

Tau fake rate determination from early data

Philip Bechtle¹ Sylvie Brunet¹ Michel Janus²
Mathias Uhlenbrock³

¹DESY Hamburg

²Physikalisches Institut, University of Freiburg

³Physikalisches Institut, University of Bonn

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1 Introduction

- Method of tau fake rate determination

2 Results from preparatory studies

- Tau fake rates from MC samples
- Expected precision for 10 pb^{-1} of data
- Systematics

3 Outlook and further plans

Tau fake rate

- Rate of QCD jets misidentified as hadronically decaying tau leptons by the existing tau reconstruction algorithms

Global remarks/objectives

■ Motivation

The tau fake rate is a crucial number for all analyses relying on tau reconstruction, for QCD jets will be abundant in LHC data

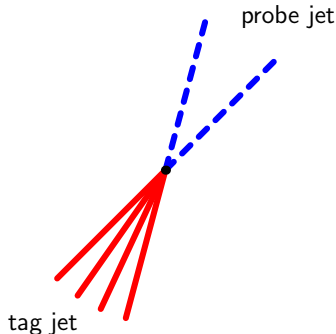
■ Goals

- Determination directly from early data (independent of MC)
- Provide collaboration with corrections for reconstruction and systematic error estimation

Tau fake rate determination from QCD dijet events

Method: tag and probe

- use back to back (in ϕ) dijet event of which one jet is randomly chosen and required to be a QCD jet (tag jet)
- the other is then known to be very likely another QCD jet (probe jet)
- subject probe jet to tau reconstruction algorithms



Tau fake rate f

$$f = \frac{\# \text{ probe jets identified as taus}}{\# \text{ all probe jets}}$$

Event topology cuts

- $|\eta| \leq 2.5$ for each jet
- $p_T \geq 15$ GeV for each jet
- $|\Delta\phi| = \pi \pm 0.30$ (back to back)
- $|\Delta p_T| < \frac{p_{T\max}}{2}$ (p_T balance)

Tag jet cuts

- # tracks ≥ 4
+ 1 track/50 GeV Δp_T
(removes most of the true taus)

Probe jet cuts

- no further cuts (to keep the whole spectrum)

Reconstruction algorithms

- TauRec (calorimetry based)
- Tau1p3p (track based)

Fake tau candidate criteria

- overlap: $|\Delta R| \leq 0.15$

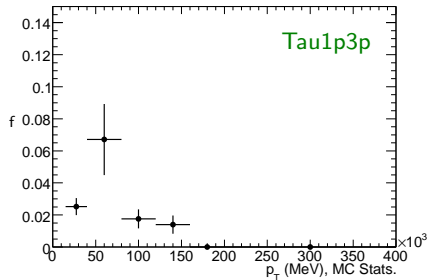
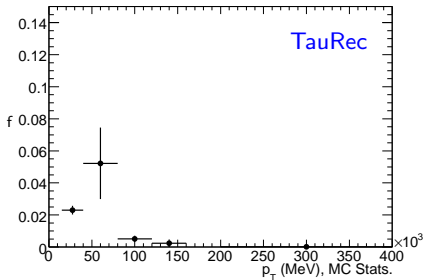
Preparatory studies using MC

| Physics ID | Channel (p_T (GeV)) | Cross section (nb) @ 14 TeV | Cross section (nb) @ 10 TeV |
|------------|--------------------------|--------------------------------|--------------------------------|
| 5009 | Dijet J0(8-17) | 17,600,000 | 11,700,000 |
| 5010 | Dijet J1(17-35) | 1,380,000 | 867,000 |
| 5011 | Dijet J2(37-70) | 93,300 | 56,000 |
| 5012 | Dijet J3(70-140) | 5,880 | 3,280 |
| 5013 | Dijet J4(140-280) | 308 | 152 |
| 5014 | Dijet J5(280-560) | 12.5 | 5.12 |
| 6023 | $W \rightarrow \tau\nu$ | 17.3 | 12.0 |
| 6052 | $Z \rightarrow \tau\tau$ | 1.58 | 1.13 |

List of input datasets

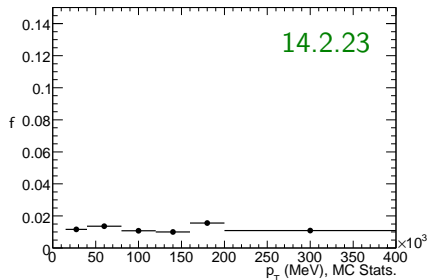
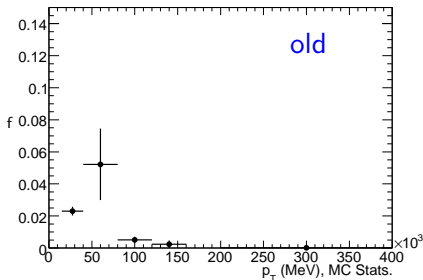
- Cross sections in leading order
- Event generator: Pythia

Preparatory studies using MC: Results



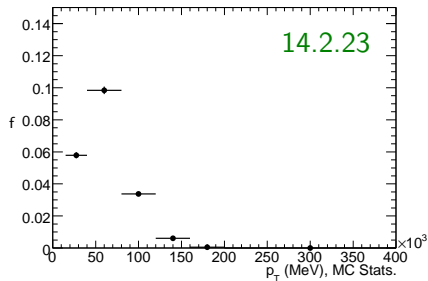
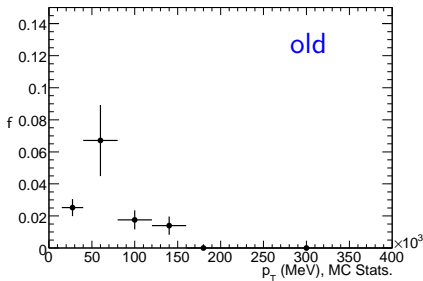
| p_T range (GeV) | TauRec | | Tau1p3p | |
|----------------------|-----------------|---|-----------------|---|
| | MC stat. (%) | exp. prec. dat. 10 pb^{-1} (%) | MC stat. (%) | exp. prec. dat. 10 pb^{-1} (%) |
| 15-40 | 2.3 ± 0.3 | ± 0.07 | 2.5 ± 0.5 | ± 0.07 |
| 40-80 | 5.2 ± 2.2 | ± 0.03 | 6.7 ± 2.2 | ± 0.04 |
| 80-120 | 0.5 ± 0.2 | ± 0.004 | 1.8 ± 0.6 | ± 0.008 |
| 120-160 | 0.2 ± 0.2 | ± 0.005 | 1.4 ± 0.6 | ± 0.01 |

Preparatory studies using MC: TauRec Results



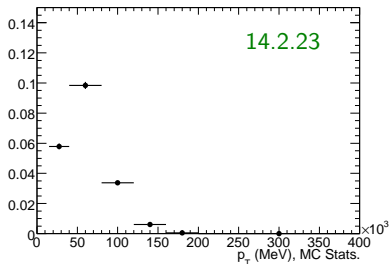
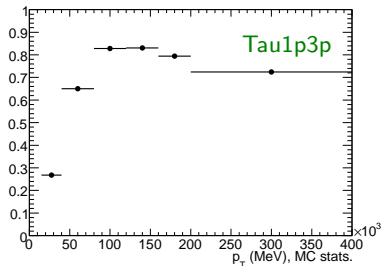
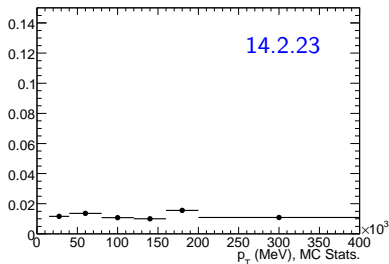
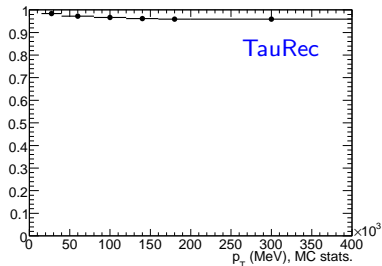
| p_T range (GeV) | TauRec old | | TauRec new | |
|----------------------|-----------------|---|-----------------|---|
| | MC stat. (%) | exp. prec. dat. 10 pb^{-1} (%) | MC stat. (%) | exp. prec. dat. 10 pb^{-1} (%) |
| 15-40 | 2.3 ± 0.3 | ± 0.07 | 1.2 ± 0.1 | ± 0.2 |
| 40-80 | 5.2 ± 2.2 | ± 0.03 | 1.4 ± 0.1 | ± 0.7 |
| 80-120 | 0.5 ± 0.2 | ± 0.004 | 1.1 ± 0.1 | ± 2.4 |
| 120-160 | 0.2 ± 0.2 | ± 0.005 | 1.0 ± 0.1 | ± 6.8 |

Preparatory studies using MC: Tau1p3p Results

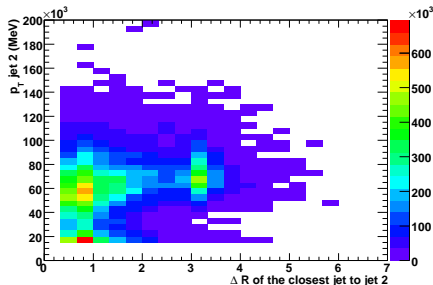


| p_T range (GeV) | Tau1p3p old | | Tau1p3p new | |
|----------------------|-----------------|---|-----------------|---|
| | MC stat. (%) | exp. prec. dat. 10 pb^{-1} (%) | MC stat. (%) | exp. prec. dat. 10 pb^{-1} (%) |
| 15-40 | 2.5 ± 0.5 | ± 0.07 | 5.8 ± 0.2 | ± 0.5 |
| 40-80 | 6.7 ± 2.2 | ± 0.04 | 9.8 ± 0.2 | ± 1.9 |
| 80-120 | 1.8 ± 0.6 | ± 0.008 | 3.4 ± 0.1 | ± 4.2 |
| 120-160 | 1.4 ± 0.6 | ± 0.01 | 0.7 ± 0.1 | ± 5.9 |

Comparison Plots : Reconstruction vs Identification



Preparatory studies using MC



Jet environment

- back to back jets at $|\Delta R| = 3$
- many close jets at $|\Delta R| \approx 1$

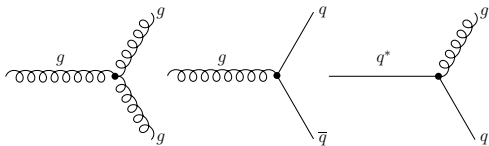
Method flexible

- Selection has to be adapted to the (jet) environment according to the signal of interest
- Method can mimic different environments using e.g. isolation cuts

Main sources of systematic errors

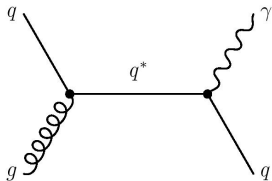
- Presence of real taus in the selected sample (negligible)
- Possible correlations between tag and probe side (partly addressed, low)
- Uncertainties from the definition of the overlap (negligible)
- Uncertainties from the origin of the jet
- Dependence on the type of the jet
- Fake rate due to other particles (electrons, muons, etc.)

Dependency on jet type



Fake rate from dijets

- Study of back to back jets gives combined rate of misidentified quarks and gluons (gluons dominate)

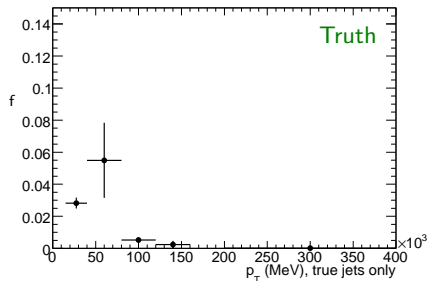
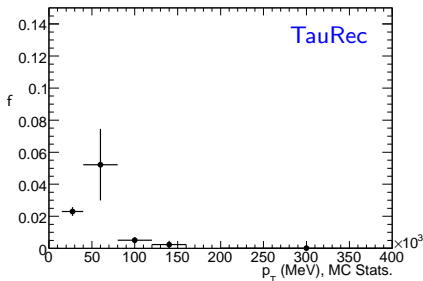


Fake rate from photon-jets

- Study of back to back jet and photon gives fake rate exclusively due to quarks

- Dijet events provide a way to evaluate tau fake rates from early data using a tag-probe method
- Tau fake rates expected to be at the $\mathcal{O}(1\%)$ level for low transverse momenta ($p_T < 200$ GeV)
- Significant measurement possible with 10 pb^{-1} of data
- Address remaining systematic error studies
- Can be used to tune/correct MC tau reconstruction and assign systematic uncertainties to analyses

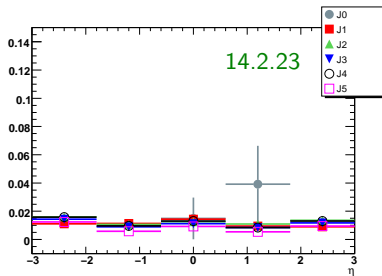
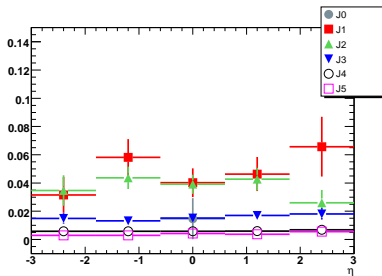
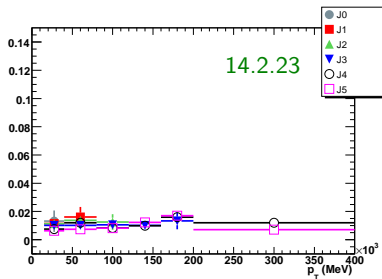
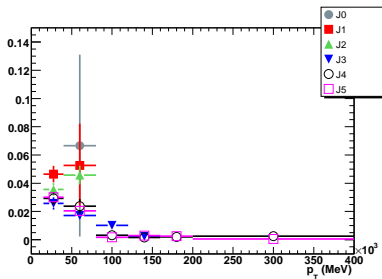
Backup: truth match



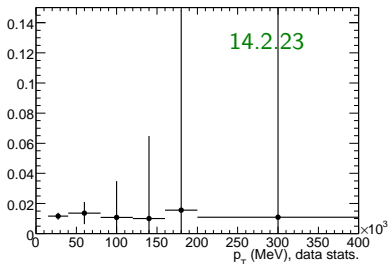
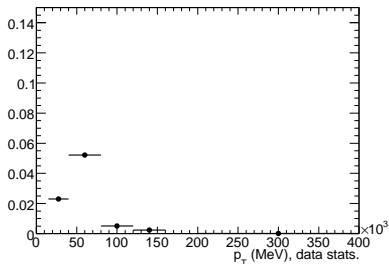
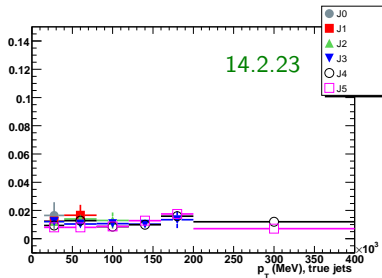
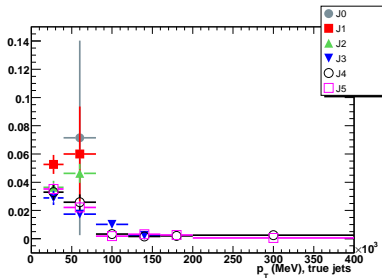
Comparison with expectation (MC truth)

- Comparison for TauRec algorithm
- MC statistics shown
- \rightarrow Agreement convincing

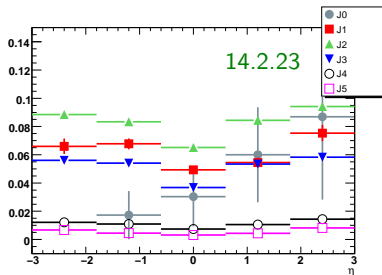
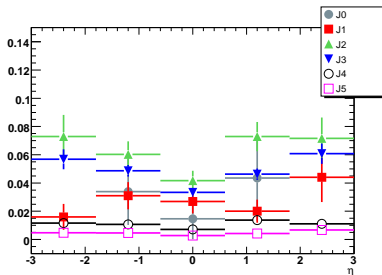
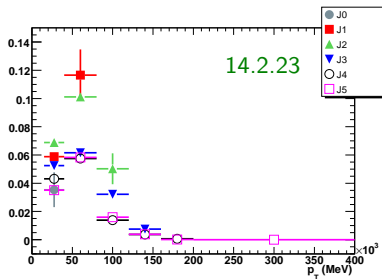
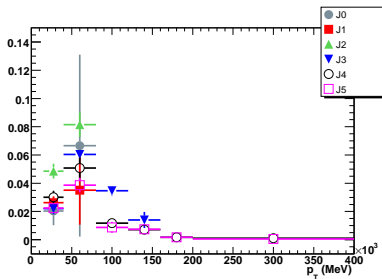
Comparison Plots TauRec: Fake Rate vs p_T and η



TauRec: Fake Rate (true jets) and expected precision



Comparison Plots Tau1P3P: Fake Rate vs p_T and η



Tau1P3P: Fake Rate (true jets) and expected precision

