CLIC MDI

IWLC10 workshop 20-10-2010

Lau Gatignon / CERN

for the MDI team & related WG

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Outline

- Introduction
- Detector layout
- The QD0 magnet
- Anti-solenoid
- QD0 integration in detector
- QD0 stabilisation
- Pre-alignment of QD0
- IP feedback
- Vacuum
- Post-collision line
- Input for cavern layout with Push-pull
- Summary and Outlook

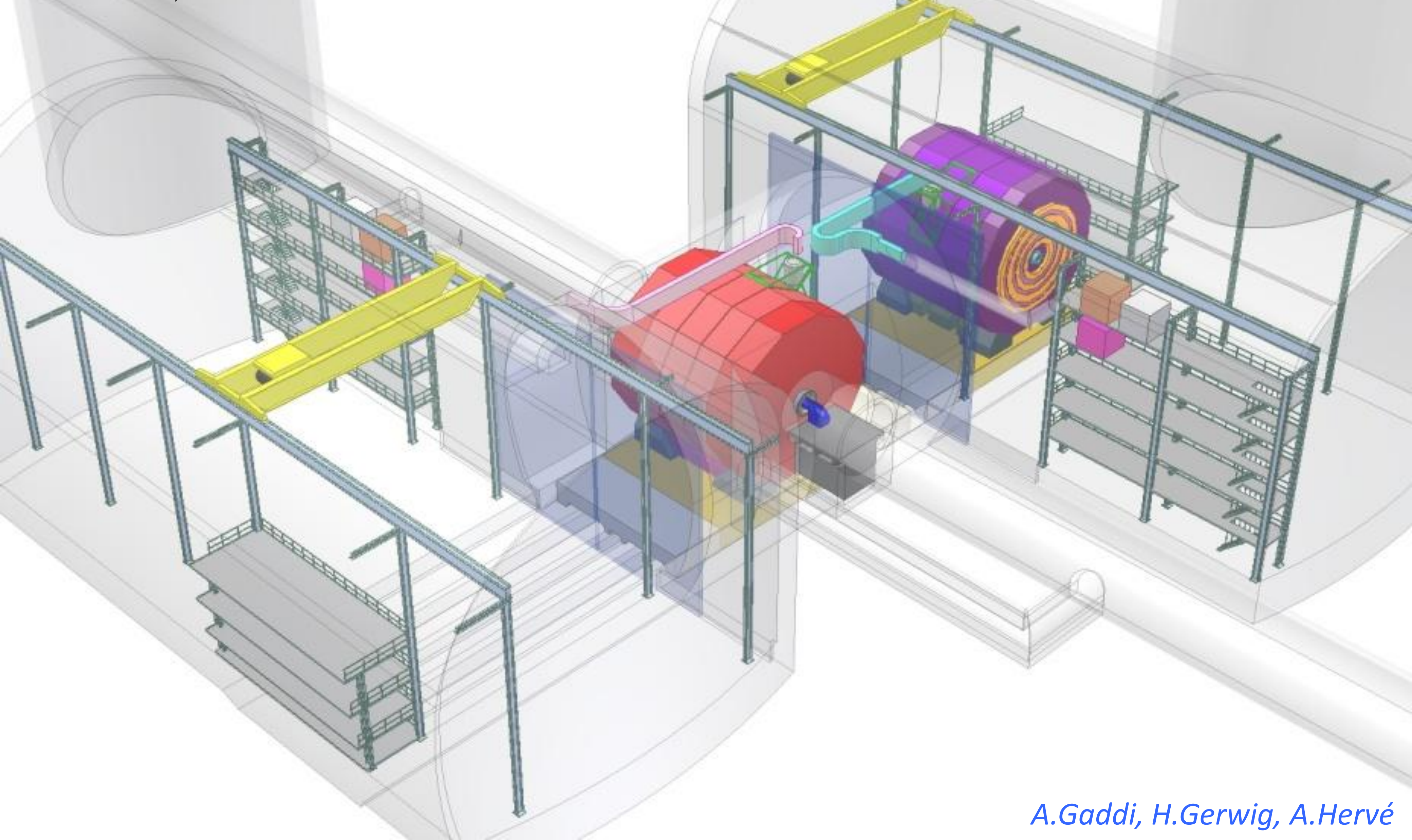
Some relevant CLIC parameters

Beam parameter	Value
Center of mass energy	3 TeV
Total Luminosity	5.9 10^{34} $cm^{-2}s^{-1}$
Luminosity L_{99} (within 1% of energy)	2 10^{34} $cm^{-2}s^{-1}$
Linac repetition rate	50 Hz
Number of bunches per pulse	312
Number of particles per bunch	3.72 10^{9}
Bunch separation	0.5 ns
Bunch train length	156 ns
Beam power per beam	14 MW
Nominal horizontal IP β function	6.9 mm
Nominal vertical IP β function	0.068 mm
Horizontal IP beam size	45 nm
Vertical IP beam size	1 nm
Bunch length	44 μm

$L^* = 3.5$ m

The CLIC interaction region: one IP, two Experiments

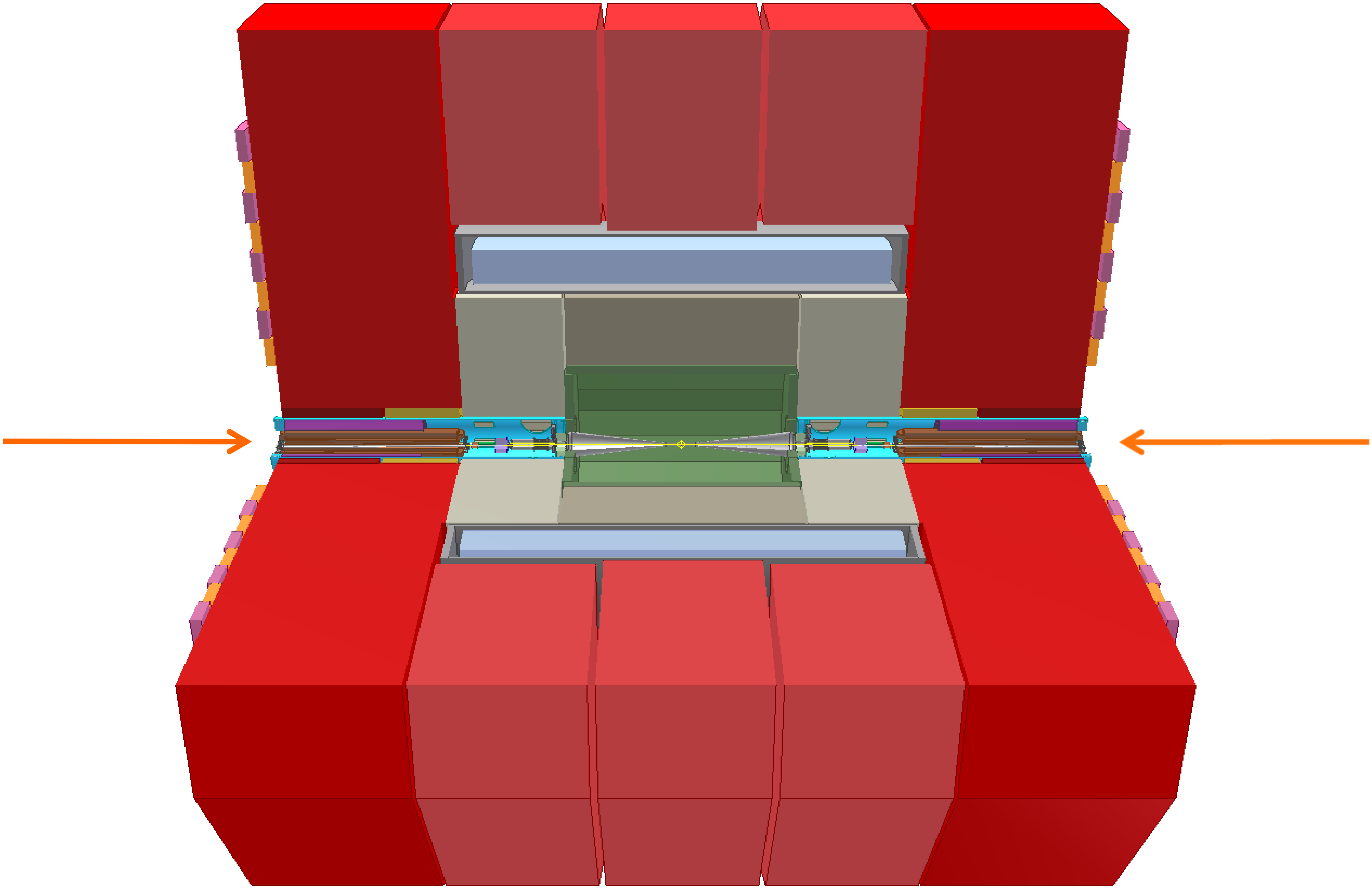
→ **Push-Pull scheme**



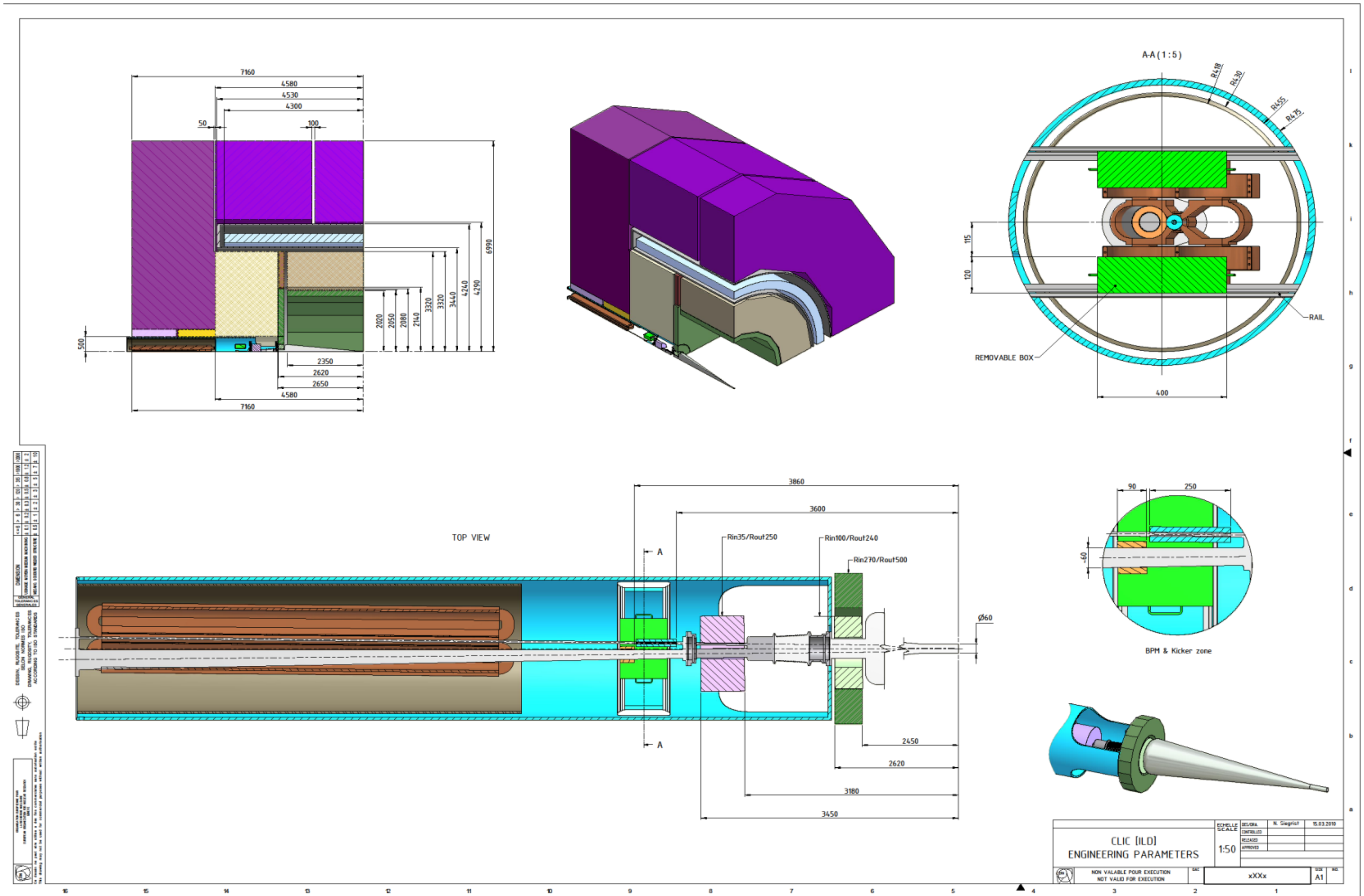
A.Gaddi, H.Gerwig, A.Hervé

e.g.: LATEST VERSION OF CLIC_SID DETECTOR

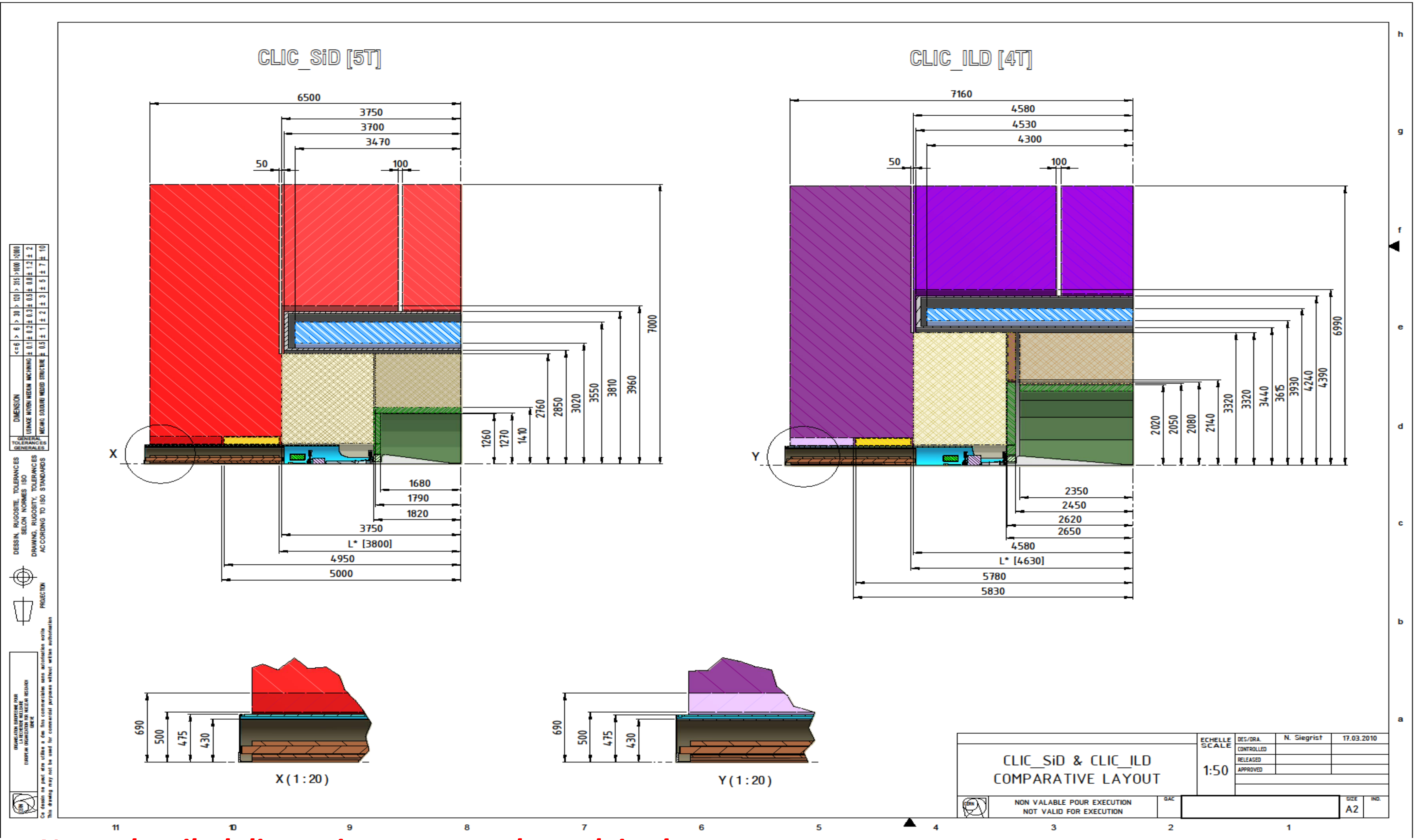
N.Siegrist, H.Gerwig



ILD parameter drawing



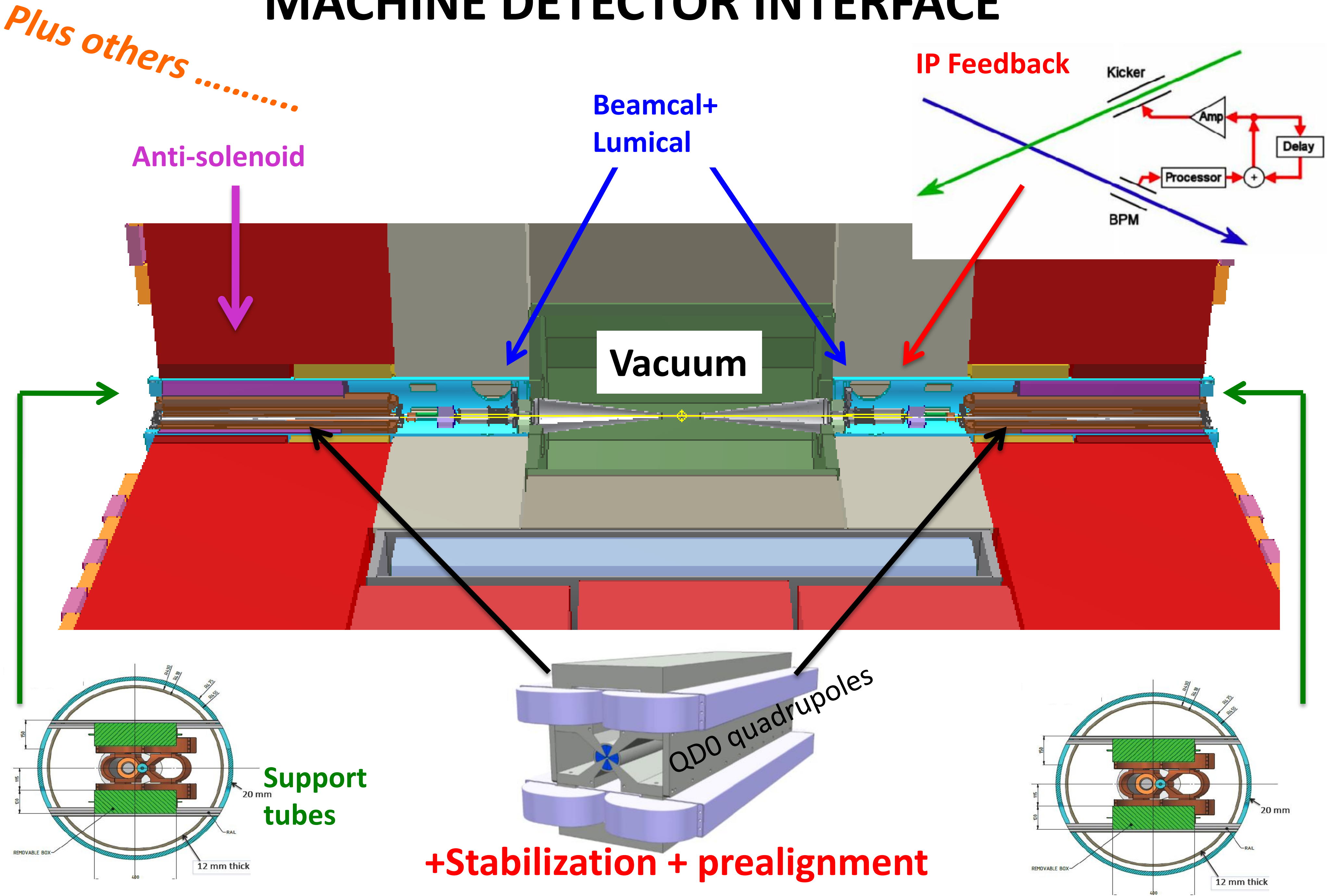
Comparison between the two detectors



Note: detailed dimensions constantly evolving!

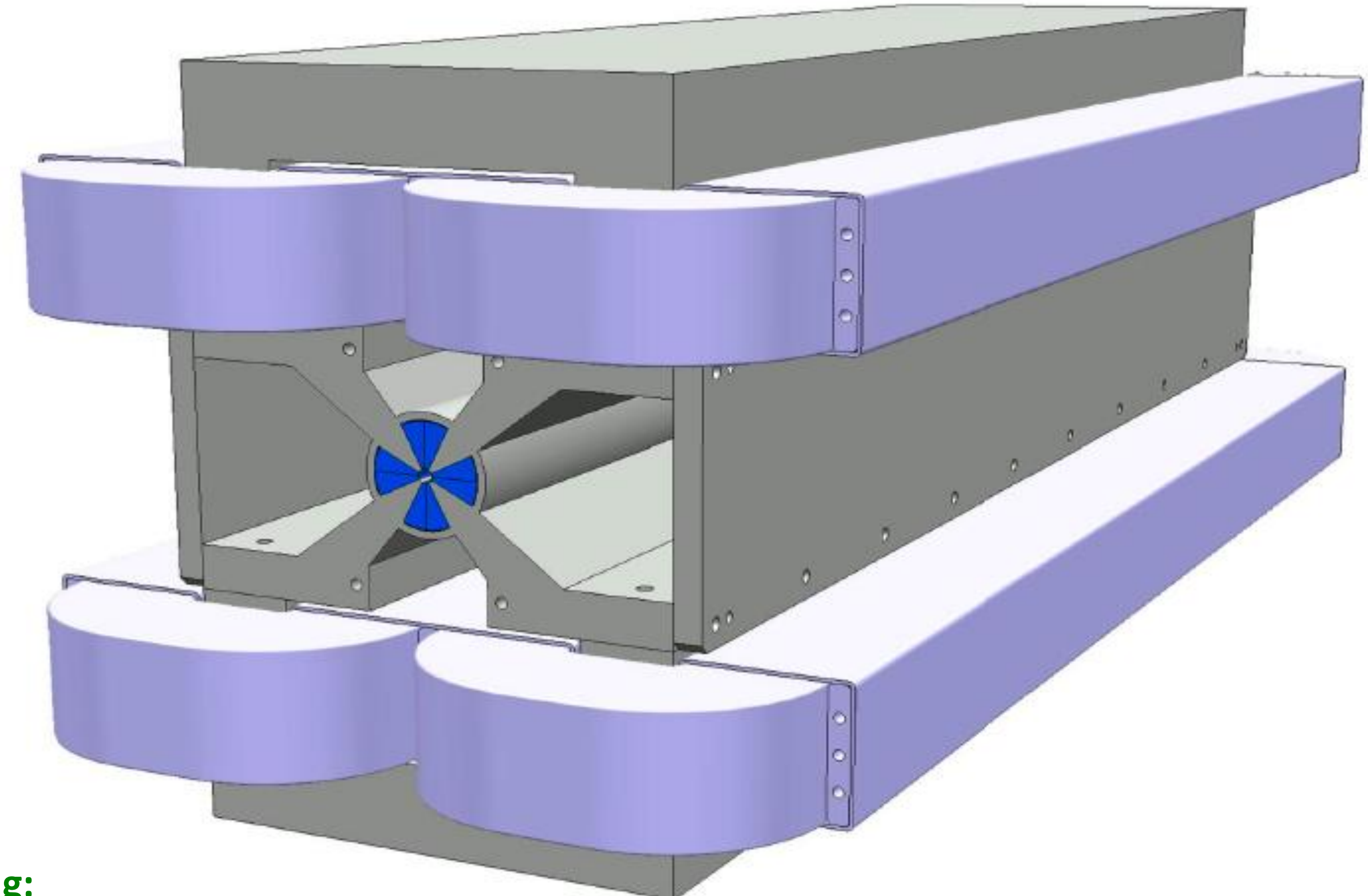
H.Gerwig et al

MACHINE DETECTOR INTERFACE



Concept of the hybrid QD0 magnet

See M.Modena, WG5

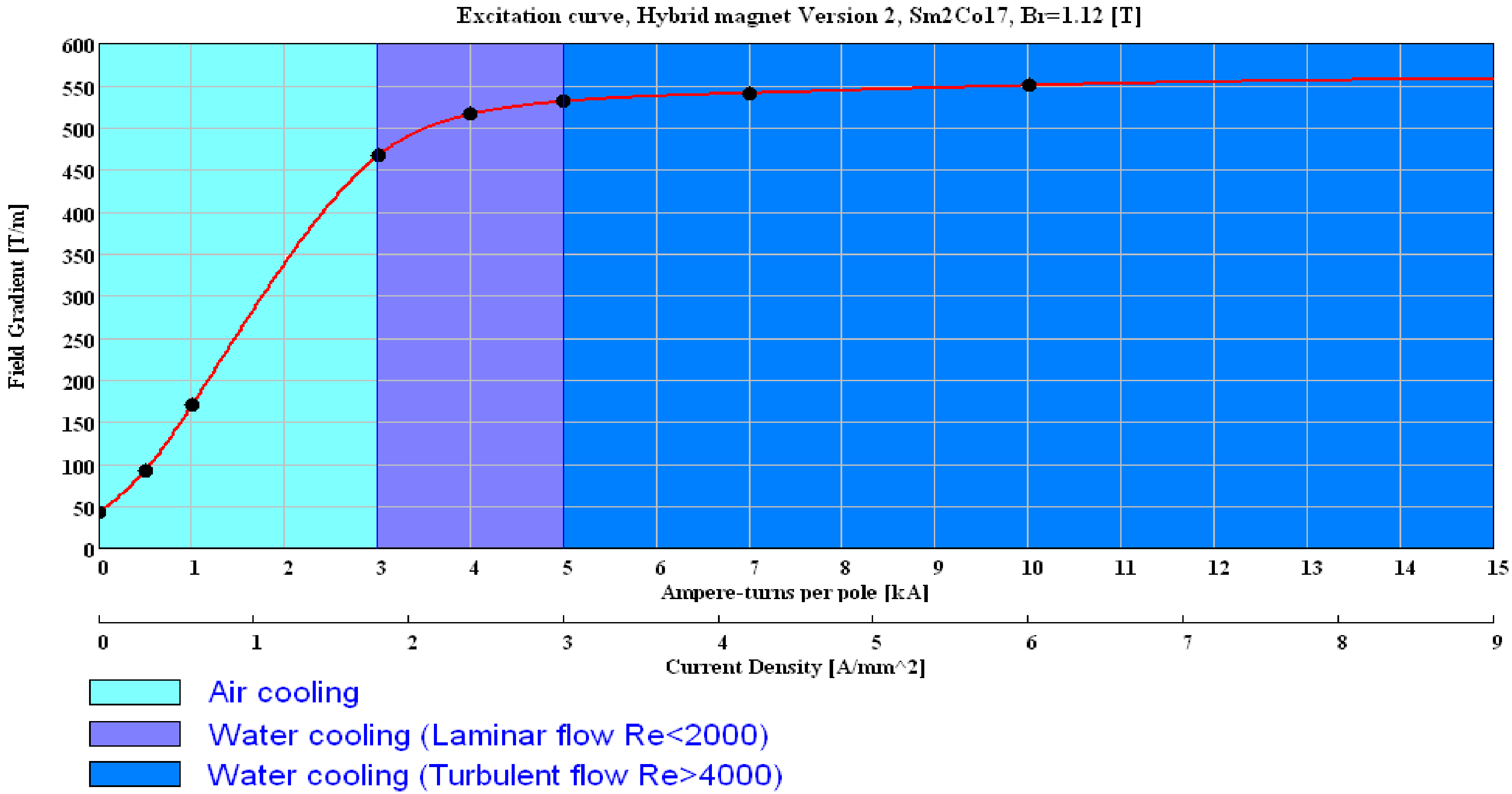


Modeling:

Obtain 531 T/m with Sm_2Co_{17}
590 T/m with $Nd_2Fe_{14}B$

Stabilised in position (double tube)
Coils mounted independent of yoke

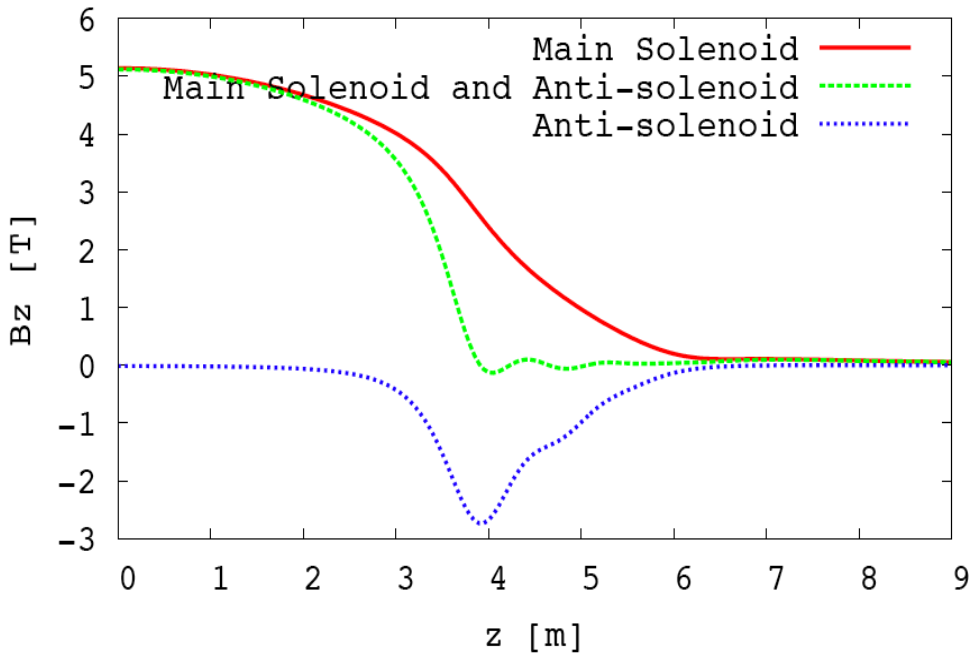
"Hybrid Short Prototype":

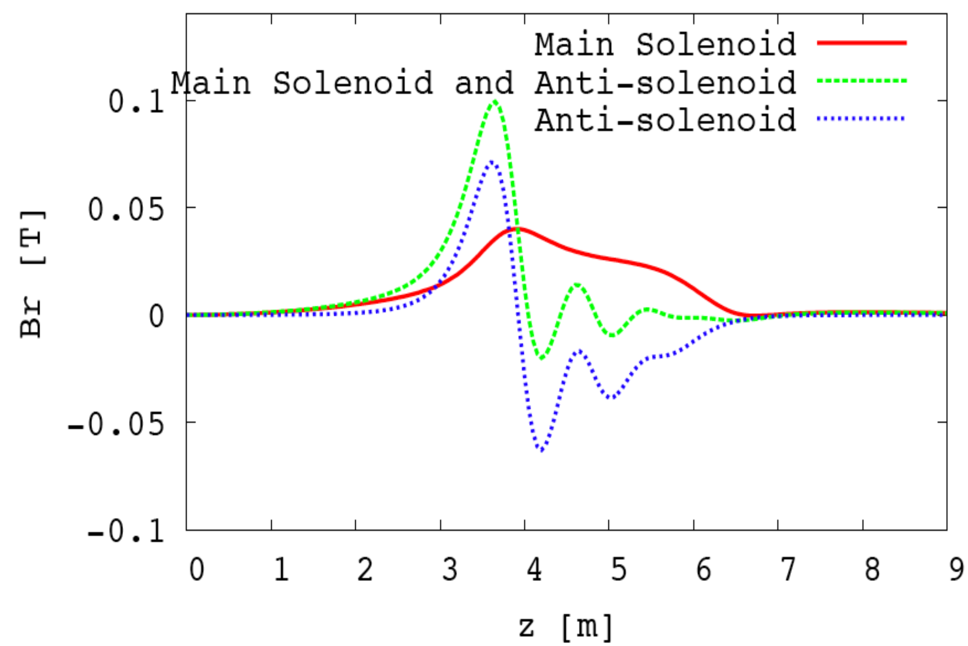


"CLIC09 Workshop" 12-16 October 2009 , M. Modena

Anti-solenoid

The permanent magnet material and Permendur in QD0 are protected by the anti-solenoid, that partly cancels the main solenoid field.





It surrounds QD0 and is made of several coils, powered with different currents.
It also compensates to a large extent the effect of the main solenoid on the beams.

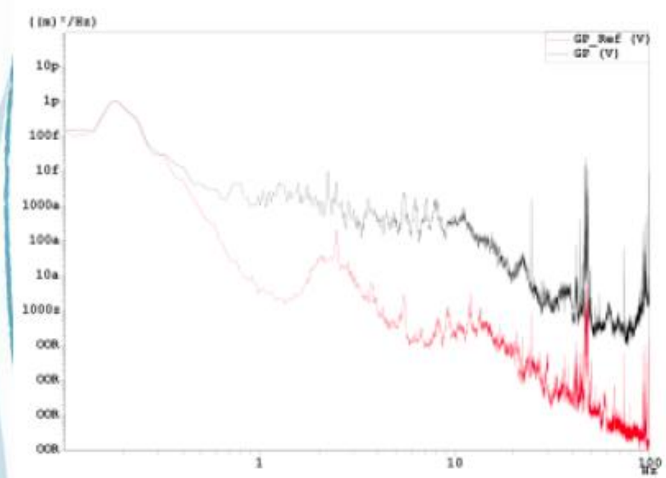
See presentation by B.Dalena in WG5

Note: Ground movements & vibrations

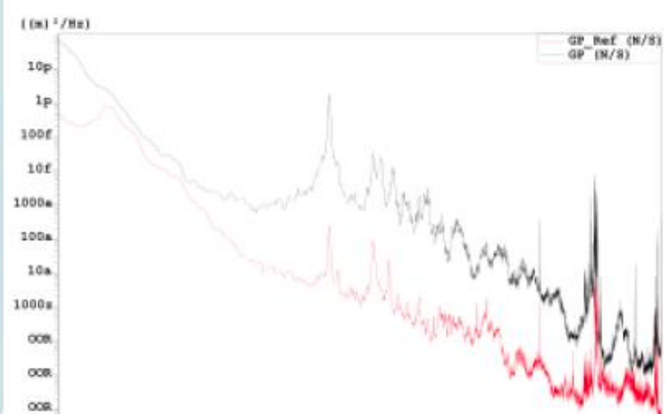
CMS top of Yoke measurement

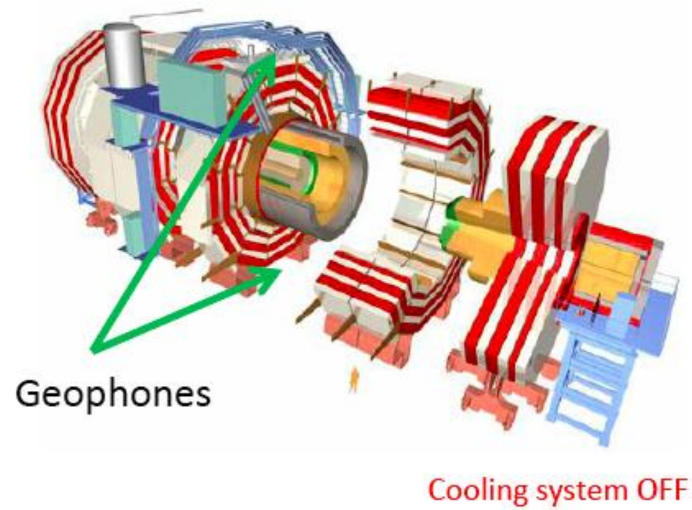
Suspend QD0 from the tunnel, not from the detector

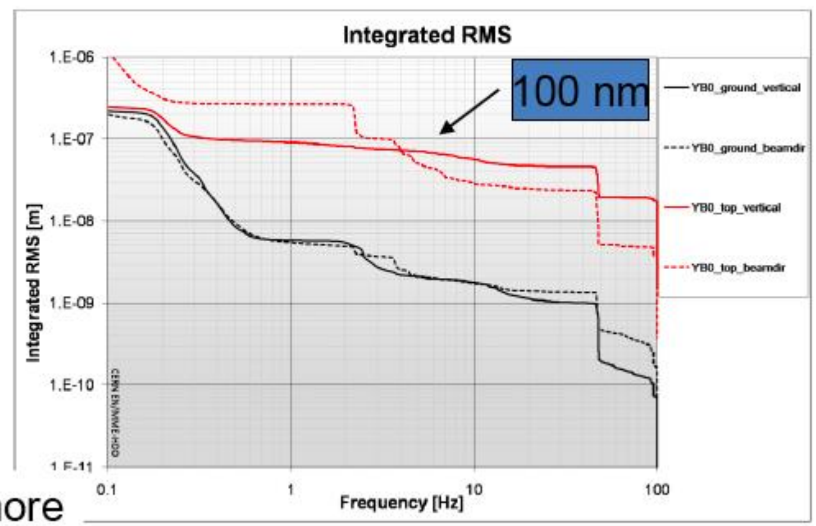
PSD of the signals Vertical direction



PSD of the signals Beam direction





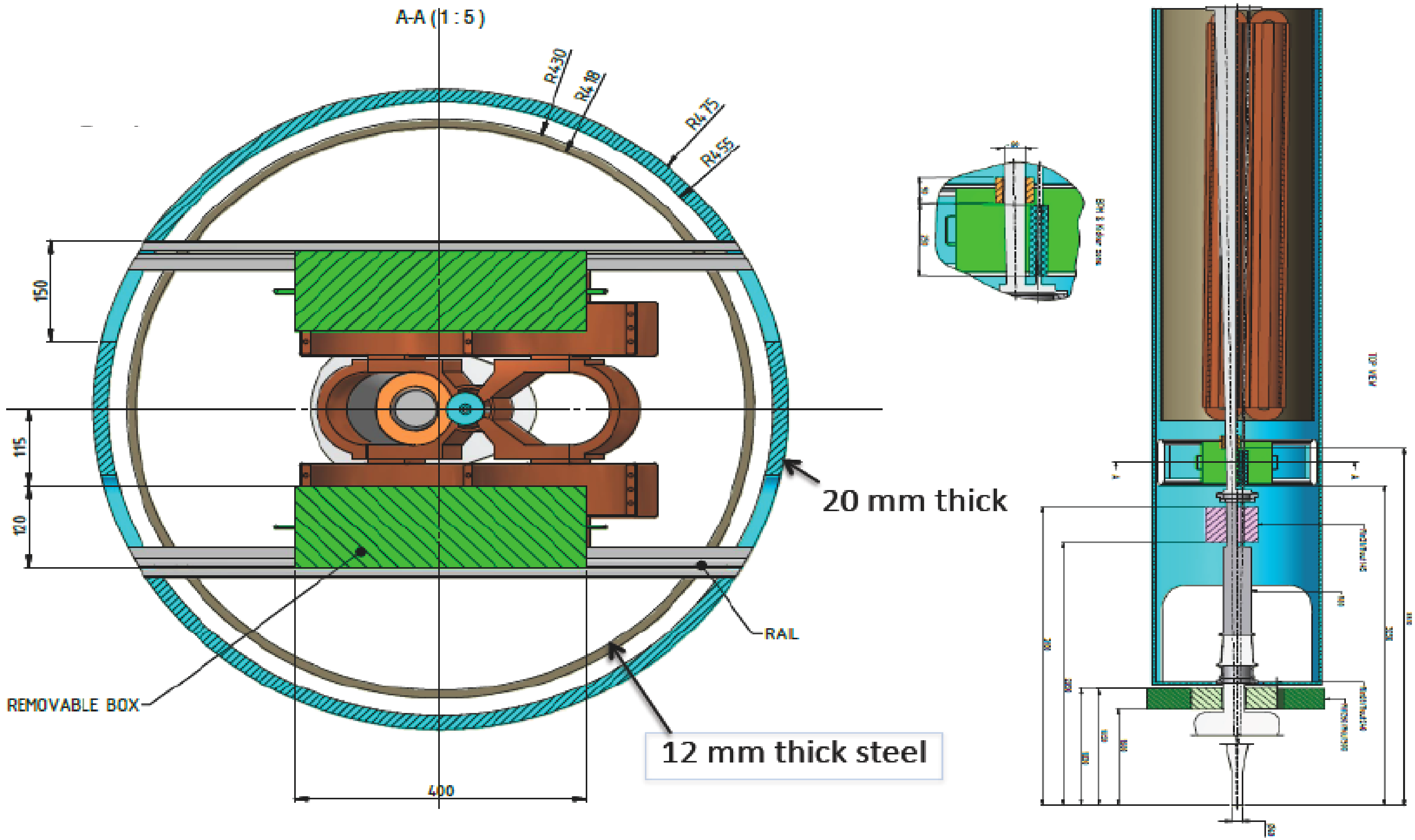


Why: because detector moves much more than specs (CMS measurements?)

M.Guinchard and A.Kuzmin

Courtesy H.Gerwig

Cross-section support tube, dimensions



Stabilization of QD0

Any vertical movement of QD0 moves the beam
at the Interaction Point by a comparable amount

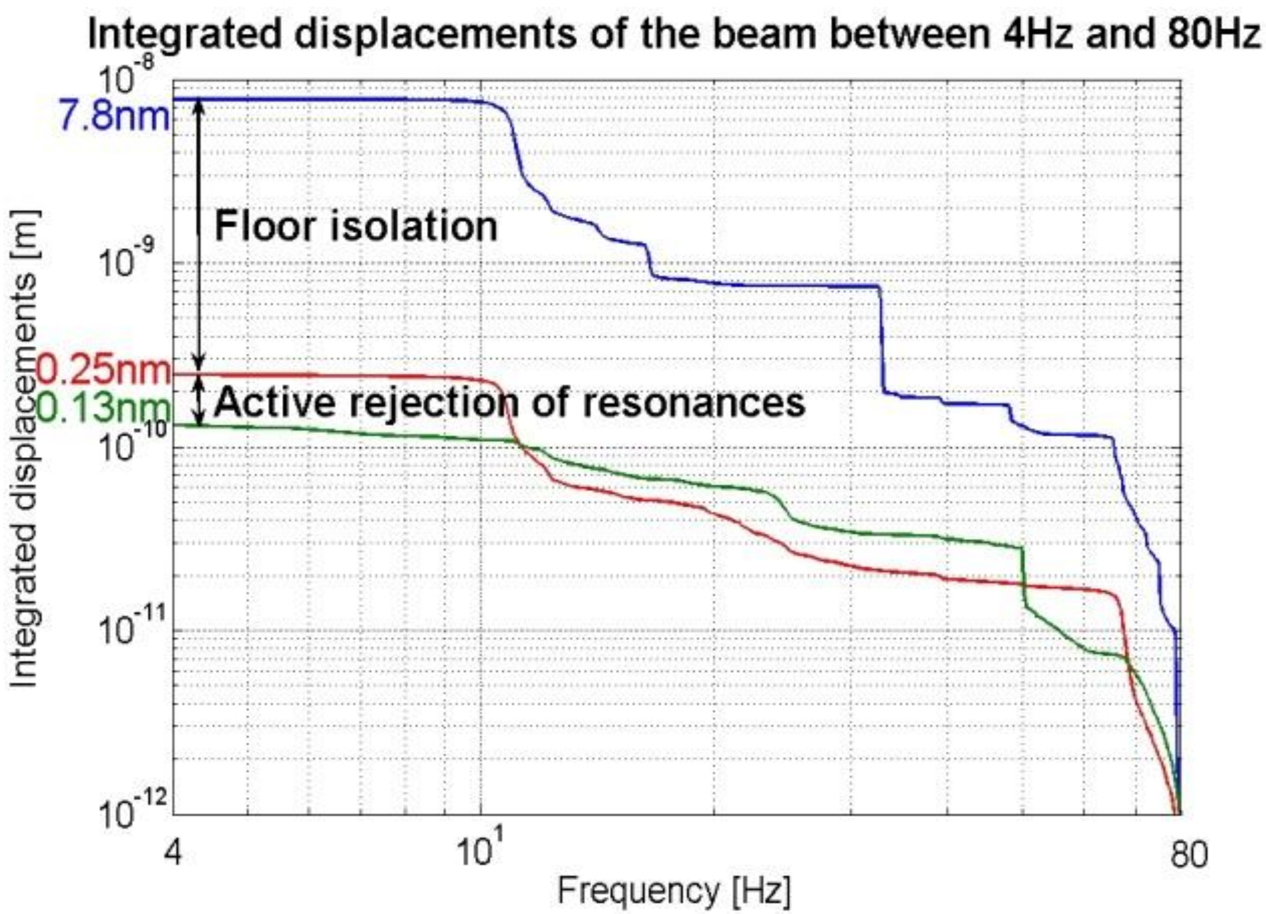
➡ **Need to stabilize QD0 position**
In particular vertical position to 0.15 nm RMS @ 4 Hz,
depending on performance of feedback loops

- ❑ Need to measure QD0 position — Capacitive gauges + geophone (relative + absolute measm't)
- ❑ Need to correct QD0 position — Piezo-actuators; Elastomer support
- ❑ Feedback loop — Optimised controller

Stabilization to 0.13 nm at 4 Hz has been achieved in the lab

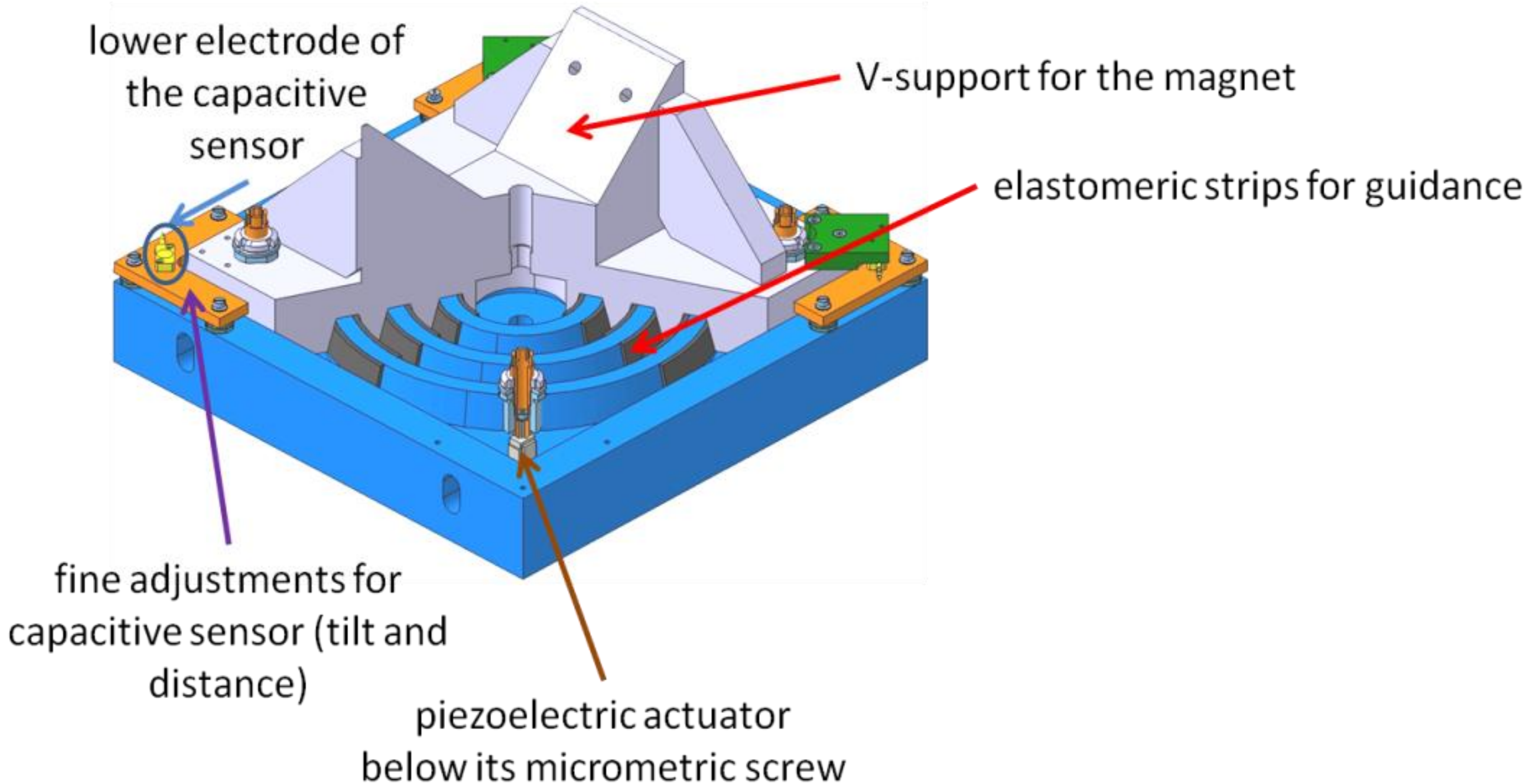
But on a large and massive table

Courtesy A.Jeremie / LAPP



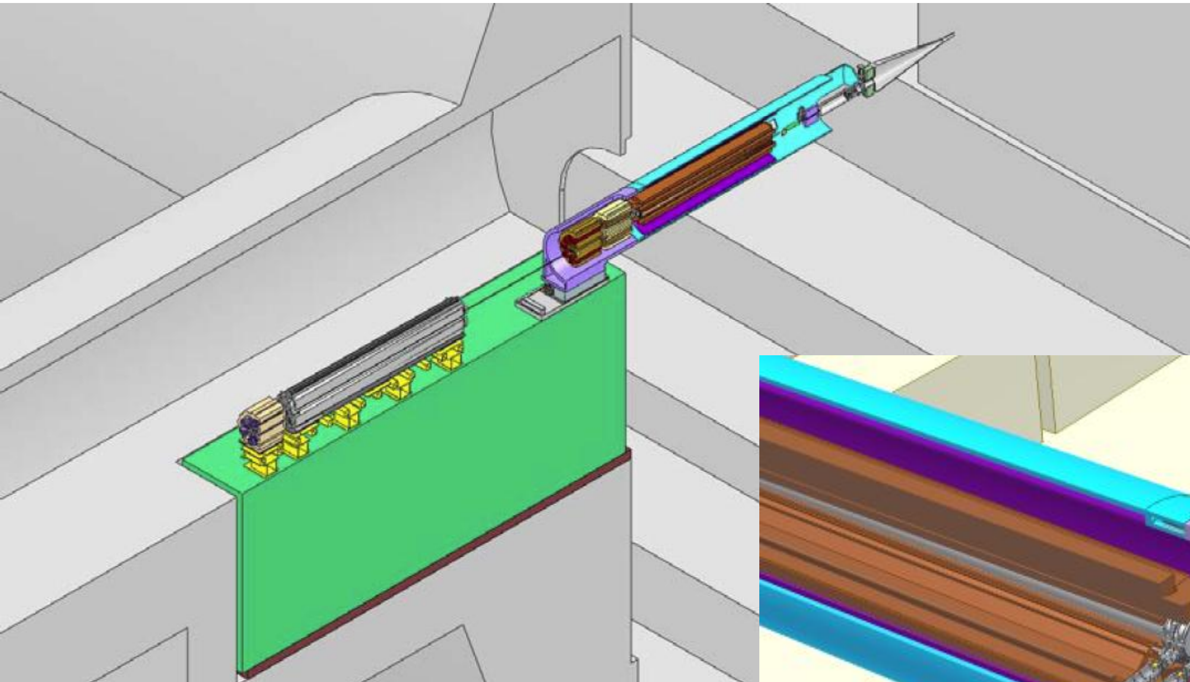
➡ **To be adapted to the MDI environment**

Preliminary design of a stabilisation device

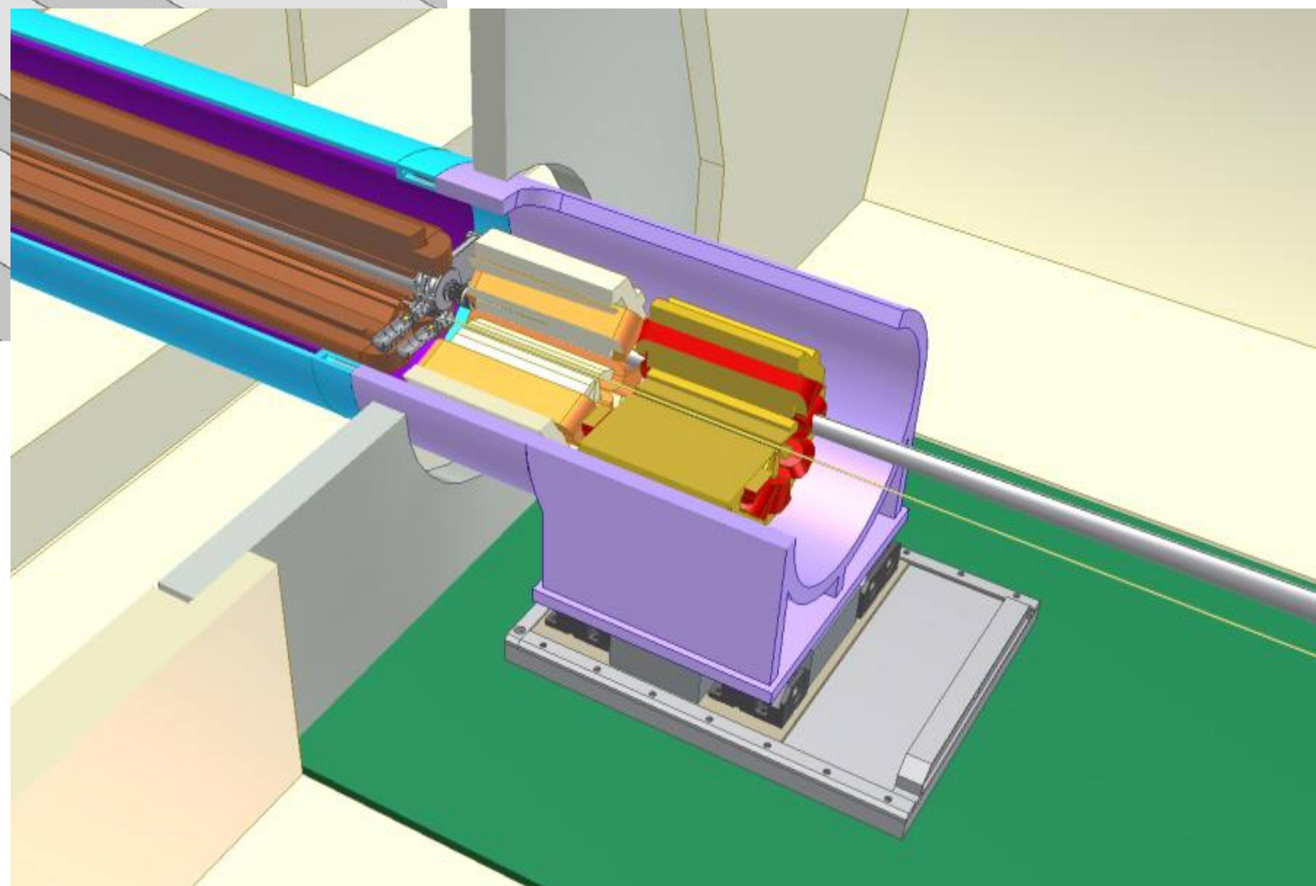


See A.Jeremie's presentation, WG5

The QD0 support tube and QF1 are mounted on a pre-isolator



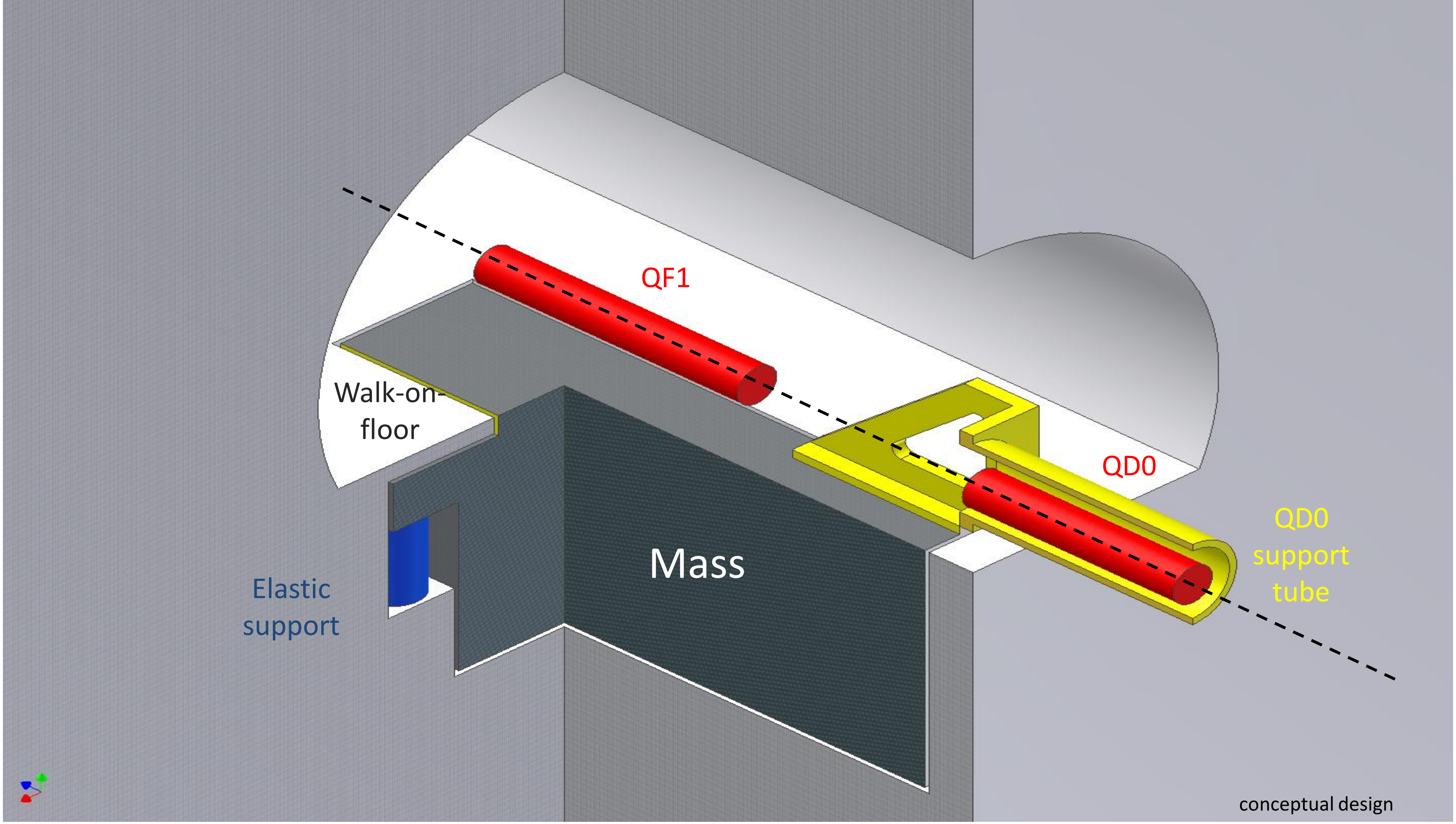
Concrete mass of ~ 80 tons mounted on calibrated springs.
Eigenfrequency ~ 1 Hz.



Designed to reduce vibrations by a factor of ~ 30.

See A.Gaddi talk, WG5

How can it be realized ?



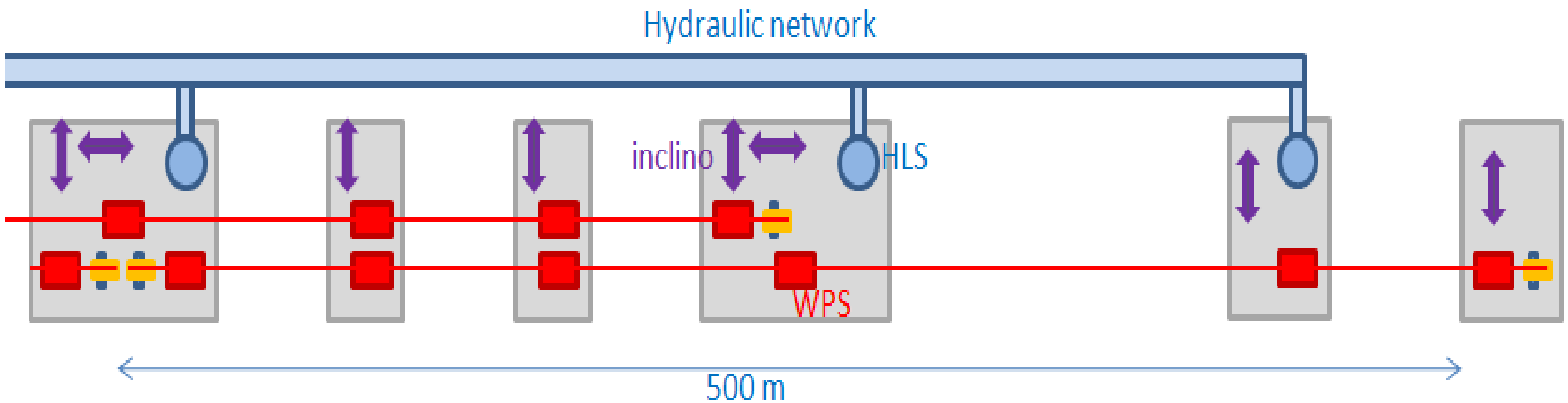
QD0 Pre-alignment

The QD0 magnets have to be pre-aligned to 10 μm RMS precision for the beam tuning algorithm to converge

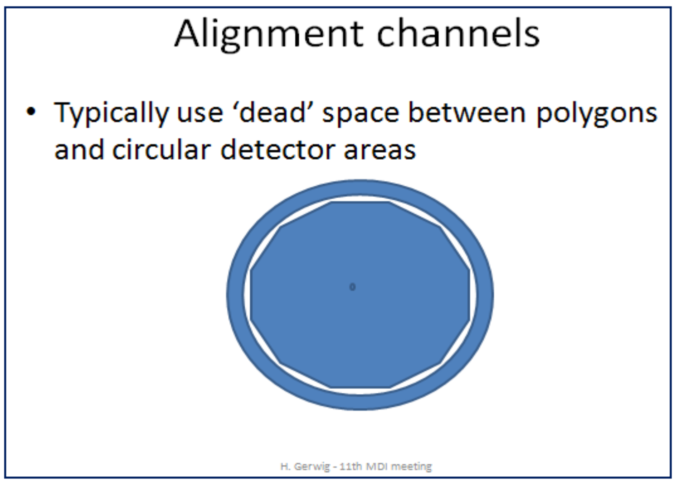
- QD0 w.r.t. the last 500 m of the BDS line — Two Wire Positioning Systems per QD0, One inclinometer with 2 axes, Hydrostatic leveling system for sag
- One QD0 w.r.t. the other QD0 — Network of RASNIK systems, Channels through detector
- Adjustment equipment — CAM movers with 5 DOF

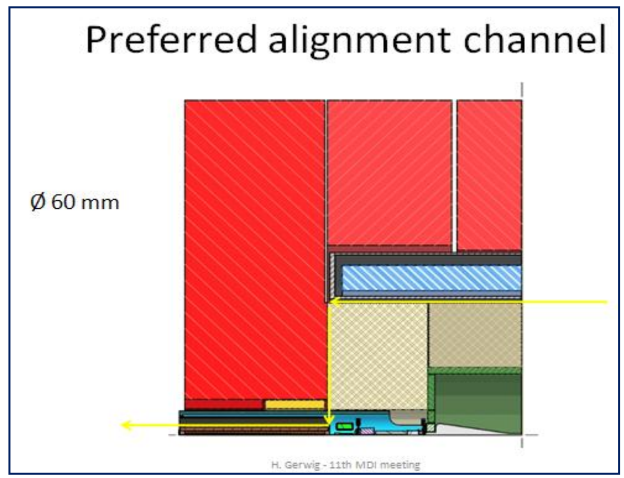
See H.Mainaud Durand in WG5

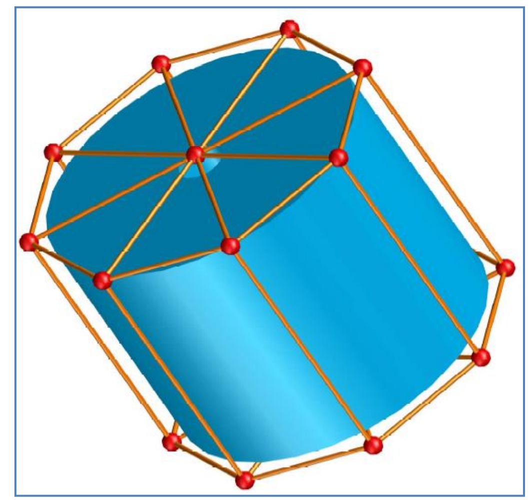
Wrt BDS:



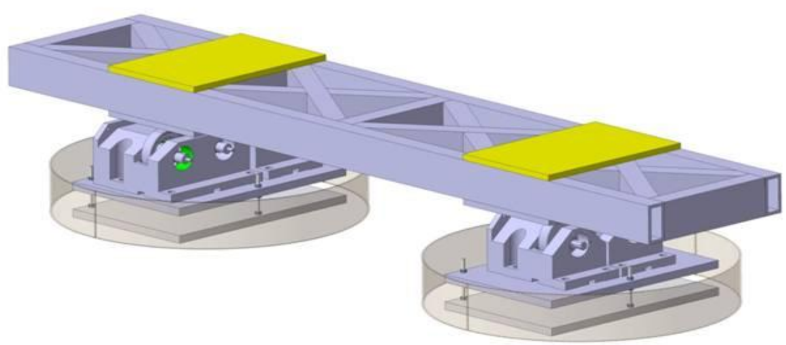
QD0 vs QD0:







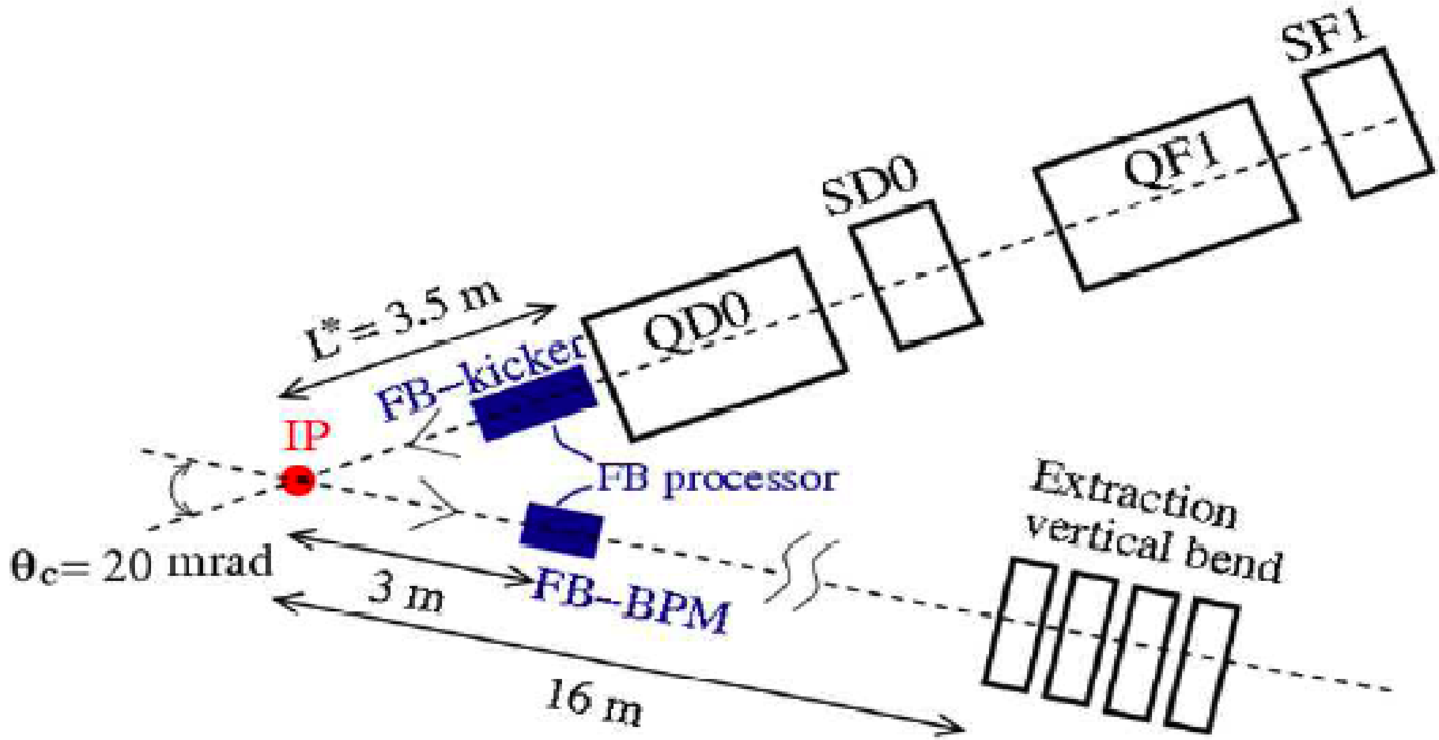
Cam mover:



CLIC IR
IP-FB BPM and kicker positions

The choice of the position of the IP-FB elements is a compromise between:

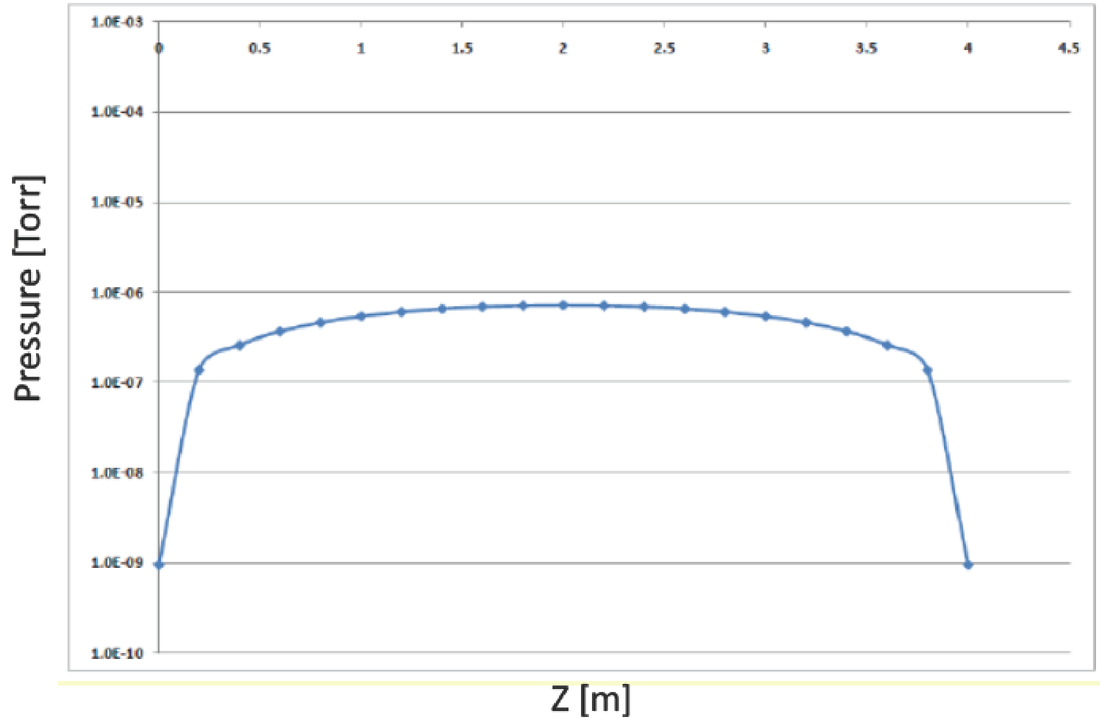
- Reduction of latency
- Avoiding possible degradation of the BPM response due to particle background/backsplash and possible damage of electronics components



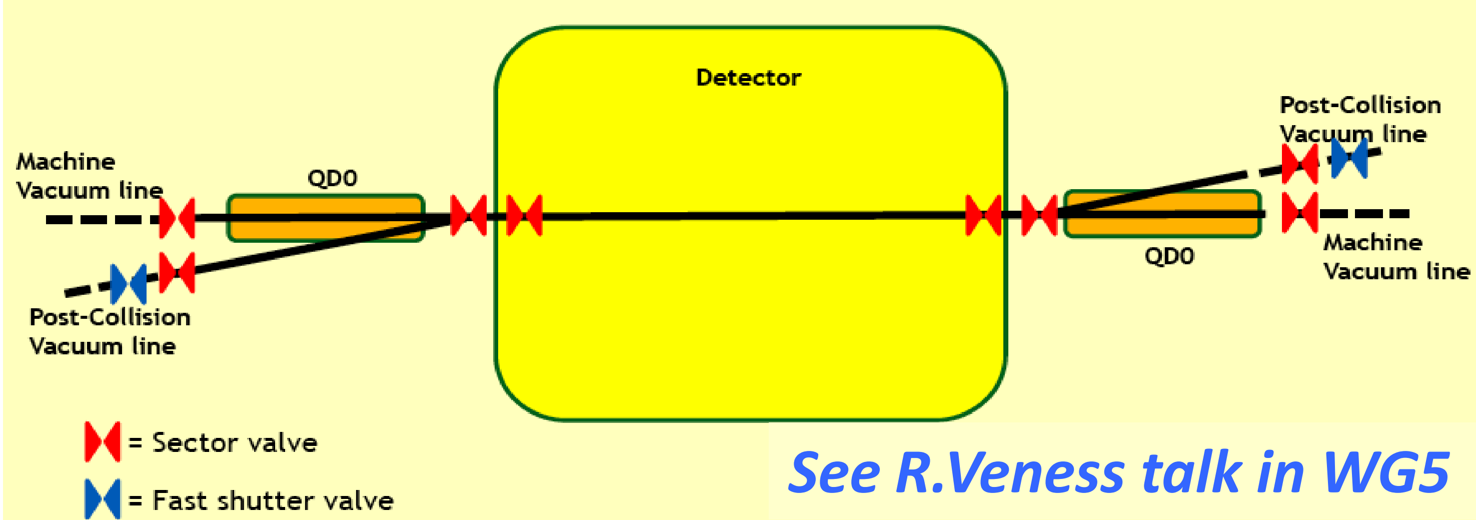
If FONT elements 3 m apart from IP, then beam time-of-flight = 10 ns

VACUUM SYSTEM

- Vacuum pressure in IR not so critical: $10^3 - 10^5$ nTorr
- Beryllium chamber in the detector. May need special coating against electron cloud.
- Unbaked chamber inside QD0 is sufficient
- Need sectorizarion and isolation of QD0 chamber to ensure “fast” push-pull operation
- Direct connection with spent beam vacuum (modest pressure, but large volume and large energy deposited on dumps and absorbers).

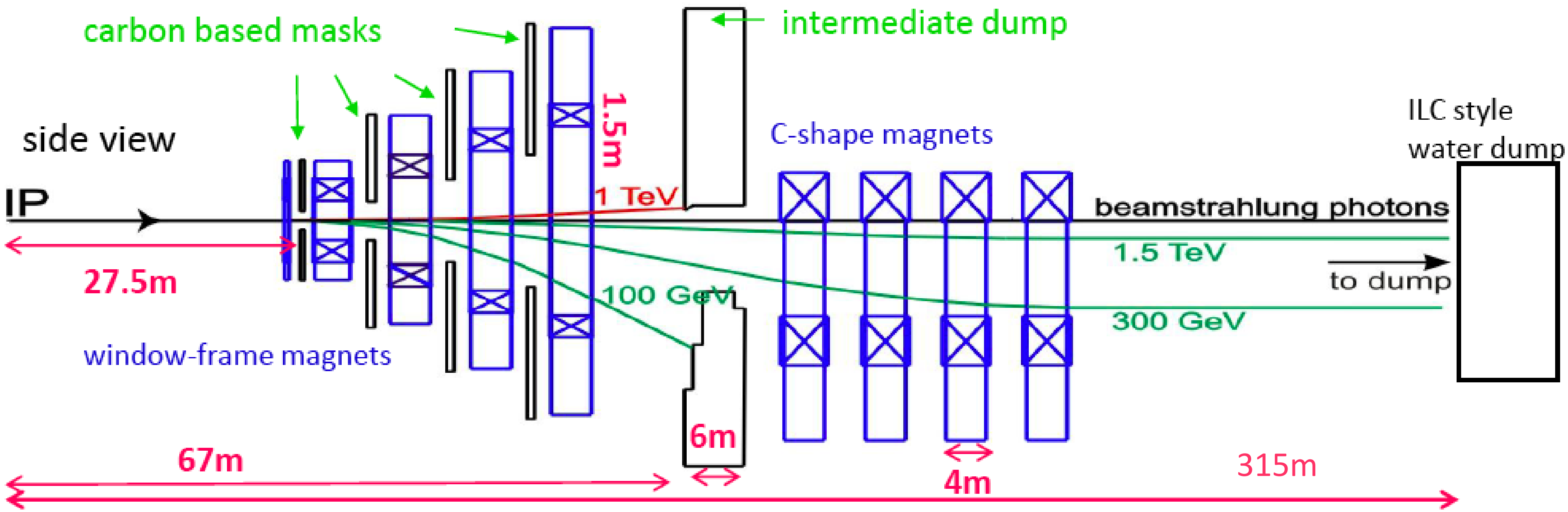


Static pressure in QD0 after 100 hours of pumping



See R.Veness talk in WG5

Post-Collision line present design:



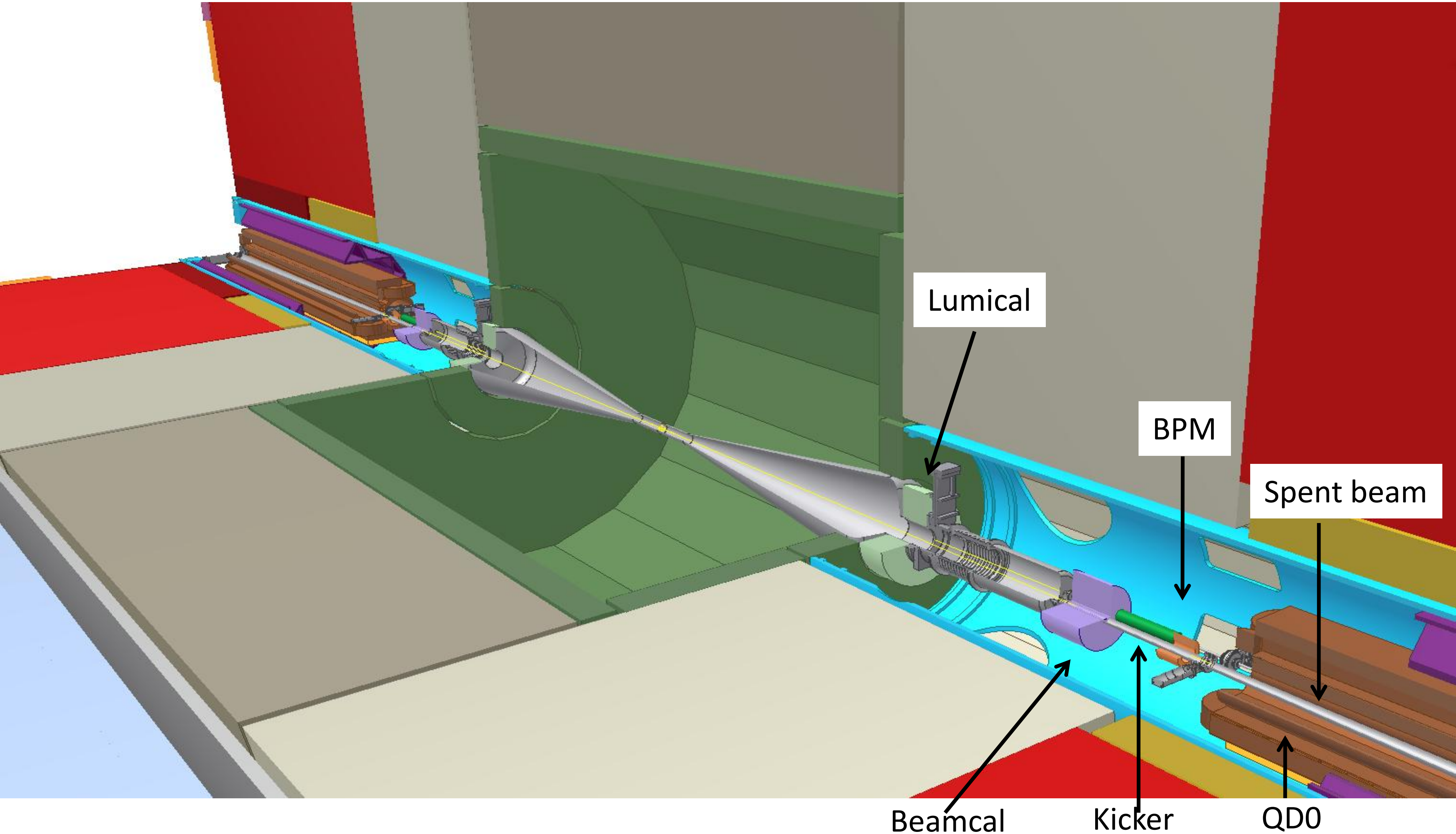
1. Separation of disrupted beam, beamstrahlung photons and particles with opposite sign from coherent pairs and particles from e+e- pairs with the wrong-sign charge particles

   → Intermediate dumps and collimator systems

2. Back-bending region to direct the beam onto the final dump

   → Allowing non-colliding beam to grow to acceptable size

Integration of QD0 magnets and IP Feedback systems in IR



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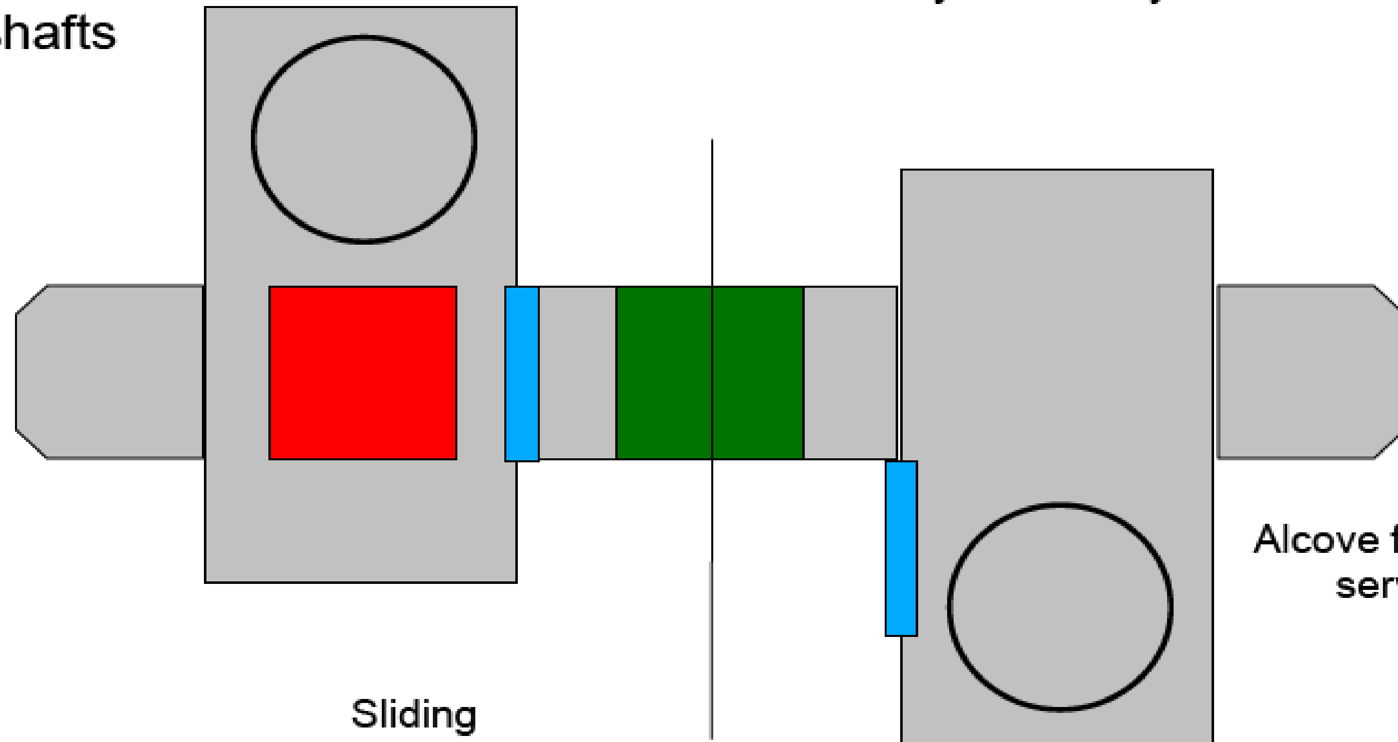
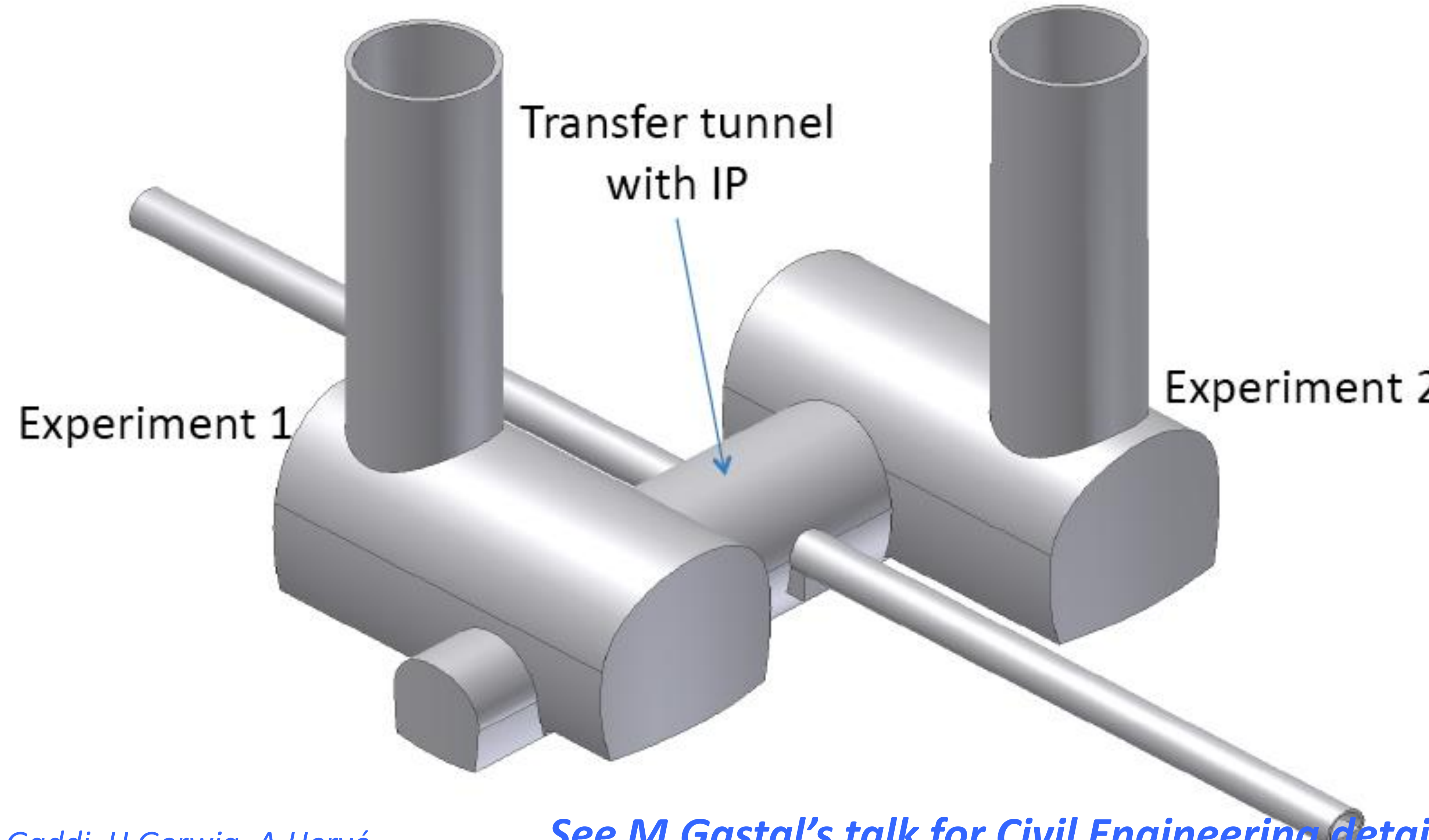
UX Cavern optimization.

Cavern volume: 95,000 m^3
2 x Φ16m shafts



CLIC cavern



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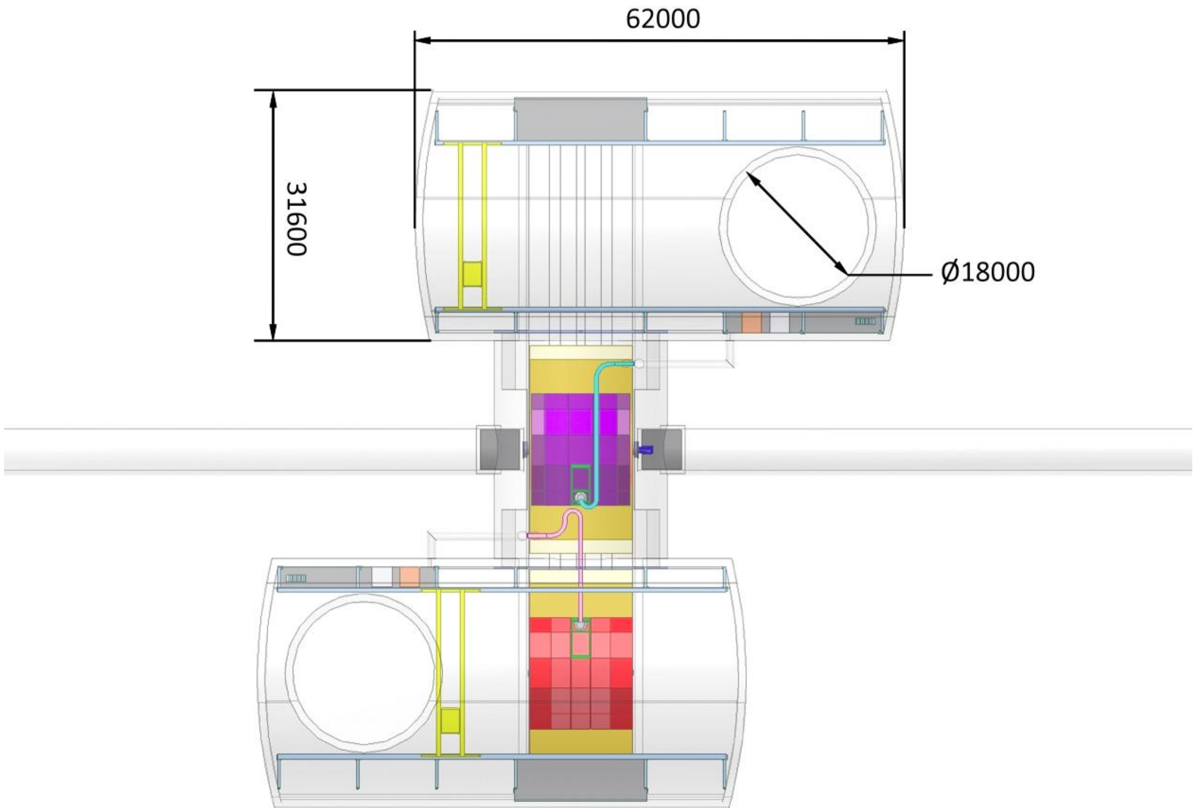
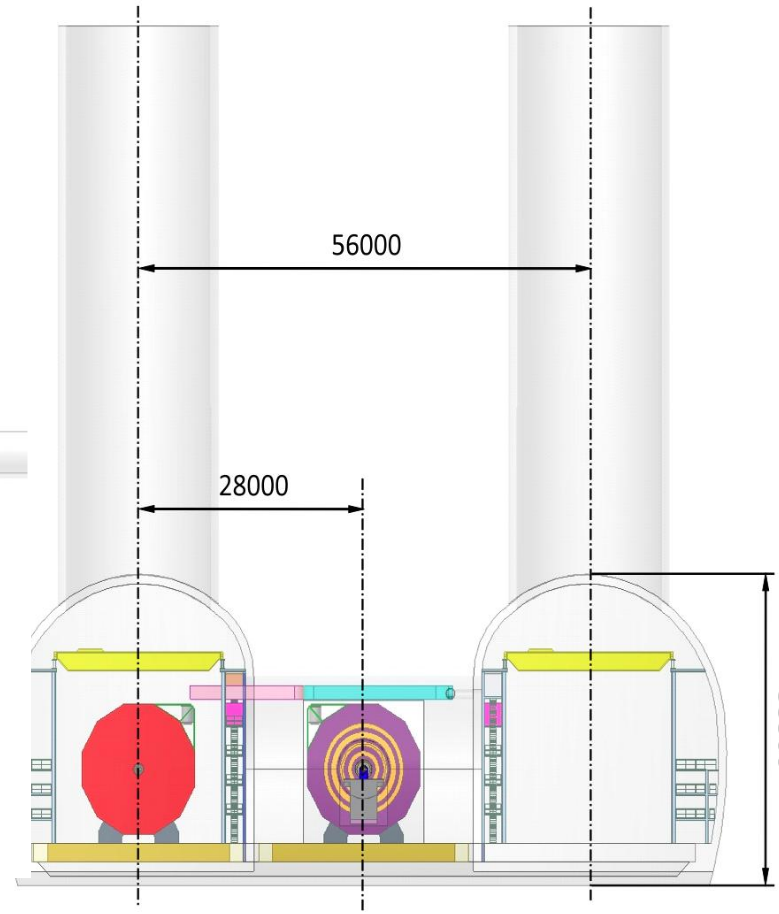
See M.Gastal's talk for Civil Engineering details

Top view:

Side view:





Summary and Outlook

- The CLIC MDI has made enormous progress towards the CDR
- Due to the suspension of QD0 from the tunnel and the mounting on a pre-isolator, the push-pull system is decoupled from the QD0 stabilization and pre-alignment issues
- The integration of machine components inside detectors has been defined
- Continuous progress is being made with stabilization and pre-alignment
- Prototyping and/or tests are under way for QD0, IP feedback (FONT), stabilization, pre-isolator, etcetera. Those will continue during the TDR phase
- More details in the forthcoming MDI talks (WG5 and combined/related sessions)

Thanks for your attention!

Spares

RMS vertical displacement reduced by a factor >10 from 4 Hz.