FDIRC Background Update Summer 2012 Production

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Pisa SuperB Collaboration Meeting

Outline

- **The new geometry**
- **The samples**
- **A patch to the MaPMT glass window miss-modelling**

- **FDIRC Backgrounds**
  - Rad-bhabha
    - Low $\kappa = \Delta E/E$ ($0.5 < \kappa < 30\%$)
    - High $\kappa = \Delta E/E$ ($\kappa > 30\%$)
  - Pairs
  - Touschek-HER/LER
  - BeamGas-HER/LER

- **FEE dose and Fluency**

- **Summary**

A new default detector configuration for SuperB

- **Several improvements to the detector model where implemented for Summer-2012 production (Geometry_CABIBBO-V03)**
  - **Final focus:** more realistic W-shield compatible with space available and integration constrains. Conical shape of 3cm thick and cylindrical shape 4.5cm thick with increased external radius.
  - **SVT:** newest L0 model (F. Bosi). L1-5 model adapted to the SuperB angular coverage ($\pm$300 mrad)
  - **DCH:** Internal radius increased to make room for W-shield (237 $\rightarrow$ 265 mm); new foils of copper and Aluminium according to latest machanical drawings
  - **EMC:** Hybrid CsI-LYSO fwd-end-cap model and RadFET monitors
  - **IFR:** new iron/Boron-loaded-polyethylene shields
  - **Detector Hall:** more realistic model using Fabrizio Raffaeilli drawings
  - **Solenoidal detector field:** field was extending beyond the Super-conducting magnet volume and was not zero inside the FDIRC FBLOCK.
- **NOTE:** found a problem with FDIRC geometry related with the MaPMT photocathode using BK7. The problem was fixed (changing material to Aluminium) and committed but not in time for Summer-2012 production. Summer-2012 samples are still usable applying a post-production patch. New production will be run if needed.

The machine background model

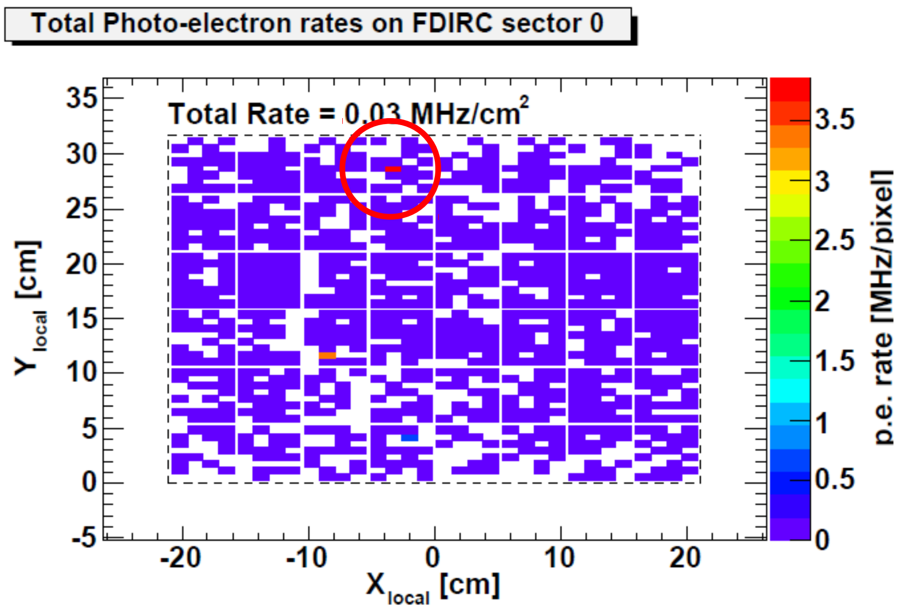
- **We are continuously our background model. The usual samples have been studied**
  - High-κ Rad-Bhabha (κ > 30%). This is the main Rad-bhabha component giving backgrounds on the detector.
    - Geometry_CABIBBO-V03/Geometry_CABIBBO-V03_LYSO: 15k/12k bunch-crossings (BC)
  - Pairs (Geometry_CABIBBO-V03): 100k BC
  - Touschek HER/LER: 88k/198k primaries
  - Beam-Gas HER/LER: 185k/283k primaries
- **In this cycle we also produced for the first time two other background sources (Geometry_CABIBBO-V03)**
  - Low-κ Rad-Bhabha (0.5 < κ < 30%): 20k BC
    - Models a significant fraction of the total Rad-bhabha losses for |Z| > 10m (first downstream dipoles)
    - These losses can contribute significantly to the neutron cloud build up process
  - Synchrotron Radiation (SR) HER/LER: 10k/10k BC

A Patch to the MaPMT glass window miss-modelling

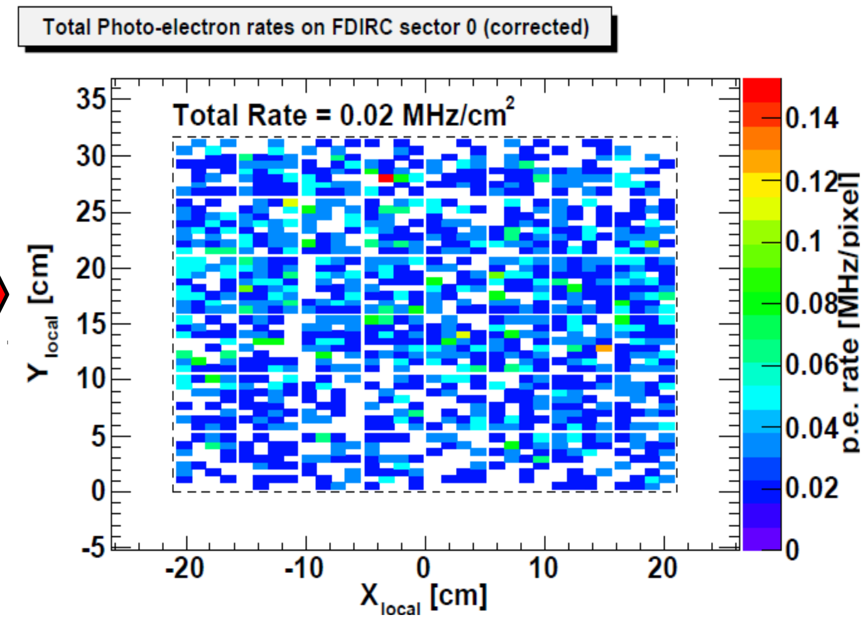
- **A closer look to the April-2012 samples revealed that there were some strange hits which consisted of many optical photons hits on a single pixel (> 20) within a fraction of a nano-sec**
- **After some studies it was concluded that the reason was a miss-modelling of the MaPMT glass window. See next talk by N. Arnaud for more details**
- **A fix was implemented but not in time for the Summer-2012 production. The samples are still usable applying a patch filtering these strange hits**
  - Within an event (bunch-crossing), look for pixels with more than 15 hits.
  - Check if all these hits are within a fraction of nano-sec and if they come from the same mother
  - All such hits are then excluded from the background rates estimation

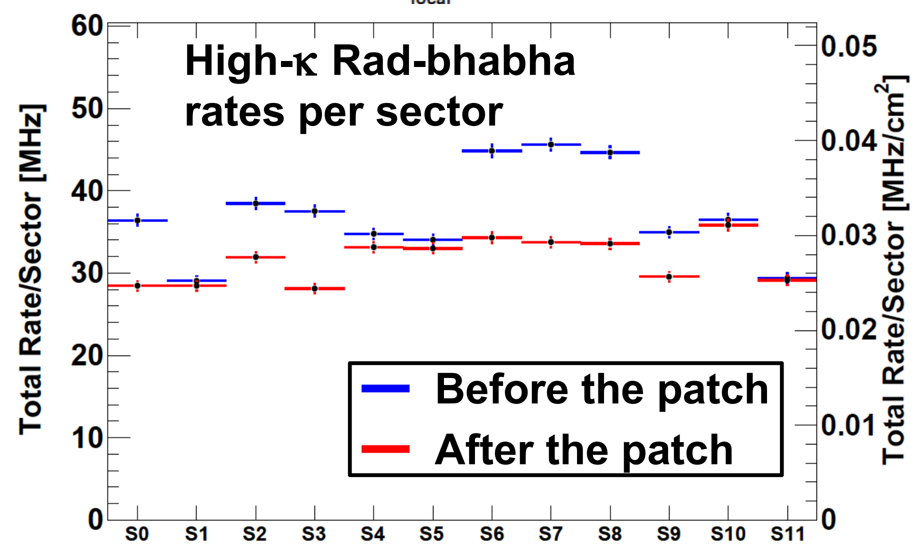
The patch in action

Before the patch



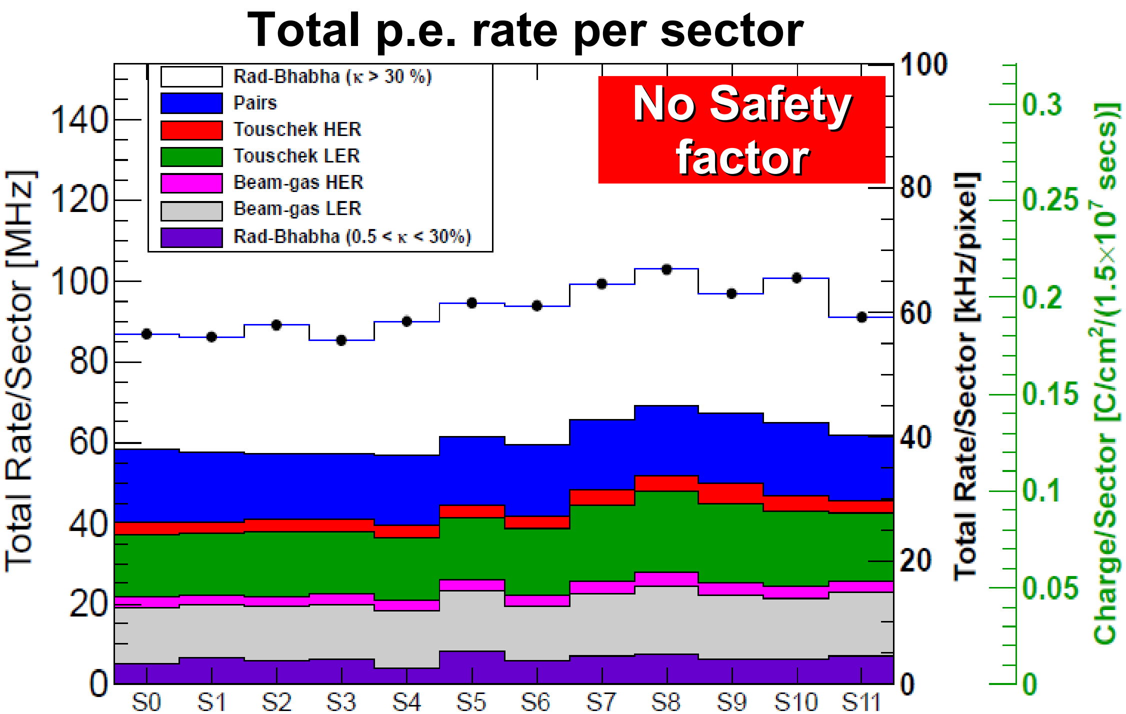
After the patch

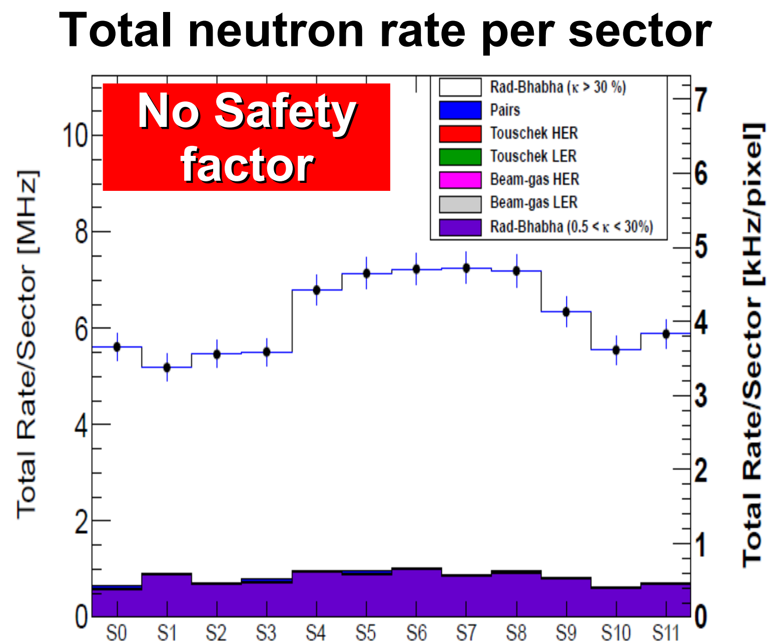


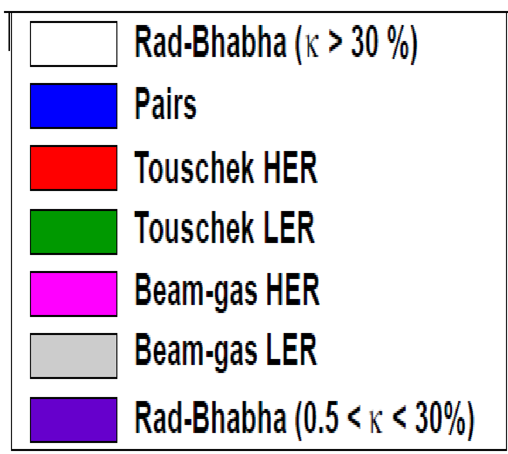


- **Algorithm correctly identify “hot pixels” and filter them out**
- **The total rates in some sectors get significantly reduced by up to 25-30%**

Total bkg rates on FDIRC







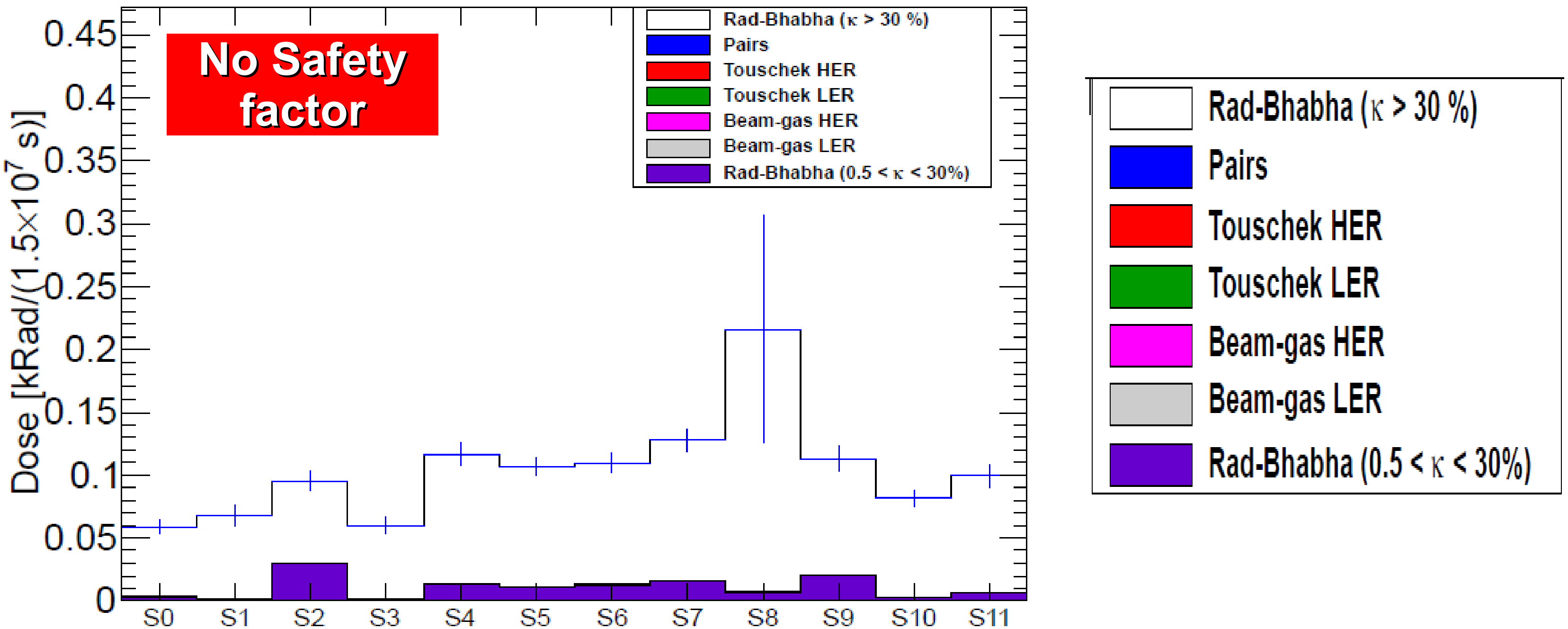
- **After all improvements on the final focus and FDIRC shieldings Rad-bhabha is not the main contribution. All background sources give similar contributions**
- **It is verified that the Low-κ Rad-bhabha give a small but non-negligible contribution total rates. It is ~10% (~15%) of High-κ Radbhabha p.e. (neutron) rate**
- **Summary: p.e. rate ~65kH/sector/pix (~0.2 C/cm^2/year). Neutron rate ~5 kH/sector/pix**

FEE Dose and fluency: The dose

- **Doses:** (total deposited energy on FEE per sector)/(total mass per sector)

  Quoted doses are for 1.5×10^7s $\Rightarrow$ 10ab^{-1} integrated luminosity
- **Main doses on FEE are due to electrons/positrons (ionization) and some heavy ions (very minor component)**
- **Main source of doses are Rad-bhabha (both low and high κ). The other sources are negligible (a factor of 100 smaller)**
- **Summary Dose: ~120 Rad/sector/year**

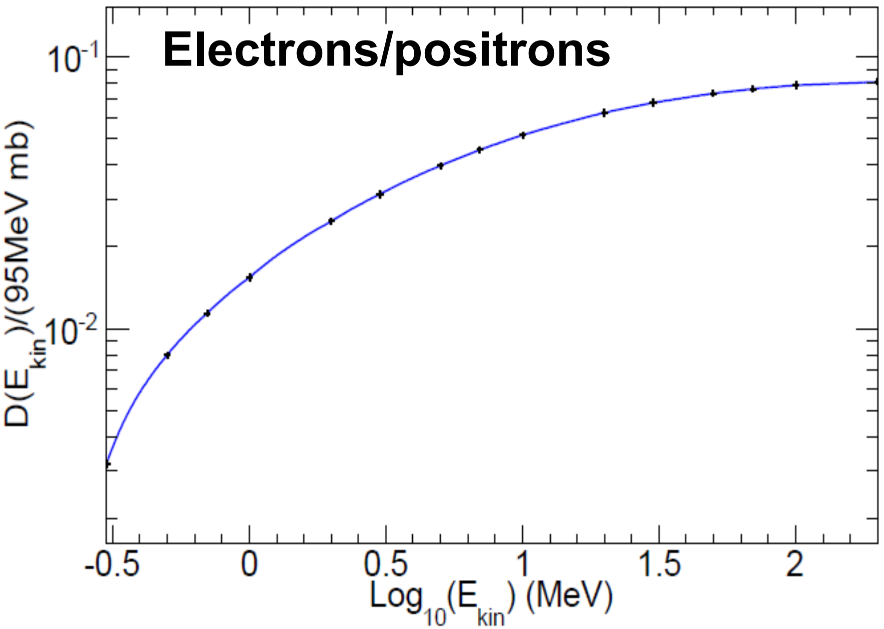
Total dose per sector on FEE

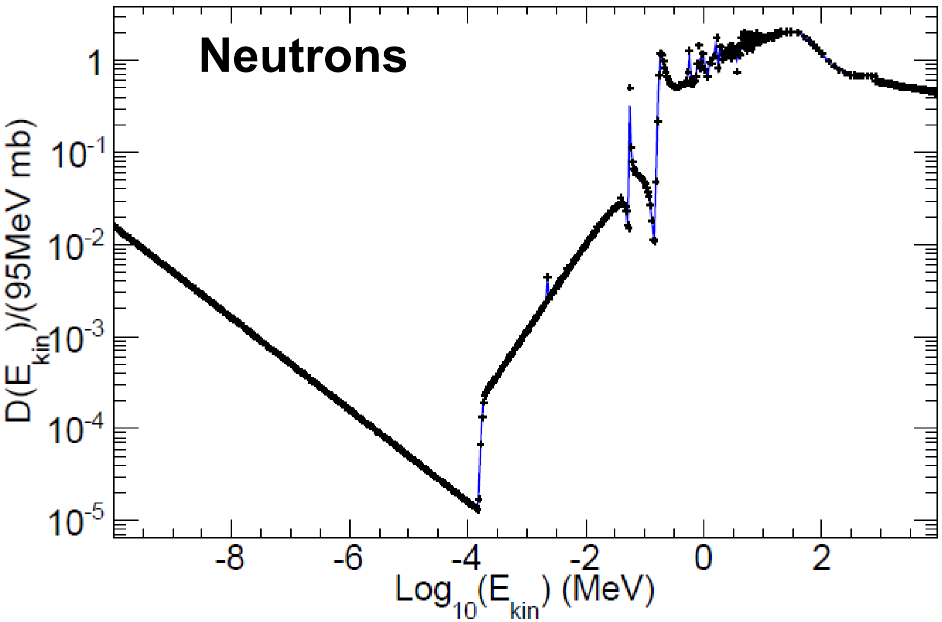


FEE Dose and fluency: The fluency (reminder)

- Estimate the 1MeV neutron equivalent fluency per sector
- Particle fluxes are scales by the damage function relative to 1MeV neutrons: $D(E_{kin})/(95MeV\ mb)$. Different damage function for different particles types
- Quoted fluency per sector are for 1.5×10^{7}s $\Rightarrow$ $10ab^{-1}$ integrated luminosity

$D(E_{kin})/(95MeV\ mb)$ vs $Log_{10}(E_{kin})$

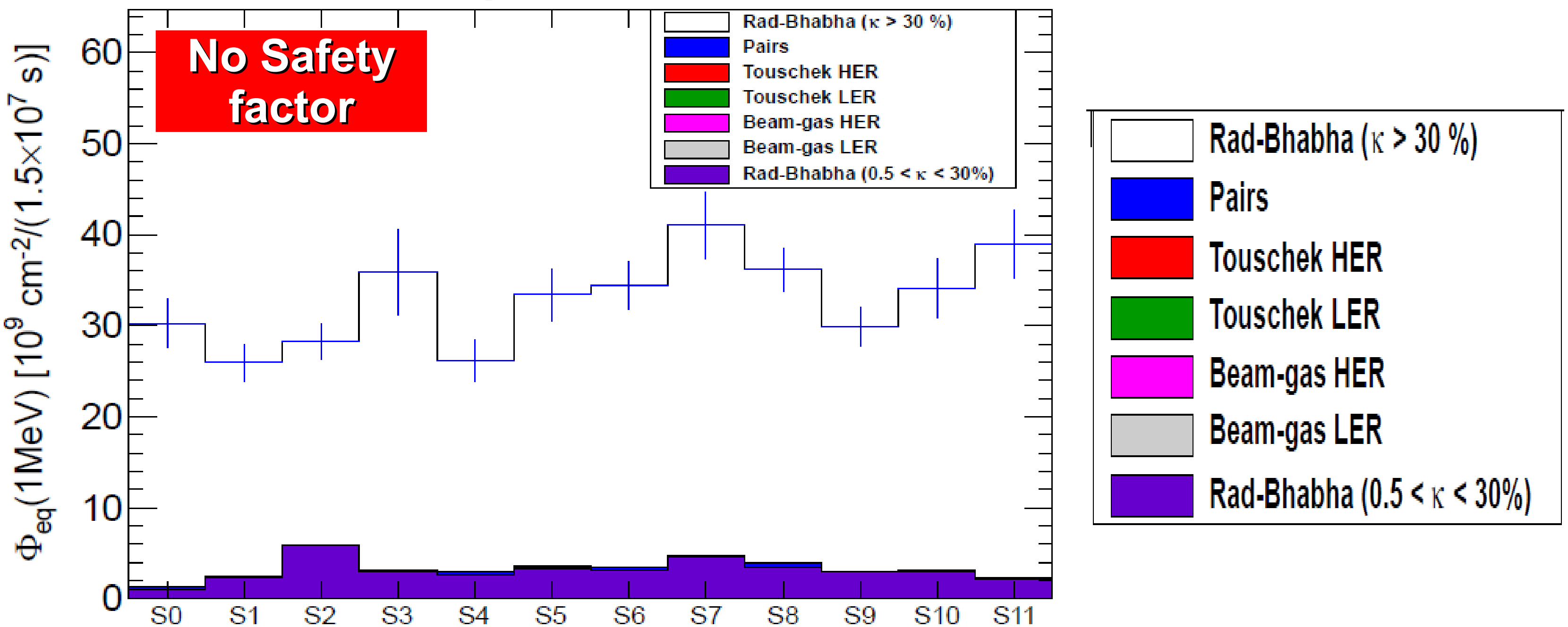




FEE Dose and fluency: The fluency (results)

- **Estimate the 1MeV neutron equivalent fluency per sector**
- **Particle fluxes are scales by the damage function relative to 1MeV neutrons: $D(E_{kin})/(95\text{MeV mb})$. Different damage function for different particles types**
- **Quoted fluency per sector are for 1.5×10^{7}s $\Rightarrow$ 10ab^{-1} integrated luminosity**
- **Summary fluency: ~33×10^{9} (1MeV neutrons) cm^{-2}/year**

Total dose per sector on FEE



Summary

- **A very complete set of background samples have been analysed**
  - Rad-bhabha (low and high κ)
  - Pairs
  - Touschek and BeamGas (HER/LER)

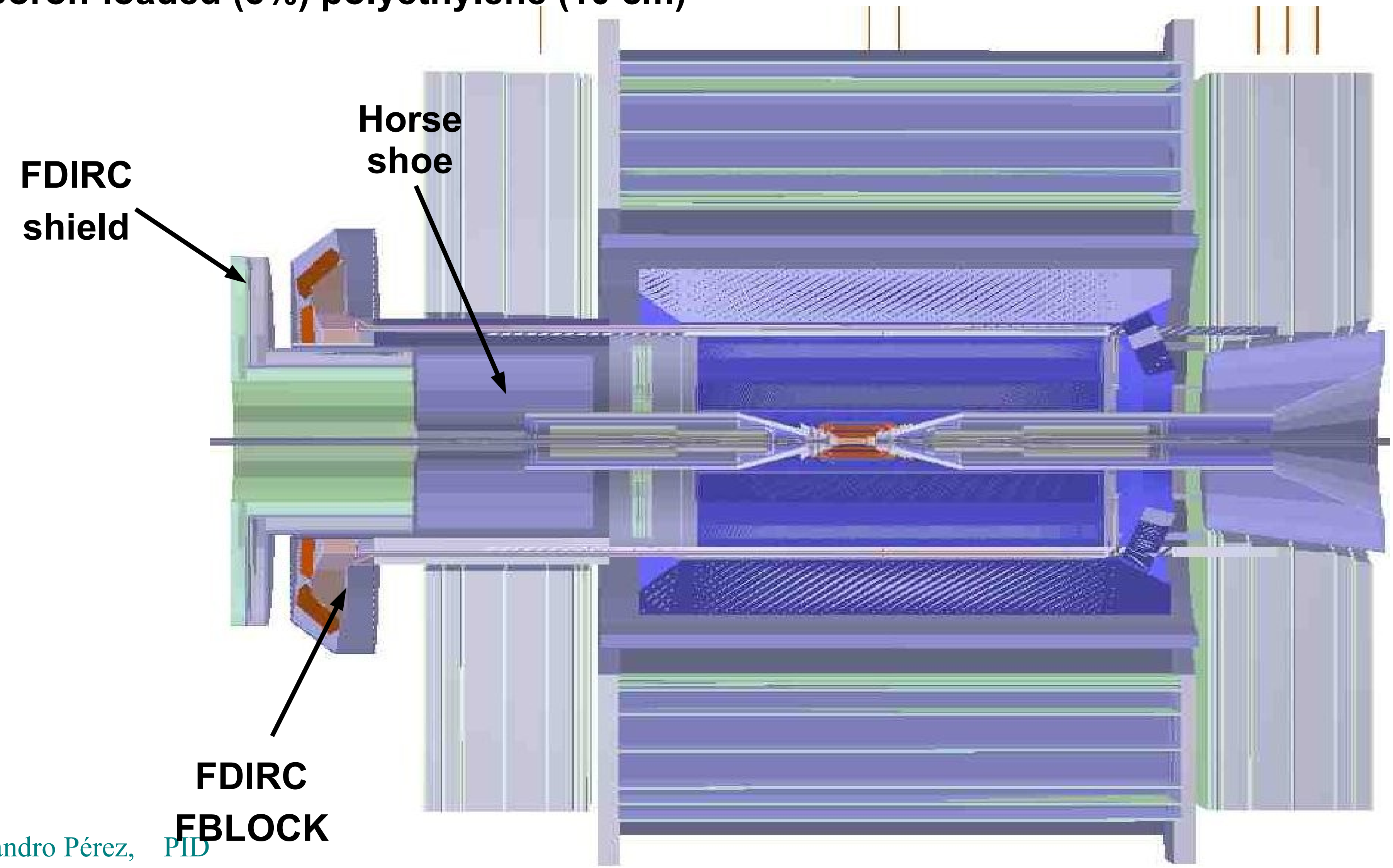
- **Rates**
  - All background sources give similar contributions
  - p.e. rates are ~65 kH/sector/pixel (~0.2 C/cm^2/year)
  - Neutron rates are ~5 hH/sector/pixel

- **FEE dose and fluency**
  - Doses are ~120 Rad/sector/year
  - 1MeV neutron equivalent fluency is ~33×10^9 cm^{-2}/year

Backup

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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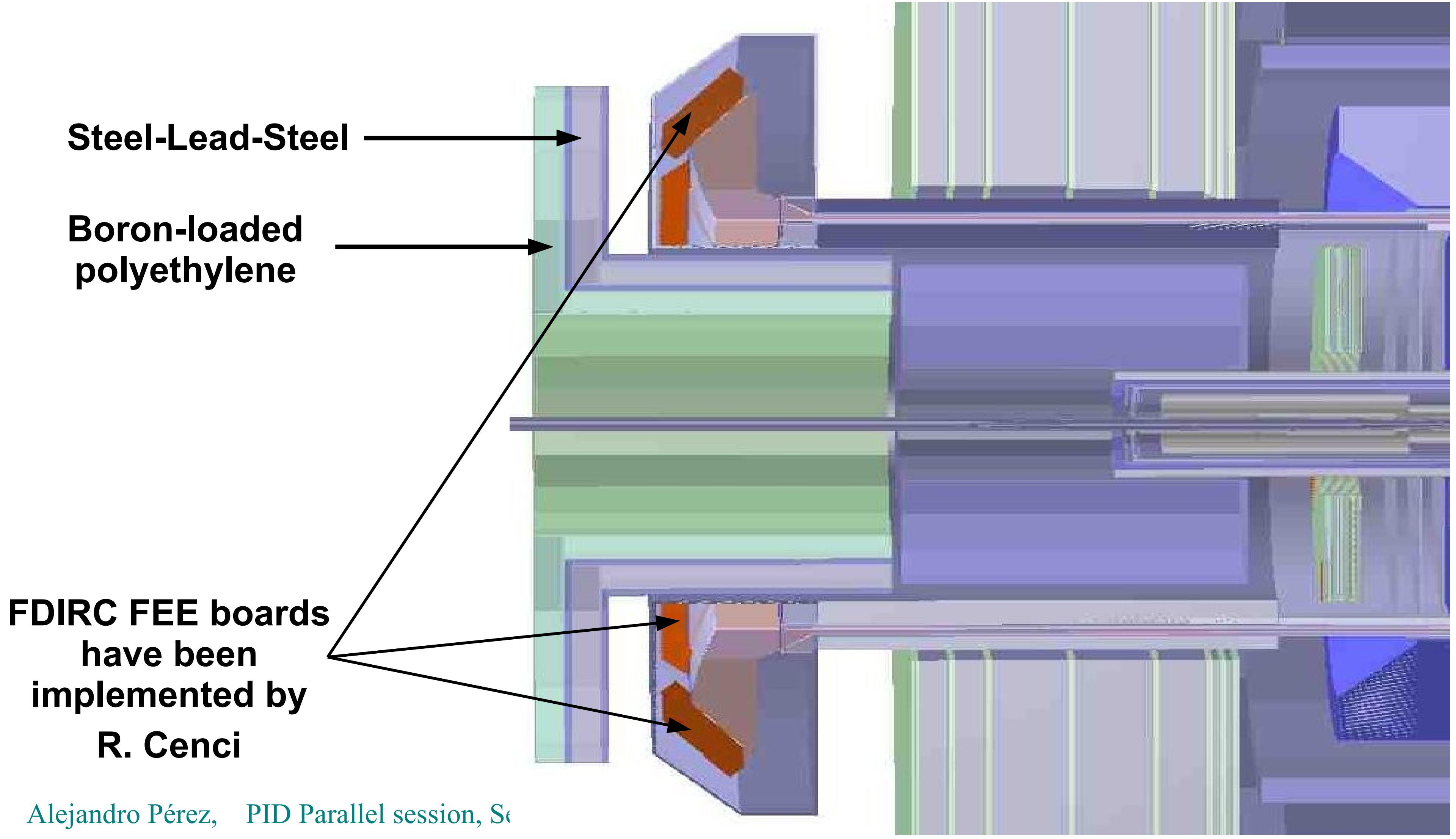
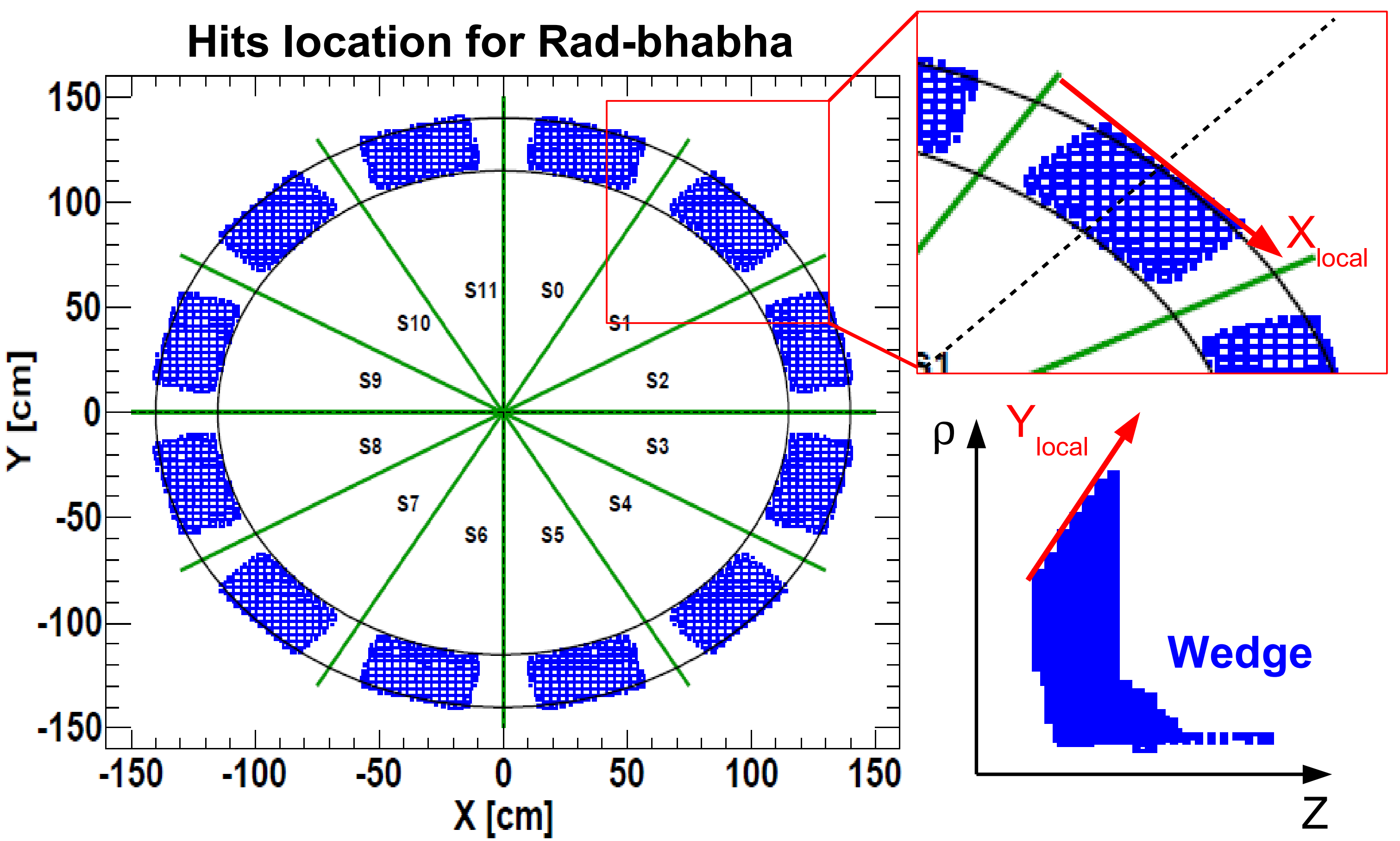


Bkg rates on the FDIRC: Strategy (I)

- **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}



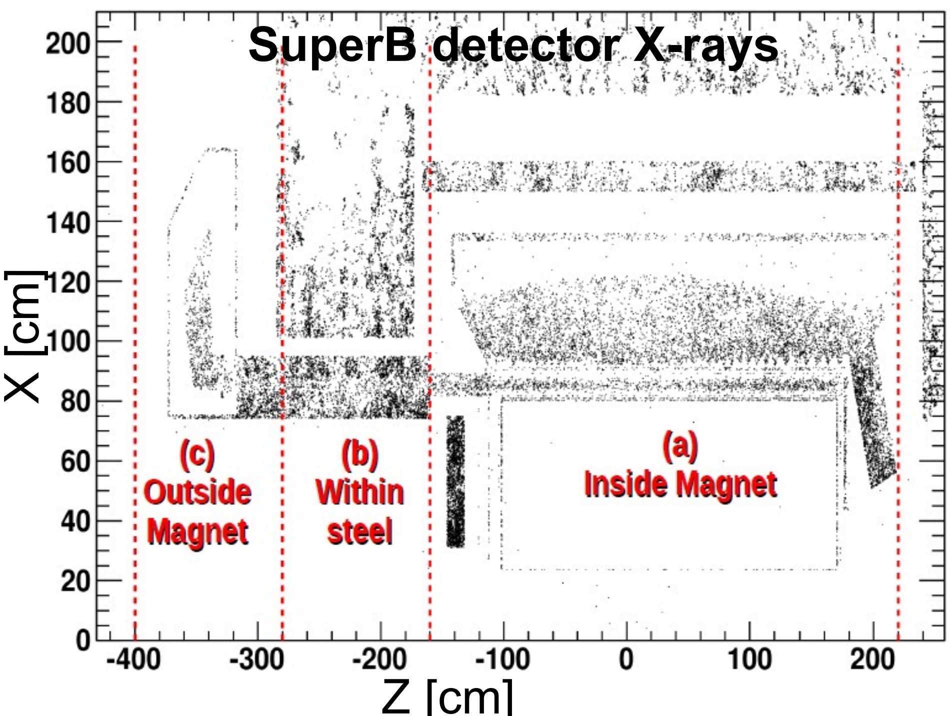
X_{local}:
From -width/2
up to width/2

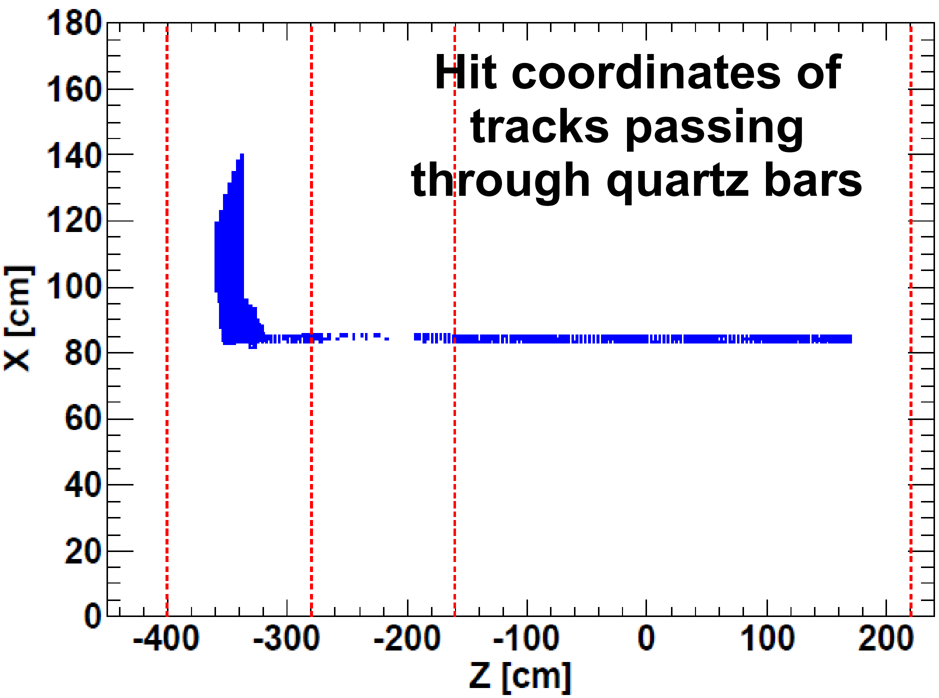
Y_{local}:
From 0.0
up to Length

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

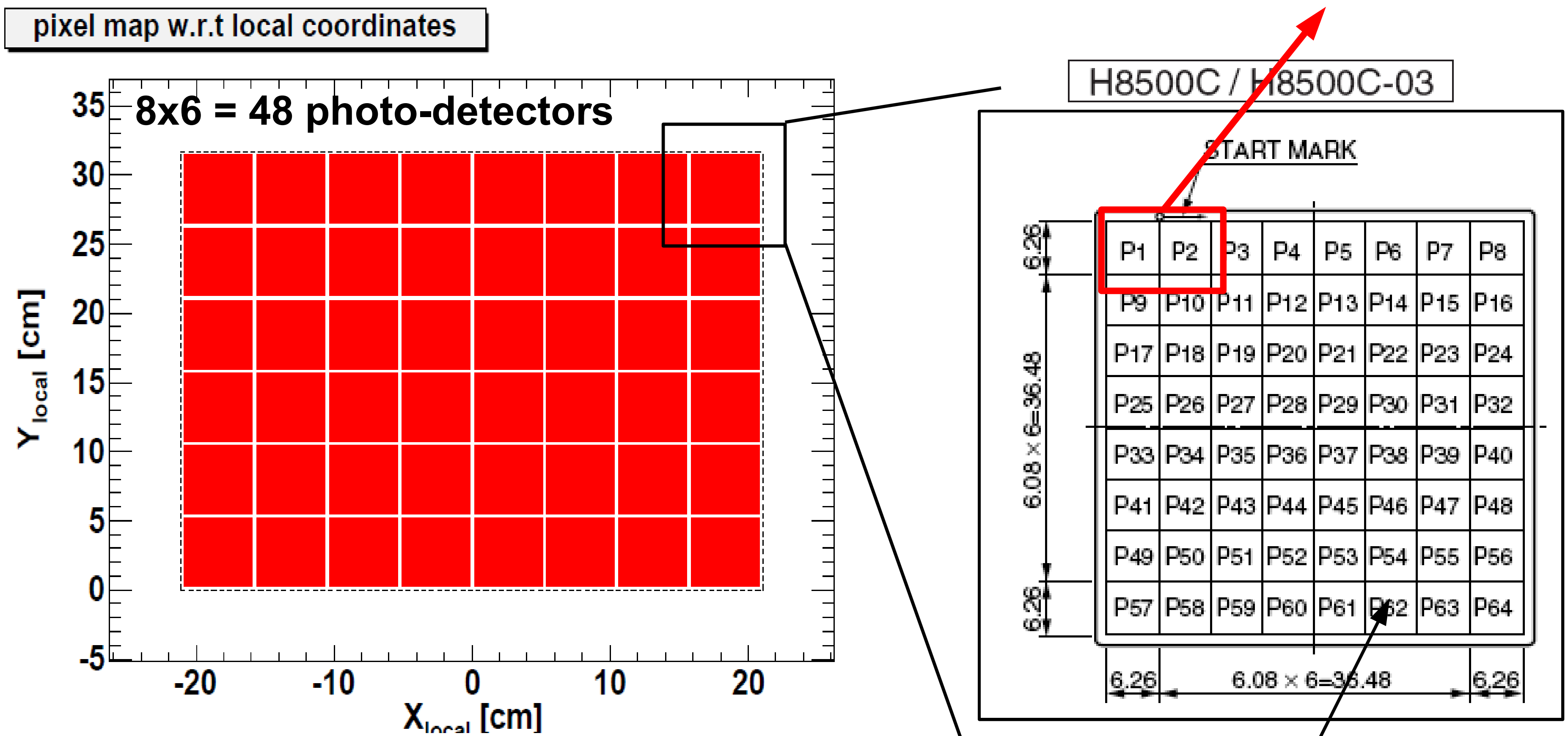




Bkg rates on the FDIRC: Pixel map

- For each sector have an array 8x6 = 48 photo-detectors
- Each detector is an 8x8 = 64 array of PMTs (pixels) with ~6.08mm pitch

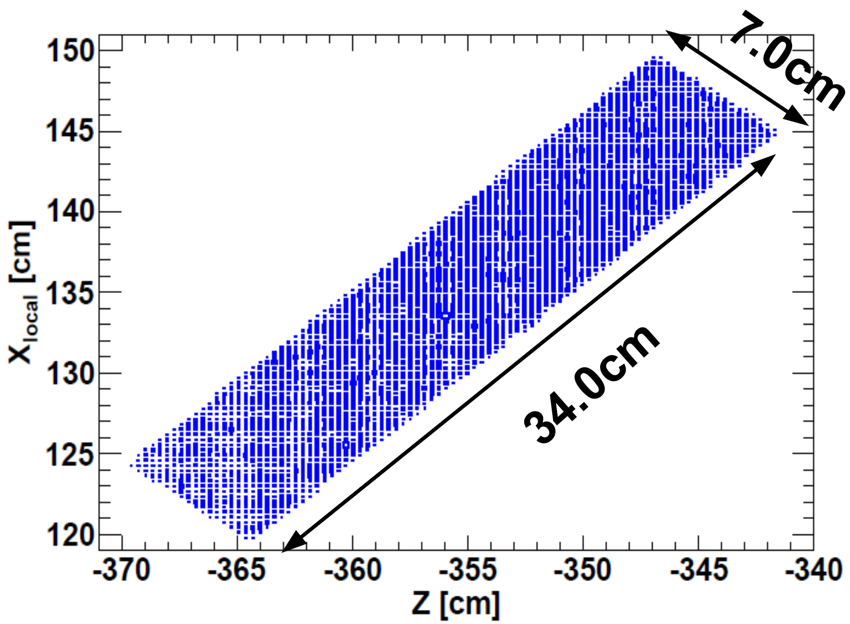
Group 2 channels into one = 32 channels

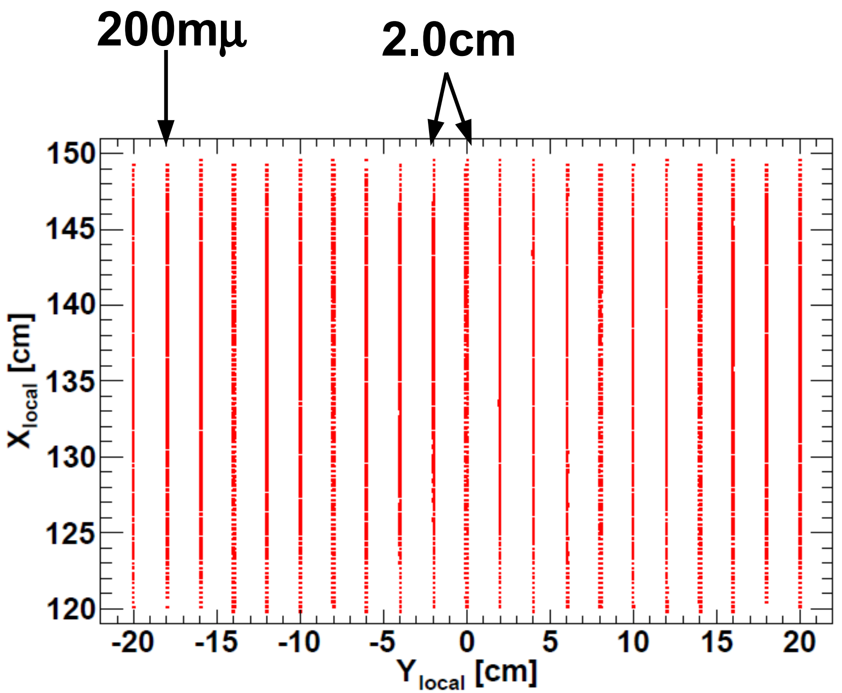


pixel

FEE Dose and fluency: geometric model and strategy

- **BRN implementation of FDIRC FEE**
  - FEE boards are silicon boxes of 7.0cm x 34.0cm x 200µ
  - 21 boards per sector separated 2cm
- **The FEE boards are instrumented**
  - Incident particle information (4-p, position, time, particle type): fluency
  - Deposited energy: doses
- **As a first approach will consider all the board in a sector as a single element and will estimate doses and fluences**





FEE Dose and fluency: FEE hits