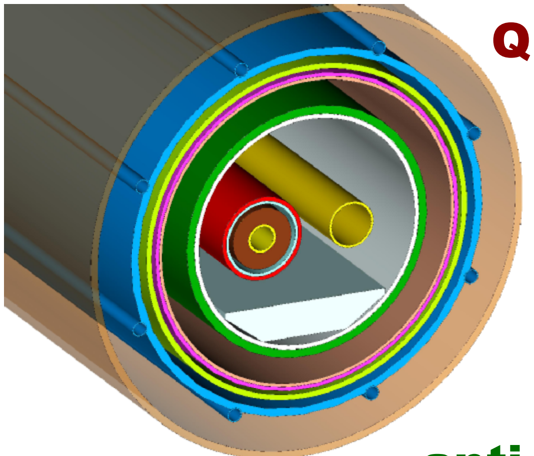
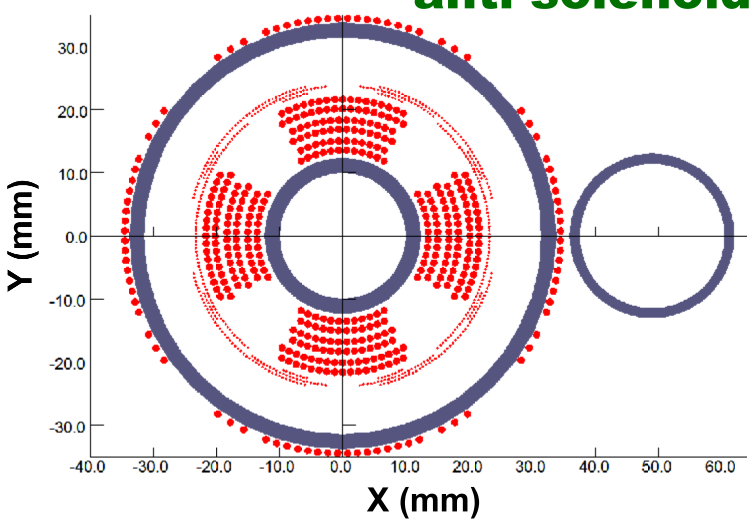
Superconducting Final Focus for ATF2

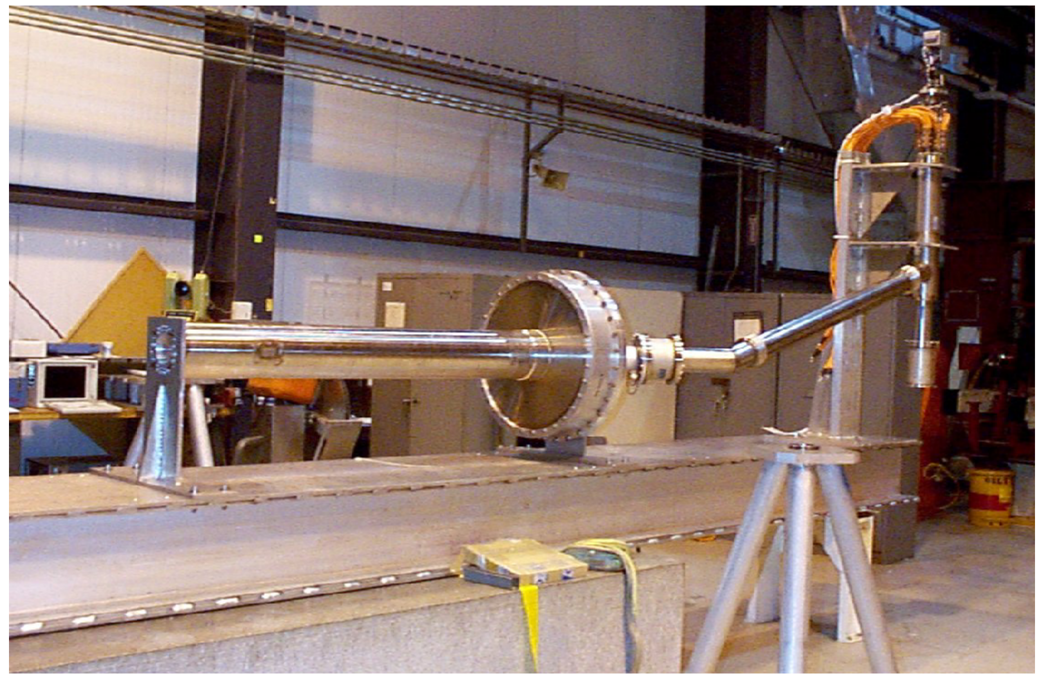
Brett Parker for the Superconducting Magnet Division at BNL



QD0 is self shielded.

Cryostat includes a force neutral anti-solenoid.

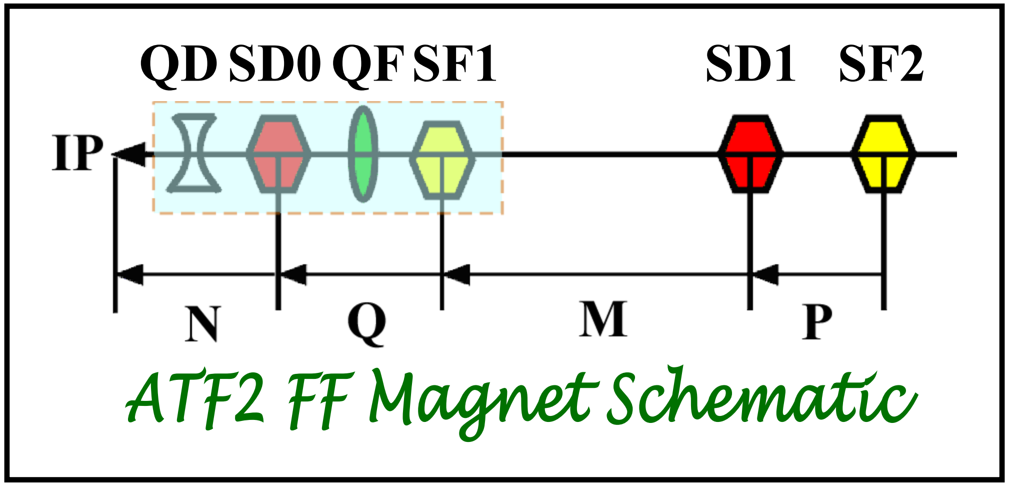


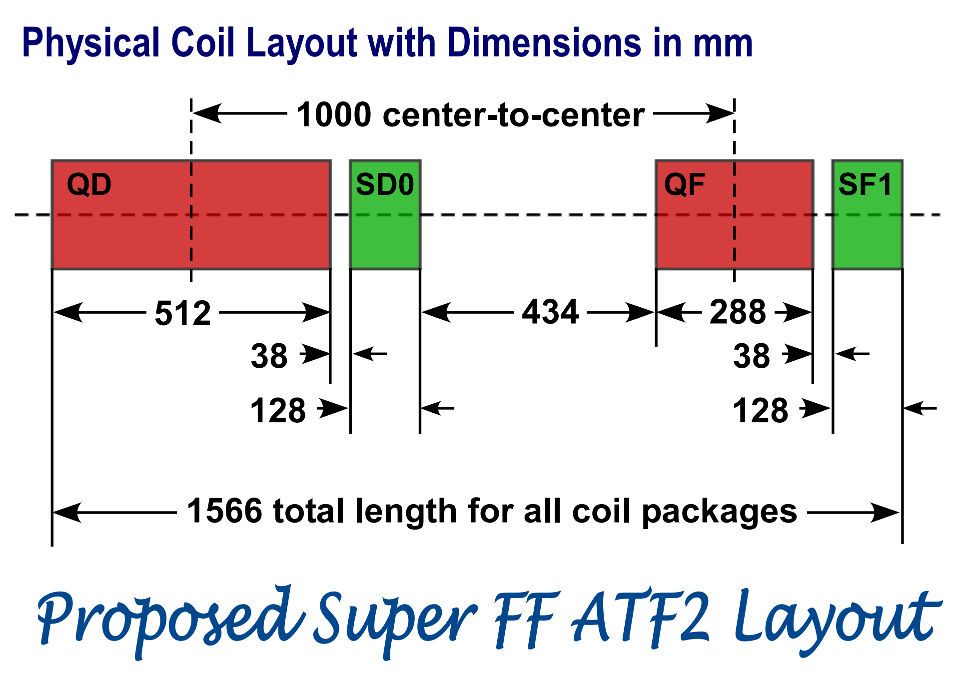


GG Style, HERA-II Upgrade Magnet

Superconducting Final Focus for ATF2

- Need both QD and QF but not the extraction line quads; same number of main quads as in R&D prototype.
- Combine the FF magnets in common magnet and service cryostats (save).

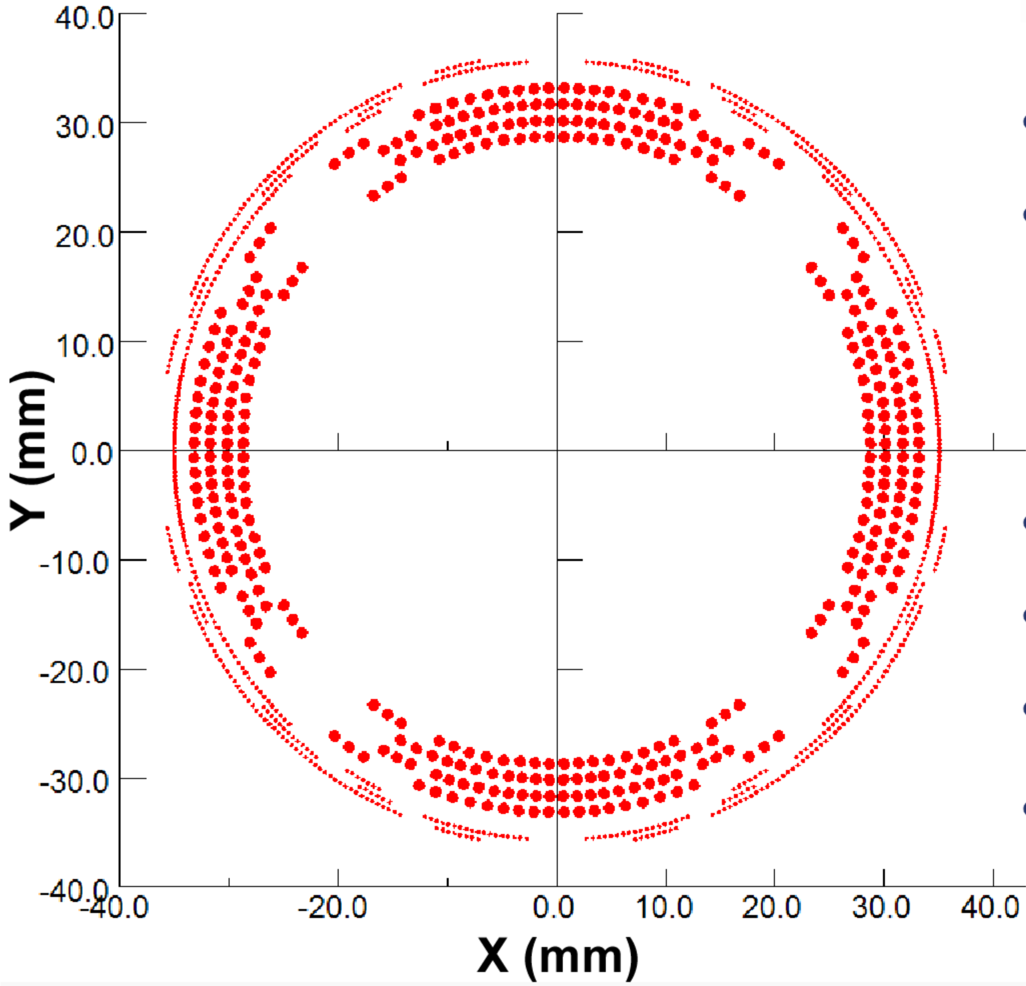


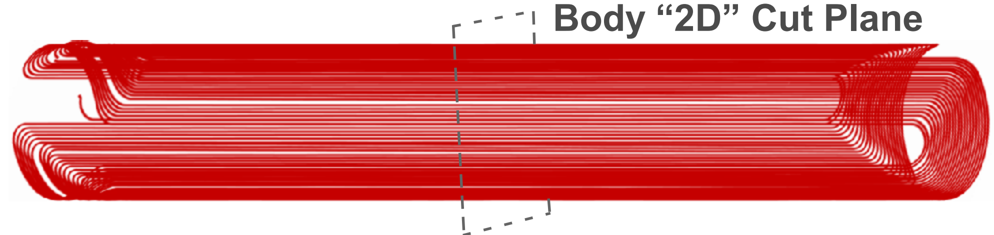


- No detector solenoid -> so no point in having an anti-solenoid (saves leads).
- Can reach desired SD0/SF1 fields with a low-current conductor (saves leads).
- No need for active shielding.
- With all of the above, it looks like we can reuse the R&D Service Cryostat.

ATF2 QD/QF Coil Design Summary

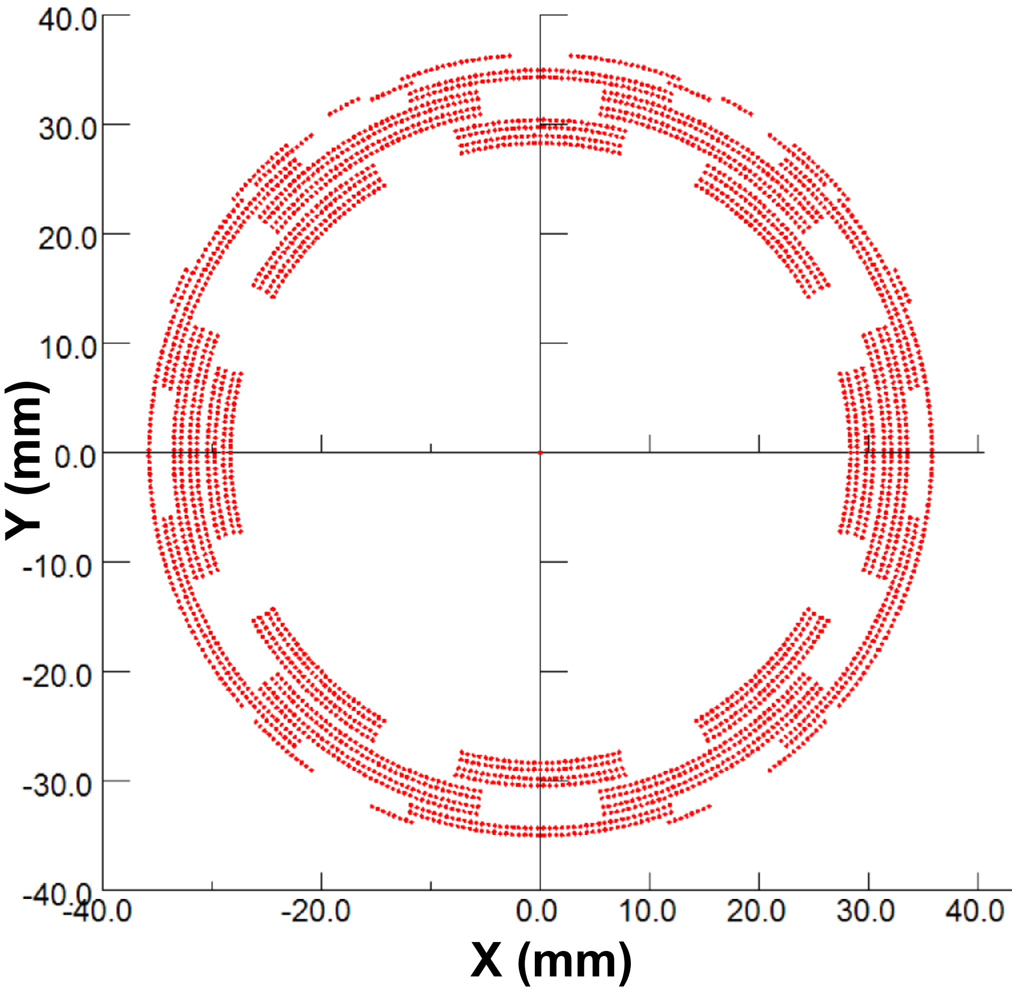
Coils are wound from both seven-strand cable & single-strand wire





- 4 Layer Quadrupole Winding
- Single Layer:
  - Dipole Corrector Winding
  - Skew-Dipole Winding
  - Skew-Quadrupole Winding
- 50 mm ID Clear Aperture
- 3 mm Wall Thickness
- QD: $L_{coil} = 512$ mm, $L_{mag} = 475$ mm
- QF: $L_{coil} = 288$ mm, $L_{mag} = 250$ mm

ATF2 SD0/SF1 Coil Design Summary

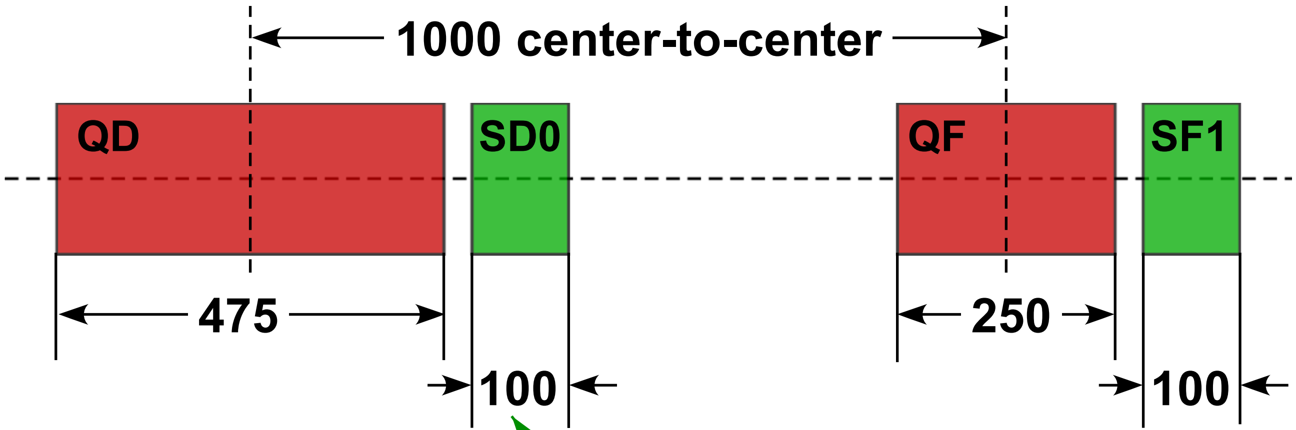


Here all coils are wound using single-strand wire -> low-power current leads

- 4 Layer Octupole Winding
- 4 Layer Sextupole Winding
- 2 Layer Skew-Sextupole Winding
- Single Layer Dipole & Skew-Dipole
- Skew-quadrupole needed?
- 50 mm ID Clear Aperture
- 3 mm Wall Thickness
- SD0 and SF1 wound the same
- SD0/SF1: L_{coil} = 128 mm,
  L_{mag} = 100 mm
- Low current operation through use of single-strand conductor

Proposed ATF2 FF Magnetic Design

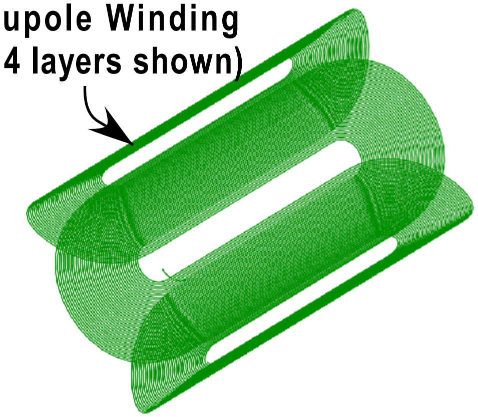
Proposed Magnetic Lengths with Dimensions in mm



Should we increase L_{mag} to 125 mm?

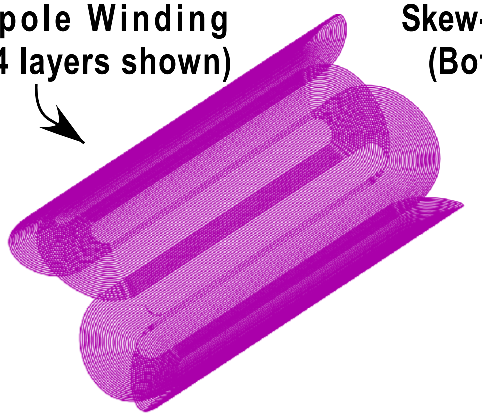
3D coil designs were made for all magnets

Sextupole Winding
(1 of 4 layers shown)



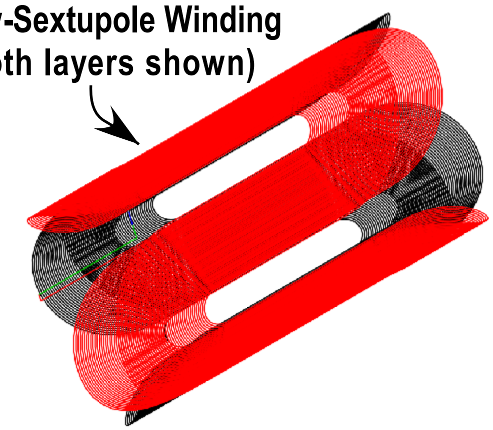
L_{mag} = 100 mm

Octupole Winding
(1 of 4 layers shown)



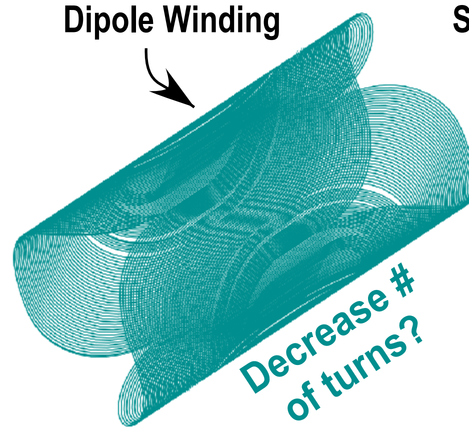
L_{mag} = 110 mm

Skew-Sextupole Winding
(Both layers shown)



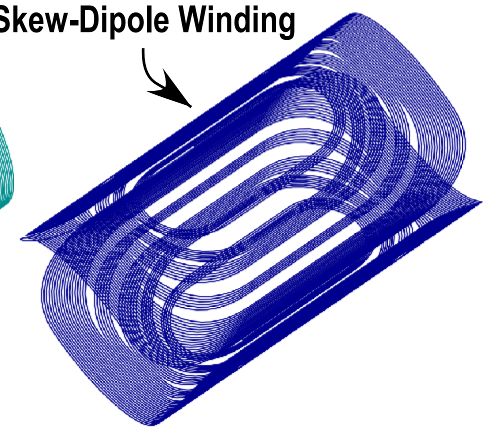
L_{mag} = 98 mm

Dipole Winding



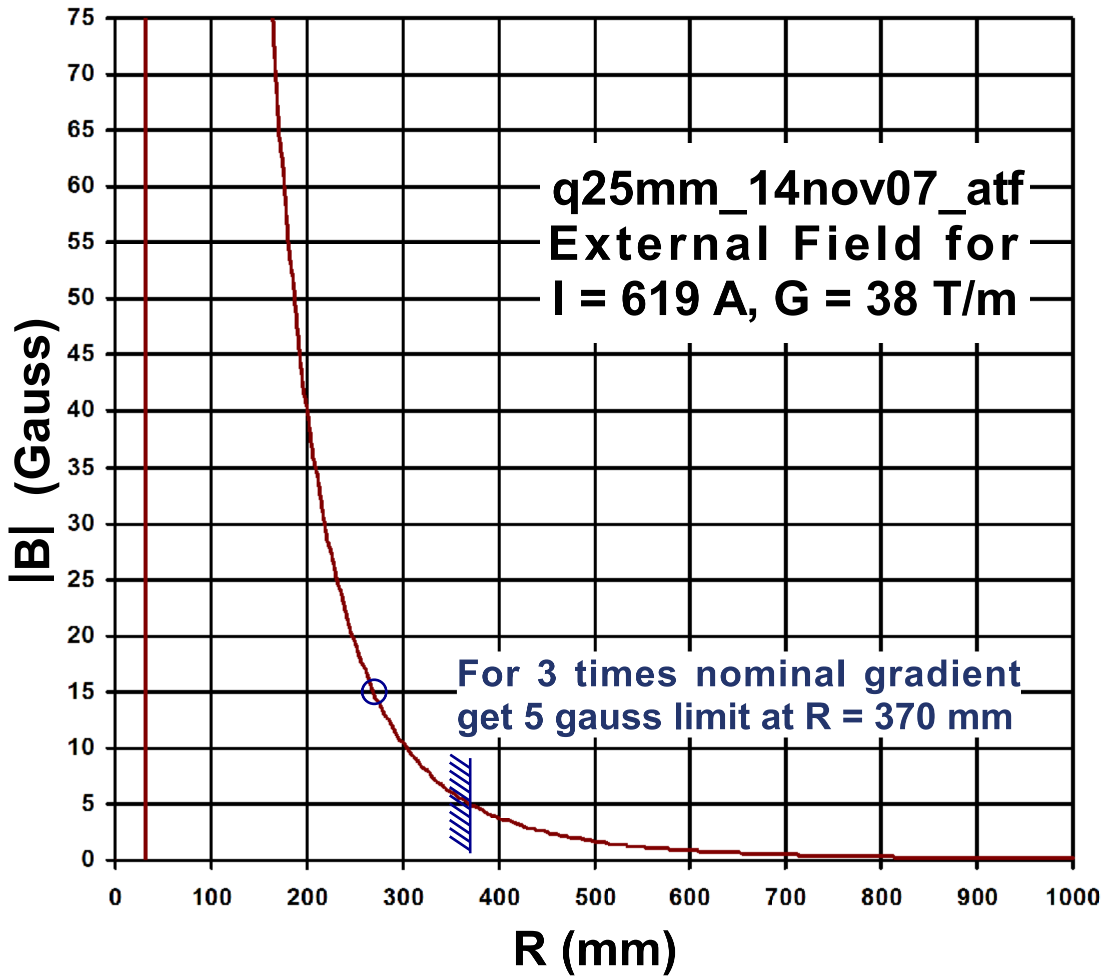
L_{mag} = 76 mm

Skew-Dipole Winding



L_{mag} = 88 mm

ATF2 QD/QF Without Active Shielding

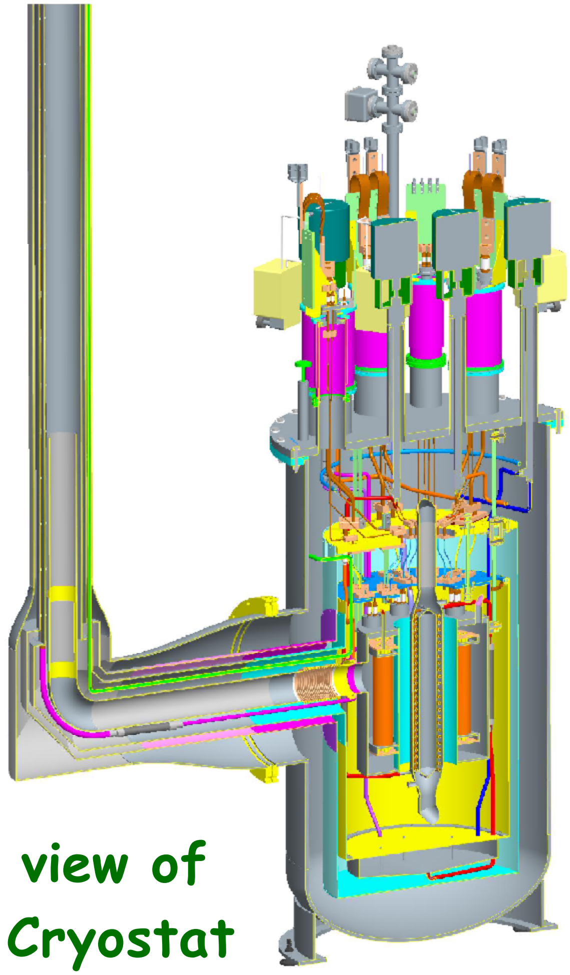


In order to simplify the QD and QF coil designs (to reduce cost) we produce them without active shields.

Limit personnel access in immediate region next to magnet to ensure that magnetic field exposure is smaller than 5 gauss.

"Three times nominal gradient" was suggested as design goal if we ever want to further reduce β^* in the future.

Reuse R&D Prototype Service Cryostat for ATF2



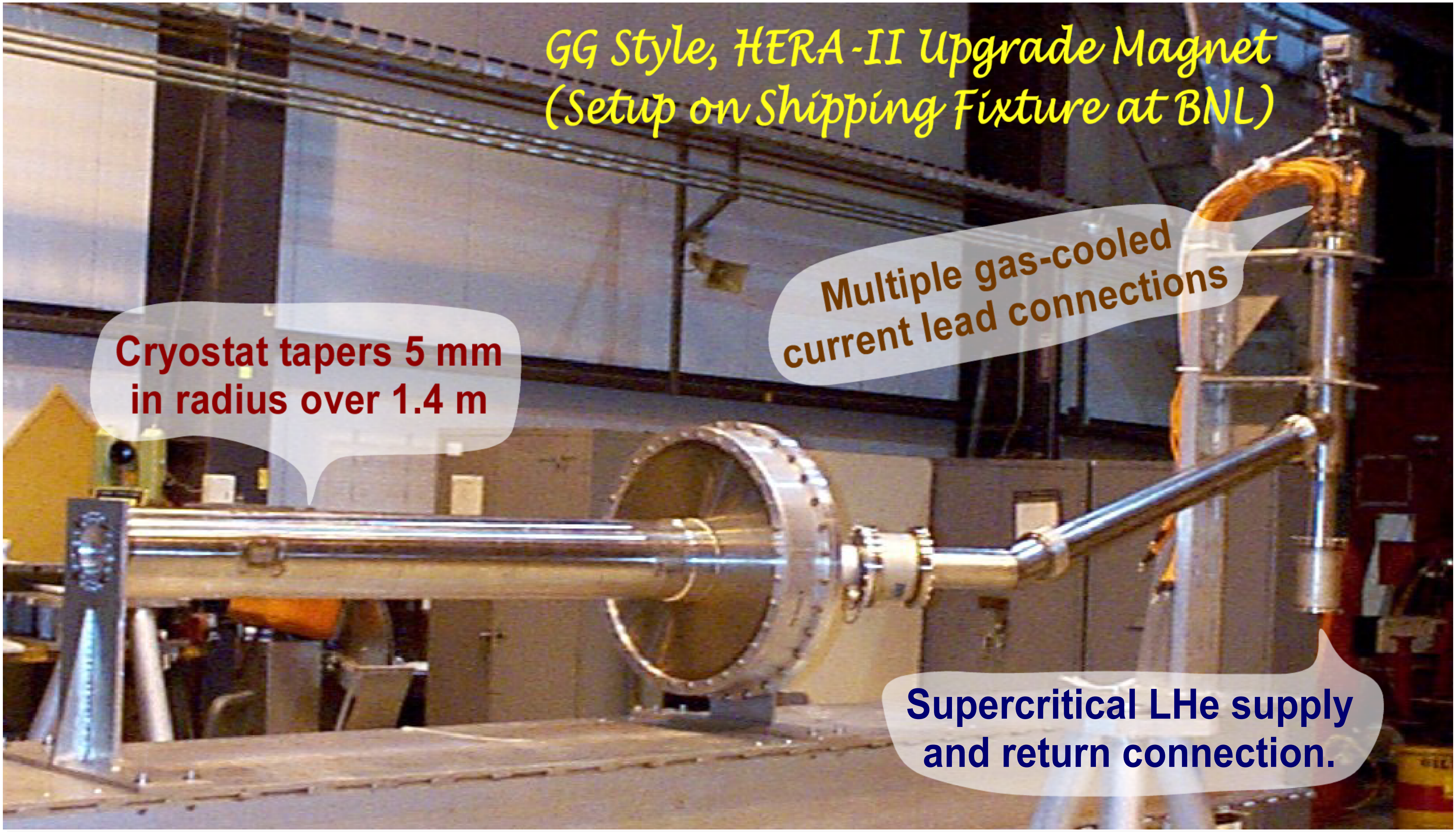
Cutaway view of Service Cryostat for the QD0 R&D Prototype

Considered cooling coils in a simple 4.2°K helium bath, but then what we are testing does not look (or act) like the actual ILC FF system.

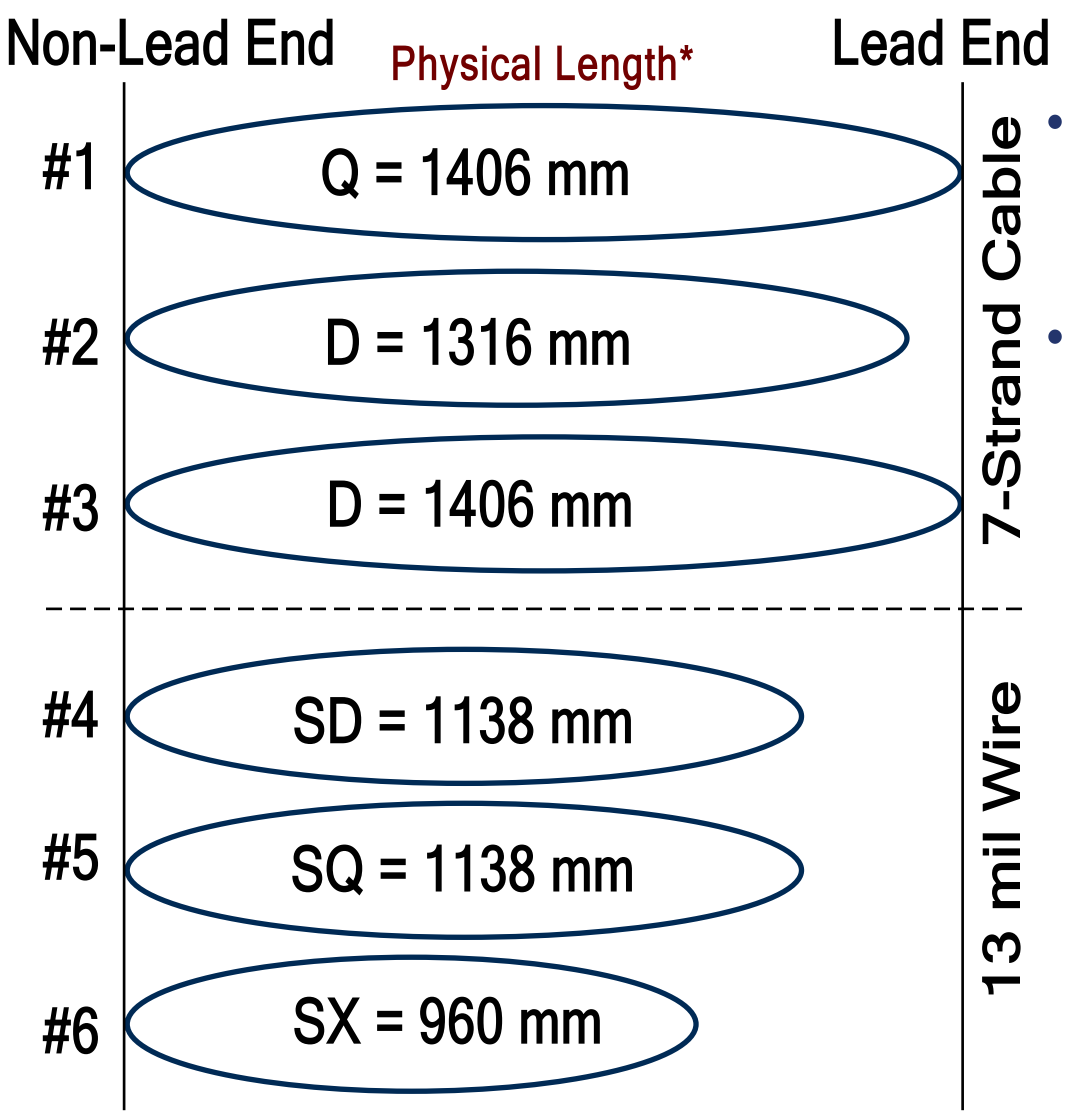
To keep with a He-II system there is a big advantage if we can reuse the Service Cryostat from the QD0 R&D prototype.

Unfortunately QD0 prototype R&D schedule is being stretched out; so reusing the service cryostat at ATF2 may lead to a time conflict.

Suggestion to Reuse HERA-II Upgrade Magnets

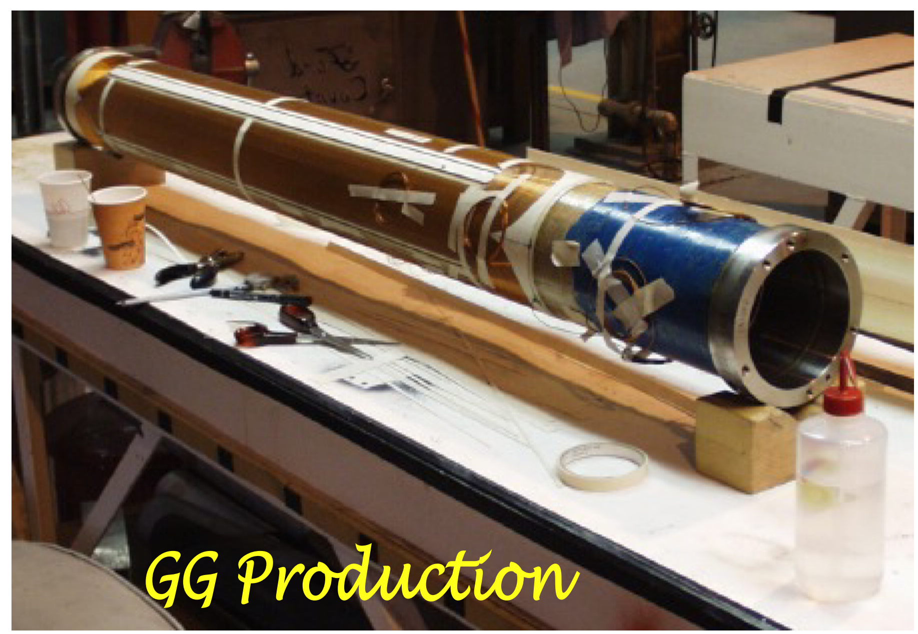


GG Coil Winding Layout Schematic



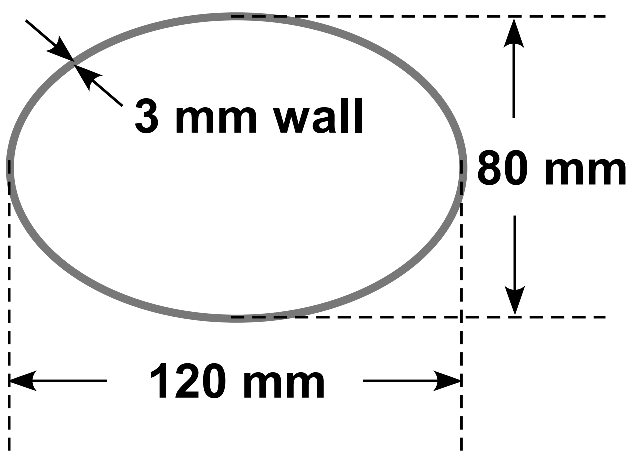
*In all cases magnetic length is less than the coil physical length.

- GG has multi-function coil layout with quad, dipole, skew-dipole, skew-quad and sextupole windings.
- Three GG magnets were produced (two were put in service + one spare).

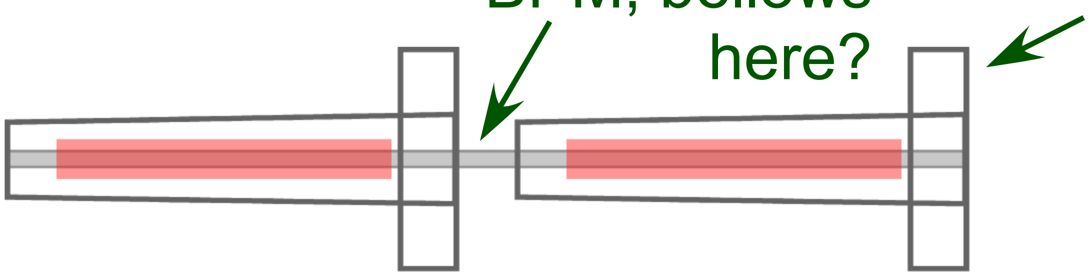


Some Additional GG Magnet Design Details

The GG quadrupole coil has 1.336 m magnetic length, so with T.F. = 7.08 x 10^{-3} T/(m·A) we reach 4.5 T/m at 636 A excitation for the desired integrated gradient (but without times 3 factor).



- GG has a cold independently cooled, tapered, elliptical shape beam tube (120 x 80 small end).
- There is about 200 mm warm-to-cold transition at each end (slightly more for start of magnetic length).



Propose to use two GGs to make FF; possibly with a warm beam tube insert.

Do we really want to make ATF2 FF this way?

Reusing HERA-II magnets is probably the cheapest way to go but...

- **The GG quadrupole magnetic length may be too long to make reasonable FF optics (must check).**
- **Cold mass is cooled by <u>flowing supercritical LHe</u> (few Bar & 4.35°K), beam tube is cooled by <u>flowing cold gas or LN2</u> (at say 77°K) and the current leads are cooled by <u>flowing gas</u>; many potential sources to excite vibrational modes?**
- **Probably should do vibration tests to determine GG's suitability for ATF2?**

Now there are two options to provide superconducting FF magnets at ATF2 that we can explore.