Community Support for Physics with high-luminosity proton-nucleus collisions at the LHC

D. d'Enterria[1], I. Grabowska-Bold[2], C. Hadjidakis[3], J.P. Lansberg[3], R. McNulty[3,4], and N. Surname...[n]

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Introduction

Brian Petersen
Filip Moortgat

LPC Meeting
30 August 2021

Run 3 Luminosity Targets

- LPCs were asked to provide input on public luminosity targets beyond proton-proton lumi for ATLAS/CMS
  - To be used in MTP etc.
- Compiled a complete set based on past input as well as HL-LHC WG5 Yellow Report (arXiv:1812.06772)
  - Assuming 3 years of running and ~4 months of HI in Run 3
  - Where relevant quote also Run 3+4 total targets
- Adjusted a few targets
  - LHCb target for Run 3 increased to balance Run 3 and Run 4 given the predicted luminosity per year
  - pPb targets reduced wrt YR as on high side for achievable luminosity and looks infeasible for LHCb
- Luminosity targets are minimum targets, not aspirations
  - Should be achievable barring major problems in the LHC or changes to the overall program

https://indico.cern.ch/event/1068719/contributions/4494117/attachments/2299916/3913037/Introduction.pdf

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LPC Meeting
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Proposed Luminosity Targets

- Proton-proton production (not incl. HI reference runs)

Experiment	Run 3	Run 3+Run 4	
ATLAS, CMS	160/fb	-	
LHCb	25/fb	50/fb	Was >15/fb
ALICE	200/pb	-	

- PbPb production

Experiment	Run 3	Run 3+Run 4
ALICE, ATLAS, CMS	6/nb	13/nb
LHCb	1/nb	2/nb

- pPb production

Experiment	Run 3	Run 3+Run 4	
ATLAS, CMS	0.5/pb	1/pb	Was 0.6/pb
ALICE	0.25/pb	0.5/pb	Was 0.3/pb
LHCb	0.1/pb	0.2/pb	Was 0.3/pb

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Proton-nucleus collisions at the LHC

Physics with high-luminosity proton-nucleus collisions at the LHC - Workshop

4 Jul 2024, 09:00 → 5 Jul 2024, 16:25 Europe/Brussels

503/1-001 - Council Chamber (CERN)

David d'Enterria (co-chair) (CERN), Iwona Grabowska-Bold (AGH University of Krakow (PL)), Cynthia Hadjidakis (Université Paris-Saclay (FR)), Jean-Philippe Lansberg (co-chair) (Université Paris-Saclay (FR)), Ronan Mcnulty (University College Dublin (IE))

Description

The workshop on "Physics with high-luminosity proton-nucleus collisions at the LHC" will take place at CERN Council Room on 4th-5th July 2024.

The aim of this workshop is to discuss experimental and theoretical issues connected to the physics of proton-nucleus collisions in Run-3 and Run-4 at the LHC. Past results from by the ALICE, ATLAS, CMS/TOTEM, LHCb, and LHCf experiments will be discussed as well as the future measurements to be carried out. The main topics of the workshop include:

- Constraints of nuclear parton distributions functions (nPDFs).
- Small-x QCD and gluon saturation physics.
- GPDs/TMDs/dPDFs with photon-induced processes in UPCs
- "Small system" p–A benchmark measurements for interpreting A–A collision data.
- Photon-photon collisions in p-A
- Double- and triple-parton scattering in p-A.
- Impact of collider p–A (in particular p-O) measurements for ultra-high energy cosmic rays physics.
- pA, fixed-target, and EIC complementarities
- Beyond the Standard Model opportunities.

Workshop supported by EU Horizon 2020 research and innovation programme under grant agreement No. 824093 (STRONG-2020)

Participant List

109 participants

26 talks from the 4 LHC experiments and the theory community

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1. Proton-nucleus collisions at the LHC: The machine point-of-view
Dr Roderik Bruce (CERN)
04/07/2024, 09:25

2. Importance of pPb HL LHC data for nPDF fits
Ingo Schienbein, Ingo Schienbein, Ingo Schienbein (Universite Grenoble Alpes)
04/07/2024, 09:45

3. Double- and triple-parton scattering in p-A collisions
Matteo Rinaldi, Matteo Rinaldi
04/07/2024, 10:10

5. CMS studies and plans in hadronic proton-nucleus collisions at the LHC
Christopher Mc Ginn (Massachusetts Inst. of Technology (US))
04/07/2024, 11:00

6. ATLAS studies and plans in hadronic proton-nucleus collisions at the LHC
Riccardo Longo, Riccardo Longo (Univ. Illinois at Urbana Champaign (US))
04/07/2024, 11:25

7. ALICE studies and plans in hadronic proton-nucleus collisions at the LHC
Florian Jonas (University of California Berkeley (US))
04/07/2024, 11:50

12. Learning on exotic (XYZ) systems from pPb collisions at the HL LHC
ELENA GONZALEZ FERREIRO (Universidade de Santiago de Compostela (ES)), Elena Gonzalez Ferreirc
04/07/2024, 12:15

9. Exclusive quarkonium photoproduction in pPb collisions at the HL-LHC
Chris Flett (IJCLab)
04/07/2024, 13:40

10. Photon-photon physics in high-luminosity pPb collisions at the HL LHC
Lucian Harland-Lang (Durham University), Dr Lucian Harland-Lang (University College London)
04/07/2024, 14:05

11. Inclusive quarkonium photoproduction in pPb collisions at the HL LHC
Kate Lynch (University College Dublin (IE))
04/07/2024, 14:25

24. pA physics with tagged protons at the LHC
Michael Pitt (The University of Kansas (US))
04/07/2024, 14:45

26. pA collisions with neutron tagging in the ZDCs
Mark Strikman, Mark Strikman (Penn State University), Mark Strikman (Pennsylvania State University (US))
04/07/2024, 15:05

8. LHCb studies and plans in hadronic proton-nucleus collisions at the LHC
Cesar Luiz Da Silva (Los Alamos National Laboratory (US)), Dr Cesar Luiz da Silva (Los Alamos National Lab)
05/07/2024, 09:00

14. Impact of collider p–A (p-O) measurements for ultra-high energy cosmic rays physic
Dr Hans Peter Dembinski (TU Dortmund)
05/07/2024, 09:25

13. Impact of p-Pb (p-O) measurements at LHCf for ultra-high energy cosmic rays physi
Lorenzo Bonechi (Istituto Nazionale di Fisica Nucleare (INFN)), Lorenzo Bonechi (INFN Section of Florence), Lorenzo Bonechi (Universita e INFN, Firenze (IT))
05/07/2024, 09:50

20. Proton-nucleus collisions with PYTHIA8/Angantyr
Christian Bierlich, Christian Bierlich (Lund University (SE))
05/07/2024, 10:15

27. Hydrodynamics application to proton-nucleus collisions
Prof. Soeren Schlichting (Universität Bielefeld)
05/07/2024, 10:40

16. CMS studies and plans in photon-induced proton-nucleus collisions at the LHC
Gian Michele Innocenti (Massachusetts Inst. of Technology (US))
05/07/2024, 11:15

17. ATLAS studies and plans in photon-induced proton-nucleus collisions at the LHC
Sruthy Jyothi Das (University of Colorado Boulder (US))
05/07/2024, 11:40

18. ALICE studies and plans in photon-induced proton-nucleus collisions at the LHC
Daniel Tapia Takaki (University of Kansas)
05/07/2024, 12:05

19. LHCb studies and plans in photon-induced proton-nucleus collisions at the LHC
James Daniel Brandenburg (University of Florida (US)), James Daniel Brandenburg (Ohio State University (US))
05/07/2024, 12:30

21. Complementarities between the HL-LHC pPb and fixed-target runs and EIC
Charlotte Van Hulse (Universidade de Santiago de Compostela (ES))
05/07/2024, 14:00

25. Toroidal Vorticity at LHC and EIC
Maria Zofia Stefaniak (Ohio State University (US))
05/07/2024, 14:25

22. Small-x QCD and gluon saturation physics
Piotr Kotko, Piotr Kotko (AGH UST)
05/07/2024, 14:45

23. Parton collectivity in p-A collisions
Bjoern Schenke (Brookhaven National Lab)
05/07/2024, 15:10

15. Beyond the Standard Model opportunities in p-A collisions at the LHC
Dr sylvain fichet
05/07/2024, 15:35

Proton-nucleus collisions at the LHC

Fully considering the aforementioned advantages of the pA collisions compared to pp and AA collisions, we have identified **nine main topics for a strong physics case motivating a complete HL pA run for the LHC**. This programme should be understood with the four main LHC detectors, ALICE, ATLAS, CMS and LHCb, as well as the small LHC detectors, LHCf, ...

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The 9 main research axes of such a programme are:

1. **constraints of nuclear parton distributions functions**
2. **small-x QCD and gluon saturation physics**
3. **photon-induced processes in UPCs and GPDs/TMDs/dPDFs**
4. **benchmark measurements for interpreting AA collision data.**
5. **photon-photon collisions**
6. **double and triple parton scatterings**
7. **impact of collider pA measurements for ultra-high energy cosmic rays physics.**
8. **complementarities with EIC and fixed-target LHC measurements**
9. **opportunities beyond the Standard Model**

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This document is based on recently published scientific papers, as well as oral contributions presented during a workshop at CERN on July 4-5, 2024. In the next section, we review technical beam and detector aspects. In the third section, we present the scope of the 9 research axes along with selected flagship measurements. It is then complemented by a brief discussion of additional ideas beyond these 9 subjects.

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Anticipated outline :

- Executive summary (1 page)
- Accelerator considerations (1 page)
- 1 page per topic

Drafting coordinated by speakers at the July workshop, but the contributions of anybody is welcome

[Similar procedure than for the FT4LHC contribution to the previous ESPPU : https://indico.cern.ch/event/777124/]

Proton-nucleus collisions at the LHC

Summary of workshop on
"Physics with high-luminosity proton-nucleus collisions at the LHC"

https://indico.cern.ch/event/1389579/overview

Ronan McNulty
University College Dublin

Forward physics meeting
CERN, July 15-16 2024

Link to the summary :
https://indico.cern.ch/event/1367517/contributions/6021279/attachments/2896211/5078042/pA_workshop_summary_mcnulty.pdf