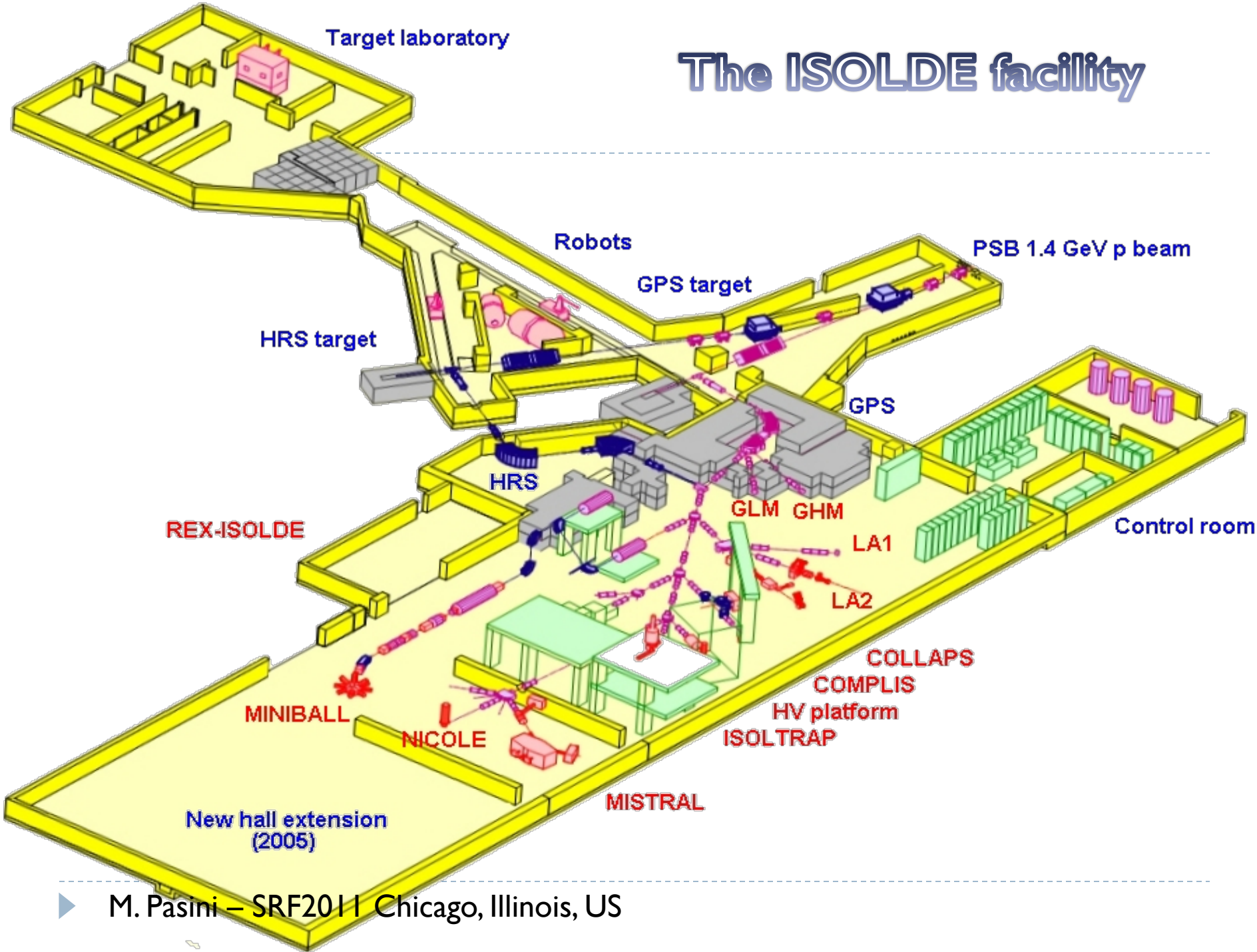
HIE-ISOLDE Quarter Wave Nb/Cu Cavity

M. Pasini, SRF2011 Chicago, Illinois, US

Overview

- HIE-ISOLDE project
- Choice of the geometrical parameters
- RF design parameters
- Steering compensation
- Multipacting simulation
- Nb Sputtering
- First Tests results
- New mechanical design
- Cryomodule design
- Summary

The ISOLDE facility

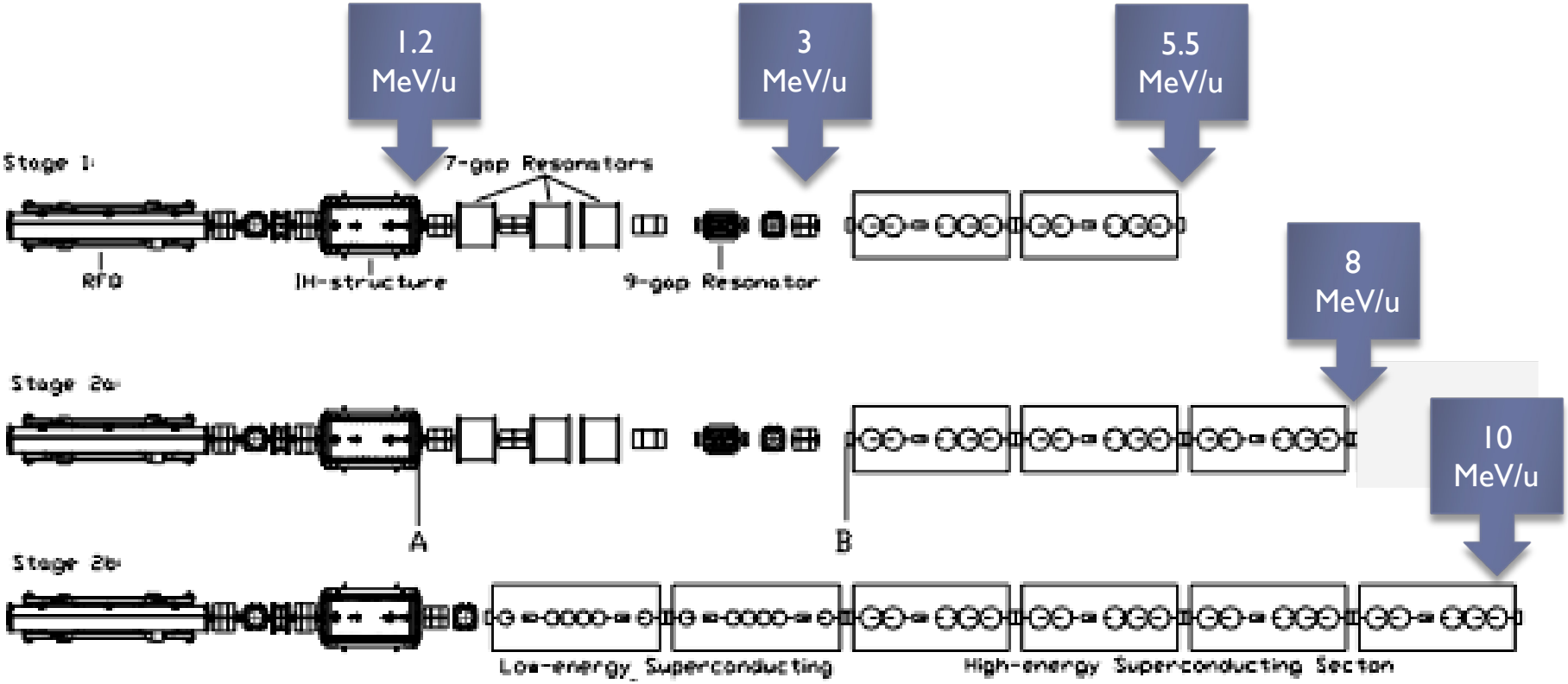


HIE-ISOLDE SC-linac

- SC-linac between 1.2 and 10 MeV/u
- 32 SC QWR (20 @ β_0=10.3% and 12@ β_0=6.3%)
- Energy fully variable; energy spread and bunch length are tunable. Average synchronous phase ϕ_s= -20 deg
- 2.5<A/q<4.5 limited by the room temperature cavity
- 16.02 m length (without matching section)
- No ad-hoc longitudinal matching section (incorporated in the lattice)
- New beam transfer line to the experimental stations

HIE-ISOLDE LINAC - layout

3 stages installation



QWR cavities (Nb sputtered)

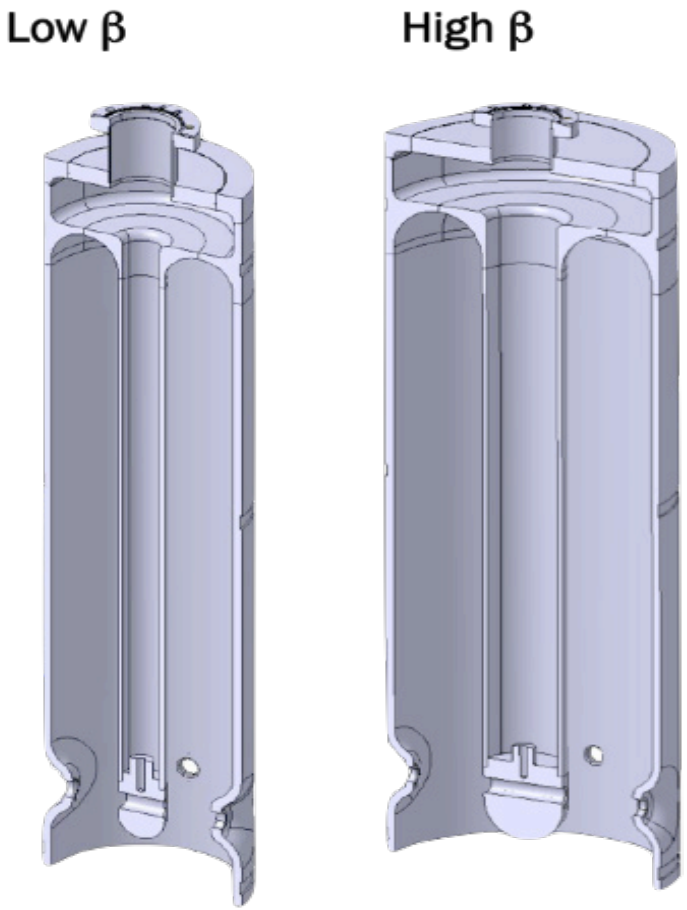


Table 1: Cavity design parameters

Cavity	**Low β**	**highβ**
No. of Cells	2	2
f (MHz)	101.28	101.28
β_0 (%)	6.3	10.3
Design gradient E_{acc}(MV/m)	6	6
Active length (mm)	195	300
Inner conductor diameter (mm)	50	90
Mechanical length (mm)	215	320
Gap length (mm)	50	85
Beam aperture diameter (mm)	20	20
$U/E_{\mathrm{acc}}{}^2$ (mJ/(MV/m)^2	73	207
$E_{\mathrm{pk}}/E_{\mathrm{acc}}$	5.4	5.6
$H_{\mathrm{pk}}/E_{\mathrm{acc}}$ (Oe/MV/m)	80	100.7
R_{sh}/Q (Ω)	564	548
$\Gamma = R_{\mathrm{s}} \cdot Q_0$ (Ω)	23	30.6
Q_0 for 6MV/m at 7W	$3.2 \cdot 10^8$	$5 \cdot 10^8$
TTF max	0.85	0.9
No. of cavities	12	20

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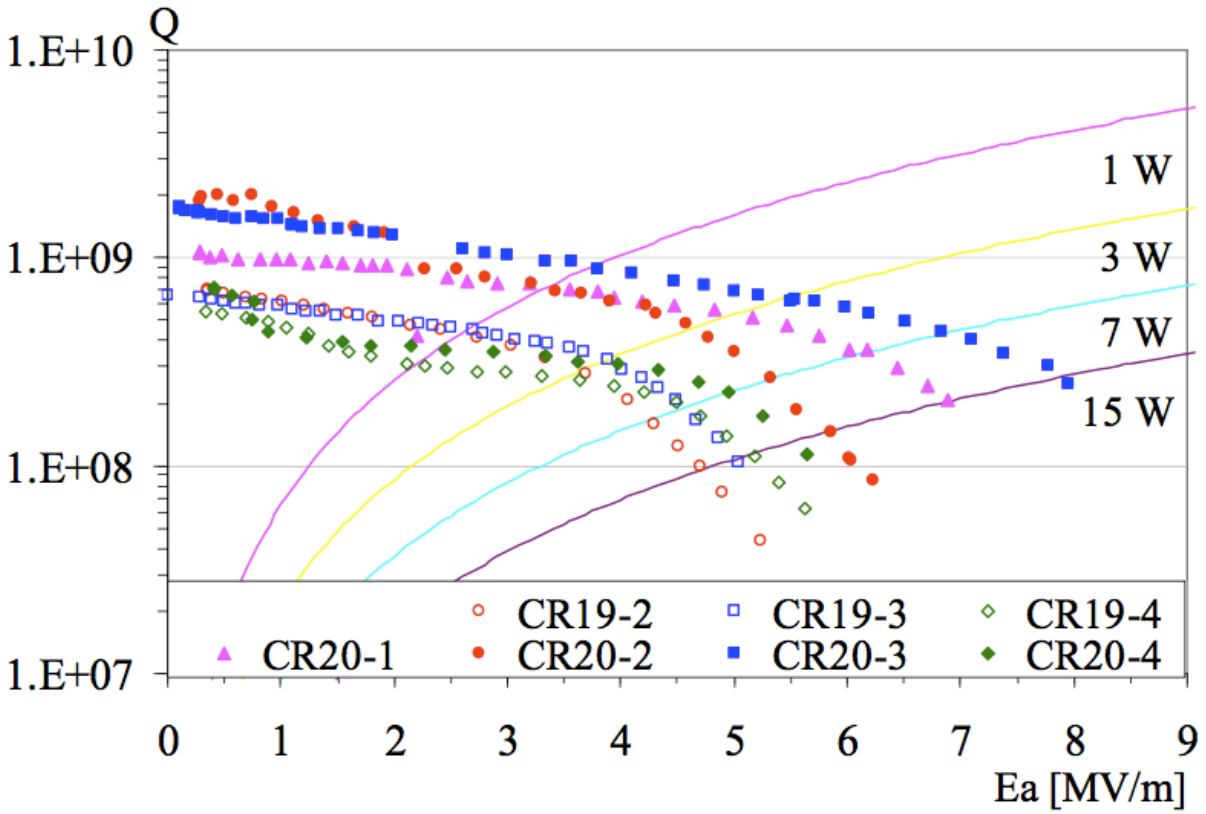
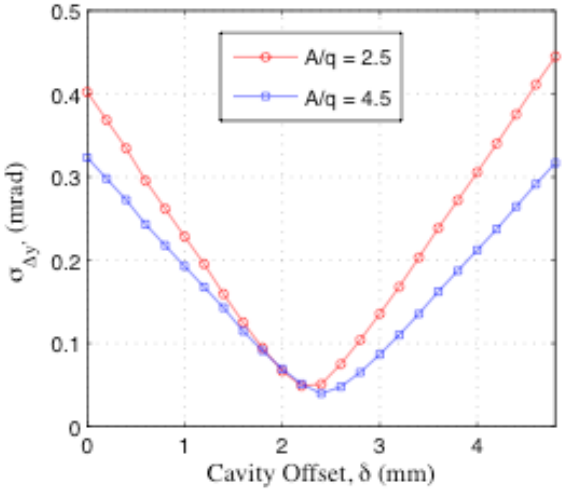
Choice of the gradient: 6 MV/m

A. Porcellato talk SRF2005



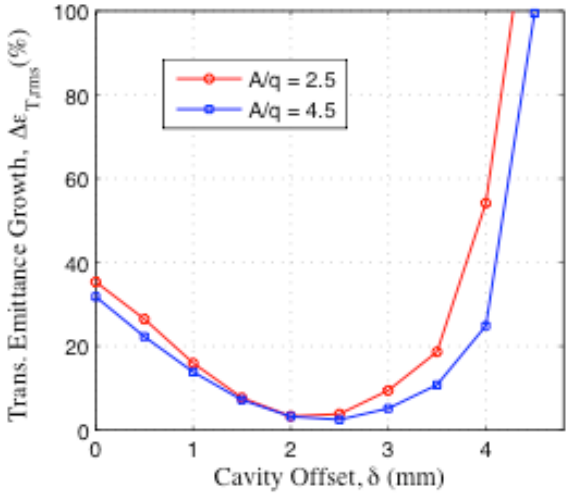
Optimisation of Beam Steering Compensation

- Optimised the Cavity Geometry for a Single Cavity Offset for all Cavities of a Given Family:
  - FOR ALL BEAMS IN THE ACCEPTANCE: 2.5 < A/Q < 4.5
  - MINIMISE EMITTANCE GROWTH
  - MAXIMISE ACCEPTANCE ON OFFSET
  - USE A RACETRACK SHAPED APERTURE IN THE HIGH BETA CAVITY



OPTIMISATION ROUTINE

Courtesy of M. Fraser



TRACK MULTIPARTICLE SIMULATIONS

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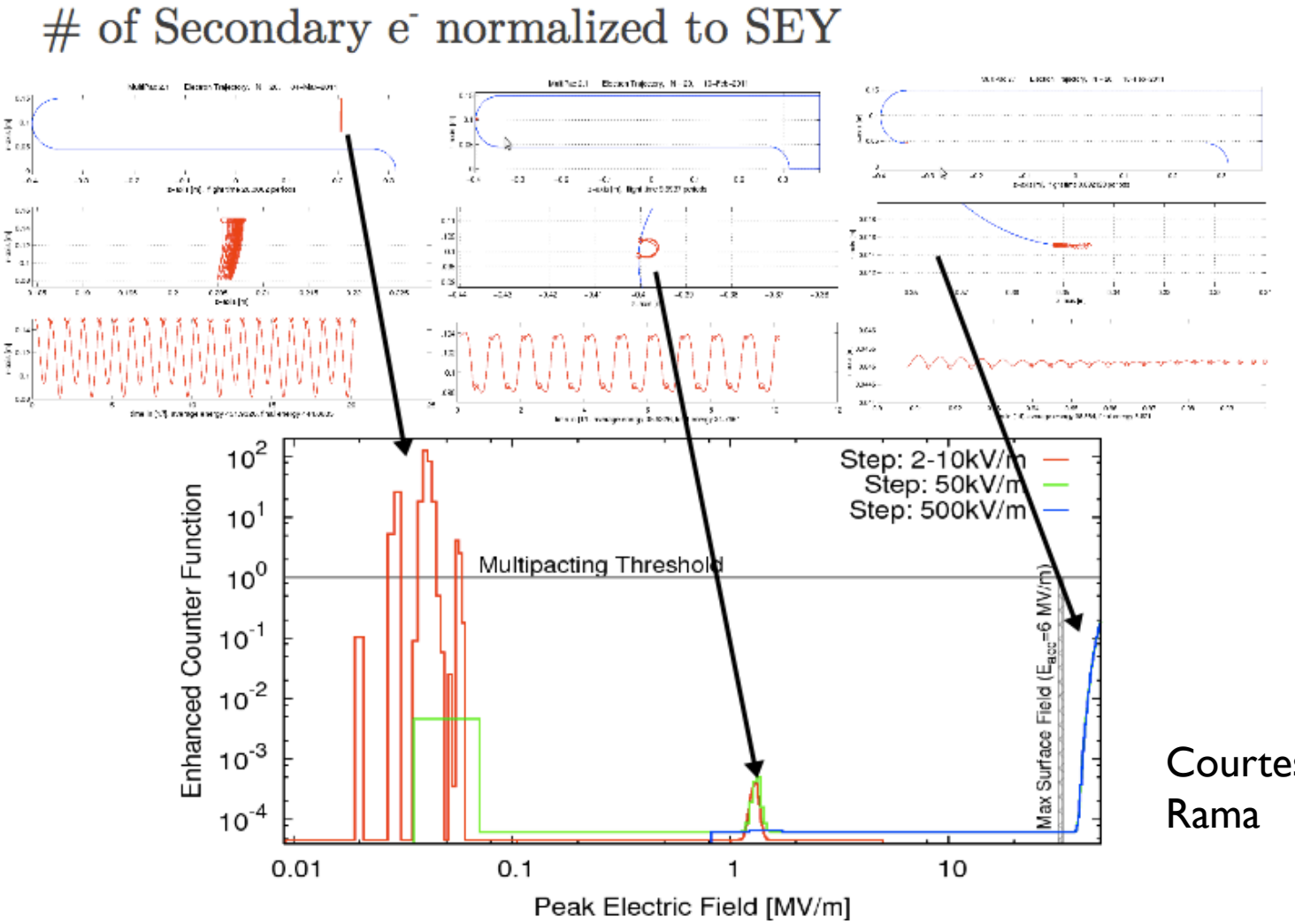
Multipacting simulations (2D)



Courtesy of C. Rama

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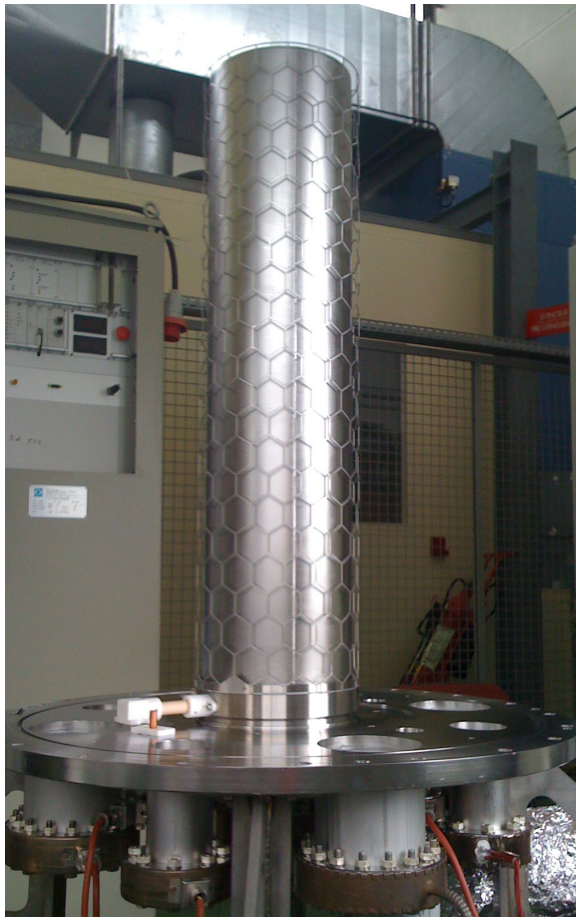
Nb sputtering (TUP067)



Courtesy of S. Calatroni

Diode and Magnetron sputtering

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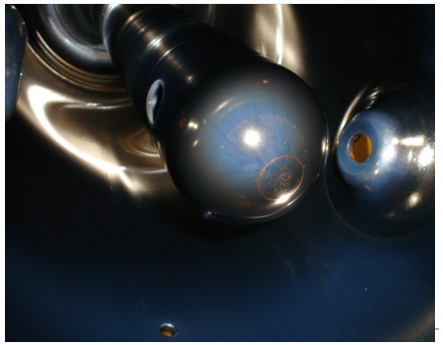
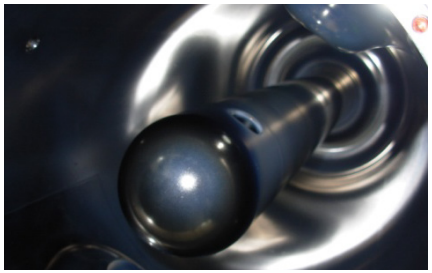
Nb Sputtering and RF Tests

Tested

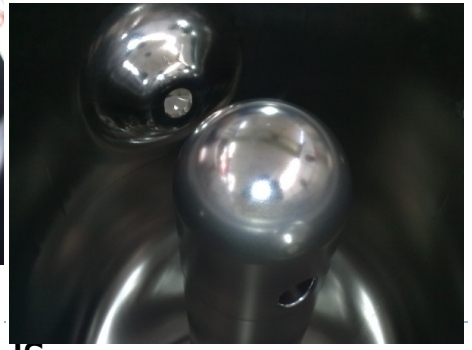
UnTested

Q1.3 Magnetron 22.2.2010	Q1.4 Magnetron 30.6.2010	Q1.5 Diode 15.4.2011	Q2.1 Magnetron 29.3.2011
Ion etching None	**Ion etching** During 10 min $P=3.6*10^{-2}$ mbar Cavity U=572V; I=0.76 A Coil I=30A; U=34V	**Ion etching** During 10 min $P=3.6*10^{-2}$ mbar Cavity U=540V; I=0.76 A Coil I=30A; U=34V	**Ion etching** During 10 min $P=3.6*10^{-2}$ mbar Cavity U=540V; I=0.76 A Coil I=30A; U=34V
Magnetron sputtering Coating time= 8h20 $P=1.5*10^{-2}$ mbar Cathode I= 3A; U=244V Cavity I=3.24A; U=80V Coil I=40A; U=50V T_{cavity}=150 C	**Magnetron sputtering** Coating time= 8h20 $P=1.5*10^{-2}$ mbar Cathode I= 3A; U=244V Cavity I=3.24A; U=80V Coil I=40A; U=50V T_{cavity}=150 C	**Diode sputtering** Coating time= 38h $P=1.5*10^{-1}$ mbar Cathode I= 1.65A; U=450V Cavity I=3A; U=80V T_{cavity}=150 C	**Magnetron sputtering** Coating time= 8h $P=8*10^{-3}$ mbar Cathode I= 2.5A; U=360V Cavity I=3.9A; U=80.4V Coil I=30A; U=36V T_{cavity}=150 C



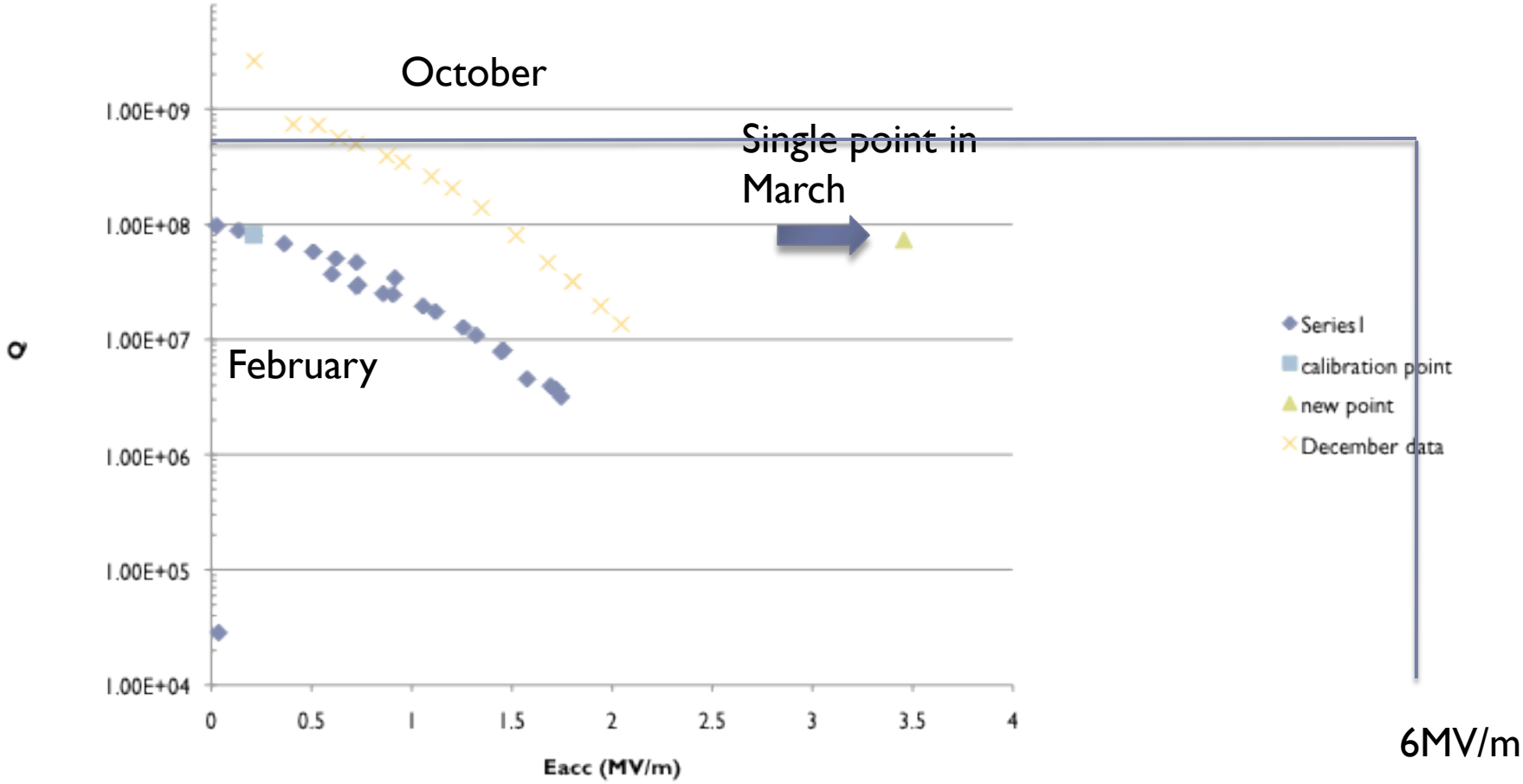


HPWR 100 bar:
OK



Courtesy of S. Calatroni

RF Test Results



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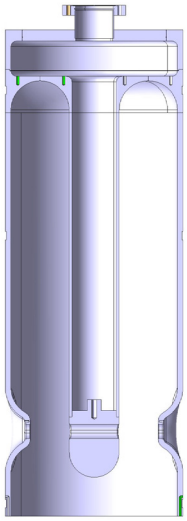
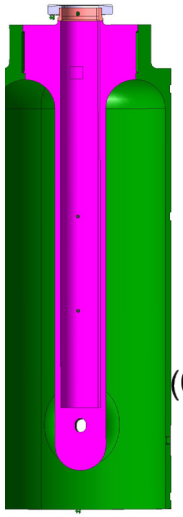
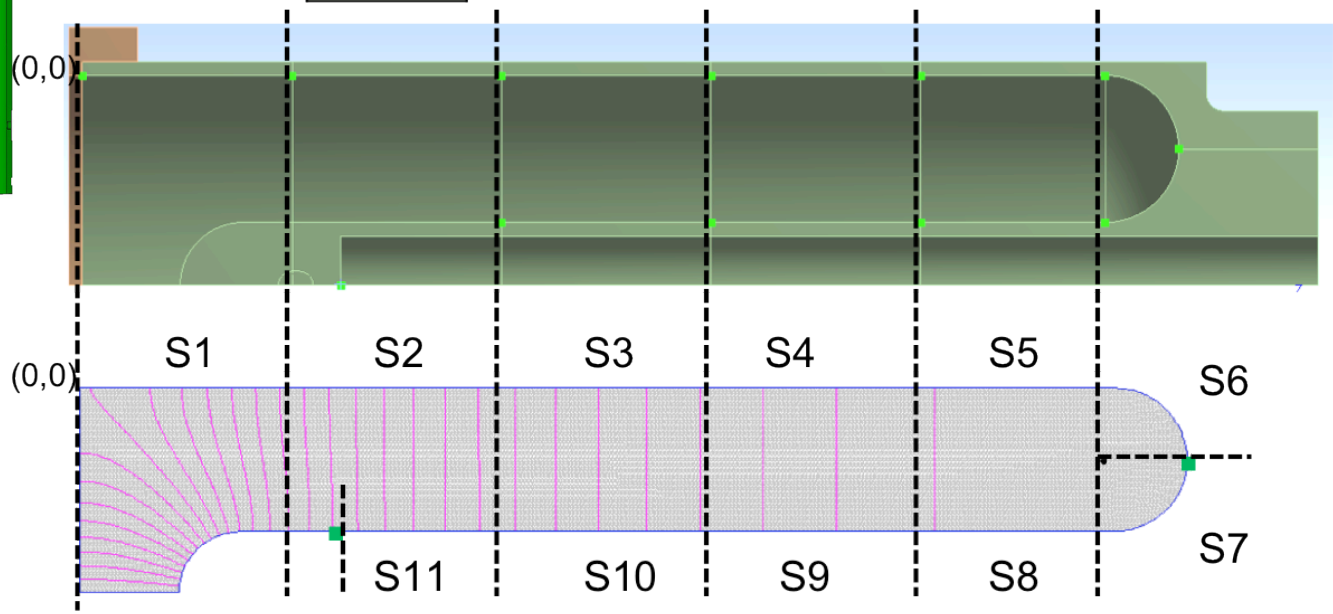
New mechanical design





Fron Ansys to SuperFish

Z1 : 150 Y1 : 0	Z2 : 150 Y2 : 150	Z3 : 150 Y3 : 300	Z4 : 150 Y4 : 450	Z5 : 150 Y5 : 600	Z6 : 150 Y6 : 732	
N1	N2	N3	N4	N5	N6	Z7 : 97.5 Y7 : 784.5 N7
		Z11 : 45 Y11 : 300	Z10 : 45 Y10 : 450	Z9 : 45 Y9 : 600	Z8 : 45 Y : 732	
N12	Z12 : 0 Y12 : 185	N11	N10	N9	N8	



Expected Pressure sensitivity of 0.01Hz/mbar

Cryomodule Design

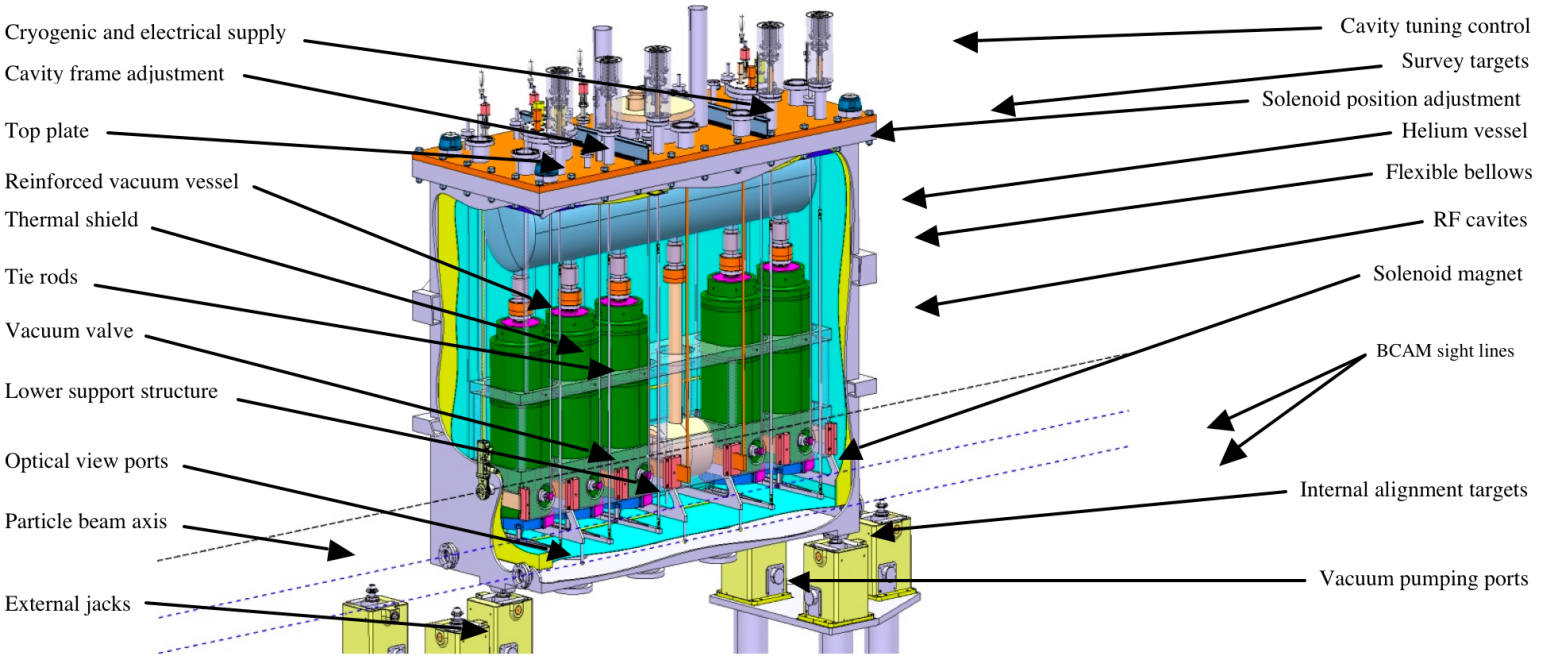
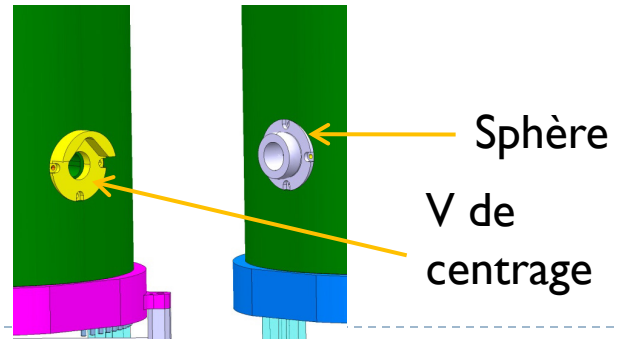
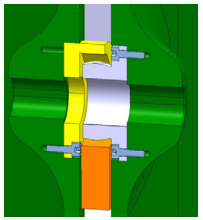


Figure 1: The HIE-ISOLDE high beta cryo-module.





Courtesy of A. Bouzoud

Summary

- The project is ongoing: the development of the cavities is on the critical path and we need to get a good coating as soon as possible.
- CERN has made an effort in updating a lot of the infrastructure that was dating back from the LEP cavities
- Cryomodule design will be frozen by the end of the year

Acknowledgments

- HIE-ISOLDE design team: many CERN groups: RF, ABP, BI, VSC, MSC , CRG, MME and many others
- External collaborators:
  - INFN-LNL
  - TRIUMF
  - Cockcroft Institute
- K.U.Leuven
- ISOLDE collaboration
- EU
- Lund University
- CERN