Di-Tau Reconstruction and Identification with ATLAS

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Special thanks to:

Dirk Duschinger, Lorenz Hauswald, Wolfgang Mader, Arno Straessner, Sebastian Wahrmund

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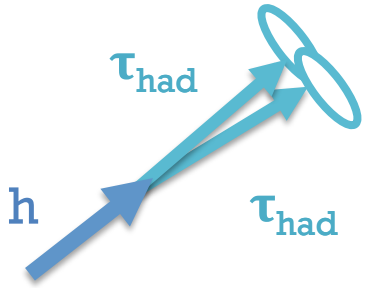
iktp

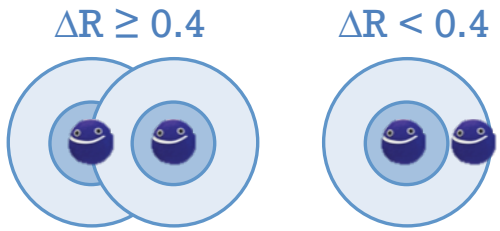
ATLAS EXPERIMENT

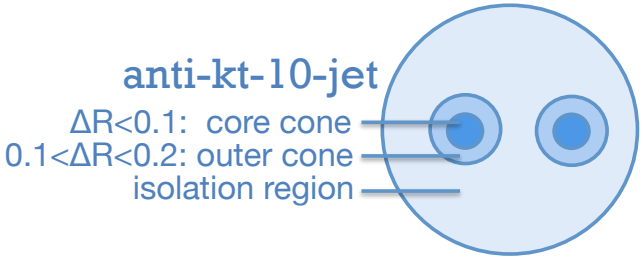
Bundesministerium für Bildung und Forschung

Overview

- Reconstruction of boosted tau pair topologies
- H->hh, A->Zh, gg->hh
- **Standard tau reconstruction:**
  - Reconstruction of single hadronic tau decays
  - Highly boosted tau pairs can not be reconstructed separately
  - Merge into the same anti-kt-4 seed jet
- **Di-tau reconstruction:**
  - Search for anti-kt-10 jets as di-tau seeds
  - Filter for subjets with associated track(s)
- **Di-tau identification:**
  - QCD background separation
  - BDT based

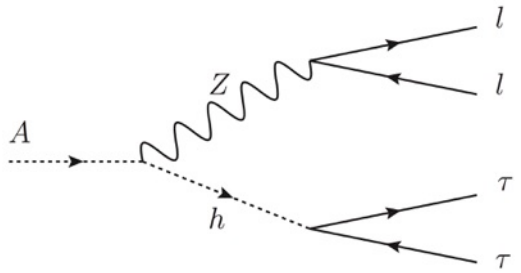


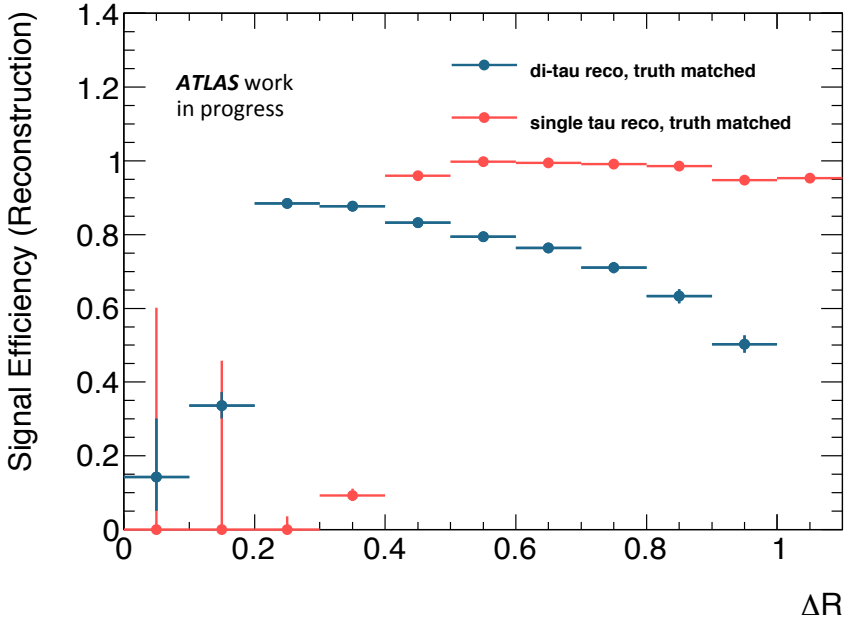


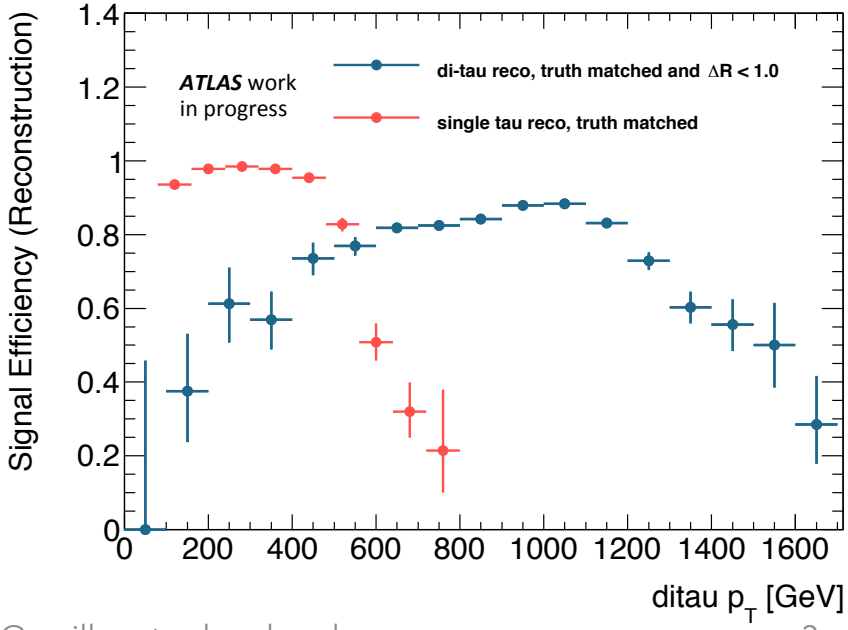


Di-Tau Reconstruction

- $A \rightarrow Z\,h \rightarrow ll + \tau\tau$ mit m_A=2 TeV (Pythia8)
- **tauRec:** taus merge at $\Delta R < 0.4$ and $p_T > 500$ GeV
- **DiTauRec:** efficiencies of up to 90% at $0.2 < \Delta R < 0.4$ and 400 GeV $< p_T <$ 1200 GeV

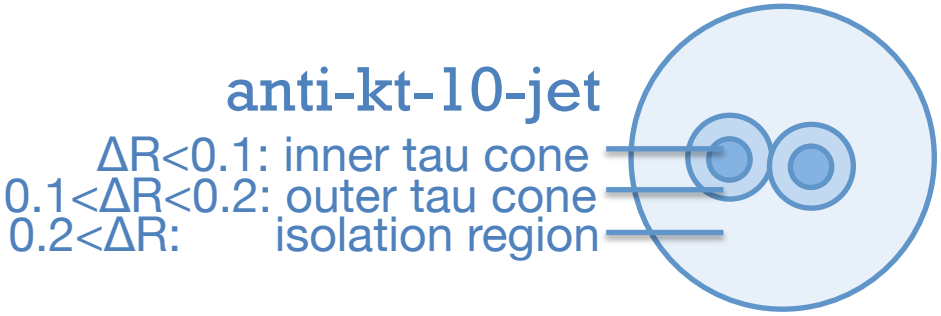


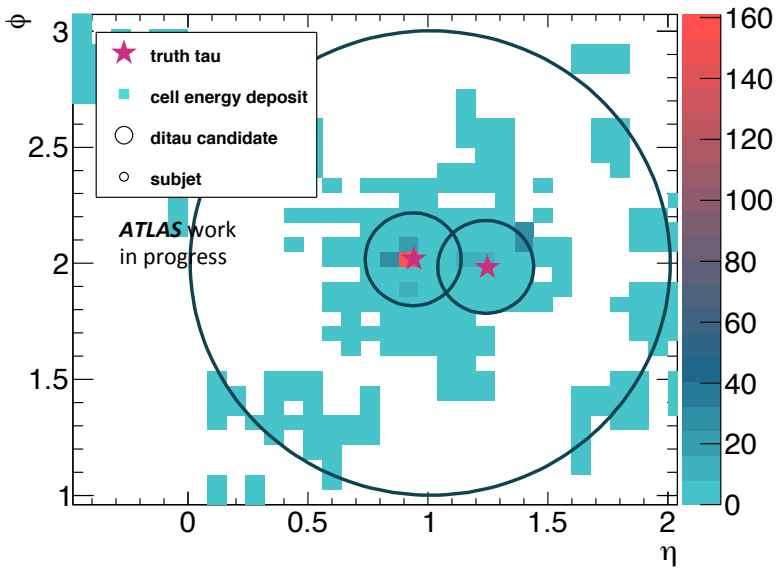




Di-Tau Reconstruction

- Anti-kt-10 jets seeds
- Filter for 2 subjets with at least one associated track (full hadronic) or 1 subjet + electron or muon candidate (semi-leptonic)
- Track and vertex association
- Electron and muon finder
- Cell based ID variable calculation

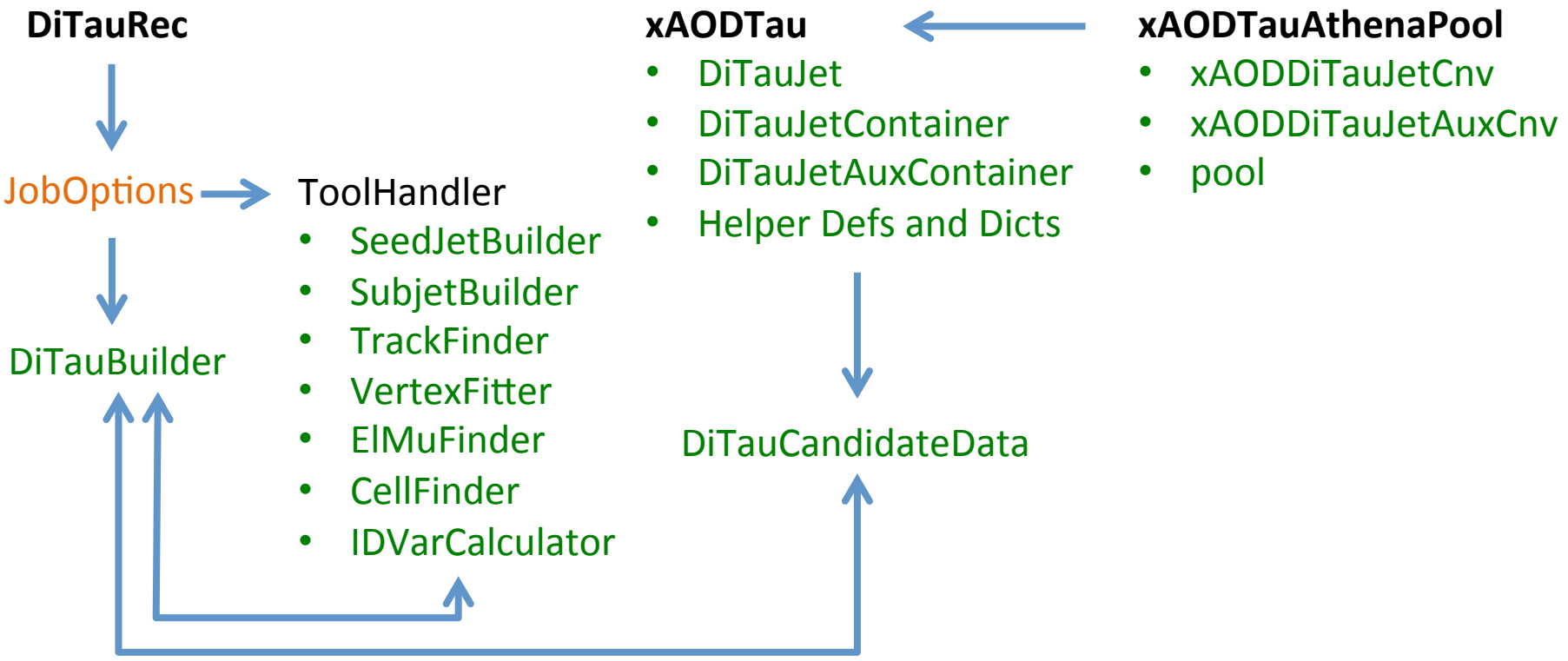




Di-Tau Reconstruction

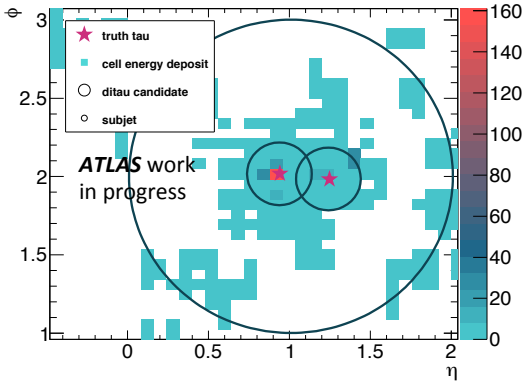
- **Cuts for release 20.7:**
- **Jet** $p_T > 300$ GeV
- **Subjet** $p_T > 15$ GeV, nTracks > 1, n < 5
- **Track** $p_T > 1$ GeV, IPd0Max = 1, IPz0Max = 1.5
- **Electron** $p_T > 7$ GeV, $|\eta| < 2.47$, author: Electron or Ambiguous
- **Muon** $p_T > 7$ GeV, $|\eta| < 2.47$, muon quality = 2 (MuonSelectionTool)

Implementation

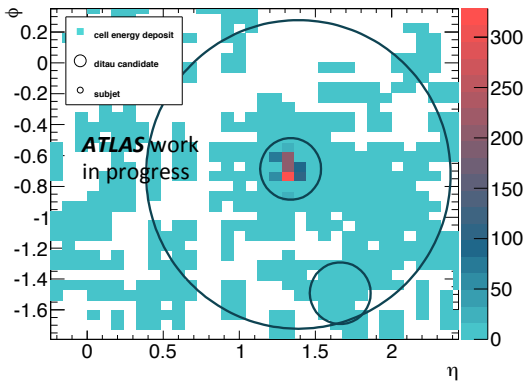


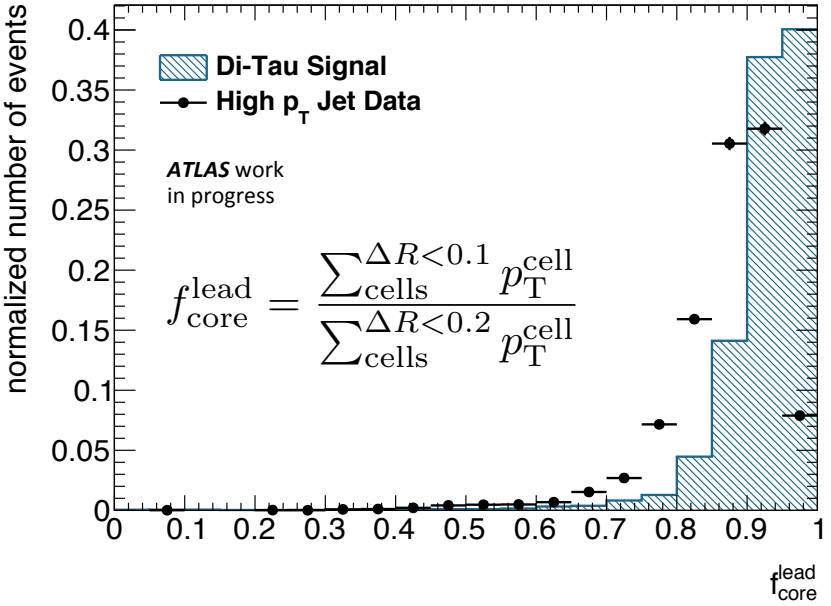
Di-Tau Identification

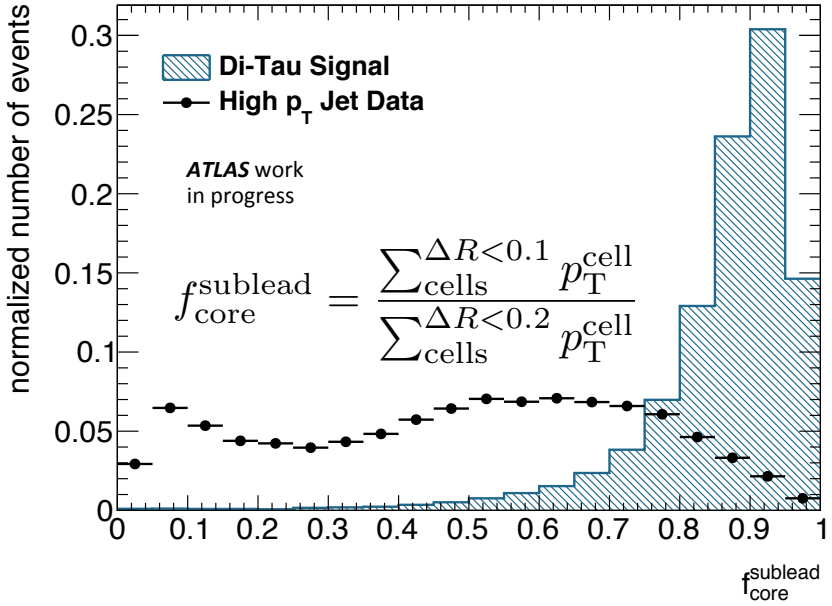
Di-tau signal



QCD background







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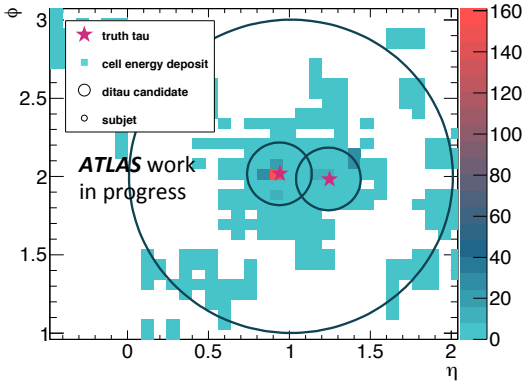

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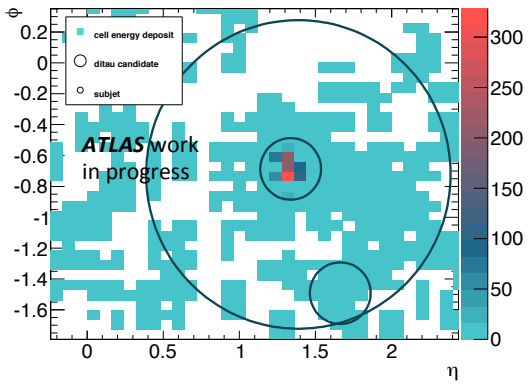

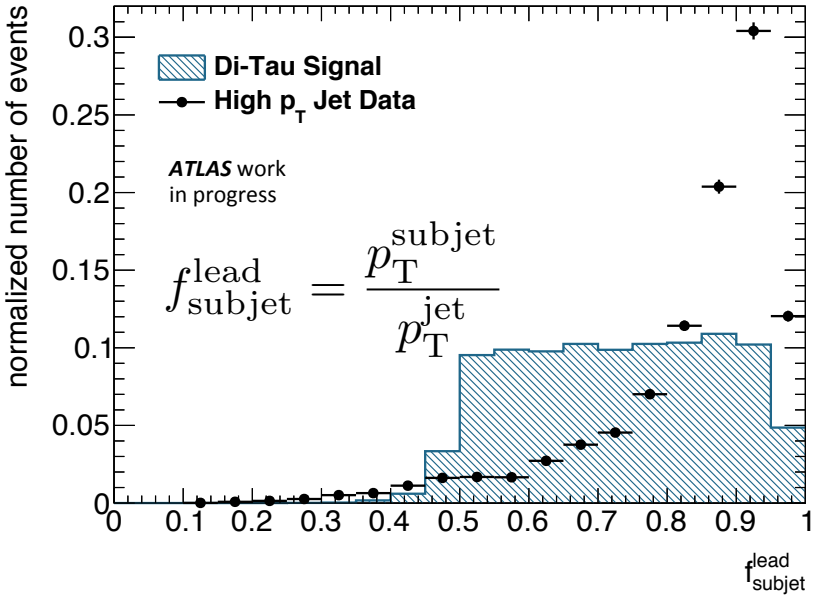

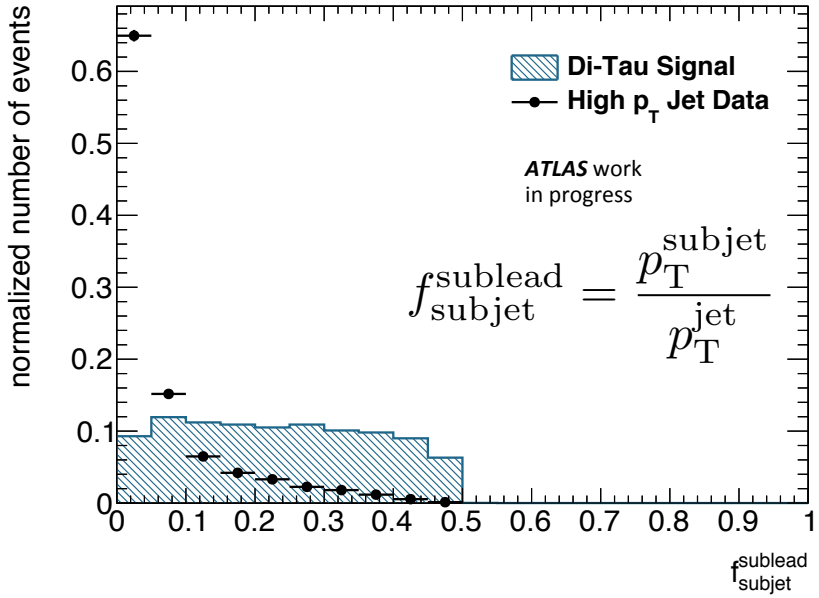

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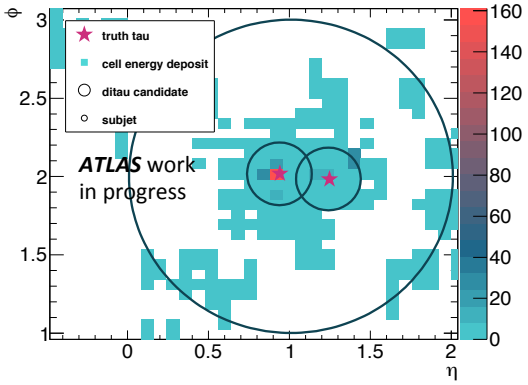

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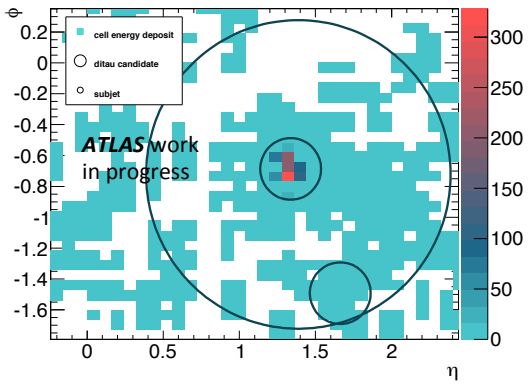

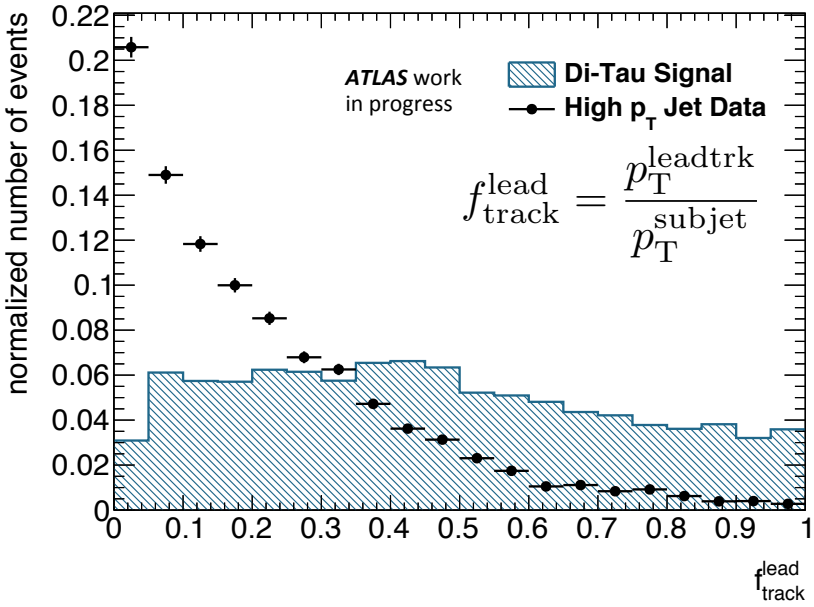

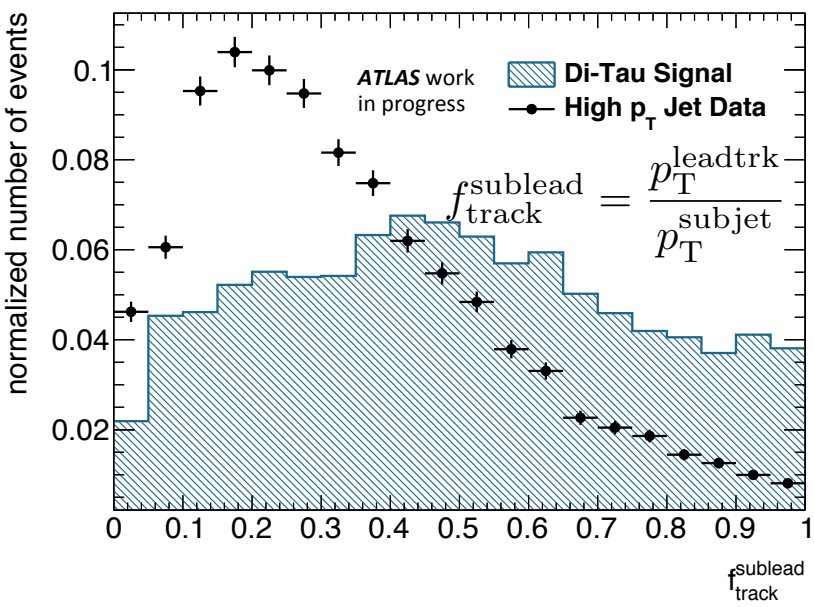

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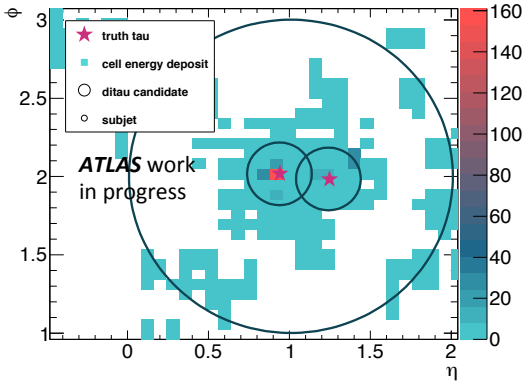
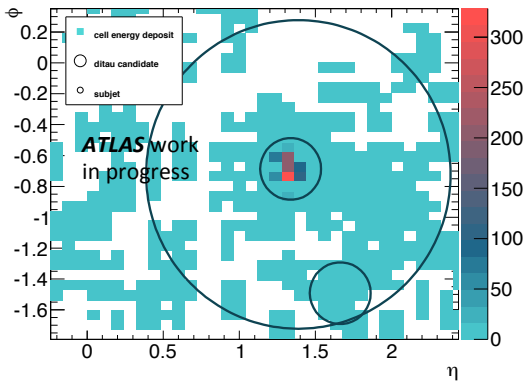
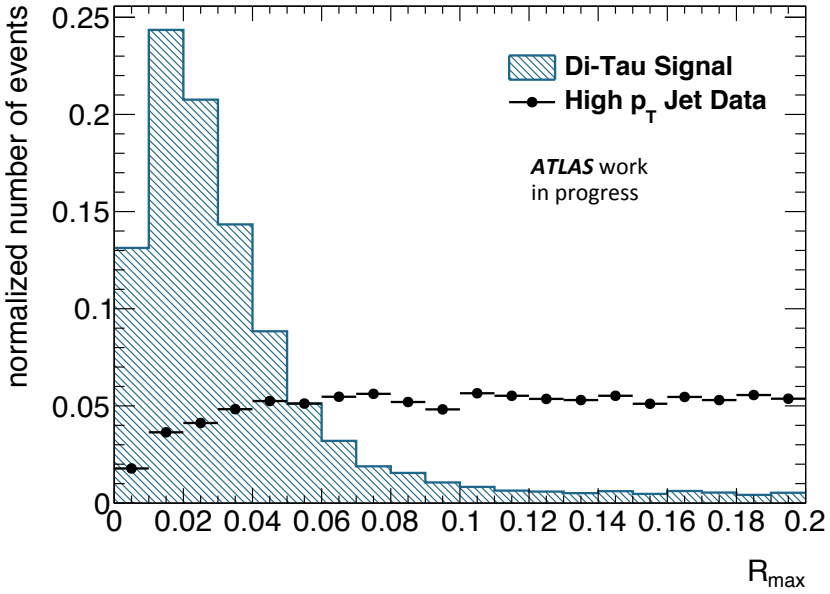


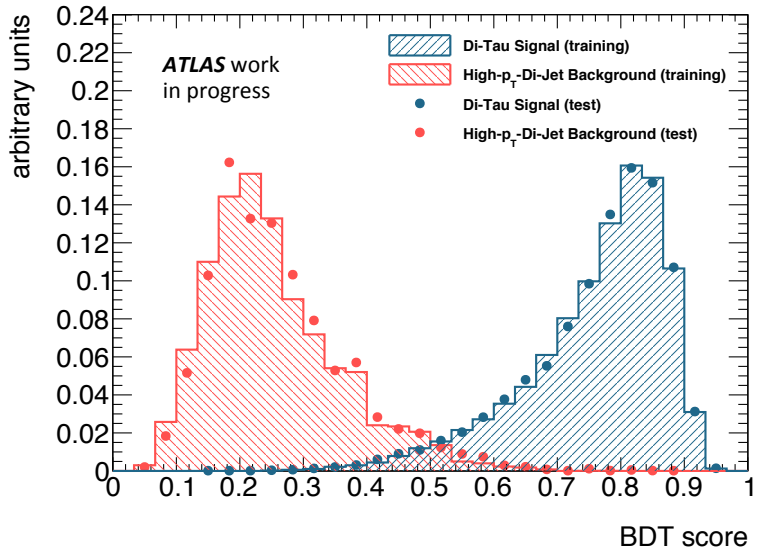
QCD background

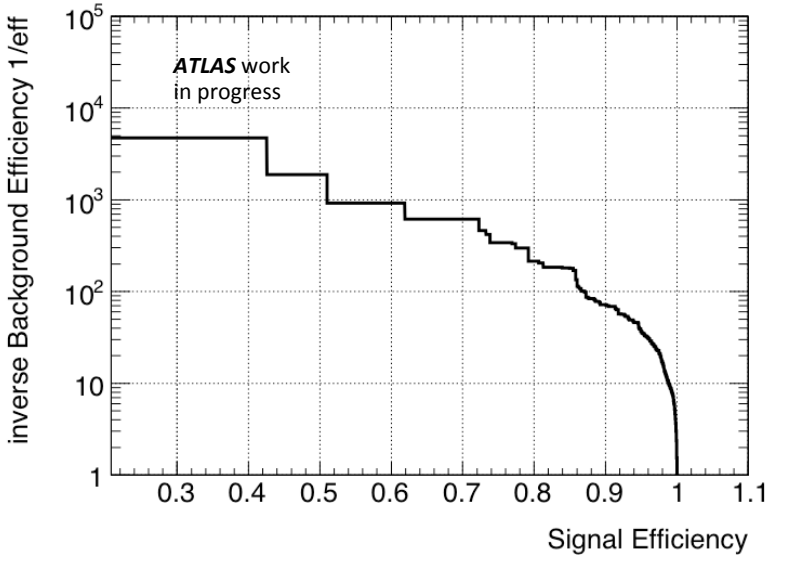




Di-Tau Identification

- Signal: Pythia8, $A \rightarrow Z\,h \rightarrow ll + \tau\tau$, $m_A = 2$ TeV (60k)
- Background: high-p_T di-jet data (10k)
- BDT with 9 ID variables (TMVA)





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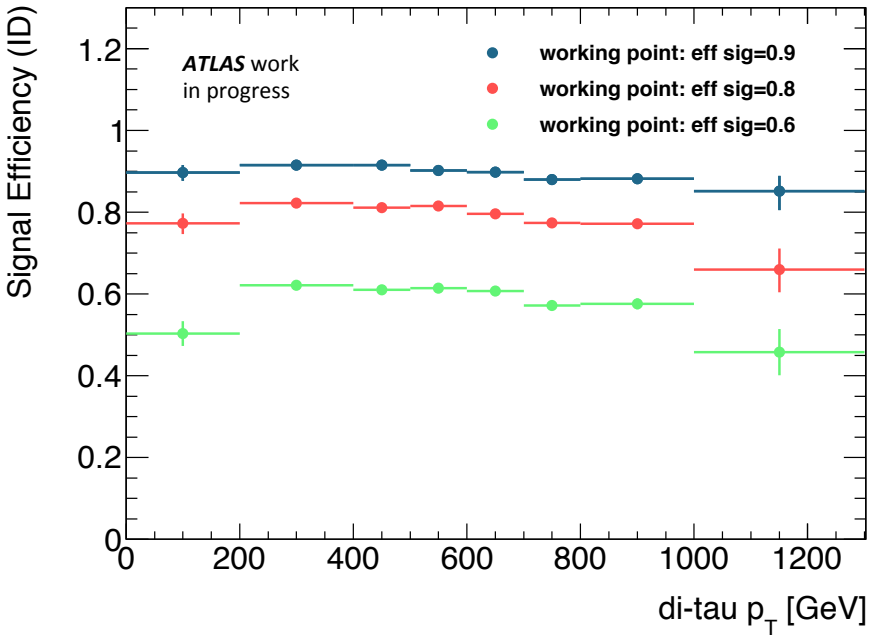
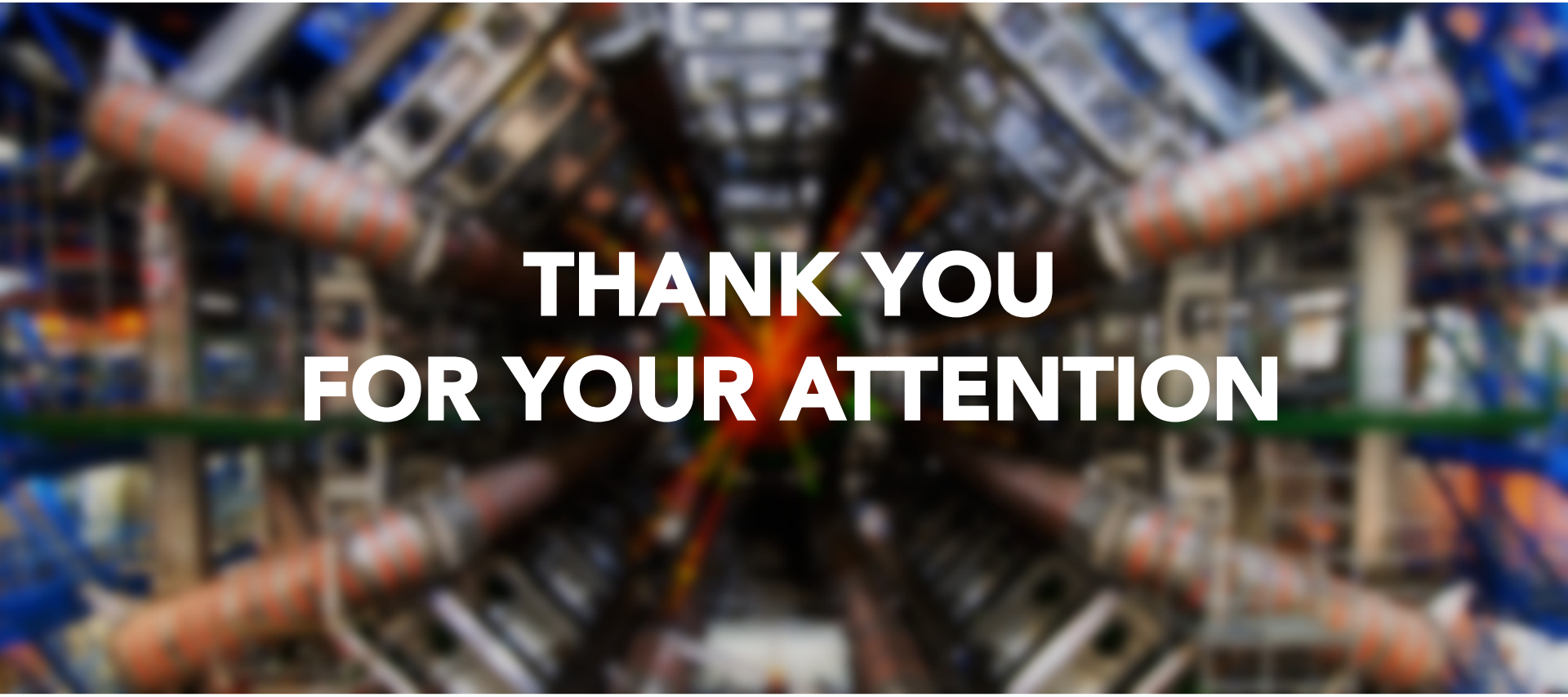


- **Future plans:** update DiTauID for xAOD input
- MC multi-jet background

Summary and Outlook

- New reconstruction method for boosted tau pairs
- DiTauRec available in Athena release 20.7.2
- Validation in G/H->hh->bb $\tau\tau$
- Proof of concept for Di-Tau Identification
- High efficiency in QCD background separation
- Work in progress on DiTauID

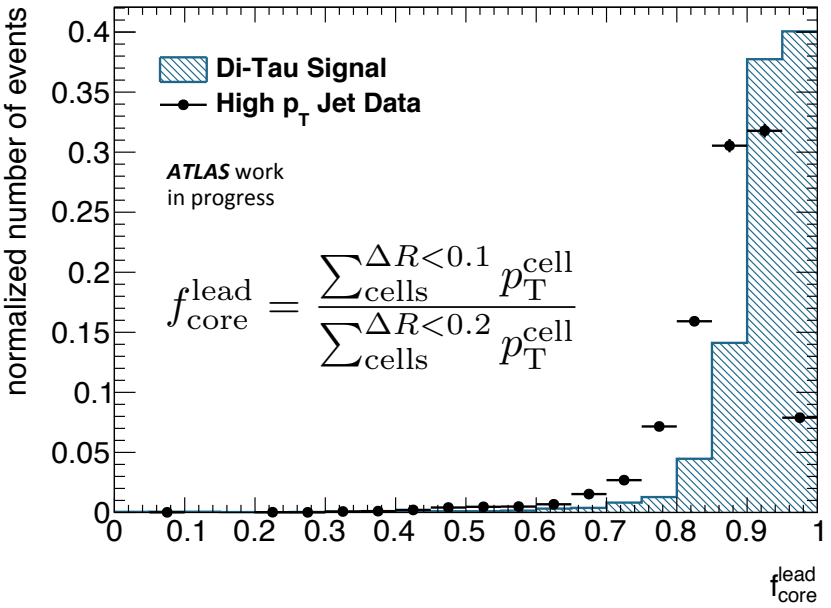

THANK YOU
FOR YOUR ATTENTION

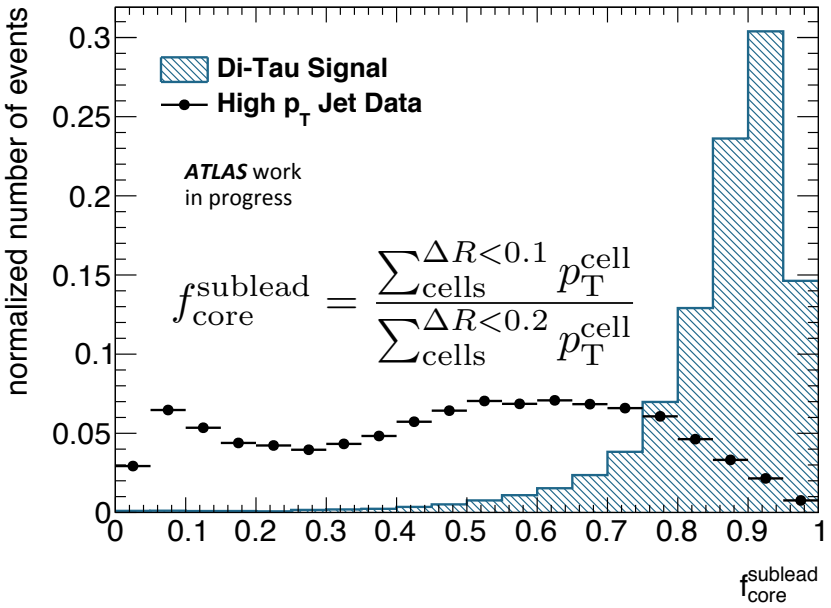
BACKUP

Di-Tau EDM Output

- Di-tau jet pt, eta, phi, m, E
- Subjets pt, eta, phi, m, E
- 3 ID variables + 1 per subjet
- BDT scores
- ElementLinks to:
  - Anti-Kt-10 seed jet
  - Tracks
  - Vertices
- optional: Cells for ID studies

Di-Tau Identification





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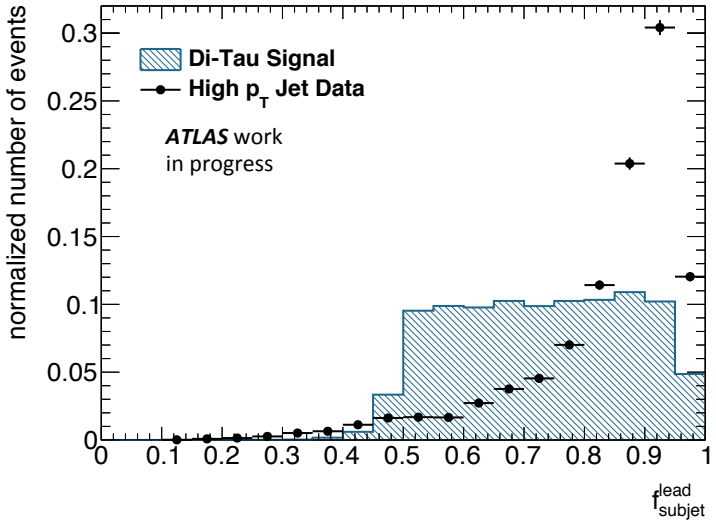

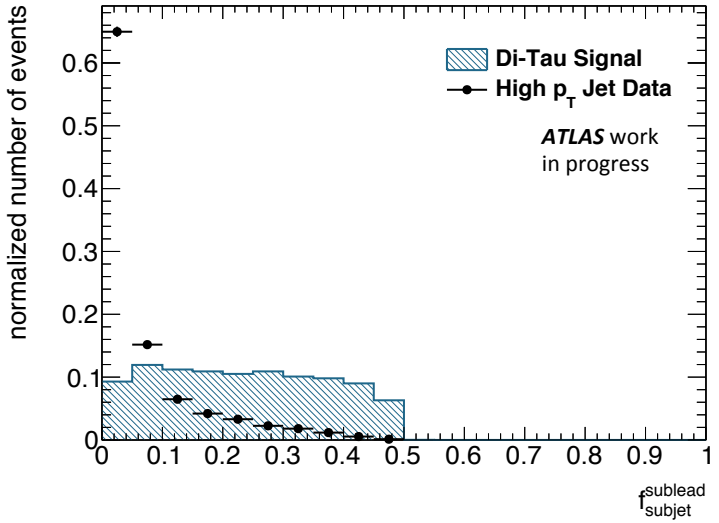

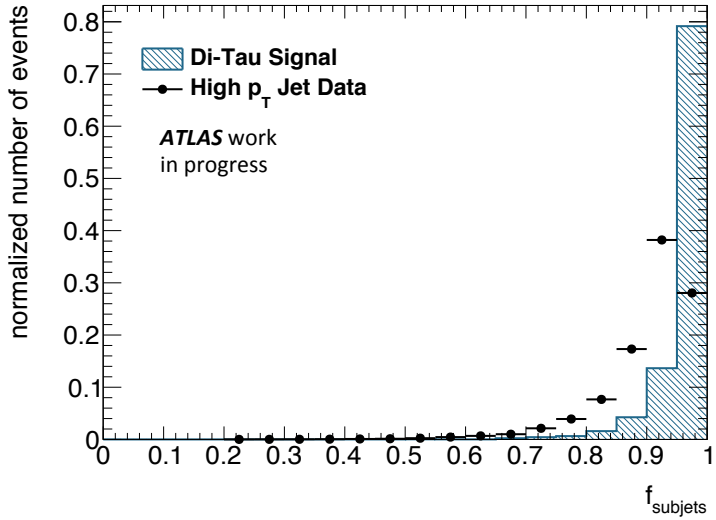

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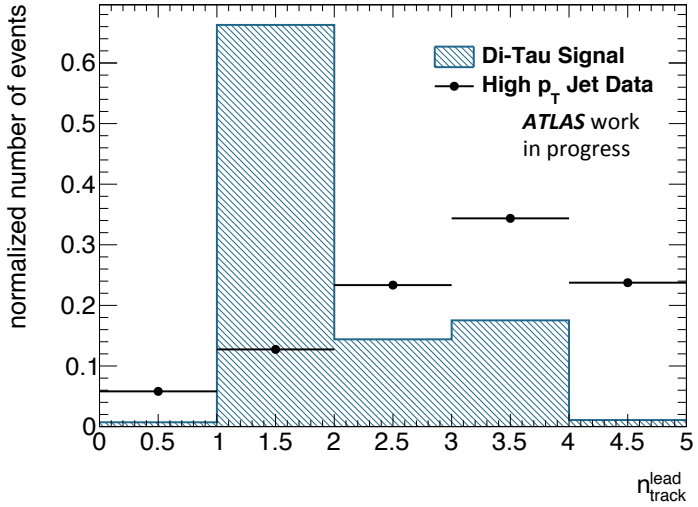

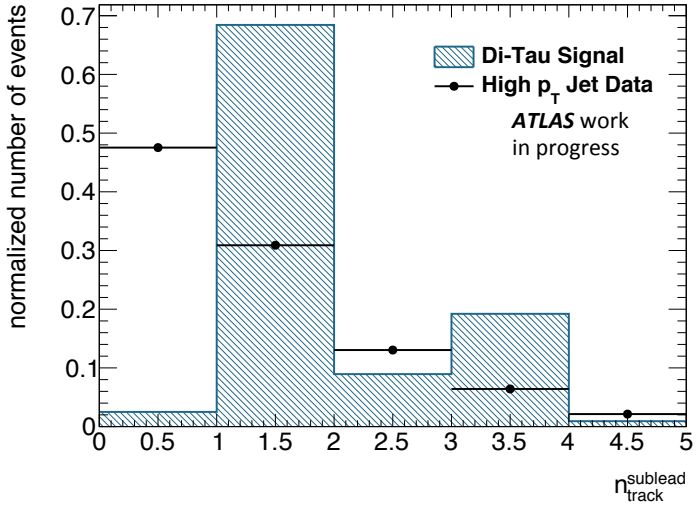

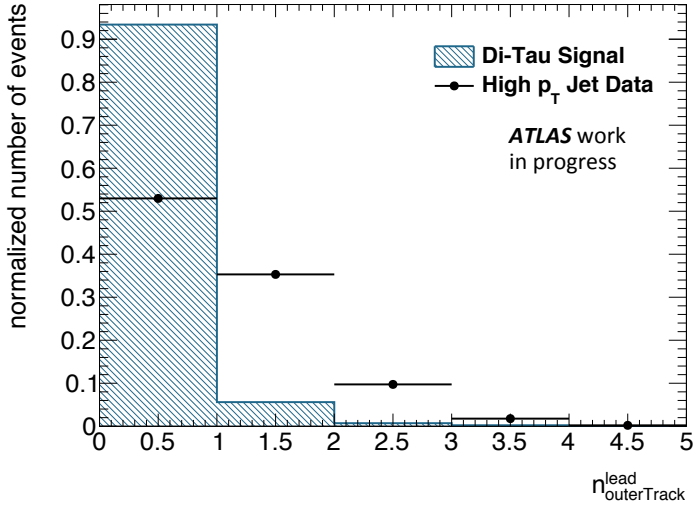

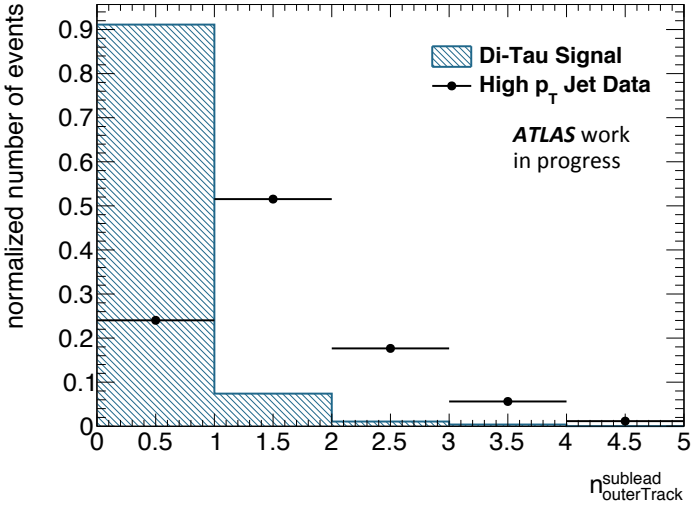

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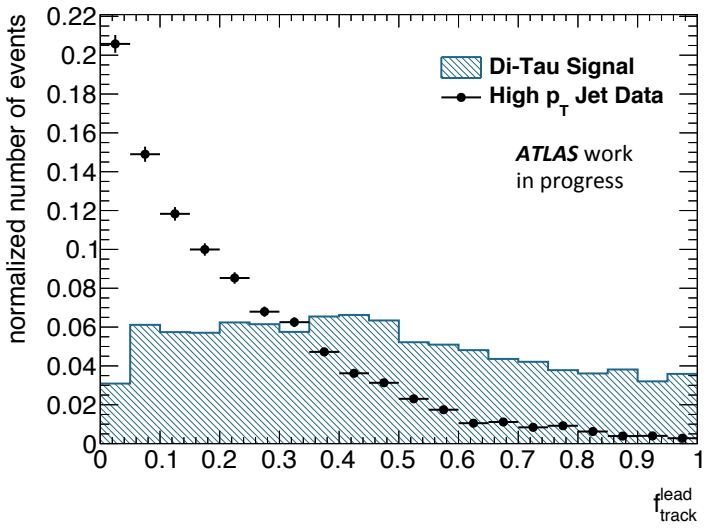
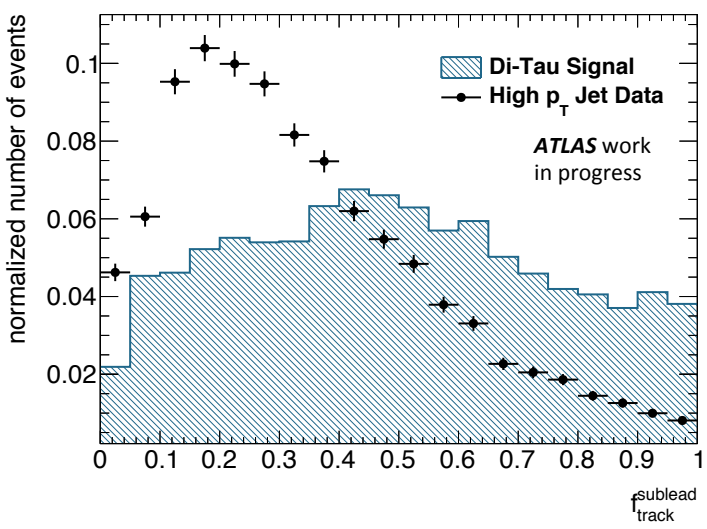
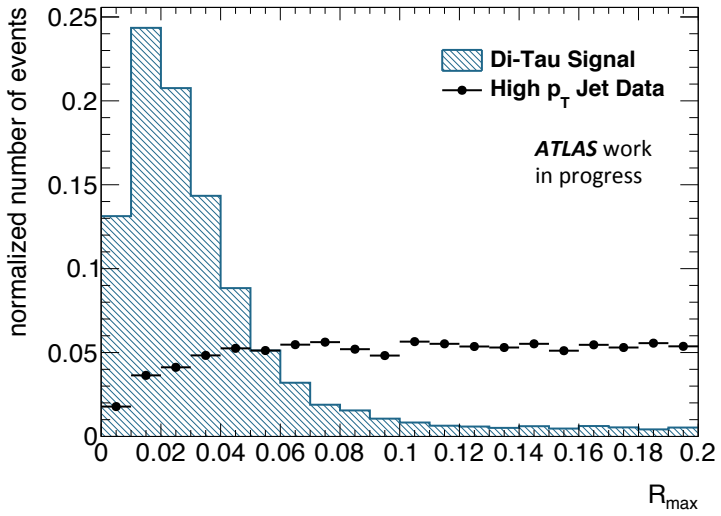
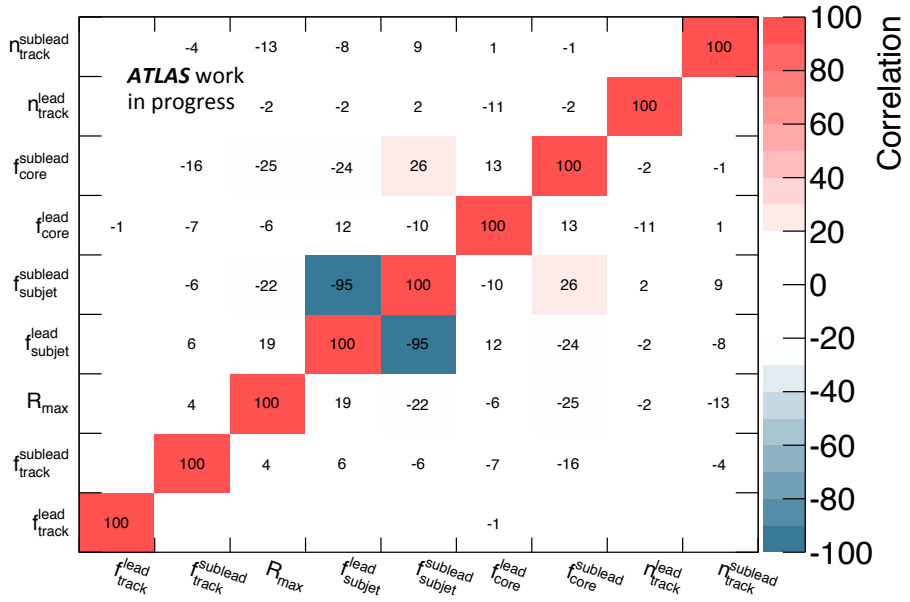




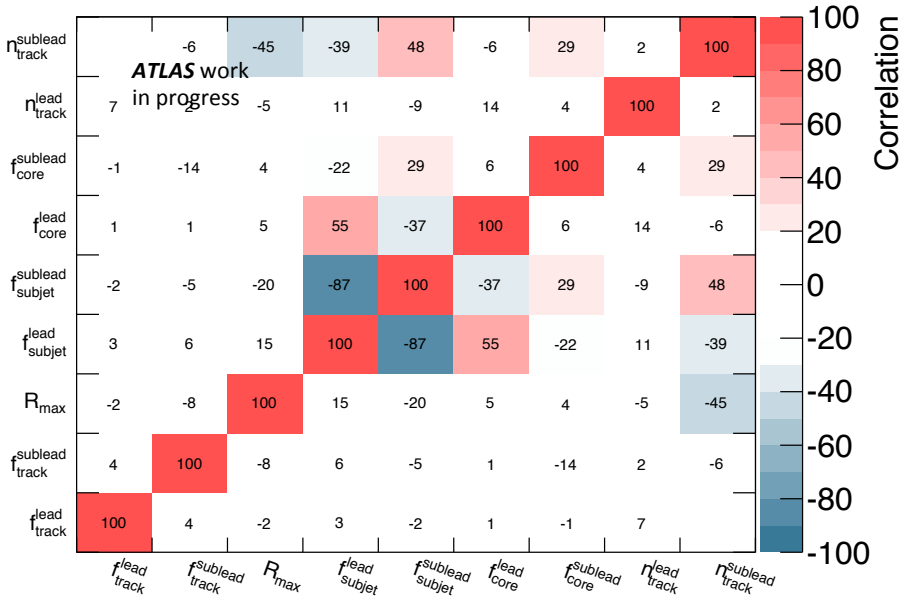


Correlation

Signal



QCD background



Di-Tau Identification