magnets

Magnetic measurement methods used

- Stretched wire measurements is the main method for measuring magnet strength (transfer function), multipole contents, magnetic axis, and fiducialization
- Rotating coils are used for measurements of the multipole contents of the AR magnets
- Hall probe mapping will be used for the magnet strength (transfer function), multipole contents, magnetic axis, and fiducialization of the swept SR dipole magnets

MMF in building 15 for prototype magnets, and AR and BTA magnets

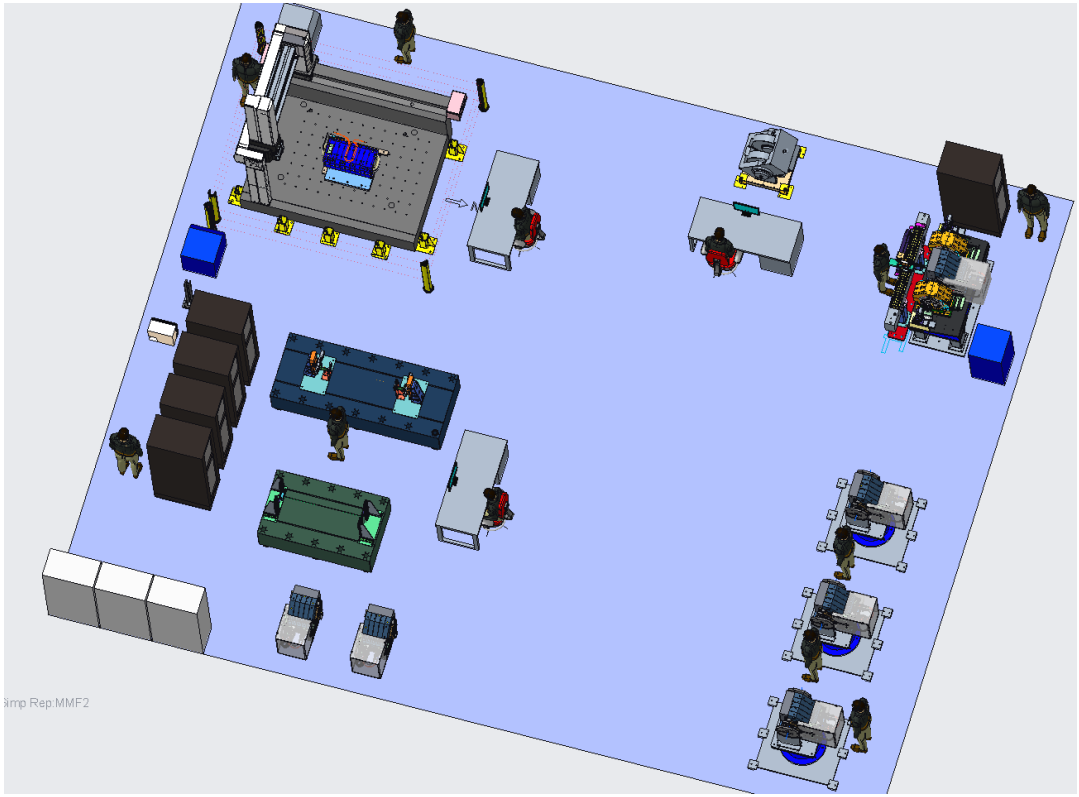
- Hall probe scanner
- 2 stretched wire systems (raft + bench)
- 1 rotating coil system
- CMM with Hall probes
- Calibration magnet
- 2 stands for QA inspection of magnets



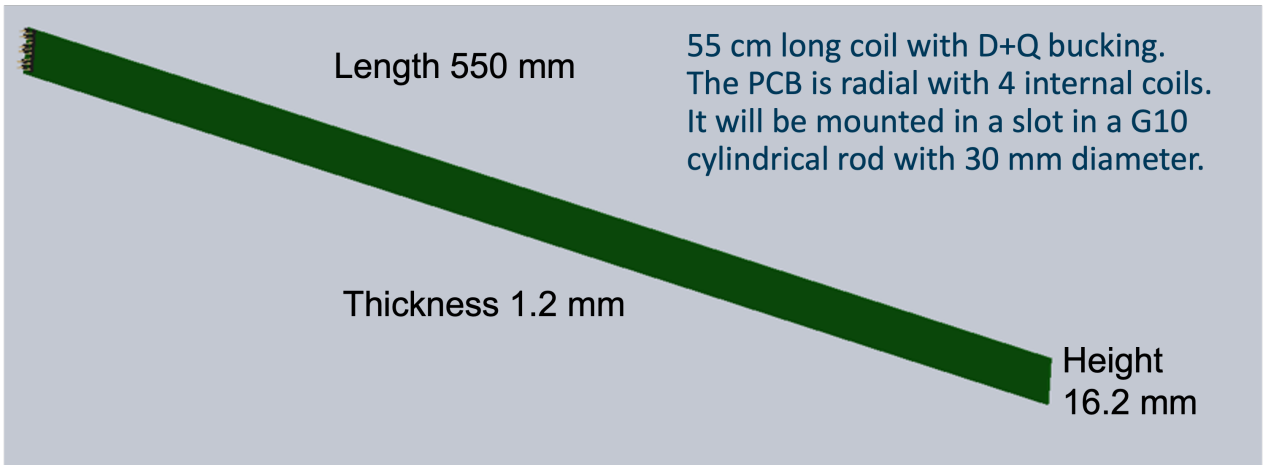
MMF in building 15, status as of September 29, 2022.

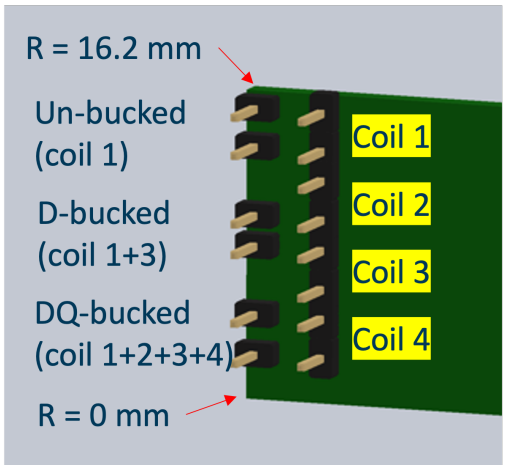
MMF in building 77 for SR, ATS, and STA magnets

- Hall probe scanner
- 3 stretched wire systems (raft + 2 benches)
- CMM with Hall probes
- Calibration magnet for Hall probes
- 3 stands for QA inspection of magnets



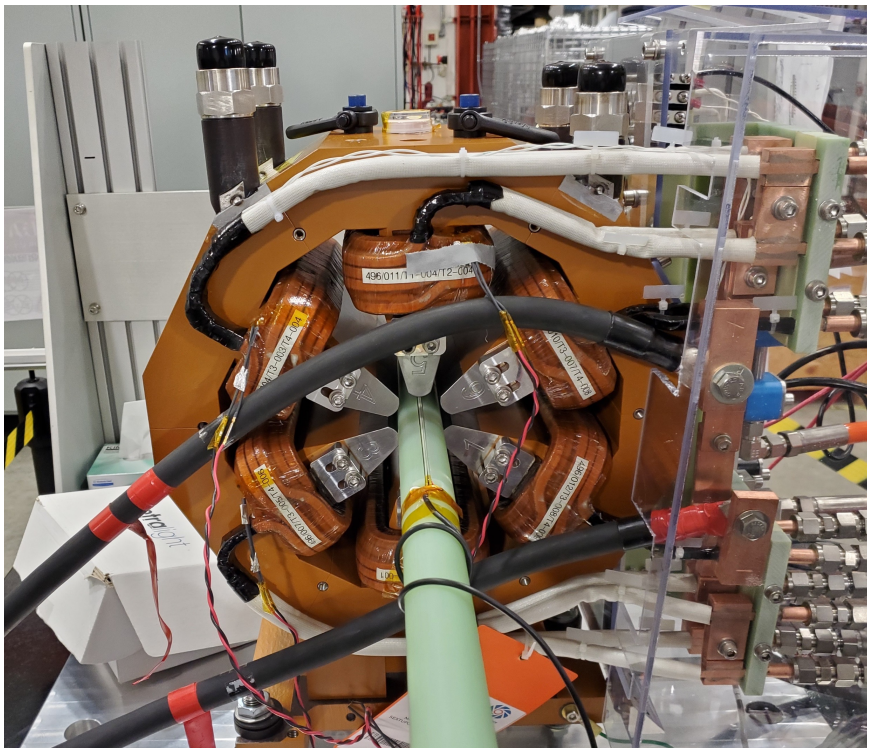
Printed Circuit Board (PCB) coils for the AR magnets





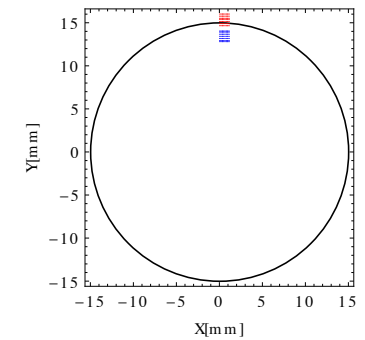
- The delivery time was 6 months instead of quoted 2 weeks.
- The maximum bucking ration for first batch of PCBs was 530 but typically around 100.
- A new batch of PCBs, from other vendors, has arrived and will be tested soon.

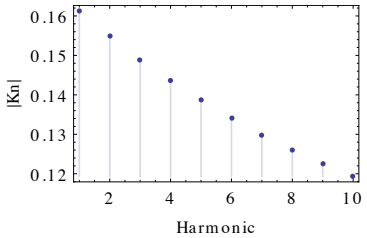
Measurement on sextupole magnet

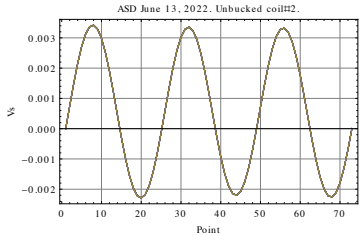


ASD Magnet at the rotating coil stand
Bucking ratio is 533 for the sextupole component

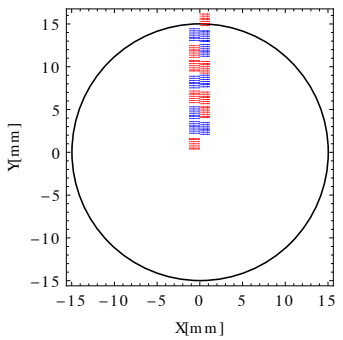
Unbucked

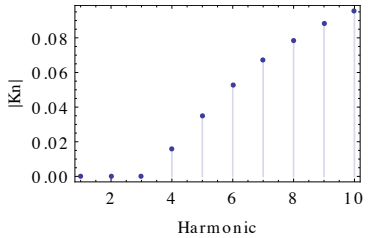


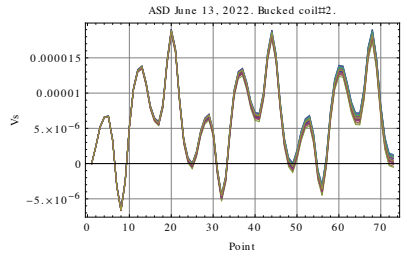




Bucked







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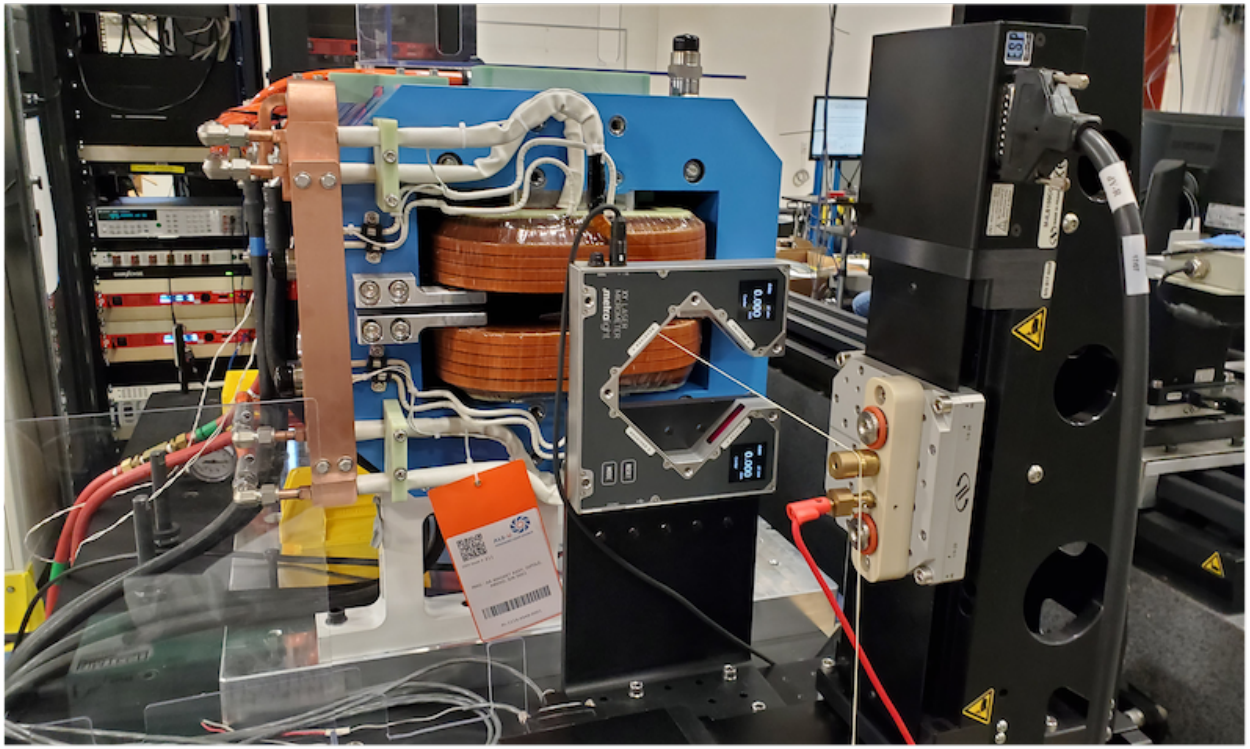
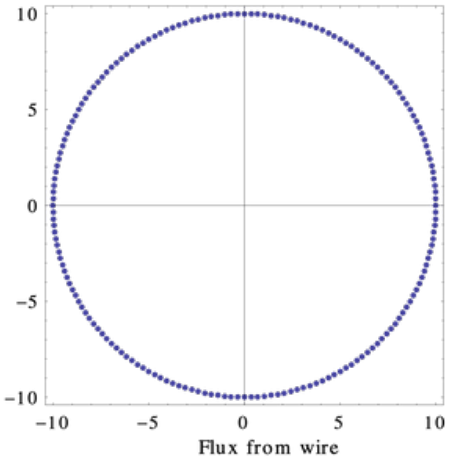
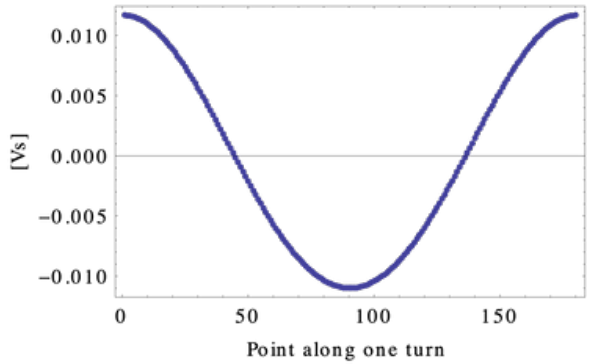
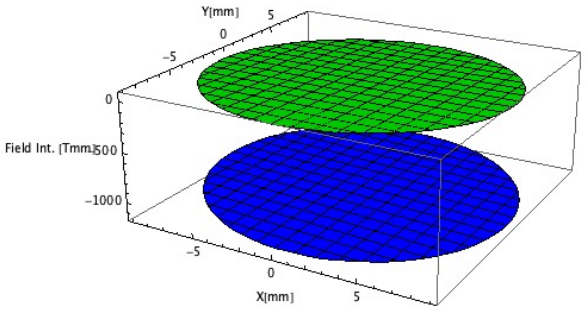
Stretched wire measurement at the raft in building 15







Normally FFT on a circle is used but Cauchy method [ref. Chavanne] available

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Point {X,Y} = {0, 0} mm.
Cauchy: {IBx,IBy} = {4.66555, -1093.79} Tmm.
The normal quadrupole strength is 6.90059T.
The skew quadrupole strength is -0.00777554T.
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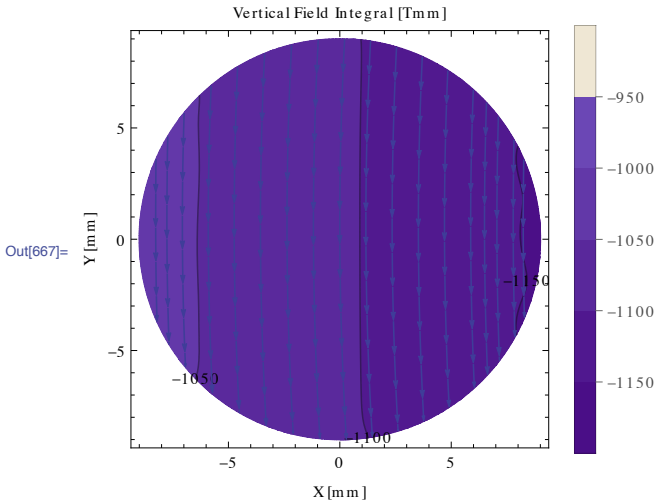
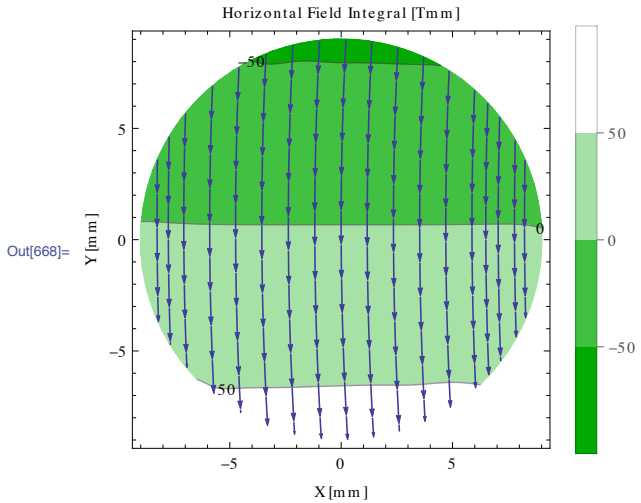
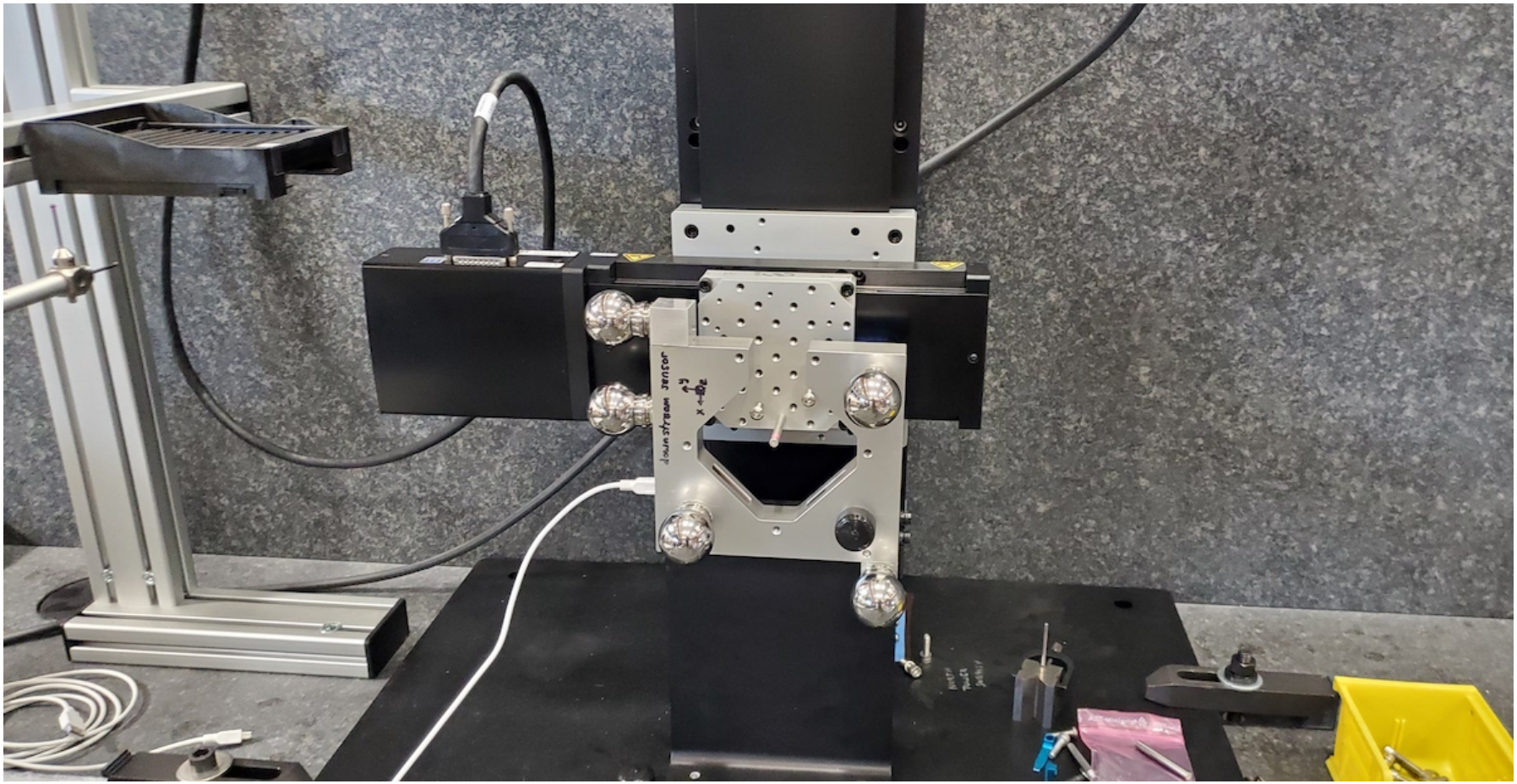


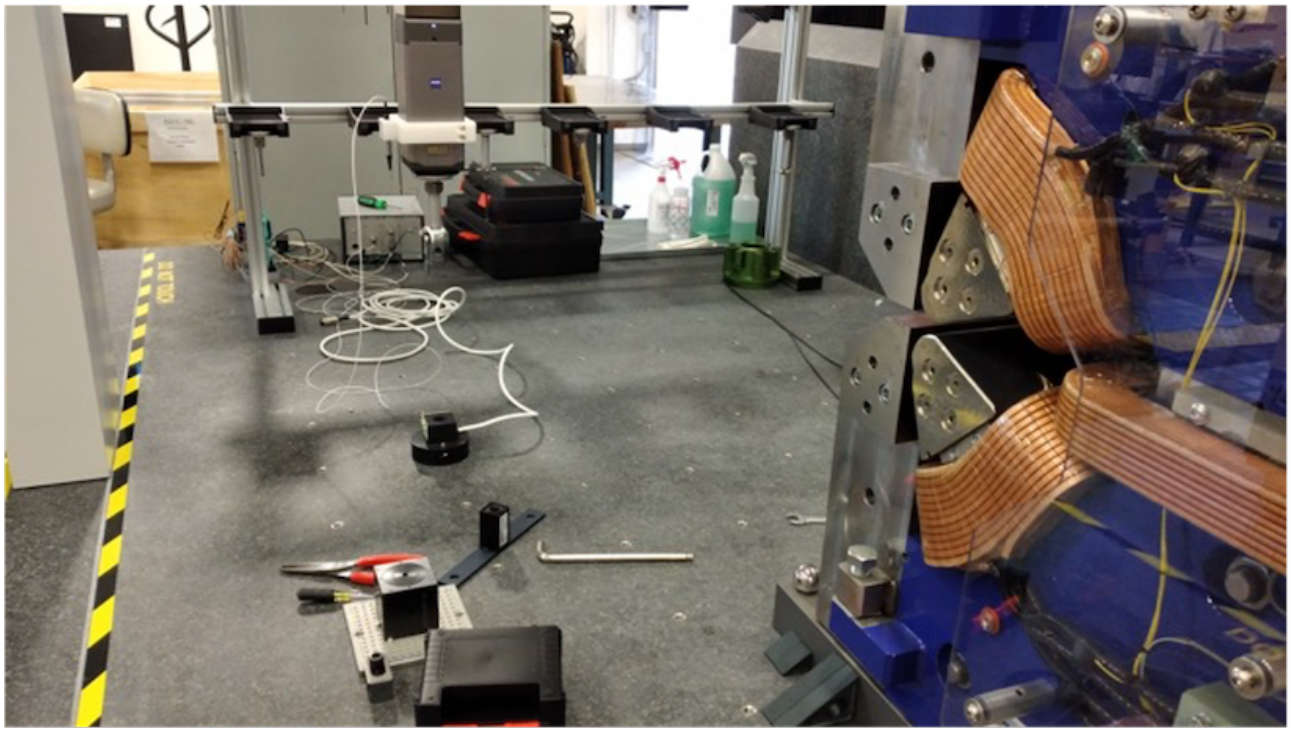


The wire travel path
can have arbitrary shape.

XY laser micrometers for wire position are calibrated using the CMM

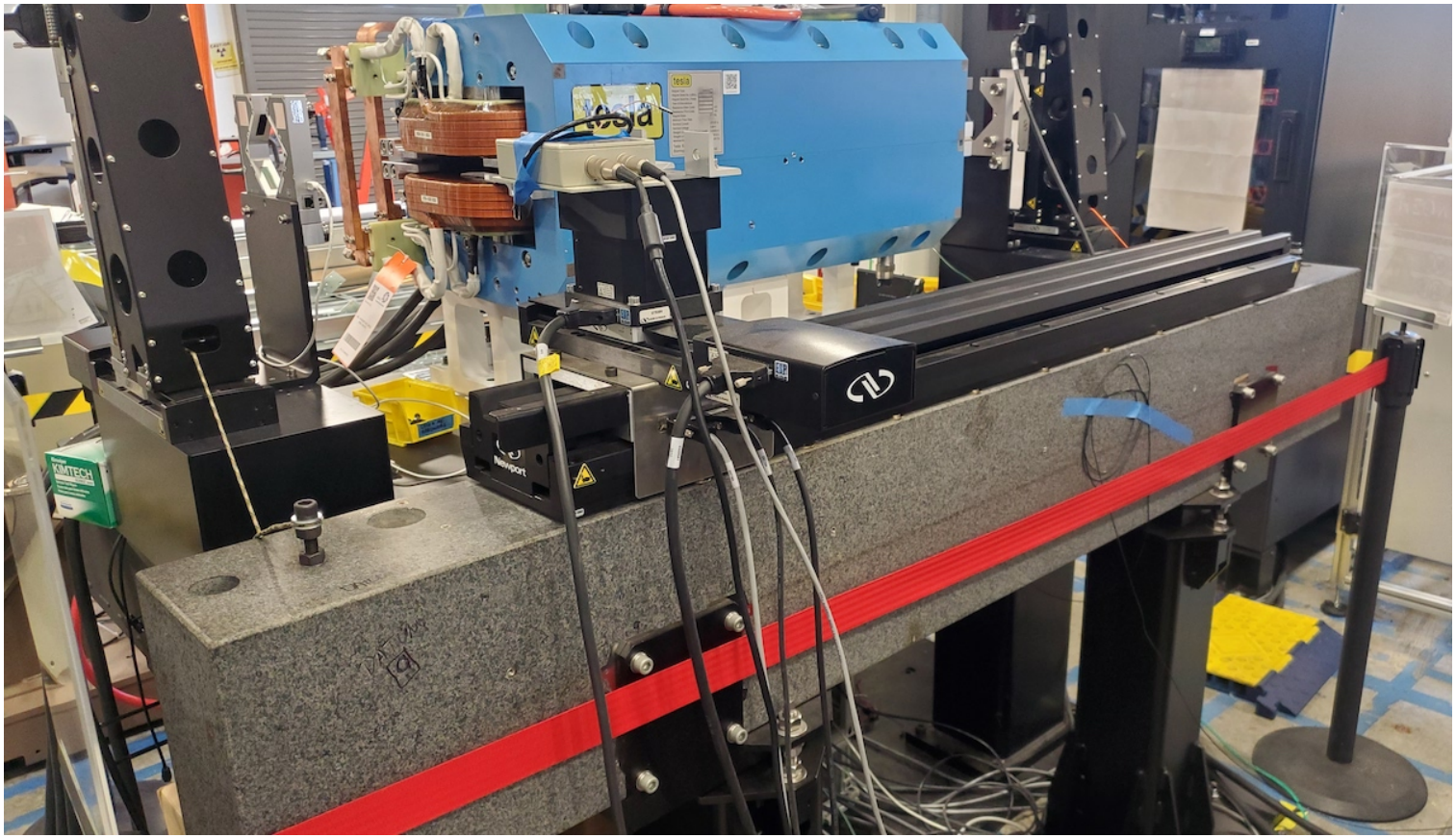


Hall probe sensor on the CMM



Extension arm to reach the center of ABEND

Hall probe scanner with 1.2 m travel length



Summary

- The commissioning of all features of the magnet measurement facility is work in progress.
- The rotating coil and stretched wire setups are working and produce reliable data
- The measurement campaign on the first article AR magnets is almost complete.
- Challenges have been abundant with the COVID pandemic, lock-downs, supply chain delays, and difficulties to recruit personnel.
- The measurement results for the 700 ALS-U magnets will be reported in about two years from now.

Thank you

Thank you for listening!

Thanks to the team:
D. Beard, J. Chrzan, J. De Ponte, S. Dimaggio, M. Johansson, M. Lerche, R. Kuravi, S. Marks, K. Mccombs, M. Munoz, T. Shah, J. Strezo, C. Swenson, A. Turner, J. Wirdzek, and D. Yeagly