Standard Model and Higgs (SMH) Working Group

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Les Houches 2005

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SMH Convenors

- Theory   Dittmaier, Fixione, Willenbrock
- ATLAS   Buttar, Unal
- CMS   Drollinger, Nikitenko
- Tevatron   Martinez-Perez, Soldner-Rembold
- Monte Carlo   Richardson

Topics

- SM benchmarks for LHC start:
    - what are the expected cross sections? inclusive jet, W/Z, top, W+jets, isolated photons
    - what are the expected uncertainties?
    - What process to use as a luminosity monitor?
- PDF uncertainties
    - situation now
    - after HERA II and Tevatron Run II
    - after 1 year of LHC
    - PDF's of Heavy flavours
    - reliability of NLO DGLAP
    - differences between CTEQ and MRST and Les Houches (2001) project for benchmark comparisons
- MC
    - MC at NLO
    - MC simulations *vs* NLO predictions
    - Matrix Elements and Parton Shower matching
    - MC tuning and underlying events
- Multi-parton and NNLO:
    - tree-level
    - conventionnal NLO
    - new developments (strings and twistors..)
    - NNLO *vs* soft-collinear approximations
    - Needed NNLO for which observables
- Precision Higgs cross sections
    - Review and updates
    - soft gluon resummations
    - Higgs in association with heavy quarks
    - Diffractive Higgs
    - Tevatron background measurements for heavy Higgs
- Electroweak corrections for LHC and LC (related to multi-parton)

Many ways to contribute

- Many topics
- Individual/Small collaboration
- Subgroups
  - Based on feedback from participants
  - Informal discussions/presentations
  - Chance for new collaborations to form

Subgroups

- SM benchmarks and PDF's   Ferrag
- Monte Carlo   Richardson
- Higgs via weak-boson fusion   Unal
- Higgs decay to WW   Nikitenko
- Higgs with top quarks   Gascon-Shotkin
- Higgs with bottom quarks   Willenbrock
- …   …

Samir Ferrag

A key point: standard candles must be fully understood by LHC experiments
to believe any claim of new physics (unless spectacularly clear)

▶ $t\bar{t}$ production

▶ W and Z production (possibly with jets)

▶ Single-inclusive jet and dijet production

▶ Photon and di-photon production

Issues to be addressed here:

▶ Predicted cross sections, and their uncertainties

▶ Standard candles as luminometers

Some remarks:

▶ Must improve understanding of power-suppressed effects in jet
production

▶ Single-inclusive photons still not well understood

▶ For which processes do we really need NNLO results?

Frixione

Monte Carlo

Peter Richardson

- Simulation of many hard jets (CKKW and variants)
- MC@NLO and variants
- Addition of new processes
- Standardization of C++ based event generators
  - Tuesday, May 17 (Frixione)

  ▶ Can we agree on a minimal set of modules (say, shower, hard event, UE, hadronization, ...) with well-documented interfaces that the non-expert can understand?

  ▶ Definition of a few stardard classes that all MC authors should use

Higgs subgroups

- Higgs via weak-boson fusion   Unal
- Higgs decay to WW   Nikitenko
- Higgs with top quarks   Gascon-Shotkin
- Higgs with bottom quarks   Willenbrock

Standard Model Higgs

Tevatron
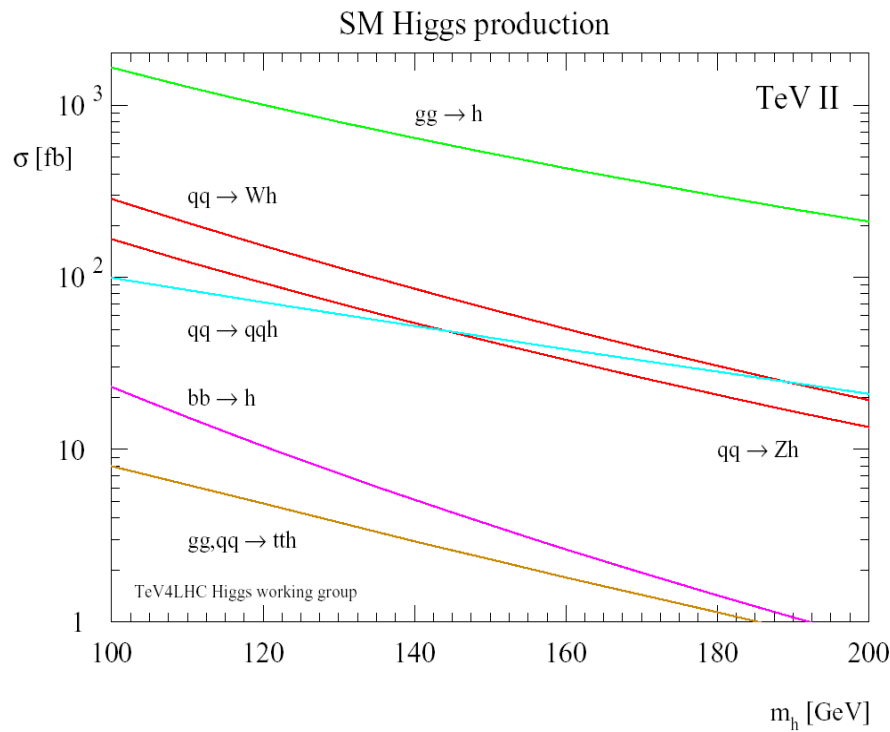
LHC
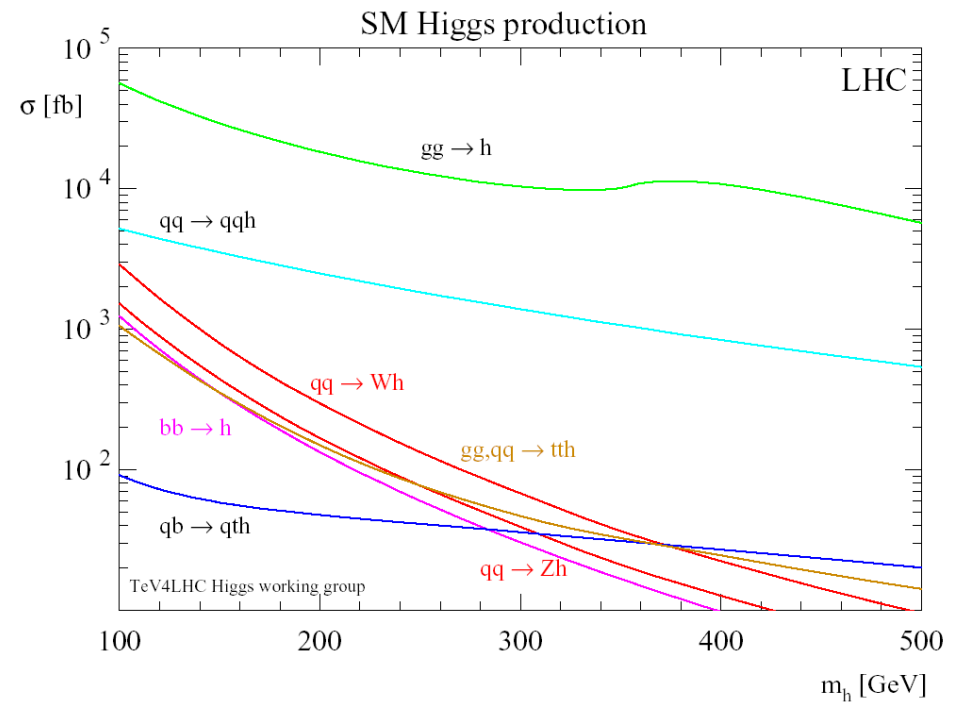
# Theoretical developments

- **Weak-boson fusion**
  - PHASE – LO event generator   Accomando, Ballestrero, Maina
  - NLO differential cross section   Figy, Oleari, Zeppenfeld; Berger, Campbell
- $h \to WW$
  - $gg \to WW$ background   Binoth, Ciccolini, Kauer, Kramer
  - tt background   Kauer
  - Approximate NLO pT distribution   Smith, van Neerven
- **Higgs with top quarks**
  - $gg, qq \to ttA$ @ NLO   Dittmaier, Kramer, Spira
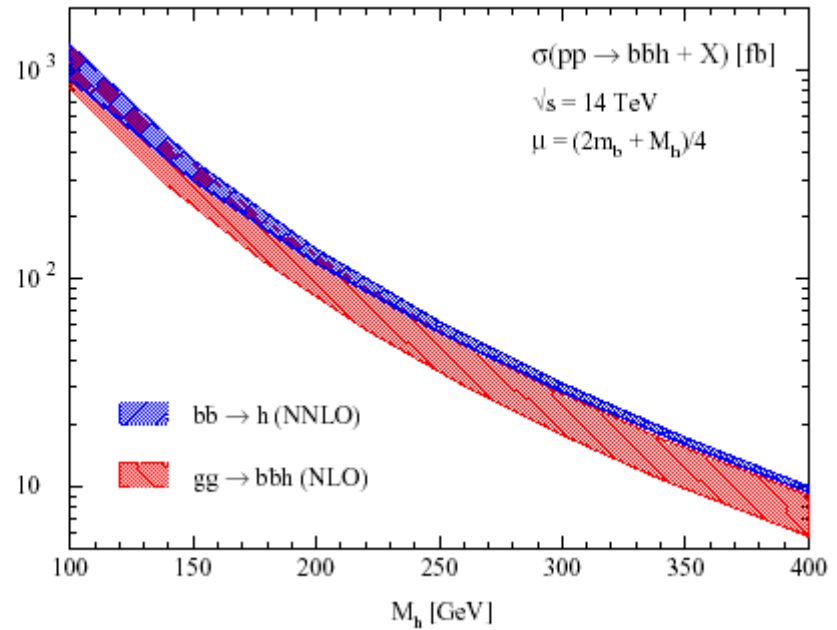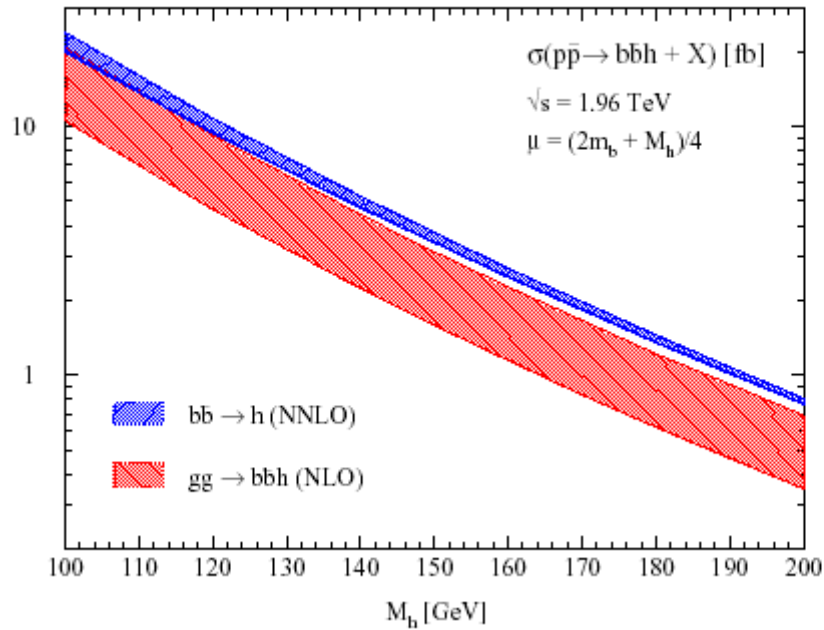
Higgs with bottom quarks

Inclusive cross section
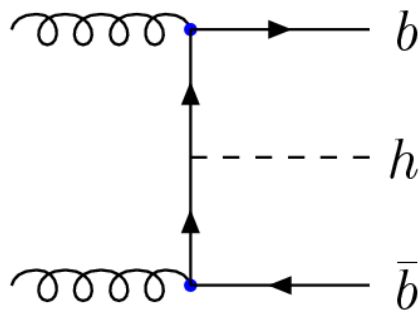
Expansion in $\alpha_S \ln(m_h/m_b)$
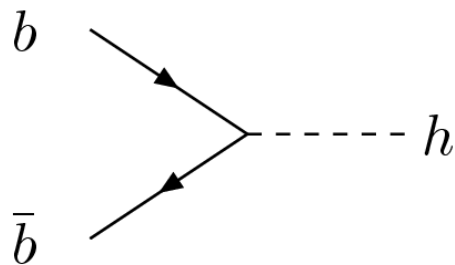
Expansion in α_S

and $1/\ln(m_h/m_b)$

Aivazis, Collins, Olness, Tung;
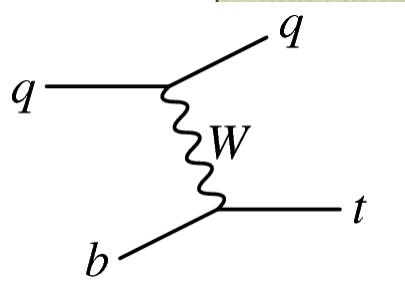Chuvakin, Smith, van Neerven

Les Houches 2003

bb→h @ NNLO – Harlander and Kilgore

gg→bbh @ NLO – Dittmaier, Kramer, Spira;   Campbell et al.

Dawson, Jackson, Reina, Wackeroth

Some examples of b-initiated processes

Process	Interest	Accuracy
single-top t-channel	SM, top EW couplings and polarization, Vtb. Anomalous couplings.	NLO
single-top + W		NLO
Wbj	SM, bkg to single top	(NLO)
gamma+b	SM, SUSY bkg, b-pdf	NLO
Z+b		NLO
inclusive h,A	SUSY discovery/ measurements at large tan(beta)	NNLO
(h,A)+b		NLO
H + t	SUSY discovery, couplings	NLO
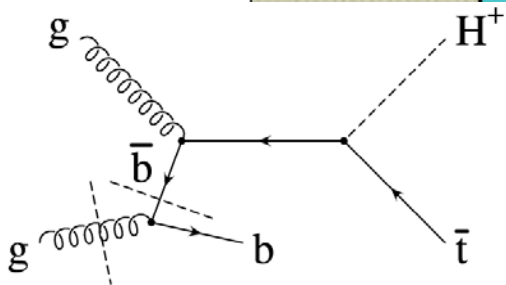
Higgs Working Group @ TEV4LHC, BNL, Febraury 2005

Maltoni

Higgs with bottom quarks

- Understanding of heavy-quark PDF's
  - Advantages and limitations
- Z + heavy quarks as a benchmark
- Strategy for Monte Carlo simulation
  - Combining bb → h, gb → hb, gg → bbh

SMH Working Group

Lots to do, lots to learn to prepare
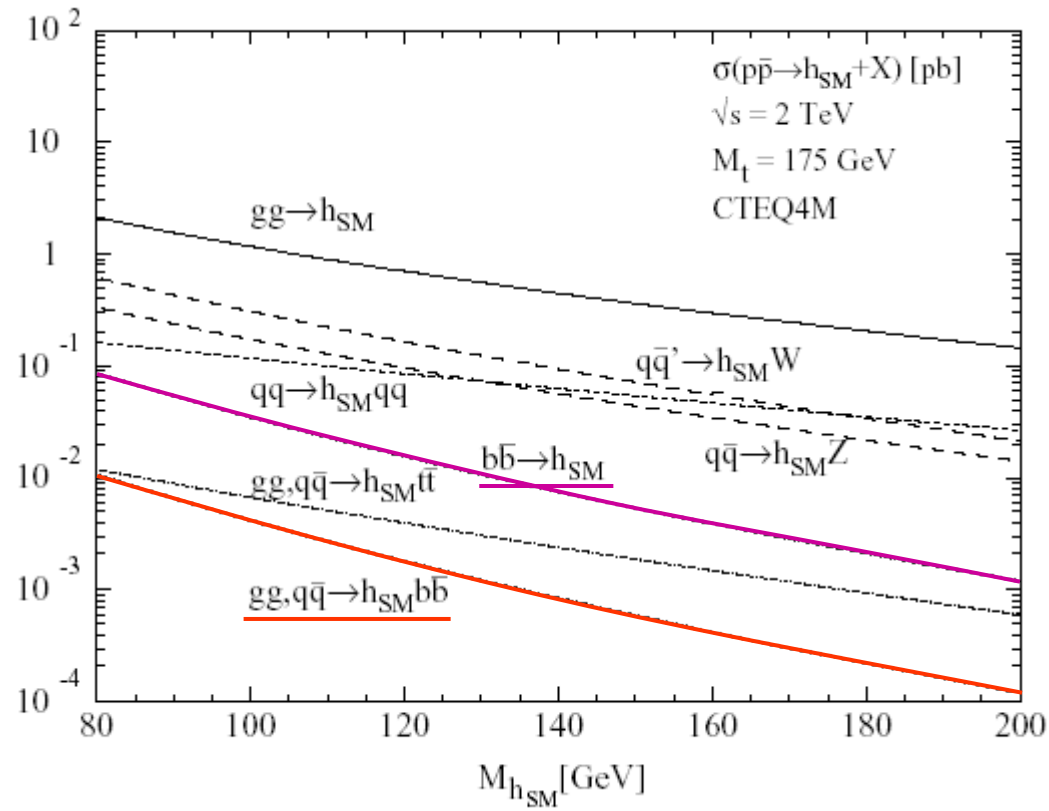for the LHC revolution

Subgroups

Organizational meeting Th 14:00

First subgroup meetings:

- SM benchmarks and PDF's   Ferrag   Th 16:00
- Monte Carlo   Richardson   F   9:00
- Higgs via weak-boson fusion Unal   F   16:00
- Higgs decay to WW   Nikitenko   F   9:00
- Higgs with top quarks   Gascon   F   11:00
- Higgs with bottom quarks   Willenbrock Th 16:00

Run II SUSY/Higgs Workshop (1998)

Spira