1. Top quark mass measurements

a) Known methods make it possible to achieve O(0.6 GeV) uncertainty in the top quark measurement at the LHC. The precision increases slightly with the increase in integrated luminosity up to 300/fb while no gain is expected from the high-luminosity phase.

b) Latest experimental techniques (endpoint method, J/psi) alone can provide precision competitive with more conventional methods but can be more cleanly interpreted as measurements of the pole quark mass. Moreover, these new techniques are nearly insensitive to the production mechanism of top quarks making results for the top quark mass immune to possible contaminations from New Physics.

c) The top quark mass can be measured with O(0.1 GeV) uncertainty at the ILC either from the threshold scan or by direct reconstruction of the Breit-Wigner peak at a higher-energy electron-positron collider. Muon colliders, with smaller beamstrahlung, can probably be used to measure the top quark mass with even higher precision by detailed studies are not available.

d) The physics case for measuring the top quark mass with 0.1 GeV precision, compared to 0.6 GeV precision, is not very clear. Indeed, for precision electroweak fits, the full use of 0.6 GeV error on the top quark mass requires decreasing error on the W-mass to 4 MeV. If no New Physics is seen up to very high scales, the vacuum stability may be an issue where exact value of the top quark mass is important. However, the plausibility of this scenario requires careful consideration and clearly goes beyond the mandate of the top quark working group.

2. Kinematics of top-like final states

a) Current theoretical understanding makes it possible to predict the total cross-section for top quark pair production to about 3 percent and basic kinematic distributions to within 15-20 percent (the errors -- in particular the uncertainty on parton distribution functions -- deteriorate if boosted regime is considered). The accuracy of kinematic distributions will be improved within a few years by extending existing theory for kinematic distributions to next-to-next-to-leading order and by better understanding of parton distributions in the relevant kinematic range.

b) Normalized angular distributions, in particular the ones that are sensitive to spin-correlations of top quarks, often appear to be less affected by theoretical uncertainties than other (energy-related) distributions. This suggests that the use of angular kinematic distributions in searches for physics beyond the Standard Model may be quite powerful.

c) It is important to understand if LHC experiments are able to clarify the issue of forward-backward asymmetry observed at the Tevatron. The LHCb will provide their sensitivity .. and estimates of the ultimate reach of ATLAS/CMS for the asymmetry at the LHC, including the high-luminosity option, will be provided.

Work in progress

3. Top quark couplings

a). Measurements of top quark couplings requires theory predictions for many associated production processes, through NLO QCD. Many are available (ttZ, tt +photon, ttH) including decays of top quarks, radiation in the decay and also matched to parton showers. More robust predictions (e.g. for ttA or arbitrary admixtures of left/right currents in ttZ, tWb) can be obtained using existing framework.

b) Expected sensitivity to top-Higgs Yukawa coupling at 3000/fb LHC in di-photon final state is close to 6 sigma (and none at 300/fb !).

Work in progress

c) Studies of other couplings (ttZ and tt+photon, ttH with Higgs decays to muons) are underway

Work in progress

d). ILC can measure top couplings to Z's and photon's to sub-percent precision.

These conclusions are very preliminary

4. Rare decays

a) Rare decays of top quarks ($t \to Zq,\ t \to \gamma q,\ t \to gq,\ t \to Hq$) can be measured at the LHC and at the ILC. Branching fractions of up to 10^-6 can be achieved. In general, LHC and the ILC can reach very similar sensitivities.

b) At 250 GeV ILC meaningful limits on rare decays can be set using single top production.

c) At the LHC, the high-luminosity option gives a factor of two gain in sensitivity to rare decays.

d) LHC and ILC are complementary -- LHC can do more channels but is not good for understanding the Lorentz structure of couplings while ILC can not study flavor-changing couplings of tops to gluons.

5. New particles decaying into top-like final states

a) Vanilla stops at 14 TeV LHC with the integrated luminosity of up to 3000/fb can be observed up to masses slightly beyond 1TeV using existing methods and hopefully beyond that using new analysis techniques

b) Stealthy stops that decay to tops and light neutralinos can be observed at the LHC using spin correlations. Further studies at the ILC through stop threshold scan can give definitive information and lead to precise measurements of stop mass, couplings etc.

c) Resonance in top quark pair production: Kaluza-Klein gluons with masses up to 4(6) TeV at integrated luminosity 300(3000)/fb at 14 TeV LHC can be observed in lepton+ jets channel.

d) Top quark partners (charge 2/3, -1/3 and 5/3) can be observed if their masses are below 0.8/1.1/2 TeV at 8/14/33 TeV LHC.

Work in progress

These conclusions are very preliminary

5. Detector/algorithms

a) Because of the pile-up, high-luminosity LHC is unfavorable for high-precision measurements that require reconstruction of jets with the transverse momenta smaller than 100 GeV.

b) Efficiency of jet mass/substructure algorithms linearly degrades with increasing top quark transverse momentum. The degradation of efficiency could be mitigated by a pT-dependent cone size in the algorithm or additional granularity from detector readouts, as much of the degradation is due to ISR/FSR.

c) At the ILC, residual pile-up (overlay events from photon collisions) are under control

d) To measure electroweak couplings at the ILC at a percent level, luminosity and beam polarizations have to be measured precisely; current estimates suggest that this can be done to better than 0.5%.