



Bundesministerium für Bildung und Forschung





Oliver Rieger University of Hamburg 21.11.2016 SFB 676 Meeting





Bundesministerium für Bildung und Forschung



Part ONE

... introduces concepts and results of the LHC *run1* analysis





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Part ONE

... introduces concepts and results of the LHC *run1* analysis

Part TWO

- Reloaded analysis at 13 TeV
- Ideas and improvements for LHC *run2* analysis





- Higgs mechanism provides masses for gauge bosons and fermions
- Spontaneous symmetry breaking: Non-zero vacuum expectation value → particles acquire a mass
- Couplings proportional to particle mass

 $\lambda_f \propto rac{m_f}{v}$ and $\lambda_W^2 \propto g M_w$



- bb (0.58)
- ττ (0.063)
- CC (0.029)
- μμ (0.00022)



- WW (0.21)
- gg (0.081)
- ZZ (0.026)
- γγ (0.0023)
- Z+γ (0.0015)





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reduced coupling



and in combination with ATLAS









Are we talking about the same mass generation mechanism for all lepton generations?





Are we talking about the same mass generation mechanism for all lepton generations? CMS, 4.9 fb⁻¹ at 7 TeV, 19.7 fb⁻¹ at 8 TeV т_н = 125 GeV 0-jet 0.34±1.09 CERN-PH-EP/2014-001 2014/06/13 CMS $\lambda_{\tau\tau h}$ 1-jet CMS-HIG-13-004 1.07±0.46 2-jet (VBF tag) Evidence for the 125 GeV Higgs boson decaying to a pair of 0.94±0.41 τ leptons $II+LL' + I+L\tau_h$ The CMS Collaboration* τ^+ -0.33±1.02 Η→ττ 0.78±0.27 0 2 4

Best fit μ



















21.11.2016







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<u>Main Challenge</u>

Very small branching fraction for $h \rightarrow \mu\mu$

- Consider all Higgs production mechanisms
 - \rightarrow Target topologies with enhanced S/B
 - \rightarrow Profit from the best muon p_T resolution
- Good description of signal/background events

Run I Analysis: Event Selection





















CMS Integrated Luminosity, pp

CMS Integrated Luminosity, pp, 2016, $\sqrt{s} =$ 13 TeV

Data included from 2016-04-22 22:48 to 2016-10-27 14:12 UTC Data included from 2010-03-30 11:22 to 2016-10-27 14:12 UTC 45 45 60 60 LHC Delivered: 41.07 fb^{-1} Total Integrated Luminosity ($m fb^{-1}$) **2010, 7 TeV, 45.0** pb⁻¹ Total Integrated Luminosity ($m fb^{-1}$) 40 40 CMS Recorded: 37.82 fb^{-1} **2011, 7 TeV, 6.1** fb^{-1} 50 50 **2012, 8 TeV, 23.3** fb^{-1} 35 35 **2015, 13 TeV, 4.2** fb^{-1} **CMS Online Luminosity** 30 30 40 **2016, 13 TeV, 41.1** fb^{-1} 40 25 25 30 30 20 20 20 20 15 15 10 10 10 10 5 5 n 0 1 NON 0 1 Apr 1 May 1 Jun 2 Jul 1 AUG 1 Sep 1^{0ct} 1 Dec 2 101 2 Jun 1 sep 1^{0ct} 1 May 1 Aug Date (UTC) Date (UTC)









Evidence could become feasible after LHC run2





Reload Analysis at 13 TeV

Run II Analysis: Reloaded at 13 TeV





Run II Analysis: Reloaded at 13 TeV





Run II Analysis: Universität Hamburg Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG



Run II Analysis: Updated Event Selection





Run II Analysis: updated Event Selection





Run II Analysis: Updated Event Selection

Universität Hamburg







Remove the bias from:

- detector misalignments,
- reconstruction software,
- uncertainties in the magnetic field



'Rochester corrections'



Z mass constrained correction

- Z mass peak is used for finer tuning of the corrections
 Independent from
- Independent from any physics modelling

References for the method :

EPJC V72, 10.2194 (2012) (arXiv:1208.3710[hep-ex]) AN-2012/062, AN-2012/298

> μ^+ : -2. 4 < η < -2. 1 (used muons: isolated, tight ID, p_T and η criteria) SFB 676 Meeting | SM Higgs Decays to Muons

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Muon momentum CORRECTIONS work in progress



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Higgs MC studies!

Outlook (ToDo):

- Apply all corrections (PileUp reweighting, Muon SF, Trigger,...)
- Data/MC comparison

Understand the different effects on data and MC!





 σ_{SM}

- Summary of the LHC *run1* analysis \geq 7,4 (6.5^{+2.8}_{-1.9}) observed (expected) 95% CL limit on $\frac{\sigma}{-1.9}$
- $h \rightarrow \mu\mu$ evidence could become feasible ($L_{int} = 300 \text{ fb}^{-1}$)
- Overview of challenges, plans and ideas for LHC run2
- First look into muon momentum corrections and their improvements on $Z \to \mu \mu$





BackUp





Higgs MC studies!







Higgs MC studies!

