Experimental Aspects of Long-Lived HV particles

Goals for this discussion

- Catalogue final states
- Trigger and Data Management
- Analysis handles
- Are there definite holes in sensitivity?
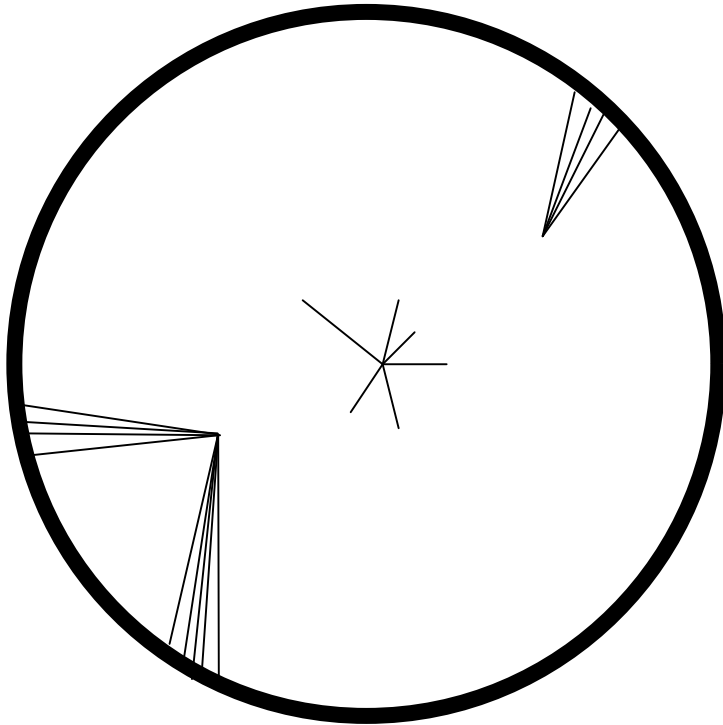 - if yes, what can be done for SLHC?

Displaced Vertices

- Decays into leptons, photons, b-jets, gluons.
  - Two vertices per event - many combinations, at least one triggerable?
- Few cm from IP
  - standard tracking will likely pick those up. Good for muons, can be challenging for electrons, needs study for jets (DØ analysis in progress)
- Tens of cm from IP
  - standard tracking will not pick those up (trigger and off-line ramifications, next slide)
  - Jets without tracks, narrow jets, off-pointing and delayed photons, muons are challenging (only local muons, may be still some efficiency loss)
- Inside ECAL
  - delayed photons, delayed jets without tracks, narrow jets
- Inside HCAL
  - Delayed jets, jets with no EMF, jets with no tracks, narrow jets
- Inside muon system
  - Delayed muon segments, anomalous pattern of segments, i.e. no segments in first station, a lot in the second and few or none in the third
- One vertex inside HCAL, one outside
  - large MET

Yuri Gershtein, Davis 2007

Before We Get to Data Analysis...

- Trigger - most crucial at this stage
  - Small IP muons, high pT electrons/photons, very high pT jets are probably O.K. - need to check the crossing assignment
  - everything else might need dedicated triggers
- Event content
  - Data volume is huge, most analyses will be done on reduced format; it will be a pain (or altogether prohibitive) to go to full data.
  - It's expensive to keep all tracker hits. CMS analysis format right now only keeps hits on reconstructed tracks for future re-alignment
  - Time frames for the calorimeter hits are not kept
  - Keep this information for "regions of interest" in an event? May be can keep all or some info for small fraction of events? Fast way of selecting which ones?
- Data management
  - Dimuons constitute small fraction of the data. Dijets are most of the data. The smaller your stream, the more convenient it is to work
  - "Flags" for interesting jetty events?

Handles

Kazana, Wrochna, Zalewski, CMS CR 1999/019

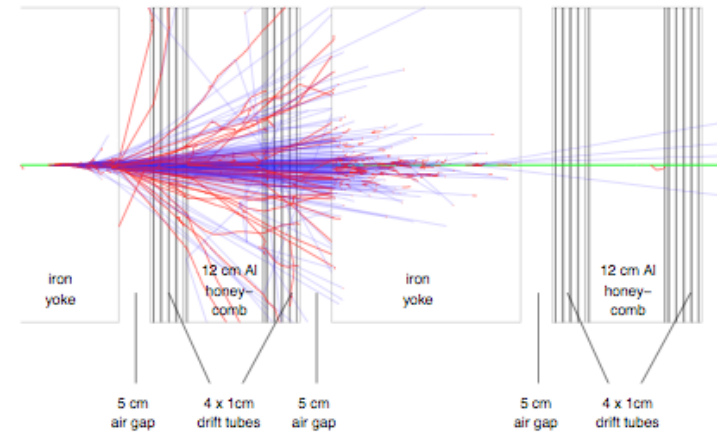Electromagnetic shower in CMS Muon Detector caused by a 22 GeV photon. GEANT

Jets without tracks look like noise!

Jets do not have time to open up - become narrow - even more like noise!

May be these narrow jets can be pointable? Especially if decay is inside ECAL?

Do we save hits next to all jets like this??

Decays in muon system can produce interesting (and triggerable!) signatures in muon system.

Especially good at CMS - absorber/yoke between muon stations

Pointing & Timing

- ATLAS has clear advantage - longitudinally segmented calorimeter, and calorimeter timing
- CMS:
  - Preshower in endcap (unfortunately at $|\eta|>1.6$)
  - Off-pointing showers will have elongated transverse profile, but so would converted photons and EM jets
  - Some timing information
    - ECAL: signal in ~6 25ns frames, ~0.5-1 ns precision.
    - HCAL: signal in ~ 2 25 ns frames, timing resolution?
  - In endcap, HCAL has 2 longitudinal segments, may be enough for pointing?
  - Can HO & first muon station be used for pointing jets that started in HCAL?

Ideas for SLHC

- ## Time of flight system
  - is it useful with 200 events/crossing?!
- ## Track trigger
  - fast vertex finding from outer track layers?
  - can delta electrons and curlers from interations in the tracker be eliminated?
- ## ?