

# Snowmass EF03 kick-off

## Introduction

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# Overview

- EF03: top quark physics and heavy flavor production through EW processes
- Precision measurements of top-quark related processes
- High-precision predictions for top-quark observables
- Heavy flavor (b, c) production at hadron colliders in association with an electroweak boson
- Heavy flavor production at lepton colliders

# Connections and overlaps with other frontiers

- In Rare Processes and Precision:
  - RF1: Weak Decays and B/C - RF1 focuses on bottom and charm decays, including b factories, EF03 focuses on heavy flavor production
- In Cosmic:
  - (CF1: Dark matter particle-like - relevant for us when dark matter is produced at a collider in association with top) - also in EF10
- In Theory frontier:
  - TF02: EFT
  - TF06: theory techniques for precision physics
  - TF07: Collider Phenomenology
  - (TF08: BSM model building)
- In Accelerator:
  - AF3: Accelerators for EW/Higgs - top physics requires thinking about accelerator configurations
  - AF4, Multi-TeV Collider
- Community Frontier: We (like everyone) care about community involvement

# Connections and overlaps with other EF groups

- EF01 - ttH, Yukawa couplings of top quark
- EF04 - EFT fits
- EF05 - Precision QCD, in particular MC generators
- EF06 - PDF fits to include top data, PDF uncertainties in top measurements
- BSM physics with top-quark final states is covered by the BSM EF groups
  - (EF08 - BSM, model-specific)
  - (EF09 - EFT fits, new fermions)
  - (EF10 - dark matter)

# Why top physics?

- The top quark is special: it is (still) the heaviest elementary particle with strong connections to the electroweak symmetry breaking sector:

$$y_t^{\text{SM}} = \frac{\sqrt{2}m_t}{v} \sim 1 \quad \delta m_h^2, \lambda(Q^2) \propto m_t^2$$

- Its detailed exploration may provide a first glimpse of physics beyond the Standard Model.
- It decays before hadronization and spin information is transferred to its decay products.
- Copious production of top quarks at the LHC motivate advances on both the experimental and theory side which enables a very rich and successful top physics program:
  - precision measurements of top quark properties: mass, couplings, ...
  - searches for rare processes: single top, , FCNC, ...
  - measurements of a wide variety of observables and in new kinematic regimes: spin correlations, asymmetries, polarization, boosted top, jet substructure, ...

# Why study heavy flavor production?

- Here we will study the prospects for heavy flavor production (bottom and charm) in association with EW gauge bosons or through EW interactions

## At hadron colliders:

- Precision probes of pQCD and heavy-quark factorization schemes
- $W+c$  production accesses the strange quark content of the proton
- $Z+b$  production probes the b-quark PDF
- heavy flavor production through EW processes

## At lepton colliders:

- Production of bottom and charm pairs as precision probes of QCD and heavy-quark fragmentation schemes
- Polarized beam measurements of b-quark form factors
- Weak couplings of b-quark

# Meetings

- Energy frontier kick-off was last week (<https://indico.fnal.gov/event/24264/>)
- Other EF groups are having (have had) their kick-offs (<https://indico.fnal.gov/category/1100/>)
- We plan to have EF03 meetings every other week, Thursdays at 1pm EDT
  - Opportunity for students and postdocs to present their progress, get feedback, discuss
- The next few EF03 meetings will have overview talks from larger efforts
  - ILC, ESG, HL-LHC, etc
  - Inform everyone (including ourselves) on previous studies and existing work
  - We will build on those with dedicated EF03 studies over the next year

# Documentation, coordination of studies

- Thanks for uploading your proposed studies as “Letter of Interest”
  - We will look through those and will ask questions or coordinate as necessary
- We have also created a google doc for more immediate coordination
  - Everyone is welcome to edit/add/comment on the document and to find topics or collaborators
  - <https://docs.google.com/document/d/17aPp9XpJAImmPInPNtgV21rG2zEiFS2IHkO-ooC4rcQ>



# Today

- Discussion of these slides and any other topics relevant to starting EF03 work
- 5-minute presentations by groups on their plans