



# Flavour Tagging Commissioning with Data

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Flavour Tagging Meeting  
14/07/15



## Aims

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

## Timescale

- Plan was to present on EPS conference.
- Problems with alignment have caused problems with flavour tagging. (See later slides)
- We have decided to delay until improved data is available.
- Now will aim for Lepton Photon at the back end of august.

## Progress on Note

- 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 are being addressed.
- In a good position for Lepton Photon when new data is taken.



### 3 Samples

- MC Sample:

- **Full xAOD**

- 50ns dijet MC sample data
  - Split into 4 slices and the re-weighted (see next slide) 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:

- Stable beam collisions
  - **FTAG** derivation
  - ~30K Events from Run 270806, 270816, 270949 and 270953
  - This corresponds to 13K events passing cuts.
  - Contains Latest Alignment - Improved errors but still problems here to discuss.

“data15\_13TeV.00270953.physics\_Main.merge.DAOD\_FTAK1.f611\_m1463\_p2375/”  
“data15\_13TeV.00270949.physics\_Main.merge.DAOD\_FTAK1.f612\_m1463\_p2375/”  
“data15\_13TeV.00270816.physics\_Main.merge.DAOD\_FTAK1.f611\_m1463\_p2375/”  
“data15\_13TeV.00270806.physics\_Main.merge.DAOD\_FTAK1.f611\_m1463\_p2375/”

- We are using NTuples created using Run2BTagOptimisationFramework



## 4 Details and Cuts

- 20.1.5.3 with all tags recommended by CP group
- Running xAOD fix on full xAOD
- **HLT\_j60 Trigger for MC with Leading Jet  $P_T > 70 \text{ GeV}$ .**
- **HLT\_j60 Trigger for Data with Leading Jet  $P_T > 70 \text{ GeV}$ .**

- AntiKt4EMTopoJets
- Run1LooseBadCuts and “ugly” jet removal.

- Jet Calibration:

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

- **No GRL Being Applied**

Select event if leading jet has:

- $n_{\text{jets}} \geq 1$
- $|\eta| < 2.5$
- $P_T > 70 \text{ GeV}$
- $\text{JVT} > 0.641$  if ( $P_T < 50 \text{ GeV}$  and  $|\eta| < 2.4$ )

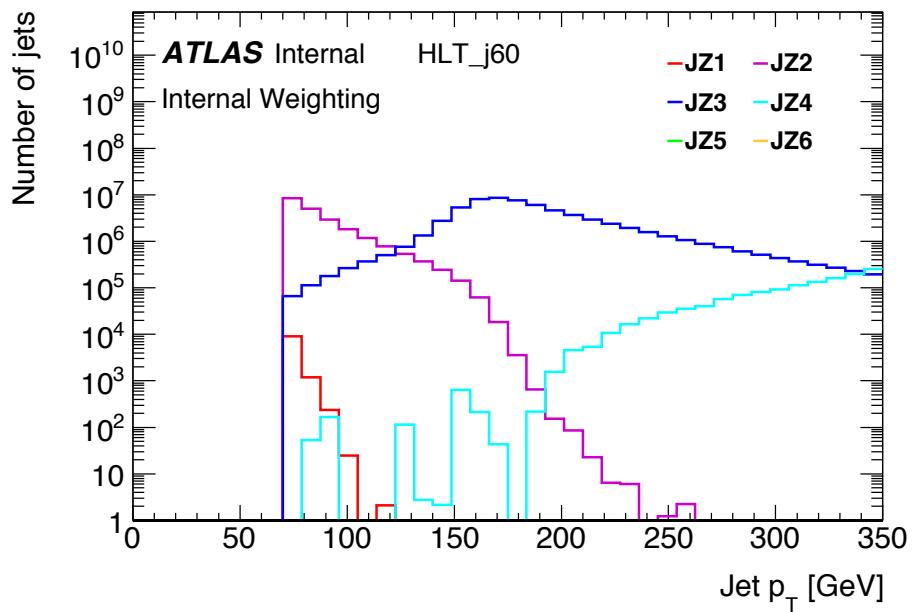
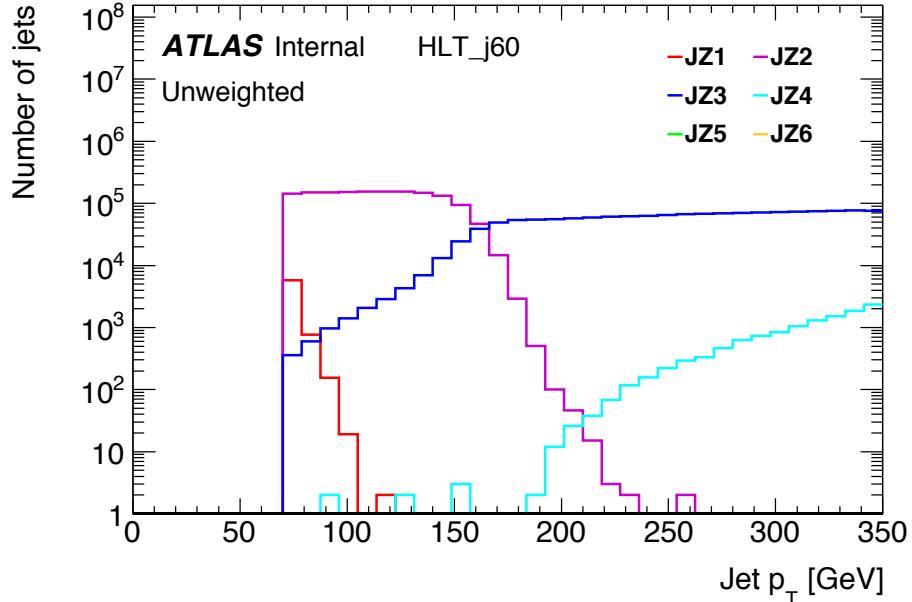
Then plot subleading if subleading jet has:

- $P_T > 25 \text{ GeV}$
- $|\eta| < 2.5$
- $\text{JVT} > 0.641$  if ( $P_T < 50 \text{ GeV}$  and  $|\eta| < 2.4$ )

### Just For MC

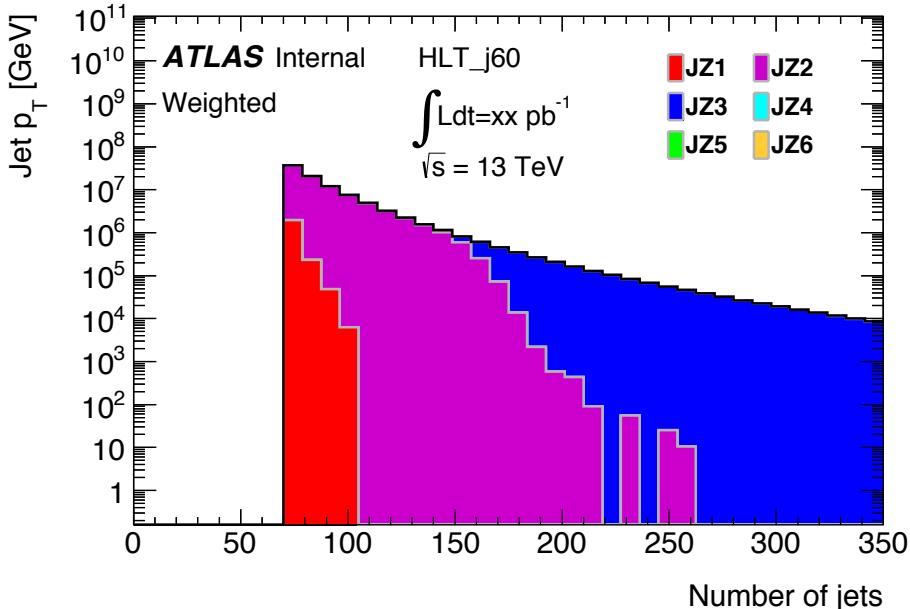
- Truth Dijet Test applied to MC to clean sample
- $(\text{Lead } P_T + \text{Sublead } P_T)/2 < 1.4 * \text{Truth Lead } P_T$ , for  $n_{\text{jet}} > 1$
  - $(\text{Sublead } P_T < 1.4 * \text{Truth Sublead } P_T)$ , for  $n_{\text{jet}} = 1$
  - LabDr\_HadF truth matching.

## 5 Di-jet sample re-weighting



$$\frac{\text{Total Weight}}{\text{(# Events)}} = \frac{mcwg * (\text{Filter Eff.}) * (CS[fb]) * (Lumi[fb}^{-1}])}{}$$

Xs (fb)	Eff.	Slice and Energy
7.8420E+13	6.7198E-04	#JZ1W 20-60 GeV
2.4334E+12	3.3264E-04	#JZ2W 60-160 GeV
2.6454E+10	3.1953E-04	#JZ3W 160-400 GeV
2.5464E+08	5.3009E-04	#JZ4W 400-800 GeV
4.5536E+06	9.2325E-04	#JZ5W 800-1300 GeV
2.5752E+05	9.4016E-04	#JZ6W 1300-1800 GeV

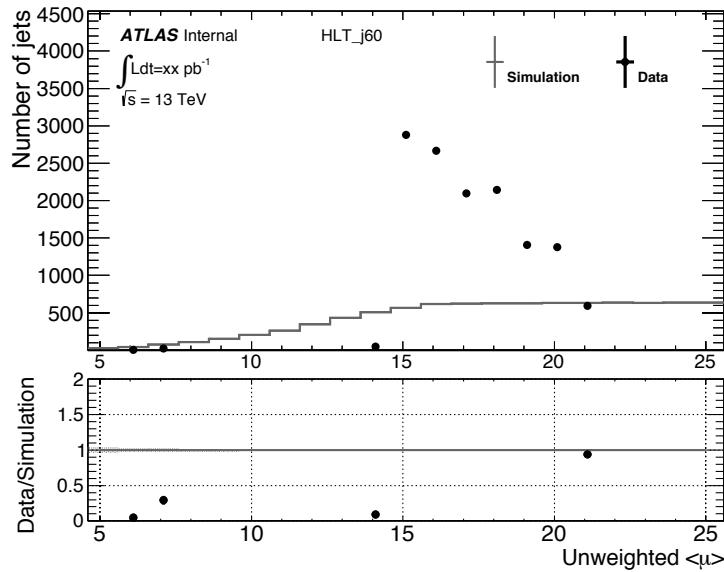


Then integral of MC is normalised  
to integral of data

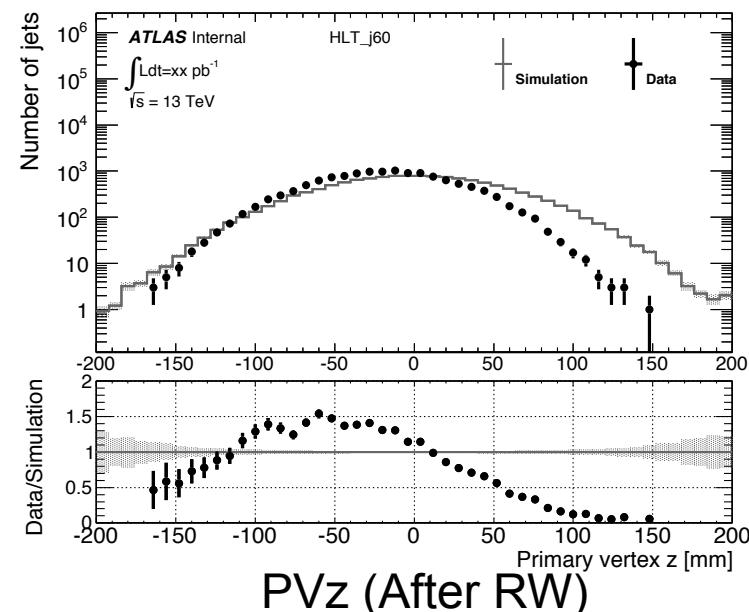
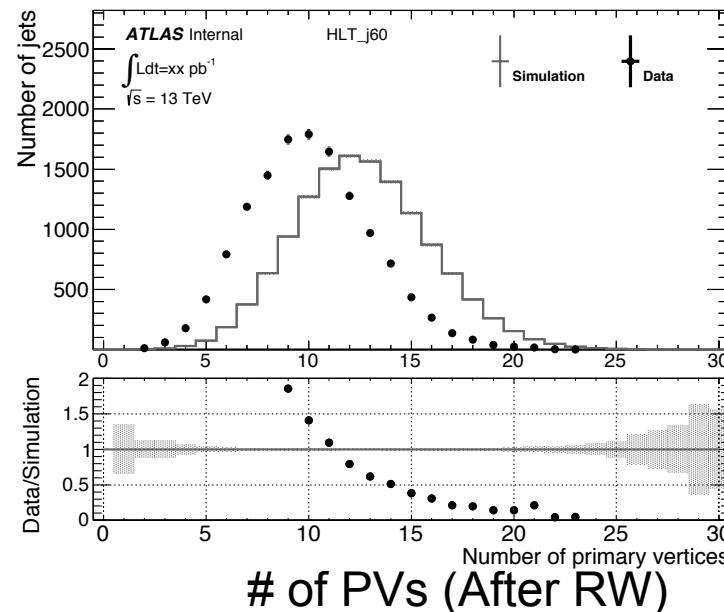
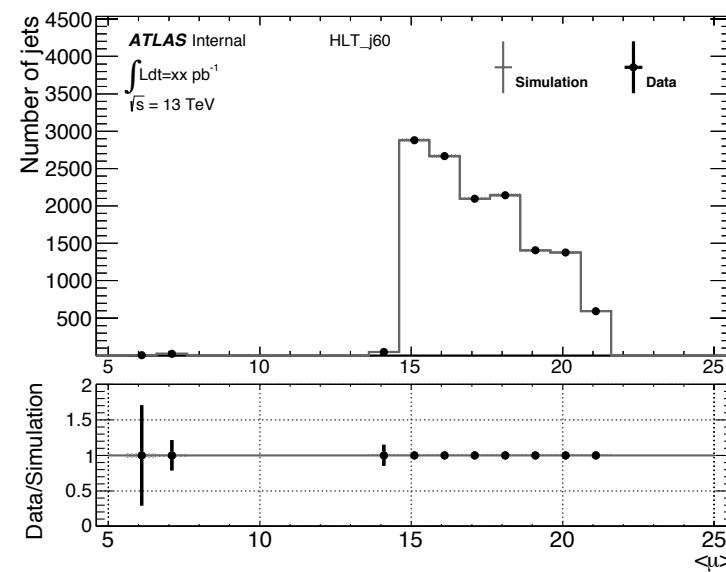


## 6 $\langle\mu\rangle$ Reweighting

Before:



After:



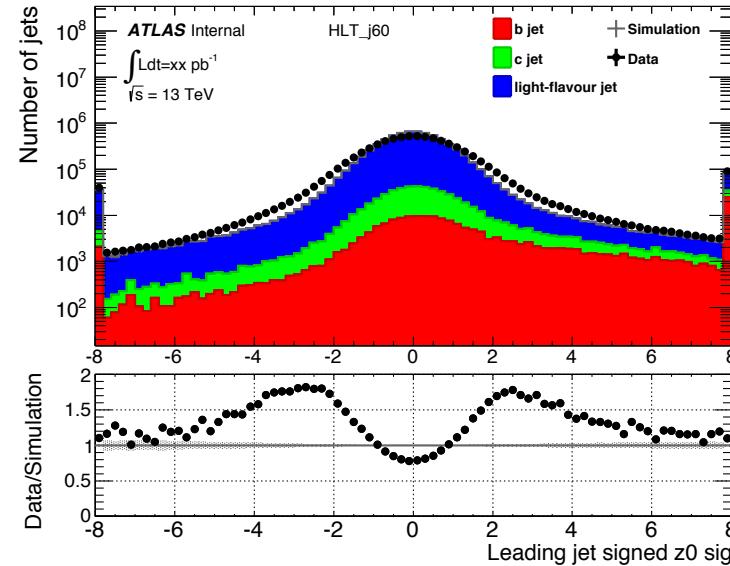
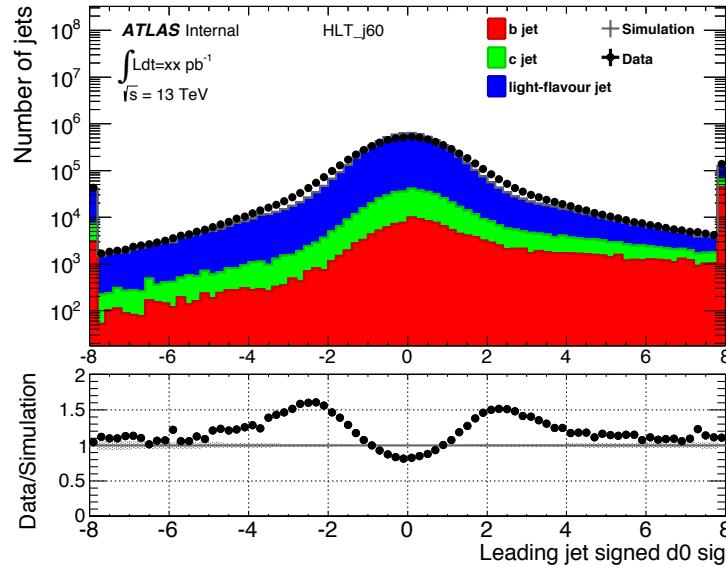


7

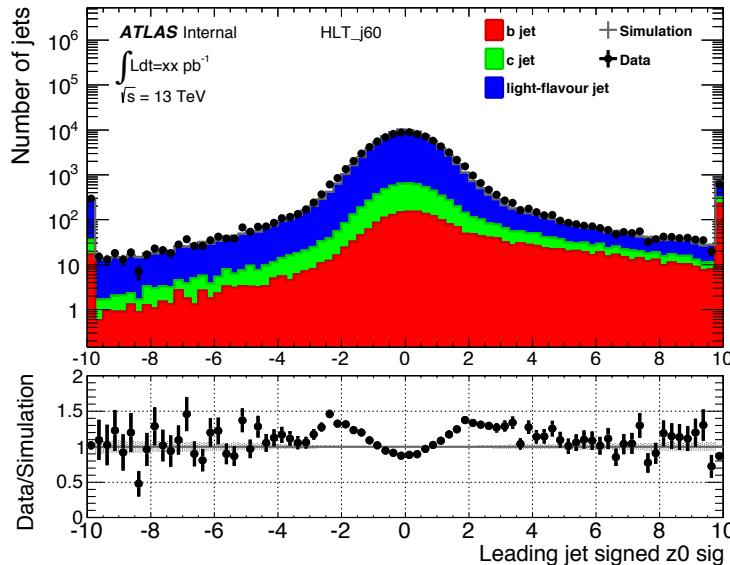
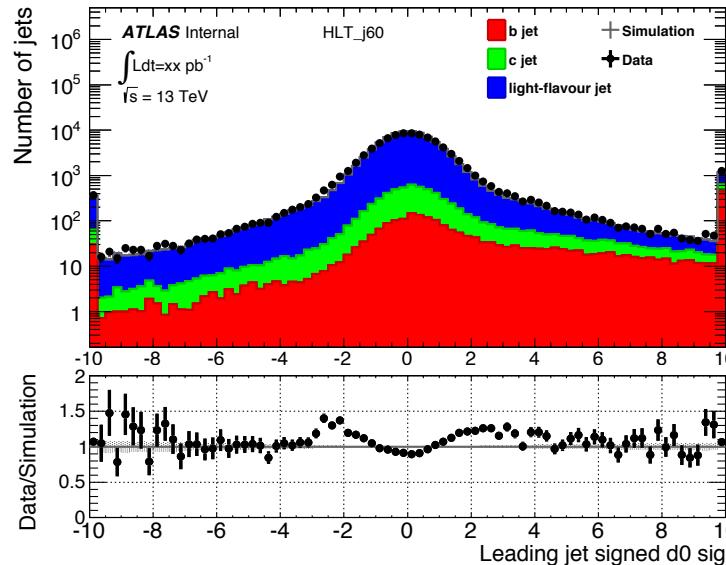
# Alignment Issues - IP3D d0 sig and z0 sig



Previously: *Pixel errors calculated with wrong conditions*



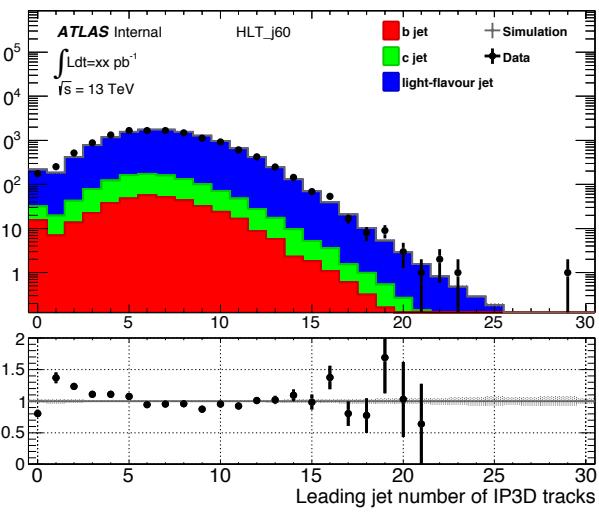
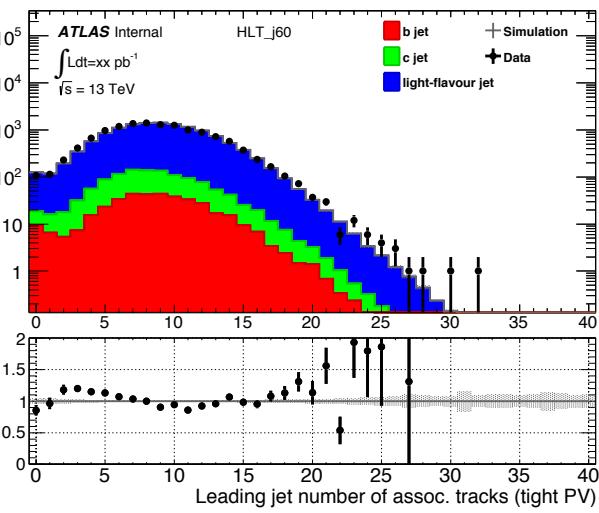
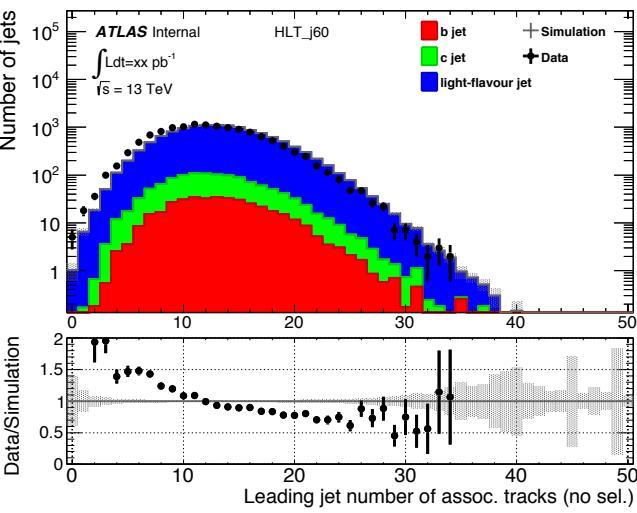
Newest: *Updated errors, but still problems.*





## 8 Track Distributions

### Leading Jet:

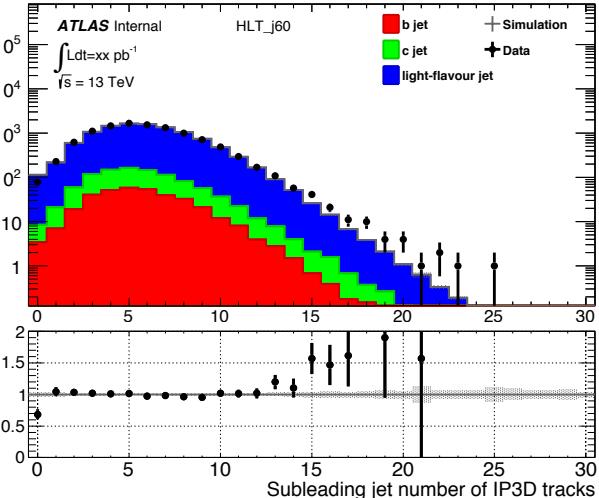
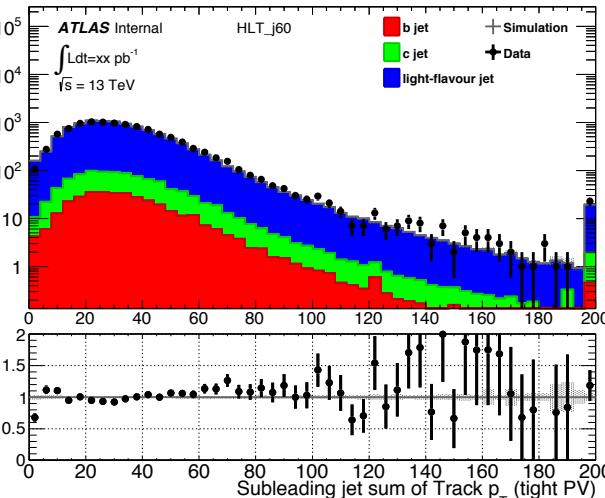
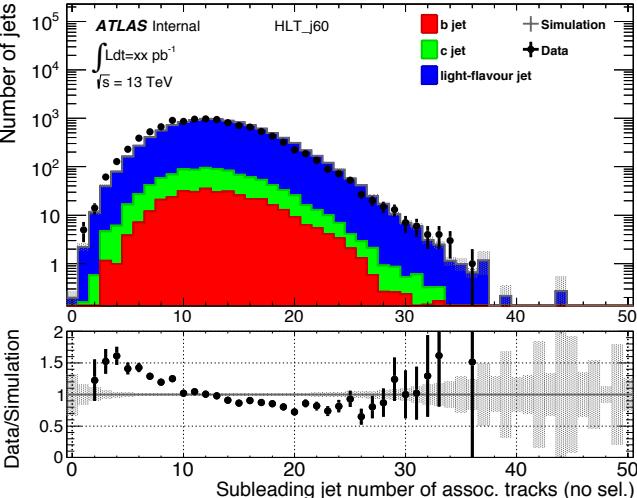


# Tracks:  
Directly from Track Container

# Tracks:  
Tight PV Selection

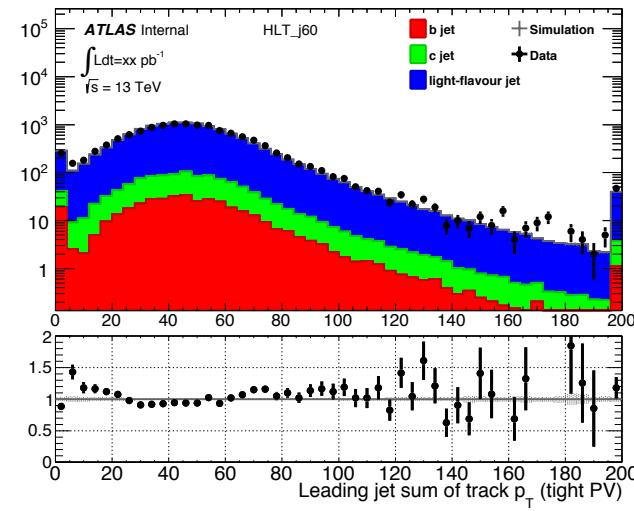
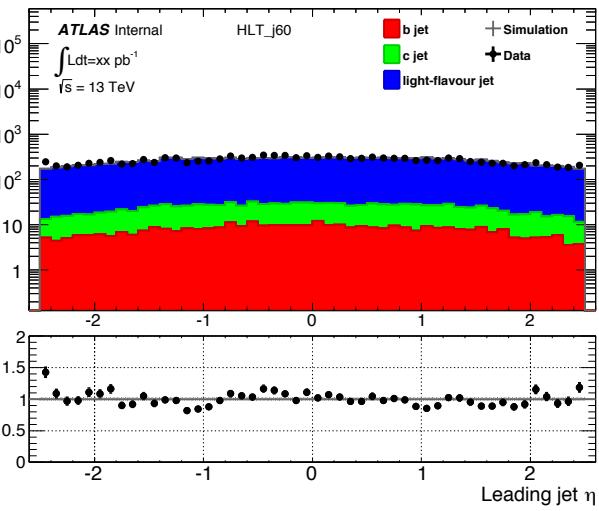
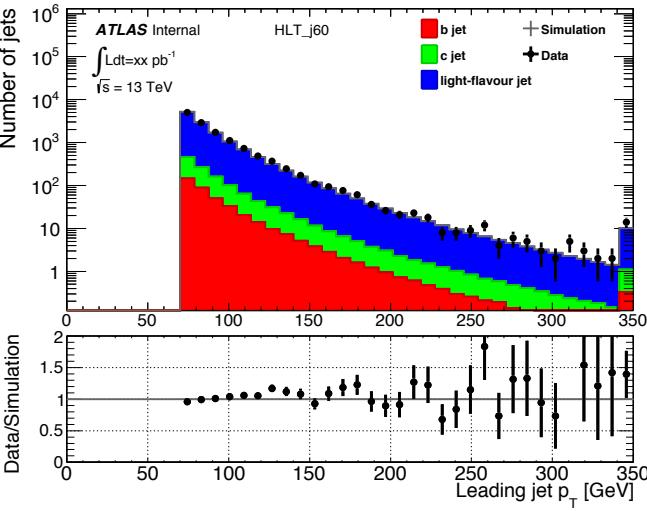
# Tracks:  
IP3D Selection  
 $P_T > 1 \text{ GeV}$

### Sub-Leading Jet:



# 9 Jet Kinematic Distributions

Leading Jet:

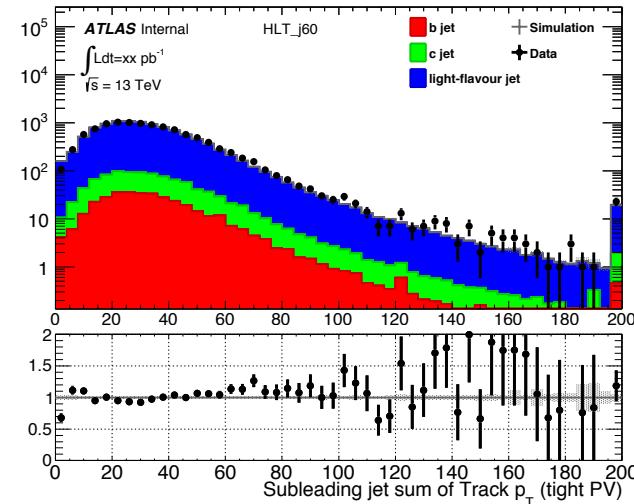
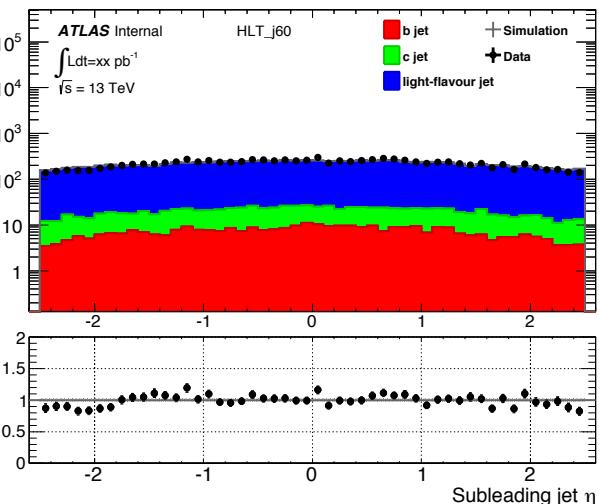
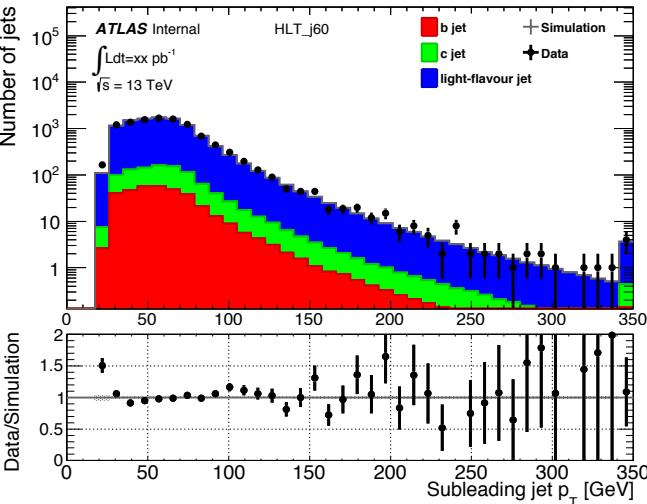


Jet  $P_T$

Eta

Sum of Track  $P_T$

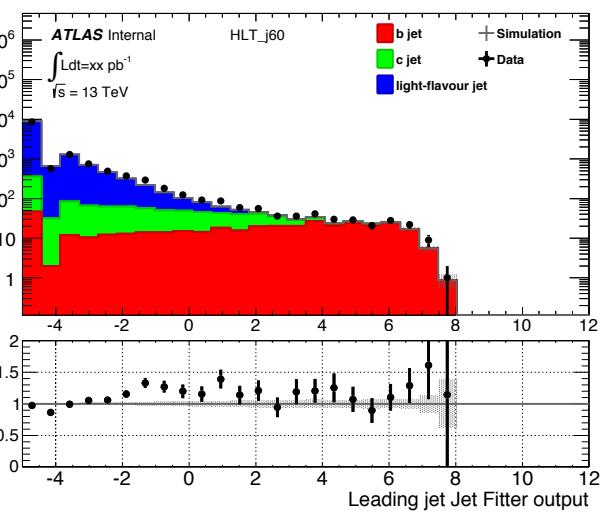
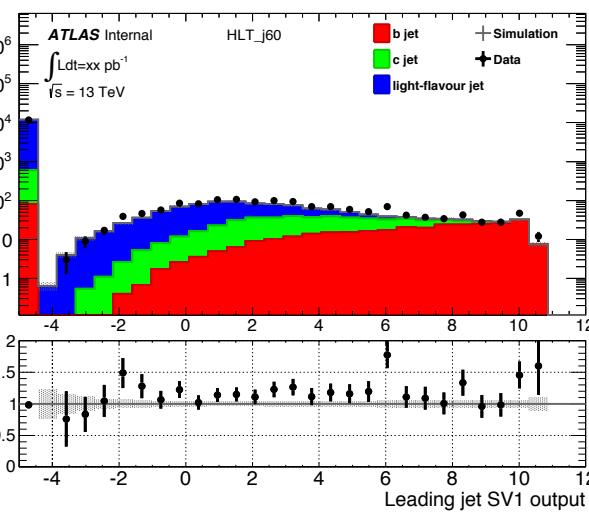
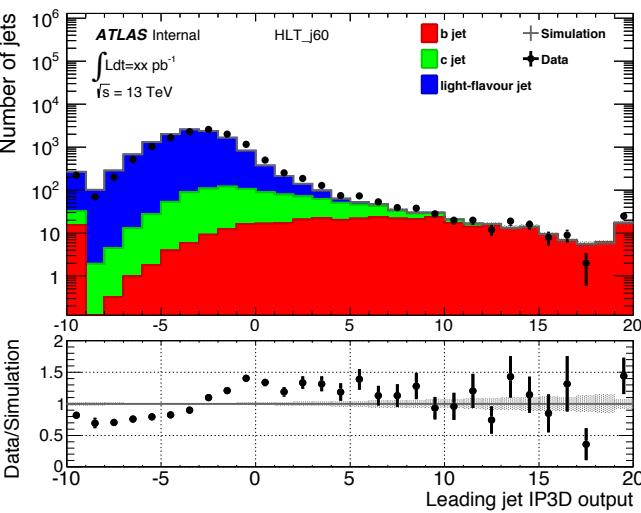
Sub-Leading Jet:





# 10 Input Taggers

## Leading Jet:

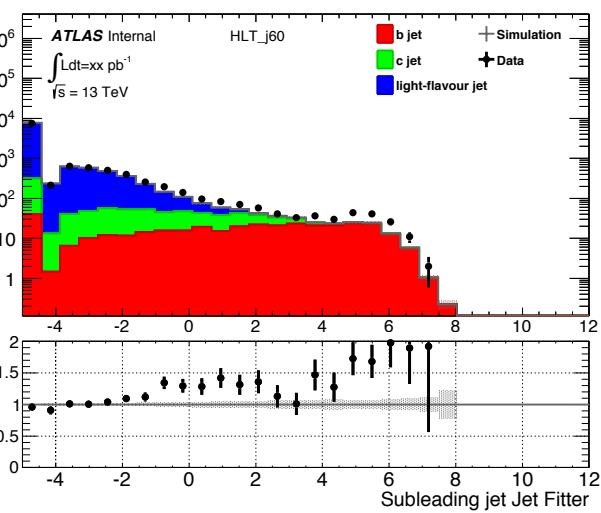
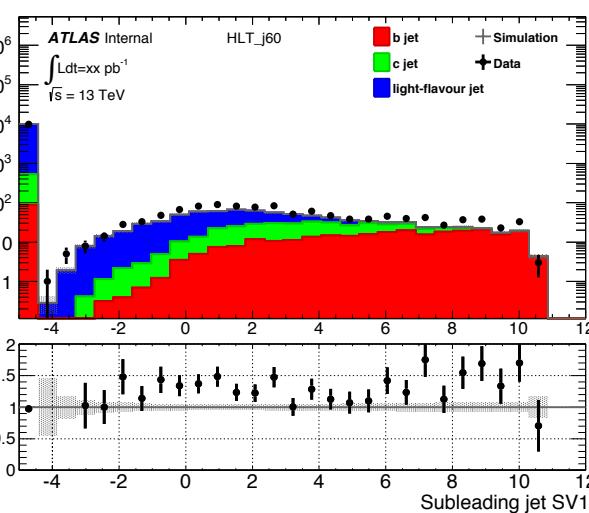
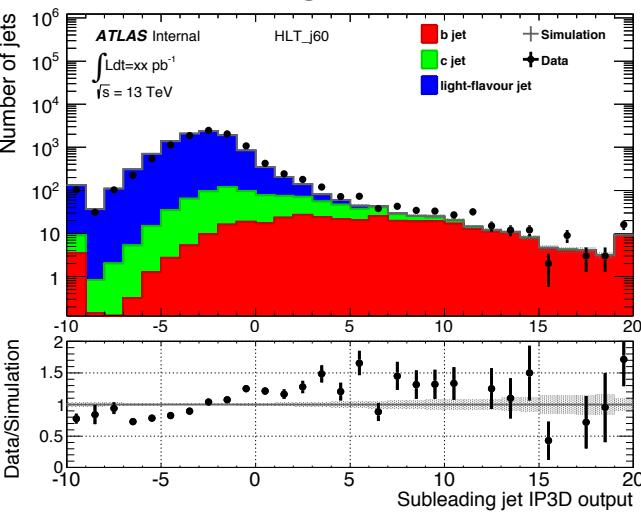


IP3D

SV1

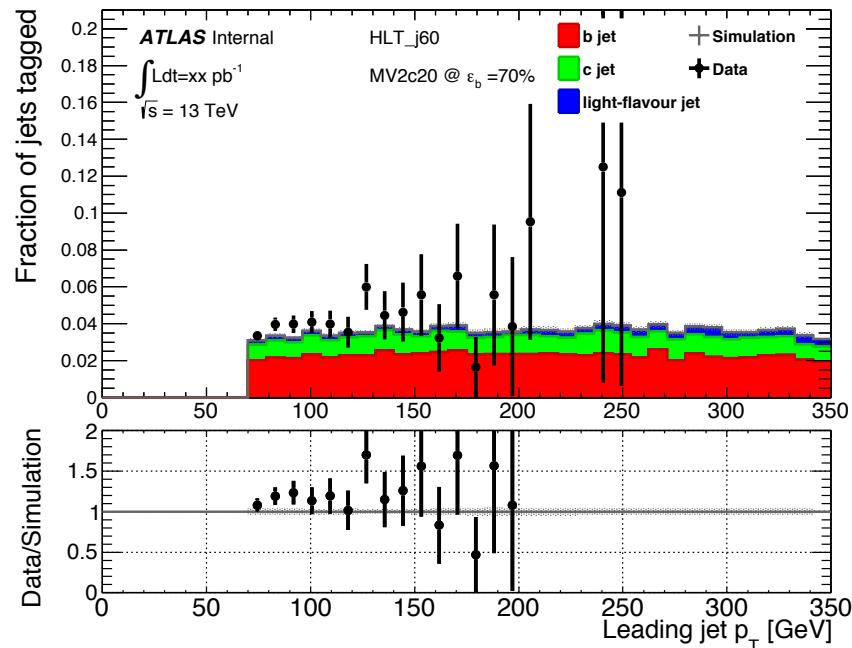
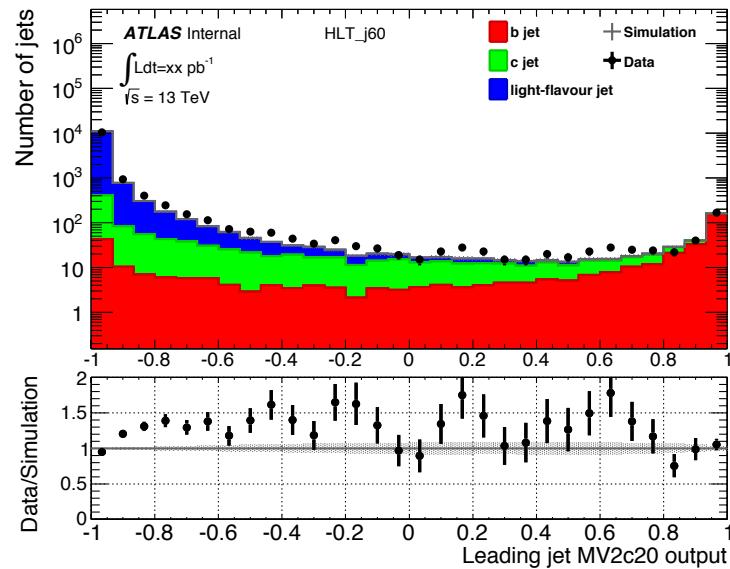
JF

## Sub-Leading Jet:



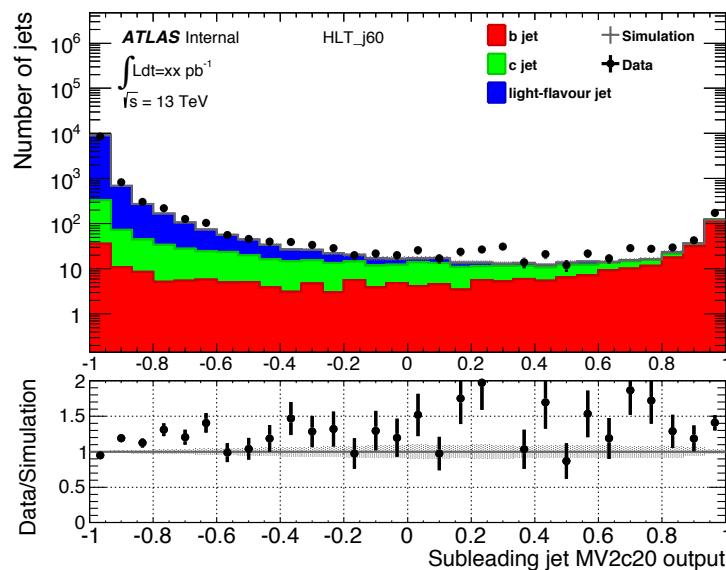


## Leading Jet:



## Sub-Leading Jet:

MV2c20



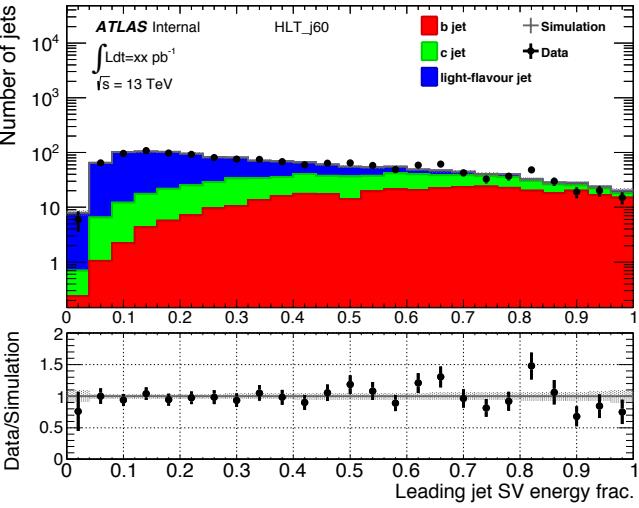
Tag Rate

Only 504 Leading Jets Tagged

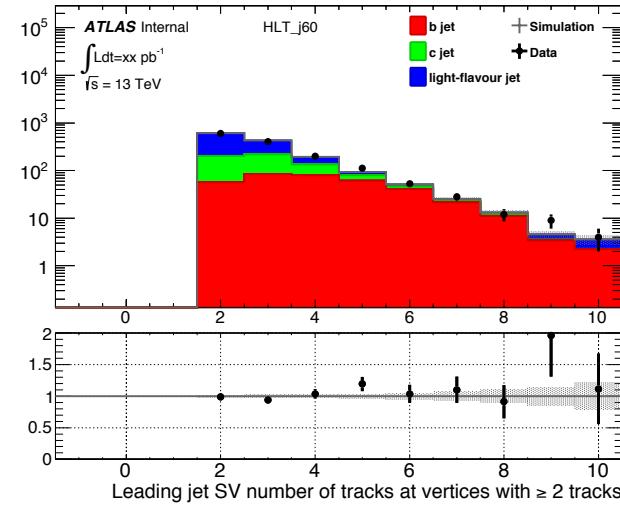
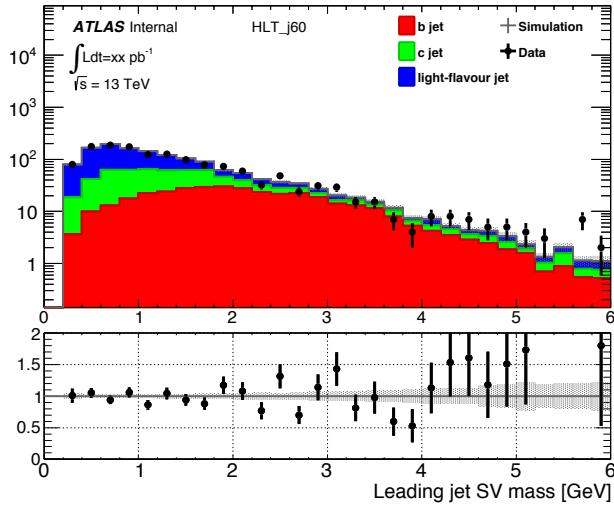


# 12 SV1 Variables

Leading Jet:



Only Filled if a Secondary Vertex is found

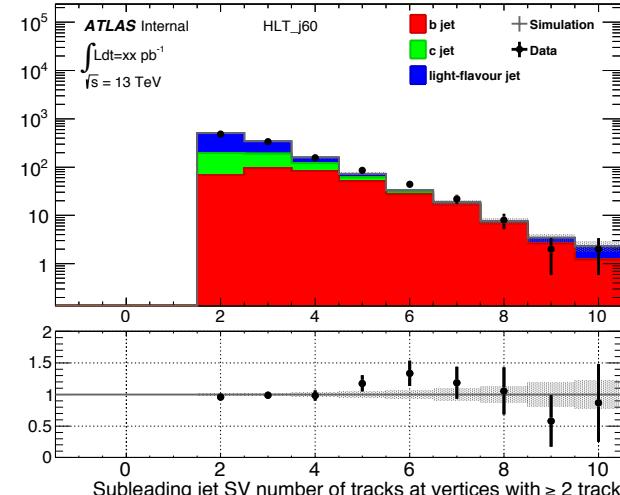
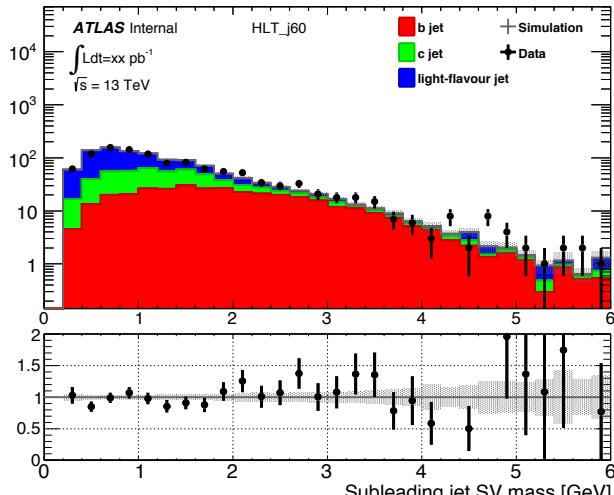
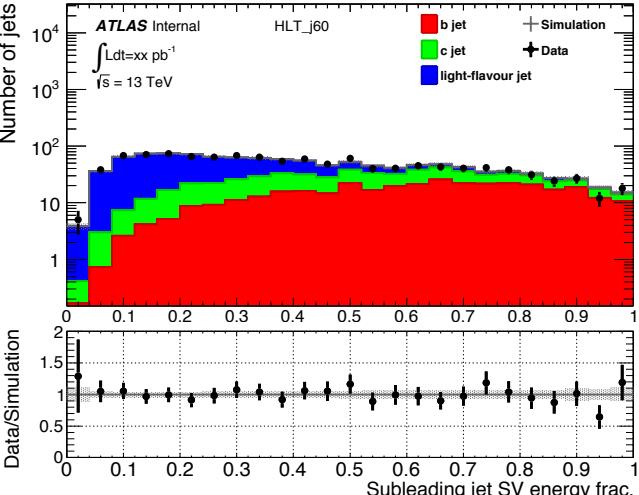


Energy Frac.

SV1 Mass

# Tracks at  
SV1 Vertex

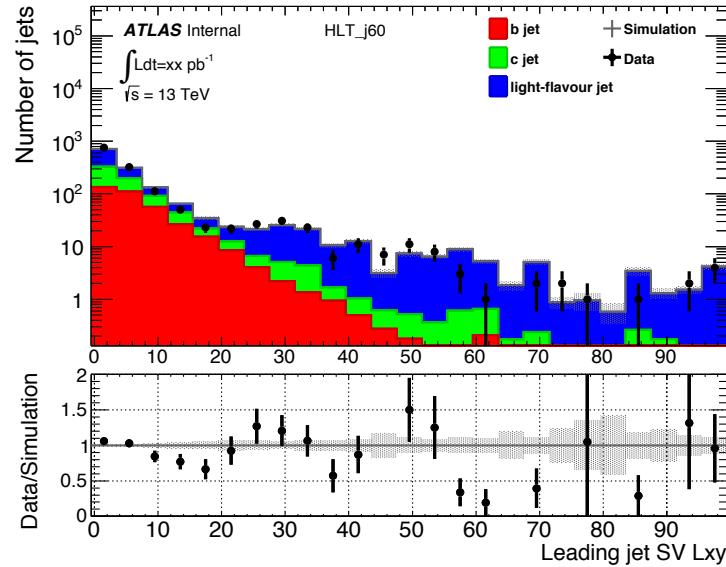
Sub-Leading Jet:



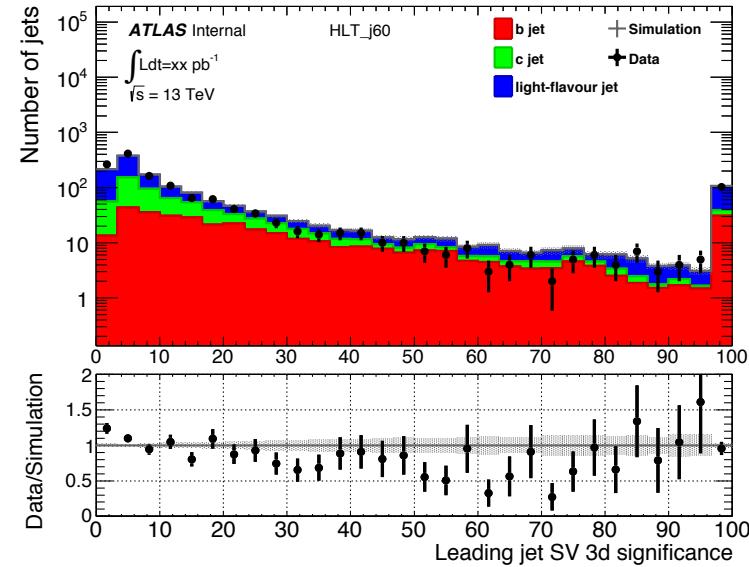


## 13 SV1 Variables Cont.

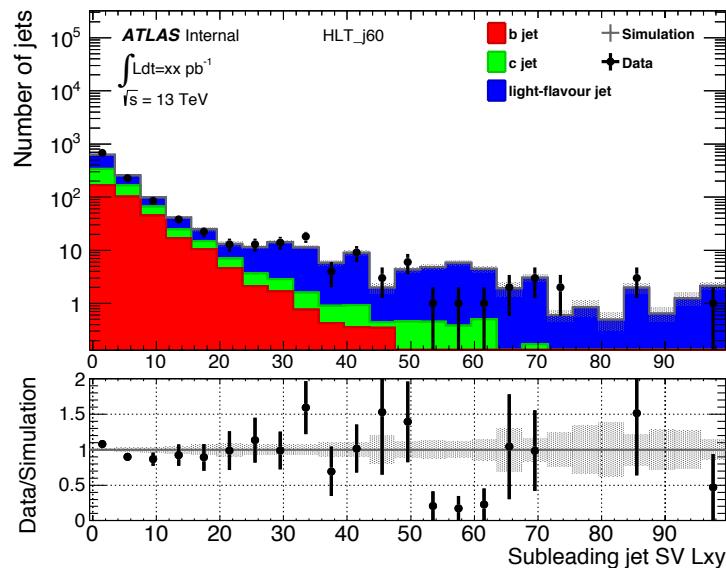
Leading Jet:



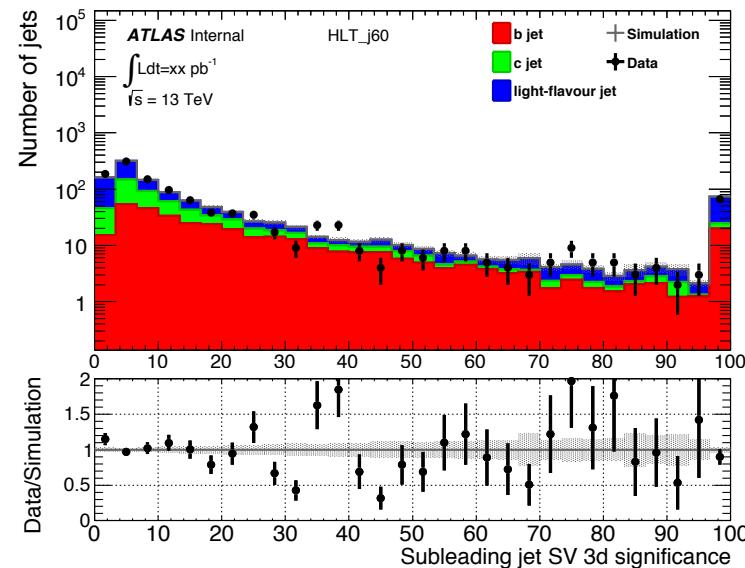
Only Filled if a Secondary Vertex is found



Sub-Leading Jet:



SV1 L<sub>xy</sub>

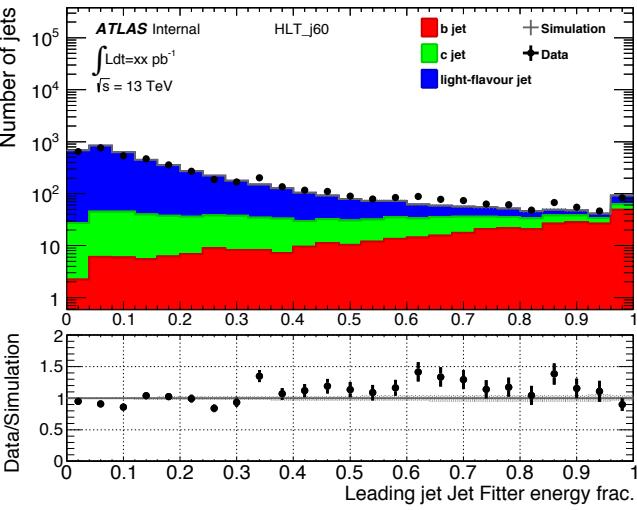


SV1 3D Sig

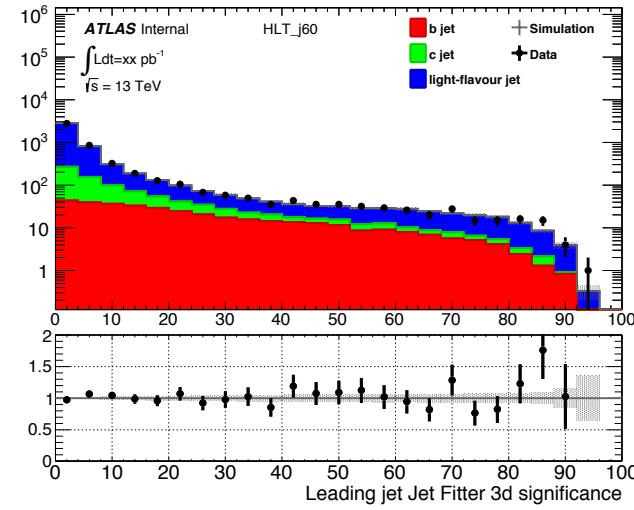
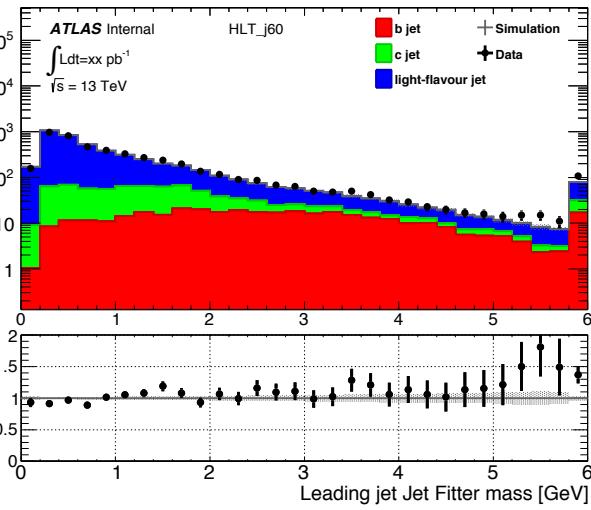


# 14 JF Variables

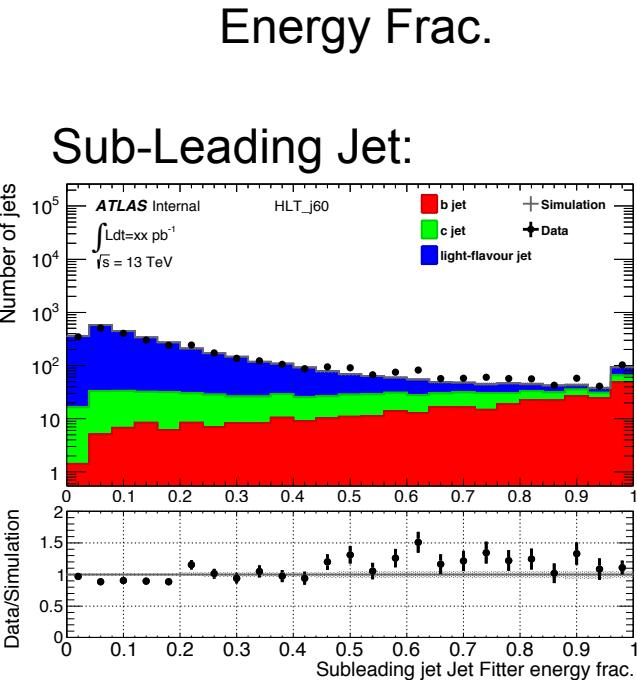
Leading Jet:



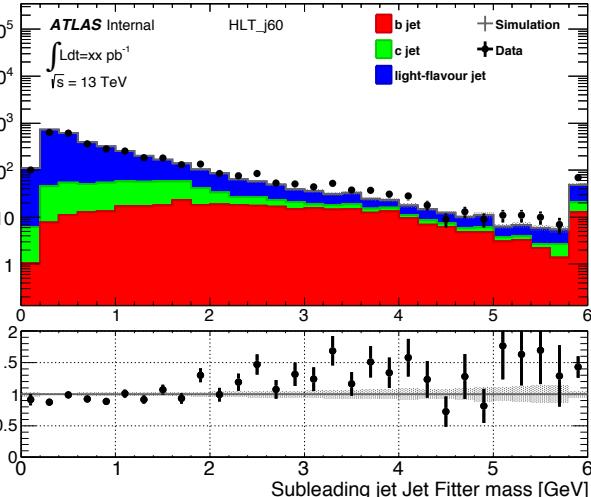
Only Filled if a Jet Fitter Vertex is found



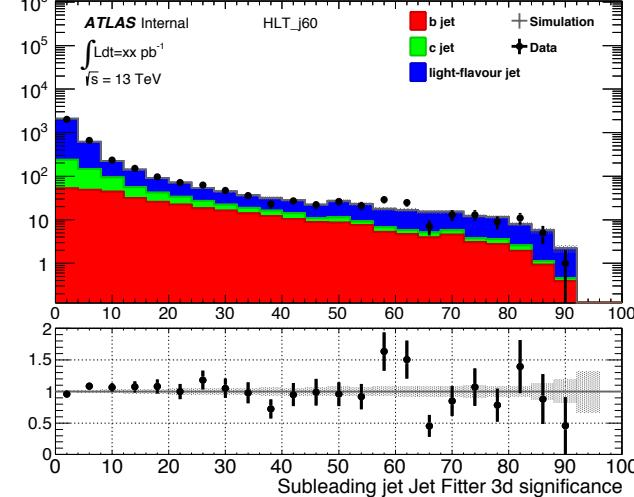
Energy Frac.



JF Mass



JF 3D Sig

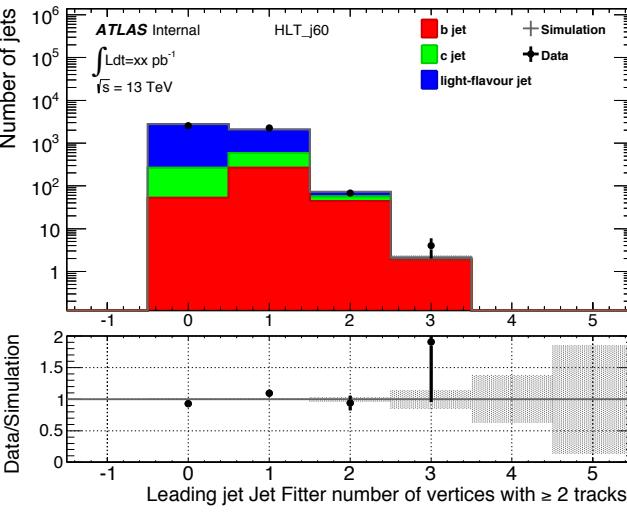


Sub-Leading Jet:



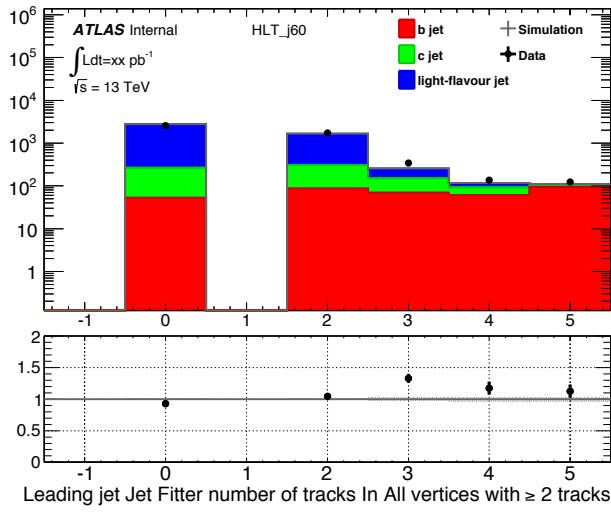
# 15 JF Variables Cont.

## Leading Jet:

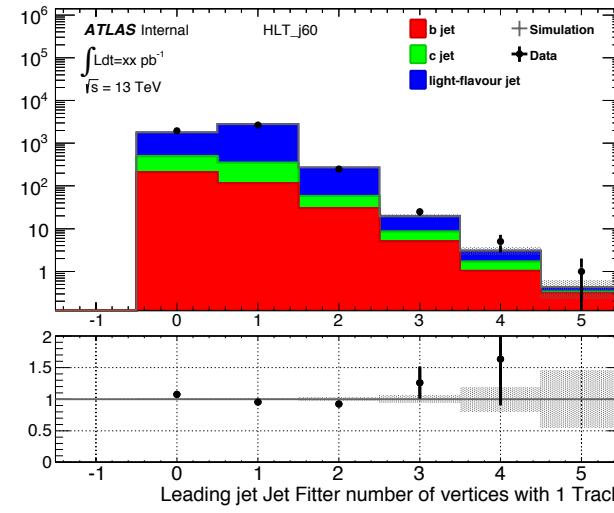


# Vertices with  
at least 2 Tracks

Only Filled if a Jet Fitter Vertex is found

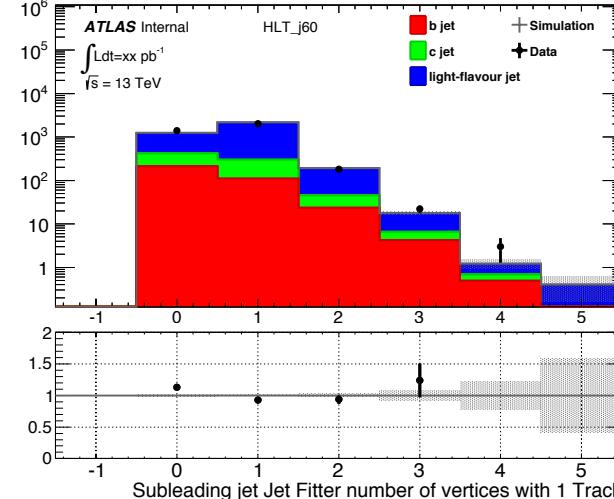
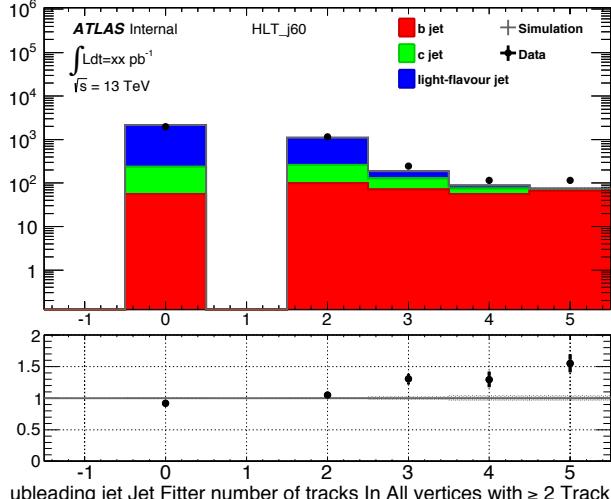
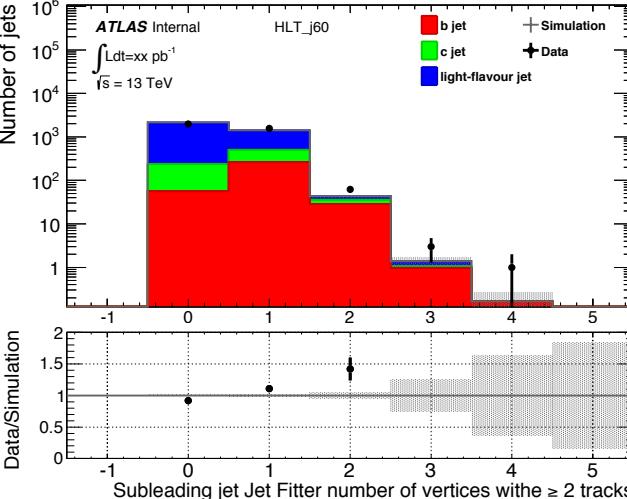


# Tracks at Vertices  
with at least 2 Tracks



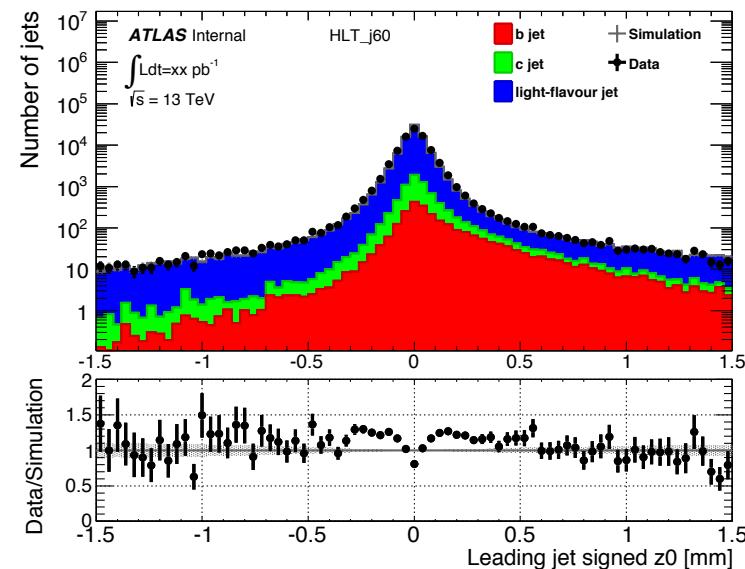
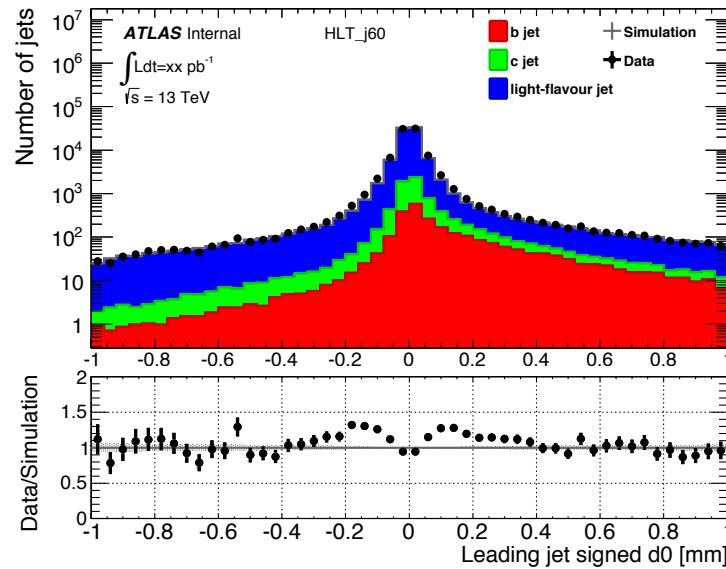
# Vertices with  
1 Track

## Sub-Leading Jet:



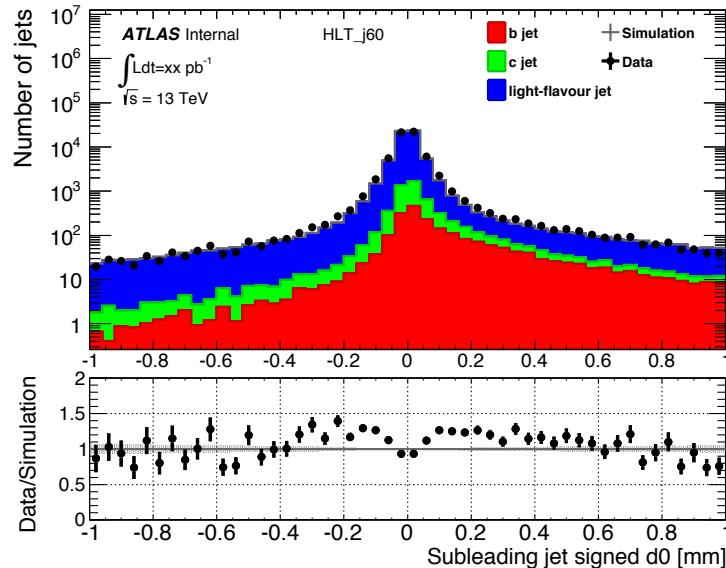


## Leading Jet:

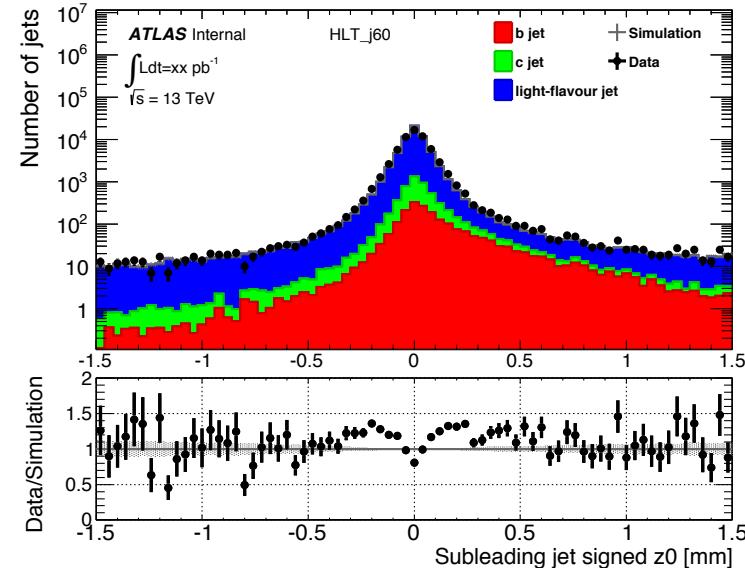


## Sub-Leading Jet:

IP3D d0

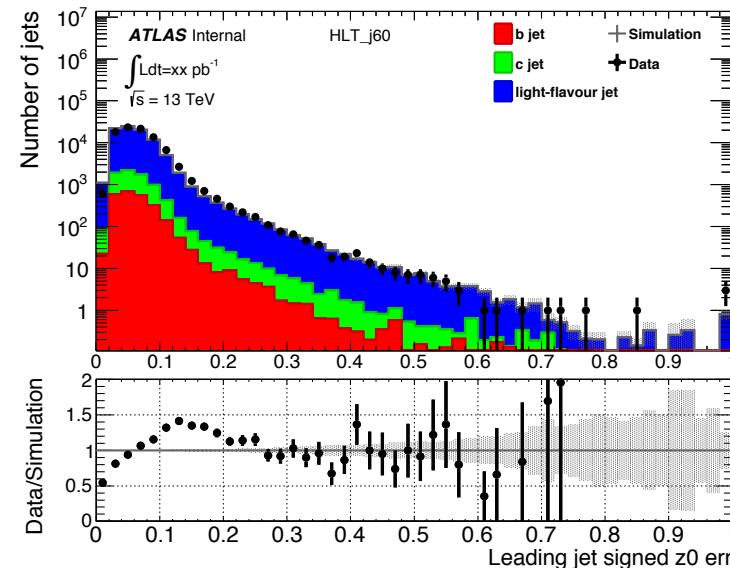
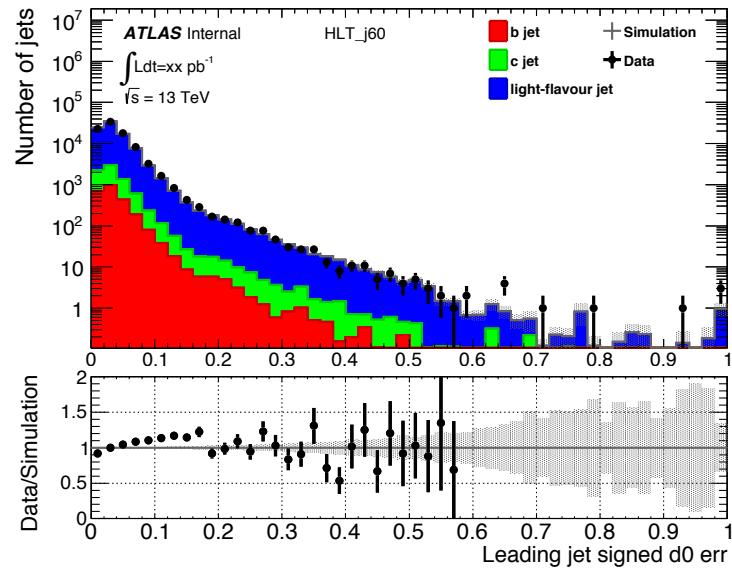


IP3D z0

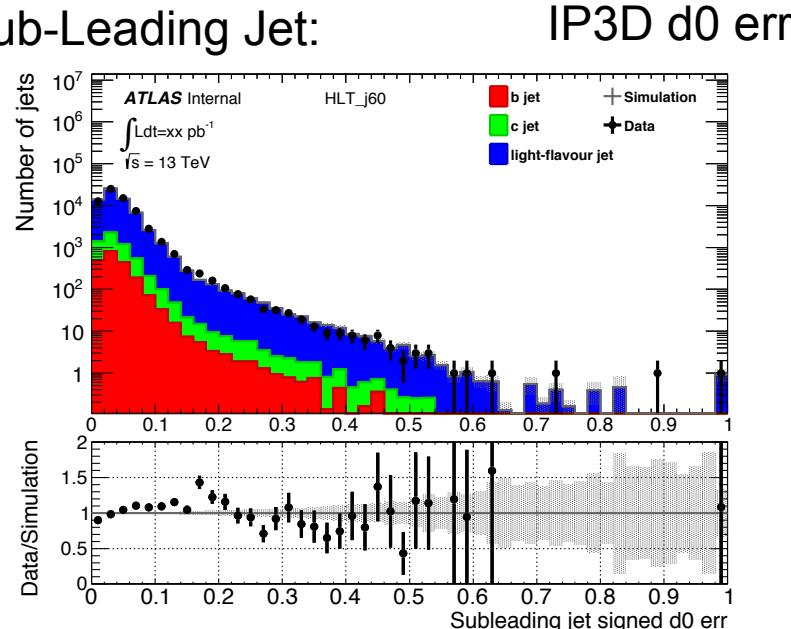




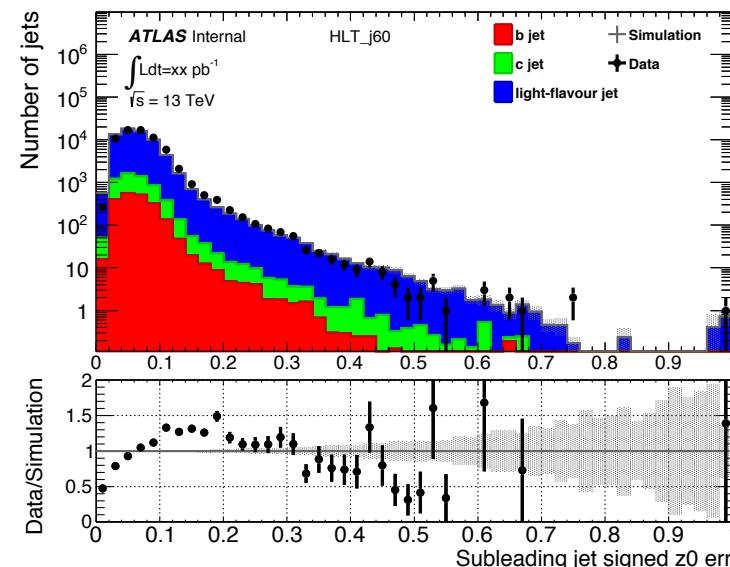
## Leading Jet:



## Sub-Leading Jet:

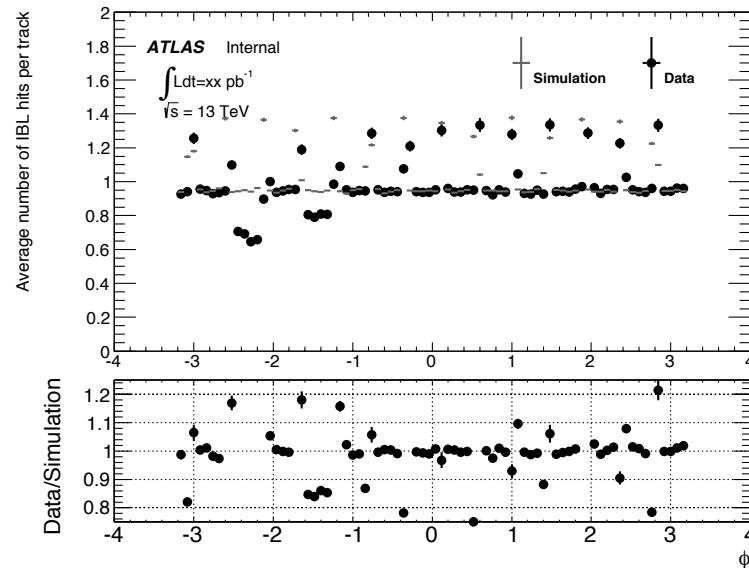


## IP3D d0 err

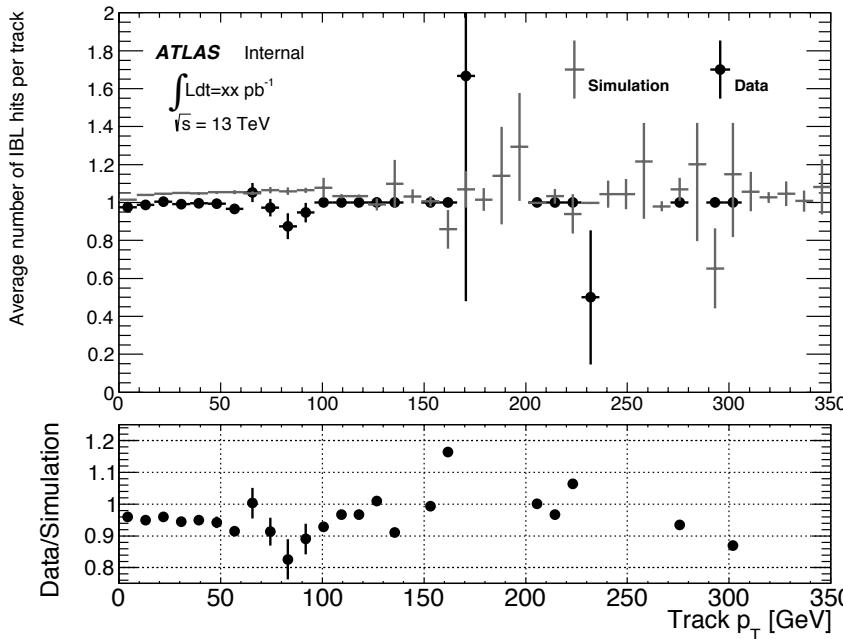
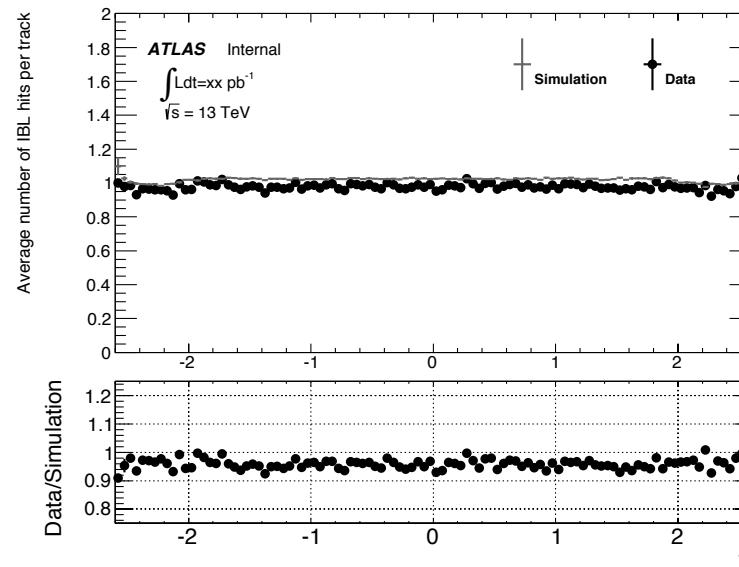


## IP3D z0 err

vs. Phi



vs. Eta



vs. Track  $p_T$

I'm not sure we should extend  
to a track  $p_T$  of 350 GeV

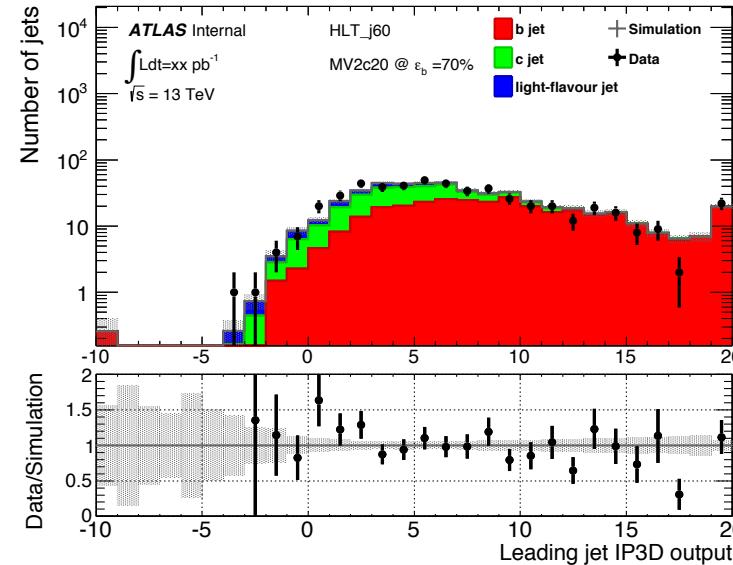
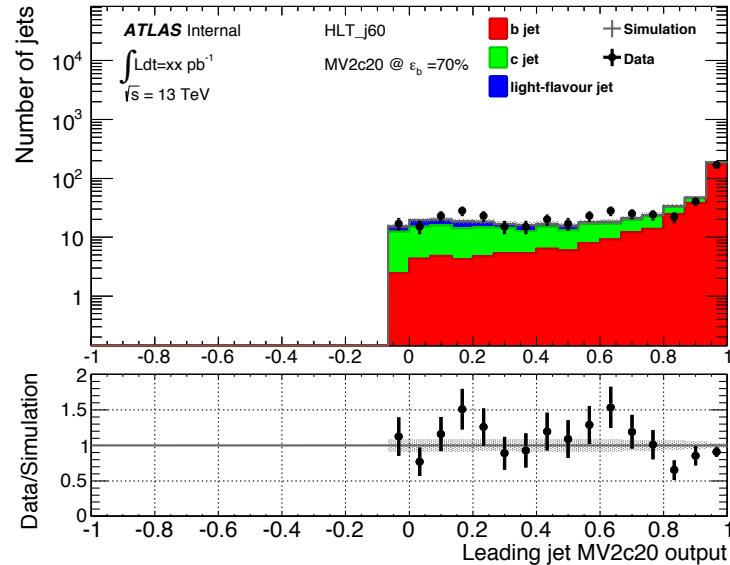


# 19 b Enhanced Sample - Leading Jet

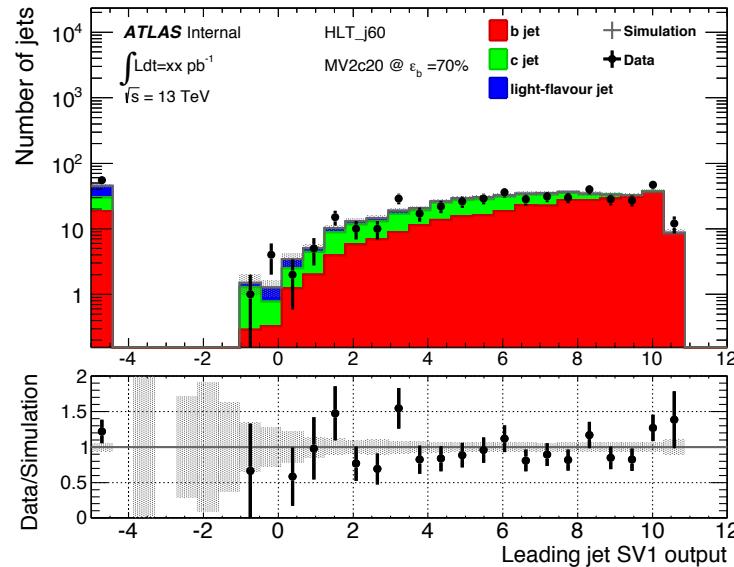
MV2c20:

Leading MV2c20 > -0.0436 which is 70% b-efficiency

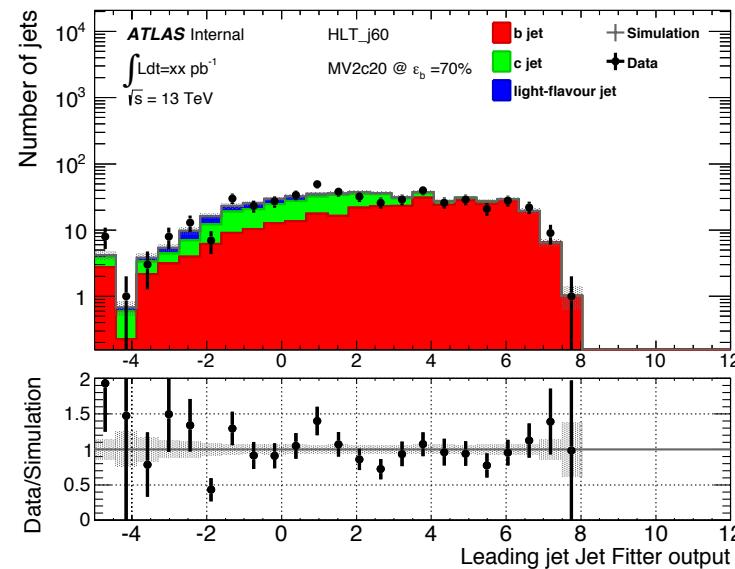
IP3D:



SV1:



Jet Fitter:





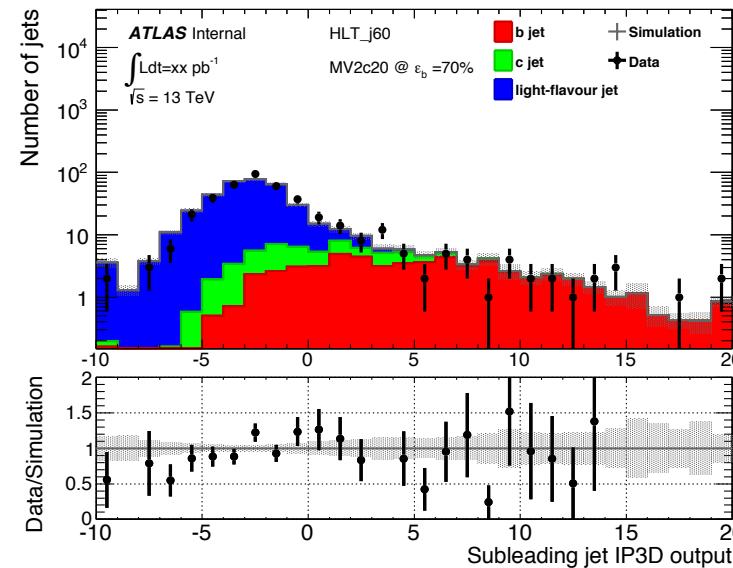
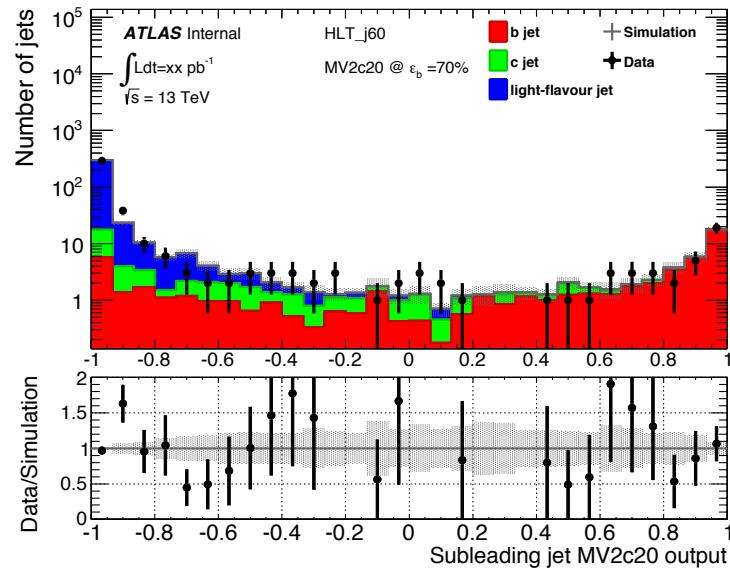
# 20 b Enhanced Sample - Subleading Jet



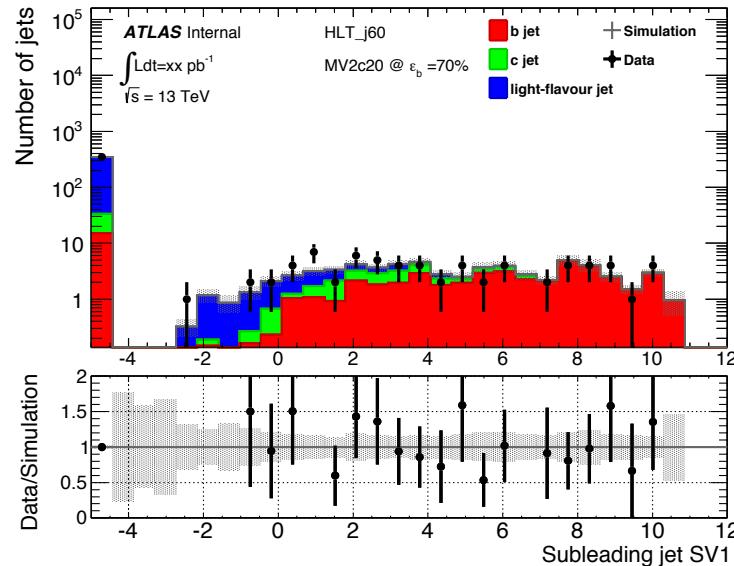
MV2c20:

Leading MV2c20 > -0.0436 which is 70% b-efficiency

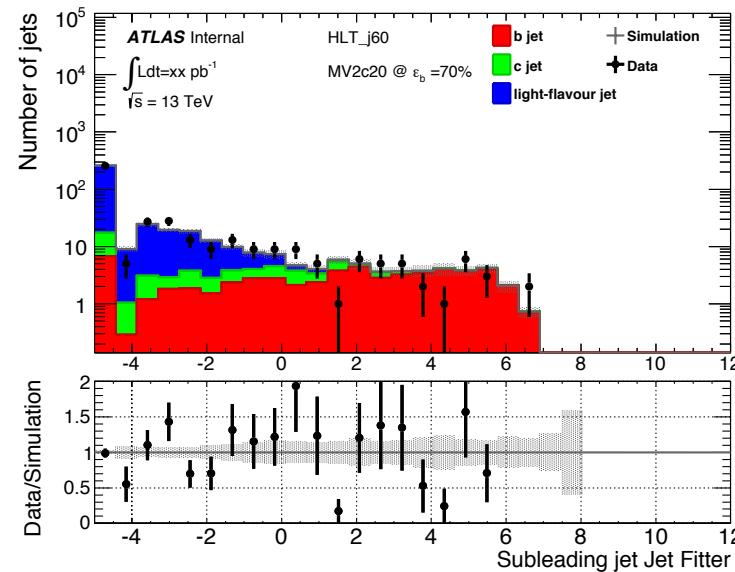
IP3D:



SV1:



Jet Fitter:





## Conclusions

Some good agreements:

- SV1 and JF tagger inputs.
- Jet kinematic variables.

Some problems:

- Tracking alignment, to be sorted.
- Low statistics.

Some additions to be made:

- Show d0 and z0 errors directly.

In a good place for Lepton Photon in August

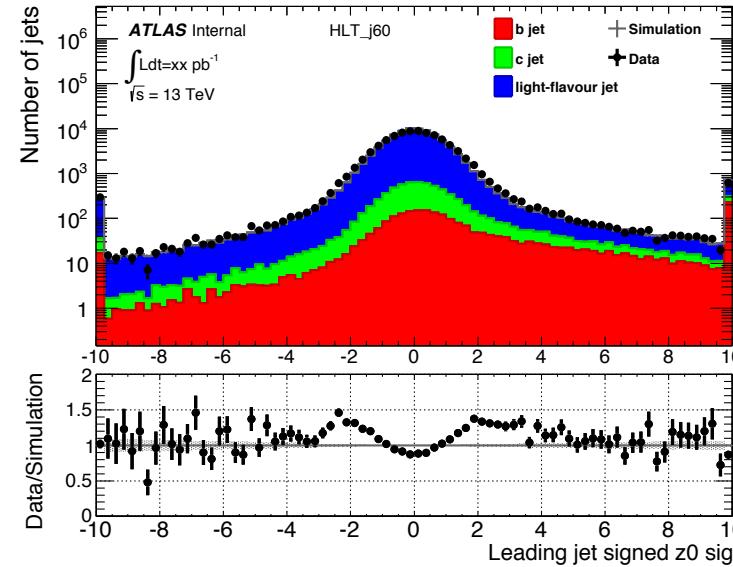
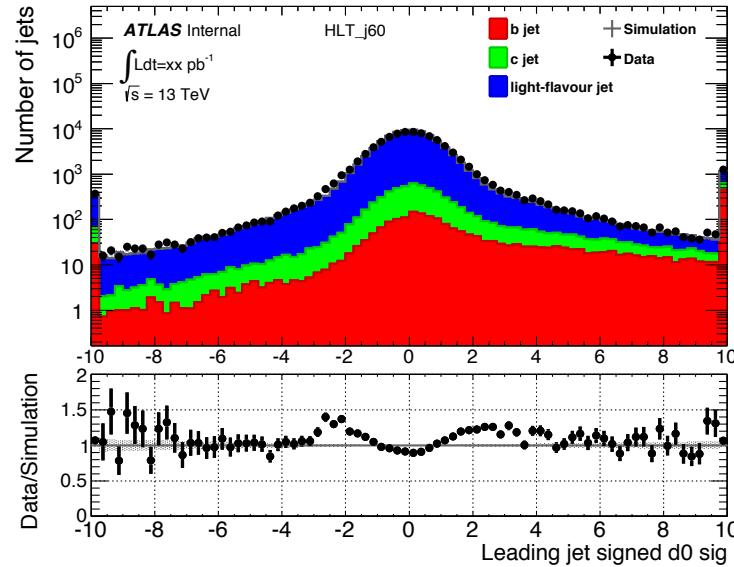
- Ready for more data with improving alignment!



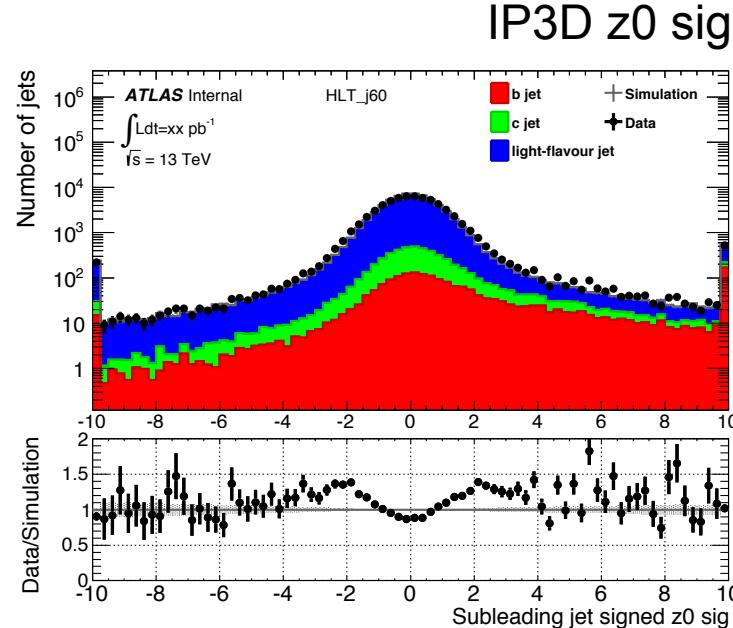
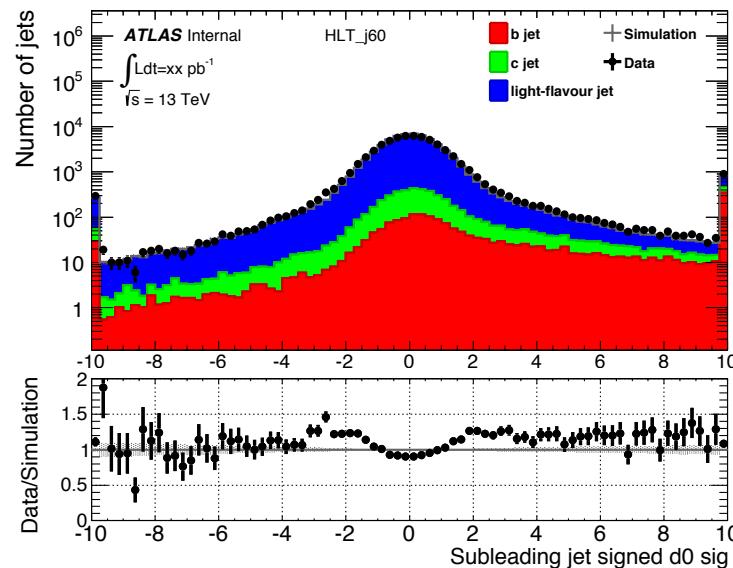
# Backup



## Leading Jet:



## Sub-Leading Jet:



## IP3D d0 sig

## IP3D z0 sig