11th ATF2 Project Meeting

Thursday 13 January to Friday 14 January 2011
at SLAC

Status Report to ATF2 Technical Board

Brett Parker, BNL-SMD

URL : http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=4904

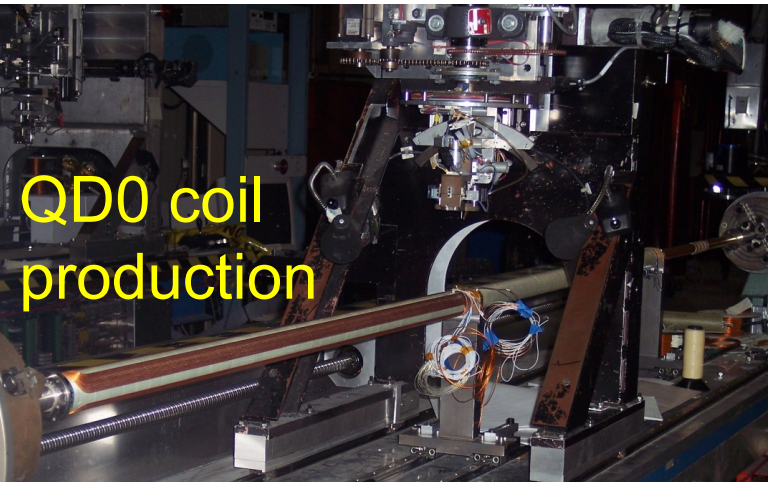
Outline

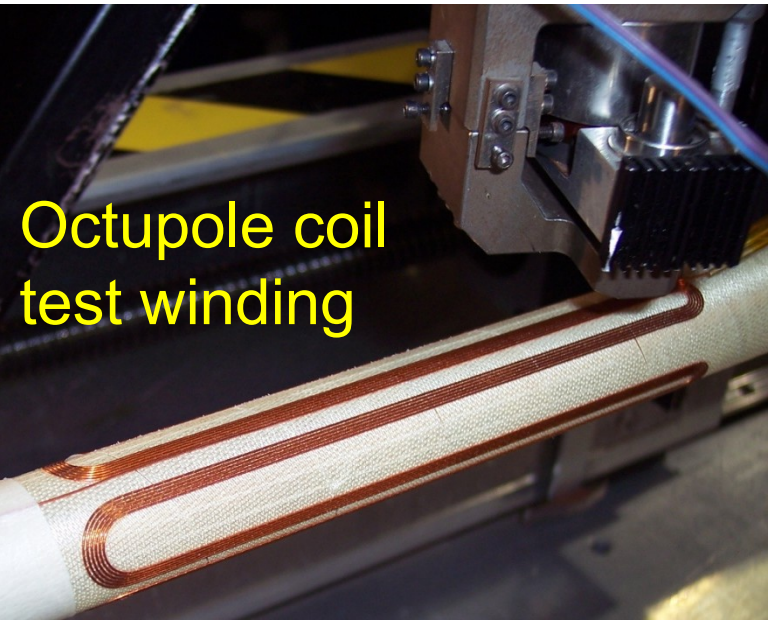
- ATF2 and QD0 R&D Prototype Status
- Vibration/Field Stability Measurement Status
- Work Plan and Prospects Beyond 2012

ATF2 Superconducting Upgrade
FF Magnet Production Status

- Main coil, quadrupole and sextupole, windings are complete and warm magnetic measurements indicate field quality is very good (for details see first three backup slides).
- We are waiting to complete winding of correction coils since further production has been deferred.
- Preliminary magnet cryostat design completed.
- Detailed design work and material orders on hold.
- Tentative cryogenic interface exists (BNL / KEK).
- KEK production of cryogenic supply box has also been deferred.

QD0 R&D Prototype Coil Winding Status



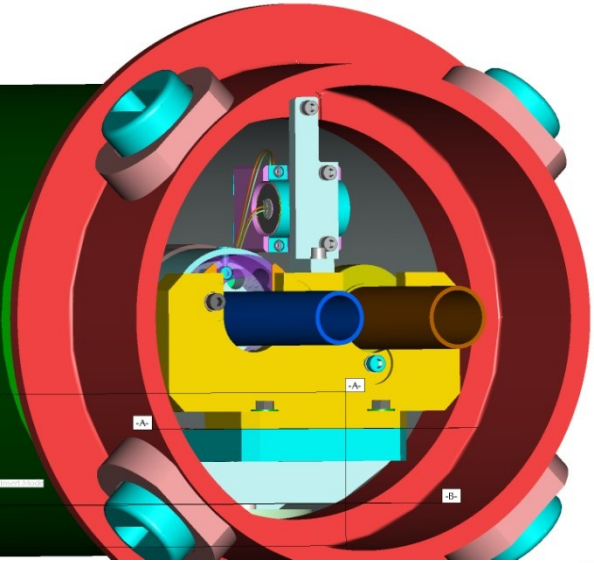


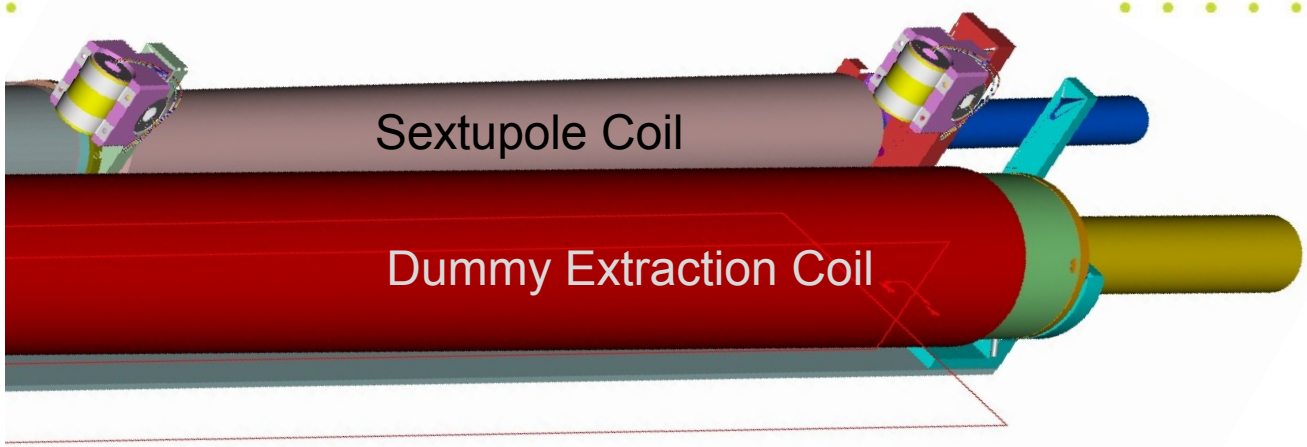
- To control coil support tube position during winding, we split QD0 coil in order to have a fixed support.
- Coil winding of all the quadrupole layers is complete and the measured harmonic agree with expectations.
- Vertical cold test has been done; tested to 10% above operating current without quenching; forced quenches with spot heater, saw no degradation.
- Have started winding octupole coil correction windings; next we will start winding the main sextupole coil sets.

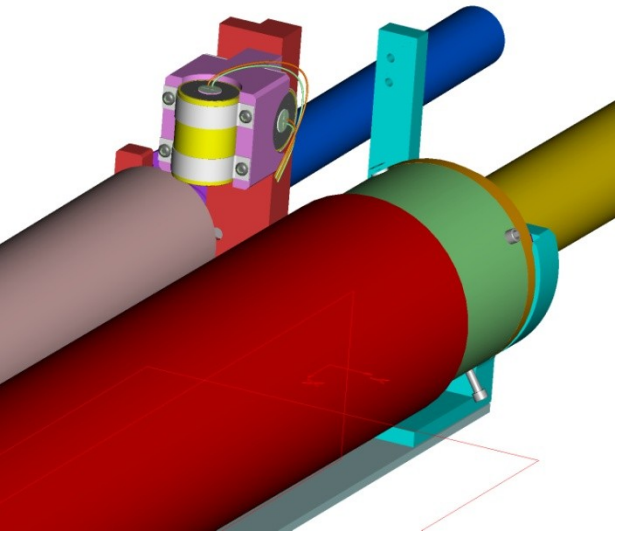
Progress towards QD0 R&D Prototype Vibration and Field Stability Studies

- At previous meetings we reported on:
  - **Possibilities to use the NSLS-II stretched wire system to measure (DC) field centering along the length of the quadrupole and sextupole coils.**
  - **Using existing laser system to measure QD0 cryostat and cold mass motion during horizontal testing**
- We report now on new developments to:
  - **Incorporate geophones, similar to what was done for RHIC IR quadrupole testing, into the QD0 cold mass.**
  - **Develop a warm pipe insert for QD0 to permit truly independent stabilization of a pick up coil inside the cold bore and then directly measure field motion to correlate with cold mass and cryostat motion.**

Geophone Locations Inside QD0 Cold Mass



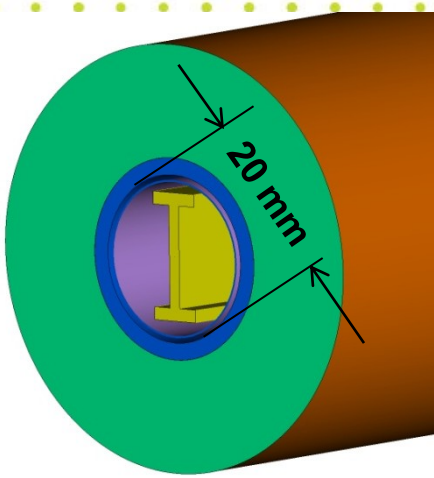


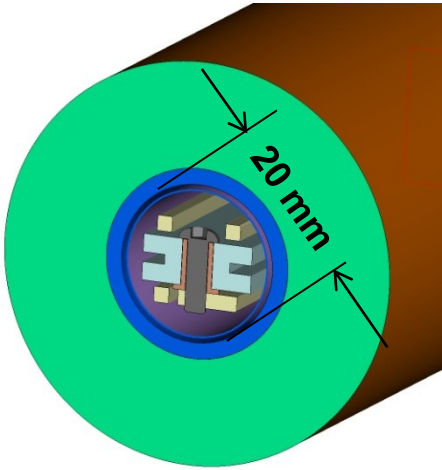


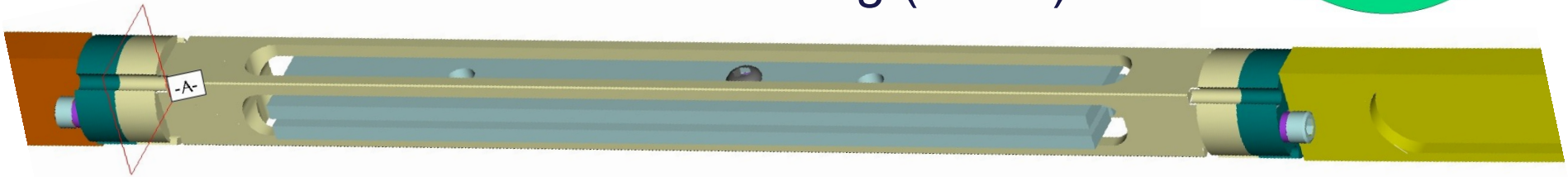
- Building upon RHIC IR quad experience, we look to put geophones inside the QD0 R&D prototype cold mass.
- Two mounting points at the coil support attachment points are under consideration.
- Only make measurements with coils off!
- Work underway to determine if fringe fields from coils might still damage sensors.

QD0 Field Stability Direct Measurement

- Develop thin walled, warm finger design with test coil stabilized independent of QD0 structure.
- Multi-turn probe coil would be mounted in fixture that could be rotated 90º to measure changes in either the horizontal or vertical field.
- It is critical to carefully adjust coil centering so as to minimize sensitivity to power supply ripple.
- Do this adjustment via deliberate AC current excitation of the magnet coils.
- Need to determine if “I-Beams” on either side of coil holder have to be non-conducting (or SS).







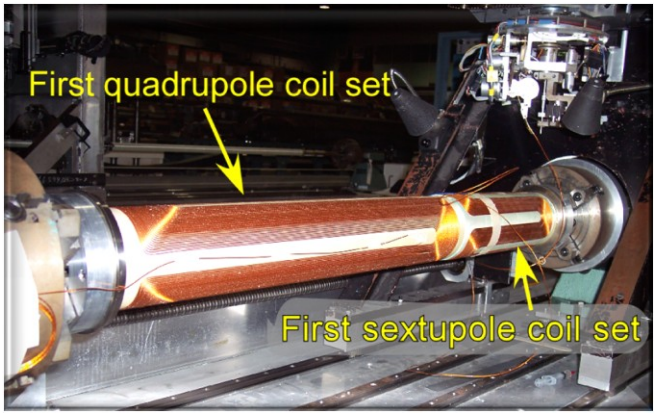
Work Planning and Future Opportunities

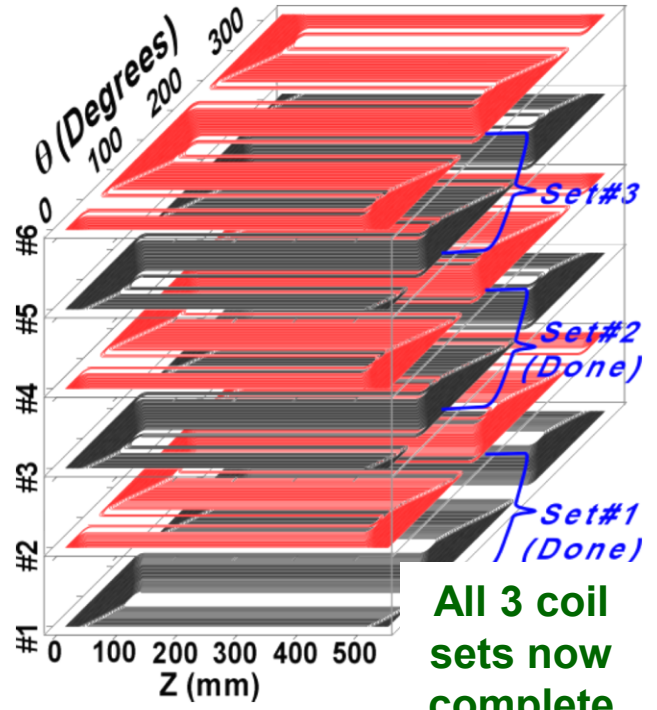
- By concentrating on QD0 R&D work we sought, in an environment of reduced (rather than increasing) ART funding to maximize the information available for the ILC TDR (i.e. before 2012 end of 1st phase ILC R&D).
- To accomplish this we had to defer work on the ATF2 superconducting magnet upgrade (which can anyway only occur after 2012 with a follow on ATF2 program).
- If ART funding beyond 2012 is available, it is of course possible to apply the QD0 R&D experience to ATF2 using the existing coils and gain experience under actual accelerator operation while facilitating beam studies that require exceptional field quality.

Backup Slides

ATF2 Coil Winding Overview

- Winding of the main quadrupole (six layers) and sextupole (four layers) coils now complete.
- Production measurement results for field harmonics are consistent with our understanding of the requirements for future ATF2 "pushed β* optics" studies.





All 3 coil sets now complete

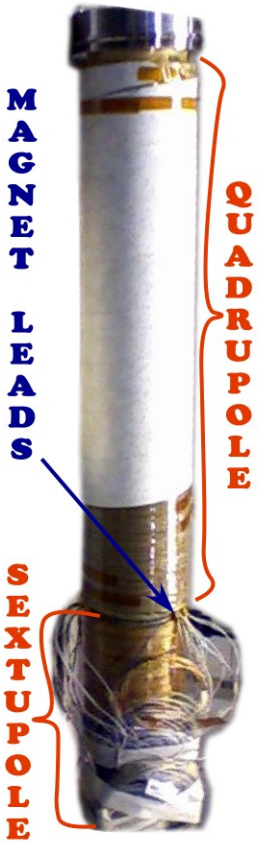
Summary of Integral Field Quality in ATF2 Magnet

Normal	Quadrupole	Sextupole
I.T.F.	26.959	194.00
Fld. Ang. (mr)	-12.5	14.8
Leff(m)	--	--
b1	--	-0.3
b2	10000.0	--
b3	1.2	10000.0
b4	-1.3	0.6
b5	0.4	-0.8
b6	0.7	0.1
b7	0.0	0.2
b8	-0.1	0.4
b9	0.0	0.4
b10	0.0	0.1
b11	0.0	0.5
b12	0.0	0.1
b13	0.0	0.0
b14	0.0	-0.1
b15	0.0	-0.5

Skew	Quadrupole	Sextupole
I.T.F.	26.959	194.00
Fld. Ang. (mr)	-12.5	14.8
Leff(m)	--	--
a1	--	-8.6
a2	--	--
a3	-1.2	--
a4	-2.2	-2.0
a5	-0.3	-1.5
a6	0.1	-4.2
a7	0.2	-0.4
a8	0.1	0.2
a9	0.1	0.3
a10	-0.2	0.2
a11	0.0	0.1
a12	0.0	-0.2
a13	0.0	-0.1
a14	0.0	0.0
a15	0.0	0.0

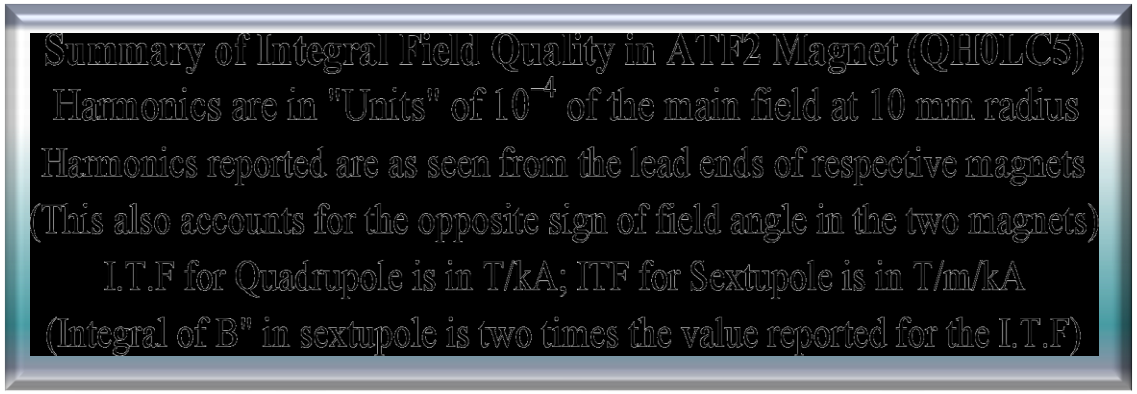
Harmonics are in "Units" of 10^{-4} of the main field at 25 mm as seen from the lead ends of respective magnets (yielding opposite sign of field angle in the two magnets). I.T.F for Quadrupole is in T/kA; ITF for Sextupole is in T/m/kA (Integral of B" in sextupole is two times the value reported for the I.T.F).

ATF2 Coils



Summary of Integral Field Quality in ATF2 Magnet

- Because field harmonics change rapidly with reference radius, we recalculated the measurements for R_{ref} = 10 mm (for easy comparison to the present ATF2 magnets).
- The poorest quad harmonics (b3,a3), are now only **49. parts per million**.
- The areas highlighted in blue are all **smaller than 200 parts per billion**.



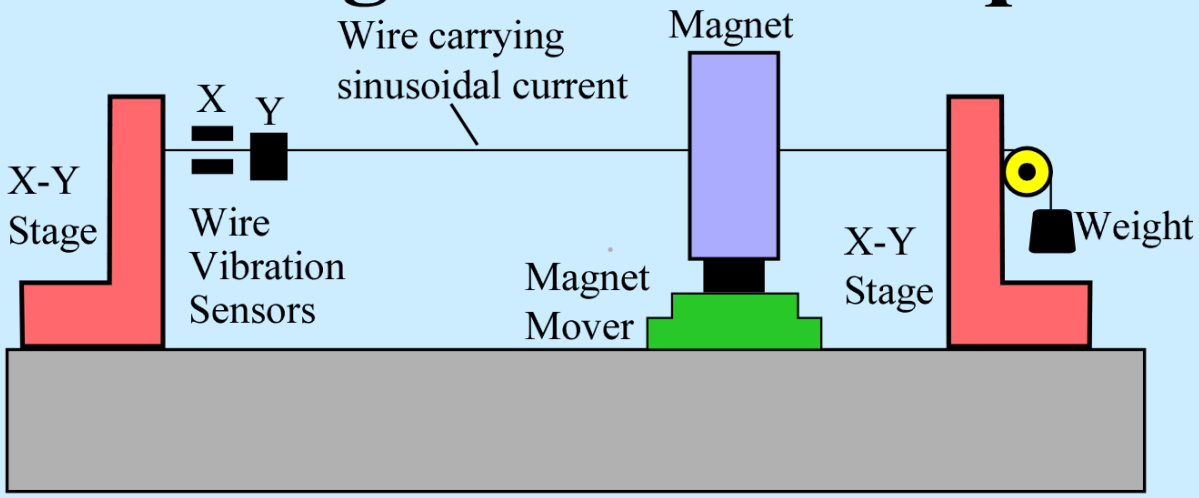
	Quadrupole	Sextupole
I.T.F.	26.959	194.00
Fld. Ang. (mr)	-12.5	14.8
Leff(m)	--	--
b1	--	-1.6
b2	10000.0	--
b3	0.49	10000.0
b4	-0.20	0.3
b5	0.025	-0.133
b6	0.018	0.006
b7	0.000	0.005
b8	0.000	0.004
b9	0.000	0.002
b10	0.000	0.000
b11	0.000	0.000
b12	0.000	0.000
b13	0.000	0.000
b14	0.000	0.000
b15	0.000	0.000
a1	--	-53.8
a2	--	--
a3	-0.49	--
a4	-0.35	-0.79
a5	-0.016	-0.238
a6	0.001	-0.270
a7	0.002	-0.010
a8	0.001	0.002
a9	0.000	0.001
a10	0.000	0.000
a11	0.000	0.000
a12	0.000	0.000
a13	0.000	0.000
a14	0.000	0.000
a15	0.000	0.000

Integral Field Quality in ILC QD0 Prototype: Harmonics are in "Units" of 10^{-4} of main field at 5.0 mm radius.

Normal	Lead End Half Run 49	Non-Lead End Half Run	Both Halves (Vector sum)	Skew	Lead End Half Run 49	Non-Lead End Half Run	Both Halves (Vector sum)
I.T.F. (T/kA)	211.893	209.168	421.05	I.T.F. (T/kA)	211.893	209.168	421.05
Fld. Ang. (mr)	9.8	2.8	6.3	Fld. Ang. (mr)	9.8	2.8	6.3
Leff(m)	1.069	1.069	--	Leff(m)	1.069	1.069	--
b1	--	--	--	a1	--	--	--
b2	10000.0	10000.0	10000.0	a2	--	--	--
b3	-1.4	-7.7	-4.5	a3	-1.1	-19.3	-10.2
b4	-0.4	-1.9	-1.1	a4	-2.2	-3.2	-2.7
b5	0.2	-0.3	-0.1	a5	-0.4	-0.8	-0.6
b6	0.2	0.0	0.1	a6	0.6	0.2	0.4
b7	-0.1	-0.1	-0.1	a7	0.0	0.1	0.1
b8	0.0	0.0	0.0	a8	0.1	0.0	0.1
b9	0.0	0.1	0.0	a9	0.0	0.0	0.0
b10	-0.2	-0.2	-0.2	a10	0.1	0.0	0.1
b11	0.0	0.0	0.0	a11	0.0	0.0	0.0
b12	0.0	0.0	0.0	a12	0.0	0.0	0.0
b13	0.0	0.0	0.0	a13	0.0	0.0	0.0
b14	0.0	0.0	0.0	a14	0.0	0.0	0.0
b15	0.0	0.0	0.0	a15	0.0	0.0	0.0

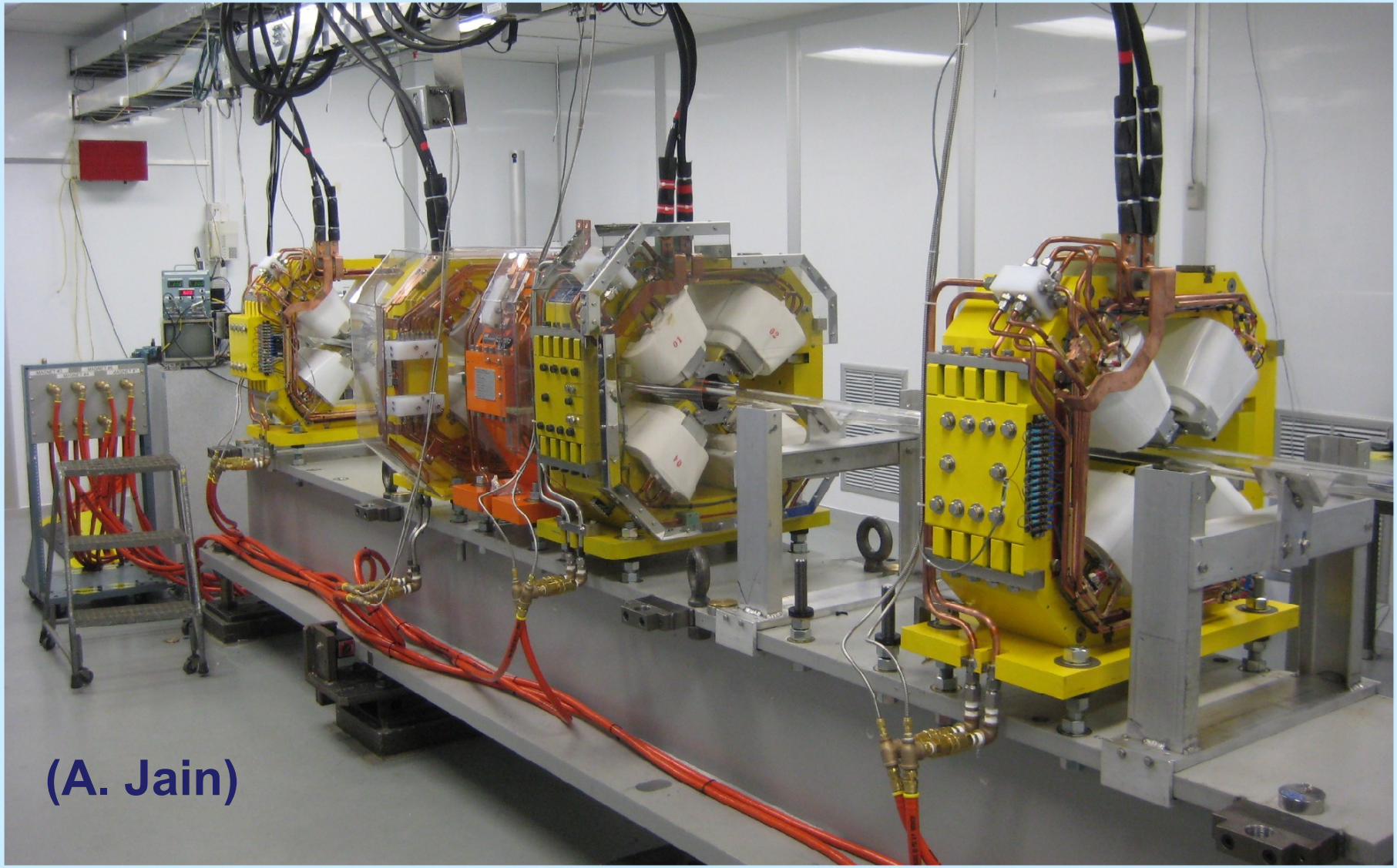
The Vibrating Wire Technique: Basics

(A. Jain)

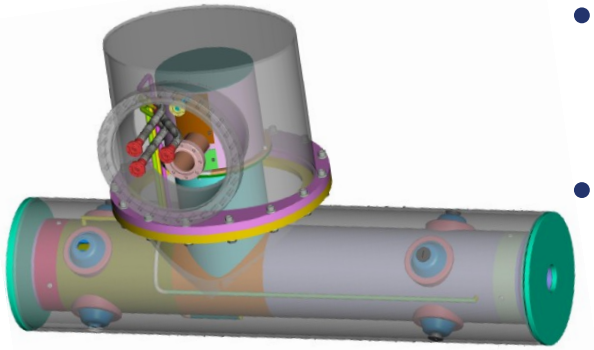


- An AC current is passed through a wire stretched axially in the magnet.
- Any transverse field at the wire location exerts a periodic force on the wire, thus exciting vibrations.
- The vibrations are enhanced if the driving frequency is close to one of the resonant frequencies, giving high sensitivity.
- The vibration amplitudes are studied as a function of wire offset to determine the transverse field profile, from which the magnetic axis can be derived.

NSLS-II Prototypes in Vibrating Wire Test Stand

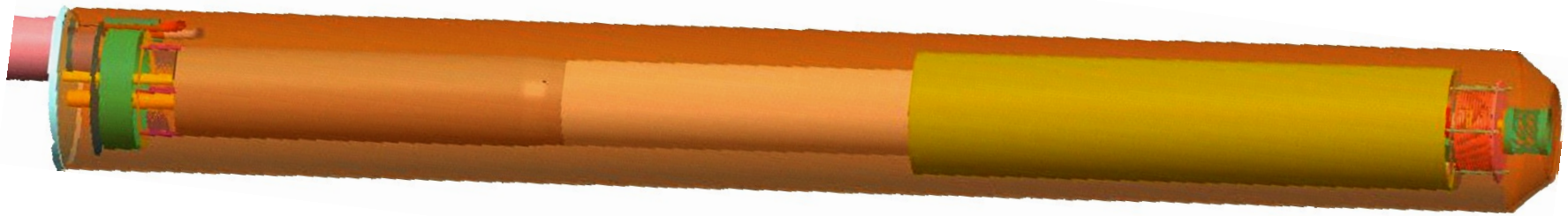


ILC R&D Prototype and ATF2 Comparison



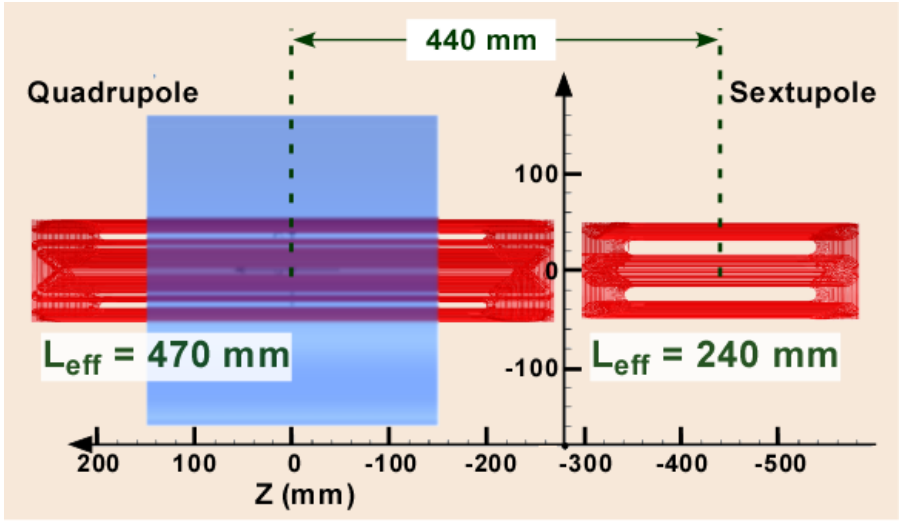
ATF2 Upgrade Magnet
(concept test with beam)

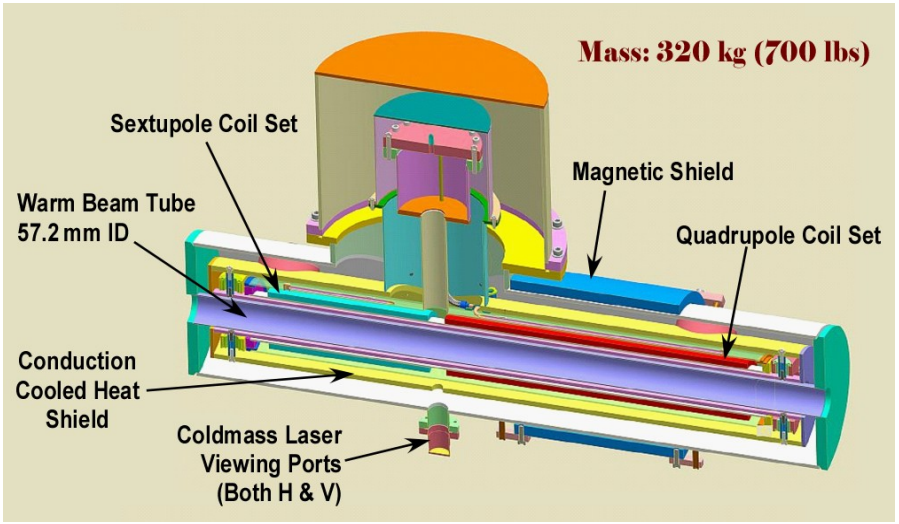
- Both are compatible with 1.9K testing via an ILC-style Service Cryostat (SC) at BNL.
- ATF2 magnet should be 4.2K tested at BNL with SC and the ATF2 Cryogenic Box before being shipped to KEK.
- The ATF2 magnet can be tested with beam; there is no way to beam test R&D prototype.



ILC QD0 Full-Length R&D Prototype Magnet Program
(a full-scale, instrumented, 1.9K ILC SC, systems test)

ATF2 Upgrade Production/Design Status

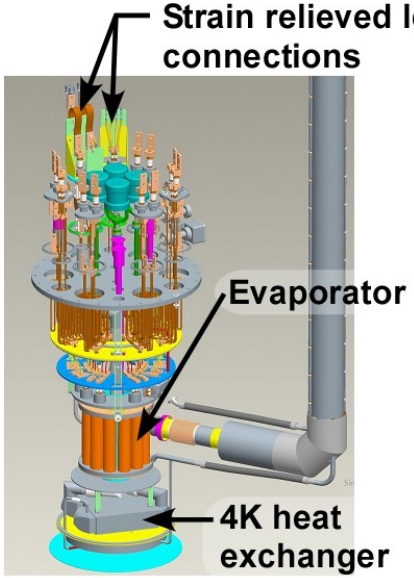


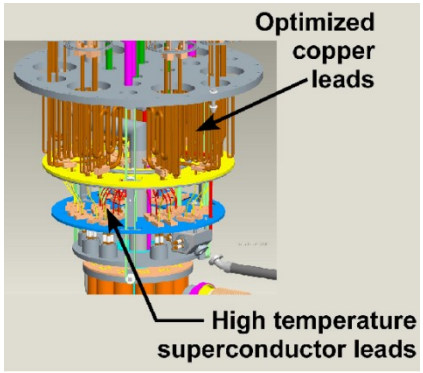


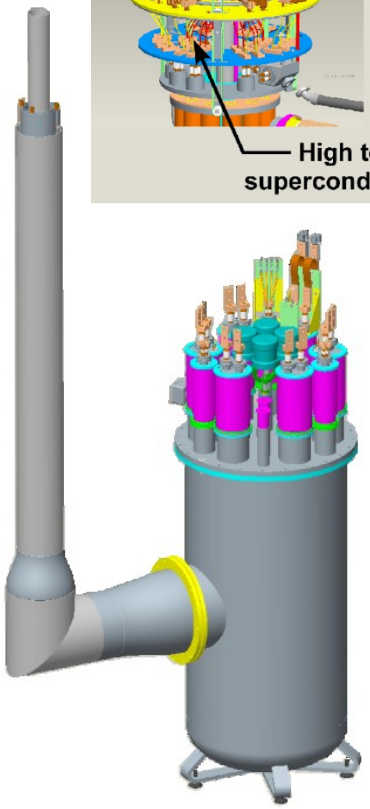
- Main coil winding now complete.
- Measured harmonics are small.
- A first pass cryogenic interface made at '09 face-to-face meeting.
- Magnetic shielding calculations (homework) done; results indicate we can make both Hor./Vert. laser penetrations (through the quad's magnetic shield) at the center of each magnet coil without spoiling their good harmonics and still ensuring sufficiently low B-field at the external geophone locations.

Service Cryostat & Other ILC Activities at BNL

Service Cryostat Under Construction at BNL





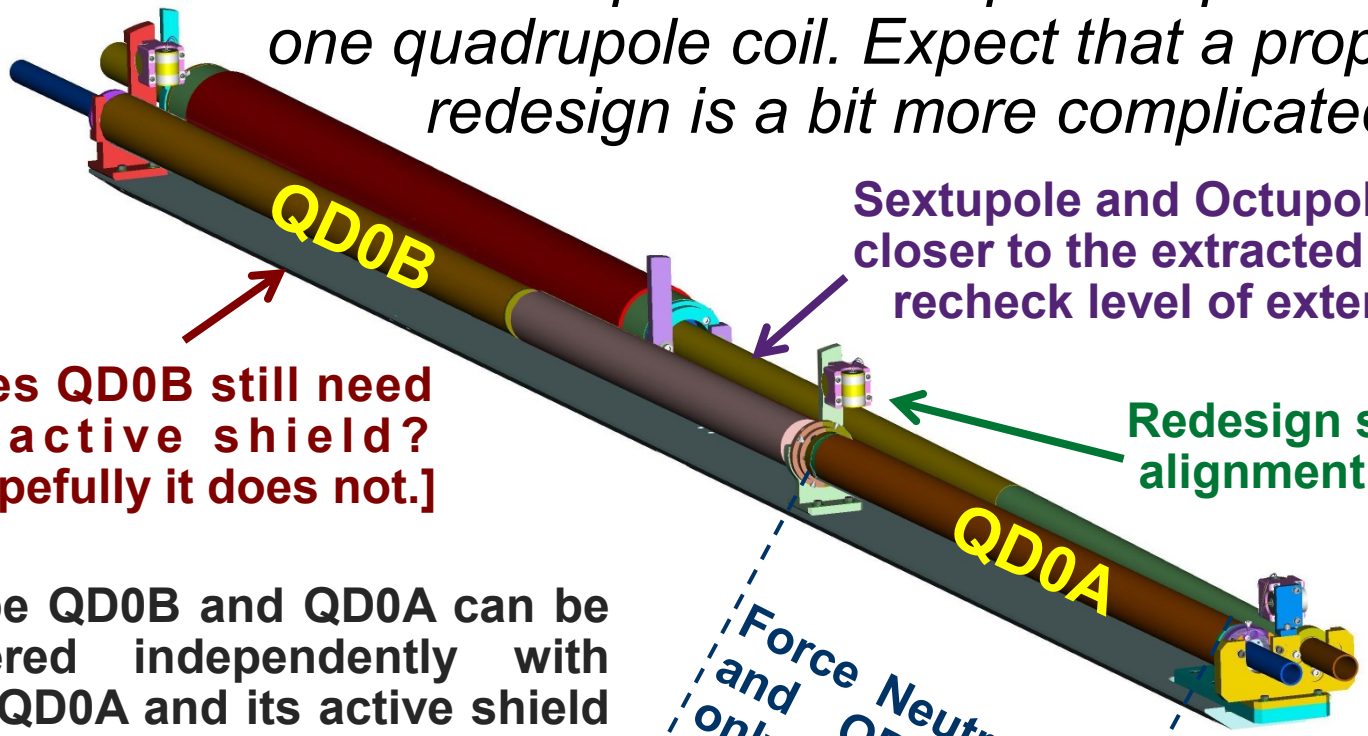


Develop option that allows for ILC-like 1.9K tests at BNL and 4.2K operation at ATF2 (KEK) with cryo-coolers.

- SC design features for ATF2 mode nearly finished.
- Detailed drawings for SC and QD0 now underway.
- SC and QD0 long lead time items are identified (initiate critical orders).
- For MDI, look to restart work on QF1 cryostat and the cryogenic transfer lines.
- Demonstrate ILC-like FF magnet system production and operation.
- Common ILC/CLIC work.

Universal Final Focus (Cartoon) Issues

Here I took the CAD layout from slide #7 and did cut/paste to swap sextupole and one quadrupole coil. Expect that a proper redesign is a bit more complicated.



Sextupole and Octupole coils are now closer to the extracted beam; so must recheck level of external B-field.

Does QD0B still need an active shield? [Hopefully it does not.]

Redesign support & alignment scheme.

Maybe QD0B and QD0A can be powered independently with only QD0A and its active shield run in series?

Do QD0A and QD0B have to have the same coil structure and magnetic length?

Force Neutral Anti-Solenoid and QD0A Active Shield only need to extend over this region?