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EW Physics: Heavy flavor and top quark physics

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Abstract

This report summarizes the work of the Energy Frontier Topical Group on EW Physics: Heavy flavor and top quark physics of the 2021 Community Summer Study (Snowmass).

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1.1 Introduction

Overarching questions:

- How can the full exploration of the heaviest known elementary particle help elucidate the Higgs sector and inform about possible physics beyond the SM?
- What is the optimal way to guarantee that we take full advantage of the physics potential of top quark studies at different colliders and running scenarios?
- What is the ultimate precision that can be reached for the measurement of a well-defined top quark mass and how much does it improve the reach of a global EW precision fit? What else can be learned? And if we want to push for the highest possible precision what is needed to reduce the theoretical uncertainties to $t\bar{t}$ threshold cross sections at the required level?
- What is the potential for discovery and studies of rare top-quark production processes, such as multiple top production and top in association with other heavy SM particles, and what is their impact on a global EFT fit and direct BSM searches?
- What can be learned from measurements of top quark properties other than the top quark mass and couplings such as spin correlations, asymmetries, polarization in new kinematic regimes, and what is the achievable/required precision?
- What are the optimal top quark observables for constraining EW top quark couplings in EFT fits? What can we learn from these constraints about BSM physics?
- What is the potential of multi-differential cross sections in top quark production processes to simultaneously extract α_s, m_t, and the gluon PDF?
- What is the potential of heavy-quark production cross sections (also in association with EW gauge bosons) to probe heavy-quark PDFs, and could this impact the achievable precision of Higgs+HQ production processes?
- What can be learned from precision measurements of heavy-quark production (cc,bb,tt) at lepton colliders, and are systematic uncertainties from theory under control, especially higher-order electroweak corrections?
- There will be improvements in theory and analysis techniques after the LHC is finished taking data. How can these be used to improve our understanding of the top quark and its interactions in the foreseeable absence of top physics data?
- Is it possible to realistically project systematic uncertainties affecting precision measurements of top quark observables and heavy flavor production to be able to compare different collider options. Can we learn from the lessons of Tevatron to LHC or Snowmass 2013 compared to LHC data with 150 fb^{-1}?