Status of the Spiral 2 project at GANIL

T. Junquera

IPNO Orsay (CNRS) and GANIL

SRF09, Berlin, September 21st, 2009

What is Spiral 2 ?

• In 2001 A new Radioactive Ion Beam facility (Spiral) start to operate at GANIL (ISOL principle, using the former cyclotrons as a Driver, and a new cyclotron for post-acceleration)

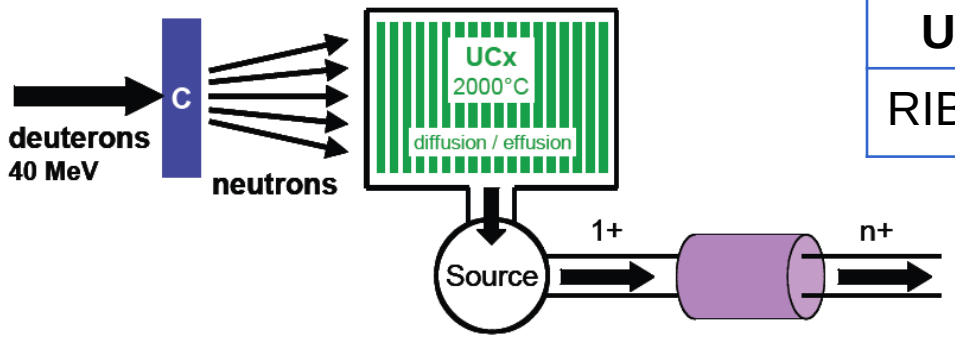
• In 2005: decision by the french Ministry of Research to construct a new facility: Spiral 2. Financial support is given by CEA, CNRS and Normandy Regional Council.

Based on a SC Linac Driver, associated to a High Power Production System (converter, target, ion source) delivering RI beams to cyclotrons for post acceleration and using new and existing experimental areas.

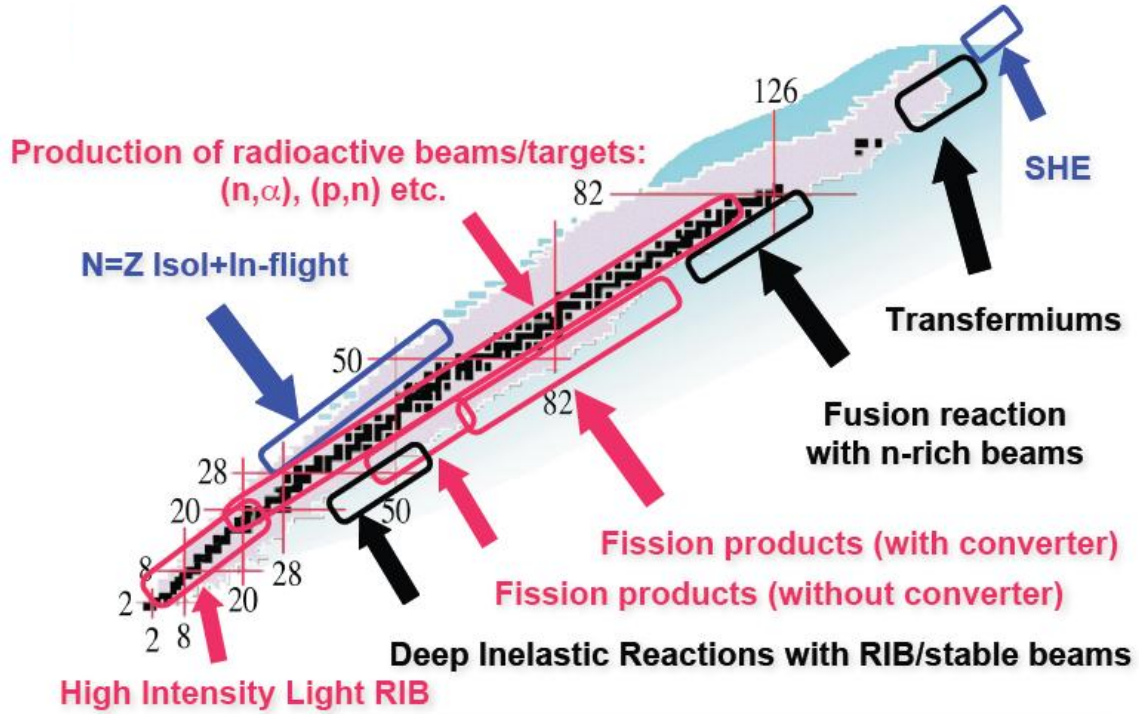
2009 : we are in the middle of the road …

ISOL (Isotope Separation On Line) technique to produce Rare Isotope Beams

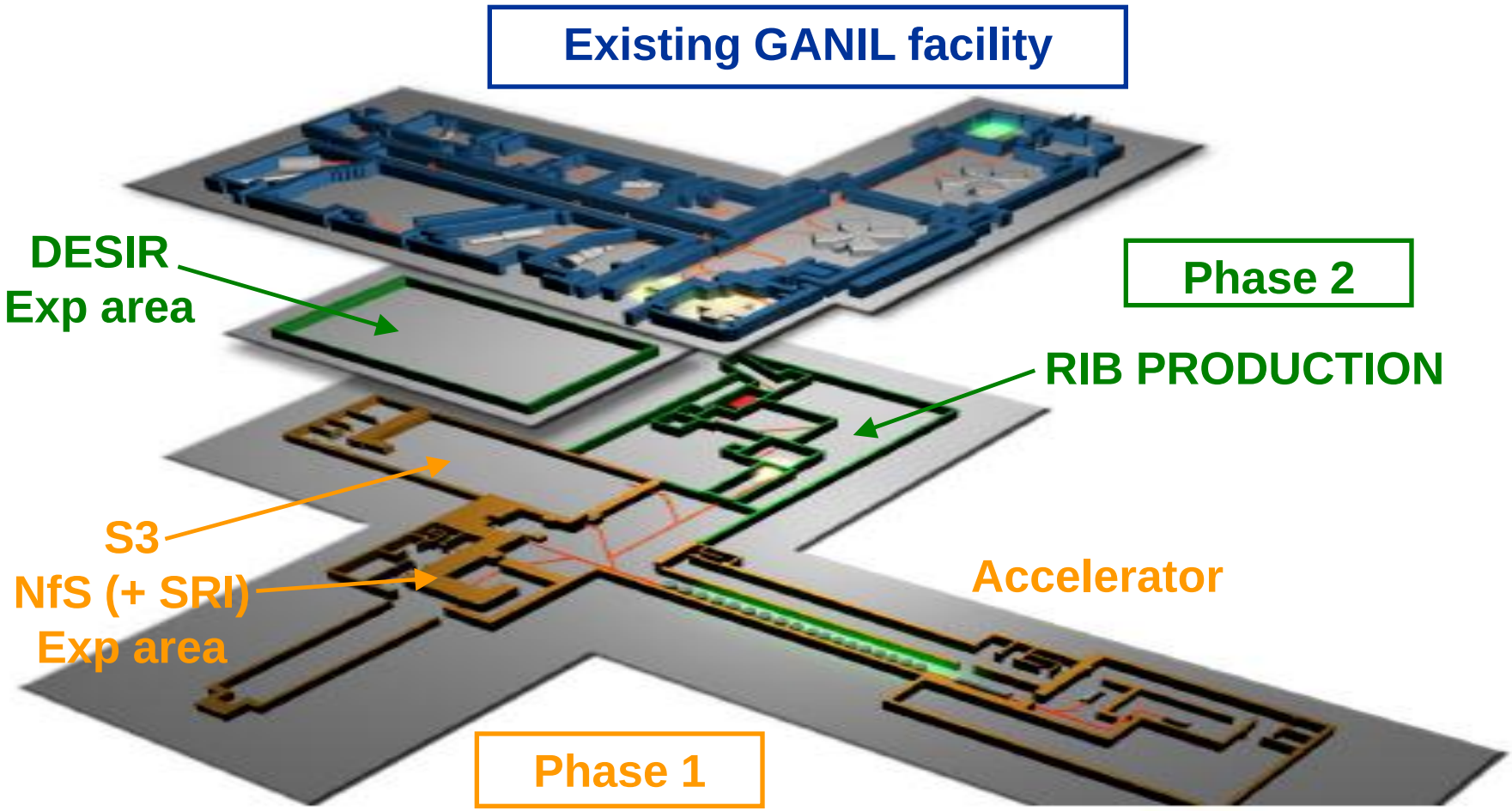
Spiral 2 Goals
UCx target: 10^{14} fissions/s
RIB (60<A<140):10^{6} to 10^{10}pps



⇨light-ion stable beams
⇨heavy-ion stable beams
⇨RIB induced reactions

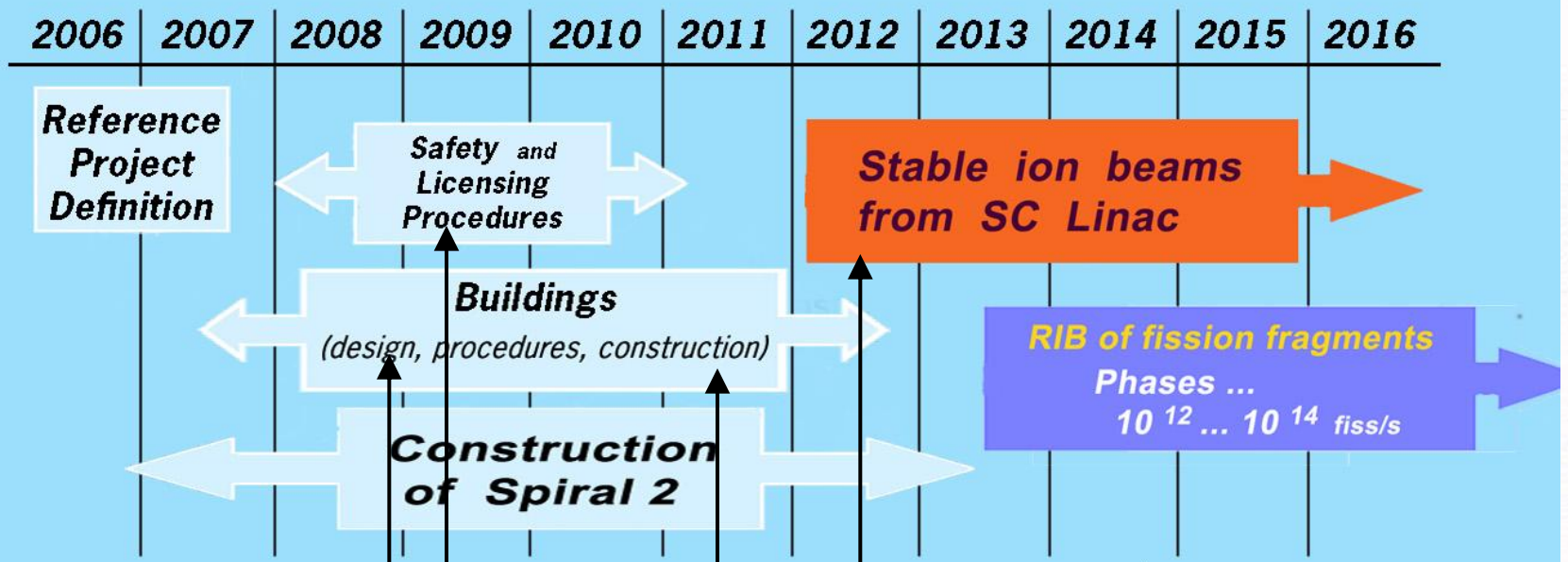


Spiral 2 construction phases



+ Annexes = Conventional facilities for PH 1 & 2

Reference planning (September 2007)

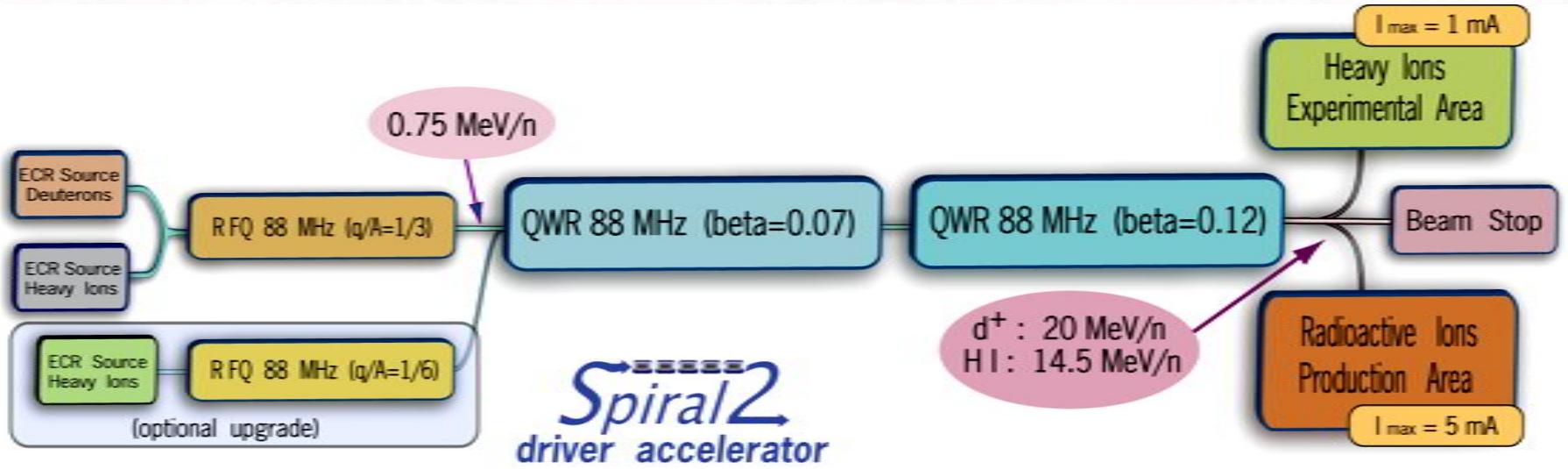


Phase 1

- Preliminary Safety Report
- First beam tests
- Tunnel installation begins
- Buildings contracts

September 2009

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)

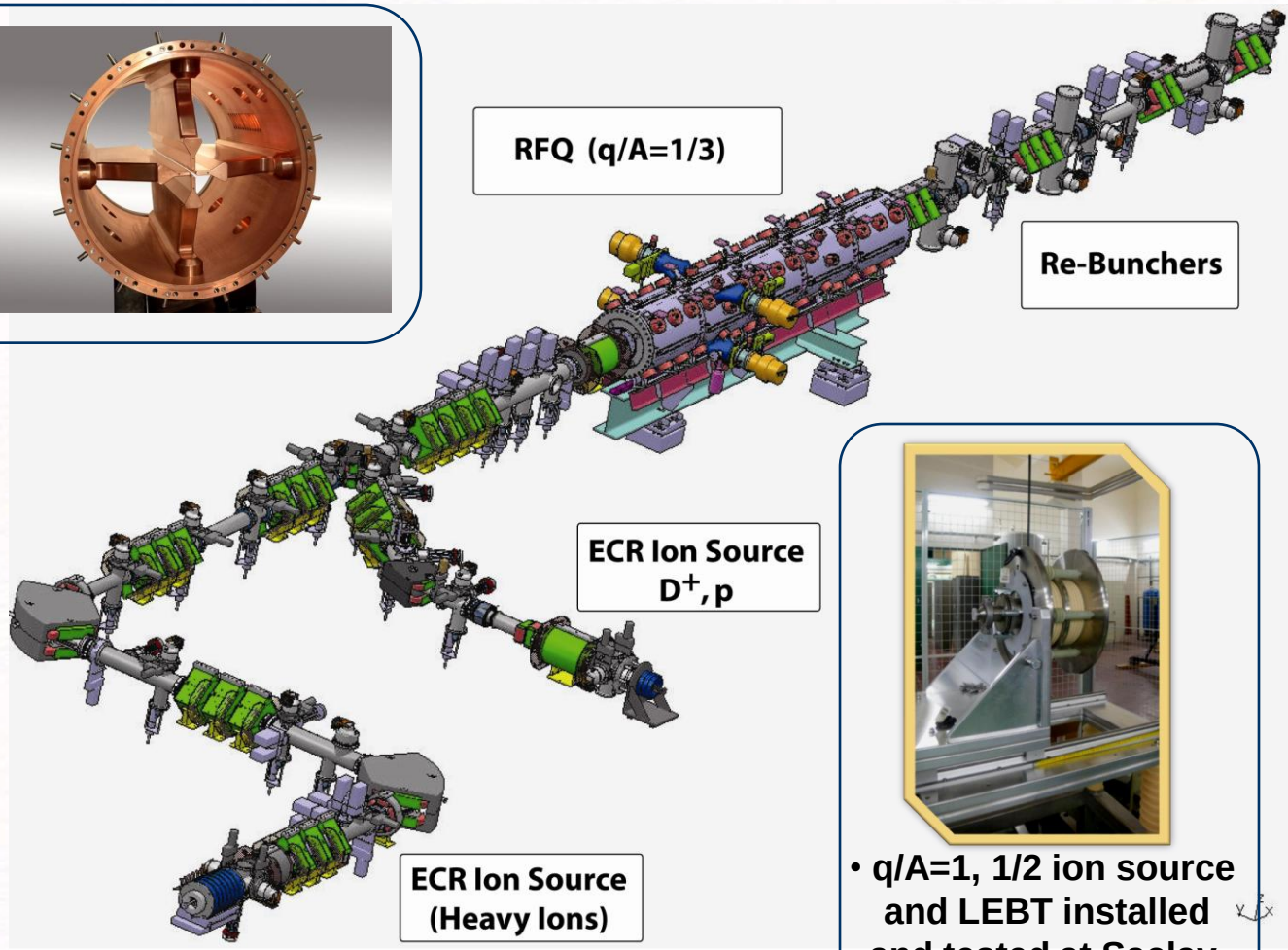
D^+ : ECR ion source
Heavy Ions: ECR Ion Source
Slow and Fast Chopper
RFQ (1/1, 1/2, 1/3) & 3 re-bunchers

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)

Injector construction

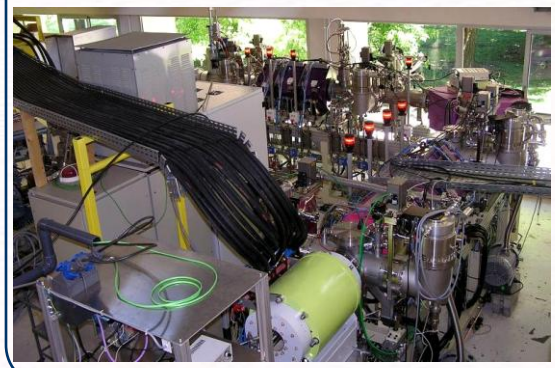
Grenoble, Saclay, GANIL, Lyon, Strasbourg

RFQ design & follow-up by CEA Saclay
- **first module: end 2009**
- **final assembly and test at GANIL (2011)**



- **q/A=1/3 ion source and LEBT installed and tested at Grenoble**

(2009-2011)

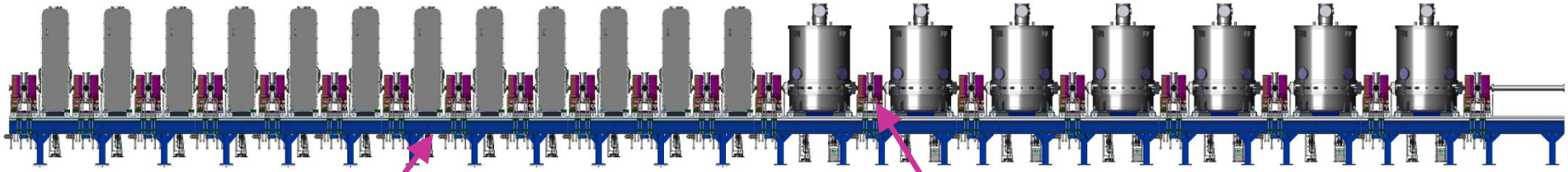


- **q/A=1, 1/2 ion source and LEBT installed and tested at Saclay**

(2009-2011)

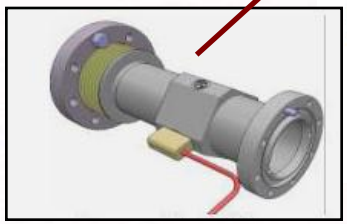
SC Linac construction

Orsay, Saclay, GANIL, Grenoble

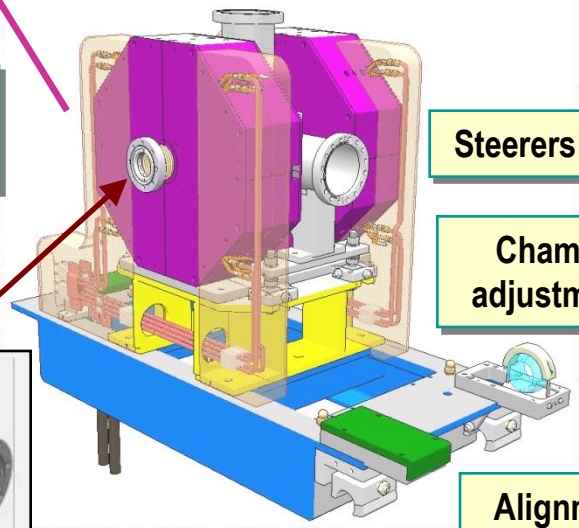


Each cryomodule is installed on independent supports with alignment adjustments

Room temperature sections : Q-poles



Beam Position Monitor



reducing beam losses ***(< 1W/m)***

⇒ *space for corrections and diagnostics*

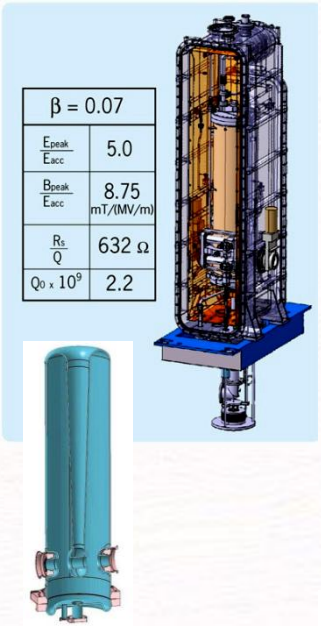
⇒ *room temperature Q-poles*

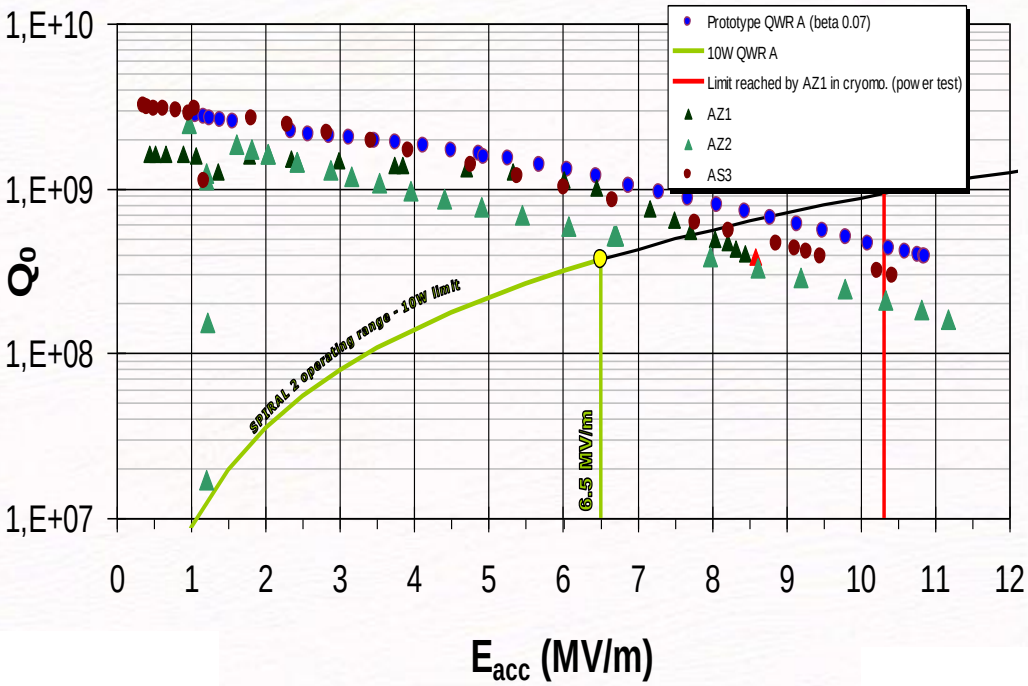
⇒ *special supports for precise alignment*

SC Linac construction

Orsay, Saclay, GANIL, Grenoble

Low energy cryomodules (beta 0.07): CEA Saclay





⇒ **More details in G. Olry presentation Thursday 24th.**

First cryogenic tests (july-december 2008)

- Cryomodule static losses 4K : 7 W
- Valve box + cryo. lines + cryomodule: 25 W
- tests with power coupler: November, December 2008
- pre-series cavities: reception and test July 2009 (OK)

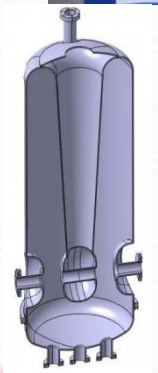
(QWR fabrication: Zanon and SDMS)

SC Linac construction

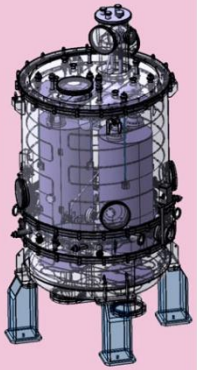
Orsay, Saclay, GANIL, Grenoble

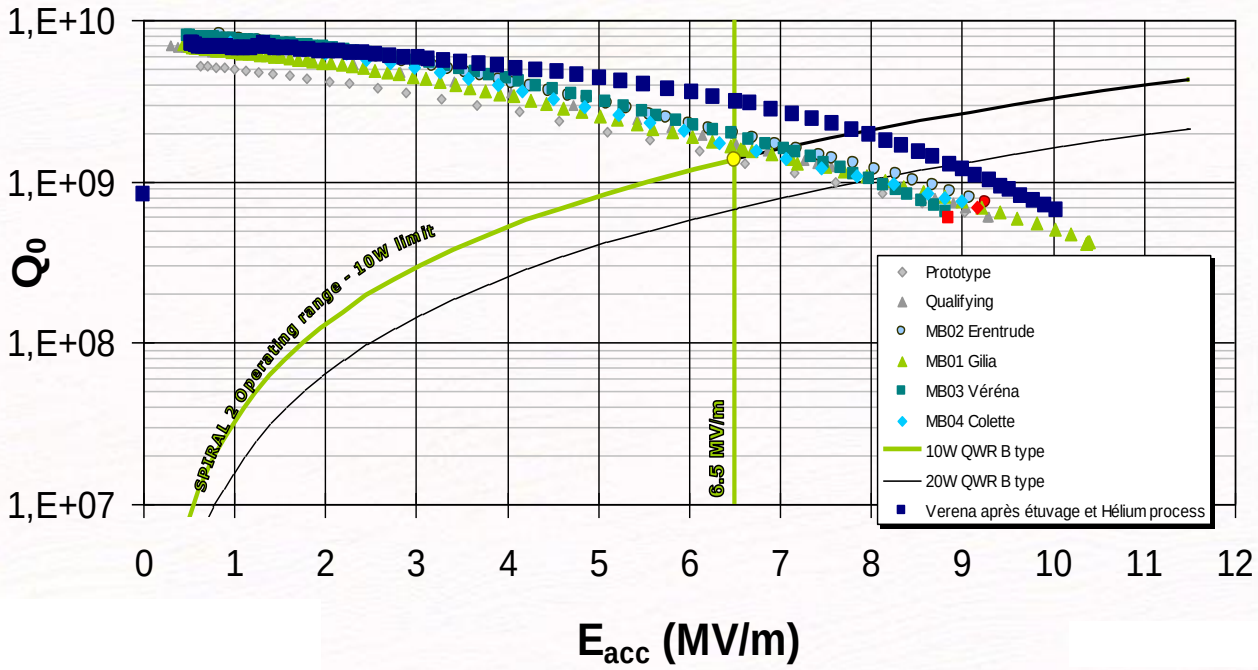
High energy cryomodules (beta 0.12): CNRS/ IPN Orsay

- QWR fabrication by RI
- cryostats by SDMS



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





First cryomodule test January - February 2008

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

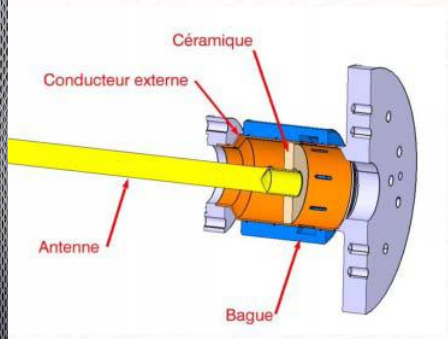
⇒ **More details in G. Olry presentation Thursday 24th.**

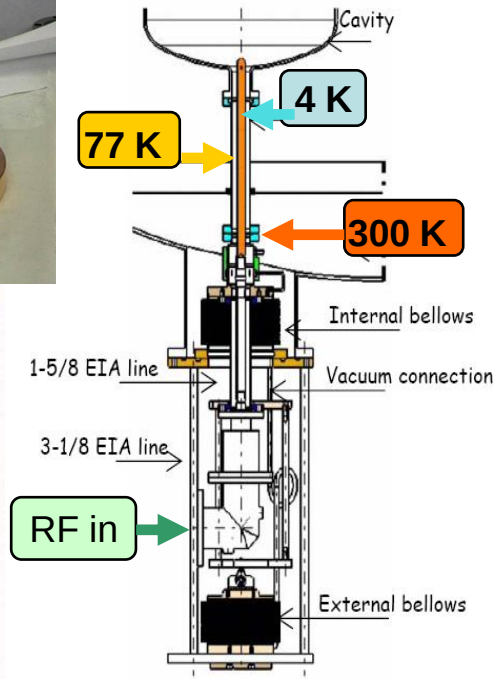
SC Linac construction

Orsay, Saclay, GANIL, Grenoble

RF Power Couplers

developed at CNRS Grenoble

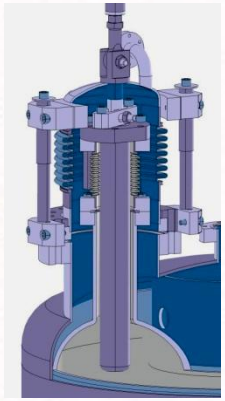


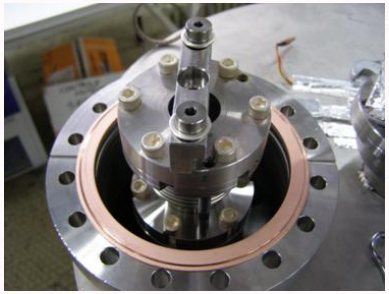


- test station 40 KW, clean room
- prototypes: fully tested at 40 KW CW
- nominal operation between 5 and 15 KW
- Contract for series production (30 units) in September 2008
- first prototypes couplers tested on A and B cryomodules : 2008
- first series couplers assembled and tested on cryomodules: end 2009

SC Linac construction

(gallery)





New QWR tuner

Delivery of QWR (RI manufacturing) waiting for assembly and test (Orsay)

Assembly of power coupler (Saclay)

Delivery of power couplers waiting for test

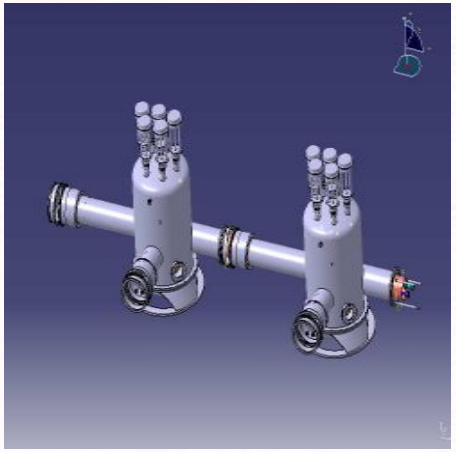
(Grenoble)

SC Linac construction

Cryogenic Plant

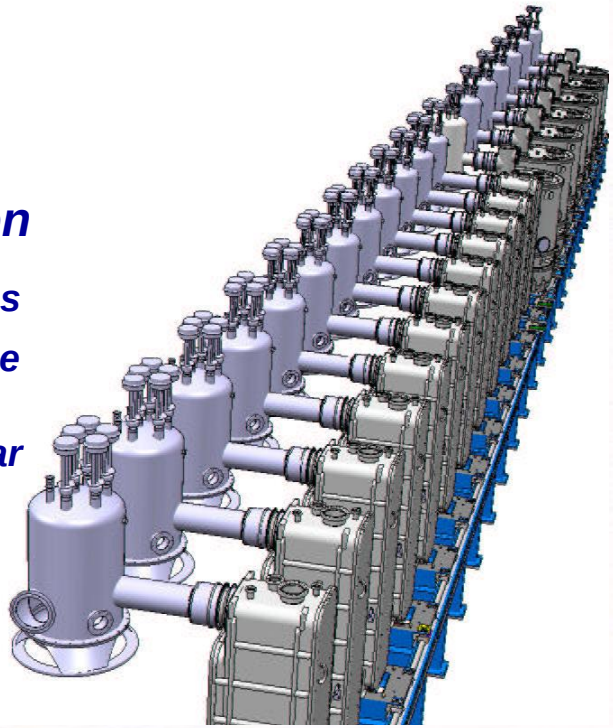
		Load	
		4.3 K	60K
Linac		643 W	1500 W
LHE	Beam line	80 W	300 W
Total		723 W	1800 W
Liquefier request		**1000 W**	**2400 W**
Others	Ganil	10 l/h	

1200 W



Cryogenic distribution

- *independent valves boxes*
- *special box to connect the cryoplant*
- *pressure stability ± 5 mbar*



Call for Tenders

- *two companies: on going technical discussions*
- *contract signature: November 09*
- *installation 3rd Qr. 2011*

SC Linac construction

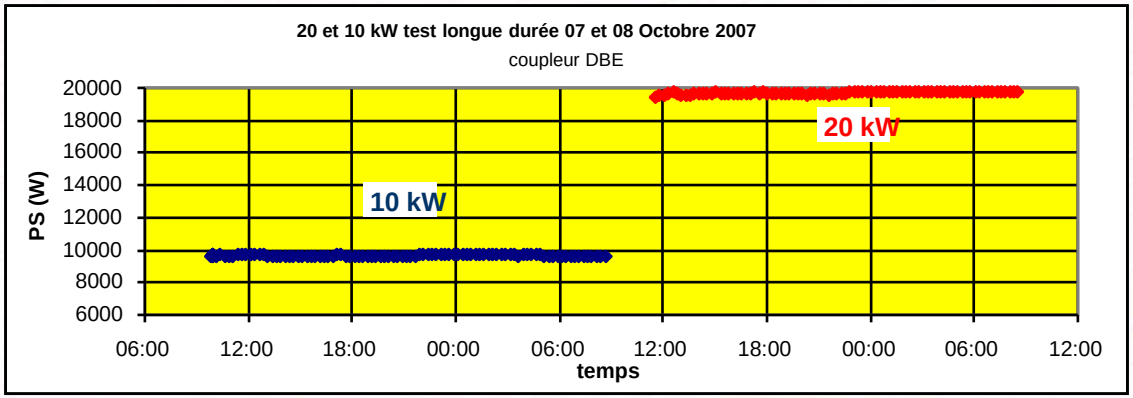
Orsay, Saclay, GANIL, Grenoble

RF Systems developed by GANIL, Saclay, Orsay

Solid State / modular RF Amplifiers

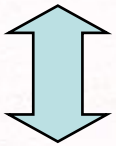
RF Amplifiers Test Stand

- **Digital Low Level RF system**
- **RFQ amplifiers: 4 x 50 KW vac. tubes prototype tested in may 2009**
- **Solid State amplifiers: prototypes tested end 2007 and 2008.**
- **Contracts for series: end 2009**
- **Master oscillator, clocks, reference pulses: developed by LAL Orsay**



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***

Activation and dose calculations

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

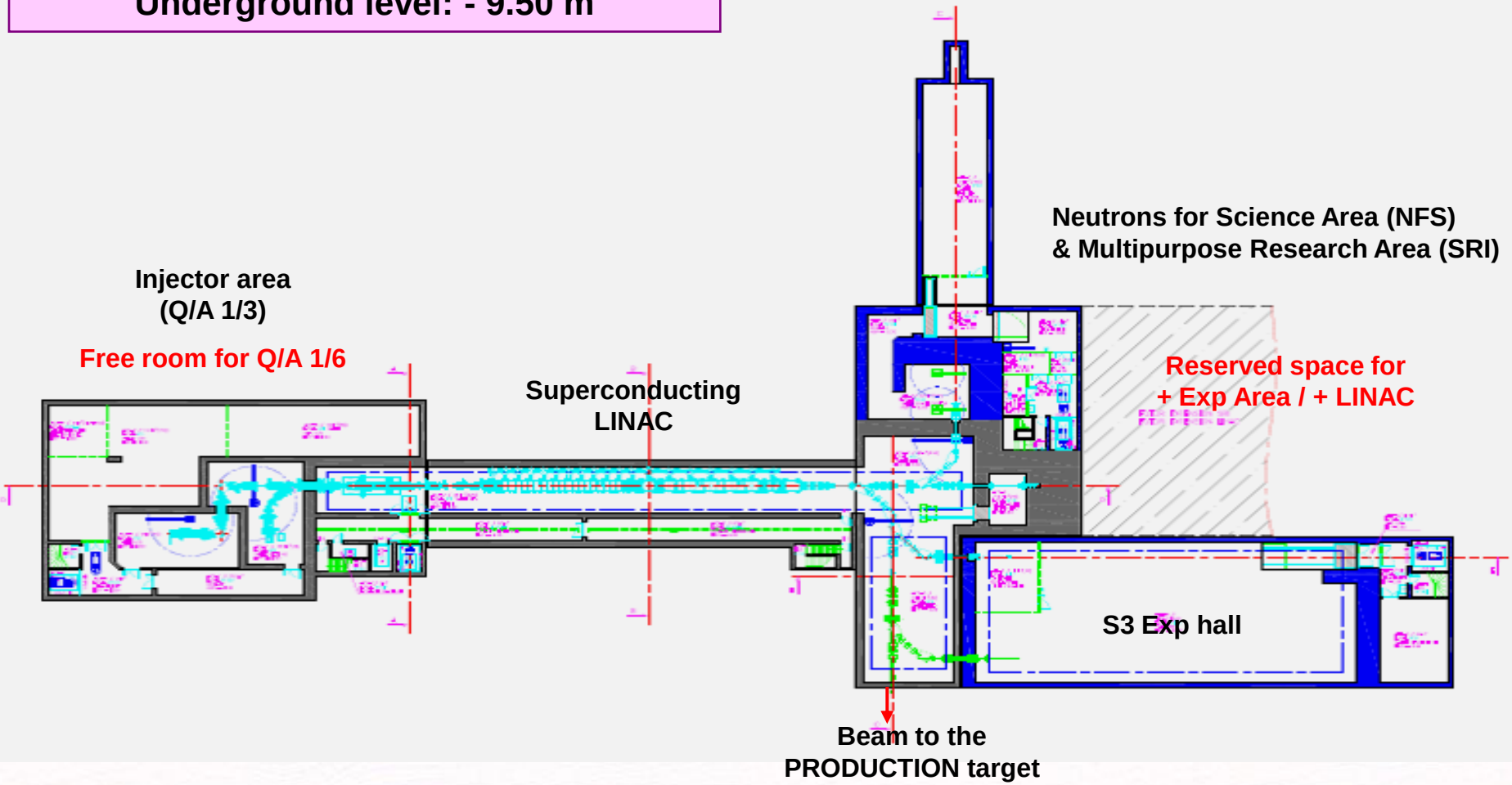
- offices, labs and workshops limit 7.5 µSv/h,
- maintenance operations limit 100 µSv/h

Licensing procedure:

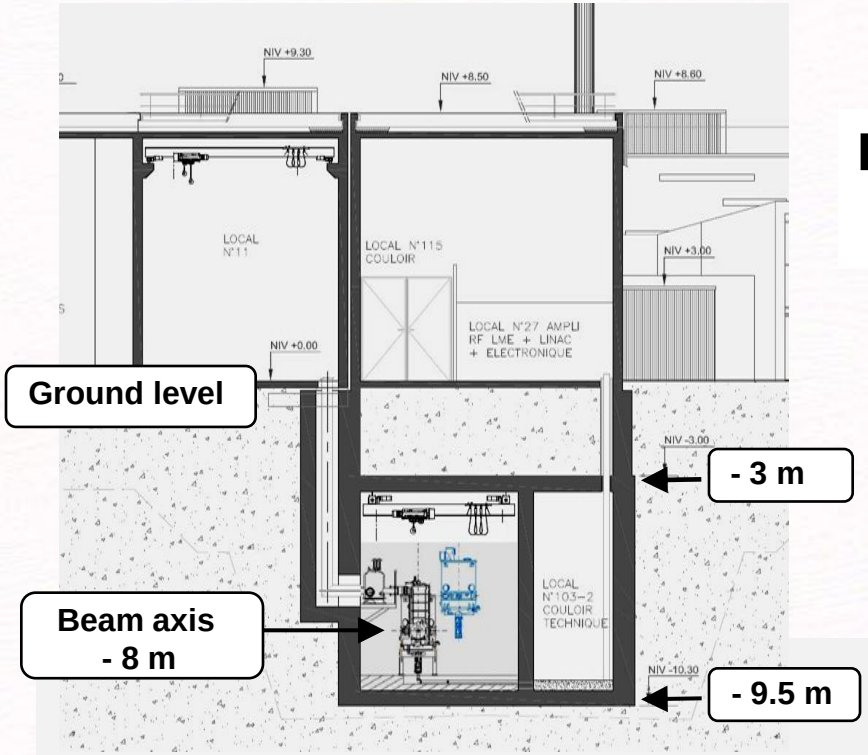
First Safety Report was presented in April 2009

Phase One Construction

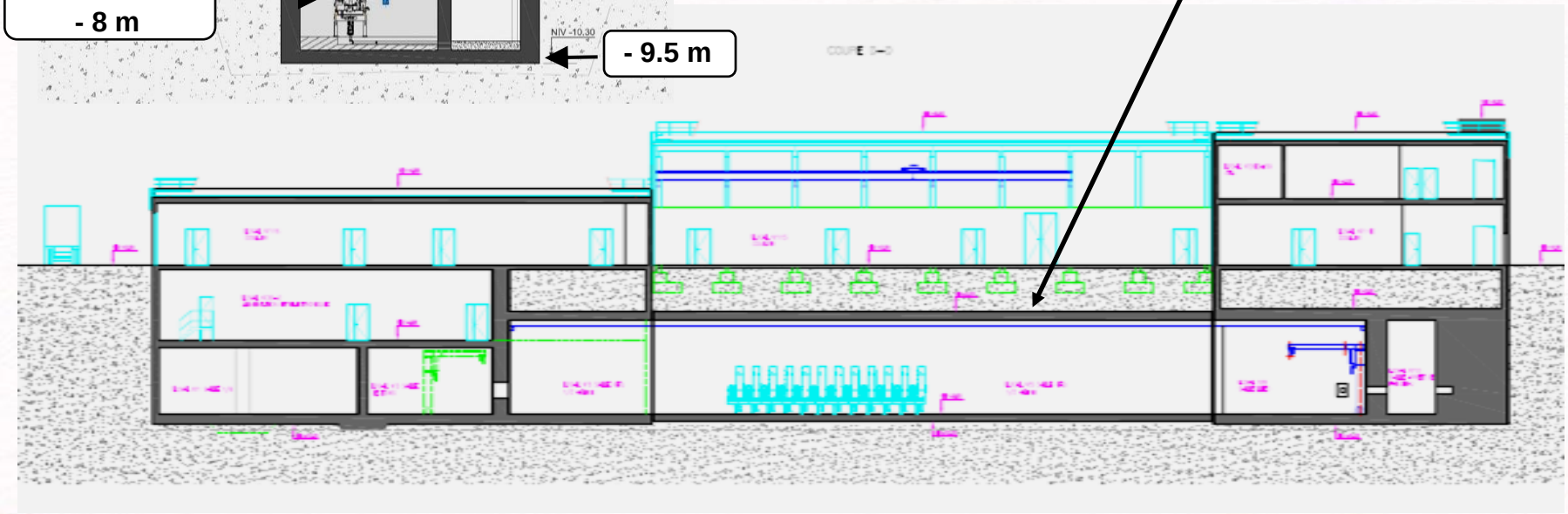
Underground level: - 9.50 m



Phase 1 : Buildings
Cross section views



Filling up layer (most probably using the calcareous stone extracted during the excavation)



Phase 1 Ground level Buildings

Goals: in two years from now (at the next SRF conference)

- SC Linac installation in progress
- First complete beam tests of injector