

HL/HE-LHC WG1

Introduction to topical meetings

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Goals of the HL-LHC Workshop

- 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**
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- **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 fb^{-1})

- for some processes we may want to show evolution of results for lumi above 3 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)

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**
 4. Top cross section
 5. Top properties
 6. Top couplings
 7. Top mass
 8. 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

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 (this week), 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 18-22. 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]

+

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