Validation of the FastSim background mixing framework code

Alejandro Pérez
INFN – Sezione di Pisa

LNF SuperB Collaboration Meeting

Outline

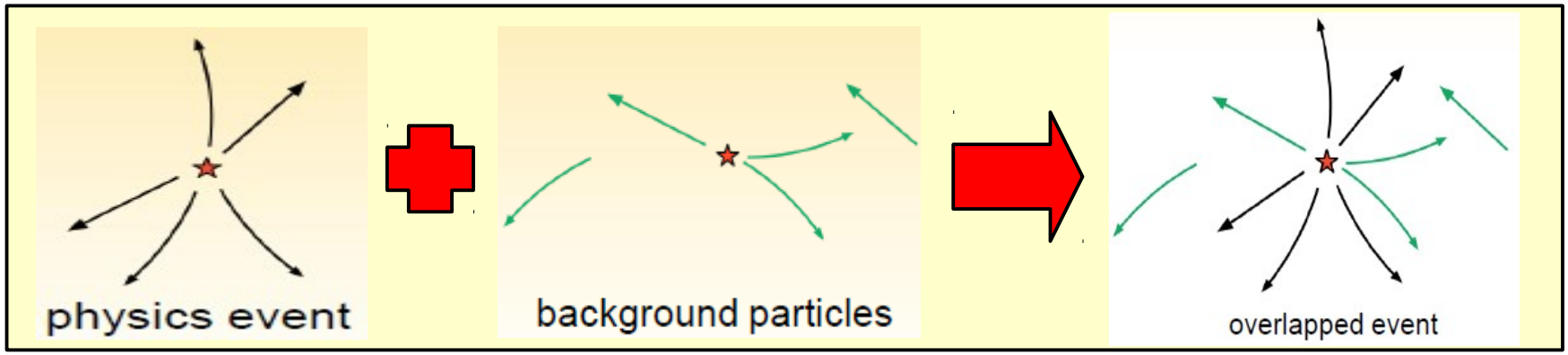
- **The fastsim background-mixing-framework (Bkg-mix-frame): How does it works?**
- **First validations studies**
  - Artificial background frames with single particles
- **Summary and Outlook**

Bkg-Mixing-frame code: how does it works?

- **Code inputs:**
  - Background frame files for every source: Bhabha/Rad-bhabha, Pairs, Touschek and beam-gas.
    - Usual file format: particles corresponding to one bunch-crossing (BC, f_bc = 226.7MHz $\rightarrow$ 4.4ns) that either hit the detector (fastsim) or that exit the final focus boundary (FullSim)
    - Special treatment for neutrons (FullSim): neutrons are tracked up to thermalization and capture (~120 μs) all around the detector
  - Parameters:
    - f_bc
    - 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!**

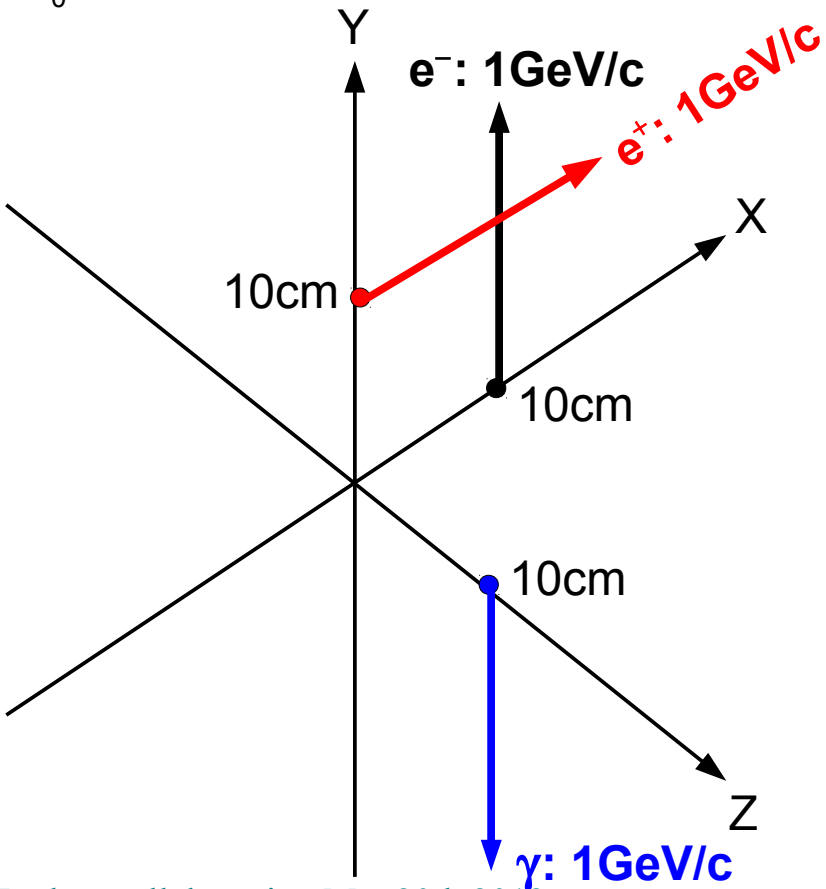
Bkg-Mixing-frame code: how does it works?

- **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: Fast-sim cannot simulate neutrons. Bkg-neutrons replaced by photons with E(γ) = E_{kin}(neutron)
  - From this moment on fast-sim treats equally all the particles in the event



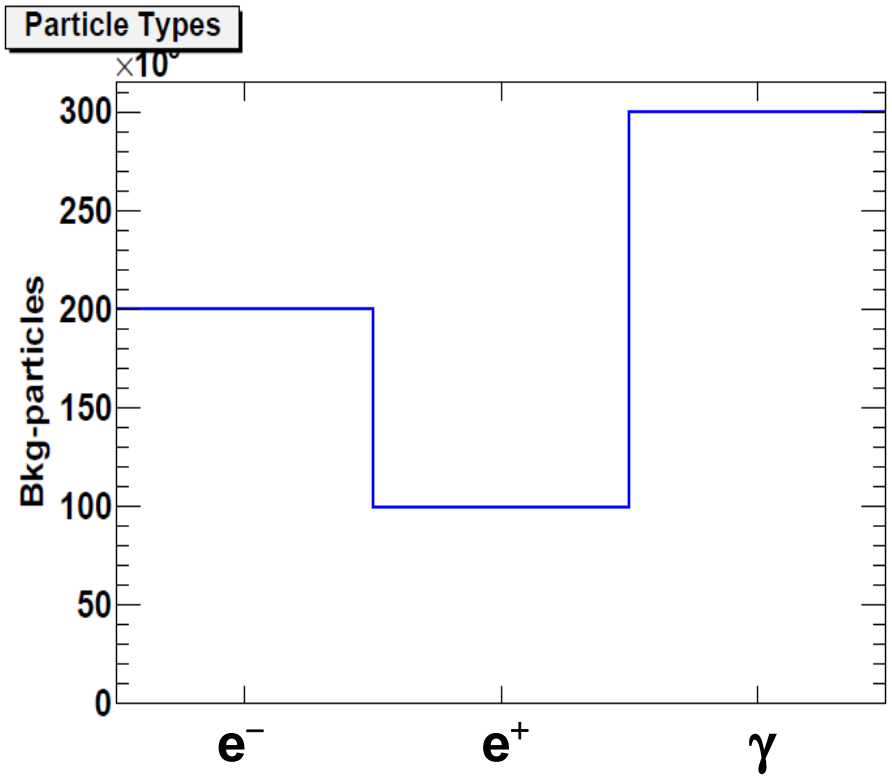
First Bkg-Mixing-frame validation studies: Strategy

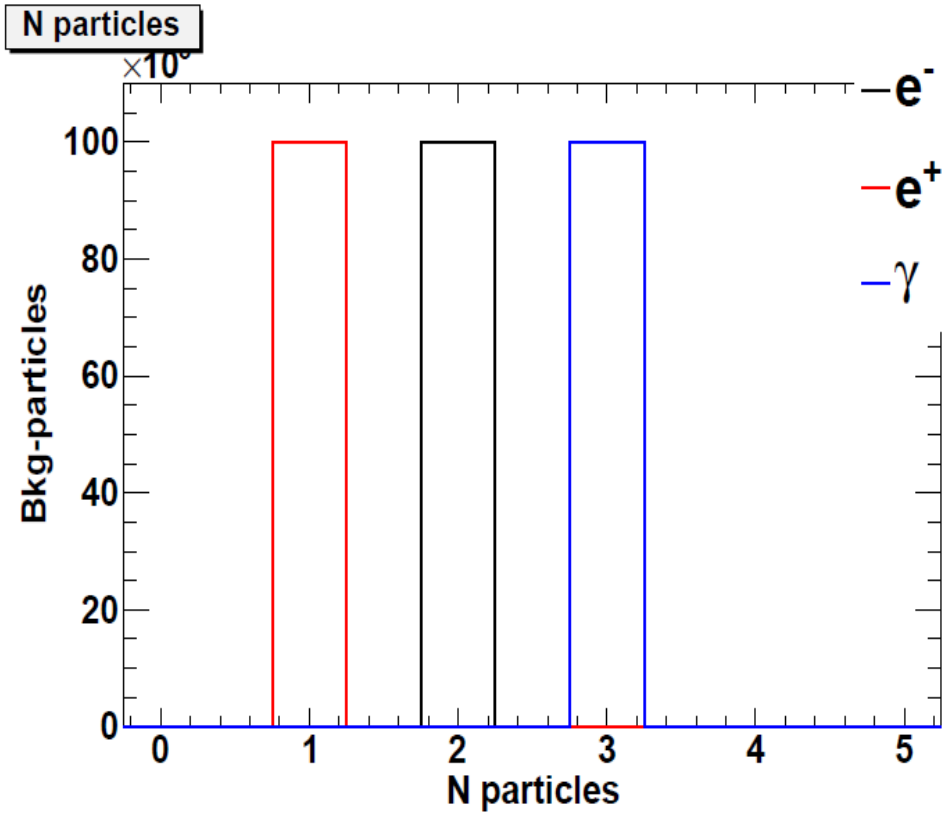
- **Generated three artificial background sources with single particles:**
  - e^-: P = (0,1,0) GeV/c; Vtx = (10,0,0) cm; t_0 = -0.25μs, Δt = 1.0μs
  - e^+: P = (1,0,0) GeV/c; Vtx = (0,10,0) cm; t_0 = -0.50μs, Δt = 1.0μs
  - γ: P = (0,-1,0) GeV/c; Vtx = (0,0,10) cm; t_0 = -1.00μs, Δt = 1.0μs
- **Mixing proportion $2e^-$:$1e^+$:3γ**
- **The generated physics event has only neutrinos in the final state so that the main particles in the event come from background $\overline{B^0} \to \nu_e \overline{\nu}_e$ and $B^0 \to \nu_e \overline{\nu}_e$**
- **Check that the list of primaries in the event excluding the neutrinos are the ones that were putted in**



First Bkg-Mixing-frame validation studies: Results

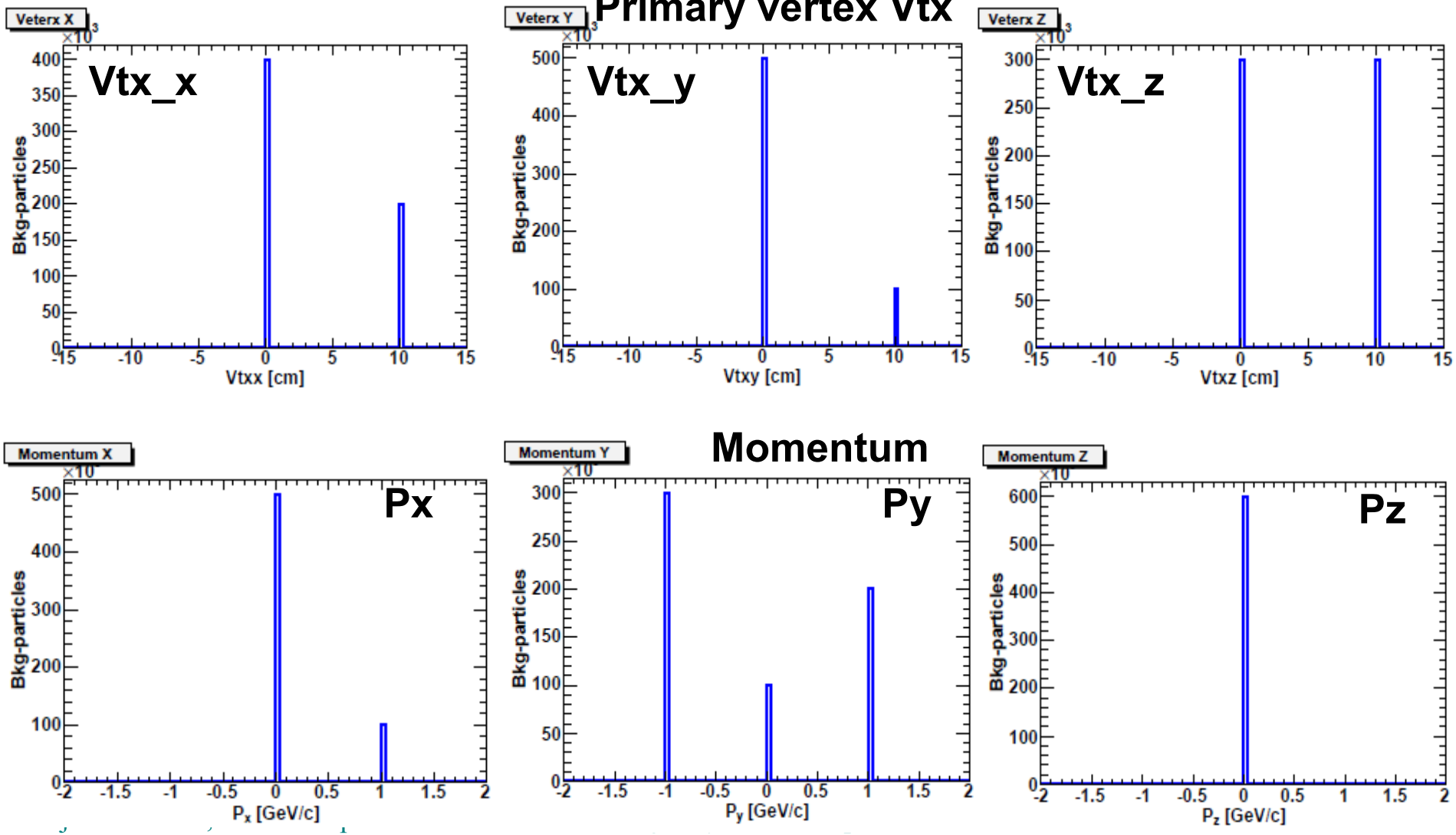
- **The mixing proportion of the artificial background sources is as expected**





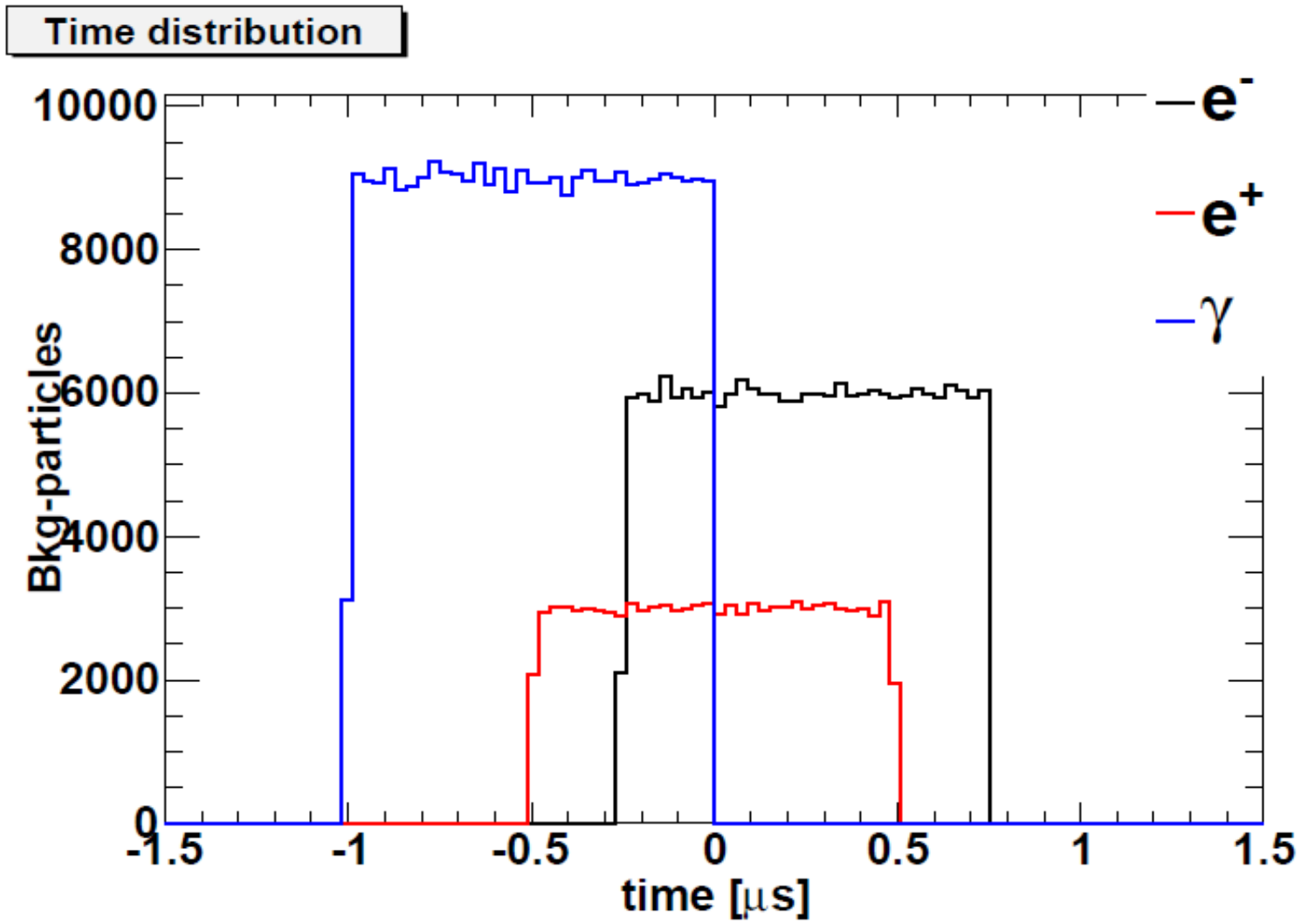
First Bkg-Mixing-frame validation studies: Results

- The mixing background primary vertex and momentum is as expected



First Bkg-Mixing-frame validation studies: Results

- The mixing background time structure is as expected



Summary and Outlook

- **A first look at the Bkg-mixing-frame code seems to show that is working properly, but still more checks need to be done**

- **Next developments**
  - Include Touschek and beam-gas samples (~1 week):
    - Unbiasing method needed
    - Already implemented for EMC fullsim studies
  - Validation studies including more realistic background samples: Rad-bhabha, Pairs, Touschek and beam-gas (~2 weeks)
  - Want to develop a bkg-frame QA code with the help of the subsystem experts to understand the effect of background on the detectors


Backup