Background Trigger Rate Estimates for the MM Trigger Algorithm

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Introduction

What we know about current trigger rates

Studies based on the current Small Wheel

Estimates for the MM trigger algorithm

Conclusions

Introduction

• In order to calculate resources, it is important to understand what sort of trigger rates we expect

• The task is not trivial, because a large fraction of the trigger rate found in Run 1 was not coming from the collision (about 10% of triggers) and, instead, from poorly-simulated physics (secondary scatters in the FCAL/HEC, about 90% of low p_T triggers, according to Kevin Black)

• Studies exist with current data and offline cuts, however, which can give us an idea of the expected trigger rates

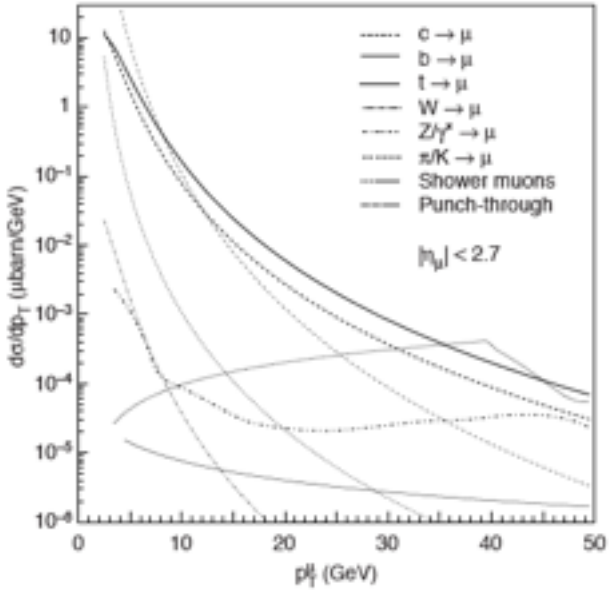
• Here, I compile and survey those studies, and try to provide an estimate of the rate of segments expected in the MM detector

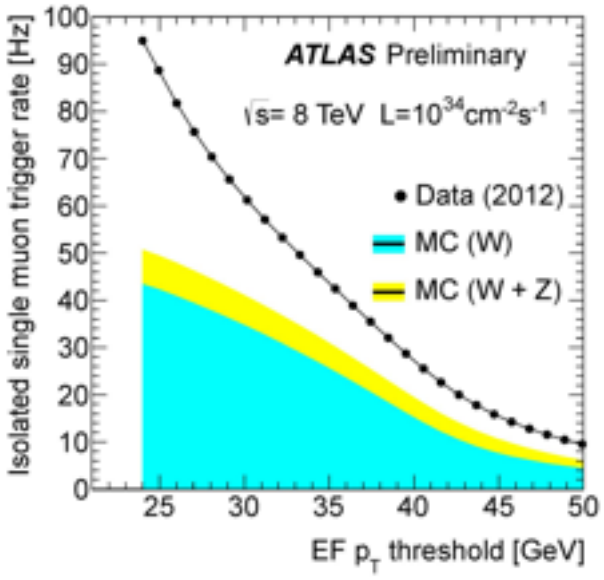
What we know about trigger rates

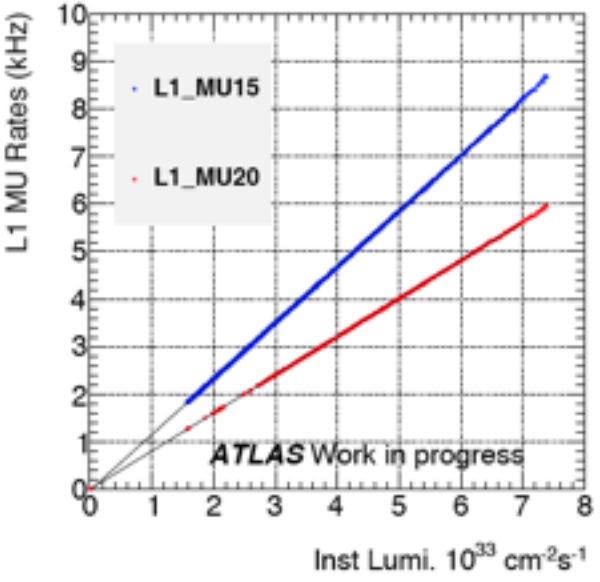
- Most studies focus on L1_MU20 trigger rates, which is not really the full story for segment rates in the MM

- Above 20 GeV extrapolated rates in the full detector to $3x10^{34}$ $cm^{-2}s^{-1}$ are about 60 kHz

- Already at 20 GeV, this is dominated by fakes and heavy flavor decays





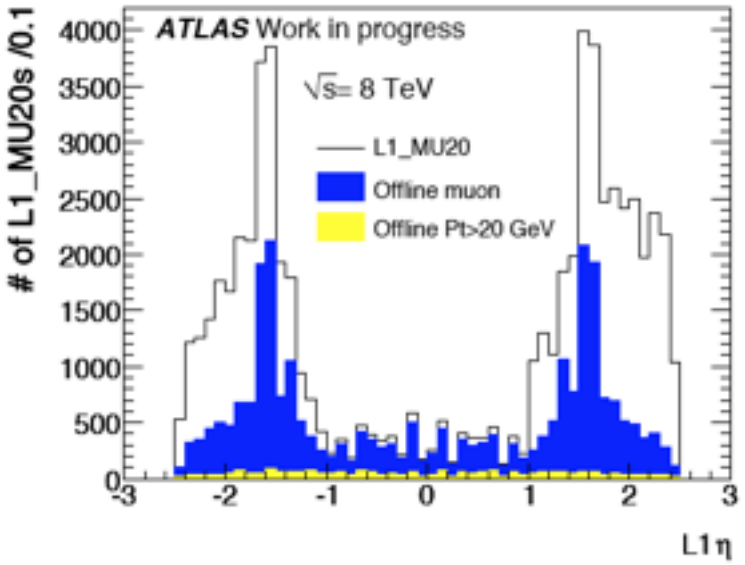


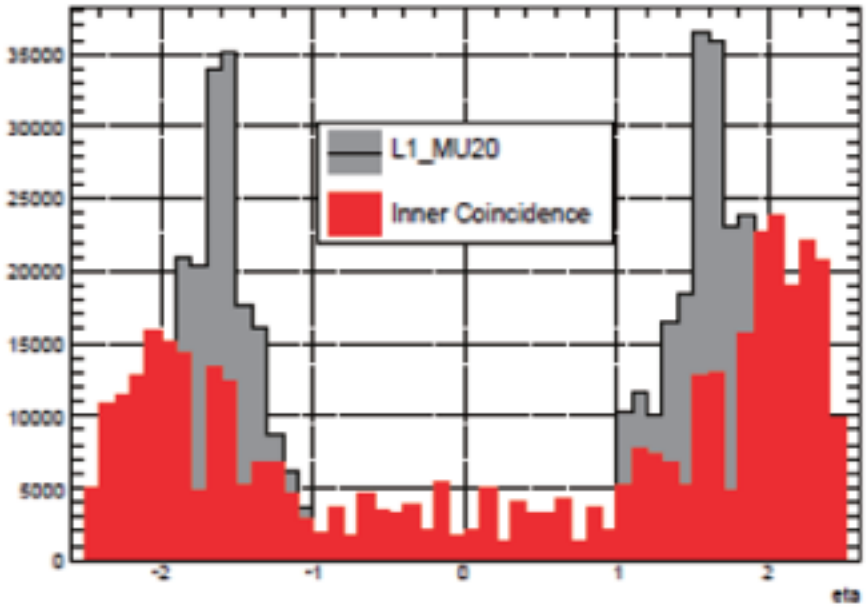
What we know about trigger rates

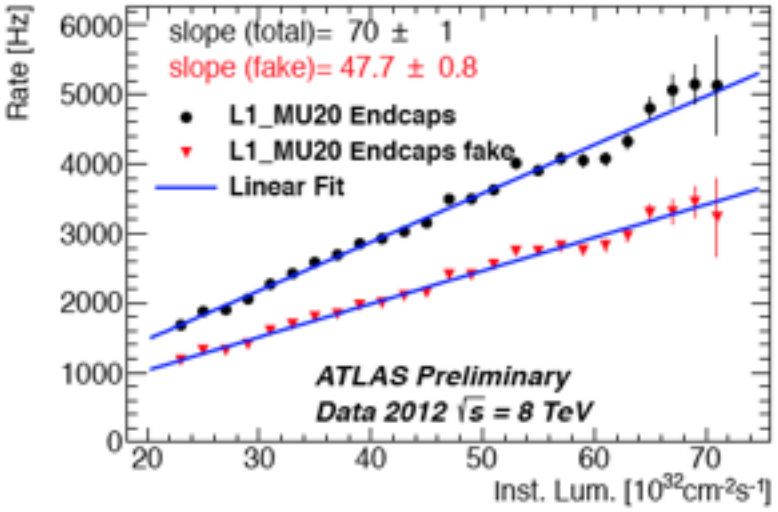
- About 60% of the full L1_MU20 trigger rate are fake triggers in the end cap

- A simple requirement of having an inner segment reduces this rate significantly (about 36%)

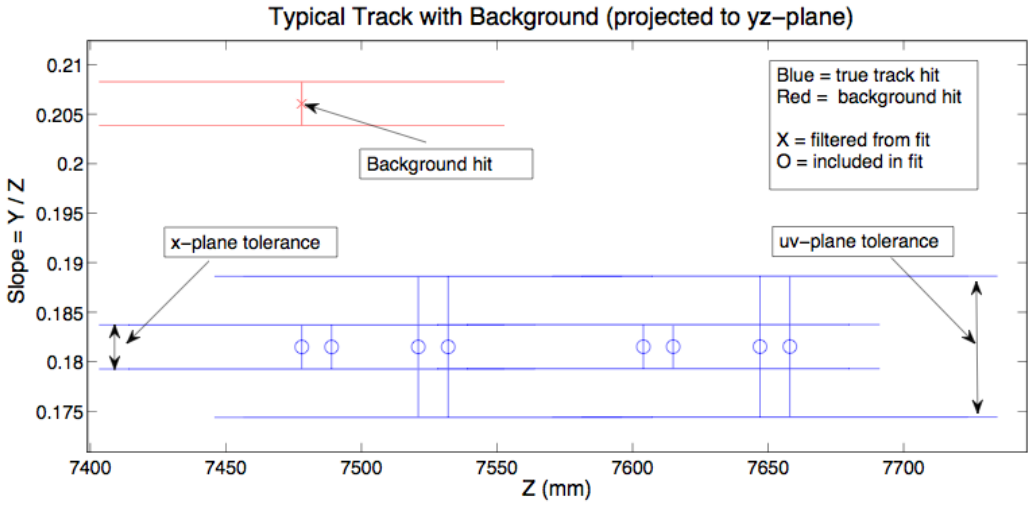
- Additional cuts can be placed on this inner segment

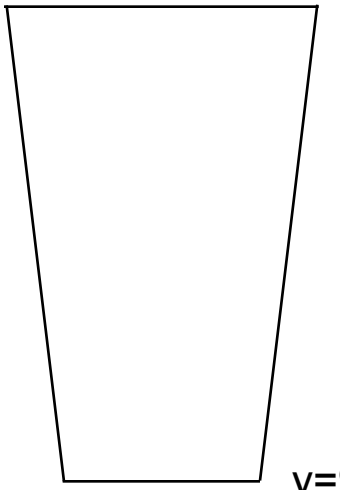






Mrad needed for coincidence

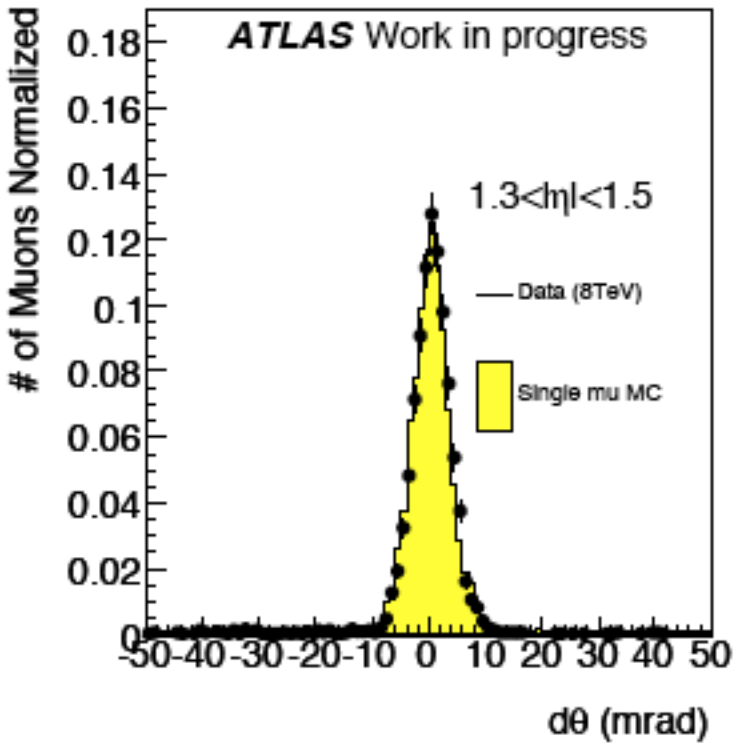


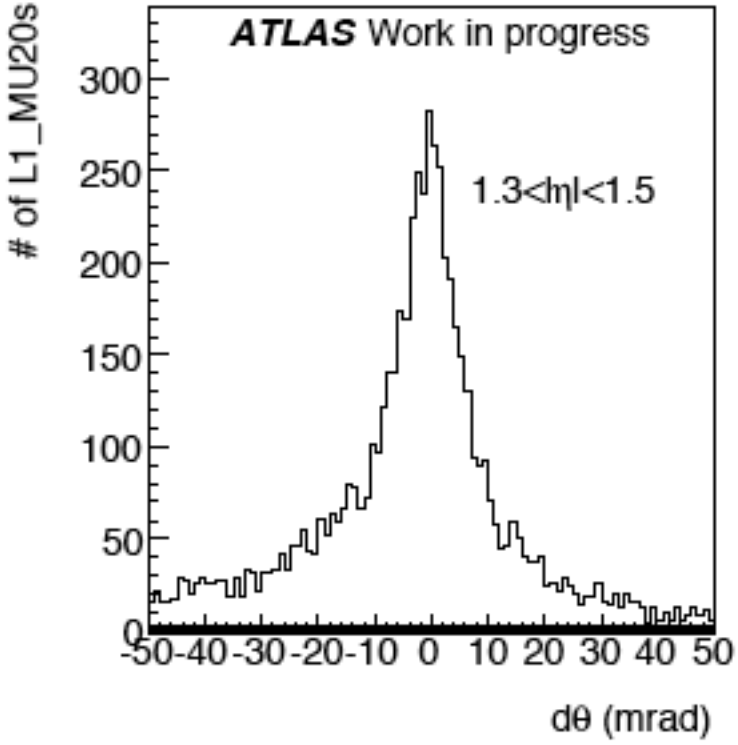


y=982mm

- x-plane slope tolerance is 0.00025
- However, you can get a segment with just 2X hits in the same plane
- Largest possible $\Delta\theta$ is at the bottom of the sector implies $\Delta\theta_{max}$~150 mrad!
- Clearly, 2X requirement will need to be tightened to include hits from different planes (implicit cut of 27 mrad, vuxx would be slightly preferable, 20 mrad for same “ionization” tolerance)

Effect of Coincidence Requirement





- 27 mrad will not cut fake rates significantly, with 20 mrad, fake rates may be reduced by another ~30%

- Taking numbers from slide 4, we expect 14 kHz of end cap L1_MU20 fake triggers 3×10^{34} $cm^{-2}s^{-1}$

- A reduction by 0.66x0.70=0.46, so to 6 kHz is expected from coincidence requirements

Translating to Segment rates

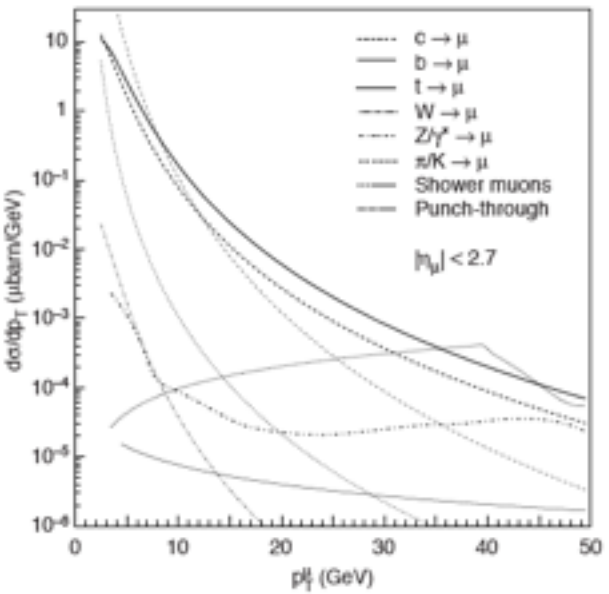
- First look at the expected scaling of hard physics rates

- At p_T>20 GeV expect about 2×10^{-2} μb (very approximative!)

- At p_T>4 GeV (so that it gets through the calorimeter) we expect about 100 μb (very approximative!)

- So the physics rate goes from 7 kHz (20 GeV cut) at 3×10^{34} $cm^{-2}s^{-1}$ to about 40 MHz (4 GeV cut, same luminosity)

⇒every event has a physics muon in one end-cap!



Translating to Segment Rates

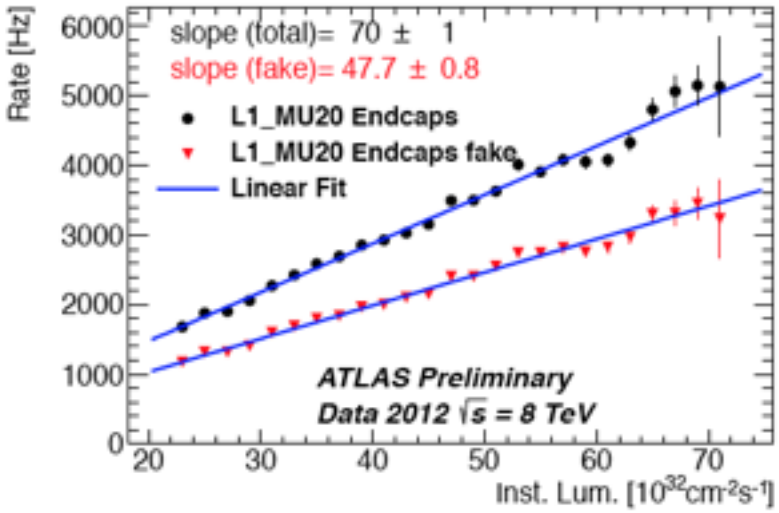
• Now, let's consider Kevin Black's estimate that only 10% of all L1 muon triggers are physics triggers (slide 2)

• This implies a segment rate in the MM of 400 MHz (probably too high by a factor of 2, because many of those triggers originate from beyond the SW and the discussion in slides 4-6)

• Fake particles may scale faster than signal at high luminosity (not expected, from slide 4 and the plot on the right) so let's add a safety factor of 2

• We get 800 MHz or 20 segments per bunch crossing

• Since we need to integrate over 2 BCs, it's 40 segments, but we have effectively 20 sectors (some overlaps) in the 2 end-caps in total, so we reach about 2 segments/roads are active per sector at any given time at 3×10^{34} $cm^{-2}s^{-1}$



Conclusions

- I did a very back of the envelope calculation of the expected segment rates in the MM detector at $3x10^{34}$ $cm^{-2}s^{-1}$

- These are based on some studies from Run 1, some information provided by Kevin Black (also based on studies) and the addition of some safety factors

- We should take these results with a grain of salt, but the estimate comes to about 2 roads/segments active per sector at any given time (using 10 for benchmarking is probably very safe)

- A significant reduction of fake segments (O(25%)) can be achieved with the xx uv vu xx geometry, rather than using the current xx uv xx uv geometry (with the same tolerance for ionization signals)

- Realistic simulation would be highly welcomed in order to confirm these numbers and we should pursue it