Background frames for fastsim

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Outline

- **April 2012 production: the fastsim bg-frames**
  - The samples
  - Some issues
- **The Touschek and BeamGas implementation in fastsim: unbiasing method**
- **Summary and Outlook**

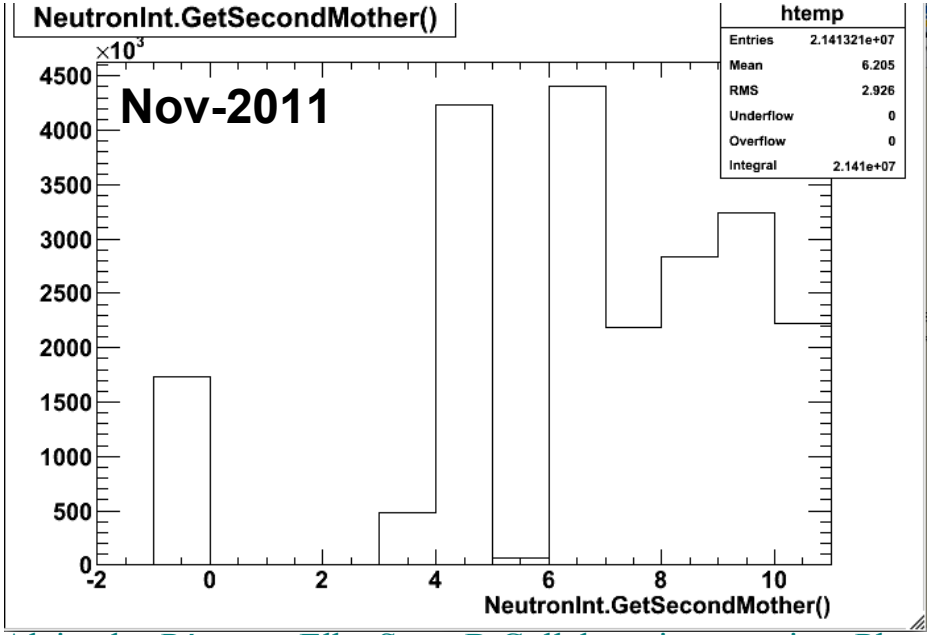
April 2012 production: Fast-sim background frames

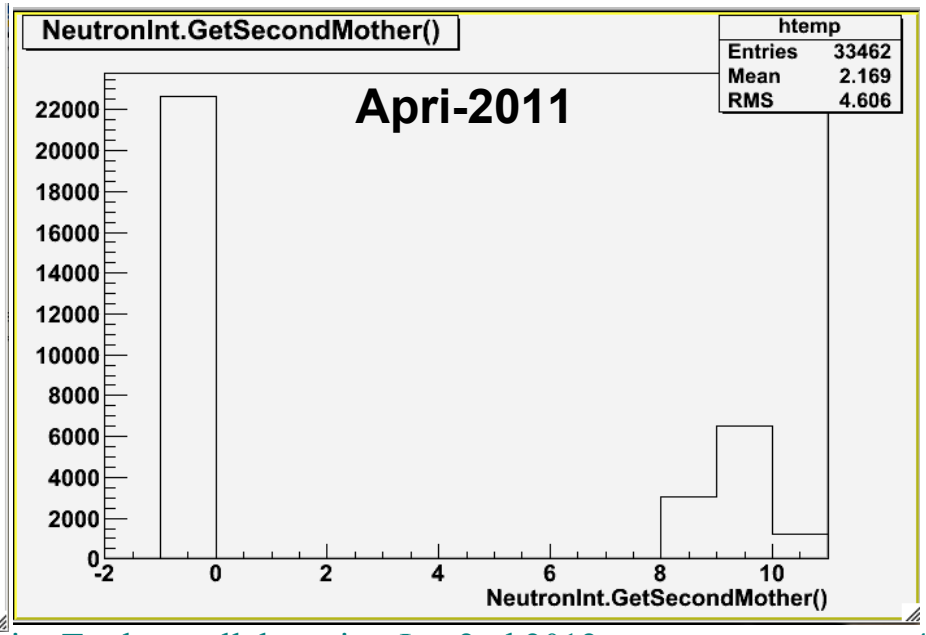
- **Produced the fast-sim bg-frame samples for all the background sources considered up to now:** Geometry with the W-shield increased up to 4.5cm thick
  - Rad-bhabha: 1M bunch crossings
  - Pairs (2-photon): 100k bunch crossings
  - Touschek HER/LER: ~250k primary losses
  - BeamGas HER/LER: ~280k primary losses

- **It is the first time Paris, Touschek and BeamGas bg-frame samples are produced with BRN:**
  - Pairs bg-frame sample need to be compared with the samples produced with fast-sim
  - Touschek/BeamGas samples are biased (see later slides)

April 2012 production: some issues with the bg-frames

- **Geometry hierarchy change in BRN since Nov-2011 production**
  - Changed was propagated to boundaries and instrumented volumes definitions
  - Missed to propagate the change to bg-frames ⇒ GetSecondMother variable of Neutron-interactions screwed-up
  - GetSecondMother variable is used to select the neutron interactions inside the EMC
  - For more information see Chih-hsiang talk



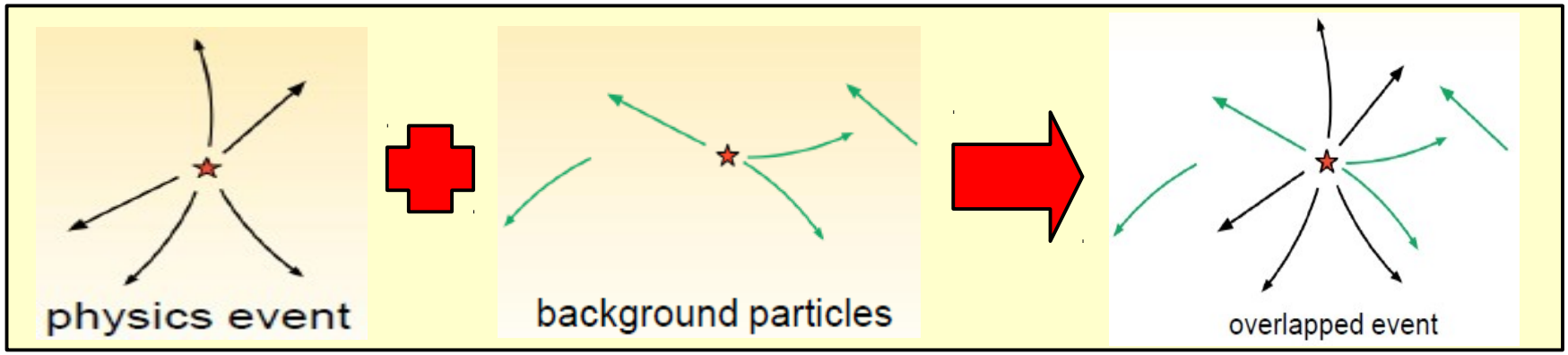


Fastsim bkg-mixing-frame code: how does it works?

- **Code inputs:**
  - Background frame files for every source: Bhabha/Rad-bhabha, Pairs, Touschek and beam-gas.
    - Format: particles corresponding to one bunch-crossing (Rad-bhabha/Pais) or lost-primaries (e.g. Touschek/Beam-Gas) that exit the final focus boundary
    - Special treatment for neutrons (FullSim): neutrons are tracked up to thermalization and capture (~120 μs) all around the detector. Each neutron interaction is recorded (deposited energy)
  - Parameters:
    - Bunch-crossing frequency (f_bc = 226.7MHz $\rightarrow$ 4.4ns)
    - Some selection: Zmin/Zmax and Emin/Emax
    - Background start-sensitive-time-window (t_0) and sensitive-window (Δt)
      - This parameters depends on the background time-structure (long temporal tails) as well as detection sensitive windows
      - Different background sources can have different (t_0, Δt) depending which detector is more sensitive to a particular Bkg-source: e.g Rad-Bhabha (EMC) and Pairs (SVT) $\Rightarrow$ **time optimization!**

Fastsim bkg-mixing-frame code: how does it works?

- **What the code does?**
  - For every background source:
    - Calculate # BC fitting in the background sensitive-window: N_bc = f_bc * Δt
    - For each physics event randomly read N_bc entries of the background-frame input file (list of background particles)
    - Randomly populate the (t_0, t_0 + Δt) time window with a flat distribution
  - Add the background particles (4-momentum, vertex, time) to the list of "physics" particles
  - Special treatment for neutrons interactions: Fast-sim cannot simulate neutrons. Bkg-neutrons interactions replaced by photons with E(γ) = E_{kin}(neutron)
  - From this moment on fast-sim treats equally all the particles in the event

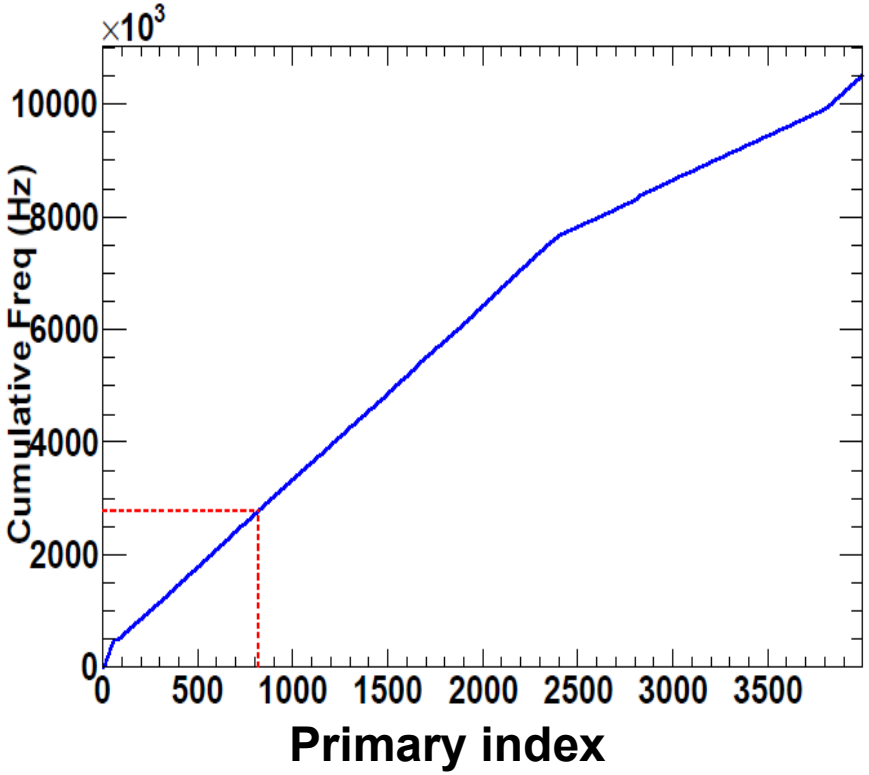


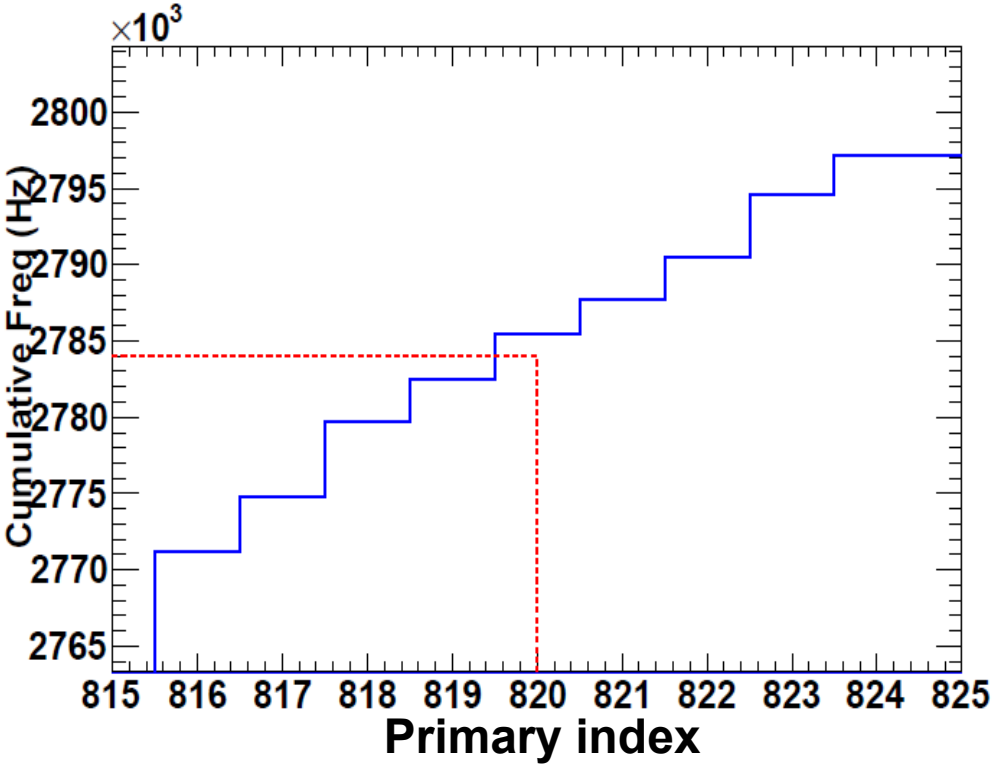
Treatment of biased samples

- **The biased samples**
  - Touschek and Beam-Gas samples are biased,
    - Sample consist of a list of primaries which are particles lost at the beam pipe near by the IP
    - Each primary has a weight (frequency) such that the total sum of weights (Wtot) is the total particle rate near by the IP
    - Each weight divided by Wtot (relative frequency) is the conditional probability that this primary loss actually occurs
- **Unbiasing method**
  - The time between two consecutive BC is 1/f_bc $\Rightarrow$ The expected number of particles losses during this time interval due to a background source (Touschek/BeamGas) is N_bkg = Wtot/f_bc
  - In order to unbias the sample,
    - Generate a random number N_sample following a Poisson distribution with mean N_bkg
    - Sample N_sample primaries from the background sample using the relative frequencies

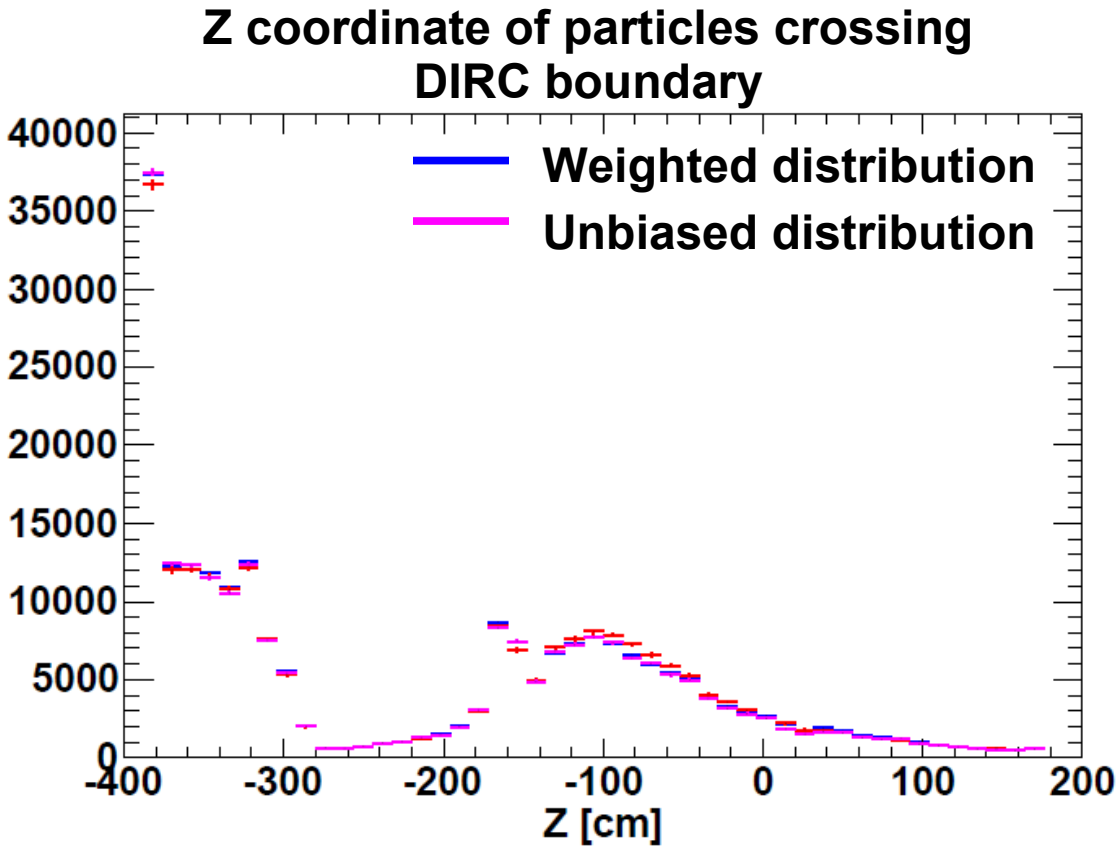
Treatment of biased samples: en example

- **Touschek-LER sample**
  - Total sum of weights = 10.5MHz
  - N_bkg during two consecutive BC = 0.047 primaries
  - For a time interval of 1ms = 227273 BC ⇒ 10682 Tous-LER primaries
- **Sample 10682 primaries out of the Tous-LER sample**





Treatment of biased samples: en example



- Distribution for weighted and and unbiased tend to be the same as number of BC increases (as expected)
- Developed a module to unbias the samples that is being used for FullSim analyses
- Unbiased method already used for performances studies on the EMC
- FDIRC background effects will use the same method

Summary and Outlook

- **Produced bg-frames for all background sources: Rad-bhabha, Pairs, Touschek and Beam-Gas**

- **Developed a code for the treatment of biased samples (Touschek and Beam-Gas)**
- **Code has been validated and used for detector performances studies: EMC and FDIRC in the future**
- **Still need to implement the code inside FastSim Bkg-mixing framework**

- **Outlook**
  - bkg-frame QA code development with the help of the subsystem experts to understand the effect of background on the detectors
  - Documentation in the Wiki


Backup