

In-house Development of Scientific Instrumentation

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Who are we and what do we do?

The **Correlated Quantum Matter group** is jointly funded by UZH and PSI, where it is part of the Laboratory for Neutron and Muon Instrumentation (LIN).

Research topics

- The overarching theme of our research are quantum materials governed by strong electronic correlations
- We work on discovering and understanding novel quantum states such as quantum spin liquids, skyrmion lattices, novel superconductors.
- We probe and tune properties of quantum materials to establish their functionality

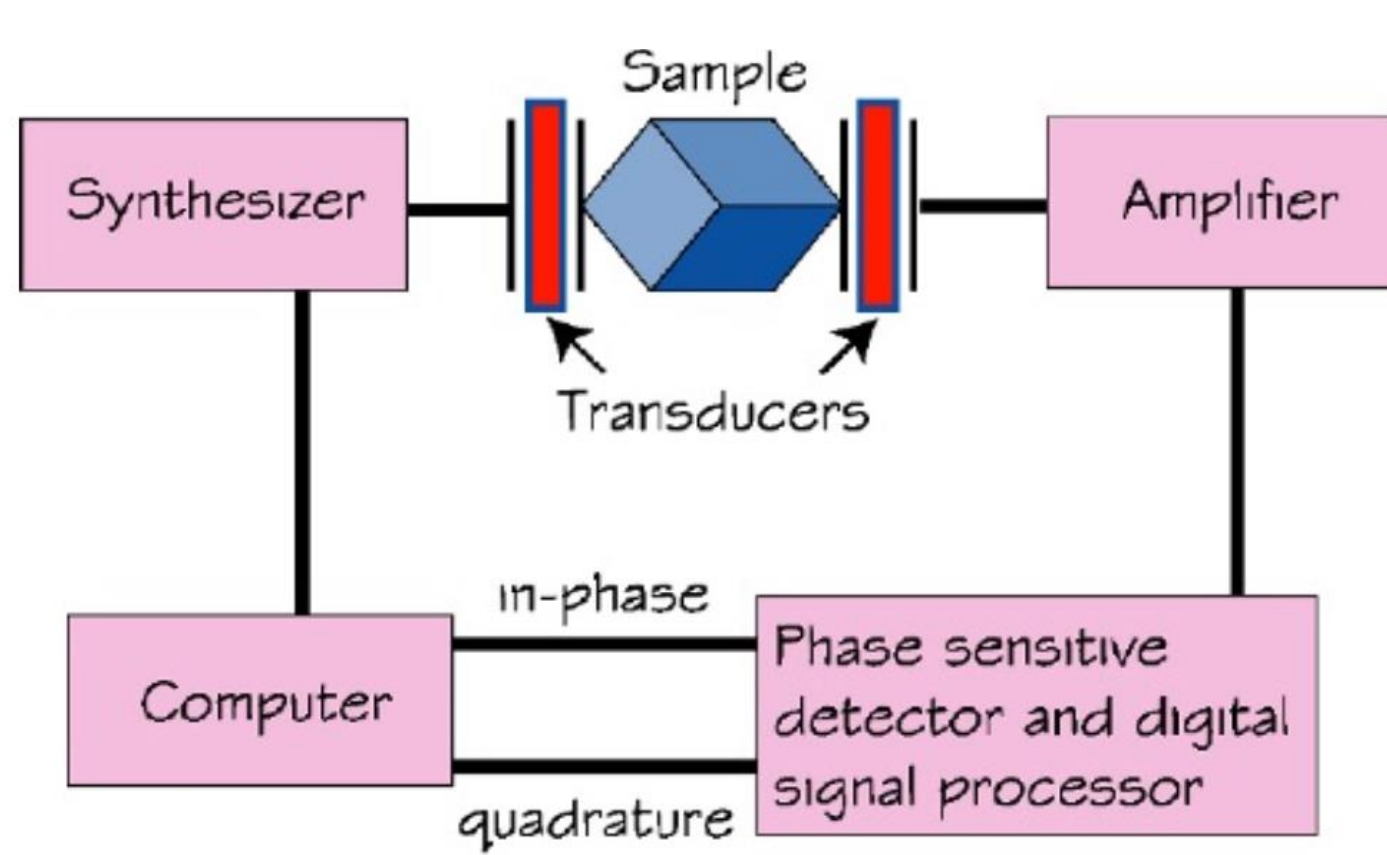
How do we do this?

- Develop scientific instruments to probe coupling of charge, spin and lattice degrees of freedom.
- Develop ways to tune materials (e.g. with strain)
- At the same time, we actively build synergies between UZH and PSI through LIN

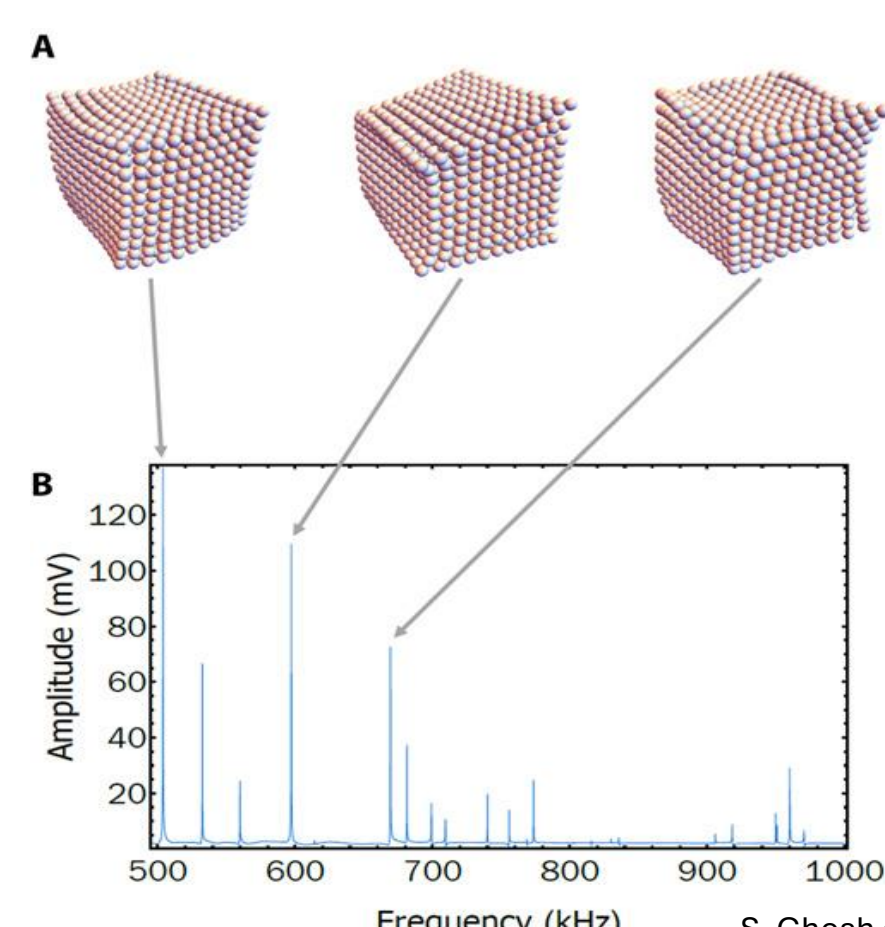
Resonant Ultrasound Spectroscopy

Motivation:

Resonant Ultrasound Spectroscopy (RUS) is highly sensitive to changes in the eigen vibration modes. It is able to measure all elastic moduli C_{ij} simultaneously. Thus, all quantum phenomena, which couple to lattice can be detected. RUS is probes symmetry breaking of the lattice and can discover new phases.

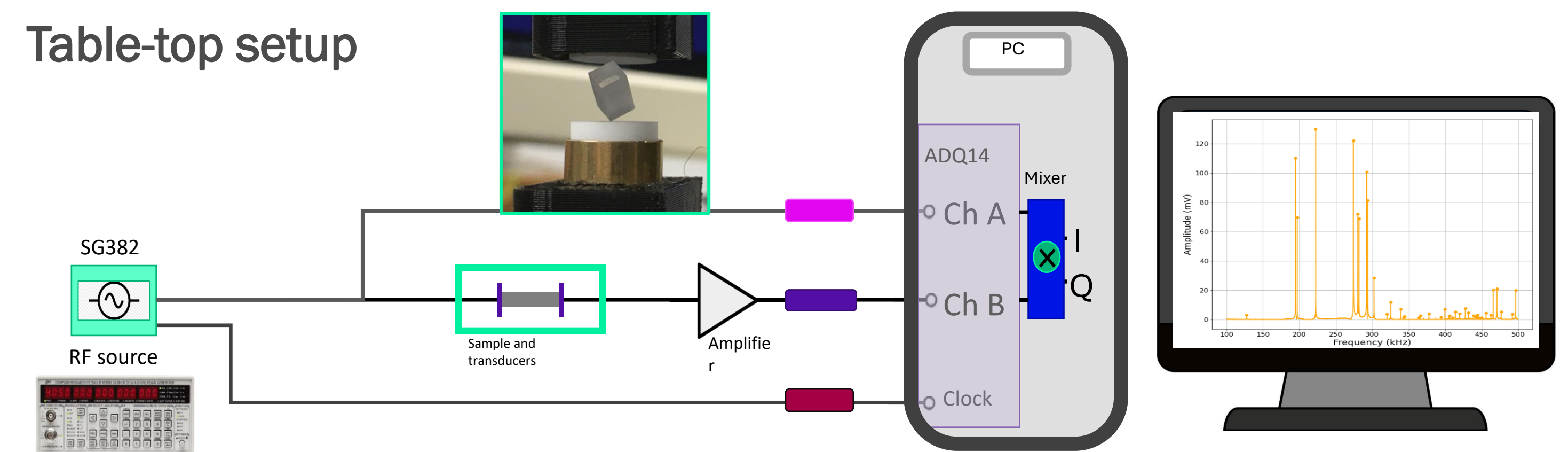


A. Migliori et al, Physica B. **183**, 1-14 (1993)

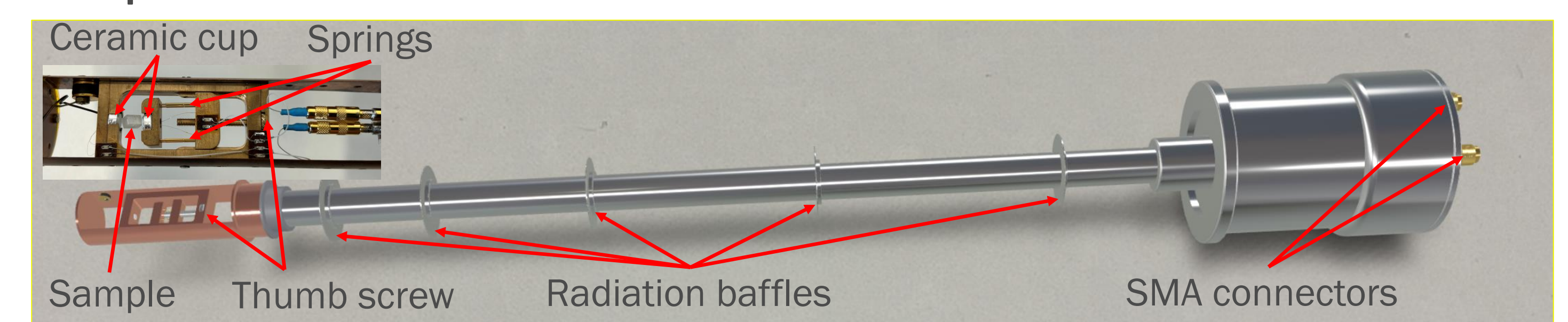


S. Ghosh et al, Science advance. **6**, 10 (2020)

Table-top setup



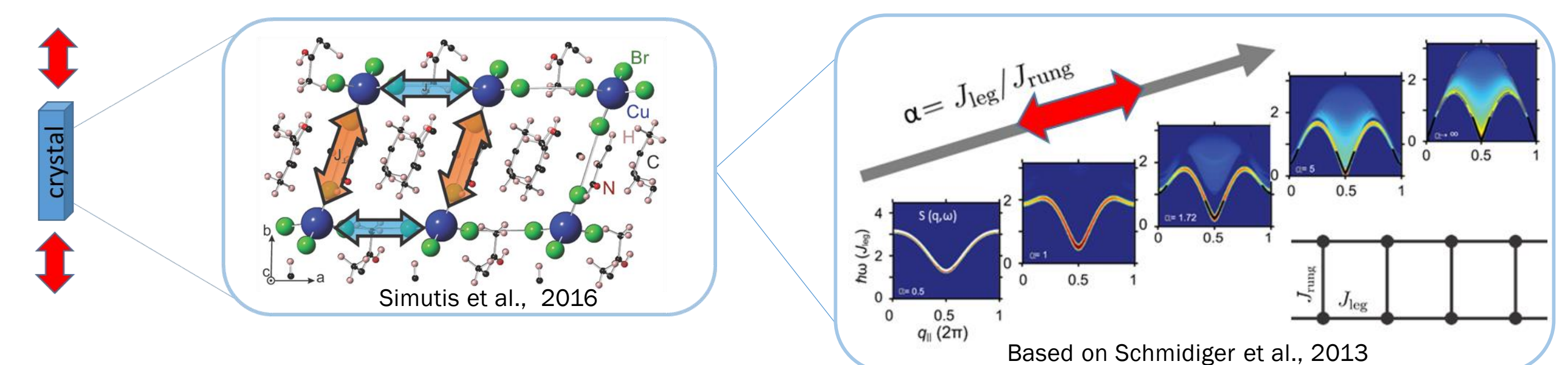
Sample stick for PPMS:



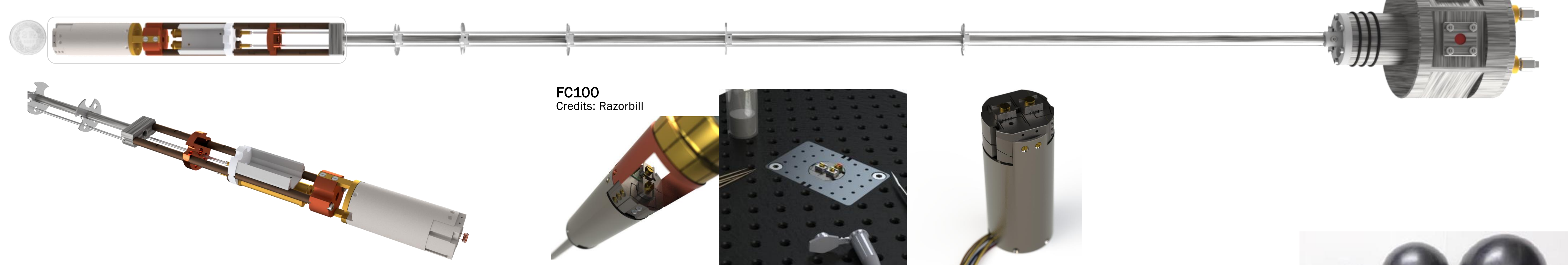
Nuclear Magnetic Resonance under strain

Motivation: Quantum Properties "On Demand"

- Emergent properties of quantum matter ultimately depend on the overlap of the electronic wavefunctions between different atoms
- Insulating limit: control of the antiferromagnetic exchange energy.
- Metallic limit: small changes in Fermi surfaces can lead to dramatic modifications of quantum phases



Tools: NMR and Uniaxial Pressure Cells



FC100 Credits: Razorbill

High-energy neutron spectrometry

Motivation: Measure fast neutron background for improved shielding

- Fast neutron beam is stopped by a stack of stainless-steel and polyethylene discs, scattering fast neutrons out of the way, allowing for neutron background measurements behind it.
- Black spheres: moderator (shells) & detector (^3He , at the sphere's center).
- Access a wide energy range: combine spheres of different sizes and moderator materials.
- Experimental goal: develop new detectors with extended energy range (10^{-2} eV – 10^8 eV) and sharper resolution, to accurately measure the entire neutron spectrum, for more effective shielding solutions.

