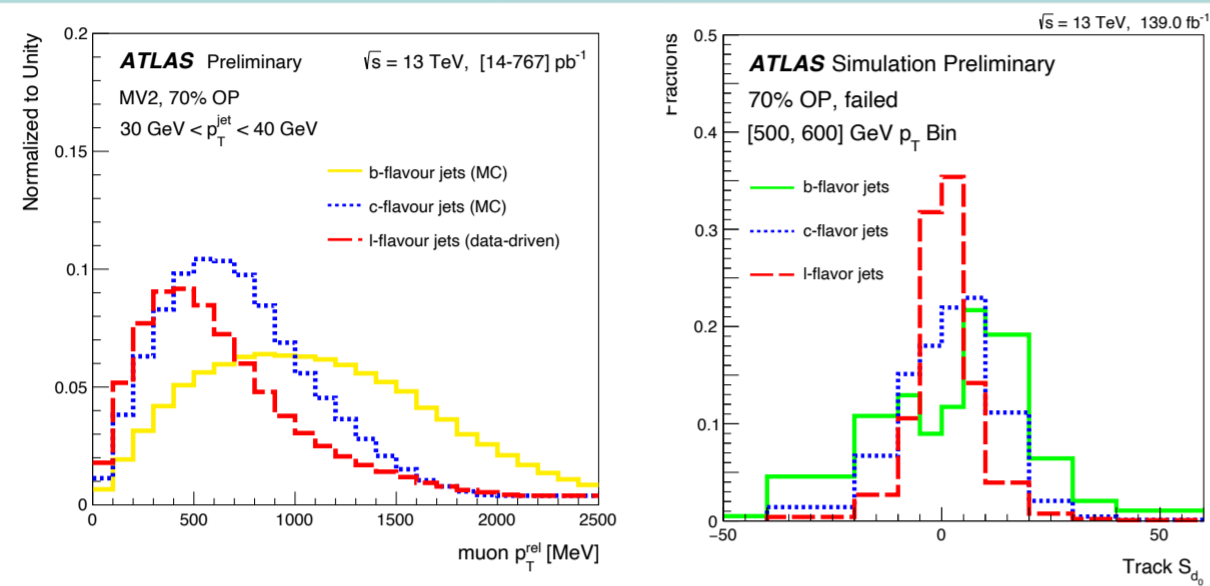


MEASUREMENT OF THE B-TAGGING EFFICIENCY USING MULTI-JET EVENTS IN ATLAS

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Introduction

- Identification of jets initiated by b-quarks [1]
- The baseline method for the calibration of b-tagging efficiency uses di-lepton $t\bar{t}$ events [1]:
 - Reliable SM standard candle to perform flavour identification calibrations
 - Relies on assumption that the top-quark exclusively decays into $t \rightarrow Wb$
 - Uncertainty reaches 8-10% in low jet p_T region
 - Limited coverage at high p_T even with full Run II data



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The power of multi-jet events

Template fit on **flavour discriminant variables** to determine b-tagging performance using multi-jet events:

- Independent cross-check of $t\bar{t}$ -based calibration
- Different set of systematic uncertainties
- **First calibration of data events up to jet $p_T = 1.2$ TeV**
- **Improved uncertainty for jet $p_T = [20-40]$ GeV**

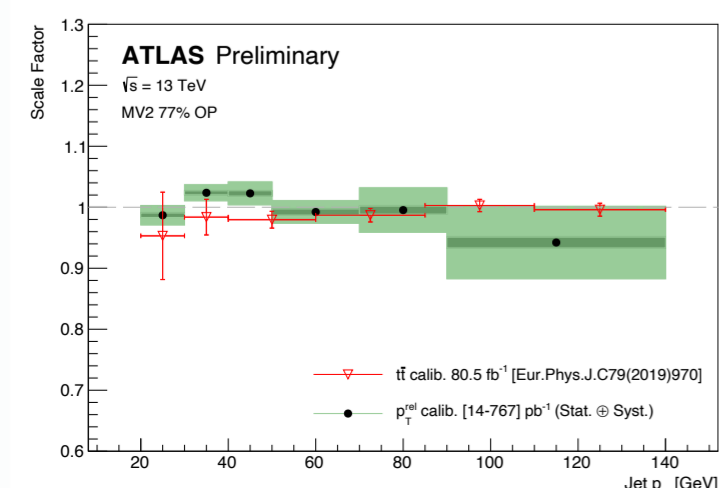
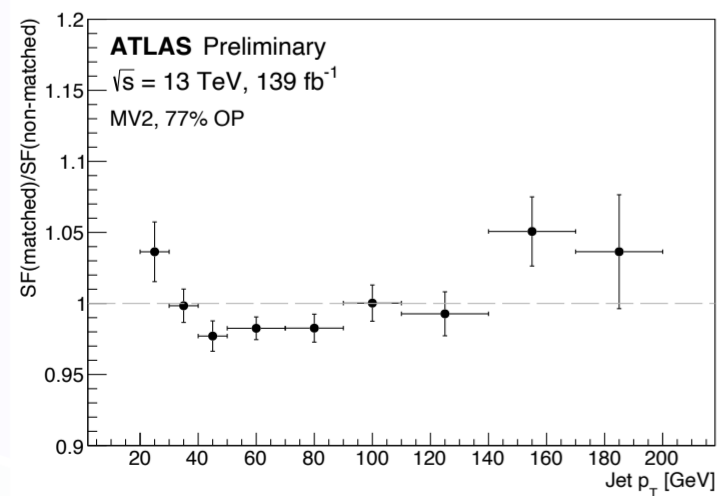
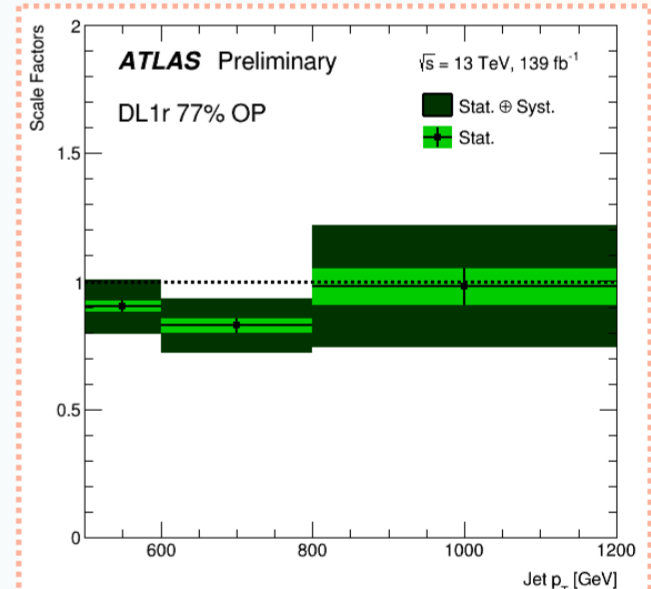
Selecting semi-leptonic $b \rightarrow \mu + X$ decays using a muon-in-jet requirement:

- $BR(b \rightarrow \mu + X) = 20\%$
- Increases fraction of b-jets
- Good resolution of muon variables to perform the calibration
- Requiring one jet tagged at 85% OP to be back-to-back with jet containing a muon (calibration object)

The beauty of semi-leptonic decays

High p_T calibration [2]

- Selecting events with un-prescaled single jet trigger
- Fitting on ratio between the **signed transverse impact parameter** and its uncertainty, S_{d_0} of the muon-jet
- Dominant contribution systematic uncertainties arising from:
 - Physics modelling
 - Tracking simulation



Muon p_T^{rel} calibration [3]

- Selecting events with pre-scaled muon-in-jet trigger
- Fitting on muon p_T^{rel} , muon momentum projected on the plane transverse to the jet+muon axis
- Main uncertainty is coming from simulation modelling and depends on jet p_T
 - Modelling of the muon momentum in the b-hadron rest frame (p^*) in the jet $p_T < 70$ GeV region
 - Jets containing two b- or c-hadrons in the jet $p_T > 70$ GeV region
- Dedicated extrapolation of the b-tagging efficiency scale factors from the semi-leptonic decay to the inclusive b-hadron decay:
 - Using tag-and-probe method on di-leptonic $t\bar{t}$ events
 - Ratio of the SF derived in the muon-in-jet case over the case where no muon is matched to the probe jet
- **Good candidate to assess b-tagging performances with a small integrated luminosity (for example in the first year of Run III)**

10th Edition of the Large Hadron Collider Physics Conference, 16-20 May 2022

[1] ATLAS Collaboration, "ATLAS b-jet identification performance and efficiency measurement with $t\bar{t}$ events in pp collisions at $\sqrt{s} = 13$ TeV", Eur. Phys. J. C 79 (2019) 970

[2] ATLAS Collaboration, "Measuring the b-jet identification efficiency for high p_T jets using multi-jet events in proton-proton collisions at $\sqrt{s} = 13$ TeV recorded with the ATLAS detector", ATL-PHYS-PUB-2022-010

[3] ATLAS Collaboration, "Measurement of the b-jet identification efficiency with the p_T^{rel} method in multi-jet events using pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS Detector", ATL-PHYS-PUB-2022-025