Detector for Photon Collider

A.F.Zarnecki, University of Warsaw

* Physics requirements
* Collider requirements
* Detector requirements

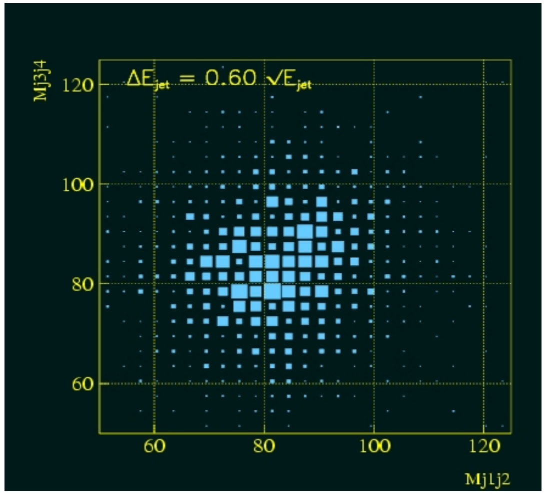
Physics requirements

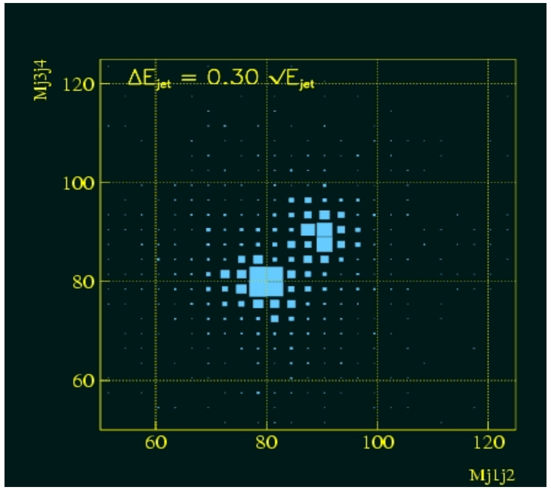
Demands on the PLC detector are even higher than for the detector at the ILC:

- no beam energy constraint
- higher backgrounds

Example:

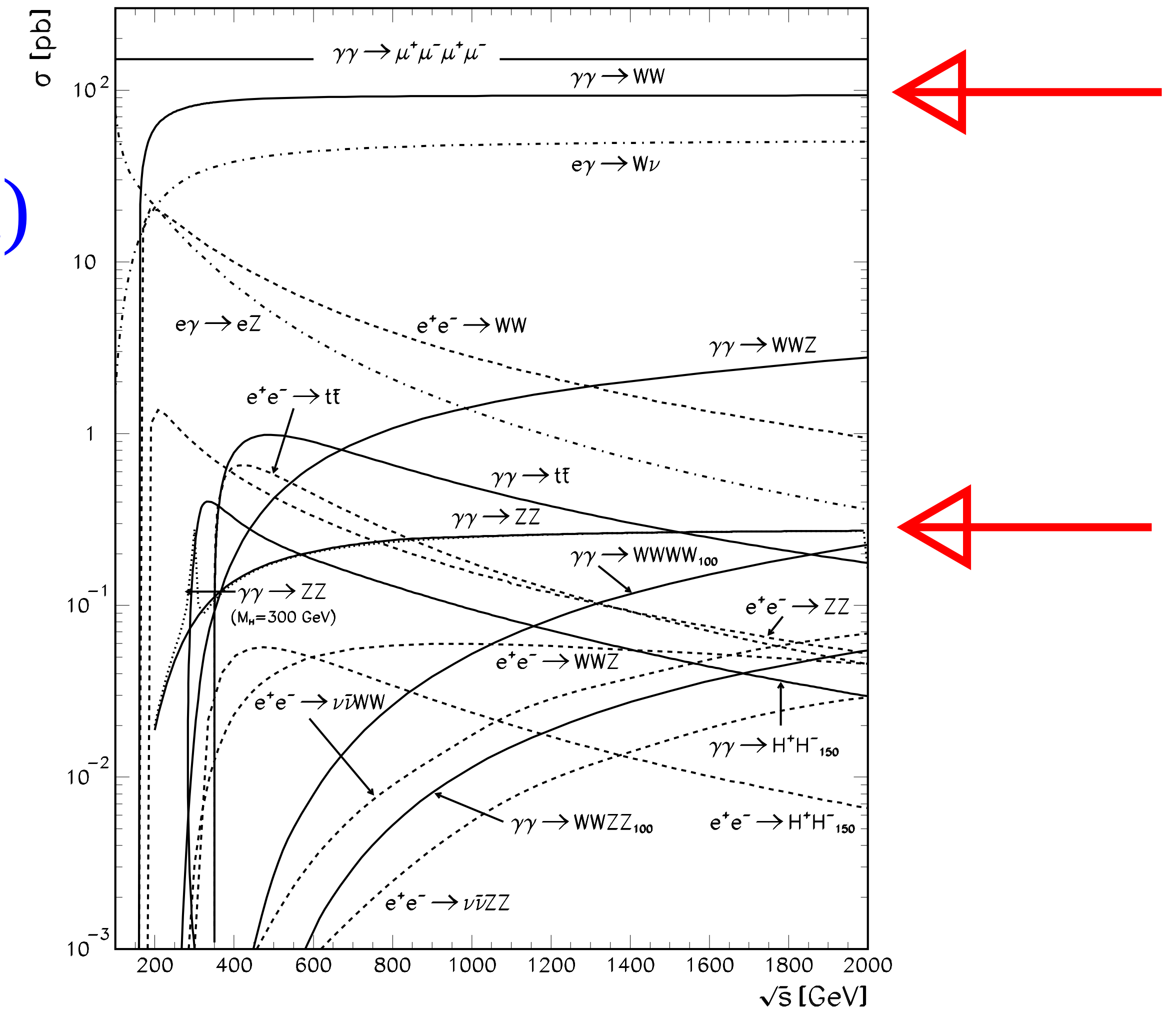
separation of WW/ZZ events
=> hermetic calorimeter
with fine granularity
and very good resolution





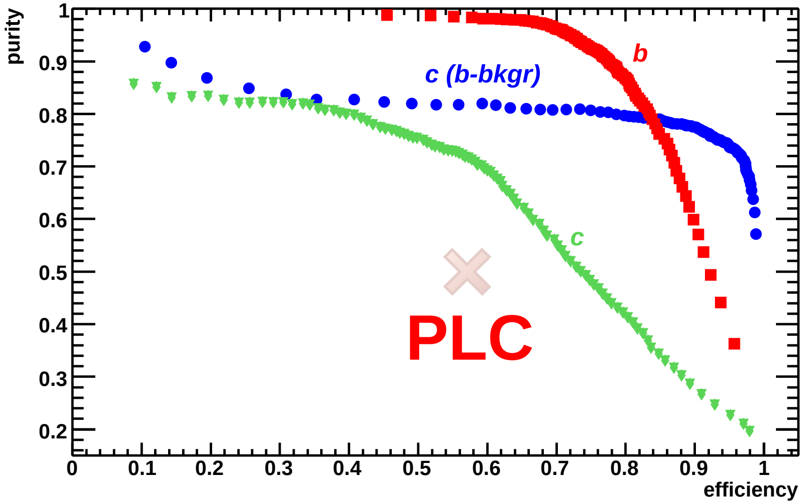
Separation of Higgs boson decays to WW and ZZ

Much more difficult,
due to large cross section
difference (ZZ @ loop level)



Physics requirements

Flavor tagging crucial for Higgs branching ratios:



charm background much stronger at PLC:

$\sigma \propto Q_q^4$

$\sigma^{LO}(\text{cc, ccg}\ ) \gg \sigma^{LO}(\text{bb, bbg})$

Physics requirements

We need detector with
* high hermecity
* good vertex detector, efficient b-tagging
* particle identification
* calorimeter system with fine granularity
  and high resolution
* instrumentation for luminosity measurement

UCL/HEP 94-04

UNIVERSITY COLLEGE LONDON
DEPARTMENT OF PHYSICS
AND ASTRONOMY

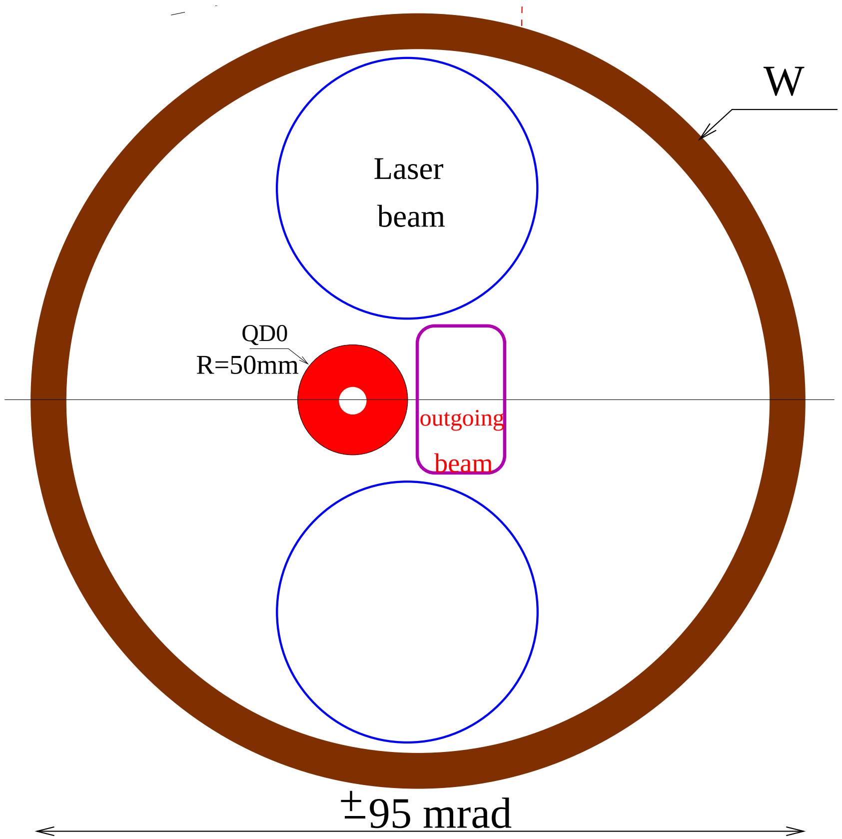
Detector Questions for a Gamma-Gamma Collider

David J. Miller

Collider requirements

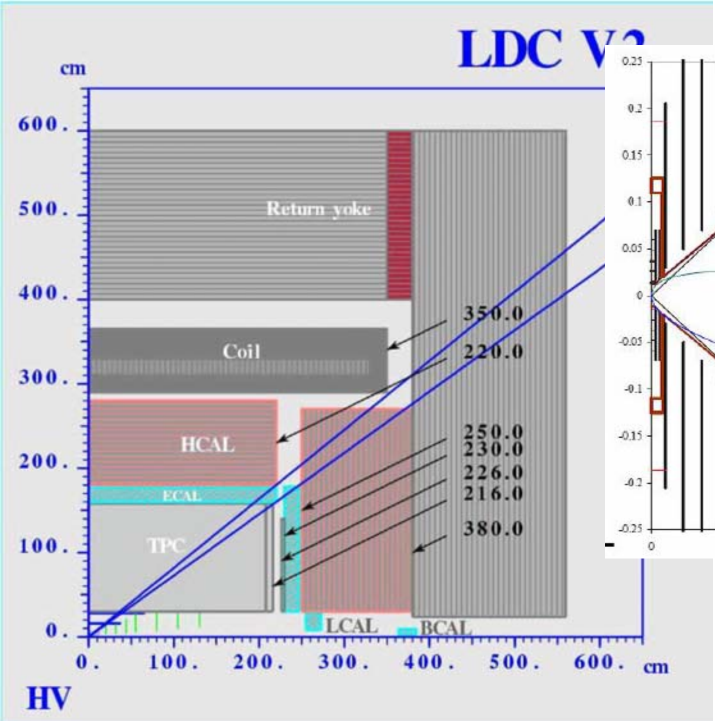
Interference of the laser optics with the detector

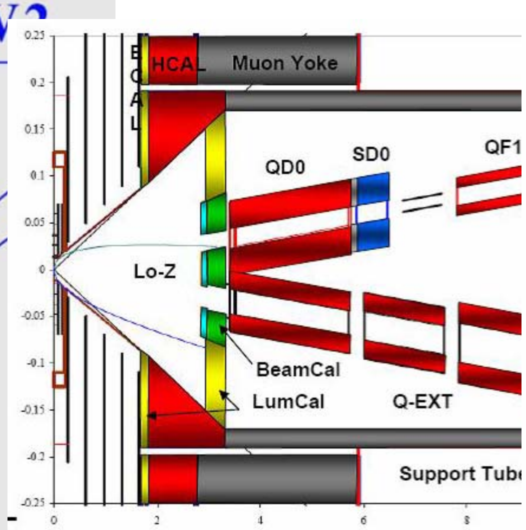
Layout of the quad, electron and laser beams at the distance 4 m from the interaction point (IP)

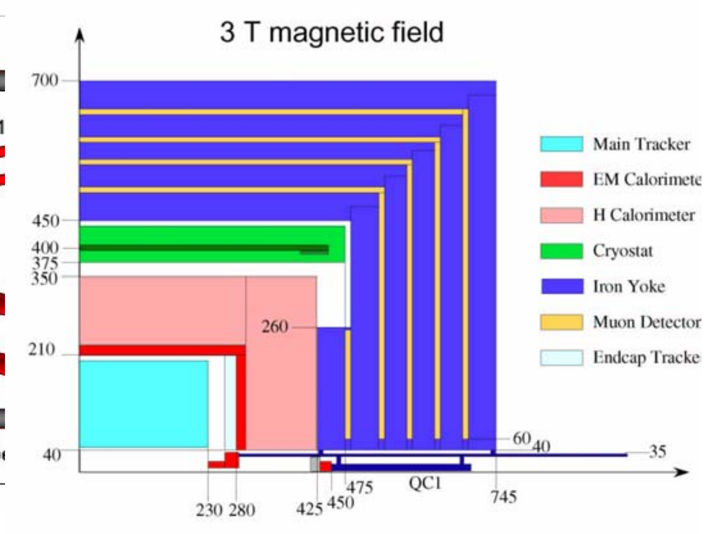


Open angles in detectors

LDC SID GLD



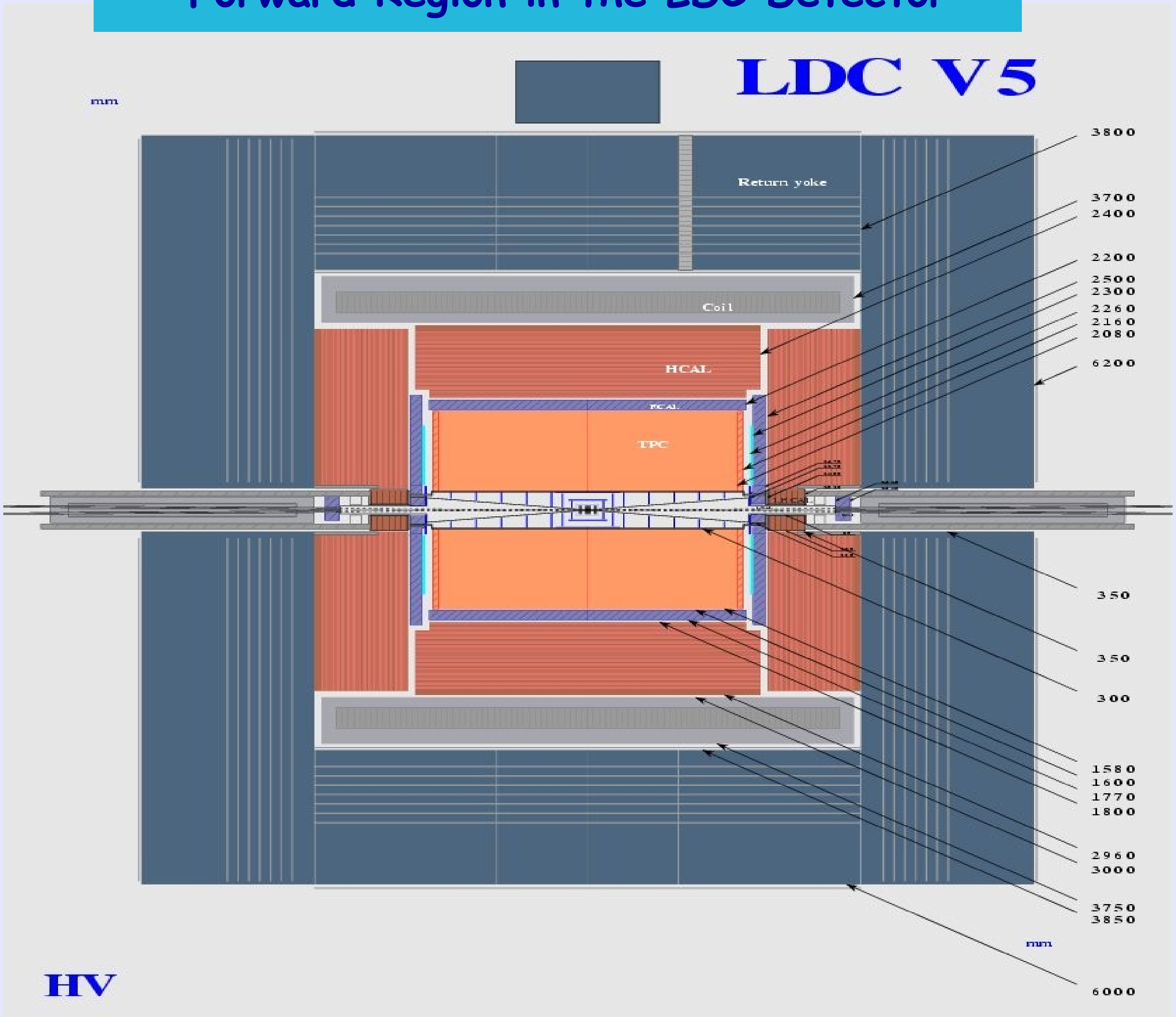




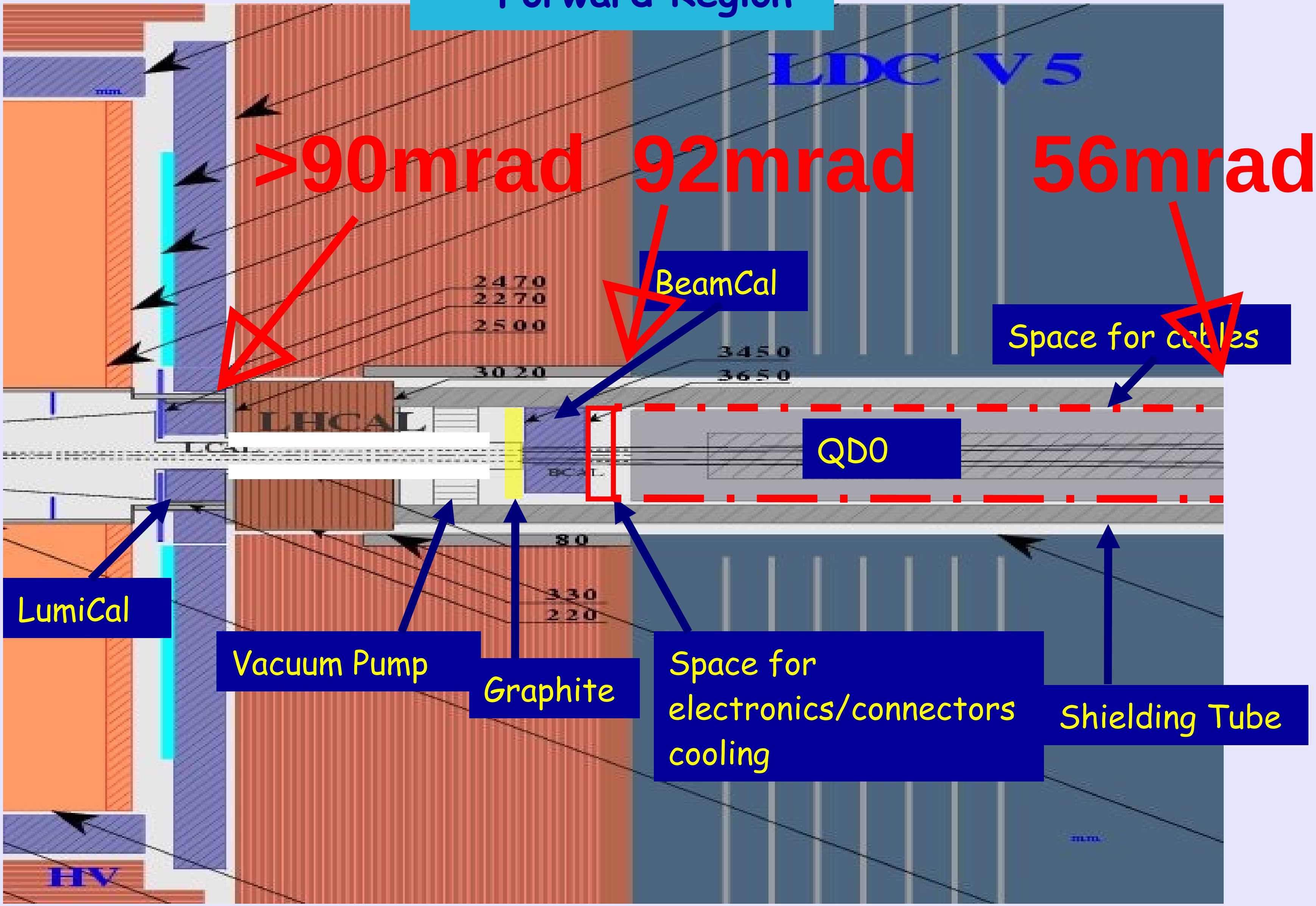
θ=±45 mrad ±33 mrad ±50 mrad

that is less than required 95 mrad

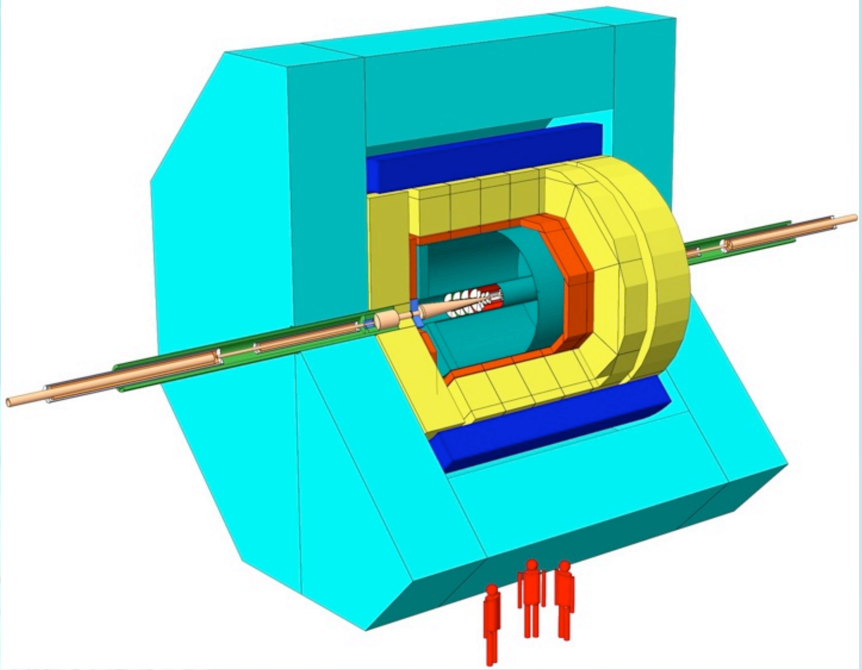
Forward Region in the LDC Detector

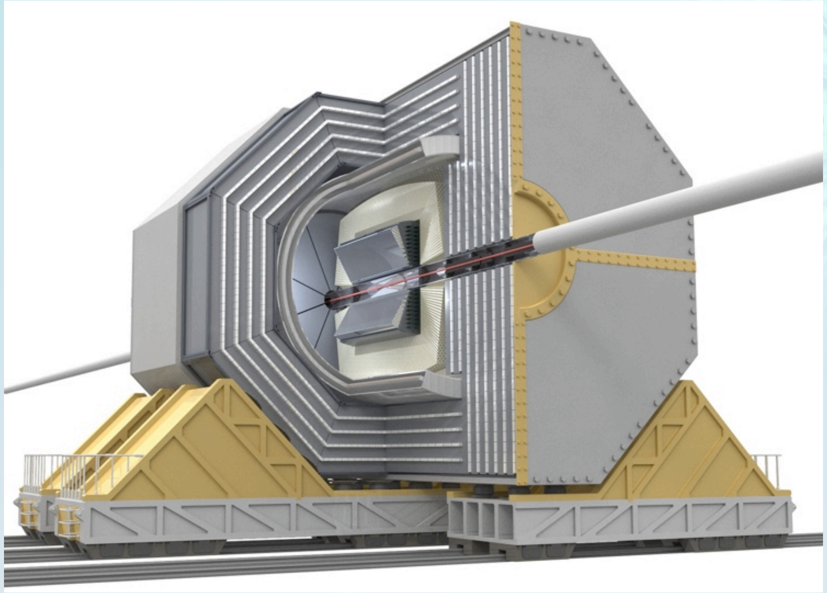


Forward Region

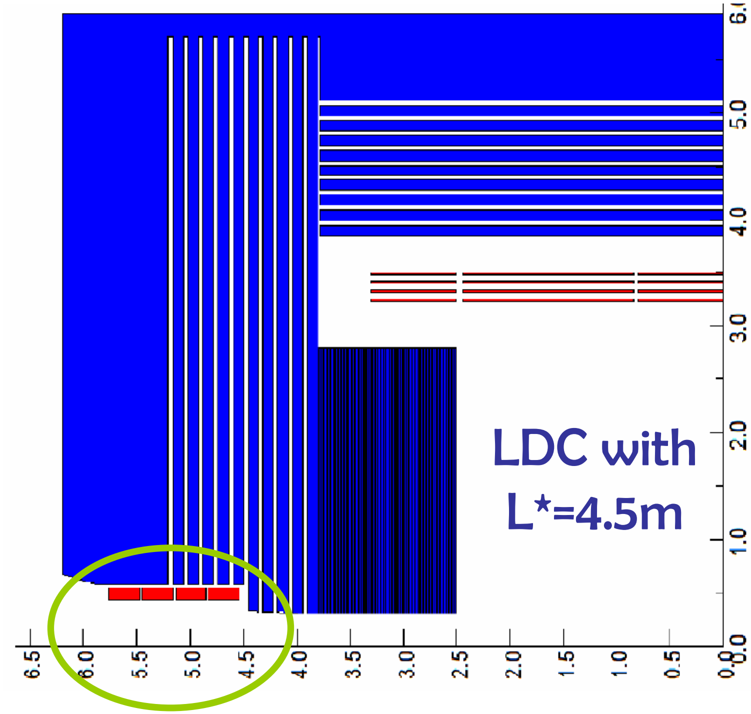


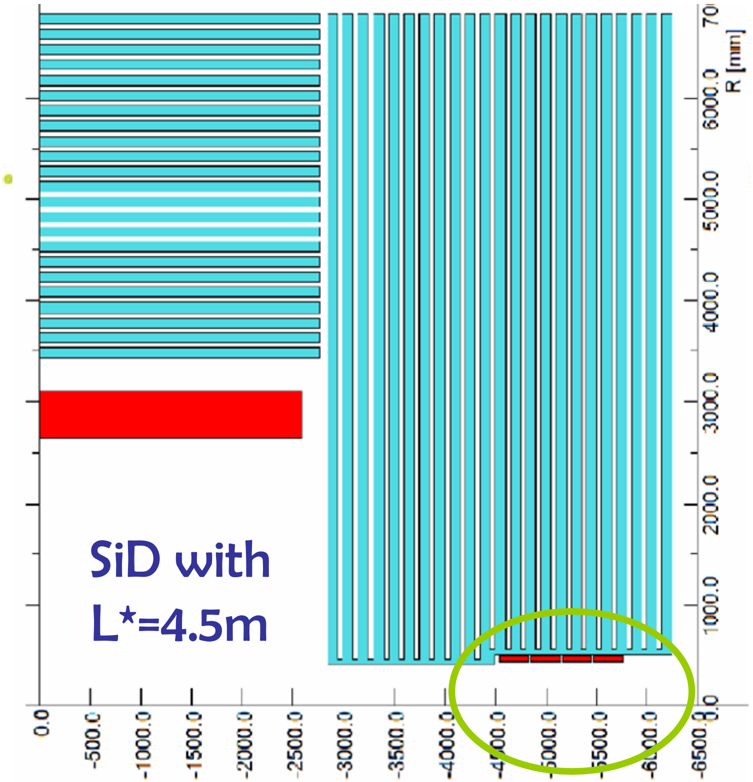
ILD = GLD ⊕ LDC





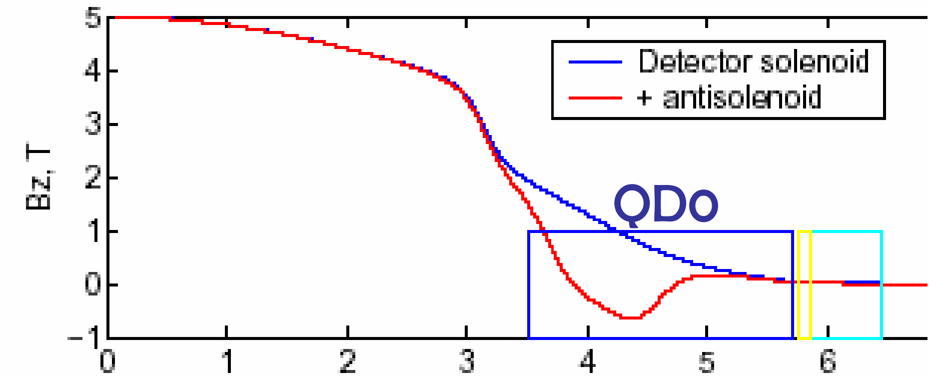
Antisolenoids





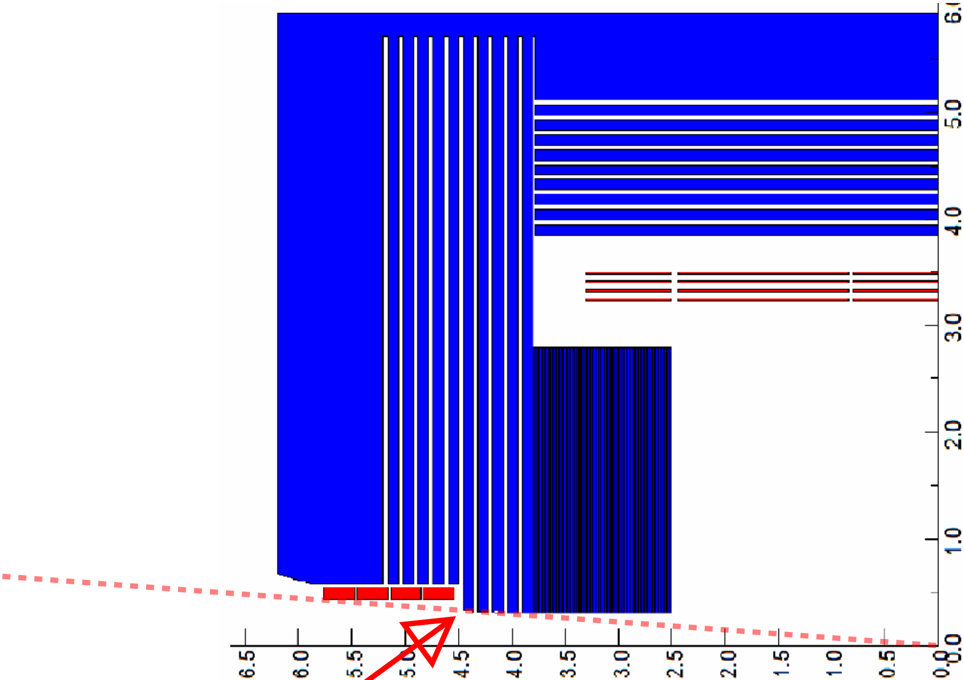
- Antisolenoids for local compensation of beam coupling
- Depend on all parameters (L*, field, sizes, etc) and is a delicate MDI issue

B.Parker, BNL



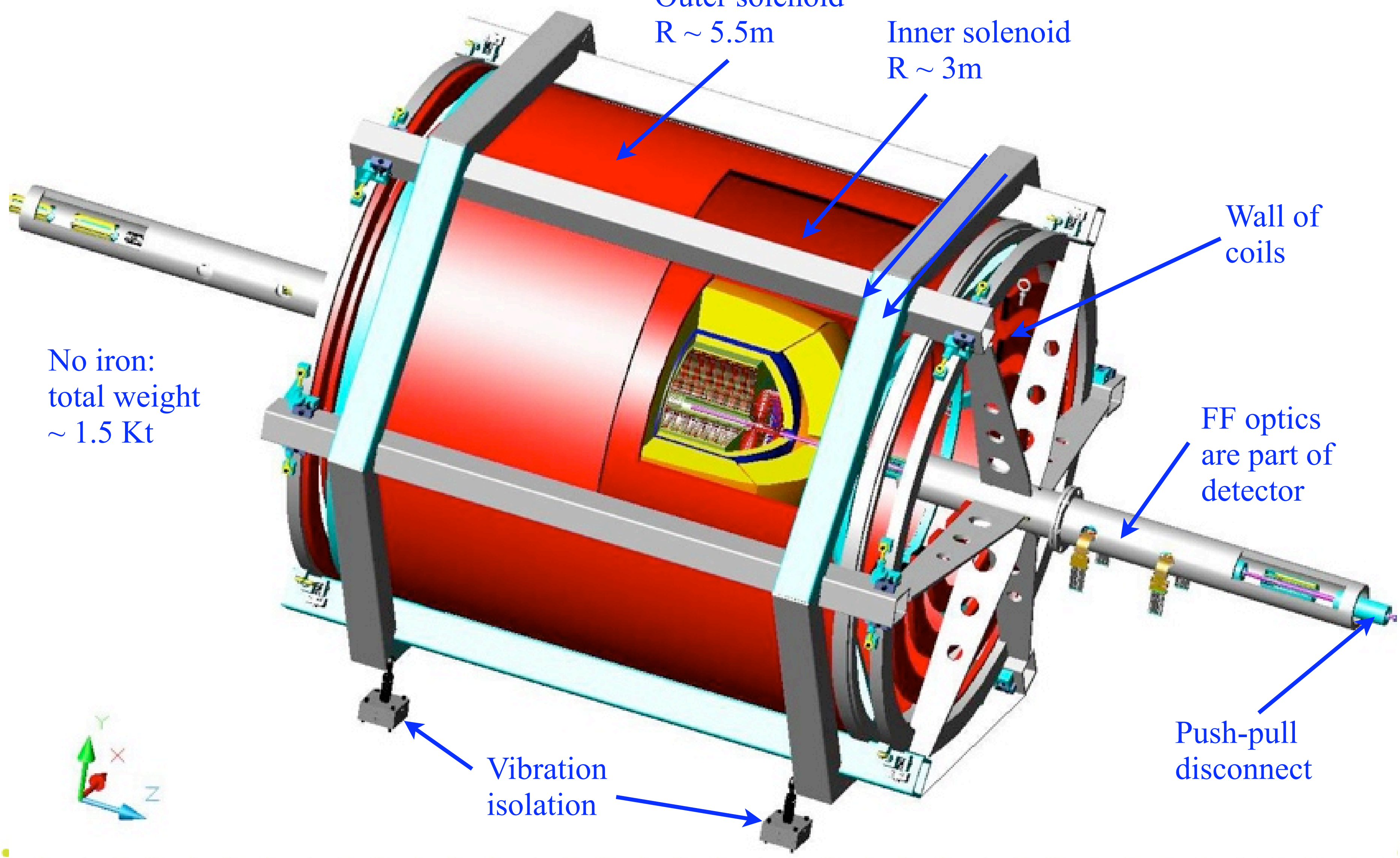
Example of optimal field for local compensation of coupling (SiD, L*=3.5m)

Yoke design not fixed yet...

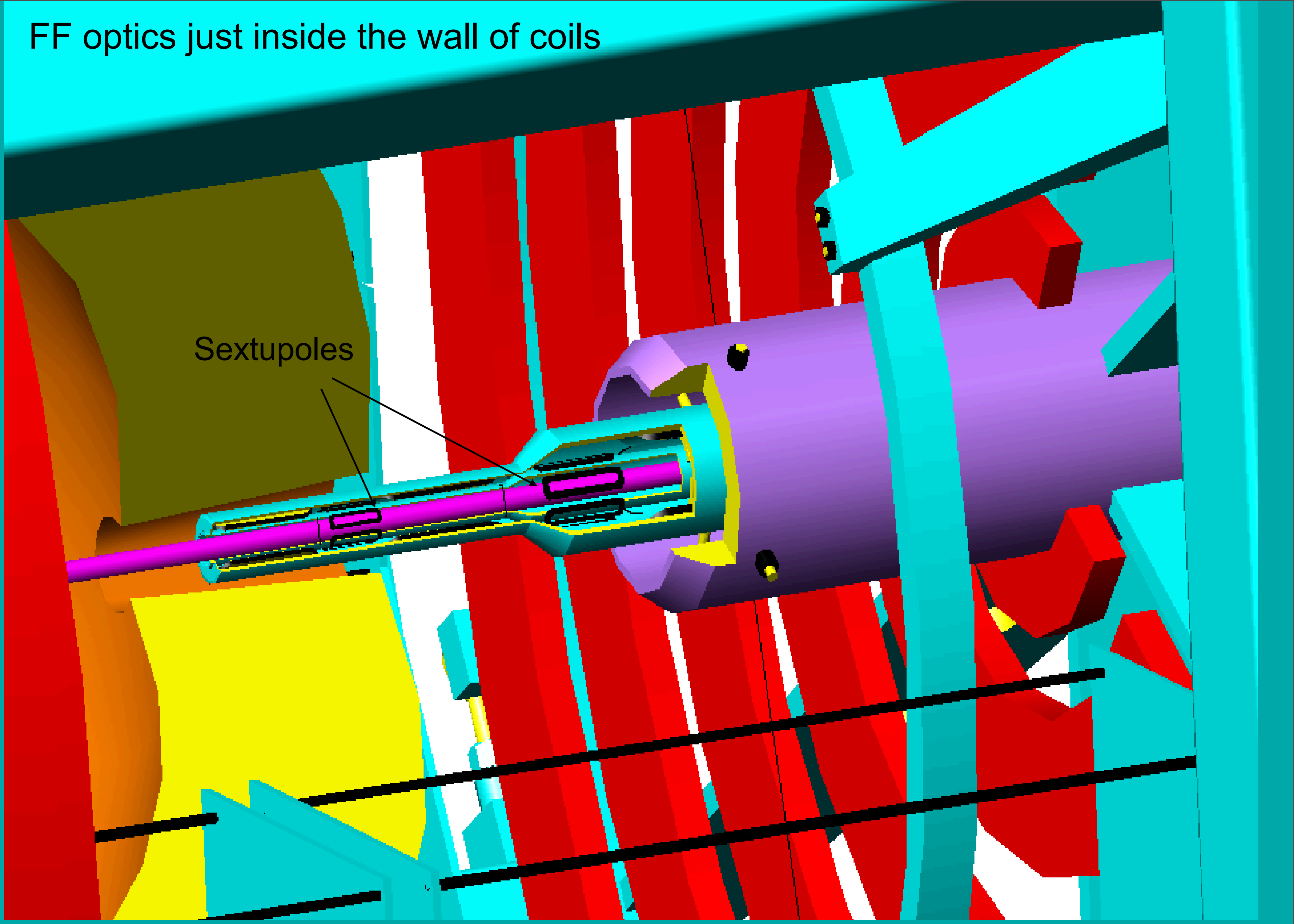


78mrad

Quick overview of detector geometry

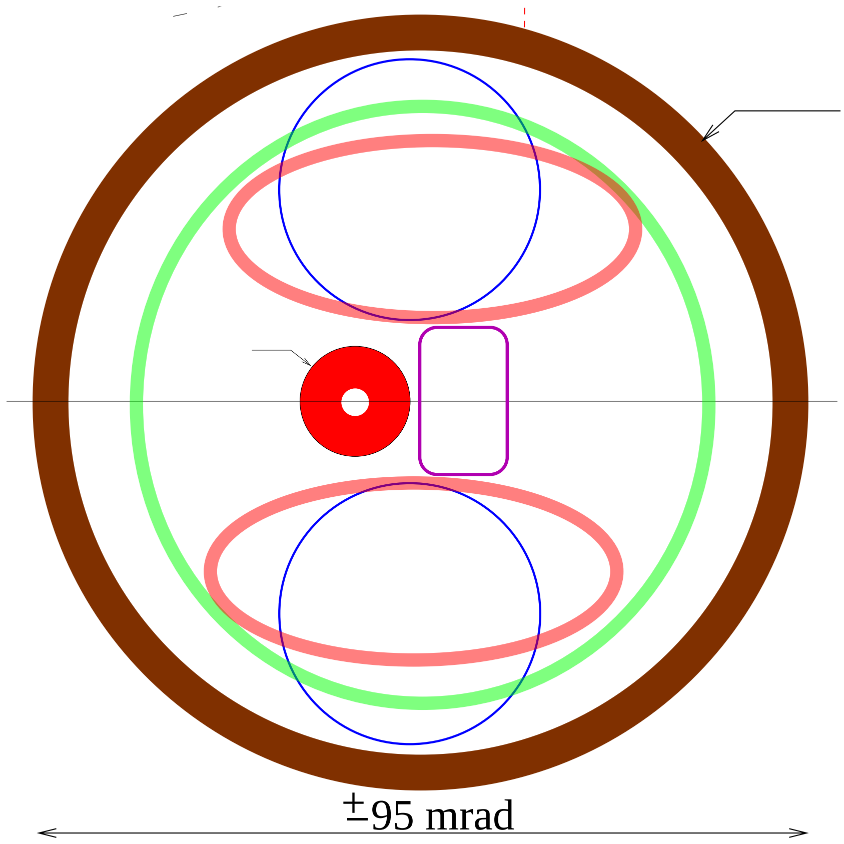


FF optics just inside the wall of coils



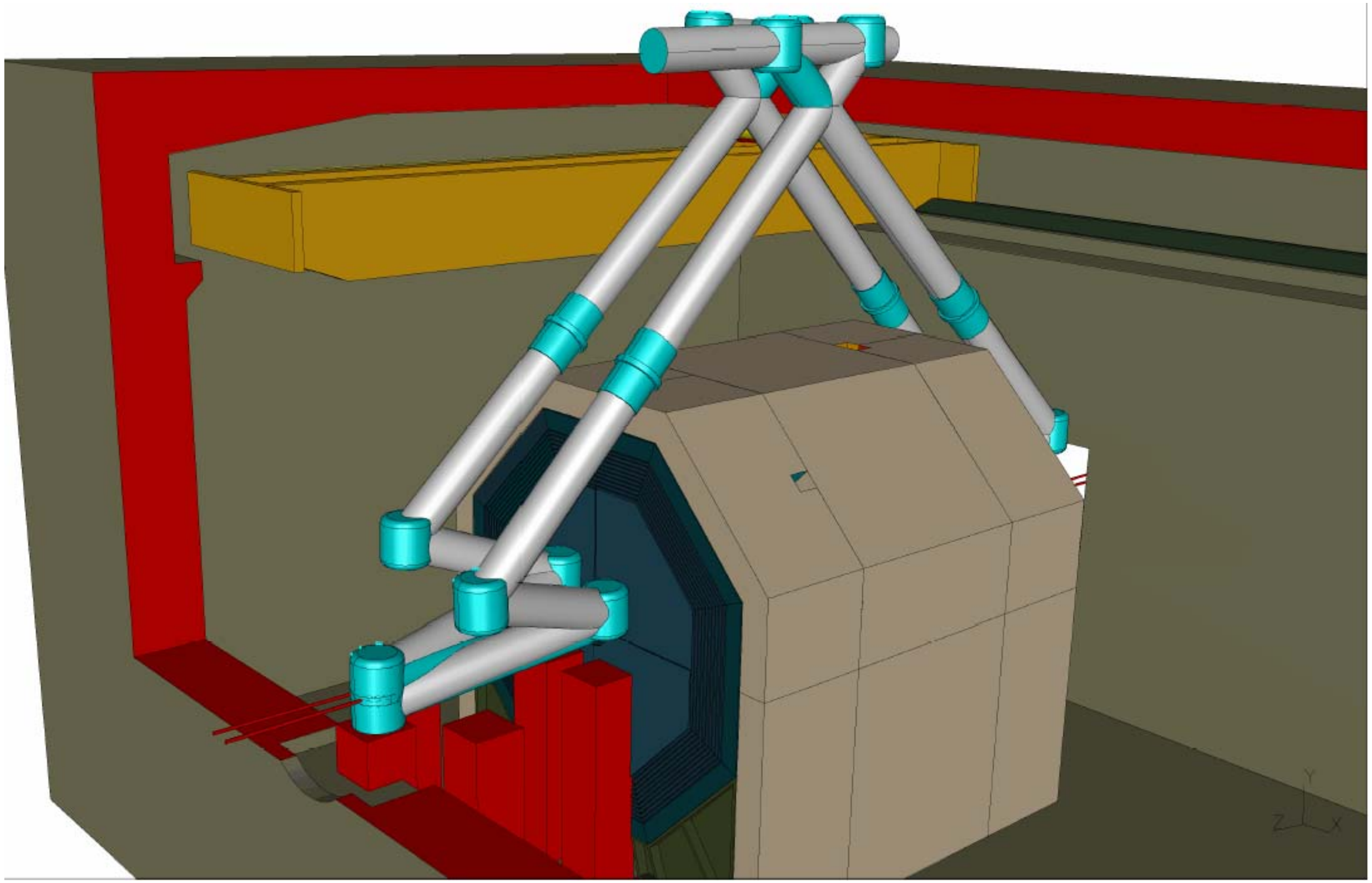
Cryostat with single bore quads and sextupoles

Could We reduce our demands?



View of the detector with the laser system
(the pumping laser is in the building at the surface)

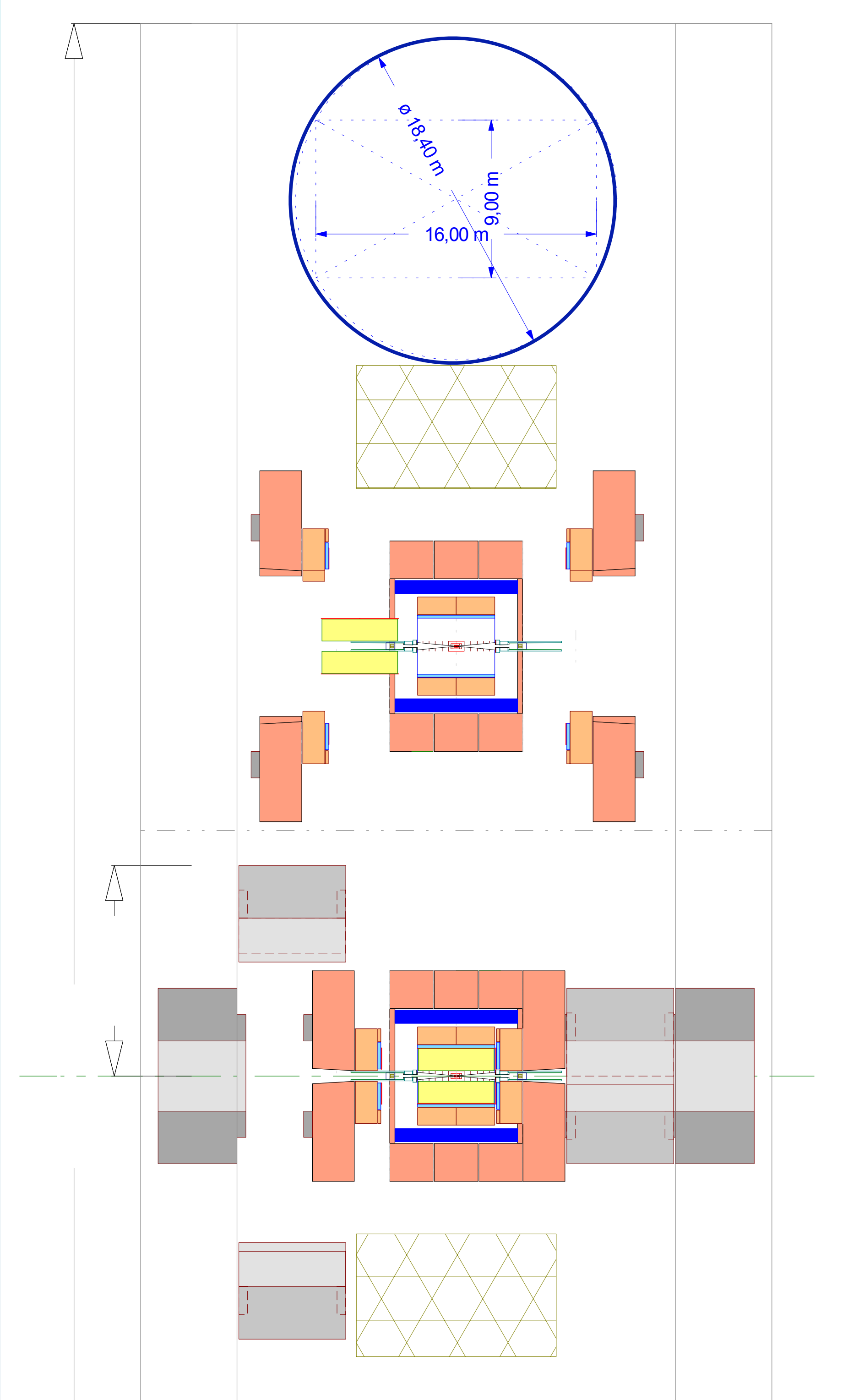
Klemz, Monig…



The above scheme does not fit the ILC experimental hall !

What about push-pull?

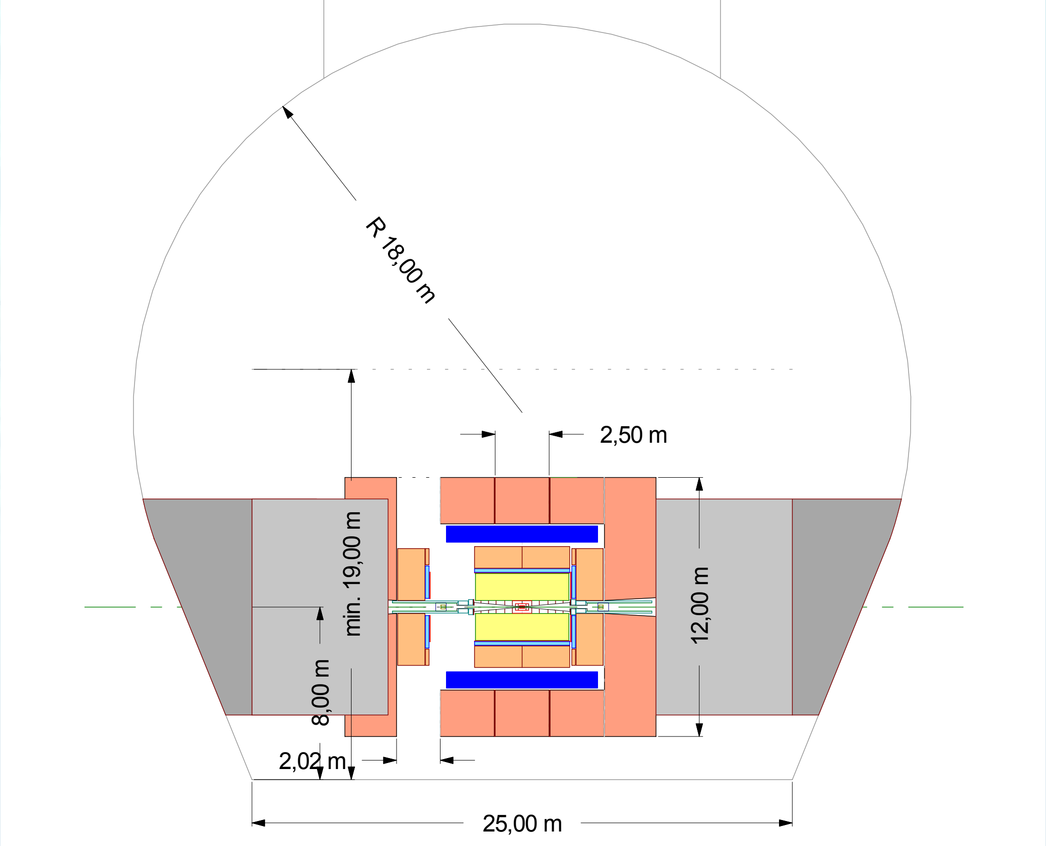
LDC in Underground Hall



Half of underground hall

surface assembling as CMS

Should the cavity move together with the detector?

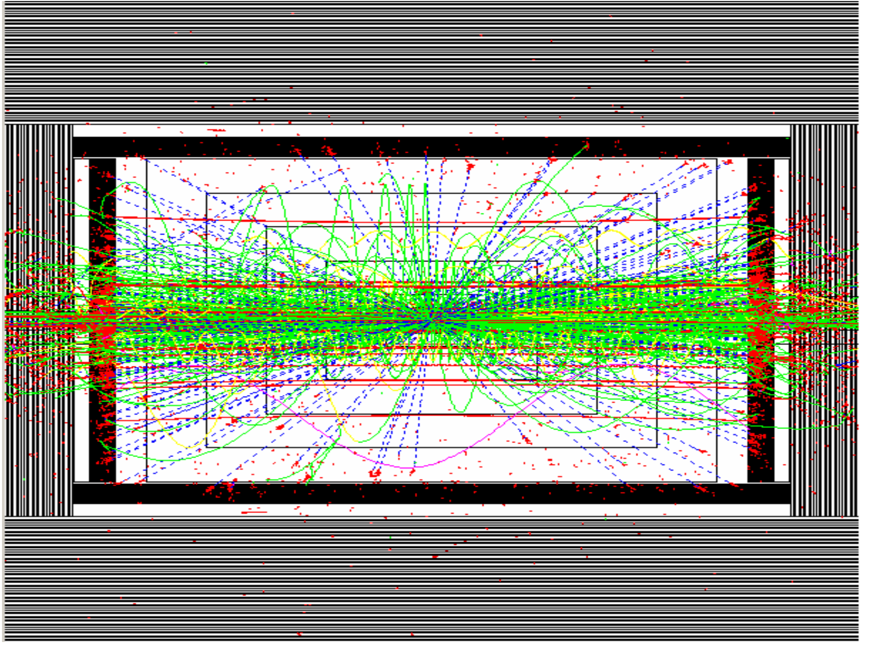


Surface hall size : 50m (later 70m) x 30m; 2 x 80t crane; hook 19m above floor.

ILC:

Event Pile Up During Bunch Train

Livetime 40 μs ~ 130 BX

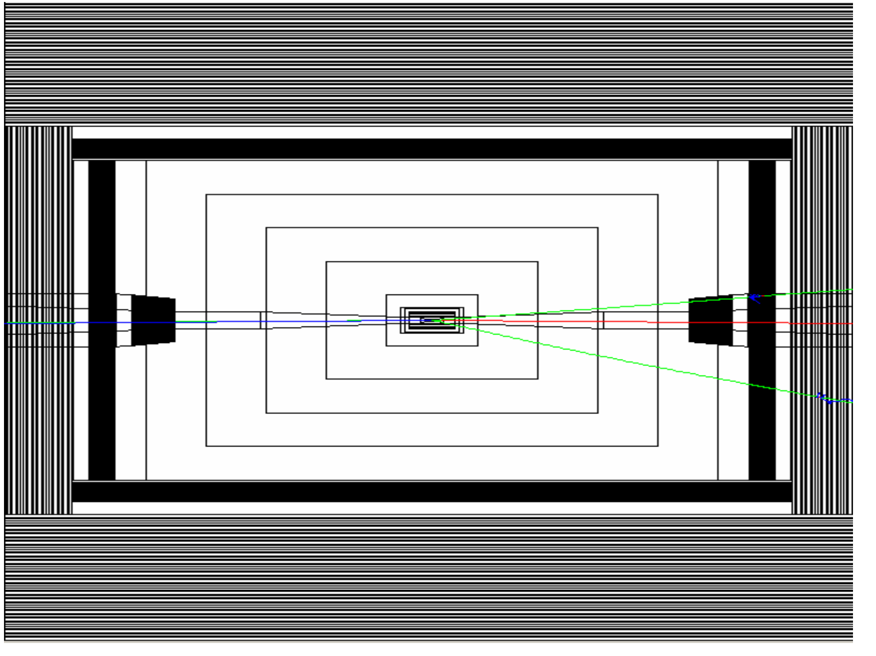


18k e pairs/130 BX

50 μ pairs/130 BX

86 hadronic events/130 BX

Livetime 100ns ~ 1 BX



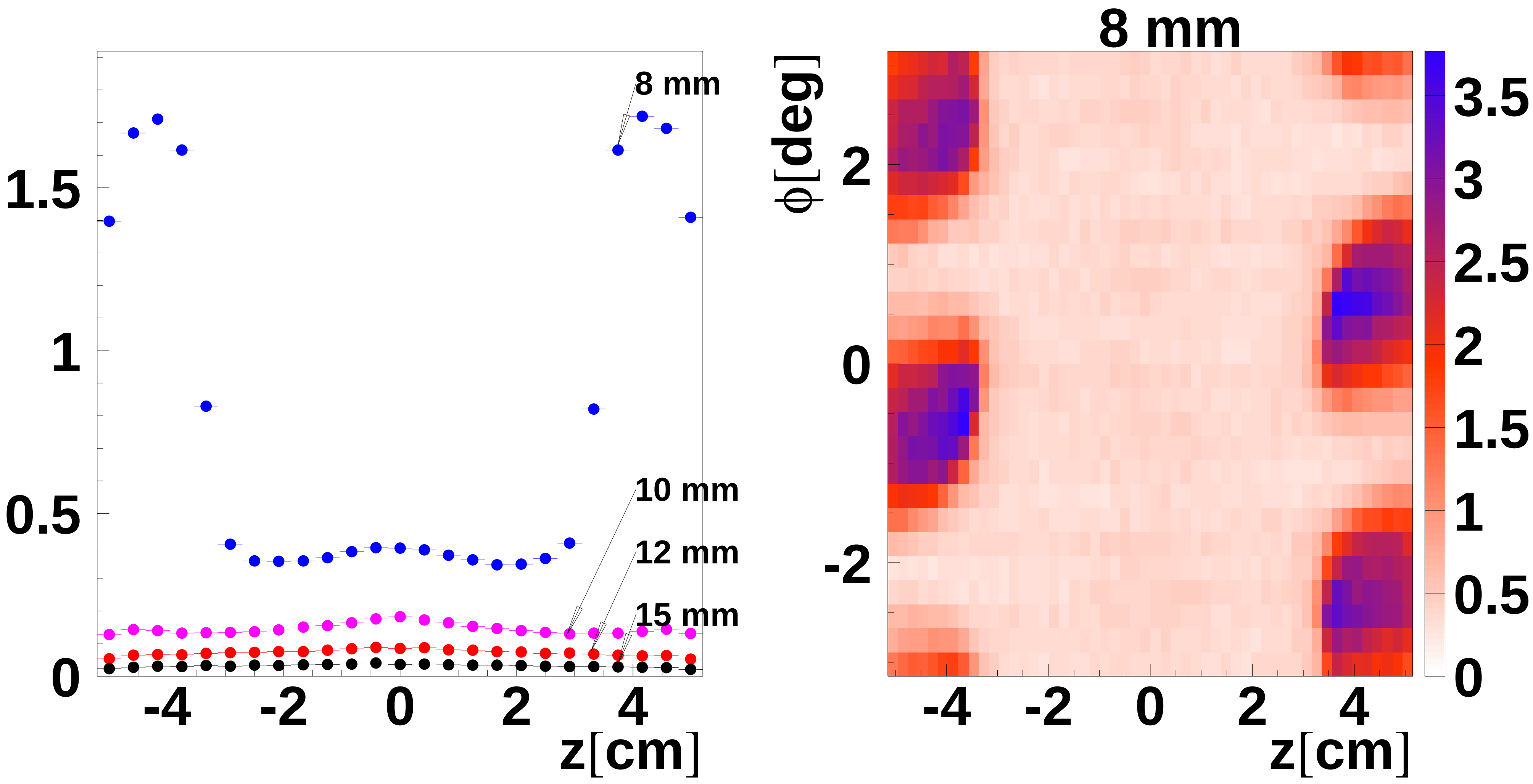
140 e pairs/ BX

0.4 μ pairs/BX

0.7 hadronic events/BX

Add Muons from Collimators, MeV Photons from Pairs, Neutrons, Synchrotron Radiation and Possible Shower Products from Uncertain Beam Tails!

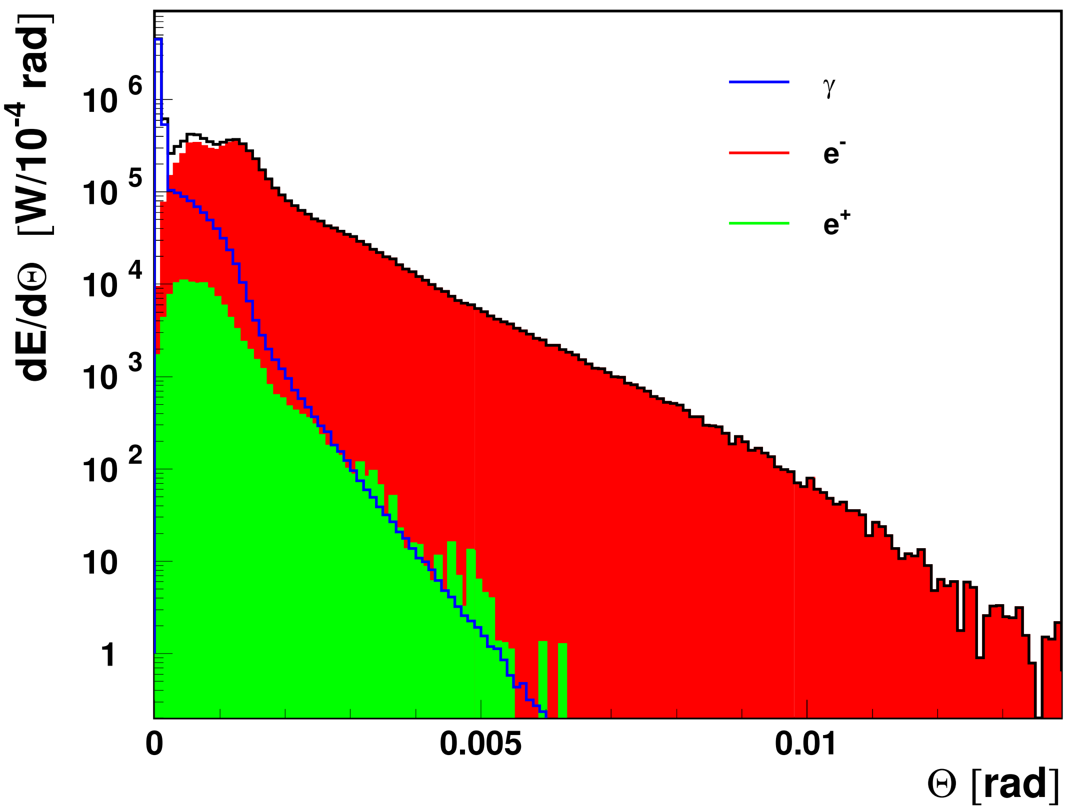
Hits/mm²/BX, 1st layer



PLC

Beam simulation results for 34 mrad beam crossing angle.

Angular energy flow observed 3m from IP (one beam).



Background (beam halo) mainly due to electrons.

About 15 mrad opening angle needed to contain the outgoing beam.

⇒ What effects contribute to the beam background?

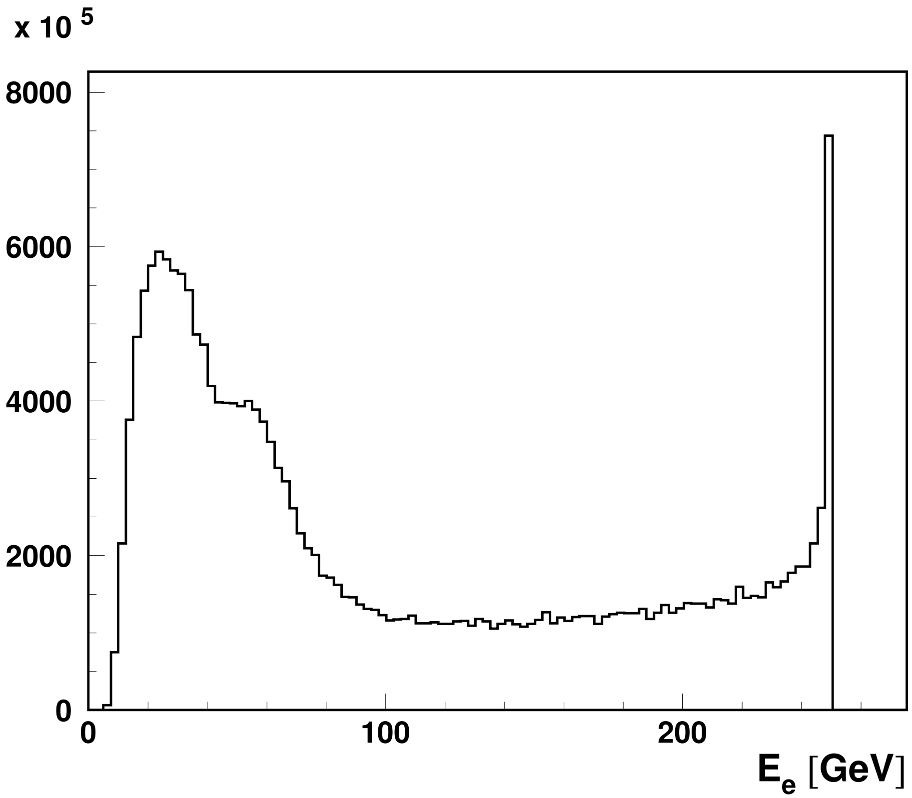
⇒ Why is the beam background much higher than for e^+e^-?

Beam-beam interactions

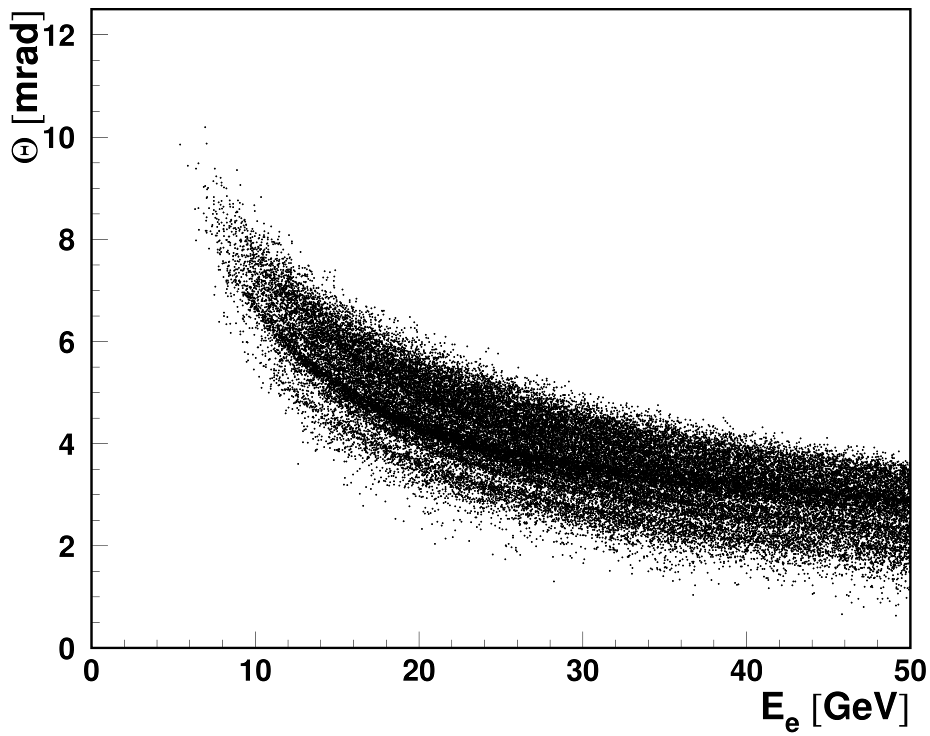
Large background is due to low energy electrons resulting from Compton scattering.

Lower energy $\Rightarrow$ larger deflection

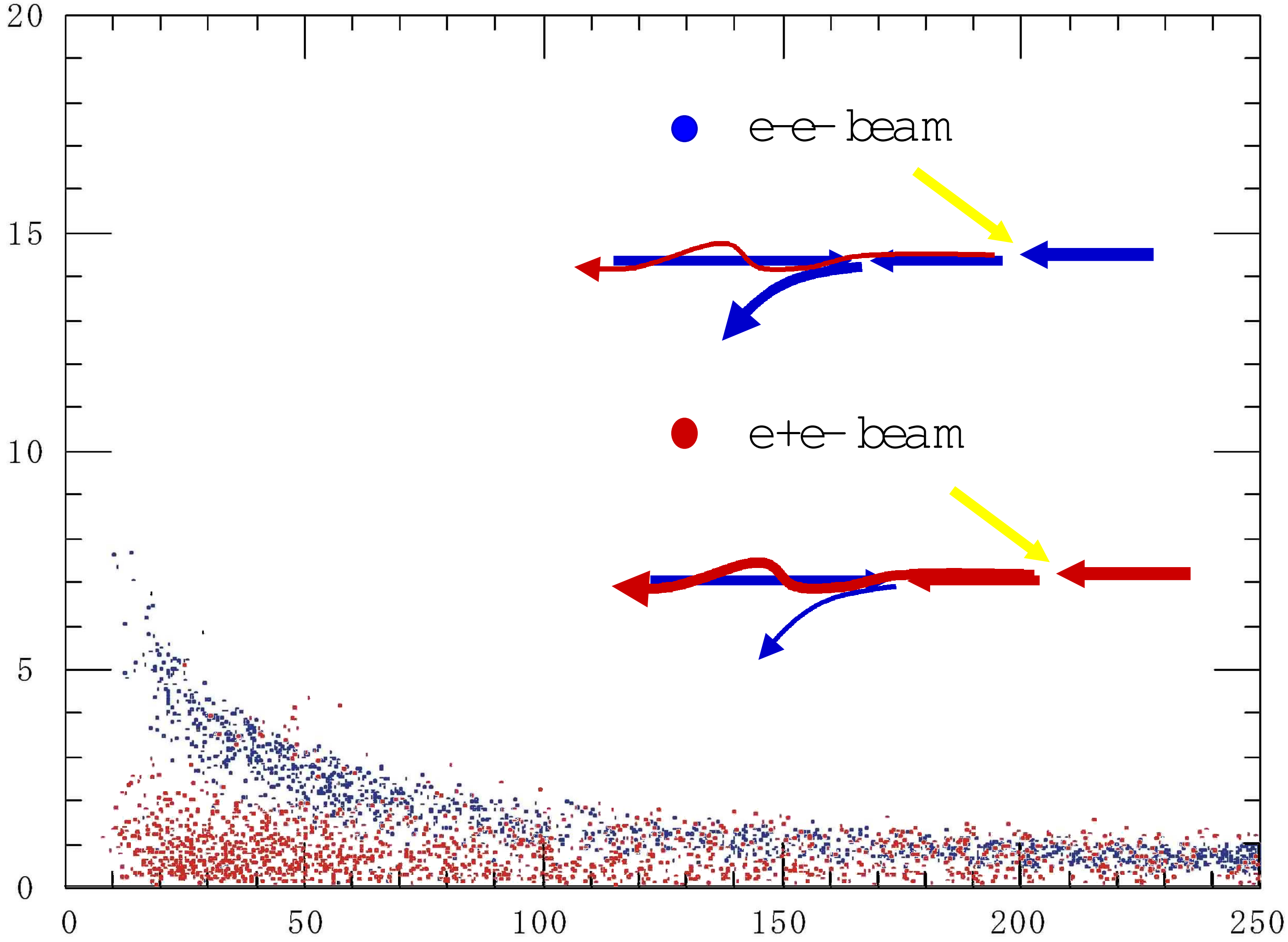
Electron energy distribution at IP
after Compton scattering



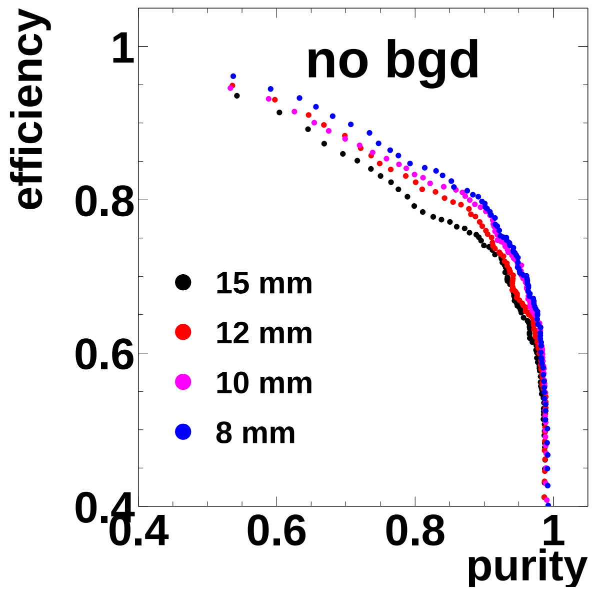
Electron deflection at IP
as a function of energy

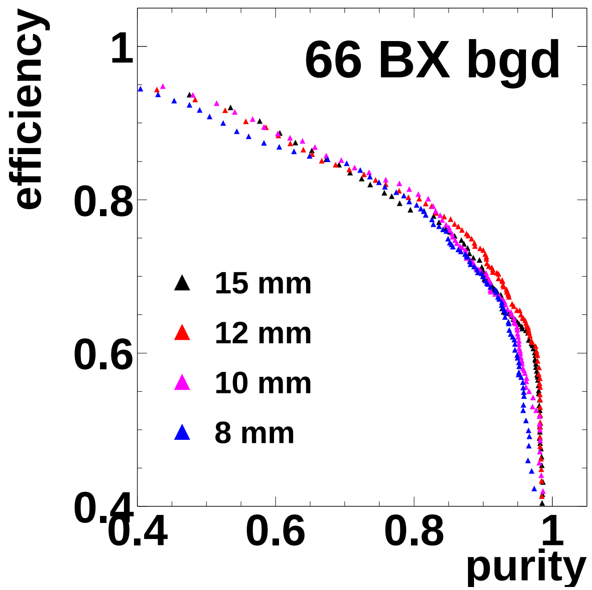


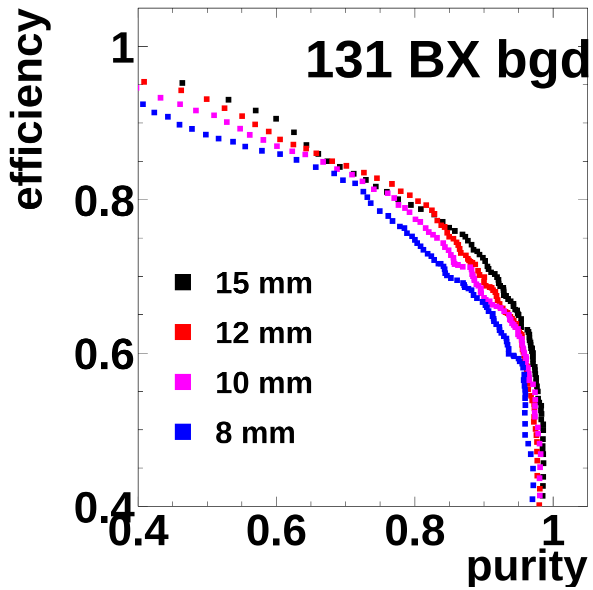
Disruption of Spent Electrons



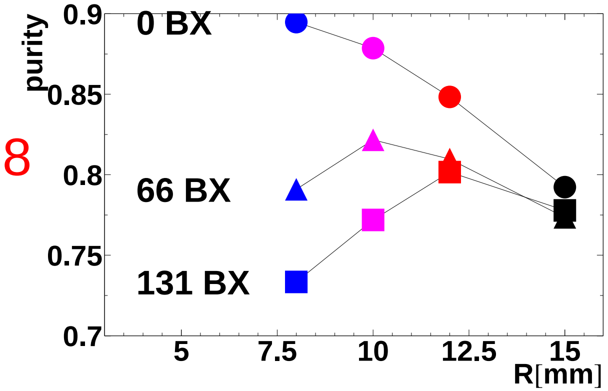
Jet flavour tagging: b

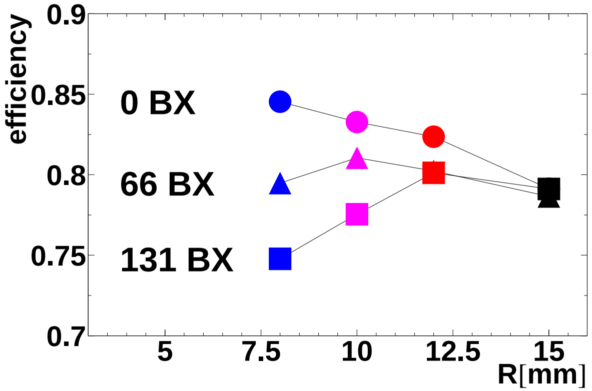






Efficiency 0.8

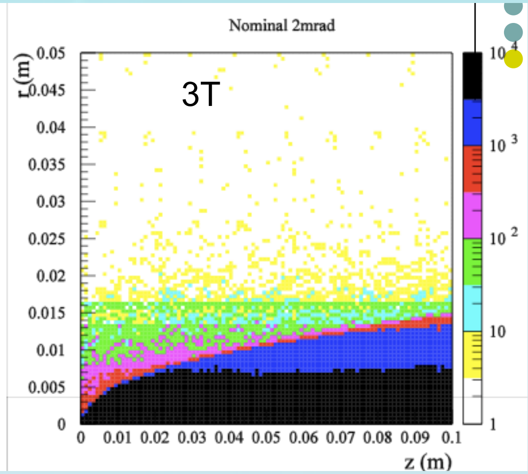


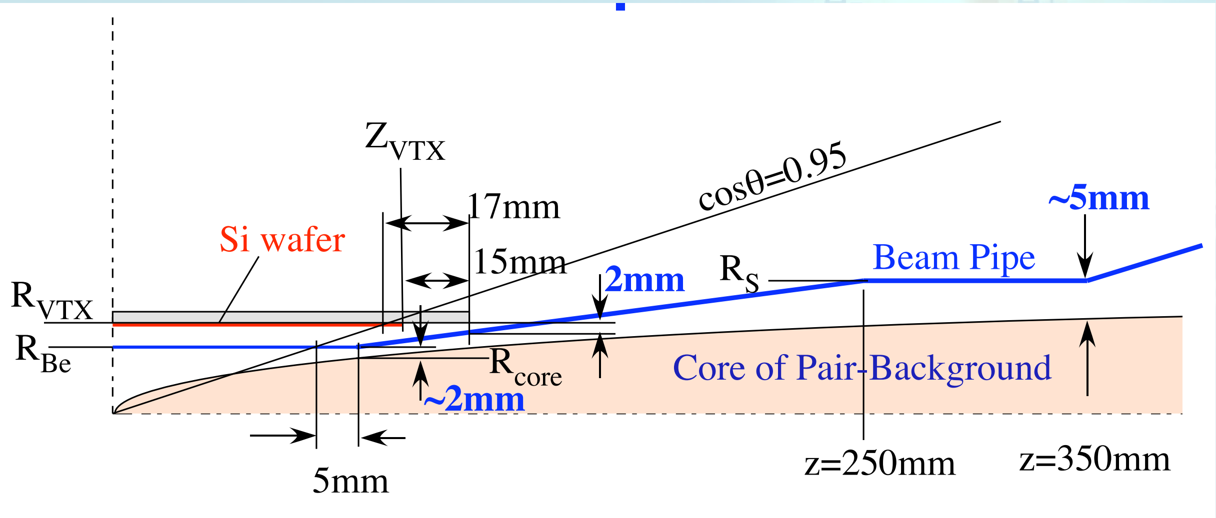


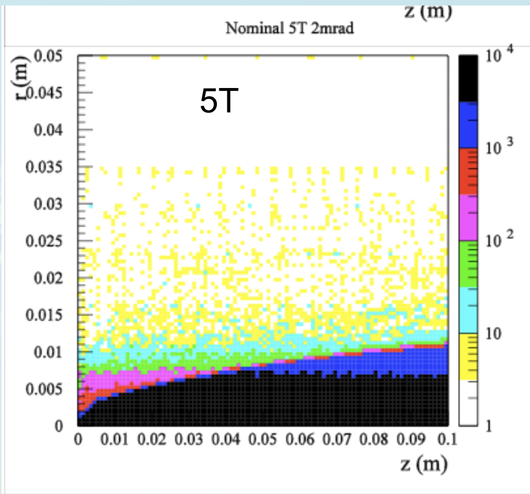
Purity 0.8

What is the best choice for PLC?

- Pairs are focused by solenoidal field in the detector towards the forward region
- Pairs trajectories envelope depends on magnetic field
- Careful desing of beam pipe is mandatory







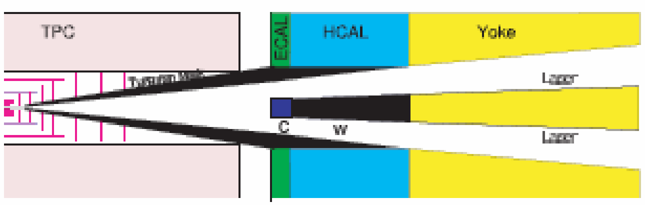
T. Tauchi

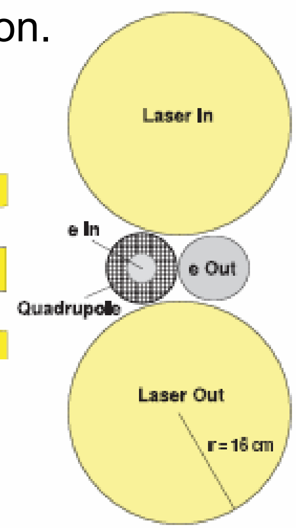
Keeping Options Alive

- **The Physics may lead us to Giga Z or Gamma Gamma.**
  ILC machine design should minimize future modifications needed.

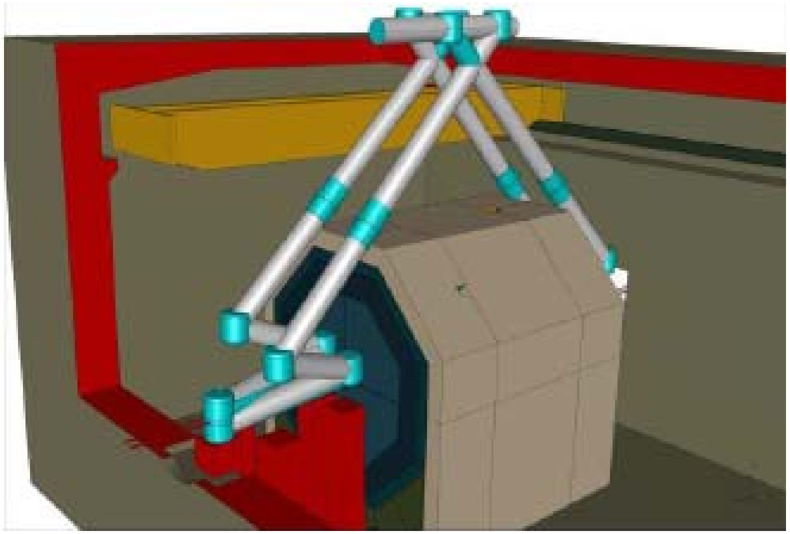
- **Gamma Gamma Physics**
  S channel production of Higgs and study of CP properties
  Single and Associated particle production extends mass reach
  for higher mass Higgs and SUSY

$\gamma\gamma$ needs 25 mr crossing angle
to accommodate beam disruption.
Mirrors focus lasers to collide
with beams ~ mm from IP





Laser Cavities Recirculate Light
to match the bunch spacing



10.2.3 Conclusion

The $\gamma\gamma$ option adds significantly to the physics reach of the ILC. In order to maintain this option the ILC design should include a capability to run the detector with a 25 mrad crossing angle. The detector should also be designed so that the area around the beam pipe can be easily replaced with one configured for 25 mrad running. Space in the detector hall should be reserved for the laser and optics installations.