DE LA RECHERCHE À L'INDUSTRIE

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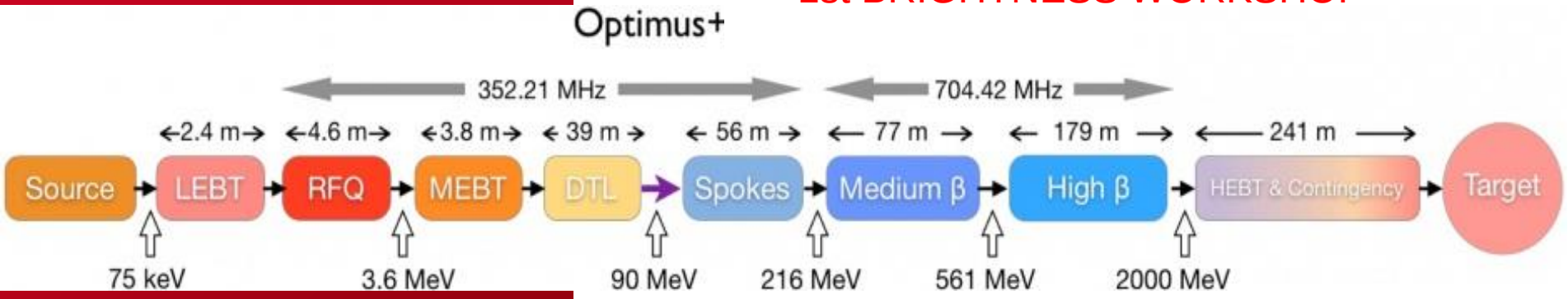
EUROPEAN SPALLATION SOURCE

ENGINEERING CHALLENGES FOR BIG SCIENCE PROJECTS AT CEA-IRFU

1st BRIGHTNESS WORKSHOP



Florence ARDELLIER

www.cea.fr

CONTENTS

Challenges

for

Large Science Projects ?

CHALLENGES FOR LARGE SYSTEMS ENGINEERING

Innovative, complex, integrated, compact and gigantic, more powerful and sensitive ……

New technologies to use and to custom

Environnement contraints: intense beams, magnetic field, accessibility, safety rules, …

Reliability , « long » life cycle

Limited Budget : prototypes and demonstrators have to be limited

Internationale collaborations with several contact persons, different standards

Very tight time schedule

Splitted contributions with complex interfaces

CHALLENGES FOR LARGE SYSTEMS ENGINEERING

Innovative, complex, integrated, compact and gigantic, more powerful and sensitive ……

New technologies to use and to custom

Environnement contraints: intense beams, magnetic field, accessibility, safety rules, …

Reliability , « long » life cycle

Limited Budget : prototypes and demonstrators have to be limited

Adapted « technical » tools :
→ PLM, CAD, ERP…

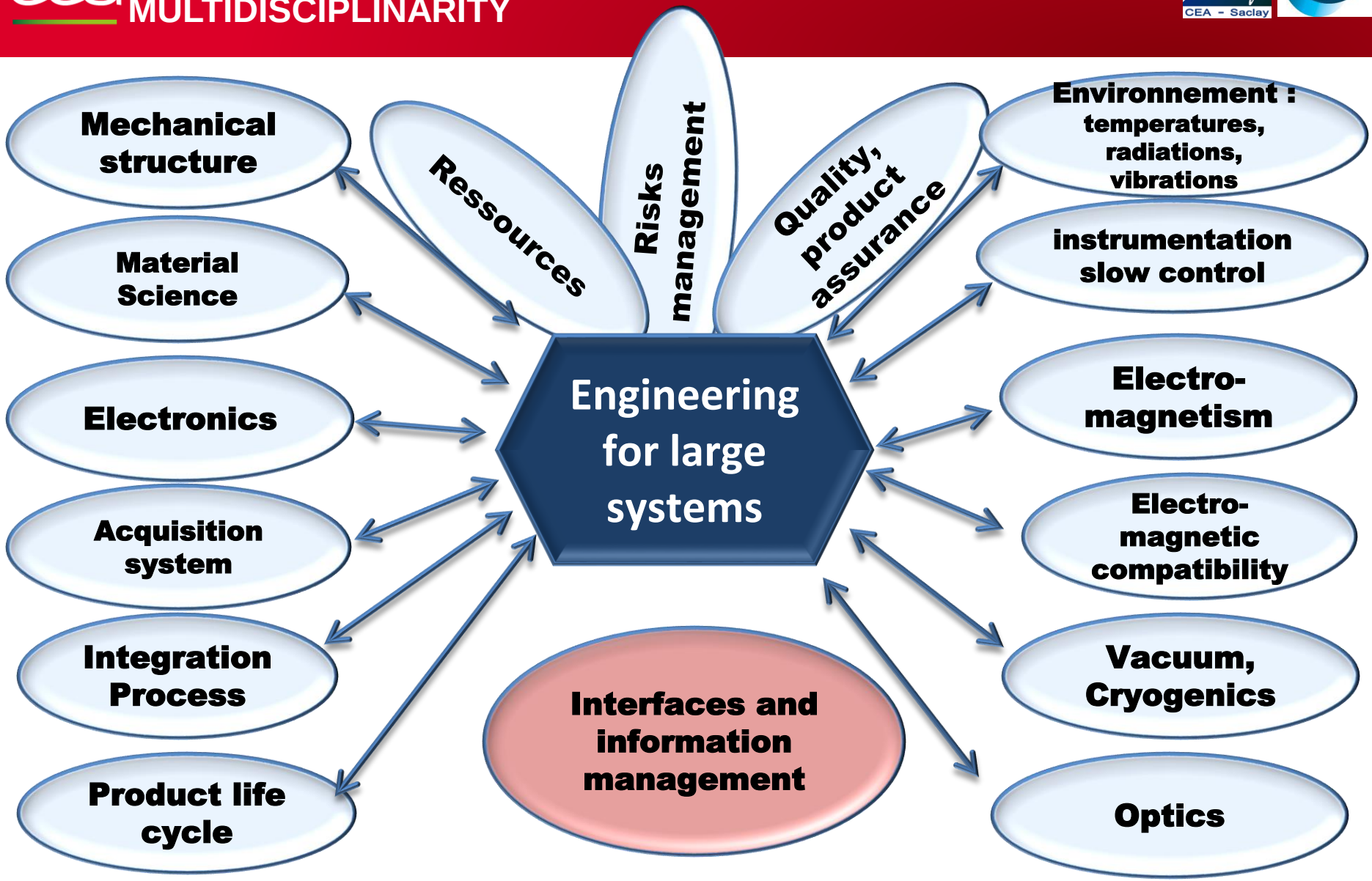
Internationale collaborations with several contact persons, different standards

Very tight time schedule

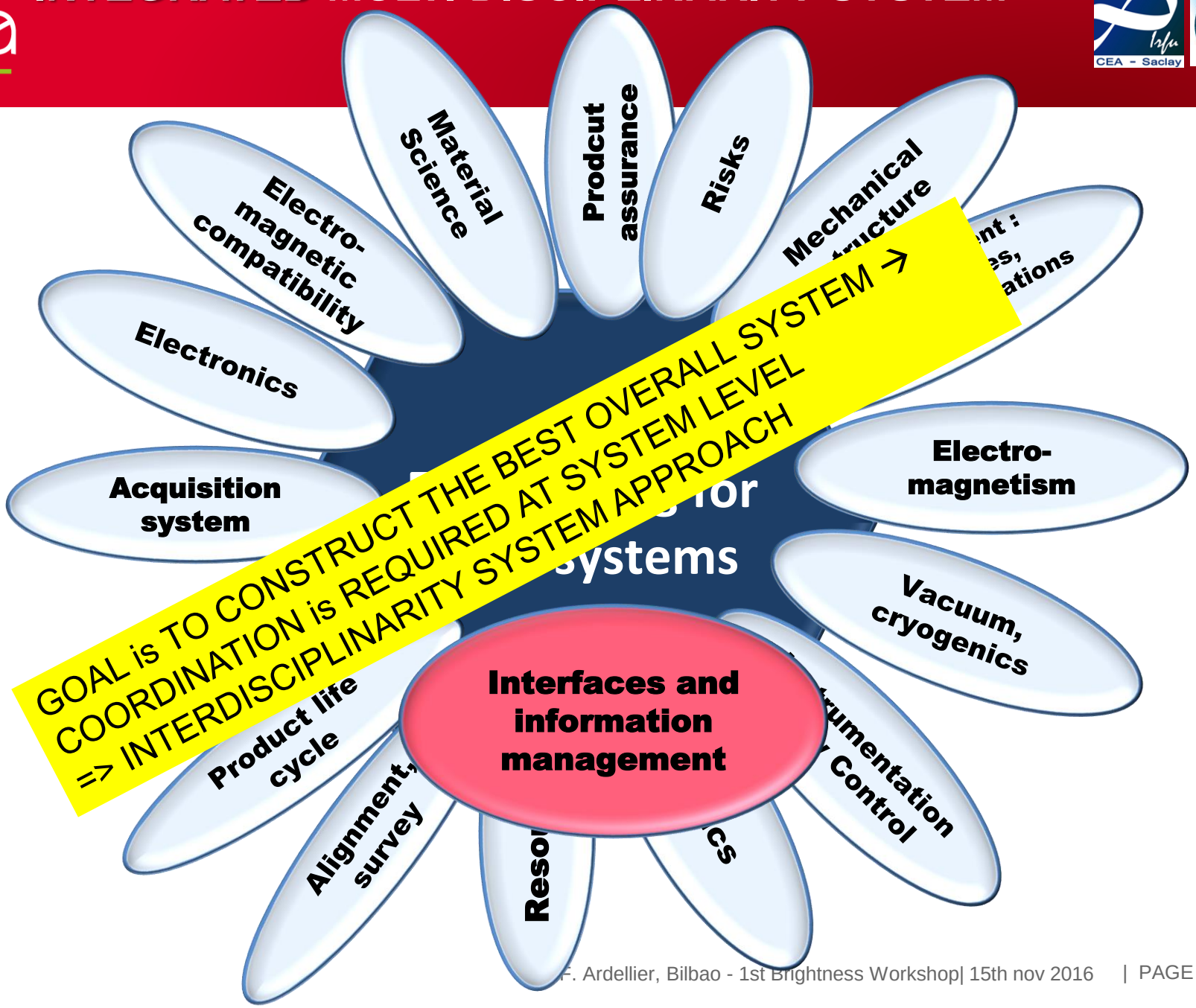
Splitted contributions with complex interfaces

Customized methodology and process

CHALLENGES FOR LARGE SYSTEM ENGINEERING : MULTIDISCIPLINARITY



INTEGRATED MULTI DISCIPLINARITY SYSTEM



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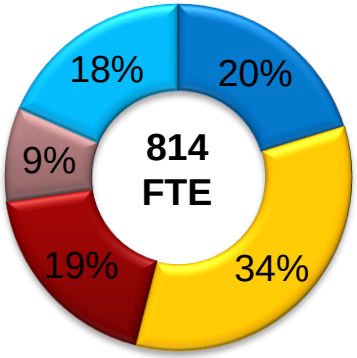
IRFU ORGANISATION AND SOME HIGHLIGHT CONTRIBUTIONS TO LARGE SCIENCE PROJECT

IRFU : SCIENCE, TECHNOLOGY AND ENGINEERING



~800 FTE
632/615 CDI/CDI-CEA

- Physicists 165 FTE
- Engineers 274 FTE
- Technicians 152 FTE
- Adm. Staff 72 FTE
- PhD & Post Docs 150 FTE

Missions

- Physics of the two infinites
- Technology for Radiations
- Engineering

Institute of Research into the Fundamental laws of Universe

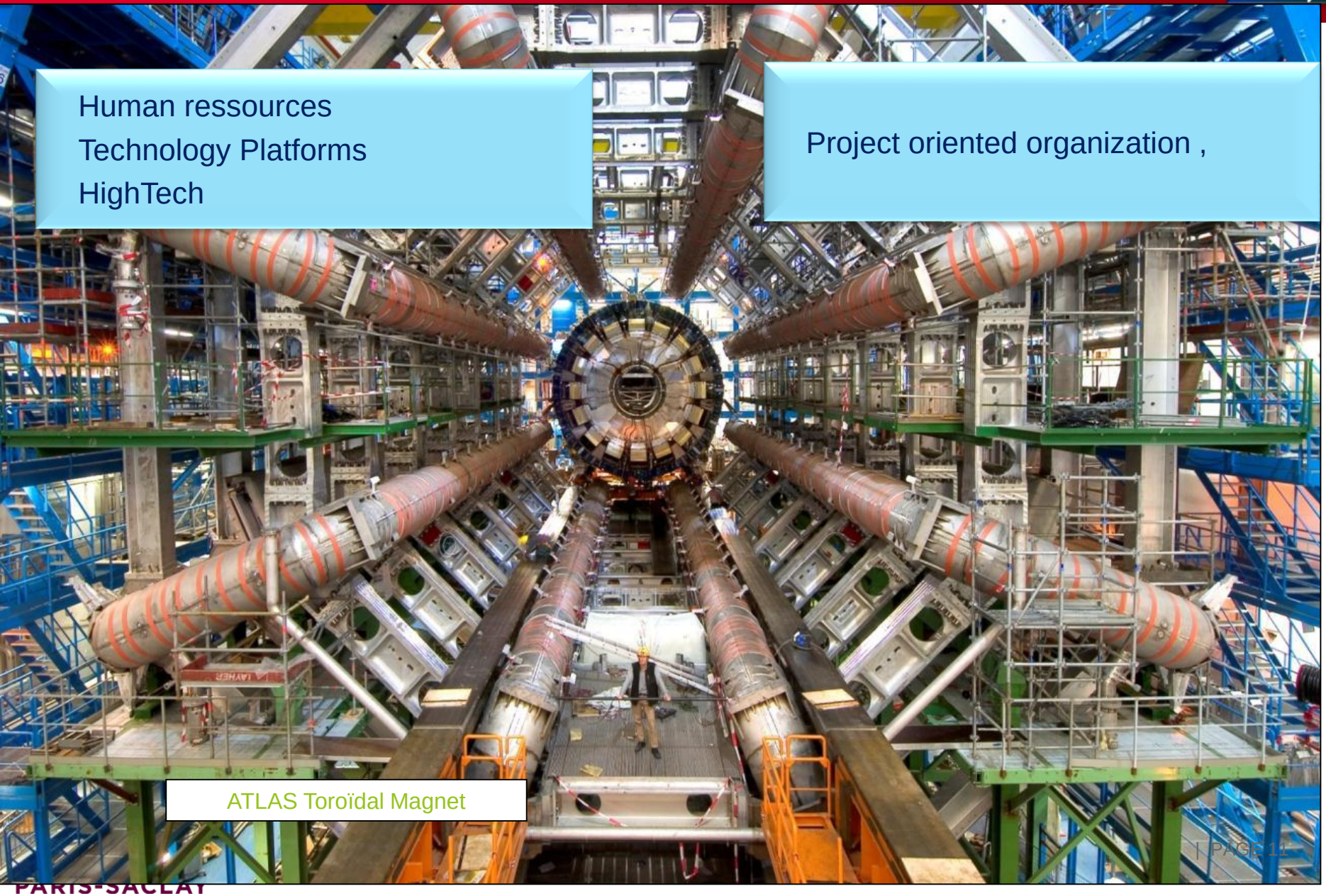
116 perm. 94 temp.	**SAp**: Astrophysics Space technologies	**SACM**: Accelerators, Supra. Magnets	125 perm 25 temp
56 perm. 29 temp.	**SPhN**: Nuclear Physics	**SEDI**: Detectors, electronic, computing	125 perm. 11 temp.
72 perm. 45 temp.	**SPP**: Particle Physics	**SIS**: Systems engineering	97 perm. 15 temp

IRFU CONTRIBUTES TO WORLD LARGE INFRASTRUCTURES IN PHYSICS

PARTICIPATION TO LARGE PROJECT ENGINEERING CHALLENGES

Human ressources
Technology Platforms
HighTech

Project oriented organization ,



ATLAS Toroïdal Magnet

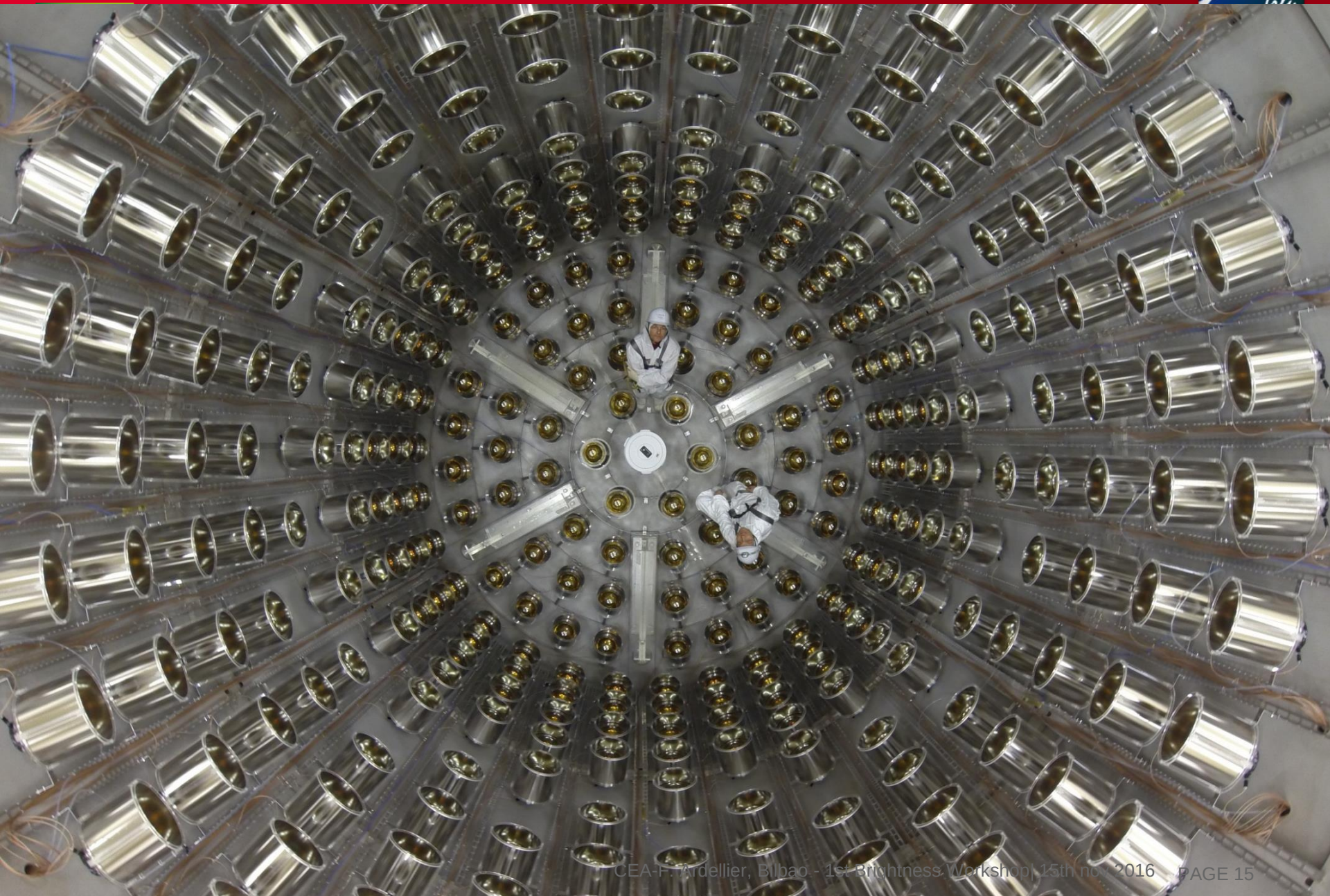
SPIRAL2 : RFQ & CRYOMODULES

RFQ

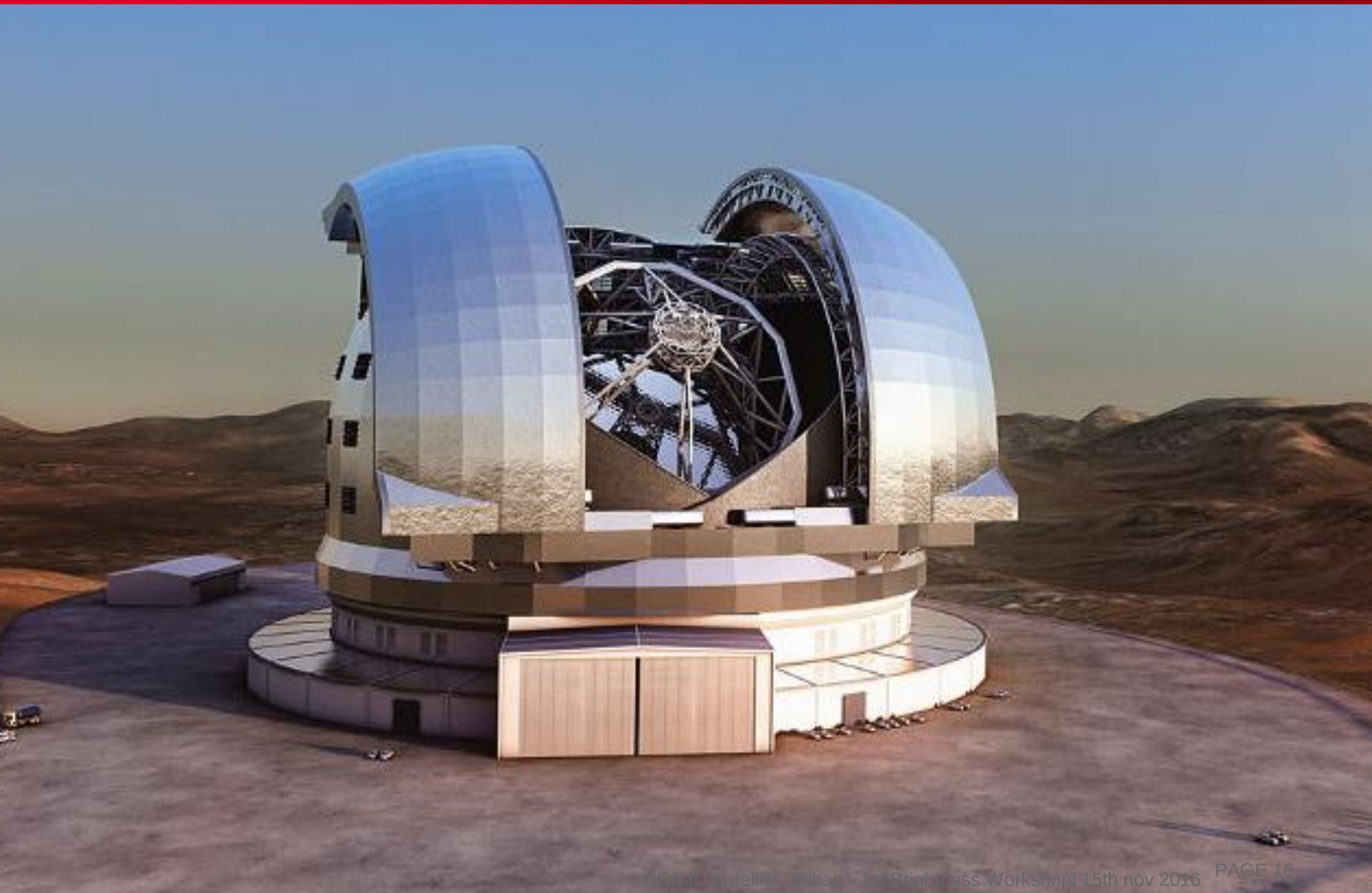

XFEL : C RYOMODULES ASS

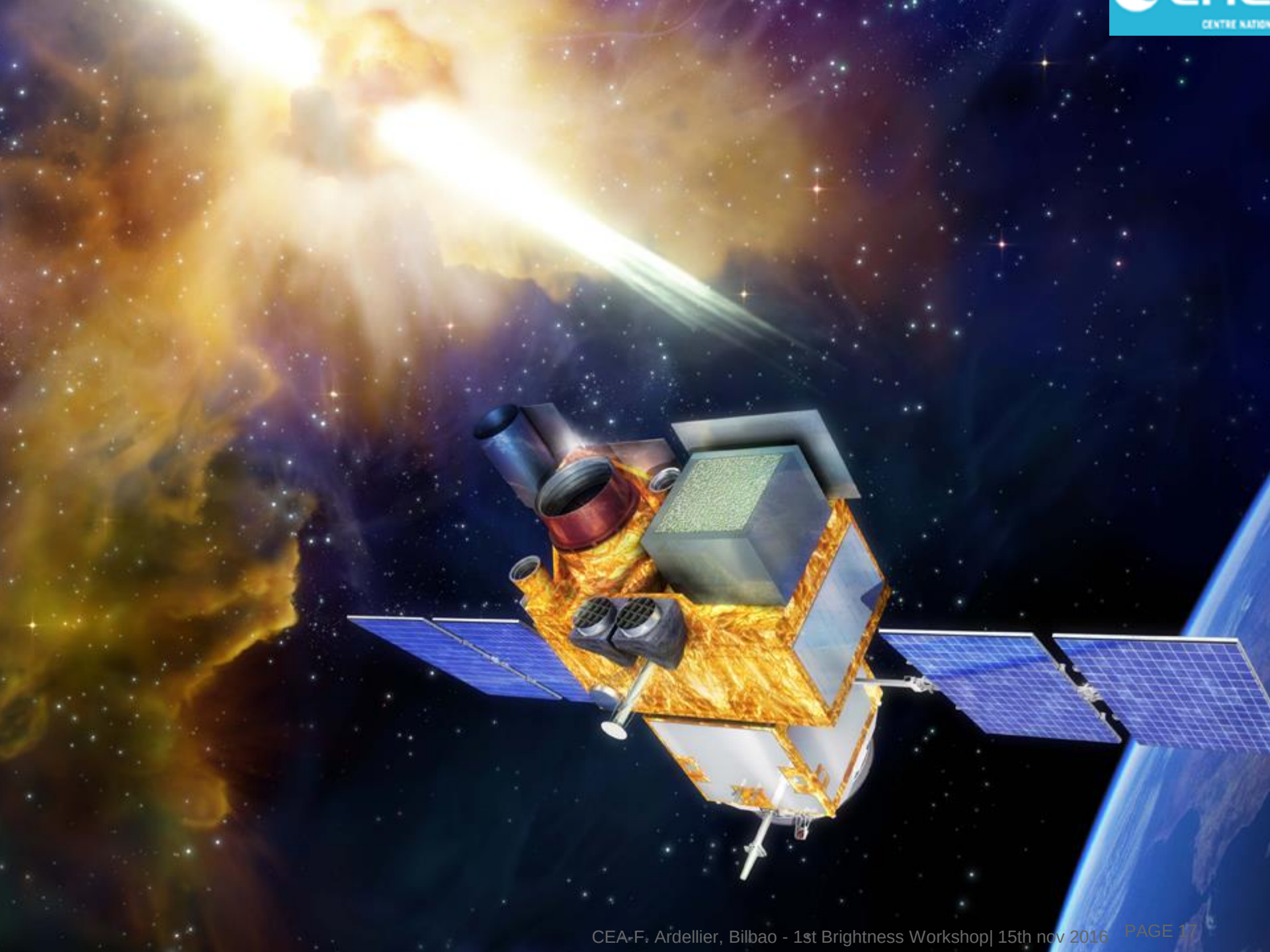
JT-60SA TEST STATION (TEST FACILITY MAGNETS FOR FUSION TOKAMAK)

DOUBLE-CHOOZ : NEUTRINO PHYSICS

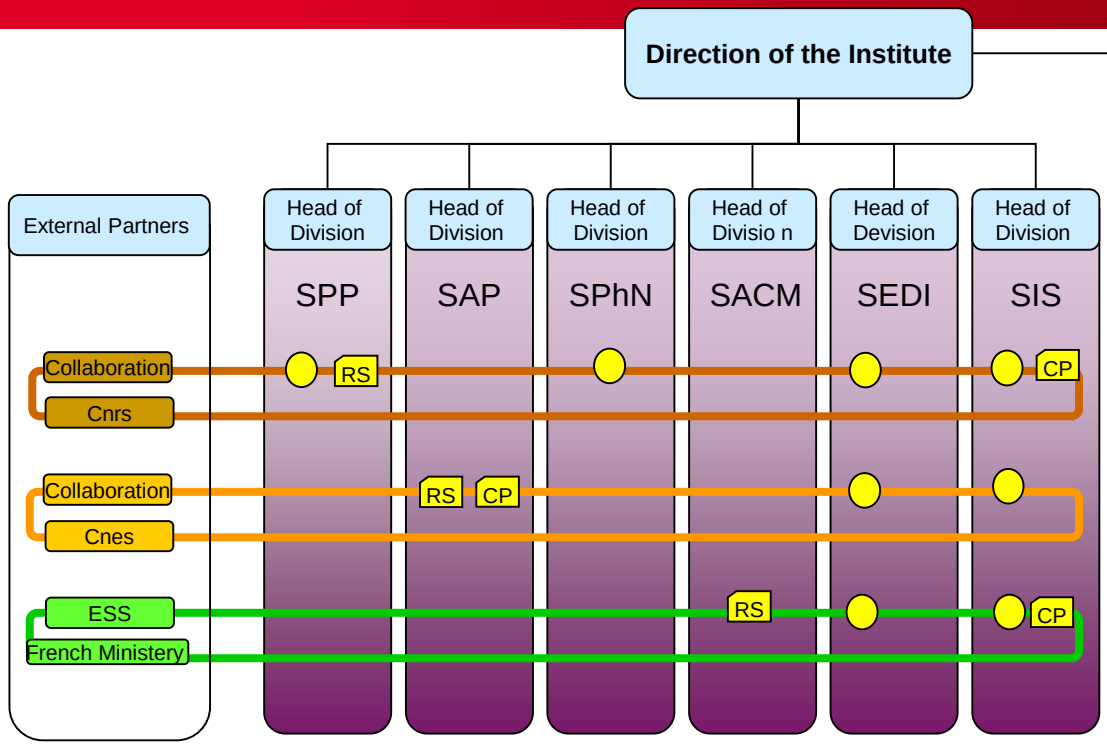


EXTRA LARGE TELESCOPE UNDER CONSTRUCTION (LEADED BY ESO)

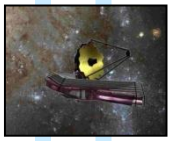




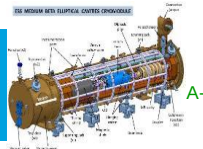
IRFU ORGANISATION FOR BIG SCIENCE PROJECTS CHALLENGES



Projet
Double Chooz
A-NEUTR-01-03



Projet
JWST-MIRI
A-JWSTM-02



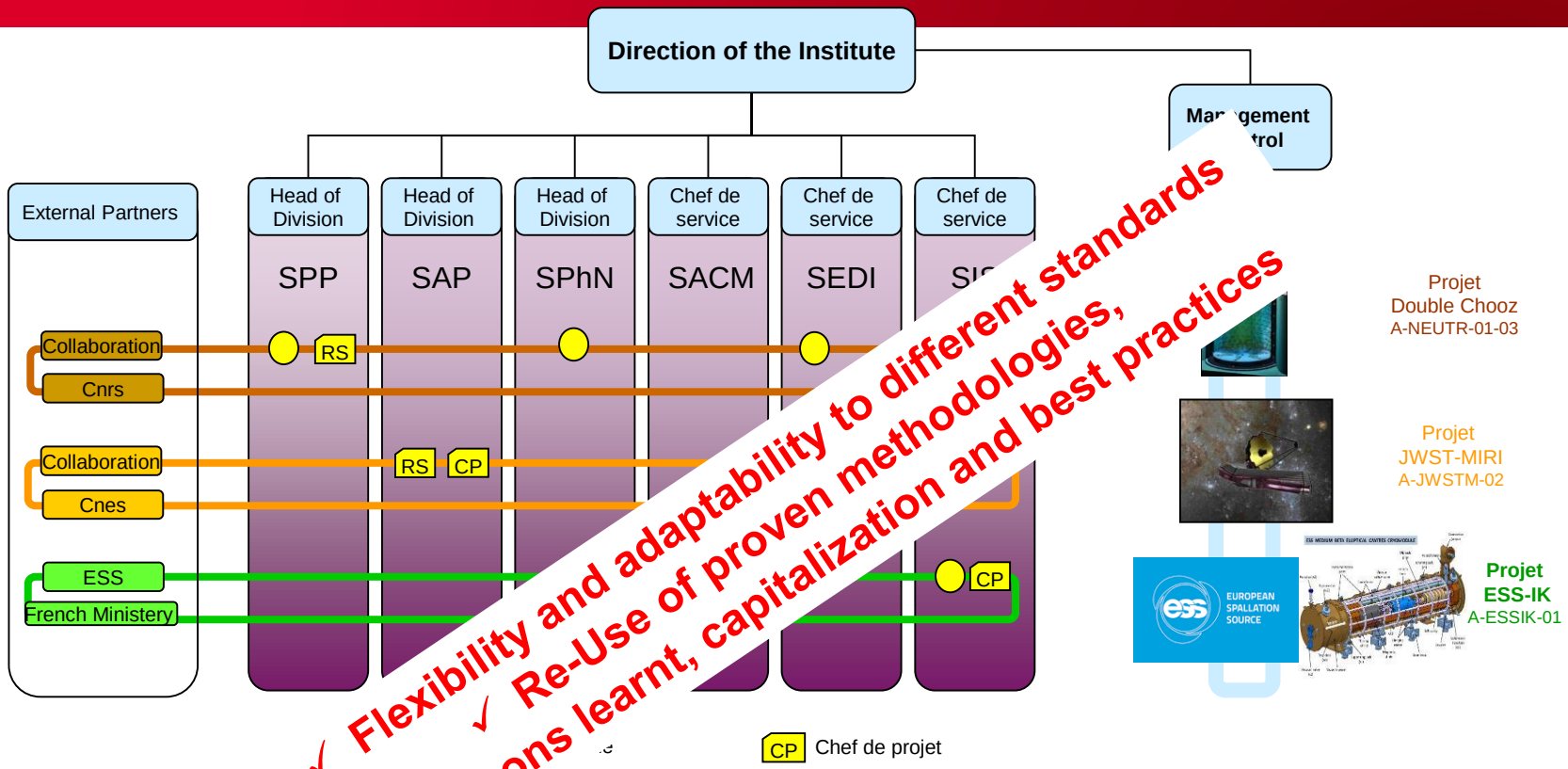
Projet
ESS-IK
A-ESSIK-01

Direction of the institute : Provide ressources, cover risks, realise arbitrations

Head of Division : manage human resources and guaranty adequate skills

Project direction : Project Manager & Scientist Responsible in charge to deliver instruments / components with the respect performances / cost / time schedule

IRFU ORGANISATION FOR BIG SCIENCE PROJECTS CHALLENGES



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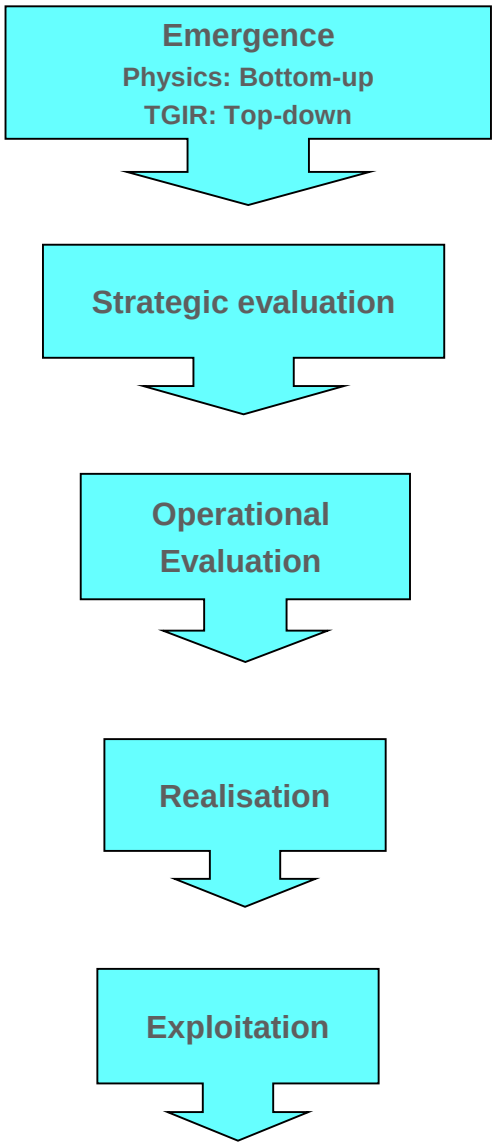
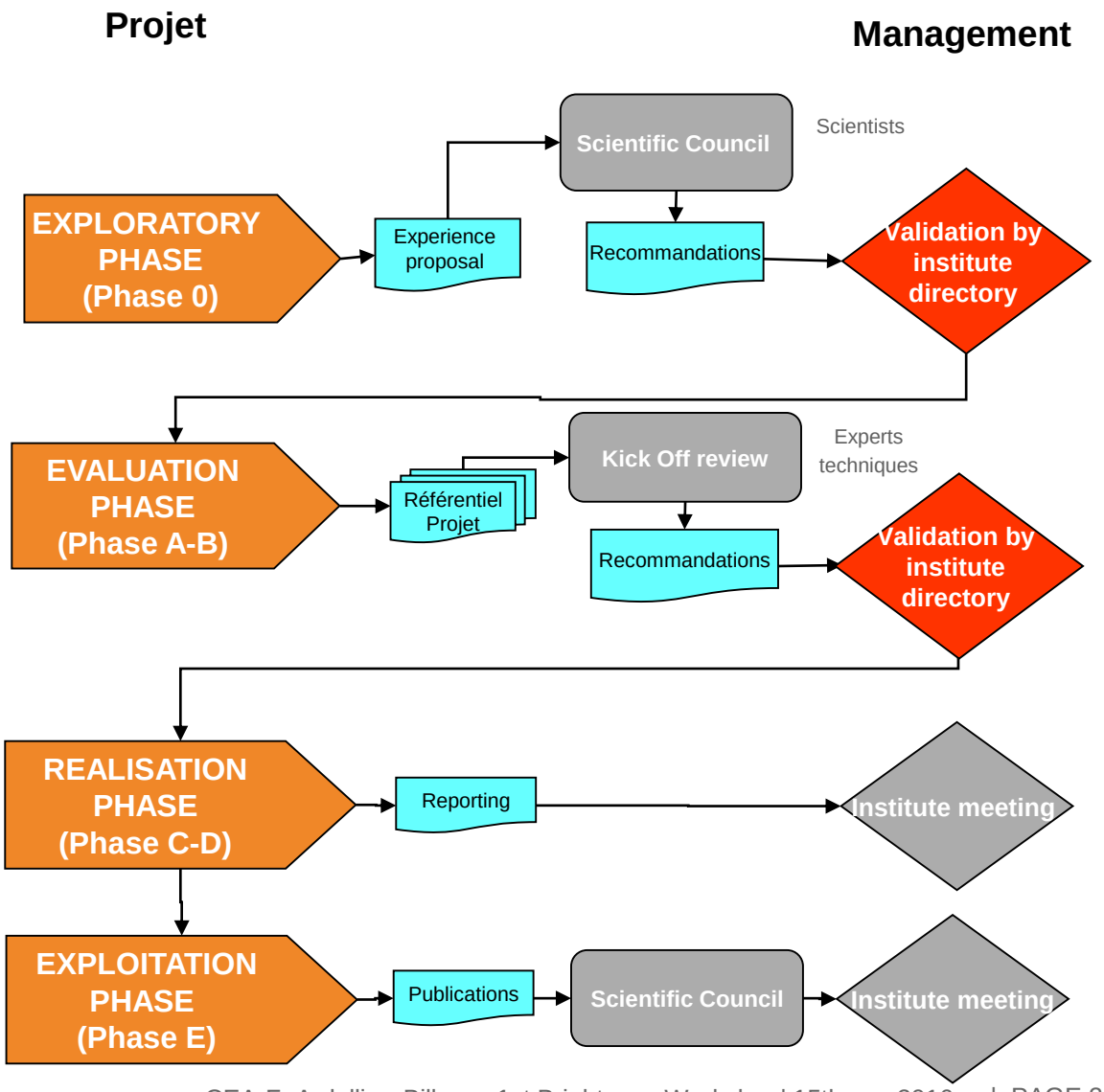
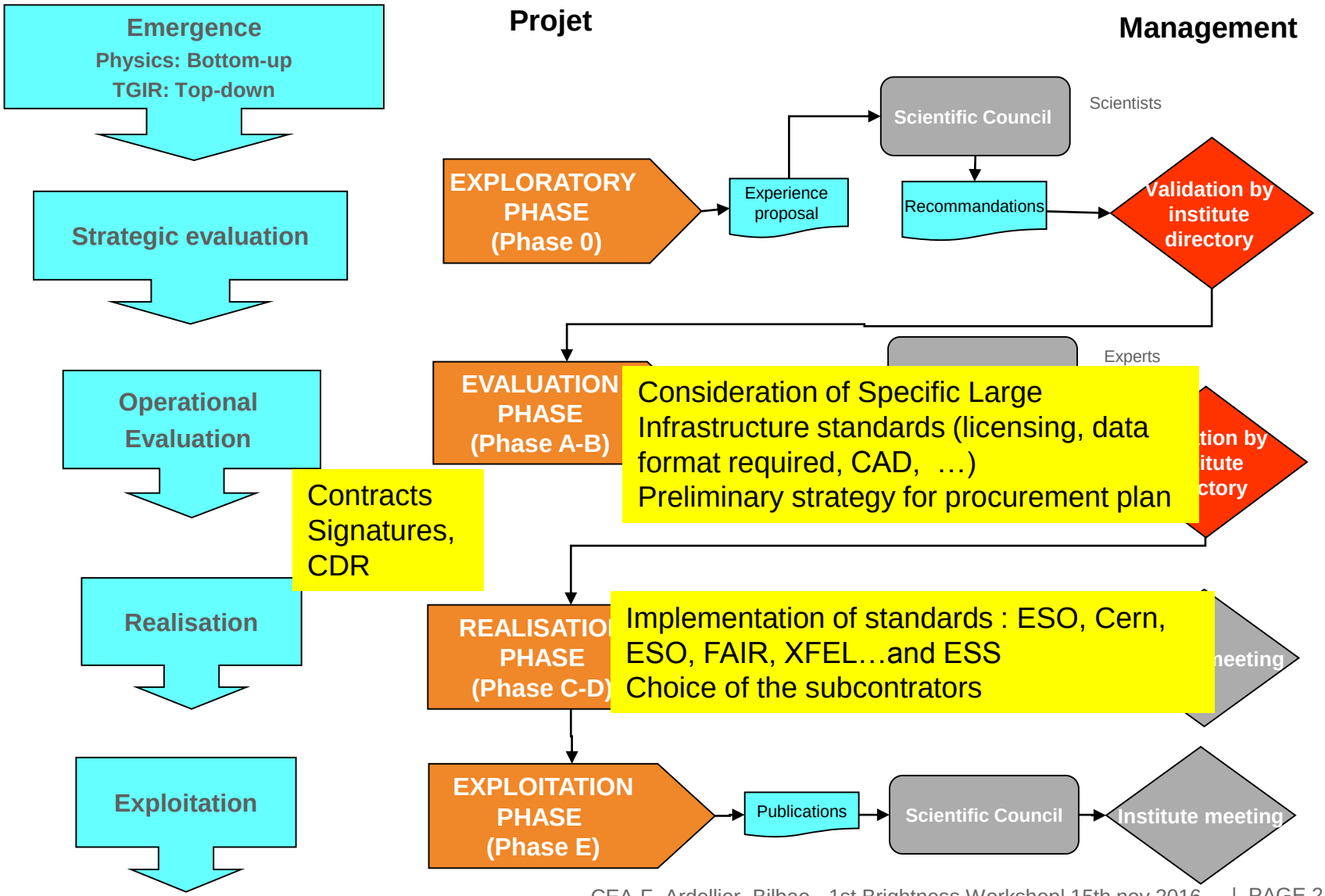
IRFU « STANDARD » PROCESS OF THE PROJECTS MANAGEMENT

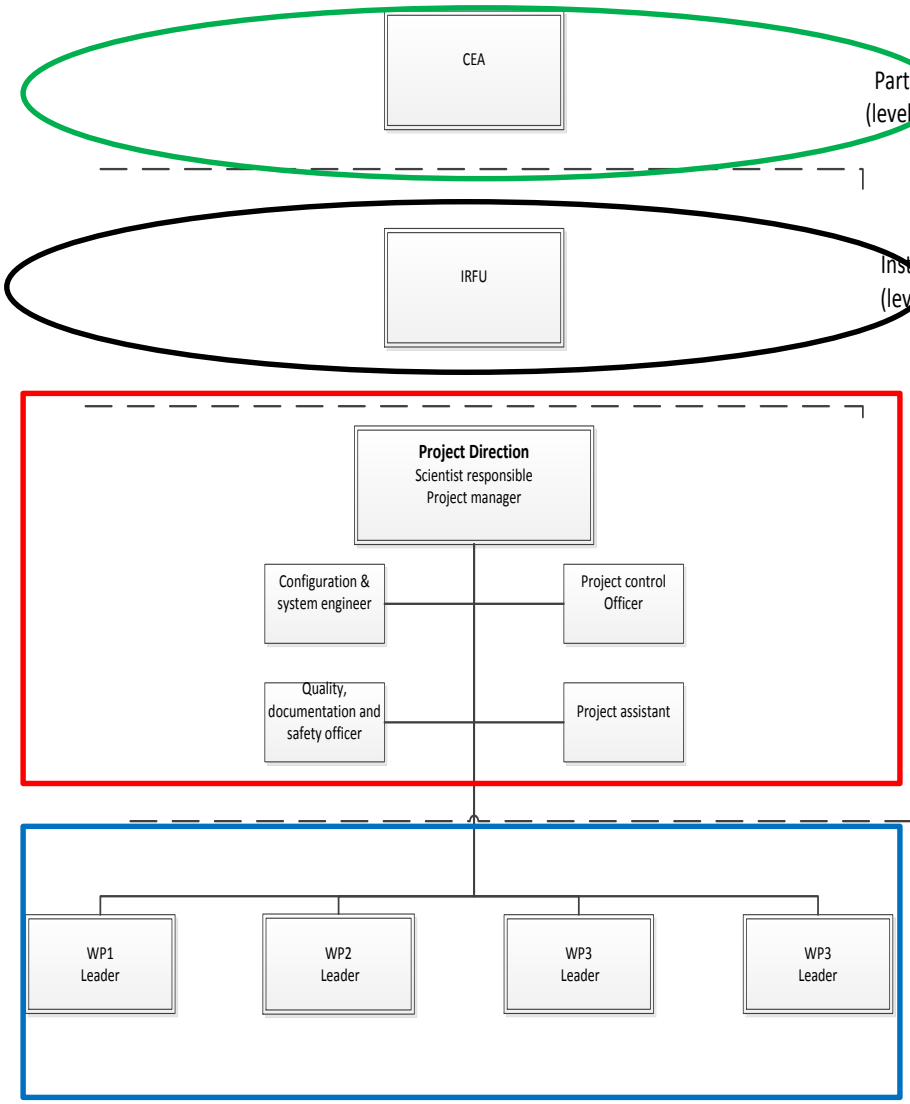




STANDARD PROCESS OF THE PROJECTS MANAGEMENT



IRFU « STANDARD » ORGANISATION



Organisms governance (CEA) → strategy

Laboratories directory (Irfu) →
Programmatic : steering committee, financial boards, risks, change SoW …

Project Management → system management including PAQ, configuration, risks register, conformity meeting, schedule,…

Technical & Engineering Level (Work-Packages leaders) → technical design and developments, realisation process choices and follow up, technical qualifications and acceptance, schedule…

FOR INKIND CONTRIBUTION PROJECTS, KEYS ENGINEERING PARAMETER TO SET UP :

- ✓ Contribution perimeters and deliverables :
  - ✓ Reference Scope of Work to be approved during Kick Off meeting
- ✓ Interfaces definition
  - ✓ Technical : limit of the components delivered and associated documentation
  - ✓ Format of data exchanges
  - ✓ Organisation and communication / decision scheme
- ✓ Process for changes / deviations management
  - ✓ Implemented from reference configuration
- ✓ Risks management

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CEA IN KIND CONTRIBUTION FOR ESS ACCELERATOR

- CEA IKC OVERVIEW
- MANAGERIAL INTERFACES
- INTERFACE DRAWINGS
- DEVIATION PROCESS CONTROL
- RISK REGISTER

CEA IN KIND PERIMETER FOR ESS ACCELERATOR CONSTRUCTION

1. CEA – IRFU contributes to 4 different ESS WPS

   For Elliptical Cryomodules WP

   - Collaboration with CNRS/ IPNO for Cryomodules CAD Design
   - ESS partners for cavities (INFN/LASA & STFC) in the assembly process

Diagnostics

Juin 2016 : Doppler
Nov 2016 : EMU
Avril 2019 : nBLM
Juin 2019 : profileurs faisceau non invasifs

Integrated Control System

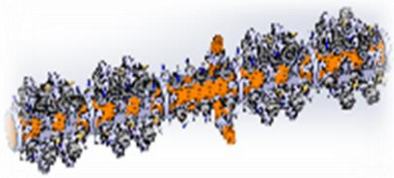
Mi-2016 : Proton Source LEBT
2017 : RFQ coupleursconditioning
Mi 2018 : RFQ vaccum & thermal contril

EPICS

RFQ

Mid 2018: delivery ar Lund

- RFQ & support
- Thermal system
- Tools for assembly in tunnel

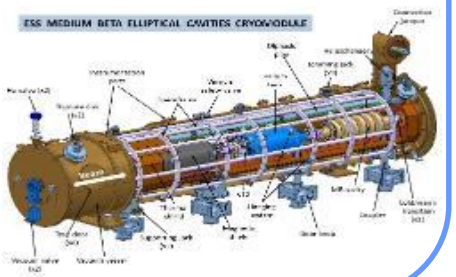


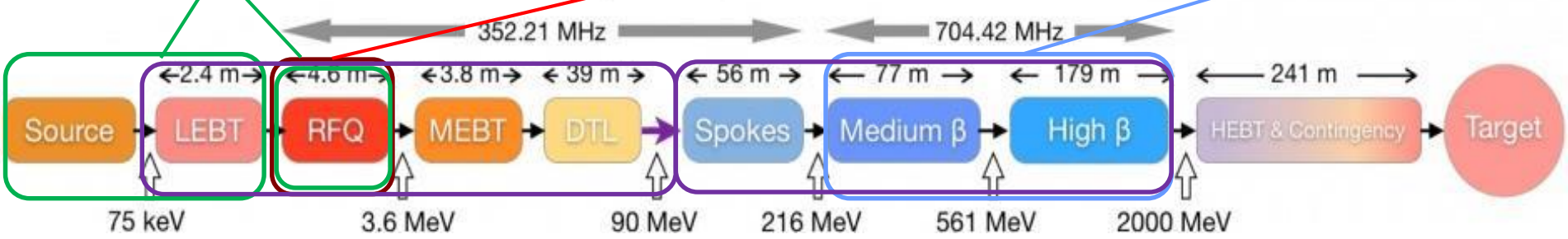
Elliptical Cryomodules

Demonstrators (M-ECCTD & H-ECCTD)
30 Elliptical Cryomodules

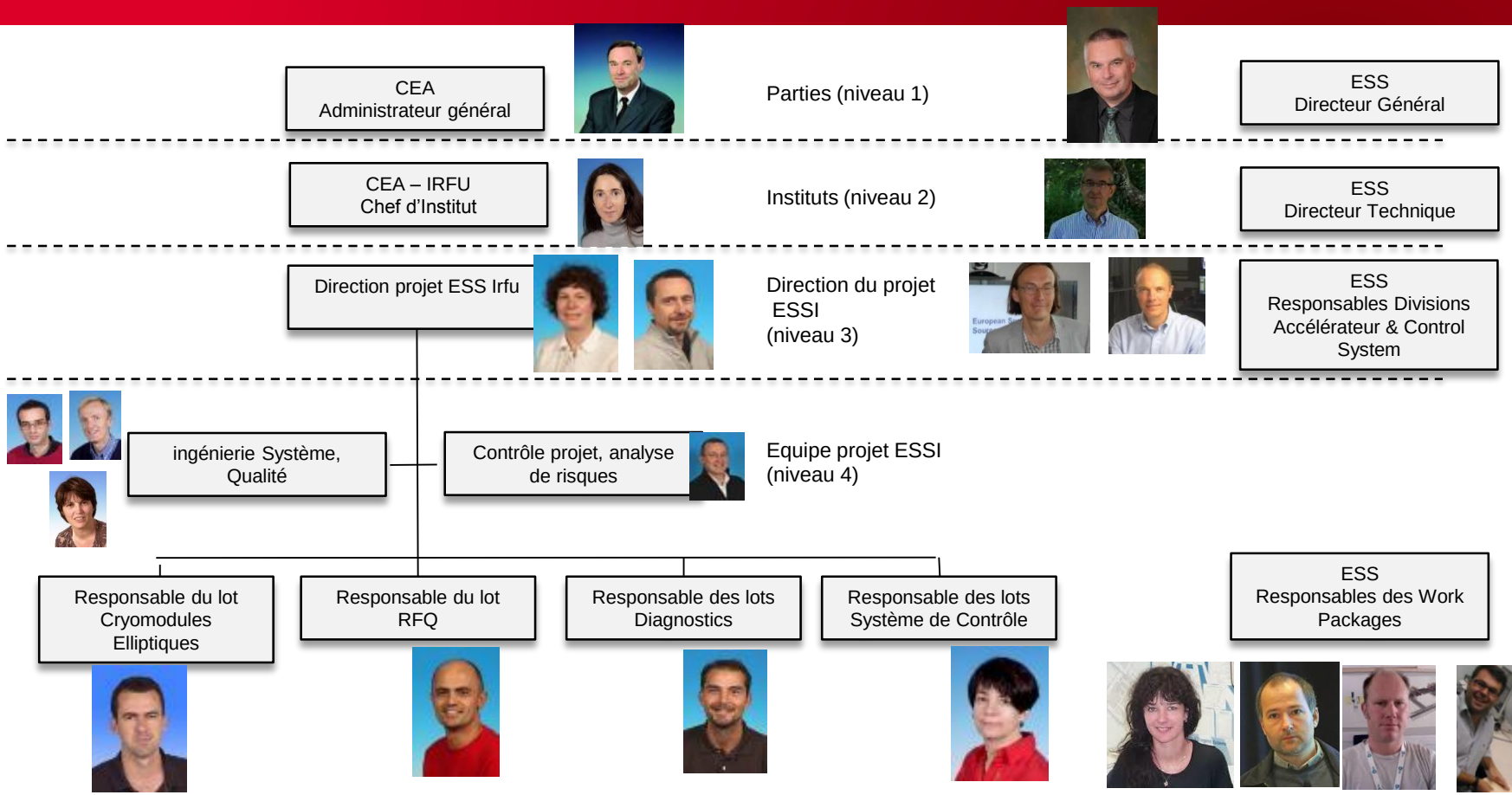
- **Components supply (apart cavities) t et caractérisation des composants (sauf cavités)**
- **Assemblage & part of Cryomodules tests**

2018-19 : 9 CM Med β
2019-22 : 21 CM High β





IRFU IKC for ACCELERATOR CONSTRUCTION : BILATERAL AGREEMENT between ESS-ERIC & CEA

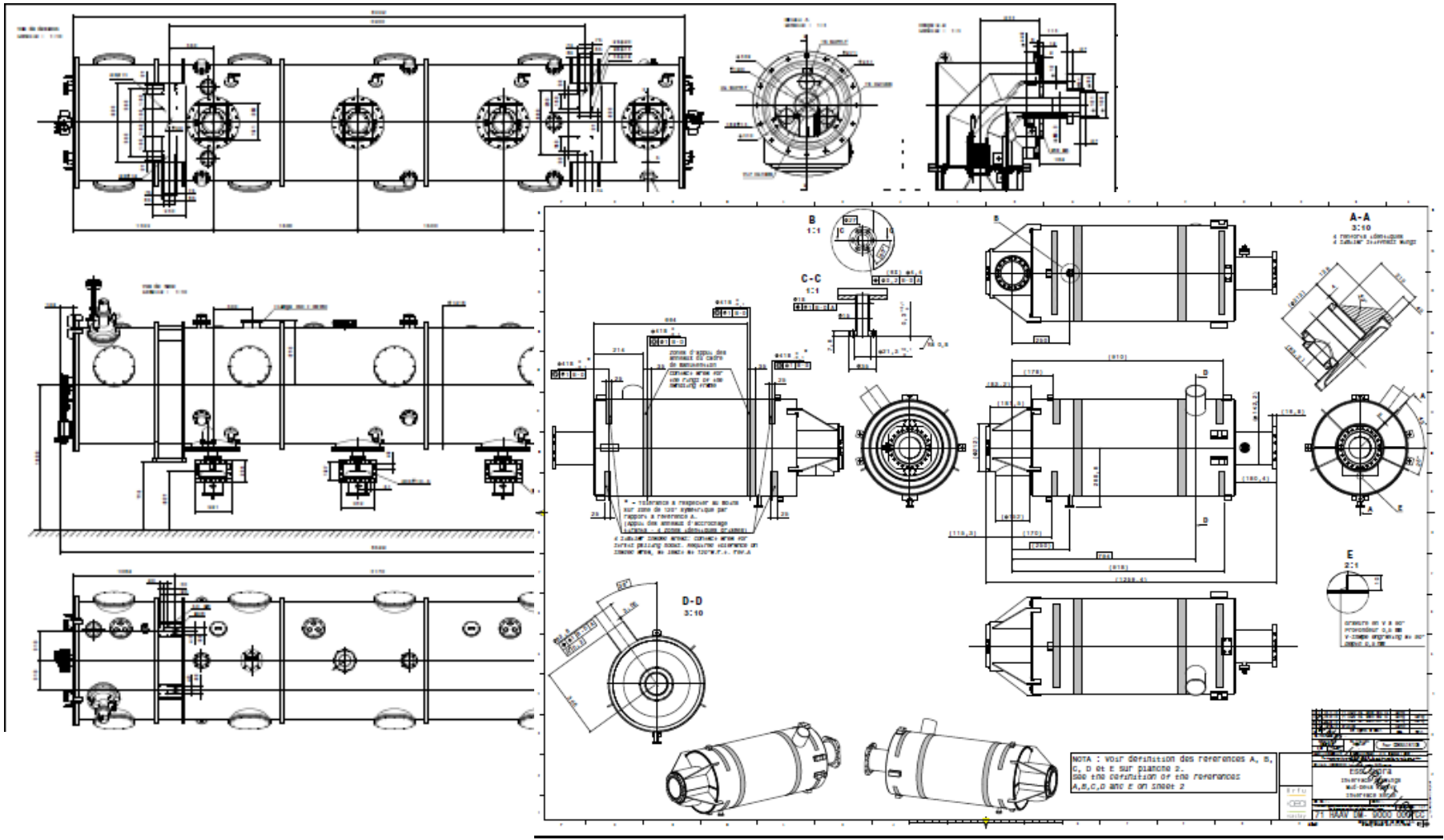


- Niveau 1 : Strategy : meeting on demand,
- Niveau 2 : Coordination Committee for IKC follow up : 2 / years,
- Niveau 3 : Reporting & Technical Coordination : 2 / months
- Niveau 4 : Monthly reports & weekly exchanges

INTERFACES CONTROL DOCUMENT

Resources allocation

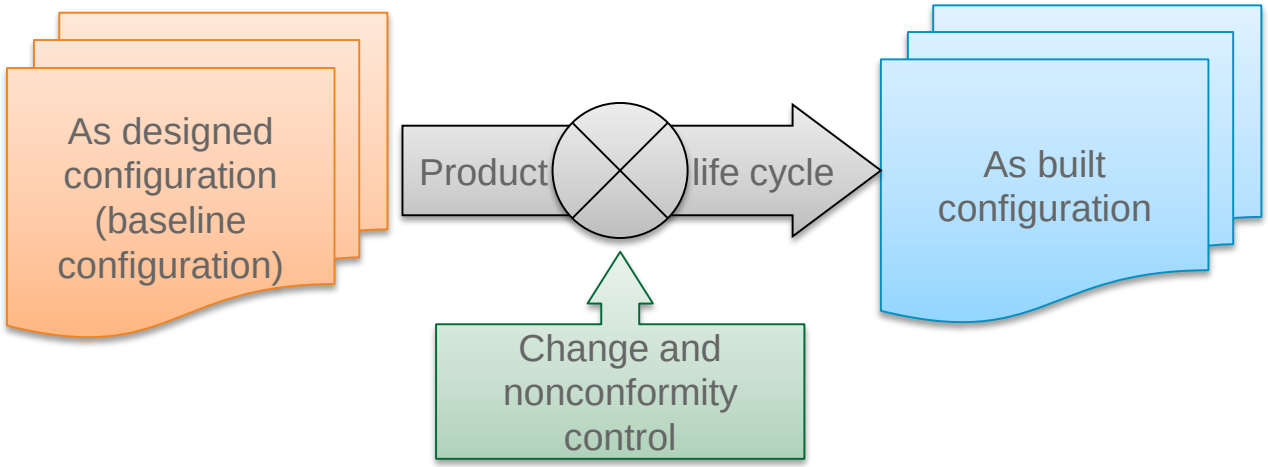
Interface drawings : limit the technical perimeter of procurement and get compliant the integration from the preliminary design until the Factory Acceptance Checks / Tests



DEVIATION CONTROL SYSTEM

The procedure CEA-ESS-PJT-AQ-0004 (Procédure de traitement des non-conformités et des demandes de modification du projet ESSI) covers non conformity and change request.

It describes the process for the control of non conformities and for the configuration baseline changes.



For the ESSI project, the reference configuration for an item is the configuration defined at the kick off meeting (extract from ESSI Quality Plan).

CLASSIFICATION OF THE DEVIATIONS INTO 3 LEVELS

	MINOR CEA WP responsibility N1	INTERMEDIATE MAJOR CEA PMO/WP responsibility L2	MAJOR ESS responsibility N3
Safety of people and equipment		X	DEVIATION WITH « USE AS IS », « REPAIR » AND « SCRAP » DISPOSITIONS TRANSMITTED TO ESS ---------- ALL MAJOR NONCONFORMITIES RELATIVE TO CAVITIES
Operational, fucntional and technical requirements		X	
Interfaces with subsystems of the accelerator		X	
Reliability, maintenability and availability		X	
Lifetime		X	
Changes or nonconformance from approved qualification or established procedure		X	
Internal interfaces	X		
Deviations occurred during assembly and test	X		

Minor deviation:

Deviation which cannot be classified major.

In case of several minor deviations on the same component, the classification shall be reevaluated (remain minor or reclassified major).

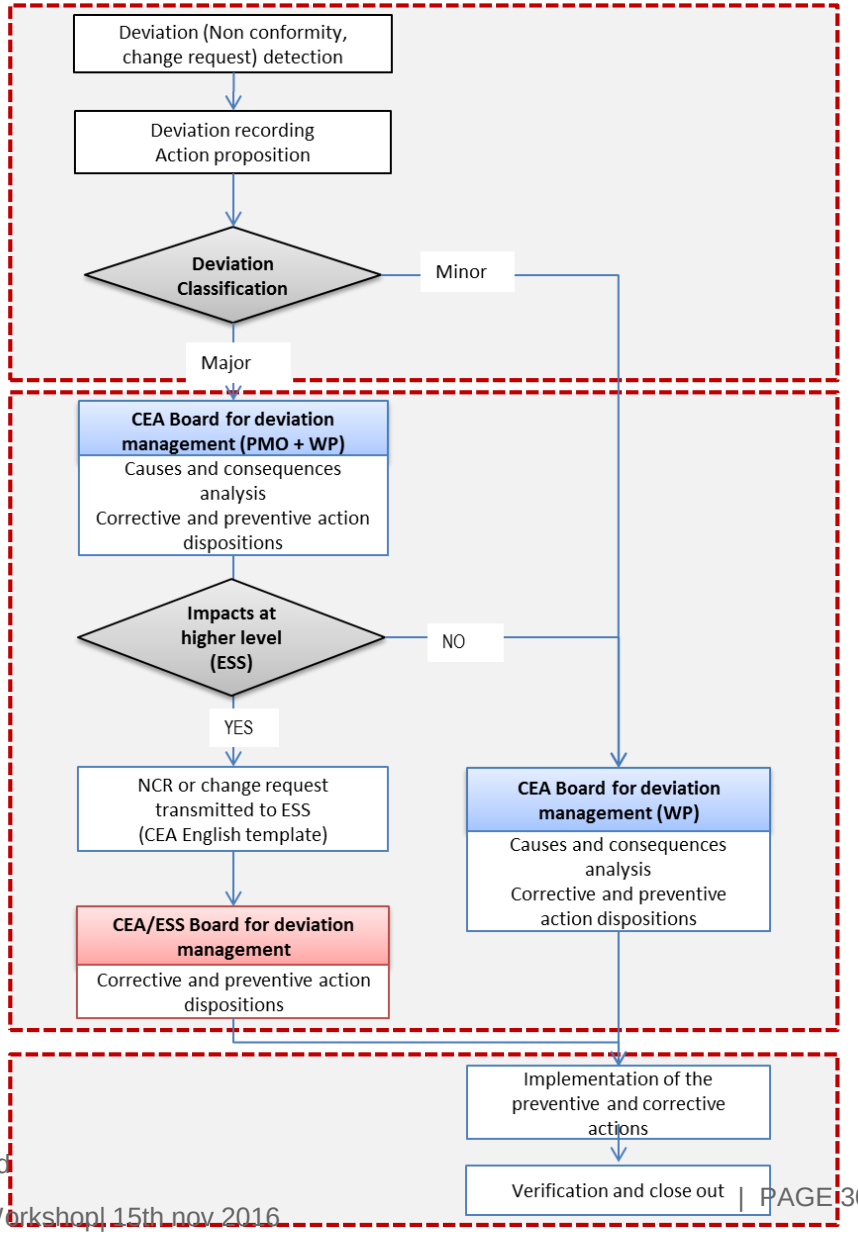
PROCESS FLOWCHART SHARED WITH ESS

Procédure de traitement des non-conformités et des demandes de modification du projet ESSI (Référence CEA-ESS-PJT-AQ-0004)

Step 1: Detect and record the deviation

Step 2: Analyse the root causes and the consequences
Validate the corrective and preventive actions

Step 3: Implement the actions
Step 4: Check the actions and close the report



RISKS MANAGEMENT

Risks register is shared with ESS and updated every 6 months

Initial : 18 risks in severe zone 01/2015

Currently : 9 risks in severe zone

Currently : 9 risks in severe zone

ESSI All WP risks portfolio - before mitigation

	Negligible (1)	LOW (2)	MEDIUM (4)	HIGH (8)	VERY HIGH (16)
Very Likely (16)	-	-	1	-	-
Likely (8)	-	1	4	10	2
Not likely (4)	-	-	4	12	5
Unlikely (2)	-	3	3	3	5
Not Credible (1)	-	-	-	3	-

ESSI All WP risks portfolio - under mitigation

	Negligible (1)	LOW (2)	MEDIUM (4)	HIGH (8)	VERY HIGH (16)
Very Likely (16)	-	-	-	-	-
Likely (8)	-	1	2	3	-
Not likely (4)	-	1	6	14	6
Unlikely (2)	-	4	2	6	5
Not Credible (1)	-	-	2	3	1

ESSI All WP risks portfolio - after mitigation

	Negligible (1)	LOW (2)	MEDIUM (4)	HIGH (8)	VERY HIGH (16)
Very Likely (16)	-	-	-	-	-
Likely (8)	-	1	-	-	-
Not likely (4)	-	-	3	1	-
Unlikely (2)	-	5	13	5	2
Not Credible (1)	1	6	8	4	7

Most critical risks (9) - in **severe** zone - are currently :

- Management & Engineering : Unclear definition of interfaces K64
- CM assembly : Assembly contractor not fully efficient (at the starting time mainly) K64
- CM components : Series components integrated not matching performances K64
- CM components / Couplers : Pre-serie will not reach the expected performance during conditioning K128
- RFQ : Couplers not reaching specifications (800 kW) K64
- RFQ : Difficulties to perform RFQ sections brazing K64
- RFQ : RFQ compromised during conditioning K64

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CONCLUSIONS

KEY ELEMENTS FOR EFFICIENT INFORMATION MANAGEMENT :

1. Perimeters (SoW) and Interfaces well identified and managed very accurately

2. Data to be registered have to be identified as « useful by users » (scientists and / or large infractructure organization) and could / will be provided by partners / contributors.

3. Standards baseline and methodology have to be fixed in the reference configuration and integrated in the Product Assurance Plan :
   → Requirements for partners

4. Communication, exchanges and decisions at the right level
   1. Keep a collaborative spirit

5. Engineering tools must integrate « system approach »
   1. → Multi physics platform for design
   2. Virtual reality for communication, interferences, maintenance plan …
   3. Collaborative Platform for data exchanges
   4. ERP, …

Engineering Soft Tools must be customised to the needs and not drive the project

INKIND CONTRIBUTION FOR ESS IS AN EXISTING CHALLENGE

COLLABORATIVE SPIRIT IS ONE KEY FOR SUCCESS

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THANK YOU FOR YOUR ATTENTION