Superconducting nanowire single X-ray photon detector based on WSi

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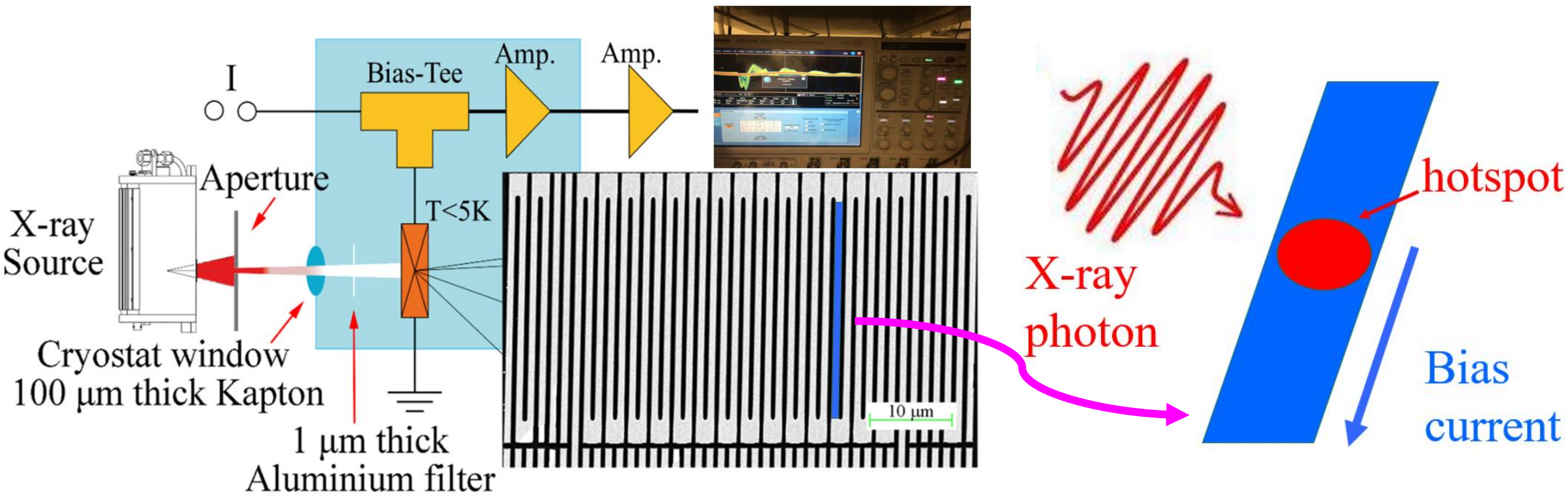
FNSNF Swiss National Science Foundation

Universität Zürich Physik-Institut

Operation of the WSi-X-SNSPD

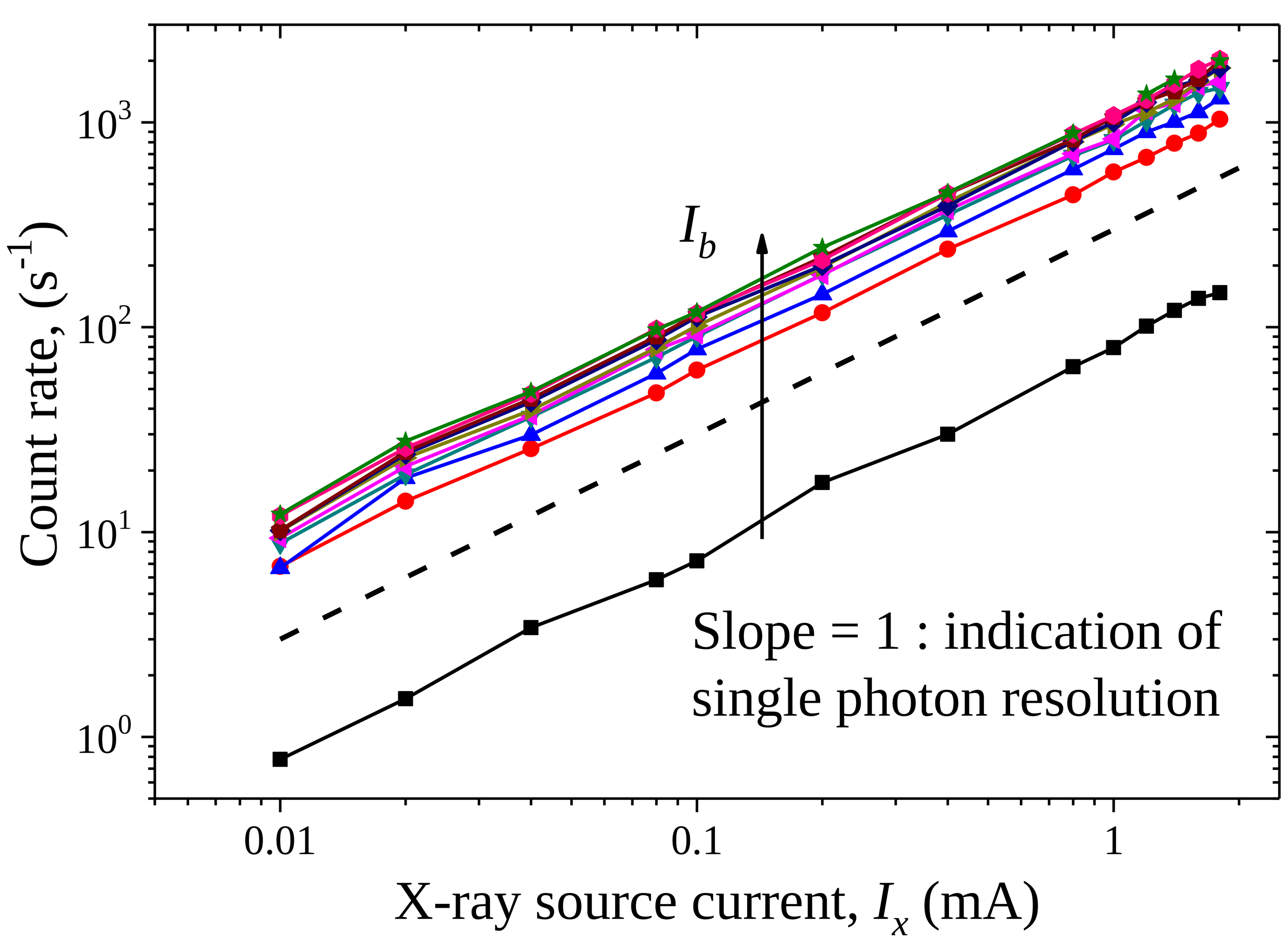


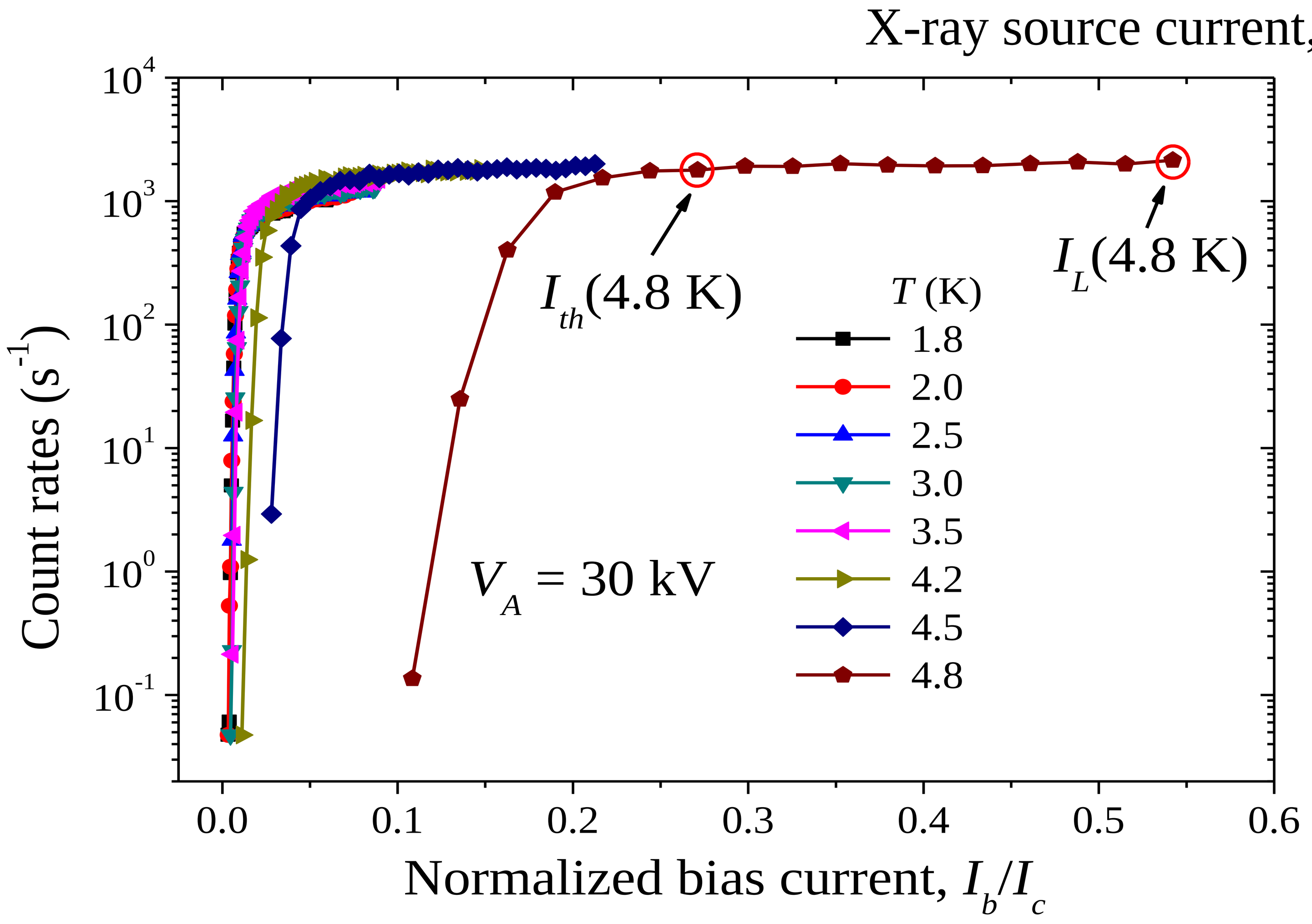
An incident X-ray photon will break Cooper pairs and induce a normal conducting **hotspot**. The hotspot shunts the bias superconducting current into the amplifier, and the resulting detection signals are collected by an oscilloscope.

A 100 nm thick superconducting WSi film with T_C ~ 5 K was prepared by magnetron sputtering technique. The narrow stripes (~ 900 nm) were then patterned by electron-beam lithography with hydrogen silsesquioxane (HSQ) resist and etched by reactive ion etching in SF_6. The experiment has been carried out in a *Janis* He-3 bath cryostat, and the X-ray photons come from an X-ray tube with a W target from *Oxford Instruments*.

characteristics of the detector

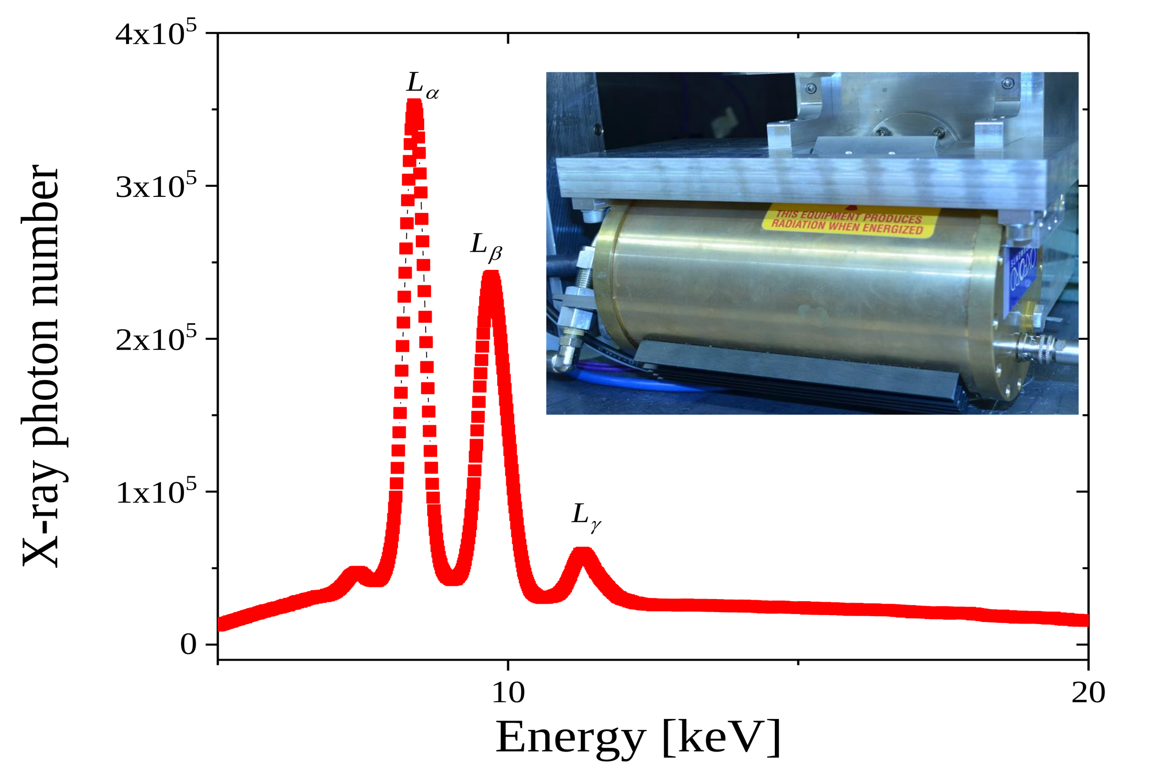
Demonstration of the single-photon detection ability. The dashed line shows a slope of unity.



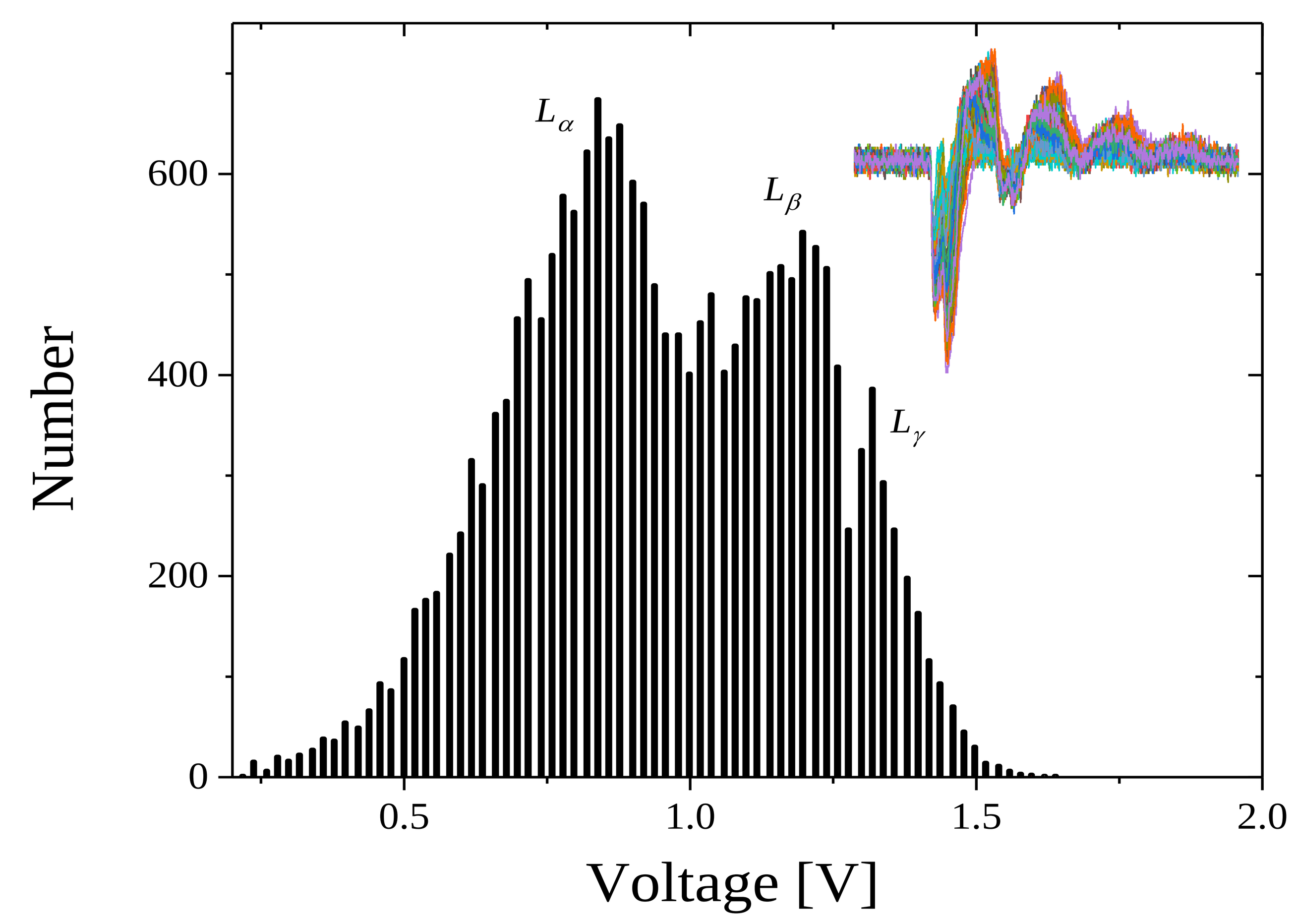


Count rates as functions of the reduced bias current (normalized by the critical current at each temperature) with an acceleration voltage of 30 kV .

Possible energy resolution of the detector



Characteristic X-ray spectrum from the X-ray tube with a W target.



Histogram of the pulse amplitude distribution with I_b = 70 µA at T = 2 K. Inset: detection signals collected by the oscilloscope.

Comparison with previous X-SNSPDs

Sample	T_c (K)	w (nm)	size (µm²)	CPSPSM (cps)	rise time (ps)	hotspot (nm)	I_L/I_c	I_{th}/I_c
Nb	8.40	360-410	131×55	0.2	250	420	5.5% @1.75K	——
TaN-A	6.70	275-340	35×33	2.1	750	540	52% @1.85K	8% @1.85K
TaN-B	7.00	1800-1900	66×119	1.3	910	——	32% @1.85K	——
$W_{0.8}Si_{0.2}$	4.97	920	41.6×28	2.7	400	874	54% @4.8K	5% @1.8K

Summary and outlook

Compared with other superconducting materials for SNSPD fabrication, WSi based detectors have a better detection efficiency due to the relatively high X-ray photon absorption. Though the critical temperature is lower than in other superconducting films used for detector fabrication, the WSi detector can be operated just below its critical temperature (T_C ~ 5 K), above the boiling point of liquid helium (~ 4 K).

Xiaofu Zhang, Qiang Wang, and Andreas Schilling, AIP Advances **6**, 115104 (2016)