

Dedicated Level-2 Trigger for Highly Ionising Particles at ATLAS

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Motivation for exotic triggers

Long lived particles require dedicated triggers:

- Large efficiency enhancement
- Access to new regions of parameter space
- Low rates achievable by using special characteristics

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HIP Signatures

2011 Monopole Search

Dedicated HIP Trigger

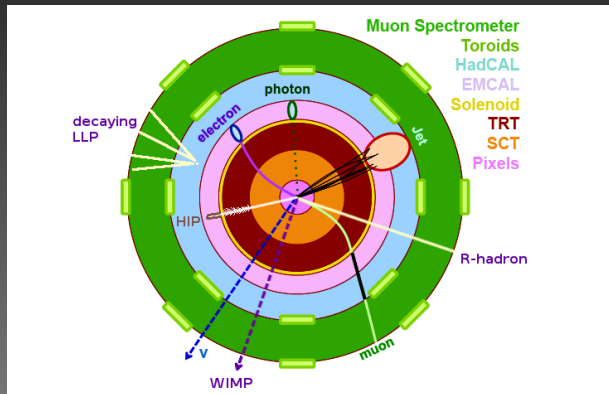
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HIP Trigger Performance

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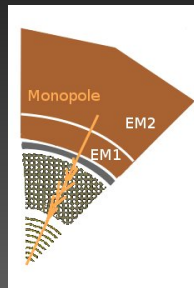
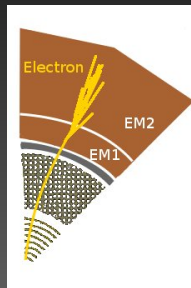
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Signatures of Highly Ionising Particles in ATLAS

Magnetic monopoles, QBalls etc. will have a characteristic signature in ATLAS:

- A large localised energy deposit in the liquid argon (LAr) electromagnetic (EM) calorimeter
- A high ionisation track in the Transition Radiation Tracker (TRT)
- Production of large amounts of δ -rays, which are energetic electrons emitted from the material along the trajectory of the HIP



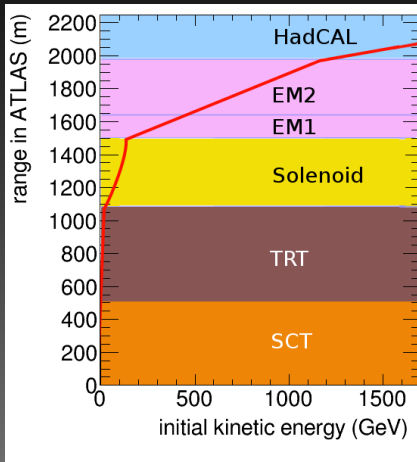
Need for new trigger

Standard single electron and single photon triggers were used to search for monopoles in 2011. Restrictions imposed by these:

- Requires energy deposition in second EM Layer
- High threshold for single triggers without prescales

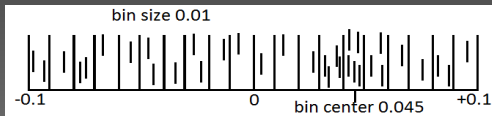
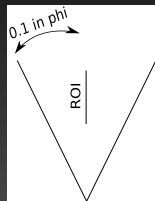
The new HIP trigger has:

- No need for energy deposition in the second layer of EM2
- Uses the high ionisation hit feature of the TRT



Implementation

- Level-1 trigger system (LVL1) identifies Regions of Interest (ROI) for latter trigger stages
- The LVL1 includes details of where in η and ϕ the Rols are located
- Build a cone of ± 0.1 around the ROI in ϕ
- 20 bins in ϕ of size 0.01 and match the TRT hits within these bins
- Pick hits from bin with highest number of High Threshold (HT) TRT hits and 2 adjacent bins



- The LVL1 trigger has an energy threshold of 18 GeV - drastic drop in threshold compared to previous analysis
- There is no requirement of energy deposition in second layer of the EM Calorimeter
- Two handles on the algorithm
 - Number of High Threshold TRT hits
 - Fraction of High Threshold TRT hits over total TRT hits

These give enough leverage to discriminate between signal and background

Fraction of HT TRT hits from trigger

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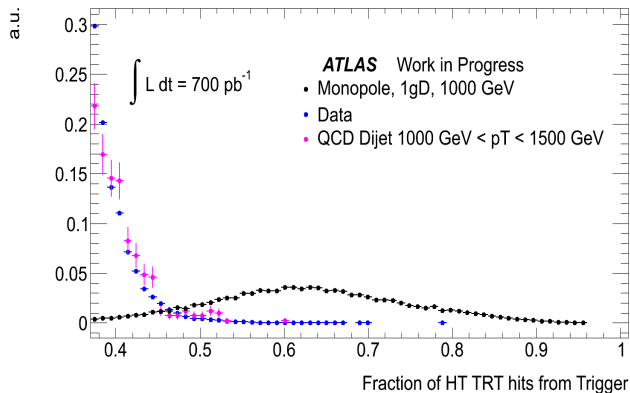
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Performance of HIP trigger compared to standard triggers

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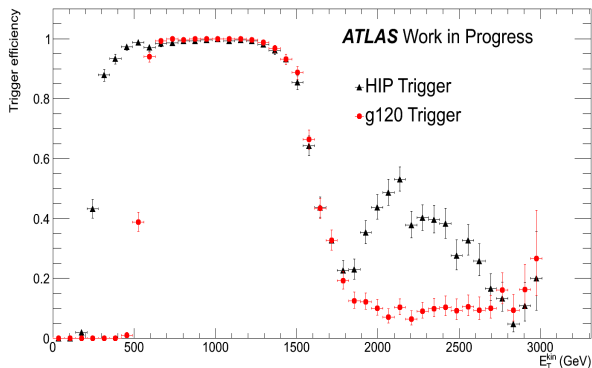
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Using Monopole with charge 1gD and mass 1000 GeV

Triggering on different charges

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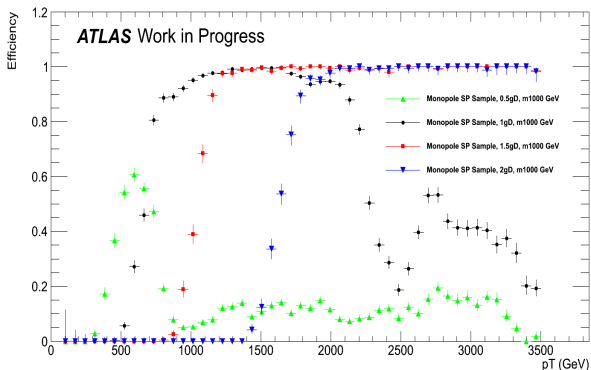
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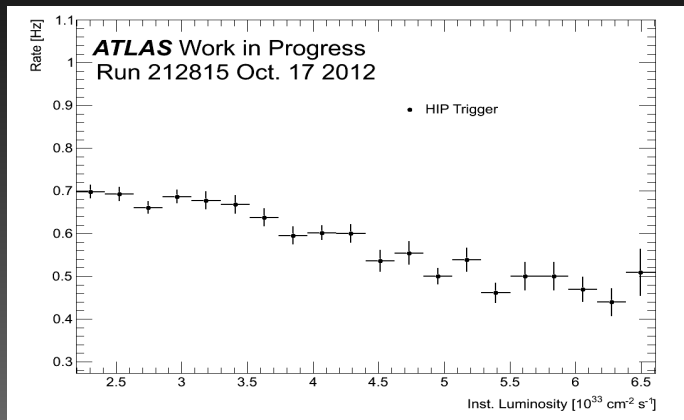
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At 14 TeV collisions:

- The threshold on LVL1 trigger to the HIP trigger would be inevitably increased
- The pile up will also be much larger than in 2012
- The eta distributions of clusters triggered from signal and background suggest an eta dependent cut could be applied on the two handles of the trigger
- This would help to reduce the rate while rejecting a lot more background
- Will change the cone algorithm to a narrow road

High pile up effects of trigger

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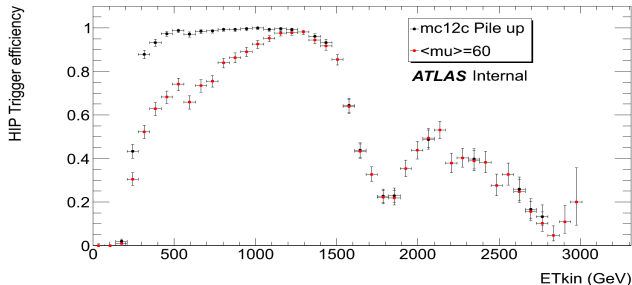
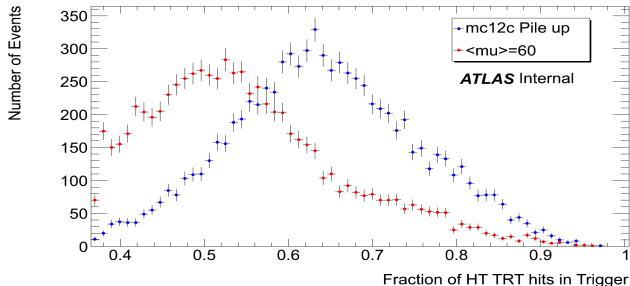
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- The trigger ran from Sept. 27, 2012 till the end of Run 1
- It collected about $7fb^{-1}$ of data during this period
- At the moment we're analysing the data that has been collected from this trigger - hopefully completed this summer
- The efficiency of the trigger has been far better compared to the previous analysis $\sim 33\%$ vs $\sim 14\%$
- Further improvements are in progress

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The eta of clusters from triggered events

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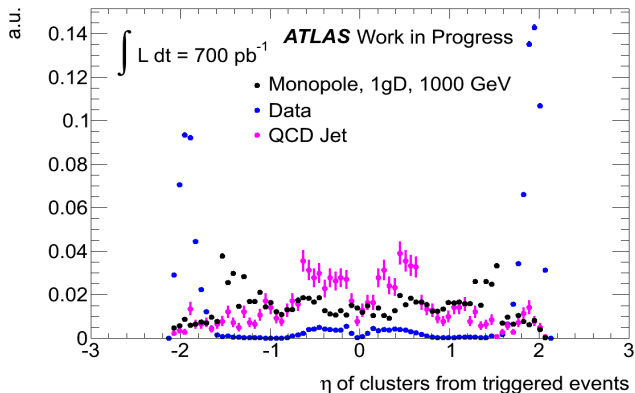
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Total number of HT TRT hits from trigger

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