Muon L1/HLT preparation

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2015 PbPb collision plan

- PbPb runs, week 47-50
  - $\sqrt{s_{NN}}$ = 5.02 TeV
  - Bunch spacing: 100-200 ns
  - Pileup: ~a percent, expect 0.7% (similar to the 2011 data taking)
  - Peak collision rate: ~20-30 kHz (expected β* was recently changed, might be re-discussed)

- "Reference" pp data at $\sqrt{s}$ = 5.02 TeV:
  - To happen either right before or after the PbPb run, from the PbPb time budget

- Release to be used by Tier-0: 7_5_X

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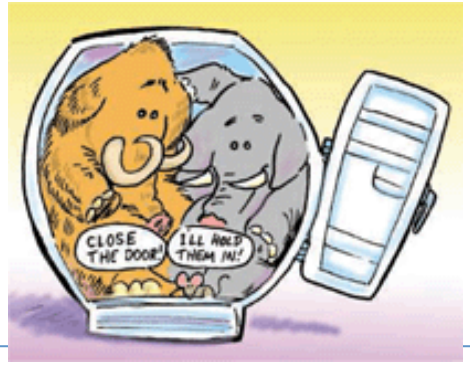
Current situation

In 2011, L1_DoubleMuOpen played the key role

In 2015, we have
- Doubled energy
- 10 – 15 times higher rate

What should we do?
- Tighten L1 quality bits
- Tighten HLT filters
- Prioritize paths for prescale order



- Rate limitations, L1:
  - Pixel:
    - Dedicated PbPb firmware exists, tests are not successful so far
    - pp firmware could provide
      - With 25 μs hold-off: 3 kHz with 8% or 10 kHz with 30% dead time
      - With 10 μs hold-off: 3% 10% (less tested)
  - Tracker: read-out in VR in 10-bit FED mode: ~10 kHz
  - ECAL: ~12 kHz

  → L1 limit: ~3 - 10 kHz

  - Rate limitations, HLT:
    - Driven by available disk space: ~1.5 PB can be archived at the FNAL T1
      - No other tape archive storage at any other T1
      - The 1.5 PB is for RAW + prompt RECO + AOD + prompt Skim
      - Vanderbilt T2 to store prompt RECO + AOD + prompt Skim, but no RAW (~900 TB of disk space preserved for this)
      - MIT and SPRACE could also host ~100-200 TB of AOD or prompt Skim
    - Preliminary data tier strategy of the 1.5 PB space:
      - Write out AOD instead of prompt RECO, but also keep some prompt RECO for detailed data quality/reconstruction algorithm checks

        → ~850 TB of RAW, ~620 TB of AOD and ~70 TB of prompt RECO

      → Estimated HLT bandwidth limit: ~250 Hz

      - Estimate being refined using preliminary PDs, see later

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Summary of L1/HLT strategy

Underline : un-prescaled path

<Dimuon Peripheral>

Fed by L1_DoubleMu0_Cent30-100

L2_DoubleMu0_NHitQ 18 Hz
+ loose paths

<Dimuon Central>

Fed by L1_DoubleMu0_Cent0-30

L3_DoubleMu0_"cut"
"cut" depends on bandwidth condition

<EWQ>

Fed by exclusive L1 seeds

HLT_L2(3)Mu20	24(6) Hz
HLT_L2_DoubleMu10	< 1 Hz

<T&P>

Fed by exclusive L1 seeds
L2(3)_MuX_NHitQY

4 paths : X = 3,5,7,15 evenly distributed
Y = # of hit filter, 10-15

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- Due to the HLT bandwidth, we can not use a simple LX_DoubleMu0 triggers in raw
- Centrality dependent cut and pre-scale are implemented
- 30%-100% Peripheral ➔ L2 paths to be un-prescaled
- 0-30% Central ➔ L3 paths + further filter to be un-prescaled

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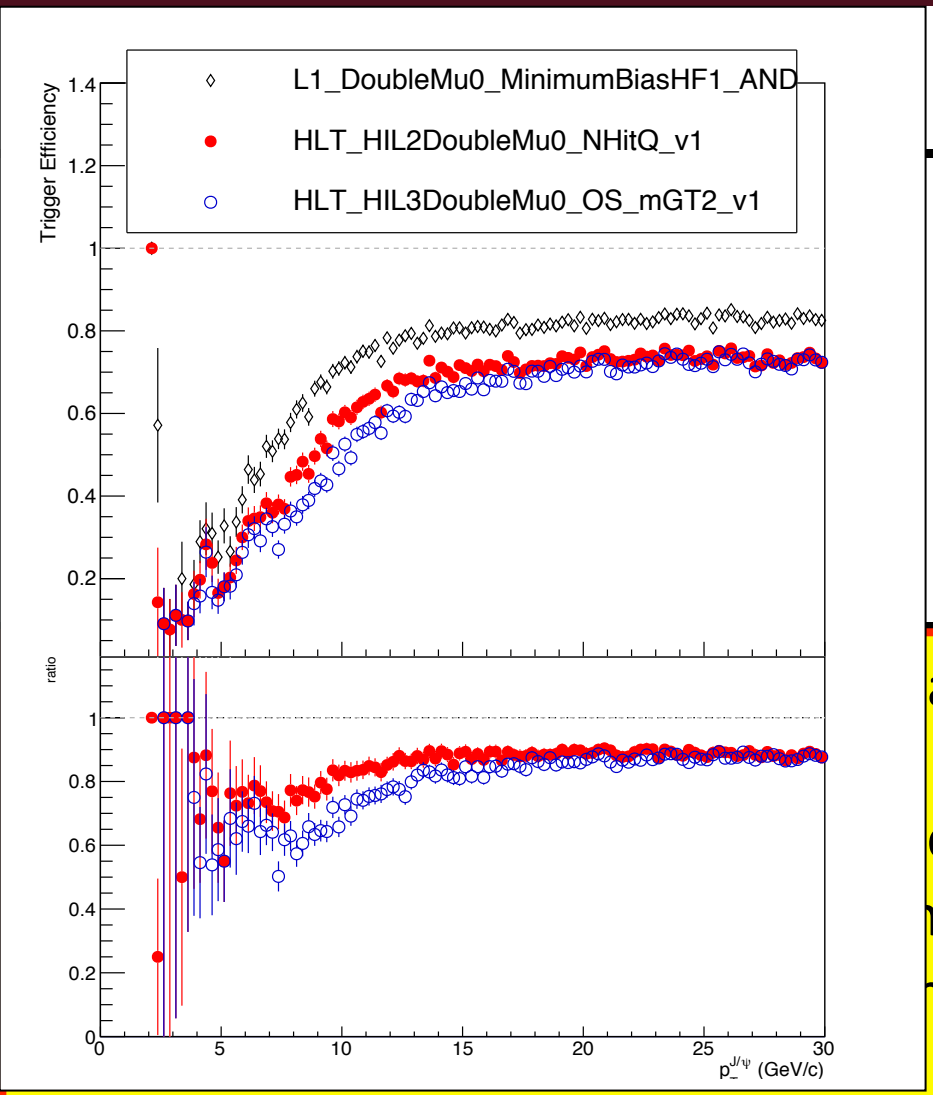

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Summary of L1/HLT strategy

- Single Muon triggers

  (a) Very high p_T for W and Z

  ➔ No extra filter above L2(L3) algorithm

  (b) p_T of 3, 5, 7, 15 GeV for T&P

  ➔ Very tight cuts (e.g. # of hits = 10 for L2)

<EWQ>	<T&P>
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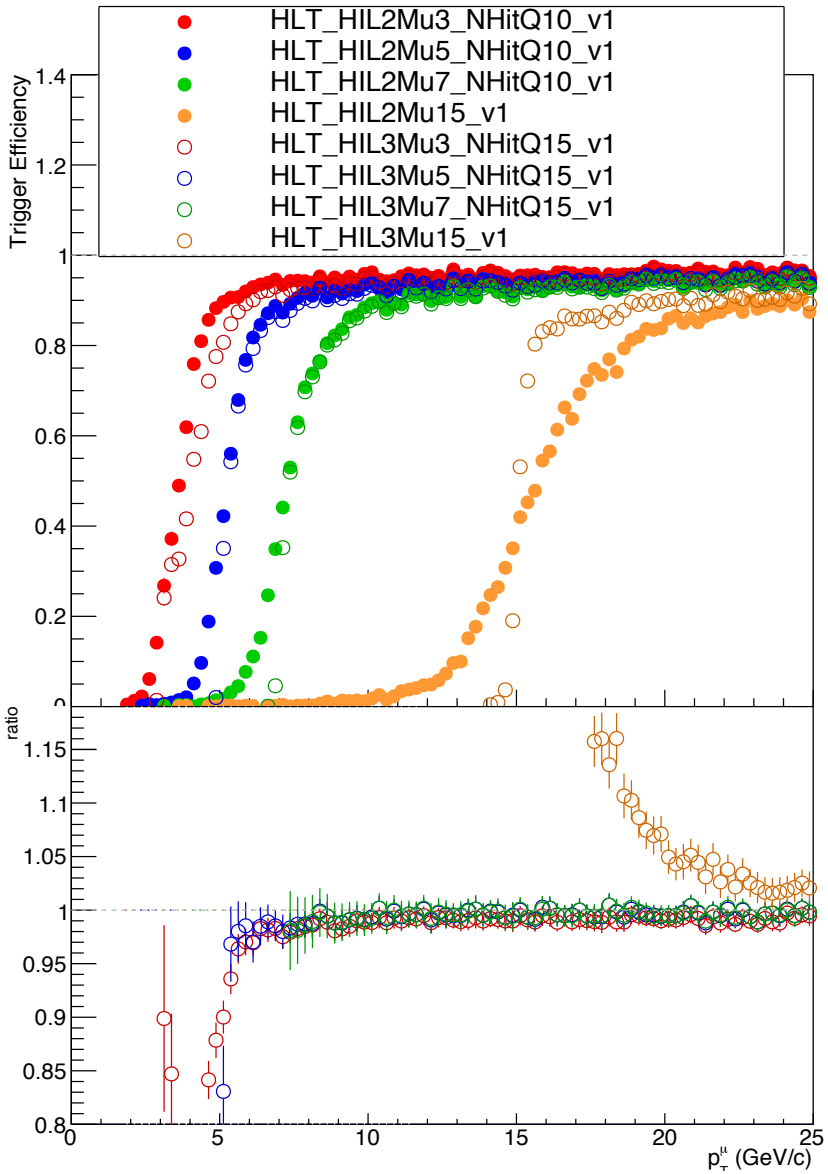

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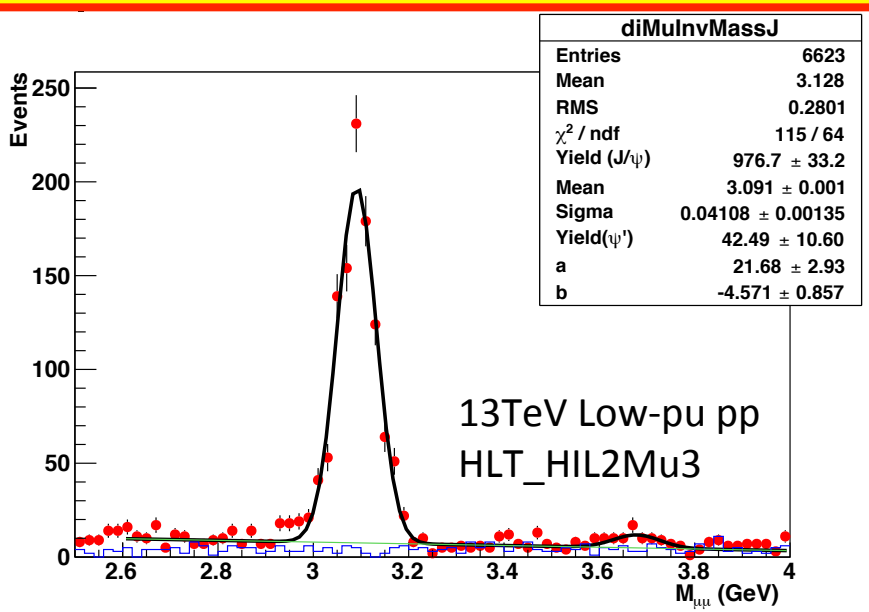

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Rate estimation

- Extrapolation from 2011 run
  - Detector condition factor : [Run2]/[Run1] of HYDJET
    - Two upgrades in detector & HighQuality algo.
    - Huge fake suppression for high_pt_single and double
  - Collision Energy factor :
    x1.3 for single and x2 for double (conservative)
- Caveat
  - This estimation seems to be very conservative. Because the estimation is always higher than HYDJET results while 13TeV pp trigger rate is less than PYTHIA by factor of ~2

		Run1 Condition	Run1 Cond.+ HighQ	Run 2 Cond. (HighQ)	
	Collision rate :	Scaled by 1.6kHz	Scaled by 1.6kHz	Scaled by 1.6kHz	Run2 / Run 1 Ratio
Single Mu	L1, 3	112	65	53	0.47
	L1, 7	39	19	7	0.18
	L2, 3	39	38	26	0.67
	L2, 3 && NHitQ	29	28	25	0.86
	L2, 7	11	10	4.4	0.40
	L3, 3	26	25	11.2	0.43
Double Mu	L1, 0	37	24 (*)	5.8	0.16
	HLT_L1, 0	6	6	5.8	0.97
	L2, 0	15	6	4.9	0.33
	L3, 0	5.8	3	0.91	0.16

To-do items after QM

- Rate correction factor
  - Cross-check with pp real data 13TeV and PYTHIA MinBias
  - Jaebum, Bumgon, Émilien
- Estimation of J/psi's in T&P channels
  - How much rate should we assign for T&P?
  - Prashant (BARC)
- Optimization of #NHitQ filter in L2 and L3
  - Chris (UMD), Songkyo
- Development of macro for trigger efficiency
  - Ex) Relative eff. of (L3_DoubleMu0_NoCowboy)/(L1_DoubleMu0)
  - André
- Exact(!) estimation of PD data size and pre-scale determination
  - Jason (UIC), Ian (Rutgers)
- Maintenance of DQM machinery
  - Mihee, Kisoo