Data Mixing Module: Introduction and Status

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# Mixer Module for Data

- What it is:
    - General tool to overlay Real Data (zerobias triggers) on top of MC hard scatter events
        - can actually overlay anything you want on anything else (Data on Data, MC on MC, MC on Data, etc.)
- Why?
    - take detector noise, pileup, etc. from Data rather than trying to model it

- Strategy for Production Running:
    - A zerobias "library" can be created with collisions matching the luminosity profile of the data being simulated
        - assumes one writes enough zerobias events during physics running
    - overlay *one* zerobias interaction per MC hard scatter
        $\Rightarrow$ proper simulation of noise, pileup

Mixer Module for Upgrade Studies

- Multiple Overlay of Data Events
  - Technique used heavily at Tevatron by both experiments to model high occupancies for Run IIb upgrades
  - Is certainly possible
    - DataMixer uses MixingModule base classes that allow full flexibility in number of "pileup" events, distribution (Poisson, Fixed, etc.)
  - Tevatron Experience:
    - Detector occupancy is dominated by hits from real particles
    - adding <1% noise a few times over is irrelevant if each beam crossing has ~10% occupancy (or more!)

Mixer Module Overview
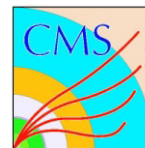
Some Details:

- A variety of options for overlay procedure
  - Tracker/Muon:
    - combination of Digis: your choice of input level
      - calibrated, zero-suppressed, select from standard input list
    - overlapping hits in same detector element are merged
      - "Geometry agnostic" → Hits are associated to the same Channel ID with no geometry input
      - works for any self-consistent set of files
        - » may be useful for Tracker studies
    - Code behavior has been extensively checked by Tracker experts
      - M. Assunta Borgia, D. Giordano
        - » studies of noise/signal overlays

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Mixer Module Overview

- – Calorimeter:
  - combination of calibrated RecHits or Digis, your choice
    - – choose separately for Ecal and HCal
  - energies in hit cells are summed
  - Current implementation of Digis merging is done after zero-suppression
  - Working with HCAL group to do "correct thing" for MC overlay
    - – E. Berry, C. Tully
    - – get baseline noise directly from overlay data event, then digitize
    - – working with R. Wilkinson

Data Mixer Status

- Have overlaid Cruzet4 data with MC, and with other Cruzet4 data
  - working to get some test samples out
- CMSSW_2_X, CMSSW_3_X
  - Code is in releases, compatible with other code base:
    - SimGeneral/DataMixerModule
      - several people are already using it...
    - `/test` directory has README instructions for running
    - For now, please use tag v00-01-17
      - compatible with new Mixing/Base
      - sorting out some weirdness with _3_X at the moment...
  - Requires both streams to be processed to the same (appropriate) level, e.g. Digis, depending on what you want
    - There are _cff.py files for this partial Reconstruction, as well as post-Mixing Reconstruction using the new merged output in the `/python` directory

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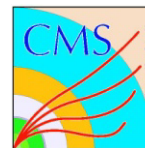
Data Mixer Plans

- **Near Term Plans:**
  - Incorporation of new Digi overlay for HCal
    - Anyone know anything about ECal?
  - Comparison of overlays using the standard Mixer vs. DataMixer combining at Digi/RecHit level
    - how important is the Calorimeter zero suppression issue?
    - What do we expect for the trackers?
    - etc.
  - Incorporation of FASTSIM overlay
  - Wide Advertisement
    - this tool can be very useful for a wide variety of studies...
      - start giving more talks once things settle down
      - beta-testers welcome!