Maximizing the US investment at the LHC and beyond through a precise understanding of theoretical effects

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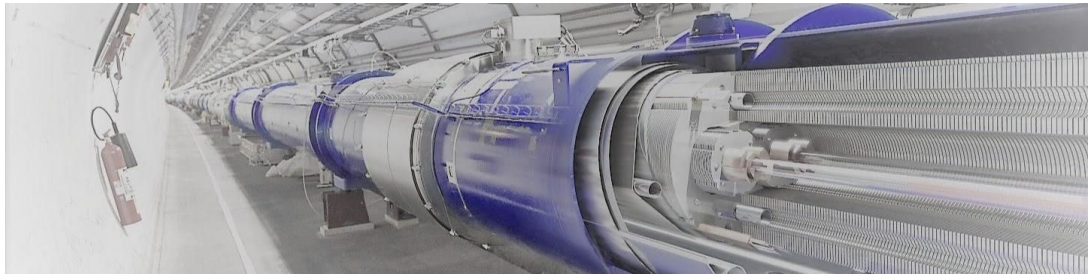
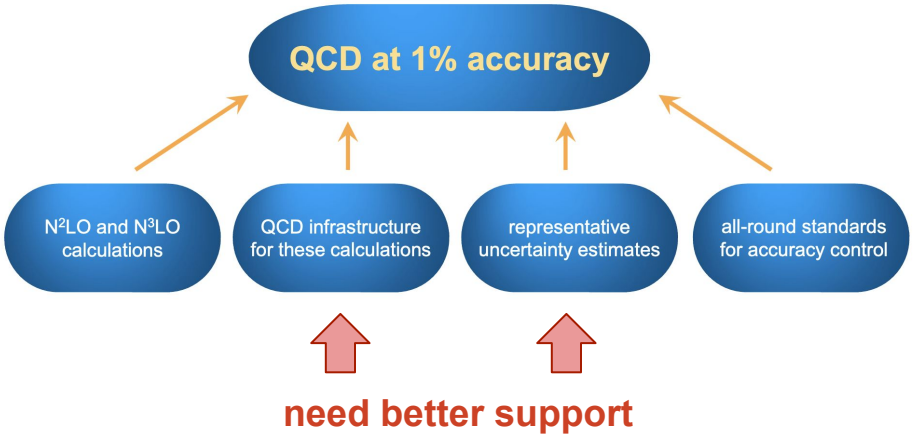
and authors of an open letter to P5 (in preparation)



HL-LHC needs precision theory **infrastructure**

- Ambitious experimental programs at the LHC and future colliders rely on a precise understanding of theoretical uncertainties
  - Important for several EF science drivers, including the Higgs boson, searches for dark matter, and more
  - Aiming for 1% precision on QCD to achieve these goals
    - arxiv.org/abs/2209.14872
  - Other theoretical effects (electroweak) also critical

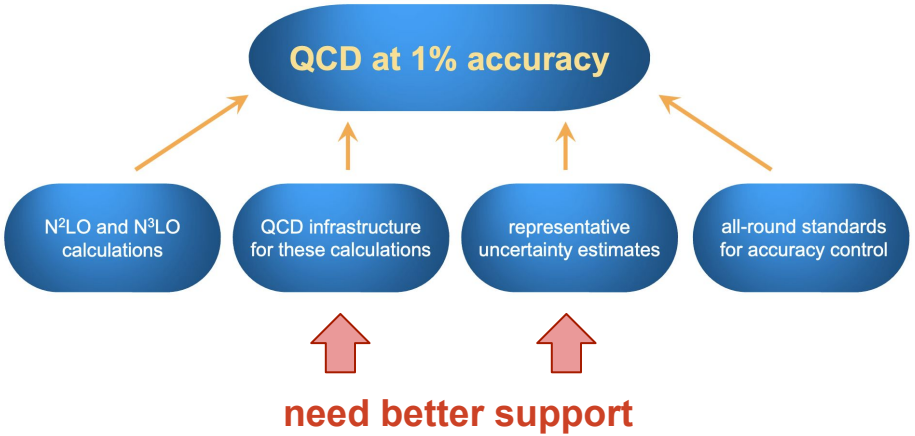


These goals require **both** NxLO theory calculations and compatible infrastructure (parton showering programs; parton distributions; efficient computer codes;...)

HL-LHC needs robust **uncertainty quantification**

Major hurdles toward achieving this goal

- LHC experiments are exceptionally complex
- Difficulties with quantifying systematic uncertainties in experiment and theory
- Precision measurements and improvements to systematic uncertainties take significant effort and expert knowledge
- Critical codes are developed and maintained by a small group of people with unstable funding
- Difficult to train and retain junior scientists with relevant expertise
- Need better ways to encourage close cooperation between theorists and experimentalists



This is all solvable, but requires a system-wide action!

The plan

- Following up on multiple discussions and town hall presentations by Neumann and Szafron with an open letter to P5 by a group of scientists from LHC collaborations and theory
  - *Comments still being accepted, plan to send in about a week*
- Suggesting several ways that P5 can support these efforts to enable the best use of the LHC data
  - Funding opportunities to encourage building communities across theory and experiment
  - Longer postdoctoral fellowships in phenomenology to enable long-term developments
  - Increased support for critical theoretical infrastructure
  - Involvement of experimentalists in the development of essential codes
  - … and more

For questions about the Open Letter or to join the discussions, please email Pavel Nadolsky (nadolsky@smu.edu), Stefan Hoeche (hoeche@fnal.gov) or Ashutosh Kotwal (ashutosh.kotwal@duke.edu)