Searches for Long-Lived, Stable Massive Particles with ATLAS

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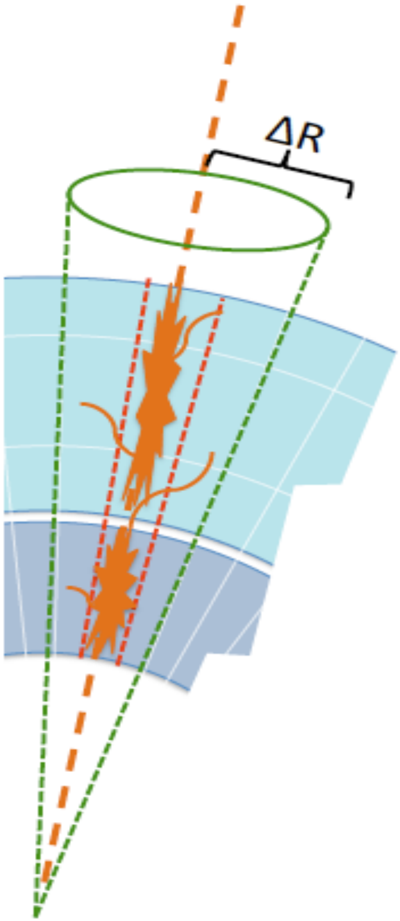
Physics in Collision XXXI
Vancouver, BC, Canada

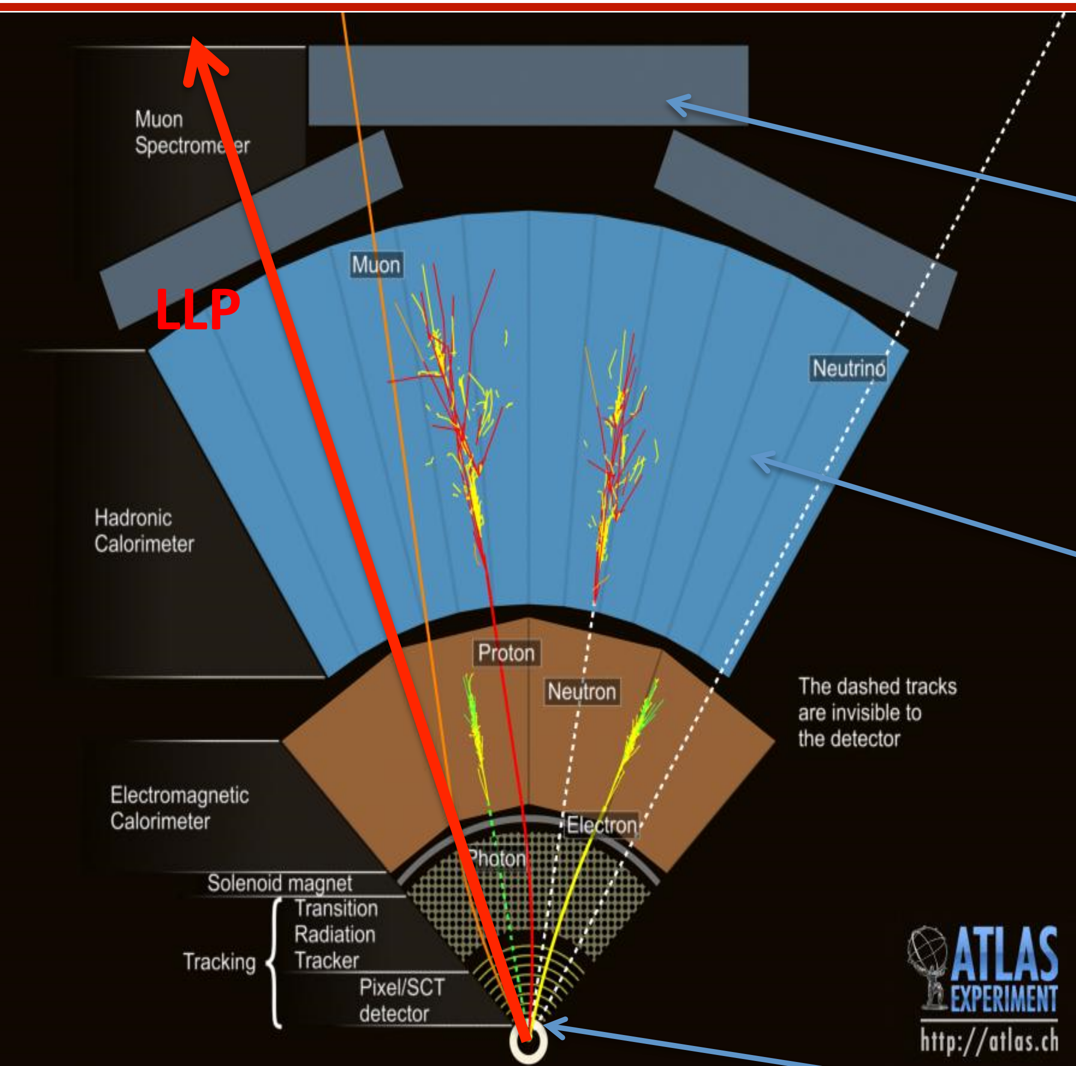
Long-lived particle: Overview



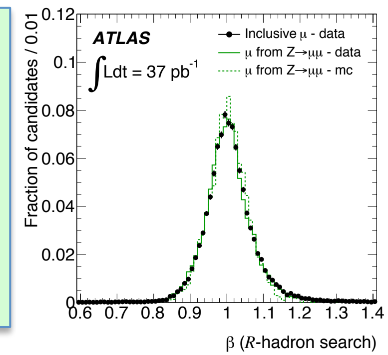
- If we can exploit LLP-unique characteristics, there is no physics background only instrumental backgrounds => Challenge: can we measure these properties with good enough precision?
- Ideally combine uncorrelated discriminators – ***use different subdetectors of ATLAS!***
  - ***Time of Flight: exploit slowness of particle***
  - ***dE/dx: exploit the slow particle's anomalous ionization energy loss***

Measurement of β and p enables mass reconstruction $m = p/\beta\gamma$

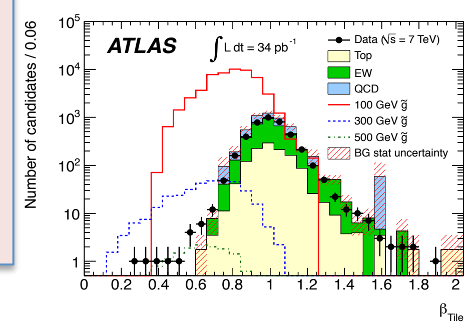
Long-Lived Charged Particles



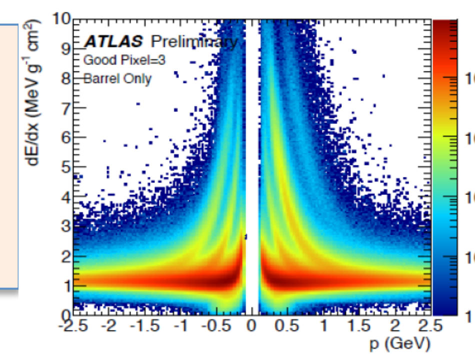
Muon spectrometer time-of-flight Observable: Delayed signal, low beta object



Tile Calorimeter time-of-flight Observable: delayed signal



Pixel Detector d*E*/dx Observable: High ionization



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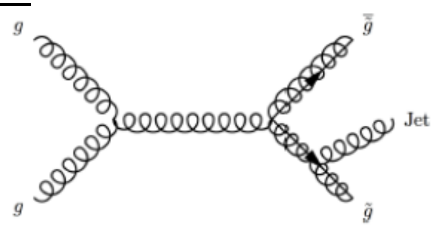
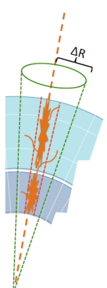
Observables

- Use various observables throughout ATLAS to get a handle on slow moving charged particles

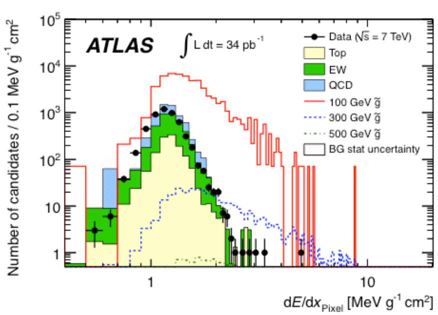
Muon agnostic approach

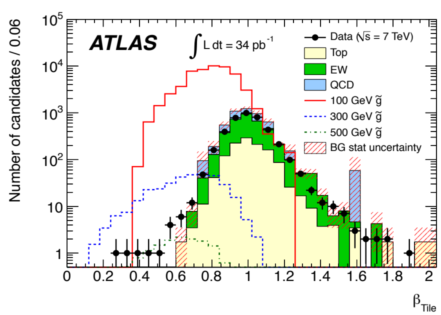
Use ISR/FSR trigger on MET>40GeV





Strategy
Use two independent discriminators to efficiently suppress backgrounds.
Selections
Candidate: good quality ID-based track with pT>50GeV and |η|<1.7 far from jets with ET>40GeV, ΔR>0.5.





Muon spectrometer (MS) approach

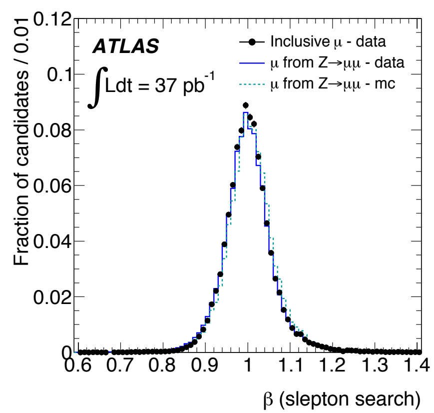
Strategy
Two separate selections seeded by
- *combined* inner detector and MS track (heavy μ-like particles)
- *MS standalone* track (R-hadrons hadronizing to neutral states)

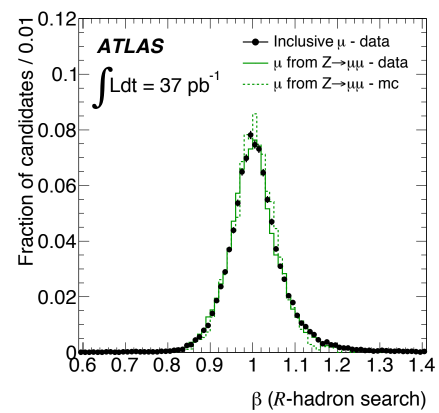
Combined

Selections
- Event: muon trigger (pT>13 GeV), Vertex cut, Z->μμ, veto if > 2 cands
- Candidate: pT>40 GeV, β quality and range

MS Standalone

Selections
- Event: μ trigger (pT>40 GeV), based only on MS data, Vtx cut, Z->μμ veto
- Candidate: pT>60 GeV, β quality and range

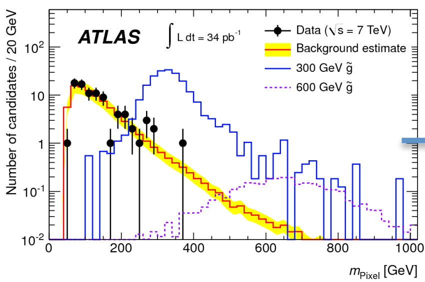


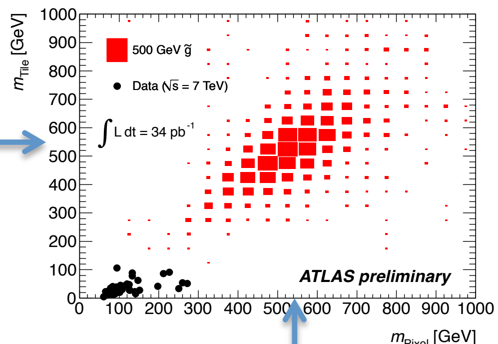


Measurements

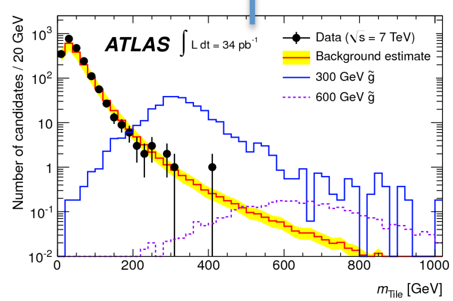
- Get background estimate from data. Use multiple subdetectors to subdue background from noise

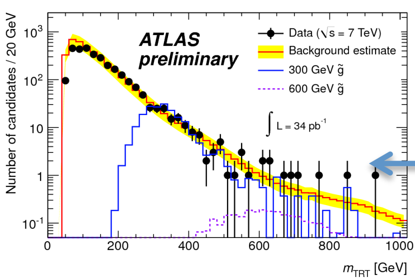
Muon agnostic approach





Extract mass in two subdetectors – use 2d plane to remove bkgd



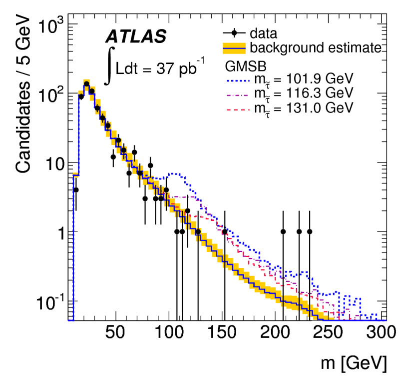


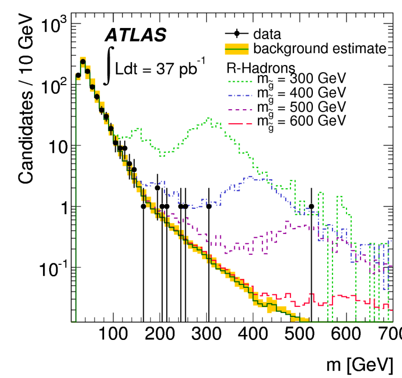
Ensure no signal is missed by using TRT – additional discriminator

Muon spectrometer approach

Use β measurements to extract a mass for standalone and combined muon spectrometer based analysis

Provides sensitivity to R-hadrons and stable single charged particles (e.g. sleptons)





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See poster for more details!