Flavour Tagging Commissioning with Data

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Exotic Dijet Weekly
27/07/15

Aims

• Need to Commission Flavour tagging for Run2
- New tracker and new alignment will affect b-tagging.
- Important prerequisite for physics analysis with b-jets.

• Pub note for Data Commissioning for Flavour Tagging in Run2 Data
- Comparing data to MC in dijet and top events.
- This talk will focus on dijet events.
- Discussions of top events will occur in the top group.

Progress on Note

• Originally aimed for EPS
- Delayed due to problems with impact parameter resolution.

• Now targeting for Lepton Photon
- First set of plots produced, framework in place.
- Note is written: https://cds.cern.ch/record/2032461
- First reading has occurred and first set of comments have now been addressed.

3 Samples

- MC Sample:

- **Full xAOD**
- 50ns dijet MC sample data
- Split into 4 slices and the re-weighted (see backup) JZ1W-JZ4W - No JZ0W used.
- ~ 8M Events.

"mc15_13TeV.361021.Pythia8EvtGen_A14NNPDF23LO_jetjet_JZ1W.merge.AOD.e3569_s2576_s2132_r6630_r6264/"
"mc15_13TeV.361022.Pythia8EvtGen_A14NNPDF23LO_jetjet_JZ2W.merge.AOD.e3668_s2576_s2132_r6630_r6264/"
"mc15_13TeV.361023.Pythia8EvtGen_A14NNPDF23LO_jetjet_JZ3W.merge.AOD.e3668_s2576_s2132_r6630_r6264/"
"mc15_13TeV.361024.Pythia8EvtGen_A14NNPDF23LO_jetjet_JZ4W.merge.AOD.e3668_s2576_s2132_r6630_r6264/"

- Data Sample:

- 50ns data from stable beam collisions.
- **FTAG** derivation
- ~6M Events from 7 Runs: 270806, 270953, 271048, 271298, 271421, 271516 and 271595
- This corresponds to 770K events passing cuts.

"data15_13TeV.00270806.physics_Main.merge.DAOD_FTAG1.f611_m1463_p2375/"
"data15_13TeV.00270953.physics_Main.merge.DAOD_FTAG1.f611_m1463_p2375/"
"data15_13TeV.00271048physics_Main.merge.DAOD_FTAG1.f611_m1463_p2375/"
"data15_13TeV.00271421.physics_Main.merge.DAOD_FTAG1.f611_m1463_p2375/"
"data15_13TeV.00271516.physics_Main.merge.DAOD_FTAG1.f611_m1463_p2375/"
"data15_13TeV.00271595.physics_Main.merge.DAOD_FTAG1.f611_m1463_p2375/"

- We are using NTuples created using Run2BTagOptimisationFramework

Details and Cuts

- 20.1.5.3 with all tags recommended by CP group
- Running xAOD fix on full xAOD

- **HLT_j60 Trigger with Leading Jet P_T > 70 GeV.**

- AntiKt4EMTopoJets
- Run1LooseBadCuts and "ugly" jet removal.

- Jet Calibration:

```
- calibfile  ="JES_MC15Prerecommendation_April2015.config"
- calSeg     ="JetArea_Residual_Origin_EtaJES_GSC" (_Insitu for data)
```

- GRL = *"data15_13TeV.periodAllYear_DetStatus-v63-pro18-01_DQDefects-00-01-02_PHYS_StandardGRL_All_Good.xml"*

Select event if leading jet has:
- njets ≥ 1
- $|\eta| < 2.5$
- $P_T > 70$ GeV
- JVT > 0.641 if ($P_T < 50$ GeV and $|\eta| < 2.4$)

Then plot subleading if subleading jet has:
- $P_T > 35$ GeV
- $|\eta| < 2.5$
- JVT > 0.641 if ($P_T < 50$ GeV and $|\eta| < 2.4$)

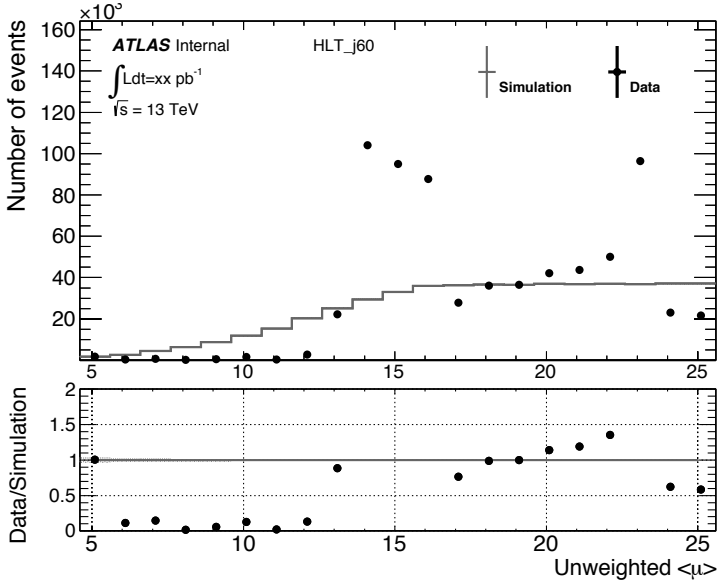
Just For MC

Truth Dijet Test applied to MC to clean sample
- (Lead P_T +Sublead P_T)/2 < 1.4* Truth Lead P_T, for njet > 1
- (Sublead P_T < 1.4 * Truth Sublead P_T), for njet =1

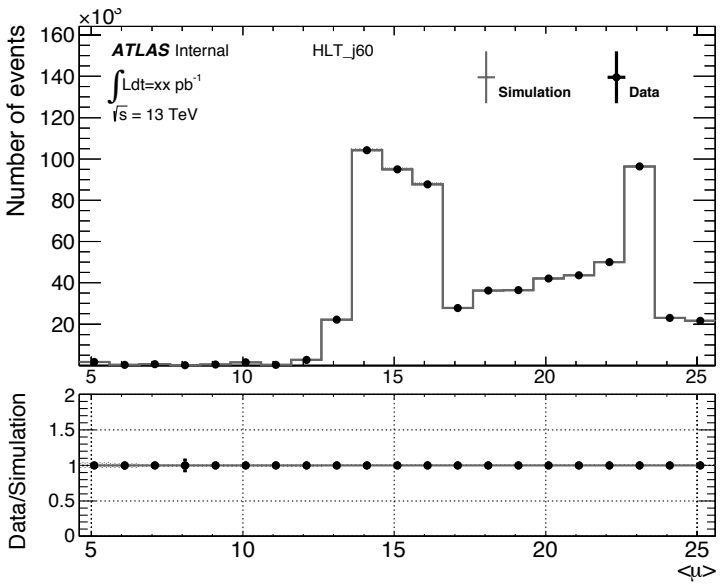
- LabDr_HadF truth matching.

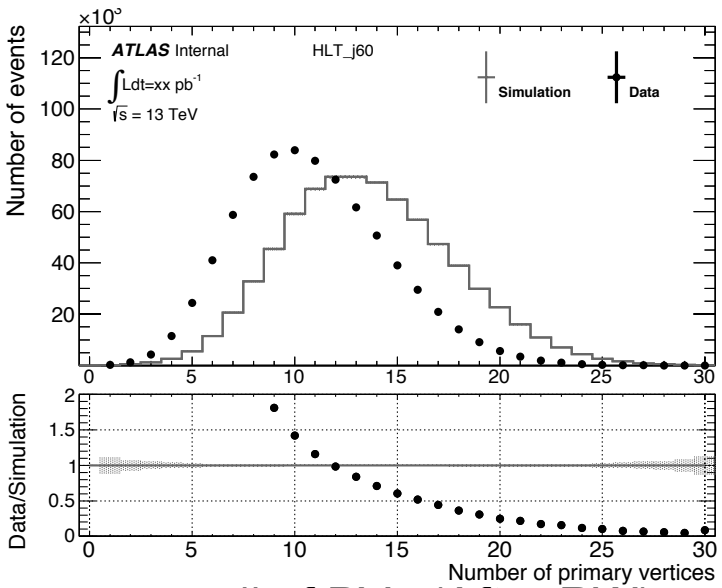
<μ> Reweighting

Before:

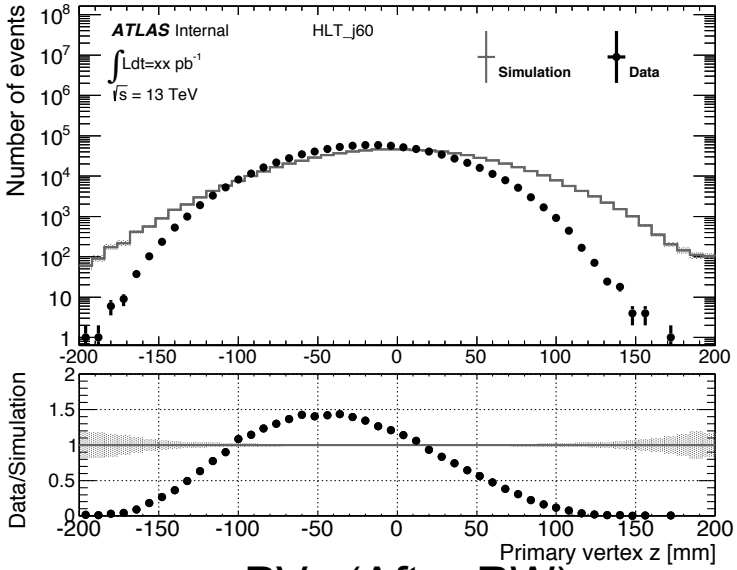


After:





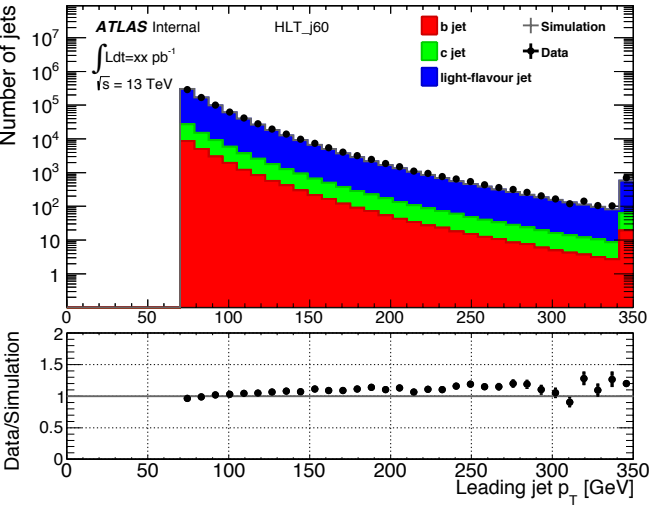
# of PVs (After RW)



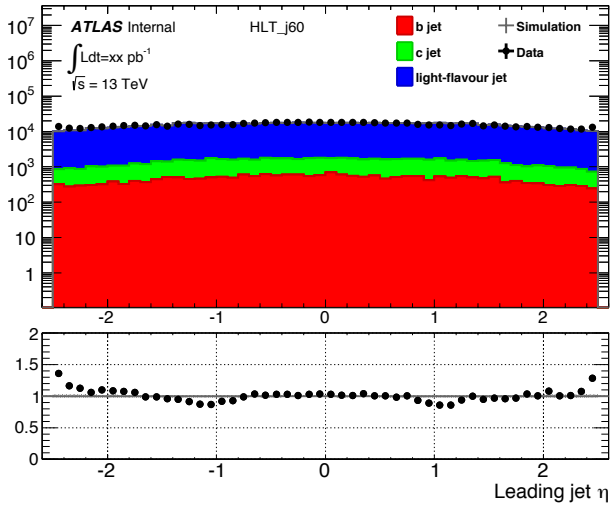
PVz (After RW)

Jet Kinematic Distributions

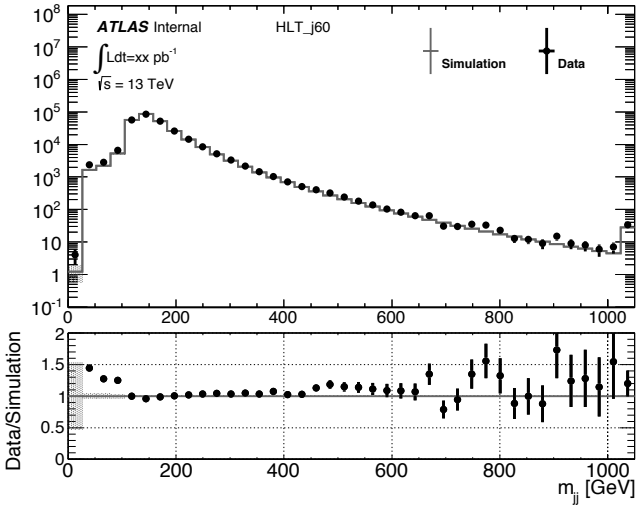
Leading Jet:



Jet P_T

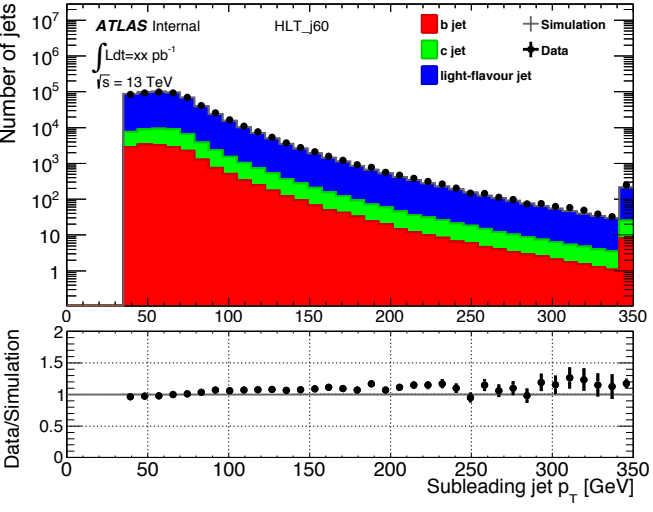


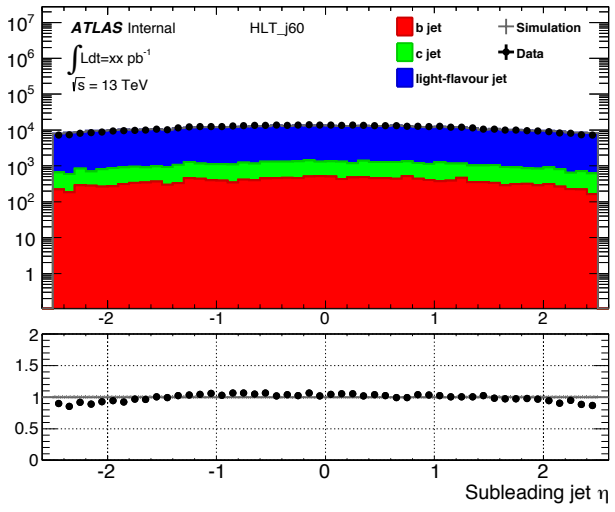
Eta



m_{jj}

Sub-Leading Jet:

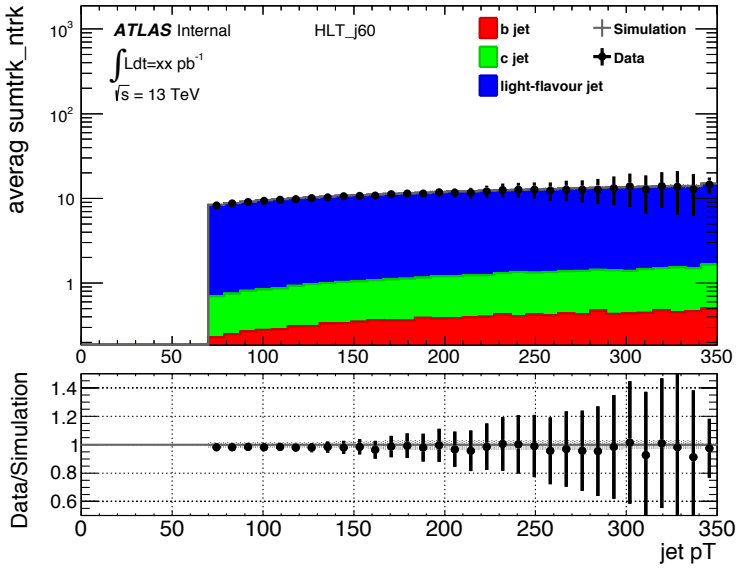




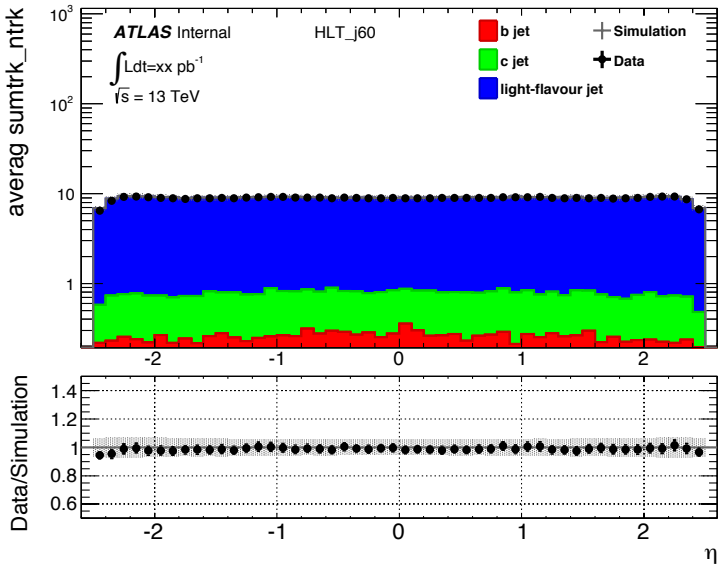
$|y^*| < 1.6$

Tracks / # Jets

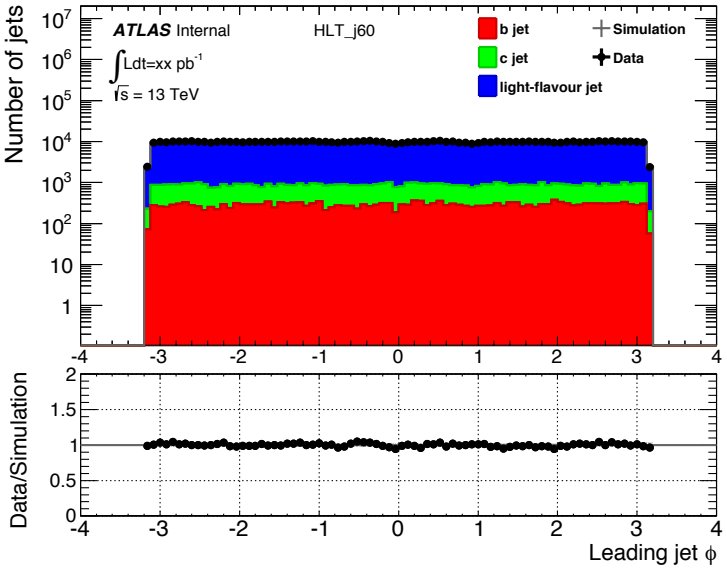
Vs. Jet pT: *Tight PV*



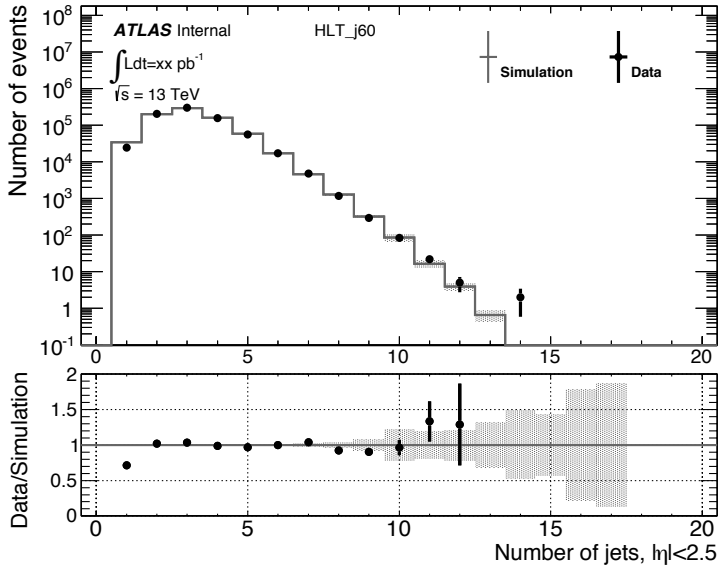
Vs. Eta: *Tight PV*



Vs. Phi: *Tight PV*

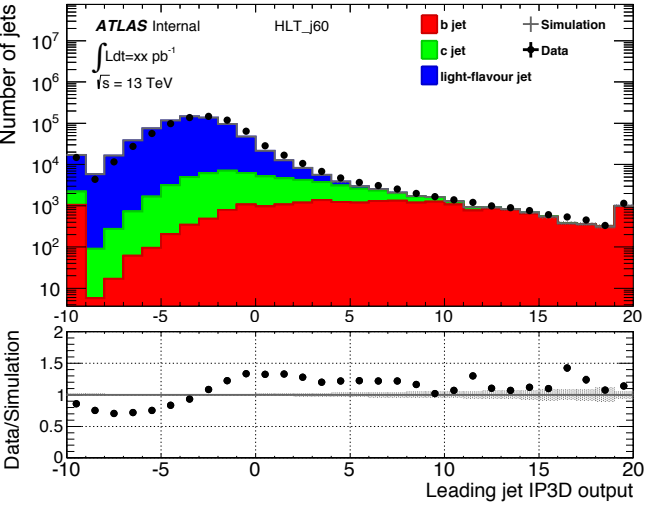


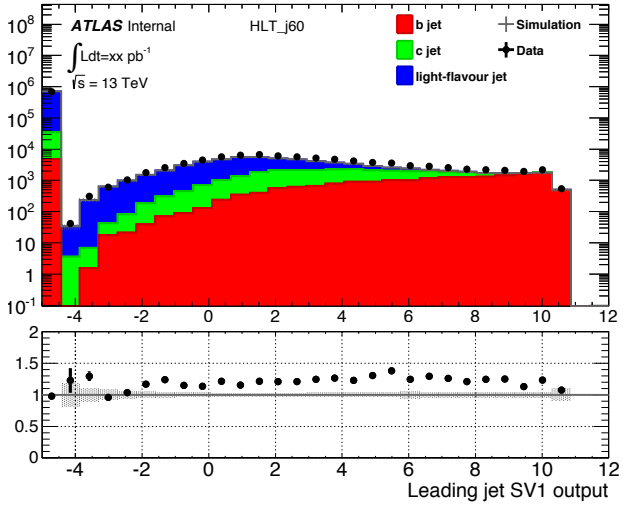
Jet Multiplicity:

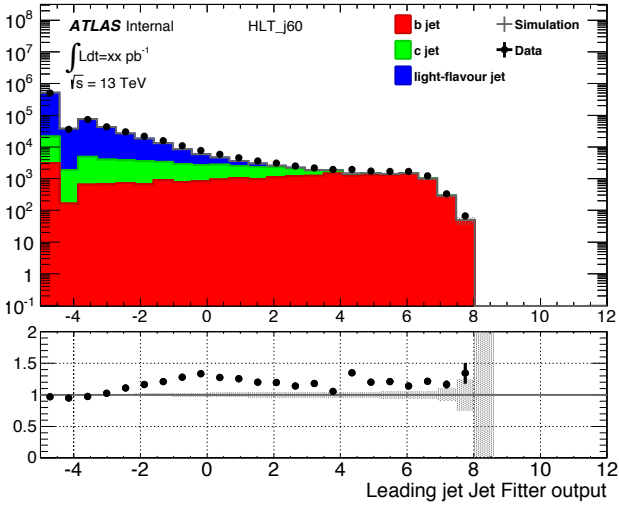


Input Taggers

Leading Jet:

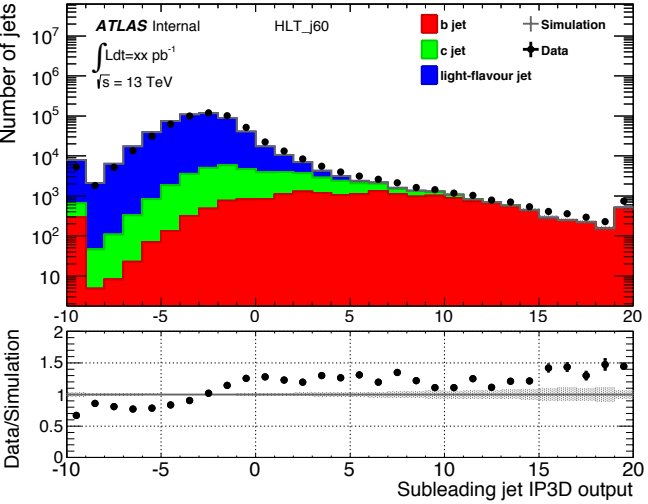


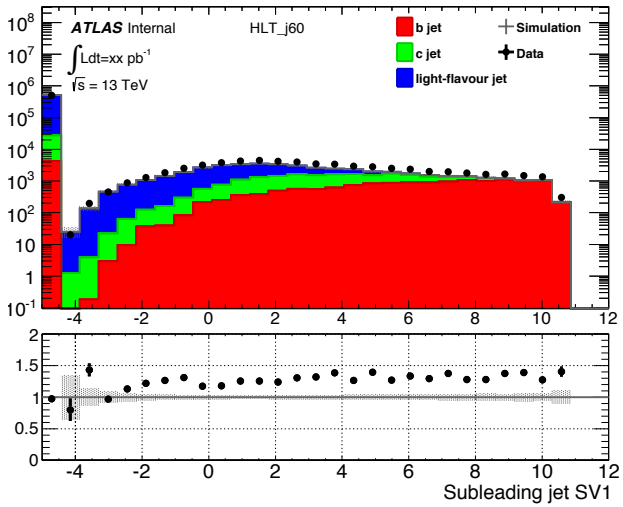


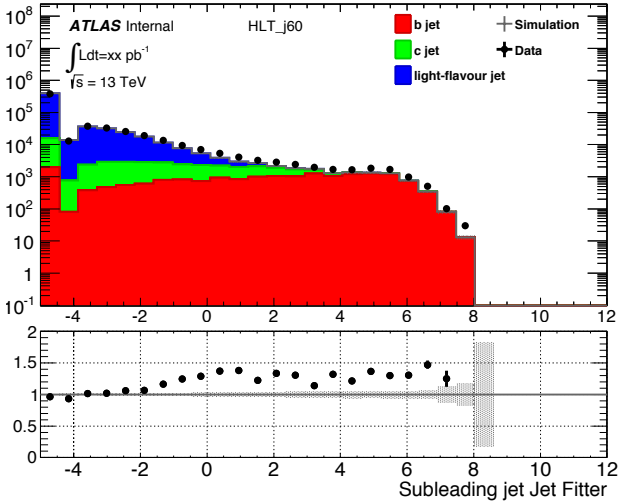


IP3D SV1 JF

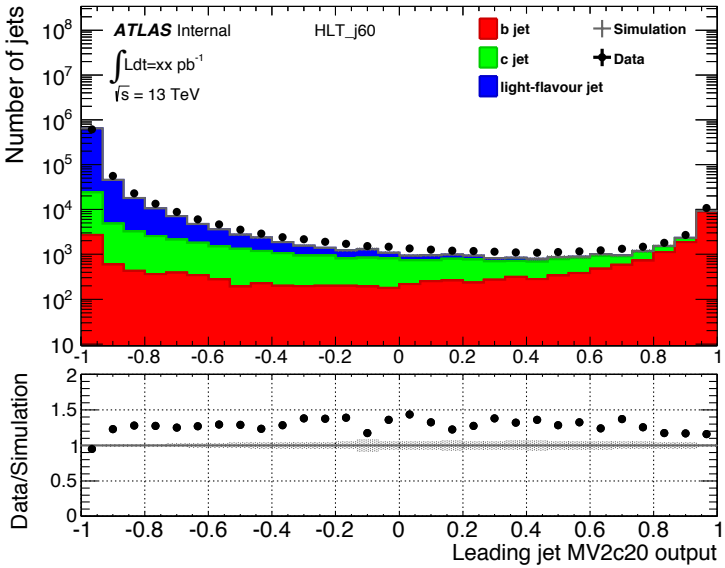
Sub-Leading Jet:

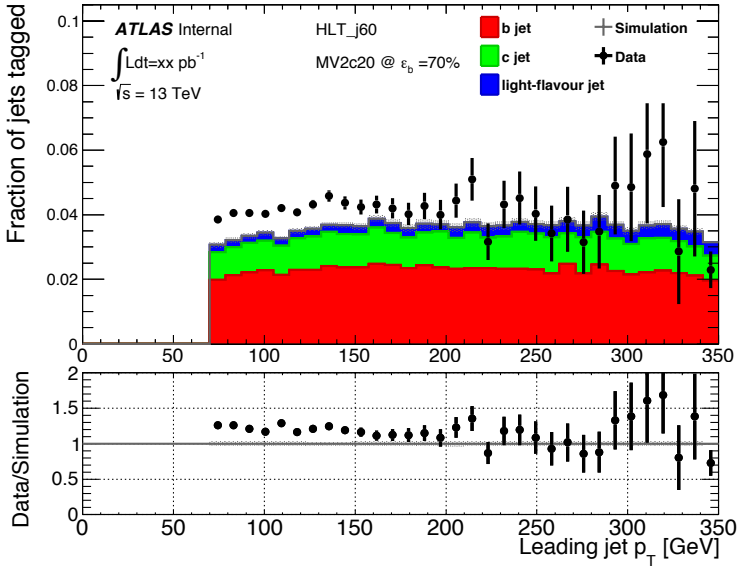






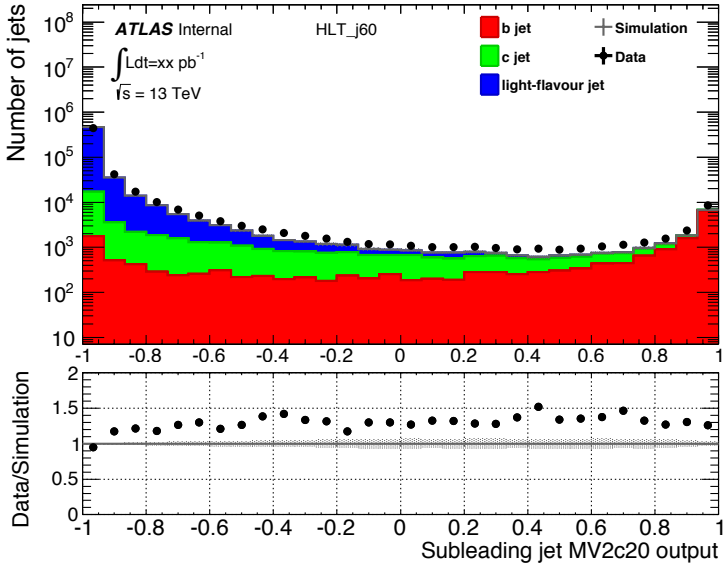
Leading Jet:





Sub-Leading Jet:

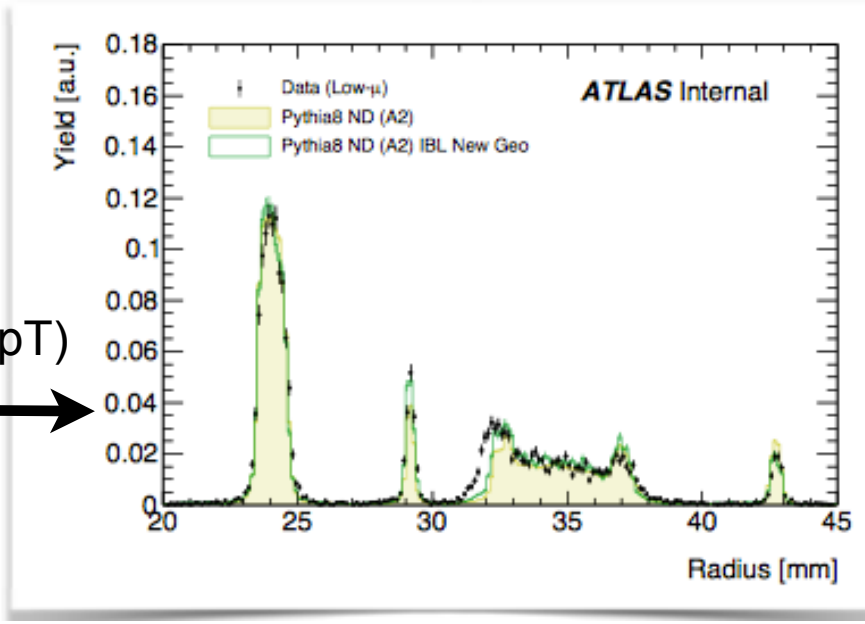
MV2c20

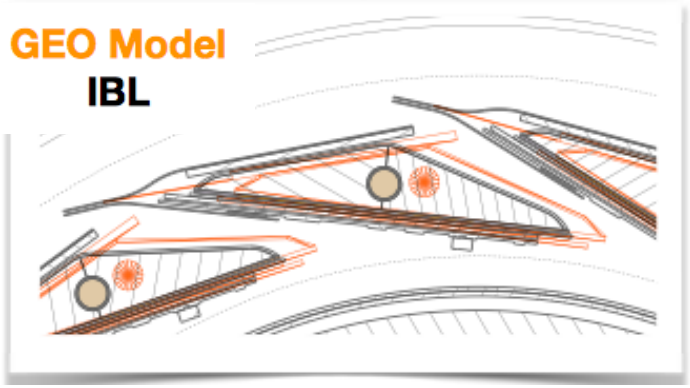


Tag Rate

Problems

- Problem with error scaling
  - Has been fixed in the newest data
- Imperfect alignment (high pT)
- Geometry tag missing 23% IBL material (low pT)
  - New Geo. Tag Produced and validated.
- Angle of overlap issue
  - Geo. Tag available for 25ns data.





Simone Pagan Griso, Heather Gray

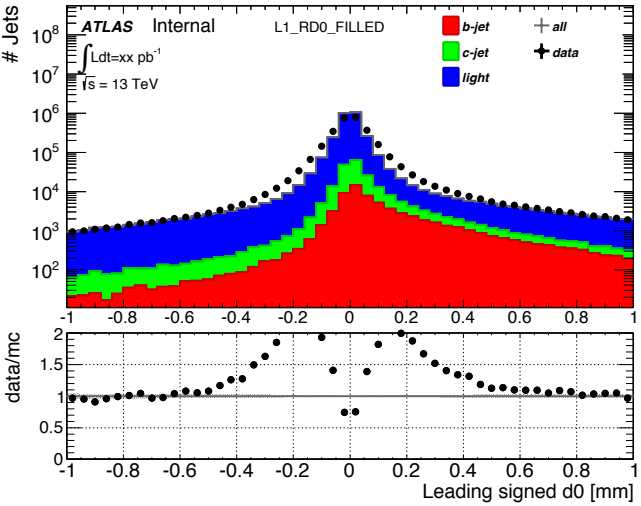
https://indico.cern.ch/event/433839/contribution/6/attachments/1128840/1612854/PC_20jul.pdf

Proposal

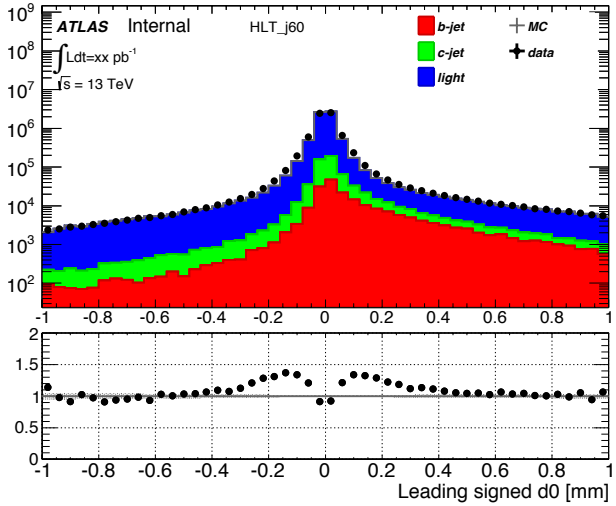
- Suggest **updating tracking geometry** ahead of 25 ns data
  - Improve impact **parameter significance** in data
  - More appropriate use of **error scaling**
- However
  - Inconsistent with **50 ns data** until the next reprocessing
  - Inconsistent in terms of material description with the **MC**
  - At least one **known problem** in the updated geometry
- We think this is the most appropriate strategy because it allows us to obtain the highest quality data we can even at the cost of the complexity of a **geometry mismatch** between data and MC

Signed d0 and d0-Significance

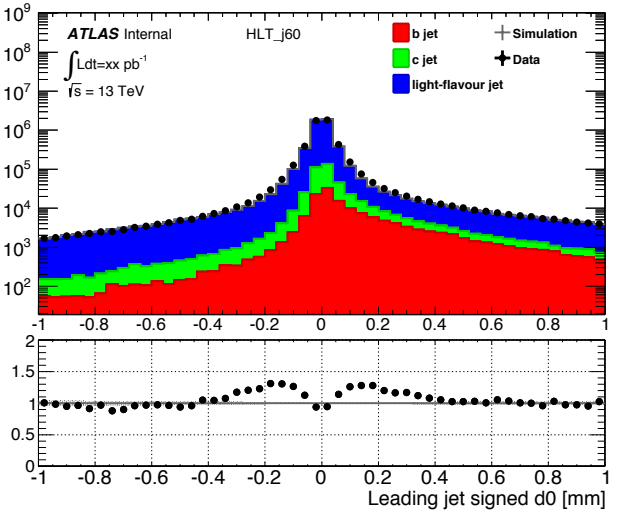
d0:



First Stable Beams (267073)
- Poor Alignment

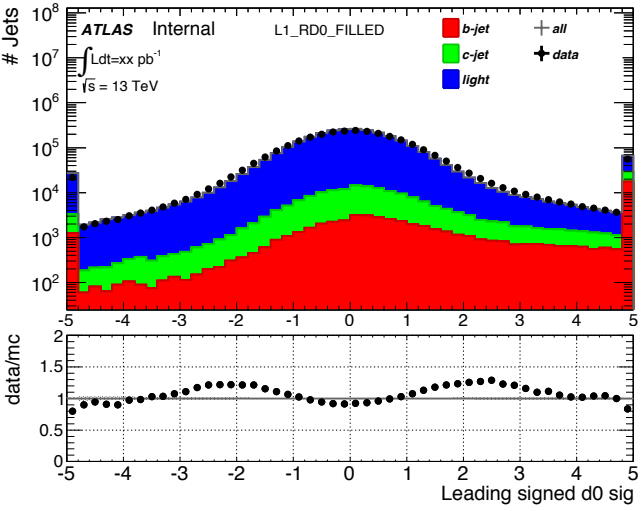


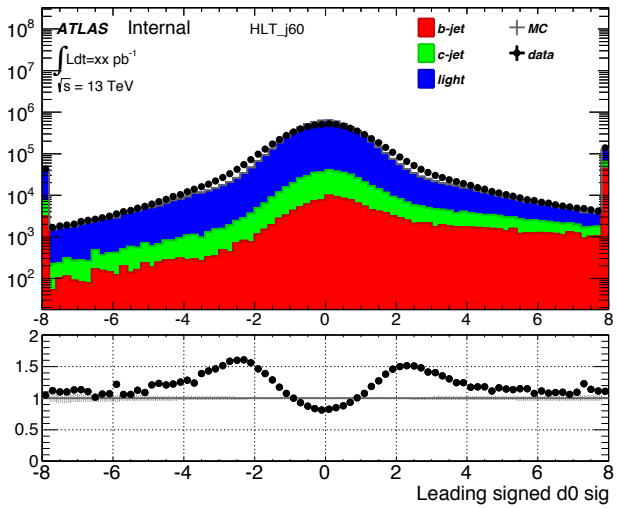
Run 267639
- Improved Alignment
- Faulty Error Scaling

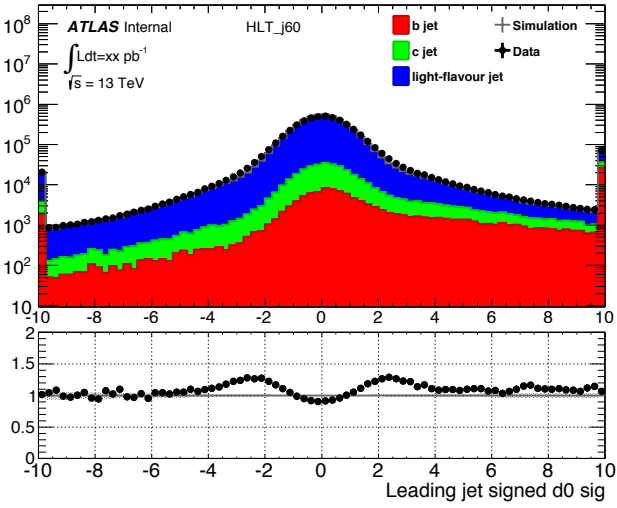


Current (270806-271595)
- Missing Material
- Overlap Issue

d0 Significance:

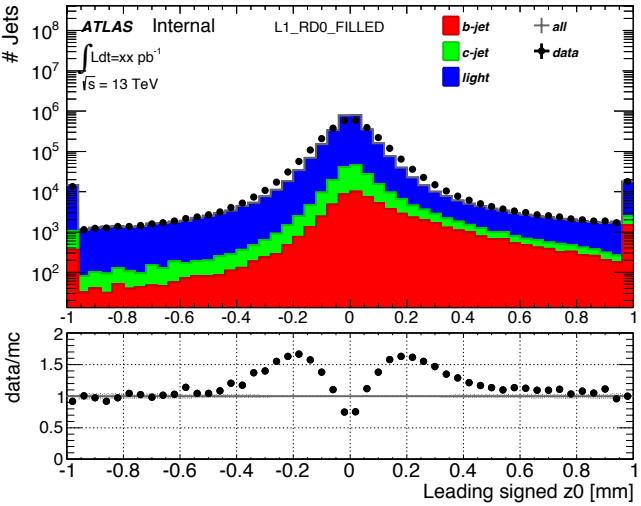




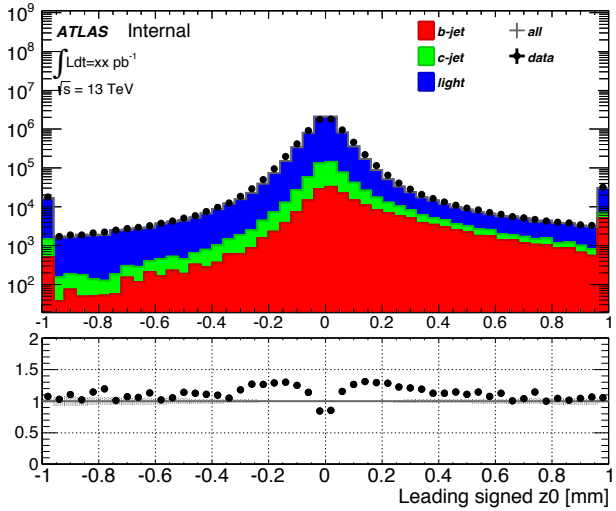


Signed z0 and z0-Significance

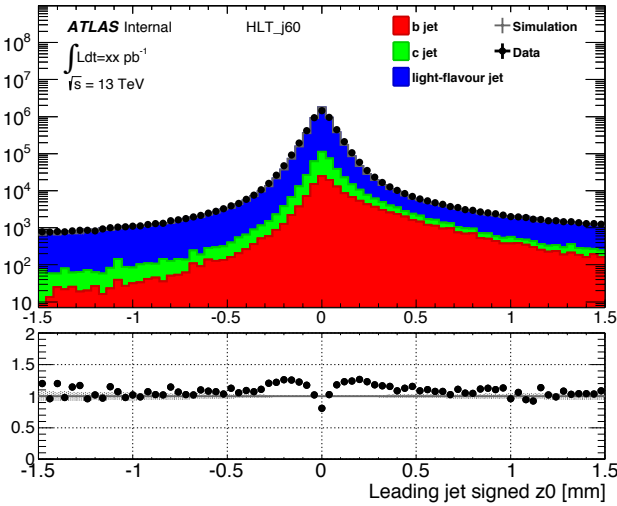
z0:



First Stable Beams (267073)
- Poor Alignment

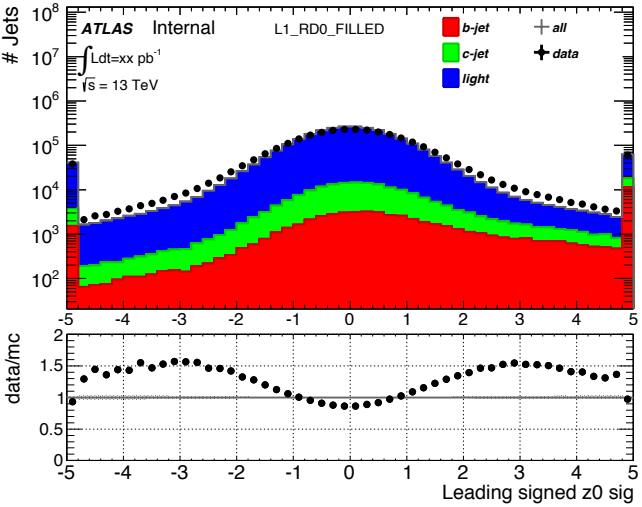


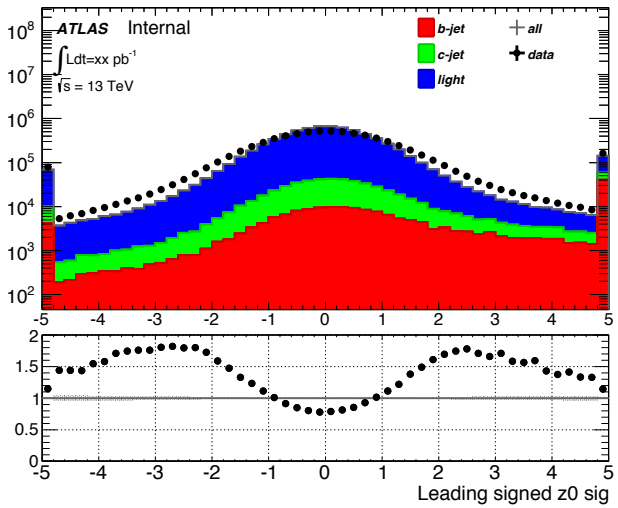
Run 267639
- Improved Alignment
- Faulty Error Scaling

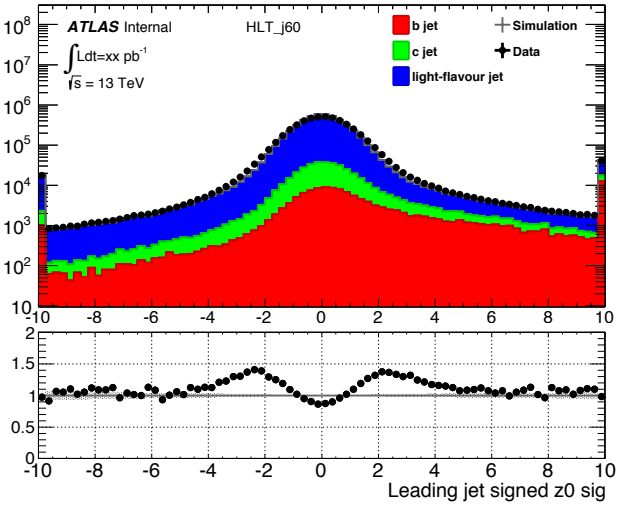


Current (270806-271595)
- Missing Material
- Overlap Issue

z0 Significance:

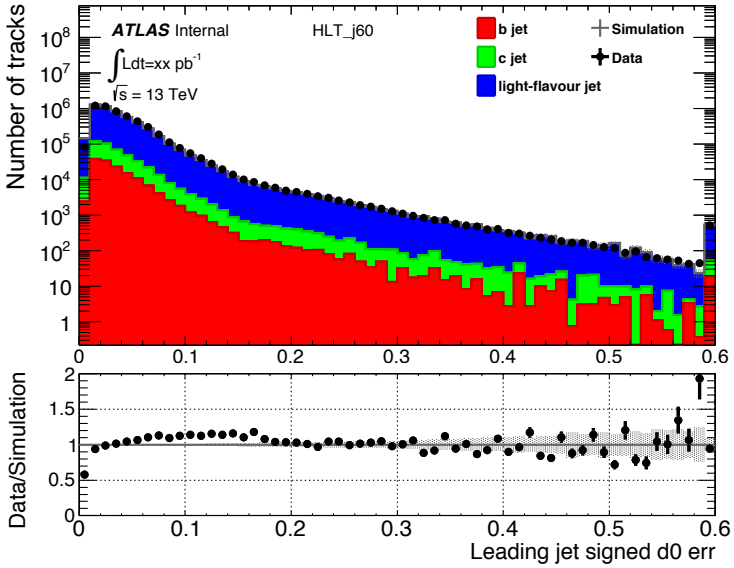


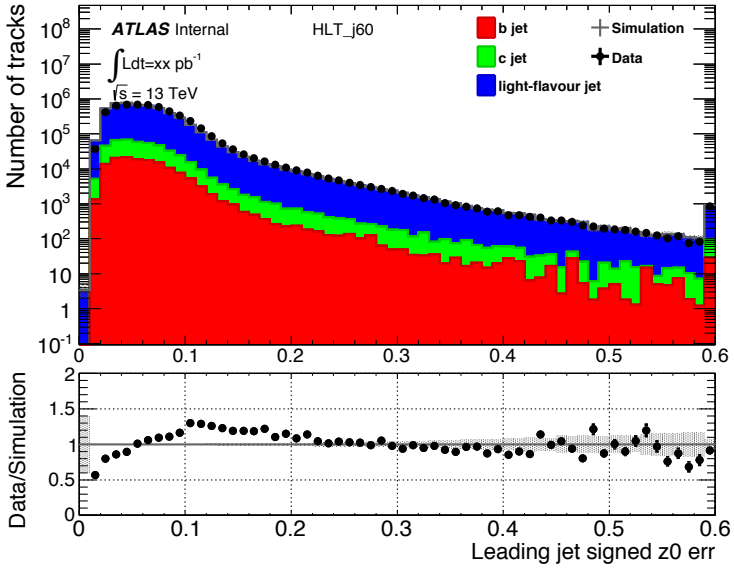




IP3D d0 err / z0 err

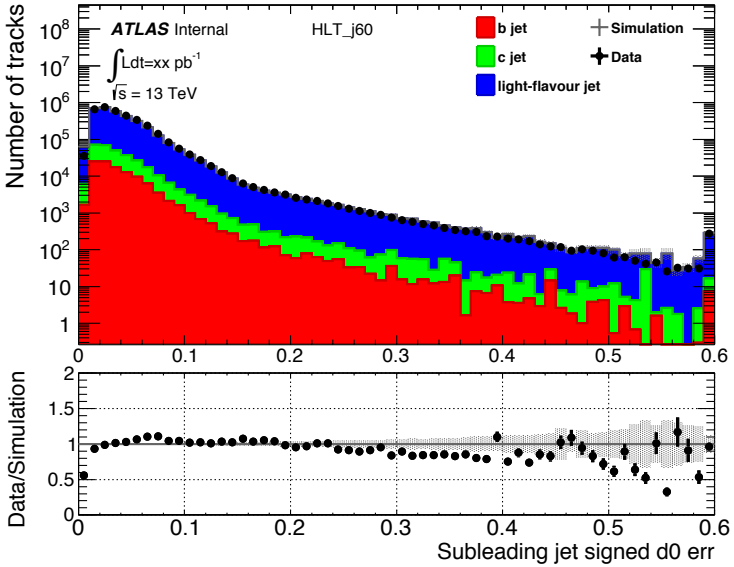
Leading Jet:



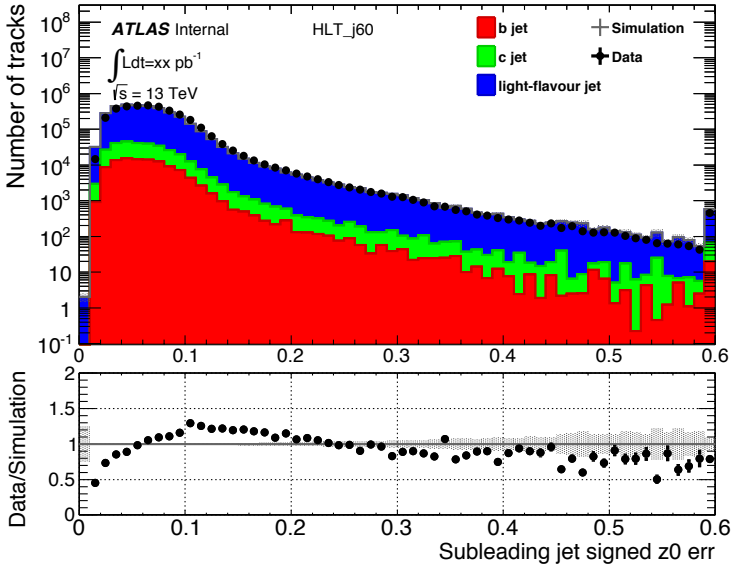


Sub-Leading Jet:

IP3D d0 err

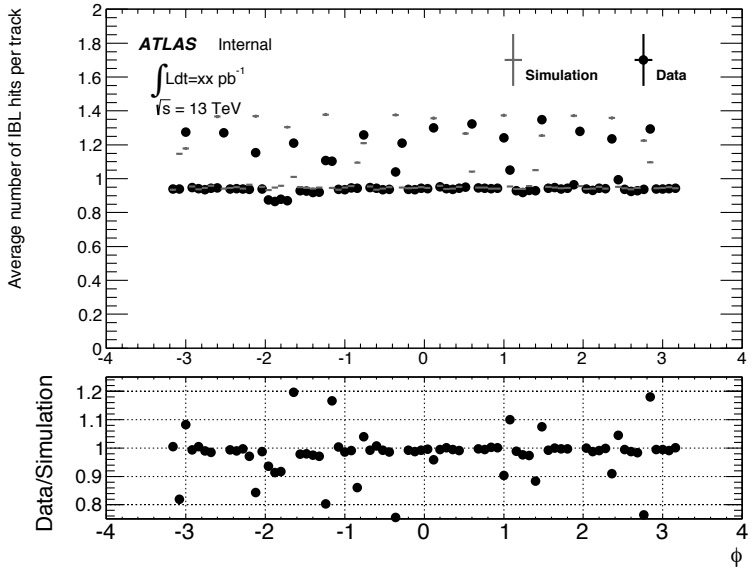


IP3D z0 err

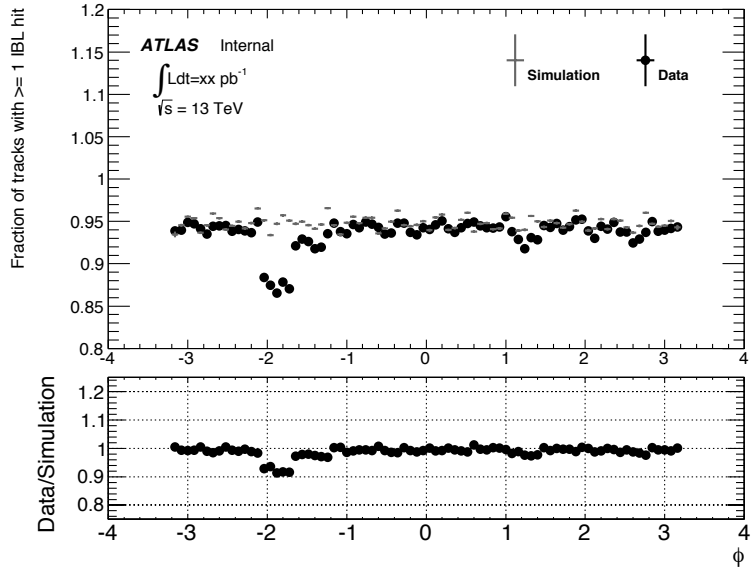


Track Studies - Average # IBL Track Hits

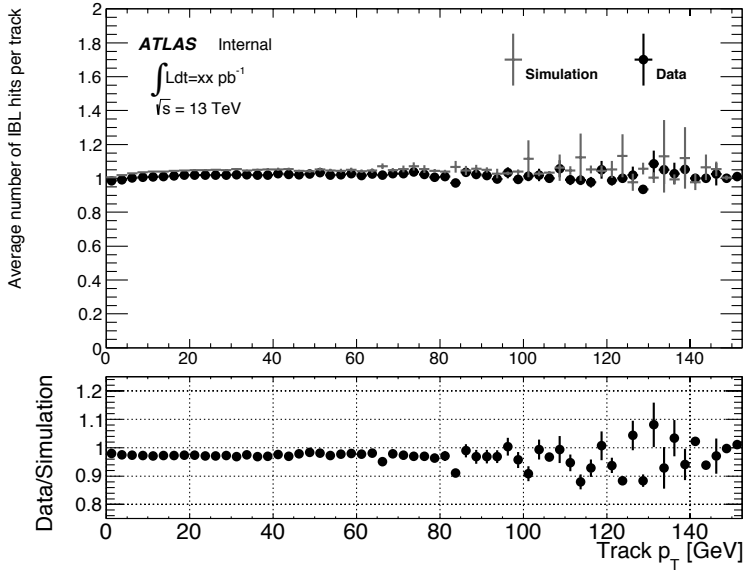
vs. Phi



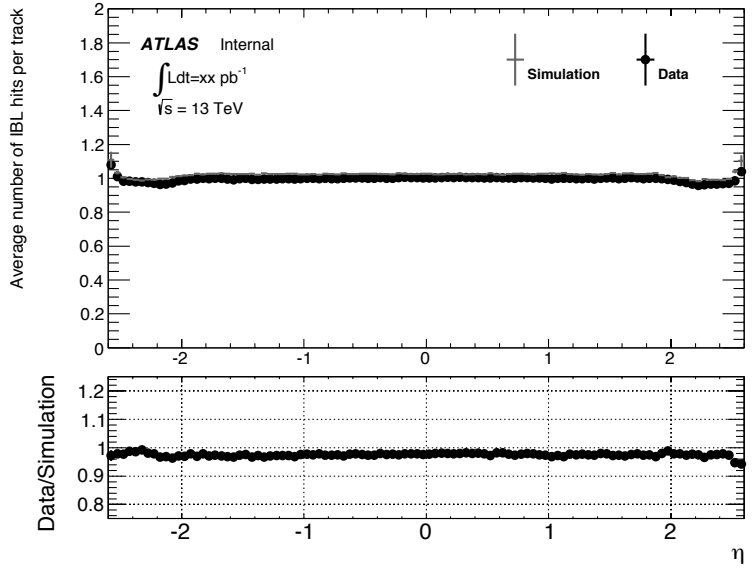
Hits >= 1 vs. Phi



vs. Track pT

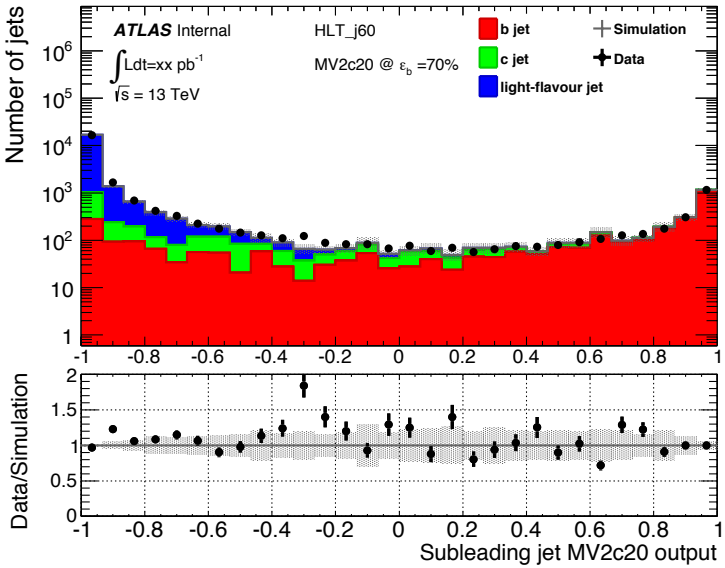


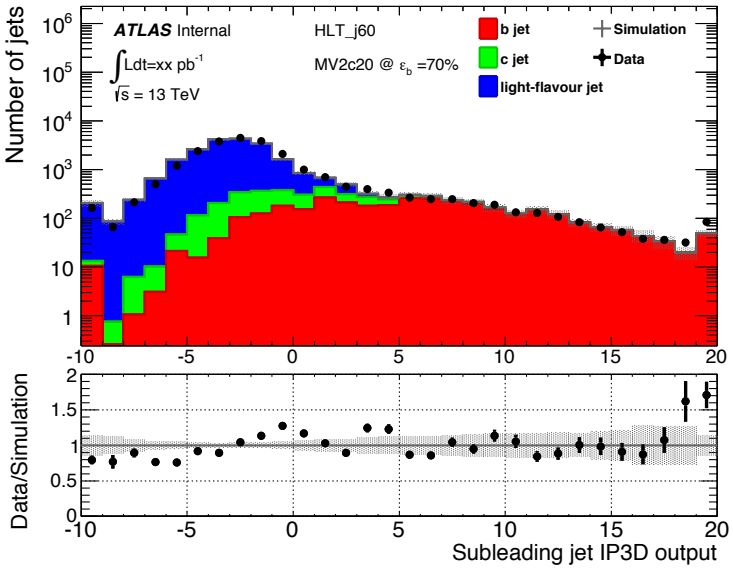
vs. Eta



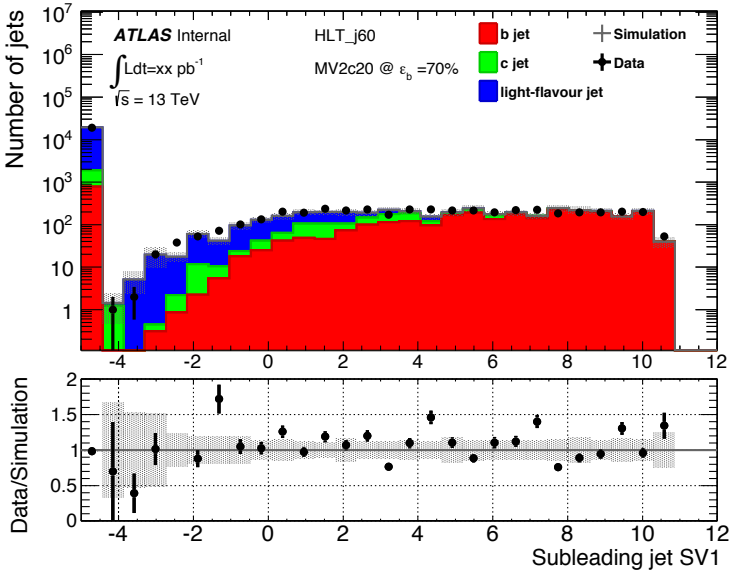
b Enhanced Sample - Subleading Jet

MV2c20: *Leading MV2c20 > -0.0436 which is 70% b-efficiency* IP3D:

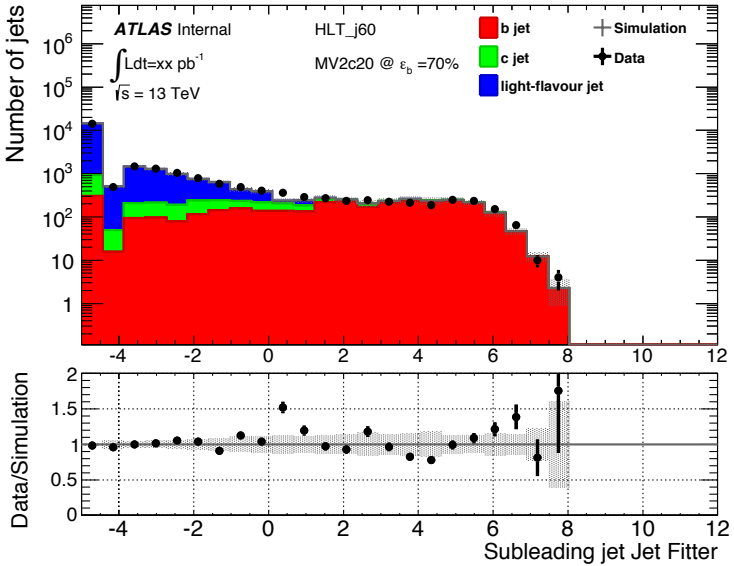




SV1:

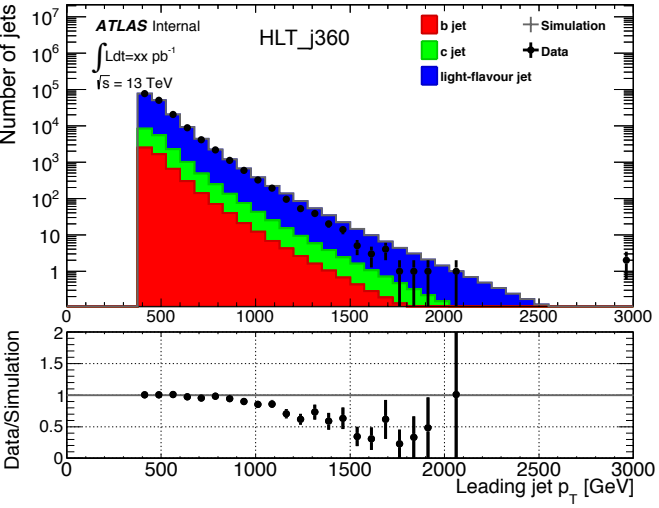


Jet Fitter:

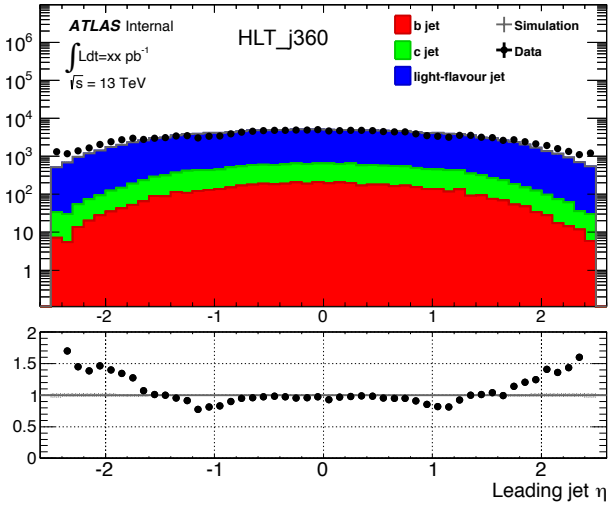


Higher pT comparisons - Jet Kinematics

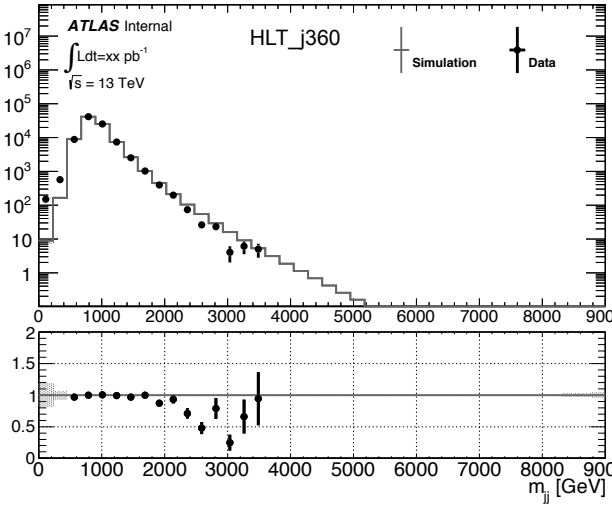
Leading Jet:



Jet P_T

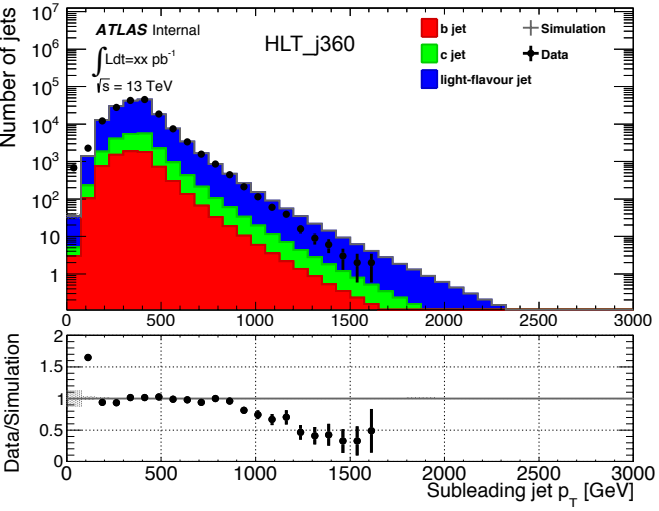


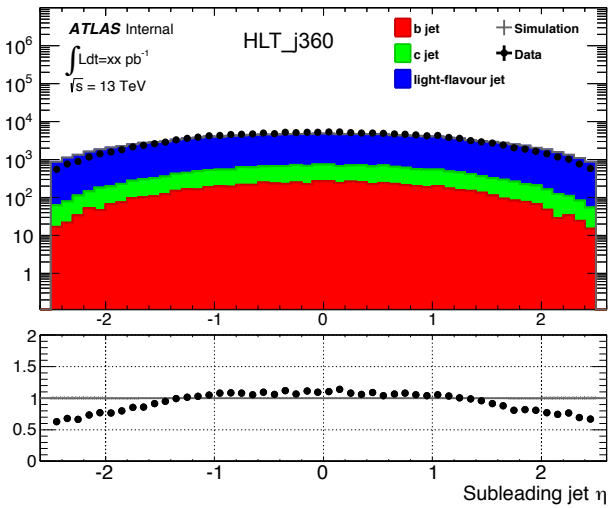
Eta



m_{jj}
$|y^*| < 1.6$

Sub-Leading Jet:



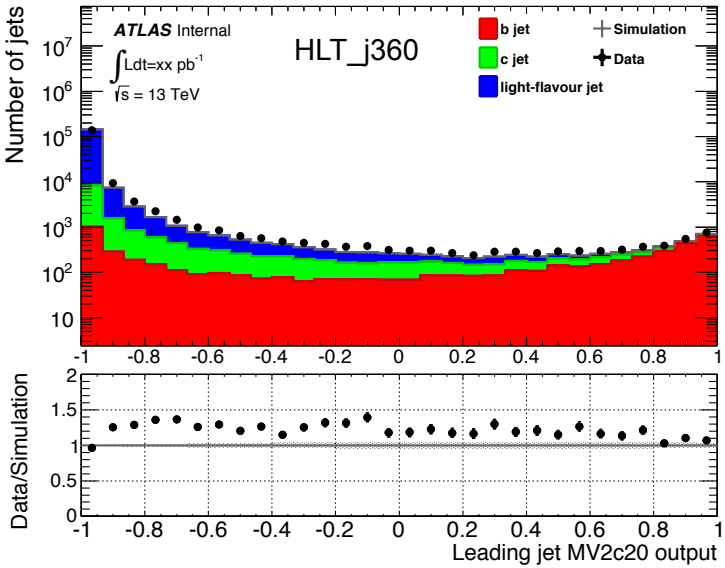


HLT_j360
Leading P_T > 400 GeV
JZ3-JZ9

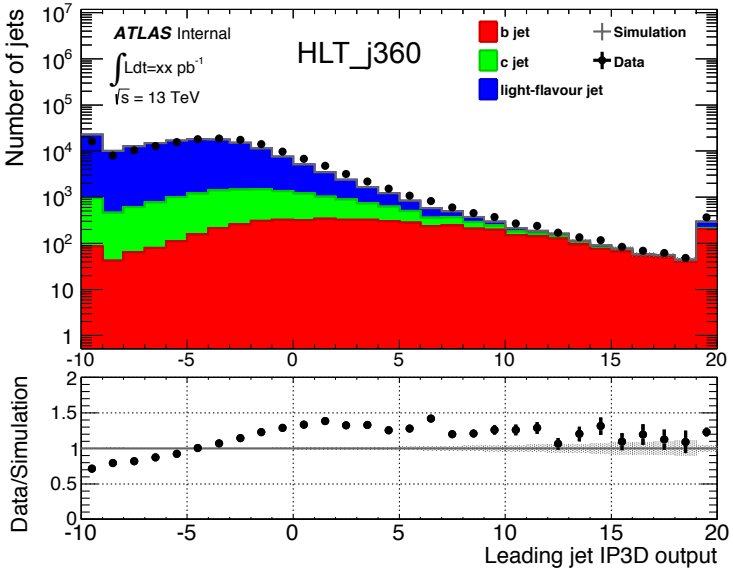
- Ning had seen large discrepancies at high pT in the older data
- Newer data resolves this problem, Ning has confirmed this.

Higher pT comparisons - Discriminants

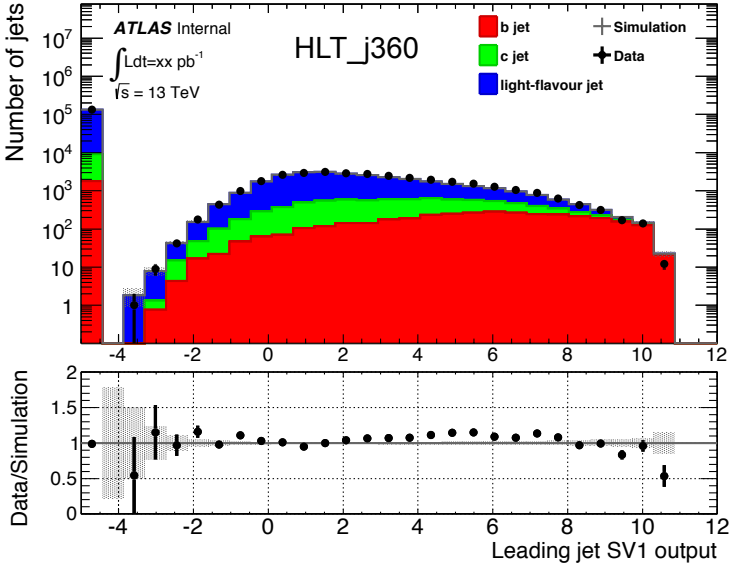
MV2c20:



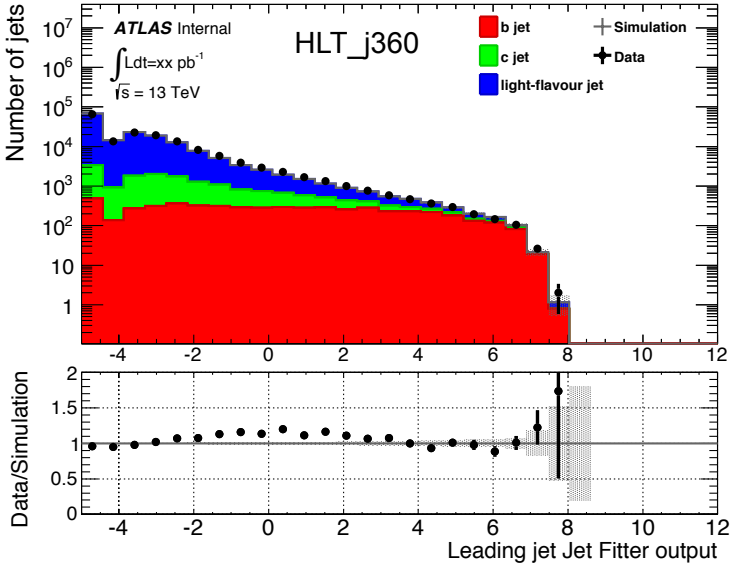
IP3D:



SV1:



Jet Fitter:



Conclusions

IP resolution will improve in coming weeks
- This will hopefully improve b-tagging Data/MC

- Ready for more data with improving alignment!
- This will show that we have a good understanding of b-tagging allowing us to move forwards with b-tagging analyses.

Future Plans

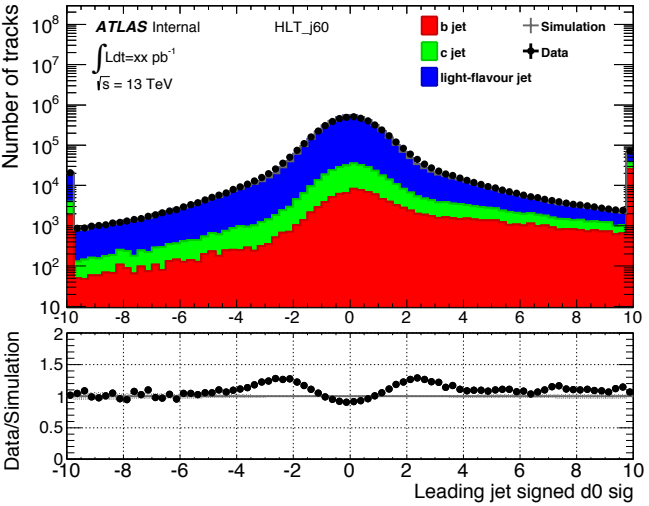
Improving high-pT b-tagging.
- Ongoing track studies with Antonello and Andrea
- Previous talk on studies: https://indico.cern.ch/event/393645/contribution/13/attachments/787730/1079785/b-Tag_Meet_2015_05.pdf

Apply improvements in high-pT b-tagging to di-b-jet analysis.

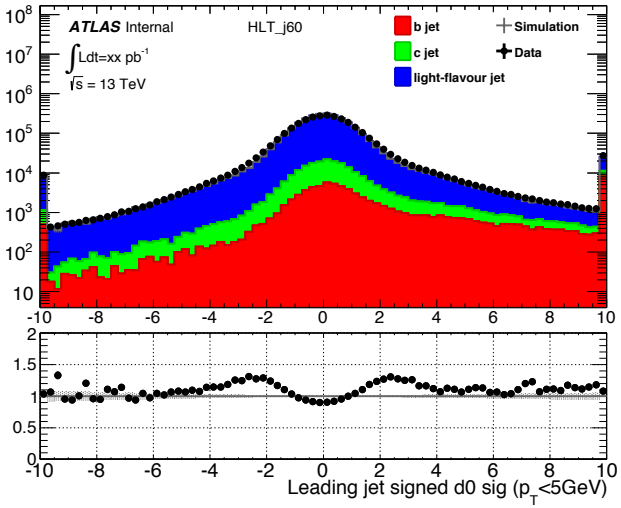
Backup

Signed d0/z0 Significance - Varying Track pT

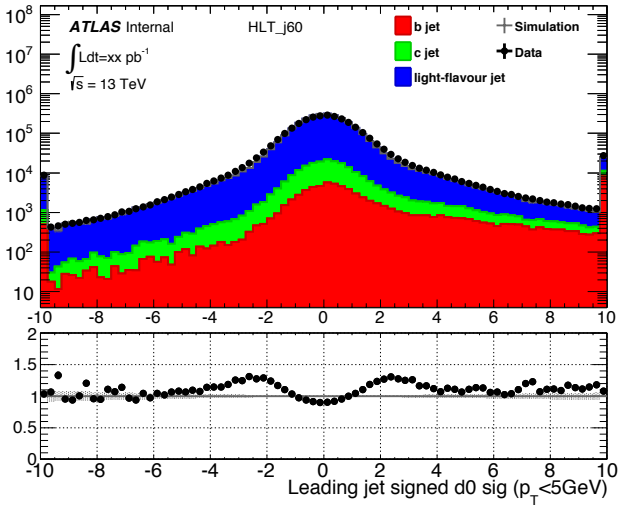
d0 Significance:



All (pT > 1 GeV)

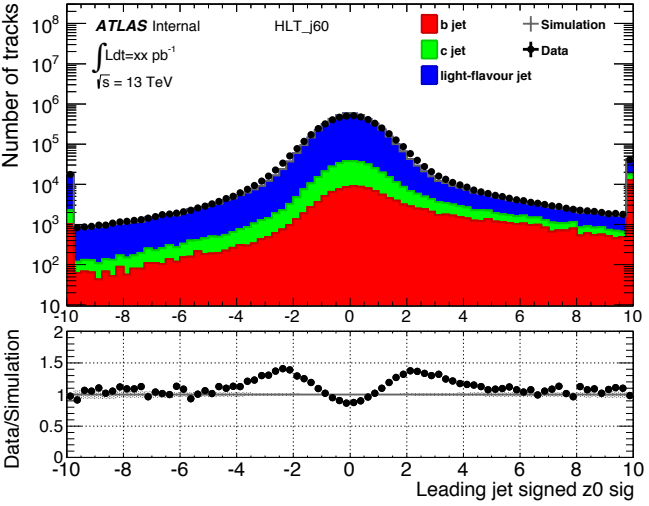


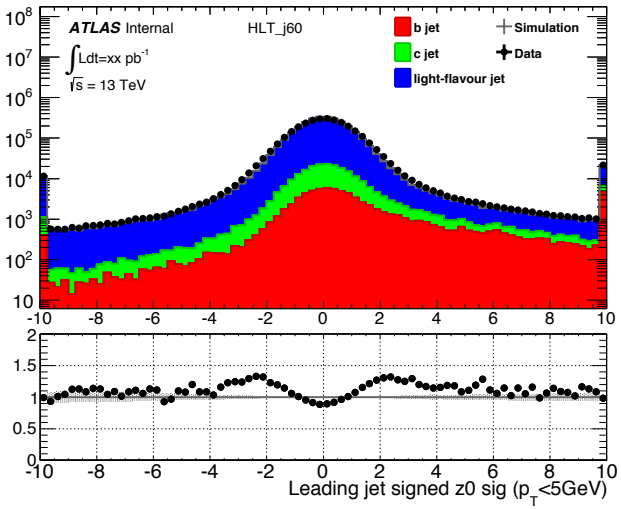
1 GeV < track pT < 5 GeV

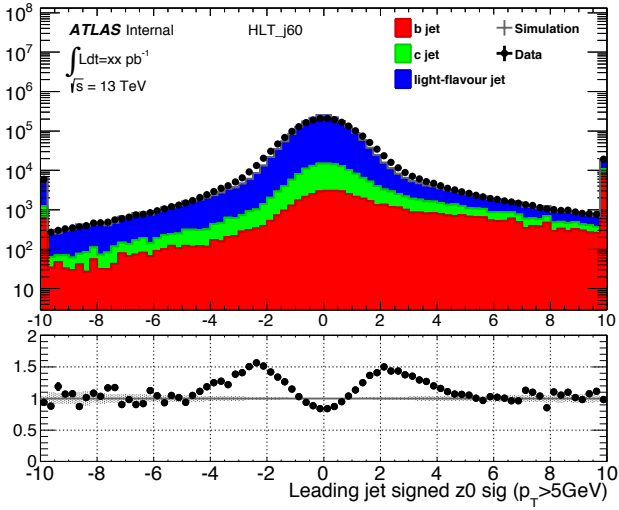


track pT > 5 GeV

z0 Significance:

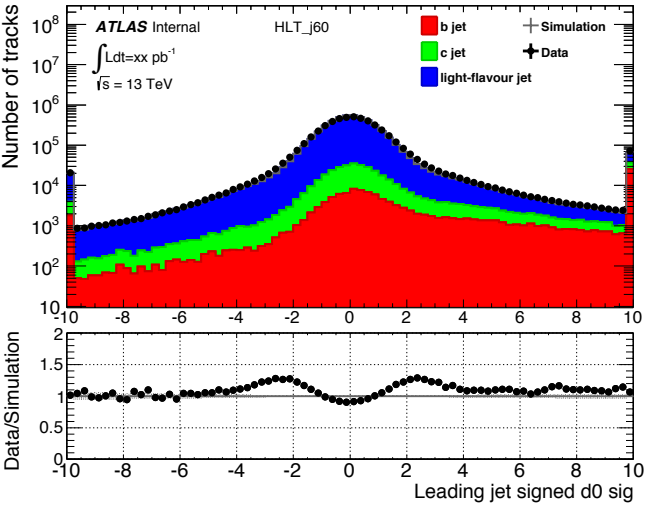


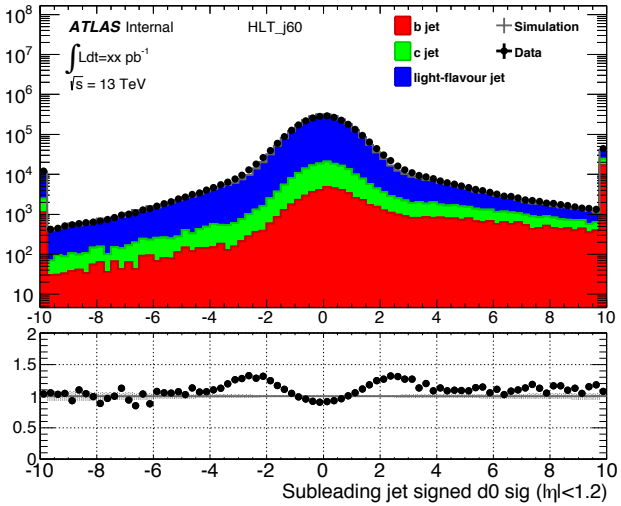


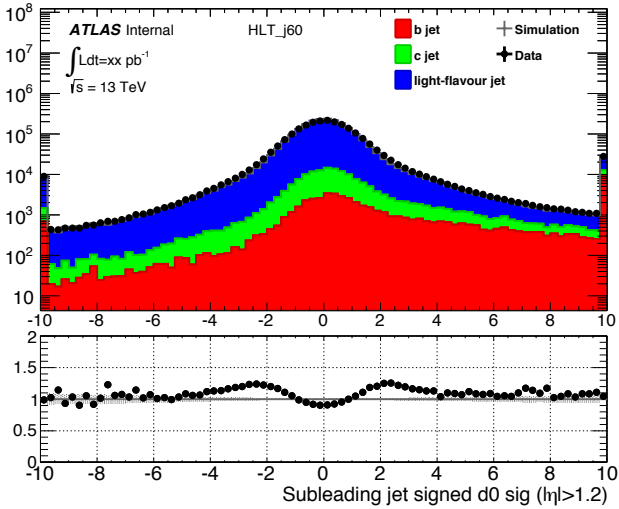


Signed d0/z0 Significance - Varying η

d0 Significance:







All | $|\eta| < 1.2$ | $|\eta| > 1.2$

z0 Significance: