Solenoid effects and compensation

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Interaction Region magnets

Detector Solenoid

- It causes beams (incoming, spent) orbit deviation

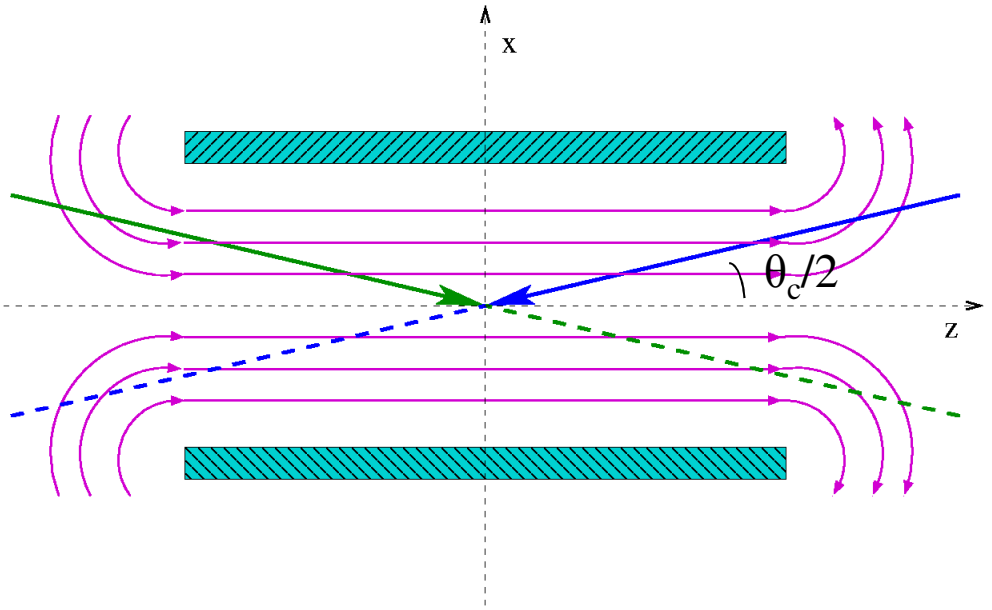
$\Rightarrow$ DiD-AntiDiD

- Due to short L*(3.5m) the detector solenoid field overlaps QD0 field, worsening beam orbit deviation, dispersion and coupling

$\Rightarrow$ Anti-Solenoid (compensating solenoid)

Solenoid Effects

- ***Weak focusing***: in the two transverse planes
- ***Orbit deviation***: the beam is bent as it traverses the magnetic field
- ***Coupling between x-y plane***: the particle position in one plane depends on the position in the other plane
- ***Dispersion***: particles at lower energies experience a larger deflection than those at higher energies
- The beam emits ***Incoherent Synchrotron Radiation*** (ISR) as it is deflected

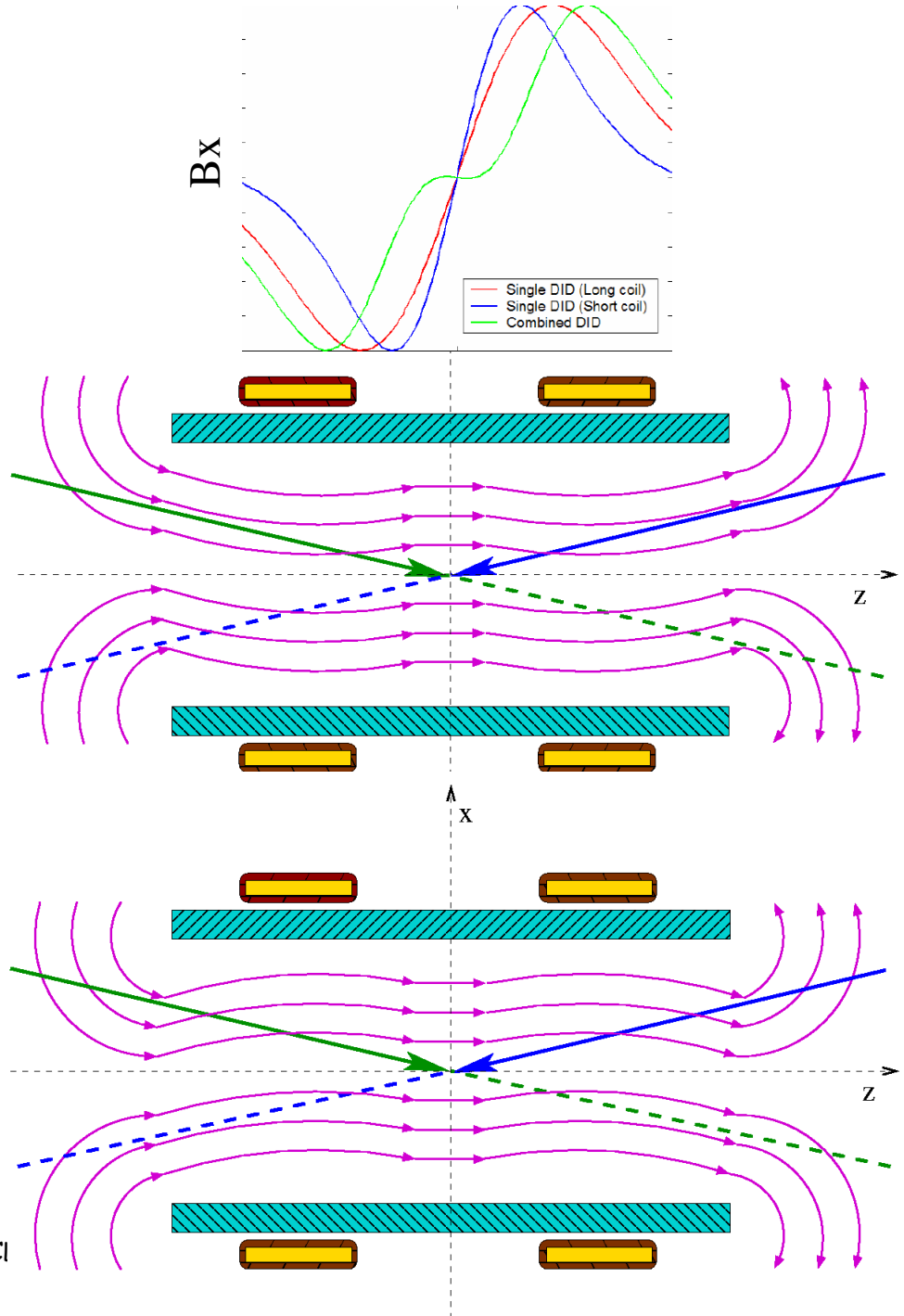


Schematic view of the two beam colliding with a crossing angle in the detector solenoid.

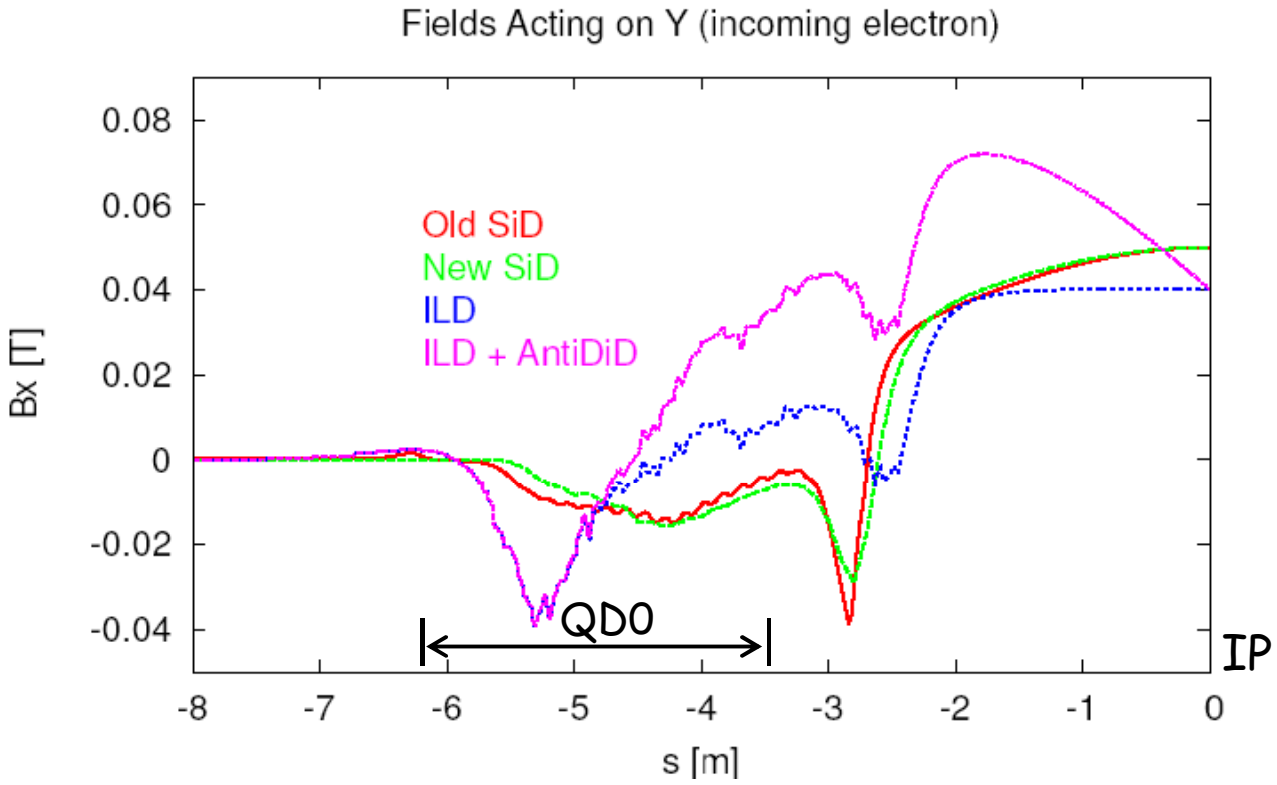
DiD - AntiDiD

- DiD
  - Coil wound on detector solenoid giving transverse field (Bx)
  - It can zero y and y' at IP
  - But the field acting on the outgoing beam is bigger than solenoid detector alone ⇒ pairs diffuse in the detector
- AntiDiD
  - Reversing DiD's polarity and optimizing the strength, more than 50% of the pairs are redirected to the extraction apertures

A. Seryi



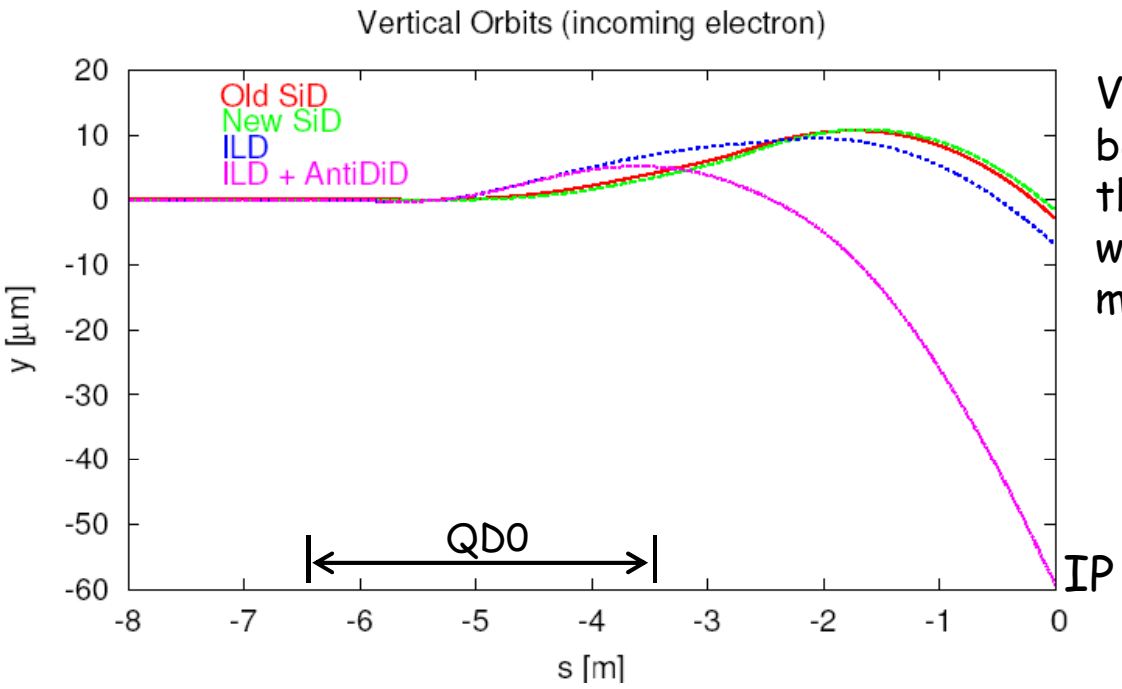
Detector Solenoid magnetic fields



B_x component of solenoid fields in the beamline reference system

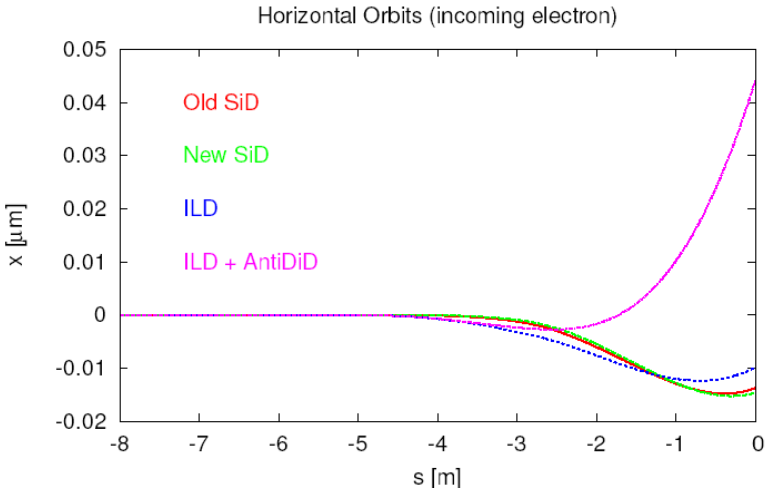
Old SiD: http://www-project.slac.stanford.edu/lc/bdir/Meetings/beamdelivery/2005-10-04/index.htm
New SiD: Kurt Krempetz (FNAL)
ILD (AntiDiD): A. P. Sailer (CERN) Mokka database

Orbits



Vertical orbits deviation in the beamline reference system due to the Solenoid field and its overlap with QD0 (and the other FF magnets) .

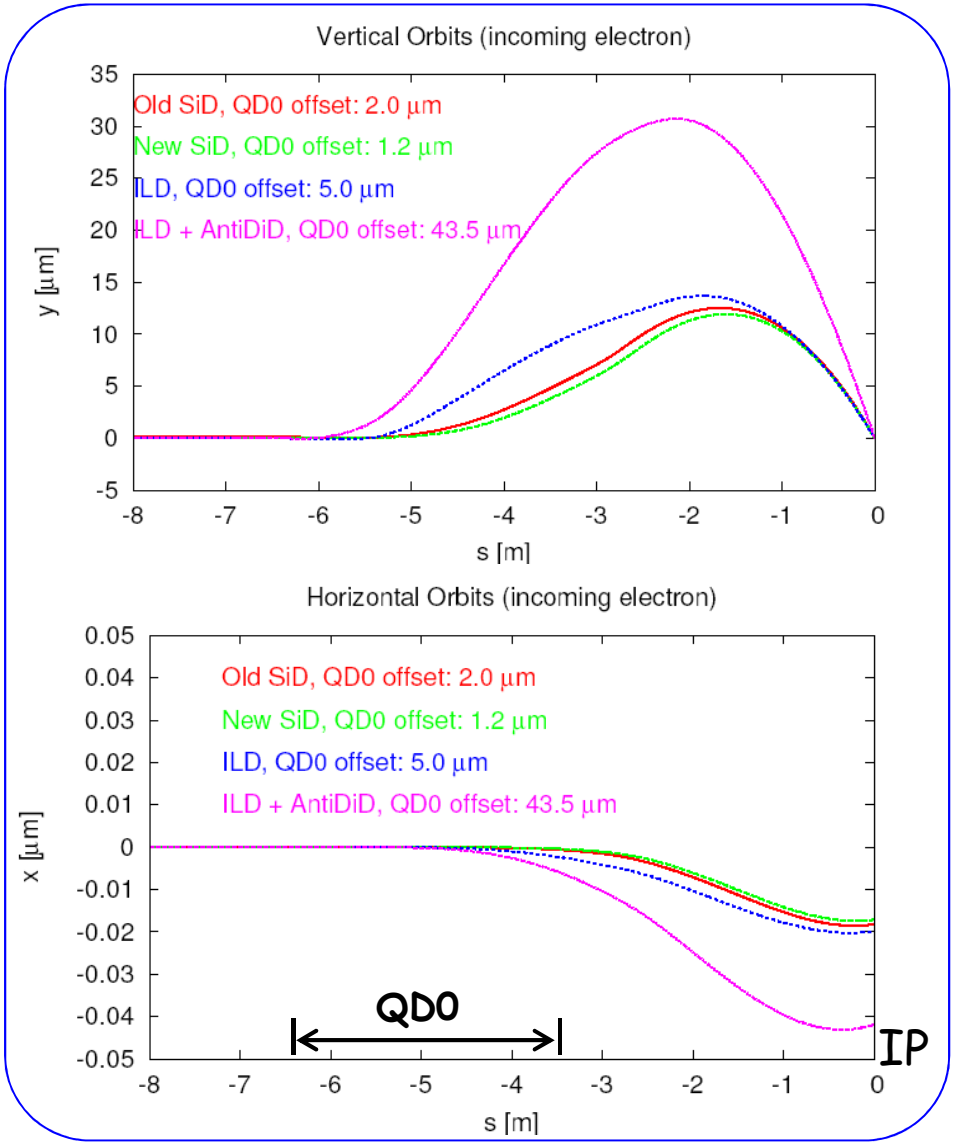
Horizontal orbits deviation in the beamline reference system due to the Solenoid field and its overlap with QD0(and the other FF magnets) .



Vertical offset correction (1/2)

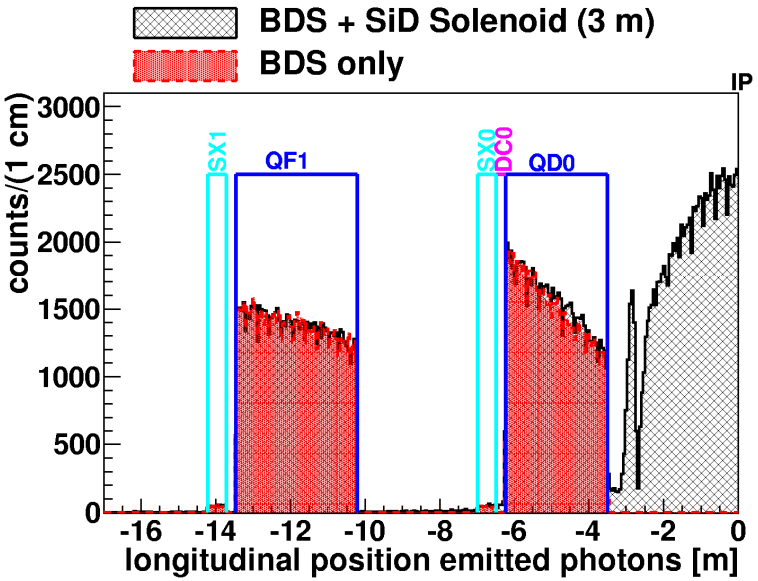
- Compensation of detector solenoid effects:
  - J.J. Murray, SLAC-CN-237
  - Y. Nosochkov and A. Seryi, PRST-AB 8, 021001 (2005)
  - B.Parker and A. Seryi, LCC-0143

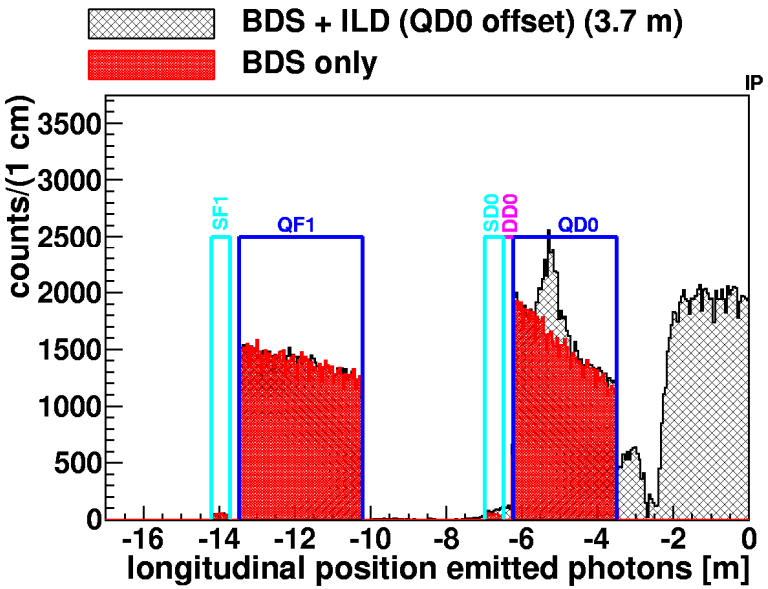
- The vertical offset at IP can be compensated with QD0 offset.

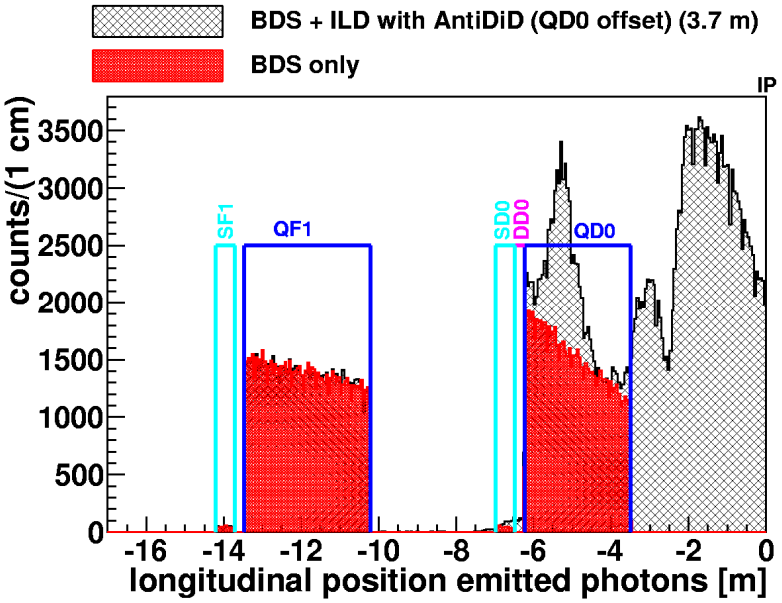


Synchrotron Radiation photons

- Optic distortion compensated
- CLIC nominal beam tracked trough BDS and BDS + Solenoid considering Synchrotron Radiation
- Longitudinal position of emitted photons shown
  - ILD (ILD + AntiDiD)
  - SiD







Luminosity Loss

Map	Bz [T]	L[m]	Lumi loss [%]
Old SiD	5	2.8	~4.0
New SiD	5	2.8	~3.0
ILD	4	3.7	~4.0
ILD + AntiDiD	4	3.7	~25.0

- luminosity calculation by GUINEA-PIG
- CLIC half horizontal crossing angle 10 mrad
- ILD values are computed with QD0 offset: 5μm (ILD), 43.5μm (ILD+AntiDiD)

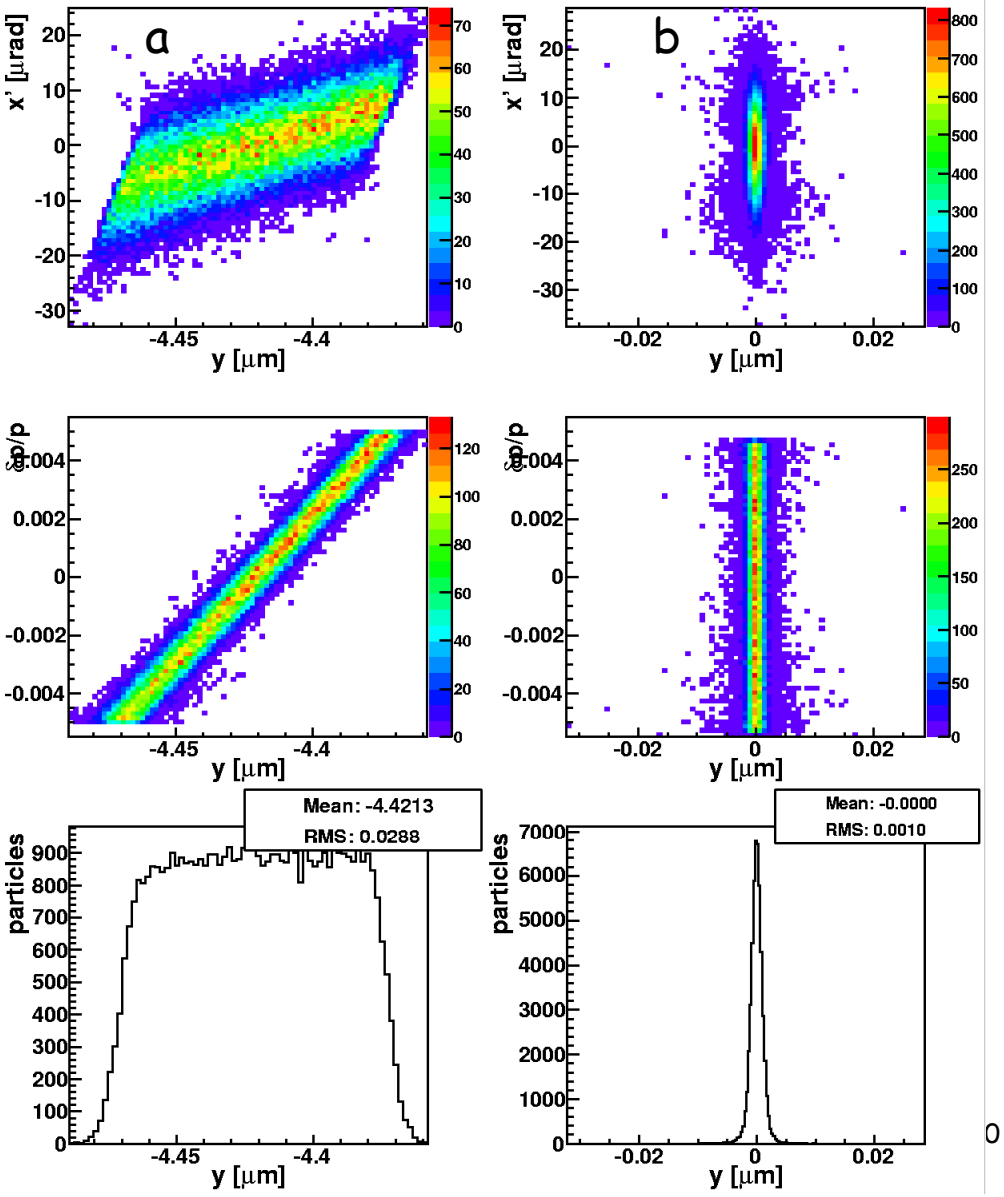
Solenoid and QD0 overlap

Beam sizes increase at IP

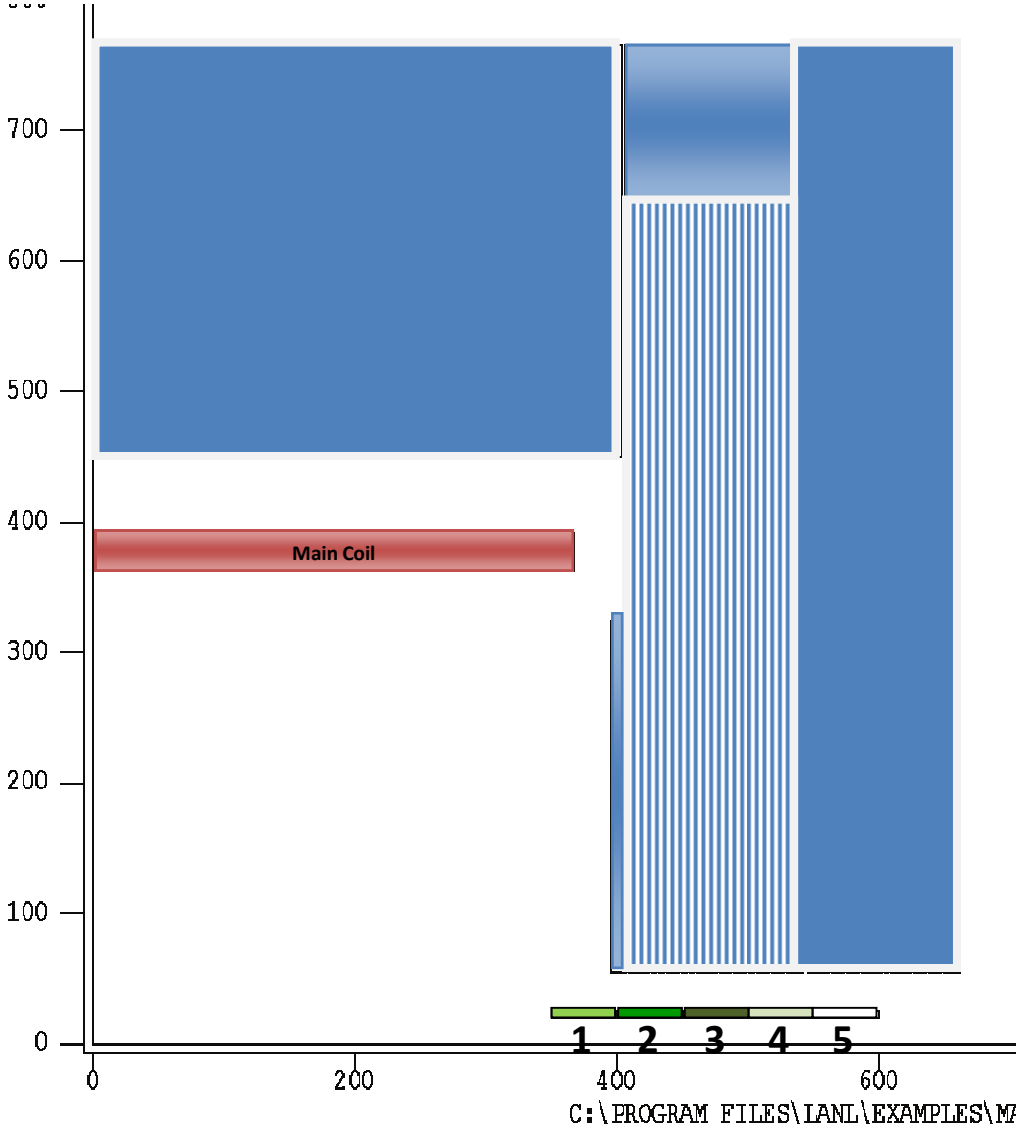
< x',y > coupling and
vertical dispersion at IP

a) Tracking trough FFs and IP Solenoid
b) Tracking trough FFs only

Nominal CLIC beam 3 TeV CM



FE model



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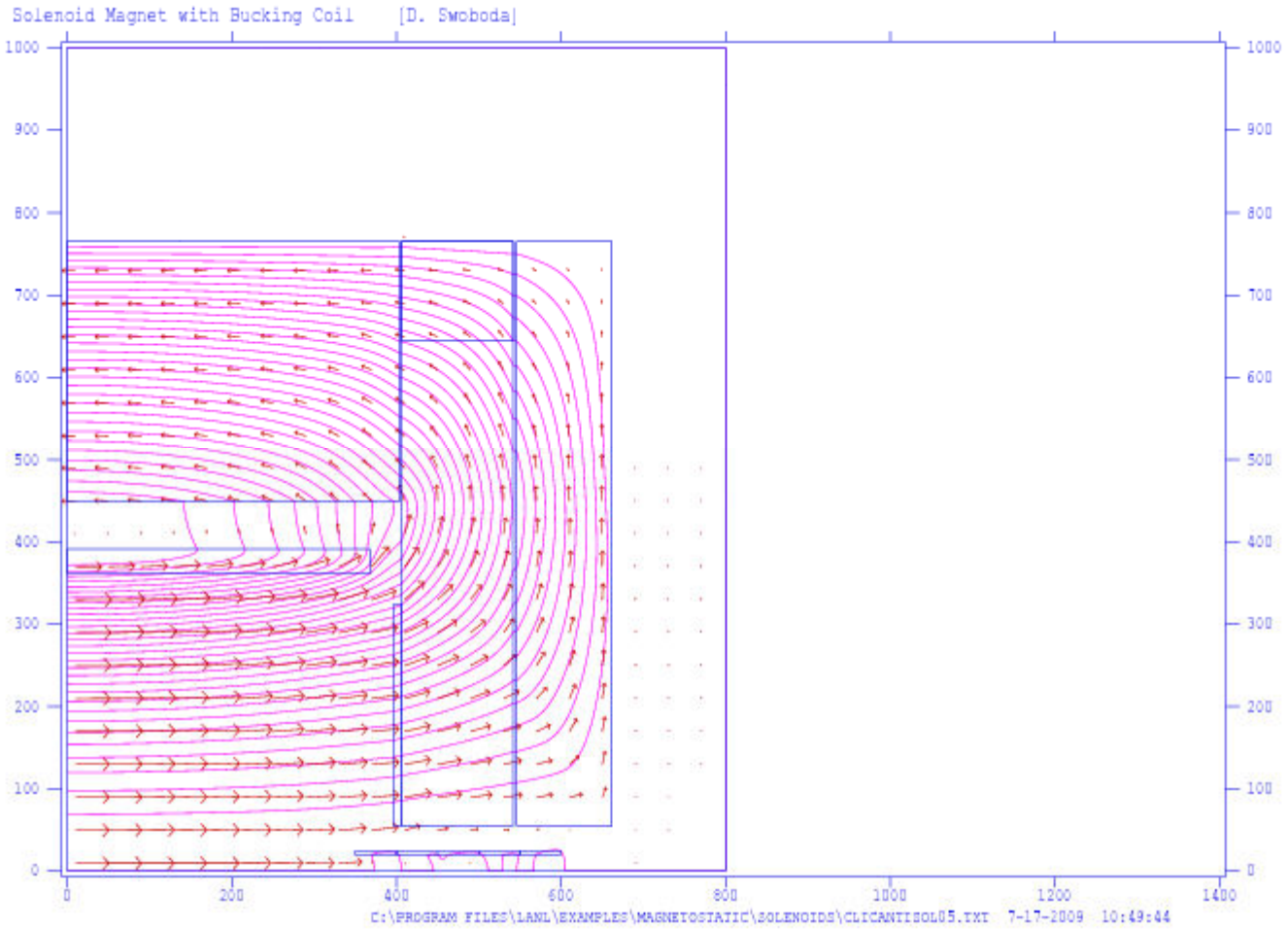
Field Plot with bucking coils



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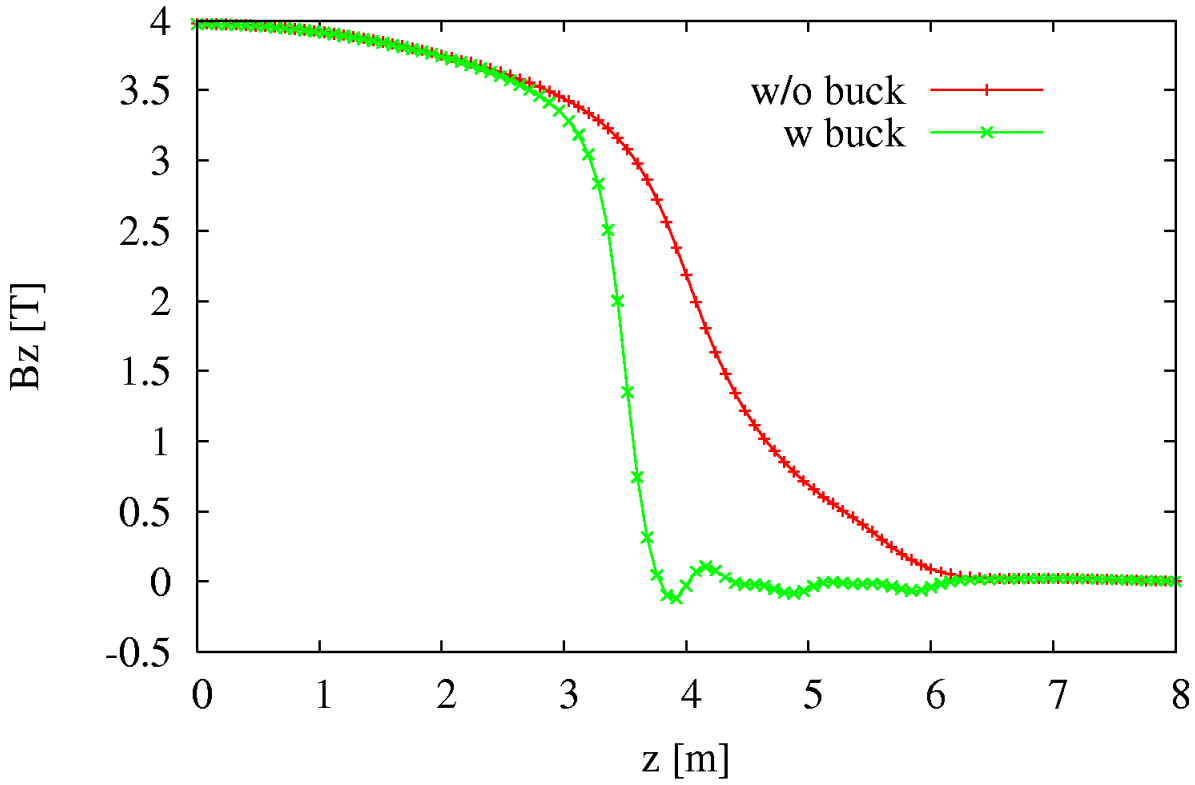
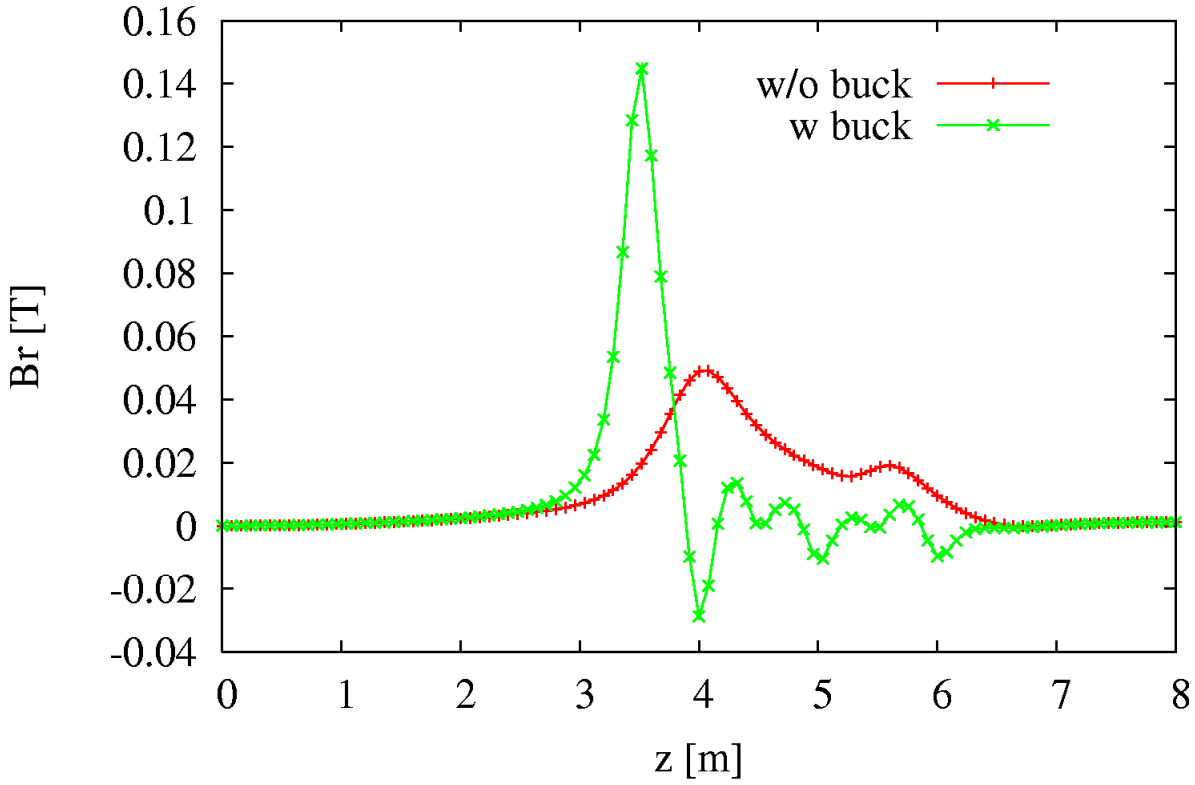
Longitudinal Field component



Radial Field Component

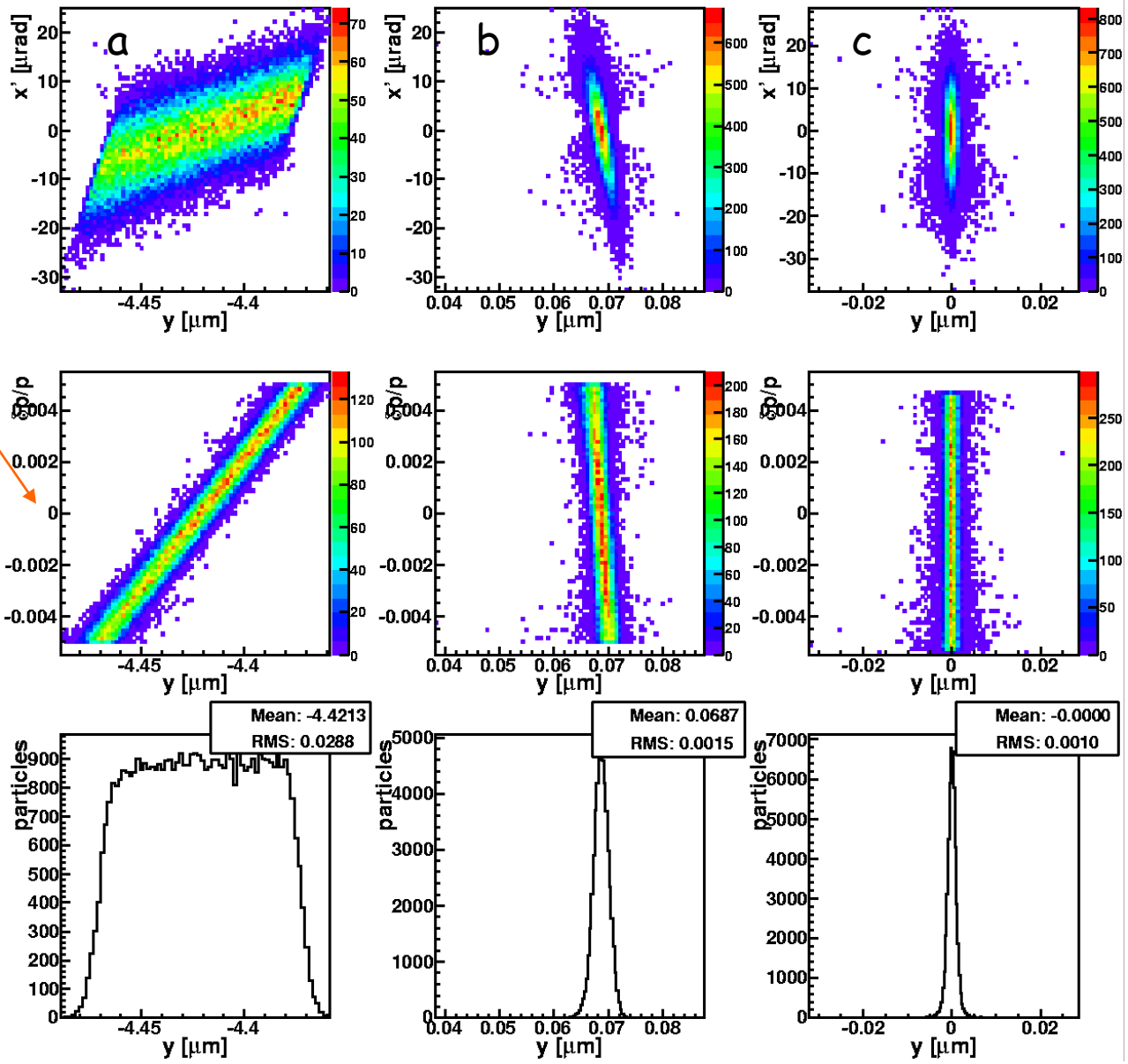


Vertical dispersion and <x',y> coupling

< x',y > coupling and vertical dispersion at IP

a) Tracking trough FFs and IP Solenoid
b) Tracking trough FFs and IP Solenoid + bucking coils covering QD0
c) Tracking trough FFs only

Residual <x',y> coupling and dispersion can be compensated using the other FFs magnets



Conclusion and Outlook

- Compensation of detector solenoid effects on the beam size
  - AntiDiD increases the luminosity loss due to Synchrotron Radiation up to 25%
  - Anti-Solenoid (bucking coils covering QD0) reduces (> 90%) the optical distortions at IP
    - Interference with QD0 to be studied
    - Radiation to be evaluated
    - Main Solenoid field distortion in the tracker to be considered