HL/HE-LHC WG1 Introduction to topical meetings

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From Eckhard Elsen Intro

Goals of the HL-LHC Workshop

- Provide a detailed assessment of the physics reach of the upgraded detectors with ~3 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?

highest experimental potential

- 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

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 analyses are also expected

HL/HE-LHC Reference parameters for YR

- **Reference parameters**
  - **HL-LHC**
    - **$\sqrt{s}$=14 TeV, 3 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 TeV, 15 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**
    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->ll, yy->ZZ, yy->WW, yy->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: tgq, 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]

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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