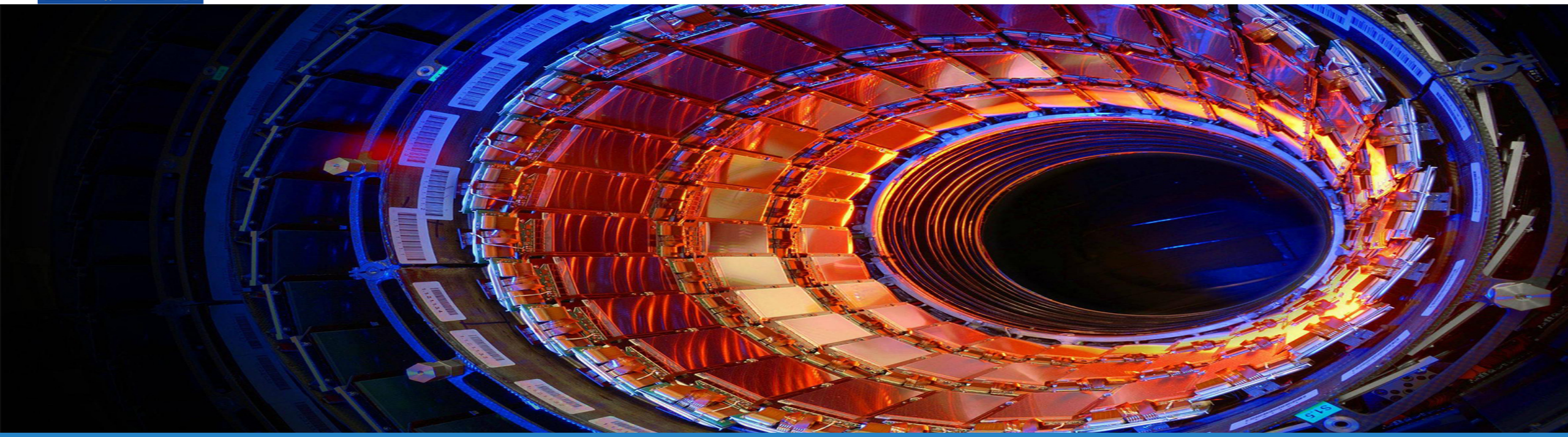

# VA1/WP10 : NLOAccess:
# Automated perturbative NLO calculations for heavy ions and quarkonia

J.P. Lansberg (IJCLab, Orsay)

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## 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**
- Creation of a **queue system** handling user's requests
- Creation of **file storage cloud server**
- Update of the NLOAccess **website** nloaccess.in2p3.fr
- A first working test of MG5aMC @NLO

- Update of the **HELAC-Onia Web** branch nloaccess.in2p3.fr/HO
  - 2 step **registration**, creation of a cloud folder; system-wide password protection
  - Remote computation of our server cluster with **graphical user interface** or via the upload of **input files**
  - Run status **management**. Run **history**.
  - **Plot** result creation. Various **output** file generation.
- 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**, IHEP, China (Experiment, CMS)
  - Dr. Nodoka **Yamanaka**, UMass Amherst, USA (Theory, Nuclear and Hadronic Physics)
  - Dr. Marc **Schlegel**, Tübingen U., Germany (Theory, Spin physics)
  - Prof. Zhenwei **Yang**, Tsinghua U., China (Experiment, LHCb)
- First virtual IAB meeting on Sept 28, 2020

## Main scientific results

- **First leading-$p_T$ NLO study of inclusive quarkonium photoproduction at the future US EIC with HELAC-Onia**:
  - Internship of Y. Yedelkina
  - 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
  - Paper submitted for publication
- **Complete NRQCD study with HELAC-ONIA of quarkonium-pair production including (NNLO) loop-induced contributions.**
  - Inclusion of the corresponding process in HELAC-ONIA.
  - Published in Eur.Phys.J. C79 (2019) no.12, 1006

## Main scientific results

- **First complete NLO CEM study quarkonium-pair production with a tuned version of MG5aMC**
  - Test of the MG5aMC phase-space integration algorithm near threshold where the CEM is applicable.
  - Integrator need some improvement for an automated usage for an integration of the CEM in MG5aMC
  - Published in Phys.Lett. B807 (2020) 135559
- **First study of TMD evolution at NLL accuracy for gluon-induced production with an application to quarkonium-pair production.**
  - Essential step toward the automation of the computation of TMD effects in gluon-gluon scatterings.
  - Another essential step : algorithmic procedure to compute the azimuthal dependence generated by the linearly polarised gluons from the helicity matrix elements.
  - Published in Eur.Phys.J. C80 (2020) no.2, 87

## Main scientific results

- **Generation of new nPDF distributions in the LHAPDF format based on nuclear PDF re-weighting using heavy-flavour production in proton-nucleus collisions.**
  - Validation by comparing the corresponding prediction with HELAC-ONIA with LHC and RHIC data.
  - Future inclusion in NLOAccess
  - Paper to be submitted for publication
- **Computation of proton-nucleus cross section at NLO in MG5aMC**
  - Internship of A. Safronov (now PhD in WUT)
  - Two PDF sets loadable; cross product computed
  - New plots (nuclear modification factor) to be generated on the fly

## Dissemination and outreach activities

1. Seminar by C. Flore at IPN Orsay, France, 6/06/2019
2. Talk by C. Flore at *2nd LHCb Heavy Ion Workshop*, Chia, Italy, 5/09/2019
3. Talk by C. Flore at the *FTE@LHC and NLOAccess STRONG-2020 joint kick-off meeting*, CERN,7/11/2019
4. Talk by V. Lafage at the *FTE@LHC and NLOAccess STRONG-2020 joint kick-off meeting*, CERN, 7/11/2019
5. Talk by C. Flore at *Quarkonia as tools 2020*, Aussois, France, 13-14/01/2020
6. Talk by O. Mattelaer at *Quarkonia as tools 2020*, Aussois, France, 13-14/01/2020
7. Talk by J.P. Lansberg at *Jet Observables at the Electron-Ion Collider*, Virtual meeting, 27-29/7/2020
8. Talk by J.P. Lansberg at *SPD Physics Workshop*, Virtual meeting, 30/9-1/10/2020
9. NLOAccess used for a Master class at doctoral lectures at Paris-Saclay U. by J.P. Lansberg in 1/2020
10. 3 Master internships : Y. Yedelkina, A. Safronov & E. Ligout.
11. PhD of C. Flore & F. Scarpa

## Access to the facility during the reporting period ↔ Deliverables

- 93 registered users (83% of planned maximum possible users in P1) from
  - Europe (~ 75%),
  - Asia (~ 20%)
  - North America (~5%)
- 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 1000 runs performed despite the reduced 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
  - Can be used to produce science
  - MG5aMC at NLO soon online (only at LO available on the Madgraph website)
  - CEM in MG5aMC also soon available
- **Planned**
  - Automated TMD-based event generators
  - Inclusion of *pA* collisions (at NLO) in MG5aMC
  - Potential inclusion of other codes (FDC, …)