



Data Lake as a Service for Open Science

Riccardo Di Maria (CERN)

Muhammad Aditya Hilmy (CERN IT/OpenLab)

March 25th, 2022 - Data Management & Big Data, Session II, ISGC 2022



Science Projects



**EUROPEAN OPEN
SCIENCE CLOUD**

Horizon2020
European Union Funding
for Research & Innovation

Partners

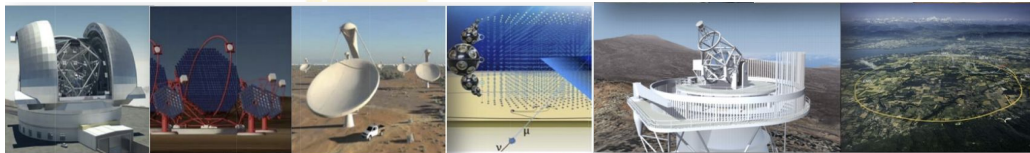


rijksuniversiteit
groningen



Project Goals

- Prototype an infrastructure adapted to exabyte-scale **future needs** of large science projects
- Ensure sciences drive the development of EOSC
- Address FAIR data management principles



The Data Lake

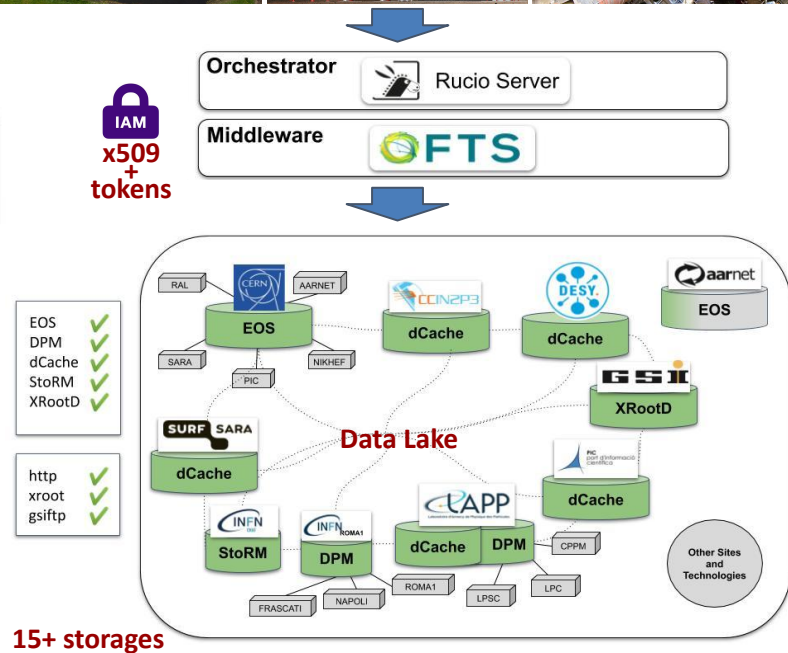
- Data Lake as modular ecosystem of services and tools shaped around the ESCAPE scientific communities
 - federated data management and access solution
 - heterogeneous resources
 - e.g. integration of HPC and **commercial Clouds**
- Hiding complexity and providing transparent access to data
 - layer for orchestration of resources as entry point for sciences
 - define data policies and rules
 - content delivery and caching layer
 - HTTP data access and Tokens awareness for future sustainability
 - latency hiding and file re-usability
 - facilitate ingress/egress with Clouds and HPC
- Storage and compute resources not necessarily colocated

Sciences



NETWORK OPTIMIZATION

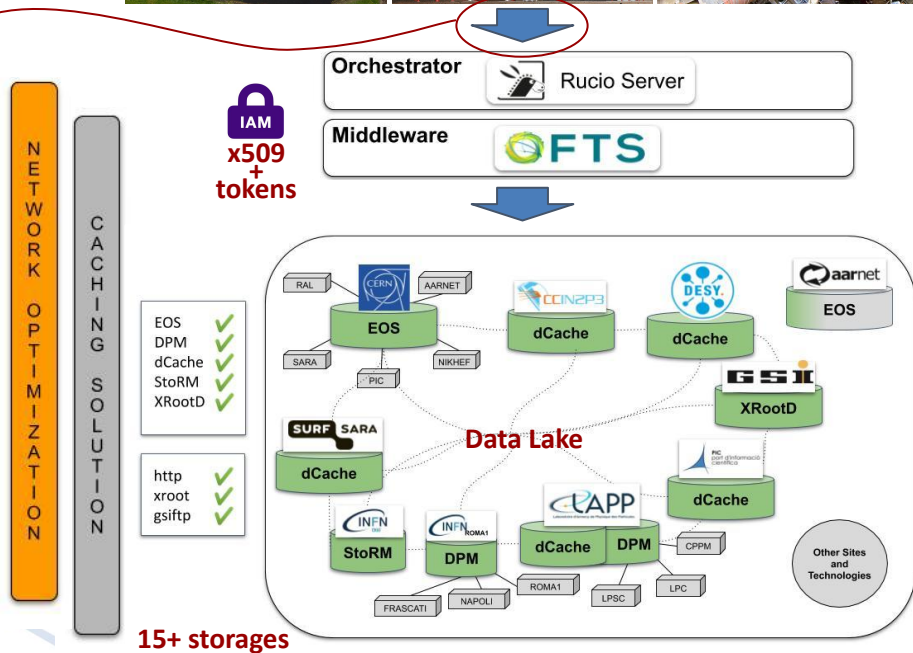
CACHING SOLUTION



DLaaS for Open Science

- Goal: make **end-user comfortable** in embarking on a Data Lake experience
 - abstract the complexities of the Data Lake from the scientists
→ focus on doing science instead of data procurement
- An ever-increasing number of experiments are looking at Rucio Data Management system
 - **DLaaS** potentially interesting for both **aficionados** and **newcomers**

Sciences



As It All Started

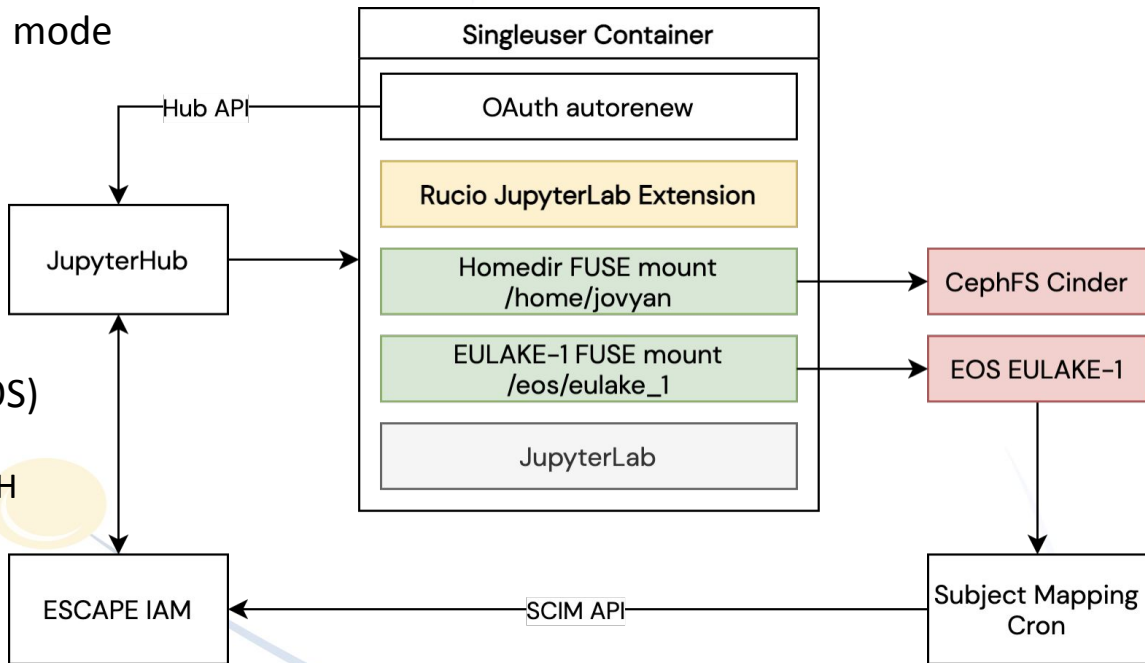
- An idea presented at CS3 2020 by the Rucio team [1]
- Development of a “Rucio JupyterLab Extension” as part of GSoC 2020 [2,3]
- A long time has passed, many things have happened...
 - CERN OpenLab Summer Student to concretise the effort in 2021
 - [deployment](#), [docker-images](#), [documentation](#)
 - DataLake-as-a-Service (DLaaS) in production-like phase
 - extensively exploited during ESCAPE “Data and Analysis Challenge” in November 2021 by SKA, MAGIC, CTA, ATLAS, KM3NET, LOFAR, FAIR
→ [3rd ESCAPE DIOS Workshop](#)
 - EU projects e.g. EOSC-Future and CS3Mesh4EOSC/ScienceMesh
 - other communities e.g. EGI



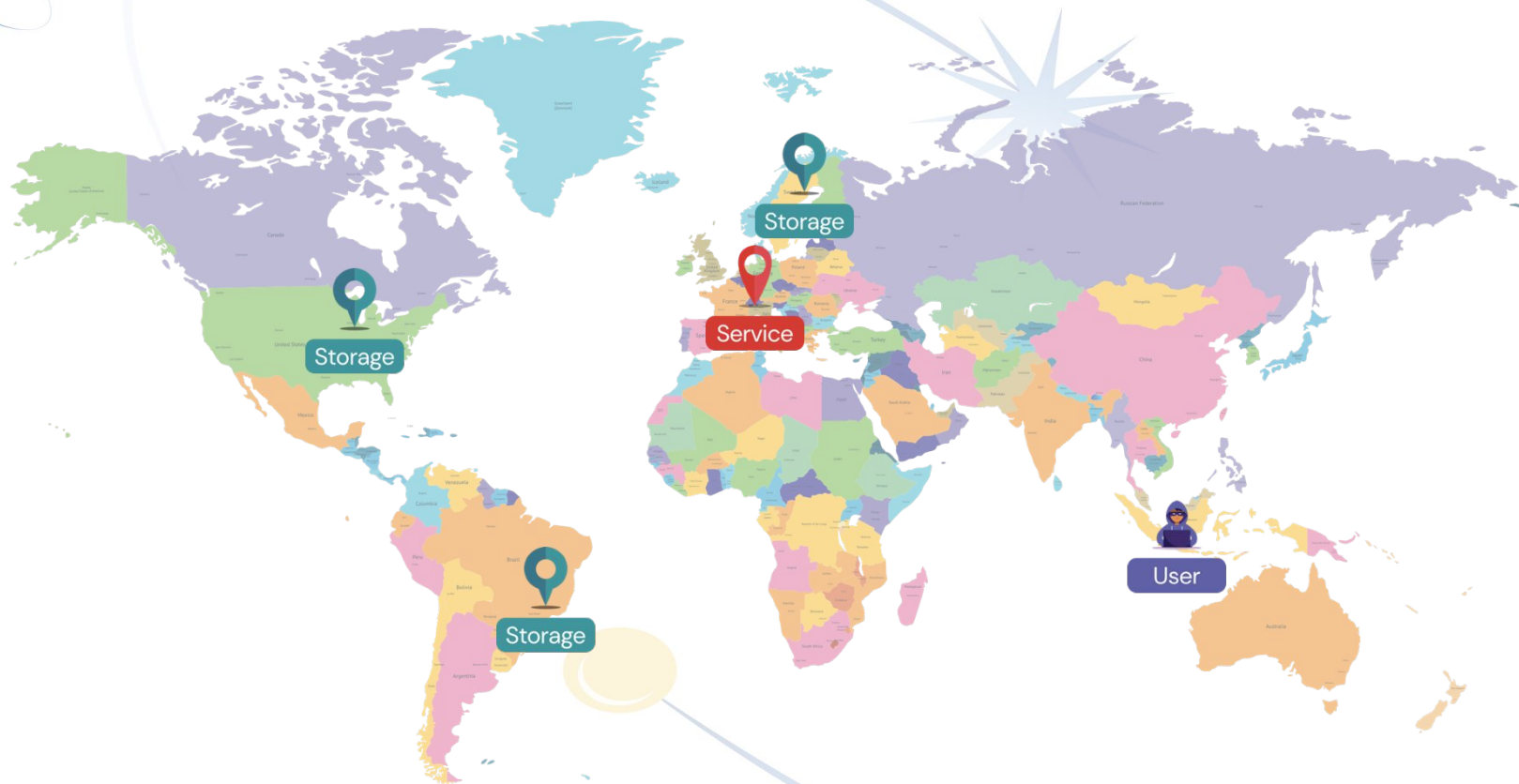
DLaaS Implementation

RSE = Rucio Storage Element

- Deployed in Kubernetes, using Zero-to-JupyterHub Helm chart → <https://escape-notebook.cern.ch>
- OAuth authentication using ESCAPE IAM (X509 still supported)
- [Rucio JupyterLab Extension](#) in Replica mode (i.e. TPC to local storage) used
 - download mode still possible (if configured)
 - connected to ESCAPE Data Lake
 - automatically pre-configured to use OpenID Connect
 - 2 FUSE mounts to EULAKE-1 (EOS)
 - ESCAPE RSE in r-only
 - additional RSE in r/w: SCRATCH
 - making files available *aka* creating a replication rule to move files to EULAKE-1



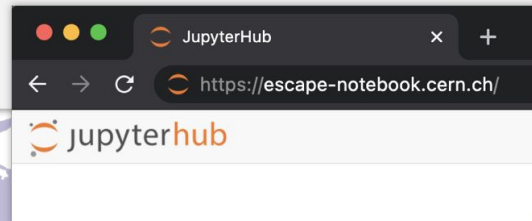
DataLake-as-a-Service for Open Science



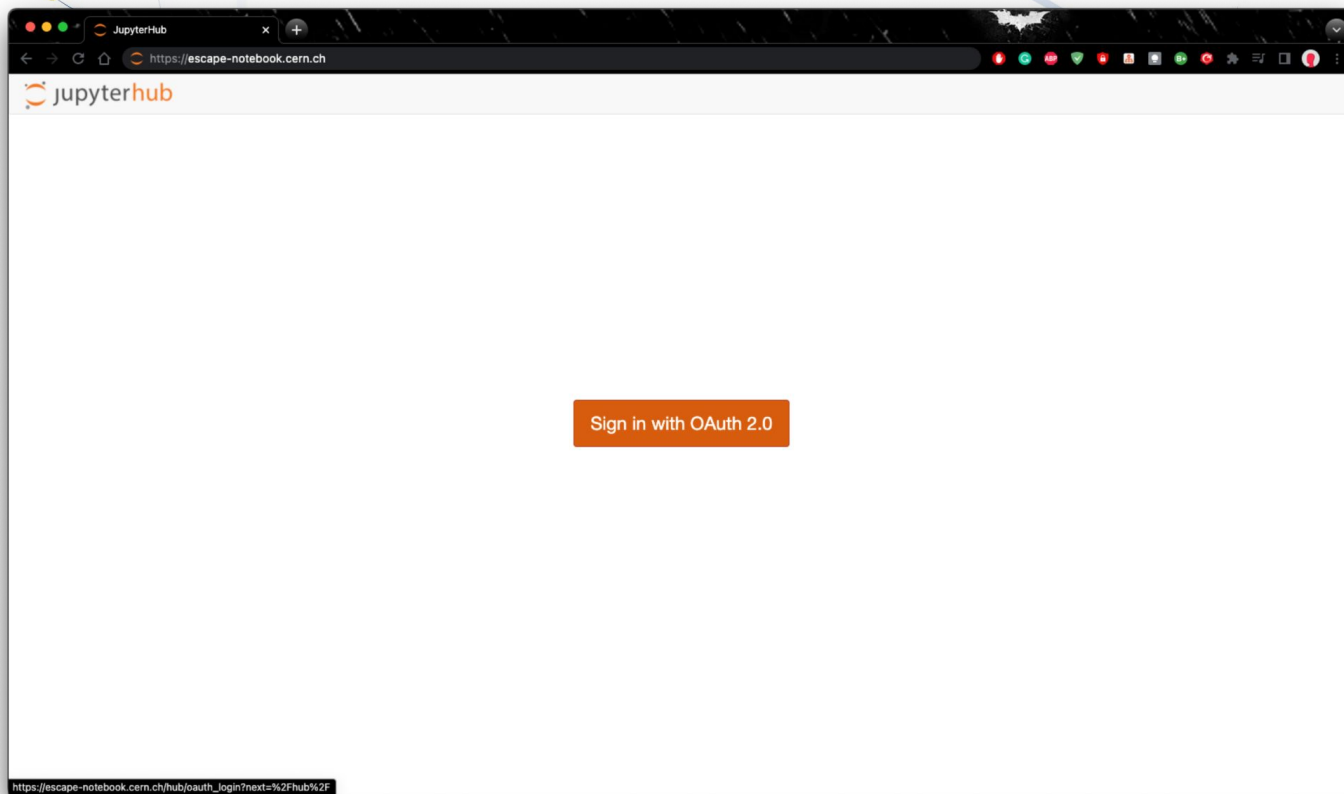
Contact DLaaS

→ Scientists Contact DataLake-as-a-Service

Requests are handled by Jupyter servers at CERN, Geneva



Sign in with OAuth 2.0



ESCAPE Indigo IAM for Auth

INDIGO IAM for escape-Log in

https://iam-escape.cloud.cnaf.infn.it/login

ESCAPE
European Science Cluster of Astronomy &
Particle physics (ESCAP) research infrastructures

Welcome to **escape**

Sign in with your escape credentials

Sign in

[Forgot your password?](#)

Or sign in with

Your X.509 certificate

Google

eduGAIN

Not a member?

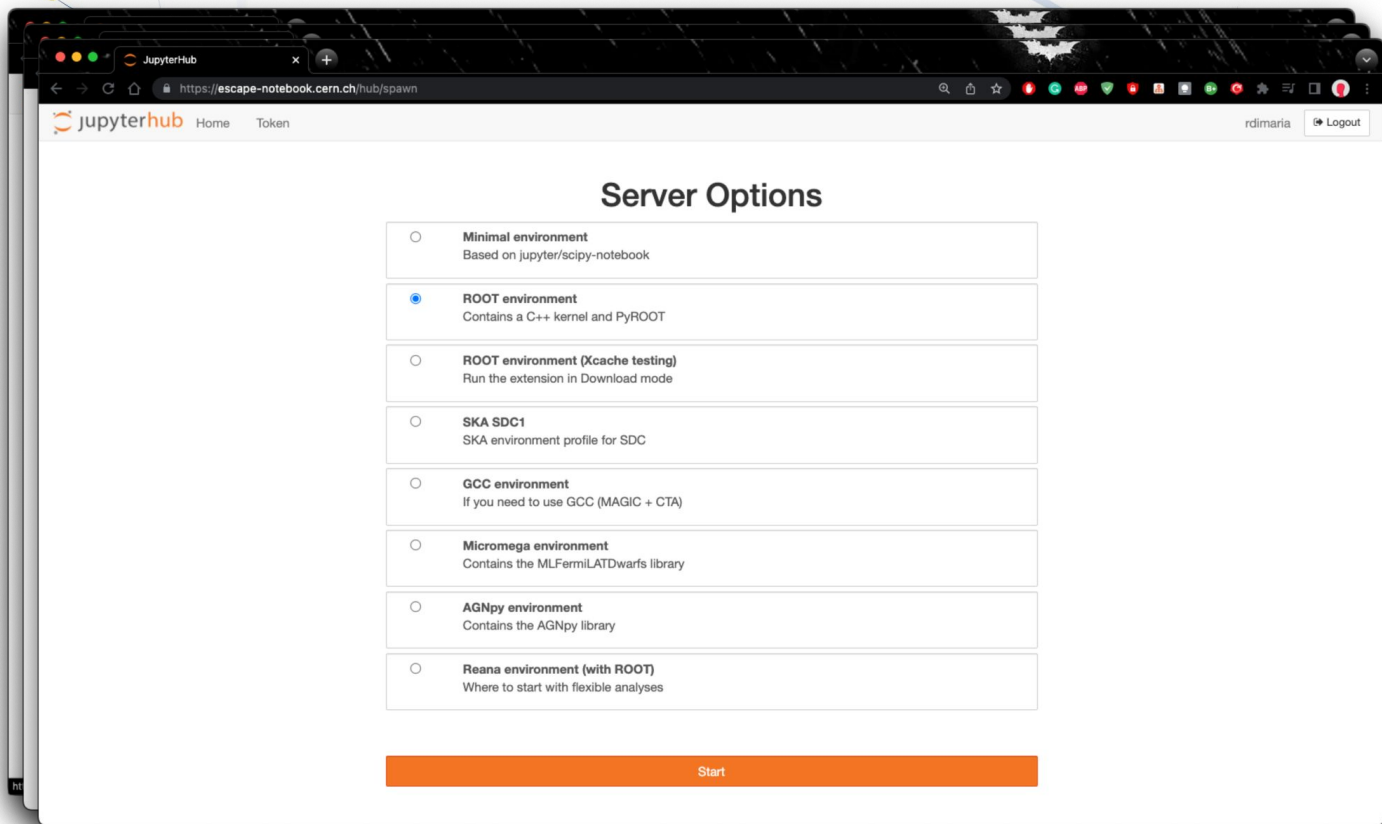
Apply for an account

[Privacy policy](#)

You have been successfully authenticated as
CN=Riccardo Di
Maria, CN=770219, CN=rdimaria, OU=Users, OU=Organic



Multiple Server Options for Sciences



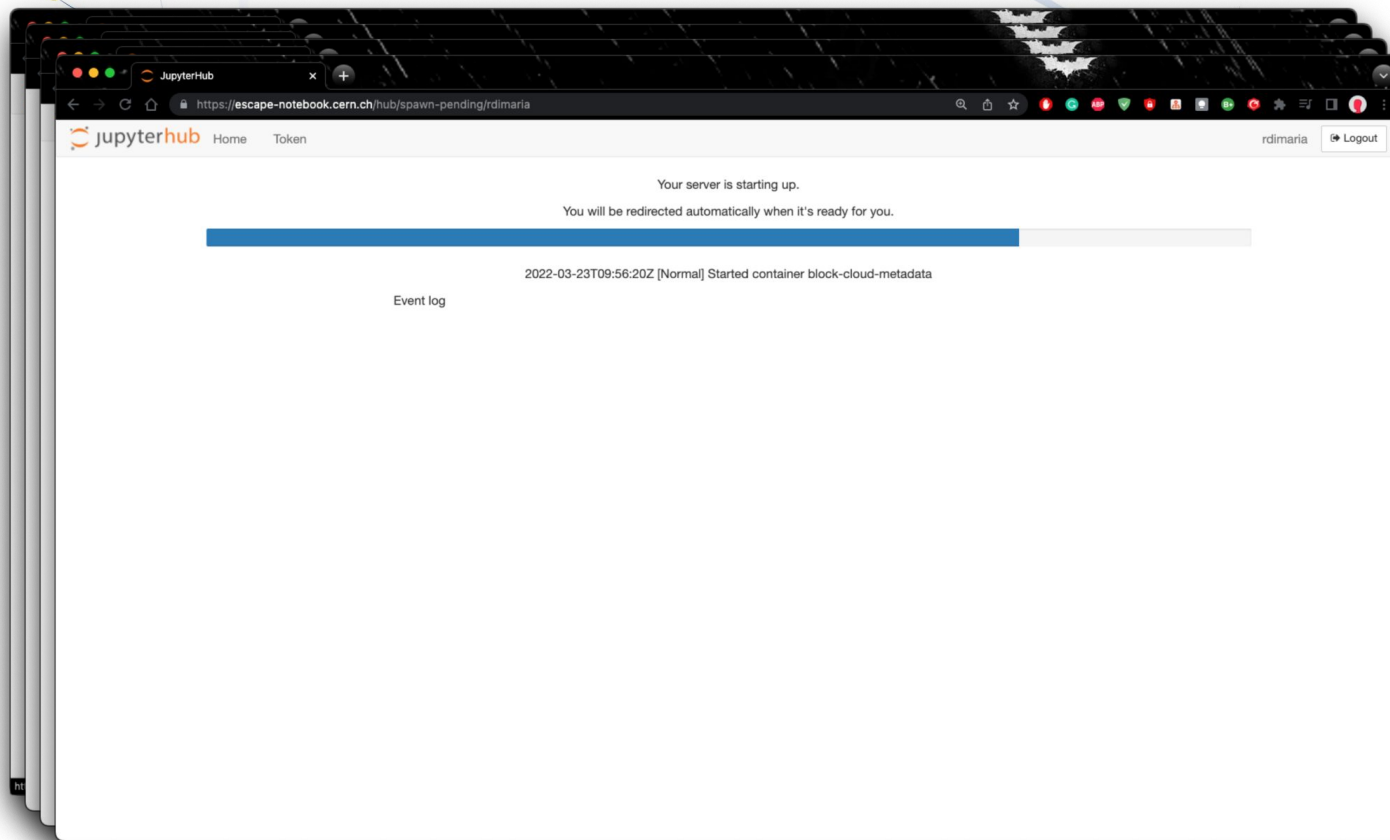
The screenshot shows a web browser window displaying the JupyterHub interface. The URL is <https://escape-notebook.cern.ch/hub/spawn>. The page title is "Server Options". There are eight radio button options:

- ☐ **Minimal environment**
Based on jupyter/scipy-notebook
- ☒ **ROOT environment**
Contains a C++ kernel and PyROOT
- ☐ **ROOT environment (Xcache testing)**
Run the extension in Download mode
- ☐ **SKA SDC1**
SKA environment profile for SDC
- ☐ **GCC environment**
If you need to use GCC (MAGIC + CTA)
- ☐ **Micromega environment**
Contains the MLFermiLATDwarfs library
- ☐ **AGNpy environment**
Contains the AGNpy library
- ☐ **Reana environment (with ROOT)**
Where to start with flexible analyses

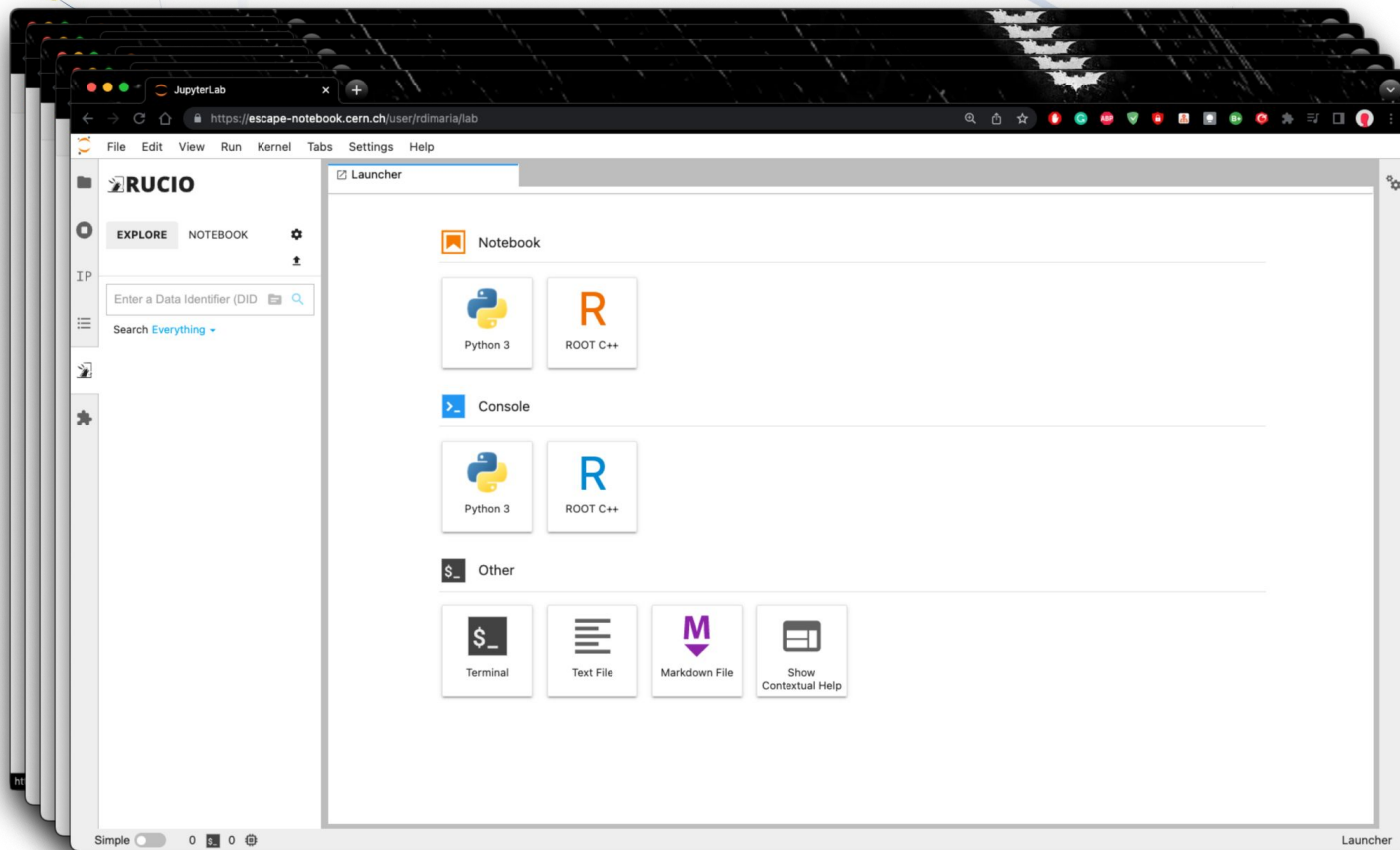
At the bottom of the page is a large orange button labeled "Start".



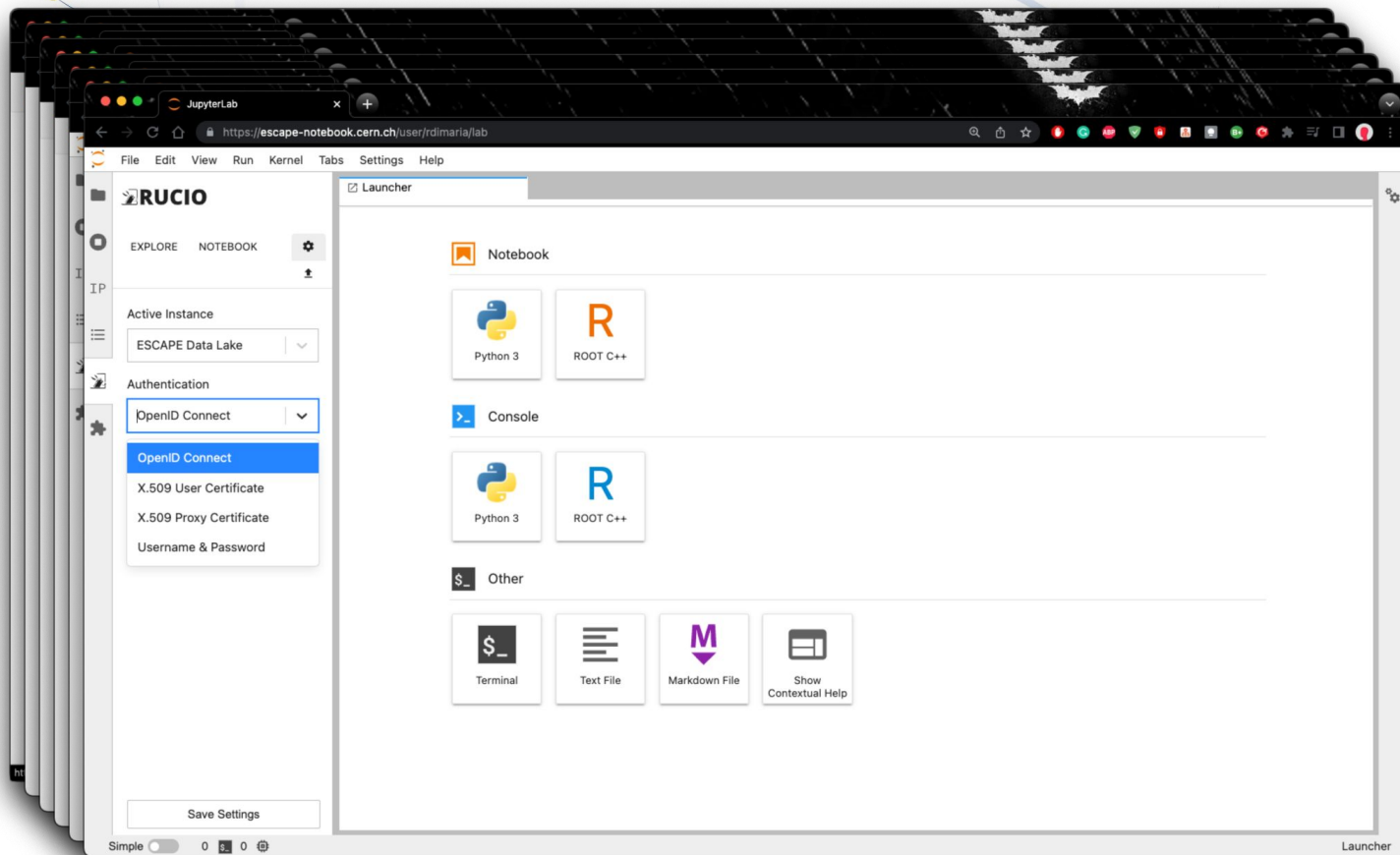
K8s-Pod per User



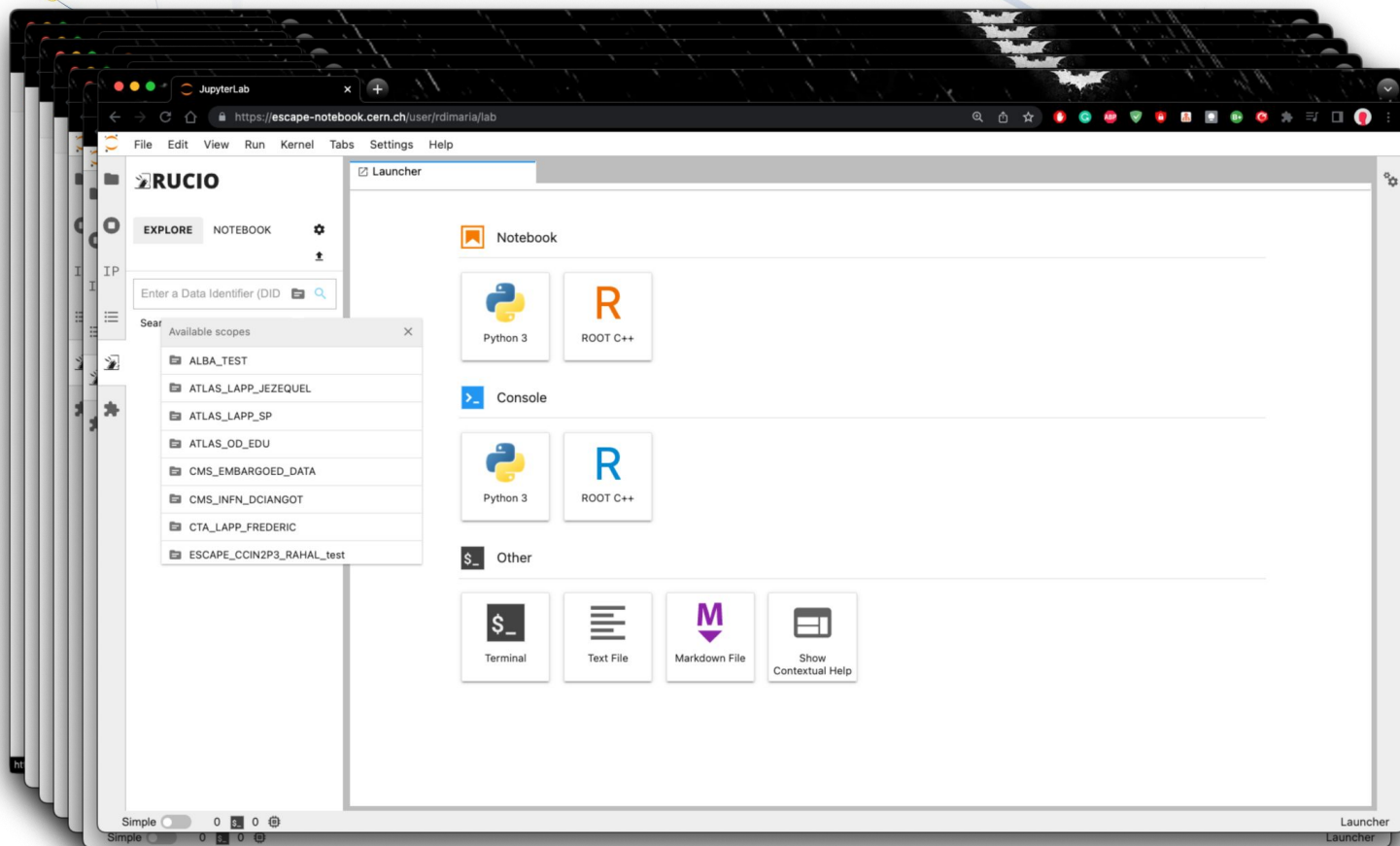
Jupyter Notebook with Rucio Extension



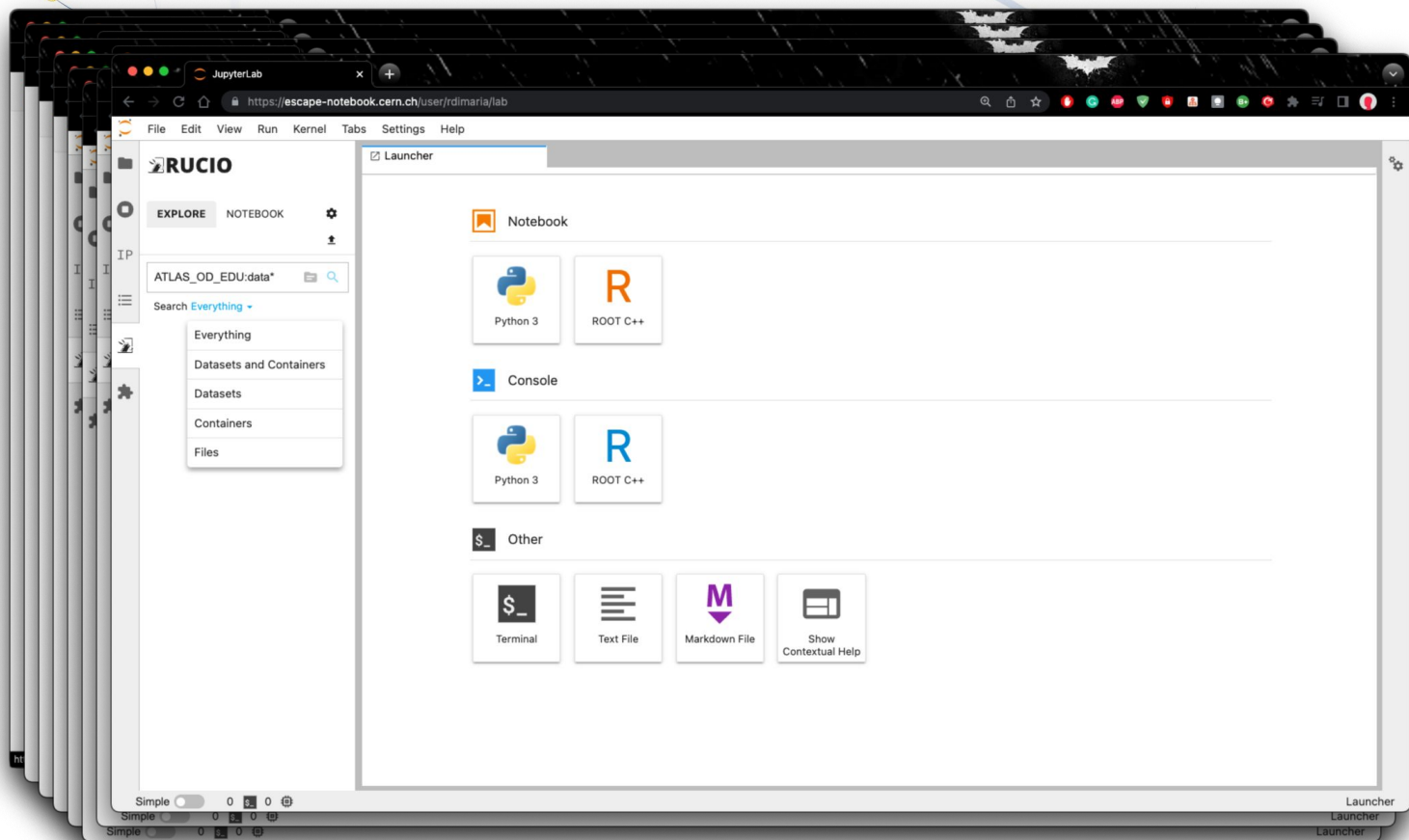
ESCAPE Rucio Instance and OpenID Connect



Data Browsing



Data Browsing



Data Browsing

→ Scientists Browse Data in the ESCAPE Data Lake

Requests are relayed to Rucio servers at CERN, Geneva

The image features a world map with three location pins: one in North America (USA), one in Europe (UK), and one in Asia (Japan). An inset box in the bottom left shows a workflow: a Jupyter Notebook icon (labeled 'jupyter' and 'Notebook') with a red arrow pointing to a Rucio icon (labeled 'Rucio'). To the right, a screenshot of the Rucio web interface is displayed. The interface has a header with the Rucio logo and navigation tabs for 'EXPLORE' and 'NOTEBOOK'. Below the tabs is a search bar containing the text 'ATLAS_OD_EDU:data'. Underneath the search bar is a dropdown menu labeled 'Search Everything'. The 'SEARCH RESULTS' section shows two entries: 'ATLAS_OD_EDU:data_13TeV_1largeRjet1lep_2020' and 'ATLAS_OD_EDU:data_13TeV_1lep1tau_2020', each with a folder icon and a link icon.



Data Browsing

The screenshot shows a JupyterLab interface with a file browser on the left and a launcher on the right. The file browser lists several files, with 'ESCAPE_CERN_TEAM-testing:the100mb.dat' highlighted and marked as 'Available'.

File Name	Size	Status
ESCAPE_CERN_TEAM-testing:261038		
ESCAPE_CERN_TEAM-testing:group	1.27KiB	
Replicating files...		
ESCAPE_CERN_TEAM-testing:kk	15B	Not Available
ESCAPE_CERN_TEAM-testing:kk1		
ESCAPE_CERN_TEAM-testing:kk2	5B	
ESCAPE_CERN_TEAM-testing:kk3	12B	
ESCAPE_CERN_TEAM-testing:the100mb.dat	102.4MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-05102020-1.dat	1MiB	
ESCAPE_CERN_TEAM-testing:thesmall-2-07102020.dat	1MiB	
ESCAPE_CERN_TEAM-testing:thesmall-2.dat	1MiB	
ESCAPE_CERN_TEAM-testing:thesmall-3.dat	1MiB	
ESCAPE_CERN_TEAM-testing:thesmall-4.dat	1MiB	
ESCAPE_CERN_TEAM-testing:thesmall-5.dat	1MiB	
ESCAPE_CERN_TEAM-testing:thesmall-66.dat	1MiB	

The launcher on the right shows options for Notebook, Console, and Other. The Notebook section includes Python 3 and ROOT C++. The Console section includes Python 3 and ROOT C++. The Other section includes Terminal, Text File, Markdown File, and Show Contextual Help.



Redirection to ESCAPE Rucio WebUI

The screenshot shows a web browser window with the URL `https://escape-rucio-webui.cern.ch/rule?rule_id=71f827534e314c86af8c5d57d21c3dbe`. The page title is "Rucio UI - Rule". The breadcrumb navigation shows "You are here: Rule [71f827534e314c86af8c5d57d21c3dbe]". The page displays the "Rule metadata" for a dataset.

Property	Value
account	espinhal
activity	User Subscriptions
copies	1
created_at	Thu, 01 Oct 2020 13:41:36 UTC
did_type	FILE
expires_at	never + ✕
grouping	DATASET
id	71f827534e314c86af8c5d57d21c3dbe
ignore_account_limit	false
ignore_availability	false
locked	false
locks_ok_cnt	1
locks_replicating_cnt	0
locks_stuck_cnt	0
name	the100mb.dat
notification	NO
priority	3
purge_replicas	false
rse_expression	EULAKE-1
scope	ESCAPE_CERN_TEAM-testing
split_container	false
state	OK
updated_at	Fri, 02 Oct 2020 06:10:37 UTC

At the bottom of the rule metadata section, there is a blue button labeled "Boost rule".



Make Data Available “Locally”

The screenshot shows the JupyterLab interface with the RUCIO file browser on the left and the Launcher panel on the right. The RUCIO interface displays a list of files under the 'EXPLORE' tab. The file 'ESCAPE_CERN_TEAM-testing:kk' is highlighted, and a red circle is drawn around the 'Make Available' button next to it. The Launcher panel on the right shows options for Notebook (Python 3, ROOT C++), Console (Python 3, ROOT C++), and Other (Terminal, Text File, Markdown File, Show Contextual Help).

RUCIO File List:

File Name	Size	Status
ESCAPE_CERN_TEAM-testing:261038		Available
ESCAPE_CERN_TEAM-testing:group	1.27KiB	Available
ESCAPE_CERN_TEAM-testing:kk	15B	Not Available
ESCAPE_CERN_TEAM-testing:kk1		Available
ESCAPE_CERN_TEAM-testing:kk2	5B	Available
ESCAPE_CERN_TEAM-testing:kk3	12B	Available
ESCAPE_CERN_TEAM-testing:the100mb.dat	102.4MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-05102020-1.dat	1MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-2-07102020.dat	1MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-2.dat	1MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-3.dat	1MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-4.dat	1MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-5.dat	1MiB	Available
ESCAPE_CERN_TEAM-testing:thesmall-66.dat	1MiB	Available



Make Data Available “Locally”

→ Make Available

Rucio initiates transfers from worldwide storages to CERN RSE which is serving DLaaS



Add Data to Notebook

The screenshot shows the JupyterLab interface with the following components:

- Left Sidebar (File Explorer):**
 - Search bar: ESCAPE_CERN_TEAM-testing:*
 - SEARCH RESULTS:

File Name	Size
ESCAPE_CERN_TEAM-testing:261038	
ESCAPE_CERN_TEAM-testing:group	1.27KiB
ESCAPE_CERN_TEAM-testing:kk	15B
ESCAPE_CERN_TEAM-testing:kk1	
ESCAPE_CERN_TEAM-testing:kk2	5B
ESCAPE_CERN_TEAM-testing:kk3	12B
ESCAPE_CERN_TEAM-testing:the100mb.dat	102.4MiB
Available	
ESCAPE_CERN_TEAM-testing:thes data_test	
ESCAPE_CERN_TEAM-testing:thes Press Enter to proceed, Esc to cancel	
ESCAPE_CERN_TEAM-testing:thesmall-2.dat	1MiB
ESCAPE_CERN_TEAM-testing:thesmall-3.dat	1MiB
ESCAPE_CERN_TEAM-testing:thesmall-4.dat	1MiB
ESCAPE_CERN_TEAM-testing:thesmall-5.dat	1MiB
ESCAPE_CERN_TEAM-testing:thesmall-66.dat	1MiB
ESCAPE_CERN_TEAM-testing:thesmall.dat	1MiB
ESCAPE_CERN_TEAM-testing:ykajdakdaspkkROK.txt	324.56MiB
- Main Area (Notebook):**
 - Tab: Untitled1.ipynb
 - Language: Python 3
 - Code cell: []:



Use Data for Analysis

The screenshot displays a JupyterLab environment within a web browser. The interface is divided into several panels:

- Left Panel:** Contains a sidebar with 'EXPLORE' and 'NOTEBOOK' tabs. Below these is the 'ATTACHED DISKS' section, showing a disk named 'ESCAPE_CERN_TEAM-testing:the100mb.dat' with a sub-entry 'data_test'.
- Top Panel:** The 'Untitled2.ipynb' notebook is open, showing a series of code cells.
 - Cell [1]: `data_test`
 - Cell [1]: `/eos/eulake_1/ESCAPE_CERN_TEAM-testing/5f/43/the100mb.dat`
 - Cell [3]: `!ls -l /eos/eulake_1/ESCAPE_CERN_TEAM-testing/5f/43/the100mb.dat`. The output shows a file listing: `-rw-r--r-- 1 8619 2688 107373568 Oct 2 2020 /eos/eulake_1/ESCAPE_CERN_TEAM-testing/5f/43/the100mb.dat`.
 - Cell [4]: `data_test.pfn`
 - Cell [4]: `'root://eosulake.cern.ch:1094/eos/eulake/tests/rucio_test/eulake_1/ESCAPE_CERN_TEAM-testing/5f/43/the100mb.dat'`
- Bottom Panel:** Shows the status bar with 'Simple' mode selected, 'Python 3 | Idle', and 'Saving completed'.



DataLake-as-a-Service for Open Science

→ Scientists' Analysis Workflows Read Data

The code runs on the Notebook server at CERN, and the output is shown to the user



Output of Analysis (Small-Sized Files)

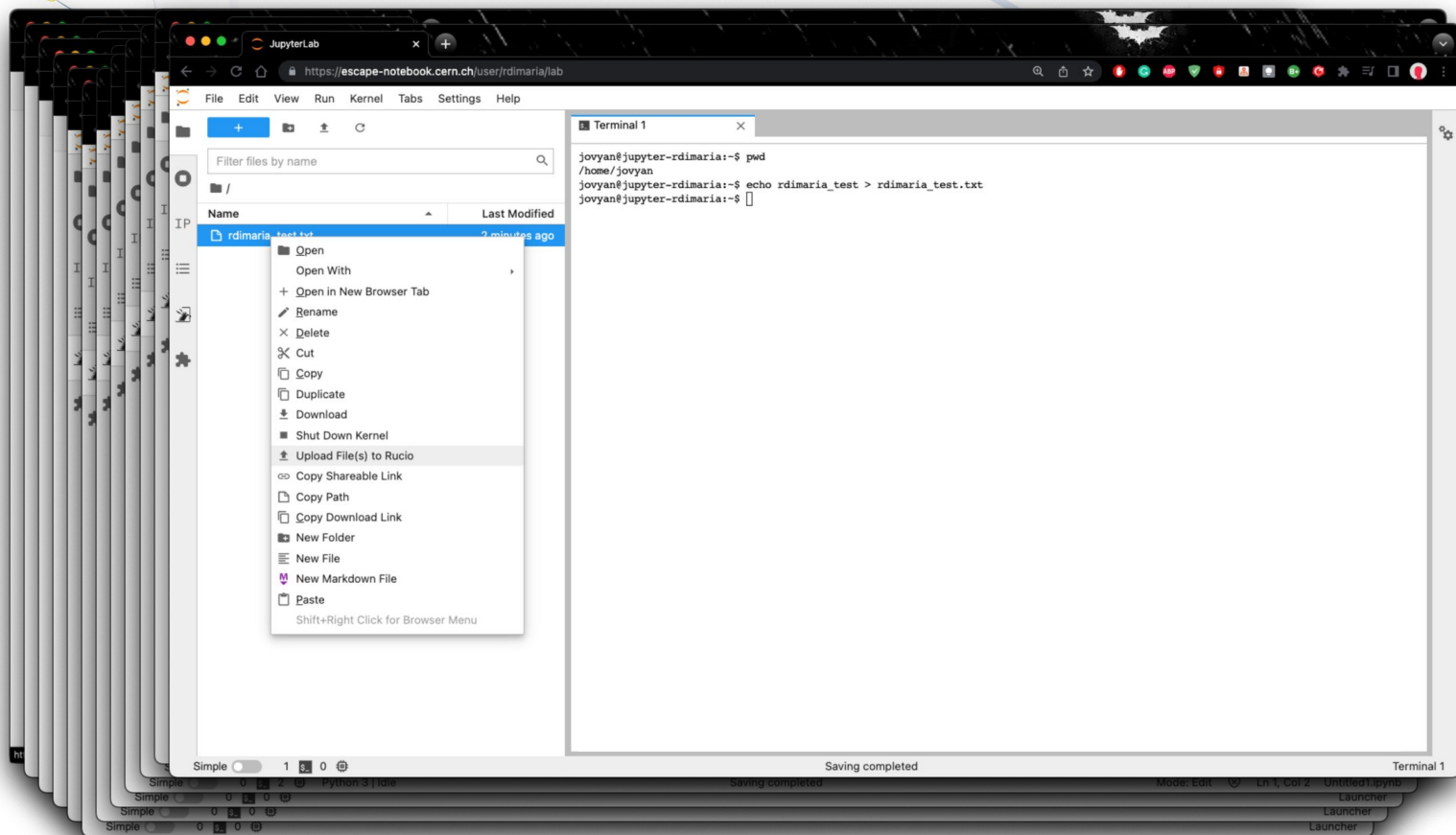
The screenshot displays a JupyterLab environment. On the left, a file browser shows a directory with a file named `rdimaria_test.txt`. The main area features a terminal window titled "Terminal 1" with the following output:

```
jovyan@jupyter-rdimaria:~$ pwd
/home/jovyan
jovyan@jupyter-rdimaria:~$ echo rdimaria_test > rdimaria_test.txt
jovyan@jupyter-rdimaria:~$
```

Below the terminal, a status bar indicates "Saving completed" and "Terminal 1". At the bottom of the interface, several stacked notebook thumbnails are visible, each showing a "Simple" notebook with a "Python 3 | Idle" kernel.



Data Preservation Use Case



Data Preservation Use Case

The screenshot displays a JupyterLab environment within a web browser. The browser address bar shows the URL `https://escape-notebook.cern.ch/user/rdimaria/lab`. The JupyterLab interface includes a file browser on the left, a central workspace, and a terminal window on the right.

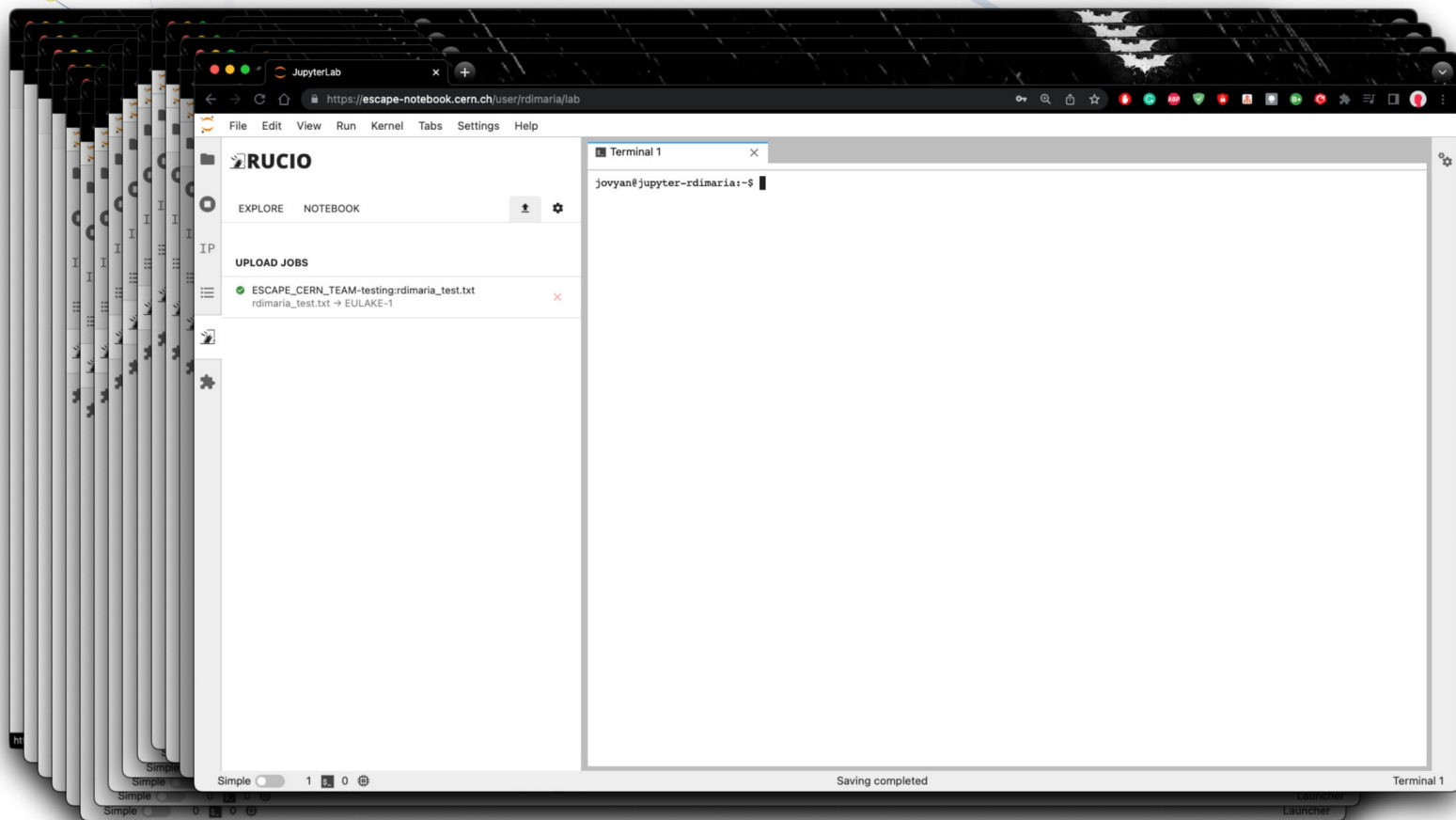
In the file browser, a file named `rdimaria_test.txt` is listed with a last modified time of 5 minutes ago. The terminal window shows the following commands and output:

```
jovyan@jupyter-rdimaria:~$ pwd
/home/jovyan
jovyan@jupyter-rdimaria:~$ echo rdimaria_test > rdimaria_test.txt
jovyan@jupyter-rdimaria:~$
```

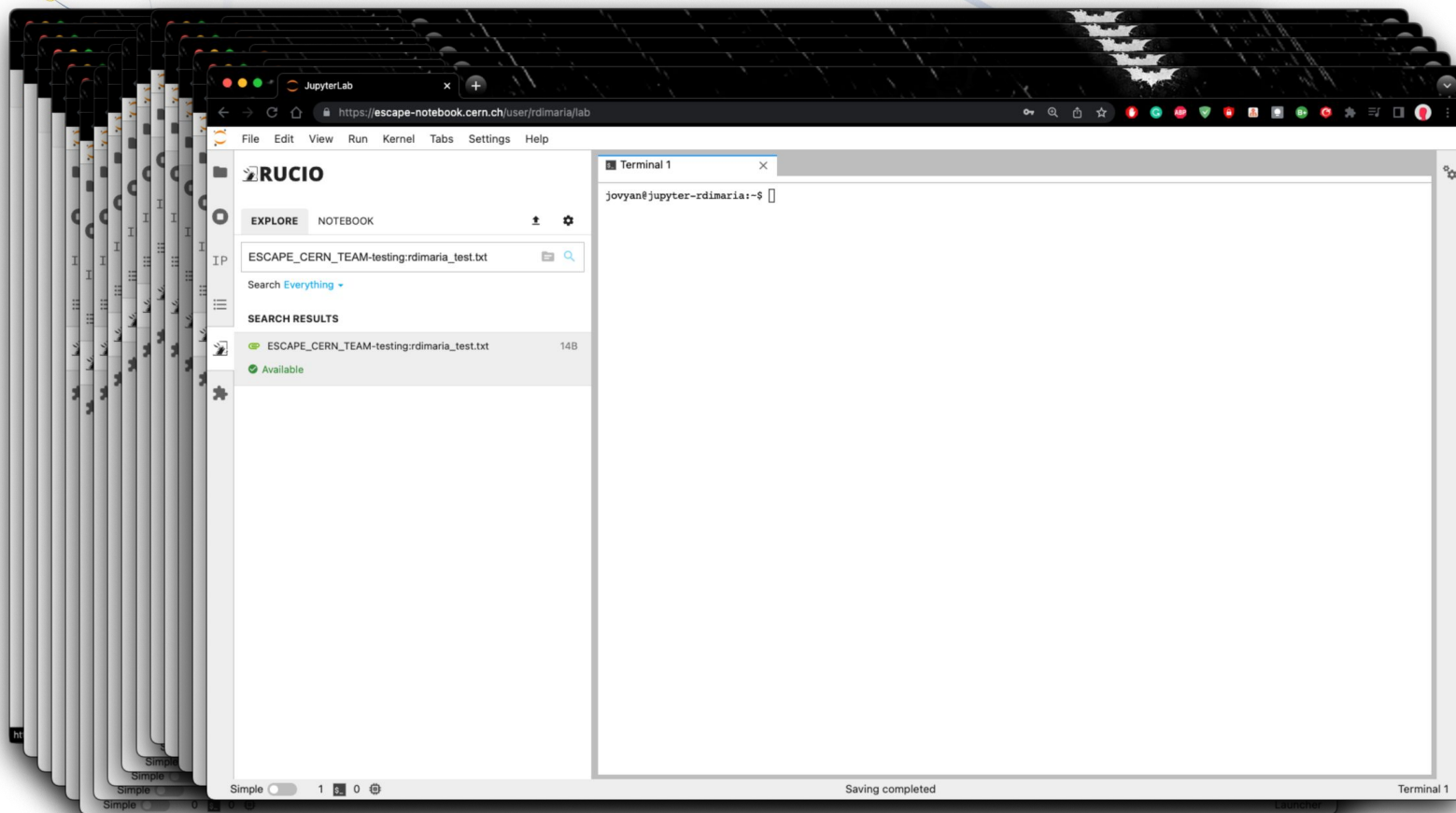
An RUCIO upload dialog is open in the center of the workspace. The dialog title is "Upload rdimaria_test.txt to Rucio". It contains a warning message: "You are not using X509 as the authentication method, upload may fail if the destination RSE does not support your authentication method." Below the warning, there are three input fields: "Destination RSE:" with a dropdown menu showing "EULAKE-1", "Lifetime (in seconds):" with a text input field containing "Leave empty for indefinite", and "Scope:" with a dropdown menu showing "ESCAPE_CERN_TEAM-testing". At the bottom, there is a checkbox labeled "Add files to a dataset" which is checked. The dialog has "Cancel" and "Upload" buttons.



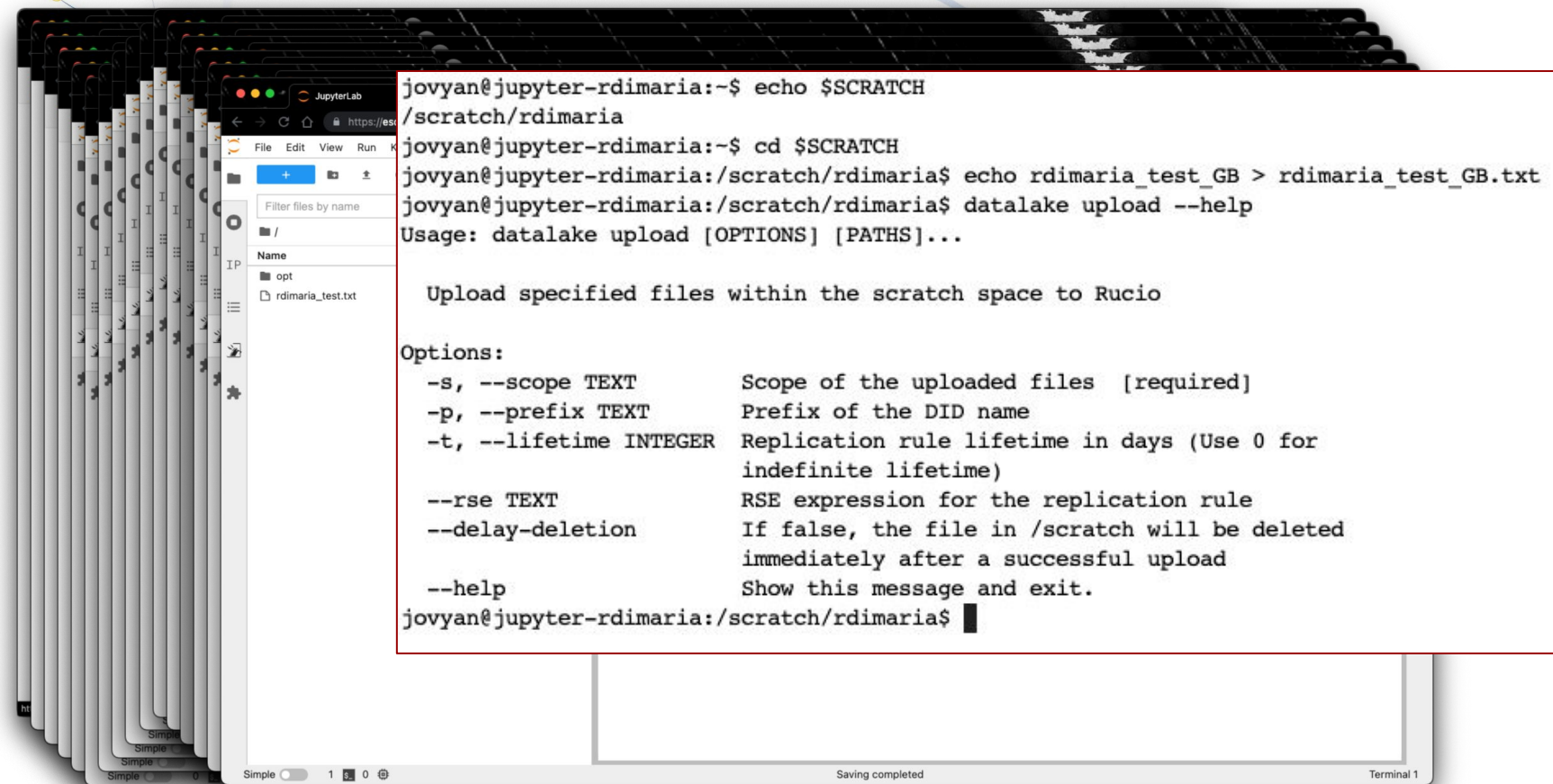
Data Preservation Use Case



Data Preservation Use Case



Output of Workflow or Analysis (Large-Sized Files)



The image shows a JupyterLab interface with a terminal window. The terminal displays the following commands and output:

```
jovyan@jupyter-rdimaria:~$ echo $SCRATCH
/scratch/rdimaria
jovyan@jupyter-rdimaria:~$ cd $SCRATCH
jovyan@jupyter-rdimaria:/scratch/rdimaria$ echo rdimaria_test_GB > rdimaria_test_GB.txt
jovyan@jupyter-rdimaria:/scratch/rdimaria$ datalake upload --help
Usage: datalake upload [OPTIONS] [PATHS]...

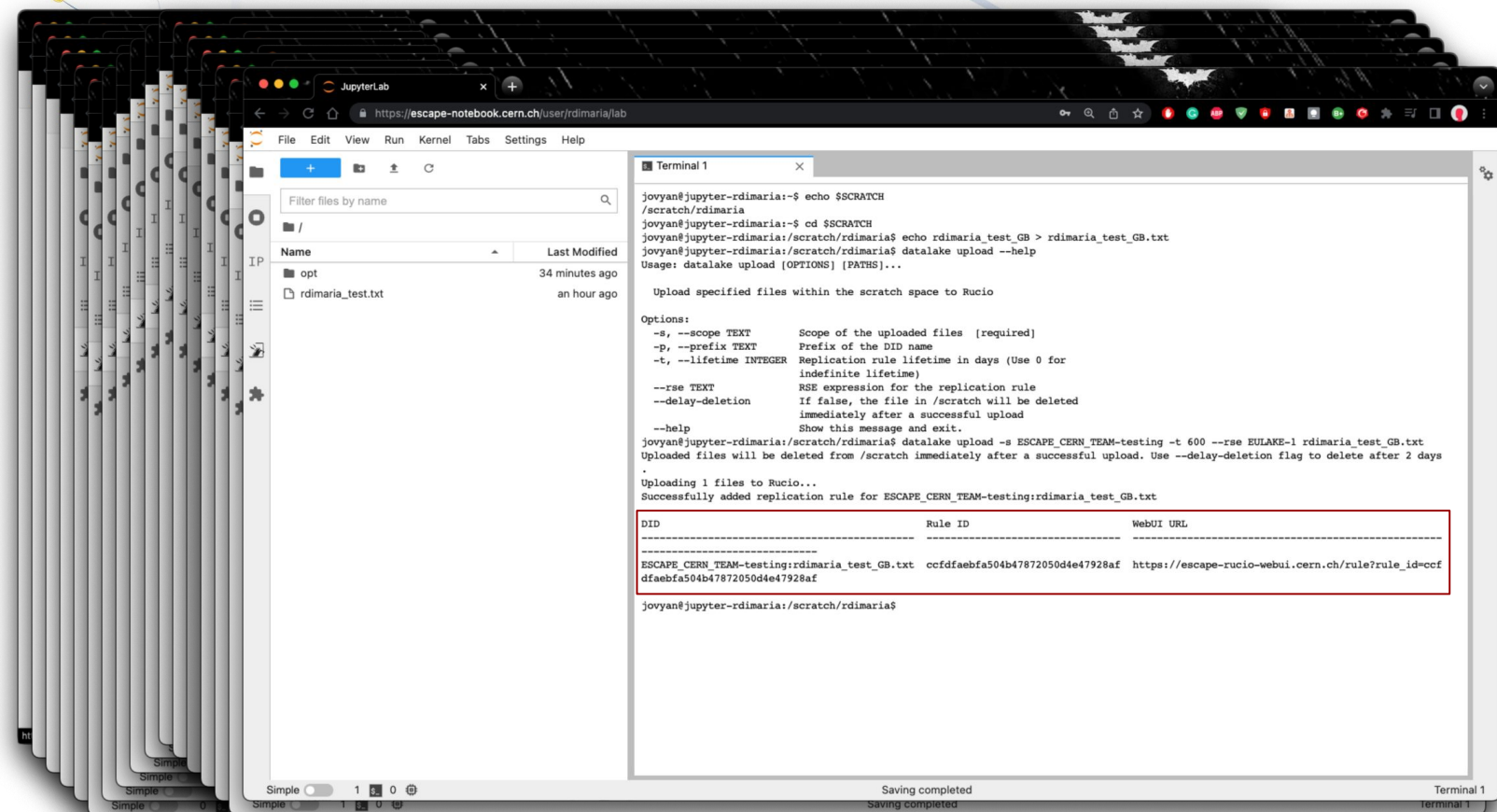
Upload specified files within the scratch space to Rucio

Options:
  -s, --scope TEXT          Scope of the uploaded files [required]
  -p, --prefix TEXT         Prefix of the DID name
  -t, --lifetime INTEGER    Replication rule lifetime in days (Use 0 for
                             indefinite lifetime)
  --rse TEXT                RSE expression for the replication rule
  --delay-deletion          If false, the file in /scratch will be deleted
                             immediately after a successful upload
  --help                    Show this message and exit.
jovyan@jupyter-rdimaria:/scratch/rdimaria$
```

The JupyterLab interface on the left shows a file browser with a filter "Filter files by name" and a list of files including "opt" and "rdimaria_test.txt". The terminal window is titled "Terminal 1" and shows the command history.



Data Preparation and Processing Use Case



The screenshot displays a JupyterLab environment. On the left, a file browser shows a directory structure with files 'opt' and 'rdimaria_test.txt'. The terminal window on the right shows the following commands and output:

```
jovyan@jupyter-rdimaria:~$ echo $SCRATCH
/scratch/rdimaria
jovyan@jupyter-rdimaria:~$ cd $SCRATCH
jovyan@jupyter-rdimaria:/scratch/rdimaria$ echo rdimaria_test_GB > rdimaria_test_GB.txt
jovyan@jupyter-rdimaria:/scratch/rdimaria$ datalake upload --help
Usage: datalake upload [OPTIONS] [PATHS]...

Upload specified files within the scratch space to Rucio

Options:
  -s, --scope TEXT      Scope of the uploaded files [required]
  -p, --prefix TEXT     Prefix of the DID name
  -t, --lifetime INTEGER Replication rule lifetime in days (Use 0 for
                        indefinite lifetime)
  --rse TEXT            RSE expression for the replication rule
                        If false, the file in /scratch will be deleted
                        immediately after a successful upload
  --delay-deletion      Immediately after a successful upload
  --help               Show this message and exit.
jovyan@jupyter-rdimaria:/scratch/rdimaria$ datalake upload -s ESCAPE_CERN_TEAM-testing -t 600 --rse EULAKE-1 rdimaria_test_GB.txt
Uploaded files will be deleted from /scratch immediately after a successful upload. Use --delay-deletion flag to delete after 2 days
.
Uploading 1 files to Rucio...
Successfully added replication rule for ESCAPE_CERN_TEAM-testing:rdimaria_test_GB.txt
```

DID	Rule ID	WebUI URL
ESCAPE_CERN_TEAM-testing:rdimaria_test_GB.txt	ccfdfaebfa504b47872050d4e47928af	https://escape-rucio-webui.cern.ch/rule?rule_id=ccfdfaebfa504b47872050d4e47928af

```
jovyan@jupyter-rdimaria:/scratch/rdimaria$
```



Data Preparation and Processing Use Case

The image displays a JupyterLab environment with a terminal window and a RUCIO web interface. The terminal window shows the following commands and output:

```

jovyan@jupyter-
/scratch/rdimar
jovyan@jupyter-
jovyan@jupyter-
jovyan@jupyter-
Usage: datalake
Upload specif
Options:
-s, --scope T
-p, --prefix '
-t, --lifetim
--rae TEXT
--delay-delet
--help
jovyan@jupyter-
Uploaded files
.
Uploading 1 fil
Successfully ad
DID
-----
ESCAPE_CERN_TEA
dfaebfa504b4787
jovyan@jupyter-

```

The RUCIO web interface shows the file 'ESCAPE_CERN_TEAM-testing:rdimaria_test_GB.txt' being uploaded and replicated. The interface includes a search bar and a list of search results.

SEARCH RESULTS

File Name	Size
ESCAPE_CERN_TEAM-testing:rdimaria_test_GB.txt	17B

Replicating files...



Rucio CLI Available

The image displays a stack of JupyterLab windows. The top window shows the Rucio web interface in a browser. The interface has a sidebar with 'EXPLORE' and 'NOTEBOOK' tabs. The 'EXPLORE' tab is active, showing a search bar and a list of search results. The search results list includes 'ESCAPE_CERN_TEAM-testing:rdimaria_test_GB.txt' with a size of 17B. The main content area shows the Rucio logo and a search bar. The terminal window on the right shows the following commands and output:

```
jovyan@jupyter-rdimaria:/scratch/rdimaria$ rucio whoami
created_at : 2019-12-05T16:43:26
account    : rdimaria
status     : ACTIVE
email      : riccardo.di.maria@cern.ch
deleted_at : None
updated_at : 2019-12-05T16:43:26
account_type : SERVICE
suspended_at : None

jovyan@jupyter-rdimaria:/scratch/rdimaria$ rucio list-rees
ALPAMED-DPM
ANS_WEBDAV
CERNBOX-CS3
CNAF-STORM
CNAF-STORM-TAPE
CNAF_OPS_TEMP
DESY-DCACHE
DESY-DCACHE-NDR
DESY-DCACHE-TAPE
EULAKE-1
EULAKE-EC
FAIR-ROOT
GSI-ROOT
IN2P3-CC-DCACHE
IN2P3-CC-LSST-DEST
IN2P3-CC-LSST-SOURCE
IN2P3-NA-DPM
IN2P3-NA-DPM-FED
IN2P3-ROMA1
JUPYTER-SCRATCH-EULAKE
LAPP-DCACHE
LAPP-WEBDAV
ORM-INJECT
PIC-DCACHE
PIC-DCACHE-TAPE
PIC-INJECT
SARA-DCACHE
SARA-DCACHE-TAPE
SARA-SWIFT

jovyan@jupyter-rdimaria:/scratch/rdimaria$
```

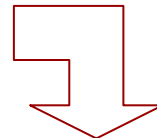
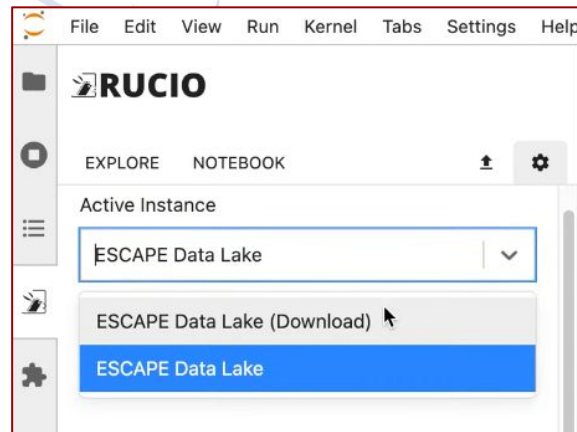


XCACHE Integration

Server Options

- ☐ **Minimal environment**
Based on jupyter/scipy-notebook
- ☐ **ROOT environment**
If you need to use PyROOT
- ☒ **ROOT environment (Xcache testing)**
Run the extension in Download mode

Start



```

jovyan@jupyter-muhilmy:/scratch/muhilmy$ rucio list-file-replicas ATLAS_LAPP_JEZEQUEL:data.root --protocol root
+-----+-----+-----+-----+-----+
| SCOPE          | NAME          | FILESIZE | ADLER32 | RSE: REPLICAS |
+-----+-----+-----+-----+-----+
| ATLAS_LAPP_JEZEQUEL | data.root    | 4.660 kB | ef084c63 | EULAKE-1: root://xcache-redirector.cern.ch//root://eoseulake.cern.ch:1094//eos/eulake/tests/rucio_test/eulake_1/ATLAS_LAPP_JEZEQUEL/bd/8f/data.root |
| ATLAS_LAPP_JEZEQUEL | data.root    | 4.660 kB | ef084c63 | ALPAMED-DPM: root://xcache-redirector.cern.ch//root://lapp-testse01.in2p3.fr:1094//dpm/in2p3.fr/home/escape/rucio/lapp_dpm/ATLAS_LAPP_JEZEQUEL/bd/8f/data.root |
+-----+-----+-----+-----+-----+

```



DLaaS Use Cases

- Data discovery and access
- Submitting jobs to external services (remote computing)
 - conveniently browse data in Rucio through the extension
 - access file PFN directly from the Notebook
- Data preparation and processing
 - prepare/process data and upload back to the Data Lake
- Data preservation
 - produce data and upload to the Data Lake



Future Developments and Prospectives

- Additional kernel compatibility (currently, only Python supported)
- Token-support for direct download and upload → OIDC integration ongoing at storage level
- Integration with content delivery and caching layer (successfully tested only at small scale)
 - XCache can be integrated to allow faster file download → transparent for the end-user
- Multi-VO or off-site (CERN) deployment, and distribution model for sciences
- **DLaaS** interesting for both **aficionados** and **newcomers** of **Rucio**
 - community-driven “development and operation”
 - needs and requirements of different experiments and sciences
 - addressing long term sustainability beyond ESCAPE mandate
 - ongoing proposal to establish a **Special Interest Group**



Conclusion and Next Steps

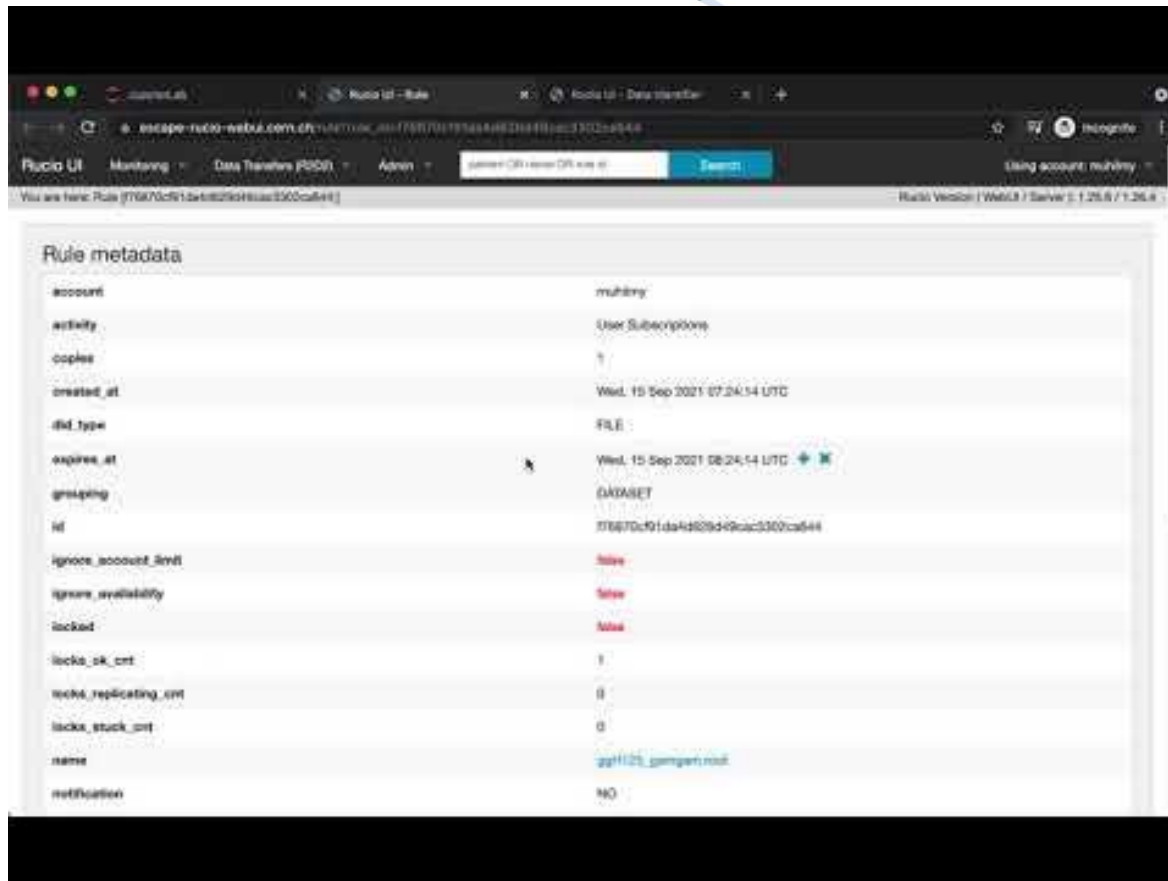
- **DLaaS** hides the complexities of the Data Lake from the end users (so that they are happy and productive!)
 - interesting for both **aficionados** and **newcomers** of **Rucio**
 - community-driven development, hence driven by the needs of different experiments and sciences
- ESCAPE managed to pilot and prototype a Data Lake infrastructure fulfilling functional data management needs of flagship ESFRIs from several scientific disciplines
 - sensible technologies choice from WLCG environment and LHC experiments
 - successful assessments of the Data Lake in 2020 and 2021
 - pivotal to test model and concepts for several communities: Astro-particle Physics, Electromagnetic and Gravitational-Wave Astronomy, Particle Physics, and Nuclear Physics **pursuing together** FAIR and open-access data principles
 - exploring non-HEP-standard scenarios and collaboration with other communities, e.g. PaNOSC, ExPaNDS, CS3MESH4EOSC
- ESCAPE end in 2022 → addressing long term sustainability



Backup Slides



DataLake-as-a-Service for Open Science



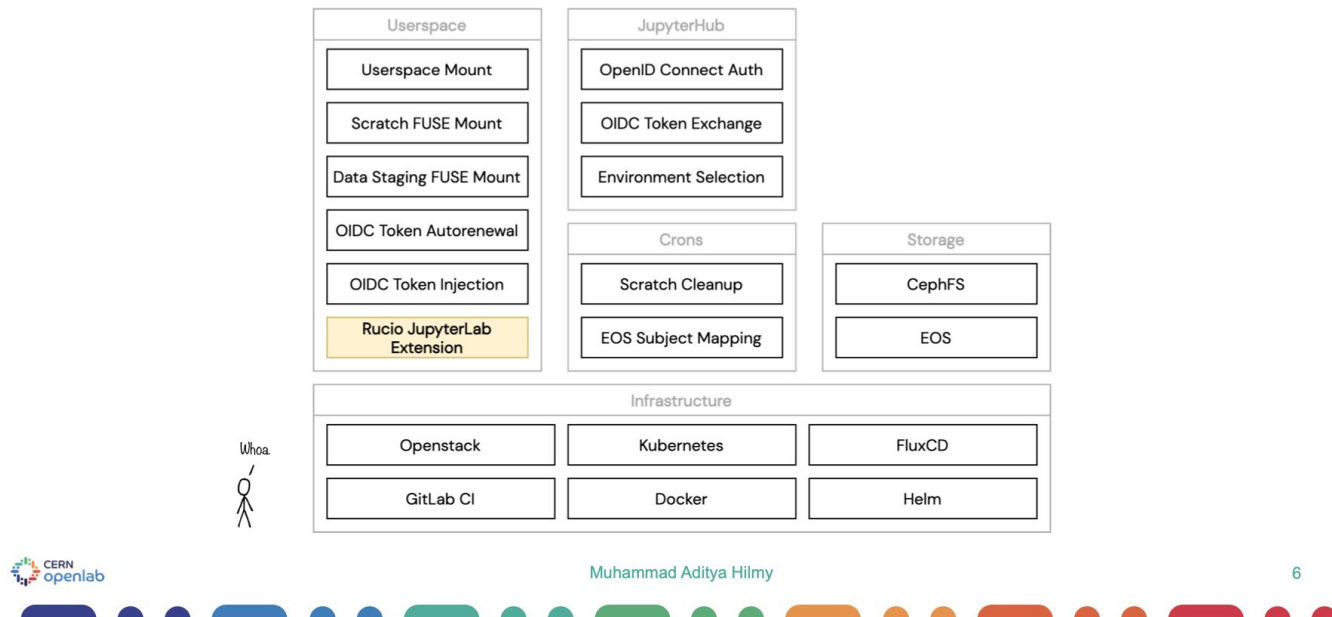
The screenshot shows the Rucio UI web interface. The browser address bar displays the URL: `escape-rucio-webui.com.cn/rucio/ui/Rule/176670c9f1da4d829d49cac3301ca644`. The page title is 'Rule metadata'. The interface shows a table of rule metadata with the following fields and values:

Field	Value
account	ruhling
activity	User Subscriptions
copies	1
created_at	Wed, 15 Sep 2021 07:24:54 UTC
id	176670c9f1da4d829d49cac3301ca644
id_type	FILE
expires_at	Wed, 15 Sep 2021 08:24:54 UTC
grouping	DATASET
ignore_account_limit	False
ignore_availability	False
locked	False
locks_ok_cnt	1
locks_replicating_cnt	0
locks_stuck_cnt	0
name	ggfH125_gamgert.m01
notification	NO



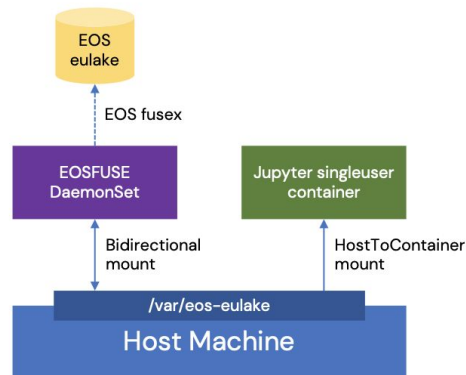
Backup Slides

The Data Lake as a Service



FUSE mount to EOS eulake

- There are two FUSE mounts to the same EOS instance:
 - `/eos/eulake_1` → `/eos/eulake/tests/rucio_test/eulake_1`
 - `/scratch` → `/eos/eulake/tests/jupyter-scratch`
- FUSE mount is implemented using k8s DaemonSet, mounting to a folder in the host, with Bidirectional mount propagation
- Singleuser containers bind to the mount folder, with HostToContainer mount propagation
- Uses OAuth2 authentication
 - ESCAPE IAM user is mapped to EOS user using crons



OAuth2 in EOS FUSE mount

- In the singleuser container:
 - JWT is stored in a file in the following format:
 - `oauth2:<jwt>:<token-introspection-endpoint>`
 - Example: `oauth2:eyJ...:iam-escape.cloud.cnaf.infn.it/userinfo`
 - Note: token introspection endpoint doesn't have the "https://" part
 - The token file must have at most 0600 permission
 - An environment variable needs to be set:
 - `OAuth2_TOKEN=FILE:/path/to/token/file`
- In the EOSFUSE DaemonSet container:
 - EOS FUSEx daemon (eosxd) needs to be configured for SSS authentication
 - SSS keytab needs to be present

Docs: <https://eos-docs.web.cern.ch/using/oauth2.html>



Singleuser container setup

Some things need to happen:

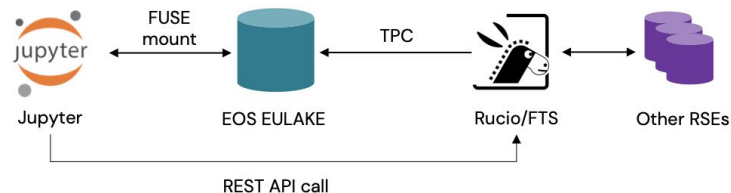
- OAuth token exchange (eos-eulake and rucio)
 - Uses a modified version of SWAN's KeyCloakAuthenticator
- Enable token autorenewal
 - Uses [swanoauthrenew](#)
- Write token files to /tmp
- Set OAUTH2_TOKEN env for EOS authentication
- Write rucio.cfg file



Backup Slides

Making files available

- Replica mode: uses Third Party Copy (TPC)
- EULAKE-1 is a Rucio Storage Element and is FUSE-mounted to /eos/eulake_1
- When “Make Available” is clicked:
 - The extension creates a replication rule to move requested files into EULAKE-1
 - Lifetime is set to 7 days (configurable by service admins)
 - Rucio will move the files to EULAKE-1
 - Once the replication status is OK, the extension translates the Physical File Name into local path
 - `root://eos-eulake.cern.ch:1094//eos/eulake/tests/rucio_test/eulake_1/file` → `/eos/eulake_1/file`
 - File is accessible as if it were local



Uploading files in scratch (..technically EOS eulake)

When “datalake upload” is run:

- The script translates local path to full Physical File Name:
 - `/scratch/muhilmy/file` → `root://eoseulake.cern.ch:1094//eos/eulake/tests/jupyter-scratch/muhilmy/file`
- The file in scratch is added to the Rucio replica catalogue
- A replication rule is created to move the files from scratch space to a destination storage
- Rucio will move the files to the destination storage
- When the replication status is OK, Rucio will delete the file in scratch
- A cron job will run every 24h to delete files (and folders) older than 2 days old that might not be in the Rucio catalogue

