Planning Projects for Run 3

Clara Leitgeb DESY APP Meeting, 26.10.2021





LHC Plans for Run 3



pp data

- > Special low- μ run ($\mu < 0.02$) for 2 days in first week of August 2022
- > Probably $\sim 20 \text{ nb}^{-1}$ of data ($\sim 10 \times$ the luminosity of LHCf data in run 2)
- → also due to upgraded readout electronics in LHCf arm 2!
- > No concrete official schedule for 2022 yet
- > Final decision on CME: $\sqrt{s} = 13.6 \text{ TeV}$

LHC Plans for Run 3



pO and OO data

- > Special heavy-ions run in 2024 for 7-8 days
- > Probably $\sqrt{s} = 6.37 \text{ TeV}$ (OO) and $\sqrt{s} = 9 \text{ TeV}$ (pO) (run 2 Pb reference) or $\sqrt{s} = 6.8 \text{ TeV}$ (OO) and $\sqrt{s} = 9.6 \text{ TeV}$ (run 3 pp reference)

Overview of Possible Collision Energies



 \rightarrow Too high energies to directly compare with CTA or HESS target energies? Does that impact the potential modelling improvement we get in a lower energy range?

Photon and π^0 spectra of diffractive processes in pp collisions (run 3)

- * Validation and input for hadronic interaction models
- > Dominant uncertainty in run 2: energy scale, single hit correction
- > Statistical uncertainties large at high photon energies
- > More stats allow reconstructing π^0 from two photons (\rightarrow potentially +1 BSc or MSc student)
- → 1 PhD student

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Measure pion exchange cross section with LHCf, ZDC and AFP

- "New" process, potential impact on muon multiplicity in hadronic models (muon deficit problem)
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Prospect studies for pO and OO

- * Best proxy for inital interaction of CRs in atmosphere \rightarrow test and improve modelling
- Simulations for pO and OO
- Find preliminary selection criteria, background estimation, systematic uncertainty, analysis optimization
- > LHCf needs to be moved by 15 mm on O-remnant side to avoid too large neutron multiplicities \rightarrow loose 0° coverage
- > In best case prepare pO analysis to be ready when data is taken
- → 1 PhD student and/or 1 Postdoc

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- → 1 student (maybe Master project?)

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Simulation tuning and comparisons

- * Testing and tuning hadronic models
- * Using LHC results for improvement of EAS simulation
- → 1 PhD student (overlap with AP group?)

Conclusion

- > Run 3 plans for LHC become more and more fixed, especially the pp-collision part
- > pp collisions will happen at $\sqrt{s} = 13.6$ TeV, low- μ run for LHCf in August
- > Oxygen run less clear: 7-8 days in 2024, no final decision on CME
- > Likely values for CME in LHC collisions correspond to CR energies 10¹⁶-10¹⁷ eV: Too high?
- > Different analysis projects possible, need to decide:
 - \rightarrow Priority to pO preparation studies?
 - $\rightarrow\,$ What is needed from a theoretical perspective to improve hadronic interaction simulations for AP?





- > Paper by Eugenio Berti on Forward Physics with LHCf and FASER in Run 3
- > ATLAS Weekly 31.8.2021
- > pO-OO Workshop 2021
- > LHCf meeting with LHCC referees in 2019
- > LHC Heavy Ion WG kick-off meeting, Jul 2021
- > LHC schedule, last updated June 2021
- > Particle data group, Cosmic Ray Physics