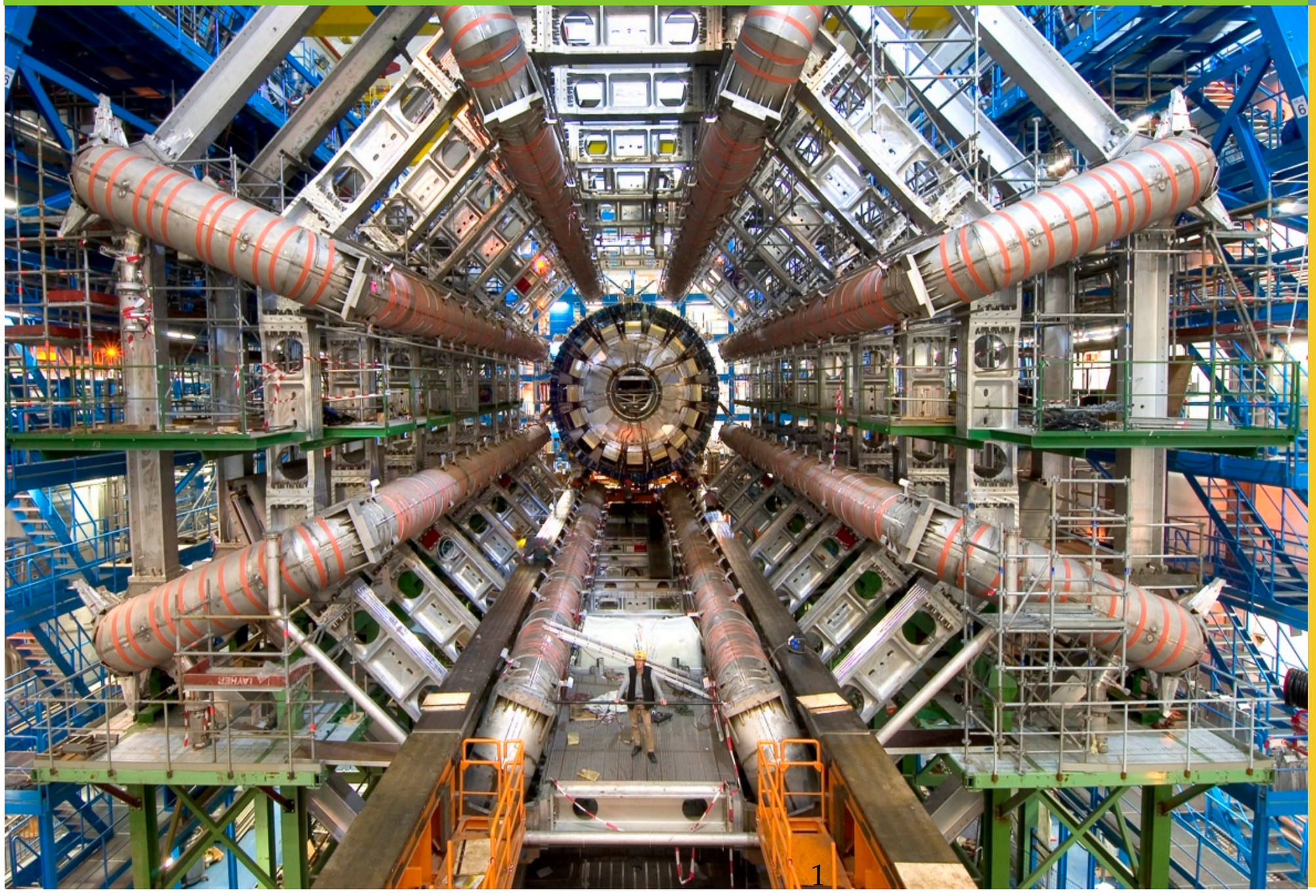
Performance of the track reconstruction in proton - proton collision with the ATLAS detector at the LHC



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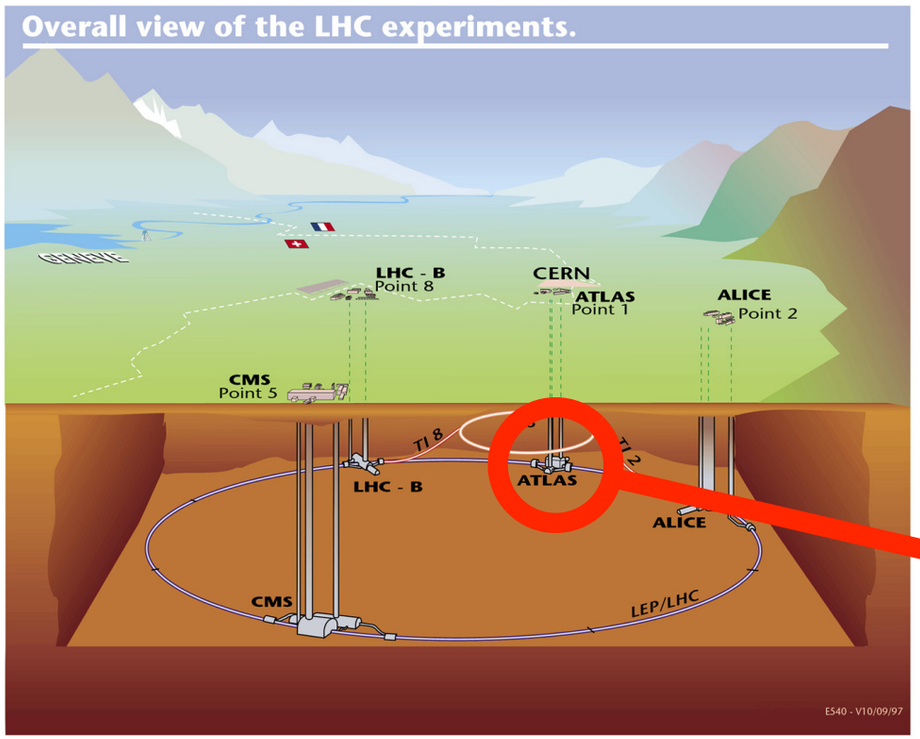
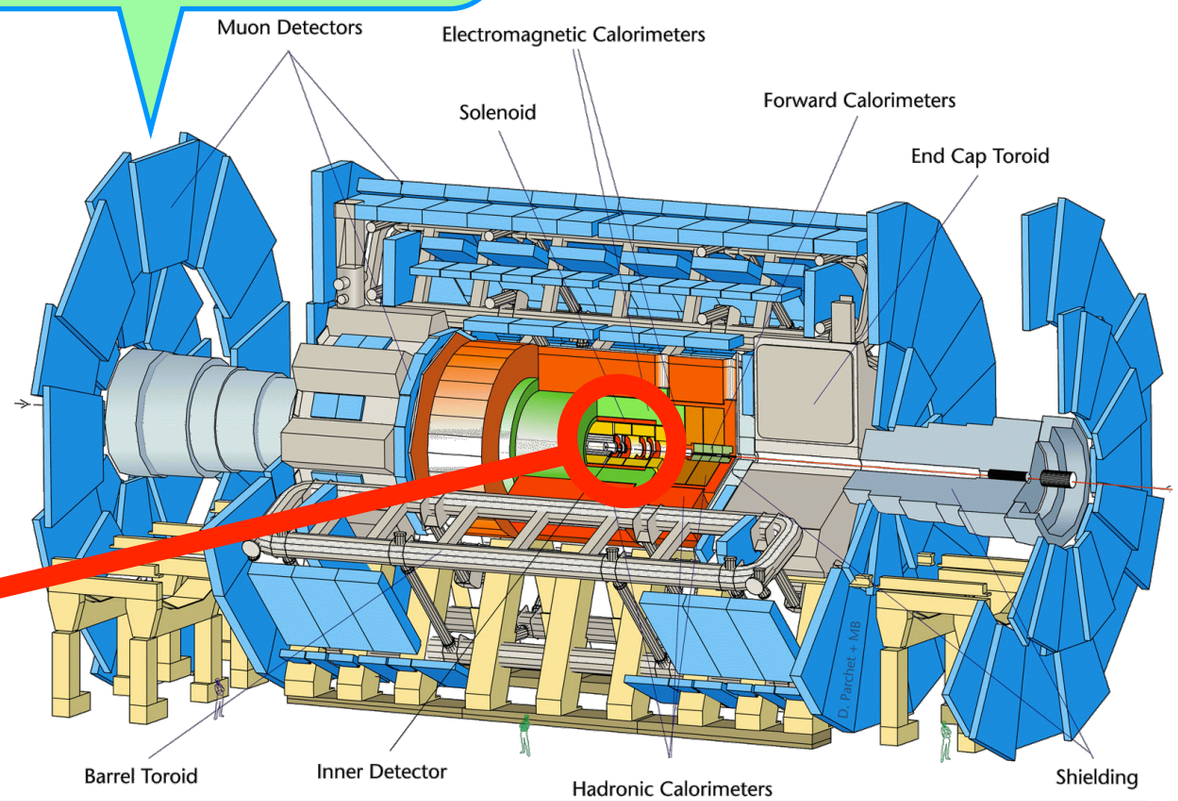
Outline

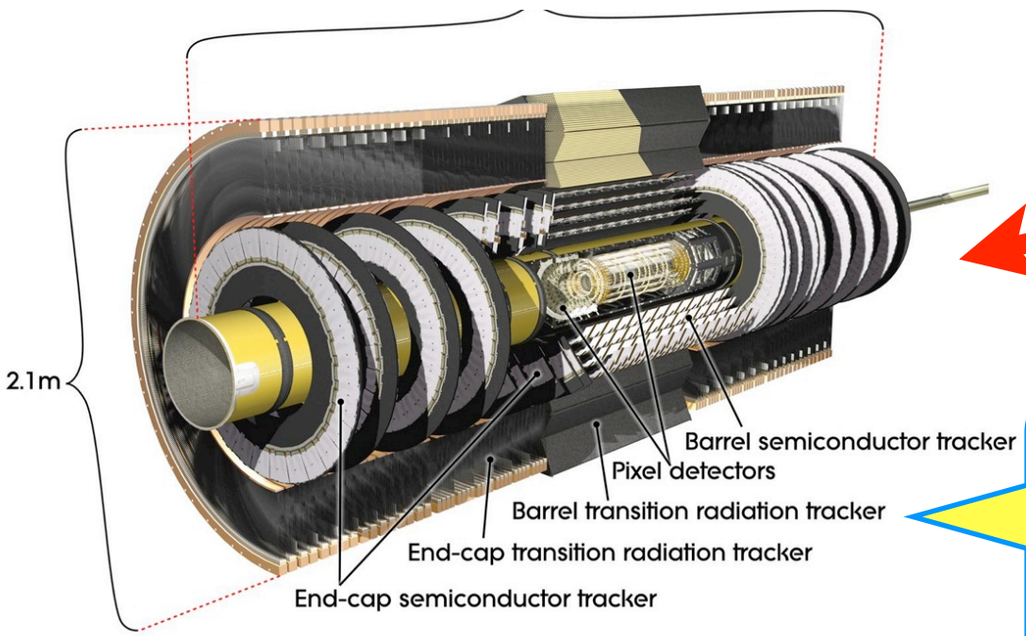
- ATLAS Tracking System layout
- Track and vertex reconstruction
- Material estimation
- Alignment
- Studies on impact parameter resolution

The ATLAS Experiment



Length ~ 45 m
Radius ~ 12 m
Weight ~ 7000 ton
Electronic channels ~ 10^8





Tracking System: Pixel Detector; Semi-Conductor Tracker; Transition Radiation Tracker.
Length ~ 6.2 m **Radius** ~ 2.1 m **Acceptance** $|\eta|<2.5$

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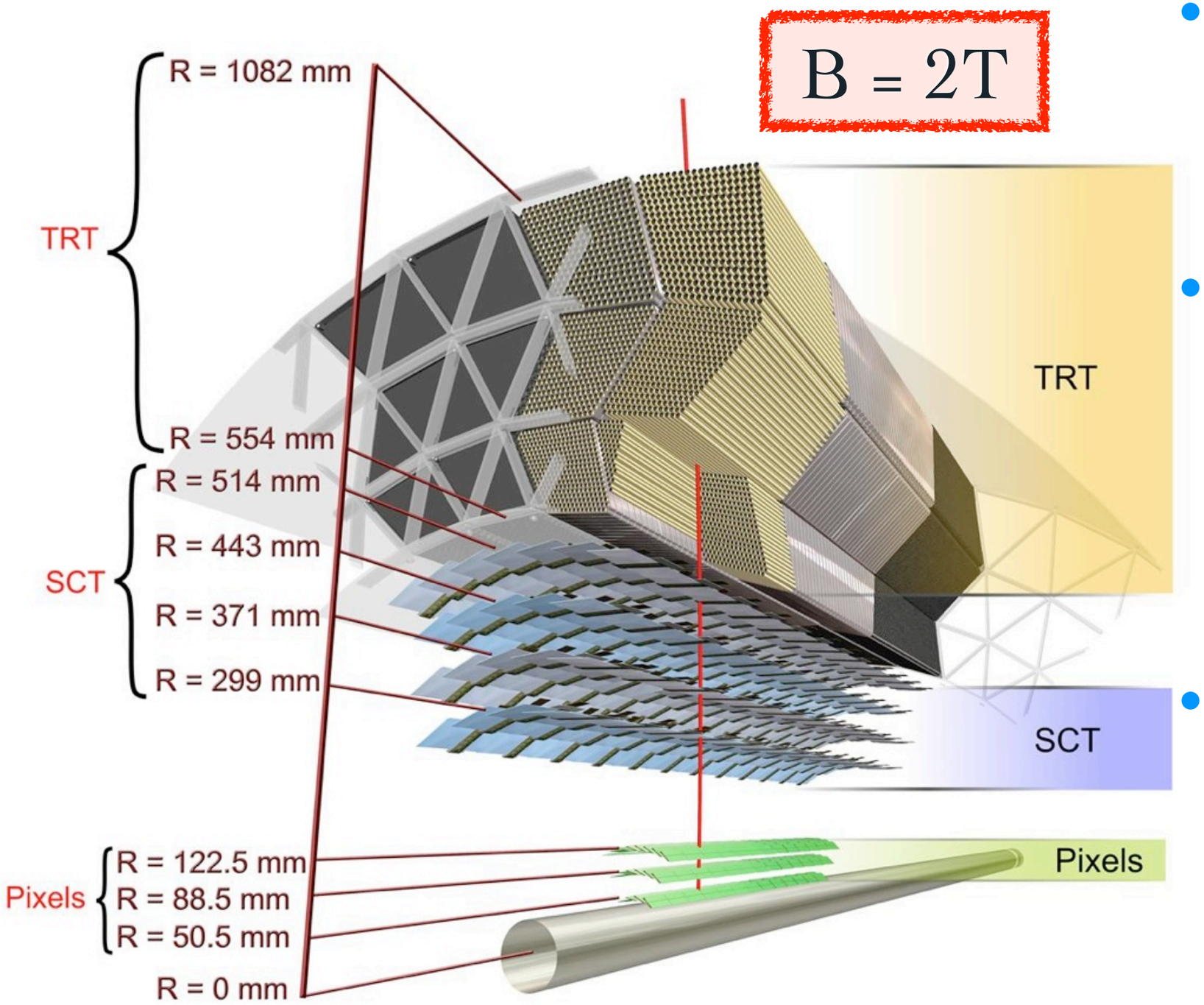
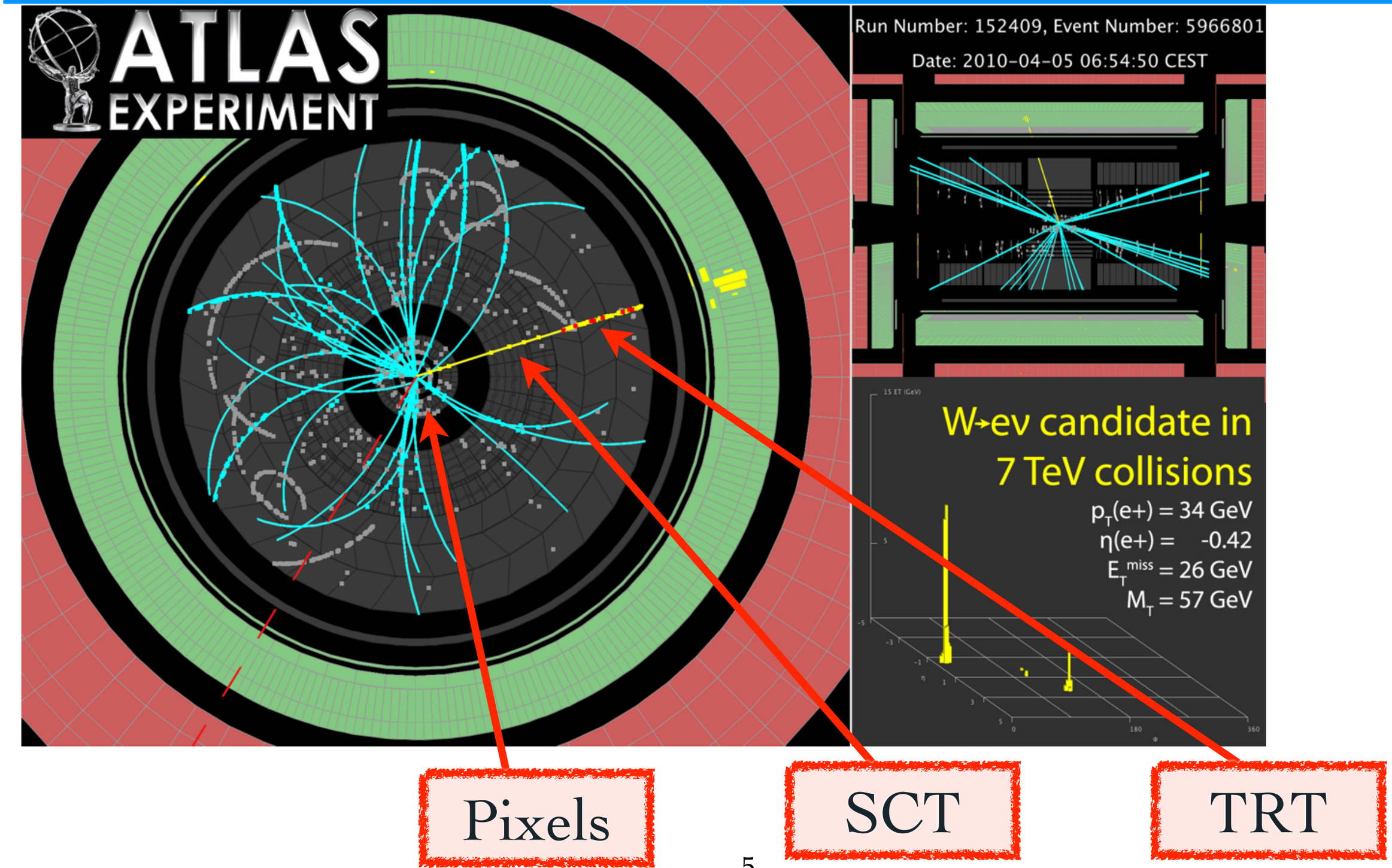
ATLAS tracking system

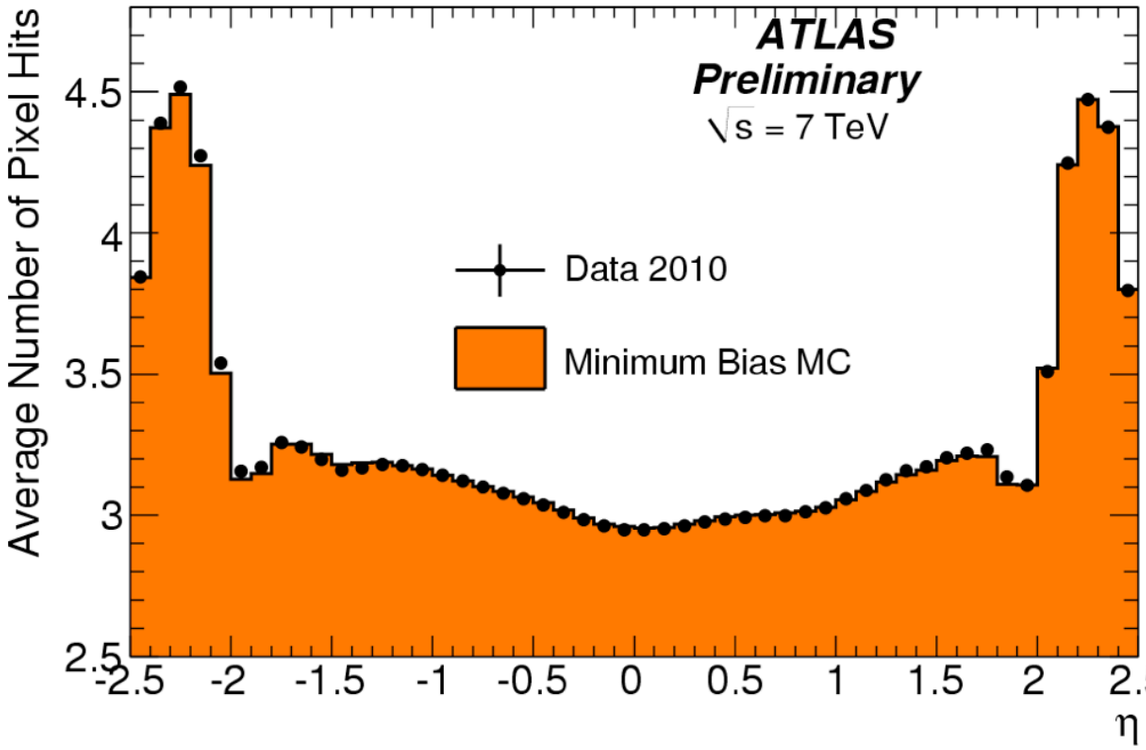


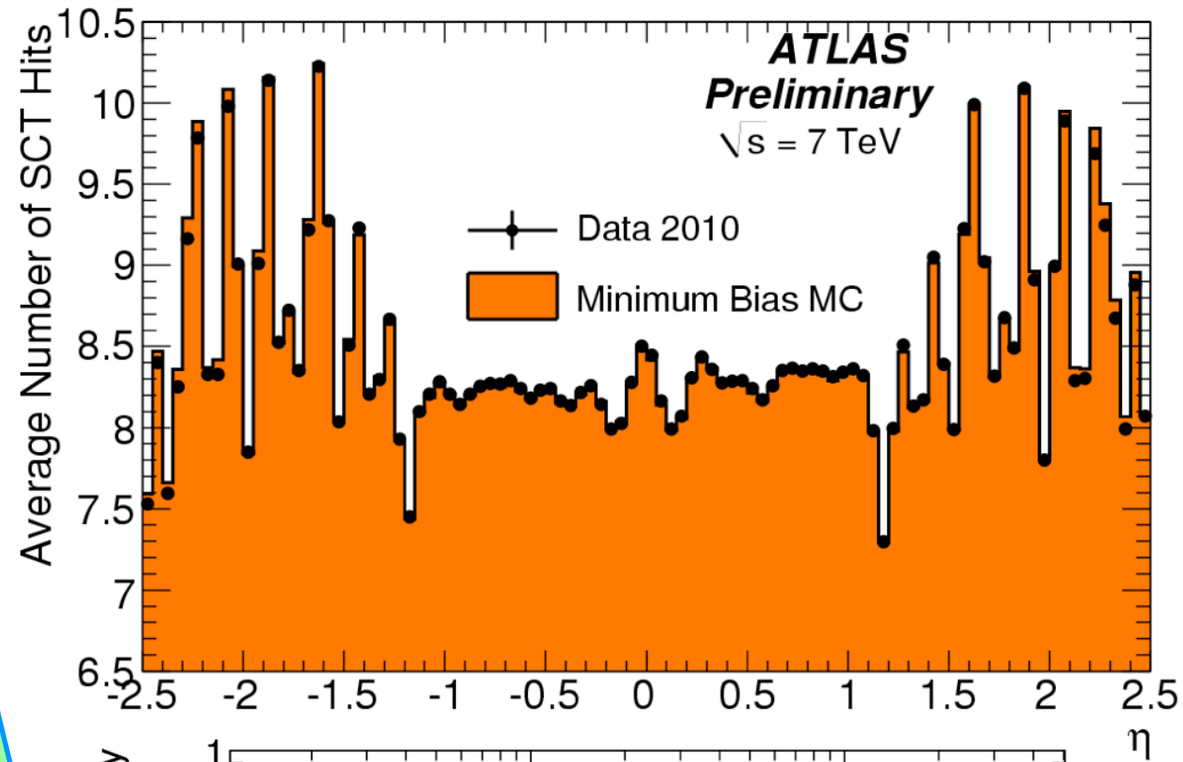
- TRT:
  - ~ 100k channels
  - ~ 36 hits / track
  - single hit $\sigma_x = 130$ μm
- SCT:
  - ~ 6.3M channels
  - 4 double barrel layers - 9 double endcap disks
    - 80 mrad stereo angle
    - strip pitch 80 μm
- Pixels:
  - ~ 8 10^7 channels
  - 50 x 400 μm
  - $\sigma_{(R\phi)} \sim 10$ μm; $\sigma_{(z)} \sim 115$ μm
  - 3 barrel layers - 3 endcap disks

A nice event display

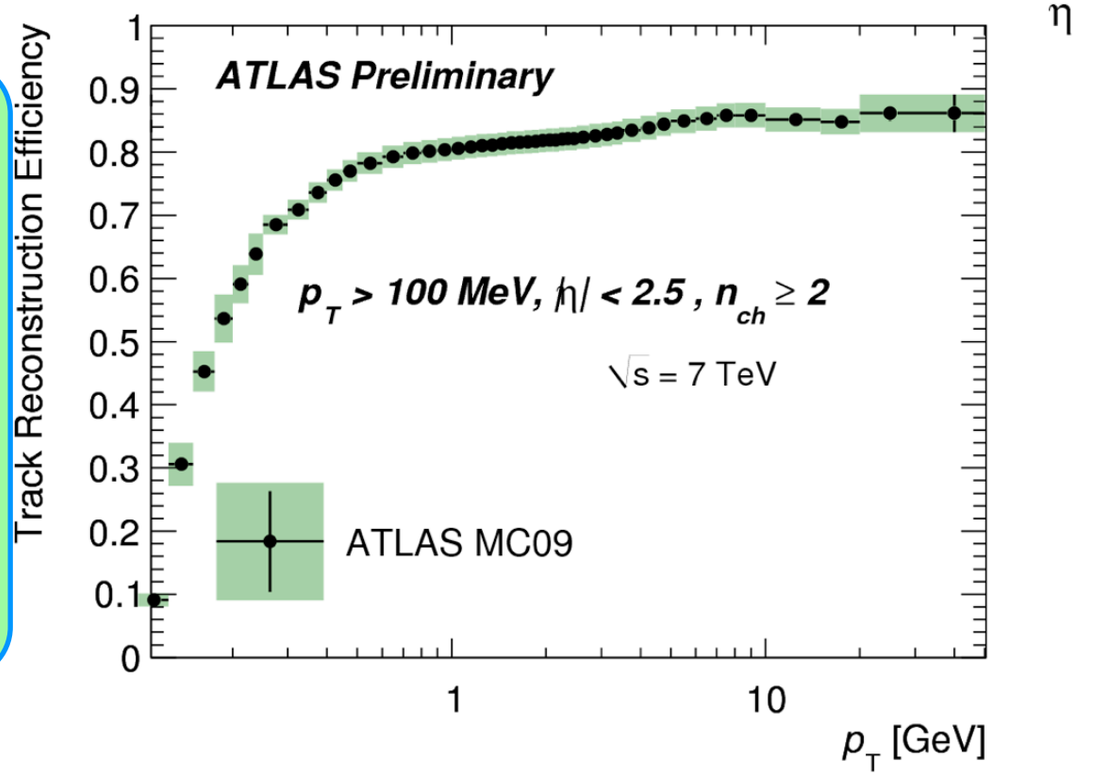


Track reconstruction

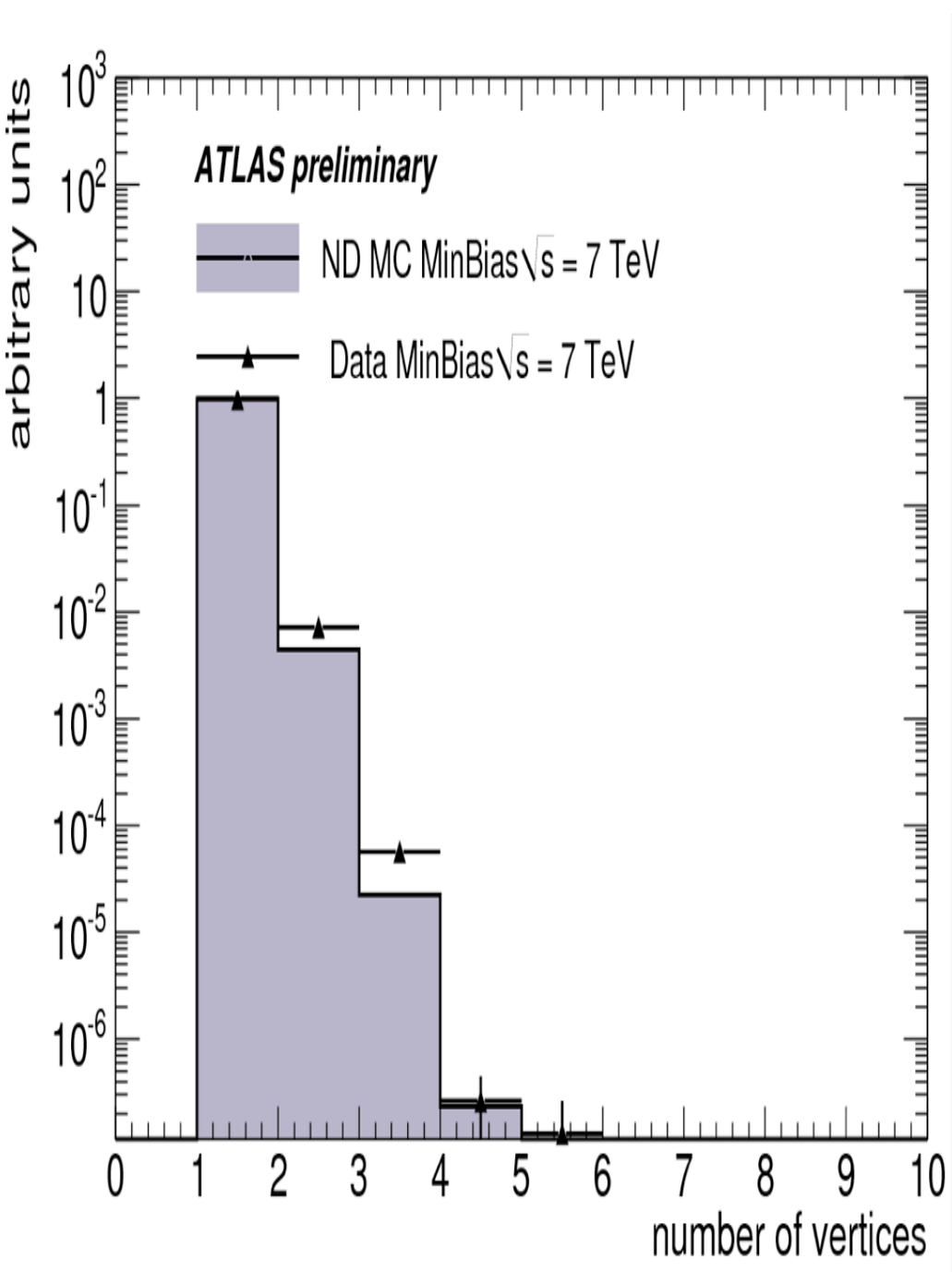


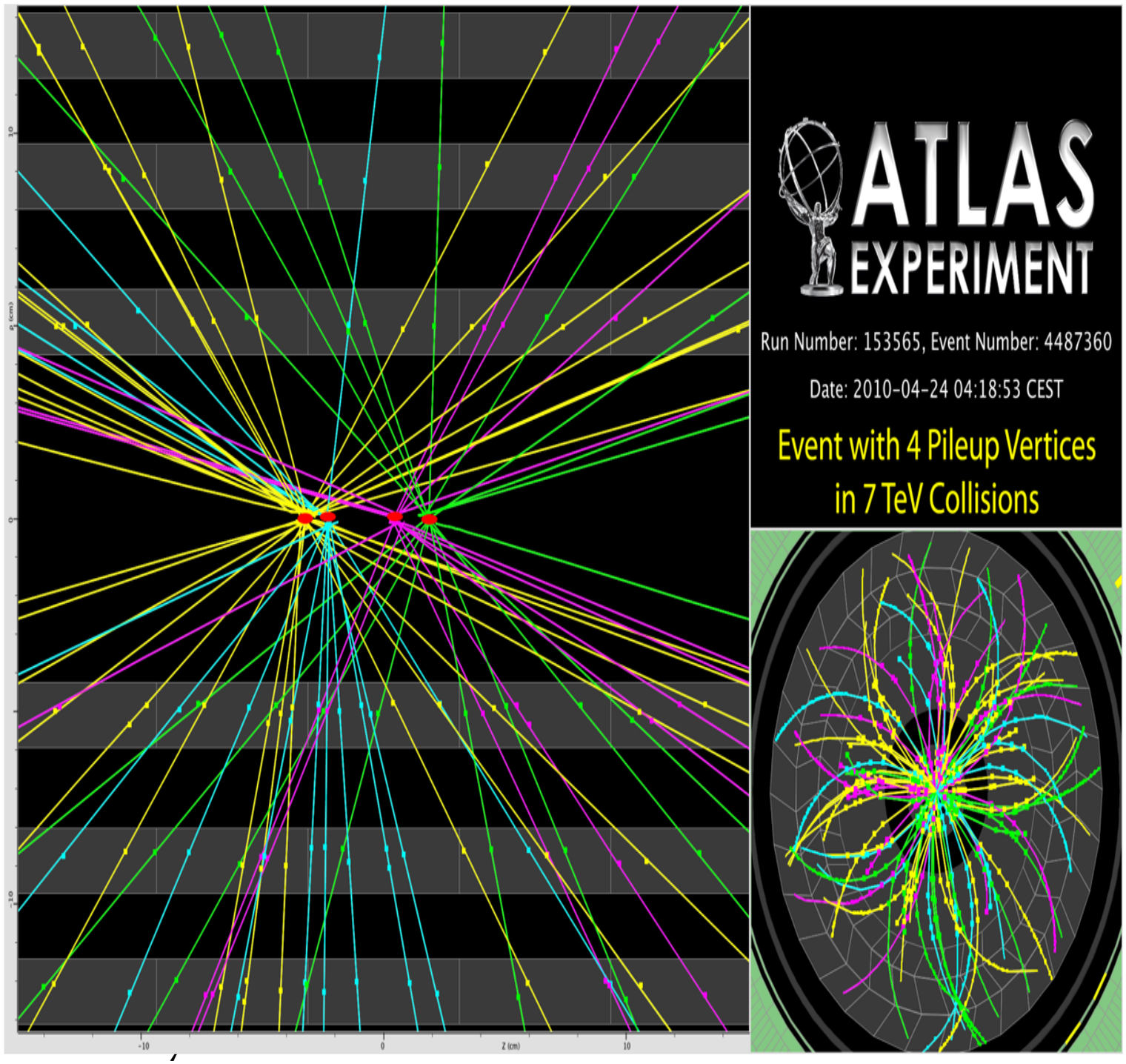


- Average hits multiplicities in bin of η:
  - the agreement is very good, the detector structure is well described by the simulation

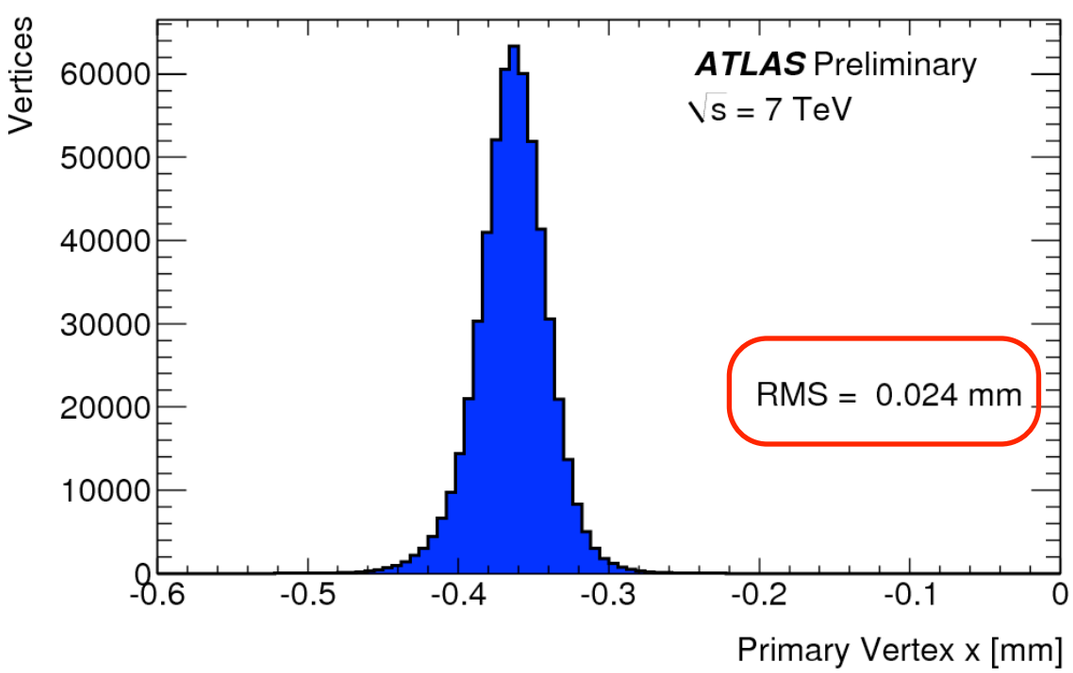


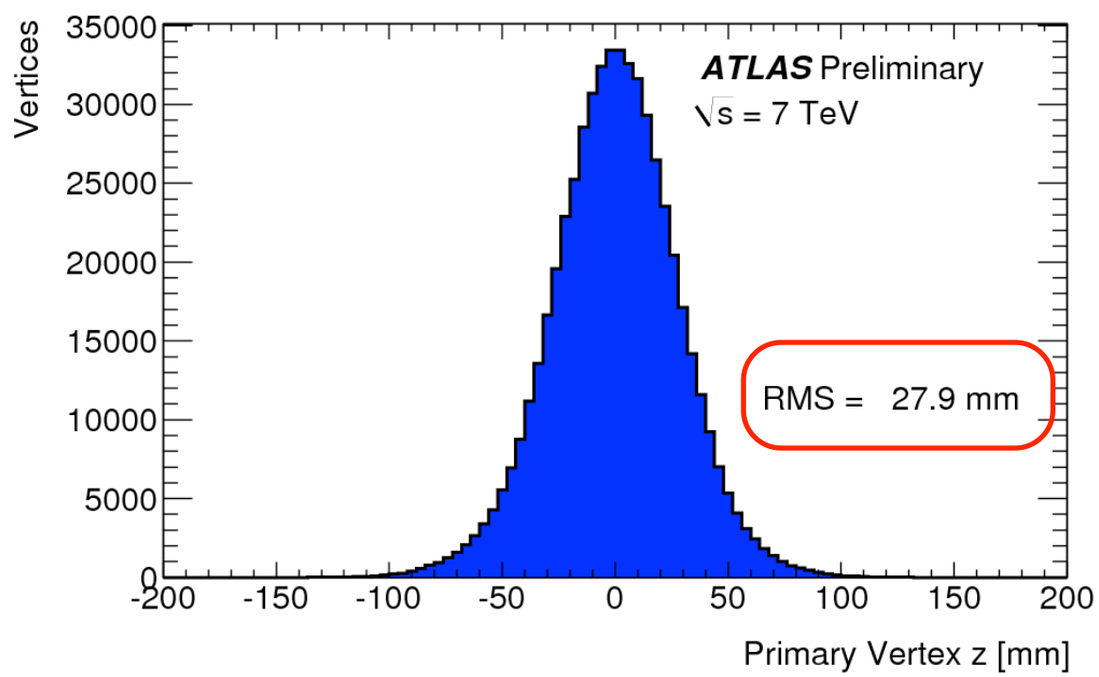
Vertex reconstruction

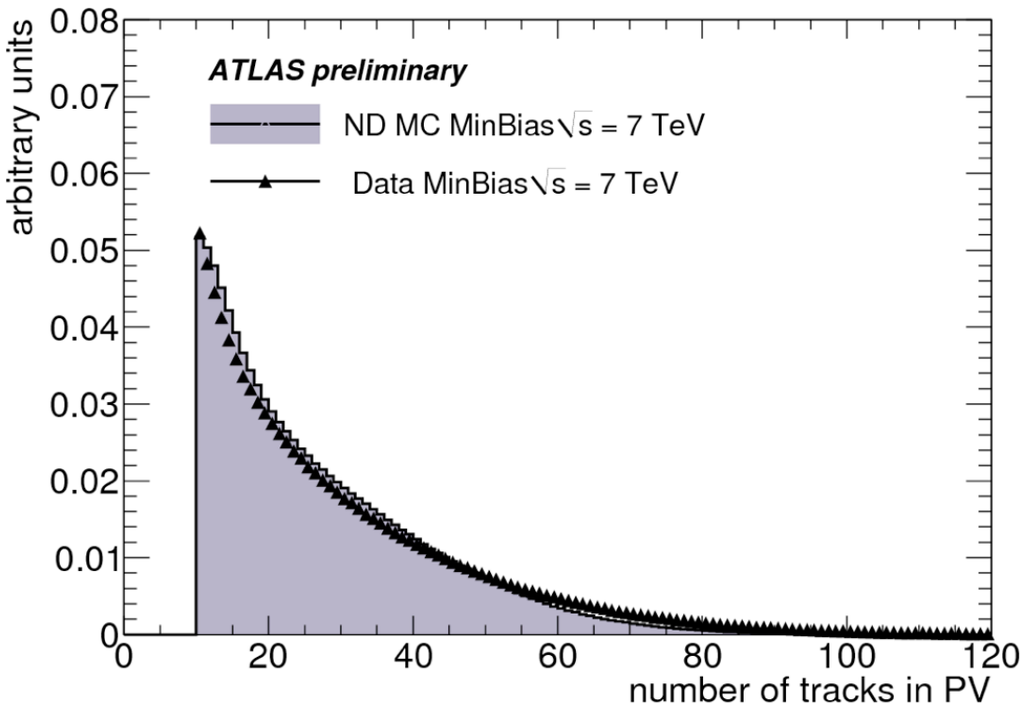


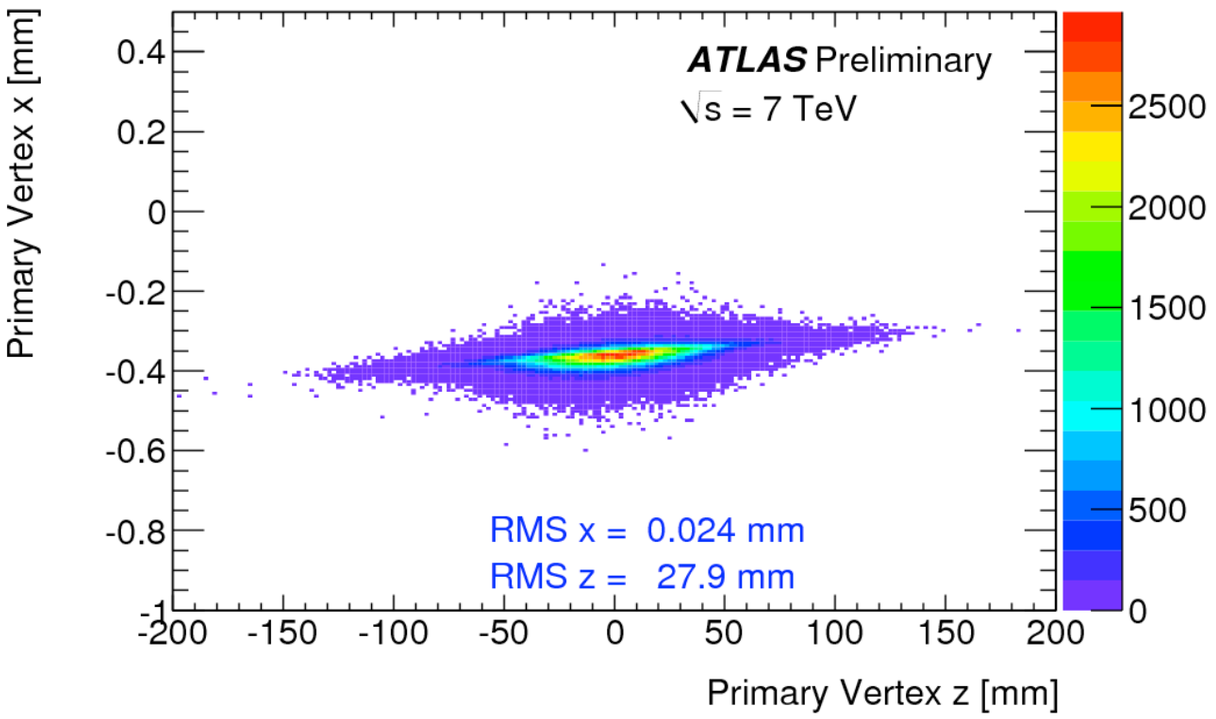


Vertex reconstruction









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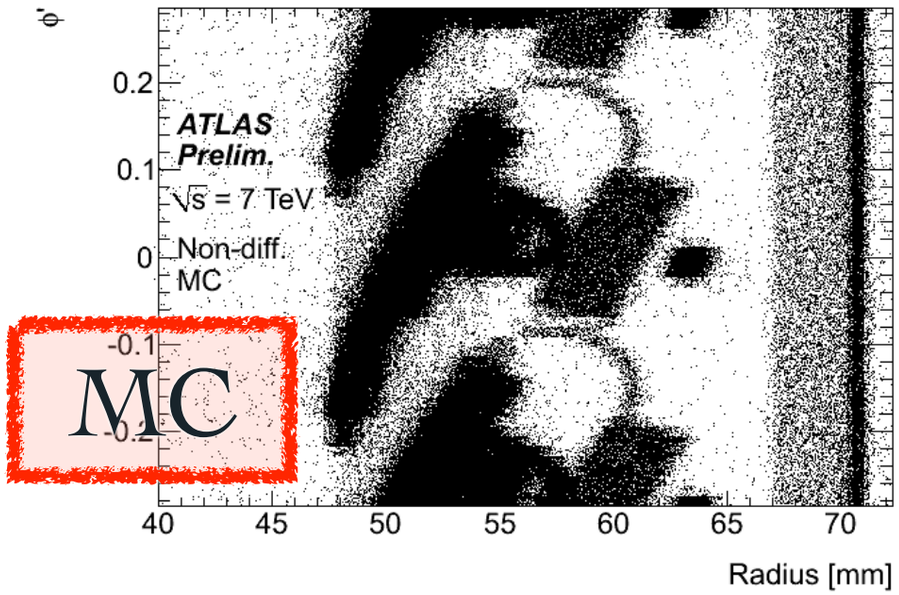
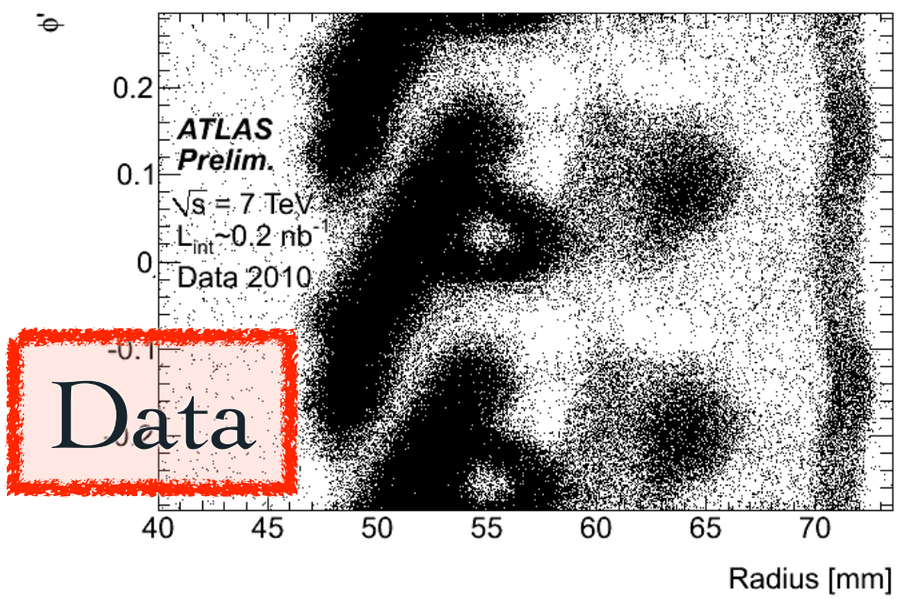
More on vertices: material estimation

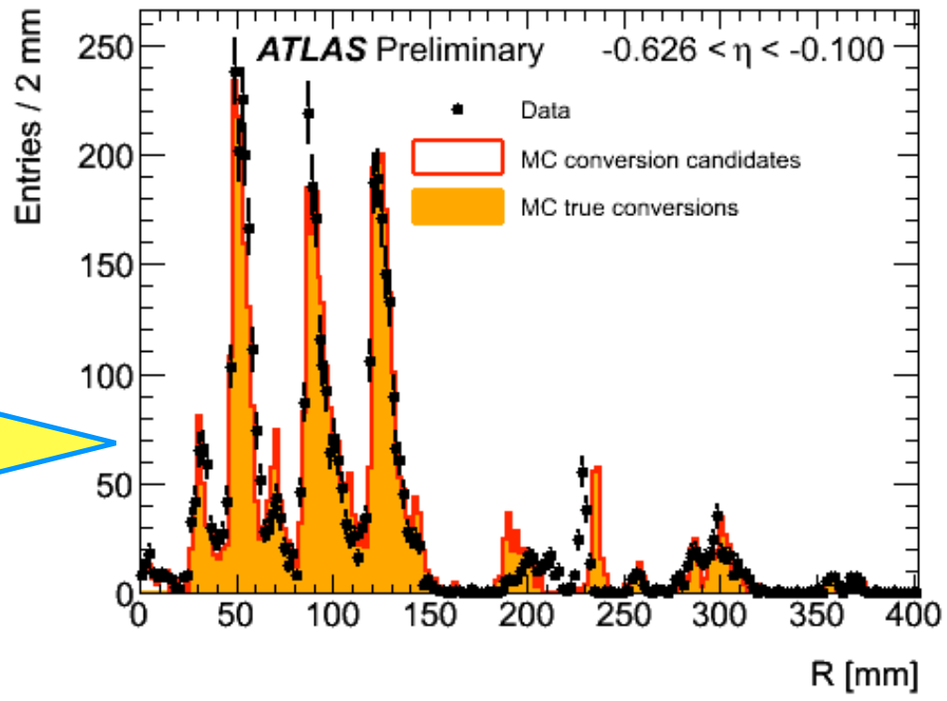
- Vertex reconstruction can also be used to map the material of the Pixel Detector



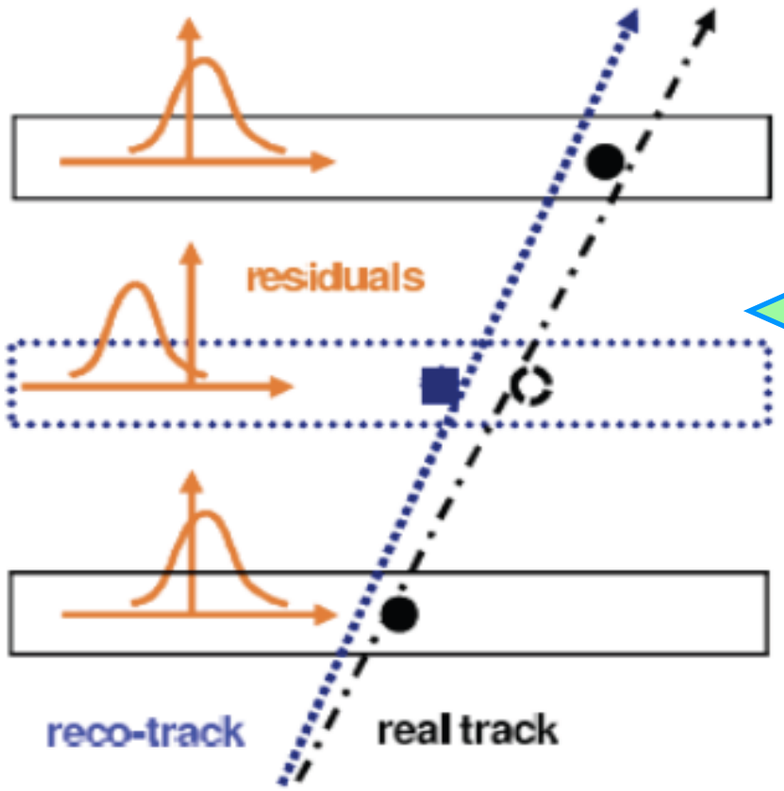


Hadronic interaction: Here tracks compatible with the primary vertex or with γ-conversions or decays of light hadrons are rejected to find vertices from material interactions

γ-conversions: 3 pixel barrel layers clearly visible

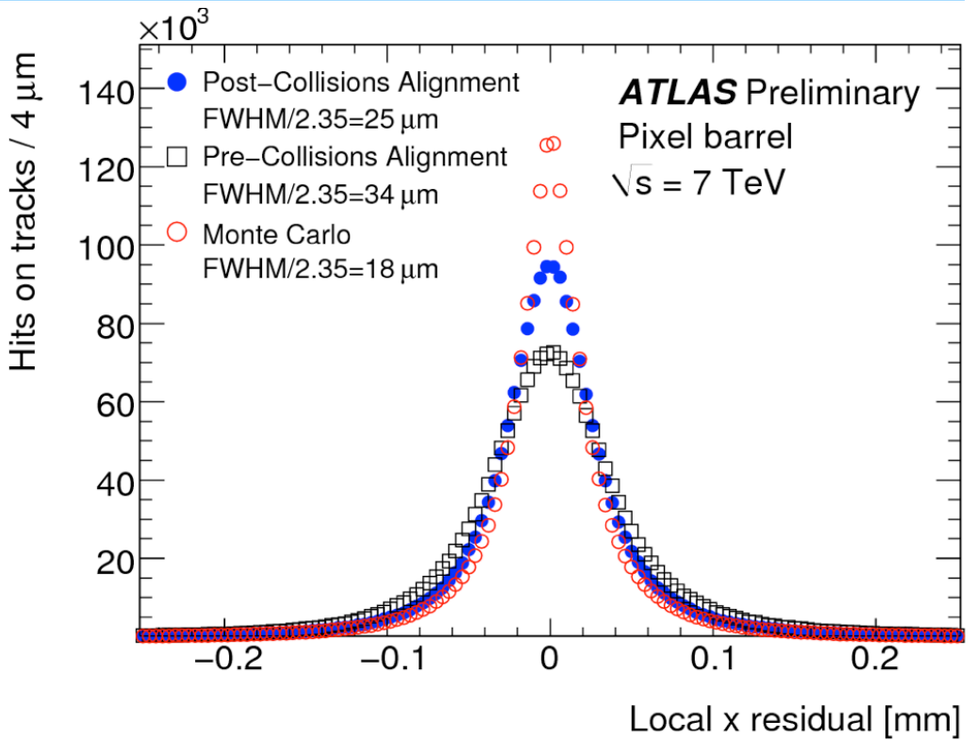


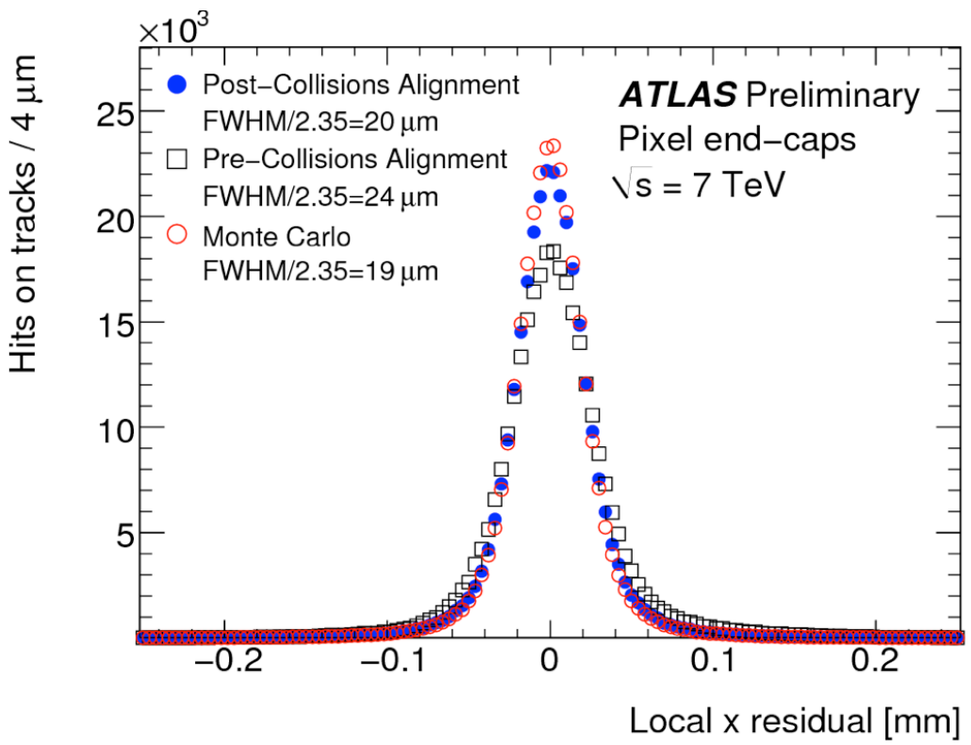
Alignment



Alignment based on minimization of the track-hit residuals:

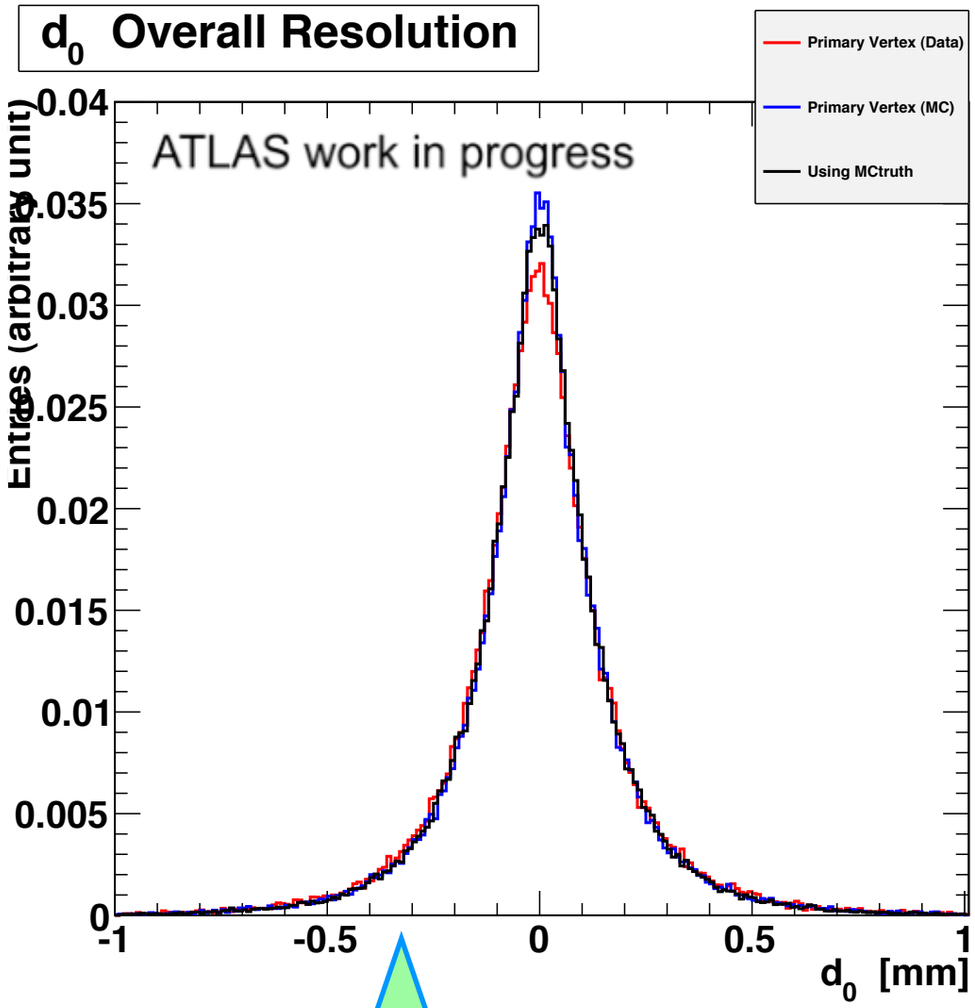
$\chi^2=\sum_{tr}\mathbf{r}^T\mathbf{V}^{-1}\mathbf{r}$





- Good results with cosmics (pre-collisions alignment)
- Improvements with first collisions (post-collisions alignment)

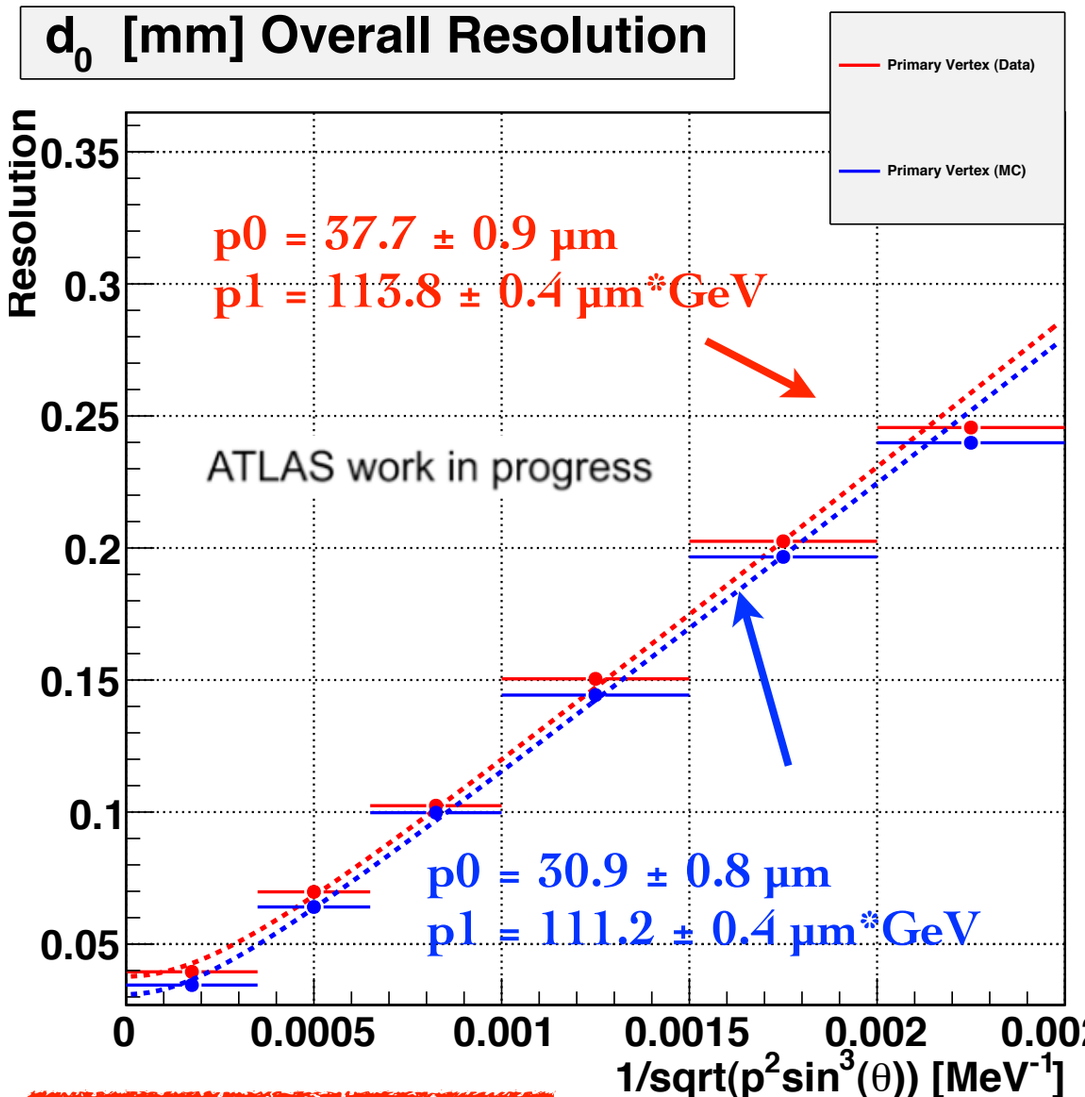
Studies on impact parameter resolution



- Non-gaussian distribution: this includes all track's categories!
- The classification of the tracks will lead to more reasonably (but definitively NOT) gaussian distributions

- Aim of my studies: Provide information about tracking resolution (impact parameter resolution) in data and MC
- How? Possibility to have residual w.r.t primary vertex (PV) and MCtruth (only the first for data!)
  - 3 variables per track (mainly longitudinal and transverse impact parameters): d_0, z_0, $z_0\sin\theta$
- Study of these variables as function of track parameters:
  - η (intrinsic detector resolution and hit pattern depends on pseudorapidity)
  - $1/\sqrt{(p^2\sin^3\theta)}$ (**multiple scattering dependence**)
- and of track categories:
  - for the time being just 0, 1, >1 b-layer hits

Studies on impact parameter resolution



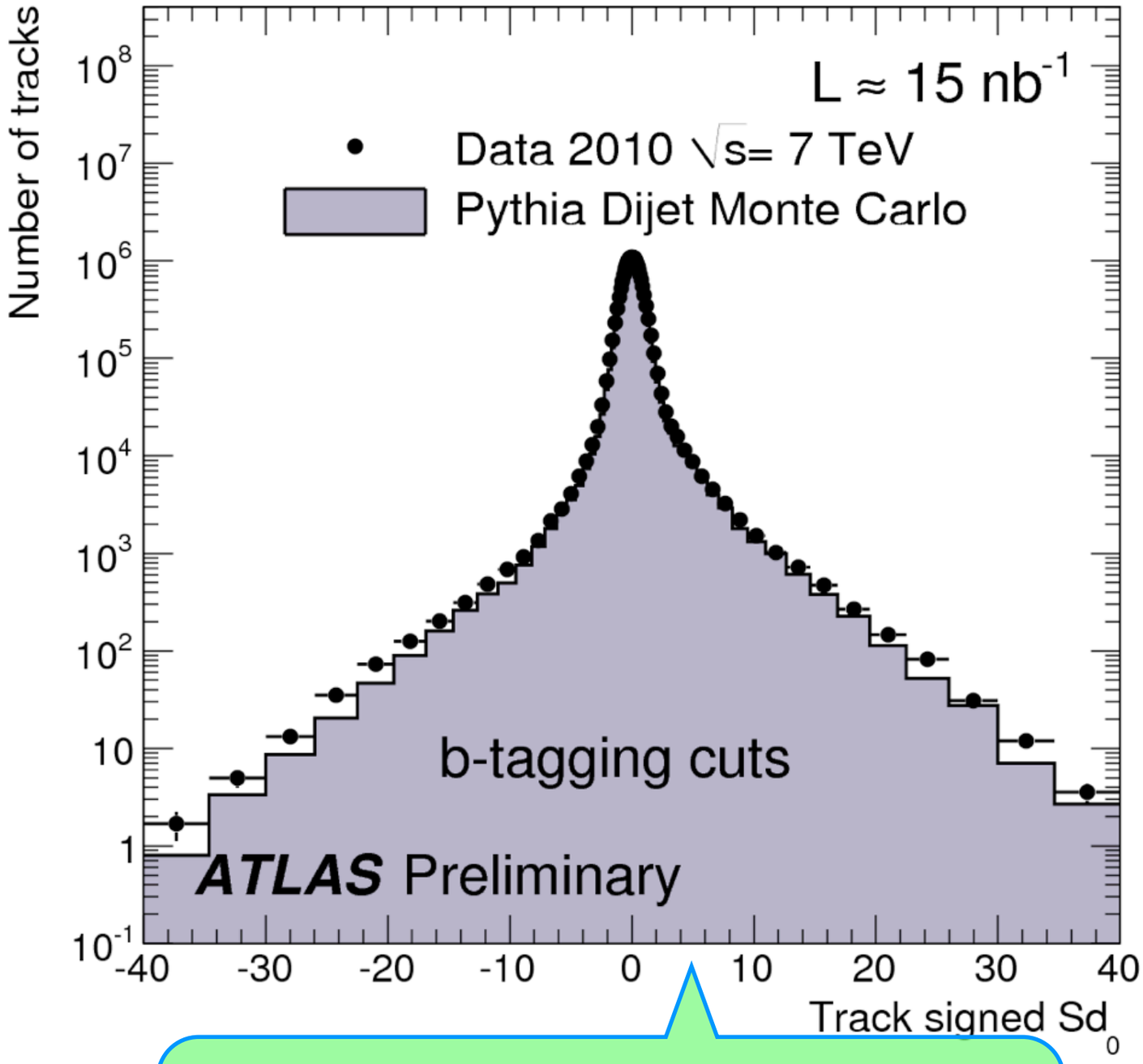
Fit function:

$$\sqrt{p_0^2+\frac{p_1^2}{p^2\sin^3\theta}}$$

- Determine asymptotic resolution (p0) and material contribution in the beam-pipe and in the pixels (p1)
- Design asymptotic resolution is near!!
- Multiple scattering contribution is described better than 10%

Summary

- First few months of LHC running @ 7 TeV has already yielded a wealth of physics results
- ATLAS features a three-component Inner Detector wich is designed for tracking and vertexing
  - good agreement between data and MC for basic quantities that means good understanding of the detector performance
- Tracking and vertexing are essential for many applications (i.e. mapping of detector material)
- In particular, the excellent impact parameter resolution allows to perform heavy flavour physics analisys (i.e. B physics, J/ψ)



IP signed significance (d_0/σ_{d0})

2010: An exiting year so far...