STATUS OF THE SARAF SUPERCONDUCTING ACCELERATION MODULE

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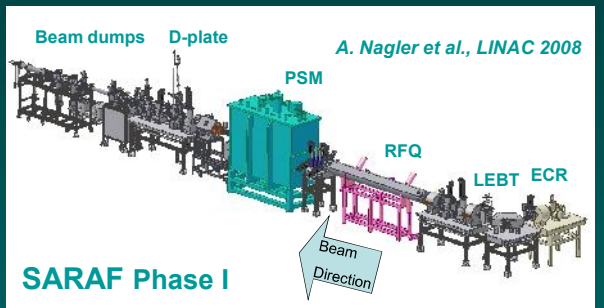
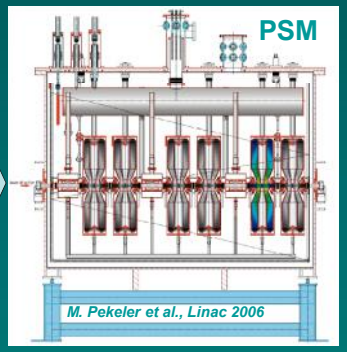
SARAF phase I and the Prototype Superconducting Module (PSM)

The accelerator at Soreq Applied Research Accelerator Facility (SARAF) is a linear, high current, 176 MHz RF accelerator designed for acceleration of 2 mA proton and deuteron beams up to 40 MeV. Phase I of the accelerator includes a normal conducting front end and a Prototype Superconducting Module (PSM) containing 6 half wave resonators. Currently, phase I of the accelerator is in operation at Soreq NRC.



HWR Parameters	
Operating Frequency	176 MHz
E_{peak} E_{acc}	25 MV/m 5.3 MV/m
$Q_0@E_{peak}$ $P_{dis}@E_{peak}$	>4.7×10^8 <10 W
Q_{ext} Bandwidth	~ 1.3×10^6 ~130 Hz
Operating Temperature	4.2°K
β_{geom} $L_{acc}=\beta\lambda$	0.094 ~160 mm

Beam Direction

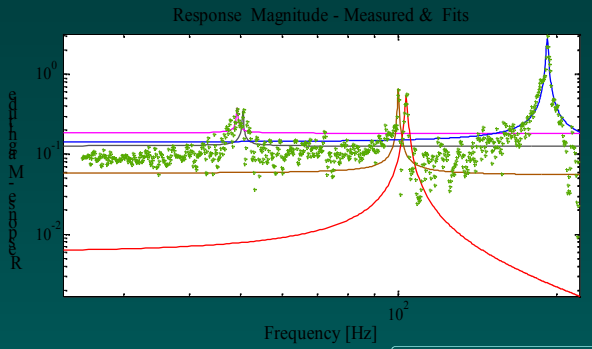


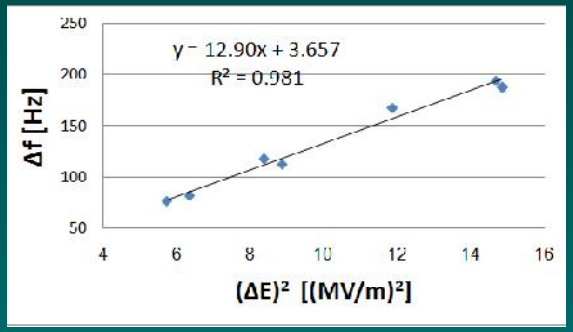
- Cryostat contains six half wave resonators
- Three superconducting solenoids for beam focusing
- Protons and Deuterons (2 mA) acceleration from 1.5MeV/u
- Separate insulation and cavity vacuum

Static and Dynamic Lorentz detuning

Dynamic Lorentz Force

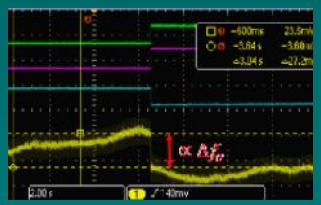
- A Phase Locked Loop was used to track the resonance frequency of the cavity
- A sinusoidal modulation of the field amplitude in the cavity was produced.
- The Lorentz Transfer function was measured for frequencies between 20 and 220 Hz.





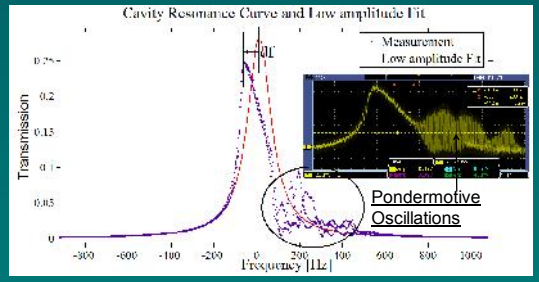
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5
Ω_m [Hz]	49.3	50.5	100	103	192
k_i Hz/(MV/m)²	0.42	0.27	0.38	0.49	3.5
Q_m	82	118	192	123	104

- Mechanical modes were identified
- A fit was used to extract each mode's parameters

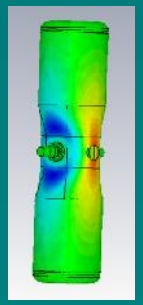


Static Lorentz Force

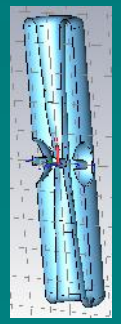
- The RF field in the cavity was pulsed and the resonance frequency shift was measured (Left, Top).
- A Network Analyzer was used to make high power frequency sweeps.
- The Cavity resonance curve was measured for different power levels (displayed to the right)
- When the cavity is driven off resonance with high amplitudes 200 Hz pondermotive oscillations start.



CST MWS Simulations



- CST MWS mechanical solver was used to calculate the cavity deformation resulting from a uniform pressure applied to its surface (Left)
- The resonance frequency of the deformed structure was evaluated using the Eigenmode solver and the frequency shift was calculated
- A preliminary design for a β=0.13 HWR and its figures of merit (Right)

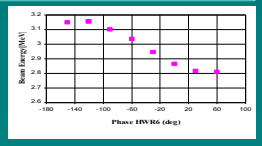


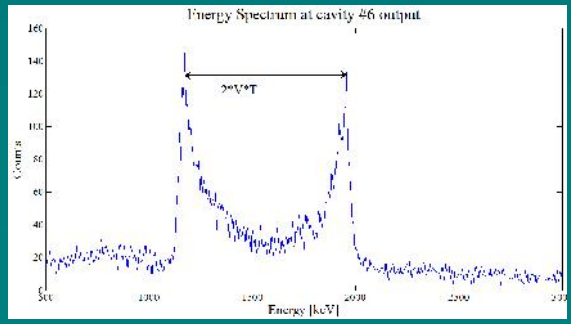
Parameter	Value	Units
β	0.13	
R/Q_0	231	Ω
G	43	Ω
E_{peak}/E_{acc}	4.13	
B_{peak}/E_{acc}	9.3	mT/(MV/m)
ω_0	176	MHz
$L_{acc}=\beta\lambda$	221	mm
L_{re}	260	mm

Beam Measurements

L. Weissman, DIPAC'09

- The RFQ and HWRs were operated using two RF frequencies resulting in a random phase between each beam bunch and the RF field
- The energy spectrum was measured using Rutherford Backscattering off a gold foil.
- Distance between the two peaks depends on the cavity voltage
- The actual cavity voltage can be extracted from the spectrum





SRF11, Chicago, USA, July 2011