SWAN, Rucio, and Jupyter

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CS3 - Cloud Storage Synchronisation and Sharing
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https://indico.cern.ch/event/970232/

CERN

Motivation

It started with an idea

Help scientists work productively with lots of data

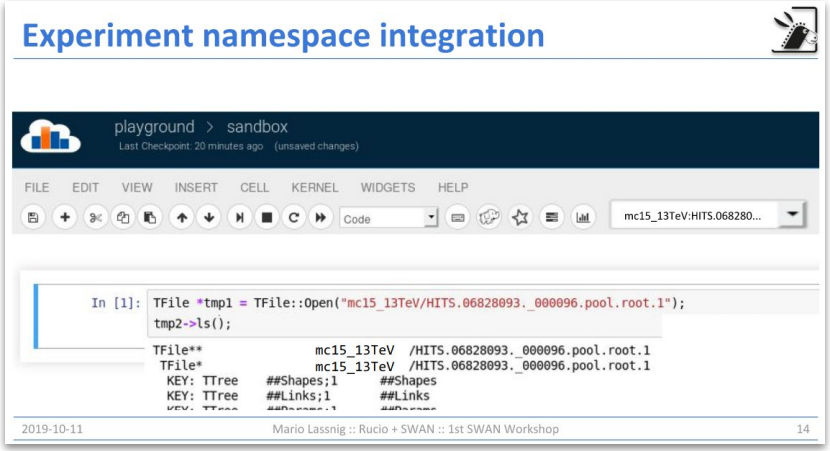
Integrate Jupyter-based notebooks with Exascale data

Access and search large datasets with ease

Avoid switching between different services and UIs

Transparent integration with notebook formats

Facilitate sharing of data



Circulated idea

Received very positive feedback

Presented idea "outside" at CS3 in Copenhagen

Two natural candidates presented themselves: SWAN and Rucio

SWAN introduction

CERN's Jupyter Notebook Service

Analysis only with a web browser, no local installation needed

Calculations, input data and results *"in the Cloud"*

Support for multiple analysis ecosystems and languages

Python, ROOT C++, R and Octave

Easy sharing of scientific results: plots, data, and code

Integration with existing CERN resources

Storage	CERNBox/EOS
Software	CVMFS
Mass processing power	Spark

Rucio introduction

Rucio provides a mature and modular scientific **data management federation**

- **Seamless integration** of **scientific and commercial** storage and their network systems
- Data is stored in **global single namespace across heterogeneous resources**
- Facilities can be **distributed at multiple locations** belonging to **different administrative domains**
- **Orchestration of dataflows** with both low-level and high-level policies

Principally developed by and for the ATLAS Experiment, now with many more communities

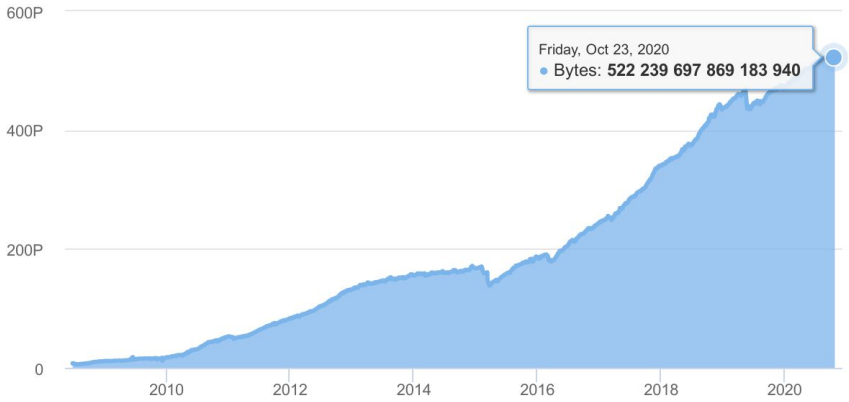
Rucio is free and open-source software licenced under *Apache v2.0*

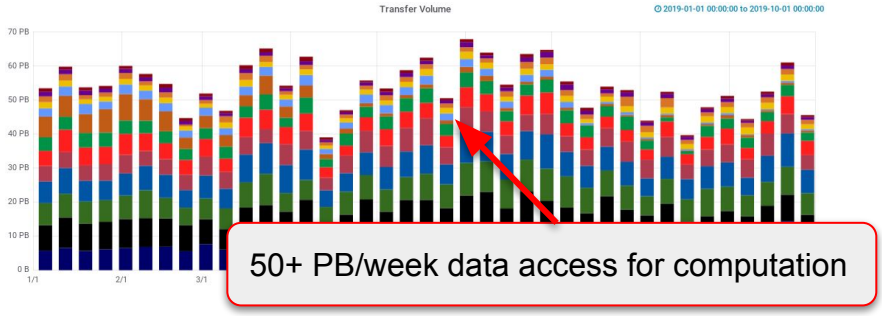
A sense of scale

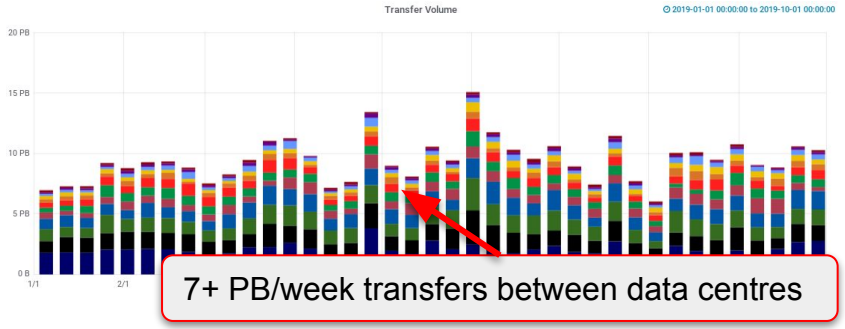
ATLAS Experiment

- 1B+ files, 500+ PB of data, 400+ Hz interaction
- 120 data centres, 5 HPCs, 2 clouds, 1000+ users
- 500 Petabytes/year transferred & deleted
- 2.5 Exabytes/year uploaded & downloaded

Increase 1+ order of magnitude for HL-LHC







From idea to project

Google Summer of Code 2020

Collaboration between Rucio, SWAN and H2020 ESCAPE

Muhammad Aditya Hilmi

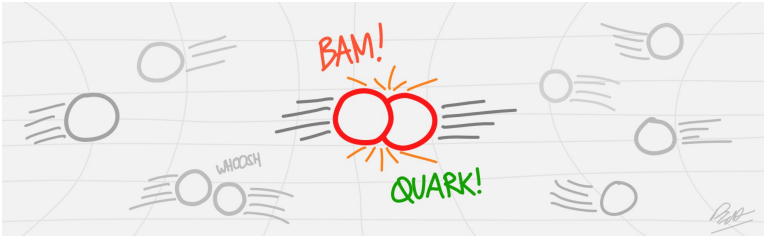
https://didithilmy.github.io/gsoc2020/

Jupyterlab Extension

Generic extension, compatible with any Jupyterlab installation

Remote configuration for easier management

https://github.com/rucio/jupyterlab-extension



The plugin

Browse Rucio namespace

Search for datasets

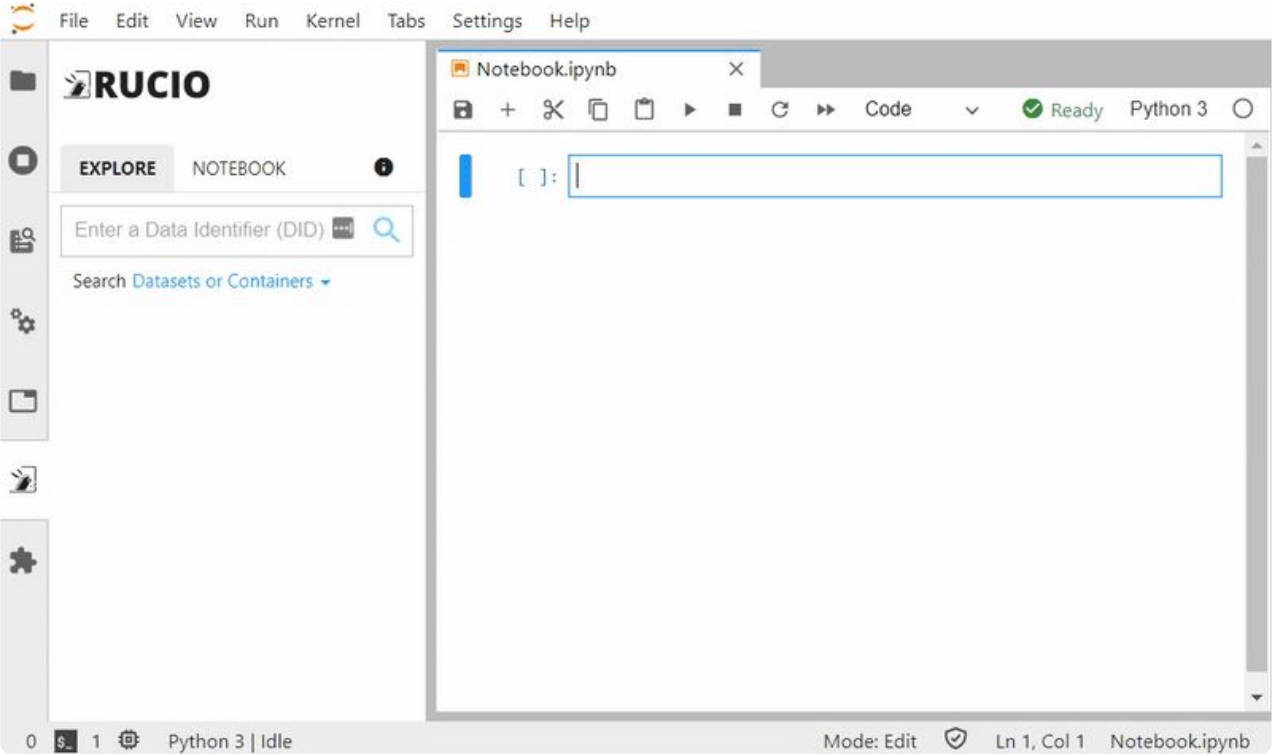
Inject them in the notebook

Easily replicate datasets locally

Share your notebooks

Resolve file paths automatically

Rucio authentication support



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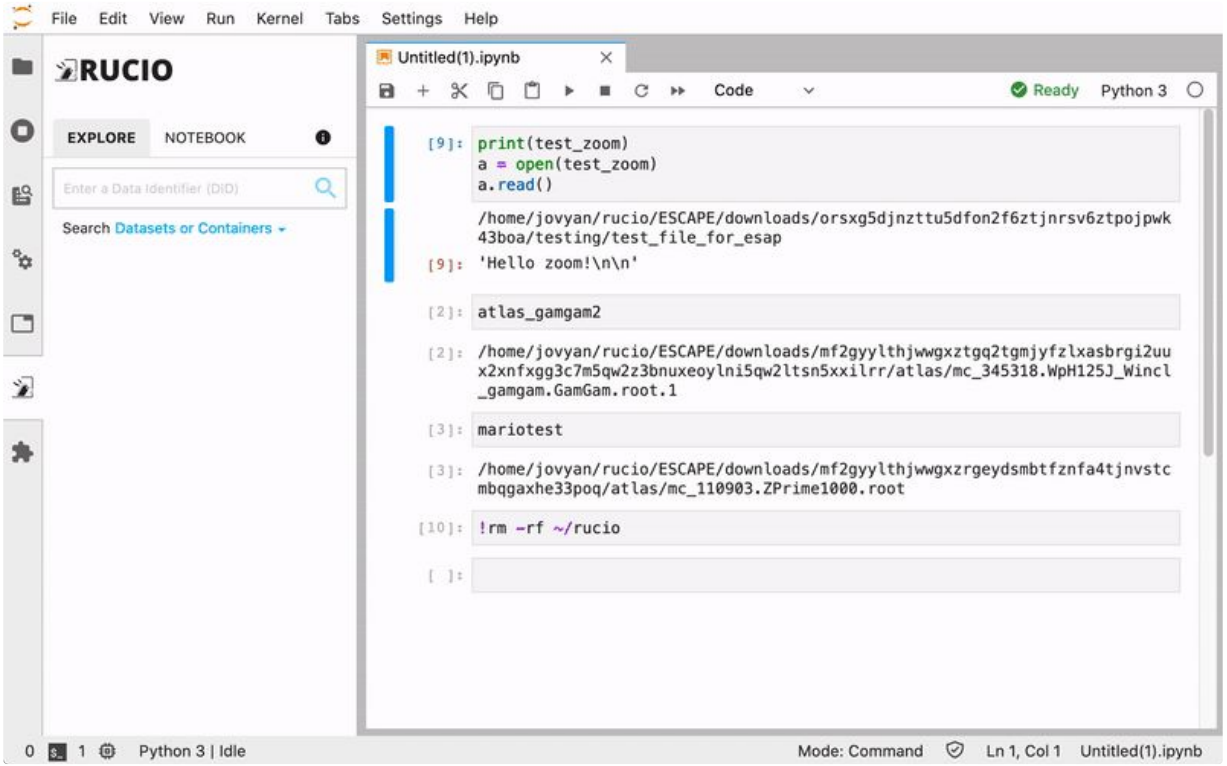

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File Edit View Run Kernel Tabs Settings Help

RUCIO

EXPLORE NOTEBOOK

Active Instance

ESCAPE

Rucio Authentication

X.509 User Certificate

X.509 USER CERTIFICATE

Certificate file path

/home/jovyan/certs/x509up

Key file path

/home/jovyan/certs/x509up

Enter the private key path if the certificate file does not include it.

Save Settings

Untitled(1).ipynb

Code Ready Python 3

```
[12]: print(test_zoom)
      a = open(test_zoom)
      a.read()
```

```
/home/jovyan/rucio/ESCAPE/downloads/orsxg5djnzttu5dfon2f6ztjnrsv6ztpojpwk
43boa/testing/test_file_for_esap
```

```
[12]: 'Hello zoom!\n\n'
```

```
[2]: atlas_gamgam2
```

```
[2]: /home/jovyan/rucio/ESCAPE/downloads/mf2gyylthjwwgxztgq2tgmjyfzlxasbrgi2uu
x2xnfxgg3c7m5qw2z3bnuxeoylni5qw2ltsn5xxilrr/atlas/mc_345318.WpH125J_Wincl
_gamgam.GamGam.root.1
```

```
[3]: mariotest
```

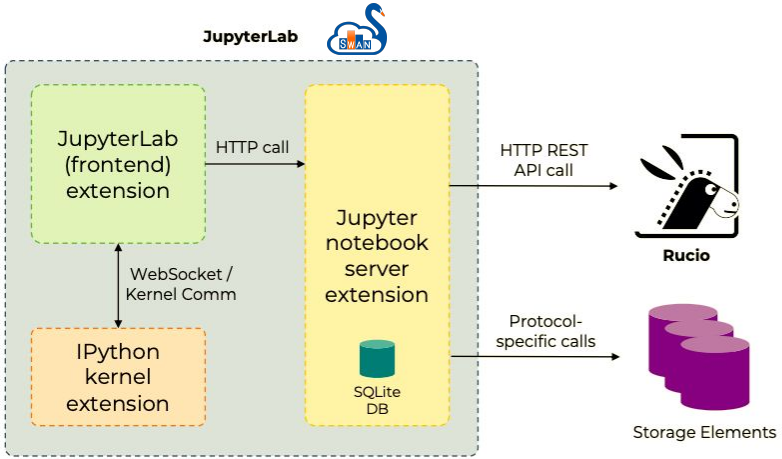
```
[3]: /home/jovyan/rucio/ESCAPE/downloads/mf2gyylthjwwgxzrgeydsmbtfznfa4tjnvstc
mbqgaxhe33poq/atlas/mc_110903.ZPrime1000.root
```

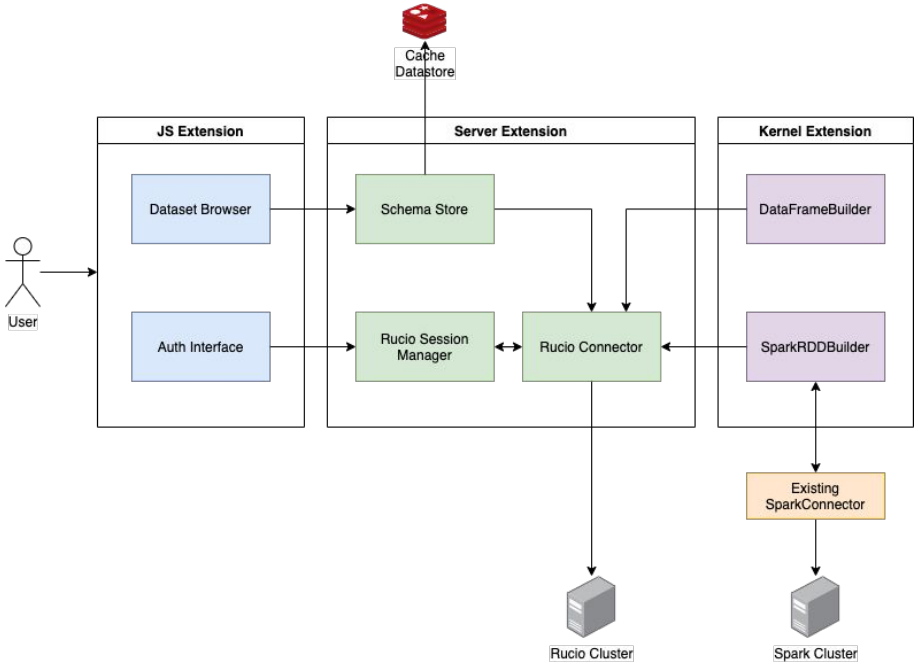
```
[10]: !rm -rf ~/rucio
```

```
[ ]:
```

0 1 Python 3 | Idle Saving completed Mode: Command Ln 1, Col 1 Untitled(1).ipynb

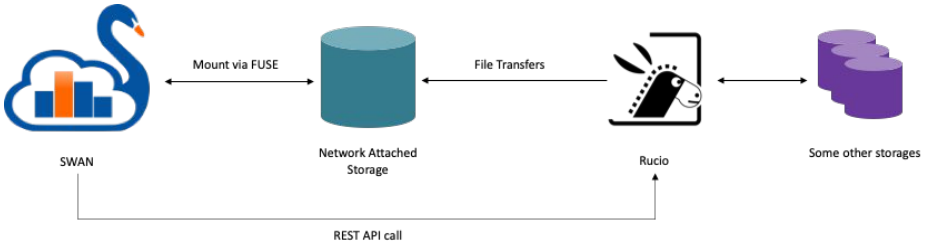
Plugin architecture overview





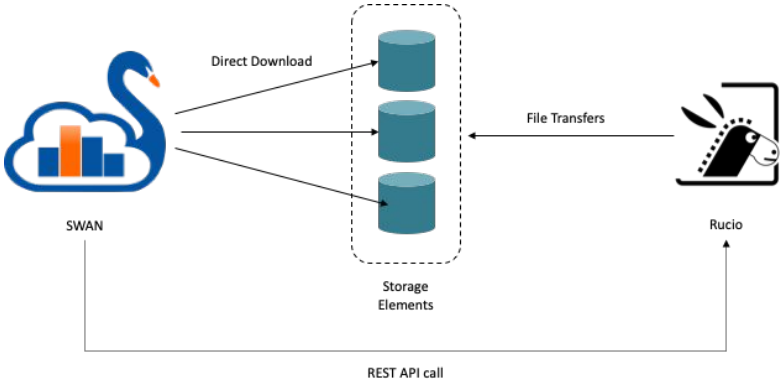
Modes of operation

Replica mode



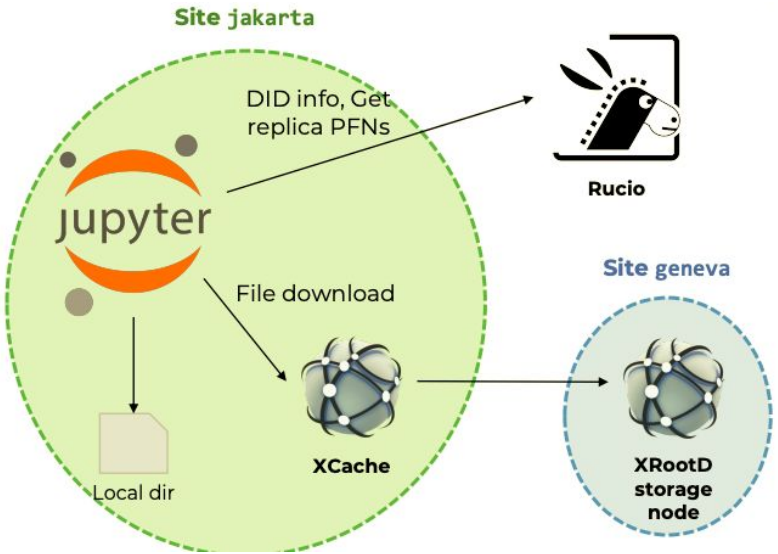
Uses network-attached storage as a Rucio Storage Element
Transparently uses Rucio's file transfer capability

Download mode



Downloads data directly to the user's directory
using Rucio clients for transparent access

Plugin architecture for caching



1. Assign a site name to existing RSE
   - `rucio-admin rse set-attribute --rse XRD1 --key site --value geneva`
2. Register XCache host + port to Rucio
   - `rucio-admin config set --section root-proxy-internal --option jakarta --value xcache:1094`

Site name

```
[root@rucio rucio]# SITE_NAME=jakarta rucio list-file-replicas test:file1
+---------+-------+-----------+----------+-------------------------------------------------------------------------------+
| SCOPE   | NAME  | FILESIZE  | ADLER32  | RSE: REPLICA                                                                  |
|---------+-------+-----------+----------+-------------------------------------------------------------------------------|
| test    | file1 | 10.486 MB | c9dbba2a | XRD1: root://xcache:1094//root://xrd1:1094//rucio/test/80/25/file1 |
+---------+-------+-----------+----------+-------------------------------------------------------------------------------+
```

Cache prefix

H2020 ESCAPE evaluation results

Pilot Data Lake - 9 sciences/experiments, 10+ RSEs, 5 storage technologies

- LOFAR exploited plugin during 24h Full Dress Rehearsal exercise
- SKAO/CERN actively integrating plugin as part of broader ESCAPE service
- ATLAS Open Data evaluation (next slide) performed within this environment

ESCAPE Data Lake proved maturity to scale up to Prototype phase

- More sciences/experiments and RSEs
- Plugin as keystone of the next phase since Science Analysis Platform for end-users is a main objective
- Plugin extremely facilitates HEP/non-HEP community end-users to assess and perform analysis workflows

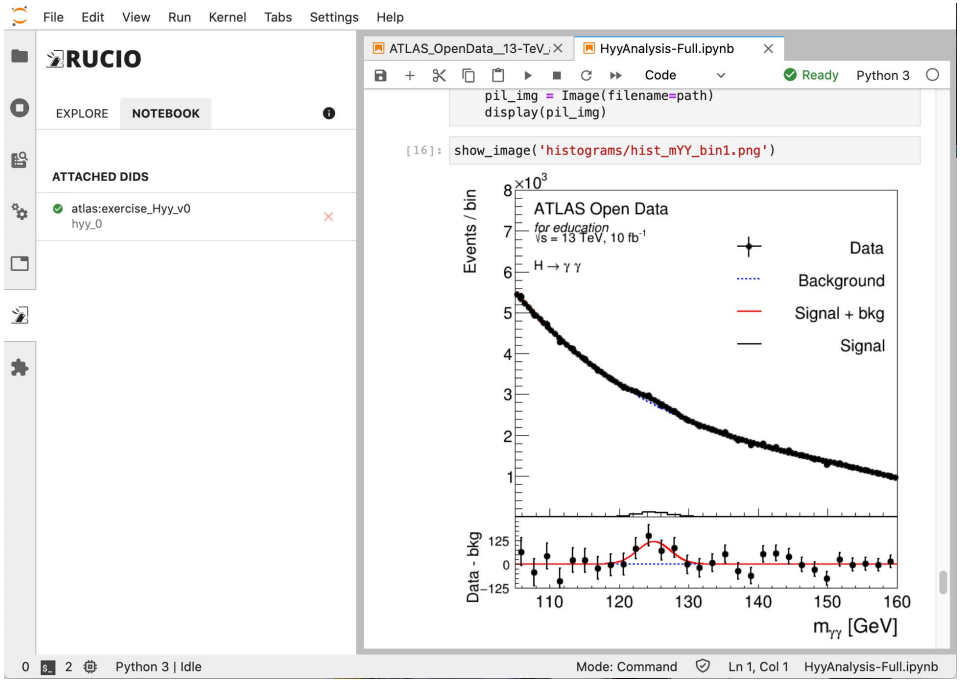
More authentication methods

- Token-based AuthN/Z integration for the plugin

Caching and Latency Hiding layer

- PoC already successful during GSoC - plugin towards a more consolidated integration within the Data Lake

ATLAS Open Data evaluation results




```python
chain_data = ROOT.TChain("mini")
chain_paths = hyy_0[0:4]
for path in chain_paths:
    chain_data.AddFile(path)

chain_ggH125 = ROOT.TChain("mini")
chain_ggH125.AddFile(hyy_0[5])

chain_VBFH125 = ROOT.TChain("mini")
chain_VBFH125.AddFile(hyy_0[6])

chain_WH125 = ROOT.TChain("mini")
chain_WH125.AddFile(hyy_0[7])

chain_ZH125 = ROOT.TChain("mini")
chain_ZH125.AddFile(hyy_0[8])

chain_ttH125 = ROOT.TChain("mini")
chain_ttH125.AddFile(hyy_0[4])
```

Summary and outlook

Deploy it in production at CERN

Already got interest from non-HEP (SKAO, LOFAR, …) communities to contribute via H2020 ESCAPE

Investigate compatibility for more kernels

ROOT / C++ seems useful, as it is the current de-facto analysis language

More authentication methods

OAuth/OpenID Connect already supported by Rucio and SWAN

Share notebooks across JupyterLab installations

Allow connection to publicly-accessible Rucio installations and their RSEs

Automatic Rucio instance configuration from notebook metadata

Go from a crazy idea to a useful plugin in less than a year thanks to very dedicated people!

And of course extra special thanks to our GSoC student Muhammad!

CERN