Acquisition and Control System Engineering team

Yves-Marie ABIVEN, on behalf of ISAC team

MAXIV 7-9 October 2024

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Outline

- SOLEIL Upgrade
- ISAC Team organisation
- Technical approach for the team
- Quality: tools, process and indicators
- ISAC integration into IT and Data management strategy
- Conclusion

SOLEIL Upgrade

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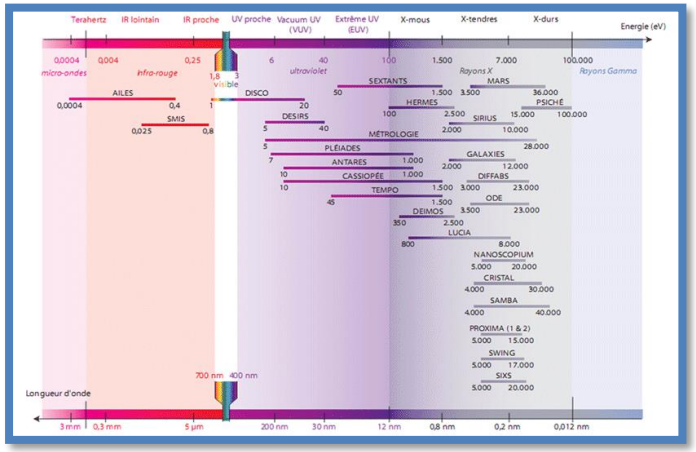
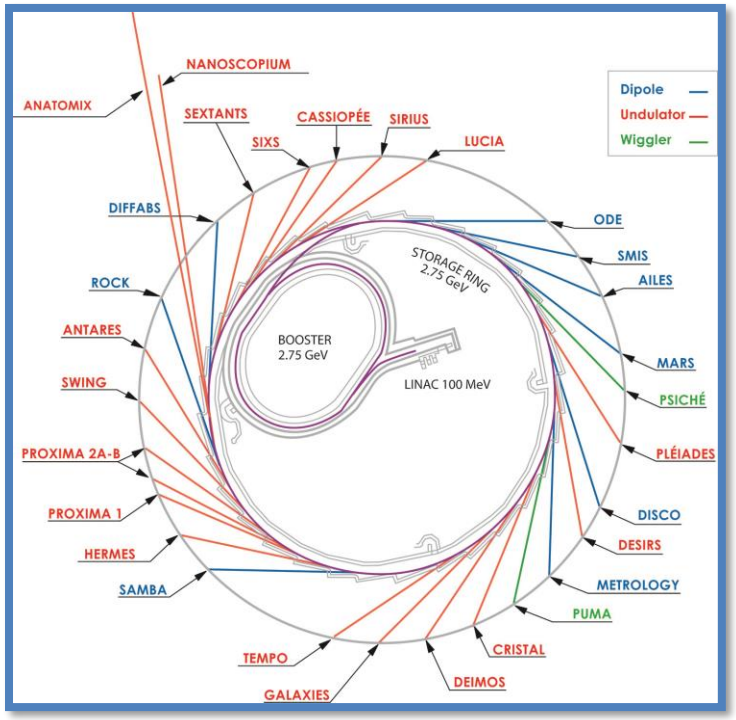
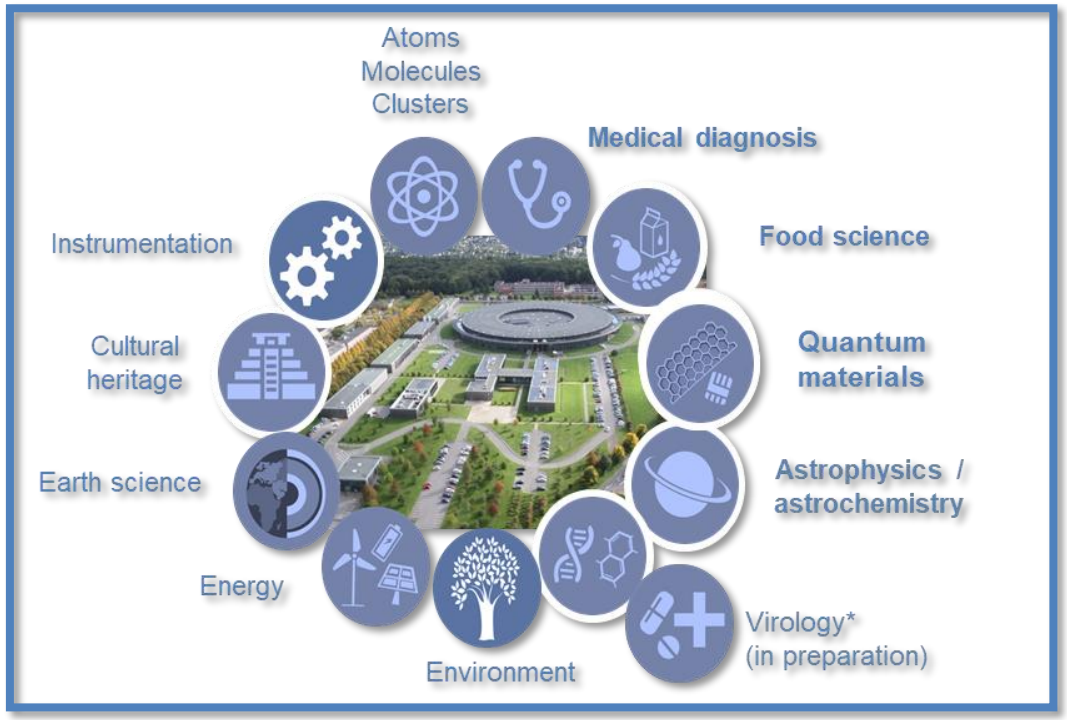
SOLEIL in a nutshell

- Storage ring 354m, 2.75GeV
- 29 beamlines
- 9 orders of magnitude in energy from far IR to hard X-rays
- Open to external users in 2008
- ~ 450 staff members







in 2022
~ 2746
single users
(~150 remote access)

More than
12 000
users since 2008

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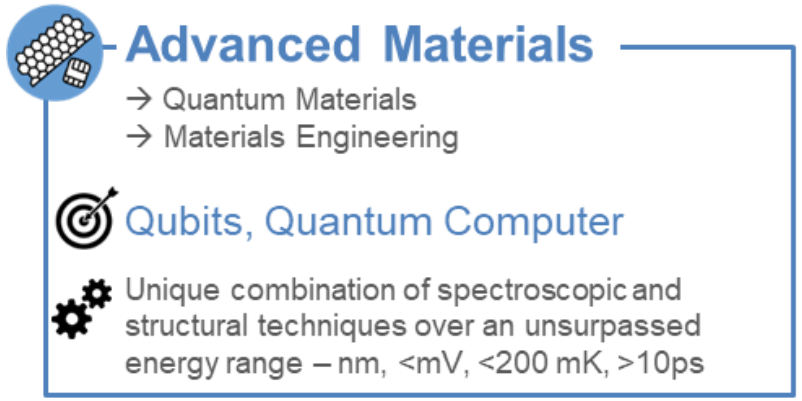
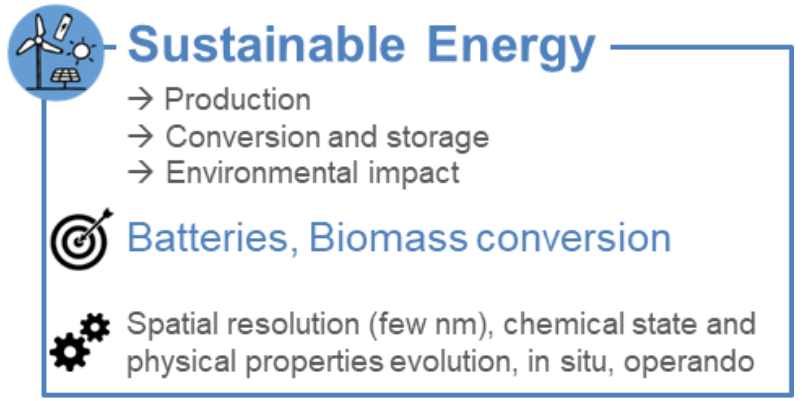
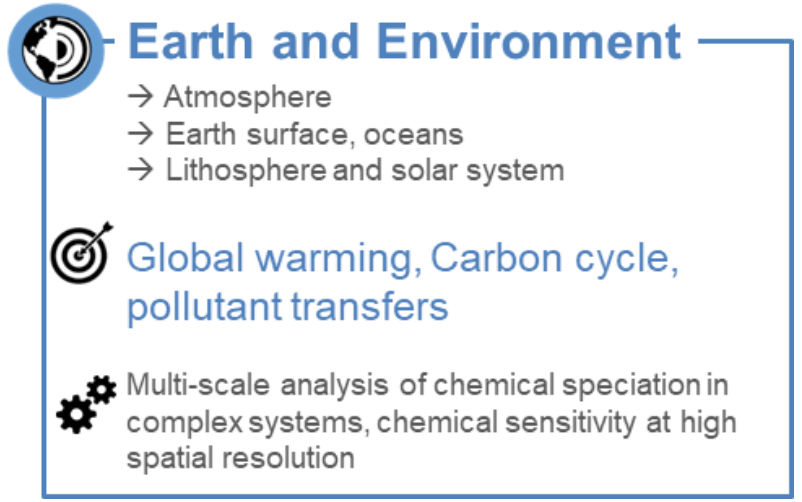
Science drivers

- **Major Upgrade** of the accelerators and Beamlines addresses new scientific and societal challenges
- The upgrade will bring the unique range of SOLEIL techniques to unprecedented **spatial and temporal resolutions**

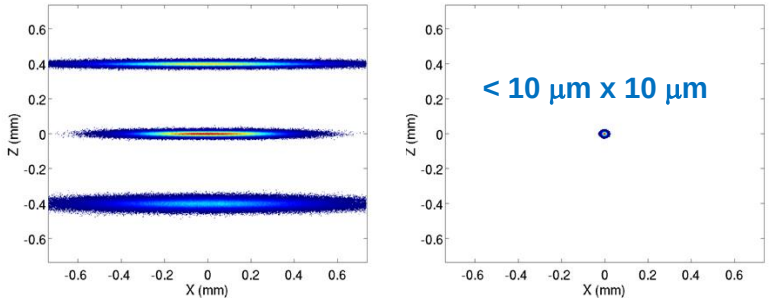




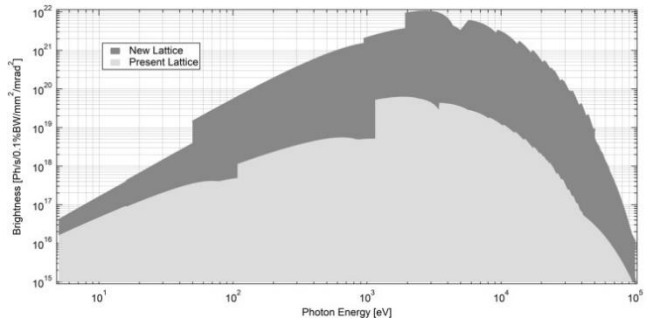


- Better performances for Accelerator and photon sources
  - Reaching an emittance **< 100 pm.rad.**
  - Keeping the same electron beam energy : **2.75 GeV**
  - Preserving a maximum current of **500 mA** in the multibunch mode.

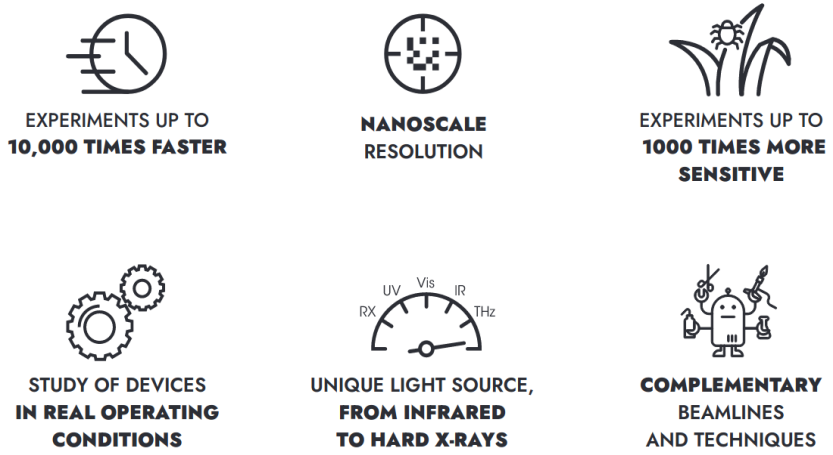
Beam SIZES



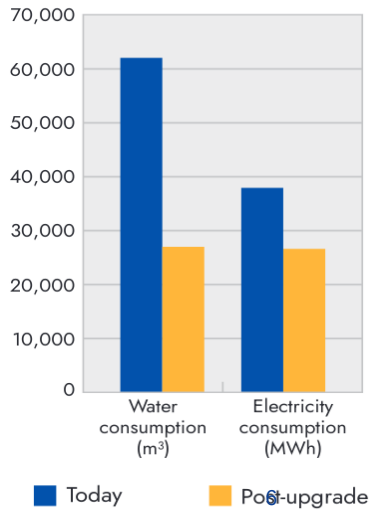
Brightness



- New access mode with **more efficient use** of the SOLEIL Beamline

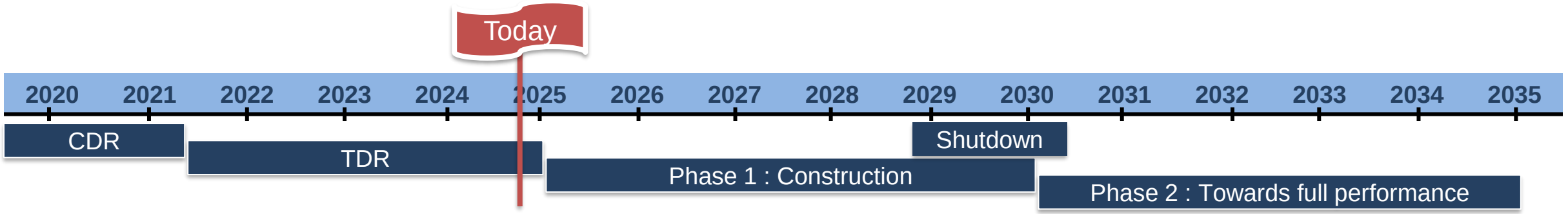


- Green infrastructure
  - Reduction in the facility environmental footprint
  - Lower power and water consumption
  - Reduce operational cost



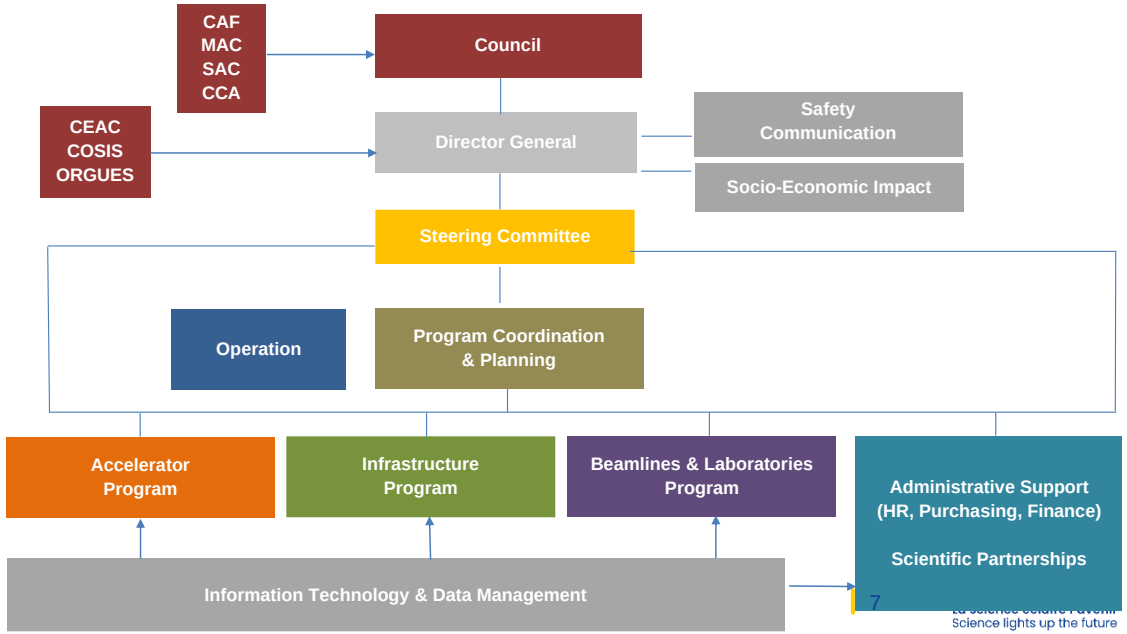
SOLEIL II

- Upgrade Timeline



- Team involvement in TDR organisation

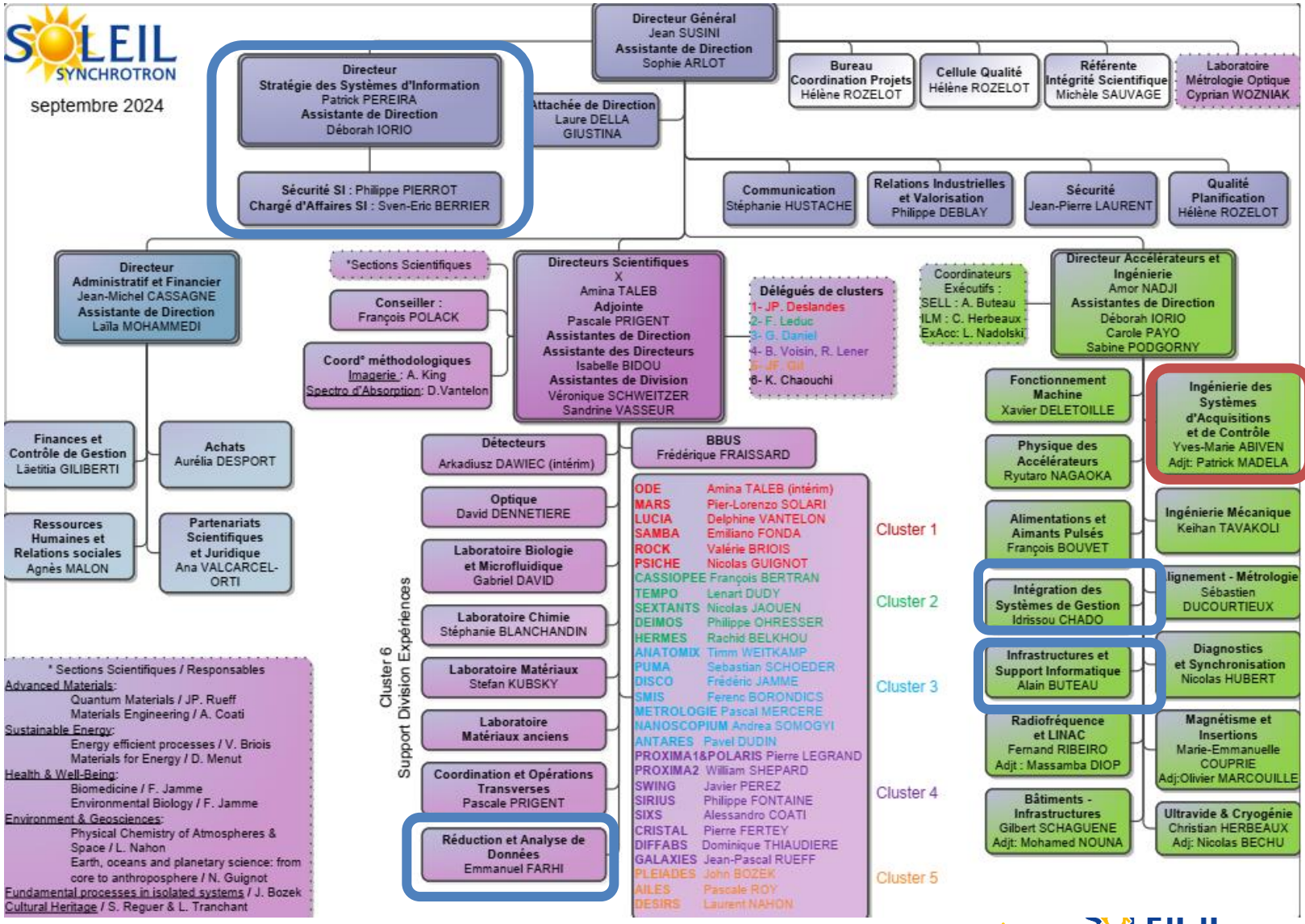
Team involvement



ISAC Team organisation

Computing group in SOLEIL organisation

- IT strategy in the general Direction
- Electronic and computing experts:
  - Accelerator and Engineering unit
    - Electronics Control Acquisition
    - Computing Control Acquisition
    - IT infrastructure
    - DataBase Managment
    - Service desk
  - Scientific unit
    - Scientific Analysis



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Acquisition- and Control Systems- Engineering Team

- The **Acquisition- and Control Systems- Engineering** team (**ISAC group**) is in charge of the **control- and acquisition- service architecture** in SOLEIL that **interconnects physical and virtual systems.** Our approach is to apply both proven and **new solutions & technologies** .

- Team objectives are to **gather insightful information** valorising technicals and scientifics Data. The team contributes to **Data acquisition, Data transport up to Data processing**.

- The team offers services on the whole **engineering cycle** :

  Specification, Support/Advices, development/deployment and MCO on the Control-acquisition infrastructure and services provided for **accelerators, beamlines systèmes and others SOLEIL's infrastructure**. The team builds solutions based on **industrials standards or de facto standard from our scientific ecosystem.**

- This work is done closely with Technical and scientifics users as well as **collaborations with academic, scientifics or industrials partners.**

ISAC members

- **22 team members** with multiskills…not exhaustive!
  - **9 Software** experts
    - 6 C++ Developers
    - 3 Java Developers
    - 1 Data Engineer (open position)
  - **11 Electronics & Embedded system** experts
    - 2 FPGA developers
    - 1 Electronic designer
    - 4 PLC developers
    - 3 Motion control developers(1 open position)
    - 1 Robotic developer
  - **5 Students** with work study contract
- In charge of
  - ~12000 Electronics devices (motion, cPCI, PLC, Robotics, …)
  - ~36000 Tango devices and ~12000 Device server started
- Involved in daily operation with **Oncall duty 24/7**:
  - Software
  - DaQ and motion control
  - PLC

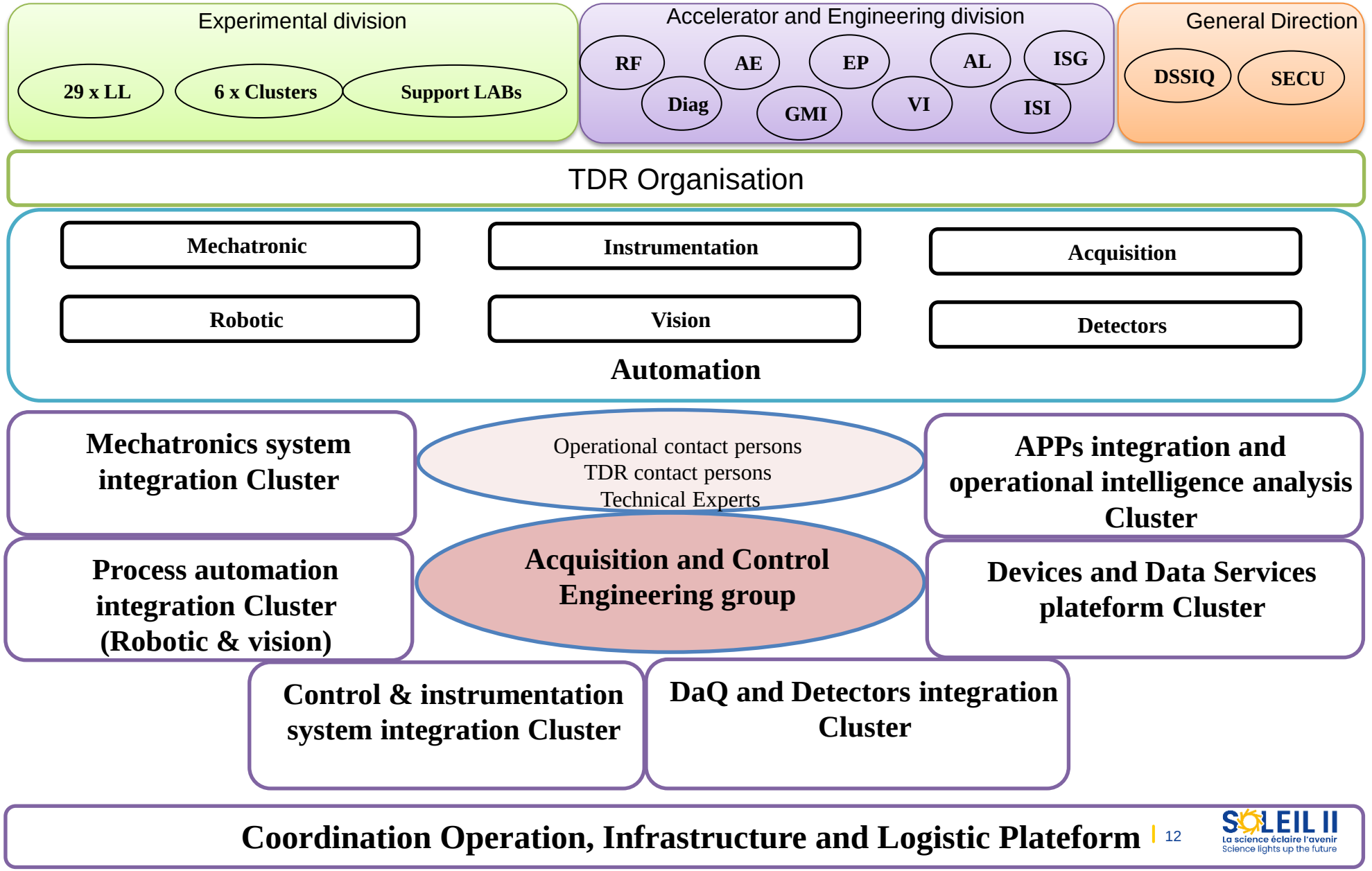
- **Transversal expertise**
  - Software architect
  - Mechatronic/Robotic designers
  - CI/CD integrators
  - Electrotechnical technicans
  - Operational coordinators
  - Project manager
  - Subcontractor manager

Team organisation

Teams with use cases requirements

Engineering developped to valorized data

Internal organisation



Technical approach for the team

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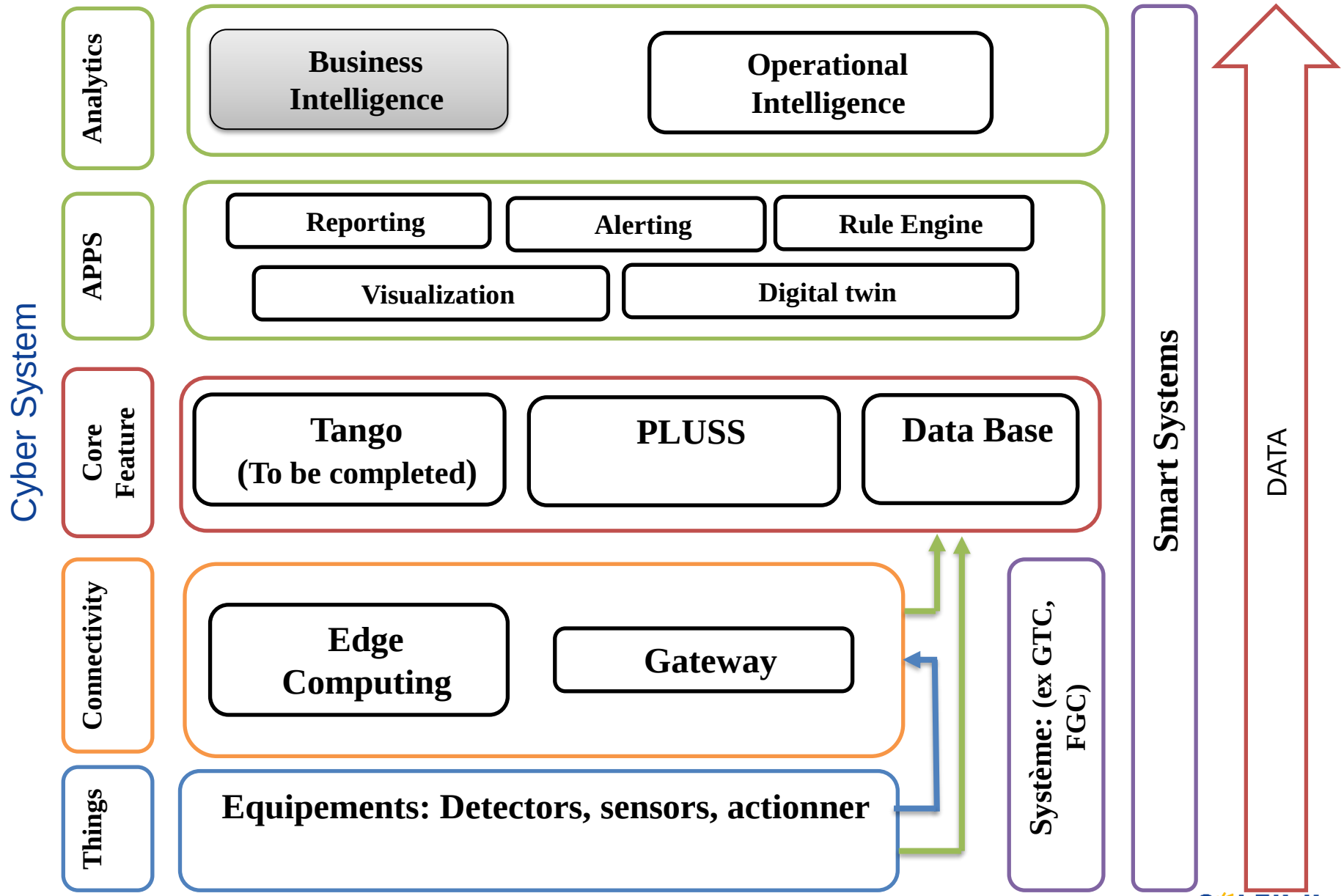
Global system approach – Data-Driven

- Understanding Accelerators and beamlines technics
- Sharing global overview from sensors up to data valorization
- Offering efficient architecture, well balance between Embedded system, classic software models and Advanced methods (IA, …)
- Security by design



Core Service plateform for SOLEIL II

- Service Platform
  - **TANGO, PLUSS, Data Sources managment. (See Datamanagment pres.)**

See Gwenaelle presentation

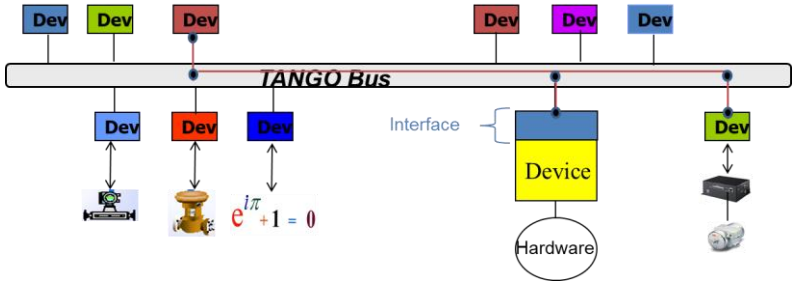
- Tango is FOSS
  - TANGO organisation
    - Tango is a consortium with 11 core members
      - ELI Beamlines, DESY, ALBA, ESRF, SOLEIL, SKAO, ELETTRA, INAF, SOLARIS, MAX-IV, SKA-ZA
    - Tango Controls is a free open-source device-oriented controls toolkit for controlling any kind of hardware or software and building SCADA (supervisory control and data acquisition) systems.
    - Operating system independent (built for Windows, Linux, MAC)
    - Supports C++, Java and Python.

- PLUSS
  - a scalable, reliable and event-driven data bus (or broker) deployed at facility scale (Kafka),
  - a document-oriented database acting as shared data repositories (mongoDB)
  - a features-rich API manager of data retrieval through micro-services (WSO2 API manager).

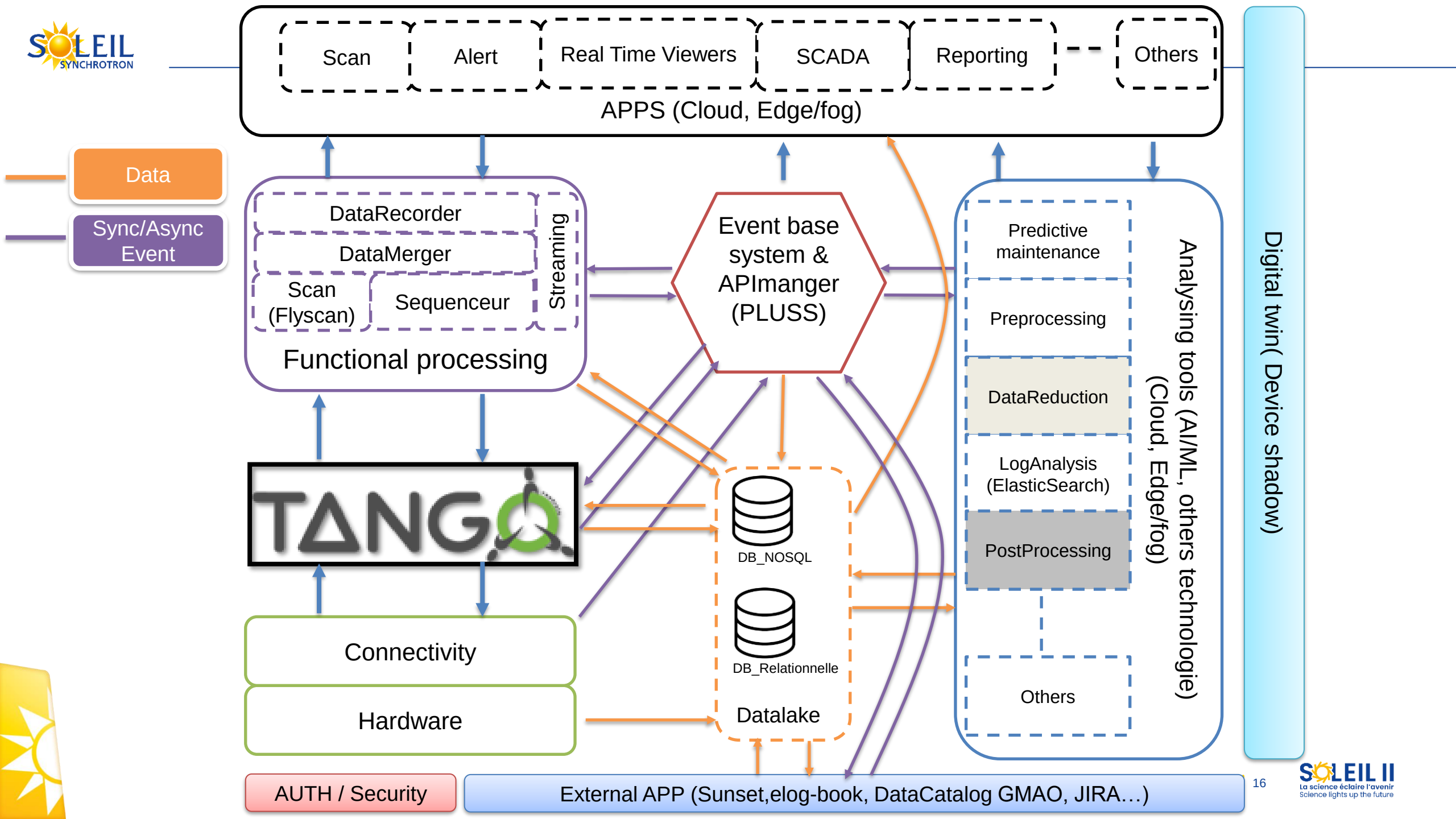
- Data Management
  - Scientific data and metadata collection
  - Technical data management
  - Work in progress about data catalog

  - Tango devices
    - An abstract concept : the «device», a server that provide an interface (or API) to remotely interact with.

    A device = a polymorphous object
    - Tango device provide a remote API that consist of « Commands » and « Attributes »
    - Runtime API introspection allows building generic clients (GUI, devices, scripts)
    - Support RPC communication (CORBA) and event communication (ZMQ)



https://www.tango-controls.org/
https://tango-controls.readthedocs.io/en/latest/overview/introduction.html


Scan
Alert
Real Time Viewers
SCADA
Reporting
Others
APPS (Cloud, Edge/fog)
Data
Sync/Async Event
DataRecorder
DataMerger
Scan (Flyscan)
Sequenceur
Streaming
Functional processing
Event base system & APImanger (PLUSS)
Predictive maintenance
Preprocessing
DataReduction
LogAnalysis (ElasticSearch)
PostProcessing
Others
Analysing tools (AI/ML, others technologie) (Cloud, Edge/fog)
Digital twin(Device shadow)
TANGO
DB_NOSQL
DB_Relationnelle
Datalake
Connectivity
Hardware
AUTH / Security
External APP (Sunset,elog-book, DataCatalog GMAO, JIRA…)

Quality: tools, process and indicators

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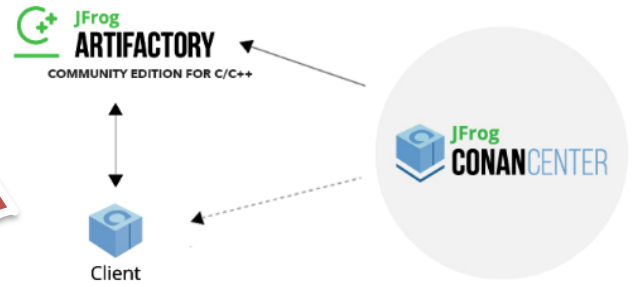
Quality tools

- Obsolescence of the Sofware building factory
  - Moving from SVN to Gitlab
  - maven to Conan
- Old C++ 03 to C++11 (and more)
- Tango 9
- CentOS 6 to centOS 7 (and next one?)
- 32bits (still remaining) to 64bits

upgrade in progress



See Soleil Computing and deployment presentation

Confluence

- Use for documentation
- Identify information about services and products provided
- Knowledge data base

MAINTI 4

- Manage Equipment in operation
- Hardware configuration
- Planned and corrective maintenance
- Tracking changes of the physical systems

See Maintenance and operational analysis presentation

- ITIL process implemented for SOLEIL
- Services and change requests centralized in a unique portal
- Agile methode use to treat the request (work in progress)

Jira

- Configuration lifecycle managment
- In house development features
- Settings/parameters files for systems in operation

- Project portfolio follow up

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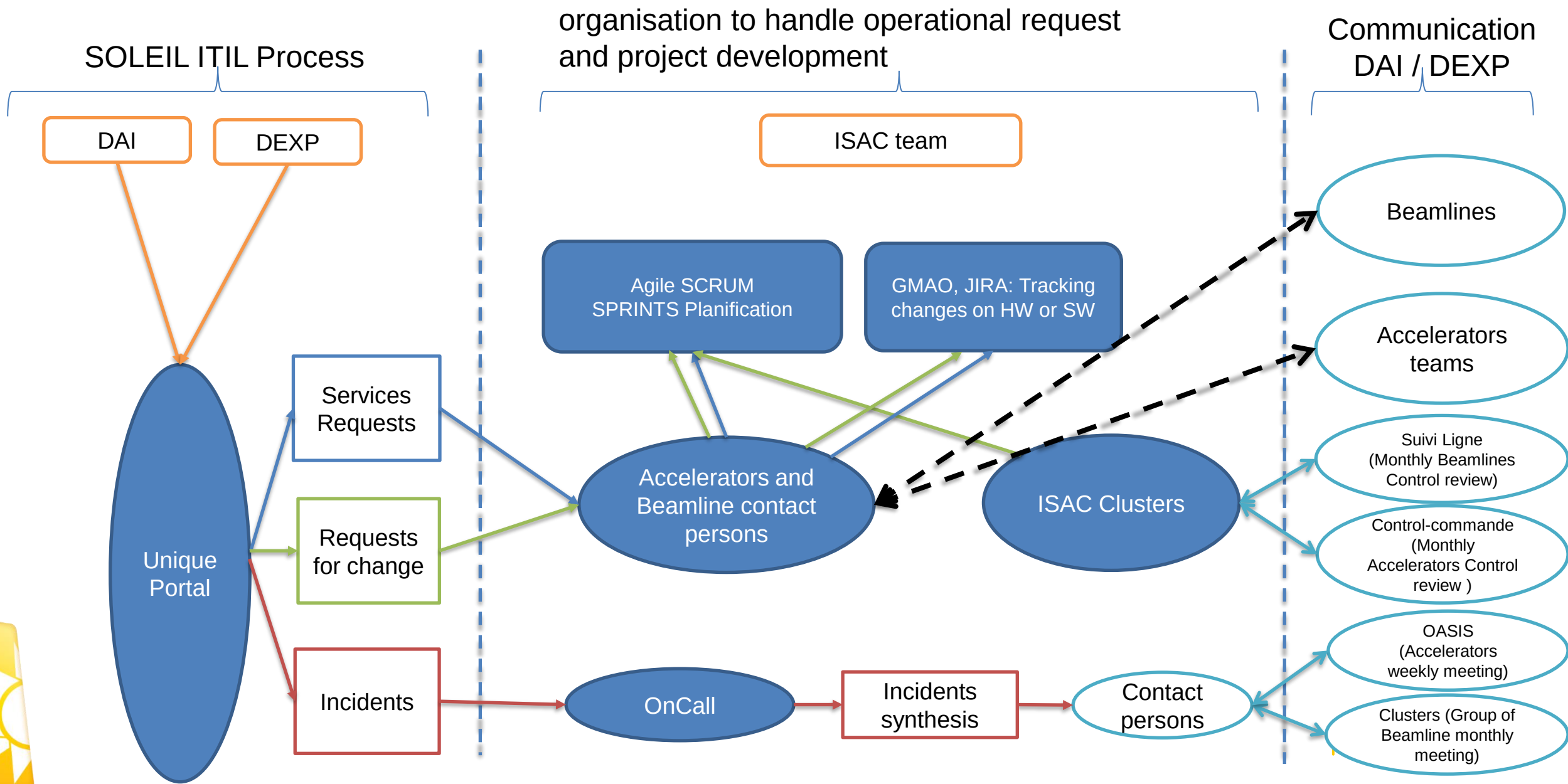
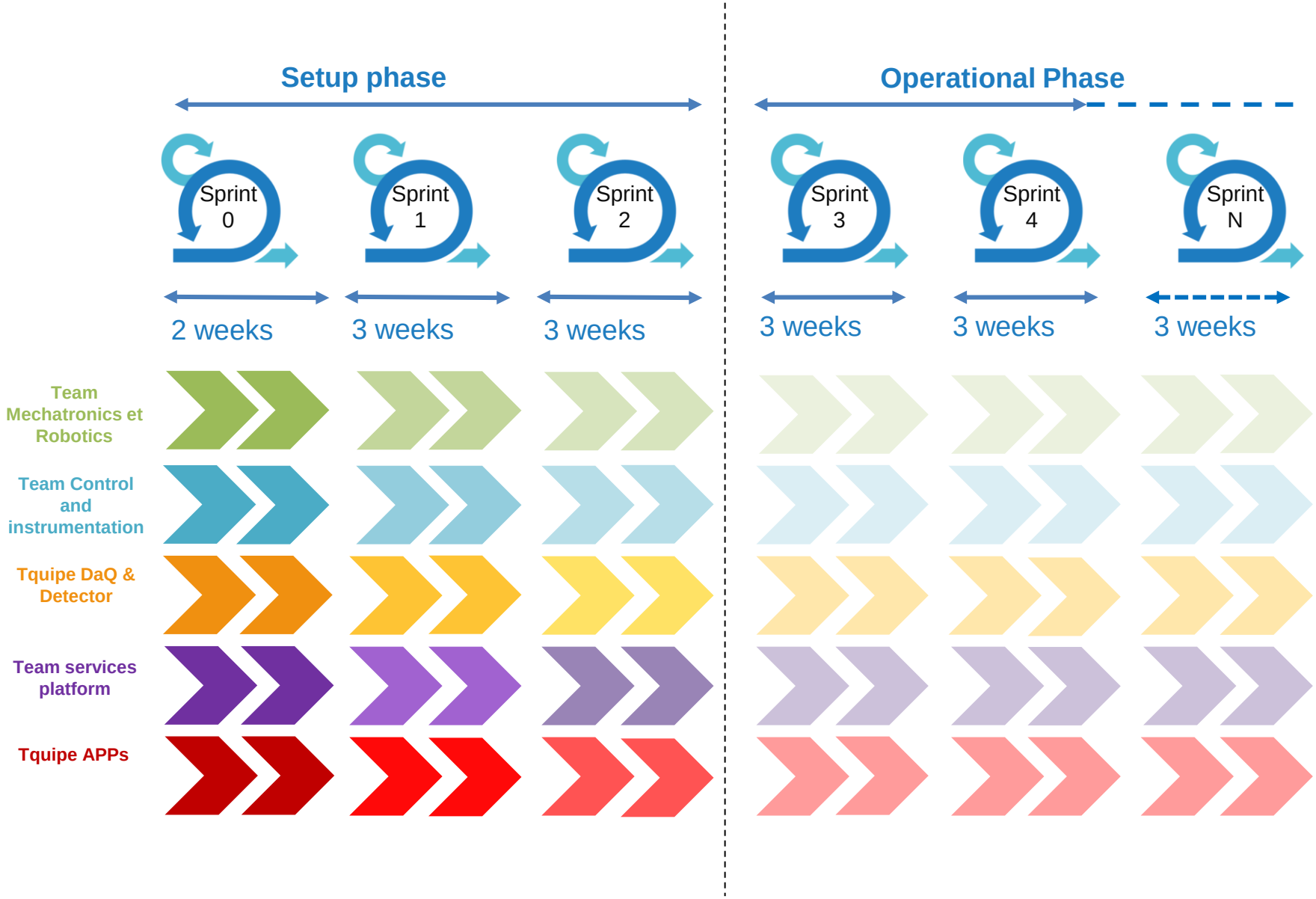
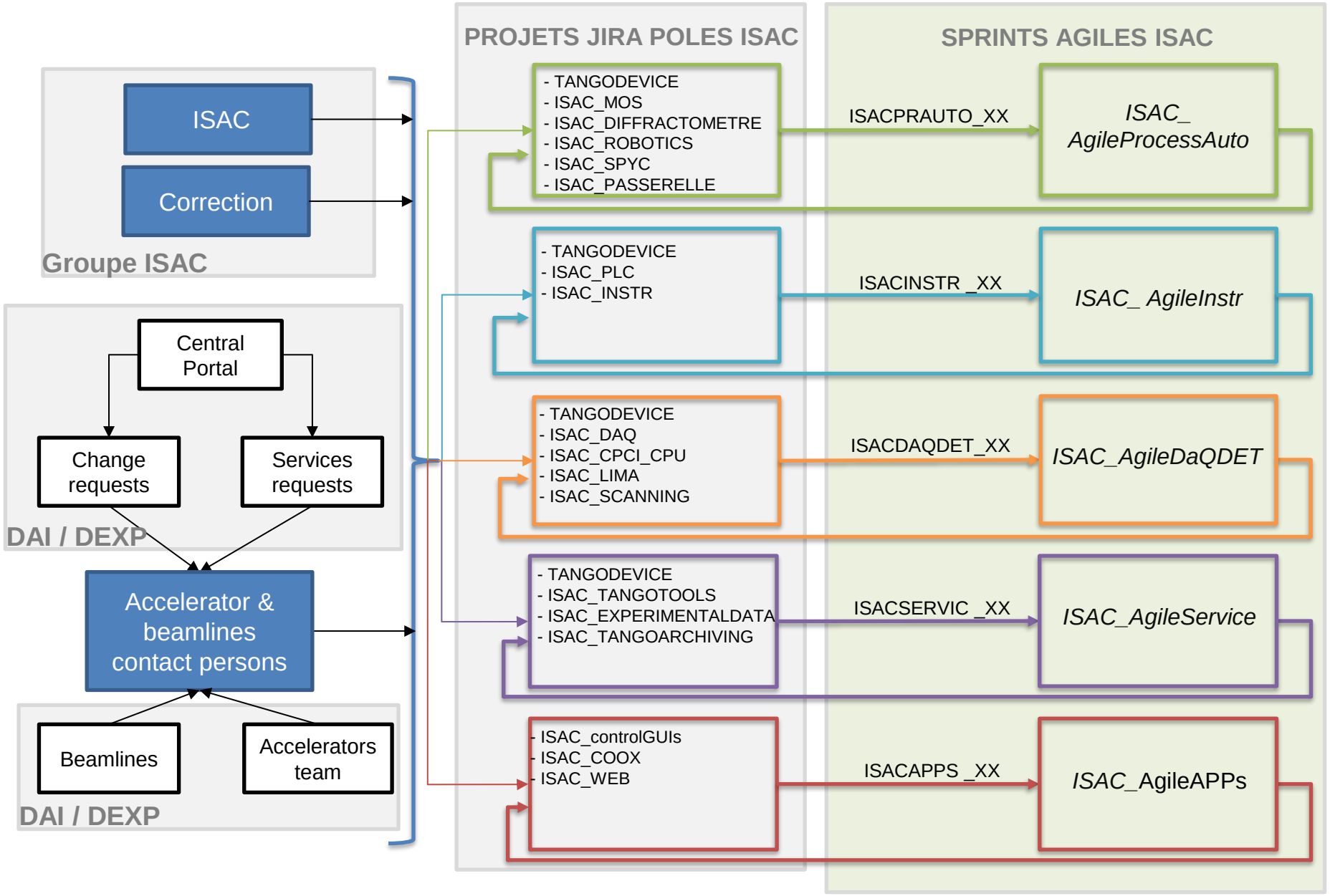
ISAC organisational process



Agile scrum organisation



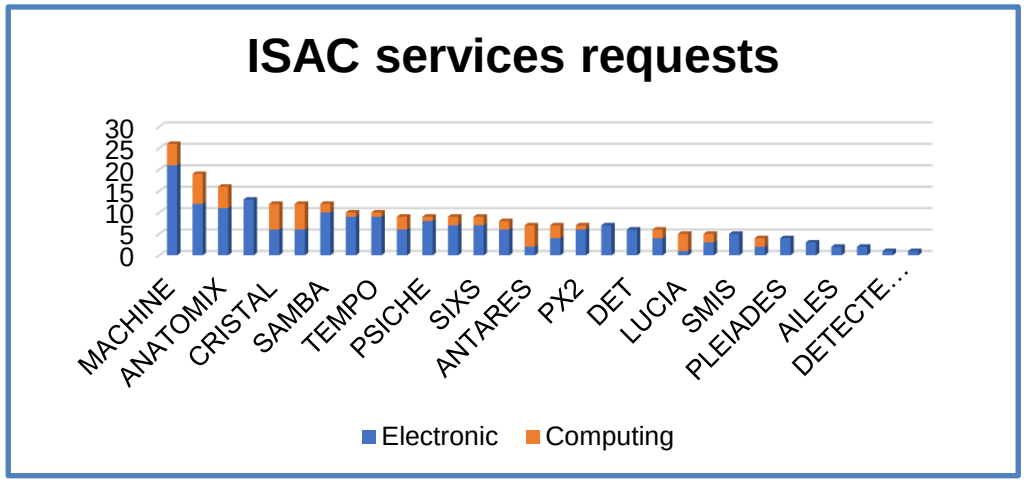
Product Backlog



Operational indicators

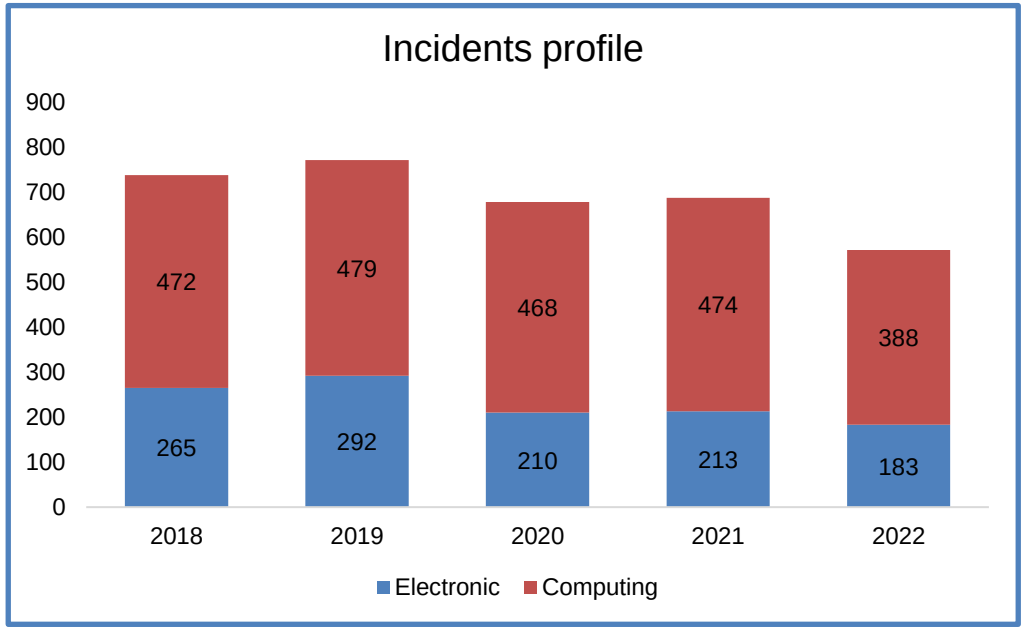
- Technical configurations

- **>250** cabling documents
- **900** cPCI board parameters files
- **>1900** Motorized systems parameters
- **>65000** paramters stored in archiving DB



- Sofware in operation

- **459** c++ Devices
- **32** Java Devices
- **44** IHM / API
- **175** PLC programs
- **30** SPI code and parameters
- **20** FPGA Firmware / **250** VHDL codes
- **70** Embedded codes Galil / DeltaTau
- **5** Robotic codes



ISAC integrated in IT and Data managment strategy

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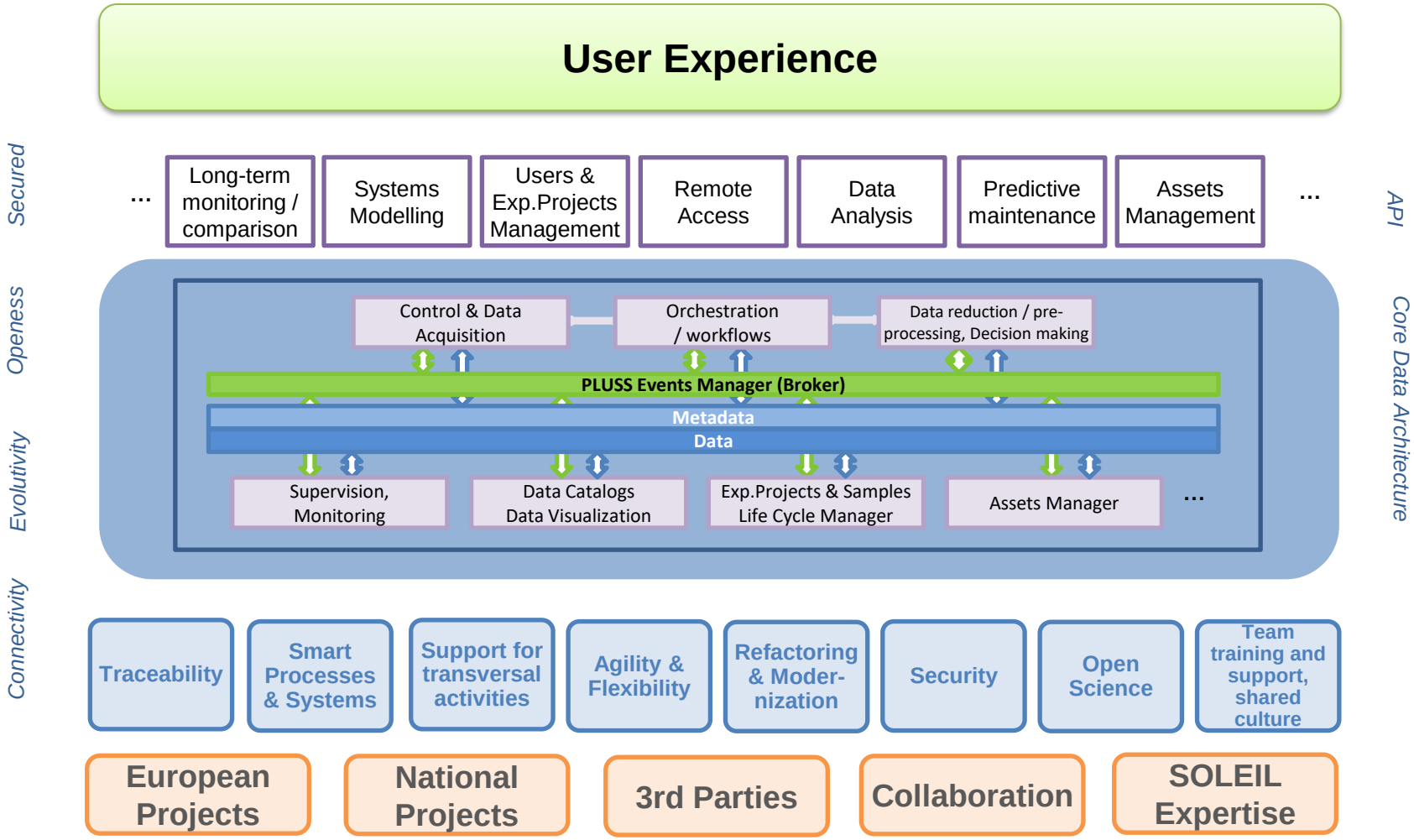
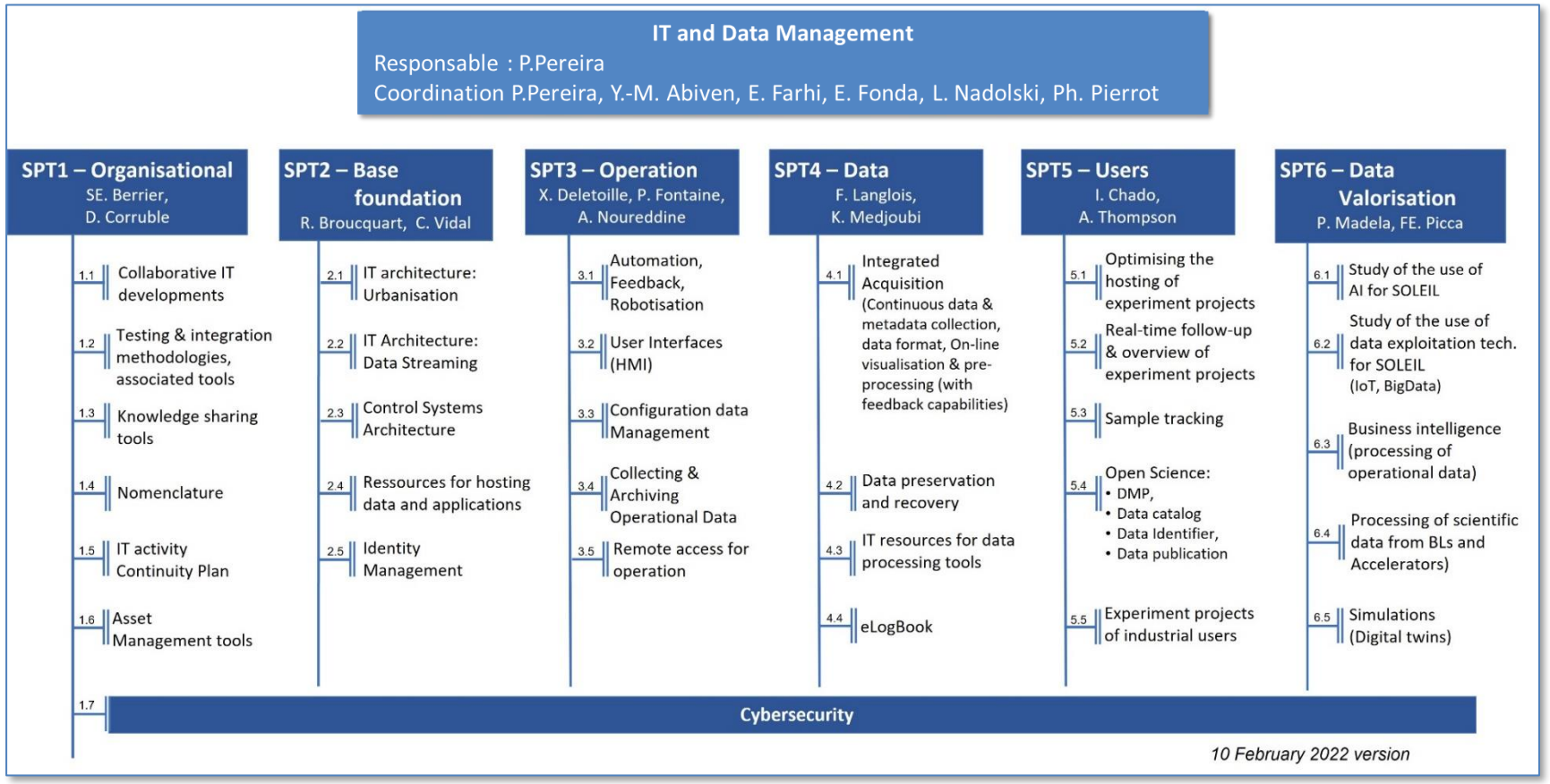
Overall IT and data Managment stategy

- To improve the user journey.

- A Data-Driven approach



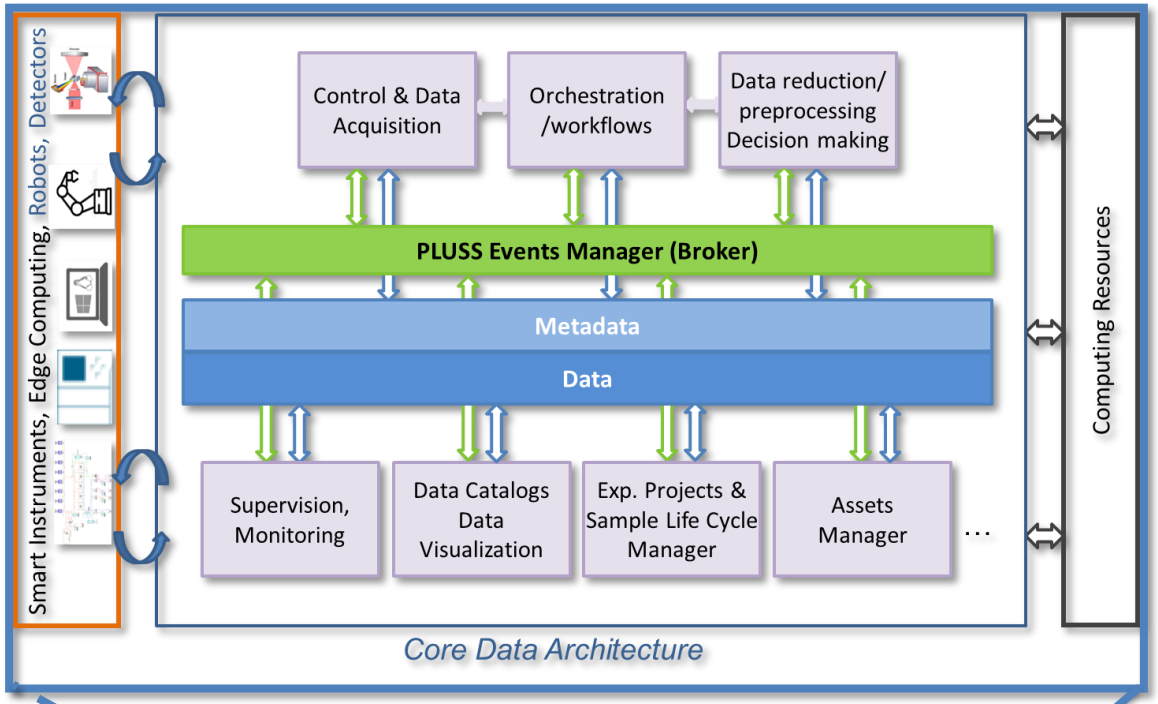
TDR, IT and data managment program

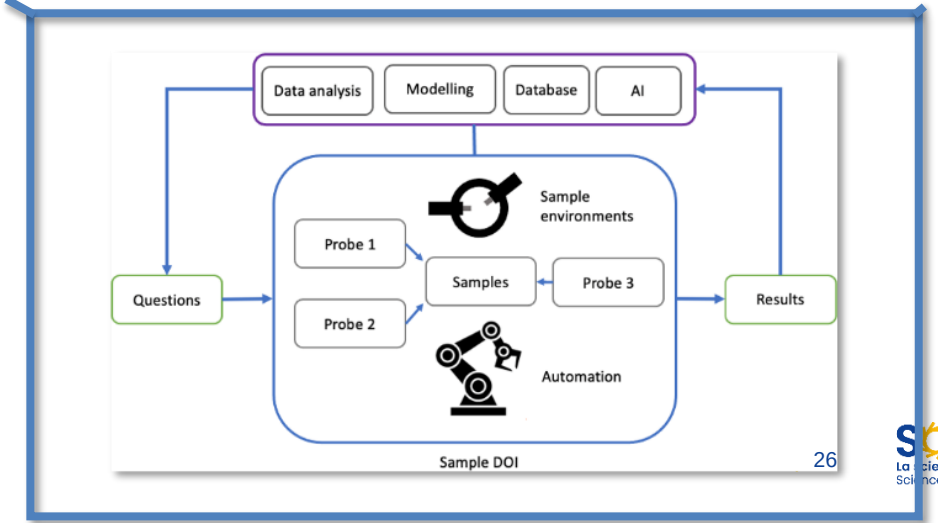


- Transvers program of SOLEIL upgrade to support accelerators and beamlines program
- Transversal cross-disciplinary organisation involving accelerators, scientific and computing teams.
- Program manage by a steering committee which report to SOLEIL's board Directors.
- 6 workpackages lead by pair. 38 sub-tasks addressed to improve organisation, control architecture, future operation, Data acquisition, User experience improvement, New Data processing including AI.

Towards integrated IT and data managment infrastructure

- Automated data managment process
- Automated and integrated pipeline between control-acquisition and data processing
- Towards autonomous system





Roadmap

2022

- ICA/ECA merged into ISAC
- Setting up ISAC organisation

2024

SOLEIL II contruction organiation

Mechatronic:
- Trajectory manager, coupling ID and monochromator

Service platform
- PLUSS for control.
- Archiving upgrade
- SciCAT
- Accelerators Digital Twin

DaQ & DET
- Flyscan deployment
- Streaming solution Analysis
- µTCA Framework and cPCI upgrade

Control and instrumentation
OPCUA.
Specification for SOLLEIL II

Automated processes
- Identifying process to automatise
- platform for robotic and mechatronic
- Robotic deployment

APPs
- IHM and APPS: building Web, Python, software framework
- Deploying operational tools (ELK, Alarm, monitoring…

2025

SOLEIL II Construction for control and computing

Mechatronic:
- Trajectory manager, coupling ID and monochromator
- Cryo-Nanopositioning
- Mechatronic systems deployements

Service plateform
- PLUSS for control.
- automation tools evaluation
- Archiving upgrade
- Accelerators Digital Twin
- Lib Nexus upgrade

DaQ & DET
- Flyscan deployment
- Streaming solution Analysis
- µTCA Framework

Control and instrumentation
IIOT.
Automatic test eand deployment
Development for SOLLEIL II

Automated processes
- Development of a sensor fusion platform for robotic and mechatronic
- Robotic deployment

APPs strategy definition for:
- IHM and APPS: Web, Python, software Package
- Operational tools (ELK, Alarm, monitoring…
- Bigdata tool for technical data

2026

SOLEIL II Construction for control and computing

Mechatronic:
- Automation beam and sample
- Mechatronic systems deployements

Service plateform
- PLUSS for control.

- Data automation tools evaluation
- Accelerators Digital Twin
- DataBase management

DaQ & DET
- Flyscan deployment
- Streaming solution Analysis
- µTCA Framework

Control and instrumentation
OPCUA.

Automated processes
- Development of a sensor fusion platform for robotic and mechatronic
- Robotic deployment

APPs strategy development for:

- IHM and APPS: Web, Python, software Package
- Operational tools (ELK, Alarm, monitoring…
- Bigdata tool for technical data

2027

SOLEIL II Construction for control and computing

Validating POC from previous studies

Preparing upgrade with ISAC contribution to TDR Programme

Software building factory upgrade, monitoring and operational automation, operating system upgrade, annual maintenance

conclusion

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Projet et Organisation

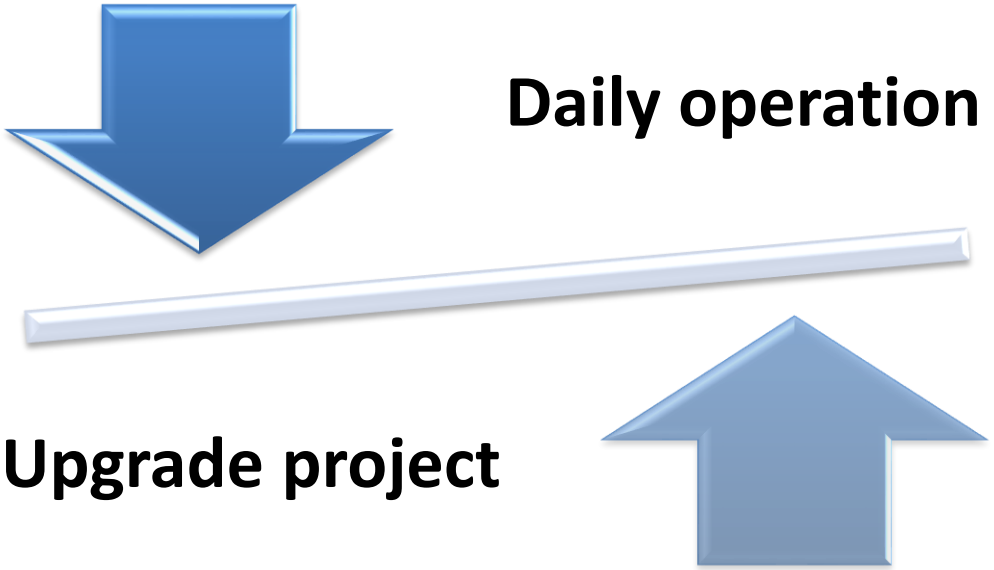
- Organisation

  .

  – Sharing homogenous practices for operation and project management.
  – Developing a collective overview of system for accelerators, beamline and labs.
  – Organised in business unit to provide efficient tools for scientific instrument.
  – Opportunity to collaborate.

- Next steps - Development or improvement -

  – Tools to enhance automation in the data-driven strategy.
  – Integrate control system in the microservice strategy.
  – Systems and data interoperability.
  – Application using advanced technology for control and operational business.



Architecture and technology Transformation

complexity/reliability/maintenability

Collaboration
Strong community

Tak
Obrigado
감사합니다
Gracias
Merci
شكرا لك
Thank you
Danke
Grazie