The Level-1 muon trigger for CMS
Ioanna Papavergou, on behalf of the CMS collaboration

The Level-1 Muon Trigger at CMS
The hardware-based Level-1 Trigger (L1) is the first part of the CMS Trigger system. Its main goal is to perform a physics selection and as a result it reduces the bunch crossing rate of 40 MHz delivered by LHC down to 100 kHz.
Muons can be tracked from their ionization deposits in CMS
Goal of the L1 muon trigger:
- Optimising muon reconstruction to achieve the highest efficiency and quick trigger decisions (<4 μs)
The L1 trigger algorithms:
- Identify muon tracks and assign πT & quality.

The L1 muon trigger Algorithms

The BMTF algorithm
Combines DT & RPC information:
✓ Extrapolator unit: forms acceptance windows and super-primitive pairs
✓ Tracker Assembler Unit: Receives paired super-primitives and combines them to reconstruct a track. At the end a quality bit is assigned in every track based on its length
✓ Assignment unit: Uses look-up tables (LUTs) to assign πT, η and φ in a track.

The OMTF algorithm
✓ Uses DT and CSC tracks and RPC hits
✓ Uses 52 Golden Pattern (GP) modules
✓ Calculates Δρ between hits and a reference hit, uses GPs to calculate log-likelihood of a πT-sign hypothesis
✓ Best GP based on the highest non-zero layers log-likelihood and highest sum of log-likelihood

The L1 muon trigger performance in 2017
Efficiency vs. πT for all muons (-2.4 < η < 2.4).
The full single muon dataset from 2017 was used for these plots.
Left: Zoom in the region $p_T < 50$ GeV
Right: Full πT range.

The L1 Dimuon Invariant Mass
The GMT is able to extrapolate the muon track reconstruction to the vertex by using a programmable LUT that has been optimised for 2017 data taking. This upgrade resulted in improvement of the L1 muon trigger resolutions in πT, η, φ and in the L1 dimuon invariant mass. For the invariant mass spectrum below, part of the MuOnia sample collected in 2017 was used.

The efficiency of the L1 muon trigger was measured using the tag and probe method and found to be greater than 90% for all the Track Finders

References:

ioanna.papavergou@cern.ch
The research project presented was carried out within the framework of a Marie Sklodowska-Curie ITN funded by the Horizon2020 program of the European Commission