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4-th Concept IP Design

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For the 4th -Concept team

http://physics.uoregon.edu/~lc/wwstudy/concepts/

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Basic principles put in grounds

Iron could be omitted as it adds ~15% to the field value only (field outside of long solenoid is zero).

Homogeneity can be restored by adding current at the ends of main solenoid.

Second solenoid closes the flux (minimal configuration).

Muons can be identified with dual readout calorimeter scheme in more elegant way

Usage of dual solenoidal system plus end wall current system allows:

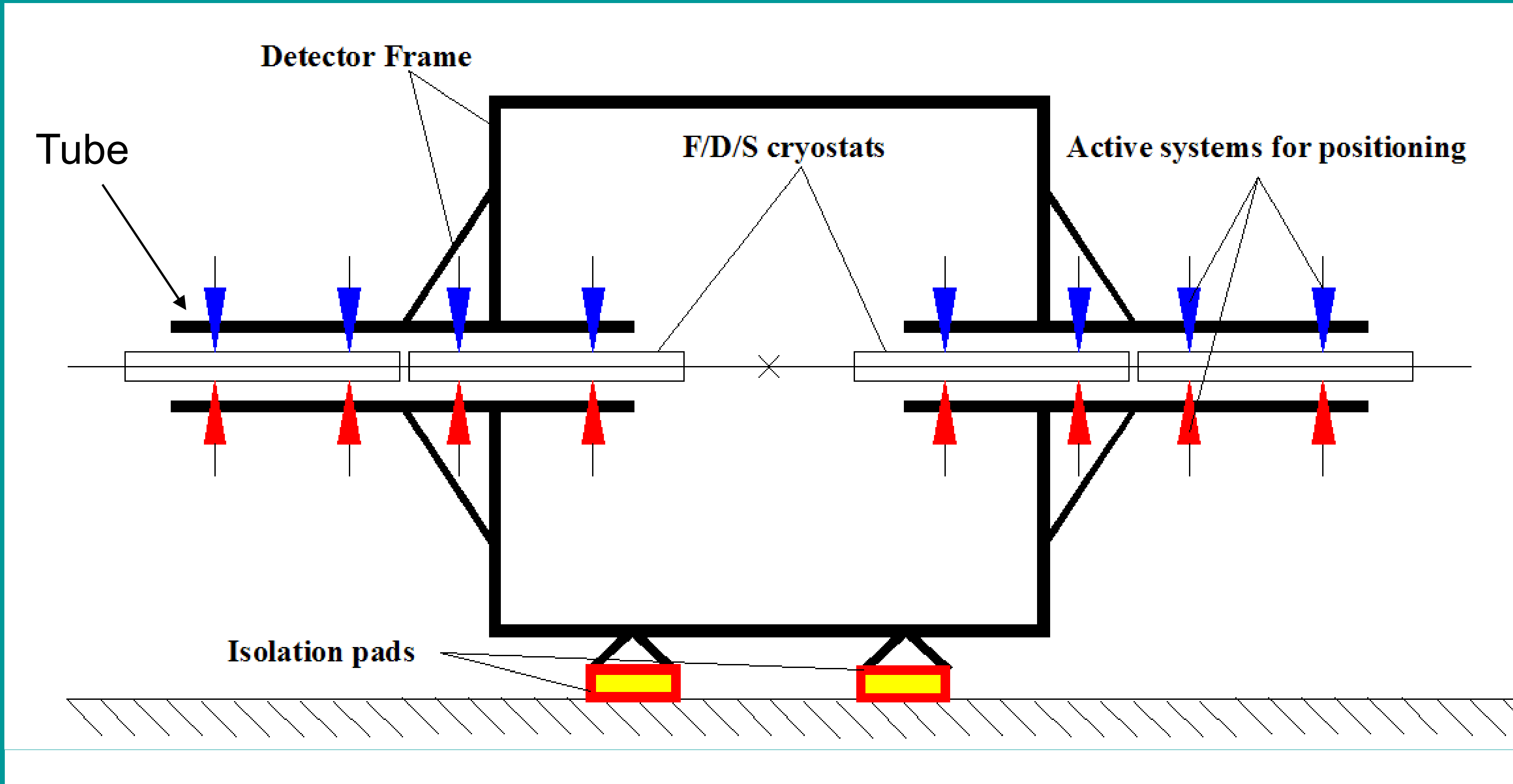
1) Strict confinement of magnetic field inside limited region
2) Spectroscopy of muons in magnetic field between solenoids

Modular design allows easy modification, re-installations…

All these allow lightweight detector having flexible functionality and remarkable accuracy

No problem with push-pull concept under discussion now

Concept of FF optics installation



Active systems for positioning include stepping motor-driven micro-positioning movers plus piezoelectric fast movers with active loop feedback.

Thanks to the absence of iron all elements are visible from single point.

So detector carries final focus optics. More detailed view

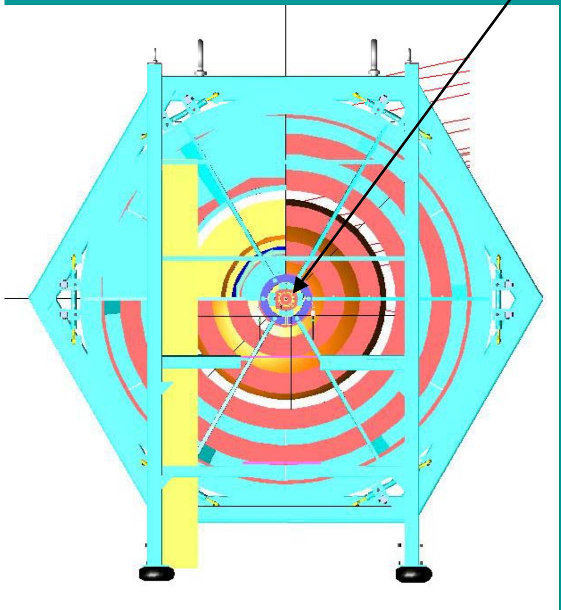
Total stored energy~2.77 GJ

FF optics has trimming possibilities-mechanical and electric

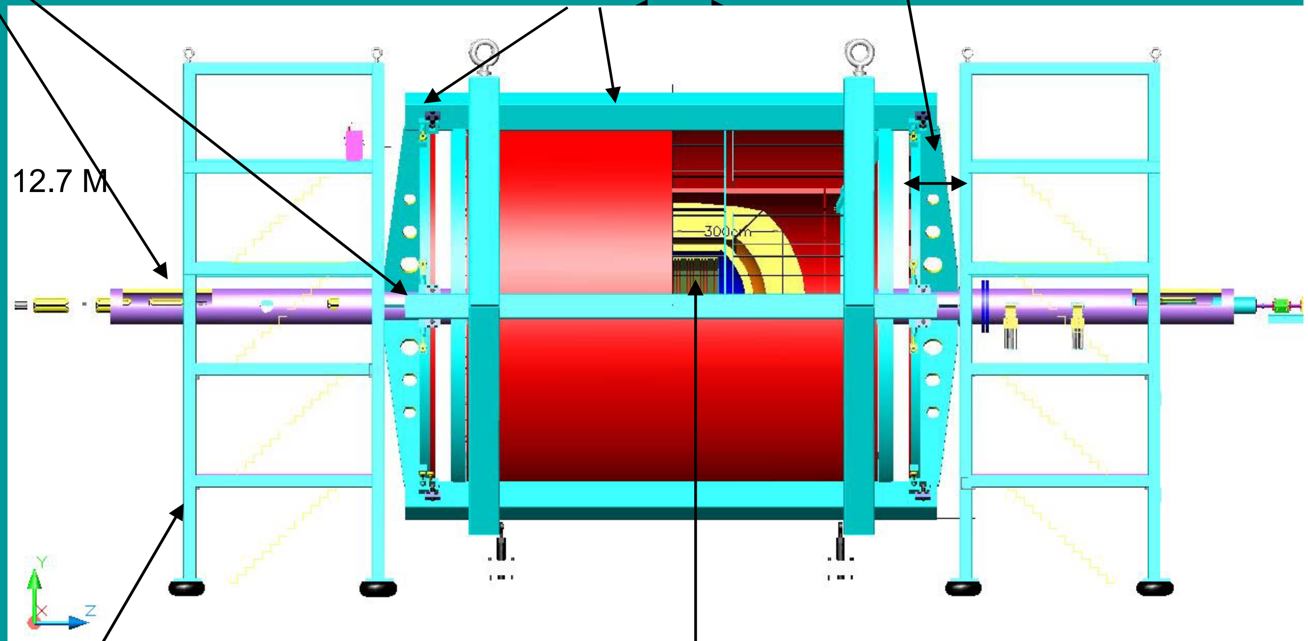
12.9 m

Frame holds solenoids And all other elements

WALL OF COILS CAN BE RELOCATED IN Z



12.7 M



Front end equipment hut

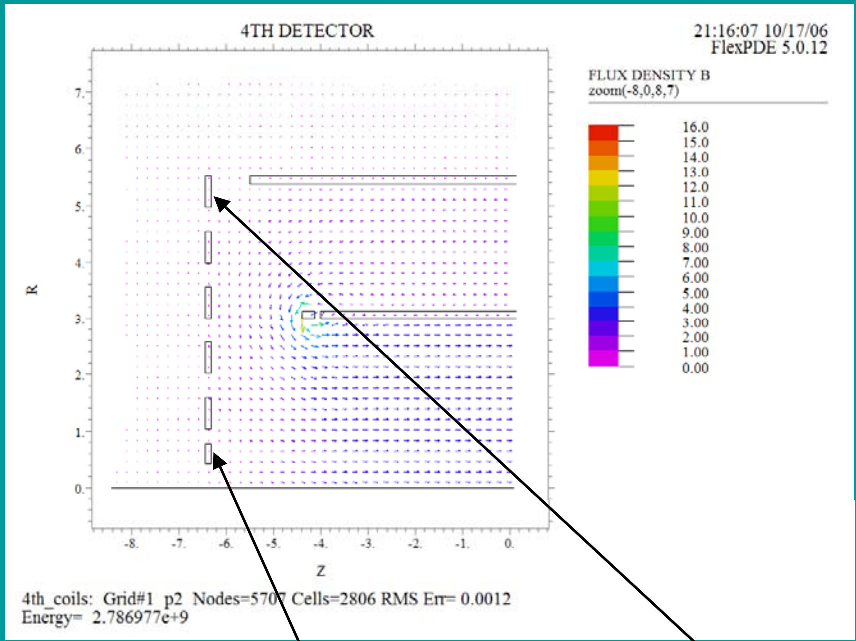
L^*~3m

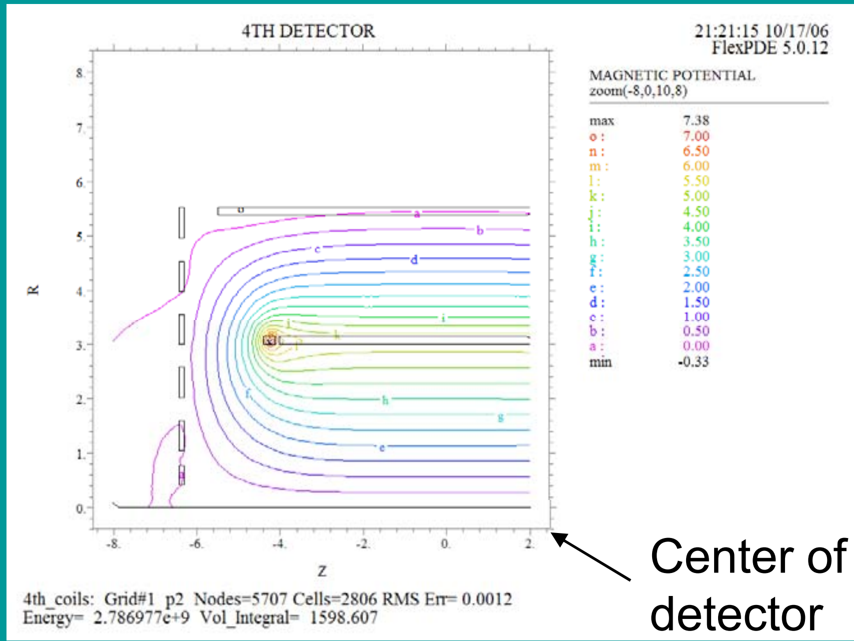
~30 m

Total weight majorettes by 300 tons in optimistic estimation, so E/M ratio ~10MJ/kg

Wall of coils

Axis-symmetrical system of coils restricts propagation of field out of detector





Center of detector

All side coils are **room-temperature** ones;

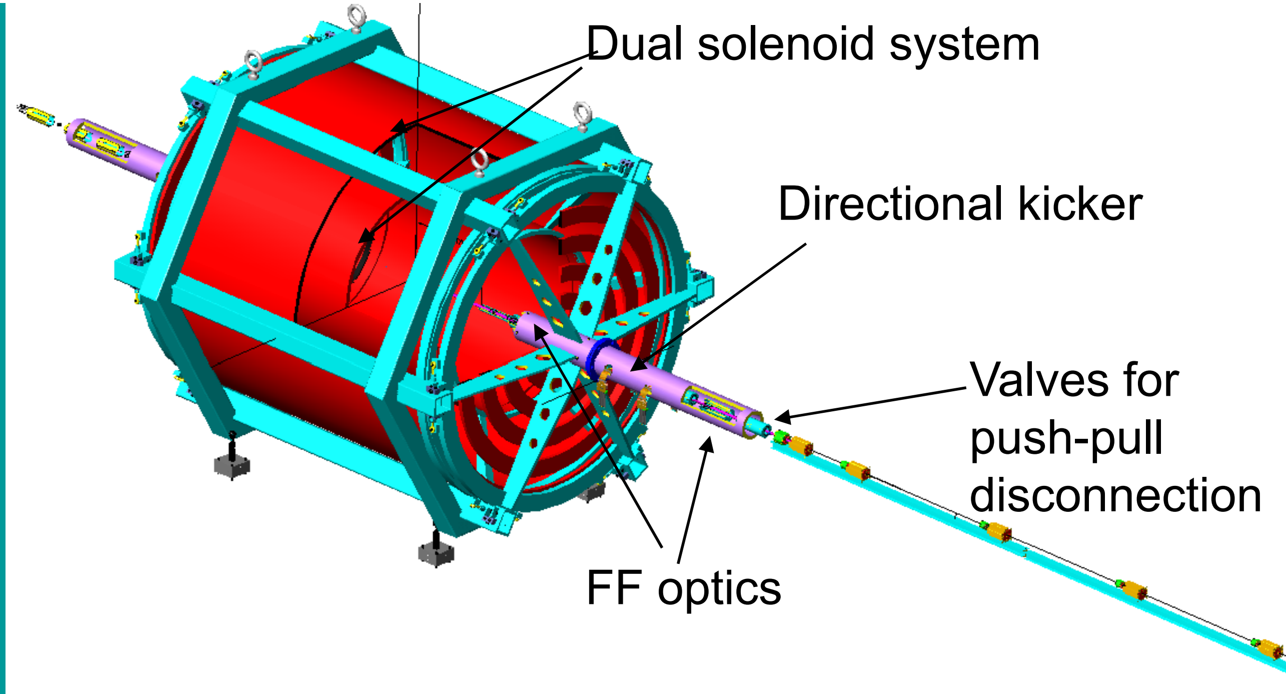
Current density: 1; 8; 4.2; 3.3; 3.7; 1.7 A/mm^2

Forces :1.75; 102; 131; 135; 111; 10 tons

In future optimization all coils will have ~same current density; water cooled (required only for #2)

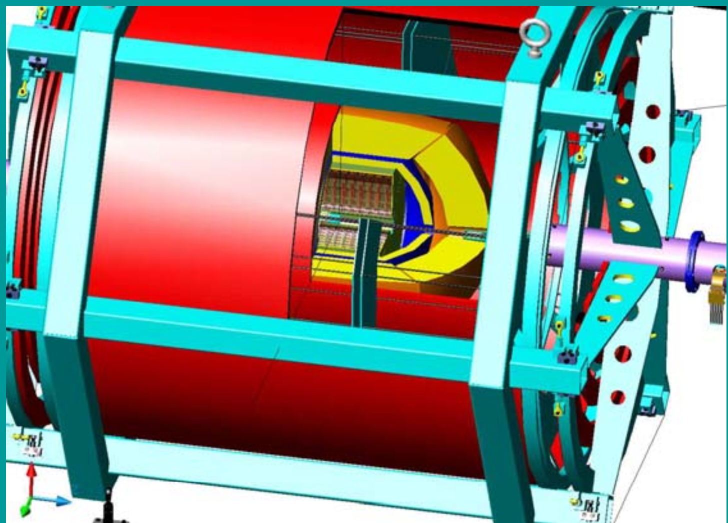
Field outside detector can be zeroed to any level by proper current distribution;
Coils can be fixed easily at the end plates

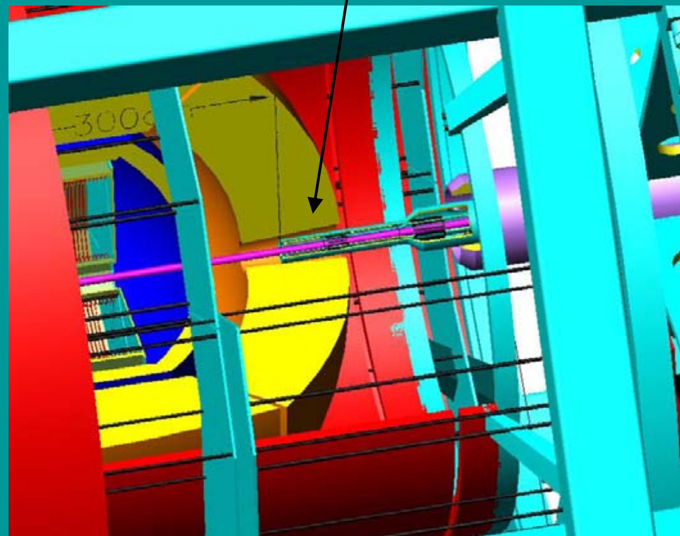
(Effective CMS Current density ~14.2 A/mm^2 , meanwhile typical practical current density in directly cooled SC wire is 1500A/mm^2 for 3.5 T field--- lot to think about)



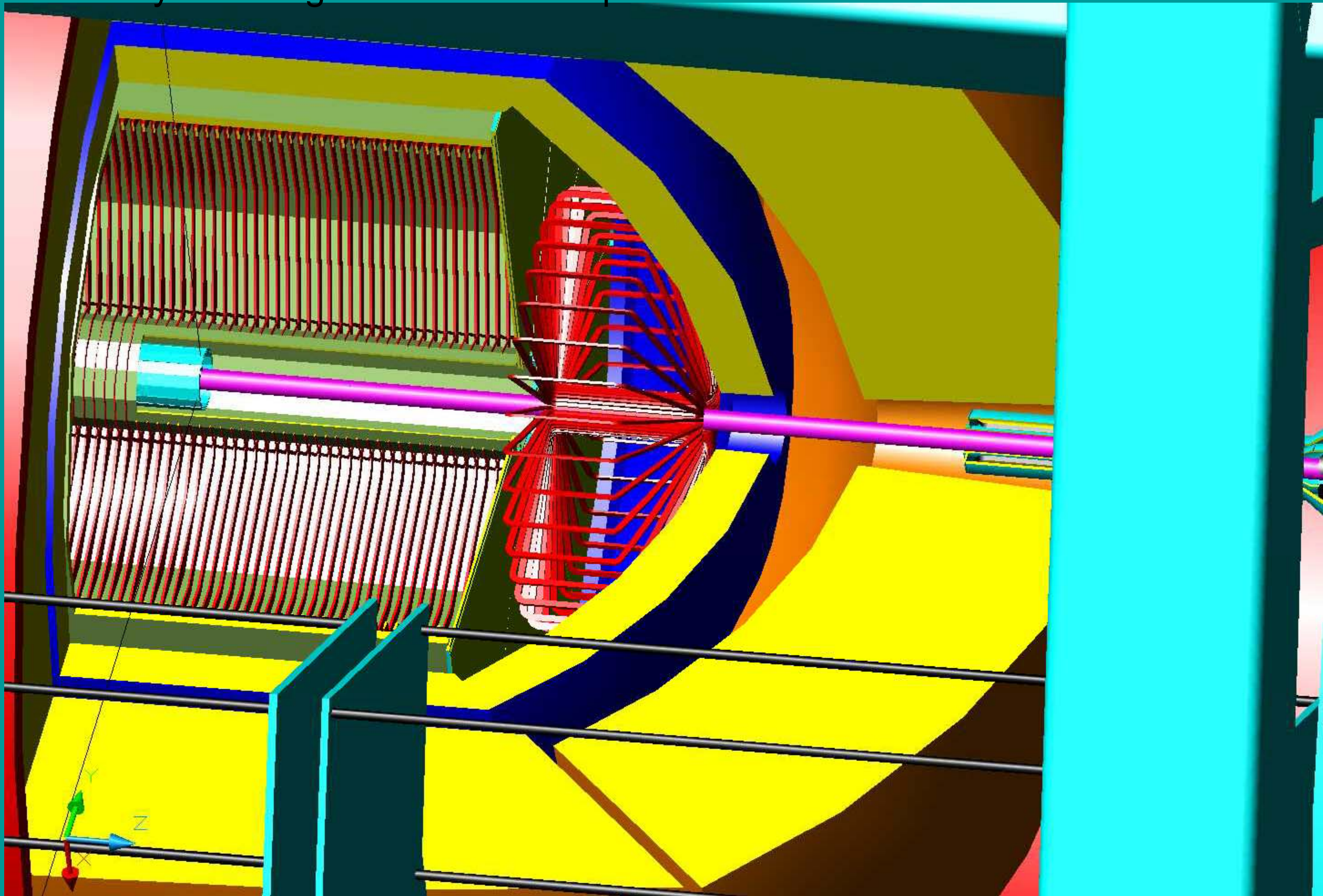
Final focus optics, mounted inside a cylinder attached to the detector by consoles.

This reduces influence of ground motion.

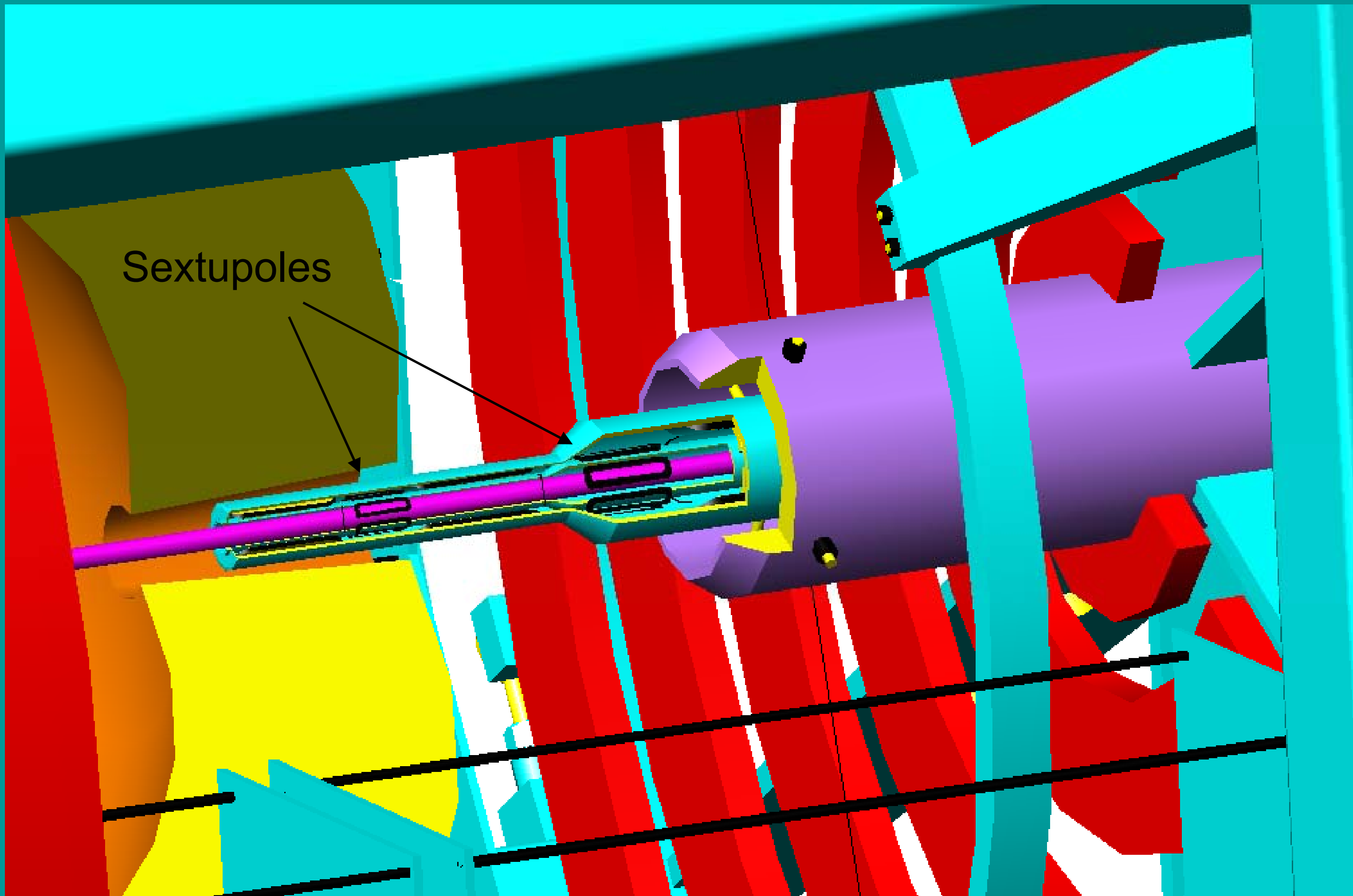




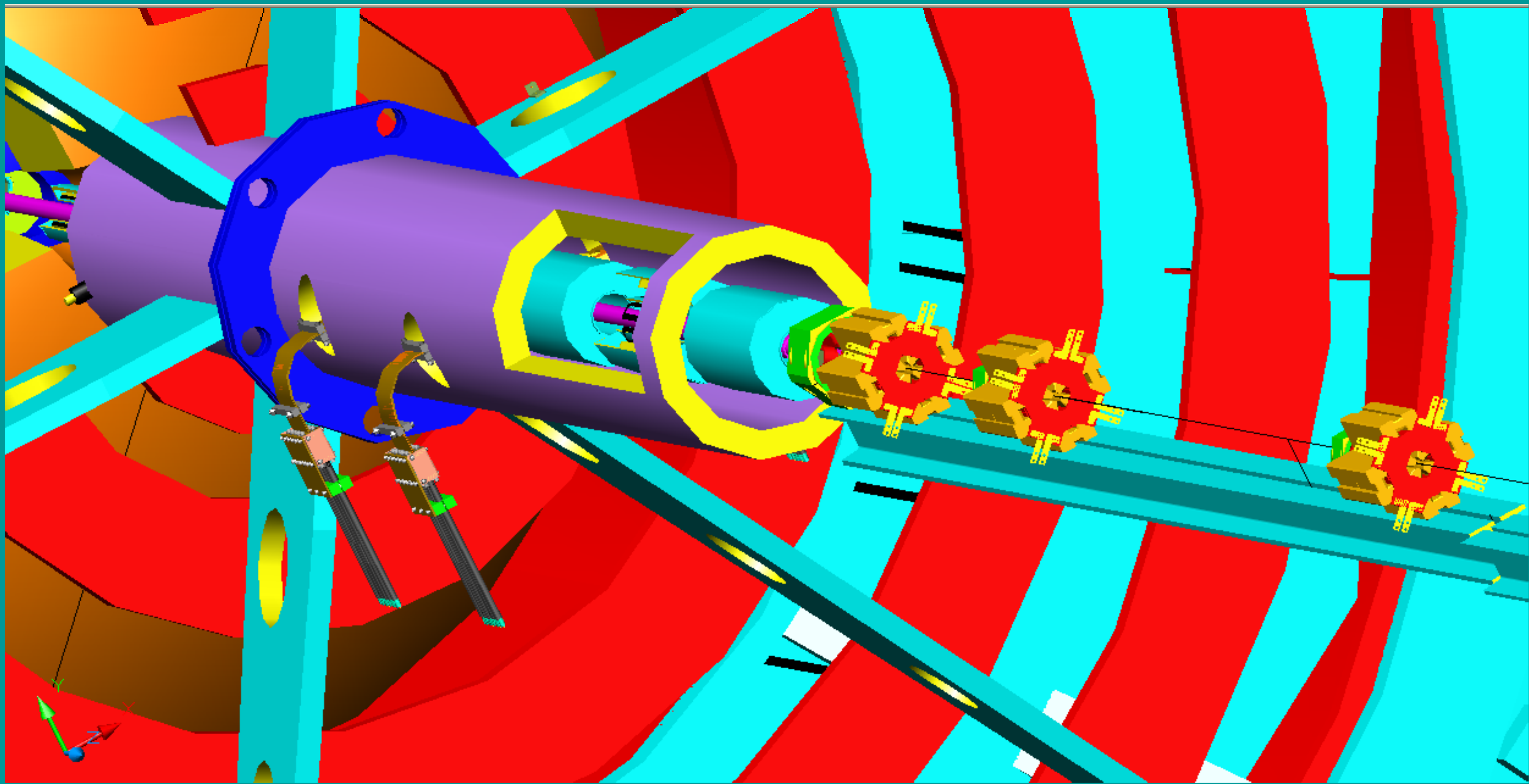
Recent addition – toroid between TPC and calorimeter for increase of momentum resolution for particles with small angle. TPC will come to r=20cm radially and extend to z=1.7m axially including the readout end plates.



Other look to the FF optics

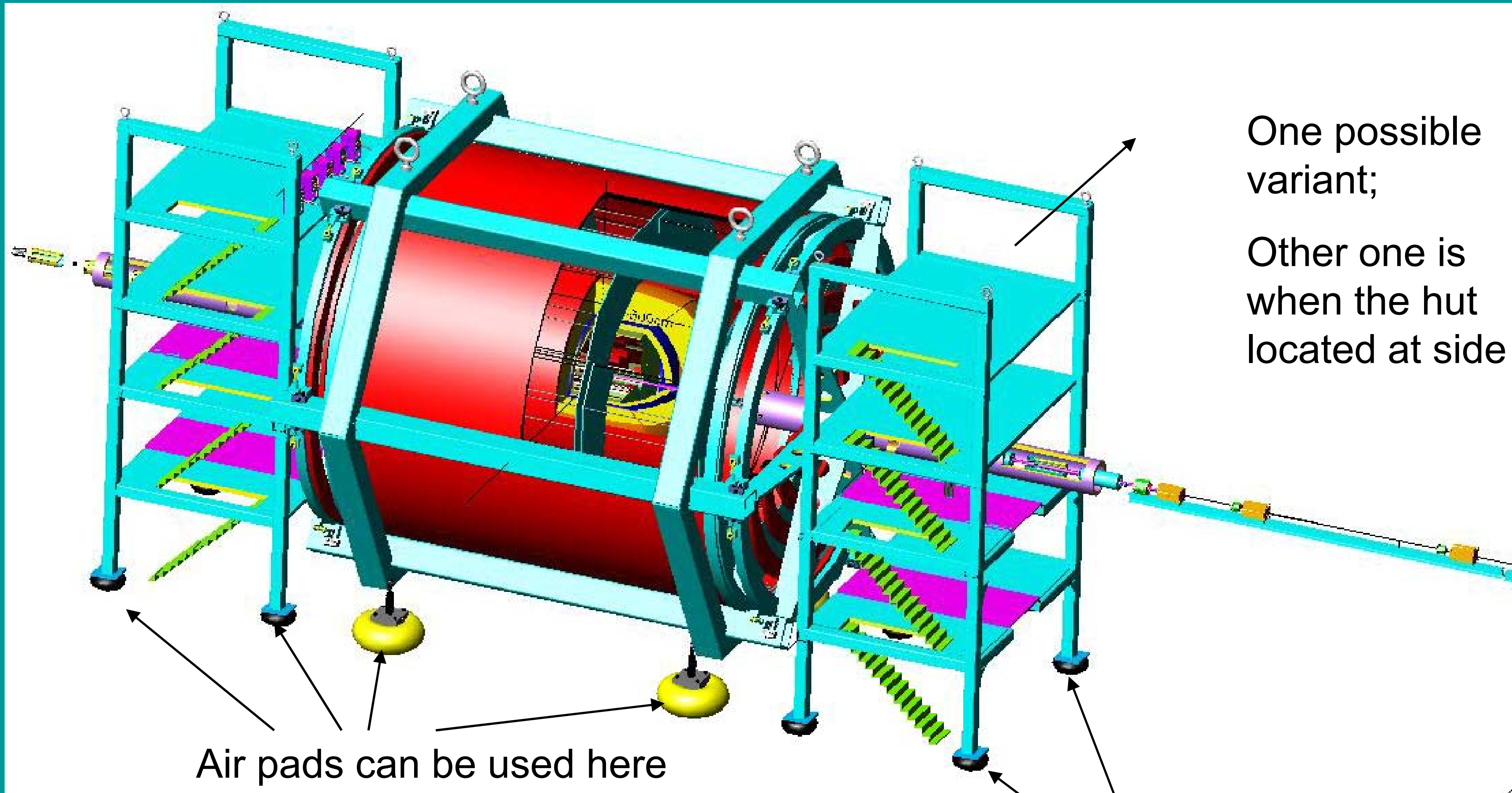


Shown is Cryostat with single bore quads and sextupoles



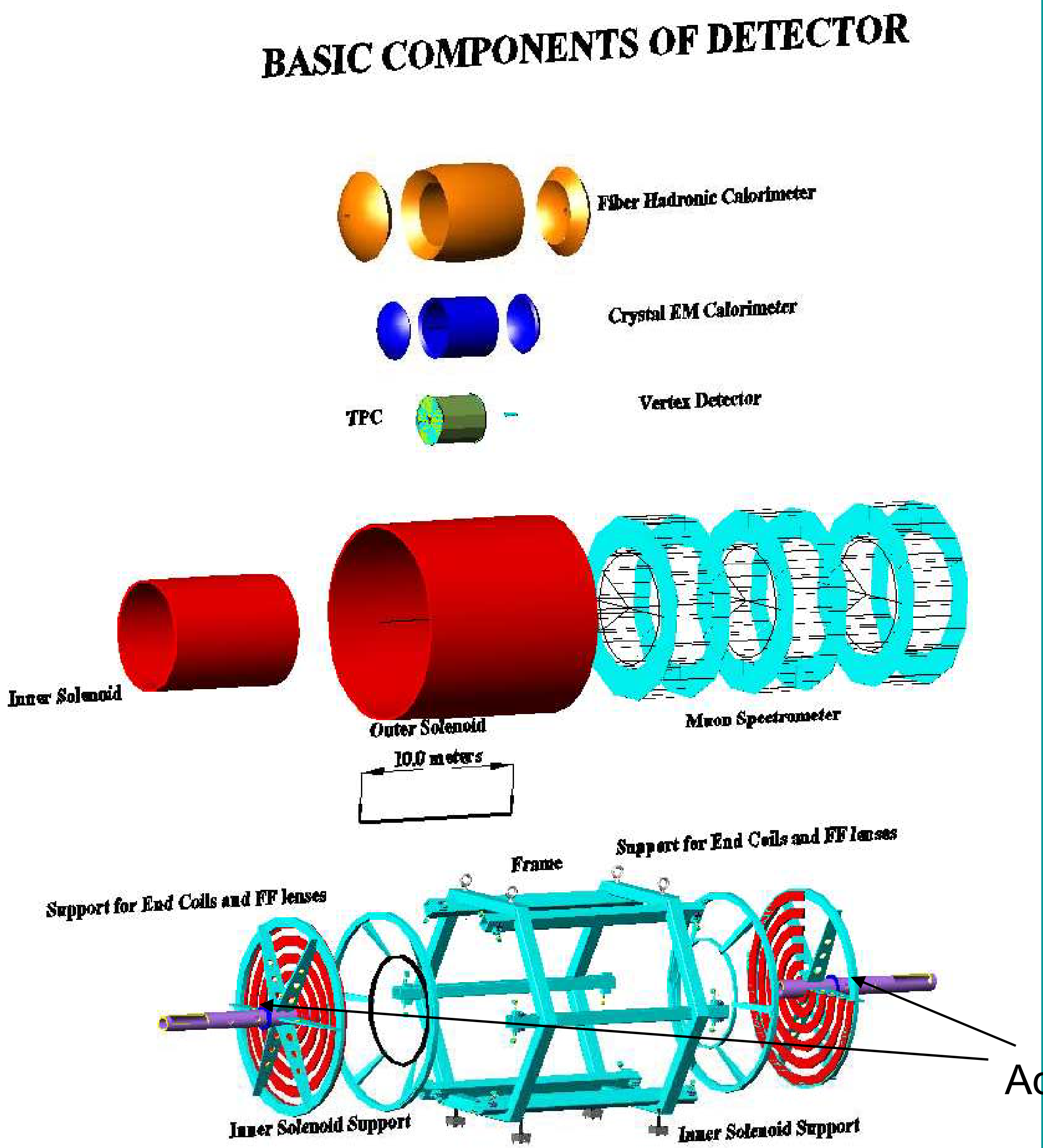
Look to the detector FF optics from outside

Detector end-electronics installed on the separately standing consoles.



During movement some restraints can be applied

Console (hut) has anti-vibration footers.



Detector is well structured-modular

If collisions with different energies of e^+-e^- beams can give any advantage, detector can modified to asymmetric one

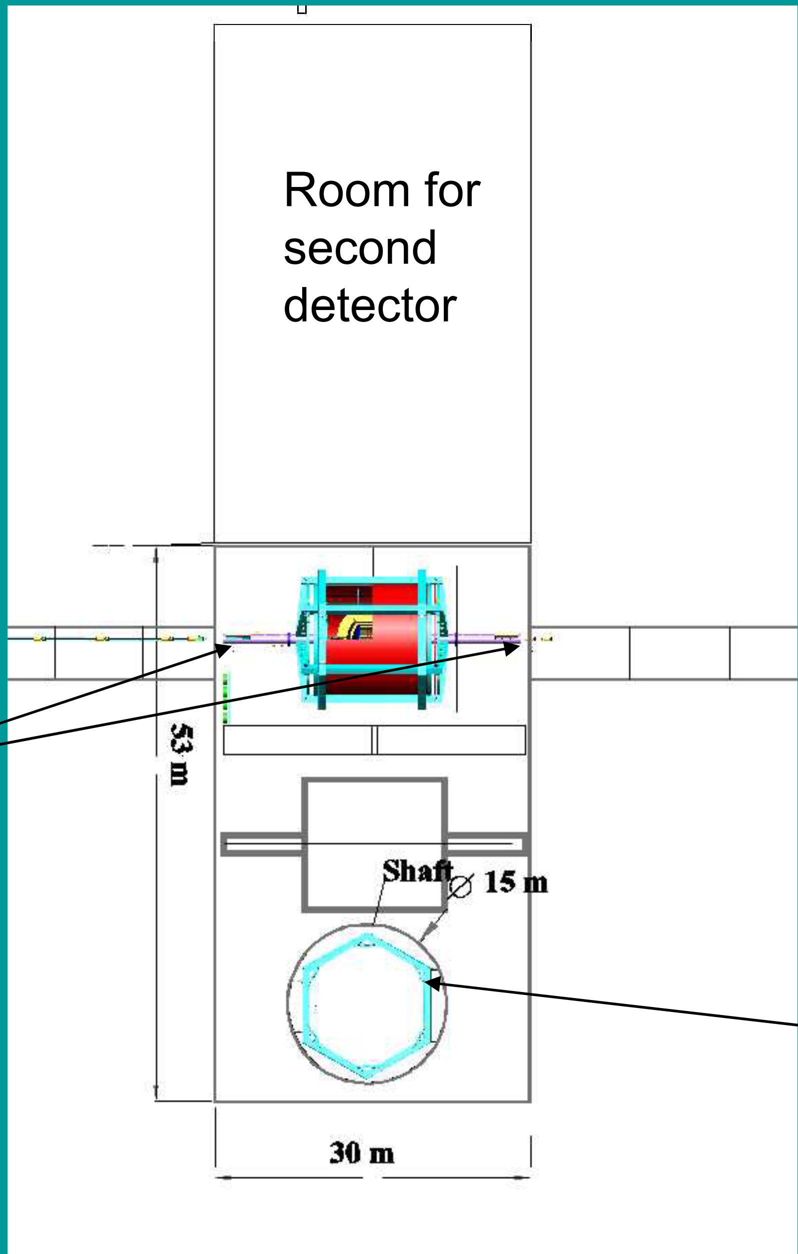
Here *background* reactions can be shifted in z from IP;

Useful Higgs created at IP

(Vice versa with Asymmetric B-factory)

Additional flanges

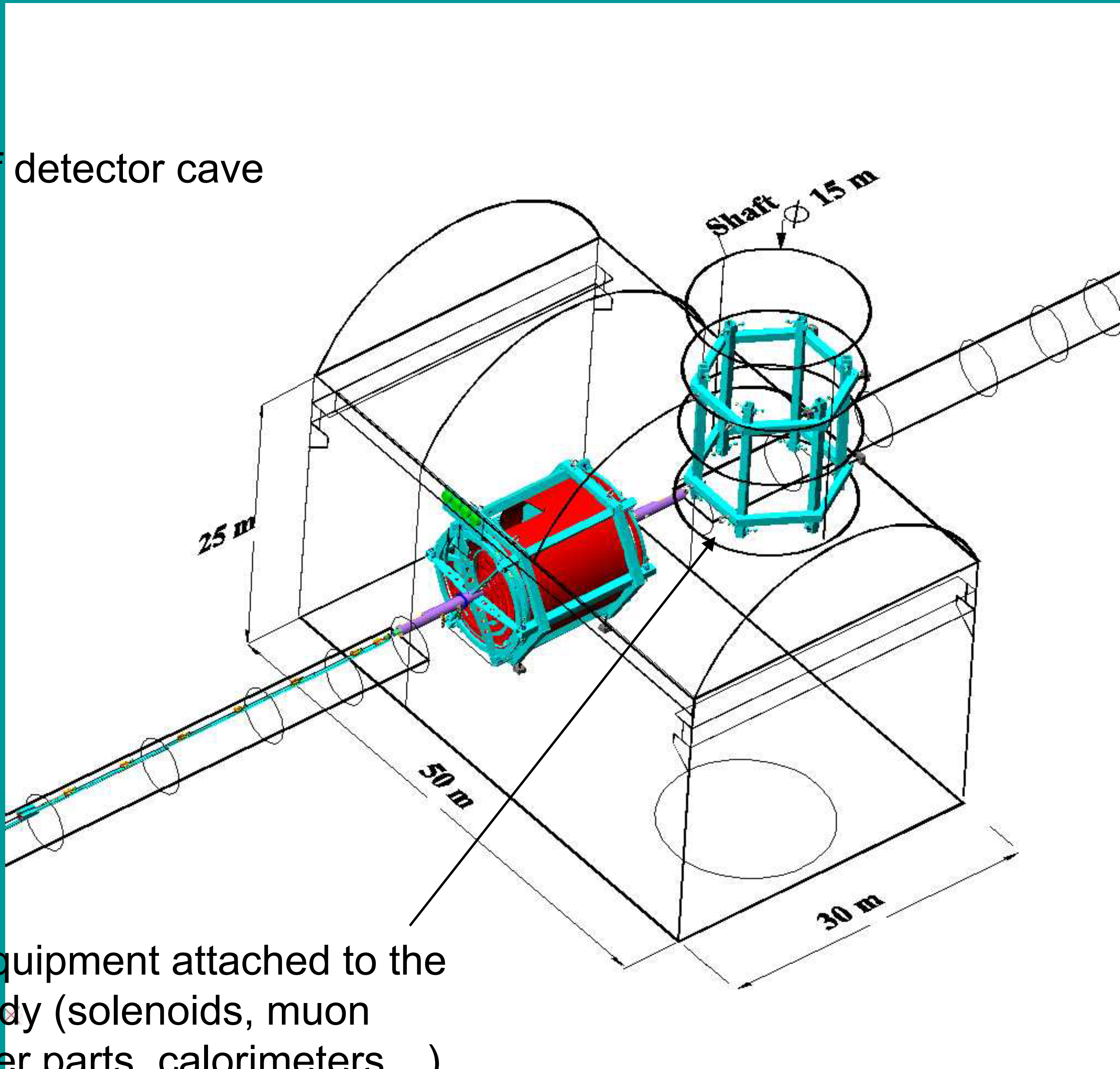
Installation in push-pull scenario



Places for disconnection

Coils installed in frame in Upper building

Concept of detector cave



Mostly of equipment attached to the frame already (solenoids, muon spectrometer parts, calorimeters…)

Pretty modest

CONCLUSIONS

4th-concept allows easy installation into cave as **it has no heavy Iron;**

Elements of FF optics mounted on detector frame allow better protection against ground motion;
Field can be made homogeneous to satisfy TPC request and measured accurately as, again, there is no interference from Iron (10^{-4});

4-th concept easily accommodates 14 mrad optics. Head on collision scheme allows undoubted benefits for HEP and for the beam optics. Directional kicker with TEM wave for example can be used here;

Measures against vibrations force to locate front end electronics in a separate hut installed on vibration-isolative footers;

Modular concept of 4-th detector allows easy exchange of different equipment, such as TPC, vertex detector, sections of calorimeter, etc.;

Detector could be manufactured at lowest cost;

Detector can be reassembled quickly to take benefits from different energy of colliding e^+e^- beams;
Detector allows relatively quick flip of magnetic field orientation for calibration of asymmetry; this is beneficial for collisions with polarized beams.

Back-up slides

Different energy of colliding beams. It is natural to keep such possibility for ILC. Here all background products generated out of center in contrast with asymmetric B-factory.

ILC accelerating structure is a standing wave type; it allows acceleration in *both* directions. One can consider the possibility to work at *double energy with a stationary target*. For this action, the beam accelerated in the first linac must be redirected traverse IP into another one. The phasing could be arranged in a relatively simple way, the optics need to be specially tuned for this.

Zero crossing angle. Nonzero angle initiated by NLC/JLC type machines. Crossing angle vas not required for TESLA, VLEPP. Zero angles give advantages in optics, preventing from SR in magnetic field of detector and degradation of luminosity. So we think, that this option must be kept in detector design.

Monochromatization –the ability to arrange collision at IP in such a way, that low energy particles from the first beam collide with the higher energy ones in the opposing beam. This idea was considered for circular machines a long time ago. For a single pass system, as the ILC is, realization of such program becomes much easier procedure. Despite significant SR energy spread generated during collision, this might be important for measurements at narrow resonances, including low energy option (Giga-Z).

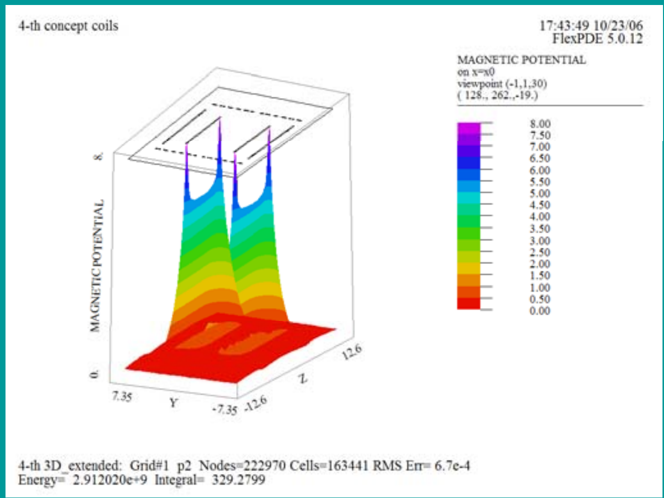
Work with nonzero dispersion at IP. This might be useful for monochromatization and to simplify the FF optics.

Adiabatic focusing at IP. Focusing arranged with *multiplet* of quadrupoles, rather than a doublet so that the strength of the lenses changes slowly from lens to lens.

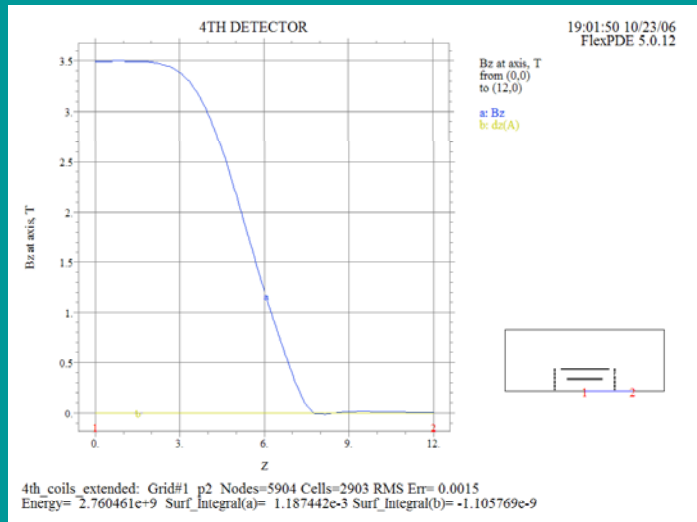
Peculiarity for registering of collisions with *both polarized beams*. Registration of back-forward asymmetries of secondary products is the main task for operation with polarized particles. This question requires special attention. 4-th magnet allows easy swap polarity.

For homogeneity the current density in main coil has longitudinal dependence.

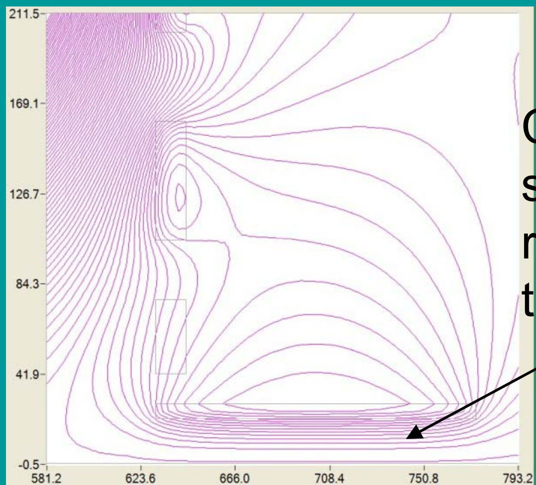
In simplest case it is a Helmholtz-type system with increased current at the ends.



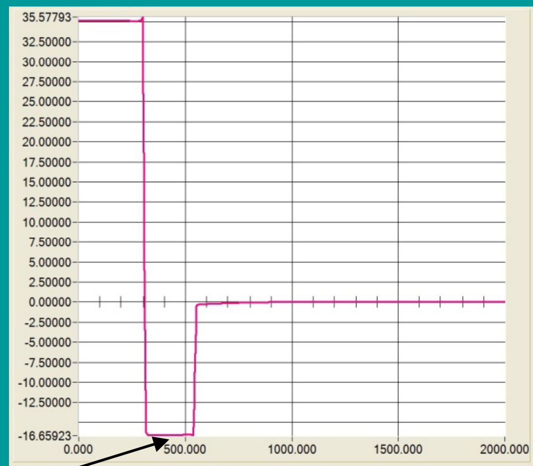
Magnetic potential



Stored energy is ~2.77GJ for 3.5T axial field



Compensational solenoid deals with residual part of transverse kick



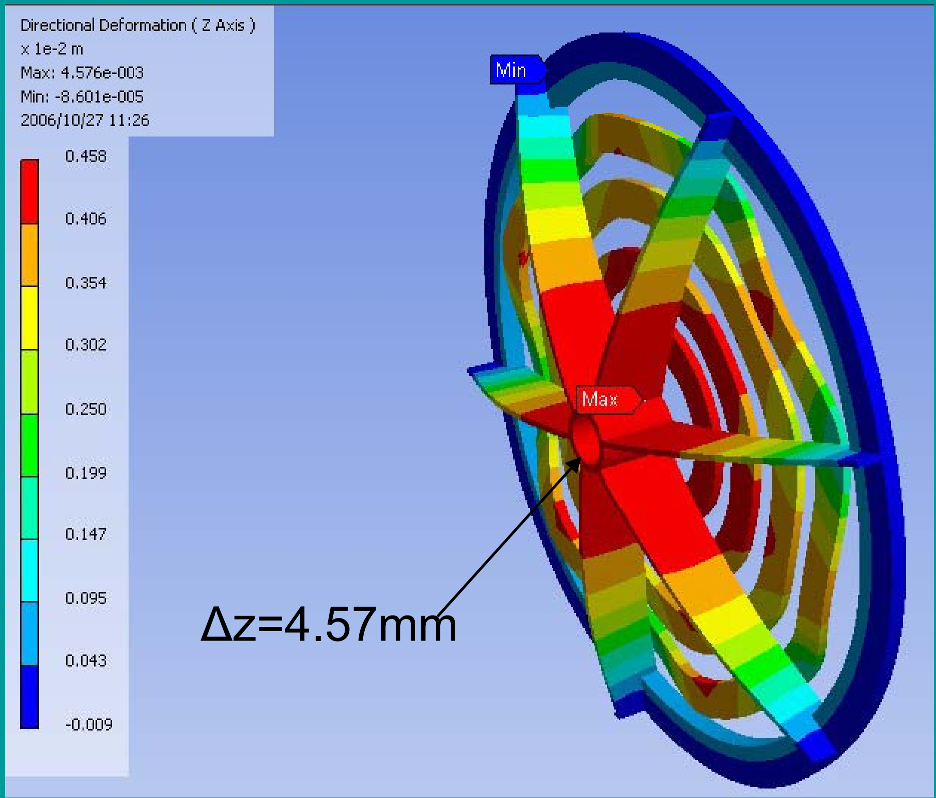
Field used for spectrometry of muons

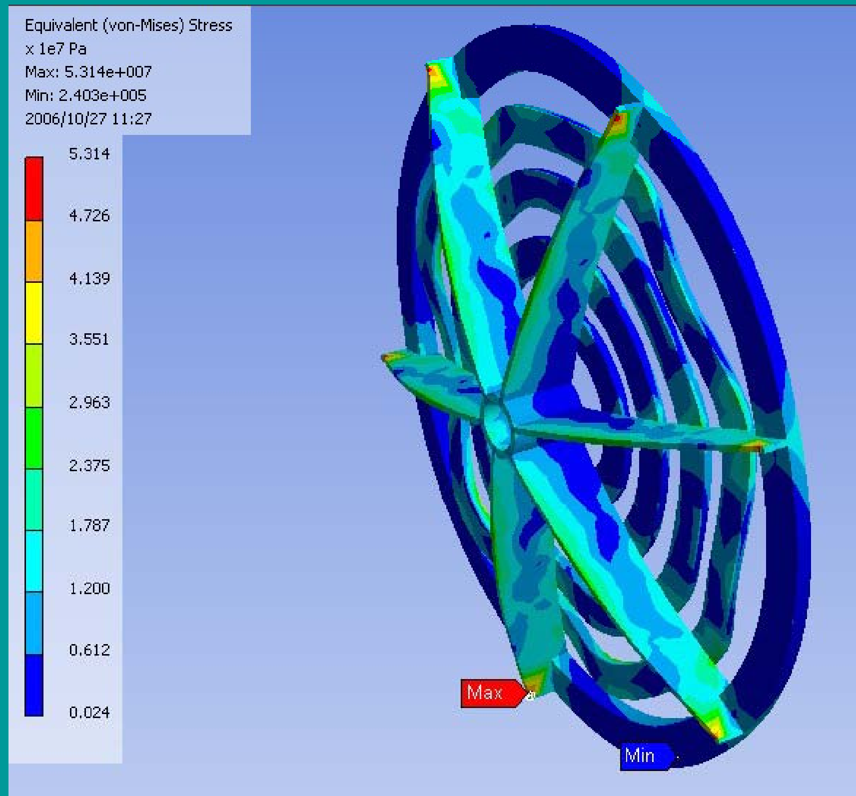
Field across detector

Deformations of end plates

Maximal deformation is in the middle of holder. It is below 5mm.

Active movers of FF lenses will compensate this effect easily.





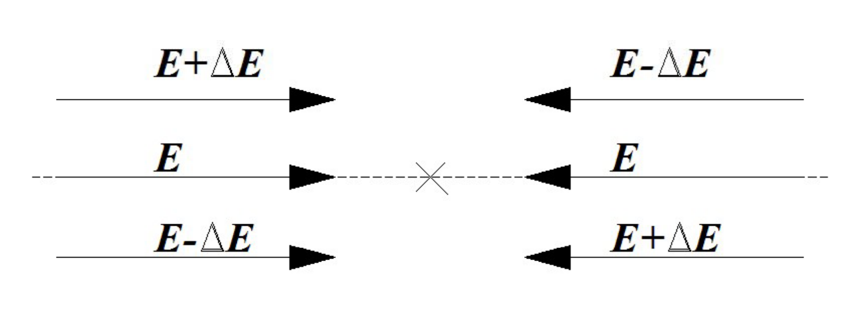
Deformation of FF holder is in z-direction.

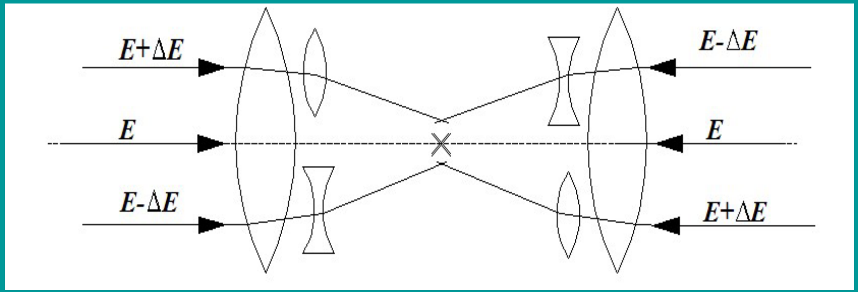
Reinforcement can be done as well.

Calculated by V.Medjidzade

Calculations carried by B.Wands also

Monochromatization



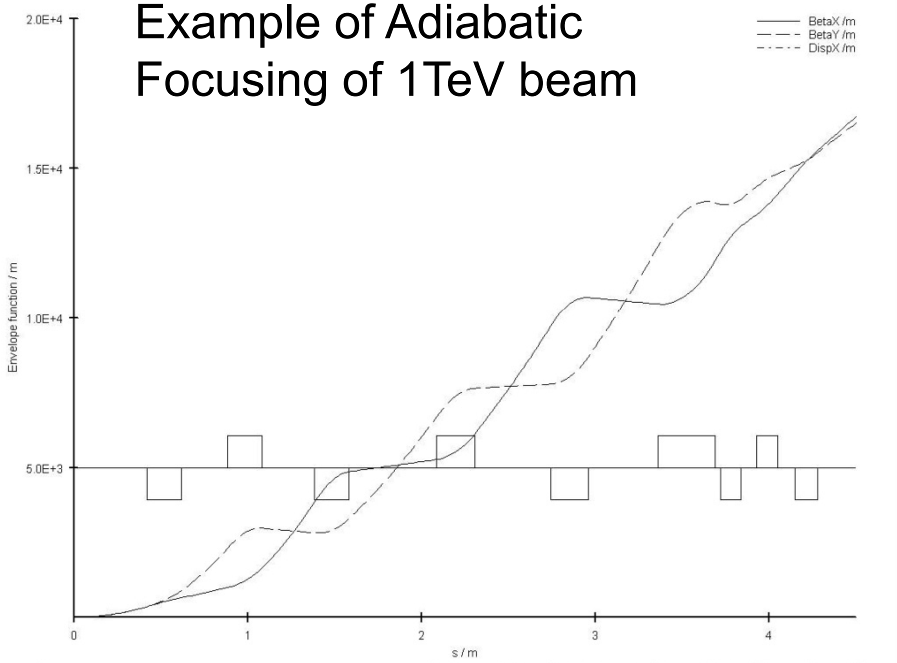


Residual chromaticity at IP is a positive factor for monochromatization

Adiabatic focusing

In addition to standard optics we are considering the adiabatic final focusing with local compensation of chromaticity and residual dispersion at IP

Example of Adiabatic Focusing of 1TeV beam



Envelope function behavior for the multiplet of lenses around IP. IP supposed to be at *s*=0, left point at abscise axis. Beta-functions for x and y directions at IP in this example is chosen equal the same with values 0.05cm.

Chromaticity $\cong -\frac{1}{4\pi(HR)}\int G(s)\beta(s)ds$

gradient changes, β *~const,* so chromaticity might be lowered significantly by neighboring lens

14 mrad crossing angle can be accommodated by 4th CD frame

Active system supposed to be in use for moving the lenses. It eliminates influence of asymmetric deformations induced by ponderomotive forces and ground motion

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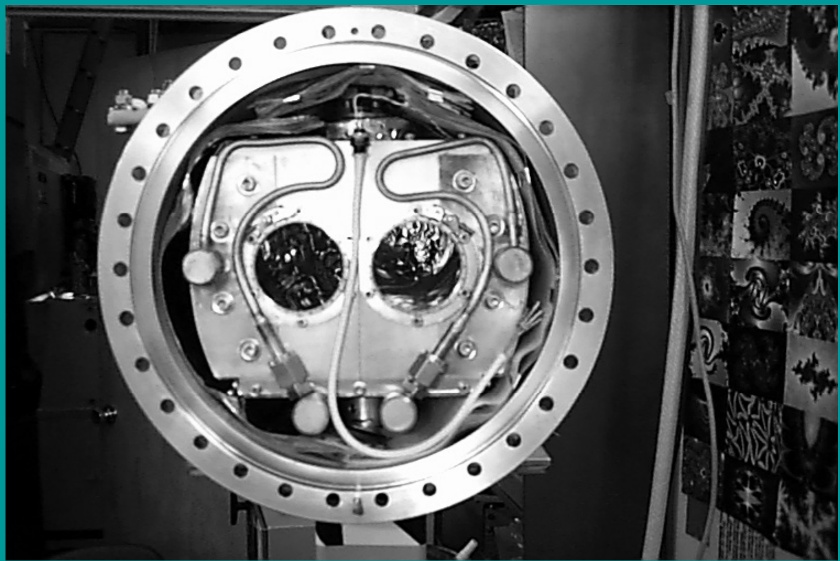
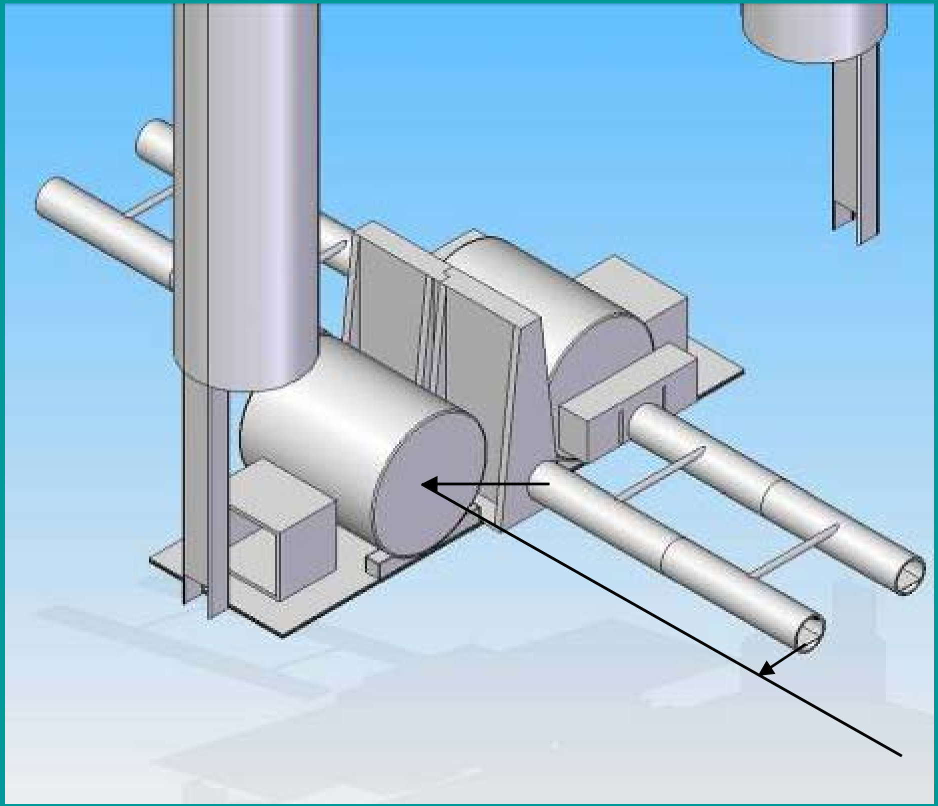


Dual bore SC quadrupole developed and tested at Cornell.
Distance between room temperature walls ~25mm
Septum between SC apertures~5 mm

Beam optics with crossing angle might look pretty similar.

One recommendation…



The service tunnel must be shifted so its axis runs through the center of second detector even the only one detector will be in operation at the beginning.

This is in case …