Open Science in Astronomy
The SKA case

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IAA-CSIC

Spain National EOSC Tripartite event – 19th Sept 2023

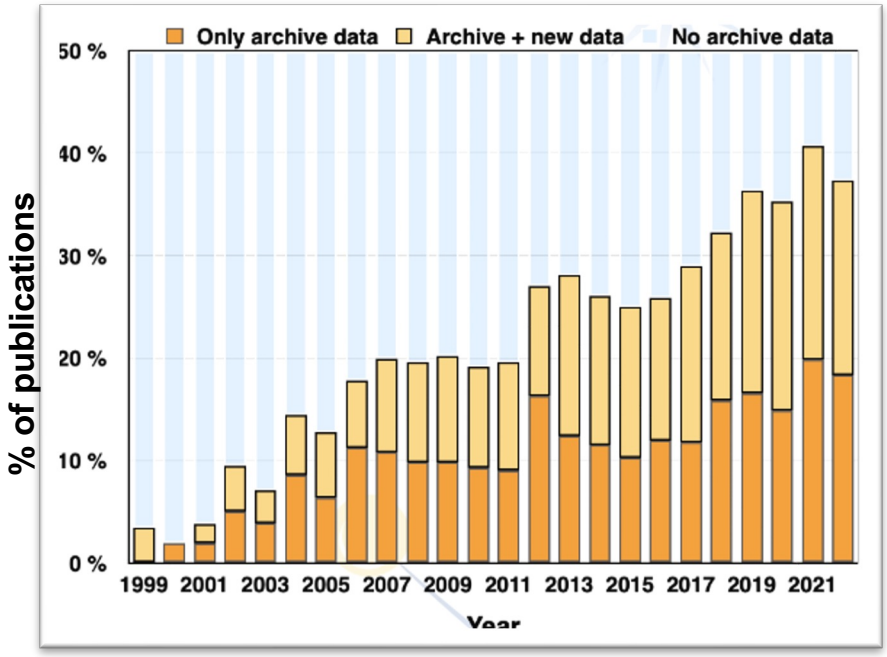
Astronomy: pioneer in Open/FAIR Data

IVOA (a case of study for the EC [1])

- Established in 2002
- Developing standards required to make data FAIR
- Open and Inclusive framework:
  - –Anyone can publish data / develop a VO tool

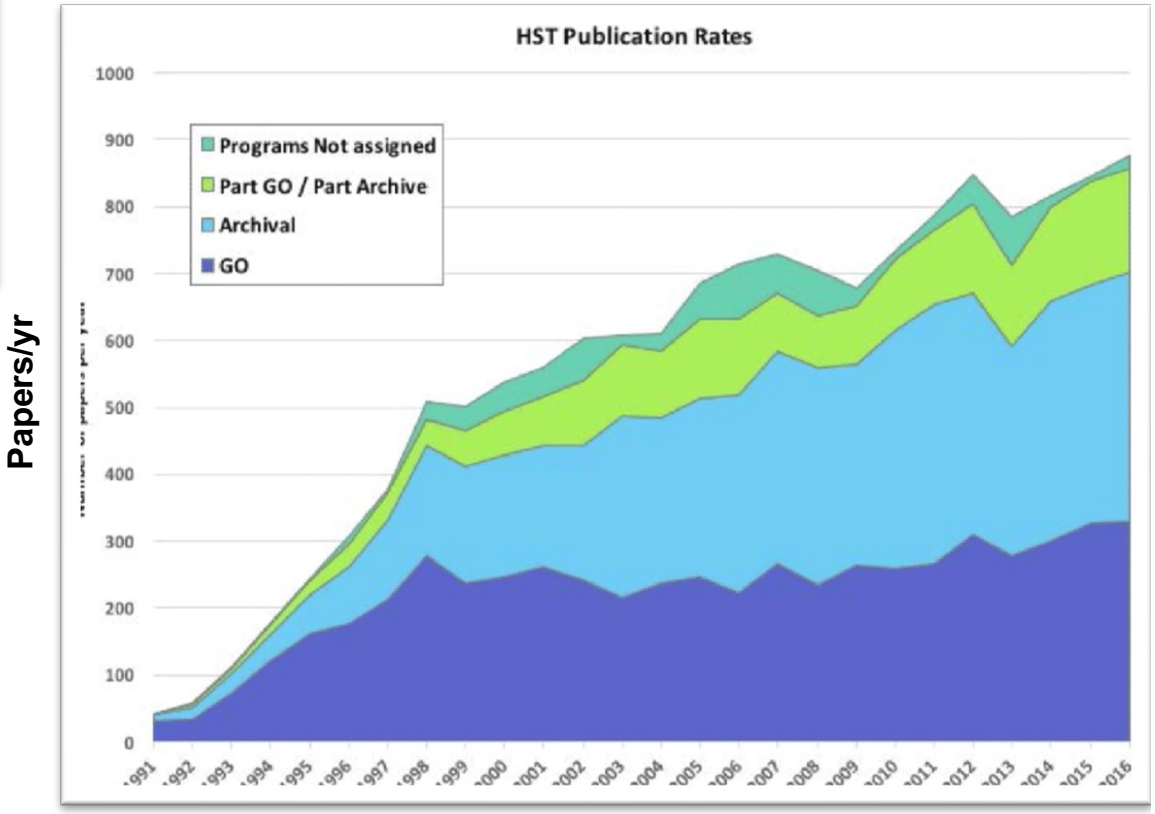
[1] Turning FAIR into reality : final report and action plan from the European Commission expert group on FAIR dat, 2018, https://data.europa.eu/doi/10.2777/1524

Astronomy: pioneer in Open/FAIR Data



Source: M. Romaniello's talk "The VO-Service at ESO". ESO Telescope Bibliography

- Data are preserved in archives
- Published after an embargo period
- Culture of re-using data

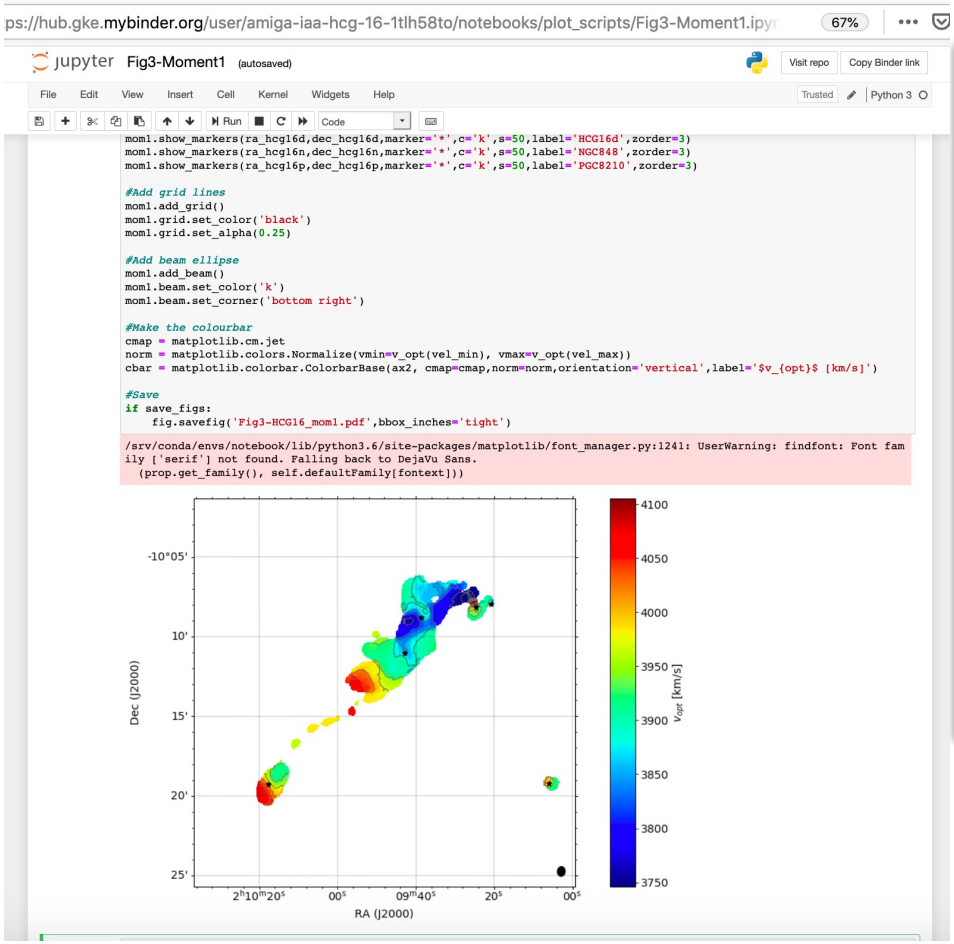


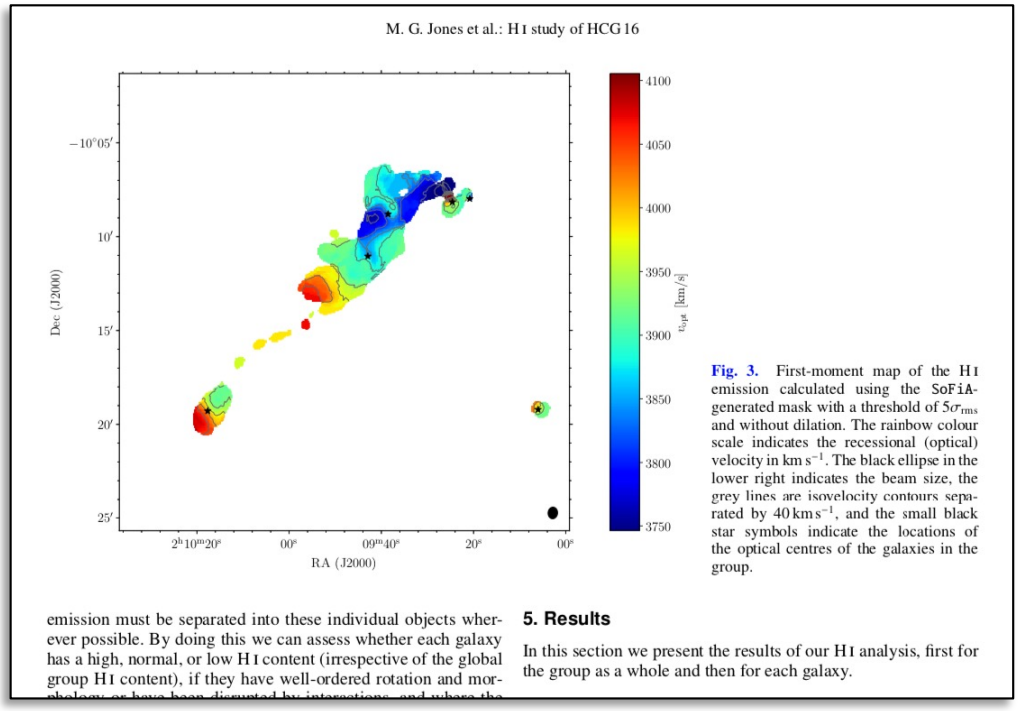
Source: 10.1051/epjconf/201818610003

Enhancing the scientific returns from investments in astronomical infrastructures

Understandable Software for supporting Scientific Reproducibility

- **Open Notebooks:** https://doi.org/10.5281/zenodo.2631868
- **Scientific workflows:** networks of analytical steps [...] including computationally intensive jobs on HPC (https://doi.org/10.1002/cpe.994)





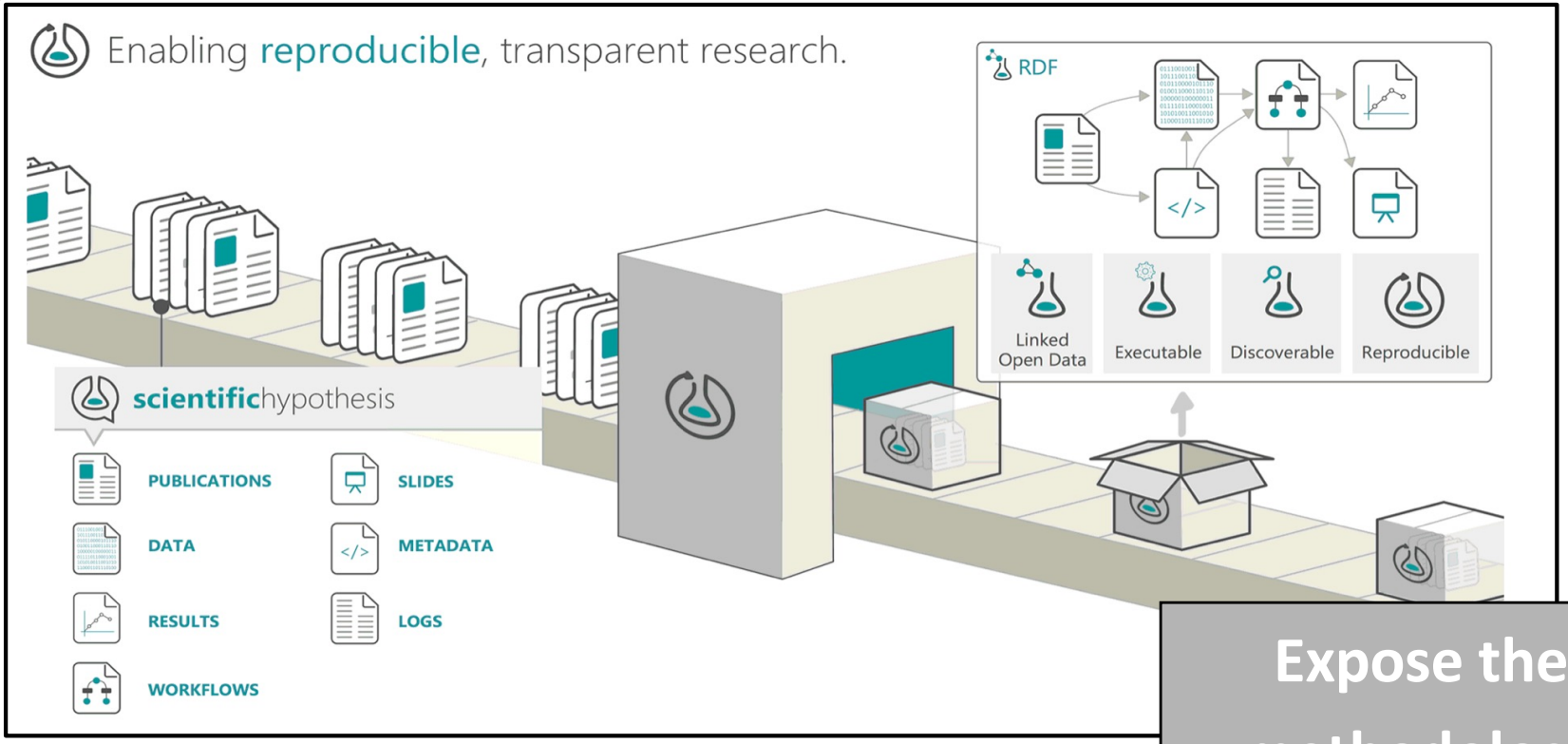
M. G. Jones et al. A&A. 2019

Opening all involved elements: Research Object

Workflow 4Ever

EU funded FP7 STREP Project
December 2010 – December 2013

Coordinator of WP
"Astronomy Use Case"



Expose the methodology

- **input and output examples**
- **annotations** (human/machine readable)
- **metadata:** data + software versión + config. parameters, execution environment, description of main steps, etc
- **interoperability**

Big Data science:
The Square Kilometre Array case

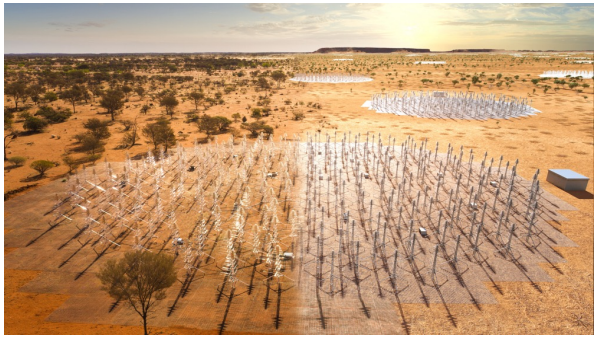
The Square Kilometre Array Observatory

Open key questions in Astrophysics, Astrobiology and Fundamental Physics

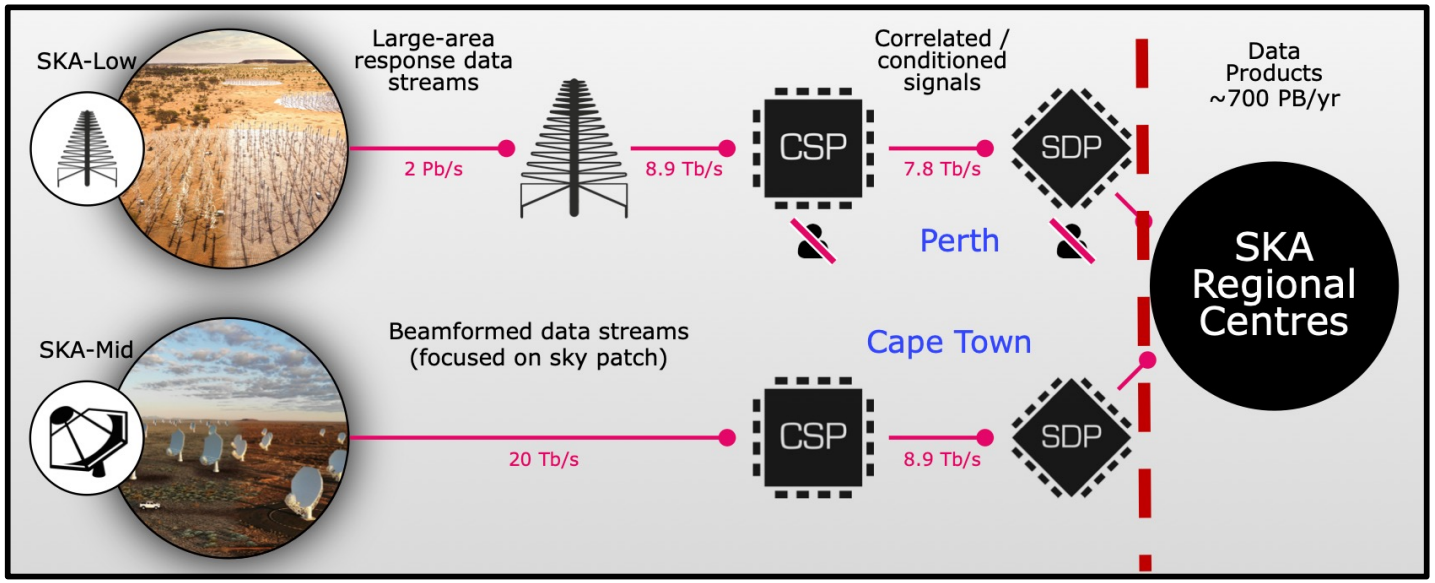
- Formation of the 1st galaxies in a dark Universe dominated by atomic gas
- Evolution of the atomic gas and star formation till the current epoch
- Strong Field Tests of Gravity Using Black Holes
- Active Galactic Nuclei and the Galactic Centre
- Extrasolar planets (proto-planetary disks, biomarkers)

SKAO

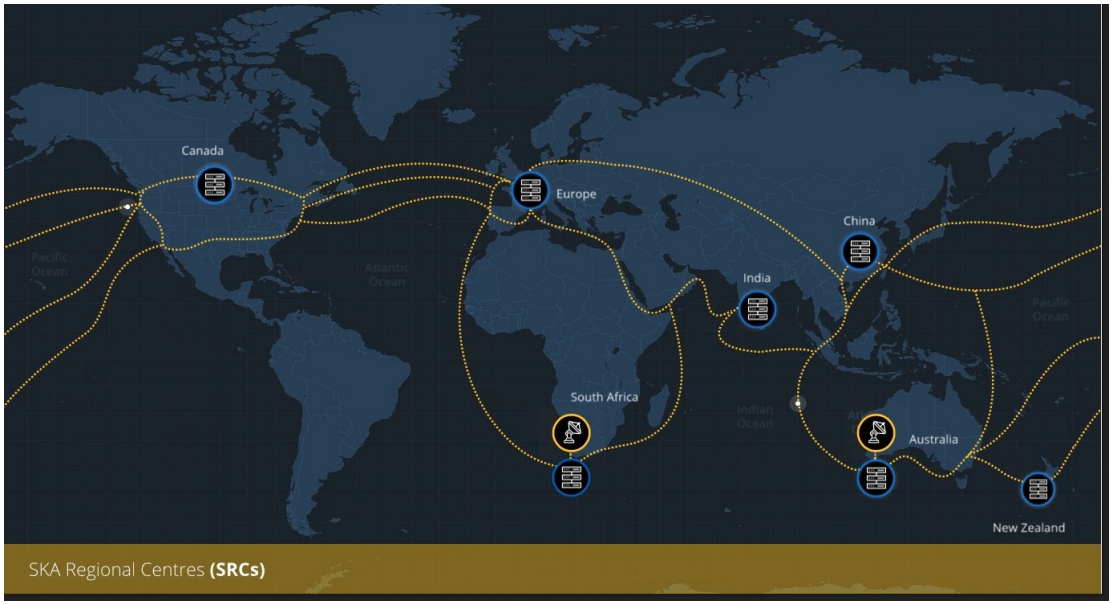
- 2024: Commissioning
- 2026: Science verification
- Q2 2029: End of construction



The Square Kilometre Array "case"



Credits: Mathieu Isidro (SKAO)



Credits: AENEAS project

The SKA Regional Centres, the core of the SKA Science

The Challenge: extraction of Scientific Knowledge

Huge and complex data volumes
Large teams distributed globally

A shared challenge for data-intensive research

Computing / storage / network / human resources will be needed:

Open Science & e-Science

- Efficient exploitation of Distributed Computing Infrastructures
- Large international alliances of scientists
  - Tools to enhance scientific collaboration
  - Platforms to share data, methods and knowledge

Open Science is the Aim and also the Mean

The SKA and Open Science

ENDORSED by the Council: Construction Proposal (CP) and Observatory Establishment and Delivery Plan (OEDP)

3. Impact of the SKA
3.3.2 Open Science

Adoption of Open Science values

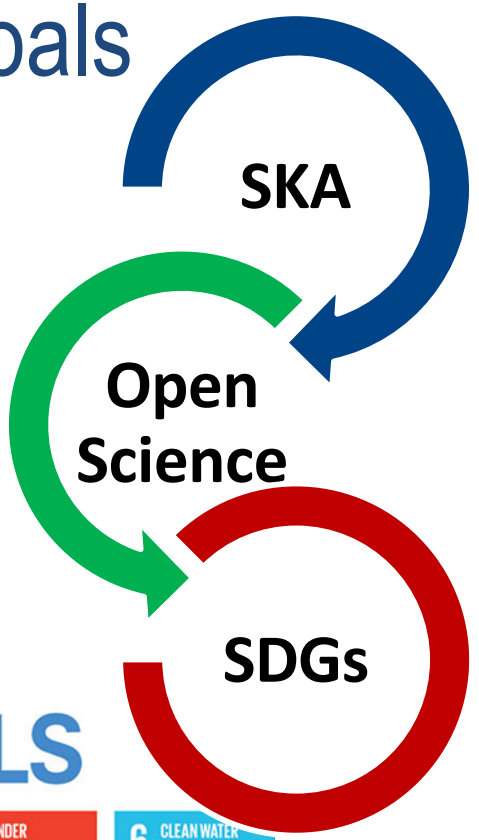
*"**Open Science**, based on the precept of making scientific research collaborative, transparent and accessible to all**, is rooted in SKA's foundational principles**. So is the related concept of scientific reproducibility, a fundamental aspect of the modern Scientific Method since the 17th century allowing independent teams to have access to methodology and tools to be able to confirm experiments and validate results."*

6. Observatory operations
6.1.2 Scientific success metrics

Reproducibility as a metric of success

*"Reproducibility of SKA science data products. This metric will measure how complete **the workflow description** is that is linked to each SKA data product. […] must reflect completeness of the **provenance information** for each data product and accessibility of the software used. This is related to how well SKA science data products **adhere to the FAIR principles** ."*

Sustainable development goals



Credits: UNESCO

The SKA, Open Science & SDGs

Acceleration of knowledge transfer to Society, pandemics, sanitary crisis

- Speed up building of **skills**
- **Teaching**, e.g. access to public archives, **fostering collaborative** practices
- **Citizen** science

Science hidden behind paywall barriers = limitation to science progress

- Free access to research sources to the whole community, avoiding reinvention
- Data and results more accessible and reliable
- Promotion of **scholarly exchange** of ideas

Promote equity, diversity and inclusion: All previous ítems +

- A tool enabling an **objective evaluation** of work
- Barriers are even more emphasized to scientist women in places where their **contribution tend to be ignored or anonymized**

ESCAPE

Consortium:

Source: https://projectescape.eu/sites/default/files/2022-04-12%20%E2%80%94%20SCiMMA%20Webinar.pdf

- Budget: **15.98 M€**
- From **Feb. 2019** until **Jan. 2023 (extended)**
- Coordinator: **CNRS-LAPP**

Toward a Spanish SKA Regional Centre fully engaged with Open Science

http://dx.doi.org/10.1117/1.JATIS.8.1.011004

espSRC: Supporting the Spanish Community

- **>20 data analysis projects:**
  - SKA related & non-SKA
- **SKA precursors proposals**
  - E.g.: 2 PI MeerKAT proposals
- **Open Science Training**
  - 1st SKAO – OS School
  - Droplets
- **SKA Data challenges:**
  - SDC2:
    - Spanish team 5th/40 +
    - Gold Medal on Reproducibility
  - SDC3:
    - Spanish team led by IFCA
    - Collaboration with CESGA

Credit: SKAO – https://www.skao.int/en/news-events/contact-skao-magazine

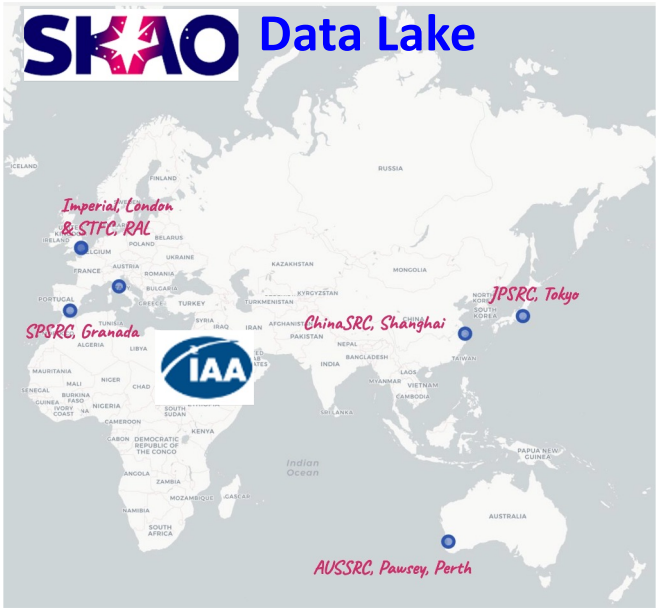
espSRC: Supporting the SRC network development

SRC Steering Committee Working Groups

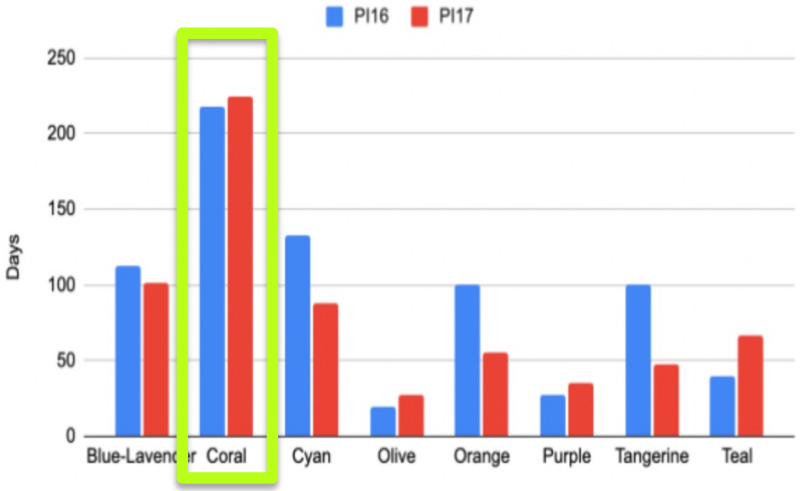
- Design phase (IAA-CSIC, BSC, OAN, IFCA, ICE/IECC-CSIC, Univ. Valencia, RedIRIS)

Builder of testbeds for technologies

- Mini-SRCNet demonstrator
- Data Management system (SKAO Data Lake)



9 agile teams. Development capacity:



CORAL TEAM

Lead by IAA-CSIC = Product Owner + Scrum Master

Conclusions

- Astronomy is **Pioneer** in Open Science: Spanish VO
- Involvement in EOSC through e.g. ESCAPE H2020 Project:

  IFAE, UCM, INTA-Spanish VO, IAA-CSIC
- Astronomy is facing an extreme Big Data challenge: the SKA Observatory

  Principles aligned with those of EOSC, as an ESFRI is involved in

  EOSC projects and its community engaged with OS

Scientific infraestructures are key for implementing OS

With financial support from GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN