Systematic Uncertainty Study Part1

Tau of TTTT

Fabio Iemmi[1] Huiling Hua[1] Hongbo Liao[1] Hideki Okawa[2]
Yu Zhang[2]

[1]IHEP

[2]Fudan University

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Outline

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List of systematic uncertainties for TTTT

Uncertainty source	Type
Luminosity	Norm
Cross section uncertainties	Norm
QCD (1tau0l) fake rate	Shape
Pileup	Shape
Level-1 ECAL prefiring	Shape
Trigger efficiency	Shape
Identification and isolation efficiency for e and mu	Shape
Identification efficiency for τ	Shape
Energy scale of τ	Shape
Jet Identification	Shape
Jet energy scale	Shape
b-tag efficiency and mistag rate	Shape
Emiss resolution and response	Shape

Table: Systematic uncertainties

Luminosity

- https://twiki.cern.ch/twiki/bin/view/CMS/TWikiLUM
- uncorrelated effects and correlated effects?

	2016	**2017**	**2018**	**2016-2018**
Recommended luminosity [$1/fb$]	36.33	41.48	59.83	137.65
Recommended uncertainty	1.2	2.3	2.5	1.6

Prefiring reweighting

- taken into account only in 2016 and 2017 data-taking eras
- uncorrelated
- Shape uncertainty
- produce 2 additional templates filling the prefiring_up and prefiring_do while all the other weights are norminal value

Pileup systematic uncertainty

- The PU present in the Monte Carlo samples does not exactly match the PU present in the data.
- difference is corrected by reweighting simulated events to match the PU distribution in data
- reweight the all MC by pileupWeight_up and pileupWeight_down, rerun the whole analysis, get the distribution

Muon efficiency uncertainty

- uncertainties provided by Muon POG `https://twiki.cern.ch/twiki/bin/view/CMS/MuonUL2016`
- mounSF = trackSF* IDSF* IsoSF
- tracks efficiency uncertainty, ID efficiency uncertainty and ISO efficiency uncertainty
  - both systematic and statictic error
- ISO efficiency SF
  - Muon_miniPFRelIso_all in nano for miniISo
  - The isolation efficiency are computed with TnP on DY events and might not be representative of high jets multiplicity environment, or boosted muons topology.
  - It seems MinoISO SF and uncertainty not provided by muon POG? yes
  - Have to produce SF ourselves `https://cms-talk.web.cern.ch/t/re-muon-id-systematics-error/11241/2`
- Tracker SF
  - SF are computed on Z->mumu events in the range 40 < pT < 60 GeV. The recommendation is to apply them for muons with pT in

Electron efficiency uncertainty

- https://twiki.cern.ch/twiki/bin/view/CMS/EgammaUL2016To2018
- energy scale and smearing
  - nanoaod: Residual energy scale and resolution corrections are applied to the stored electrons
  - energy scales of electrons and muons are known with an uncertainty of less than 1%, neglect
- ID efficiency uncertainty
  - from SF and uncertainties from POG

Tau uncertainty

- https://twiki.cern.ch/twiki/bin/viewauth/CMS/TauIDRecommendationForRun2
- efficiency to discriminate against jets (a.k.a. tau identification efficiency)
    - it seems we need to apply genMatch before apply SFs, why
- efficiency to discriminate against electrons
- efficiency to discriminate against muons
- energy scale of genuine taus
- energy scale of genuine electron misidentified as taus.
- no need for muon to tau energy scale correction.
    - uncertainty of muon to tau energy scale is 1% uncorrelated in DM
- uncorrelated accross years

CorrectionlibTool for SF

- https://gitlab.cern.ch/cms-tau-pog/jsonpog-integration/-/tree/master
- https://gitlab.cern.ch/cms-nanoAOD/jsonpog-integration/-/tree/master/examples
- For UL analyses the usage of json files + correctionlibTool developped together with the XPOG is recommended for ES, SFs and trigger SFs
- Have implemented the CorrectionlibTool in my code and used the official json files for the SF and correction

Jet JES

- JEC
  - The jet corrections are a set of tools that allows the proper mapping of the measured jet energy deposition to the particle-level jet energy
  - to data and MC
  - JEC applied in NanoAOD
    - minimum correction recommended by JME
    - data: L1L2L3 MCtruth corrections + L2L3Residuals
    - MC: L1 + L2L3 MC-truth
- JEC uncertainty
  - `https://twiki.cern.ch/twiki/bin/view/CMS/JECDataMC`
  - Comes not in the form of event weight, but shifting the jet pt
  - for both data and MC
  - Shifting the jet pt according to uncertainty and then rerun the analysis
  - https://gitlab.cern.ch/cms-nanoAOD/jsonpog-integration/-/tree/master/POG/JME
  - uncertainty correlation analysis: https://twiki.cern.ch/twiki/bin/view/CMS/JECUncertaintySources

Jet JER

- JER
  - jet energy resolution (JER) in data is worse than in the simulation and the jets in MC need to be smeared to describe the data
  - Jets of MC samples are not smeared, smeared in our code
  - With the scaling method, corrected fourmomentum of a reconstructed jet is rescaled with a factor
  - `https://twiki.cern.ch/twiki/bin/view/CMSPublic/WorkBookJetEnergyResolution`
  - https://twiki.cern.ch/twiki/bin/view/CMS/JetResolution

Jet ID efficiency

- https://twiki.cern.ch/twiki/bin/view/CMS/JetID13TeVUL
- No SF required so no uncertainty to consider

B tag

- A bit complicated, might need different stratedy for BDT and HT channels

Outline

Two Uncertainty types

- Efficiency SF uncertainty
  - Comes in the form of event weight, easy to implement
- Energy scale uncertainty
  - need to scale up and down the energy scale and redo the whole analysis(from object selection to event selection)
  - JEC and Tau engergy scale

Adding lumilosity uncertainty

- `lumi_13TeV lnN 1.012 1.012 1.012 1.012 1.012 –`
- before: expected signficance 0.0719726; limit 27.3750
- after: expected significance 0.0672532; limit 29.3750
- Considering systematic uncertainties makes results worse as expected

Backup

back up