



OSCARS

Open Science Clusters' Action
for Research & Society



Virtual Research Environment (VRE)

A new environment for MUST

Léo Chazallet, 13 Novembre 2025
Réunion utilisateurs MUST

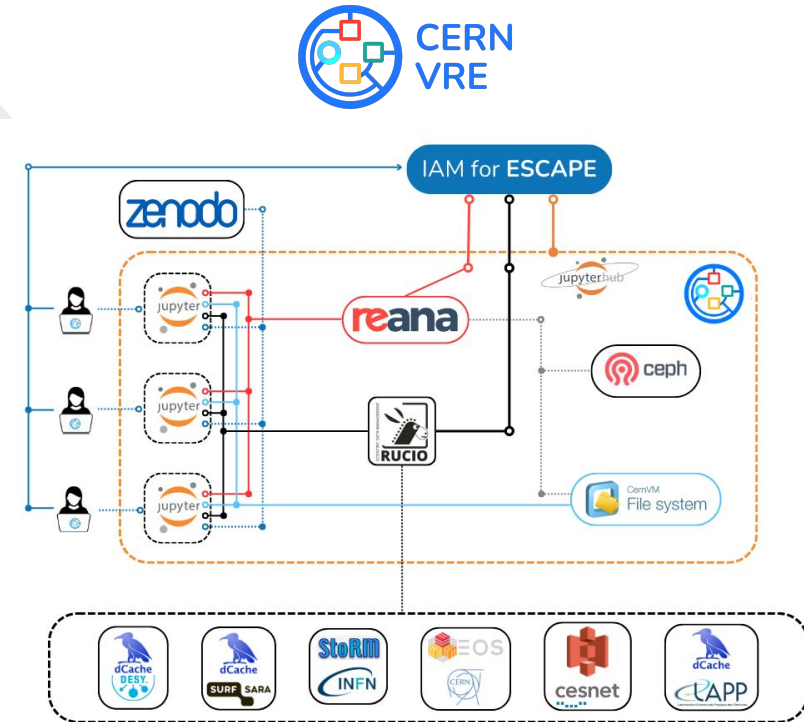


Funded by
the European Union

- Analysis platform developed by **CERN** for **interactive scientific work**
- Accessible through a **JupyterHub** interface
- Collection of tools for **storage, analysis, and more**
- Designed to make **workflows simpler and faster**

->in compliance with **Open Science, FAIR principles**
(EOSC/ESCAPE/OSCARS)

Doc VRE CERN : <https://vre-hub.github.io/>



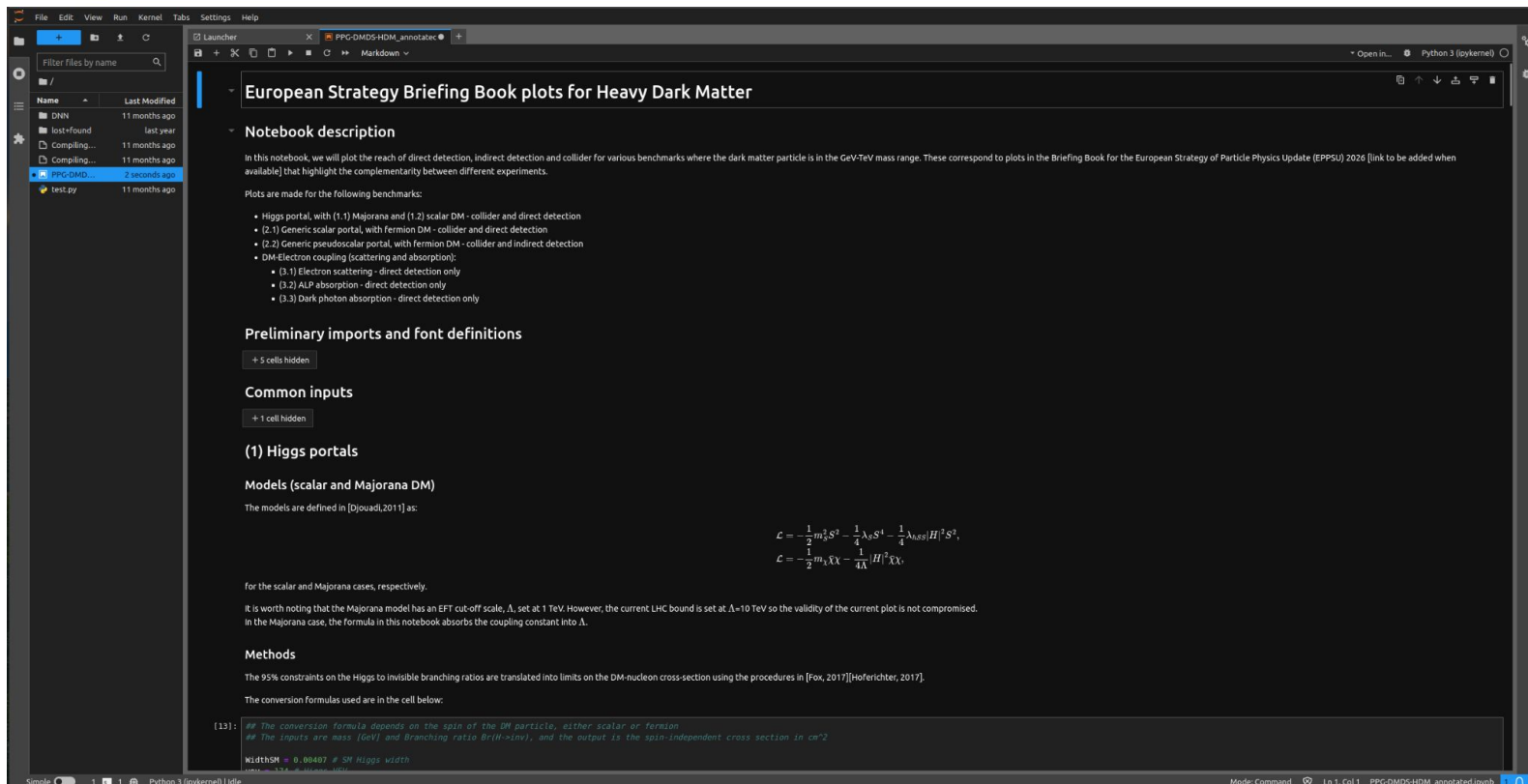
Jupyter Hub

- **Multi-user version** of Jupyter
- Allows multiple users to use Jupyter **simultaneously**
- Manages **access, resources, and shared environments**

Jupyter Notebook

- **Web interface** for writing and executing code
- **Combines code, text, and visualizations** in a single document
- Ideal for **interactive analysis and data exploration**





The screenshot shows a Jupyter Notebook interface. On the left is a file browser with a search bar and a list of files. The main area displays a notebook titled "European Strategy Briefing Book plots for Heavy Dark Matter". The notebook content includes a description, benchmarks, preliminary imports, common inputs, Higgs portals, and models for scalar and Majorana DM. A code cell at the bottom is partially visible.

European Strategy Briefing Book plots for Heavy Dark Matter

Notebook description

In this notebook, we will plot the reach of direct detection, indirect detection and collider for various benchmarks where the dark matter particle is in the GeV-TeV mass range. These correspond to plots in the Briefing Book for the European Strategy of Particle Physics Update (EPSU) 2026 [link to be added when available] that highlight the complementarity between different experiments.

Plots are made for the following benchmarks:

- Higgs portal, with (1:1) Majorana and (1:2) scalar DM - collider and direct detection
- (2:1) Generic scalar portal, with fermion DM - collider and direct detection
- (2:2) Generic pseudoscalar portal, with fermion DM - collider and indirect detection
- DM-Electron coupling (scattering and absorption):
 - (3.1) Electron scattering - direct detection only
 - (3.2) ALP absorption - direct detection only
 - (3.3) Dark photon absorption - direct detection only

Preliminary imports and font definitions

+ 5 cells hidden

Common inputs

+ 1 cell hidden

(1) Higgs portals

Models (scalar and Majorana DM)

The models are defined in [Djouadi, 2011] as:

$$\mathcal{L} = -\frac{1}{2}m_\chi^2 S^2 - \frac{1}{4}\lambda_\chi S^4 - \frac{1}{4}\lambda_{h,\chi} |H|^2 S^2,$$
$$\mathcal{L} = -\frac{1}{2}m_\chi \bar{\chi}\chi - \frac{1}{4\Lambda} |H|^2 \bar{\chi}\chi,$$

for the scalar and Majorana cases, respectively.

It is worth noting that the Majorana model has an EFT cut-off scale, Λ , set at 1 TeV. However, the current LHC bound is set at $\Lambda \sim 10$ TeV so the validity of the current plot is not compromised. In the Majorana case, the formula in this notebook absorbs the coupling constant into λ .

Methods

The 95% constraints on the Higgs to invisible branching ratios are translated into limits on the DM-nucleon cross-section using the procedures in [Fox, 2017][Hoferichter, 2017].

The conversion formulas used are in the cell below:

```
[13]: ## The conversion formula depends on the spin of the DM particle, either scalar or fermion
## The inputs are mass [GeV] and Branching ratio Br(H->inv), and the output is the spin-independent cross section in cm^2
widthSH = 0.00407 # SM Higgs width
sigma = 3.94 # 10^-44 cm^2
```

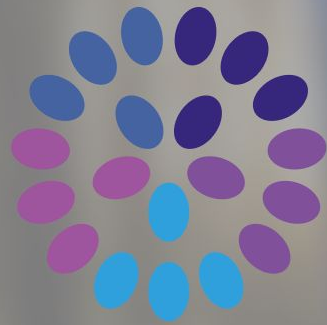
- **VRE deployed locally on MUST in a Kubernetes cluster**
 - Thanks to the work of **Jean Multigner**
 - **Pre-production**
- > A new interface similar in spirit to **lappui / VMs**, and potentially a replacement in the future
- Our own new platform for **data analysis** with **specific storage management, authentication and resources**



- **Immediately accessible** at your convenience: <https://jupyter.must-dc.cloud/>
- Login **LDAP** (the same one you use for your PC)
- A **new pod** starts every time for **each user**
- **Tutorials/example images** available (Python, Tensorflow) under Training environments or base image : *datascience notebook* under Work environments
- Possible to **leave** the notebook **without affecting** the user's **workstation**
- Not accessible via VPN
- **Specifications** (subject to change based on the number of users)
 - 5 Go storage
 - 32 Go RAM
 - 4 CPU
- **Be careful with your data!!! No backup, do not store sensitive data**

- - User management -> currently user jovyan
- - Group management
- Access to different storage areas
 - - NFS
 - - CVMFS
 - - MUSTFS
- - Submit a job on HTCondor (dask?)
- - User documentation

And others suggestions ... ?



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Thank you