

Real-time Calibration and Alignment

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Current CMS calibration - Maurizio

- Three types of calibration (same in ATLAS):
 - HLT conditions, ~ 2 minutes, eg beamspot
 - Prompt calibration loop, for initial processing, 48 hours, eg problematic cells, pixel alignment
 - Offline, $O(\text{months})$, need **large integrated luminosity**
 - Main barrier to full real-time calibration in both experiments
 - CMS calorimeter was not designed to be calibrated fast - need sizeable number of balance events for each cell
 - Currently use $Z \rightarrow ee$, could perhaps use J/ψ for higher stats

ATLAS High-Granularity Timing Detector - Emma

- Motivation: control pileup - vertices overlap in space but not in time
- Sensors (1mm^2) have $\sim 40\text{ps}$ resolution, 2-4 hits per track $\rightarrow \sim 30\text{ps}$ per track
- Various sources of time resolution degradation: clock distribution to ASICs, jitter from eg cables, temperature cycles, etc
- Can calibrate via mean timing of bunch crossings, allows calibration of variations over timescales $\sim 10\text{-}30$ x integrated calibration time
 - In more central regions, **1ms** calibration window works, further out need longer to acquire necessary stats

Discussion points

- Need to motivate people to work on automating monitoring / calibration procedures. Incentivise via overlaps with ML?
- Should we re-think calibrations? Variations we are currently averaging away. Doing things faster would be better for trigger and offline.
- How complicated do calibrations need to be? LHCb did away with the most complicated and slowest parts.
- Huge potential impact on triggers - $O(50\%)$ of events recorded are thrown away because below trigger turnon (set by online : offline resolution, ie a function of trigger calibration) and it's difficult to work on turnon

Discussion points, 2

- If Real-Time Analysis is used for calibrations, it becomes more useful to the collaboration as a whole.
- RTA in LHCb has been nice in focussing efforts on analysis improvements where they're most useful, data format and content is set by trigger
- Need MC to capture time variation to take full advantage - current bookkeeping etc is often inadequate
- (Despite CMS strides in data size, it takes time to refine it - will face significant size hurdles at start of HLLHC)