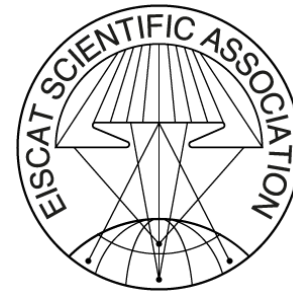




GOSC: What users' need? Radar Case Study Group

Incoherent scatter radar data fusion
and computation case study

*Co-chairs: Ingemar Häggström, EISCAT, Sweden
Xinan Yue, IGGCAS, China,
Secretary: Yin Chen, EGI Foundation, Netherlands
22 September 2022*



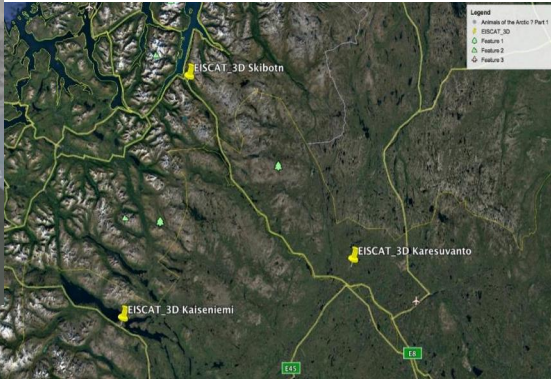
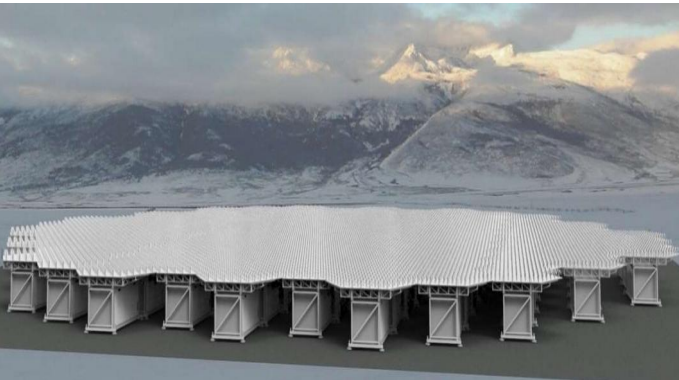
The work is partly funded by the European
Commission under H2020 Framework Programme

GOSC Case 1 Space Physics

Incoherent scatter radar data fusion and computation

EISCAT_3D radar, EISCAT Scientific Association, Sweden

Sanya Incoherent Scatter Radar (SYISR), Institute of Geology and Geophysics, China



Menu

- Portal home
- Realtime graphs +
- Realtime analysis +
- EISCAT Schedule and Data Access
- EISCAT Experiment request (Interface)
- EISCAT Experiment request (Schedule version)
- EISCAT Monthly accounts (Access)

HQ Operations Schedule, June 2021

Select year and month

Year: 2021

Month: June

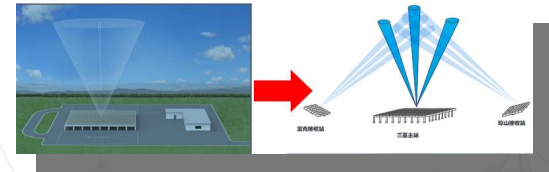
Select function

Select sites

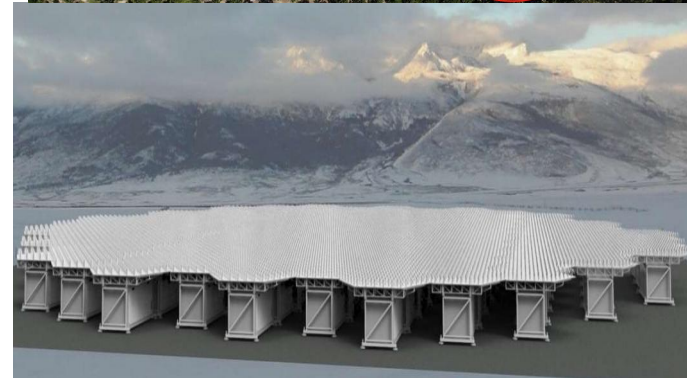
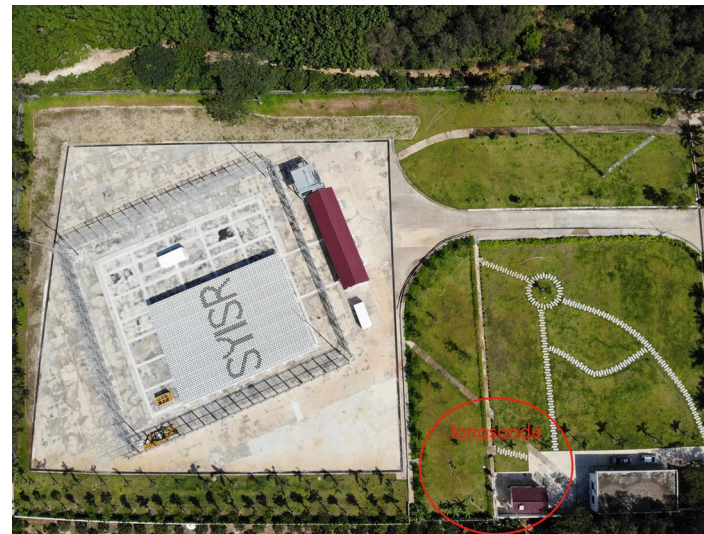
Requester: [None]

Query

Year	Month	Day	Time	Function	Site	Requester	Status
2021	06	01	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	02	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	03	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	04	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	05	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	06	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	07	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	08	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	09	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	10	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	11	00:00	Scheduled	EISCAT_3D	[None]	Active
2021	06	12	00:00	Scheduled	EISCAT_3D	[None]	Active



- Next generation of incoherent scatter radar systems
 - HPLA HighPowerLargeAperture
- Similar hardware
 - Systems of distributed phased array radars
 - Enable comprehensive three-dimensional observations of the atmosphere and ionosphere.
 - Increased temporal and spatial resolution
 - Continuous measurement capabilities
 - Inclusion of detailed incoherent scatter radar data into climate and Earth system modeling.
 - Large VVVV
 - Velocity, Volume, Versatility, Variability



Use Case Mission

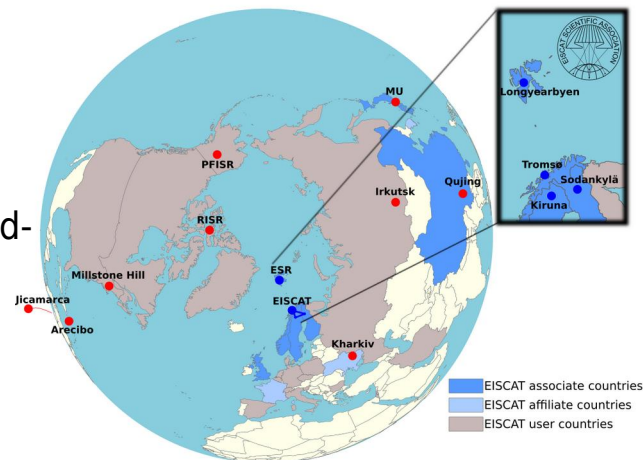
- Objectives

- To explore **data and metadata models** for collaborative production and sharing.
- To develop **enhanced algorithms**, methods for cloud-based radar data processing and federated data learning.
- Other issues to address for **data interoperability**.



- Key deliverables

- Exploration of technical solutions for EISCAT and SYISR **(Meta)data federation**.
- Deployment of GOSC technical solutions supporting the cloud **federated data processing** and **on-demand data movement**.
- Recommendations for analogous research infrastructures in OSCs.



Challenges

- **Data interoperability**
 - Convert the different data to a radar independent format
 - Wrapper routines
 - Processing in each others analysis software
 - Harmonize on-site DSP routines
- **E-Infrastructure interoperability**
 - Across continental data sharing and transmission on Cloud
- **Policies issues**
 - Resource provision need to align with national policies, funding objectives, computing centers' own interests
 - Embargo period is applied to data access
- **Governance & sustainability issues**
 - Funding to sustain the development
 - Long-term resource and technical support

VO eiscat.se @ EGI

- **Cloud resources:**

- Turkish TUBITAK(10 core CPU VM, 30TB)
- CNIC/CSTCloud (30core CPU VM, 100GB, later can be up to 2TB)

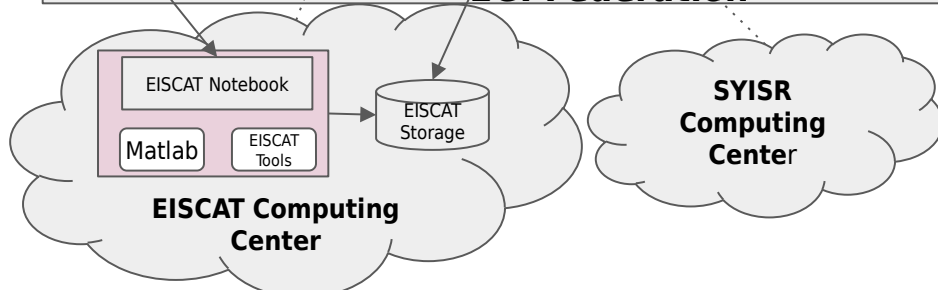
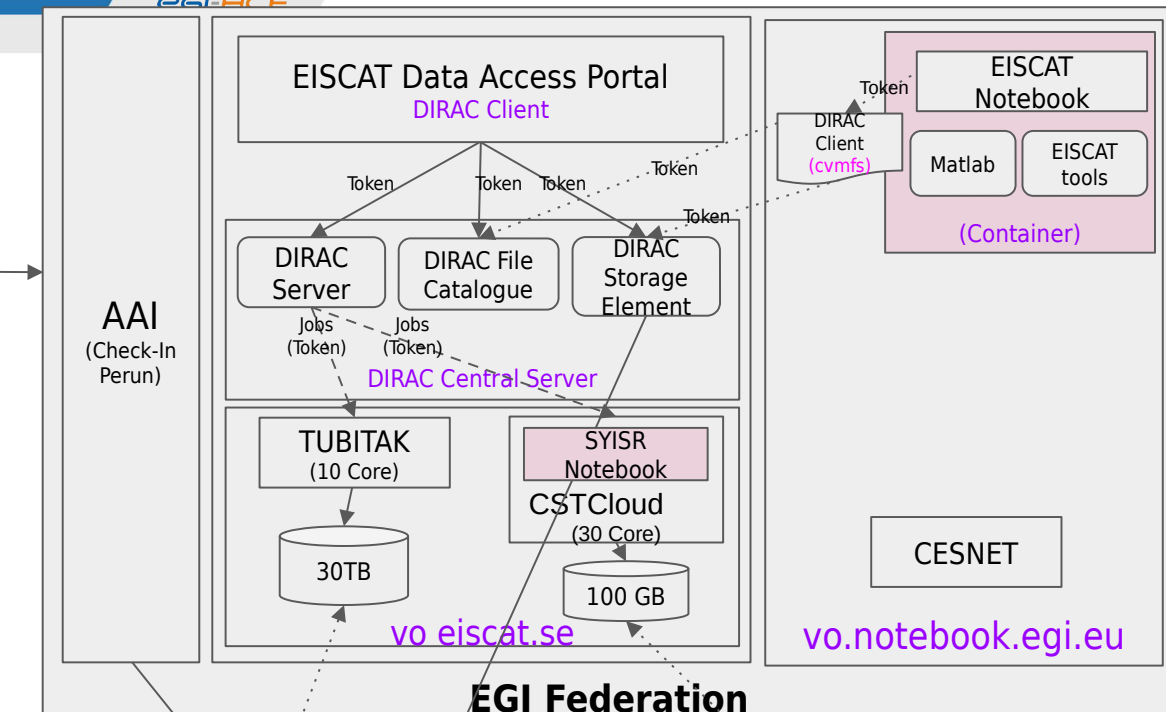
- **AAI**

- User login via check-in and Perun
- User registration is approved by EISCAT admin in Perun

- **DIRAC-based EISCAT Data Access Portal**

- Metadata-based data search and download, job submission for data processing
- AAI (Check-In, Perun)
- DIRAC Server - access to Cloud (TUBITAK, CSTCloud) for job submission
- DIRAC File Catalogue - EISCAT Metadata, EISCAT User access control based on EISCAT data access policy
- DIRAC Storage Element - enable search for EISCAT data in EISCAT's own storage
- Notebook users should be able to access storage for data processing (DIRAC SE, FTS, ...)

System Setup



- **EISCAT Data Access Portal (DIRAC)**
 - User access via Check-In/Perun
 - Access token is passed to DIRAC File Catalogue (by DIRAC Client)
 - DIRAC File Catalogue return token with user information
 - (DIRAC Client) access DIRAC Storage Element with token
 - DIRAC Storage element enables search of EISCAT data (in the EISCAT storage)
 - DIRAC Server submits Jobs to Cloud
 - TUBITAK (10core, 30TB) + CSTCloud (30Core, 100GB)
 - **Token access to the Cloud is ongoing**
- **EISCAT Compute Center**
 - Jupyter notebook
 - User access via Perun
 - Matlab enabled
 - Not yet access to DIRAC Storage Element - cannot perform search, and have lower performance
 - EISCAT Storage: EISCAT data
- **EISCAT Notebook Container**
 - Enable EISCAT user access
 - Notebook+DIRAC image
 - dirac.egi.eu cvmfs repository is configured alongside eiscat cvmfs repository (eiscat.egi.eu)
 - DIRAC client is available via cvmfs
 - **pass user access token to the DIRAC File Catalogue to get user information**
 - **Access the DIRAC Storage Element to search and retrieve data from the EISCAT storage**
 - Will include Matlab
 - **Token to use EISCAT license?**
 - Will include EISCAT Tools



1. Integration of EGI Check-In
2. Installation of **OpenStack** and **EGI FedCloud Virtual Appliance**

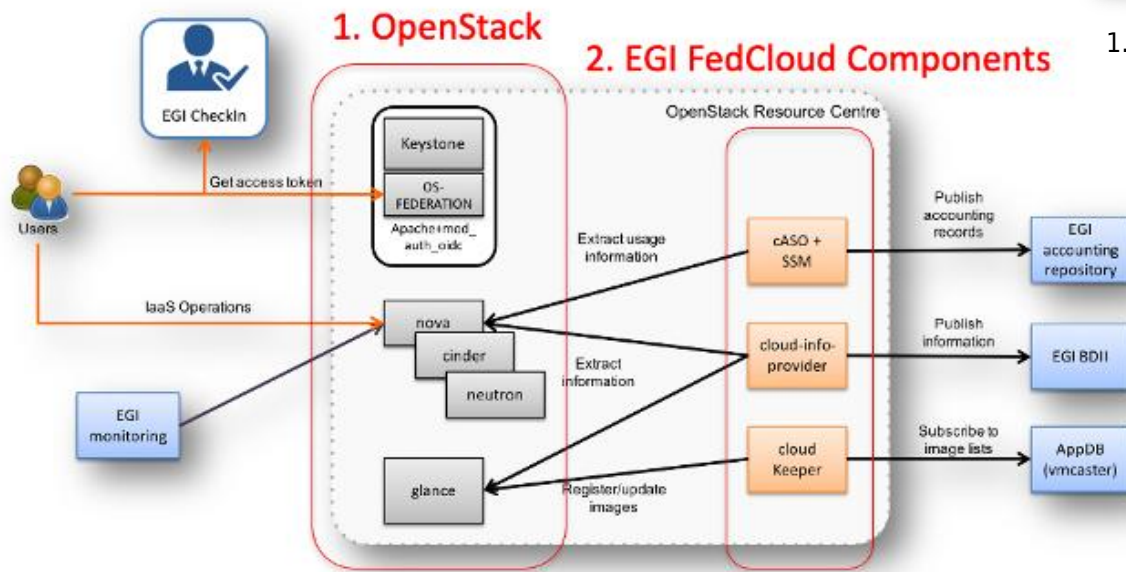


3. Capture by EGI Monitoring



4. Configuration of VO: **EISCAT.SE**

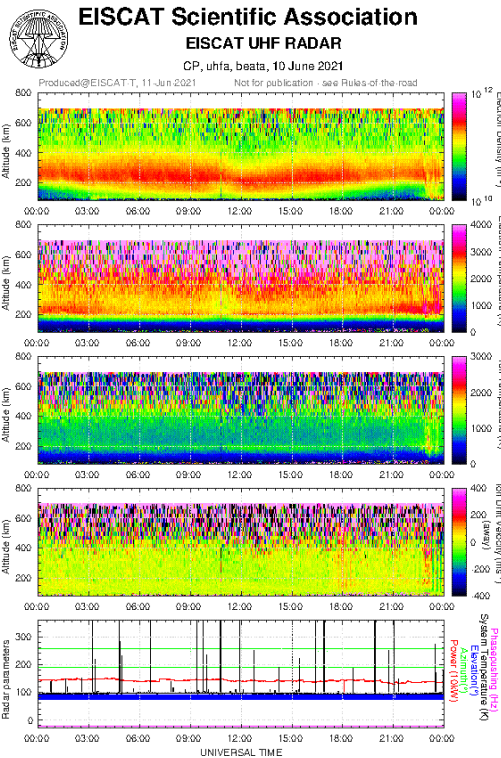
Installation procedure



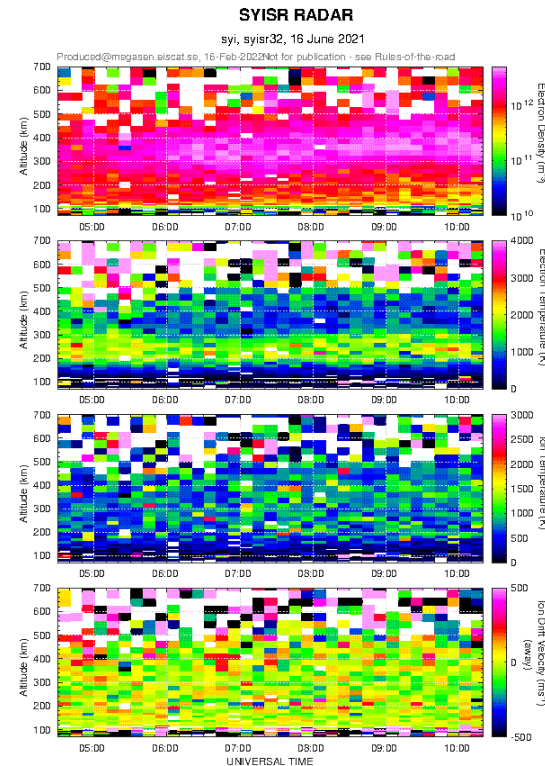
Integration of China's CSTCloud with EGI FedCloud is completed (Joint activities with GOSC TI WG)

Analysis interoperability

- **Analysis (GUISDAP)**
- Internally radar independent
- EISCAT wrapper
 - Single beam setup
- SYISR wrapper
 - Multi beam setup
 - Test also for EISCAT_3D

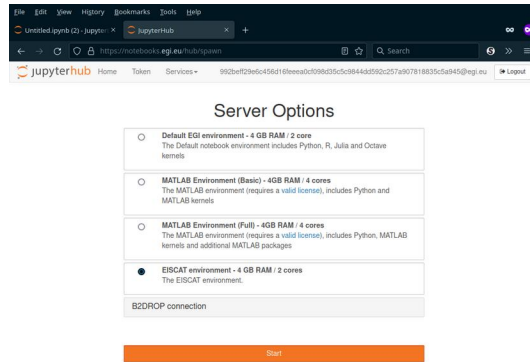


EISCAT analysis results



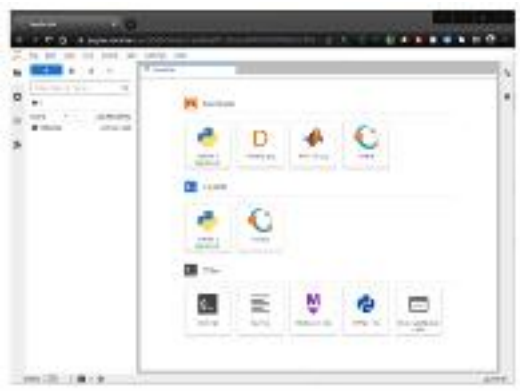
SYISR analysis results

Jupyter notebooks

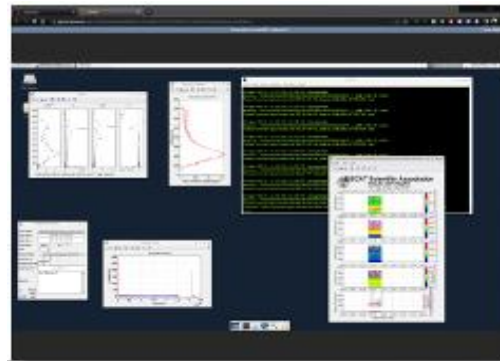


1. Login by EGI Check-In

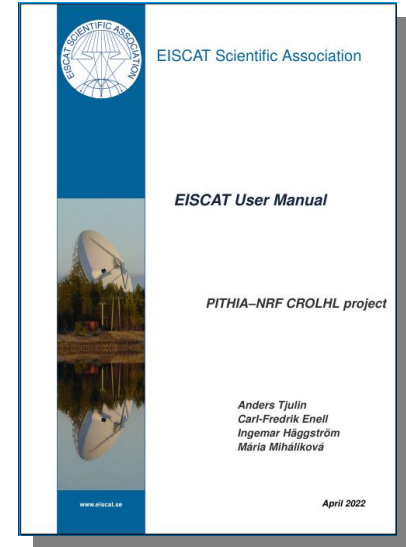
2. Select server



3. EISCAT Jupyter Notebook landing page



•Jupyter Notebook Desktop workspace with EISCAT GUISDAP application analysis running



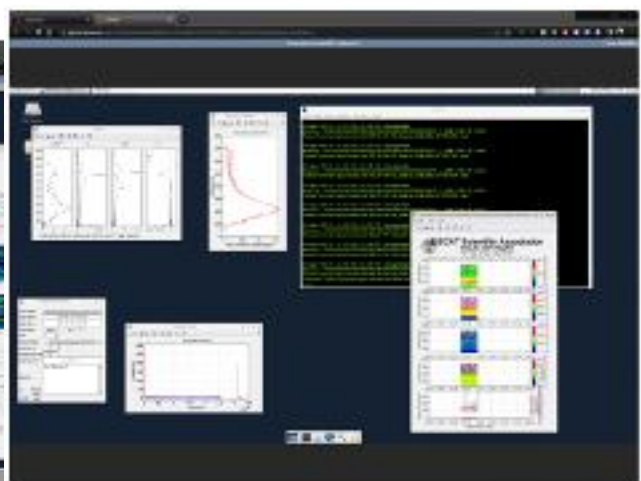
User Manual

EISCAT Notebook is in production:
<https://notebooks.egi.eu/>
<https://jupyter.eiscat.se/>

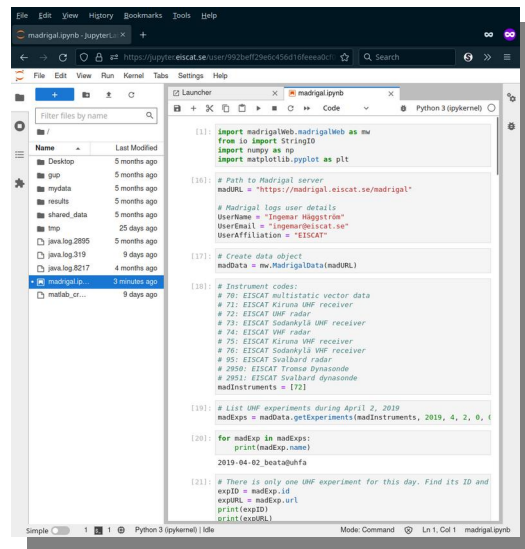
Notebook screenshots



RTG (xfce+matlab)



GUIDSAP (xfce+matlab)



```

import madrigalweb, madrigalweb as mw
from io import StringIO
import numpy as np
import matplotlib.pyplot as plt

# Path to Madrigal server
madURL = "https://madrigal.eiscat.se/madrigal/"

# Madrigal logs user details
username = "Tingemar Haggstrom"
userEmail = "lingemar@eiscat.se"
userAffiliation = "EISCAT"

# Create data object
madData = mw.MadrigalData(madURL)

# Instrument codes:
# 70: EISCAT multi-static vector data
# 71: EISCAT Kiruna UHF receiver
# 72: EISCAT UHF radar
# 73: EISCAT Sodankylä UHF receiver
# 74: EISCAT VHF radar
# 75: EISCAT Kiruna VHF receiver
# 76: EISCAT Sodankylä VHF receiver
# 80: EISCAT Svalbard radar
# 2050: EISCAT Kiruna dynamo
# 2051: EISCAT Svalbard dynamo
madInstruments = 1721

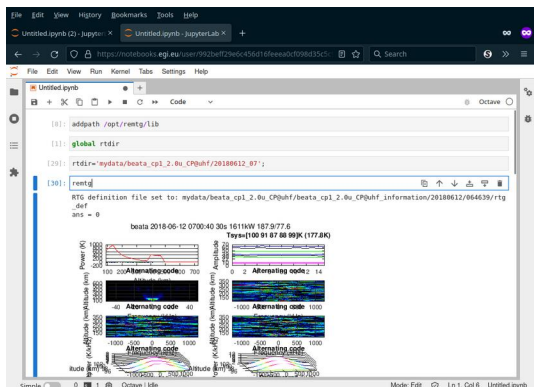
# List UHF experiments during April 2, 2019
madExps = madData.getExperiments(madInstruments, 2019, 4, 2, 0, 1)

for madExp in madExps:
    print(madExp.name)
    print(madExp.id)
    eqURL = madExp.url
    print(eqURL)

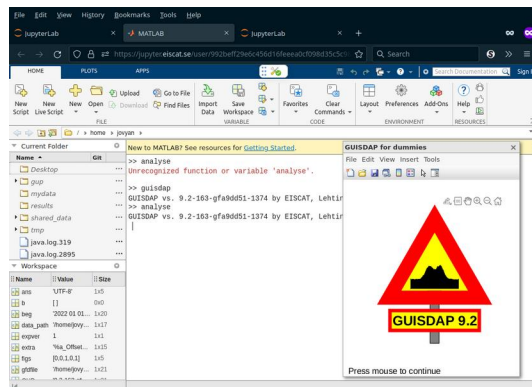
# There is only one UHF experiment for this day. Find its ID and
# eqURL = madExp.url
print(eqURL)

```

Madrigal (python)




RTG (octave)

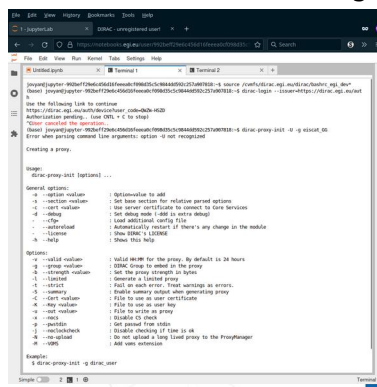


New to MATLAB? See resources for [Getting Started](#).

GUIDSAP for dummies


GUIDSAP 9.2

GUIDSAP (Matlab)



```

dirac-cvmfs-install -h
dirac-cvmfs-install --help

Options:
  -h, --help                  Show this help
  -v, --verbose                Verbose mode
  -p, --port PORT              Use PORT as the primary port (default: 9080)
  -u, --url URL                Use URL as the primary URL (default: https://dirac.cern.ch)
  -s, --ssl-cert SSL-CERT     Use SSL-CERT as the primary SSL certificate (default: /etc/ssl/certs/ca-bundle.crt)
  -c, --cert CERT             Use CERT as the primary certificate (default: /etc/ssl/certs/ca-bundle.crt)
  -k, --key KEY               Use KEY as the primary key (default: /etc/ssl/private/ssl-cert-snakeoil.key)
  -f, --force                  Force installation
  -i, --install-only           Install only
  -u, --update                Update only
  -d, --debug                  Enable debugging
  -q, --quiet                  Quiet mode
  -n, --no-check               Do not check the installation
  -r, --no-root               Do not install to the root directory
  -e, --extra-dir EXTRA-DIR  Extra directory for the installation
  -t, --test                  Test mode
  -o, --output-dir OUTPUT-DIR Output directory for the installation
  -a, --all                    All options

```

Dirac-cvmfs (Terminal)

- **Why important**
 - CSTCloud and EGI integration is one of the **first** Cloud federation across continent
 - EISCAT and SYISR science communities are the **first** test
 - e.g., user access from Europe/China, data interoperability, data sharing & movement, federated data process, etc.
- **Next steps**
 - **Notebook developments**
 - EISCAT+Matlab: Matlab with Jupyter environment
 - EISCAT: radar independent mode setup w. lagprofilers
 - SYISR: calibration routines
 - Some legalities (RoR, ToU...)
 - **Technical implementation**
 - EGI: DIRAC integration with Jupyter notebook
 - EGI+EISCAT: Job submission from DIRAC to HPC
 - CNIC: notebook to be accessible by all
 - EISCAT+EGI: integration EISCAT notebook with DIRAC
 - SYISR+CNIC: testing EISCAT notebook, data interoperability