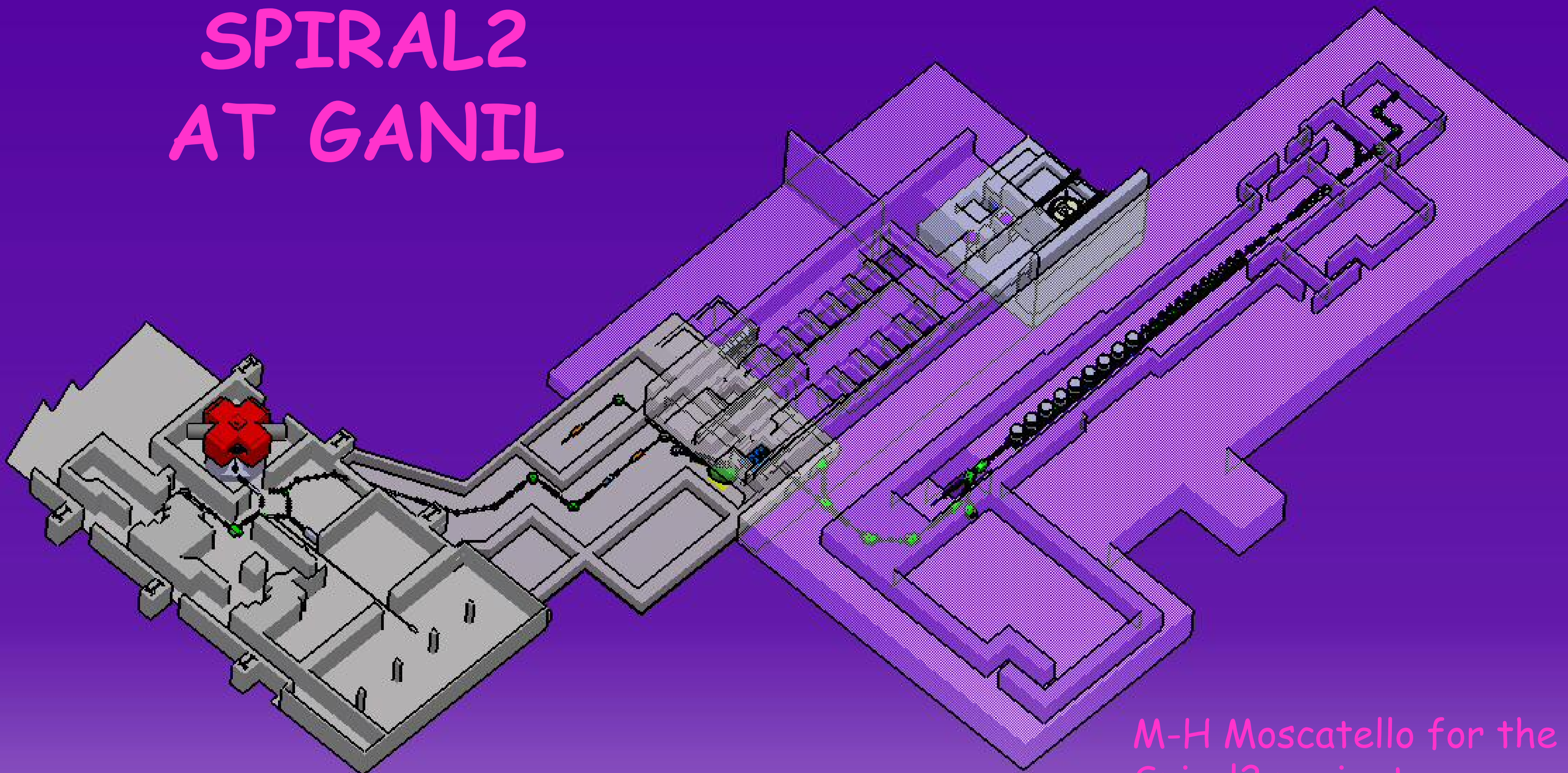
SPIRAL2 AT GANIL

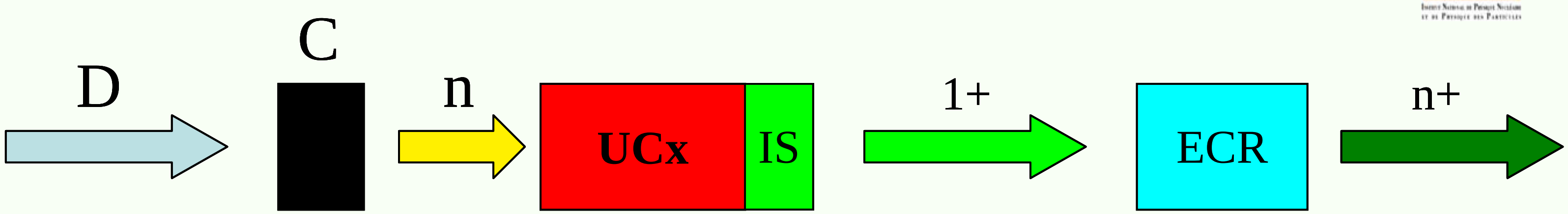


M-H Moscatello for the Spiral2 project group
Ganil-CEA/CNRS

Summary

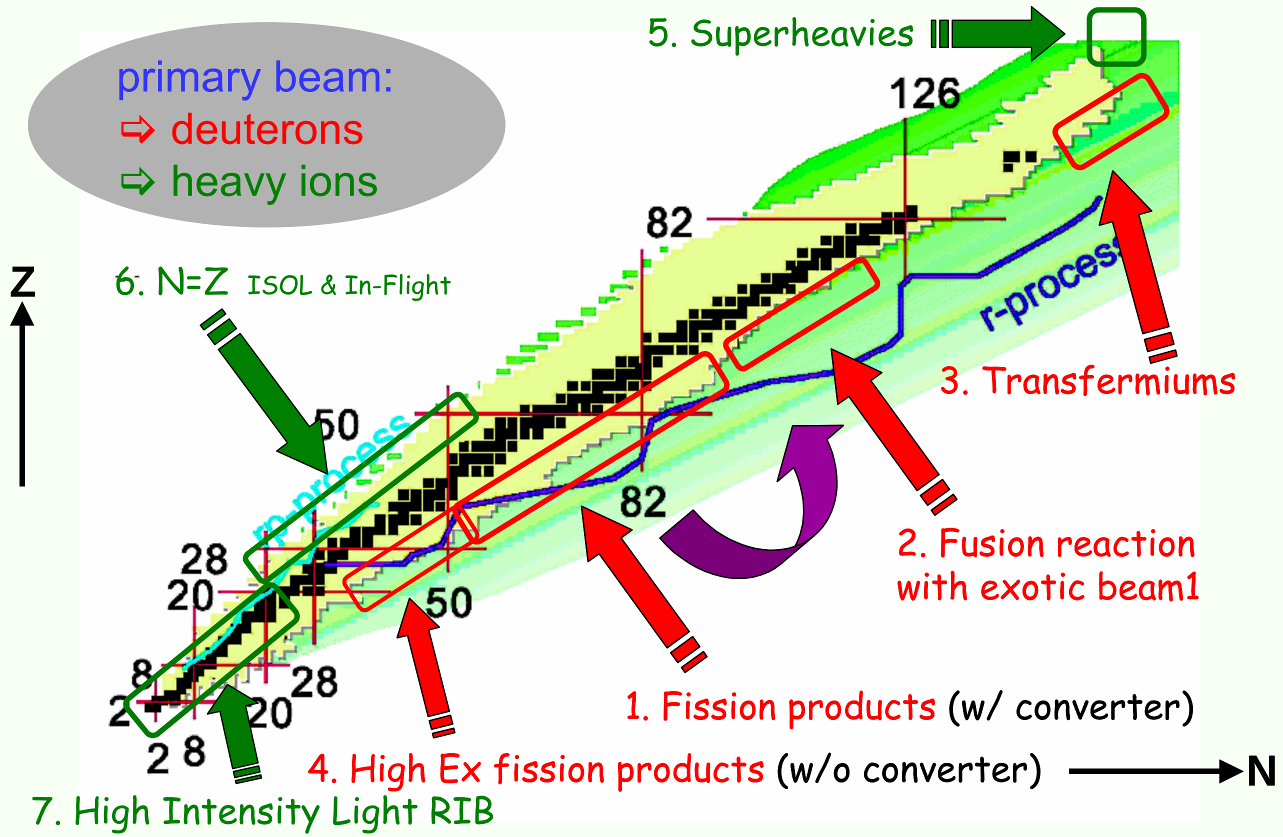
- Spiral2 principle
- Spiral2 layout
- Driver accelerator specifications
- Beam Dynamics
- Deuteron and ion sources
- RFQ
- Superconducting linac
- RF System
- Cryogenics
- Mechanical layout
- Conclusion

Spiral2 principle

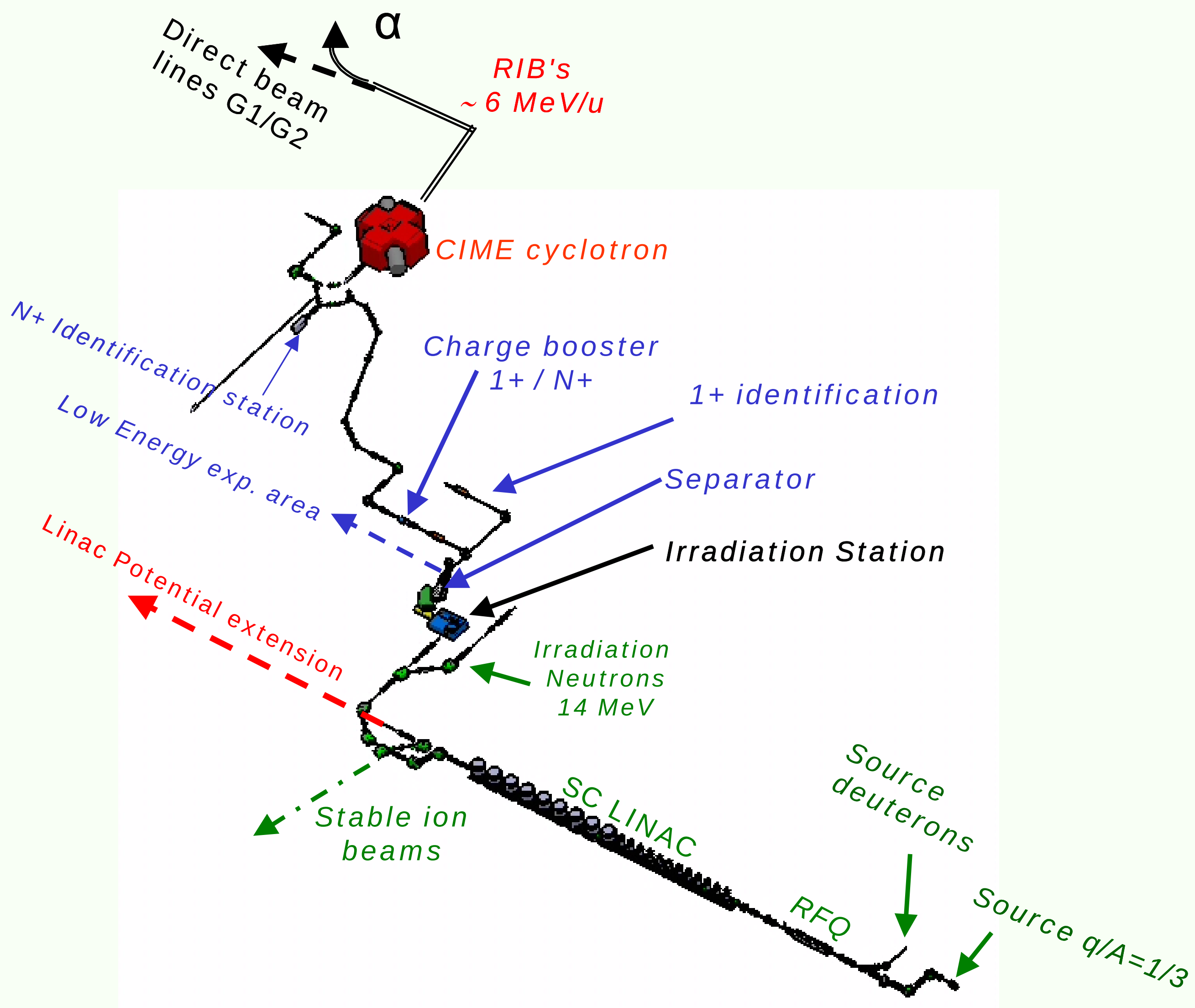


10^{13}-10^{14} fissions/s

Intermediate step between existing RIB facilities, and future projects like EURISOL or RIA.



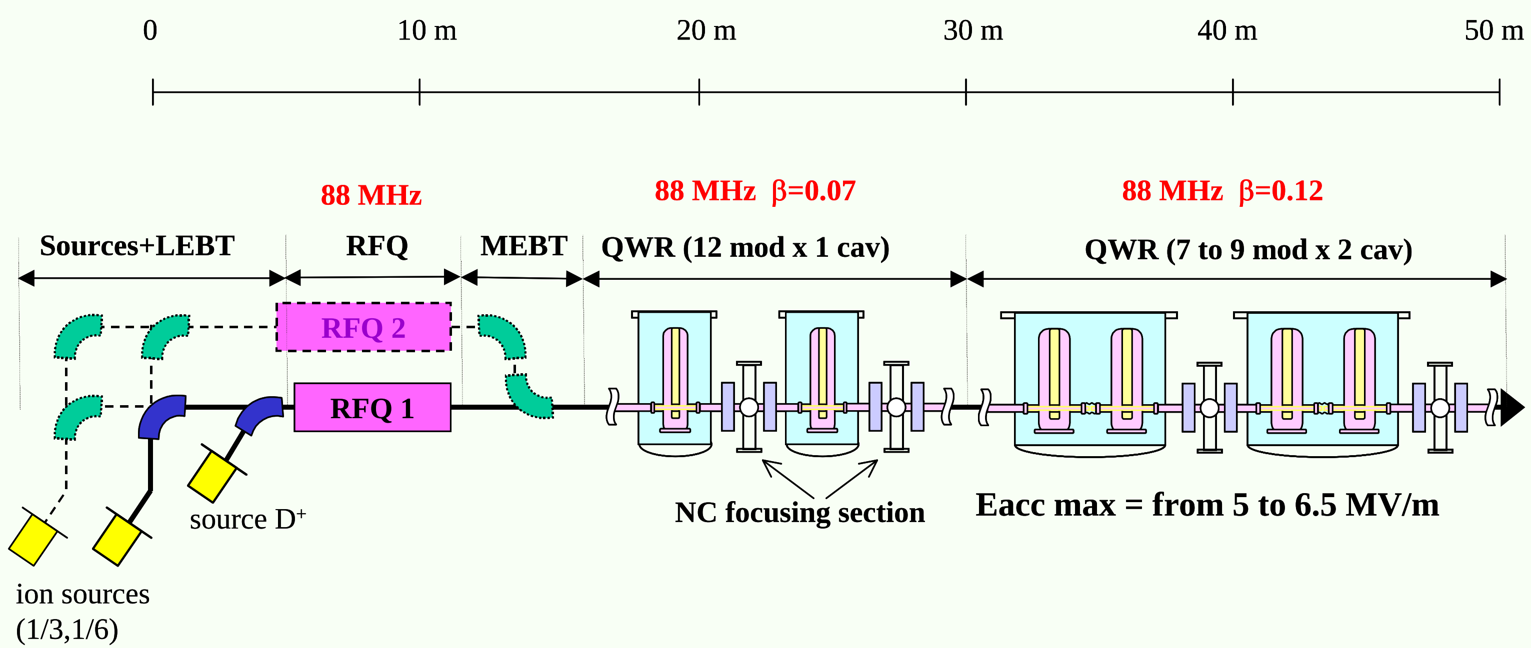
Spiral2 layout



Driver Accelerator Specifications

- A CW accelerator
- 0.15–5 mA of, 40-MeV deuterons
- Up to 1 mA (Argon) for q/A=1/3 ions, 14.5 MeV/u
- Two ion sources, one for deuterons, the other one for ions q/A=1/3
- Maximum energy gain for each kind of ion (this implies independently phased cavities)

- Optimisation of the accelerator for q/A=1/3, in order to have the possibility to increase the ion energy in the future
- Possible fast chopper placed in the MEBT, with the ability of selecting from 1/50 to 1/100000 bunch
- Possibility for the SC linac to accelerate ion beams of q/A=1/6 (up to 1 mA) in a second step



Beam Dynamics

Last results:

Start-to-end simulations, with the D^+ beam (the most constraining for the SC linac, due to the halo)

Gaussian distribution, troncated at 4σ, ε_{rms}**=0.2π.mm.mrad**

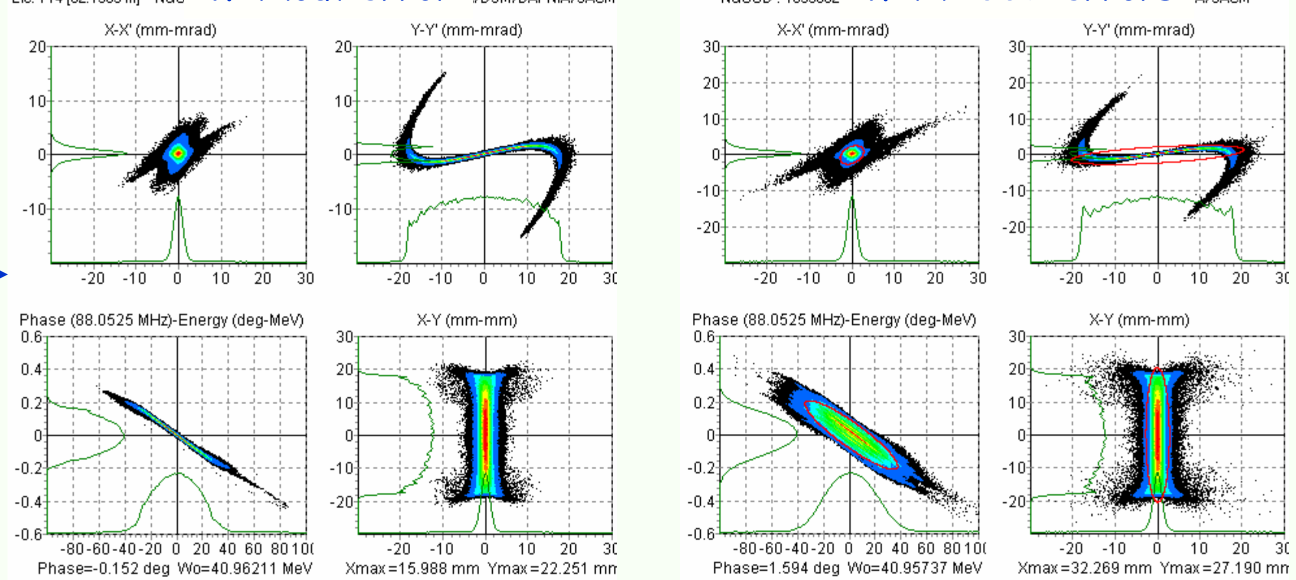
Multi-particle calculation, including beam space-charge, errors (static and dynamic).

Set of 100 linacs, to combine all the errors, each linac simulated with 13000 macroparticles

Matching of the beam, on beam profile monitors (6 are needed in the SC linac, 1 after each of the first 6 cavities)

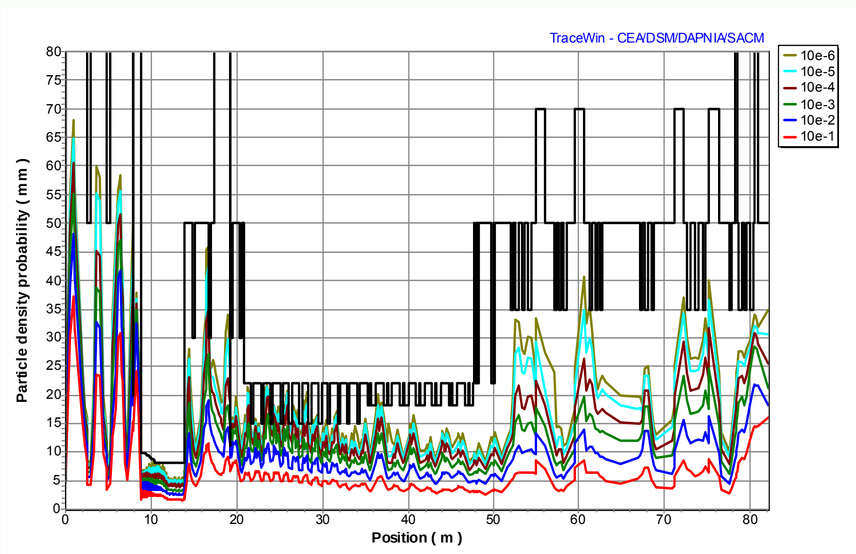
D^+ beam distributions on target →

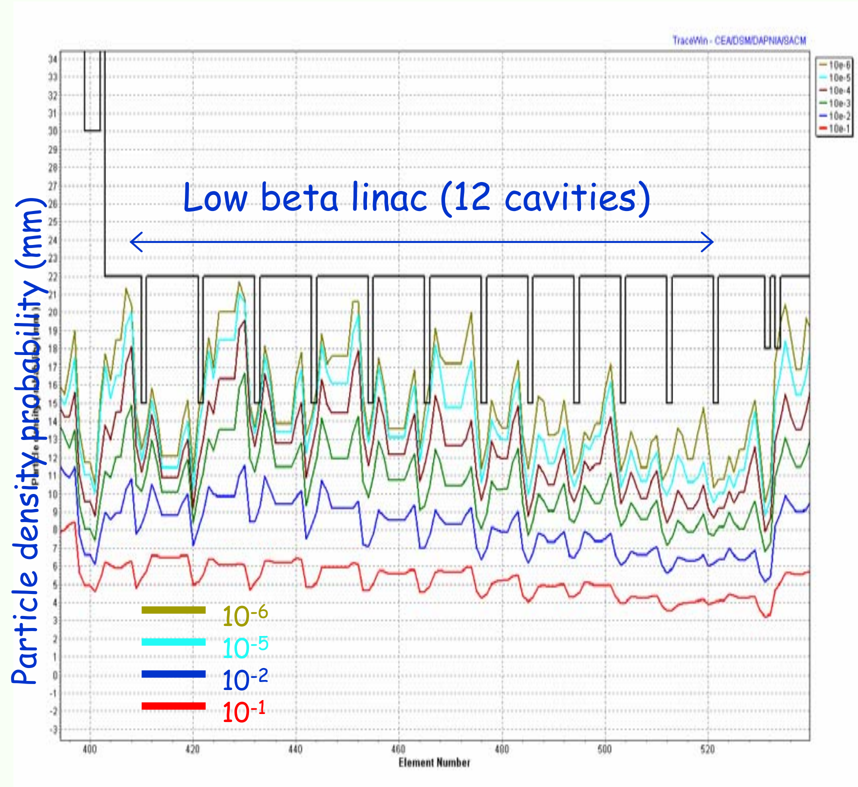
Without error | With 100% errors



Beam Dynamics

Losses in the SC linac with 100% errors:
the first cavities may receive some 0.1 W losses (10^{-6})
0.8 W in one of the first Qpoles
in the 2nd family, 0.1W losses in the 1st cavity





Nest step: add slits in the MEBT to distribute localised losses, and to show that losses in the SC linac can be cancelled with slits in MEBT
Enlarge the beam aperture in the first cavities (presently: ϕ=30mm, can be enlarged, very low gradients in the 9 first cavities)

Deuteron and ion sources

Phoenix ion source

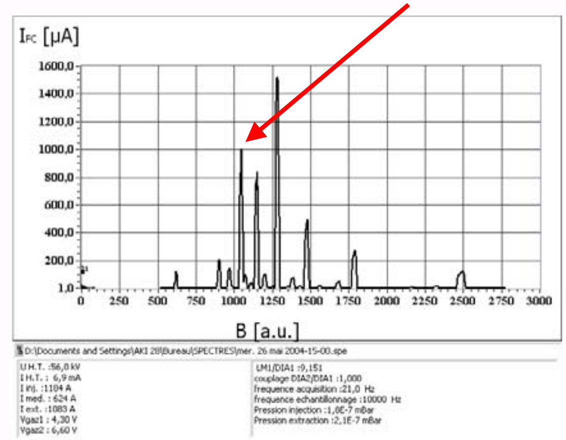
Deuteron source

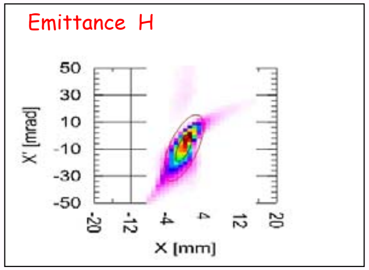
Emittance measurement have been performed on a 4mA beam

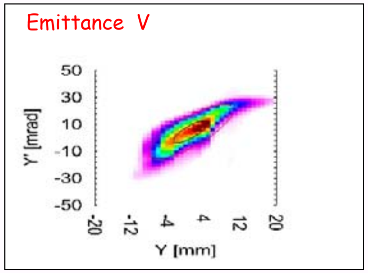
⇨ $\varepsilon_{rms} \approx 0.1\ \pi$.mm.mrad

(cf. poster MOP73)

PHOENIX 28 GHz : high current extraction (Ox)
SPIRAL II nominal beam for $^{16}O^{6+}$ 1 mAe 60 KV $\varepsilon_{H\&V}$ < 0.4 π.mm.mrad





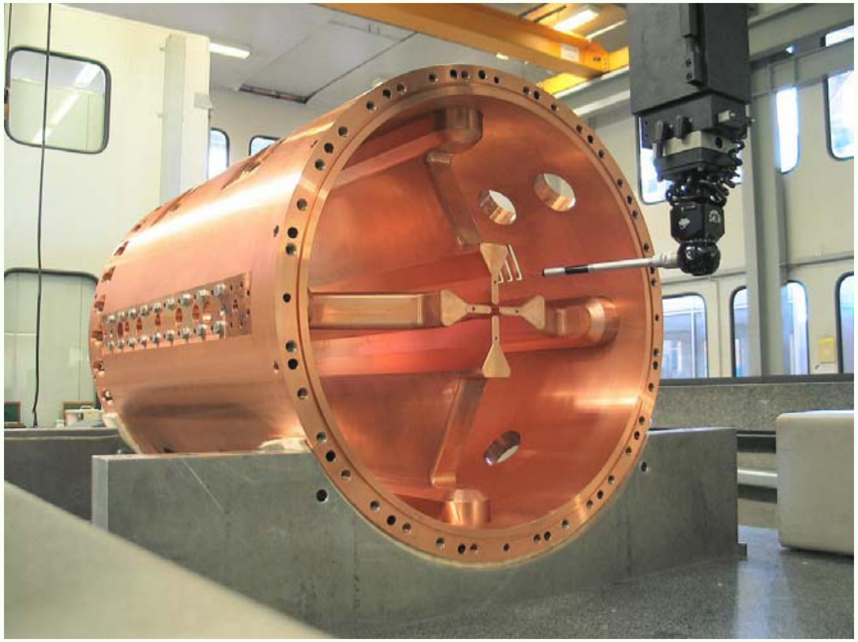


$E_{y\ norm}$ =0.26 π.mm.mrad
$E_{x\ norm}$ =0.18 π.mm.mrad

RFQ

88.05 MHz 4-vane, normal conducting structure, without any brazing, mechanical assembly

Parameter	*Value*
Length	5.077m
Mean aperture R_0	8.1 – 10.0 mm
Vane voltage	100 – 113 kV
Modulation	1 – 1.99
Input rms emittance (π.mm.mrad)	0.2 (D^+) / 0.4 (1/3)
Transverse emittance growth	0
Peak electric field	1.65 kp
Transmission w/o errors	>99.9%
Transmission with errors	99.87%
Input energy	20 keV/u
Output energy	0.75 MeV/u



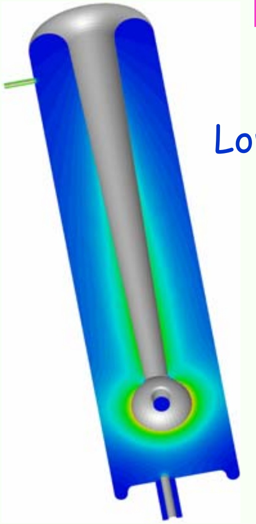
The 1m prototype was tested at low level at CEA/Saclay, last weeks
It will be transported to LNS-Catania next week, to perform full power tests in September

Superconducting linac

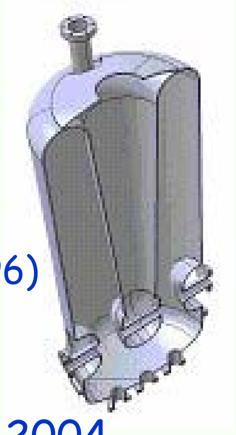
	Low beta	High beta
Optimal β	0.070	0.12
E_{peak}/E_{acc}	5.00	5.54
B_{peak}/E_{acc} (mT/MV/m)	8.75	10.1
Operating E_{acc} (MV/m) ($\beta\lambda$)	6.5	5. to 6.5
R_s/Q (Ω)	632	520
Quality factor Q_0	$2.2\ 10^9$	$1.7\ 10^9$
Cavity losses (@ E_{acc}=6,5 MV/m) (W)	1.75	8.2
Gasket losses (@ E_{acc}=6,5 MV/m) (mW)	26 mW	

88.05 MHz
Short cryostats (1 or 2 cavities)
Normal conducting Qpoles
No steering effect compensation

Prototypes under construction



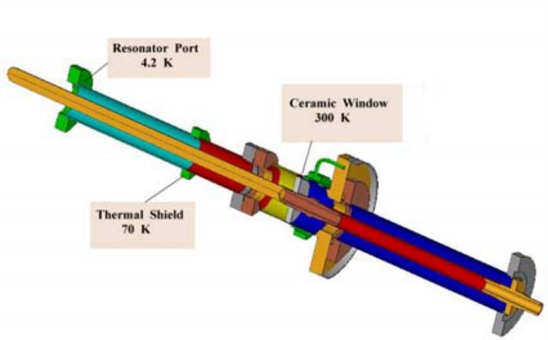
Low beta cavity



High beta cavity
(cf. poster TUP96)

Tests planned in November 2004

Same power coupler for both cavities (≠ antenna penetration)
Both types, disk and cylinder ceramics are under construction

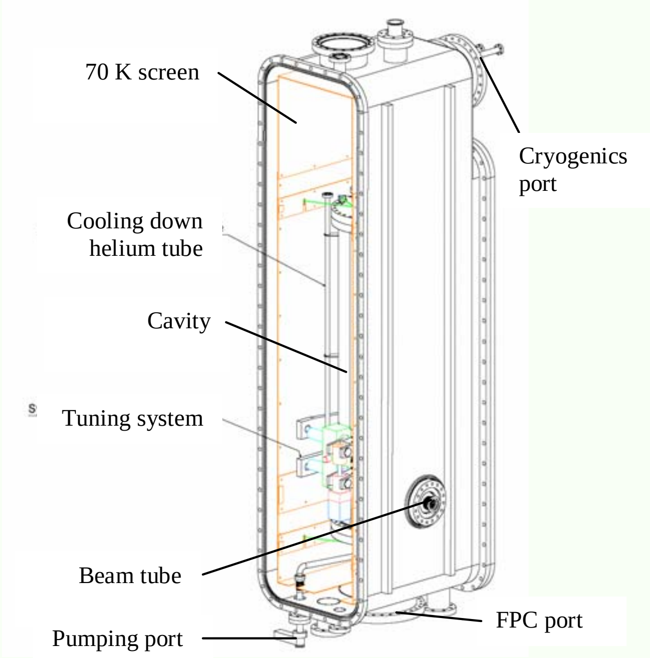


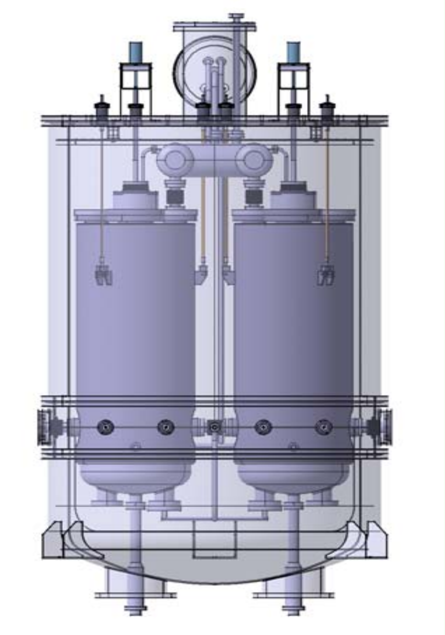
Coupler with ceramic disk window

Tests planned in early 2005

Superconducting linac

Low beta family cryostat

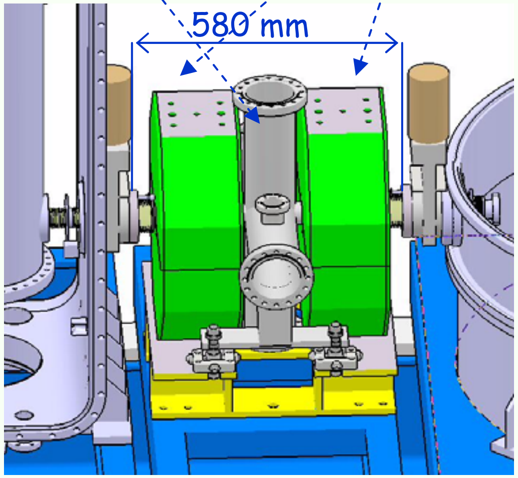




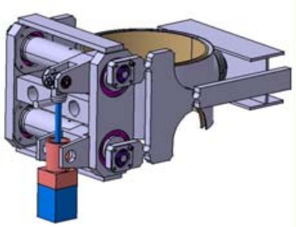
High beta Family cryostat

Diagnostic box

Warm Qpoles



Intertank normal-conducting section

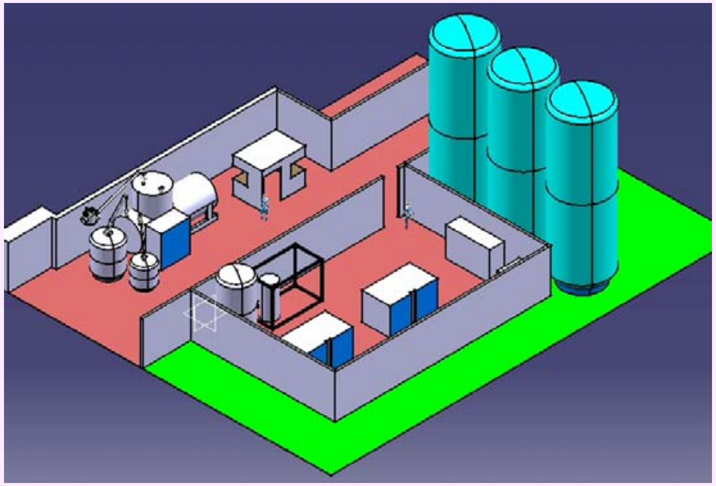


Tuning system for the low β cavity:
The cavity is deformed in the direction perpendicular to the beam axis

RF systems

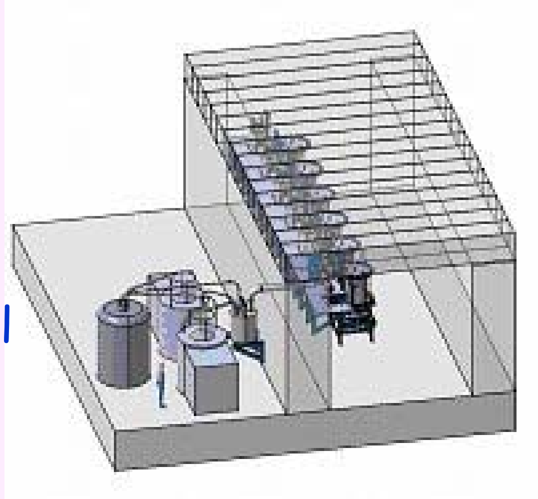
- solid state technology chosen for the SC linac: 1kW modules will be combined according to the power needed for each cavity (ranging from 1 to 13 kW)
- Low lever RF based on digital solution, to fit the requirements of all the cavity types, RFQ, SC linac, normal conducting bunchers

Cryogenics

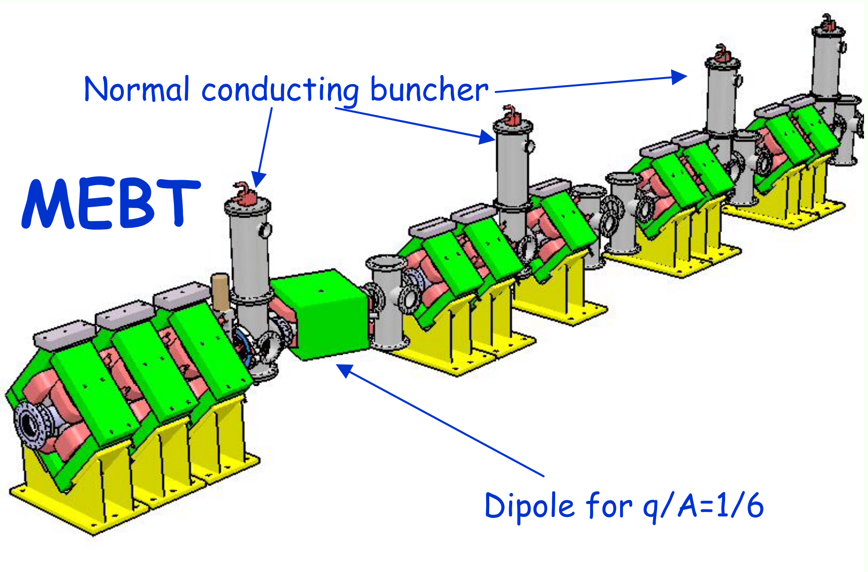


Liquefier power:

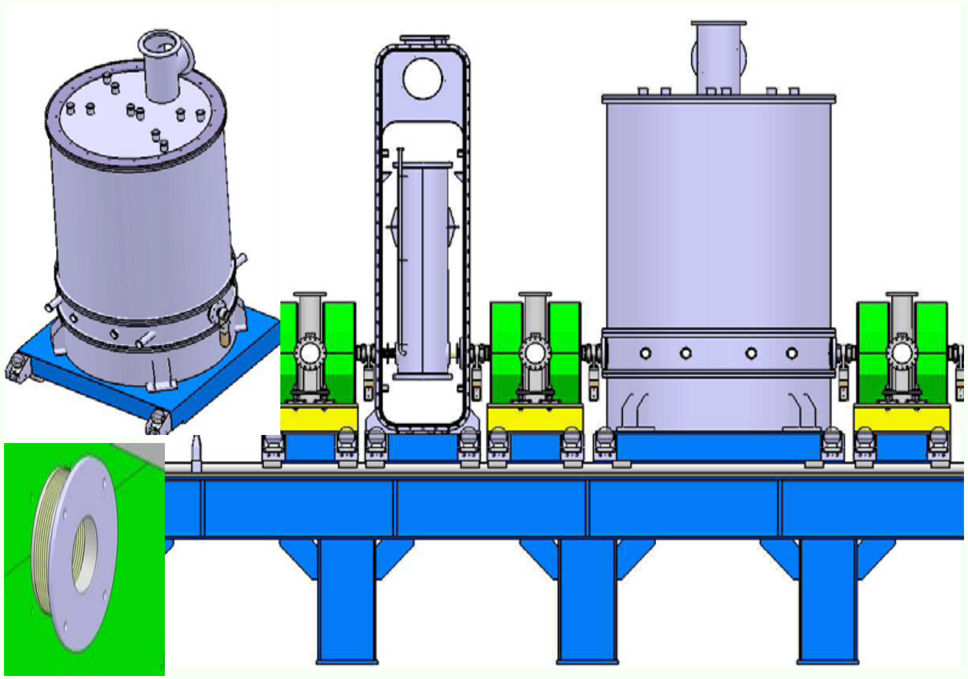
- 900W @ 4K (needed: 570W)
- 2000W @60-80K
- 10l/h for external users



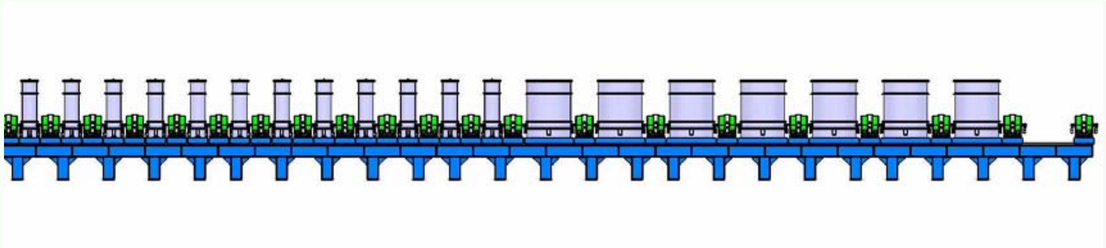
Mechanical layout

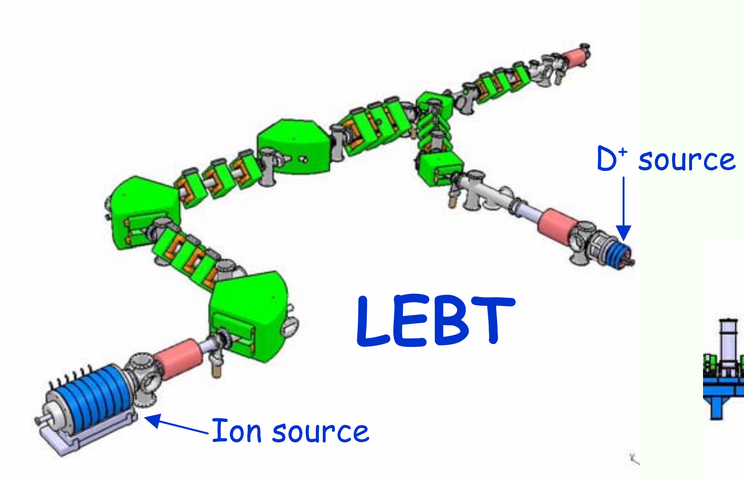


Cryomodule mounting



SC linac



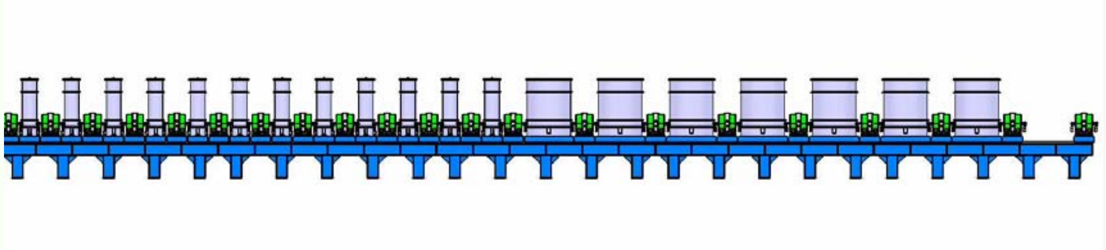


Conclusion

-Cavity prototype (RFQ, QWRs) test results planned for 2004 last term

-Final design to be frozen for the end of year 2004

-Waiting for project construction decision.....



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Spiral2 detailed design study started at the end of 2002.
It is a collaboration between:
CEA/DAPNIA/SACM,SIS,CEA/DPTA
CNRS/IN2P3/IPNO,IRES,LPC Caen, LPSC
GANIL-CEA/CNRS

and,

special thanks to Argonne and Legnaro accelerator experts for all fruitful discussions, for their help and advice.