Experimental top threshold scan

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Introduction

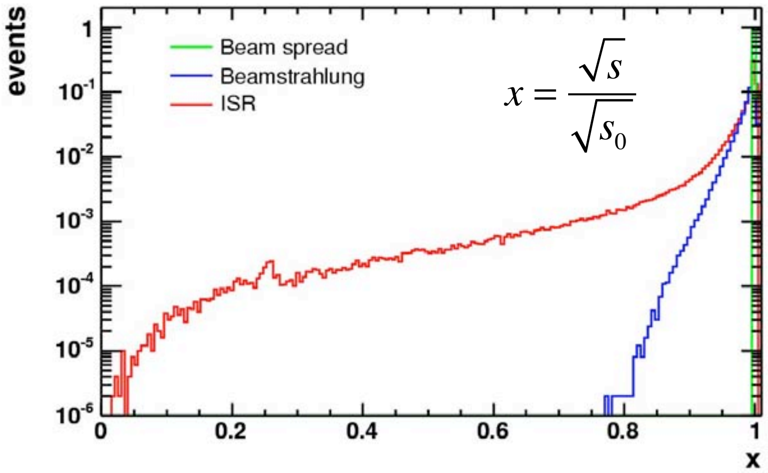
- Precision top mass essential Standard model measurement
  - Test of QCD and variants at the top threshold
  - Constrain standard model (in conjunction with Higgs measurement)
- Top mass measurement requirement of 50 MeV
  - ~3 parts in 10^4
  - High precision possible due to beam line constraint
- **Linear collider ≠ LEP**
  - Linac energy spread
  - Beamstrahlung
  - Single measurement of bunches before collision
- Other considerations
  - Effect of initial state radiation
    - Required theoretical precision
  - Bhabha scattering at wide angle
    - Theoretical precision of differential distributions

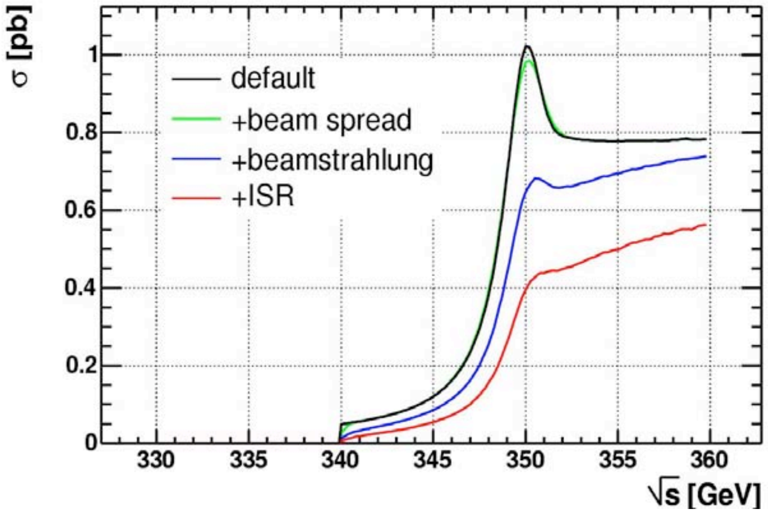
Experimental top threshold

- Precision threshold measurement require
  - Determination of luminosity spectrum $\frac{dL}{d\sqrt{s}}$
    - Bhabha acolinearity
  - Average centre of mass energy $\langle\sqrt{s}\rangle$
    - Energy spectrometer (WG4)
    - Radiative returns
  - Calculation of Initial state radiation
    - Theoretical precision
- Effect on top cross section

$$\sigma'(\sqrt{s}) = \frac{1}{L_0}\int_0^1 L(x)\sigma(x\sqrt{s})dx$$

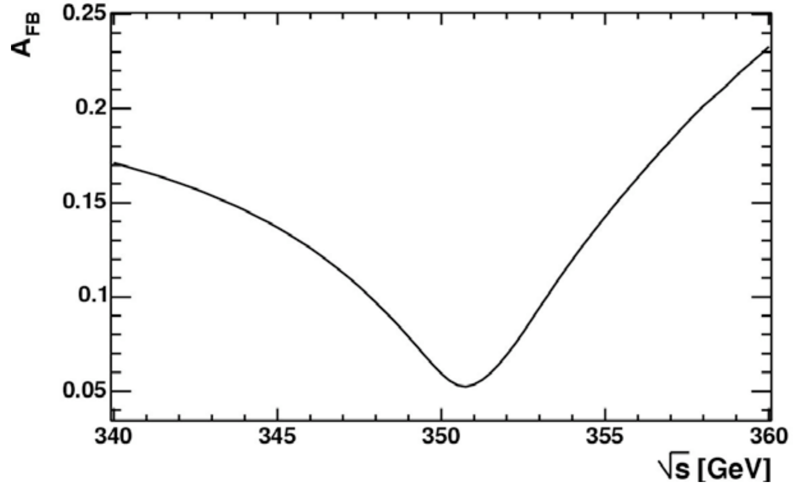
  - Effective loss in luminosity
  - Systematic shift in top mass
    - Dominant systematic error?

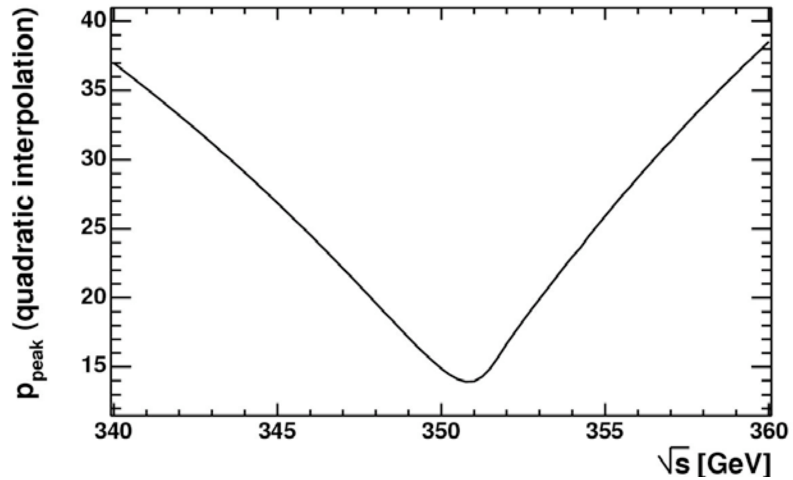




Differential quantities

- Current analysis only includes total cross section
  - Differential distributions are useful for providing additional constraint of the top mass
  - Distributions help understanding of correlation between top mass and strong coupling constant
- Effect of luminosity spectrum not so clear on these quantities
  - Full generator required
  - Differential distributions available at NNLO and can in used in conjunction with full NNLL full cross section
- Work started (plan made) and will continue (SB+TT) after Snowmass



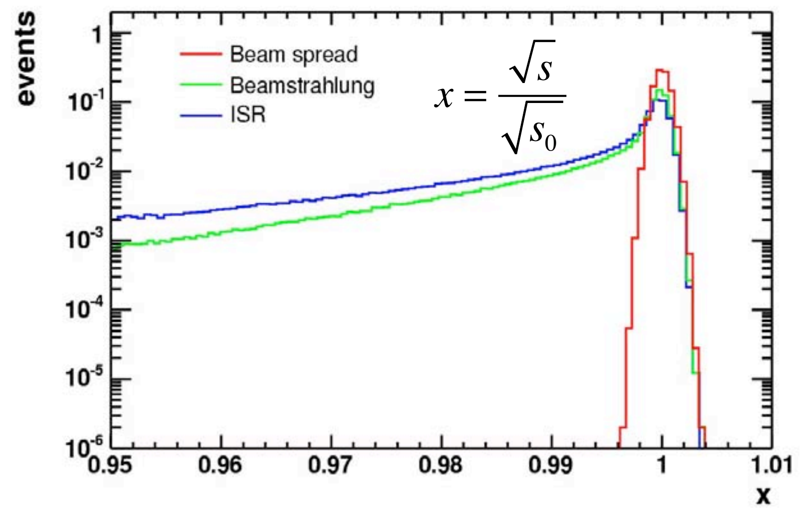


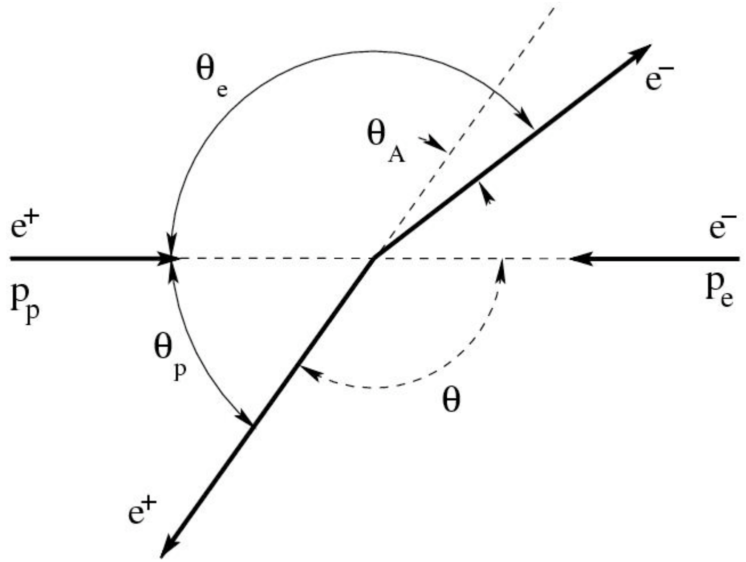
Luminosity spectrum

- Bhabha acolinearity can be used to monitor luminosity spectrum
  - Acolinearity sensitive to momentum mismatch between beams
  - Assuming only one beam has radiated then acolinearity gives the center of mass energy of collision

$$x = \sqrt{\cot\left(\frac{\theta_e}{2}\right)\cot\left(\frac{\theta_p}{2}\right)}$$

- Extraction of luminosity spectrum
  - Insensitive to absolute energy scale
  - Difficult to extract luminosity spectrum from observed acolinearity
  - Previous analysis (Moenig) showed promise, must be extended for wider classes of beam spectra
  - Precision can be better than 10^{-4} due to high envisioned resolution of forward trackers

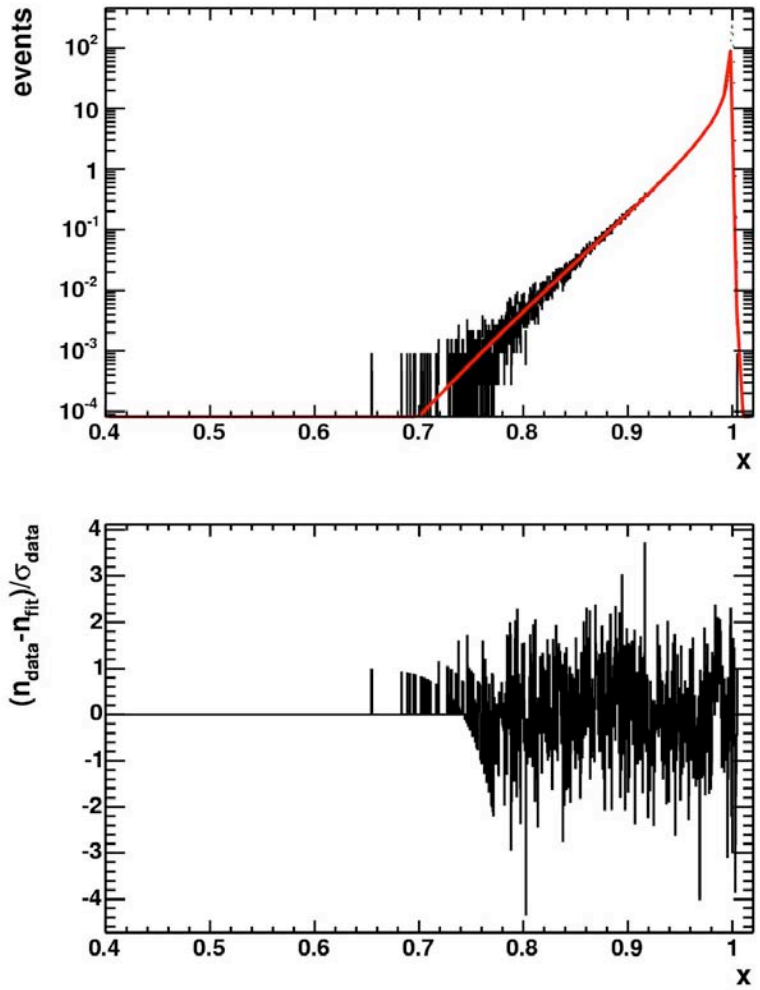




Beamstrahlung spectrum (350GeV)

- Beamstrahlung main unknown
  - Integrated ILC accelerator simulations available
  - 350 GeV samples just available (G. White)
  - Generated luminosity weighted spectra for whole bunch train
    - Include in favorite Generators
    - New parameterizations
  - Evaluate changes in the accelerator down to physics analyses
- Example fit of 350 GeV cold accelerator
  - CIRCE⊗Gaussian

	CME (500)	CME (350)
a0	0.337	0.307
a2	18.576	28.739
a3	0.419	0.319
bs (%)	0.089	0.096



Post Snowmass plans

- Event generator
  - Essential for detector event simulation
  - Also can implement energy variation effects for distributions (p, A_{FB} & polarization)
  - SB + Thomas Teubner to investigate
- Luminosity spectrum and average energy
  - Must verify Bhabha acolinearity method works with realistic beam spectra
  - Design of energy spectrometer is ongoing (see AWG4) precision of $>10^{-4}$ expected
  - Analysis of Radiative returns for absolute energy calibration wrt Z mass
- Theoretical uncertainties (whole QCD/top group)
  - Wide angle Bhabha scattering precision (distributions)
  - Initial state radiation
- Perform full analysis
  - Sensible scan strategy, with reasonable luminosity per point
  - Perform all analyses (top, Bhabha, radiative return)
    - Complete understanding of top threshold

Summary and conclusions

- Full top threshold analysis not complete
  - Luminosity spectrum extraction using acolinear Bhabha scatters
    - Progress made at Snowmass, coherent approach with accelerator simulators
  - Average centre of mass energy
    - Radiative returns
    - Energy spectrometer
  - Detector simulation
    - Top pair counting experiment not expected to set a tough requirement on existing detector designs
    - Requirements for Bhabha scattering and Radiative Z returns might set the requirements of the low angle tracking and EM calorimeter
    - Coherent approach to detector simulation within QCD/top group (limited manpower)

  - Top threshold can be used as template for all threshold studies including
    - WW threshold (Radiative returns)
    - SUSY(energy spectrometer)