MMODA

Multi-Messenger Online Data Analysis

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ODA team

XRISM Workshop
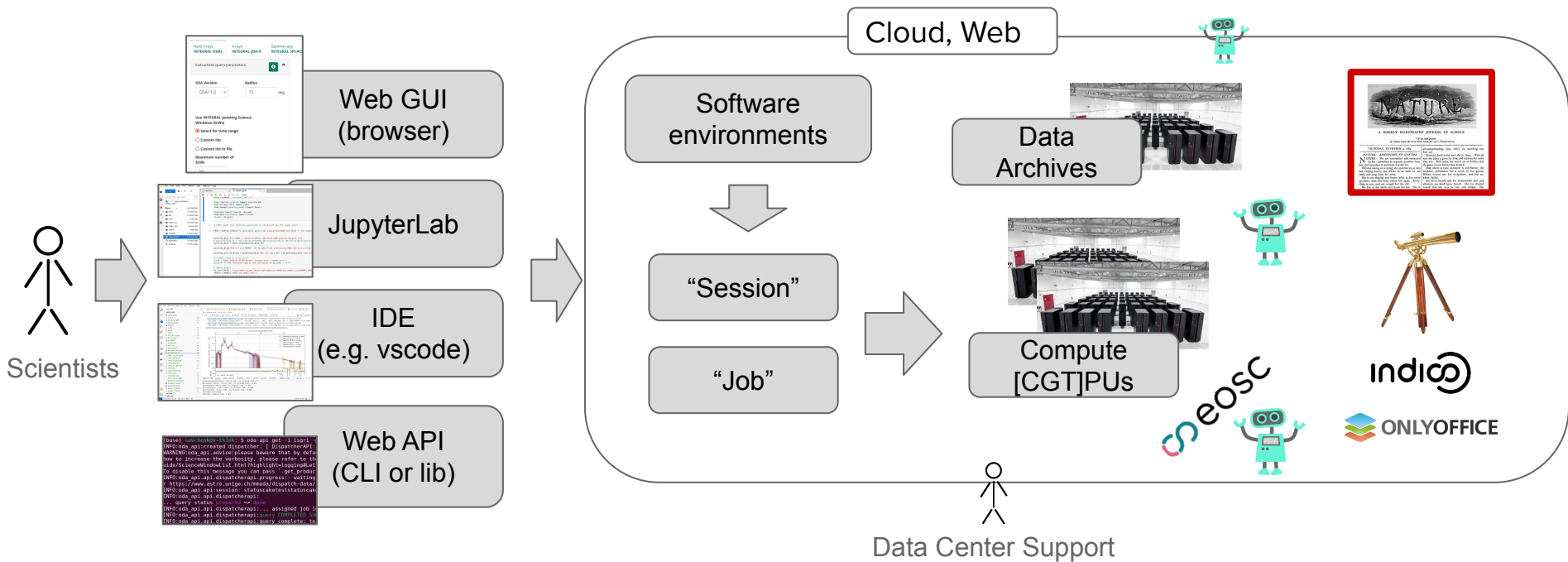
Geneva

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).

Scientists

Web GUI (browser)

JupyterLab

IDE (e.g. vscode)

Web API (CLI or lib)

Cloud, Web

Software environments

"Session"

"Job"

Data Archives

Compute [CGT]PUs

Data Center Support

eosc

indigo

ONLYOFFICE

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/

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

INTEGRAL ODA

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 ISGRI-expert | jemx-expert | radio MWA | nb2w-example | gravitational waves SGWB |

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?
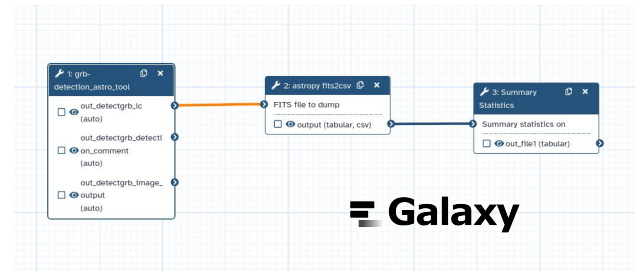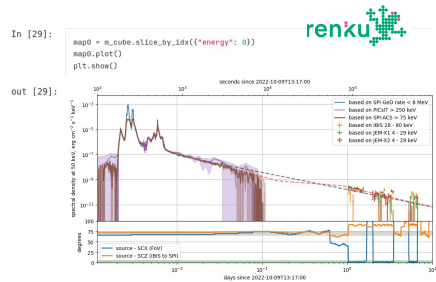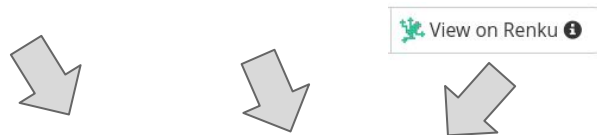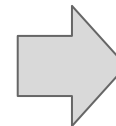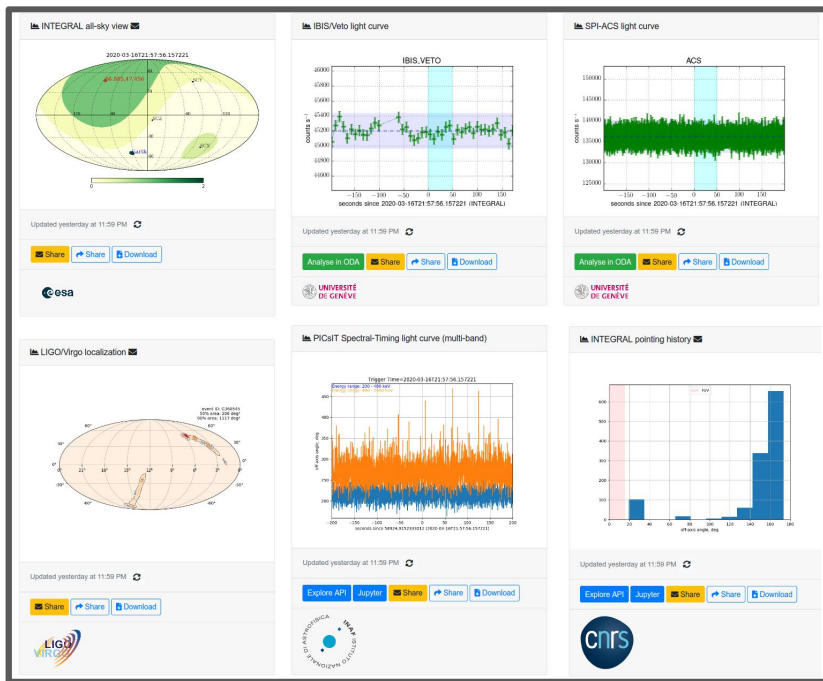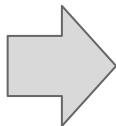
Use Case 3: Transients, also multi-messenger

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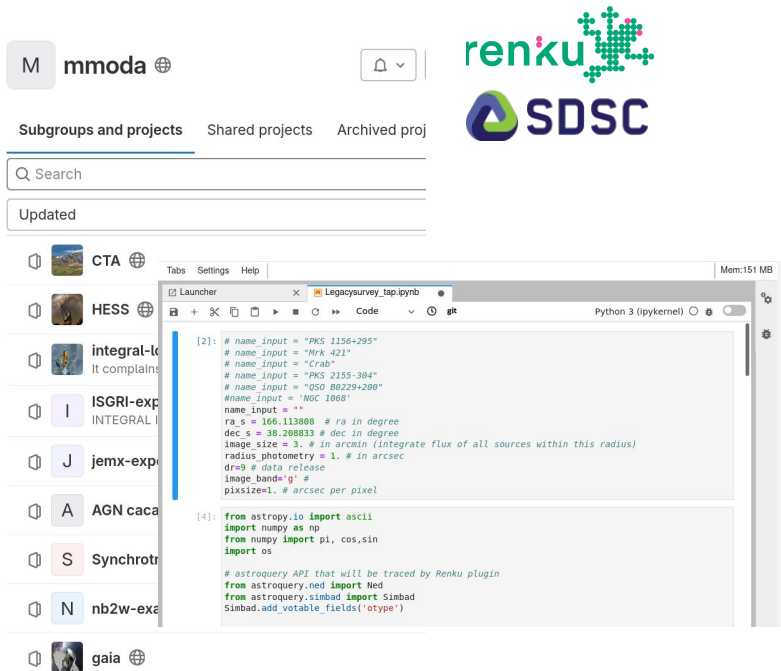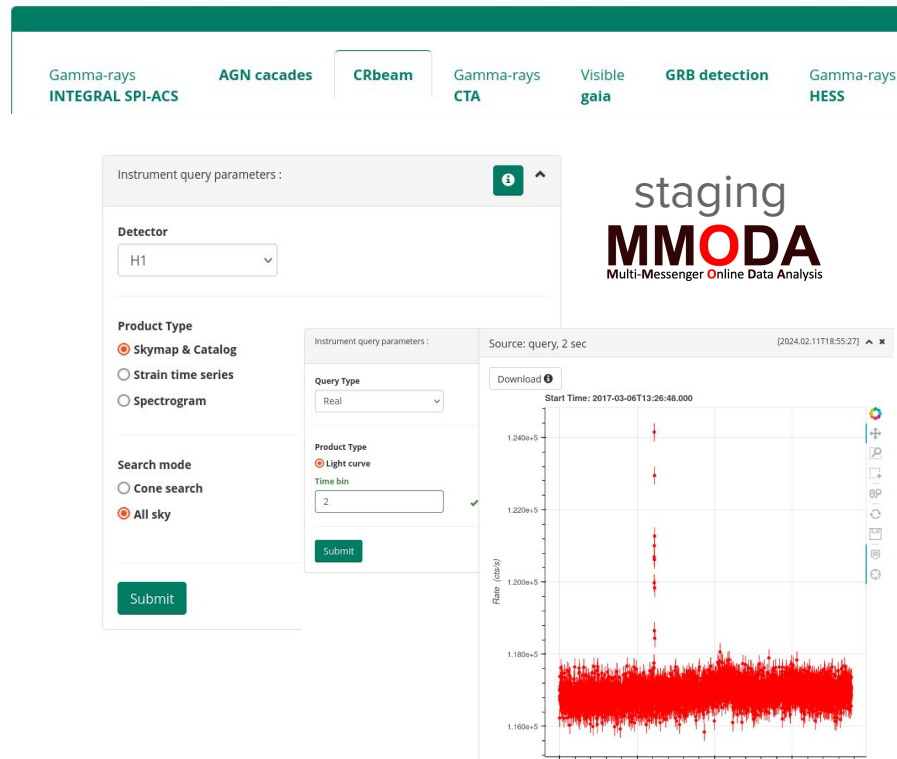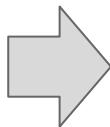
SciMMA, MOSSAIC,
VOEvent, GCN,
ATel, Kafka, ...

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.

https://gitlab.renkulab.io/astronomy/mmoda/

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**.
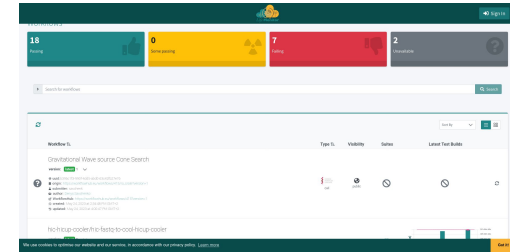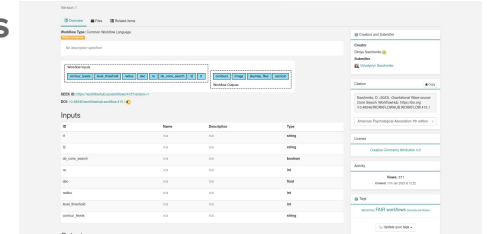
Summary

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.