SPIRAL2 PROJECT :

INTEGRATION OF THE ACCELERATOR PROCESSES,

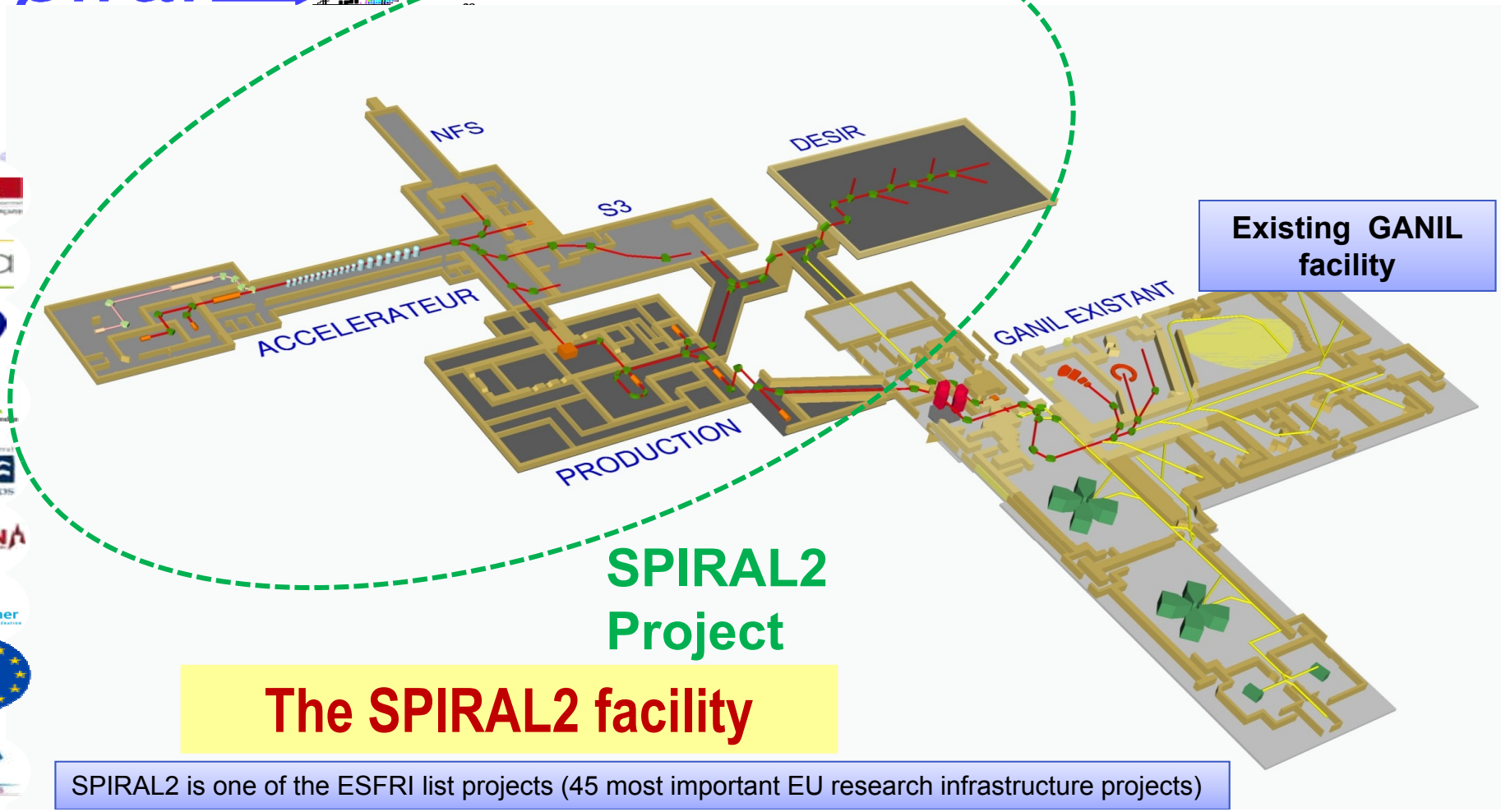
CONSTRUCTION OF THE BUILDINGS

AND PROCESS CONNECTIONS

OUTLINE

- ✓ Introduction
- ✓ Definition of the needs and preliminary design
- ✓ Implementation studies
- ✓ Building construction
- ✓ Process connections
- ✓ Conclusion

Introduction

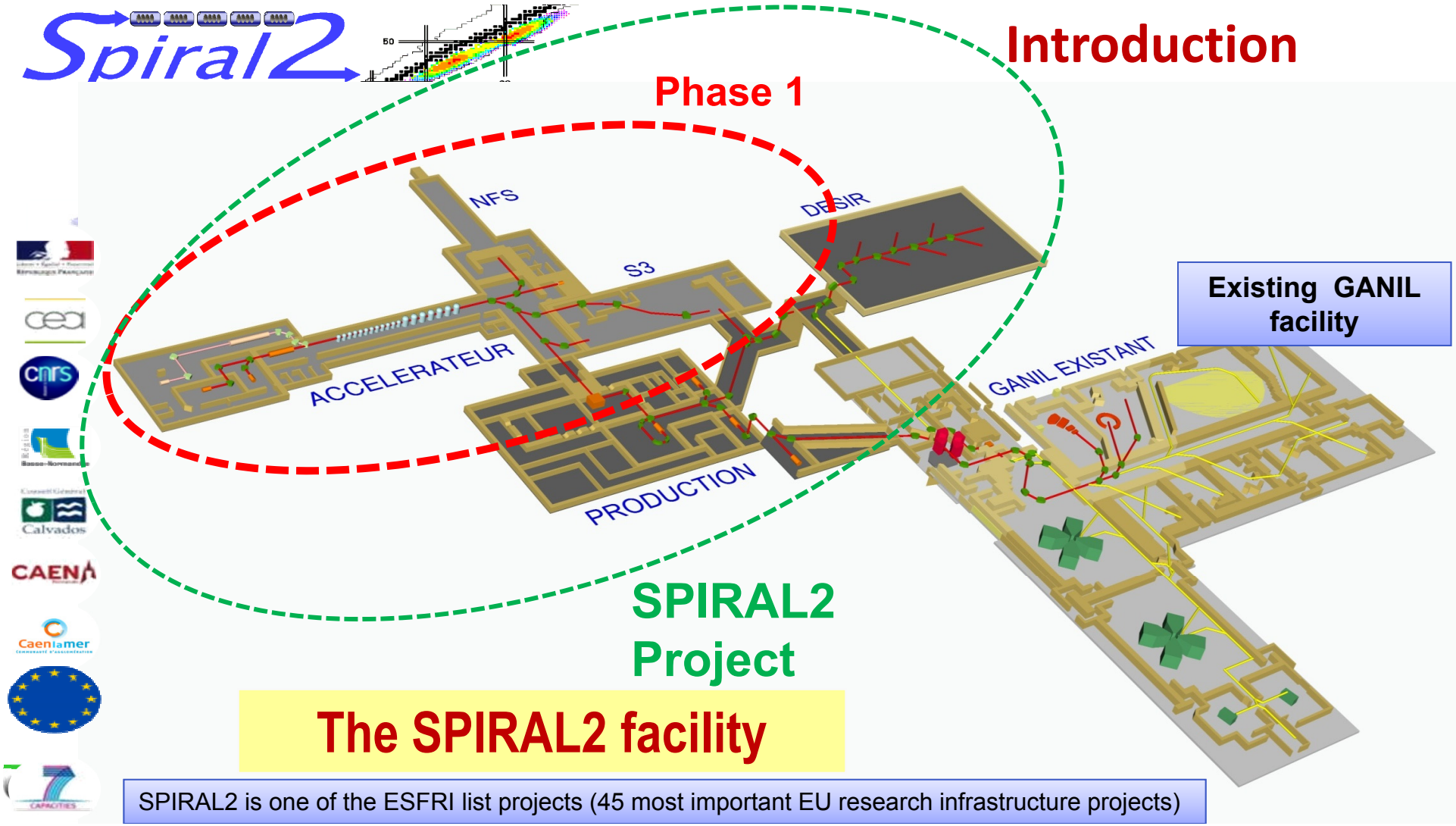


SPIRAL2 Project

The SPIRAL2 facility

SPIRAL2 is one of the ESFRI list projects (45 most important EU research infrastructure projects)

Introduction



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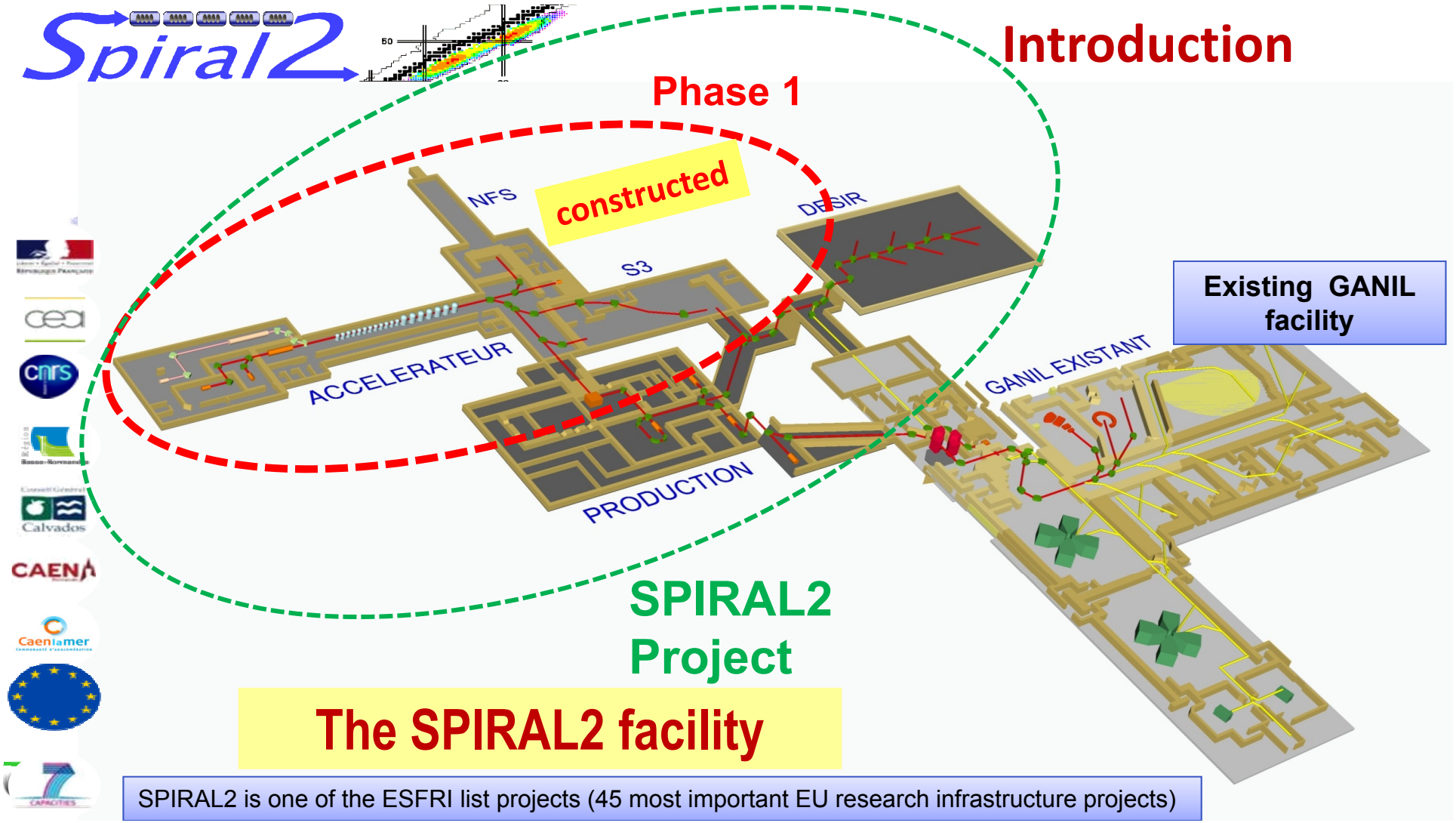

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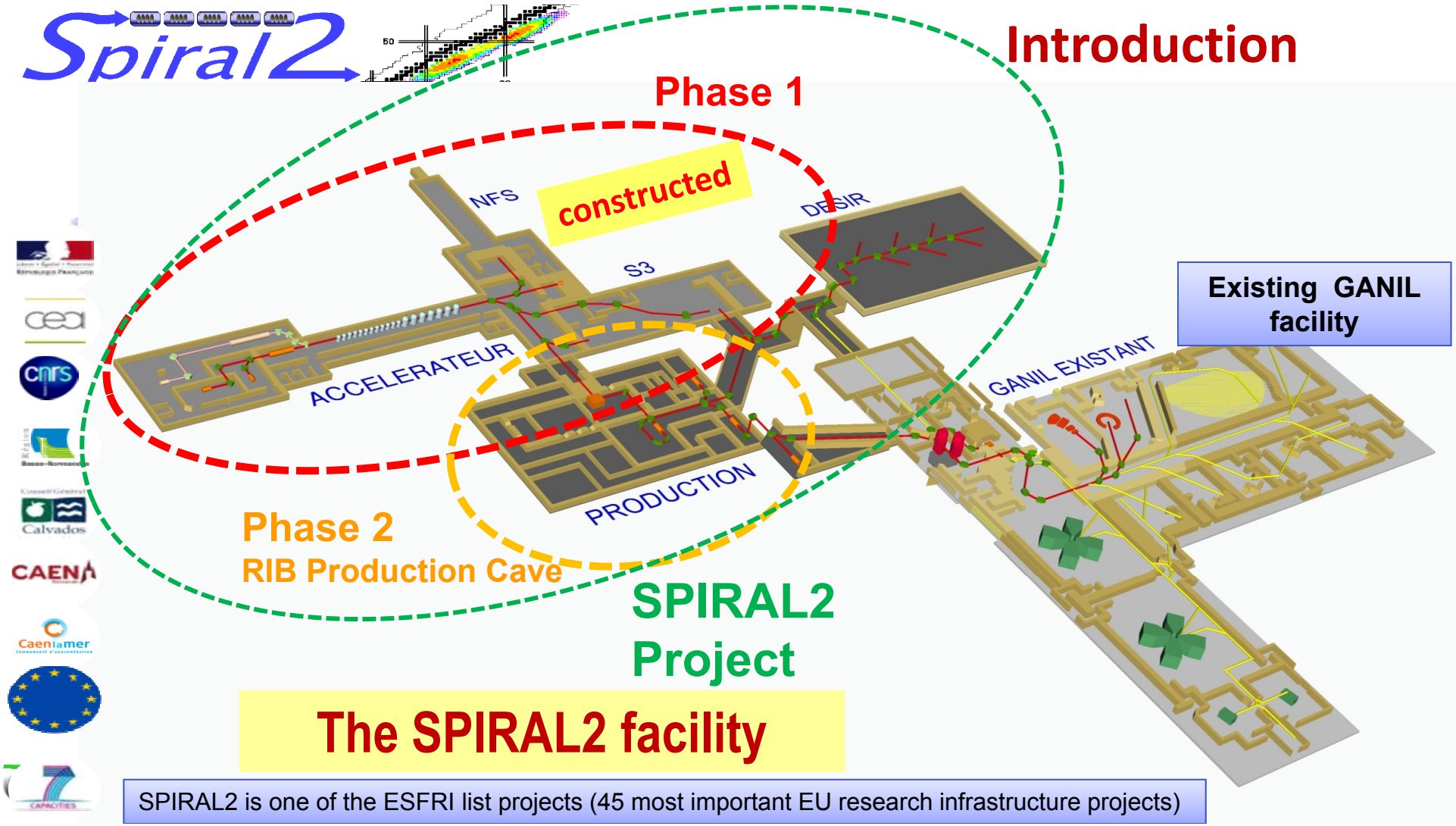

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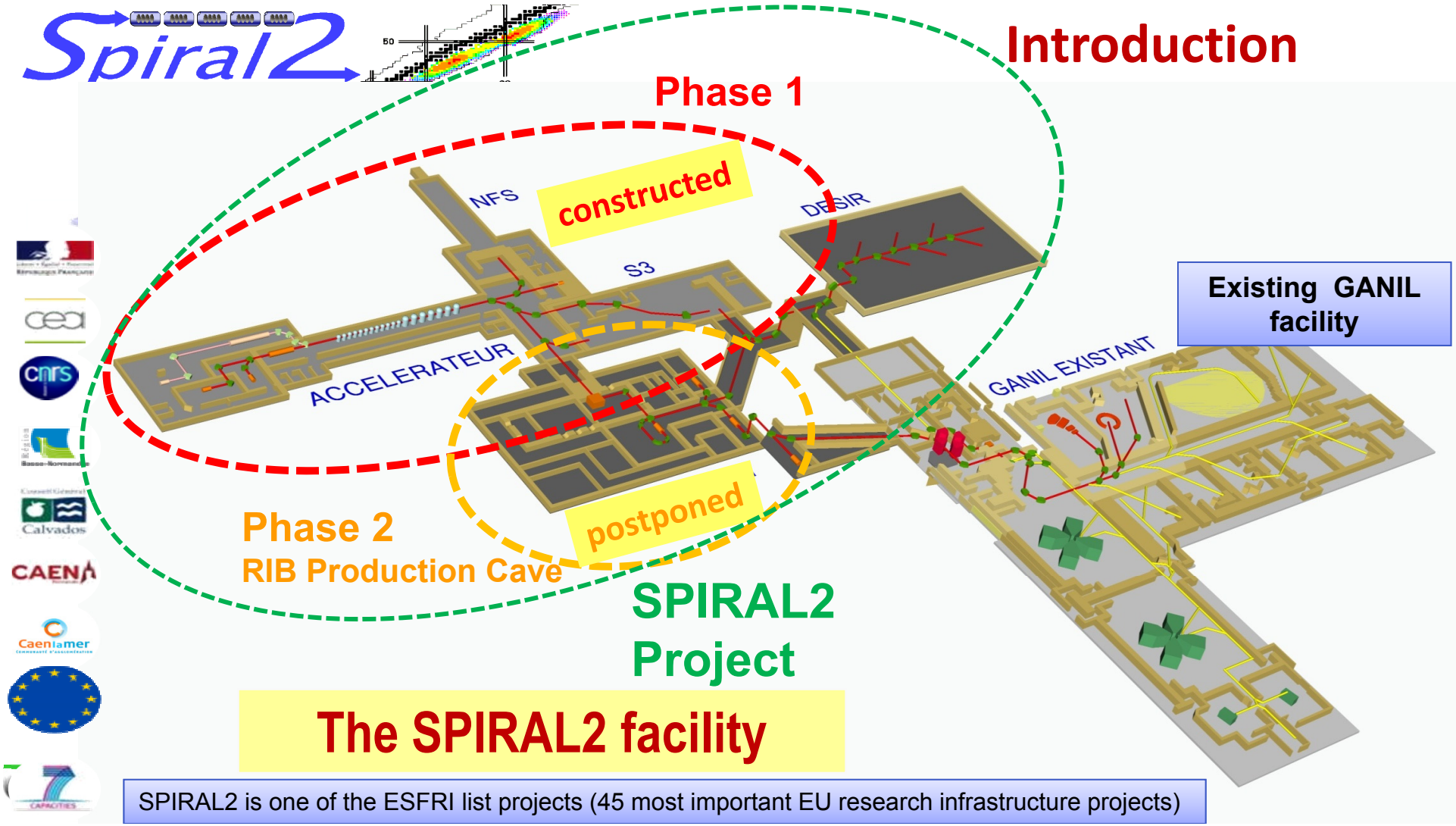

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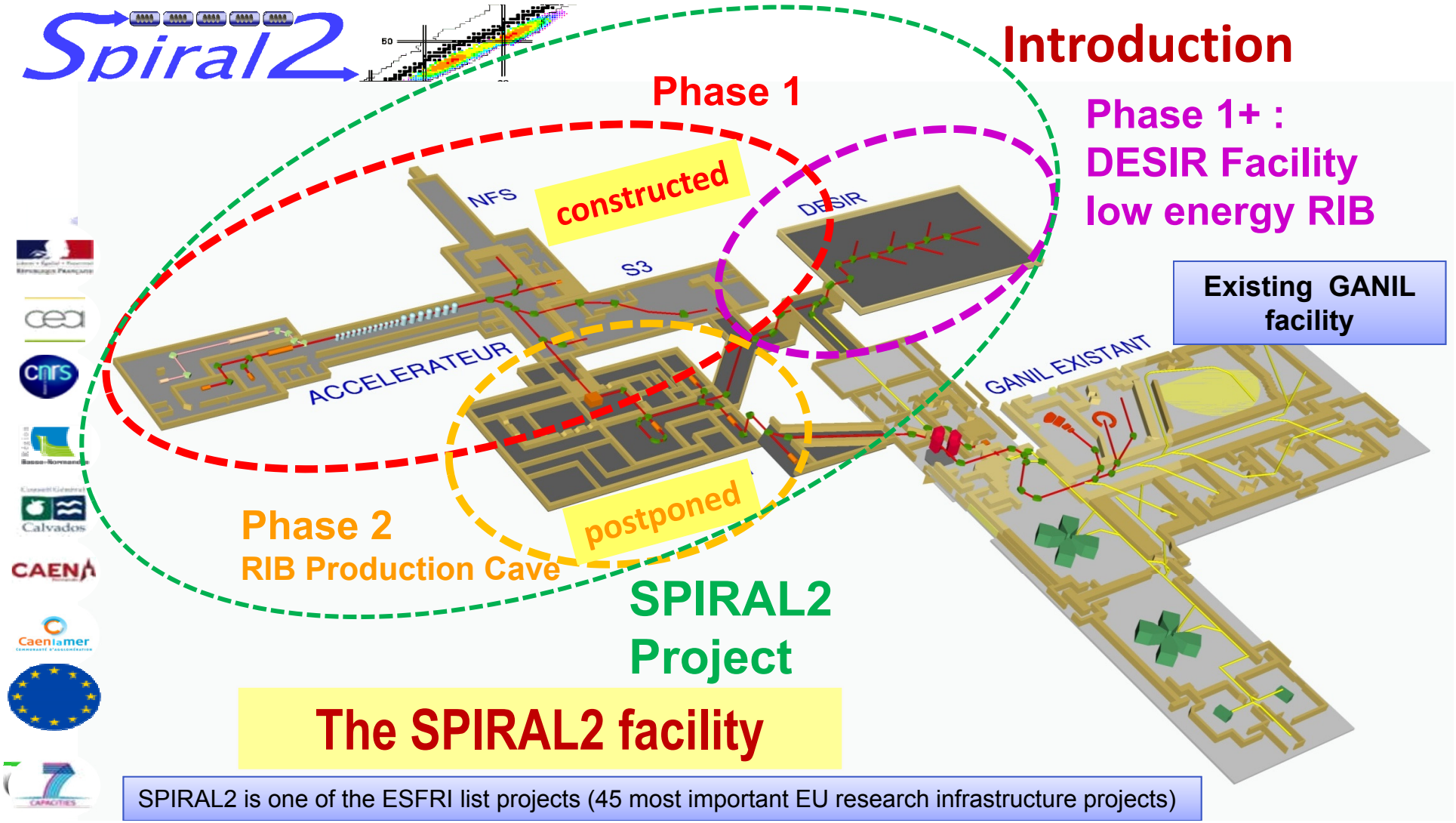

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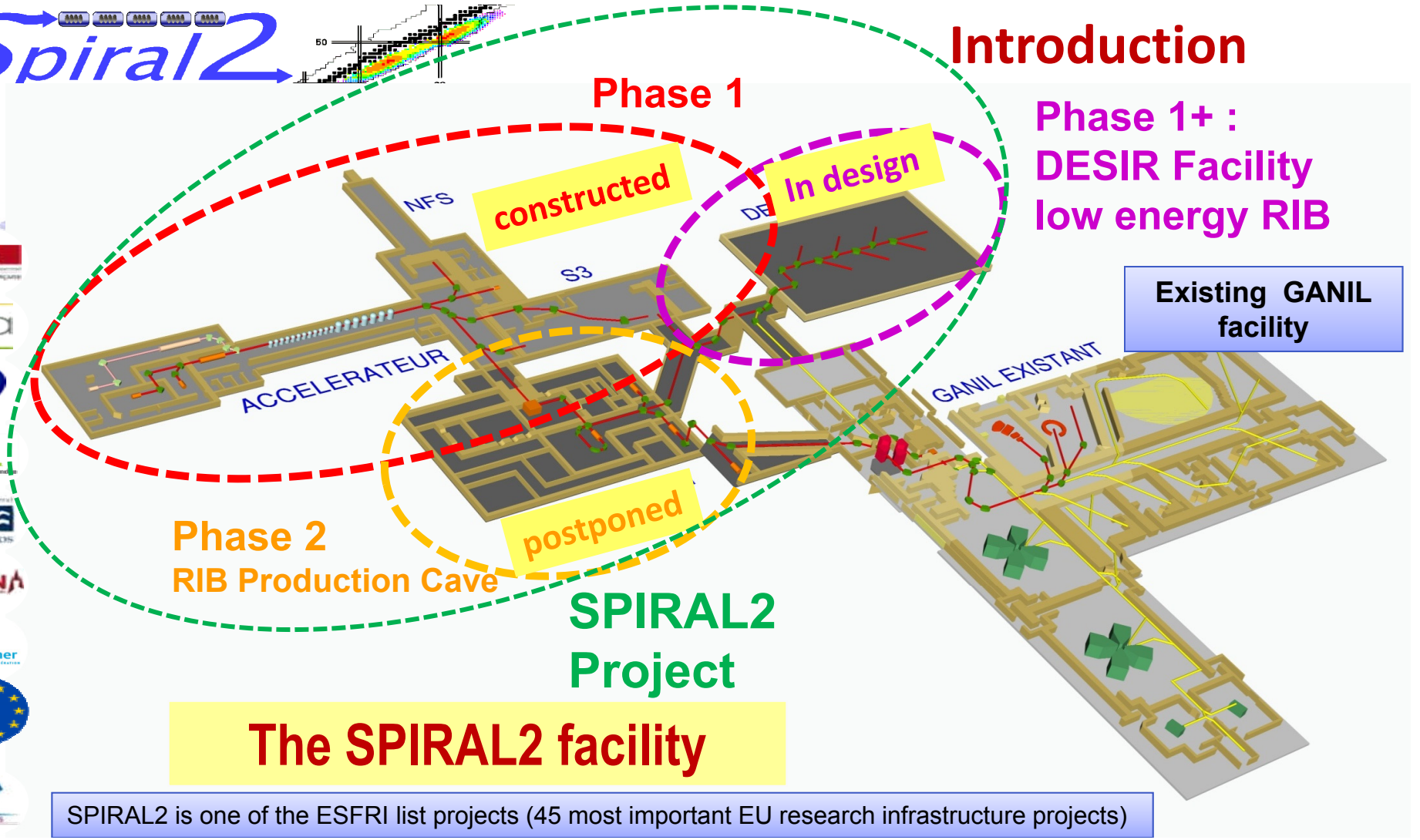


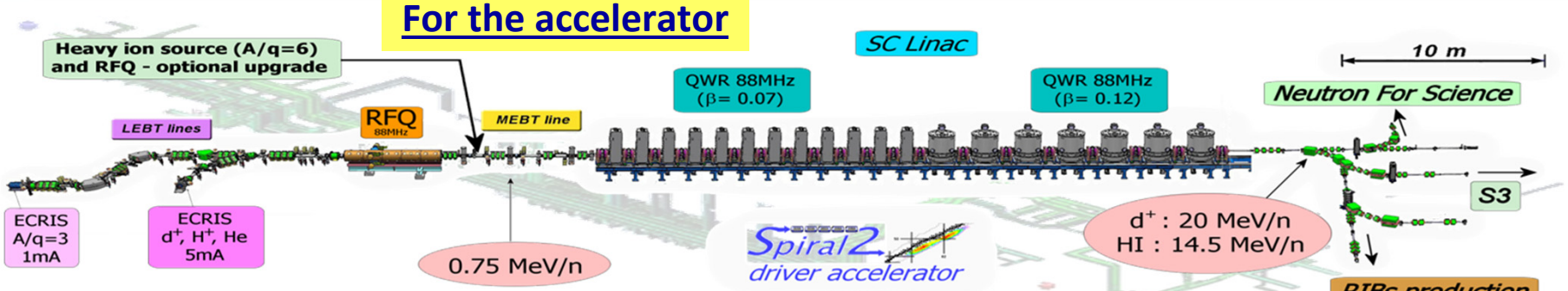
The SPIRAL2 facility

SPIRAL2 is one of the ESFRI list projects (45 most important EU research infrastructure projects)

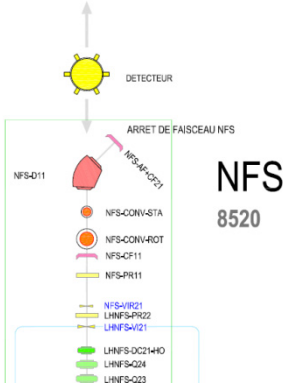
Definition of the needs and preliminary design

1) Baseline Configuration of the processes

For the accelerator



For NFS



For S3

Definition of the needs and preliminary design

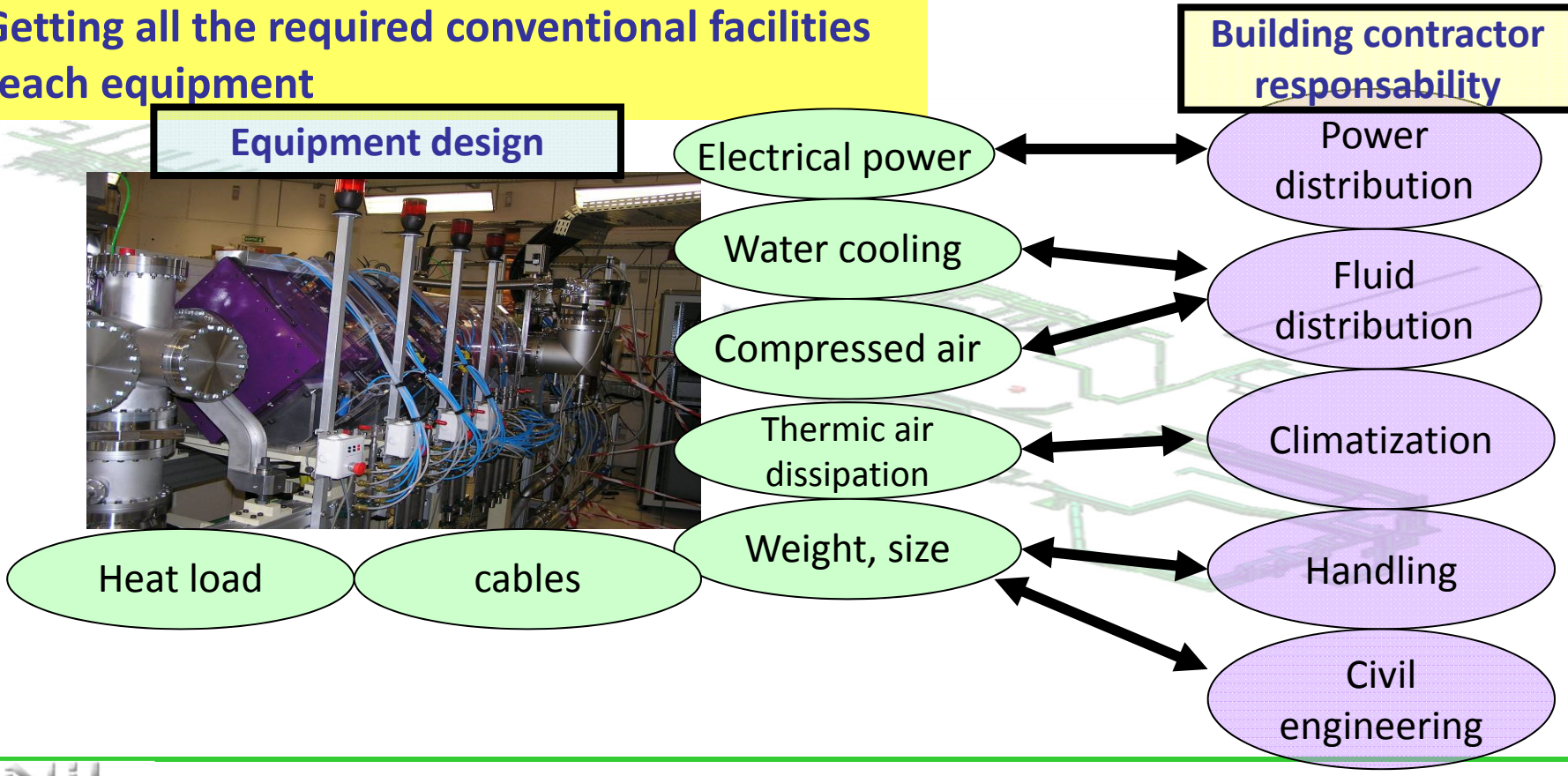
2) Implementation of the SPIRAL2 Product Breakdown Structure (PBS)

- Mixed with geographical structure (for ex : by beam line section) and with technical structure (by trade for ex : electricity supply)
- 6 levels
- Representation of the project organization, the budget, the documentary structure…
- provide codification for equipments and for plans

Code PBS	Arborescence Produits					
	Niv 1	Niv 2	Niv 3	Niv 4	Niv 5	
8000	SPIRAL II - REALISATION					
8200	ACCELERATEURS					
8210		Injecteur (Protons, Deutons & Ions q/A=1/3)				
8211			Source ECR (Ions q/A=1/3)			
8212			Source ECR (Deutons/Protons)			
8213			LBE1 (Ions q/A=1/3)			
8213.1				Aimants		
8213.1.1					Solénoïdes	
						LBE1.SOL11
8213.1.2					Quadrupôles	
						LBE1.Q11
						LBE1.Q12
						LBE1.Q13
						LBE1.Q14
						LBE1.Q15
						LBE1.Q16
						LBE1.Q21
						LBE1.Q22
						LBE1.Q23
						LBE1.Q24
						LBE1.Q25
						LBE1.Q26
8213.1.3					Dipôles	
						LBE1.D11
						LBE1.D12
8213.1.4					Hexapôles	
8213.2				Vide		
8213.3				Diagnostics		

Definition of the needs and preliminary design

3) Getting all the required conventional facilities for each equipment



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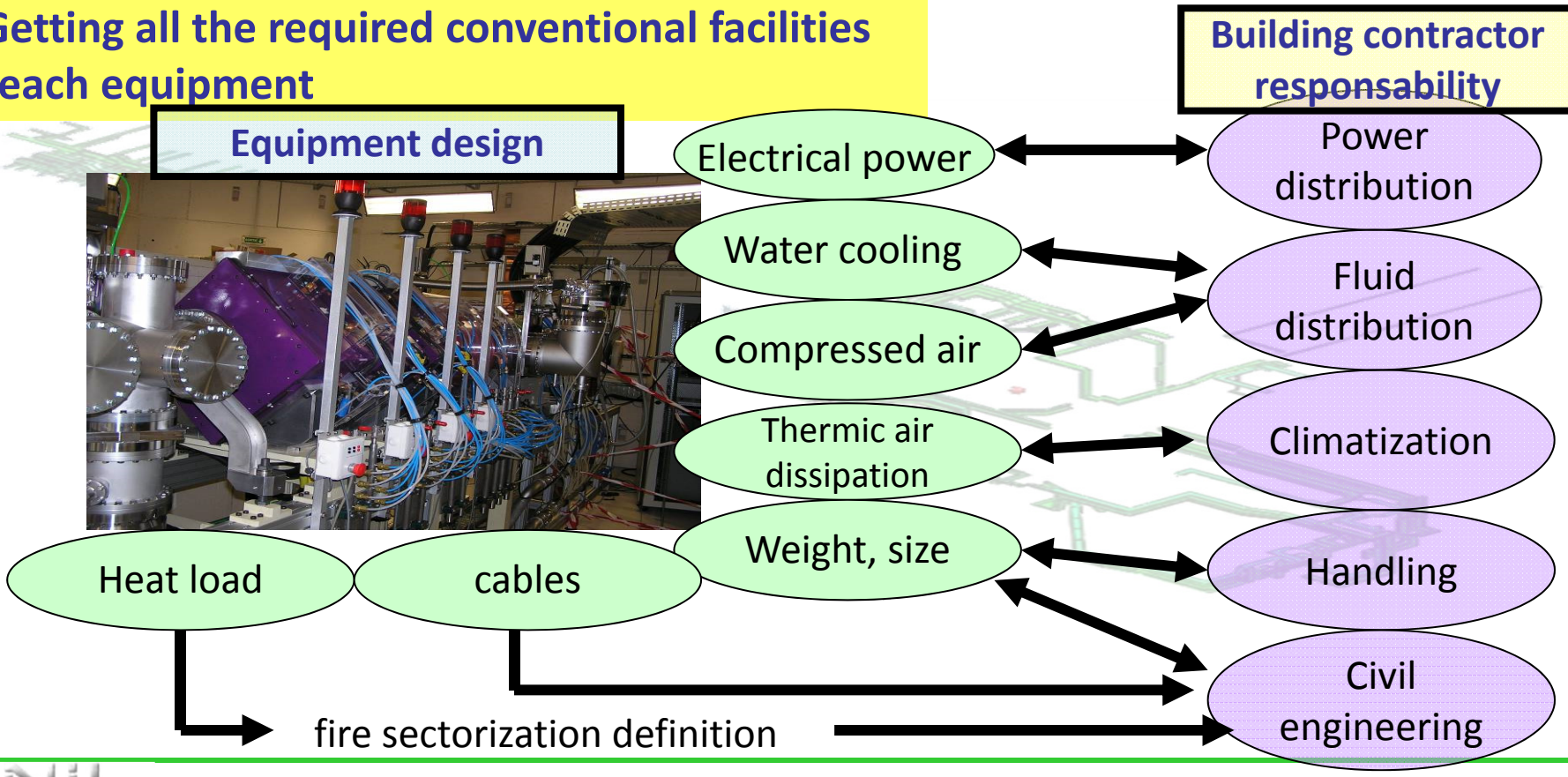

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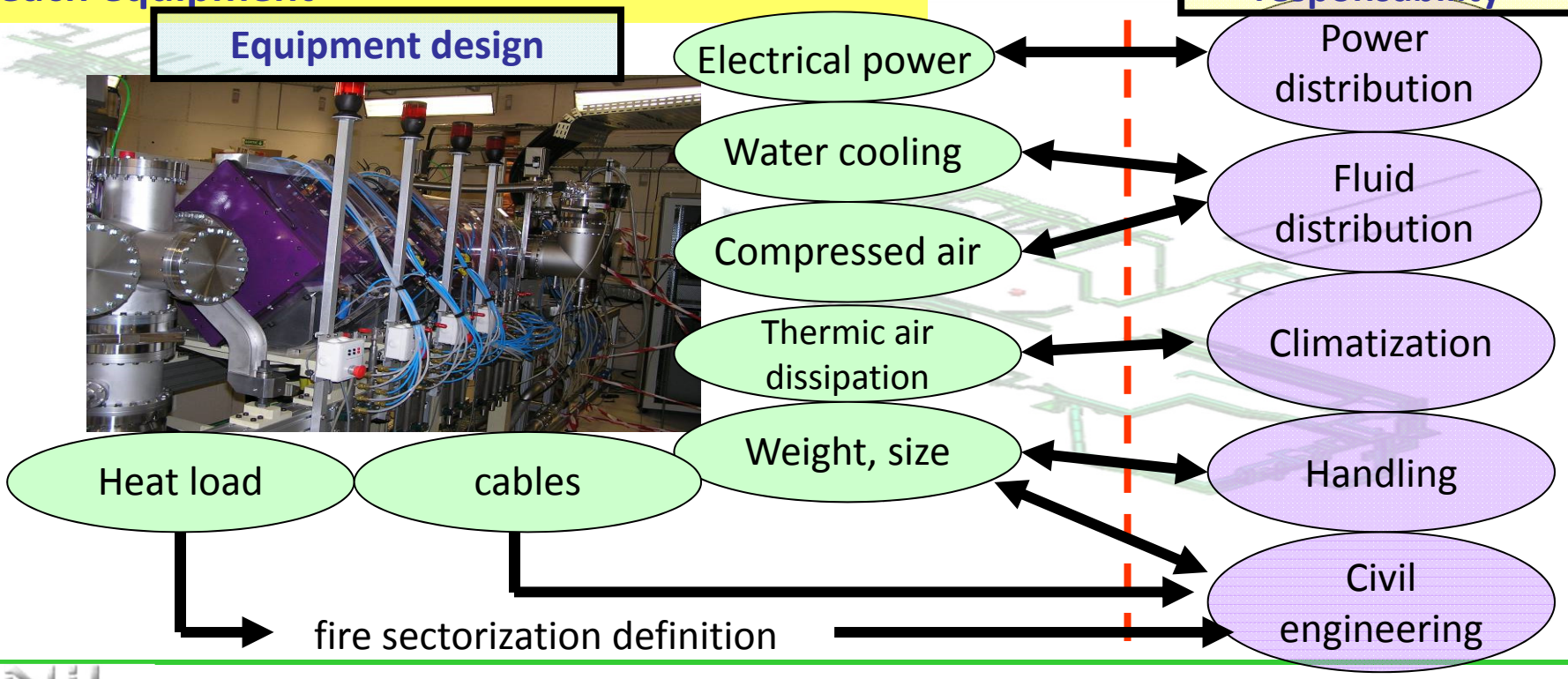
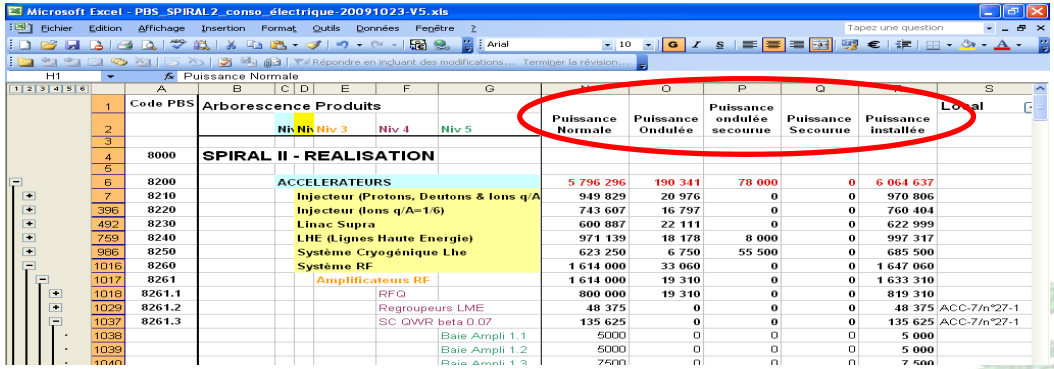


Definition of the needs and preliminary design

4) Data collection with EXCEL files elaborated from PBS



Code PBS	Arborescence Produits	Puissance Normale	Puissance Ondulée	Puissance ondulée secourue	Puissance Secourue	Puissance installée	Local
8000	SPIRAL II - REALISATION						
8200	ACCELERATEURS	5 796 296	190 341	78 000	0	6 064 637	
8210	Injecteur (Protons, Deutons & Ions q/A	949 829	20 976	0	0	970 806	
8220	Injecteur (Ions q/A=1/6)	743 607	16 797	0	0	760 404	
8230	Linac Supra	600 887	22 111	0	0	622 999	
8240	LHE (Lignes Haute Energie)	971 139	18 178	8 000	0	997 317	
8250	Système Cryogénique Lhe	623 250	6 750	55 500	0	685 500	
8260	Système RF	1 614 000	33 060	0	0	1 647 060	
8261	Amplificateurs RF	1 614 000	19 310	0	0	1 633 310	
8261.1	RFQ	800 000	19 310	0	0	819 310	
8261.2	Regroupeurs LME	48 375	0	0	0	48 375	ACC-7/n°27-1
8261.3	SC QWR beta 0.07	135 625	0	0	0	135 625	ACC-7/n°27-1
	Baie Ampli 1.1	5000	0	0	0	5 000	
	Baie Ampli 1.2	5000	0	0	0	5 000	

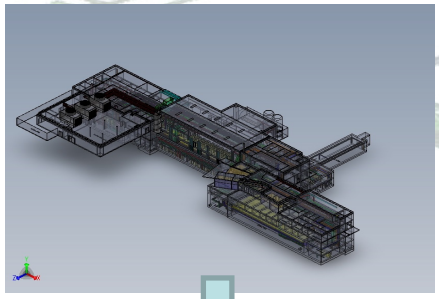
5) Generation of synthesis data in order to define building Interfaces for each room and for each work package

Pièce à pièce Electricité bâtiment ACC						
n° pièce	désignation pièce	Pnormale (VA)	Pondulée (VA)	P ondulée secourue (VA)	Psecourue(VA)	Ptotale
ACC-1/n°1	Salle 1/6	119 375	0	0	0	119 375
ACC-1/n°2	Salle 1/3	149 875	500	0	0	150 375
ACC-1/n°3	Salle Deutons	22 875	0	0	0	22 875
ACC-2/n°4	Salle RFQ 1/6	43 625	0	0	0	43 625
ACC-2/n°5	Salle RFQ 1/3 + LINAC	30 125	0	0	0	30 125
ACC-2/n°103-1	Couloir technique 103-1	36 625	6 250	0	0	42 875
ACC-2/n°103-2	Couloir technique 103-2	60 500	0	0	0	60 500
ACC-2/n°6	Refroidissement RFQ 1/6	125 000	4 000	0	0	129 000
ACC-2/n°7	Refroidissement RFQ 1/3	187 500	0	0	0	187 500
ACC-3/n°8	Salle LHE1	17 000	0	0	0	17 000
ACC-3/n°9	Salle LHE2	4 500	0	0	0	4 500
ACC-3/n°10	Salle Arrêt Faisceau	0	0	0	0	0

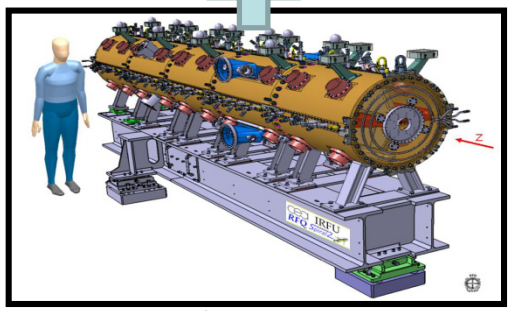
Base : for the building preliminary design and secondly for writing the work package call for tenders (building and process connections)

Definition of the needs and preliminary design

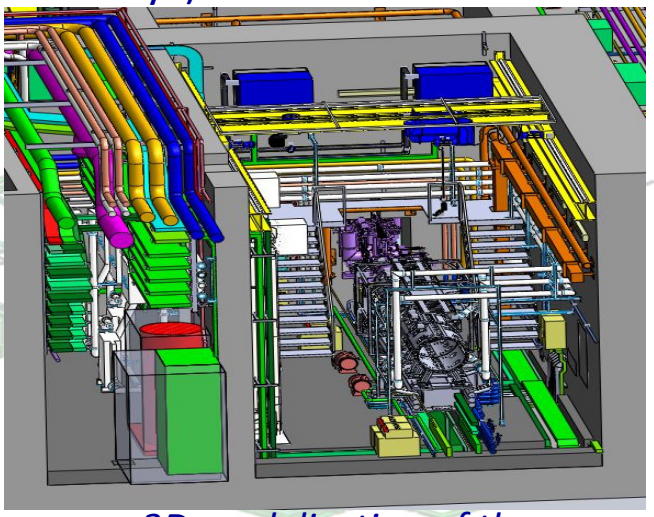
preliminary design → Decision to design the entire project with 3D tools (high degree of complexity of the processes and very high level of the integration including connecting pipes and cables trays).



3D model of the building design with SolidWorks



3D model of the processes design with CATIA



3D modelization of the facility with SolidWorks tool Beam axis is -8 m

guarantee our ability to install, set up and maintain the equipments.

Implementation studies

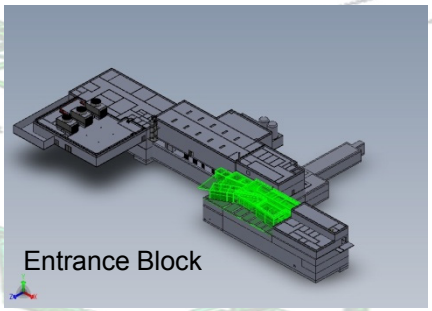
3D synthesis operation

The integration and synthesis process consisted in:

- Positioning equipments into the building and providing these equipments with all services and connections necessary for their functioning.
- Ensuring the spatial coherence for all equipment in respect of the architectural constraints and technical capacities, for both exploitation and maintenance

Organization :

For each firm : same software, same graphics rules and same modelization structure (by building level and by block)

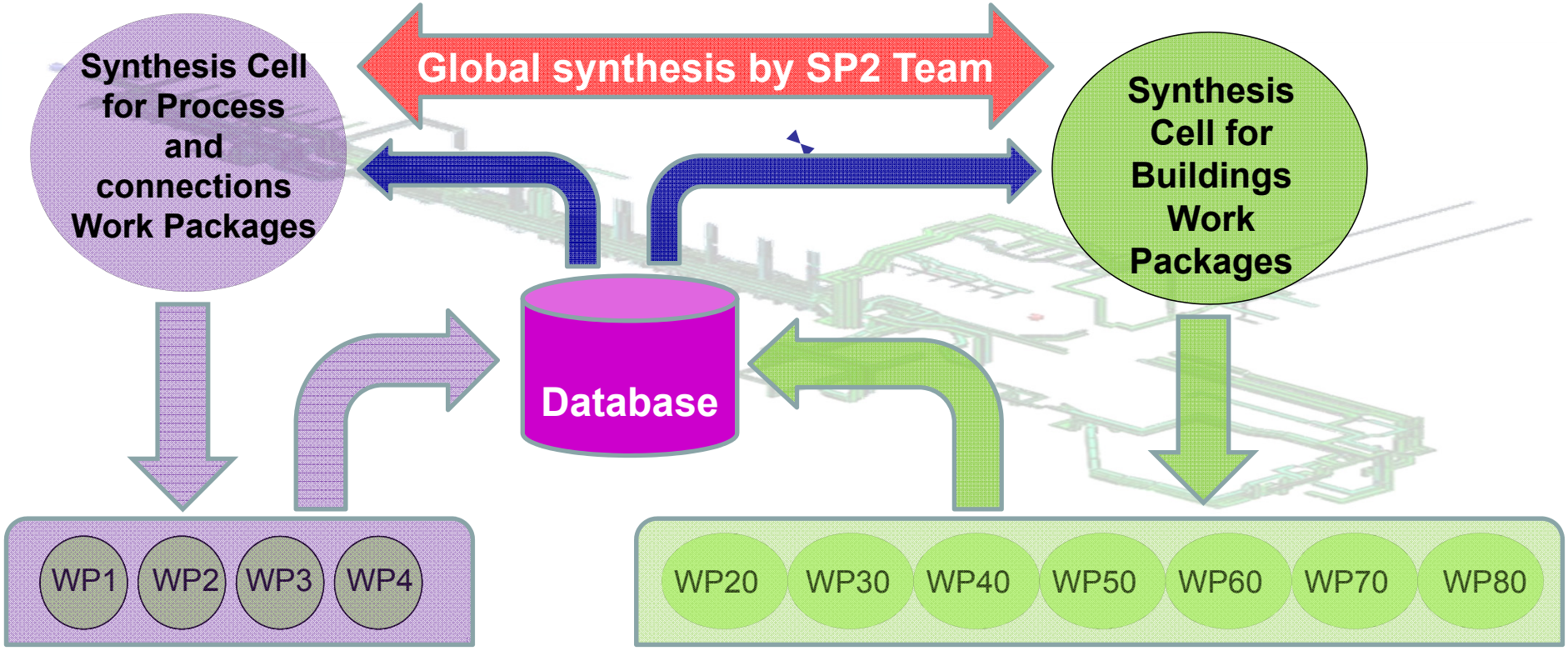


The synthesis process was carried out synchronizing nine companies, the building prime contractor, the assistant and the SPIRAL 2 project team, day after day over a twelve months period (March 2011 to March 2012)

it was a challenge!

Implementation studies

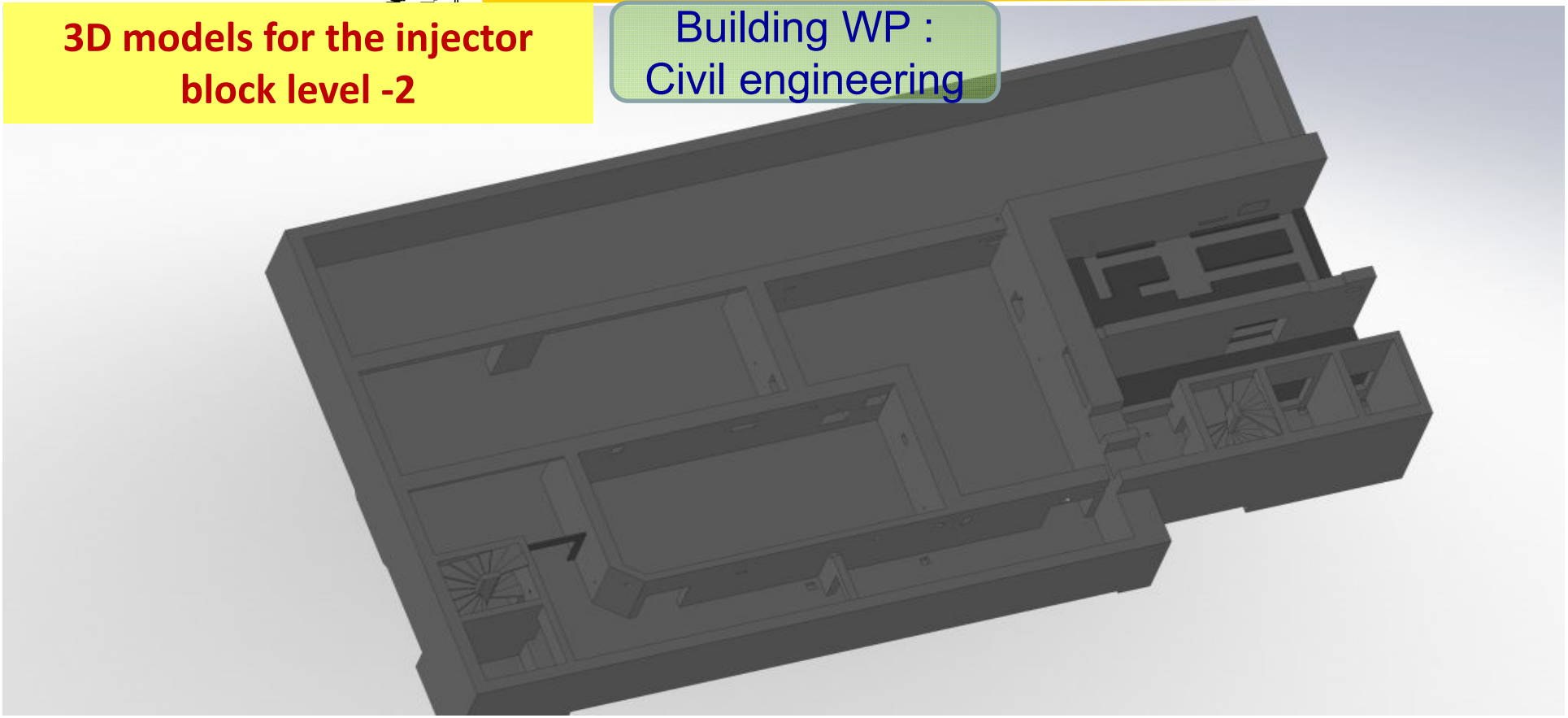
Organization of 3D synthesis operation



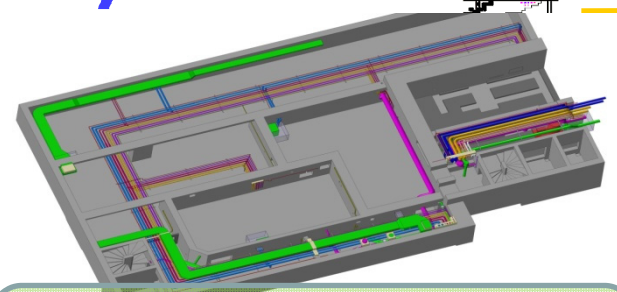
Implementation studies

3D models for the injector block level -2

Building WP :
Civil engineering

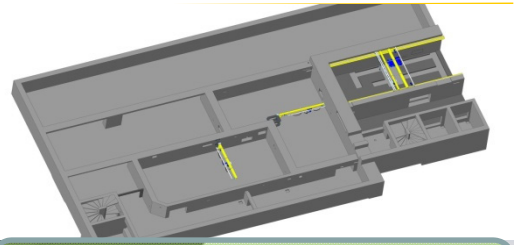


Implementation studies

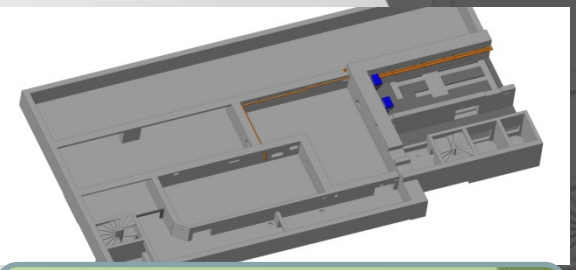


Building WP : water cooling system and non nuclear ventilation

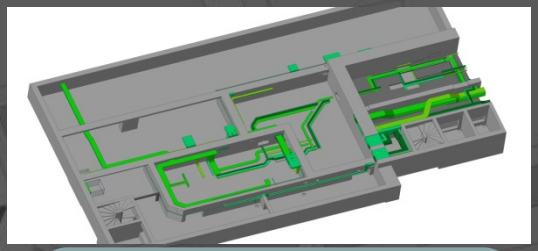
Building WP : Civil engineering



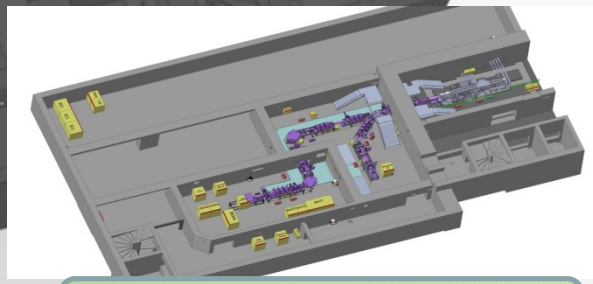
Building WP : cranes



Building WP : nuclear ventilation



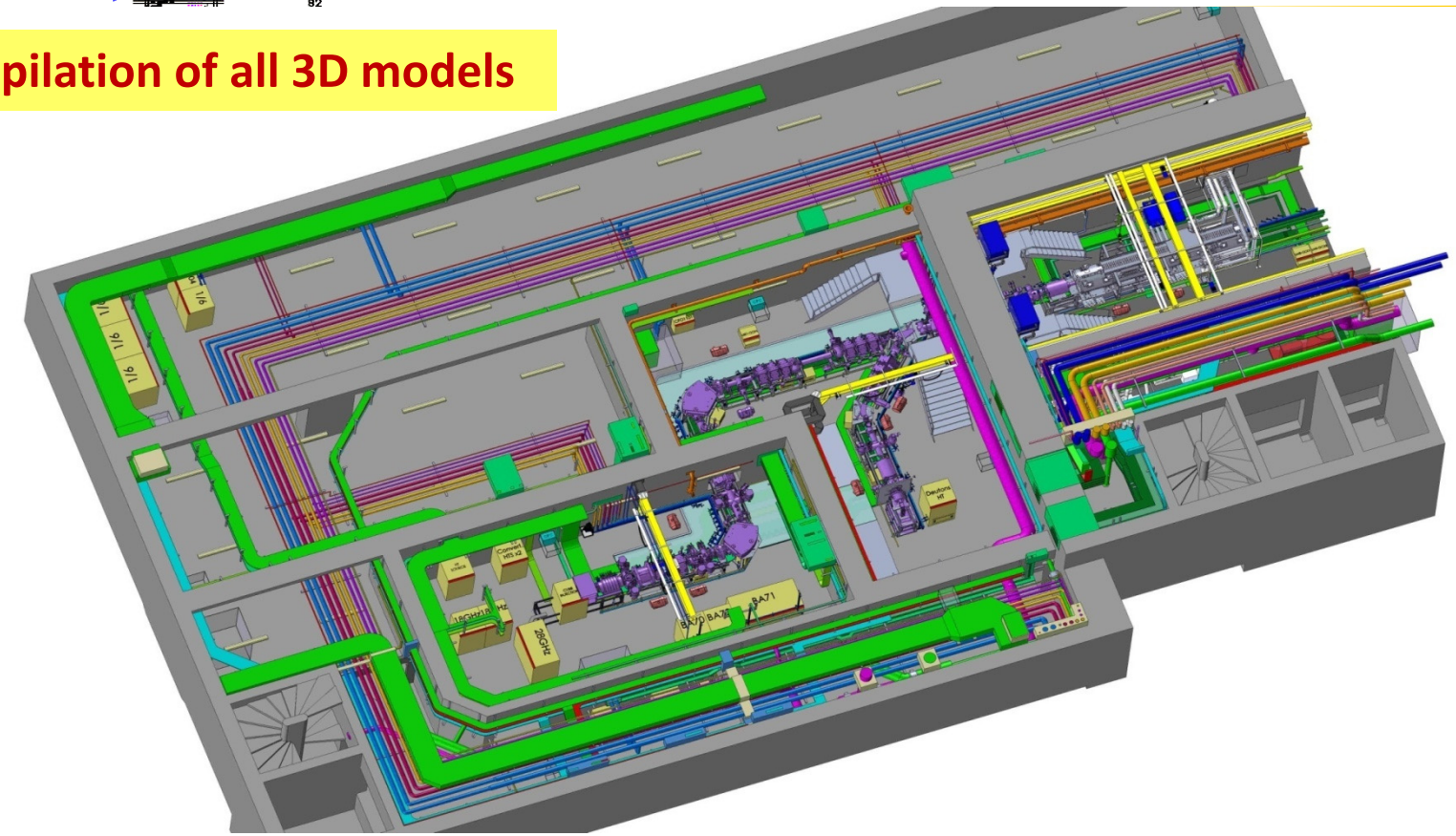
Process WP : electrical connections



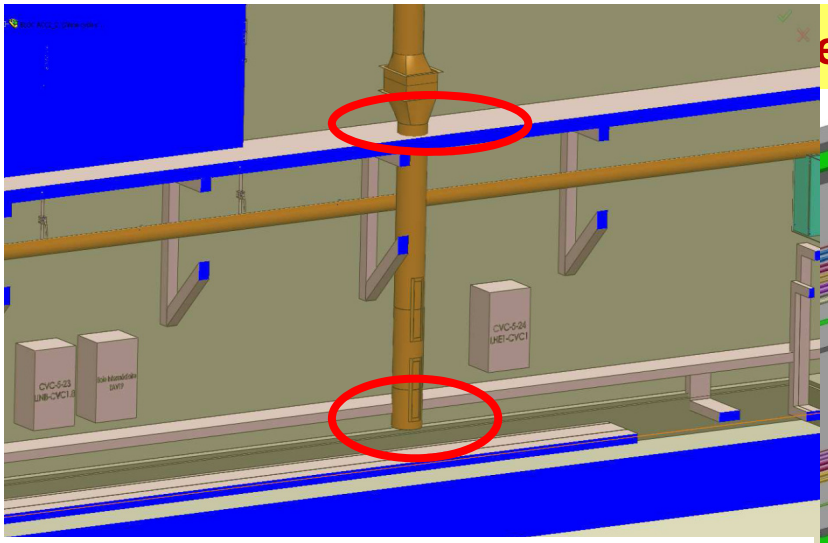
Processes

Implementation studies

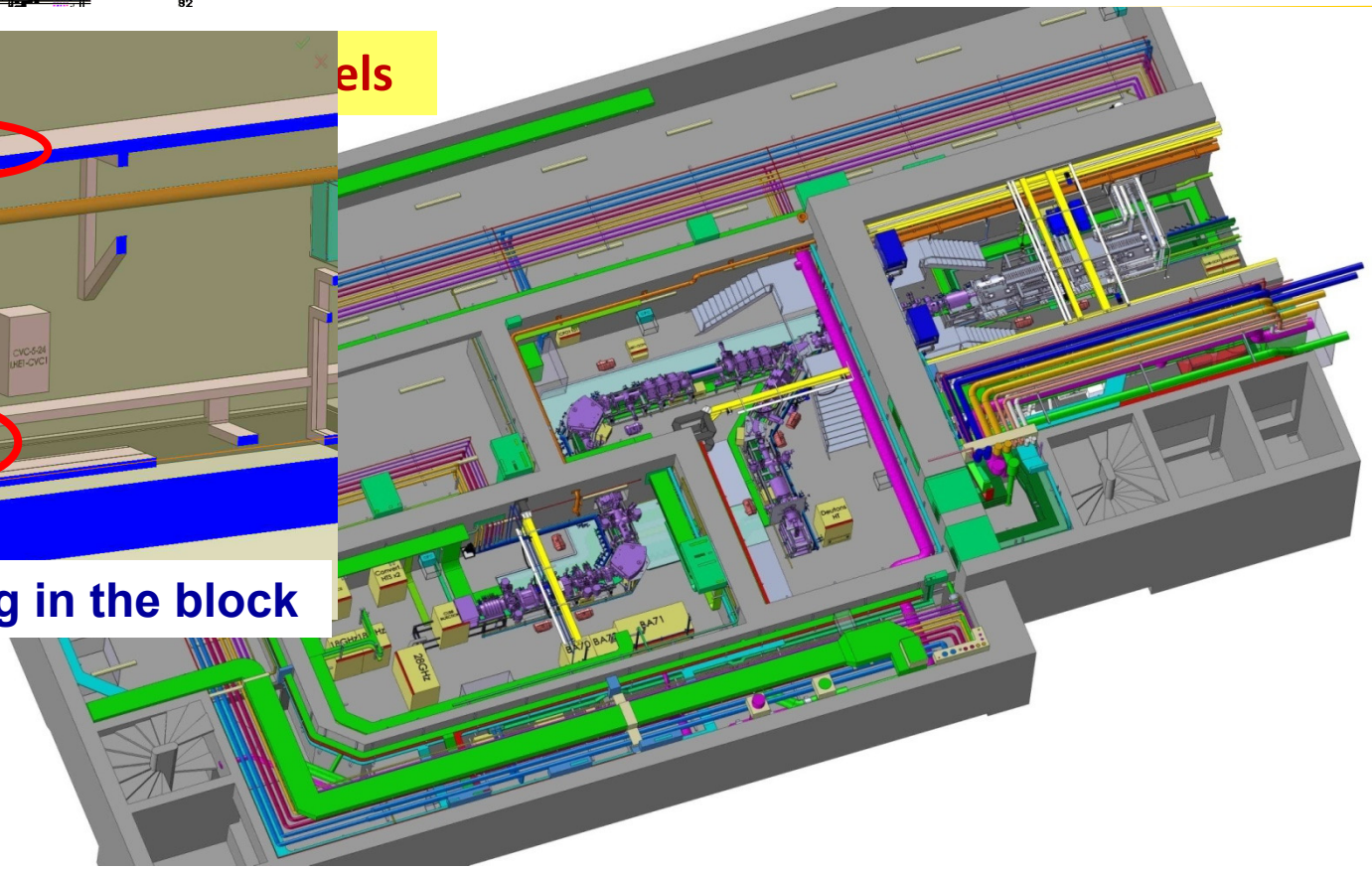
Compilation of all 3D models



Implementation studies

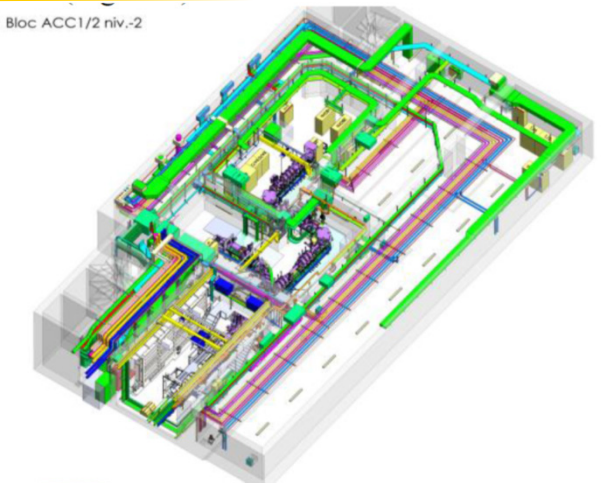


Interference checking in the block



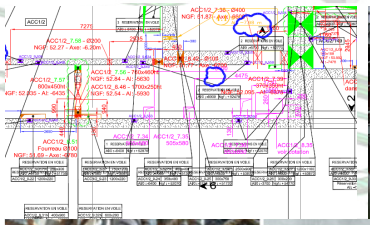
Implementation studies

The synthesis process has provided :

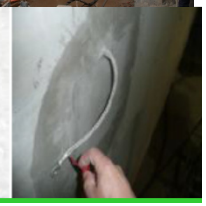


➢ A 3D high definition global integration without spatial interference

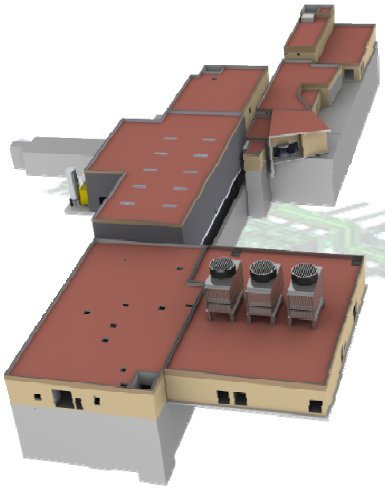
➢ The size and position of more than 1,000 reservations (reinforcement needed to realize the concrete floors and walls)



➢ The position of ground pin connections
(good electromagnetic compatibility ⇨ high beam quality)



Building construction



Buildings :
Height : +8,80 m; Depth : -9,50 m
4 levels
~ 100 rooms
7200 m^2
Surface area :
Width = 80 m ; Length= 133 m

The key dates of the building construction are:
- Construction permit: October 2010
- Excavation start: January 2011
- Pouring of first concrete: September 2011
- First process installation: November 2012
- Building handover: October 2014
- Processes connection handover: April 2015

Status of building construction : Mai 2011

Status of building construction : Mai 2012

Status of building construction : Mai 2012

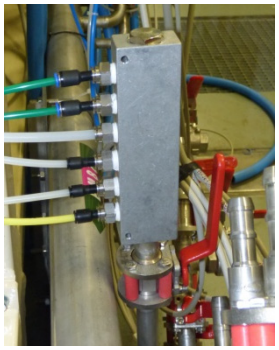
In October 2014, 14,000 m3 of concrete were poured with 2200 T steel reinforcement (280,000 hours for civil engineering)

Status of building construction : October 2014

Process connections

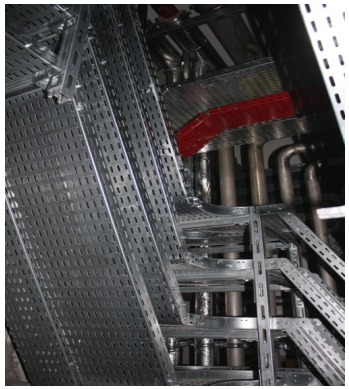
Four work packages directly managed by the SPIRAL 2 team have been contracted to realize this “connecting work”:

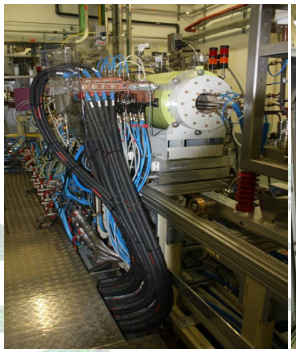
- One fluid work package for the water cooling connections and air connections (700 valves).
- One RF power distribution work package to distribute the 600 kW@88 MHz (for accelerator cavities) through 1,200 m of coaxial lines (broadcast).

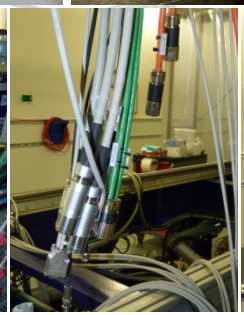




Process connections

- Two electrical work packages to install 10,000 m of cable trays, 400,000 m of cables, more than 20,000 connectors and the electrical distribution cabinets.

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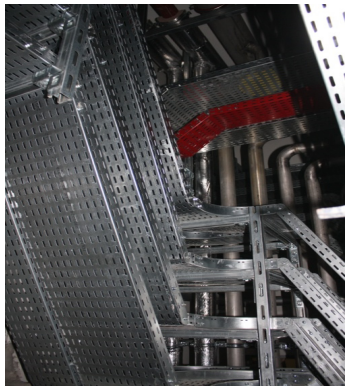






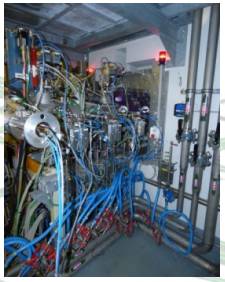

Difficulties with RF and small electronic connectors

Default rate before correction<1% : ☺

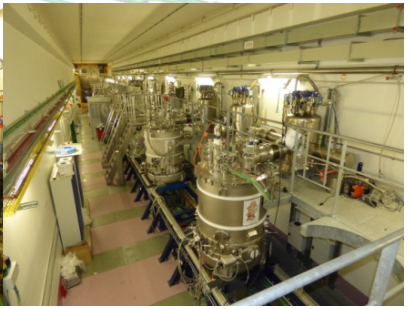
Conclusions

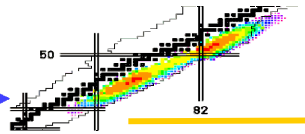
✓the buildings are now constructed,


✓ the main part of the cables and connections are installed,




✓ the injector is under tests and the superconducting LINAC is now being installed.



Conclusions

For the integration, synthesis, construction and set up of a complex facility such as SPIRAL 2 our main feedback concerns the followings:

1. **The Contractors underestimated the complexity and the number of connections required by our processes.**

2. **The data collection and synthesis is an enormous task (a lot of time and resources). Spreadsheet files is not appropriate. A database seems much more adapted.**

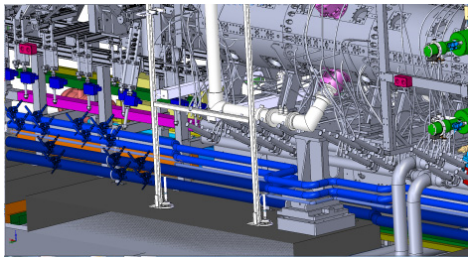
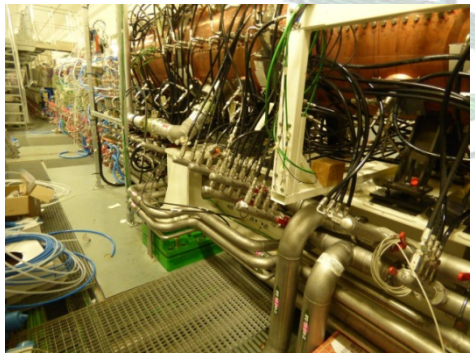
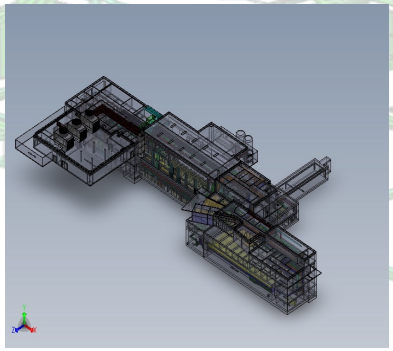
3. **For a large facility, a detailed 3D modelization with a high level of integration is required.**
    - **Risks were minimized (spatial interference, difficulties of assembly and maintenance).**
    - **It's a powerful tool to design and construct buildings and infrastructures, and then, to control the execution (potential tool to operate).**

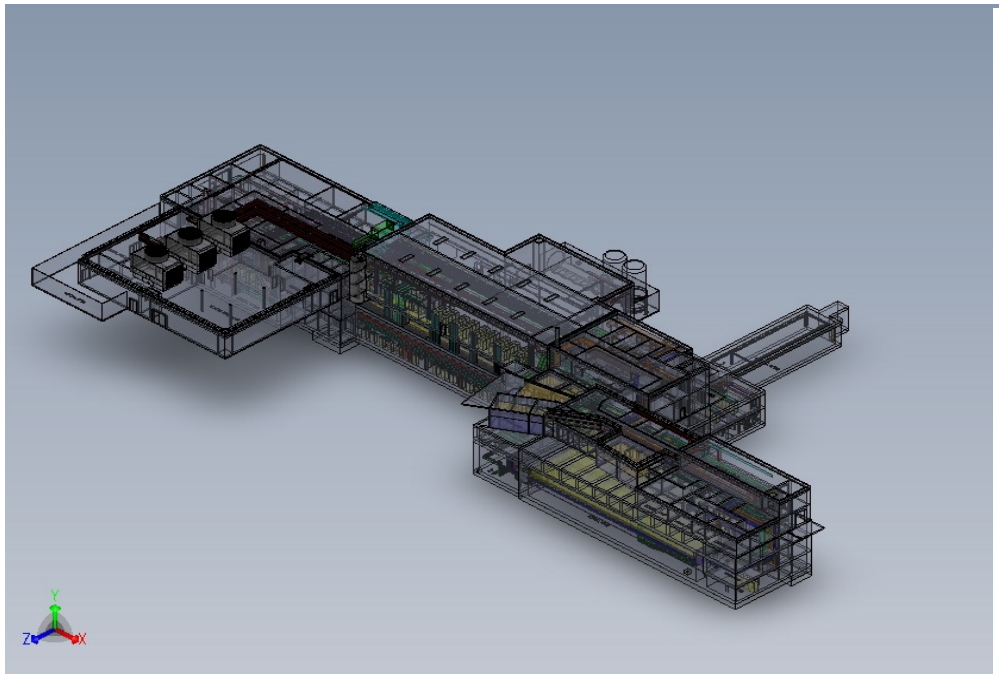
Conclusions

4. 3D model file sizes are enormous and global assemblies are often difficult to visualize. Simpler model in particular for the processes are required.

5. The goal is reached:

Such as designed = Such as built or 3D = Reality

Thank you for your attention

On behalf the team of the SPIRAL2 integration cell and the whole SPIRAL2 project team