VA1/WP10 : NLOAccess:
Automated perturbative NLO calculations for heavy ions and quarkonia

Carlo Flore (IJCLab, Orsay)

Measures taken to facilitate the access and create new opportunities for access

- Installation of dedicated **servers** and hard **disk** (funded by local sources)

- Creation of user and job **databases,** a **queue system** handling user requests, a **file-storage cloud server**

- Update of the NLOAccess **website** nloaccess.in2p3.fr

  - 2-step **registration**, creation of a cloud folder; system-wide password protection
  - Run-status **management**. Run **history**
  - Possibility to delete the account

- Update of the HELAC-Onia Web branch nloaccess.in2p3.fr/HO/

  - Remote computation on our server cluster with **graphical user interface** or via the upload of **input files**
  - **Plot** creation. Various **output**-file generation.

- Online version of **MG5aMC** running at **NLO:** nloaccess.in2p3.fr/MG5/

  - Generation of the code for **any (B)SM process up to NLO**
  - **Code-process database;** user **cards uploadable**
  - **Plot** creation. Various **output**-file generation. **Interface** to codes such as PYTHIA.

- First complete **user guide** for HELAC-Onia

Organisation of the International Assessment Board

- 8 researchers

- Balance: theory – experiment, EU – non-EU, genders
  - Prof. Asmita **Mukherjee**, IIT., Mumbai, India (Theory, Spin physics)
  - Dr. Barbara **Trzeciak**, CTU Prague, Czech Republic (Experiment, ALICE)
  - Dr. Cynthia **Hadjidakis**, IJCLab Orsay, France (Experiment, ALICE)
  - Prof. Elena **Ferreiro**, USC, Spain (Theory, Heavy-Ion Physics)
  - Dr. Emilien **Chapon**, *CEA, Saclay* (Experiment, ATLAS)
  - Dr. Nodoka **Yamanaka**, *Nagoya U., Japan* (Theory, Nuclear and Hadronic Physics)
  - Dr. Marc **Schlegel**, Tübingen U., Germany (Theory, Spin physics)
  - Prof. Zhenwei **Yang**, PKU, China (Experiment, LHCb)

- New Virtual IAB meetings scheduled for the end of 2022

Main scientific results

- Publication of the High Luminosity LHC onium review:

  - Prospects for quarkonium studies at the HL-LHC.

  - Strong contribution from NLOAccess participants

  - Published in Prog.Part.Nucl.Phys. 122 (2022) 103906

- Cure of the unphysical behaviour of NLO quarkonium photoproduction at ep colliders:

  - Extension of the method developed in Eur.Phys.J.C 81 (2021) 6, 497

  - Further step towards stable NLO quarkonium results for the future EIC

  - Developement of dedicated codes and usage of NLOAccess codes for the study

 - Available on arXiv:2112.05060 [hep-ph]; under review for Phys. Lett. B

Main scientific results

- ## Computation of proton-nucleus NLO cross sections in MG5aMC

  - PhD of A. Safronov at WUT

  - Two PDF sets loadable; cross product computed

  - Nuclear modification factors **generated on the fly** with nPDF and scale uncertainites

- ## Computation of lepton-induced NLO cross sections in MG5aMC

  - PhD of L. Manna at WUT; 3 month internship at UCLouvain

  - Validation of photoproduction NLO cross sections in MG5aMC
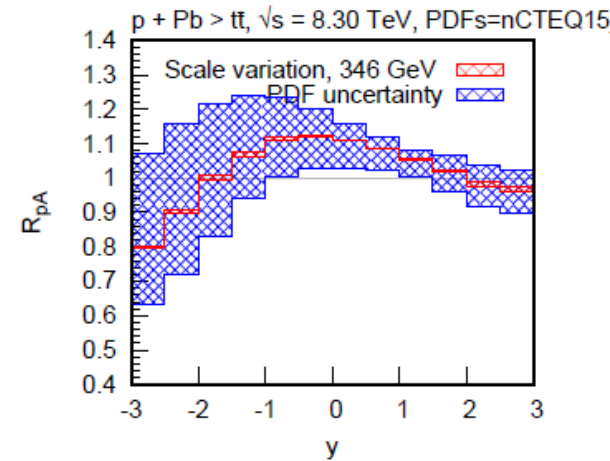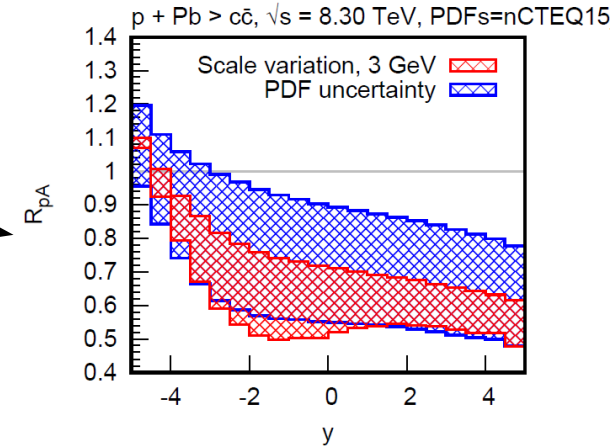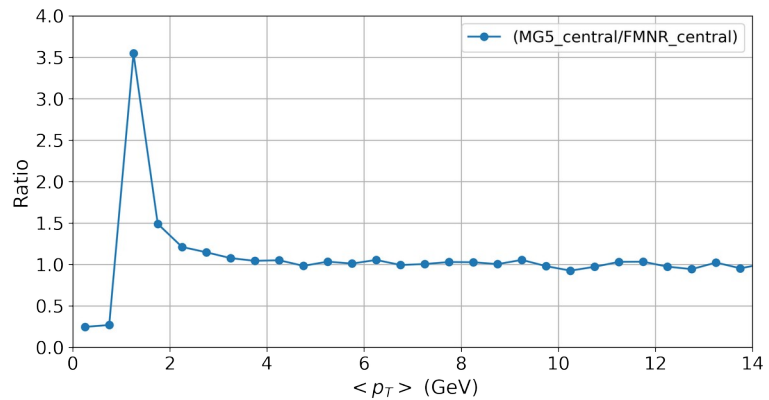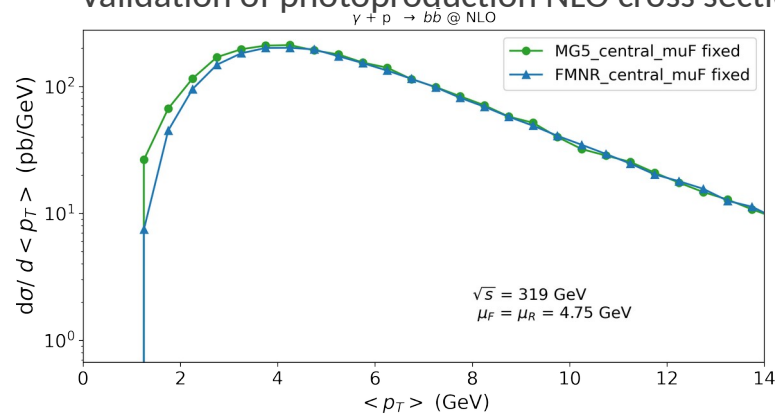
Access to the facility during the reporting period ↔ Deliverables

- 368 registered users from
  - Europe (53.8%),
  - Asia (21.7%)
  - North America (20.7%)
  - South America (1,6%)
  - Africa (1.9%)
  - Oceania (0.3%)

- e-infrastructure service provided:
  - *Common services* : data generation (cross-section computation) & storage of the generated data;
  - *Thematic services* : access to self-generated codes based on the user request.

- More than 3900 runs performed despite the reduced advertisement activity since the outbreak of the COVID-19 pandemic

Dissemination and outreach activities

21 talks since the end of September 2021:

- A. Safronov at 61st Cracow School of theoretical physics, Zakopane, Poland, 20-24/09/2021
- J.-P. Lansberg and Y. Yedelkina at QCD-N, Alcalà, Spain, 4-8/10/2021
- K. Lynch and Y. Yedelkina at Exploring QCD with tagged processes Workshop, IJCLab Orsay, France, 11-22/10/21
- K. Lynch and Y. Yedelkina at Exploring QCD with tagged processes Workshop, IJCLab Orsay, France, 11-22/10/21
- K. Lynch and Y. Yedelkina at Franco-Ukranian Workshop, IJCLab Orsay, France, 27-29/10/21
- Y. Yedelkina and A. Safronov at Quarkonium as Tools 2022, Aussois, France, 9-15/01/2022
- Y. Yedelkina at Xfitter Workshop, IJCLab Orsay, France, 9-11/03/2022
- C. Flore at Progress in algorithms and numerical tool for QCD, IJCLab Orsay, France, 07/06/2022
- A. Safronov at ICHEP 2022, Bologna, Italy, 07/07/2022
- K. Lynch and Y. Yedelkina at EICUG Early Career Workshop 2022, CFNS Stony Brook University, USA, 24-25/07/2022
- C. Flore at Quarkonium Working Group 2022, GSI Darmstadt, Germany, 28/09/2022
- J.P. Lansberg at QCD Evolution 2022, University of Virginia, US, 9-13/05/2022
- J.P. Lansberg at Synergies between the EIC and the LHC, CERN, 20-21/06/2022
- J.P. Lansberg at Diffraction and Low-x 2022, Corigliano Calabro, Italy, 24-30/09/2022
- C. Flore at Joint STRONG-2020/HF2022 session, Institut Pascal, Orsay, France 17/10/2022

- 3 PhD students: J. Bor (co-PhD with RUG), K. Lynch and Y. Yedelkina (co-PhD with UCD)

- 2 Master internships in 2022: A. Colpani Serri, M. Chithirasreemadam;

- 4 Hands-on sessions:

  - NLOAccess tutorial at Quarkonium as Tools, 12/01/2022 by C. Flore, O. Mattelaer and H.-S. Shao;

  - Tutorial on LO matching and merging at Aussois Quarkonium Week 2022, 27/03-03/04/2022 by O. Mattelaer;

  - NLOAccess tutorial at PHENIICS Doctoral course "Quarkonium production phenomenology" (J.P. Lansberg, Paris-Saclay U) 27/06-1/07/2022 by C. Flore (2h/day).

  - MG5 hands on session during CERN Summer Student Program 6-8/07/2022 by O. Mattelaer (3h/day)

Progress beyond the state of the art, expected results and potential impact

- **Realised**

  - Secure web access with storage

  - HELAC-Onia running well

  - MG5aMC at NLO online as well

  - Both have been and can be used to produce science and perform training

  - 6 months extension through travel money for C. Flore's contract

- **Planned**

  - Inclusion of $pA/AB/\pi p$ collisions (at NLO) in MG5aMC

  - Inclusion of ep and eA collisions (at NLO) in MG5aMC

  - Automated TMD-based event generator

  - Potential inclusion of other codes (FDC, NLO η_Q)

  - no money for further extension