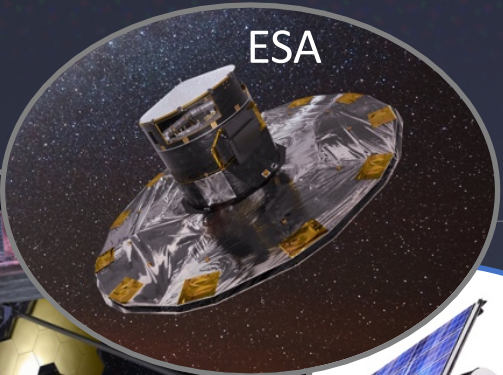
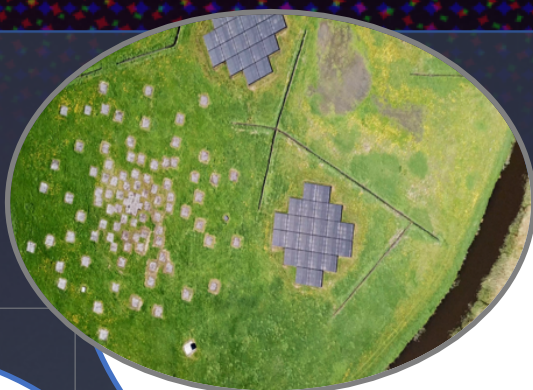


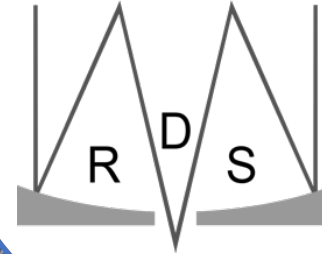
ASTRO@NFDI



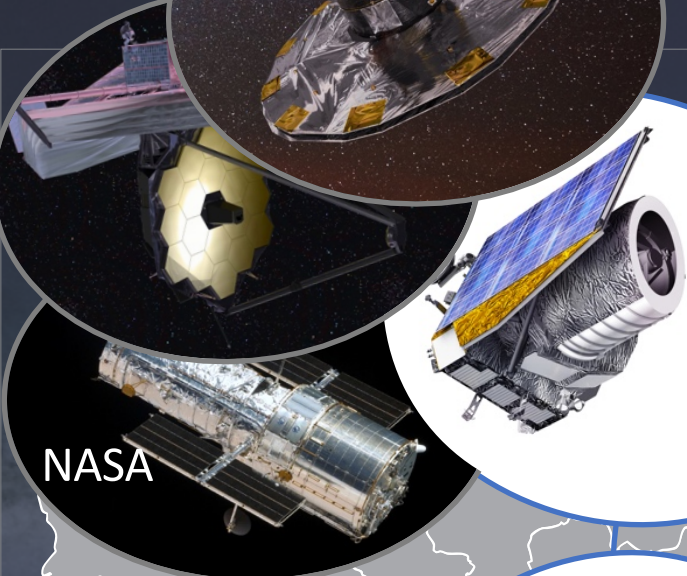
ESA



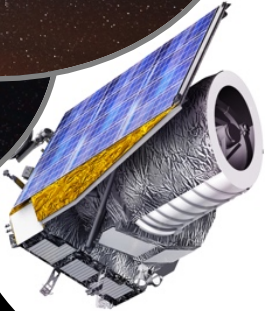
LOFAR + data
archive Jülich



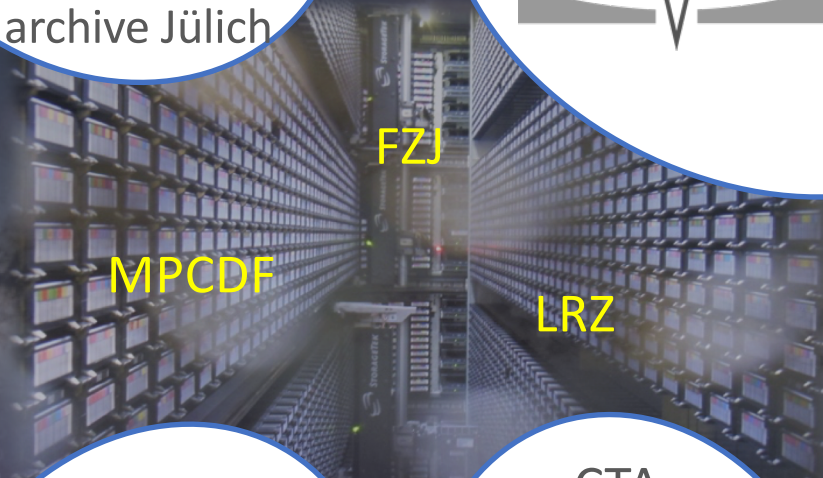
KAT. Komitee für
'Astro. Teilchen. Physik



NASA



DLR



FZJ

MPCDF

LRZ



LSST
partners



VDR

+
SKA



Astro@NFDI Endeavour

CTA
data center

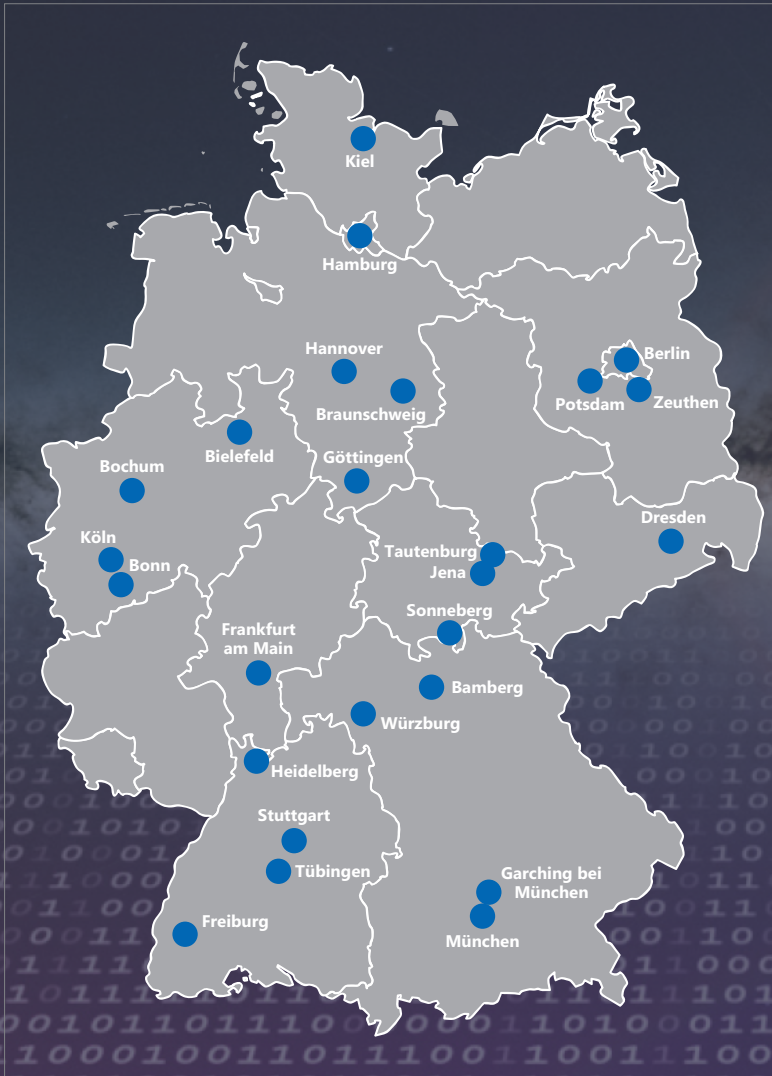


ESO



19.02.2020

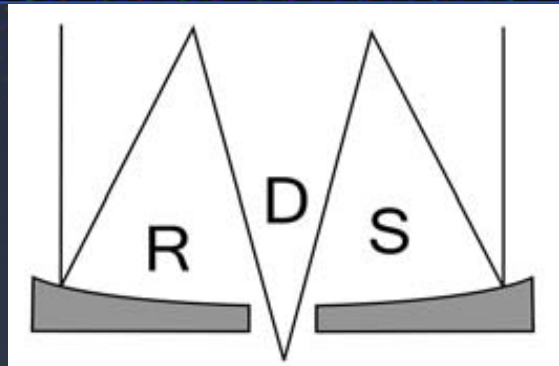
Astro@NFDI



- Rat deutscher Sternwarten
 - 3 Helmholtz Institutes
 - 2 Leibniz Institutes
 - 7 Max-Planck Institutes
 - 26 University institutes
 - 1 state institution
 - 1 private institution
- Komitee für Astroteilchenphysik
 - 3 HPC centers + HTW
 - 4 ESFRI Projects (ESCAPE)
 - 7 international organizations

Who we are:

- About 3000 researchers in the area of astronomy, astrophysics and particle astrophysics (“**astrophysics**”) in Germany
- About 50 university and non-university institutions (Helmholtz, Leibniz, Max-Planck) + HPC Centers
- Tightly linked to international and intergovernmental organization and facilities (e.g. ESO, SKA, CTA, EST)
- Organized in the Council of German Observatories (RDS) and the Committee for Astro-Particle Physics (KAT)



Denkschrift 2017

Perspektiven der Astrophysik in Deutschland 2017-2030

Von den Anfängen des Kosmos bis zu Lebensspuren auf extrasolaren Planeten

Matthias Steinmetz, Marcus Brüggen, Andreas Burkert, Eva Schinnerer, Jürgen Stutzki, Linda Tacconi, Joachim Wambsganz, Jörn Wilms (Redaktionskomitee des Rats deutscher Sternwarten)

Astro@NFDI: “Capture data today to answer questions of tomorrow”

- Infrastructure project driven by and for the astrophysics community
- Serves the needs of a diverse and dynamic community
- Addresses fundamental and growing data challenges that astrophysics is encountering now, and other sciences soon
- Unique dissemination channel for training, education and public engagement in data science
- Ready-to-go exploratory development platform for data-driven science
- Professionally managed like a large instrumentation project
- With a long record in data management, accessibility, interoperability and reusability

Why astronomy & astrophysics is arguably different than other sciences

Experiment



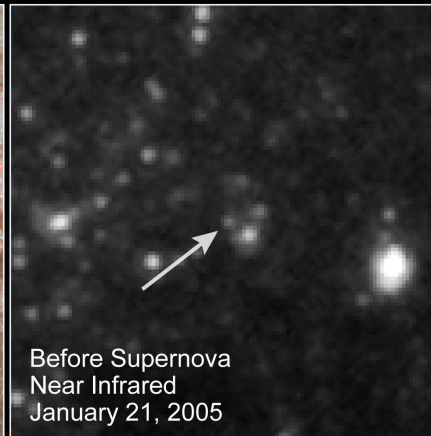
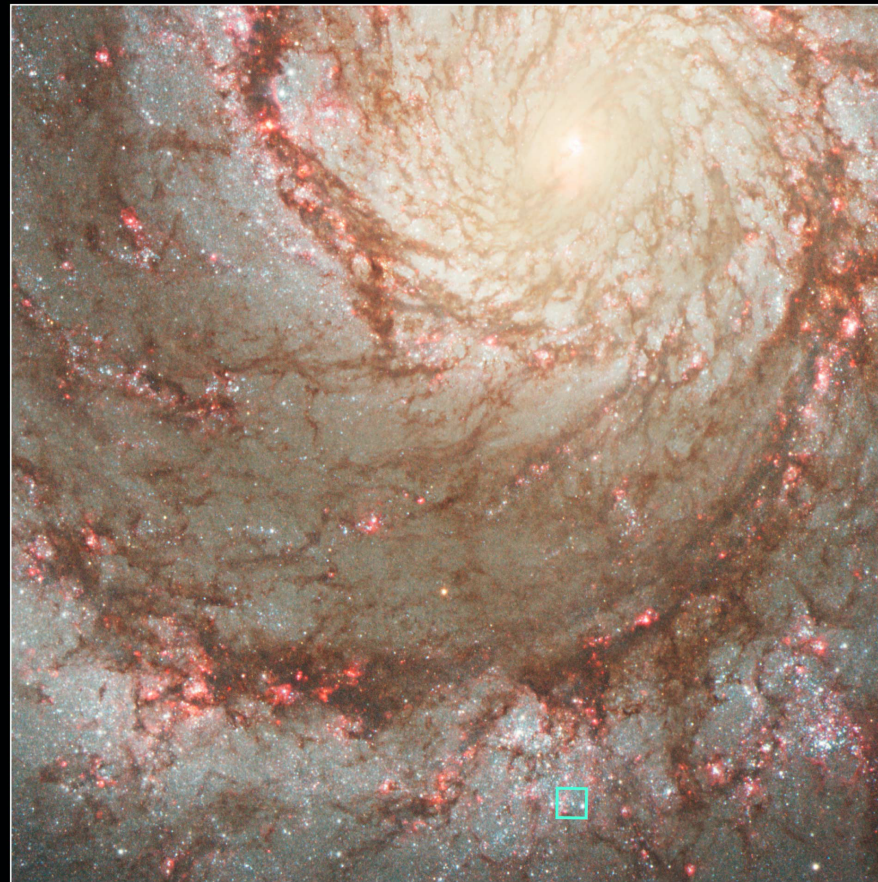
Physics: Controlled & focused experiments to approach the fundamental theory of space, time and matter

Observatory

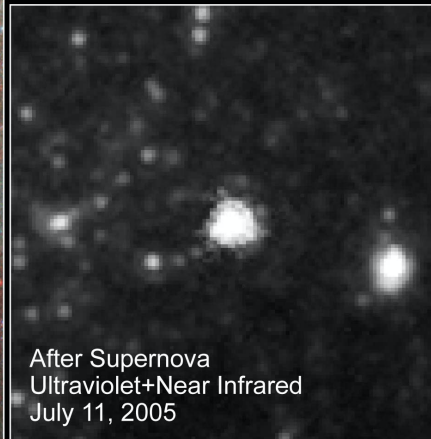


Astronomy: Cannot do experiments with the Universe! Explore the diversity of objects and processes $\Rightarrow$ Multiple Data Irreversibility challenges!

Reusability



Before Supernova
Near Infrared
January 21, 2005



After Supernova
Ultraviolet+Near Infrared
July 11, 2005

Supernova 2005cs in the Whirlpool Galaxy • M51
Hubble Space Telescope • Advanced Camera for Surveys

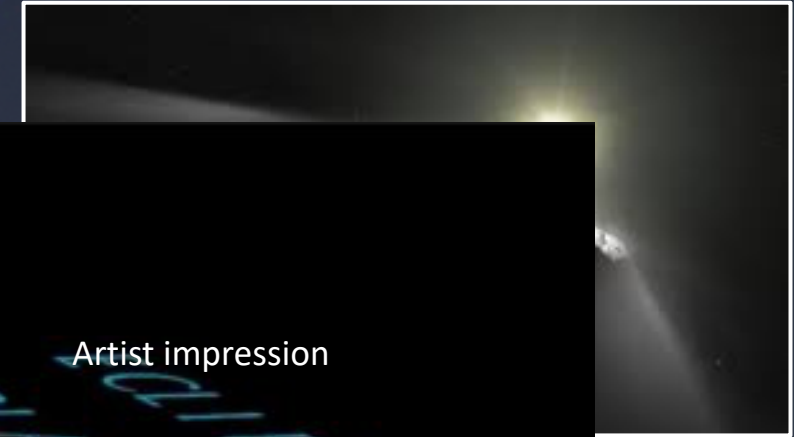
NASA, ESA, W. Li and A. Filippenko (University of California, Berkeley),
S. Beckwith (STScI), and The Hubble Heritage Team (STScI/AURA)

STScI-PRC05-21

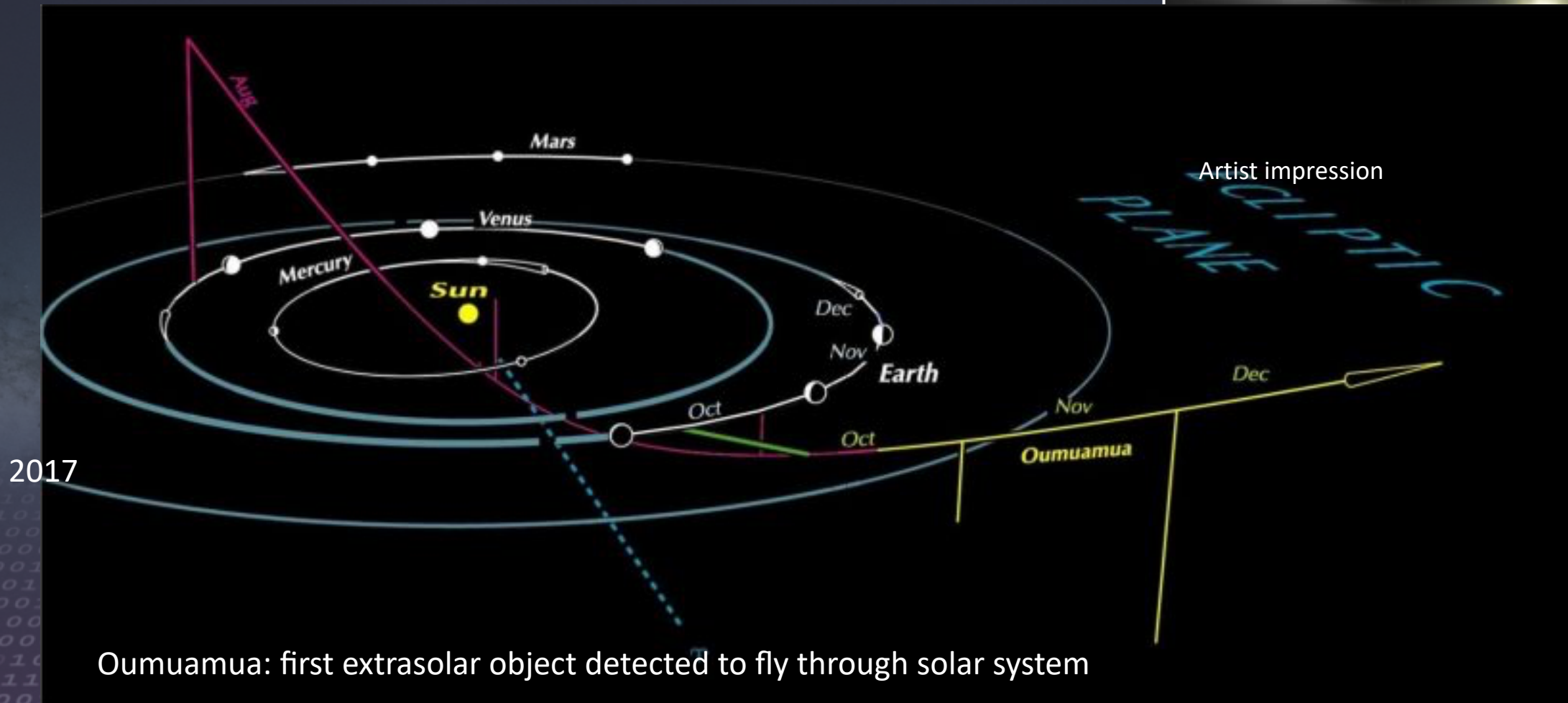
More than 50% of
publications using the
Hubble Telescope are
based on archival data



Reusability



Artist impression



2017

Oumuamua: first extrasolar object detected to fly through solar system

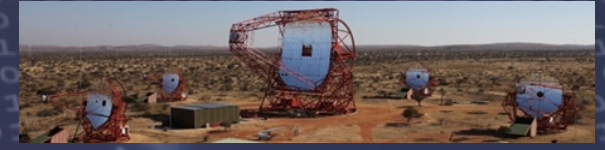
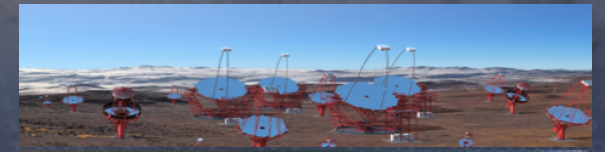
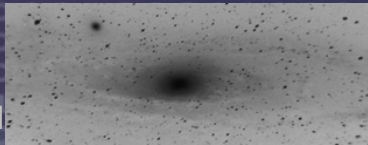
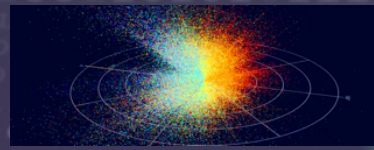
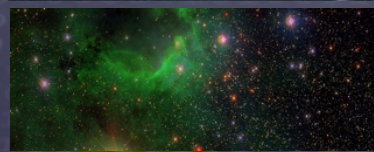
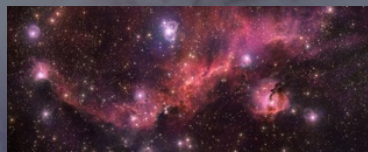
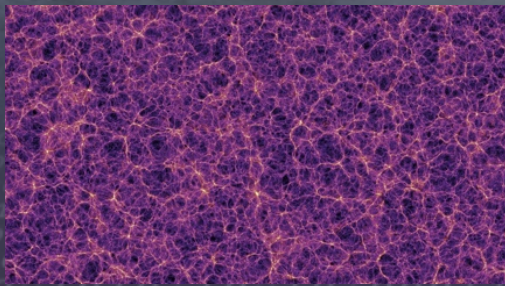
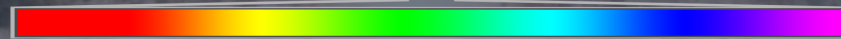
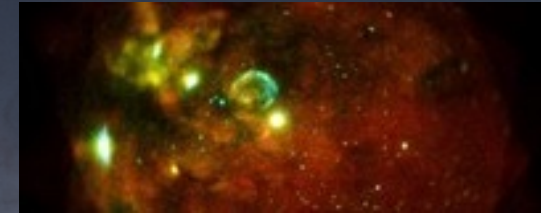
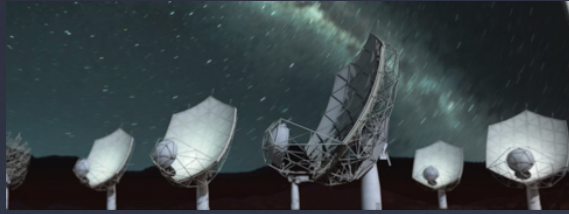
Unfortunately no data of the approach available

19.02.2020

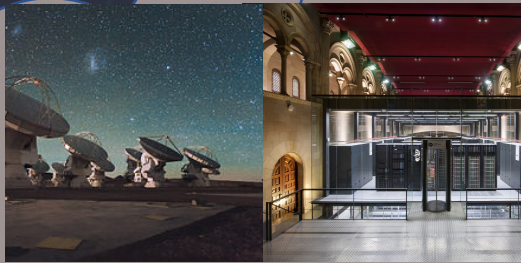
Astro@NFDI Endeavour

7

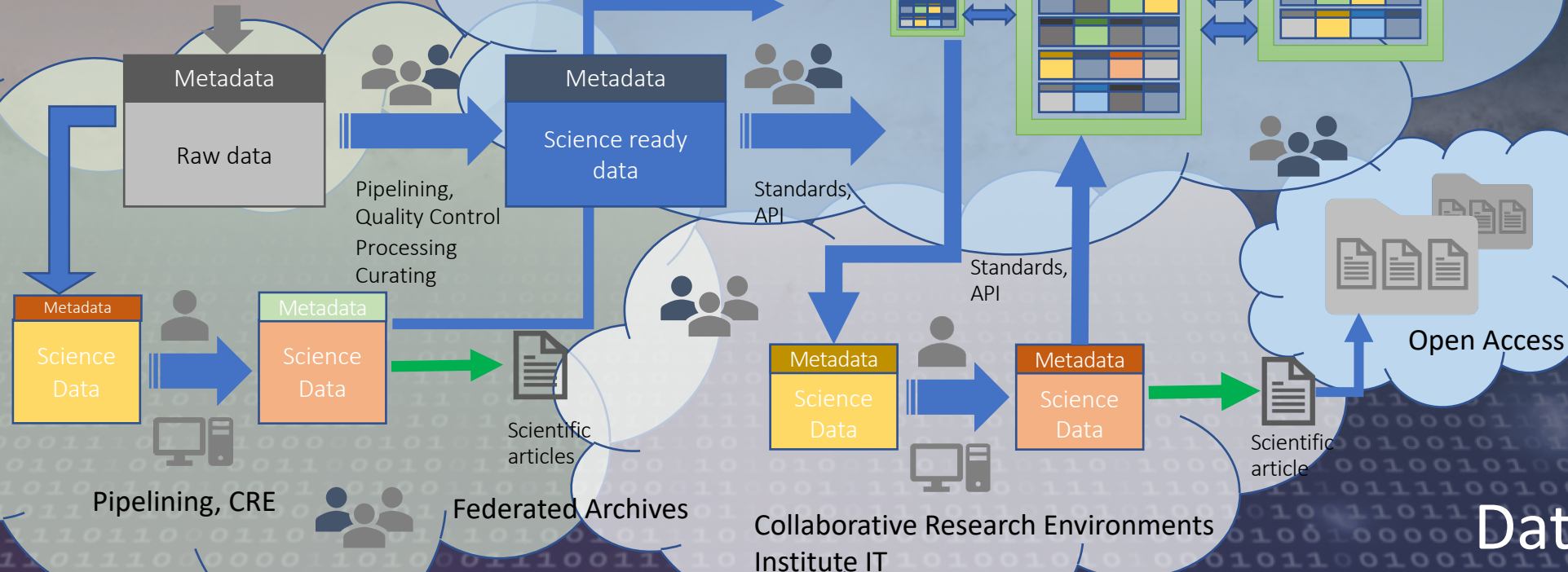
Our Data – now and in the future



TA2: Data infrastructures



Data sources:
Observations, Simulations
Expected data production:
several Exabyte/year



Data Flows
Scientific Workflows

Work in international Bodies
Support Community Efforts
& Open Source

AAI
Resource Allocation
Accounting

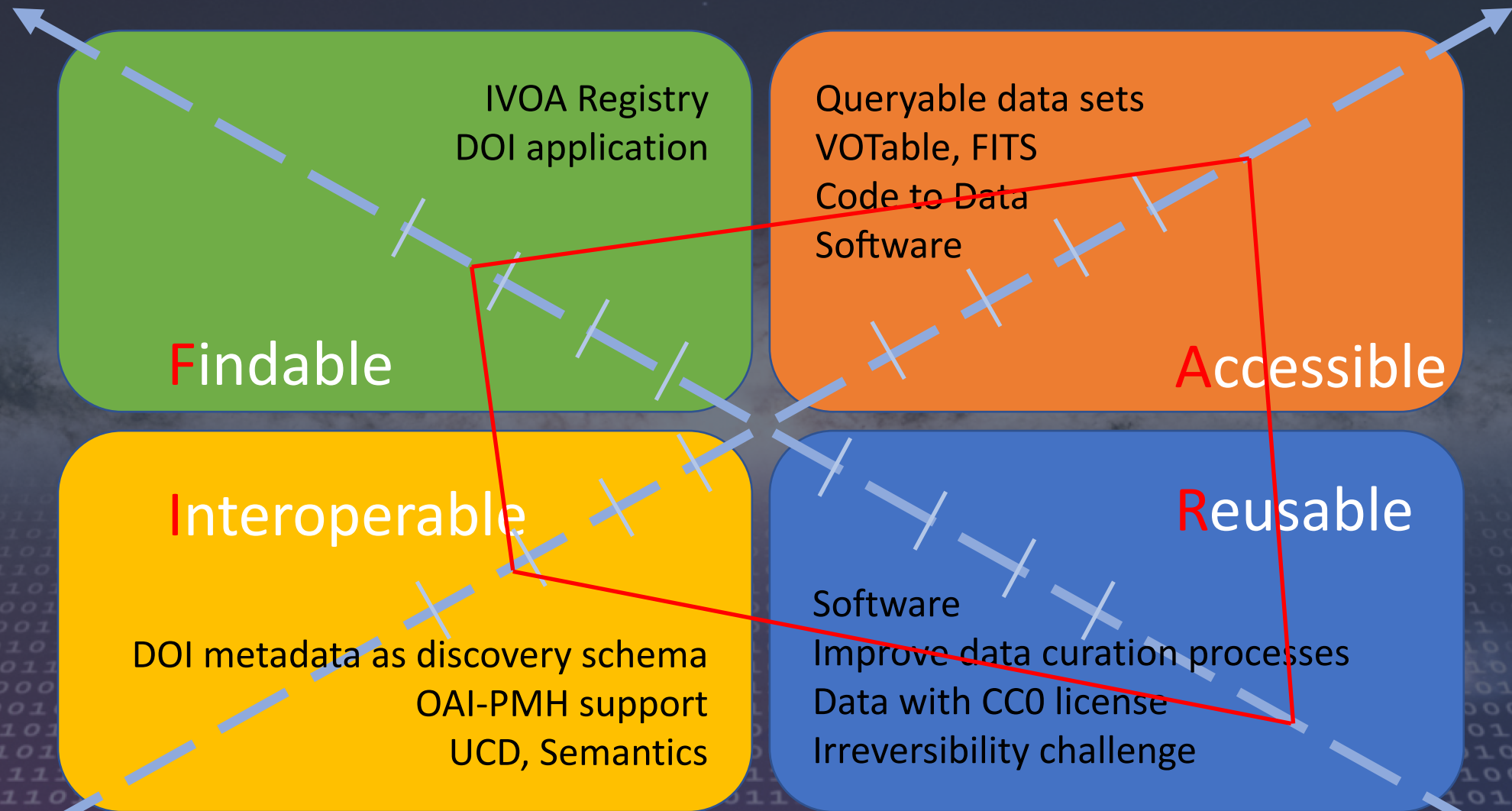
Data Archive Building
Archiving Procedures
DOI

Maintain Data Services
Initiate further development of
Standards & Protocols

Collaborative Research
Environments
Federated Archives

Data Management Support
Software Management Support
Consulting

Astro@NFDI, FAIR Data (now) www.astro-nfdi.de/how-fair-is-your-data/



Astro@NFDI: IVOA Approach

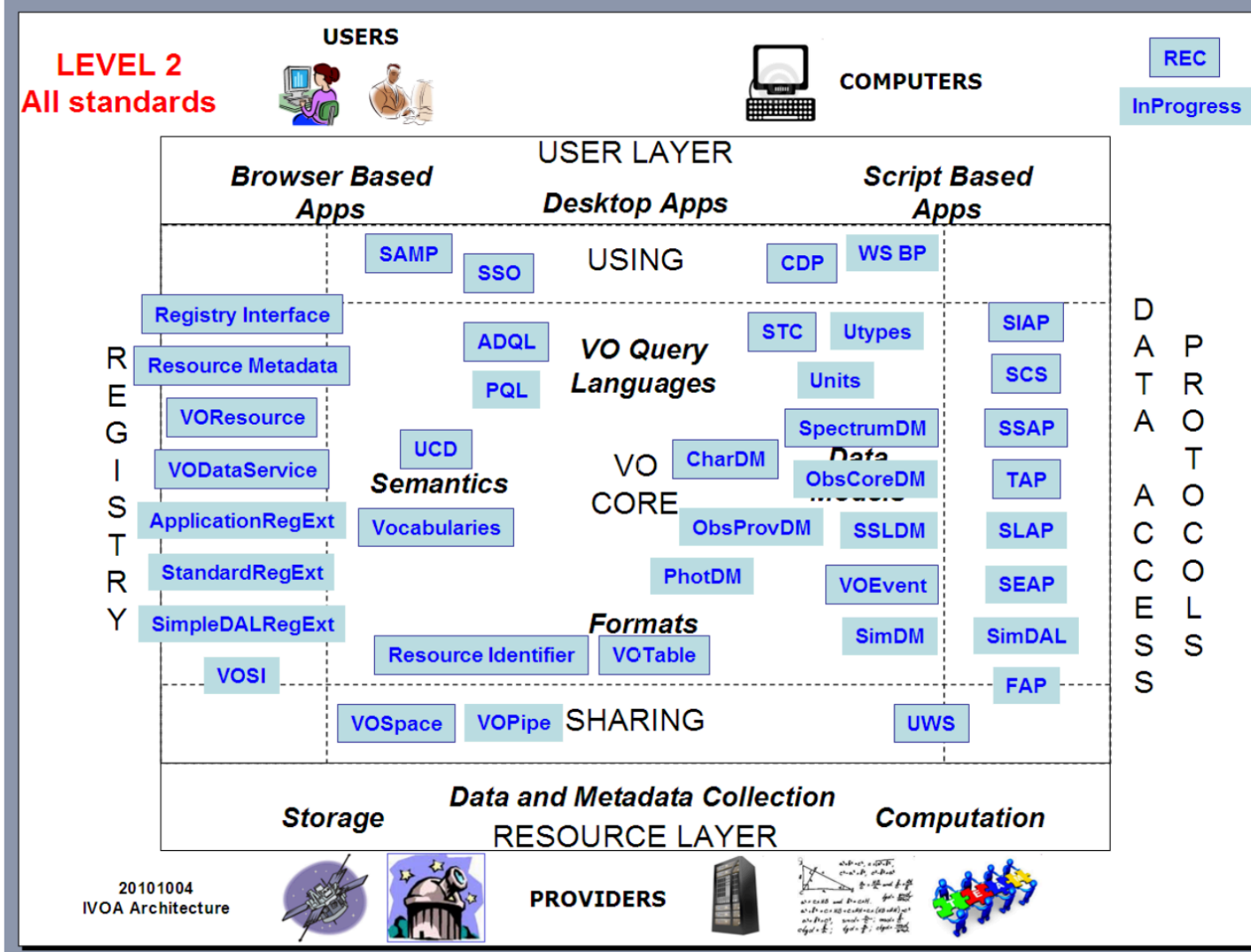
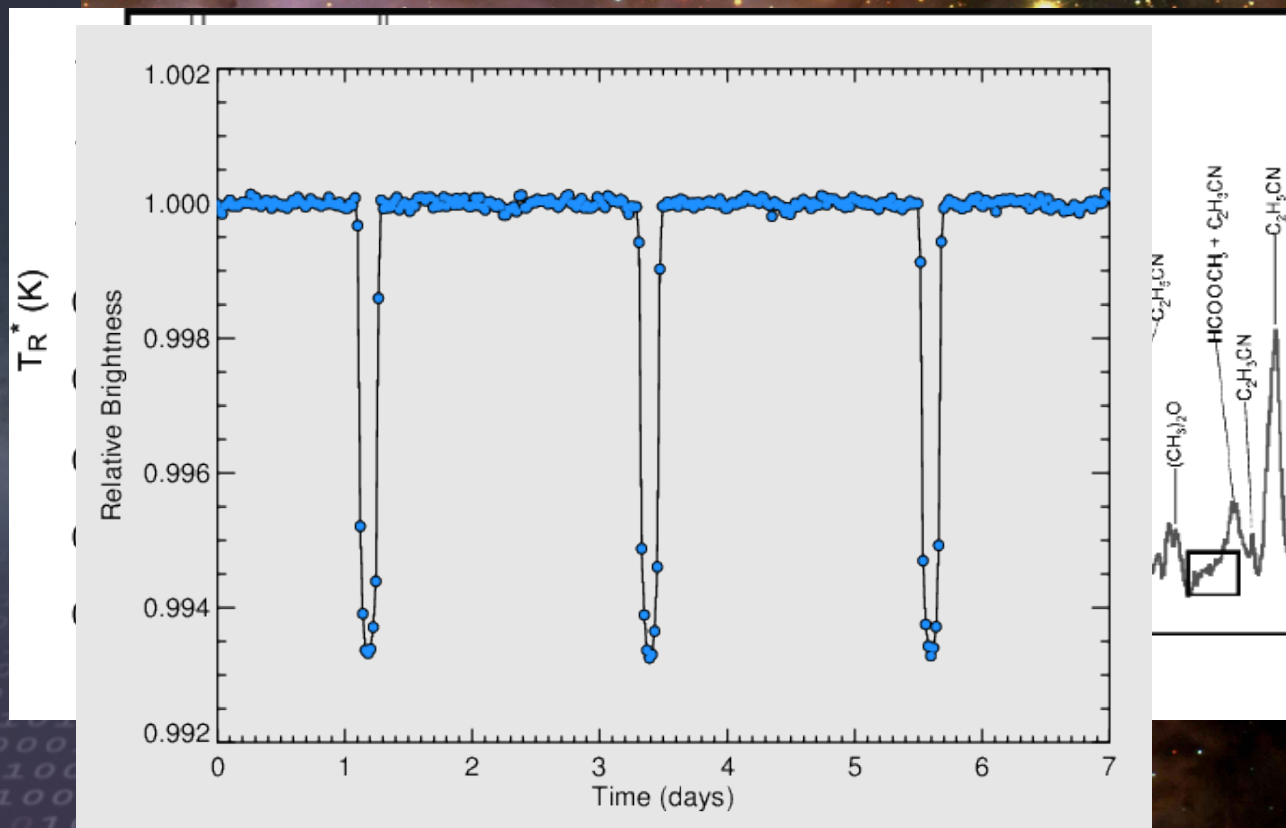


Figure 3: IVOA Architecture Level 2

TA3: Diverse requirements ...



Multiple
wavelength

Time domain

Spectra

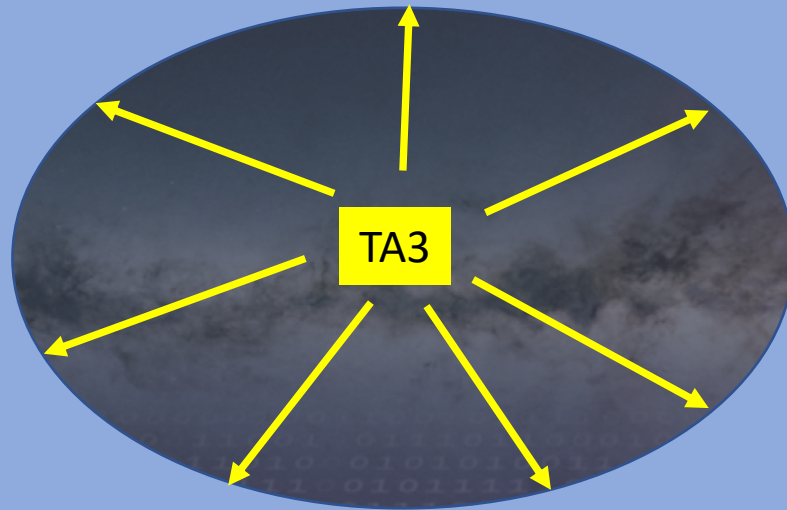
Simulations

Time baseline

Data set size

etc. ...

TA3: Diverse requirements ...



Task Area 3

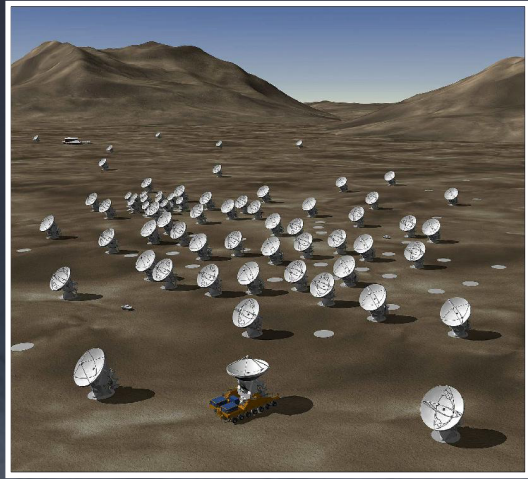
Multiple
wavelength
Federate generic services

■ **serves them all**
Time domain

Spectra
■ **unites them**
Simulations

■ **opens up new interdisciplinary research**
Data size
Images
etc. ...

Workflows - Task Area 4



Combining
different
wavelength

Final
image



Data
reduction

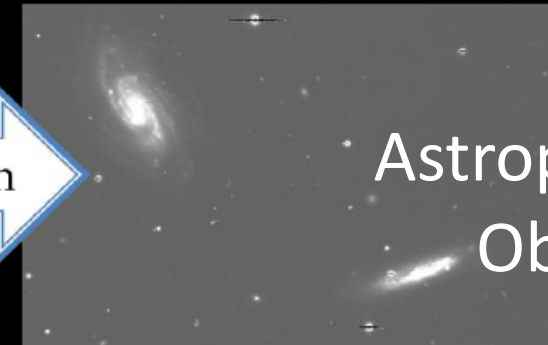
e.g. Machine
learning

Combining
single
telescopes

Original
data



Reduction

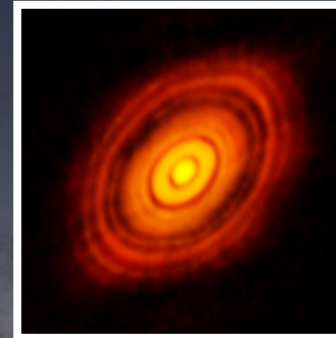


Astrophysical
Object

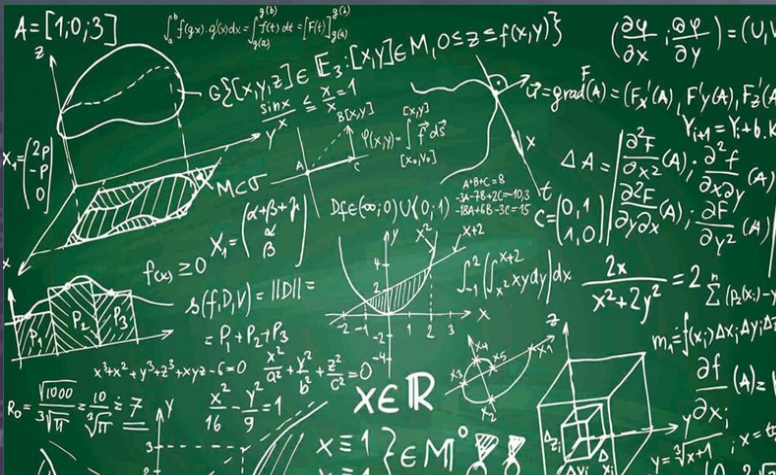
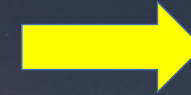
Different Data Workflows for different communities

Defining standards and designing general software modules for

- Data analysis of observational data
- Astrophysical Simulations
- Instrument Design



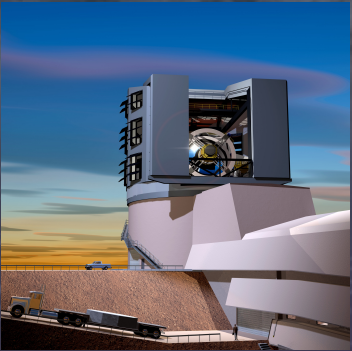
Change of research methodology



TA5: Data Irreversibility Challenges

- **Previously:** (most) data could be stored and reanalyzed/reused in data life cycle
- **Now:** data rates increasingly large – even after on-line analysis (FPGA, GPU, HCP, AI etc.)
only parts of data can be stored
- **Soon:** only tiny fraction of data can be stored: **dramatic loss of information**

LSST



20 TB/night

1.5 PB/yr

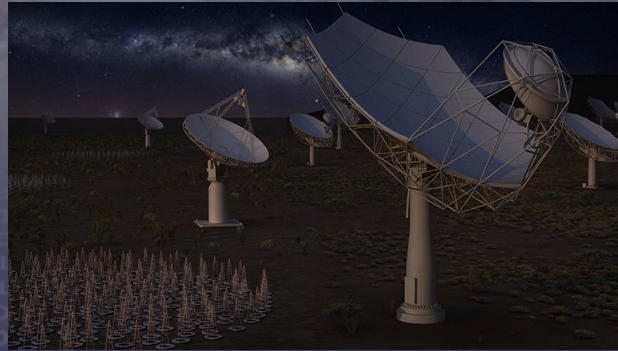
CTA



40 TB/night

4 PB/yr

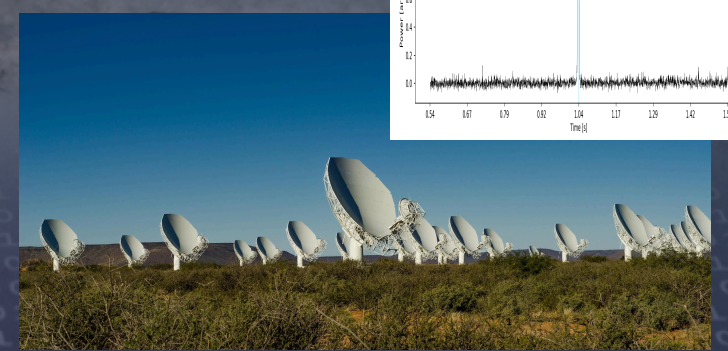
SKA



5 EB/day

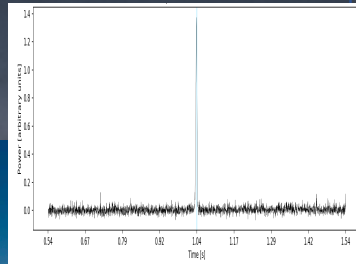
300 PB/yr

MeerKAT – now!



3 PB/day

4 PB/yr



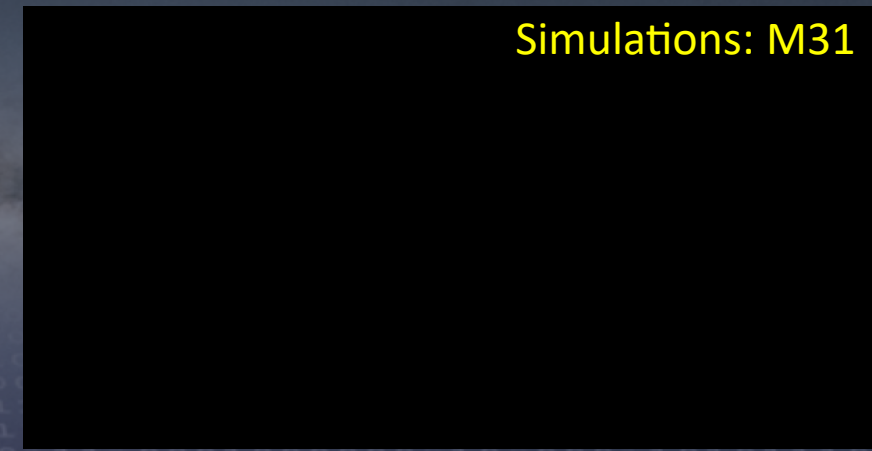
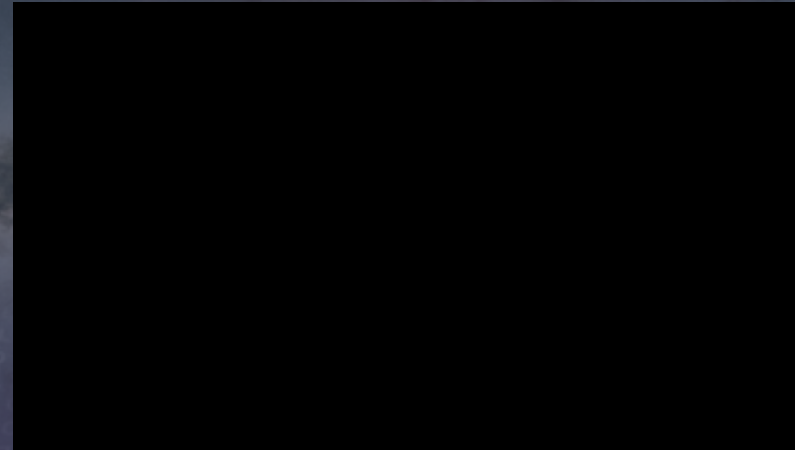
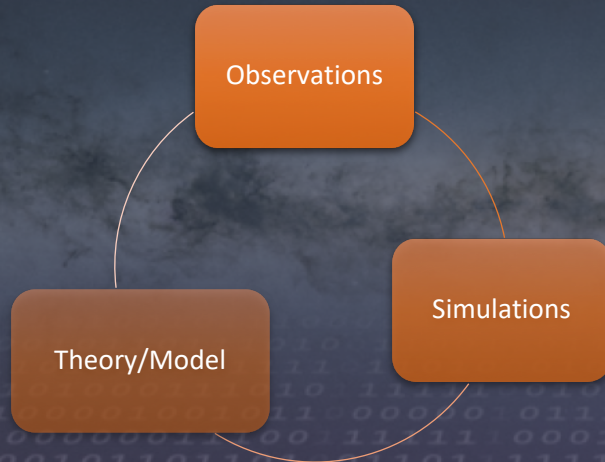
raw data

archived

Simulations and data irreversibility

Impact of information loss needs to be described, understood and accounted for

- a) Simulations must be used to gauge nature and impact of information loss, while...
- b) To infer physics, observations in presence of information loss must be compared with simulations considering the limitations due to information loss:



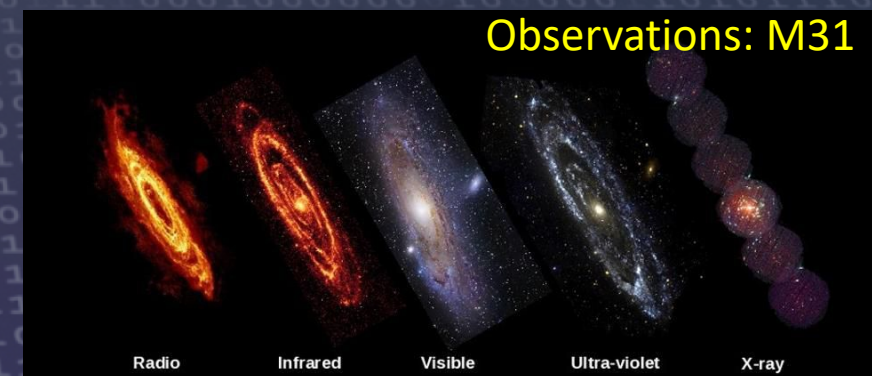
Today, simulations are huge too.

Example “Illustris TNG”: 19 Million CPU hours,

>13 Billion particles, 250 TB total volume

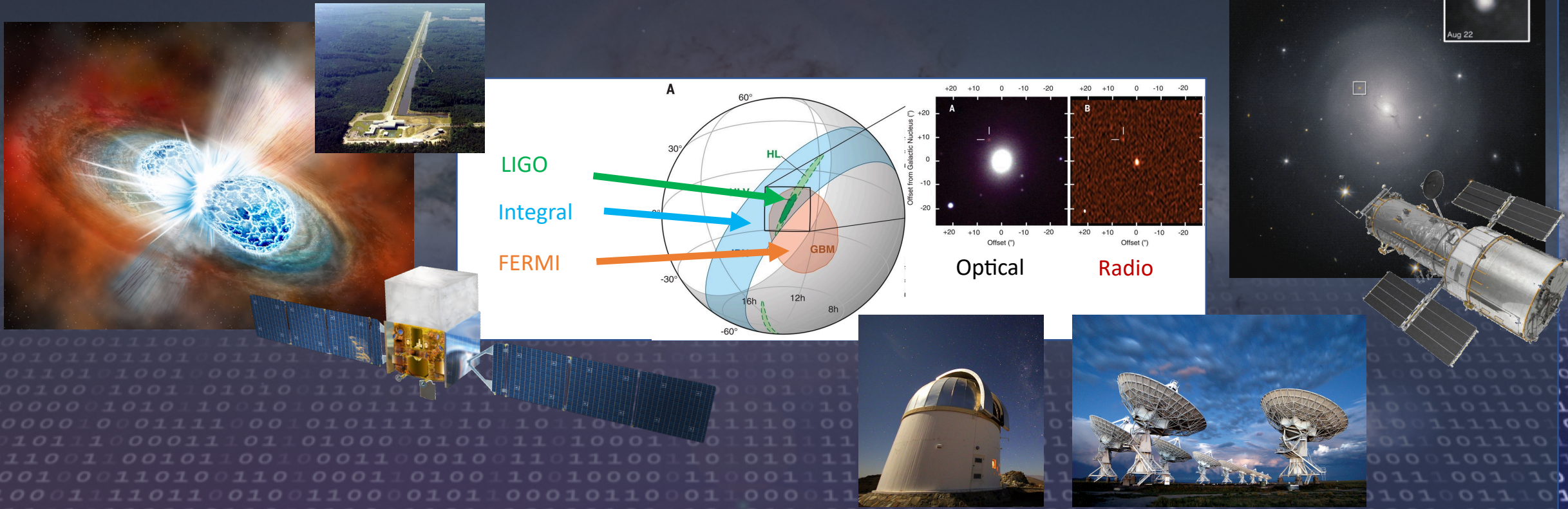
“Universe in time, space and more...”

Astro@NFDI Endeavour



Adapted life-cycle needs to be fast, dynamical and scalable

- Archives must be re-analysed, re-evaluated and insight must be fed back into online analysis
- Online analysis must be fast and reliable with low false-alarm probability



Triggers are very complex and interwoven between different instruments and archives

Our laboratories and experiments cannot be controlled

Unusual complexities & diverse external interferences affecting online processing severely

A generic challenge
for most sciences



External interference:
Known & unknown

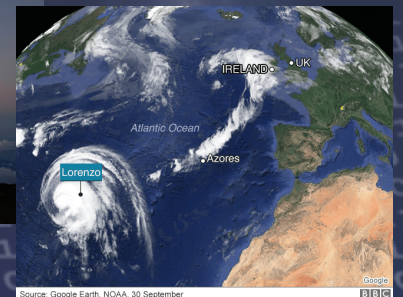
Openness of data
is essential
("reproducibility")

"We need to solve it for astronomy, in collaboration with others, for the benefit of all."
(with other foreseeable positive consequences, e.g. green computing)



TA6 Synergies & Cross-cutting

- Despite different, community-specific needs, **many challenges are common**.
- Different communities have advanced on individual aspects to different degrees. **Sharing expertise and common developments in cross-cutting topics are desirable**.
- Challenges are preferences to develop own solutions and reluctance to share services.
- Especially **new challenges** for Astro@NFDI community will emerge in other fields and considerable gains are possible by **cooperative approaches**.
- NFDI will profit from **extensive ASTRO@NFDI's expertise** with **common services, common access, interchangeable formats, archives** developed for diverse communities.

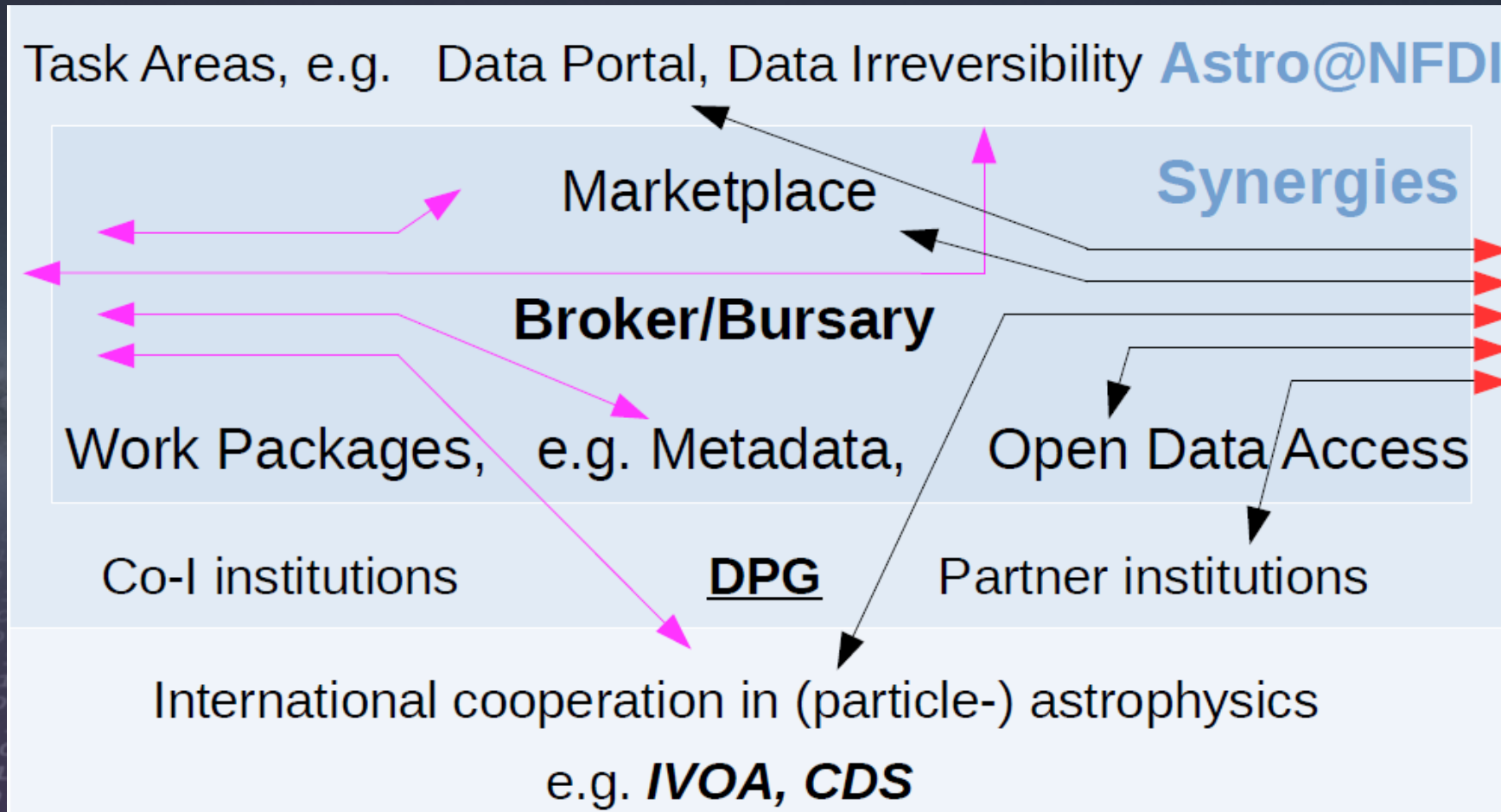


TA6: Cross-cutting activities & synergies

Year 1

PAHN-PaN

DAPHNE
FAIRmat



TA7: Training, Education & Outreach: Challenges

Unlike any other sciences, dense and successful societies & observatories thanks to huge

aria, local
nd data



Haus der Astronomie

@HdAstro

Follow

Haus der Astronomie will host the new @IAU_org Office of Astronomy for Education @astro4edu - we are looking forward to exciting new tasks!



Haus der Astronomie to host IAU Office of Astronomy for E...

haus-der-astronomie.de

1:23 am - 28 Nov 2019



IAU-OAD

@Astro4Dev

Follow

IAU has selected @HdAstro as the location for the Office of Astronomy for Education. The OAE will promote #astronomy in #education and seek to achieve the education goals in the IAU Strategic Plan. @astro4edu Welcome to the IAU family = OAD-OAE-OAO-OYA iau.org/news/pressrele...

Planetarien in Deutschl

Größe der Kuppel des Planetariums



19.02.2020

Astro@NFDI Endeavour

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Training

Expert users

Data & training
resources

Analyze, promote
& foster



19.02.2020

Education

Teachers Students

Edu resources
Visiting seminars
Career prospects
Gender gap



Astro@NFDI Endeavour

Outreach

Media Amateurs Schools

Communication training
& resources
Pedagogical approaches
School curricula
Citizen science
Active engagement



25

Citizen Science

23.05.2011 12:36 Uhr Frankfurt 11:36 Uhr London 06:36 Uhr New York 19:36 Uhr Tokio

n-tv

Home Politik Wirtschaft Börse Sport Panorama Unterhaltung Auto Technik Wissen Ratge

Frage & Antwort Fundsache A-Z

n-tv.de Startseite » Wissen » PSR J2007+2722 im Fuchschén : Amateure entdecken Radiopulsar

WISSEN



WISSEN

"Es trifft oft Macher-Typen"
Frustr ist ein Burn-out-Symptom

Fleisch, Wurst und Süßigkeiten
Kinder schlagen über die Stränge

Gespräch mit ISS-Besatzung
Papst telefoniert ins All

Schmerzmittel für sterbende Nutztiere
Geier profitieren von Verbot

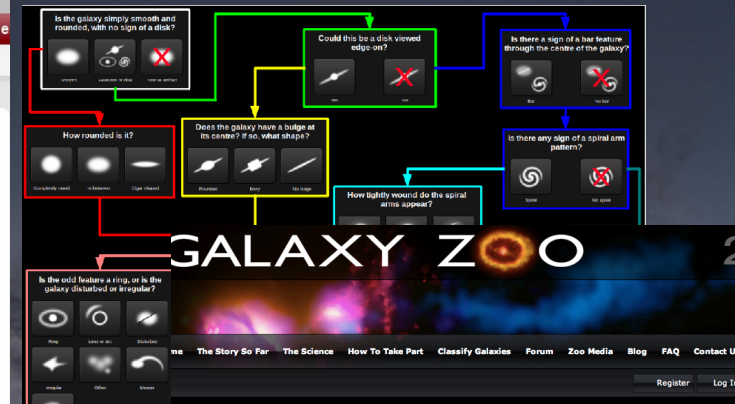
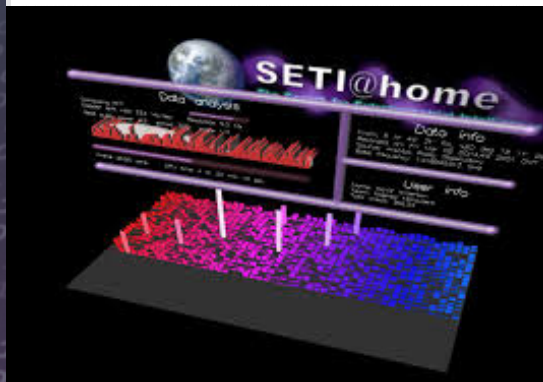
Männer mit Bauch betroffen
Sex-Probleme durch Übergewicht

Dank elektrischer Impulse

Sonntag, 15. August 2010

PSR J2007+2722 im Fuchschén Amateure entdecken Radiopulsar

Der Neutronenstern befindet sich 17.000 Lichtjahre von der Erde entfernt und dreht sich 41 Mal pro Sekunde um seine eigene Achse. Entdeckt hat ihn unter anderen ein Student aus Mainz.



CLASSIFICATION COUNT: ZOONOMETER™

57,000,071

Galaxy Zoo Giveaway

The Zoonometer™ has been steadily ticking away, toward our target of 60 million classifications. We can hardly believe it, but we're nearly there! To mark this historic moment in Galaxy Zoo's history, we're giving away prizes to the people that provide the clicks that take us to our target.

Keep Up with the Race

You can keep up to date Galaxy Zoo via the [Galaxy Zoo Blog](#) and through our [Twitter](#) feed.

The person that makes the 60 millionth classification will receive a bundle of goodies, including a Galaxy Zoo t-shirt and mug, a Galaxy Zoo poster and an original Sloan Digital Sky Survey image.



Einstein@Home
World Year of Physics 2005

23:05:14

CamStudio
RenderSoft
CamStudio
OPENSOURCE

BOINC Statistics
User: santigony
Team:
Project Credit: 1872.37
Project RAC: 62.88

Search Information
Ascension: 0.00 deg
Declination: 0.00 deg
Completed: 100.00 %
CPU Time: 04:30:24



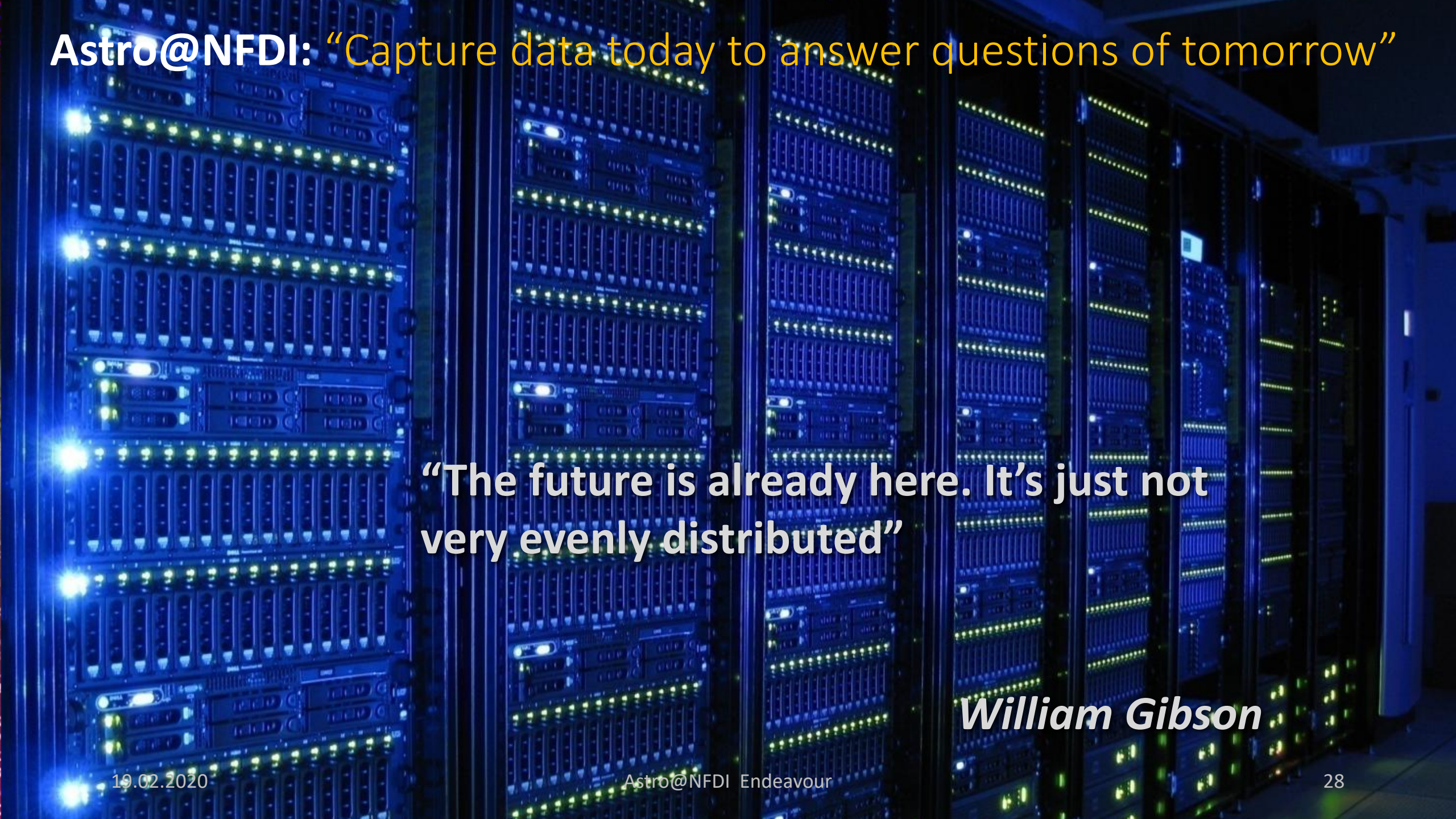
19.02.2020

Astro@NFDI Endeavour

26

Astro@NFDI: “Capture data today to answer questions of tomorrow”

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- Ready-to-go exploratory development platform for data-driven science
- Professionally managed like a large instrumentation project
- With a long record in data management, accessibility, interoperability and reusability



Astro@NFDI: “Capture data today to answer questions of tomorrow”

“The future is already here. It’s just not very evenly distributed”

William Gibson