FDIRC and FTOF backgrounds: another look

Pisa SuperB Meeting, September 20th 2012

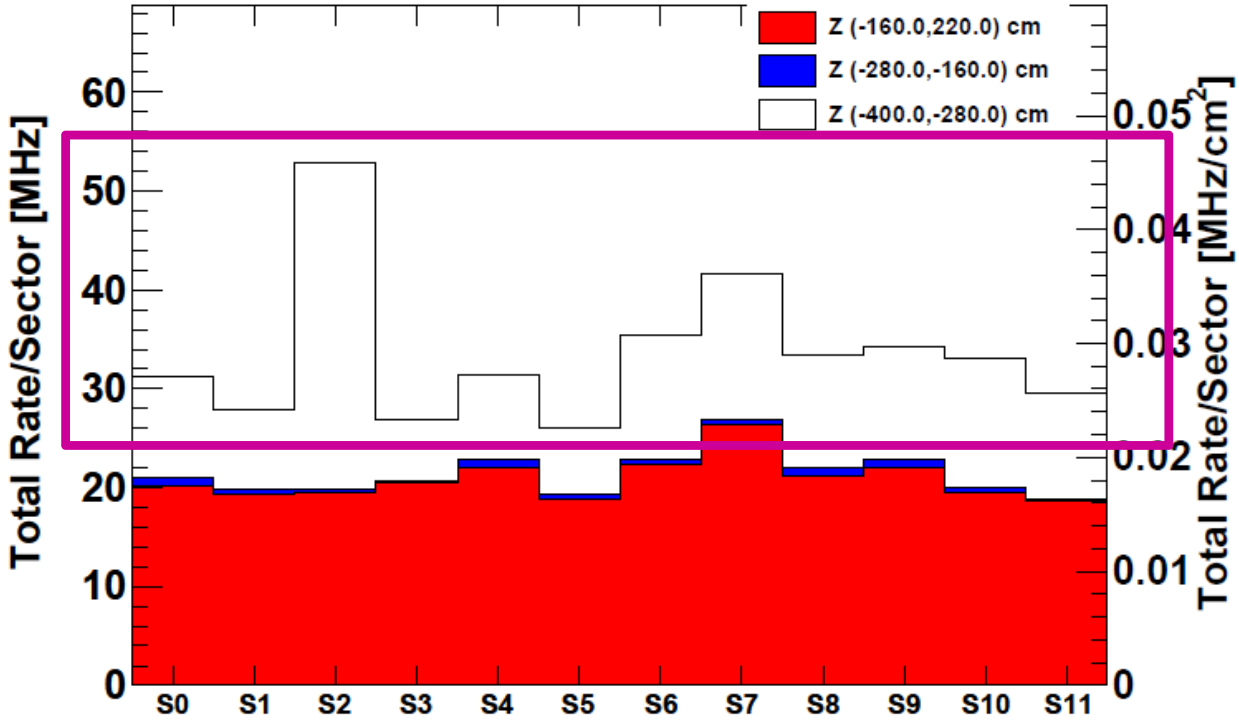
Nicolas Arnaud, Martino Borsato – LAL

- Investigated structure in the Rad. Bhabha FDIRC rate per sector
  → Found unphysical hits traced down to a bug in the photocathode material
  - Cross-check + plots complementary to Alejandro's analysis

- Short update of the FTOF background based on the Summer 2012 production
  → More to come 'soon'

Structure in the FDIRC background?

- Starting point: Alejandro's plot in his Elba background talk showing the background rates per sector for the rad. Bhabha sample

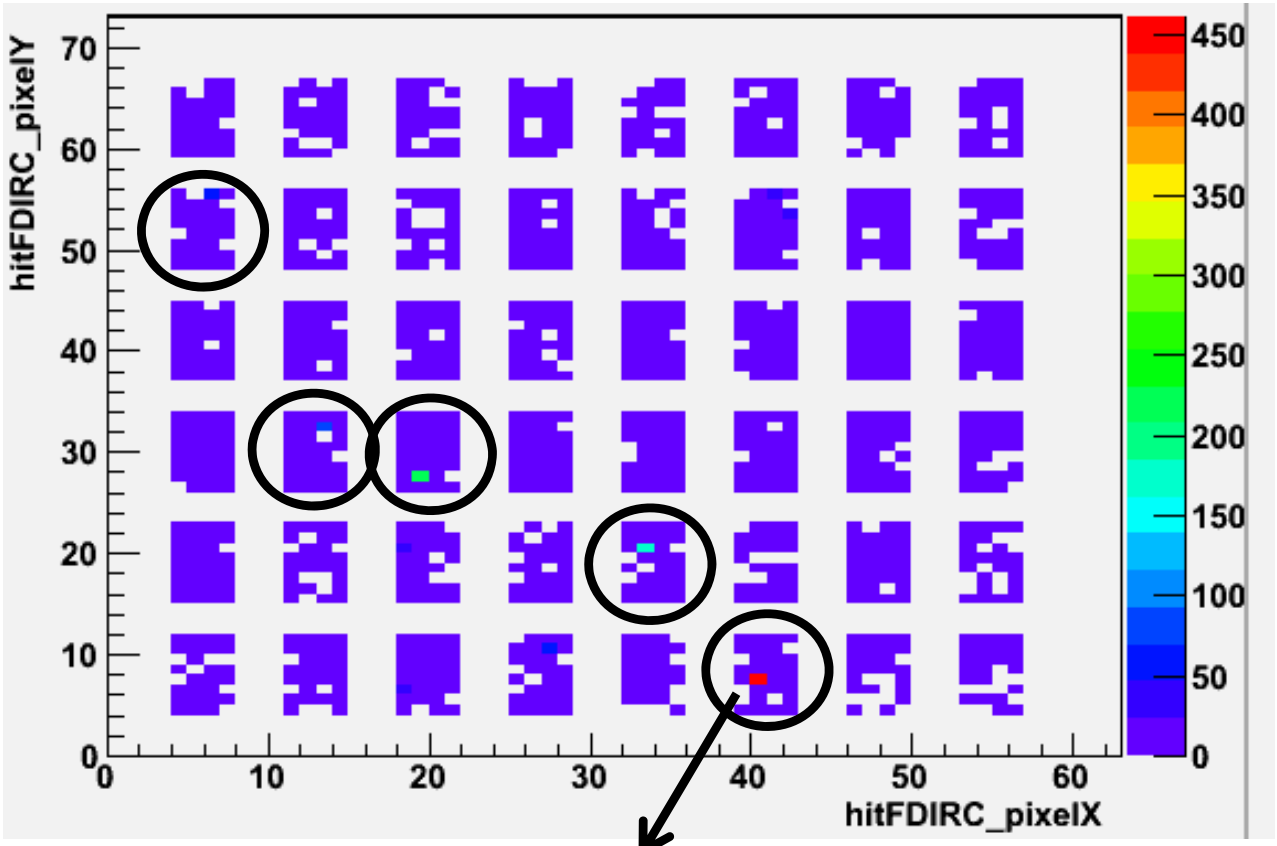


- Where do the large sector-to-sector differences come from?

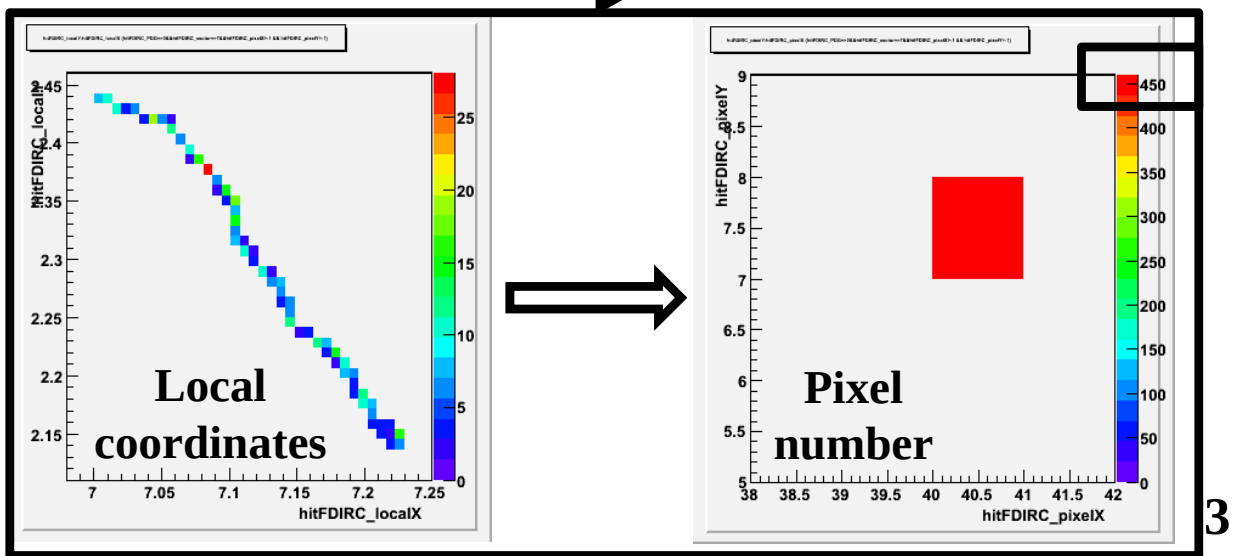
→ Development of background analysis codes independent from Alejandro's one
  - Only common point: the snippet converting the local coordinates of a MaPMT hit into sector & pixel numbers

Pre-production sample

- A few pixels are hit much more than the others
  → Note the large range on the colour code scale: from 0 to 450!

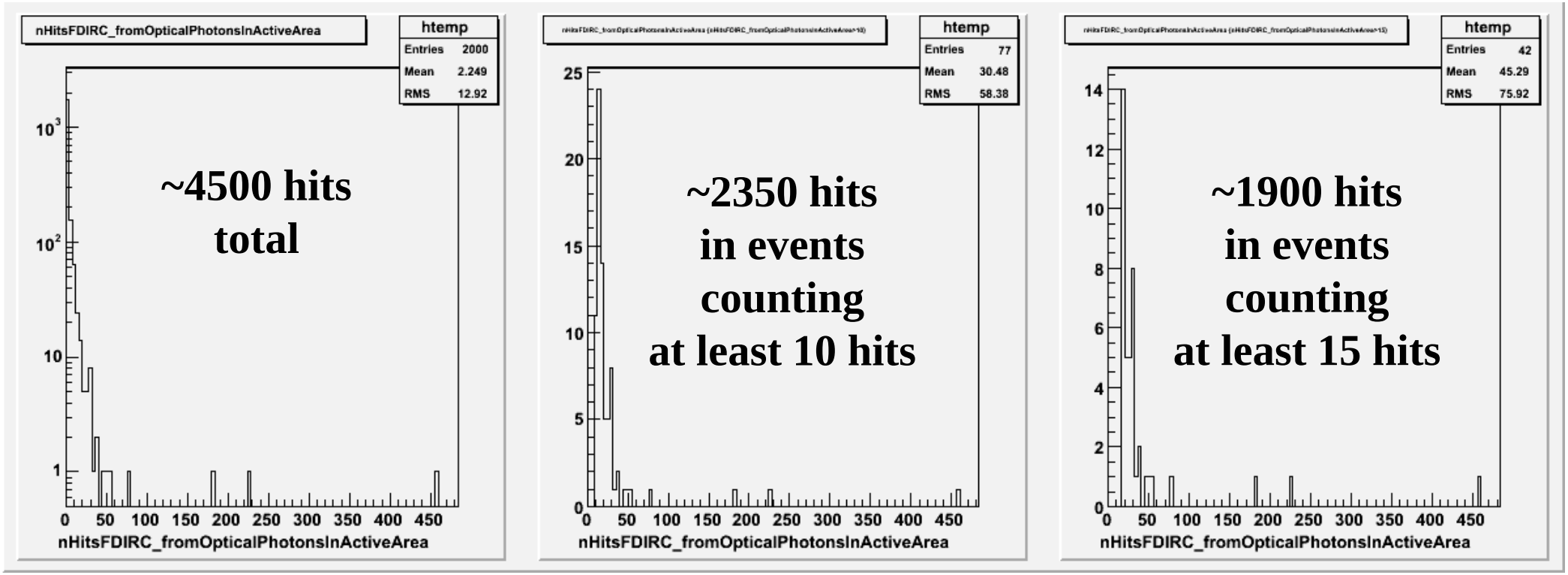


- They are concentrated in a few events in which certain pixels are ‘shot’
  → ~450 hits in a single pixel!



Pre-production sample

- The few events with many localized hits account for a large fraction of the bkg



- The true optical photons associated with these hits often have their creation vertex exactly coincident with the MaPMT hit

- These optical photons induce exactly two MaPMT hits

→ They can't be physical!

Issue found and fixed

- Help from Alejandro and Doug
  - Hard for a non-expert to correlate a hit position with a detector element
    → Desperetely seeking x-ray maps of the detector/detector components…

- Problem: MaPMT photocathode simulated using BK7 glass
  → Optical photons are generated in that volume and are counted twice due to a software feature
  - See discussion in the fullsim sympa mailing list for details

From: "Douglas A. Roberts" <roberts@umd.edu>
Subject: Re: Pre-production samples for the Summer 2012 production
Date: Wed, 1 Aug 2012 09:34:13 -0400

I think I found the source of the double hits. Normally, the sensitive detector's ProcessHits gets called when the photon gets killed at the optical boundary at the photocathode. It never actually enters the photocathode. But when the photon gets created inside the photocathode, it triggers the GEANT call to ProcessHits before it gets killed. Then it gets called again the normal way.

One fix for this is to change the material of the photocathode to Aluminum. This way no Cherenkov photons would be created in the cathode itself. I've tested this in the stand-alone version and it seems to work without breaking anything else.

Issue found and fixed

- Help from Alejandro and Doug
  - Hard for a non-expert to correlate a hit position with a detector element
    → Desperetely seeking x-ray maps of the detector/detector components…

- Problem: MaPMT photocathode simulated using BK7 glass
  → Optical photons are generated in that volume and are counted twice due to a software feature
  - See discussion in the fullsim sympa mailing list for details

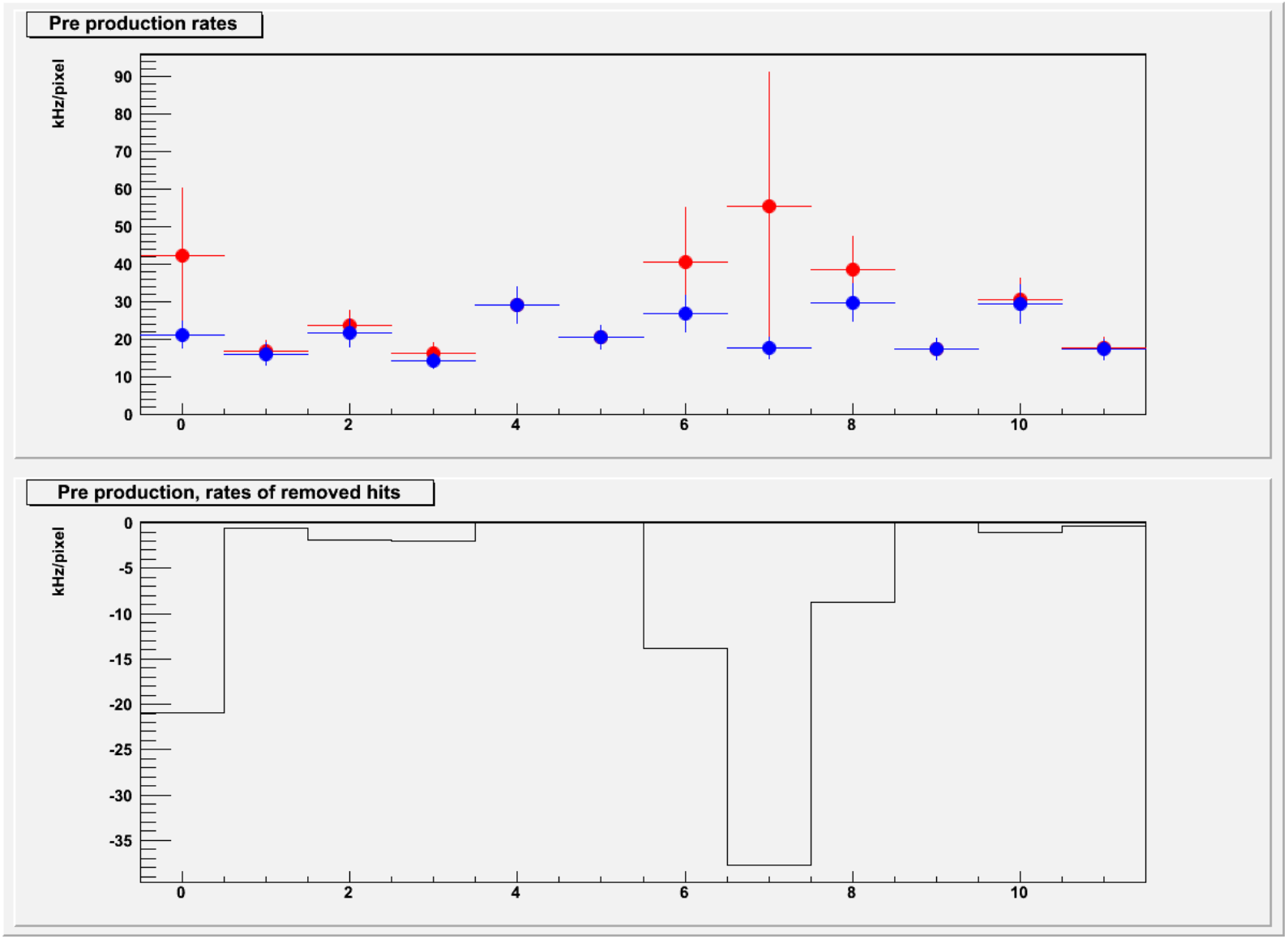
- Simple fix: change the photocathode from BK7 glass to aluminium

- Bug fix not included in the release used for the large Summer production
  - Problem to be corrected at the analysis level to get correct rates
  - Private rad. Bhabha production (Alejandro) with the fix included
  → Al. photocathode to be used in future productions

- Two different recipes followed to remove spurious hits
  - Alejandro: identify bursts of hits close in time and remove all but one
  - Nicolas: remove duplicate hits and hits with coincident vertex & detection point

Results of the cleaning procedure

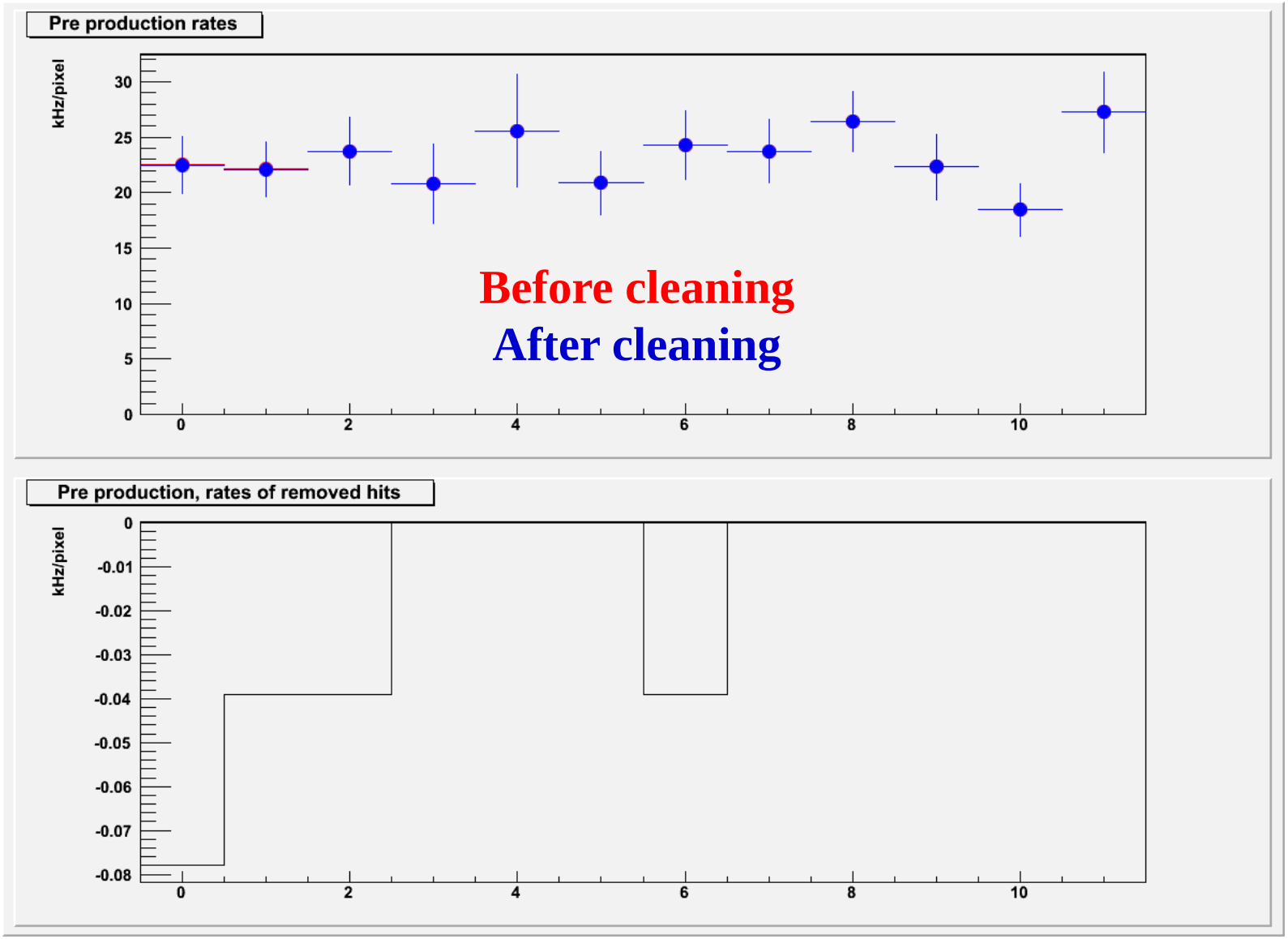
- Pre production rate before and after cleaning



→ Note that the errors are meaningful – RMS(distrib)/√(# of bunch crossings)

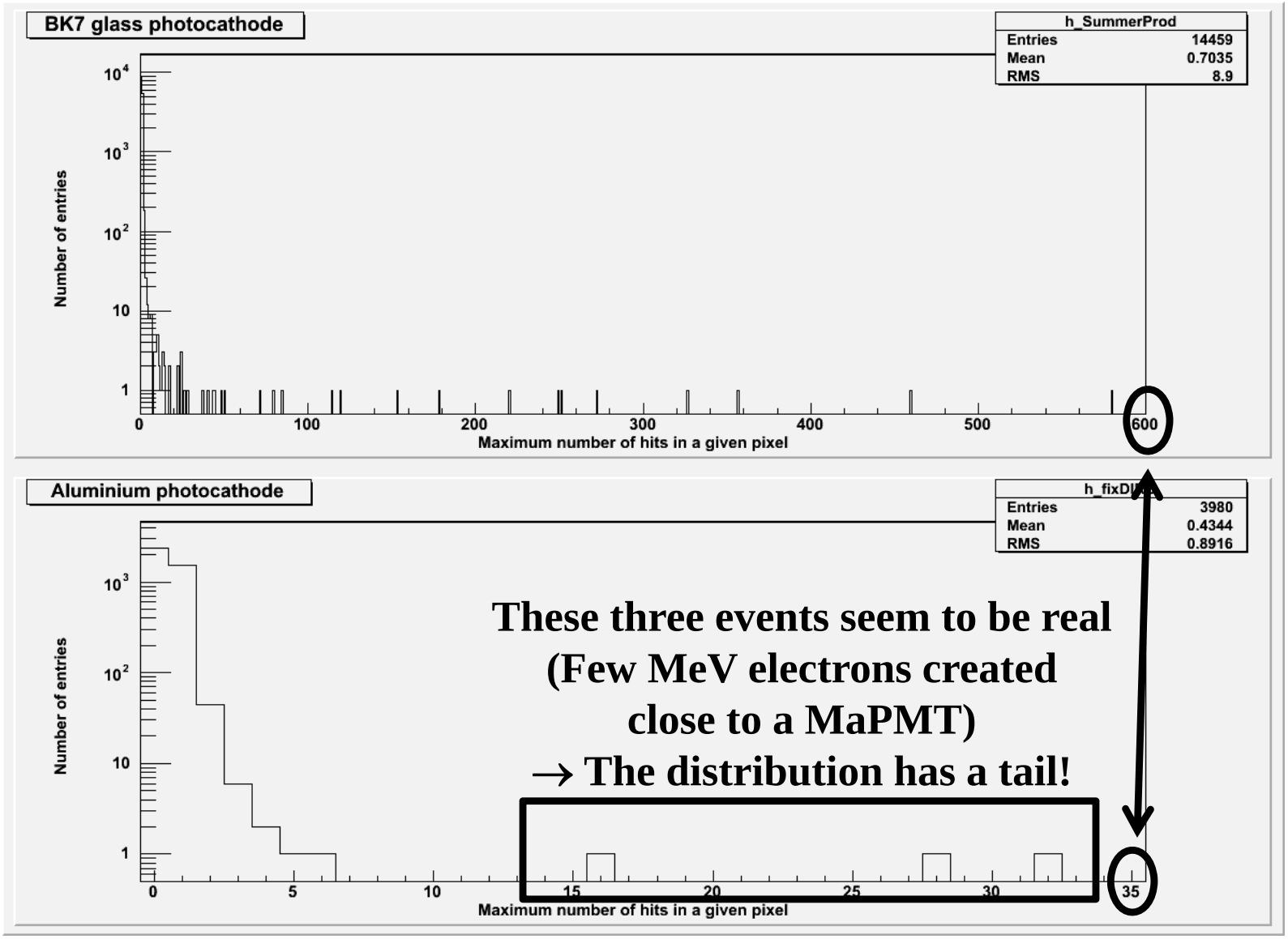
Results of the cleaning procedure (cont'd)

- Negligible effect on the private sample generated with the fix included



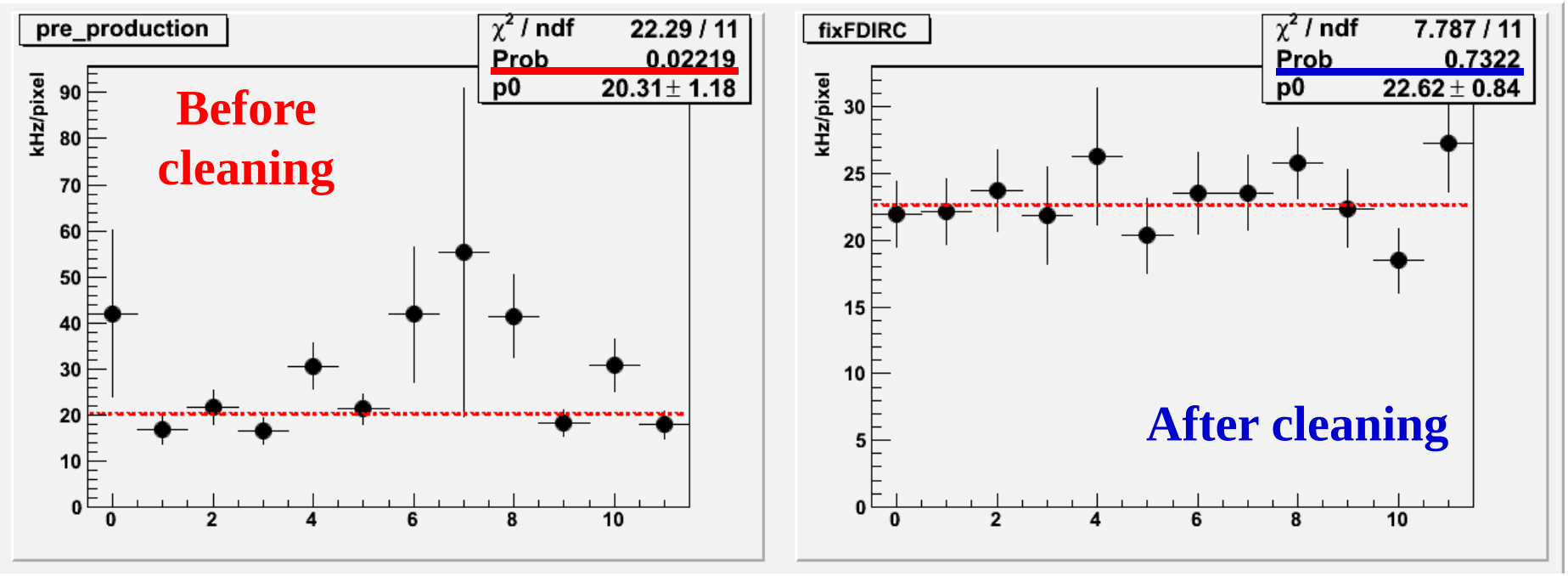
Results of the cleaning procedure (cont'd)

- Bursts of hits are almost all gone
  → No the different x-axis ranges

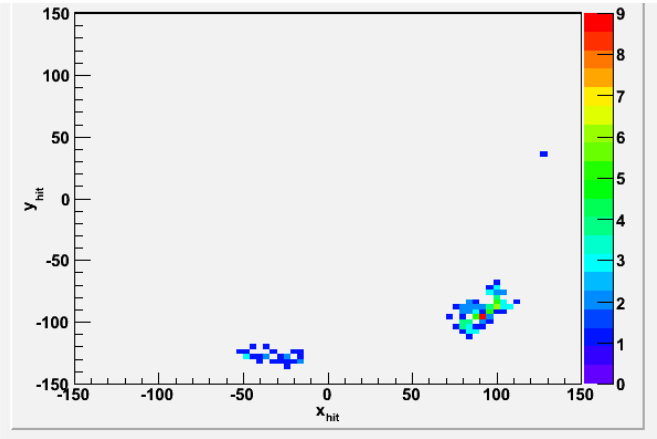


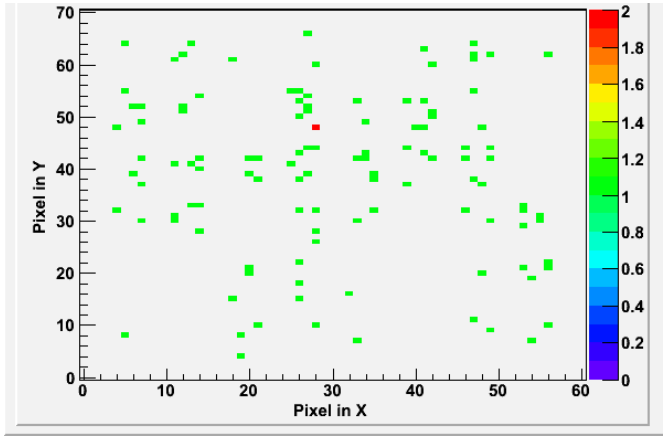
Results of the cleaning procedure (cont'd)

- Sector rates look flat after cleaning



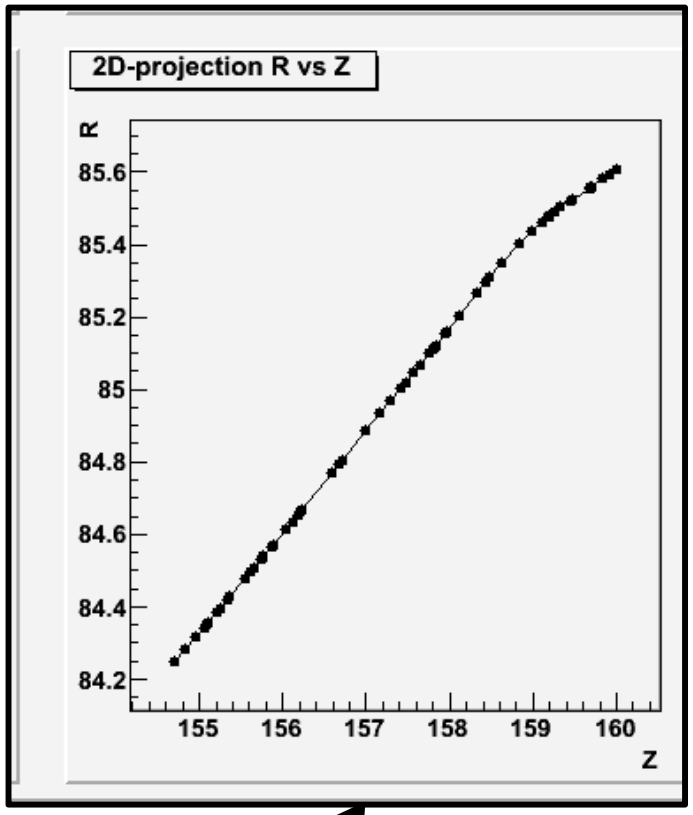
- An example of a remaining (and valid) 'splash' event
  - → 142 pixels hit in a given sector; only 1 hit / pixel
    - 5 tracks have 10 or more photons detected





Results of the cleaning procedure (cont'd)

Creation vertices of the optical photons



[Bar radius I think…]

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  - → 142 pixels hit in a given sector; only 1 hit / pixel
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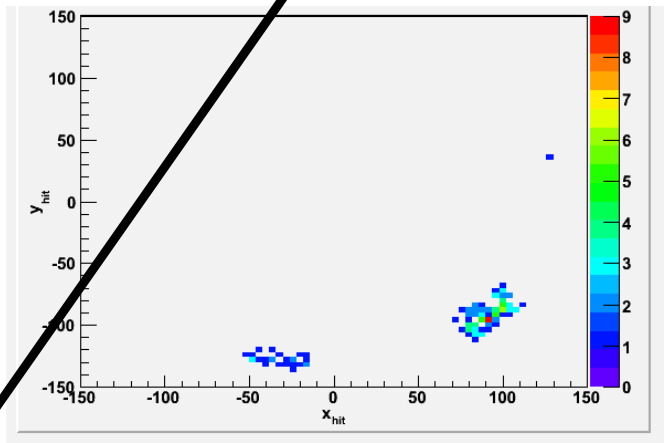
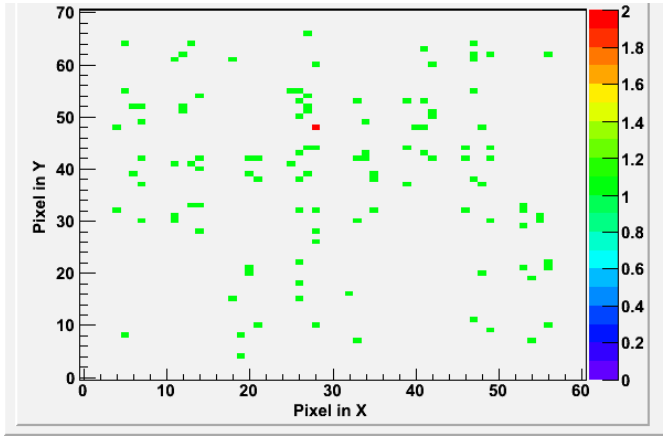
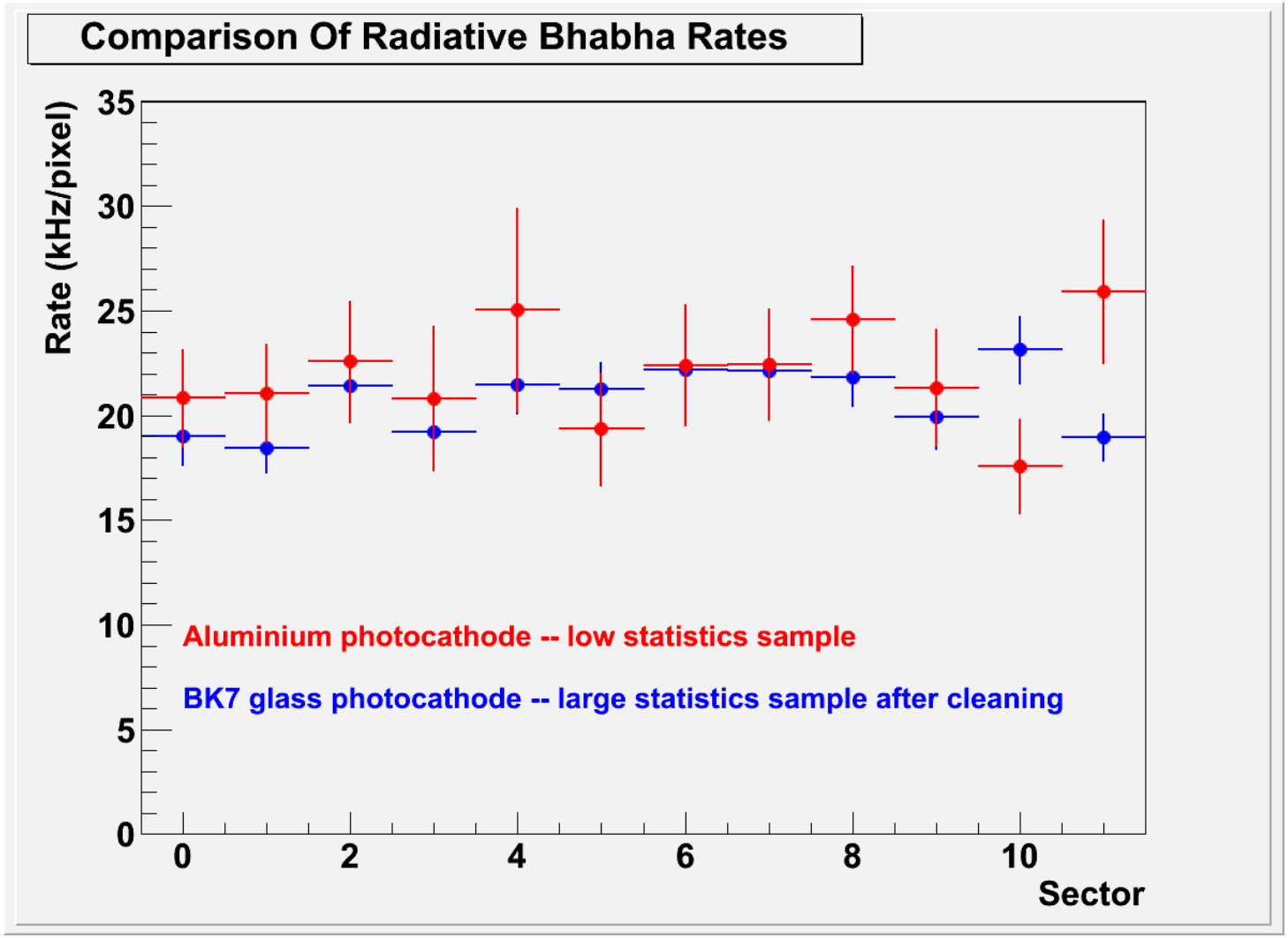




- Largest contribution from a 370 MeV Bhabha particle reaching a bar 'by chance'

Full production background rates

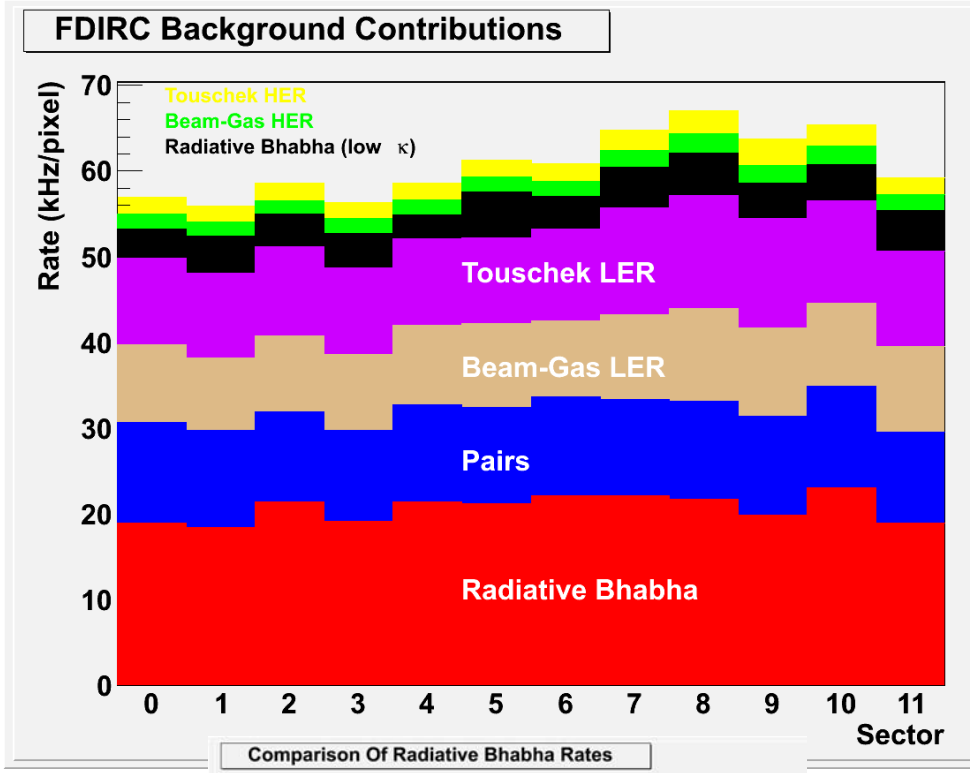
- Comparison between the full production rates after cleaning and the rates computed for the private (fixed) production

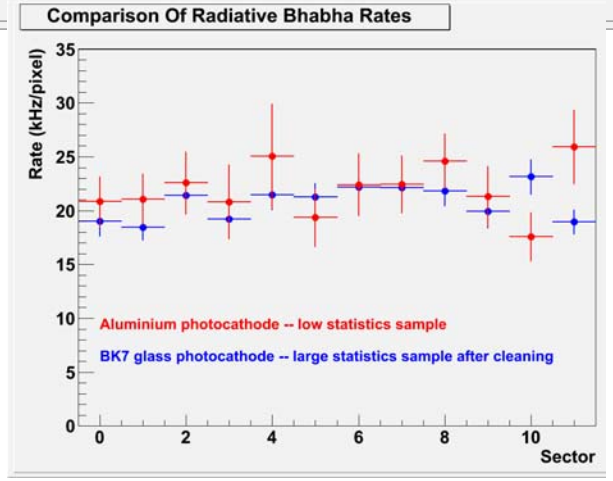


→ Compatibility: χ^2/NDF = 10.8/11 ⇔ prob. = 0.46

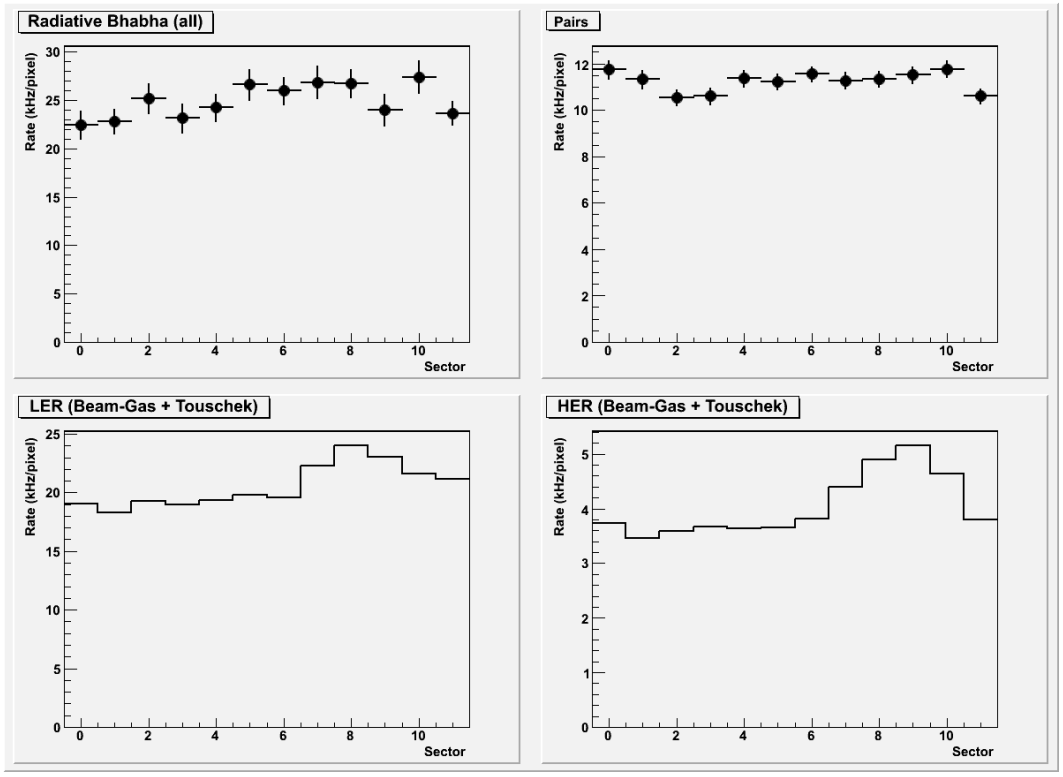
Full production background rates (cont'd)

- Rates – consistent with Alejandro's computation



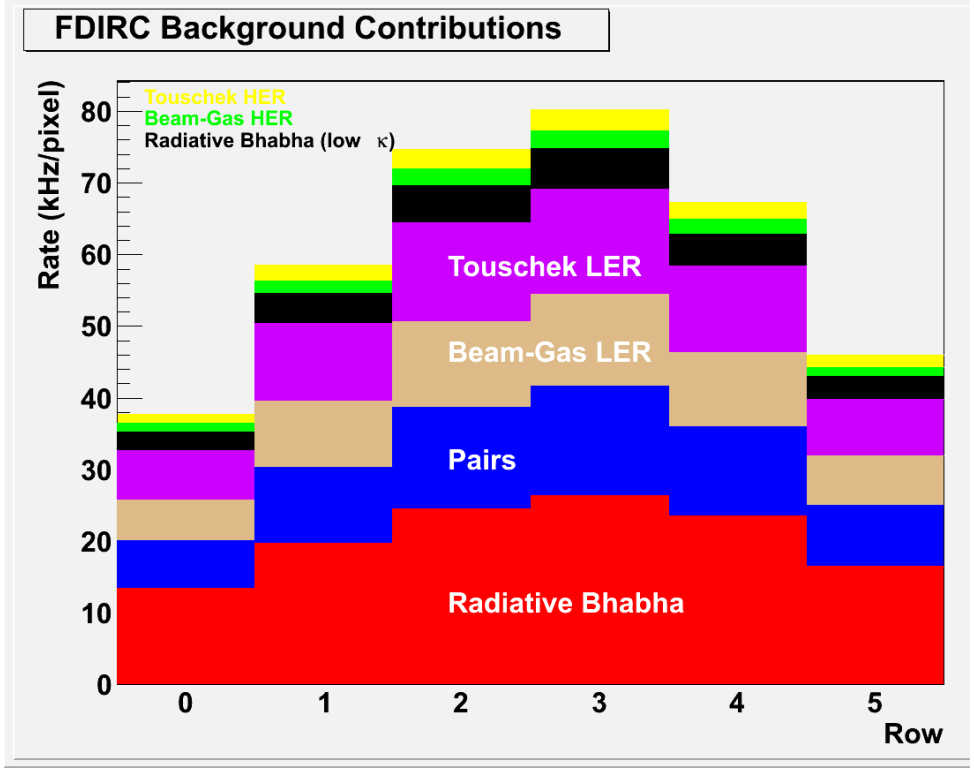


- Unweighted samples have natural errors
- What about weighted samples!?

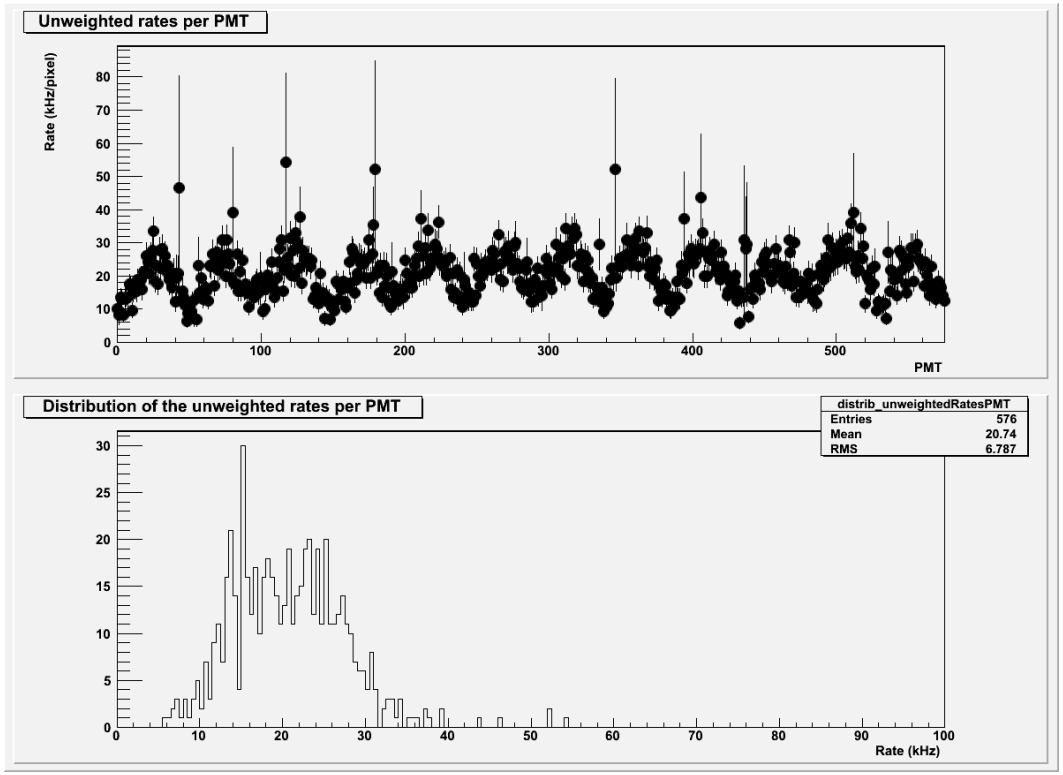


Full production background rates (cont'd)

- Rates per PMT row



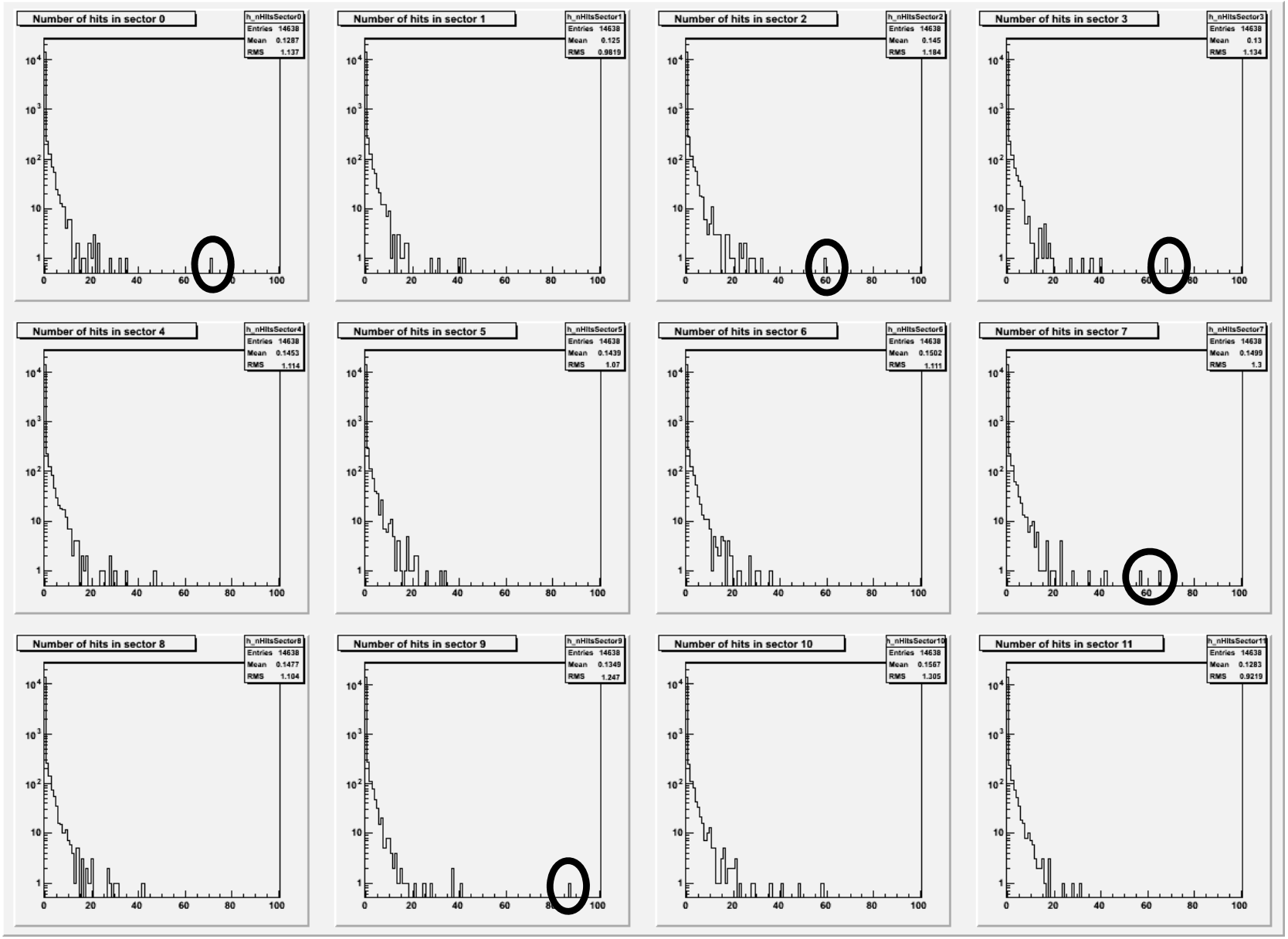
- PMT rates (rad. Bhabha)



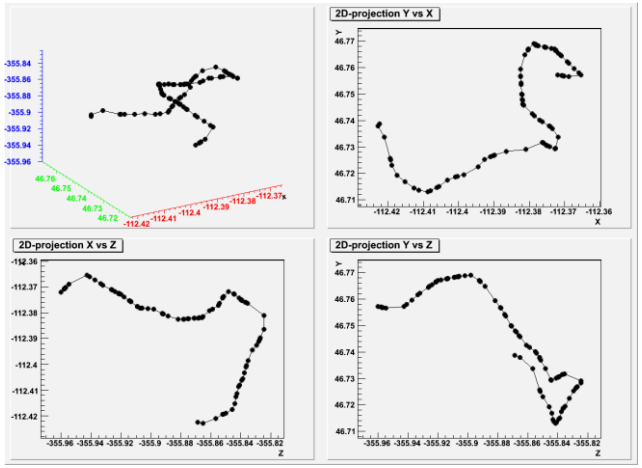
Full production background rates (cont'd)

- Remaining tails in the distributions of the # of hits / bunch crossing in a given sector

x-axis Range: 0 → 100



Two comments about the simulation



- Only optical photons detected by a MaPMT are recorded
  - Quantum efficiency taken into account
    → No way to know how many photons were generated
  - Nor to know the pathlength followed by the mother particle to generate these optical photons
  - Hard to check the optical photon generation using simulated events
    → Naive estimation (order photons by increasing creation time; assume straight line between two consecutive photon vertices) leads to large dN/dx

  → Any (simple) way to do better?

- Various sets of FDIRC-related variables in BRN output ntuples
  - DIRCHits → particles interacting with the quartz not producing opt. γ
  - FDIRCHits → FDIRC hits
  - DRCFEEHits → FDIRC front-end electronics hits
  - SOBHits → ???
  - DircWorld_boundary → FDIRC boundary

  → Documentation needed

  → Choose better naming conventions!?

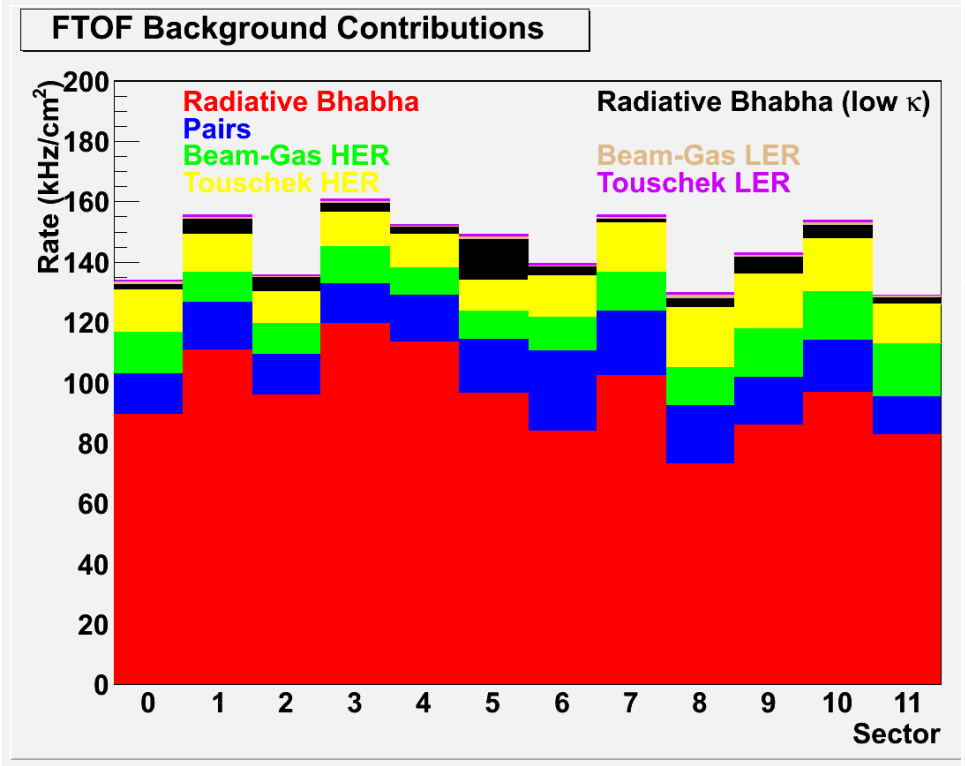
  → Get rid of the ‘SOBHits’ set if not used

Quick update about the FTOF background

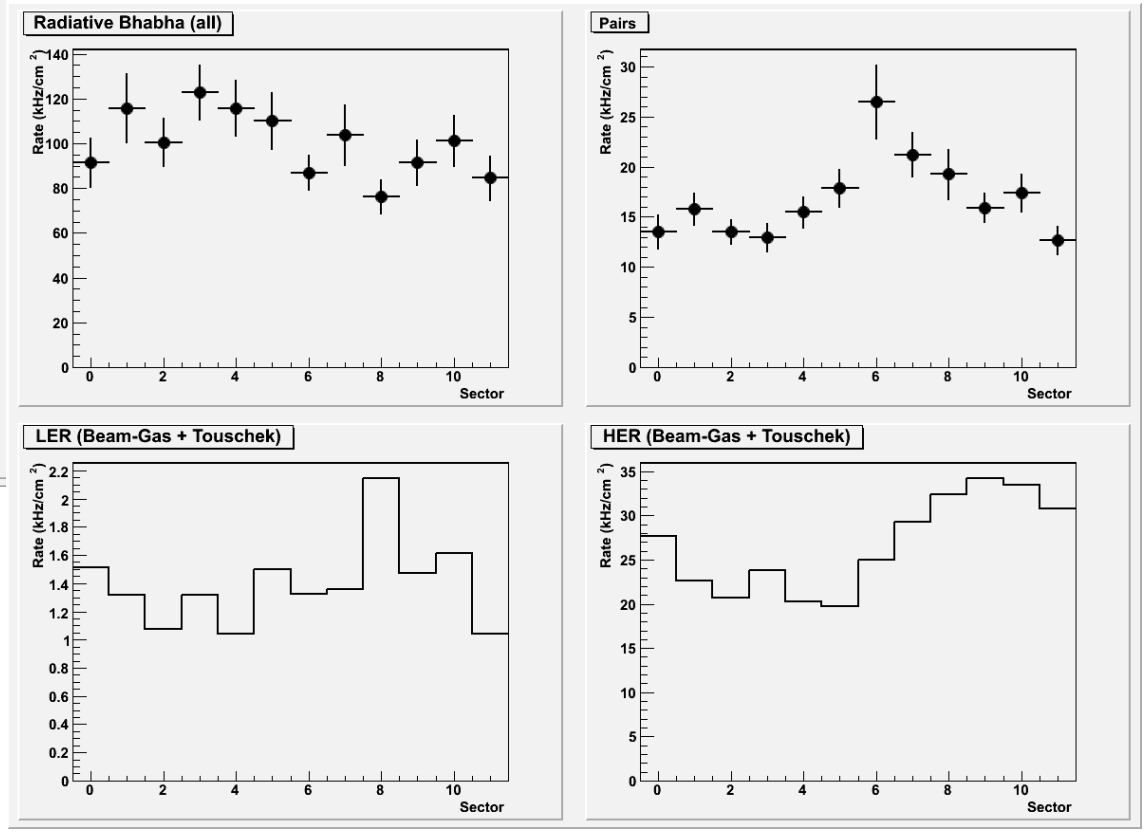
- Most of the time spent looking at the FDIRC background…
- Truth history for FTOF hits stored since this Summer production
  → Thanks!
- See Leonid's presentation in Elba for details about the simulation
  - One additional information though: the quantum efficiency must be applied offline as BRN assumes 100% QE for the MCP-PMTs – <QE>~10% [Leonid]
- Rad. Bhabha dominant background
  - Unlike the FDIRC for which several sources are ~equally contributing to the bkg
- Space available for the FTOF on the forward side better known
  → Simulation to be modified in the near future according to the design evolution
- No time (yet) to look into the origin of the background

FTOF background rates per sector

- Total rates

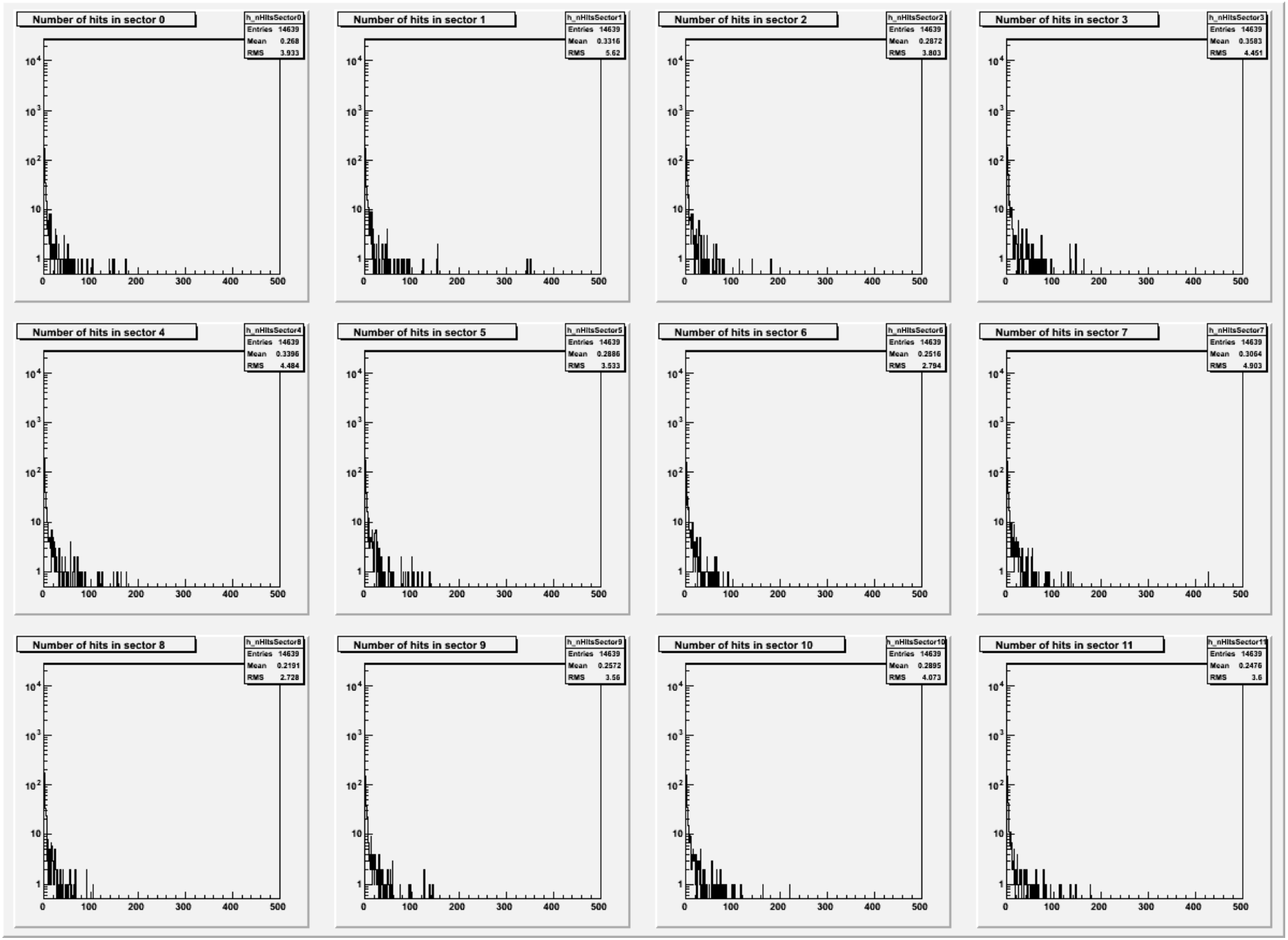


- Individual background contributions



FTOF background rates per sector (cont'd)

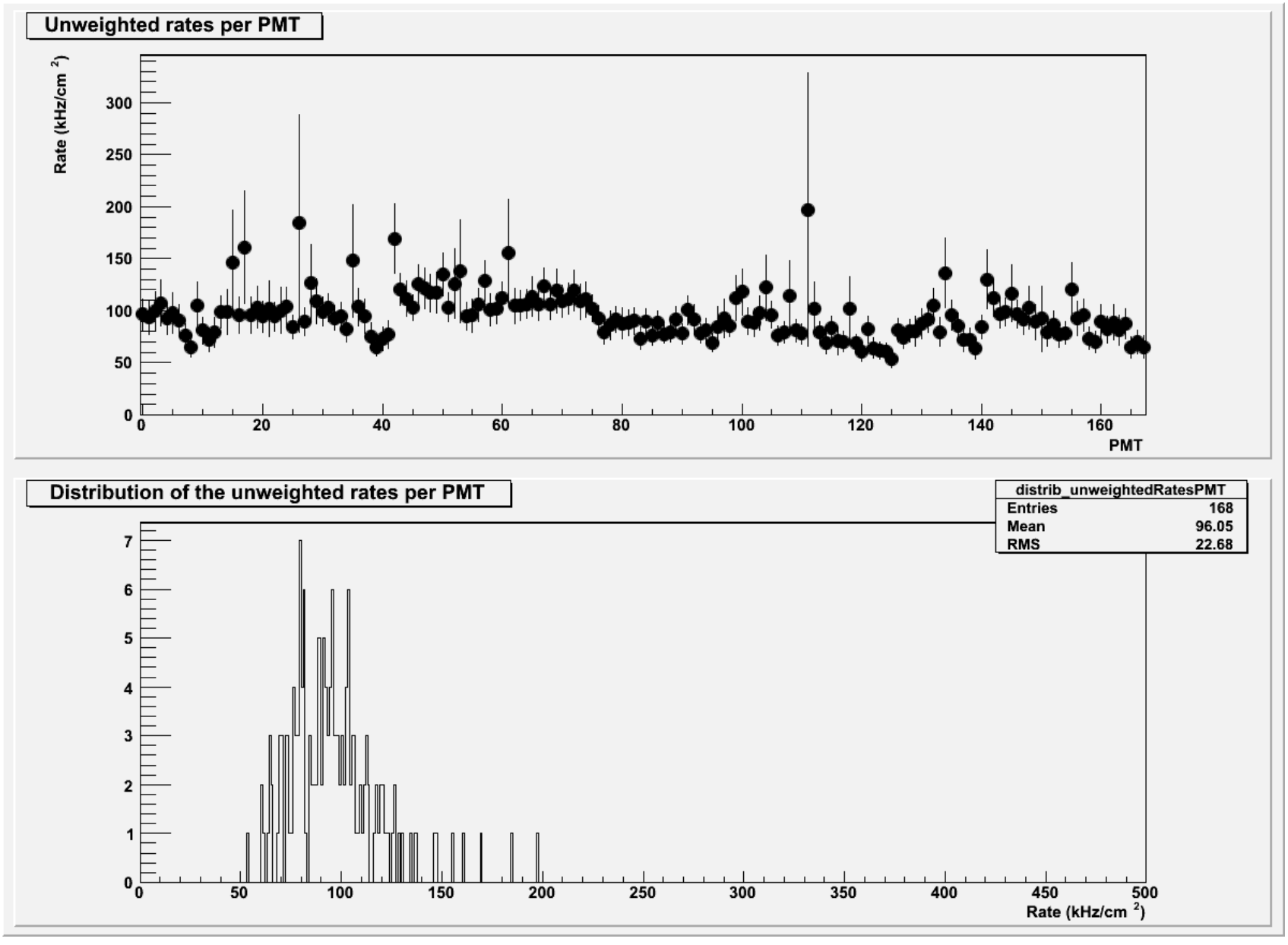
x-axis Range: 0 → 500



→ Note: raw plots produced directly from the ntuples ⇒ they 'assume' 100% Q.E.

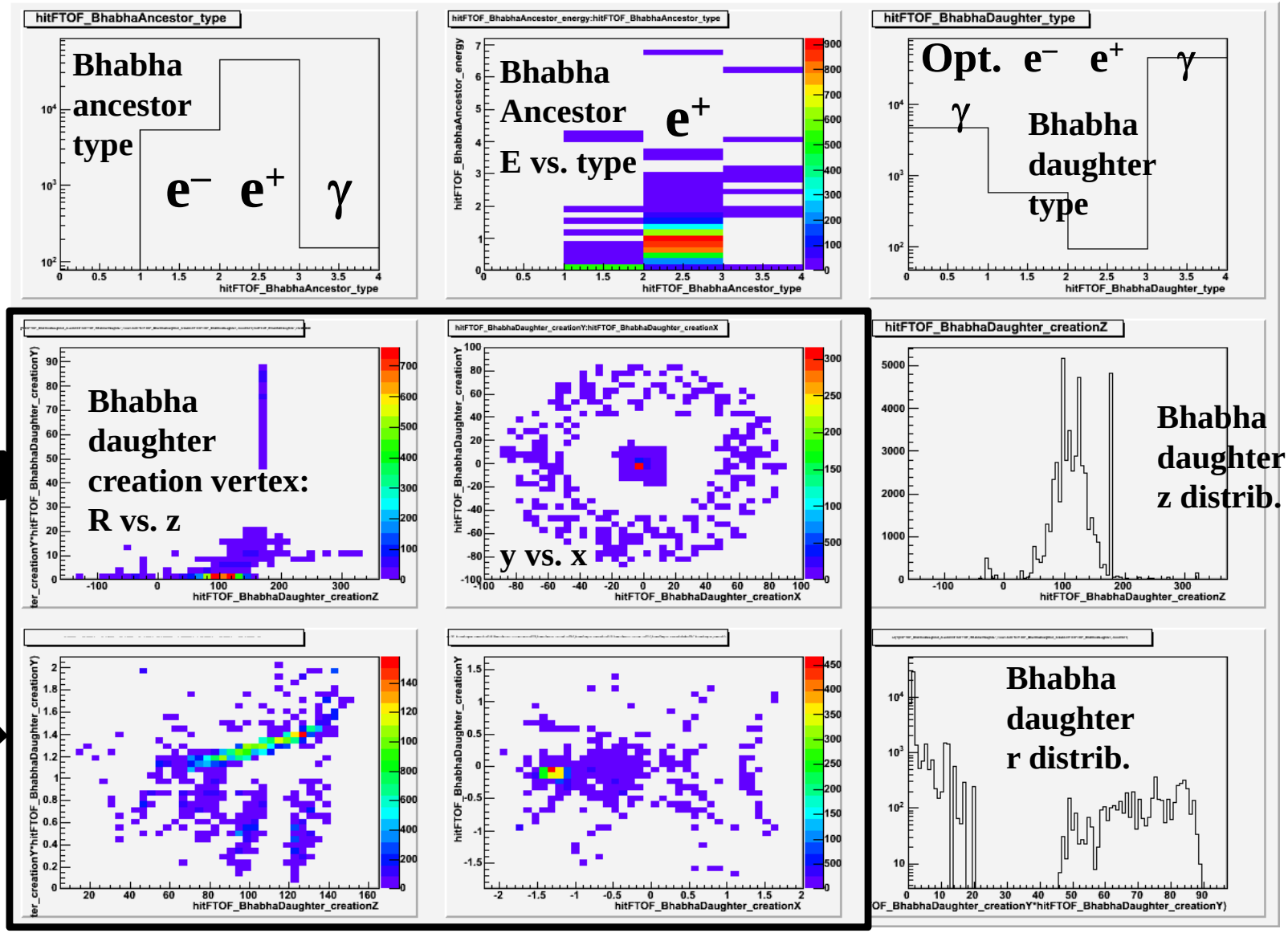
FTOF background PMT rates

- In the rad. Bhabha sample



Origin of Rad. Bhabha FTOF background

- For each hit, use truth information to construct its genealogy up to the Rad. Bhabha
- Look at the BhaBha ancestor
- And to its first daughter



Zoom

- Direct Bhabha
- Off-energy e^+ hitting the beam pipe at z around +1 meter