# Post-collision line status

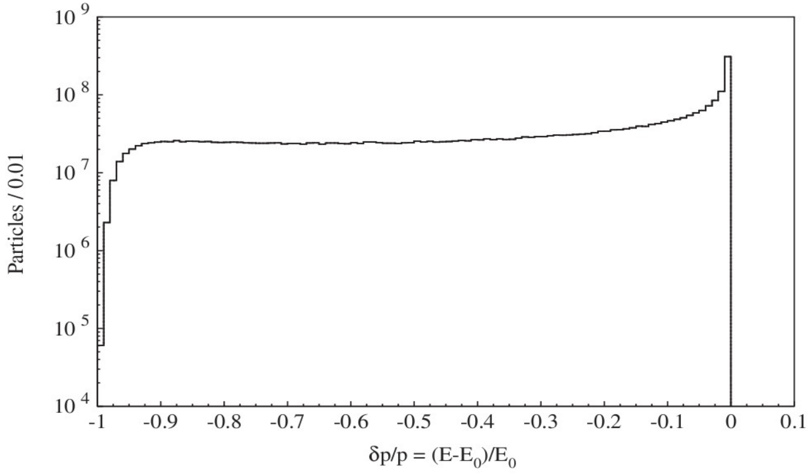
- CLIC CDR post-collision line design
- New design
- Conclusions
- Future plans

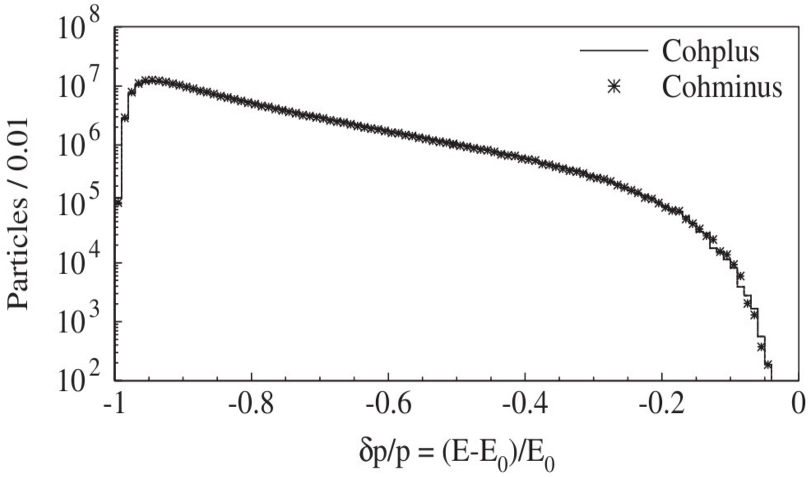
# CDR design - requirements

- Beam line from IP to main dump
- Transport highly disrupted 14MW beam safely to dump
- Minimising the back scattering background to the detector
- Luminosity monitoring
    - Separation of disrupted particles from beamstrahlung photons

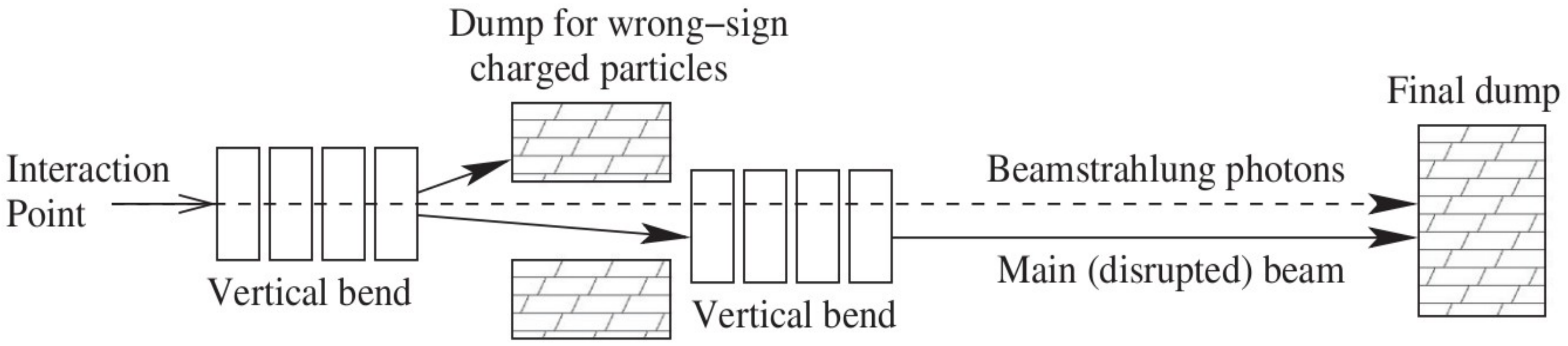
# Post-collision beam

- Disrupted beam
- Coherent pairs
- From **A. Ferrari *et. al*, PRSTAB 12, 021001 (2009)**
- Large spread of energies, opposite sign charge particles – intermediate dump needed





# Post-collision line conceptual design (CDR)

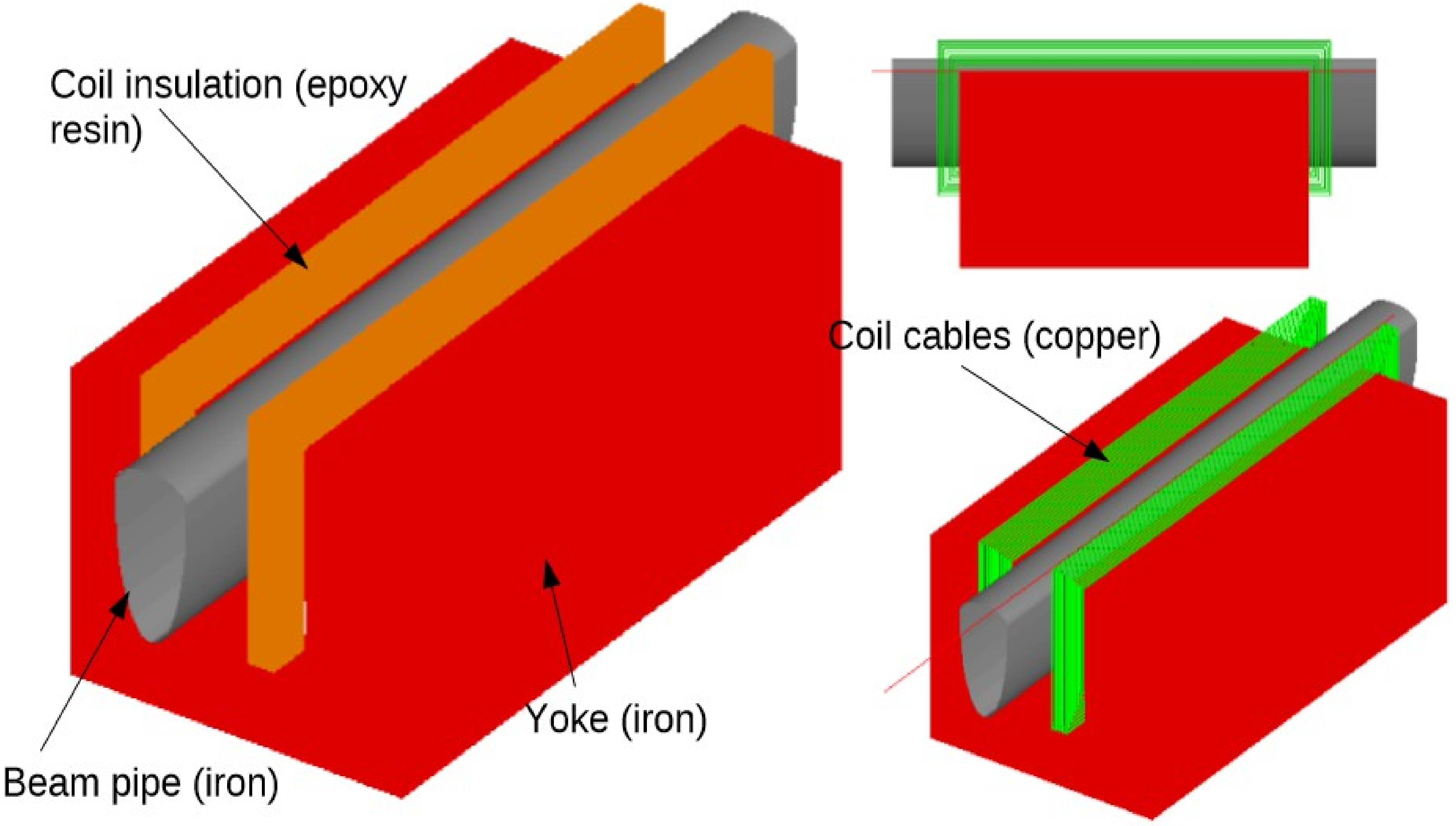


- **[A. Ferrari *et. al*, PRSTAB 12, 021001 (2009)]**

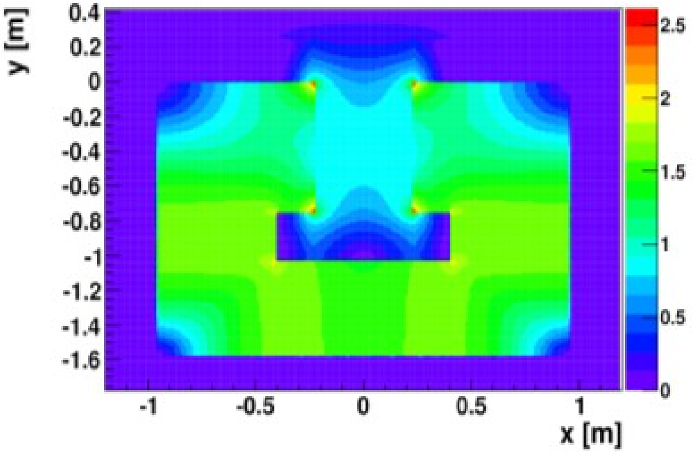
# CDR design

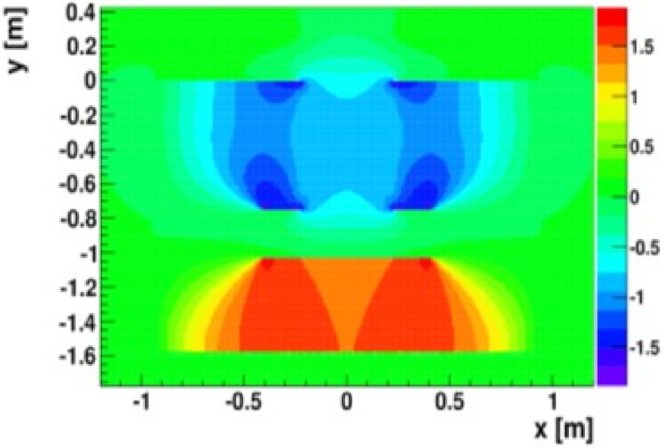
- Post-intermediate dump magnets suffer from scattered radiation from intermediate dump
- The radiation damage and resulting lifetime of these magnets were calculated using BDSIM (Geant4)
  - Conclusion - magnet protection from radiation damage was marginal

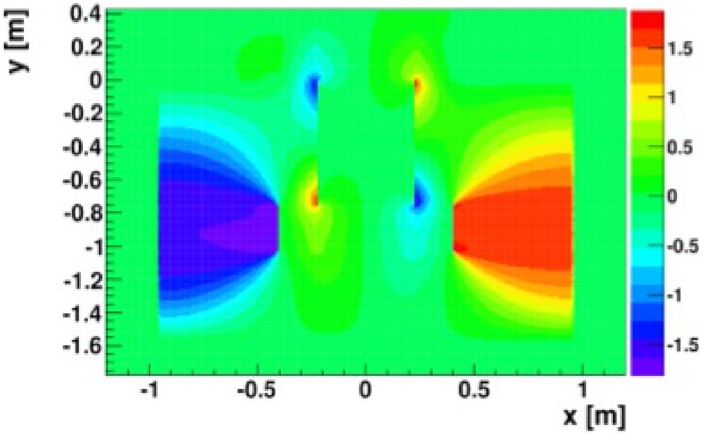
# C-shaped magnet

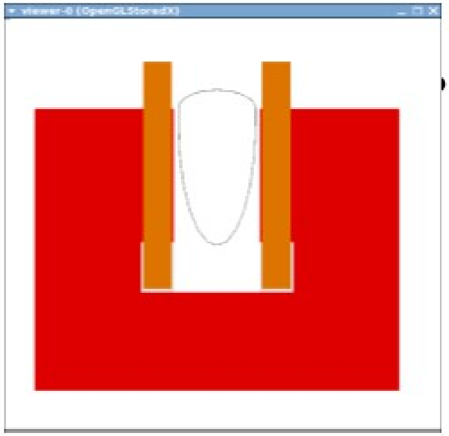


# C-shaped magnet fields





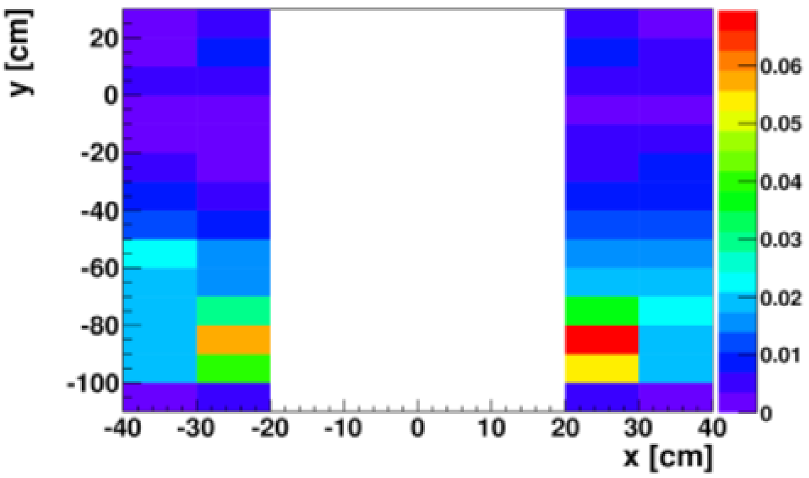




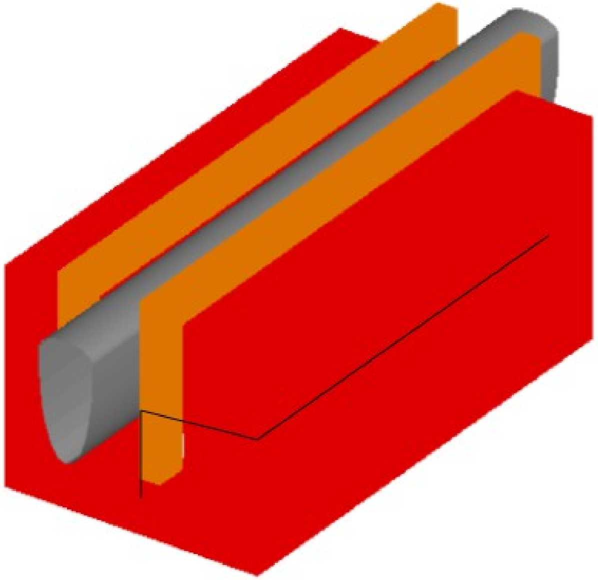
- 2D magnetic fields in Tesla (Alexey Vorozhtsov)
- B, Bx, By

# Magnet lifetime

- *Updates to the Post Collision Line, L. Deacon, IPAC 2012*:
  - Right: energy dep. In magnet 5 (first magnet after intermediate dump) coil insulation material (W/cm$^3$)
  - Standard magnet lifetime 8 +/- 1 years with 10cm X 10cm X 10cm cells with 0.5m iron shield in front of magnet



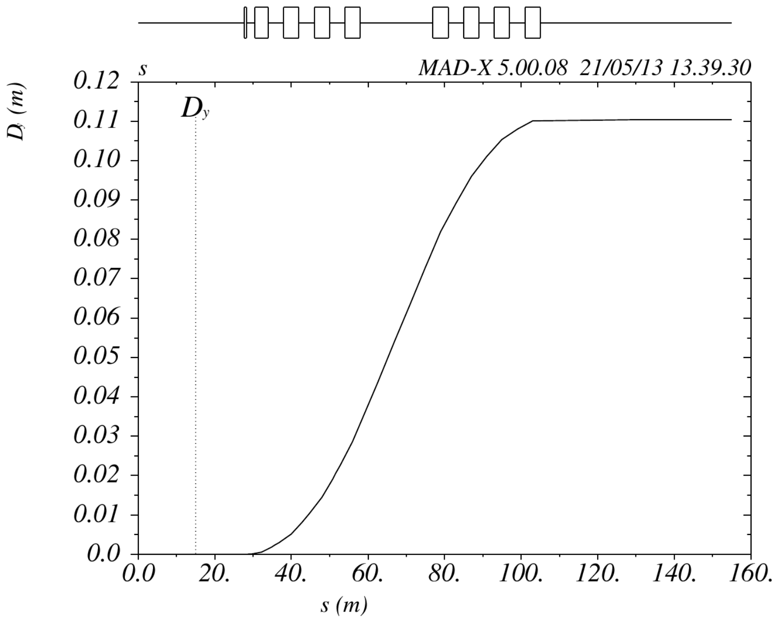
# Solutions previously considered



- Move the coils – field quality?
- Radiation hardened coils (up to $10^{10}$ Gy from $10^{7}$ Gy – see **CERN 82-05**)
- Improve shielding – intermediate dump?
- Move magnets downstream

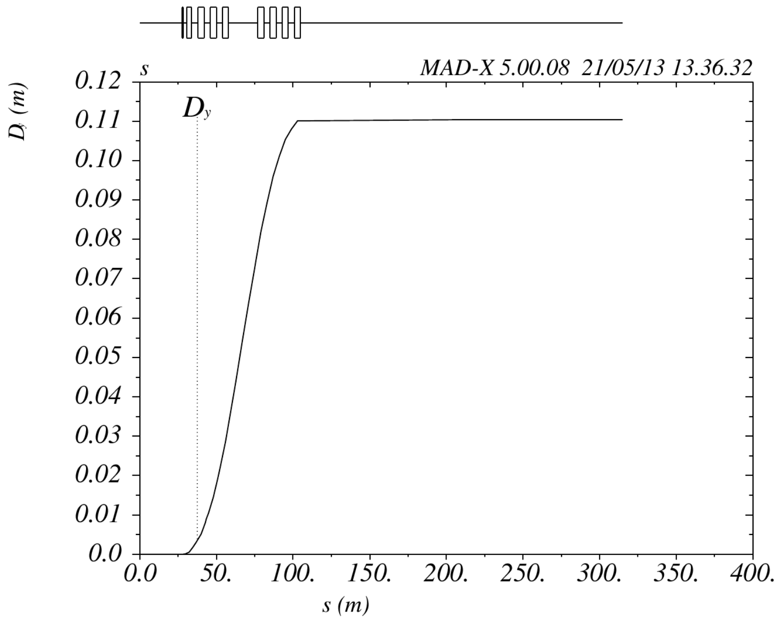
# PCL first design

- Chicane + 50m drift + main dump
- Intermediate dump at 67m - 73m



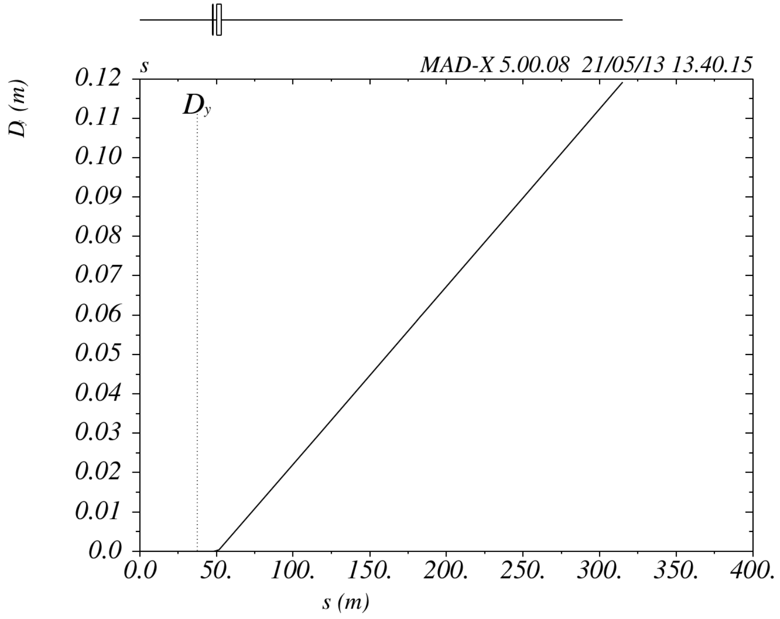
# PCL optics – iteration 2

- Second iteration – final drift extended by 210 metres
  - Could we make even better use of the extra space available?

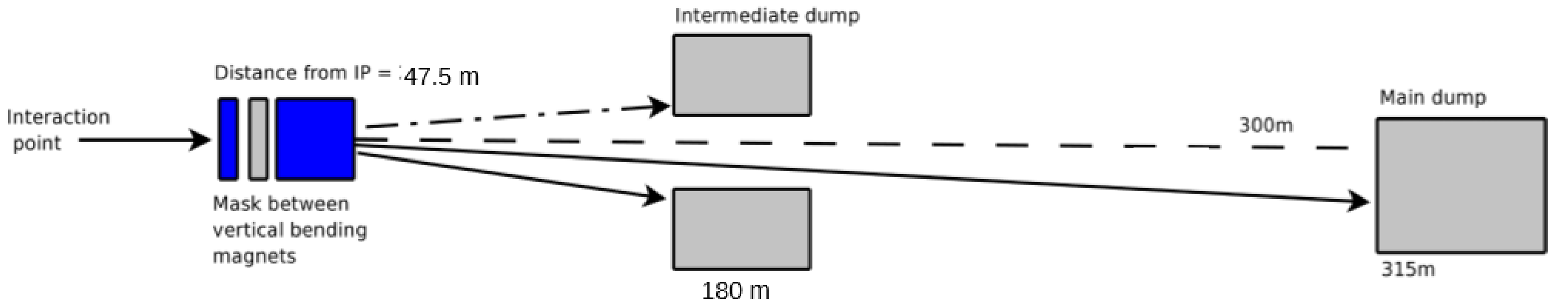


# PCL optics – iteration 3 (current)

- One magnet with B=0.7 tesla instead of 8 magnets with B=0.8 tesla
- Magnet moved 20m downstream – more separation from incoming beam line.
- Intermediate dump moved to 180 m – no significant effect on beamstrahlung signal
- No need to bend back the beam - angle relatively small (few mrad), and there is no polarimeter.



# New layout



Intermediate dump

Distance from IP = 47.5 m

Interaction point

Main dump

300m

Mask between vertical bending magnets

180 m

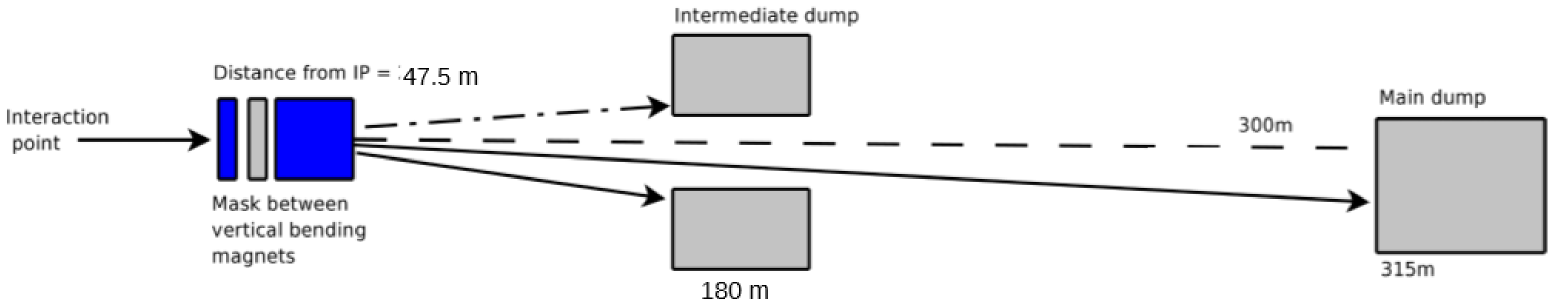
315m

- Fewer, weaker magnets - 4m * 0.7 T instead of

  32m * 0.8 T

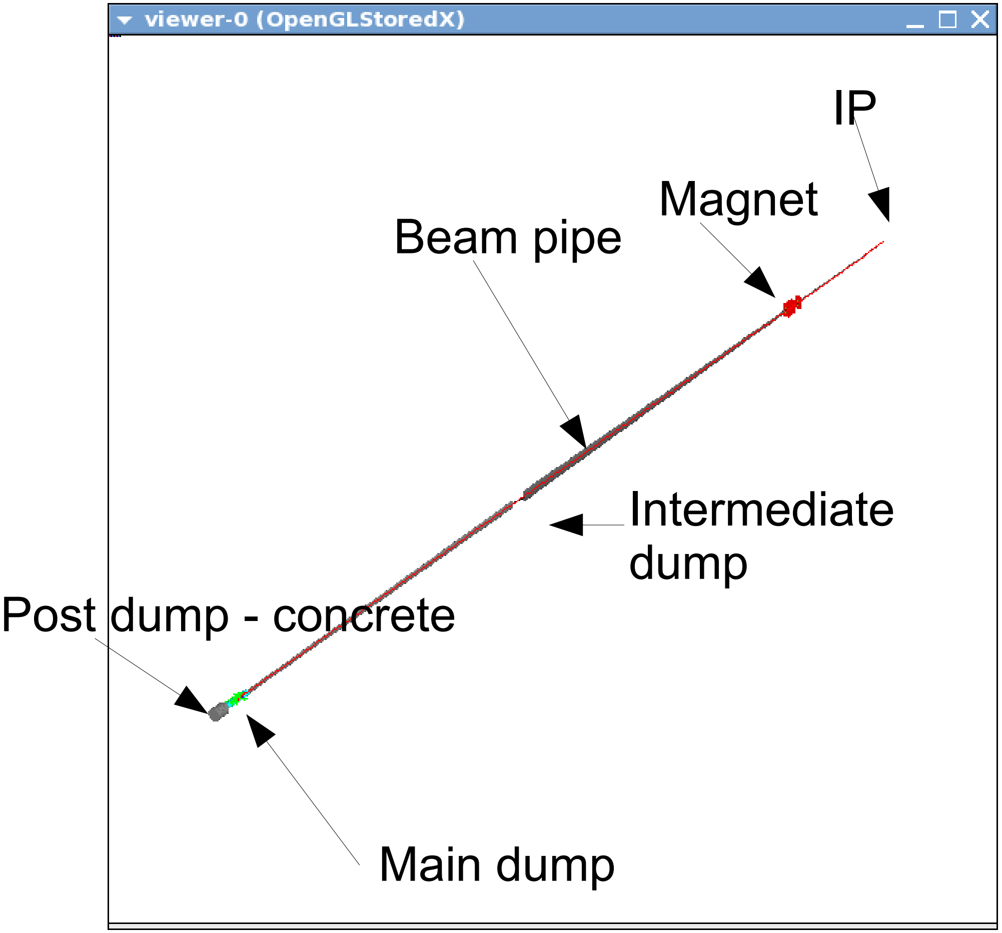
  - Cost and power consumption will be reduced significantly
- Intermediate dump moved downstream from 67m to 180m
- Beam pipe dimensions adjusted
- No magnets downstream of intermediate dump -> no radiation damage problems

# New layout



- We need to consider the back scatter to the detector – photons, electrons, neutrons scattered back to detector from intermediate dump
- Assuming time window of 150ns (bunch train) + ~100ns (detector integration time) particles scattered back from <40m could cause background to the detector
- So better to have magnet at 47.5m than 27.5m (old CDR design)

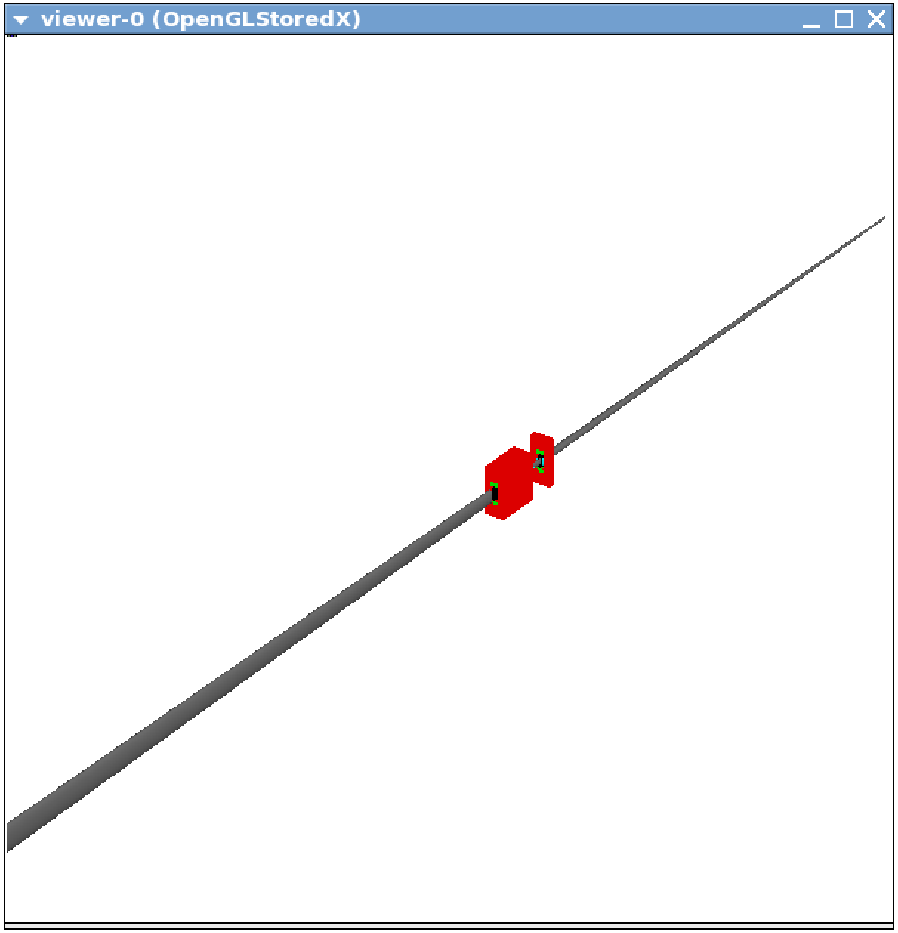
# Simulation



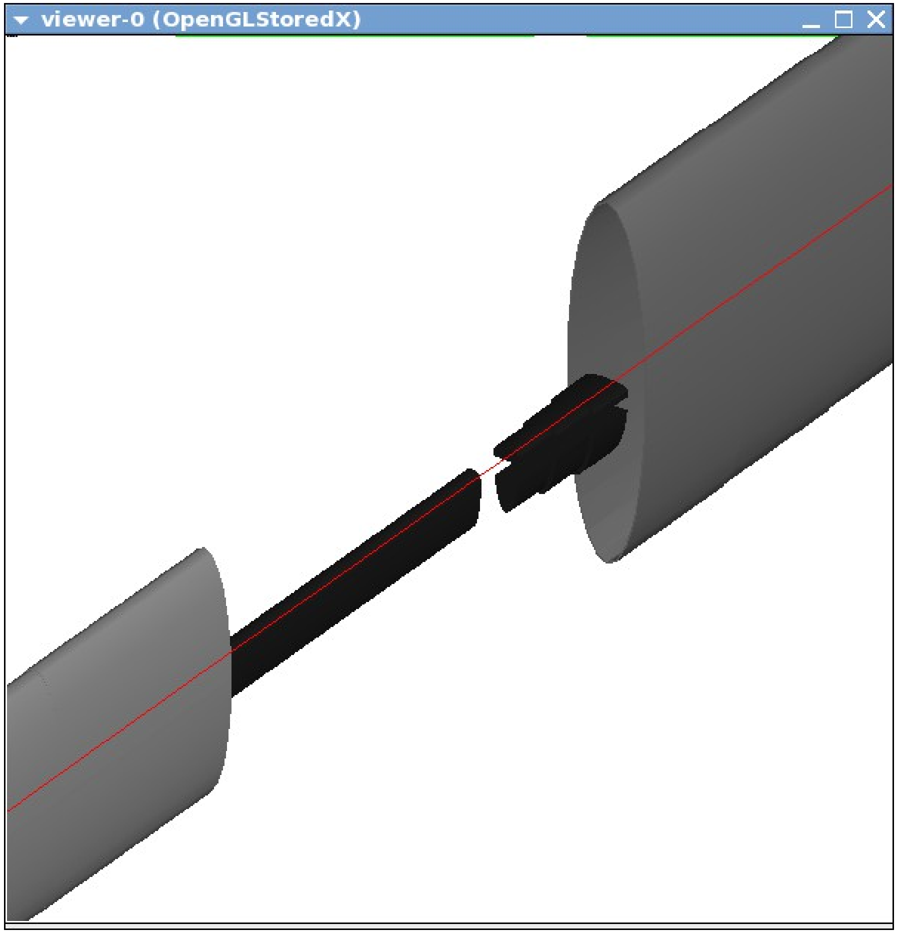
- Screenshot showing the entire post-collision line with an electron track in red
- Tunnel included but not shown

# Simulation

- Magnet 1a and 1b



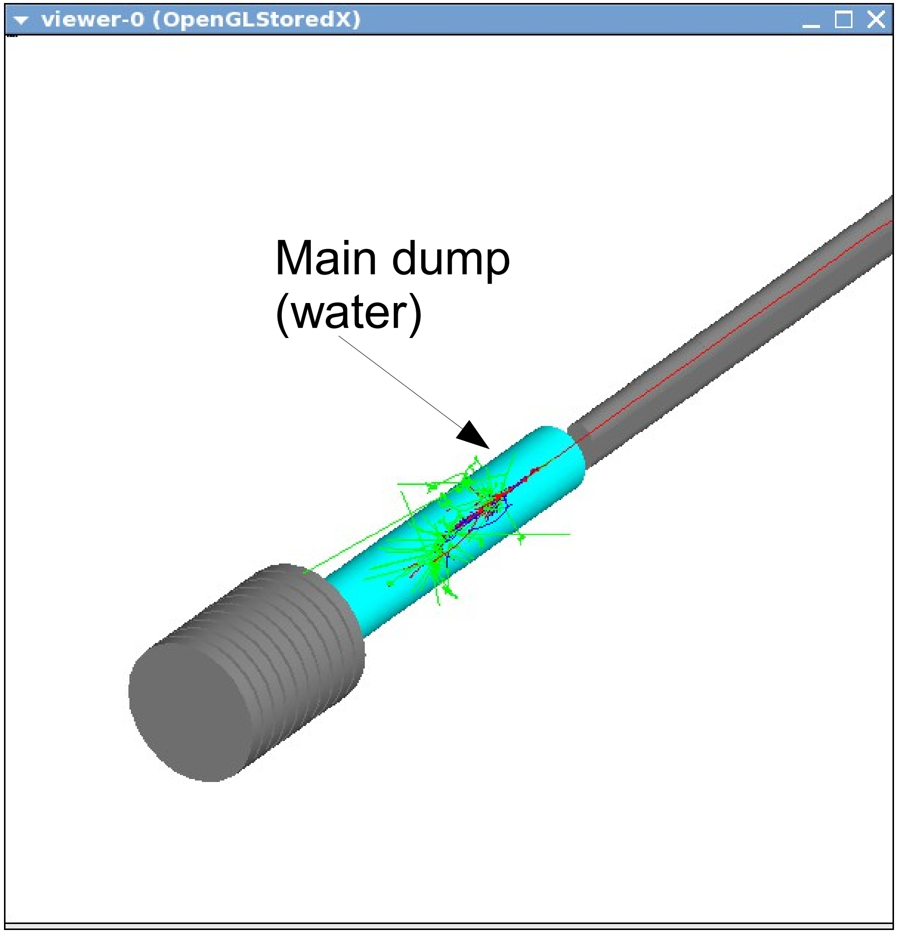
# Simulation



- Intermediate dump (aperture shown)

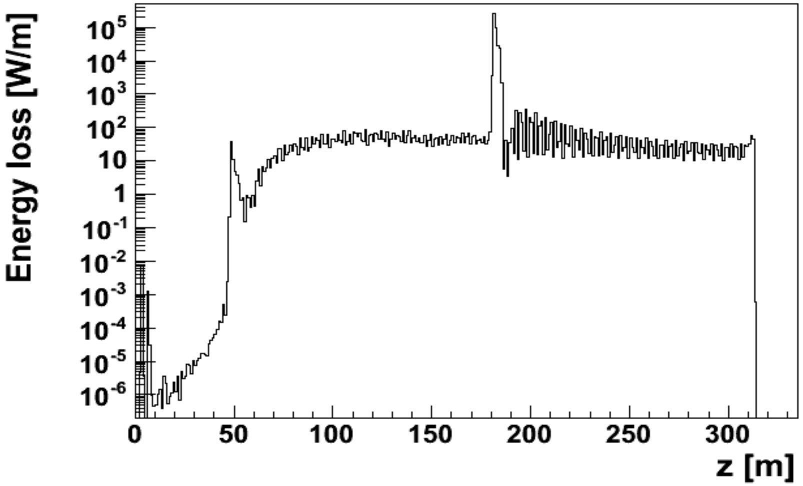
# Simulation

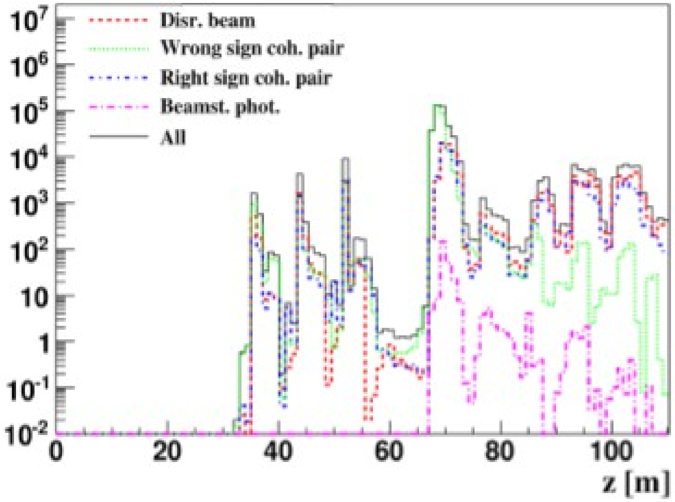
- Main dump (water shown) with e-m shower
- Concrete around main dump



# Beam losses with new layout

- Beam losses in new layout (top) are small, less than ~100 W/m
- CDR baseline design (bottom): ~kW/m losses





# Back scatter to detector - CDR

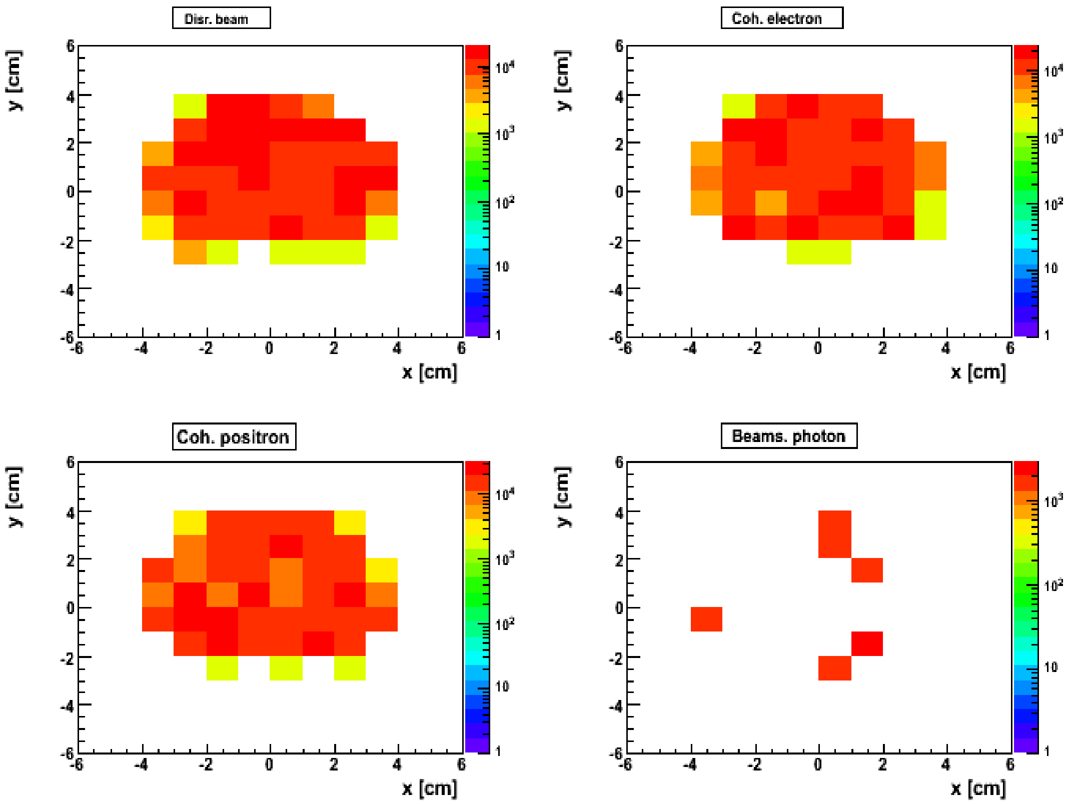
- In the CDR version of the post collision line, there were $7.2^{+4.6}_{-1.8}\times10^{5}$ photons per $m^2$ per bunch crossing per beam back scattered in a 2m * 2m plane in the detector counted by the simulation.
- The back scattered neutron flux density was $3.9^{+1.6}_{-1.1}\times10^{4}$ neutrons per $m^2$ per bunch crossing per beam (averaged across the whole detector area).

# Back scatter to detector – new post collision line

- A simulation was run to determine the back scattered particle flux for the new design
- ~3 million disrupted beam particles were fired ($8*10^{-4}$ of one bunch).
- The appropriate numbers of coherent pairs and beamstrahlung photons also fired.

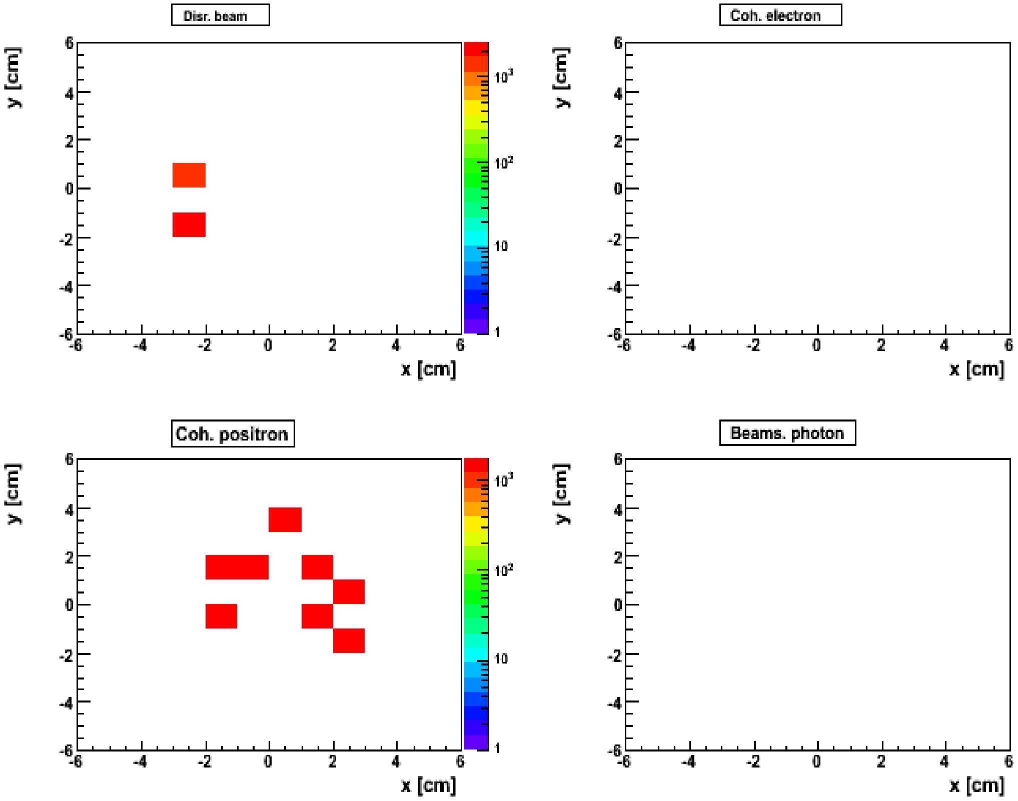
# Back scatter to detector – new post collision line – preliminary results

- Right: back scattered photons per $m^2$ at the detector
- By beam type
- $\sim 10^4$ per $m^2$ (fewer than in CDR version)



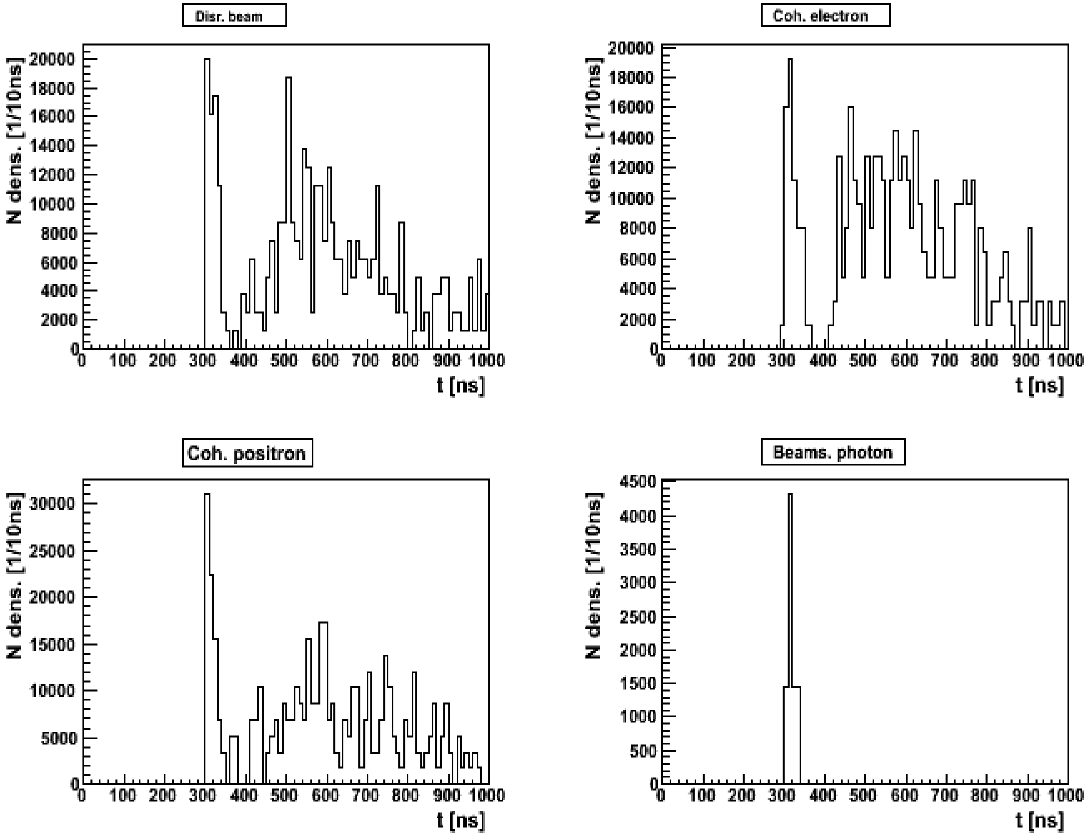
# Back scatter to detector – new post collision line – preliminary results

- Right: back scattered neutrons per $m^2$ at the detector
- By beam type
- $<10^3$ per $m^2$ (fewer than in CDR version)



# Back scatter to detector – new post collision line – preliminary results

- Right: photon time of arrival (first ms)
- All photons arrived after 300 ns
- All neutrons arrived later than 1ms



# Future plans

- Back-scatter (statistics, particle energies, include main dump)
- Compare apertures and beam pipe volume between CDR and new version
- Effect of vacuum level on the losses
- Radiation to incoming (BDS) beam line.
- Study the effect of acoustic vibrations from the main dump affect on the final focus.
- Evaluate magnetic interference with incoming beam line (with M. Modena *et. al.*)

# Effect on beamstrahlung signal

- Top: beamstrahlung profile before intermediate dump
- Bottom: after intermediate dump
- FWHM = 0.7 cm
- Attenuation ~ 0.03 % - negligible
- Max attenuation ~ 0.07% (max. kick due to vertical offset in colliding beams)