Karlsruhe Institute of Technology

European Research Council
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GRAVITHELIUM
Gravitational wave detectors cooled with superfluid helium

Institute for Beam Physics and Technology
Institute for Technical Thermodynamics and Refrigeration

Conceptual design of a low noise lab-scale He-II supply unit for Q-factor measurements of cryogenic suspensions in GRAVITHELIUM

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GRAVITHELIUM

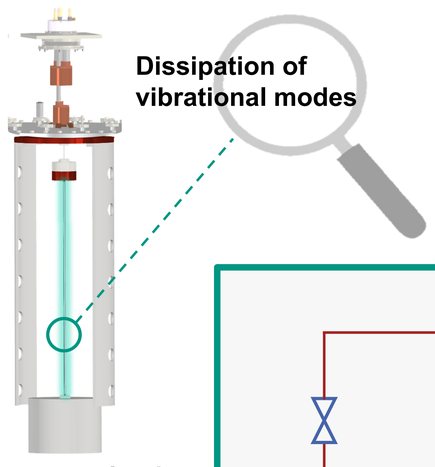
Campaign I

Monolithic suspensions, empty titanium suspension tubes

Campaign II

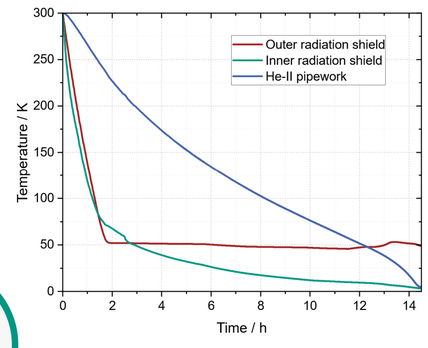
He-II filled titanium suspension tubes

Investigation of dissipation mechanisms in He-II for ultra-low-noise applications

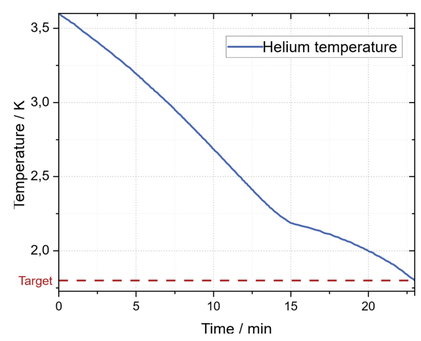


Cool-down

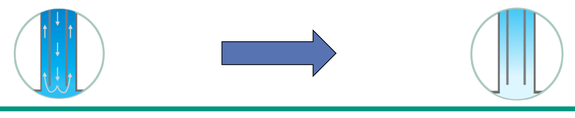
Cool down in ~ 15 hours



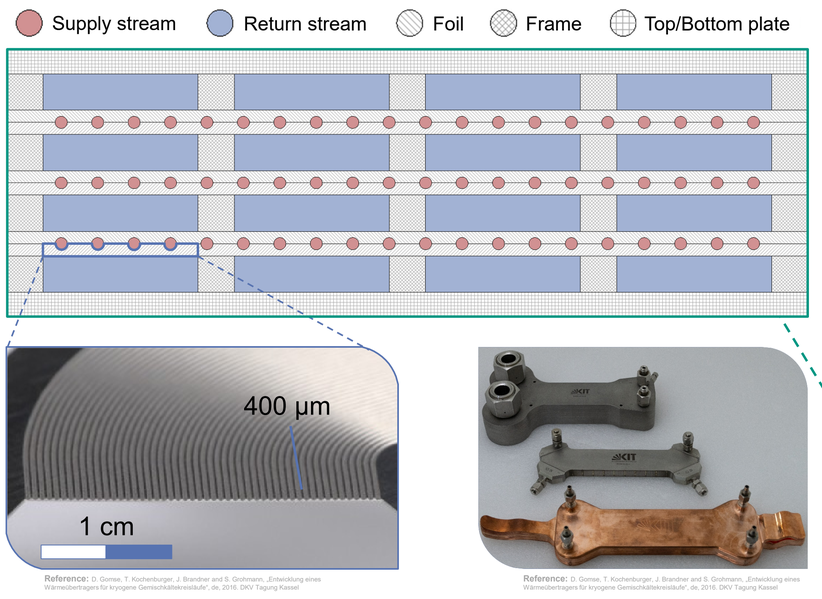
Phase 1: Supercritical helium flow

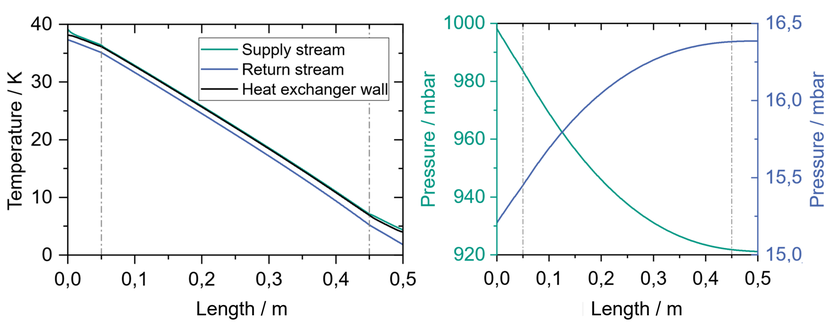


Phase 2: Pumping on the He-bath

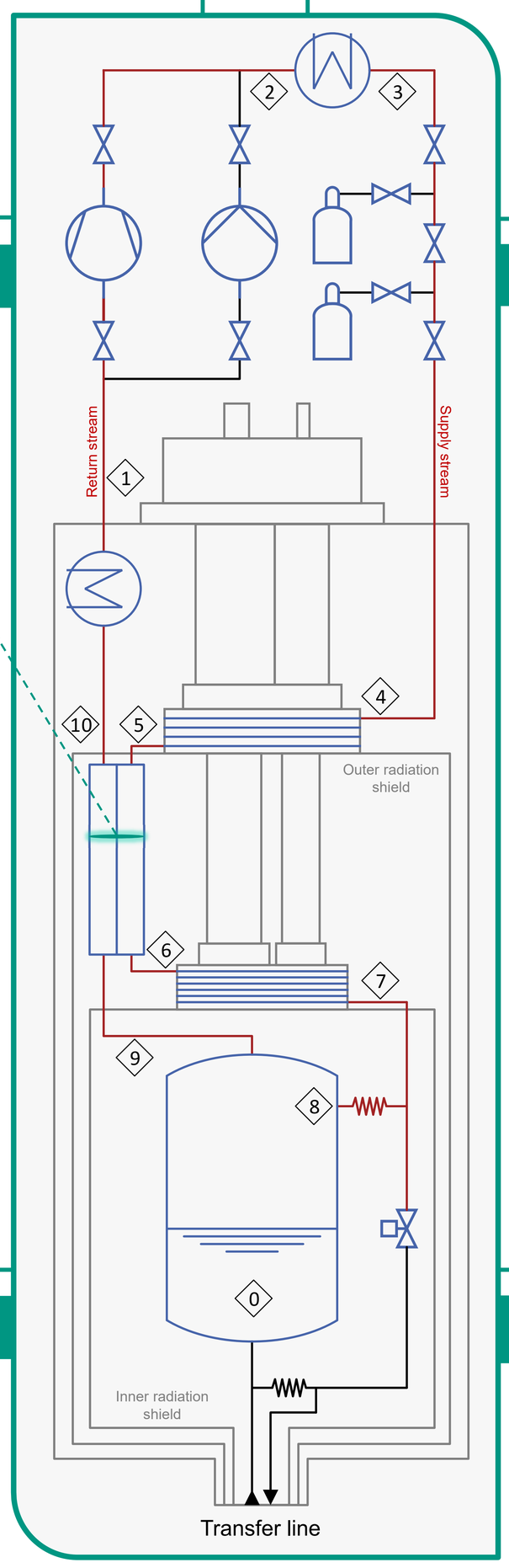


Foil-frame-counter-flow-heat-exchanger





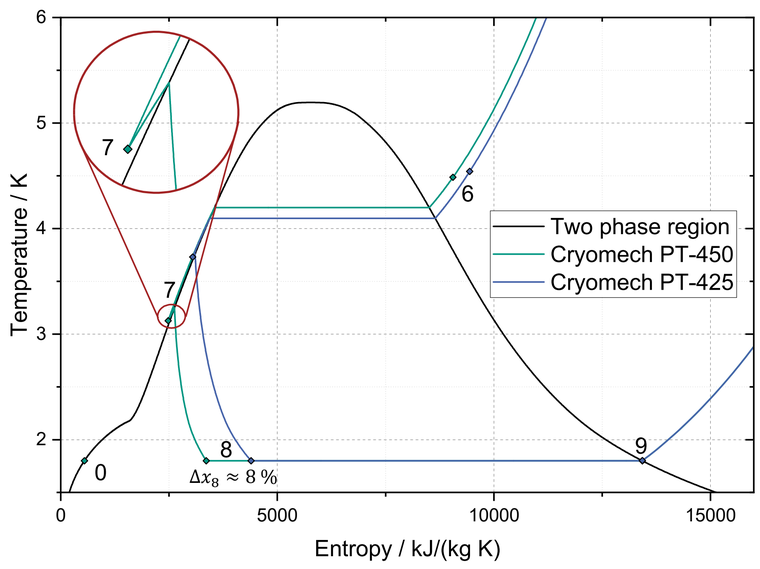
	$\dot{Q}$ / W	T_{in} / K	T_{out} / K	p_{in} / mbar	p_{out} / mbar	Δp / mbar
Supply stream	4	39	4.5	998	991	7
Return stream	4	1.8	37	16.38	15.15	1.23



Steady-state

	PT-425	PT-450	Bluefors [1]	Jahromi [2]
T_{He} / K	1.8	1.8	1.8	1.76
$\dot{Q}_c$ / mW	400	400	440	250
$\dot{Q}_{c,max}$ / mW	640	1000	-	-
x_8 / %	70	78	-	-
$\dot{M}$ / $\frac{mg}{s}$	24.7	22.2	-	-
P_{el} / kW	14	25	>12	8.8

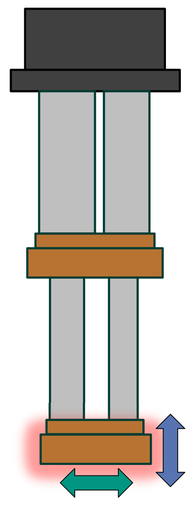
[1] PT425 1K Pulse Tube Cryocooler. Bluefors.com. Feb. 22, 2019. https://bluefors.com/products/pulse-tube-cryocoolers/pt425-1k/
[2] Amir E. Jahromi et al., Modeling, development, and experimental validation of a Joule–Thompson superfluid refrigerator using a pulse tube cryocooler

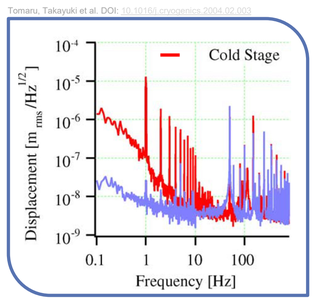


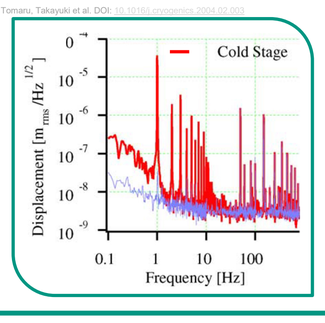
400 mW @ 1.8 K achivable with the PT-425 or PT-450
cooling powers of up to 1 W theoretically possible

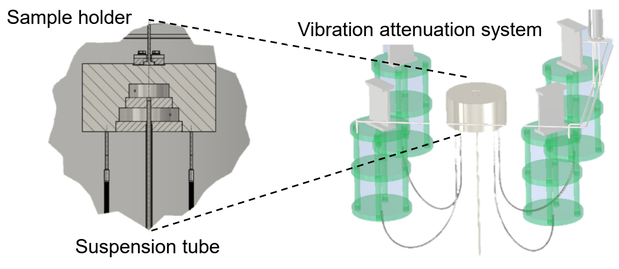
Vibration attenuation system for GRAVITHELIUM

Main vibration source

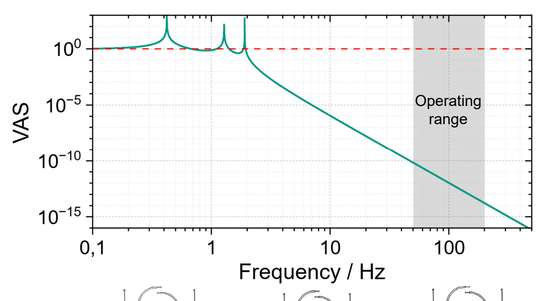


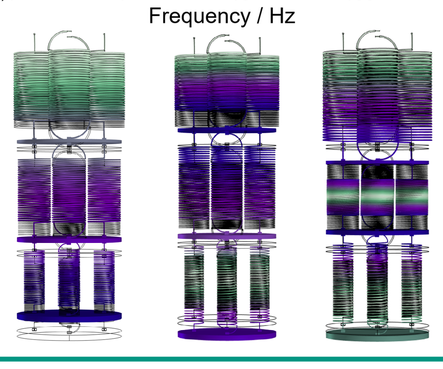


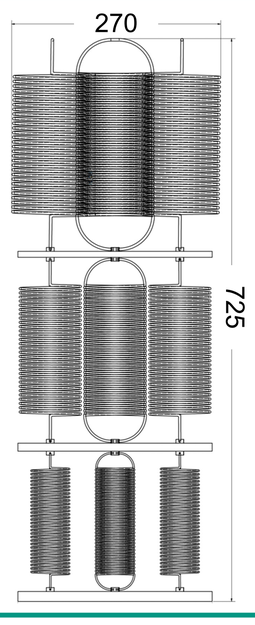




Proof of concept for a He-II attenuator







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