

MMODA

Multi-Messenger Online Data Analysis

Volodymyr Savchenko

[ODA team](#)

[XRISM Workshop](#)

Geneva

12/02/2024

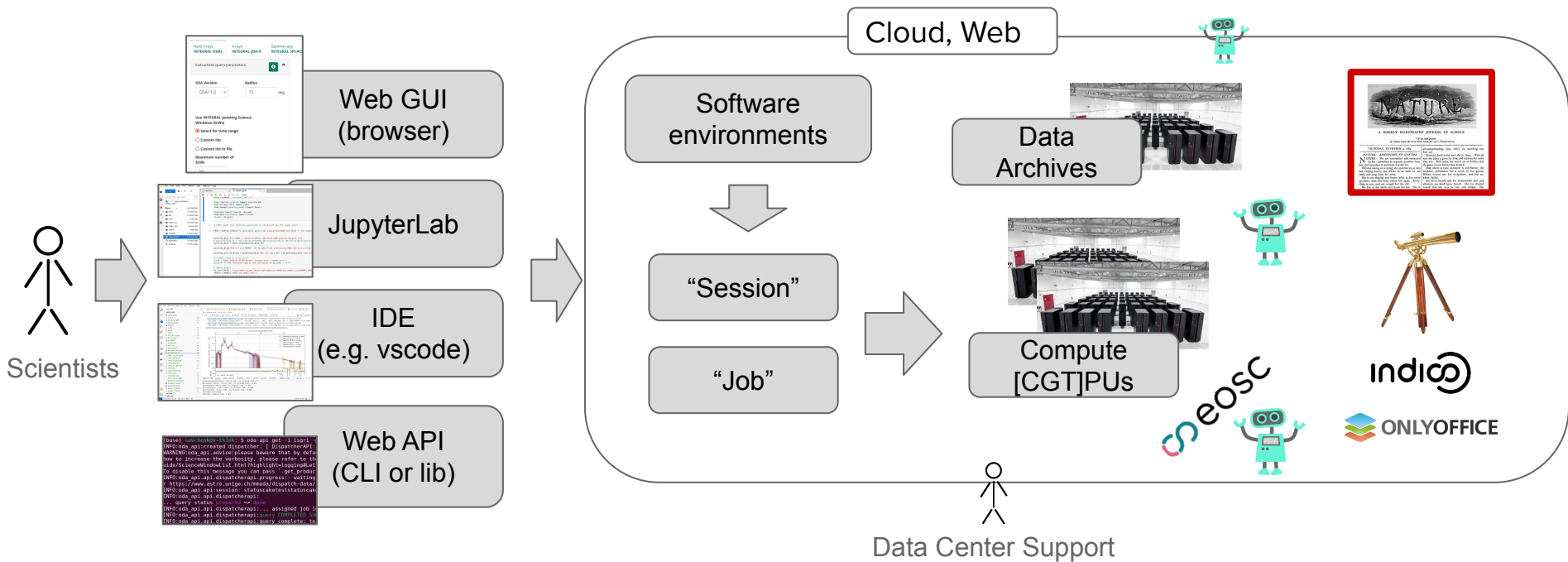
<https://github.com/oda-hub/>

What is Web-based (“Online”) Data Analysis?

Web (World-Wide) started in CERN in **1989** as **protocol + standard** for **sharing data across the world**.

CERN also developed (Worldwide LHC Computing) **Grid (~1999)**, meant to be “**Web of Compute and Storage**”, **sharing compute and storage resources**.

The idea really took off widely when industry reinvented the concept as **cloud (~2007, kubernetes etc)**.



Web Data Analysis Platforms and MMODA

- Grid technologies, e.g. in [EGI](#)
- HEASoft [HERA](#) (API included in HEASoft **fv**)
- [SciServer](#)
- [Swift-XRT products for GRBs](#)
- ESA [DataLabs](#)
- [Galaxy](#)
- EOSC/ESCAPE/[ESAP](#)
- CERN [VRE](#)
- [Open On Demand](#)

MMODA: UNIGE/CDCI, INTEGRAL,
SwissUniversities/ORD/AstroORDAS, **EOSC/ESG**,
CTA, SKA, ACME, ongoing funding for 4 more years.

Several sites, “main” currently in [UNIGE](#), 100s of
users, used for production of INTEGRAL.

Focus on building **synergies and tool ecosystem**
<https://github.com/oda-hub/>

The image displays a collage of screenshots from various web data analysis platforms. On the left, there is a screenshot of the ESCAPE ESAP IVOA Query interface, showing a search for 'h.e.s.s.' in the IVOA catalog. In the center, a workflow diagram illustrates the process: Find, Launch, Switch, and Use. On the right, there are screenshots of the INTEGRAL Science Windows interface, showing object details (Object name: 402 1700-377, RA: 257.815417, Dec: 41.589417), instrument query parameters (OSA Version: OSAT0.2), and data plots (a purple heatmap and a green bar chart). At the bottom right, the MMODA logo is displayed: Multi-Messenger Online Data Analysis.

Use Case 1: GUI for your tooling

As much as the GUI for tools is needed (for simple analysis), it can be provided in Web platforms like MMODA. Lot's of modern GUI Desktop Apps are web apps anyway (e.g. electron-based). Typically also supports mobile.

INTEGRAL OSA

Main

startLevel: COR

endLevel: IMA2

GENERAL_levelList: COR,GTI,DEAD,BIN_I,BKG_I,CAT_I,IMA,IMA2,BIN_S,SPE,LCR,COMP,CLEAN

CAT_refCat: \$ISDC_REF_CAT[ISGR_FLAG=0] browse

SWITCH_disableIsgrI:

SWITCH_disablePICsIT:

SCW1_GTI_gtiUser: browse

SCW1_GTI_TimeFormat: IJD

SCW1_GTI_BT1_Names: IBIS_CONFIGURATION IBIS_BOOT ISGR_RISE_TIME VETO_PROBLEM SOLAR_FLARE BELT_C

ISGR IMA ISGR SPE and LCR PICsIT analysis

Save As Load Reset Run Quit Help hidden



INTEGRAL ODA

Contact us Sign in Help

Object name * 4U 1700-377 Resolve

RA * 257.815417 Dec * -41.593417

The right ascension. The declination.

Start time * 2003-03-15T23:27: End time * 2003-03-16T00:03: Time unit ISC

INTEGRAL ISGR I INTEGRAL JEM-X INTEGRAL SPI-ACS Polar Magic Antares

Instrument query parameters

Use Science Windows Source: GRB120711A - Right LMC X-4 View

Download Catalog GRB120711A View

OSA Version OSA10.2

Use INTEGRAL pointing Science Windows (SCWs) Select for time range

Processing ...

MMODA Multi-Messenger Online Data Analysis

And because it's Web, no need to install and no need to copy the data. Can rent resources owned by someone else.

Use Case 2: Multi-messenger Data and Models Blend

MMODA
Multi-Messenger Online Data Analysis

Gamma-rays
INTEGRAL SPI-ACS

AGN cacades

CRbeam

Gamma-rays
CTA

Visible
gaia

GRB detection

Gamma-rays
HESS

Gamma-rays
ISGR1-expert

jemx-expert

radio
MWA

nb2w-example

gravitational waves
SGWB

XRISM?

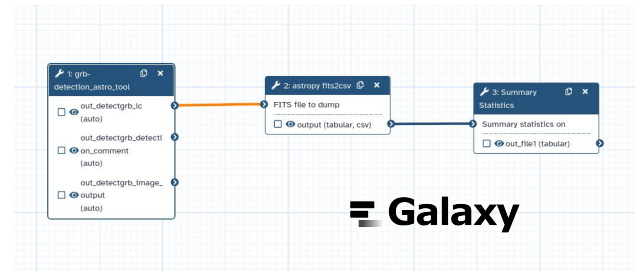
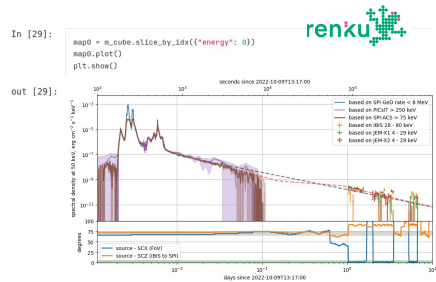
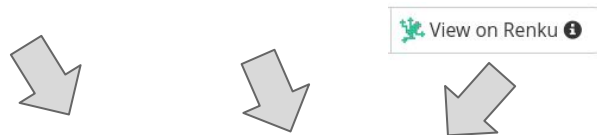
Web protocols are interoperable: easy to connect to any environment. It means no problems using tools in the same environment, no environment reconciliation trouble.

Different instruments with their own nuances, own **remote data archives**, interfaces to suitable **compute resources** (e.g. GPU), all output “standard results” for **ready for blending**.

E.g. combining **MM** data for a **GRB** is easier than ever.

XRISM through HEASoft will be naturally supported, just need to add some standard workflow (can take from hands-on?).

Will be able to **combine** directly with **INTEGRAL**, **Gaia**, **MWA**, etc
If a suitable model generator (SIXTE?) is available it can be integrated. Or connect to sciserver?

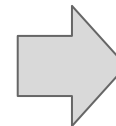
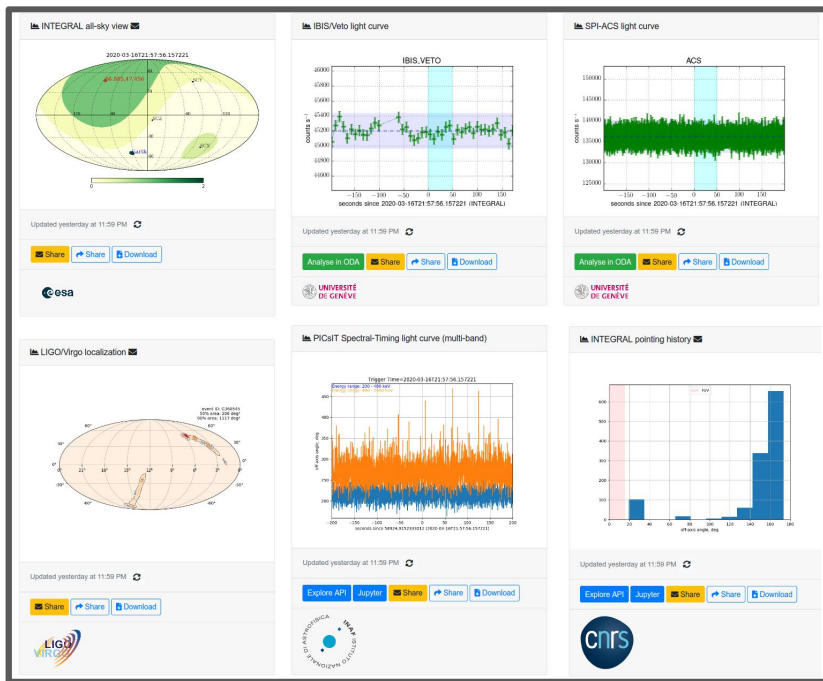
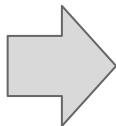


Galaxy

Use Case 3: Transients, also multi-messenger

Web brings diverse resources together **fast**. This matches the world of transients, since we have all the tooling in the same place. One the most used MMODA services is all-sky gamma-ray observations with INTEGRAL.

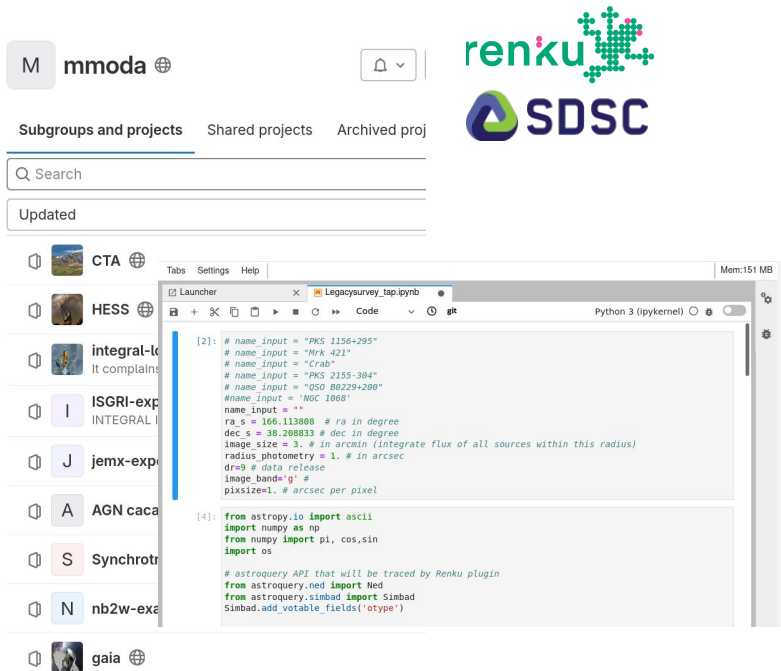
SciMMA, MOSSAIC,
VOEvent, GCN,
ATel, Kafka, ...



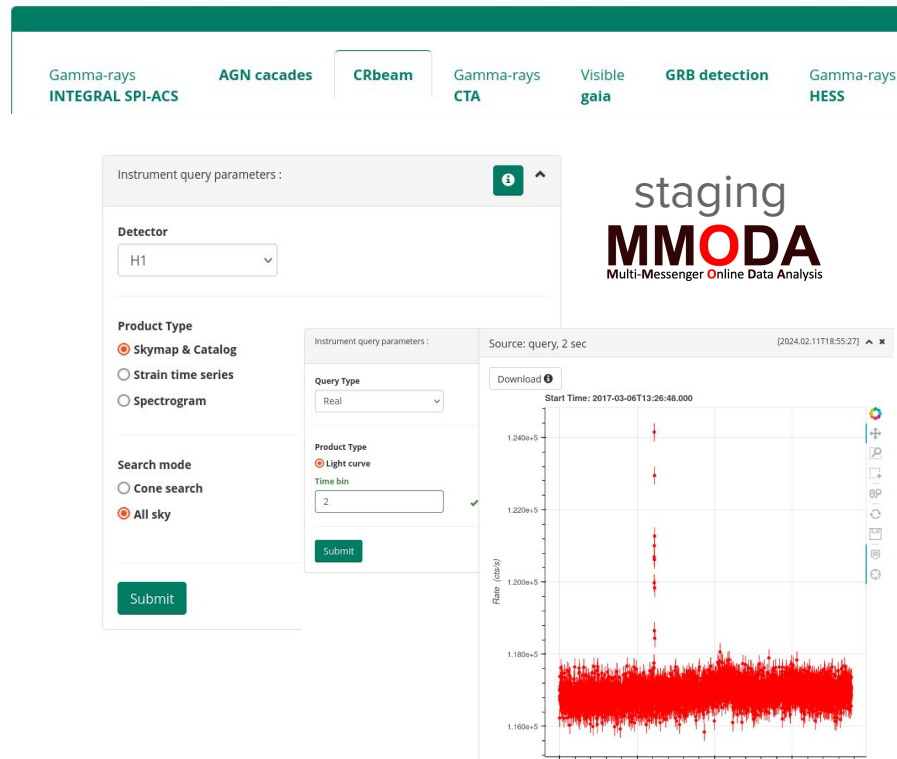
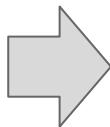
TIMESTAMP	TOPIC	TITLE	SUBMITTER
4 months ago	hermes.message	INTEGRAL follow-up of S231016an	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231015bc	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231015m	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231015g	Volodymyr Savchenko
4 months ago	hermes.message	INTEGRAL follow-up of S231014aa	Volodymyr Savchenko

MMODA as Workflow dev environment

Developing services is hard. Developing domain-specific analysis is very hard. MMODA answer is **division of labor**, we create **JupyterLab** (renkulab) **development environment** allowing expert users to easily contribute analysis workflows.



The screenshot shows the MMODA web interface. On the left, a sidebar lists various astronomical projects: CTA, HESS, INTEGRAL, ISGRI-exp, jemx-exp, AGN cacade, Synchrotr, and gaia. The main area displays a JupyterLab notebook with Python code for data analysis, including imports for astropy, numpy, and Simbad, and a function to integrate flux within a radius.



The screenshot shows the MMODA staging interface. At the top, a navigation menu includes: Gamma-rays INTEGRAL SPI-ACS, AGN cacades, CRbeam, Gamma-rays CTA, Visible gaia, GRB detection, and Gamma-rays HESS. The main content area is titled "Instrument query parameters:" and includes a dropdown for "Detector" (H1), a "Product Type" section with radio buttons for "Skymap & Catalog", "Strain time series", and "Spectrogram", and a "Search mode" section with radio buttons for "Cone search" and "All sky". A "Submit" button is at the bottom. To the right, a "staging MMODA Multi-Messenger Online Data Analysis" logo is visible. Below the form, a plot shows "Flux (cts/s)" on the y-axis (ranging from 1.160e+5 to 1.240e+5) and "Time" on the x-axis. The plot displays a red signal with a noisy baseline and several sharp peaks. A "Submit" button is also present in the plot area.

Publishing and Sustainability of Data and Workflows

One of **main assets of MMODA** is **annotated workflow catalog**, associated **ontology**, and visualization tools.

The catalog is adapted for publishing in **persistent DOI-minting repositories** (zenodo, workflowhub, etc).

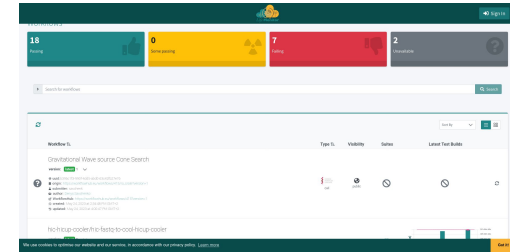
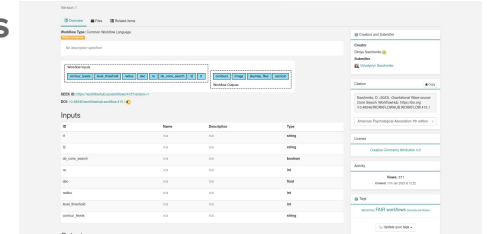
Bots keep it up-to-date and alive LifeHub recuperates and refines scientific results in papers.

Demonstrated use of the workflow catalog in other platforms: **ESA DataLabs**, **Galaxy/EOSC***.

MMODA Gallery contains a collection of ready results.

Transient analysis results of MMODA workflows are sent to, **SciMMA**, **GCN**, **TNS**, some of them are indexed and preserved.

We are working with “**almost traditional**” **publishers and journals** especially innovative like **EPIScience**.



Summary

Multi-Messenger Online Analysis (MMODA) and alike are building the World Web of FAIR Data and Compute, making **analysis accessible and interoperable**, facilitating **multi-messenger** research.

Also works well for teaching, trainings. Opens access for developing countries.

Did not talk about authz/n (AAI), compute and storage federation, etc, all crucial aspects which take time.

Key assets contributed by/to MMODA will have long life time: **workflows and results** integrated (or in process) with “permanent” **publishing** services. Some MMODA components, e.g. web visualization tools for Astro data, can be (and are being) reused beyond MMODA platform.