STATUS OF THE CONSTRUCTION OF THE SPIRAL2 ACCELERATOR AT GANIL

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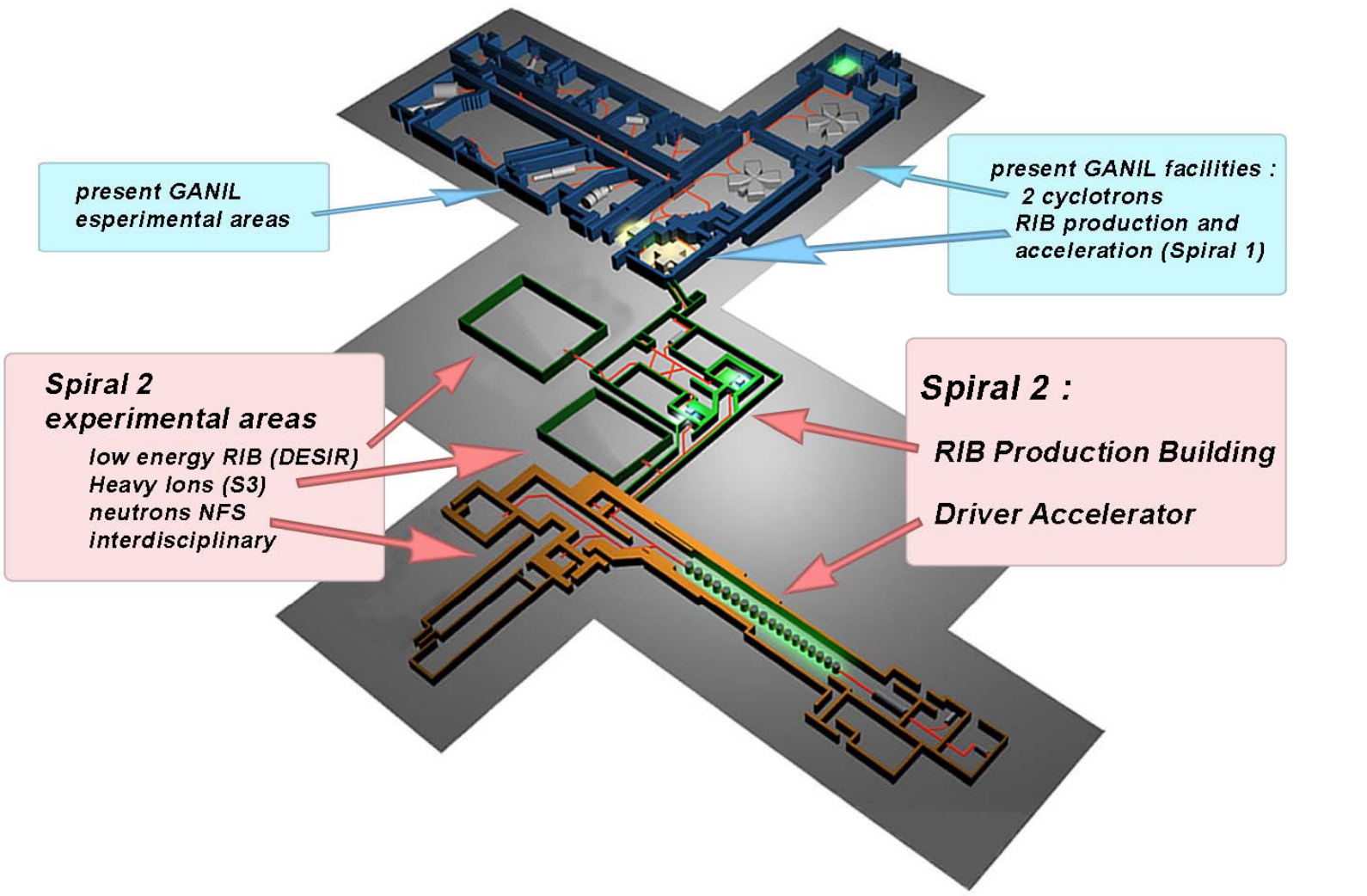
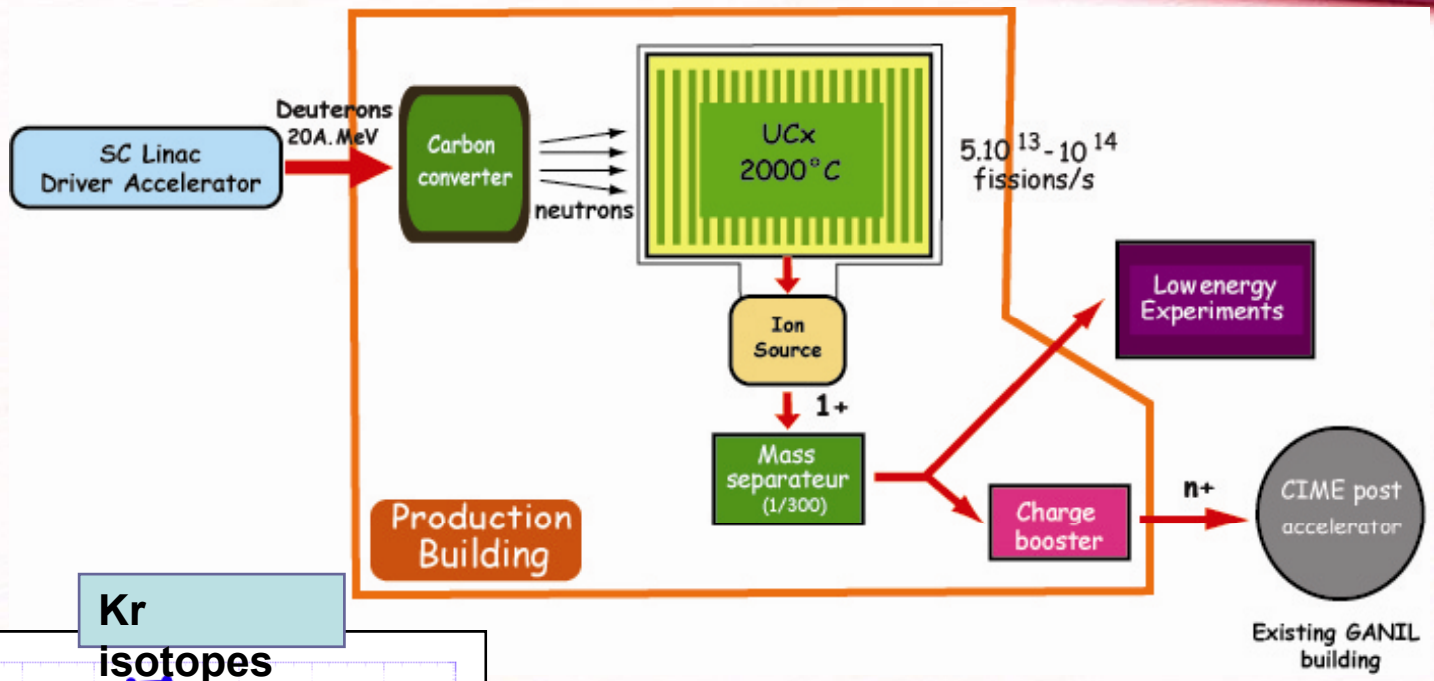
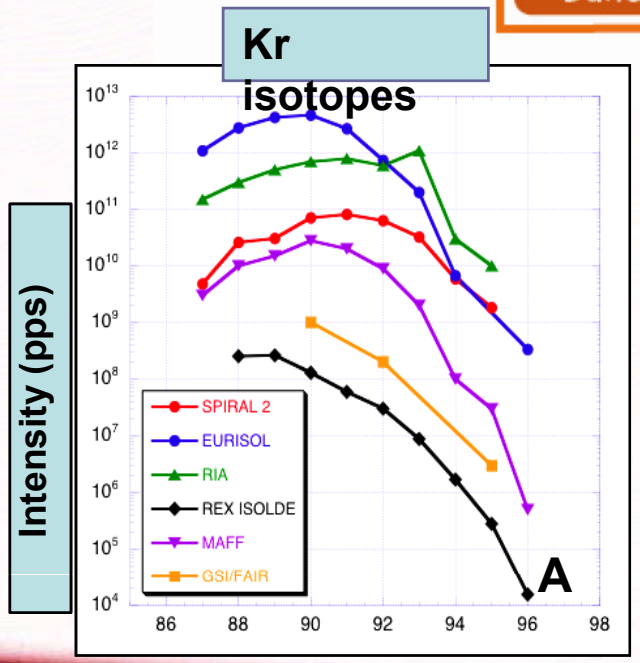
(on behalf of the Spiral 2 project team)



SPIRAL 2@GANIL – Next generation of ISOL Facility

SPIRAL2 main goal : The high intensity frontier
both for stable heavy ions and secondary Radioactive Ion Beams





Production of Radioactive Ion Beams (ISOL method)

Expected yields: > 10^9 pps for ^{132}Sn

> 10^{10} pps for ^{92}Kr

- direct irradiation of the UCx target with deuteron beams for production of ^{3,4}He, ^{6,7}Li, or ^{12}C

Development of the Spiral 2 collaboration:

- "Green Light" for Spiral 2 project was given in March 2005
- Based on a large collaboration :

  ⇒ France: CEA and CNRS laboratories
  ⇒ International partners: laboratories from **Germany, Italy, Polland, USA, Canada, CERN, Romania**, **Israel, India, Spain, Bulgaria, Russia, …**
  ⇒ In the frame of the next **EU program : SPIRAL2 Preparatory Phase**

Physics / Instrumentation collaboration:

- **call for « Technical Proposals » (TP) for SPIRAL2 Instrumentation**
- **TP Signed by 200 physicists from 14 countries**
- **Signatures of the Memorandums of Understanding expected in 2009-2010**

At the end of the Preparatory Phase, the goal is to establish SPIRAL2@GANIL as an International European Facility

Recent developments:

- **In the July-September 2007 period, project strategy was adopted (construction roadmap, plannings and budgets)**

Two phases were decided:

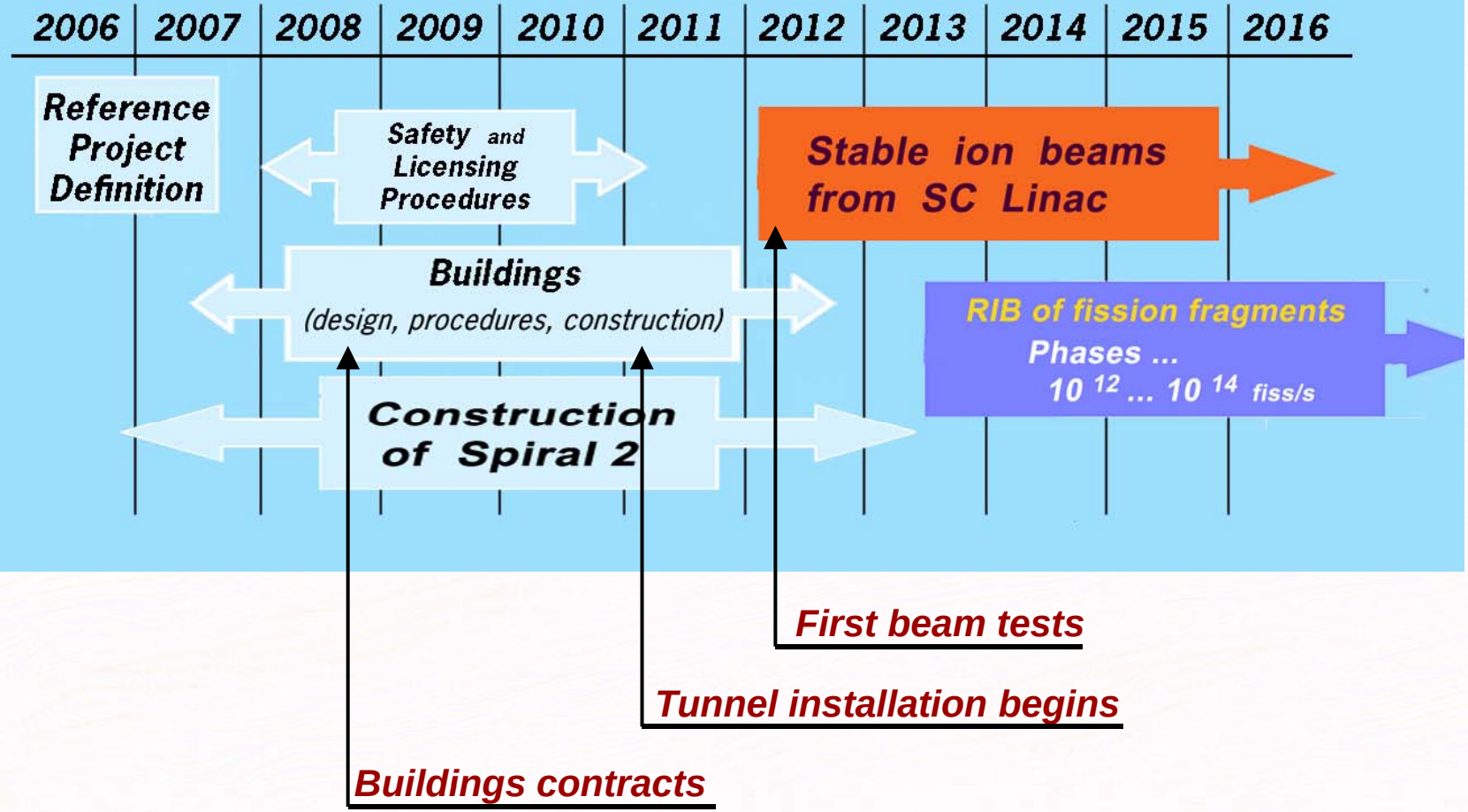
- **Phase 1. Driver Accelerator and first experimental areas**
- **Phase 2. RIB Production building and associated experimental areas**

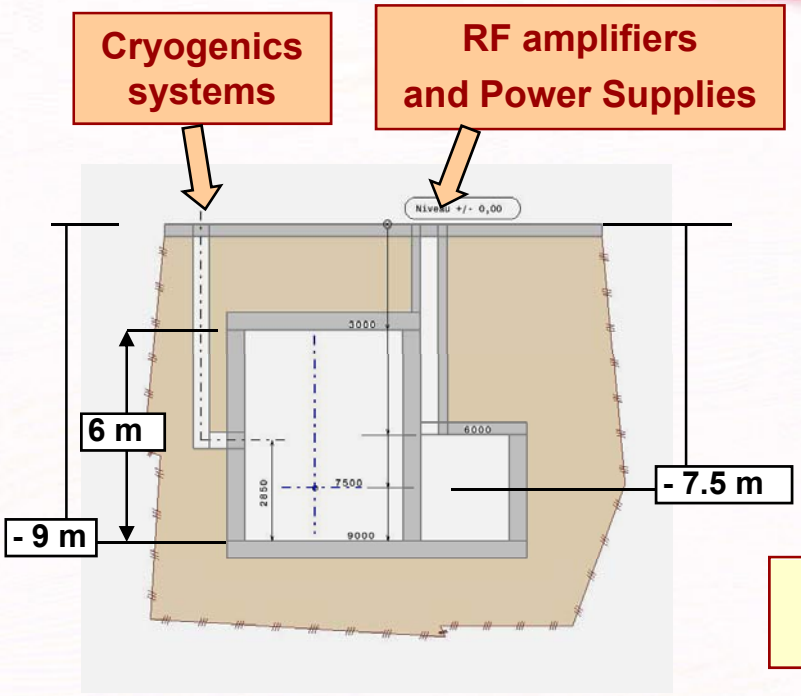
GANIL (and Spiral 2) is a NUCLEAR LICENSED FACILITY

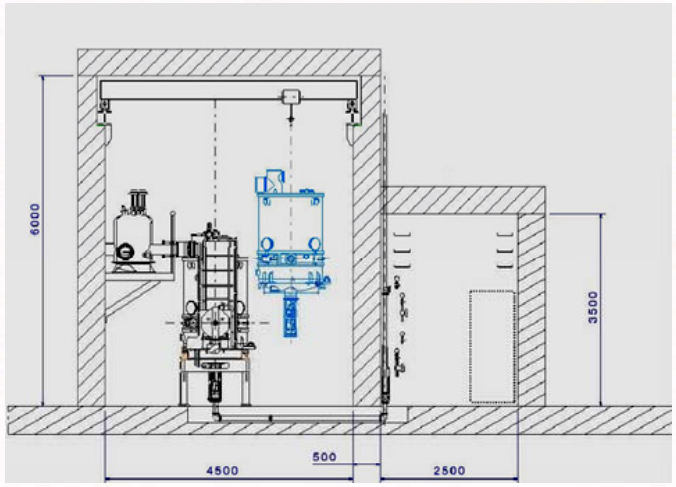
Plenary meeting with Nuclear Safety Authorities (ASN France) Jan 2008

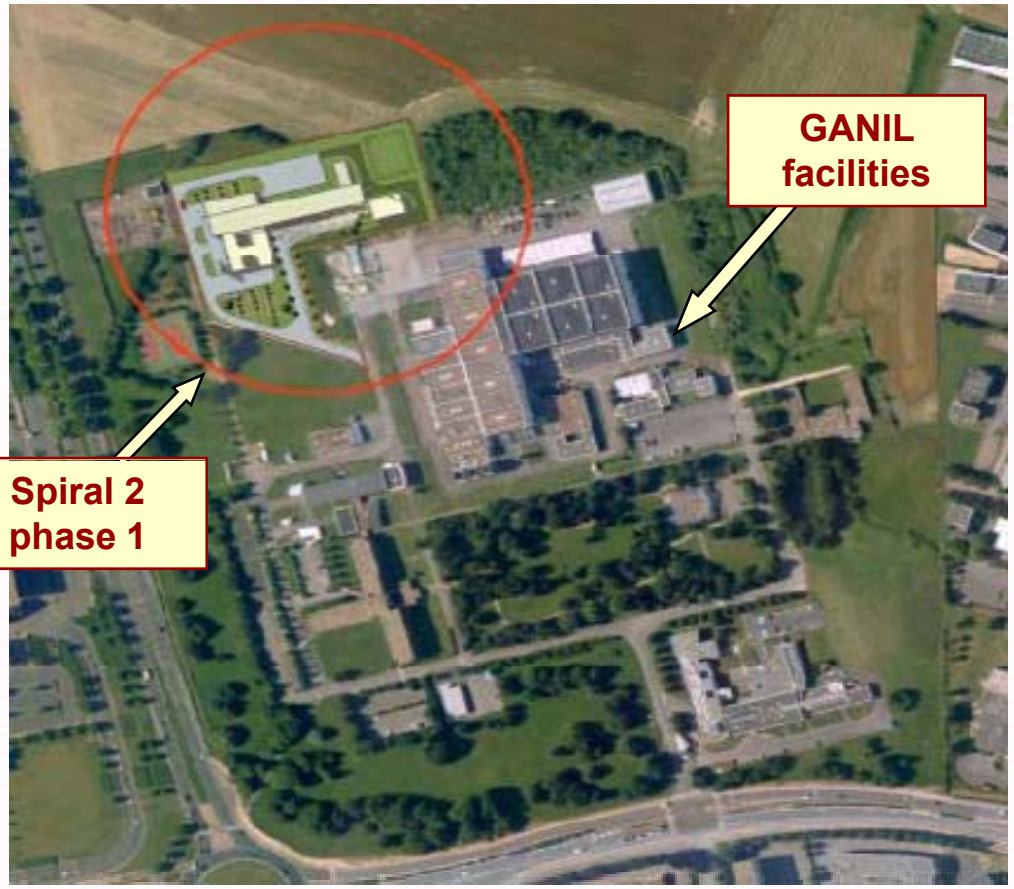
⇒ ***Licensing procedure endorsed***
A global safety report leading to a single ministerial decree with steps

Reference planning



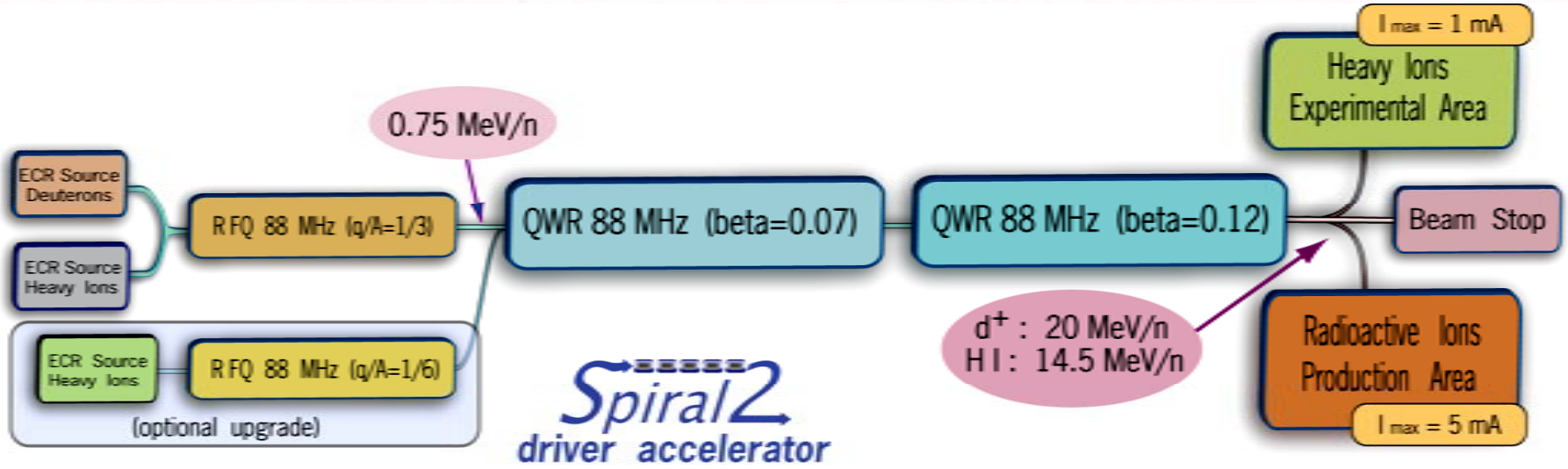






- *Spiral 2 new buildings*
- *Linac tunnel*
- *Contracts: October 2008*

SPIRAL2 DRIVER ACCELERATOR Baseline Configuration: October 2006



beam	p+	D+	ions	ions
Q/A	1	1/2	1/3	1/6
I (mA) max.	5	5	1	1
W_O min. (Mev/A)	2	2	2	2
W_O max. (Mev/A)	33	20	14.5	8.5
CW max. beam power (KW)	165	200	44	48

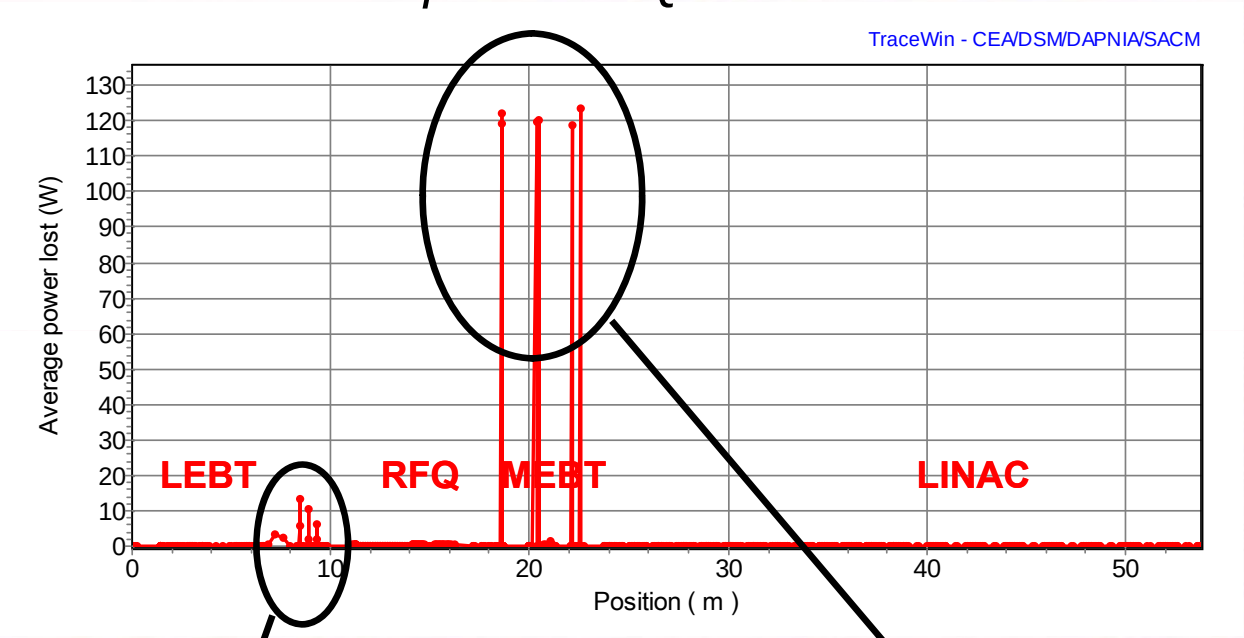
Total length: 65 m (without HE lines)

D^+ : ECR ion source
Heavy Ions: ECR Ion Source
Slow and Fast Chopper
RFQ (1/1, 1/2, 1/3) & 3 re-bunchers

12 QWR beta 0.07 (12 cryomodules)
14 QWR beta 0.12 (7 cryomodules)
1 KW Helium Liquifier (4.2 K)
Room Temperature Q-poles
30 Solid State RF amplifiers (10 & 20 KW)

Beam losses and safety studies

⇒ *Intensive beam dynamics studies confirm the importance of emittance control at the input of RFQ and before the Linac*

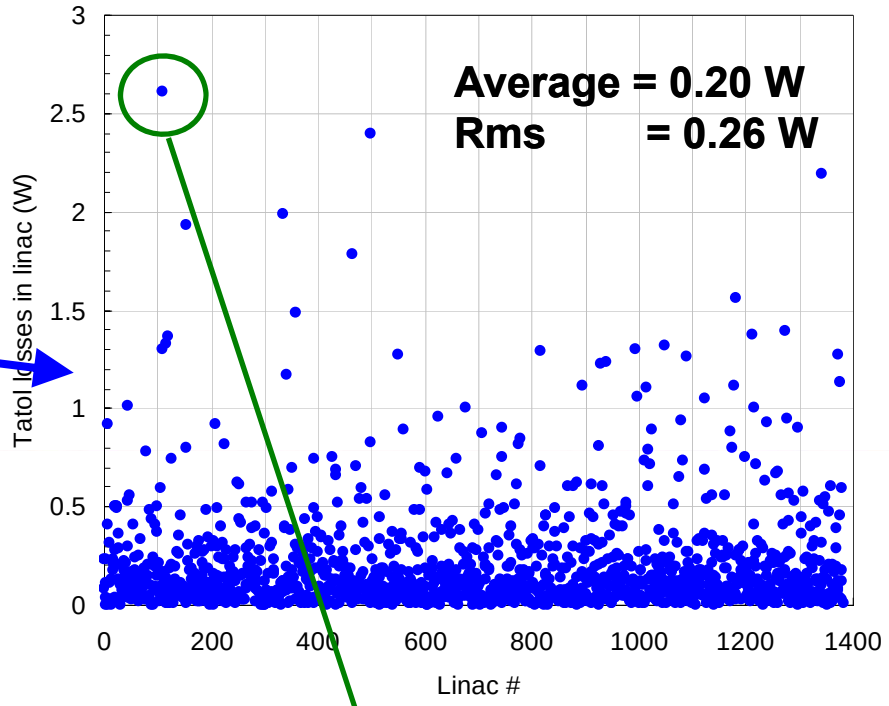


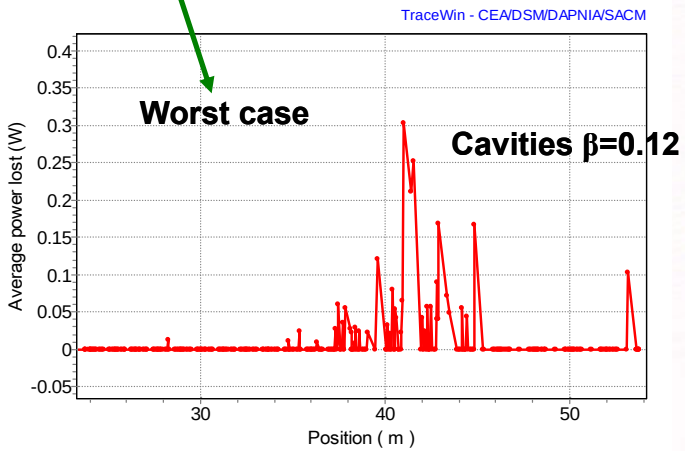
6 slits system to remove beam halo coming from the RFQ in order to protect the linac. About 6x125 W beam losses on slits

3 slits system to control emittance input in RFQ and remove beam halo coming from LEBT line. About 40 W beam losses on slits

LINAC calculations *(Didier Uriot SACLAY/CEA/DAPNIA October 2007)*

- Codes: TraceWin / Partran/Toutatis.
- Client/Server architecture (40 PCs).
- 1400 Linacs,1million particles for each
- Matching and correction scheme for each linac
- **Corrected and uncorrected errors**
- Diagnostics errors.
  - Results for Deuterons 5 mA , 20 MeV.A



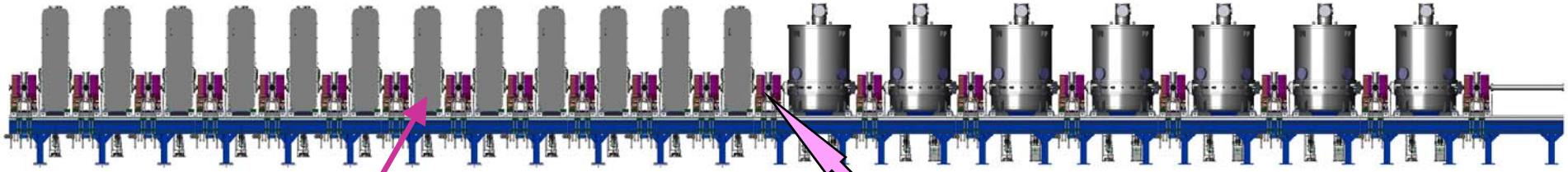


Poster in this conference:

MOP 070: Beam Dynamics and Error Studies of the Spiral 2 Driver Accelerator (P. Bertrand et al.)

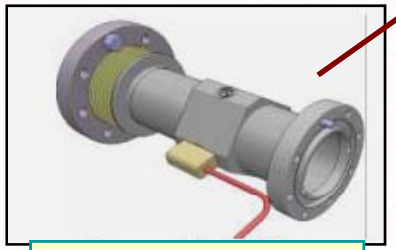
reducing beam losses ⇒ corrections and diagnostics

⇒ Q-poles at R.T. and special supports for precise alignment

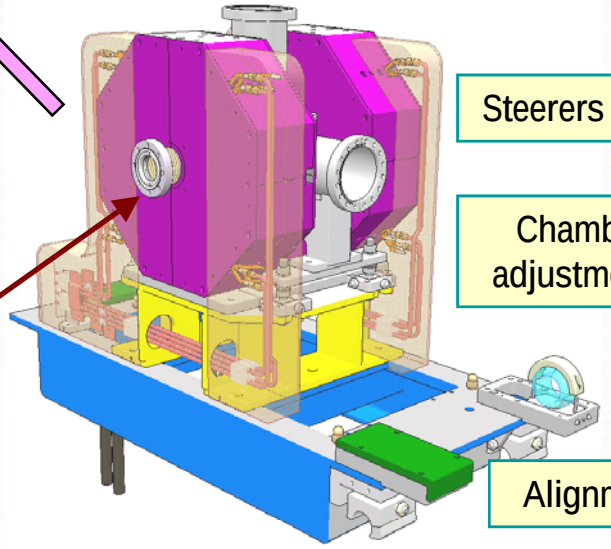


Each cryomodule is installed on independent supports with alignment adjustments

Room temperature sections : Q-poles



Beam Position Monitor



Steerers coils

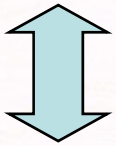
Chamber adjustments

Alignment

Support adjustments

Spiral 2 safety goals

- ***calculations (with correction schemes) : < 10 mW/m***



- ***reasonable goal : < 1 W/m***

Doses rates

	Technical Staff	*People/Environment*
Normal operation	***< 2 mSv/year***	***< 10 µSv/year***
Incidental situation	***< 10 mSv/year***	***< 10 µSv/incident***
Major incident	***< 20 mSv/incident***	***< 100 µSv/incident***
Major accident	***Variable according to situation and potential impact***	***< 1 mSv/accident***

- offices, labs and workshops limit 7.5 µSv/h,
- maintenance operations limit 100 µSv/h

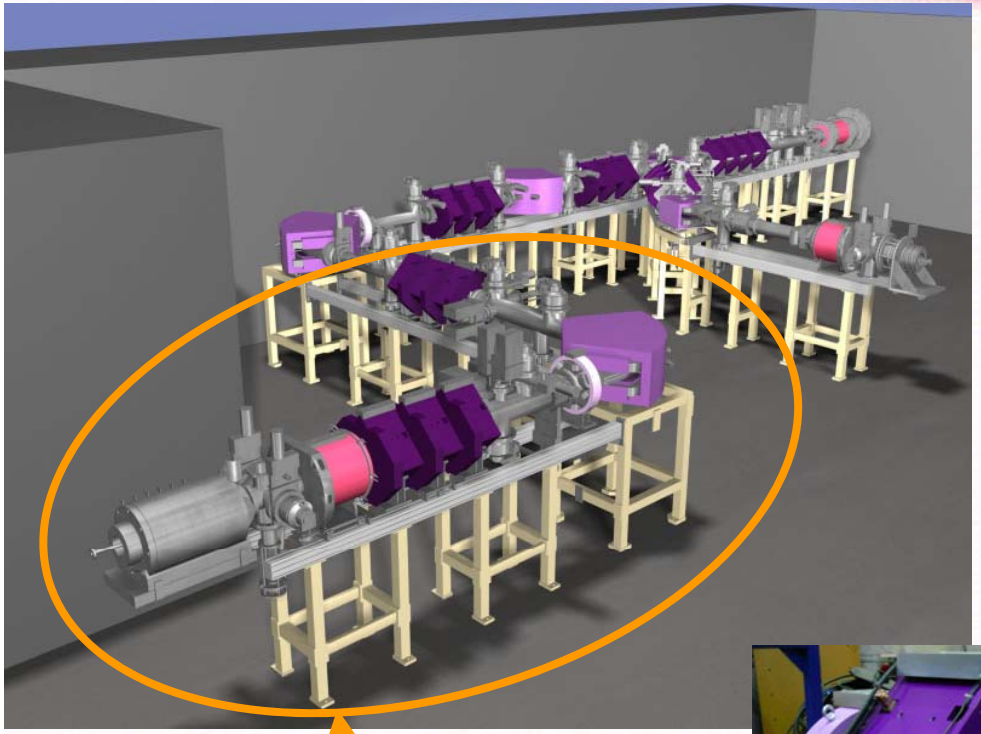
Activation and dose calculations

- ***MCNPX 2.5 code***
- ***modelling of all components***
- ***maintenance schemes***

Licensing procedure:

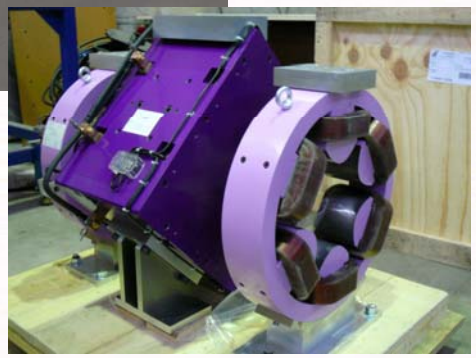
First Safety Report must be ready for the beginning of 2009

Injector construction



Heavy Ion Line: Test of ECR sources, diagnostics and LEBT components

(Grenoble end 2008)



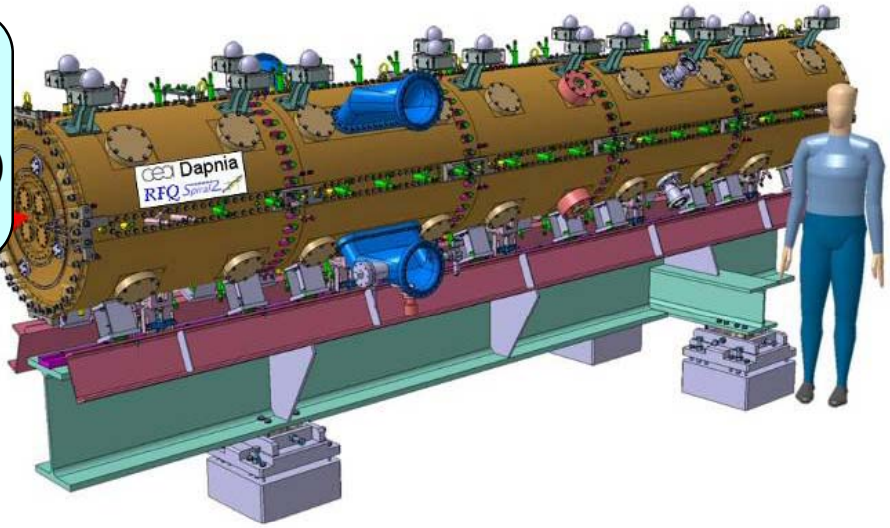
LEBT elements constructed

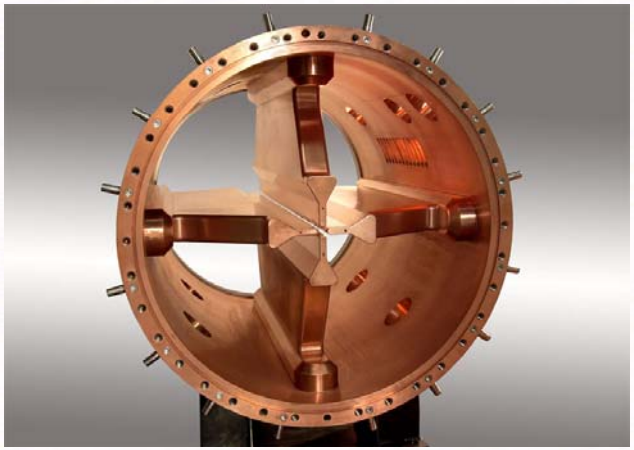
New ECR source
A-PHOENIX (using SC coils)

- Goal at 18 GHz: Ar8+: 1 mA
- June 2008: 0.4 mA

Injector construction

RFQ (q/A: 1, 1/2, 1/3)
88 MHz , length: 5 m
Prototype: tested at full RF power (2005-2006)
Contract signature : June 2008





Tests with beam:

- *proton/deuteron LEBT*
- *RFQ cavity*

⇒ ***CEA/Saclay (2009-2010)***

SC Linac construction

End of 2008 : all the orders for SC QWR, power couplers and associated cryogenic components will be placed

Before final installation at the GANIL site, the cryomodules are assembled and tested in two laboratories:

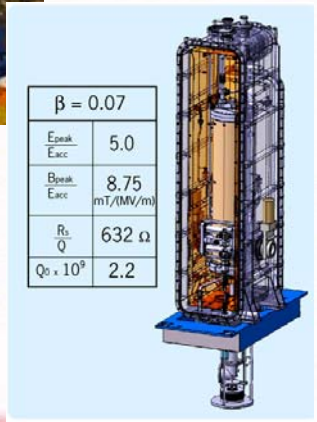
- Low energy cryomodules (beta 0.07): CEA / Saclay
- High energy cryomodules (beta 0.12): CNRS/ IPN Orsay

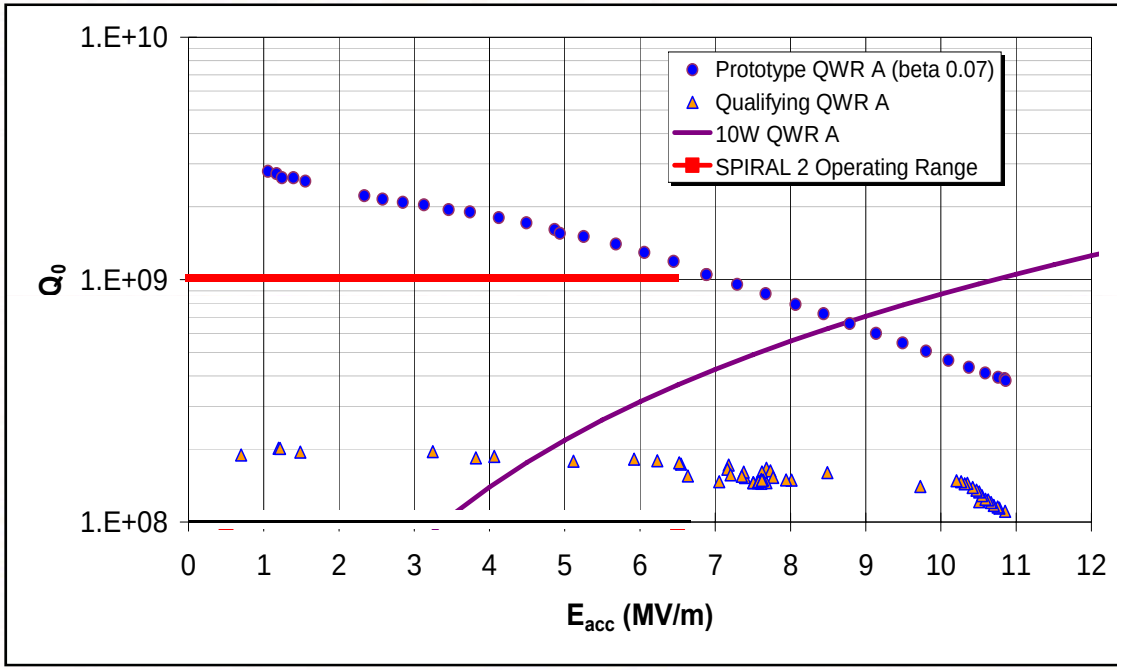
Main development steps:

- Initial R&D and prototyping : 2003-2005
- Test facilities and Cryomodules qualification: 2006-2008
- Series assembly and tests: 2009-2011

SC Linac construction

Low energy cryomodules (beta 0.07): CEA / Saclay





First cryogenic tests (july-september 2008)

- Cryomodule static losses 4K : 7 W
- Valve box + cryo. lines + cryomodule: 25 W
- Installation of the power coupler: next test October-November 2008

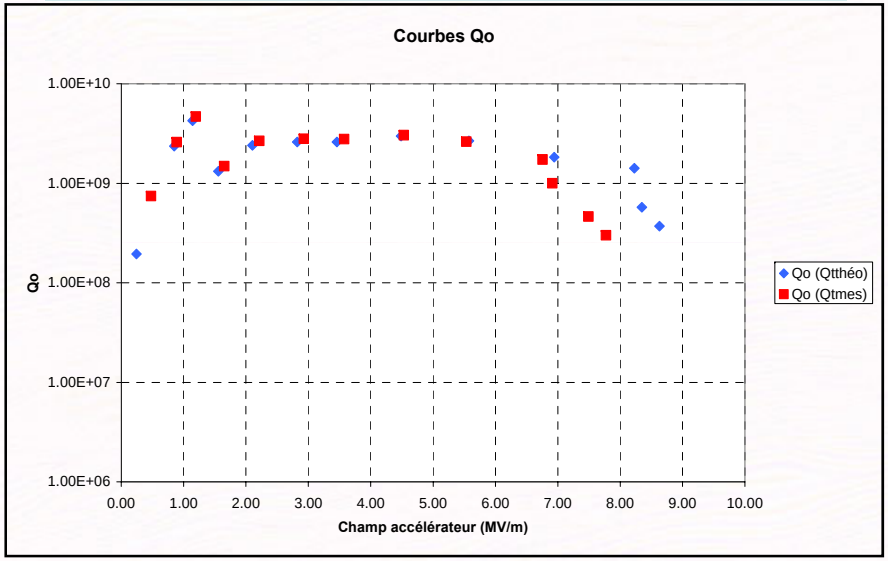
SC Linac construction

High energy cryomodules (beta 0.12): CNRS/ IPN Orsay

β=0.12	
$\frac{E_{peak}}{E_{acc}}$	5.5
$\frac{B_{peak}}{E_{acc}}$	10.1 mT/(MV/m)
$\frac{R_S}{Q}$	521 Ω
$Q_0 \times 10^9$	1.7

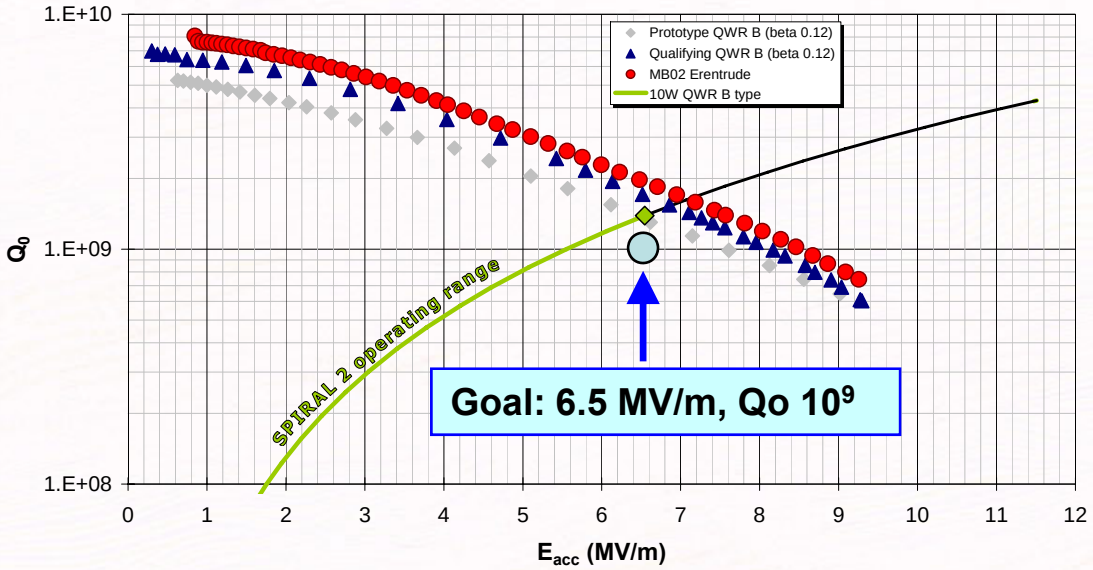
Results with the first B cryomodule (β=0.12)

(Jan. – Feb. 2008)



- 8 MV/m with RF Power Coupler
- static losses at 4K: 13 W
- total losses (including cryo lines and valve box) : 25 W
- alignment tests OK
- tuner tests OK
- contamination tests OK

New cavity test (first of series fabrication) Sept. 2008

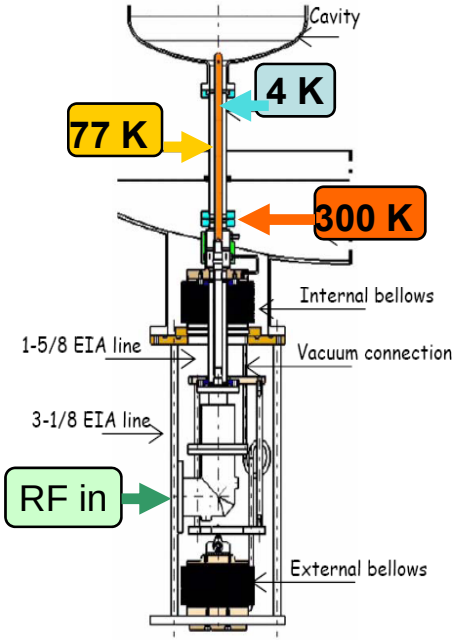


More information in this conference:

- **SC Linac poster MOP053 R. Ferdinand et al., "The Spiral 2 Superconducting Linac"**
- **RF couplers poster THP076 Y. Gomez et al., "Spiral 2 RF coupler design and tests"**

RF Power Couplers

- **developed at CNRS/Grenoble**
- **prototypes: fully tested at 40 KW CW**
- **nominal operation between 5 and 15 KW**
- **Contract for series production (30 units) in September 2008**

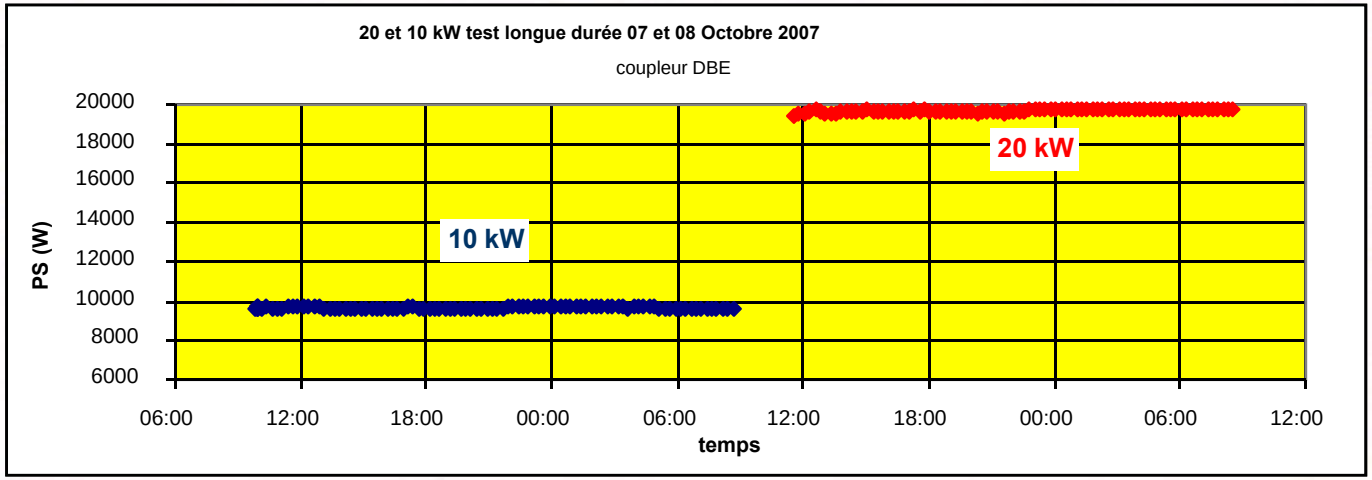


Solid State / modular RF Amplifiers

RF Amplifiers Test Stand

More information in this conference:

- **poster THP048, M. DiGiacomo and B. Ducoudret, "RF Power Amplifiers for the Spiral 2 Driver"**
- **poster M. THP076, DiGiacomo and al., "Design of the MEBT Rebunchers for the Spiral 2 Driver"**



ACKNOWLEDGEMENTS

•This work is the result of a large Project Team composed of people from GANIL and associated CEA and CNRS laboratories.

• It is also the result of an exceptional international collaborative effort

⇒ Peer reviews, technical meetings, workshops, etc. have contributed to assess and establish the grounds for the design and construction of Spiral 2

⇒ Present and future bilateral collaboration agreements will contribute with important equipments and Instruments

First beam: 2012