Minimum bias simulation of parasitic collisions

Sanae Ezzarqtouni

`sanae.ezzarqtouni@cern.ch`

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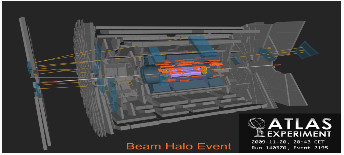
Non-collision backgrounds and Parasitic collisions

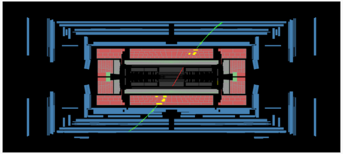
Non-collision backgrounds:

- The term **non-collision backgrounds (NCB)** refers to signals seen in the ATLAS detector which have not been produced by normal collisions of the LHC beams.

- The main components are:

☞ Beam Induced Background (BIB): are due to proton losses upstream of the interaction point.



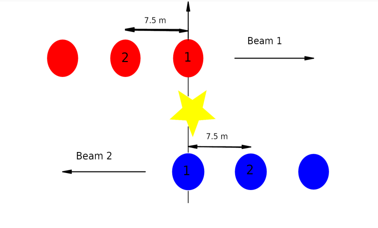


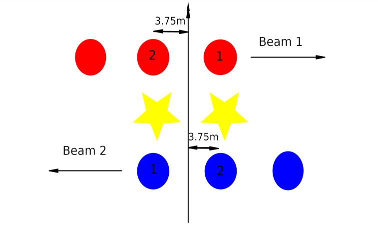
☞ Cosmic rays background: mainly from highly energetic muons traversing the detector top to bottom

☞ *Parasitic collisions*

Parasitic collisions:

Parasitic collisions: are proton collisions with other bunches that happen outside of the nominal interaction point.





Parasitic collisions at $z = \pm$ n$\times$3.75 m, n=1,2,3...

ATLAS detector

Le dtecteur ATLAS:

Calorimetry:

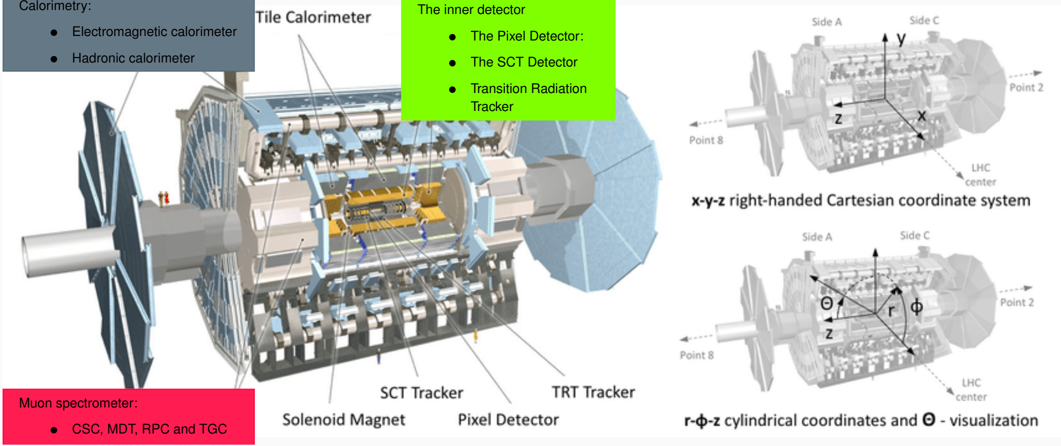
- Electromagnetic calorimeter
- Hadronic calorimeter

The inner detector

- The Pixel Detector:
- The SCT Detector
- Transition Radiation Tracker

Muon spectrometer:

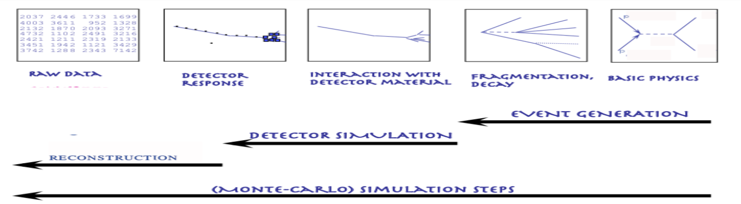
- CSC, MDT, RPC and TGC



Monte Carlo simulation of Parasitic collisions

Monte Carlo simulation of Parasitic collisions:

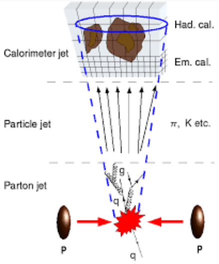
- **Event Generation:**
  - ✗ The generators (Pythia) generate the process (minimum bias).
  - ✗ we modify the interaction point ,and we generate events for the nominal interaction point(z=0),3.75m and -3.75m.
- **The detector simulation:**
  - ✗ This step propagates each particle produced in the material of the detector and simulates its energy losses.
- **Digitization and Reconstruction:**
  - ✗ It converts the lost energy into a signal (charge, current, time ...).
  - ✗ The signal is reconstructed into tracks and energy deposits.



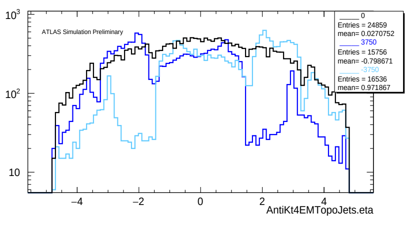
Parasitic events identified by the calorimeter system

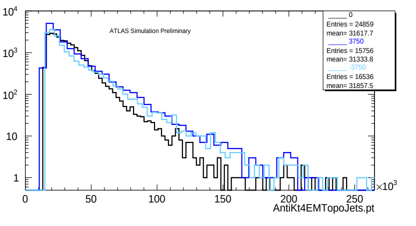
Introduction to the Jets:

- A jet is something that happens in high energy events: a collimated bunch of hadrons flying roughly in the same direction
- Jets are reconstructed by the $anti - k_t$ algorithm
- jets are clustered using R= 0.4 with Topological calorimeter cluster inputs.
- The variables used to characterize jets produced by parasitic collisions are:
  - the jet transverse momentum: p_T
  - the timing of the jet: t_{jet}
  - the pseudorapidity η



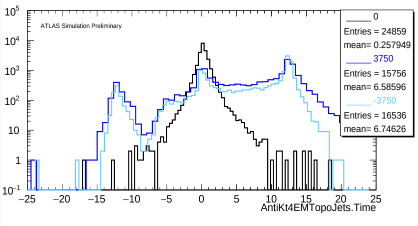
Rsultats:Jets:





- The jets from parasitic collisions in z=3.75m may traverse the detector from side A to C.
- The jets from parasitic collisions in z=-3.75m reach the detector in the side A.
- the reconstructed time of the parasitic particles can be written as:

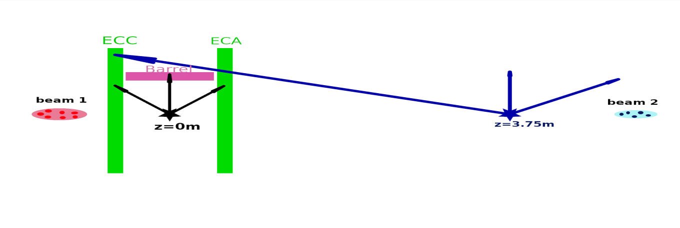
$$\Delta t_{parasitic} = \frac{\sqrt{(3.75 \pm z)^2 + r^2}}{c} - \frac{\sqrt{z^2 + r^2}}{c} \quad (1)$$



Parasitic events identified by the pixel detector

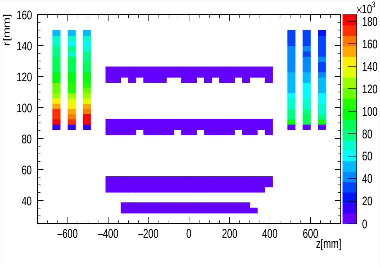
Pixel Clusters

- A cluster is a group of neighbouring pixels in which charge was deposited, ideally originating from the same particle.
- The pixel detector extends over a length of 650 mm.
- Parasitic particles cross the pixel detector with a trajectory almost parallel to the beam pipe, because they are in the very forward region.
- To identify the parasitic events we use:
  - the total number of pixel clusters per event
  - the global z position

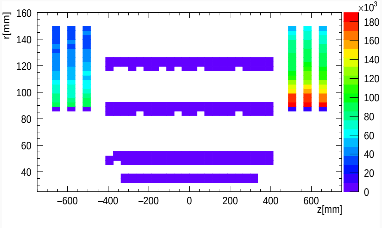


Pixel Clusters:

z vs r for z=3.75m:



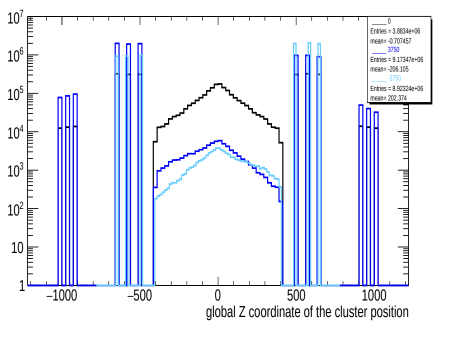
z vs r for z=-3.75m:



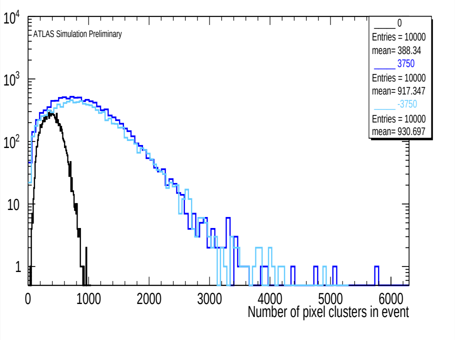
- for z=3.75m: most of clusters are in the EndCap C
- for z=-3.75m: most of clusters are in the EndCap A

Pixel Clusters:

globalZ position:

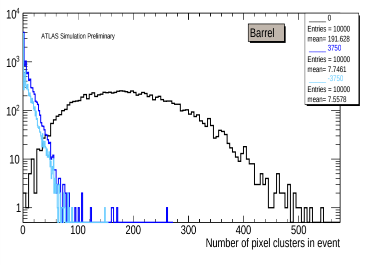


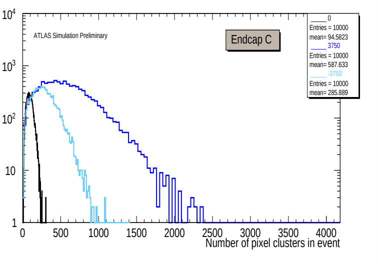
total number of clusters per event

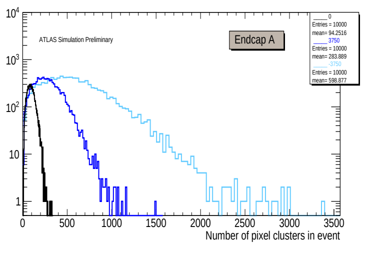


Pixel Clusters:

Number of clusters per event in the barrel and the EndCaps:



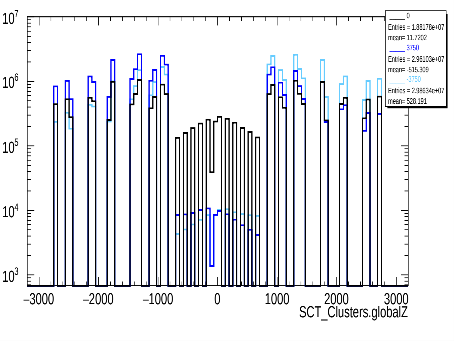




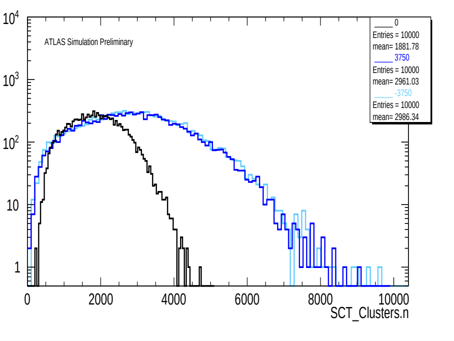
Parasitic events identified by the SCT detector

SCT Clusters:

globalZ position:

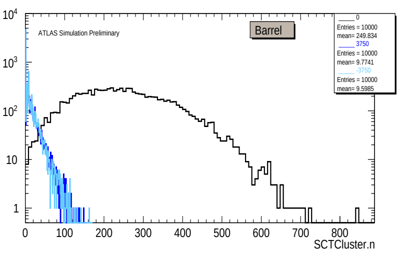


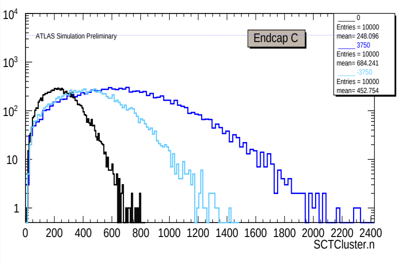
number of clusters per event :

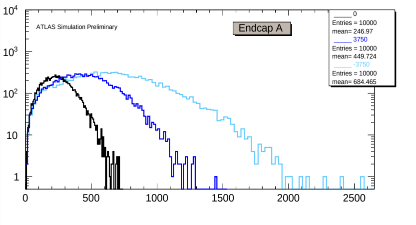


SCT Clusters:

number of clusters per event in the barrel and the EndCaps:







Conclusion

Conclusion:

- Three different methods to identify parasitic collisions.
- SCT and Pixel detectors can help indicating the presence of parasitic collisions for z = 3.75m.
    - Parasitic collisions at z=3.75m generate mostly fragments almost parallel to the beam pipe, that then interact mainly with the end-caps C
    - Parasitic collisions at z=-3.75m generate hits mostly in the end-caps A.
- Parasitic collisions can leave signatures in the calorimeters of ATLAS
    - exploit timing and pseudorapidity information from the calorimeter system.
- Plan to also add the muon response.

THANKS FOR YOUR ATTENTION!

QUESTIONS