Studies about Theory Uncertainties in the precision determination of Standard Model fundamental parameters

Initial motivations

The precision reached by recent & ongoing LHC determinations of α_s and m_W
requires a control over TH uncertainties that is unprecedented at hadron colliders.

The assessment of such uncertainties is notoriously challenging and
demands the input from the community of TH/EP experts.

The discussion has been structured with 3 main points:

- TH unc. in observables: The estimate of TH uncertainty in observables used in the measurement (e.g. ptZ, leptonic distributions, etc.) requires a technical discussion among experts to establish what the state-of-the art precision is (e.g. scale uncertainties, PDFs, non-pert effects, QCD⊕QED, ...)

- Propagation of TH unc. in the measurement: The implementation and propagation of the above uncertainties in the analyses involves many subtle points (e.g. statistical interpretation, correlations, ...). It is necessary to establish how different sources of error (e.g. scales, PDFs) impact the extracted parameter. Interaction with EP experts crucial for this step

- Reduction of TH unc. with data-driven techniques: Data is often used to improve the quality of the modelling and reduce TH unc. (e.g. via profiling of PDFs or scales, tuning). Can we validate the robustness of these methods with some simplified examples (e.g. is any bias being introduced)? Can we formulate criteria for the applicability of this class of approaches?

The meeting organised on February 26th 2024

https://indico.cern.ch/event/1368033/timetable/

Daniel Froidevaux	**Overview of LHC EW WG1 studies in the context of precision measurements**
Xuan Chen	**Fixed-order predictions for leptonic observables (QCD, EW, PDFs).**
Tobias Neumann	**Resummation and PDF uncertainties for leptonic observables**
Valerio Bertone	**Non-perturbative aspects**
Paolo Torrielli	**Propagation of scale uncertainties to ptlep templates after tuning to ptZ**
Alexander Yohei Huss	**Bayesian Estimates for TH Uncertainties**
Frank Tackmann	**Theory Uncertainties and Correlations from Theory Nuisance Parameters**
Mika Anton Vesterinen	**Theory uncertainties in the LHCb MW measurement**
Stefano Camarda	**Theory uncertainties in the alphaS measurement from ptZ**
Maarten Boonekamp	**Propagation of TH uncertainties in data driven approaches**
Simone Amoroso	**Profiling of PDF uncertainties**
All	**General discussion on the way forward**

Specific tasks to be investigated

https://twiki.cern.ch/twiki/bin/view/LHCPhysics/THuncertainties

Modelling of non-perturbative corrections in extraction of α_s

Main coordinators
Bacchetta, Bertone, Bozzi, Camarda
Description
Assessment of the impact of the choice of the non-perturbative model in the α_s extraction

Correlation between α_s and the gluon PDF

Main coordinators
Camarda, D'Enterria, Giuli
Description
Study of the correlation for different proton PDF sets to assess potential biases in the extraction of α_s

PDF profiling in M_W extraction

→ see Amoroso's talk

Main coordinators
Amoroso, Cridge
Description
Assessment of tolerance factor in PDF profiling, and impact on M_W uncertainties and consistency with global PDF sets

State of the art predictions for the ptW/ptZ ratio

→ see Rottoli's talk

Main coordinators
Neumann, Rottoli, Tackmann model
Description
Assessment of theoretical uncertainties in the ratio using state-of-the-art predictions for the kinematical distributions

Propagation of theory uncertainties through tuning of MC generators

Main coordinators
Torrielli, Vicini
Description
Assessment of the residual uncertainties and impact on M_W extraction

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Work is in progress,
but no quantitative results are ready
for a discussion today

A follow-up meeting will be organised
in late fall, for a detailed discussion