The Top Mass Report

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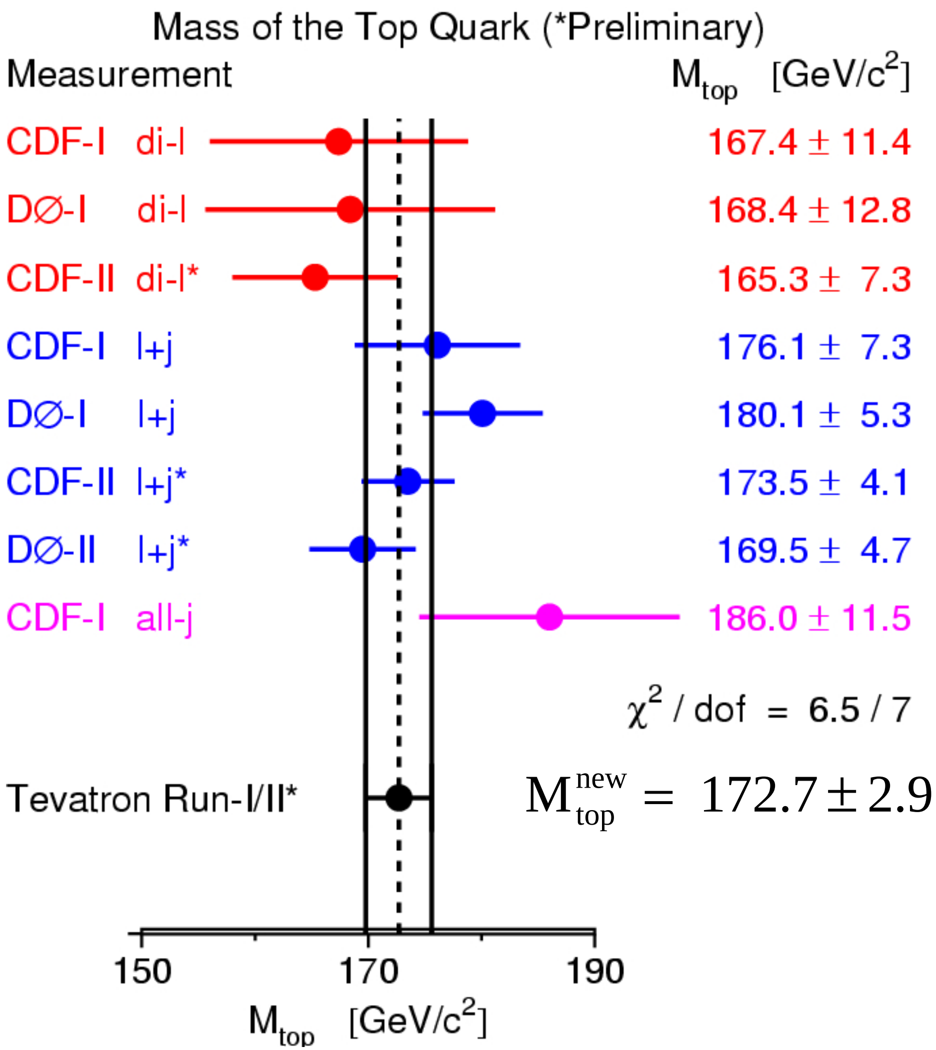
Introduction

- Basic outline
  - Why is this measurement interesting?
  - How is it done at the Tevatron?
  - What are the Tevatron results?
  - What do we expect the Tevatron results to be?
  - How is it done at the LHC?
  - What are the LHC expectations?
  - What are the outstanding issues/concerns?

- Main missing piece of information is some detailed information about LHC plans

Status



$$M_{top}^{new} = 172.7 \pm 2.9\ \mathrm{GeV}/c^2$$

- 30% reduction in ΔM_{top}
- Already systematics limited
  - Δ(stat) = 1.7 GeV/c^2
  - Δ(syst) = 2.4 GeV/c^2
- described in detail in hep-ex/0507091
- Tevatron combination will achieve ΔM~1.5 GeV/c^2 or smaller with >6 fb^{-1}

The Fit (all quantities in GeV/c^2)

- JES: 2.0
  - aJES: 0.3
  - bJES: 0.7
  - cJES: 1.0
  - dJES: 0.01
  - iJES: 1.4
  - rJES: 0.8
- Signal : 0.9
- Bgd: 0.9
- UN/MI: 0.3
- Fit: 0.3
- MC: 0.2
- Statistical: 1.7

Total Systematic: 2.4

➔ **iJES scales with statistics**

Details: Error Classes

- JES
  - aJES: D0 Run-II e/h calibration
  - bJES: JES issues specific to b-jets
  - cJES: fragmentation and OOC showering
  - dJES: correlated w/i experiment but *not* RunI&II
  - iJES: in-situ calibration from W→jj
  - rJES: remaining JES (e.g. relative response, MI, UE, etc.)
- Signal : signal modeling (ISR,FSR,PDF,NLO)
- Bgd: QCD fraction, Q^2 scale
- UN/MI: D0 Run-I Uranium noise and MI
- Fit: fit method, finite MC stats
- MC: Pythia vs Herwig (vs ISAJET)
- Statistical: limited data statistics

➔ **JES, Sgnl, and Bkgnd Modeling will limit Tev ΔM_{top}**

Correlations

- Uncorrelated: Stat, Fit, iJES
- Correlated across all measures
  - in same experiment and run: aJES, dJES
  - in same experiment: rJES, UN/MI
  - in same channel: Bgd
  - everywhere: Signal, bJES, cJES, MC
- Correlation taken to be 0 or 100%
  - Requires more work to determine more precisely
  - CDF/D0/Theory workshop (11Oct) to initiate dialogue and begin ironing-out details
  - Tev/LHC correlations will also be important (this workshop is initiating that dialogue)

Proposed Outline

I. Introduction

II. Theory Overview

III. Top Mass Determination at the Tevatron

- A. Methods
  - 1. Template
  - 2. Matrix Element
  - 3. Kinematic
- B. Results
- C. Combination
  - 1. Method
  - 2. Limitations
  - 3. Outstanding Issues

Proposed Outline

III. Top Mass Determination at the Tevatron

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D. Systematic Uncertainties

1. Jet Energy Scale
   a. determination
   b. uncertainties
   c. limitations
2. Signal Modeling
   a. ISR/FSR
   b. PDF
   c. NLO
   d. Q^2 scale
3. Background Modeling
   a. normalization
   b. shape
4. Miscelaneous

Proposed Outline

III. Top Mass Determination at the Tevatron

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E. Extrapolations

1. What we learned from Run 1
2. What we expect from Run 2

F. Using Mtop to look for New Physics

1. Comparison across channels
2. Differential distributions, dM/dX

IV. Top Mass Determination at the LHC

A. Methods

B. Systematic Uncertainties

C. Expectations

Proposed Outline

IV. Top Mass Determination at the LHC

…

D. Outstanding Issues

1. Issues for LHC to address
2. Issues for Tevatron to address
3. Issues for B-factories to address
4. Issues for HERA to address
5. Issues for Theorists to address

V. Conclusions

Next

- We will need to identify people to write the parts I. - IV.C (today)
- We need some detailed input from the LHC experiments (e.g. internal notes)
- After the two experimental sections are written, we should arrange an informal meeting to discuss IV.D and V. (in late December or early January?)

Backup Slides

The Fit

Correlation coefficients (Published Run-I: C1(HAD) – D1(DIL); Preliminary Run-2: C2(LJT) – D2(LJT))

	C1(HAD)	C1(LJT)	C1(DIL)	D1(LJT)	D1(DIL)	C2(LJT)	C2(LJT)	C2(DIL)	D2(LJT)
C1(HAD)	1								
C1(LJT)	0.32	1							
C1(DIL)	0.19	0.29	1						
D1(LJT)	0.14	0.26	0.15	1					
D1(DIL)	0.07	0.11	0.08	0.16	1				
C2(LJT)	0.04	0.12	0.06	0.10	0.03	1			
C2(LJT)	0.35	0.54	0.29	0.29	0.11	0.45	1		
C2(DIL)	0.19	0.28	0.18	0.17	0.10	0.06	0.30	1	
D2(LJT)	0.02	0.07	0.23	0.07	0.02	0.07	0.08	0.03	1

The two C2(LJT) columns are marked: Split by JES determination

Mt = 172.7 +/- 2.9 GeV/c^2

χ^2/dof = 6.5 / 7 (49%)

	C1(HAD)	C1(LJT)	C1(DIL)	D1(LJT)	D1(DIL)	C2(LJT)	C2(LJT)	C2(DIL)	D2(LJT)
Pull:	+1.19	+0.51	-0.48	+1.67	-0.34	+0.18	+0.24	-1.11	-0.86
Weight:	+1%	-0.2%	+1%	+19%	+2%	+36% (both C2(LJT) combined)		+8%	+33%

Error Classes: Jet Energy Scale Uncertainties

- Intricate because
  - CDF and D0 employ different philosophies for determining their JES
  - Within each there is a mix of modeling uncertainties (ie. theory) and simulation uncertainties (ie. detector description)
  - Run 1 and Run 2 not exactly the same
- Tricky to precisely determine because
  - The modeling and simulation uncertainties not always easy to untangle
  - We lack an ideal control sample (ie. high statistics, high purity, well measured, well modeled)
  - There is some overlap with "Signal" category (e.g. Out-of-Cone ~ FSR)

Error Classes: Signal Modeling Uncertainties

- Includes ISR, FSR, PDF, and NLO related uncertainties
- Important because
  - Correlated among all measurements
  - Will also be correlated with LHC measurements
  - Expected to be among dominant in future
- Tricky to precisely determine because
  - The above categories don't cleanly separate
  - Difficult to specify "reasonable" modeling variations in order to quantify related systematic
  - Few good control samples in which to use data to limit modeling variations
- CDF and D0 employ different philosophies/methods

Error Classes: Other Uncertainties

- Background Related
  - Dominated by modeling uncertainties which affect shape of fitted mass distribution (e.g. Q^2 scale)
  - Many of the “Signal” comments apply here as well
  - Could become a dominant contribution
- Fit Related
  - Presently treated as uncorrelated… can this last?
- Statistics Related
  - soon to be small (yeah Tevatron!)
  - LJT : Δ(stat) ~ Δ(syst) already
  - DIL : Δ(stat) ~ Δ(syst) at 2 fb^{-1}
  - HAD : anticipate similar to DIL

The Measurements

	Published Run-I					Preliminary Run-2			
	C1(HAD)	C1(LJT)	C1(DIL)	D1(LJT)	D1(DIL)	C2(LJT)	C2(LJT)	C2(DIL)	D2(LJT)
Mtop	186.0	176.1	167.4	180.1	168.4	173.5		165.5	169.5
Stat	10.0	5.1	10.3	3.6	12.3	2.7		6.3	3.0
iJES	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	3.3
aJES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
bJES	0.6	0.6	0.8	0.7	0.7	0.6	0.6	0.8	0.7
cJES	3.0	2.7	2.6	2.0	2.0	0.0	2.0	2.2	0.0
dJES	0.3	0.7	0.6	0.0	0.0	0.0	0.0	0.0	0.0
rJES	4.0	3.4	2.7	2.5	1.1	0.0	2.3	1.4	0.0
Signal	1.8	2.6	2.8	1.1	1.8	1.1		1.5	0.3
MC	0.8	0.1	0.6	0.0	0.0	0.2		0.8	0.0
UN/MI	0.0	0.0	0.0	1.3	1.3	0.0		0.0	0.0
Bgd	1.7	1.3	0.3	1.0	1.1	1.2		1.6	0.7
Fit	0.6	0.0	0.7	0.6	1.1	0.6		0.6	0.6
Syst	5.7	5.3	4.9	3.9	3.6	4.6	3.5	3.6	3.6
Total	11.5	7.3	11.4	5.3	12.8	5.3	4.4	7.3	4.7

Split by JES determination

(all quantities in GeV/c^2)
(original authors consulted in every case)

Extrapolations: What can we expect?

- Considered three scenarios
  - "Lazy" == only improvement is from additional stats
  - "Proactive" == additionally assume some progress on systematics related to JES (3→2), and modeling (e.g. for LJT non-JES syst 1.5→1.0 GeV/c^2)
  - "Proactive++" == same as Proactive + D0(R2-DIL) + D0(R2-HAD) + CDF(R2-HAD) (assumed these look like CDF(R2-DIL))
- Take as inputs present analyses in world average and project to larger datasets (1, 2, 5, & 8 fb^{-1})
  - use *expected* stat uncertainty in projections

Extrapolations: Projections for ΔM_{top} in GeV/c^2

	Lazy	ProAct	ProAct++	
1 fb^{-1}	1.15			JES
	0.76			Signal
	0.84			Bkgnd
	0.42			Other
	1.9			Syst
	1.2			Stat
	2.2			Total
2 fb^{-1}	1.9	1.6	1.6	Total
5 fb^{-1}	1.6	1.4	1.3	Total
8 fb^{-1}	0.98	0.85		JES
	0.63	0.40		Signal
	0.79	0.53		Bkgnd
	0.46	0.48		Other
	1.5	1.2	1.2	Syst
	0.5	0.5	0.4	Stat
	1.6	1.3	1.2	Total