ATLAS Tau Identification: Electron Fake Rejection in Run II

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PHYSICS AT THE TERA SCALE
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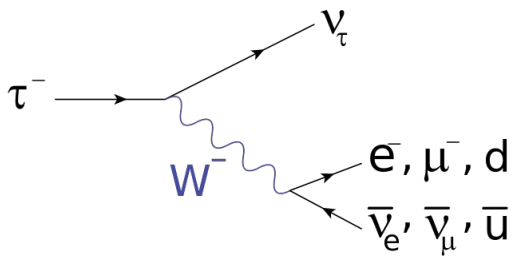
FSP 101 ATLAS

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Overview

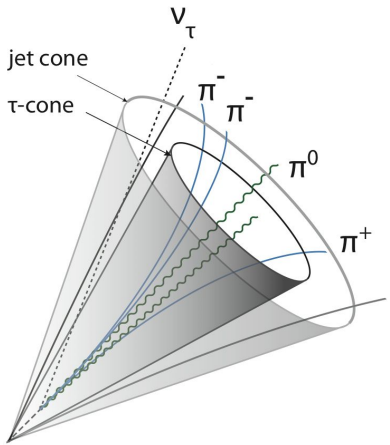
I. Motivation
II. Run II Electron Fake Rejection
III. Efficiency Measurement
IV. Summary

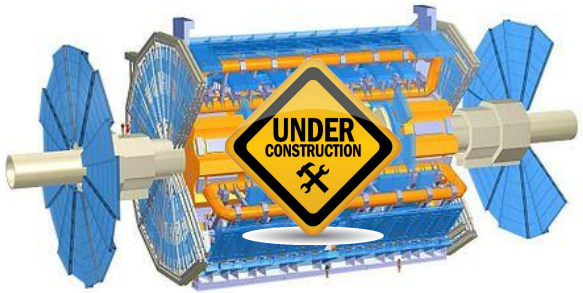


- heaviest lepton
  - mass: **1.777 GeV**
  - ~ **87µm** decay length
- hadronic decay channels (“τ”)
  - **50%** (15%) mit **1** (3) charged pions
  - main **backgrounds**: jets and **electrons**

Tau Leptons in ATLAS

1. Reconstruction
2. Identification - discrimination against:
   a. Jets (multivariate BDT technique)
   b. Electrons
3. Calibration
4. Scaling
   a. scale factors from efficiency measurements



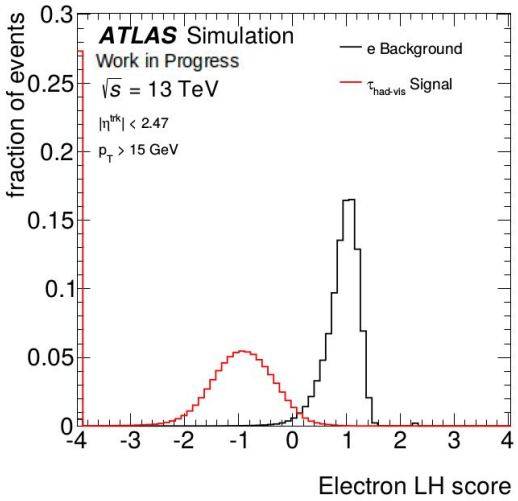


Changes in Run II:

- Performance changes:
  - IBL affecting tau-vertex resolution
  - calorimeter readout
- **new electron rejection method**
  - in harmony with electron identification
- reoptimised energy calibration, identification
- Substructure information

Electron Overlap Removal I - Method

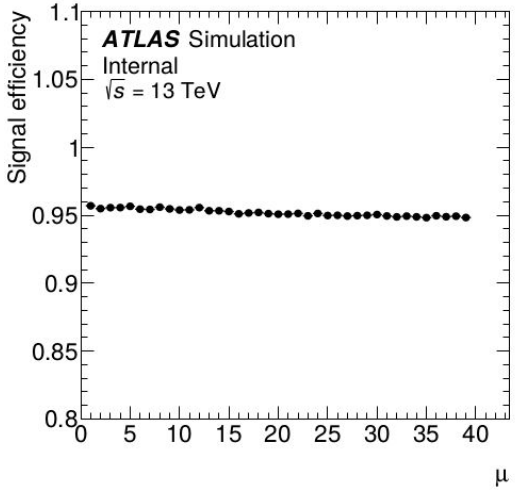
- electrons e fake 1-track τ-candidates
- Run I: additional BDT for identification
- Run II: align with electron definition
  - ➢ discriminator for e: **likelihood score LH**
    - ➢ shower shape information from calorimeter
    - ➢ reconstructed hits in tracking detector
    - ➢ TRT information

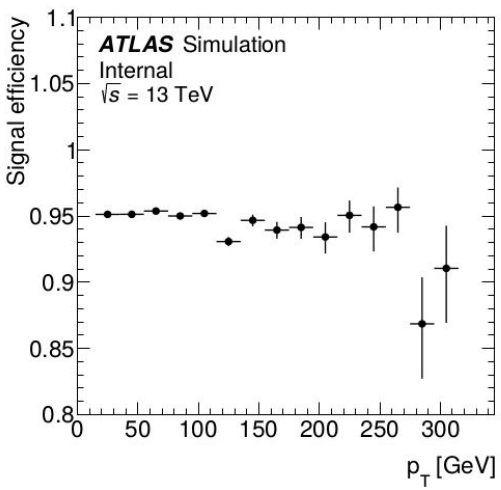


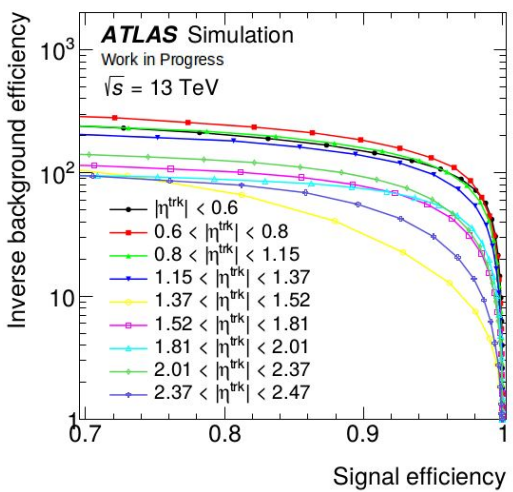
➔ **overlap removal e > τ: EleOLR**
- dependent on electron **LH** and τ-candidate **kinematics**

Electron Overlap Removal II - Expected Results

- cuts tuned
  - ➢ yield **~95% signal efficiency** ($Z \to \tau\tau$)
- stable against <mu>
- flat in pseudorapidity and p_T

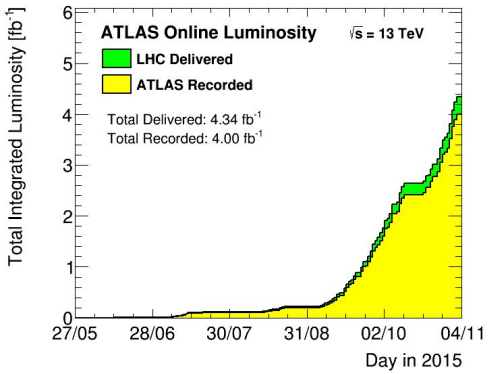


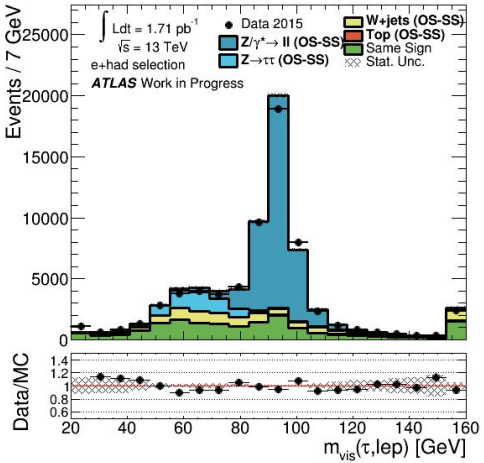


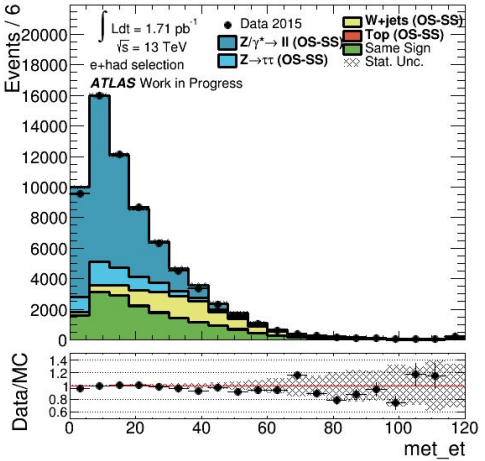


Efficiency measurement I - Tag & Probe

- aim: derive **scale factors** for EleOLR method
  - efficiency measurement in data and MC
- define tag- & probe-lepton pair
  - e+τ final states from Z-decay
  - measure efficiency on probe lepton

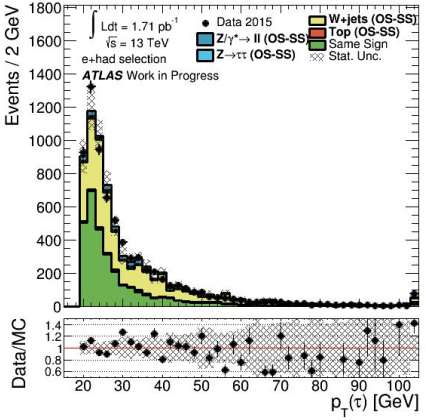


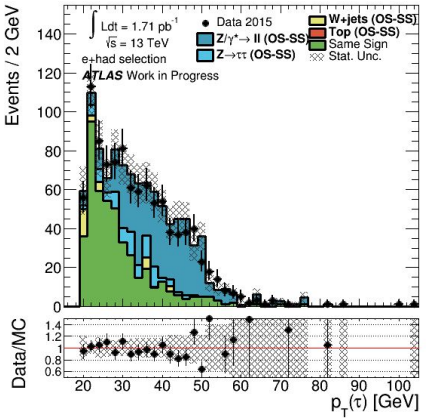




Efficiency measurement II - Bkgd Estimation

- Z→ee from simulation
- background contributions:
  - Z→ττ, ttbar from simulation
  - W+Jets from simulation + scaling:
    - ★ define pure W region
    - ★ data/MC comparison - scalefactors
  - QCD multijets from data driven method “OS-SS”
    - ★ same charge for e and τ in data (SS)
    - ★ subtract SS simulated events from data
    - ★ extract shape of QCD background
    - ★ apply scale factor from QCD region R_{QCD}

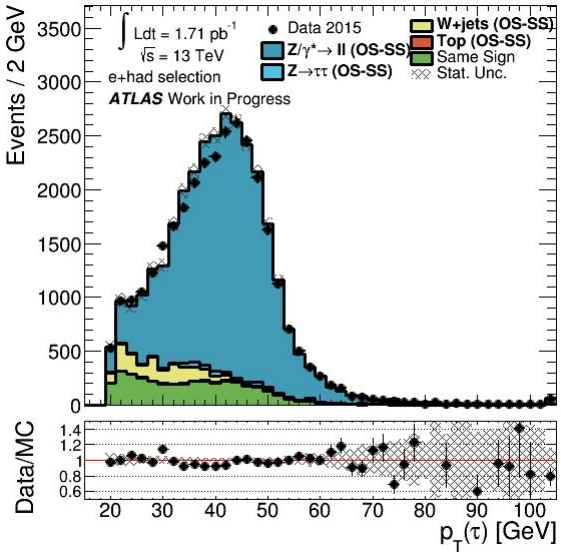


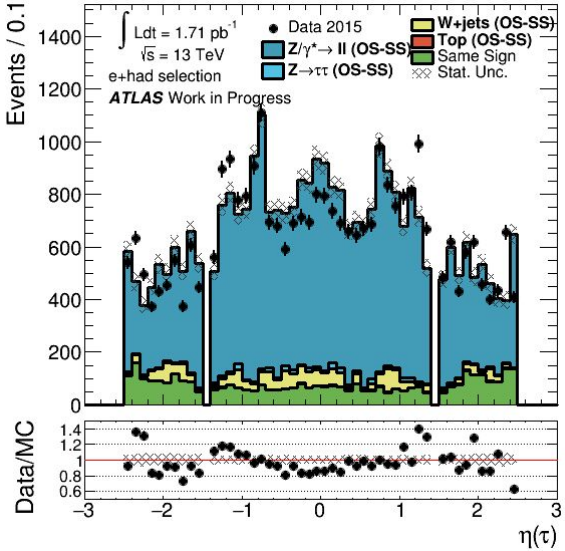


$$bkgd^{OS} = R_{QCD} Data^{SS} + (k_w^{OS} W^{OS} Z\tau\tau^{OS} + top^{OS}) - R_{QCD} (k_w^{SS} W^{SS} + Z\tau\tau^{SS} + top^{SS})$$

Efficiency measurement IV - probe kinematics

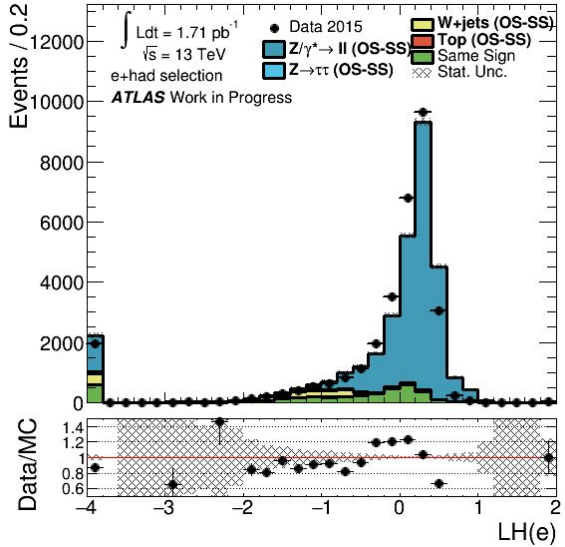
- inspection of probe lepton kinematics
  - ➢ properties of electrons faking taus
- good agreement, features under investigation

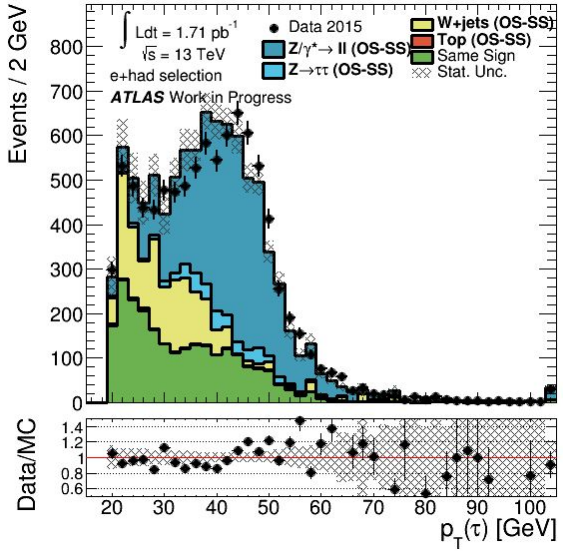


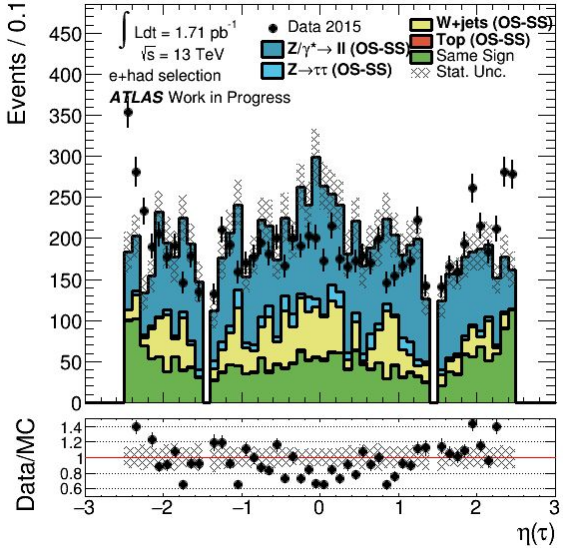


Efficiency measurement IV - EleOlr application

- application of EleOLR on events
  - strongly dependent on electron LLH tune/configuration
  - discrepancy in high-eta from outdated LLH tune
  - sample purity not yet satisfactory

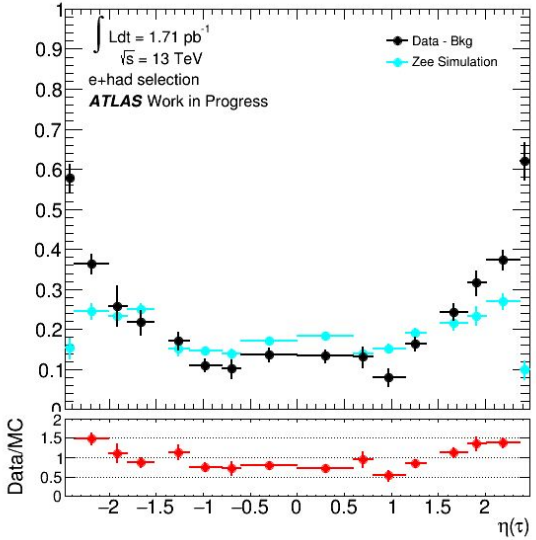


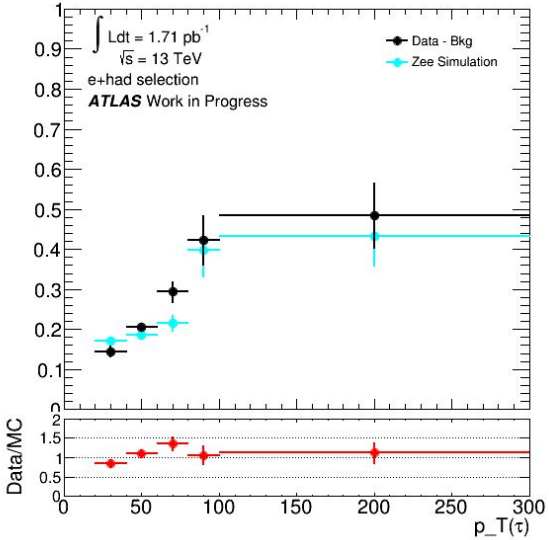




Efficiency Measurement V - Efficiency Calculation

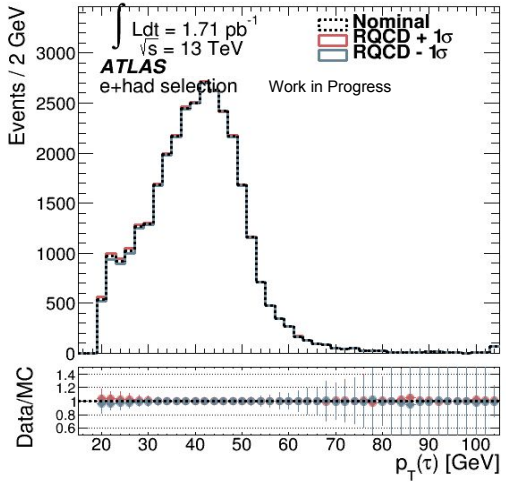
- calculate bin-by-bin efficiency in pT and eta
  - eff_bin = #events after EleOLR / #total events
- shown with binomial statistical errors
- calculate on data and MC
  - extract scalefactor bin by bin

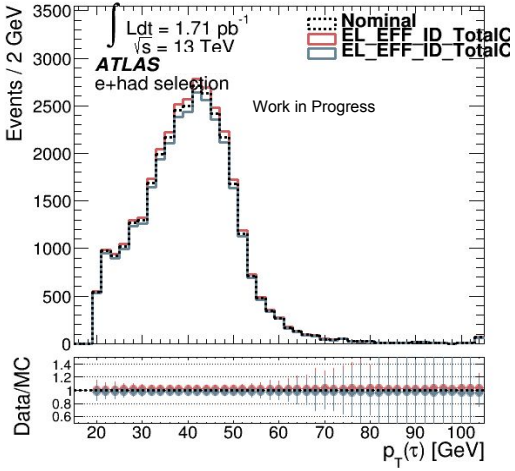




Efficiency measurement V - Next Steps

- optimisation control & signal region definitions
- validation of background estimate
- inclusion of systematics
  - background estimation
  - efficiencies for electron
  - electron energy calibration/resolution
- retune cuts for EleOLR for new LH definition





Summary

- Run II: important changes for tau leptons in ATLAS
- new electron rejection
  - overlap removal EleOLR
  - based on electron likelihood
- efficiency measurement on data and MC
  - background estimation OS-SS
- extraction of scale factors
  - from data/MC comparison