FullSim Geometry developments

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LNF SuperB Collaboration Meeting

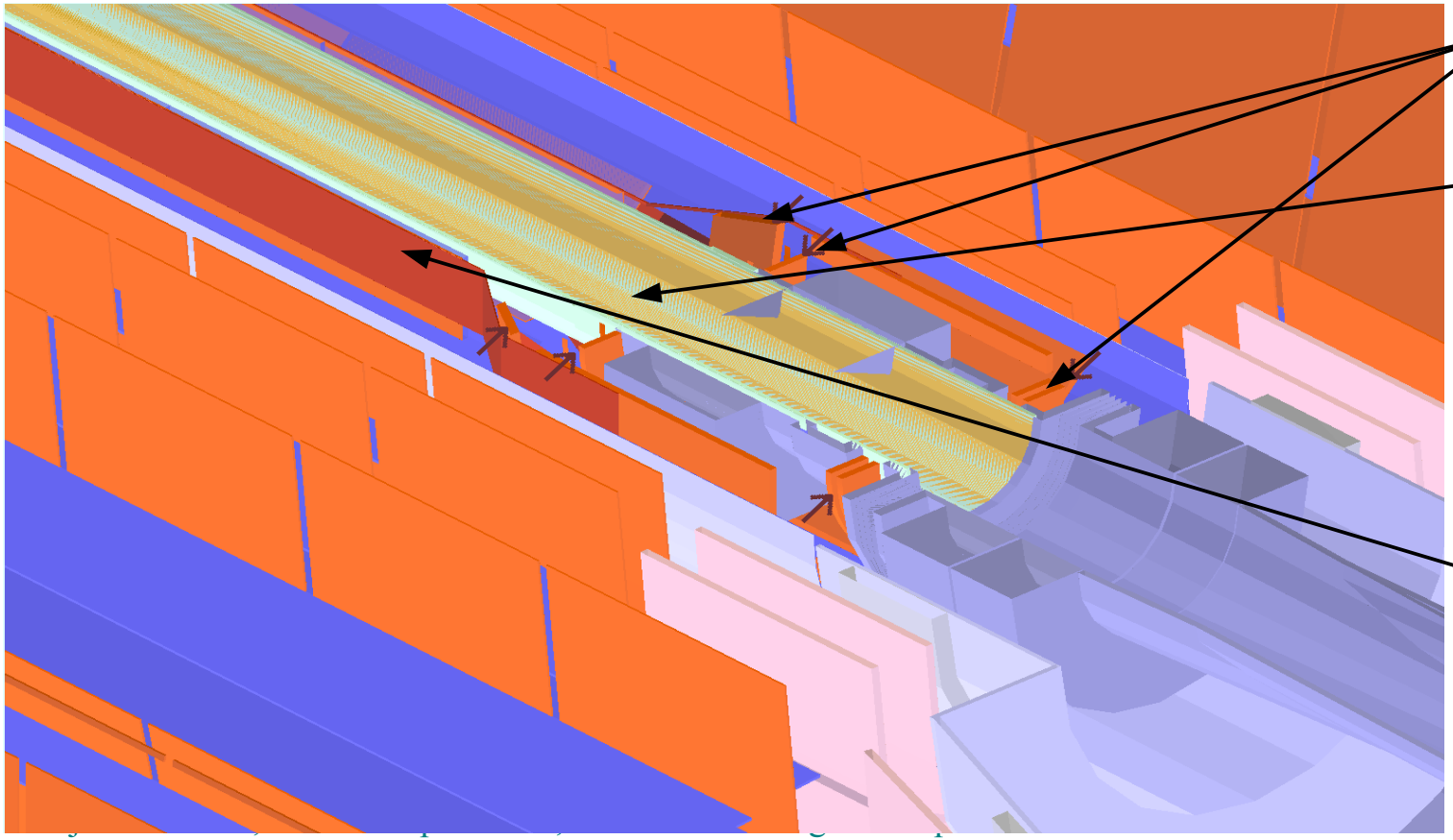
Outline

- **New elements included in the geometry**
  - Radiation monitor (Rad-mon)
  - Permanent magnets (PM) close to the IP
  - FDIRC shield and FEE
- **Geometry fixes and some issues**
- **Final focus magnetic model fixes**
- **Summary**

Rad-mon

A. Di Simone
S. Tammaro

- **Started some preliminary studies to design a radiation monitor**
- **1st request was some scoring volumes to asses the expected dose**
  - Done and committed
- **The scoring volumes used for detection with the same set-up used for other FEE boards**



PMs close to the IP

- **Design based on Mike Sullivan's FF drawings**
- **Material**

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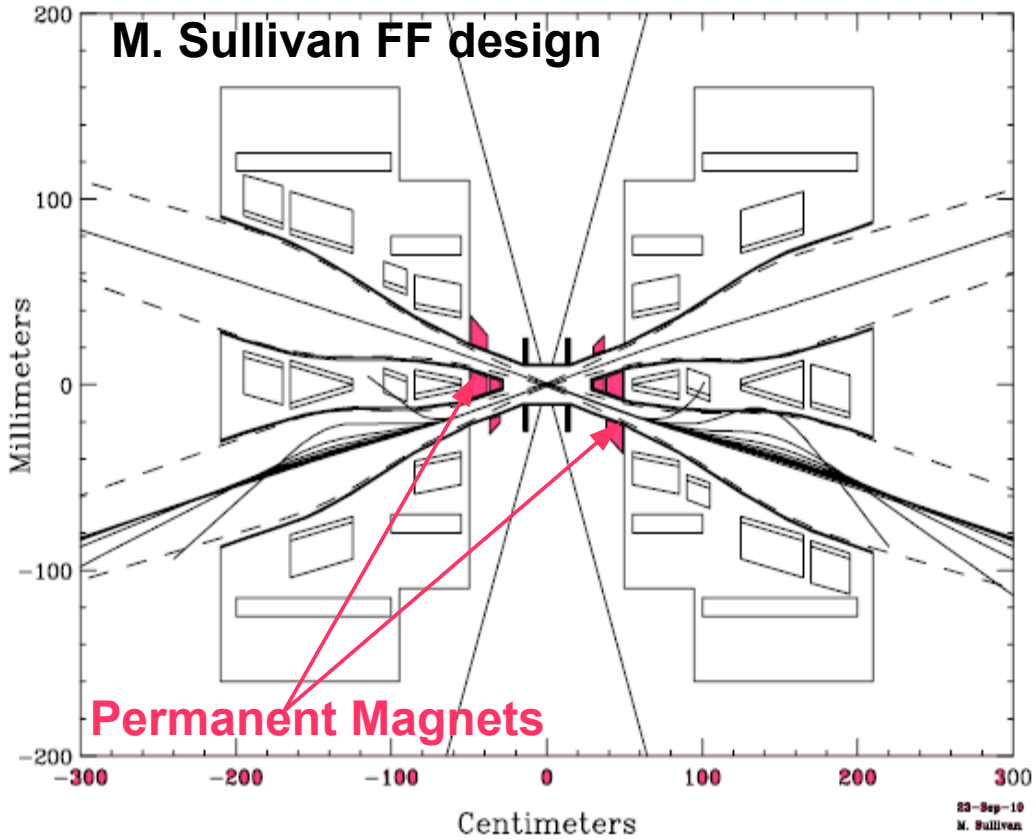
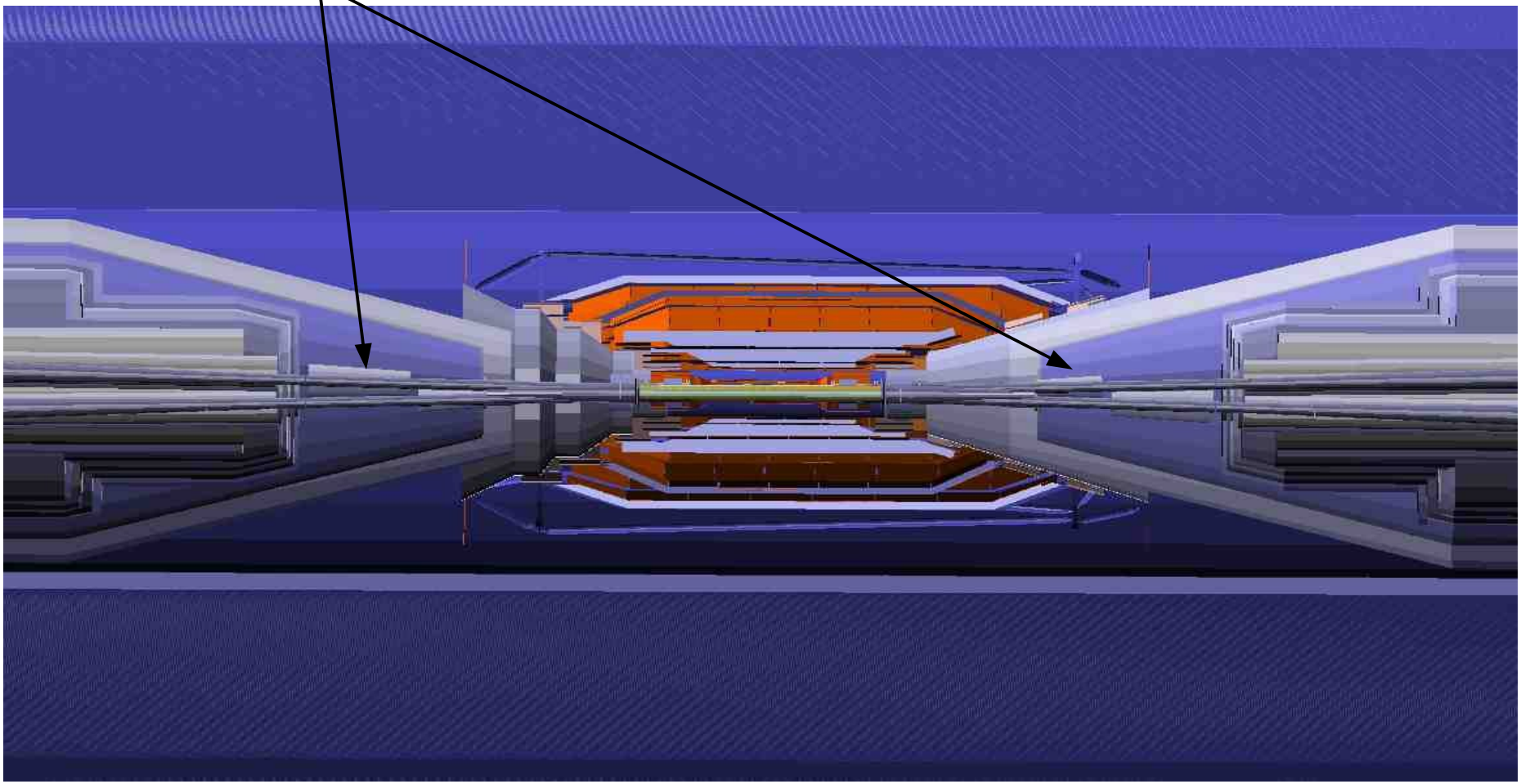


PMs close to the IP: BRN implementation



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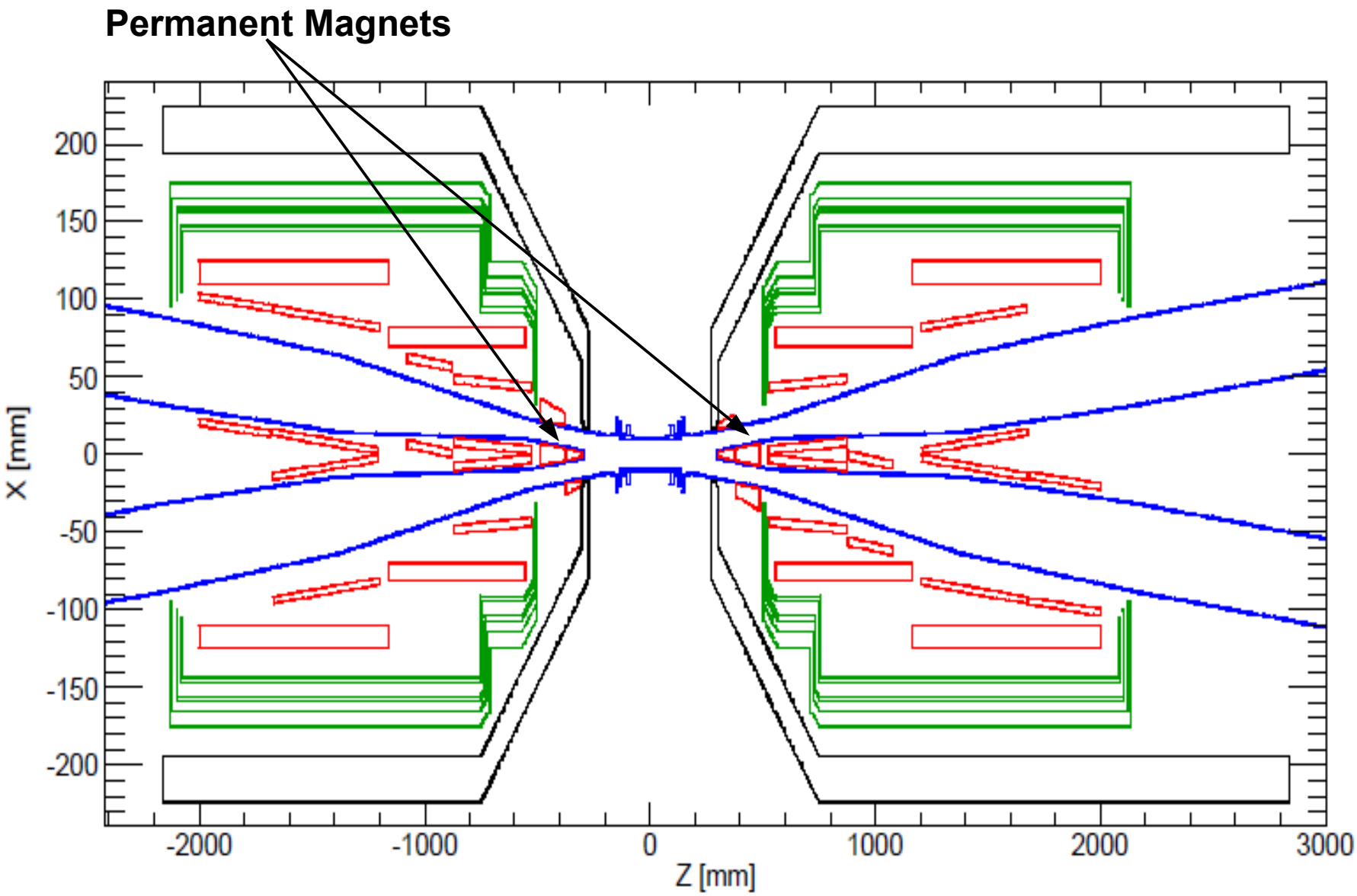
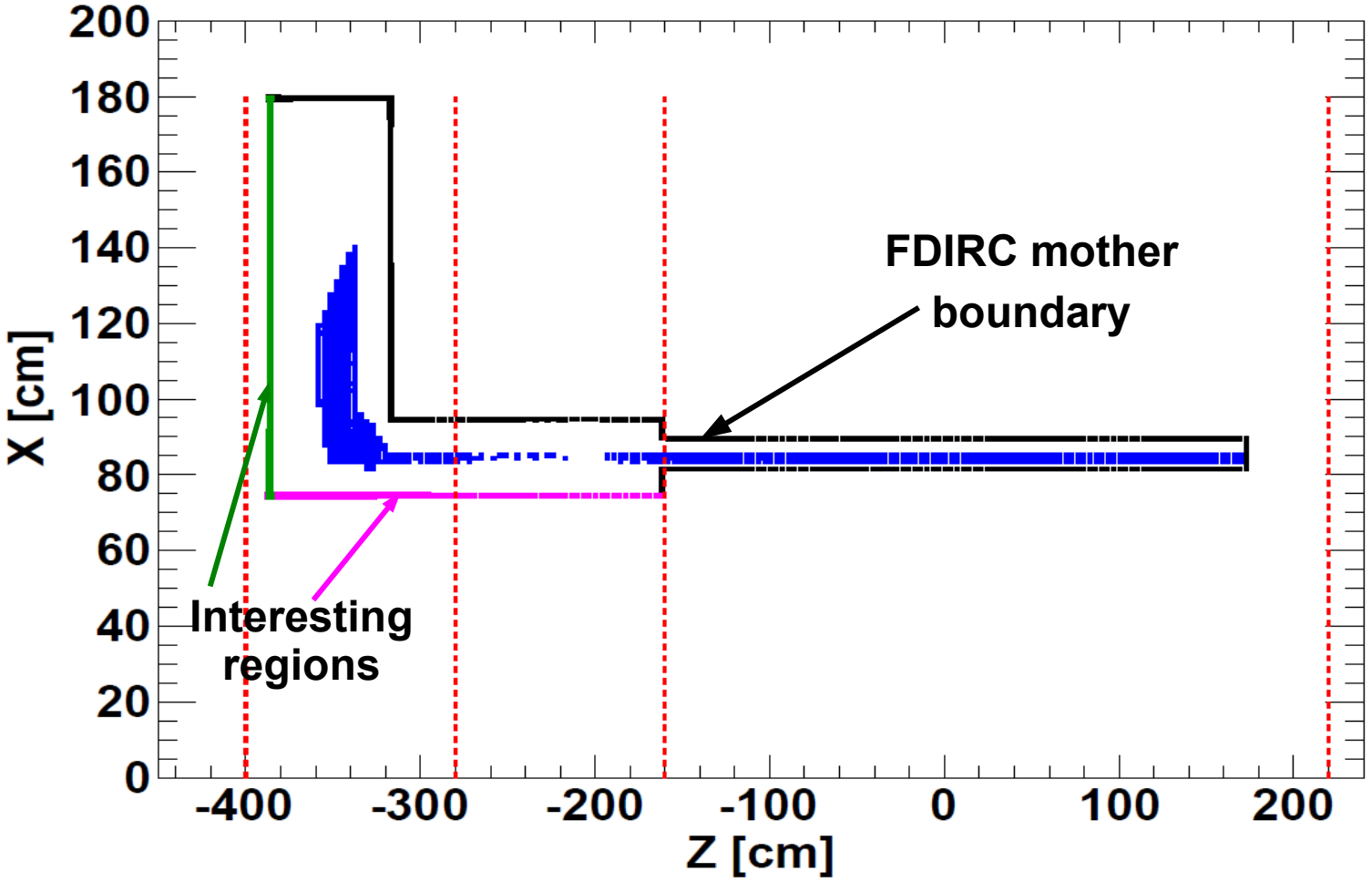
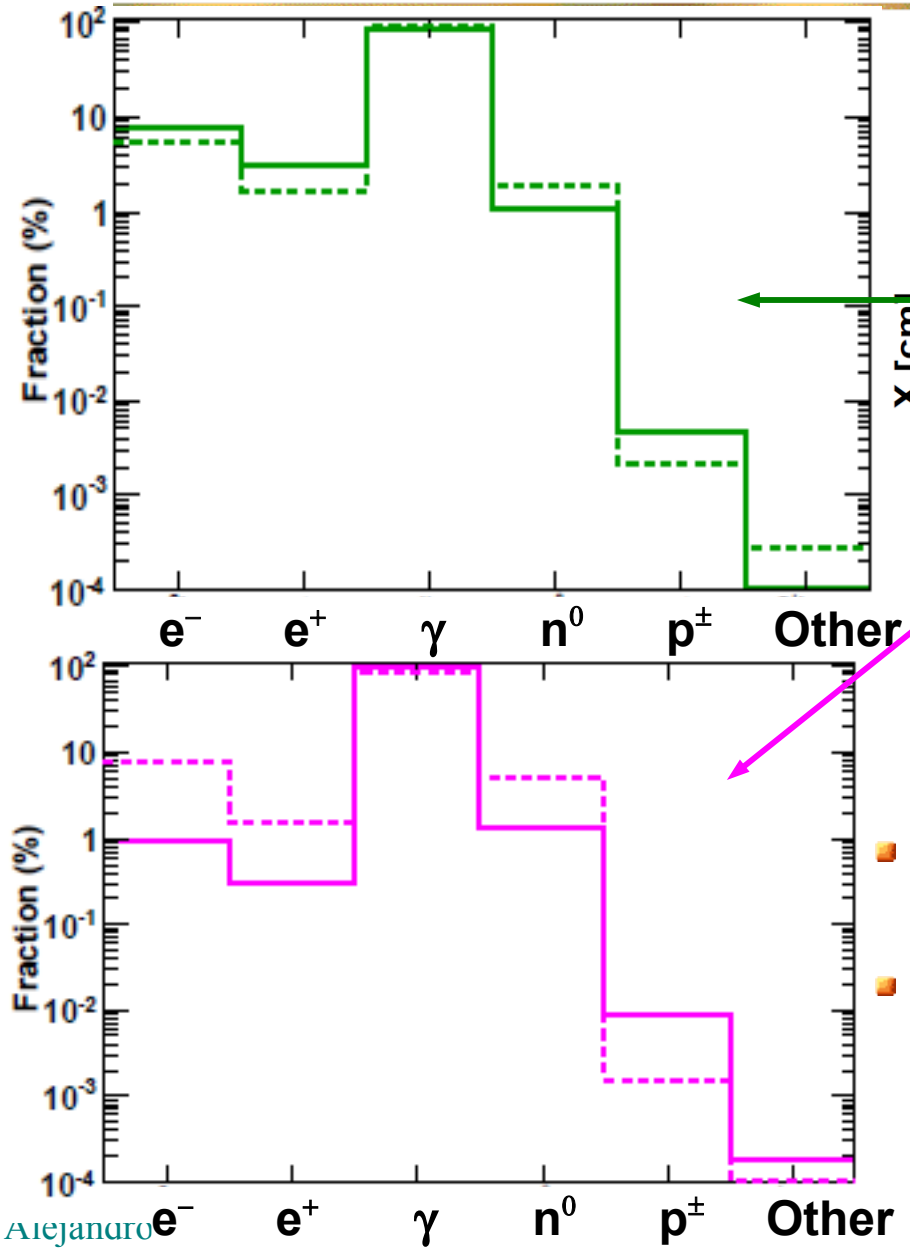


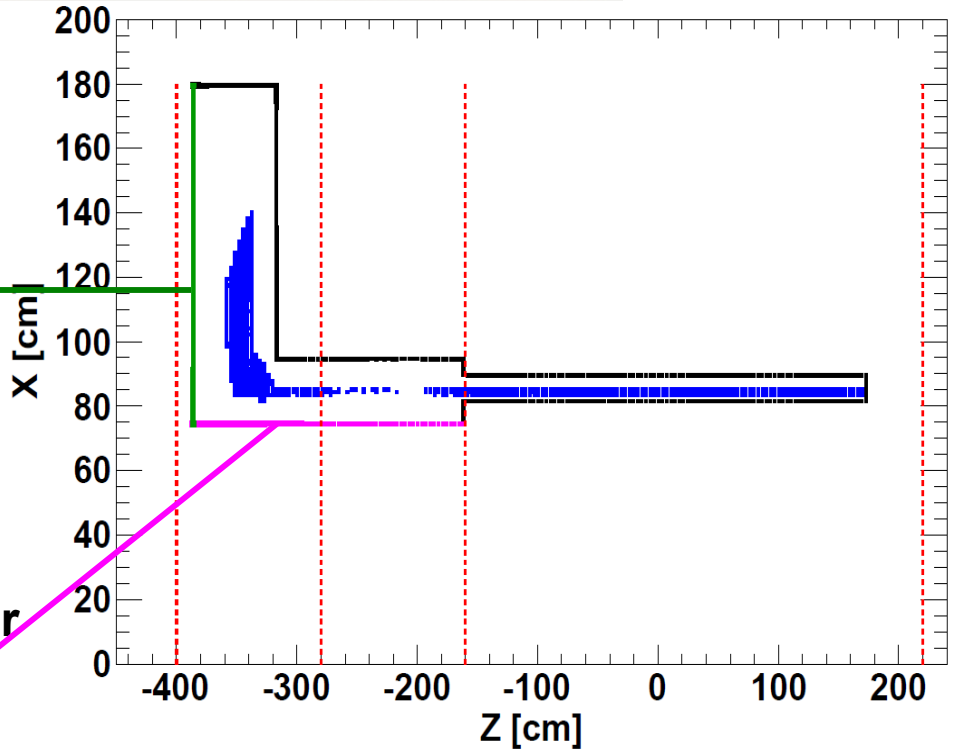
Particle fluxes on the FDIRC FBLOCK (I)

- Study the flux of particles through interesting regions of the the FDIRC mother boundary (magenta and green regions)
- Try to understand the nature of the particles crossing those boundaries (PID and spectrum)



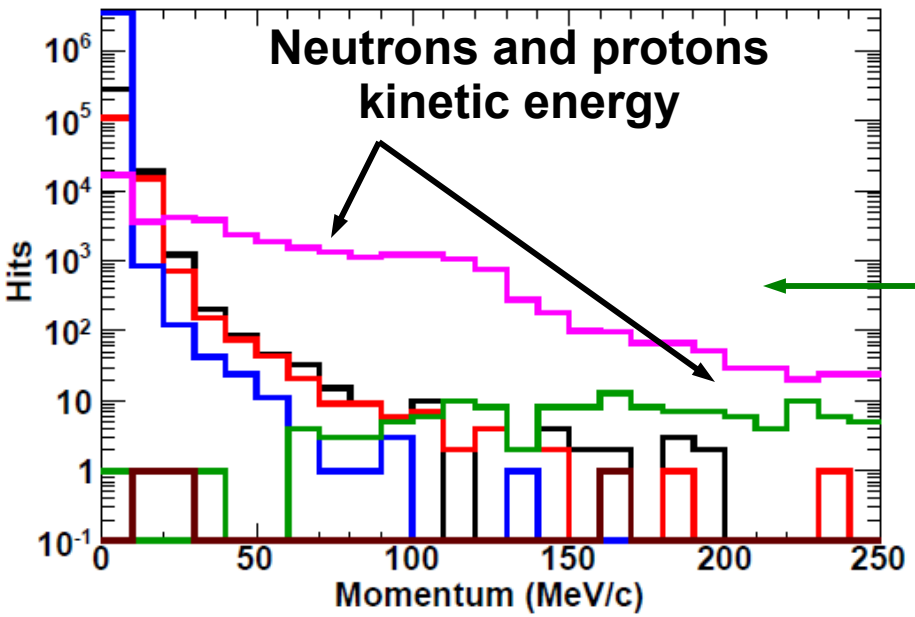
Particle fluxes on the FDIRC FBLOCK (II)

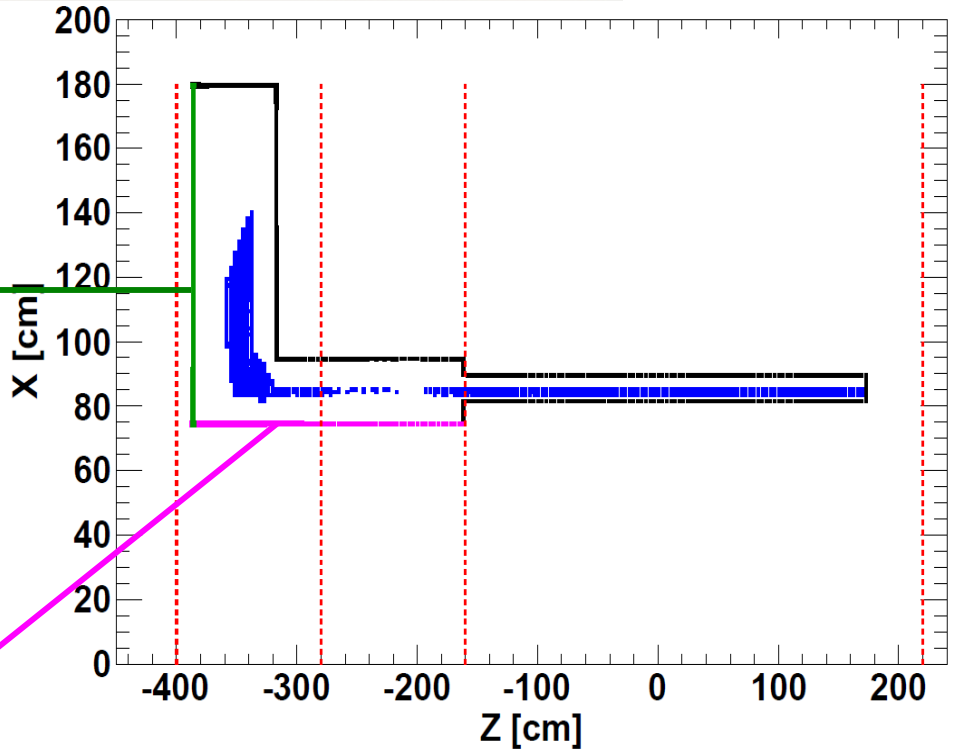


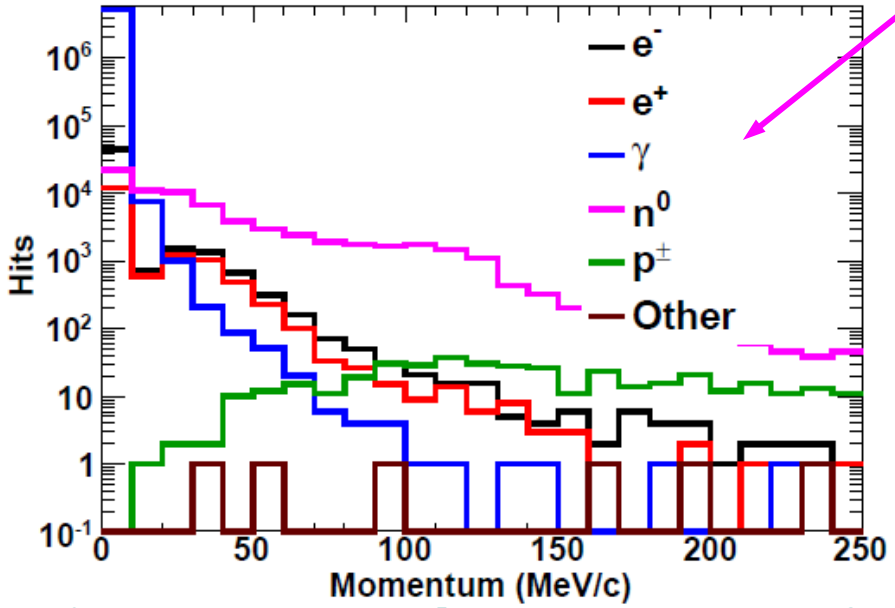


- The main contribution to the flux are γ (~90 – 98%) and $e^\pm$ (1-10%)
- In the second place are neutrons (~1%)

Particle fluxes on the FDIRC FBLOCK (III)

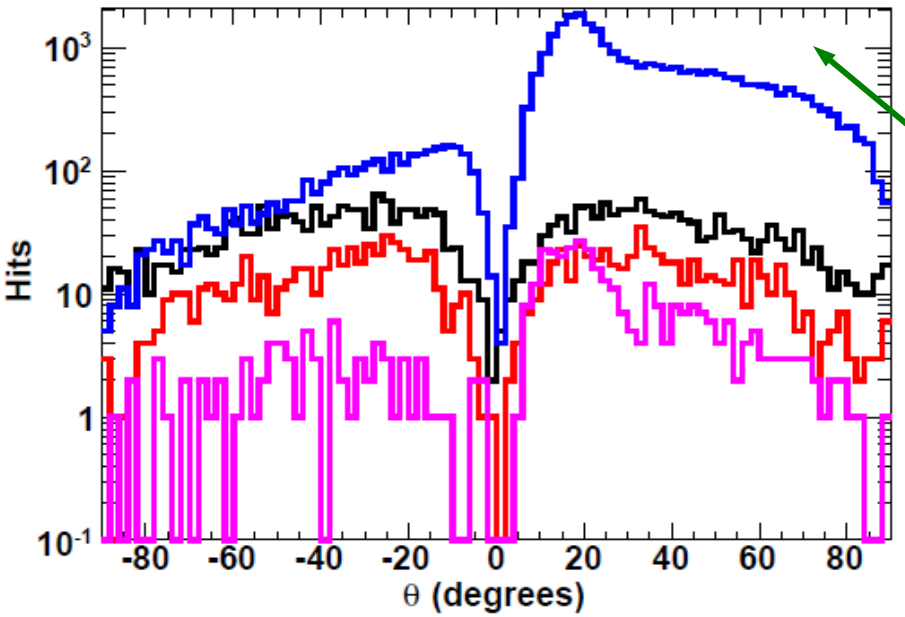


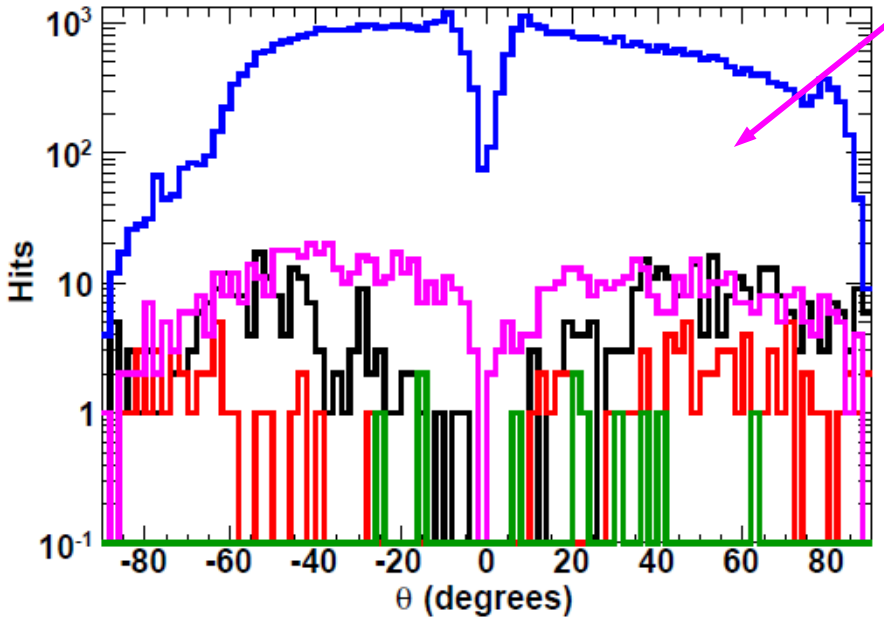


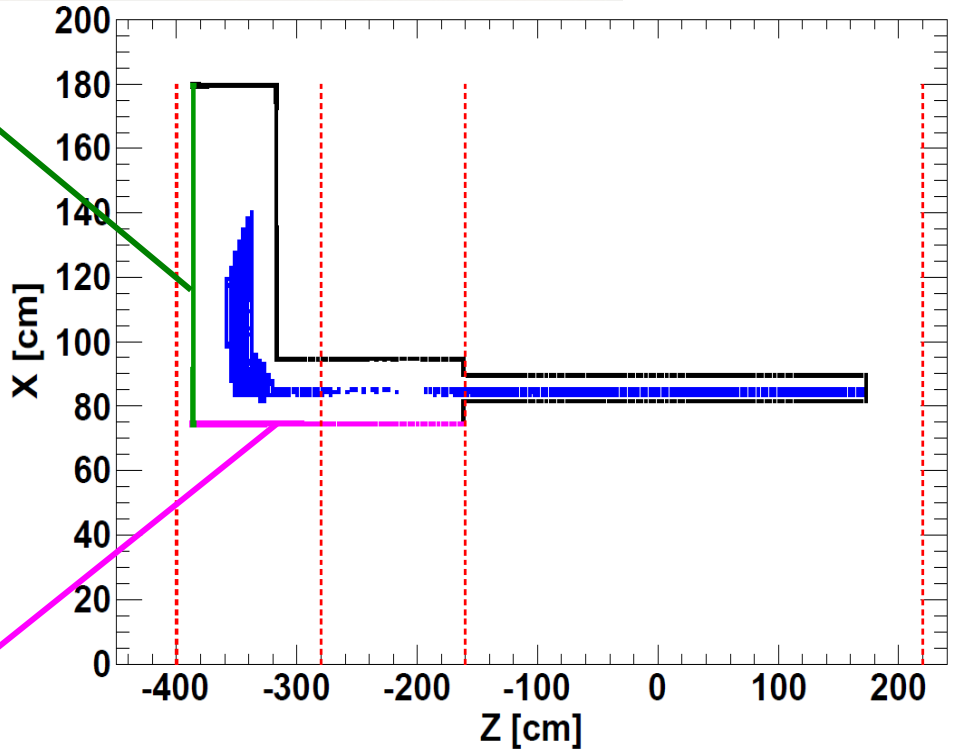


- The main contribution of the flux are γ and $e^{\pm}$ doesn't with energies below 200 MeV
- Neutrons and protons on the other hand have a harder spectrum (kinetic energy)

Particle fluxes on the FDIRC FBLOCK (IV)





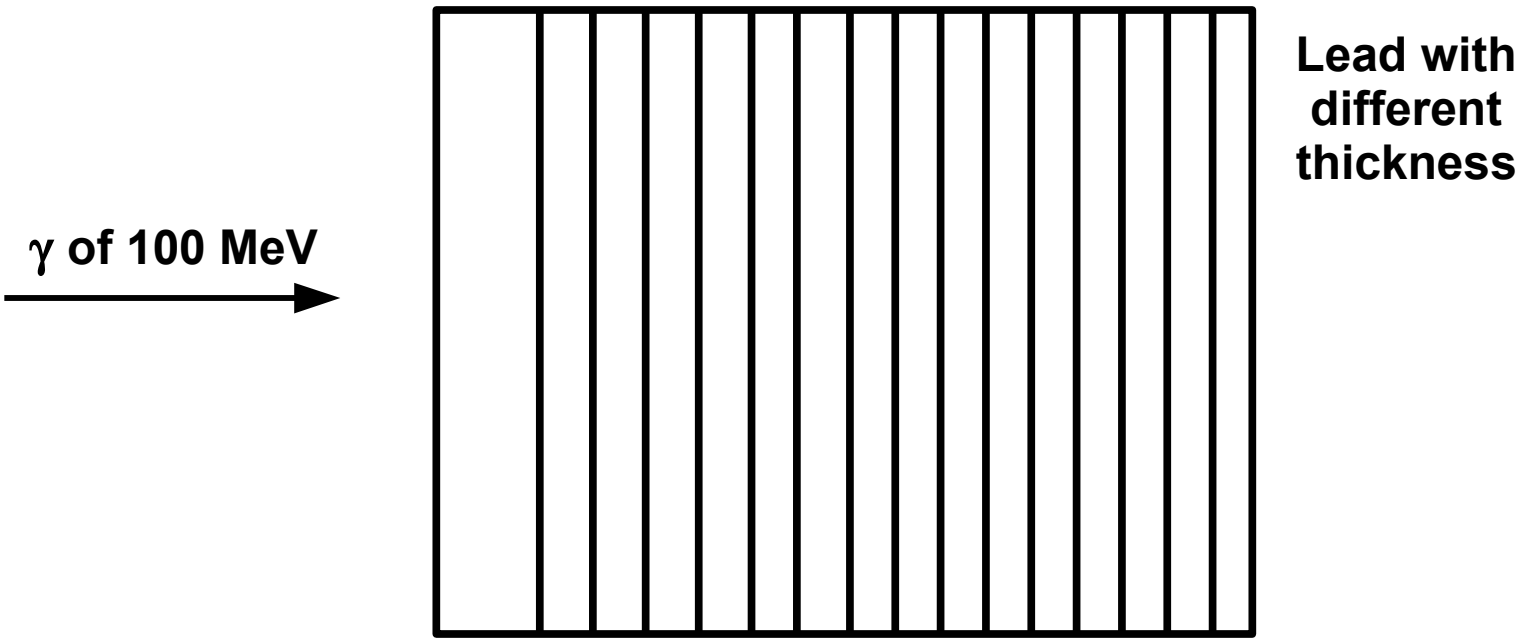


- **Incident angle:**
  - **θ = 0 means normal incidence**
  - **θ > 0 means particles coming more or less from the IP**
- **Most of the particles have a not-normal incidence**

FDIRC Lead shield studies (I)

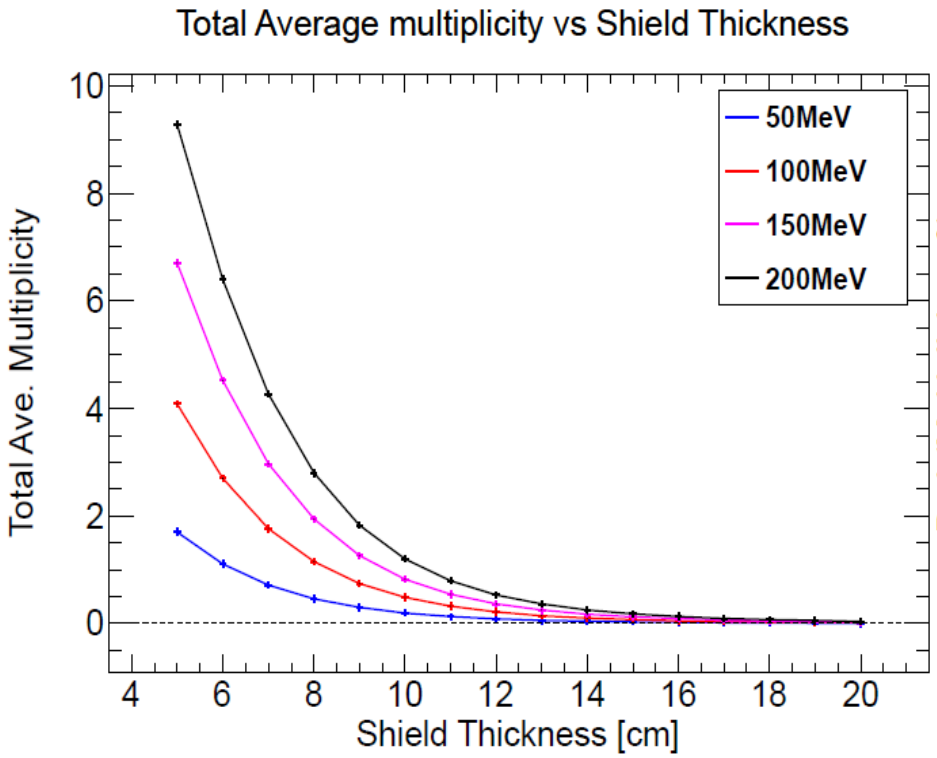
- **Shot particles ($e^{\pm}$, γ, n^0) at normal incidence on Lead for**
  - Different lead thickness: 5 – 20 cm (1cm steps)
  - Different incident energies: 50 – 200 MeV (50MeV steps)
- **Study the particle multiplicity and spectrum at the other end of the shield**
- **Optimization: thickness for which the probability to have more than one particle on the other side of the shield is lower than 10%**

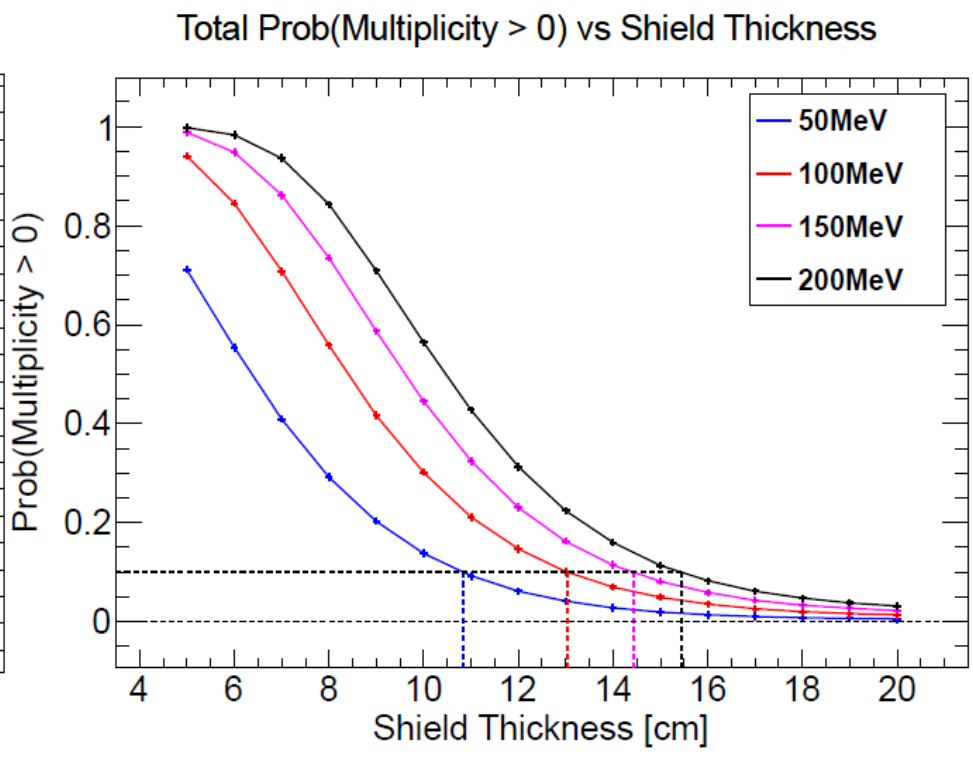
Probability(Multiplicity > 0) ≤ 10%



FDIRC Lead shield studies (II)

Incident photons

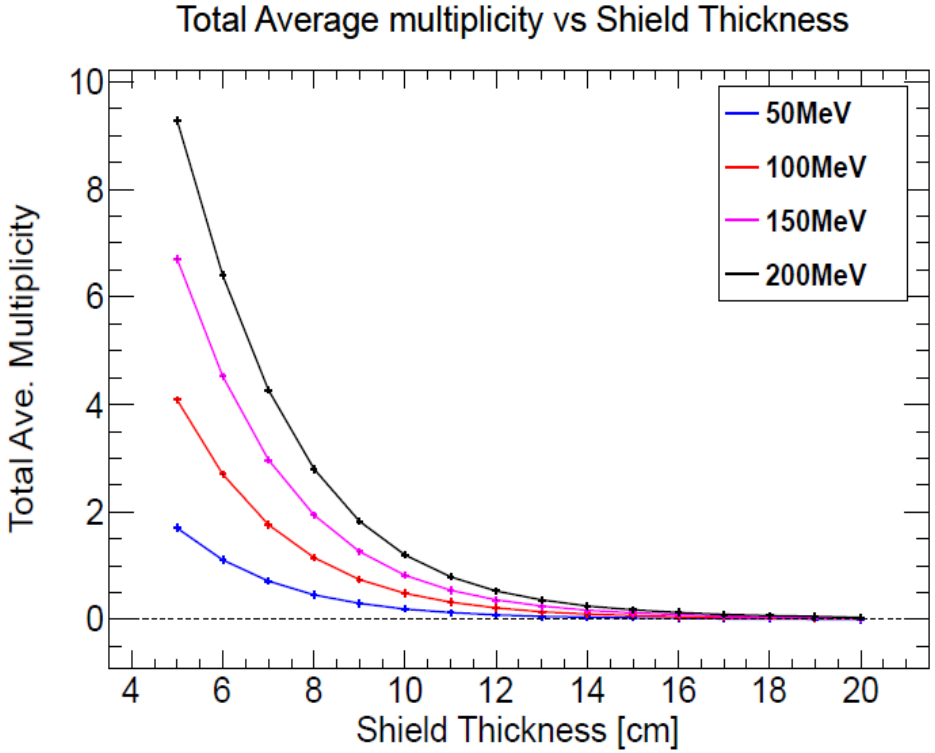


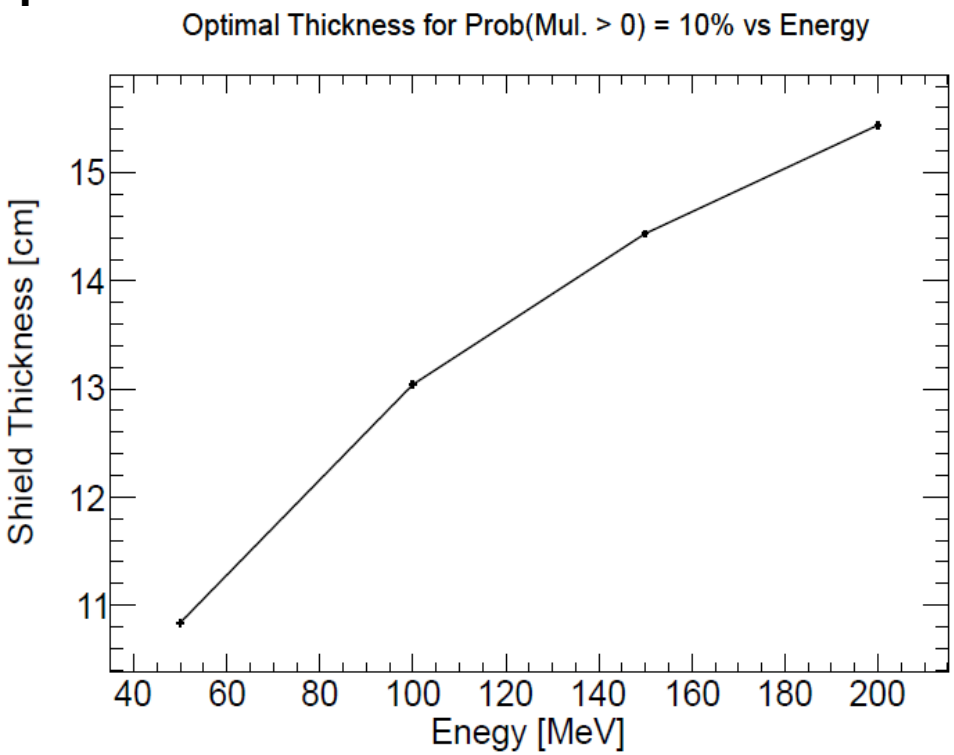


- **Multiplicity at the other end of the lead shield due mainly to photons and electrons/positrons (very small contribution from neutrons)**
- **Higher the energy of the incident photon, thicker must be the lead shield**

FDIRC Lead shield studies (II)

Incident photons

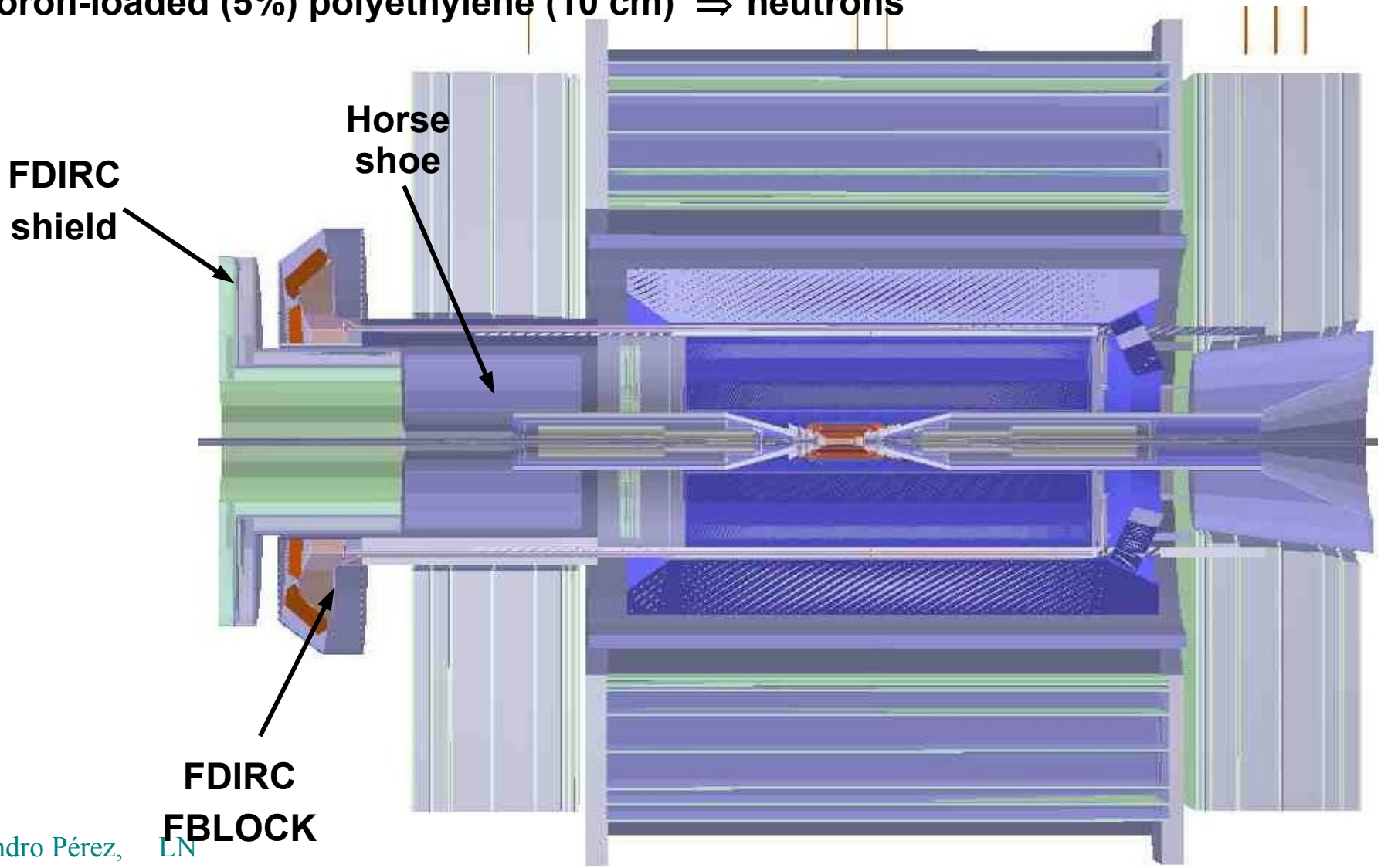




- **Multiplicity at the other end of the lead shield due mainly to photons and electrons/positrons (very small contribution from neutrons)**
- **Higher the energy of the incident photon, thicker must be the lead shield**
- **In order to reduce the photon flux by a factor of 10 for photons up to 150MeV, the lead shield thickness needs to be 14.4cm**

FDIRC shield: BRN implementation

- Steel-lead-steel sandwich (2.5-10-2.5 cm) ⇒ photons and electrons/positrons
- Boron-loaded (5%) polyethylene (10 cm) ⇒ neutrons



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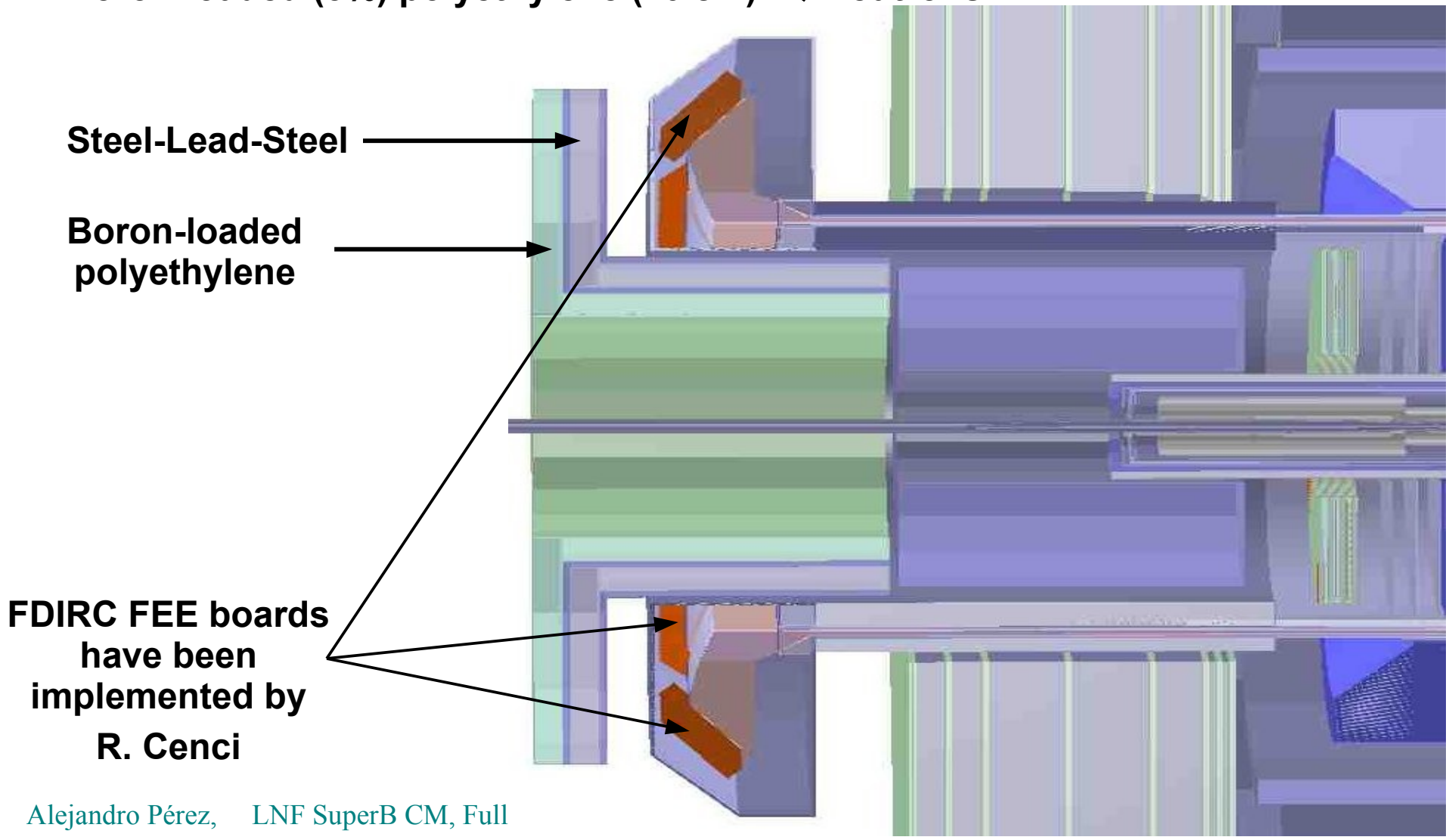
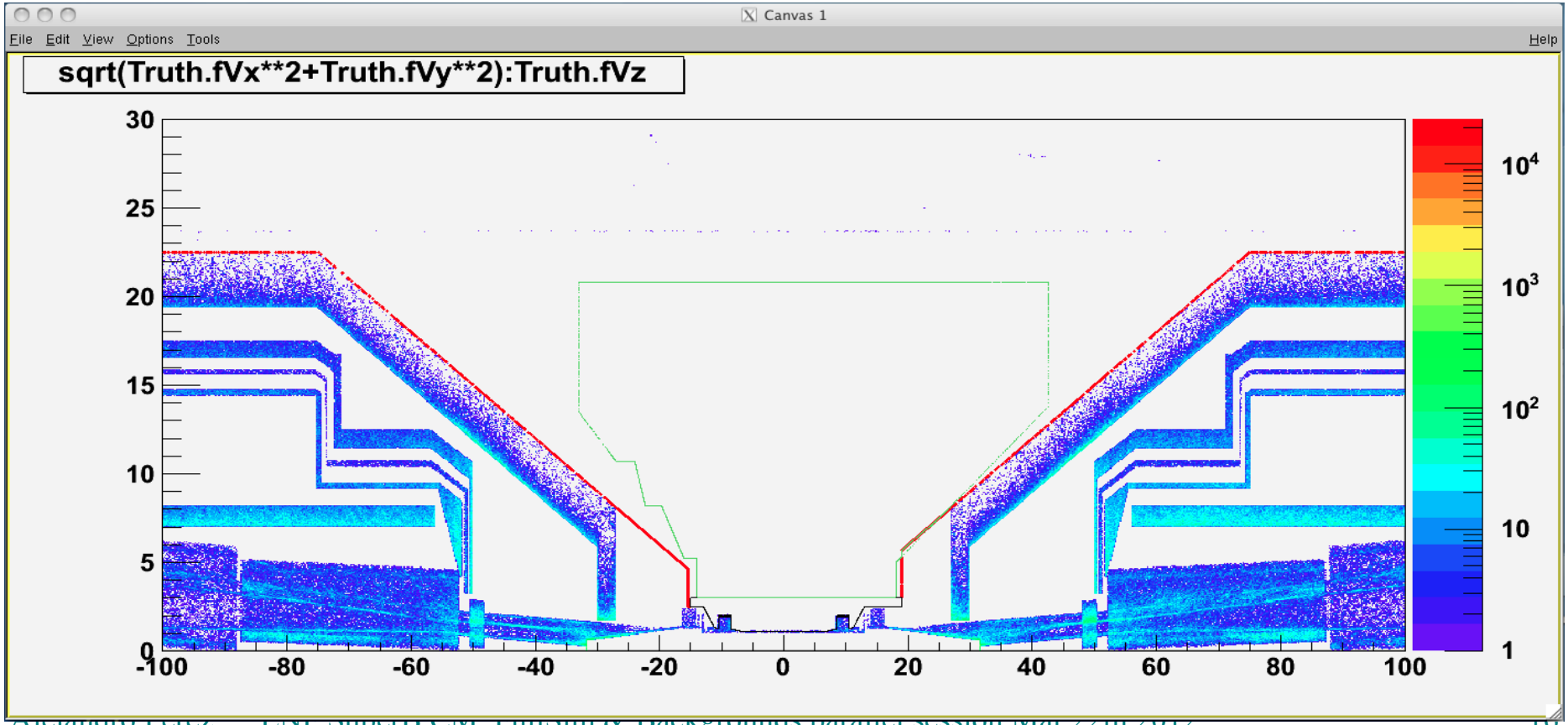


Geometry fixes and some issues

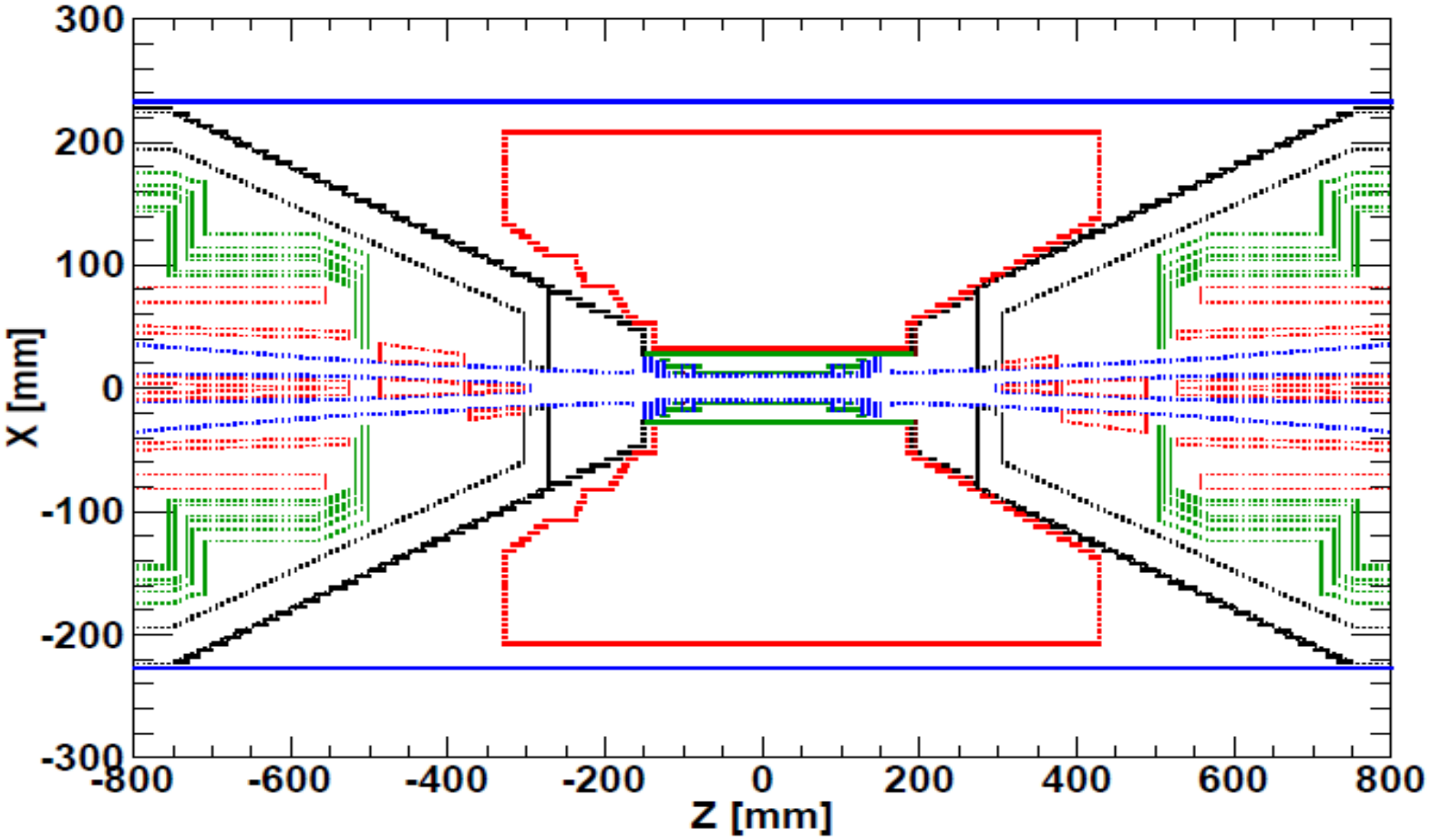
- **Some geometry problems related with FF and SVT**
  - Overlaps between SVT, SVT_L0, inner_detector and FF mother volumes
  - Overshooting of SVT mother out of inner_detector
  - This results in some confusion when instrumenting boundaries

    ⇒ Hit assignment: loss of some hits when instrumenting FF mother boundary



Geometry fixes and some issues

- Added clearances (10μm) at several places to get rid of several overlaps
- Redefined inner_detector and FF boundaries to fix SVT protruding
- Overlaps inside the SVT_L0.gdml: added clearances



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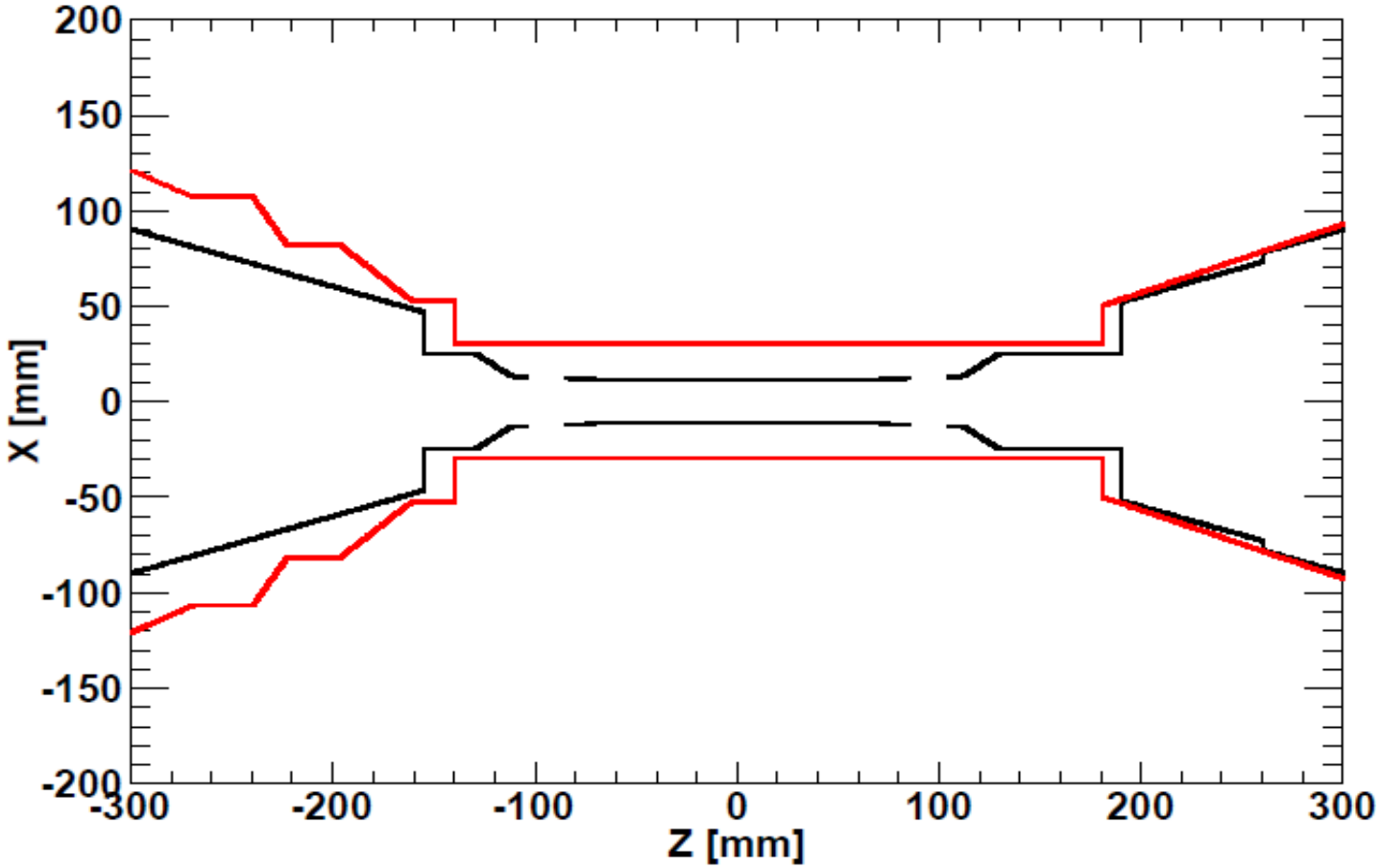

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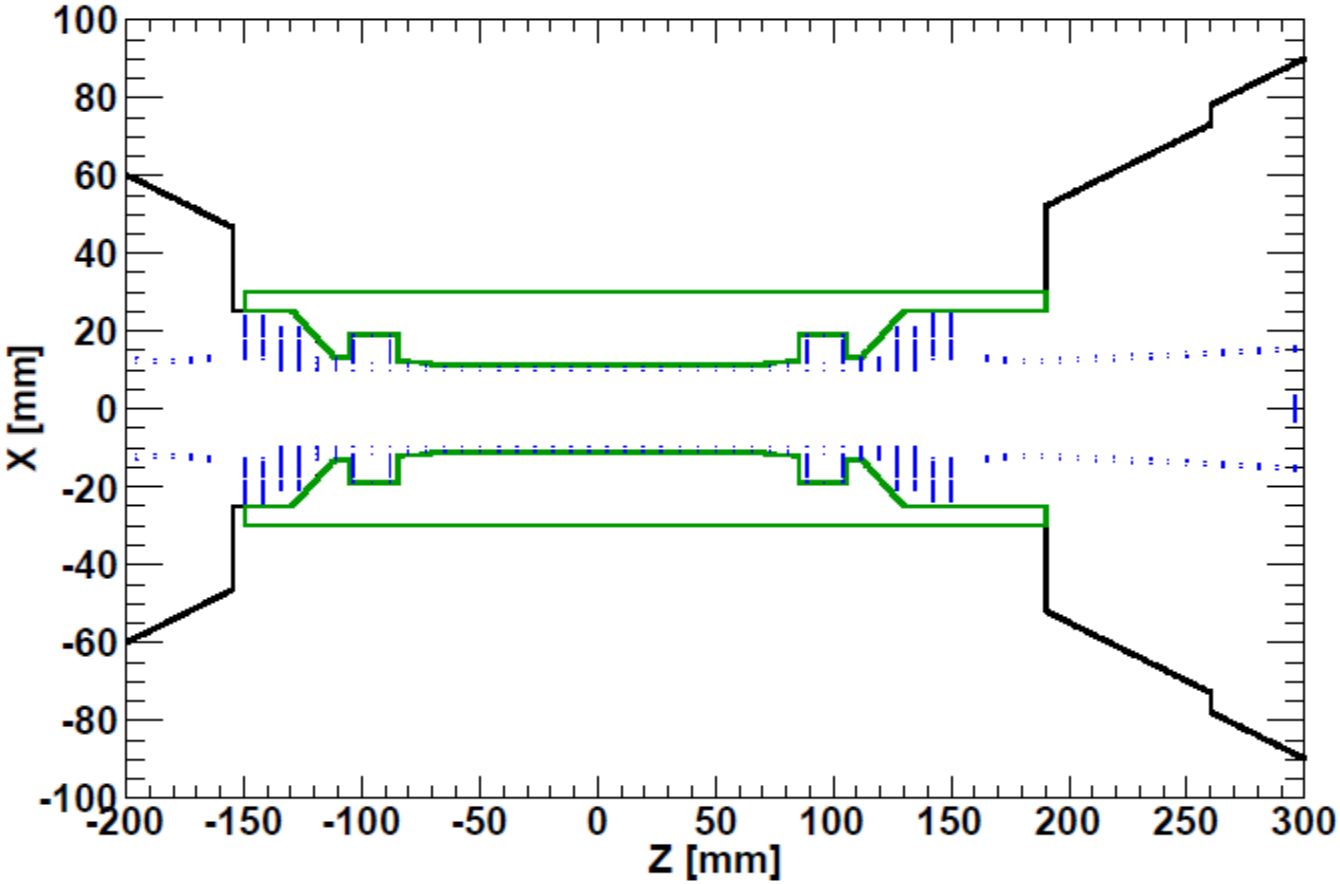


Geometry fixes and some issues

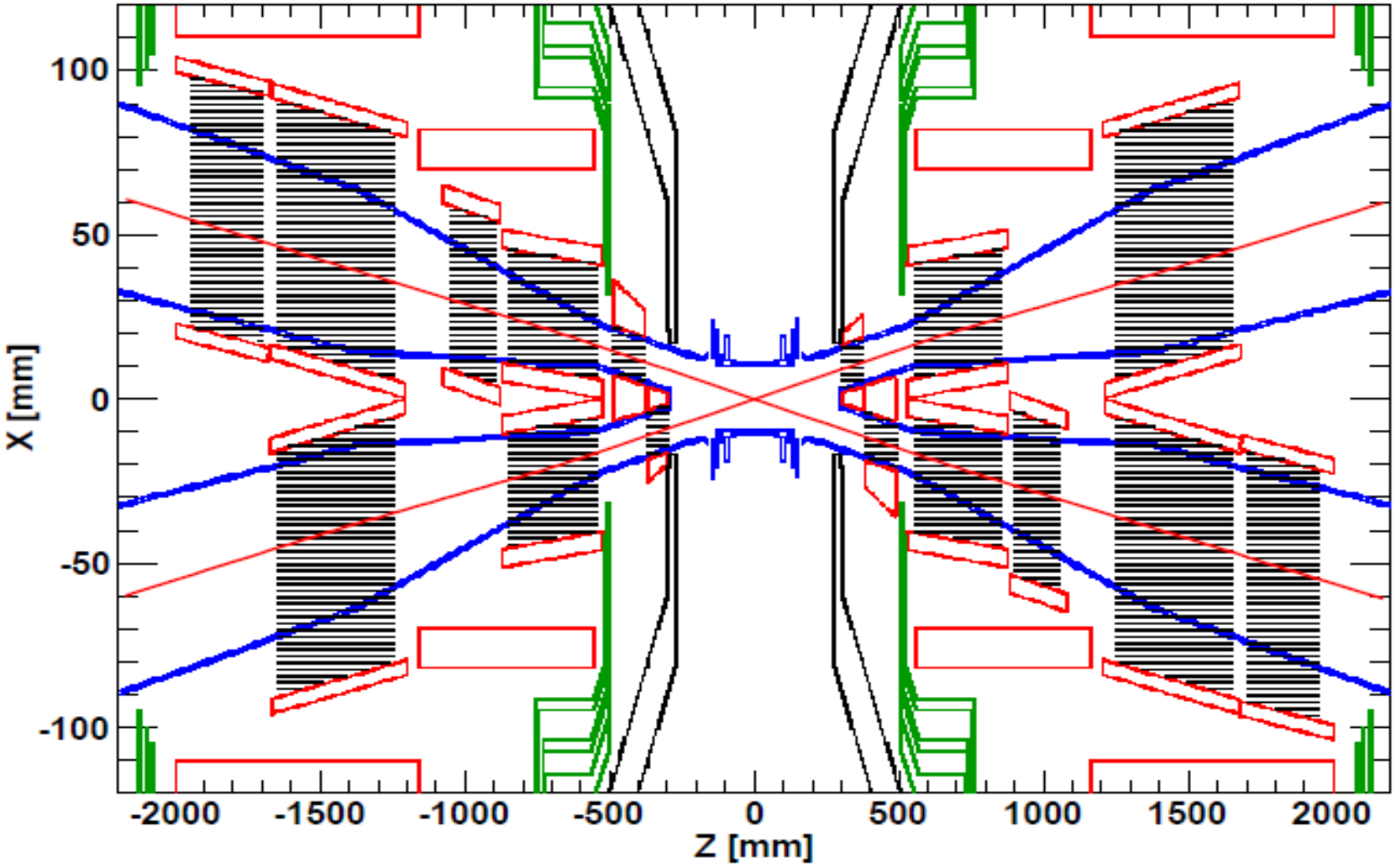
- **Ran G4 geometry test**

http://mailman.fe.infn.it/superbwiki/index.php/Geant4_SuperB_simulation_main_portal/GeoDebug

- **FF, SVT_L0, Inner_detector and FDIRC shield show no geometry problems, but found several errors like**
  - Overlapping errors for IFR crates with scintillator
  - Overshooting of bwd-EMC FEE crates outside mother volume
  - Overlapping of bwd-EMC scintillator and Pb
  - Overshooting of fwd-EMC FEE outside mother volume
  - Overlapping between sectors FDIRC sectors
  - …
- **The individual Overshooting/Overlapping goes from 0.1 – 10 μm. The individual problems are relatively small but there are many of them**
- **Could this be the reason of the stuck tracks?**
- **Maybe adding some clearances will fix this?**

FF Magnetic model fixes

- **Used the BfieldDumper module to spot and fix several problems on the FF Magnetic model. New model seems to be OK**



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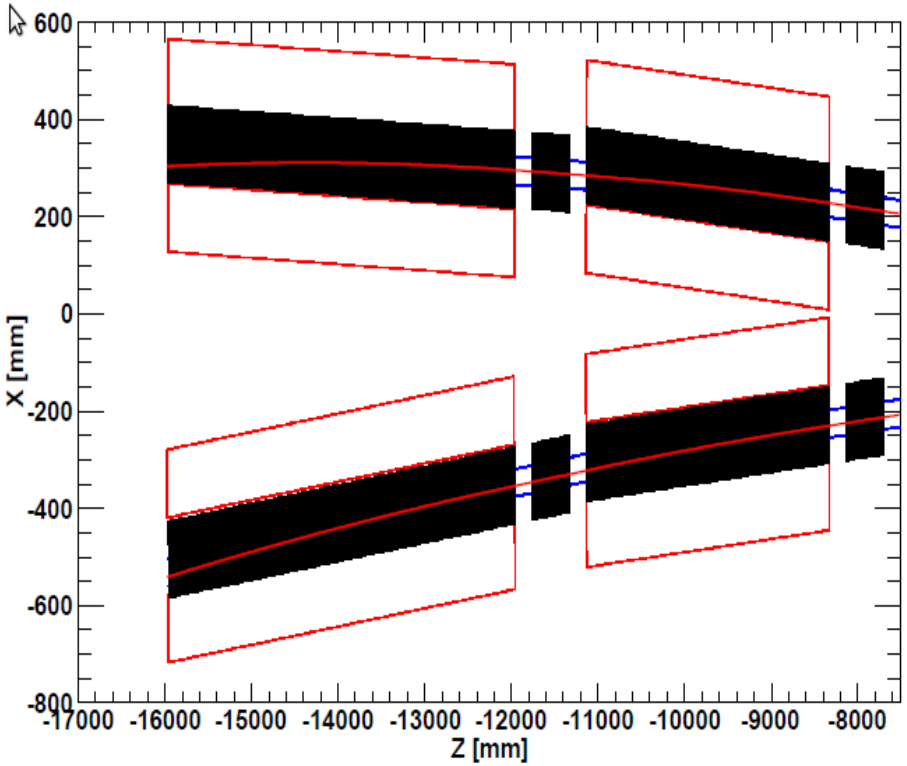
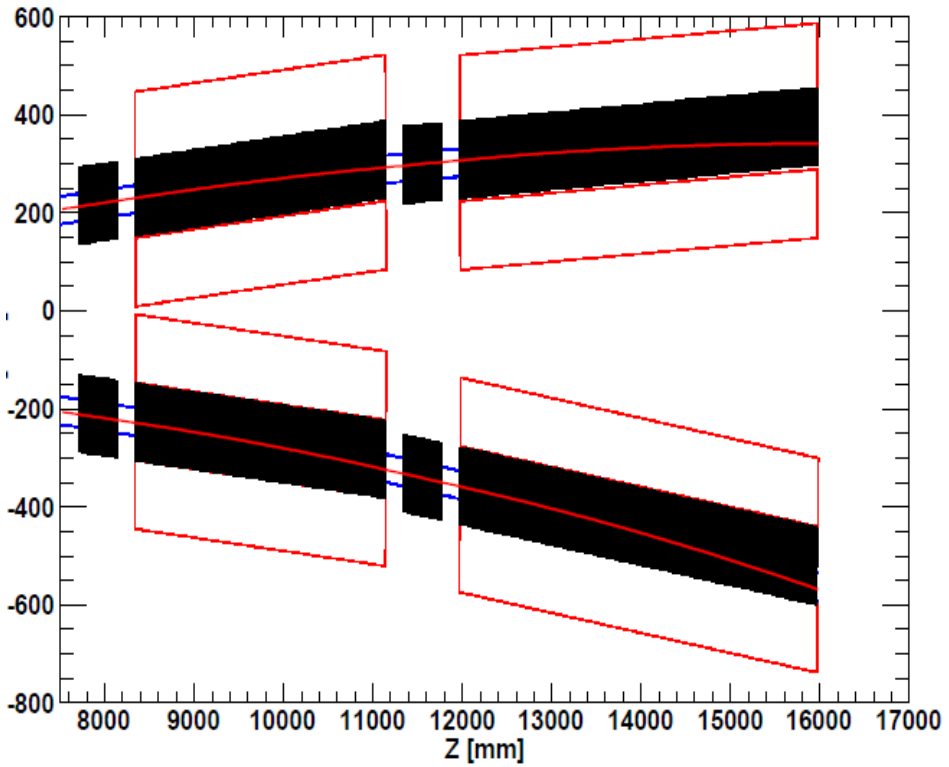
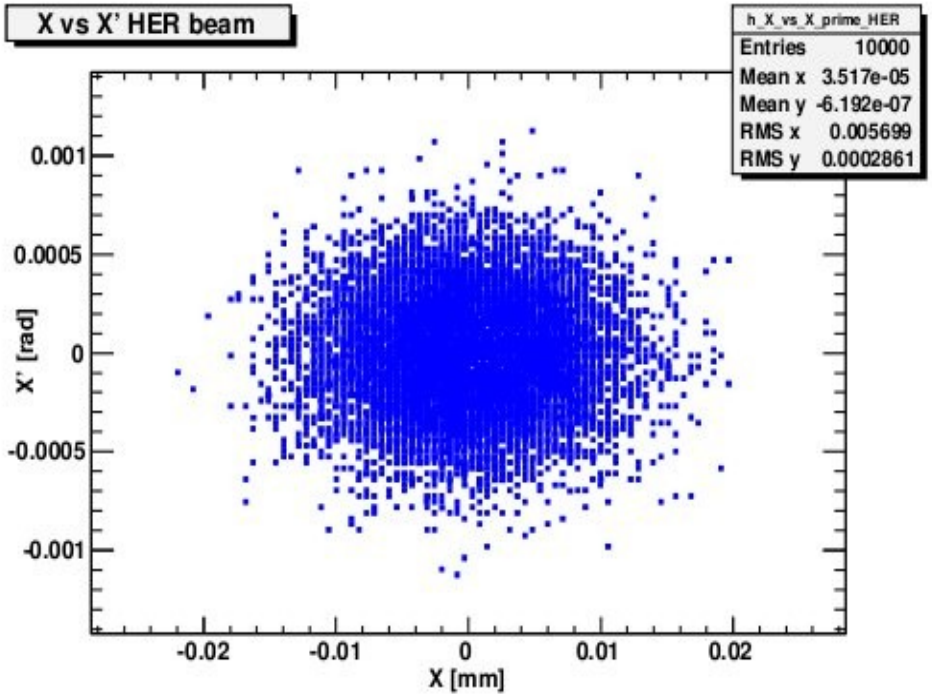




FF Magnetic model: additional tests (I)

- **Use final focus v12 sf11 layout**
- **Generate particles (10k) with the beam parameters (HER and LER) at the IP:**
  - All particles are generated at Z = 0 and at the nominal beam energy

parameter	HER (e^+)	LER (e^-)
Energy	6.69 GeV	4.18 GeV
σ_X	7.3×10^{-3} mm	8.7×10^{-3} mm
β_X	26.0 mm	32.0 mm
σ_Y	36.0×10^{-6} mm	35.0×10^{-6} mm
β_Y	253.0×10^{-3} mm	205.0×10^{-3} mm
α_Z	-30mrad	π+30mrad

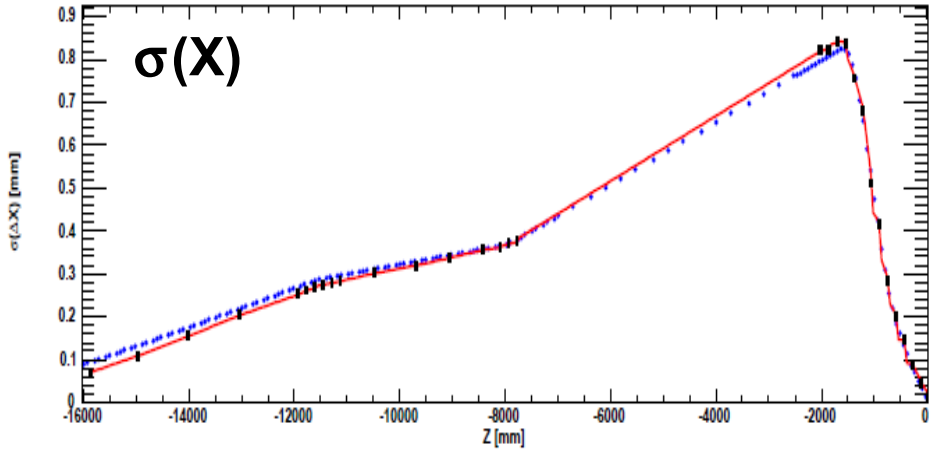


- **Feed this particles into Bruno which transport them into the final focus field**
- **Use scoring cylinders to study beam optics as a function of Z**
- **Goal: comparison with design values**

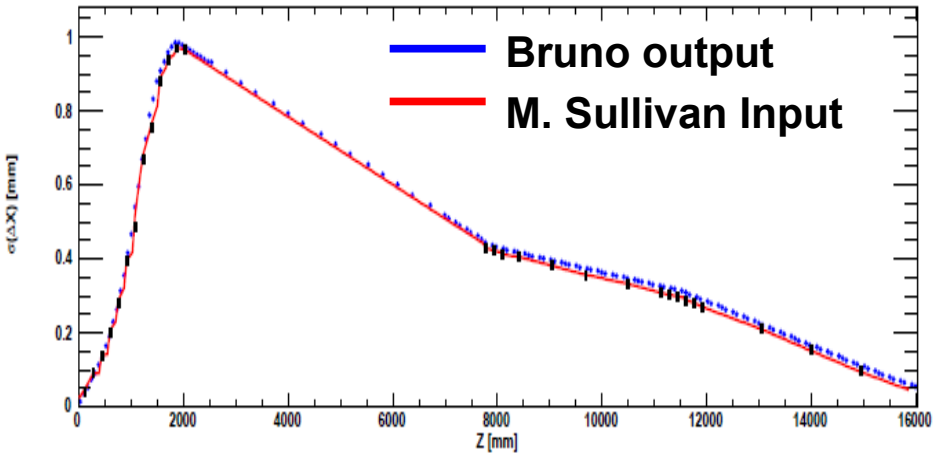
FF Magnetic model: additional tests (II)

Beams σ(X) and σ(Y)

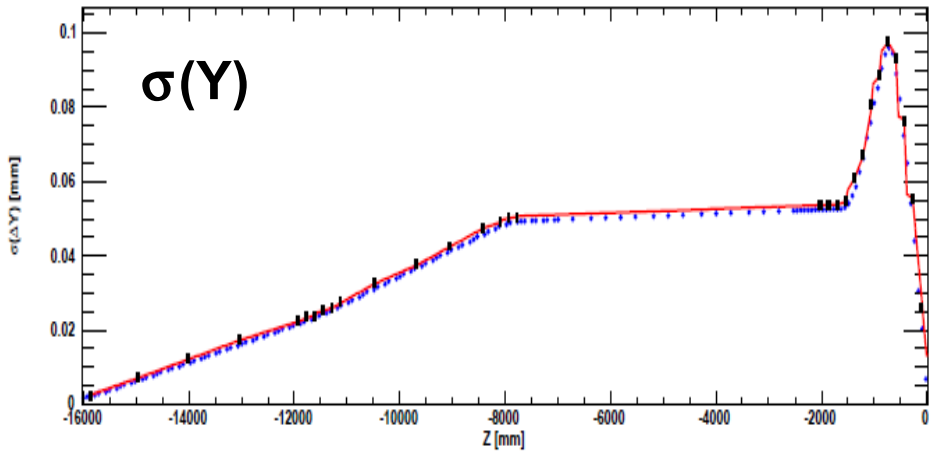
LER-Down-stream



HER-Down-stream



Z vs σ(ΔY)



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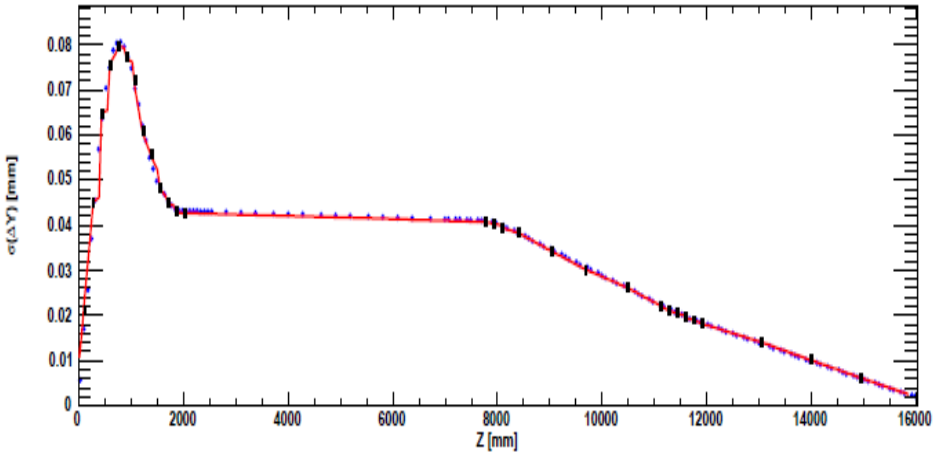
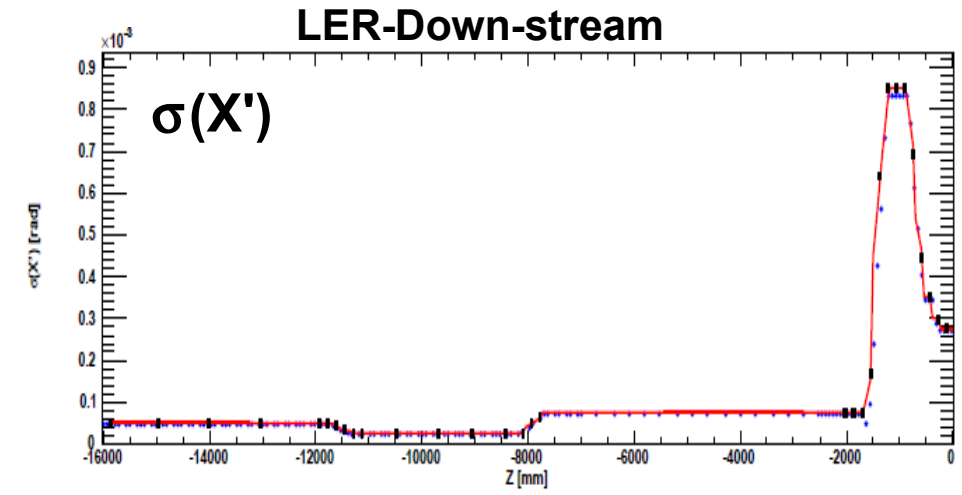
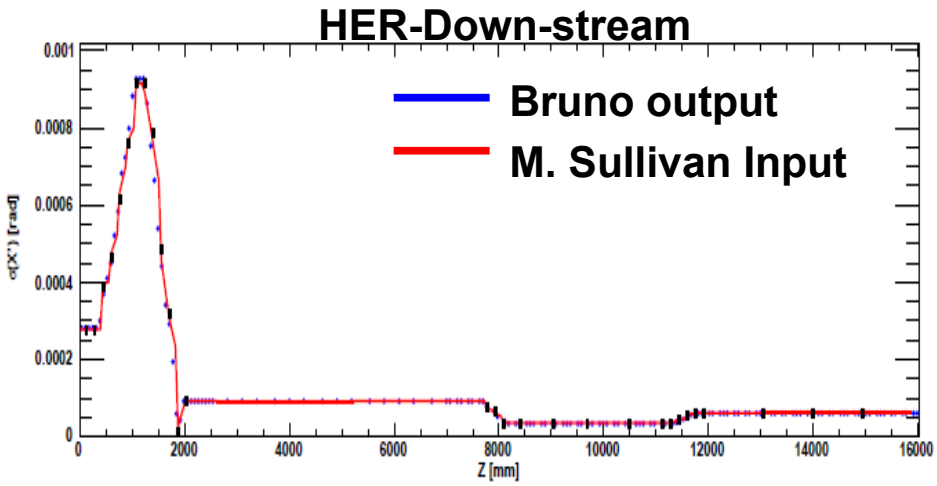
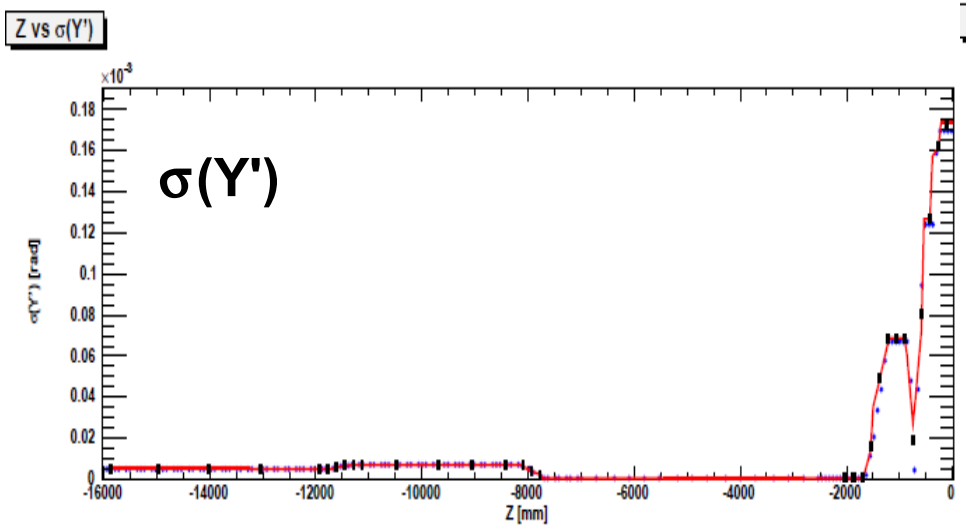


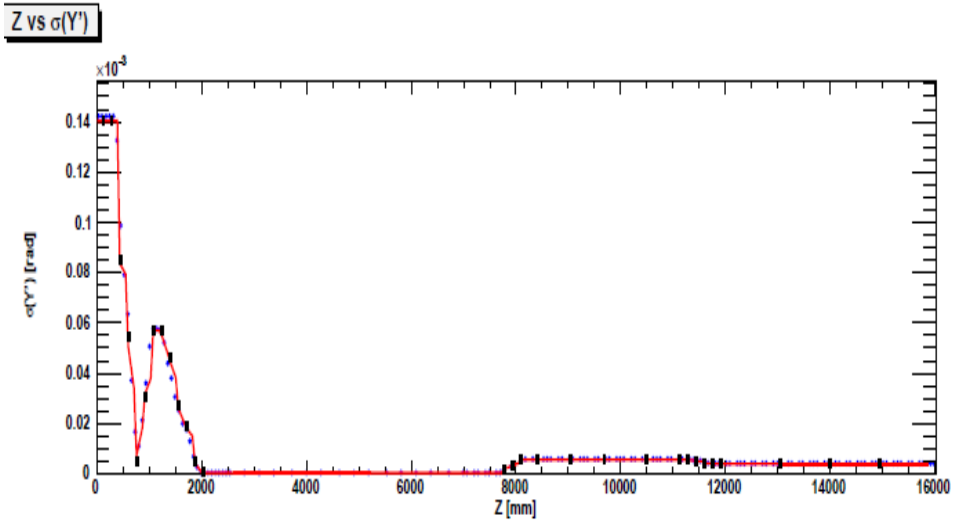
FF Magnetic model: additional tests (II)

Beams σ(X') and σ(Y')





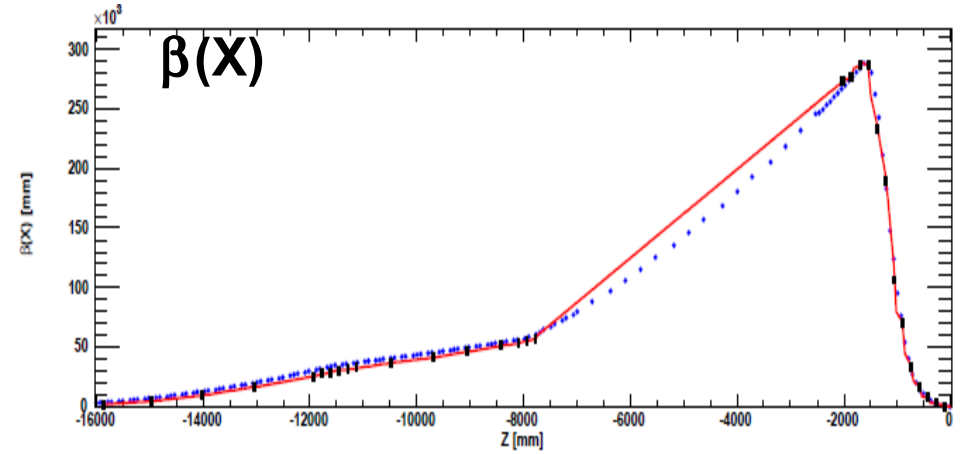




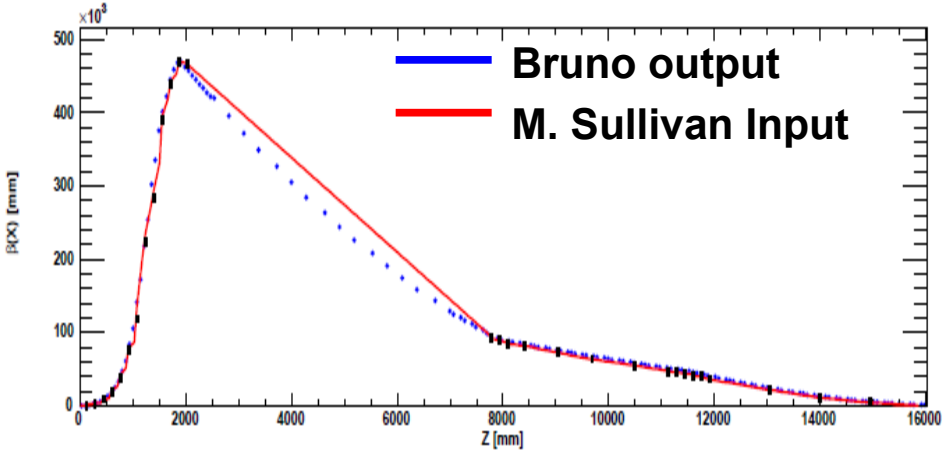
FF Magnetic model: additional tests (II)

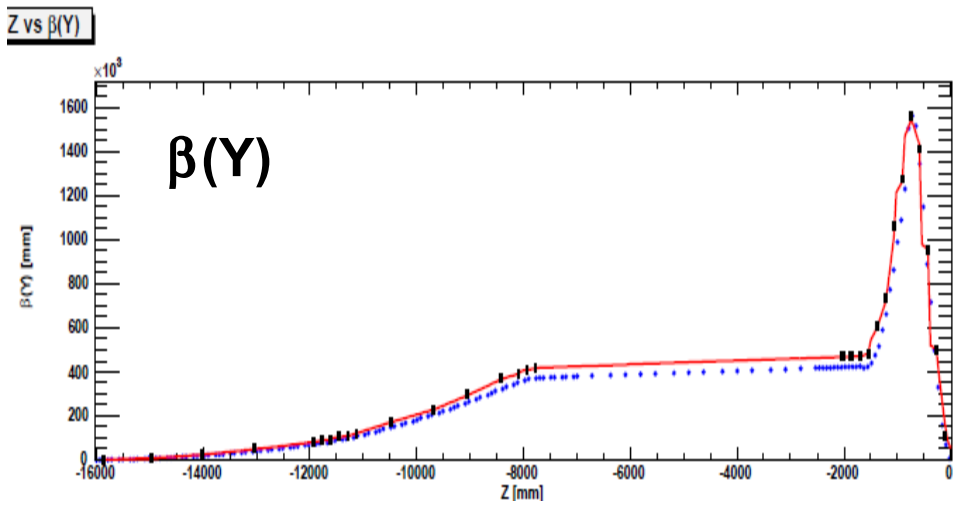
Beams β(X) and β(Y)

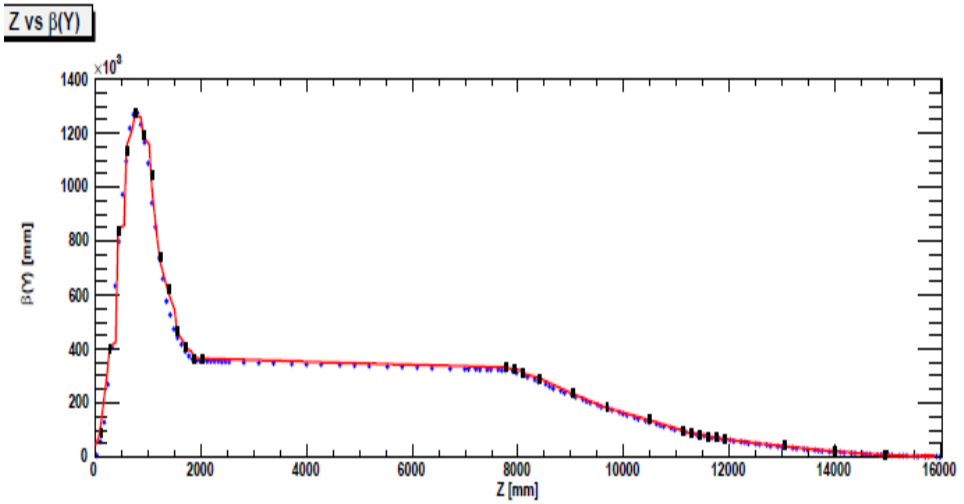
LER-Down-stream



HER-Down-stream







Summary and Outlook

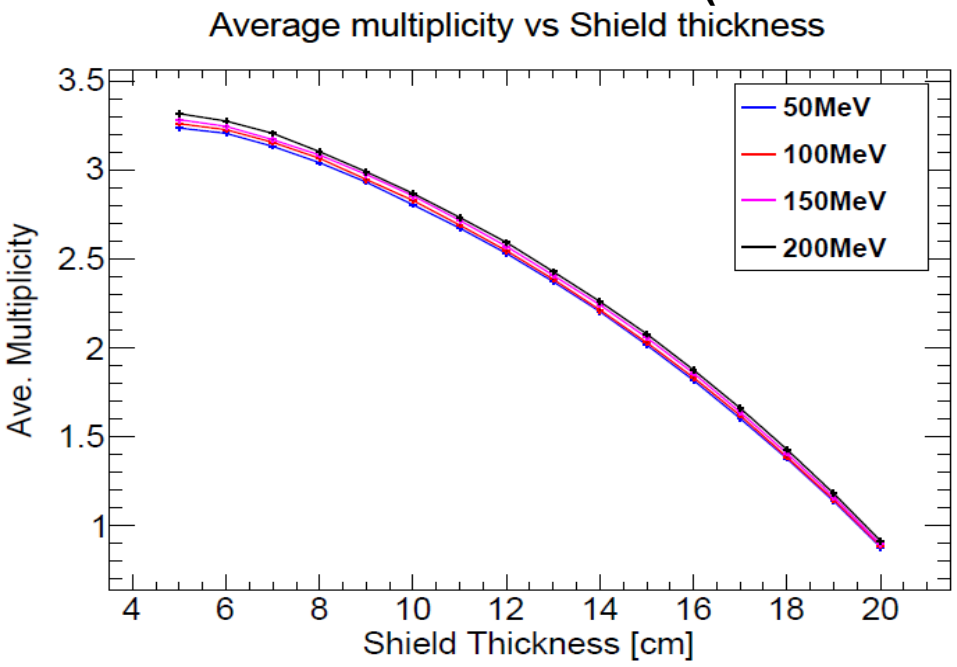
- **Rad-mon ready for next production**
- **PM implemented**
- **FDIRC Shields:**
  - Steel-lead-steel (2.5-10-2.5 cm) sandwich
  - Boron-loaded polyethylene shield (10 cm)
- **FDIRC FEE:**
  - FEE boards implemented and instrumented by Riccardo
  - Ready to study the doses and neutron fluxes
- **Spotted and fixed several geometry problems (overshooting/overlapping). SVT_L0 and FF show no problems, but still some others remind**
- **Spotted some problems with FF magnetic model. They have been fixed and committed**

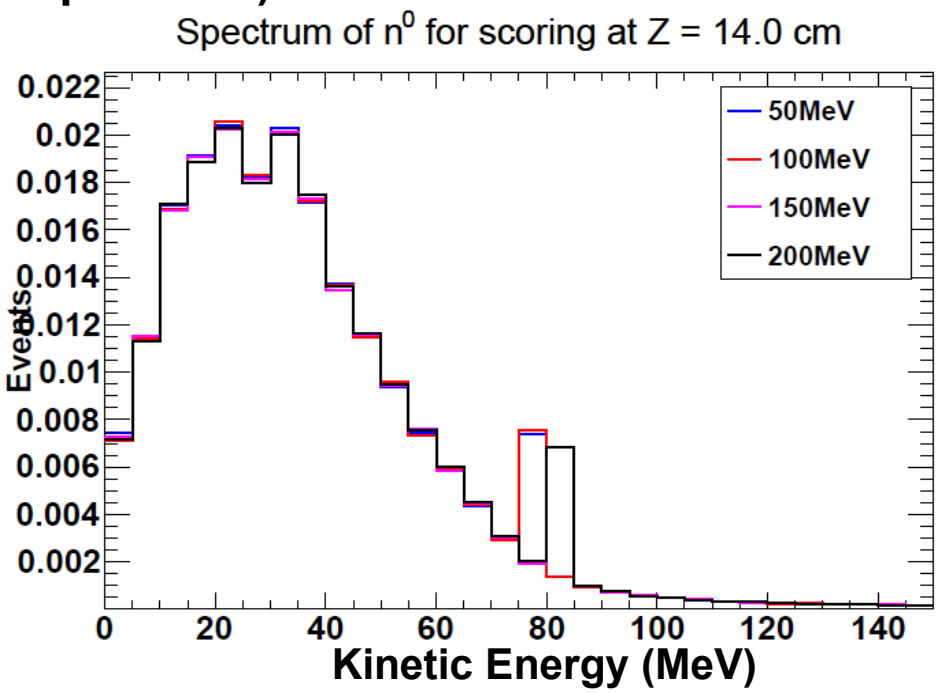
- **Next steps:** finalize Tungsten shield optimization studies


Backup

FDIRC Lead shield studies (III)

Incident neutrons
(neutron multiplication)





- **Incident neutrons with kinetic energies from 50 to 200 MeV get multiplied by a factor of ~2.3 for lead thickness of 14cm**
- **The kinetic energy spectrum of those neutrons has a slight variation with the incident neutron kinetic energy**
- **Outgoing neutrons have a significant amount of kinetic energy (10 – 70 MeV)**

⇒ Add a Boron-loaded (5%) polyethylene shield