SIMULATIONS AND FIRST RF MEASUREMENTS OF COAXIAL HOM COUPLER PROTOTYPES FOR PERLE SRF CAVITIES

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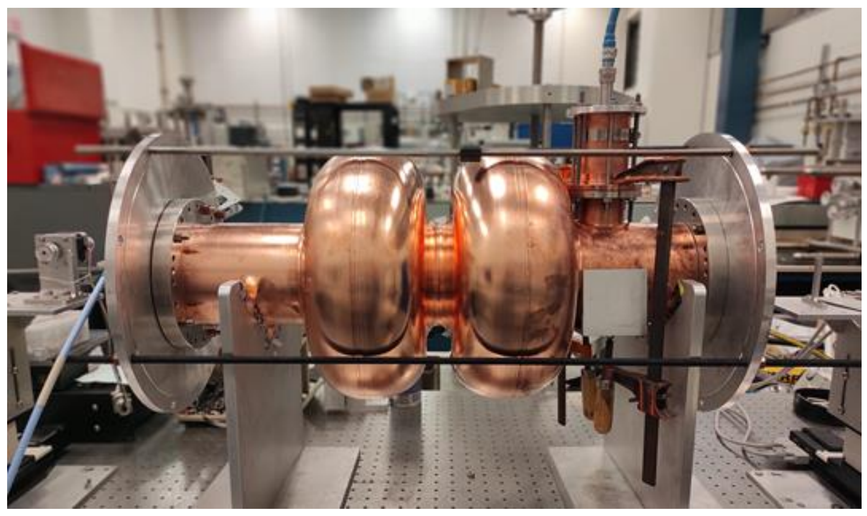
Introduction

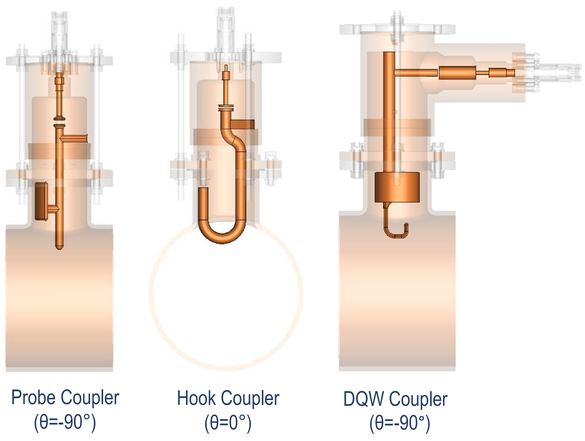
PERLE (Powerful Energy Recovery Linac for Experiments) is a multi-turn ERL based on SRF technology currently under study and to be hosted at Orsay.

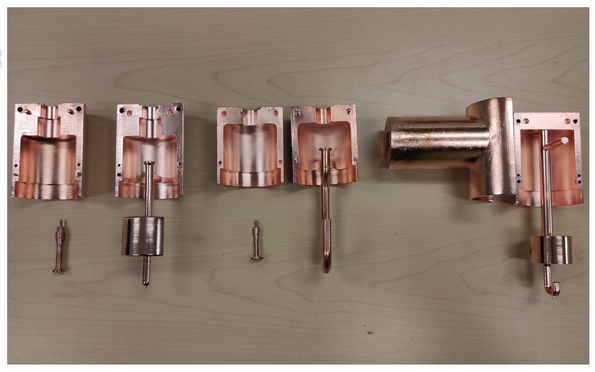


The installation of coaxial-type HOM couplers is being considered to mitigate the beam-induced HOMs effect. 3D-printed plastic and Cu-coated prototypes of optimized Probe, Hook, and DQW HOM couplers were fabricated to simulate and validate their RF performance on an 801.58 MHz 2-cell PERLE Cu-cavity.

HOM Coupler Prototyping

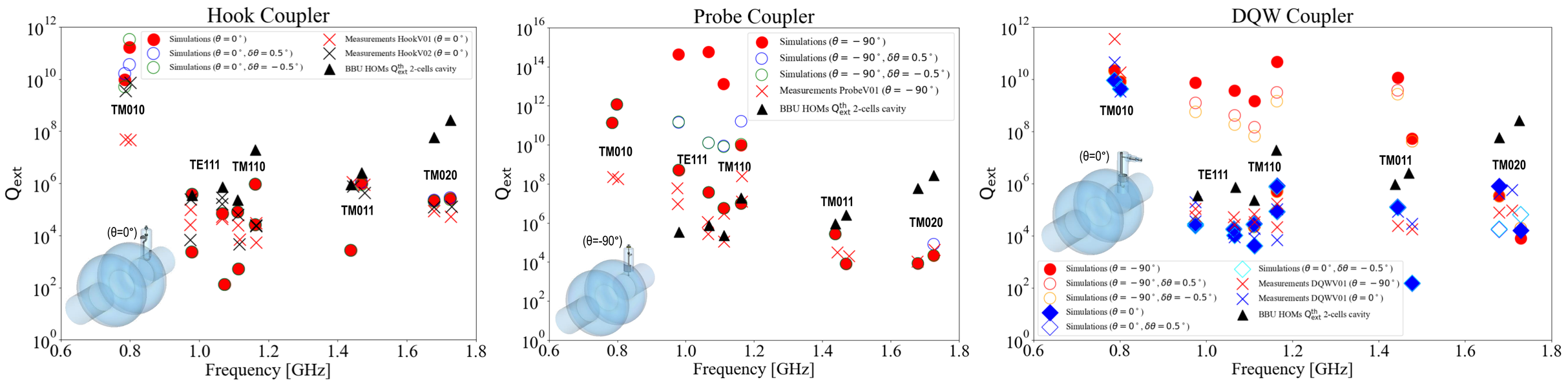
To evaluate in a design phase HOM coupler transmission behavior via low-power RF measurements at room temperature, expensive Nb coupler fabrication can be avoided.





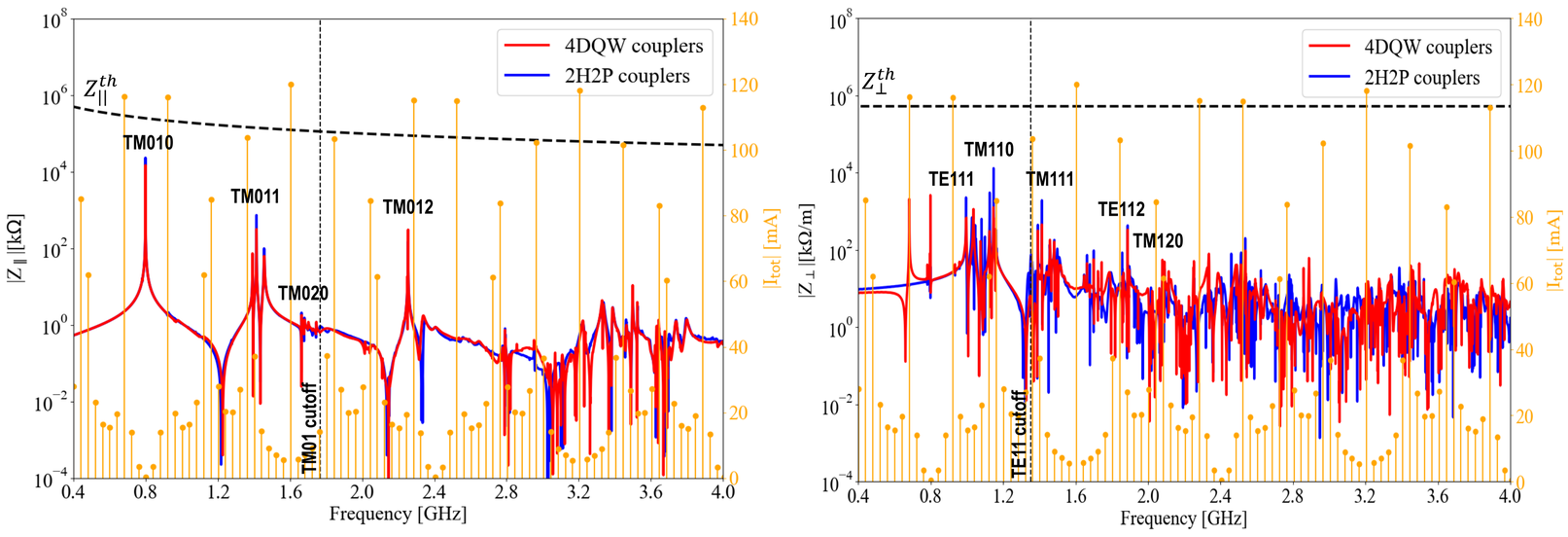
A potential cost-saving and time-efficient technique currently under development at CERN involves 3D-printing HOM couplers using epoxy and copper-coating the surface via electroplating to impart necessary electrical characteristics.

RF Measurements



The study found that simulated eigenmode CST results agree with measurements for the studied configurations. The couplers demonstrated satisfactory performance in rejecting the FM and in damping HOMs. Measured Q_{ext} values meet the BBU requirements. The DQW coupler is our preferred solution for damping both monopole and dipole HOMs. Some measured modes deviate significantly from their simulated value. This might be due to cavity imperfections and weak RF contact in the clamped assembly. Additionally, the orientation of the coupler can have a significant impact, as even a small tilt can cause a change in Q_{ext} by several orders of magnitude. Other sources of error include the challenges associated with measuring the separate polarizations of dipole modes in a VNA and obtaining accurate measurements of S11 and S22 for modes with wake coupling to the antennas.

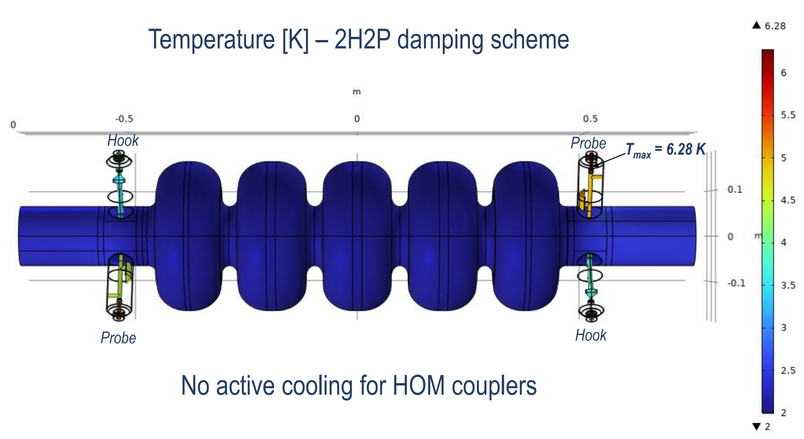
HOM Power Deposition and RF-Heating for the 5-cell Cavity – Conclusions



HOM Power Propagating Through Ports

	P^*_L [W]	P^*_M [W]	P^*_H [W]	P^*_{tot} [W]	BPs [%]	FPC [%]	Hooks [%]	Probes [%]	DQWs [%]
2H2P	5.66	9.16	60.39	75.21	82.17	10.49	2.57	4.77	-
4DQW	4.20	7.97	52.57	64.74	76.71	14.40	-	-	8.89

P^*_L (HOM power from 0.802 to 2.4 GHz), P^*_M (HOM power from 0 to 4 GHz), P^*_H (HOM power above 4 GHz), P^*_{tot}(HOM power for the whole beam spectrum)



No active cooling for HOM couplers

The 4DQW damping scheme shows promising results in damping both monopole and dipole modes below the BBU stability limits. Coaxial couplers have a small ratio of power extraction, and BP absorbers are needed to absorb the power propagating out of the BPs. The probe coupler's upper antenna on the cavity's FPC side reaches a maximum temperature of 6.28 K due to dynamic RF-heating load when no active cooling is applied to the HOM couplers.