SPIRAL II HIGH INTENSITY RADIO FREQUENCY COOLER

a.k.a. SHIRaC

STATUS REPORT

SHIRAC COLLABORATION

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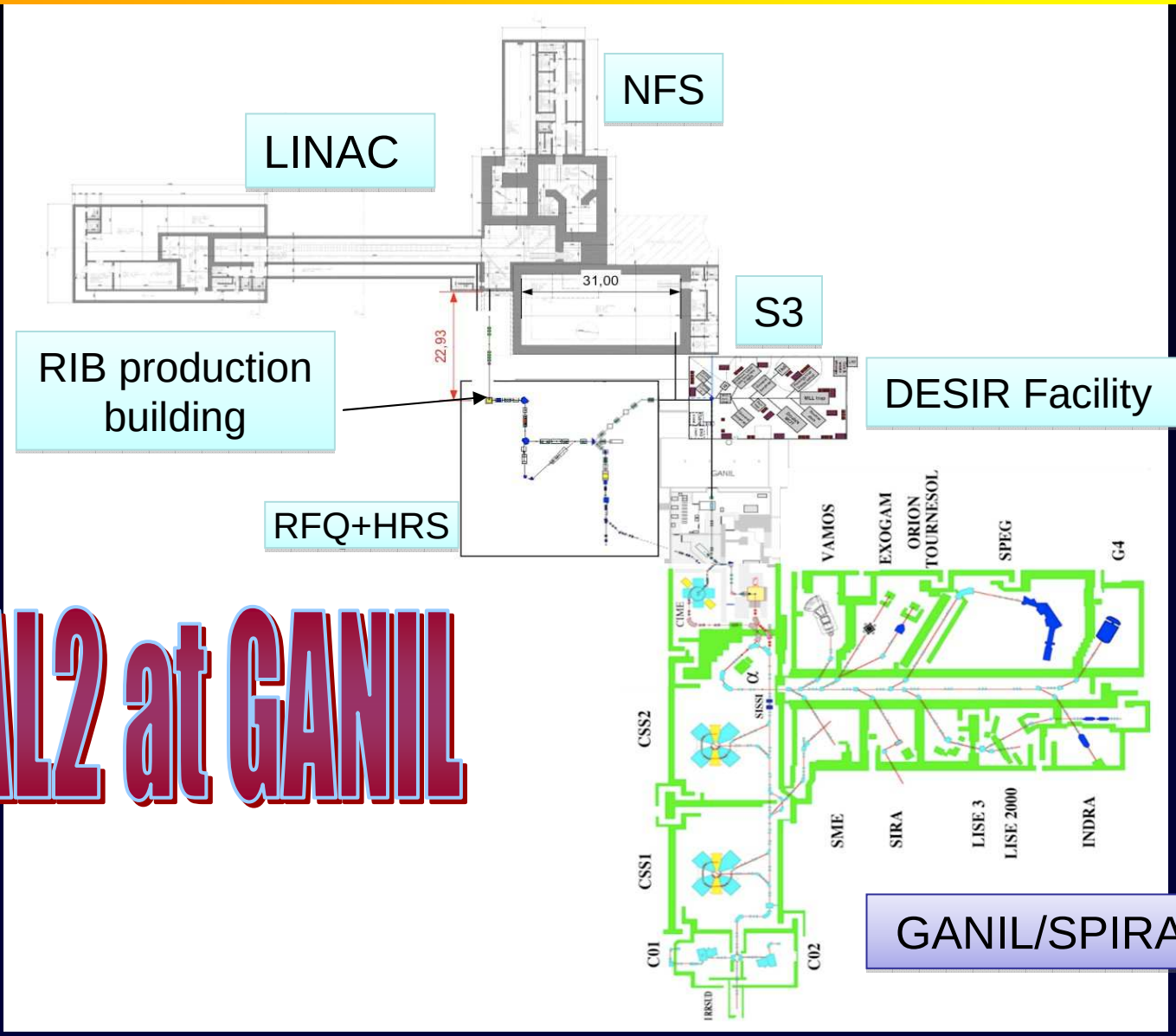
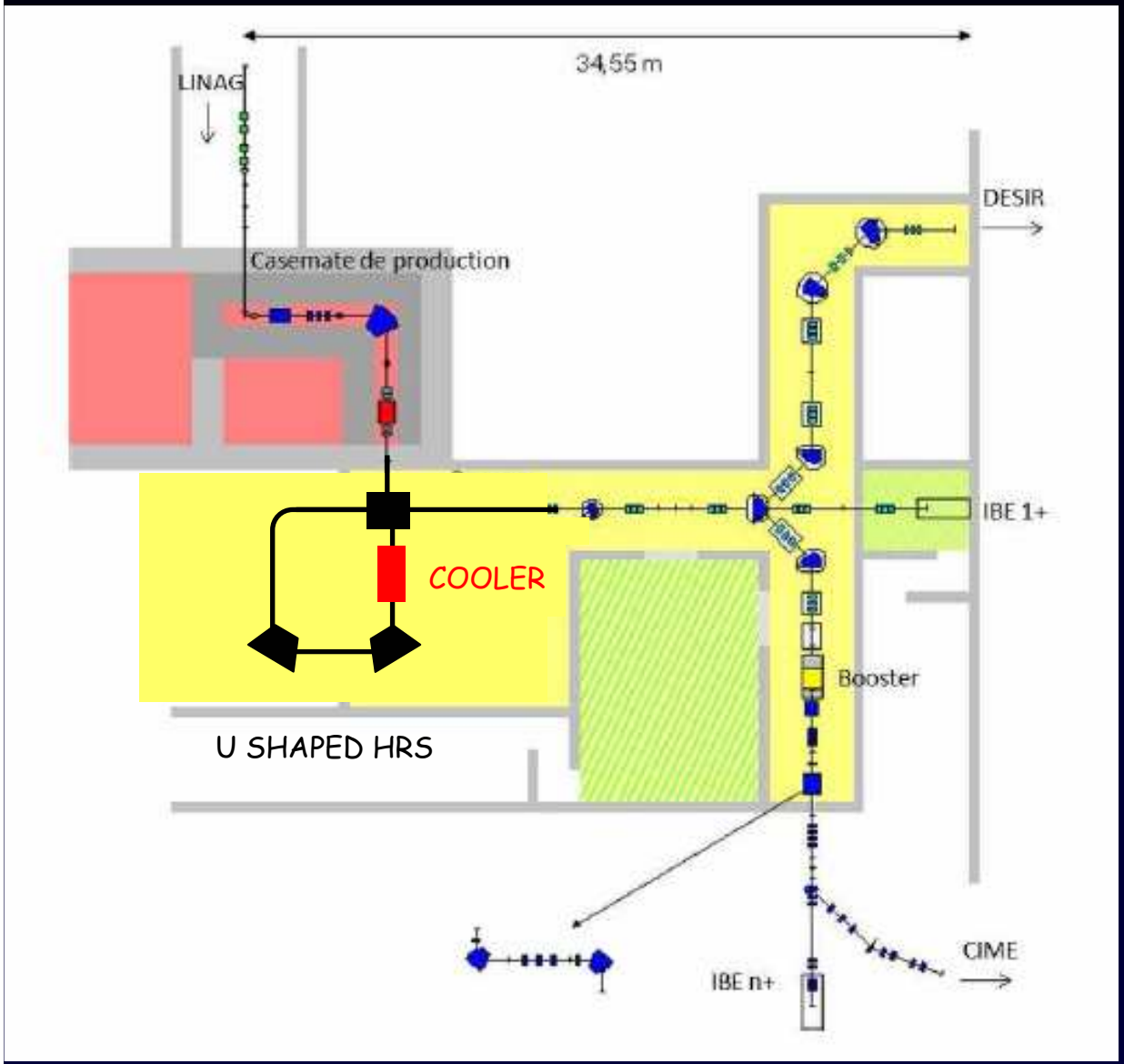
OUTLINE

- DESIR@SII
- Why/how cooling ?
- Status and recent results
- 2010
- Conclusion

DESIR@SII


NFS
LINAC
31,00
S3
22,93
RIB production building
DESIR Facility
RFQ+HRS
SPIRAL2 at GANIL
VAMOS
EXOGAM
ORION
TOURNESOL
SPEG
G4
CIME
SISSI
CSS2
SME
SIRA
LISE 3
LISE 2000
INDRA
CSS1
C01
C02
IRSTD
GANIL/SPIRAL 1

Why & How Cooling the beam?



COOLER and HRS are « part » of SPIRALII Phase II and included in the production building

WHY & HOW COOLING the beam?

- Requirements for High Resolution Spectrometer (HRS):
  low emittance to reach best performances

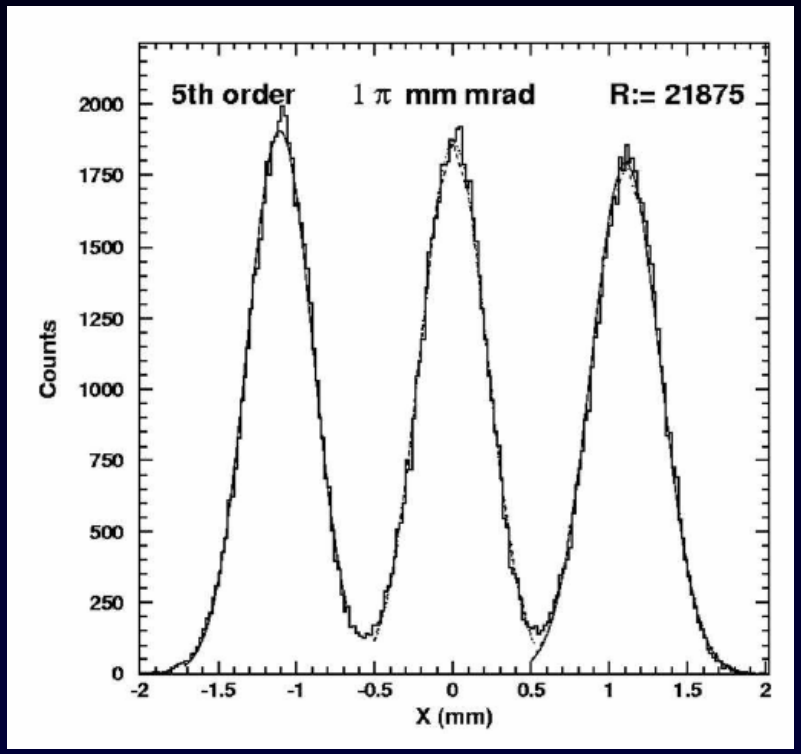
  HRS needs ~1 π mm mrad
  Ion source (ECS) ~ few 10 π mm mrad

- BUFFER GAS TECHNIQUE + RF for beam guiding
  (R.B. Moore O. Gianfrancesco NIM B 204 203) Many running around the world

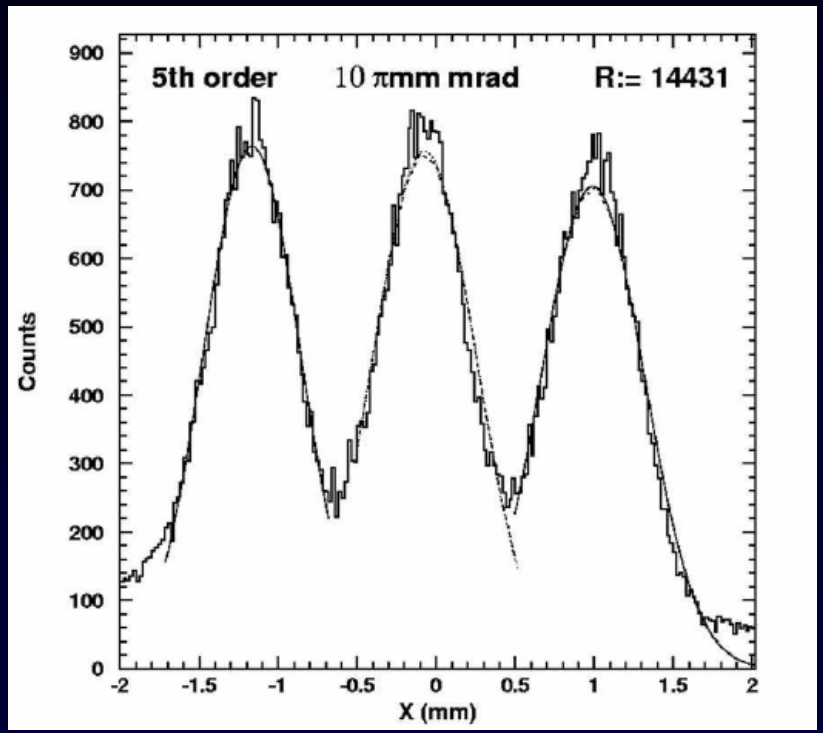
- The new challenge: Cooling of high intensity beams (μA)
  with high transmission

Beam emittance and resolving power

Calculation by T. Kurtukian Nieto
(With OLD HRS configuration)



R ~22000



R ~14400

STATUS

Decay, excitation, and storage of radioactive ions
DESIR
Désintégration, excitation et stockage d'ions radioactifs

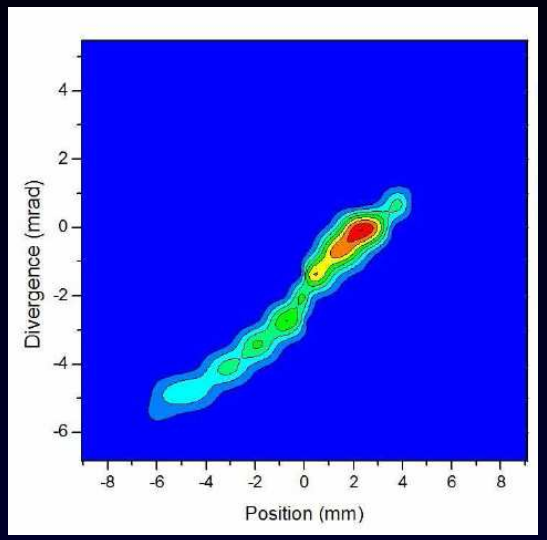
Work achieved in 2009-2010

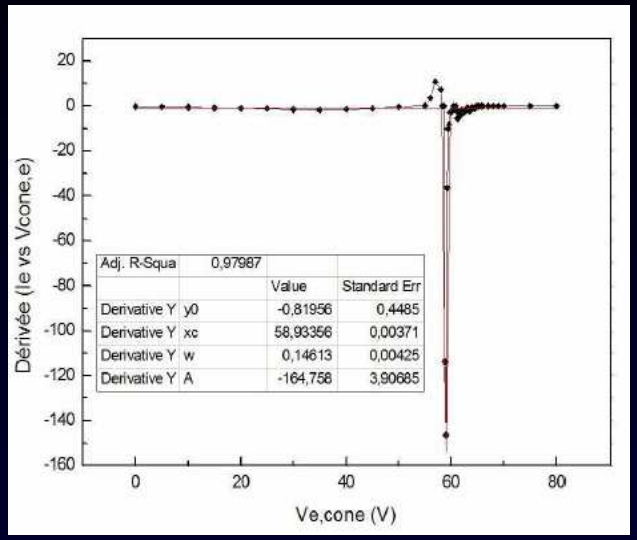
- Last tests on the modified prototype I (transmission & emittance measurements)
- Manufacturing of New Cooler
- Improved RF system
- Slow control
- New Cooler set up at LPC
- Since SII week set up at LPC, new design for breakdowns, simulations for coupling with HRS

Last Tests with SHIRAC I (PhD Thesis F. Duval 2009)

Alkali Ion gun 3keV
I = 25 nA

RF: 1800 Vpp @5MHz
He : 0. 5Pa
HT = 2900V

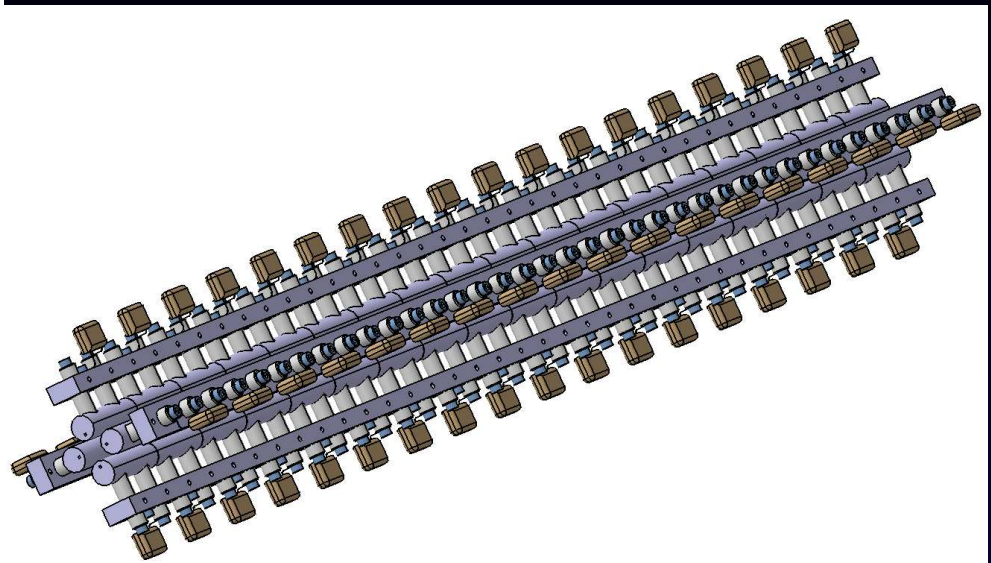




ε=2 pi mm mrad @ 60 keV
ΔE = 0.145 eV
Transmission = 25%

- very promising results (to be confirmed with prototype II and higher intensity)
- good agreement with simulations (space charge & Microscopic approach)
- simulations show that the transmission is limited by the acceptance (r_0)

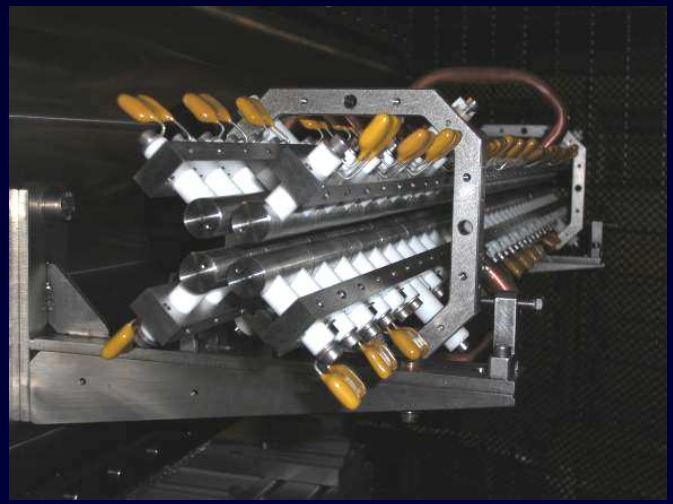
New cooler manufacturing and assembling (end 2009)

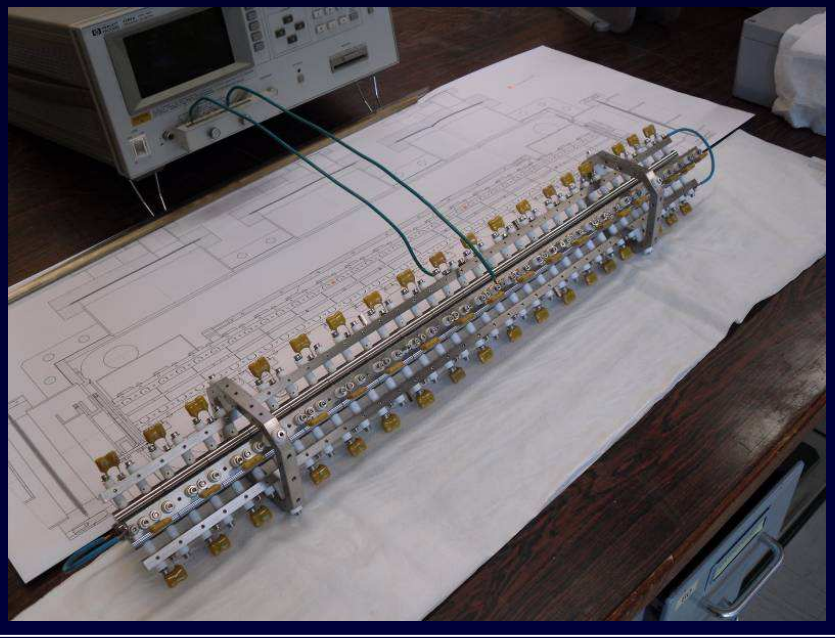


Simulated with
SC & Microscopic approach

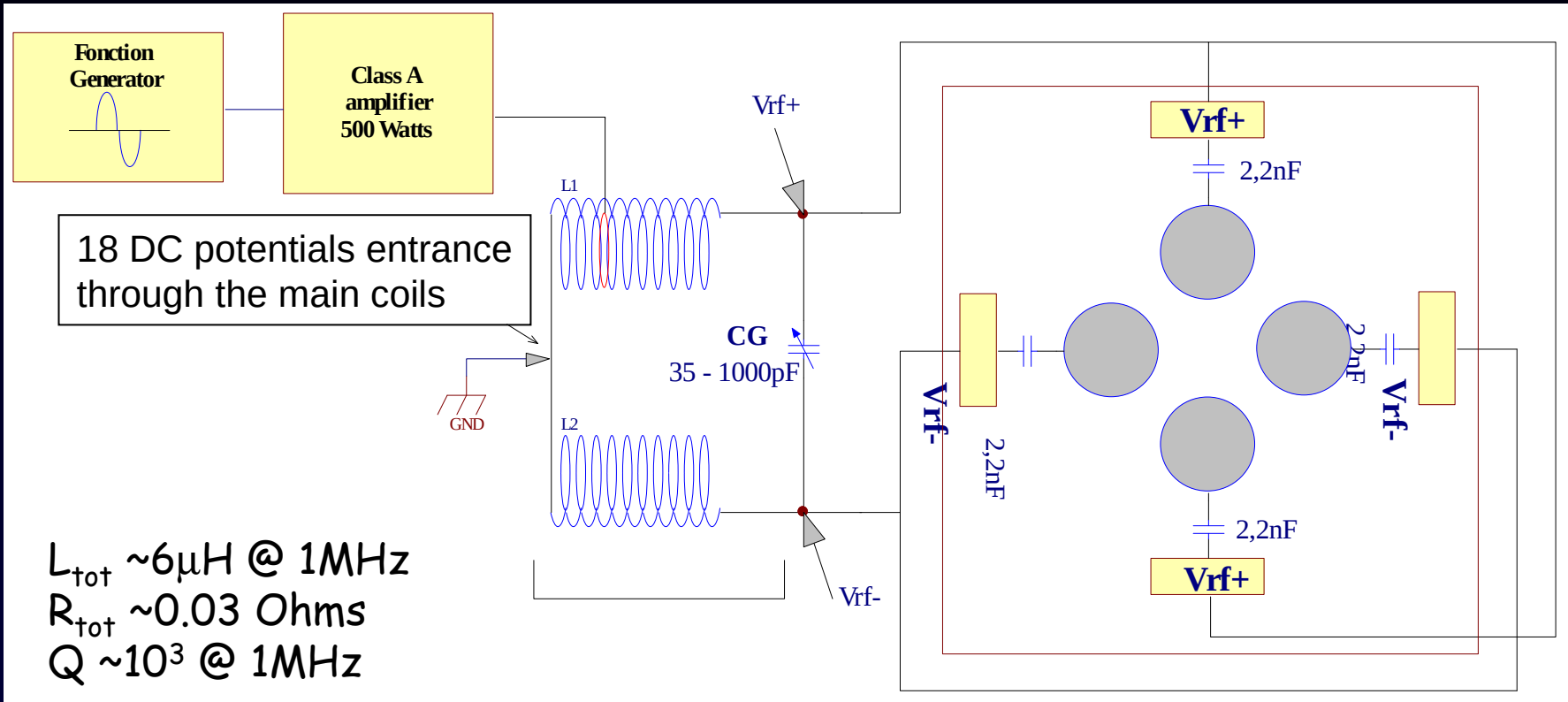
→ Requirements:

700 mm long
R_0=5 mm
10 MHz RF
10 kV_{ptp}



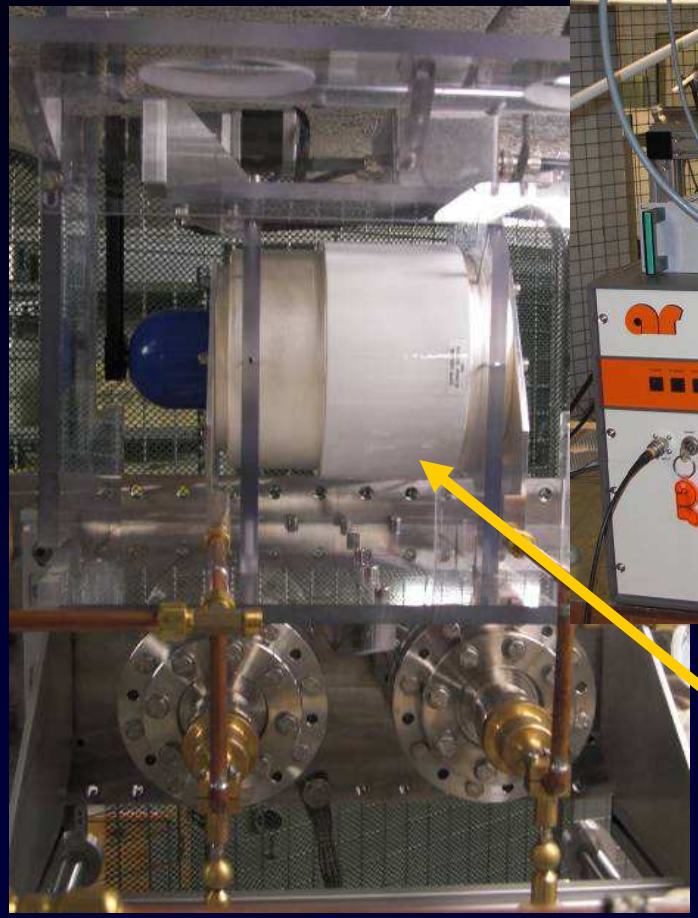


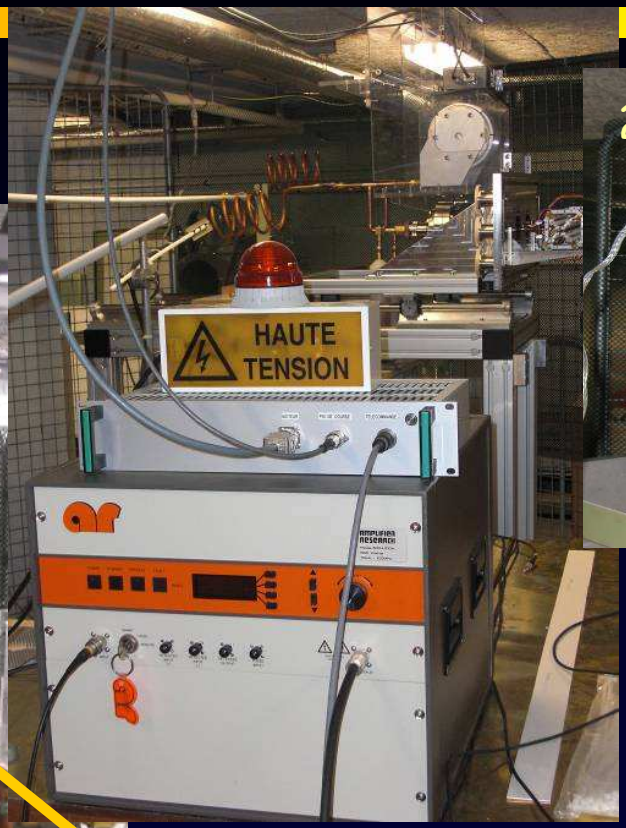
RF system layout

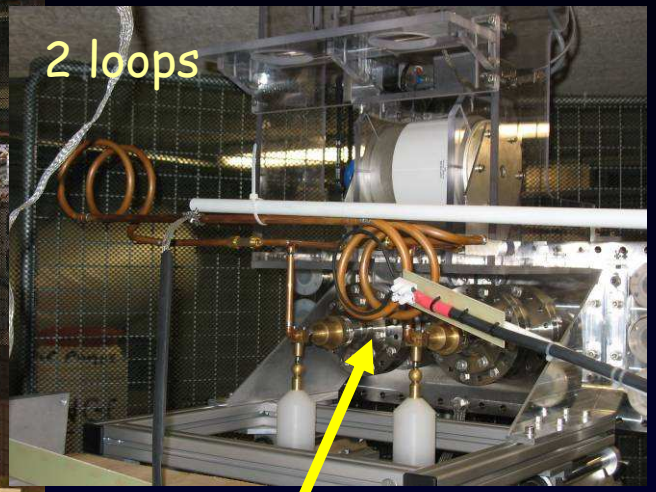


- Resonance Frequency tunable via adjustable capacitor
- No ferrite cores for the inductive coupling with amplifier
- DC potentials for the segments guided inside the coils (no HV filters)
- Asymmetries compensated mechanically by translation of middle point

High Voltage RF Developments



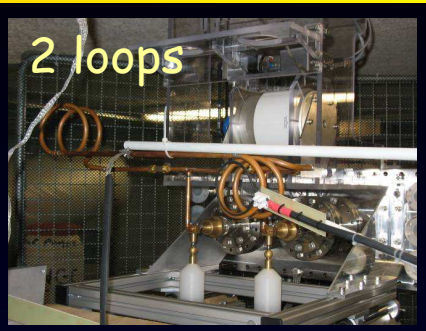


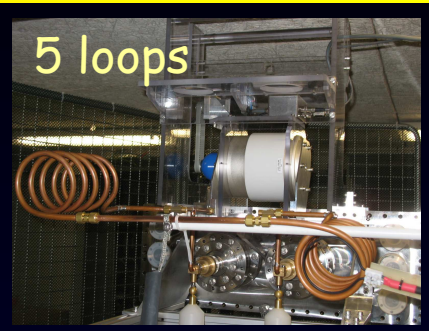


- 500 W amplifier
- Resonant circuit with Inductive coupling (no ferrite cores)
- Tunable capacitor for broadband use

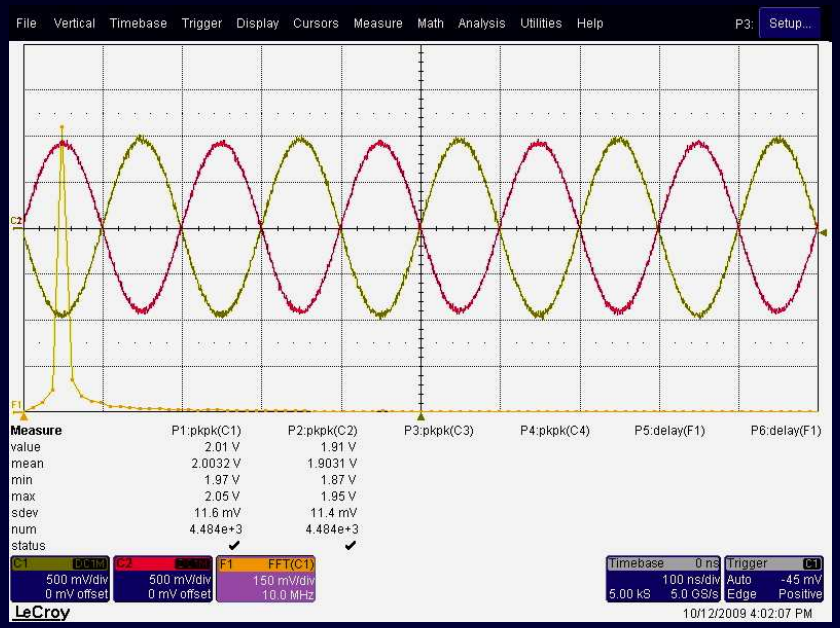
RF performances and limitations

- 9 MHz 5.8 KV 2 loops secondary





- 6.5 MHz 8 KV 5 loops secondary
- Highly Harmonic



- <u>Present limitations:</u>
  → INSULATOR Breakdown at ~8 kV…

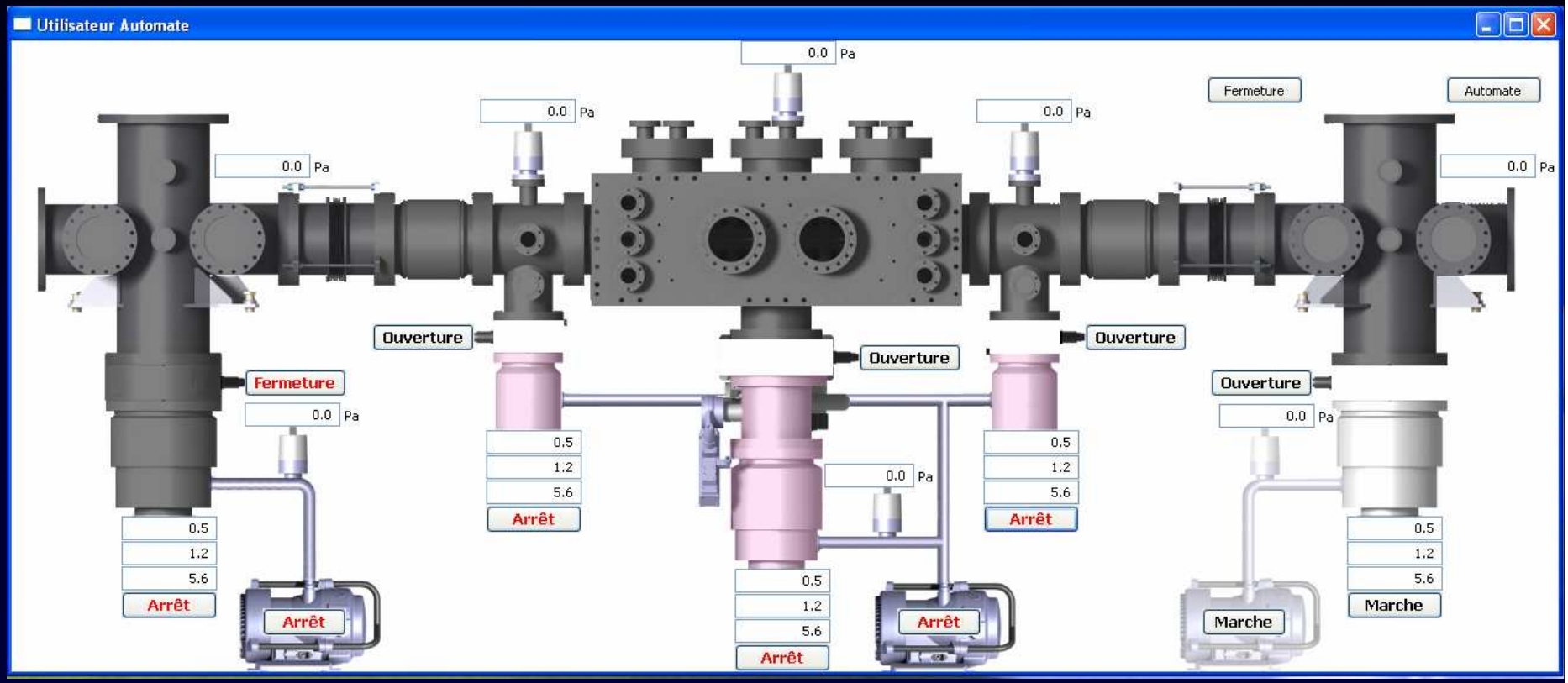
Investigations underway → improved design and new materials needed (PEEK)

Insulator burning VRF~8 kV

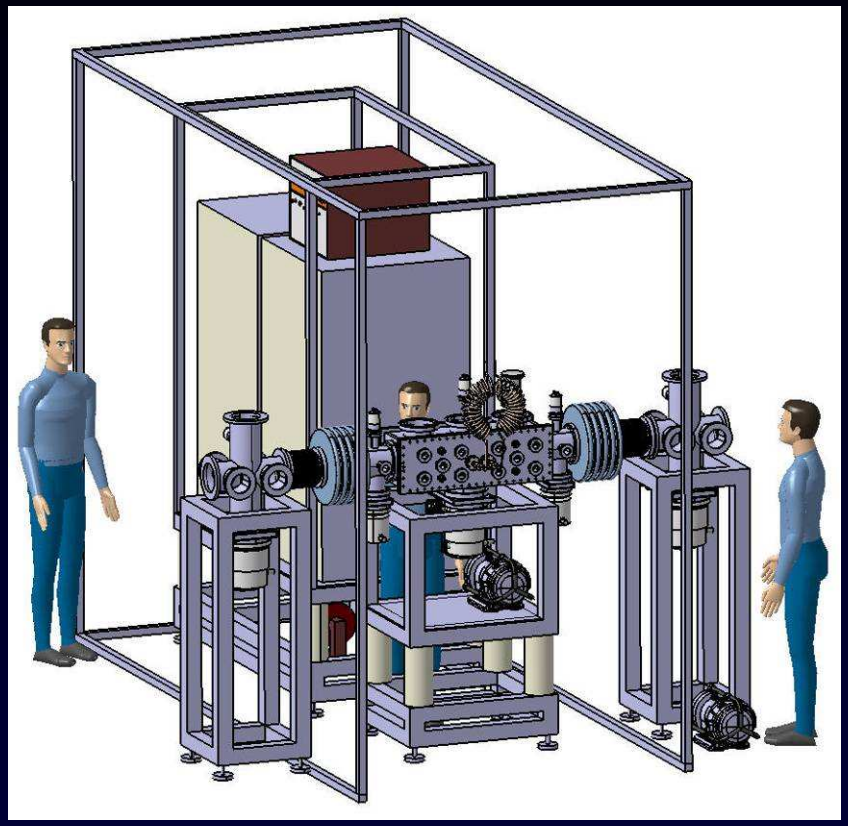
~7 mm

New design larger gap/frame for higher HV
Open frame for better RF coupling
Very few data in this range of RF voltage
Other material PEEK (Poly Ether Ether Kepone) will be tested

Slow Control (vacuum system, RF, DC, gas…)



LPC SET UP in 2010



From Drawings to reality…

To be done…

- Completed in July 2010
- Test with high intensity beams soon

other studies

Because of gas flow Extraction and Injection region are critical
Simulations show that under 10^{-4} mbar T>65%
Additional pumping and by passes added in these regions to decrease gas diffusion

↓

For 5 10^{-2} mbar in the cooler
injection and extraction ~5 10^{-5} mbar

Coupling with HRS Simulations of EINZEL lens located at 1 m from the extraction
Different designs give parralell or focused beam 1 m away

Work underway…

Nuclear environment

Cooler should be the most irradiating part in the yellow zone

Mechanical design for confinement
→ double valve OK
→ anti sismic frame OK

Maintenance : minimize part failure, internal electronics simplification
Segmented rod → one single resistive rod ?

Gas : recycling Helium ?

Two identical coolers ?

Overview and outlook

Work on a 1st prototype
Emittance within requirements
Transmission (25%) limited by acceptance

- RF system ~ OK, higher HV and RF requires new design and new materials
- Construction of SHIRaC , mechanics, slow control, vacuum system, safety, RF system…
- Setup completed in JULY 2010
- Couplings with HRS underway
- Cooling of μA beams For HRS requirements to be confirmed in 2010-2011
- Nuclear environment

THANK YOU FOR YOUR ATTENTION