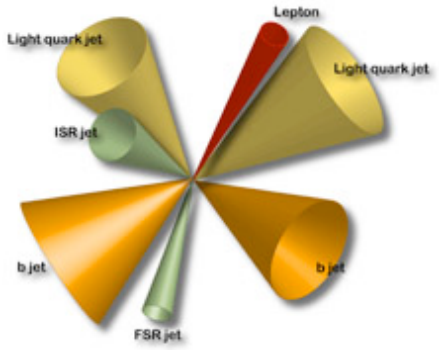
Energy Frontier: Top Quark Group

Snowmass 2013 Community Summer Study



Conveners: Kaustubh Agashe, Robin Erbacher, Cecilia Gerber, Kirill Melnikov, Reinhard Schwienhorst

R. Erbacher -- Snowmass@LHC Lunch Meeting -- May 28, 2013

Working Group Summary

Goal: To understand properties of top quarks, how the top quark fits into the bigger picture, and why are its properties relevant to the future of the energy frontier.

Activities:

- top quark mass (contacts: A. Mitov, M. Vos , S. Wimpenny)
- kinematics of top-like final state (contacs: M. Schulze, A. Jung, J. Shelton)
- top quark couplings (contacts: J. Adelman, M. Baumgart, A. Garcia-Bellido, A. Loginov)
- rare top decays (contacts: N. Craig, M. Velasco)
- new physics in top-like events (contacts: T. Gollling, A. Ivanov, J. Hubisz, M. Perelstein)
- top quark detection algorithms (contacts: S. Chekanov, J, Dolen, J. Pilot, R. Poeschl, B. Tweedie)

Top mass / Top kinematics

- What is the top quark mass parameter that is measured at a hadron collider?
- How precisely can the top quark mass be measured?
- How precisely should the top quark be measured? What do we learn from improving precision on the top quark mass by a factor 10?
- What is the right facility to measure the top quark mass to the required precision?

- How well kinematic distributions in processes with top quarks pair can/should be known?
- What are physics cases where a better knowledge of top quark kinematic distributions is important?
- Can improved knowledge of kinematic distributions be translated into better couplings measurements?

Couplings / New Physics / Rare Decays

- How well the top quark couplings to electroweak gauge bosons, the gluon and the Higgs boson can be constrained at various colliders?
- How does achievable precision translate into the reach for BSM physics?

- Is there physics beyond the Standard Model which is primarily accessible through processes with top quarks?
- What are generic types of such physics and how to search for it?
- What is the role of a LC to study such physics ?

Are there decays of top quarks mediated by FCNCs? How well can they be studied at the LHC and future collider? What are the implications of observations of such decays? How well CKM matrix elements Vts and Vtd can be measured?

Top algorithms and detectors

- What are the challenging issues for detecting top quarks at future colliders?
- Can new algorithms be developed or existing algorithms improved substantially ?
- Can top quarks become standard candles, for example for jet energy scale measurements ?
- Is their any top quark physics that is limited by proposed parameters of detectors at future colliders?

Group charge, summaries, working pages

Snowmass on the Mississippi a.k.a CSS 2013

Log In

Quick Links

- **TWiki registration**
- **Pre-meetings**
  - Community Planning Meeting
  - All pre-Snowmass Meetings

Groups

- Energy Frontier
- Intensity Frontier
- Cosmic Frontier
- Frontier Capabilities
- Instrumentation Frontier
- Computing Frontier
- Education and Outreach
- Theory Panel

Google Search

www.snowmass2013.org
WWW

Fully Understanding the Top Quark

Conveners: Kaustubh Agashe (Maryland), Robin Erbacher (UC Davis), Cecilia Gerber (Illinois-Chicago), Kirill Melnikov (Johns Hopkins), Reinhard Schwienhorst (Michigan State)

Click here to send email to the conveners

The mailing list for the top quark working group is snowmass-top AT slac.stanford.edu.
Click here to be added to the top quark snowmass mailing list or to modify your list membership. The mailing list archive is here.

The first meeting of the top group was on January 30, 2013.
The second meeting of the top group was on February 20, 2013.
The third meeting of the top group is on March 13, 2013.

SUMMARIES

The documents linked below briefly describe "the state of each topic" in this field of top quark-related physics (and in some case, indicate possible directions for future work). We plan to use these as the basis for the actual studies during the Snowmass process.

(1). Precision top physics:

(i) Top quark (flavor-preserving) couplings: topcouplings.pdf

(ii) Top quark mass: top-quark-mass.pdf

(iii) Top quark production and final state kinematics: top-production.pdf

Top Mass

1. Top quark mass

Contacts: Marcel Vos, Alexander Mitov, Steve Wimpenny
Email the contacts

1. Should come up with a consistent scheme to compare top masses. These studies have been going on for years, but I think wee need someone to think about this and write it up.
2. Explore different methods to measure mass at hadron collider and their complementarity. J/Psi method, plus dilepton method. Both of these should be quantified as to their unique contribution and how much they could reduce overall uncertainty.
3. For dilepton method, also need to do NLO simulation for accurate prediction of dilepton events.
4. Prescription on how to do matrix element analysis at NLO.
5. Try out new color reconnection in Pythia 6.4.27.
6. Muon collider top mass measurement - any possible contribution?

- Wanted: General help with white paper and collation of information.
- Studies: Experiments should investigate the use of lepton distributions for Mtop.

Top Couplings

- Very large topic, very large charge.
- Results of Delphes studies coming in from ttH (H->gg). Infrastructure is ready! (Andrey, Jahred) Need someone to look at ttH (H->mumu).
- A partial list of questions needing attention:

1) Is it possible to differentiate scalar vs pseudoscalar ttH couplings at various colliders?

2) What are the default selection and then reconstruction efficiencies for busy ttbar+jets events (including heavy flavor jets identification) at large pileup. This is useful not just for top couplings, but more generally

3) Is it possible to bound the axial component of the top's coupling to gluons (at various colliders)? What variables should we use?

4) Add to ttH studies - can we do H->mumu? Need to generate 1-2 backgrounds first

Kinematics of top-like final states

3. Kinematics of top-like final states

Contacts: Markus Schulze, Andreas Jung, Jessie Shelton
Email the contacts

Top AFB:
1. Improved prediction of SM ttbar
2. Check different new physics scenarios that could contribute and how they can be probed in other channels.
3. Top quark spin and polarization measurements - sensitivity?
4. Which distributions are sensitive to new physics? At different colliders?
5. How well are these distributions understood theoretically?
6. What uncertainties limit the understanding of these distributions experimentally.
7. What should the benchmark scenarios be? Need someone to choose.
8. What about top Afb at LHCb ?

Kinematics of top-like final states

- Afb/Ac : LHC people can answer this-- what sensitivity can we get with higher luminosities? How do systematics effect this?
- Spin correlations: Help identify theoretical uncertainties and how they effect measurements.
- Kinematical predictions: Theory errors? How are these effected by high luminosity and high pile-up? Systematic uncertainties on these?
- Boosted tops: How well can we use these to predict differential distributions?

Rare top decays

4. Top quark rare decays

Contacts: Nathaniel Craig, Mayda Velasco
Email the contacts

1. Is it possible to measure Vts and Vtd directly from decays or other direct measurements? At the LHC or at lepton colliders?
2. What sensitivity to FCNC in the decay can be reached at the LHC? In particular,
what updates to ATLAS and CMS TDR estimates are necessary?
3. How does this compare to coupling limits from a linear or muon collider?
4. Can we describe these in a framework that is consistent and comparable between different colliders? For FCNC contributions to both production and decay modes?
5. Update existing limits to operator description?
6. Update FCNC signal expectations for various motivated BSM theories, commensurate with current direct limits?
7. Relationship between different operators and their effect on existing experimental searches?

- Right now could use help with:
- t-> gq at LHC
- t->Zq and t->g q at the ILC

New Physics in Top-like Events

- See Tobias Golling's presentation from last week.
- Studies: Several ongoing studies can use help.
- Light/stealthy stop (close to top mass)
- Stops at the ILC (so far allowed by LHC)
- Heavier stops beyond 14 TeV LHC

Top Algorithms and Detectors

- White paper coming along with ongoing studies.
- Could use some ATLAS participation.
- Need help:
- b-tagging studies
- N-subjettiness (tau3/tau2)
- isolated muons
- large pT?