FDIRC Background Update Summer 2012 Production

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Pisa SuperB Collaboration Meeting

Outline

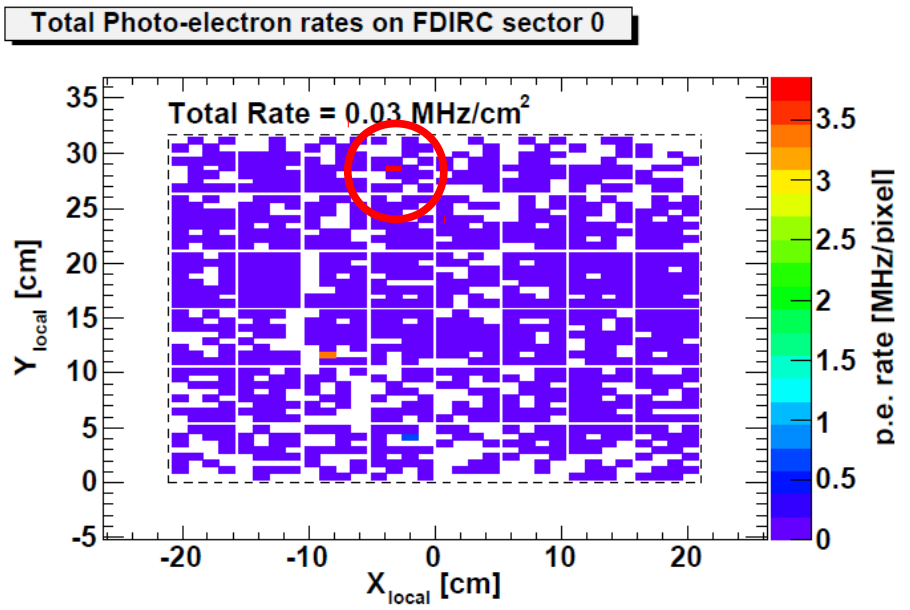
- **A patch to the MaPMT photo-cathode miss-modelling**
- **FDIRC Backgrounds**
  - Rad-bhabha
    - Low $\kappa = \Delta E/E$ ($0.5 < \kappa < 30\%$)
    - High $\kappa = \Delta E/E$ ($\kappa > 30\%$)
  - Pairs
  - Touschek-HER/LER
  - BeamGas-HER/LER
- **FEE dose and Fluency**
- **Summary**

A Patch to the MaPMT photo-cathode miss-modelling

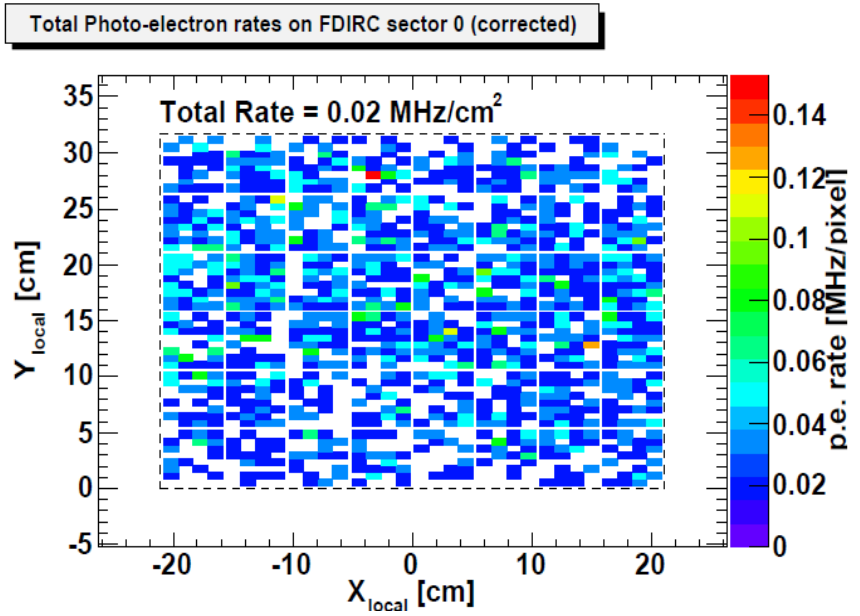
- **A closer look to the April-2012 samples revealed that there were some strange hits which consisted of many optical photons hits on a single pixel (> 20) within a fraction of a nano-sec**
- **After some studies it was concluded that the reason was a miss-modelling of the MaPMT photo-cathode.**
  - It was incorrectly modelled as BK7 glass
  - Replacing the material to aluminium fixed the problem
  - See next talk by N. Arnaud at the PID Parallel session on (Sep. 20th at 11:00am)
- **The fix wasn't implemented 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

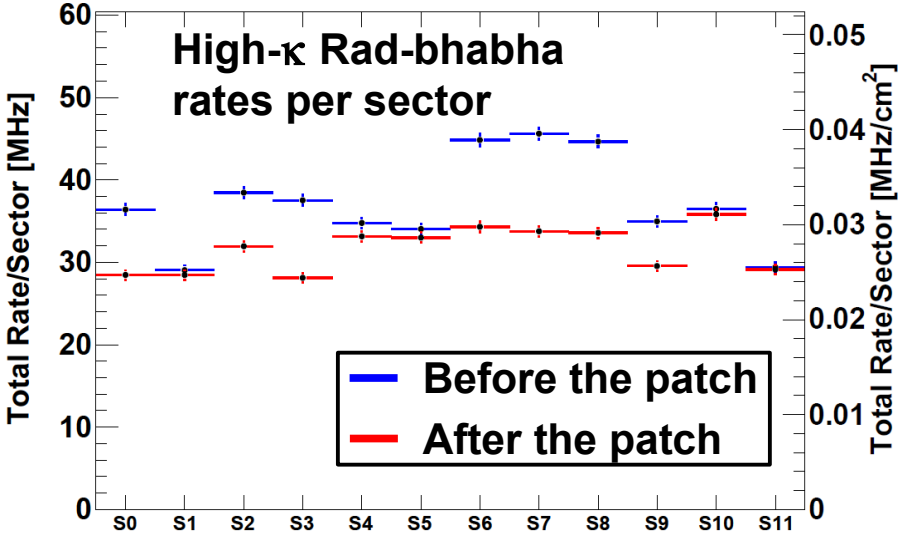
Before the patch



After the patch

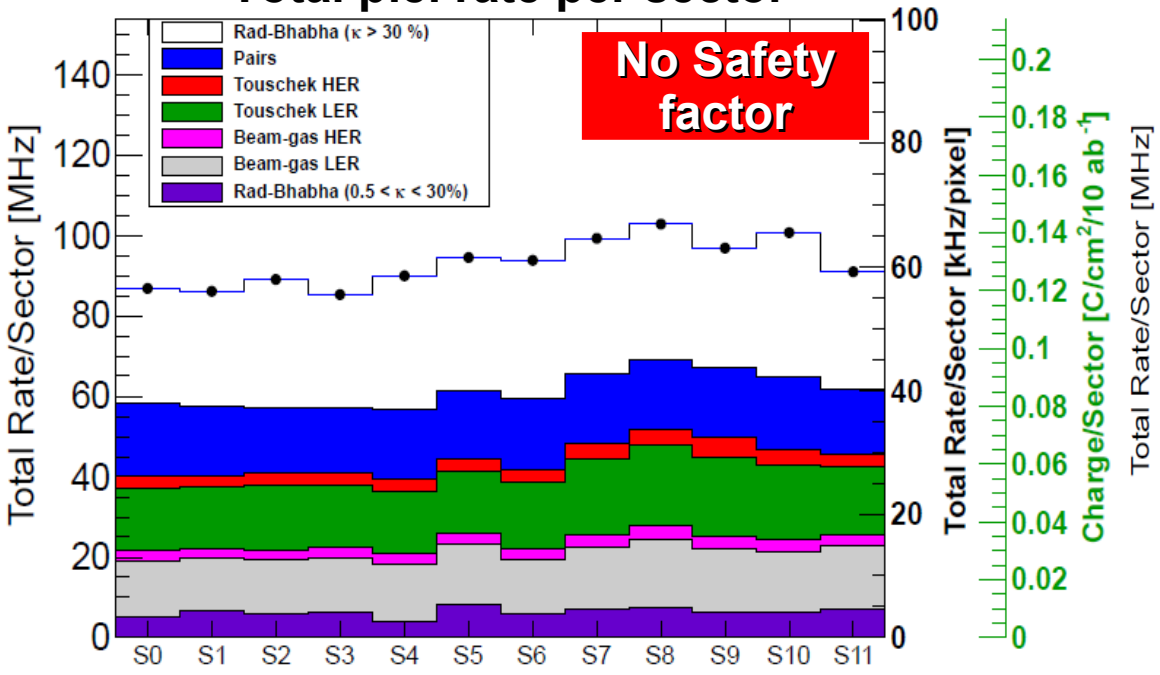


- Algorithm correctly identify “hot pixels” and filter them out
- The total rates in some sectors get significantly reduced by up to 25-30%

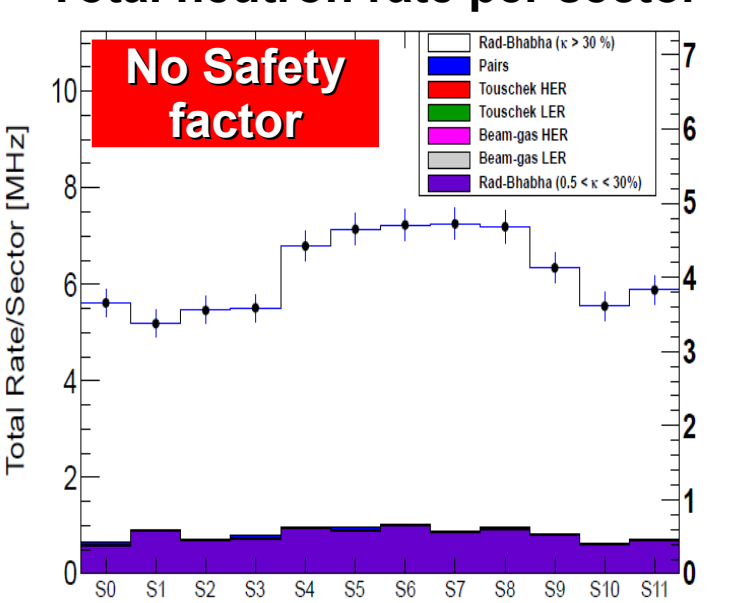


Total bkg rates on FDIRC

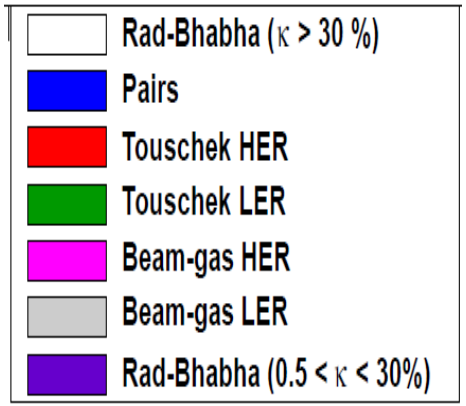
Total p.e. rate per sector



Total neutron rate per sector



- 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 (~0.13 C/cm^2/10ab^{-1}). Neutron rate ~5 kH/sector/pix

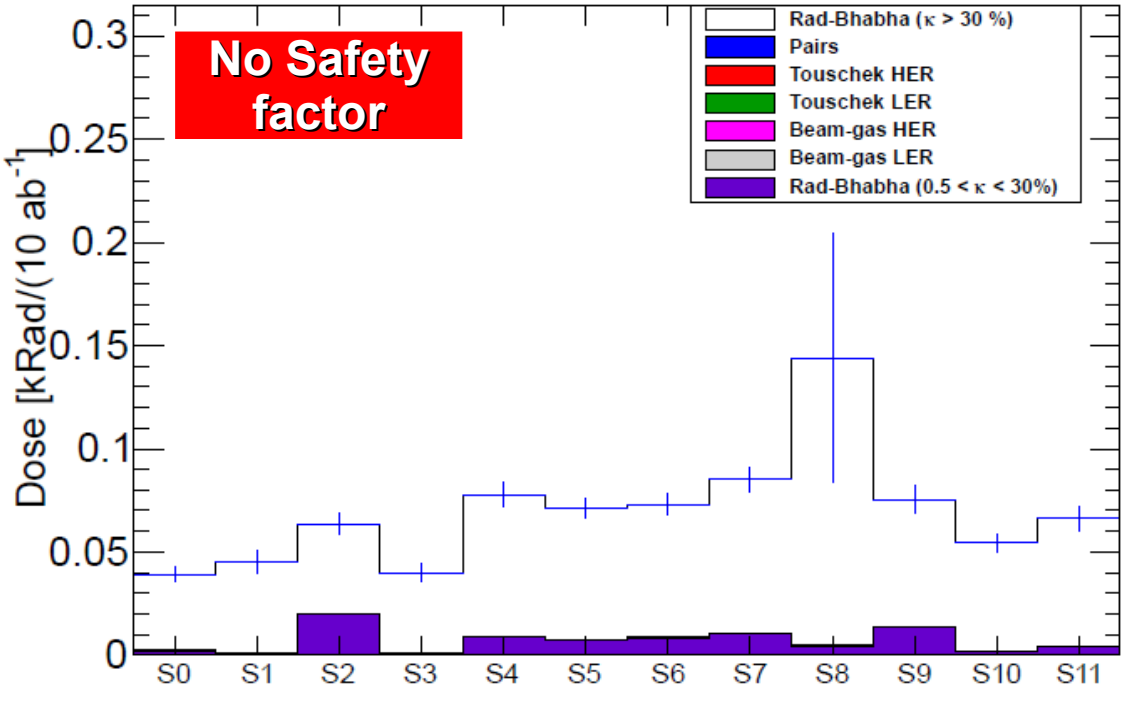


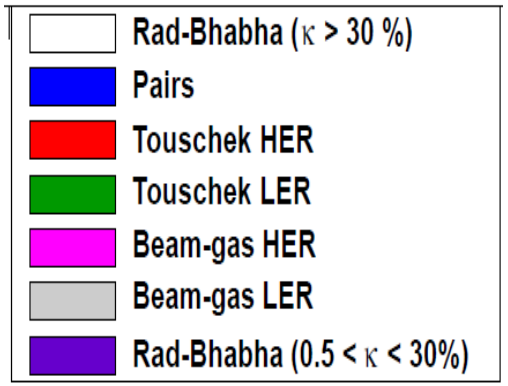
FEE Dose and fluency: The dose

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

  Quoted doses are for 1.0×10^{7}s $\Rightarrow$ 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: ~80 Rad/sector/10ab^{-1}**

Total dose per sector and on FEE

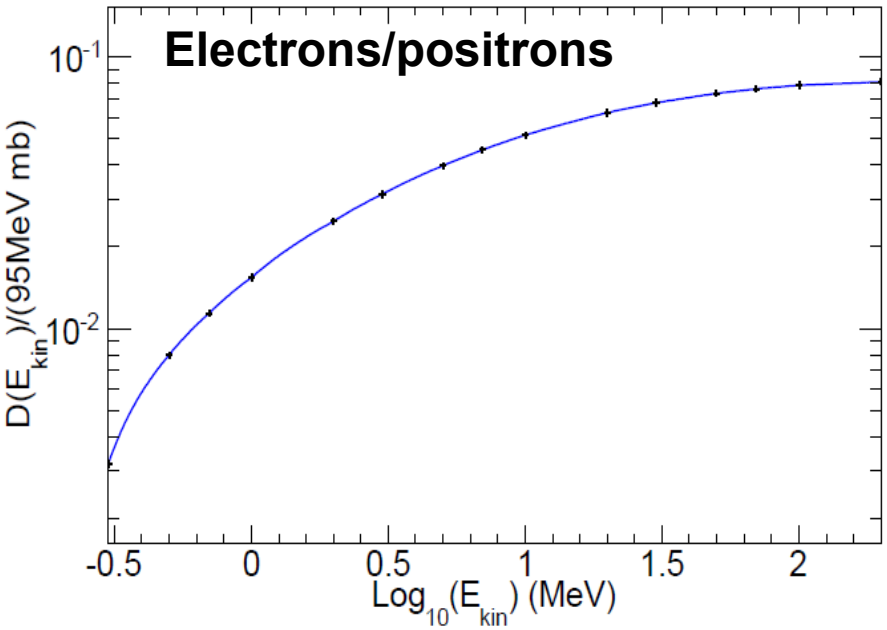


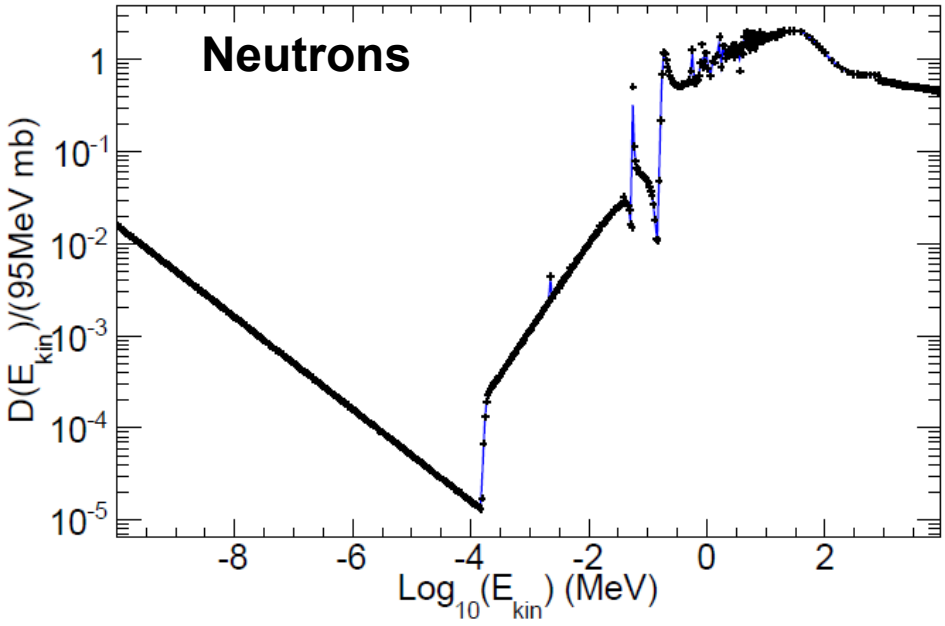


FEE Dose and fluency: The fluency (reminder)

- 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 $1.0\times10^{7}s \Rightarrow 10ab^{-1}$ integrated luminosity

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

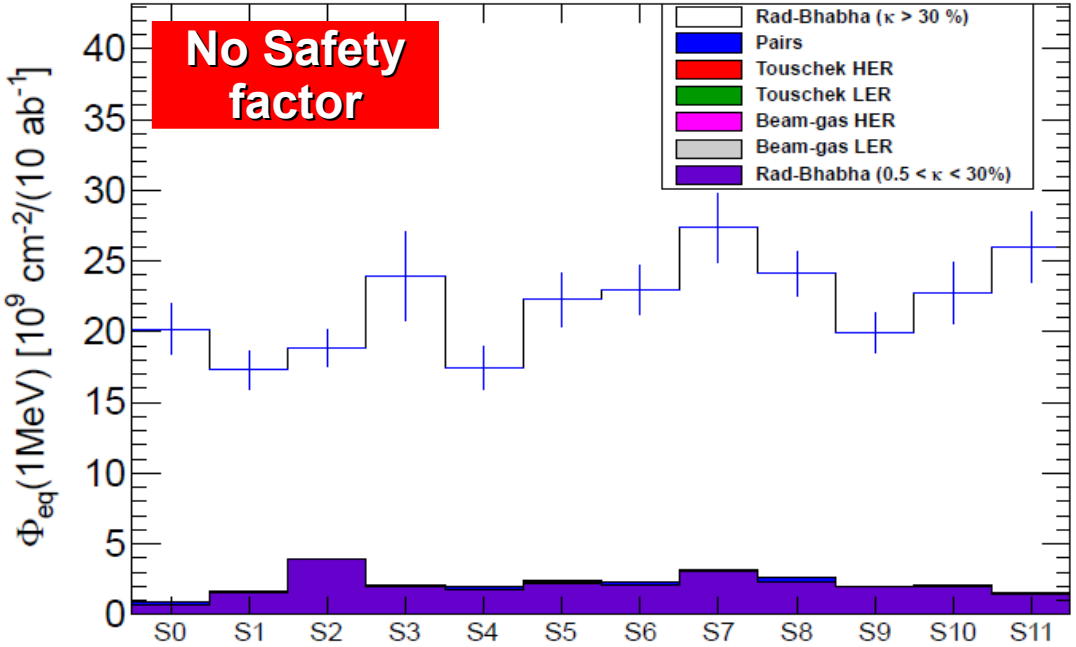


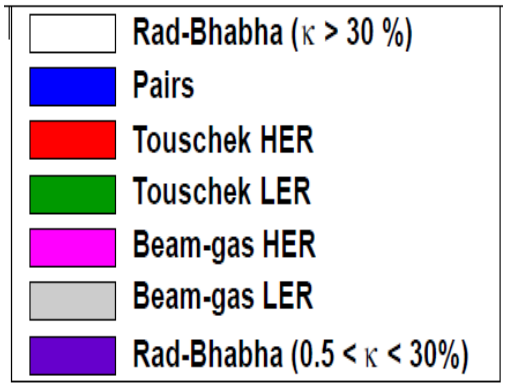


FEE Dose and fluency: The fluency (results)

- Estimate the 1MeV neutron equivalent fluency per sector
- Particle fluxes are scales by the damage function relative to 1MeV neutrons: $D(E_{kin})/(95MeV\ mb)$. Different damage function for different particles types
- Quoted fluency per sector are for $1.0\times10^{7}s \Rightarrow 10ab^{-1}$ integrated luminosity
- Summary fluency: $\sim22\times10^{9}$ (1MeV neutrons) $cm^{-2}/10ab^{-1}$

Total fluency per sector and per board on FEE





Summary

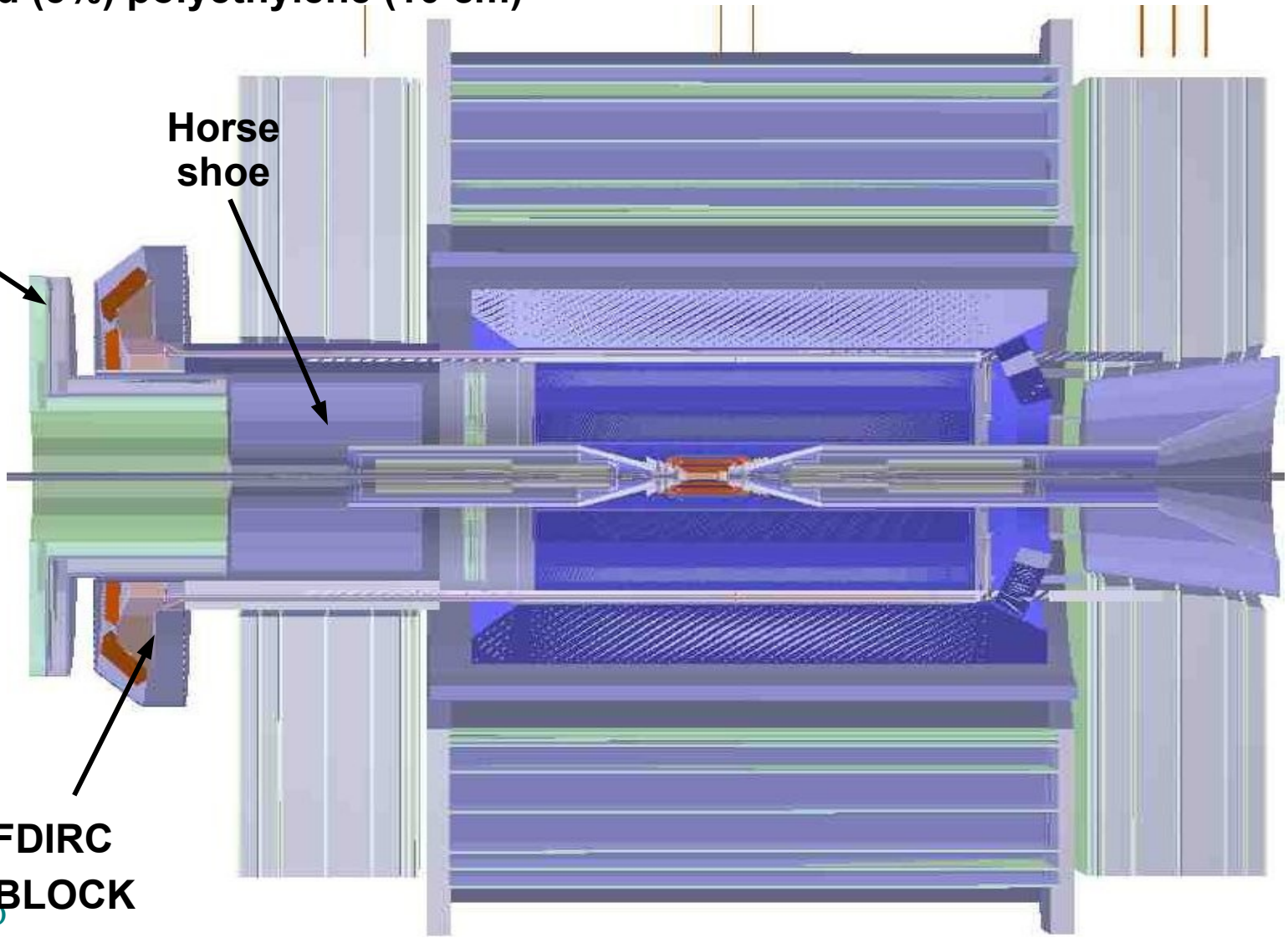
- **Rates**
  - All background sources give similar contributions
  - p.e. rates are ~65 kH/sector/pixel (~0.13 C/cm^2/10ab^{-1})
  - Neutron rates are ~5 kH/sector/pixel

- **FEE dose and fluency**
  - Doses are ~80 Rad/sector/10ab^{-1}
  - Φ_{eq}(1MeV n^0) ~22$\times$10^9 cm^{-2}/10ab^{-1}


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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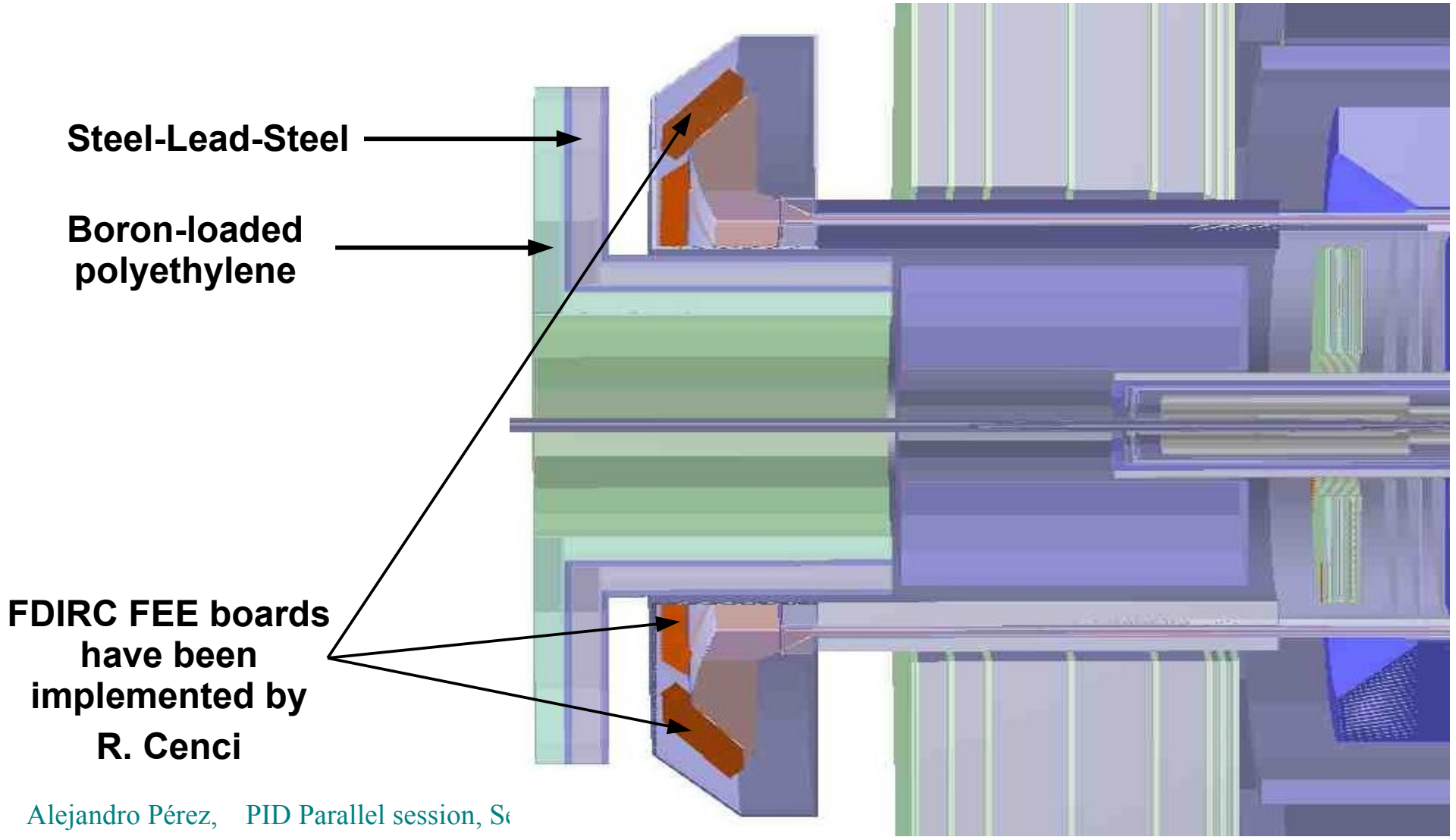
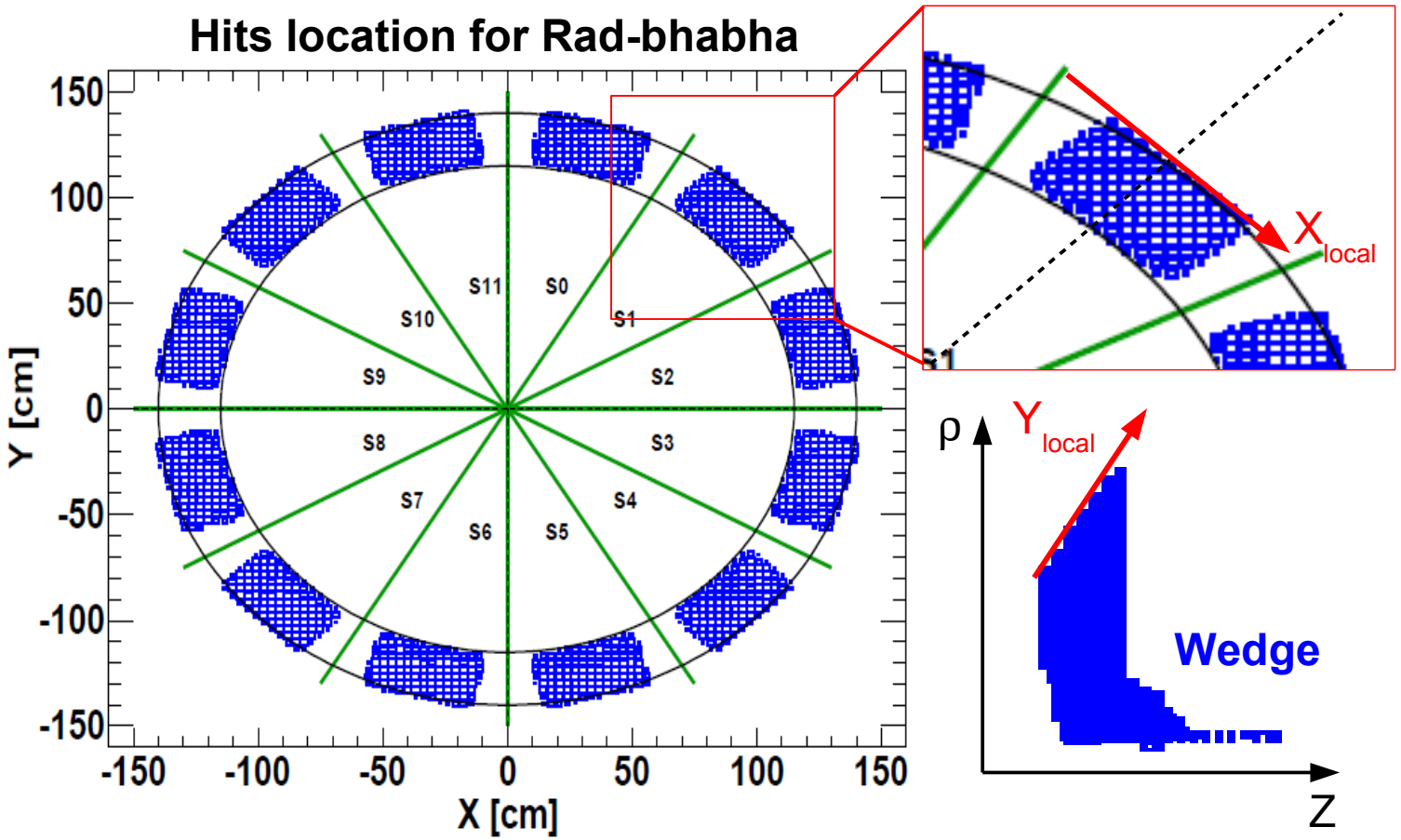
- Boron-loaded (5%) polyethylene (10 cm)



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}



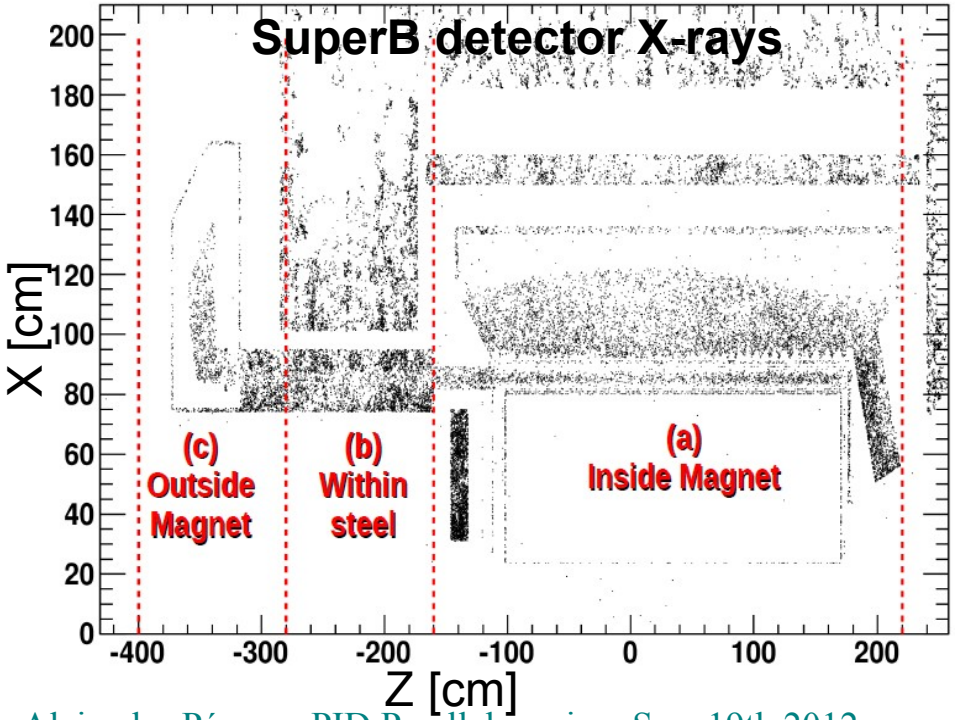
X_{local}:
From -width/2
up to width/2

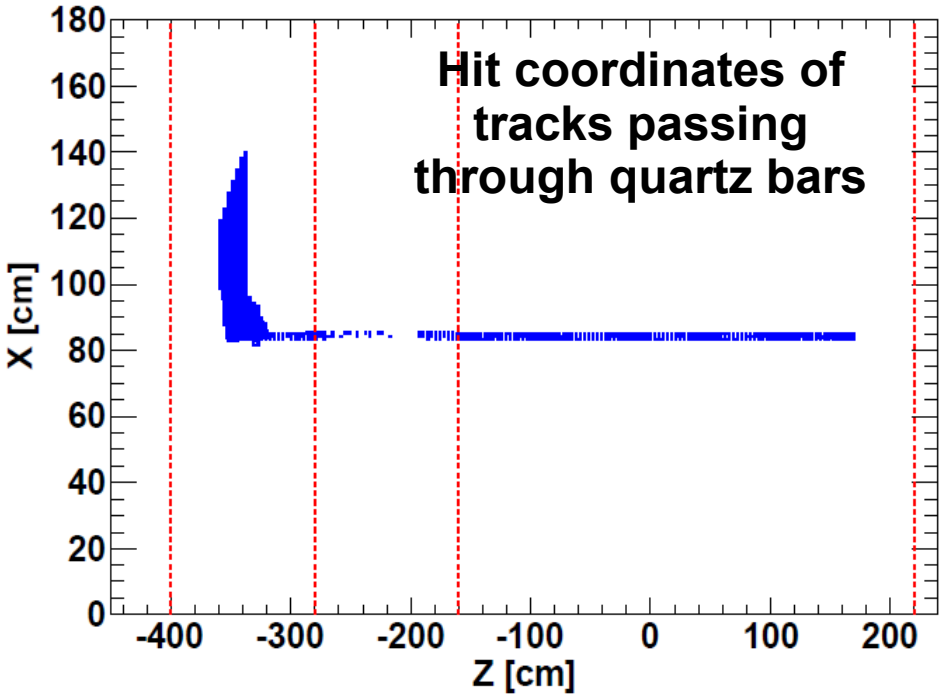
Y_{local}:
From 0.0
up to Length

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

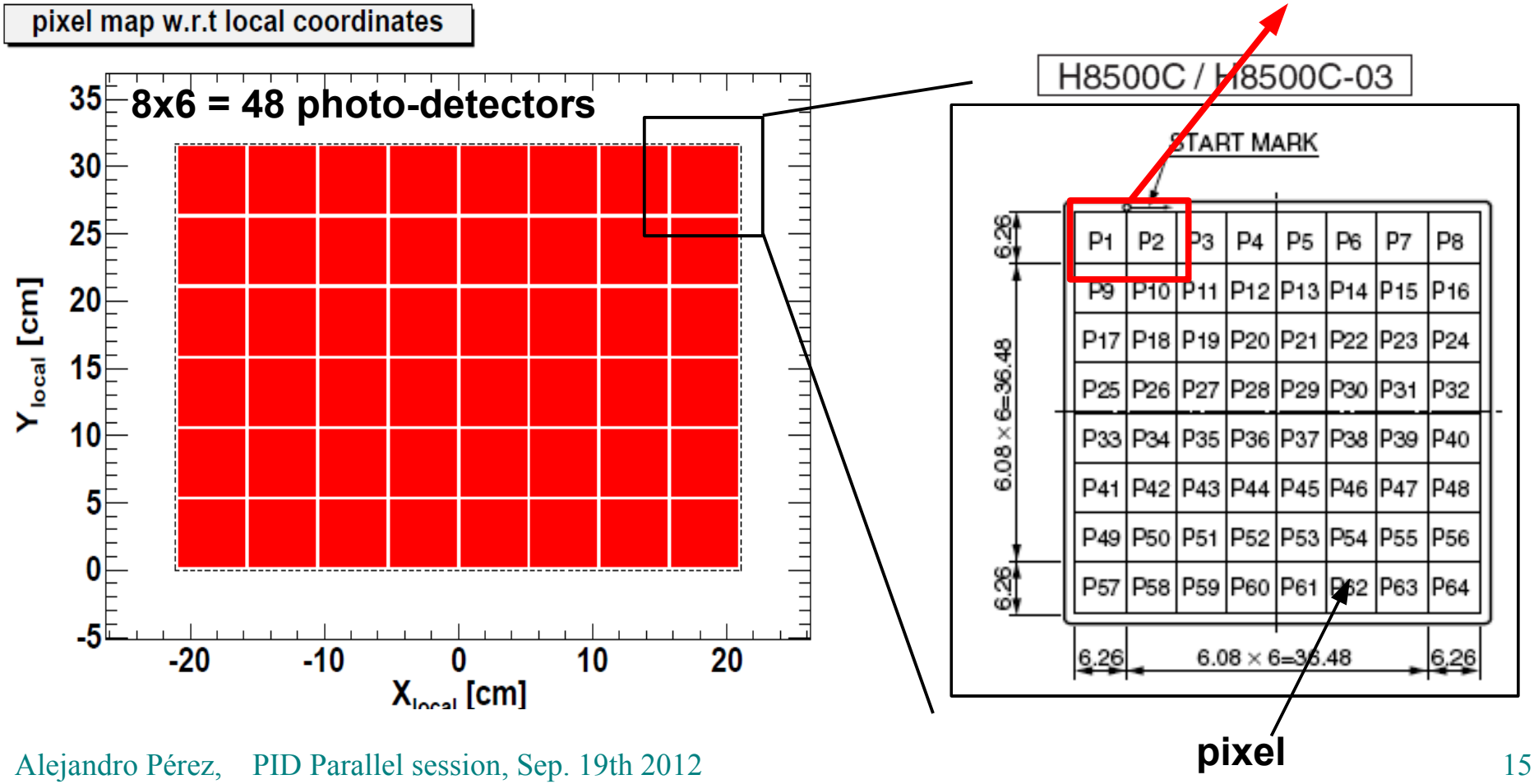




Bkg rates on the FDIRC: Pixel map

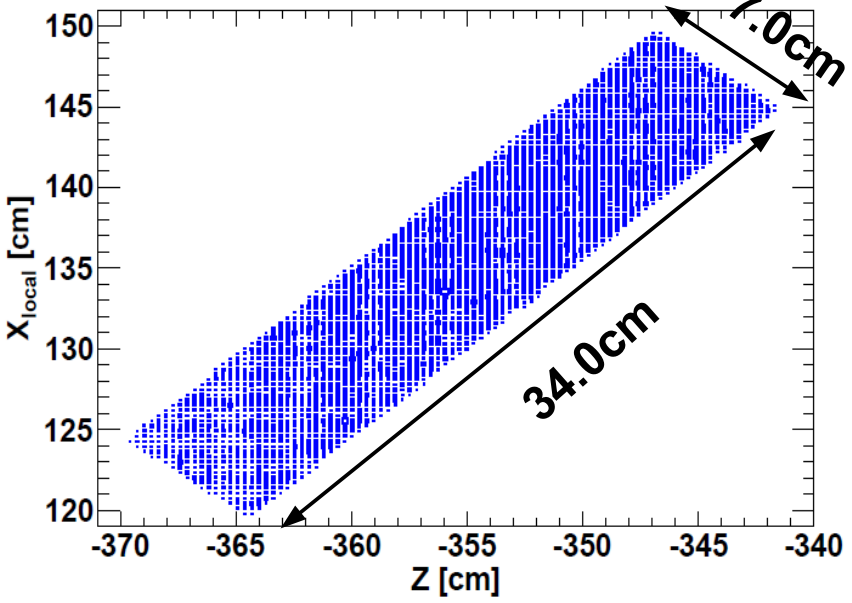
- For each sector have an array 8x6 = 48 photo-detectors
- Each detector is an 8x8 = 64 array of PMTs (pixels) with ~6.08mm pitch

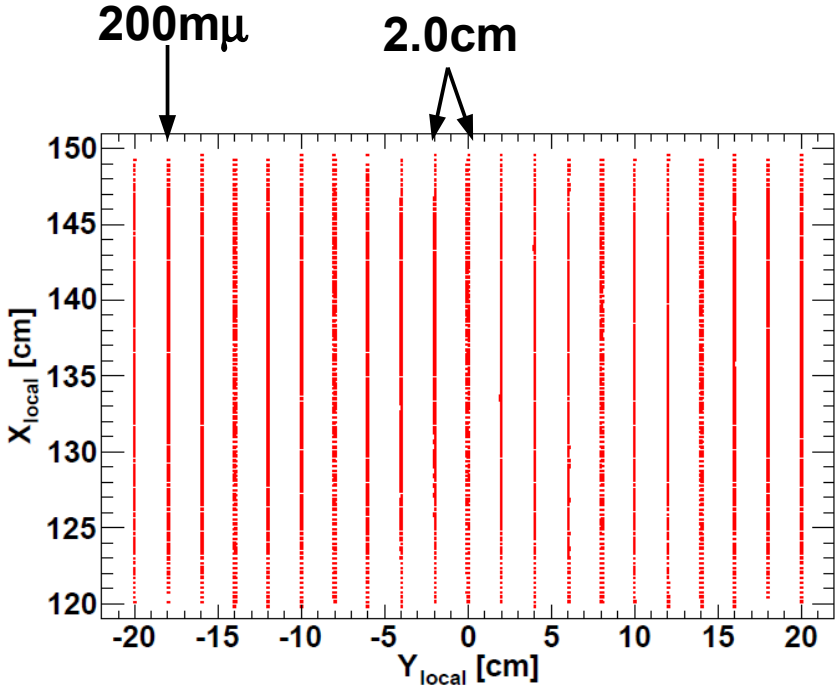
Group 2 channels into one = 32 channels



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