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Latest cryogenic test results of the superconducting beta=0.069 CH-cavities for the HELIAC-project

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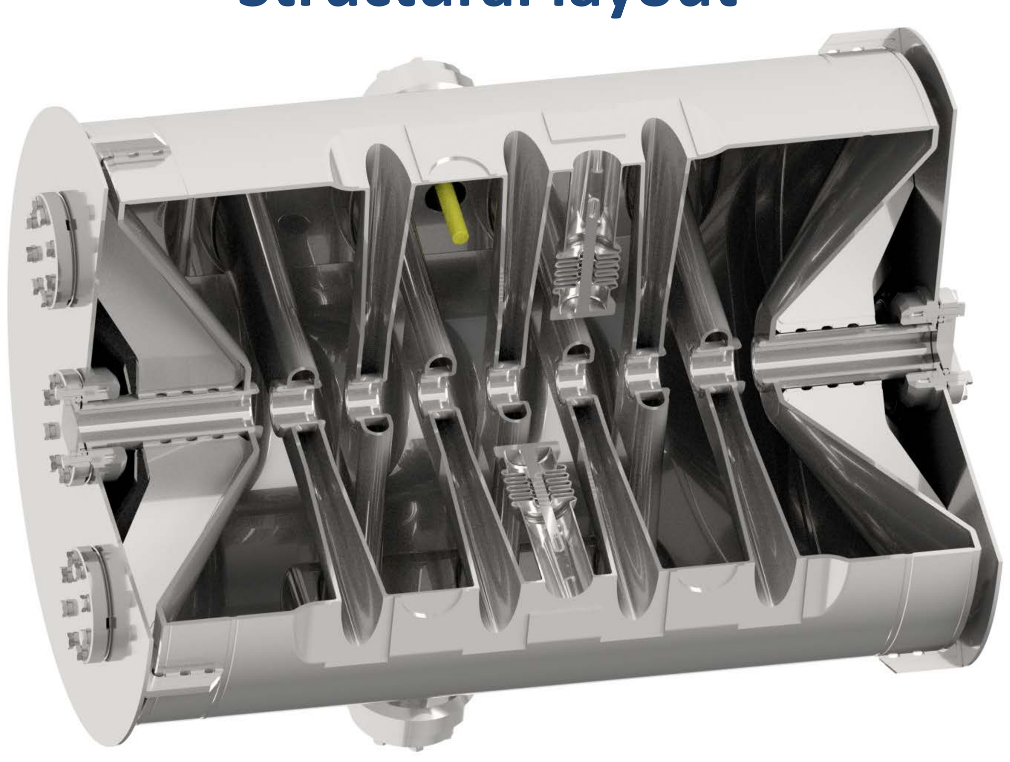
Abstract:

The upcoming FAIR (Facility for Antiproton and Ion Research) project at GSI will use the existing UNILAC (UNIversal Linear Accelerator) as an injector, reducing the beam time for the ambitious Super Heavy Element (SHE) program. To keep the UNILAC user program competitive a new superconducting (sc) continuous wave (cw) high intensity heavy ion LINAC should provide ion beams with max. duty factor above the coulomb barrier. The fundamental sc LINAC design comprises a low energy beam transport (LEBT)-section followed by a sc Drift Tube Linac (DTL) consisting of sc Crossbar-H-mode (CH) structures for acceleration up to 7.3 MeV/u. The latest milestones towards the new cw LINAC HELIAC (HELmholtz LInear ACcelerator) have been the successful tests and commissioning of the first demonstrator section with heavy ion beam in 2017 and 218 as well as the successful test under cryogenic conditions of the second CH-cavity in 2018. Now the third CH-cavity has been tested at cryogenic temperatures of 4 Kelvin at the Institute for Applied Physics (IAP) at Goethe University Frankfurt (GUF). The results of these measurements as well as the status of the HELIAC-project will be presented.

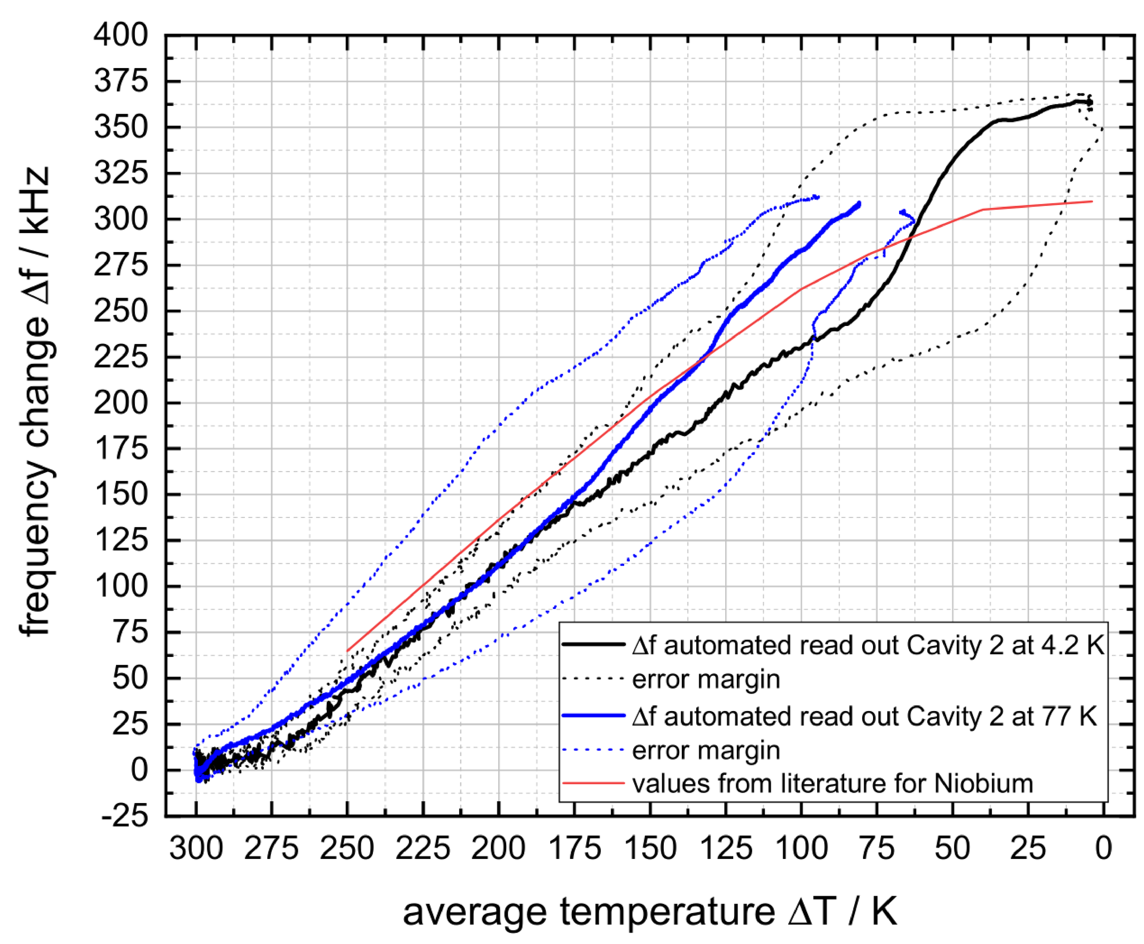
Structural layout



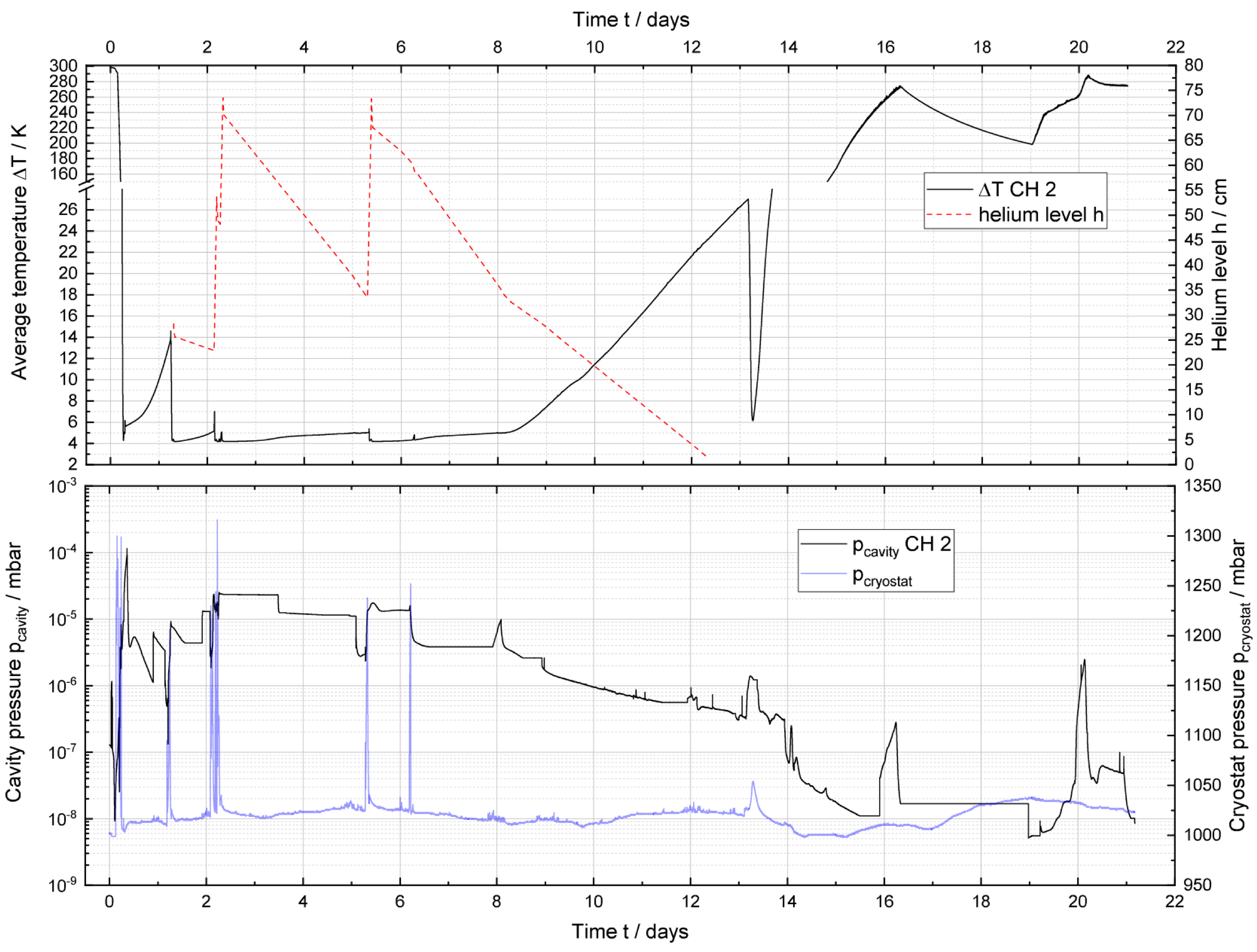
Parameter	β	f	Eff. Length (βλ-def.)	Inner diam.	E_a	E_p/E_a	B_p/E_a	G	R/Q
Unit	-	MHz	mm	mm	MV/m	-	mT/(MV/m)	Ω	Ω
Value	0.069	216,816	381.6	400	5 .5	6.5	< 10	51	1050

Cooldown of CH 2 at 4.2 K

- The frequency change from room temperature to 4.2 K was Δf ≈ 264 kHz
- Intermediate measurements during the construction phase with liquid nitrogen suggested Δf ≈ 244 kHz at 4.2 K
- The finale resonance frequency at 4.2 K was 216.816 MHz which is ≈ 10.8 kHz above the design frequency



Long term recording during cold test of CH 2



- Due to design faults the power coupler and pickup have been manufactured without ventilation holes
- The enclosed air inside the couplers could only be evacuated via their screw thread
- After one week of active evacuation we started the cooldown with a cavity pressure around $1 \cdot 10^{-7}$ mbar
- During the cooldown the pressure dropped down to $1 \cdot 10^{-8}$ mbar for a short time
- With increasing helium level the pressure rose several orders of magnitude up to $1 \cdot 10^{-4}$ mbar
- The ion getter pump was not sufficient to handle the rapid increase; an additional turbomolecular pump was used
- After three days the pressure was constant in the range of $1 \cdot 10^{-5}$ mbar while a helium gas detector delivered helium leakage rates about $5 \cdot 10^{-4}$ mbar l / s
- This indicated a cold leak so that we aborted test
- The next consecutive step will be a in-depth search for the position of the leak under warm conditions

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