Pre project

CYclotrons**REN**ovation

GANIL Scientific Council 2024

TECHNICAL MOTIVATIONS AND OBJECTIVES

- ***Statement***

  Cyclotrons maintenance and refurbishment reduced to the strict minimum for ten years due to the GANIL manpower dedicated to :

  - ✓ SPIRAL2 building then commisionning
  - ✓ Compliance projects following the 1st safety review

  ➔ **Aging ↗ Reliability ↘ Manpower for curative maintenance ↗**

  Statement shared by the Working Group led by R. Clédassou (IN2P3) and Ph.Rebourgeard (IRFU) in 2021 :

  ➔ **Strong recommandation to lead an ambitious refurbishment program to be started as soon as possible**

- ***Launch of the pre project CYREN :*** **17th march 2022**

- ***Objectives of the project***
  - **Purpose n° 1** : to keep the facility in operational condtions for at least 20 years (Maintenance in Operating Conditions (MOC))
  - **Purpose n° 2** : to optimize manpower needed for maintenance after refurbishment

SCOPE AND METHODOLOGY

➢ *Scope : original facility*

Cyclotrons et experimental caves

- **Power Supplies and Magnets**
- **RF cavities and systems**
- **Remote control**
- **PLCs**
- **Vacuum systems**
- **Diagnostics**
- **Production targets**
- **Ions Sources**

Infrastructures and utilities

- **Electricity Distribution**
- **Cooling systems**
- **HVAC**
- **Buildings**
- **Various networks (water, air, gas)**
- **Computer Infrastructures**

Safety / Security / Radioprotection Systems

- **Radioprotection devices** *(radiation detectors, active dosimeters, gamma spectrometers, …)*
- **Access Management System**
- **Fire Safety System**

➢ *Methodology*

➢ Many Working Groups (about 40 people involved)

- ✓ Devices overview considering many criteria such as : old age, reliability feedback, spares availibility, impact in case of failure, recovery strategy, …
- ✓ Determination of what needs to be done and how
- ✓ Cost and manpower evaluation for implementing the necessary actions

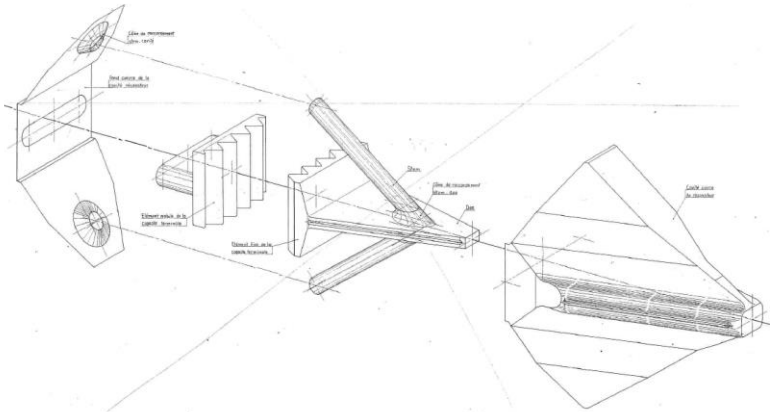
➢ Synthesis

- ✓ **BASELINE scenario** : refurbishement programme with only one new CSS RF cavity
- ✓ **COMPLETE scenario** : BASELINE scenario extended to 4 new CSS RF cavities
- ✓ 2 DEGRADED scenario : in case of insufficient budget
- ✓ Identification of the part of this program relating to the recurrent operating budget for MOC

Risk : cooling circuit leak, unreachable for repairing

➔ **At least, manufacturing of a new cavity and keeping an old one as a spare : BASELINE scenario**

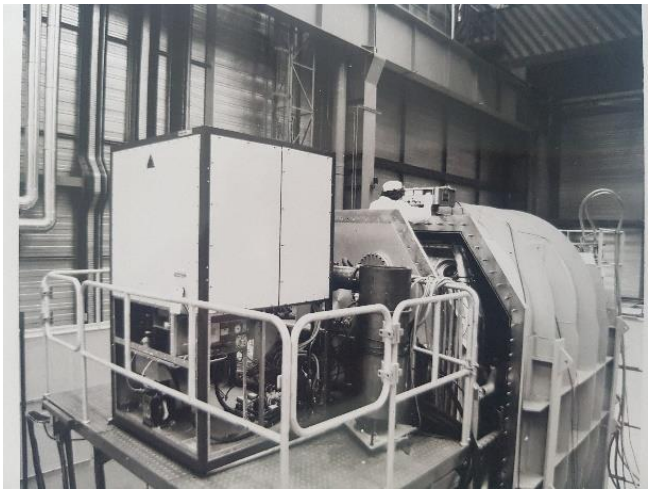
➔ **Replace the 4 SSC RF cavities : COMPLETE scenario**



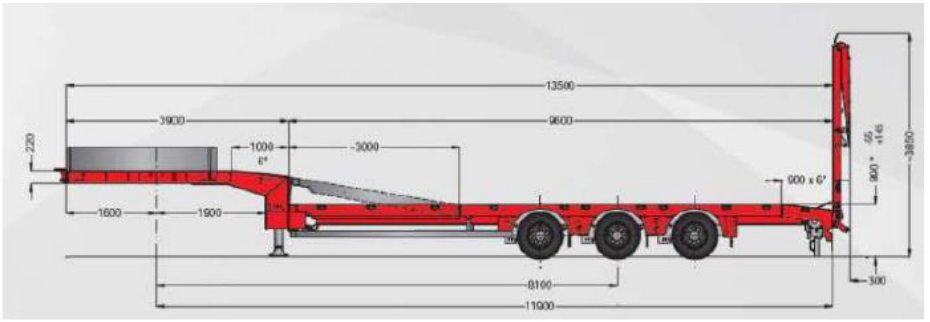
Issues to be assessed

- ***Sourcing***
  - ✓ At least one company able to manufature a SSC RF cavity
  - ✓ Evaluated cost : **5,7 M€** first cavity, 4 M€ each other
  - ✓ Manufacturing delay : **2 years** first cavity then 1 cavity per year
- ***RF charaterization*** of the new cavity
  - ✓ **8 months**
  - ✓ No test stand available => qualification in a SSC cave
- ***Storage conditions*** of the spare cavity
- ***Handling issue :*** How to take a cavity out of a cyclotron cave and out of the building

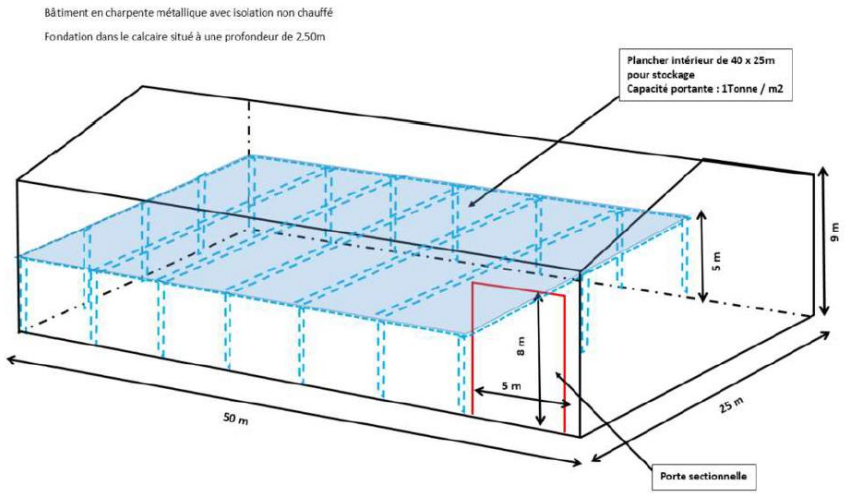
SPARE CAVITY : STORAGE CONDITIONS



- **Vacuum chamber needed**
- **Nitrogen inerting of the chamber and the cooling circuits to prevent corosion**

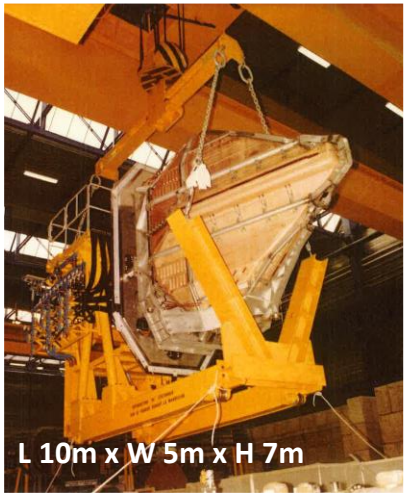


Storage on a trailer for easy moving



New 2200 m² storage building *(not only for spare cavity)*

RF CAVITIES : HANDLING ISSUE



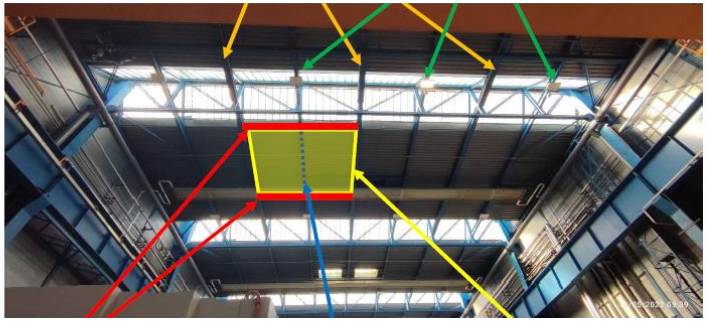
40 years ago

assembly area

Now

- ✓ 200 concrete beams and 200 concrete blocks to remove
- ✓ Door not high enough to pass trough and take a cavity out of the building

➔ **Forseen solution : Pass trough the roof**



Strengthen the steel frame before making an opening in the roof

Mobile crane

3 working months

RF CAVITIES : MILESTONES AND IMPACT

- ***January 2024 :*** ***Launch of a dedicated pre project***
  (Project Manager : PE. Bernaudin, Scientific Manager : M. Rejmund)
- ***January 2025 :*** ***End of dedicated pre project***
- ***April 2025 :*** Call for tender for Technical Assistance
- ***Decembre 2025 :*** Start of the Technical Assistance contract, writing of the technical specifications
- ***June 2026 :*** Call for tender for cavities manufacturing, tenderers skills validation
- ***March 2027 :*** Start of the manufactoring contract
- ***Sept 2028 – Nov 2029 :*** 1st cavity delivery, installation and RF characterization
- ***2030, 2031, 2032 :*** 3 next cavities

COMPLETE SCENARIO

~24,2 M€ 12,2 FTE

Cyclotrons unavailibility

14 months in 2028-2029

10 months in 2030, 2031 and 2032

Unavailibility of cyclotrons to be optimised by the Project

- *Off line RF qualification ?*
  => test bench (feasability and cost not evaluated yet)
- *Parts of RF cavities 2, 3 and 4 replacement (after new cavity 1) instead of new cavities manufacturing*

BASELINE SCENARIO : ~8,1 M€ 4,8 FTE

OTHER MAJOR TOPICS

Power Supplies

~5,6 M€ 11,5 FTE

360 PS over 30 years old to refurbish or replace

Cooling Systems

~1,8 M€ 1,2 FTE

6 months of unavailibility in 2027

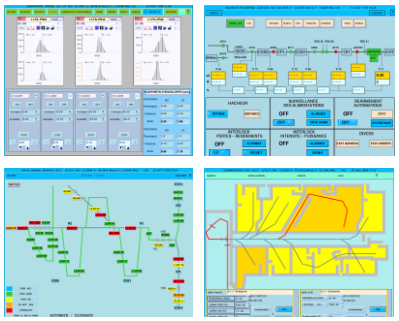
Project Management Contract

Radiation detectors

~2,2 M€ 0,8 FTE

60 detectors to replace

Remote control



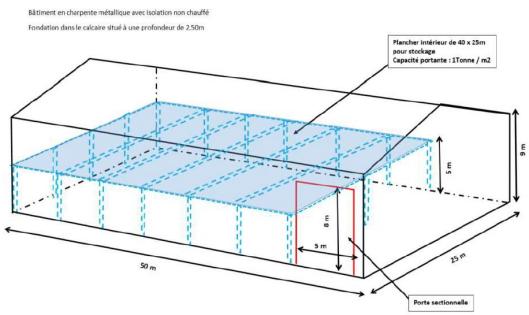
~1,8 M€ 5 FTE

Code refactoring

VME crates virtualisation

Software engeneering contract

Storage building



~2,4 M€ 0,5 FTE

2200 m²

COSTS OVERVIEW

Topic	Refurbishement Part of recurrent budget (k€)	Refurbishement Additional budget (k€)	Cavities Budget (k€)	CYREN COMPLETE scenario Total budget (k€)
Buildings / logistics	525	1 700	0	2 225
Infrastructures and utilities	3 236	420	0	3656
Computers infrastructure	223	75	0	298
SSR Systems	2 162	991	0	3153
Power Supplies / Magnets	2 008	2 172	0	4180
PLCs	270	0	0	270
RF cavities and RF Systems	777	305	19310	20392
Remote control	1 000	330	0	1330
Diagnostics	223	152	0	375
targets – Ions Sources	65	0	0	65
Vaccum systems	450	140	0	590
Total without uncertainties and hazards (k€)	***10 939***	***6 285***	***19 310***	***36 534***
Uncertainties and hazards	3 807	1 781	5 473	11 061
Total (k€)	**14 746**	**8 066**	**24 783**	**47 595**

BASELINE scenario : 31 104

Cyclotrons facility value estimated today at over 500 M€

1,5 M€ allocated by the State-Region Plan Contract 2023-2027

21 M€ allocated by French Ministry of Research and Education

Undergoing discussions between France and Germany

SCHEDULE AND MANPOWER OVERVIEW

➢ *Retained hypotheses*

- ✓ **Extended shutdowns only for RF cavities : to be optimised after pre project**
- ✓ Other works during 2nd semester of each year, to minimise impact on the community
- ✓ Start of the preparatory phase as soon as 2023 and start of refurbishment program in 2024

➢ *« As soon as possible » schedule*

- ✓ **BASELINE scenario in 6 years : 2024 to 2029** *(light residual in 2030)*
- ✓ **COMPLETE scenario in 9 years : 2024 to 2032**

BASELINE scenario

	2024	2025	2026	2027	2028	2029	2030	Total
Total estimated (FTE)	***11,90***	***15,10***	***10,92***	***5,80***	***5,86***	***3,10***	***1,10***	***53,77***
Margin for uncertainty 30% (FTE)	*3,57*	*4,53*	*3,28*	*1,74*	*1,76*	*0,93*	*0,33*	*16,13*
Total (FTE)	***15,47***	***19,63***	***14,20***	***7,53***	***7,61***	***4,03***	***1,43***	***69,90***

COMPLETE scenario

	2024	2025	2026	2027	2028	2029	2030	2031	2032	Total
Total estimated (FTE)	***11,83***	***15,18***	***10,92***	***5,80***	***6,21***	***3,75***	***3,55***	***2,15***	***1,80***	***61,17***
Margin for uncertainty 30% (FTE)	*3,55*	*4,55*	*3,28*	*1,74*	*1,86*	*1,13*	*1,07*	*0,65*	*0,54*	*18,35*
Total (FTE)	***15,37***	***19,73***	***14,20***	***7,53***	***8,07***	***4,88***	***4,62***	***2,80***	***2,34***	***79,52***

Backup

RF CAVITIES WATER LEAKS HISTORY

C01		nov-06	6	Fourche inférieure	Fuite due au manchonnage des tuyaux de refroidissement suite à la refection partielle de l'électrode en 1990 (OAE) : DEE PAPILLON remplcé par un DEE 180°
		sept-07	10	Panneau mobile sur hypodrome	Très complexe. 1 MOIS d'arret. Du à un ecrasement d'un coude au montage initial.
		oct-08	6	Fourche inferieure	
		mars-14	5	DEE	Tube applatit au montage initial
		avr-14	14	FOND	
		févr-15	1	BOUCLE DE COUPLAGE	
		mars-15	12	PORTE HF ANTIDEE ET RETOUR MASSE INFERIEUR	
		juin-15	12	PORTE HF ANTIDEE ET RETOUR MASSE INFERIEUR	Pas au même endroit que mars 2015
		juil-15	5	DEE	Refection totale electrode et circuits de refroidissement. Durée : 2 ans d'arret
C02		juil-02	6	Fourche inferieure	Refection totale electrode et circuits de refroidissement. Durée : 2 ans d'arret
		sept-02	5	DEE	Réfection totale du DEE (9 mois d'arret)
		juil-10	14	FOND	Très complexe. 1 MOIS d'arret.
		mars-14	15	PORTE HF ANTIDEE ET RETOUR MASSE INFERIEUR	
		avr-14	12	PORTE HF ANTIDEE ET RETOUR MASSE SUPERIEUR	
		mai-21	12	PORTE HF ANTIDEE ET RETOUR MASSE SUPERIEUR	ACCESSSIBLE : ANTIDEE supérieur
R1		mars-01		COUVERCLE ENCEINTE	Casse de la céramique de la boucle de couplage
		janv-07	7	Panneau capacitif mobile OUEST	1 mois d'intervention (pendant ARRET MACHINE). Complexe.
CSS1	NORD	juin-00	8	1/4 PEAU INF D	
		juin-01	8	1/4 PEAU INF D	Même circuit que 2000, un peu plus loin
		janv-02	8	1/4 PEAU INF D	
		juin-02	8	1/4 PEAU INF D	Réfection partielle du circuit (2m/20m) par SDMS IN SITU
		oct-02	2	TRIMMER	Inversion entrée/sortie circuit de refroidissement de la boucle inductive TRIMMER (refection tuyaux TRESSE NOBEL de 1990) : erreur humaine
		oct-03	8	1/4 PEAU INF D	
		oct-04	8	1/4 PEAU INF D	
		mai-06	8	1/4 PEAU INF D	
		juin-07	8	1/4 PEAU INF D	
		juil-07	8	1/4 PEAU INF D	
		janv-08	8	1/4 PEAU INF D	Refection totale du circuit par ACIEROC. Prestation compliquée car sous traitant non spécialiste : Nettoyage mal fait, brasures mal réparties, tuyau non monobloc, Peau déformée...
		janv-18	7	1/4 PEAU INF G	
	SUD	mars-07	3	FOND PARTIE CENTRALE	Tentative de réparation infructueuse. On vit avec une fuite à 1.10-6 mbar.l.s-1
		juil-12	7	1/4 PEAU INF G	
		juin-19	17	1/4 PEAU SUP G	
CSS2	NORD	juin-06	14	DEE SUP	Fuite réparée en bout de nez ELECTRODE (réparation complexe)
		janv-07	10	STEM	Jonction planaire DEE/STEM (complexe)
		ÉTÉ 2010	14	DEE SUP	Reprise de la réparation de 2006
		juin-13	10	Fuite au passage STEM/GAP	Réparation COMPLEXE (3 semaines d'arret)
		mars-14	10	Fuite en bas du STEM SUP	Réparation réussie sans la dépose des peaux
	SUD	oct-02	2	TRIMMER	Inversion entrée/sortie circuit de refroidissement de la boucle inductive TRIMMER (refection tuyaux TRESSE NOBEL de 1990) : erreur humaine REFABRICATION TOTALE DE LA BOUCLE
		juin-10	16	1/4 PEAU SUP D	Fuite au niveau d'une soudure CUIVRE/INOX d'un rccord CAJON (SCHUNT DU CAJON)
		nov-16	7	1/4 PEAU INF G	Deux fuites distinctes de réparées en 1 semaine sur ce circuit (dont 1 avec ARALDYTE)
R2					Aucune fuite à ce jour
CIME	NORD	oct-07	10	PLONGEUR	
	SUD				Aucune fuite à ce jour

+ 1 leak in 2022 on CSSE North