CLIC QD0 R&D Status

Michele Modena, CERN TE-MSC

CLIC QD0 Status

...the conceptual QD0 design was presented 1 year ago at "CLIC09 Workshop".

MAIN PARAMETERS and BOUNDARY CONDITIONS:

*... Studies (new) for a CLIC FF conceptual design has started in **June 2009** within the scope of the newly created "Machine Detector Interface "(MDI) Working Group*

"Nominal" Requirements for CLIC FF Quad: *(from Specifications by D. Schulte, R. Tomas, and from discussions with L. Gatignon, D. Swoboda et al. at the "MDI WG Monday Meetings":*

- **Gradient:** highest possible towards a nominal value of: **575 T/m**)
- **Required Length**: **2.73 m** *(but the real FF Quad will be cut in different longitudinal sections...)*
- **Magnet Bore Radius:** 3.8 mm + 0.3mm estimated for a vacuum chamber thickness *(as proposed with TE Vacuum Group)* + 0.025(tolerance) = **4.125mm**
- **Field Quality:** a 1st specification exist, but needs and requirements to be further discussed with CLIC Beam Physic Group
- **Geometric (layout) boundary conditions**:

  Major one is: presence of the "**spent beam pipe**": conical shape (10 mrad aperture), min. distance from the FF (at the front end for a L* = 3.5 m): **35 mm**

- *Other boundary conditions like:*
  - *Anti-solenoid presence*
  - *Stabilization requirements*
  - *Detector design and its interfaces*

  Were recently put also on the table for discussion.

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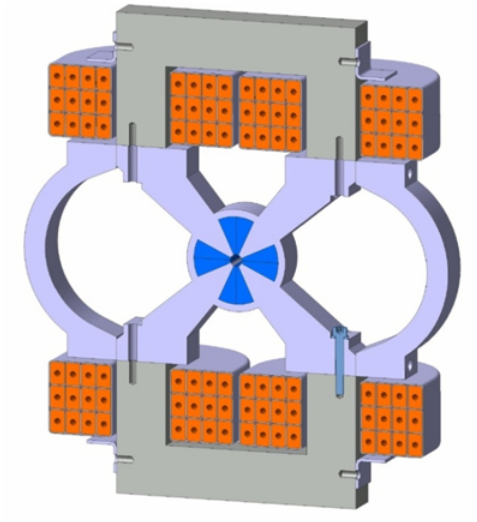
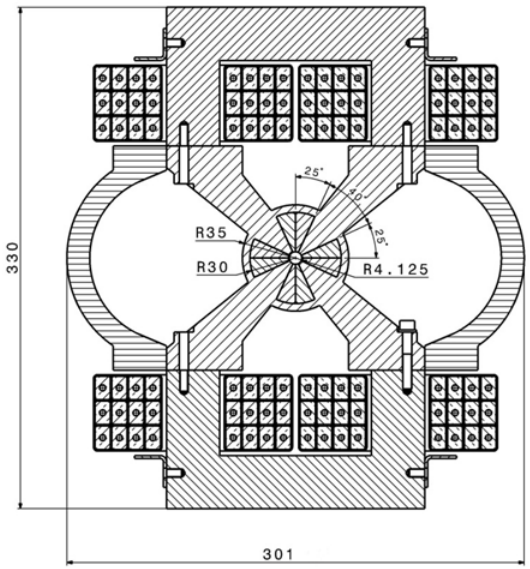
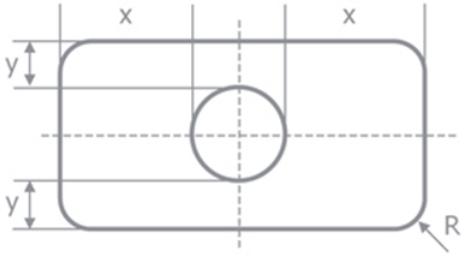
...the CONCEPTUAL DESIGN:

"Hybrid Short Prototype" (Version 2):





Conductor ID (ex. from "LUVATA" Catalogue)	6822
height/width [mm]	15.4/10
hole diameter [mm]	4.0
x/y [mm]	5.70/3.00
R [mm]	1.50
N turns per pole	12
Conductor Length [m] per pole for 1m magnet	28.5
Minimal bending radius [mm]	20
Insulation thickness [mm]	0.5
Mass per m	1.25 kg/m



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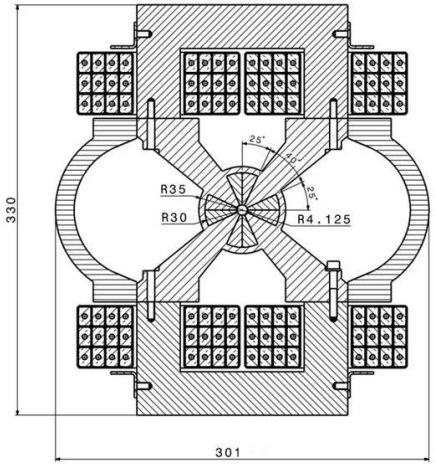
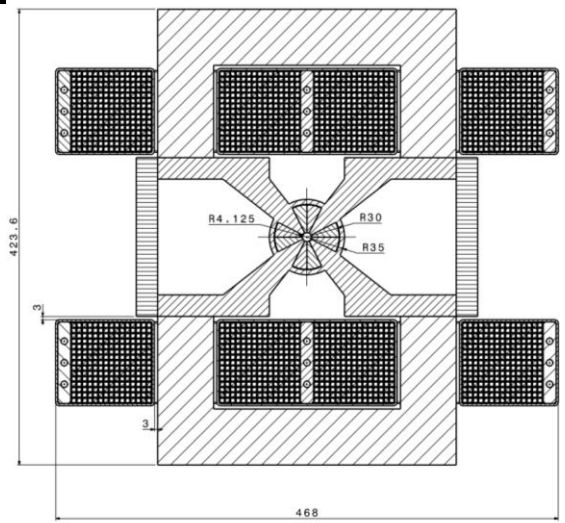
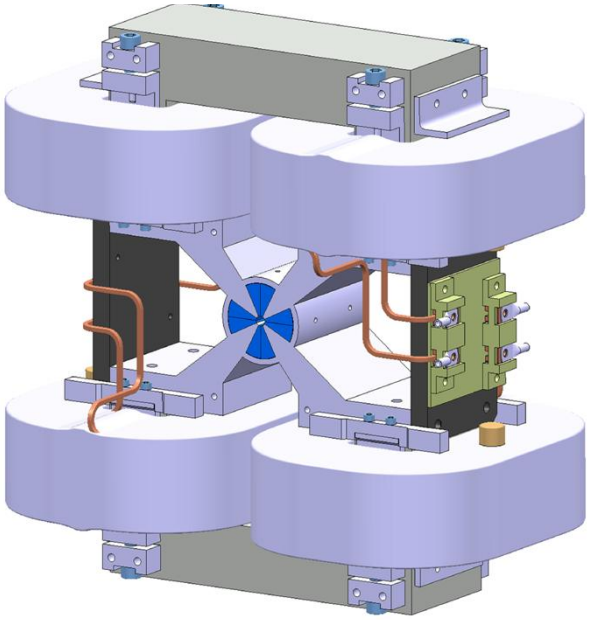
CLIC QD0 Status

...Where we are TODAY with the SHORT Prototype:

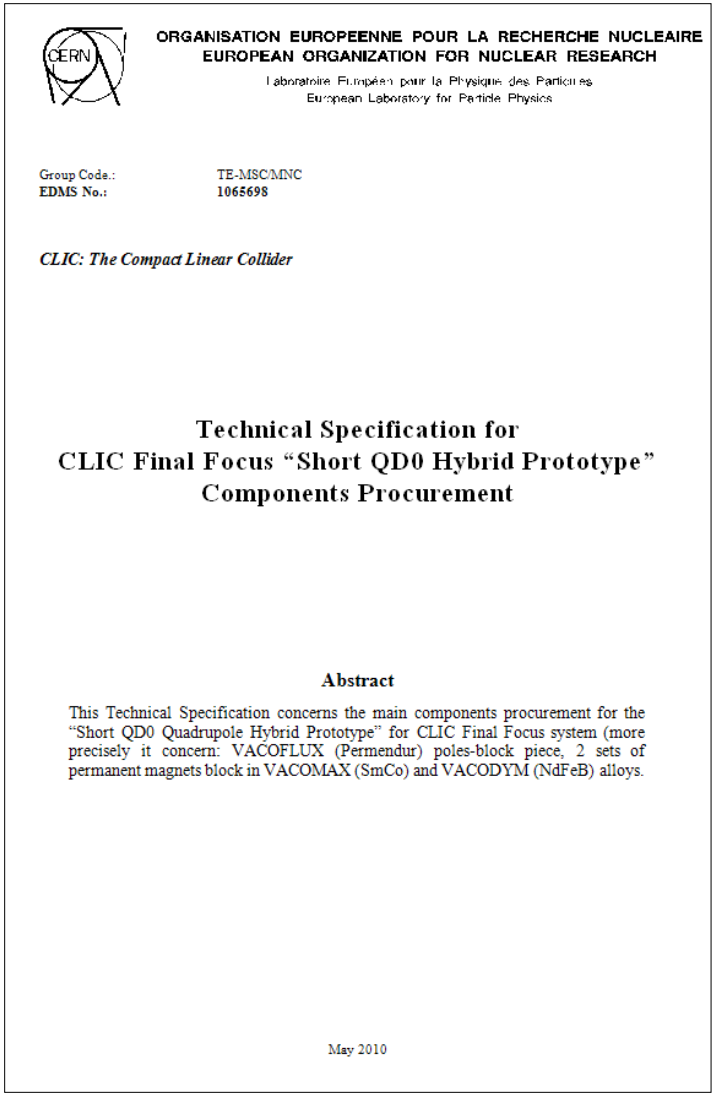




CLIC QD0 Main Parameters		100mm prototype	Real magnet 2.7m
Yoke			
Yoke length	[m]	0.1	2.7
Coil			
Conductor size	[mm]	4×4	4×4
Number of turns per coil		18×18=324	18×18=324
Average turn length	[m]	0.586	5.786
Total conductor length/magnet	[m]	0.586×324×4=760	5.786×324×4=7500
Total conductor mass/magnet	[kg]	26.8×4=107.2	265.2×4=1060.8
Electrical parameters			
Ampere turns per pole	[A]	5000	5000
Current	[A]	15.432	15.432
Current density	[A/mm^2]	1	1
Total resistance	[mOhm]	896	8836
Voltage	[V]	13.8	136.4
Power	[kW]	0.213	2.1



CLIC QD0 Status



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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

Group Code.: TE-MSC/MNC
EDMS No.: 1065698

CLIC: The Compact Linear Collider

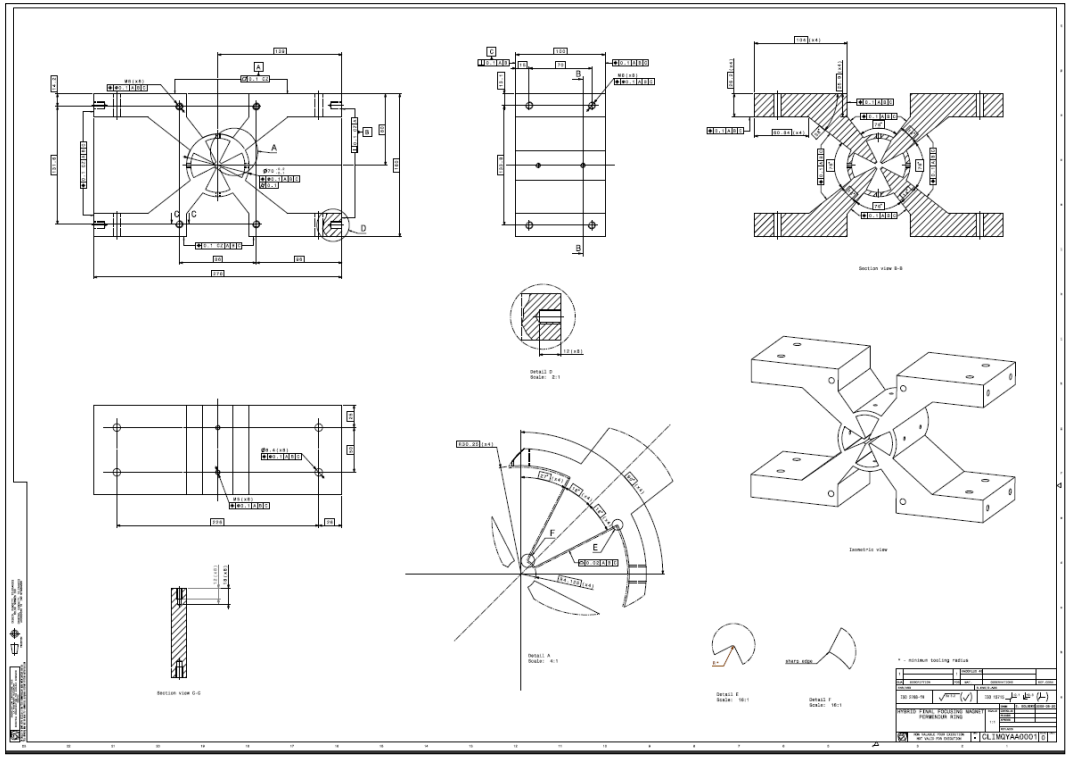
Technical Specification for
CLIC Final Focus "Short QD0 Hybrid Prototype"
Components Procurement

Abstract

This Technical Specification concerns the main components procurement for the "Short QD0 Quadrupole Hybrid Prototype" for CLIC Final Focus system (more precisely it concern: VACOFLUX (Permendur) poles-block piece, 2 sets of permanent magnets block in VACOMAX (SmCo) and VACODYM (NdFeB) alloys.

May 2010

- *Procurement of the critical parts (Permendur/PM blocks assembly): Ongoing at Vacuumschmelze (D)*
- *Special tooling: under fabrication*
- *Winding and assembly will follow (at CERN)*



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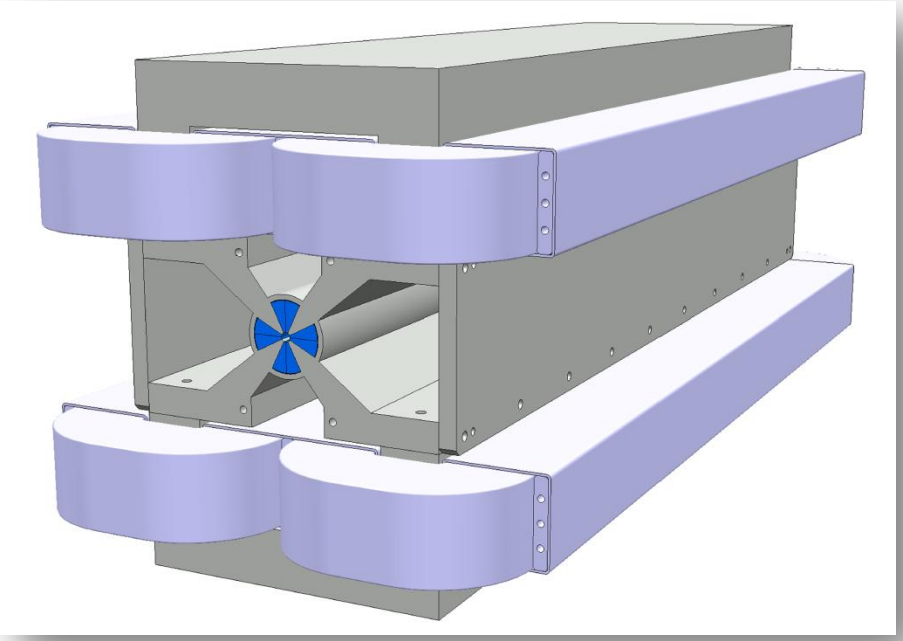
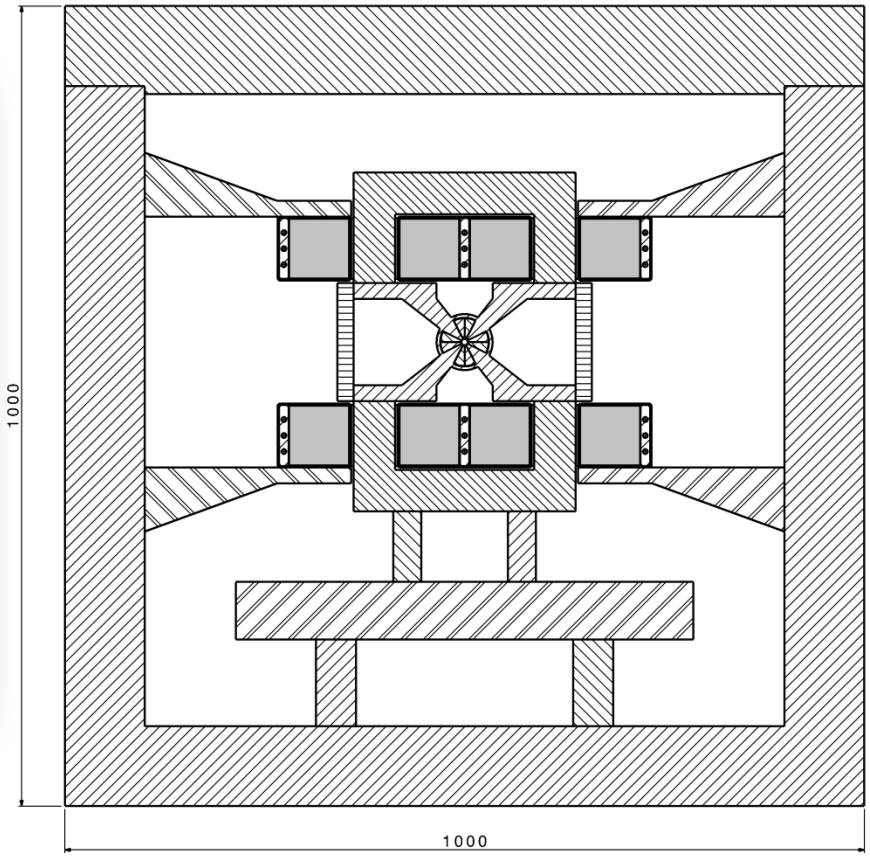
Studies for a "full size" design (remind: 2.7 m length!):

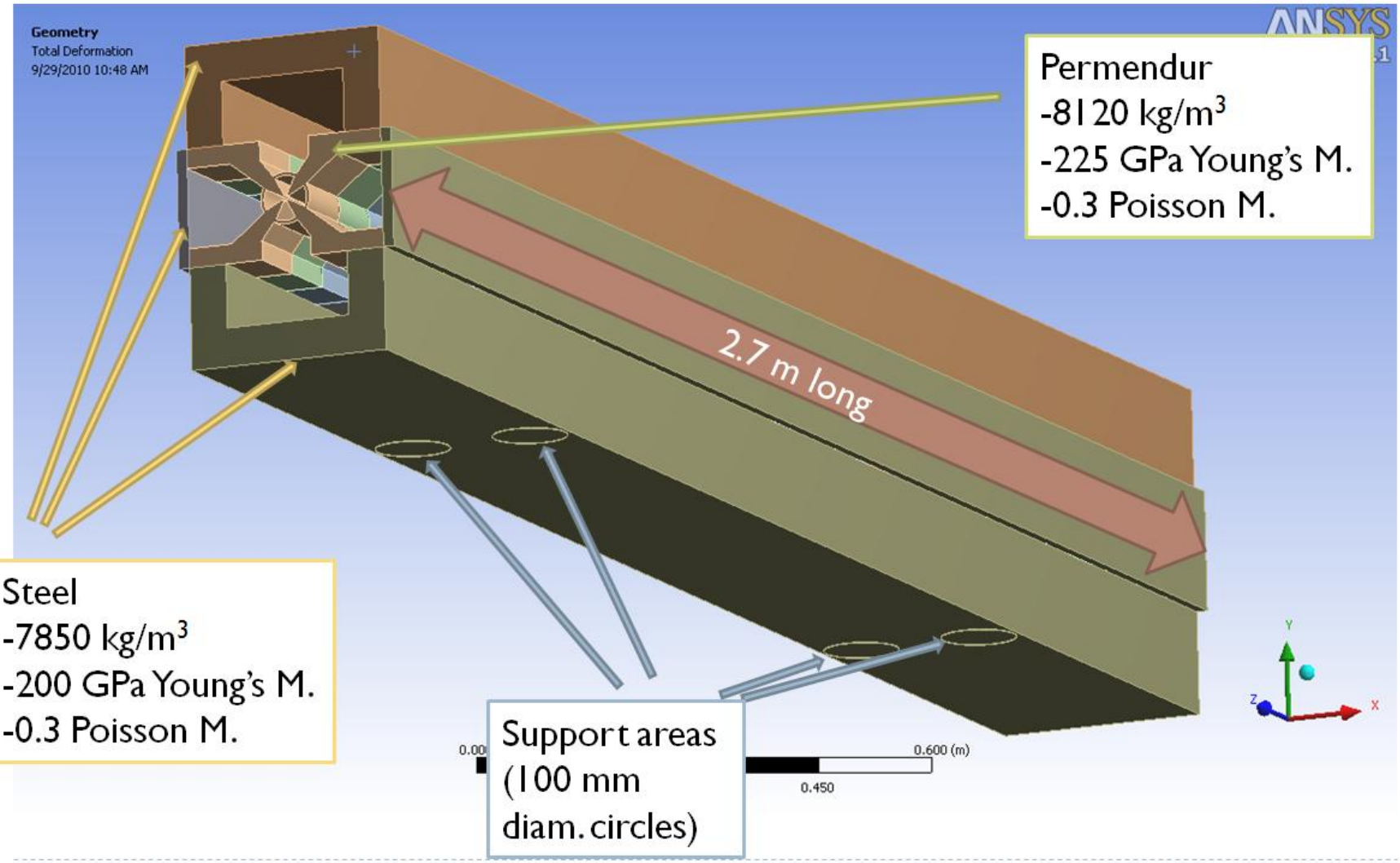
One major point: to suspend independently the coils from the magnet core assembly





CLIC QD0 Status

Mechanical assessment of a "full size" structure:



CLIC QD0 Status

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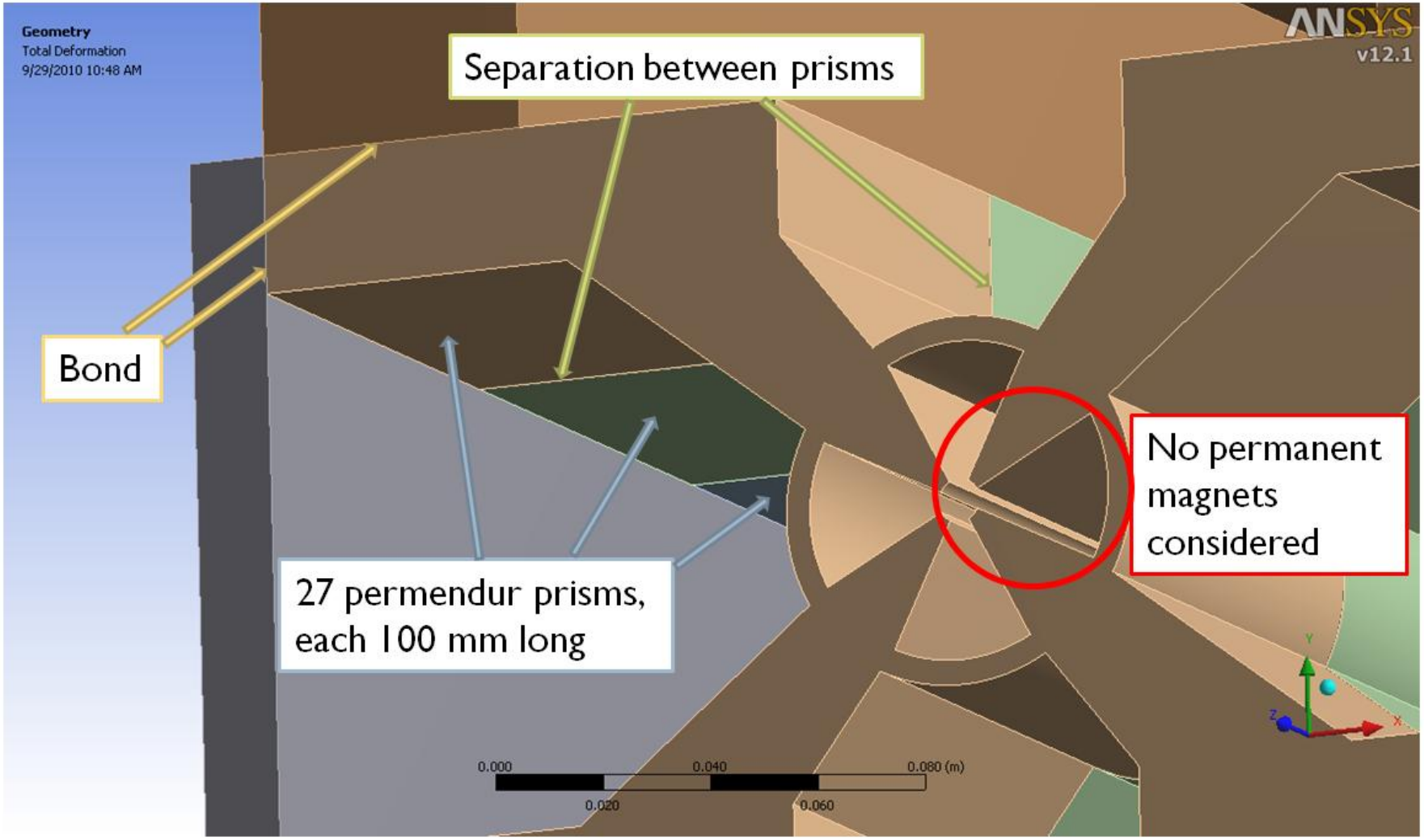

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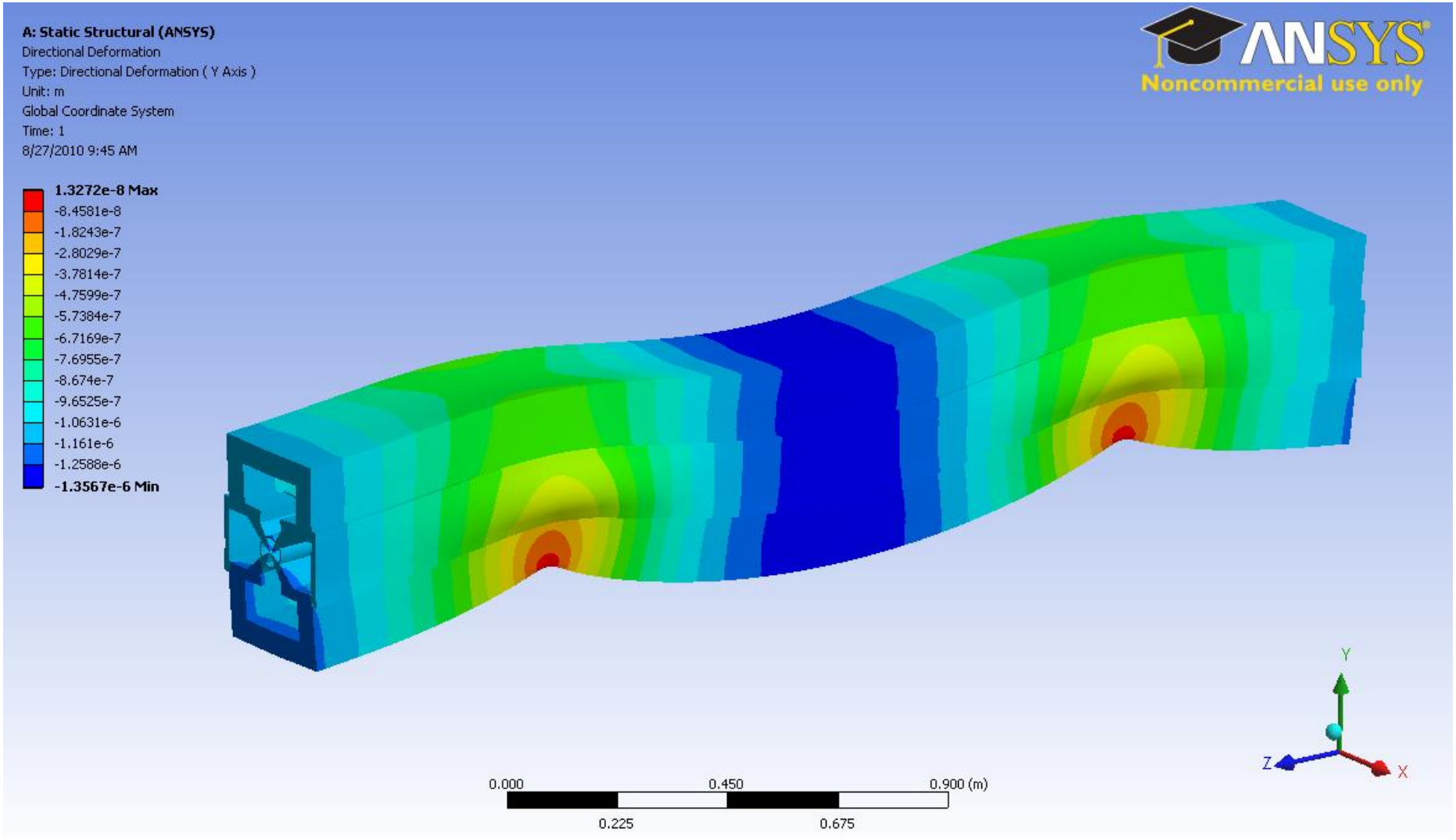

CLIC QD0 Status

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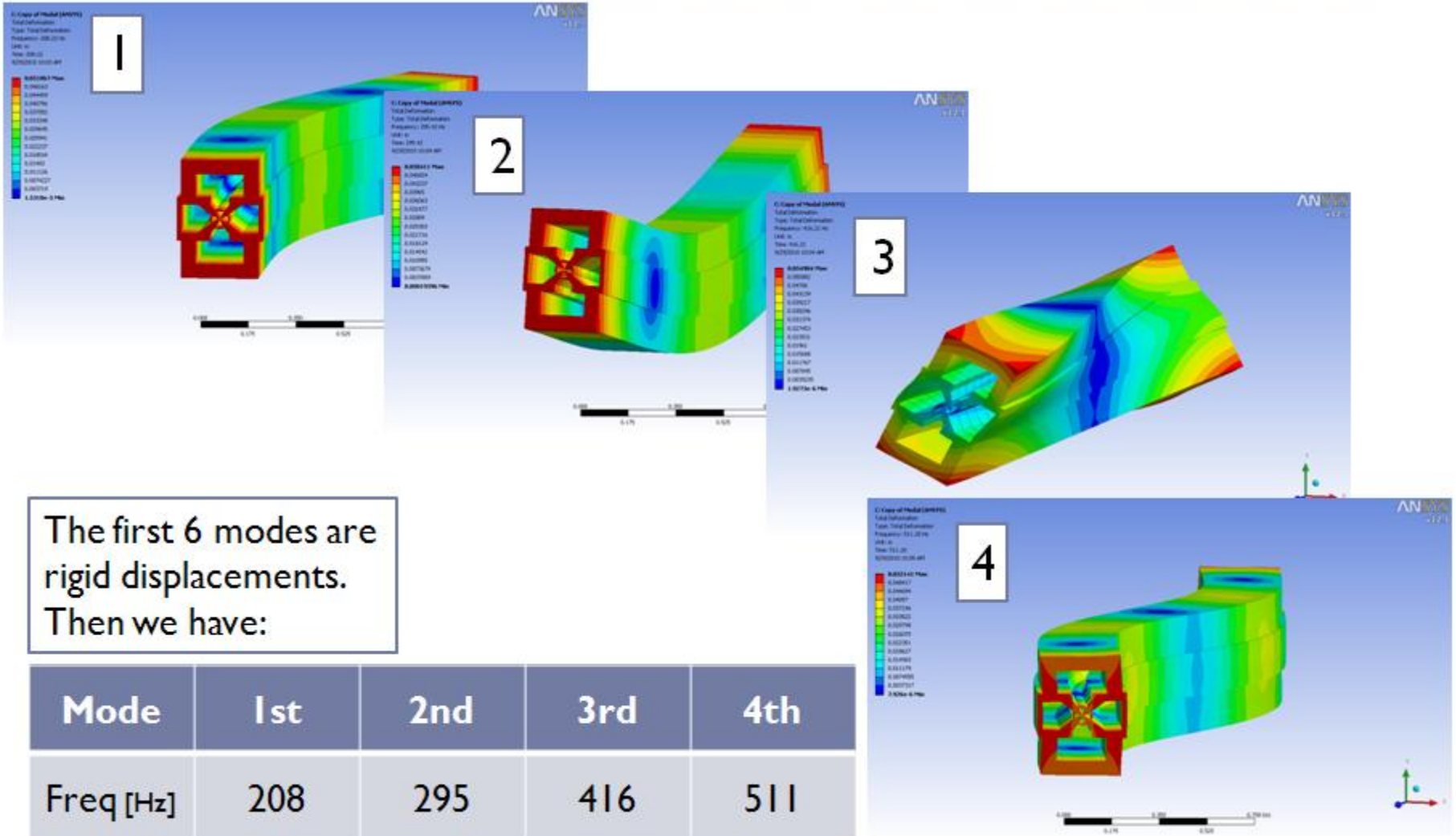


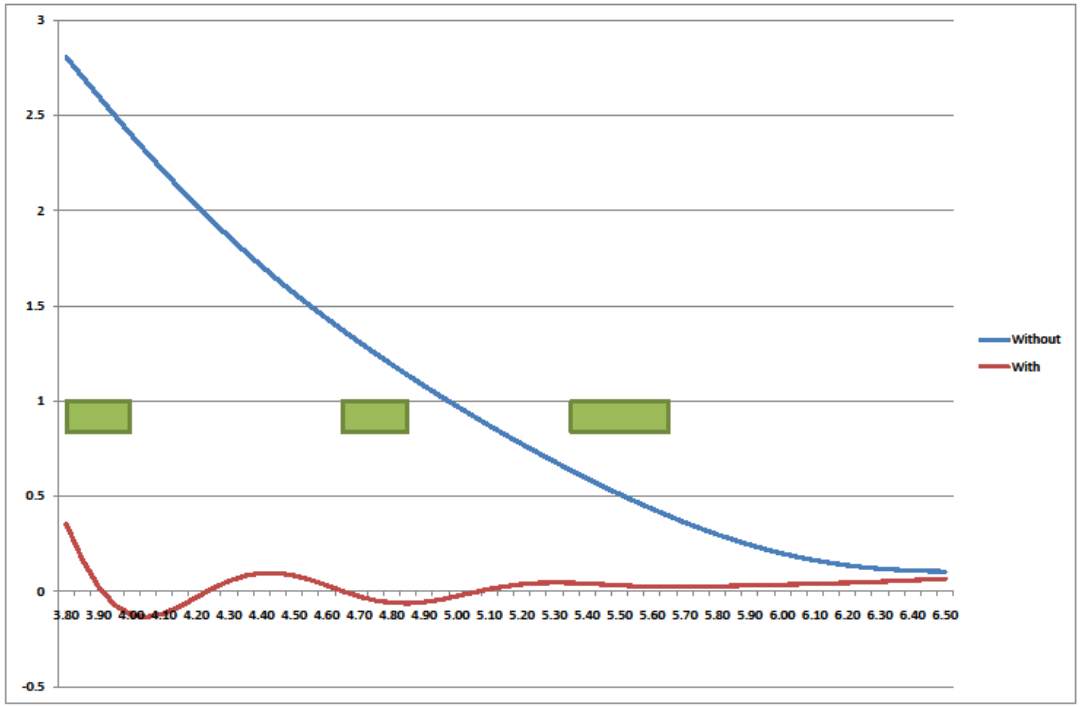
The first 6 modes are rigid displacements. Then we have:

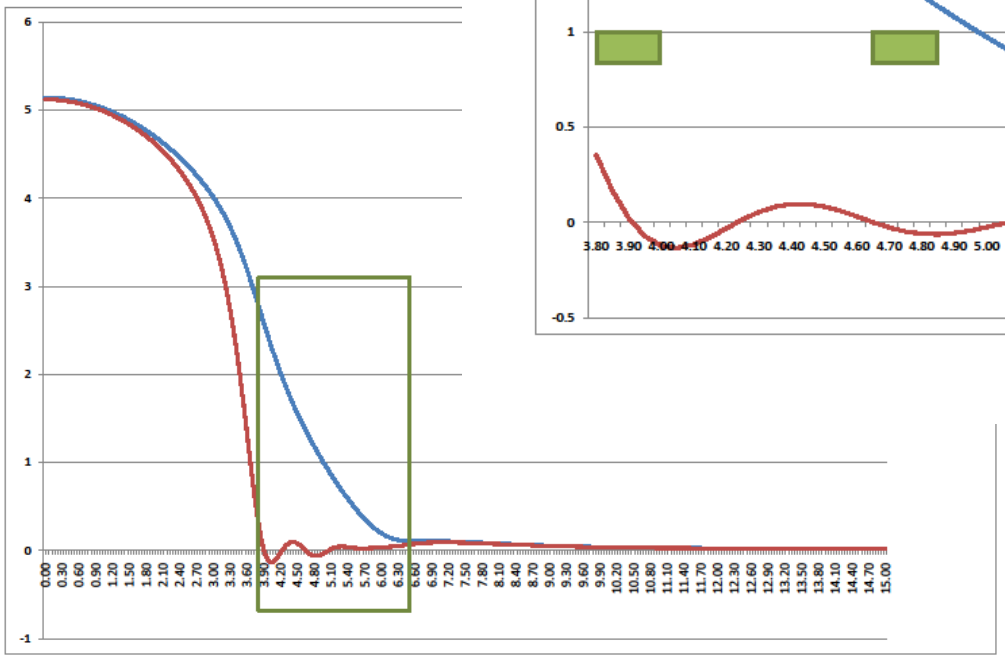
Mode	1st	2nd	3rd	4th
Freq [Hz]	208	295	416	511

CLIC QD0 Status

Impact of Detector field:

*(refer to presentation of **B. Dalena** in WG 6 Session of Wednesday 20 Oct. morning)*





Axial Magnetic Field in the experiment and in the QD0 region:

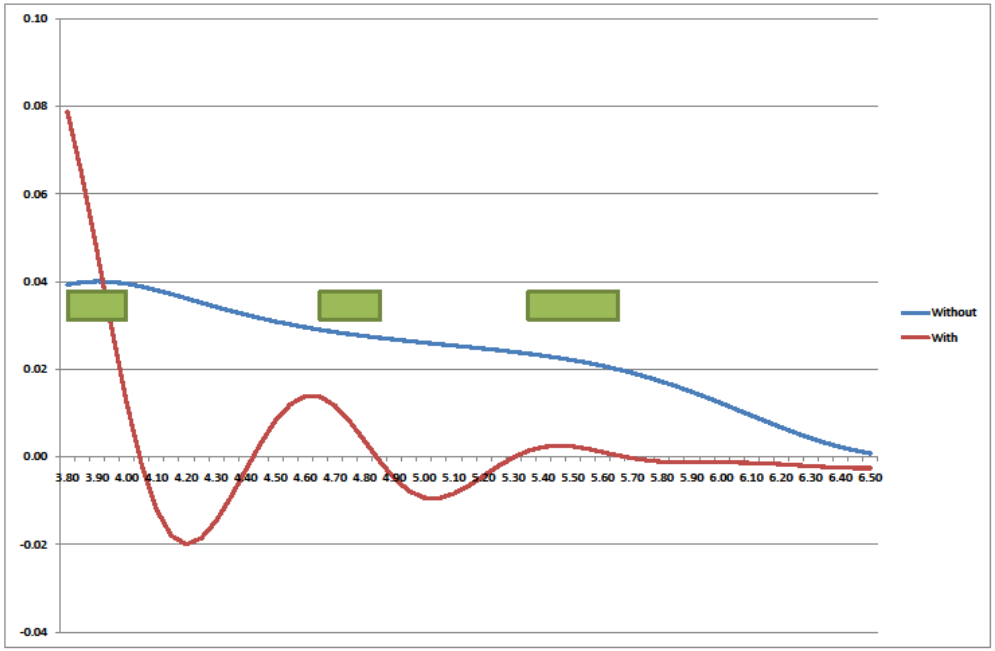
Values are in Tesla. The grey box indicate the region of QD0 (2.7 m long)

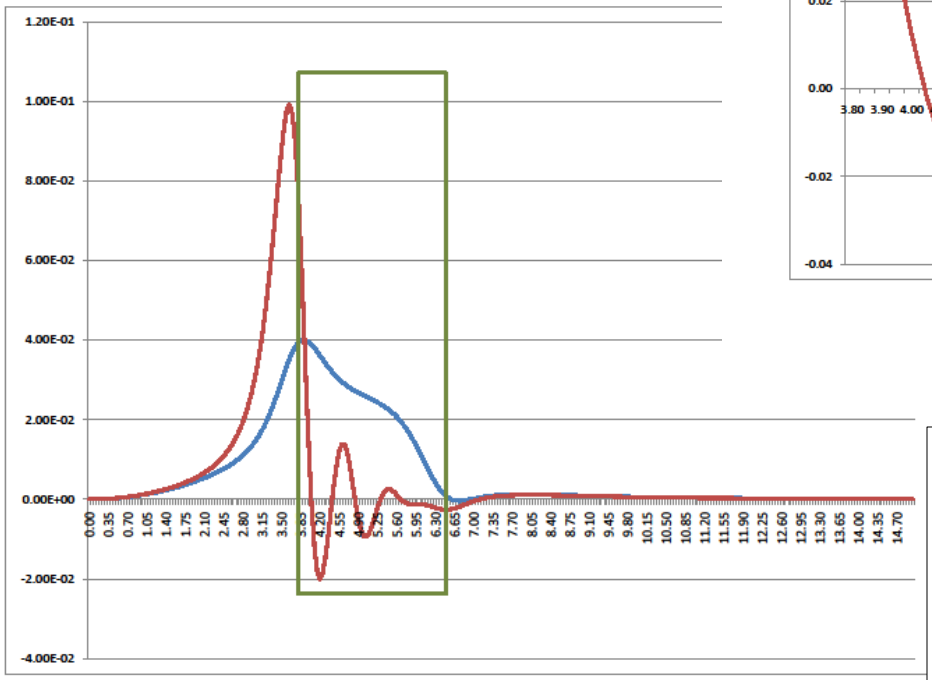
Impact of Detector field:

Radial Magnetic Field in the experiment and in the QD0 region:

Values are in Tesla. The grey box indicate the region of QD0.

NOTE: the magnetic field is plotted versus the real beam nominal direction (i.e. trajectory on a 10 mrad angle with the main solenoid axis)



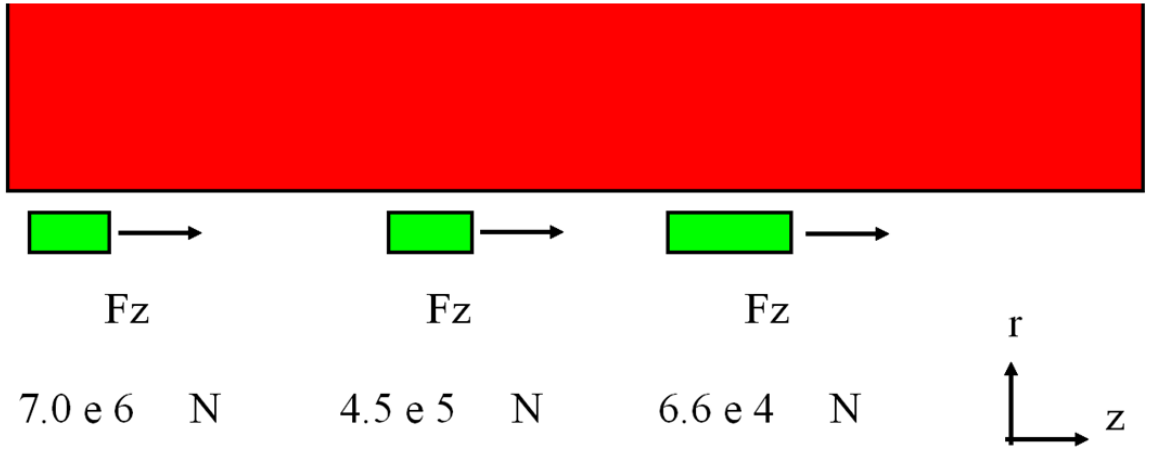


…these values are still too high, work on-going with CERN, BE-ABP to optimize the anti-solenoid design and with CERN, PH-CMX to investigate feasibility of the anti-solenoid, supports, etc.…

Impact of Detector field:

Load Case 1:

both solenoid AND antisolenoid are energized



- Resulting forces tend to push the antisolenoid **away** from the IP
- Radial forces on the coils are **centripetal-like** (less stable)

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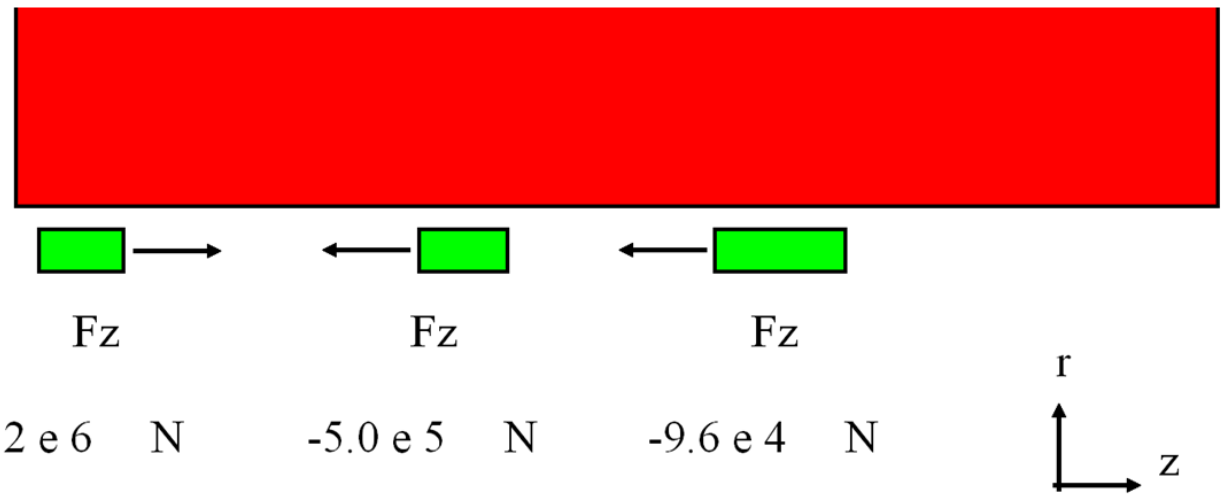
Impact of Detector field:

Load Case 2:

ONLY the antisolenoid is energized



- The antisolenoid coils are **attracting** between them
- Radial forces on the coils are **centrifugal-like** (stable)

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…forces depends (in modules AND sign) by the scenario (powering of experiment solenoid or not, discharge transient, etc.) computation just started…

Conclusions:

-***The QD0 design proposed last year was modified (slightly) in order to minimize the eventual impact of coils vibrations.***

-***A short prototype is under construction.***

- ***Studies towards a "full size" design are ongoing. Main aspects under study:***
  - ***Impact of experiment solenoid: → OPTIMIZATION of the anti-solenoid needed***
  - ***Mechanical assessment (deformations, vibrations, supporting, etc.): → toward a full size design***

Acknowledgments:

This presentation resume the contributions of:

A. Vorozhtsov *(Hybrid Magnet concept&design – magnetic analysis),*

A. Bartalesi *(mechanical analyses),*

E. Solodko *and* ***P.Thonet*** *(manuf. design and prototypes procurement and future assembly).*

Thank you for the attention

Extra slides

CLIC QD0 Status