MICE Spectrometer Solenoid Magnetic Measurements Plans

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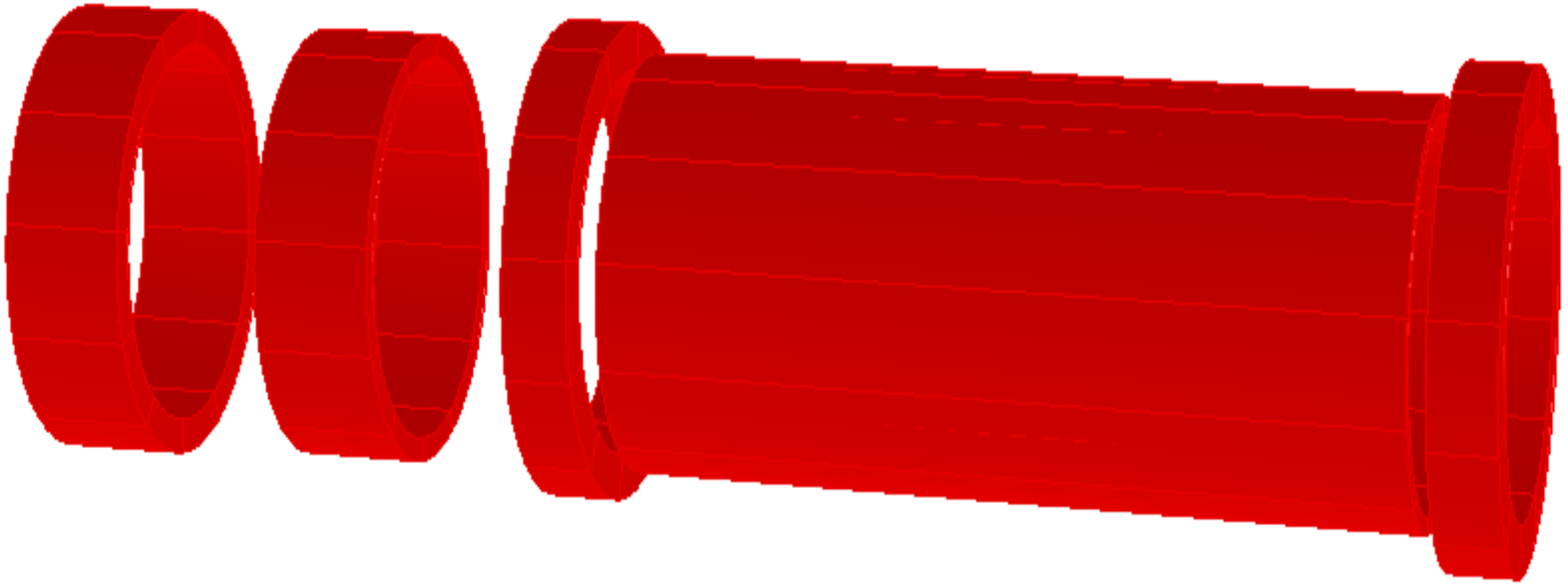
MICE Spectrometer Solenoid Meeting
LBNL, February 17th, 2012



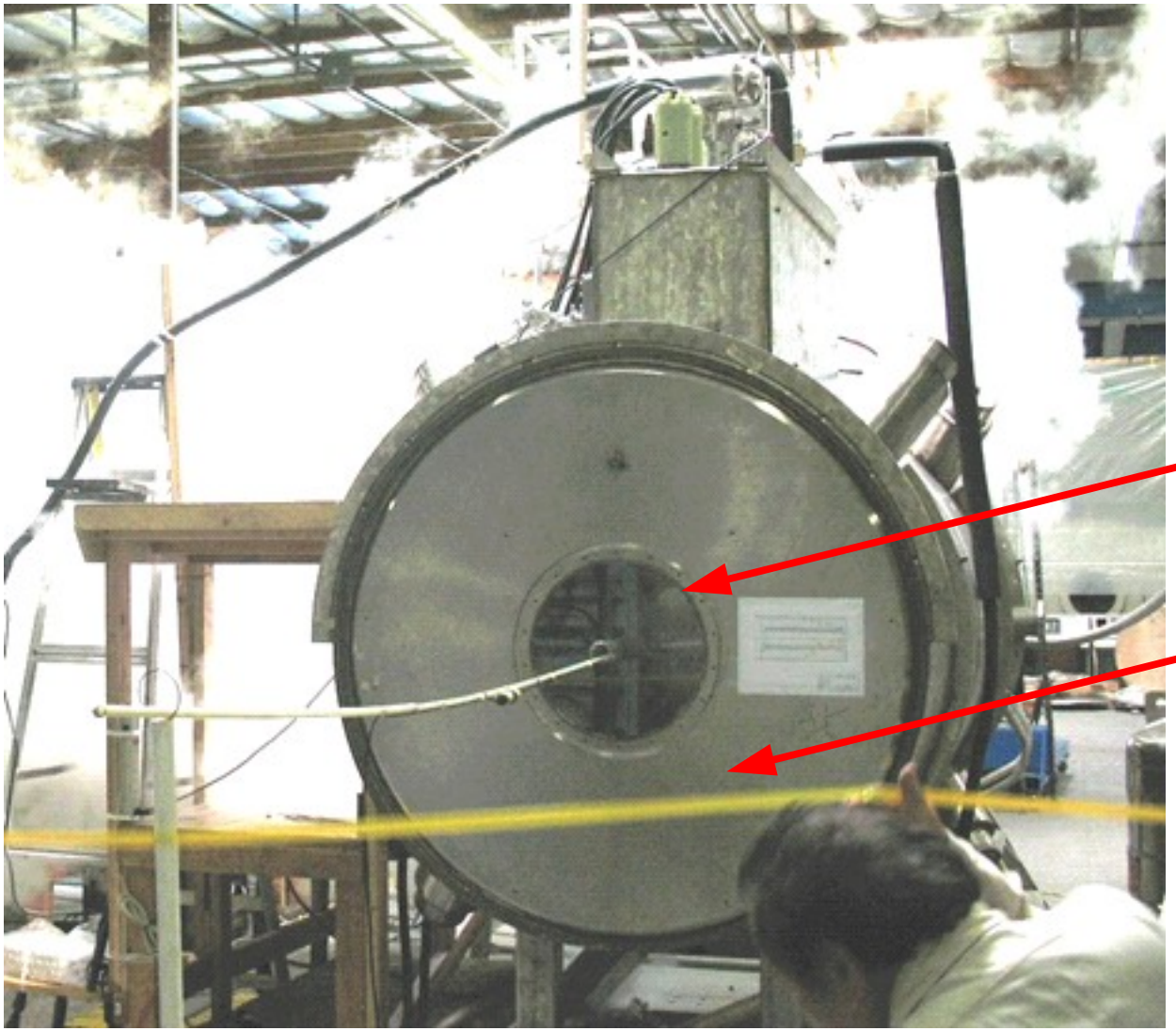
Measurement Plan

- Scan axial and transverse field along axis of solenoid warm bore tube
- Setup:
  - Hall probe installed in a holder connected to a long shaft
  - Bearings to center probe in non-magnetic stainless steel guide tube
  - Guide tube supported/centered within warm bore
- Hand-driven positioning system with 1 mm (i.e., “ruler”) accuracy
- Record probe voltage and position with DAQ
- Coarse measurement first, followed by detailed measurement
- Schedule estimate:
  - 1 day: setup + preliminary measurement for verification
  - 1 day: full scan
- Mock-up / testing at Fermilab using a Tevatron dipole @ 4T

Equipment List

- Fermilab:
  - 3D Senis Hall Probe (10 T range) with holder
  - G10 shaft with scale and centering bearings (2.6m)
  - Stainless steel guide tube
    - OD = 3.2 cm, Wall thickness = 0.7 mm, Length $\leq$ 3.5 m
  - Multiplex DVM with USB adapter
  - Laptop with Labview DAQ
- LBNL/Wang NMR:
  - Table with AC power at >5m distance from magnet
  - Support for centering the guide tube within warm bore

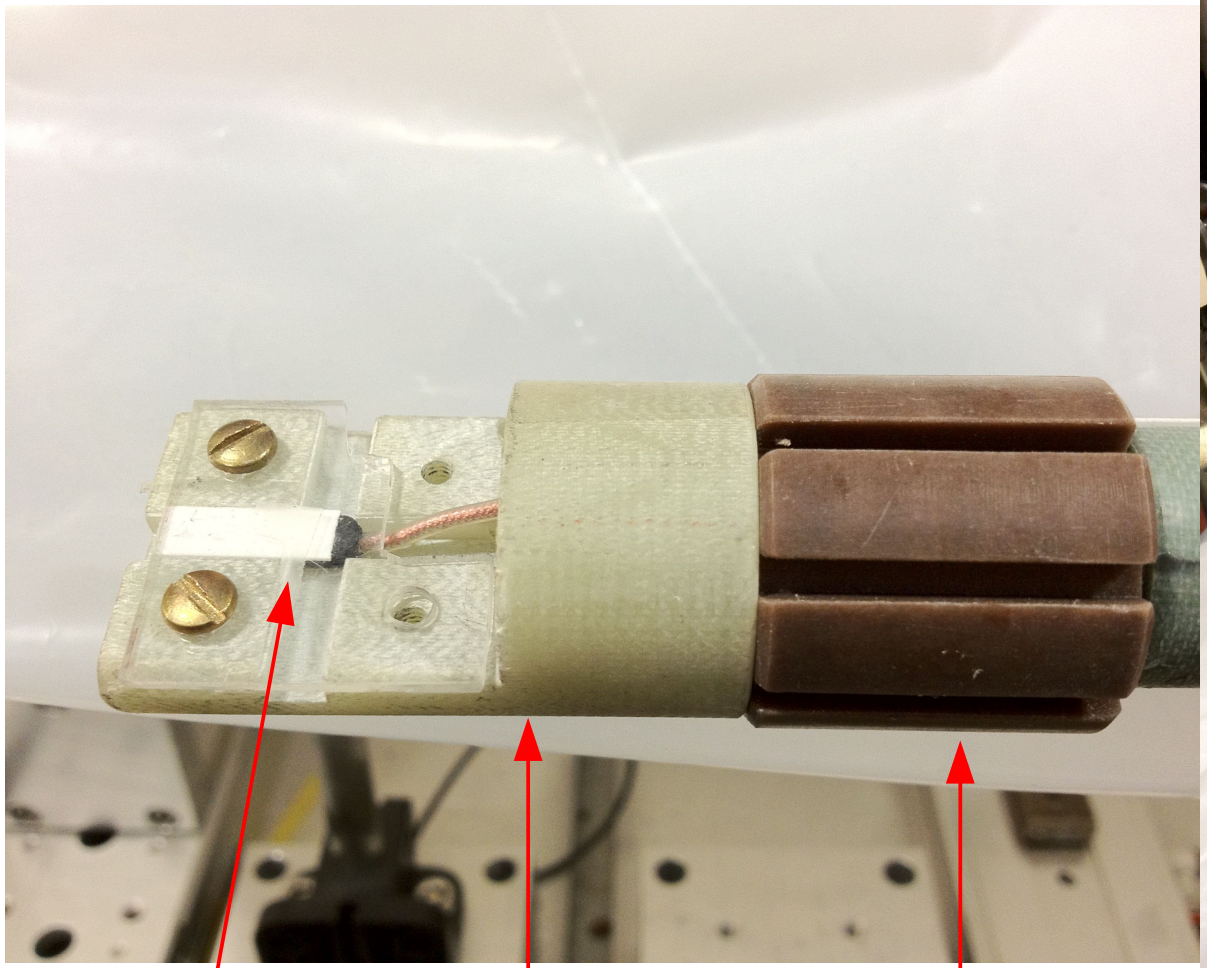
Guide Tube Centering

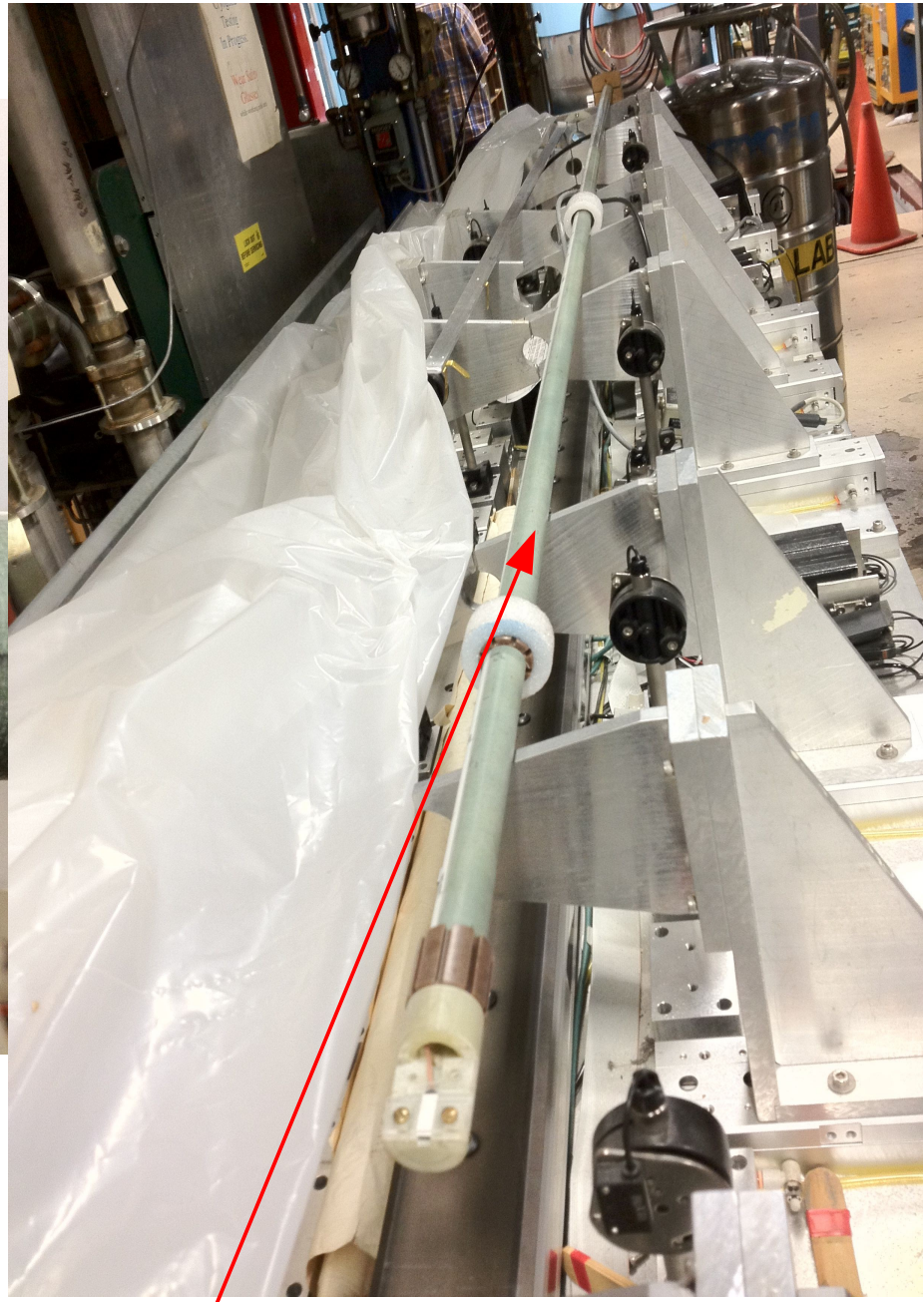


Use these pre-existing (?) disks for centering

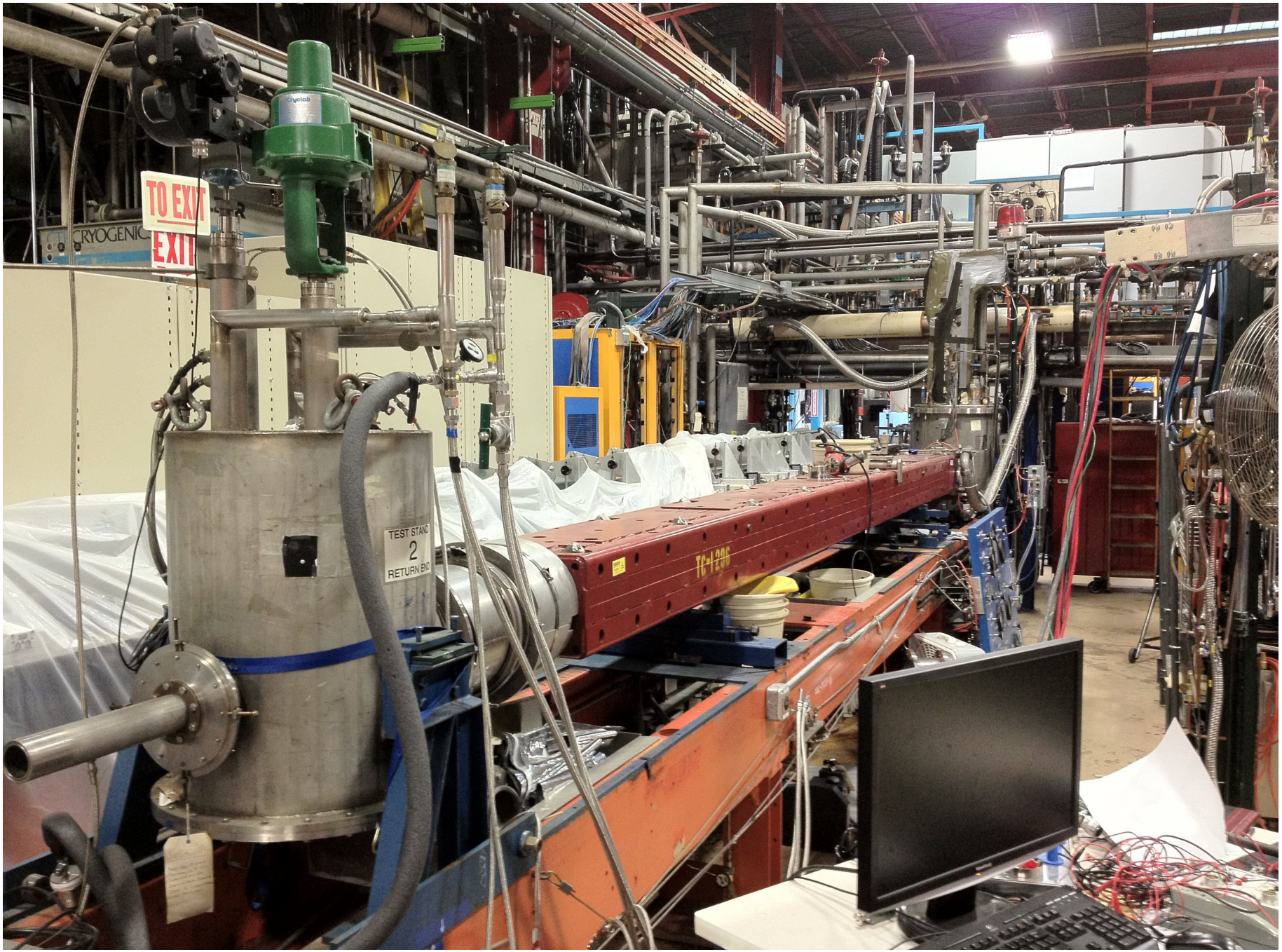
Fiducial markers?

Hall Probe


Probe with plexiglass cover
Holder
Centering bearings


Shaft with scale (2.6m)

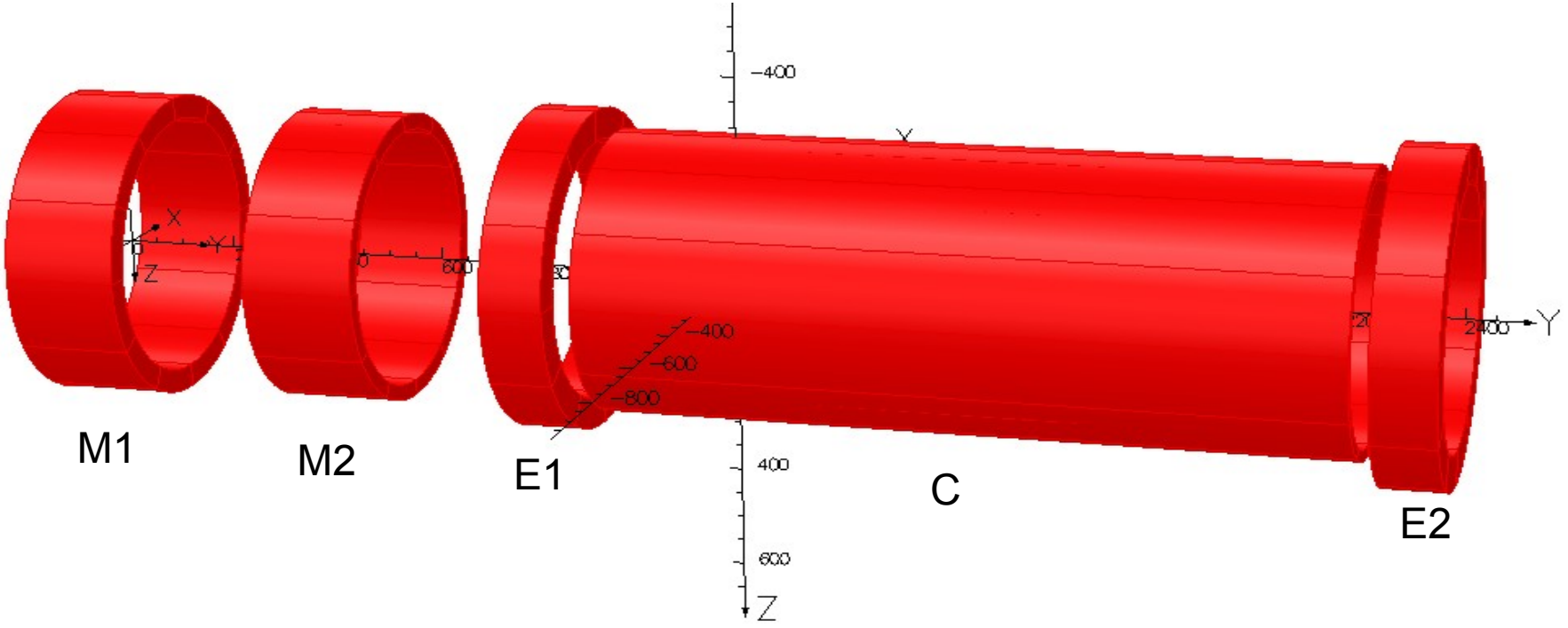
Tevatron dipole for testing and calibration up to 4T:



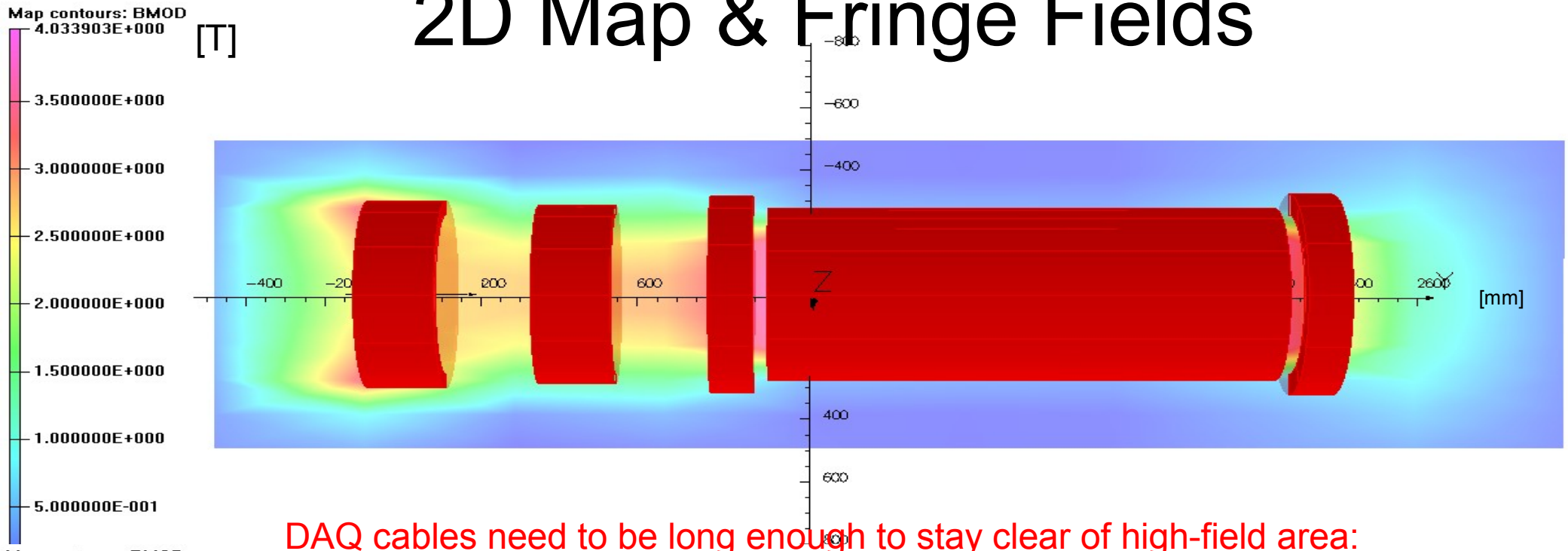
OPERA Simulations

	Match 1	Match 2	End 1	Center	End 2
Inner Coil Radius (mm)	258	258	258	258	258
Coil Thickness (mm)	46.165	30.925	60.905	22.125	67.783
Coil Length (mm)	201.268	199.492	110.642	1314.30	110.642
Current Center Axial Position* (mm)	124.00	564.00	964.00	1714.00	2464.00
Current Center Radial Position* (mm)	281.083	273.463	288.453	269.063	291.891
Coil Average J (A mm^{-2})	137.67	147.77	124.28	147.66	127.09
Number of layers per Coil	42	28	56	20	62
Number of Turns per Layer	115	114	64	768	64
Total Number of Turns	4830	3192	3584	15360	3968
Design Current (A)**	264.83	285.60	233.68	275.52	240.21
Coil Self Inductance (H)^	12.0	5.0	9.0	40.0	11.3
Coil Stored Energy (MJ)**	0.42	0.20	0.26	1.55	0.32
Peak Field in Coil (T)**	5.30	4.32	5.68	4.24	5.86
Temperature Margin at 4.2 K (K)**	~1.6	~1.8	~1.5	~2.0	~1.5

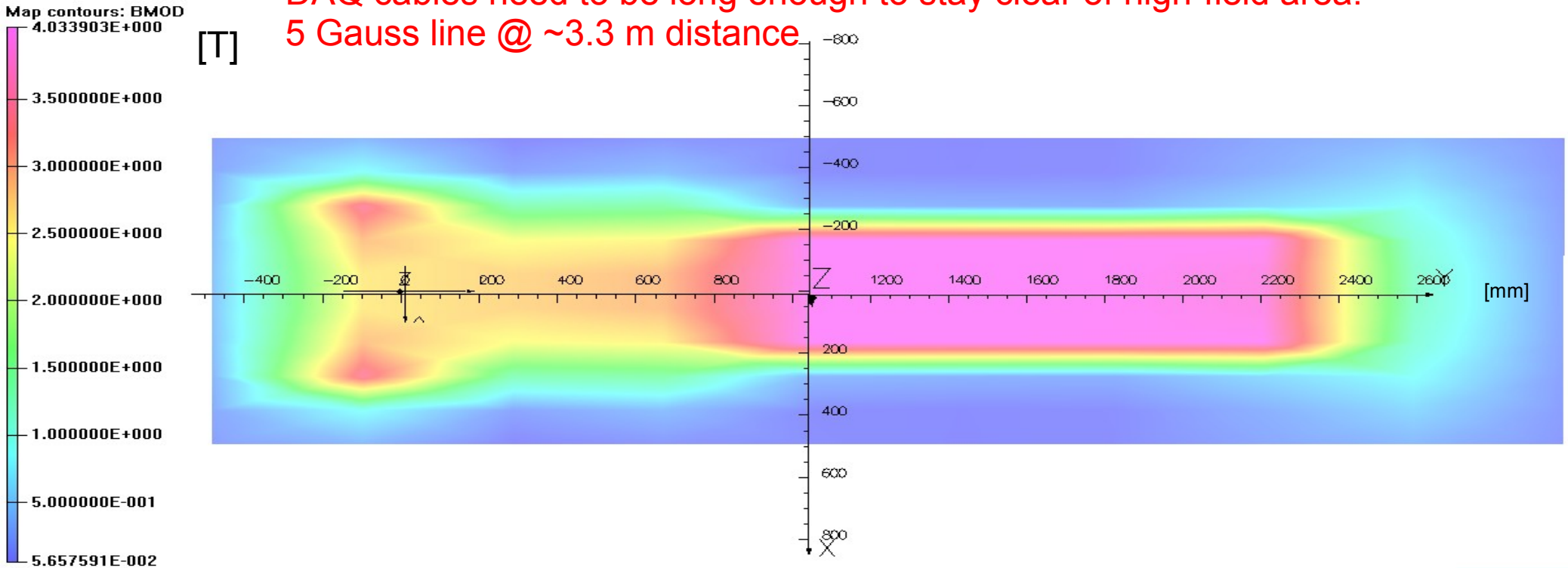
From “The Results of Tests of the MICE Spectrometer Solenoids” (Virosted & Green) IEEE Transactions on Applied SC, Vol. 20, No. 3, June 2010



2D Map & Fringe Fields

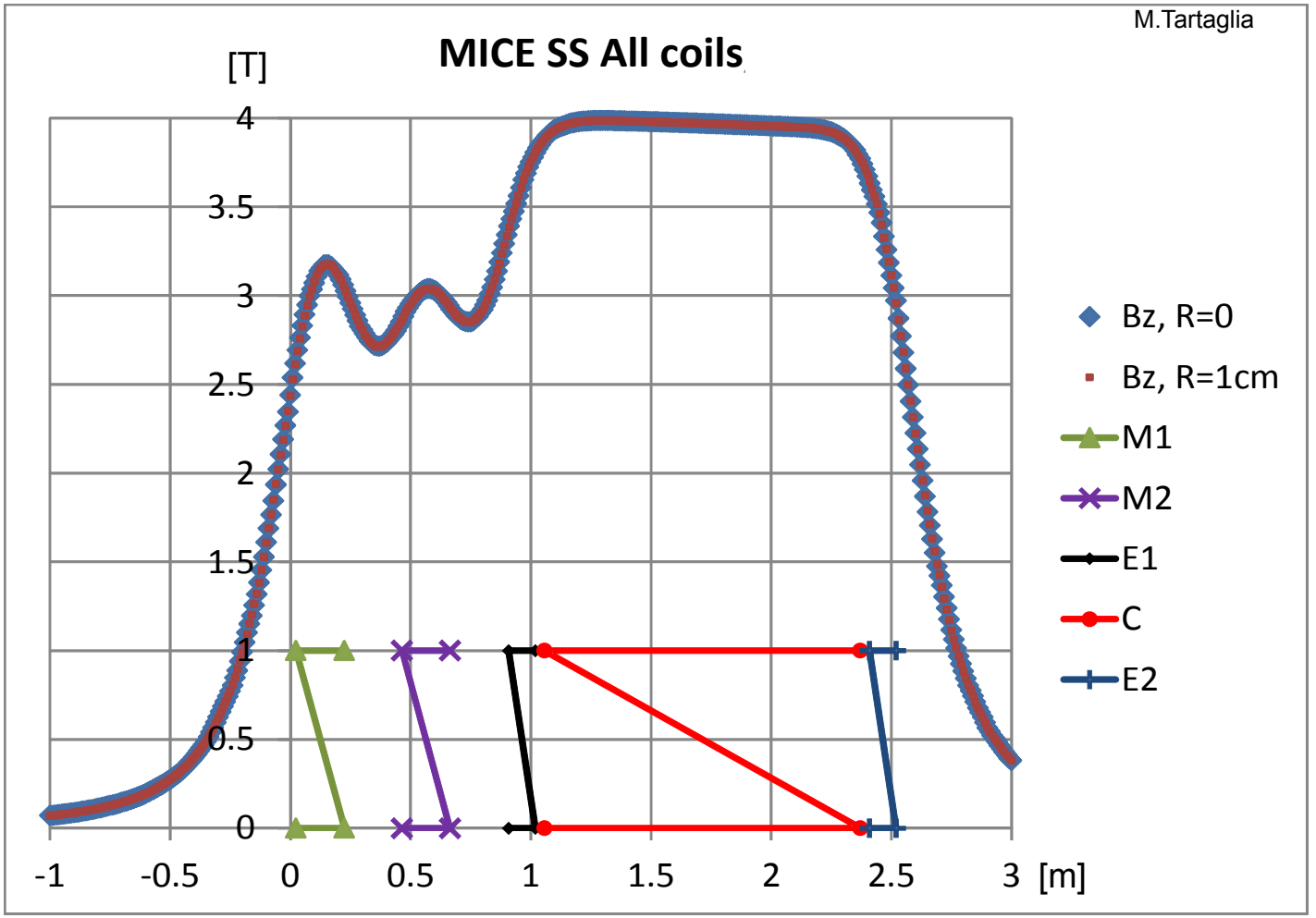


DAQ cables need to be long enough to stay clear of high-field area:
5 Gauss line @ ~3.3 m distance



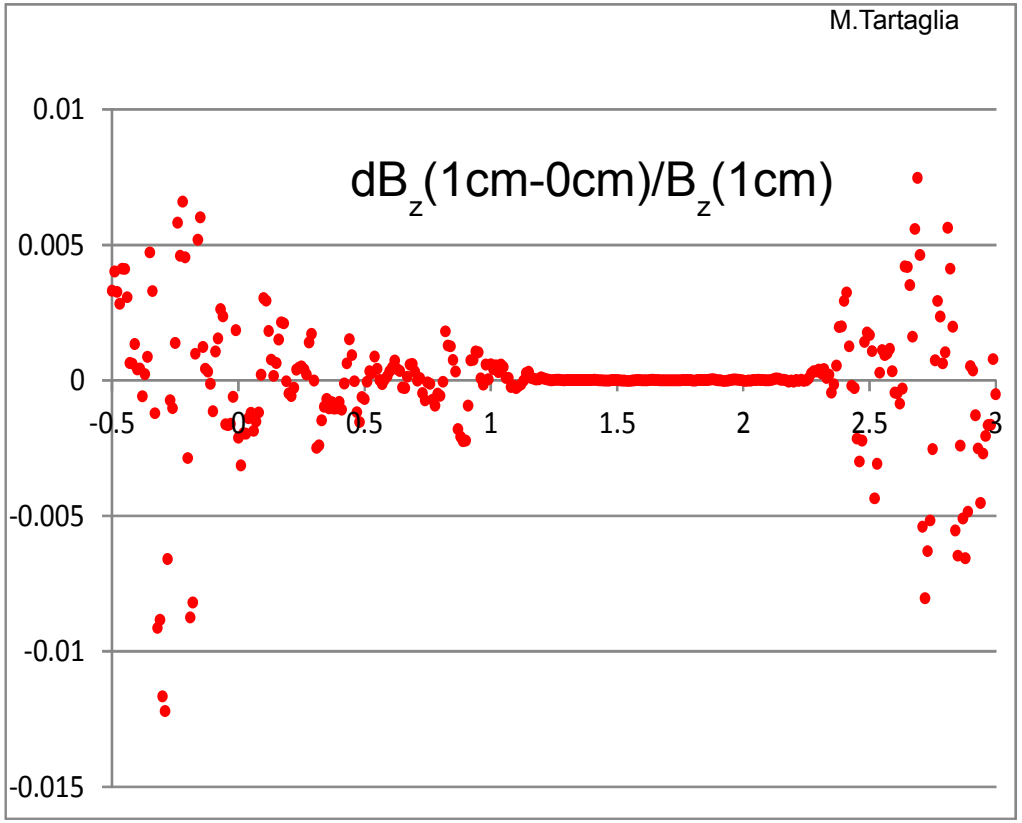
Opera

Estimating Sensitivity to Probe Positioning

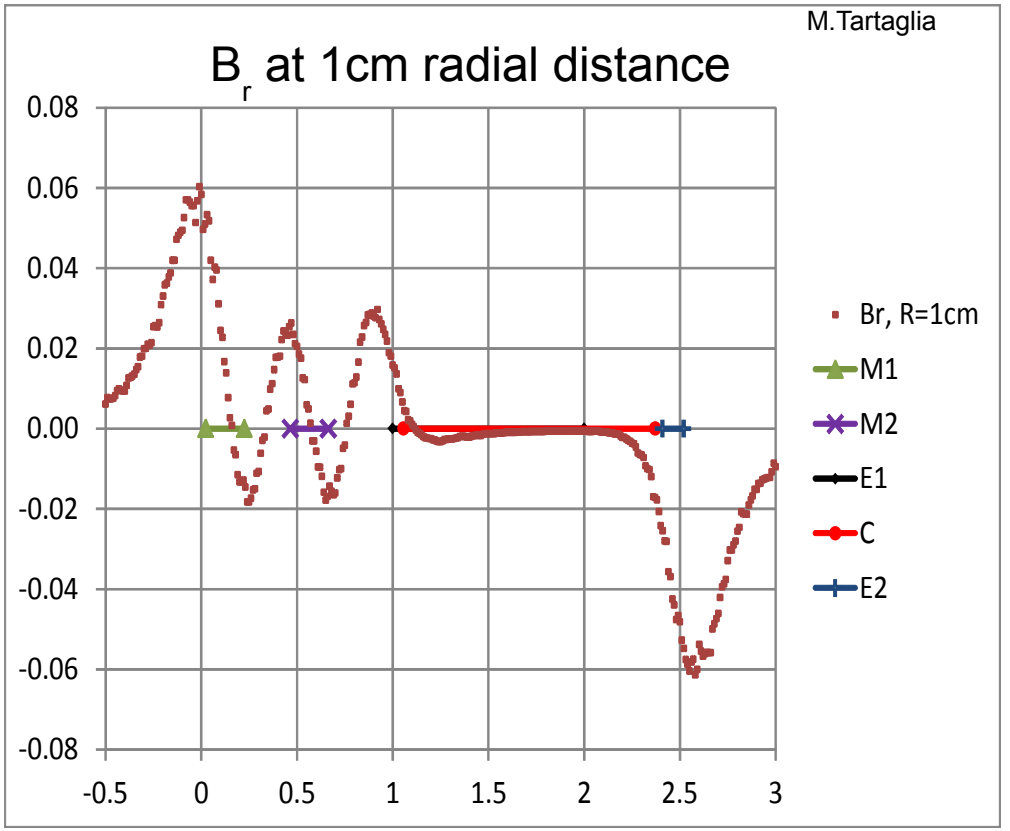


Comparing B_z on axis with B_z slightly off axis (1cm)

Estimating Sensitivity to Probe Positioning



Small effect of 1cm offset w.r.t. center axis



Negligible effect of radial field component on B_z measurement (in case of probe tilt)

Questions for Discussion

- Power configuration of coils for our measurement:
  - All coils ON vs individual coils ON?
  - Coils at full current vs coils at partial current?
- Granularity (in z) of measurement:
  - Time constraints: finer measurement vs reproducibility, time stability, etc.
- Range (in z) of measurement:
  - Affects length of stainless steel guide tube (max 3.2 m total length)
- Determination of magnetic center, i.e., off-axis field measurements
- Centering the apparatus:
  - Fiducial markers and centering disks?
- Infrastructure:
  - Power requirements: stable & quiet
  - Internet access at Wang NMR
  - Temperature/climate stability at Wang NMR
- Schedule for this measurement, i.e., when?
- What tests are made at RAL to fully qualify the magnet?