News from Overall Contacts

Stefan Dittmaier (Freiburg), Chiara Mariotti (Torino)

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LHC Higgs Cross Section Working Group Workshop at CERN

July 5-6, 2010

LHC Higgs Cross Section Working Group

**MC Group
MC4LHC**

PDF4LHC

Creation announced in January 2010.
Kickoff meeting on February 3, 2010.
Preparatory workshop in Torino Nov. 23-24, 2009
Inauguration workshop in Freiburg April 12-13, 2010

Task: SM and MSSM Higgs Cross Section and BRs
- Compute and agree on cross sections and Brs
- Use the same Standard Model input parameters
- Strategy on uncertainties (scale, α_s, PDF, etc.)
- Monte Carlo at NLO for the signal
- Define pseudo-observables
- Cross sections of background SM processes

**SM Cross
Section
Task
Force**

Beyond SM and MSSM?
Other SUSY scenario NMMSM,
Invisible Higgs, Higgsless, etc.

**Statistics
Forum**

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LHC Higgs Cross Section Working Group Organization

https://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections

Overall Contacts

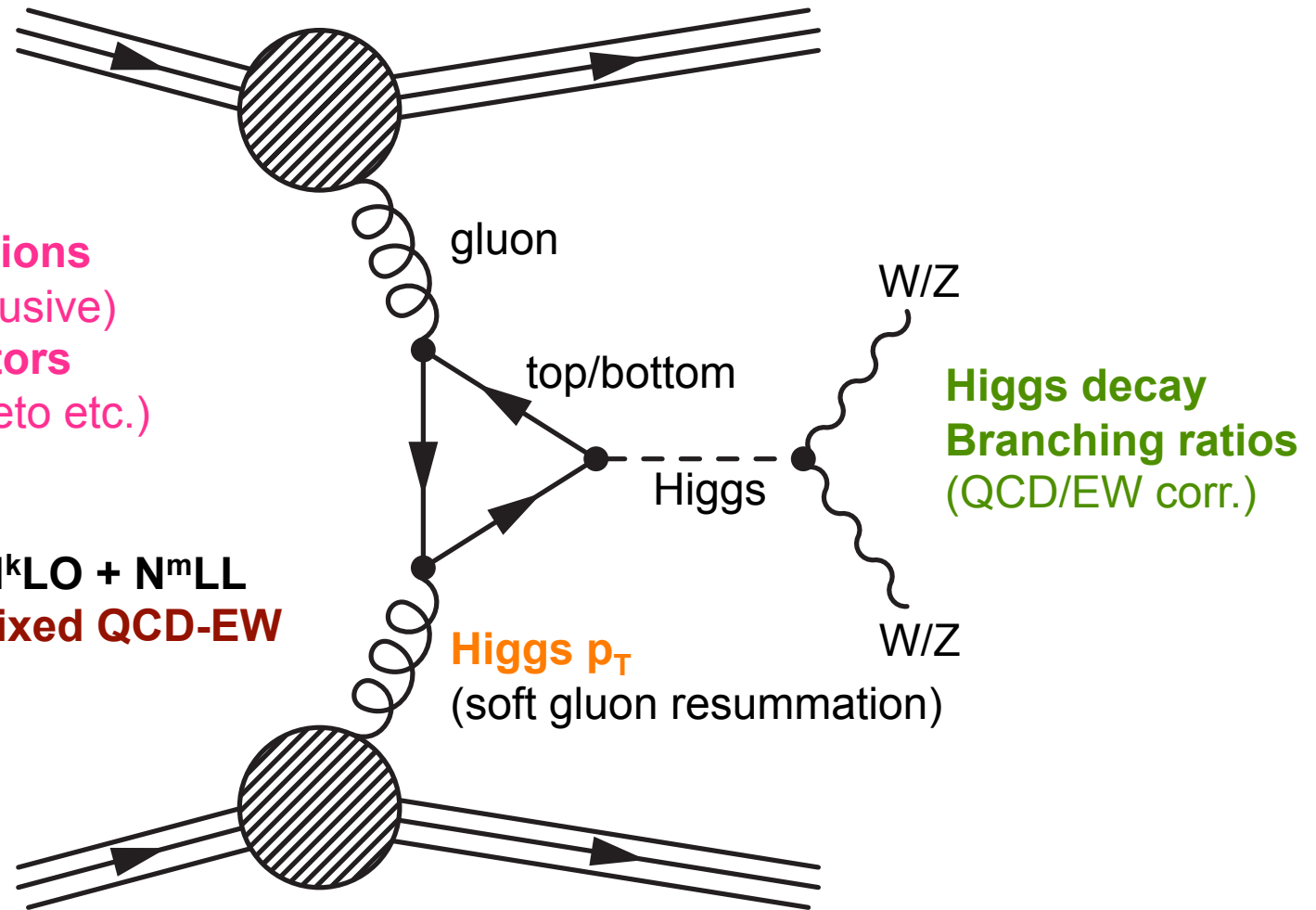| ATLAS	CMS	THEORY	
Reisaburo Tanaka (LAL)	Chiara Mariotti (Torino)	Stefan Dittmaier (Freiburg)	Giampiero Passarino (Torino)

Subgroup Contacts and Link for Subgroup Wiki

Group	ATLAS	CMS	LHCb	THEORY	
1. *ggF*	Jianming Qian (Michigan)	Fabian Stöckli (CERN)		Massimiliano Grazzini (Firenze)	Frank Petriello (Wisconsin)
2. *VBF*	Daniela Rebuzzi (Pavia) Sinead Farrington (Oxford)	Christoph Hackstein (Karlsruhe)		Ansgar Denner (PSI)	Carlo Oleari (Milano-Bicocca)
3. *WH/ZH*	Giacinto Piacquadio (CERN)	Jim Olsen (Princeton)	Clara Matteuzzi (Milano-Bicocca)	Stefan Dittmaier (Freiburg)	Robert Harlander (Wuppertal)
4. *ttH*	Simon Dean (UCL)	Chris Neu (Virginia)		Laura Reina (Florida)	Michael Spira (PSI)
5. *MSSM neutral*	Markus Warsinsky (Freiburg)	Monica Vazquez Acosta (IC)		Michael Spira (PSI)	Georg Weiglein (DESY)
6. *MSSM charged*	Martin Flechl (Freiburg)	Sami Lehti (Helsinki)		Michael Krämer (Aachen)	Tilman Plehn (Heidelberg)
7. *PDF*	Joey Huston (Michigan State)	Kajari Mazumdar (TIFR)		Stefano Forte (Milano)	Robert Thorne (UCL)
8. *Branching ratios*	Daniela Rebuzzi (Pavia)	Ivica Puljak (Split)		Ansgar Denner (PSI)	Sven Heinemeyer (IFCA)
9. *NLO MC*	Jae Yu (Texas)	Marta Felcini (UCD)		Fabio Maltoni (Louvain)	Paolo Nason (Milano-Bicocca)
10. *Pseudo-observables*	Michael Dührssen (CERN)	Martin Grünewald (Ghent)		Sven Heinemeyer (IFCA)	Giampiero Passarino (Torino)

ggF, VBF, WH/ZH, ttH, MSSM Higgs

Higgs Cross Sections
 (inclusive/exclusive)
Differential K-factors
 (effect of jet-veto etc.)
SM Backgrounds

QCD correction $N^kLO + N^mLL$
EW correction, Mixed QCD-EW

gluon

top/bottom

Higgs

Higgs p_T
(soft gluon resummation)

W/Z

W/Z

Higgs decay
Branching ratios
(QCD/EW corr.)

PDF+α_s uncertainties
Renormalization/Factorization scale dependence

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ggF, VBF, WH/ZH, ttH, MSSM Higgs

Cross Section

ggF
HIGLU (NLO QCD+EW)
HPro (NLO QCD)
FEHiPro (NNLO QCD+EW)
HNNLO (NNLO QCD)
ggh@NNLO (NNLO QCD)

VBF
VV2H (NLO QCD)
VBFNLO (NLO QCD)
HAWK (NLO QCD+EW)

WH/ZH
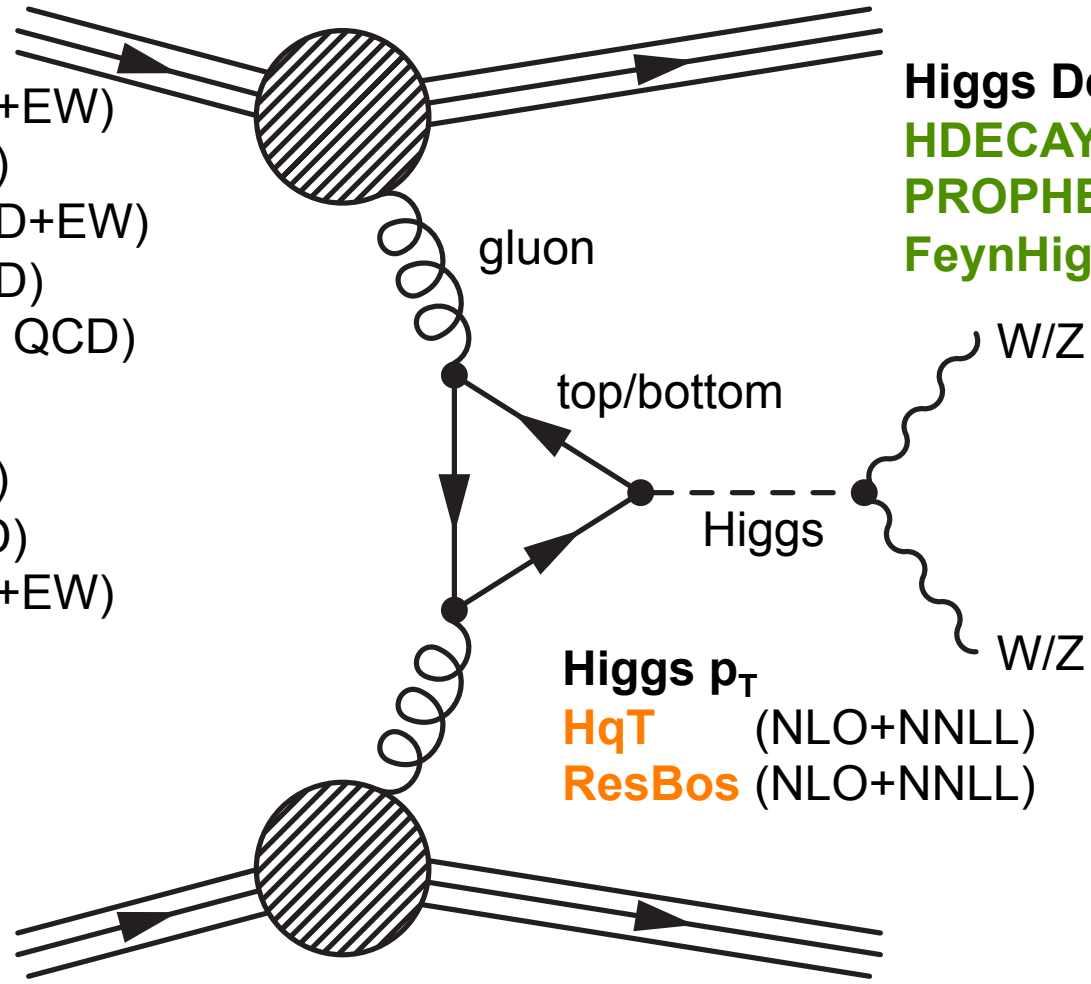**V2HV** (NLO)

ttH
HQQ (QCD LO)

bbH
bbH@NNLO (NNLO)

+ private codes.

gluon

top/bottom

Higgs

Higgs Decay
HDECAY (NLO)
PROPHECY4f (NLO)
FeynHiggs, CPSuperH

W/Z

W/Z

Higgs p_T
HqT (NLO+NNLL)
ResBos (NLO+NNLL)

PDF: MSTW, CTEQ, NNPDF, etc.

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Outlook

- ATLAS and CMS want to use most precise NNLO inclusive cross sections for 7TeV data Higgs analyses.
  - Higgs cross section and BR calculations are pretty mature now.
  - NNLO(+NNLL) ready for ggF, VBF, VH, and NLO for ttH.
  - Data driven background estimation will be performed.
- Next step is to study the exclusive Higgs cross sections.
  - Differential distributions for Higgs signal, ex. Higgs p_T.
  - Cross sections with experimental cuts.
  - Comparison with LO PS MC and NLO MC, normalization to NNLO.
- How one can estimate the theoretical error in data-driven background estimation?
  - Study the theoretical errors for SM background processes that are relevant to Higgs.
  - Data-driven method, ex. qq/gg→WW/ZZ estimation in H→WW/ZZ.

7 TeV Higgs Cross Section and BRs

- Standard Model Input Parameters
  - It is very important to assure common inputs for Higgs and SM XS.

  https://twiki.cern.ch/twiki/bin/view/LHCPhysics/SMInputParameter
  - Replace W-width Γ_W=2.141±0.041 GeV (PDG) with theory prediction?
- Cross Section Calculation
  - M_H=[90,1000]GeV (up to meaningful Higgs mass)
  - Δ=5GeV step for [90,200]GeV, Δ=10-50GeV for [200,1000]GeV.
  - Should be coherent among ggF, VBF etc. and MC for later combination.
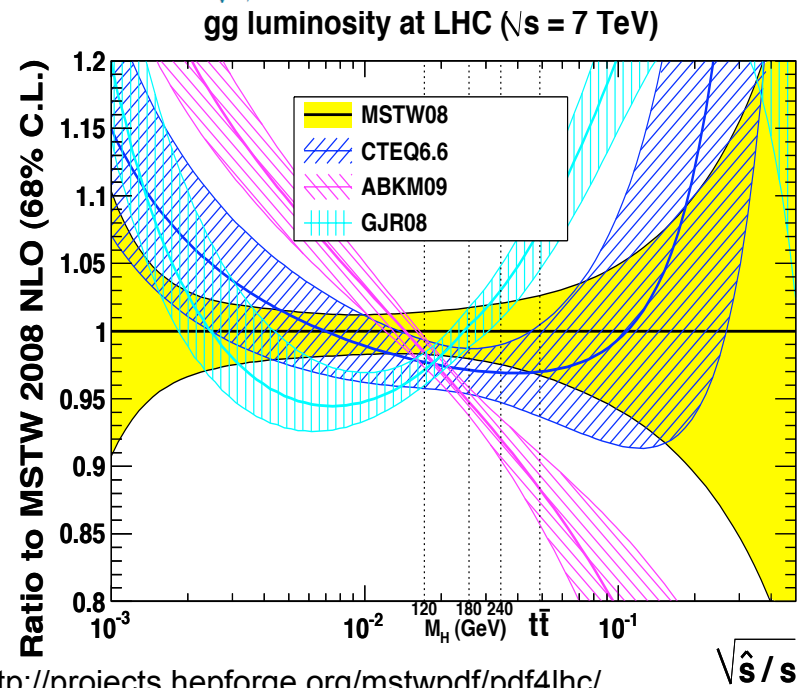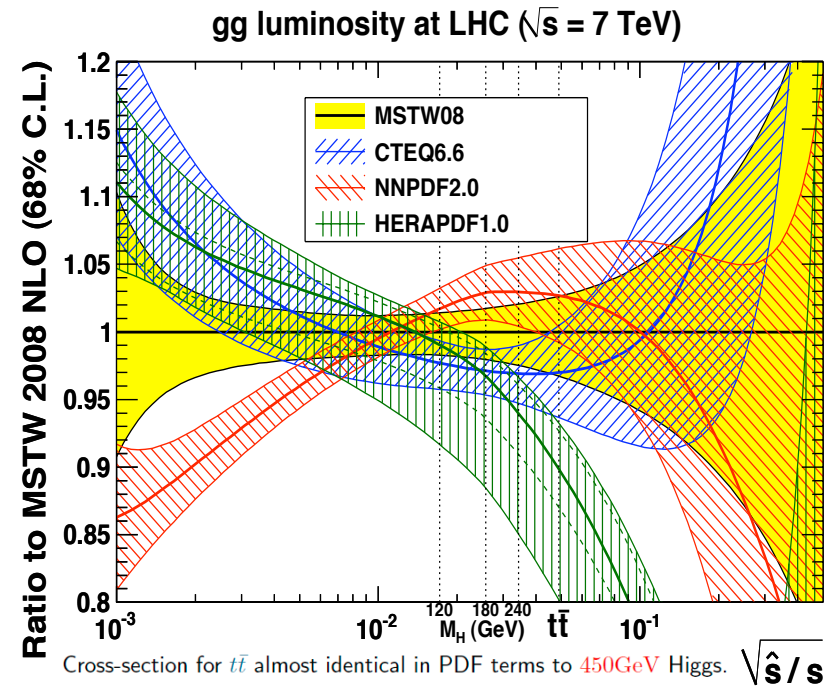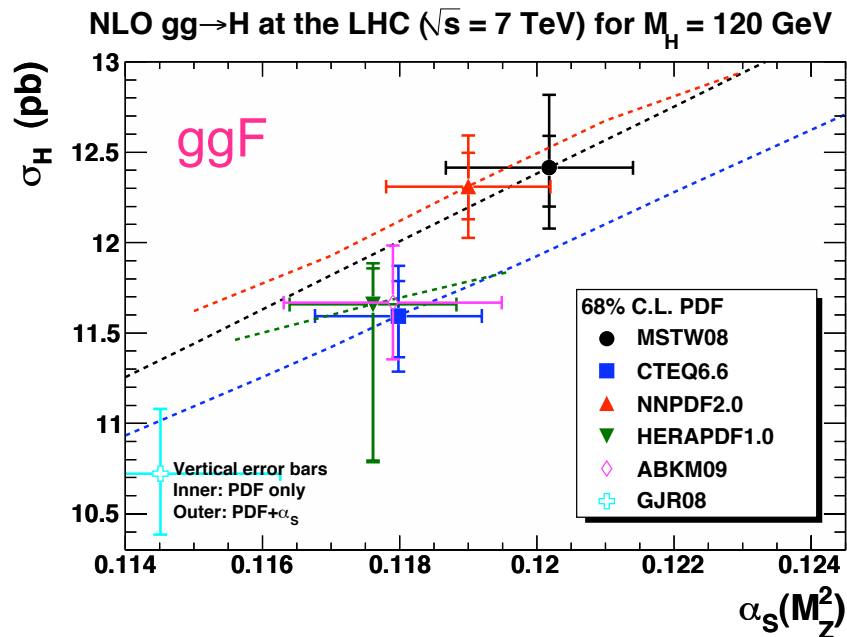- Common PDF set
  - Try PDF4LHC recipe

PDF4LHC Recipe

- In February, we have asked PDF4LHC working group the recommendation on PDFs and in α_s values (and their uncertainties).

- PDF4LHC group decided to study LHC benchmark processes: $W^\pm, Z^0, t\bar{t}, gg \rightarrow H \ (M_H = 120, 180, 240 \text{ GeV})$

- PDF4LHC Recipe (June 2010)
  - Use global fit PDF sets: MSTW, CTEQ and NNPDF
    - HERAPDF, ABKM and (G)JR are optional but recommend to check.
  - Take midpoint for central value
  - $\Delta\alpha_s = \pm 0.0012$ for 68% C.L. and ± 0.0020 for 90% C.L.
  - Envelope method for errors
  - Use NLO PDF error estimation via envelope method for NNLO

PDF4LHC http://www.hep.ucl.ac.uk/pdf4lhc/

PDF4LHC Working Group

PDF benchmarking, G.Watt
http://projects.hepforge.org/mstwpdf/pdf4lhc/

gg luminosity at LHC ($\sqrt{s}$ = 7 TeV)

Cross-section for $t\bar{t}$ almost identical in PDF terms to $450\,\mathrm{GeV}$ Higgs.
Also $H + t\bar{t}$ at $\sqrt{\hat{s}/s} \sim 0.1$.

NLO gg→H at the LHC ($\sqrt{s}$ = 7 TeV) for M_H = 120 GeV

gg luminosity at LHC ($\sqrt{s}$ = 7 TeV)

Dotted lines show how central PDF predictions vary with $\alpha_S(M_Z^2)$.   http://projects.hepforge.org/mstwpdf/pdf4lhc/

Goals of this workshop

1) **Come to the agreement on QCD and PDF+α_s error definitions for inclusive cross sections.**

   ➢ We intend to publish the results as CERN Yellow Report to be ready by the next Bari Workshop in November.

2) **Strategy for exclusive calculations with NLO MC and the SM background study.**

   ➢ Study the Higgs signal exclusive distributions and the cross section within the acceptance.

   ➢ Study the theoretical errors on the SM backgrounds that are relevant to Higgs. This will be a very good occasion to open the new horizon of our activities, and we shall call for more contributions from ATLAS, CMS and Theory community.

3) **Theory and Experimental errors.**

   ➢ We shall discuss theoretical errors. Also experimental errors related to theory (ex. theory error in data-driven method).

Round Table Discussion
Tuesday Afternoon, July 6

- PDF4LHC recipe: PDF+α_s definition, envelope or others?

- MC at NLO: exclusive calculation study like Higgs p_T?

- Beyond SM/MSSM scenario?

- SM background study in H→γγ, WW and ZZ via data-driven?

- Theoretical and Experimental error assignment?

- Publish or Perish?

- Future Workshops?

For discussion materials, please check the InDico agenda.

http://indico.cern.ch/conferenceOtherViews.py?view=standard&confId=92082

Subgroup Contacts:

Please write the minutes of the subgroup session.

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Communication Tools

- Mailing List, InDico, TWiki … any request?
- SharePoint … please try it. Several groups are using.
  - https://espace.cern.ch/lhc-higgs/
- Common Repository … we will go for SVN (CERN default)

Future

- Publication
  - CERN Yellow Report by Bari workshop (November)?
    - We are already well advanced in inclusive cross sections and BRs.
  - Citation policy on theory papers is very important.
- Future Workshops
  - Bari in November 4 (Thu.) – 5 (Fri.), 2010.
  - BNL in Spring/Summer 2011, Paris (LAL/LLR) in Autumn 2011?

LHC Status

- Goal $\int Ldt = 1fb^{-1}$

  by the end of 2011

- New record last week

  with 7x7 bunches

  Peak lumi. $L \sim 10^{30}$ cm^{-2} s^{-1}

2010 goal: $L = 10^{32}$ cm^{-2} s^{-1}

  (800 bunches, $\beta = 3.5$m)

http://lpc.web.cern.ch/lpc/

2010/07/02   11.20

LHC 2010 RUN (3.5 TeV/beam)
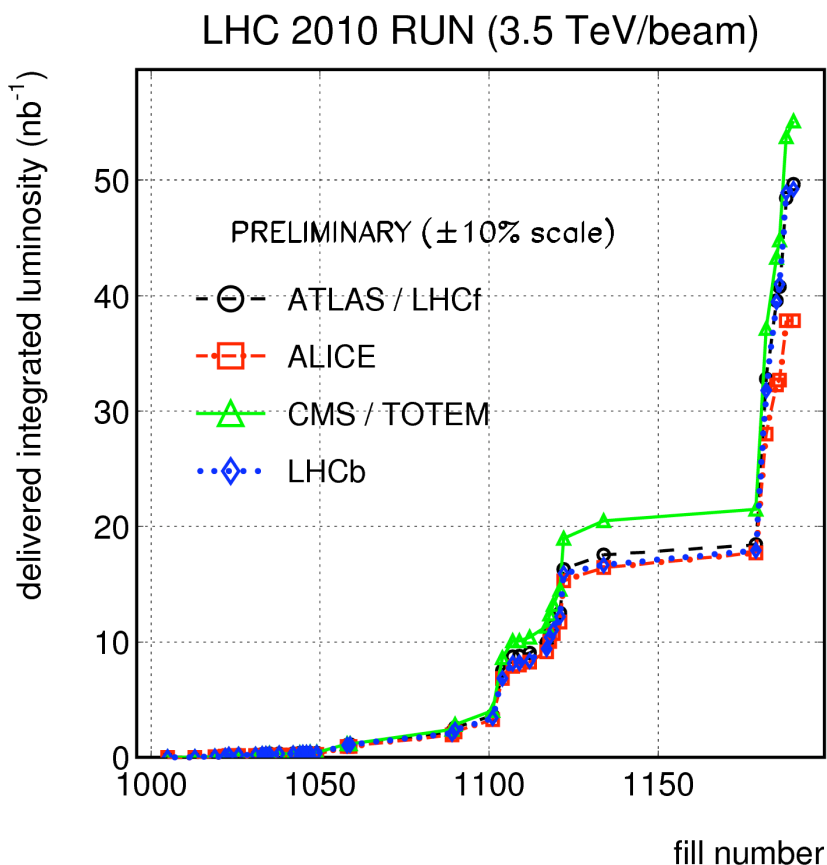
$\int Ldt > 50$nb^{-1} delivered LHC luminosity.

$\rightarrow$ Each ATLAS/CMS should have observed ~1 event of 120 GeV/c^2 Higgs (H$\rightarrow$bb)

  σ_{SM}(ggF+qqH+VH+ttH)=13.6 pb @ 7 TeV

Wish to have fruitful and clear discussions !

No Goooal !!!

Higgs Field