PERFORMANCE OF A PROTOTYPE 176 MHZ β=0,09 HALF-WAVE RESONATOR FOR THE SARAF LINAC

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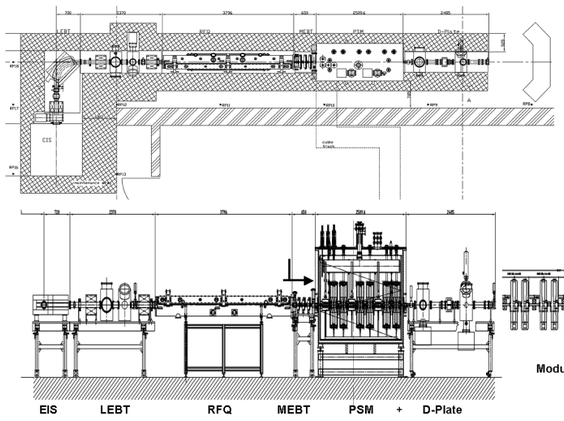
ABSTRACT

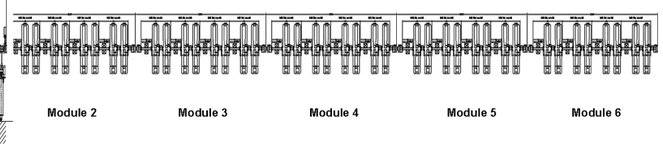
A prototype 176 MHz β=0.09 half-wave resonator was designed, built and tested at 4 K in a vertical test cryostat at ACCEL. Peak electric fields of 44 MV/m corresponding to peak magnetic fields of 95 mT were achieved after some RF processing. The quality factor at the design gradient of E_{peak} = 25 MV/m allows operation with cryogenic losses well below 10 W rf losses. Multipacting was observed at very low field (Epeak = 0.1 MV/m) and intermediate fields (Epeak = 7-10 MV/m). Three dimensional multipacting calculations predicted these multipacting levels. Calculations show, that the low field multipacting should be strongly reduced with a new slightly changed geometry. Additional six cavities for a prototype superconducting module will be produced with this new shape.

THE SARAF LINAC AT THE SOREQ INSTITUE IN YAVNE, ISRAEL

Parameter	Value	Unit
Ion species	**protons / deuterons**	
Energy maximal	**40**	**MeV**
Energy minimal	**5**	**MeV**
Energy adjustment accuracy	200	keV/step
Current maximal	**2 (4)**	**mA**
Current minimal	40	µA
Current adjustment accuracy	5	µA/step
Current stability at maximum current	+/- 2.5	%
Current stability at minimum current	+/- 5	%
Current structure	**continuous wave (cw)**	
Transversal emittance (normalised, rms)	< 1	π*mm*mrad
Longitudinal emittance (rms)	< 4	π*nsec*keV/nucleon
Operation	**6000**	**hours/year**
Losses	**1**	**nA/m**



SARAF Phase I



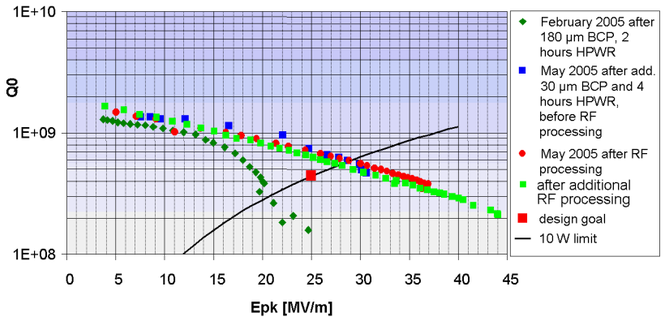
SARAF Phase II

VERTICAL TEST FACILITY AT ACCEL

Since January 2005, RF tests of HWR cavities can be done at ACCEL.

Vertical test facility for testing half-wave resonators at ACCEL. Cavities are prepared at ACCEL by buffered chemical polishing in closed loop with acid temperature control below 15 °C followed by high pressure rinsing, drying by pumping and clean room assembly

VERTICAL TEST RESULTS



Parameter	Units	Measured value	Comments
Resonant frequency	MHz	176.94658	
Power in cavity @ Epk=25 MV/m	W	7	It is less than 10 W of SARAF specification
Quality factor of the cavity Qo @ Epk=25 MV/m		6.567e8	
Maximum Epk	MV/m	44	At 63 W in the cavity and 98 W forward power
Maximum Bpk	mT	94	
Maximum measured cavity quality factor Qo		1.857e9	@ Epk=3.9 MV/m
Pickup quality factor		1.766e10	
Sensitivity for He pressure Δfo/Δp	Hz/mbar	-56	It is more than 16 Hz/mbar of design parameter
Lorentz force detuning $\Delta fo/\Delta Epk^2$	$Hz/(MV/m)^2$	-0.428	$\Delta fo/\Delta Ea^2$=-3.63 $Hz/(MV/m)^2$
Maximum radiation level	µSv/h	5600	@ Epk=44 MV/m

State of the art peak magnetic and electric fields reached with our surface preparation technique.

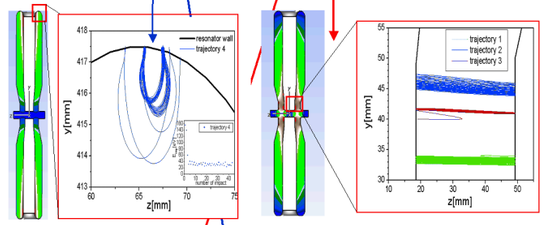
Experimental Findings:
- Capacitive MP at low field is easy to overcome at the very initial field rising after cooldown. The cavity can be driven to high fields
- The horseshoe MP is observed as expected and easy to overcome and disappears
- Also after long pumping time (no rf) MP barrier is easy to cross for **the first** field rise.

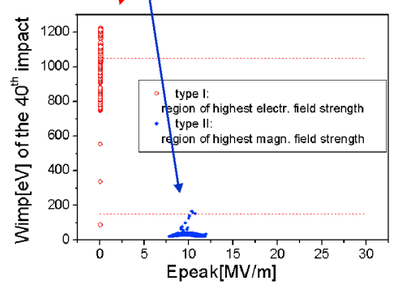
BUT
- Capacitive MP at low field level hard to overcome and repeatedly appearing during operation at higher field levels.
- After rf conditioning (at high fields) capacitive MP comes back
- Capacitive MP only gets weaker with extended time of testing

Concerns:
- Long term operation
- Stable operation of the srf module and the linac

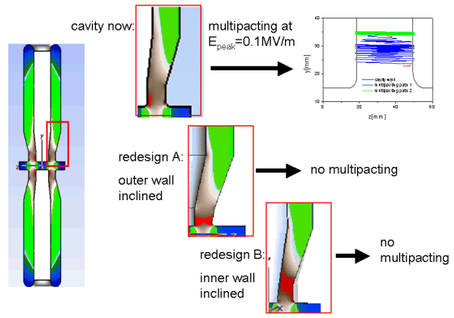
MULTIPACTING

Two types of multipacting, at very low field (capacitive) and at intermediate fields (horseshoe) were predicted and are observed a all tests. When processed through horseshoe multipacting, it never comes back. But the capacitive multipacting is an issue.





Multipacting was seen to be not a problem because of small impact energy or low electric field.



DECISION FOR NEXT CAVITY
The second cavity will be built with inclined inner wall.
Manufacturing of second cavity will be completed in August.
Vertical tests are scheduled for September

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