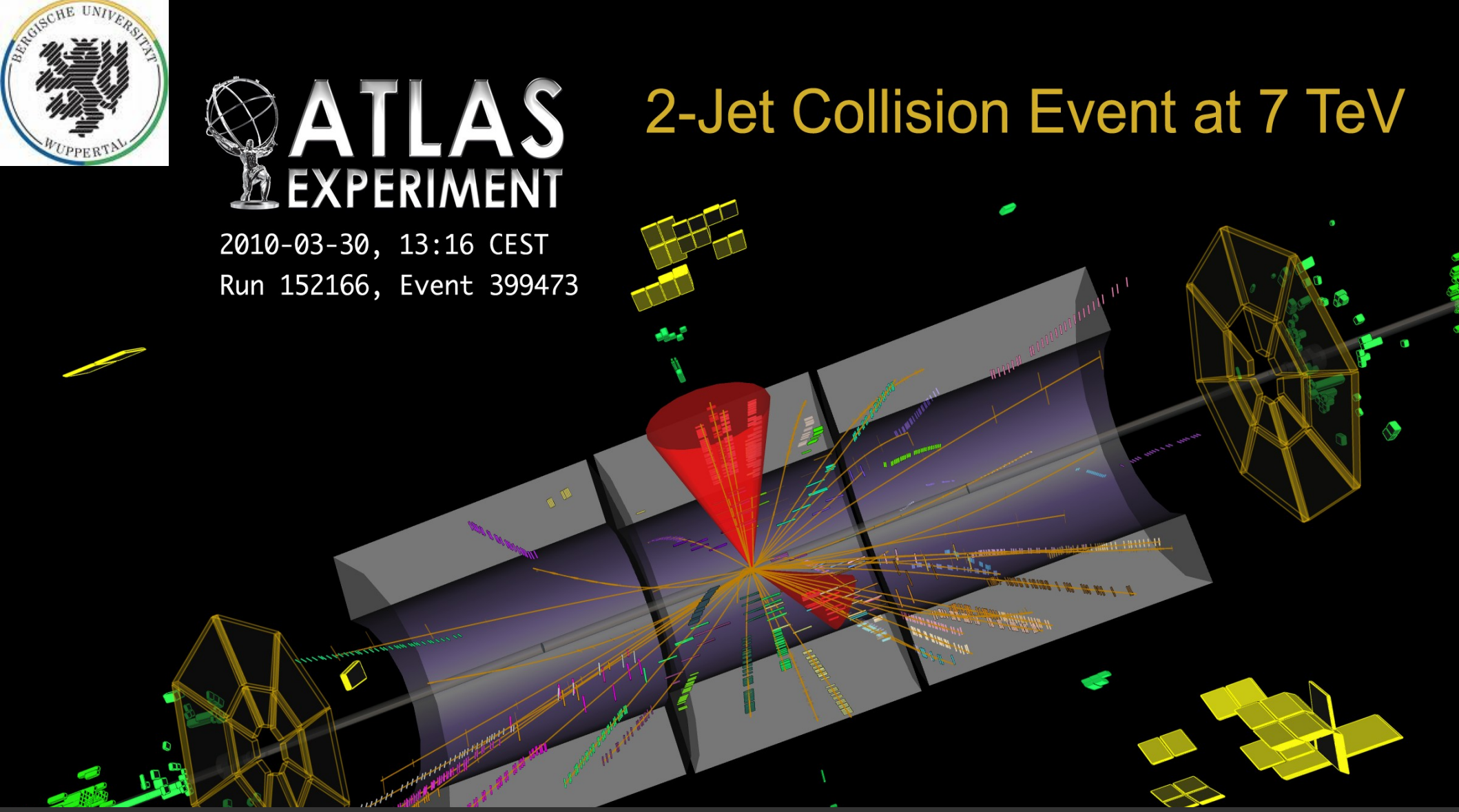


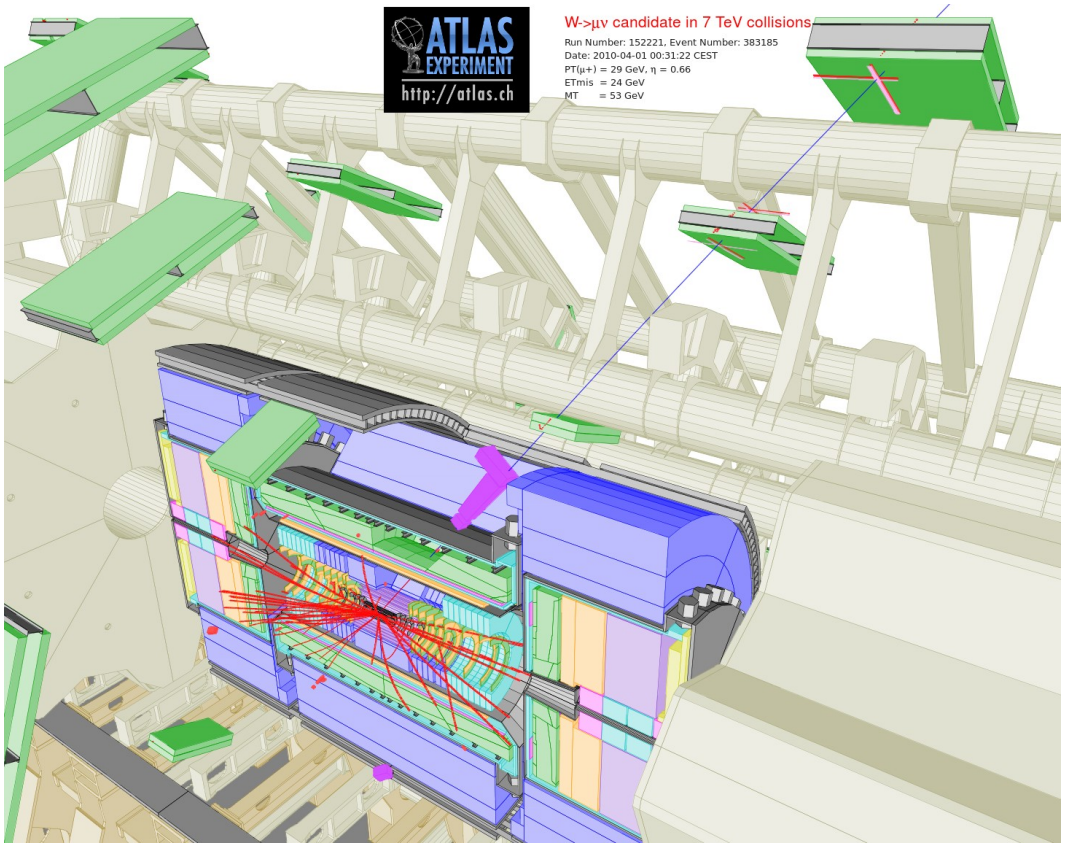
Tracking, Vertexing and B-tagging at ATLAS

Thorsten Kuhl, University of Wuppertal

On behalf of the ATLAS Collaboration

FSP 101 ATLAS

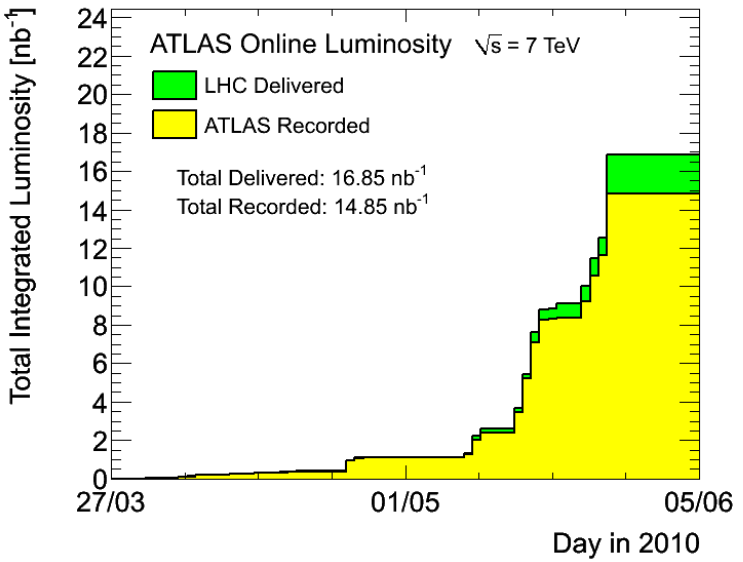
Detector and Data Set



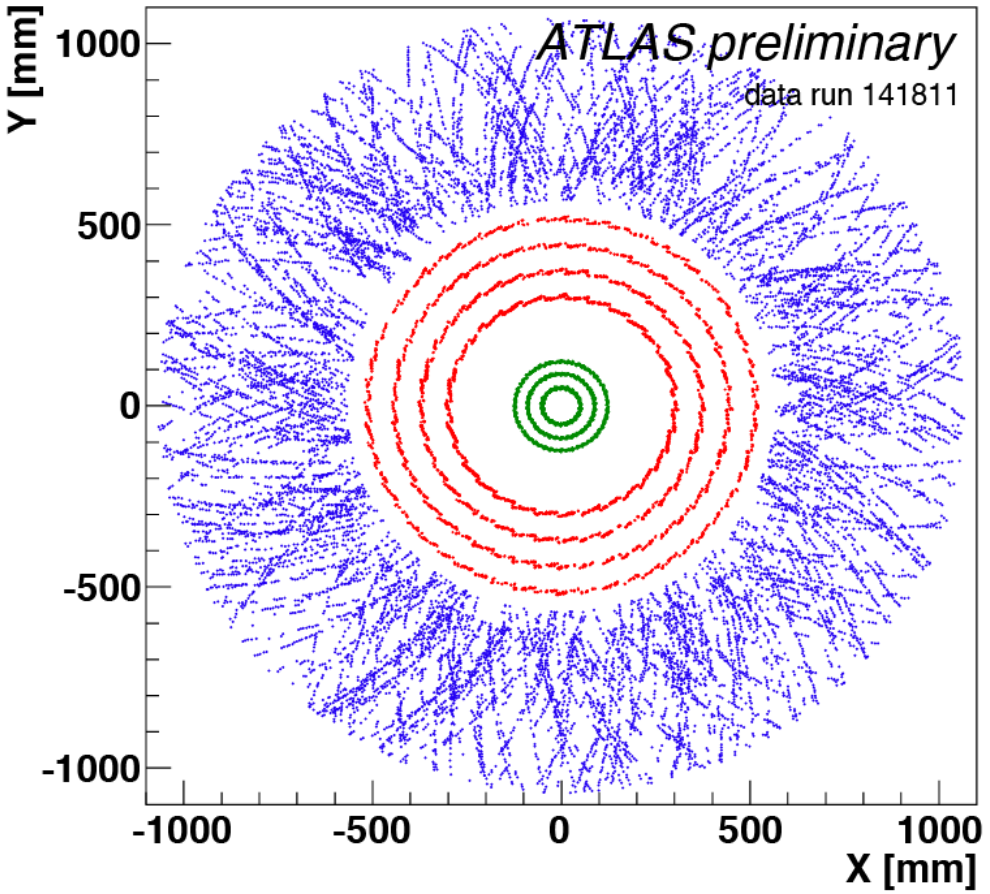
Multi purpose detector:

- Tracking system
- Liquid Argon-Calorimeter and HadronicTile (Barrel)
- Large muon system with air core toroid

- Atlas recorded 15nb^{-1} at 7 TeV
  Results based on 0.4 to 1 nb^{-1}



Atlas Inner Detector



- Pixel Detector:
  3 barrel layers, 2 x 3 end-cap discs $\sigma_{r\phi} \sim 10\ \mu m$, $\sigma_z \sim 115\ \mu m$
- Silicon Strip Detector (SCT)
  4 barrel layers, 2 x 9 end-cap discs, stereo pairs of single sided sensors $\sigma_{r\phi} \sim 17\ \mu m$, $\sigma_z \sim 580\ \mu m$
- Transition Radiation Tracker (TRT)
  73 barrel straw layers 2x160 end-cap radial straw discs
  $\sigma_{r\phi} \sim 130\ \mu m$

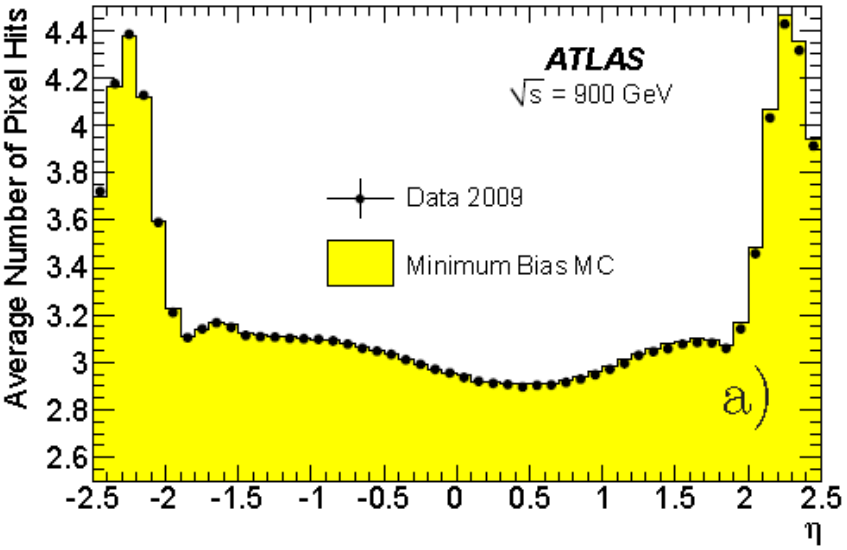
Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.5%
SCT Silicon Strips	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	98.0%

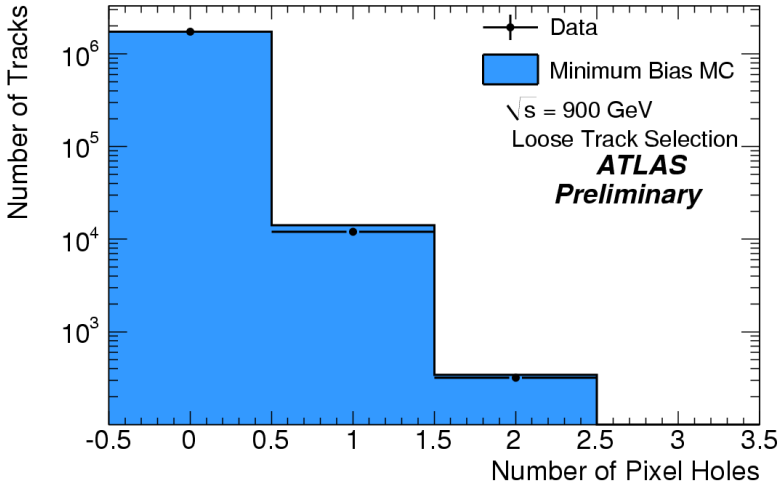
All components operational > 97.5%!

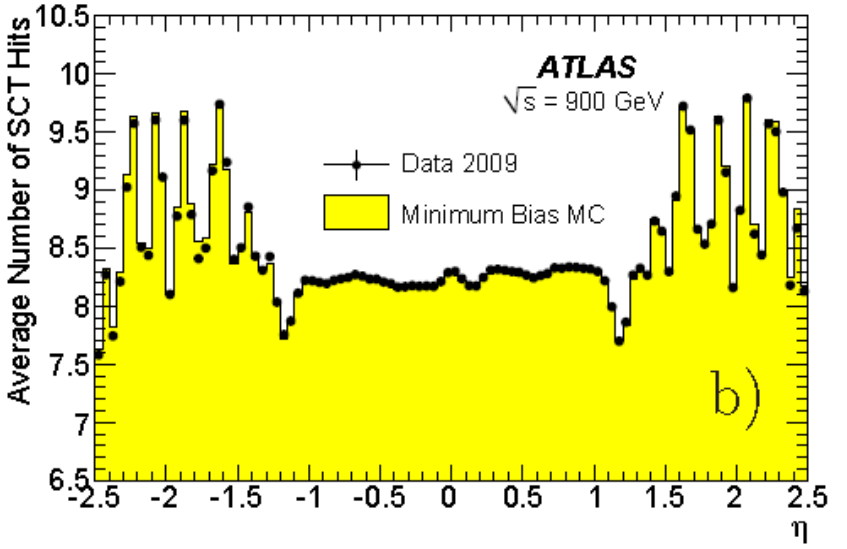
Number of Hits on Track

Detailed studies comparing data/MC:

- Monte Carlo samples reflect conditions during data taking: beam spot position, inactive modules, noisy channels
- In general, excellent understanding of detector
- Reconstruction performance tested to high level e.g. holes (= missing hits) on track







Residuals and Hit Efficiencies

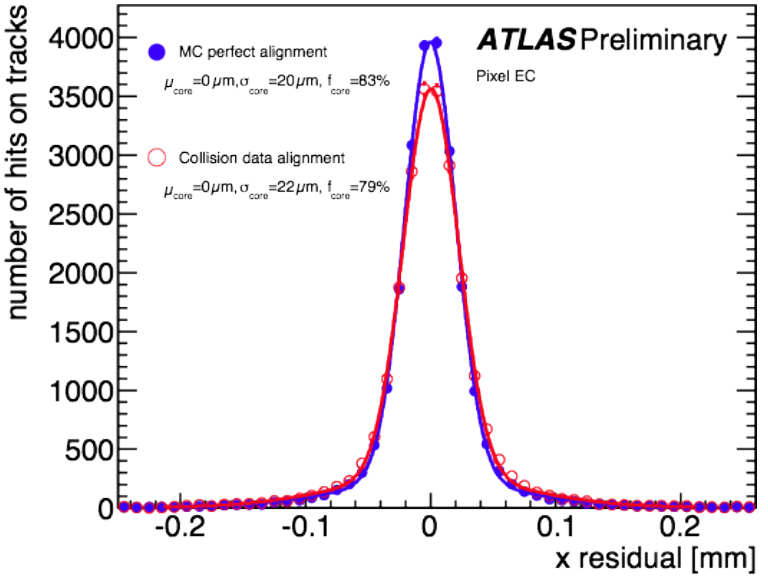
SCT hit efficiency for hits if expected (excluding dead modules and chips)

→ close to 100%

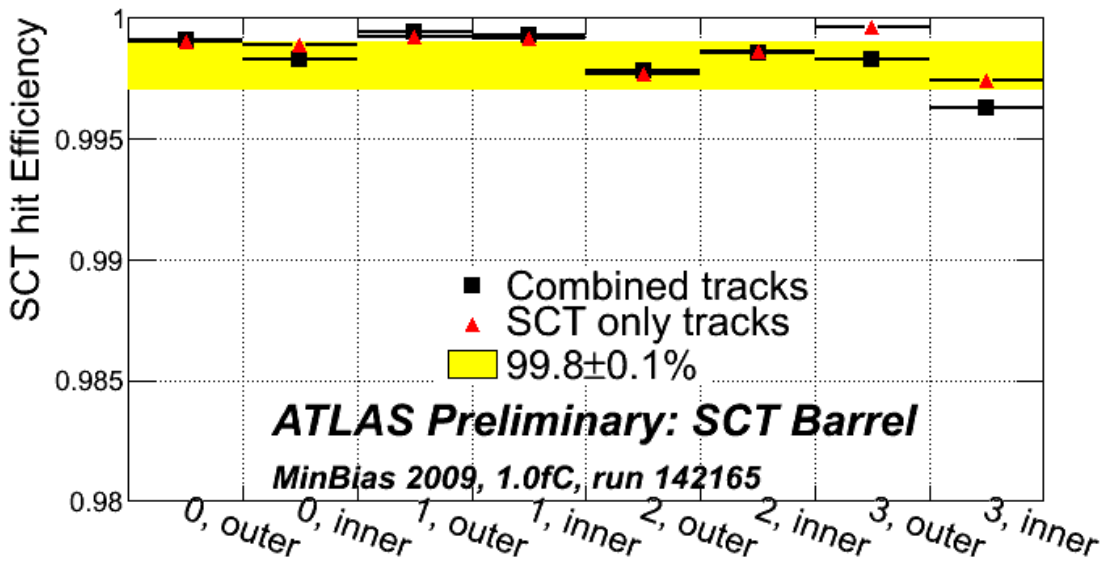
Silicon and TRT Residuals:

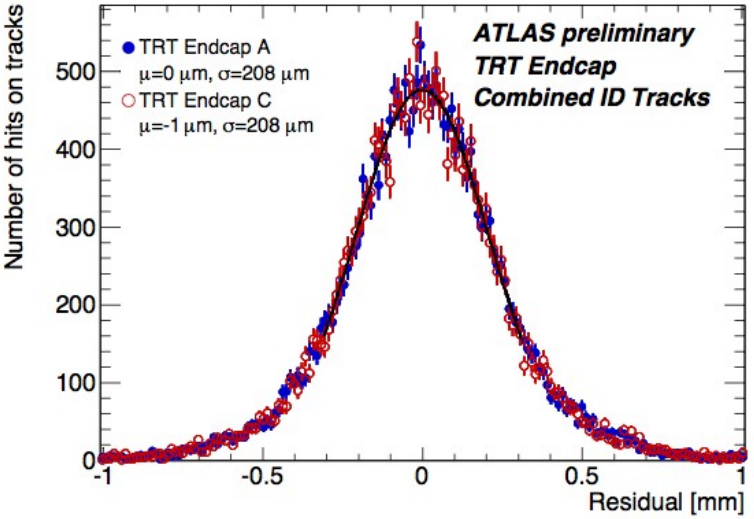
➔ Mostly in good agreement except one endcap not reach full potential

➔ More results for alignment in talk from Igor Potrap



Pixel Residuals



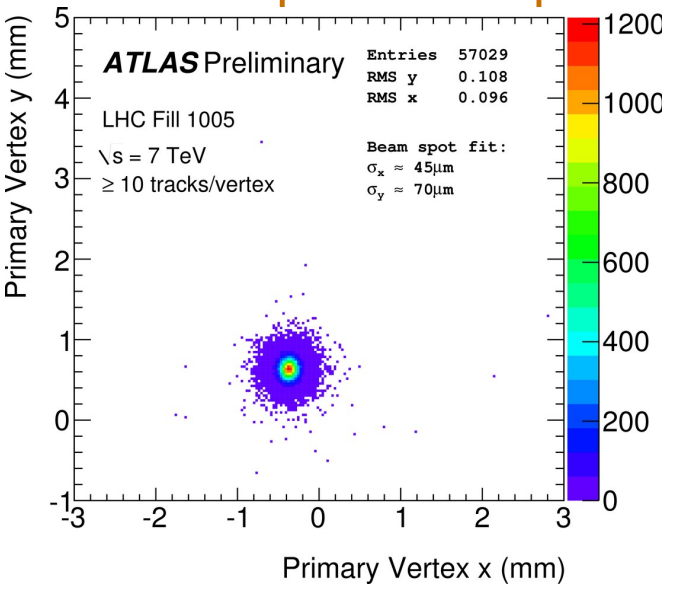


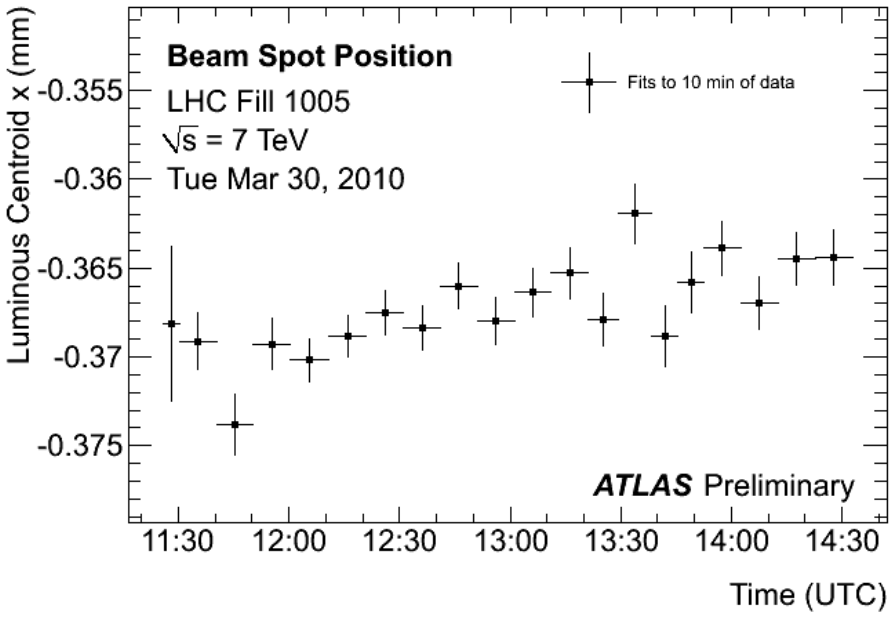
TRT Residuals

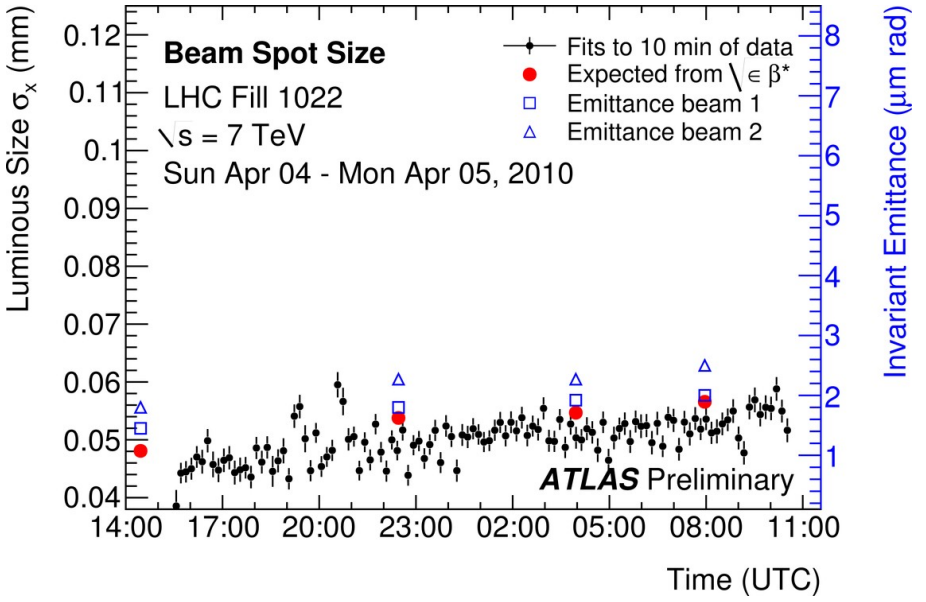
Vertexing

- Prompt reconstruction of beam spot per 10 minutes for vertices with 4tracks+
- Evolution of beamspot in time agrees with prediction → feedback to machine

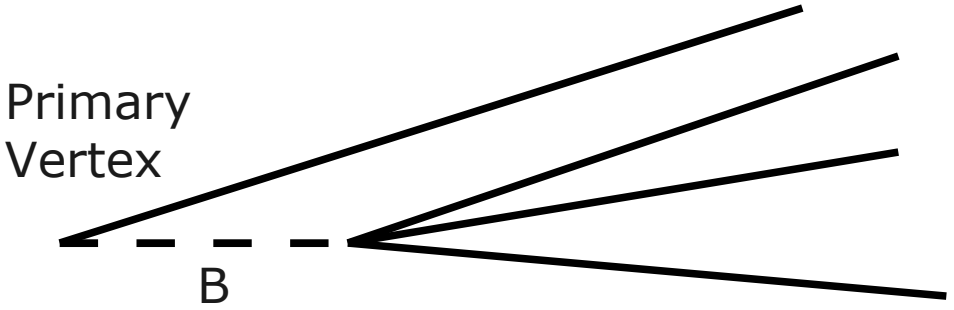
Vertex position spread







b-Tagging



Inclusive jet-wise b-Tagging:

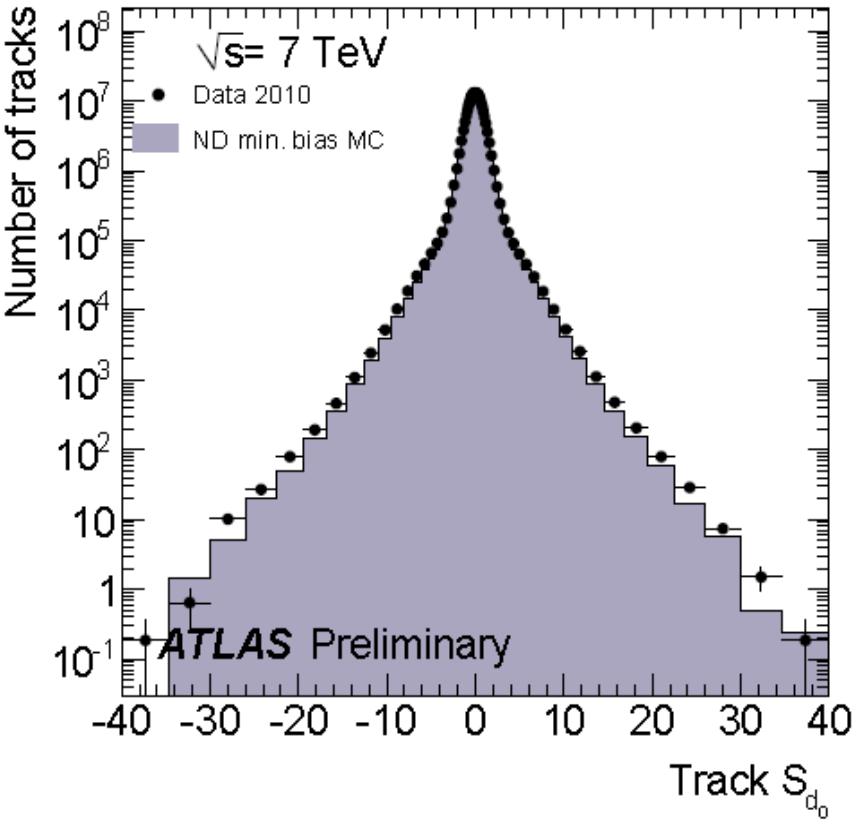
- Important tag for Top, Higgs, SUSY signatures
- Looking for tracks separated from primary vertex, secondary vertices and "soft" Leptons

Detector requirements:

- Good impact parameter resolution

First data → use Robust algorithm:

track counting, jet probablity



Impact parameter significance $S_{d0}=d_0/\sigma_{d0}$

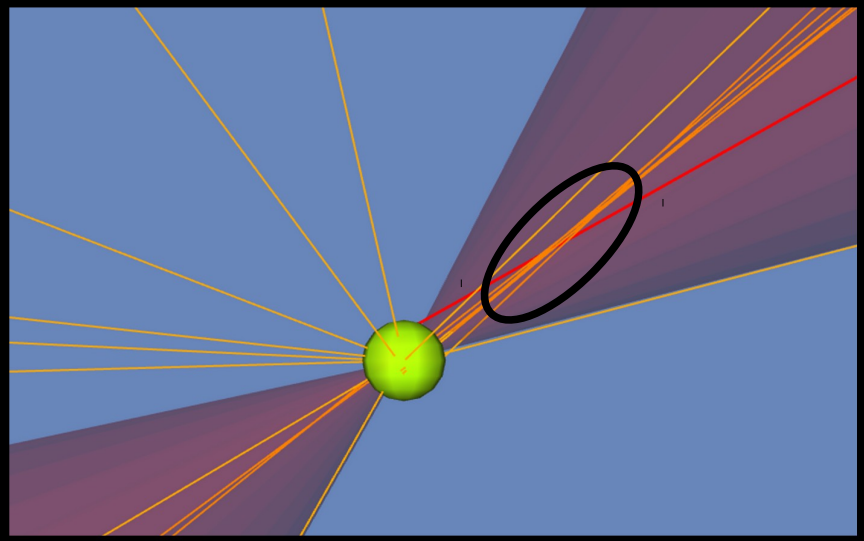
b-Tagging

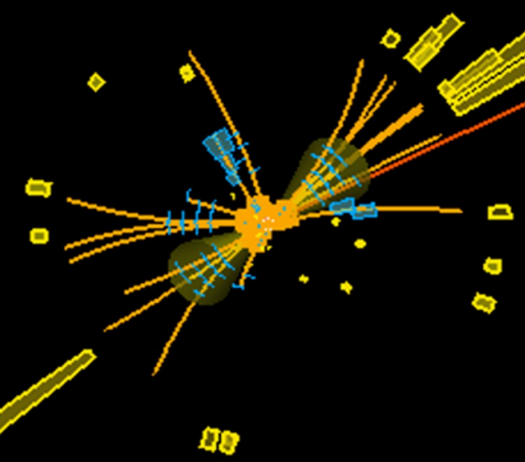
ATLAS EXPERIMENT
http://atlas.ch

Run 152409
Event 4349994

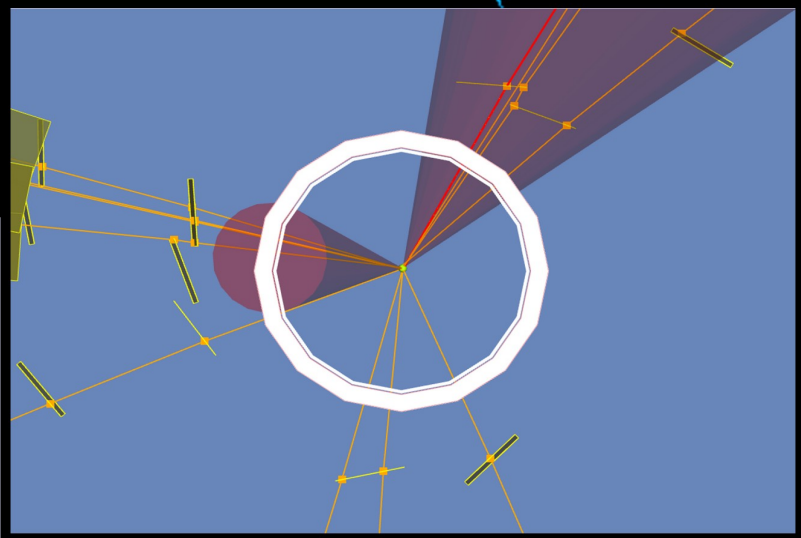
b-tagged jet in 7 TeV collisions

p_T^{jet}=49 GeV
6 b-tagging quality tracks in the jet, including one muon





Candidate with displaced tracks and soft (red) muon



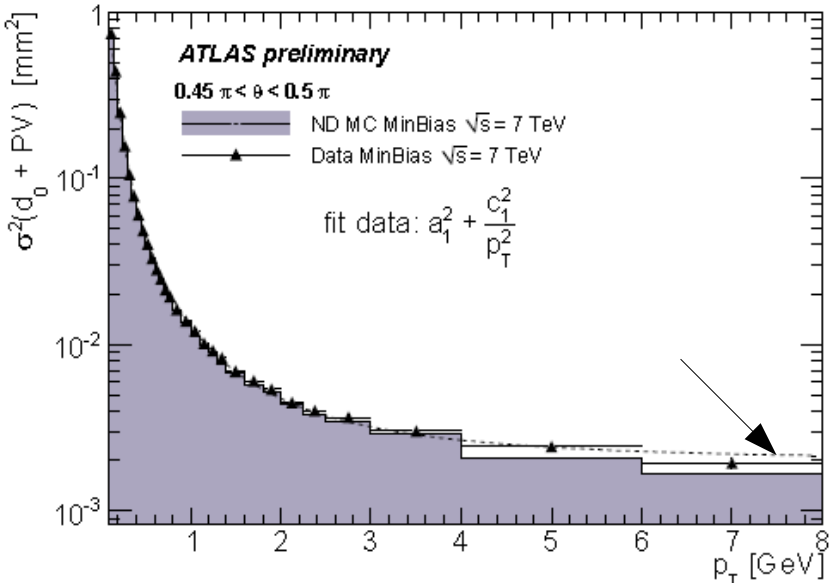
Track Resolution Study

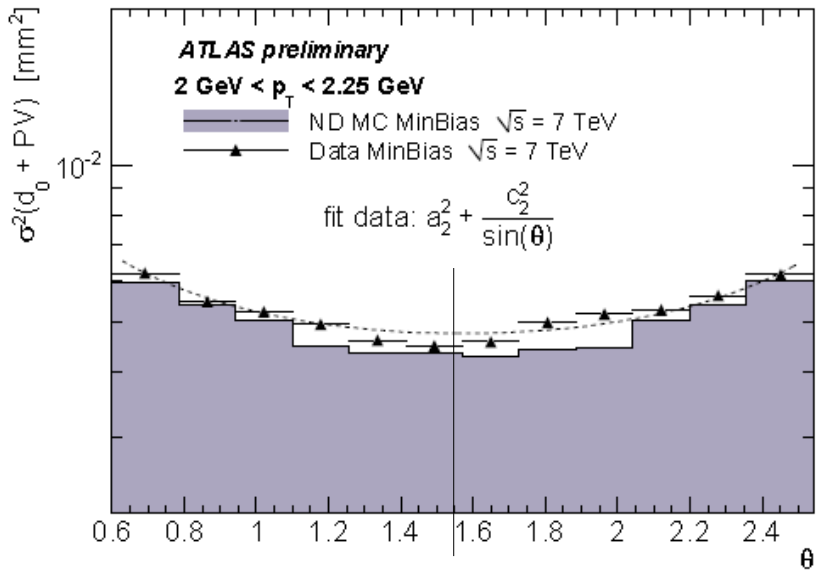
- Track impact parameter resolution:

$$\sigma^2(d_0) = \sigma^2_{\text{intrinsic}} + \sigma^2_{\text{scatter}}$$

$$= \sigma^2_{\text{intrinsic}} + b^2/p_T^2 \sin\theta$$

- Good agreement between data and Monte Carlo; consistent results for all p_T and θ



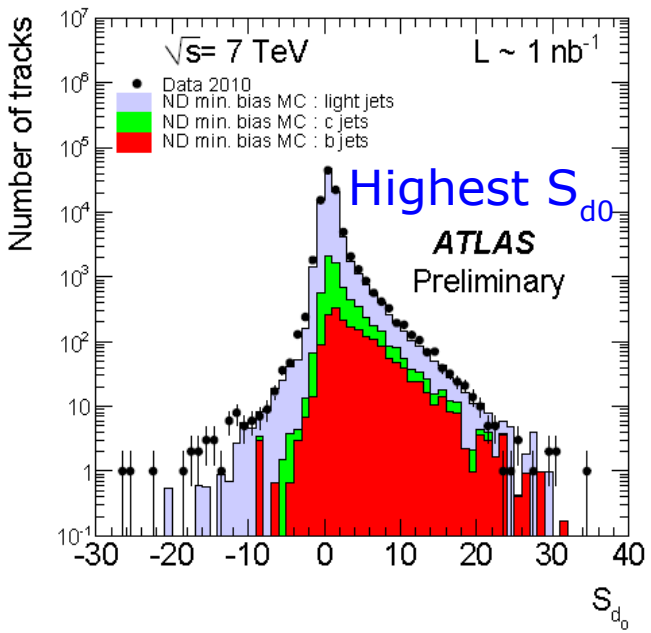


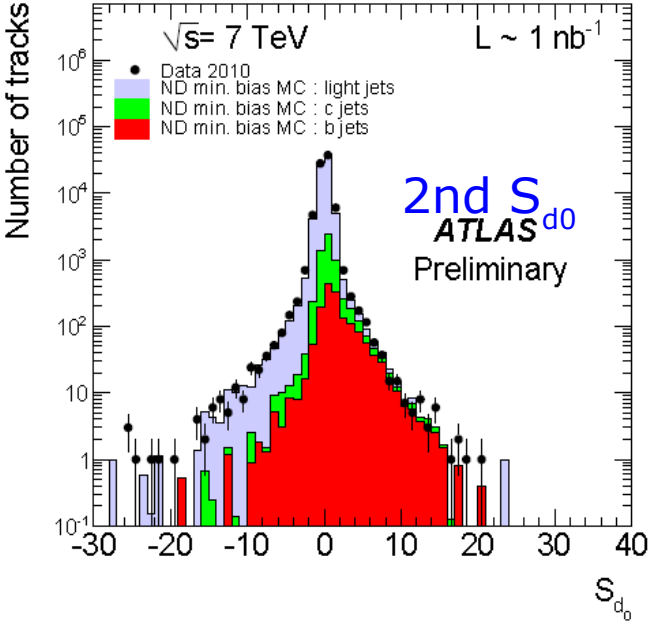
$\eta = 0$

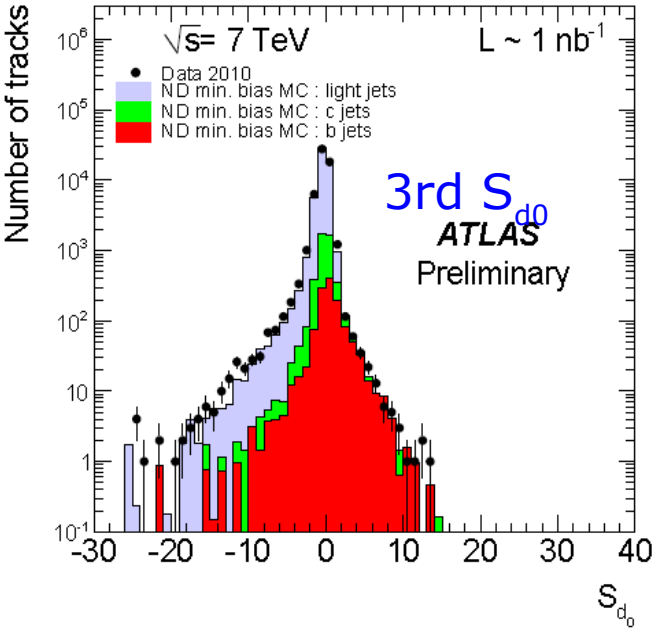
Track Counting Method

Track Counting:

- Order tracks by the signed impact parameter significance $S_{d0}=d_0/\sigma_{d0}$
- Count tracks exceeding certain threshold of S_{d0}
- Ask for minimal number of tracks with this requirement
- Essential: good description of 1st , 2nd and 3rd highest S_{d0} distribution



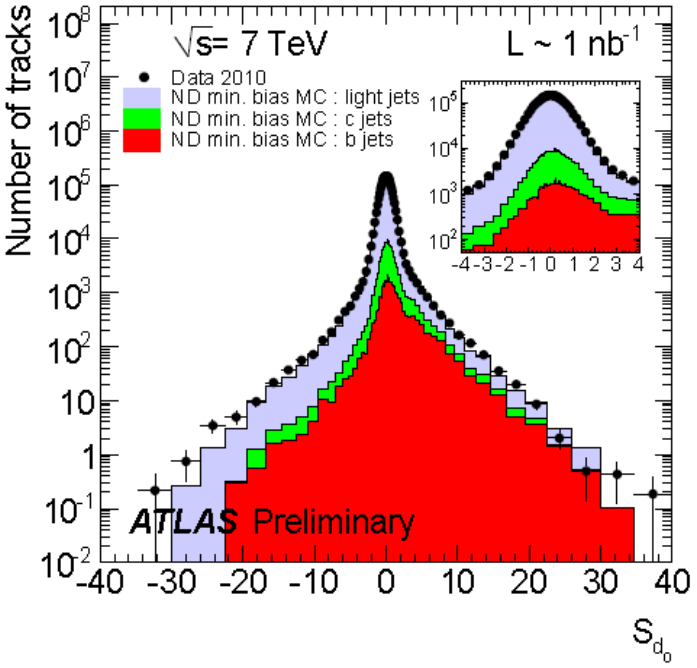


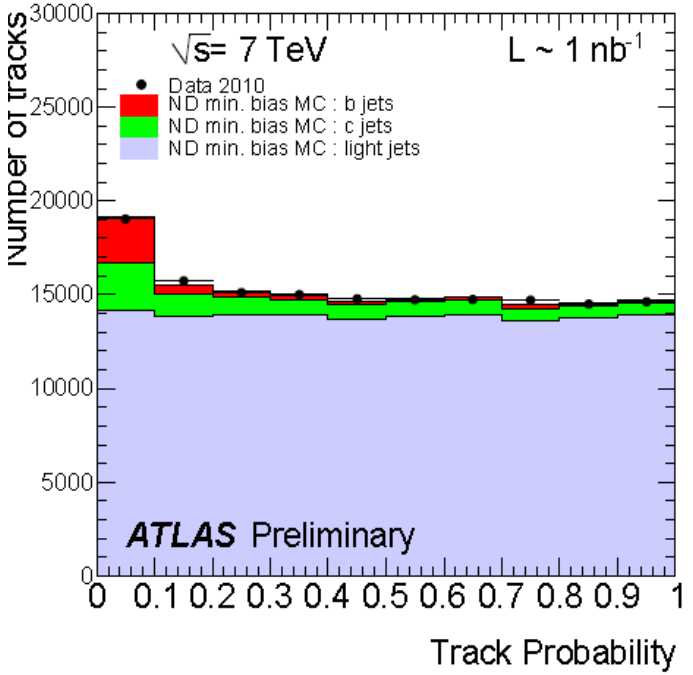


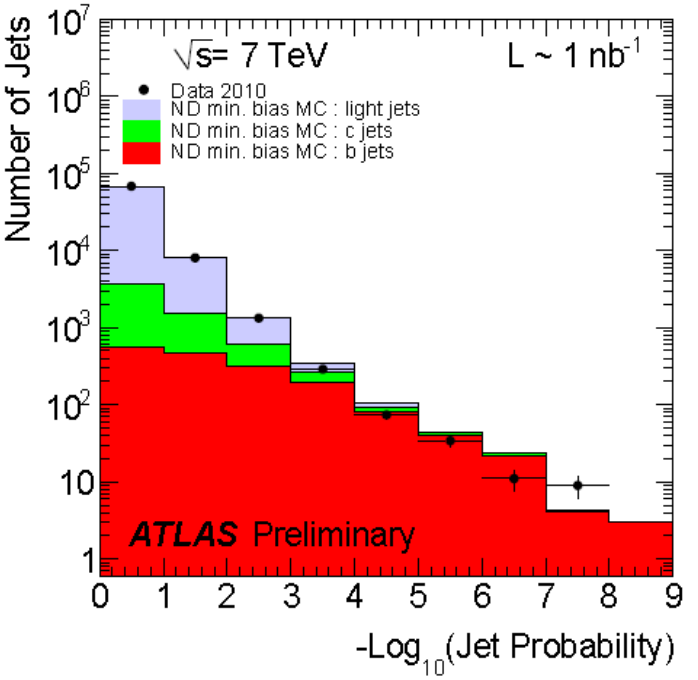
Jet Probability

Jet Probability:

- Probability that all tracks are from primary vertex
- Use negative S_{d0} to parameterize primary track distribution
- Build product of the track probabilities



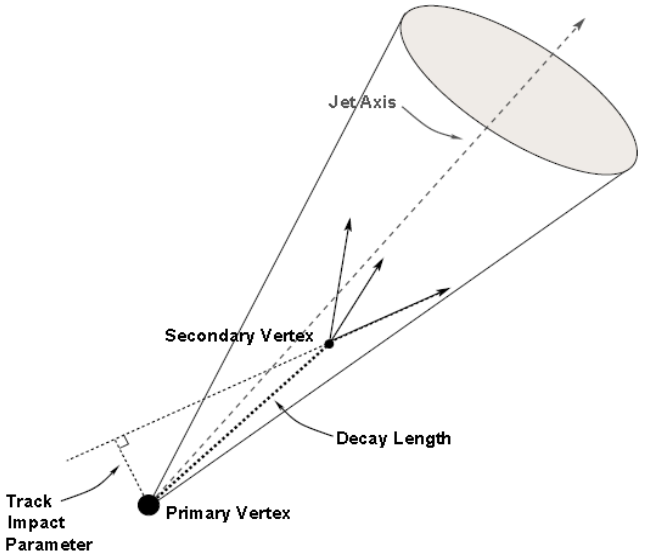


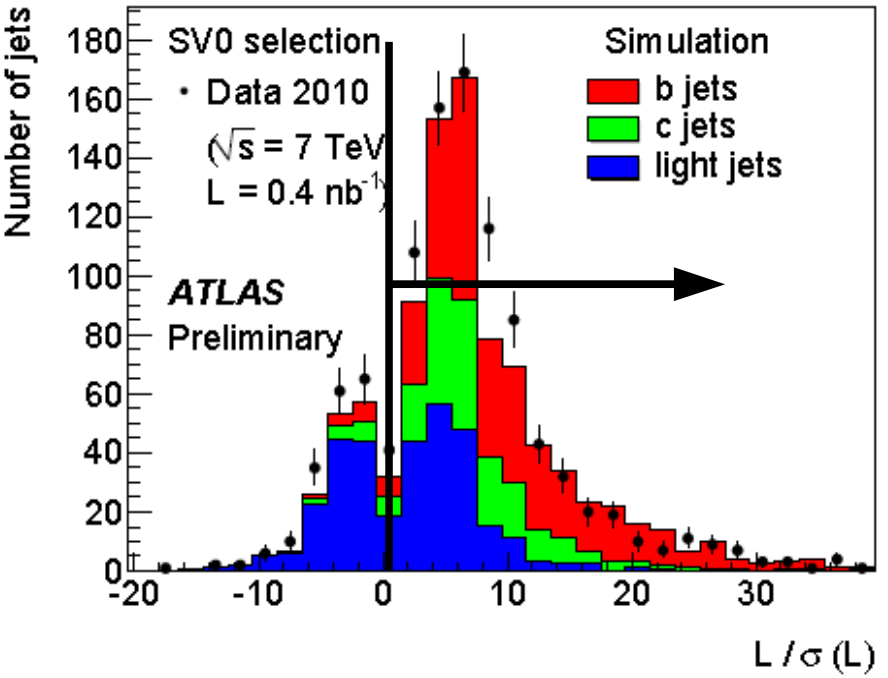


SV0: Secondary Vertex Finder

Secondary vertex finder SV0:

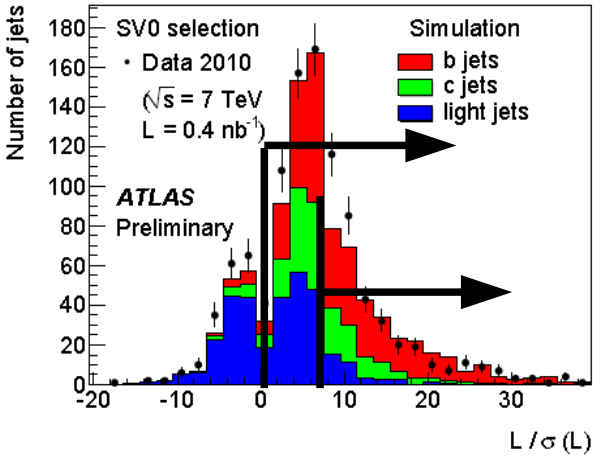
- Use tracks well separated from primary vertex (2.3σ)
- Fits two tracks
- Remove K^0, Λ^0, photons and material interactions
- fit inclusive vertices from remaining tracks
- Excess at large flight length significance L/σ(L) → consistent with expectation from b-jets

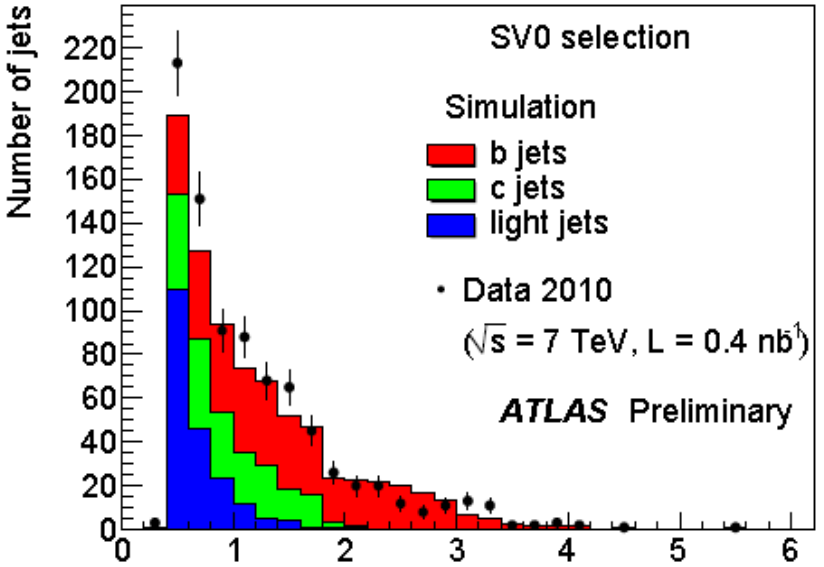




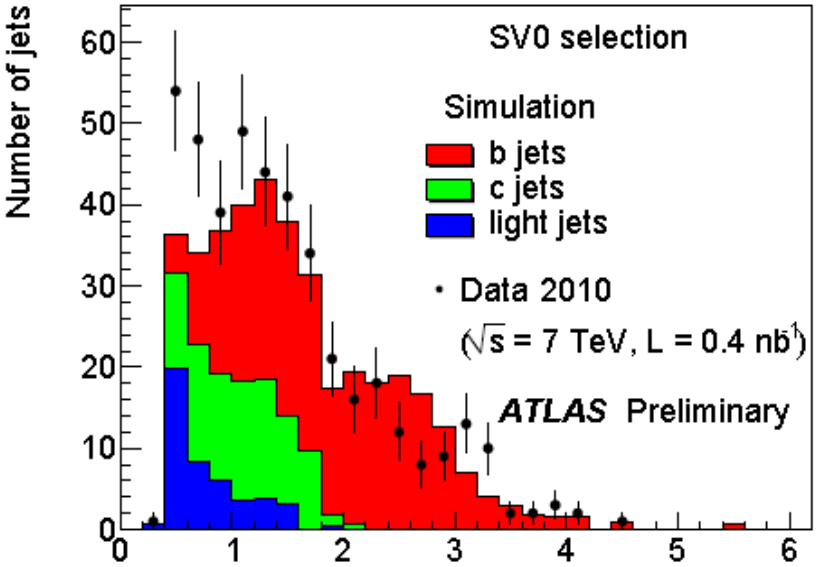
SV0 (II)

- Vertex Mass m_{vxt} general described good before and after cut on high decay length significance ($L/\sigma_L > 7$)
  - → nice separation from b-jets and c-jets





$L/\sigma_L > 0$ → $L/\sigma_L > 7$



Summary

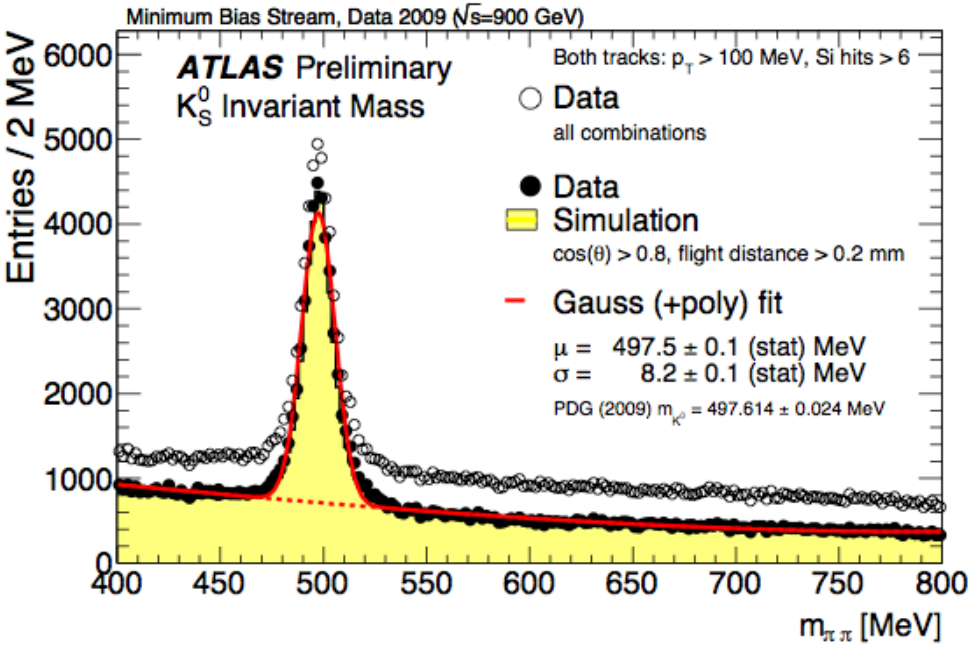
- Presented results of tracking, vertexing and b-tagging for the inner detector
- Tracking in generell well understood:
  - Detector fully operational (> 97%)
  - Residuals are in good agreement with the expectation (I. Potrap)
  - First constraints of material in the inner detector achieved (K. Tackmann)
- B-tagging:
  - Shown results for three b-tagging algorithms:
    - Track counting method
    - Jet probability method
    - Secondary vertex tag SV0
  - Good agreement between data and Monte Carlo
- Inner detector performs exceptionally well for the first data
  - ➔ Ready for exiting physics ahead

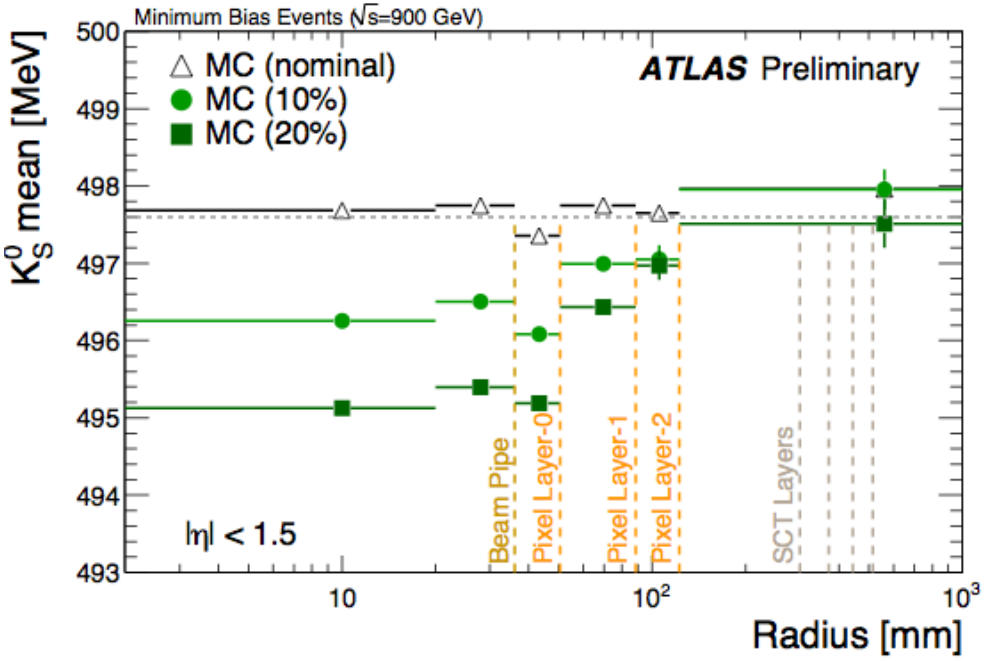
Backup

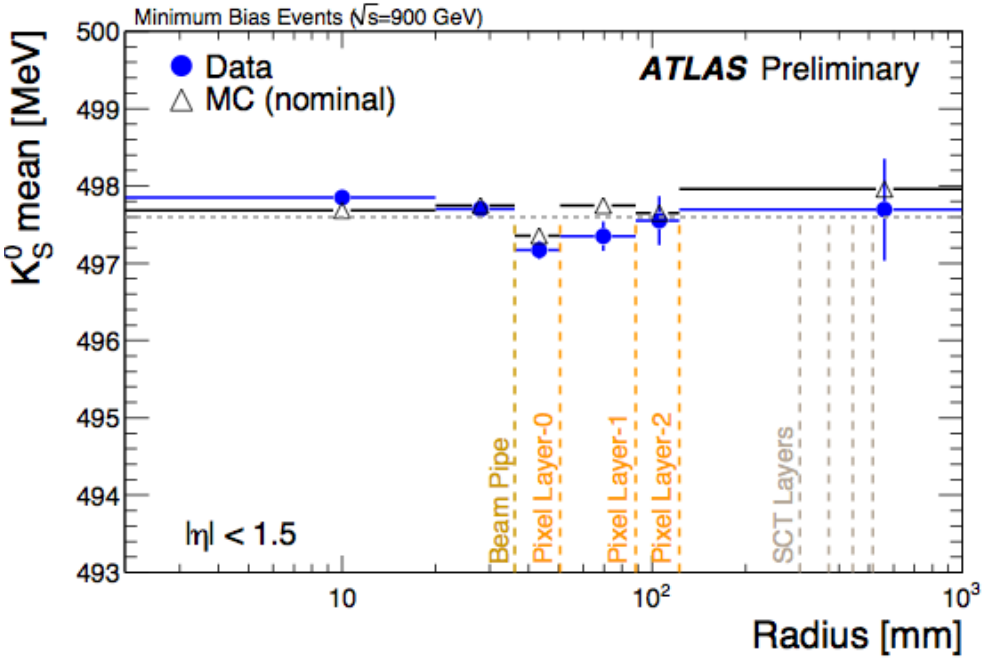
Inner Detector Material

Weak hadrons good for testing tracking performance:

- K^0 mass spectrum is sensitive to material distribution in the inner detector
- Data show reasonable agreement with nominal Monte Carlo







Jet Probability (II)

- Track multiplicity for $S_{d0}>0$ → good data/Monte Carlo agreement
- Jet Probability:
  - For $\mathcal{P}_{jet}<0.058$ (60% efficiency): 25% c-Jet efficiency

    Data: 6213 jets; Monte Carlo: 6230 jets