Status of the cryomodules for the SPIRAL 2 superconducting LINAC

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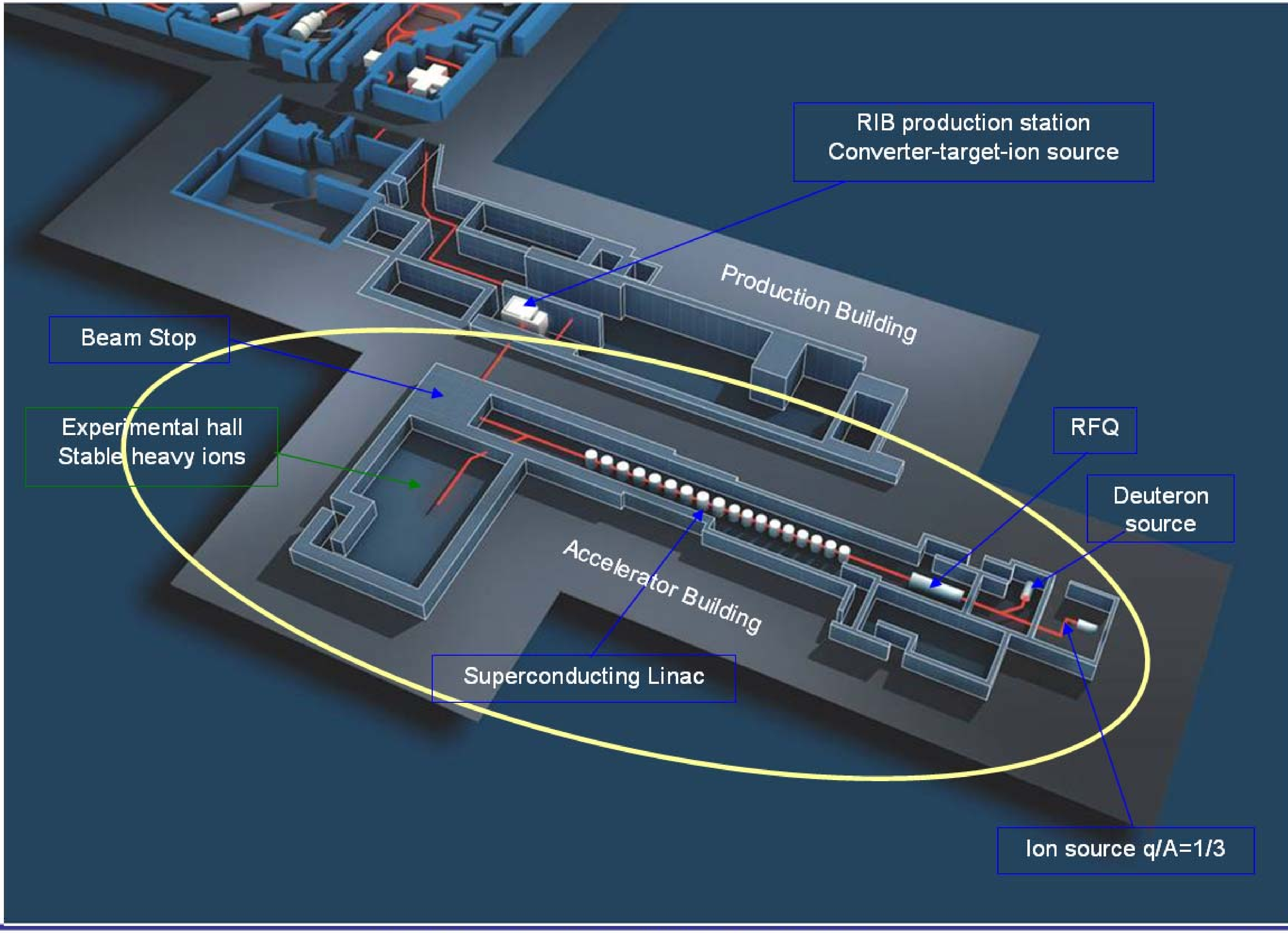
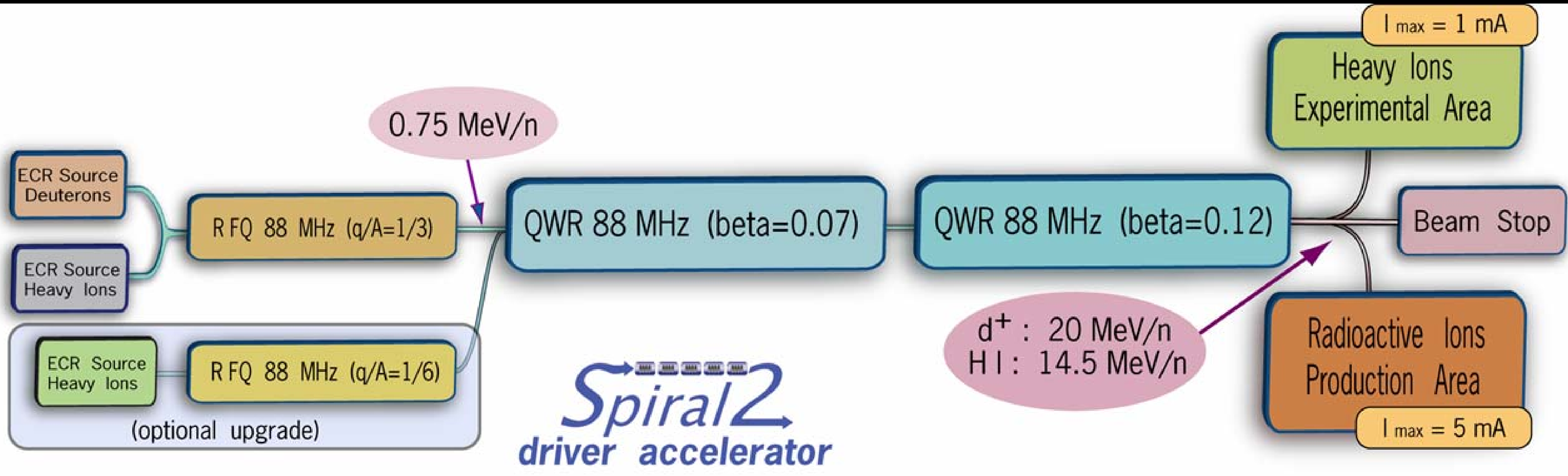
SPIRAL 2 Layout





Energy and intensity requirements	**D^+ (1.5 - 40 MeV),** **H+ (33 MeV)** **H2+(1.5 - 40 MeV)** **Heavy Ions (2 - 14.5 MeV/A), bunched** **Heavy Ions (0.75 - 14.5 MeV/A) unbunched**	**I_{max}=5mA** **I_{max}=5mA** **I_{max}=5mA** **I_{max}=1mA** “
Injector	**D^+: ECR ion source** **Heavy Ions: typ. Phoenix V2 (reference 0^{6+})** **Slow Chopper** **RFQ (1/1, 1/2, 1/3)** **4 MEBT Bunchers**	**0.5-5 mA** **1mA** **>200µs, <100 Hz** **113 kV, 160kW** **165 kV, 8 kW**
SC Linac	**12 QWR beta 0.07 (12 cryomodules)** **14 (+ 2) QWR beta 0.12 (7 (+1) cryomodules)** **Room Temperature Q-poles**	**E_{acc}^{max}= 6.5 MV/m** «
HEBT lines	**3: Heavy Ions, Beam Stop, RIB production**	

I max = 1 mA

ECR Sou Deutero

ECR Sou Heavy I

ECR Heavy

ea

n Stop

ns

a

mA

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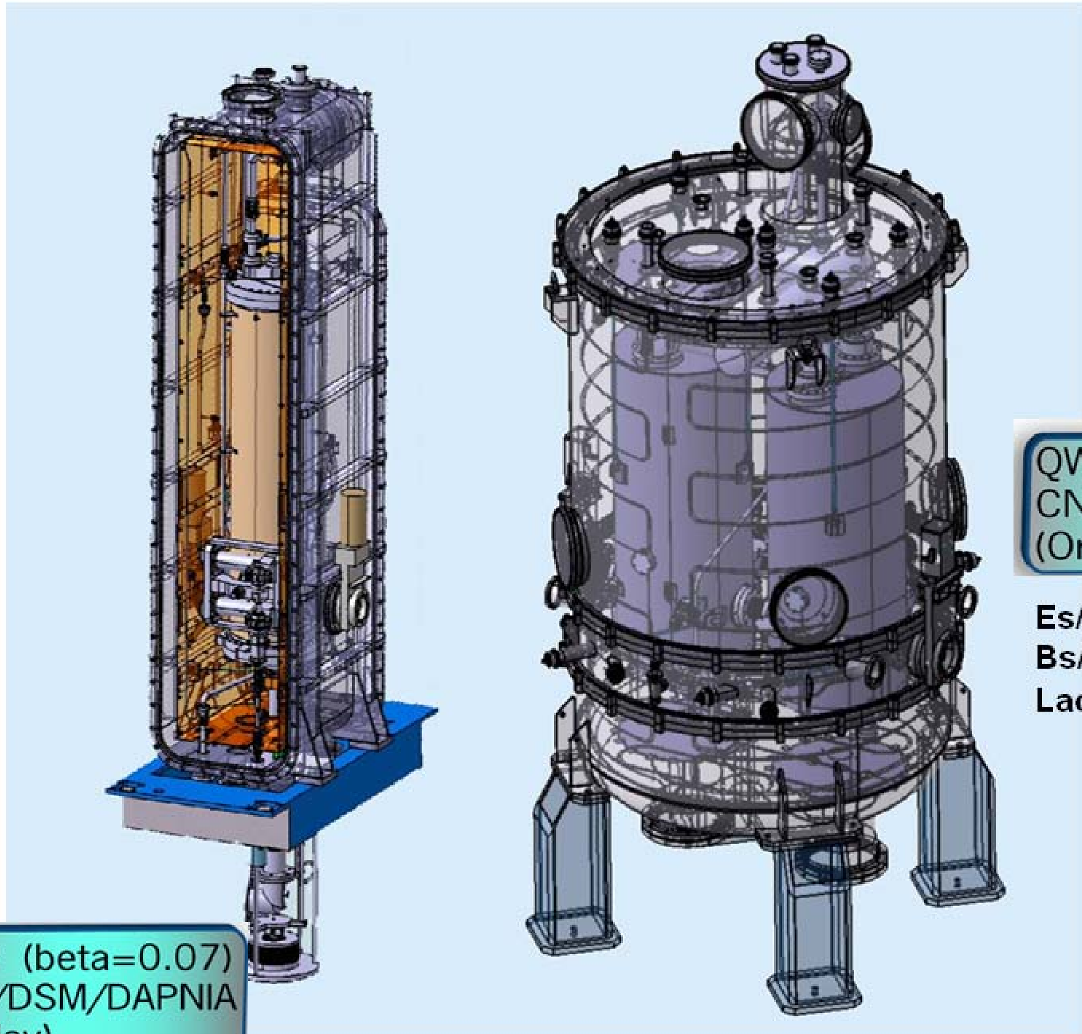
Inject

SC L

HEBT



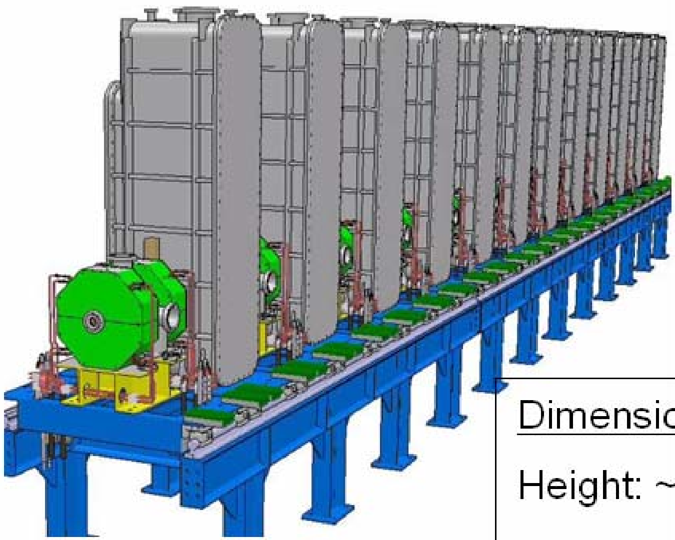
QWR (beta=0.12)
CNRS-IPN
(Orsay)

Es/Eacc = 4.76
Bs/Eacc = 9.35 mT/(MV/m)
Lacc = 0.41 mm = β×λ

QWR (beta=0.07)
CEA/DSM/DAPNIA
(Saclay)

Es/Eacc = 5
Bs/Eacc = 8.7 mT/(MV/m)
Lacc = 0.24 mm = β×λ

Cryomodule A – QWR β = 0.07



One cavity / cryomodule

12 units on the LINAC

1 spare cryomodule

1 spare cavity

<u>Dimensions:</u>

Height: ~ 3.2 m

L_{cryom} = 610 mm

L_{Gap} = 580 mm

2 access doors

Cryogenic pipes

Cavity + LHe tank + magnetic shield

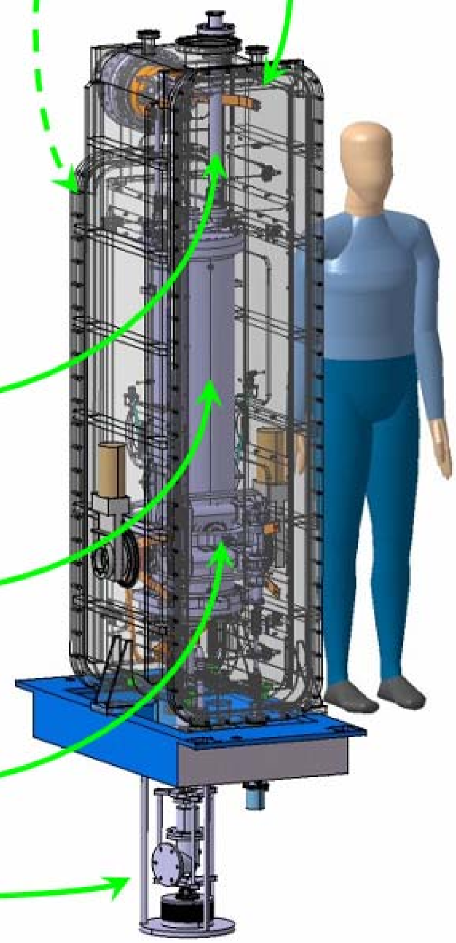
Helium :experimental results : 3.35Hz/mbar (calculated 3.4 Hz/mbar)

Frequency tuner

Optimized for ± 25 kHz at 4K

Power coupler

10 kW solid state amplifier



CEA-Saclay

Cryomodule A

Qualification cavity (ZANON)

Vacuum vessel
on its support

- Qualification cavity received on march 2007
  - Test of the cavity in July 2007
  - Tests of the cryomodule: oct. 2007 – Feb. 2008
- Two series of tests on the cryomodule:
  - 1. Cavity with β=1 antenna – Oct. 2007
    - Cryogenic performances
    - Q0= f(Eacc) curve: validation of the clean assembling procedure
    - Cavity frequency tuning
    - Simulation of the effects of pollution with the diagnostic boxes
    - Analysis of misalignment caused by displacements during cooling down
    - Mechanical vibrations – optimization of the damper of Legnaro type
  - 2. Dismounting and remounting of the cryomodule with the power coupler
  - 3. Cavity with power coupler – Feb. 2008
    - RF power tests of the cryomodule in the accelerator configuration

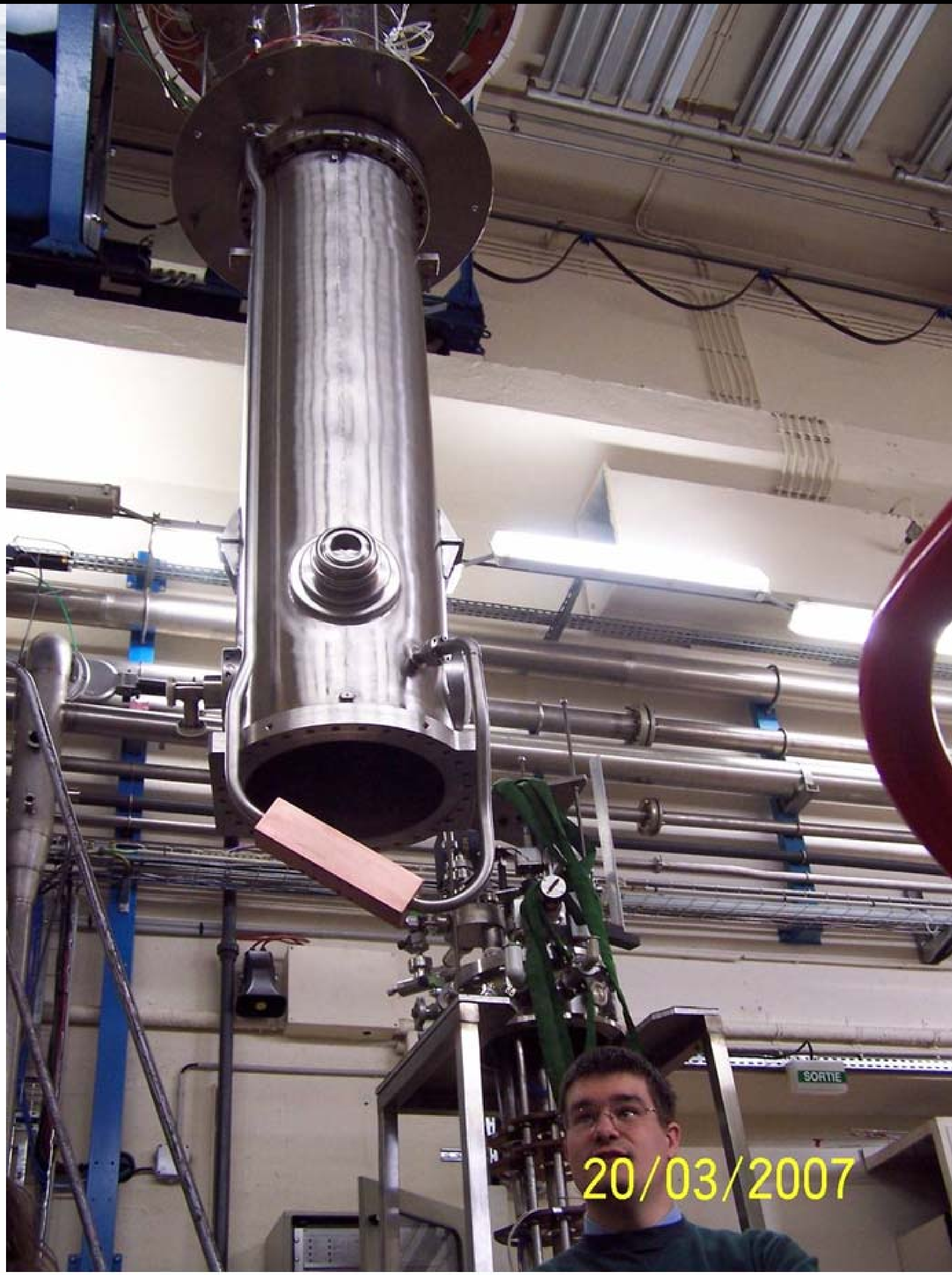
CEA-Saclay

...ule A

Qualification
cavity (ZANON)

Vacuum vessel

on its support



...7

...008

...ments

...amper

...nodule

...elerator

...aclay

Cryomodule A

Serial cryomodules:

CEA-Saclay

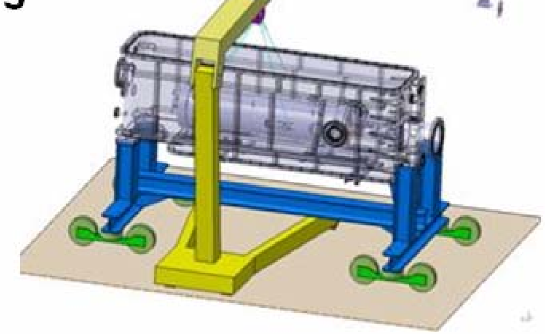
Ongoing call for tender, cavities order ~ September 2007
Order of the cryostats ~ End 2007
Test of the last cryomodule at Saclay ~ End 2010

Infrastructure needed at Saclay for the cryomodules A:

1. **A new large clean room for the assembling of the cavity in the vacuum tank**
2. **RF power test bench at 88MHz – ready: end of Sept. 2007**

The vacuum vessel has to be placed inside the clean room to mount the cavity and to close its volume in clean conditions

=> A large clean room is needed

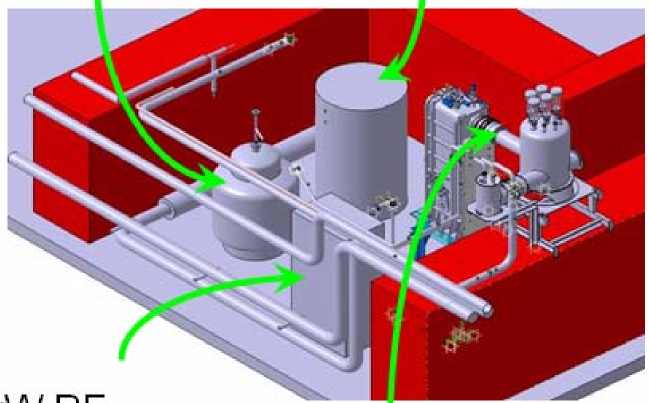


The clean room should be ready at the end of Nov. 2008

Vertical tests of all the cavities +
RF power tests of all cryomodules

Dewar continuously filled by a helium liquefier

Vertical cryostat for cavity tests



10kW RF amplifier

Cryomodule with the cryogenic valve box

Cryomodule B – β=0.12

2 qualification QWR manufactured by ACCEL

IPN - Orsay

One tested in vertical cryostat.

- Modification with the prototype cavity
  - Helium tank made from Titanium
  - Connection between the tank and the cavity at level of the beam tube and the cavity donut. (improve stability versus bath pressure fluctuations).
  - Modification of the electric field area to reduce the low level multipacting barrier (30-80 kV/m) seen on the first prototype.

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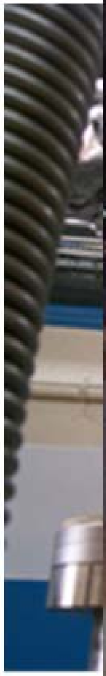


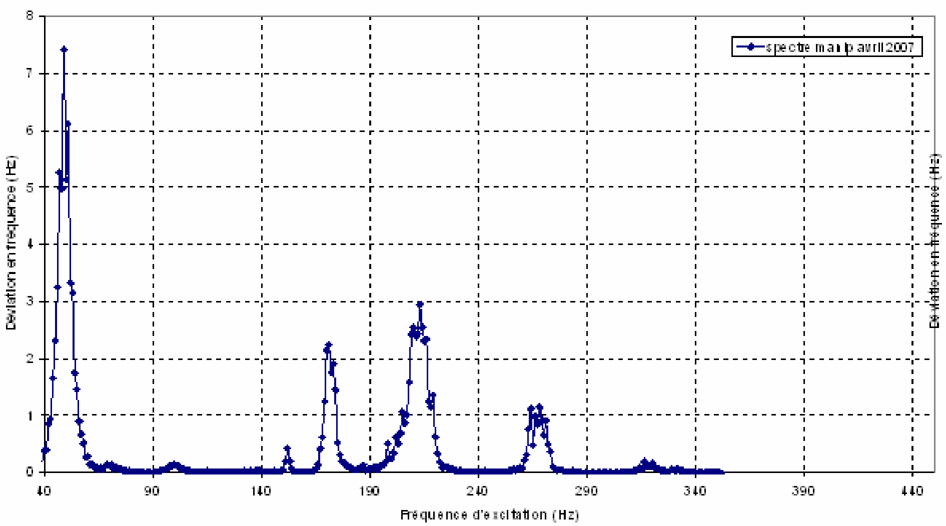
- Moc

Qualification QWR B Tests

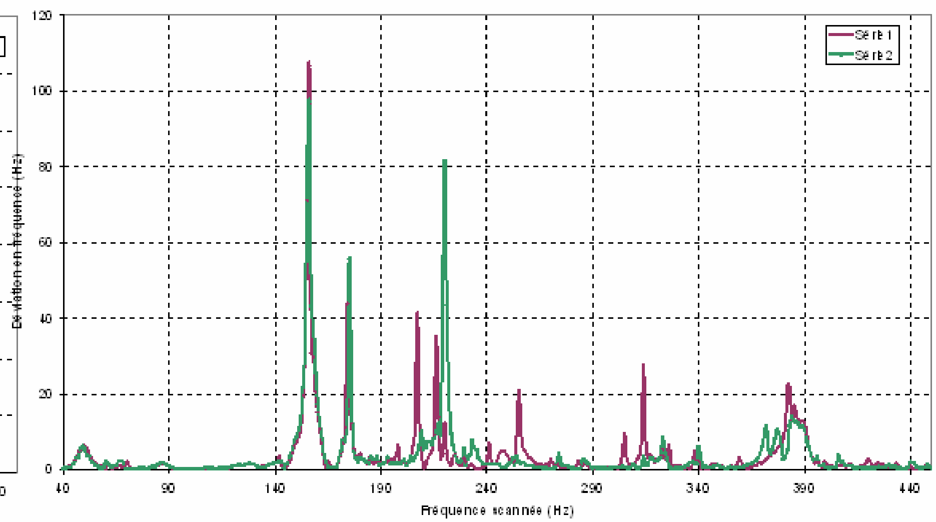
IPN - Orsay

- Low level MP barrier (30-80 kV/m) is still present
- Depend strongly on the surface quality (adsorbed gas…under study).
- Pressure sensibility about 6 Hz/mbar better than the 18 Hz/mbar for the prototype
- Quench associated with temperature increase in the bottom of the cavity (under study)

Microphonics



Without excitation in CV



With excitation in CV

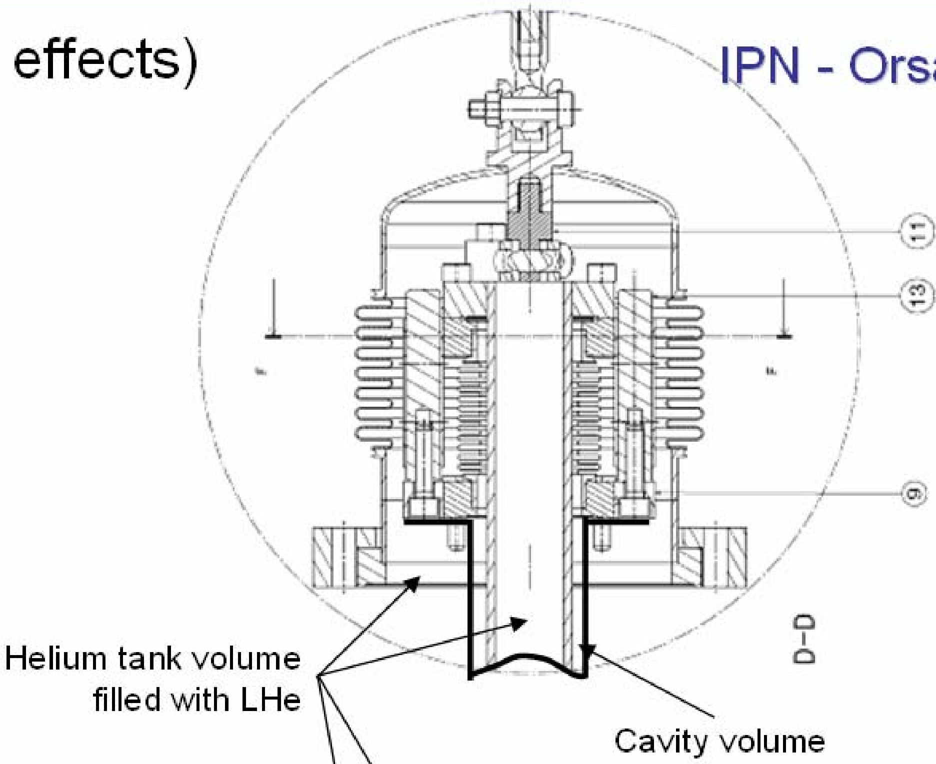
Mechanical excitation amplitude not measured

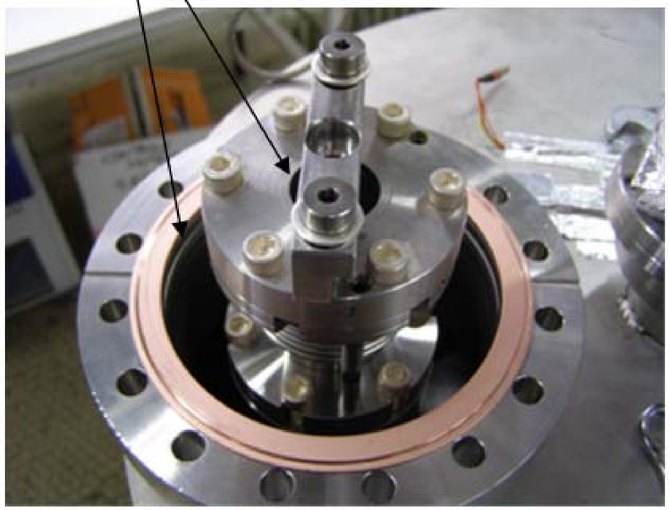
Cold tuning system

IPN - Orsay

No deformation process (too small effects)

Insertion of a plunger on the top

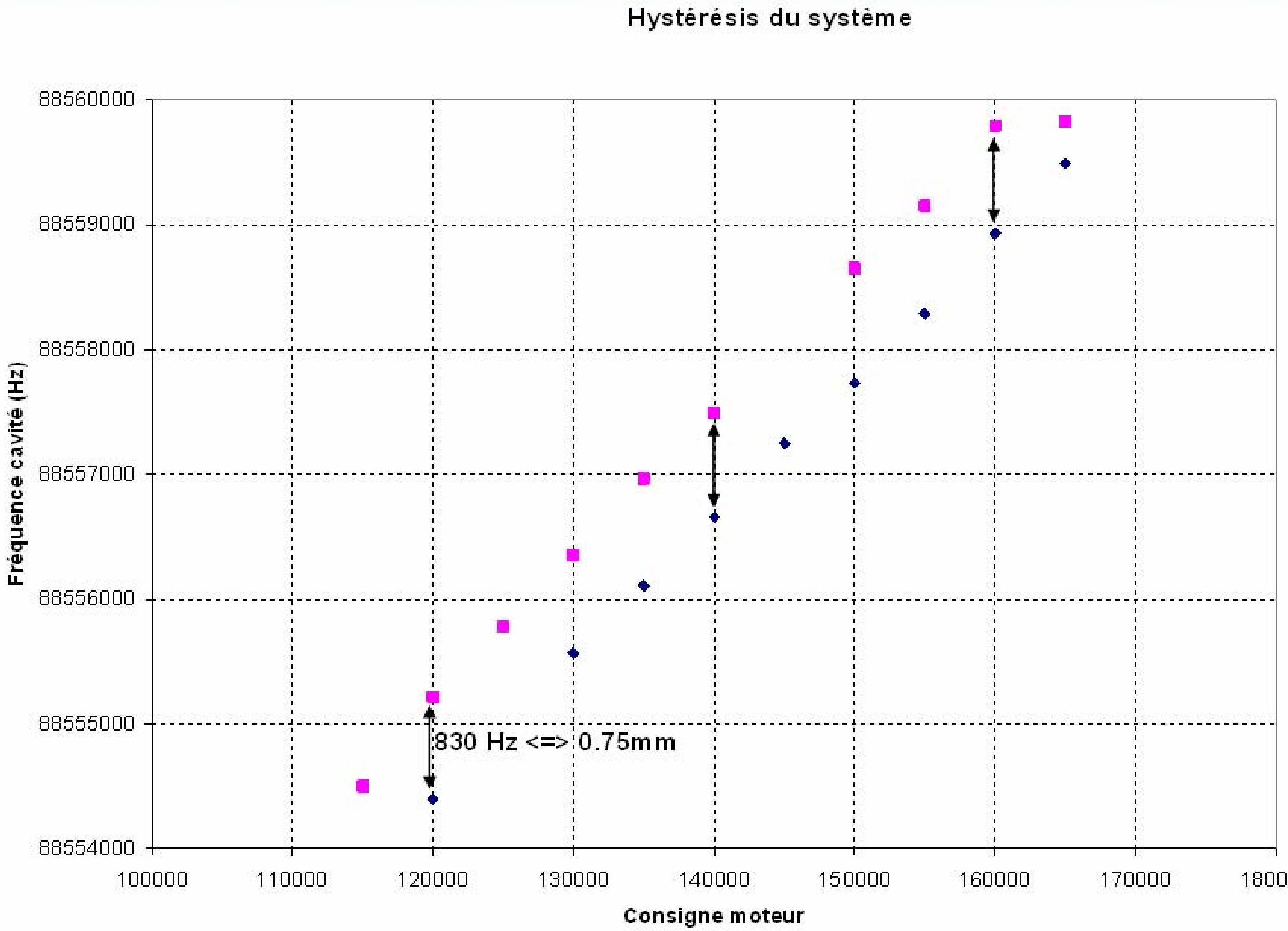




High RRR tube filled with liquid helium moved inside the magnetic volume of the cavity

Cold tuning system results

- Plunger effect tested @ 4.6 MV/m and 6.8 MV/m
- No noticeable effect on RF characteristics
- Sensitivity measured to ~1.1 KHz/mm (ϕ30 mm test plunger).
- Final system ±4 kHz.

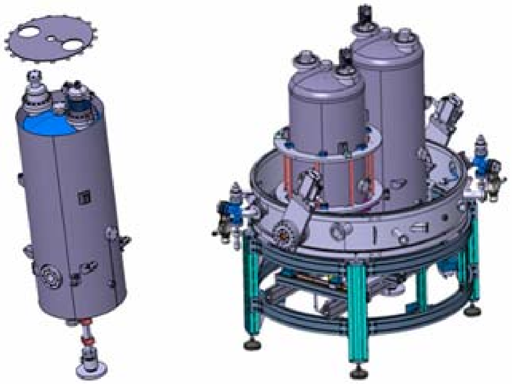


- Cavity errors adjusted with plunger length and diameter
- 830 Hz measured hysteresis expected to decrease on the final mechanism (at present being manufactured)

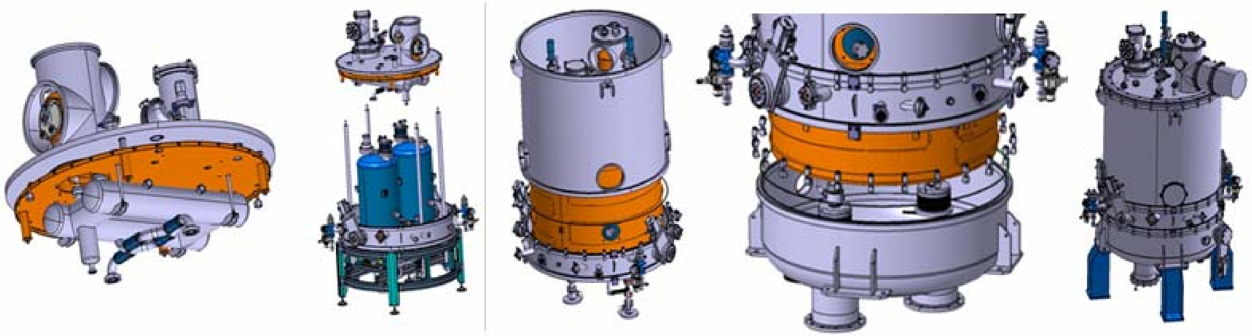
IPN - Orsay

Cryomodule B assembly

IPN - Orsay

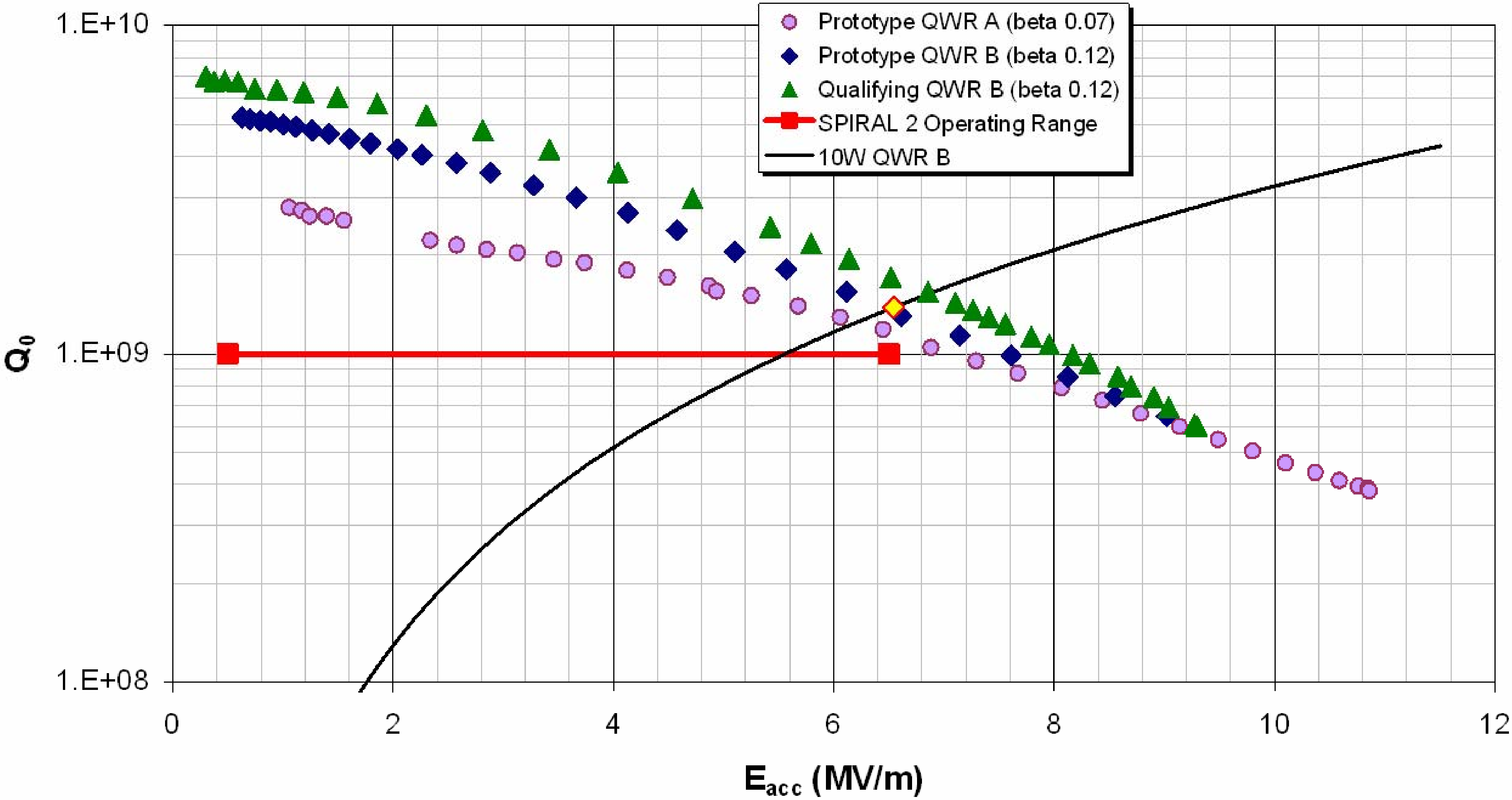


Inside clean room



Outside clean room

first QWRs tests



Es/Eacc < 5
Bs/Eacc < 10 mT/MV/m
Lacc = $\beta \times \lambda$

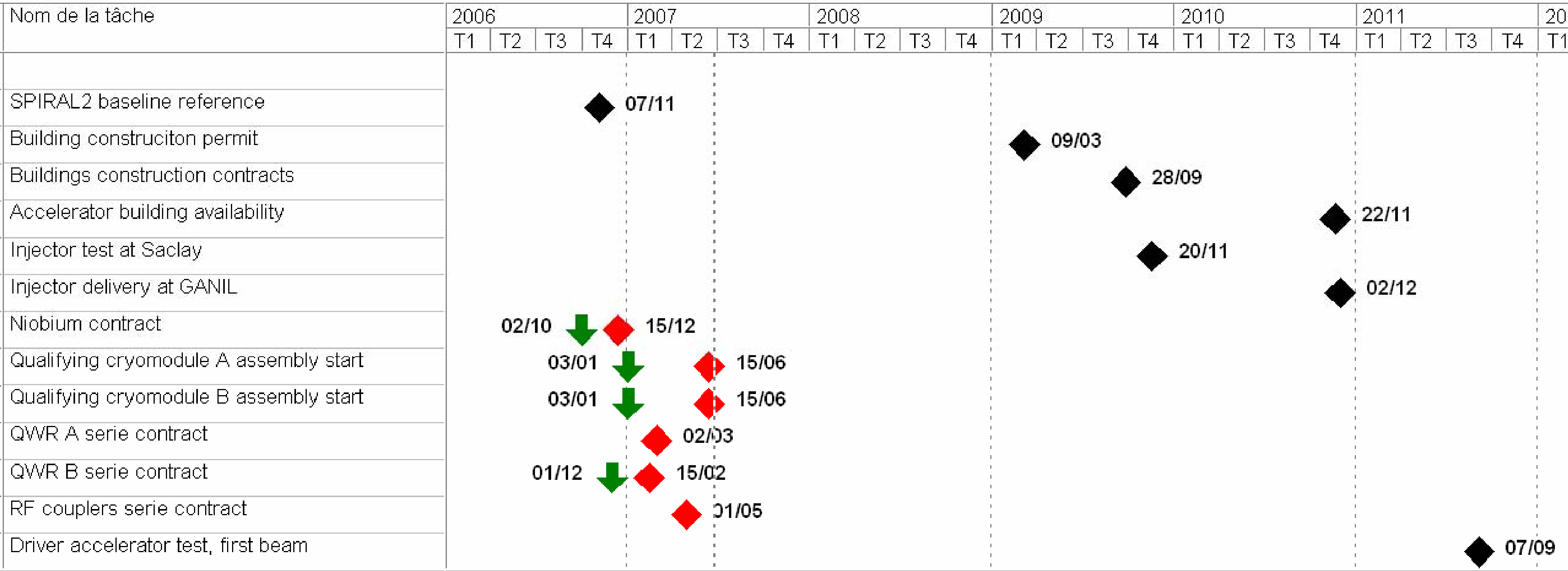
The couplers

LPSC - Grenoble

- Provide up to 12kW
- Disc shape window
- Fixed coaxial antenna
- Fixed coupling
- Deposits 1W on cavities bottom
- 2 couplers tested up to 40kW (head to head)
- Test bench in a new clean room
- Call for tender about to started (33 units)

Prototype coupler with disc window

Standing wave test bench in clean room



Some critical operations :

- Buildings, authorizations, decisions: 2007-2008
- Injector: preliminary tests at Saclay : 2009-2010
- Cryomodules A and B: tests of 12+14 cavities. Assembly of 12+7 cryomodules, RF power tests, He liquefier, He distribution: 2007-2010. Site Installation: 2010 -2011
- Beam tests: end 2011

Thank you for your attention