



# NLOAccess: where do we stand?

Carlo Flore

University & INFN, Cagliari

FTE@LHC & NLOAccess STRONG 2020  
joint kick-off meeting

Nov., 7<sup>th</sup> 2019

# Outline

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1. The NLOAccess framework
2. HELAC-Onia and its web realisation
3. What's next?
4. Conclusions

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# **1. The NLOAccess framework**

# The NLOAccess project

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- MadGraph and extension for nPDFs to be included
- ✓ HELAC-Onia is included

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## **2. HELAC-Onia and its web realisation**

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

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- based on off-shell recursion relations

# HELAC-Onia - Basic methodology

NRQCD factorisation:

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

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- $\langle \mathcal{O}_n^{\mathcal{Q}} \rangle$  are the **LDMEs**

# HELAC-Onia - 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

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- built with Flask Python microframework
- file input as first way to submit a run

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- live user run status
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- guided\* input file creation and submission

\*online guide still missing

# HELAC-Onia Web - Homepage

HELAC-Onia Web | Home

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

HELAC-Onia Web Request Registration References Contact us Login

NLOAccess

IPN

UCL

LPTHE

INFN

Automated perturbative NLO calculation with HELAC-Onia Web

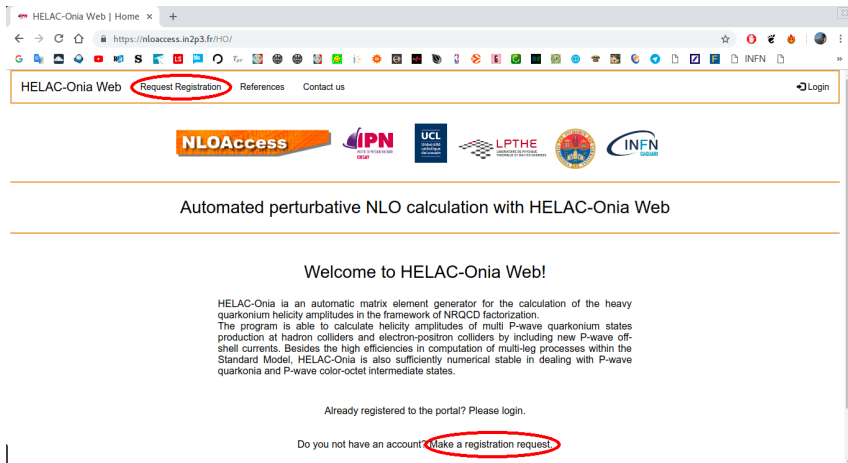
Welcome to HELAC-Onia Web!

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.

Already registered to the portal? Please login.

Do you not have an account? Make a registration request.

# HELAC-Onia Web - Homepage



The screenshot shows the HELAC-Onia Web homepage in a web browser. The browser's address bar displays the URL `https://nloaccess.in2p3.fr/HO/`. The navigation bar at the top includes the text "HELAC-Onia Web" followed by a red circle around the "Request Registration" link, and then "References" and "Contact us". A "Login" button with a right-pointing arrow is located on the far right of the navigation bar. Below the navigation bar, a row of logos is displayed, including NLOAccess, IPN, UCL, LPTHE, and INFN. The main content area features the heading "Automated perturbative NLO calculation with HELAC-Onia Web" in a large, bold font. Below this heading, the text "Welcome to HELAC-Onia Web!" is centered. A paragraph of text describes the program's capabilities: "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." Below this paragraph, the text "Already registered to the portal? Please login." is centered. At the bottom of the main content area, the text "Do you not have an account?" is followed by a red circle around the "Make a registration request" link.

HELAC-Onia Web | Home x +

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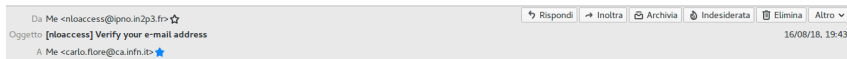
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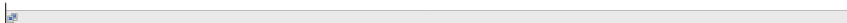
Dear user,

You started the HELAC-Onia WEB profile creation process. To continue, you need to verify that this address is yours. To do so, please click [here](#). Please note that this link will expire in 24 hours.

Best regards,

--

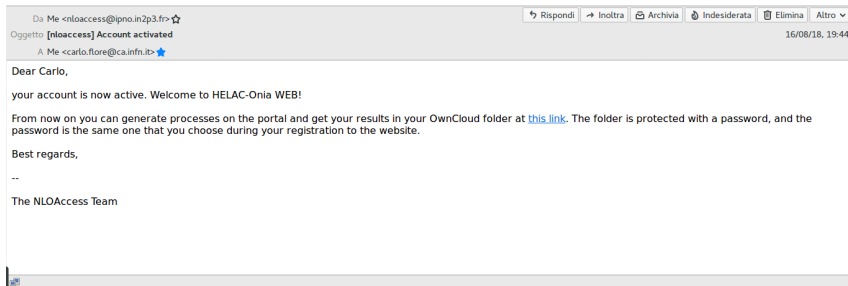
The NLOAccess Team



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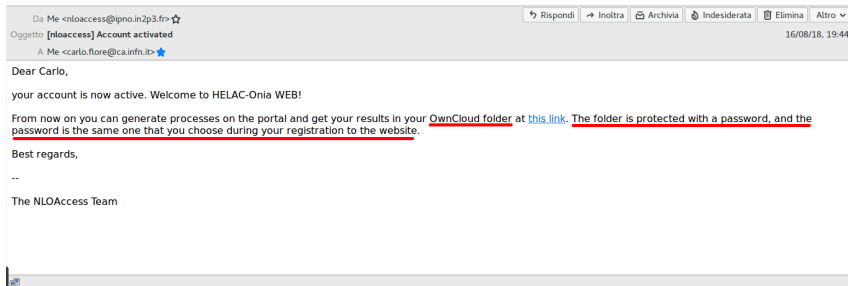
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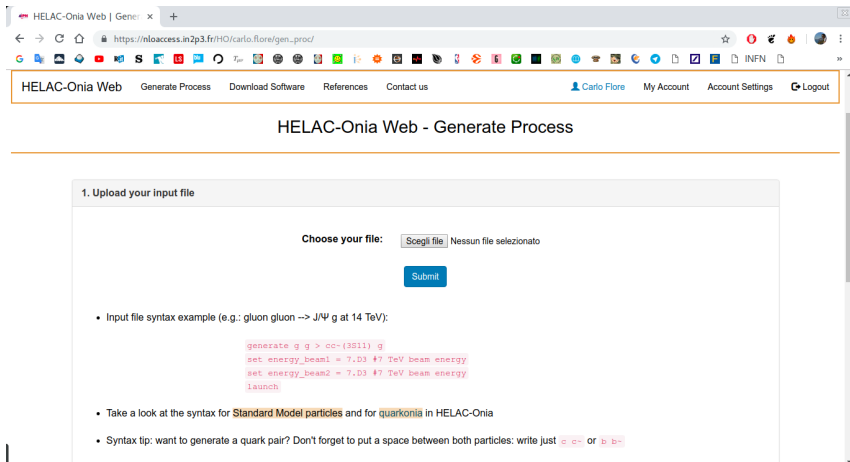
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# HELAC-Onia Web - Run submission (I)



HELAC-Onia Web | Generate Process

HELAC-Onia Web Generate Process Download Software References Contact us Carlo Fiore My Account Account Settings Logout

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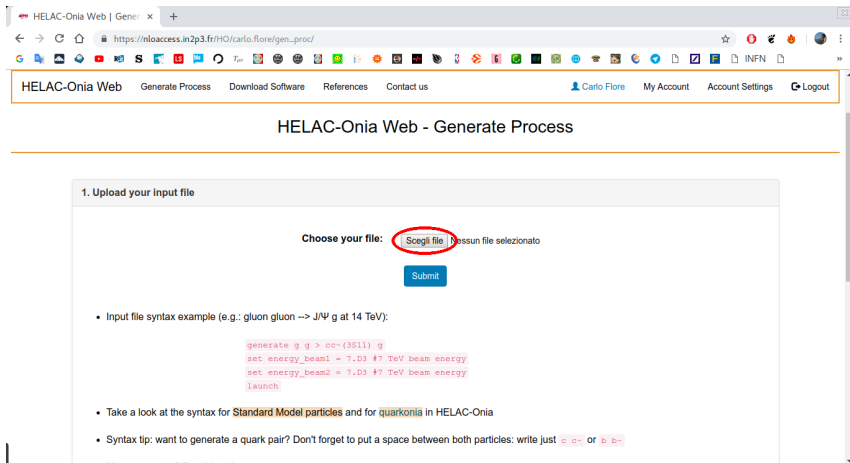
### 1. Upload your input file

Choose your file:  Nessun file selezionato

- Input file syntax example (e.g.: gluon gluon  $\rightarrow$   $J/\Psi$  g at 14 TeV):

```
generate g g > cc-(3S11) g
set energy_beam1 = 7.D3 #7 TeV beam energy
set energy_beam2 = 7.D3 #7 TeV beam energy
launch
```
- Take a look at the syntax for **Standard Model particles** and for **quarkonia** in HELAC-Onia
- Syntax tip: want to generate a quark pair? Don't forget to put a space between both particles: write just `c c-` or `b b-`

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```

# HELAC-Onia Web - Run submission (II)

HELAC-Onia Web | Guide: x

Process generation Download Software References Contact us

Carlo Fiore

## HELAC-Onia - Guided file submission

Create an input file

Input next command(s):

Add command(s)

Your input file:

generate p p > cc-(3s11) cc-(3s11) g  
set energy\_beam1 = 3500.d0  
set energy\_beam2 = 3500.d0  
set qcd = 2  
set Scale = 1  
set ScaleFactor = 1.0  
set mintconia = 2.0  
set ptDisQ = T  
launch

Remove line(s) containing:

Remove line(s) Clear file

Submit job



# HELAC-Onia Web - Input file

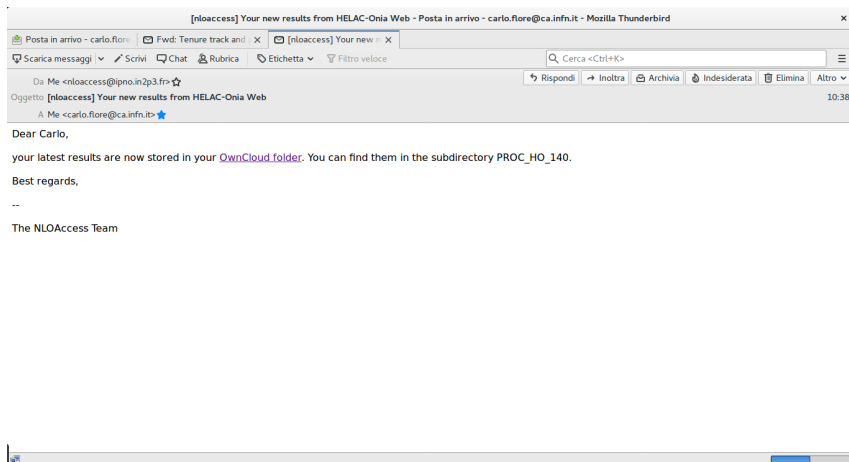
The input file should be in the following form:

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

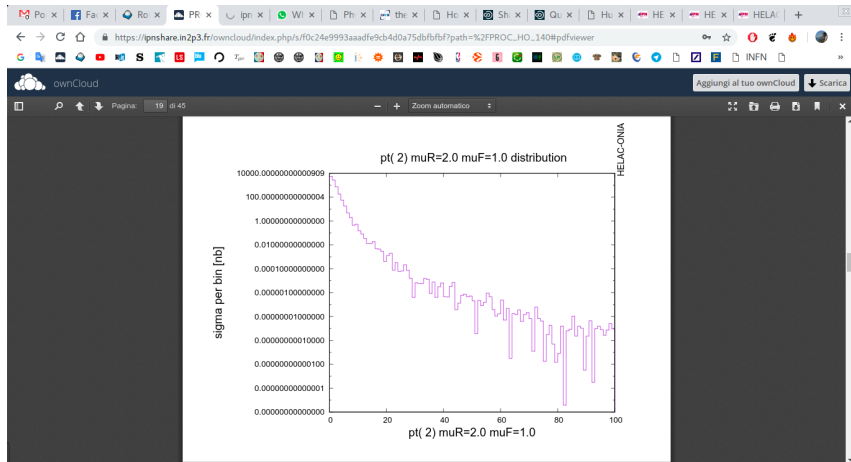
Users can have control on several kind of parameters via the set command:

- 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  $m_q$ ).
- kind of output (ROOT, Gnuplot, TopDrawer or LHE)

# HELAC-Onia Web - Results



# HELAC-Onia Web - Results



# HELAC-Onia Web - Run status and history

HELAC-Onia Web | Run st x +

← → ↻ 🏠 nloaccess.in2p3.fr/HO/carlo.flore/account/run\_status/

Google Chrome

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NLOAccess

IPN

UCL

LPTHE

INFN

HELAC-Onia Web - Carlo's runs

Run status

Run id(s)  Remove run(s)

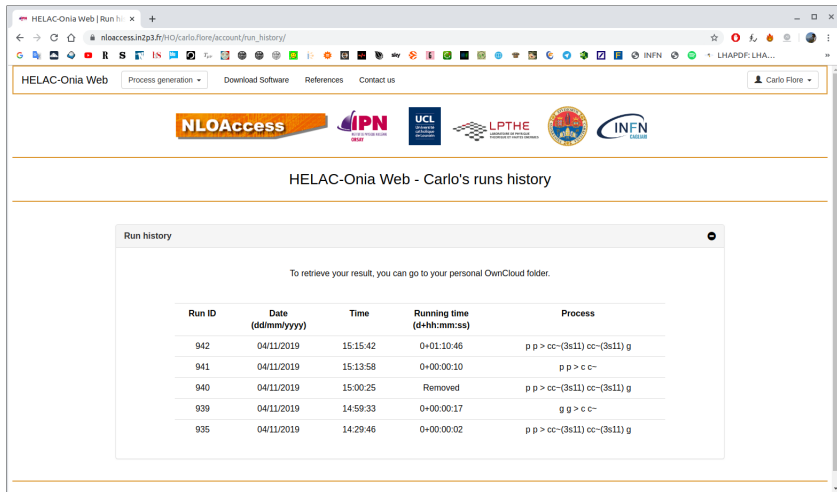
For removing multiple runs, separate the IDs with a comma or a semicolon.

Run ID	Date (dd/mm/yyyy)	Time (d+hh:mm:ss)	Idle	Running	Completed	Process
944	06/11/2019	22:43:47	0	7	0	p p > cc-(3s11) cc-(3s11) g

Refresh

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# HELAC-Onia Web - Run status and history



The screenshot shows a web browser window with the URL `nloaccess.in2p3.fr/HO/carlo.flore/account/run_history/`. The page header includes the text "HELAC-Onia Web" and navigation links: "Process generation", "Download Software", "References", and "Contact us". A user profile dropdown for "Carlo Flore" is visible in the top right. Below the header is a row of logos for NLOAccess, IPN, UCL, LPTHE, and INFN. The main content area is titled "HELAC-Onia Web - Carlo's runs history". A "Run history" panel is open, displaying a message: "To retrieve your result, you can go to your personal OwnCloud folder." Below this message is a table with the following data:

Run ID	Date (dd/mm/yyyy)	Time	Running time (d+hh:mm:ss)	Process
942	04/11/2019	15:15:42	0+01:10:46	p p > cc-(3s11) cc-(3s11) g
941	04/11/2019	15:13:58	0+00:00:10	p p > c c-
940	04/11/2019	15:00:25	Removed	p p > cc-(3s11) cc-(3s11) g
939	04/11/2019	14:59:33	0+00:00:17	g g > c c-
935	04/11/2019	14:29:46	0+00:00:02	p p > cc-(3s11) cc-(3s11) g

---

### **3. What's next?**

# What's next? (I)

HELAC-Onia Web is just the first step needed for building the NLOAccess framework.

- HELAC-Onia can be further developed
- MadGraph5\_aMC@NLO will be included on the portal
- extension to nuclear PDFs
- more observables (not only cross sections) could be calculated (open to suggestions!)

# What's next? (II)

HELAC-Onia developments:

- NLO calculations
- inclusion of TMD effects
- helpful for future fixed-target programs at the LHC



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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  $R_{AA}$ )

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## 4. Conclusions

# Conclusions

- NLOAccess:
  - aim to create a single portal for hadronic physics
  - automation and virtual access to a dynamical library
- HELAC-Onia: automated perturbative calculation for quarkonia production
- HELAC-Onia Web: improved portal is online
- MadGraph is going to be included

Suggestions are welcome!

**Thank you**

**Backup**

# HELAC-Onia Web: available PDF sets

The following PDF sets are available for the web version of HELAC-Onia:

- CT10
- CT14LO
- CT14NLO
- CTEQ6L1
- CTEQ66
- nCTEQFullNucMod\_208\_82
- EPPS16+CT14nlo\_Pb208
- NNPDF3.0\_NLO\_as\_0118

# References

- HELAC-Onia:
  - “HELAC-Onia: an automatic matrix element generator for heavy quarkonium physics”, Hua-Sheng Shao, Comput. Phys. Commun. 184 (2013) 2562 (<https://doi.org/10.1016/j.cpc.2013.05.023>)
  - “HELAC-Onia 2.0: an upgraded matrix-element and event generator for heavy quarkonium physics”, Hua-Sheng Shao, Comput. Phys. Commun. 198 (2016) 238 (<https://doi.org/10.1016/j.cpc.2015.09.011>)
  - download at <http://hshao.web.cern.ch/hshao/helaconia.html>
- NLOAccess: <https://nloaccess.in2p3.fr>
- Flask: <http://flask.pocoo.org/>