FDIRC shields

Alejandro Pérez
INFN – Sezione di Pisa

LNF SuperB Collaboration Meeting

Outline

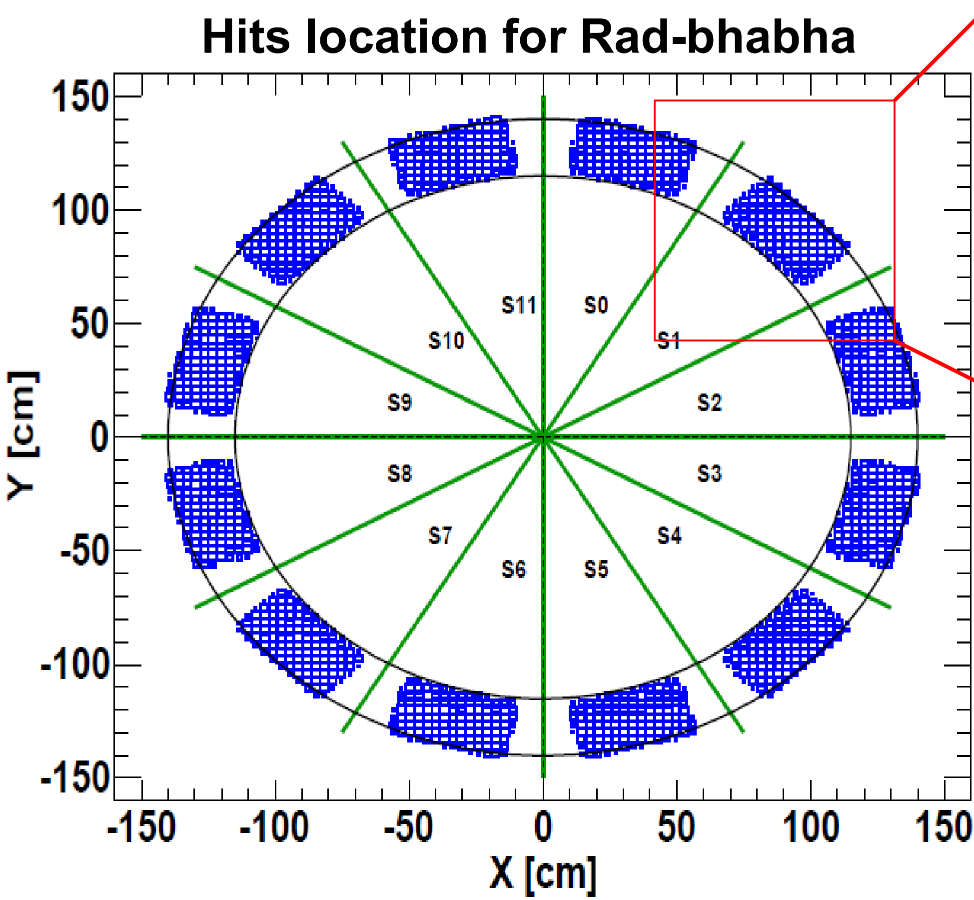
- **Machine backgrounds on the FDIRC:**
  - Reminder of previous production (LNF SuperB CM at LNF, Dec 2011)

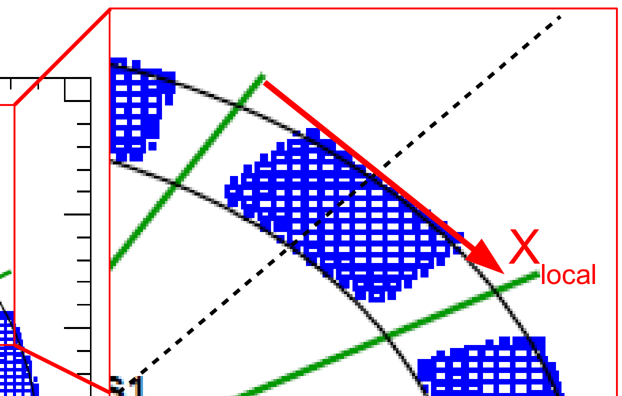
- **FDIRC Lead shield studies**

- **Summary and Outlook**

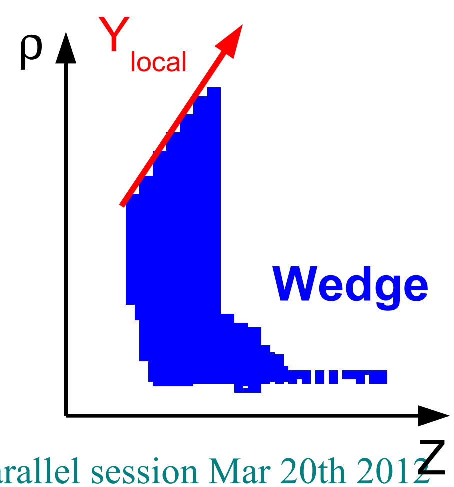
Bkg rates on the FDIRC: Strategy (I)

- **Use same sector labelling as in BABAR**
- **Determine the photo-electron (p.e.) rates per pixel** (see next slide) **for every sector and for all available background sources**
- **Use a "local" coordinate system in the instrumented plane:** X_{local} vs Y_{local}





X_{local}:
From -width/2
up to width/2

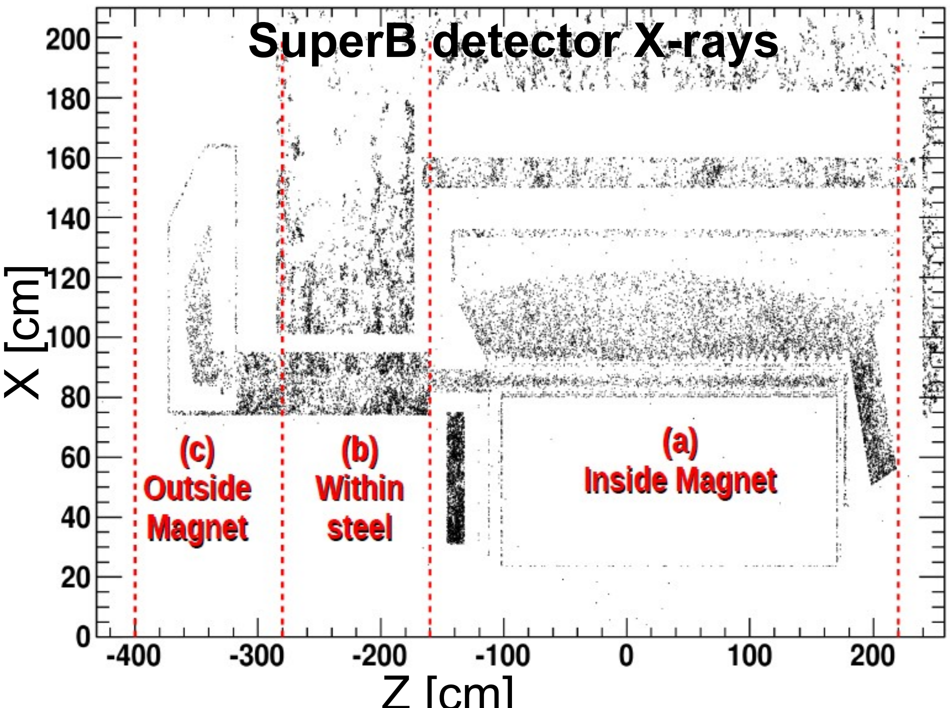


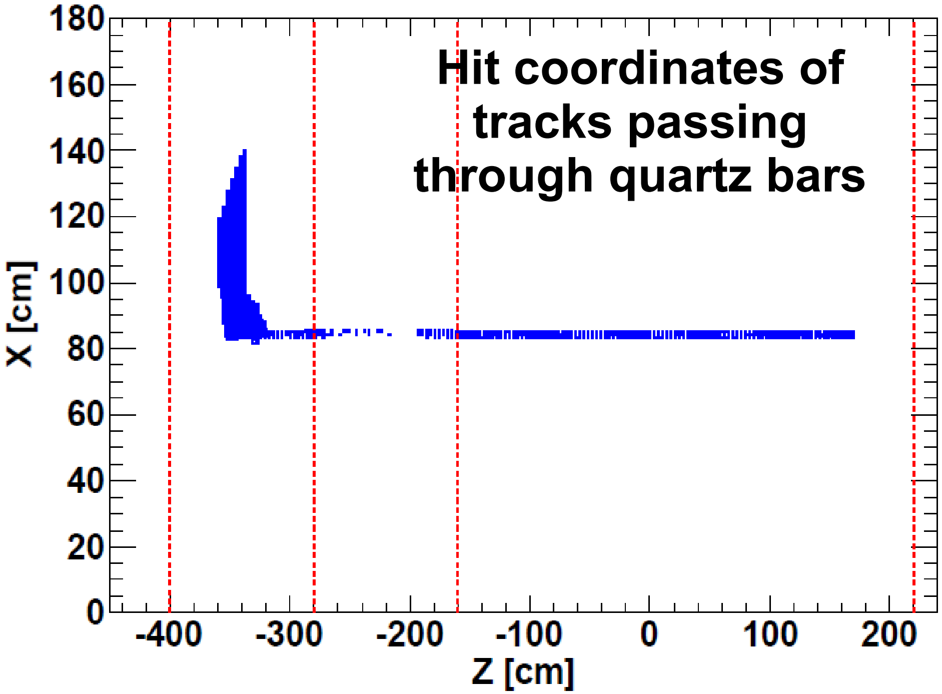
Y_{local}:
From 0.0
up to Length

Bkg rates on the FDIRC: Strategy (II)

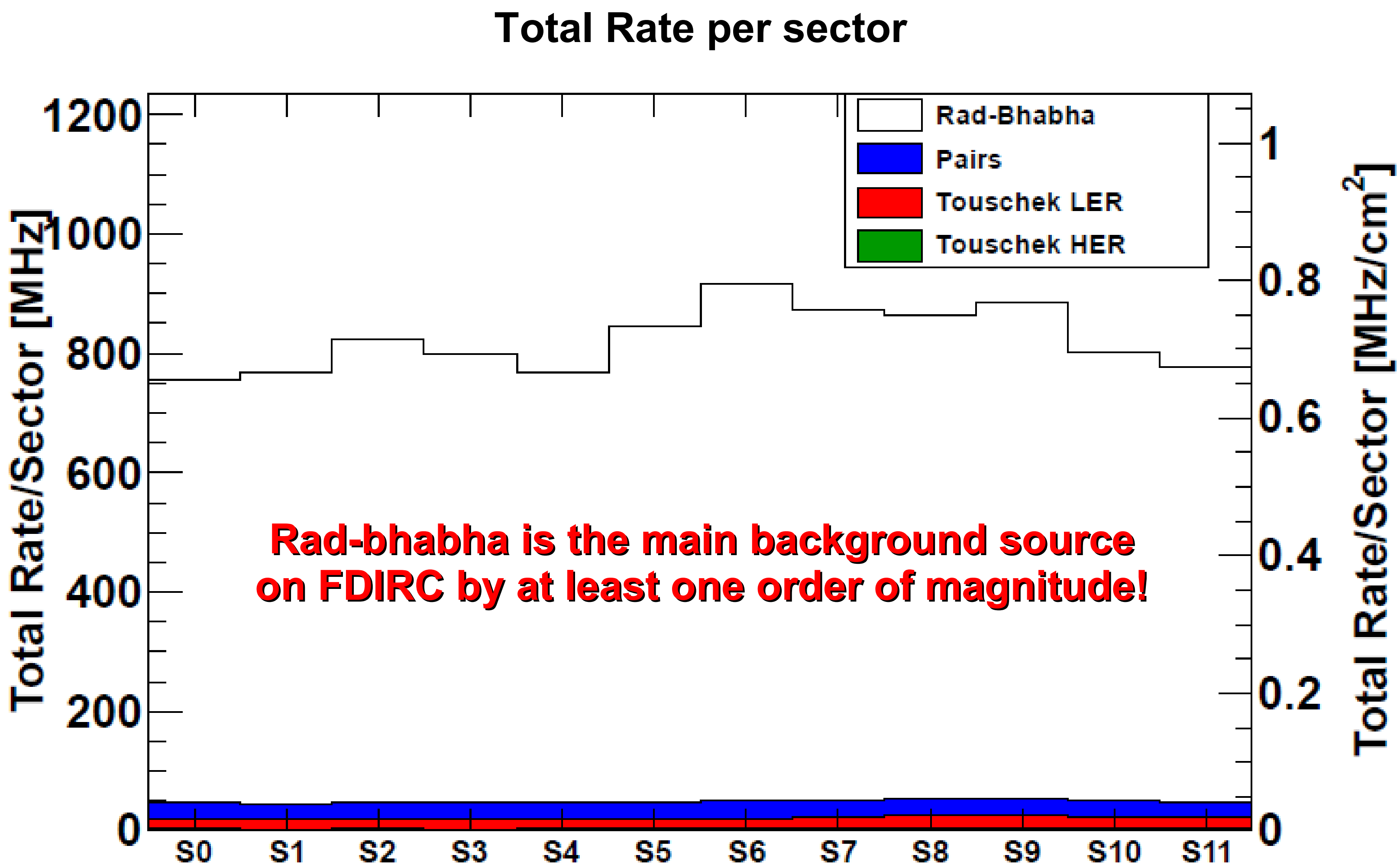
- **Study the pixel rate for different regions were the tracks hit the quartz bar:**
  - (a) Inside magnet: -160 < Z < 220 cm
  - (b) Within steel: -280 < Z < -160 cm
  - (c) Outside magnet: -280 < Z < -400 cm
- **If main contribution comes from outside magnet**

  ⇒ can reduce backgrounds by increasing shields

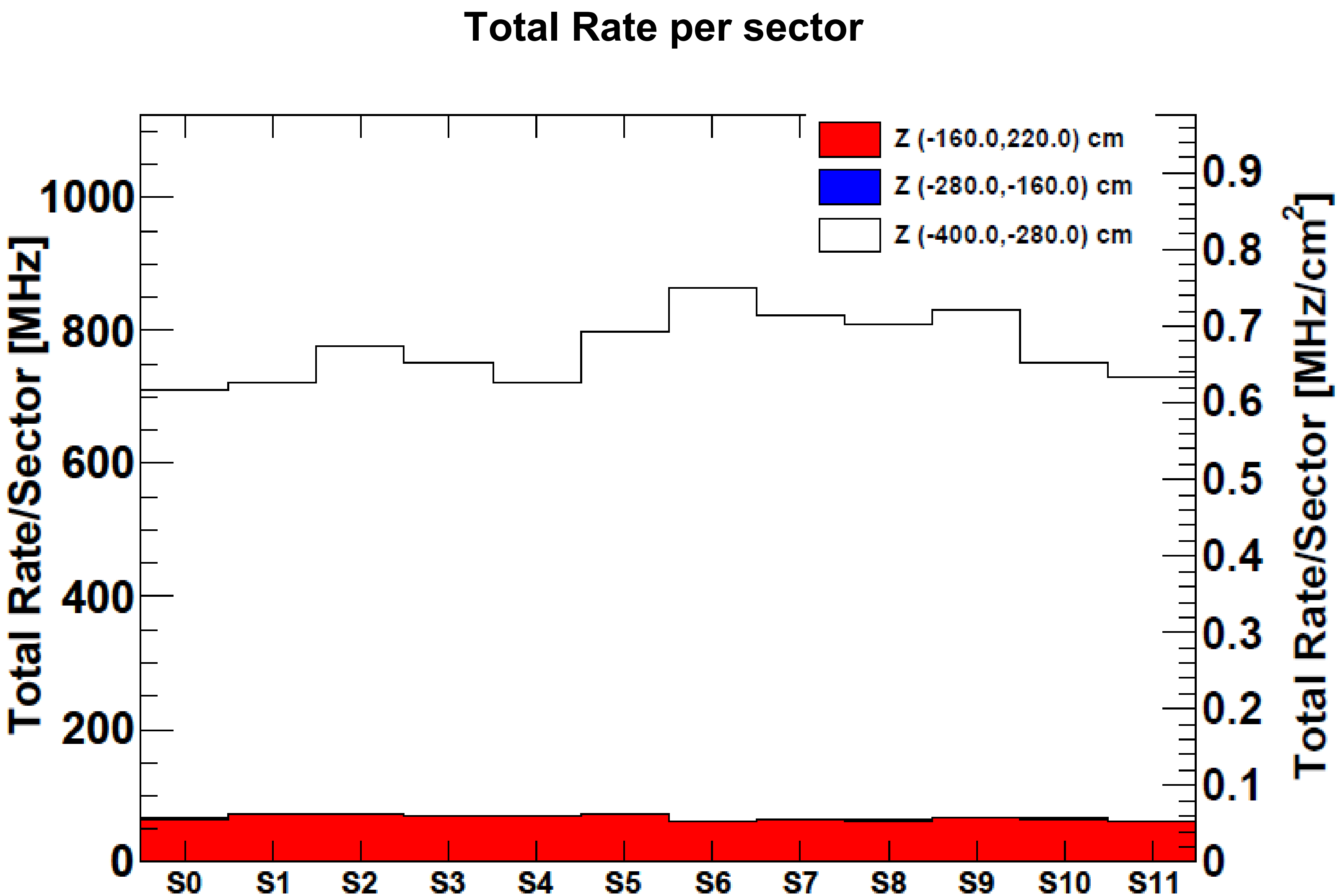




Total bkg rates on FDIRC

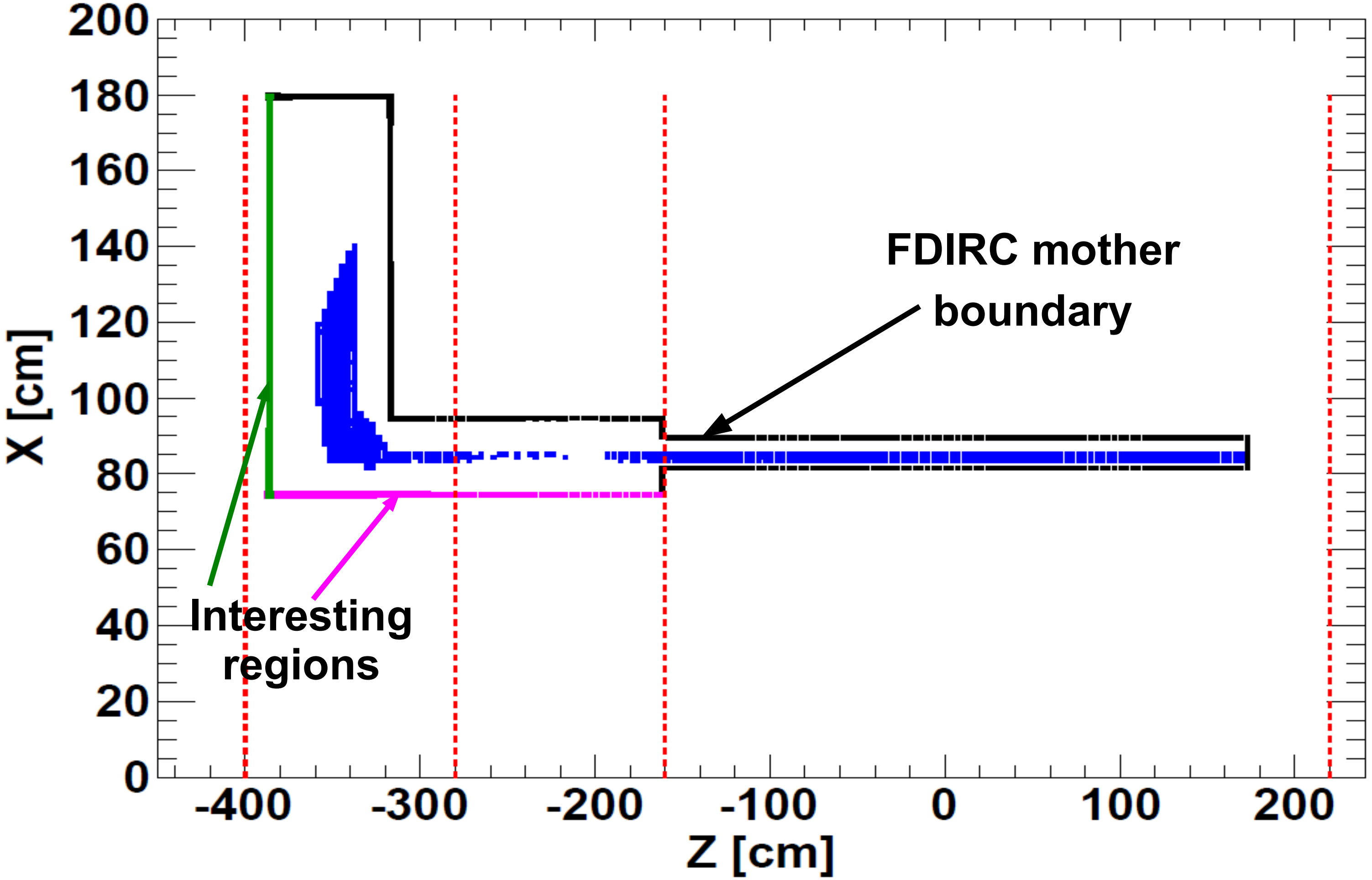


FDIRC Bkg rates from Rad-Bhabha

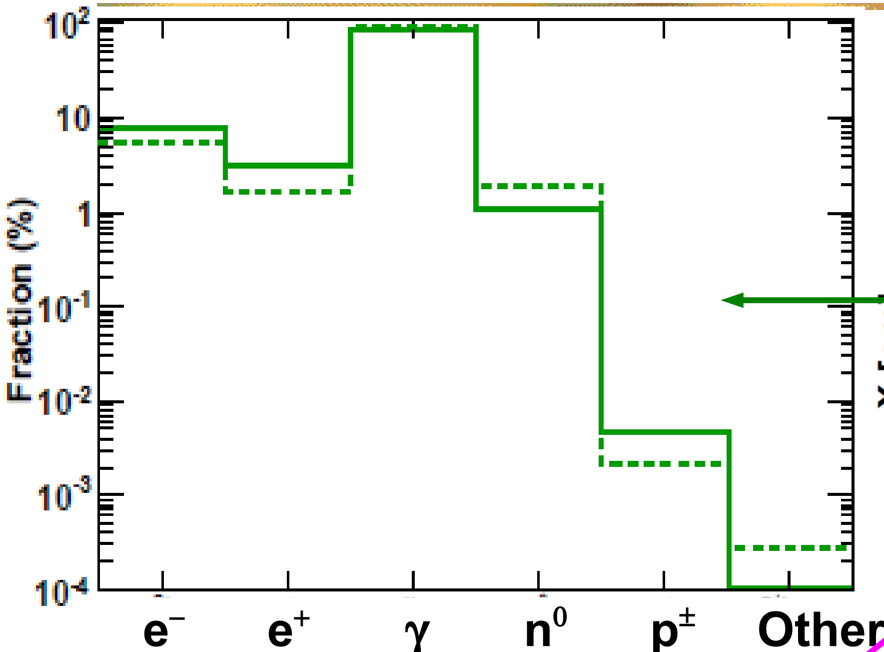


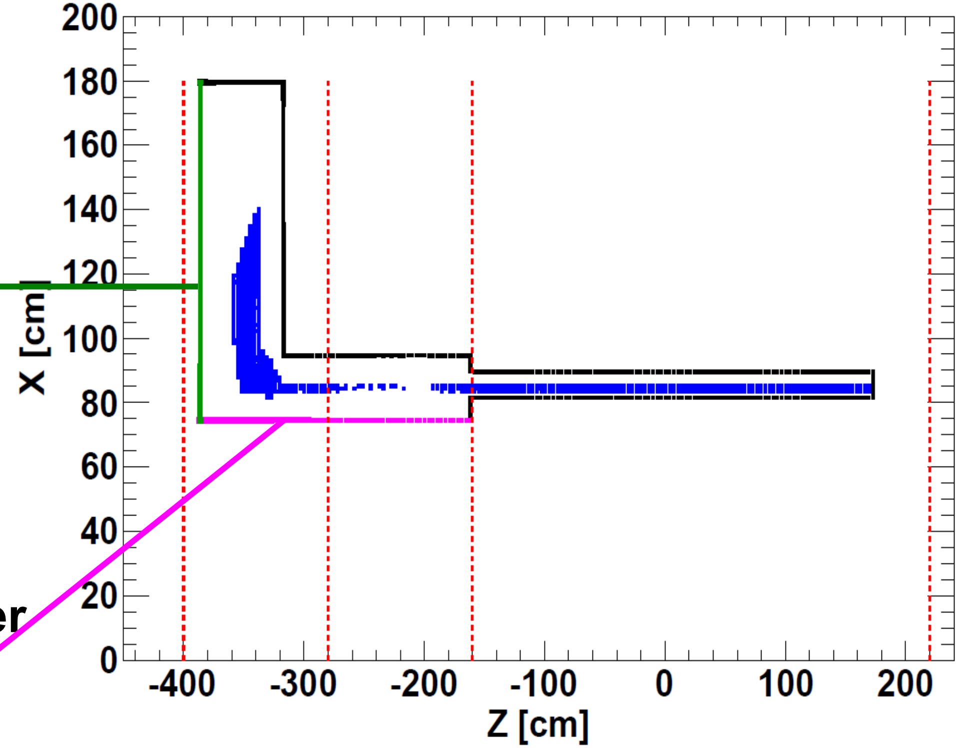
Particle flux studies (I)

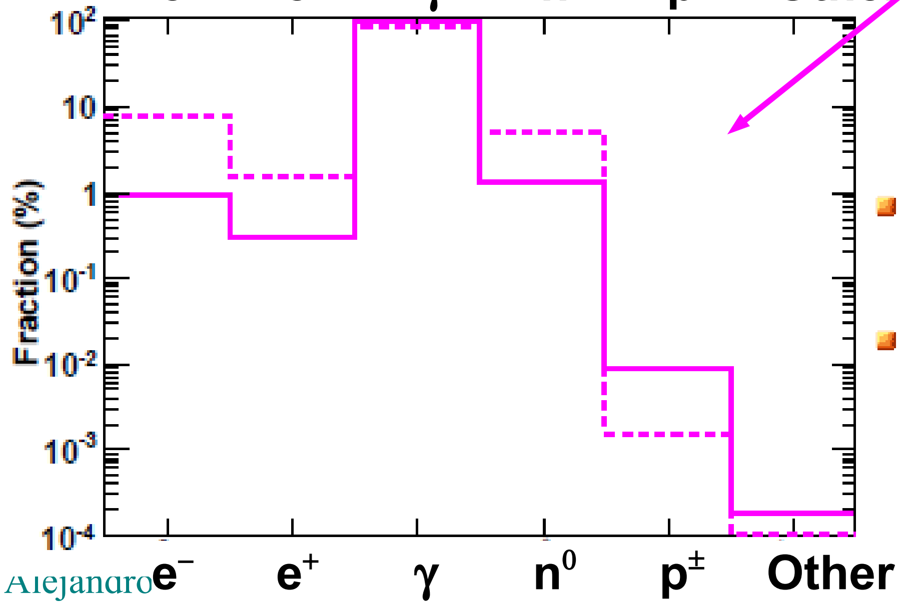
- Study the flux of particles through interesting regions of the the FDIRC mother boundary (magenta and green regions)
- Try to understand the nature of the particles crossing those boundaries (PID and spectrum)



Particle flux studies (II)

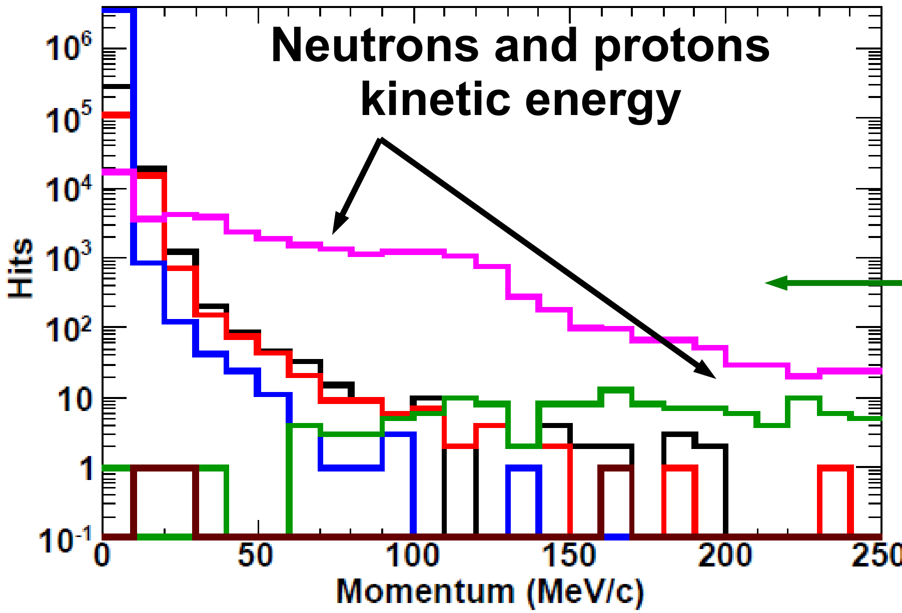


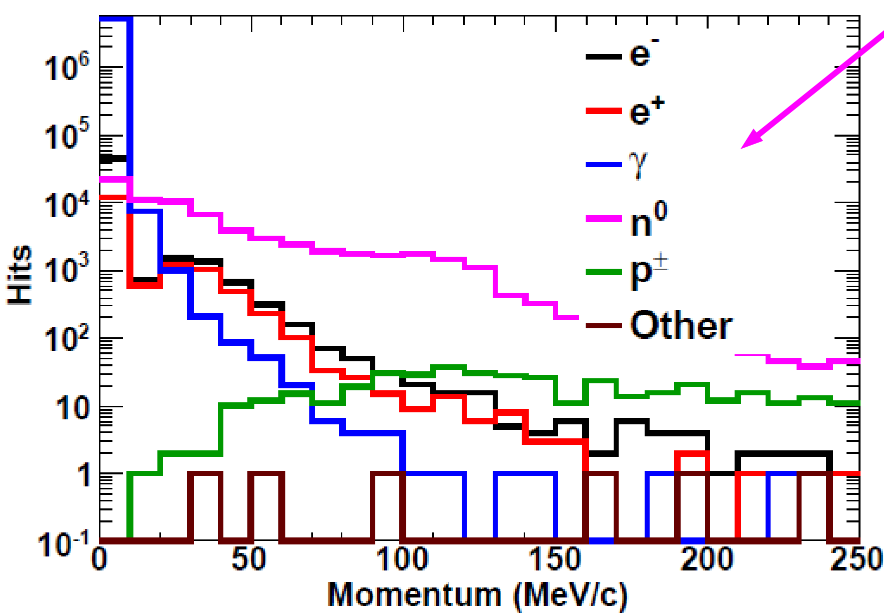


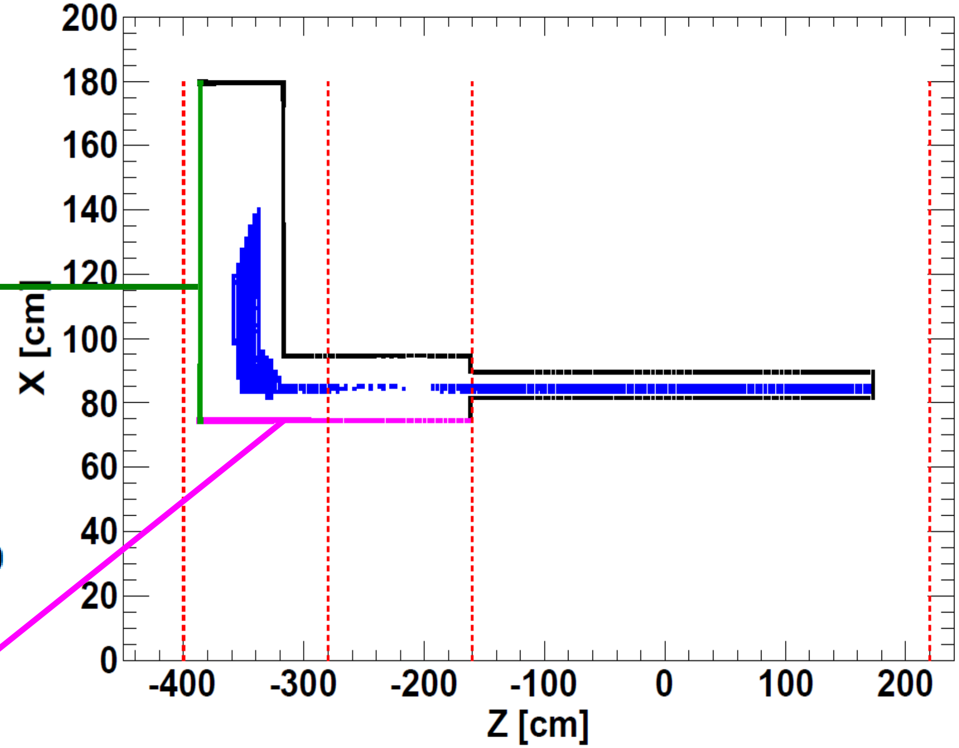


- **The main contribution to the flux are γ (~90 – 98%) and $e^{\pm}$ (1-10%)**
- **In the second place are neutrons (~1%)**

Particle flux studies (III)

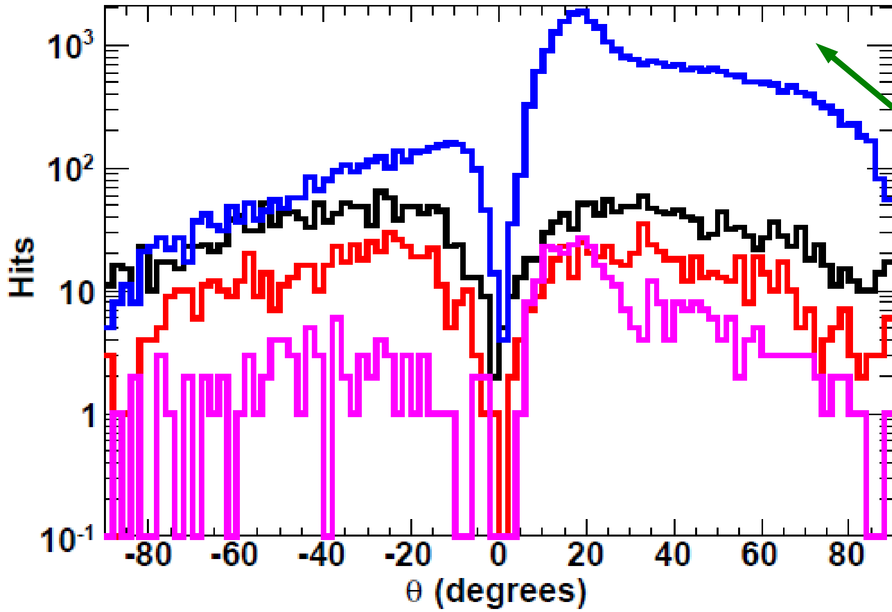


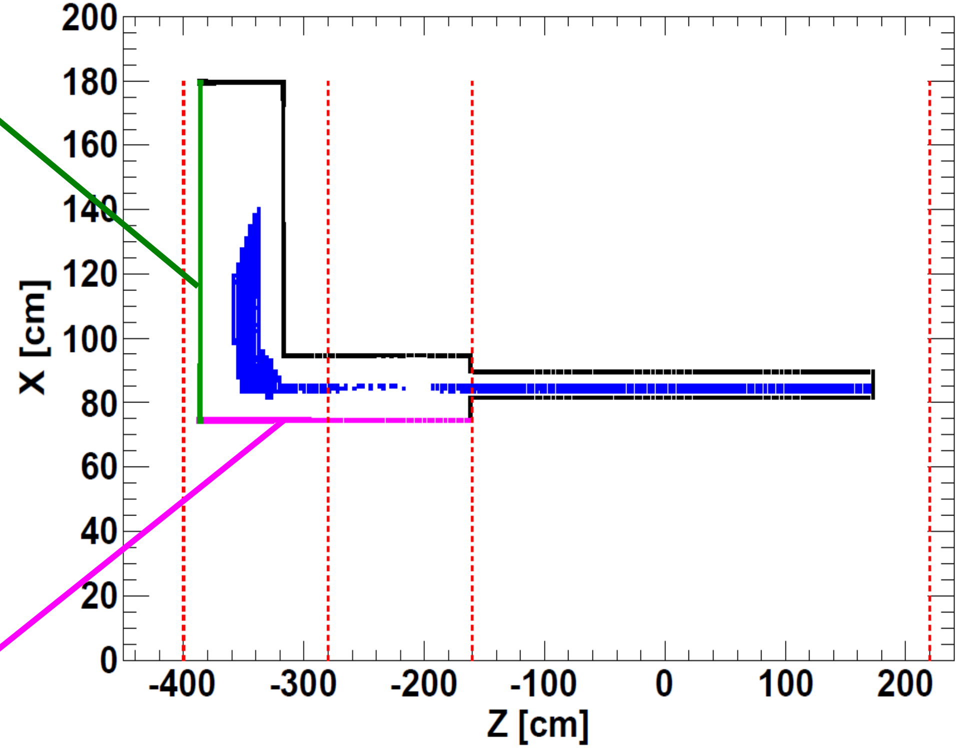


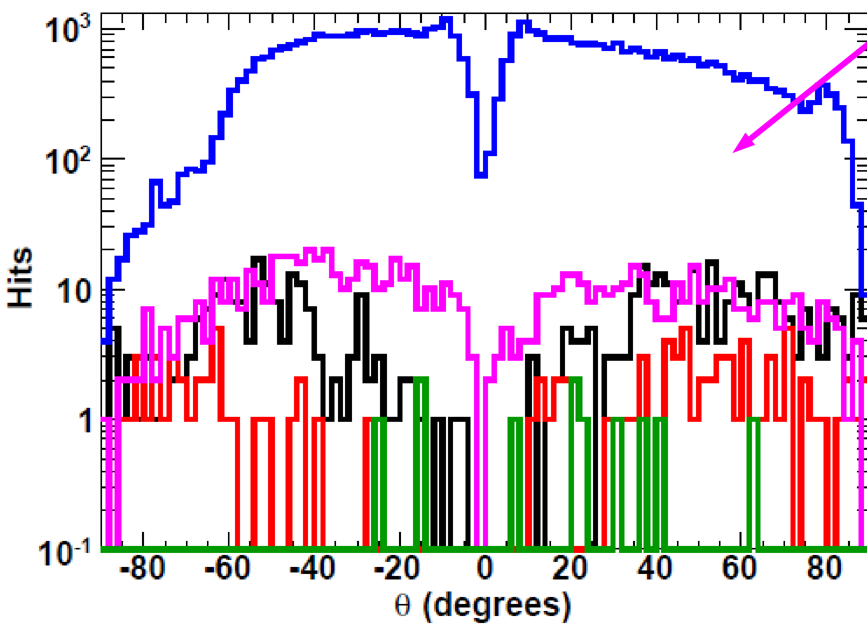


- The main contribution of the flux are γ and $e^{\pm}$ doesn't with energies below 200 MeV
- Neutrons and protons on the other hand have a harder spectrum (kinetic energy)

Particle flux studies (VI)





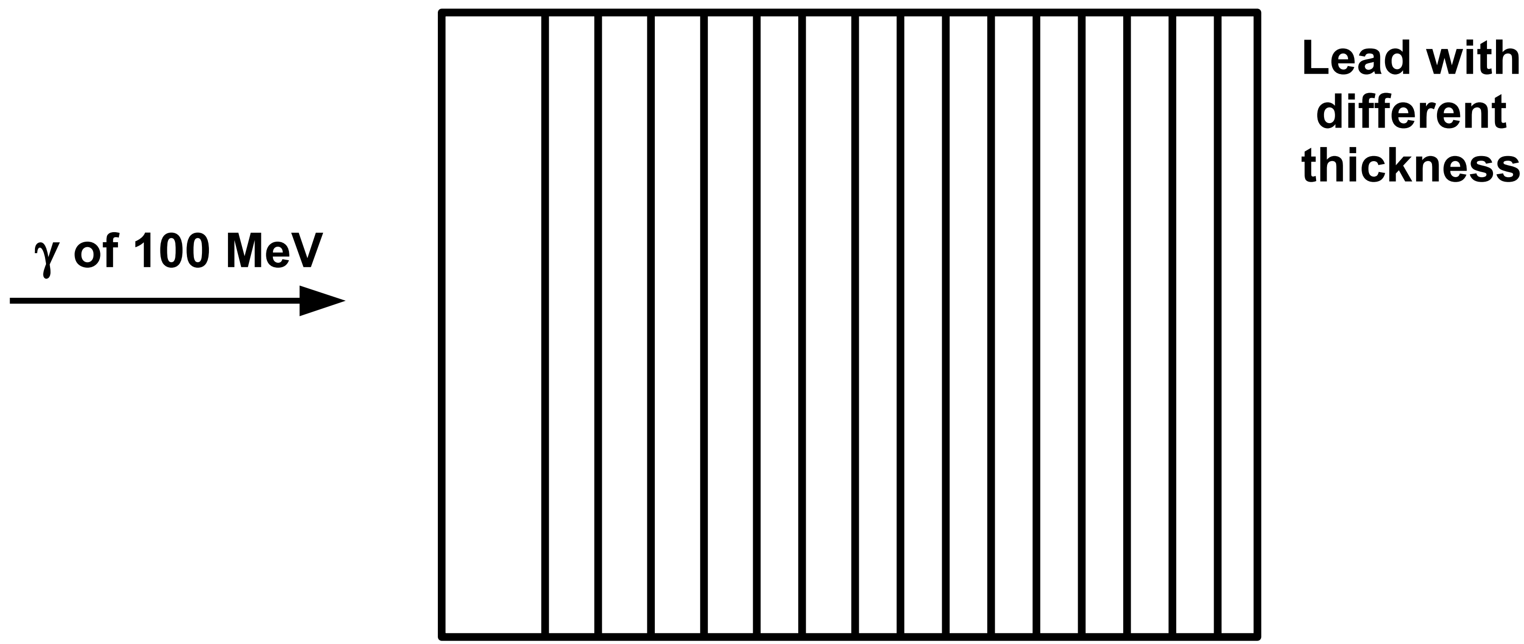


- **Incident angle:**
  - **θ = 0 means normal incidence**
  - **θ > 0 means particles coming more or less from the IP**
- **Most of the particles have a not-normal incidence**

Lead shield optimization studies (I)

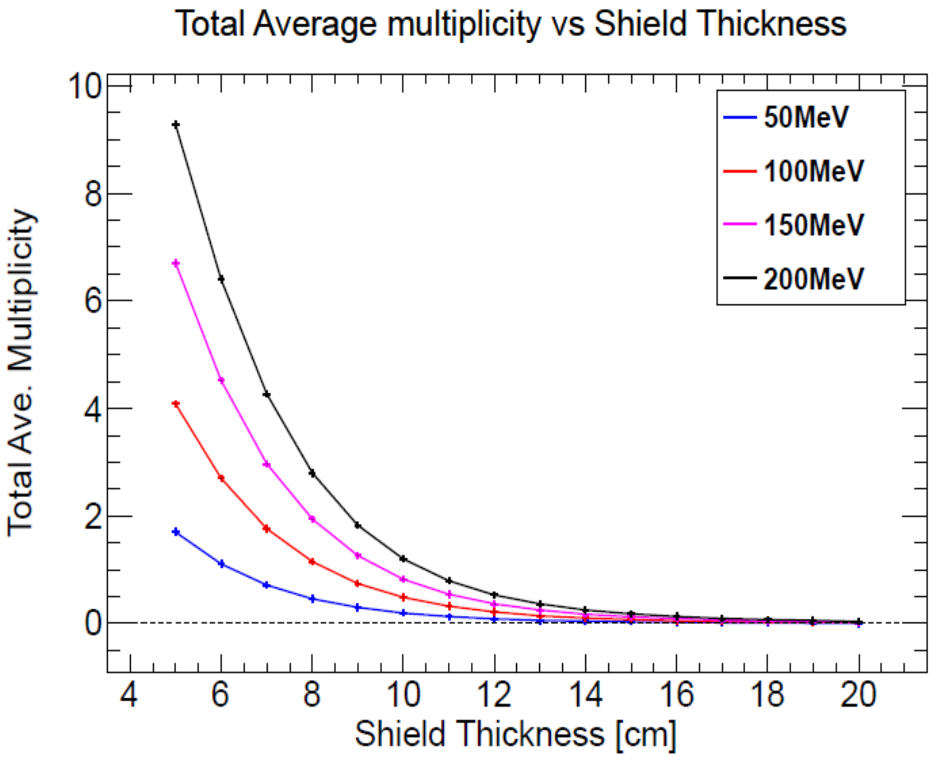
- **Shot particles ($e^{\pm}$, γ, n^0) at normal incidence on Lead for**
  - Different lead thickness: 5 – 20 cm (1cm steps)
  - Different incident energies: 50 – 200 MeV (50MeV steps)
- **Study the particle multiplicity and spectrum at the other end of the shield**
- **Optimization: thickness for which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

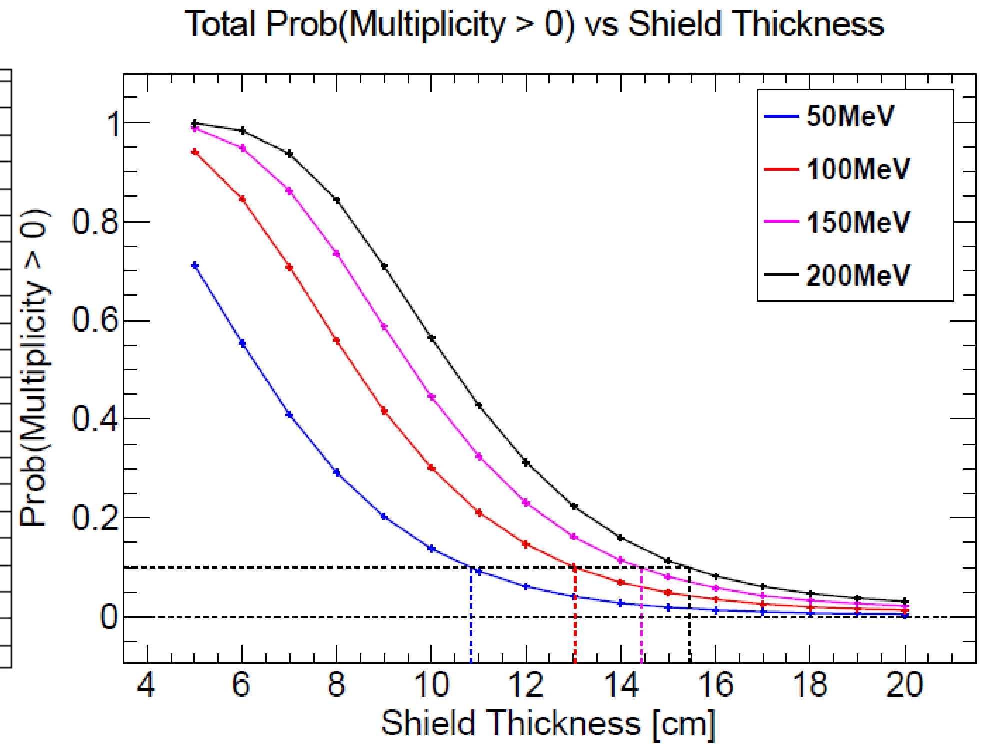
Probability(Multiplicity > 0) $\leq$ 10%



Lead shield optimization studies (II)

Incident photons

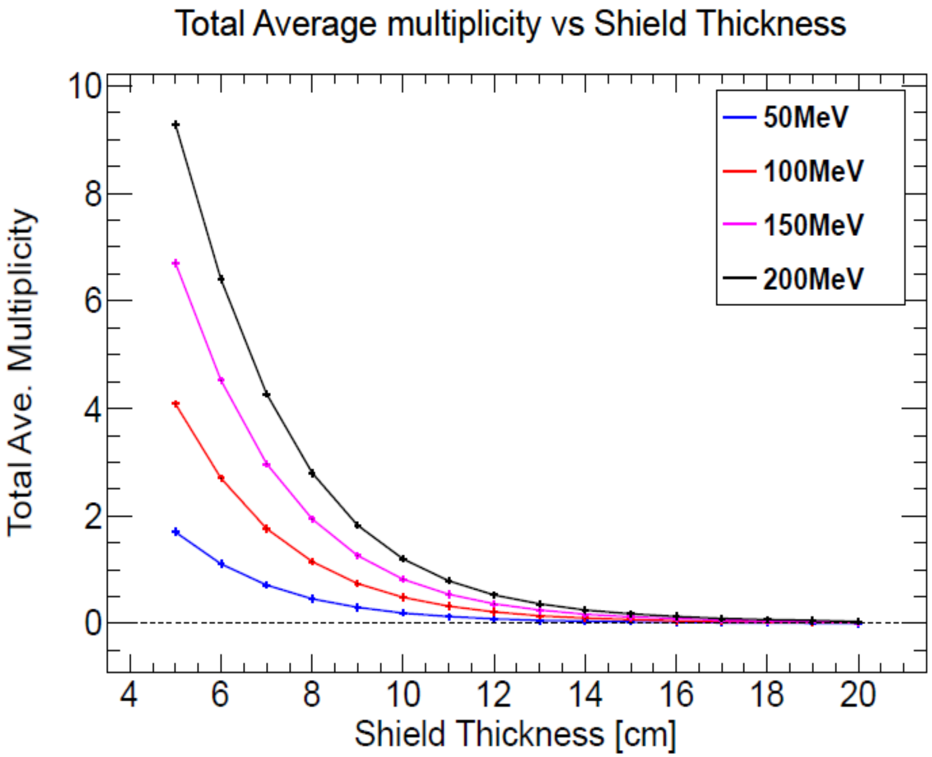


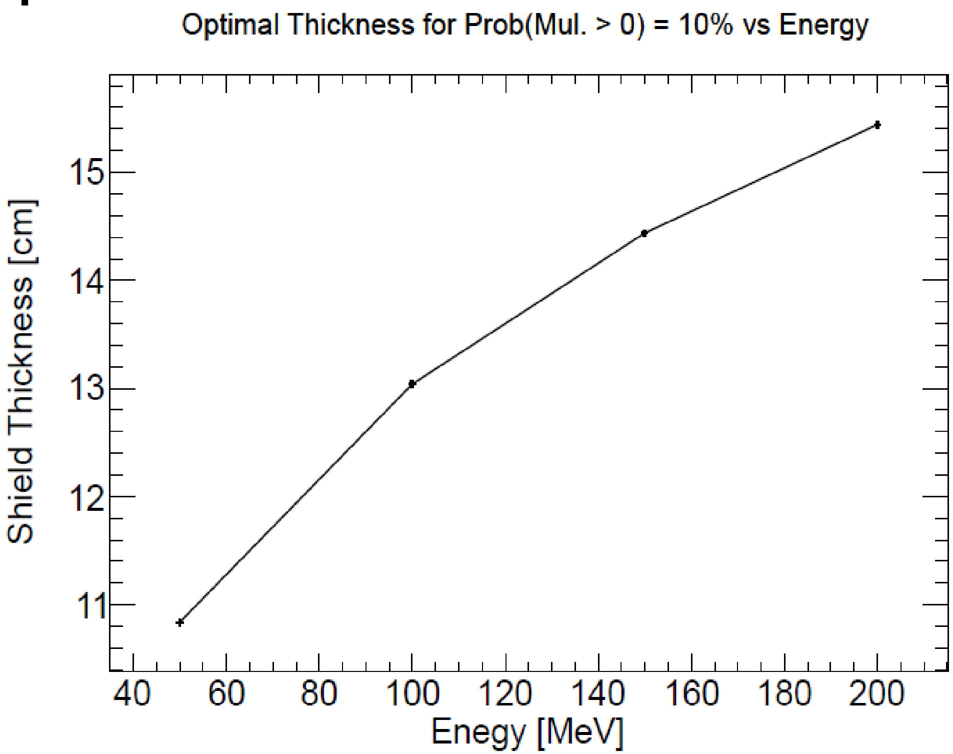


- **Multiplicity at the other end of the lead shield due mainly to photons and electrons/positrons (very small contribution from neutrons)**
- **Higher the energy of the incident photon, thicker must be the lead shield**

Lead shield optimization studies (II)

Incident photons

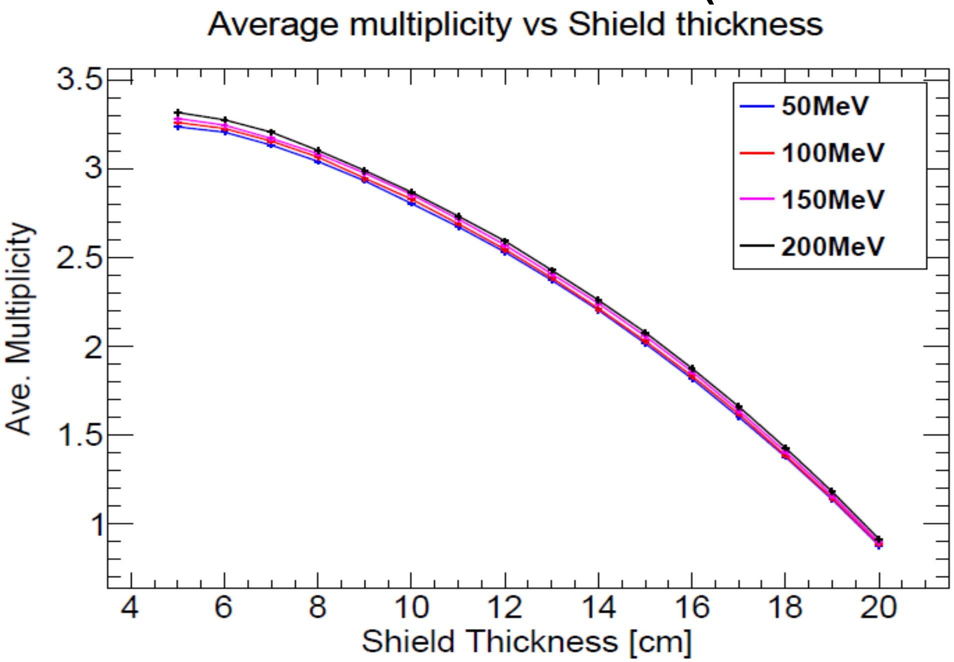


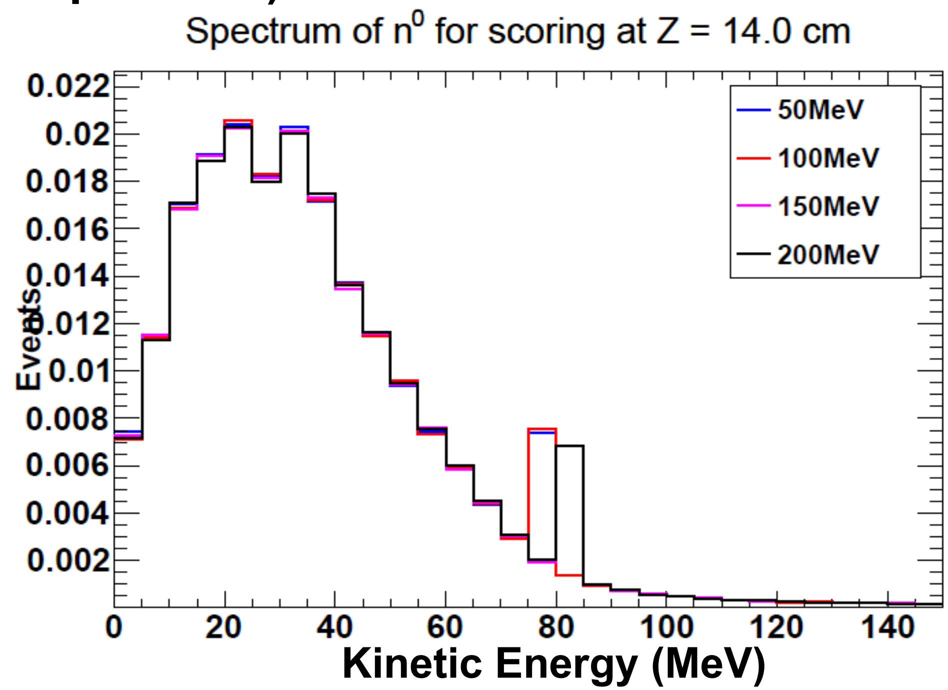


- **Multiplicity at the other end of the lead shield due mainly to photons and electrons/positrons (very small contribution from neutrons)**
- **Higher the energy of the incident photon, thicker must be the lead shield**
- **In order to reduce the photon flux by a factor of 10 for photons up to 150MeV,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

Lead shield optimization studies (III)

Incident neutrons
(neutron multiplication)

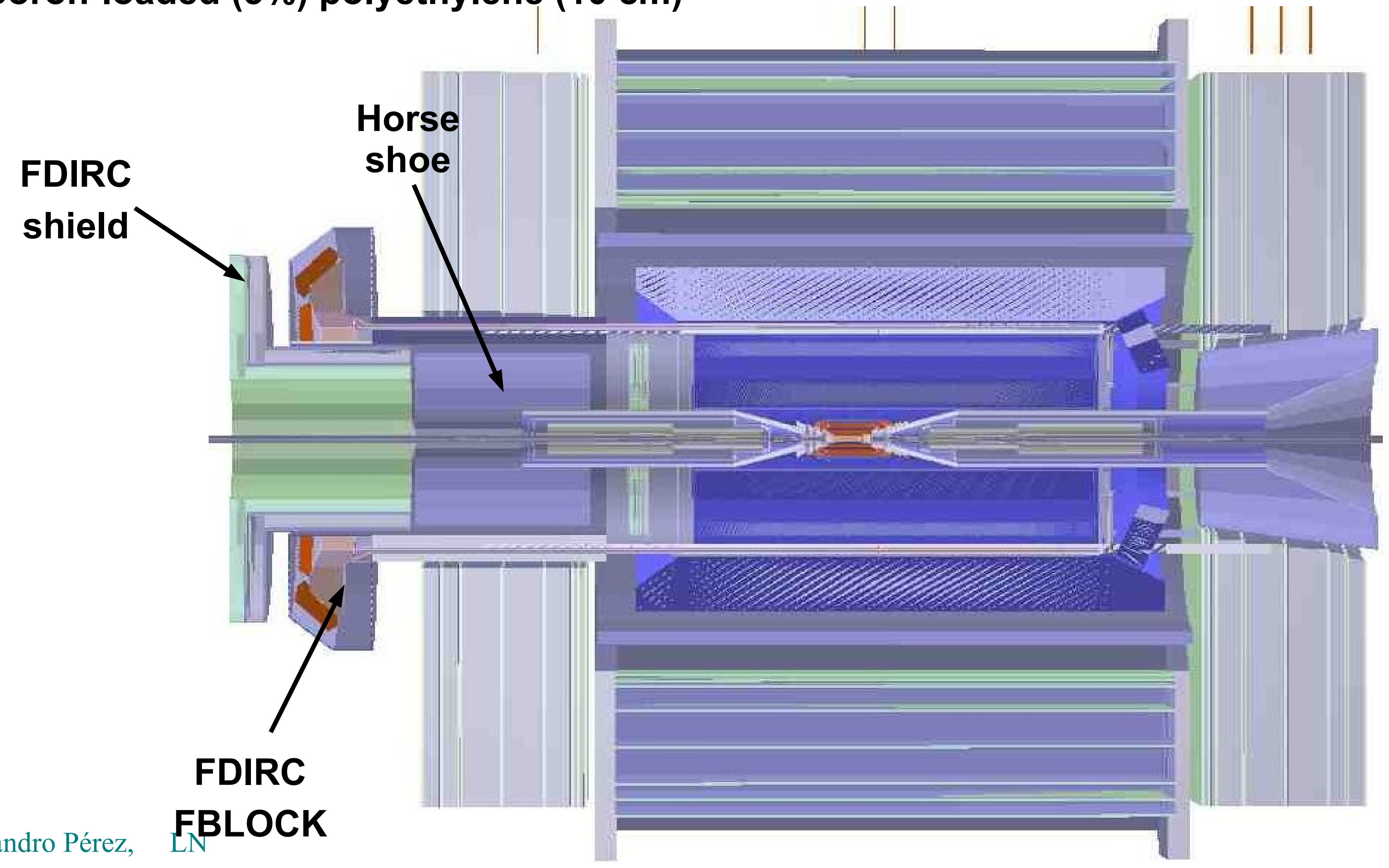




- **Incident neutrons with kinetic energies from 50 to 200 MeV get multiplied by a factor of ~2.3 for lead thickness of 14cm**
- **The kinetic energy spectrum of those neutrons has a slight variation with the incident neutron kinetic energy**
- **Outgoing neutrons have a significant amount of kinetic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

FDIRC shield: BRN implementation

- **Steel-lead-steel sandwich (2.5-10-2.5 cm)**
- **Boron-loaded (5%) polyethylene (10 cm)**



FDIRC shield: BRN implementation

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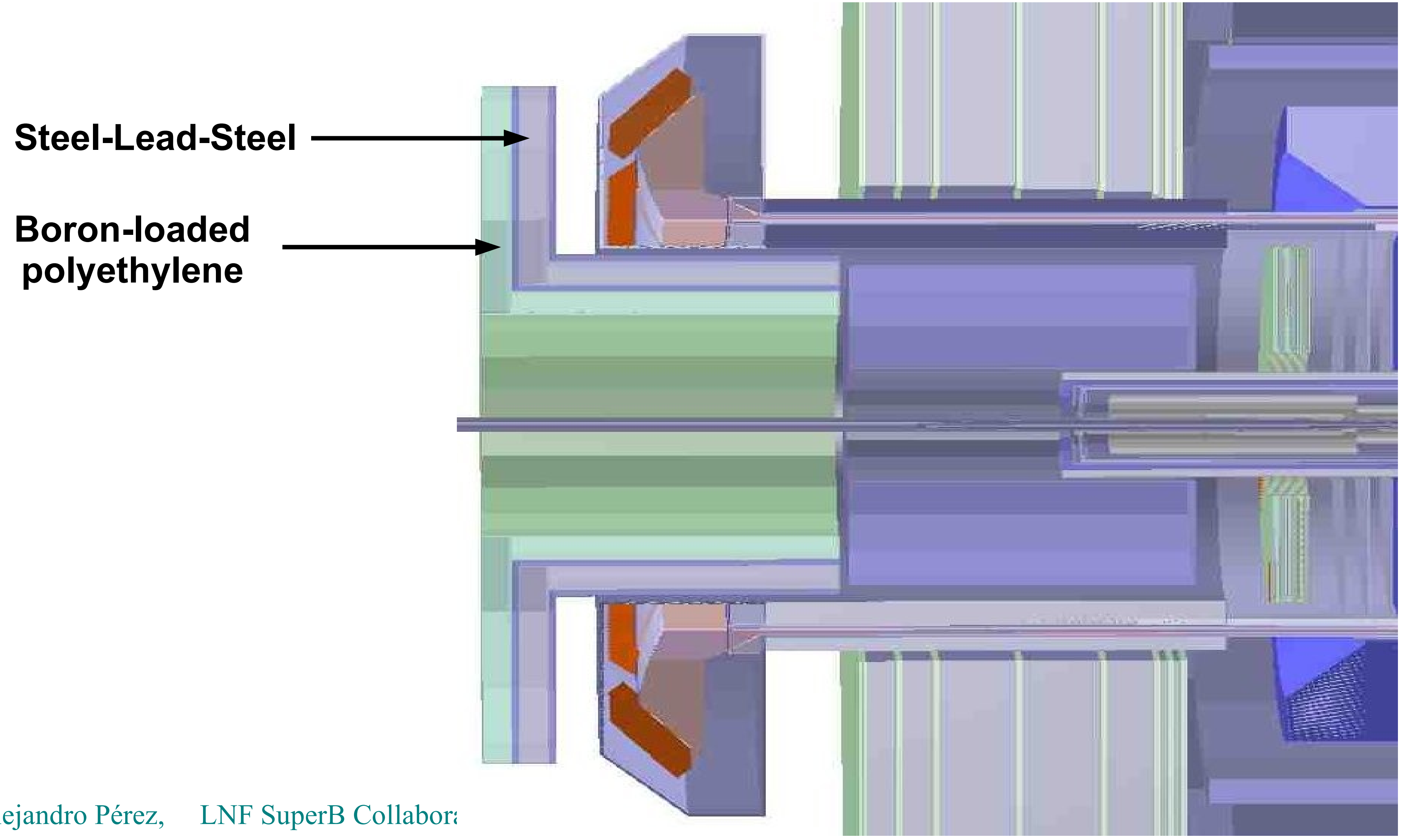

Summary

- **The main machine background contribution on the FDIRC is due to Rad-bhabha, mainly from tracks hitting the quartz bar in the FBLOCK region**
- **Main flux of particles on FBLOCK are photons with energy lower than 200MeV**
- **Lead thickness of 14cm can reduce the background by a factor of ~10**
  Shield BRN implementation: steel-lead-steel (2.5-10-2.5 cm) sandwich
- **Issues:**
  - Neutron multiplication by a factor ~2.2 for lead shield thickness of 14cm
  - Could these neutrons cause problems on the FDIRC electronics?
  - Will add a Boron-loaded polyethylene shield (10 cm)

Backup

The Focusing Detector of Internal Reflected Cerenkov Light

- **Charged particles produce Cerenkov photons**
- **Cerenkov photons transported throughout total internal reflection to a photo-camera**
- **Measure projection on the instrumented plane of the Cerenkov cone angle and measure the particle mass**