



# NLOAccess: status and updates

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Quarkonia as Tools  
(virtual meeting)

26 Mar 2021

# 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 bash could be added
- MadGraph and extension for nPDFs to be included
- ✓ HELAC-Onia is included

# HELAC-Onia (I)

HELAC-Onia is an automatic matrix element and event generator for heavy quarkonium physics [H.-S. Shao, CPC 184 (2013) 2562-2570 & CPC 198 (2016) 238-259]

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

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NRQCD factorisation:

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

- $f_{i/p}(x_1), f_{j/p}(x_2)$  are the PDFs
- $\hat{\sigma}(ij \rightarrow Q\bar{Q}[n] + X)$  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)
- $\langle \mathcal{O}_n^Q \rangle$  are the LDMEs

# HELAC-Onia (II)

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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

# NLOAccess & HELAC-Onia Web

Some facts about NLOAccess:

- general information at <https://nloaccess.in2p3.fr>
- HELAC-Onia Web: <https://nloaccess.in2p3.fr/HO/>
- note: **not definitive** working version
- 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
  - guided input file creation and submission for HO:  
[https://nloaccess.in2p3.fr/HO/downloads/HO\\_online\\_guide\\_v01.pdf](https://nloaccess.in2p3.fr/HO/downloads/HO_online_guide_v01.pdf)

# NLOAccess - Homepage

(<https://nloaccess.in2p3.fr>)

The screenshot shows the NLOAccess homepage. At the top, there's a navigation bar with links for Home, The project, Communication, Tools, Account, Downloads, and Request registration. Below the navigation bar, there's a section titled "GENERAL DESCRIPTION" with a heading "Objectives". It describes NLOAccess as a tool for automated perturbative NLO calculations for heavy ions and quarkonia. The page features several plots: a log-linear plot of differential cross-section  $d\sigma/dP_T$  (nb/GeV) versus  $P_T$  (GeV), a plot of quarkonia production rates, and a plot for 7 TeV@LHC Color Singlet  $Z < Y_{coll} < 4.5$  with  $s_{ij}^{(10)}/m_c^2 = 4$ . On the right side, there's a sidebar for "STRONG 2020" with a search bar, a "RECENT POSTS" section, and a "FOLLOW:" button.

# HELAC-Onia Web - Homepage

(<https://nloaccess.in2p3.fr/H0/>)



A screenshot of a web browser showing the HELAC-Onia Web homepage. The address bar displays the URL https://nloaccess.in2p3.fr/H0/. The page header includes the title "HELAC-Onia Web" and a navigation menu with links for "Process generation", "Download Software", "References", and "Contact us". A user profile for "Carlo Flora" is visible on the right. The main content area features logos for NLOAccess, Université Paris-Saclay, UCL, LPTHE, P2IO, and INFN.

## Automated perturbative calculation with HELAC-Onia Web

### Welcome to HELAC-Onia Web!

HELAC-Onia is an automatic matrix element generator for the calculation of the heavy quarkonium helicity amplitudes in the framework of NRQCD factorization.

The program is able to calculate helicity amplitudes of multi P-wave quarkonium states production at hadron colliders and electron-positron colliders by including new P-wave off-shell currents. Besides the high efficiencies in computation of multi-leg processes within the Standard Model, HELAC-Onia is also sufficiently numerical stable in dealing with P-wave quarkonia and P-wave color-octet intermediate states.

Generate a process or submit your input file, or logout.



This e-infrastructure is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 824983.

# HELAC-Onia Web - Run submission

The screenshot shows a web browser window titled "HELAC-Onia Web | Guide". The address bar shows the URL: "nloaccess.in2p3.fr/~hQ/carlo/area/file\_sub\_guided/". The page content is titled "HELAC-Onia - Guided file submission".

**Create an input file**

**Input next command(s):** (A large text area for entering commands.)

**Add command(s)**

**Your input file:** (A code editor showing the generated input file content.)

```
generate p p > cc-(3S11) cc-(3S11) g
set energy_beam1 = 3500.0
set energy_beam2 = 3500.0
set qcd = 2
set Scale = 1
set ScaleFactor = 1.0
set minptconria = 5.0
set nmc = 1000000
set nopt = 100000
set nopt_stop = 100000
set nopt_lim = 1000000
launch
```

**Remove line(s) containing:** (A text input field with a clear button.)

**Remove line(s)** **Clear file**

**Submit job**

**Please, remember to follow this structure for your input file:**

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

**For more examples: see this reference or take a look to the [User Guide](#).**

# HELAC-Onia Web - Run submission

The screenshot shows a web browser window with the title "HELAC-Onia Web | Guide". The main content area displays a shell-like command input field containing the following text:

```
generate p p > cc~(3S11) cc~(3S11) g
set energy_beam1 = 3500.0
set energy_beam2 = 3500.0
set qcd = 2
set Scale = 1
set ScaleFactor = 1.0
set minptconia = 5.0
set nmc = 1000000
set nopt = 100000
set nopt_step = 100000
set nopt_lim = 1000000
launch
```

Below this text, there is a small callout box with the following code snippet:

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

At the bottom of the page, there is a note: "For more examples: see this reference or take a look to the [User Guide](#)".

# 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

HELAC-Onia Web | Run 11

Process generation Download Software References Contact us

Carlo Flora

NLOAccess université PARIS-SACLAY UCL LPTHE EPLIO INFN

## HELAC-Onia Web - Carlo's runs

Run status

Run id(s)  Remove run(s)

For removing multiple runs, separate the IDs with a comma or a semicolon.

Run ID	Date (dd/mm/yyyy)	Time (d:hh:mm:ss)	Idle	Running	Completed	Process
1473	06/03/2021	17:29:37	0	7	0	p p > cc~(3S11) cc~(3S11) g

This page will automatically refresh every 30 seconds. If you want to refresh now the page, click on the button below.

refresh



# HELAC-Onia Web - Results (I)

[nloaccess] Your new results from HELAC-Onia Web - Posta in arrivo - carlo.flore@ijclab.in2p3.fr - Mozilla ... - x

File Modifica Visualizza Vai Messaggio Strumenti Aiuto

Posta in arrivo - carlo.flore@ijclab.in2p3.fr [nloaccess] Your new r... X

Scarica messaggi | Scrivi | Chat | Rubrica | Etichetta | Filtro veloce |  Cerca <Ctrl+K> | | Altro

Da Me <nloaccess@ijclab.in2p3.fr> Rispondi | Inoltra | Archivia | Indesiderata | Elimina | Altro

Oggetto: [nloaccess] Your new results from HELAC-Onia Web 19:26

A Me <carlo.flore@ijclab.in2p3.fr>

Dear Carlo,

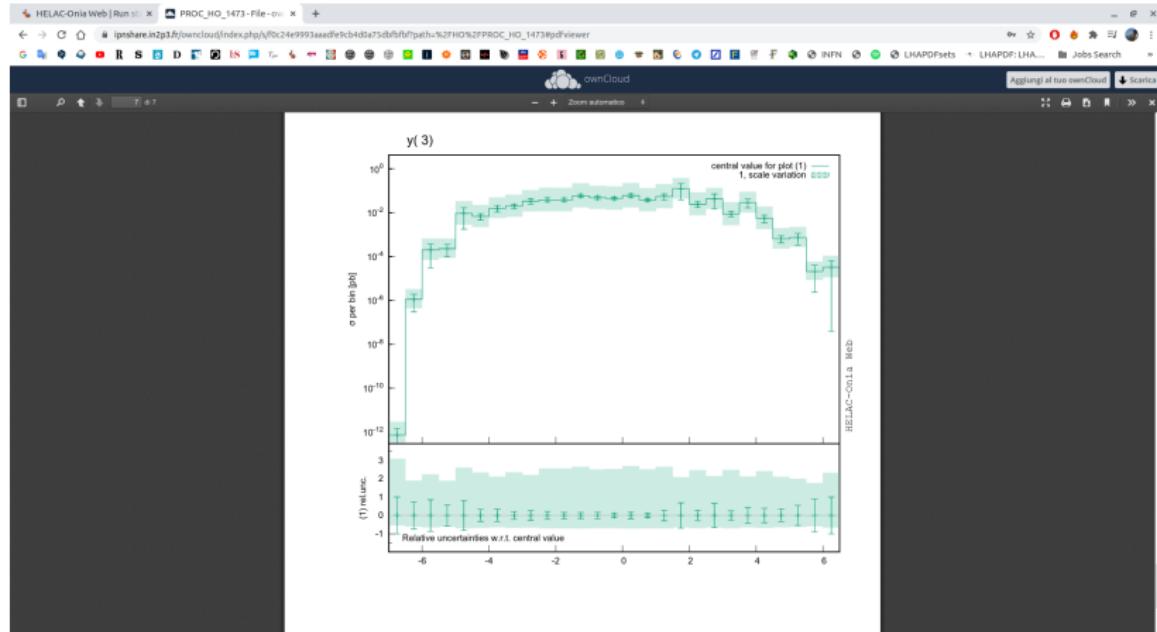
your latest results are now stored in your [OwnCloud folder](#). You can find them in the subdirectory /HO/PROC\_HO\_1473.

Best regards,

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The NLOAccess Team

# HELAC-Onia Web - Results (II)



## HELAC-Onia Web - Run history

The screenshot shows the HELAC-Onia Web interface. At the top, there are several tabs: 'HELAC-Onia Web' (active), 'Process generation', 'Download Software', 'References', and 'Contact us'. On the right side of the header, there is a user profile for 'Carlo Flora' and a 'Jobs Search' button.

Below the header, there are several logos: 'NLOAccess' (with 'L'ogo de l'Institut Jean Lebel IJL'), 'université PARIS-SACLAY', 'UCL' (Université catholique de Louvain), 'LPTHE' (Laboratoire de physique théorique et élémentaire), 'IP2I' (Institut de physique théorique et d'astrophysique), and 'INFN' (Istituto Nazionale di Fisica Nucleare).

### HELAC-Onia Web - Carlo's runs history

To retrieve your results, you can go to your personal OwnCloud folder.

Run ID	Date (dd/mm/yyyy)	Time	Running time (d:hh:mm:ss)	Process
1470	05/03/2021	11:07:59	0+04:23:34	p p > cc~(3S11) cc~(3S11) g
1469	04/03/2021	16:03:52	0+00:00:16	g g > cc~
1468	04/03/2021	15:41:24	Removed	p p > cc~(3S11) cc~(3S11) g
1467	04/03/2021	15:38:32	Removed	p p > cc~(3S11) cc~(3S11) g
1466	04/03/2021	15:29:06	Removed	p p > cc~(3S11) cc~(3S11) g
1465	04/03/2021	15:29:00	Removed	p p > cc~(3S11) cc~(3S11) g
1464	04/03/2021	15:28:03	Removed	p p > cc~(3S11) cc~(3S11) g

Total number of runs: 375  
Total running time (days, hh:mm:ss): 1 day, 19:28:35

# NLOAccess - What's next?

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MadGraph:

- MadGraph online version is only limited to LO calculation
- NLO preliminary version has already been tested (not public)
- extension to nPDFs  $\Rightarrow$  extend calculation to other observables (e.g.  $R_{pA}$  or  $R_{AA}$ )

HELAC-Onia developments:

- NLO calculations
- inclusion of TMD effects [[Wednesday talks](#)]
- helpful for future fixed-target programs at the LHC and for the EIC [[Liza's talk on Monday](#)]



**Thank you**