

# HEIG and VODF: updates from the last IVOA InterOperability meeting

Jutta Schnabel, FAU Erlangen (ECAP)

GNN Common data format group,

24th January 2025

# Overview

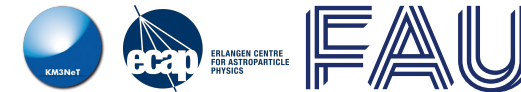
## Contributing in the IVOA



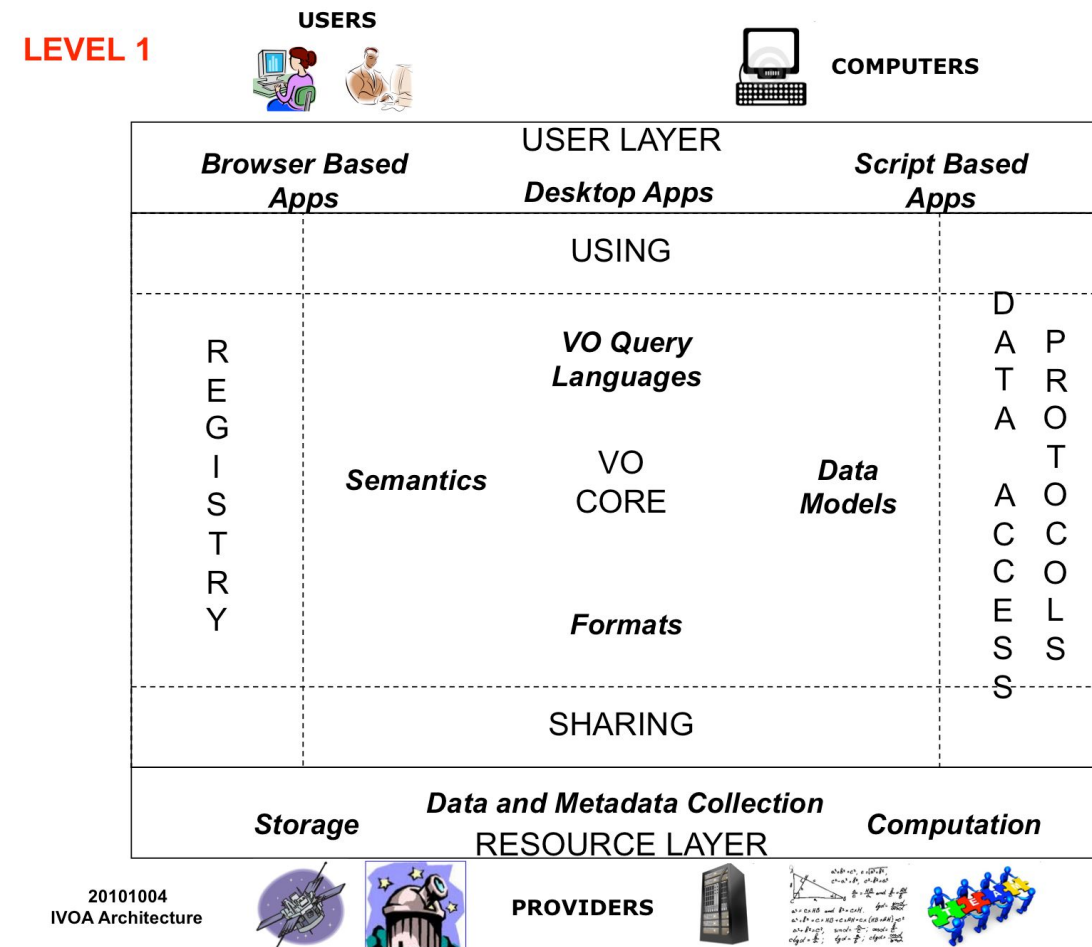
- IVOA has officially established a “high-energy interest group” covering high-energy astroparticle detectors, gravitational waves and x-ray instruments
- released note on HEIG topics and prospects
- Planning to develop common data standards for the community, working along use cases
- current developments: establishing a roadmap

# IVOA in a nutshell

## Cooperation and technical implementation



- **International Virtual Observatory Alliance (IVOA)** acts as standard-setting organization with national substructures, an Executive Committee and various working groups
  - Working groups on applications and services, but also semantics, data models and “interest groups”
- bringing together providers of astrophysics data in the **Virtual Observatory (VO)**
  - “everyone” can provide data, by registering own data server or using e.g. national VO repositories
  - access is generally open for all data, and services are provided as open desktop software or hosted by various institutions online (e.g. the [CDS portal](#))



[https://ivoa.net/deployers/intro\\_to\\_vo\\_concepts.html](https://ivoa.net/deployers/intro_to_vo_concepts.html)

# High Energy Interest Group (HEIG)

## Current developments and plans



ERLANGEN CENTRE  
FOR ASTROPARTICLE  
PHYSICS



- Started forming in 2023 from Virtual Observatory involvement in ESCAPE project
- Includes X-Ray (Chandra), [VODF](#)-initiative (Gamma-ray and neutrino) and tentatively Gravitational Waves through various representatives
- Wiki page: [VO Wiki](#)
- Session at the November Interoperability Meeting in Malta ([agenda](#)), asked for formal endorsement
- IVOA Note draft (Virtual Observatory and High Energy Astrophysics) adopted as [IVOA note](#)
- Group was officially approved and started

DRAFT – please do not distribute



International  
Virtual  
Observatory  
Alliance

## Virtual Observatory and High Energy Astrophysics

### Version 0.7

#### IVOA Note 2024-10-23

Working Group

DM

This version

<https://www.ivoa.net/documents/VOHE-Note/20241023>

Latest version

<https://www.ivoa.net/documents/VOHE-Note>

Previous versions

This is the first public release

Author(s)

Mathieu Servillat and the HE group

Editor(s)

Mathieu Servillat

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heig

Closing remarks, Simon O'Toole, IVOA Chair



## Introducing the High Energy Interest Group

- Formally approved by the IVOA Executive
- Interest Group charter is available here: <https://wiki.ivoa.net/twiki/bin/view/IVOA/HEGroup>

### **Chair**

Bruno Khelifi - *Physicist at CNRS (laboratory APC, Paris)*

### **Vice Chair**

Janet Evans - *Software Mgr for Chandra Data System (Center for Astrophysics | Harvard and Smithsonian)*

**Thank you for all the hard work to start this interest group and being so active!**

The group shall define requirements for the representation of high energy astrophysics data in the VO through:

- development of **use cases for data discovery**, access and visualization;
- identification of **metadata concepts** needed by high energy astrophysics data that are not currently supported by the VO;
- contribute to updates and additions to the relevant parts of the IVOA standards framework;
- the group will provide a well identified point of **contact for high energy astrophysics projects with IVOA**, and actively encourage their use of VO standards and protocols;
- the group will organize sessions focused on high energy astrophysics data at IVOA meetings.

## Officially contributing experiments

- Chandra X-ray Observatory;
- XMM-Newton;
- Space-based multi-band astronomical Variable Objects Monitor (SVOM);
- High-Energy Stereoscopic System (HESS);
- Cherenkov Telescope Array Observatory (CTAO);
- KM<sup>3</sup> Neutrino Telescope ([KM3NeT](#));
- NASA High Energy Astrophysics Science Archive Research Center (HEASARC).

# What does that mean for neutrinos?

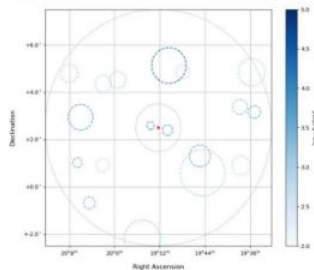
Our input to the IVOA - thanks for helping to prepare it!

## Do's and don'ts in high-energy neutrino physics

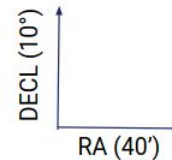
Commonalities and differences with other astronomy analyses

### What we do

- Point source analysis

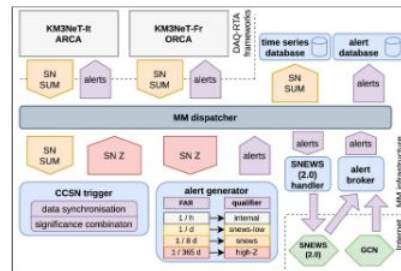


A. Albert *et al* 2021  
*ApJ* **911** 48  
 DOI: [10.3847/1538-4357/abe53c](https://doi.org/10.3847/1538-4357/abe53c)



- Alerts and follow-ups

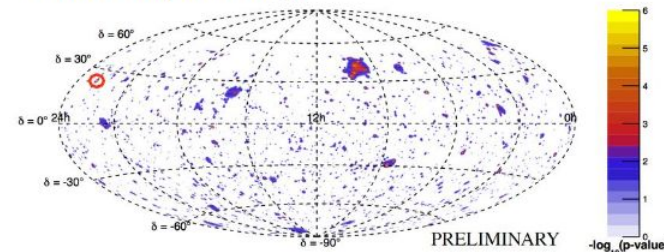
KM3NeT:  
 Implementation and first results of the KM3NeT real-time core-collapse supernova neutrino search.  
 DOI: [10.1140/epic/s10052-022-10137-y](https://doi.org/10.1140/epic/s10052-022-10137-y)



High-energy neutrino data for the VO, J. Schnabel, IVOA Interop, Malta, 15/11/2024

### What we don't do

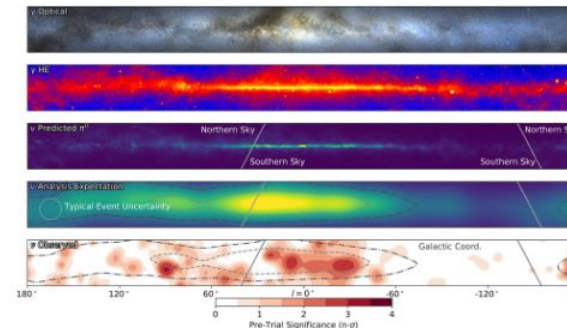
- Mission planning



Fermani, P.: Status and results from the ANTARES and KM3NeT-ARCA neutrino telescopes.  
 DOI: [10.22323/1.369.0032](https://doi.org/10.22323/1.369.0032)

- Nice pictures

IceCube: Observation of high-energy neutrinos from the Galactic plane  
 DOI: [10.1126/science.adc9818](https://doi.org/10.1126/science.adc9818)



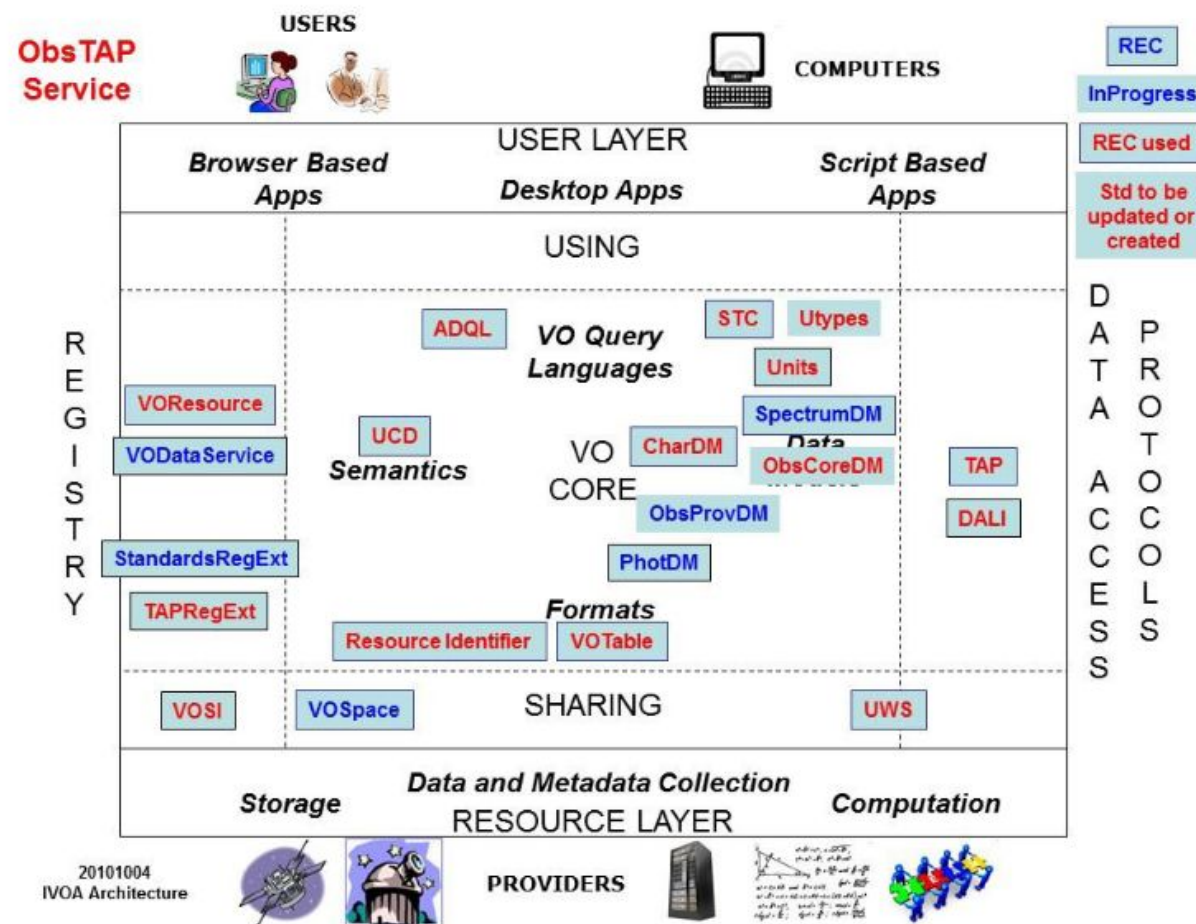
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# The note and proposed topics

Established standards

## Relevant IVOA protocols

- ObsCore and TAP
  - identification of relevant observations (by “type”==“event”?) and retrieval as table (Table Access Protocol)
- DataLink
  - link complex digital objects to table rows + description
- Storing sky survey data (HiPS, Hierarchical Progressive Survey), and producing Multi-Order coverage maps (MOCs)
- VOTable and MIVOT
  - Storing data in tables and annotating them
- Provenance
- VOEvent
  - handling of alerts
- Measurements
  - for error handling





## UC1: Re-analysing event lists

- make preselected event lists usable for additional studies
- offer the possibility to re-process parts of the analysis chain

## UC3: Transient or variable sources

- alert sending/receiving
- reprocessing of archived alerts & follow-ups

## UC4: Multi-wavelength and multi-messenger science

- joint statistical analyses across the different wavelengths
- integrating into VODF development

## UC5: Extended source searches

- long-term and wide-angle observations
- needs different concept of “observation” than generally followed in IVOA

## What is the community using?



- Currently various transient astronomy communities use Rubin/LSST + other optical time-domain surveys – AVRO custom schema
- SCiMMA – custom AVRO with embedded schema + flexible on other formats
- CHIME/FRB – VOEvent, but working on GCN JSON Schema
- GCN – moving towards GCN JSON Unified Schema
- IGWN – their own JSON (GCN working on translation to GCN JSON)
- CR-Neutrino: *preferring json over VOEvent due to readability*
- CTAO: VOEvent 2.0

*slides by Francesca Civano*

- Ad-hoc discussion started due to comments in the HEIG plenary on use of VOEvent
- Outlook: trying to harmonize with GCN
- separating schema (content) from format
- to be continued ...

## ACTIONS aka Road Map



- Close 2.1 with the solar system changes
- VOEvent 2.2: Add the json serialization or create an endorse note for it and clearly state that this is protocol agnostic (just to check if there are no traces of the vtp)
- Discoverability with the registry
- Streaming all the data into tables
- Rubin:
  - Review Rubin brokers presentations from May '24 Interop
  - Compatibility with Rubin
  - Getting in touch with the brokers (EU vs other)
- Schema:
  - Need to take into account the need of the MOC/localization probability map
  - Specialization of the schema for specific use cases/projects
  - Talk with GCN about their proposed schema: can GCN reverse back?

- Setting up Roadmap to HEIG right now (parallel meeting)
- 2-6 June 2025 Interoperability meeting in Maryland, USA

→ we can help to identify use cases for IVOA and put them on the roadmap

## Any thoughts?

### Update on VODF

- common initiative to establish data format based on gammapy
- see current docs here:  
<https://vodf.readthedocs.io/en/latest/>
- work starting with coding sprint planned for the near future



**Let's do science together  
&  
Thank you for your attention!**

# Input to the IVOA 1

## Making data discoverable

- How does your project make their data discoverable?
- Are data from your project in the IVOA registry?
- Are there problems in the IVOA ObsCore definition preventing or limiting it?

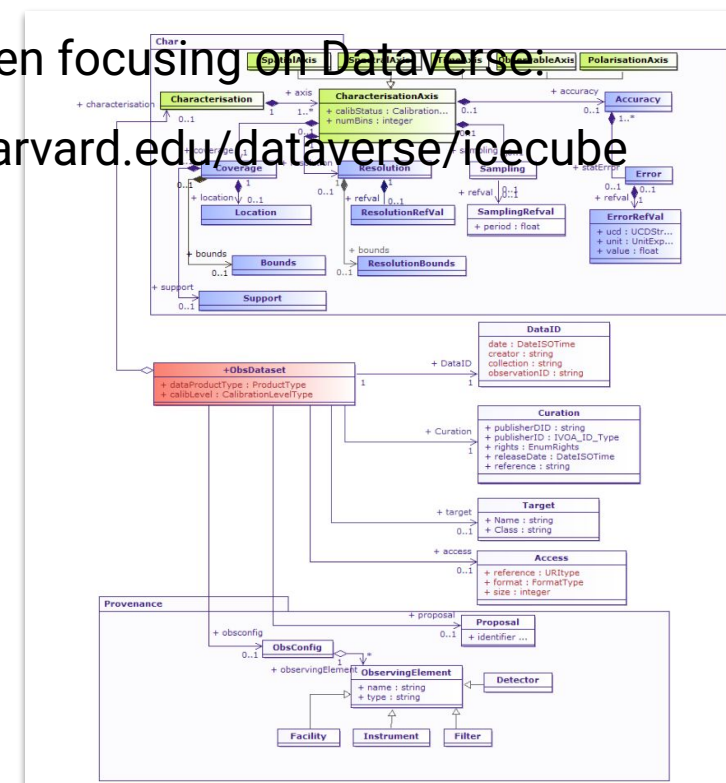
<https://icecube.wisc.edu/science/data-releases/>  
<https://opendata.km3net.de/>

**connection to aggregators?**

in icecube we've been focusing on Dataverse.  
<https://dataverse.harvard.edu/dataverse/icecube>

### IceCube

### ANTARES



# Input to the IVOA 2

## Relevant data products

- What data products are used in your data analysis?
- Are they interoperable with data from other projects?
- Do you use a data model?

not really?

3ML: Common model fitting:  
<https://github.com/threeML/>

Event lists  
simulation -> instrument responses

On case-by-case basis

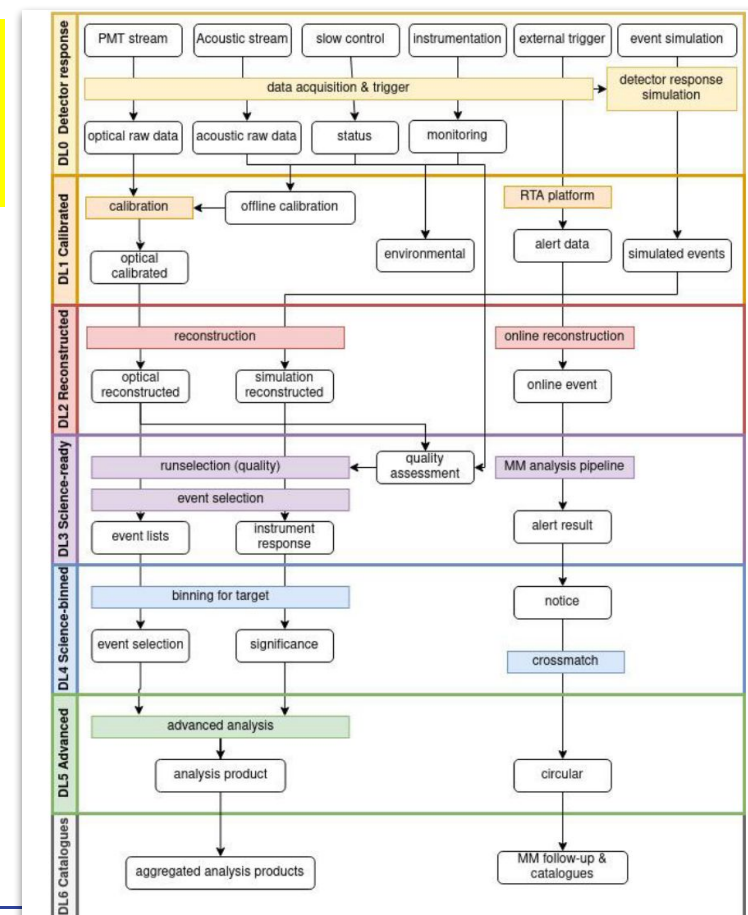


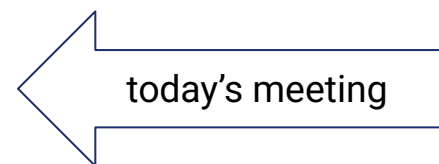
Figure 2 Overview over data entities per data levels

# Input to the IVOA 3

## Alert system

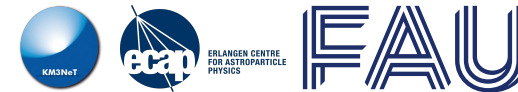
- What do you use for an alert system?
- Do you use VOevent, and if not, can you address the issues you see?

XML format difficult to read, focusing on GCN



# Input to the IVOA 4

## Follow-ups and coordination



- How do you coordinate rapid follow up observations currently?
- Are the Observing plan of your project/mission available externally and is there coordination of your project/mission among the HE projects?
- Are you familiar with the IVOA ObsLocTAP protocol and ObjObsSAP working draft of the IVOA?