Top Working Group Report
Summary of Seattle Meeting

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Fully Understanding the Top Quark

Organized around 6 subgroups:

- Mass
- Couplings
- Kinematics
- Rare Decays
- BSM w/top in final state
- Detectors for Top

Organization of the top sessions

1) Summary presentations from conveners of each subgroup allowing for plenty discussion/vetting of the conclusions/ assessing progress

2) “lunch” presentations from individual studies, including detailed ILC & CLIC studies

Top Quark Subgroups

- **Mass,** High priority item, unique to this group
- **Kinematics (including AFB)**

- **Couplings** overlap with Higgs (ttH)
- **Rare Decays**

- **BSM w/top in final state,** overlap with NP group
- **Detectors for Top (including algorithms and boosted tops),** also connected with BSM via extrapolation of capabilities to HE/High PU.

Crucial to have discussions across groups

Documentation Update

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Top quark working group report

Conveners: K. Agashe, R. Erbacher, C. Gerber, K. Melnikov, R. Schwienhorst

A. Mitov, M. Vos, S. Wimpenny, M. Schulze, etc.

1.1 Introduction

This is the introductory Section for the report on top quark snowmass 2013 studies. The top quark was discovered in 1995 [1, 2].

1.2 The top quark mass

This is the top quark mass Section.

A summary of top quark mass measurements from the Tevatron is shown in Fig. 1-1.

1.3 Top quark couplings

This is the top quark couplings Section.

1.4 Kinematics of top-like final states

This is Section on the kinematic studies with top-like final states.

1.5 Rare decays

Observation of rare top quark decays will most certainly imply physics beyond the Standard Model.

- Plan is to produce a white paper from each subgroup which will be summarized in the top group 30-pages report.
- In some cases, several different white papers on particular topics will also be available.
- In some cases, overlap with other groups will exist (desire to minimize duplication in the interest of time)

Top Quark Mass

- High Priority, in pretty good shape
- Based on two contributions
- Includes projections for 14 TeV LHC, 33 and 100 TeV pp collider with traditional and new (J/Ψ) methods.
- Highest precision can be achieved with dedicated tt threshold scans at TLEP, ILC & CLIC

Discussions/Ideas that will require more thought

- top mass precision and vacuum stability of the SM: evaluate and discuss the veracity of the calculation and the plausibility of the scenario

Kinematics of final states

- Focusing on theoretical studies and experimental projections.
- Theoretical studies reveal that soft gluon resummation is mandatory in boosted regime.
- Ongoing studies of AFB (Forward/Central) at LHC 14
  - Effect is reduced compared to 7/8TeV, control of systematic errors crucial
  - Looking for input on error scaling from CMS/ATLAS, expect to have result by Minneapolis.
- Ongoing studies at LHCb
  - Theoretical idea being implemented by the collaboration.
  - Results need approval from LHCb, but authors are optimistic it will be ready for Minneapolis.
- Other new ideas, define observables in ttbar+jets, spin correlations in dileptons a good way to look for NP.

Top Quark Couplings

- Electroweak-scale mass makes top a prime candidate to manifest BSM physics: measure the gauge and Yukawa couplings predicted by SM to look for deviations.
- Work ongoing on various fronts, some more advanced than other
  - Single top, V_{tb}, anomalous couplings
  - ttbar+Photon, ttbar+Z
  - ttbar + W
  - ttbar + Higgs
    - Challenging, overlap with the Higgs group.
- Will need a concentrated effort to have concrete summaries/tables with projections for the report.

Rare Top Decays

- LHC and ILC reach comparable sensitivities to top quark rare decays (top to Zq, γq, gq, Hq)
- However, they are complementary
  - LHC can do more channels but is not good for understanding the Lorentz structure of couplings
  - ILC can not study flavor-changing couplings of tops to gluons
- Various tables/extrapolations available for the report.
- Overall pretty good shape.
- Wish list:

  If additional resources are available before the Minneapolis meeting, dedicated study of $t \to Zq, t \to \gamma q$ at 250 GeV ILC and dedicated study of $t \to hq, t \to gq$ at 14 TeV LHC would be extremely useful.

NP decaying to top

- Common session with NP group
- Ongoing studies on searches for stop, ttbar resonances and top partners likely included in the top writeup with individual white papers as supporting documentation.

- Some overlap/consistency with detectors and algorithm subgroups will need to be resolved by Minnesota.
  - Need to apply some of the findings from the detectors/algorithms groups to get projections at high boost (high energy) and perhaps at high pileup.

- Will need a concentrated effort to have concrete summaries/tables with projections for the report.

Top and Detectors

- White paper based on Snowmass Delphes MC simulation that allowed different PU and detector configurations. Done for threshold, boosted and extremely boosted configurations
- Threshold: High luminosity runs unfavorable for high precision inclusive SM top studies based on reconstruction of low pT jets due to pile-up corrections leading to large uncertainty in jet-energy (see https://indico.fnal.gov/getFile.py/access?contribId=118&sessionId=5&resId=6&materialId=slides&confId=6969)

  Need to make sure these conclusions are consistent with assumptions made in extrapolations throughout the report.
- Boosted: Top tagging still viable at high PU with some degradation of performance, some variables more than others.
  - can be mitigated with algorithms and finer segmentation in the future.
- LC & CLIC full simulation studies presented and will be included in a dedicated white paper.

Conclusions

- Productive workshop, many interesting discussions!
- Thank you to everybody that participated in person, remotely, or by submitting contributions, and for skipping lunch.
- Need to ensure consistency between top and detector studies findings and extrapolations done in other studies & complete missing items in tables as good as we can.
- Lots of good material, we are well on track for the Minnesota timescale!