Measurement of $t\bar{t}$ cross section in the lepton+jets channel at $\sqrt{s}$ = 13 TeV with the ATLAS detector

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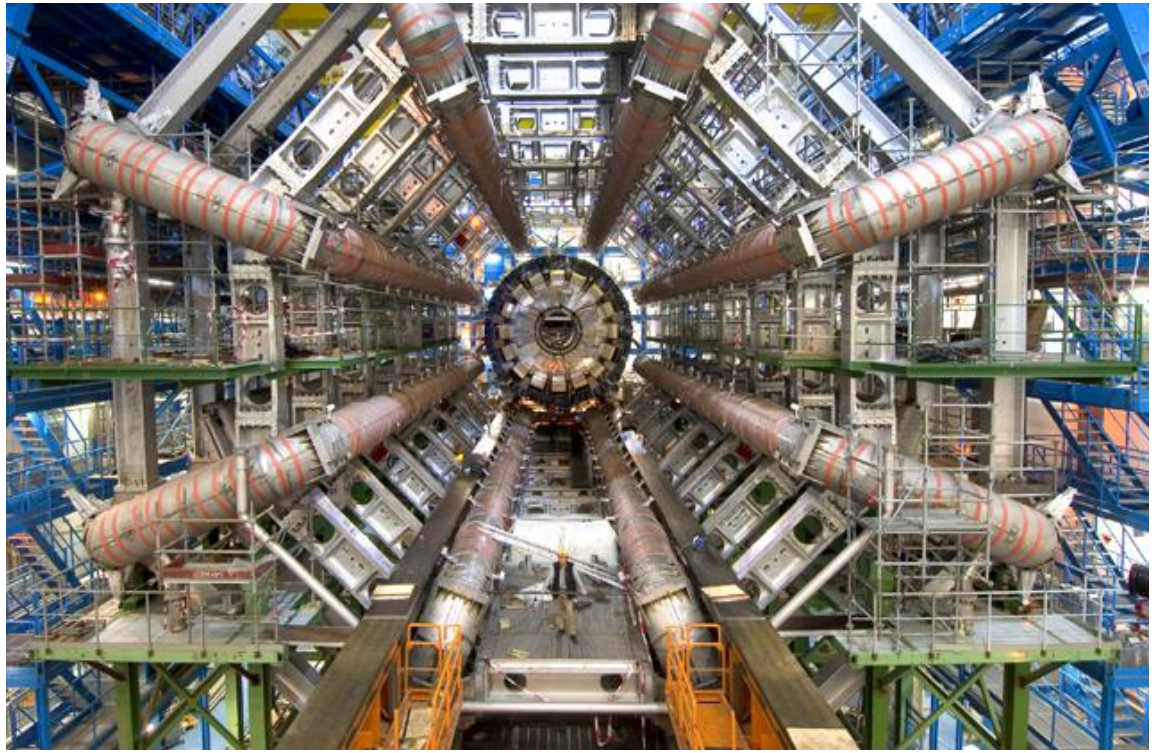
ATLAS Top Quark Group

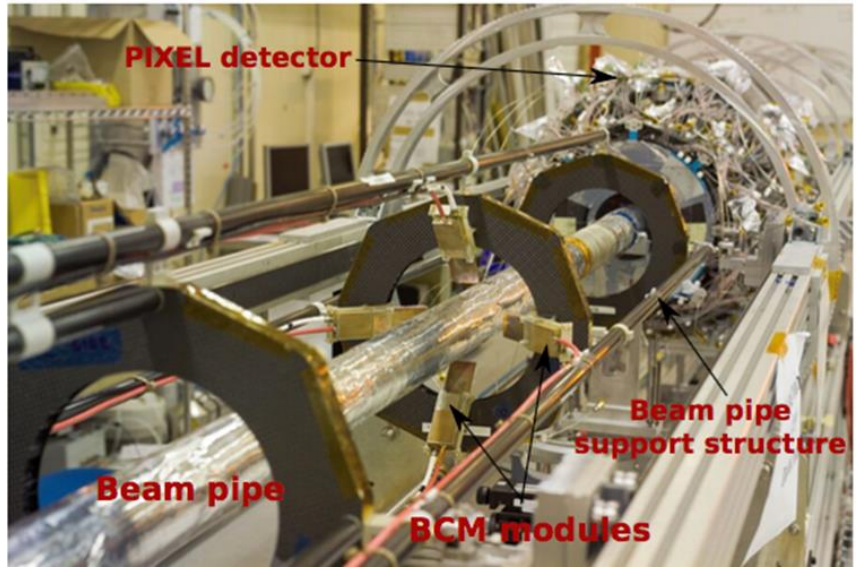
- Studies top quark production at LHC and precision measurements of its properties
- Top quark is biggest background for physics beyond the Standard Model searches
- Cross section is an important property used for overall modeling of the top quark

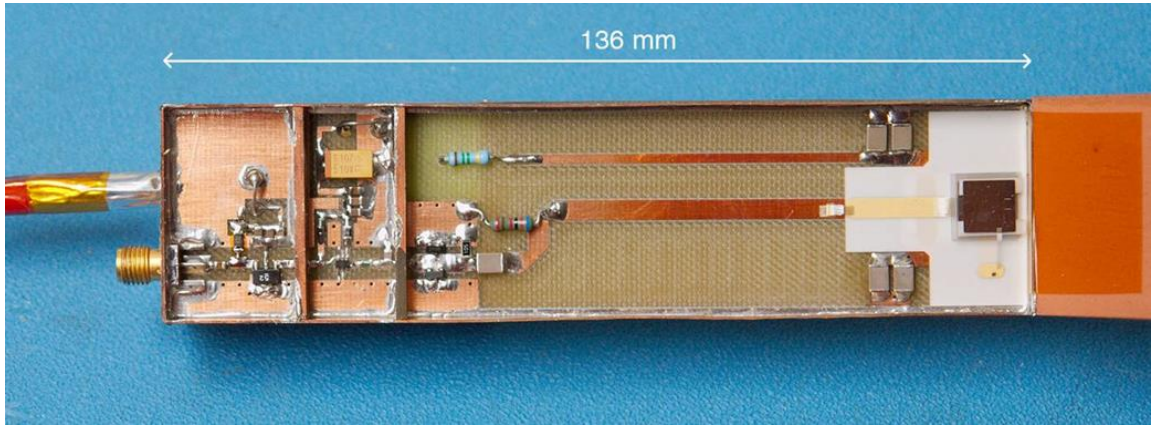


http://cdn.arstechnica.net/Science/March10/Atlas_detector.jpg

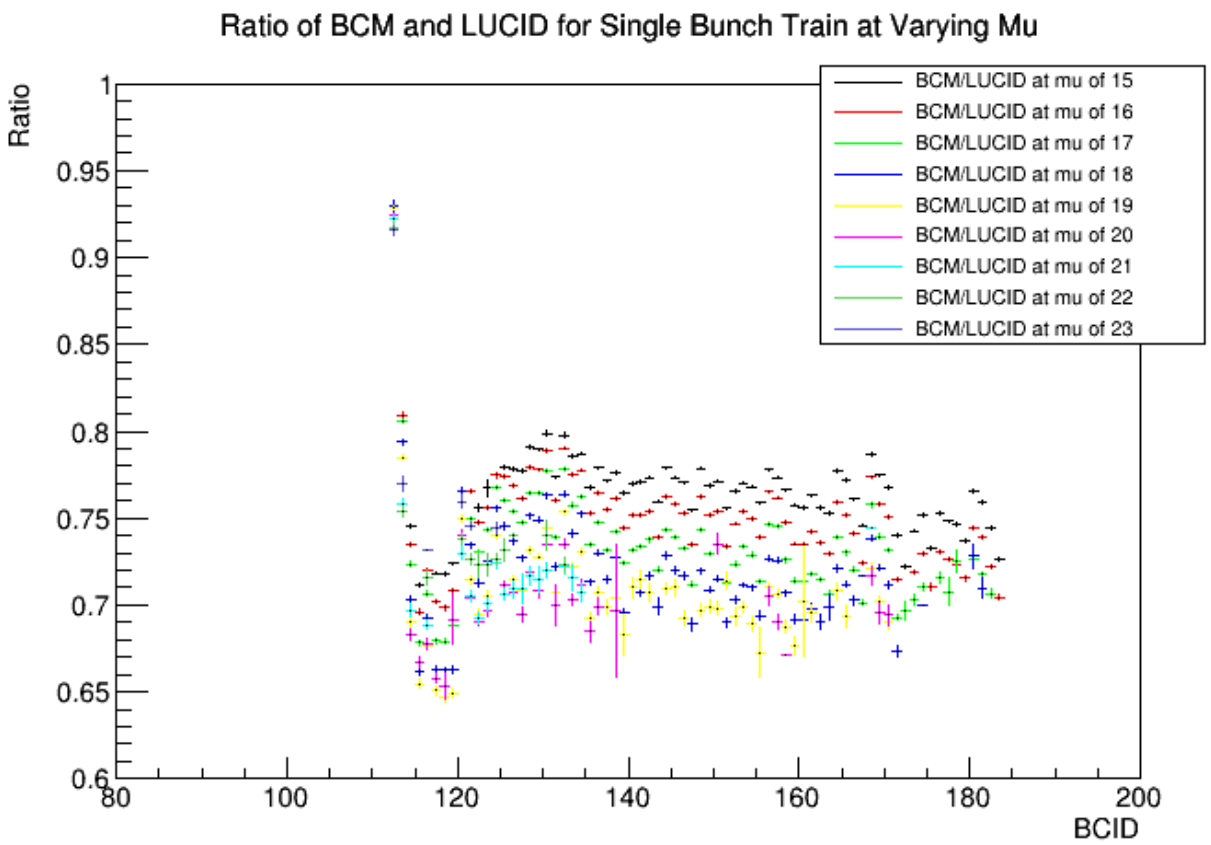
BCM Sub-Detector

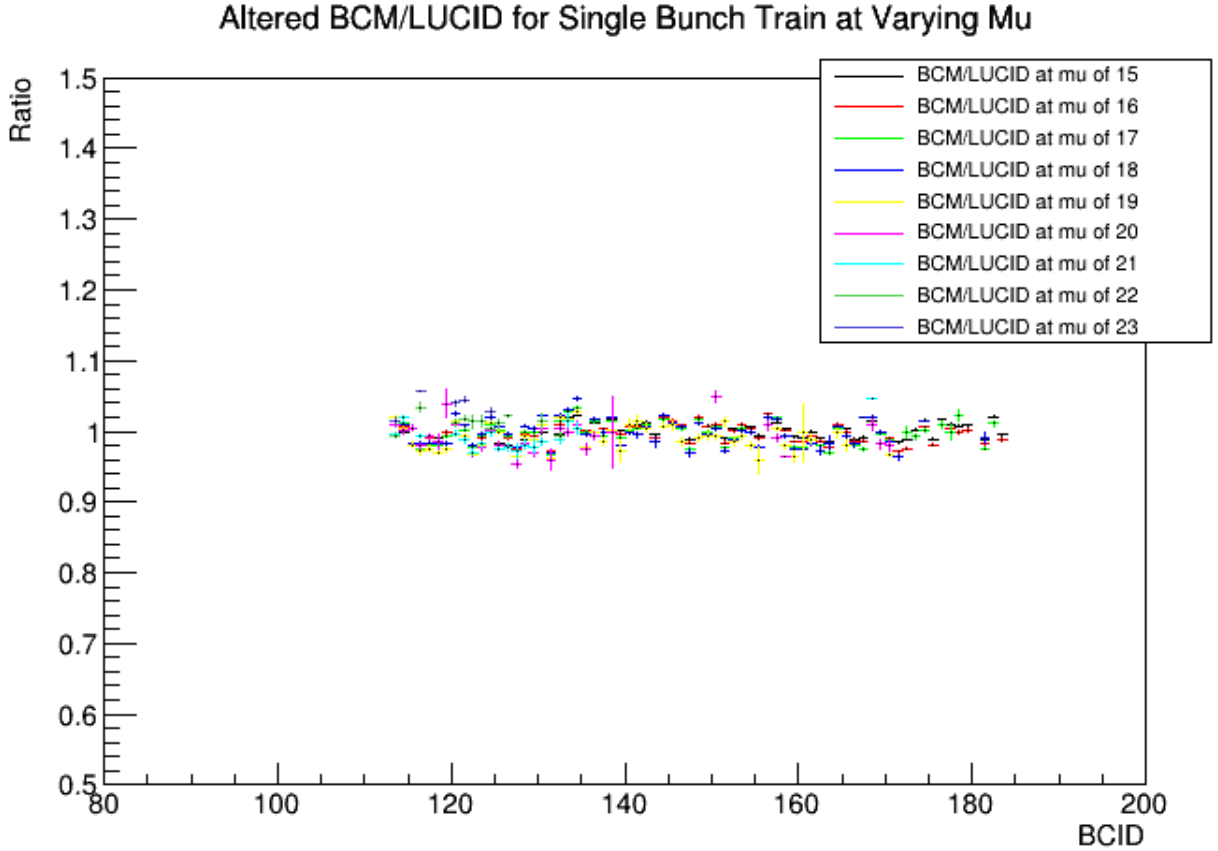
- ATLAS Diamond Beam Conditions Monitor
- Monitors collision/background rate:
  - Abort Beam if losses are large
  - Provide bunch-by-bunch luminosity measurement
- Provides uncertainty in luminosity to all ATLAS measurements
  - Cross section and luminosity are related by:
    - $Number\ of\ Events = Luminosity * \sigma_{t\bar{t}}$



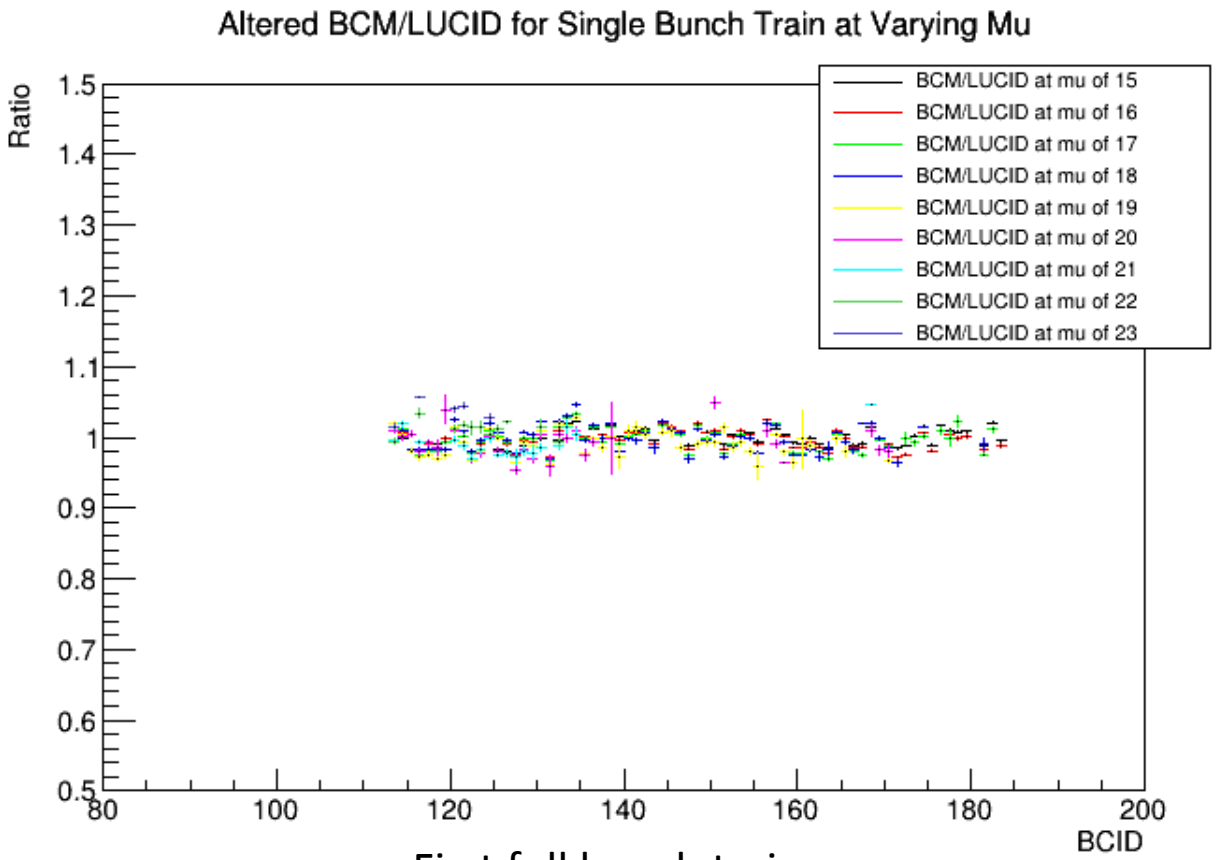


BCM/LUCID Ratio Plots Before and After Using Scale Factors

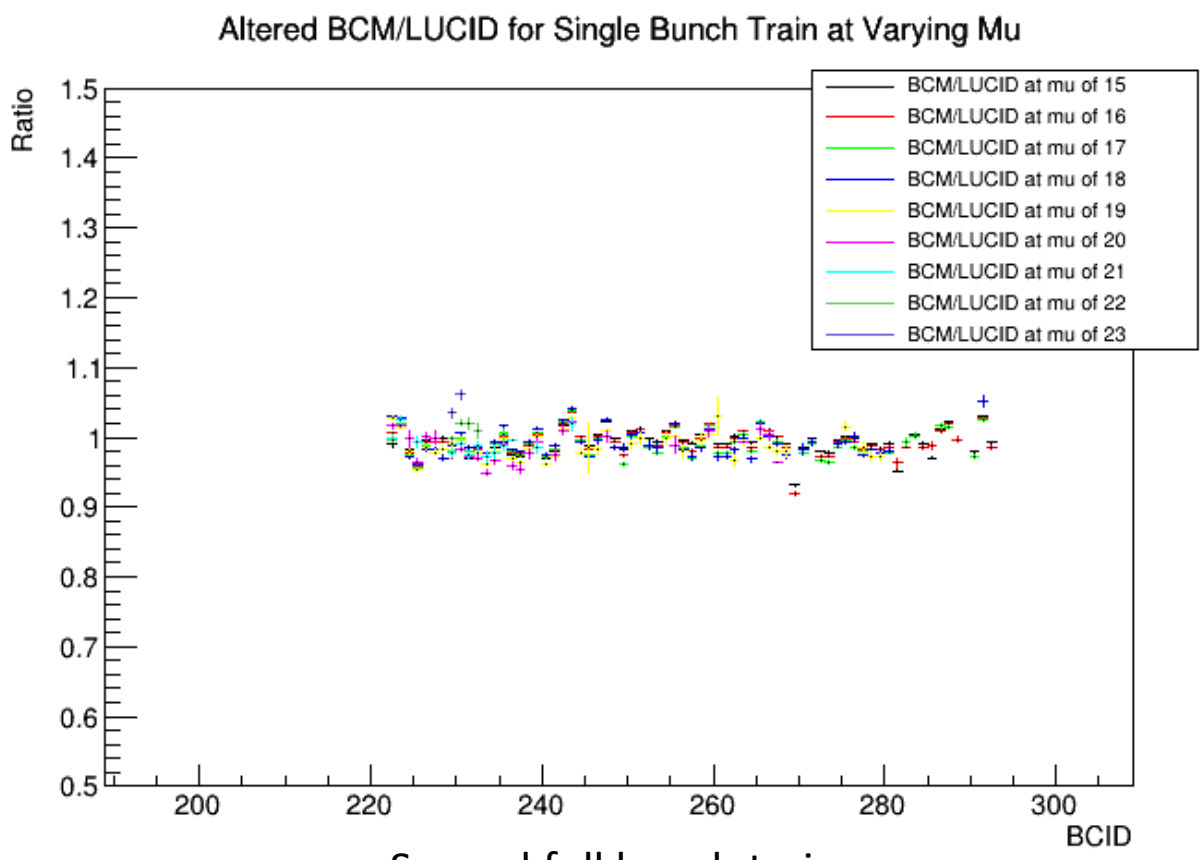




BCM/LUCID Ratio for First and Second Bunch Train

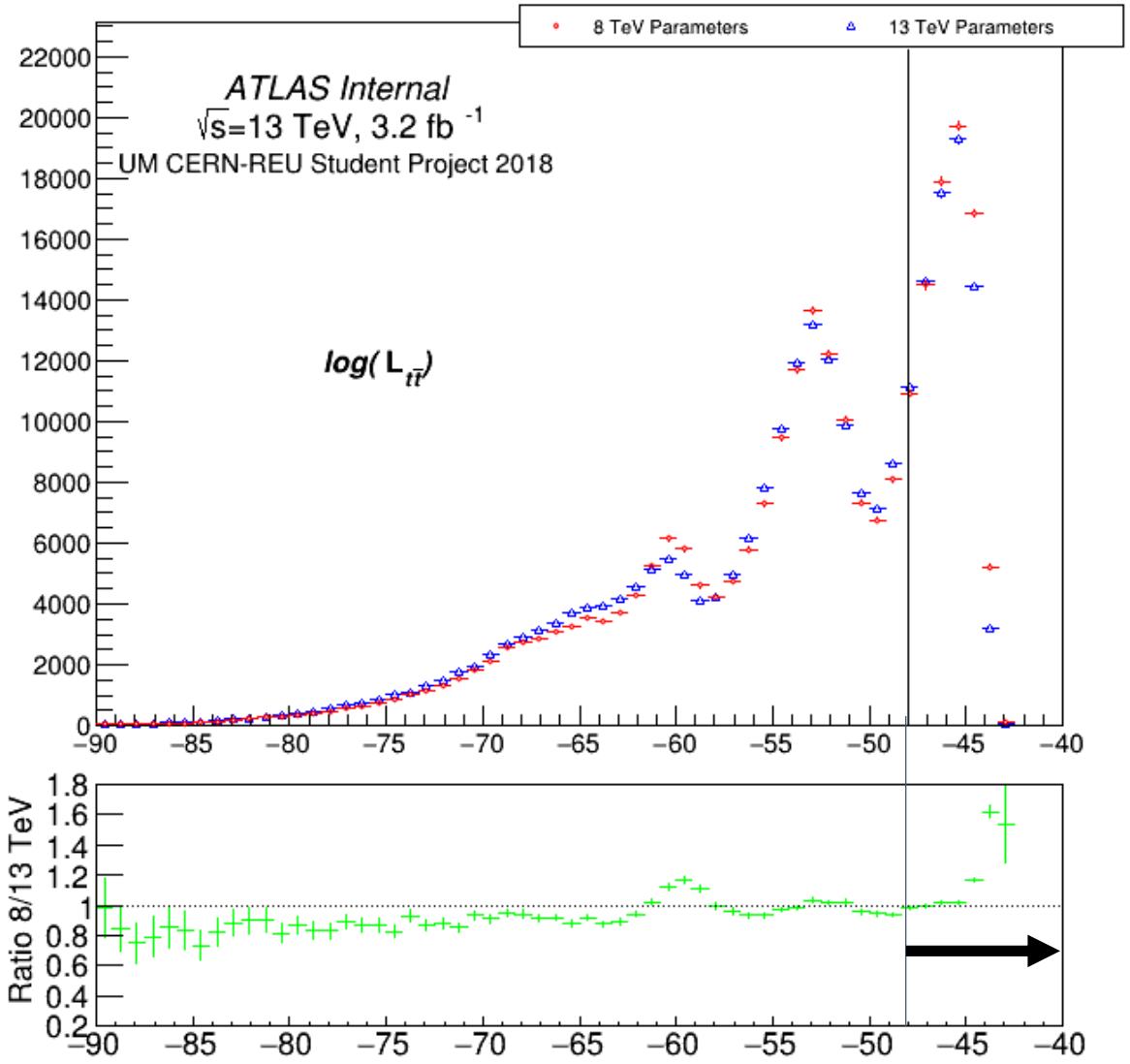


First full bunch train



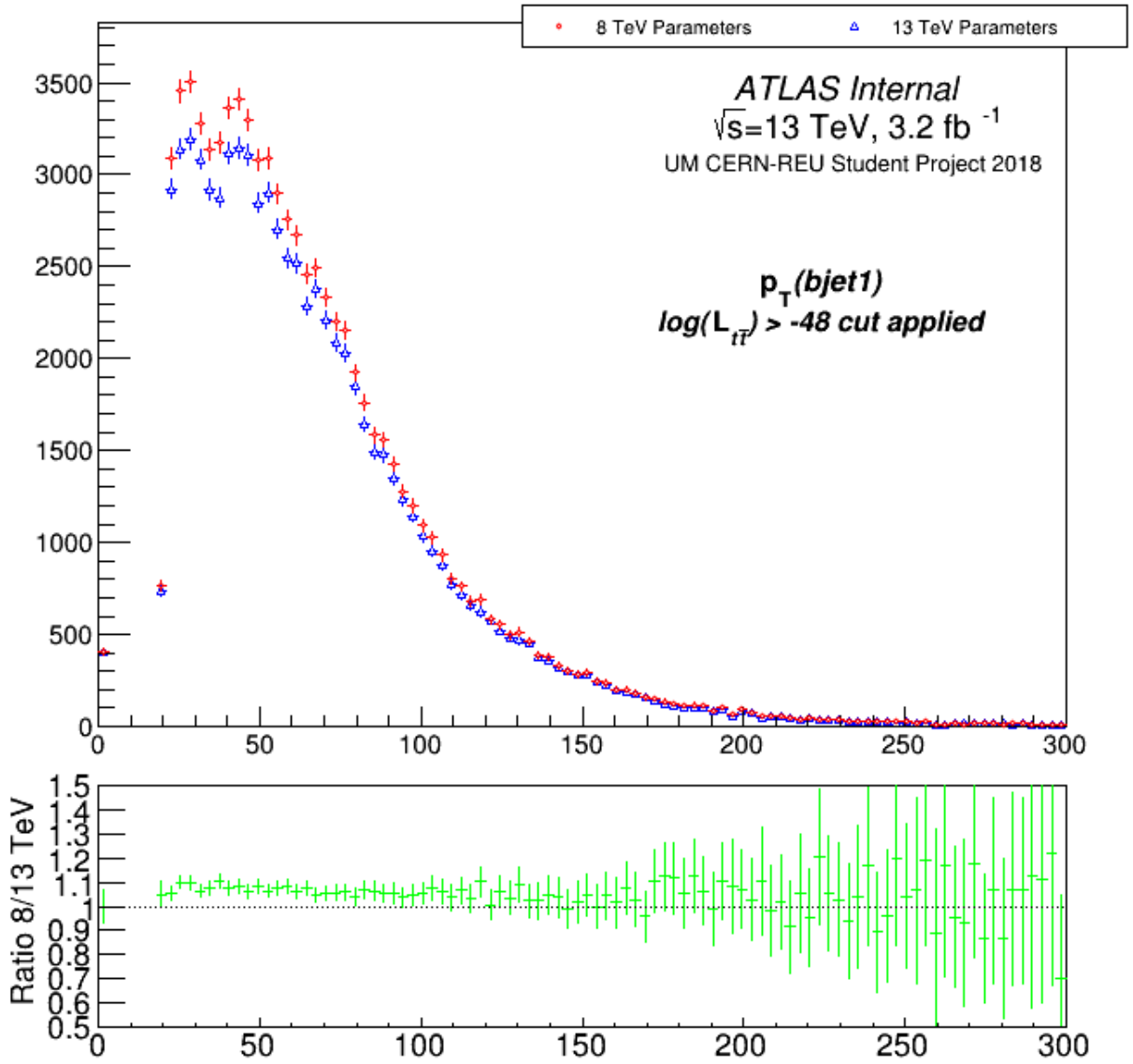
Second full bunch train

Log Likelihood of $t\bar{t}$



Vertical line at $\log(L_{t\bar{t}}) = -48$. A cut of $\log(L_{t\bar{t}}) > -48$ is used to select more pure $t\bar{t}$ events. This cut is the same as the 8 TeV W helicity paper: *Eur. Phys. J. C (2017) 77:264 DOI 10.1140/epjc/s10052-017-4819-4*

Discrepancy Between Transfer Functions for Transverse Momentum of Leading b-jet



There is about a 10% difference in the p_T range of ~ 20-100 GeV.

Summary and Outlook

- Compared BCM and LUCID
  - Discrepancy is dependent on μ and BCID
  - Obtained correction factors for data collected in 2016
- Compared 8 Tev and 13 TeV transfer functions
  - Noticed ~10% difference in kinematic variables
  - 13 TeV transfer functions result in better mass resolution
- Possible Future Work:
  - Refine correction factors for 2016 data and extend to multiple year data
  - Determine whether the 13 TeV parameters result in smaller signal to background ratio
  - Compare transfer functions with Dihiggs hypothesis

Acknowledgements

- Many thanks to Dr. Harris Kagan and Dr. Shaun Roe for taking me on as a summer student
- A big thank you to Dr. Suyog Shrestha and Dr. Nicola Venturi for their patience and advising throughout the summer
- Thanks to Steve Goldfarb, Jennifer Roloff, Junjie Zhu, and Myron Campbell for this amazing opportunity through the Michigan CERN-REU program
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Questions?

Backup

Derivation & Object Selection

- HIGG5D2 Derivation
- Moriond 2017 CP recommendations
- ntuple production code based on CxAOD Framework
- Single lepton trigger

Lepton

Tight (Medium) Likelihood *e* (μ)
pT > 27 GeV, |eta| < 2.5 (2.4) *e* (μ),
FixedCutTightTrackOnly Isolation

Jets

AntiKt4EMTopo Jets
Quality criteria – pass JVT and jet cleaning
b-jet: pT > 20 GeV, |eta| < 2.5, MV2c10 @ 85% WP
Non-b jet: pT > 20 GeV, |eta| < 2.5, non-b tagged

MET

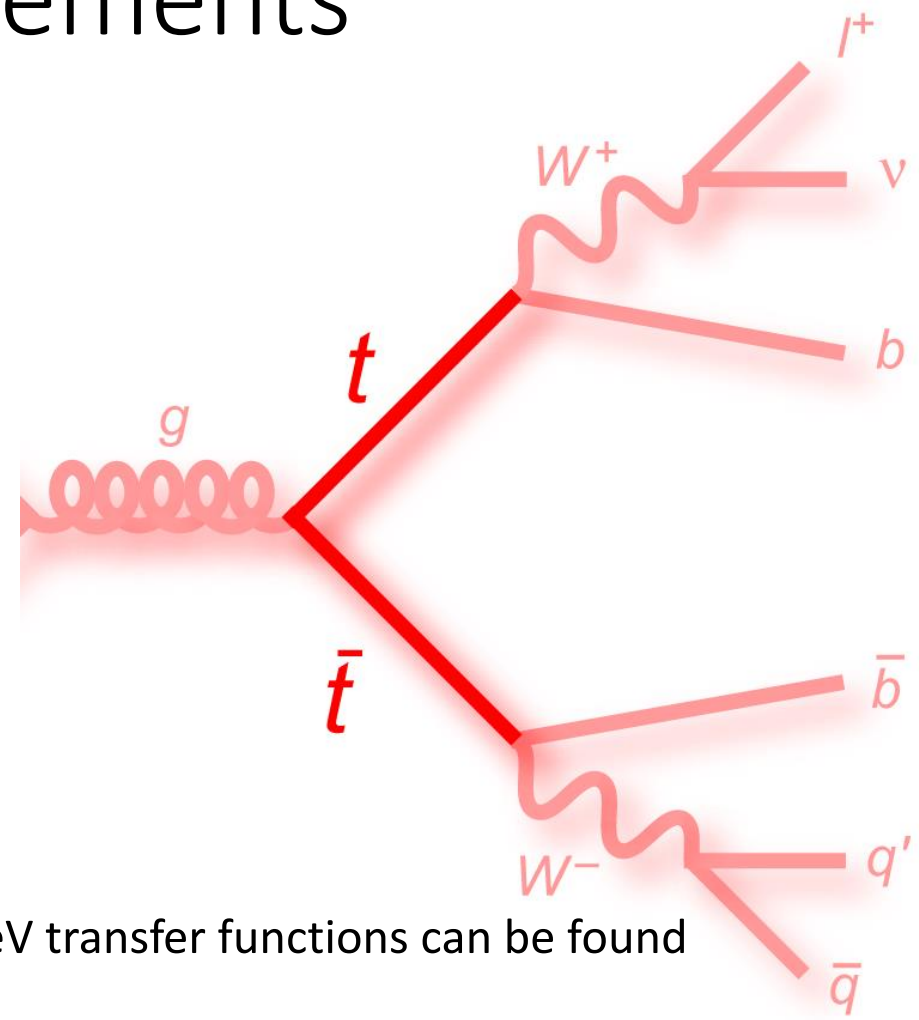
Loose Leptons, JVT-passed jets and TrackSoftTerm used for MET calculation.

Overlap Removal between *e* & μ

Shrinking Cone lep-jet OR

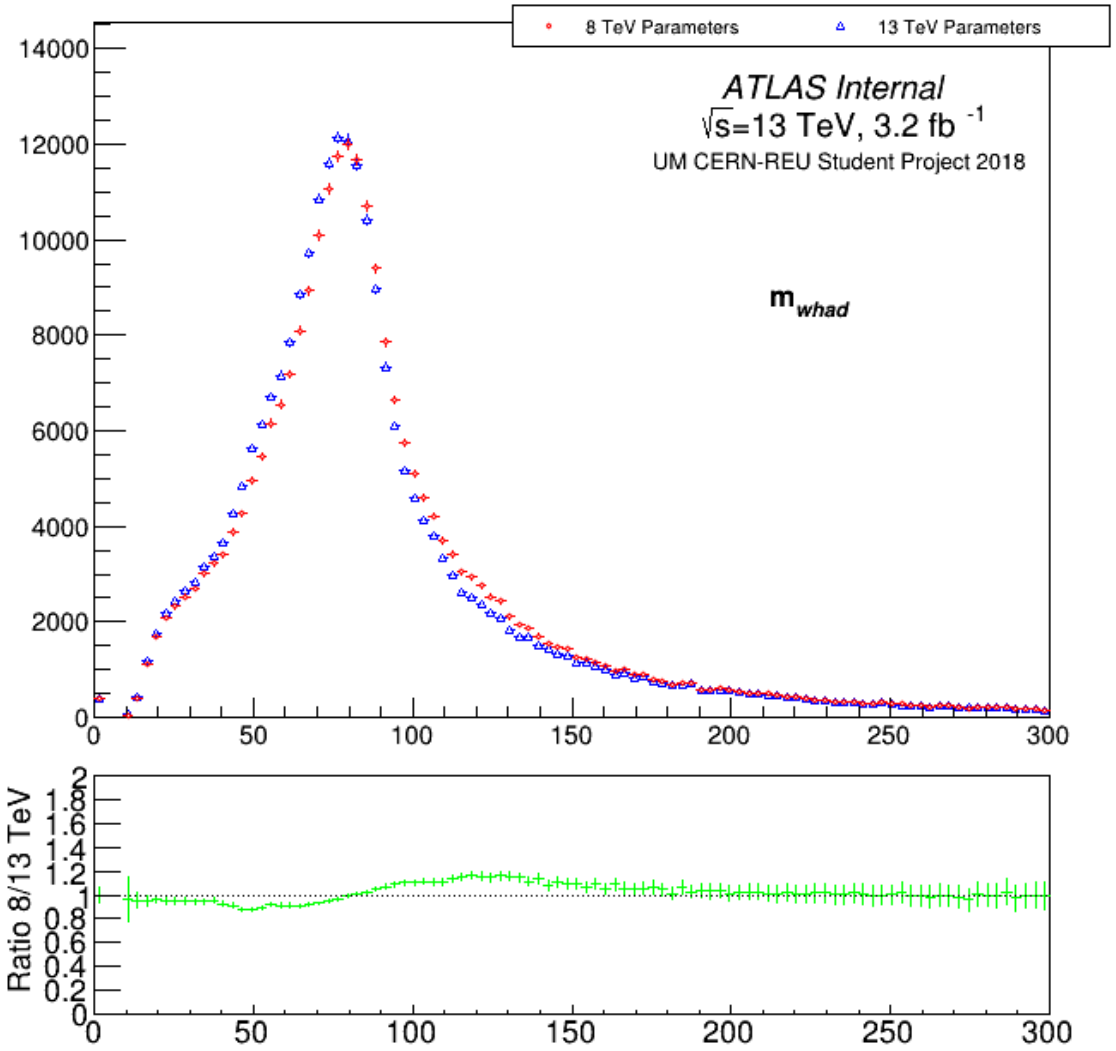
Pre-Selection Requirements

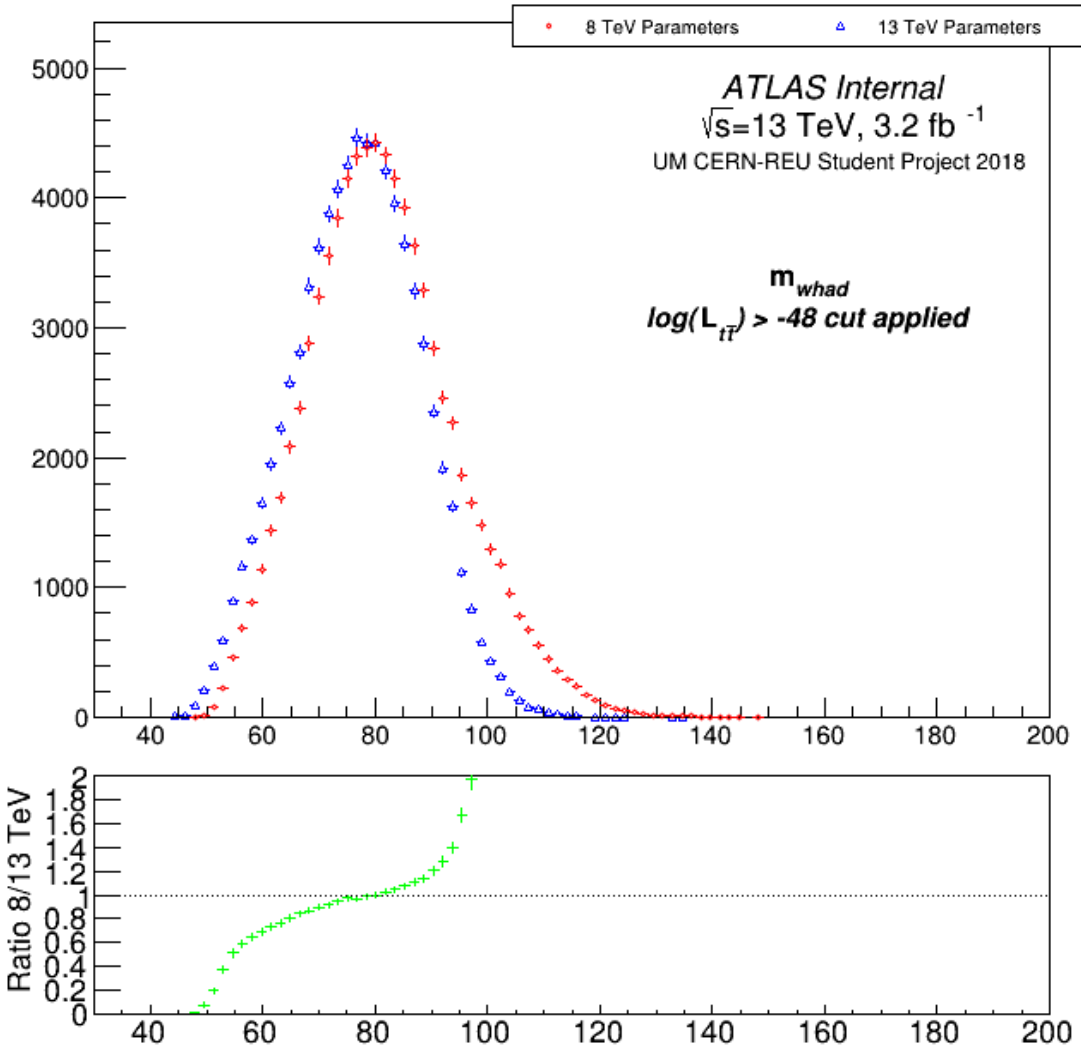
- Single lepton trigger
- Primary vertex with at least 2 tracks
- At least four jets
  - With at least two b-tagged
- Each jet must have $p_T > 20\ GeV$ and $|\eta| < 2.5$
- One trigger-matched lepton

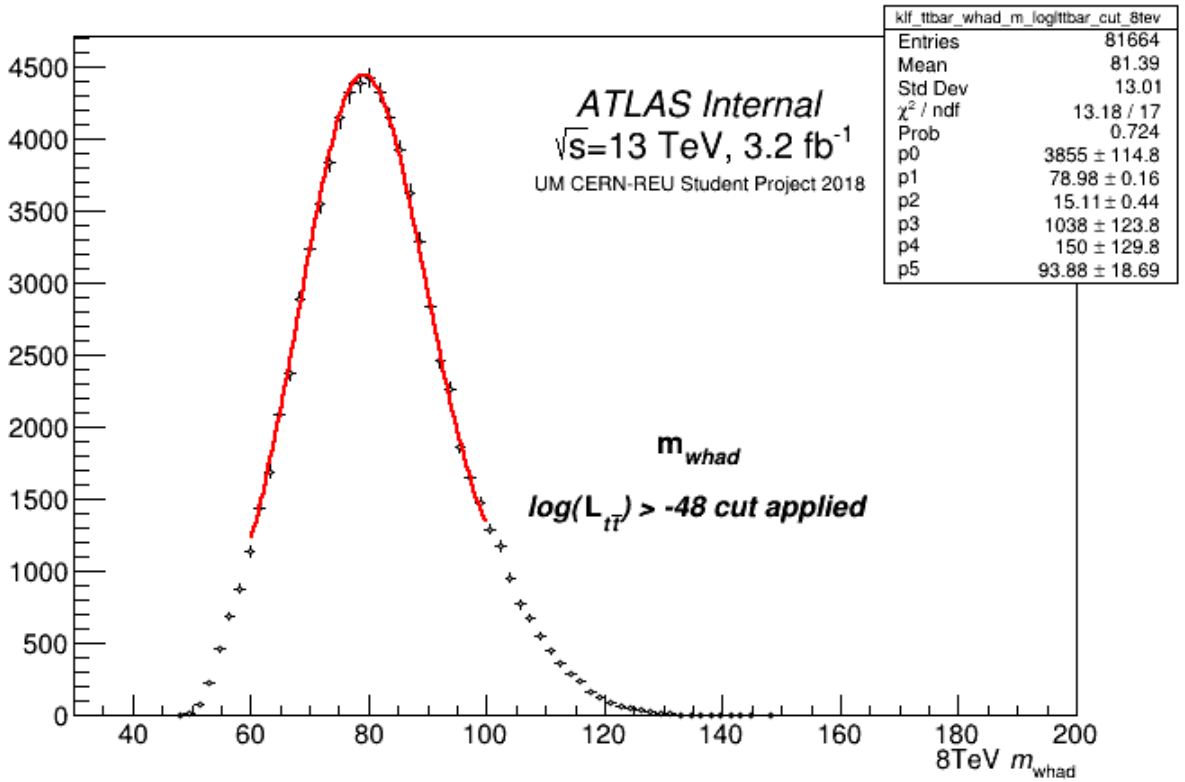


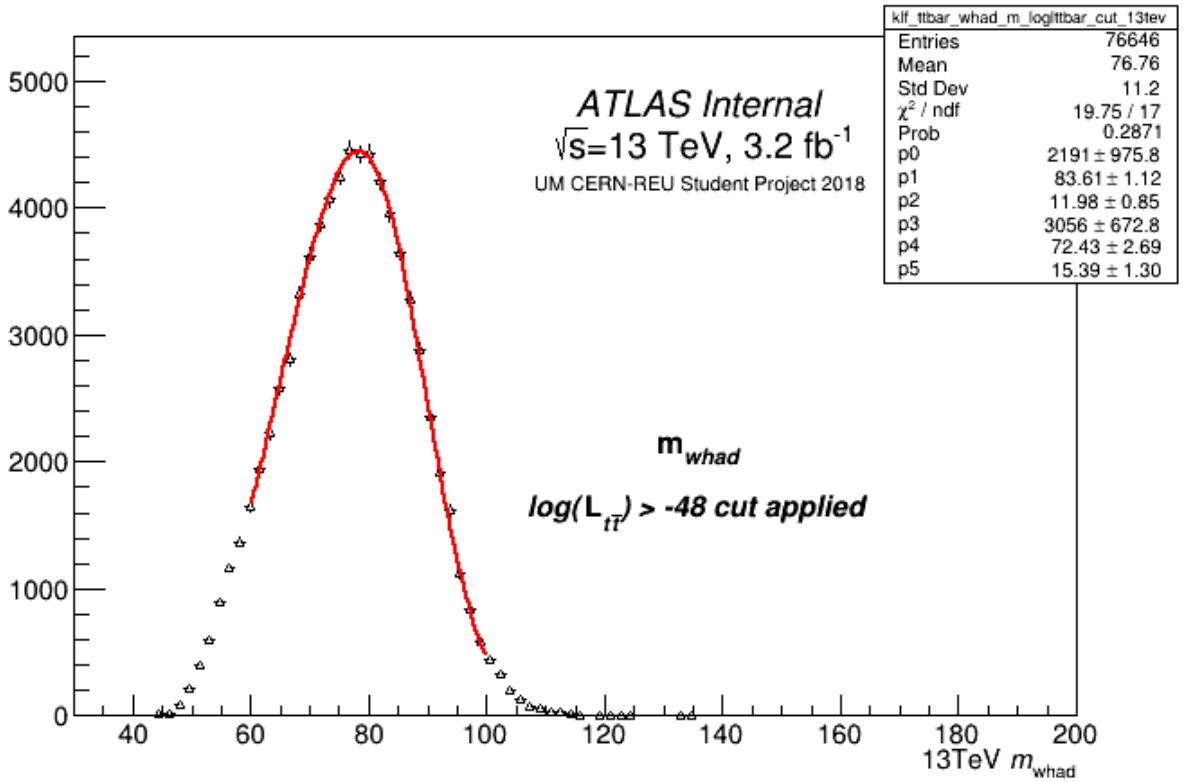
- Pre-selection requirements and other details used to derive 13 TeV transfer functions can be found here: https://tinyurl.com/y7lhmutl

Kinematic distribution of mass of hadronically decaying W boson

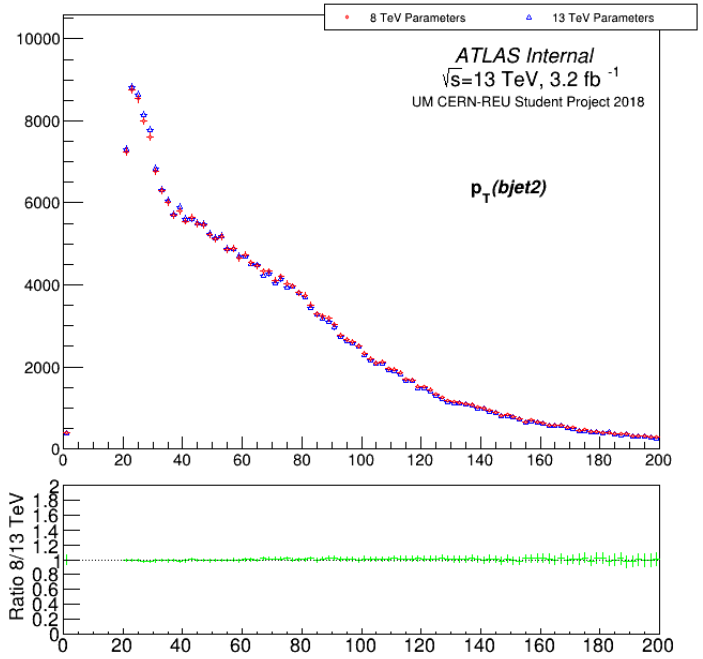


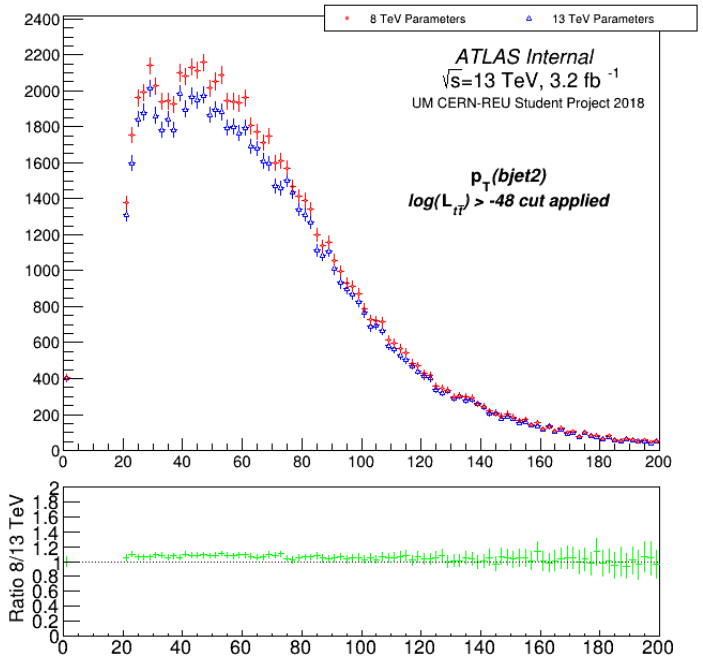






A shift to the left can be seen clearly after a double gaussian fit as been applied to the 8TeV and 13TeV results separately. The mean of m_{whad} with 8TeV parameters is ~81, while with 13TeV parameters it is ~77; however, the resolution is about 2GeV better for 13 parameters.


8 TeV Parameters
13 TeV Parameters
ATLAS Internal
√s=13 TeV, 3.2 fb -1
UM CERN-REU Student Project 2018
p_T(bjet2)
Ratio 8/13 TeV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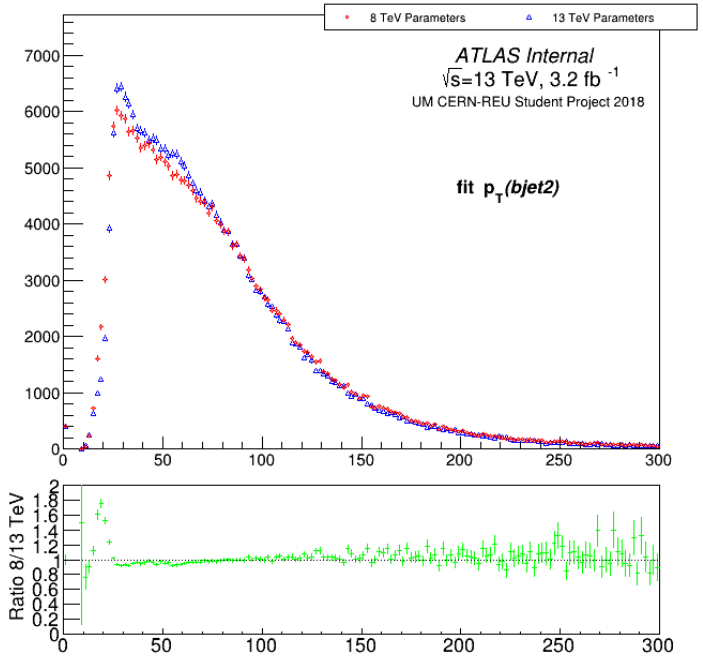
log(L_tt̄) > -48 cut applied
Ratio 8/13 TeV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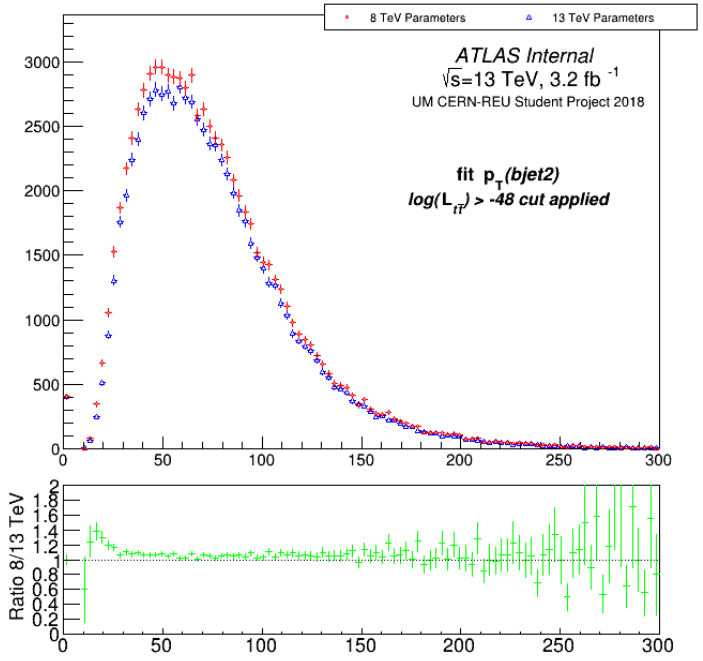
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