



# Beyond the Basics

## Complex Sample Environments for the Large Scale Facilities of PSI

Marek Bartkowiak

Advancing Neutron Facilities Together 2025, Tokai 23 Oct 2025

# Mission of Sample Environment

- Provide **control** over the ambient conditions of a sample such as temperature, magnetic field, pressure, etc
- support a **variety** of equipment
- Provide **reliable** equipment
- **Development** of new devices
- push the boundaries in parameter space



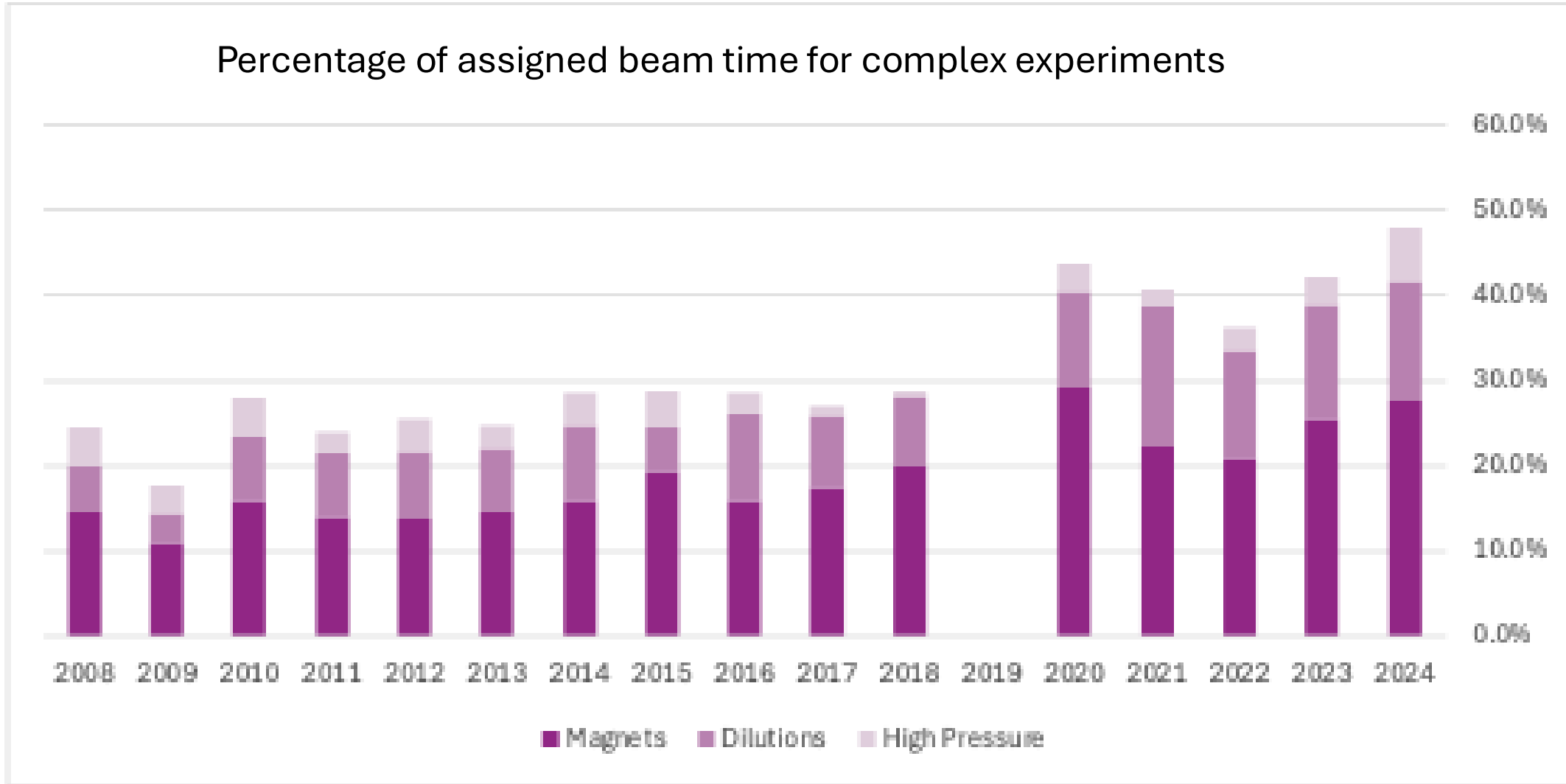
# Standard Sample Environment Equipment T,B,p



$T_{\max}$  : 1800K  
 $T_{\min}$  : 35mK  
 $B_{\max}$  : vertical 15T  
          horizontal 11T  
 $P_{\max}$  : 100kbar



# User Demand at SINQ



# Strategies to manage the work load

## Support of user program

### automation

- full control of SEE with FRAPPY
- Automatic LN2 filling...

## Development of new capabilities

### standardisation

- Fleet policy for equipment
- Standard pinouts



## Active role in research

### collaboration



# ...and a great Team – SE-Group Members



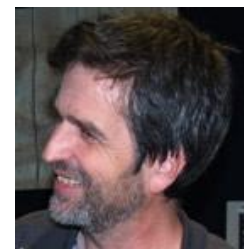
Patrick Hautle  
DNP & NMR  
Pressure safety



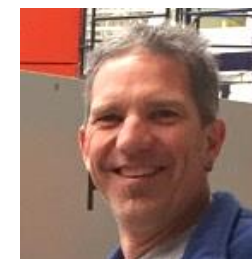
Gediminas  
Simutris  
Pressure support



Marek Bartkowiak  
Cryogenics  
And magnets



Markus Zolliker  
Software &  
electronics



Paul Schurter  
SINQ support &  
cryogenics



Silvan Stamm  
SINQ support &  
materials lab



Tina Arh  
PostDoc  
High pressure  
w. G. Simutis



Dang Xuan Dang  
Ph.D. Student  
RUS with M. Janoschek



Ilaria Villa  
PhD Student  
QSL  
With R. Sibille LNS



Anik Stark  
Student 20%  
Soft Matter Projects



Marcel Fuchs  
Softmatter support  
Support for sputterlab



Florian Fautz  
SINQ support

Sample environment groups are ideally placed to drive development as an integral part of the scientific

## extend parameter range

- electric fields
- high temperature option for cryomagnets
- combination of T, B and p

## New capabilities and concepts

- neutron optics enhanced p-cell
- ULT sample manipulation
- combined Be-filter & radial collimator

## complementary techniques

- In-situ dilatometry
- thermal conductivity and resistivity of superconductors
- Ultrasound spectroscopy

# “Pushing the Limits”

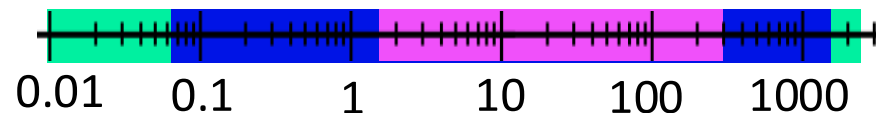
## Extend the parameter Space

# Extending the parameter space

From simply pushing the boundaries

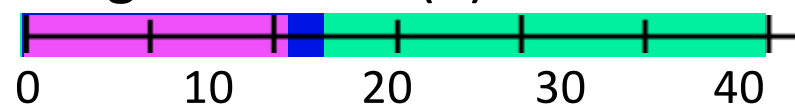
.. To multiparameter experiments

Temperature (K)



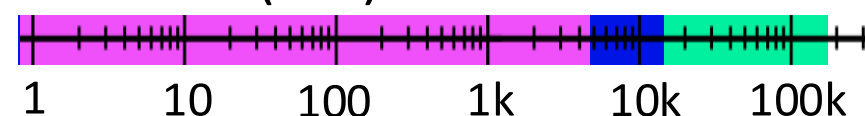
@ SING

Magnetic Field (T)



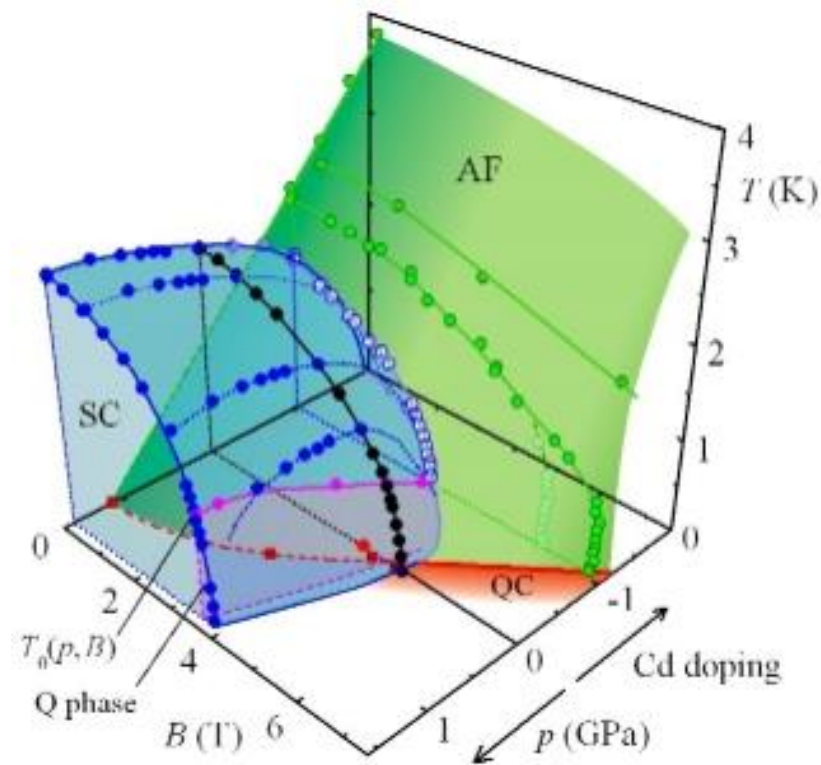
@ SING

Pressure (bar)



@ SING

- Standard SE
- with restrictions
- Not commonly available

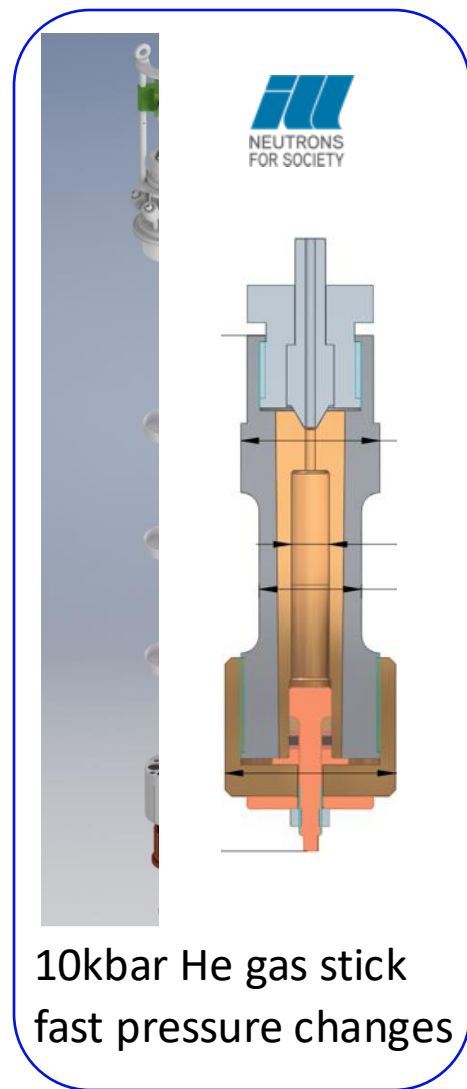


.. to: in situ  
in operando  
time dependent

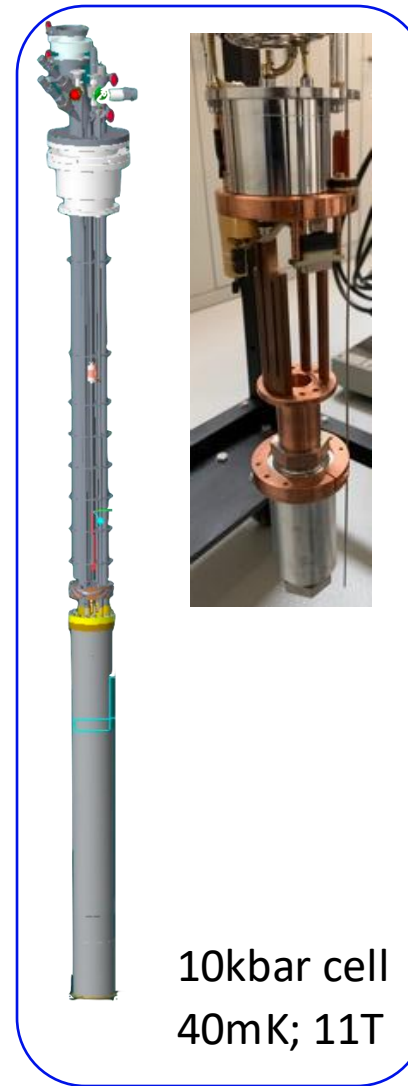
# Multiparameter control



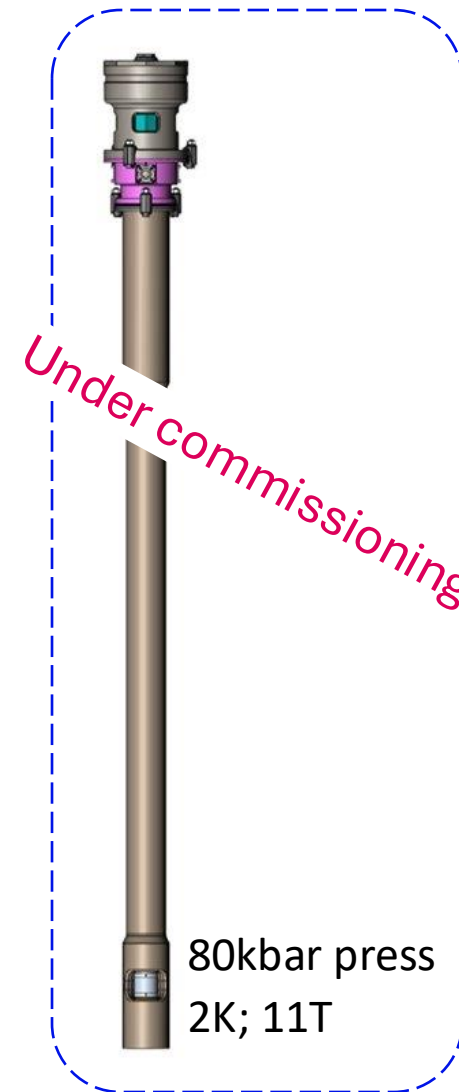
Vertical field 11T  
Ø100mm sample space



10kbar He gas stick  
fast pressure changes



10kbar cell  
40mK; 11T

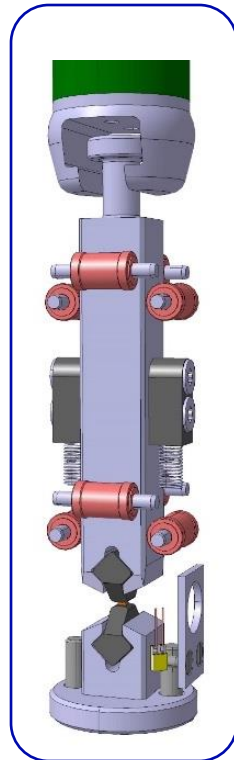
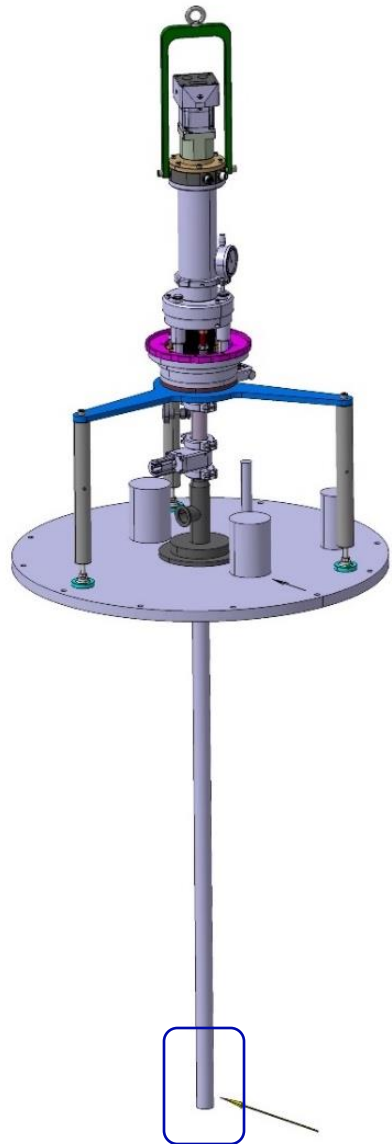


80kbar press  
2K; 11T

# In-situ uniaxial pressure device



- Tuning in-situ
- Push-pull capabilities
- Separate F, T readout
- Thermal expansion decoupling
- Large distance motion



LIN @ PSI:

Alex Bollhalder

Markus Zolliker

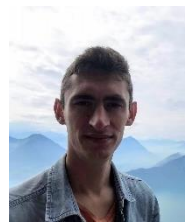
Marek Bartkowiak

Marc Janoschek



CUHK:

Qisi Wang



LQMR @ UZH:

Julia Küspert

Johan Chang



P21.1 @ DESY:

Oleh Ivashko

Martin von Zimmermann

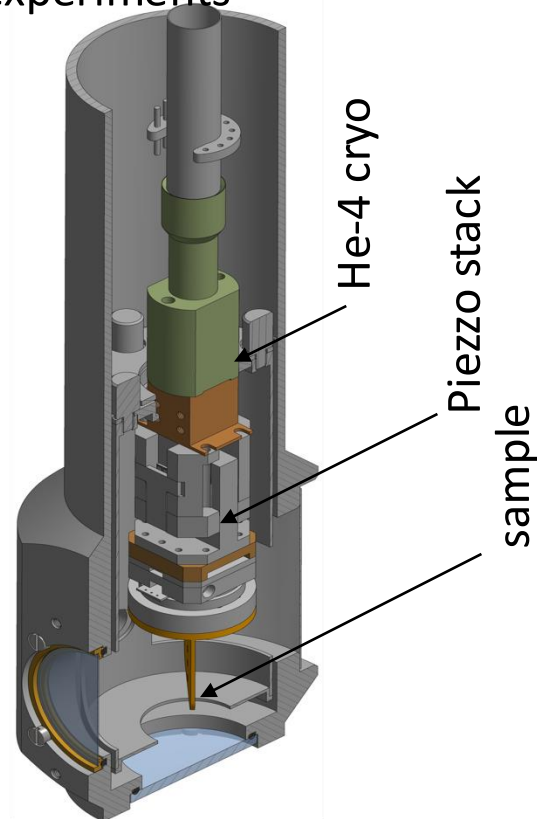
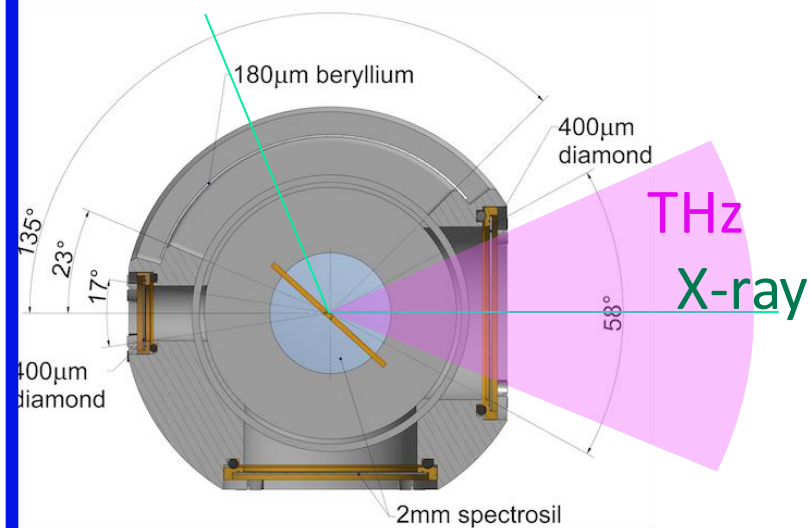


# “Looking Beyond” New Capabilities and Concepts

## Cold motion and sample alignment

### SwissFEL cryostat for pump-probe

designed for THz pump X-ray probe experiments  
operates below 5K



## Neutron optics integrated in SEE

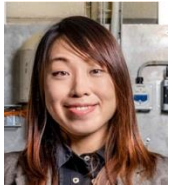
demonstrated a route to  
better signal to noise ratio

Collaboration with Neutron  
Optics Group PSI



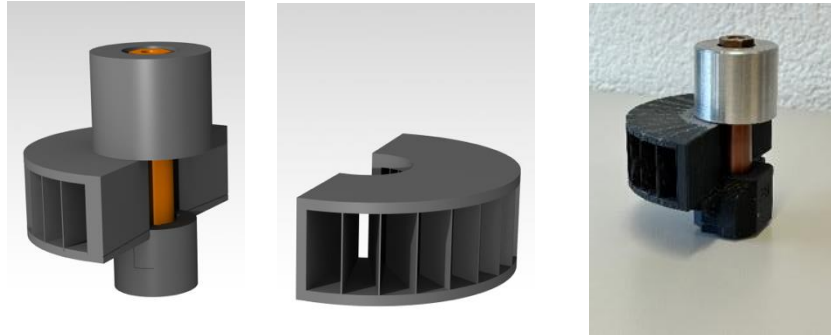
C. Klauser et al, NIMA 953 (2020) 163188

Cold motion concepts can also be applied @ SINQ

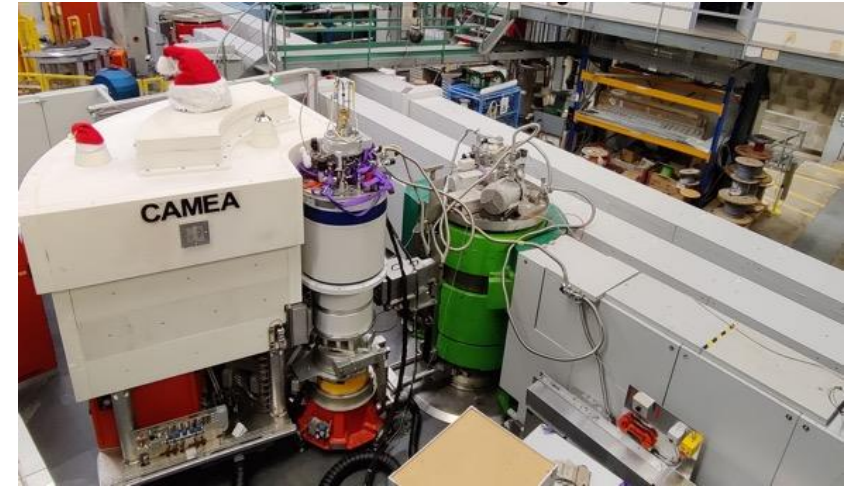


Uwe Filges  
 Andrea Plank  
 Christine Klauser  
 Masako Yamada  
 Zhanwen Ma  
 Sascha Thürsam

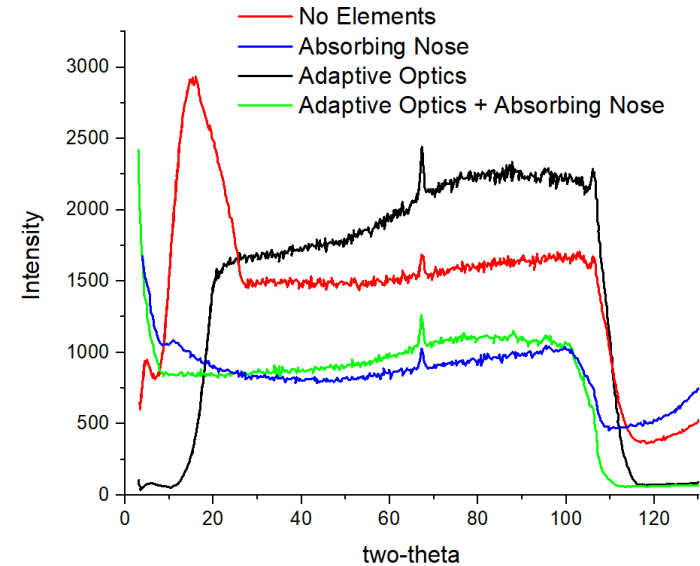
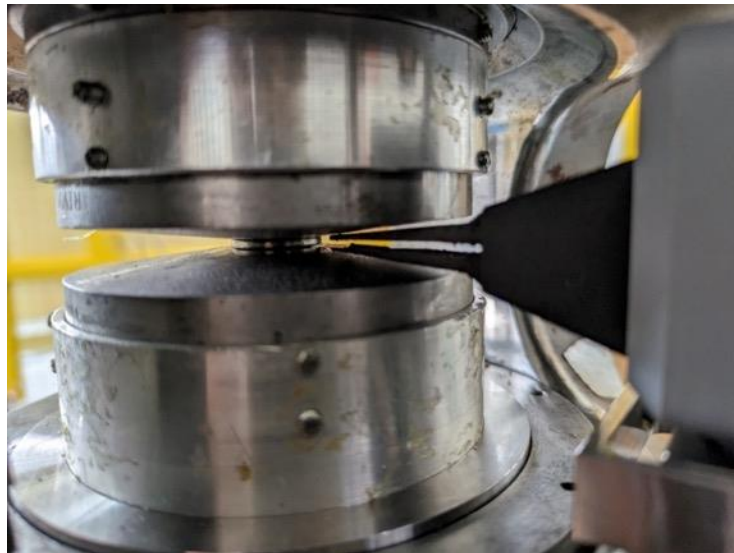
# ... and another route to better S/N



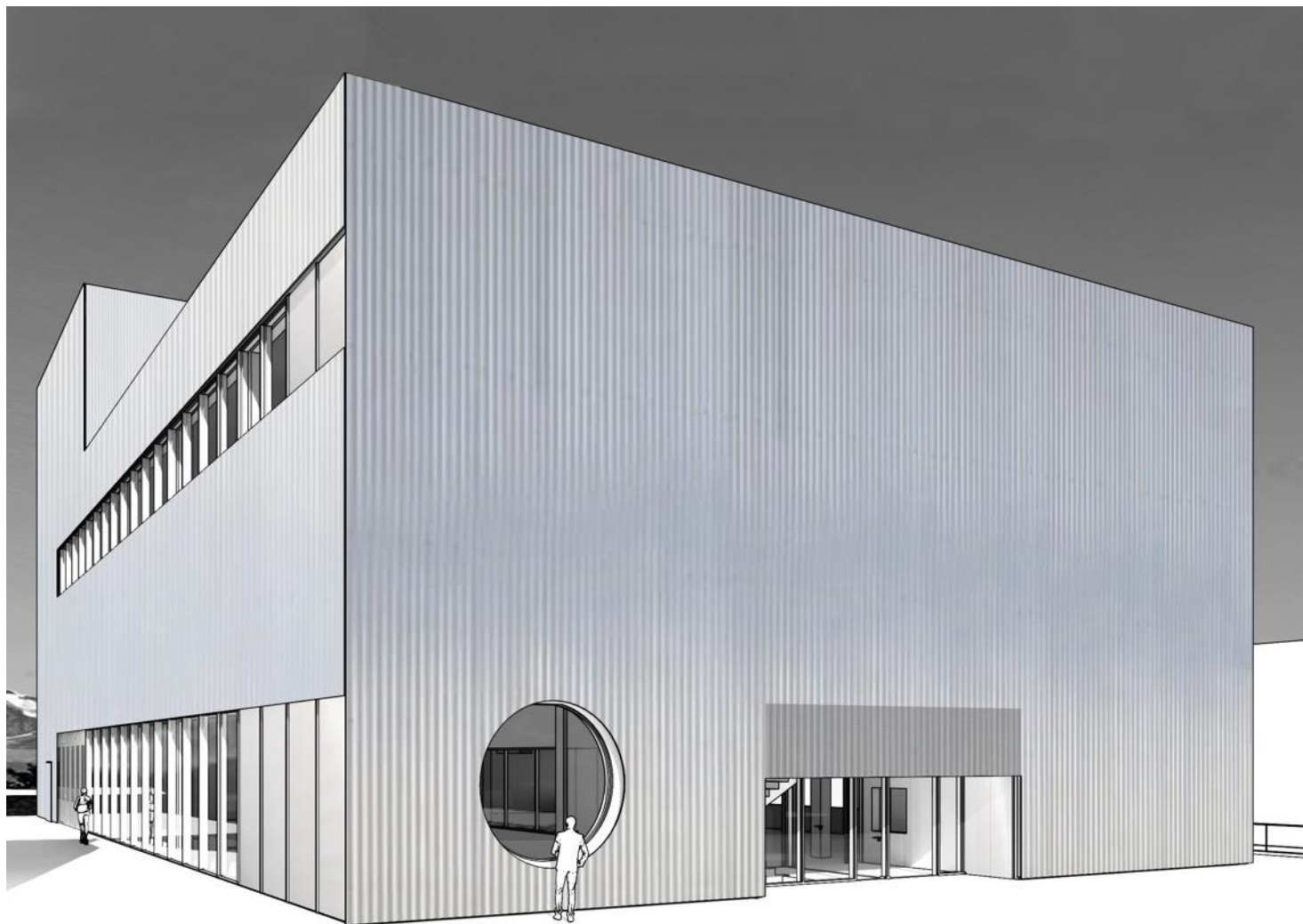
3D-printed neutron-absorbing Collimator for a clamp cell. Tested at CAMEA

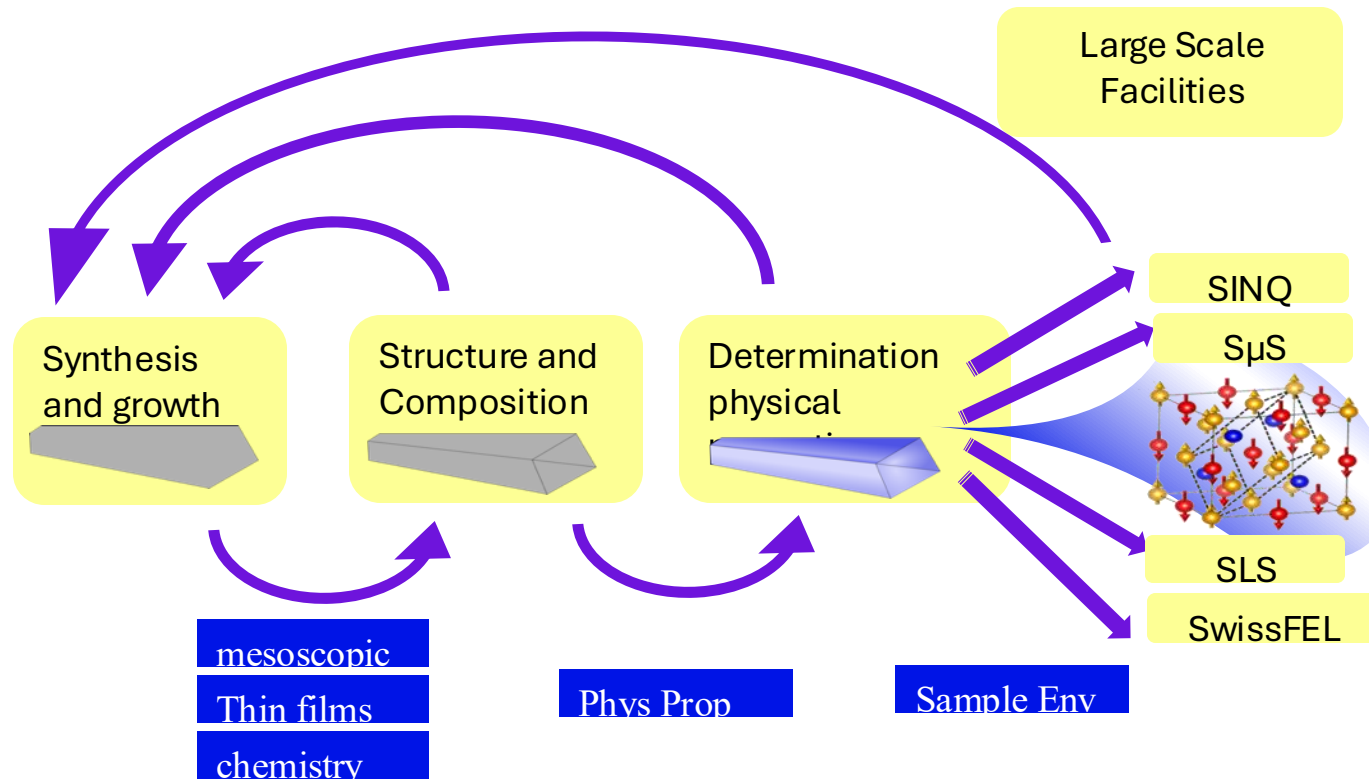


# 3D-printed neutron-absorbing collimator for PE press



# “Looking Elsewhere” Complementary Techniques





Tighter interaction between sample growth and characterization speeds up materials discovery

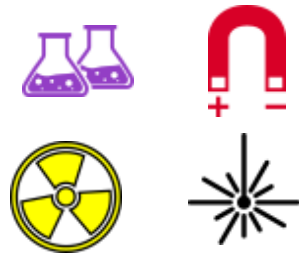
Lab based characterization methods complement and motivate large scale facility experiments

Experiments at extreme conditions (ultra-low temperatures, High pressure and magnetic field) help to reveal new states of matter

# Groups involved

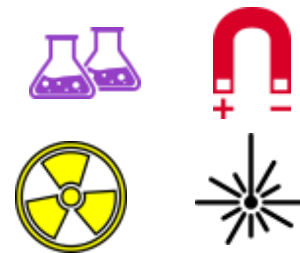
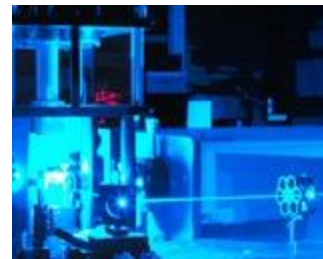
## mesoscopic

- magnetic und multi-ferroic films and nanostructures
- From basic research to device physics



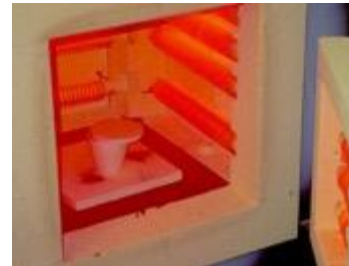
## Thin films

- Thin films of functional materials
- Materials for energy applications (Li-ion batteries, catalysis ...)
- multiferroic thin films
- Provide characterisation methodes



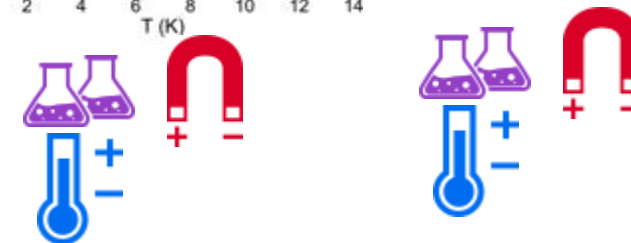
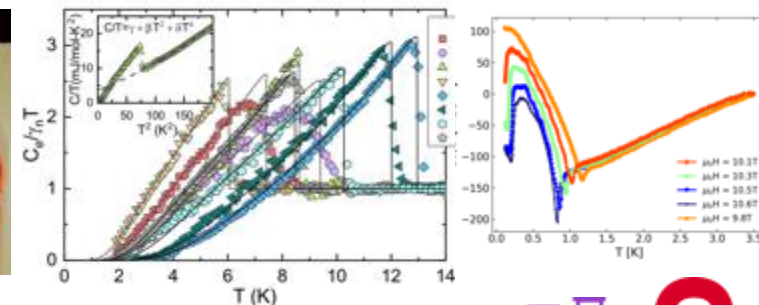
## chemistry

- Synthesis of materials with novel electronic and magnetic properties
- superconductors
- magnetic oxides
- Contribution of samples to LSF research
- characterisation methodes



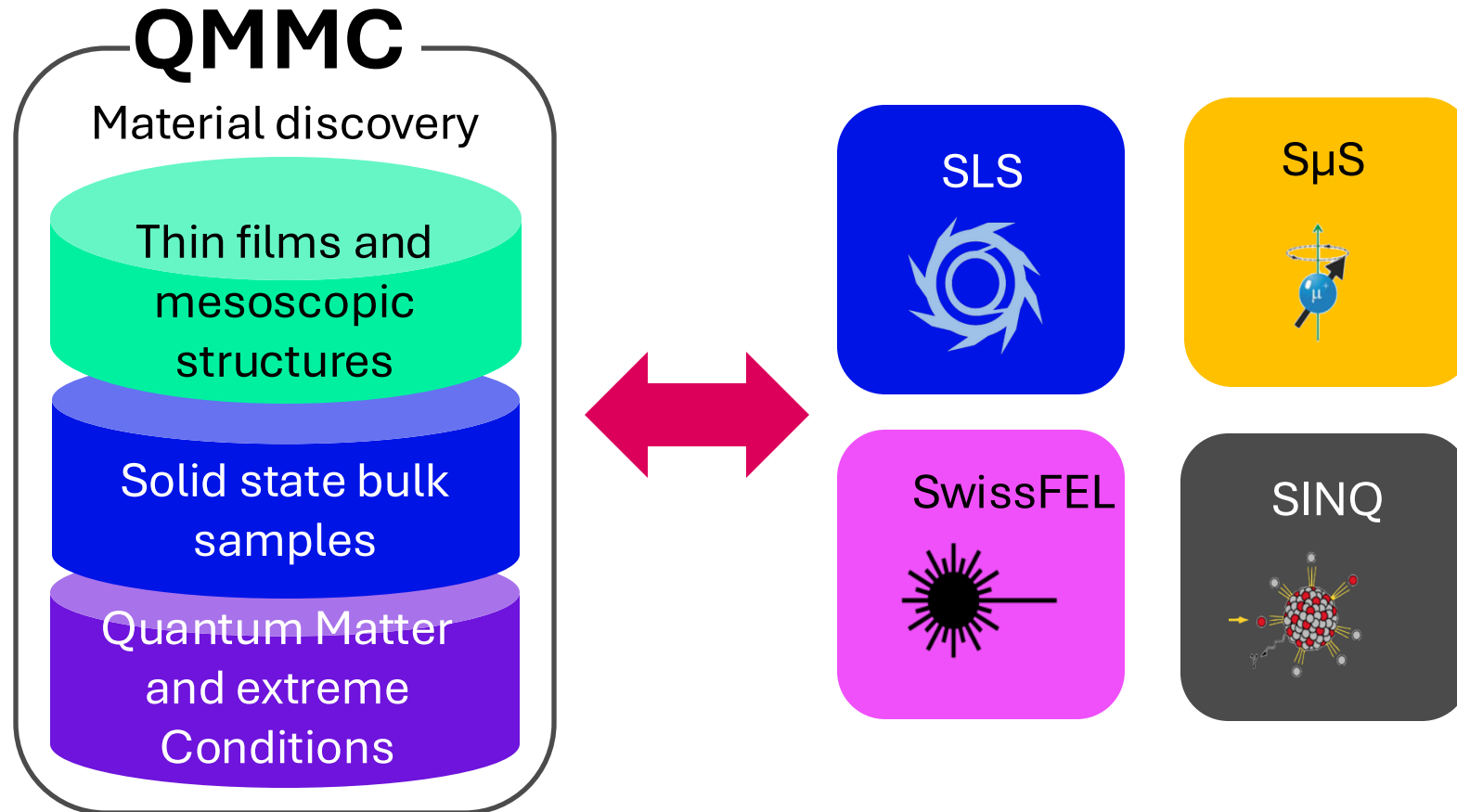
## Phys Prop

- Synthesis of novel materials
- Investigation of materials with competing interactions
- Contribution
- Provide characterisation methodes



## Sample Env

- Development of new measurement techniques
- Strongly correlated electron systems



# MIC Materials Innovation Cluster



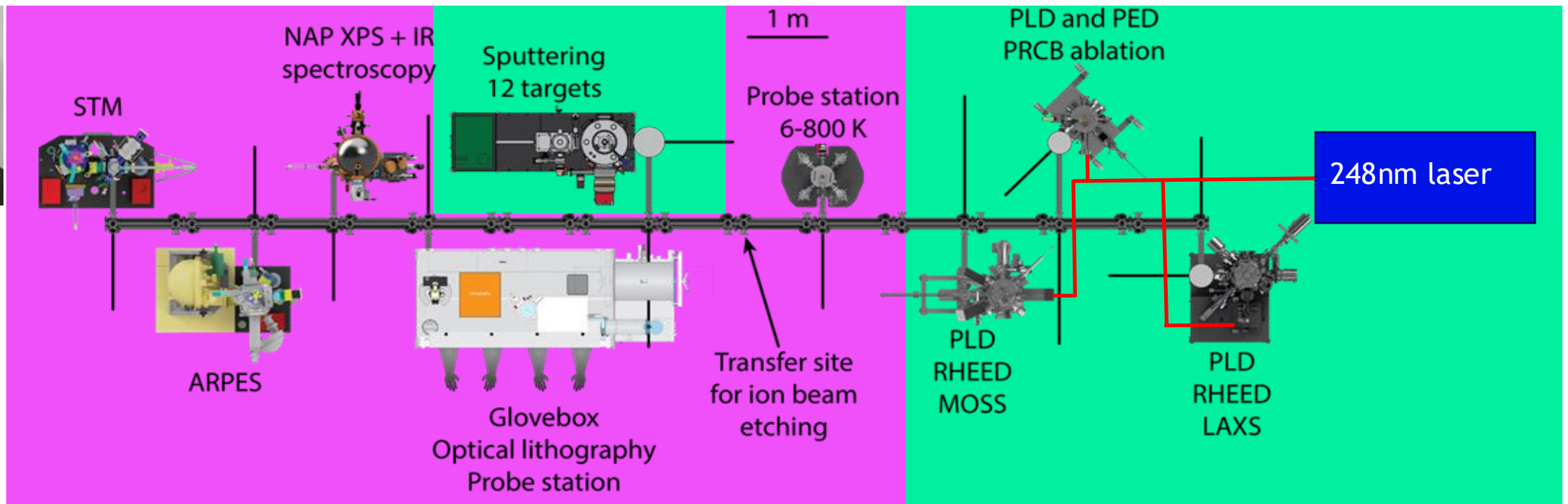
## all-in-one setup

- sample preparation
- Characterization
- measurement

*in situ* micro-patterning and characterizations (AFM, lithography), Ion etching, electrical transport, dielectric, ferroelectric characterization; (NAP)-XPS; STM, ARPES

Sample preparation and operando characterizations  
PLD with RHEED&MOSS  
PLD/PED with impedance set-up  
Sputtering set-up

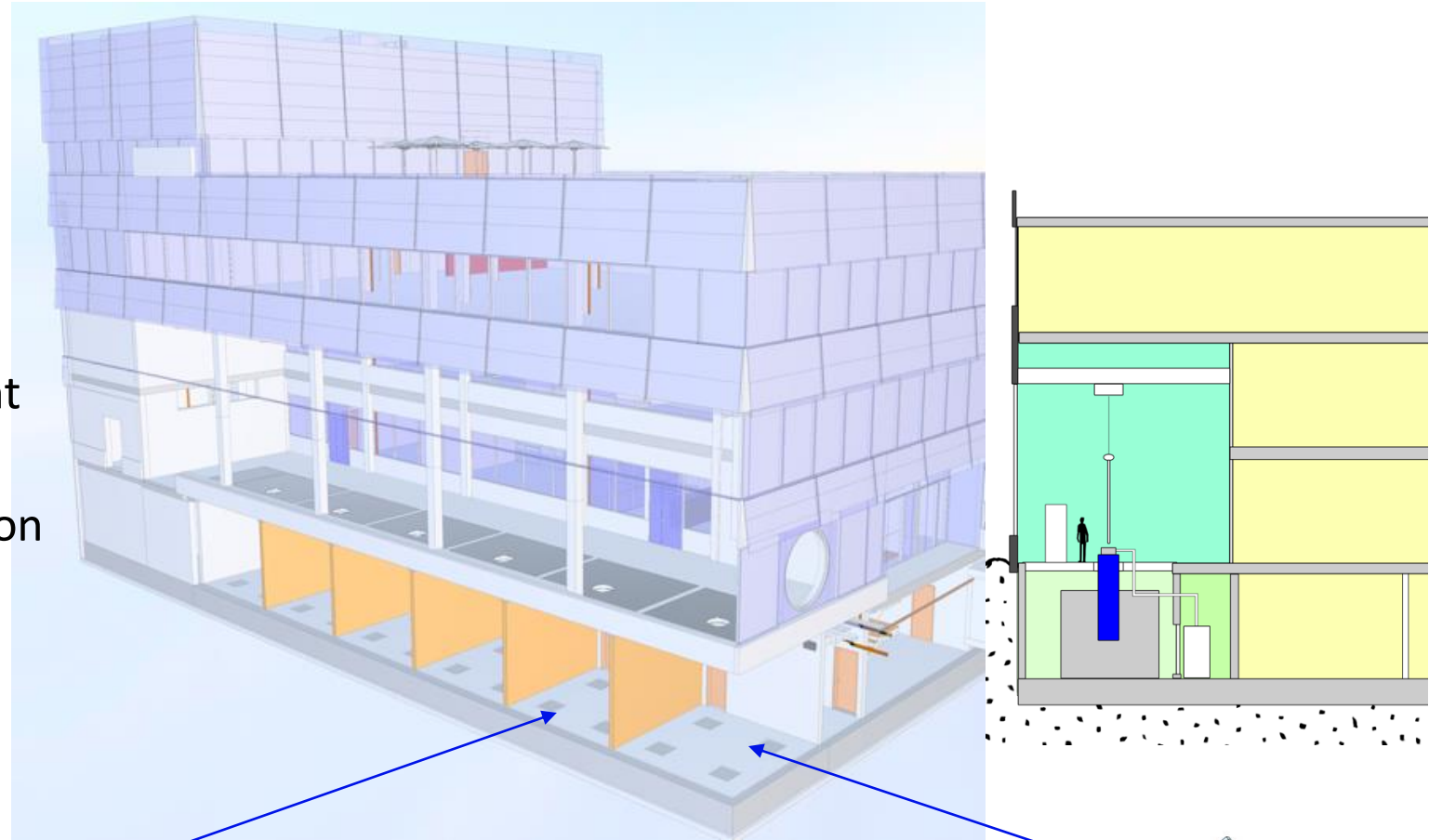
Daniele Pergolesi



# “Ultra-Low Noise Lab” for Quantum-Matter Research



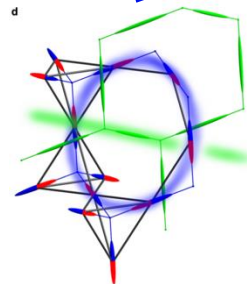
- Separated experimental areas for 6 experiments
- Non-magnetic rooms suitable for high magnetic fields
- Experiments are grounded to basement
- User access at groundfloor level → separation between setup and operation
- A crane is available for logistics



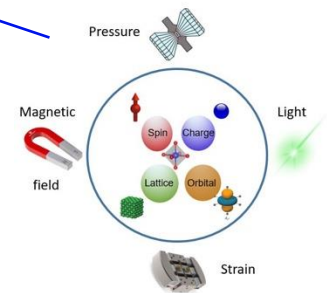
First two instruments in construction

Emergent electrodynamics in quantum spin ices materials

R Sibille



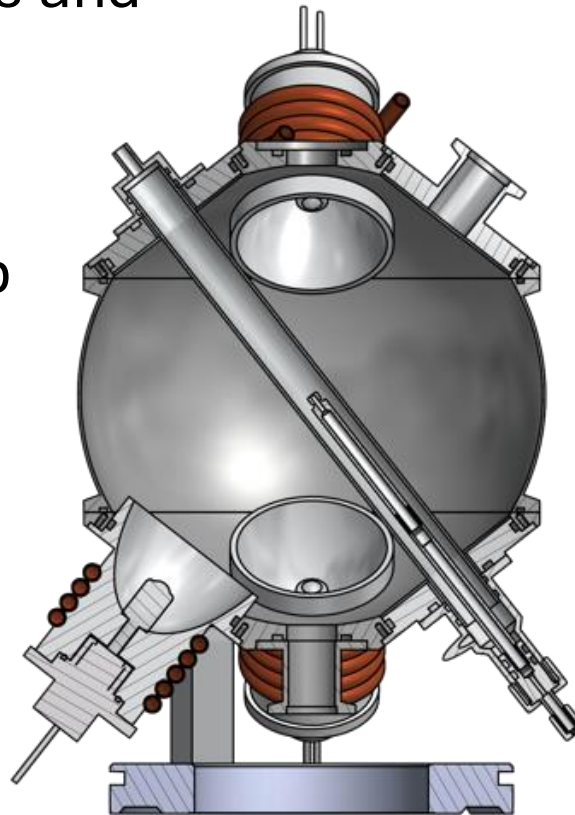
advanceNMR  
NMR Spectroscopy for  
quantum material research  
G. Simutis



# “You never walk alone” Collaborations

# Collaboration: High Temperature Furnace

- Halogen lamp furnace developed by MLZ
- Optimized for ease of use and gas loading via capillary
- reduces costs of ownership (for acquiring replacement parts)



# Collaboration: Soft Matter

## SANS sample changer with improved T range

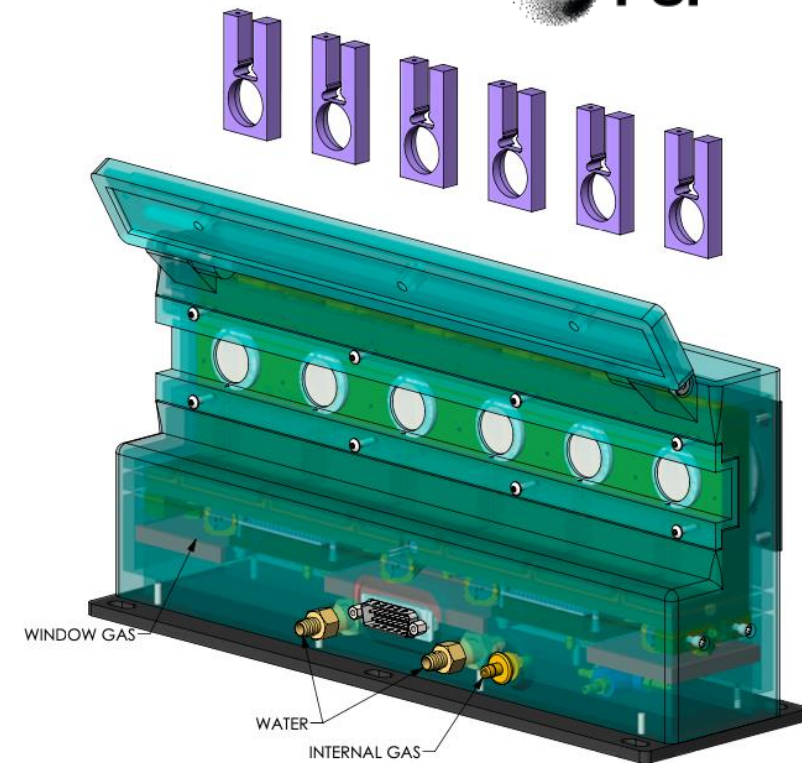
(Super Neutron 600 — developed by ILL and Quantum Northwest)

Current Specs

- temperature range -15 °C to 150 °C.
- temperature stability  $\pm 0.2$  °C.
- from -15 °C to 80 °C in 5 minutes.
- cooling down still much slower.
- compatibility with different sample cells with dedicated holders.
- flexibility with temperatures: use 2 or 3 changes in parallel.

## High Shear-rate capillary flow rheometer

- Cover a wide range of viscosity: 0.1 - 1000 mPa.s
- Provide temperature control: 20-80°C (prefer 5-80 °C)
- High Shear Rate: have the unique ability to reach above  $10^6$  s<sup>-1</sup>
- High Pressure: up to 1000 bar



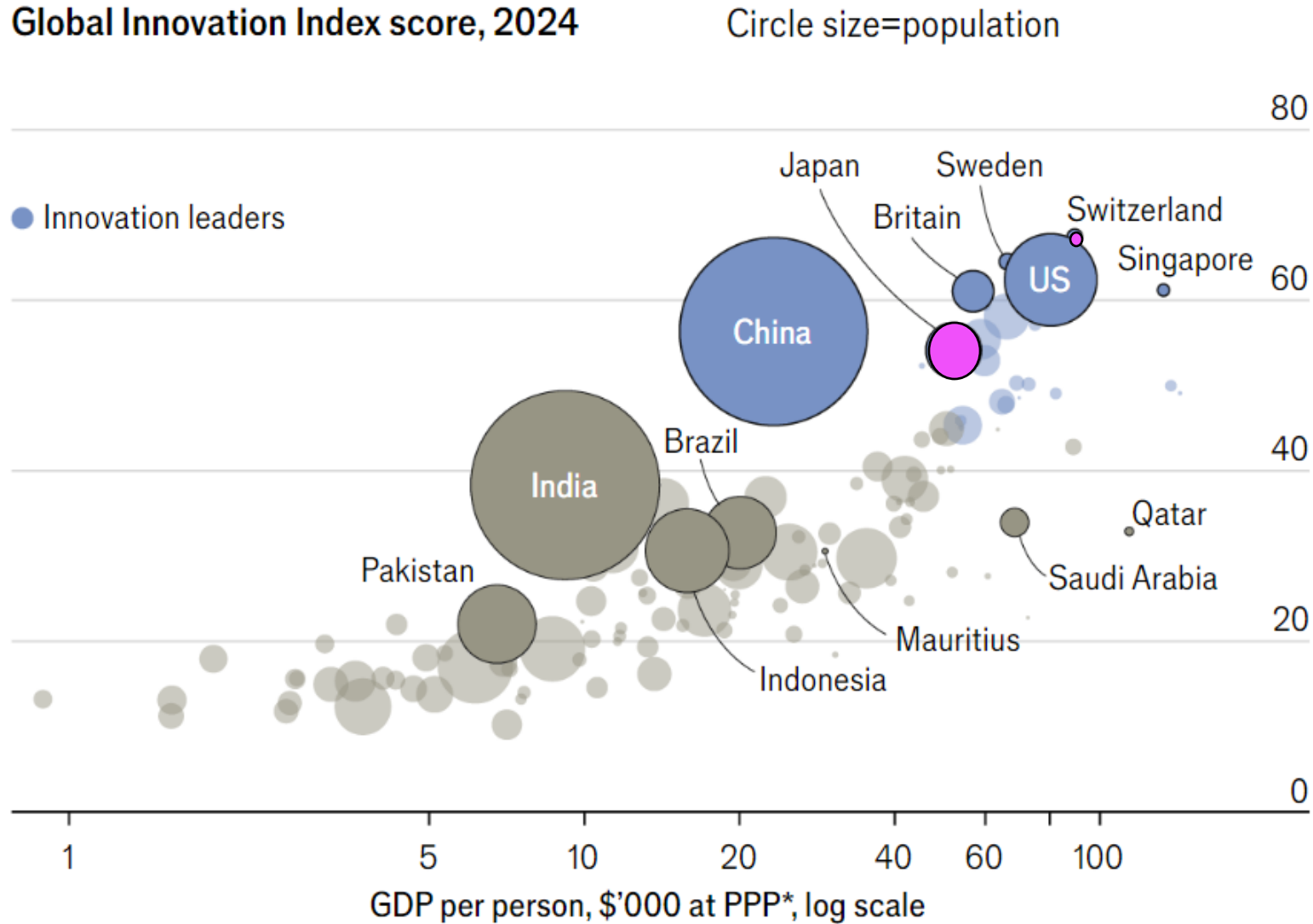


establish a standard protocol for interfacing sample environment equipment to experiment control software.

- Allows to move equipment between facilities
- Can be used by facility users and companies for equipment development
- Reduces the software integration effort at a facility

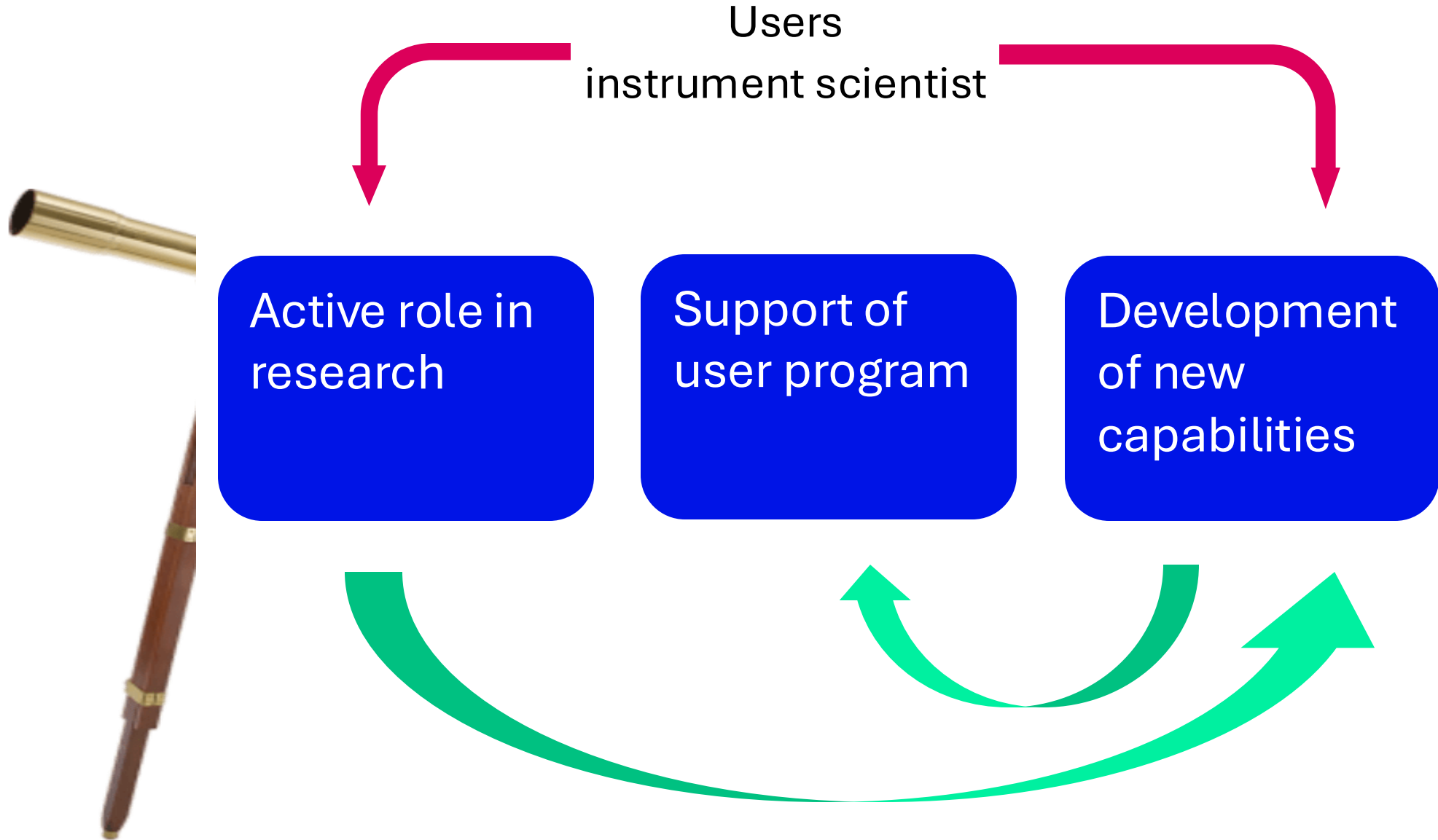


# Furthering Collaborative Development



...with you

# Summary: Our Role as Sample Environment



Active role in research

Support of user program

Development of new capabilities

*"It takes three legs to make a table stand."*

Thank you for your attention

