SPL cavity design by IPN Orsay

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Outline

Introduction

RF design

Planning

Commitment within EuCARD

WP11: SRF: SC RF technology for higher intensity proton accelerators & higher energy electron linacs

Task 4: SC Cavities for proton linacs

• Design, fabrication and tests of beta=0.65 and beta=1.0 cavities with the goal to reach announced performances.

• […]

Sub-task 1: Design and fabrication of beta=0.65 704 MHz elliptical cavity equipped with a Titanium helium reservoir. Preparation (BCP, HPR) and assembly in clean room.

[…] Test of the cavity in vertical cryostat […].

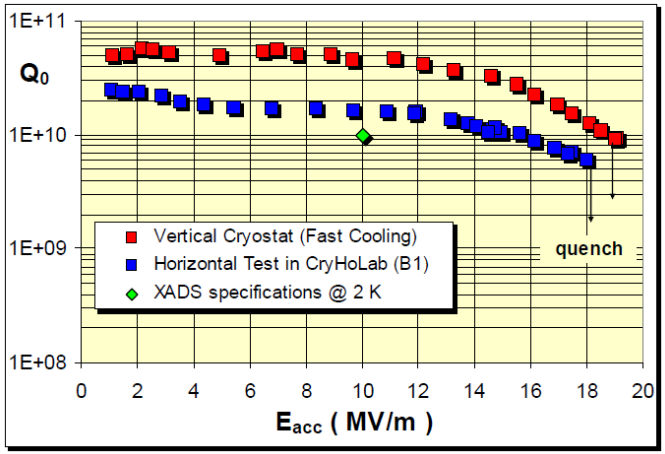
RF parameters

Table 4.11: SPL superconducting linac design parameters

Maximum peak surface electric field	50 MV/m
Maximum peak surface magnetic field	100 mT
Cavity quality factor at 2 K	$\geq 10^{10}$
Accelerating gradient ($\beta = 0.65$)	19 MV/m
Accelerating gradient ($\beta = 1.0$)	25 MV/m
R/Q ($\beta = 0.65$)	290 Ω
R/Q ($\beta = 1.0$)	570 Ω
Frequency	704.4 MHz
Number of cells	5

Conceptual design of the SPL II, CERN-2006-006

Test results of 704 MHz, 5-cell, beta 0.65



"Performance Improvement of the Multicell Cavity Prototype for Proton LINAC Projects", B. Visentin et al., LINAC 2004

Epk/Ea < 2.63
Bpk/Ea < 5.26 mT/MV/m

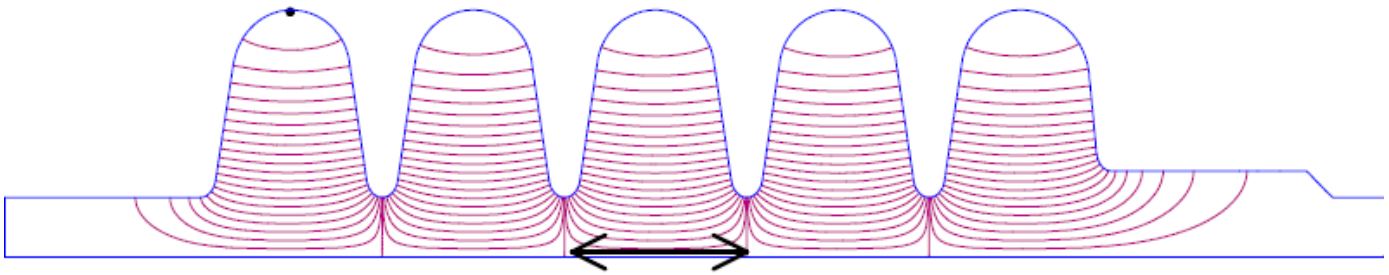
Table 4.9: Medium-β multi-cell cavity parameters (bulk-niobium structures only)

Project	f [MHz]	β	E_{peak}/E_{acc}	H_{peak}/E_{acc} [mT/(MV/m)]	N_{cell}	$(R/Q)/N_{cell}$ [Ω]
RIA	805	0.47	3.34	5.94	6	26.67
TRASCO	704	0.47	3.57	5.88	5	31.60
SNS medium-β	805	0.61	2.71	5.72	6	46.50
CEA/CNRS	704	0.65	2.60	4.88	5	63.00
SNS high-β	805	0.81	2.19	4.72	6	80.50
TTF	1300	1.00	2.00	4.16	9	115.11

(R/Q) uses the 'linac' definition.

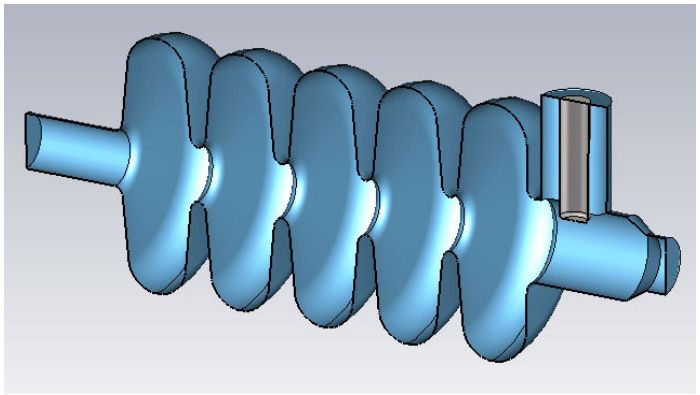
Starting from 2D to 3D

- 1999: Cavity design with SUPERFISH with no RF coupler and HOM ports

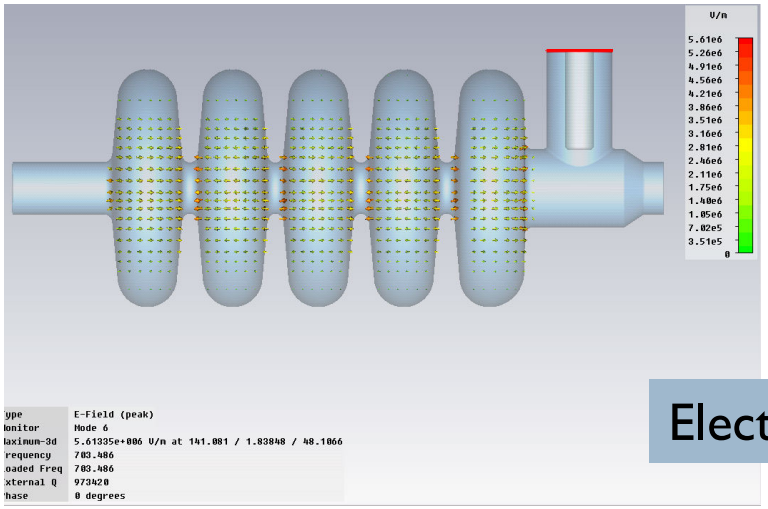


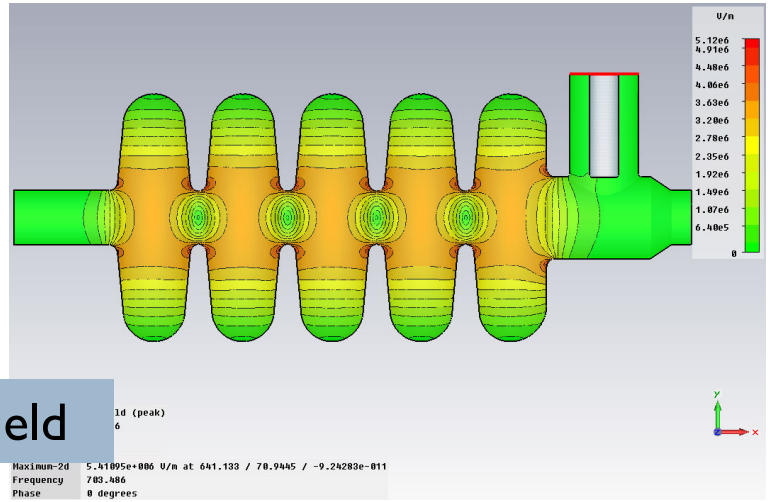
$\beta\lambda/2$=0.14m

- 2009: New 3D model with Microwave Studio

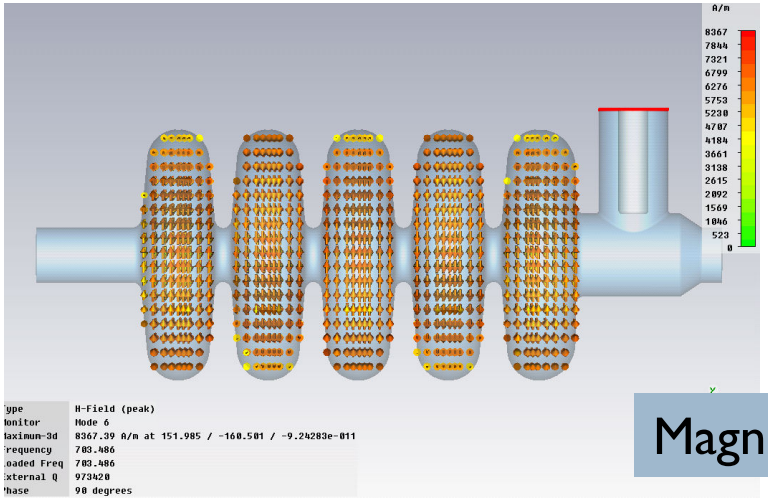


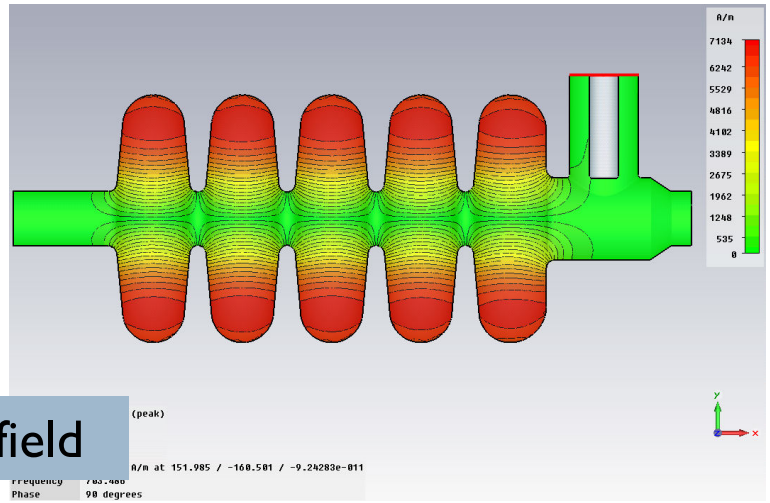
EM fields – fundamental mode





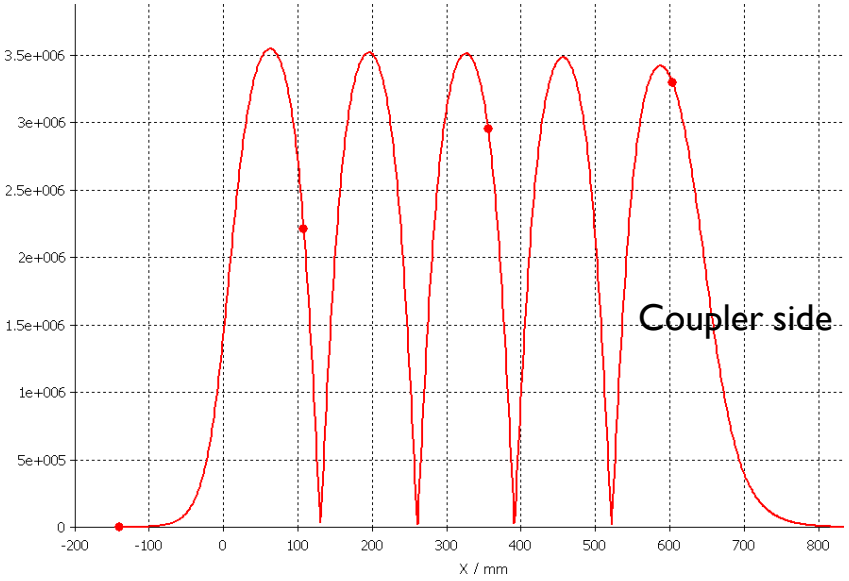
Electric field



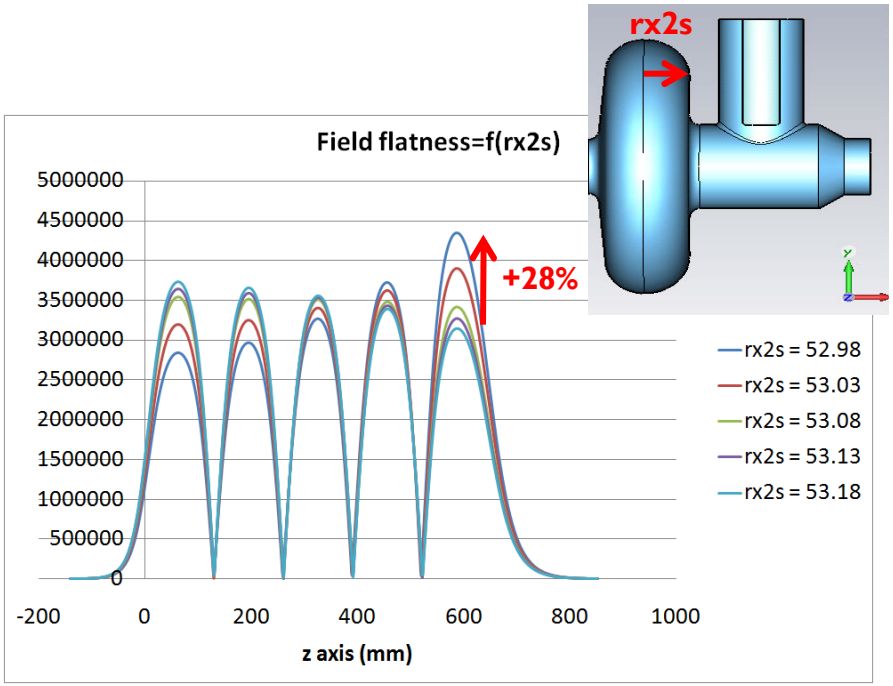


Magnetic field

RF parameters



- Field flatness < 5%
- Cell-to-cell coupling=0.74%

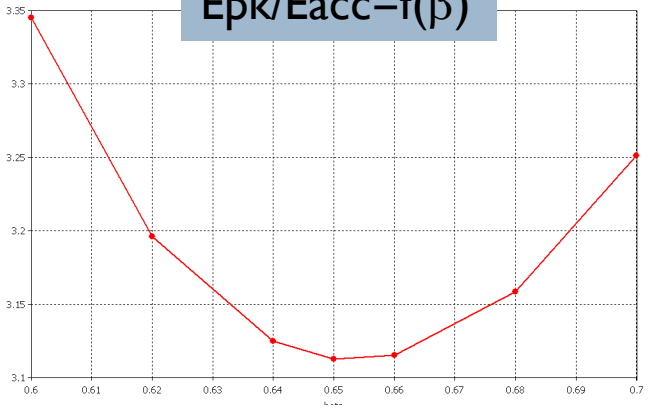


- Half-cell close to RF coupler adjusted for field flatness

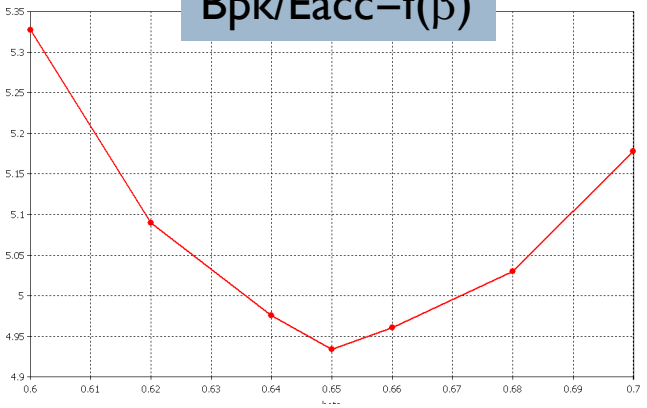
  $\Rightarrow$ 0.2 mm → +28%

RF parameters (con't)

Epk/Eacc=f(β)

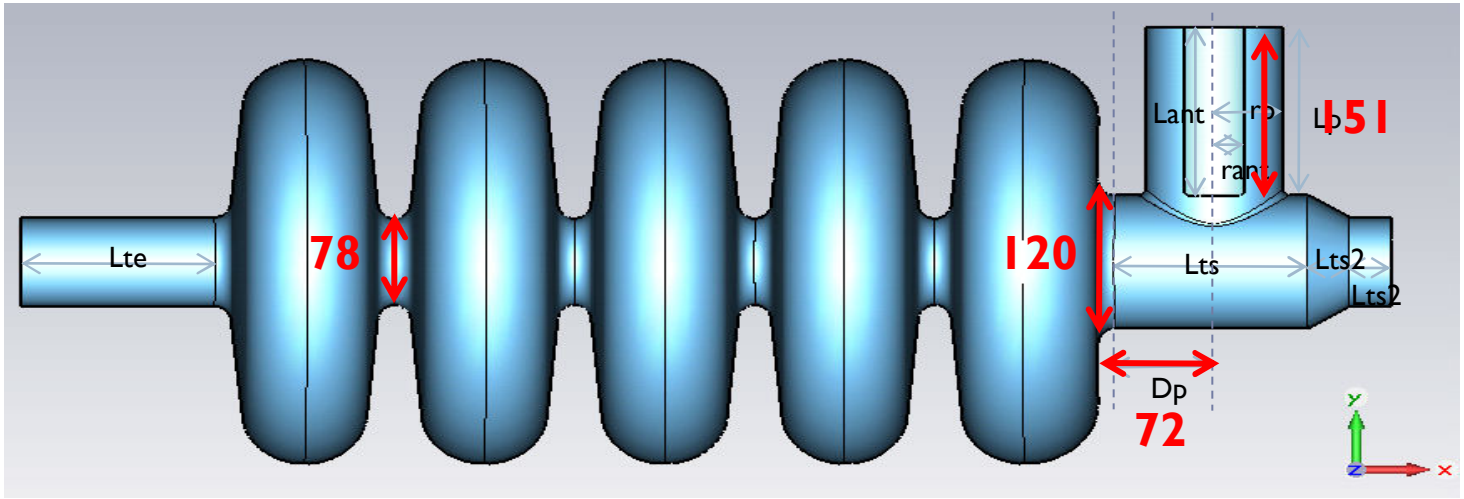


Bpk/Eacc=f(β)



f (MHz)	703.5	too be matched
Ep/Eacc	3.11	too high
Bpk/Eacc (mT/MV/m)	4.95	Ok
r/Q (Ohm)	352	Ok
G (Ohm)	200	Ok
Vacc @βopt & 1 Joule (MV)	1.26	Ok
Qo (@2K, Rres=2nΩ)	$4\ 10^{10}$	Ok

External coupling Qext

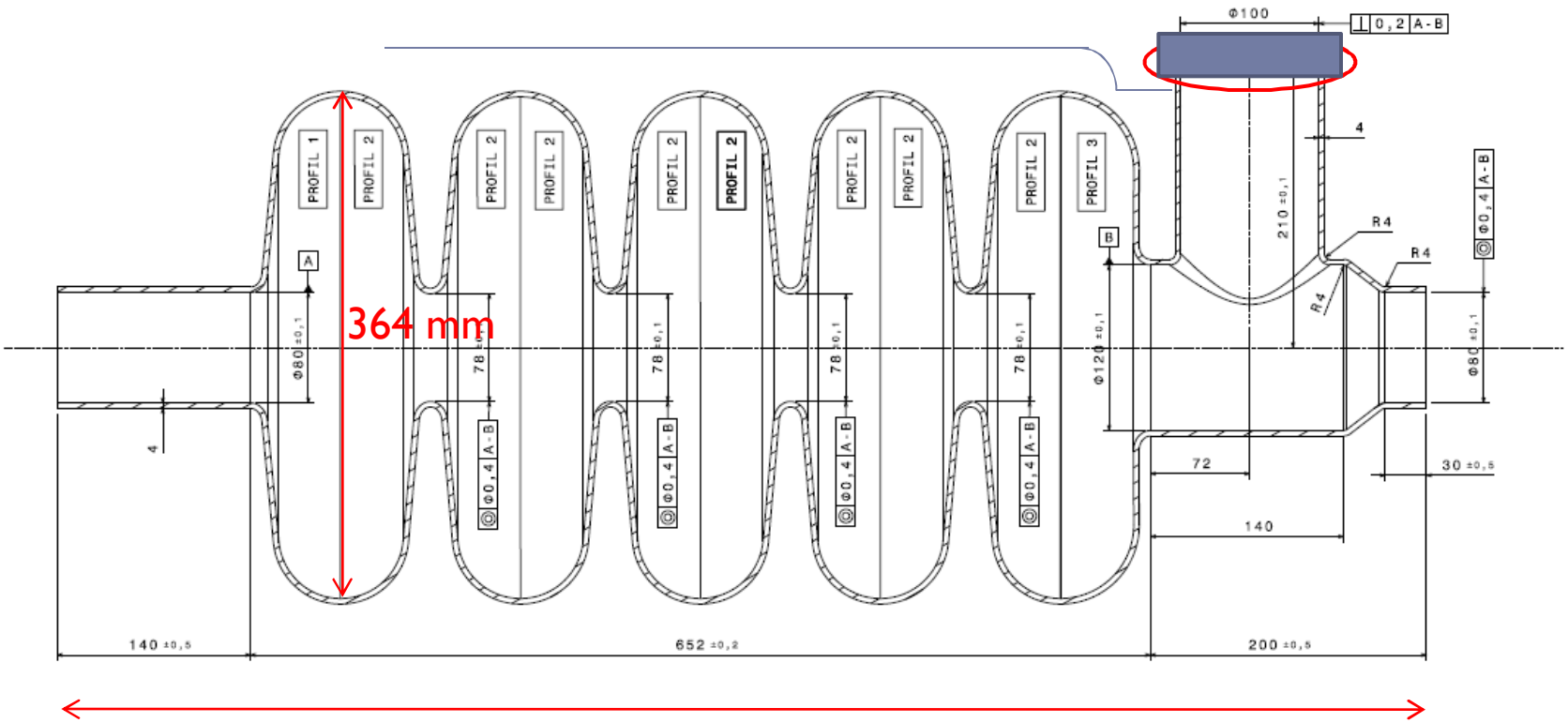


- Goal: Qext=9.7 10^5 with ∅ant=43.5 mm and ∅port=100 mm

Parameters:
- ∅beam tube=120 mm
- Lant=151 mm (1 mm of penetration inside beam tube)
- Dp=72 mm

Preliminary drawings

- No flanges, no Helium reservoir



Planning

2009

End of November: finish RF design, check HOM's

Mid-November to end of December: mechanical calculations, design of the Helium tank, check the interfaces with the cryomodule (integration of the CEA-type tuning system, and RF coupler)

2010

End of January: technical drawings ready for production, technical specifications for fabrication, Niobium order (3/4 months, ~40 k€)

February to mid-March: cavity call for tender

End of March: choice of the manufacturer

Mid-April: kick-off meeting, beginning of the fabrication (~8 months).

Thank you for your attention

IPN Orsay team

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Mechanics: H-M. Gassot
CAD: S. Rousselot