

WG3 Introduction

Anna Goussiou (ATLAS), David Sperka (CMS),
Zhen Liu & Pietro Slavich (TH)

The 16th Workshop of the LHC Higgs Cross Section Working Group,
CERN, 16-18 November 2019

Organization of the BSM-Higgs Working Group (WG3)

- Extended Higgs Sector (neutral + charged) Xiangyang Ju (ATLAS, 0), Jana Schaarschmidt (ATLAS, \pm)
Raffaele Gerosa (CMS, 0), Jan Steggemann (CMS, \pm)
Heather Logan, Rui Santos & Shufang Su (TH)
- MSSM Tim Barklow (ATLAS), Andrew Gilbert (CMS)
Stefan Liebler, Pietro Slavich & Michael Spira (TH)
- NMSSM Nikos Rompotis (ATLAS), Nadjieh Jafari (CMS)
Ulrich Ellwanger & Margarete Mühlleitner (TH)
- Exotic Higgs Decays Lily Morvaj (ATLAS), Cécile Caillol (CMS), Lorenzo Sestini (LHCb)
Zhen Liu & Jessie Shelton (TH)

Organization of the BSM-Higgs Working Group (WG3)

- **Extended Higgs Sector (neutral + charged)**
Xiangyang Ju (ATLAS, 0), Jana Schaarschmidt (ATLAS, ±)
Raffaele Gerosa (CMS, 0), Jan Steggemann (CMS, ±)
Heather Logan, **Rui Santos** & Shufang Su (TH)
- **MSSM**
Tim Barklow (ATLAS), **Andrew Gilbert** (CMS)
Stefan Liebler, Pietro Slavich & Michael Spira (TH)
- **NMSSM**
Nikos Rompotis (ATLAS), Nadjieh Jafari (CMS)
Ulrich Ellwanger & **Margarete Mühlleitner** (TH)
- **Exotic Higgs Decays**
Lily Morvaj (ATLAS), **Cécile Caillol** (CMS), Lorenzo Sestini (LHCb)
Zhen Liu & Jessie Shelton (TH)
- **Coming soon:**
- **bbH/bH associated production process**
Lei Zhang (ATLAS), Abdollah Mohammadi (CMS)
Michael Spira & Marius Wiesemann (TH)

General tasks of the WG3

- Develop benchmark scenarios for interpreting Higgs searches in BSM models
- Identify missing signatures and assess the feasibility of new Higgs searches
- Develop/maintain/combine tools for the calculation of physical observables

General tasks of the WG3

- Develop benchmark scenarios for interpreting Higgs searches in BSM models
- Identify missing signatures and assess the feasibility of new Higgs searches
- Develop/maintain/combine tools for the calculation of physical observables
- Ensure a correct description of TH/PH issues in EXP publications

General tasks of the WG3

- Develop benchmark scenarios for interpreting Higgs searches in BSM models
- Identify missing signatures and assess the feasibility of new Higgs searches
- Develop/maintain/combine tools for the calculation of physical observables
- Ensure a correct description of TH/PH issues in EXP publications
(e.g., CMS asking the MSSM conveners to preview the relevant paragraphs)

General tasks of the WG3

- Develop benchmark scenarios for interpreting Higgs searches in BSM models
- Identify missing signatures and assess the feasibility of new Higgs searches
- Develop/maintain/combine tools for the calculation of physical observables
- Ensure a correct description of TH/PH issues in EXP publications
(e.g., CMS asking the MSSM conveners to preview the relevant paragraphs)

Shouldn't such checks enter the standard workflow of all ATLAS/CMS publications on BSM Higgs?

Plenary Session Schedule

| | | |
|-------|--|---|
| 09:00 | Introduction <i>503/1-001 - Council Chamber, CERN</i> | 09:00 - 09:10 |
| | Summary of "Extended Higgs Sector" group activities <i>503/1-001 - Council Chamber, CERN</i> | <i>Rui Santos</i> 09:10 - 09:40 |
| | Summary of "Exotic Higgs Decays" group activities <i>503/1-001 - Council Chamber, CERN</i> | <i>Cecile Sarah Caillol</i> 09:40 - 10:10 |
| 10:00 | Summary of "MSSM" group activities <i>503/1-001 - Council Chamber, CERN</i> | <i>Andrew Gilbert</i> 10:10 - 10:40 |
| | Higgs and Long-Lived Particles <i>503/1-001 - Council Chamber, CERN</i> | <i>Matthew Daniel Citron</i> 10:40 - 11:10 |
| 11:00 | Coffee Break <i>503/1-001 - Council Chamber, CERN</i> | 11:10 - 11:40 |
| | Recommendations for the presentation of auxiliary information in BSM Higgs searches <i>503/1-001 - Council Chamber, CERN</i> | <i>Sven Heinemeyer</i> 11:40 - 12:00 |
| 12:00 | Summary of "NMSSM" group activities [vidyo] <i>503/1-001 - Council Chamber, CERN</i> | <i>Milada Muhlleitner</i> 12:00 - 12:30 |
| | Summary of the activities of the LHC DM WG [vidyo] <i>503/1-001 - Council Chamber, CERN</i> | <i>Philip Coleman Harris</i> 12:30 - 13:00 |

HXSWG recommendations for the Run-2 legacy papers

- It started as a vague proposal: a chance for the WG3 theorists to tell the EXP collaborations what information they would like to find in the final Run-2 papers, and for the WG3 experimentalists to say if that is feasible or pie-in-the-sky
- SC input: focus on the presentation of auxiliary information meant to facilitate future re-interpretations of the Run-2 Higgs searches in different BSM scenarios
- Call for contributions from authors of re-interpretation codes: HiggsBounds/HiggsSignals, Lilith, ...
- Should our recommendations be limited to new-Higgs searches or also address the properties of the 125-GeV Higgs? (overlap WG2 – joint recommendations?)

HXSWG recommendations for the Run-2 legacy papers

- It started as a vague proposal: a chance for the WG3 theorists to tell the EXP collaborations what information they would like to find in the final Run-2 papers, and for the WG3 experimentalists to say if that is feasible or pie-in-the-sky
- SC input: focus on the presentation of auxiliary information meant to facilitate future re-interpretations of the Run-2 Higgs searches in different BSM scenarios
- Call for contributions from authors of re-interpretation codes: HiggsBounds/HiggsSignals, Lilith, ... **(NOTE: the call is open to more codes!)**
- Should our recommendations be limited to new-Higgs searches or also address the properties of the 125-GeV Higgs? (overlap WG2 – joint recommendations?)

Early discussions on new-Higgs searches in a nutshell:

TH request:

EXP reaction:

- Model-independent 95% exclusion limits (both expected and observed) as function of all relevant parameters (mass, width...)
- The same for the exclusion likelihoods

Early discussions on new-Higgs searches in a nutshell:

TH request:

- Model-independent 95% exclusion limits (both expected and observed) as function of all relevant parameters (mass, width...)
- The same for the exclusion likelihoods

EXP reaction:

Feasible !

Early discussions on new-Higgs searches in a nutshell:

TH request:

- Model-independent 95% exclusion limits (both expected and observed) as function of all relevant parameters (mass, width...)
- The same for the exclusion likelihoods

EXP reaction:

Feasible!



Early discussions on new-Higgs searches in a nutshell:

TH request:

- Model-independent 95% exclusion limits (both expected and observed) as function of all relevant parameters (mass, width...)
- The same for the exclusion likelihoods

EXP reaction:

Feasible!



However...

The likelihoods have already been provided in $pp \rightarrow \phi \rightarrow \tau^+ \tau^-$ searches, and they proved very useful in global fits of BSM models

Early discussions on new-Higgs searches in a nutshell:

TH request:

- Model-independent 95% exclusion limits (both expected and observed) as function of all relevant parameters (mass, width...)
- The same for the exclusion likelihoods

EXP reaction:

Feasible!



However...

The likelihoods have already been provided in $pp \rightarrow \phi \rightarrow \tau^+ \tau^-$ searches, and they proved very useful in global fits of BSM models

Don't miss Sven's talk and the parallel discussion this afternoon!!!

Schedule of the afternoon discussion session for WG3

- 14:30 – 15:45 Joint session with the HH group
- 16:00 – 17:00 Discussion with VBF group on the use of “HXS4BSM” numbers
- 17:00 – 18:00 Discussion on the “Recommendations” business

HXS4BSM and its discontents

“SM-like” cross-section predictions for a scalar with mass different from 125 GeV

What for?

- “unit of measure” to compare with model-dependent BSM-Higgs XS
- also used directly to compute BSM-Higgs XS by rescaling couplings

The HXS4BSM manifesto (November 2015):

https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWGCrossSectionsCalc#2_BSM_Higgs_boson_production_cro

The numbers: https://twiki.cern.ch/twiki/pub/LHCPhysics/LHCHXSWG/Higgs_XSBR_YR4_update.xlsx

*How to account for model-dependent effects when using these “rescaled” BSM-Higgs XS?
(e.g. width effects; interference with backgrounds or with SM Higgs)*

The question was raised again in a recent CMS search for $VV \rightarrow \phi \rightarrow VV$ (HIG-17-033)

HXS4BSM and its discontents

“SM-like” cross-section predictions for a scalar with mass different from 125 GeV

What for?

- “unit of measure” to compare with model-dependent BSM-Higgs XS
- also used directly to compute BSM-Higgs XS by rescaling couplings

The HXS4BSM manifesto (November 2015):

https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWGCrossSectionsCalc#2_BSM_Higgs_boson_production_cro

The numbers: https://twiki.cern.ch/twiki/pub/LHCPhysics/LHCHXSWG/Higgs_XSBR_YR4_update.xlsx

*How to account for model-dependent effects when using these “rescaled” BSM-Higgs XS?
(e.g. width effects; interference with backgrounds or with SM Higgs)*

The question was raised again in a recent CMS search for $VV \rightarrow \phi \rightarrow VV$ (HIG-17-033)

If you are a provider or a user of HXS4BSM numbers, join the discussion this afternoon!