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

J.P. Lansberg (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 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)

- Virtual IAB meetings on June 6, 2021 & November 3, 2021

Main scientific results

- First leading-pT NLO study of inclusive quarkonium photoproduction at the future US EIC with HELAC-Onia:

  - Cross-check HELAC-ONIA; Fix existing bug in the handling the flux of quasi-real photon.

  - Demonstrate that NLOAccess can be used for physics projection

  - Published in Phys. Lett. B 811 (2020) 135926

- Cure of the unphysical behaviour of NLO quarkonium production at the LHC:

  - Important step towards stable NLO quarkonium results

  - Proposal of a new scale prescription to avoid oversubtraction of collinear divergences

  - To be used when quarkonium production is implemented in MG5aNLO

  - Published in Eur.Phys.J.C 81 (2021) 6, 497

Main scientific results

- Generation of new nPDF distributions using heavy-flavour data in *p*Pb collisions.

  - Validation by comparing predictions with HELAC-ONIA with LHC and RHIC data.

  - Available on https://lhapdf.hepforge.org/pdfsets.html usable with MG5aMC@NLO on NLOAccess

  - Published in Phys.Rev.D 104 (2021) 1, 014010

- 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
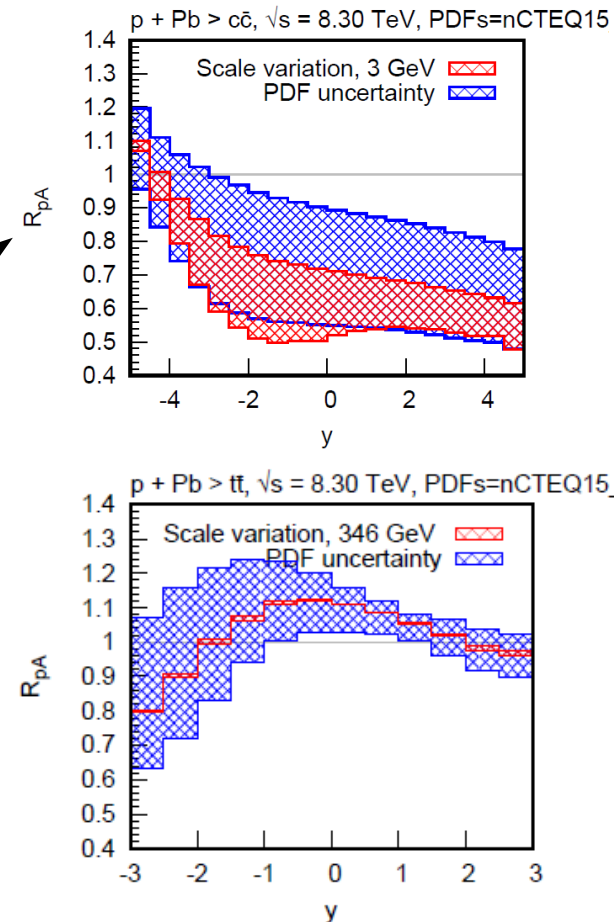
Dissemination and outreach activities

- 10 talks in 2021:
    - C. Flore at Polarization measurements in ee, ep, pp and heavy-ion collisions (virtual meeting), 18/12/2021;
    - C. Flore at Assemblée Générale du GDR-QCD (virtual meeting), 10/03/2021;
    - Y. Yedelkina and C. Flore at Virtual Quarkonia as Tools 2021 (virtual meeting), 22 & 26/03/2021;
    - C. Flore at DIS 2021 (virtual meeting), 13/04/2021;
    - C. Flore at QCD Evolution (virtual meeting), 10/05/2021;
    - C. Flore and A. Safronov at Joint workshop STRONG-2020 GDR-QCD/FTE@LHC/3D Partons/NLOAccess (virtual meeting), 02/06/2021;
    - A. Safronov at Aussois Quarkonium & QCD meeting, Aussois, France 24/06/2021;
    - C. Flore at SarWors 2021, Cagliari, Italy 08/09/2021;

- PhD of M. A. Ozcelik (07/2021);

- 3 Master internships in 2021: A. Colpani Serri, K. Lynch, Y. Yedelkina;

- 3 Hands-on sessions::
    - Joint workshop GDR-QCD/FTE@LHC/3D Partons/NLOAccess (virtual meeting), 02/06/2021, by C. Flore;
    - Aussois Quarkonium & QCD meeting (hybrid), 24/06/2021 by C. Flore and O. Mattelaer;
    - PHENIICS Doctoral course "Quarkonium production phenomenology" (J.P. Lansberg, Paris-Saclay U) 9/7/2921 by C. Flore.

Access to the facility during the reporting period ↔ Deliverables

- 138 registered users from

  – Europe (69.6%),

  – Asia (15.9%)

  – North America (13.8%)

  – Africa (0.7%)

- 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 2700 runs performed despite the reduced advertisement activity since the outbreak of the COVID-19 pandemic

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 can be used to produce science and perform training

- **Planned**

  - Inclusion of pA collisions (at NLO) in MG5aMC

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

  - Automated TMD-based event generator (requires man power)

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