

WG1: Standard Model Working Group

QCD, EW and top Physics

CONVENERS:

Paolo Nason, Dieter Zeppenfeld - TH
Alessandro Tricoli - ATLAS
Patrizia Azzi - CMS
Stephen Farry - LHCb

Presented by P. Nason, CERN and INFN, sez. di Milano Bicocca

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Goals:

- ▶ To identify problems and needs that can be dealt with in the following years (running will start in 2026)
- ▶ To document cross sections for the High Luminosity (HL) and High energy (HE) phase of the LHC, and areas where improvements are needed/desirable.
- ▶ To carry out analysis studies for the HL-HE phase.

Some of the questions discussed among conveners:

- ▶ For high energy, what is the projected luminosity?
- ▶ Are HL detector OK for HE? (Apparently, this will be the assumption)
- ▶ NLO, MC, NNLO (2 \rightarrow 3 by 2026?)
- ▶ Which new processes that will become accessible at HL-HE, and may require better precision?
- ▶ What will we need as far as EW NLO effects? NLO? EW Sudakov? EW Showers?
- ▶ Automatic tools in EFT framework: overlaps with WG3 (BSM), but uses typical methods and competence in WG1.

Suggestion by MLM: use

HL: 14TeV, 3 ab^{-1} ; HE: 27TeV, 15 ab^{-1}

SM physics topics

- ▶ Modeling of physics processes as backgrounds to Higgs and BSM (V +jets, di-bosons)
- ▶ Understand precision for W mass, lepton forward-backward asymmetry; Can it be done with high pile-up?
- ▶ Errors on production of very high mass systems, also very high transverse momentum (in connection with EFT)
- ▶ Vector Bosons, Vector boson pairs, 3 bosons, same + jets, also NNLO, (link with VBF, heavy stuff decaying in jets).
- ▶ VBF studies (also in view of pile-up, jet tagging problems, etc.)
- ▶ EFT global fits
- ▶ Status of jet physics, in connection with NLO calculations of observables involving jets, dijets at NNLO; High Energy limit;
- ▶ Boosted Stuff; Interplay between SM and Exotics searches, e.g. in boosted/semileptonic di-boson production.
- ▶ Heavy particles close/in/as jets: also W , Z , etc.

Top:

- ▶ Top cross section and production modeling
- ▶ Mass measurement
- ▶ Top properties
- ▶ FCNC; top at LHCb (Overlap with Flavour subgroup?)

Forward physics:

- ▶ How will it be studied at High Luminosity? Dedicated runs?
- ▶ Diffraction, rapidity gaps, etc.
- ▶ QCD, high-energy-small-x (BFKL etc.)
- ▶ Production of heavy object with jet vetoes, photon induced processes, etc.

QCD session:

- ▶ MC generators, F. Maltoni (TH)
- ▶ Jet and Photon physics, P. Starovoitov (EXP, ATLAS)
- ▶ HO QCD calculations, G. Zanderighi (TH)

Experimental results presented here are mostly those already made public by the collaborations.

We expect several new results to become public as part of current sub-detector TDRs for HL-LHC.

Expect new analyses as part of YR effort.

The purpose of the generic theory talks is to understand whether there are issues that require special attention.

Brief review on the state of the art, and some ideas and observations to stimulate discussion on what can be relevant to the HL-HE phase.

Program EW and Higgs

EW and Higgs session (joint session with WG2):

- ▶ HH production, Gudrun Heinrich (TH)
- ▶ High p_T Higgs production in gg , Keith Hamilton (TH)
- ▶ VV production, Marius Wiesemann (TH)
- ▶ EW physics, di- and multi-boson, VBF/VBS, Claire Lee (EXP, ATLAS)
- ▶ HO EW corrections, M. Schönherr (TH)

One generic TH talk on HO EW, with similar purpose as those on generators and HO QCD.

Focussed theory talks on cross sections for VV and HH pairs, and exp. review on EW physics, vector bosons, VBF/VBS,

High p_T Higgs: very specific request to one of the theorists that have done recent work on high p_T higgs production, following CMS measurement of $H \rightarrow bb$ at high p_T .

PDF and EW:

- ▶ PDF general talk, inc. EW effects, ep/eA DIS option, Lucian Harland-Lang (+ Juan Rojo and Jun Gao) (th)
- ▶ Experimental inputs to PDF fits: Amanda Cooper Sarkar (EXP ATLAS)
- ▶ EFT in VBF and VBS, Michael Rauch (TH)
- ▶ Precision EW measurements, Alexander Savin (EXP CMS)

For PDFs: L. Harland-Lang, J. Rojo and J. Gao have agreed to take care of PDF issues. They have written together a recent review on PDFs (arXiv:1709.04922), also including some high-luminosity prospect, and they represent three major PDF collaborations.

Also material from experts (C.Gwenlan, M. Klein, N. Armesto) on the subject of the ep/eA DIS.

Forward Physics:

- ▶ EW Physics in the forward region, Chitsanu Khurewathanakul (exp., LHCb)
- ▶ Forward Physics prospects, Roman Pasechnik (TH)
- ▶ DPS (double Parton Scattering), Photon induced production of vector bosons or jets, Marc Dunser (exp CMS)
- ▶ Diffractive forward physics and UPC (Ultra Peripheral Collisions), Christoph Mayer (exp. ALICE, covers also ATLAS and CMS).
- ▶ Brief presentation of COST project (VBS network) by Pietro Govoni.

Top physics

- ▶ Top production, Alexander Mitov (TH)
- ▶ EFT in Top Physics (TopFitter), Liam Ronald Moore (TH)
- ▶ Top Mass and cross sections, Pedro Silva (EXP CMS)
- ▶ Top properties and FCNC, Frederic Deliot (EXP ATLAS)

Flavour topics for top: in WG1 at the moment.

Workshop plans

- ▶ At this meeting we should define goals and tasks, and setup a time table.
- ▶ Define the WG boundaries, in relation to activities that may overlap with other WG (Higgs, Flavour, BSM).
- ▶ Organizing work for documenting cross sections (mostly TH).
- ▶ Define realistic analysis goals that can be proposed to the collaborations. Try to avoid duplication between ATLAS and CMS, split topics among the two experiments exploiting complementarity (good for manpower issues). Define the depth level for each study (only theoretical prediction, and to which accuracy; up to generator level; fast simulation; full simulation).
- ▶ Pair up experimentlists and theorists on common topics.

Milestones, deadlines and intermediate meetings

Schedule intermediate meetings (face-to-face, or Vidyo, or both) where people can informally show status reports, monitoring progress and discuss plans.

One possibility we are discussing is to have one or two longish meetings, plus some shorter vidyo meetings, restricted to more specific topics, with milestones and deadlines along the way. (also to be debated with organizers).