

Director's Corner

16 August 2007



Barry Barish

Physics of the top quark

This week I am participating in the XXIII International Symposium on Lepton and Photon Interactions at High Energy ([LP07](#)) in Daegu, Korea from 13 to 18 August 2007. The Lepton-Photon Symposium is held every other year and is sponsored by the International Union for Physics and Applied Physics (IUPAP). It is the major international particle physics conference in odd-numbered years and maintains a very successful format of all-plenary rapporteur talks that review the current status of a broad range of topics at the forefront of particle physics research.

This year's meeting got off to a good start, as the very first scientific talk was on the physics of the top quark. In a fast moving field like particle physics, we often joke that this year's discovery becomes next year's background as we quickly move on to new science goals. On the other hand, a new discovery can just as well open up promising new areas of research. Here at LP07, Robin Erbacher of University of California at Davis presented a talk packed with results on "Top Quark Properties" that illustrates the richness and potential of pursuing studies of our heaviest quark.

As the heaviest quark, the top quark is the most extreme case of what we refer to as electroweak symmetry breaking -- the fact that different quarks have different masses. As a consequence, the top quark presents important opportunities towards understanding the nature of the basic constituents of matter and their interactions. The search for the top quark took a long time and was one of the primary goals of particle physics in the early 1990s, finally yielding the discovery from two Fermilab experiments (D0 and CDF) in 1994 and 1995. Due to the unexpectedly large mass and many decay channels, the top quark discovery did not come early or easily. There was no "smoking gun," but rather a detailed set of measurements, when combined made a consistent and convincing case that the heaviest standard model quark had been observed.

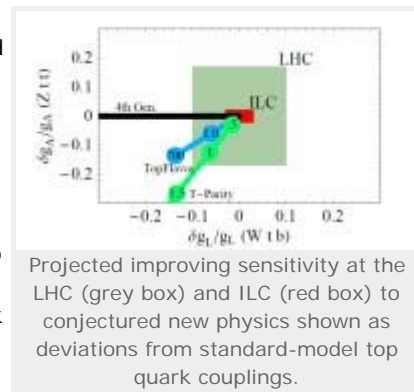
At LP07, Robin presented an impressive array of new results from Run II at Fermilab with its large data sample. These results included data on top quark production, single top production, forward-backward asymmetries, top quark mass and width, even the top quark charge (is its charge really 2/3?), and finally studies of top quark decays.

Robin's talk nicely demonstrates that top quark physics will remain a very important and fruitful research area, eventually leading up to the ILC era, when it will be possible to make precision top quark measurements. The top quark is an ideal probe of large electroweak symmetry breaking and hopefully the dynamics behind the symmetry breaking mechanism.

High precision and model-independent measurements near threshold can yield precise measurements of the top quark mass



Robin Erbacher keeping very good company.



Projected improving sensitivity at the LHC (grey box) and ILC (red box) to conjectured new physics shown as deviations from standard-model top quark couplings.

and total decay width. The neutral and charged current interactions of the top quark can be precisely determined, as well as the vector and axial-vector couplings to the Z boson in the production vertex and to the W boson in the decay vertex.

The top quark talk was a particularly appropriate first talk, because the subject represents one of the most important discoveries in particle physics in the 1990s, an active field of study this decade, and a rich future to anticipate in the era of the LHC and ILC. Of course, much more physics was presented at LP07. In addition, we have important GDE meetings as well as meeting with our oversight committees. Korea is an emerging important partner in particle physics, making significant contributions to the LHC and eventually to the ILC. We owe special thanks to Dongchul Son of Kyungpook National University in Daegu and colleagues who organised LP07.

-- *Barry Barish*

*Further reading: Want to know more about the top quark? Read "[Secrets of a Heavyweight](#)" in the latest issue of *symmetry* magazine.*



Dongchul Son, chair of the LP07 organising committee.