NLOAccess: online event generators

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NLOAccess - the framework

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

- a virtual access for automated perturbative calculation for heavy ions and quarkonia
- an online code library
- any code that could be compiled and launched via bash could be added

✓ HELAC-Onia and MadGraph5 (MG5_aMC@NLO) are included

NLOAccess - the tools

- HELAC-Onia — H.-S. Shao, CPC 184 (2013) 2562-2570 & CPC 198 (2016) 238-259
  - LO(+PS) automated event generator for quarkonia in the SM
  - based on the NRQCD framework, relies on off-shell recursion relations
  - approximate NLO calculation (*e.g.* NLO*, aNLO) feasible

    C. Flore *et al.*, Phys. Lett. B 811 (2020) 135926; H.-S. Shao, JHEP 01 (2019) 112

- MG5_aMC@NLO — http://amcatnlo.web.cern.ch/amcatnlo/list_refs.htm
  - full NLO(+PS) matrix element and event generator in the SM and for BSM phenomenology
  - LO for any user-defined Lagrangian, and at the NLO for models supporting such a calculation
  - onium feasible within (I)CEM — J.-P. Lansberg *et al.*, Phys. Lett. B 807 (2020) 135559

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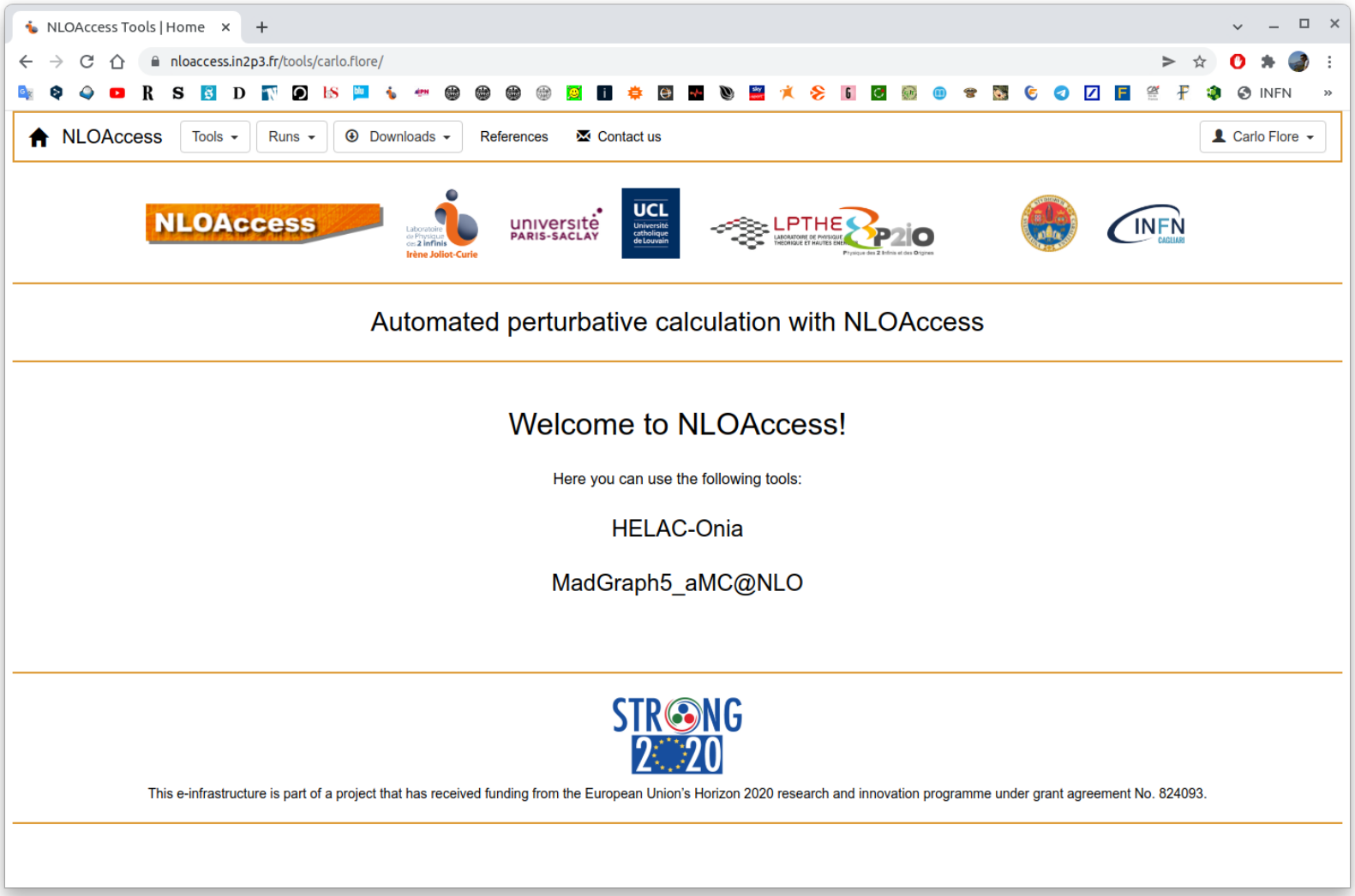
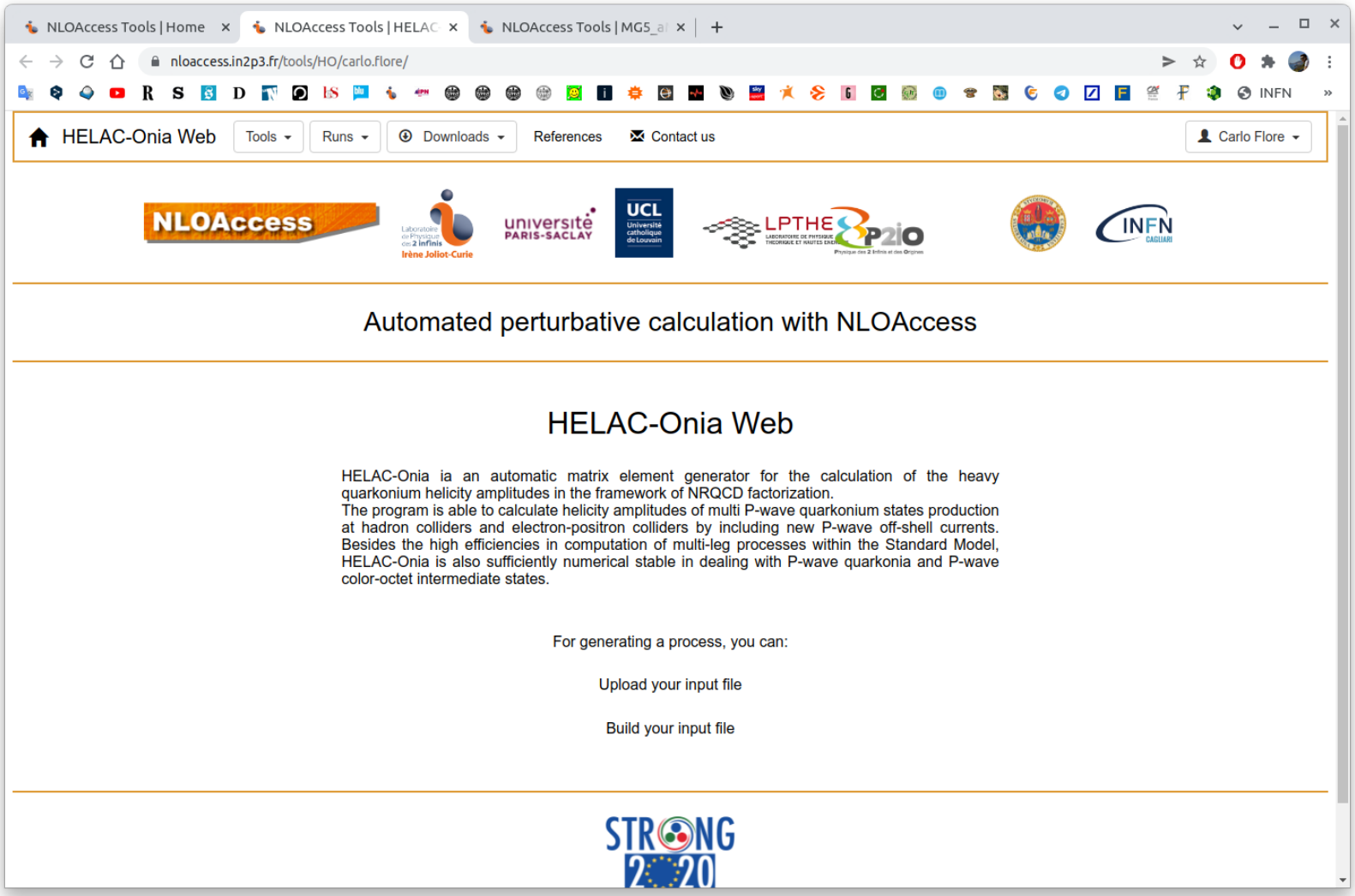
$\Rightarrow$ Les Houches Events available for both codes

NLOAccess Tools - homepage

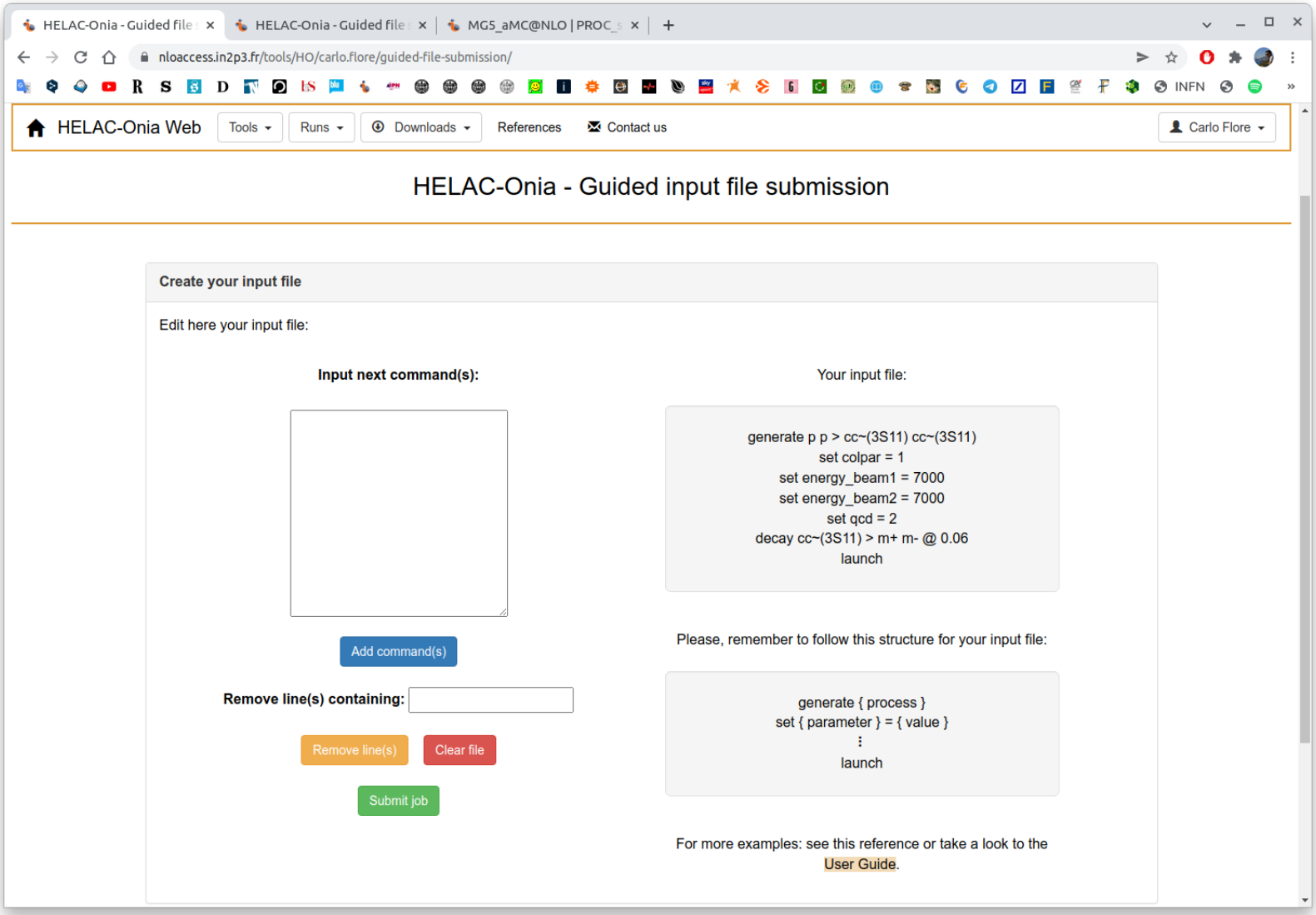
(https://nloaccess.in2p3.fr/tools/)



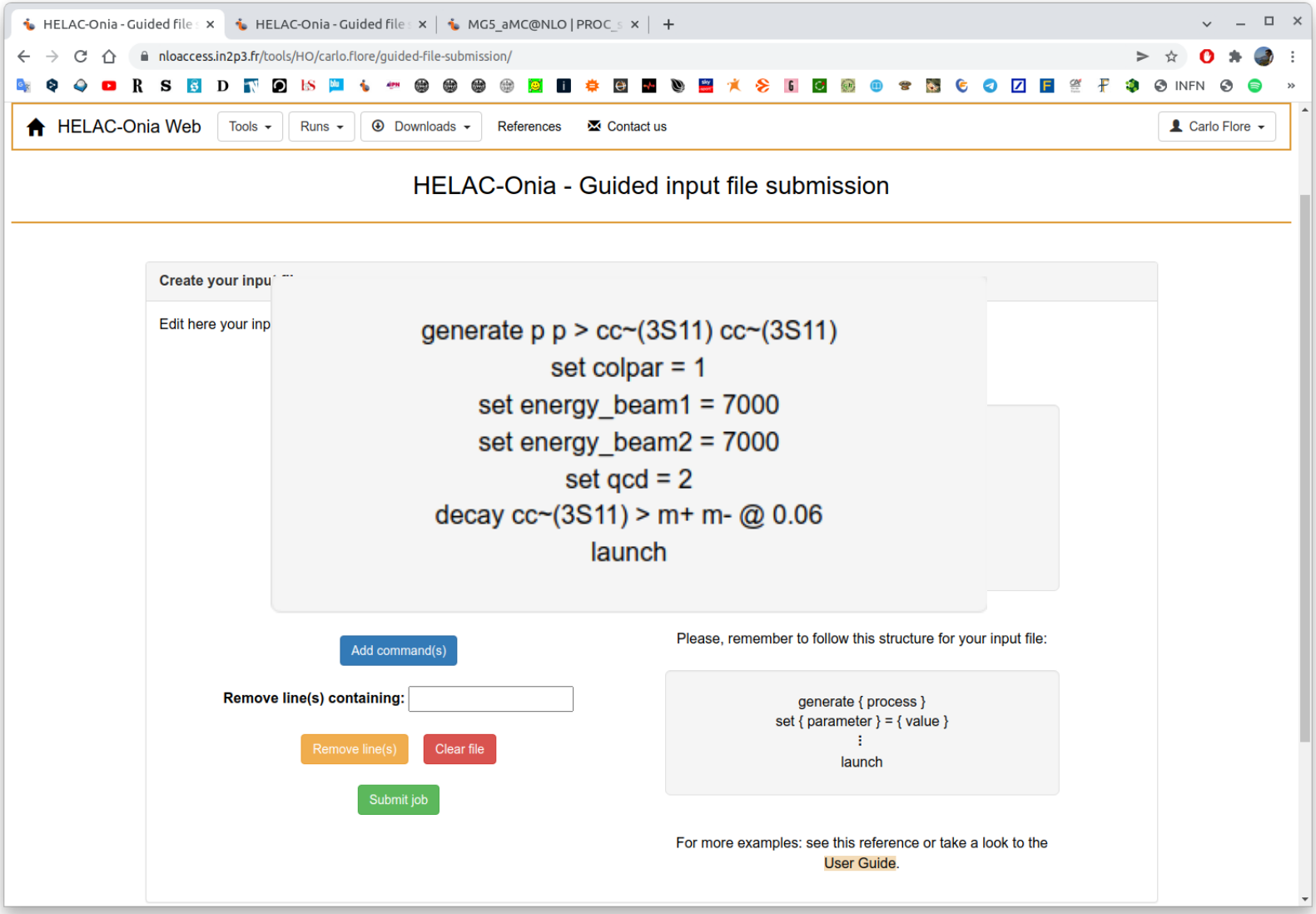
HELAC-Onia Web (https://nloaccess.in2p3.fr/HO/)



HELAC-Onia Web - run submission



HELAC-Onia Web - run submission



HELAC-Onia Web - input file

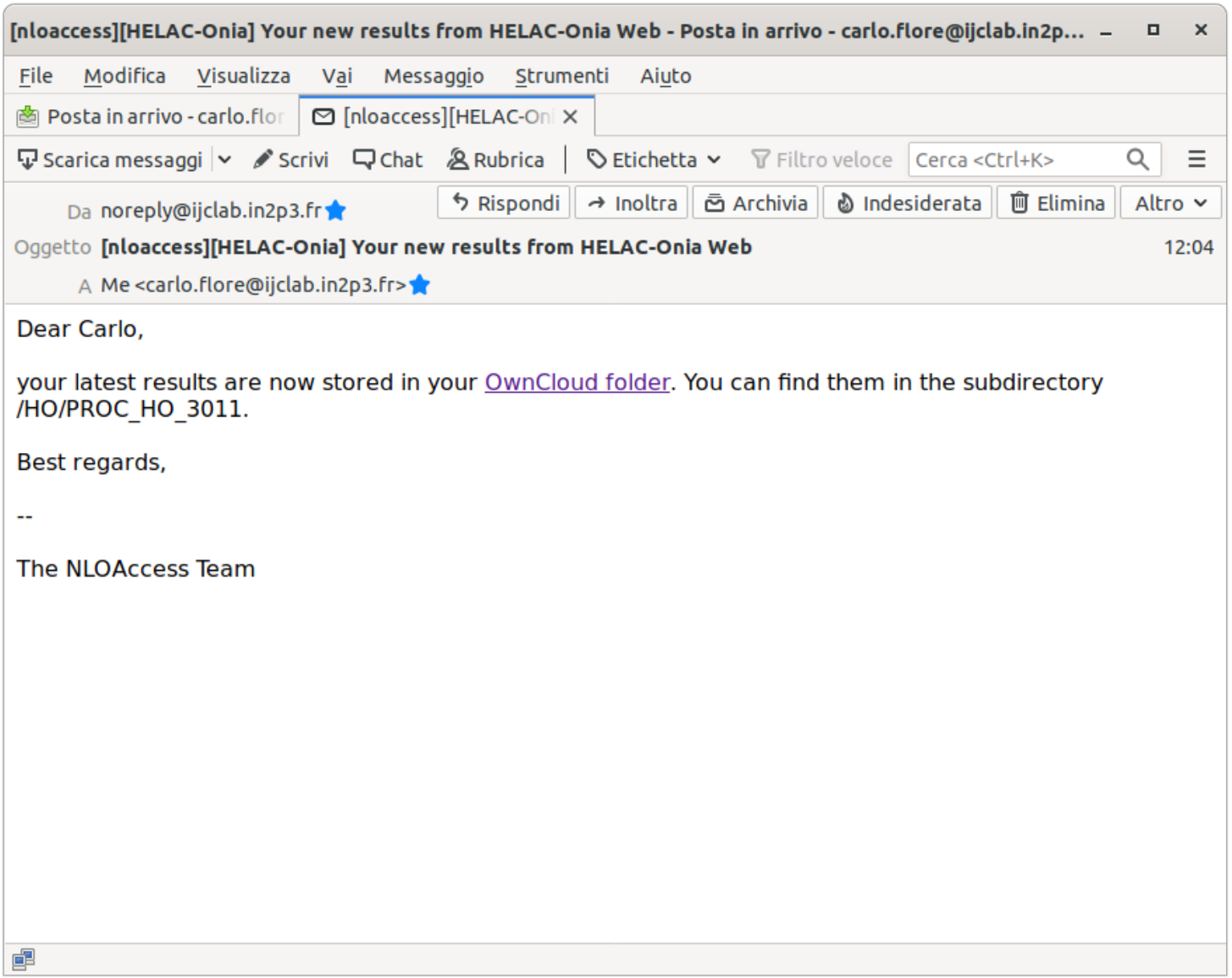
The input file should be in the following form:

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

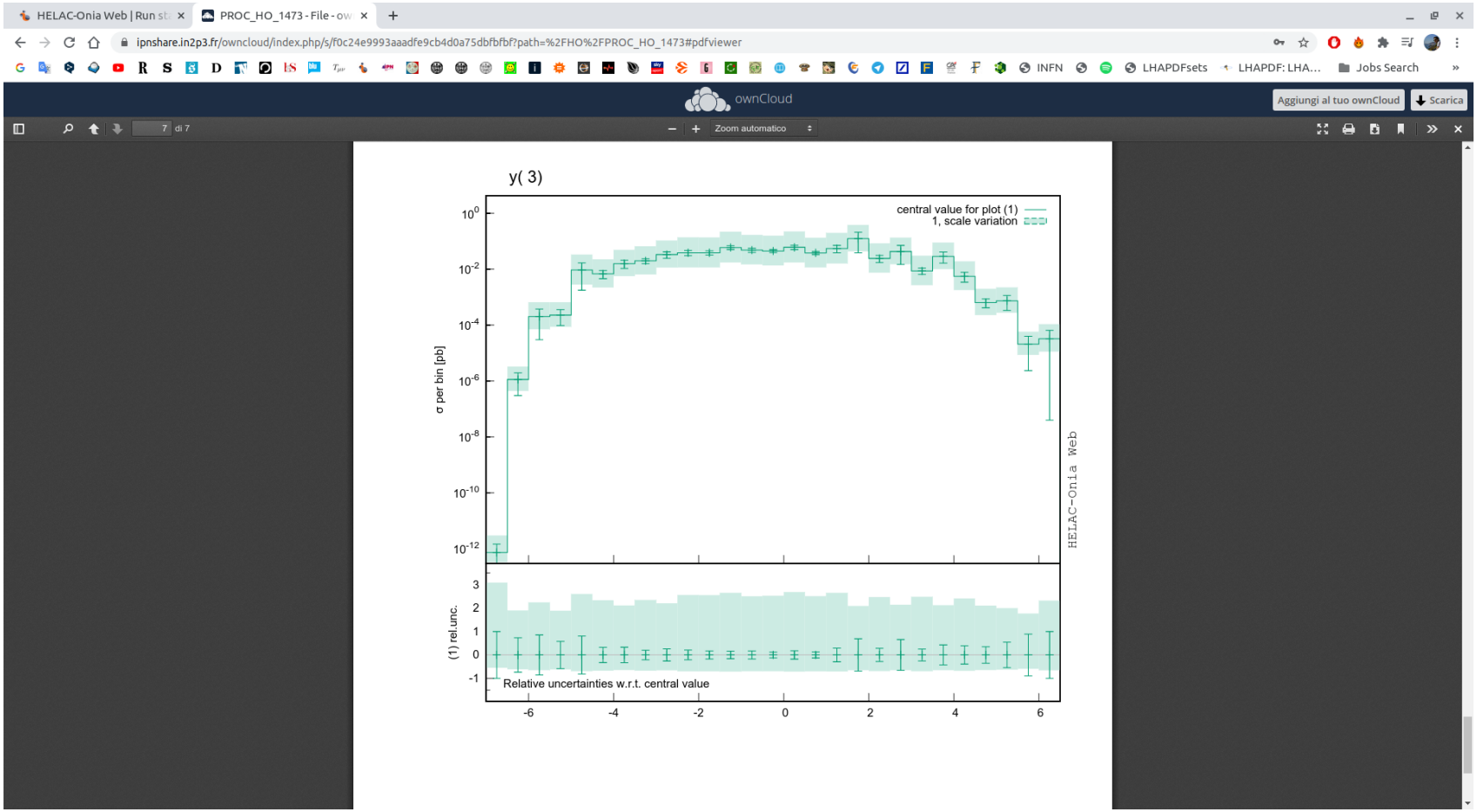
Users can have control on several kind of parameters via the `set` command:

- 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 - results (I)



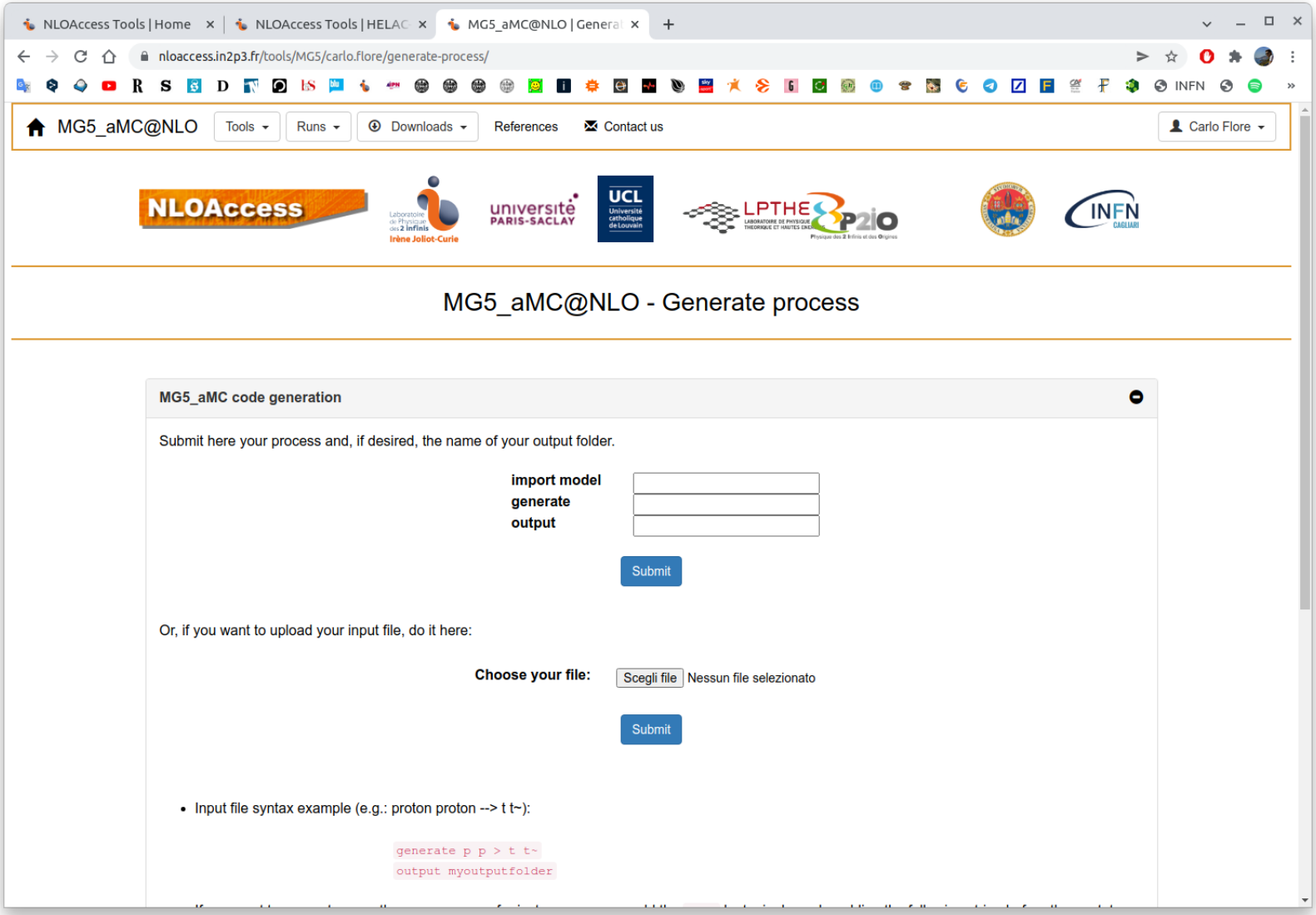
HELAC-Onia Web - results (II)



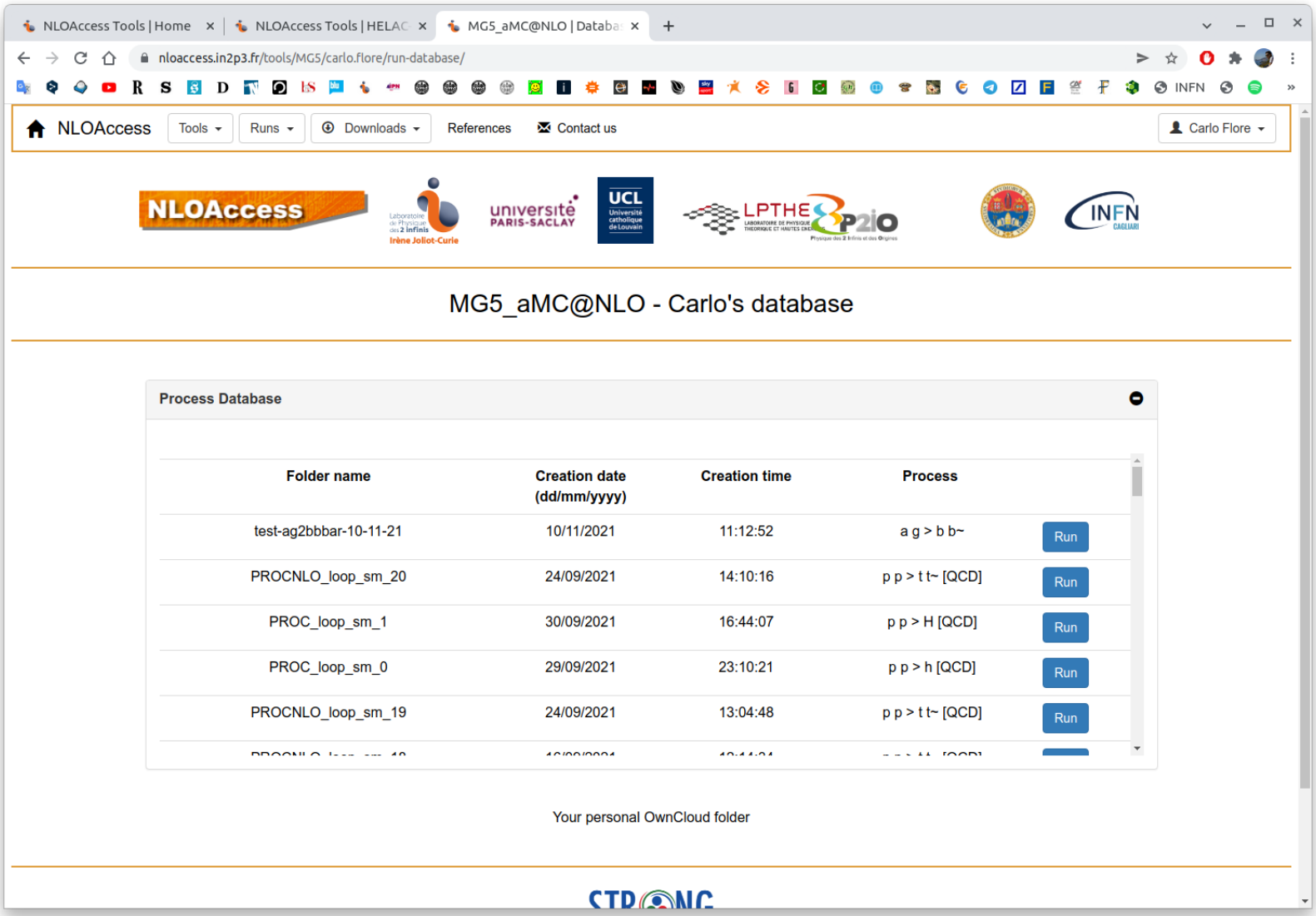
MG5_aMC@NLO (https://nloaccess.in2p3.fr/MG5/)

- MadGraph5 online version was only limited to LO calculation
- NLOAccess offers access for the first time to full NLO SM online calculation with MG5_aMC@NLO!

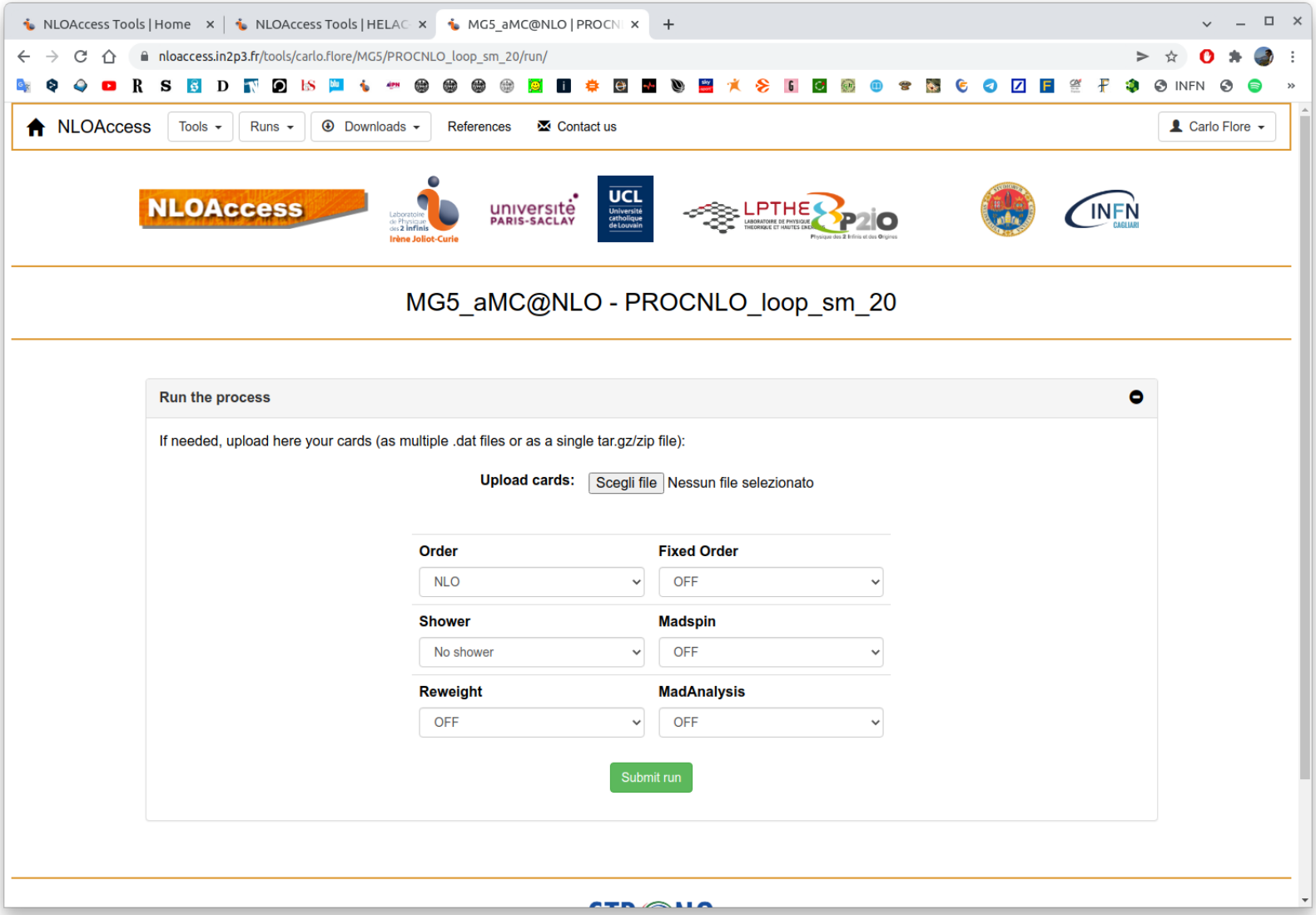
MG5_aMC@NLO - code generation



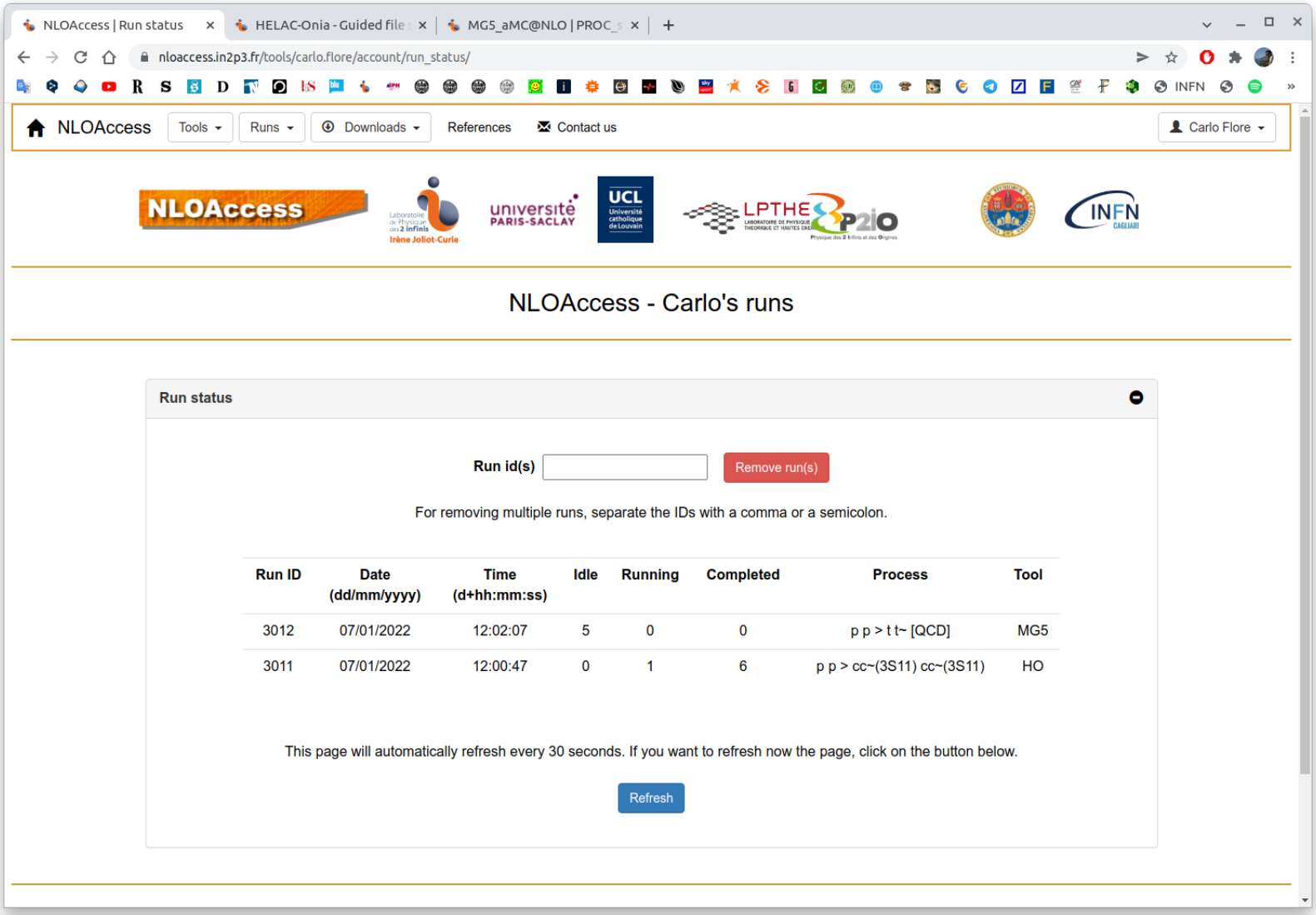
MG5_aMC@NLO - code database



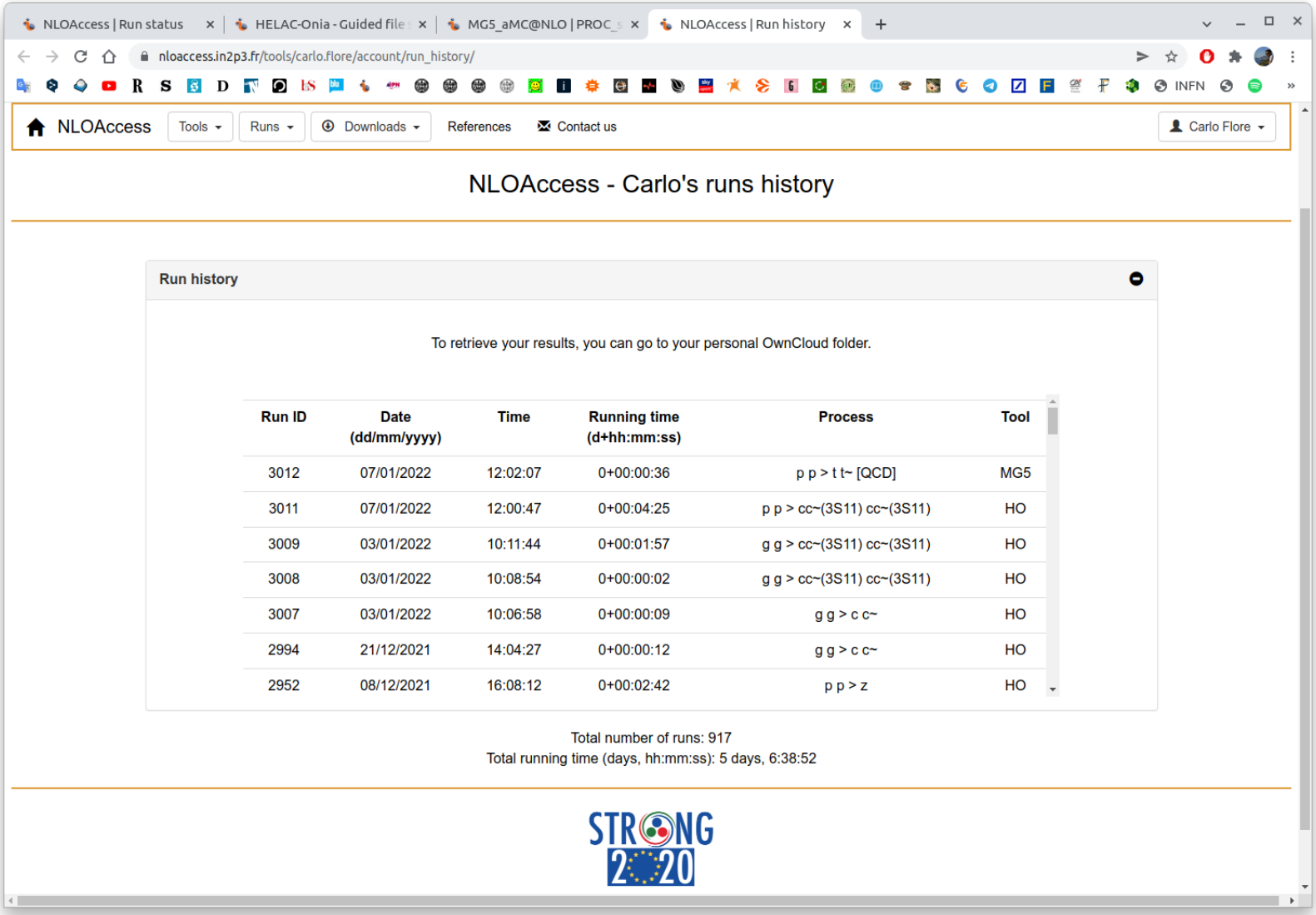
MG5_aMC@NLO - code running



NLOAccess - run status



NLOAccess - run history



Run ID	Date (dd/mm/yyyy)	Time	Running time (d+hh:mm:ss)	Process	Tool
3012	07/01/2022	12:02:07	0+00:00:36	p p > t t~ [QCD]	MG5
3011	07/01/2022	12:00:47	0+00:04:25	p p > cc~(3S11) cc~(3S11)	HO
3009	03/01/2022	10:11:44	0+00:01:57	g g > cc~(3S11) cc~(3S11)	HO
3008	03/01/2022	10:08:54	0+00:00:02	g g > cc~(3S11) cc~(3S11)	HO
3007	03/01/2022	10:06:58	0+00:00:09	g g > c c~	HO
2994	21/12/2021	14:04:27	0+00:00:12	g g > c c~	HO
2952	08/12/2021	16:08:12	0+00:02:42	p p > z	HO

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[L. Manna, WUT Warsaw]

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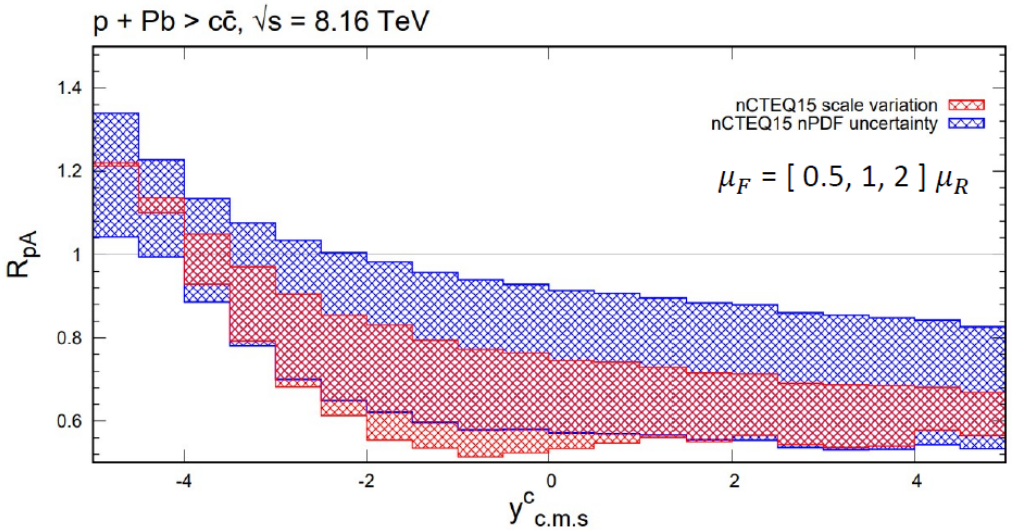
  extension to $pA/AB/\pi p$ collisions and automated computation of nuclear modification factors (*e.g.* R_{pA})

  [A. Safronov, WUT Warsaw]



from A. Safronov's talk at ICHEP 2022

NLOAccess - what's next?

- inclusion of onium production at NLO in MG5

  [A. Abdul-Hameed, LPTHE Paris]

- inclusion of spin and transverse momentum effects in HELAC-Onia

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  [suggestions are welcome!]

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Thank you

Backup

HELAC-Onia

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

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

- based on NRQCD framework
- based on off-shell recursion relations

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

NLOAccess - facts and figures

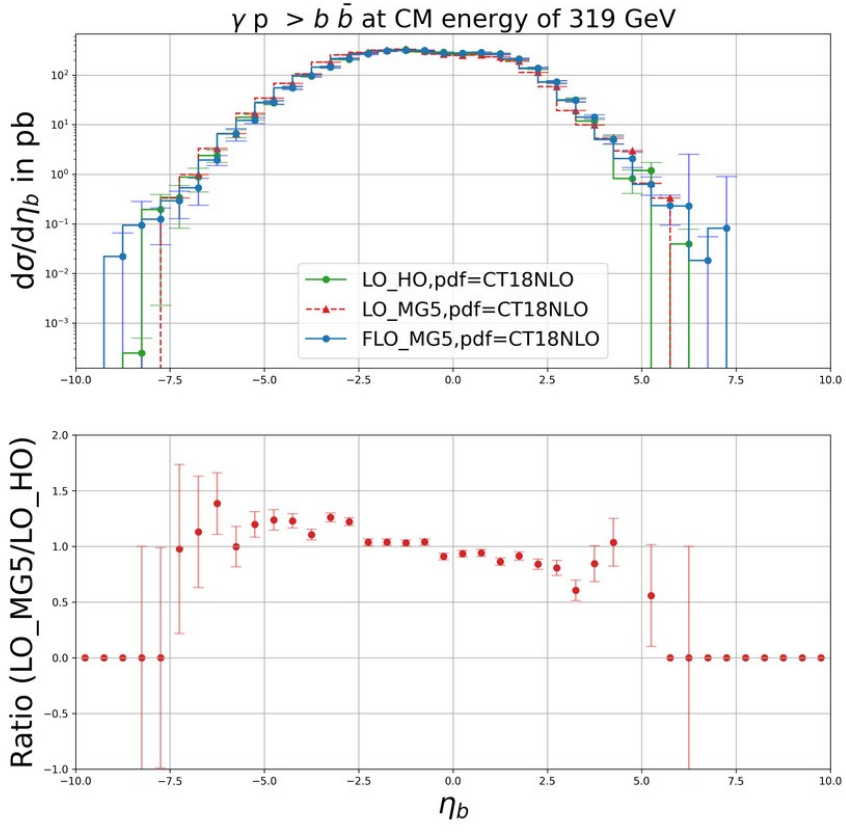
Some facts and figures about NLOAccess:

- general information at https://nloaccess.in2p3.fr
- HELAC-Onia Web: https://nloaccess.in2p3.fr/HO/
- MG5_aMC@NLO: https://nloaccess.in2p3.fr/MG5/
- 345 users from +30 countries all over the world; $\sim$ 3800 runs
- features:
  - secure two-step registration process
  - protected OwnCloud storage is given
  - file input as first way to submit a run
  - live user run status and run history
  - almost zero computational cost for the users
  - 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)

Result:



A comparison between pseudorapidity distribution of bottom quark production obtained from MG5 at LO (& FLO*) and with another LO event generator called Helac-onia (HO).

Cross section (nb)	MG5	HO
LO	$3.34 \pm 4.4*10^{-3}$	$3.34 +/- 10.08*10^{-3}$
FLO	$3.34 \pm 19*10^{-3}$	

*FLO (It's a specialty in MG5 that NLO code could be used for LO calculation as well)

courtesy of L. Manna