



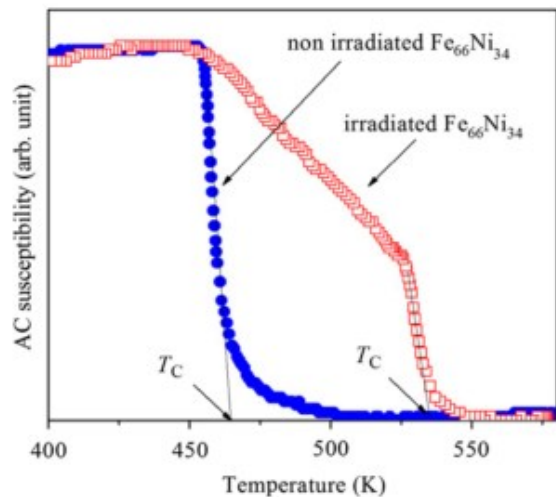
INSTYTUT FIZYKI JĄDROWEJ
IM. HENRYKA NIEWODNICZAŃSKIEGO
POLSKIEJ AKADEMII NAUK

Influence of irradiation on the magnetic properties of coordination polymers

Piotr Konieczny, Dominik Czernia

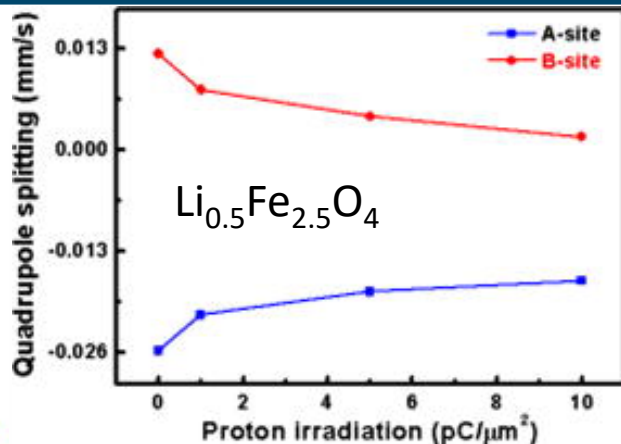


2nd Workshop on Research & Innovation in Poland
IFJ PAN, Krakow, 26-27 May, 2026



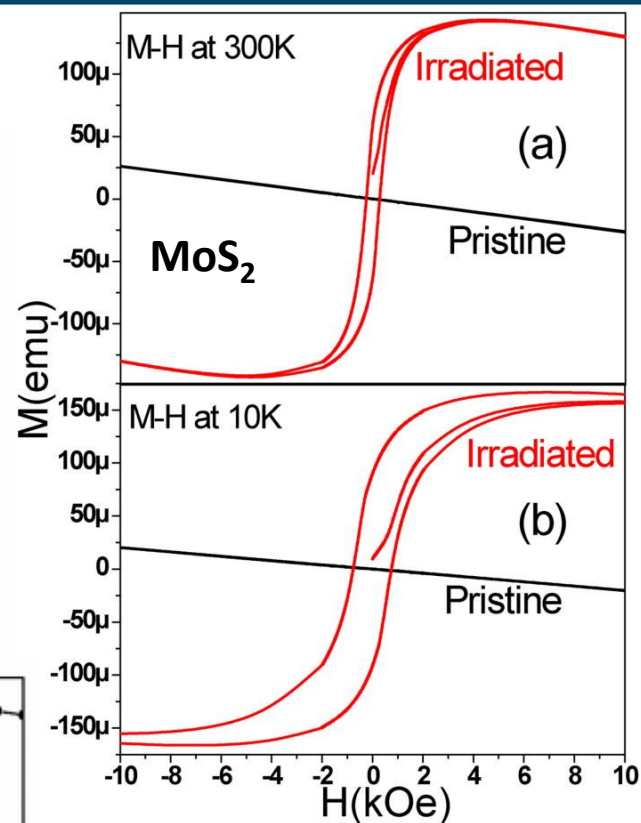
50 keV

JMMM 333(2013)



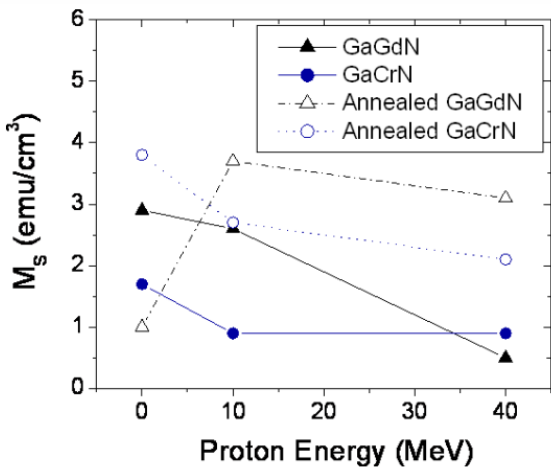
6.66 MeV

J. Appl. Phys. (2009)



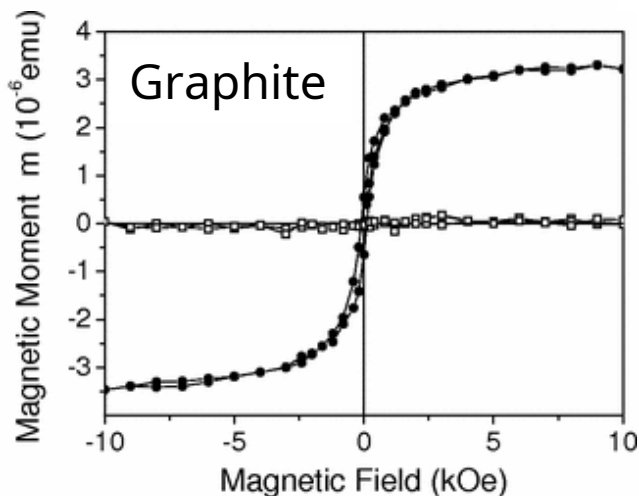
2 MeV

Appl. Phys. Lett. (2012)



10 and 40 MeV

New J. Phys. 10 (2008)



2.25 MeV

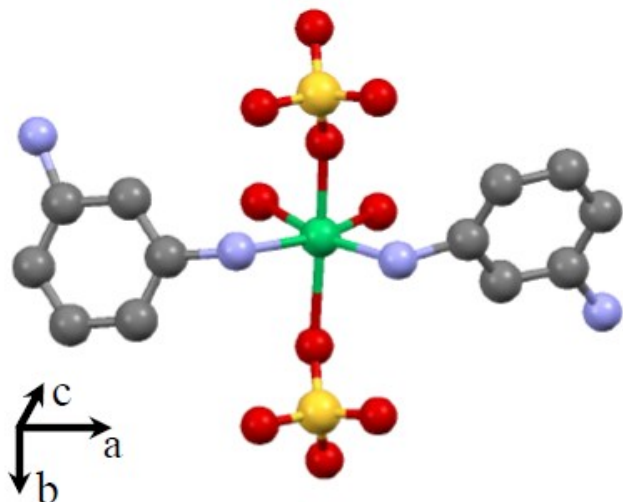
Phys. Rev. Lett. 91 (2003)



Influence of proton irradiation on the magnetic properties of 2D Ni(II) molecular ferrimagnet



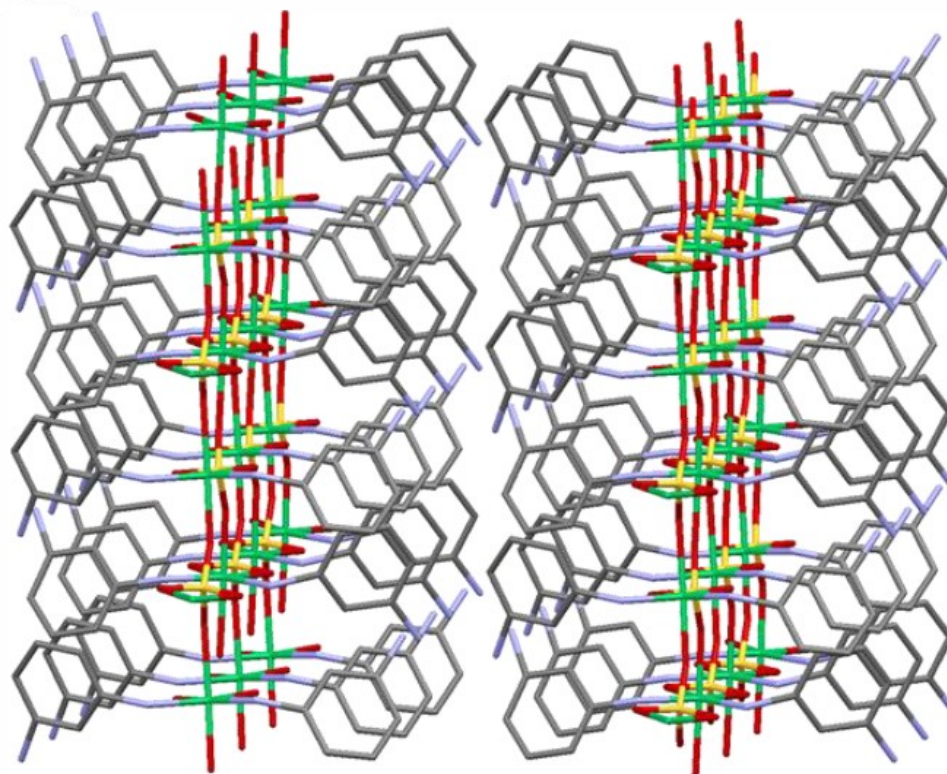
D. Czernia



$T_c = 24 \text{ K}$
PXRD, IR, DC
magnetometry

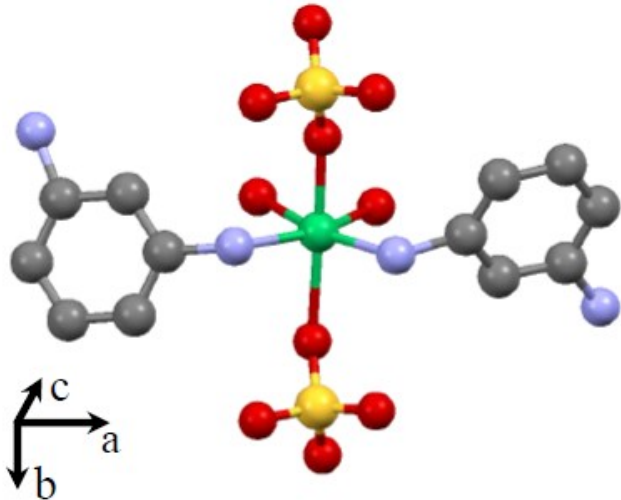


Diamantowy
Grant





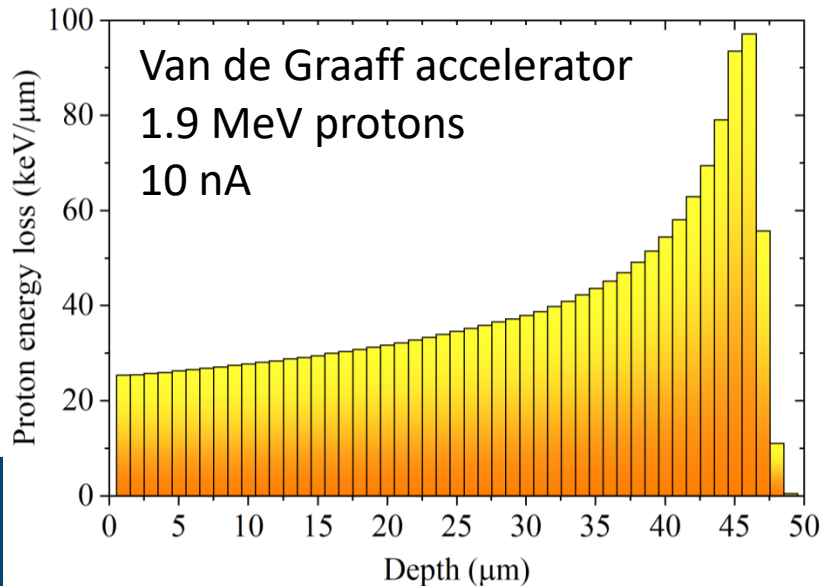
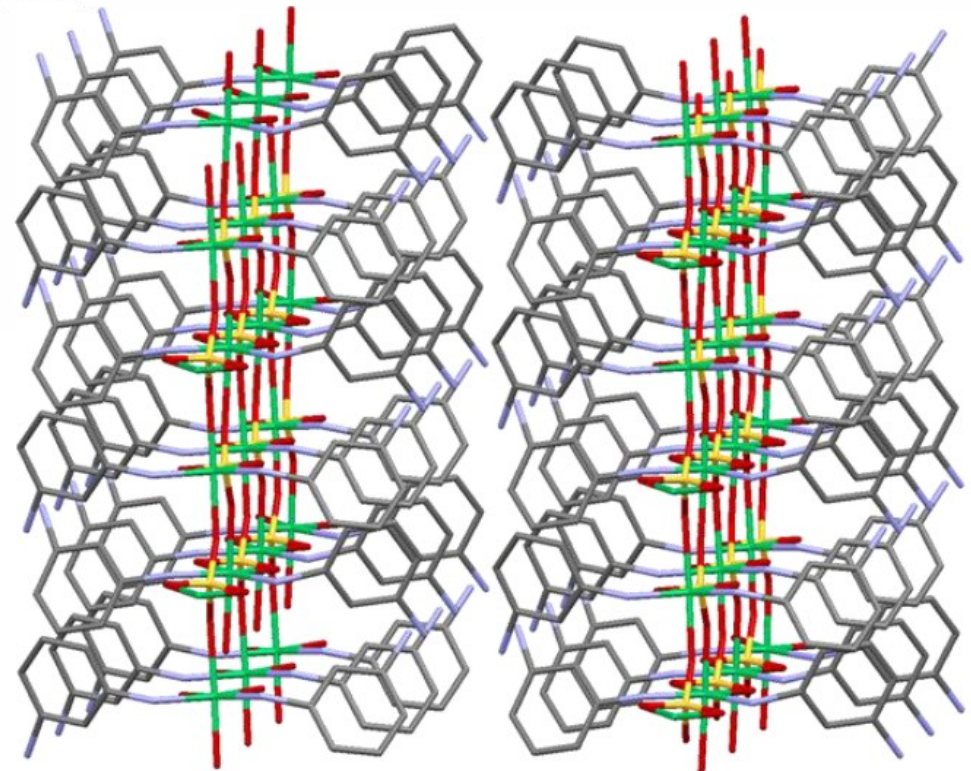
D. Czernia



$T_c = 24$ K
PXRD, IR, DC
magnetometry

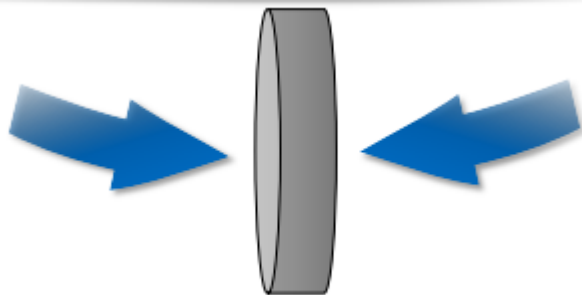
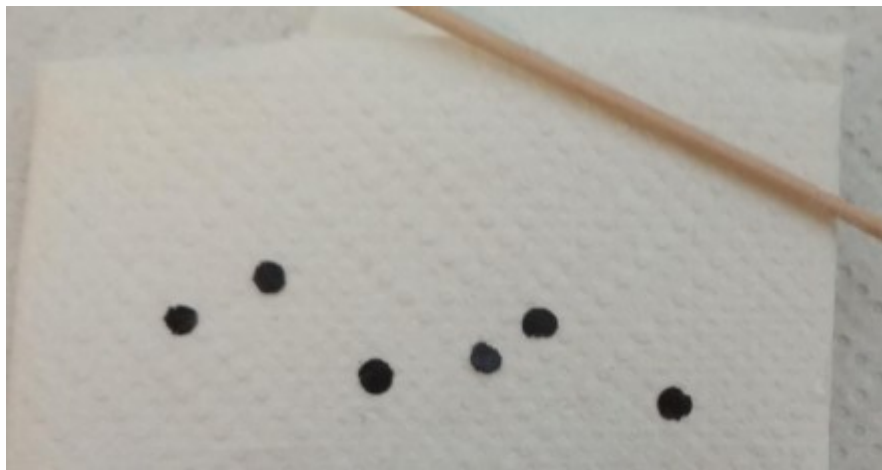


Diamantowy
Grant

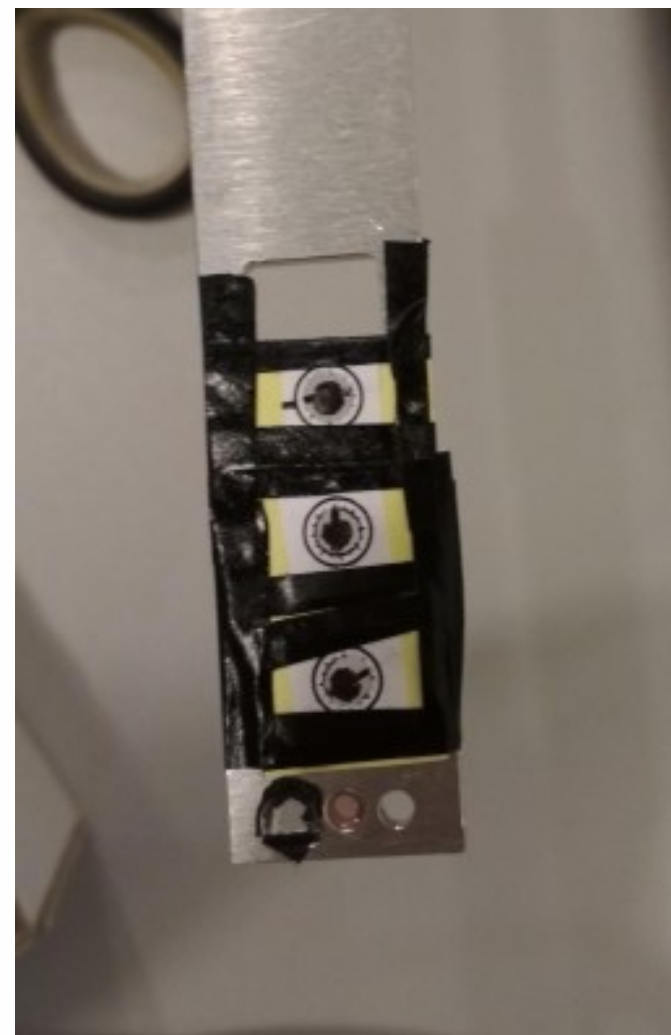




Sample preparation issue

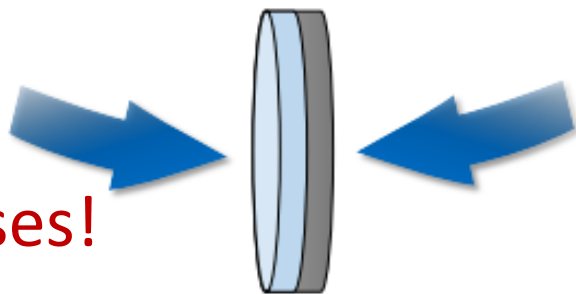
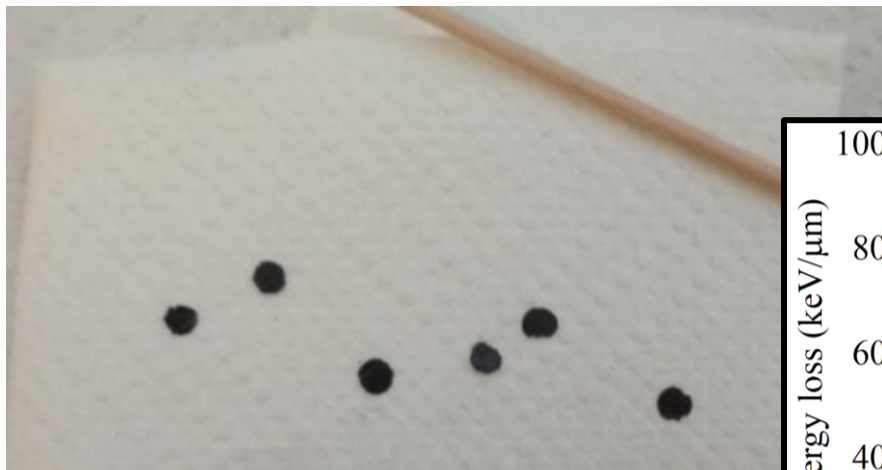


Pellet thickness
> 100 μm



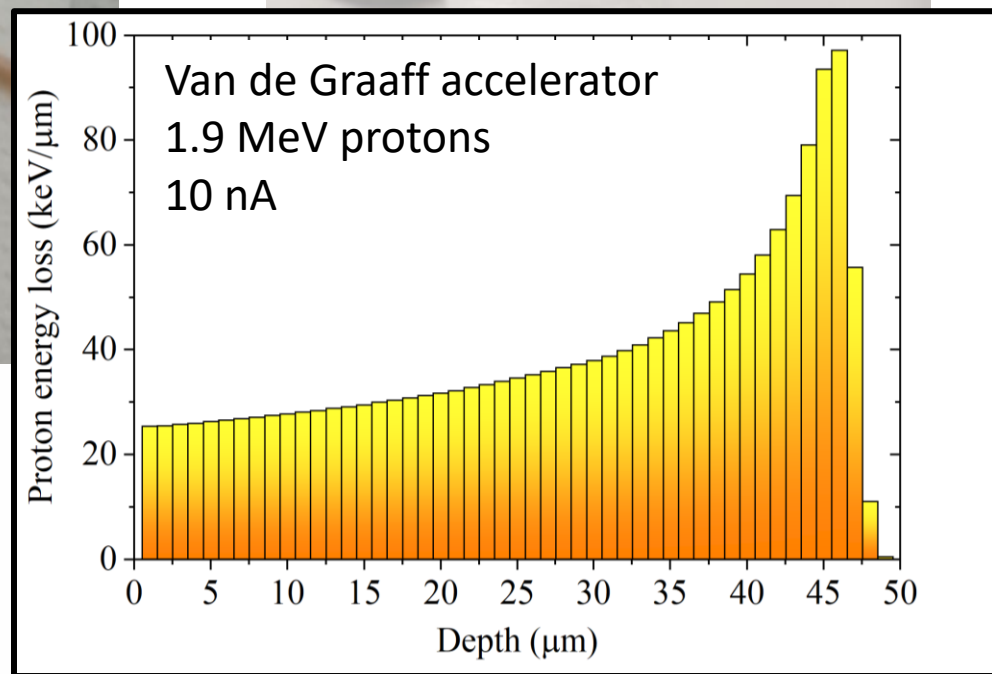


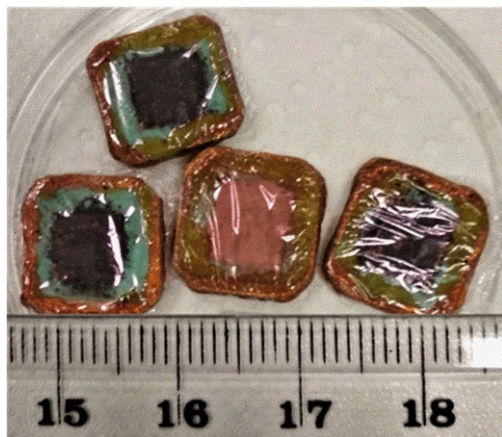
Sample preparation issue



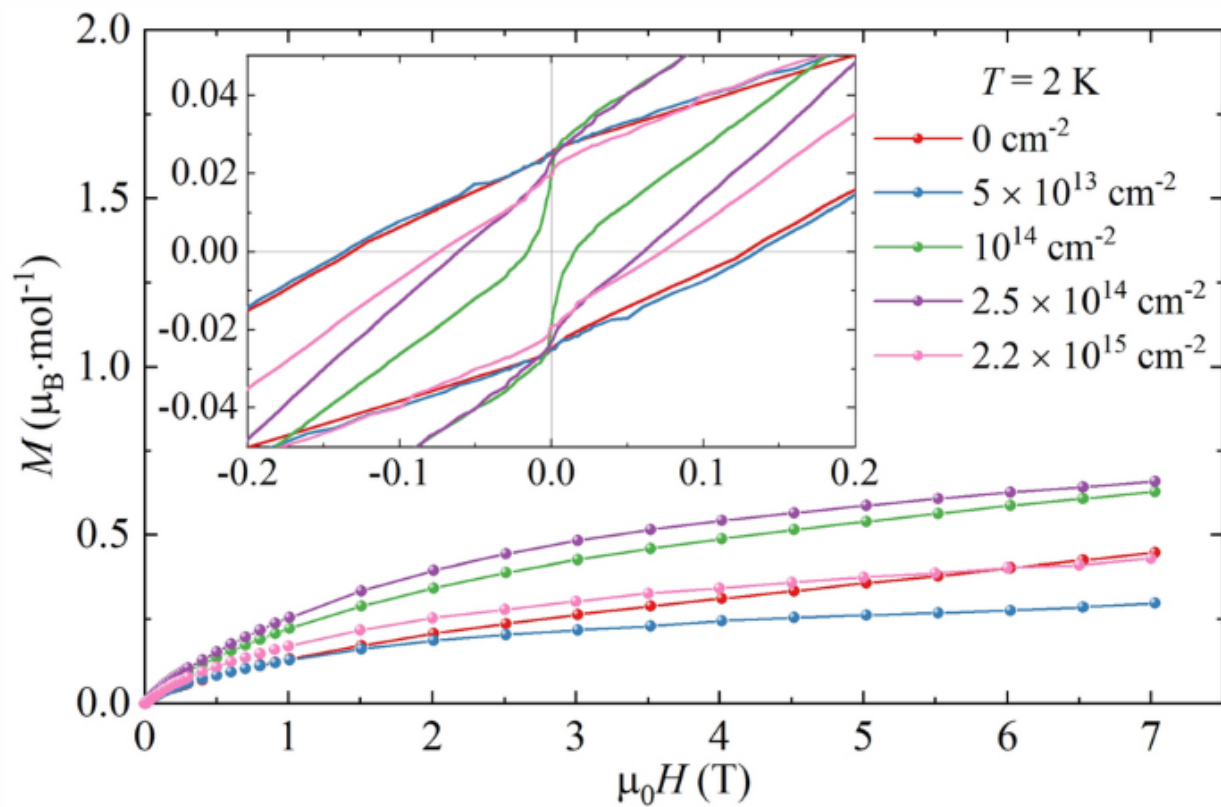
two phases!

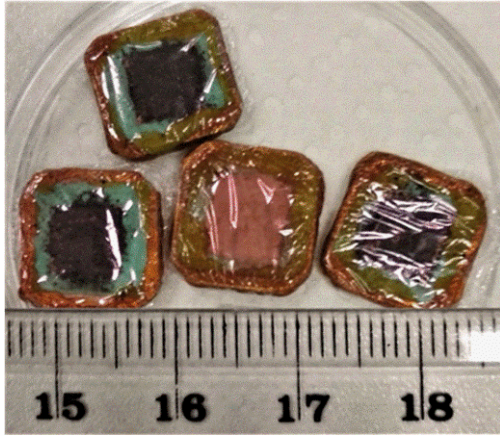
Pellet thickness
> 100 μm



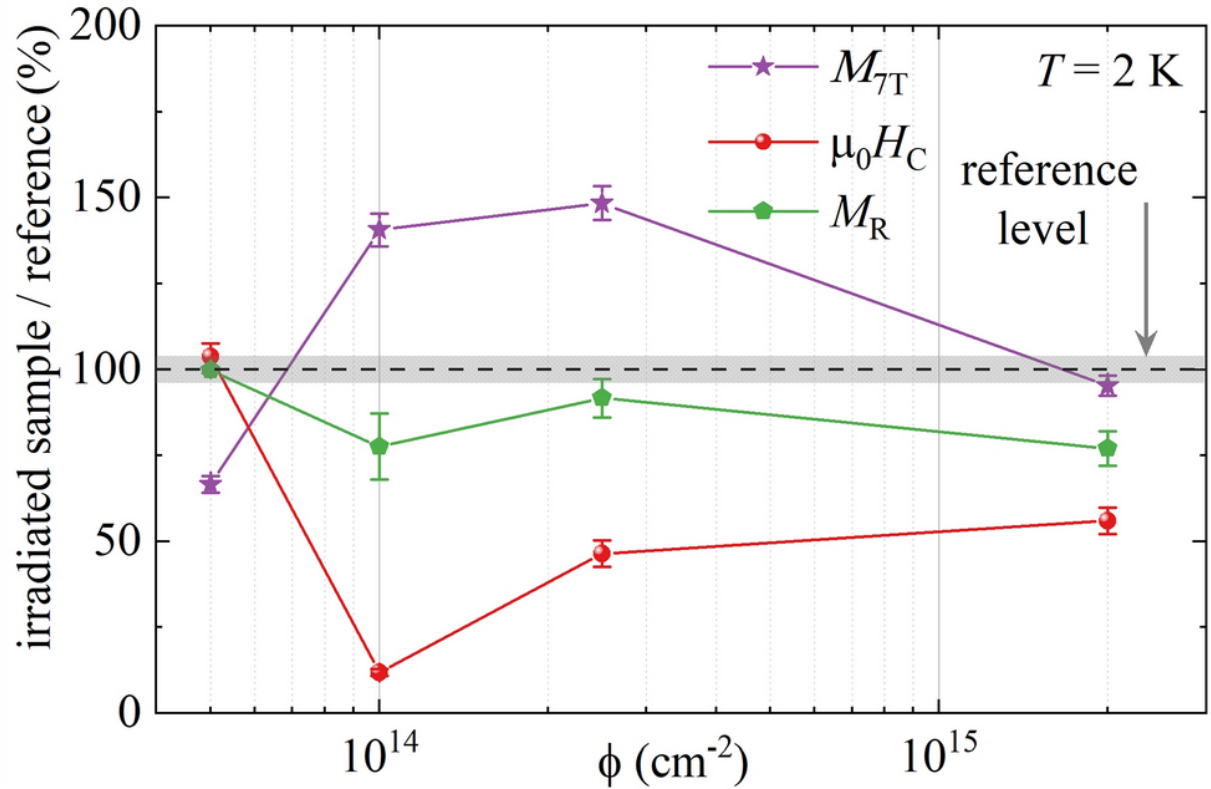


Powder layer
thickness
 $\approx 30 \mu\text{m}$





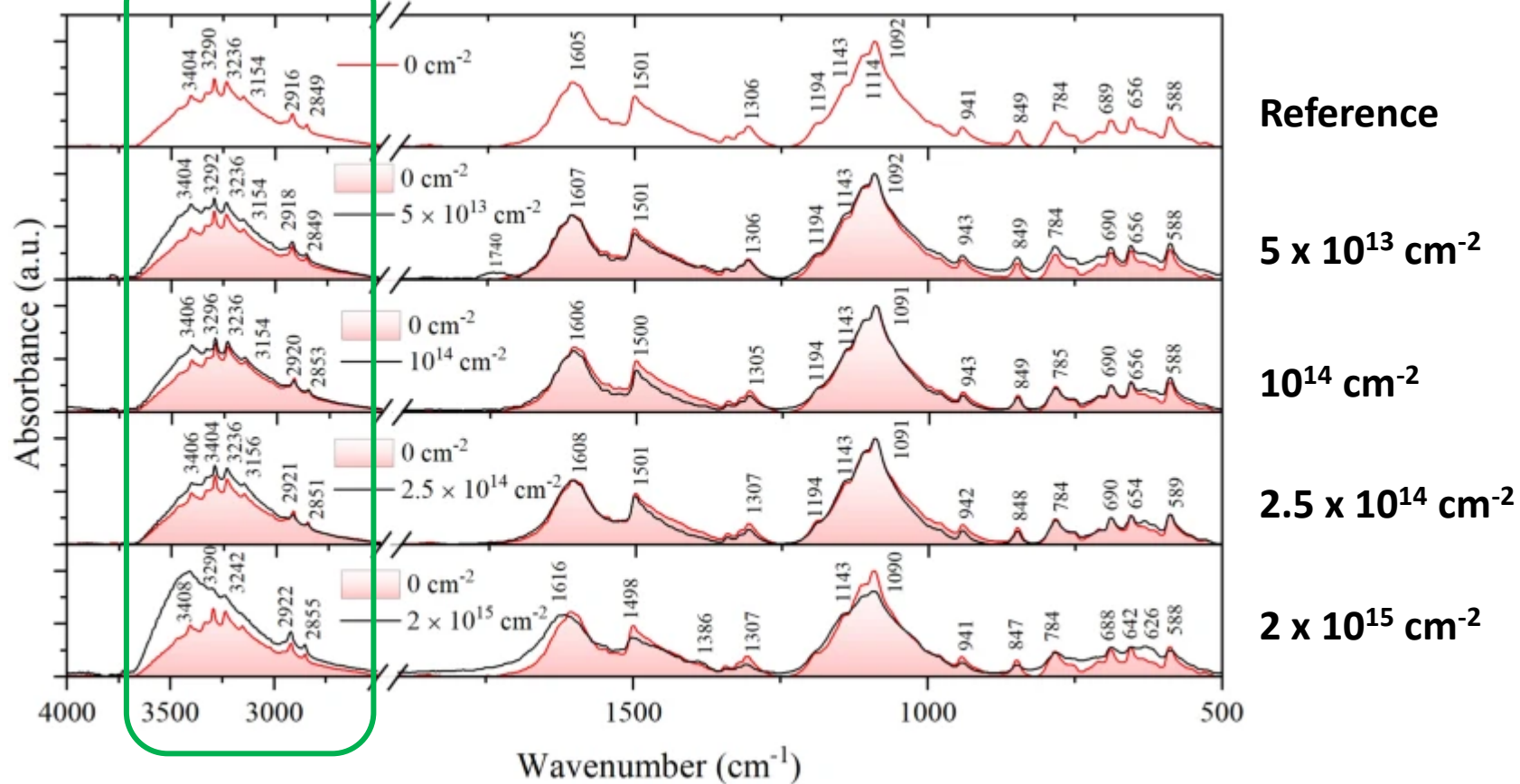
Powder layer
thickness
 $\approx 30 \mu\text{m}$



- coercive field: reduction up to 90%
- maximal magnetization (at 7T): 65% -150% of the reference sample
- degree of irreversibility $\Delta\chi_{\text{irr}}$: increase up to 40%
- Temperature of phase transition: constant



Infrared spectroscopy





Which Section (1, 2 or 3)

Required beam: particle, energy nad properties

Section 1 and 2 – depending on investigated material

All available particles with variable energy

Beam current range: **1 nA - 20 nA** – to limit sample degradation

No requirements about time structure of the beam



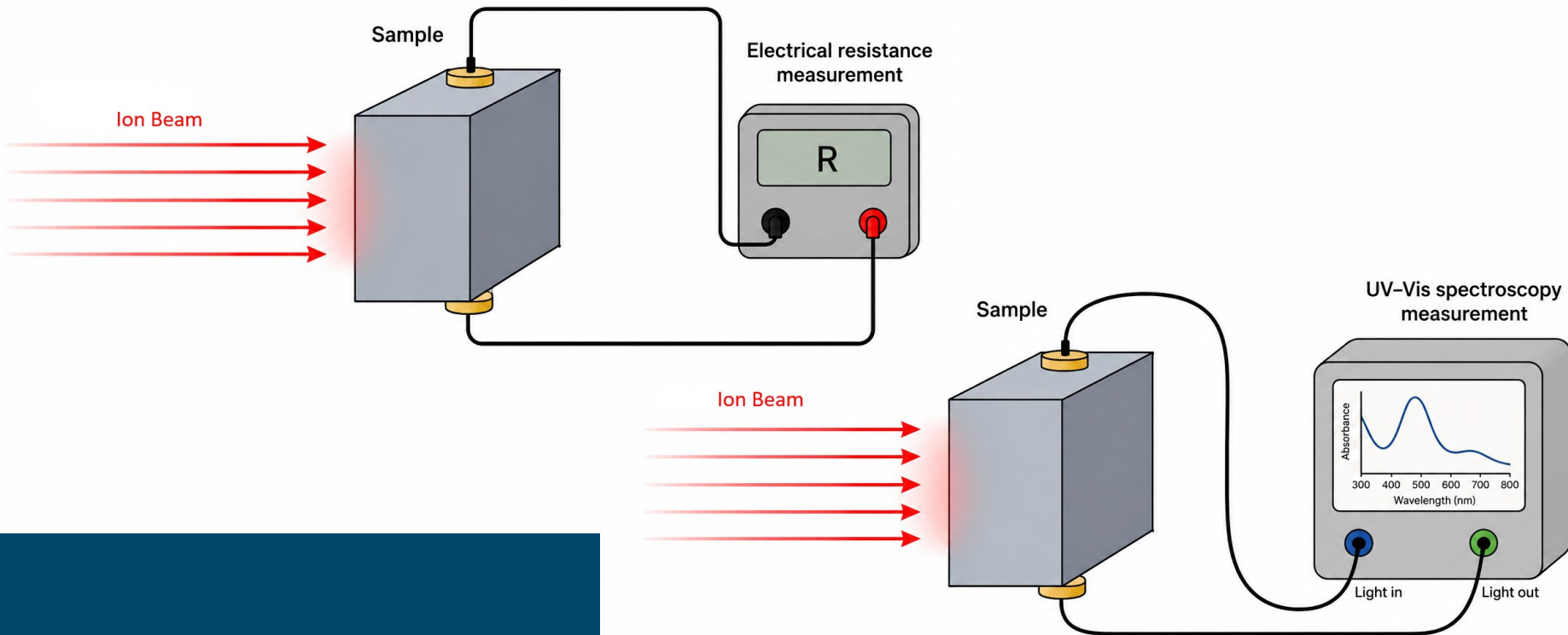
Other requirements (detection system, infrastructure)

Sample conditions:

scanning stage with cooling – to limit heating effect,

Energy degraded beam – uniform modification,

Real-Time Data: setup for electrical transport measurements and other techniques (magnetic, optic).





UNILAC <11 MeV/u

X0
Autosampler

Microprobe
Single Ion Control

M-Branch
On-line Analysis

SIS18 80-1000 MeV/u

Cave A
Irradiation Cave



Cryring 0.3-14 MeV/u

Cryring
MAT target station

SIS100 0.1-10 GeV/u

APPA Cave
High energy Cave

GSI Helmholtzzentrum für Schwerionenforschung Darmstadt



UNILAC <11 MeV/u

X0
Autosampler

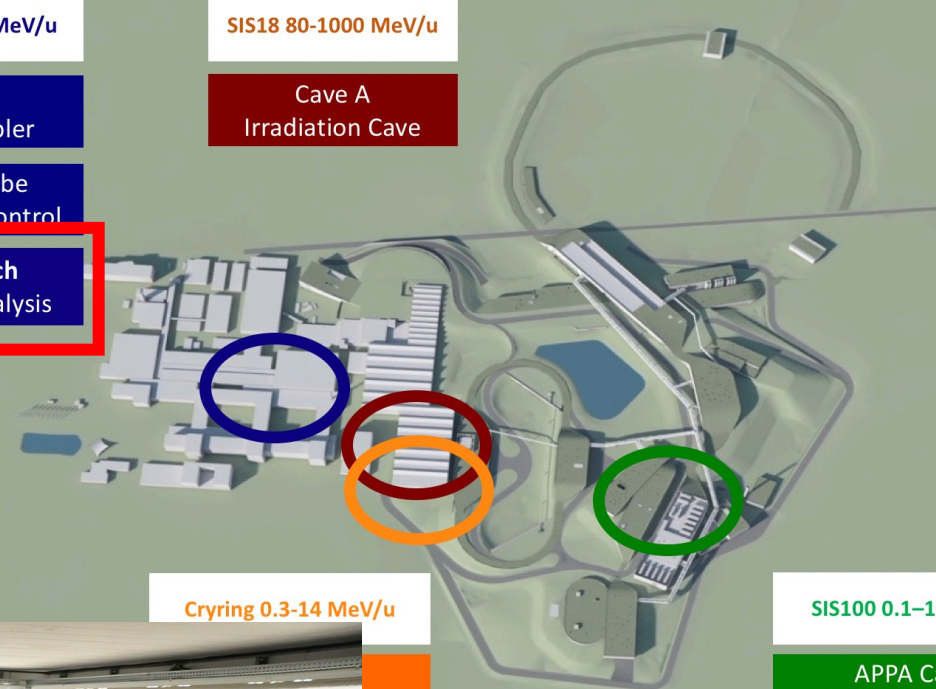
Microprobe
Single Ion Control

M-Branch
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SIS18 80-1000 MeV/u

Cave A
Irradiation Cave

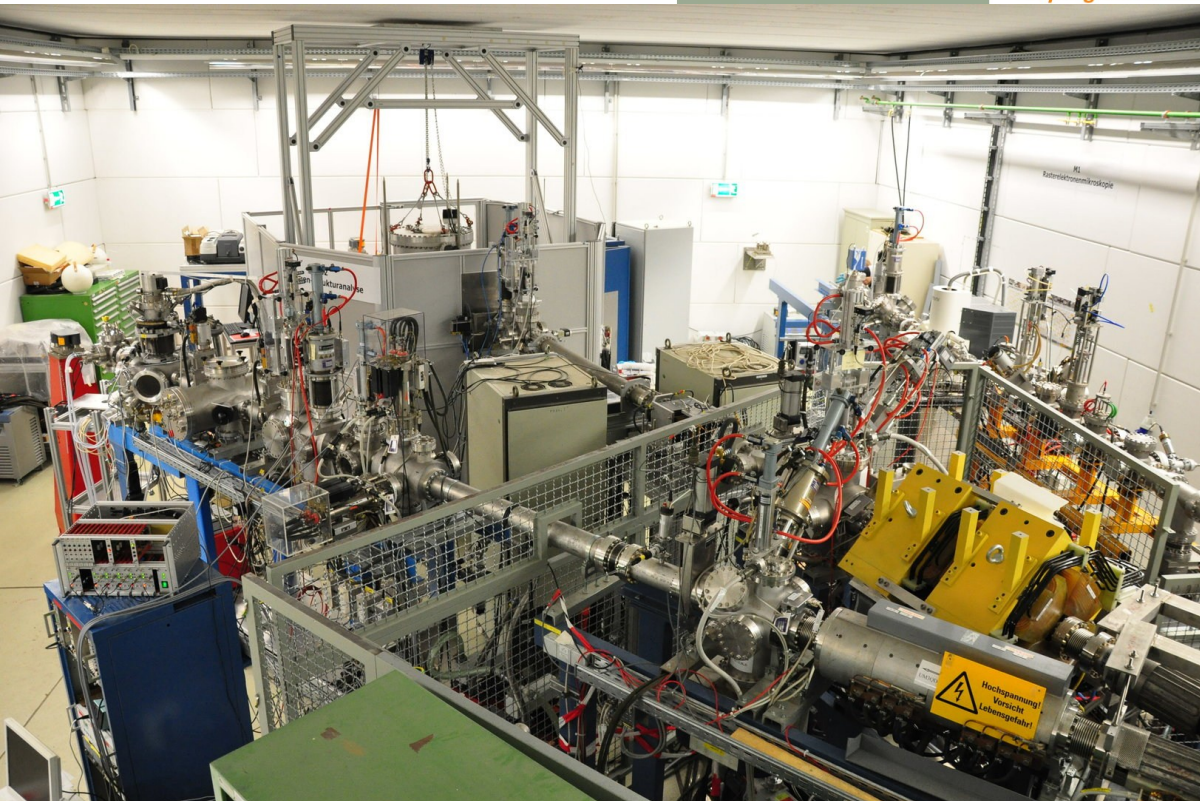
GSI Helmholtzzentrum für Schwerionenforschung Darmstadt



Cryring 0.3-14 MeV/u

SIS100 0.1-10 GeV/u

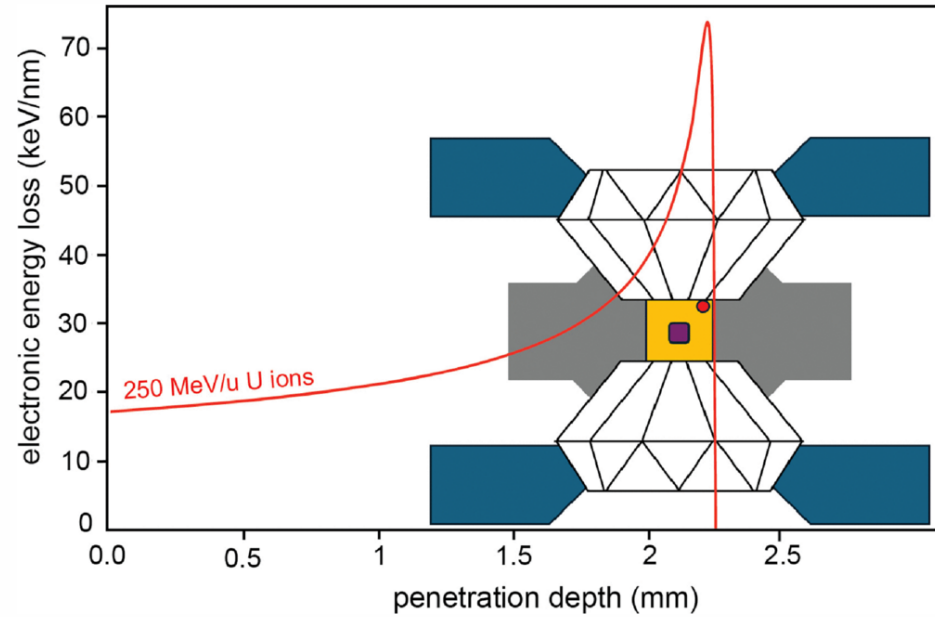
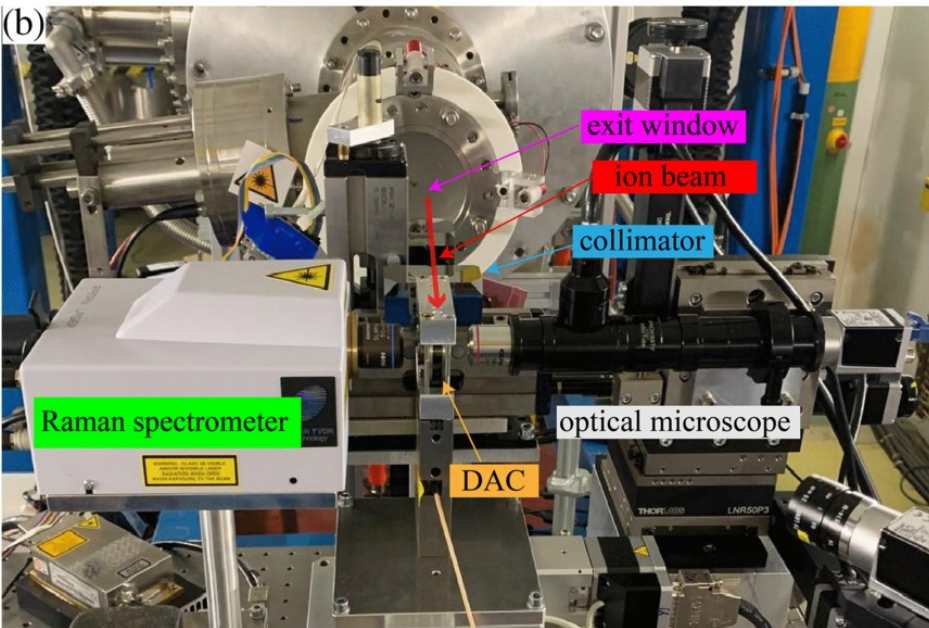
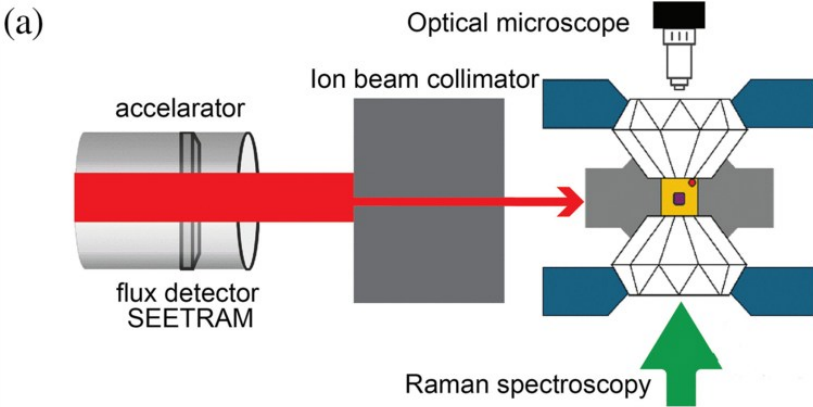
APPA Cave
High energy Cave



M1 Beamline – Scanning electron microscope and ToF-SIMS/SNMS

M2 Beamline – X-ray diffraction

M3 Beamline – In-situ spectroscopy and oven chamber



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SWOT analysis for the project

Strengths

- Builds on existing expertise in post-irradiation characterization.
- Combines irradiation with **real-time electrical transport and UV-VIS measurements**,.
- Creates a unique experimental capability in Poland and fills a clear infrastructure gap.

Weaknesses

- Risk of **sample degradation** during irradiation, especially for sensitive materials.
- Requires a highly flexible beamline: adjustable energy, current, and sample environment.
- In situ experiments are technically demanding, e.g. complex integration of optical diagnostics.

Opportunities

- Fits the growing concept of **defect engineering in functional materials**.
- Strong relevance for advanced materials research, including radiation-tolerant and tunable systems.

Threats

- Competing laboratories may develop similar in situ capabilities.
- High investment and operating costs could constrain long-term sustainability.



Conclusions

- Development of an **in situ ion-irradiation beamline** enabling real-time electric transport and UV-VIS measurements
- Direct insight into **defect-driven modification of functional materials**
- Platform for **interdisciplinary collaboration**
- Scalable concept with strong potential for application-oriented and industrial research



**THANK YOU FOR YOUR
ATTENTION**