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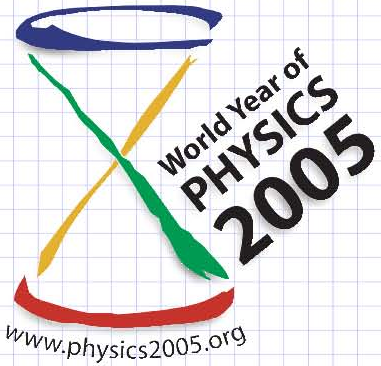
Superconducting Magnet Division

American Linear Collider Physics Group & Machine Detector Interface

QD0 external field compensation possibilities for gamma-gamma?



Brett Parker and Animesh Jain
Brookhaven Superconducting Magnet Division

Message: Direct wind technology offers design flexibility that I (BP) think should allow producing the QD0 external field compensation system needed for a gamma-gamma IR and new analytical formula (AJ) will prove helpful in performing design optimization. At this point the main challenge is to develop reasonable (iterated) design requirements for the compensation system.

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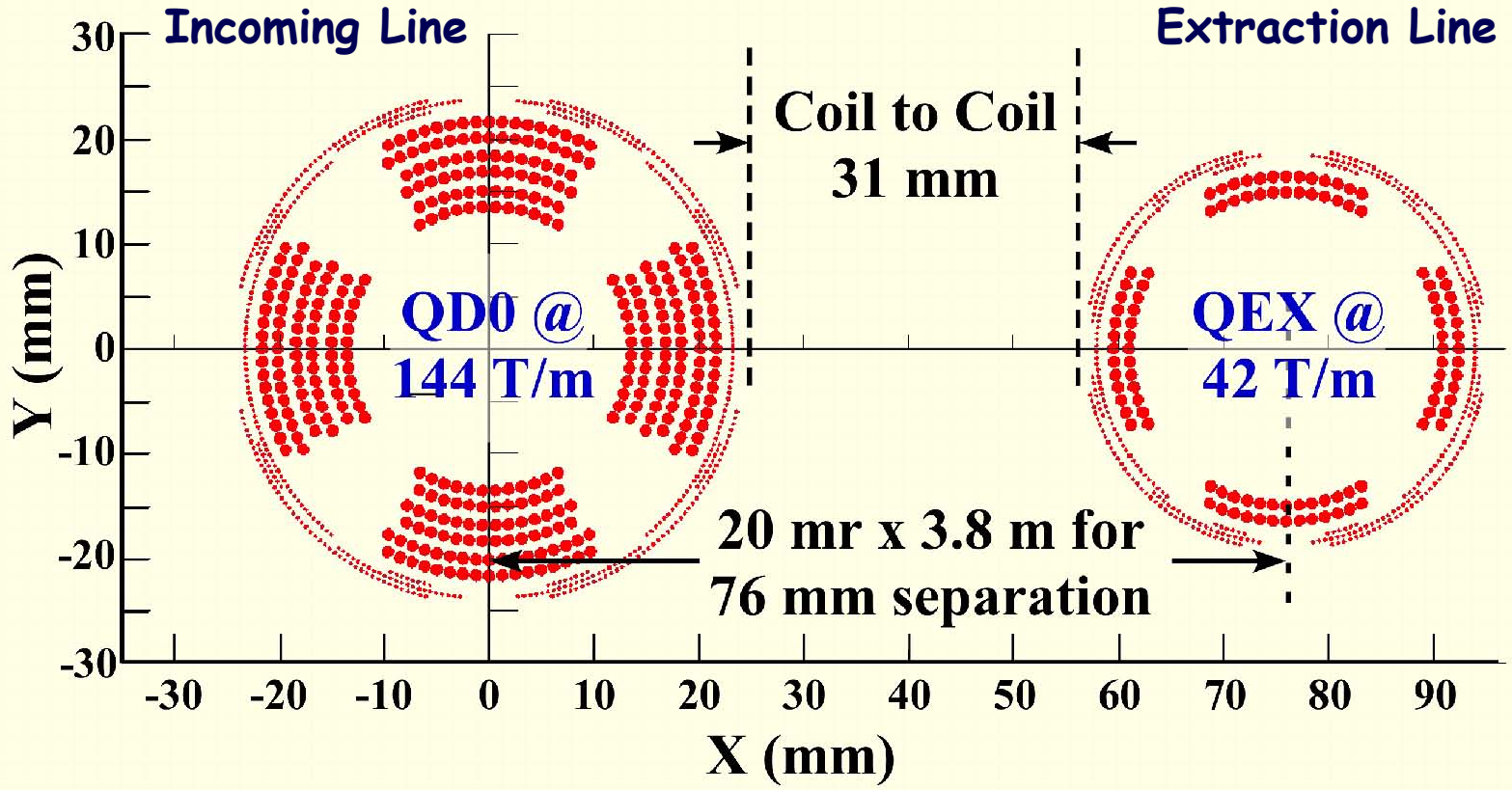
Side-by-side magnet configuration with correction elements made possible by direct wind production.



Side-by-side QD0 and QEX magnet coils (cross section at location 3.8 m from the IP).

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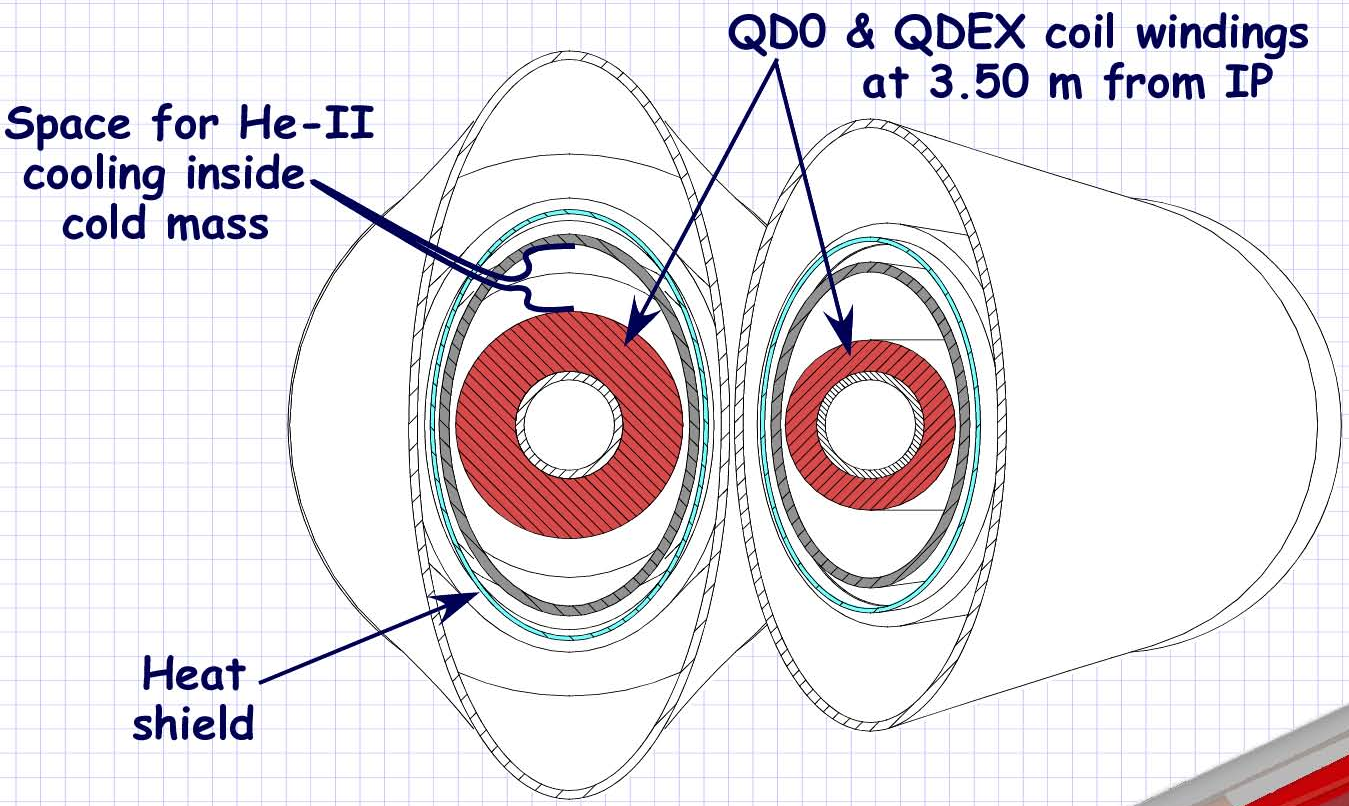
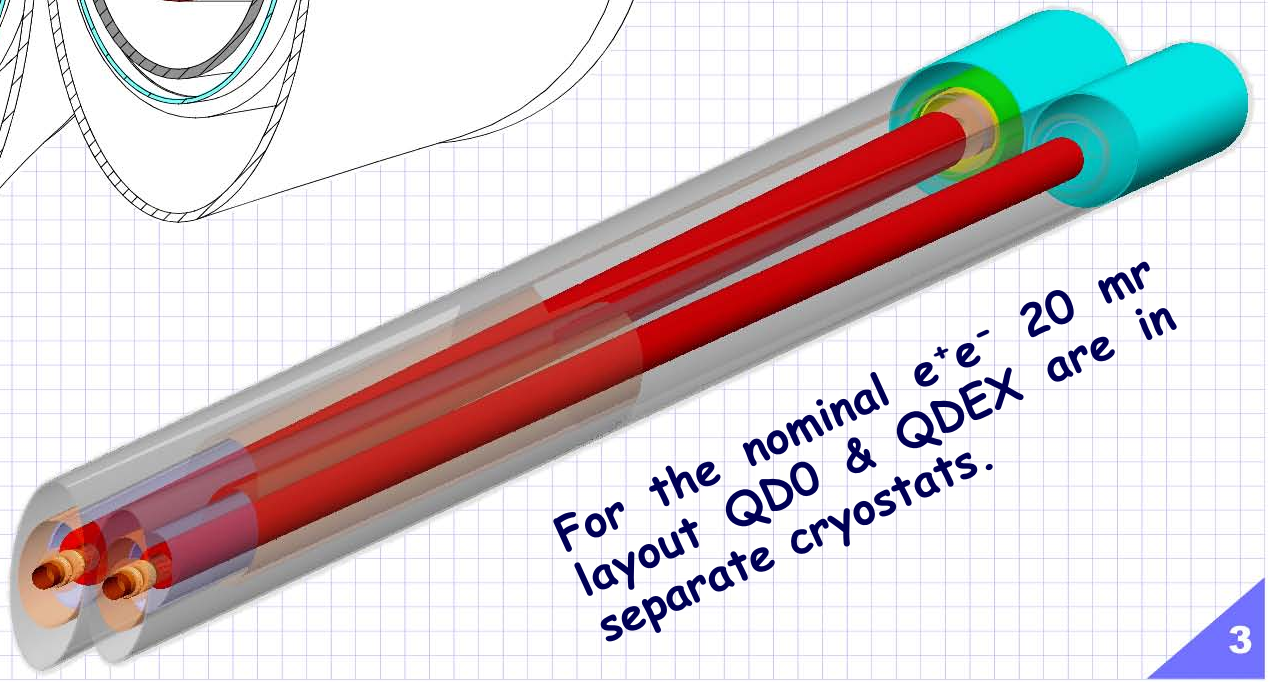
Compact Superconducting Magnet Configuration with Independent Cryostats Side-by-side.





For the nominal e^+e^- 20 mr layout QD0 & QDEX are in separate cryostats.

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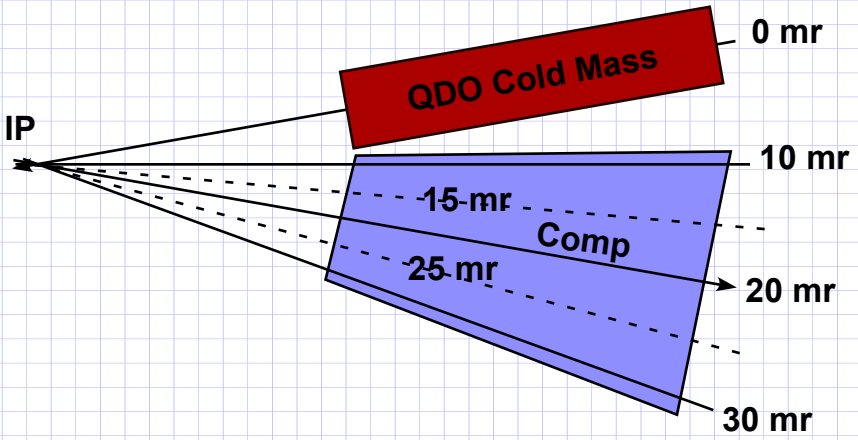
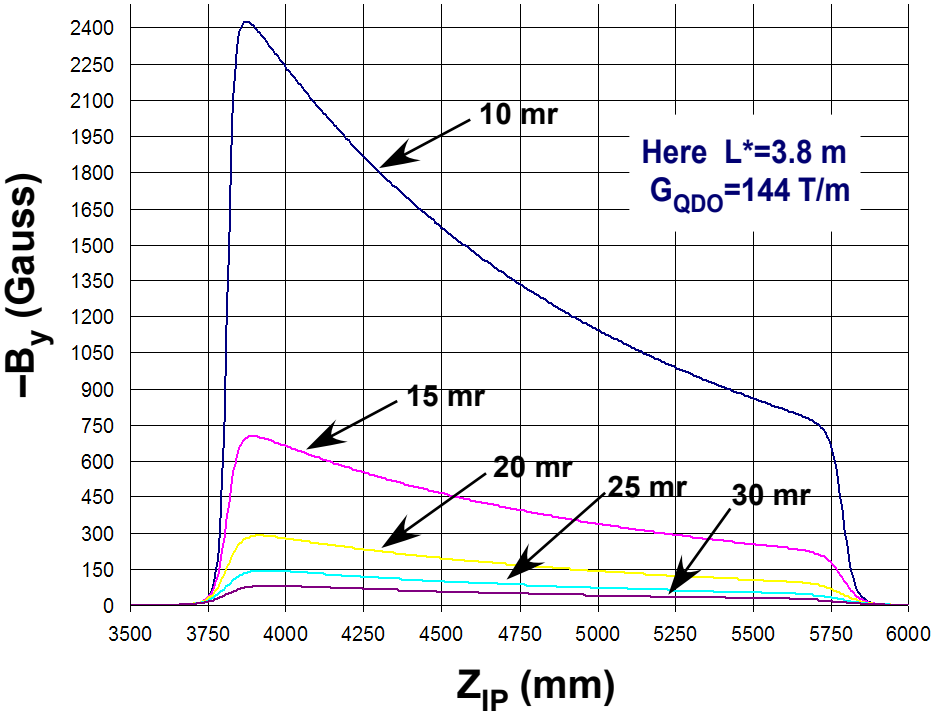
Gamma-Gamma IR Geometry Schematic



Note: X-ing angle is 20 mr and gg opening is ±10 mr so in magnet frame $\gamma\gamma$ ranges from 10 to 30 mr. But in the detector frame $\gamma\gamma$ goes from 0 to 20 mr.

External Field Plotted for Various Lines from IP



External field falls dramatically with increasing separation but the aperture must increase; this is roughly the behavior we can expect if the compensator is made with "tapered coils."

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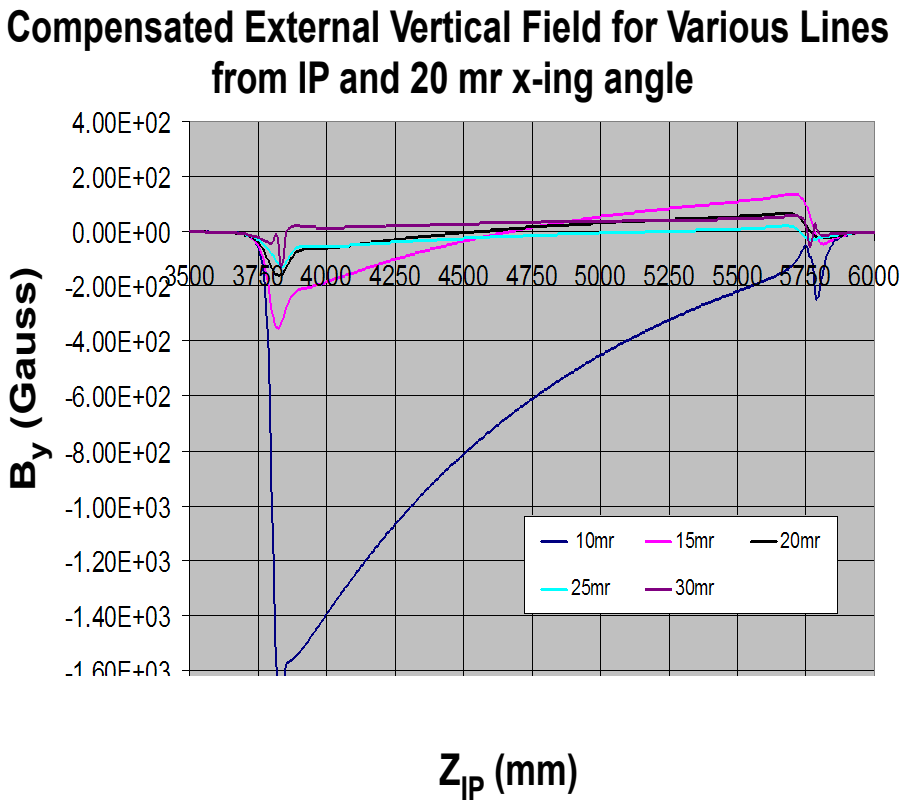
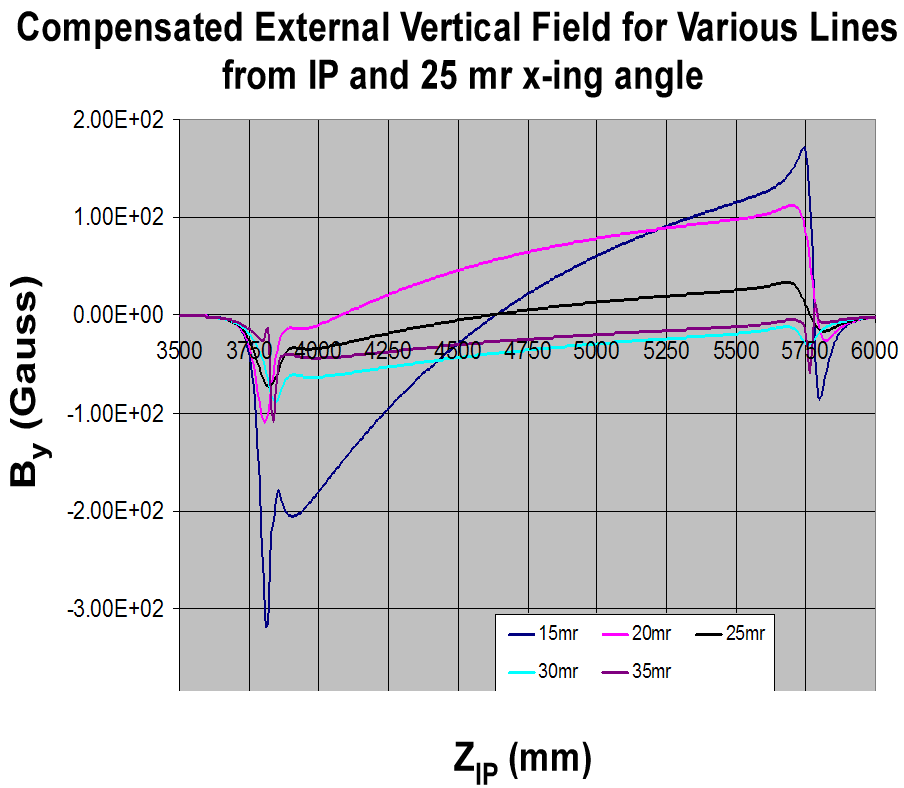
Two examples with (hand) optimization for 20 & 25 mr x-ing angles.





Optimization is more challenging the smaller the crossing angle.
Note that integral compensation is easier than local compensation.

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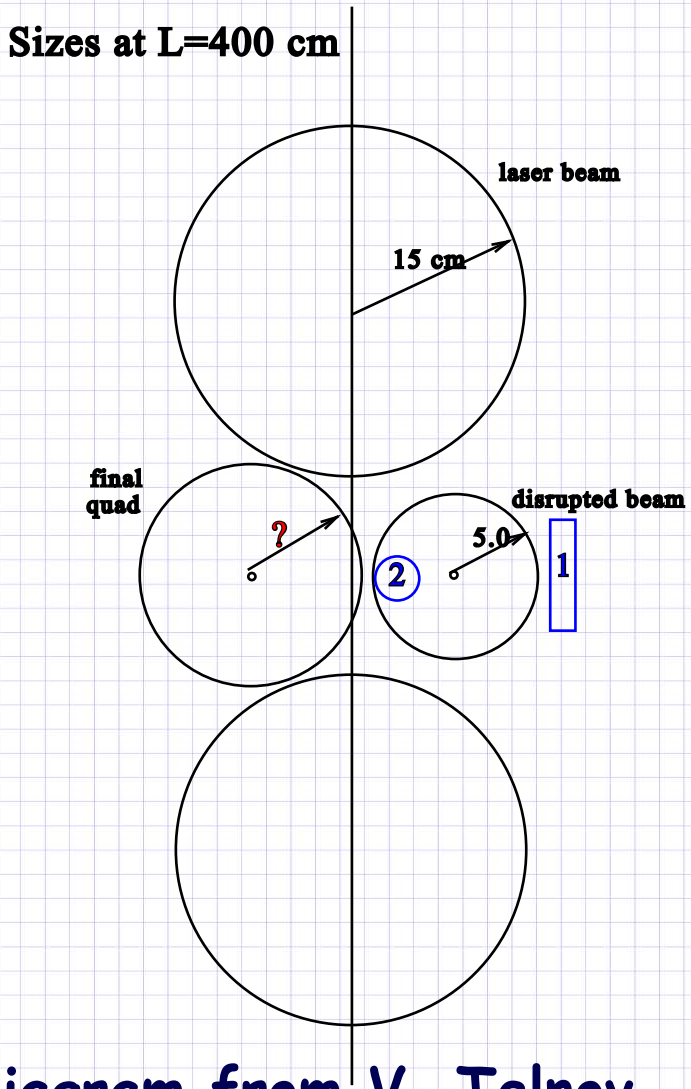

Diagram from V. Telnov

Size for final focus quad coils is actually much smaller than aperture needed for the disrupted beam.

Conductor located at position 1 does not help much at location 2.

Making the field zero at position 2 will have maximum impact on field seen by the incoming beam.

Does the space for the laser beam really need to be bigger that the magnets at this location and does this envelope change size along the beamline?

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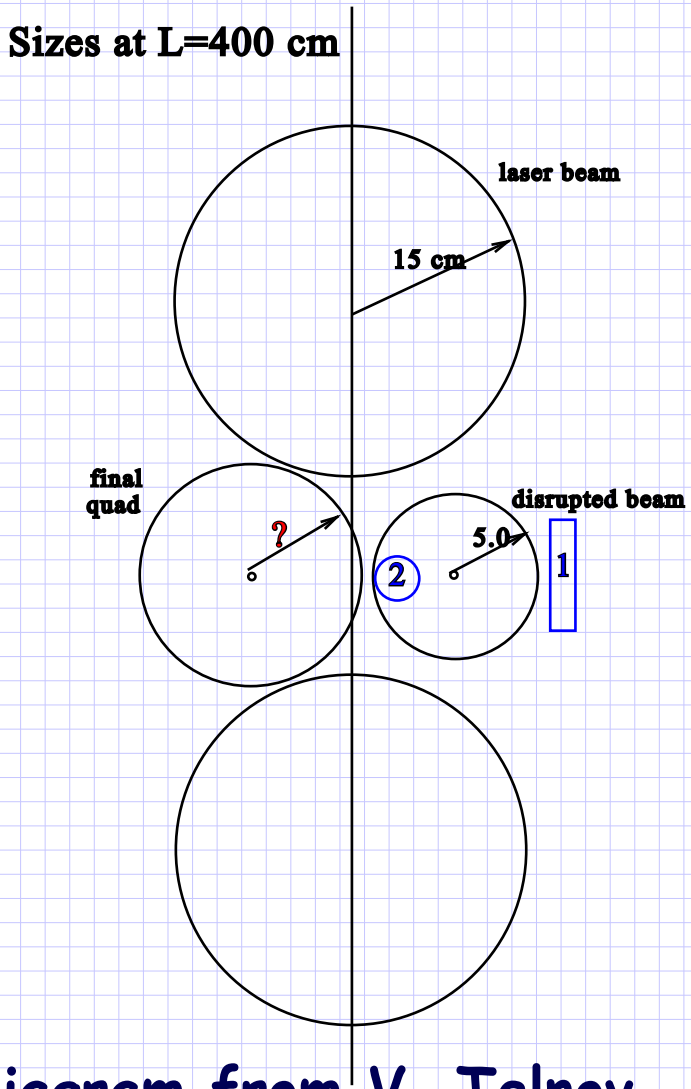
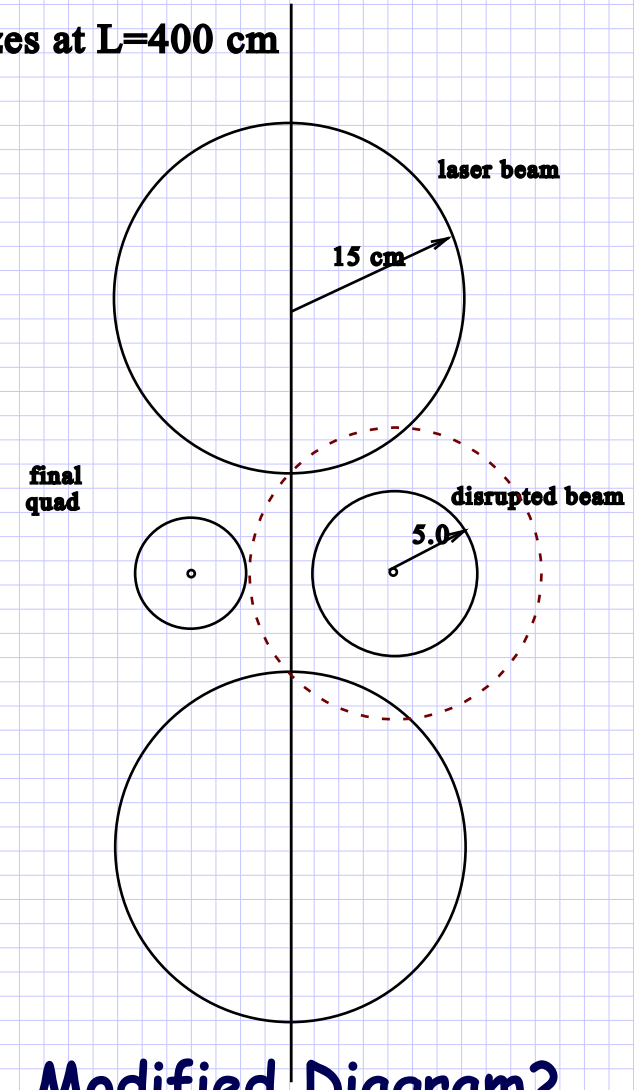


Diagram from V. Telnov



Modified Diagram?

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Summary of QT Cold Test Results.

- QT reached "short sample" with only two training quenches (both of which were above I_{op}).
- QT ran 13% above 140 T/m in 3 T background field at 4.3°K and almost reached operating gradient at 4 and 5 T background at 4.22°K.
- By pulling a vacuum on the test dewar, we brought QT to 3°K & got similar result @ 6 T background.
- At 2.5°K the LHe level fell below the end of the leads and we could not test at lower temperatures (simple pumping with no λ-plate).
- Still from these data we expect that at 1.9°K and 3 T background field I_q should be 1100 A (I_{op} = 664 A).

QT Quench Test Results

Background Solenoid (T)	Temp (°K)	Gradient (T/m)
3	4.30	158
4	4.22	139
5	4.22	134
6	3.00	137

Note: Operational Target is 140 T/m with 3 T solenoidal background field while cooled with pressurized He-II @ 1.9°K. Above data scale to 232 T/m under these conditions (for 60% short sample current).

Increased background field permits reaching large Lorentz forces but without having to go to excessive test currents.

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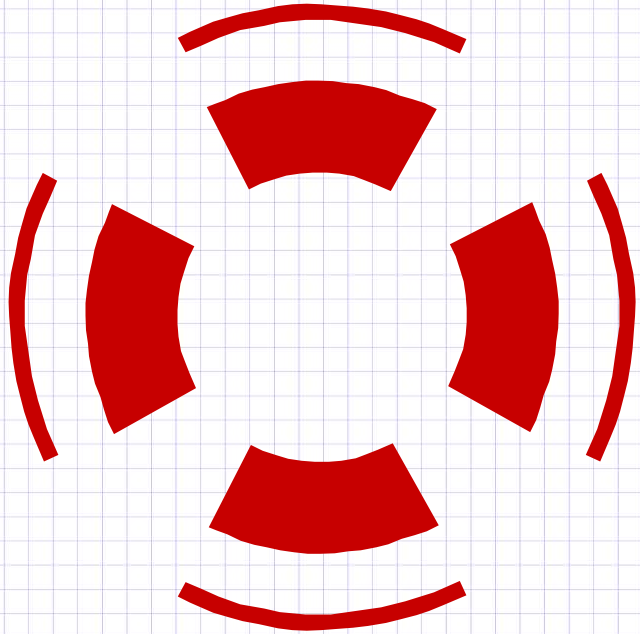
QD0 with Active Shield



Note: This solution maintains quadrupole symmetry.

Maybe we should reconsider an early concept, kill the external field with a second active shield coil of opposite polarity to the main quad?

This will do the best job close to the magnet (without messing up the field inside QD0).

Cost is transfer function reduction (magnet efficiency) but maybe we have enough margin to stand this now?

Can work on this during Snowmass.

Summary: QD0 external field compensation possibilities for gamma-gamma?

Using analytic formula as a guide, we can now make a more systematic investigation of possibilities for compensating the QD0 external field with an independent tapered coil to try to meet gamma-gamma requirements. But this may take a few iterations and be somewhat slow to converge since tracking is probably needed to judge the effectiveness of any proposed solution.

A conceptually simpler scheme, active cancelation with a concentric coil of opposite polarity, may now be viable due to recent improvements in the compact QD0 design and we should be able to have preliminary results for this before the end of Snowmass.