

Top mass shift resulting from the recalibration of flavor-dependent jet energy corrections in the $D\emptyset$ lepton+jets top mass measurement



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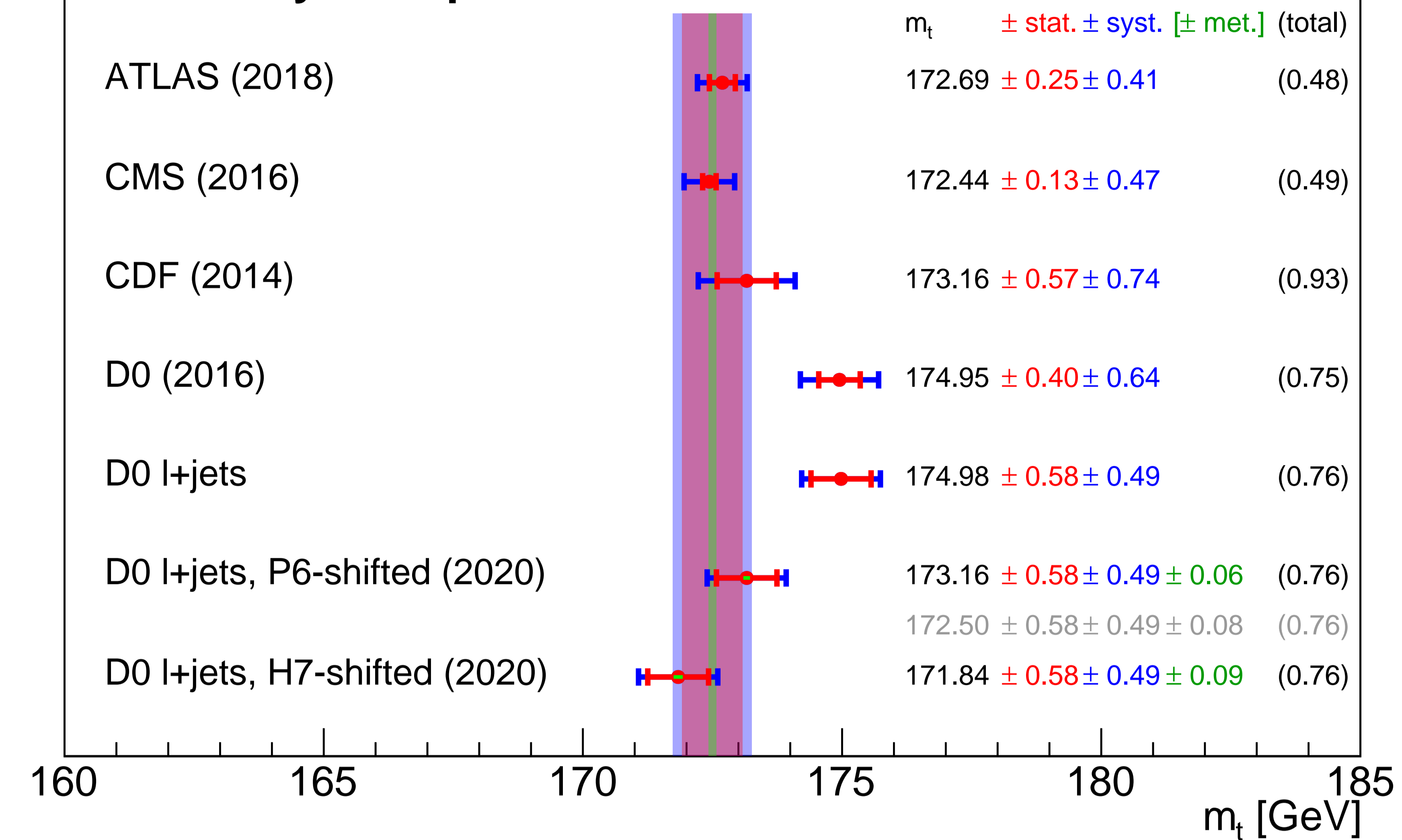
1 Background

- The most notable m_t measurements are those of the Tevatron collaborations CDF and $D\emptyset$ and those of the LHC collaborations ATLAS and CMS
- Understanding the $D\emptyset$ m_t measurement is necessary, as it diverges from the three other ones (See rightmost Fig.)
- The $D\emptyset$ Analysis Notes (ANs) were released from their five-year moratorium in early 2018, which allowed the first reproduction of the $D\emptyset$ methods
- Toni Mäkelä made an extensive study of the $D\emptyset$ flavour-dependent jet energy correction factors (F_{corr}) in his Master's thesis [1]
- There are two major steps in recalculating the F_{corr} 's:
 - Refitting the 3 Single Particle Response (SPR) parameters
 - Making parametrized F_{corr} fits based on these parameters (See Row 2 in Fig. below)

2 F_{corr} Effects on m_t

- Toni was able to match the $D\emptyset$ data points using the original SPR parameters, whereas $D\emptyset$'s fits and data presented in the ANs don't match (See Row 1 in Fig. below)
- In the new PYTHIA 6 (P6) SPR fits, Toni found similar results for RunIIa, but the results for other eras differed (See Row 2)
- In the new HERWIG 7 (H7) SPR fits, notably different results were found for all RunII eras (See Row 2)
- The $D\emptyset$ lepton+jets m_t measurement depends heavily both on b (b) and light quark (lq) corrections
- Changes in F_{corr}^b have a direct impact on b jet energies
- Changes in $F_{\text{corr}}^{\text{lq}}$ shift the b jet energies through K_{JES}
- The shifts in the b jet energies shift the hadronic and leptonic m_t profiles
- Building on the $D\emptyset$ results, a P6 based method for studying and combining the hadronic and leptonic lepton+jets m_t channels was devised [2]
- Main results presented in the lower part of the rightmost Fig.

Summary of Top Mass Measurements



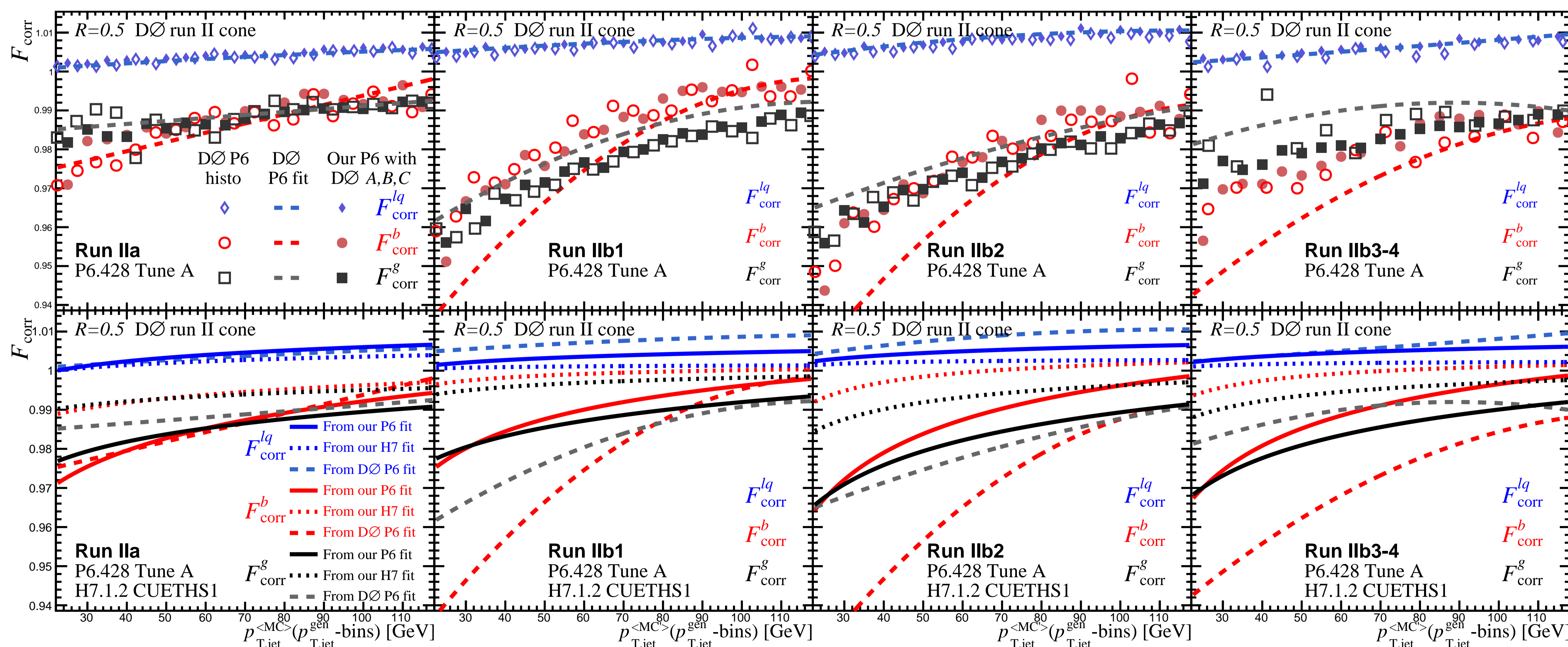
The most prominent top mass measurements and the $D\emptyset$ measurements shifted using Toni's F_{corr} values. Lepton+jets channel dominates the $D\emptyset$ result.

3 Discussion and Conclusions

- A larger m_t shift was found on H7 F_{corr} 's, and a smaller one on P6 F_{corr} 's
- The original $D\emptyset$ P6 fits have likely converged to unphysical minima
- The Herwig modelling effects have not been thoroughly considered by $D\emptyset$
- These studies were performed most of all to encourage $D\emptyset$ to reinvestigate their RunIIb F_{corr} calibrations
- In their letter released yesterday, $D\emptyset$ authors claim that our studies should still have been more thorough [3]
- We argue that at this point a re-inspection of the F_{corr} 's performed by $D\emptyset$ is the only correct way to proceed

References

- [1] T. Mäkelä, "Flavour-dependent jet energy corrections and top quark mass," 2019-06-18, <http://urn.fi/URN:NBN:fi:aalto-201906234090>
- [2] H. Siikonen, "Top Mass Shift Caused by the Recalibration of Flavor-Dependent Jet Energy Corrections in the D0 Lepton+Jets Top Mass Measurement" 2020-02-14, <https://arxiv.org/abs/2002.06073>
- [3] $D\emptyset$ Collaboration, "Precision measurement of the top-quark mass in lepton+jets final states", https://www-d0.fnal.gov/Run2Physics/WWW/results/final/TOP/T14E/D0_statement_top_mass.pdf



F_{corr} values in the four $D\emptyset$ RunII eras. Row 1: $D\emptyset$ histograms (open markers), $D\emptyset$ fits (lines) and our reproduction of the $D\emptyset$ results (closed markers). Row 2: our P6 (continuous line) and H7 (dotted line) fits vs. $D\emptyset$ fits (dashed line).