# Rucio for SPD data management

Alexey Konak
JINR MLIT
konak@jinr.ru

VIII SPD collaboration meeting
07.11.2024

# About Rucio

Rucio is an open-source software framework that provides functionality for data management and access in a distributed storage environment. Rucio also provides protection against data loss and speed up access to data through a controlled number of replicas.

Currently, the Rucio system can be used to:
– organize data in a hierarchical structure for easy navigation and management;
– unified interaction of a heterogeneous network and storage infrastructure;
– distribute data for storage;
– adaptive data replication and recovery;
– automated data transfer between storages;
– storage of all types of experimental data;
– data lifecycle management;
– storage and management of metadata;
– provides metrics for monitoring data usage, system performance and the status of various components.

Official Rucio documentation: https://rucio.cern.ch/documentation/

# Quick Rucio terminology recap

**File** – the smallest operational unit of data in Rucio.

**Dataset** – a named set of files (logical structure).

**Container** – a named set of datasets or, recursively, containers (also logical structure).

**Scope** – a scope partitions the namespace into several sub namespaces (example – *user.konak*).

**DID** – Data IDentifier, Rucio LFN for data (file/dataset/container) as combination of a scope and a name (example – *user.konak:file*).

**RSE** – Rucio Storage Element, the logical abstraction of a storage system for physical files. It has a unique identifier and a set of meta attributes describing properties.

**Replica** – a managed copy of a file.

**Rule –** a logical abstraction which defines the minimum number of replicas to be available on a RSE (example – *user.konak:file  1  JINR_SPD_LOCALGROPDISK*).

# Current status [1]

At the moment, the required set of system components of two Rucio-servers are deployed in Docker containers based on JINR cloud computing infrastructure:

- A test Rucio-server with a host certificate issued by Russian Data-Intensive Grid CA is located at https://vm221-121.jinr.ru/ .
  This server was used to development, test and debug. Also, testing and debugging of interaction with PanDA was carried out with this server as a part of production data generation. Also data replication to remote storage was tested.

- A production Rucio-server with a host certificate issued by JINR Grid CA is located at https://spd-rucio.jinr.ru/ .
  The main Rucio-server which will soon be tested and will used for the needs of the SPD collaboration.

# Current status [2]

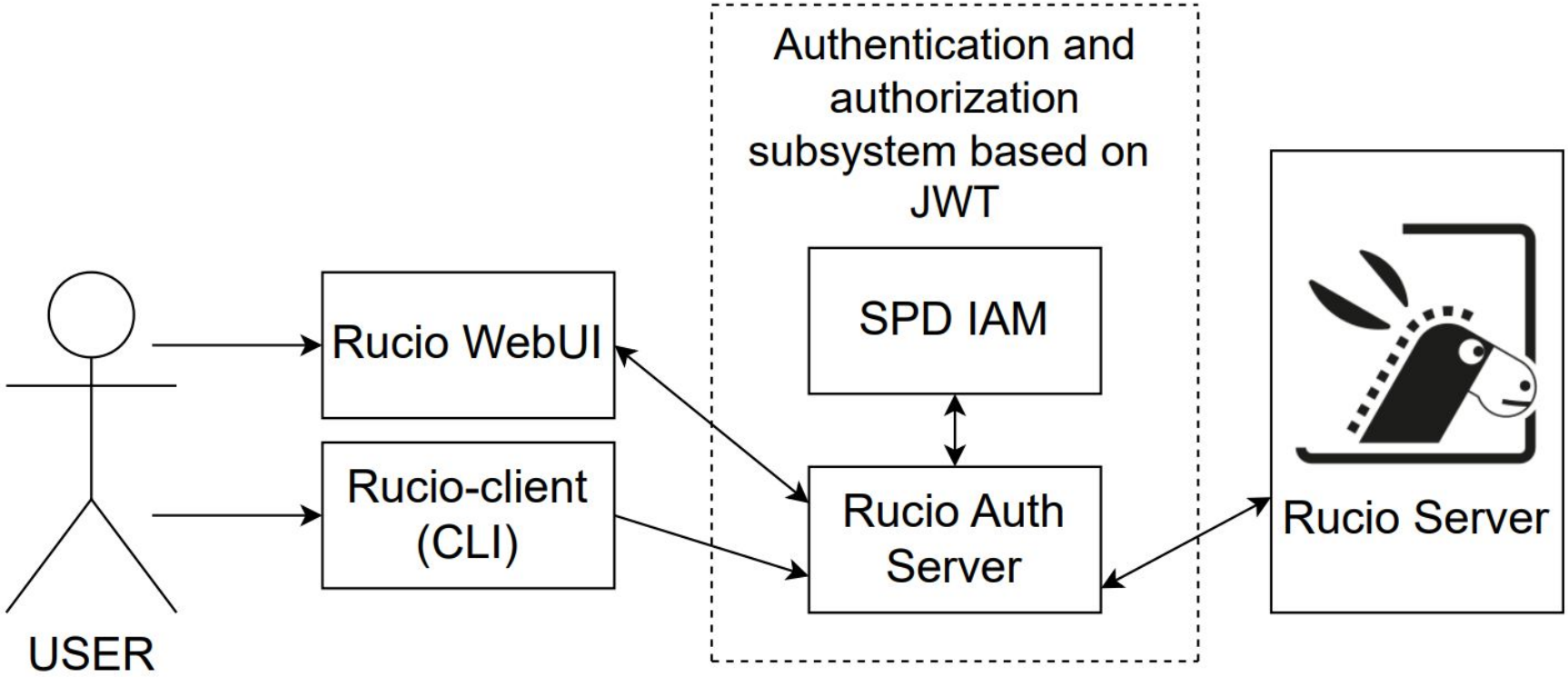
It is planned to have two copies of important data – at JINR and somewhere else. For this both servers have registered JINR and PNPI storages under EOS. JINR storage is used for uploading data, PNPI storage – for storing replicas.

For convenient work with large amounts of data, the following naming scheme is used (for example: 2050.DATA.250LT.minbias.27189.RAW.636763fd78df7d.0.)

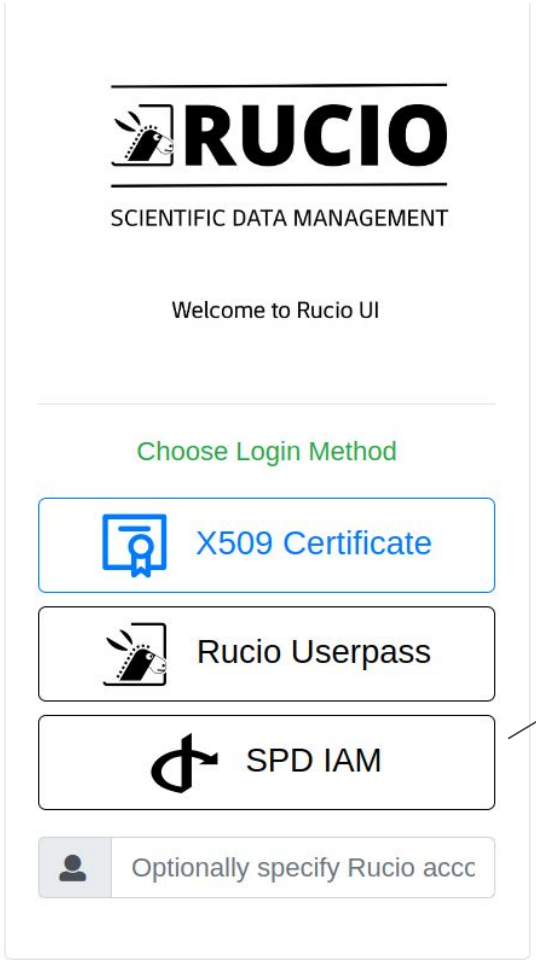
| Grouping tier | Field | Description | Example |
|---|---|---|---|
| 0 | [YEAR] | Main Scope - the year of data production | 2050 |
| 1 | [MC \| DATA] | Real data or simulated data | DATA |
| 2 | [energy][polarization] | | 250LT |
| 3 | [desc] | Short name of physics aim | minbias |
| 4 | [RunNumber] | Run number for DATA, ID for MC | 27189 |
| 5 | [data type] | EVGEN, SIMUL, RECO…. | RAW |
| 6 | [DatasetUID] | unique ID of the dataset | 636763fd78df7d |
| 7 | [Version] | for reprocessing | 0 |

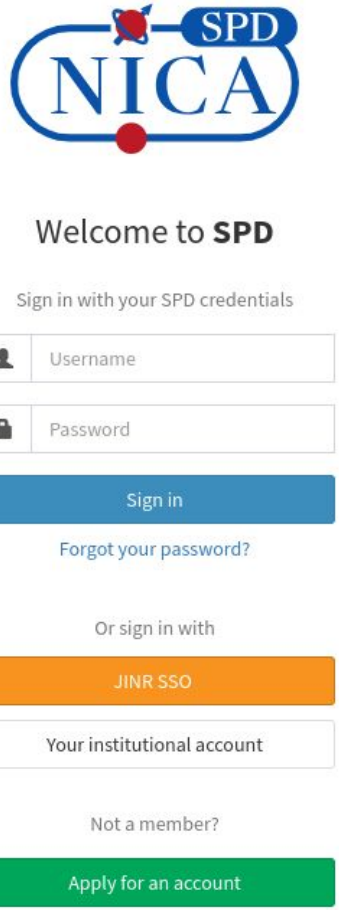
# Integration with the SPD IAM [1]

SPD IAM is used to authenticate users in Rucio using JSON Web Tokens as well as automate the registration of new users in Rucio.



# Integration with the SPD IAM [2]

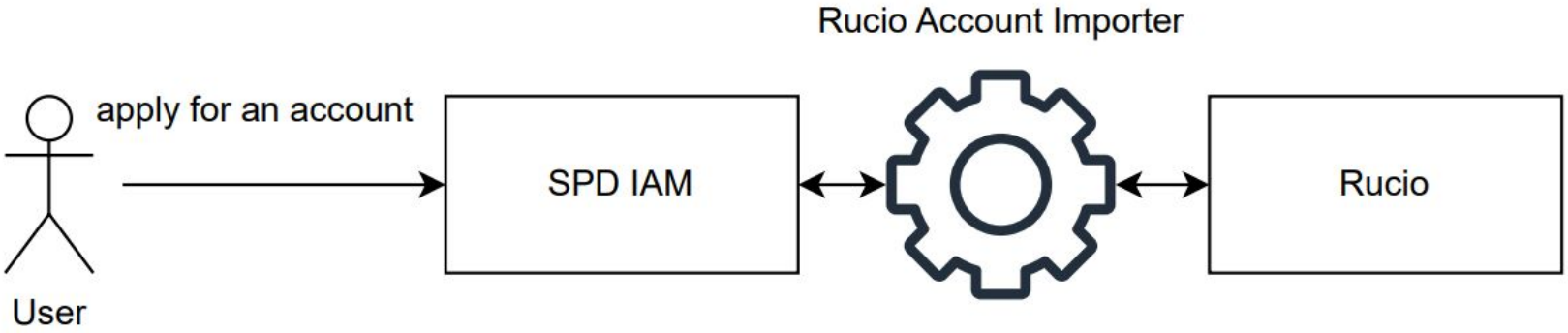


# Automation of user registration [1]

In Rucio, there is no way for the user to request registration. According to this, a registration is carried out manually by the administrator. In addition, the administrator adds identities necessary for authentication to user's Rucio account.

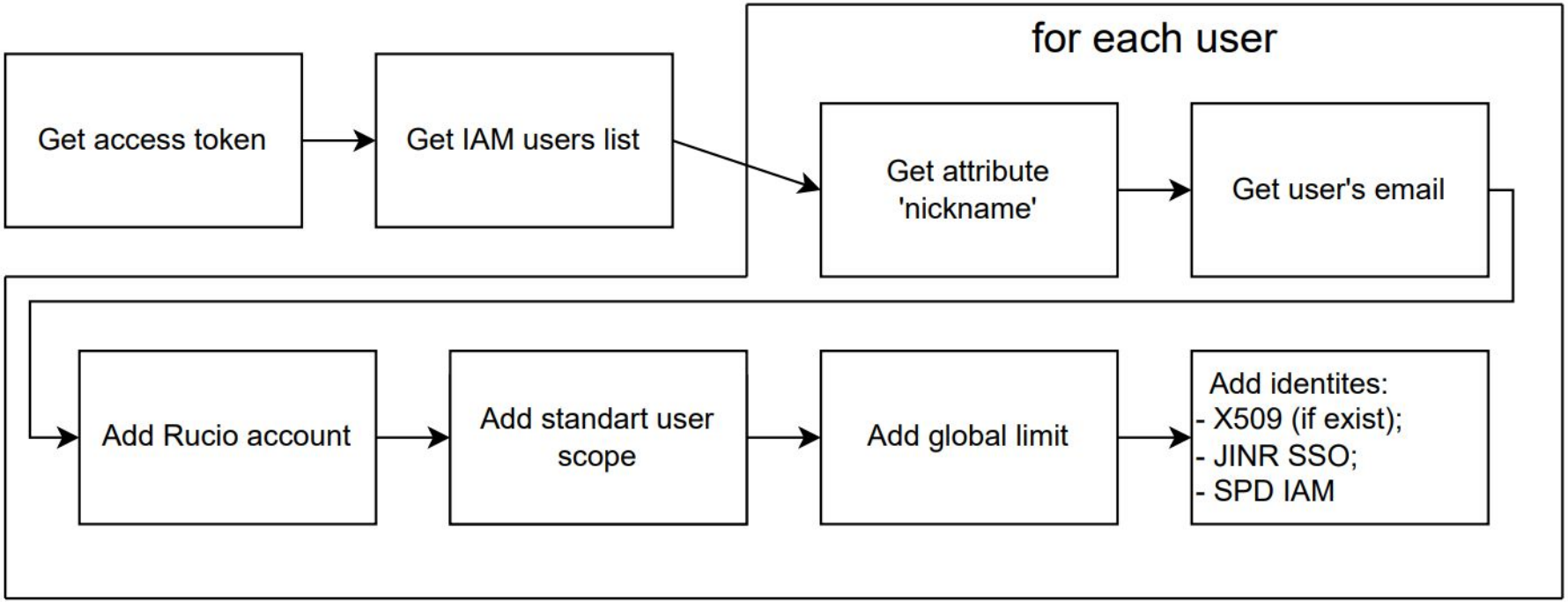
To avoid manual registration of users by the administrator of Rucio, a scheme was developed:




The Rucio Account Importer was implemented to import accounts and their user identification information from the SPD IAM to the Rucio.

# Automation of user registration [2]

The Rucio Account Importer is set to run once a day in cron. The utility adds new accounts and updates the identity information of existing Rucio accounts if new IDs appear (for example, the user add his certificate to the SPD IAM.)



# Stats about SPD data

Currently, Rucio is used for mass production of SPD. During production, we tested interaction of PanDA and Rucio in various forms as well as different data organisation.

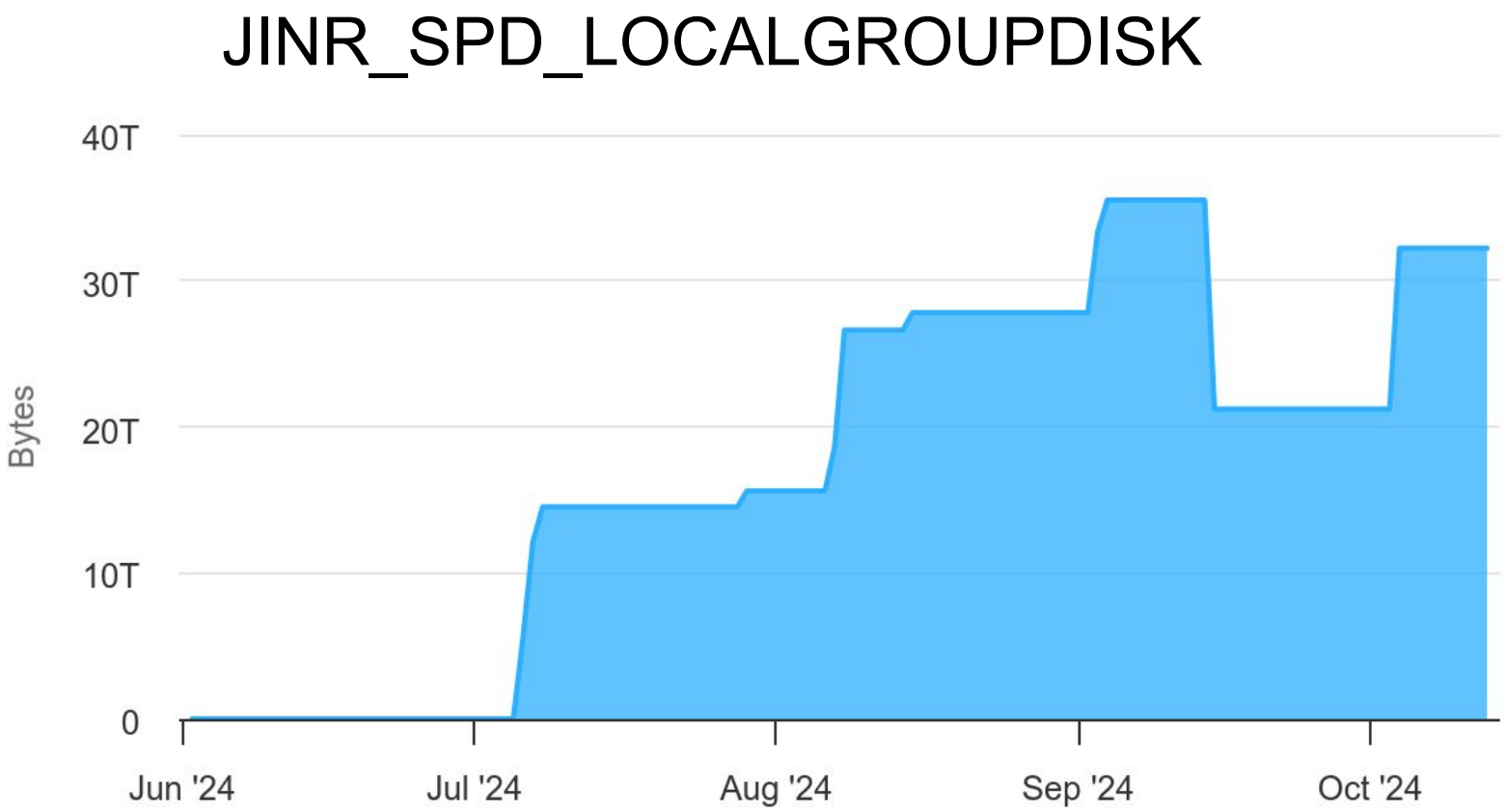
– The scope jeditest is used to test the interaction of PanDA and Rucio.

– The scope 2024 are significant data that appeared after the process of MC data generation (Simulation and Reconstruction).

– The scope archive is data of generation process (generated by PanDA).

| scope name | jeditest | archive | 2024 |
|---|---|---|---|
| total files | 24302 | 7018 | 27444 |
| files under rules | 861 | 7018 | 27444 |
| total datasets | 278 | 551 | 8 |
| size | ~ 13 TB | ~ 7 TB | ~ 20 TB |

# Production data generation



# Replication to the PNPI storage

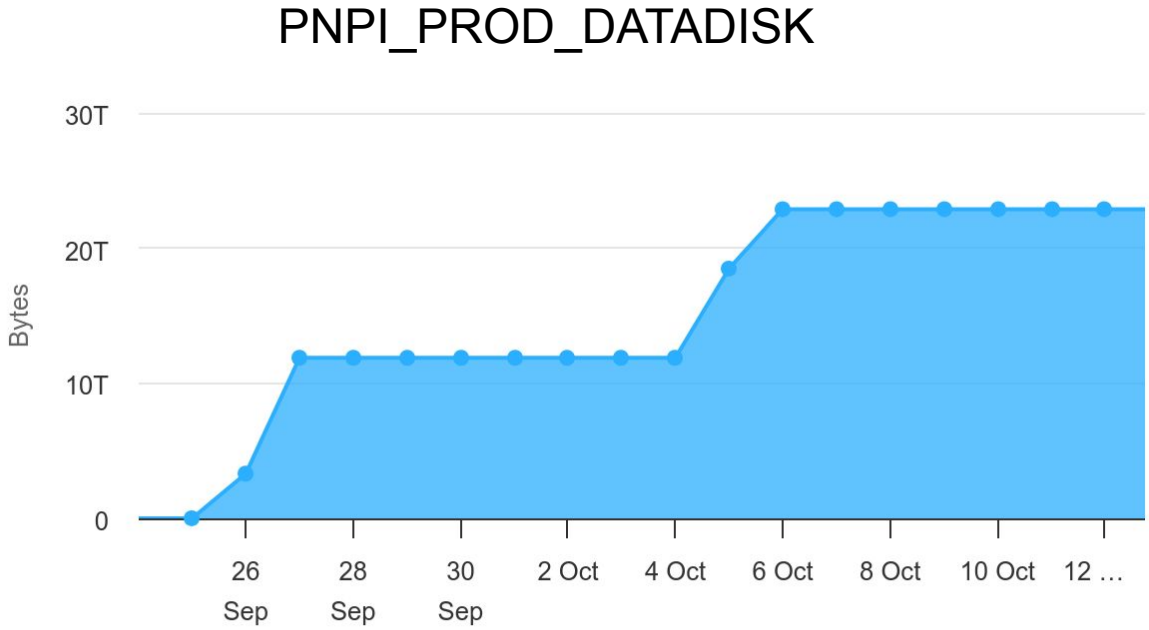
It is planned to have two copies of important data – origin data at JINR and replicas at PNPI.

Two types of replication:
– creates replication rules manually (after the first round of production data generation);
– replication rules were created by subscription (during the second round of production data generation).

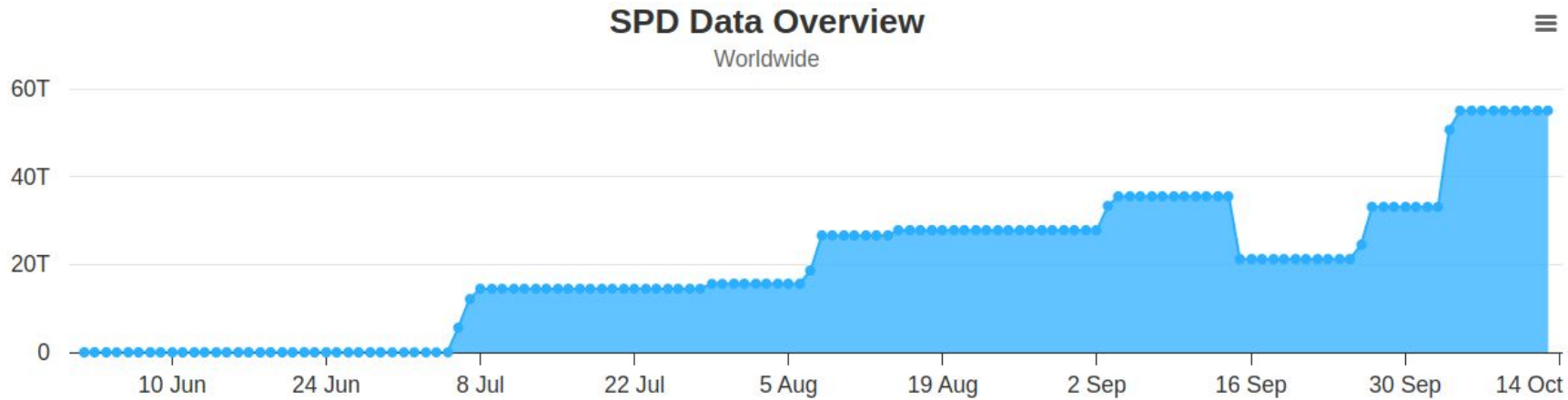
| Name | Account | RSE Expression | Creation Date | Remaining Lifetime | State | Locks OK | Locks Replicating | Locks Stuck |
|---|---|---|---|---|---|---|---|---|
| 2024:2024.MC.27GeV.test-minbias.00001.RECO.2.R | panda | PNPI_PROD_DATADISK | 2024-10-02T12:39:47.000Z | - | STUCK | 4741 | 0 | 12 |
| 2024:2024.MC.27GeV.test-minbias.00001.RECO.2.log | panda | PNPI_PROD_DATADISK | 2024-10-02T12:39:46.000Z | - | STUCK | 4769 | 0 | 16 |
| 2024:2024.MC.27GeV.test-minbias.00001.RECO.6f25043e-689f-40f7-951f-ba6e0c9f4d14.0 | panda | PNPI_PROD_DATADISK | 2024-09-26T12:41:18.000Z | - | SUSPENDED | 8 | 0 | 15 |
| 2024:2024.MC.27GeV.test-minbias.00001.RECO.6f25043e-689f-40f7-951f-ba6e0c9f4d14.1.log | panda | PNPI_PROD_DATADISK | 2024-09-26T12:40:58.000Z | - | SUSPENDED | 1429 | 0 | 22 |
| 2024:2024.MC.27GeV.test-minbias.00001.RECO.6f25043e-689f-40f7-951f-ba6e0c9f4d14.1.R | panda | PNPI_PROD_DATADISK | 2024-09-26T12:40:38.000Z | - | SUSPENDED | 537 | 0 | 889 |
| 2024:2024.MC.27GeV.test-minbias.00001.SIMUL.6f25043e-689f-40f7-951f-ba6e0c9f4d14.0.S | panda | PNPI_PROD_DATADISK | 2024-09-26T12:39:55.000Z | - | SUSPENDED | 4982 | 0 | 18 |
| 2024:2024.MC.27GeV.test-minbias.00001.SIMUL.6f25043e-689f-40f7-951f-ba6e0c9f4d14.0.P | panda | PNPI_PROD_DATADISK | 2024-09-26T12:39:10.000Z | - | SUSPENDED | 4977 | 0 | 23 |
| 2024:2024.MC.27GeV.test-minbias.00001.SIMUL.6f25043e-689f-40f7-951f-ba6e0c9f4d14.0.log | panda | PNPI_PROD_DATADISK | 2024-09-26T12:36:57.000Z | - | SUSPENDED | 4987 | 0 | 19 |

# Results of replication

- 20 TB in the form of replicas is stored on the remote storage;
- identified bad files;
- tested the FTS;
- 112 MiB/s approximate transmission speed



# SPD data management




– At the moment, files and datasets in scopes 2024 are stored indefinitely. Original files are stored at the JINR storage, replicas – at the PNPI storage.

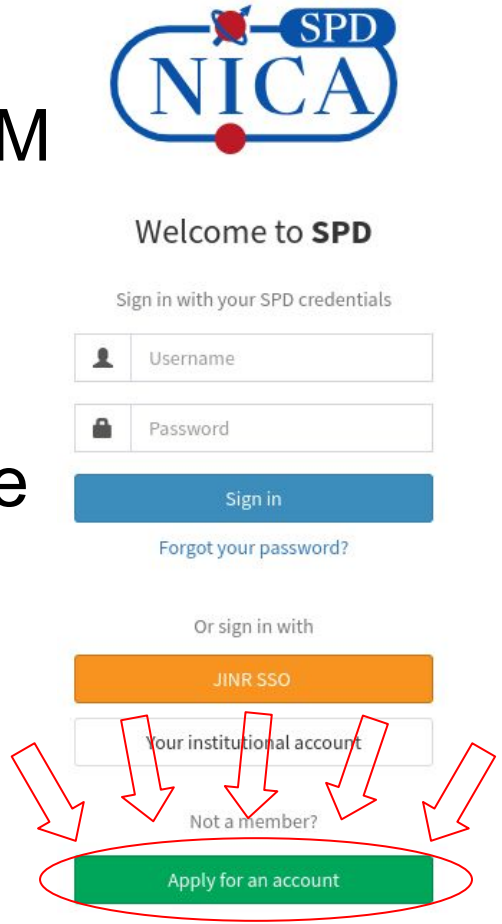
– Scope archive is stored indefinitely only at the JINR storage.

– Files and datasets in the scope jeditest were uploaded to the JINR storage and stored there. After expiration of the lifetime in the specified lifetime model this data were deleted automatically. File deletion rate in the current configuration is approximately 16 files per second.

# How to start using SPD Rucio?

1. Apply for an account in SPD IAM (https://spd-iam.jinr.ru)

2. Enter at lxui.jinr.ru and activate rucio-client.

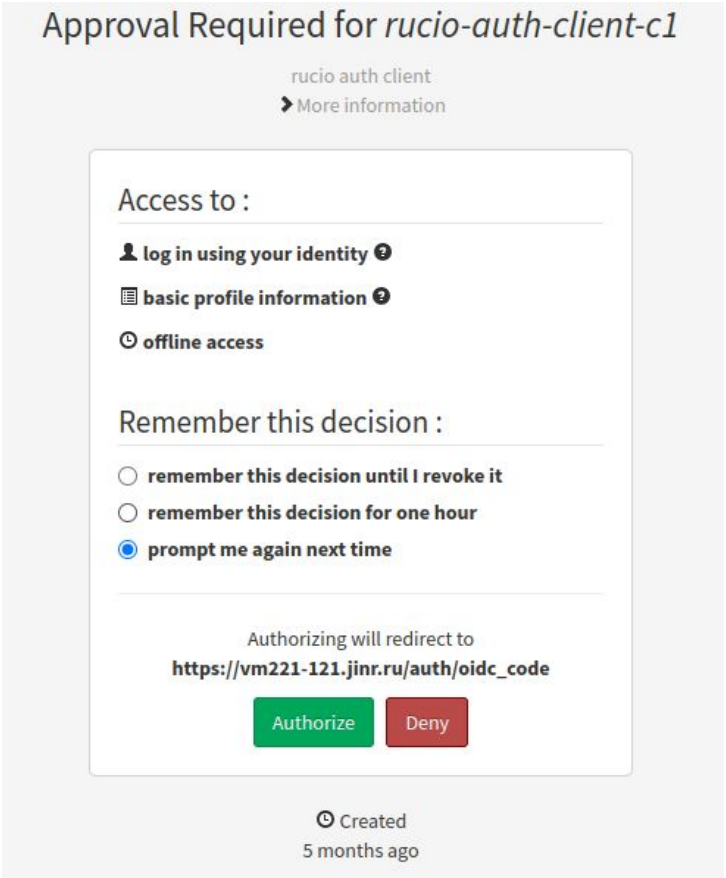


# How to use rucio-client at CVMFS [1]

1) Enter at lxui.jinr.ru using ssh
   run command at CLI: *ssh <sso_nickname>@lxui.jinr.ru*
2) Activate rucio client
   *source /cvmfs/spd.jinr.ru/sw/ddm/rucio-clients/latest/bin/activate*
3) Authenticate in rucio:
   You can authenticate via SPD IAM:
   To do this, you need to add the option *-S=oidc* to each rucio-client command
   for example run command at CLI: *rucio -S=oidc whoami*
   After running the command, you receive a message in the console
   Open following link in browser, authenticate in SPD IAM, confirm login through the client and copy paste the received code from the browser to the terminal.

   If you have a certificate issued by RDIG or JINR CA and you are registered in SPD IAM you can use proxy certificate:
   Get a proxy certificate (you must specify VO and your role)
   *voms-proxy-init -voms spd.nica.jinr:/spd.nica.jinr*
   Then export proxy certificate (path to certificate will be output to the CLI after it is received)
   *export X509_USER_PROXY=/tmp/x509up_u****
   Then you can use rucio client
   for example: *rucio whoami* (no need *-S=oidc*)

# How to use rucio-client at CVMFS [2]




**RUCIO**

**SCIENTIFIC DATA MANAGEMENT**

Please copy-paste the following code to the open terminal session with Rucio Client in order to get your access token:

**PlxtLWVOqLKGLHjabhDJu31K8C0Bwz4V0x2UxxsxuPHKUjXKR2**

```
(1.31.7) lxui04:~ > rucio -S=oidc whoami

Please use your internet browser, go to:

    https://vm221-121.jinr.ru/auth/oidc_redirect?DBll9HlaSz8Yr4pW37tTxFp

and authenticate with your Identity Provider.
Copy paste the code from the browser to the terminal and press enter:
PlxtLWVOqLKGLHjabhDJu31K8C0Bwz4V0x2UxxsxuPHKUjXKR2
suspended_at : None
email        : konak@jinr.ru
account      : konak
created_at   : 2023-12-08T08:28:47
status       : ACTIVE
account_type : USER
deleted_at   : None
updated_at   : 2023-12-08T08:28:47
```

# How to use rucio-client at CVMFS [3]

5) To view the list of DIDs, use the command (shows a list of dids match given pattern and filter)

*rucio list-dids --filter <filters> <did_pattern>*

Some examples:

*rucio list-dids --filter 'type=dataset' 2024:**

*rucio list-dids --filter 'type=file' 2024:*MC**

*rucio list-dids 2024:**

6) If you want to download files – use *eos cp /path/to/file /path/to/store/file*

for example: eos cp /eos/nica/spd/localgroupdisk/rucio/2024/e8/9d/r.2024.MC.27GeV.test-minbias.00001.RECO.2.006737.root.1 ~

```
(1.31.7) lxui04:~ > eos cp /eos/nica/spd/localgroupdisk/rucio/2024/e8/9d/r.2024.MC.27GeV.test-minbias.00001.RECO.2.006737.root.1 ~
[eoscp] r.2024.MC.27GeV.test-minbias.00001.RECO.2.006737.root.1 Total 2015.06 MB06 MB    |========>..........| 44.66 % [39.2 MB/s]
```

Rucio documentation: https://rucio.cern.ch/documentation/user/using_the_client

# Some helpful commands [1]

**rucio -h** – shows a list of commands.

**rucio whoami** – info about account under which you are logged in.
Example: *rucio -S=oidc whoami*

**rucio <command> -h** – shows a list of options for a given command and helpful information about command.
Some examples:

*rucio whoami -h*
*rucio list-dids -h*
*rucio upload -h*

**rucio list-scopes** – shows info about existing scopes.

**rucio list-rses** – shows a list of existing RSEs.

# Some helpful commands [2]

**rucio list-dids --filter <filters> <did_pattern>** – shows a list of dids match given pattern and filter.

Examples:

*rucio -S=oidc list-dids --filter 'type=file' 2024:**

*rucio -S=oidc list-dids --filter 'type=file' user.konak:file**

*rucio -S=oidc list-dids 2024:*RECO*.log*

*rucio list-dids 2024:MC.27GeV**

**rucio list-files <did>** – shows a dataset/container content.

Some examples:

*rucio -S=oidc list-files 2024:2024.MC.27GeV.test-minibias.00001.RECO.2.R*

*rucio -S=oidc list-files user.konak:test_dataset.1*

# Some helpful commands [3]

**rucio list-file-replicas --pfns <dids>** – shows a list of PFNS for given DIDs
Some examples:

*rucio -S=oidc list-file-replicas --pfns user.konak:test_dataset.1*
*rucio -S=oidc list-file-replicas --pfns user.konak:file1*

**rucio stat <did>** – shows info about given DID e.g. availability, size, type, creation time, etc…
Examples:

*rucio stat user.konak:test_dataset.1*
*rucio -S=oidc stat user.konak:file1*

**rucio get-metadata <did>** – shows full info about given DID
Example: *rucio get-metadata user.konak:file1*

# Some helpful commands [4]

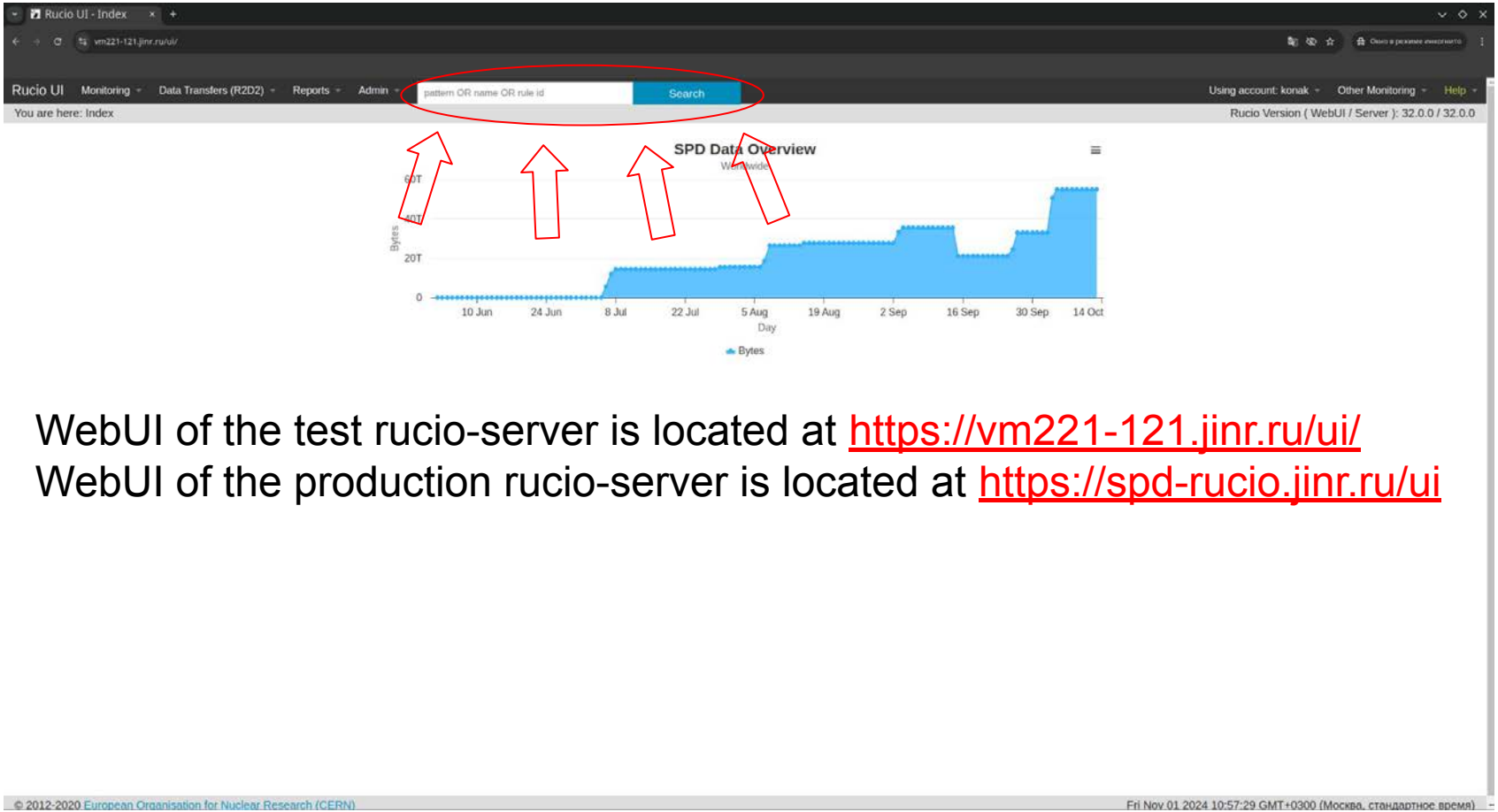
**rucio upload --rse <rse_name> --register-after-upload --lifetime <time_in_seconds> <file_name>**
– allows you to upload a file to the storage and register it in rucio.
Examples:

*rucio upload --rse JINR_SPD_LOCALGROUPDISK --register-after-upload --lifetime 3600 my_file*

*rucio -S=oidc upload --rse JINR_SPD_LOCALGROUPDISK --register-after-upload my_new_file*

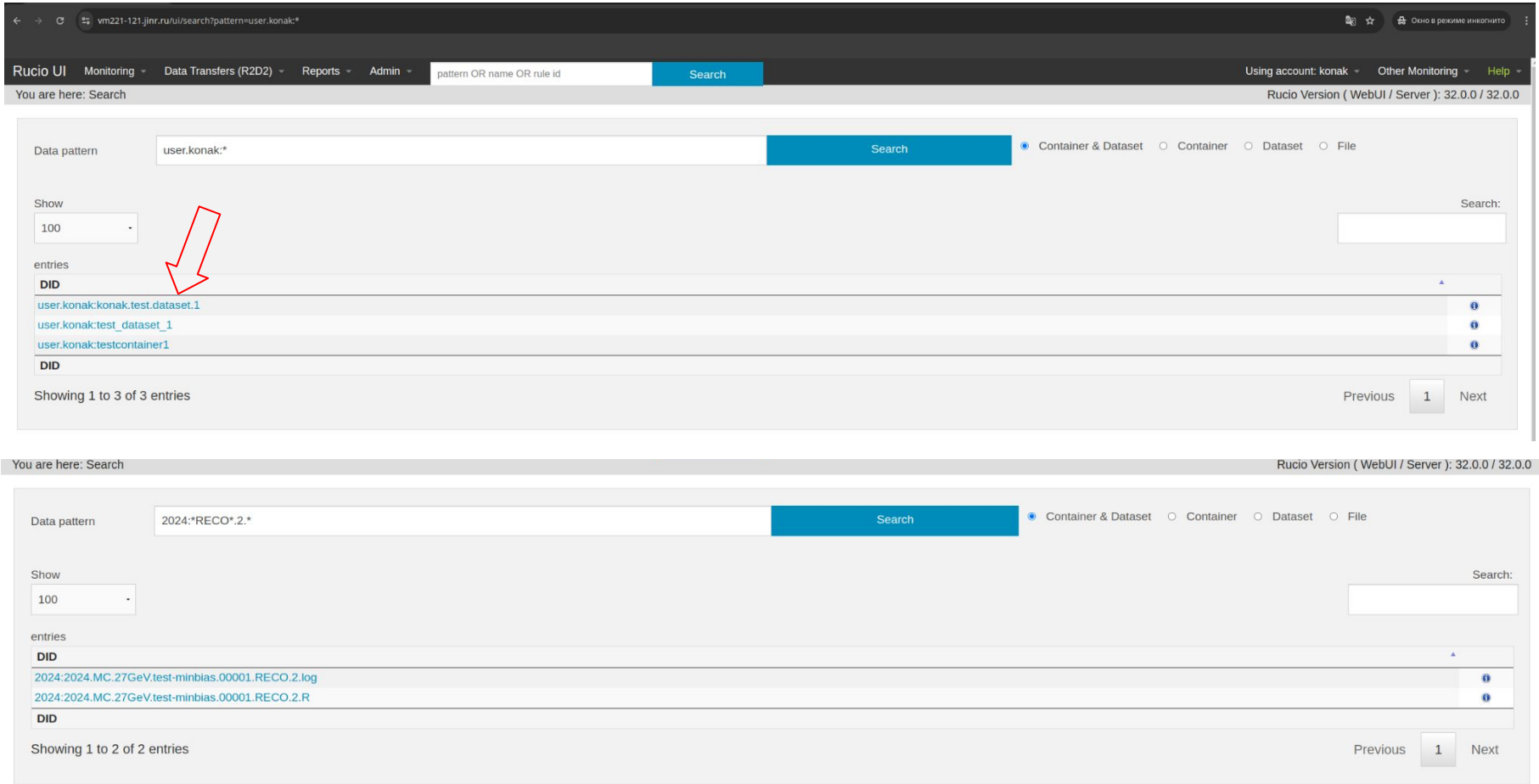
**rucio download <dids>** – allows you to download files.
Example: *rucio -S=oidc download user.konak:file1*

# Rucio WebUI [1]




WebUI of the test rucio-server is located at https://vm221-121.jinr.ru/ui/
WebUI of the production rucio-server is located at https://spd-rucio.jinr.ru/ui

# Rucio WebUI [2]



# Rucio WebUI [3]

## DID Metadata

| | |
|---|---|
| account | konak |
| availability | AVAILABLE |
| closed_at | Wed, 14 Aug 2024 09:22:23 UTC |
| created_at | Wed, 14 Aug 2024 09:19:06 UTC |
| did_type | DATASET |
| events | 0 |
| filesize | 250.58 kB |
| hidden | false |
| is_new | false |
| is_open | false |
| length | 7 |
| monotonic | false |
| name | konak.test.dataset.1 |
| obsolete | false |
| project | user |
| purge_replicas | true |
| scope | user.konak |
| suppressed | false |
| transient | false |
| updated_at | Thu, 05 Sep 2024 09:31:14 UTC |

## Rules

Show 10 entries Search:

| Rule | State | Account | Subscription | Last modified |
|---|---|---|---|---|
| JINR_SPD_LOCALGROUPDISK | OK | konak | - | Wed, 14 Aug 2024 09:21:25 UTC |

Showing 1 to 1 of 1 entries Previous 1 Next

## Dataset Replicas

Show 10 entries Search:

| RSE | State | Available Files | Available Size | Creation Date | Last Accessed |
|---|---|---|---|---|---|
| JINR_SPD_LOCALGROUPDISK | AVAILABLE | 7 | 250.58 kB | Wed, 14 Aug 2024 09:21:25 UTC | |

Showing 1 to 1 of 1 entries Previous 1 Next

## File Replica States

Show 10 entries Search:

| Filename | Replicas |
|---|---|
| jeditest:jeditest.000002.simu.000001.log.tgz | JINR_SPD_LOCALGROUPDISK |
| jeditest:jeditest.000002.simu.000002.log.tgz | JINR_SPD_LOCALGROUPDISK |
| jeditest:jeditest.000002.simu.000003.log.tgz | JINR_SPD_LOCALGROUPDISK |
| jeditest:jeditest.000002.simu.000004.log.tgz | JINR_SPD_LOCALGROUPDISK |
| jeditest:jeditest.000002.simu.000005.log.tgz | JINR_SPD_LOCALGROUPDISK |
| jeditest:jeditest.000002.simu.000006.log.tgz | JINR_SPD_LOCALGROUPDISK |
| jeditest:jeditest.000002.simu.000007.log.tgz | JINR_SPD_LOCALGROUPDISK |

# Future plans

- Monitoring system – implementation of a monitoring system to monitor the state of the system and its performance, as well as user activity and storages status.
- Naming convention – Rucio can control naming of DIDs. It is necessary to implement the naming convention in Rucio.
- Lifetime model – reviewing and adding a model to manage the lifetime of different data.
- User policy – dividing users into groups and reviewing the allowed actions for these groups.
- Testing production rucio-server – full testing of basic functionality such as authentication, data upload and download, replication, adding rules by user and automatically with subscription, etc.
- Production data generating – testing and debugging of interaction with PanDA with production server as a part of production data generation.
- Switching from the test server to production – enter to operation mode.

Thank you for your attention!