OPTIMIZED RF DESIGN OF 704 MHZ BETA=1 CAVITY FOR PULSED PROTON DRIVERS

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The high energy part of the Superconducting Proton Linac at CERN (SPL) will be composed of two families of elliptical cavities, beta = 0.65 and beta = 1. We focus on the beta = 1, 5-cell cavities, whose RF design has been developed at CEA-Saclay in the frame of EUCARD (European Coordination for Accelerator Research & Development). These cavities are aimed to work in pulsed mode (50Hz, duty cycle 5%), with a beam current of 40 mA and RF peak power 1MW.

Since these cavities should provide a challenging gradient of 25 MV/m, the RF design has been realized to optimize cavity efficiency and peak fields. The position of high power couplers has been determined to achieve the adequate external coupling, and the monopole High Order Modes have been identified and characterized. We have also carried out RF/mechanical simulations in order to optimize the mechanical behavior of cavity, in particular the Lorentz force detuning.

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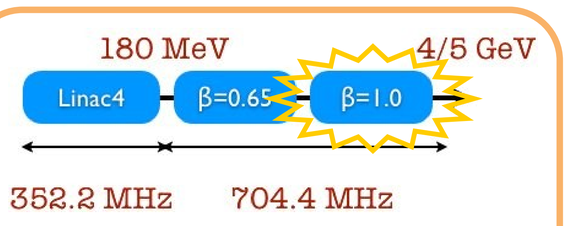
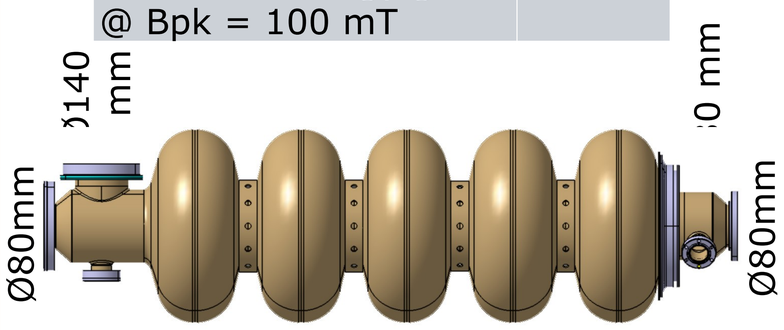
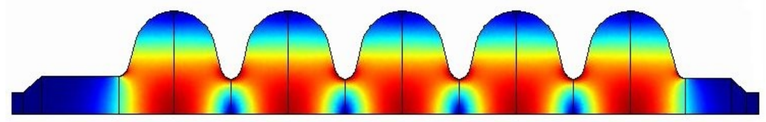


SPL DESIGN PARAMETERS	
RF frequency	704.4 MHz
Cavity beta	1
Number of cells	5
Accelerating gradient	25 MV/m
Average pulse current	40 mA
Synchronous phase	-15 °
Peak RF power	1 MW
Repetition frequency	50 Hz
Duty cycle	5%
Operating Temperature	2 K

☑ Optimization of r/Q, Epk, Bpk

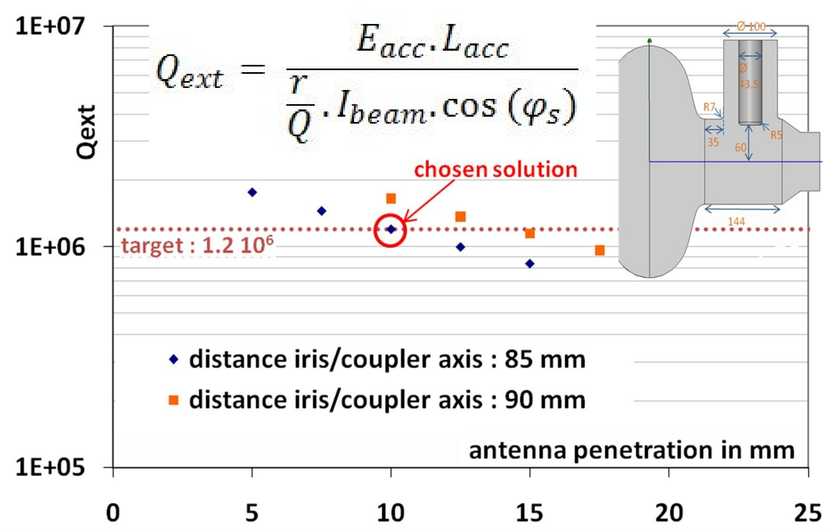
RF PARAMETERS	
Bpk/Eacc [mT/(MV/m)]	4.20
Epk/Eacc	1.99
G [Ohm]	270
Cell to cell coupling	1.92 %
r/Q [Ohms]	566
Lacc = Ngap.β.λ/2 [m]	1.0647
Maximum energy gain @ Bpk = 100 mT	25 MeV

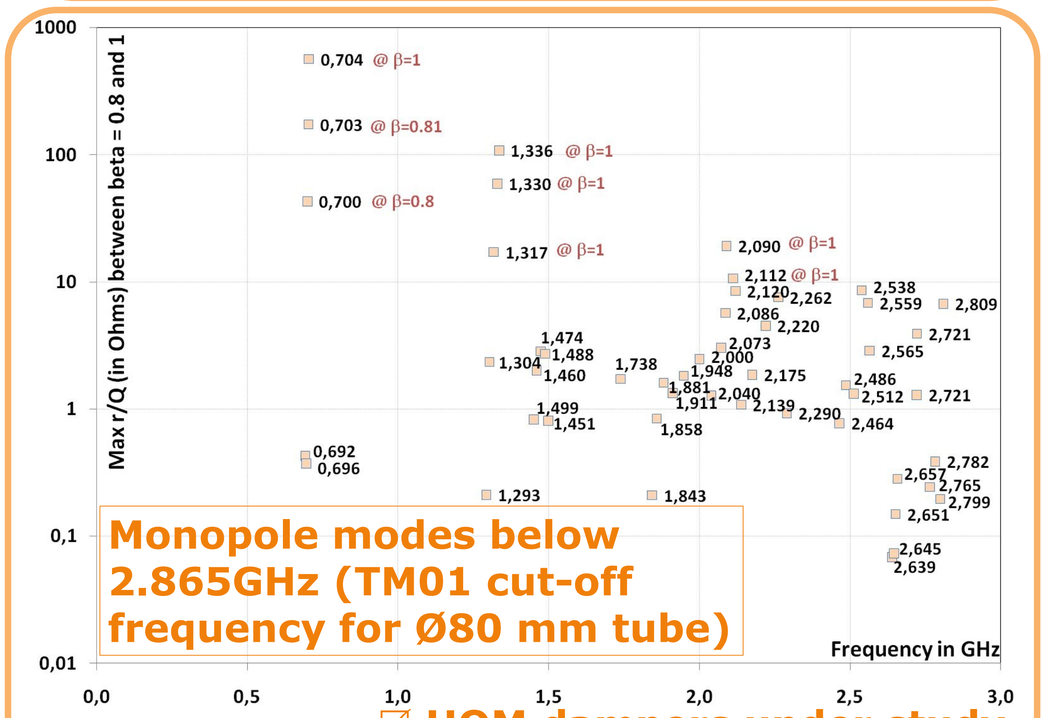




Field pattern @ 704.4 MHz

☑ Achievement of the external coupling

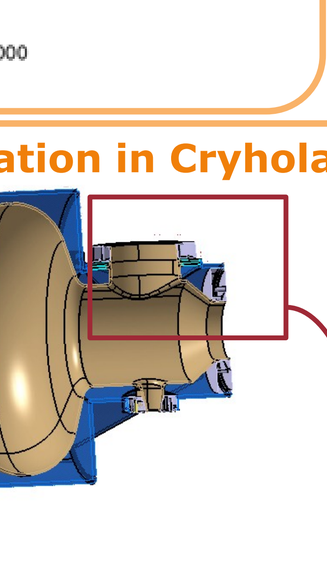


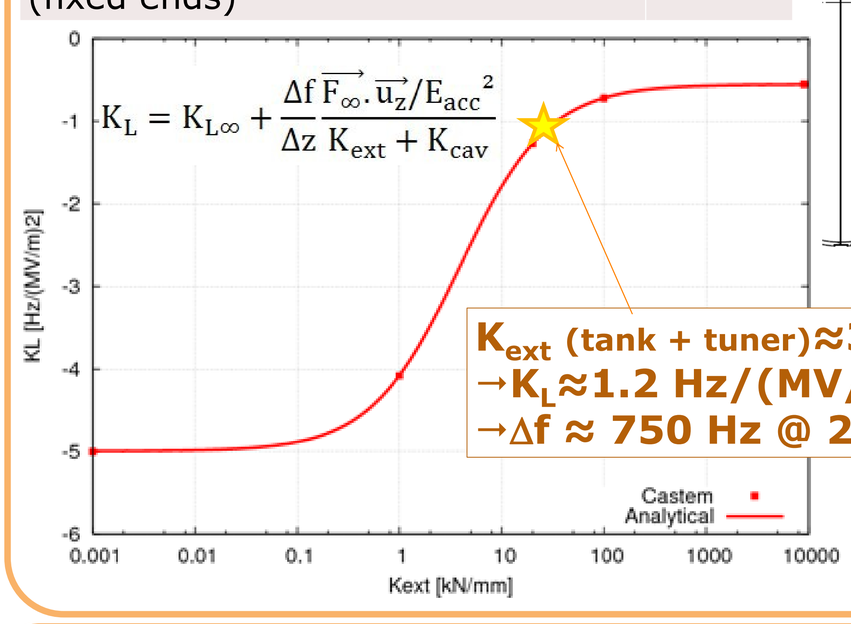


☑ HOM dampers under study

☑ Reduction of K_L with stiffening rings

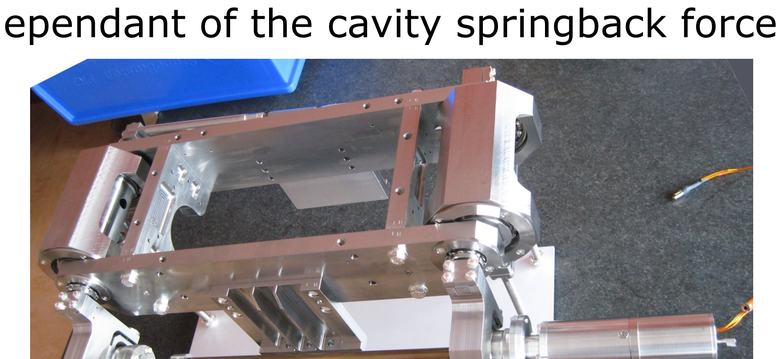
MECHANICAL PARAMETERS	
Nominal wall thickness [mm]	3
Cavity stiffness Kcav [kN/mm]	3.84
Tuning sensitivity Δf/Δz [kHz/mm]	164
KL with fixed ends [Hz/(MV/m)²]	-0.55
KL with free ends [Hz/(MV/m)²]	-5
Pressure sensitivity KP [Hz/mbar] (fixed ends)	1.2



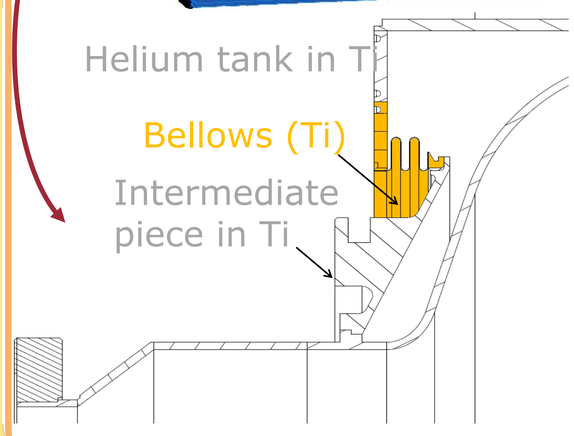


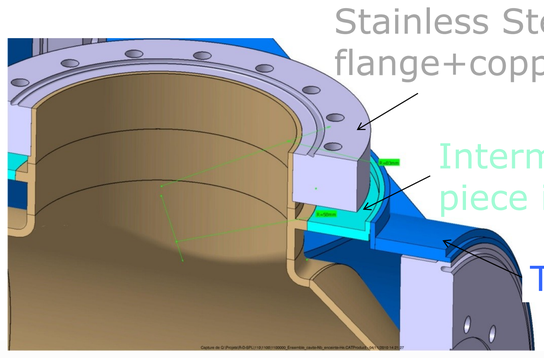
☑ Fast tuning system in pulsed mode (tests & operation)

- Saclay V type
- 1 piezo
- Planetary gearbox (1/100e)
- Piezo support has a stiffness 10 times higher than the cavity ⇨ piezo preload at 2K is independant of the cavity springback force

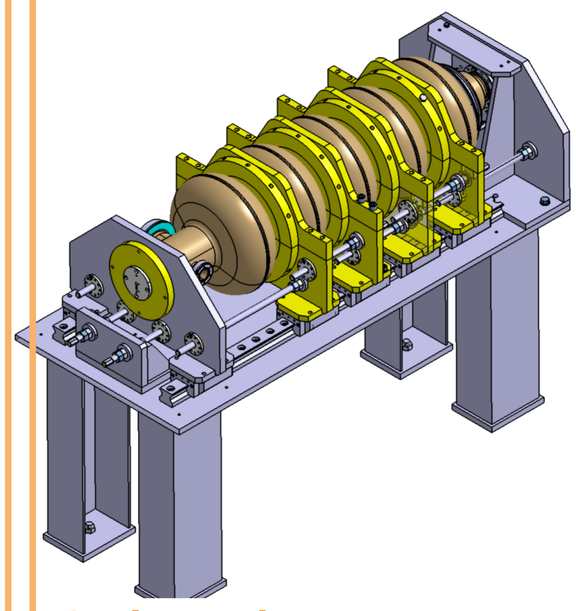


☑ Saclay prototype : possible integration in Cryholab





☑ Equipment for cavity preparation



Cavity tuning set-up (under development)

Vertical electro-polishing (installed at Saclay)