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Modeling of Superconducting Spoke cavity with its control loops systems for the MYRRHA Linac project

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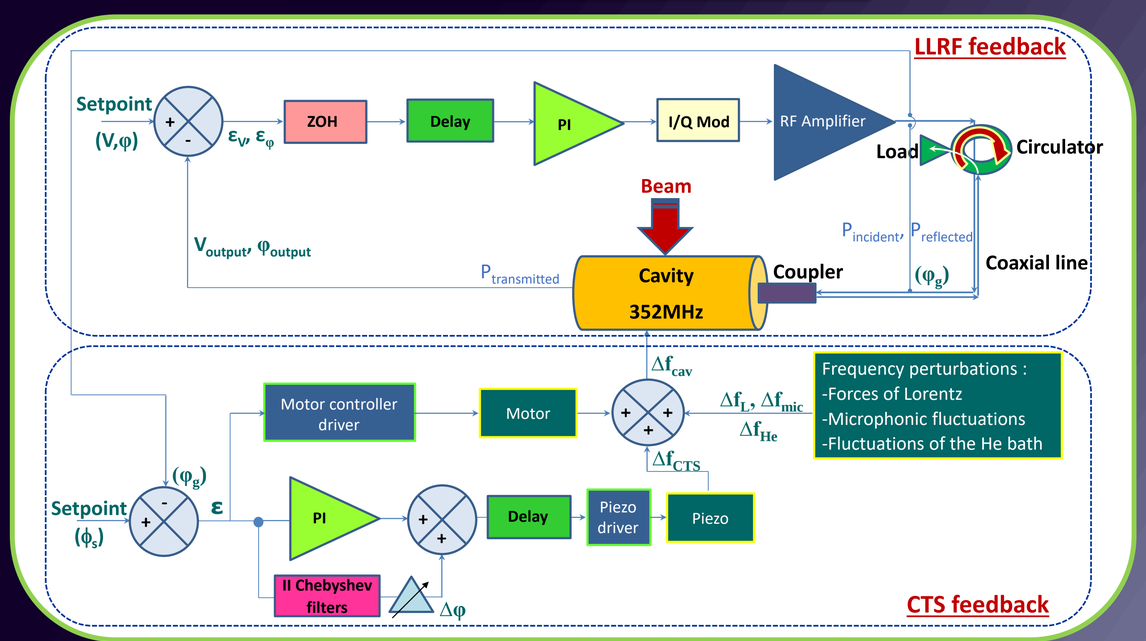
Cavity model in its environment



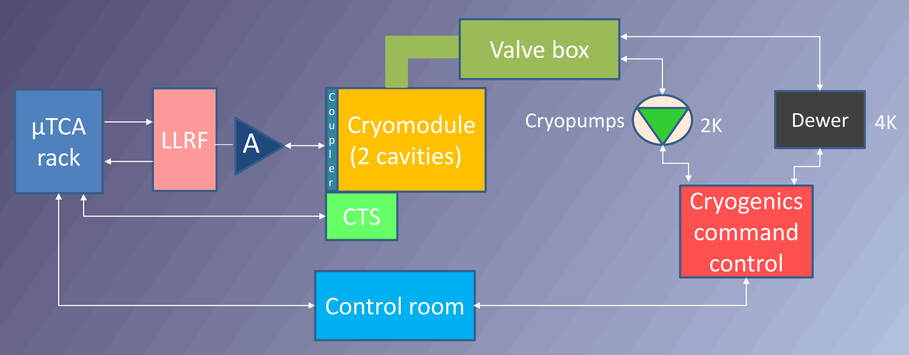
100MeV Linac (phase 1 MYRRHA project)

In the construction framework of a future 600 MeV/4mA CW Superconducting Linac accelerator for the MYRRHA project at SCK•CEN (Mol, Belgium), modeling works under Matlab/Simulink® are carried out upstream to understand the behaviour of 352 MHz single Spoke cavity with its environment and its associated feedback control loops (LLRF and Cold Tuning System). One of the main goal is to assess the feasibility of cavity failure compensation in the Superconducting Linac. Indeed, stringent reliability requirements must be fulfilled to ensure an efficient operation of the MYRRHA Accelerator Driven System: unexpected beam interruptions, due to failures, must be compensated in less than 3 seconds. Our preliminary study focuses on the fast frequency re-tuning of the cavity. Our goal is to prepare the R&D tests foreseen at IPN Orsay on a prototype cryomodule including two SC Spoke cavities equipped with couplers, tuners with feedback loop and connected to dedicate LLRF.

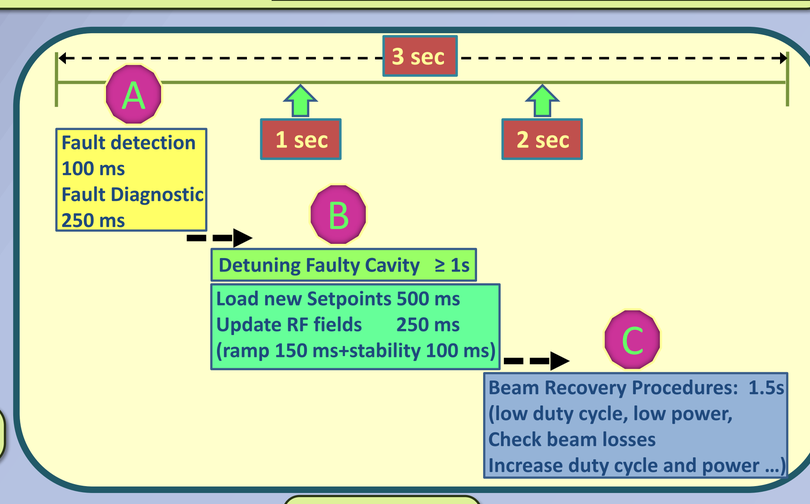
Input parameters for Spoke cavities

Single Spoke cavity β=0.375 352.2 MHz	
Number of cavities	60 (30 cryomodules)
Tc (K)	9.25
I0 (mA)	4
Z0 (Ω)	50
r/Q(Ω) [βopt=βgeom]	217
G (Ω)	109
T(He) (K)	1.9
Rs (nΩ)	20
kL (Hz/MV/m²)	-5.5
Vcav (MV)	1.7
Qo	5.2 10^9
Qt	10^12
Qi(~QL)	1.5 10^6
Eacc (MV/m)	7
ϕs(°)	-20.4
τm (ms)	1
νHe Bath (Hz)	1
PMax RF (kW)	18
νc RF ampli (kHz)	175
νc I/Q modulator (MHz)	100

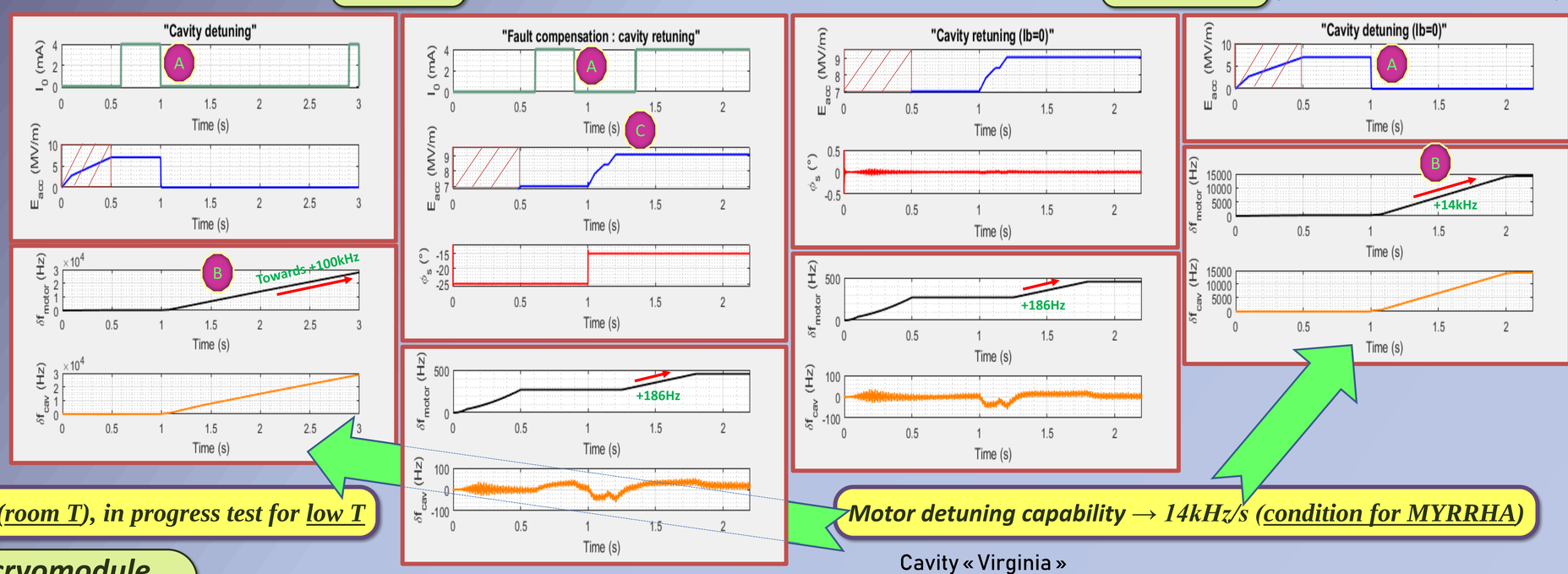
Cryomodule equipments



Fault tolerance tests : specification for MYRRHA ≤ 3s



Simulation results : Linac fault tolerance scenarii

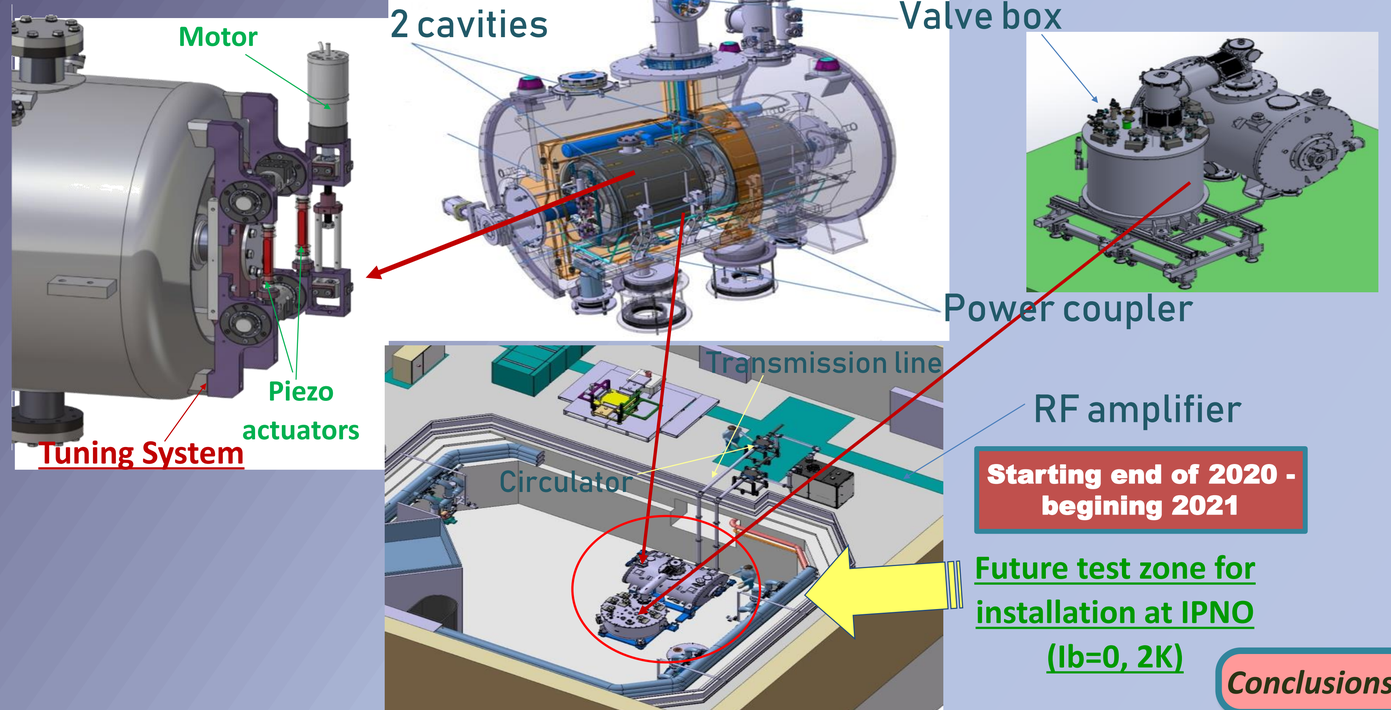


CTS fast detuning→ 15kHz/s (room T), in progress test for low T

Motor detuning capability → 14kHz/s (condition for MYRRHA)

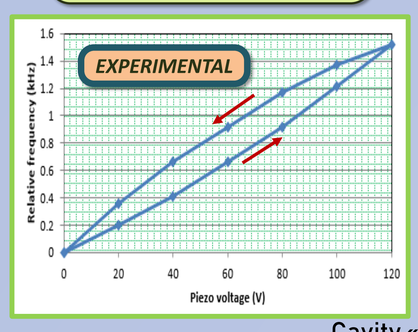
MYRRHA Spoke cryomodule prototype (under construction)

Poster "TUP087" : detailed tests of CTS ⇒

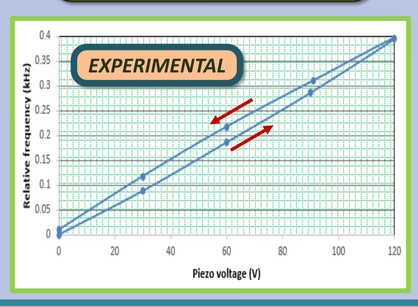


Calibration of the piezos

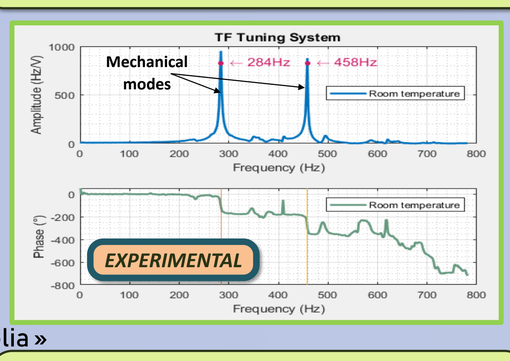
Cavity « Virginia »



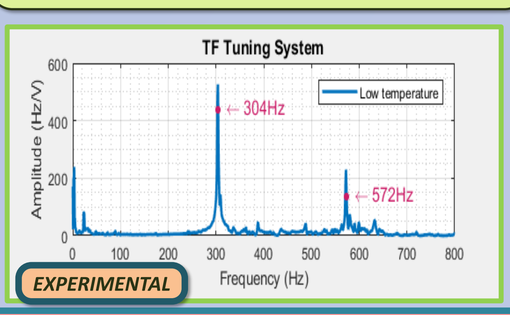
Cavity « Amelia »



Cavity spectrum Transfer Function (room T)



Cavity spectrum Transfer Function (low T)



Conclusions : Fault tolerance feasibility in less than 3 seconds + CTS fast detuning in 14kHz/s