SPL Collaboration Meeting

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IN2P3

Patxi DUTHIL

December 11th 2008

Contents

IPNO-IN2P3 (CNRS): the organization

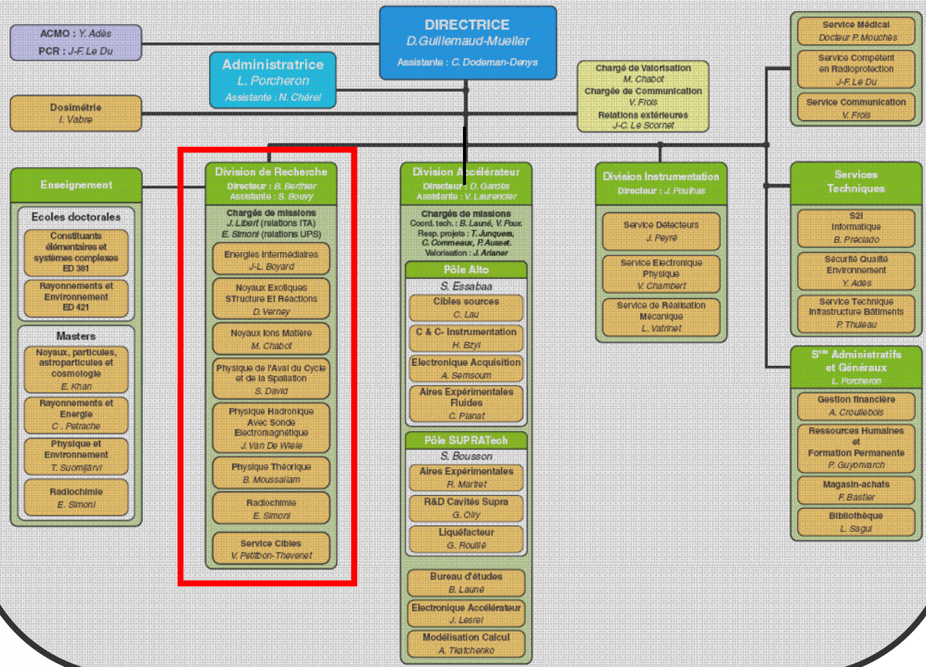
CNRS
(French) National Center for Scientific Research

In2p3
IN2P3
(French) National Institute of Nuclear Physics and Particles Physics
www.in2p3.fr

University of Paris-Sud 11 (Orsay)

Nuclear Physics Institute of Orsay

~400 people



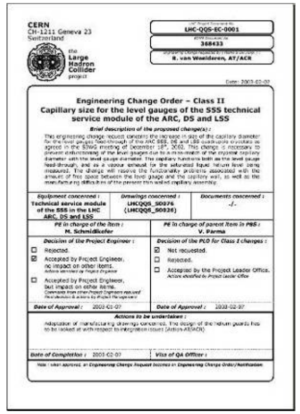
~100 workers

IN2P3's contribution to the LHC

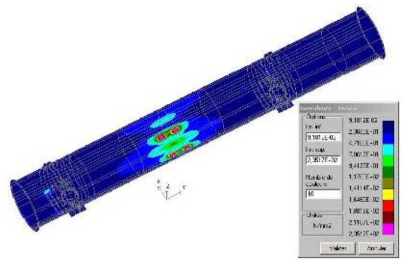
Agreement n°2

(CNRS - February 1996 → September 2006)

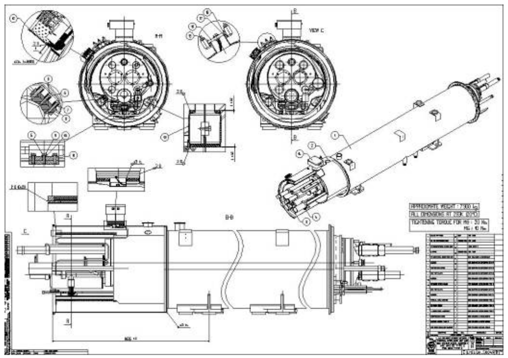
- *Cryostat and Short Straight Section assembly*
  - *Arc: 360 units for 61 alternatives*
  - *Dipole Sections: 64 units pour 34 alternatives*
  - *Magnet Sections: 50 units pour 41 alternatives*
  - *65.3 Man.Year*


CERN
CH-1211 Geneva 23
Switzerland
LHC-QQS-EC-0001
Engineering Change Order – Class II
Capillary size for the level gauges of the SSS technical service module of the ARC, DS and LSS

- *Design*
  - *Modular design*
  - *Integration and interfaces study*
  - *3D models*
  - *Numerical calculation notes*



- *Documentation*
  - *Technical specifications*
  - *Components drawings*
  - *Assembly drawings*



IN2P3’s contribution to the LHC

Agreement n°2 (CNRS - February 1996 → September 2006):

- Dipoles, Arc, DS et MS assembly tools
  Design, Calculations and assembly procedure for:
  - Tests Arc prototype
  - Cryostating Dipole
  - Assembly standard section Arc
  - Assembly standard section DS
  - Assembly standard section MS
  - Assembly Arc QQS, DS, MS

IN2P3's contribution to the LHC

- Industrial follow-up:
  - Prototype components in several industries
  - Until BDT bankruptcy: Preparation of « Requests for proposal » for the serie and follow-up of the serie at BDT and several industries
  - Dipole Vacuum vessel at FCM (Spain): 313 units
  - Bottom Tray at SIMIC (Italy): 846 units

IN2P3's contribution to the LHC

Agreement n°3 (CNRS - February 1996 → September 2006):

- Thermometry of the LHC
  - Category B: 50 K < T < 300 K → platinum thermometers were chosen
  - Category A: 1.6 K < T < 300 K

    → several types of sensors might be used,

    → each thermometer needed a dedicated calibration.

  - Program selection of category A sensors:

    - thermal cycling → long term stability,

    - magnetic field influence,

    - neutrinos flux tests within liquid helium → radiation resistance

Range	1.6 K - 2.2 K	2.2 K - 4 K	4 K - 6 K	6 K - 25 K	25 K - 50 K	50 K - 300 K
Exactitude	± 10 mK	± 20 mK	± 30 mK	± 1K	± 5 K	± 5 K

IN2P3's contribution to the LHC

Agreement n°3 (CNRS - February 1996 → September 2006):

- Thermometry of the LHC

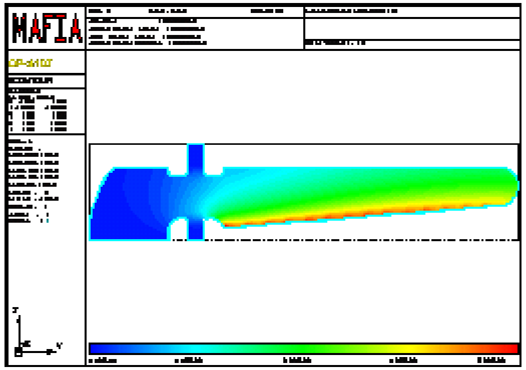
A calibration set-up was designed
- → ±7 mK for T < 2.2 K,
- → ± 10 mK for 2.2 K < T < 30 K,
- → ≤ 0.25 % for T > 30 K.

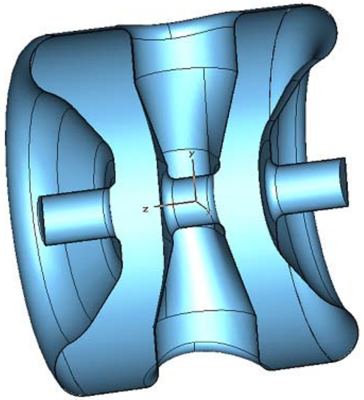
Quality program:
Industrial organization for mass production in respect with the ISO norms.

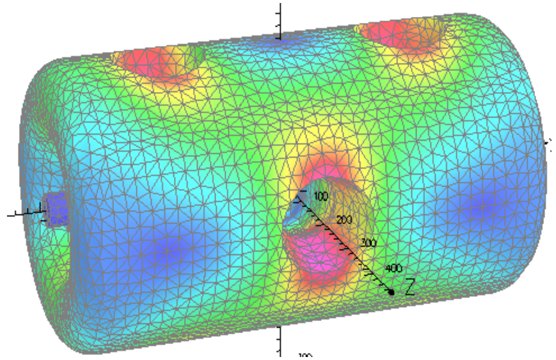
3 inserts are now available:
→ 2 for sensors calibration in vacuum,
→ 1 for sensors calibration in liquid He.

2500 thermometers per year

- *RF simulations*

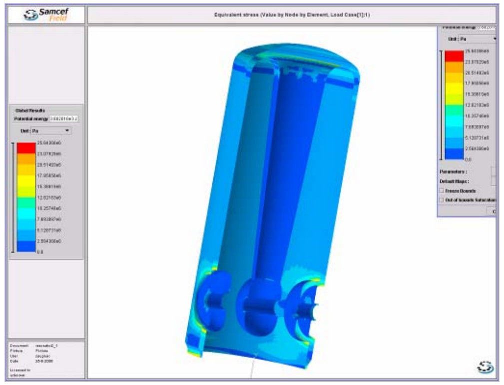


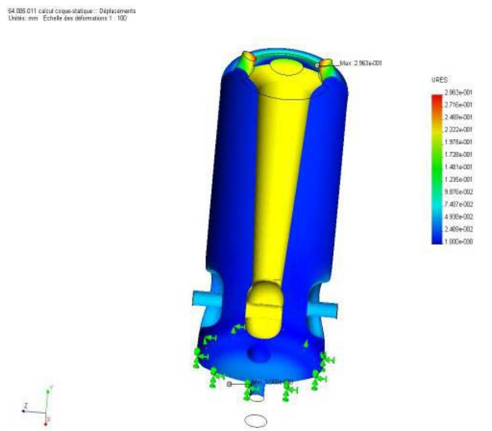


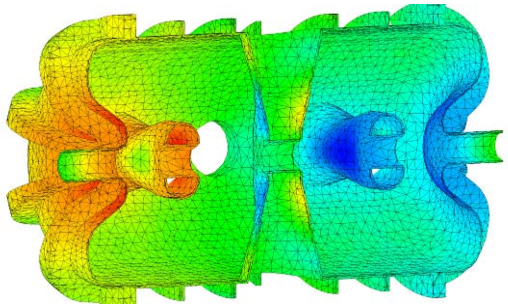


Electro Magnetic simulation: MAFIA, Microwave Studio, HFSS, SOPRANO
Optimization of Epk/Eacc and Bpk/Eacc ratios

- *Mechanical simulations*





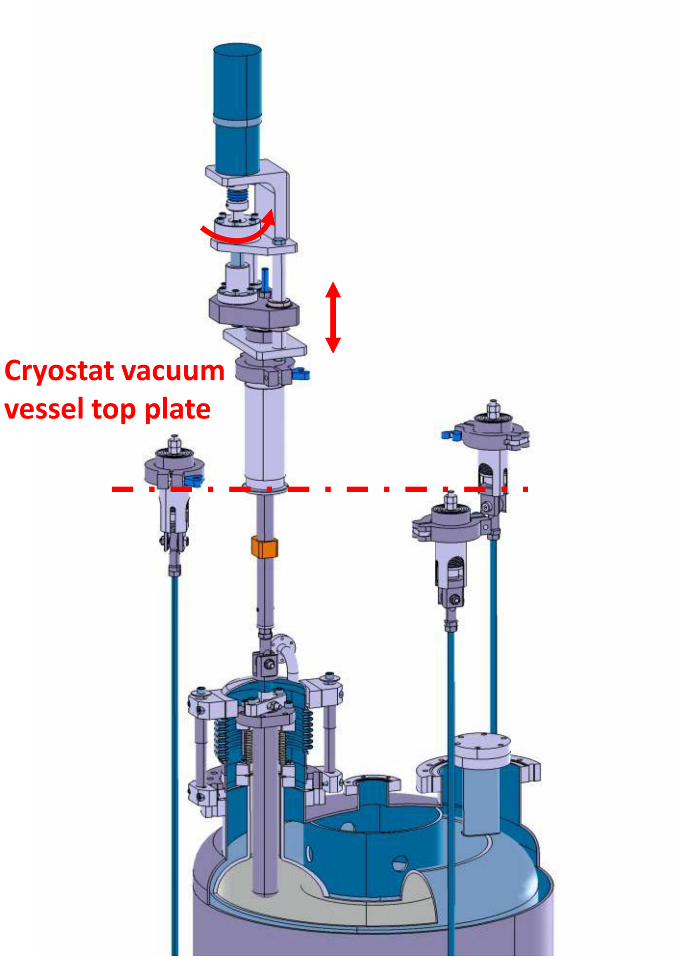


SAMCEF, COSMOS DesignStar, CASTEM
Stress, eigen modes, coupling strain / frequency variation, Lorentz forces

IN2P3's experience in Superconducting Linac

Tuning systems

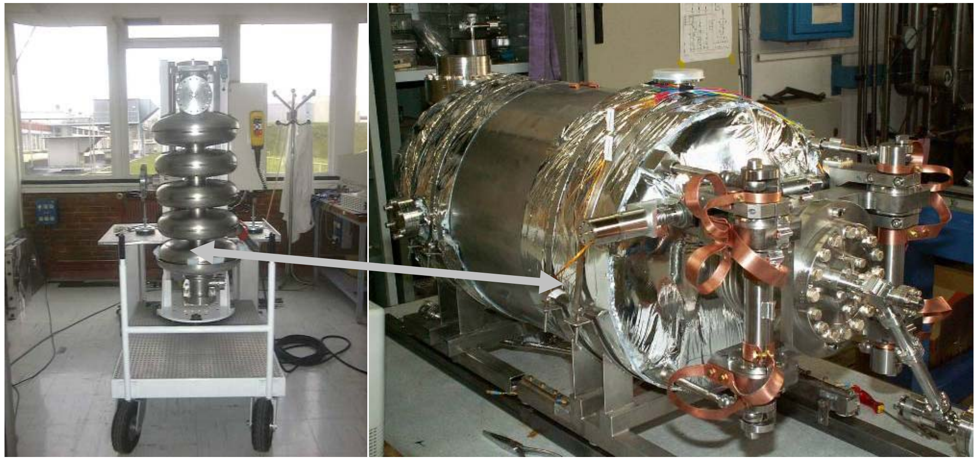
- *Displacement of a superconducting plunger into the magnetic field*



Spiral2 ***tuning system***

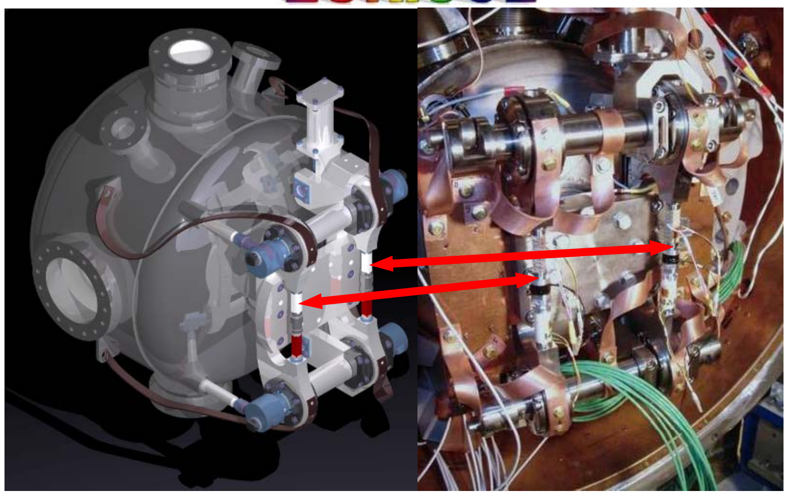
- *Wall deformation*

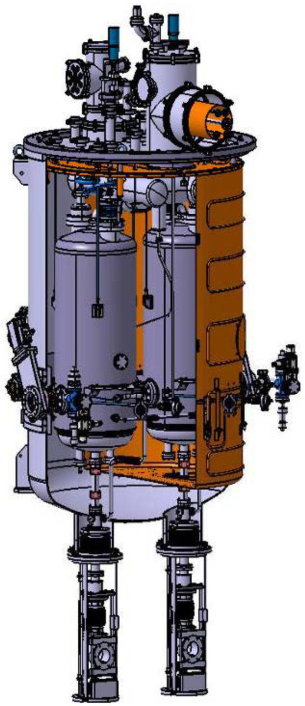
  5 Cellules 700 MHZ



Fast tuning system: use of piezo-electric actuators

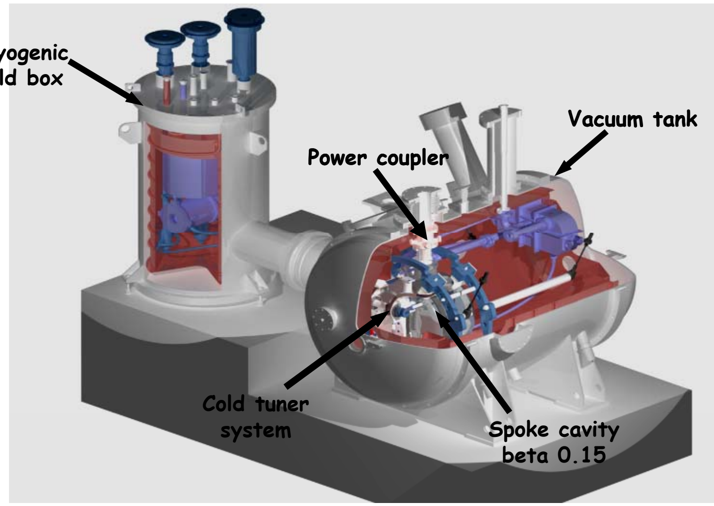
Spoke 350 MHz EURISOL





Spiral2

Prototype and series cryomodules



Test cryomodule for EURISOL

European Isotope Separation On-Line
Radioactive Ion Beam Facility

IPNO/IN2P3's facilities: The SUPRATECH platform

- *Clean room*

- *85 m2 total surface and 45 m2 class 10*
- *Ultra-pure water production, high pressure rinsing capability*
- *Temperature and humidity level controlled*
- *Distribution of He et N_2 clean gas*
- *Vacuum test inside the clean room*

IPNO/IN2P3's facilities: The SUPRATECH platform 2/9

- *Assembly hall*

- RF amplifier : 700 MHz 80 kW CW
    - Thalès tube 704.4 MHz, I.O.T. technology, 80 kW CW
    - Elliptical cavity tests : Eurotrans, Eurisol

- RF amplifier : 350 MHz 20 kW CW
    - Spoke cavity test: Eurisol, Eurotrans

IPNO/IN2P3's facilities: The SUPRATECH platform

- *Chemistry facility (FNP) (nearly operational)*
  - *bath HF:HNO3:H3PO4*
  - *on-line treatment of gas effluent*
  - *on-line treatment of liquid (low acid concentration) effluent*

- *Helium liquefier*
  - *Linde technology*
  - *Max. liquefying capacity 65 l /h (with nitrogen pre-cooling)*

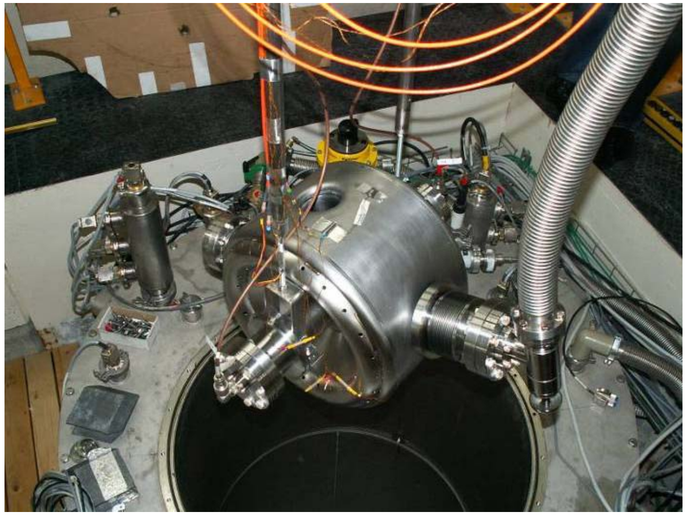
  - *Recovery helium gas network and compression system*



IPNO/IN2P3's facilities: The SUPRATECH platform

- *Cryogenics facilities*
  - RF and cryogenic tests in vertical cryostat

• Dimensions Ø=800 mm, H=2500 mm
• 2 K, 4 K without He tank, 4K with He tank
• Ampli.: 600 W @ 350 MHz and 1 kW @ 88 MHz
• RF driving (auto oscillant loop) 350 MHz, 88 MHz
• Thermometry
• Microphonics measurement by use of CRM
• Accelerometers set up (under progress)



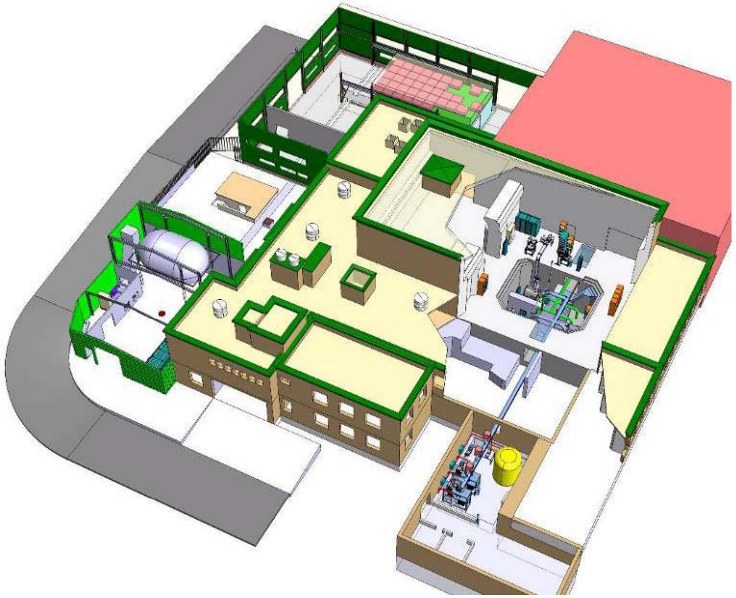
IPNO/IN2P3's facilities: The SUPRATECH platform

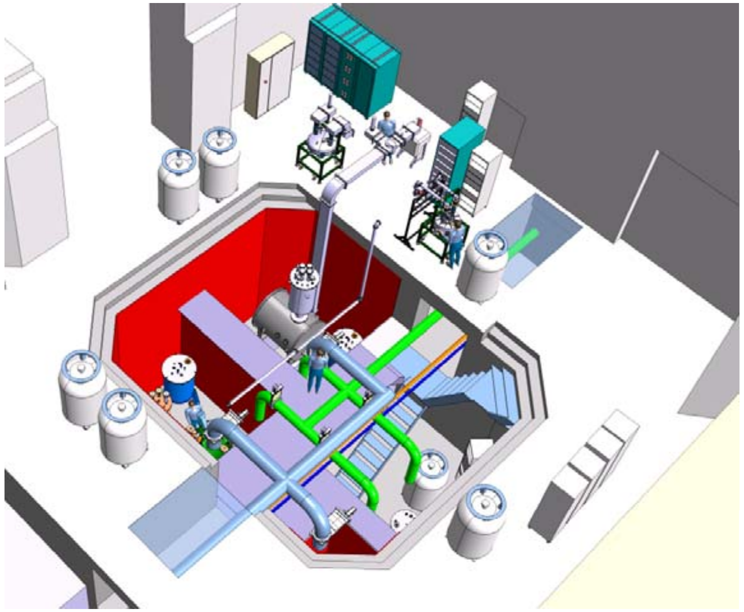
- *Cryogenics facilities*
  - RF and cryogenic tests in cryomodules
    - Refrigeration facility: 60 kW @ 25°C
    - 2 amplis 10 kW solid state @ 88 MHz (Spiral 2)
    - 1 ampli 10 kW solid state @ 350 MHz (EURISOL)
    - 1 RF source: 80 kW (IOT) @ 700 MHz (EUROTRANS - under progress)

Spiral2 ***cryomodule***

CMO:
Horizontal cryomodule for tests

- *Future cryogenics facilities (under progress)*





- *Cooling system (400 kW thermal power)*
  - *Primary network (glycol): 7-12 °C*
  - *Secondary network (non ionized water): 15-25°C*

Capabilities of the Division Accelerators

- *RF cavities, beam dynamics, RF couplers, cryostats → from the design to the tests*
  - *Numerical simulation and optimization*
  - *Design, modeling, drawing*
  - *Industrial follow-up*
  - *Assembly*
  - *Tests in dedicated environment*
  - *Quality procedures*

SPL project

- *Administrative and financial framework*
  - *Exceptional (additional) contribution of France to the CERN*
  - *1 collaboration protocol → CERN / CEA-CNRS*
    - *4 specific executive agreements (including specifications about each topic)*
      - *N°1 - LINAC 4*
      - *N°2 - SPL*
      - *N°3 - Superconductive magnets*
      - *N°4 - CLIC/CTF3*
    - *Work Packages descriptions*
    - *Work package templates have to be given*

SPL project

- *WP3: Design and construction of a full-scale cryomodule prototype for the SPL*
- *The goals:*
  - *Demonstrate on a full-scale machine the construction capability of a cryomodule housing β=1 cavities and SC quadruples;*
  - *Validate and eventually lead to the improvement of the design and construction features;*
  - *Enable RF Testing on a multi-cavity assembly in a horizontal cryo-module driven by a single RF source;*
  - *Validate by testing critical components like RF couplers, and fast piezo tuners in their real operating environment;*
  - *Understand the mechanical behavior of the cryomodule at cryogenic temperature, in particular alignment issues and evaluate heat loads;*
  - *Learning of the critical assembly phases;*
  - *Estimate cryomodule construction costs*

SPL project

- *CNRS-IN2P3 Tasks:*

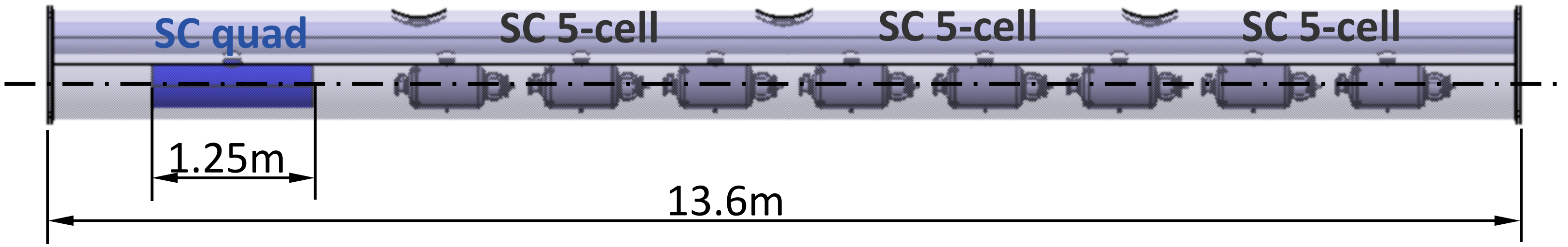
  1/ To design and integrate the cryostat and to provide cryostat components for one cryomodule prototype;

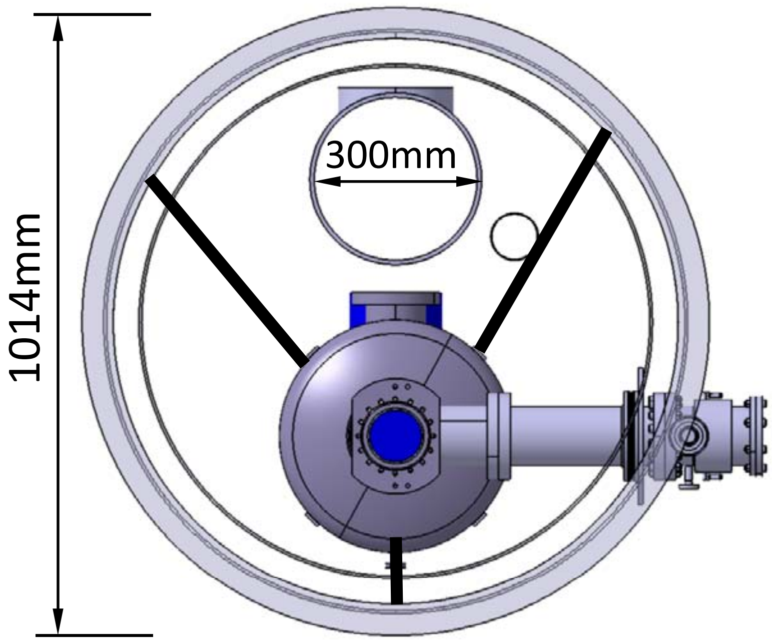
  2/ To design and provide the supporting/guiding system for the string of cavities in the cryostat;

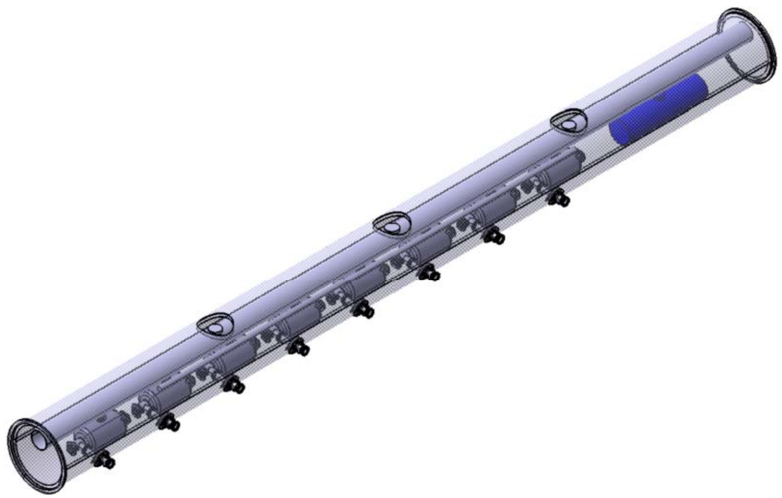
- *The deliverables:*
  - *Hardware components*
  - *Design and calculation reports, drawing files and design models (CATIA V5 R16);*
  - *Fully documented industrial production files:*
    - *Material spec.*
    - *Designed calculations (construction codes)*
    - *Production drawings*
    - *Assembly procedures*
  - *Quality assurance and safety records*

SPL project

- *Cryomodule configuration*







- *Cryomodule dimensional specifications (to be fixed)*

	Value	Comment
Active elements		
Number of cavities	8	
Approx. length of a cavity in its helium vessel	1000 mm	between flanges
Approx. outer diameter of cavity helium vessel envelope	400 mm	following design under Task 3
Number of quadrupoles	2 (1 doublet)	
Length of quadrupole doublet	1.5 m (TBC)	Doublet design by CERN
Cryostat elements		
Approx. outer diameter of doublet helium vessel envelope	TBD	Doublet design by CERN
Approx. length of vacuum vessel	13.6 m (TBC)	Depends on cryostat design
Approx. outer diameter of vacuum vessel	1014 mm (36")	Depends on cryostat design
Approx. value of vacuum vessel thickness	12 mm	Depends on cryostat design
Approx. inner diameter of He Gas Return Pipe	300 mm (TBC)	Defined by mass flow/pressure drop
Approx. thickness of He Gas Return Pipe	6 mm (TBC)	Depends on cryostat design (CNRS) and GRP design (CERN)
Number of cold supports posts	3 (TBC)	Depends on cryostat design. LHC solution/technology can be applied.
Number of Thermal shields	1	Aluminium, active cooling 50-75 K
Thermal shield MLI protection	30 layers	According to LHC technology

SPL project

○ *Positioning accuracy and stability of active elements*

Active element	Positioning accuracy of a string w.r.t. a reference beam axis					Positioning uncertainty/stability w.r.t. vacuum vessel fiducials (rms)			
	Transversal [mm]	Longitudinal [mm]	rot. x [deg.]	rot.y [deg.]	rot.z [deg.]	Transversal [mm]	rot. x [deg.]	rot.y [deg.]	rot.z [deg.]
Quadrupole	± 0.5	± 2	± 0.25	± 0.25	± 0.5	± 0.3	± 0.15	± 0.3	± 0.3
Cavity	± 0.5	± 2	± 0.08	± 0.08	N.A.	± 0.3	± 0.05	± 0.05	N.A.

x=radial; y=vertical; z=longitudinal

○ *Static heat loads per unit length (to be further defined)*

Heat Load @ 2 K [W/m]	Heat Load @ 5-10 K [W/m]	Heat Load @ 50-75 K [W/m]
0.15	1.5	5

SPL project

- *Human resources and material costs*

N°	TASK	INSTITUTE	MATERIAL COSTS (k€)	MANPOWER (man.months)
1	Cryostat design, integration and supplying of cryostat components for 1 cryomodule prototype	CNRS	124	42
2	Design and supplying of the supporting/guiding system for the string of cavities within the cryostat	CNRS	31	12
TOTAL		CNRS	155	54
TOTAL 2		CNRS+CEA	267	82.8

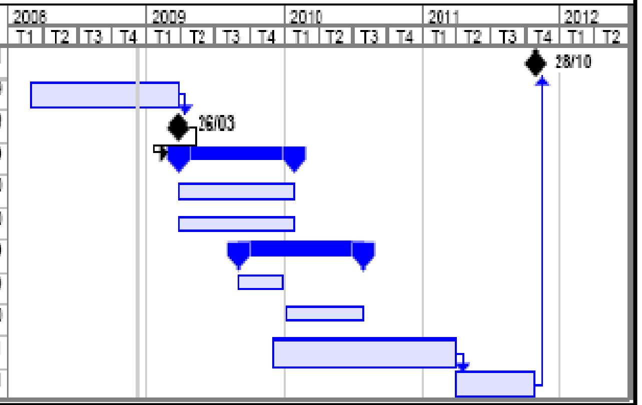
- *The team*
  - *Patxi DUTHIL*
    Project organization, supervision, mechanical and thermal calculation
  - *Sébastien BLIVET*
    Design, CAD models, mechanical calculation, production drawings
  - *Hervé SAUGNAC*
    Mechanical and thermal calculation
  - *François LAUNAY*
    Numerical thermal calculation
  - *Giles BELOT*
    Industrial follow-up
  - *Virginie LAURENCIER*
    Financial aspects
  - *Advisors for the design, the cryogenics and instrumentation aspects (SPIRAL 2, LHC, EUROTRANS, EURISOL)*

SPL project

- *Schedule*

SPL Cryomodule Prototype

N°	Nom de la tâche	Durée	Début	Fin
1	Protoype cryomodule ready for testing	1 jour	Ven 28/10/11	Ven 28/10/11
2	Conceptual design	13,5 mois	Lun 03/03/08	Mar 24/03/09
3	Conceptual Design Report	1 jour	Jeu 26/03/09	Jeu 26/03/09
4	**Detailed design**	**192 jours**	**Ven 27/03/09**	**Mar 26/01/10**
5	Vaccum Vessel with support posts and interfaces	9,6 mois	Ven 27/03/09	Mar 26/01/10
6	Thermal shields	9,6 mois	Ven 27/03/09	Mar 26/01/10
7	**Instrumentation**	**230 jours**	**Ven 04/09/09**	**Ven 30/07/10**
8	Specification	4 mois	Ven 04/09/09	Jeu 24/12/09
9	Order and supplying	7,5 mois	Lun 04/01/10	Ven 30/07/10
10	Prototype cryostat fabrication	15,8 mois	Mer 02/12/09	Jeu 31/03/11
11	Prototype cryomodule assembly	6,2 mois	Ven 01/04/11	Lun 24/10/11



Conclusion

- *Signature of the collaboration agreement is not yet finalized*
- *IN2P3 is ready to participate in the project*
  - *The project team is defined*
  - *The working framework (tools, software…) is operational*
- *But:*
  - *Need of a Product (Work) Breakdown Structure*
  - *Several specifications are to be defined*
  - *Project organization must be setup*

A lot of work for those two days…

THANK YOU !