W mass discussion

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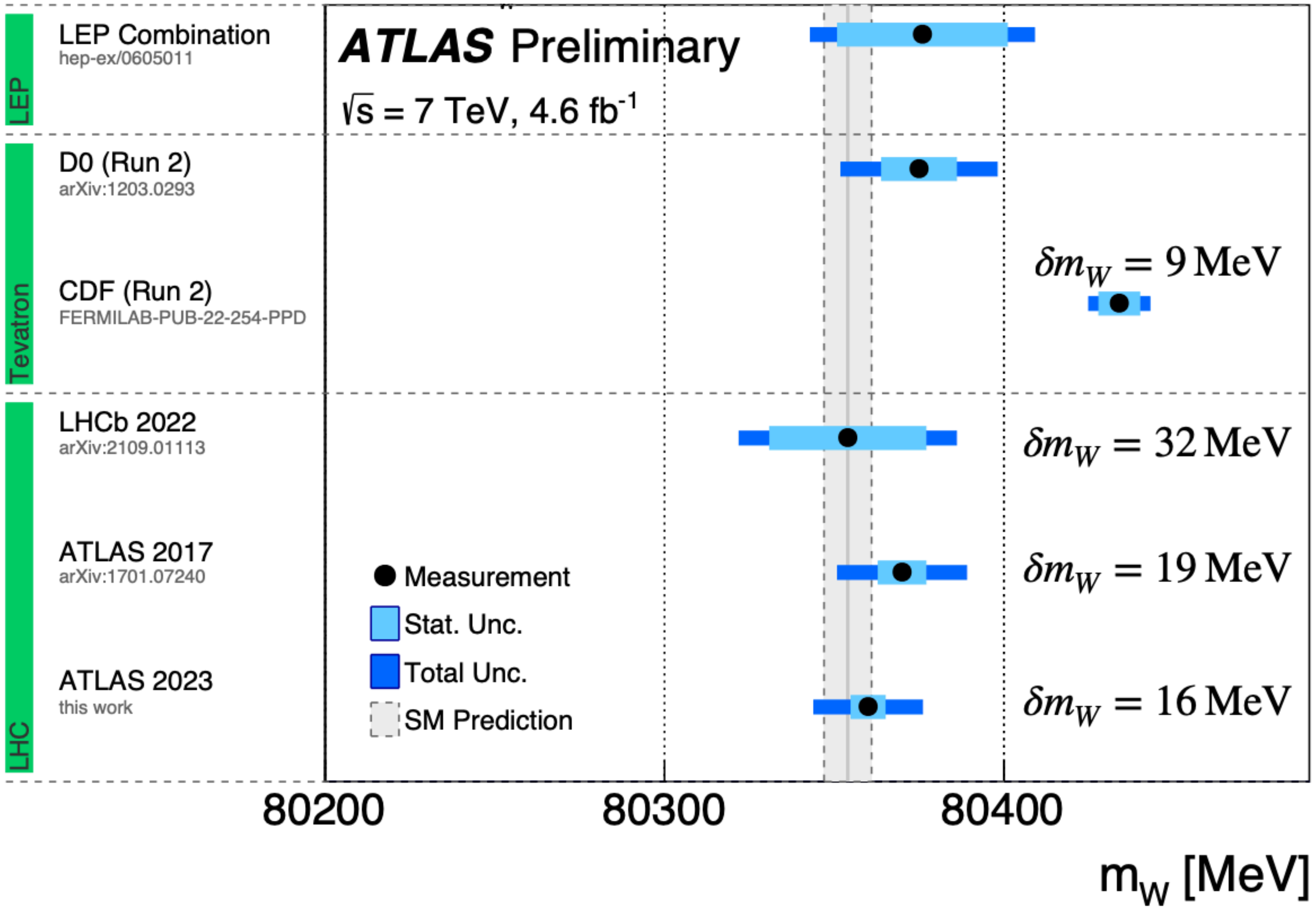
Introduction

W boson Mass a precision test of the SM



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- CDF measurement in significant tension with SM prediction and previous all measurements.
- Increased interest/attention also/especially on CMS

W boson in hadron colliders

Full kinematics of lepton and neutrino production from W boson

$$\frac{d\sigma}{d\Phi} \propto BW(Q) \times \frac{d^2\sigma}{dy\,dq_T} \times (1 + \cos^2\theta) + \sum_{i=0}^{7} A_i \times P_i(\theta, \phi)$$

BW : Breit-Wigner mass distribution

$\dfrac{d^2\sigma}{dy\,dq_T}$ double differential cross section

A's : Angular Coefficients

W boson Mass measurement at hadron colliders

- Tevatron: 1D template χ^2 fits of $P_T^l/m_T/P_T^\nu$
- ATLAS: 1D template profile-likelihood fits of $P_T^l - \eta_l/m_T^l - \eta_l$
- LHCb: 1D template likelihood fit in P_T^l
- CMS Plan: 2D fit of muon pT-η.

Theory agnostic

- We (will) have lots of data in high-PU 13 TeV runs.

- If we were to just use lepton P_T, η - *with no W-to-Z porting* - we might end up being limited by theory model systematics.

    - Theory-nuisance approach is one possibility to leverage the power of the data

- Alternative approach: Replace TNP by generic, model-independent, and analytic signal-strength modifiers to the fully differential x-section

    - PROS: no need for a frequentist definition of model uncertainties (including NP parameters)

    - CONS: no benefits from physics-motivated constraints (e.g. sum rules / evolution equations of PDFs, in situ constraints of PDFs ..)

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Theory agnostic

We start with:

$$\frac{d\sigma}{d\Phi} \propto BW(Q) \times \frac{d^2\sigma}{dy dq_T}(1 + \varepsilon_{UL}(q_T, y) \times (1 + \cos^2\theta + \sum_{i=0}^{7} A_i(1 + \varepsilon_i(q_T, y) \times P_i(\theta, \phi))$$

BW, $\frac{d^2\sigma}{dy dq_T}$ and A_i measured with best possible F.O. + logarithmic accuracy

$\varepsilon_{UL}(q_T, y)$ and $\varepsilon_i(q_T, y)$ parametrize the missing higher orders

>> To be profiled from W data only.

Theory agnostic

A template-based fit of the data will be needed

- Templates of reco-level- P_T, η built from samples of MC simulated events.
- Use event-by-event reweighting according to the cross-section equation to built templates.
- Use pre-FSR lepton kinematics from the MC record to define ϕ.
- QED shower effects will be accounted for by the MC simulation.

Theory agnostic: Questions??

- Q.1: are (low-degree) polynomial modifiers appropriate?
  - Can polynomials of (qT,y) catch the effects expected from missing higher-orders?
    - If not, is there a better base?
  - How low can we go in the degree?
    - There must be some balance between statistical precision and model dependence
    - Possible approach: compare different codes and choose the lowest degree able to fit them all
- Q.2: are pure and mixed NLO EWK effects under control?

Thank you ; Suggestions