Report on the development of the high intensity RFQ Cooler SHIRaC for DESIR@Spiral2

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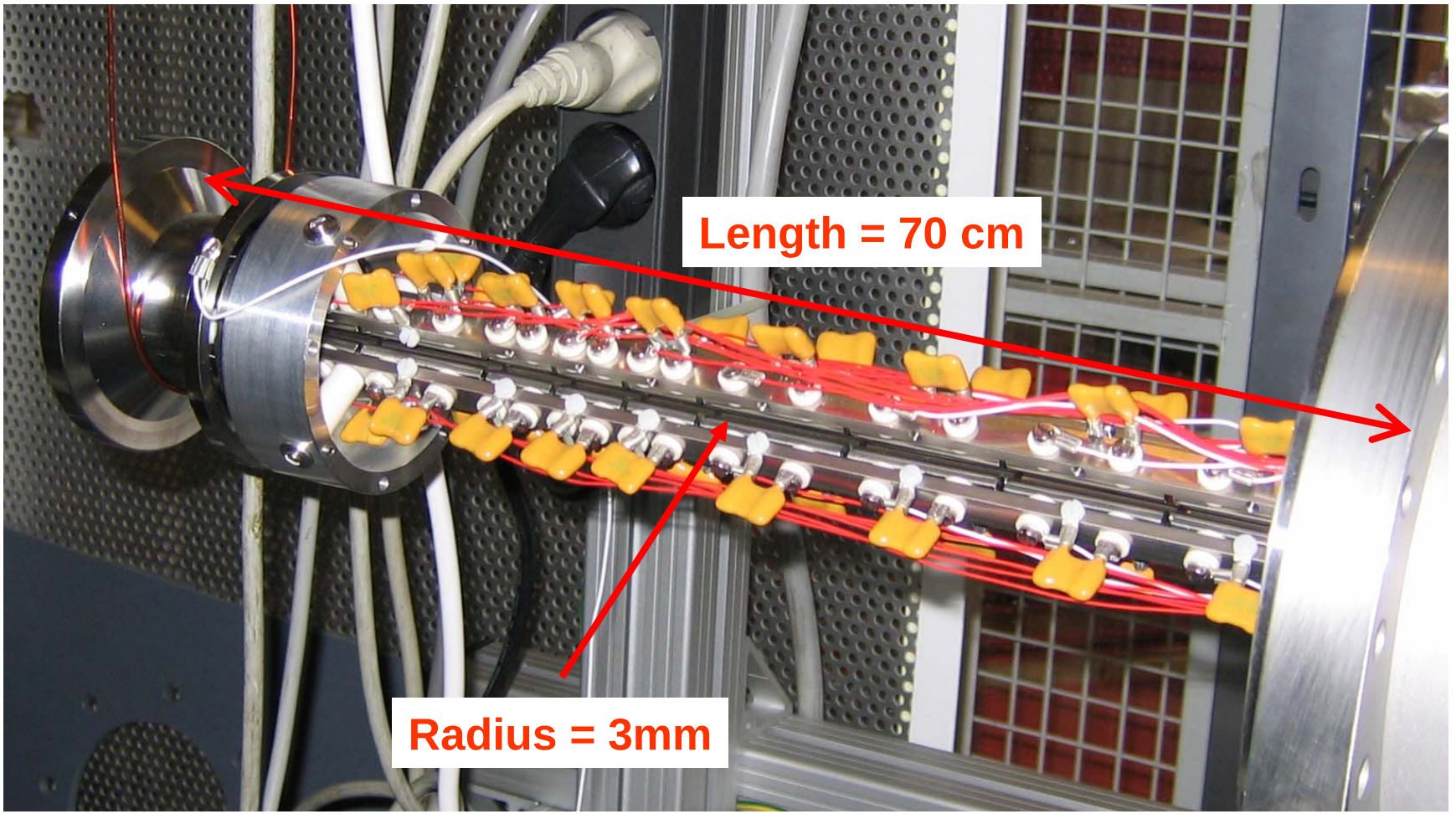
Context

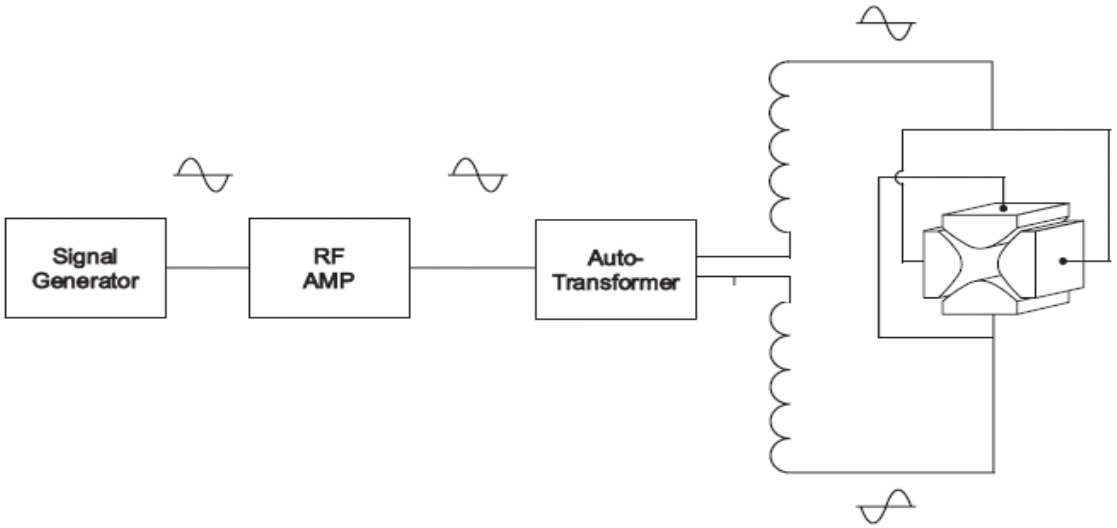
- SHIRaC : Spiral 2 High Intensity Radiofrequency Cooler
  - Emittance reduction by buffer gas cooling for HRS
- Few examples of RFQ existing in Europe
  - LPCTrap, Ganil *(G. Ban & al., NIM A 518, 712, 2004)*
  - SHIPTrap, GSI *(G. Marx & al., Hyp. Int. 132, 463, 2001)*
  - ISCool, ISOLDE *(I. Podadera & al., EPJ A, 710, 2005)*
- Requirements :

	Current technology	SHIRaC
Emittance	~ 2 π.mm.mrad	> 1 π.mm.mrad
Intensity	few nA	few µA

SHIRaC Phase I



The RF system



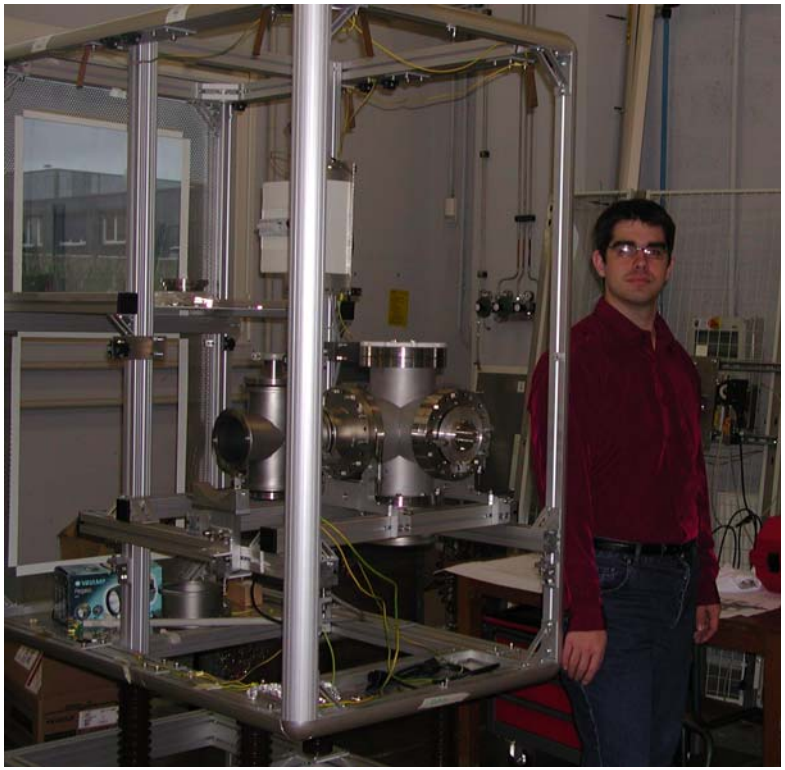
	Current technology	SHIRaC	Current SHIRaC performances
V_{RF}	$250V_{0p}$	$5000V_{0p}$	$320V_{0p}$
f_{RF}	0.3-2MHz	8-12MHz	5.5MHz

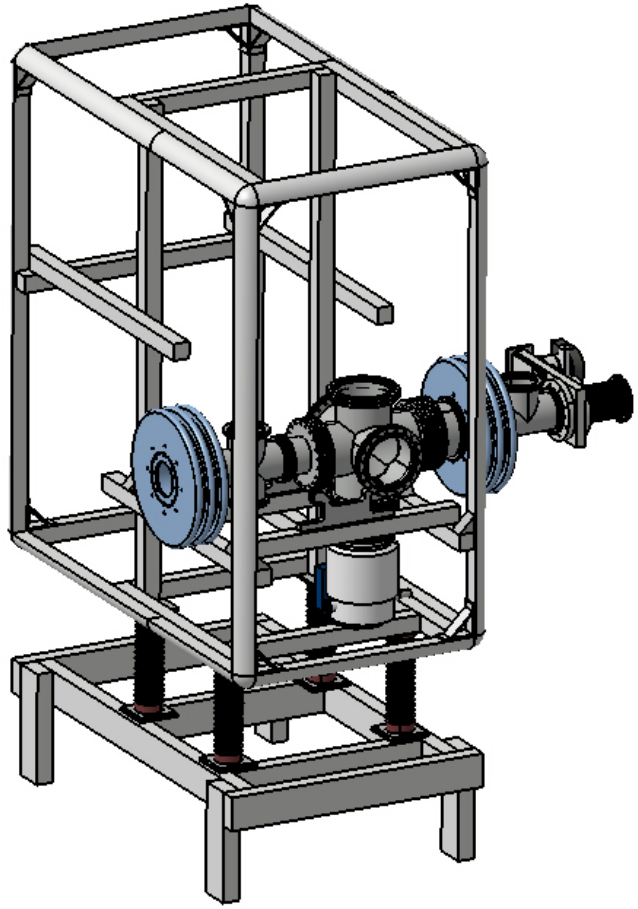
Status

- CSNSM/McGill cooler is at LPC- Caen
- Has been partially tested at Orsay
- Set-up and modifications in progress

- Next tests scheduled to start in January
  - Transmission studies, emittance, etc …
  - Test at few nA with ionization source
  - Test at few µA with ECR source + magnet

Status





Simulation tool

- We use a new simulation tool with space charge
  - MC simulation of cooling
  - Space charge
  - Electric field
- Still Simion is use as a first order tool (faster and still reliable)
- MC code to validate final design

Simulation tool

- Cooling model :
  - Microscopic approach
  - The “realistic potential”
  - McDaniel & al. (1973)

$$V(r) = \frac{B_n}{r^n} - \frac{A_6}{r^6} - \frac{A_4}{r^4}$$

➢ Validation with experimental data

- Space charge model:
  - Space charge electric field
  - Gauss Theorem

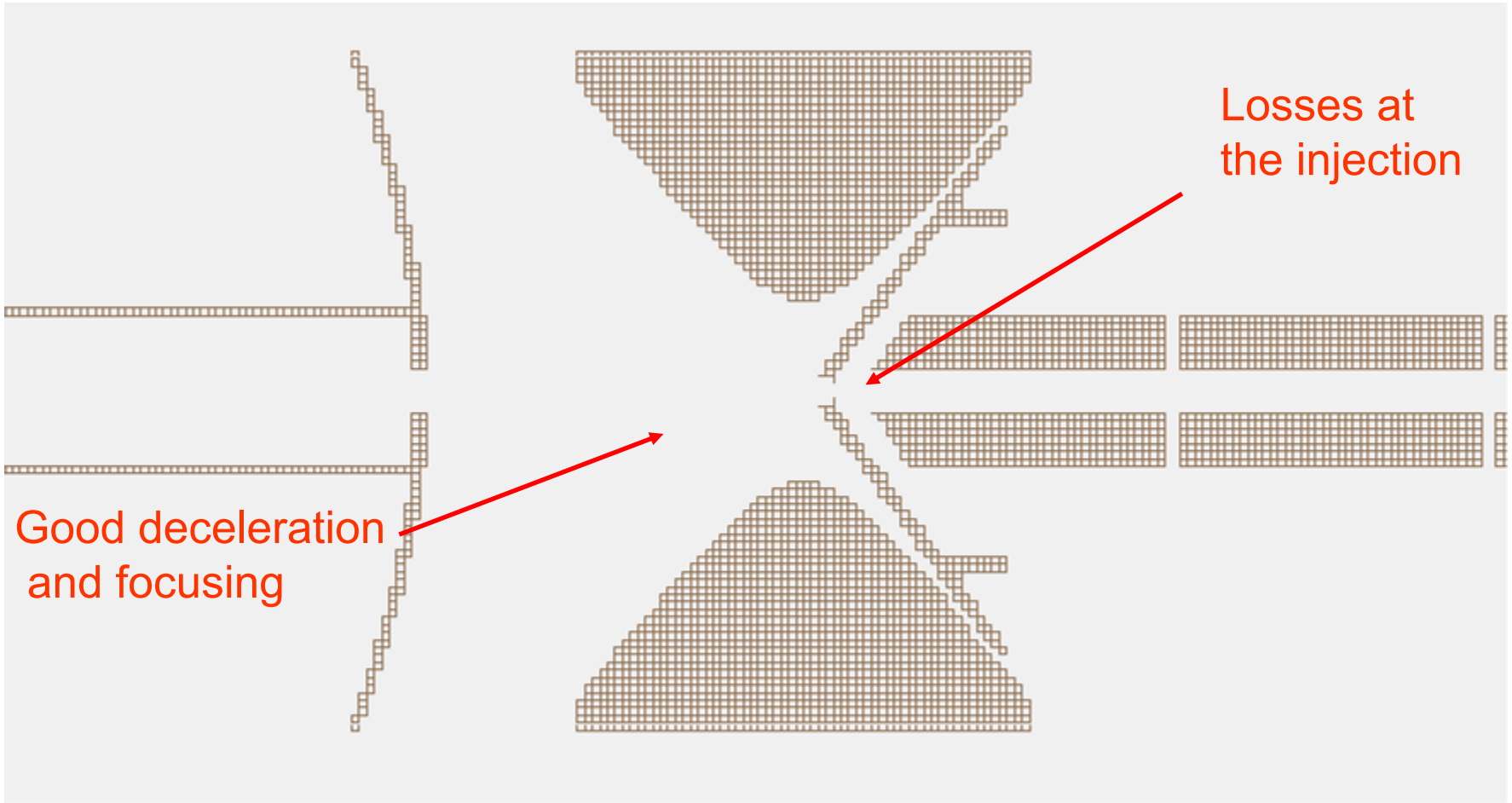
$$E_{SC}(r) \propto \frac{I.r}{2.\pi.\varepsilon_0.v.r_0^2}$$

➢ Validation with Simion beam repulsion

Numerical predictions for SHIRaC I

- Input beam : $^{133}Cs^{+}$ beam
  - Emittance : 75π.mm.mrad
  - Energy : 20keV
  - Intensity : 1μA
- Cooling distance at 0.05mbar ~ 400mm
- Output emittance > 1π.mm.mrad
- Injection efficiency ~ 25 %
  - Good deceleration and focusing
  - Losses due to the ion injection in the quadrupole

Numerical predictions for SHIRaC I



SHIRaC I vs SHIRaC II

- Two cooling sections with different r_0-radius
- 5 mm and 3 mm + 4mm junction
- Same RF on the two sections
- Better injection efficiency (~ 100%)
- Same cooling effect
- Same emittance
- Better overall efficiency
- Should be tested in 2009

Summary

- SHIRaC : RFQ Cooler for emittance reduction
- First prototype :
  - Design at CSNSM and partially tested
  - Simulated
  - Installation and modification in progress
  - Next tests scheduled to start in January at LPC-Caen
- Phase II
  - New design
  - Development of the electronics
  - Tested in 2009

Thanks for your attention

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