Non-upgrade technical contributions (eg. CP work) of DESY group to ATLAS

L. Aperio Bella on behalf of many

Jour fixe – 7th June 23



- Group activities
 - electron and photon reconstruction
 - electron identification
 - energy calibration central/forward
- People involved:
 - 3 Staff: Sarah Heim, Kerstin Tackmann, Ludovica Aperio Bella (GC)
 - 4 Post-docs: Filip Nechanský (SC), Früd Braren, Linghua Guo (very limited time), Tina Ojeda (SC)

Overview of e/gamma Activities

Focus of the group

- e/gamma reconstruction
 - Maintenance of automated nightly testing (ART) Ο
 - Implementation of matching of tracks and calorimeter clusters for Ο forward-electrons in Run 4
- Electron identification
 - Precision electron and photon efficiency measurements with full Run 2 Ο data [PAPER in circulation]
 - Run 3 performances: re-write of central efficiency measurement software Ο using the new official ATLAS software release.
 - Tuning of the Electron Identification menu with the Run3 data

Calibration

- Coordination of the effort towards the final calibration for Run-2 data Ο [PAPER in preparation] (factor of 2 improvement in several systematics entering in the scale uncertainty expected)
 - Additional improvement on the egamma calibration model including the measurement of the insitu energy response as function of the transverse momenta.
- Fully revisited Calibration chain for forward electrons for full Run-2 analysis Ο (Eq. extraction of weak mixing angle with Z x-sec measurement)

Software

Development and maintenance of e/gamma analysis tools



1000

800 600

Tracking

- Group activities
 - Run 3 and 4/5 Software Development for Simulation, Detector Description, Digitization/Data Handling and Reconstruction
 - Run 2, 3 and 4/5 Tracking Performance Studies
 - Studies towards future Track Reconstruction approaches and Software Strategies
- People Involved:
 - 3 Staff: K. Behr (SC), T, Kuhl (SC), N. Styles (GC)
 - 3 postdocs: <u>G. Gaycken (GC)</u>, T. Novak, B. Stapf
 - 5 PhD Students: N. de Biase, F. Jolly, G. Mania, M. Rodrigues, S. Sinha

Inner detector tracking I

Software coordination and track reconstruction for Run3 and beyond

Significant DESY involvement in software development and performance studies for charged particle track reconstruction

In Software coordination context

- Software Coordination ATLAS: Aim to ensure ongoing delivery of stable and performant software for the experiment while allowing sufficient scope for essential new developments (especially in face of Run4 challenges)
- Responsibility for overseeing "Demonstrator" projects for Run4 software - Including large-scale adopting of ACTS toolkit for Track Reconstruction

Clustering and Tracking in Dense Environments

- ATLAS relies on dedicated reconstruction techniques to ensure high track reconstruction efficiencies within jet cores. Uses ML techniques to classify and correct pixel clusters
- Provide CTIDE recommendations for Run 3 data taking
- Extend these techniques for use in ITk reconstruction
 - PUB note recently published

ACTS = A Common Tracking Software

CTIDE = Clustering and Tracking in Dense Environment

ITk = Inner Tracker



Inner detector tracking II

Performance and software for Run2-3 and beyond

- Study of the d₀ and z₀ track resolution in data (Run2/Run3)
 - very detailed study, looking for different track quality classes relevant for e.g. Flavour Tagging calibrations
 - includes effect of tracking in dense environments
- Inner detector alignment (Run 3)
 - Accurate detector alignment crucial for precision physics measurements
 - Reduction of the Sagitta bias (difference of the momentum scale for positive and negative tracks)

• Integrate all the new Detector into Run 4 reco software

- ITk providing solutions also for other Run4 projects to use, such as High Granularity Timing Detector (HGTD), Beam Conditions Monitors, and forward detectors
- Preparation of tracking software for Run 4
 - Implementation of masking for ITk pixel and strip modules
 - Allows detector defects to be realistically modeled in new software releases





Flavour-tagging

- Group activities
 - Bjet Calibration (VR jets and PF jets)
 - Calibration software automation
 - Algorithms and Umami framework
 - Physics validation for flavour tagging
- People Involved:
 - 2 Staff: Krisztian Peters, Priscilla Pani
 - 2 Fellows/Postdocs: Alvaro Lopez-Solis, <u>Yvonne Ng (V)</u>
 - 5 PhD Students: Judith Hoefer, Eleonora Loiacono, Marawan Barakat, Frederic Renner, Alberto Rescia
- Other institutes collaborations:
 - Jackson Barr (common DESY-UCL PhD, in glance as UCL)
 - Humboldt: TJ Khoo, A. Gonzales, D. Guest (Xbb tagger, trigger)

Flavour tagging

Key challenges and strategy:

- Development of new machine-learning based taggers for ATLAS Run-3
- Major inputs to calibrate b,c and light-jet tagging
- B-jet Calibration (Variable-radius track jets jets and Particle Flow jets)
 - b-tagging efficiency calibration (recommendations provided to ATLAS, preparing a final Run-2 paper): Efficiency measurement and calibration as a function of jet kinematic and tagger working points. DESY developed sideband method on m(lep, leading jet) substantial reduction of uncertainties.
 - X→bb tagger calibration: performance of a tagger to catch a generic boosted object decaying to two b-quarks in gluon->bb final states (PUB note in preparation)
 - Soft b-tagging calibration: Current calibration implemented for HDBS multi-b search. Extending the scope to **publish in a paper.**
 - Smoothing calibration of charm tagging efficiency: key input for tc+Etmiss SUSY search
- Calibration software automation
 - Important contribution for automation (b-tagging efficiency, light jet mistag rates), currently preparing a PUB NOTE
- Algorithms and Umami framework
 - DESY pionier the *Umami* algorithm: High-level Deep Neural Network Architecture based on low-level inputs (Strong wish to continue this effort but person power needed)
- Physics validation for flavour tagging
 - DESY Central group responsible for validating software releases. Also responsible for maintaining the validation framework crucial work during Release migration



jet-ETMiss

- Group activities
 - Run 2 (final jet calibration)
 - Early Run 3 recommendations
- People Involved:
 - 2 Staff: Christian Sander, James Ferrando
 - 1 PhD: Gediminas Glemža (+2 former students Arthur Linss & Pablo Rivadeneira)
 - 1 Former Fellow/Postdoc: Lorenzo Rossini

Jet calibration

Early Run 3 + precision Run 2 recommendations

- Run 2 (final jet calibration): submitted to EPJC (<u>https://arxiv.org/abs/2303.17312</u>)
 - per-jet flavour Energy Scale uncertainties treatment (public plots)
- Completed early Run 3 recommendations
 - Pile-up correction
 - Absolute MC JES calibration
 - **GSC** (to reduce remaining dependencies on shower shape, #tracks, ets.)
- Future involvement at small level to help keeping expertise in CP group



JES = Jet Energy Scale GSC = Global Sequential Calibration