Status of Top Mass Measurement

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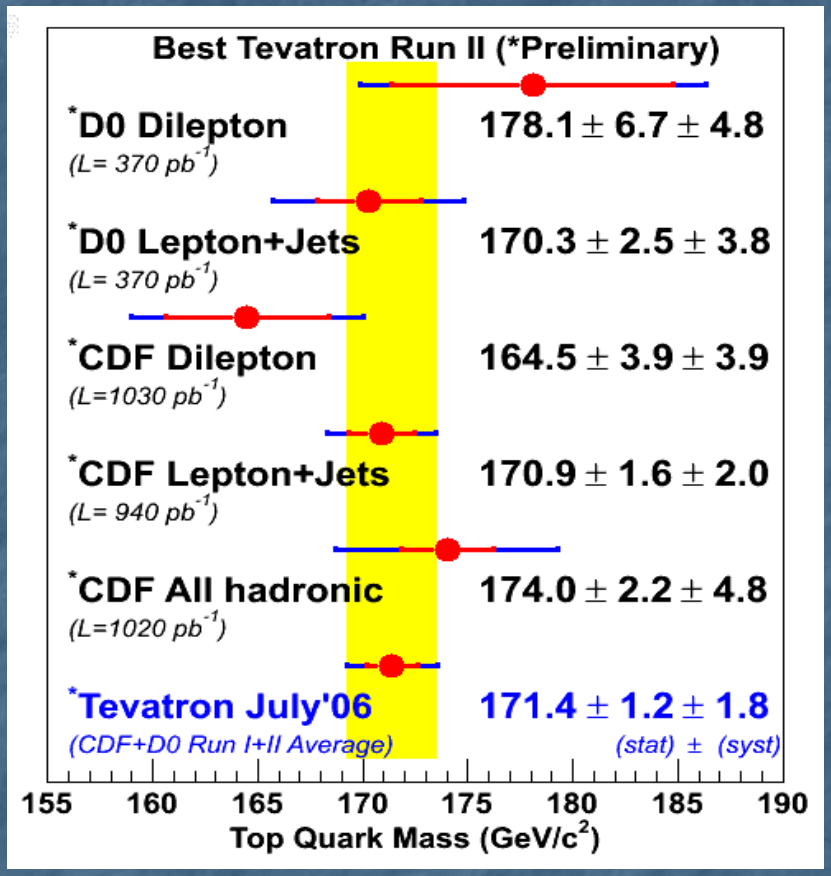
BA meeting (31.01.2007)

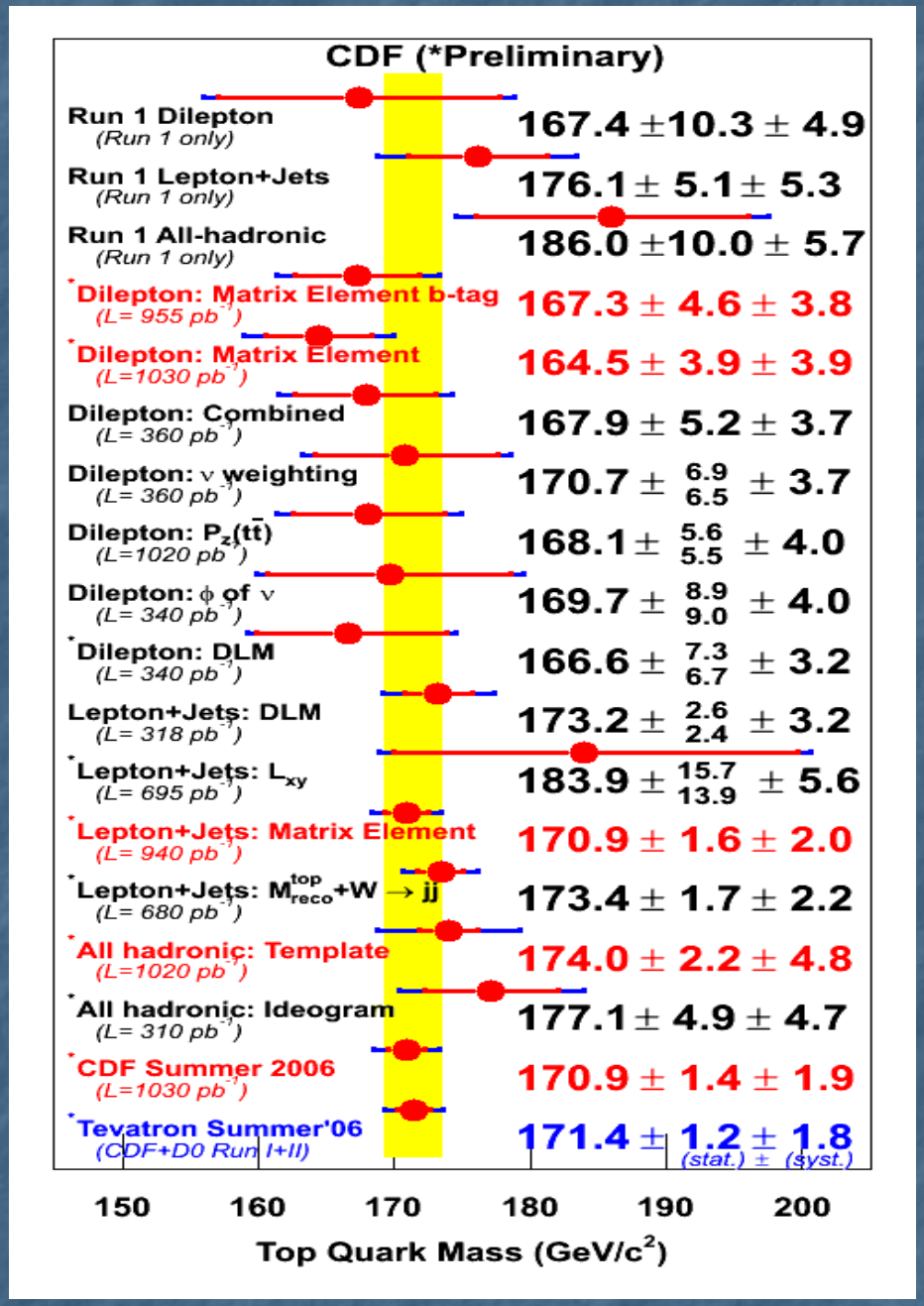
- current measurements
- future prospects
- implications of top mass measurement

Current measurements

- lots of measurements at CDF
- CDF/D0 combination:

$$\Delta M_{top} = 2.1 \text{ GeV}$$



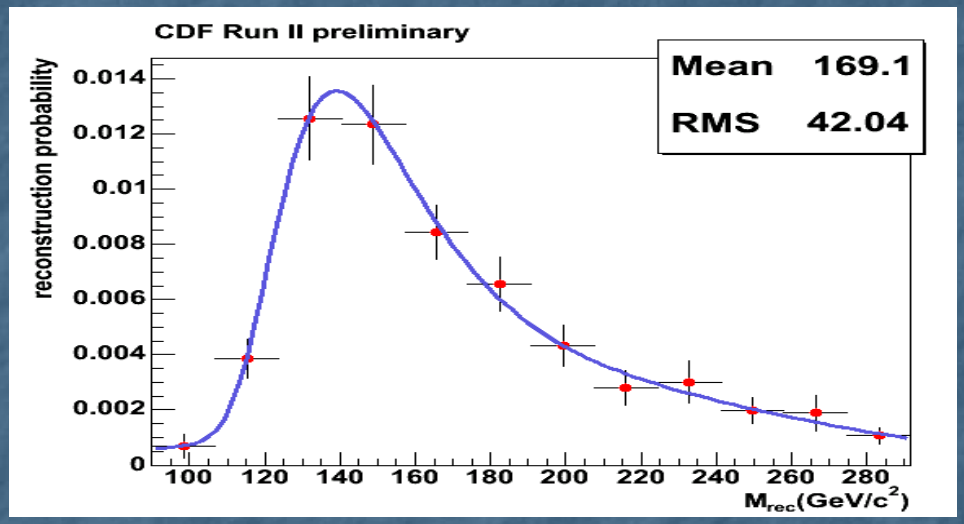


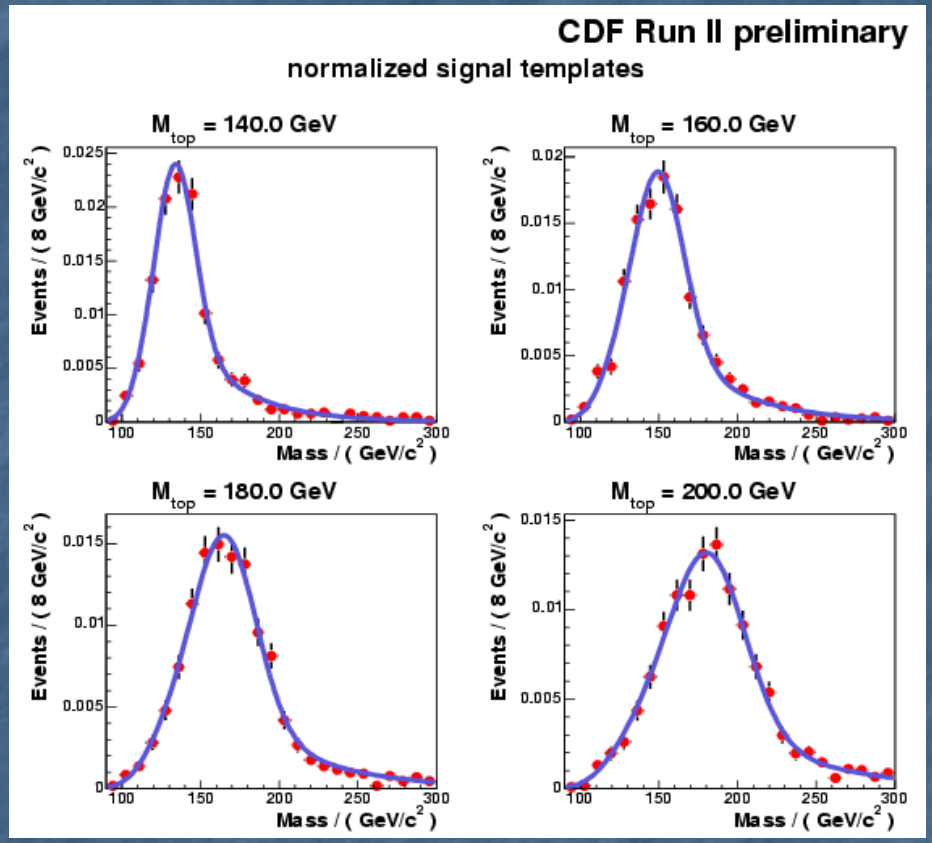
CDF template dilepton method (P_z^{ttbar})

- select M_{top} sensitive variable (we use reconstructed top mass)
- compare sensitive variable between MC and data
- speciality in dilepton channel: not enough constraints
  => use assumption about one variable: P_z^{ttbar}
  => kinematically solve the system (reconstruct mass)

in practice:

- create probab. density distributions (templates) for different input M_{top}
- create template also for background





CDF template dilepton method (P_z^{ttbar})

- comparison between MC templates and data through likelihood fit:

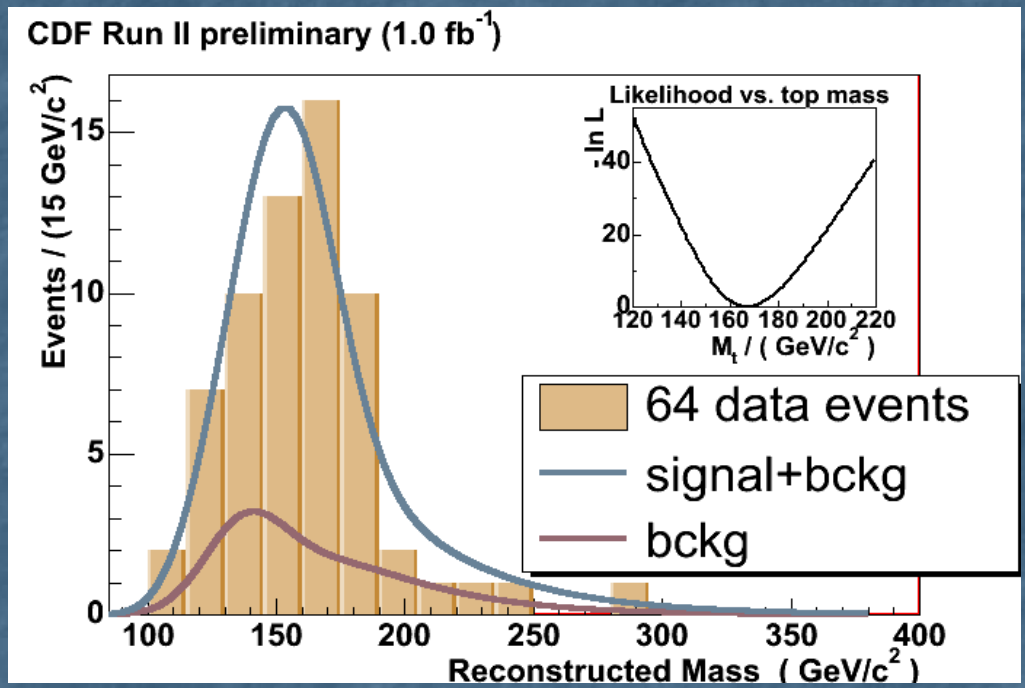
$$L = L_{shape} \cdot L_{bckg}$$

$$L_{shape}(M_{top}, n_s, n_b) = \frac{e^{-(n_s+n_b)}(n_s+n_b)^N}{N!} \prod_{i=1}^{N} \frac{n_s \cdot f_s(m_i^{rec}, M_{top}) + n_b \cdot f_b(m_i^{rec})}{n_s + n_b}$$

$$-\ln(L_{bg}) = \frac{(n_b - n_b^{expect})^2}{2\sigma_b^2}$$

- using 1020 pb^{-1}(64 events):

  $M = 168.1^{+5.6}_{-5.5} \pm 4.0$ GeV

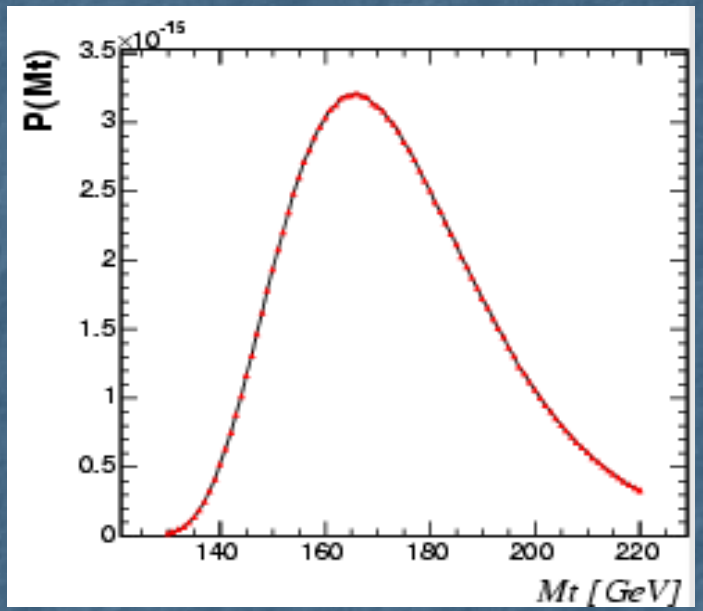


CDF ME l+j method

- use information about production mechanism ==> a priori, more information included than in template method
  ==> should be more precise
- for each event, calculate probability that measured **x** correspond to given M_{top}:

$$P(\vec{x}) = \frac{1}{\sigma} \int d\sigma(\vec{y})\ f(\tilde{q}_1) f(\tilde{q}_2)\ W(\vec{x},\vec{y})\ d\tilde{q}_1 d\tilde{q}_2$$

- use ME to calculate $d\sigma(\mathbf{y}, \mathbf{M_{top}})$
- use transfer function W(**x**,**y**) to go back from measured variables to parton level
- $f(q_1)$,$f(q_2)$ – PDF of partons inside proton

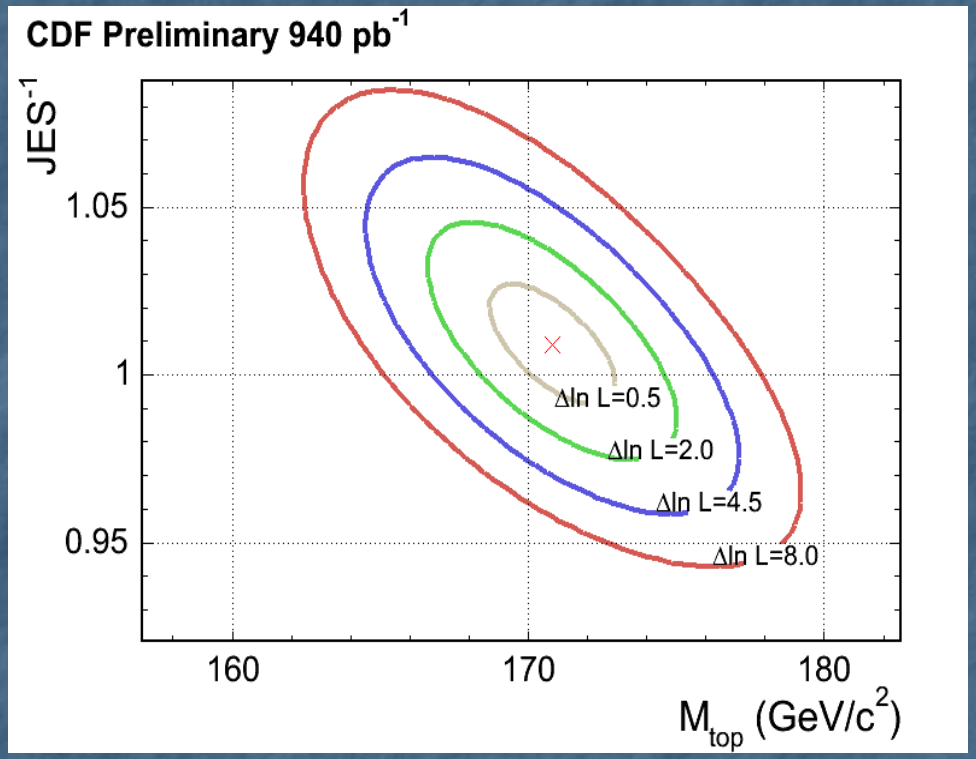


CDF ME l+j method (2)

- final likelihood is the product of individual event probabilities:

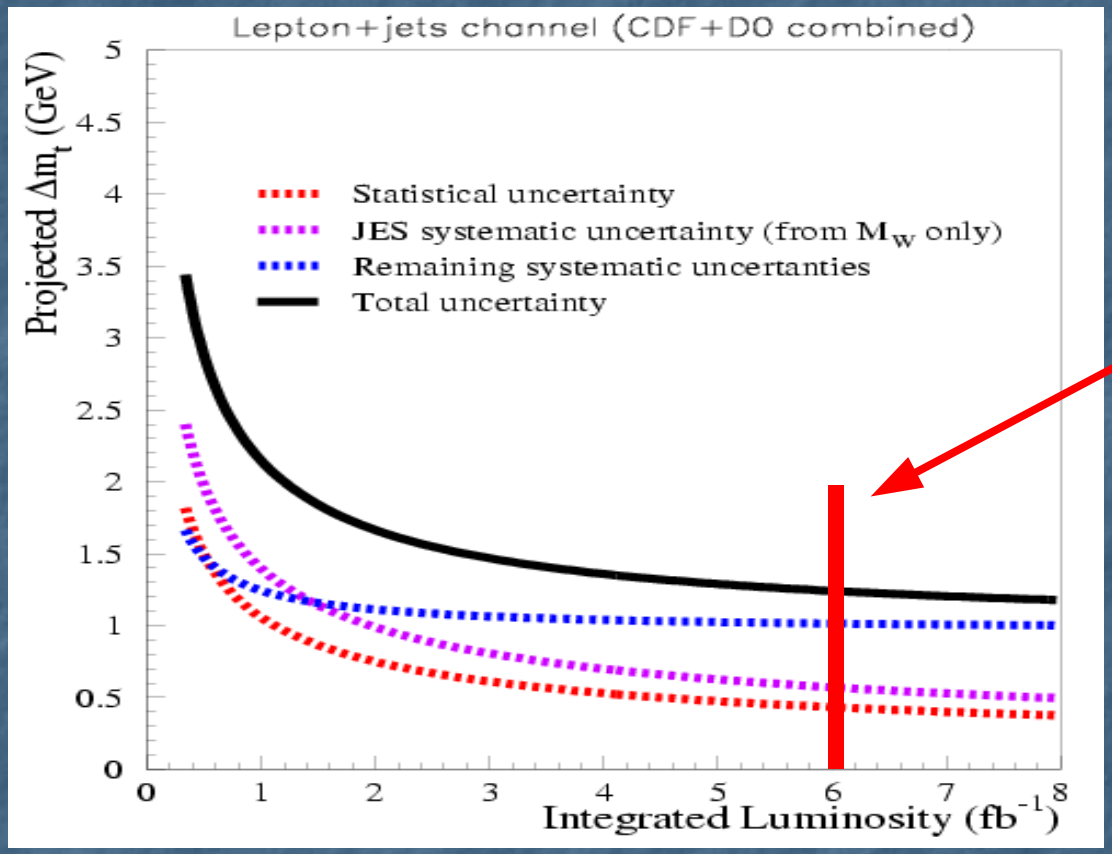
$$\mathcal{L}(M_{top}, JES, C_s; \vec{x}) \propto \prod_{i=1}^{N} [C_s P_{t\bar{t}}(\vec{x}; M_{top}, JES) + (1 - C_s) P_{W+\text{jets}}(\vec{x}; JES)]$$

- up to now: dominant syst. error from JES
- can constrain jet energy scale by fixing mass of dijet from W ==> add multiplicative factor JES
- most precise single measurement in the world
- using 940 pb^{-1}:
  M = 170.9 ±1.6 (stat) ± 2.0 (syst)
- highest sources of syst. uncertainty
  - ISR 0.7 GeV
  - FSR 0.8 GeV
  - b-JES 0.6 GeV



Future prospects at Tevatron

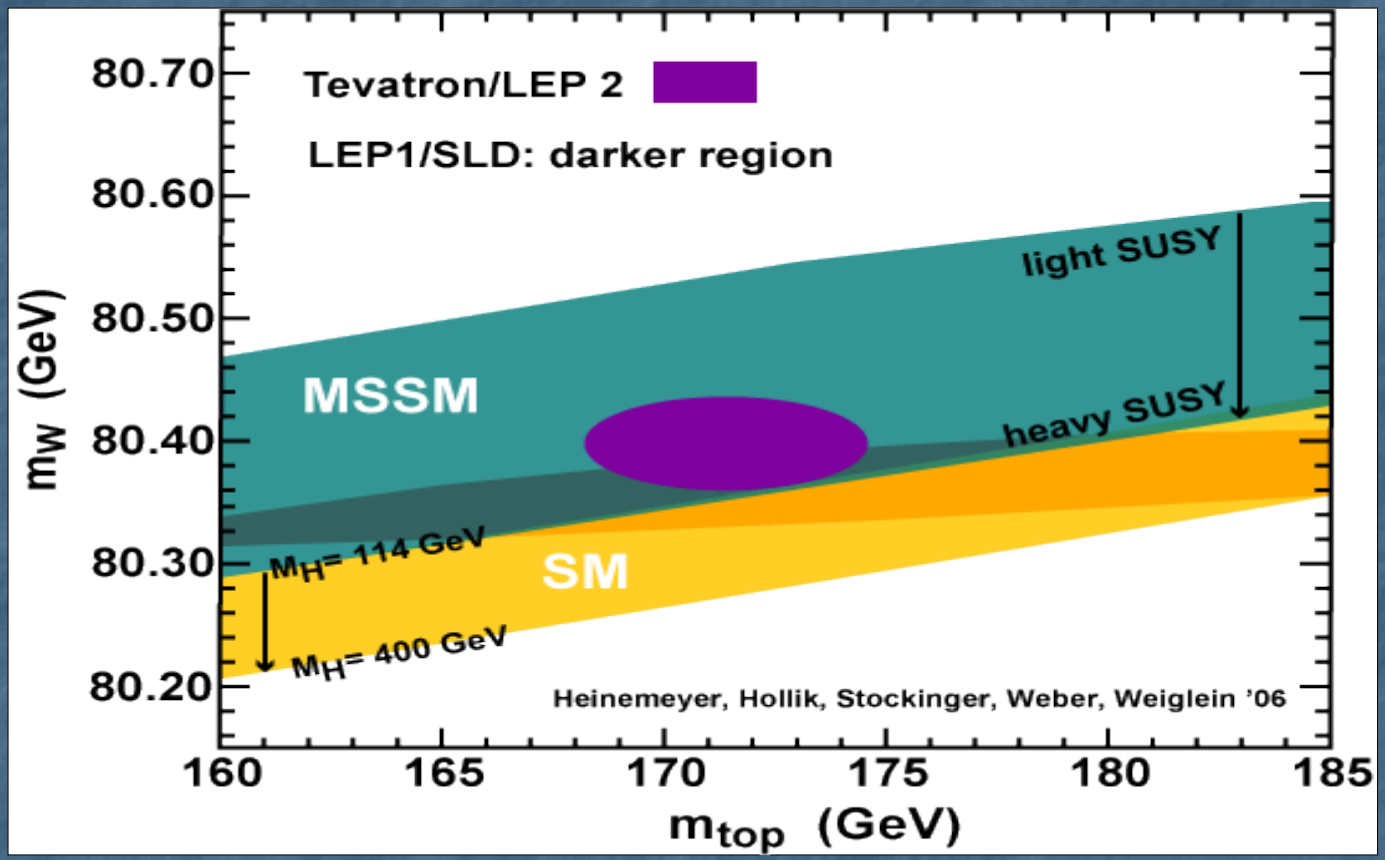
- with more data , statistical uncertainty < 0.5 GeV
- JES uncertainty will also decrease to ~ 0.5 GeV
- theoretical systematic uncertainties (ISR, FSR) will dominate ~ 1 GeV
- total uncertainty at the end of Run II : Δ Mtop < 1.5 GeV



likely to get ~ 6 fb^{-1}

Implications of top mass

- measurements of top and W mass constrain Higgs mass
- lastest measurements of M_{top} and M_W shifts Higgs into MSSM region!



Conclusion

- many top mass measurements at CDF
- current top mass average: $M_{top} = 171.4 \pm 2.1$ GeV
- at the end of Run II: Δ Mtop < 1.5 GeV
  limited by theoretical uncertainties

Backup

W mass measurements

- CDF measured M_W just couple months ago (1st measur. in Run II)
- previous world average: $M_W = 80392 \pm 29$ MeV shifted upwards