STRONG-2020 & NLOAccess

Jean-Philippe Lansberg
Laboratoire de Physique des 2 Infinis
Irène Joliot-Curie (IJCLab), Paris-Saclay U., CNRS, Orsay

Atelier "Physique Théorique des deux infinis"
(virtual meeting)
June 7, 2021

The STRONG-2020 initiative

Project duration: from 1 June 2019 to 31 May 2023

Total Budget: 10 M €

32 Work Packages (WPs):

- **MAN:** Management and Coordination
- **DISCO:** Dissemination and Communication
- 7 Transnational Access Research Infrastructures (**TA**)
- 2 Virtual Infrastructures (**VA**)

Experimental /Theoretical /Instrumentation Activities:

- 7 Networking Activities (**NA**)
- 14 Joint Research Activities (**JRA**)

Web site: http://www.strong-2020.eu/

The STRONG-2020 consortium

Consortium Agreement

- **45 participating institutions** (beneficiaries) in
- **16 countries:**
- Austria, Belgium, Switzerland, Germany, Spain, Finland, France, Croatia, Ireland, Italy, Montenegro, Netherlands, Poland, Portugal, Sweden, United Kingdom

- **Location details can be found on online Google map**

- **134 other Involved Institutions** (not receiving EU funding)

The STRONG-2020 infrastructures

Transnational Access

TA1-COSY **Dieter Grzonka** (Julich)

TA2-MAMI **Achim Denig** (Mainz)

TA3-LNF Catalina Curceanu/Carlo Guaraldo (INFN, Frascati)

TA4-FTD/ELSA **Hartmut Schmieden** (Bonn)

TA5-GSI Yvonne Leifels (GSI, Darmstadt)

TA6-ECT* Gert Aarts (Jochen Wambach) (Trento)

TA7-CERN David d'Enterria (CERN, Geneva)

Virtual Access:

Provide open-access to state-of-the-art computer codes necessary for the high-precision phenomenology of heavy ion reactions and studies of the quark gluon plasma as well as for nucleon and nuclei parton structure research.

VA1-NLOAccess ***Automated perturbative NLO calculations for heavy ions and quarkonia***

Jean-Philippe Lansberg (CNRS, Orsay) : *Extension of the well-known MadGraph automated on-line code for the novel computation of perturbative QCD cross sections in high-energy hadronic collisions at next-to-leading- order (NLO) accuracy, using meson and heavy-ion beams, and for quarkonia final-states.*

Web page: https://nloaccess.in2p3.fr/HO/

VA2-3DPartons ***Virtual Access to 3DPartons***

Hervé Moutard (CEA, Saclay) : *Development of a new combined framework to extract generalized (GPDs) and transverse momentum-dependent (TMDs) parton distributions, with higher-order fixed and twist corrections, from fits to experimental e-p and p-p data (handled in a Rivet-like format).*

Web page: http://partons.cea.fr/partons/doc/html/index.html

The STRONG-2020 research activities

Hadron Physics:

JRA7-HaSP *Light-and heavy-quark hadron spectroscopy* Marco Battaglieri (INFN, Genova), Juan Nieves (UVEG, Valencia)

NA1-FAIRnet *QCD physics at GSI/FAIR* Fritz-Herbert Heinsius (RUB, Bochum)

NA5-THEIA *Strange Hadrons and the Equation-of-State of Compact Stars* Josef Pochodzalla (Umainz)

NA6-LatticeHadrons LatticeHadrons Michael Peardon (TCD, Dublin)

Precision Physics:

NA4-PREN *Proton Radius European Network* Dominique Marchand (CNRS, Orsay), Randolf Pohl (UMainz)

JRA3-PrecisionSM *Precision Tests of the Standard Model* Mikhail Gorshteyn (UMainz), Andrzej Kupsc (University of Uppsala)

Heavy Ions:

JRA1-LHC-Combine *Inter-experiment combination of heavy-ion measurements at the LHC* Raphaël Granier de Cassagnac (CNRS, Palaiseau)

JRA2-FTE@LHC *Fixed Target Experiments at the LHC* Cynthia Hadjidakis (CNRS, Orsay), Pasquale Di Nezza (INFN, Frascati)

NA3-Jet-QGP *Quark-Gluon-Plasma characterisation with jet* Marco van Leeuwen (Nikhef, Amsterdam), Guilherme Milano (LIP, Lisbon)

NA7-Hf-QGP *Quark-Gluon Plasma characterisation with heavy flavour probes* Joerg Aichelin (CNRS, Nantes), Giuseppe Bruno (INFN, Bari)

GPD/TMD/PDFs:

JRA4-TMD-neXt *3D structure of the nucleon in momentum space* Alessandro Bacchetta (INFN, Pavia)

JRA5-GPD-ACT *Generalized Parton Distributions* Silvia Niccolai (CNRS, Orsay), Kresimir Kumericki (UNIZG, Zagreb)

JRA6-Next-DIS *Challenges for next generation DIS facilities* Daria Sokhan (UGlasgow), Francesco Bossu (CEA, Saclay)

NA2-Small-x *Small-x Physics at the LHC and future DIS experiments* Néstor Armesto (USC, Santiago de C.), Tuomas Lappi (JYU, Jyväskylä)

The NLOAccess framework

The STRONG-2020 WP **VA1-NLOAccess**:

- a virtual access for automated perturbative calculation for heavy ions and quarkonia
- automation and versatility:
  - everyone would be able to evaluate physical observables related to hadron scatterings
  - no need to pre-code
  - test the code
- any code that could be compiled and launched via a shell could be added

✓ MadGraph and its extension to nPDFs are being included

✓ HELAC-Onia is included

NLOAccess & HELAC-Onia Web

Some facts and figures about NLOAccess:

- general information at `https://nloaccess.in2p3.fr`

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  - guided input file creation and submission for HO: https://nloaccess.in2p3.fr/HO/downloads/HO_online_guide_v01.pdf

NLOAccess - Homepage

(https://nloaccess.in2p3.fr)

HELAC-Onia Web - Homepage

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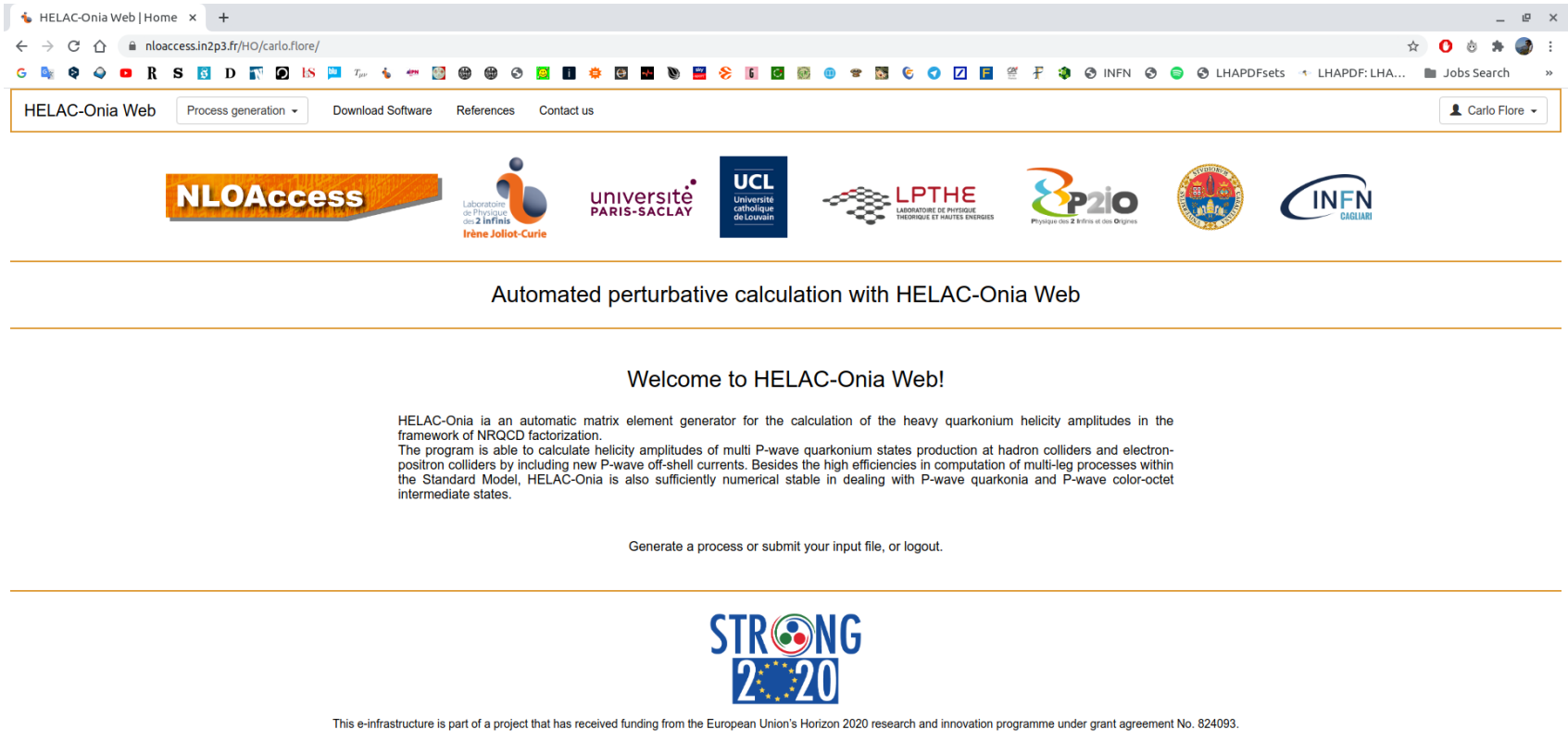
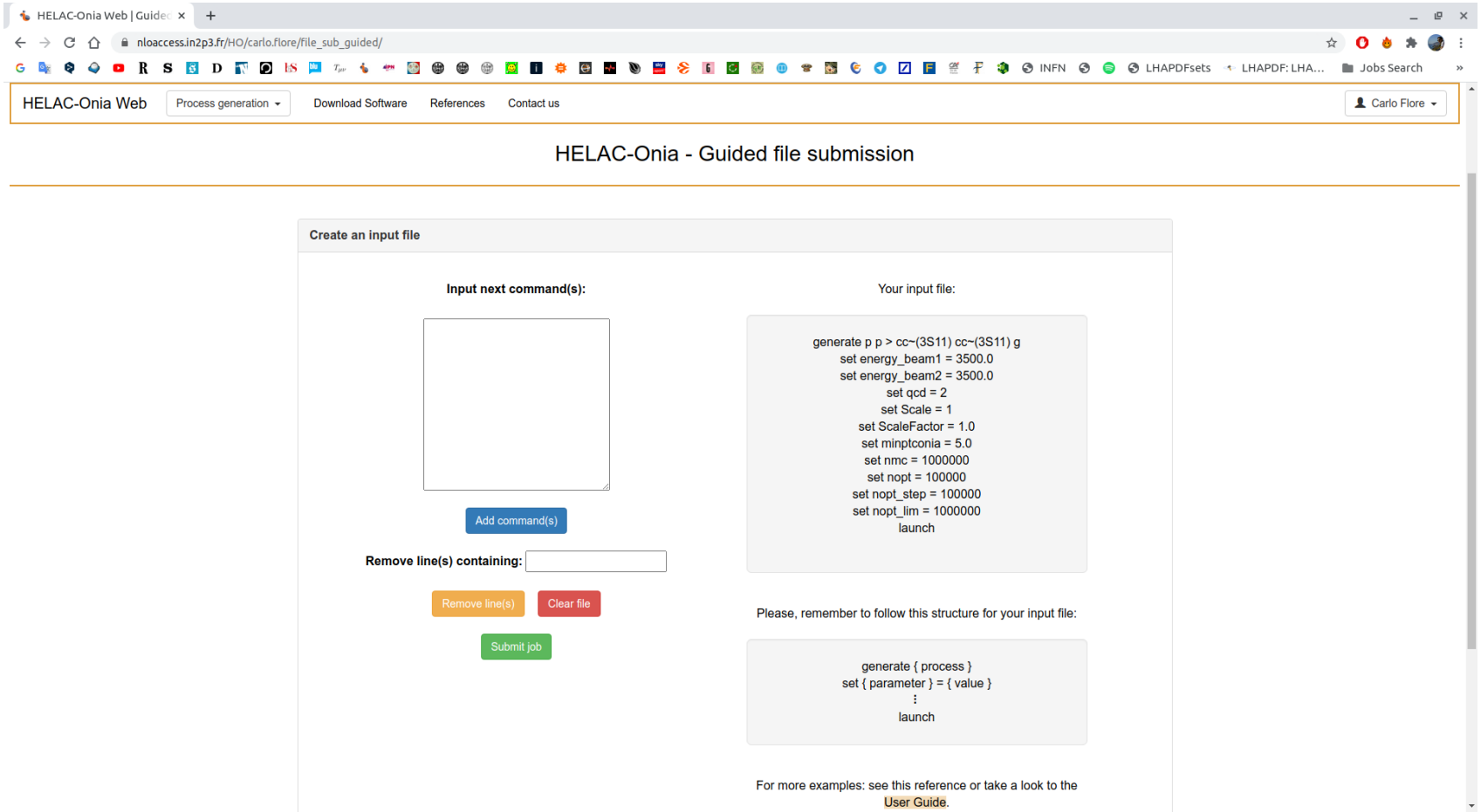


HELAC-Onia Web - Run submission



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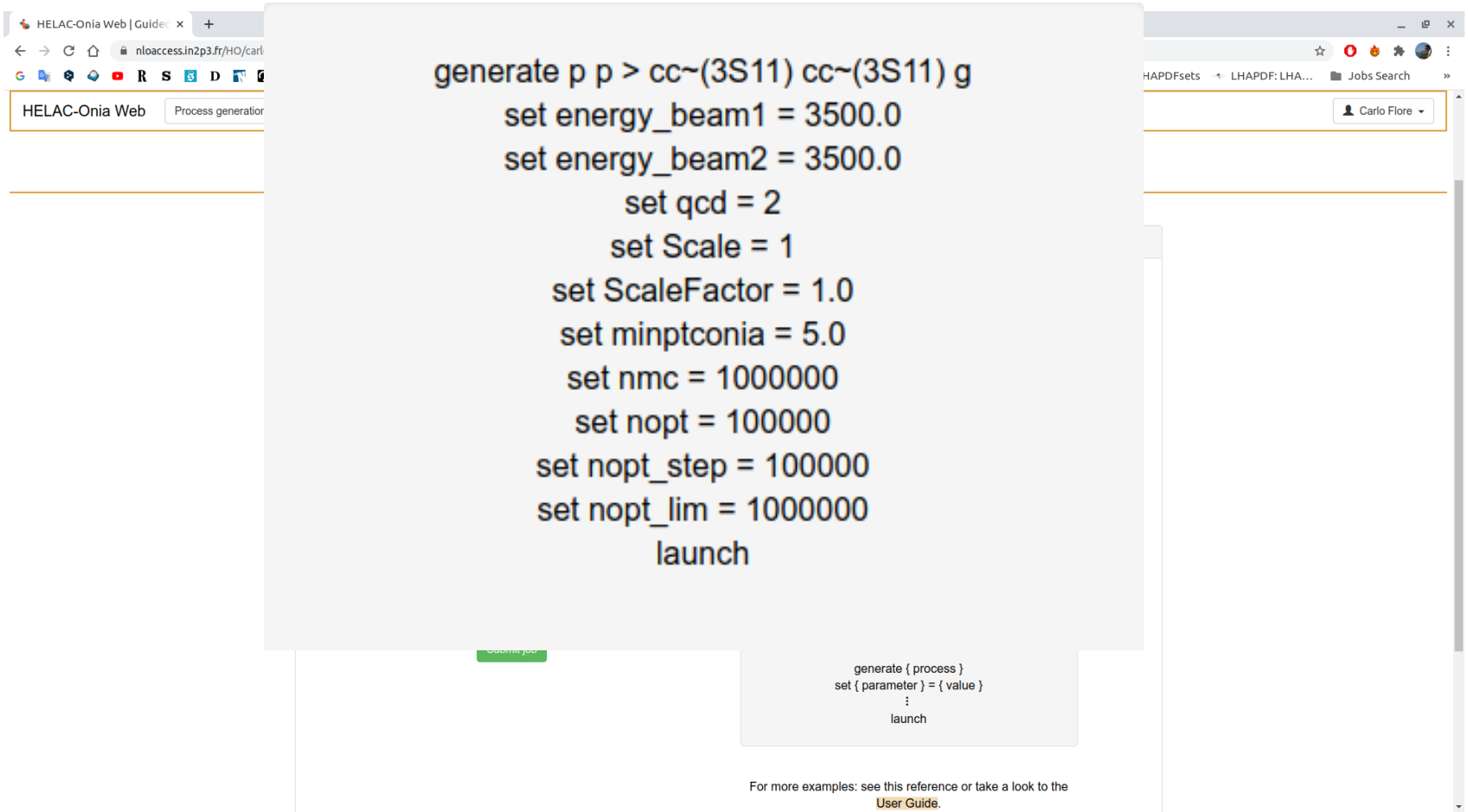
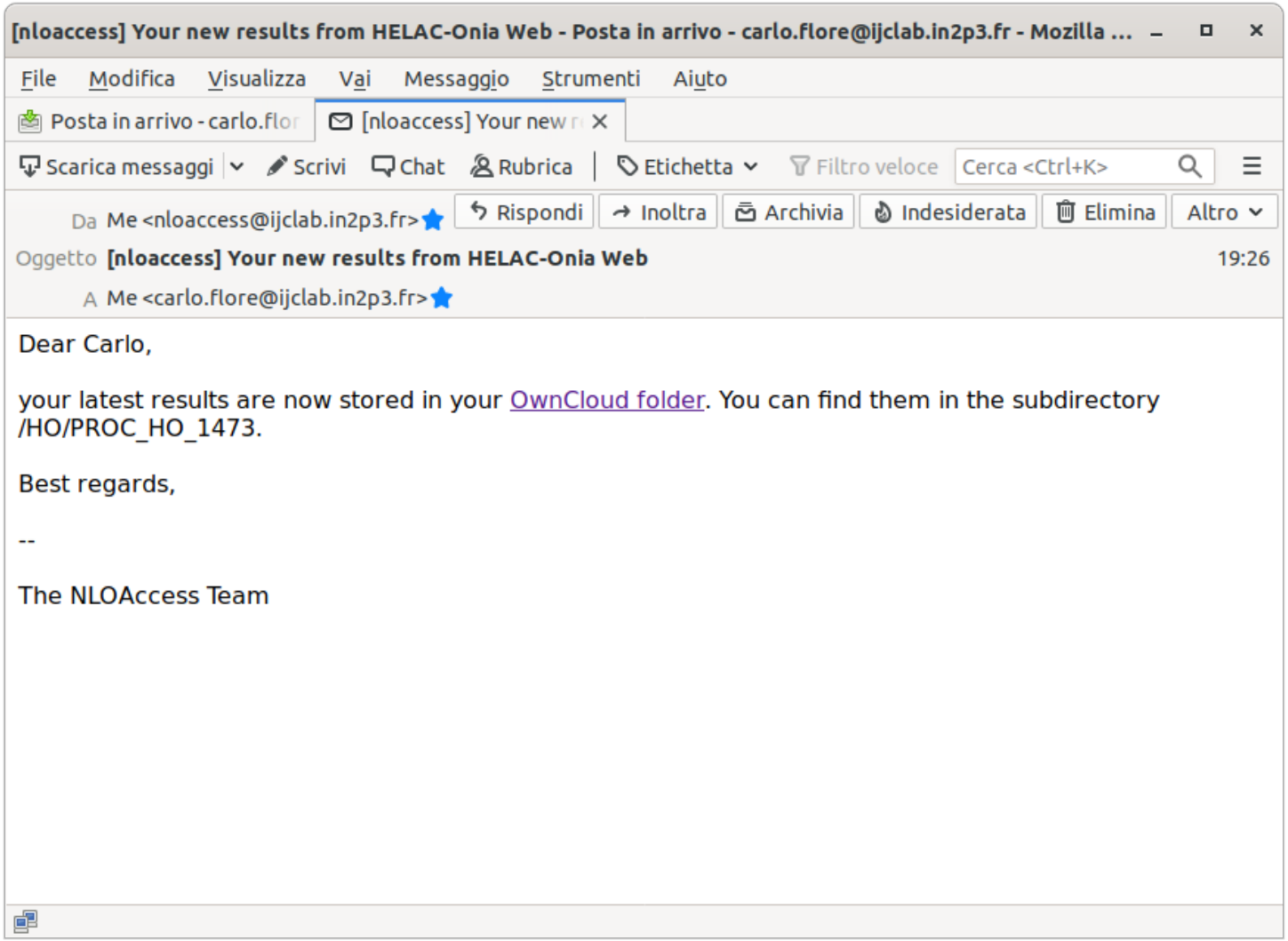
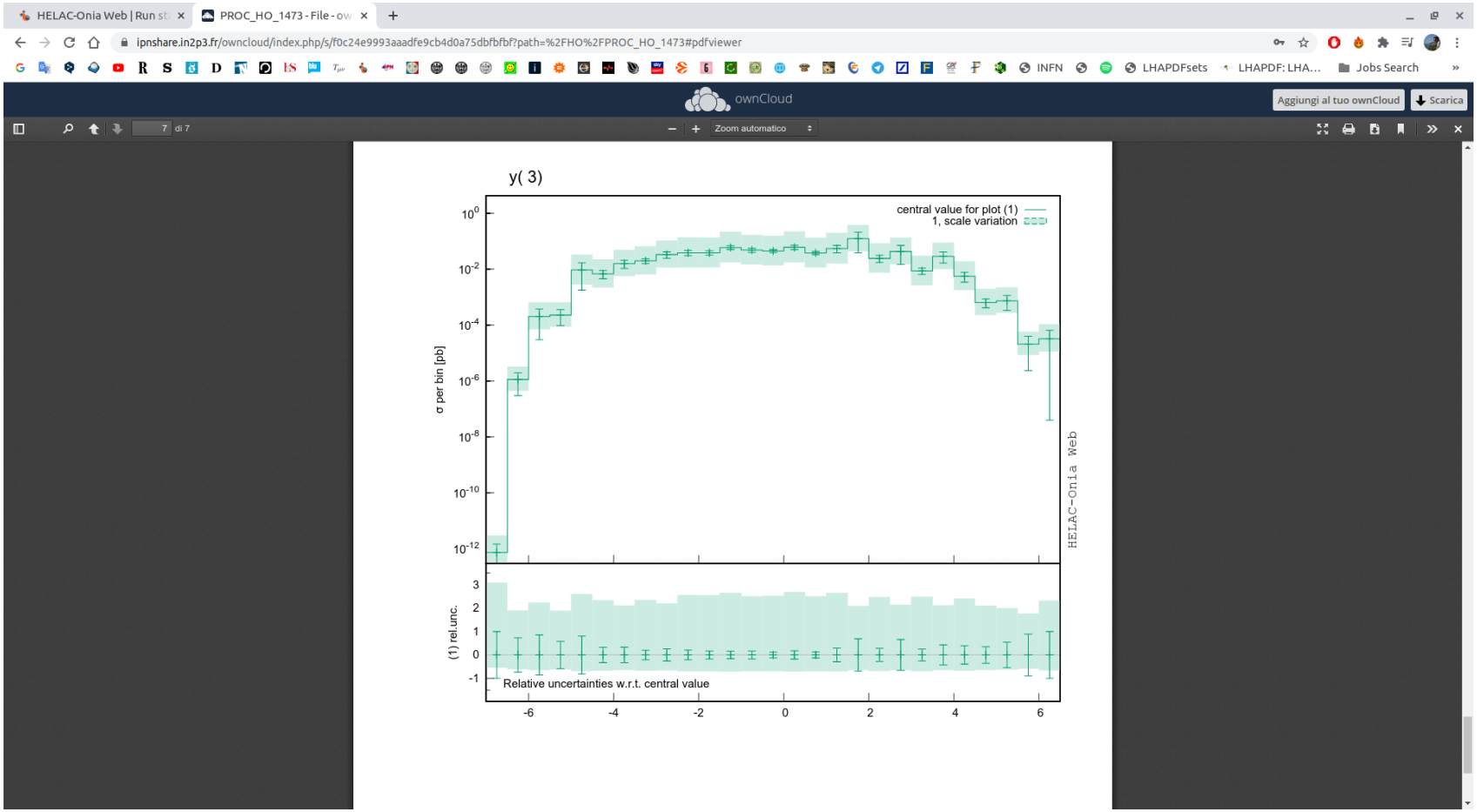


HELAC-Onia Web - Results (I)



HELAC-Onia Web - Results (II)



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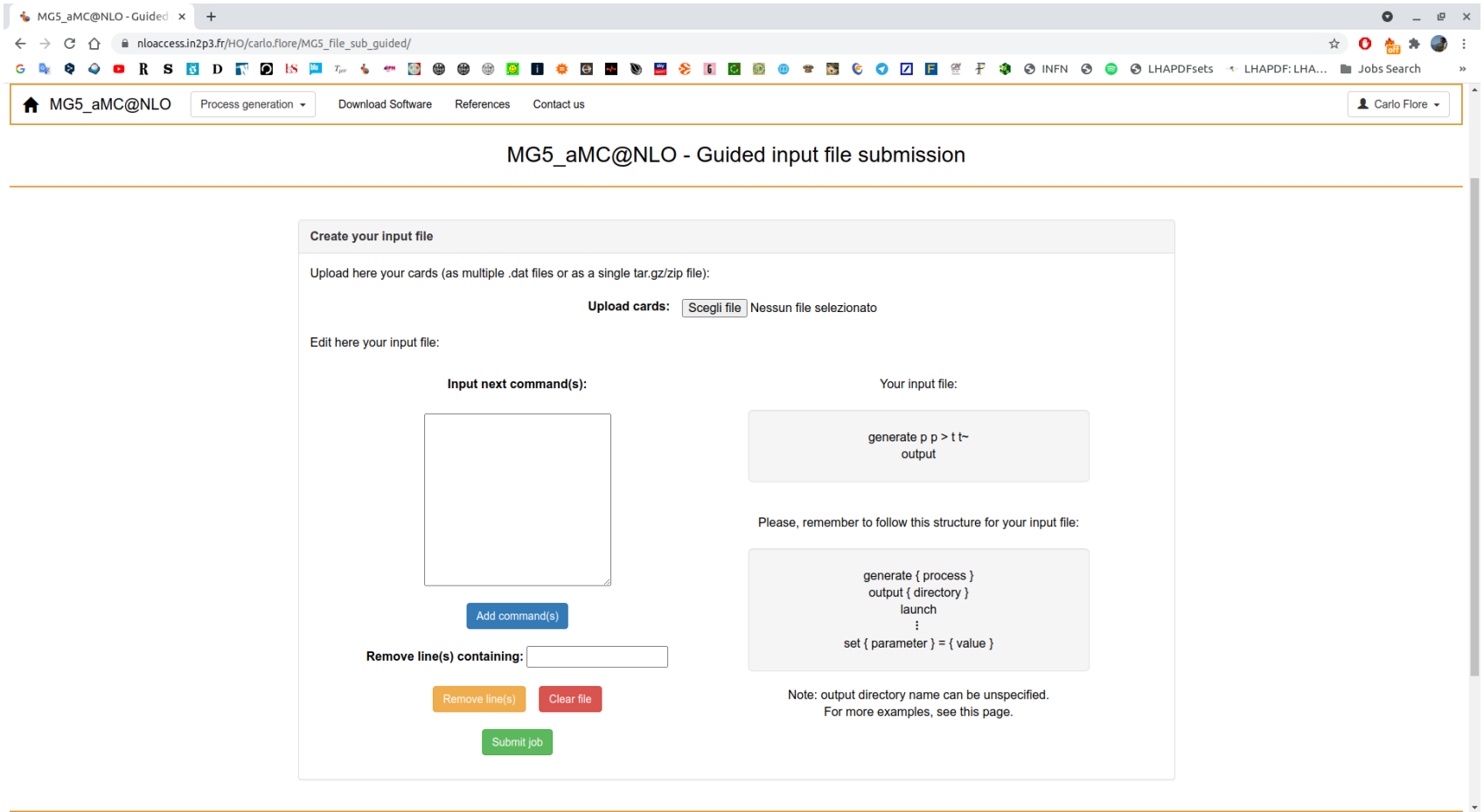

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Thank you

Backup

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H.-S. Shao, CPC 184 (2013) 2562-2570 & CPC 198 (2016) 238-259

HELAC-Onia is an automatic matrix element and event generator for heavy quarkonium physics

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NRQCD factorisation:

$$\sigma(pp \to \mathcal{Q} + X) = \sum_{i,j,n} \int dx_1 dx_2 \, f_{i/p}(x_1) f_{j/p}(x_2) \, \hat{\sigma}(ij \to Q\bar{Q}[n] + X) \, \langle \mathcal{O}_n^{\mathcal{Q}} \rangle$$

- $f_{i/p}(x_1), f_{j/p}(x_2)$ are the PDFs
- $\hat{\sigma}(ij \to Q\bar{Q}[n] + X)$ is the partonic cross section for producing a heavy quark pair in the Fock state n
- $n = {}^{2S+1}L_J^c$, with $c = 1, 8$ (color singlet or color octet)
- $\langle \mathcal{O}_n^{\mathcal{Q}} \rangle$ are the LDMEs

HELAC-Onia (II)

H.-S. Shao, CPC 184 (2013) 2562-2570 & CPC 198 (2016) 238-259

Main features:

- Standard Model calculations but BSM extension is feasible
- different kind of calculation: multiple quarkonia production, event generation, yields vs polarisation, angular distributions of quarkonia decays...
- reweighting method for estimating renormalisation/factorisation scale and PDF uncertainties
- interface with LHAPDF
- interface with PYTHIA 8, QEDPS

HELAC-Onia Web - Input file

The input file should be in the following form:

```
generate { process }
set { parameter } = { value }
  ⋮
launch
```

Users can have control on several kind of parameters via the `set` command:

- collisions parameters;
- theory parameters;
- MC setup variables;
- PDFs parameters;
- kinematical cuts;
- quarkonium specific parameters (e.g. the values of different LDMEs);
- physical constants (both EW and QCD sectors, e.g. M_Z or M_W, or m_q, or couplings).
- kind of output (ROOT, Gnuplot, TopDrawer or LHE)

HELAC-Onia Web - Run status