



# Flavour Tagging Commissioning with Data

Laurie McClymont,  
Antonello Miucci, Valerio Dao,  
Andrea Coccato, Andreas Korn,  
Tim Scanlon, Giacinto Piacquadio

Flavour Tagging Meeting  
21/07/15



## 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.

## Progress on Note

- Aiming 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.00271048.physics_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



## 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  $P_T > 70$  GeV.
- HLT\_j60 Trigger for Data 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:

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

Then plot subleading if subleading jet has:

- **$P_T > 35$  GeV**
- $|\eta| < 2.5$
- $\text{JVT} > 0.641$  if ( $P_T < 50$  GeV and  $|\eta| < 2.4$ )

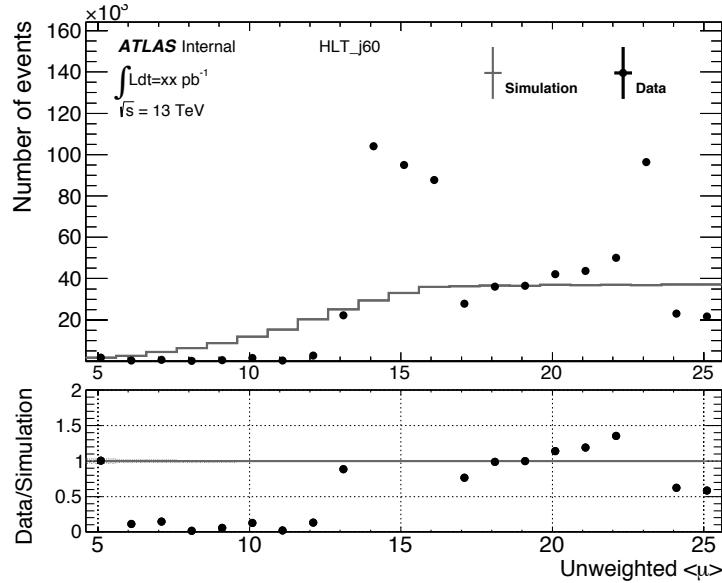
### Just For MC

- 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.

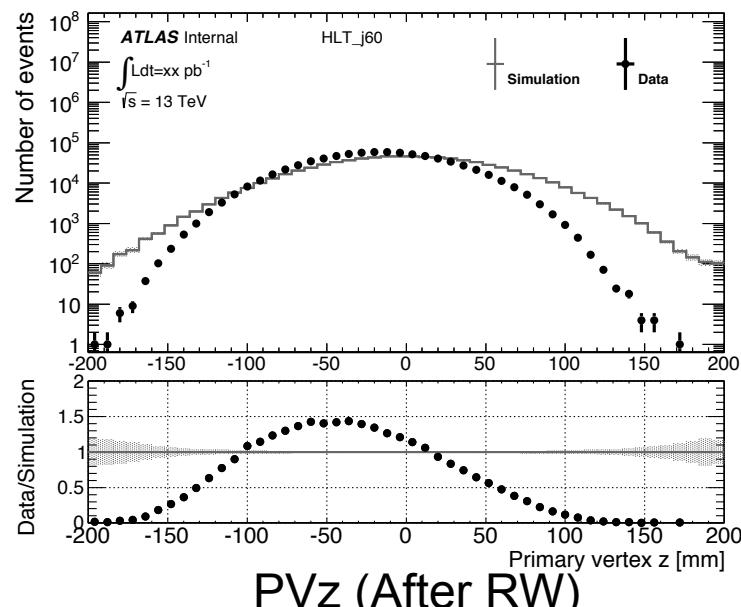
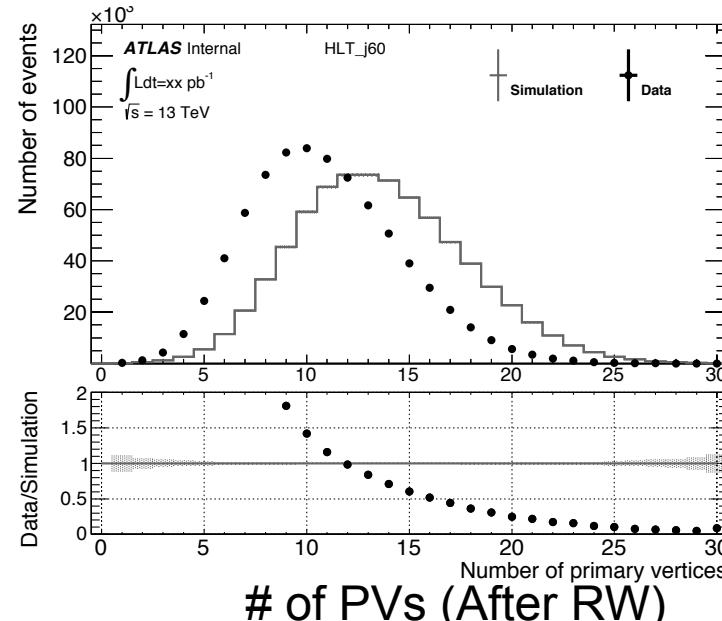
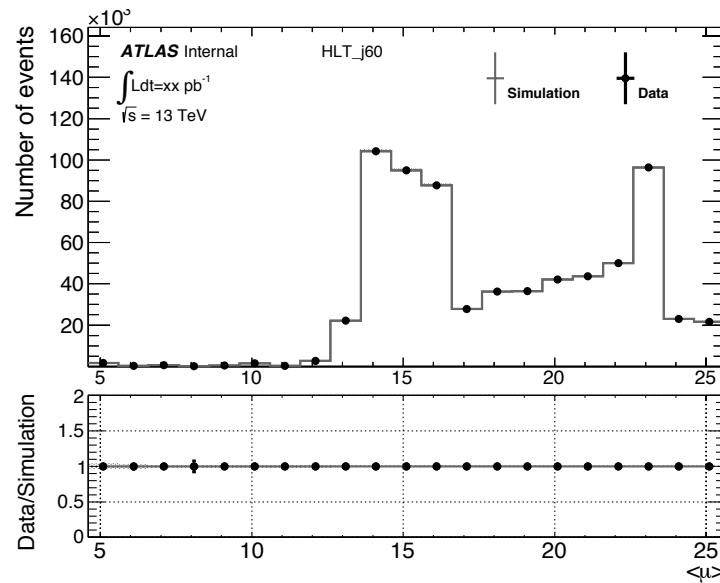


## 5 $\langle\mu\rangle$ Reweighting

Before:



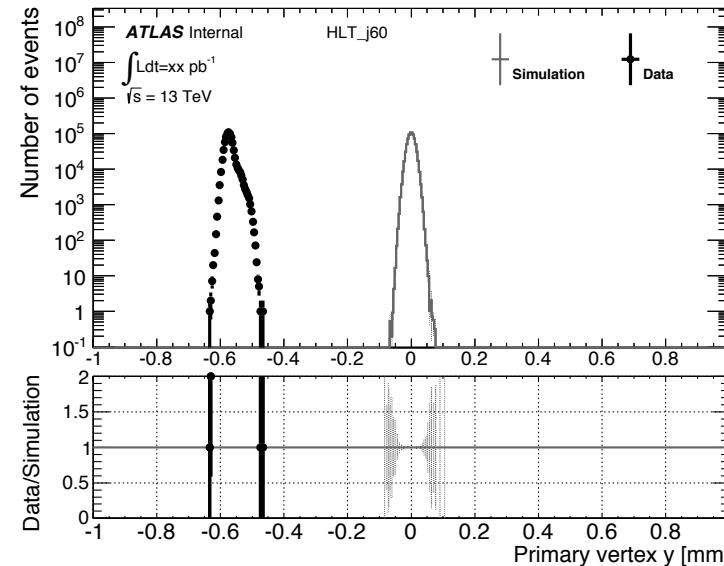
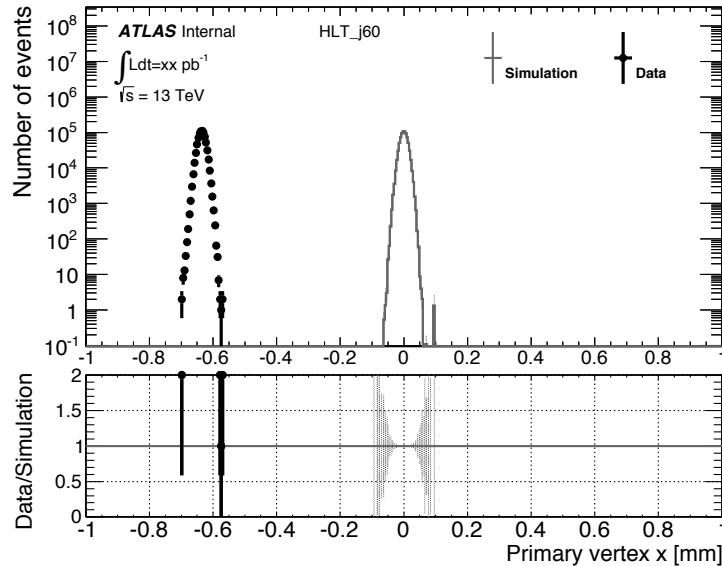
After:



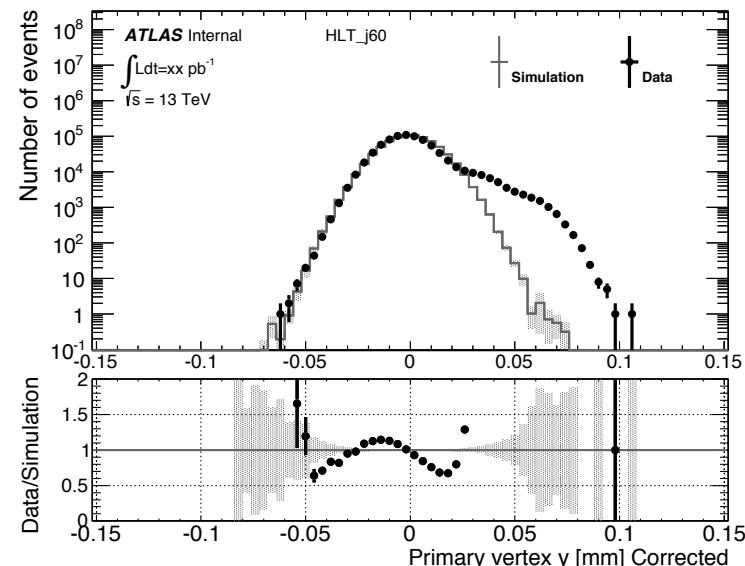
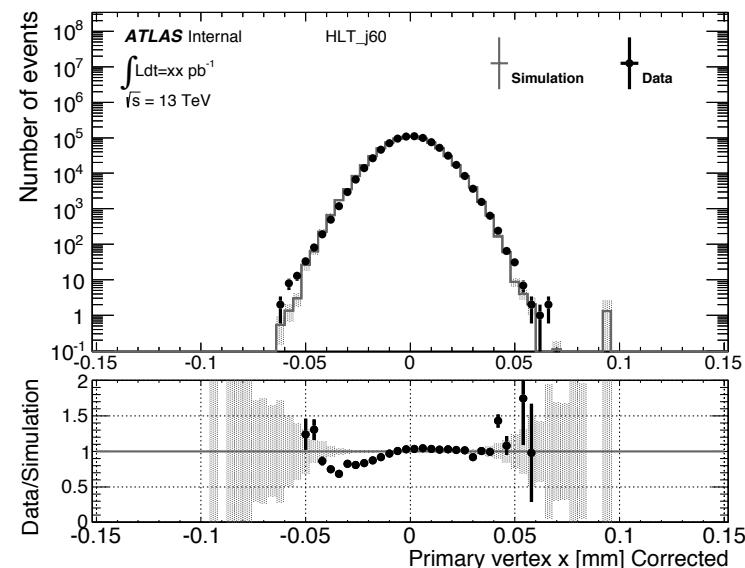


## 6 PV<sub>x</sub> and PV<sub>y</sub>

Before:



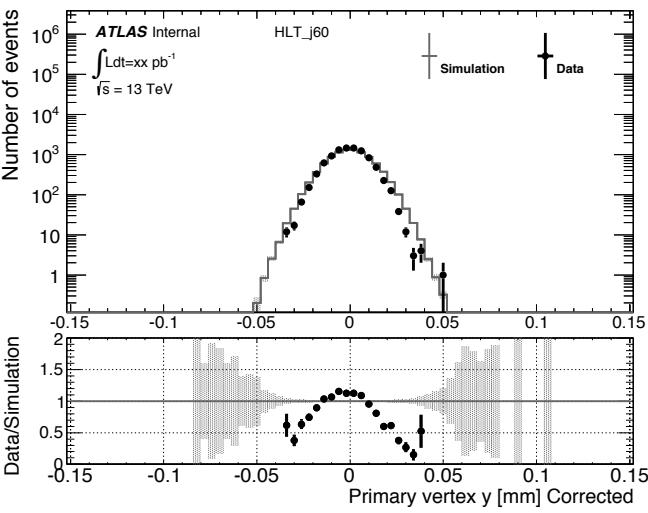
Corrected:



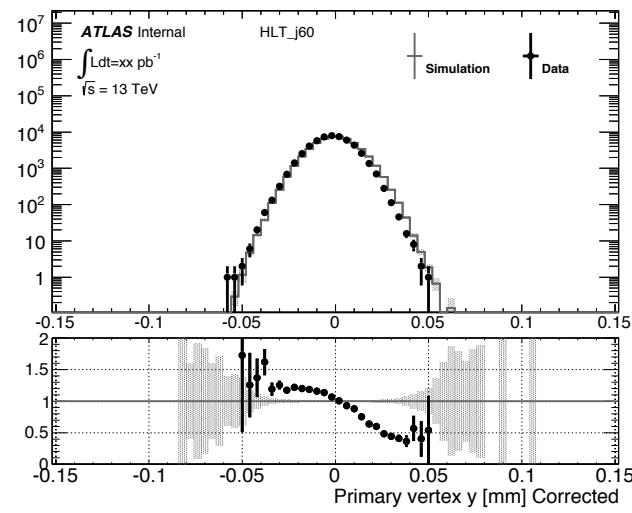


# 7 PZy Corrected - Individual Runs

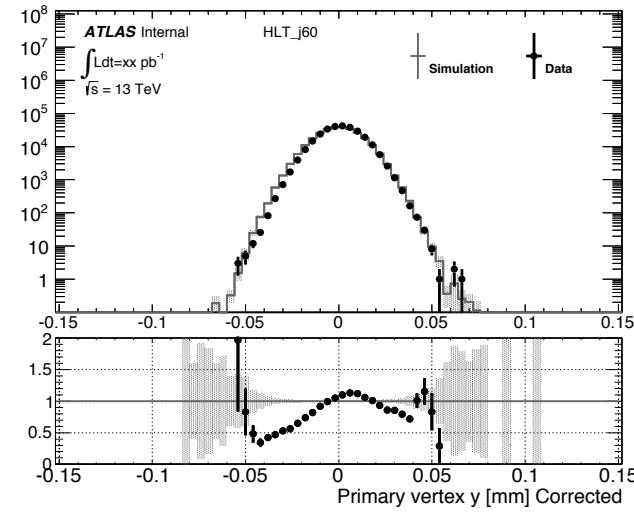
run 270953:



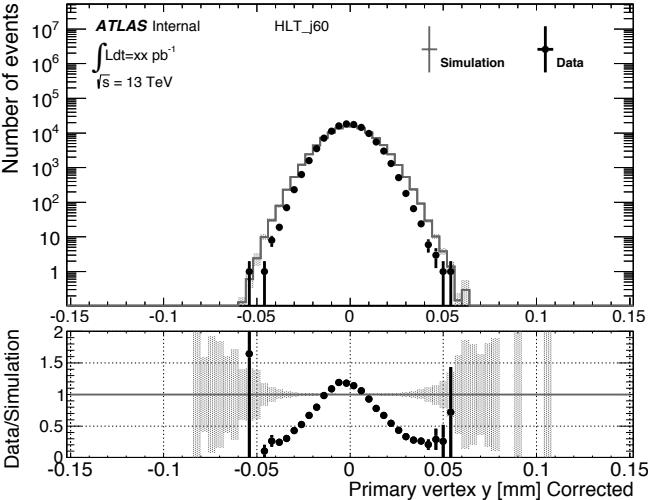
run 271048:



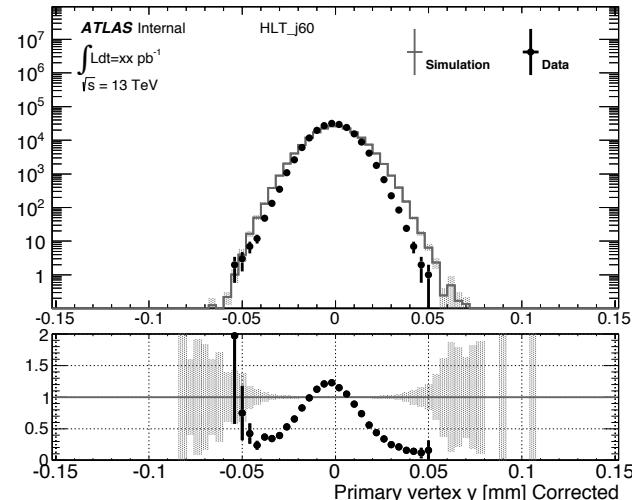
run 271298:



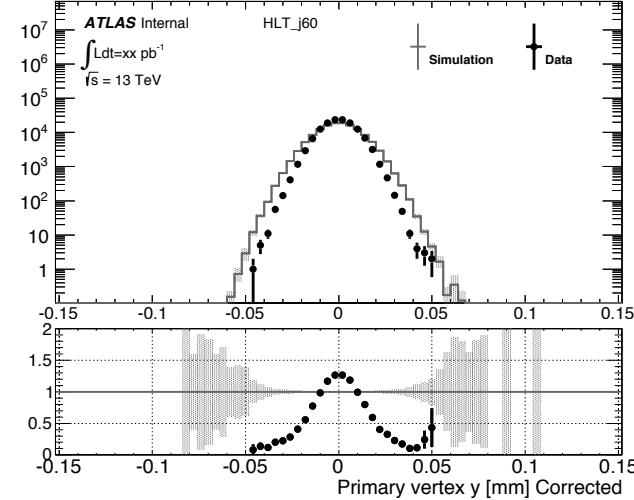
run 271421:



run 271516:



run 271595:

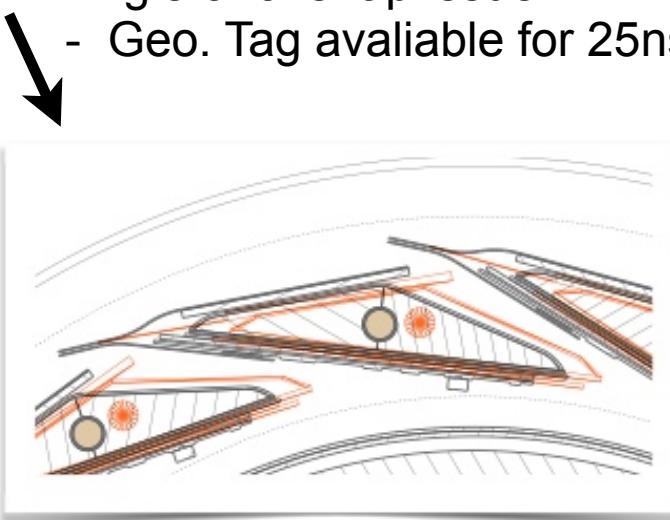




## 8 IP Update from Tracking Group

### Problems

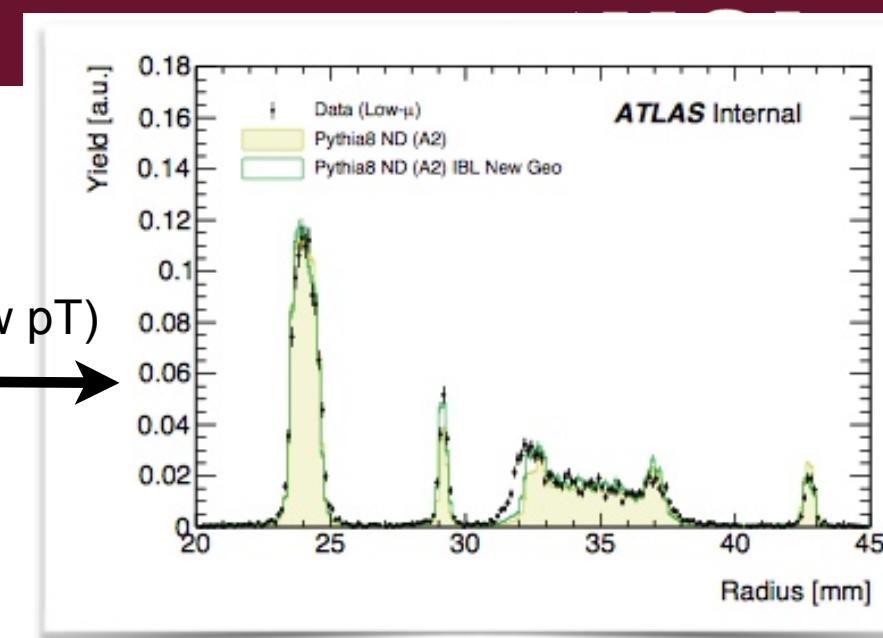
- Imperfect alignment (high pT)
- Geometry tag missing 23% IBL material (low pT)
  - New Geo. Tag Produced and validated.
- Angle of overlap issue
  - Geo. Tag available for 25ns data.



GEO Model  
IBL

Simone Pagan Griso, Heather Gray

[https://indico.cern.ch/event/433839/  
contribution/6/attachments/  
1128840/1612854/PC\\_20jul.pdf](https://indico.cern.ch/event/433839/contribution/6/attachments/1128840/1612854/PC_20jul.pdf)



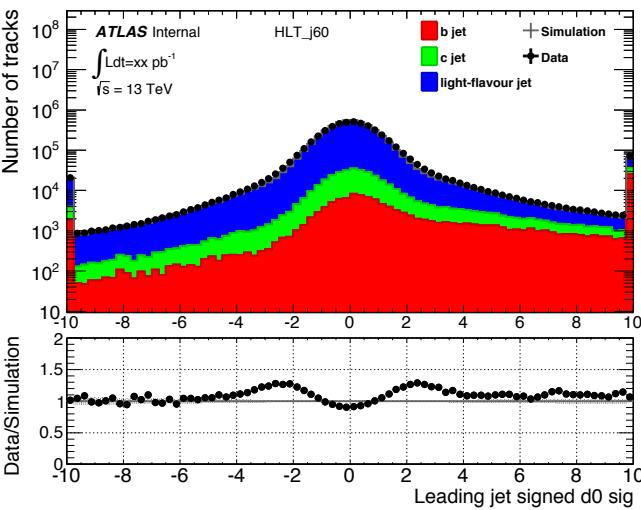
### Proposal

- 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

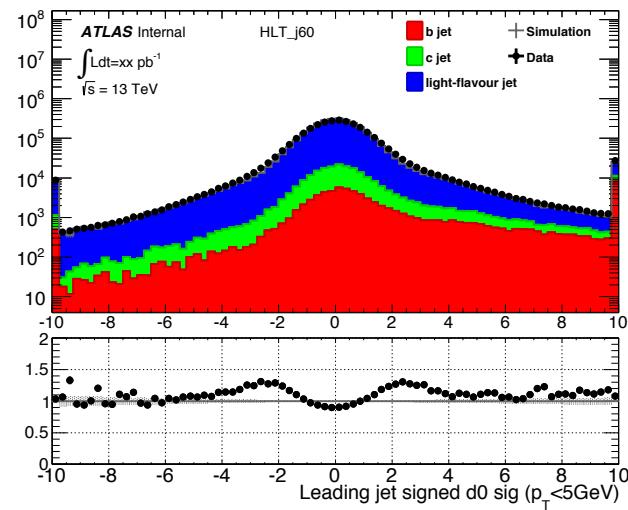


## 9 Signed d0/z0 Significance - Varying Track pT

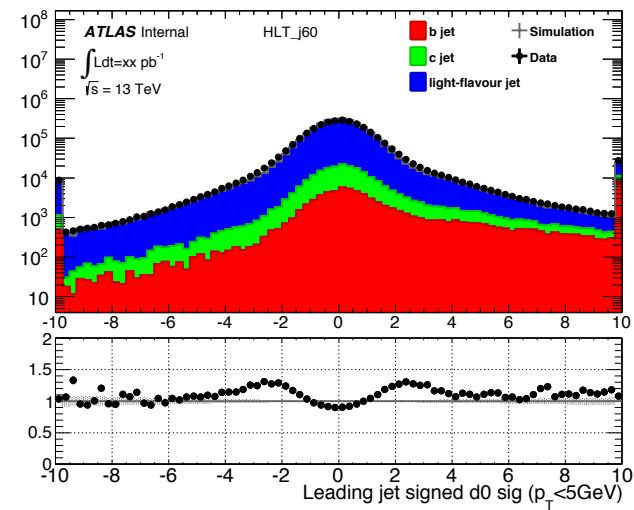
### d0 Significance:



All ( $p_T > 1 \text{ GeV}$ )

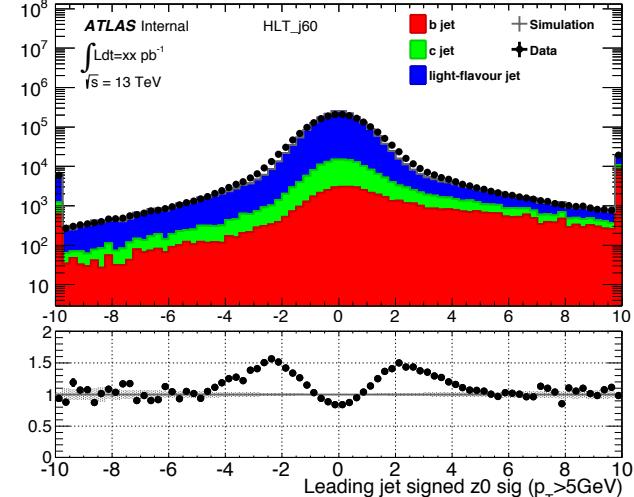
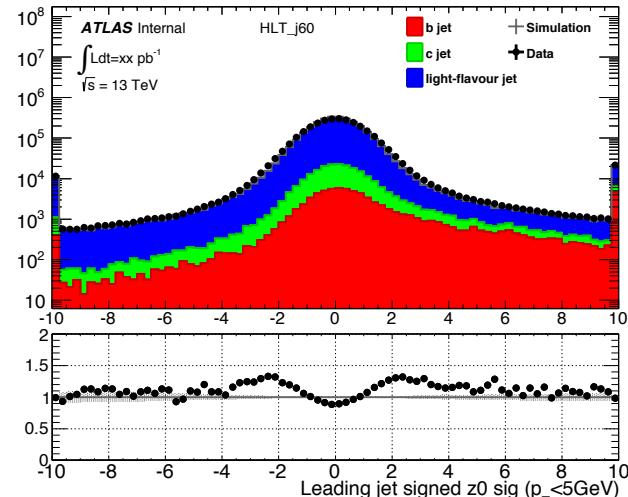
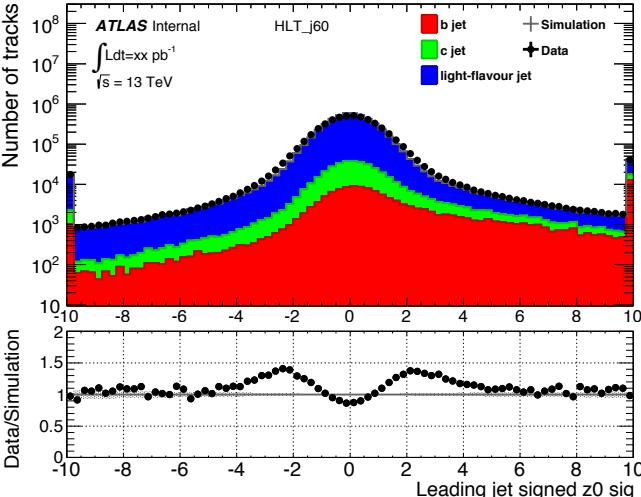


1 GeV < track pT < 5 GeV



track pT > 5 GeV

### z0 Significance:

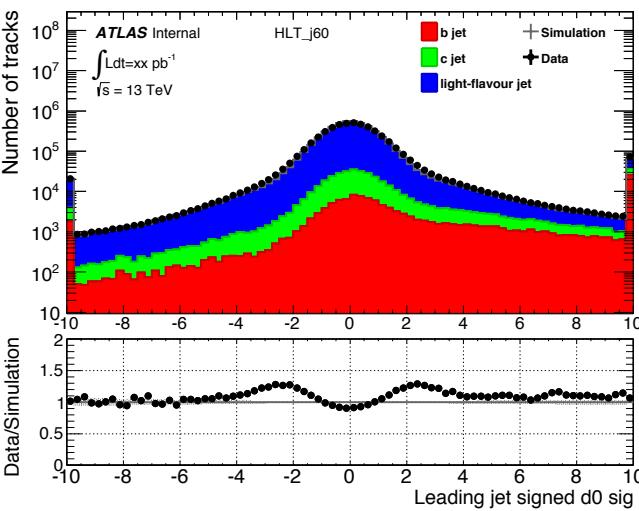




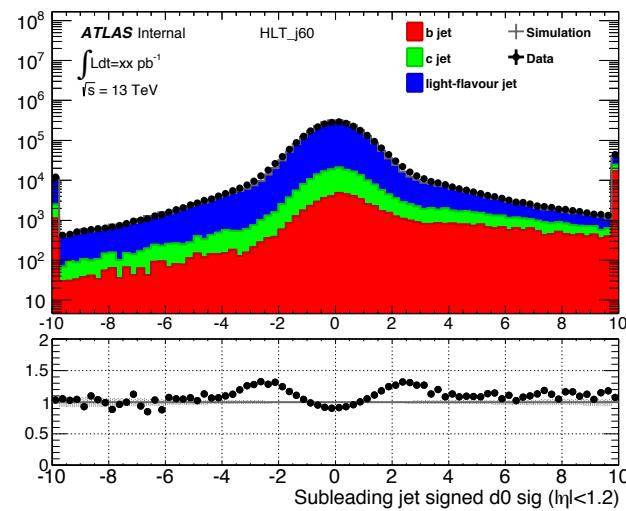
# 10 Signed d0/z0 Significance - Varying n



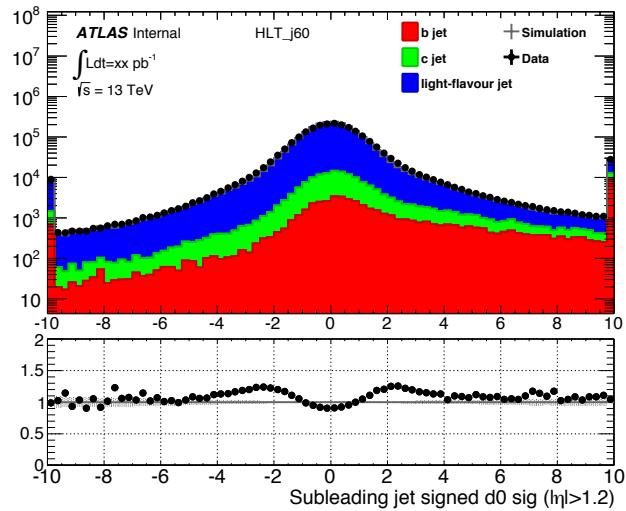
d0 Significance:



All

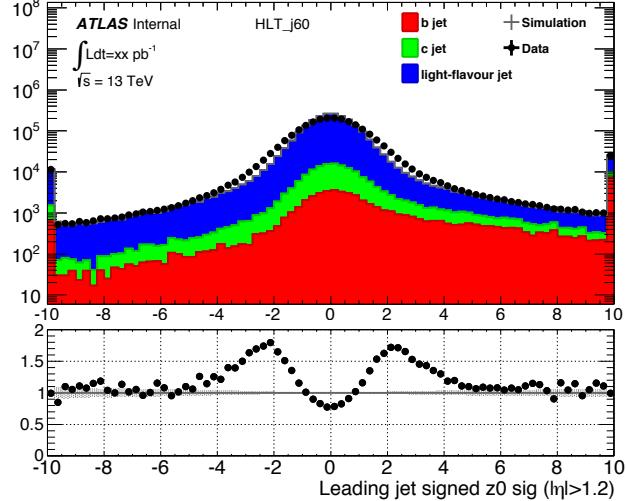
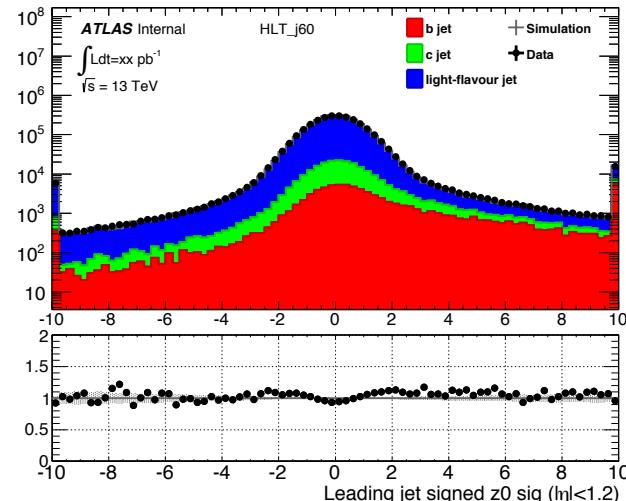
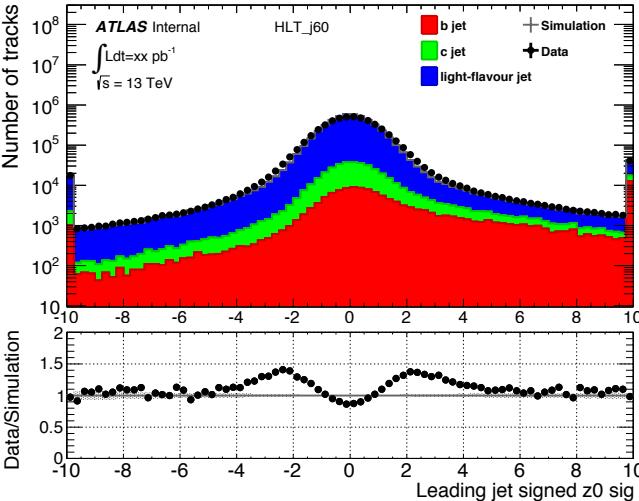


$|\eta| < 1.2$



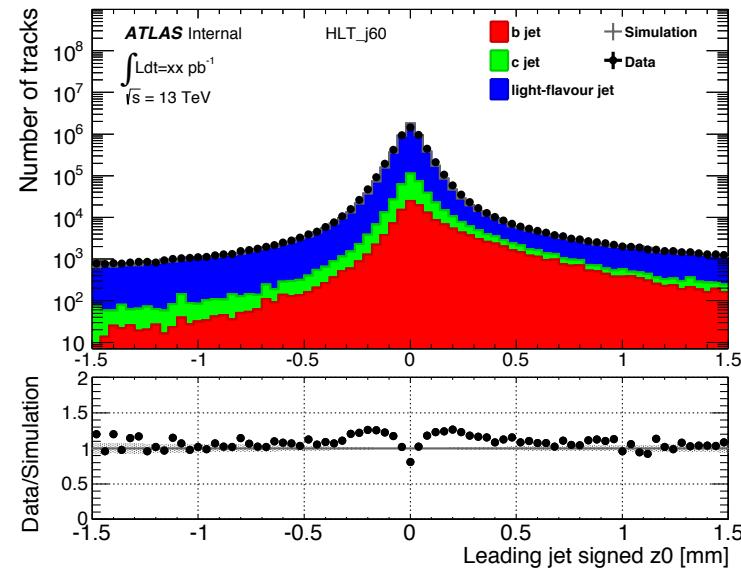
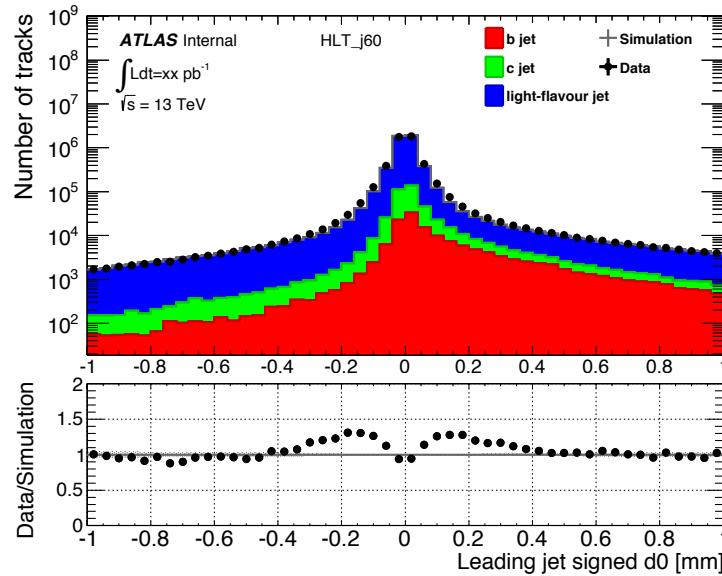
$|\eta| > 1.2$

z0 Significance:



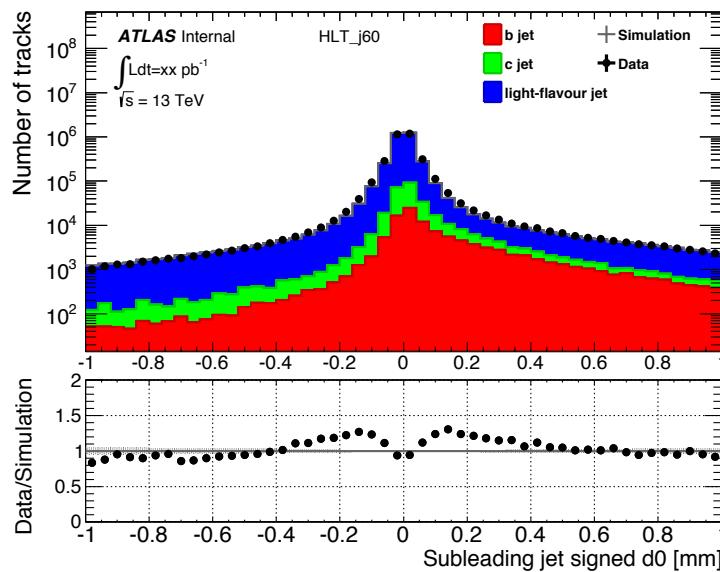


## Leading Jet:

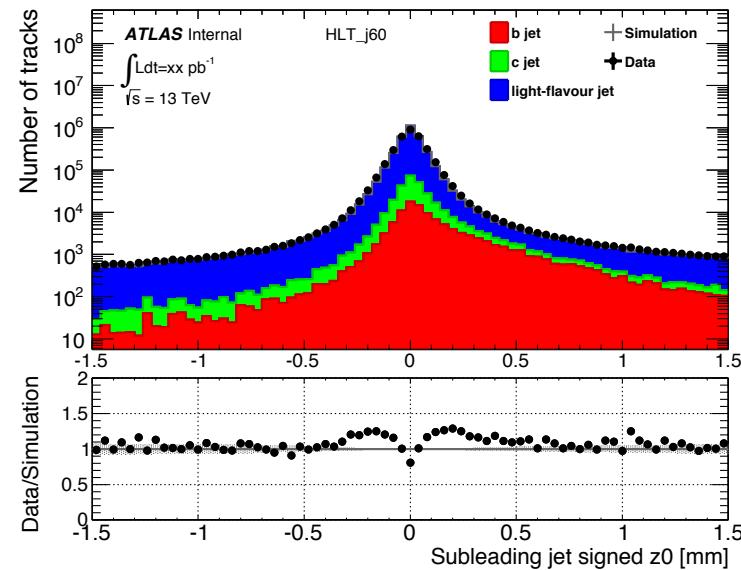


## Sub-Leading Jet:

## IP3D d0

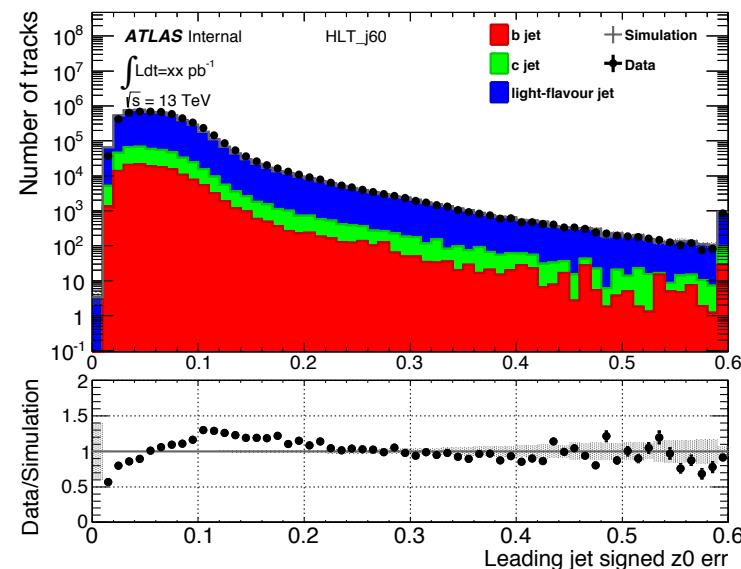
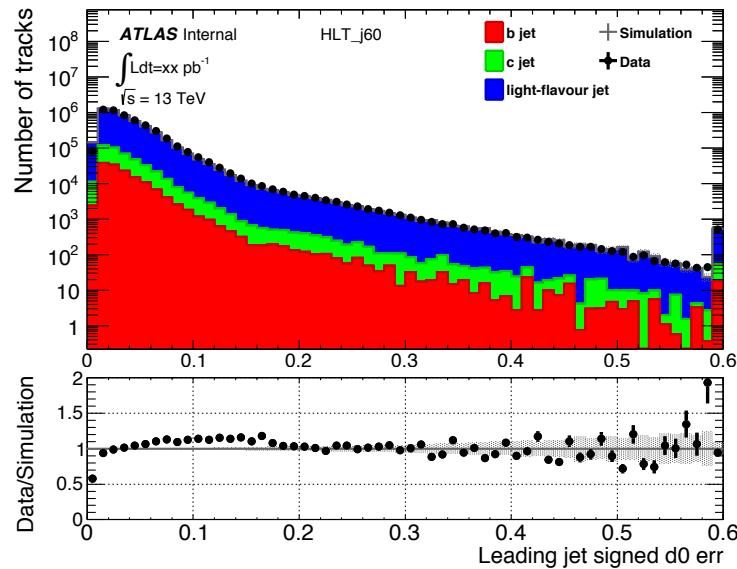


## IP3D z0



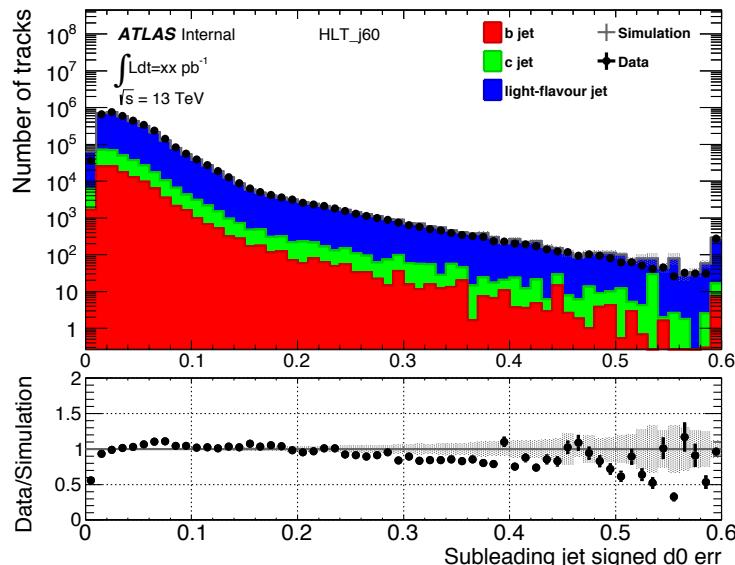


## Leading Jet:

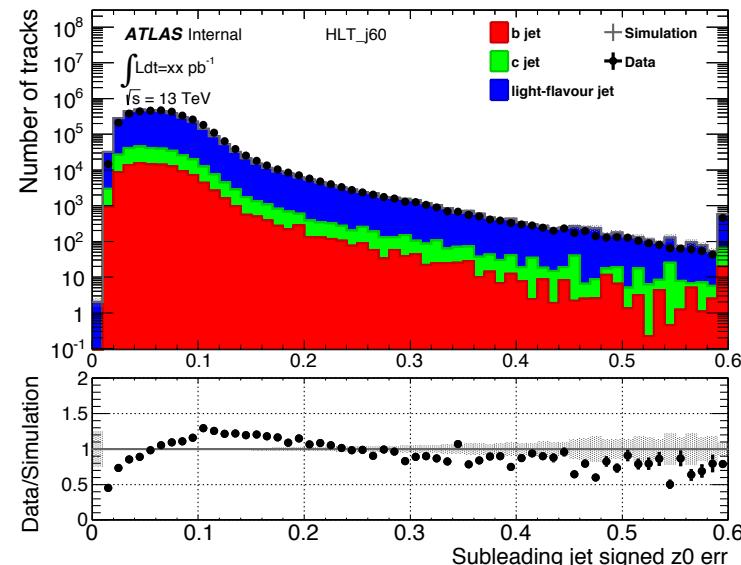


## Sub-Leading Jet:

IP3D d0 err



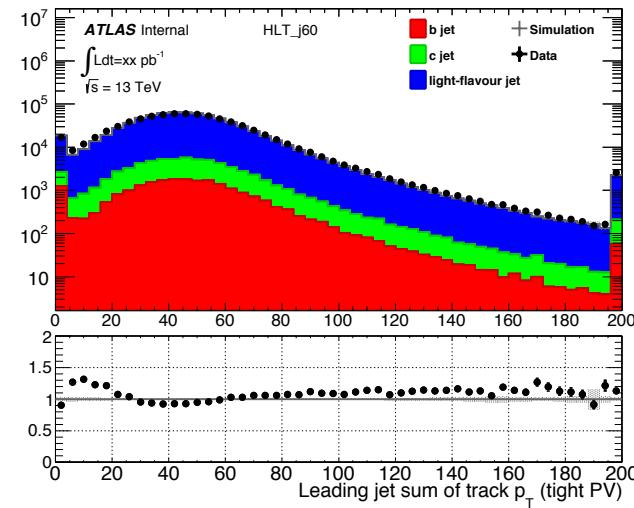
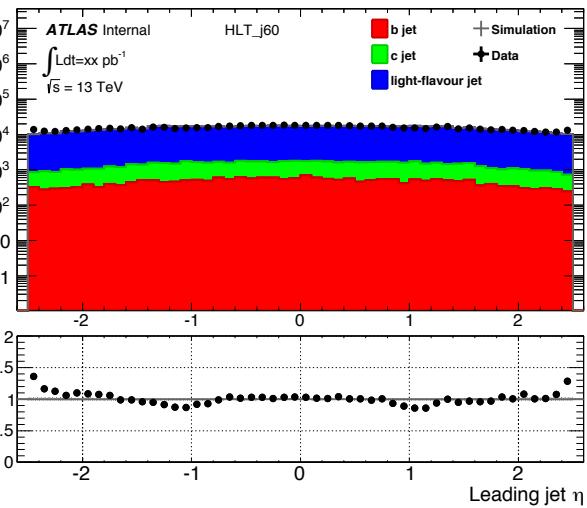
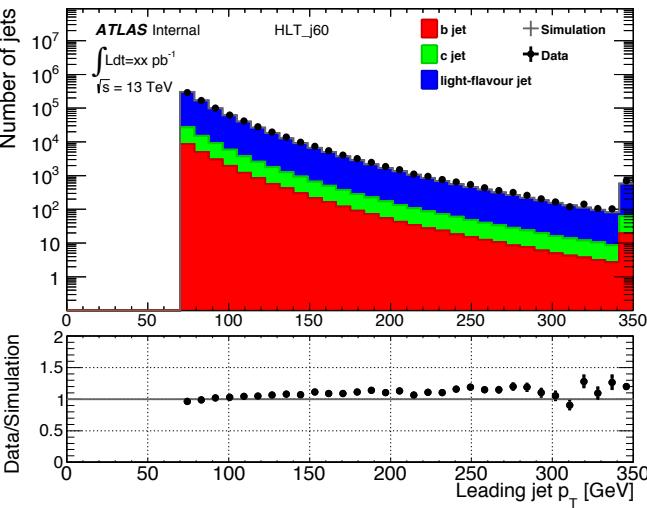
IP3D z0 err





# 13 Jet Kinematic Distributions

**Leading Jet:**

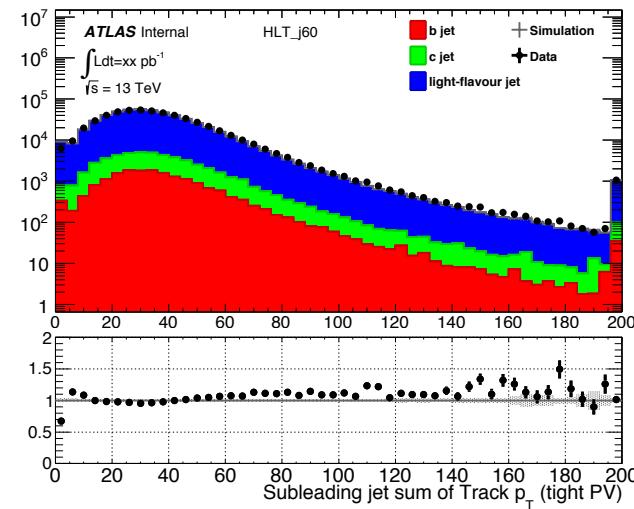
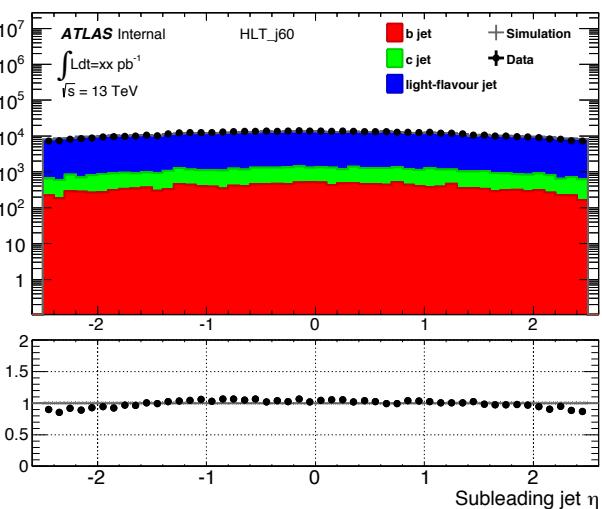
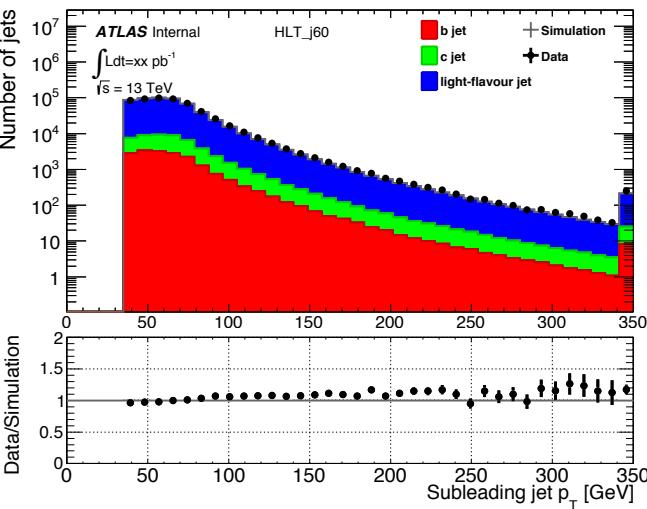


**Jet  $P_T$**

**Eta**

**Sum of Track  $P_T$**

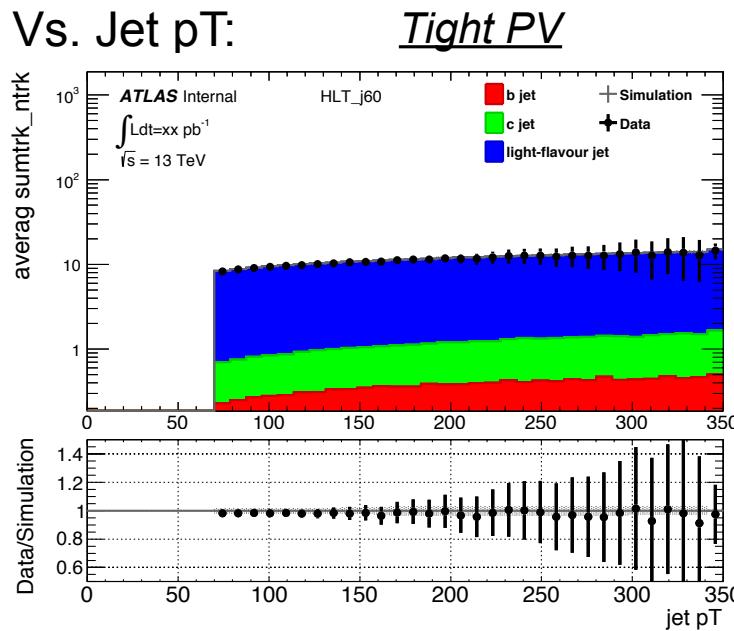
**Sub-Leading Jet:**



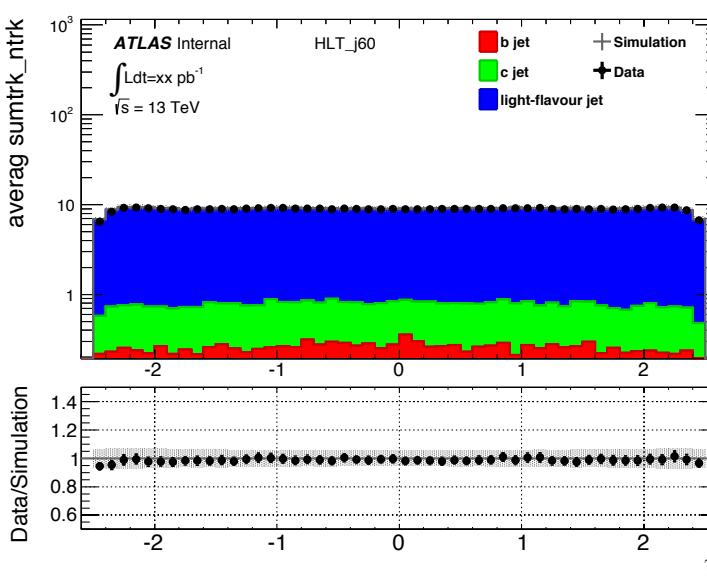


# 14 # Tracks / # Jets

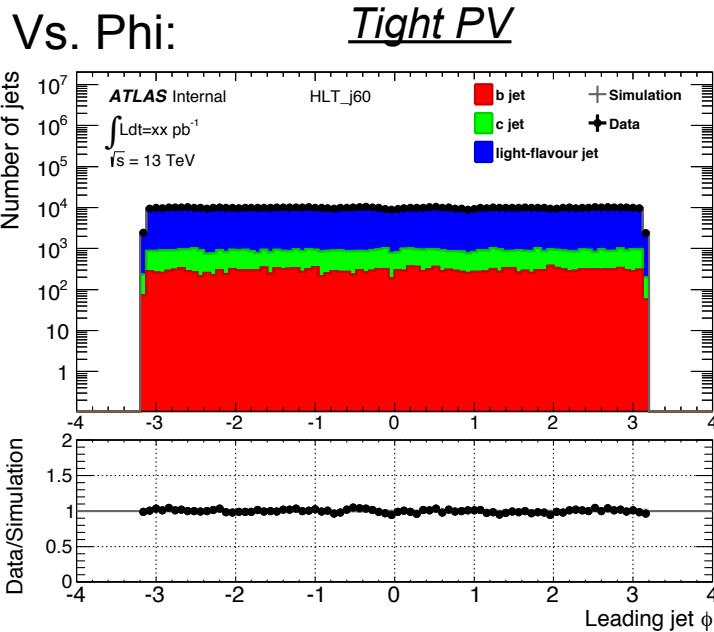
Vs. Jet pT:



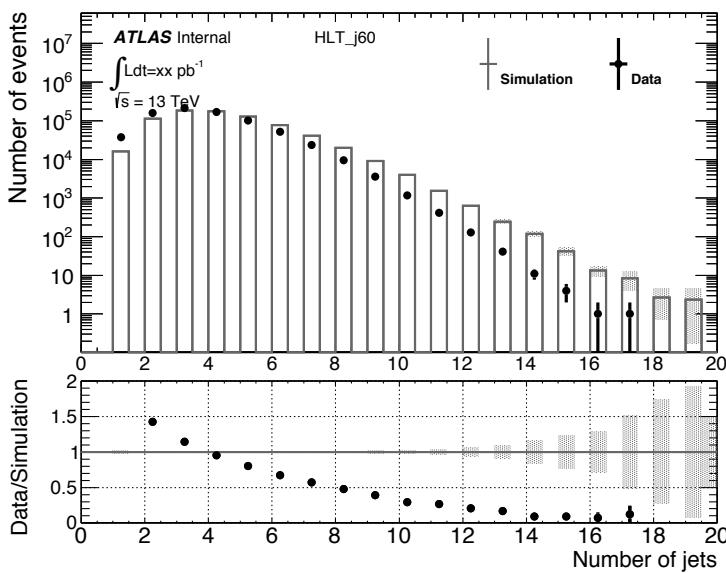
Vs. Eta:



Vs. Phi:



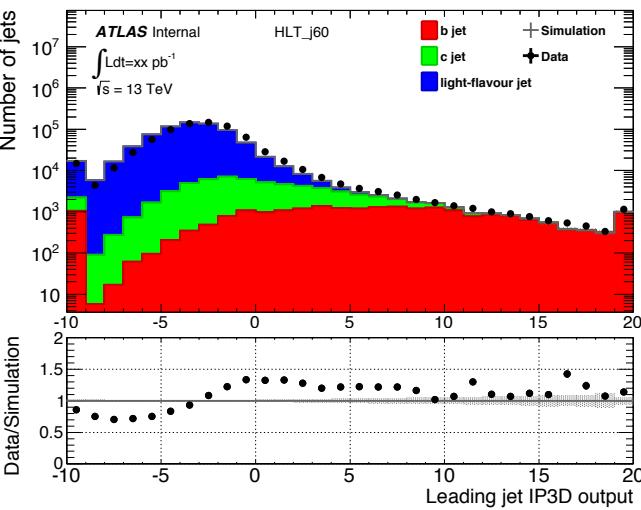
Jet Multiplicity:



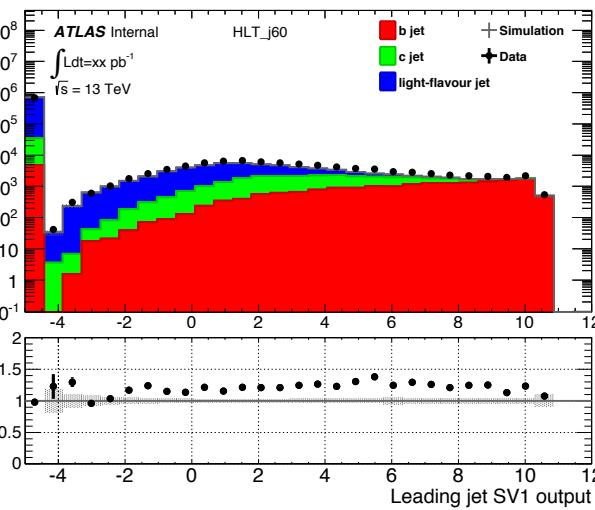


# 15 Input Taggers

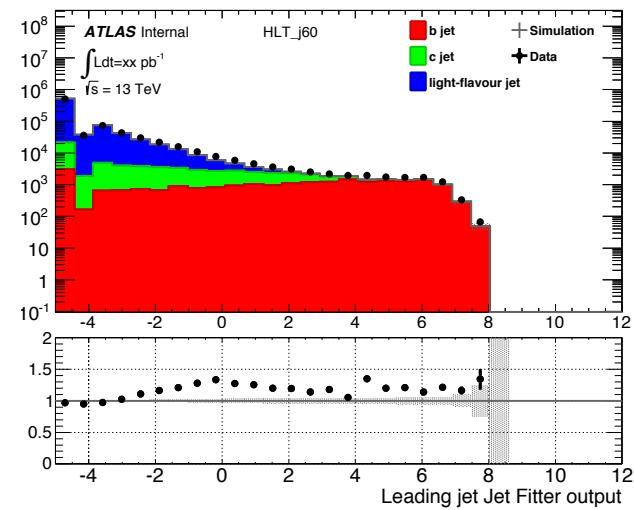
## Leading Jet:



IP3D

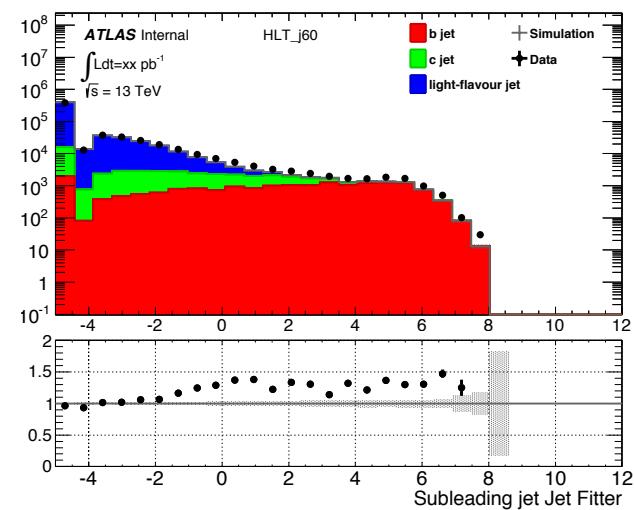
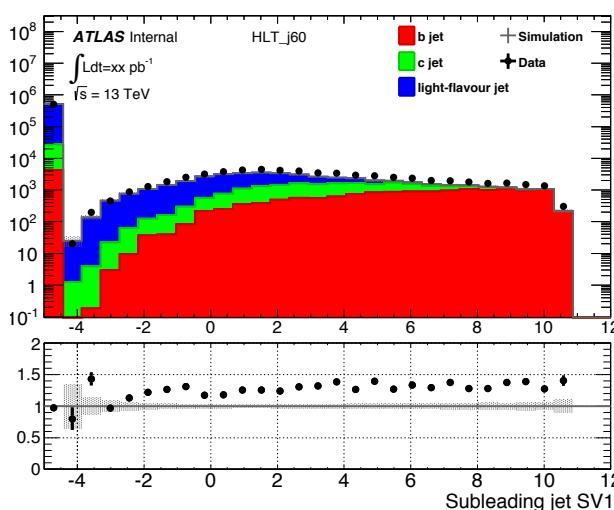
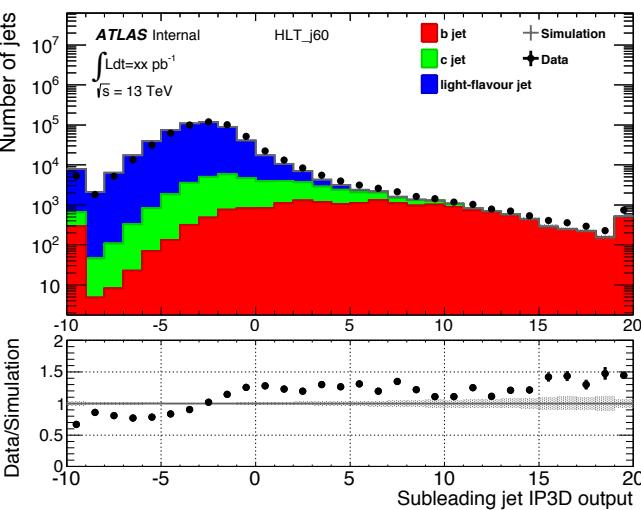


SV1



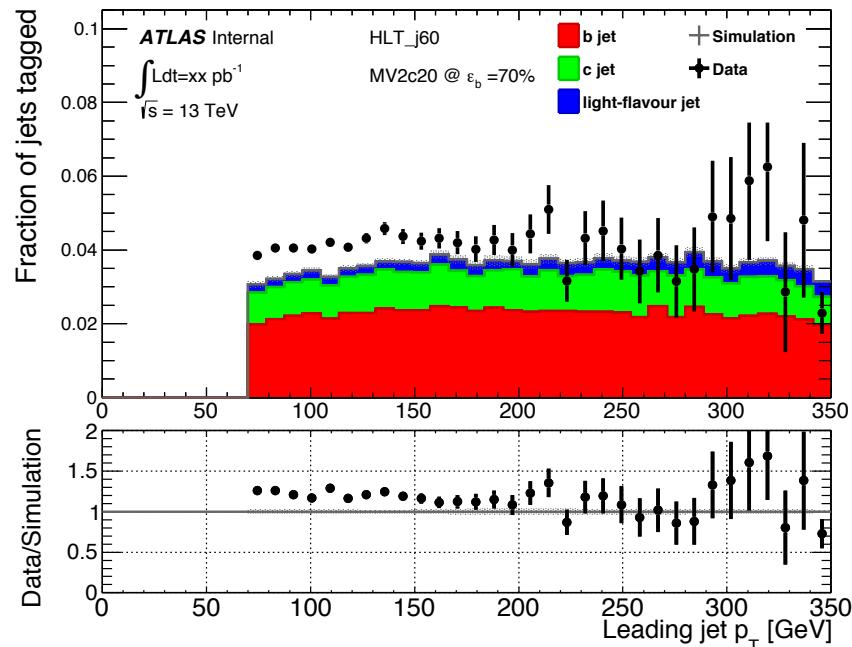
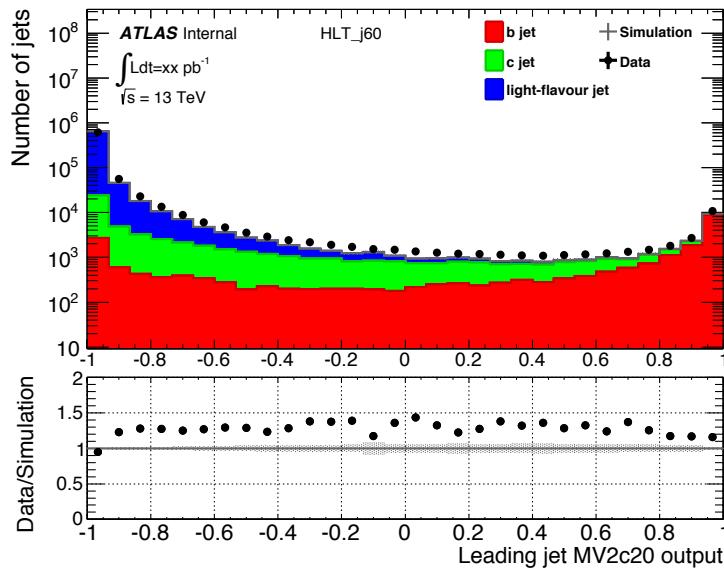
JF

## Sub-Leading Jet:



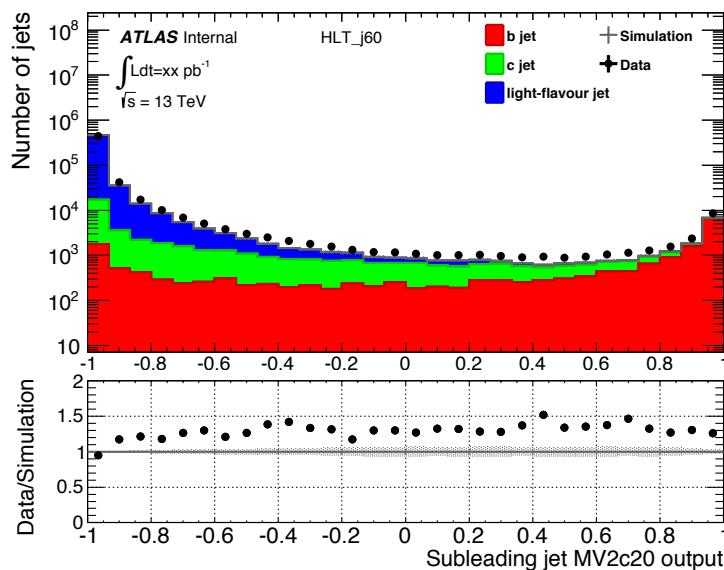


## Leading Jet:



## Sub-Leading Jet:

MV2c20



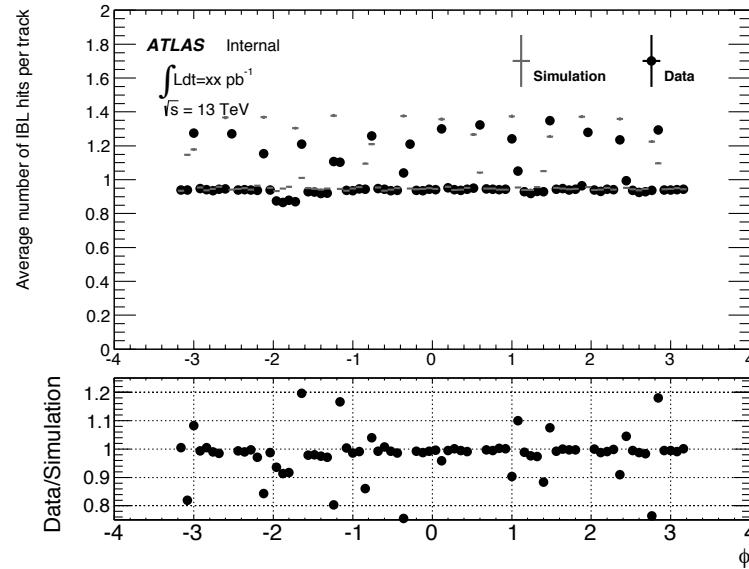
Tag Rate



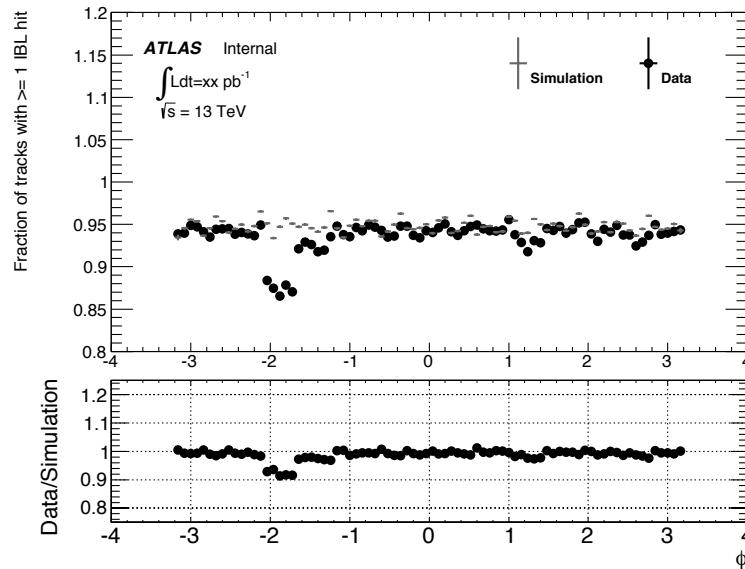
# 17 Track Studies - Average # IBL Track Hits



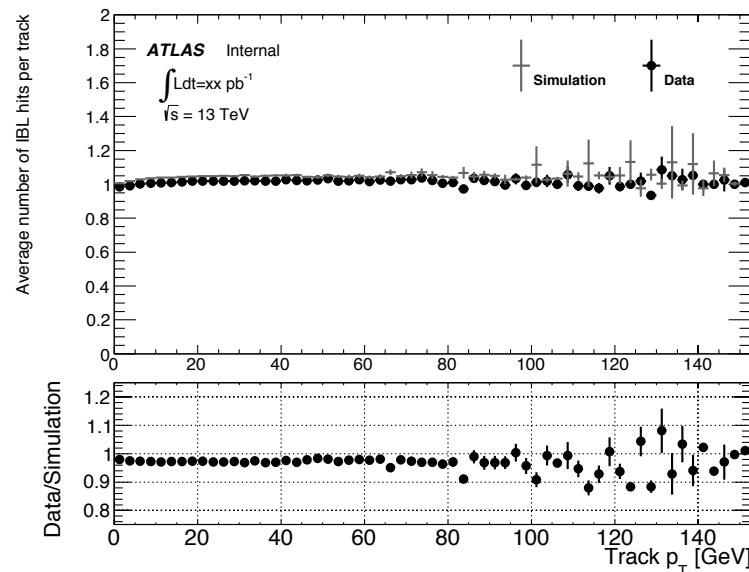
vs. Phi



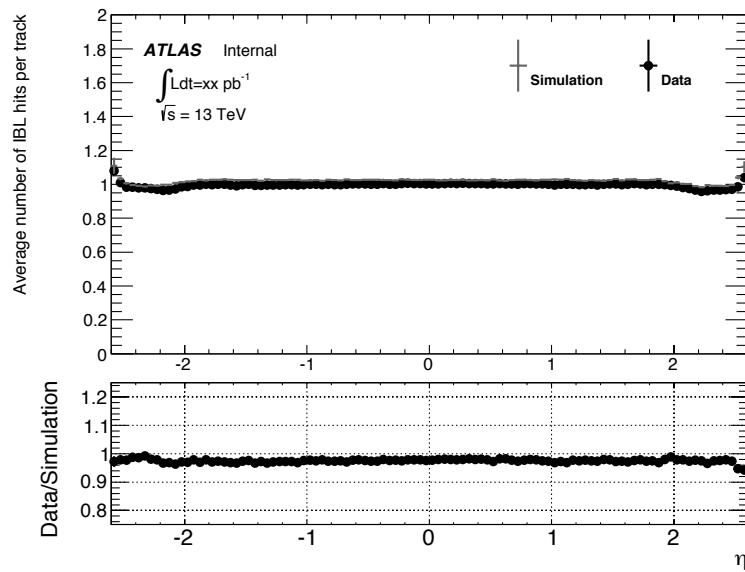
# Hits  $\geq 1$  vs. Phi



vs. Track pT



vs. Eta





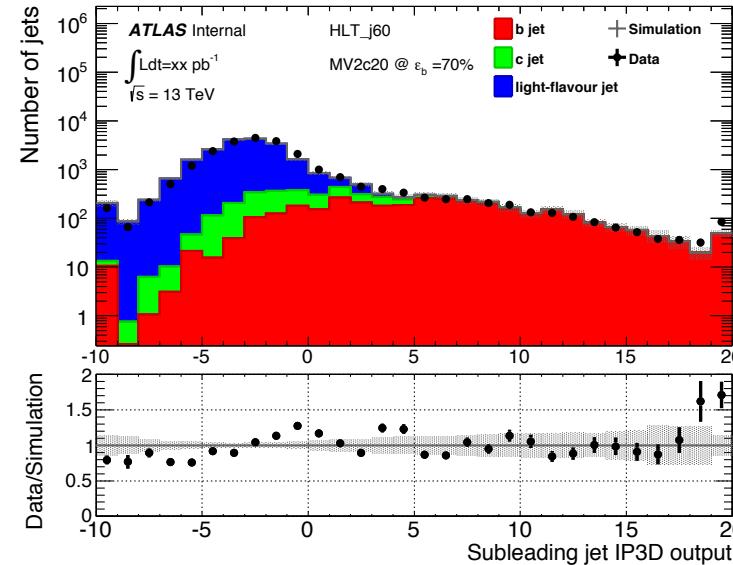
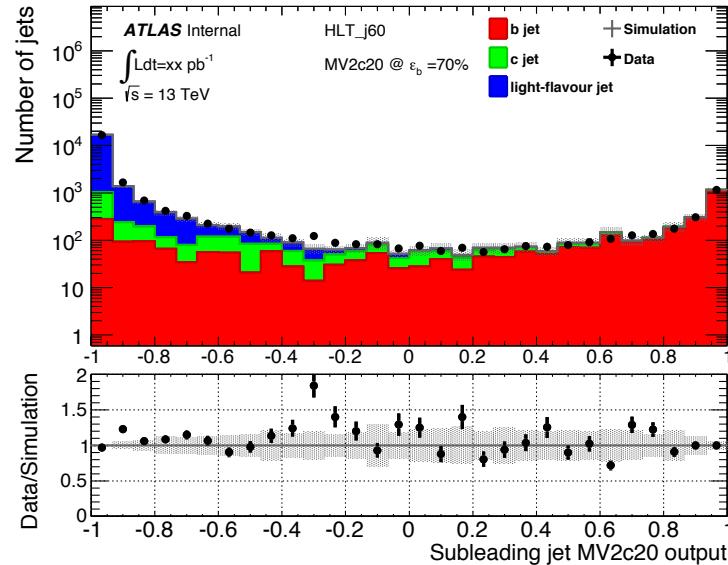
# 18 b Enhanced Sample - Subleading Jet



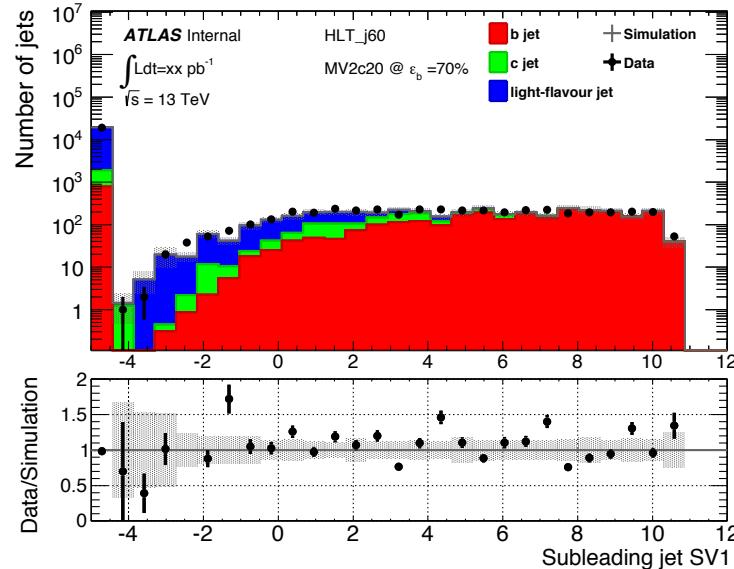
MV2c20:

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

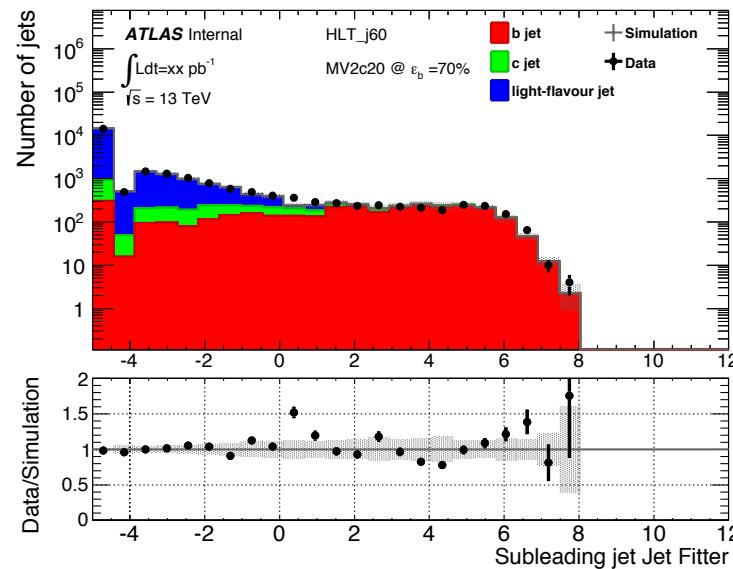
IP3D:



SV1:



Jet Fitter:





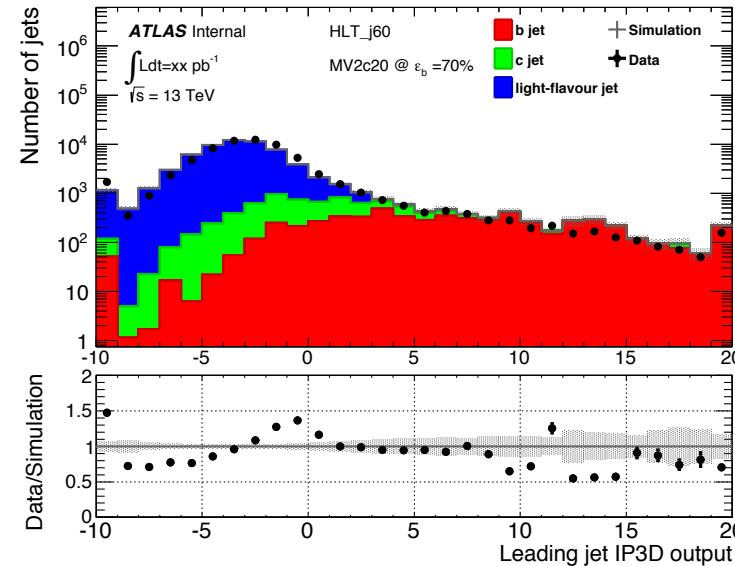
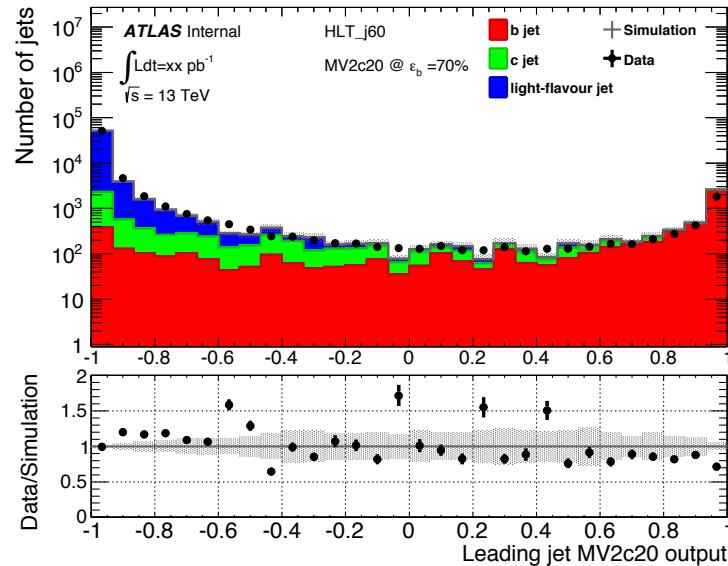
# 19 b Enhanced Sample on sublead - Leading Jet



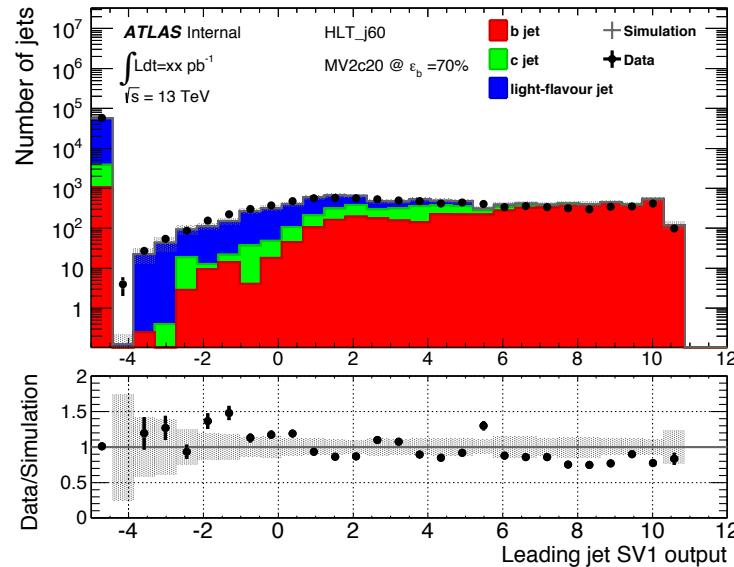
MV2c20:

***Subleading MV2c20 > -0.0436 which is 70% b-efficiency***

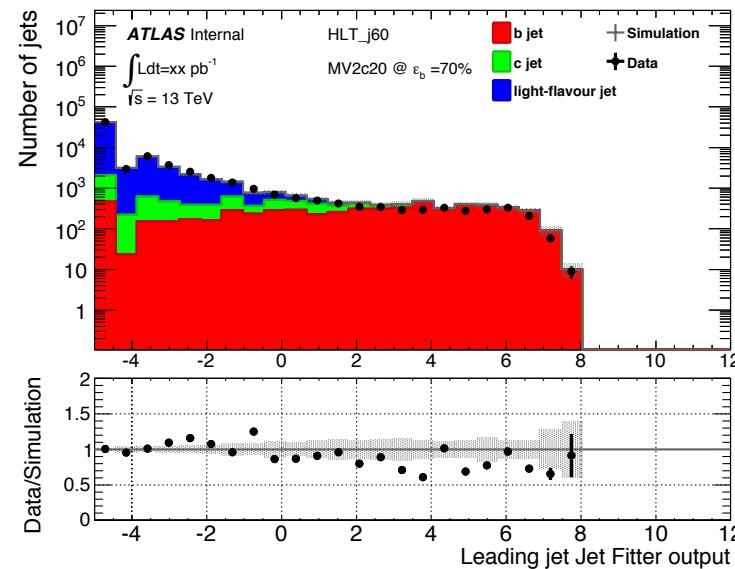
IP3D:



SV1:



Jet Fitter:





## Conclusions

IP resolution will improve in coming weeks

- Run 271298 will be reprocessed soon.
- This will hopefully improve b-tagging Data/MC

In a good place for Lepton Photon in August

- Ready for more data with improving alignment!