

# Open Science in KM3NeT

## *The Why and the How*

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Outreach and Education IV



# Why Open Science?

# Some fundamental values

## *From a moral point of view*

- Access to science is a fundamental human right
- (Publicly funded) scientists should return value to society

## *From a practical perspective*

- Scientific scoring should not be counting papers, but usable science
- Providing data is becoming more of a funding argument
- Transparency leads to efficiency increase

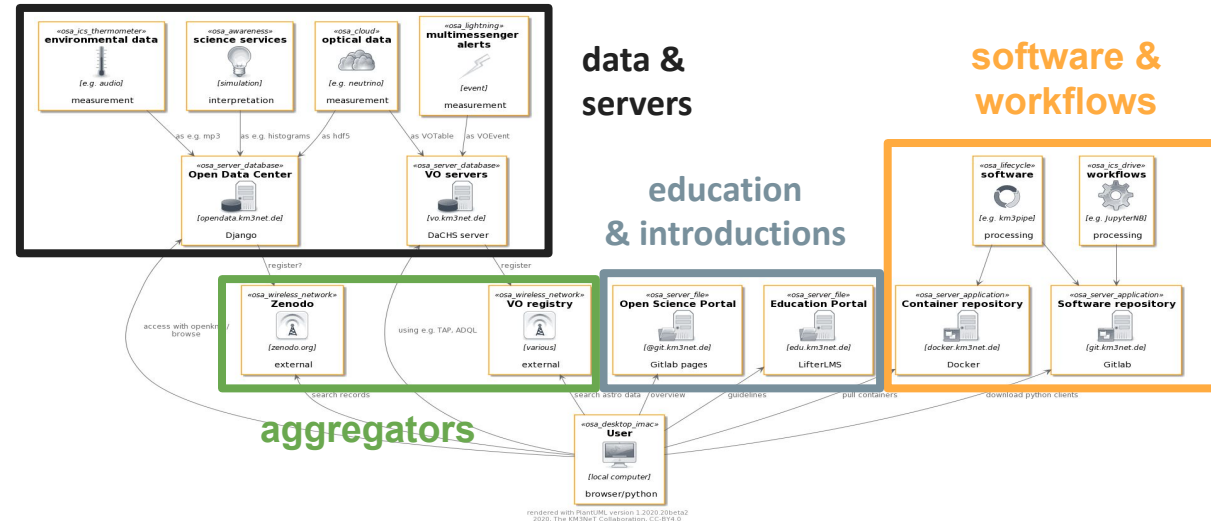
→ Engage in **Open Science**

Current best guess at what that is: [UNESCO recommendations on Open Science](#) (2021)



# FAIRness - Thinking science reproducibly

- FAIR: Findable, Accessible, Interoperable, Reproducible
- Not only FAIR data - FAIR research
- Consider data and software as scientific products
- See scientific workflow as integral part of a publication



# Organizational change

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- Think of software and data as integral part of the public part of analysis from the start
- Analysis is an (at least internally) open process, shared
- Foster community orientation in sharing of data, aiming for common formats
- Value and provide incentives to software and code curation, generating data, and providing workflows
- Adoption will increase with the shift of incentives and benefits

## Translating to experiment

- How to share the data?
- Who to cooperate with?
- Build up interfaces



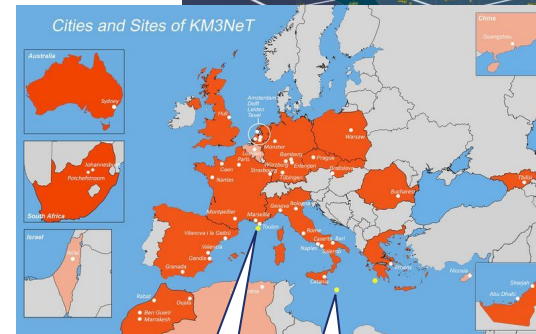
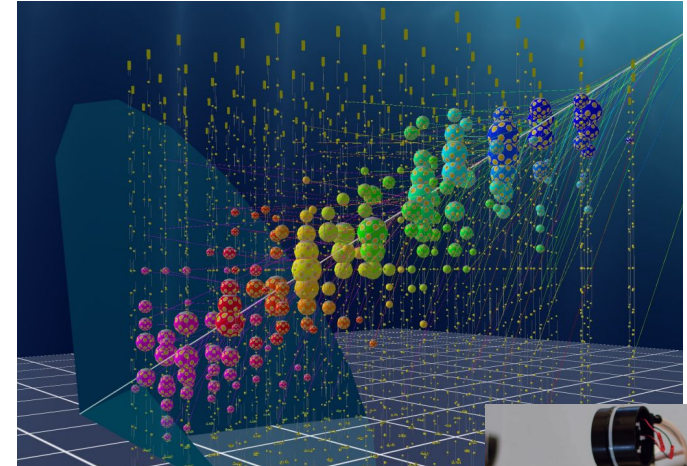
ERLANGEN CENTRE  
FOR ASTROPARTICLE  
PHYSICS



# How to get to Open Science

# KM3NeT – astro & particle physics

- Water Cherenkov detectors
- Under construction in 3 Building Blocks (BB) with 115 Strings in the deep Mediterranean Sea
  - neutrino physics (1 BB, ORCA, France)
  - astrophysics (2 BB, ARCA, Italy)
- est. completion building phase in 2028
- Worldwide collaboration with strong emphasis on Europe
- Neutrino energy range: few GeV – PeV
- Low-countrate particle detection with extensive Monte Carlo simulation for analysis



## Starting point: the policy

- KM3NeT supports the aims of open data and open science and commits to implement the necessary steps wherever possible. This includes open access data supporting publications, open source software and open data in general including the information needed to appropriately use the data.
- ...
- KM3NeT installs an Open Science Committee that works in parallel to the Publication Committee and Conference Committee and sets, maintains and further develops the procedures for KM3NeT open science.

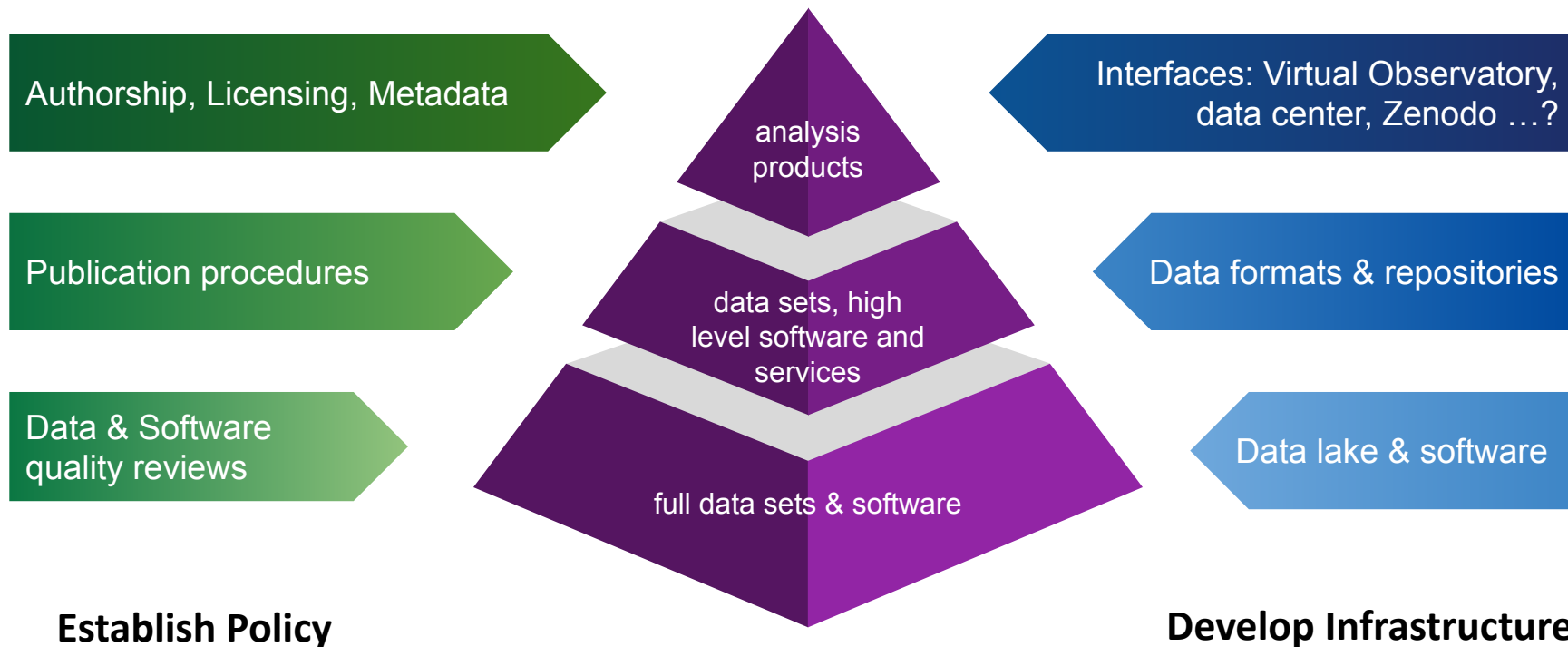
Open Science Policy adopted in 2020

- General commitment to Open Science
- Easy access to high-level analysis results
- Full release of data after an embargo period

Implementation and procedure establishment handed to Open Science Committee



# To practice: Task of the Open Science Committee



# Infrastructure development: Data Management Plan

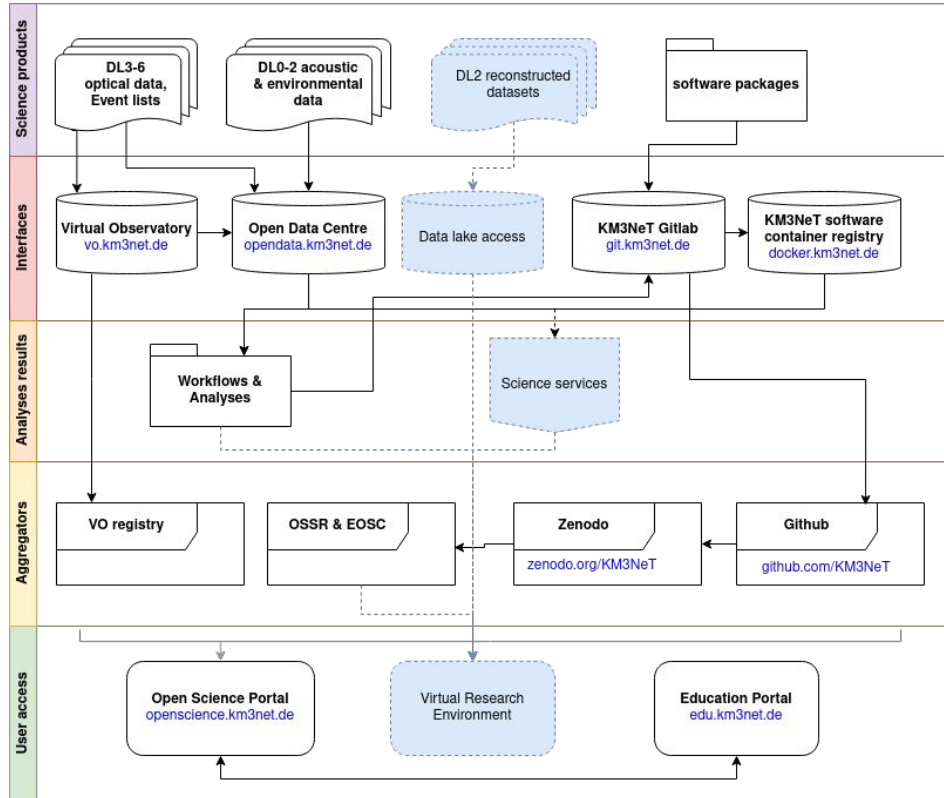
Using the Data Management Plan as tool to develop strategy and include basic setup of data dissemination

- First DMP defined in 2017 in INFRADEV project, following [Horizon 2020 DMP Template](#) (partially useful)
- New INFRADEV 2 project: Review process in 2023 to rewrite, with external review panel

## It is more than an exercise!

- Use as reference document for
  - Resource requests at HPCs
  - Future requests for HR
  - Internal development strategy
- Illustrating
  - Data types and volumes
  - Integration of computing sites
  - High-level interfaces
  - Management strategy
  - Resource requirements (Computing & HR)

# Infrastructure: The KM3NeT Open Science System



- Defining data formats and standards for **science products**
- Provide KM3NeT-side **interfaces**
  - For astrophysics: Virtual Observatory
  - For “everything”: Open Data Center
  - For software & Repositories: Gitlab and (docker) containers
- Connection to **aggregators**: VO registry, Zenodo, Github, EOSC ...
- Provide or integrate to **User platforms**
  - Open Science Portal, Education Portal

→ Constant development & Improvement

# Policy development: Example projects and data

## Common source search with CTA and KM3NeT

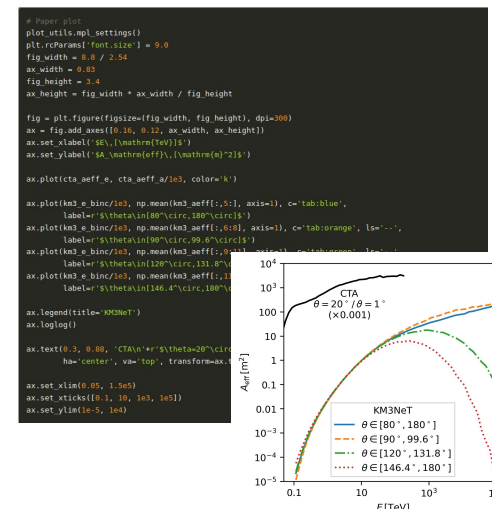
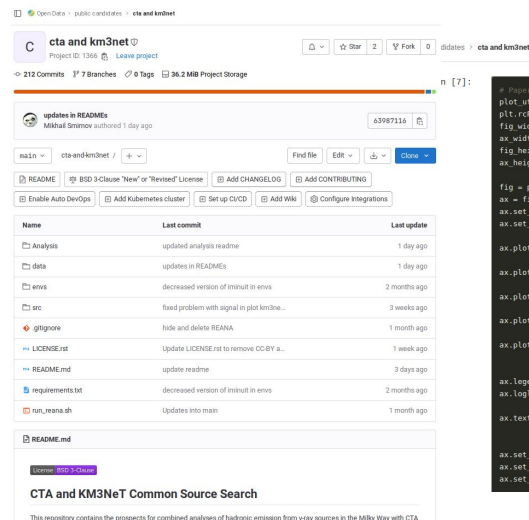
- Parallel publication of paper and code repository
- Jupyter notebooks to reproduce plots
- Available on [Github](#) and [Zenodo](#)



Requirements for  
code and interfaces



Processes for  
parallel publication



M. Smirnov, [Open-Science Integration of a Combined Analysis of KM3NeT and CTA into the EOSC Infrastructure](#) (TAUP23, 30/08, Neutrino and Cosmology 3)

# Data interface development: ANTARES legacy data

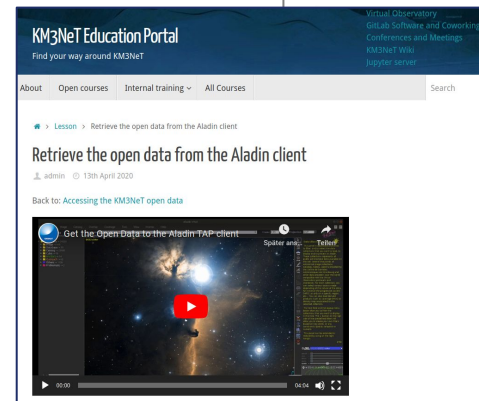
- ANTARES produced valuable data from mid 2005 until last year
- Few data sets so far provided on webpage
- Suitable example cases for KM3NeT
- Providing some ANTARES data through KM3NeT interfaces
- Offering courses in education portal using ANTARES as example data

Data set for the 2007-2017 ANTARES search for cosmic neutrino point sources

## Introduction

The present data set corresponds to the track sample (muon neutrino candidates) of a study meant to search for a point sources with data collected from January 2007 to December 2017 by the ANTARES neutrino telescope. Attached below are the effective area, the acceptance, the cumulative angular resolution distribution and the point spread function for an E-2 source spectrum. This sample encompasses the two previous released sets, with similar cuts. This increased lifetime amounts to 3125 days and to a total number of 8754 events.

More information on how the search was performed can be found in:  
[G. Illuminati for the ANTARES Collaboration, PoS\(ICRC2019\)920](#)  
[A. Albert et al., ApJL 863, L30 \(2018\)](#)



KM3NeT Education Portal  
Find your way around KM3NeT

About Open courses Internal training All Courses Search

Lesson > Retrieve the open data from the Aladin client

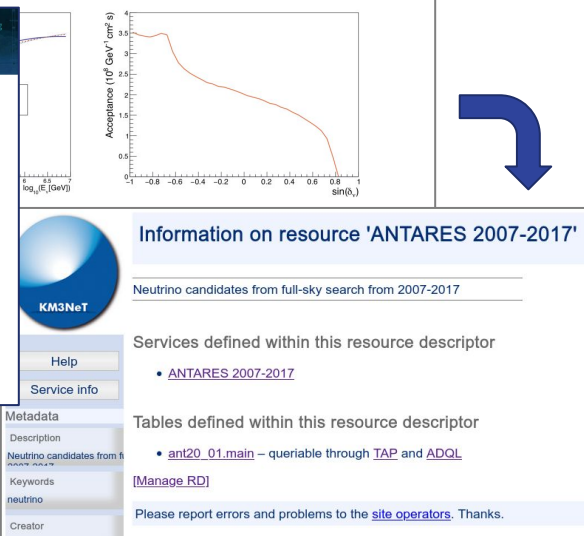
Retrieve the open data from the Aladin client

admin 13th April 2020

Back to: Accessing the KM3NeT open data

Get the Open Data to the Aladin-FAP client

Space and Time



KM3NeT

Information on resource 'ANTARES 2007-2017'

Neutrino candidates from full-sky search from 2007-2017

Services defined within this resource descriptor

- [ANTARES 2007-2017](#)

Tables defined within this resource descriptor

- [ant20\\_01\\_main](#) – queriable through [TAP](#) and [ADQL](#)

[\[Manage RD\]](#)

Please report errors and problems to the [site operators](#). Thanks.

Metadata

Description

Neutrino candidates from full-sky search from 2007-2017

Keywords

neutrino

Creator

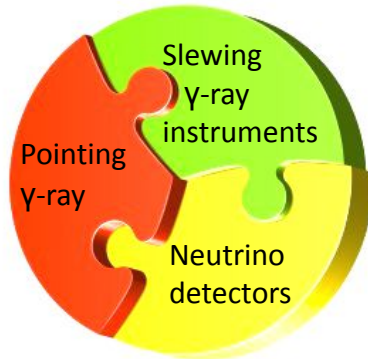
# Establishing community: VODF and ESCAPE

## Very high energy Open Data Format initiative

- Building on GADF (gamma ray)
- Established steering committee and editors
- Just started!

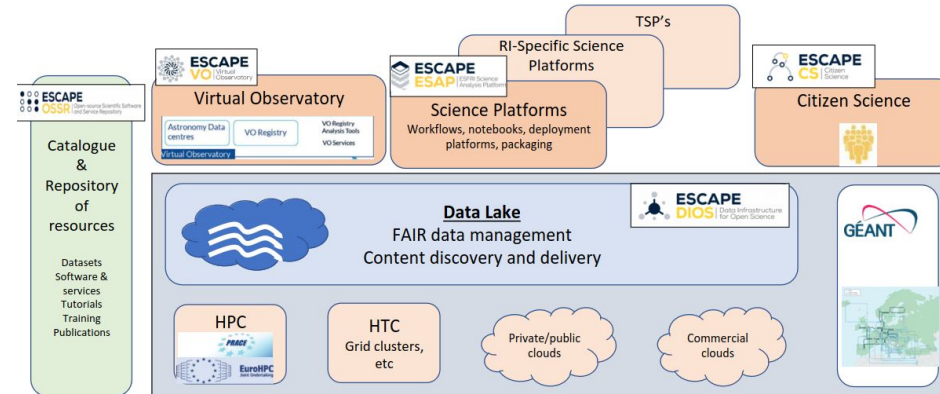
Documentation: <https://vodf.readthedocs.io>

Source & Community: <https://github.com/VODF/>



## ESCAPE and European Open Science Cloud (EOSC)

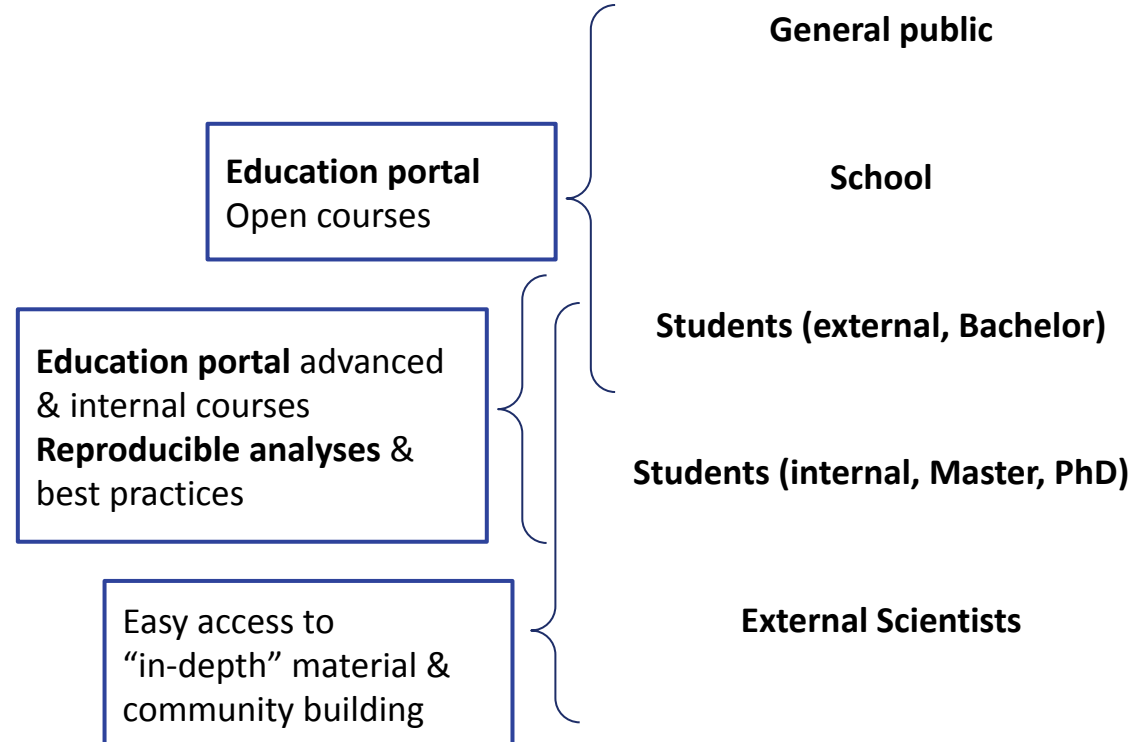
- Developed common data lake, software repository & science platform
- Application used for further development of the Open Science System



© G. Lamanna, ESCAPE to the future

# Open Science as Outreach or Education?

- Open Science can serve for both outreach & education depending on the target audience
- Same platforms can (to some extent) be used for multiple purposes
- Reproducible science reduces threshold by serving as examples
- Open Science products serve as best practice examples



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# Let's do Open Science

# & Thank you for your attention!