Workshop on
Ultimate Precision at Hadron Colliders

Institut Pascal, Paris-Saclay

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Institut Pascal

- Website:
  
  https://www.universite-paris-saclay.fr/fr/institut-pascal

- Scientific programme:
  

- Location:
  
  https://www.universite-paris-saclay.fr/fr/location-of-the-pascal-institute

- Support:
  
  - Good working environment (offices, meeting rooms, ...)
  
  - Accommodation for up to 20 people for two weeks
  
  - Limited support for travel (4 kEur)
All proposals downstream are for discussion!
Scientific objectives

- In short, try to estimate how far the LHC, its upgrades or companion machines, and low-energy data can push the exploration of QCD and Electroweak symmetry breaking by ~2035

- To be (re-)discussed:
  - QCD precision: pQCD developments; PDFs
  - Measurement precision of traditional EW parameters
  - Inputs from low-energy experiments
  - Higgs boson properties
  - TeV-scale vector boson scattering
  - Interpretation

Many documents were produced recently, or will come out this year. Complementarity?

- Context
  - HL-LHC
  - DIS: LHeC (EIC?) (a fundamental component)
  - HE-LHC
Proposed working groups

- **Topical studies**
  - A1: EW precision observables
    - W&Z mass, weak mixing angle, top mass and properties in relation with electroweak symmetry breaking.
  - A2: High energy probes of electroweak symmetry breaking
    - VBS measurements in relation with Higgs couplings. What deviations VBS are allowed and can be probed given the couplings of the Higgs? Impact of going from 14 to 27 TeV?
  - A3: Fundamental parameters at low energy
    - Prospects for g-2, $\Delta\alpha_{\text{had}}$, $\sin^2\theta_W$ in ep scattering
  - A4: Higgs boson properties
    - Limiting systematic uncertainties (not an exhaustive review), in particular related to PDFs and theoretical predictions. Where should we improve?
  - A5: EW fit & global interpretation
    - In particular, role of PDF uncertainties and correlations in global interpretation analyses. Impact of "ultimate PDFs" from various machines.
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Merge?
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● Transverse groups

  – B1: pp theory
    • Prospects for improved cross section predictions; impact on coupling measurements, PDF determination etc. Further parton shower MC developments (multilegs, NLO EW corrections..?)

  – B2: towards ultimate PDFs
    • critical review of HL-LHC and LHeC prospects. Are there limitations to be overcome to achieve the advertised precision (e.g. what is the required theory accuracy?)

  – B3: Experimental requirements.
    • Review of requirements on performance, referring to the available public documents.
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Needed?
Workshop structure

- Institut Pascal targets “long” workshops a la GGI, KITP, …

- Week 1
  - Morning: detailed, topical presentation + discussion
  - Afternoon: group activity (and/or a second detailed presentation?)

Each presentation would cover and question the area of a given working group

- Week 2
  - Plenary, open meeting with short presentations
  - One half day per WG
Workshop results & document (ambitious proposal)

- Define, in advance, a limited number of “money plots”, to be discussed at the workshop (and prepared as much as possible in advance). For example:
  - $m_W$ vs $\sin^2\theta$, experimental precision including correlations.
  - Higgs coupling overview. Self-coupling?
  - VBS cross sections; and implications on Higgs couplings to vector bosons (?)
  - Interpretation : EW fit, S/T/U,
  - PDF uncertainties

Everywhere relevant, present now / HL-LHC / HL-LHC+LHeC (or EIC) / HE-LHC

- If we manage, these results could be summarized in a relatively short document (15 pages?), with a clear message. Could be drafted ~rapidly following the workshop

- Goal : summarize the precision we can hope for at the LHC, to be used as a reference to evaluate the larger future projects
Relation with LPCC

- We would like this workshop to work as a joint meeting of the relevant LPCC working groups, dedicated to future prospects at the LHC

- Some WG's directly match their LPCC counterparts (e.g., A1/A5 and the EWWG, A4 and the HWG), and the IPa meeting can be seen as a topical meeting of the latter. Foreseen EWWG meetings during 2019 can be used for preparation.

- A3 (low energy) is disconnected from LPCC, but scientifically complementary

- For A2, the situation is unclear (to me) – a dedicated effort? How to prepare?

- Workshop document (previous page):
  - Should clarify connection with the EWWG documents in preparation (avoid overlap, conflicting statements, ...)
  - Realism can be assessed shortly before the workshop, as a function of how well the preparatory work will have progressed
Organization

- **Local organizers**
  - Fabrice, Louis, Marumi, Zhiqing and Maarten

- **Organizing committee**
  - Daniel Froidevaux; Gautier Hamel de Monchenault; Claude Charlot; Huasheng Shao; Lucia Di Ciaccio; Bogdan Malaescu; Luca Malgeri;
    - Awaiting a few answers from LHCb members

- **Advisory board**
  - Being formed; Michelangelo Mangano.
Organization

• Role of the organizing committee
  – Re-discuss WG perimeters, and workshop objectives. Missing or redundant topics?
  – Help find conveners of the WGs (can be yourself!)
  – Oversee the preparation of the workshop agenda, and the drafting of the workshop document
  – Advertise :)

• Role of WG conveners
  – Define perimeter of the detailed presentations of the 1st week; propose/invite speakers
  – Lead discussions
  – Oversee the preparation of the desired results ahead of the workshop
  – Define agenda of 2nd week