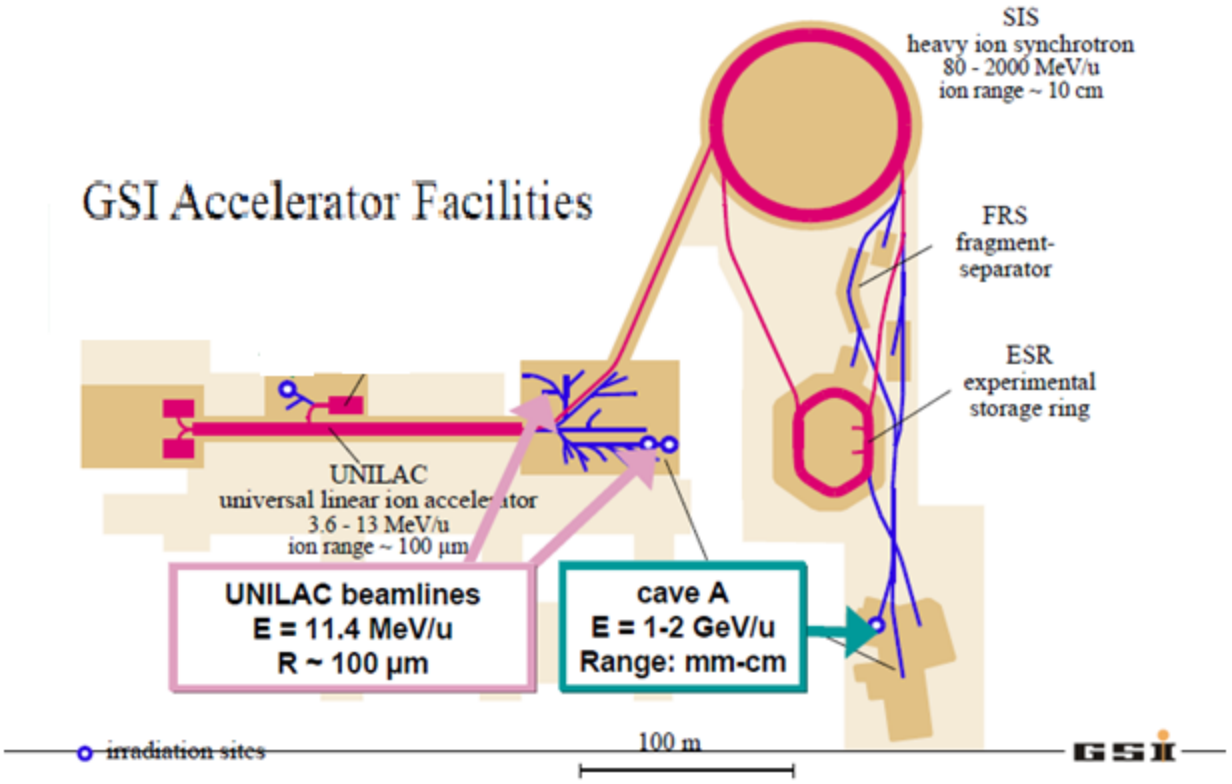
# GeV Ion Irradiation Experiments on Novel Collimator Materials

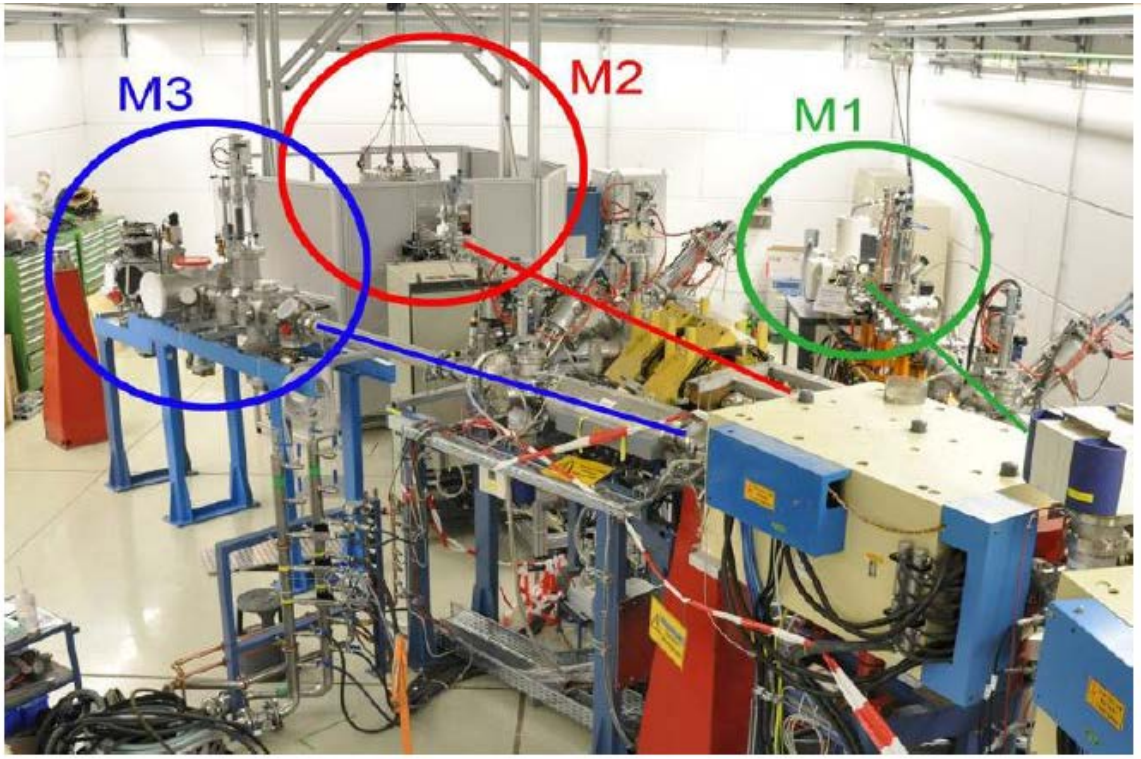
M. Tomut
GSI
F. Carra
CERN

# Beamlines for material research irradiation at GSI



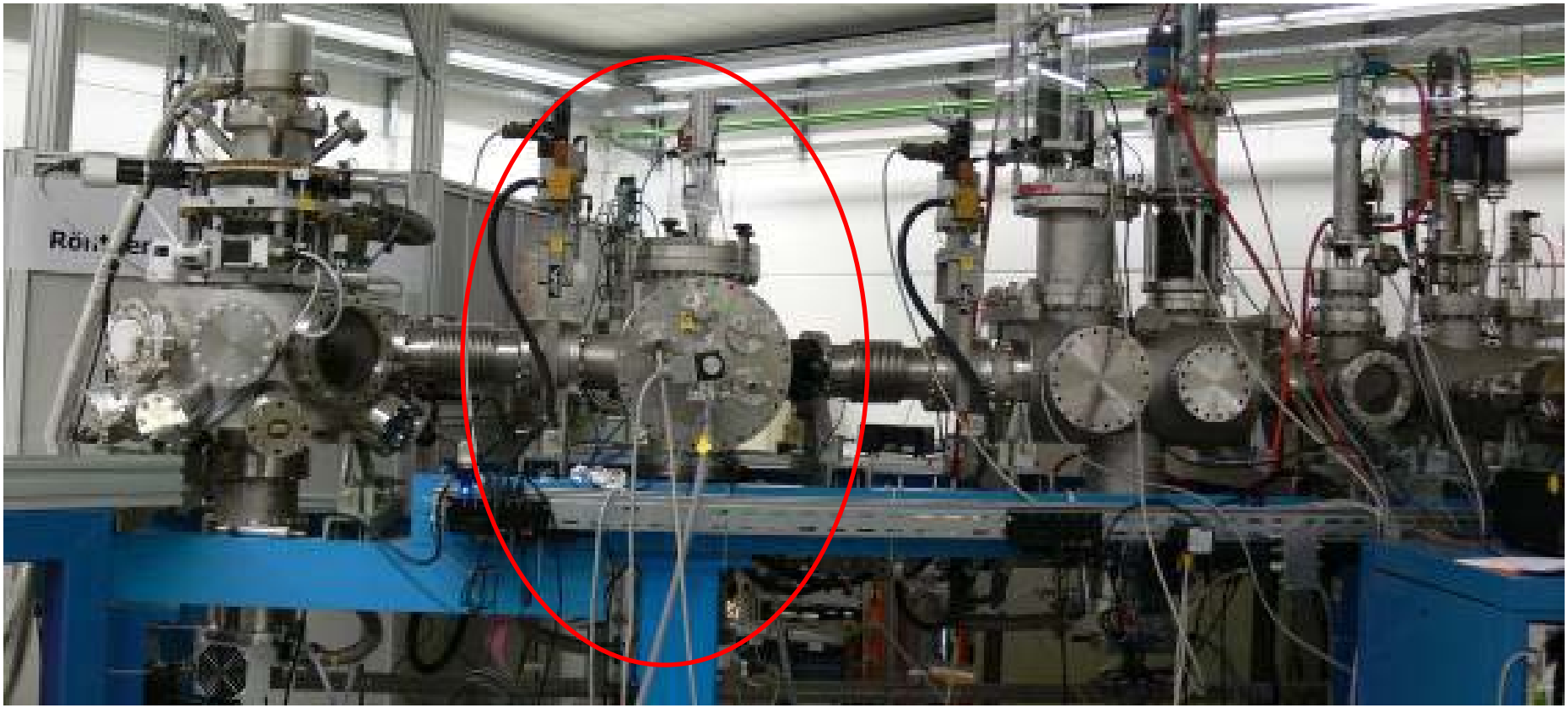
# M-branch irradiation facility at GSI
# In situ experiments

- energies close to Bragg peak  to maximize energy deposition and damage and to avoid activation
- online and in situ monitoring available: video camera,  fast IR camera, SEM, XRD, IR spectroscopy



# Irradiation at M3, UNILAC, GSI

- $^{238}U$, 1.14 GeV, 0.5 ms, 0.6 Hz, $4x10^9$ ions/cm$^2$ s
- $^{208}Bi$, 1 GeV, 0.5 ms, 3.4 Hz, $1.2x10^9$ ions/cm$^2$ s



# Irradiation experiments

fluences: 1e11, 1e12, 1e13, 5e13/1e14 i/cm$^2$ at fluxes ~5e9 i/cm$^2$s

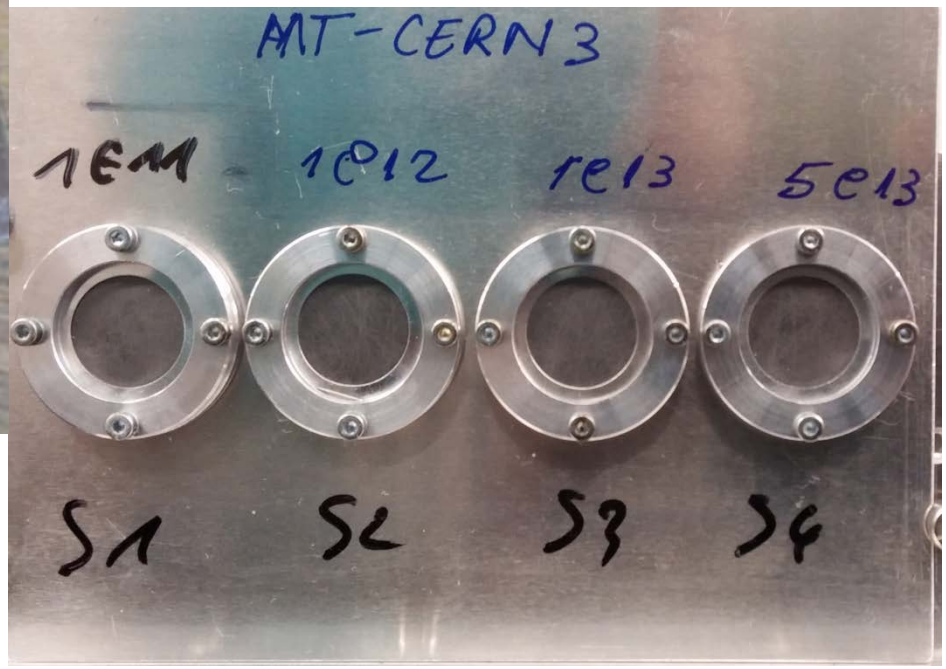
- Samples for LFA: in-plane thermal conductivity measurements
  - Mo-Gr discs in-plane and transversal; U irradiation
  - Cu-CD discs U and Bi irradiation, 4.8 MeV/u
- Samples for off-line tests: Raman, Nanoindentation, SEM
  - Cu-CD, Mo-Gr: 2orientations,CFC: 2 orientations (U, Au, Bi)
- Thermal conductivity degradation monitoring (on-line using thermal camera: estimation of time constant at cooling)
  - Cu-CD, Mo-Gr: 2orientations,CFC: 2 orientations (U, Bi)
- High energy deposition using focused U beam
  - Cu-CD, Mo-Gr 2 orientations

total 13 holders

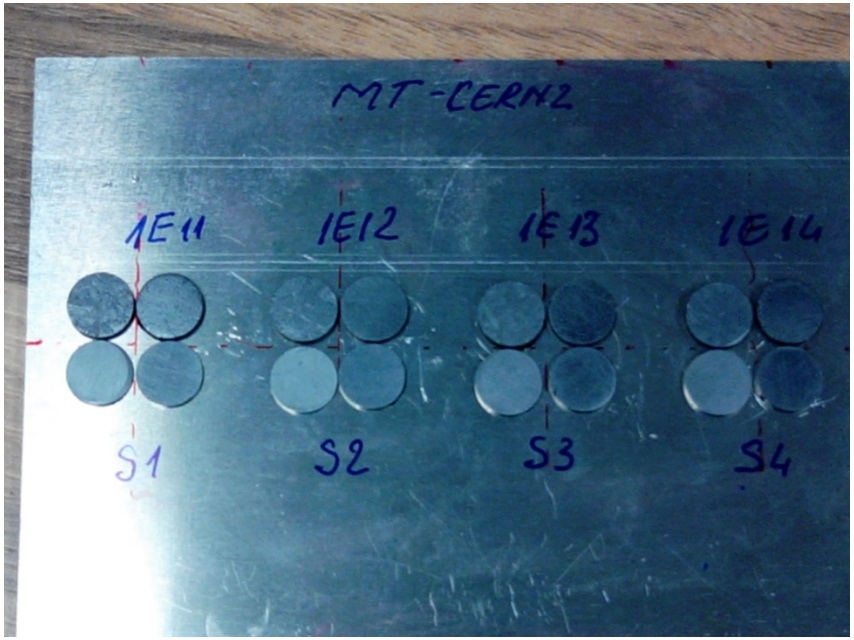
# Holders for postirradiation thermal conductivity tests- LFA in-plane

Cu-CD

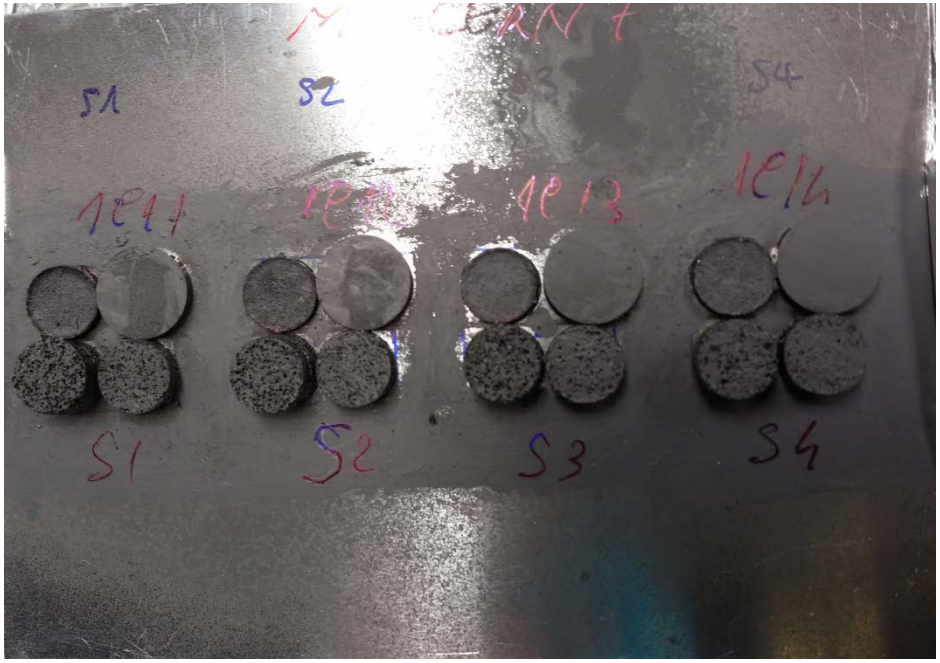

Mo-Gr I



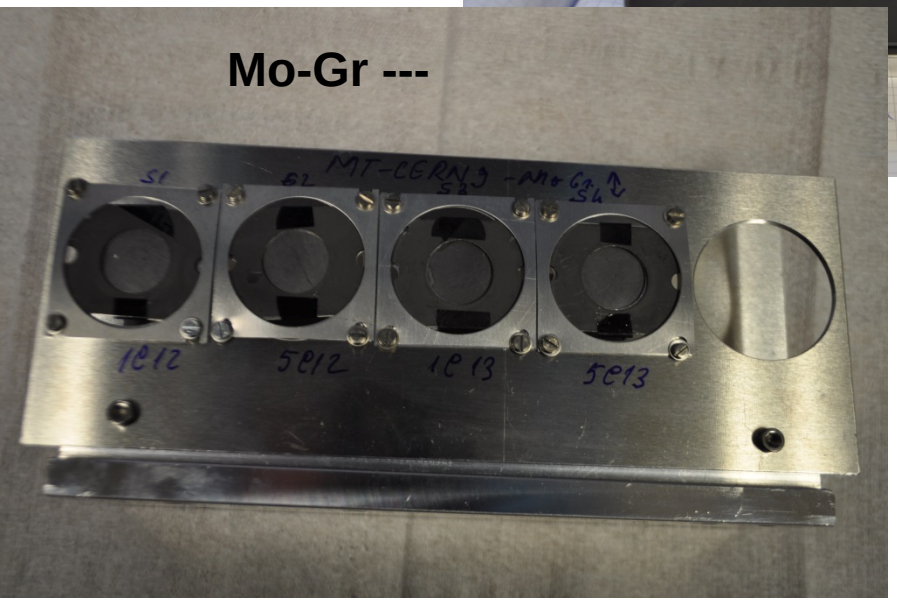
Holders for post irradiation tests:
nanoindentation,
Raman spectroscopy,
SEM

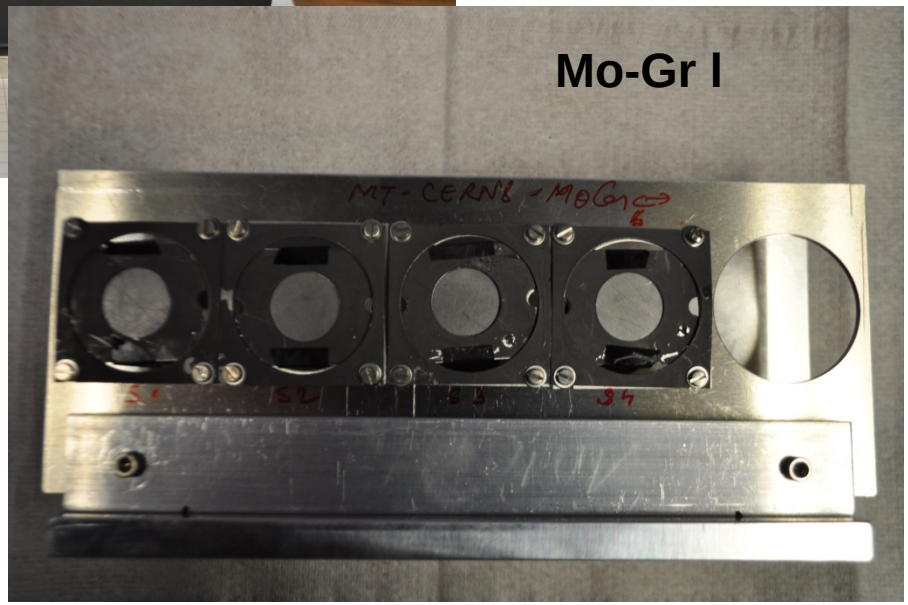



Holders for online thermal conductivity degradation tests using thermal camera



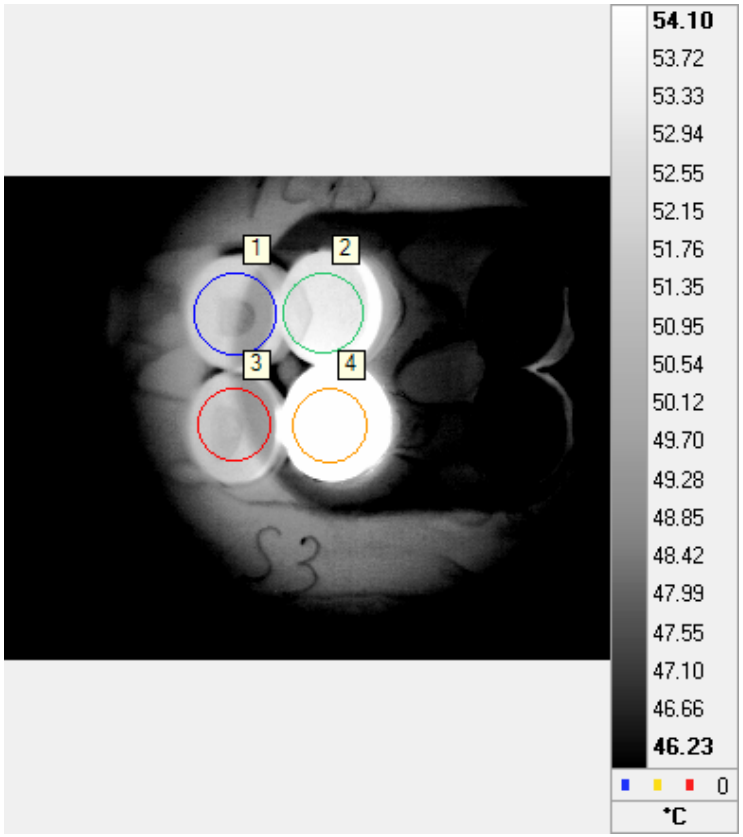
# Holders for focused beam exposure- high energy density deposition

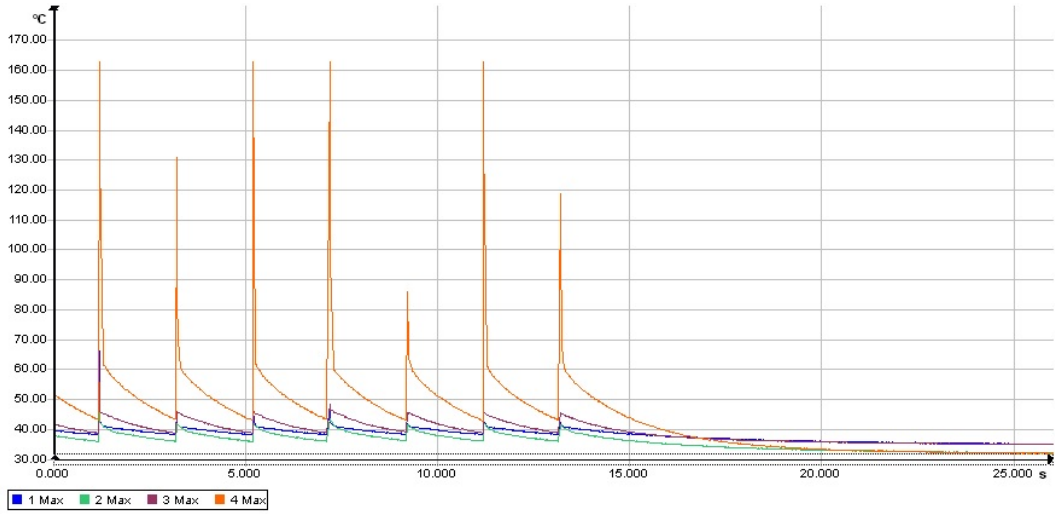



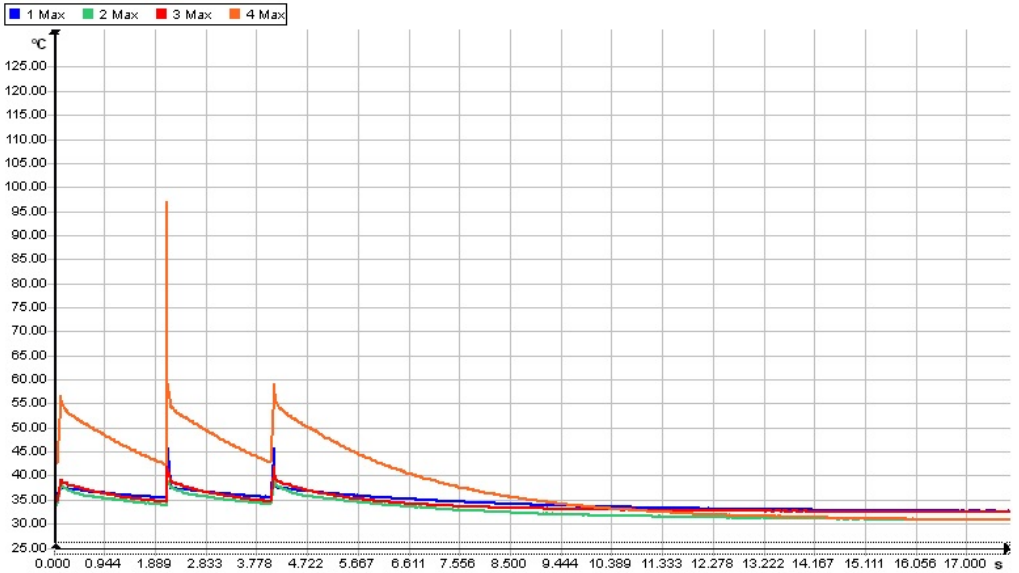



# Failure of Mo-GR samples transversal cut stress waves

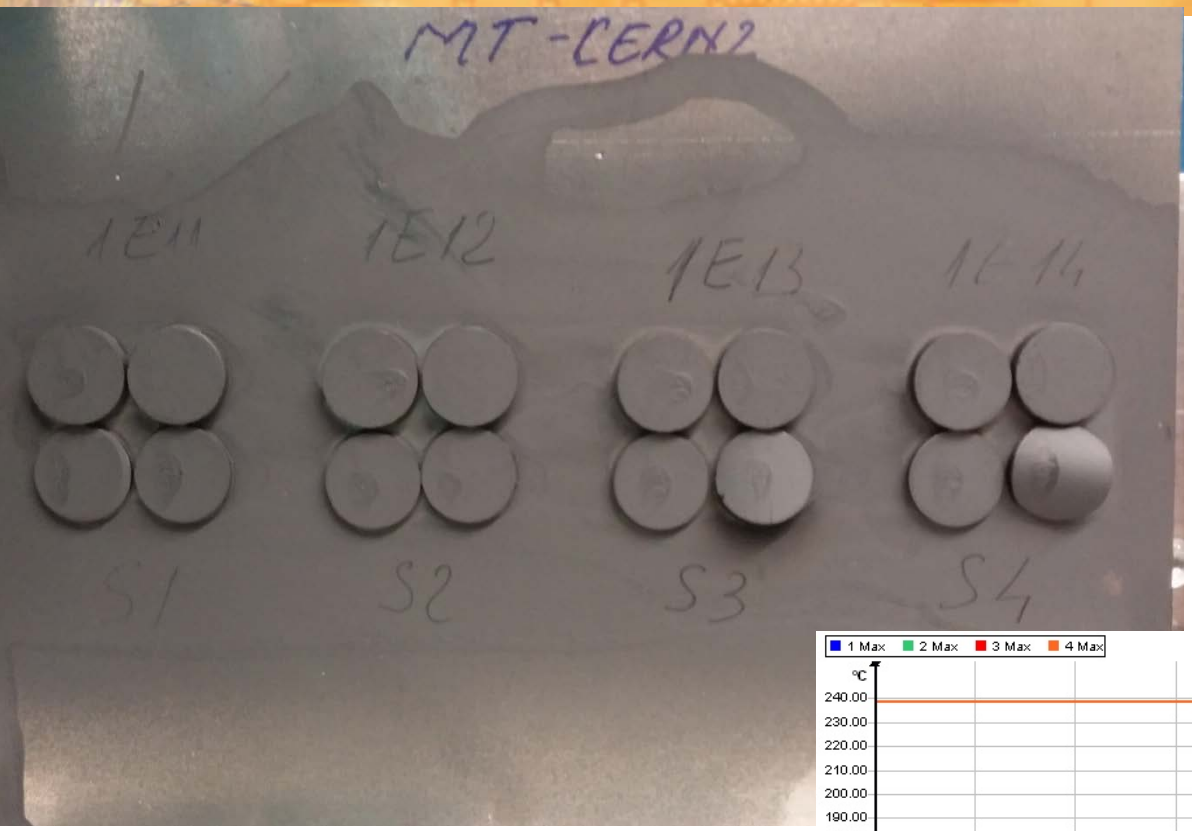
# Thermal camera monitoring of sample temperature during cooling

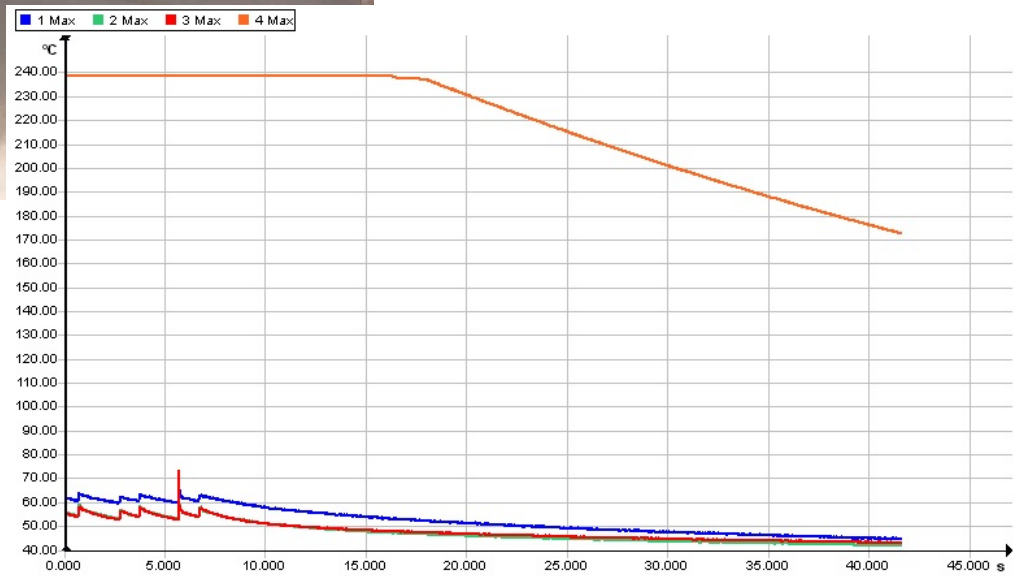


# Deformation of Mo-GR samples transversal cut starting with 6E12 i/cm²



# Increase of time constant for cooling thermal conductivity degradation