Lepton-jet related variables and jet energy corrections

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Datasets and triggers

- **Spring 15, 25 ns MC:** aMC@NLO DY+Wjets, Powheg TT

- **Run 2015D data:**

  - **DoubleMuon + DoubleEG + MuonEG + SingleMuon + SingleElectron**

  - **latest golden JSON up to run 256843, 122 pb^{-1}**

- **Unprescaled (di)lepton triggers:**
    thresholds μμ: 17/8, ee: 17/12 , μe: 17/12+8/17, μ: 20, e: 27 GeV

- **PU reweighting using number of vertices**

- **Summer15 25ns V2 JEC applied to both data and MC**
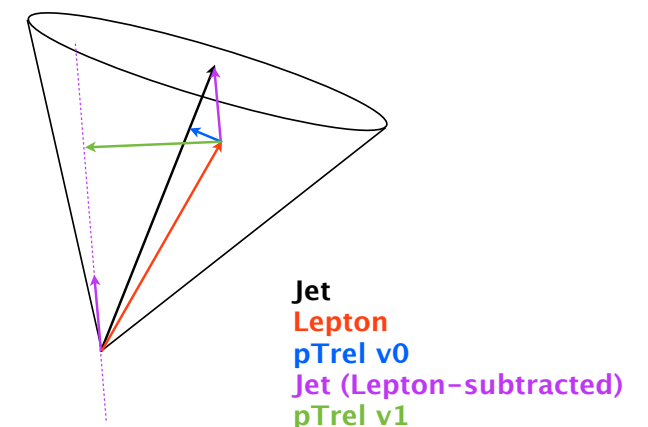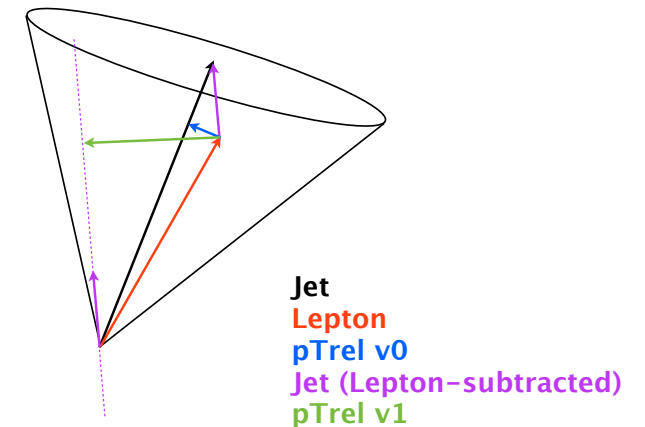
Variables used in the MVA

Isolation
- **PF miniRelIso**, **charged** had. (R=0.3)
- **PF miniRelIso**, **neutral** had. & photon (R=0.3, with EA*rho PU corrections, scaled with (0.3/R)^2)

Vertexing
- **3D IP significance** (SIP$_{3D}$)
- **2D IP |dxy|** and **|dz|**

Lep-Jet
- **Lepton's closest jet** (leptons are not removed from jet collection)
  - $p_T(\ell)/p_T$(jet): **« p$_T$ ratio »**
  - **Lepton's p$_T^{rel}$ wrt jet**
  - jet CSV b-tag

Jet
Lepton
pTrel v0
Jet (Lepton−subtracted)
pTrel v1

ID
- **(μ)Segment compatibility/**
- **(e)POG non-triggering MVA Electron Id discriminator**

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jet variables affected by JEC

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Lepton
pTrel v0
Jet (Lepton−subtracted)
pTrel v1

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affected by EA

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Jet
Lepton
pTrel v0
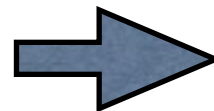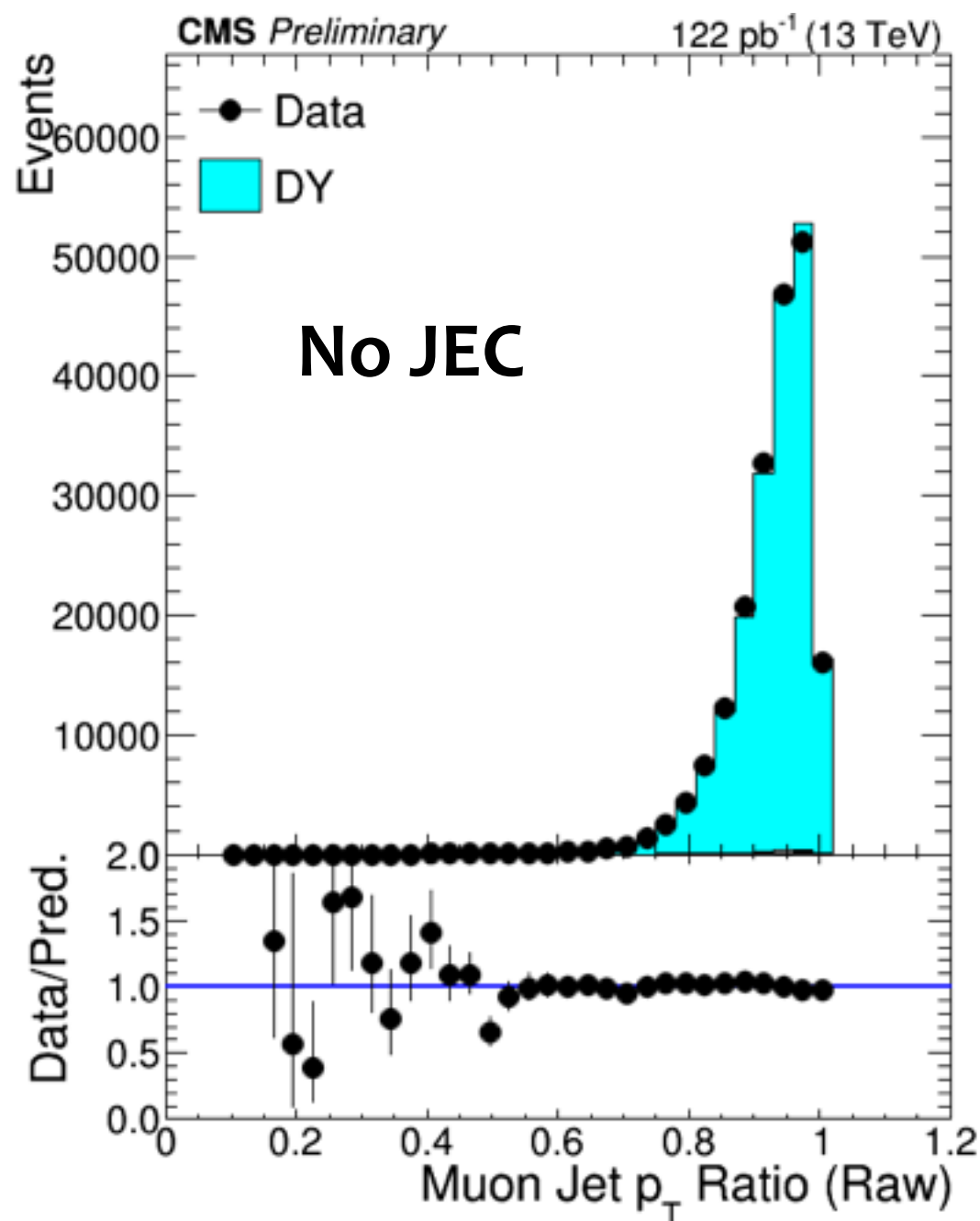**Jet (Lepton–subtracted)**
pTrel v1

ID
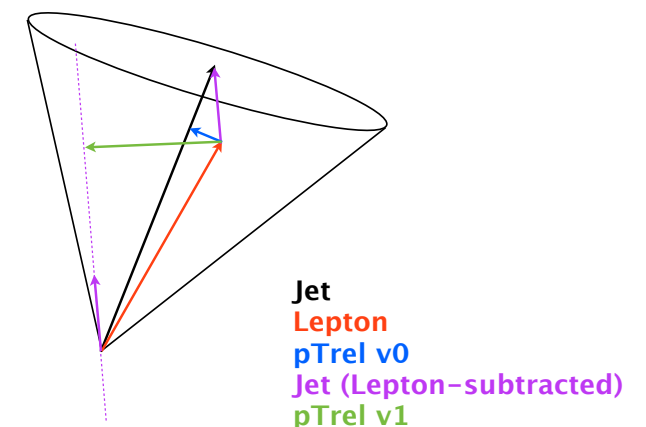
- **(μ)Segment compatibility/**
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JEC effect on p$_T$Ratio

- When applying JEC residual corrections to data,
  we got worse agreement in the lepton-jet p$_T$Ratio: $p_T(\ell)/p_T(jet)$
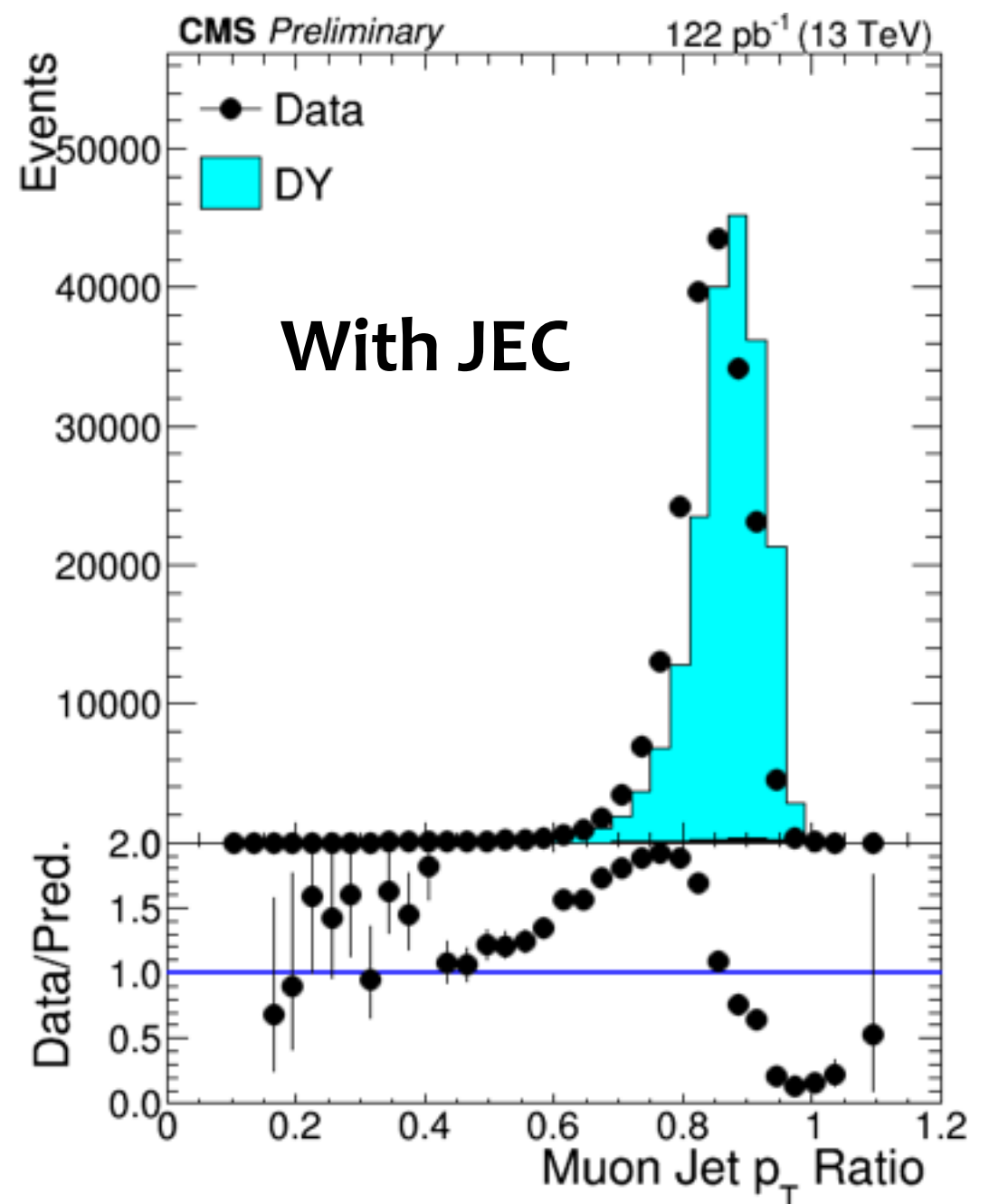
Updated definition

Problem traced to JEC tuned to set the right HF scale for inclusive jets, but not well suited for lepton-jets.

Redefine lepton-jet to avoid applying JEC to the lepton energy:

1. **subtract the lepton from the raw jet**
2. **subtract the pileup (L1 corr. applied in an additive way)**
3. **multiply by L2L3Res corr. (evaluated on the initial raw jet)**
4. **add back the lepton to the jet**

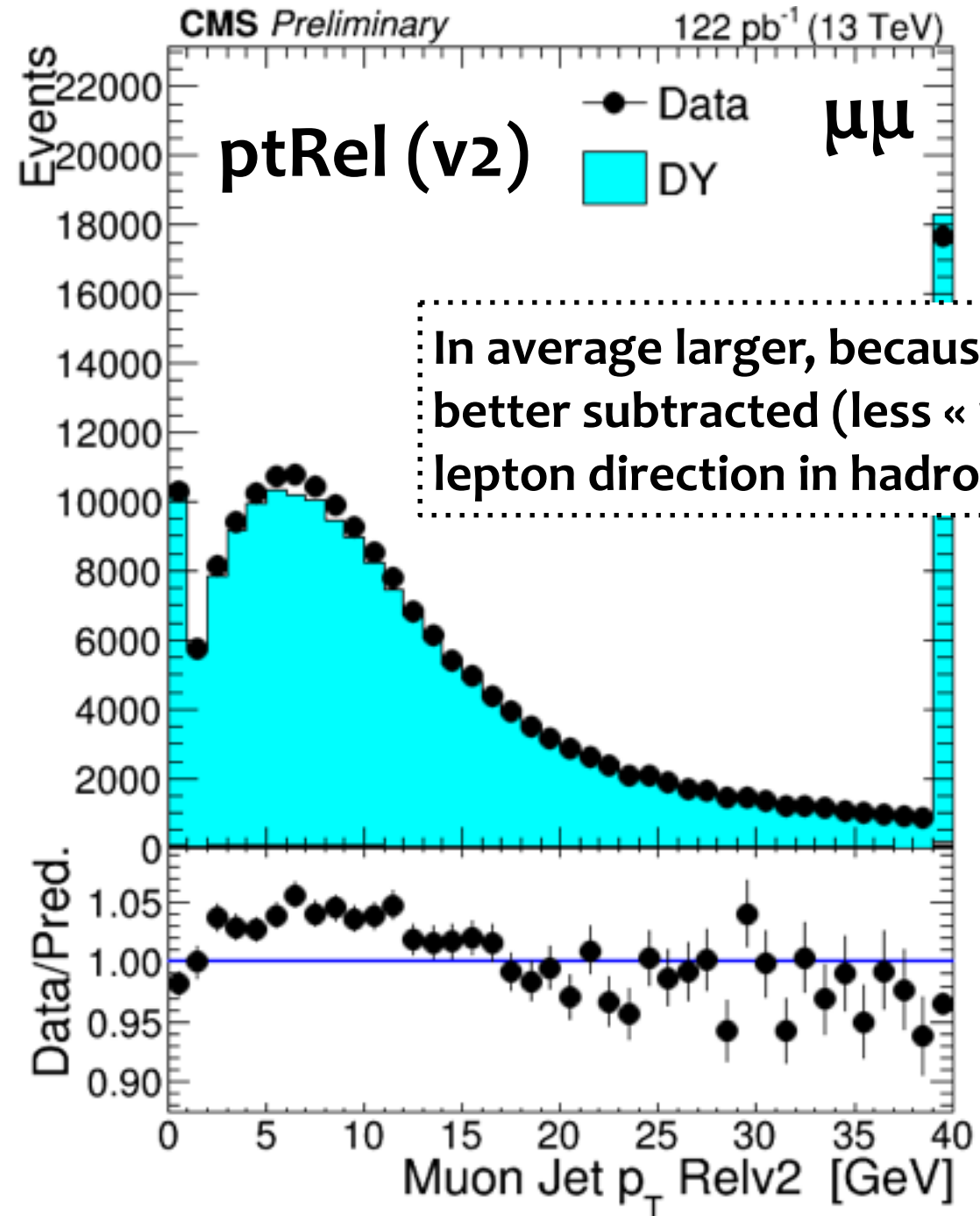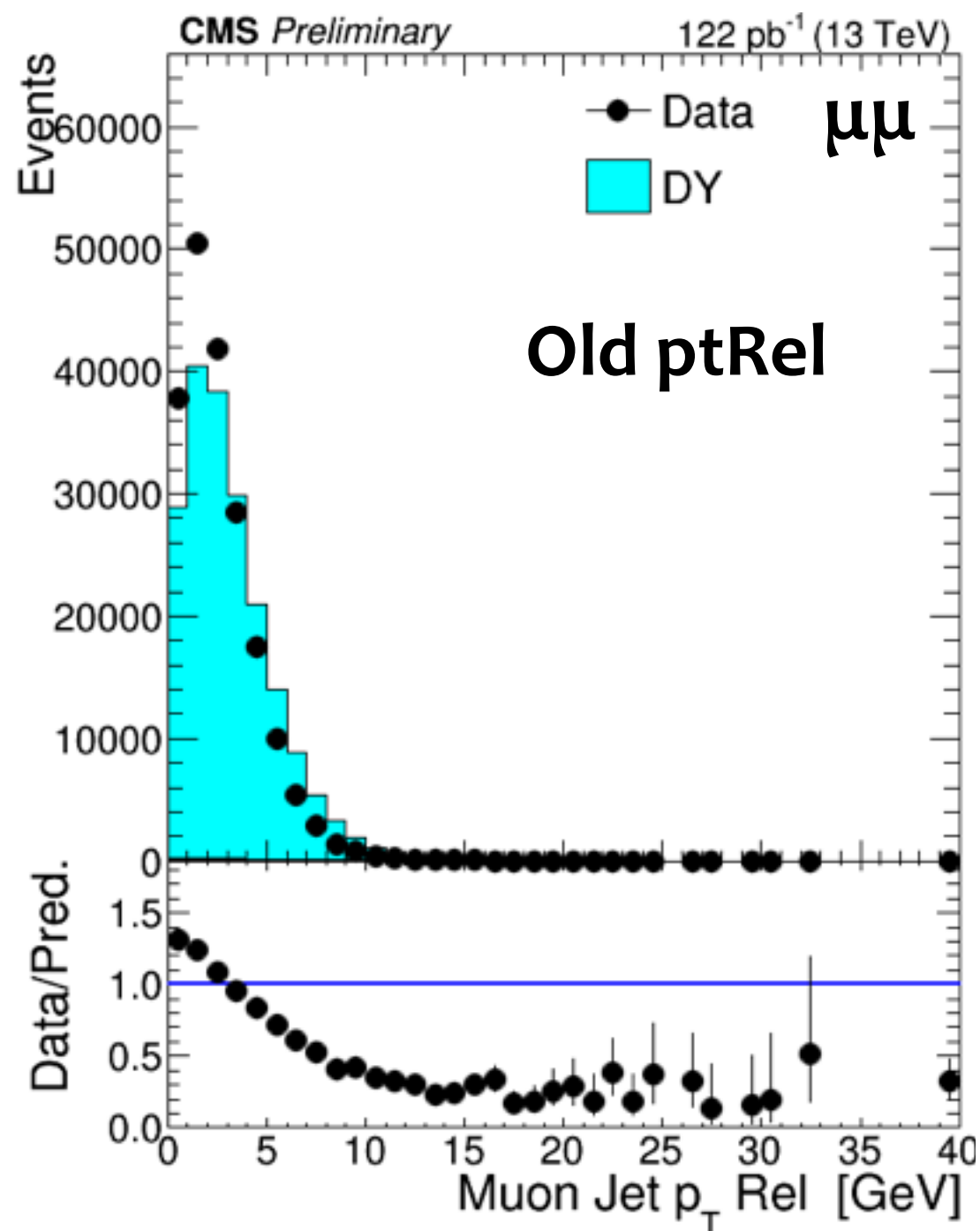**jet_LepAwareJECv2 = (raw_jet * L1 - lepton) * L2L3Res + lepton**

The above equation is intended in vectorial form for both ptRatio and ptRel.

Prompt leptons from Z
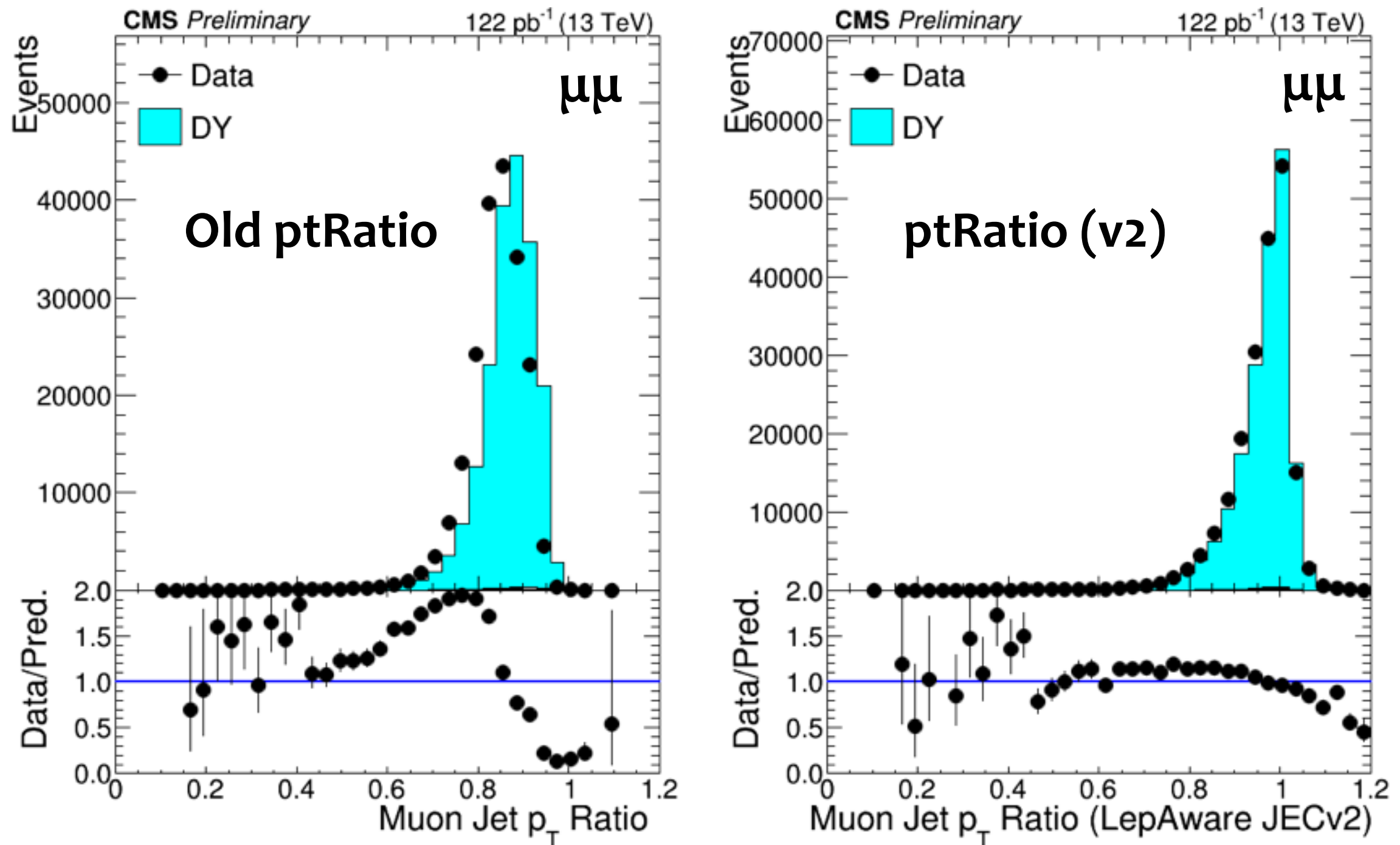
Agreement improved in the whole ptRatio spectrum, will further improve with correct HCAL scale.
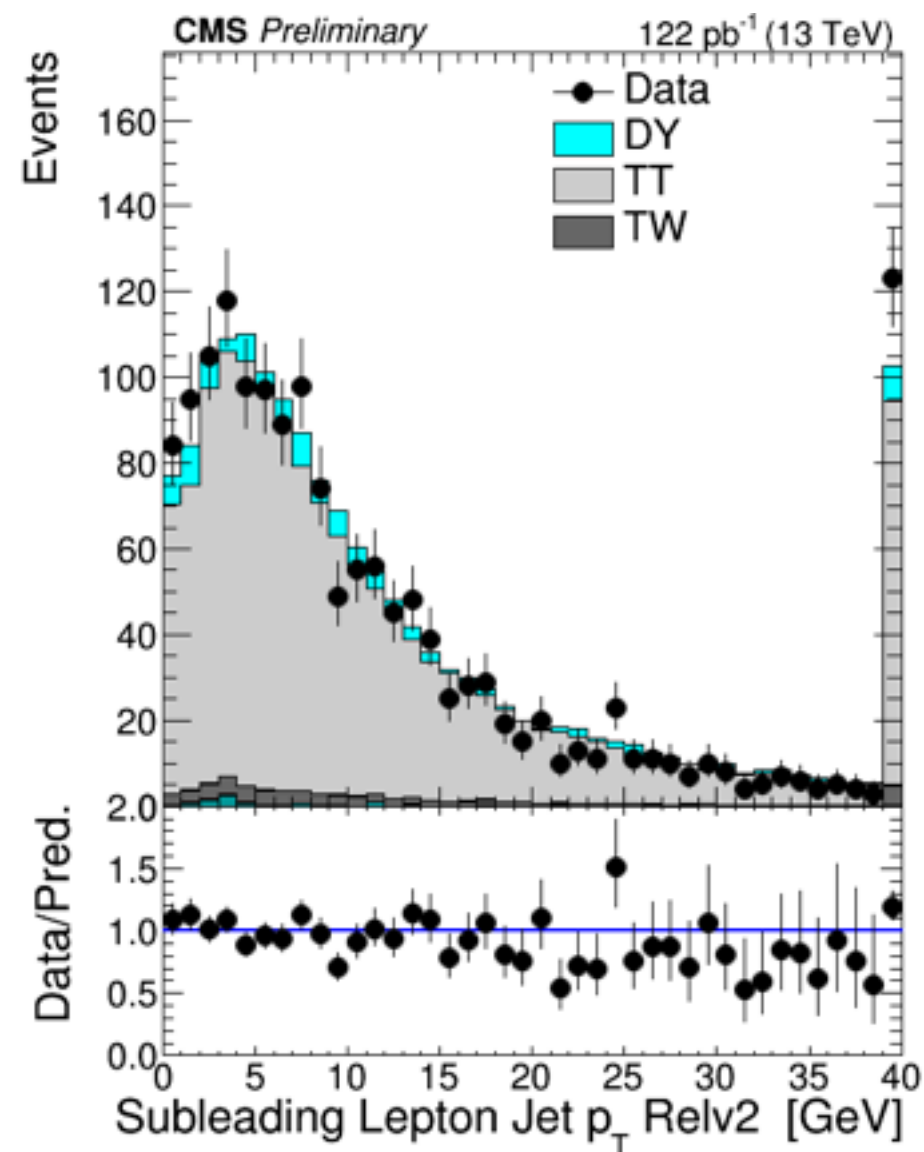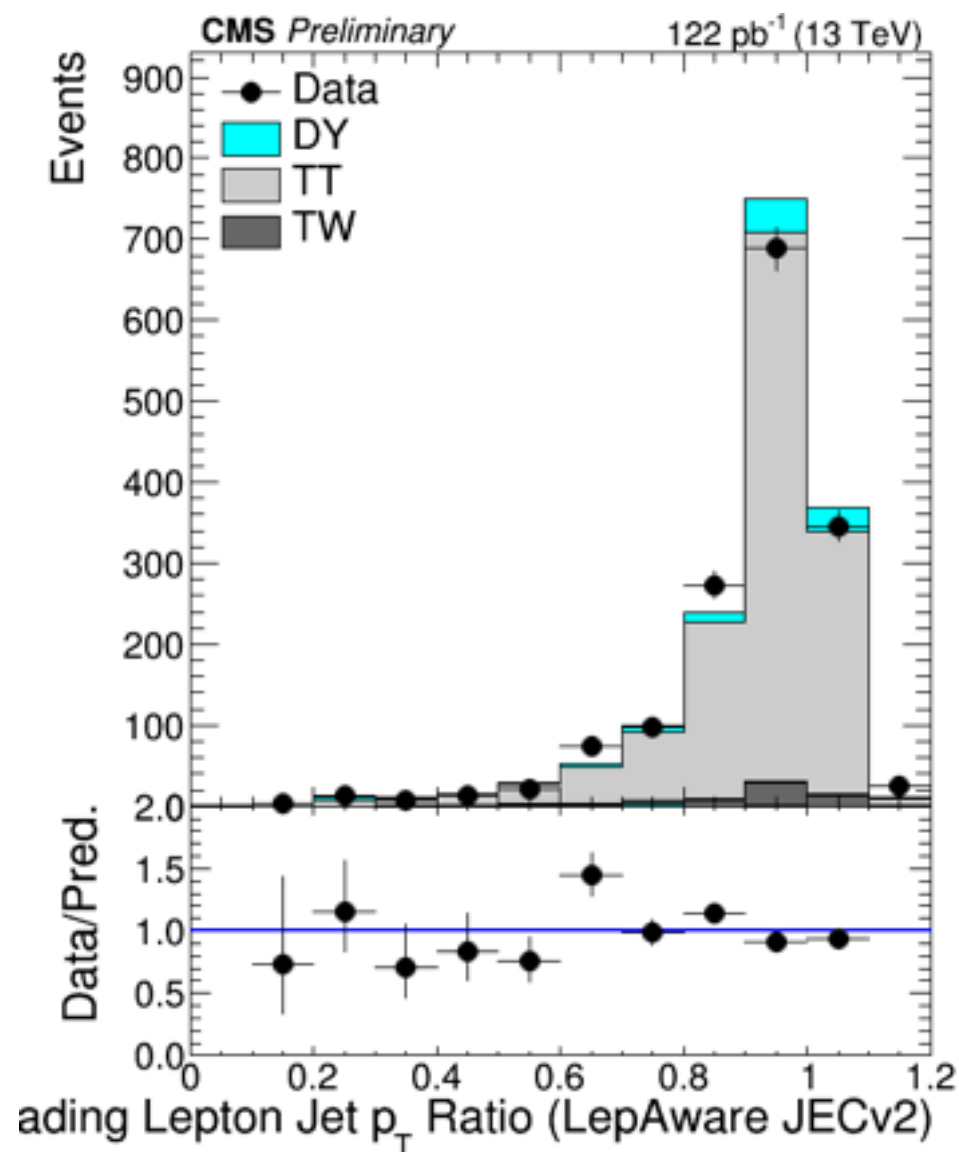
Prompt leptons from Z

Old ptRel

ptRel (v2)

In average larger, because the lepton is better subtracted (less « memory » of lepton direction in hadronic activity)

Data and MC are in much better agreement with the new definition.

Prompt leptons from ttbar

- **"Tag and Probe" approach using tt→eμ events,**
  ≥ 2jets, ≥ 1 btag (CSVM)

Data and MC are in good agreement.

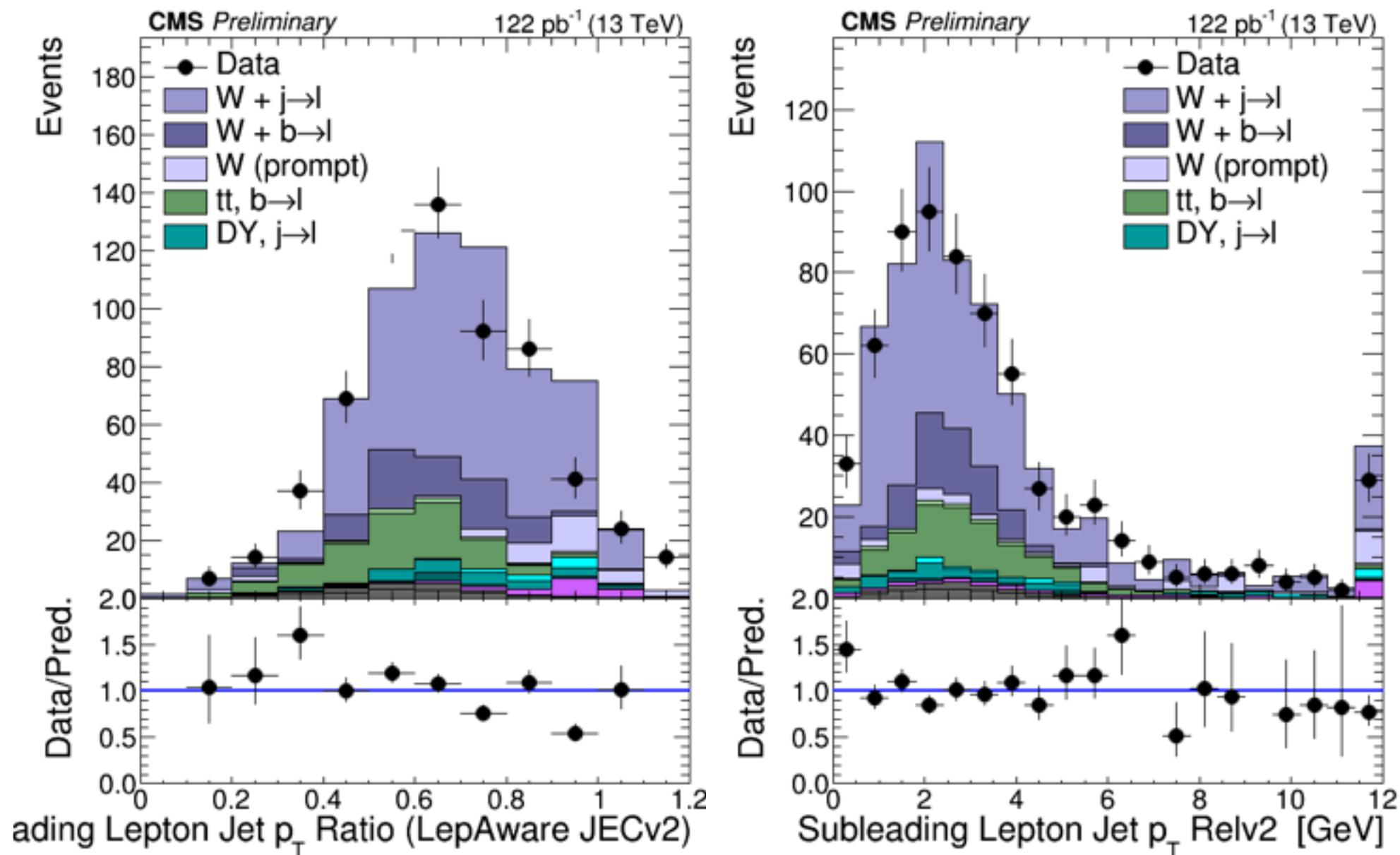# Fake leptons from ttbar

- Select **semi-leptonic ttbar events with a fake lepton**:
  - tight leading lepton (lepMVAttH > 0.6), plot the subleading
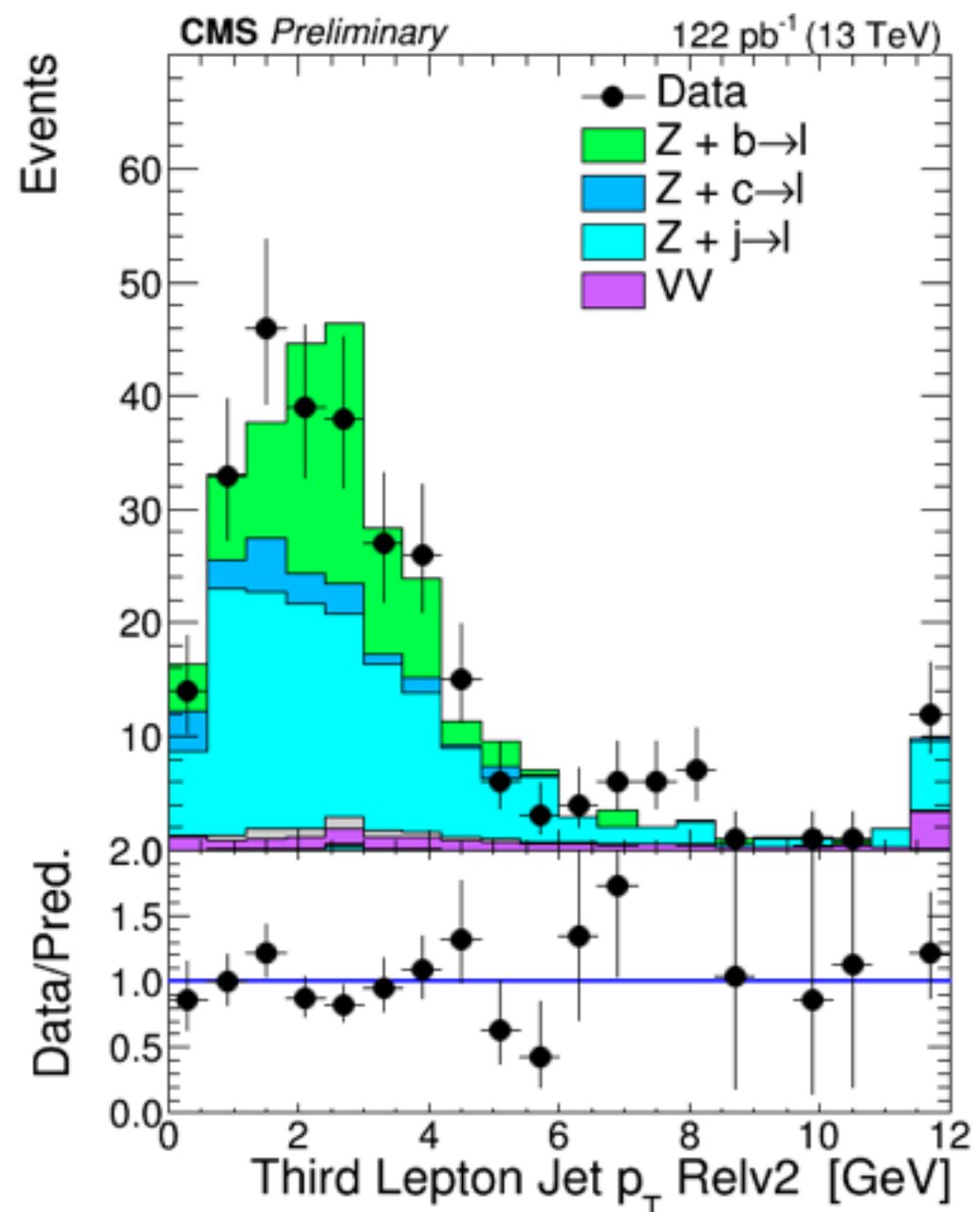 - require same sign, ≥ 2jets, ≥ 1 btag (CSVM)
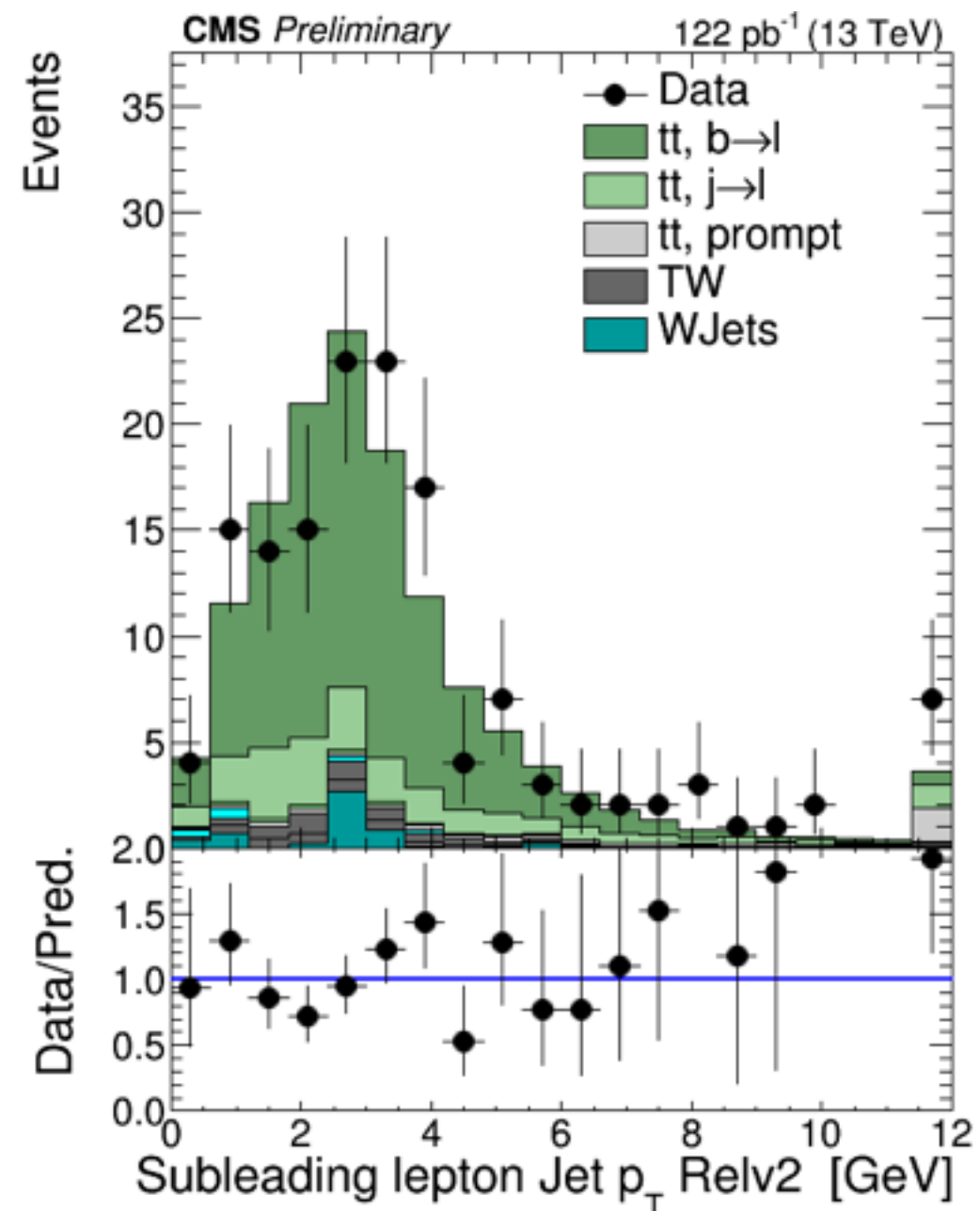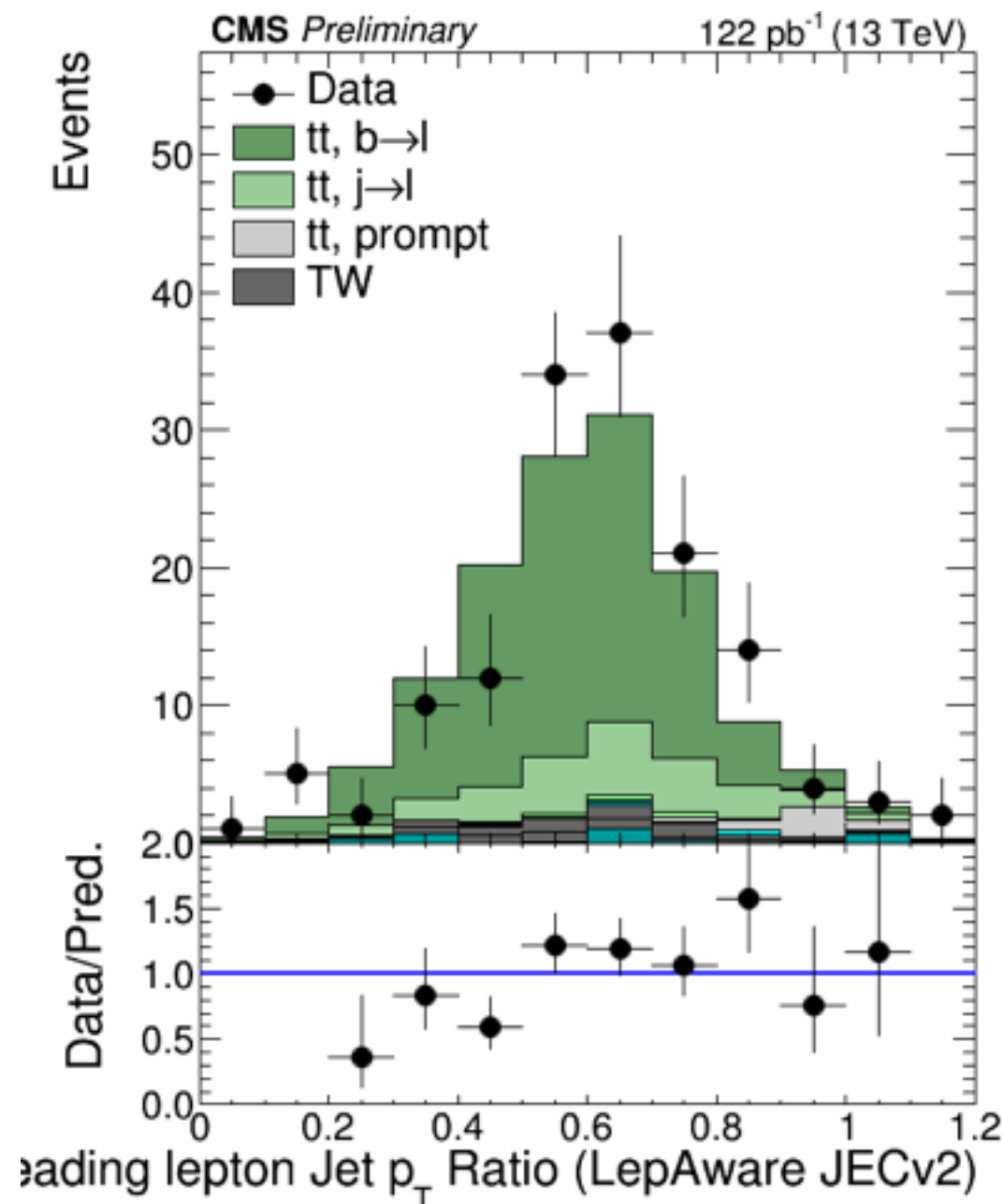
Fake leptons from W+jets
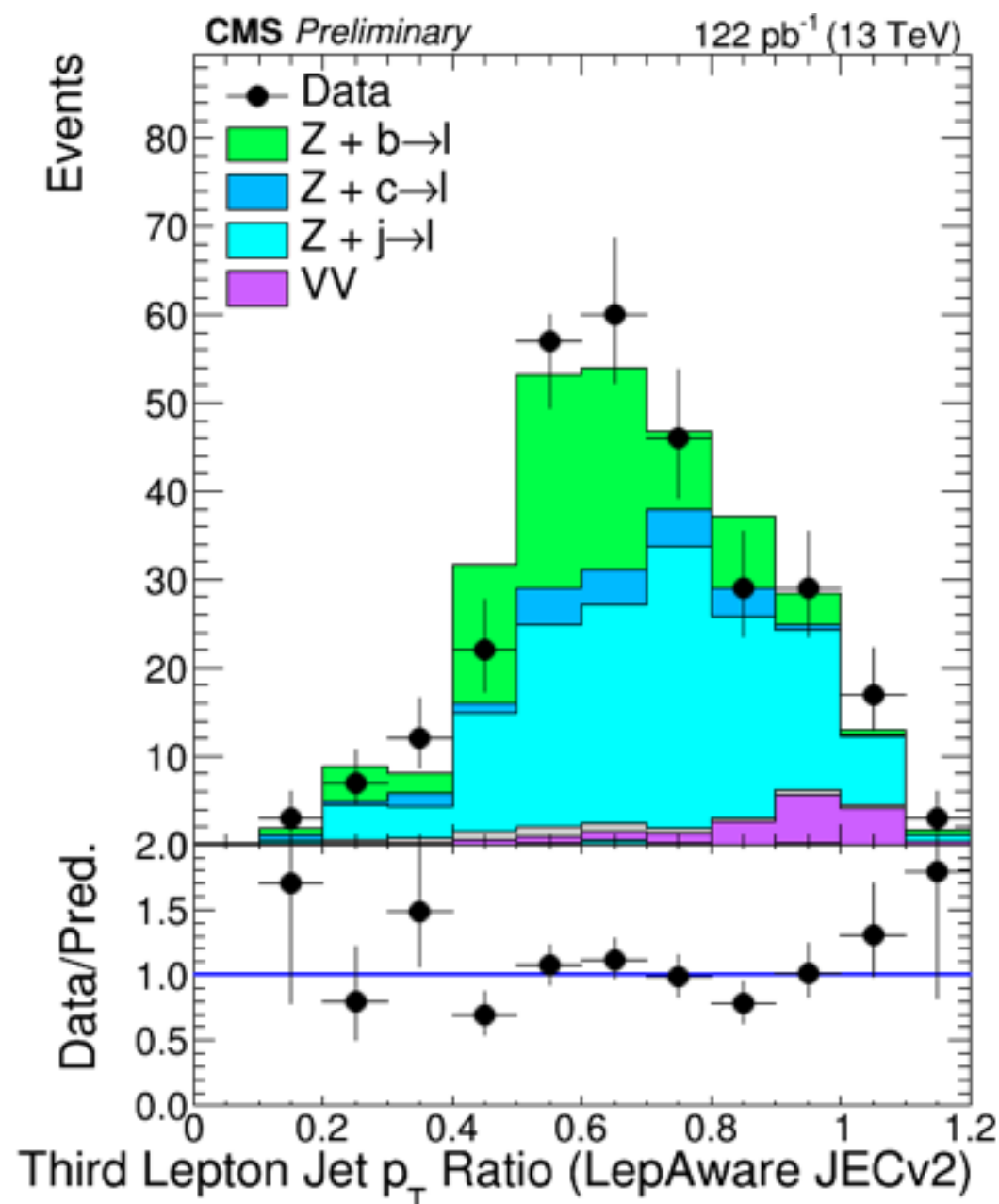
- Select **W+jets events with a fake lepton:**
  - tight leading lepton (lepMVAttH > 0.6), plot the subleading
  - require b-jet veto, $m_T(lep_1, E_T^{miss}) > 40$ GeV

Fake leptons from Z+jets

- Select **Z+jets events with a fake lepton**:
  - pair of leptons with Z inv. mass, low MET
  - look at an additional lepton with $p_T < 50$ GeV

Definition of effective area

Effective areas are extracted fitting the linear dependence of PF isolation components vs. rho (fixedGridRhoFastjetAll).

Lepton selection:

1. matched to **prompt leptons from Z with p_T > 20 GeV**

2. exclude EB/EE gap for electrons

3. 5 < rho < 25 to avoid regions with little statistics

4. **no selection cut on isolation**

The effective areas are extracted in the standard eta bins:

　　　　0.0-0.8, 0.8-1.3, 1.3-2.0, 2.0-2.2, 2.2-2.5 (η for μ, η_{SC} for e)

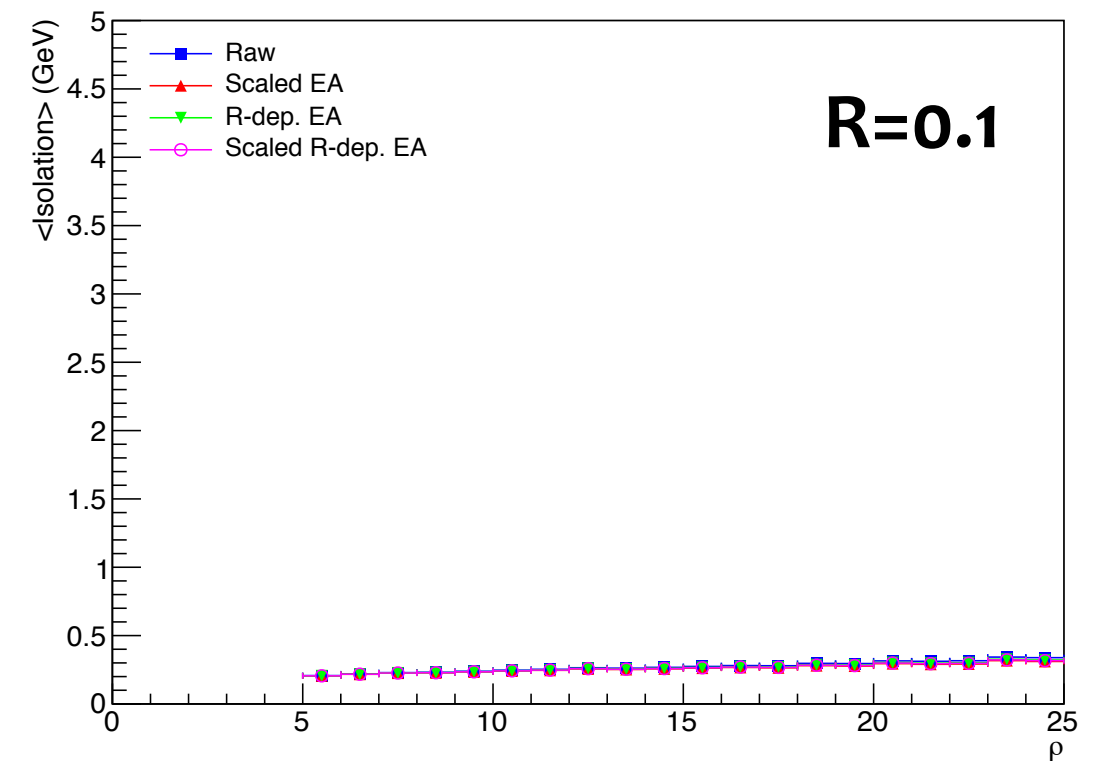and for **several cone sizes:**

0.05, 0.1, 0.2, 0.3, 0.4
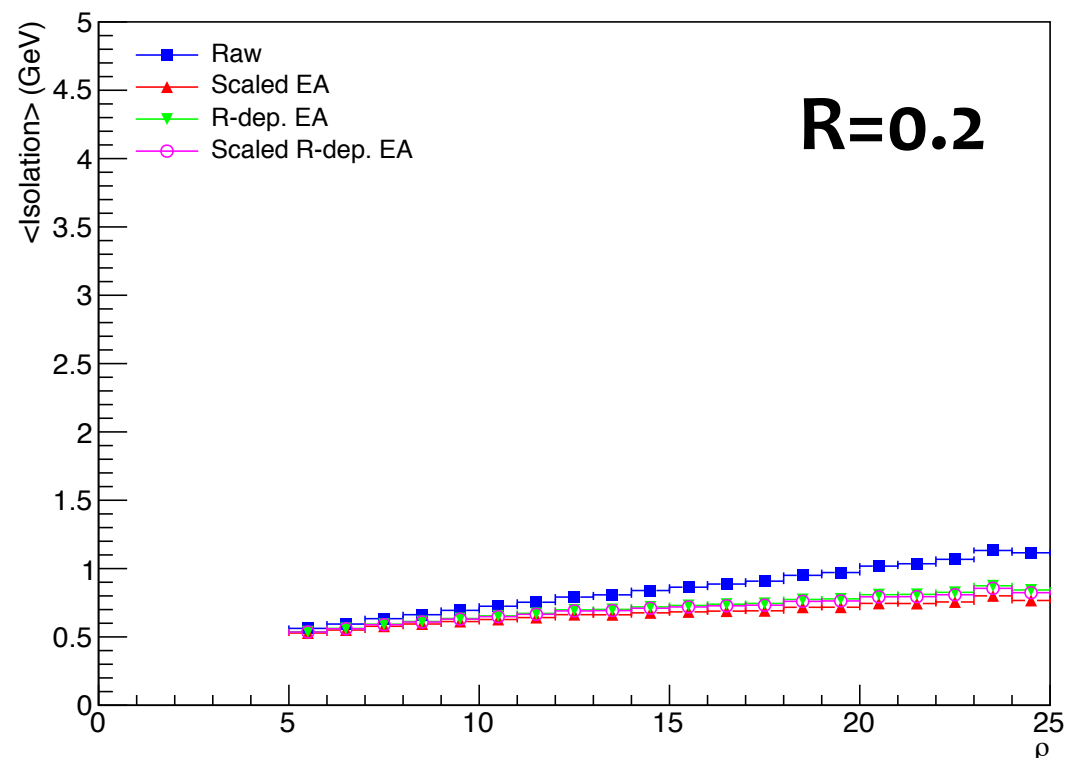
Comparison with scaled EA

Muons

Isolation vs. rho with different EAs:

1. **raw Iso**

2. **Phys14_25ns_v1 R=0.3 EA + scaling**
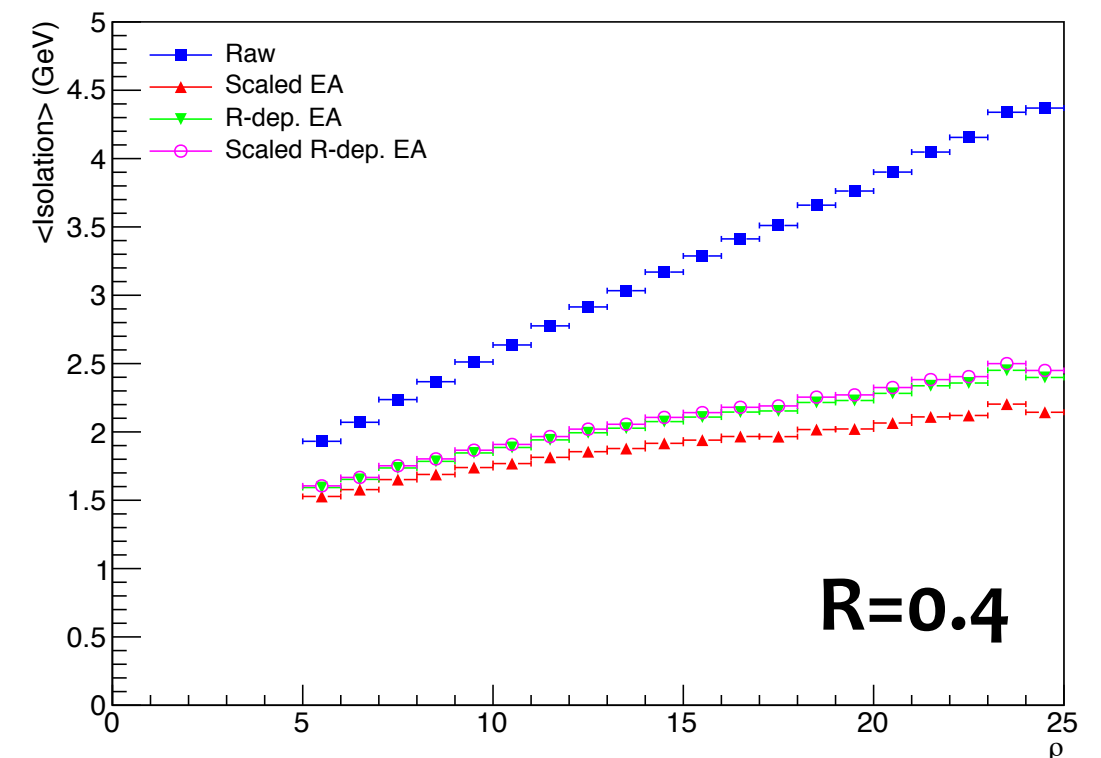
3. **new R-dep. EA**

4. **new R=0.3 EA + scaling**

Muon isolation in R=0.1 cone

R=0.1

Muon isolation in R=0.2 cone

R=0.2

Muon isolation in R=0.4 cone

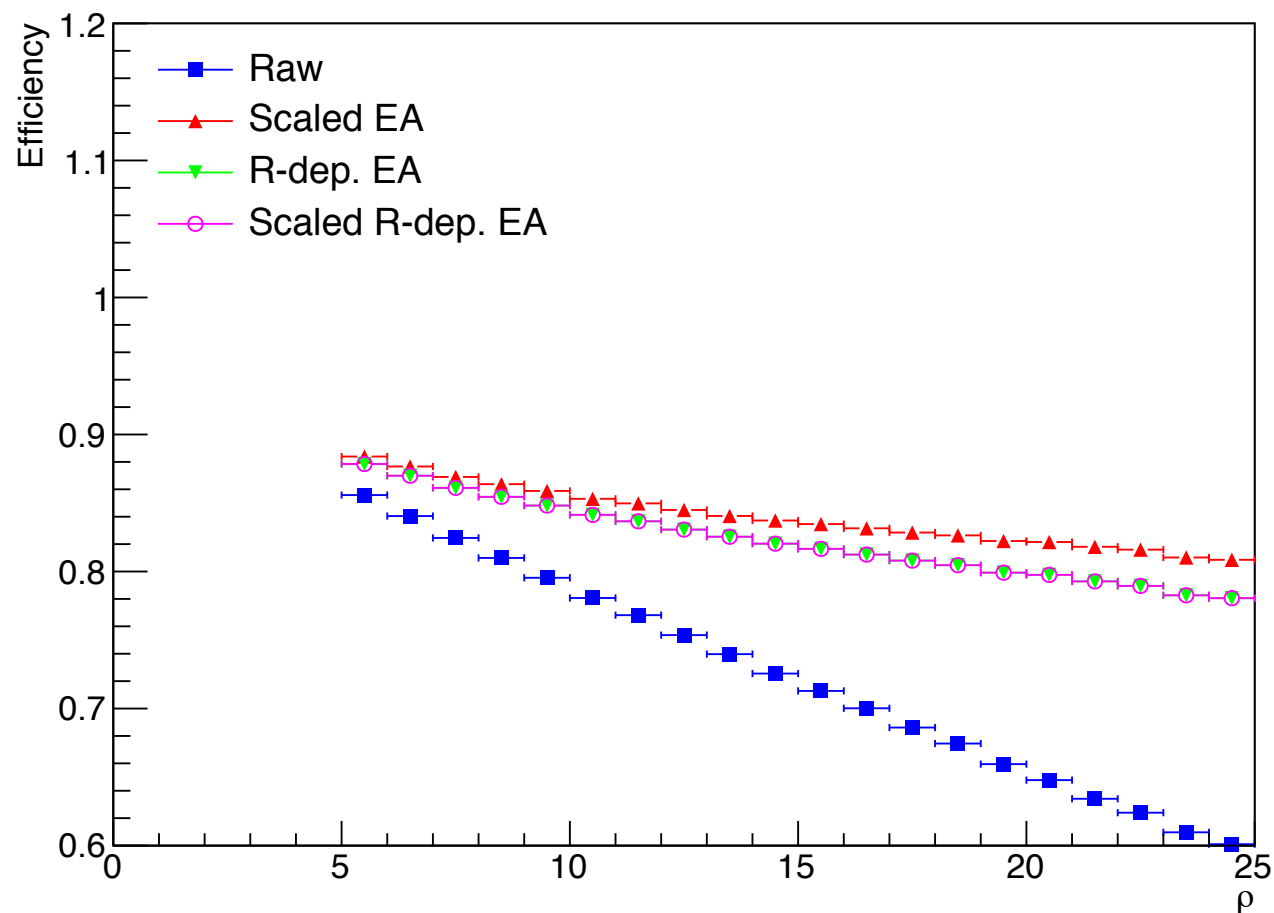**R=0.4**

Effect on lepton efficiency
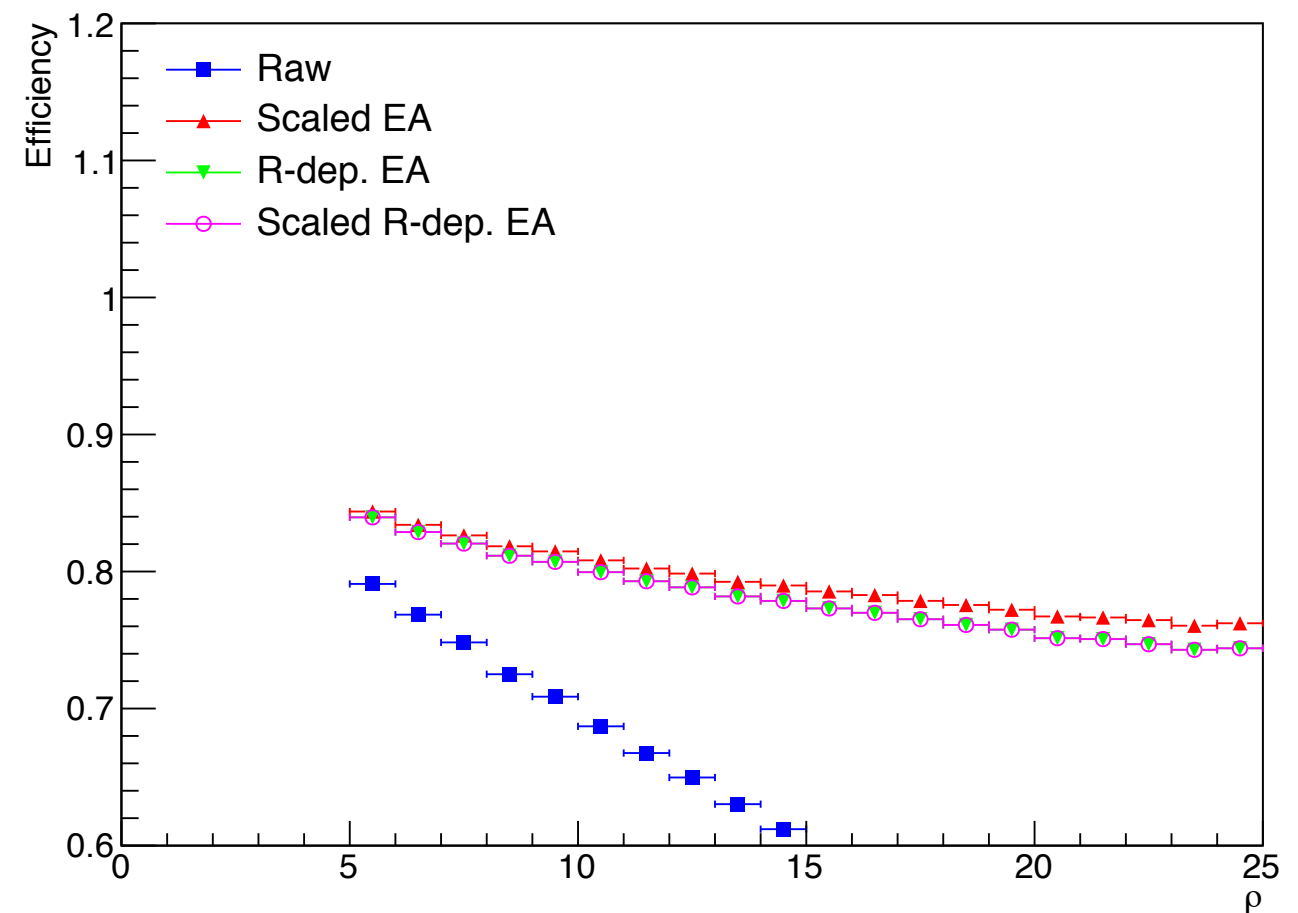
Isolation = charged + max(0,neutral-PU)   **R=0.3**

Muon: efficiency for isolation in R=0.3 cone < 0.05

Electron: efficiency for isolation in R=0.3 cone < 0.05

- **Scaled EAs and R-dependent ones give comparable results.**
- **Planning to use newly derived EAs for muons, EGM ones for electrons.**

Outlook

- We presented a more accurate method for applying JEC to lepton-jets (jets containing a hard lepton).
  The « lepton-aware » JEC is applied only to the hadronic activity surrounding the lepton, and not to the lepton itself.

- The **data/MC agreement is now good for both prompt leptons** (in Z and tt) **and fakes** (in W,Z+jets and tt semileptonic events).

- We have derived **new effective areas** for miniIso in Spring 15 MC:
  - ▸ checked that EA for 0.3 cone can be scaled to smaller cones