SM handles and candles

- project on ttbar+jets
- project on Matrix Element tools
- project on the definition of the top quark mass

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ttbar + jets

- AlpGen – MadGraph comparison : ME⇔PS matching (MLM)
  - How and what to test with data: E_T, R_{ij}, M_{ij}^2, more ?
  - Double differential : $d\sigma/dp_T^j dp_T^{min}$ (min: smallest pT from top decays)
  - How does ttbar+jet compares with W+jets, can we learn something from a comparison ? Should we use the same matching criteria ?
- NLO vs LO (ttbar+0jet and ttbar+1jet): **hep-ph/0703120**
  - Which distributions to calculate: p_T^{top}, p_T^j, η^j, $\Delta R_{j,top}$, m_{ttbar}, ...
  - Also with cuts on p_T^{top}>50,100,200GeV: p_T^j, η^j, ...
  - More ... ?
- Is the comparison the same for different jet algorithms ? Can be done at hadron level within detector geometries...
- Other matching methods SHERPA (CKKW)

- Email list and TWiki page will be made, homework will be send via these tools.

The use of Matrix Elements

- From Matrix Elements (ME's) probabilities can be calculated in theoretical calculations : $\mathcal{M}(\mathbf{p}_i|m_{top},\mathcal{A}_{spin},...)$
- Given the parameter input this results in differential distributions of the kinematics $\mathbf{p}_i$ (p_T, m_{jjb}, ...)
- But given the observed final state topology in our detector we can give these kinematics $\mathbf{p}_i^{rec}$ as an input to the Matrix Element $\mathcal{M}(\mathbf{p}_i|m_{top},\mathcal{A}_{spin},...)$
- Than we can project the probability of the observed event $P(m_{top})=\mathcal{M}(m_{top}|\mathbf{p}_i^{rec})^2$ in the dimension of the theoretical parameters, for example mtop
- This method has been used at the Tevatron to measure the top quark mass, examples:
  - CDF hep-ex/0605083
  - D0 hep-ex/0609053

The use of Matrix Elements

- From CDF/D0 papers :

fraction of events consistent with signal

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

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

parton level LO cross section

transfer function parton **y** to detector **x**

$$\mathrm{d}\sigma(q\bar{q} \to t\bar{t} \to y; m_{\text{top}}) = \frac{(2\pi)^4 |\mathscr{M}(q\bar{q} \to t\bar{t} \to y)|^2}{q_1 q_2 s} \mathrm{d}\Phi_6$$

$$\mathrm{d}\sigma(p\bar{p} \to t\bar{t} \to y;\ m_{\text{top}}) = \int_{q_1, q_2} \sum_{\substack{q_1,\, q_2 \\ \text{flavors}}} \mathrm{d}q_1 \mathrm{d}q_2\ f(q_1)\ f(q_2)\ \mathrm{d}\sigma(q\bar{q} \to t\bar{t} \to y;\ m_{\text{top}})$$

similar for background processes

The use of Matrix Elements

- Several difficulties: sample a multi-dimension space for the integration (= lots of CPU time, and more events are coming at the LHC compared to Tevatron), how to reduce the dimensions efficiently without to many assumptions ?
- Effect of radiation with ttbar+Njet events
- The use of the LO Matrix Element opens questions of robustness versus NLO effects. How to check ?
- Alternative tool is a kinematic fit where you add via Lagrange multipliers in a least-square method constraints between the observed final state particles (for example mass constraints)... maybe more robust versus NLO effects and less CPU intensive
- Compare event-by-event the use of Matrix Element tools and Kinematic fit tools
- Email list and TWiki page will be made, homework will be send via these tools.

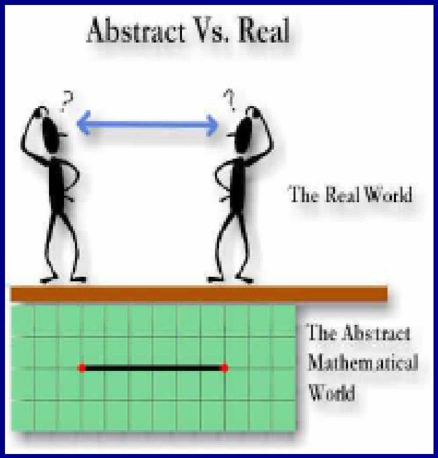
Definition of top quark mass

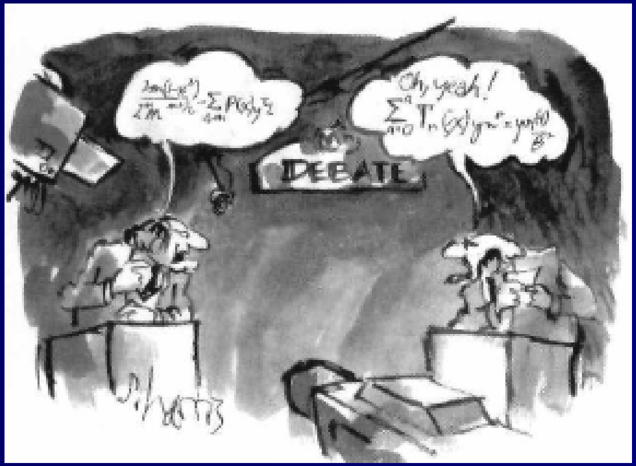
- Point not really discussed during these days due to overload
- But a clearly nice topic for a theo-exp Les Houches link
- The top quark pole mass (real part of the propagator) is ambiguous by amount proportional to Λ_{QCD}, and we aim to measure this parameter to better than 1 GeV
- Ref (example): hep-ph/9612329
- What is nice to measure at the LHC is the difference between top and anti-top mass !
- Maybe we need a correct top mass definition for this one... ?

What have we measured?

Using the top quark mass in this manner begs the question — what quantity have we actually measured? There are several options:

- pole mass
- $\overline{\text{MS}}$ mass
- `PMAS(6,1)` in PYTHIA ← probably closest given analysis techniques (transfer functions, calibration), but what does this quantity represent within PYTHIA?
- etc





CDF and DØ use the same paradigm to measure the top quark mass so the world average is consistent. Deciding what this means theoretically, however, is the subject of some debate.