Status Report of the Higgs & SM Working Group

Experimental Part I

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- Introduction
- Activities
  - Generators: LO, NLO, tuning, uncertainties
  - SM: top, W, Z, jets
  - PDF: improvements, use of W and Z
- Overview

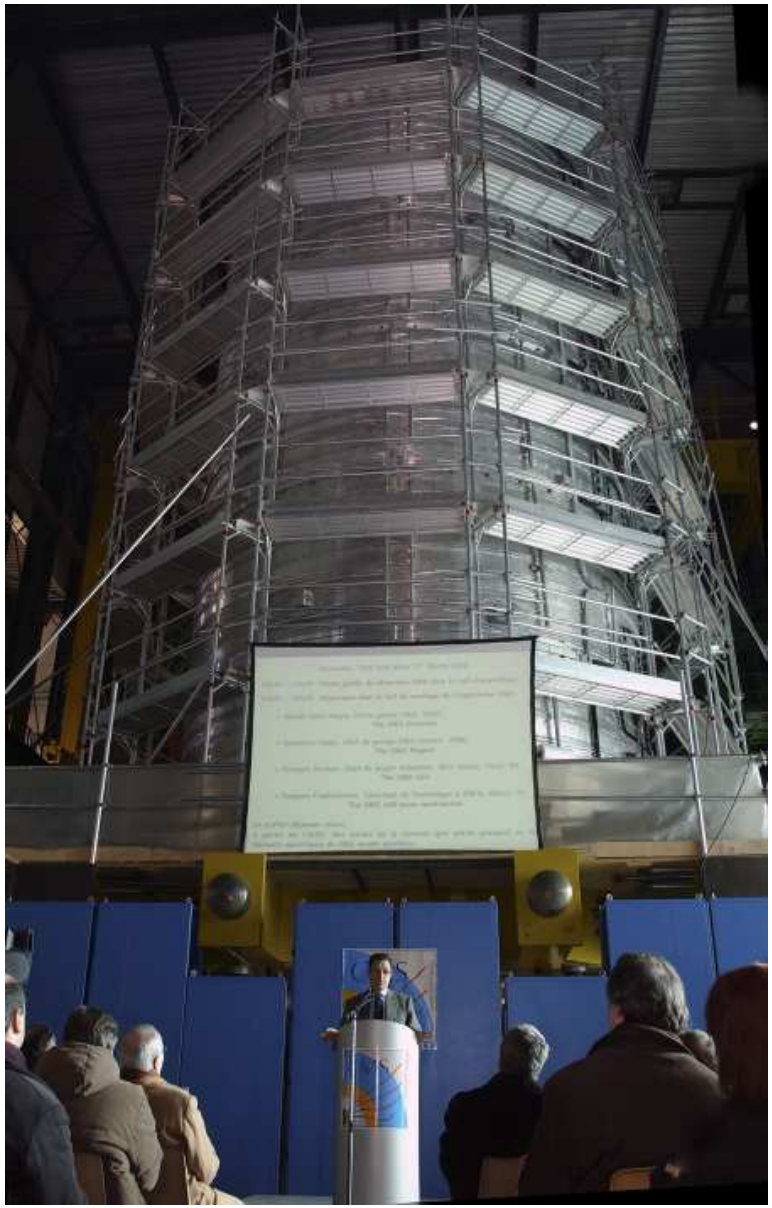
Status LHC

- reality: the construction of the LHC has started
  - installation of dipole magnets (in total 1232 + other ...)

Status ATLAS

- construction of the ATLAS detector underground
  - two (out of eight parts of the barrel toroid)

Status CMS



- magnetic coil of CMS
- some CMS events:
  - magnet test (late 2005)
  - P-TDR (early 2006)
  - go underground (2006)
  - commissioning (2006/2007)
  - first data (2007)
- hardware is getting ready
  - have to be prepared for the first data
  - we need your help

Generators: Motivation

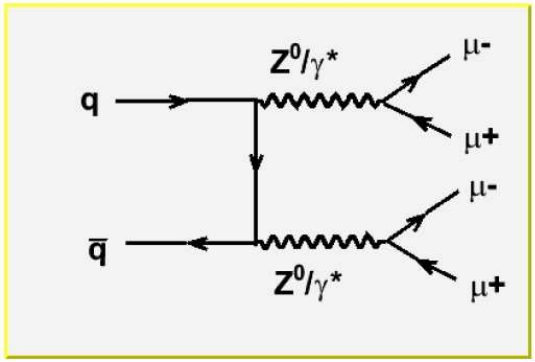
- How do we understand the data?
  - need to understand signals and corresponding backgrounds
  - important for measurements and searches (uncertainties)
  - in many cases simulation (+ detector simulation)

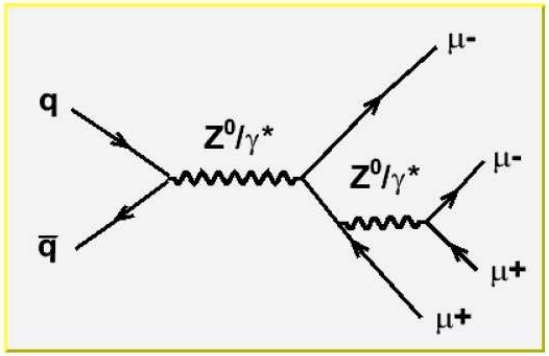
- How do we model a process?
  - if possible directly from data
  - still needs to be checked with simulation
  - or from simulations (often the only possibility)
  - need good description (including tuning)

- Test theoretical predictions
  - new physics?

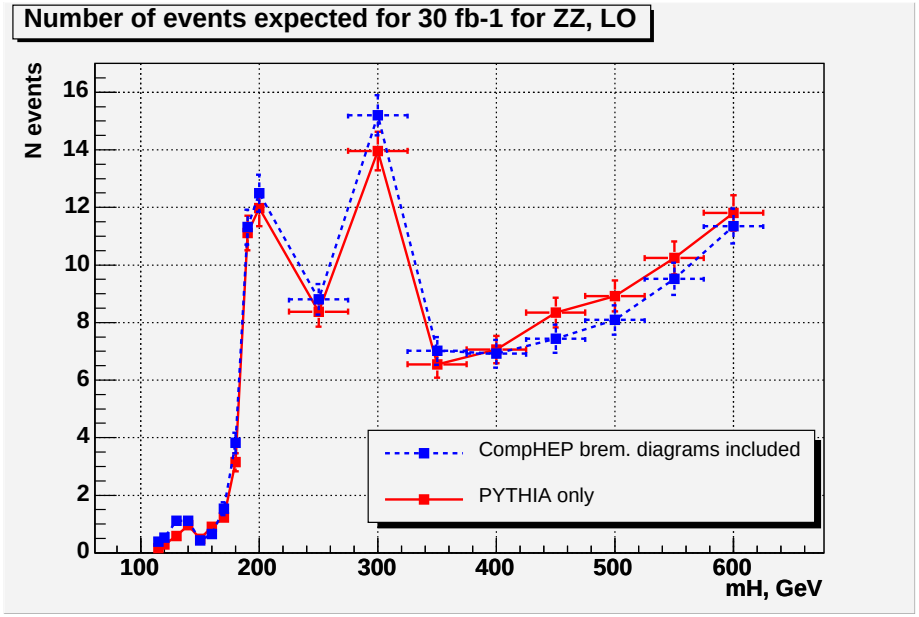
MC Studies I: ZZ Pairs

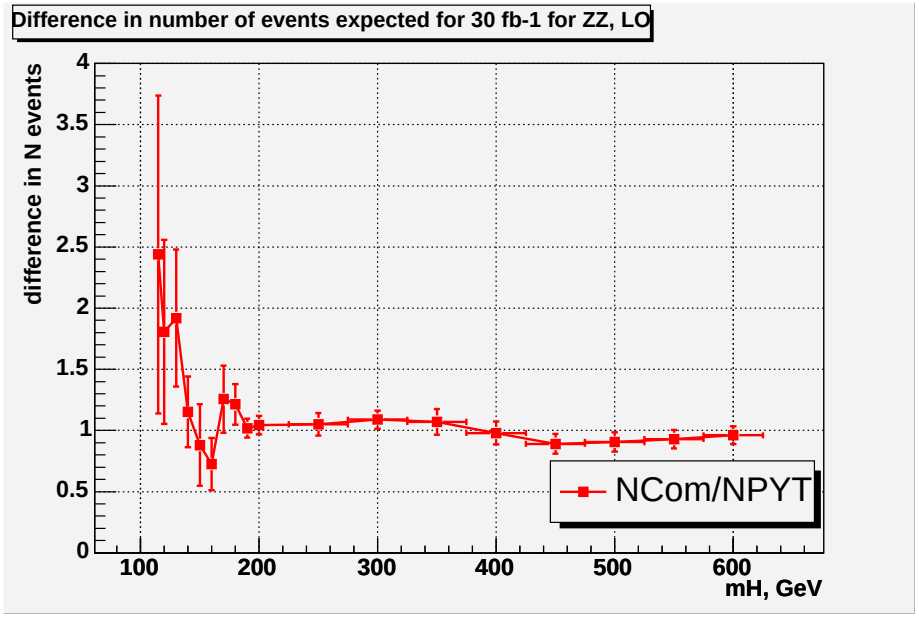
◇ LO diagrams:





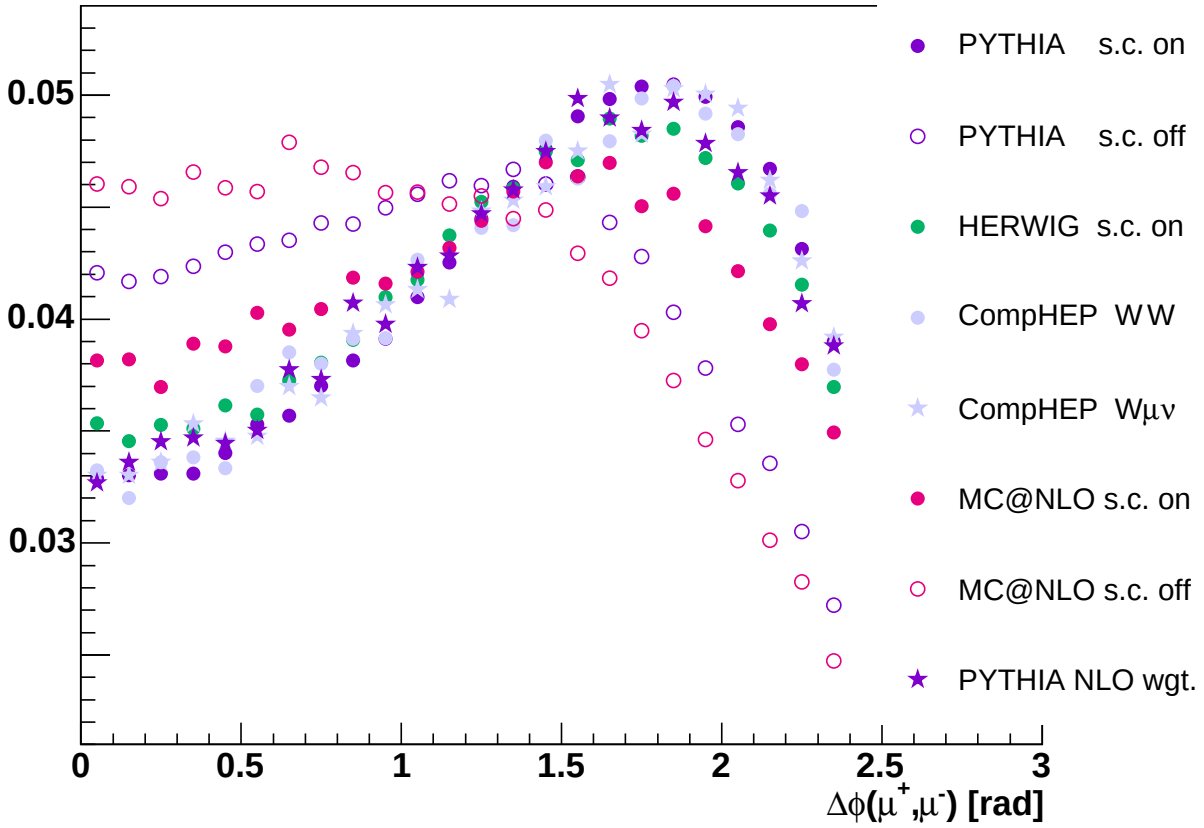
◇ after pre-selection





◇ kinematics is different as well ▷ more in MC session

MC Studies II: W^+W^- Pairs

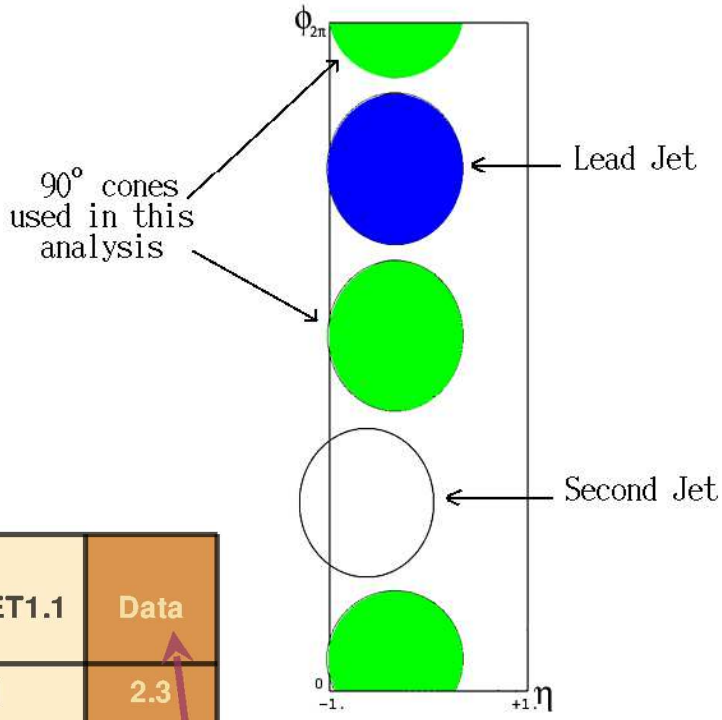


- ◇ including cuts
- ◇ important are
  - ▷ spin correlations
  - ▷ underlying event
  - ▷ higher orders
- ◇ less important
  - ▷ PDF choice
  - ▷ $2 \rightarrow 4$

- ◇ new: $gg \rightarrow W^+W^-$ gives additional $\approx 30\%$ contribution
- ◇ probably more in MC session and MC@NLO tutorial

MC Tuning I: underlying Event

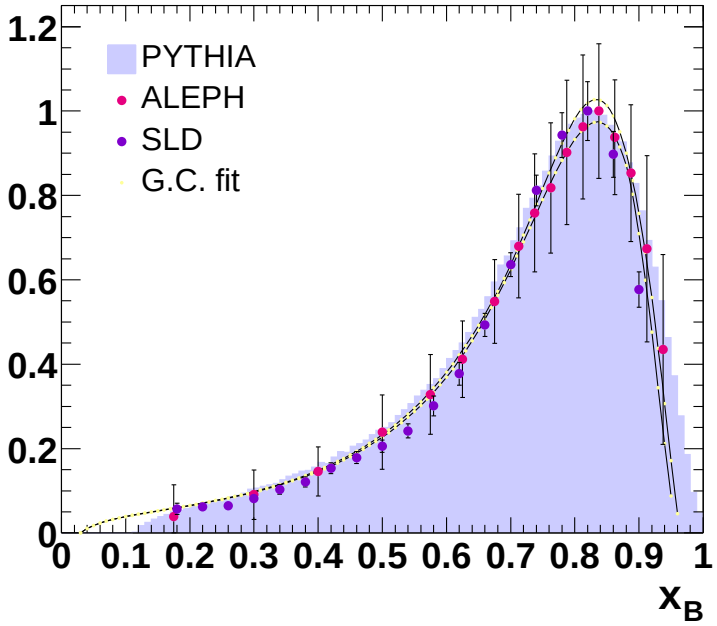
- ◇ study typical regions
- ◇ tune MCs to CDF data
- ◇ extrapolate to the LHC
  - ▷ more in MC tuning session

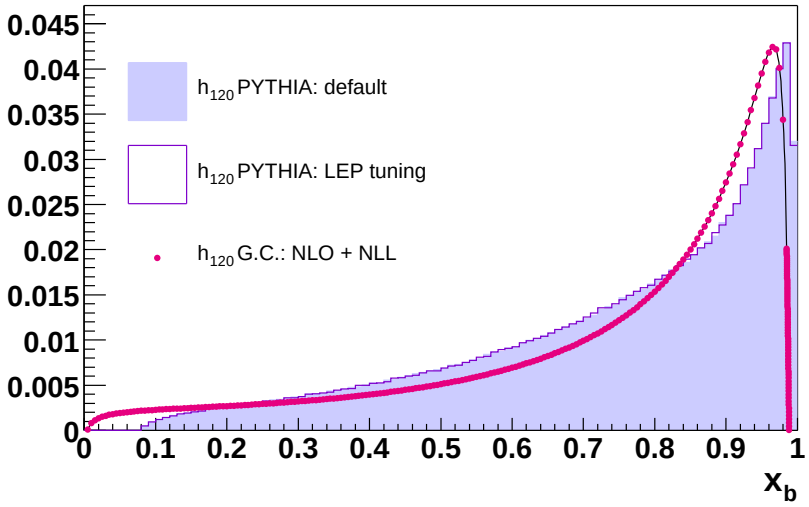


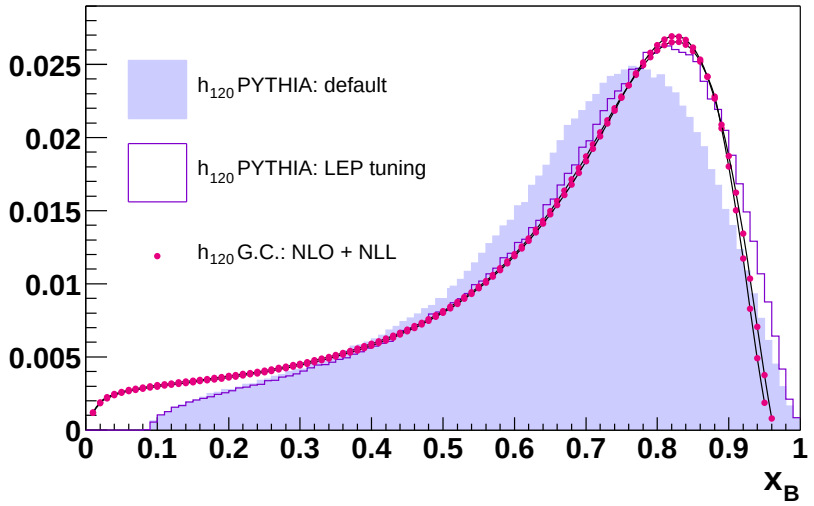
	Measurement	JIMMY4.1 Tuning A	JIMMY4.1 Tuning B	PYTHIA6.214 ATLAS Tuning	PYTHIA6.214 CDF Tuning	PHOJET1.12	Data
Tevatron	$\langle N_{chg}\rangle$ $pT_{ljet} > 10$ GeV	2.4	2.3	2.4	2.3	2.1	2.3
Tevatron	$\langle pT_{sum}\rangle$ $pT_{ljet} > 10$ GeV	2.5	2.1	2.3	2.6	2.0	2.6
LHC	$\langle N_{chg}\rangle$ $pT_{ljet} > 10$ GeV	12.2	9.2	6.6	4.7	3.0	"?"
LHC	$\langle pT_{sum}\rangle$ $pT_{ljet} > 10$ GeV	11.5	8.5	7.5	6.5	3.5	"?"
		x 5	x 4	x 3	x 2	x 1.5	x "?"

MC Tuning II: $h \to b\bar{b}$ Fragmentation

- match $Z \to b\bar{b}$ data
- apply tuned parms. to $h \to b\bar{b}$ at the LHC







- compare with NLO predictions ▷ more in MC tuning session

Standard Model: Motivation

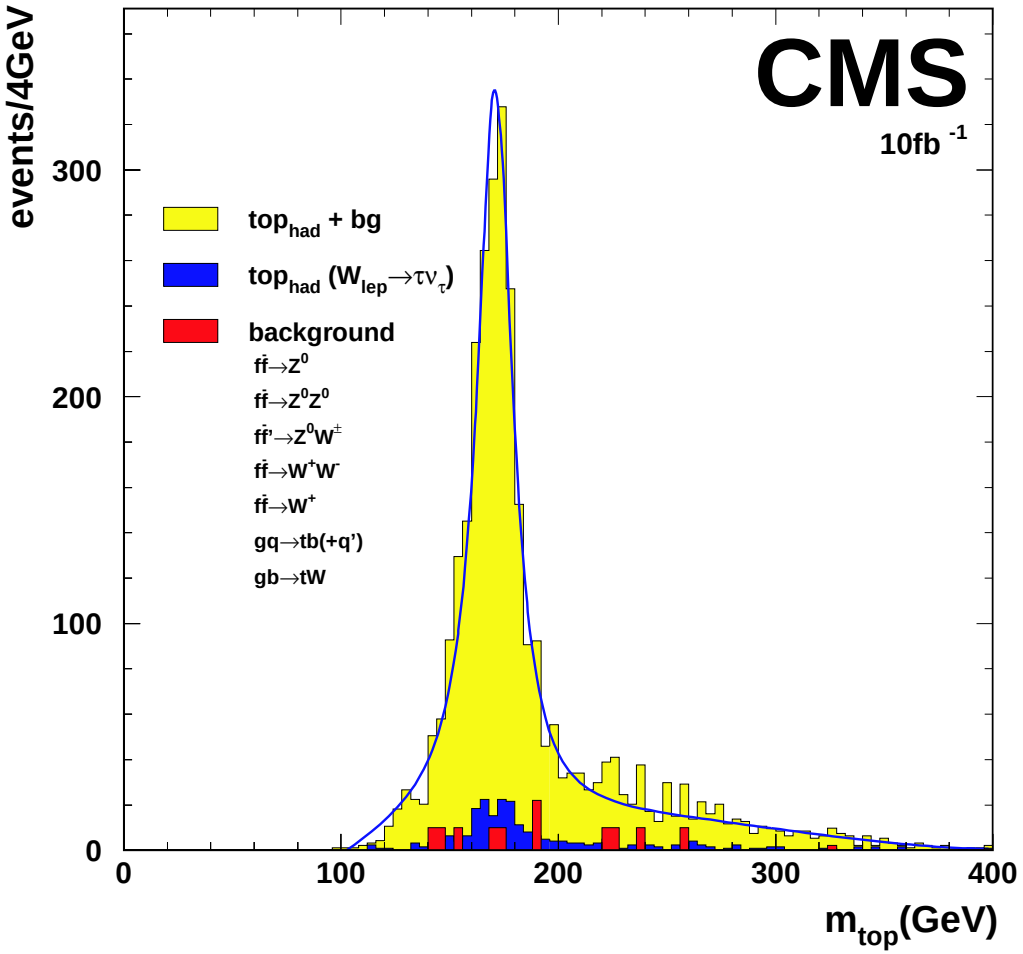
- Why is physics of the SM (still) important?
  - it will be the first physics at the LHC
  - useful for understanding the data
  - do the same physics at higher energies
  - higher precision is still possible
  - new processes (e.g. single top)
  - check consistency of the SM
  - look for deviations

- No new physics without a good understanding the SM backgrounds

W and Z Bosons

- unlimited statistics: cross sections are several nb
  - even with leptons in the final state
- useful for
  - detector calibration and alignment
  - luminosity measurement, PDFs (later)
- important background processes
- electroweak physics
  - precision measurement of the W mass and width
  - anomalous couplings
- WW, WZ and ZZ pair production
  - smaller cross sections: 120 pb, 50 pb and 16 pb
  - typically more dangerous as background (especially Higgs)

Top Physics I: Top Pairs



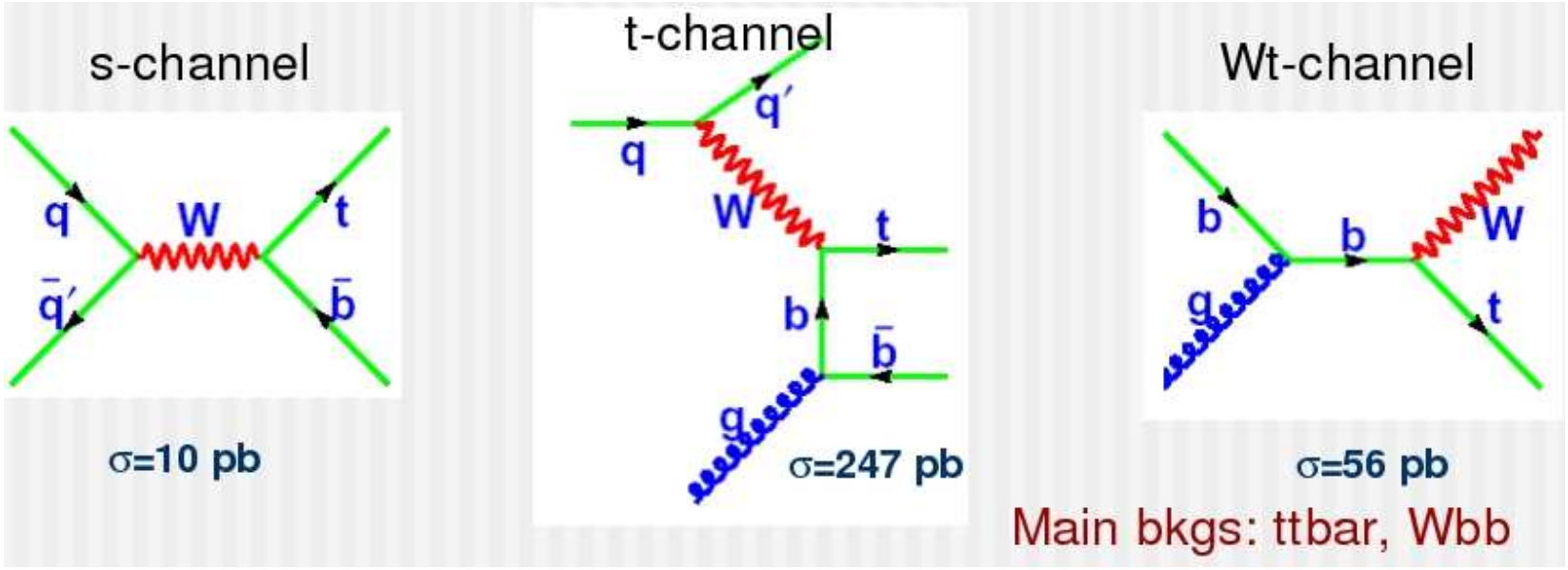
- 8M $t\bar{t}$ events per 10 fb^{-1}
  - top mass better than 1 GeV

- want to go beyond the TeVatron

- long list of analyses
  - mass, width
  - cross section
  - BR(t $\rightarrow$ Wb)
  - spin correlations
  - rare decays

- detailed understanding of many aspects is essential
  - top session

Top Physics II: Single Top

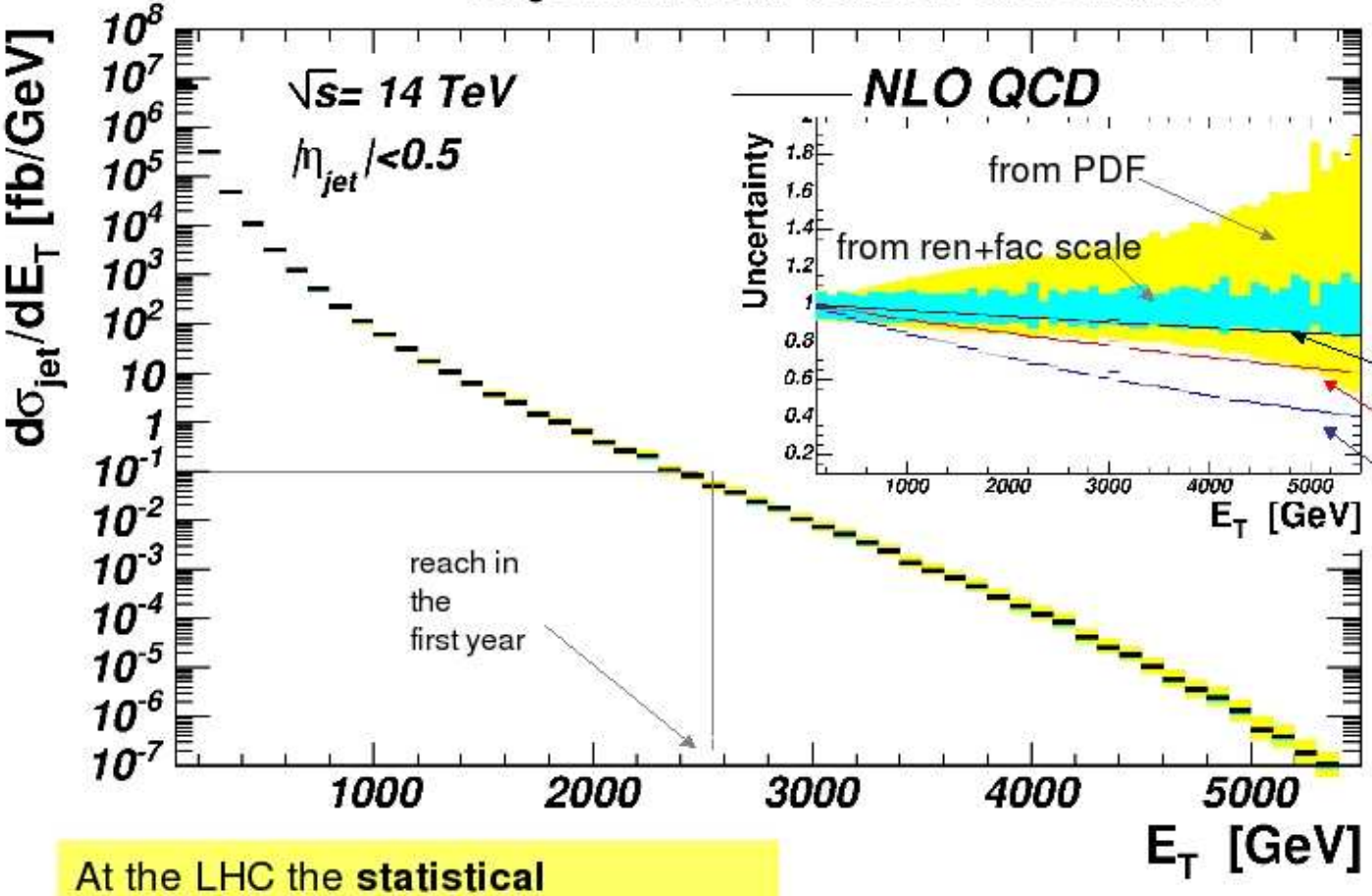


- single top not observed yet (just limits)
  - more difficult than pairs of top quarks
- direct measurement of V_{tb} ($\sigma \sim |V_{tb}^2|$)
- study polarization (weak interaction), new physics, ...
- important background for many other searches

Jet physics: Single Inclusive Cross-section

- test of pQCD in an energy regime never probed!
- validate our understanding of pQCD at high momentum transfers

Large momentum transfers and small-x !



Rather general String theory toy-model (hep-ph/0111298)

$$\sigma_{jet} = \sigma_{jet}^{SM} \cdot \left| \mathcal{A}(\hat{s}, \hat{t}) \right|^2$$

where

$$\mathcal{A}(\hat{s}, \hat{t}) = e^{-\sqrt{f(\theta)\hat{s}/\mathcal{M}_s^2}}$$

$\mathcal{M}_s = 100$ TeV

$\mathcal{M}_s = 40$ TeV

$\mathcal{M}_s = 20$ TeV

At very small distances, particles disappear into curled extra-dimensions

At the LHC the **statistical** uncertainties on the jet cross-section will be **small**.

Main systematic errors ?

Theory uncertainty ?

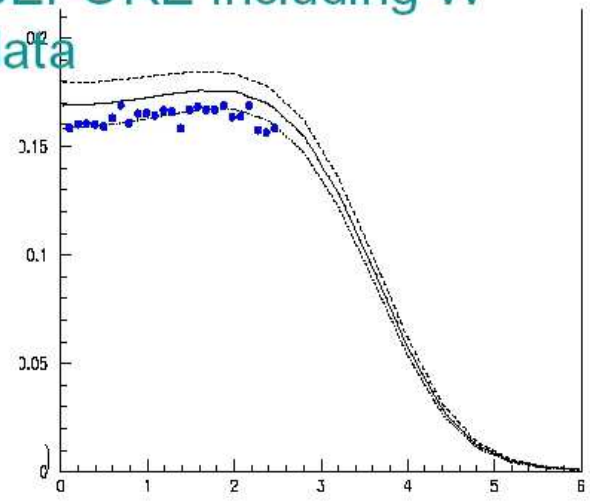
PDFs: Motivation

- PDFs are an important ingredient at hadron colliders
  - cross sections: measurements and background predictions
  - event properties: $\hat{s}$, boost, ...
- improvements with time
  - now
  - after HERA and TeVatron
  - including data of one year of LHC
- measure parton luminosity from SM processes
  - good candidates are W and Z production (see SM part)
  - expect accuracy of about 1%

Reduce PDF Uncertainties with W Bosons

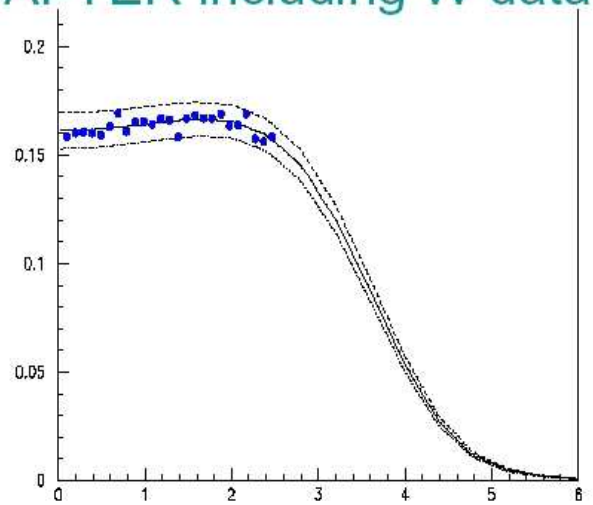
◇ include W rapidity distributions in global PDF fits

BEFORE including W data



W+ to lepton rapidity spectrum data generated with CTEQ6.1 PDF compared to predictions from ZEUS PDF

AFTER including W data



W+ to lepton rapidity spectrum data generated with CTEQ6.1 PDF compared to predictions from ZEUS PDF AFTER these data are included in the fit

◇ done with ATLFAST and $\ell^{\pm}$ selection ▷ more in PDF session

Overview: MC

- background studies: BG predictions, BG uncertainties
  - experimental part: M. Duehrssen, J. Huston, M. Schumacher, ...
- MC tuning: underlying event, fragmentation
  - experimental part: C. Buttar, V. Drollinger, A. Moraes, ...
- higher orders: MC@NLO, HO-weighting
  - experimental part: G. Davatz, M. Dittmar, V. Drollinger, A. Drozdetskiy, B. Mellado, A. Oh, B. Quayle, S. L. Wu, ...

Overview: SM

- W and Z (single and pairs)
  - experimental part: A. Cooper-Sarkar, M. Duehrssen, P. Giraud, S. Hassani, A. Schmidt, ...

- top (single and pairs)
  - experimental part: J. D'Hondt, A. Giammanco, J. Heyninck, I. van Vulpen, ...

- jets, W+jets, Z+jets, jet veto
  - experimental part: R. Mazini, A. Nikitenko, S. Odaka, A. Schmidt, ...

Overview: PDF

- evolution (HERA, TeVatron, LHC)
  - experimental part: J. Huston, J. Huston, ...
- parton luminosity
  - experimental part: S. Ferrag, P. Gras, ...
- heavy flavours
  - experimental part: T. Petersen, T. Petersen, ...
- uncertainties
  - experimental part: C. Buttar, A. Cooper-Sarkar, A. Moraes, ...

Overview of Activities

- most experimental Higgs activities can be accommodated in
  - generators (predictions, uncertainties)
  - SM (backgrounds)

- topics of exp. SMH part II are not listed in this talk

- something/somebody forgotten? complain now!

- additional activities are encouraged ...

Work a lot and enjoy the Mountains!