WORKSHOP ON TOP QUARK MASS MEASUREMENTS (VALENCIA, MAY 21 - MAY 23, 2024)

A JET ENERGY SCALE FOR B- AND C-JETS

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MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
Plan de Recuperación, Transformación y Resiliencia
CSIC Consejo Superior de Investigaciones Científicas
GENERALITAT VALENCIANA Conselleria de Educación, Universidades y Empleo
UNIVERSITAT DE VALÈNCIA
IFIC INSTITUT DE FÍSICA CORPUSCULAR
AITANA MATTER AND TECHNOLOGY

MIGUEL JIMÉNEZ ORTEGA. DATE: 23/05/2024

GUIDELINE

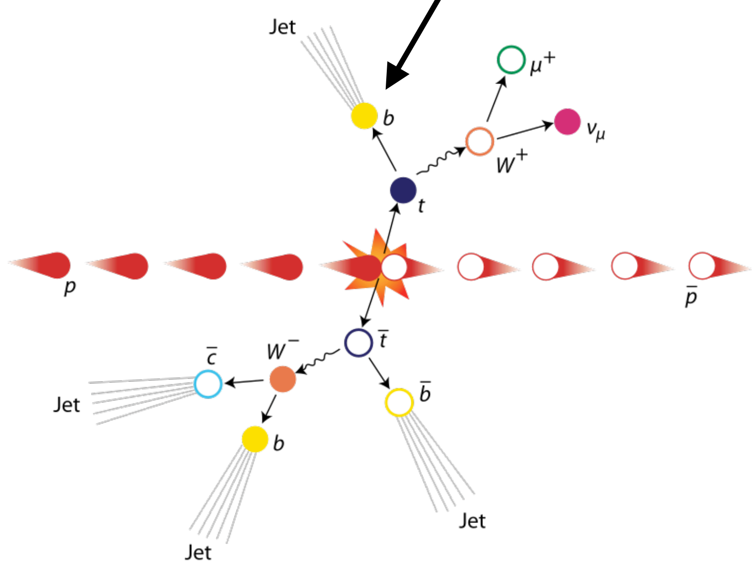
- Motivation.
- Current status.
- Current effort.
- Conclussions.
- Backup

MOTIVATION: THE IMPORTANCE OF A BJES

Why are we interested in a bJES?

https://doi.org/10.1016/j.physletb.2014.06.076

More than 95% of the decays are to a W boson and a b-quark



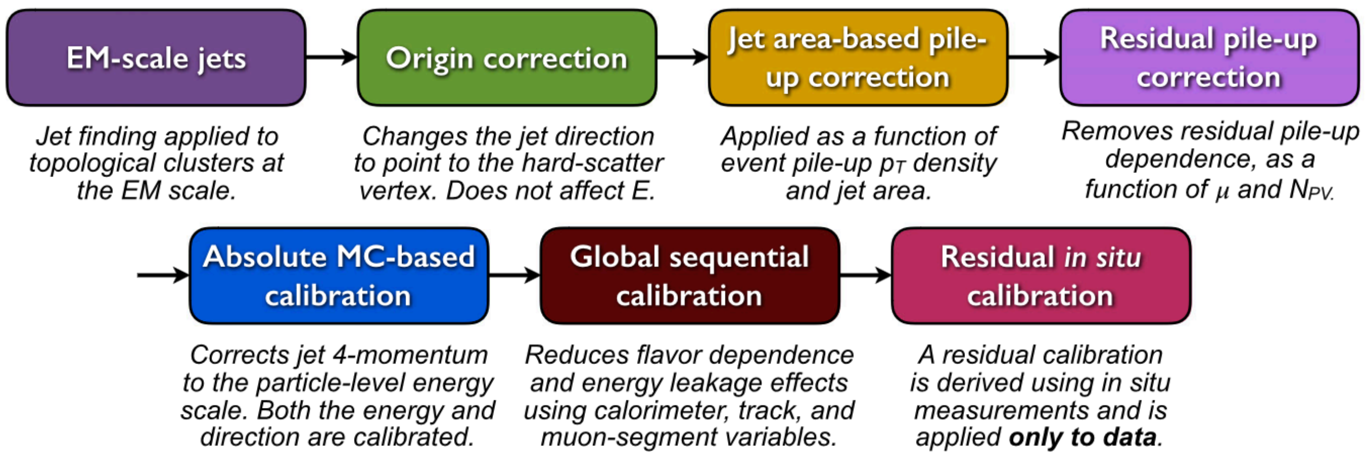
Improving precision in analysis sensitive to b–JES such as the top quark mass, $H \to b\bar{b}$, t → Wb measurements.

https://doi.org/10.48550/arXiv.2402.08713

Uncertainty category	Uncertainty impact [GeV] LHC	ATLAS	CMS
b-JES	0.18	0.17	0.25
b tagging	0.09	0.16	0.03
ME generator	0.08	0.13	0.14
JES 1	0.08	0.18	0.06
JES 2	0.08	0.11	0.10
Method	0.07	0.06	0.09
CMS b hadron $\mathcal{B}$	0.07	—	0.12
QCD radiation	0.06	0.07	0.10
Leptons	0.05	0.08	0.07
JER	0.05	0.09	0.02
CMS top quark p_T	0.05	—	0.07
Background (data)	0.05	0.04	0.06
Color reconnection	0.04	0.08	0.03
Underlying event	0.04	0.03	0.05
g-JES	0.03	0.02	0.04
Background (MC)	0.03	0.07	0.01
Other	0.03	0.06	0.01
l-JES	0.03	0.01	0.05
CMS JES 1	0.03	—	0.04
Pileup	0.03	0.07	0.03
JES 3	0.02	0.07	0.01
Hadronization	0.02	0.01	0.01
p_T^{miss}	0.02	0.04	0.01
PDF	0.02	0.06	<0.01
Trigger	0.01	0.01	0.01
Total systematic	0.30	0.41	0.39
Statistical	0.14	0.25	0.14
Total	0.33	0.48	0.42

ATLAS EXPERIMENT

MOTIVATION: THE IMPORTANCE OF A BJES



First time performing a calculation of an specific in-situ correction factor for btagged jets

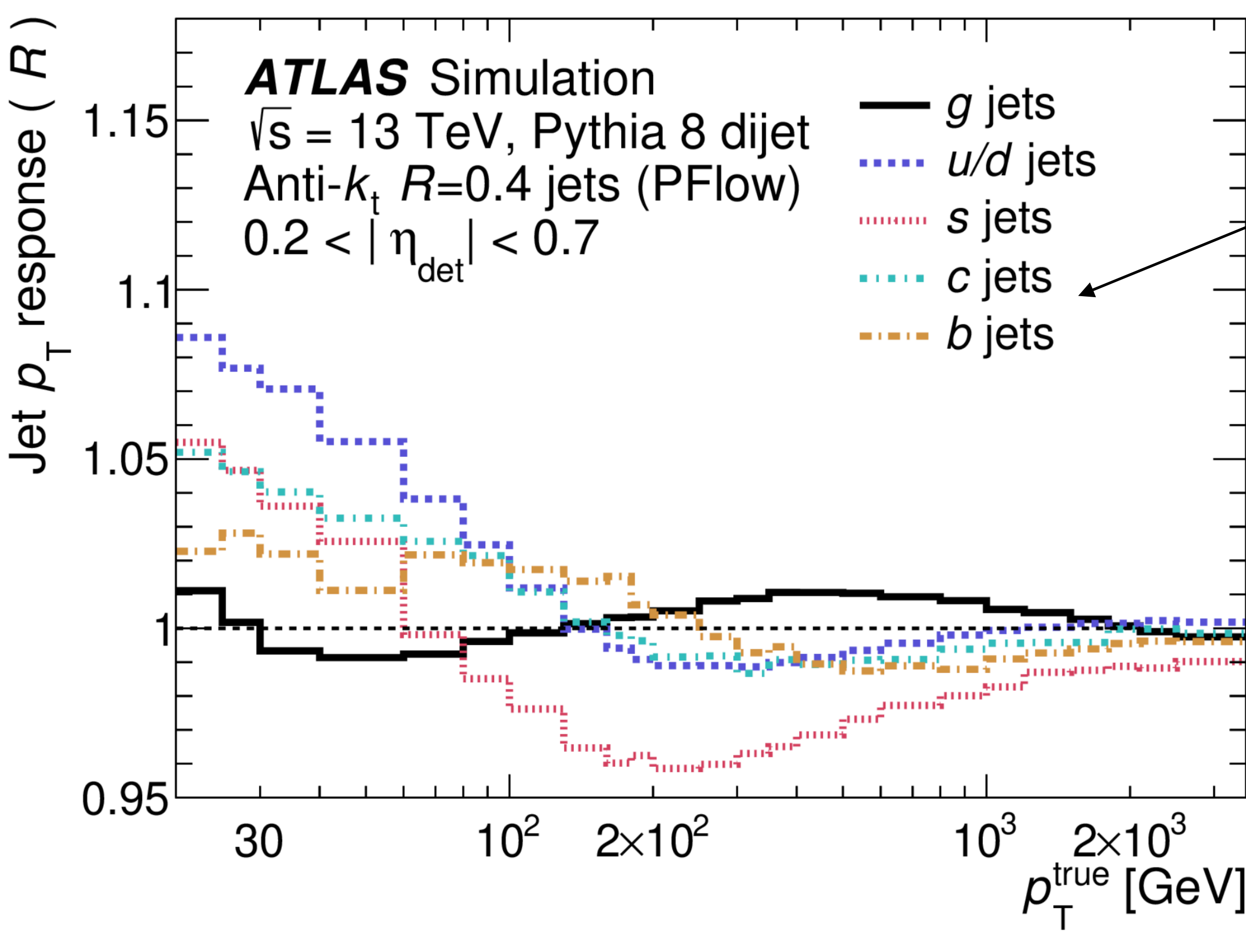
EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

10.1140/epjc/s10052-023-11837-9

Eur. Phys. J. C (2023) 83:761
DOI: 10.1140/epjc/s10052-023-11837-9
CERN-EP-2023-028
15th September 2023

New techniques for jet calibration with the ATLAS detector

The ATLAS Collaboration



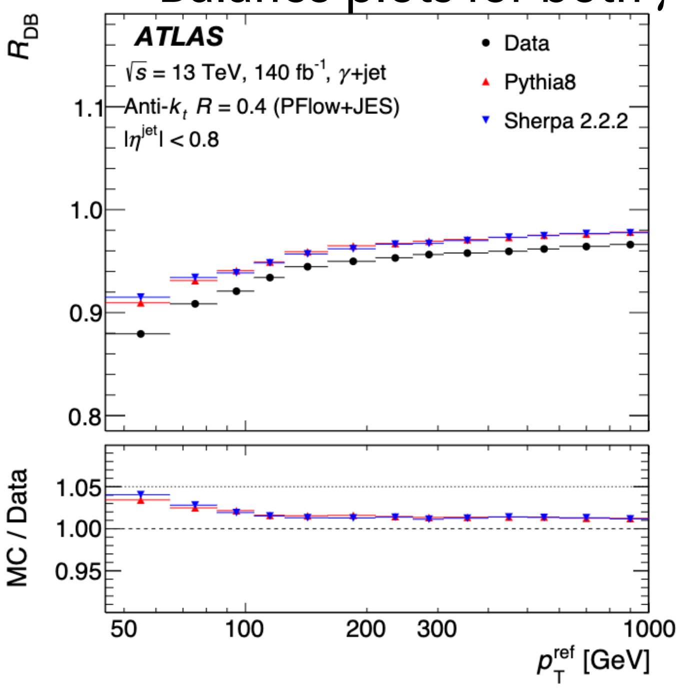
Differences due to flavour of the initiating parton

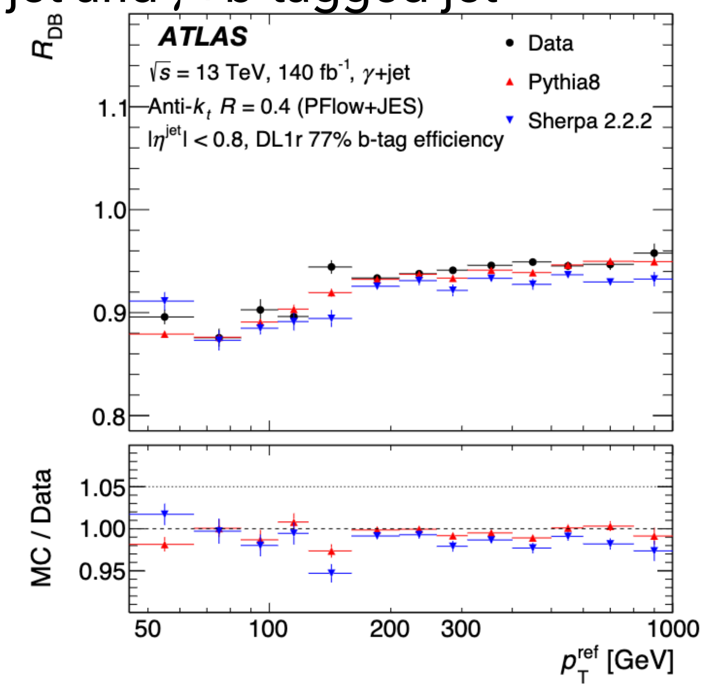
Different fragmentation functions

Missing energy from neutrinos in semi-leptonic decays of B and D-hadrons

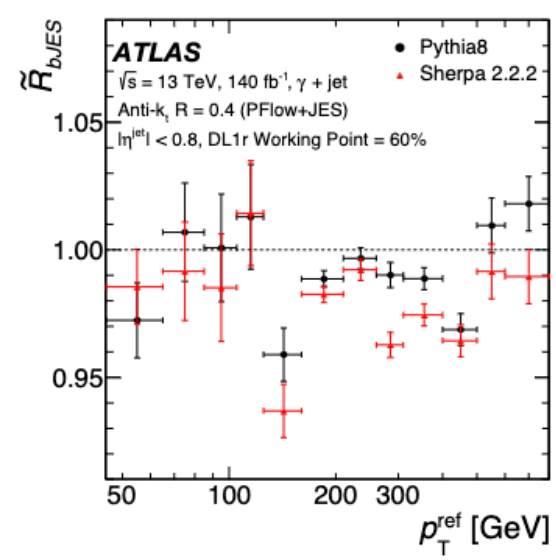
CURRENT STATUS: BJES RUN 2 REL21 FLOW JETS

Balance plots for both γ+jet and γ+b-tagged jet

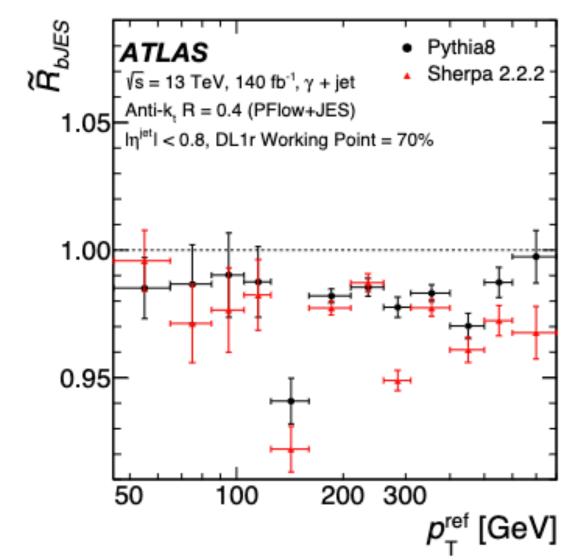




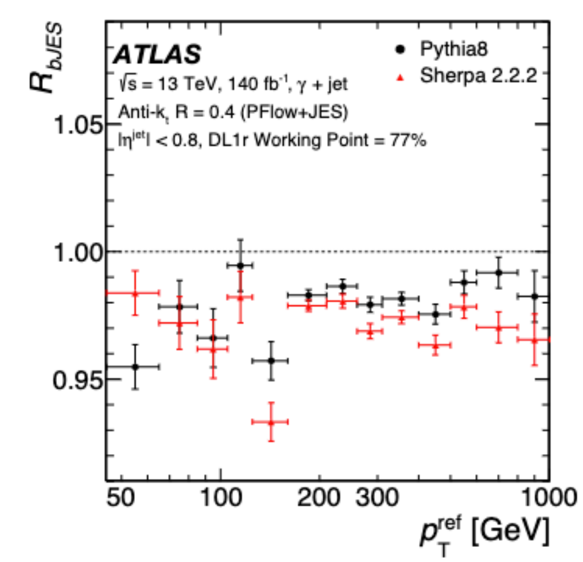
$$\tilde{R}_{b\mathrm{JES}} = \frac{\mathcal{R}^{\mathrm{MC}}_{\text{b-tagged}} / \mathcal{R}^{\mathrm{data}}_{\text{b-tagged}}}{\mathcal{R}^{\mathrm{MC}}_{\text{inclusive}} / \mathcal{R}^{\mathrm{data}}_{\text{inclusive}}} .$$



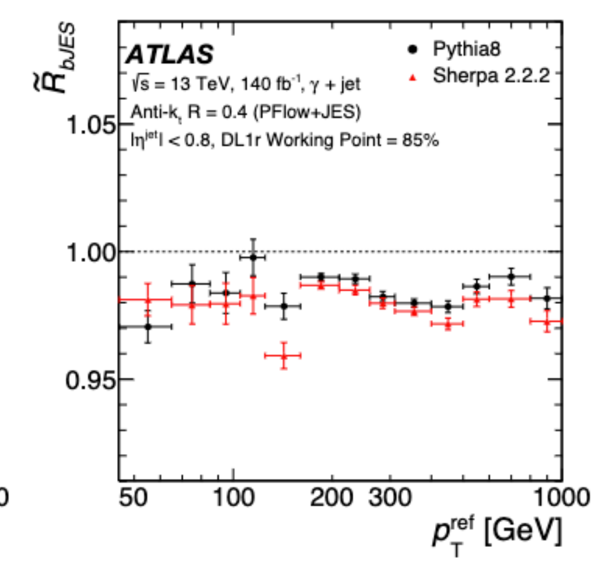
(a)



(b)



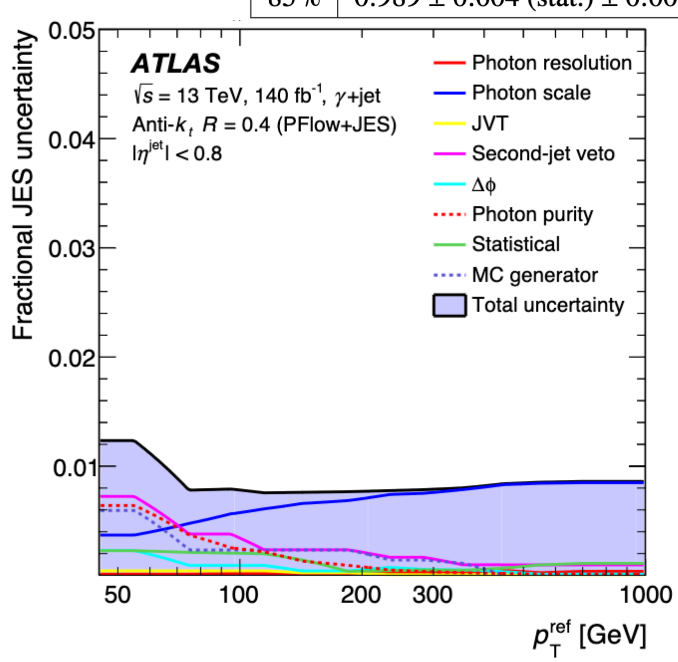
(c)

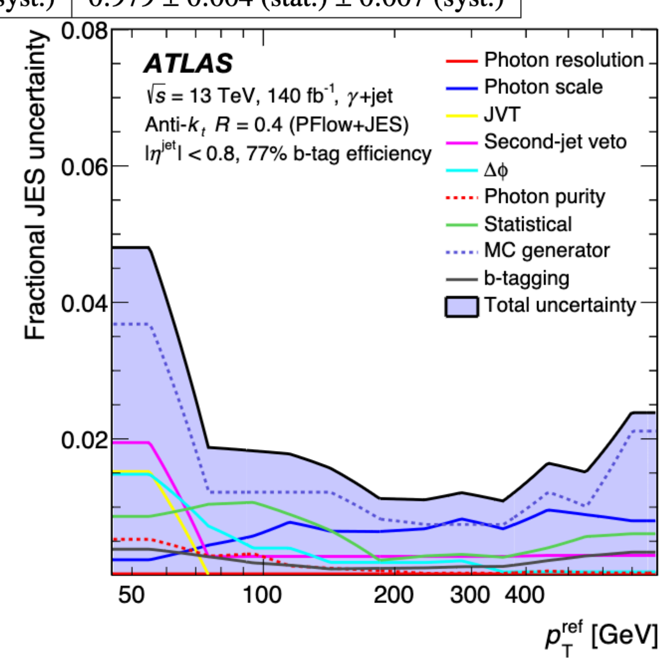


(d)

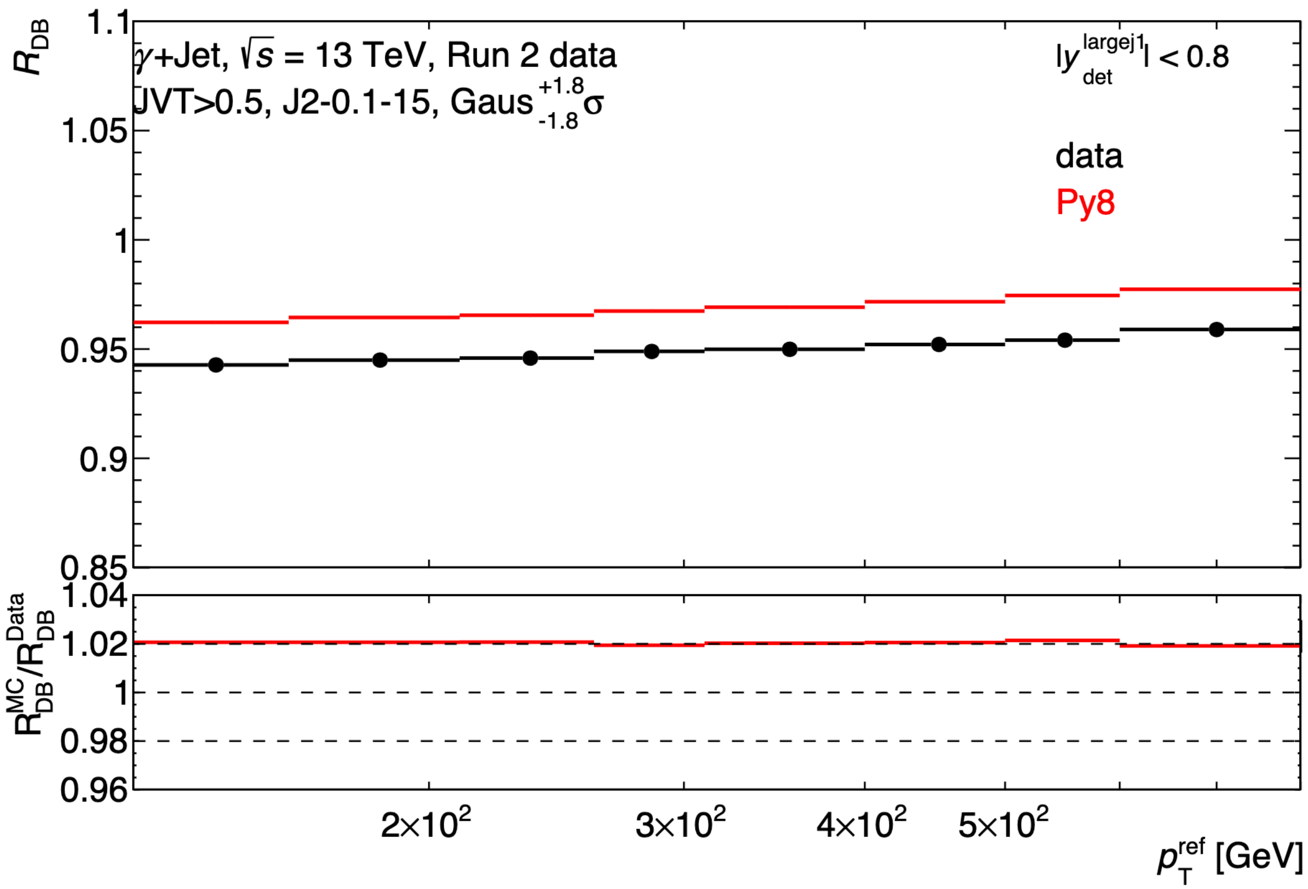
Hadron Label	Inclusive jet		WP 60%		WP 70%		WP 77%		WP 85%	
	Pythia8	Sherpa	Pythia8	Sherpa	Pythia8	Sherpa	Pythia8	Sherpa	Pythia8	Sherpa
b	1.9%	2.0%	92.1%	85.8%	81.3%	79.2%	59.2%	61.7%	36.3%	39.2%
c	14.2%	10.6%	2.3%	1.6%	13.4%	9.2%	35.4%	27.0%	57.4%	49.7%
light q or gluon	83.9%	87.4%	5.6%	12.6%	5.3%	11.6%	5.4%	11.3%	6.3%	11.1%

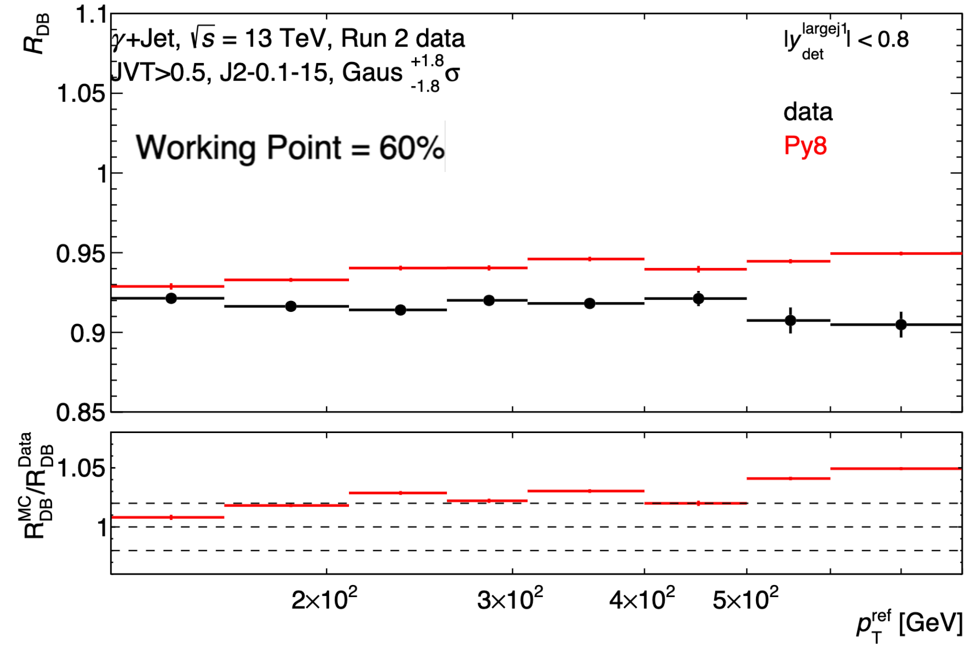
WP	Pythia 8	Sherpa
60%	0.990 ± 0.010 (stat.) ± 0.013 (syst.)	0.984 ± 0.010 (stat.) ± 0.013 (syst.)
70%	0.984 ± 0.010 (stat.) ± 0.011 (syst.)	0.974 ± 0.010 (stat.) ± 0.012 (syst.)
77%	0.978 ± 0.006 (stat.) ± 0.011 (syst.)	0.966 ± 0.006 (stat.) ± 0.011 (syst.)
85%	0.989 ± 0.004 (stat.) ± 0.007 (syst.)	0.979 ± 0.004 (stat.) ± 0.007 (syst.)

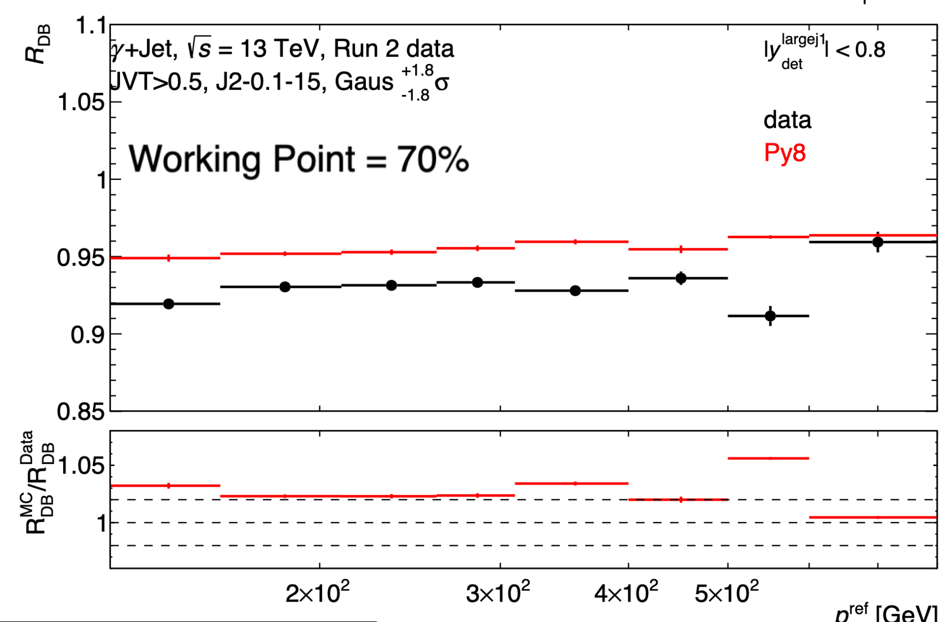




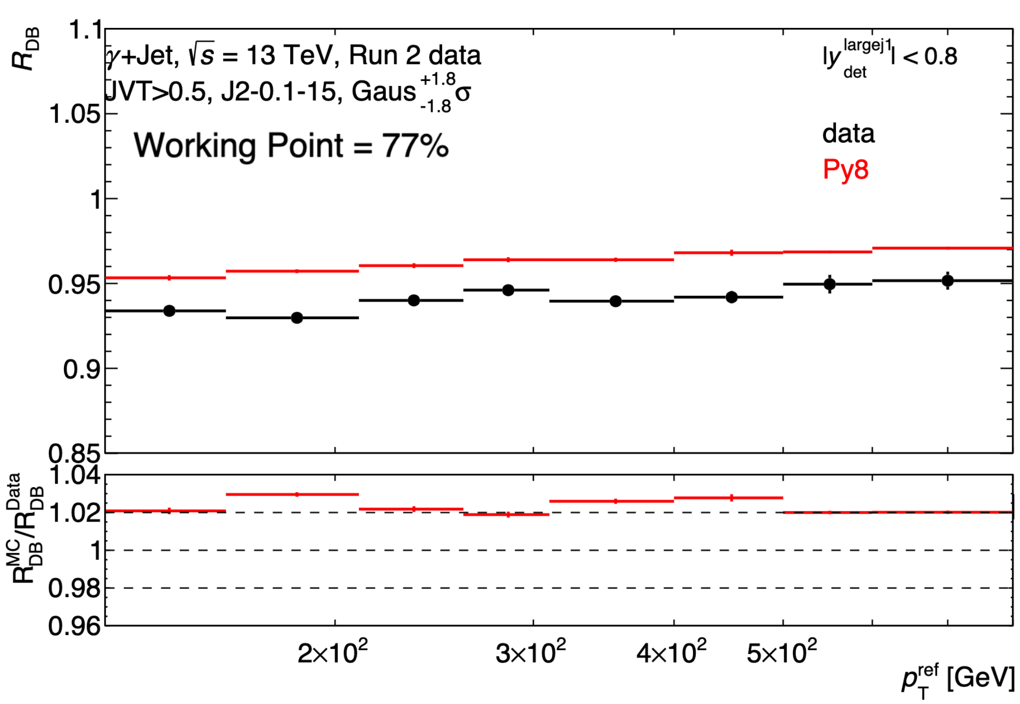
CURRENT EFFORT: BJES RUN 2 REL22

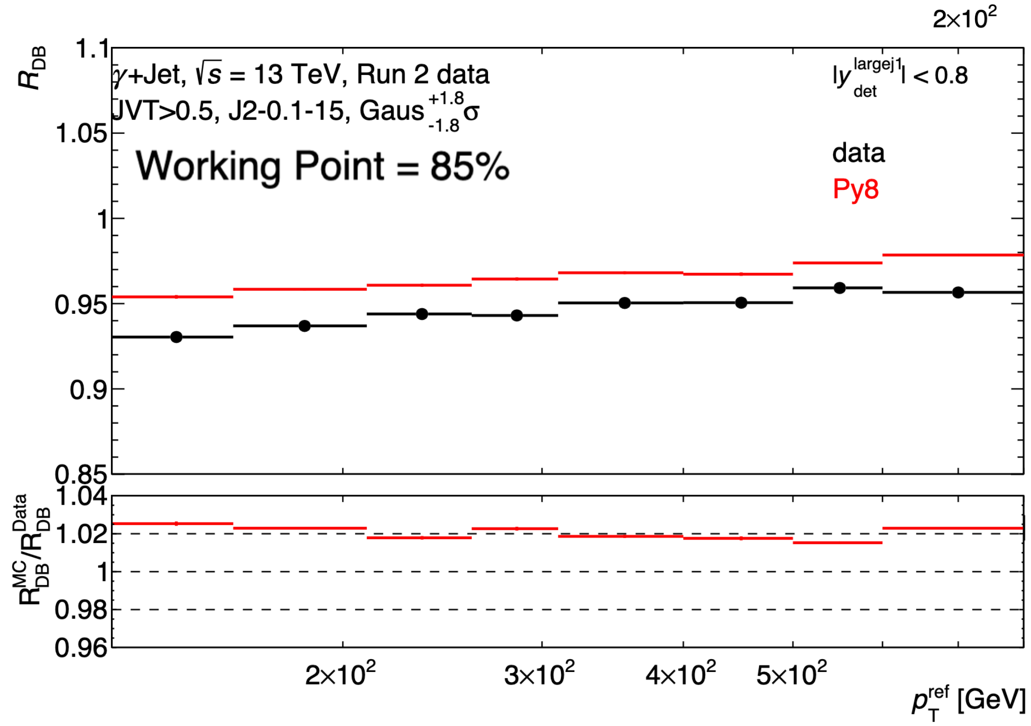






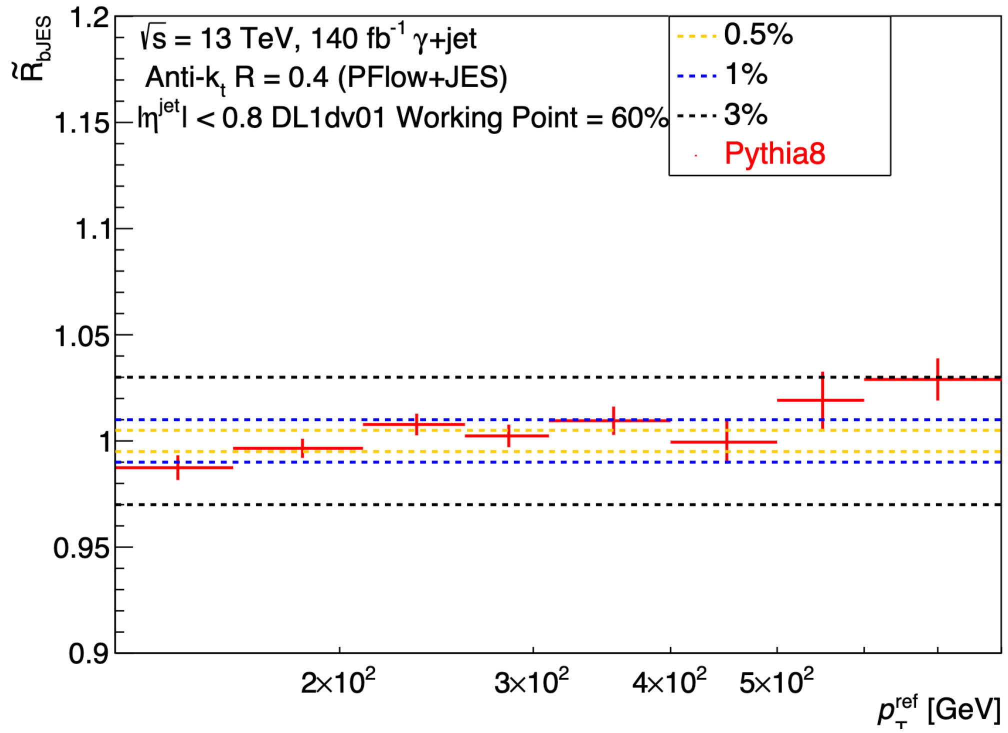
PRELIMINARY

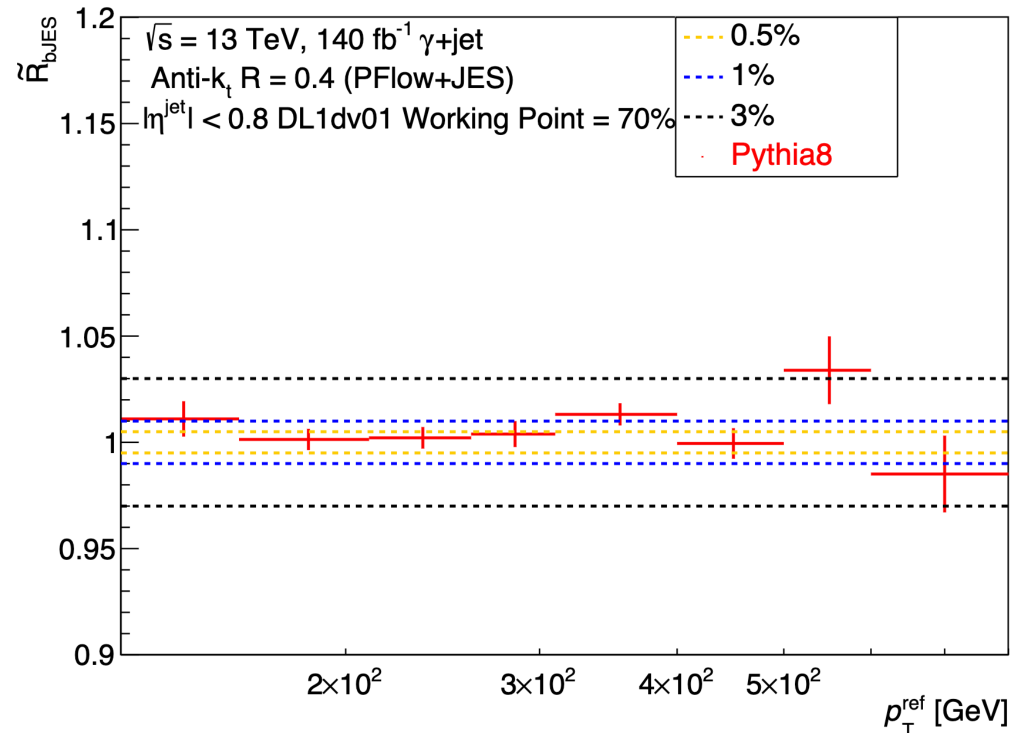


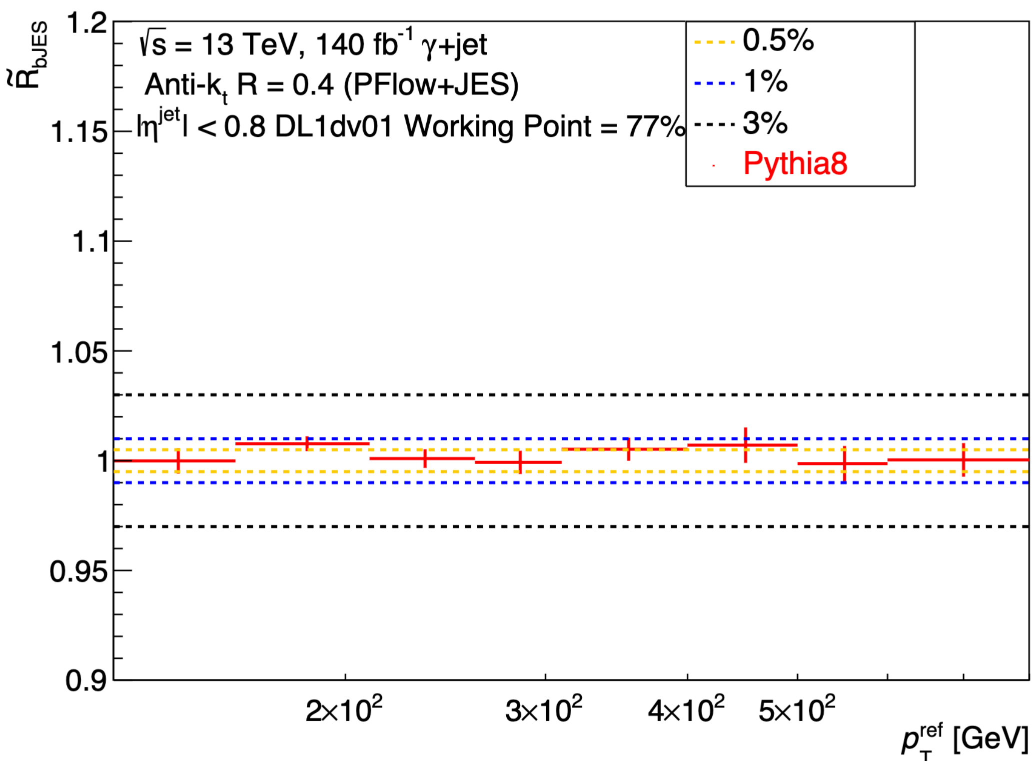


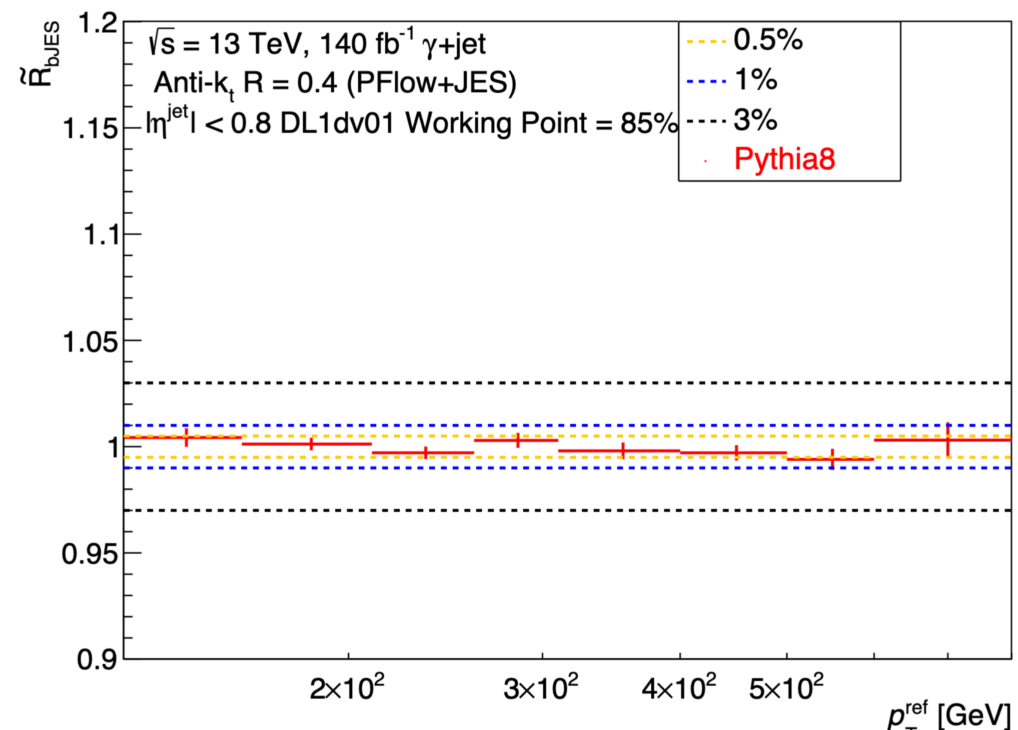
CURRENT EFFORT: BJES RUN 2 REL22

PRELIMINARY









CONCLUSIONS

- Improving precision in b–JES will improve precision analysis such as the top quark mass, $H \to b\bar{b}$, t → Wb measurements.

- In a previous work the bJES relative to inclusive sample was first measured with a precision up to 1%. Also found this bJES response to be underestimated from 1%-3% depending on the WP. Now, in Rel22 we haven't observed that large differences so far, but these studies are preliminary, we still have to check flavour compositions of the samples, btagging efficiency, performance of the taggers, etc… .

- Our plan is to provide an in-situ determination for the b-JES with a precision <1%.

THANKS FOR LISTENING!

BACKUP

EVENT SELECTION FOR SMALL-R JETS AND DATA SAMPLES

1 Event level cut

- Trigger requirement: HLT_g140_loose
- Basic cuts.

2 Photon cuts

- pT_hoton>25 GeV
- abs(eta_photon)<1.37
- Tight identification
- FixedCutTight isolation

3 Small-R jet cuts

- abs(eta_subleadingjets) $<$ 4.5
- pT_leadingjet $>$ 10 GeV
- pT_subleading $<$ max(15,0.1$\times$pT_ph)
- abs(eta_leadingjet) $<$ 0.8
- ΔR(leadingjet,photon) $>$ 0.4
- $\Delta \phi$(leadingjet,photon) $>$ 2.8

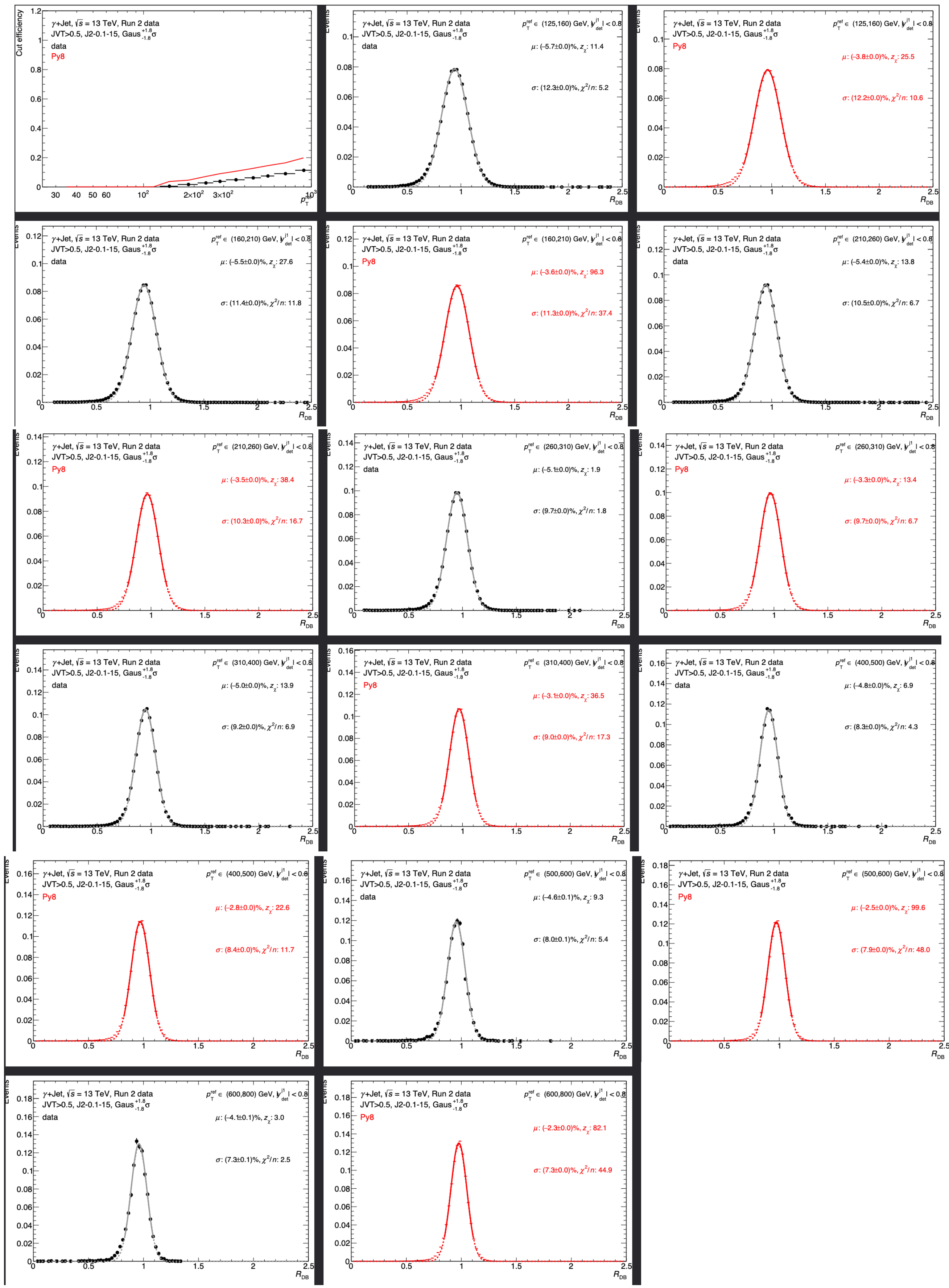
Montecarlo samples	Data samples
Py8_gammajet_direct & frag components: info tag: e8279_s3681_r*_p5557	data1*_13TeV.periodAllYear.physics_Main.PhysCont.DAOD_JETM4.grp1*_v01_p5557 . For Years: 15 16 17 and 18

https://twiki.cern.ch/twiki/bin/view/AtlasProtected/JetEtmissMC20

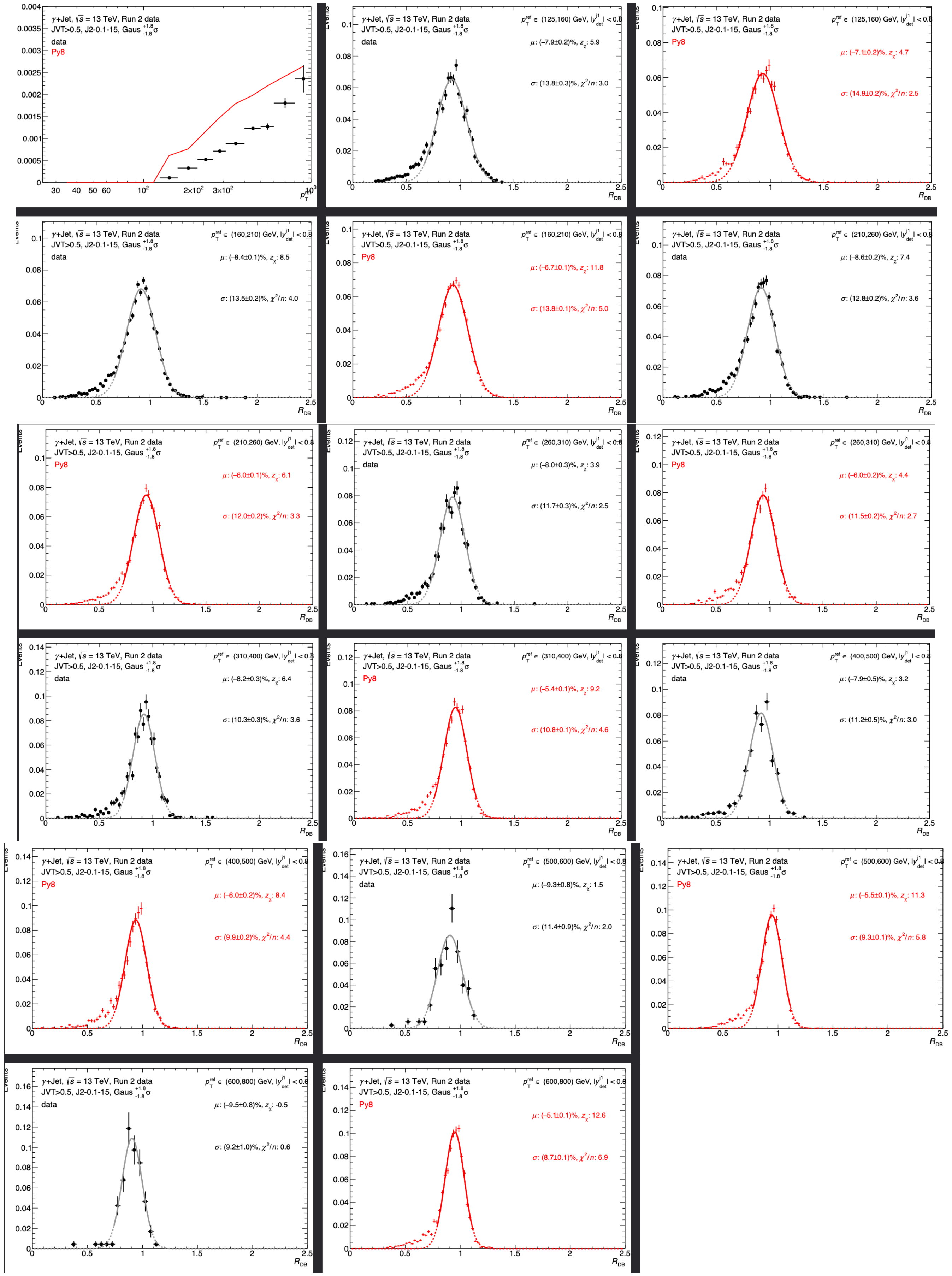
Jet Algorithm	"AntiKt4EMPFlow"
Configuration file	"PreRec_R22_PFlow_ResPU_EtaJES_GSC_February23_230215.config"
Calibration sequence for MC	"JetArea_Residual_EtaJES_GSC"
Calibration sequence for Data	"JetArea_Residual_EtaJES_GSC"
Calibration area	"00-04-82"
isData parameter in the constructor	"true" or "false"

ATLAS EXPERIMENT

GAUSSIAN FITS : INCLUSIVE CASE

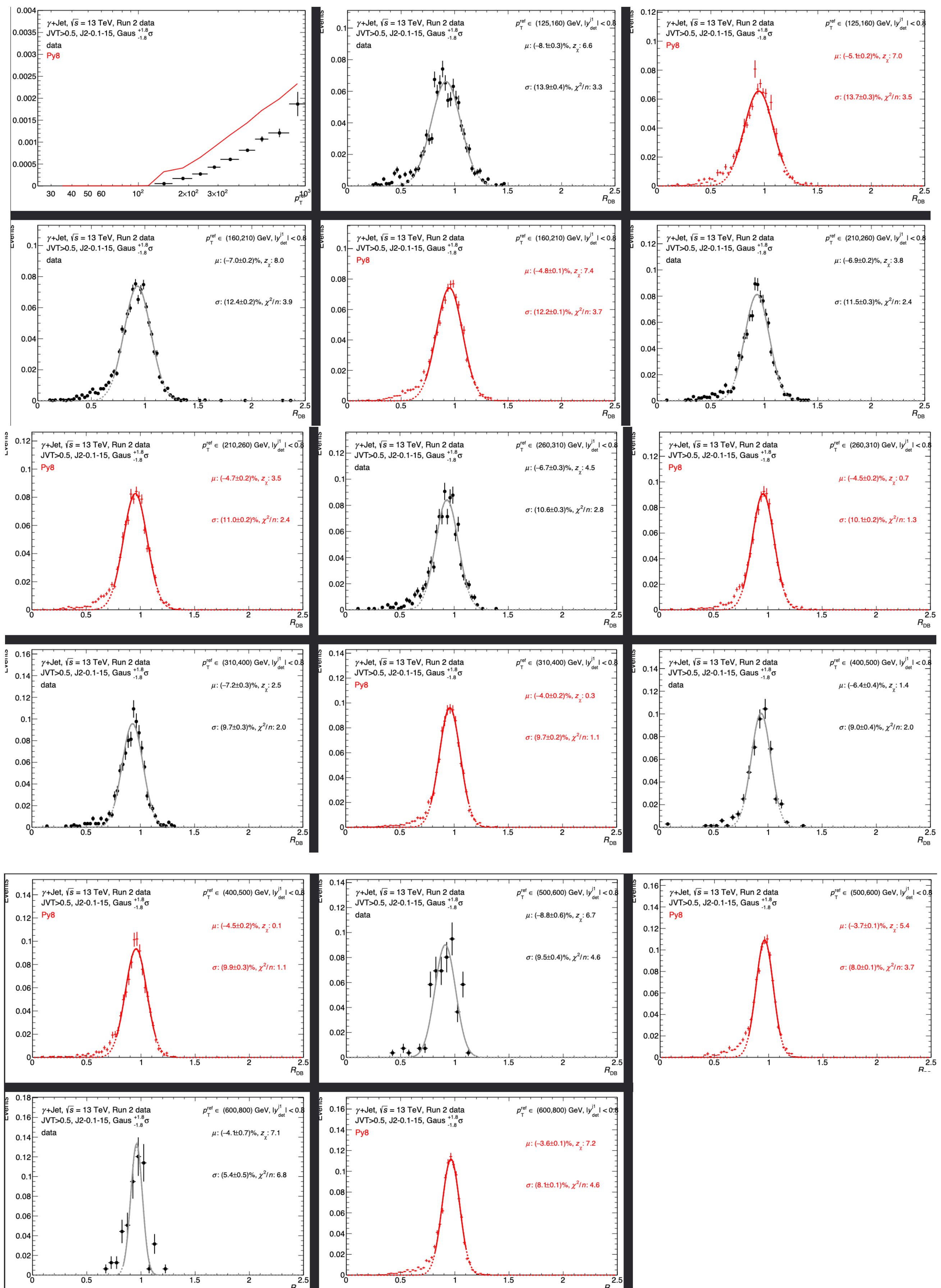


GAUSSIAN FITS : 60% WP

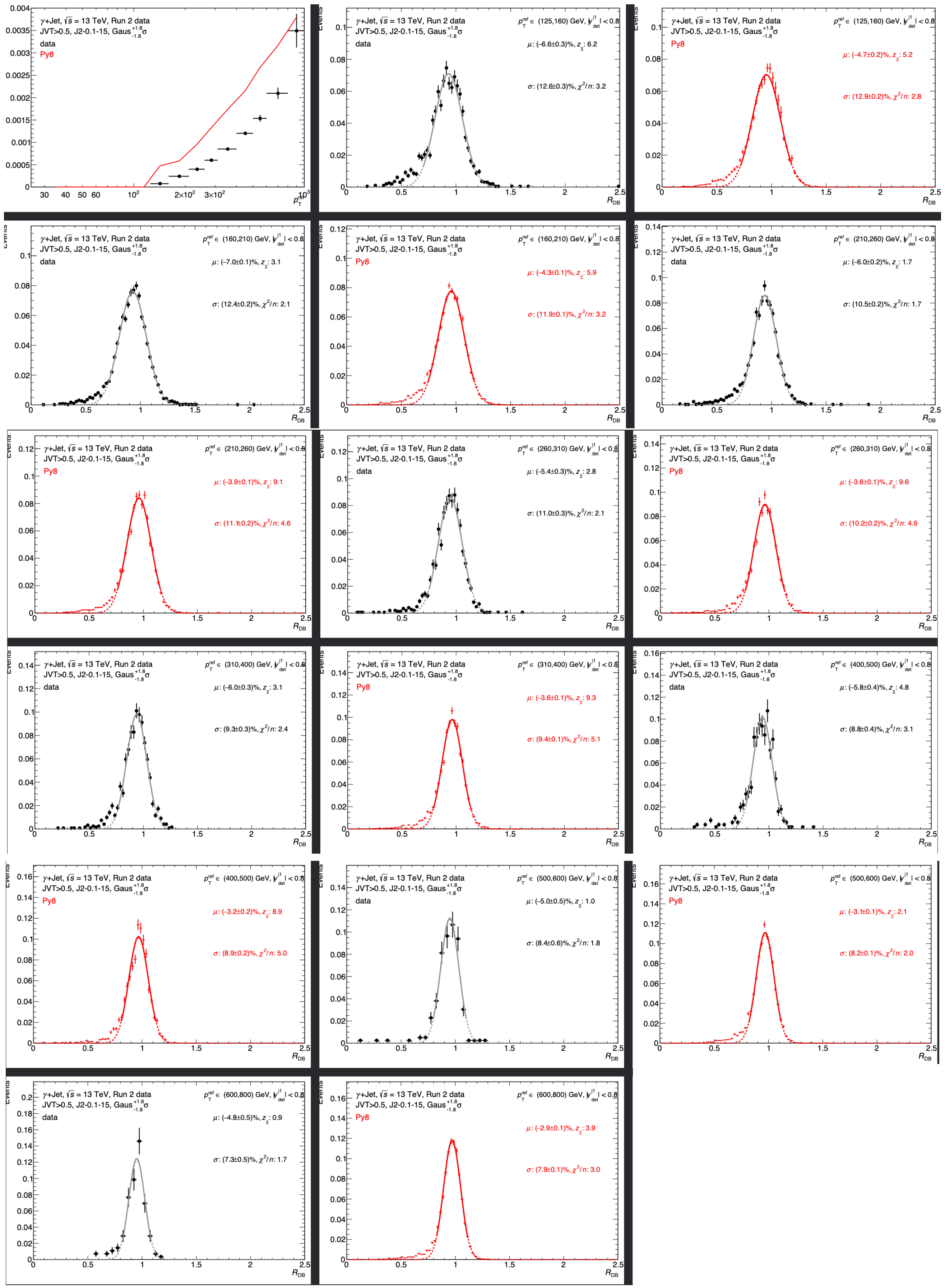


ATLAS EXPERIMENT

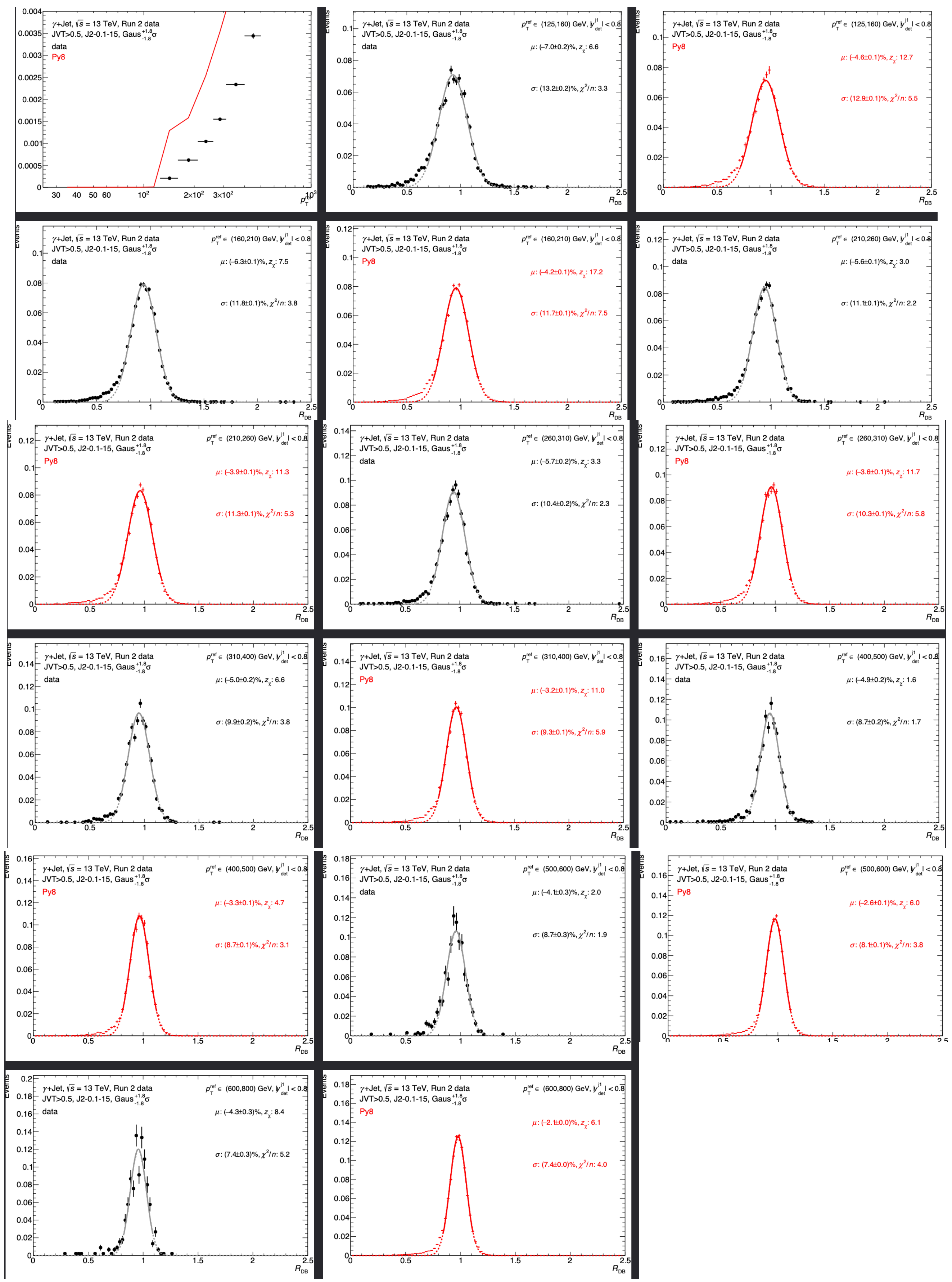
GAUSSIAN FITS : 70% WP



GAUSSIAN FITS : 77% WP



GAUSSIAN FITS : 85% WP

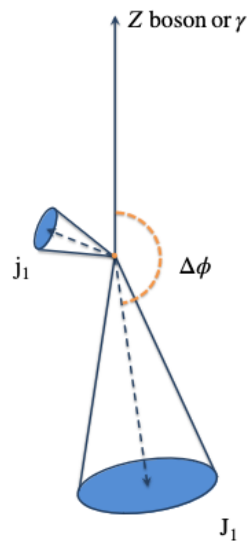


DIRECT BALANCE METHOD

Direct Balance Method

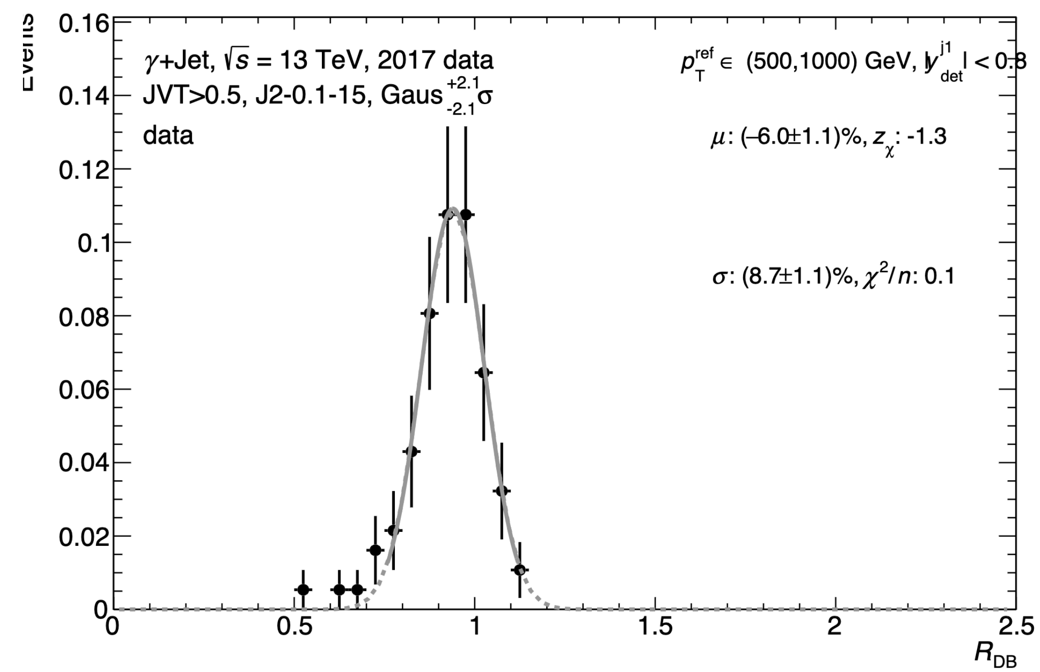
$$R_{\mathrm{DB}} = \left\langle \frac{p_{\mathrm{T}}^{\mathrm{J}}}{p_{\mathrm{T}}^{\mathrm{ref}}} \right\rangle$$

$$p_{\mathrm{T}}^{\mathrm{ref}} = p_{\mathrm{T}}^{Z} \,|\cos(\Delta\phi)|$$

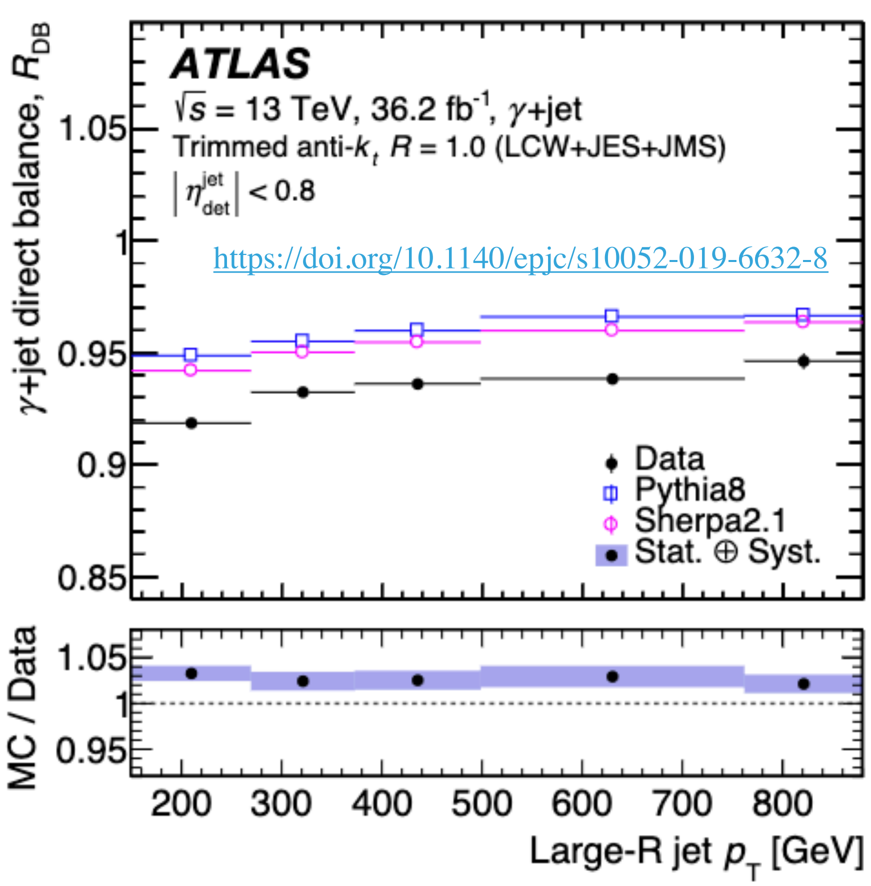


(b) Z+jet or γ+jet event

Usual example



Large-R jets



Small-R jets