First observation of electrons in the ATLAS detector

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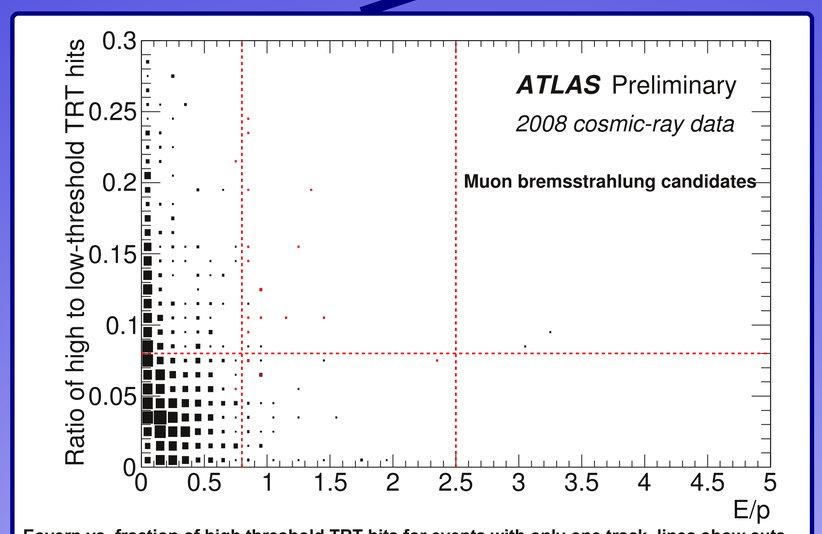
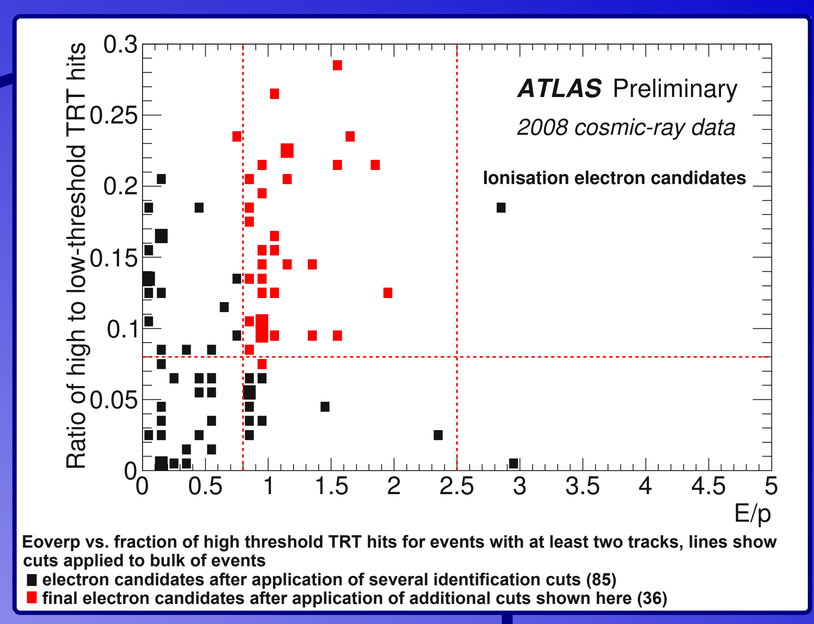
Cosmic rays and the ATLAS detector

- The ATLAS detector as one of four experiments at the LHC in Geneva providing high luminosity proton-proton collisions at 14 TeV promises precise measurements of Standard Model parameters and searches for new physics phenomena (Higgs, SUSY,...) with very small cross sections
- Therefore it is necessary to perform accurate and efficient measurements of the different particles occuring in the detector
- No data from collisions is available yet, but cosmic rays (muons) penetrate the whole volume of the detector from above at random times (1 Hz/m^2)
- They can be used to test and improve the performance of ATLAS (calibration, alignment, trigger...) and to investigate the efficiency in detecting and identifying particles, e.g. **electrons**



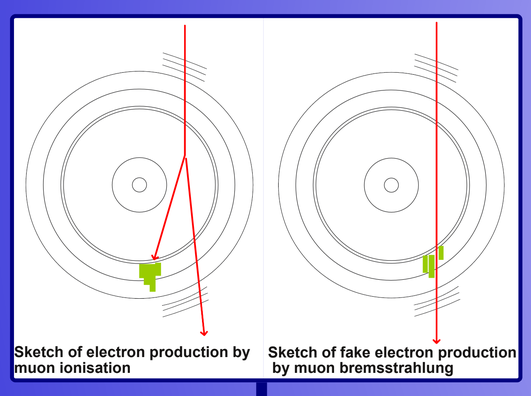
Eoverp vs. fraction of high threshold TRT hits for events with only one track, lines show cuts applied to bulk of events
■ electron candidates after application of several identification cuts (1229)
■ final electron candidates after application of additional cuts shown here (19)



Eoverp vs. fraction of high threshold TRT hits for events with at least two tracks, lines show cuts applied to bulk of events
■ electron candidates after application of several identification cuts (85)
■ final electron candidates after application of additional cuts shown here (36)

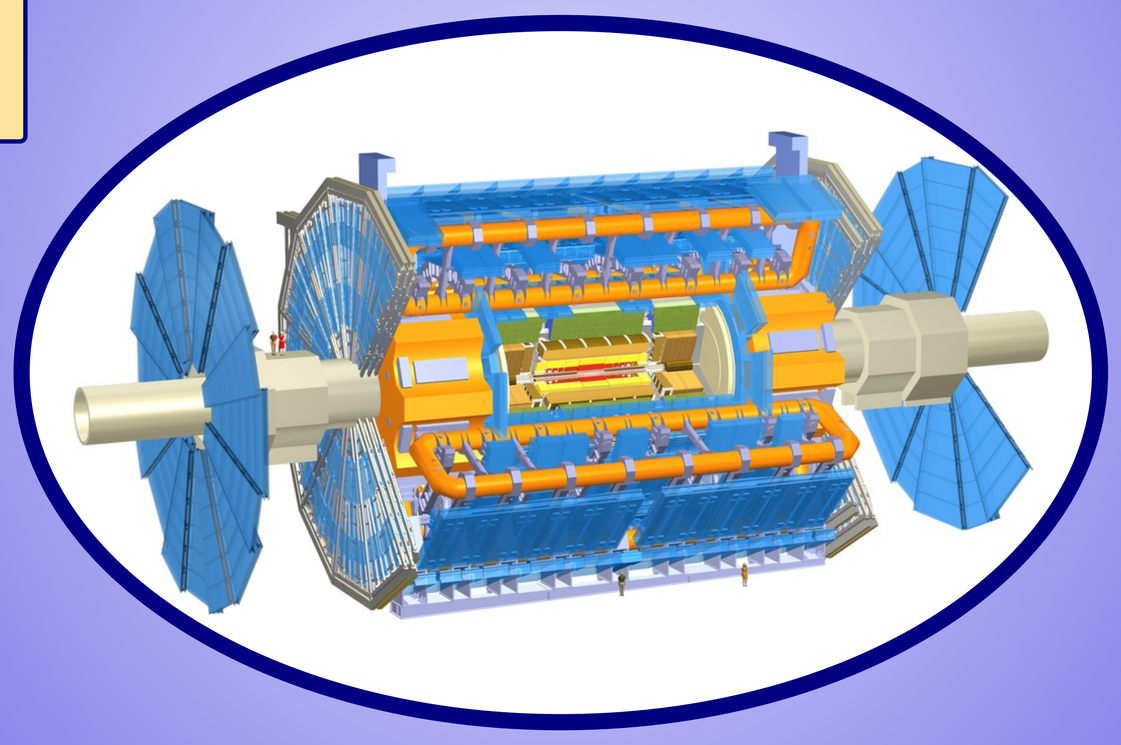
Electron identification

- Electrons have typical attributes concerning the shape of the shower in the calorimeter, the track quality and the matching of cluster and track, which are used as cut criteria to identify real electrons and reject background events
- For cosmic ray data some standard electron cuts have to be modified, because the events don't originate from the center of the detector
- Important variables are:
  E/p, Energy measured in the calorimeter over momentum measured by the track, this variable is around 1 for electrons
  Ratio of high to low threshold hits in Transition Radiation Tracker, electronic signal caused by transition radiation overcomes high threshold, electrons should produce a higher fraction (probability ~ 1/mass)



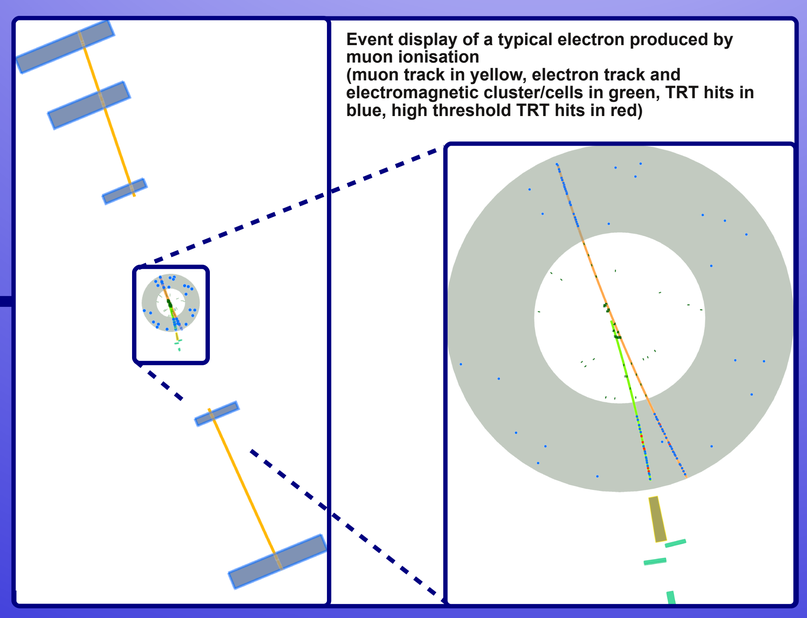
Sketch of electron production by muon ionisation

Sketch of fake electron production by muon bremsstrahlung

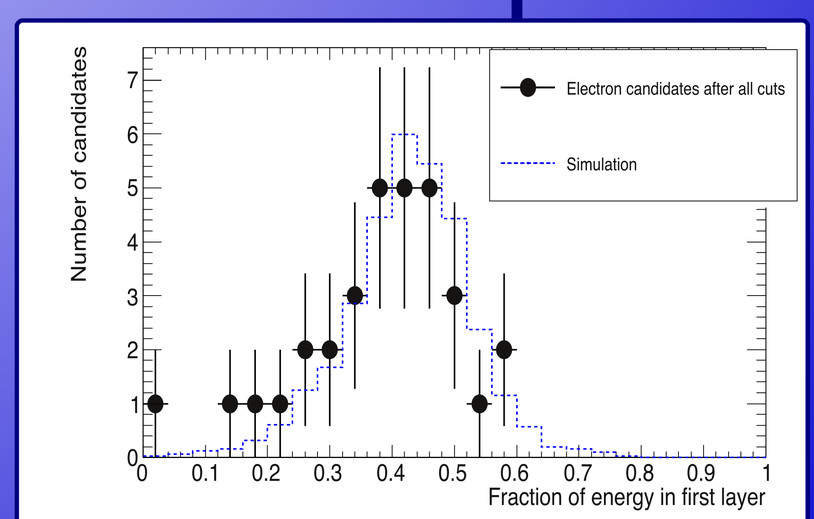


Electrons from cosmic rays in ATLAS

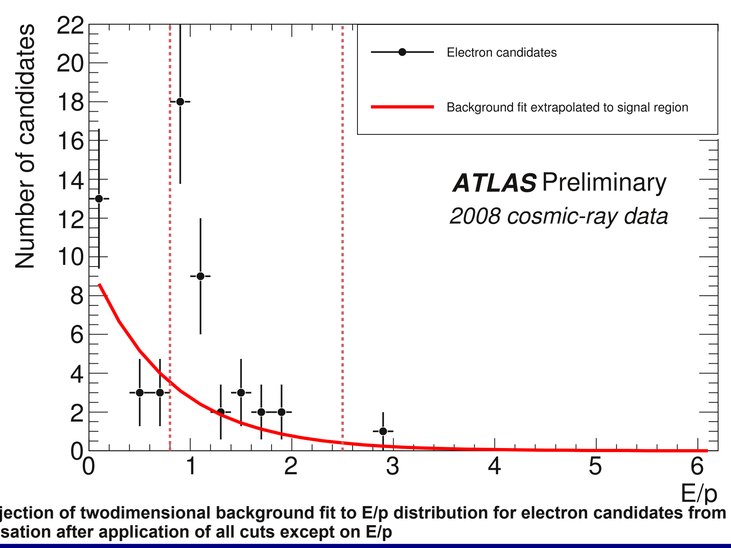
- Reconstructed electrons in ATLAS are objects, which leave a cluster in the electromagnetic calorimeter and a track in the inner detector matching the position of the cluster
- In the cosmic ray data electrons originate primarily from ionisation of atoms in the inner detector by the muons (at least **2 tracks**)
- Fake electrons are produced by high energetic muons, which leave a cluster in the calorimeter by emitting bremsstrahlung (only **1 track**)



Event display of a typical electron produced by muon ionisation
(muon track in yellow, electron track and electromagnetic cluster/cells in green, TRT hits in blue, high threshold TRT hits in red)



Typical shower shape variable for electrons - the fraction of total energy left in first layer of electromagnetic calorimeter. Distribution of final ionisation electrons compared to Monte Carlo generated single electron events



Projection of twodimensional background fit to E/p distribution for electron candidates from ionisation after application of all cuts except on E/p

Isolation of an electron sample in cosmic data

- The definition of events with one track as a background-like and with at least two tracks as a signal-like sample and the application of the cuts enables an identification of real electrons from ionisation (**36** events)
- Background estimation: A twodim. binned maximum likelihood fit is applied to the E/p vs. HT TRT ratio distribution of the ionisation electron candidates excluding all events, which overcome the cuts. The integral of the fitfunction over this excluded signal region yields the number of remaining background events (~20%)
- **This first observation of electrons demonstrates both the excellent commissioning of the Inner Detector with efficient Transition Radiation and of the calorimeter and it makes confident that early electrons will be reconstructed and identified in ATLAS.**