The Phase II upgrade: challenges for the HL-LHC

The HL-LHC introduces new challenges into the L1 Muon Trigger of CMS:
- Higher Pileup (PU) scenarios, more detector occupancy, leading to increased complexity of the muon reconstruction process.
- High PU also introduces higher L1 rates, it is not straightforward to keep the pT acceptance range of the Run II L1 muon trigger.
- High radiation environment might result into efficiency losses in the parts of the detector that are most vulnerable to ageing.

The upgraded L1T system will feature:
- Complete overhaul of the readout electronics and DAQ, increasing the accepted L1 rate to 750 kHz at a 12.5 µs latency.
- Upgrade of the L1 system to use commercial FPGA processors.
- L1 Tracks from the silicon tracker will be added to the muon trigger.
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Barrel Muon Track Finder (BMTF)

Covers the barrel region |η| < 0.8, with input from DT + RPC.
- Track reconstruction algorithm based on a Kalman filter (kBMTF):
  - On each hit estimate φ (position), η (bending), k (curvature).
  - Seed from outermost hit, propagate inwards on B field.
  - On new station, select most compatible hit with propagation.
  - Update track parameters and repeat until last DT station.

Two different variations of the algorithm with different targets:
- Vertex constrained (prompt kBMTF). Over 95% plateau efficiency for triggering muons with pT > 20 GeV.
- Non-vertex constrained (displaced kBMTF): offering sensitivity to long lived signatures for >60 cm displacements.

Going global: Benefits of a track trigger

Several options to correlate the L1 tracks with the muon chambers' information:
- Track + TF: match tracker and standalone tracks by geometrical θ-φ windows.
- Track + Stubs: match tracker + single muon station segment. Different techniques to do the matching developed in each region.

Benefits are quite clear with respect to all three considered track finders:
- Significant improvement in the lepton pT estimation.
- As a consequence, the rate is reduced, allowing L1 seeds with lower pT.
- Track+Stubs "closes gaps" where TFs are inefficient (i.e. between DT wheels).