MC Correction Part1

Search for Four top in Tau Final States

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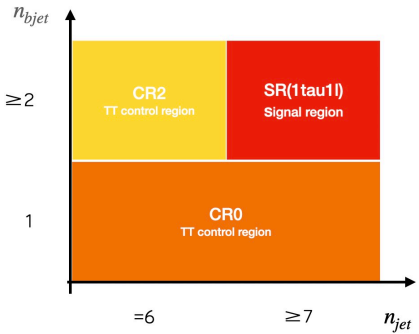
Outline

1. Prefiring reweighting
2. Pileup reweighting
3. JEC
4. TES
5. Tau ID Efficiency SF
6. Lepton ID SF

1tau1l control region definition



- Switch to the tight lepton definition from SS with top lepton MVA

SF and corrections

- Corrections we have considered
  - Prefiring
  - Pileup
  - Tau: both TES and ID SF
  - Jet: JES and JER
  - Lepton efficiency SF
- Have not considered
  - B jet: b tag efficiency correction
  - HLT SF : need to remeasure

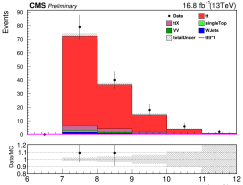
Section 1

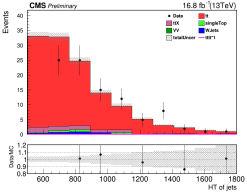
Prefiring reweighting

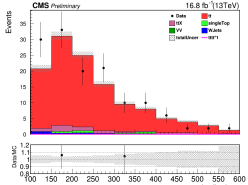
Prefiring reweighting

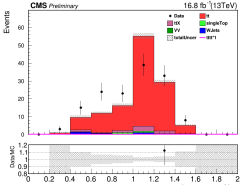
- Prefiring issue
  - 2016 and 2017, gradual timing shift of the ECAL, events can self veto if a significant amount of ECAL energy is found in the region 2 < eta< 3
  - effect is not described genuinely by the simulation but taken into account using event weights.
  - Final SF, which is applied to all events before any selection
  - Probability for a given Monte Carlo event not to prefire
- Implementation
  - Event weight already available in NanoAOD

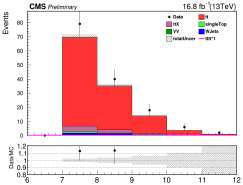
Prefiring reweighting before and after(CR0)

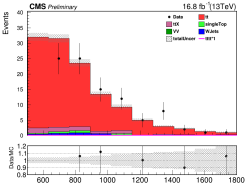


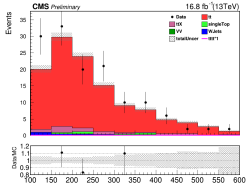


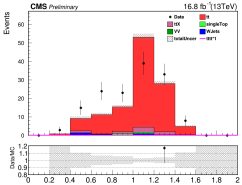




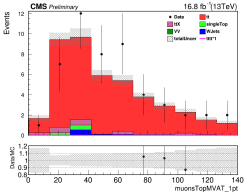


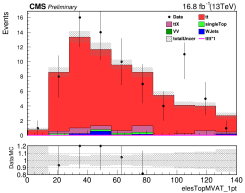


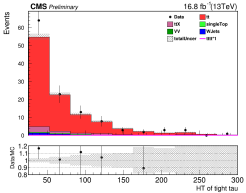


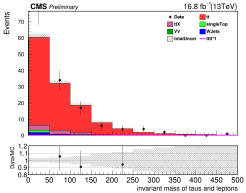


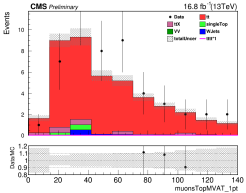
Prefiring reweighting before and after(CR0)

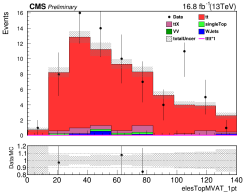


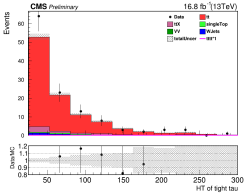


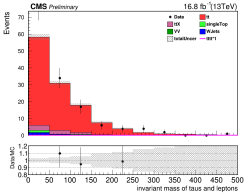




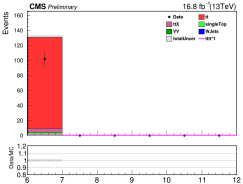


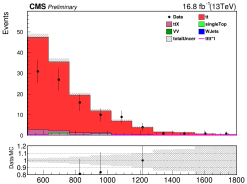


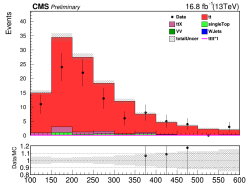


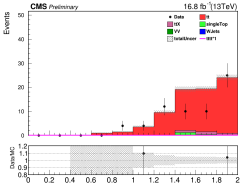


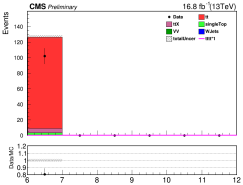
Prefiring reweighting before and after(CR2)

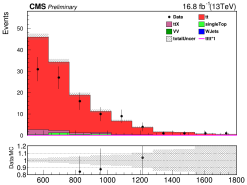


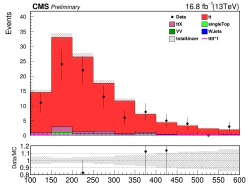


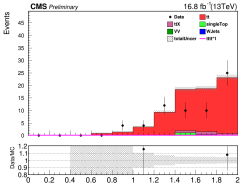




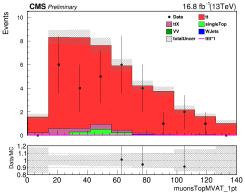


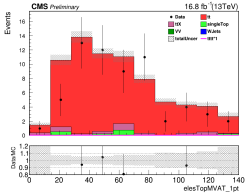


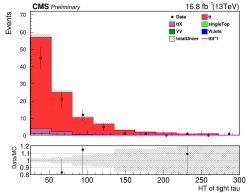


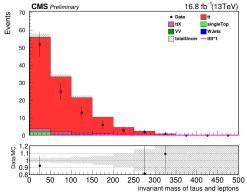


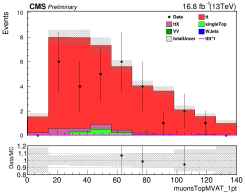
Prefiring reweighting before and after(CR2)

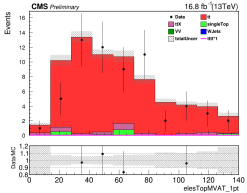


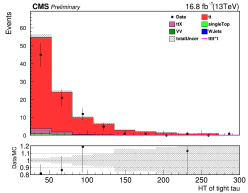


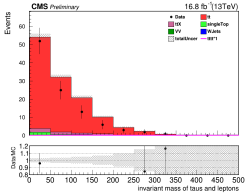












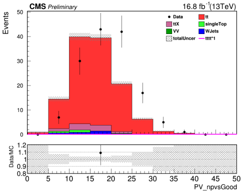
Section 2

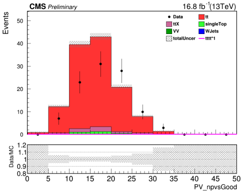
Pileup reweighting

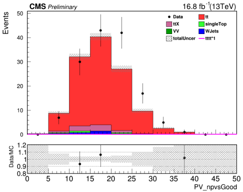
Pileup reweighting

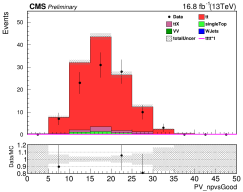
- reweighting simulated events to match the PU distribution in data
- Implementation
  - Pileup distribution (number of events as a function of pileup vertex per bunch crossing in the whole Run2)
  - Scale both data and MC pileup distribution to 1
  - For each event, $w = \frac{data(nTrueInt)}{MC(nTrueInt)}$

Pileup reweighting before and after(CR0 and CR2)



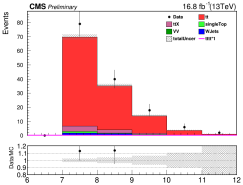


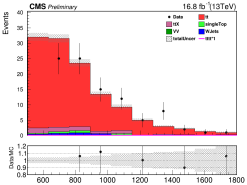


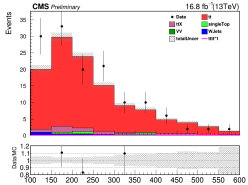


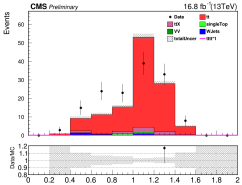
- Up prefiring reweighting, down: prefiring*pileup
- Left: CR0; right CR2

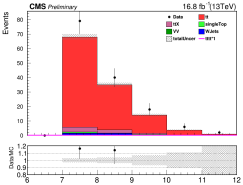
Pileup reweighting before and after(CR0)

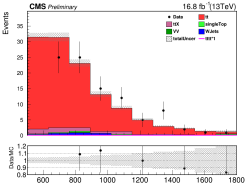


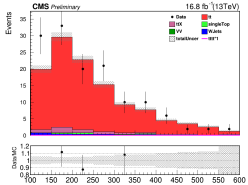


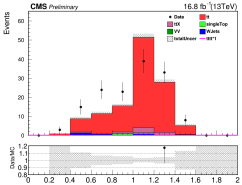




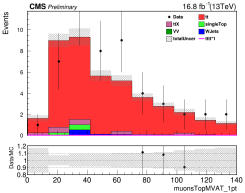


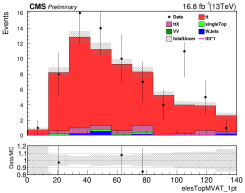


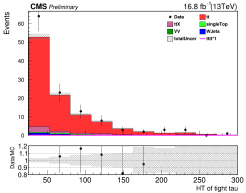


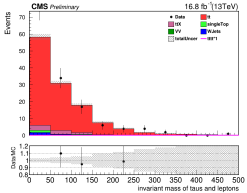


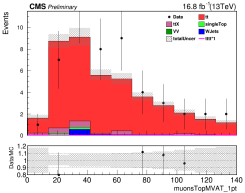
Pileup reweighting before and after(CR0)

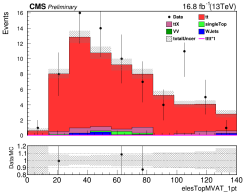


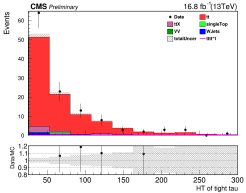


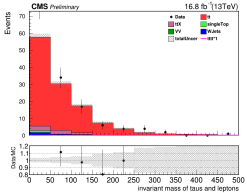




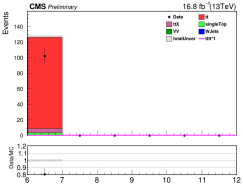


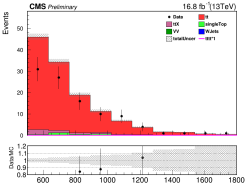


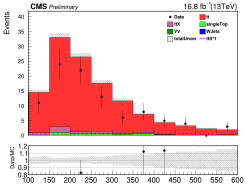


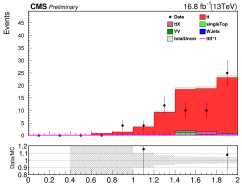


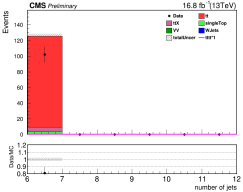
Pileup reweighting before and after(CR2)

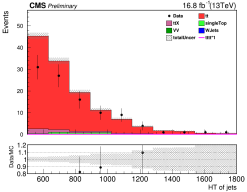


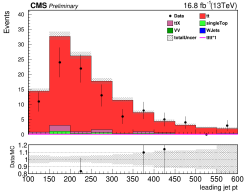


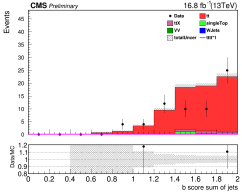




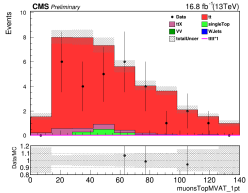


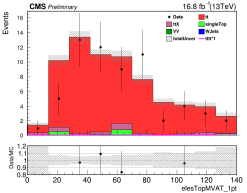


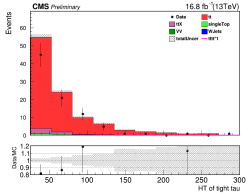


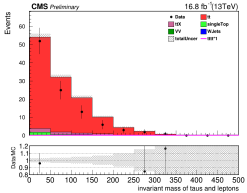


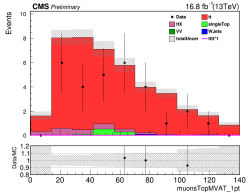
Pileup reweighting before and after(CR2)

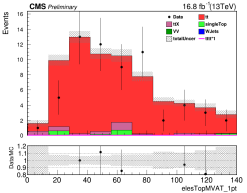


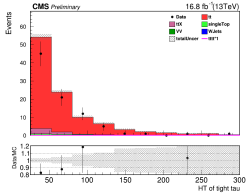


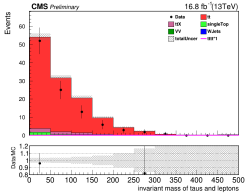












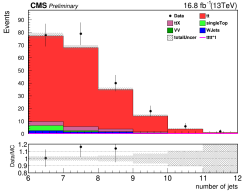
Section 3

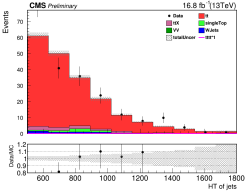
JEC

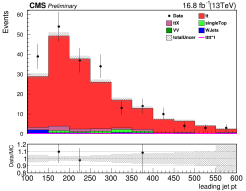
JER before and after

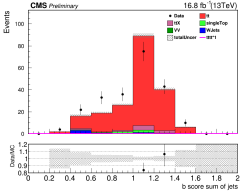
- JES(jet energy scale) already corrected in NanoAOD
- JER using POG json file to correct

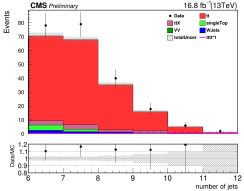
JER reweighting before and after(CR0)

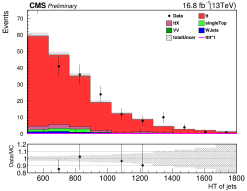


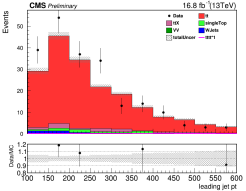


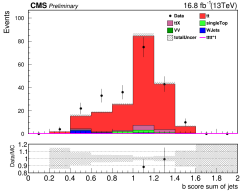






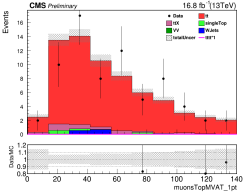


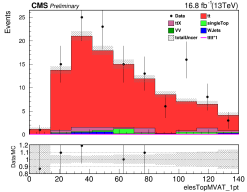


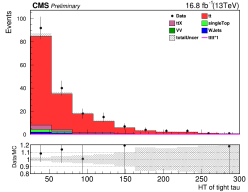


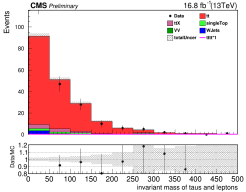
- From now on CR0 updated(include CR3)

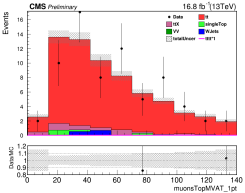
JER reweighting before and after(CR0)

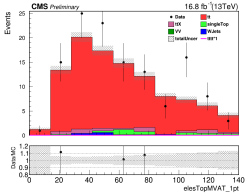


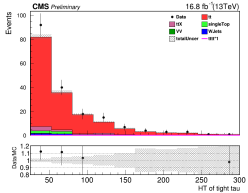


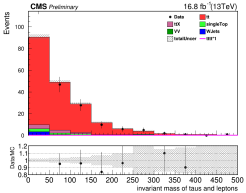












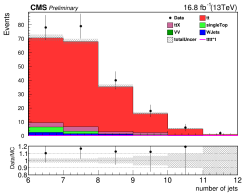
Section 4

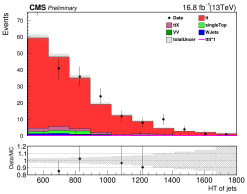
TES

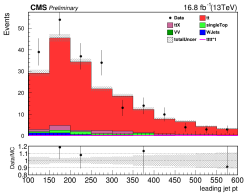
TES

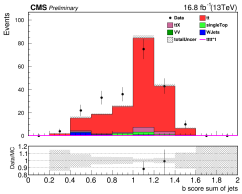
- Tau energy scale correction
- Using Tau POG json file

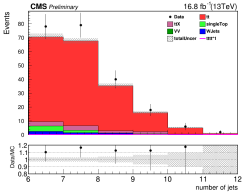
TES before and after(CR0)

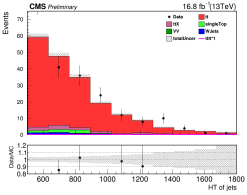


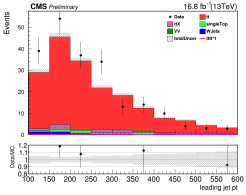


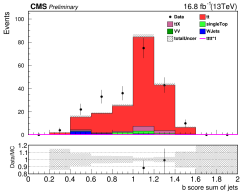




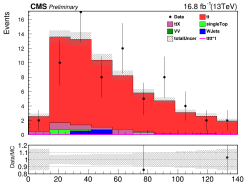


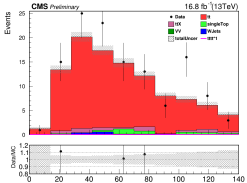


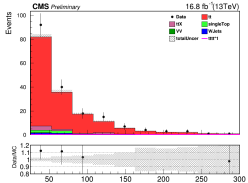


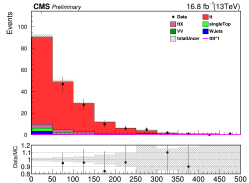


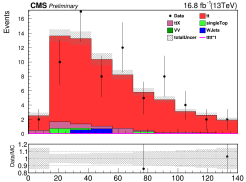
TES before and after(CR0)

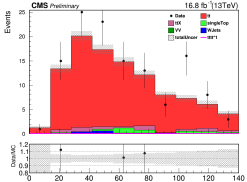


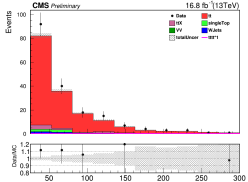


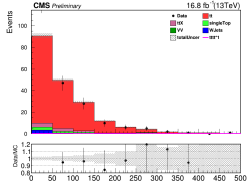




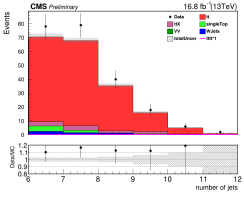


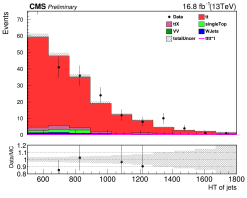


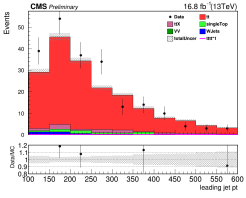


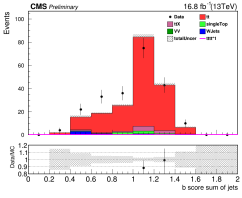


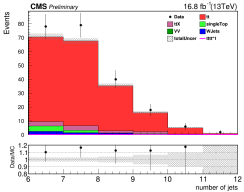
TES before and after(CR2)

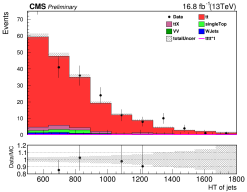


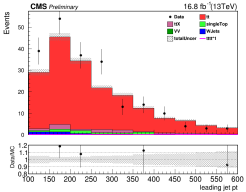


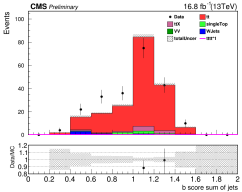




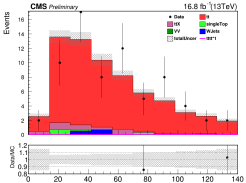


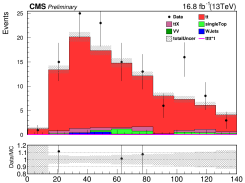


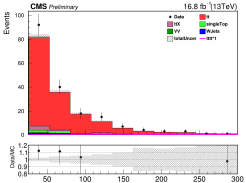


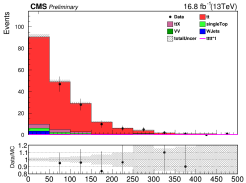


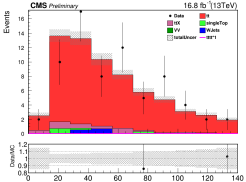
TES before and after(CR2)

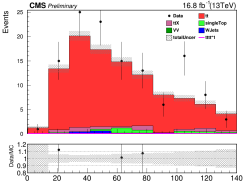


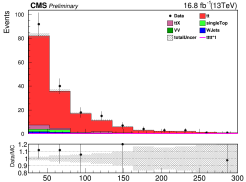


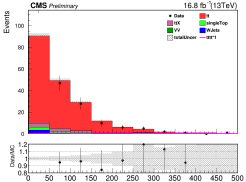








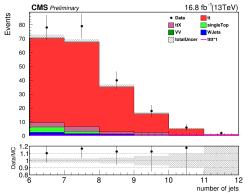


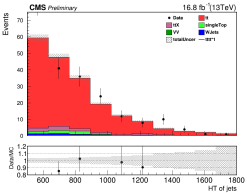


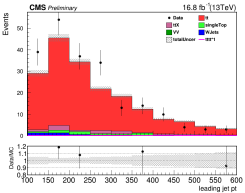
Section 5

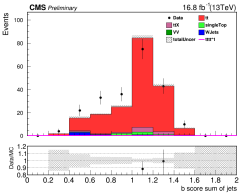
Tau ID Efficiency SF

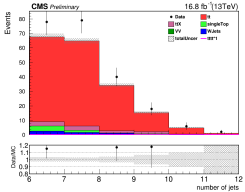
Tau ID SF before and after(CR0)

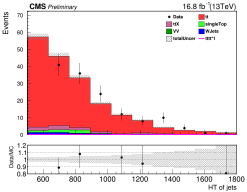


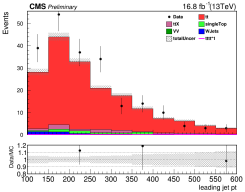


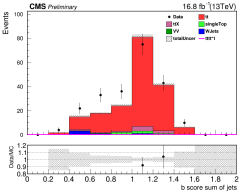




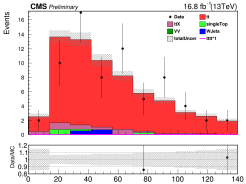


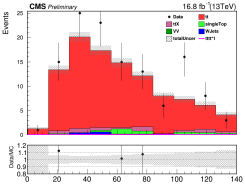


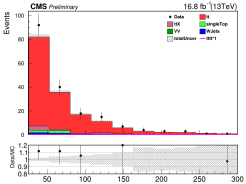


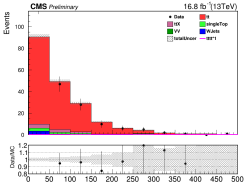


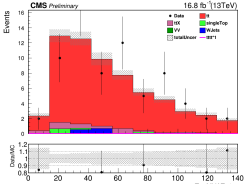
Tau ID SF before and after(CR0)

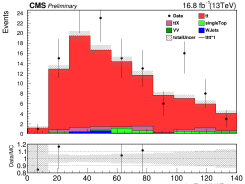


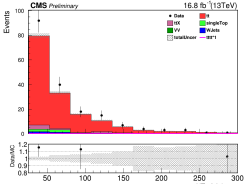


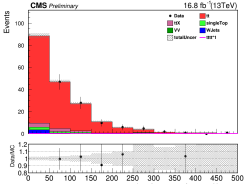




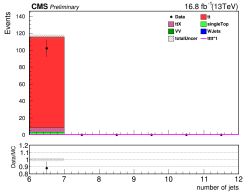


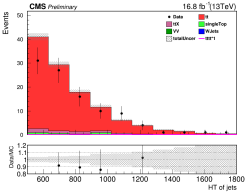


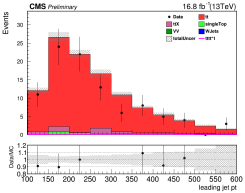


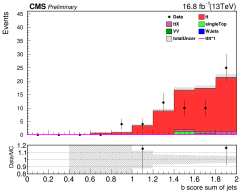


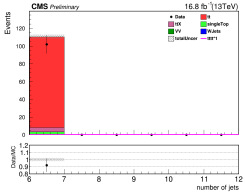
Tau ID SF before and after(CR2)

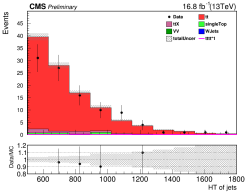


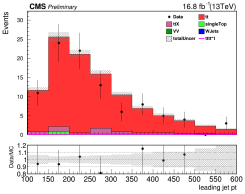


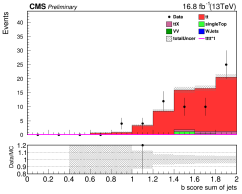




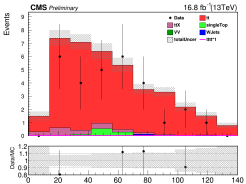


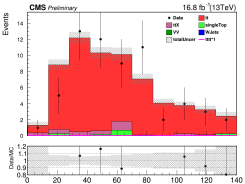


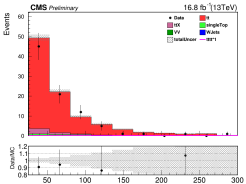


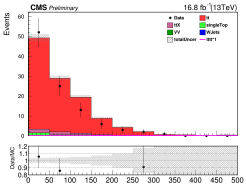


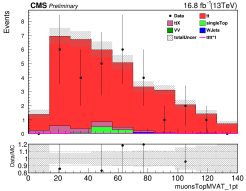
Tau ID SF before and after(CR2)

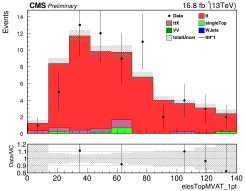


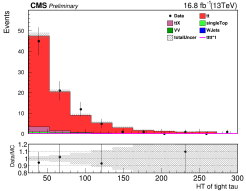


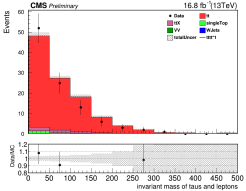












Section 6

Lepton ID SF

SS lepton with Top MVA Lepton

- Same as the SS lepton definition
  - Tight electron MVA working points; medium muon MVA working points
- All SF need to consider is the Top Lepton MVA SF
- SF provided by Kirill

Section 7

Back up

Section 8

B tag efficiency SF

B tag efficiency SF(yield)

- $SF = \frac{\varepsilon_{data}}{\varepsilon_{MC}}$
- Only using working points
  - $P(MC) = \prod_{i=tagged} \epsilon_i \prod_{j=nottagged} \epsilon_j$?
  - $P(Data) = \prod_{i=tagged} SF_i\epsilon_i \prod_{j=nottagged} SF_j\epsilon_j$?
  - $w = \frac{P_{data}}{P_{MC}}$
- If we ask 2 b tagged jets
  - the probability for jets to have such configuration is as above
- https://twiki.cern.ch/twiki/bin/viewauth/CMS/BTagSFMethods

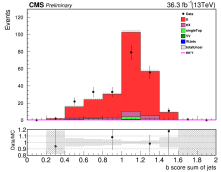
B tag uncertainty(shape)

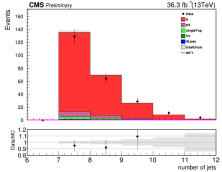
- Need to correct for both shape and yield
  - For both 1tau1l and 1tau0l, we are using the shape of the b tag score
  - >= 2 b jets(medium working points) for baseline selection
- BTV 1d) Event reweighting using discriminator-dependent scale factors from BTV
  - https://twiki.cern.ch/twiki/bin/viewauth/CMS/BTagShapeCalibration
  - $w_{event} = \prod_{i}^{N_{jets}} SF(D_i, pt_i, \eta_i, flavor_i)$
    - D_i: b tag discriminant
    - The difference between working points weight is that SF here is more bins with regard to D_i
  - Effect on event yields
    - the number of events (i.e. the sum of event weights) before and after applying b-tag weights should be identical
    - Measure the sum of event weights before and after applying b-tag event weights, without requiring any b-tag selection in both cases
    - $r = \sum w_{before} / \sum w_{after}$ represents a phase space extrapolation and should be multiplied to the b-tag event weight
    - this extrapolation could in general depend on further variables, most notably the jet multiplicity. Especially in analyses with a large number of jets (e.g. $t\bar{t}$ or $t\bar{t}H$) one should consider to measure and apply the ratio r per jet multiplicity bin
    - Measure R in region without b jet requirement

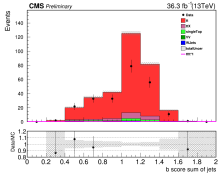
R dependance on jet multiplicity

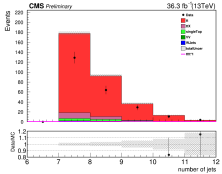
- r can vary on jet multiplicity
  - I think due to the fact that jet multiplicity impact SF, and it's not taken into account when measuring b tag SF
- No b tag selection when measuring r
- Measurement region: baseline region without b jet requirement

Distribution without considering r(no btag weight Vs b tag weight)

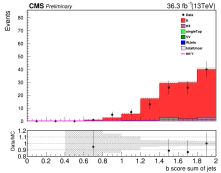


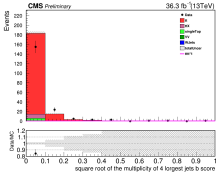


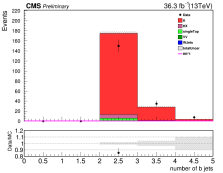


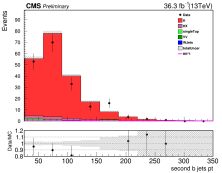


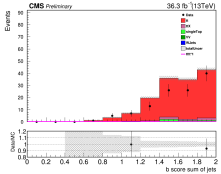
Distribution without considering r(no btag weight Vs b tag weight)

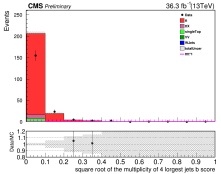


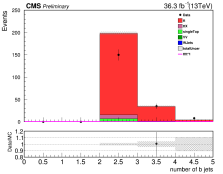


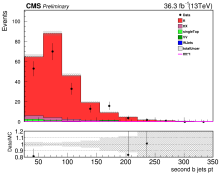






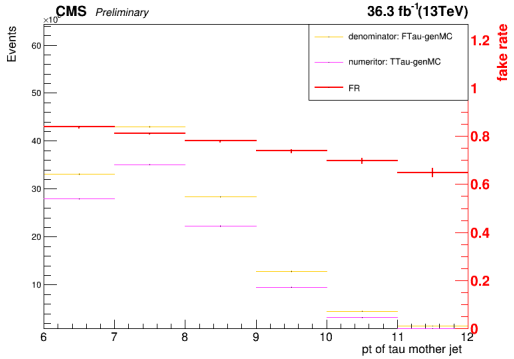




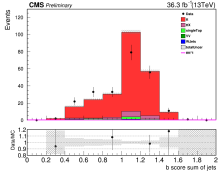


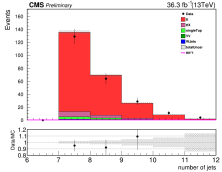
R dependence on jet multiplicity

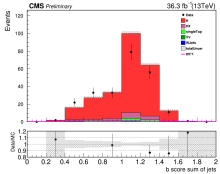
- $r = \sum w_{before} / \sum w_{after}$
- Measured in region: >=6 jets; >=1 tau; no b jet number requirement

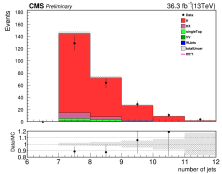


Btag weighting with Vs without R correction(CR0)

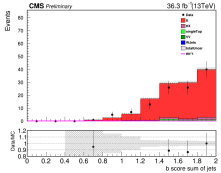


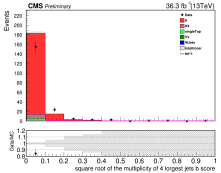


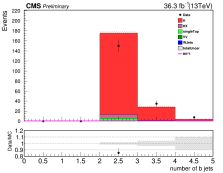


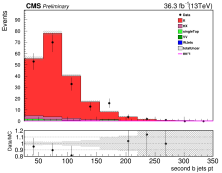


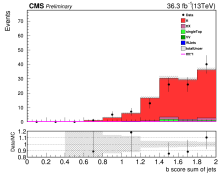
Btag weighting with Vs without R correction(CR0)

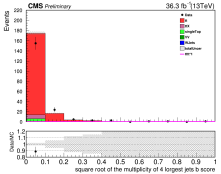


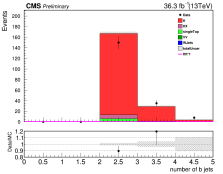


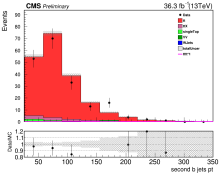












How to consider up and down uncertainty?

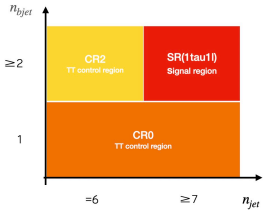
Questions

- How is our btag sf different than object SF?
  - object efficiency SF
    - electron efficiency means the probability of true electron? passing selection criteria
    - the efficiency means passing or not efficiency. Correct for event yield, after the electron selection
    - Does the event weight impact the shape of other variables?
    - efficiency means the probality of true lepton passing selection, how about non-true object passing selection criteria?
  - For electron and muon, the efficiency is high and close to 1, the 1-efficiency is close to 0 so we don't need to consider the arrangement of true leptons not passing but non-true passing

Event yield in CRs

regions	tttt	uncert	tt	uncert	qcd	uncert	ttX	uncert	VV	uncert	singleTop	uncert	WJets	uncert	total MC
1tau1lSR	1.857	0.024	218.046	3.113	0.244	0.244	11.864	1.176	0.000	0.000	5.416	1.143	1.938	0.922	239.365
1tau1lCR0	0.156	0.007	110.365	2.231	16.199	11.968	6.471	0.903	0.036	0.033	1.597	0.620	3.590	0.855	138.414
1tau1lCR2	0.269	0.008	116.342	2.243	0.000	0.000	5.591	1.008	0.000	0.000	3.101	0.878	0.533	0.171	125.837
1tau1lCR3	0.039	0.003	67.639	1.728	7.536	7.536	3.133	0.484	0.010	0.010	3.930	1.061	2.616	0.901	84.904

Table 1: 2016postVFP



- MC correction: pileup* prefiring