



IDOC : Integrated Data & Operation Center

- Context
- Ambitions, Strategy, Responsibilities, Budgets
- Projects
- Infrastructure
- Satellite operations
- Mission and processing center
- Access interfaces and virtual observatory
- Certifications and foresight
- IDOC key points
- AOB

Environment : constraints

IDOC .

At the heart

- of the IAS
- the OSU Paris Saclay.
- the P2IO labex.
- Université Paris Saclay

Demanding context of space missions

International consortia

Budgets: Juice mission: > 650 M€.

Majis instrument: > 80 M€

Strong long term commitments

Open Science, FAIR, RDA, VO,...

Interlocutors .

- Other French and foreign space laboratories
- Space agencies: CNES, ESA, NASA, JAXA, CSSAR, FKA,...
- Industrialists in the computer or space sector

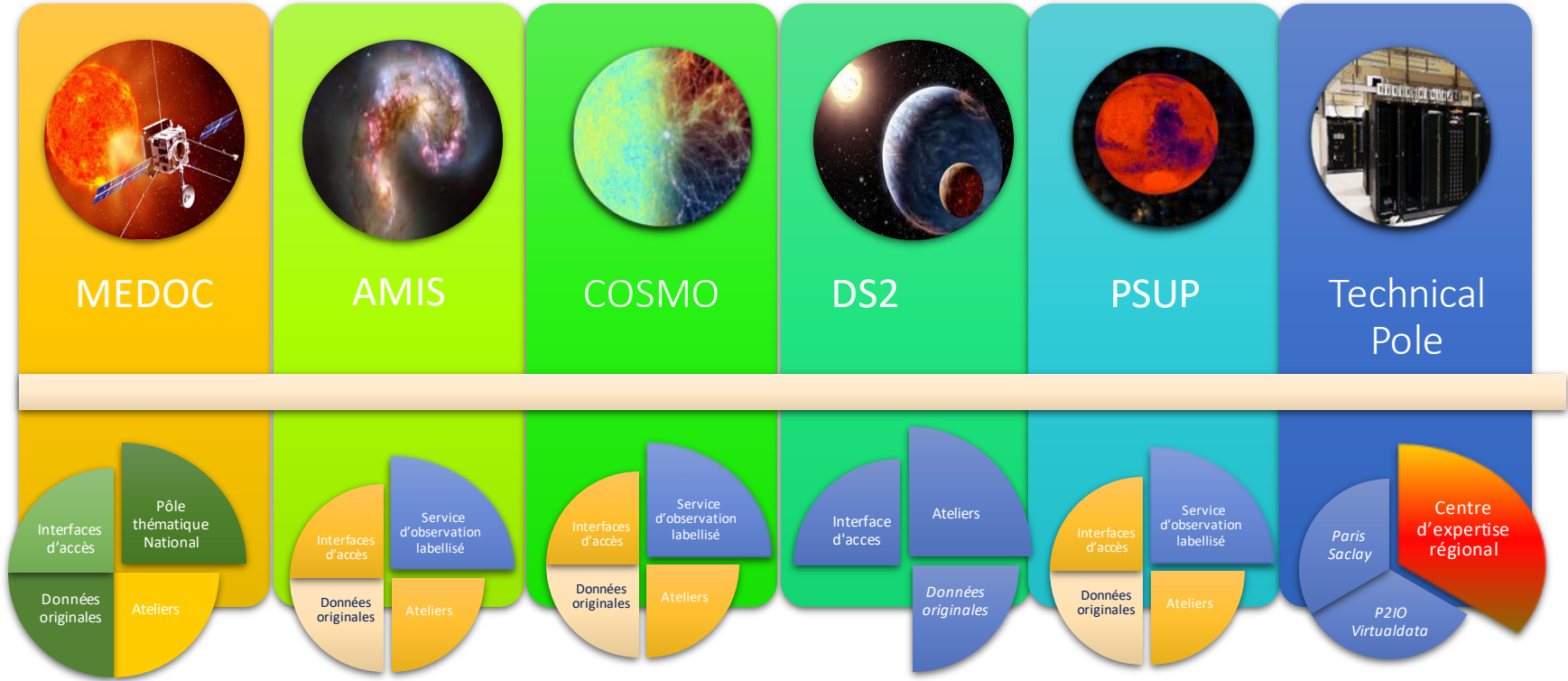
Supervisory authorities :

- Université ParisSaclay
- CNRS
- (CNES)

Funding sources :

- INSU, Université Paris Saclay, Conseil général,...
- CNES, Europe, Space Agencies,
- Average annual budget: >2 M€ (with staff)

IDOC : Ambitions

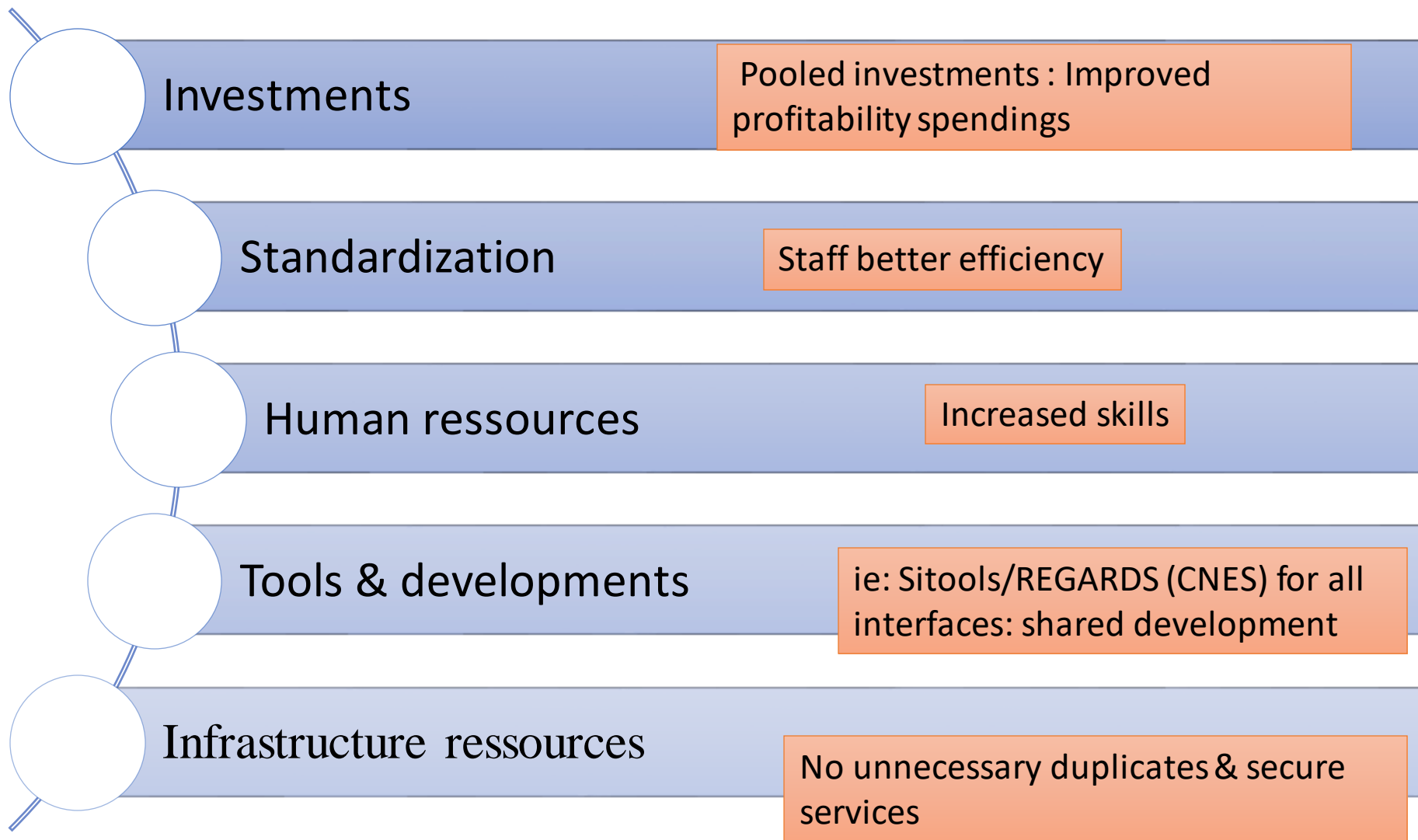


Ensure existing services and enable the emergence and visibility of new instrumental and observation services

Continue/Advance: Be recognized by a growing community as a center of expertise in supporting space missions, interpretation, access and preservation of their data

Allow a positioning for future missions

Strategy : Enhance capabilities with mutualization



Convince all stakeholders to validate and support the strategy strategy that has made it possible for IDOC to meet its commitments.

IDOC : Governance

IDOC is structured around 3 components:

1. Governance, management :

- Steering Committee.
- Scientific Manager.
- Technical Manager
- Coordinators of the different themes

Governance of IDOC resulting from .

- The recommendations of the OSUPS Board of Directors
- Recommendations of the thematic steering committees

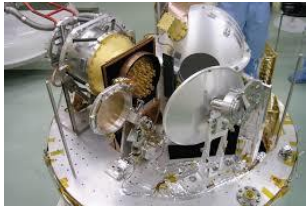
2. A technical pole

3. Autonomous scientific themes

The axes appoint a Scientific Coordinator to represent them in the IDOC steering committee

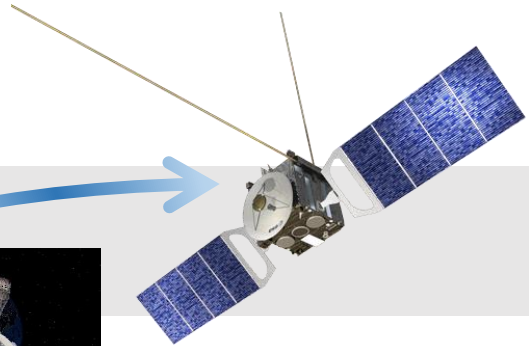
Note: MEDOC as a national thematic pole has its own steering committee and user committee

What types of projects



Before launch

0) Instruments conception & tests



1) Instrument Operations



Ground Segments

2) Pipelines

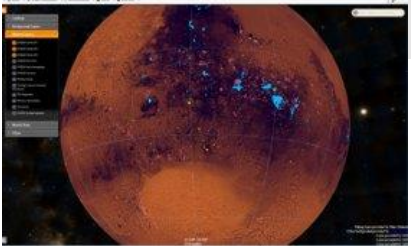


External data providers

Data Centers

3) Datasets, interfaces, tools, virtual observatories

4) Medium & long term Archive

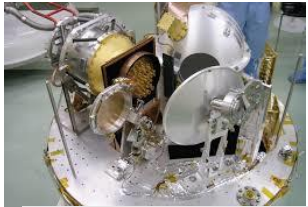


Scientific community

Outreach

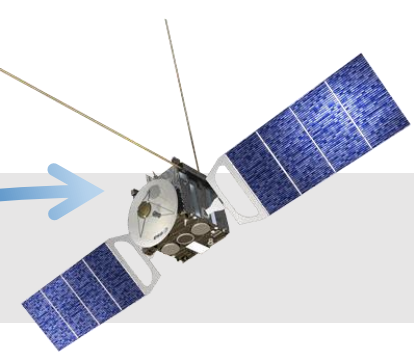


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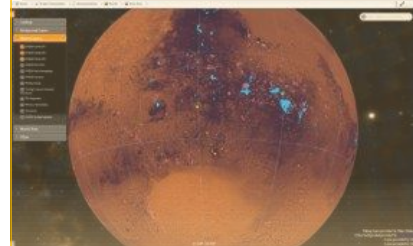


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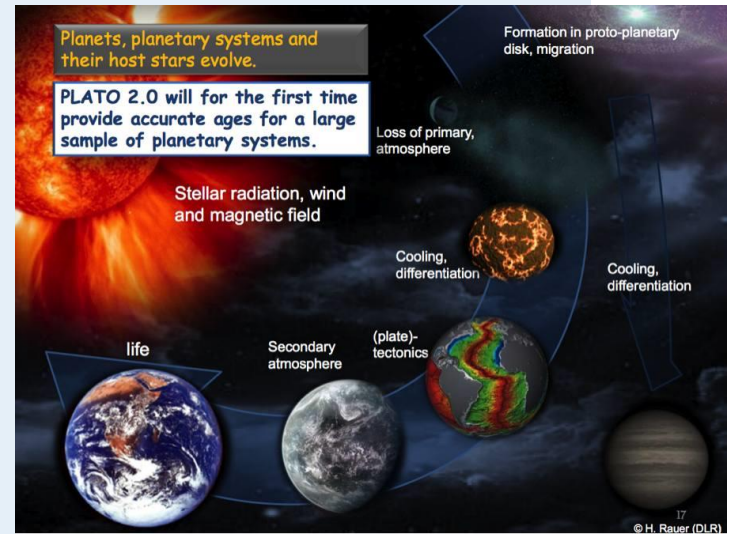
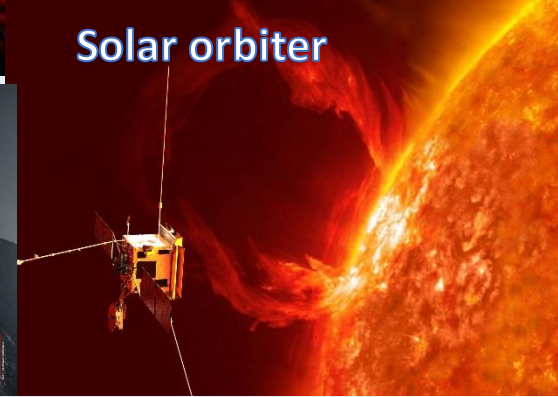
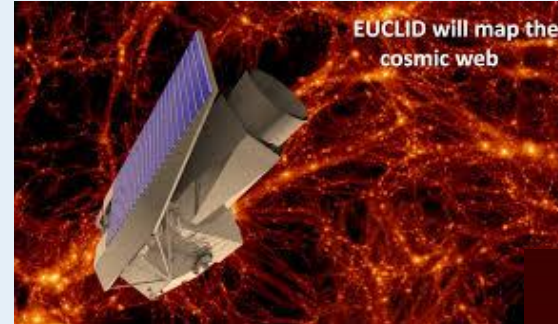
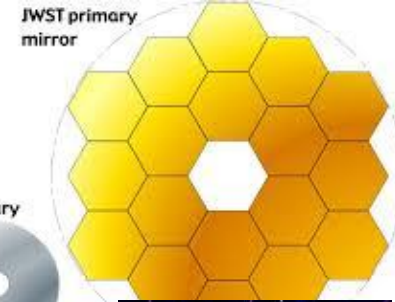
CoreTrustSeal certification

International space programs

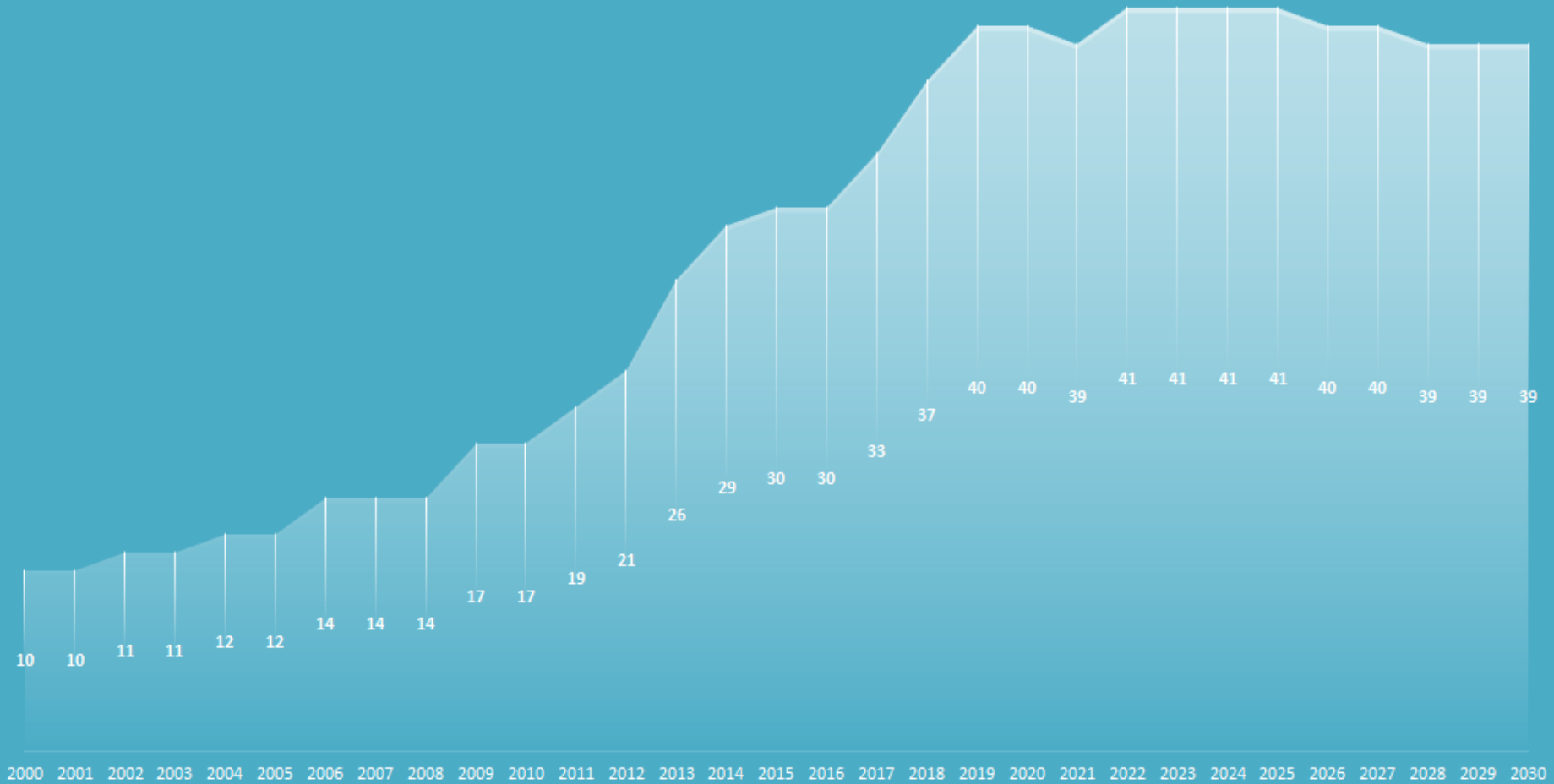
- In préparation :
WST, Euclid, Plato,
Juice, Bepi-Colombo,
Jovial, Exomars..

- Ongoing operations :
Mars-express,
SoHo, Stereo, SDO,
Solar Orbiter

- Under treatment : Rosetta,
CoRot, Planck, Herchel,
Trace, Coronas, Picard, Iras

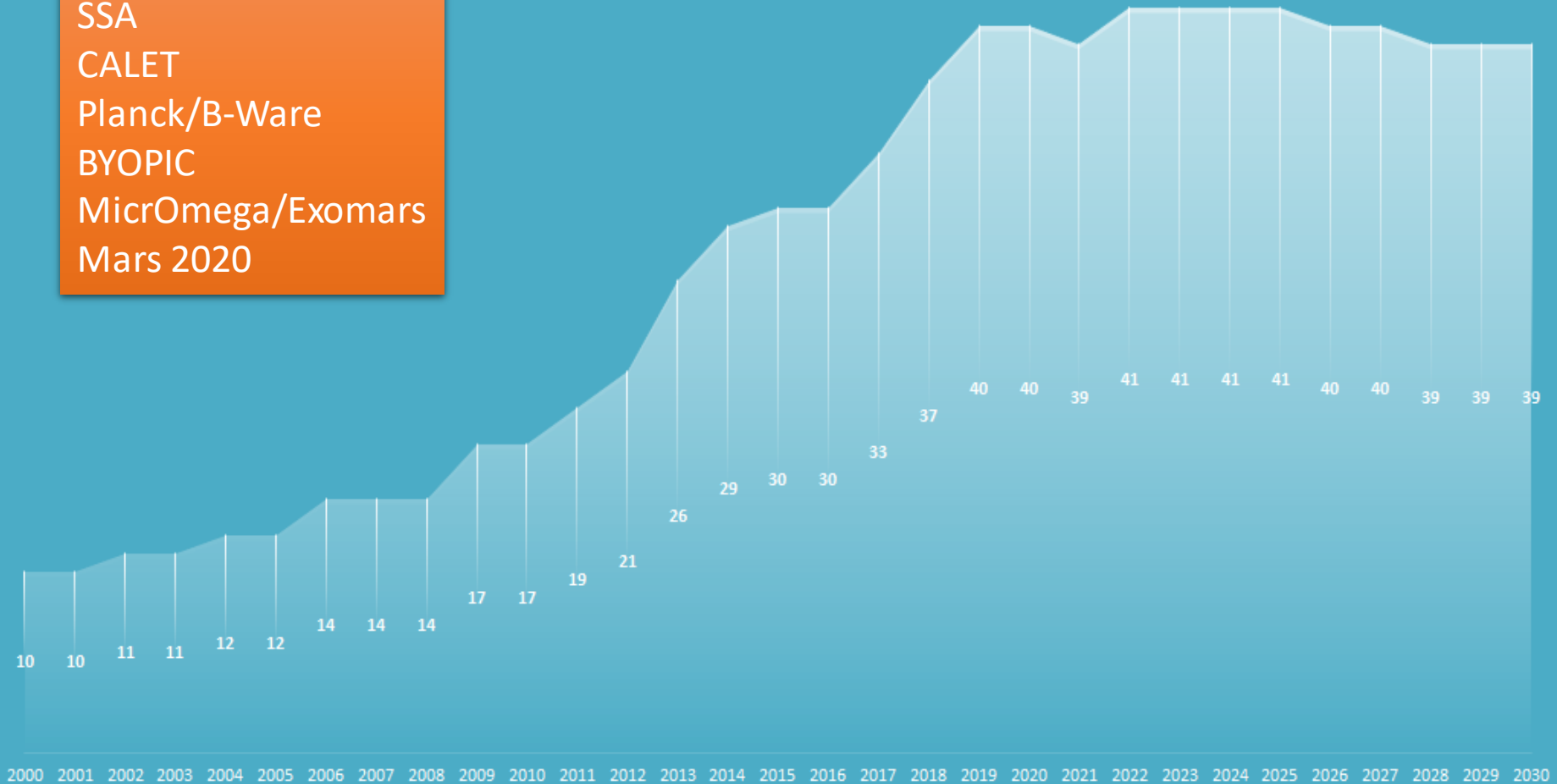


How many IDOC projects



How many IDOC projects

Jovial
SSA
CALET
Planck/B-Ware
BYOPIC
MicrOmega/Exomars
Mars 2020



Budgets



Purchase value of the infrastructure taking into account the IAS share in the mutualisations

1 888,50 € K€

Total repurchase value of mutualized infrastructure

5 060,50 € K€

Average annual budget with staff

2 159,10 € K€

Average annual budget without permanent staff

899,1 K€

Annual funding

2 159,12 € K€

Annual funding without permanent staff

899,12 K€

Annual recurrent funding

512 K€

Non recurrent smoothed funding

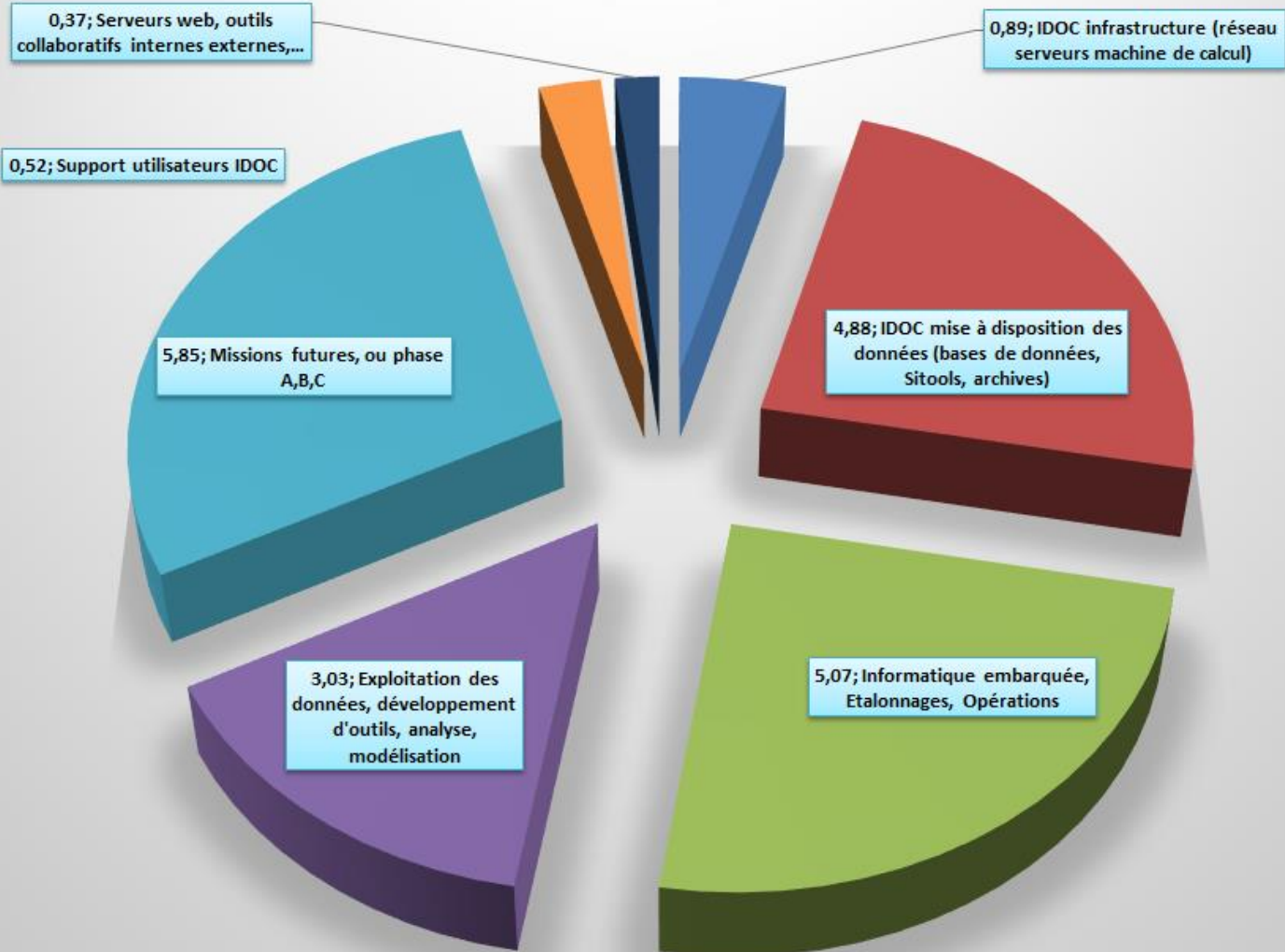
387,12 K€

Staff/operating ratio

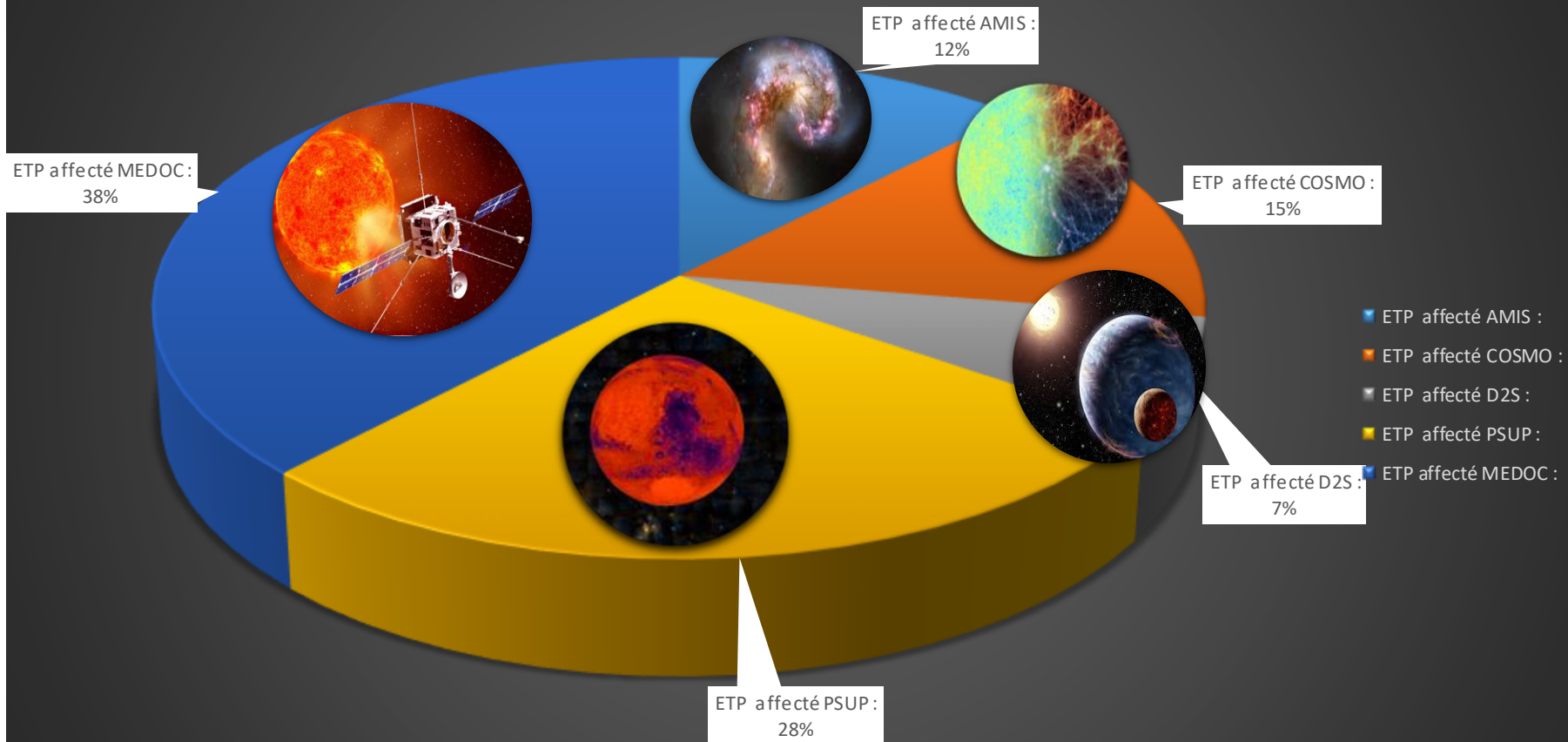
58%

Human resources : 8,6 permanents, 15,2 temporary

Répartition des ressources humaines par type d'activité (etp;type d'activité)



Distribution of human resources by scientific theme



Human resources: Skills implemented

Information systems engineering	2,8 etp
Technical and production engineering	1,4 etp
Software engineering	15,4 etp
Scientific computing	1,4 etp

Project manager or expert in information systems engineering

Project manager or infrastructure expert

Application manager

Software architect

Software developer

Webmaster

Webdesigner

Big Data Engineer

Cloud Engineer

AI Engineer

Real Time Developer

Database administrator

Computer security expert

Information system consultant

IT support manager

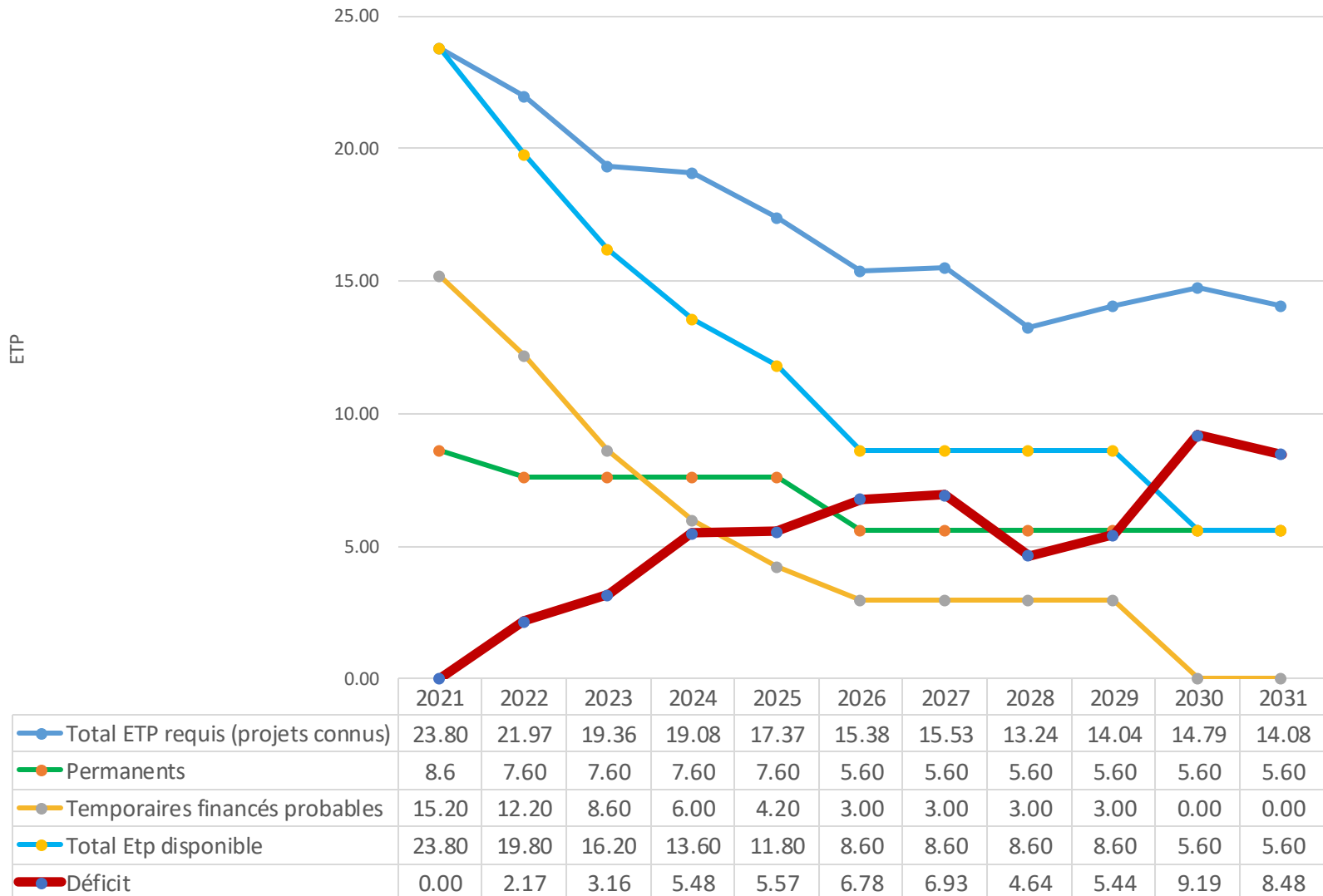
Industrial computer scientist

IT Quality Engineer / IT Methods

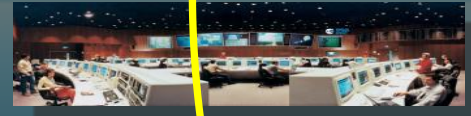
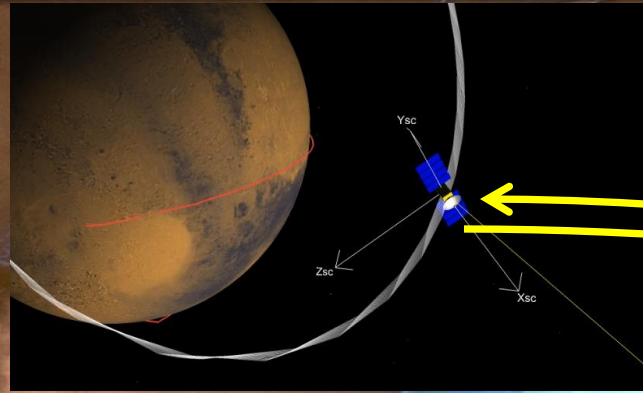
...

Human resources: currently, we have 1 permanent for \approx 2 temporary staff

IDOC Human resources: next 10 years



IDOC : In-Flight Operations : OMEGA



Ancillary Data

ESOC DDS Darmstadt
L0 Data

Telecommand validation

Omega :
Orbit planning
&
TC generation

- APID packet routing
- Sort and update
- Decompression and checking
- PDS format
- Geometrical data computation
- Data delivery : Archiving,, Access control
- Data treatment

OMEGA Storage

L1 data
L2 data
L3 data

PDS Format, Validation

External access (dedicated CO-I interface)

ESAC Archive

IDOC operations and pipelines : OMEGA example

Solar position

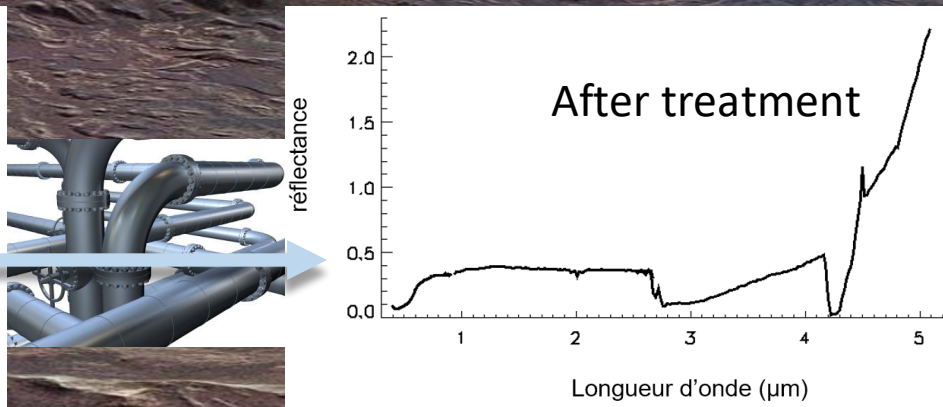
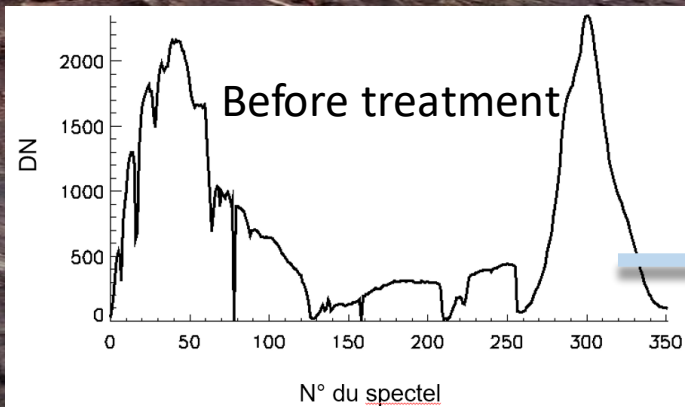
Satellite position

Displacement speed

Altitude
+

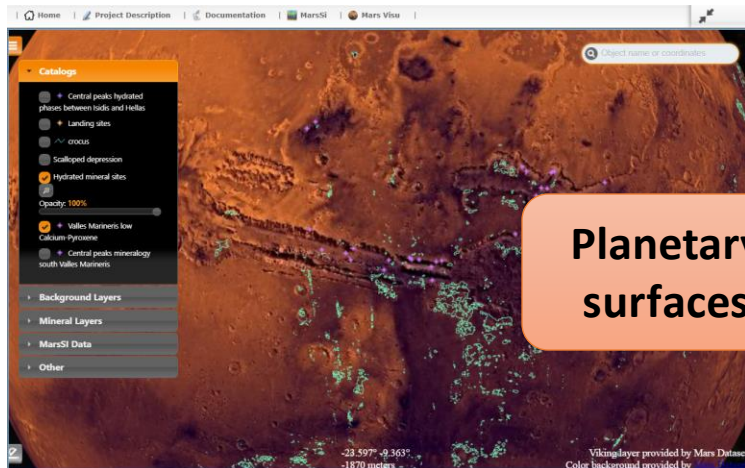
Ground topography

Fine ground texture

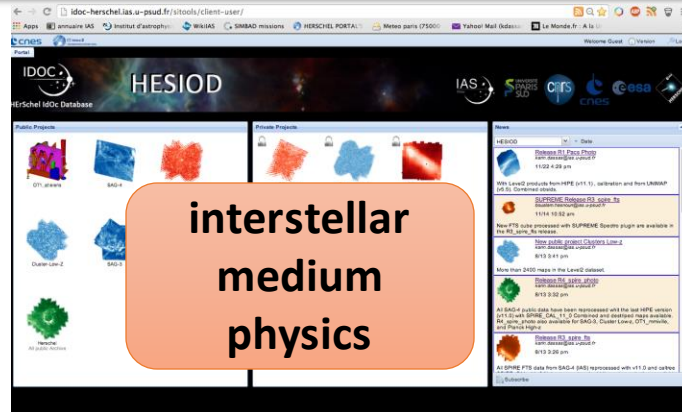


Datasets, interfaces, manipulation tools, virtual observatories

CNES common tool
Sitools -> Regards
(First stable release, open source)



Planetary surfaces

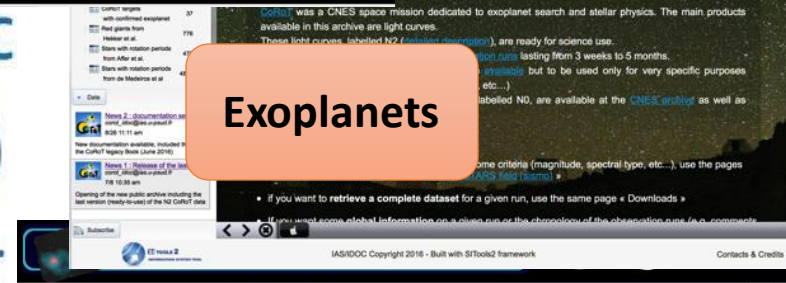


interstellar medium physics

UWS
TAP
GeoJSON
faceted filtering.

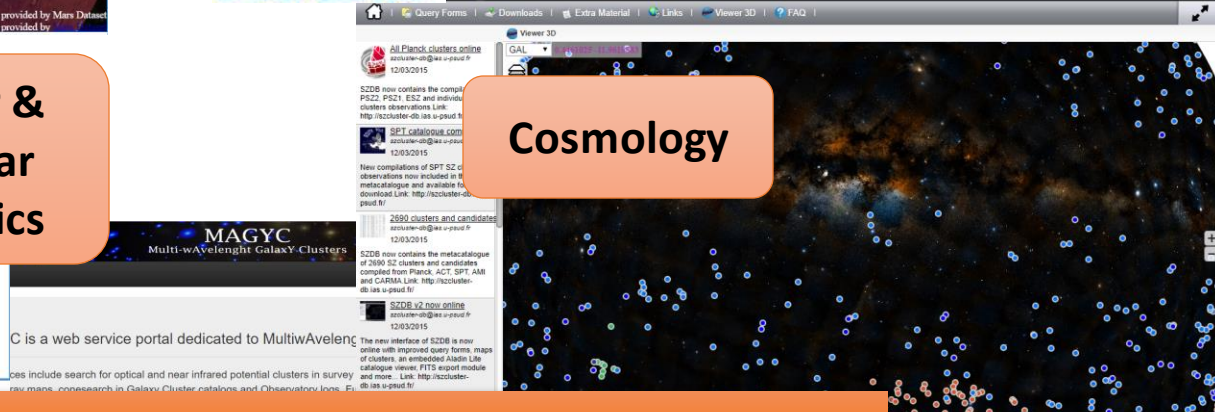


Exoplanets



Solar & Stellar physics

Cosmology



Open Science, FAIR data, OAIS standard, OV standards, DOIs

IDOC : Deliverables

23 instruments

7 Pipe-lines, level 0, 1, 2, 3

13 access portals

63 identified datasets (DOIs)

Community software

SUPREME (+Plug-in HIPE)

SITools2-Astronomy-Extension, ..

Numerical Codes (DOIs)

IRGal

DustEM

Modele 1D de vent solaire, ..

Sky surveys

Carte CO Planck

Carte opacité galactique Planck

Carte émission poussière Planck

Galaxy cluster Planck, ACT, SPT
Red giants Corot

Catalogs

On-the-fly calculation
on two sites (IAS and OCA)
UWS protocol

Simulations

IRGal

DustEM

Vent solaire 1D..

Observation data integrated within the OV

Base de données Herschel HESIOD

Base de données Corot

Base de données SOHO, Stereo, SDO,
GAIA/DEM ..

Collaborations with other Virtual Observatories

Helioviewer mirror , Aladin mirror (CDS Strasbourg), ..

Ongoing : HELIO, Flarecast (FP7/H2020 european), Mizar (Planck),

Propagation tool CDPP /IAS

IDOC : Delivred

Total upload

2894 Go

Countries

124

Visits

80952

Visitors

38275

Pages

3224927

Hits

4908635

French pages

270477

French visitors

2737

French visitors/visitors ratio

7%

Important note: Accesses via virtual observatories or direct accesses (from a program) are currently not accounted (Regards?)

IDOC : prospective strategy and certification process

- Develop skills
- Respond to quality concerns.
- Gain in efficiency
- Strengthen visibility and confidence

#CodeClub

network of computer scientists :
Regional, national

- OAIS
- ITIL guidelines
- Ongoing CoreTrustSeal certification
- DOIs (Digital Object Identifier) for each identified dataset



Durability of the data

- Organize the content
- Ensure stability
- Organize the referencing
- Certify the origin
- Describe the context precisely
- Long term data curation



Specificities of the space domain

- Data sometimes impossible to reproduce
- Volumetrics : number of files or records
- Complex formats (Jpeg2000) or specific formats (PDS, FITS,..) : convergence (HDF5, ...)
- Preserve the scientific use

IDOC

1 petabytes 2015

4 petabytes 2018

2025 ? 2035 ?

New technologies

A 3D visualization of a brain scan, likely an MRI or CT scan, showing a cross-section of the brain. A purple, T-shaped structure is highlighted, with three numbered circles (1, 2, and 3) indicating specific points of interest. The background is a textured, reddish-brown surface, possibly representing the brain's surface or a specific layer of tissue. The overall image has a dark, high-contrast aesthetic.

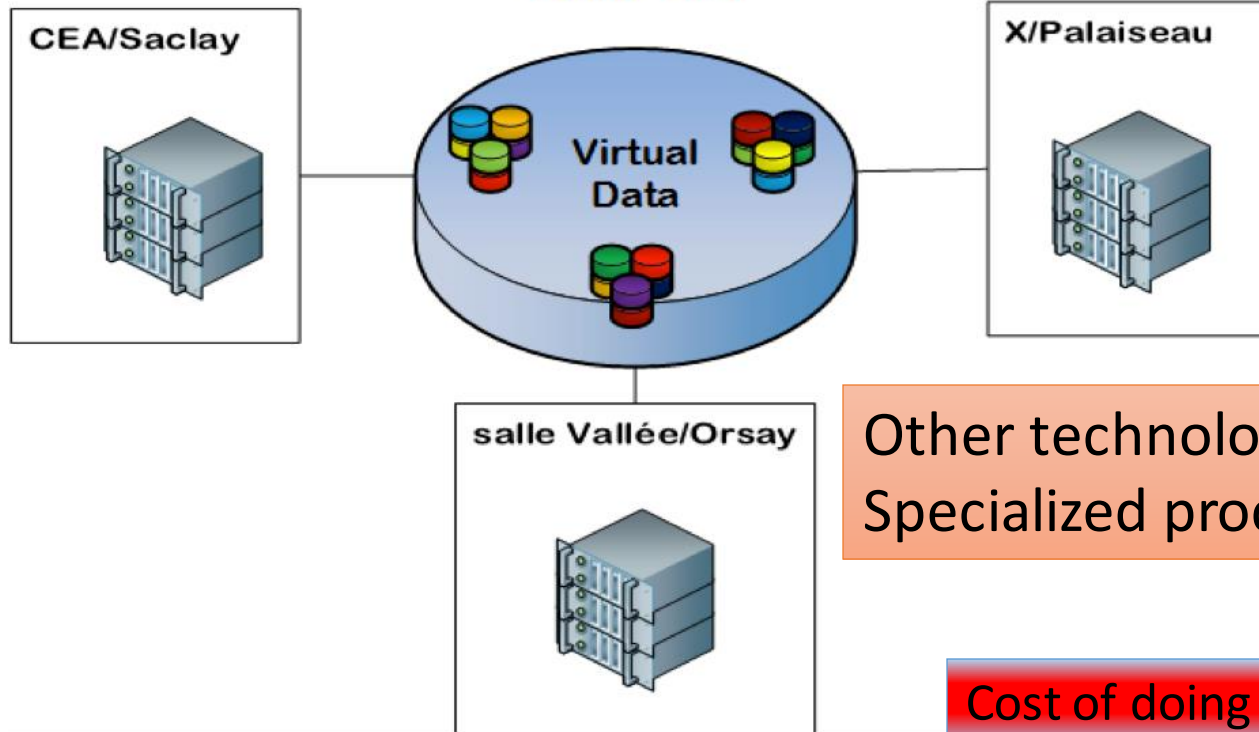
- Highly resilient distributed storage
- Machine learning
- GridCL network
- 3D reconstruction
- 3D Visualization
- Cloud/ Big Data
- Development tools

Example of a technological leap: P2IO distributed storage architecture

IDOC is a pioneer in these technologies

- CEPH for virtualization at IDOC since 2015
- CEPH for distributed storage in early 2017
- Cloud OpenStack (+450K€ Common IJCLab/Virtualdata 2021)
- Machine learning Deep learning

Data-NG



Other technological leaps to come.
Specialized processors ?

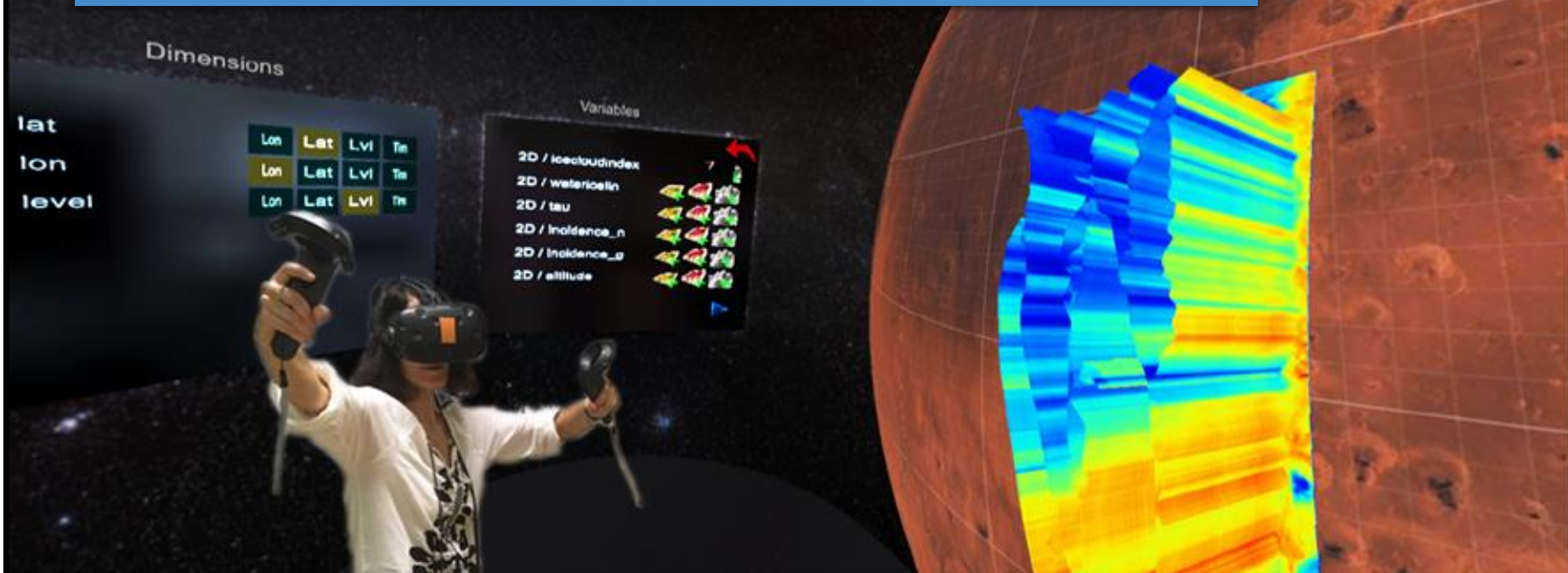
Cost of doing business

Projects and software: trends

Accès aux données :

- Easily aggregate new types of data (data cubes, models, etc.)
- Develop the use of new technologies (faceted search, processing services, etc..)
- Allow the full use of data

Integration of virtual observatory standards



Example: visualization

Develop the use of new technologies to produce new modes of data exploration

Multi-user, multi-dimensional visualization - R&T file

Development tools

Integration of a complete range of "Quality" tools

- Project management
- Intelligent development assistance



Gestion
documentation



Redmine



Gitlab



Jenkins



Gitlab-CI



Intégration continue



Gestion de
tickets



Redmine



Gitlab



Nexus



Référentiel
d'artefacts



Gestion de version



svn



Gitlab



Sonarqube

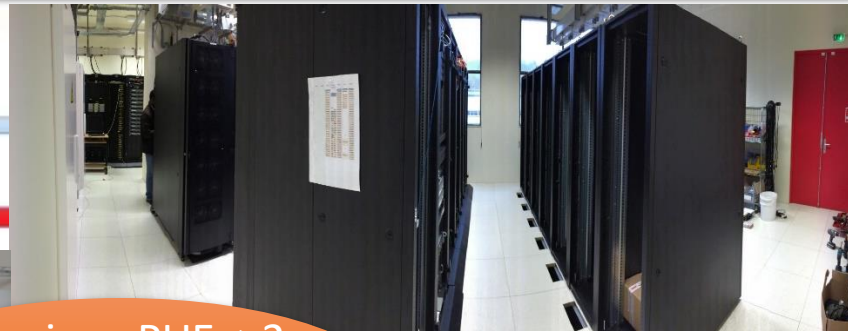
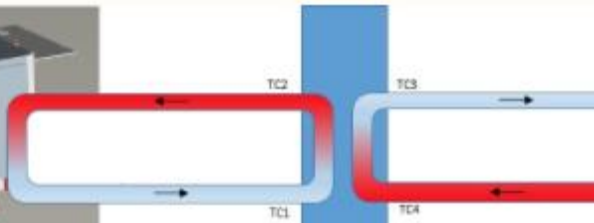


Analyse qualité

P2IO " Valley " room

IDOC virtualdata incentive incubator

- Feasibility study conducted in late 2012
- Initial implementation 2013
- Joint development of competence networks
- Governance documents
- 500 physical servers, 8000 cores, 5 PB of data
- Expansion x2 completed 2020



Previous PUE >2
Reached PUE :
< 1,3

Global budget 1st phase 1M€.
2nd phase : 2,3 M€.
Return on investment: 3 years



Level of service and cost-effectiveness impossible to achieve without mutualization.

IDOC : achievements



- IDOC includes MEDOC which is the "Thematic Pole of Solar Physics" (partnership agreement between CNES, INSU, and the University of Paris-Saclay)
- IDOC is at the heart of the "planetary surfaces" pole resulting from the reflection of the PNP
- IDOC is the mission center of the SPICE instrument of the Solar Orbiter mission and will be the mission center of
 - the Majis instrument of the JUICE mission
 - the Plato mission.
- IDOC is the driving force behind the development of the Sitools framework and its successor REGARDS under CNES project management, which is at the heart of the access interfaces.



université
PARIS-SACLAY

DÉPARTEMENT

Sciences
de la Planète
et de l'Univers

Creation 01/01/2005,

Certification as a regional competence center: 01/01/2014

Certification as a long-term spatial data archiving center: September 2016

INSU platform: summer 2018

CoreTrustSeal Certification: in progress