Events with time-shifted background

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In DD4HEP

- Particles get their information from the starting vertex (note: units is mm after multiplying with *c*)

```
104     p->time         = vsx.get_component(3) * len_unit / CLHEP::c_light;
105     p->properTime   = vsx.get_component(3) * len_unit / CLHEP::c_light;
```

- But GEANT vertices are created from the end vertex of parentless particles…

```
136     if ( p->parents.size() == 0 )  {
146       vtx->x = p->vex;
147       vtx->y = p->vey;
148       vtx->z = p->vez;
149       vtx->time = p->time;
```

- Fixed with a simple patch; upstream fix should involve logic changes

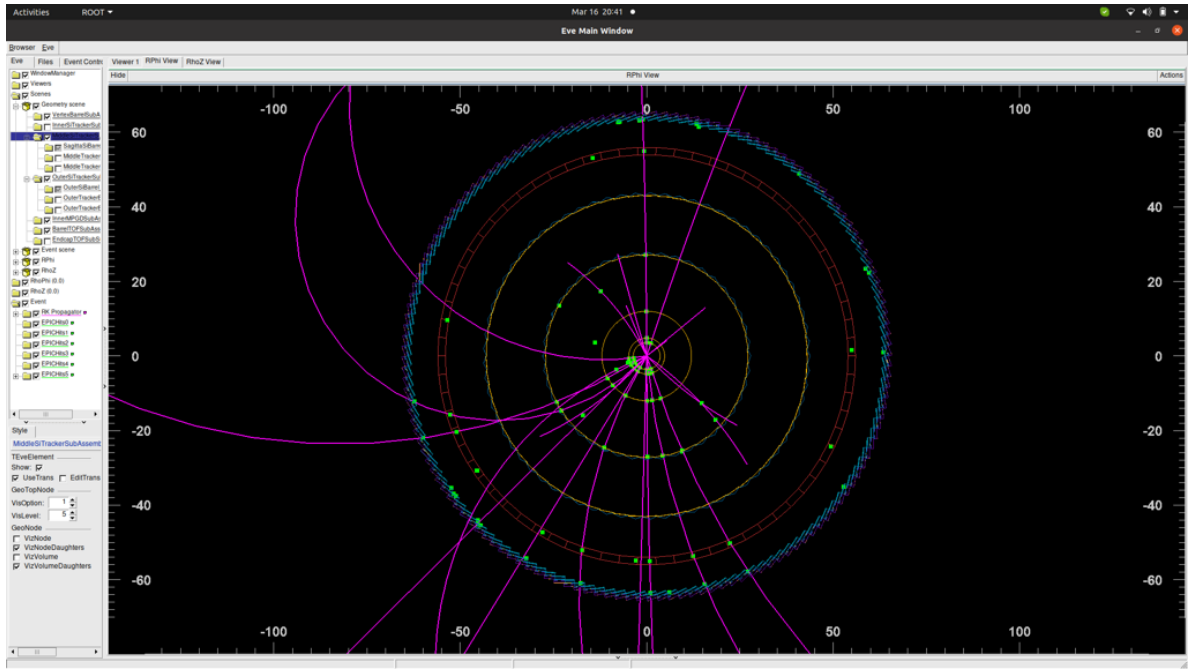
Combined HepMC events

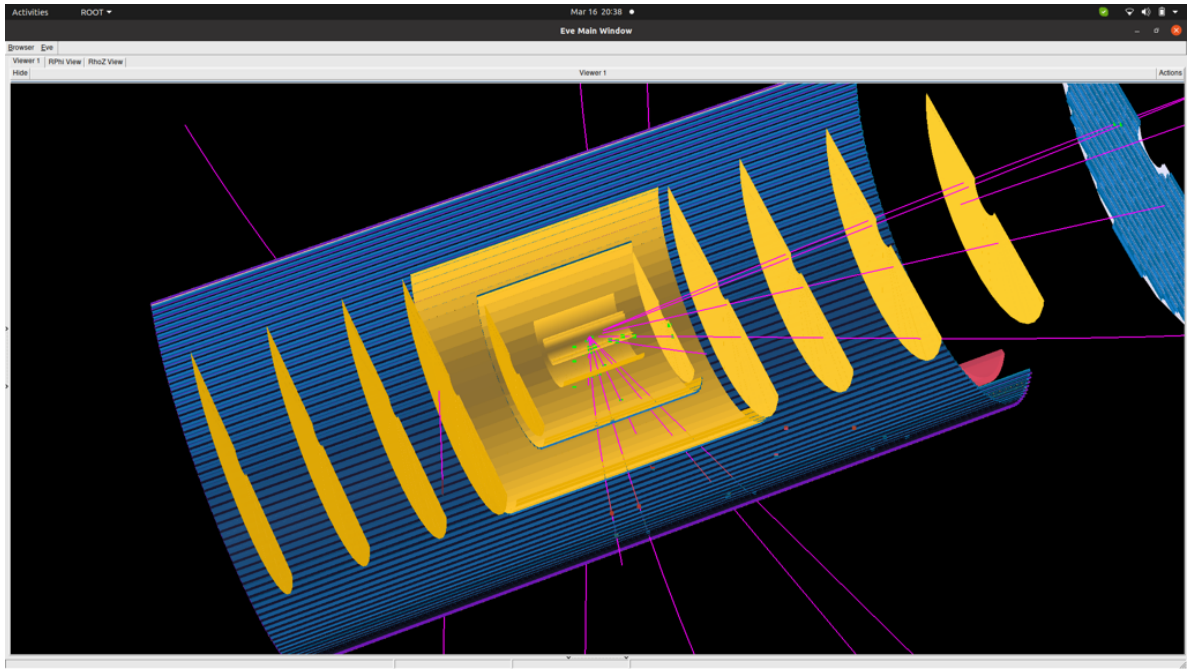
- Goal: 2μs event with one (or more, or 0) physics event at a random time and background events with realistic time distribution
  - Have: Hacky c++ code that injects arbitrary particles at arbitrary time
  - Benjamen and Rey are working on a clean and complete python implementation
- Together, we can have somewhat complete events in O(days), but…
- My understanding: Nobody has the time to develop tracking with background by end of March (DIS, HP)
  - And GEANT level events are **not saved** by default in the campaign

→ Propose to decouple from the main campaign

Proof of concept

- On top of pythia events, have two pions at +/- 10 GeV in the y-direction. Shyam produced an event display:

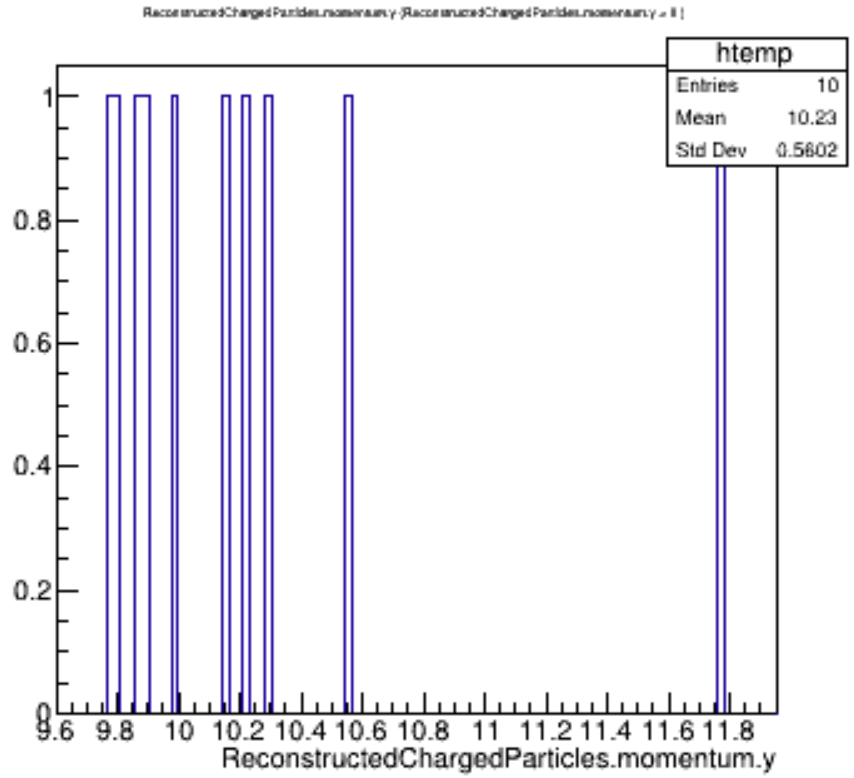




In EICRecon

- Tracking χ^2 should respect time. Just started working on how hit time information gets processed / integrated by the digitization.

- Ten upward pions after reconstruction:



Summary and Outlook

- Events merged at the HepMC level could / will be ready in time for the next campaign.
- But they should not be used. Tracking won't be ready to deal with them, and the intermediate stage is not saved.

- The preservation of time information through the hit stage is demonstrated to work. Integration and digitization is WIP.
- Once everything works at the HepMC level, will revisit merging just prior to digitization. It "should" work and would dramatically reduce GEANT costs.