Institute of High Energy Physics Chinese Academy of Sciences

# Top threshold physics

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# Introduction

- CEPC is Higgs Factory   ($E_{cms}$=240GeV , $10^6$ Higgs)
- CEPC is Z factory($E_{cms}$~91GeV) ,electroweak precision physics at Z pole.
  - **baseline L=1.6 X $10^{35}$ cm$^{-2}$s$^{-1}$ , Solenoid =3T,  3X$10^{11}$ Z boson, two years**
  - **L= 3.2 X $10^{35}$ cm$^{-2}$s$^{-1}$  , Solenoid =2T ,  6X$10^{11}$ Z boson**
- WW threshold scan runs (~160GeV) are also expected.
  - One year, Total luminosity 2.6 ab$^{-1}$  **14M WW events**



$e^+e^-$ Collider Luminosities
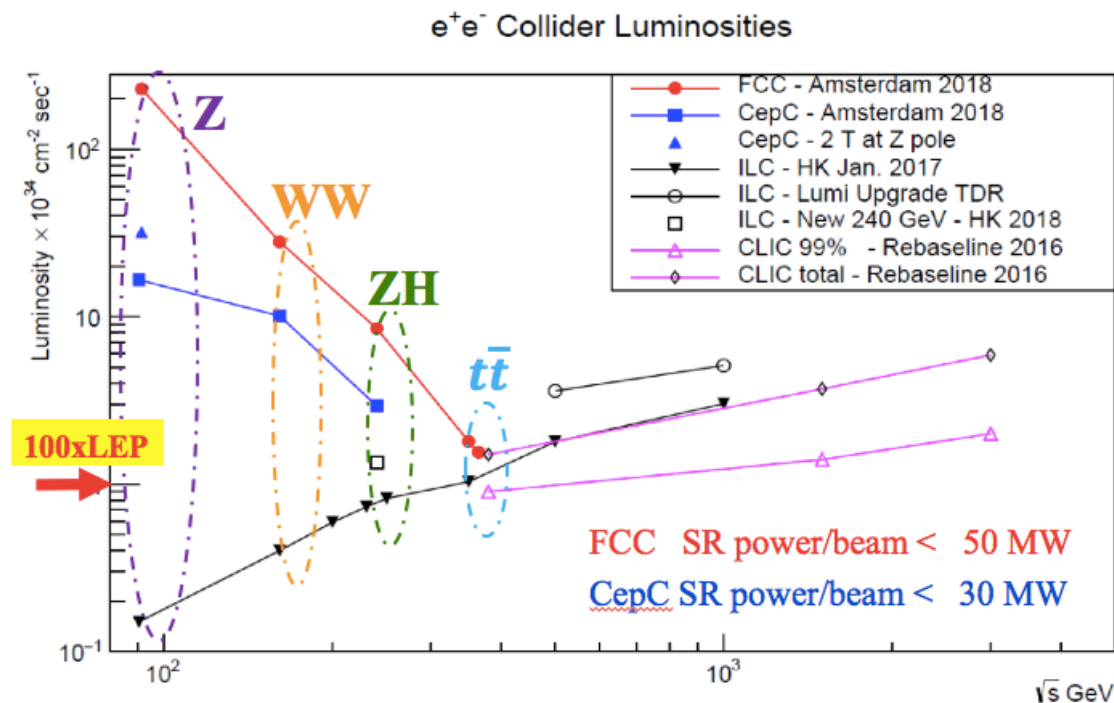
From  F. Bedeschi

# Top threshold scan

- Review of the key electroweak constant

| Fundamental constant | $\delta x/x$ | measurements |
|---|---|---|
| $\alpha = 1/137.035999139\,(31)$ | $1\times10^{-10}$ | $e^{\pm}\,g_2$ |
| $G_F = 1.1663787\,(6)\times10^{-5}\ \text{GeV}^{-2}$ | $1\times10^{-6}$ | $\mu^{\pm}$ lifetime |
| $M_Z = 91.1876\pm0.0021\ \text{GeV}$ | $1\times10^{-5}$ | LEP |
| $M_W = 80.379\pm0.012\ \text{GeV}$ | $1\times10^{-4}$ | LEP/Tevatron/LHC |
| $\sin^2\theta_W = 0.23152\pm0.00014$ | $6\times10^{-4}$ | LEP/SLD |
| $m_{top} = 172.74\pm0.46\ \text{GeV}$ | $3\times10^{-3}$ | Tevatron/LHC |
| $M_H = 125.14\pm0.15\ \text{GeV}$ | $1\times10^{-3}$ | LHC |

Top scan
Runs

From PDG2018
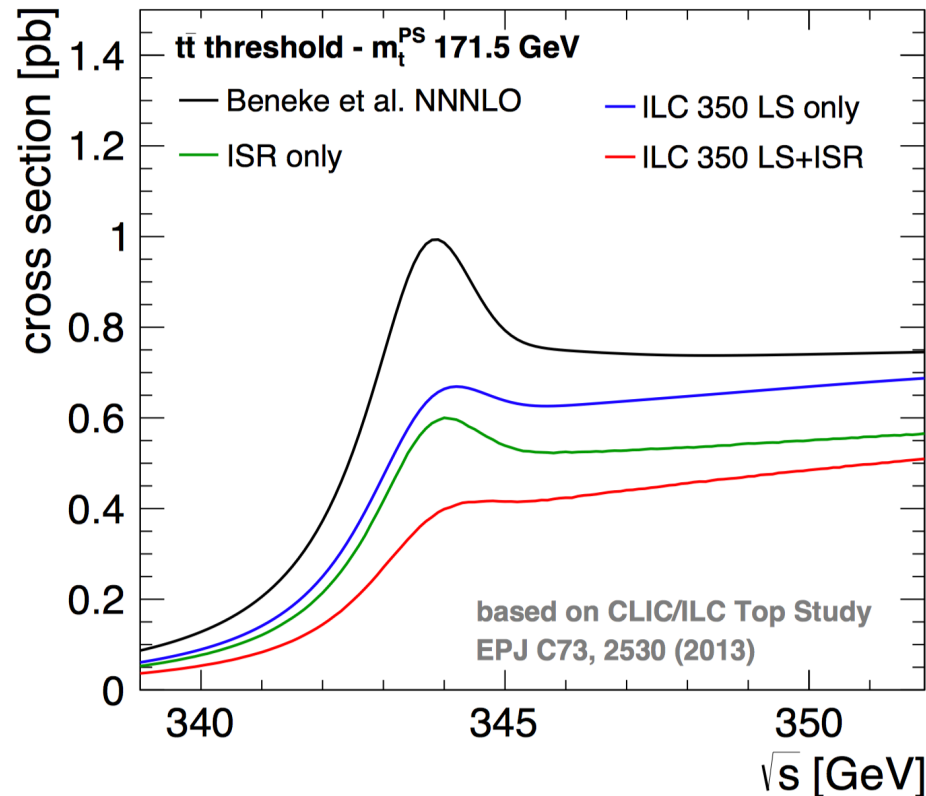
# top threshold scan

- Top threshold cross-section depends on:
  - top mass
  - top width (lifetime)
  - top-Higgs coupling
  - $\alpha$QCD
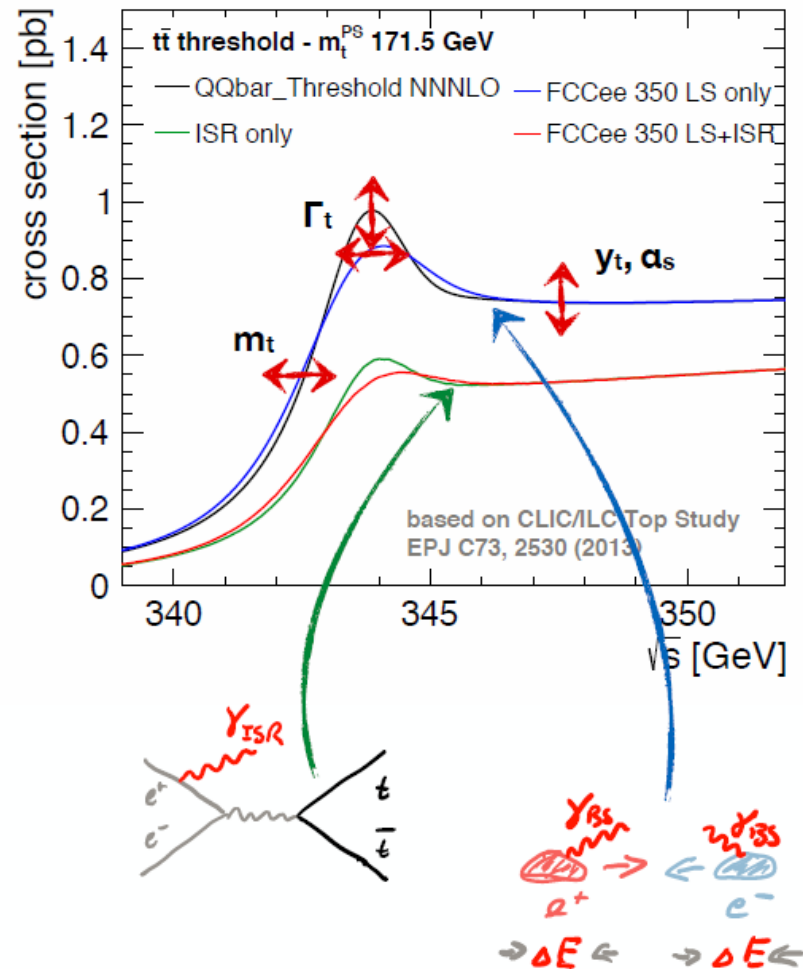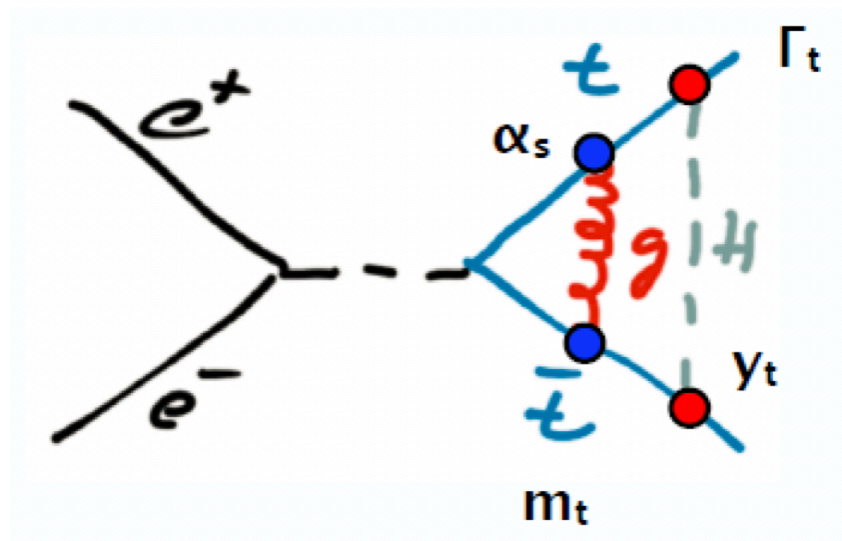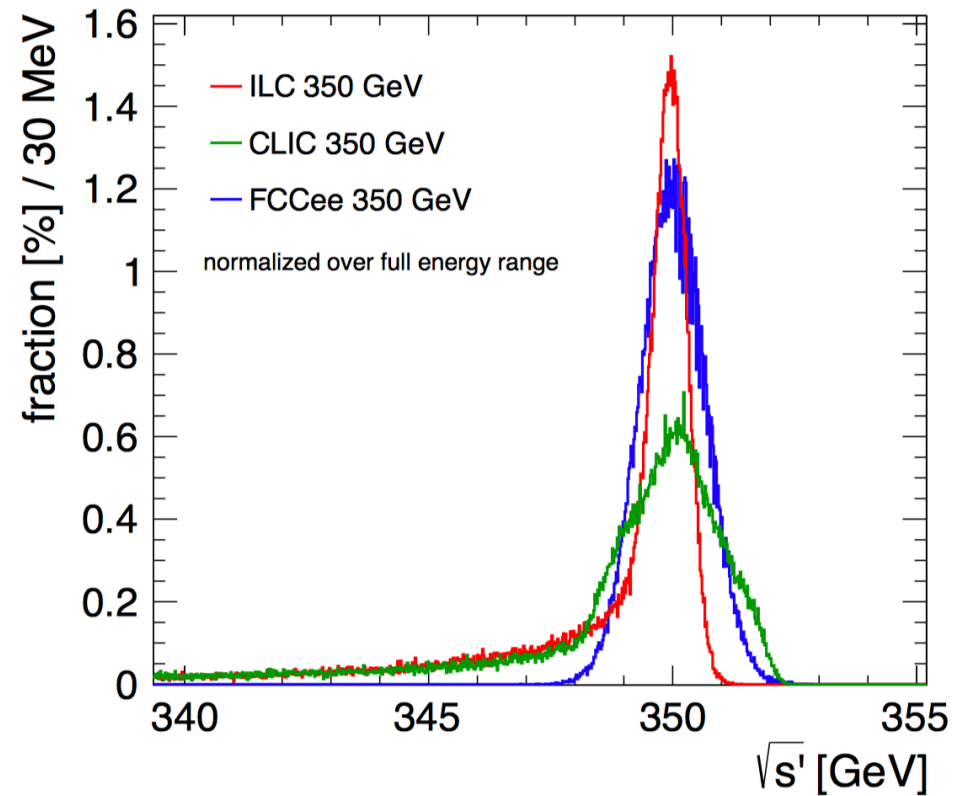


Thanks to discussion and slides from Alain Blondel
Study by Frank Simon (CLIC/ILC study, EPJC 73,(2013)2530)

# Theory prediction

- Impact due to luminosity spectrum and ISR is large
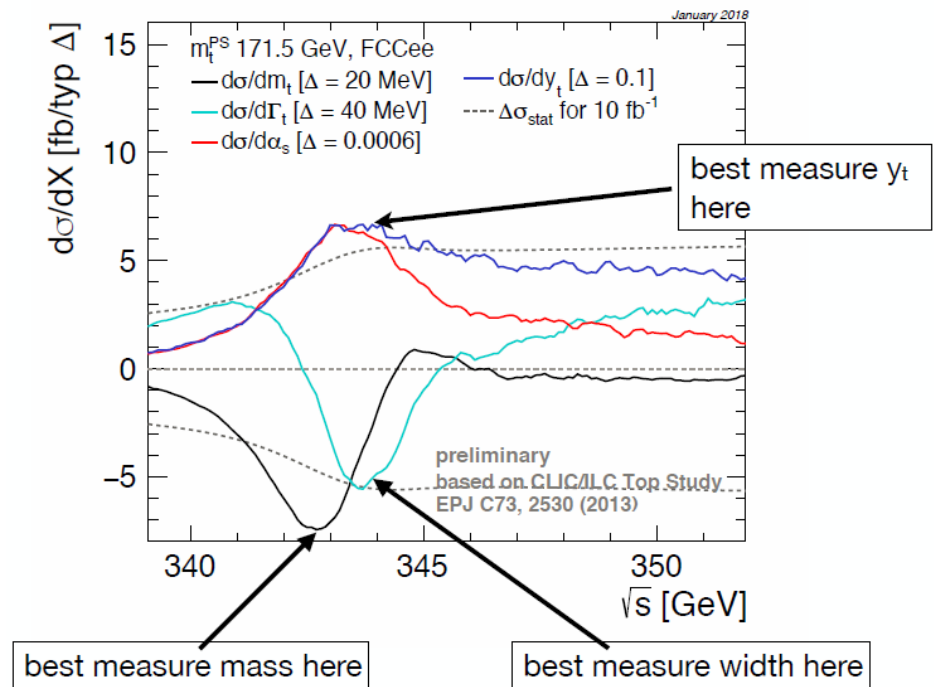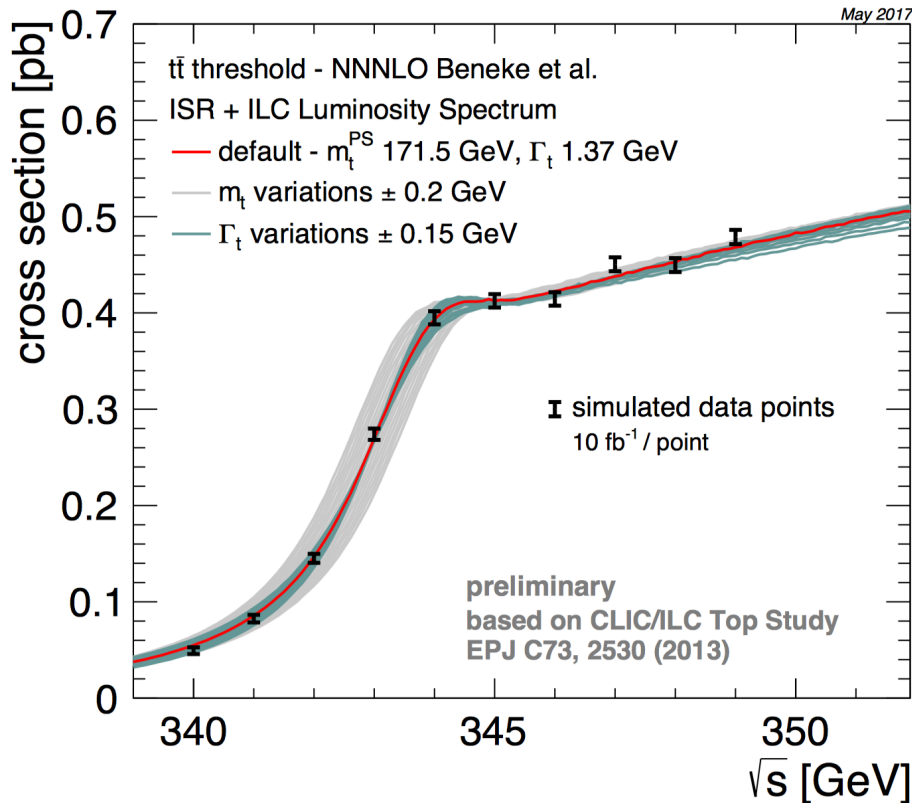- Cross section to be re-calculated with CEPC luminosity spectrum

luminosity spectrum for ILC/CLIC/FCCee

# Top threshold scan

- Strategy:
  - Need a rough scan in step of 1GeV to measure the top mass (5 fb$^{-1}$)
  - Fix the final scan points
  - since there are four parameters to fix, need at least 4 scan points
    - Scanning range 342GeV ~350GeV
    - Focusing 342GeV ~344GeV

# Top threshold scan

- ## If CEPC decided to have top threshold scan
    - Better to have integrated Lumosity larger than 200~400fb$^{-1}$
    - Need to re-calculated with CEPC lumiosity spectrum
    - Aim for 15MeV precision
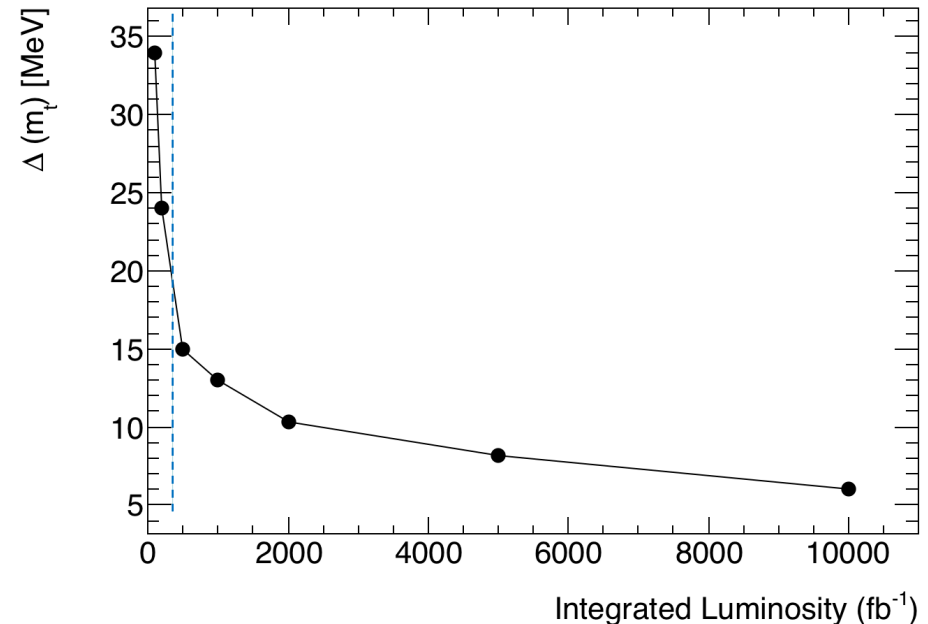
ILC/CLIC estimation with 100 fb$^{-1}$

| | |
|---|---|
| $m_t$ stat. error | 34 MeV |
| $m_t$ theory syst. (1 %/3 %) | 5 MeV/8 MeV |
| $\alpha_s$ stat. error | 0.0009 |
| $\alpha_s$ theory syst. (1 %/3 %) | 0.0008/0.0022 |

# Summary

- **Potential of electroweak measurement at CEPC**
  - Possible target for top mass precision (15MeV) for CEPC
    - Propose 200~400 fb$^{-1}$ integrated Luminosity scanning
    - Scan range : 342GeV~350GeV

# Backup