Accelerator Working Group: Beam Delivery & IR, Held
Tuesday, July 15, 8:30-10:30 am

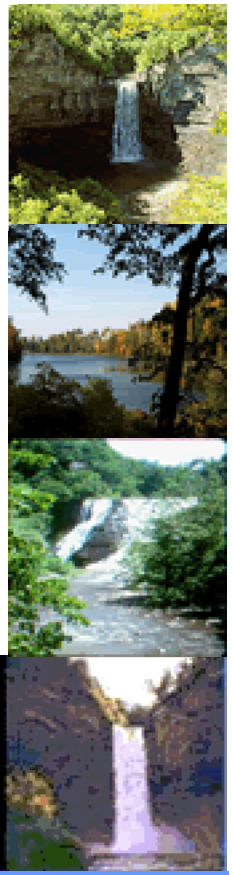
BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division
NLC - The Next Linear Collider Project

The Compact Superconducting Final Focus Doublet Option

presented by Brett Parker representing

Superconducting Magnet Division & BNL

- Review NLC Superconducting FF Design Concept.
- Use for a TESLA-like Machine (NLC-TESLA Hybrid).
- Future Research and Development Challenges.



July 13-16
Sun - Wed

American Linear Collider Workshop
Cornell University, Ithaca New York

Superconducting QD0 Concept & NLC Interaction Region Layout

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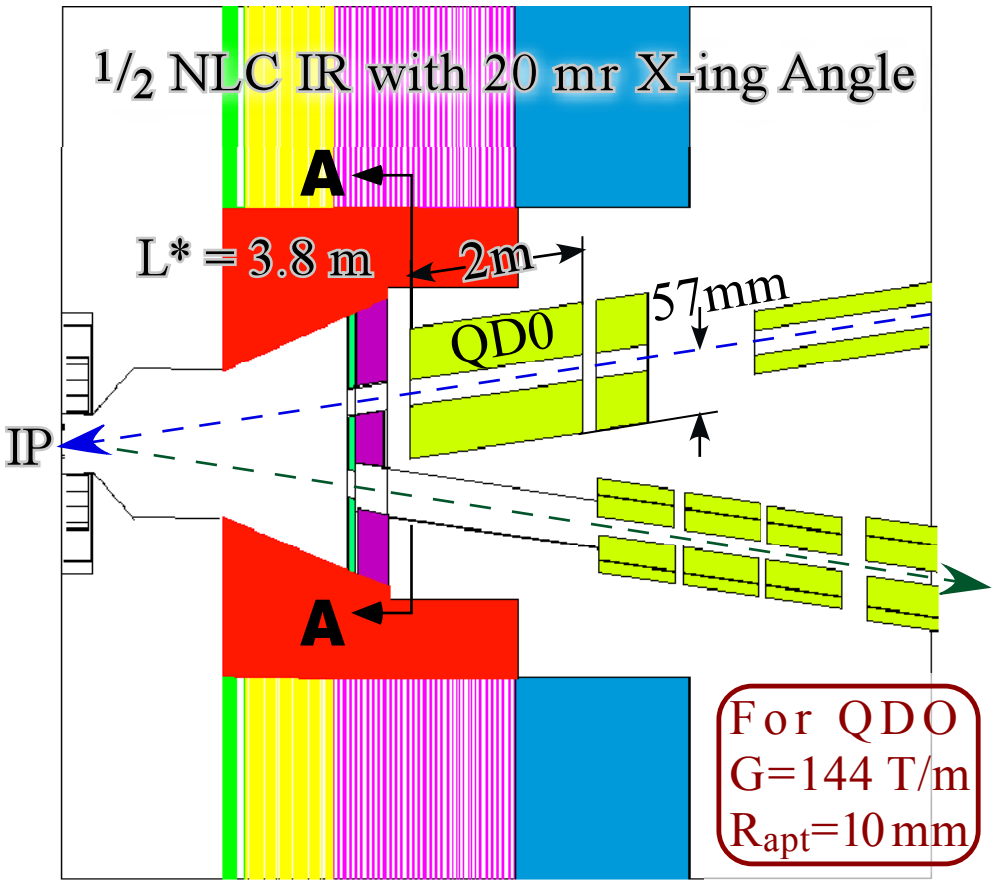
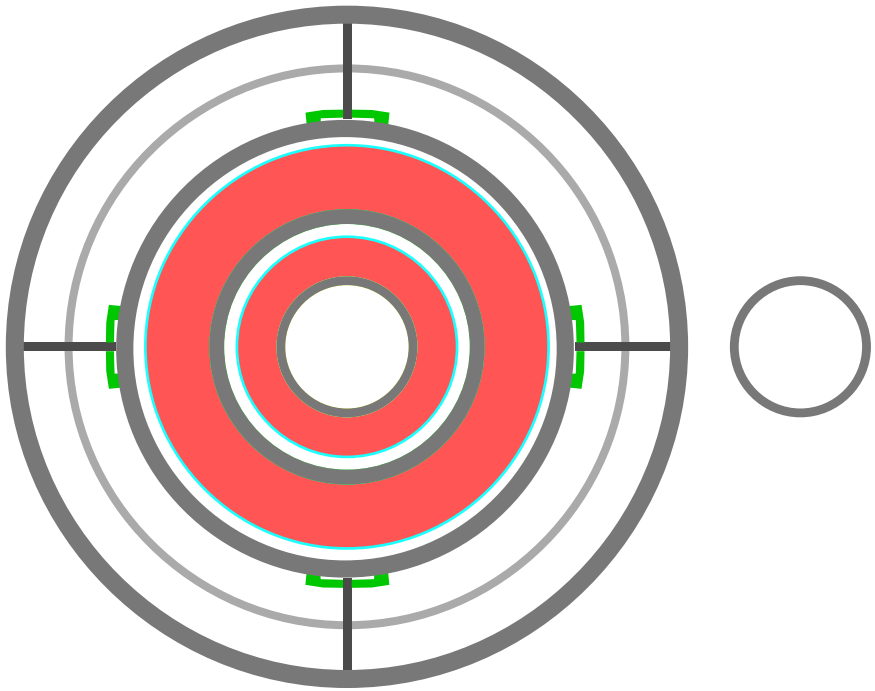
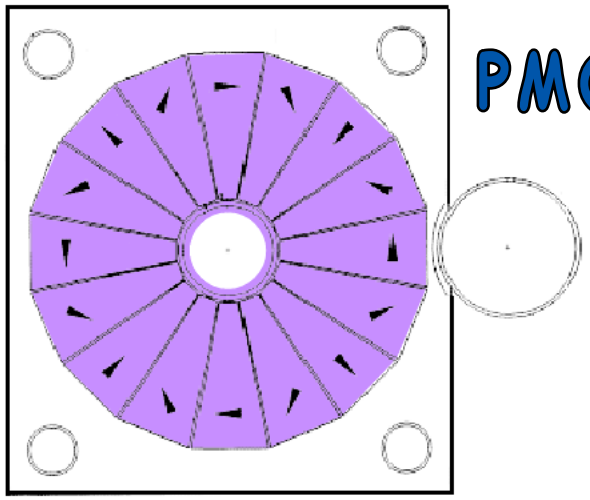


Section AA at QD0 Front End

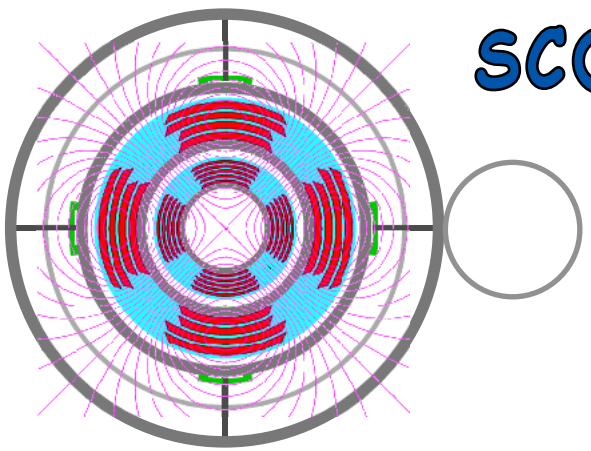


With compact FF quadrupole, QD0 shown above, the NLC crossing angle solution permits disrupted beam to pass outside the cryostat into a beam diagnostic line that ends at a high-power beam absorber.

Superconducting Alternative to a Permanent Magnet Quadrupole.



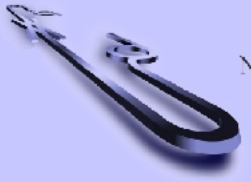
PMQ



SCQ

- Should fit in same space. ✓
- Should give same gradient. ✓
- Net force or torque in solenoid for SCQ ≈ zero (unlike PMQ).
- PMQ has extra longitudinal & transverse fields (unlike SCQ).
- For SCQ disrupted beam passes through non-zero field (unlike PMQ).

NLC Superconducting FF Work and Other LC BDS Activities.



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NLC-style IR: Have 20 mrad crossing angle & 20 mm incoming aperture. Outgoing beamline is used for diagnostics & instrumentation.

Replace permanent magnets near IP with compact superconducting ones.

Cold option gives flexibility: optics variation,
energy variation,
improved correction scheme, etc..

Issues involve: FF mechanical stability (1 nm !) & adjustability, beams interacting with off-axis solenoid & external fields, field stability, radiation resistance and coping with the 11 (22 for TESLA) MW disrupted beams.

Work is in progress at BNL (M. Harrison, S. Berg, C. Montag, B. Parker, F. Pilat and BNL-SMD) within NLC Collaboration and USLCSG Task Force.

NLC-TESLA Hybrid Optics with Fast Extraction & Tuneup Options

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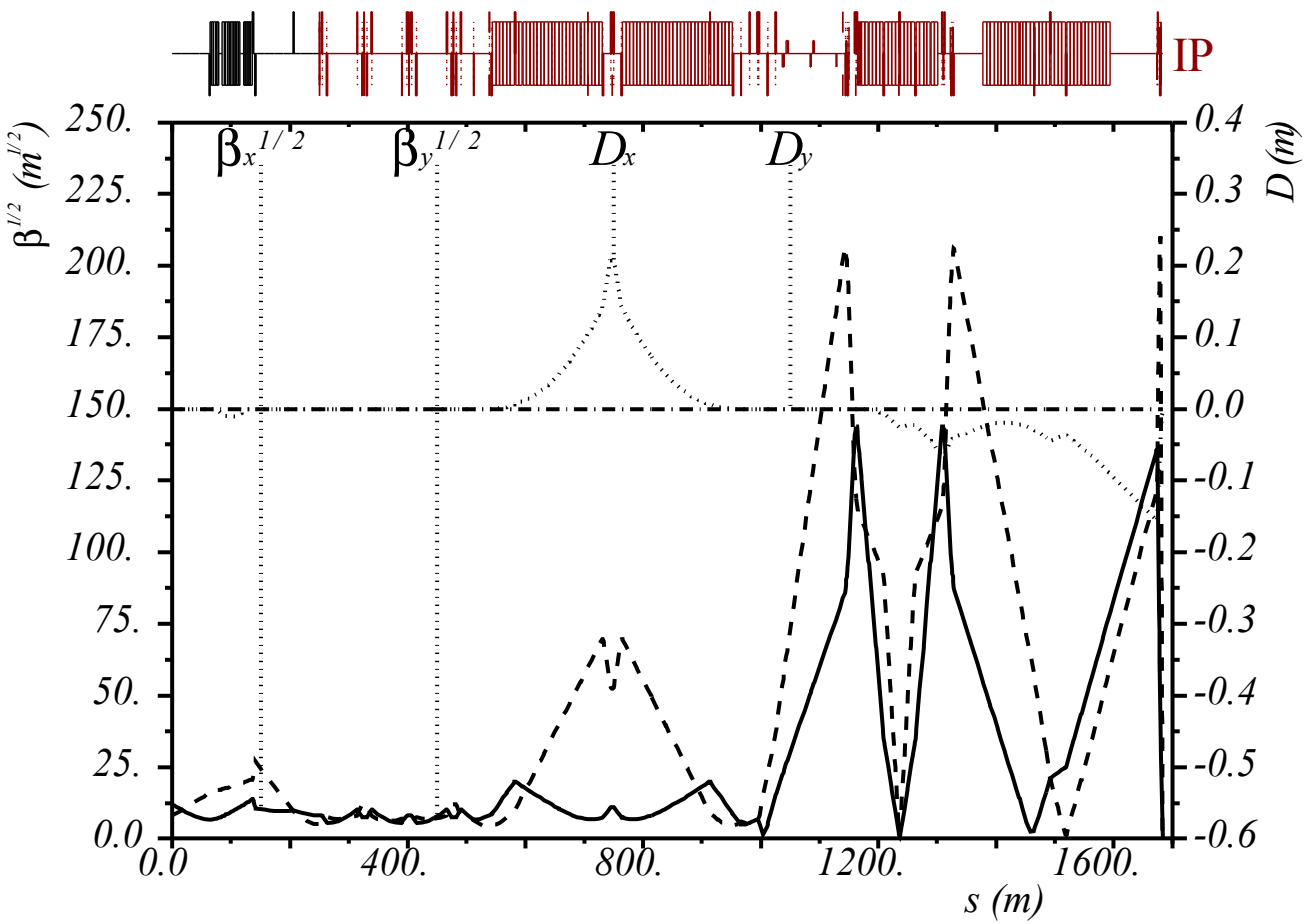
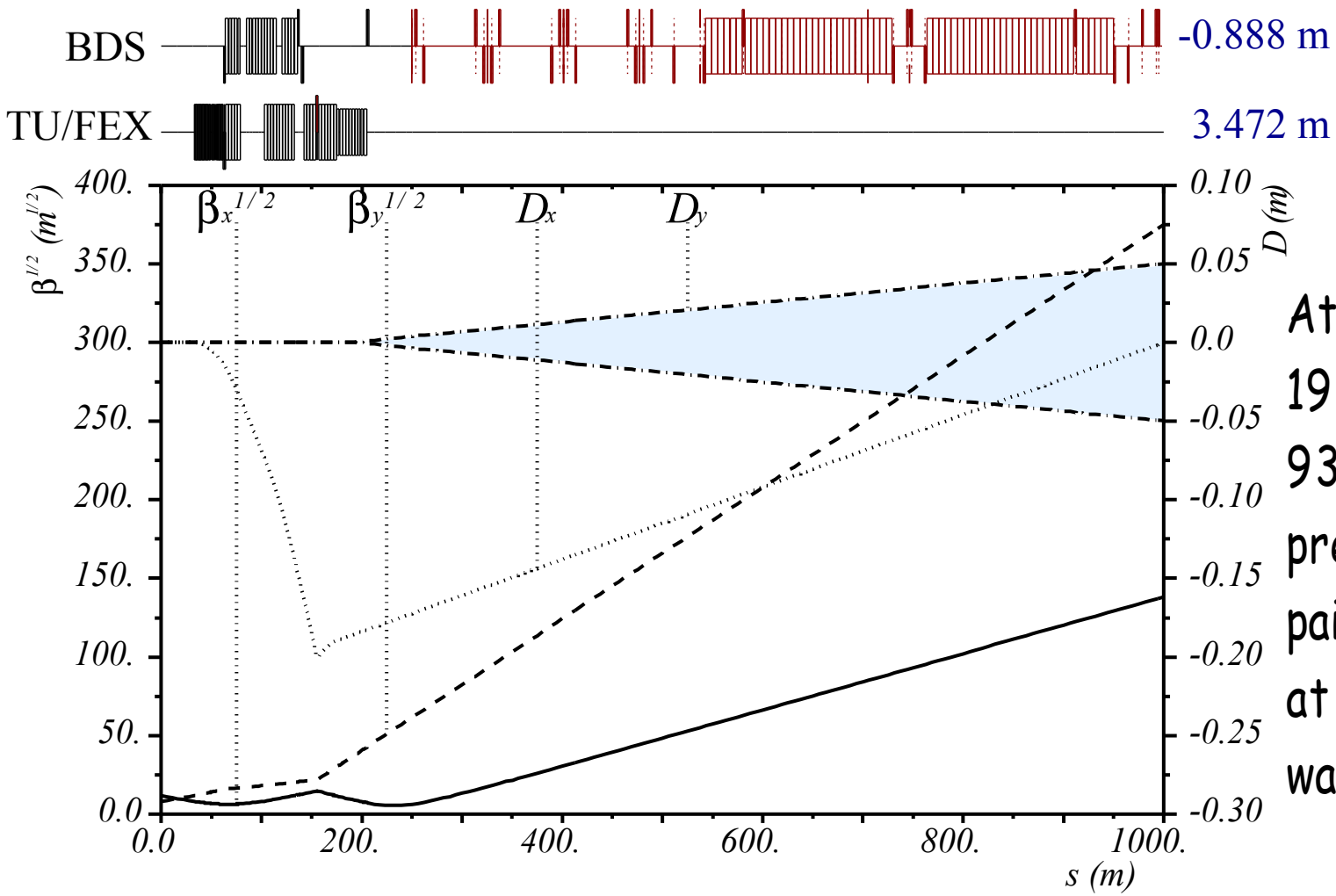


Larger $\beta^*_{x,y}$ = 15.x0.4 mm for smaller β_{peak} in unmodified NLC BDS (red) still phase differences very close to original (chromaticity compensation still works...). Extra 250 m matching section from TESLA linac is explicitly optimized for tuneup/fast extraction and could be made shorter without this added constraint.

Short matching section goes from TESLA linac directly into NLC BDS but with TESLA β^*.

Tuneup and Fast Extraction Beamline Optics Overview



At absorber face $\beta_{x,y}$ = 19 x 141 km for 608 x 93 μm spot size. For present design beam is painted vertically +/-5 cm at right angle to local water (vortex) flow.

Quadrupole used to reduce dispersion at absorber (20 cm beam line max.).

Superconducting QD0 Concept: Cross Section at Support Location

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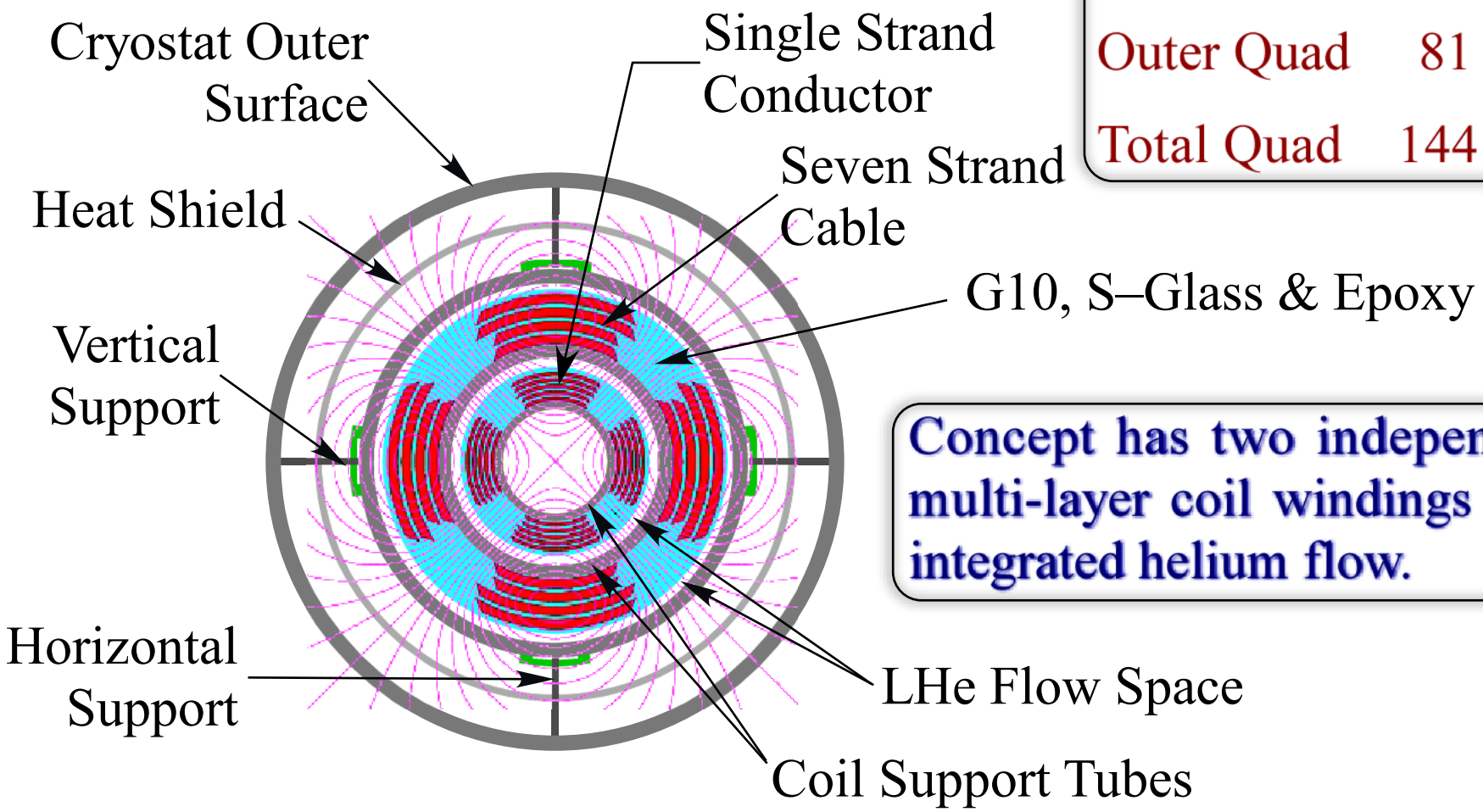
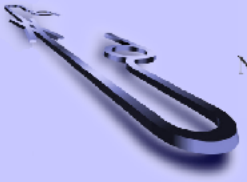
Inner Beam Tube	20 mm ID
Outer Cryostat Tube	114 mm OD

QDO Coil Parameters	
Inner Quad	63 T/m
Outer Quad	81 T/m
Total Quad	144 T/m



Concept has two independent multi-layer coil windings with integrated helium flow.

Winding Technology for Making Compact Superconducting Magnets.



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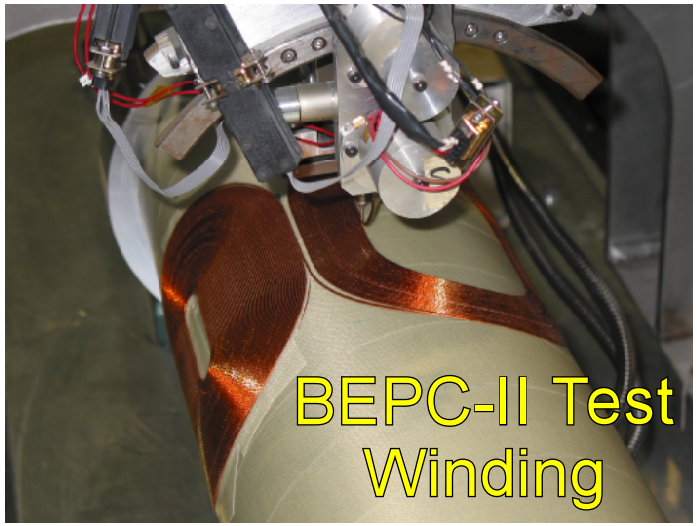
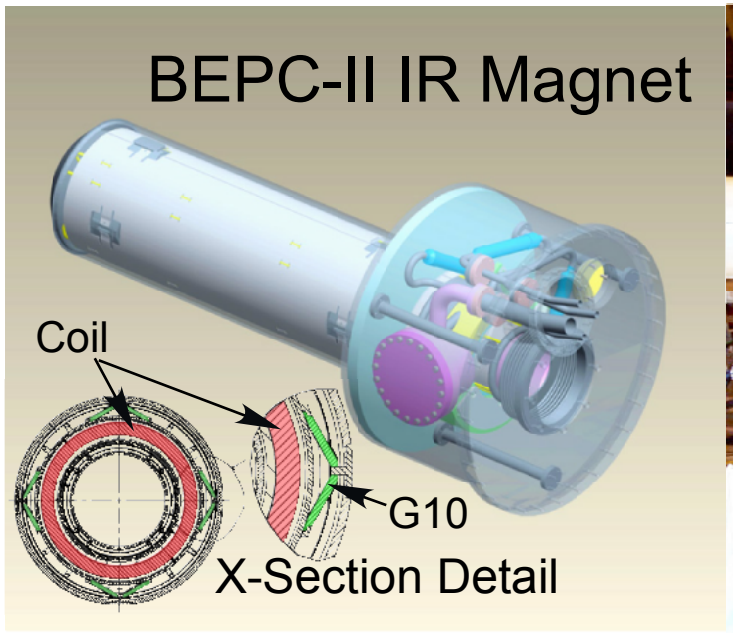


For linear collider FF take advantage of BNL technology developed for HERA-II (complete) and BEPC-II IR magnets (design in progress).



BNL LDRD Accomplishments & Areas of Ongoing Development

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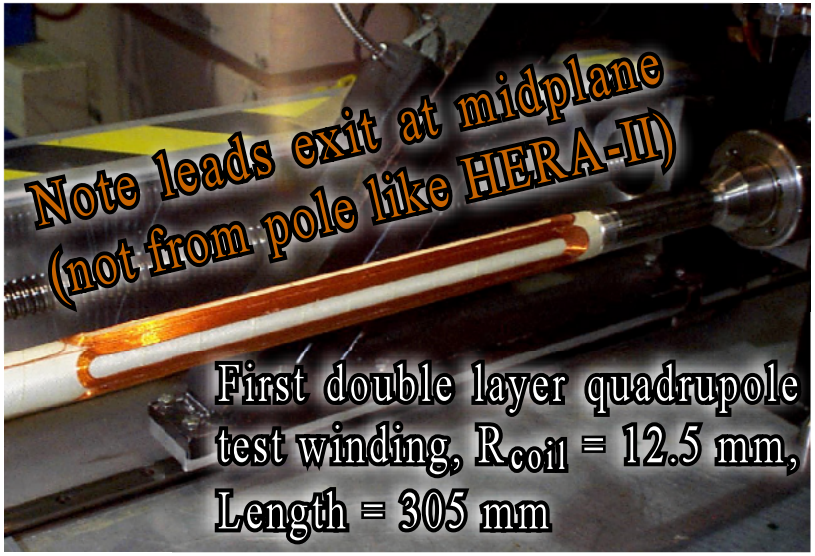
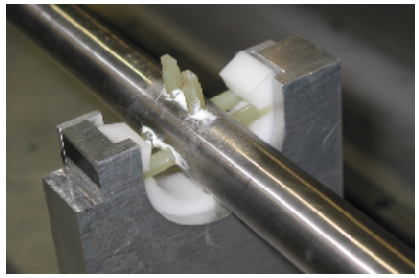
First made small diameter single-layer (HERA-II) coils with desired features. Then went on to short double-layer windings.



Next wound 1m coils (see above) & found stylus pressure bows tube. Now making 2m coils with mid-point support (right).



LDRD Ongoing Development & Goals for FY-2004

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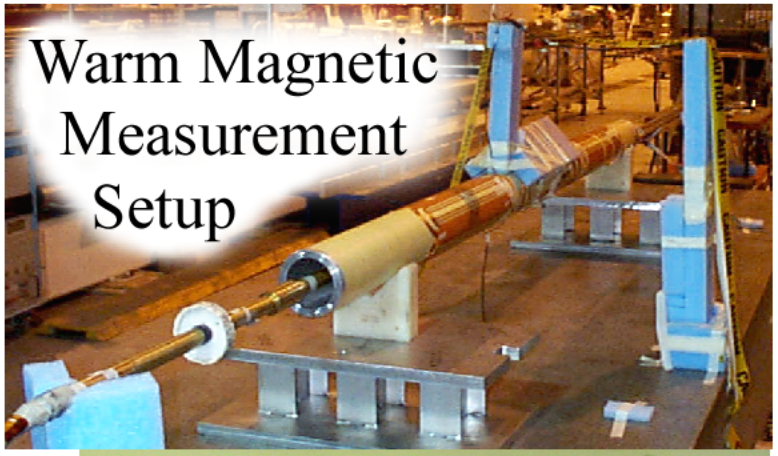
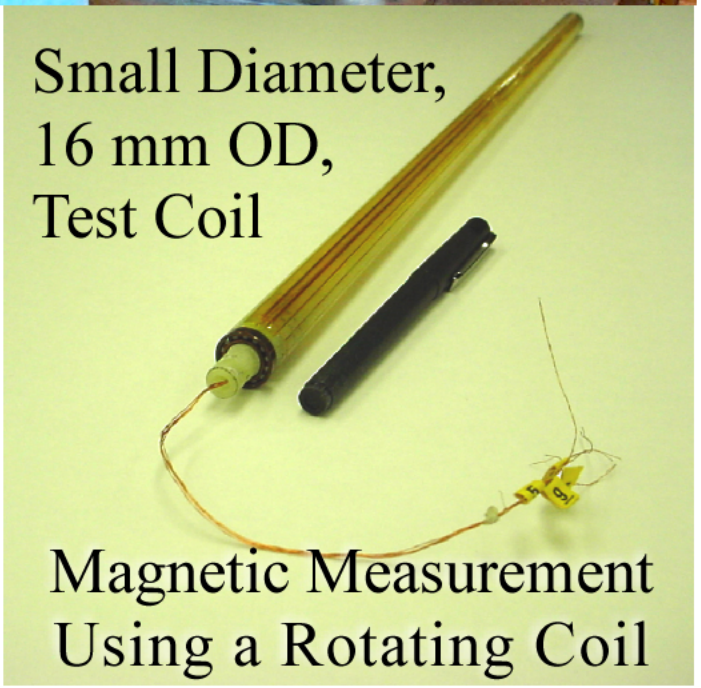
Final LDRD goals: Finish production of 2 m inner coil prototype; make warm magnetic measurements; and cold test in vertical dewar (quench).



In addition to LDRD:

- BNL involved with LC Beam Delivery System design (Energy Tuning & NLC-TESLA Hybrid).
- First steps for superconducting magnet vibration studies now underway.



Recent work looking for IR quadrupole vibration in RHIC.

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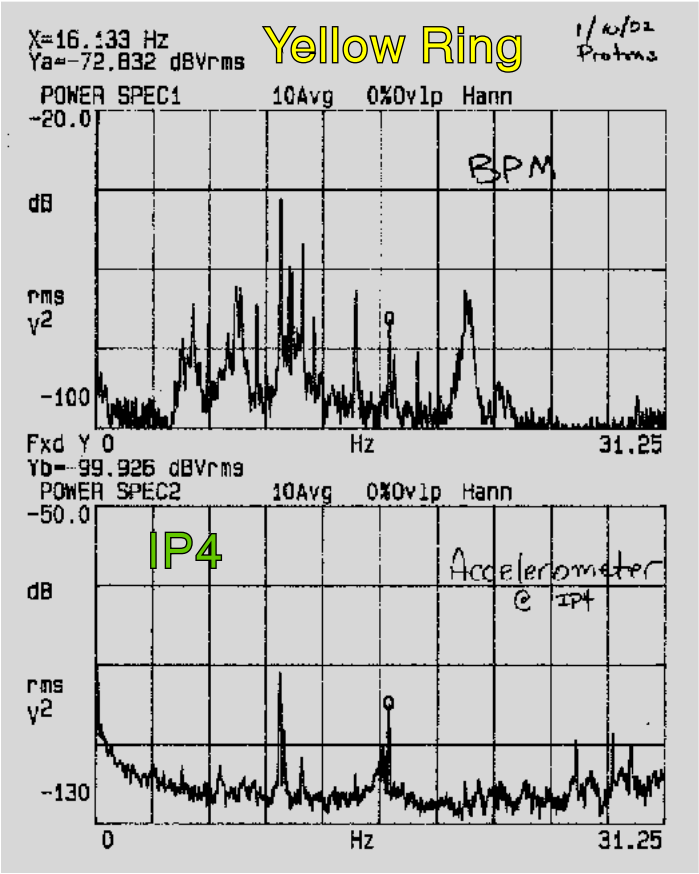
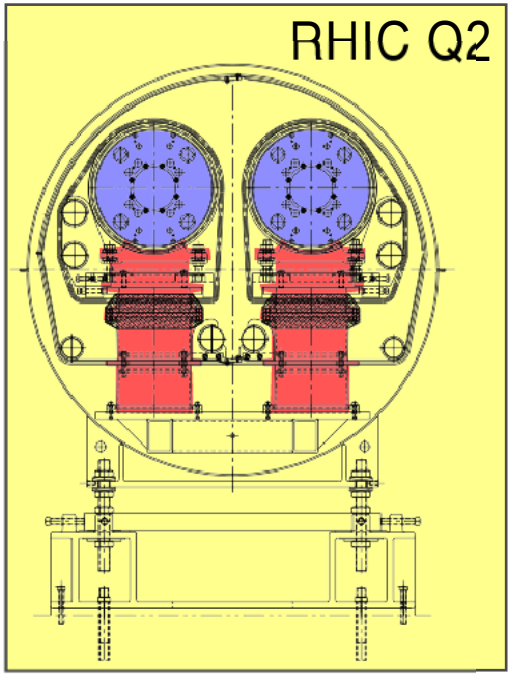
As reported at Nanobeam 2002, Christoph Montag has been able to correlate oscillatory signals on BPMs with vibration lines measured at IR cryostats.





He has observed about 200 nm horizontal but no measurable vertical oscillations. This may not be too surprising for a RHIC cryostat design which was not optimized for vibration.

Note that a traditional cryostat design has a heavy cold mass sitting atop long posts (like an inverted pendulum). A driving source in the feed can is suspected. Obviously this shows a need for careful investigation...

First Superconducting Magnet Vibrations Studies at BNL Magcool

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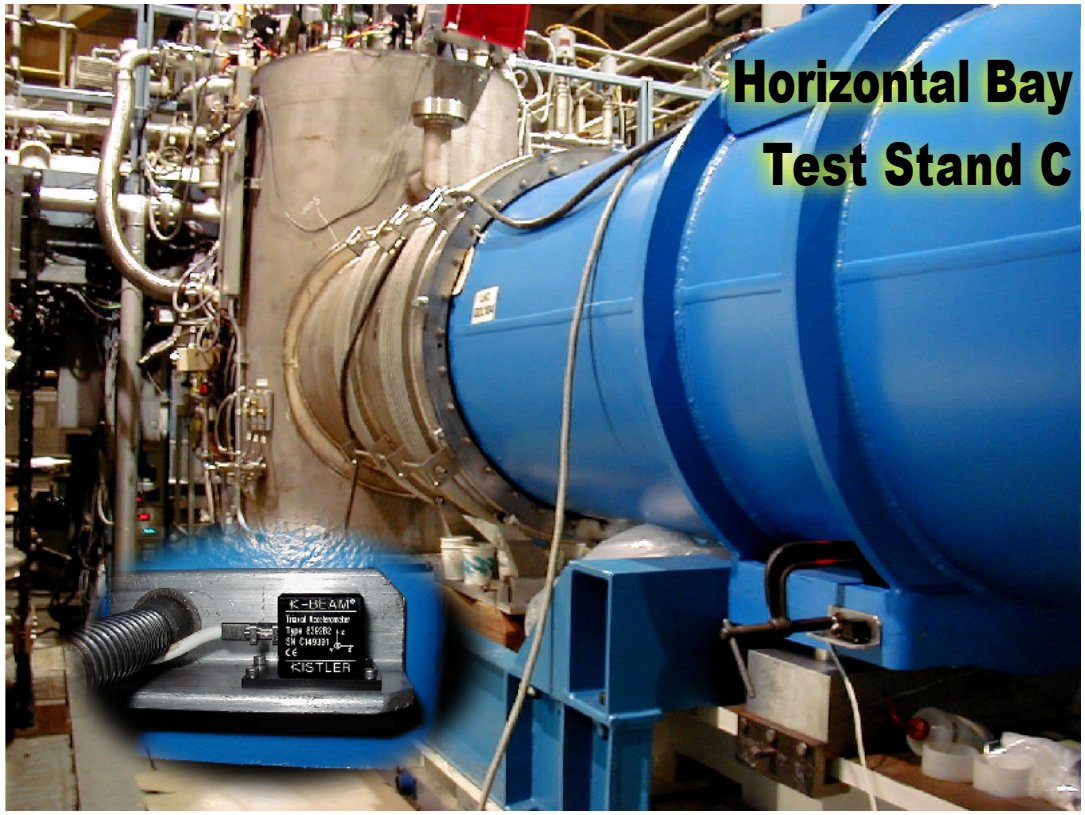
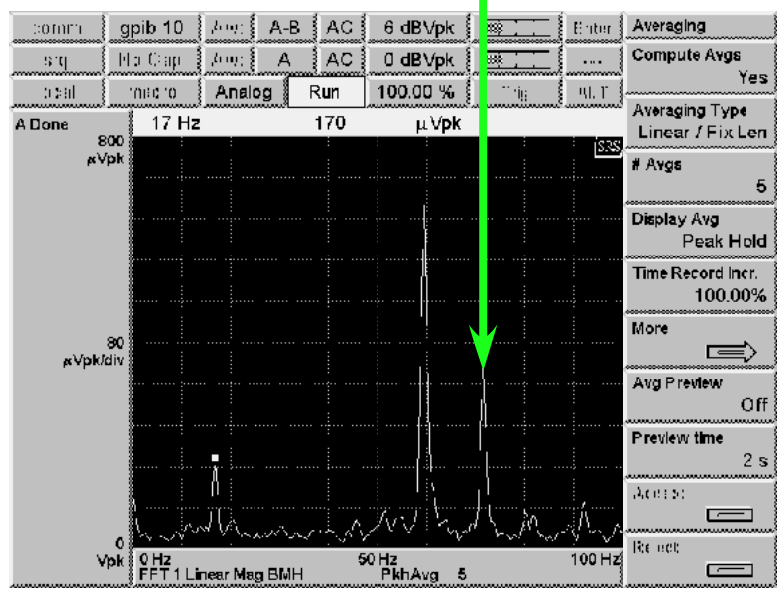
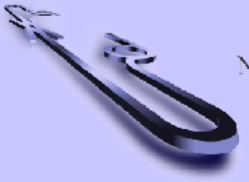




Frequency Spectrum

- Some equipment is now available (see photos).
- Thinking about how to do cold measurements.
- But still just getting started.

The NLC Compact Superconducting FF Doublet Option: Summary



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- Thanks to HERA-II and BEPC-II development, appropriate technology now exists for making compact coils (coil production parameters to be verified fiscal 2004).
- The NLC-style BDS with superconducting FF should give optics and energy tuning flexibility and can be adapted to a TESLA-like machine (NLC-TESLA hybrid).
- Important work on technical challenges (esp. 1nm NLC FF stability) remains and collaboration in doing this is both welcomed and strongly encouraged.

Thank you.
The End.
This fawn was born in the bushes outside SMD building 902.