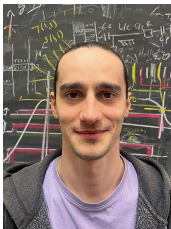


Nanofabricated bolometers with ribbon resonators



Ilya Golokolenov (Basel/Grenoble), Eddy Collin (Grenoble),

Lev Levitin, Andrew Casey (Royal Holloway)

Elizabeth Leason (Oxford), Dmitri Zmeev (Lancaster)

QUEST DMC meeting, Liverpool, 17 October 2025

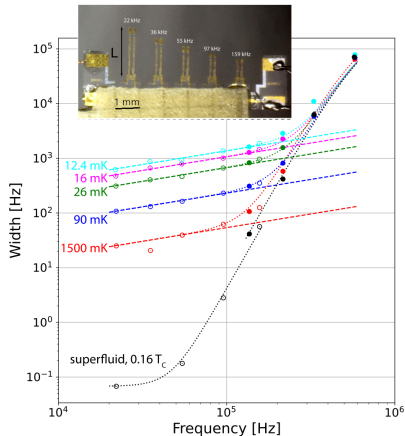
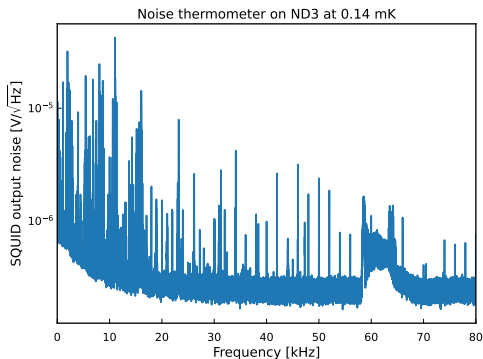
Motivation

Large cross section-to-mass ratio: strong coupling to quasiparticles

Scalability for arrays of small ($\sim 1 \text{ mm}^3$) bolometers

Well-defined frequencies and vibrational modes

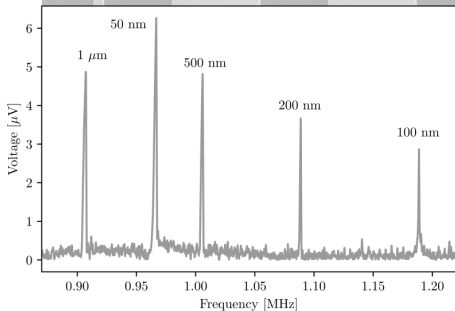
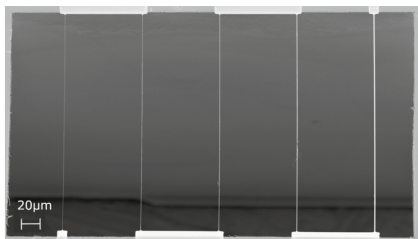
10-100 kHz range: no fridge vibrations, no acoustic emission



[MT Noble *et al.*, *APL* **122**, 163502 (2023)]

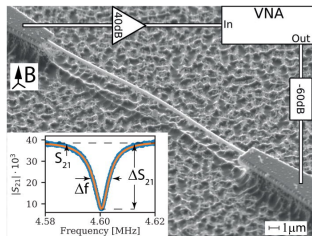
Nanofabricated mechanical resonators for superfluids

Grenoble: 100 nm strained Si_3N_4 + 30 nm Al



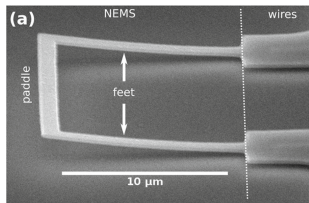
[I Golokolenov *et al.*, *JLTP* **210**, 550 (2023)]

Lancaster: 100 nm Al, $f_0 = 0.6\text{--}8$ MHz



[MT Noble *et al.*, *APL* **125**, 073502 (2024)]

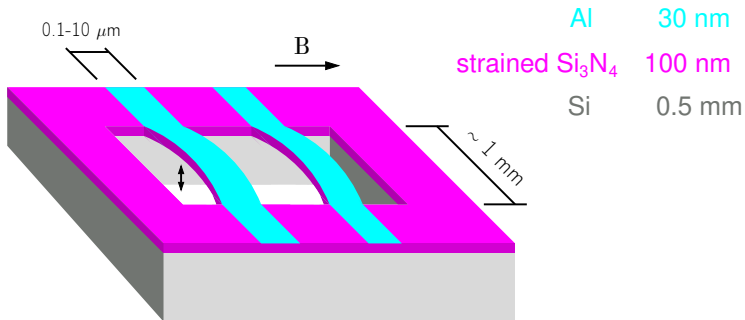
Helsinki: 150 nm Al, $f_0 = 0.4$ MHz



[T Kamppinen and VB Eltsov, *JLTP*, **196**, 283 (2019)]

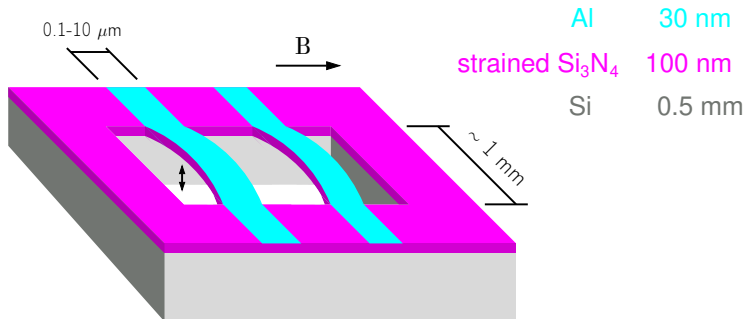
Ribbon resonators

Proposal: Grenoble beams with increased width



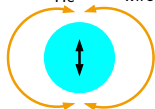
Ribbon resonators

Proposal: Grenoble beams with increased width

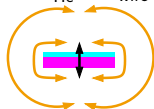


Sharp corners: small critical velocity?

$$\max v_{\text{He}} = 2v_{\text{wire}}$$



$$\max v_{\text{He}} \gg v_{\text{wire}}?$$

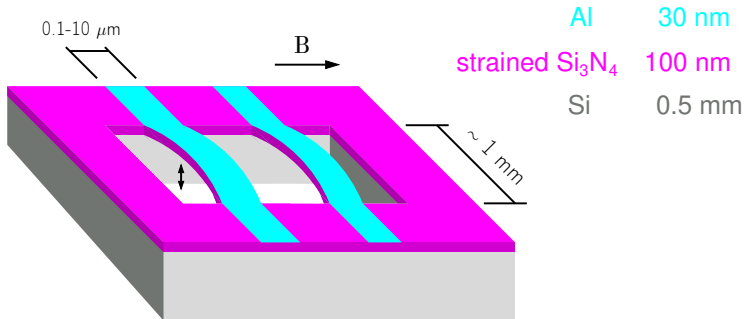


[side view]

Maybe not: [T Kamppinen and V Elstov, *unpublished*]

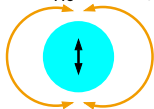
Ribbon resonators

Proposal: Grenoble beams with increased width



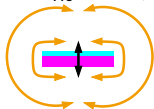
Sharp corners: small critical velocity?

$$\max v_{\text{He}} = 2v_{\text{wire}}$$



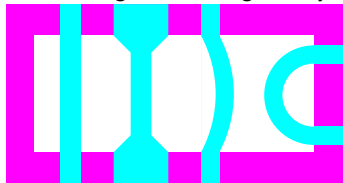
[side view]

$$\max v_{\text{He}} \gg v_{\text{wire}}?$$

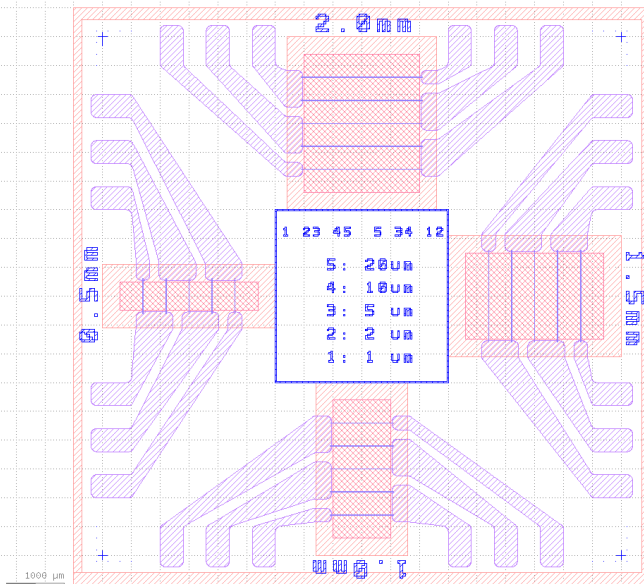


Maybe not: [T Kamppinen and V Elstov, *unpublished*]

Controlling strain with geometry



[top view]



Tests:

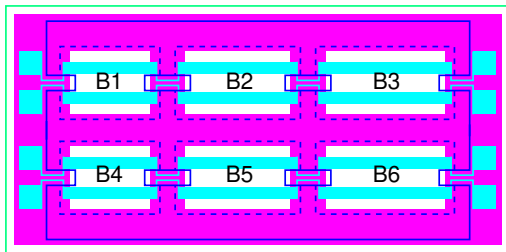
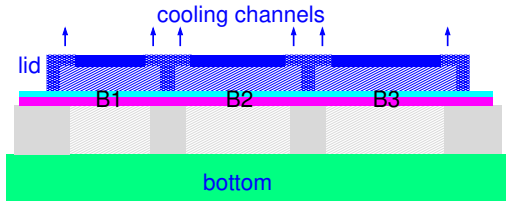
frequencies and widths in vacuum, response to helium, acoustic emission, reproducibility and reliability.

Other designs:

Bent ribbons

Narrow ribbons to explore decoupling from superfluid ^3He

Nanofabricated bolometers



Superfluid devices with stepped confinement:
[P Heikkinen *et al.*, *JLTP* **215**, 477 (2024)]

Precise bolometer volumes
and cooling channels.

Assembly in cleanroom. Protection of
ribbons from dust and damage.

Challenge: need to bond 3 wafers,
but leaktight bond not required.
May use individual lids and bottoms.
[X Rojas and JP Davis, *PRB* **91** (2015)]

Electrical leads in the cooling channels

Multiplexing: offset resonances
i.e. by varying ribbon lengths.
High reliability is essential.

