

Top Quark Threshold at the ILC

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Why?

- The Linear Collider will be a precision machine, and thus provides natural environment for precision studies of the top quark parameters.
- The top quark is currently the least precisely measured SM (known) particle, and this will still be the case after the LHC is done with it...

Currently $M_{TOP} = 178 \pm 4.3$ GeV, LHC promises ± 1 GeV

Top mass uncertainty dominates EW precision measurements, and also essential for fixing SYSE models. See Heinemeyer et al. [hep-ph/0306181]

LC promises ± 50-100 MeV (?)

+ bonus of measuring $\alpha_{\rm s}$

How?

- Top quark measurement at Linear Collider is done by a threshold scan.
- Much of the precision of the measurement depends on the knowledge of the luminosity spectrum.
 - UCL major involvement in ILC Energy Spectrometer !!

To make a concrete study of the top quark threshold we need a

t-tbar threshold event generator

Essential for detector studies + inclusion of Beam effects into differential quantities etc.

Collaboration btw FG, S.Boogert (RHUL) and T.Teubner (Liverpool Theory)



Top threshold theory status

- "Toponium" threshold different than charmonium and bottonium, due to large Γ_t (~1.5GeV)
 - -> No real toponium resonance formation !
- Precision measurement depends on knowledge of threshold lineshape, thus at threshold an exact treatment of Coulomb singularities is required, rulling out pure α_s expansion and expanding in $(\alpha_s \ / \ V)^k$!





Top threshold Event Generator



Fast Generator

- TOPPIK takes about 1 sec per calculation.
- We need to store information in

{ \sqrt{s} ; $M_t, \Gamma_t, lpha_s$ } grid

- Very inefficient if TOPPIK needs to calculate grid every time !!!
- SOLUTION:

Parametrize or interpolate ...

Starting Point will be Green's Functions

Green's functions for S-P waves

-> Complex quantities !

Can build the whole calculation from them !

300point grid for each point of $\{\sqrt{s}; M_t, \Gamma_t, \alpha_s\}$ grid



Parametrizing the Magnitude

Need to make sure that if any uncertainties are introduced in parametrization, they are less than the theoretical uncertainty



(Not Yet) Parametrizing the Phase



If parametrization does not work well enough, will work on fast multidimensional Interpolation !! (HARD?)

Summary

- Top threshold production studies at ILC need top event generator!
- Theoretical tools are there, need to be put together in a coherent and efficient way !
- First step has been made, theory output can be stored and accessed in a coherent way.
- Next step is to provide a fast lookup for Green functions, either parametrizing or interpolating ..
 - Then build the whole calculation from there..

Hoping for this project to be done by summer !! Next is Luminosity spectrum extraction, and application to top threshold .. (then detector effects ?) Complementary with BPM Energy Spectrometer !