DESIGNING CYROGENIC COMPONENTS FOR FRACTIONAL QUANTUM HALL EFFECT MEASUREMENTS.

What is Fractional Quantum Hall (FQH) Effect?

- Arises in 2D electron gas under high magnetic fields and ultra-low temperatures
- Hallmarked by the zero longitudinal resistance and quantized Hall resistance
- Phenomenon is explained by theory of FQH states

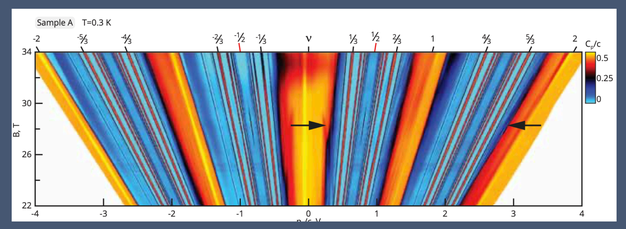

IMAGE shows Penetration field capacitance (CP) plotted vs magnetic field (B) and electron density (n0) for even-denominator FQH in monolayer graphene.
IMAGE from Zibrov, A. et Al. Nature Phys 14, 930–935 (2018)

FQH Measurements

- We make transport measurements on nanodevices made up of *graphene* layers
- Need low noise levels and ultra-low electron temperatures (<25mK)
- Need *cryogenic devices*

Why do we care?

- Promising application in *quantum computation*
- Theory predicts "non-abelian" FQH states with exotic properties
- Such states enables topological material immune to impurity.

LITERATURE REFERENCE

McClure, Douglas. 2012. Interferometer-Based Studies of Quantum Hall Phenomena. Doctoral dissertation, Harvard University.
Rasmussen, Katrine and Olsen, Christian J. S. Measuring Fractional Quantum Hall Effect. Bachelor's Thesis, University of Copenhagen

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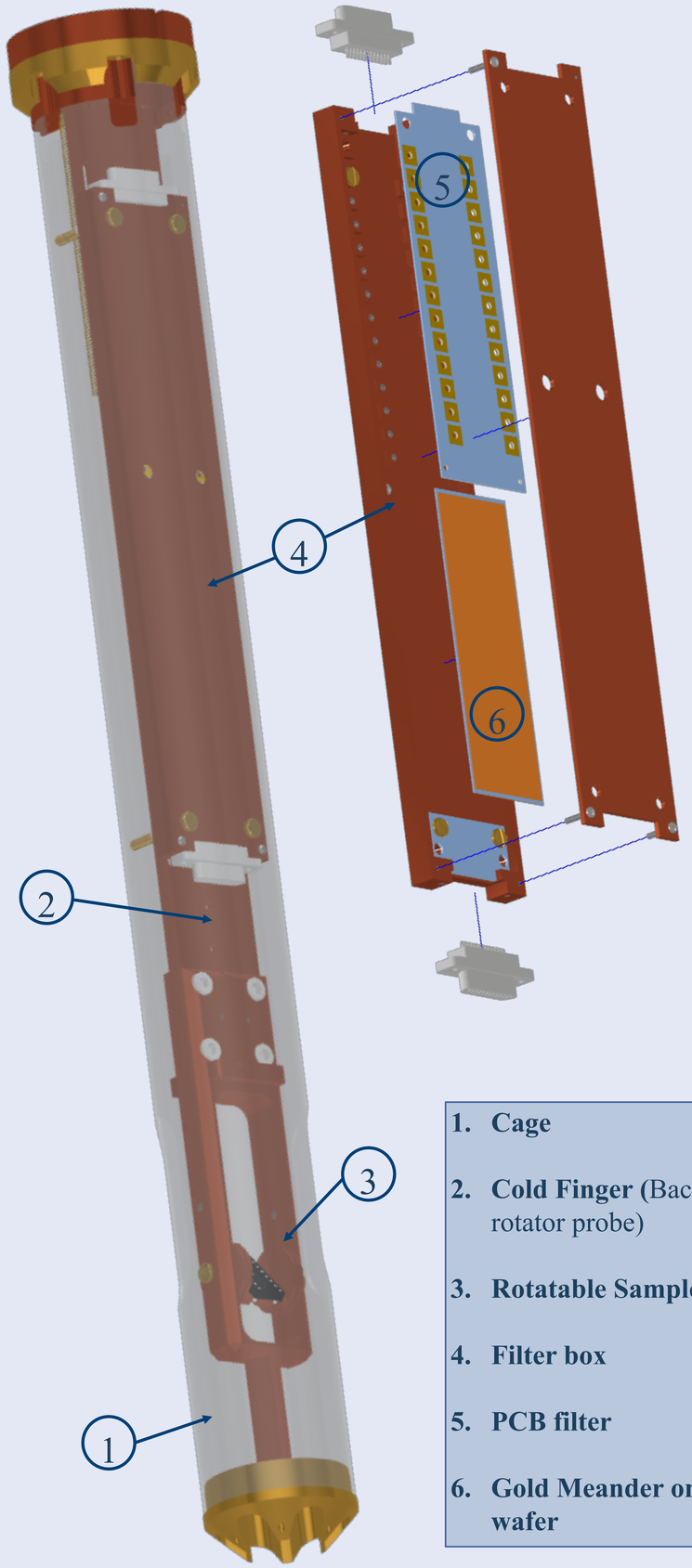
RESULTS



1. **Cage**
2. **Cold Finger (**Backbone of the rotator probe)
3. **Rotatable Sample Holder**
4. **Filter box**
5. **PCB filter**
6. **Gold Meander on quartz wafer**

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GOAL

Redesign cryogenic measurement device components to improve signal resolution.

METHOD

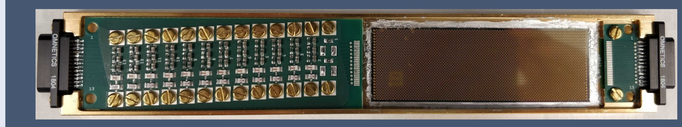
Focus: Filter box and Rotator Probe for transport measurement used in the cryogen-free dilution fridge.

Problem:

- transport measurements require wiring connected to room temperature
- but the mixing chamber in the fridge (where the sample) requires insulating since FQH measurements require low temperature

Solution:

- PCB containing RC and packaged filters: (LEFT)
- Gold meander on quartz wafer: cools the electrons (RIGHT)



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