



CMS-TDR-021

Introduction:

- HL-LHC will open up an unprecedented opportunity for HEP: high-precision SM measurements and extending BSM searches.
- The detector readout electronics and DAQ will be upgraded to allow an increased L1 trigger rate (750 kHz) with a latency of 12.5μs.
- Goal: Tag showers coming from high- p_T muons at trigger level.

Analytical Method:

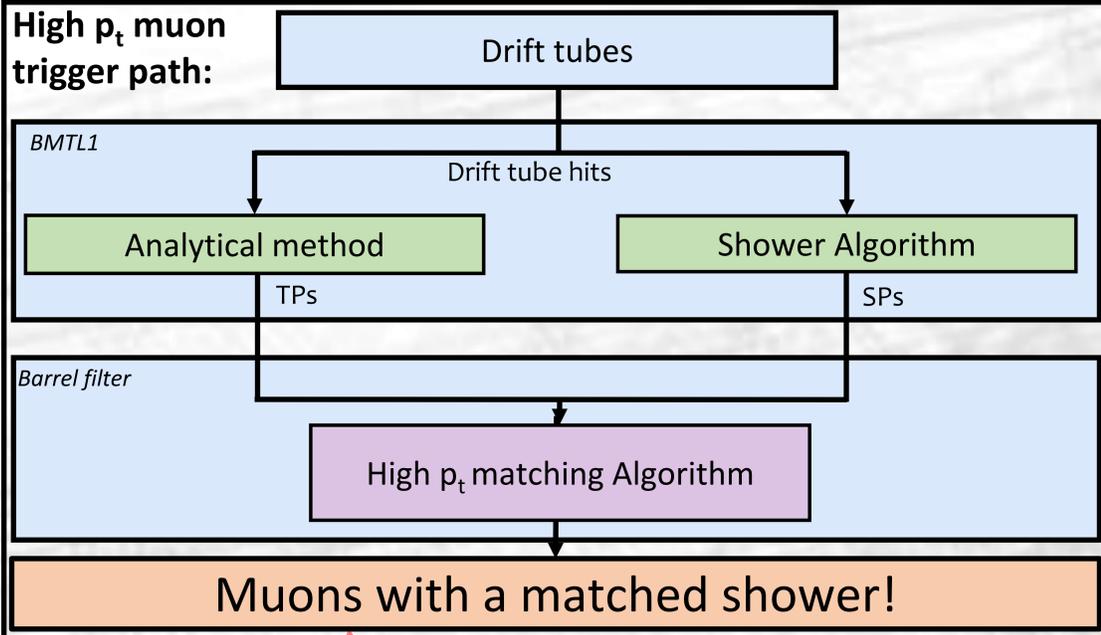
- The Analytical Method (AM) produces compatible straight line muon trigger primitives (TP) from the adjacent drift cells.
- Implemented in dedicated FPGA boards for simultaneous readout of the Drift tubes (DT).
- Matching segments within a 25 ns window is 99% efficient.**
- In case of a muon shower, multiple cells will be active in a small area, producing a combinatorial explosion of many possible trigger primitives, producing spurious data and taking too long to process.



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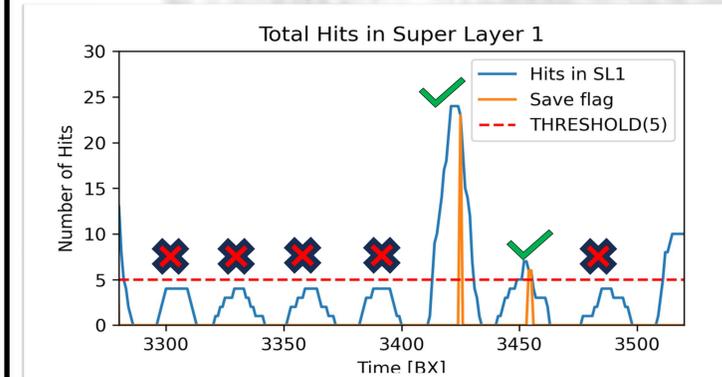
JINST 15 P02027

High p_T muon trigger path:



Shower Algorithm:

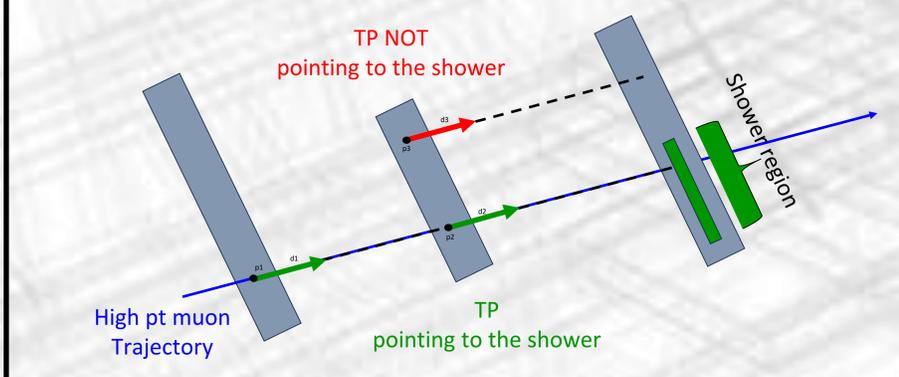
- Tags and process events with a high number of hits in a small amount of time.
- Defines an adjustable threshold to filter showers from normal muon crossings.
- Produce a shower primitive (SP) containing the spread and time information of the shower at the peak.
- High efficiency tagging events that produced electrons, with low latency (<25ns) in tagging showers.



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High p_T matching Algorithm:

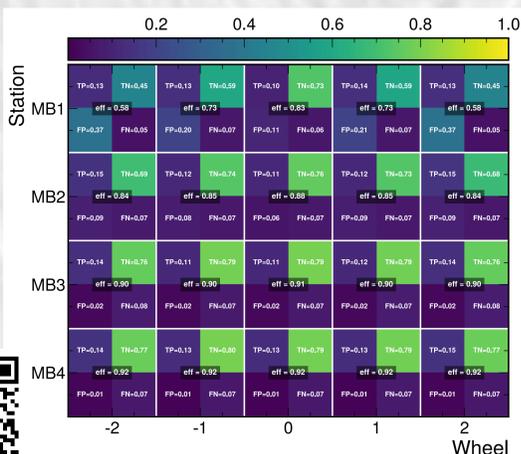
- Filters the Shower Primitives to tag the ones coming from high p_T muons.
- Recover all the information from all the 5 wheels, adjacent sectors and stations.
- For a shower to be assigned to a muon, it should have at least 1 TP pointing to it.
- Different qualities applied depending on the number of stations with TP that point to the station.



Results and future work:

- Shower algorithm trigger efficiency 60-80%.
- Ultra-low resource consumption (2.5K LUTS, 2.5K FF).
- Firmware-emulator comparison agrees up to 96%.

Check some shower events!



- Unmatched showers are certainly not related to showered high- p_T muons.
- Between 40-60% of high- p_T muons that radiated electrons can be identified by matching SPs and AM TPs.

