

# HL/HE-LHC WG1

## Introduction to topical meetings

Patrizia Azzi (CMS)

Stephen Farry (LHCB)

Paolo Nason (TH)

Alessandro Tricoli (ATLAS)

Dieter Zeppenfeld (TH)

## Goals of the HL-LHC Workshop

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- Provide a detailed assessment of the physics reach of the upgraded detectors with  $\sim 3 \text{ ab}^{-1}$ 
  - Interplay of detectors for reconstruction
    - Harsh environment – pile-up of 200
  - Careful assessment of the systematic limitations for physics measurements
    - How far can the systematic uncertainty be pushed?
- Documented Physics reach will be the basis of any new project at the energy frontier: ILC, HE-LHC, CLIC, FCC
- The Precision of HL-LHC will *talk to other* projects: Belle 2, SHiP, EDM, etc.
  - Assess the Physics reach of the Energy Doubler Option with high-field magnets which is the natural step toward a higher energy hadron collider

*highest experimental potential*

# Expected Contributions to WG1

- **WG1 activities includes SM&Top physics**
  - **Experimental analysis prospects for HL and HE**
  - **Theoretical predictions for HL and HE**
  - **Goal to prompt collaboration across experiments, and between theorists and experimentalists on specific topics to ensure good coverage and coherence of results**
- **Theorists will help define analysis goals and strategies, and will mostly focus on providing predictions for several key processes and interpretations of experimental inputs (e.g. PDF, EFT pseudo-data fits)**
- **Experimentalists are mostly focused on HL-LHC, but we expect several analyses will be extended to HE-LHC under the same performance assumptions as HL. Few new HE-only analysis are also expected**

# HL/HE-LHC Reference parameters for YR

- **Reference parameters**

- **HL-LHC**

- $\sqrt{s}=14 \text{ TeV}, 3 \text{ ab}^{-1}$  for ATLAS, CMS (LHCb up to  $300 \text{ fb}^{-1}$ )

- for some processes we may want to show evolution of results for lumi above  $3 \text{ ab}^{-1}$

- **HE-LHC**

- $\sqrt{s}=27 \text{ TeV}, 15 \text{ ab}^{-1}$

- for some processes we may want to show evolution of physics reach vs  $\sqrt{s}$ , e.g. 24-30 TeV

# Organization of Workshop structure and timeline

**Steering committee:** Michelangelo Mangano (TH, chair), Gavin Salam (TH), Aleandro Nisati (ATLAS), Andrea Dainese (ALICE), Andreas Meyer (CMS), Mika Vesterinan (LHCb)

## Working Groups:

1. SM&TOP
2. Higgs
3. BSM
4. Flavour
5. Heavy Ion

## Timeline:

- 18-20 June 2018 - Plenary meeting @CERN
- September 2018: Full Draft Chapters (one per WG 150 Pages each)
- December 2018: Submission

# WG1 current table of contents

## 1. Introduction

## 2. Theoretical tools

1. MC Generators
2. High Order QCD calculations
3. EW corrections
4. PDF tools
5. EFT tools

## 3. Electroweak processes

1. Vector boson fusion processes
2. Vector Boson scattering
3. Triboson production
4. Precision EW measurements
5. Forward EW physics

## 4. Strong Interactions

1. Jets and photons
2. Ultimate Parton Densities
3. Forward QCD physics

## 5. Top physics

1. Top cross section
2. Top properties
3. Top couplings
4. Top mass
5. FCNC

## 6. Effective coupling interpretations (SM & Top)

- The aim is to embed in SM/Top chapter both HL and HE studies
  - a chapter will start with the presentation of HL studies and then conclude with HE prospects

# WG1 Topic List (EW, QCD)

- **WG1 strategy is to spread analysis effort across experiments/theorists as much as possible**
  - i.e. whenever possible minimize analysis overlap between experiments, unless cross-checks or combinations are necessary/foreseen
  
- **SM - Electroweak**
  - VBS - same-sign WW
  - Triboson cross-sections
  - VBS – WZ
  - VBS - WV semileptonic/boosted
  - VBS ZZ
  - VBF W/Z (aTGC limits)
- **SM - QCD**
  - jets and photons
  - PDF fits
- **SM – Precision Physics with W/Z**
  - Z forward-backward asym. and weak mix. angle
  - PDF fits
  - W mass
  
- **SM - Forward QCD physics**
  - DPS e.g. same-sign WW, ZZ prod.
  - Small-x QCD with Higgs boson
- **SM - Forward EWK physics**
  - Light-by-Light scattering in pp
  - Other photon-induced processes, e.g.  $yy \rightarrow ll$ ,  $yy \rightarrow ZZ$ ,  $yy \rightarrow WW$ ,  $yy \rightarrow H$  in pp or UPC, in the context of SM measurements and for limit setting on anomalous couplings (EFT)

# WG1 Topic List (Top)

- **WG1 strategy is to spread analysis effort across experiments/theorists as much as possible**
  - i.e. whenever possible minimize analysis overlap between experiments, unless cross-checks or combinations are necessary/foreseen
  
- **Top – cross section**
  - ttbb, ttH (h->bb)
  - s-channel single top
  - 4-tops
- **Top - Properties**
  - Dead-cone
  - Charge Asymmetry
  - Spin correlations
- **Top - Mass**
  - with J/Psi
  - standard measurement
  
- **Top – couplings**
  - Tt-gamma
  - tt-W/V
- **FCNC**
  - t->Hq (q=c,u and H->yy)
  - tqH (H->bb) in production
  - tZq (production)
  - t->Zq (decay)
  - Single top: tqg, tqg vertices (q=u,c)

# Remarks on HE-LHC and Simulation

- **LHC physicists have the best know-how & simulation+analysis experiences to develop work and investigate physics potential of the “energy upgrade” of the LHC, HE-LHC**
  - Simulation tools have been prepared for HL-LHC physics studies in Experimental TDR's for LHC Phase-II upgraded detectors
  - Particle-level MC studies are important: provide expected cross-section/rates of the most important physics objects produced at HE-LHC
- **HE-LHC studies can be:**
  - 1) **Integrated HE-LHC studies:** HE-LHC studies can be included in HL-LHC analyses to compare the physics results obtained for a given physics process assuming these two colliders. Performance of the LHC Upgrade Detectors can be assumed for both scenarii for simplicity
  - 2) **Standalone HE-LHC studies:** are also welcome, especially from theorists: here you can consider the performance of a generic detector at present/future hadron colliders
    - **Delphes simulation package** is default tool to include a generic modern hadron collider detector response in the simulation studies
- **DELPHES** configuration for a generic detector is available: this page will also contain info on general MC samples that may become available for HE-LHC  
[https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HLHEWG\\_MC](https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HLHEWG_MC)

# WG1 work organization strategy

- **Collection of topics from interested parties on public google doc:**
  - <https://tinyurl.com/yaew28lx>
  - Agendas have been filled starting from this
  - Now is the time to come up with new additions!
- **First set of working meetings (last week and today), split up by block of topics.**
  - To meet the actual contributors
  - To have an overview of the topics that can be achieved
  - To have an overview of the timeline
  - To share or combine work between experiments or between experiments and theory
  - To have a better planning of how the contributions will end up in the final write-up
  - Identify and list concrete tasks for the write-up
- **Also:**
  - Identify group of people (theorists and experimentalists) with same interests such that they can develop coherent strategy and collaborations towards the YR

# Next appointments

Next general meeting in June 18-20 2018:

<https://indico.cern.ch/event/686494/overview>

Would like another set of intermediate meetings divided in topics like these ones

Different style of Agenda:

- give space to work that have matured by then
- make a check of what is developing and what is stuck
- See if anything very necessary is missing?
- Update the timeline

Proposed period: end of April/Beginning of May 2018

# Conclusions

- The WG1 plans a fast ramp up of activities towards the YR
- This set of meetings will help identify
  - People interested at contributing to SM/Top studies
  - Studies that can be completed in the given time scale
  - Tasks towards the chapter write-up
- WG1 convenors will get in touch with contributors after these meetings to define work-flow, analysis collaborations and work schedule and monitor progress
- We welcome ideas and suggestions and of course more studies
- A new set of meetings to present analysis progress will be announced soon

# Back-up

# HL/HE-LHC YR Organization

YR Steering

## Overall Coordination

[Michelangelo Mangano]

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**ATLAS Contact – CMS Contact – LHCb Contact – ALICE Contact – Theory Contact**

**Aleandro Nisati    Andreas Meyer    Mika Vesterinen    Andrea Dainese    Gavin Salam**

### WG1: Standard Model

**Alessandro Tricoli** – ATLAS  
Patrizia Azzi – CMS  
Stephen Farry – LHCb  
Paolo Nason – Theory  
Dieter Zeppenfeld – Theory

### WG2: Higgs

**Marumi Kado** – ATLAS  
Maria Cepeda – CMS  
Phil Ilten – LHCb  
Stefania Gori – Theory  
Francesco Riva – Theory

### WG3: BSM

**Monica D'onofrio** – ATLAS  
Keith Ulmer – CMS  
Xabier Cid Vidal – LHCb  
Patrick J Fox – Theory  
Riccardo Torre – Theory

### WG4: Flavour Physics

**Alex Cerri** – ATLAS  
Sandra Malvezzi – CMS  
Vladimir Gligorov – LHCb  
Jorge Camalich – Theory  
Jure Zupan – Theory

### WG5: Heavy Ions

**Zvi Citron** – ATLAS  
Yen-Jie Lee – CMS  
Michael Winn – LHCb  
Jan Fiete  
Grosse-Oetringhaus – ALICE  
Urs Wiedemann – Theory  
John Jowett – LHC