Istituto Nazionale di Fisica Nucleare
Sezione di Roma

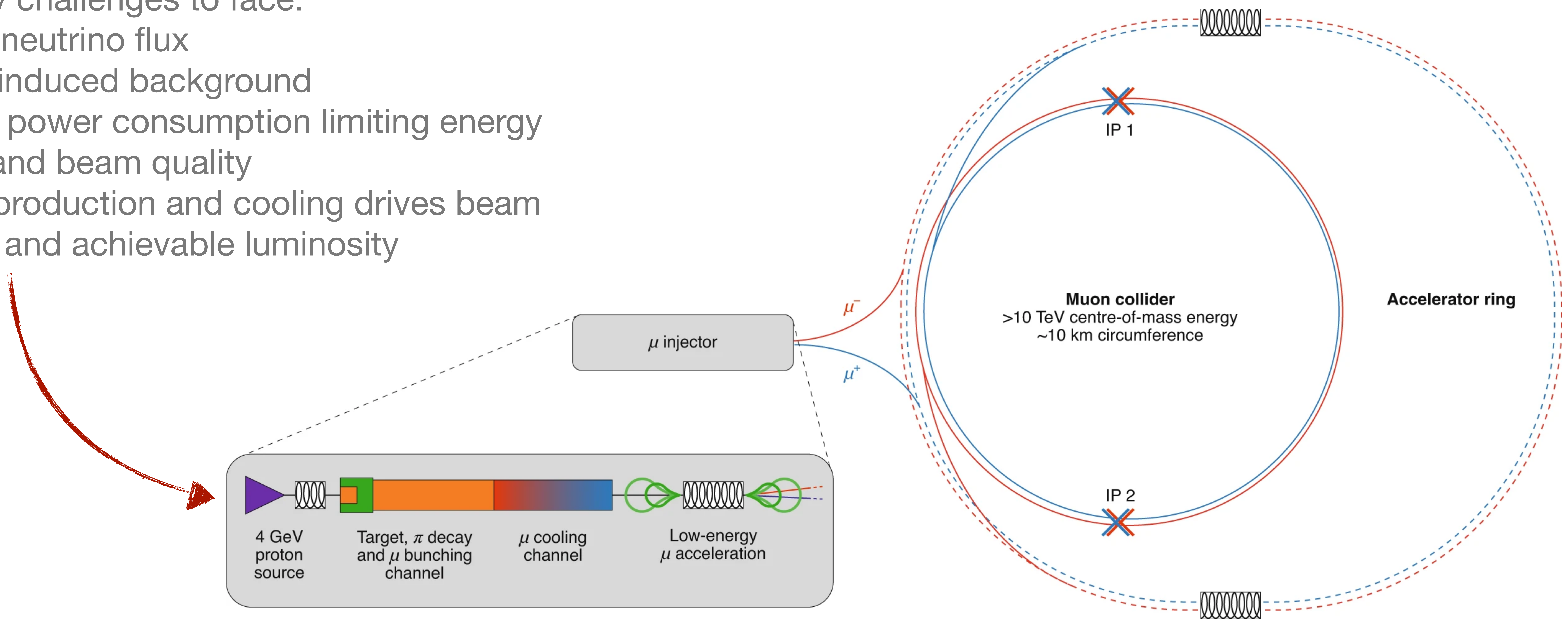
STUDIED ONsMATERIALS FOR the MUON COLLIDER

M. Bauce *et al.*

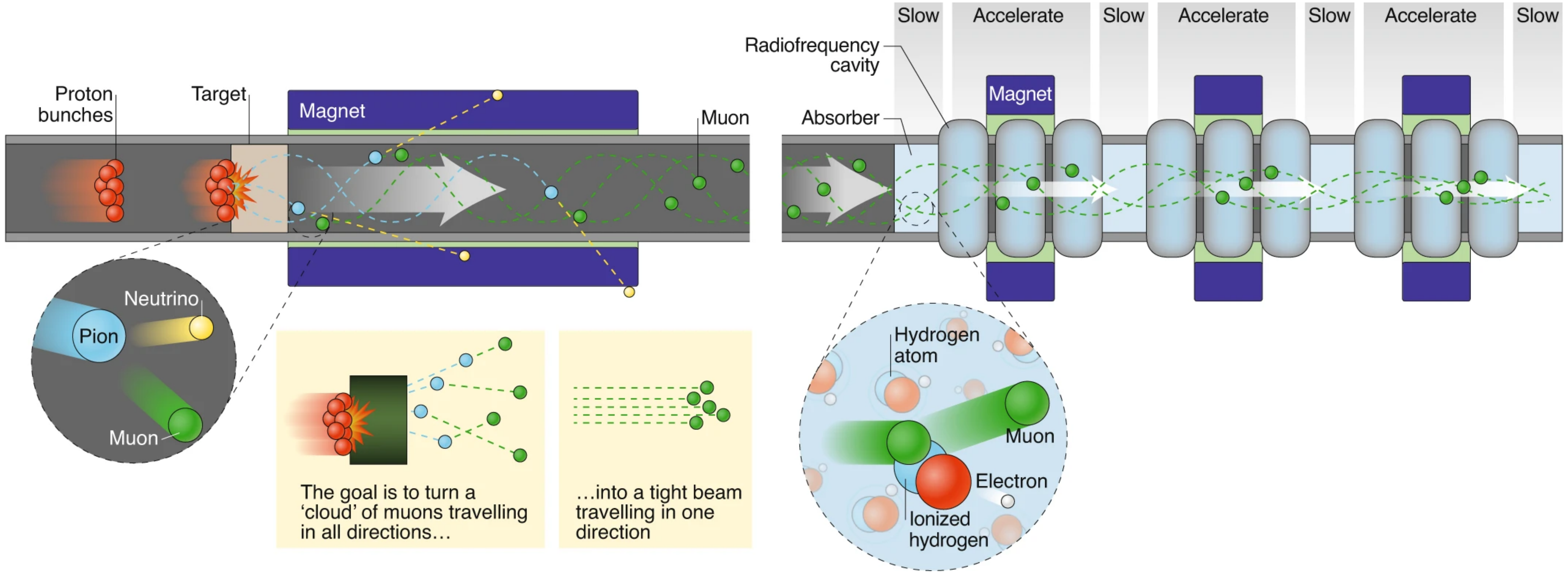
MUON COLLIDER AT a GLANCE

Many key challenges to face:

- Dense neutrino flux
- Beam-induced background
- Cost & power consumption limiting energy reach and beam quality
- Muon production and cooling drives beam quality and achievable luminosity

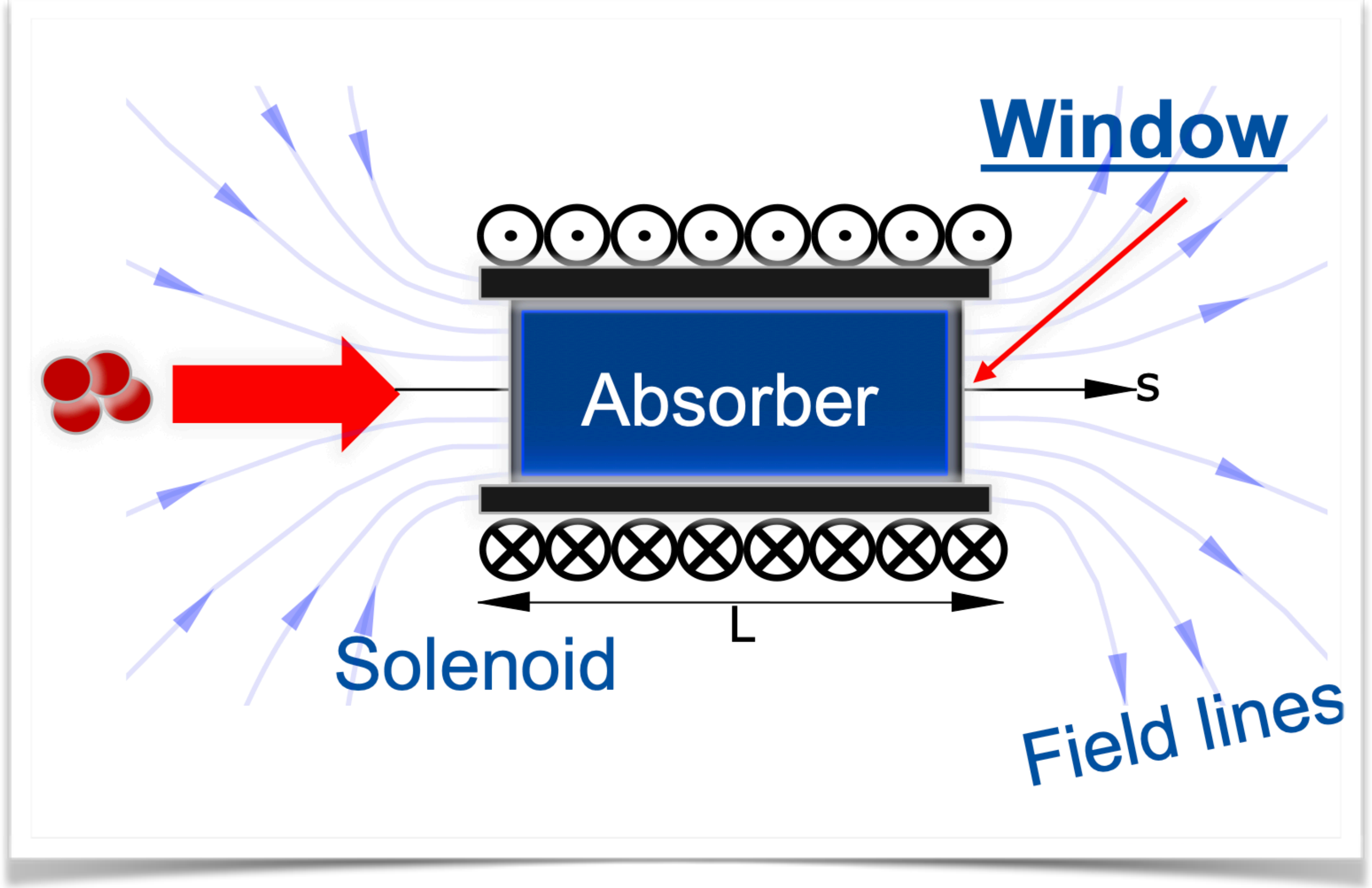


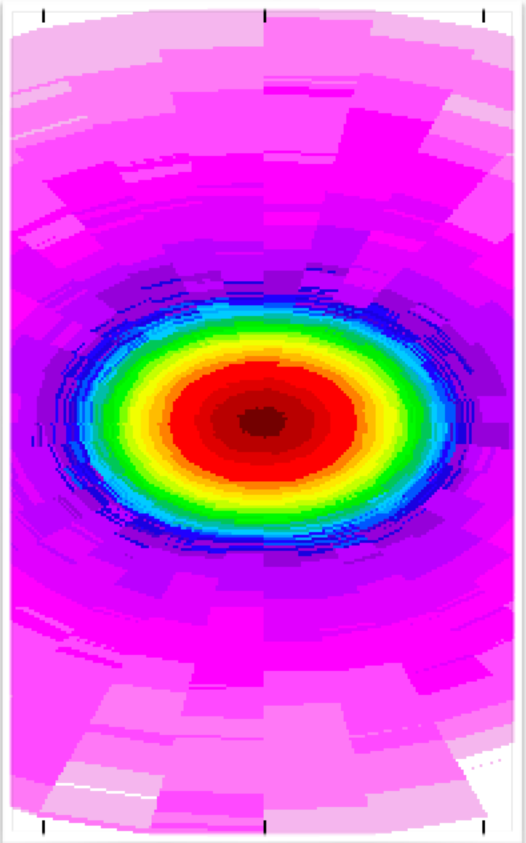
LIGHT-MATERIAL ABSORBERS FOR MUON COOLING



Parameters:

- 20 to 5 MeV cooling
- 4e12 muons/pulse
- 5 Hz repetition rate
- σ_{RMS}=0.6 mm



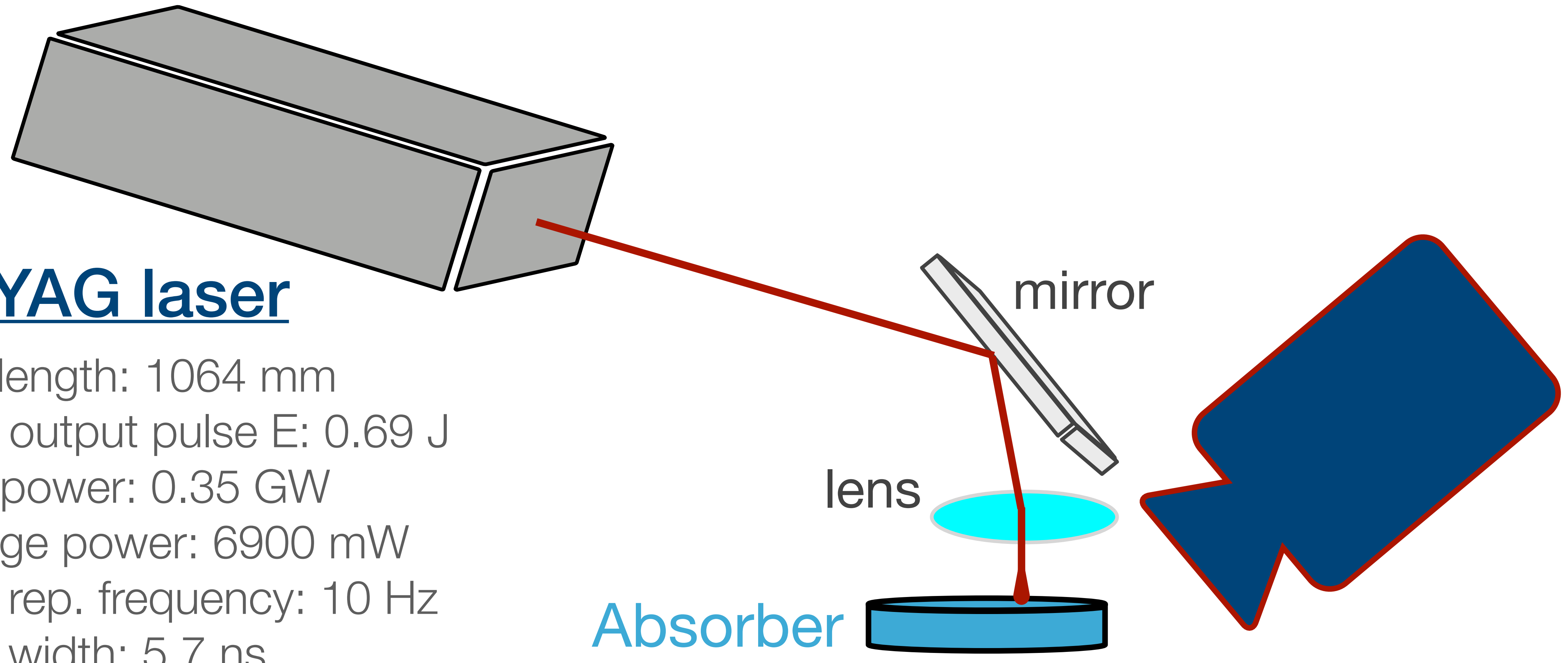


- *Low-Z* and *thin* absorbers (LiH, H_2,…) to minimize beam Multiple Scattering
- Thin windows to contain liquid absorbers (Be, Si_3N_4, SiC, C

Absorber Material Characterisation

Target crash test with photons

Ex ante ex post characterisation

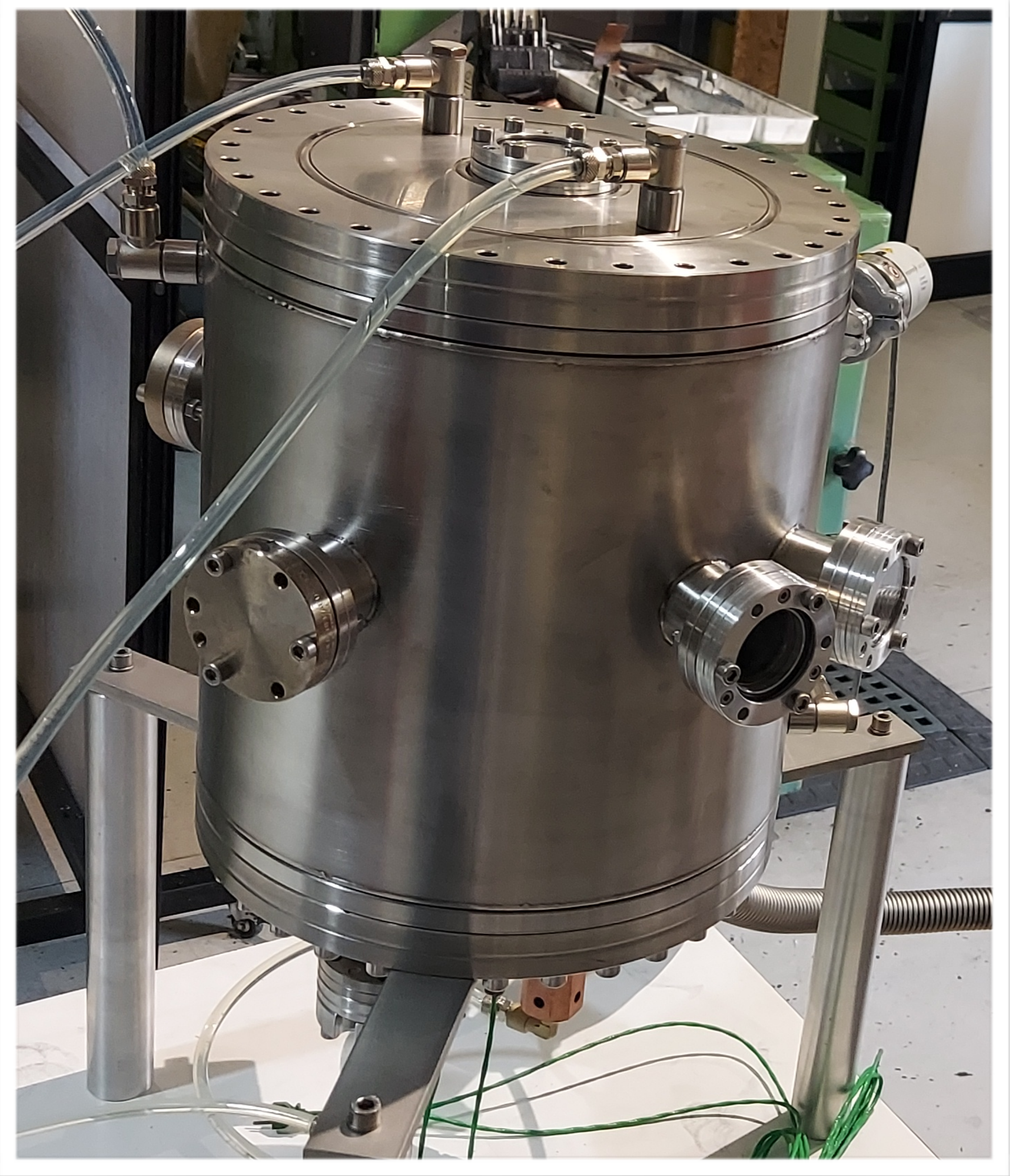


Nd:YAG laser

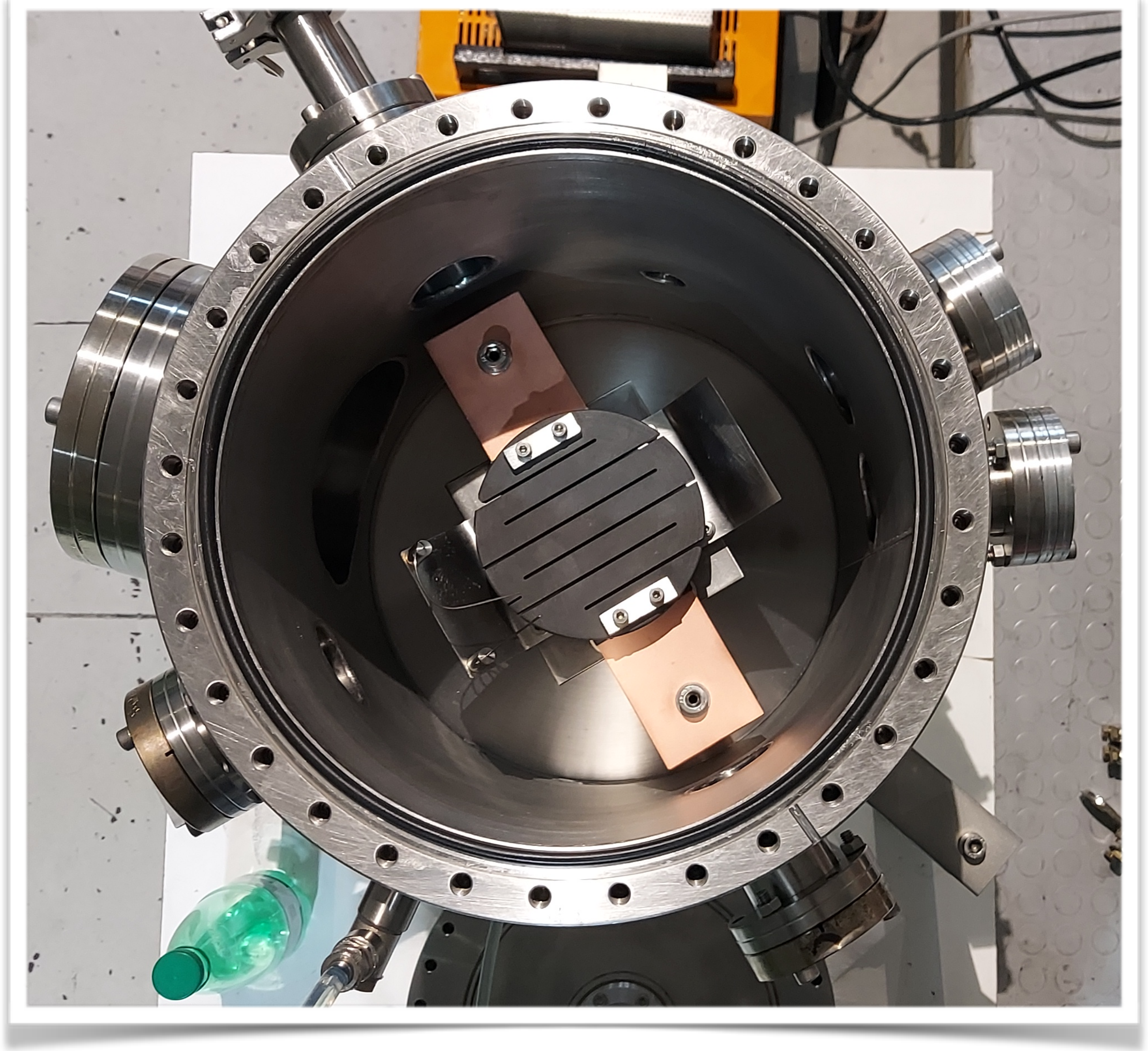
Wavelength: 1064 mm
Laser output pulse E: 0.69 J
Peak power: 0.35 GW
Average power: 6900 mW
Pulse rep. frequency: 10 Hz
Pulse width: 5.7 ns

Infrared Camera
FLIR X6901sc SLS

Optic: 17 mm, calibrated in the range [-80 °C, +300 °C]



vacuum chambers for thermal measurements



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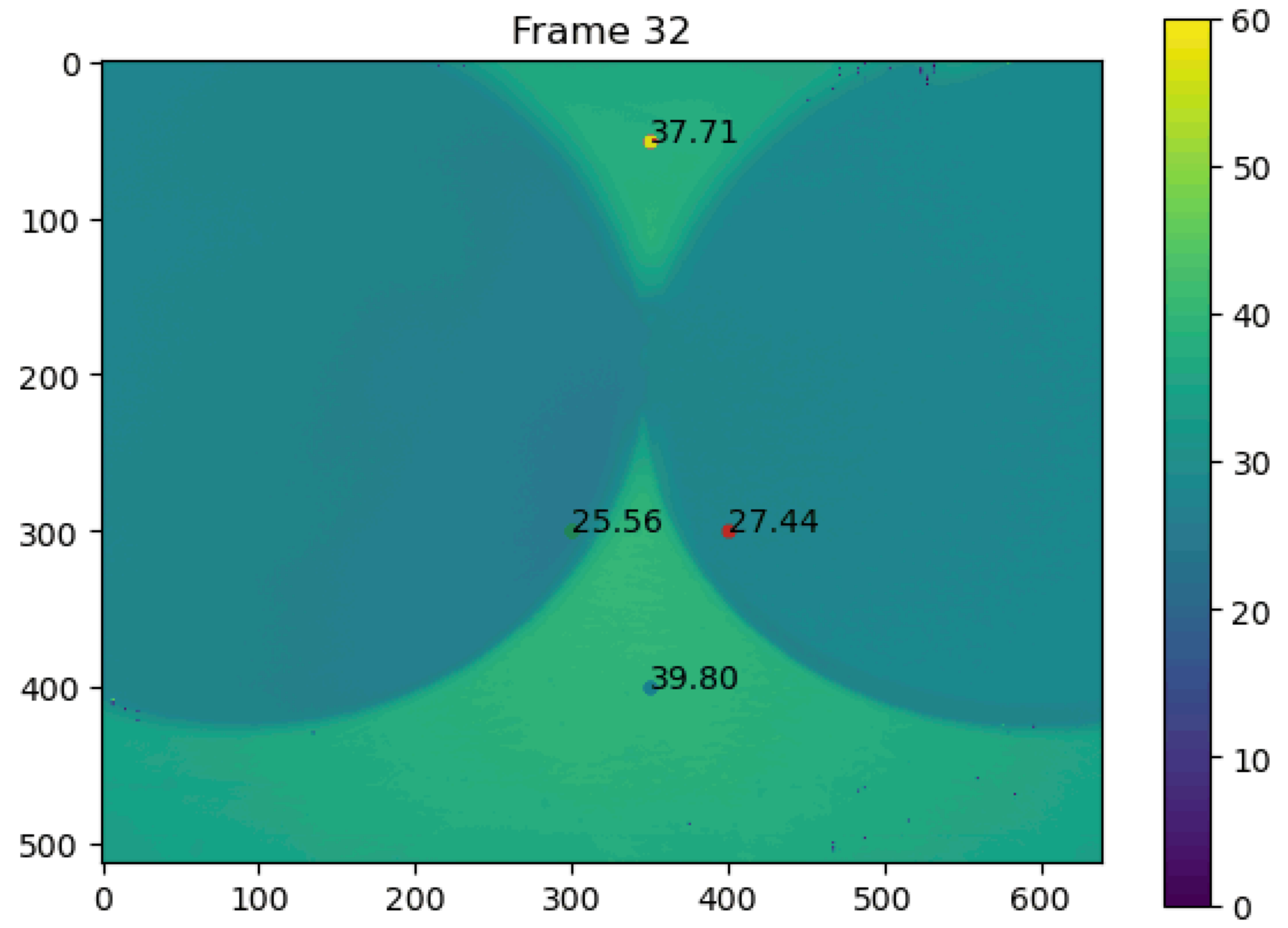
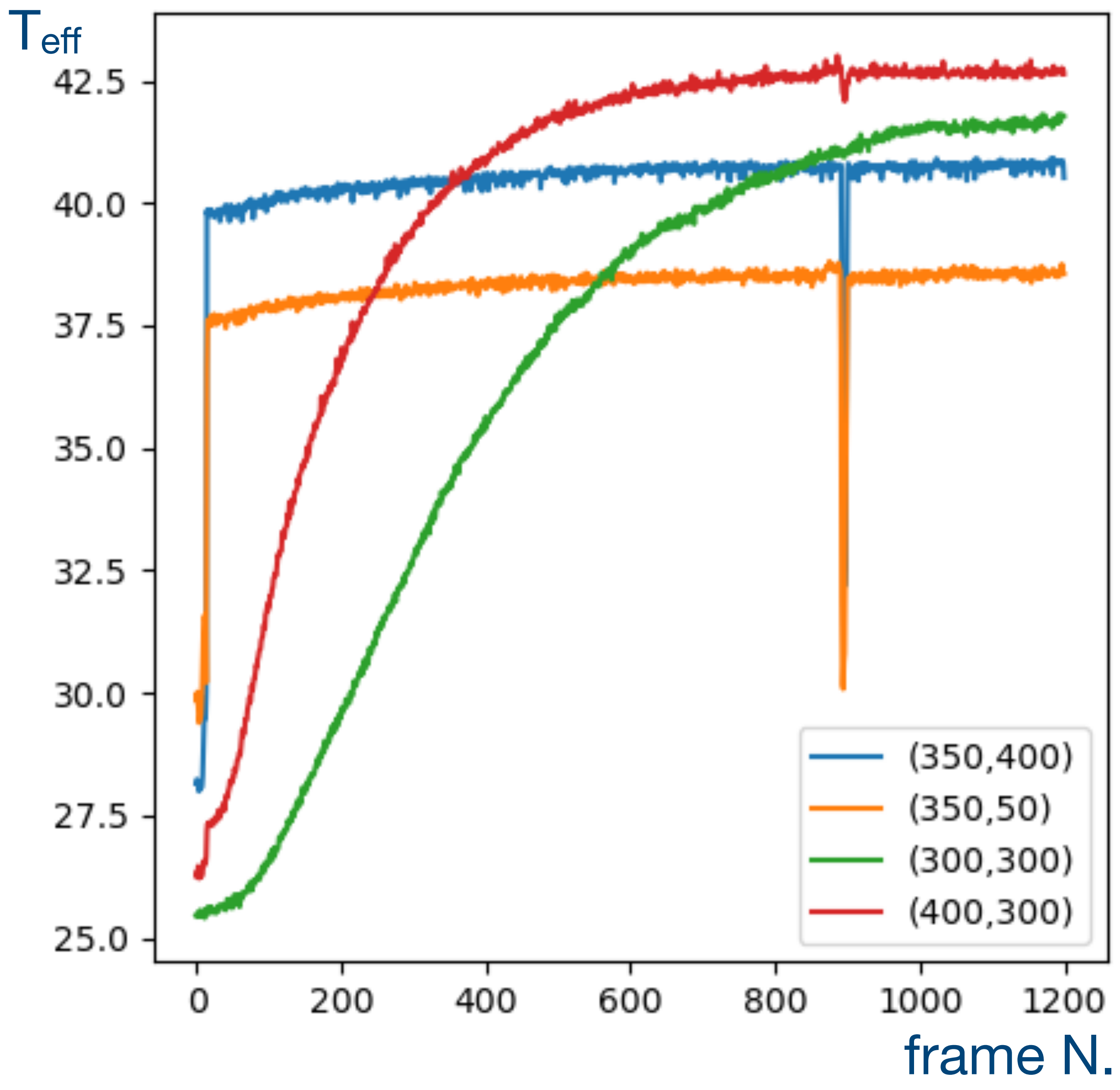
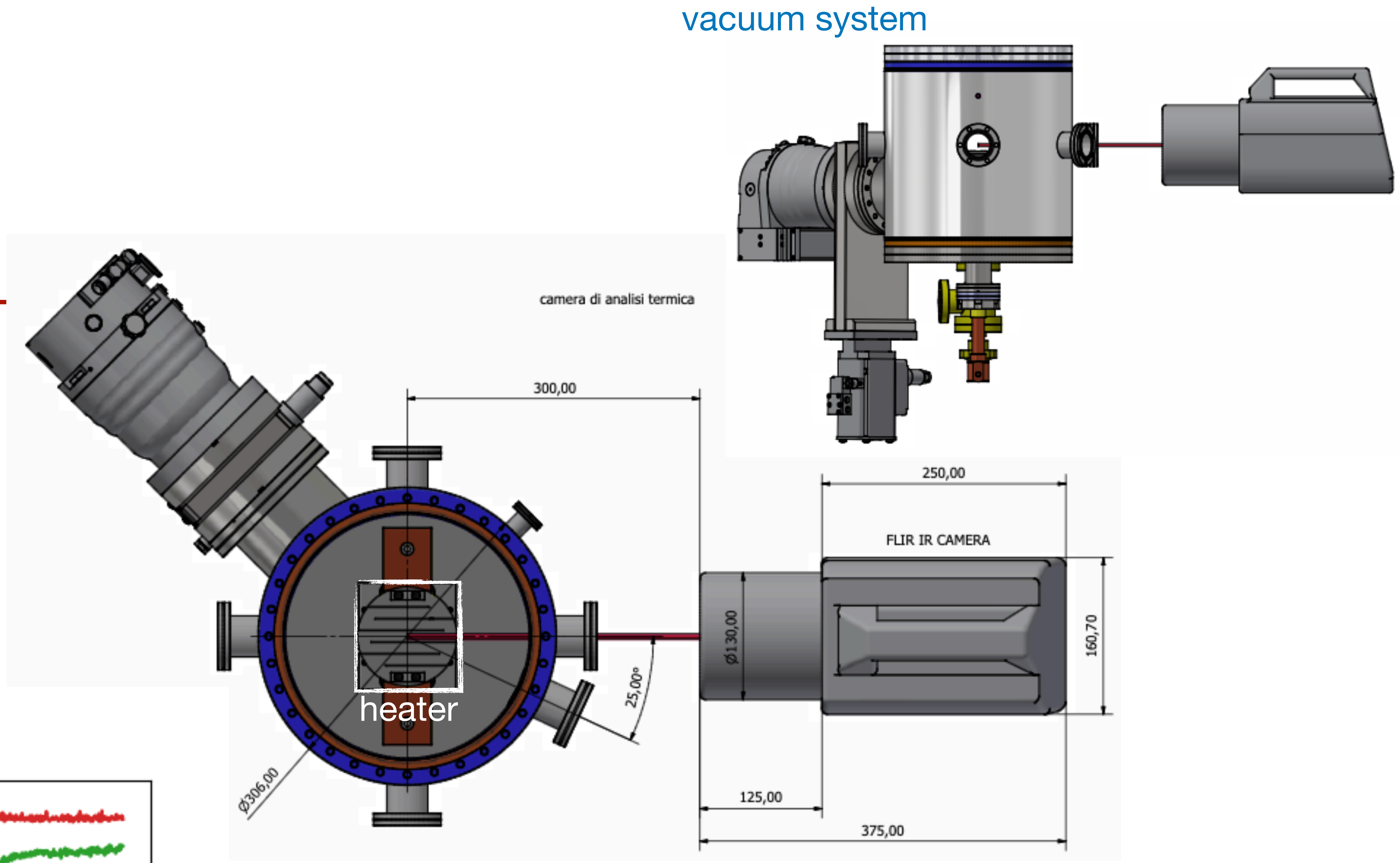
INFRARED THERMOGRAPHY

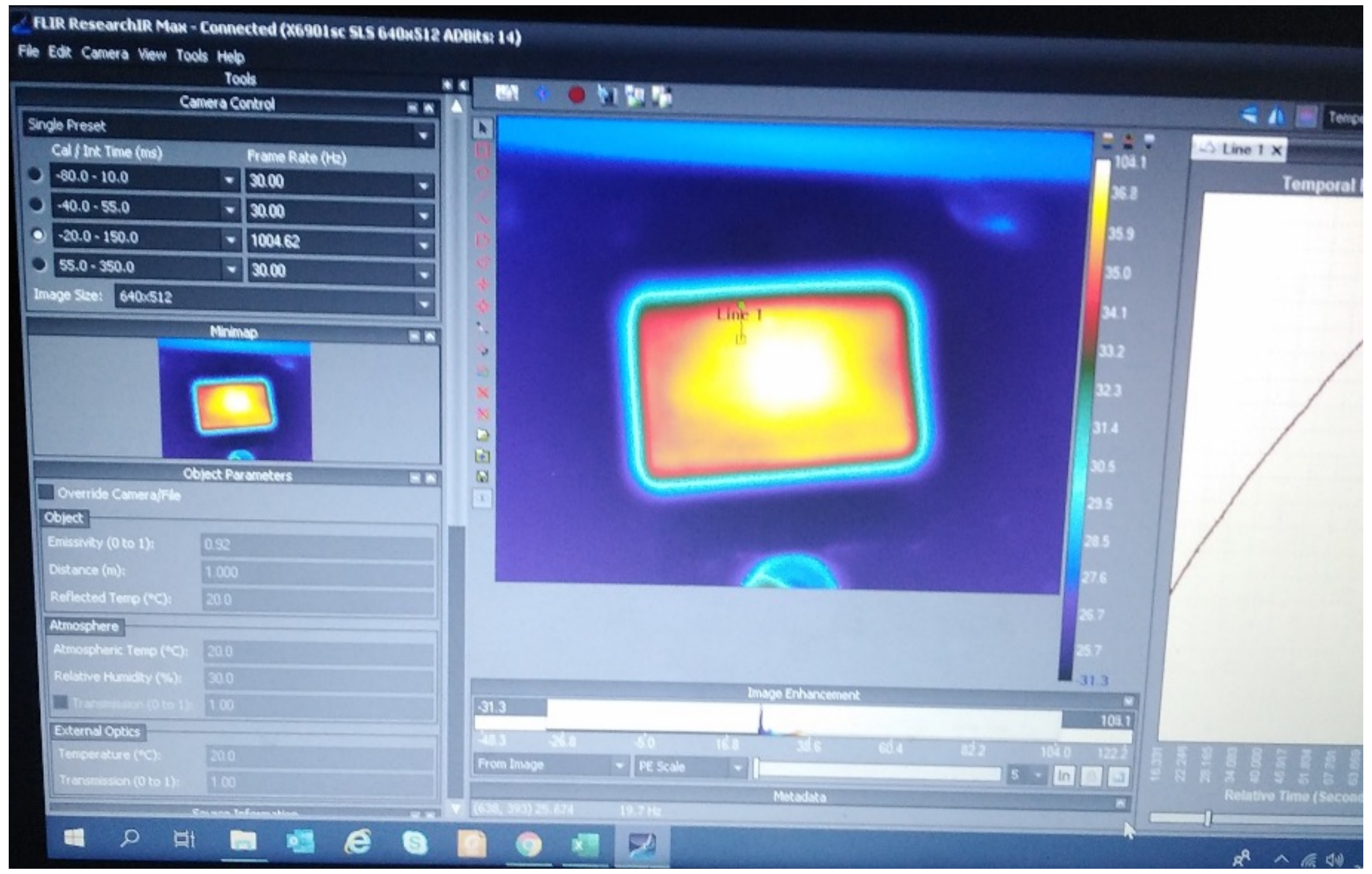
- Thermal properties of absorbers material determined through photothermal radiometry
- investigate thermal diffusivity anisotropy



Measurements of heated target thermal evolution allows measurement of material properties (e.g. diffusivity)

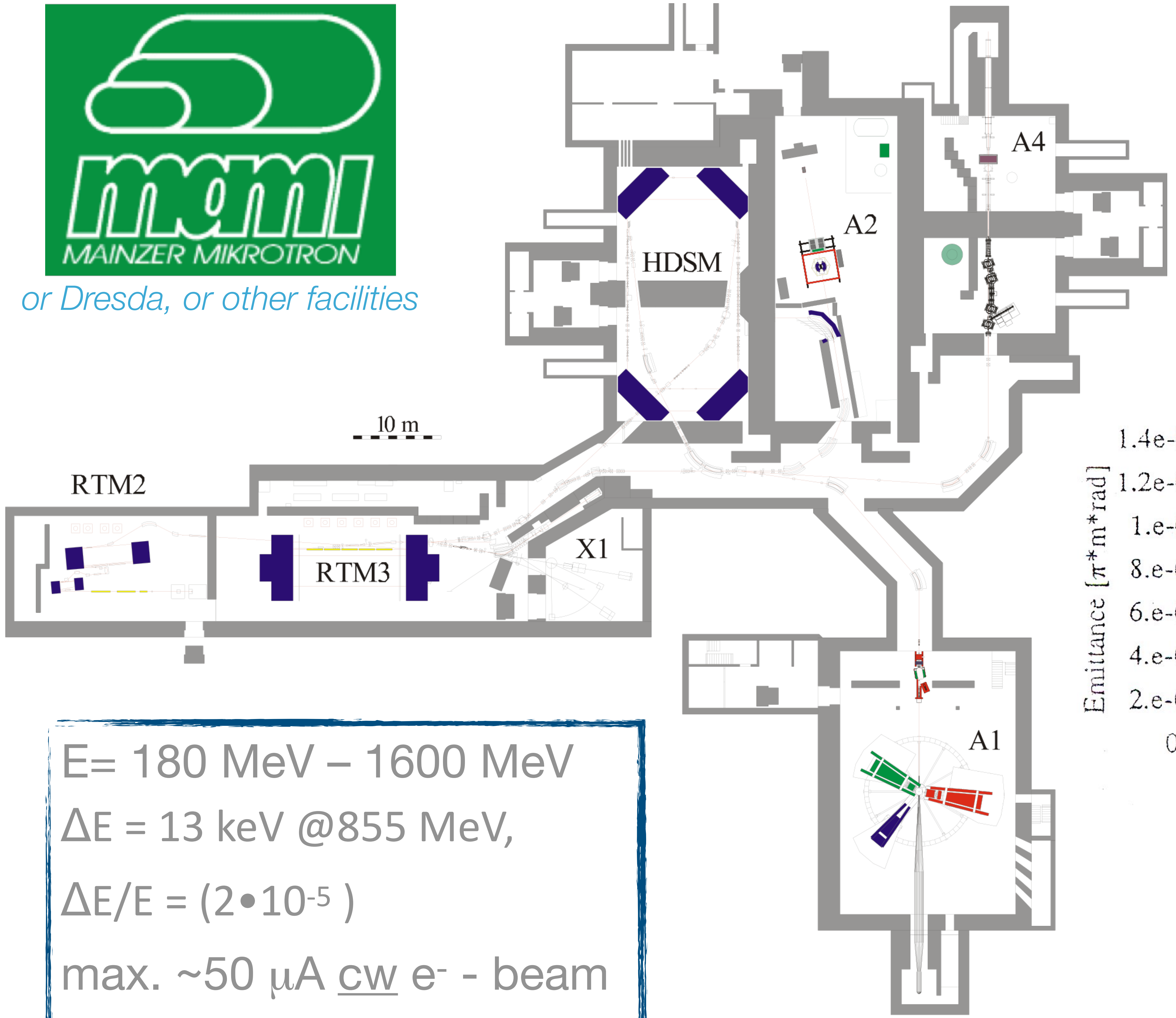






IRRADIATION tests ON PARTICLE BEAMS

or Dresda, or other facilities



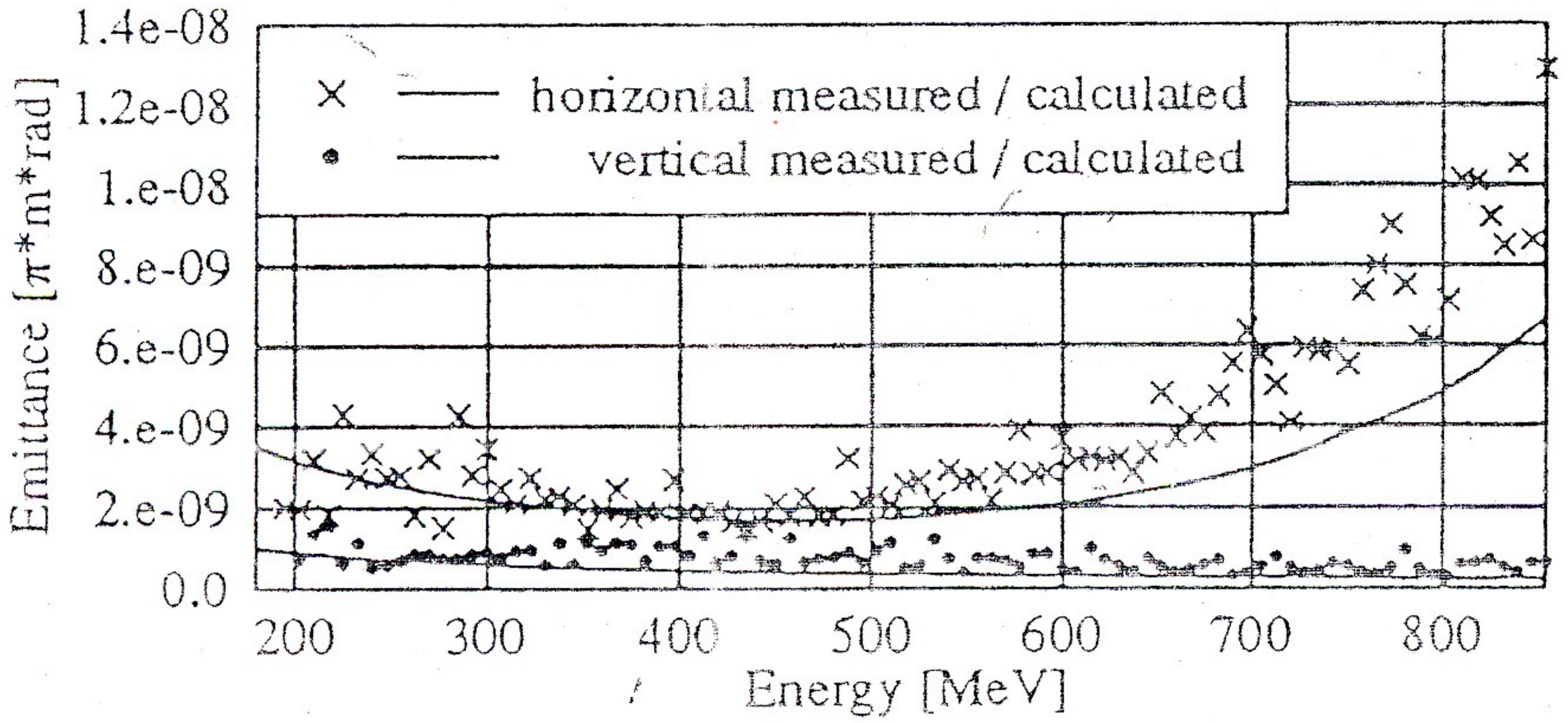
E= 180 MeV – 1600 MeV

ΔE = 13 keV @855 MeV,

ΔE/E = (2•10^{-5})

max. ~50 μA <u>cw</u> e^- - beam

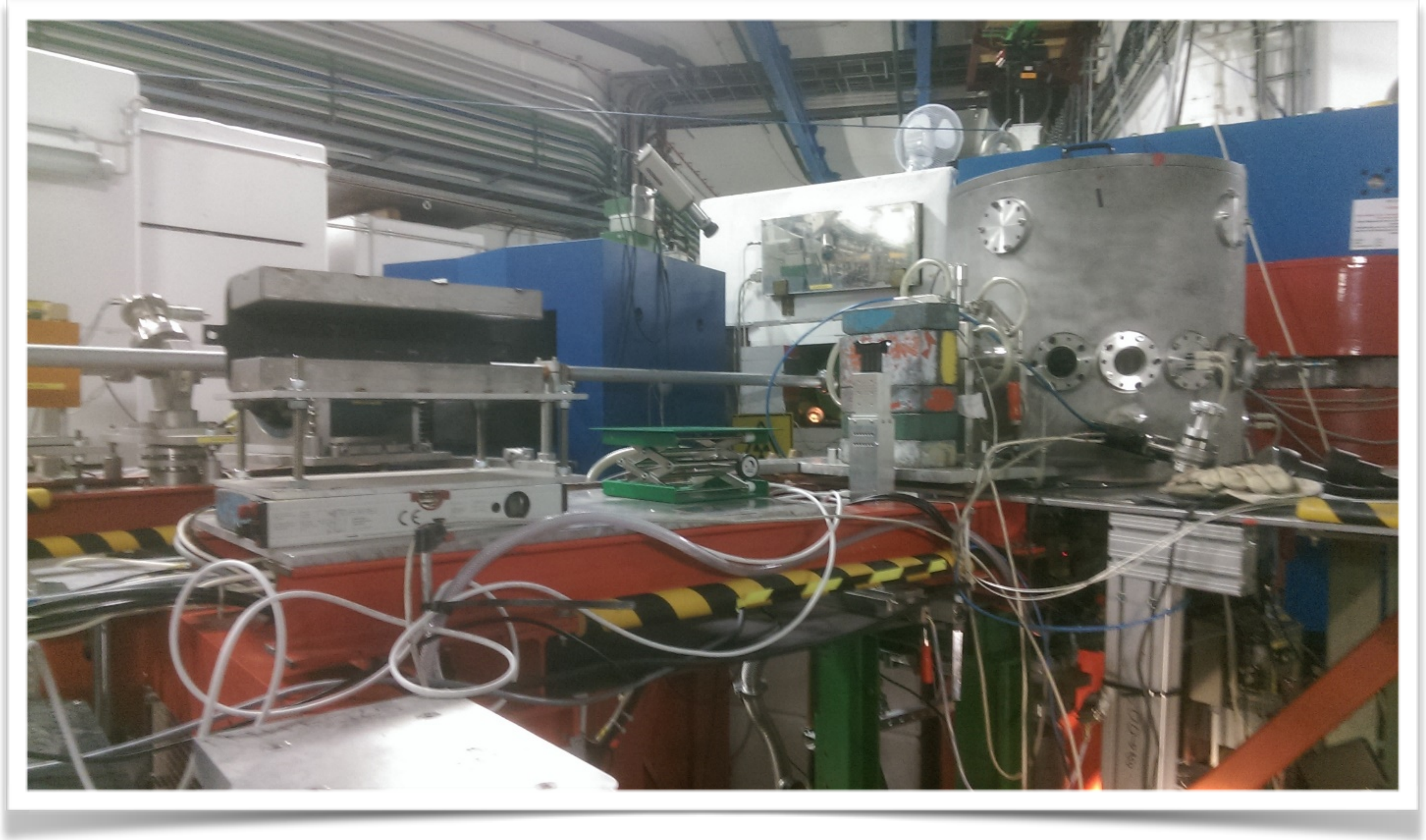
~ 7000 h / year running

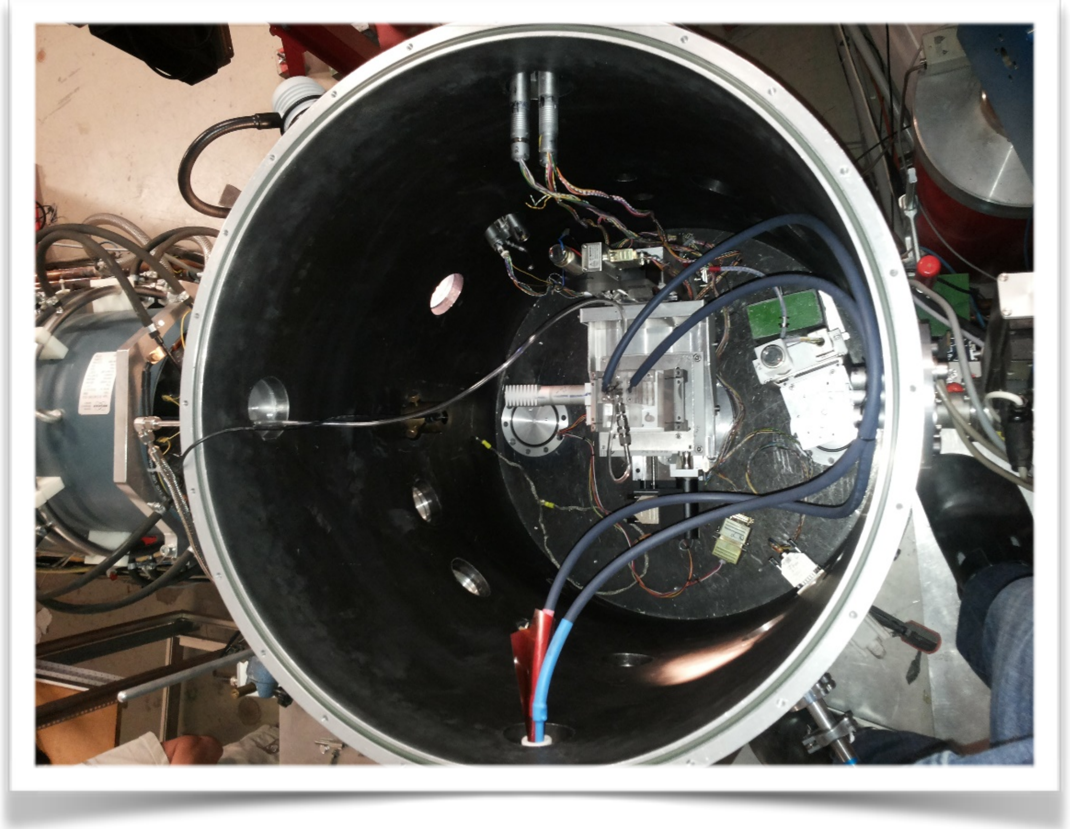


Emittance:

Vertical : ε_y=8 nm rad

Horizontal: ε_x=8 nm rad





Validation of model predictions for thermal and mechanical behaviour of materials

DEPTH PROFILING by Photothermal Radiometry

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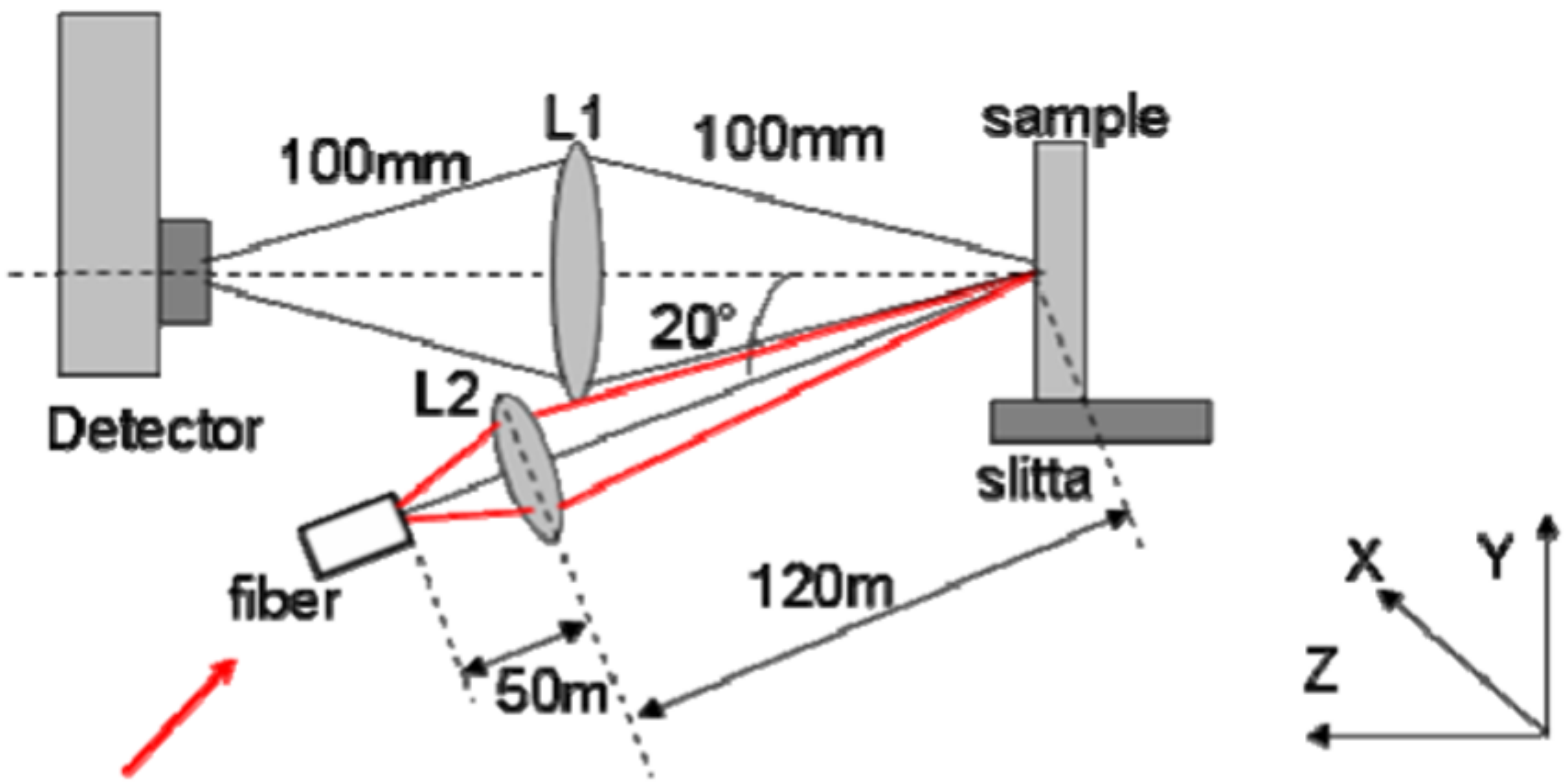
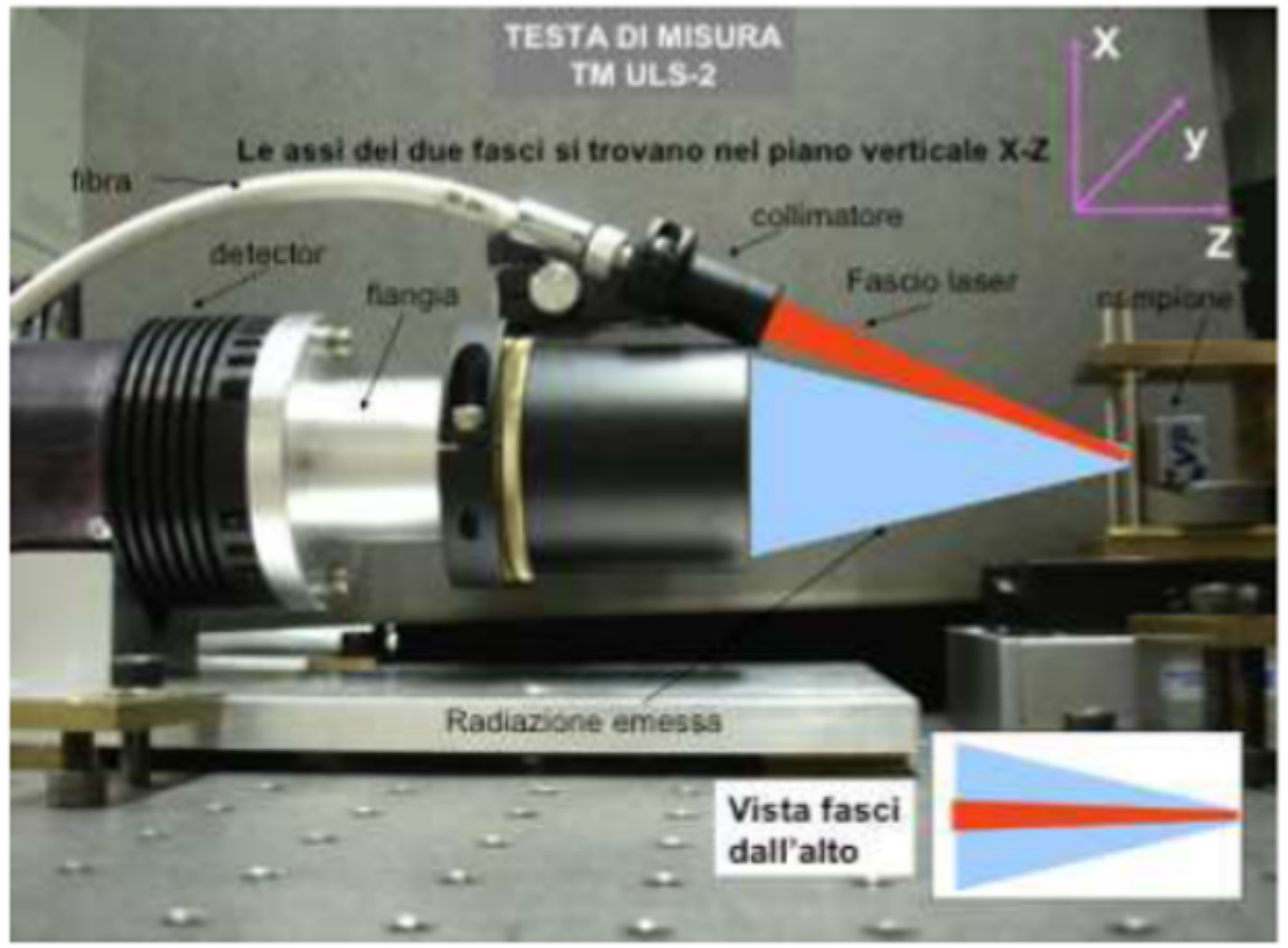
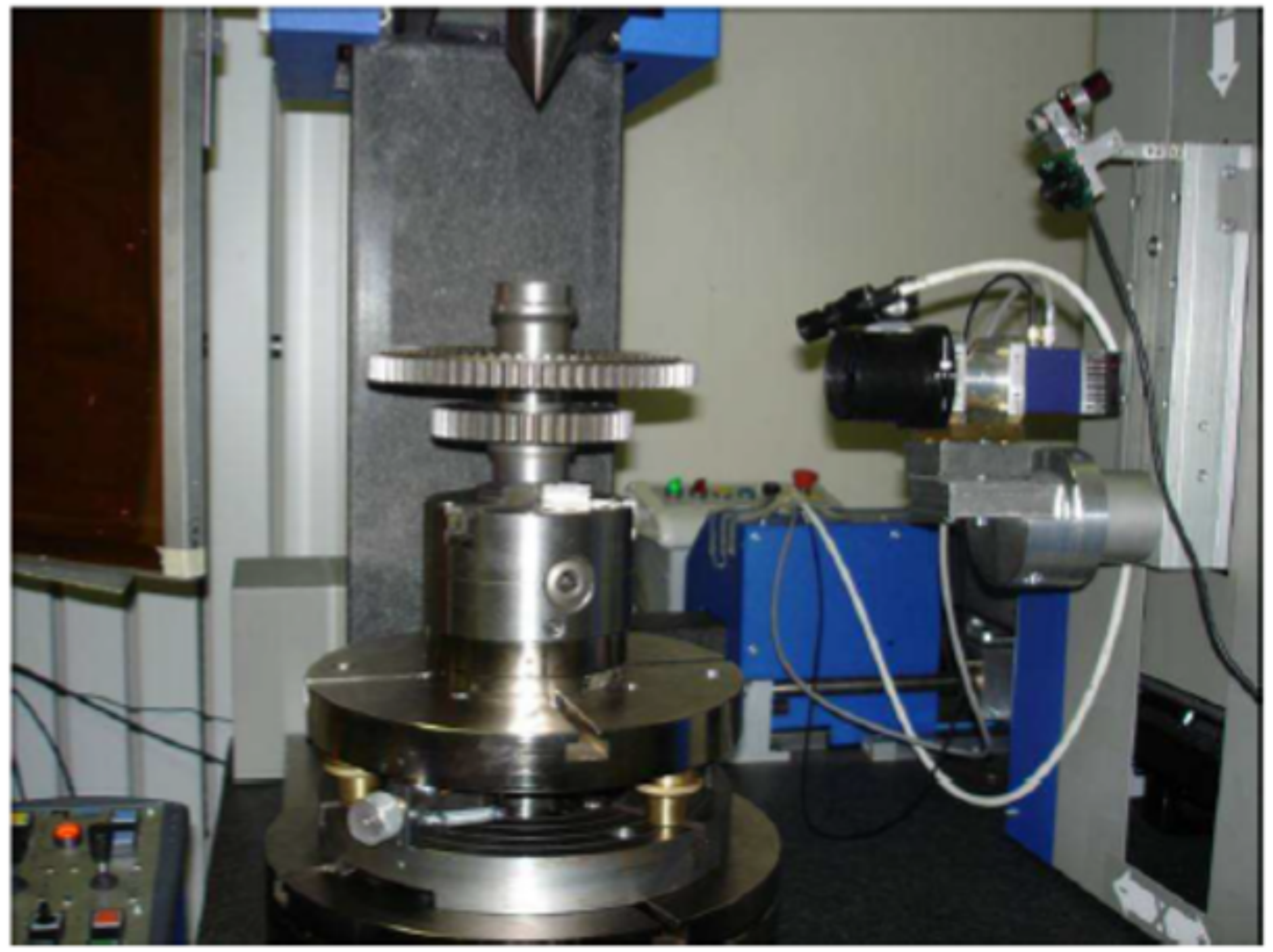




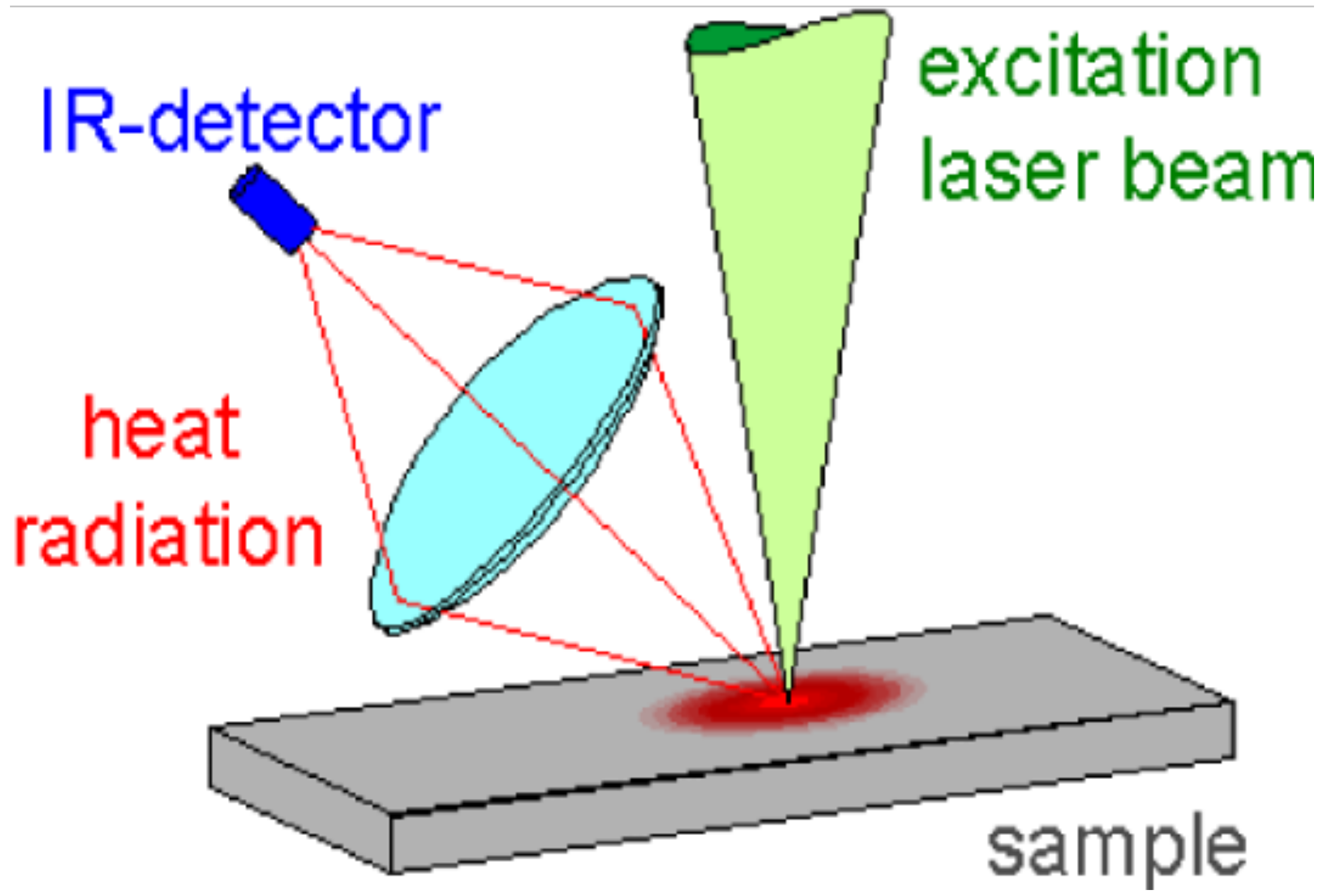


EXAMPLE of STRATIGRAPHY Studies

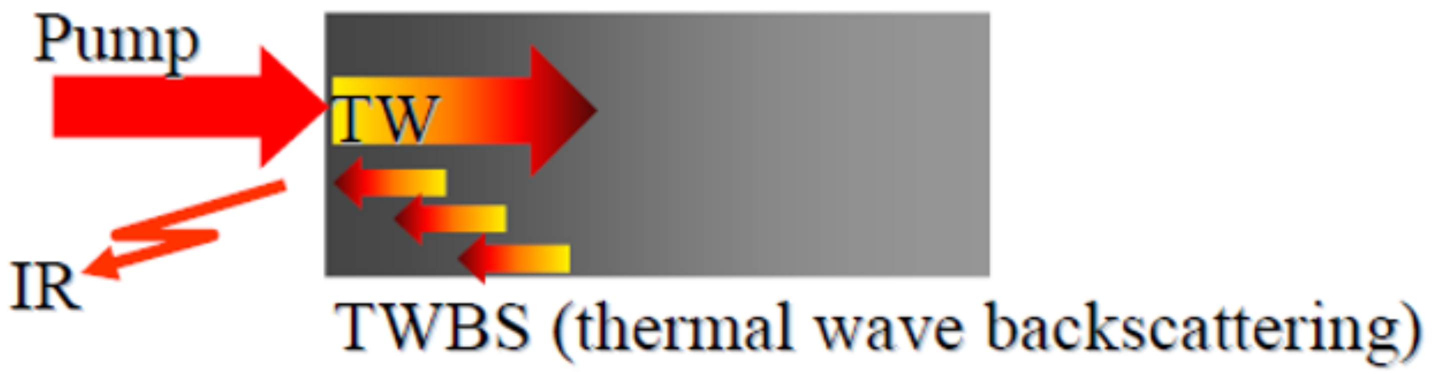
A New Device for High-Accuracy Measurements of the Hardness Depth Profile in Steels

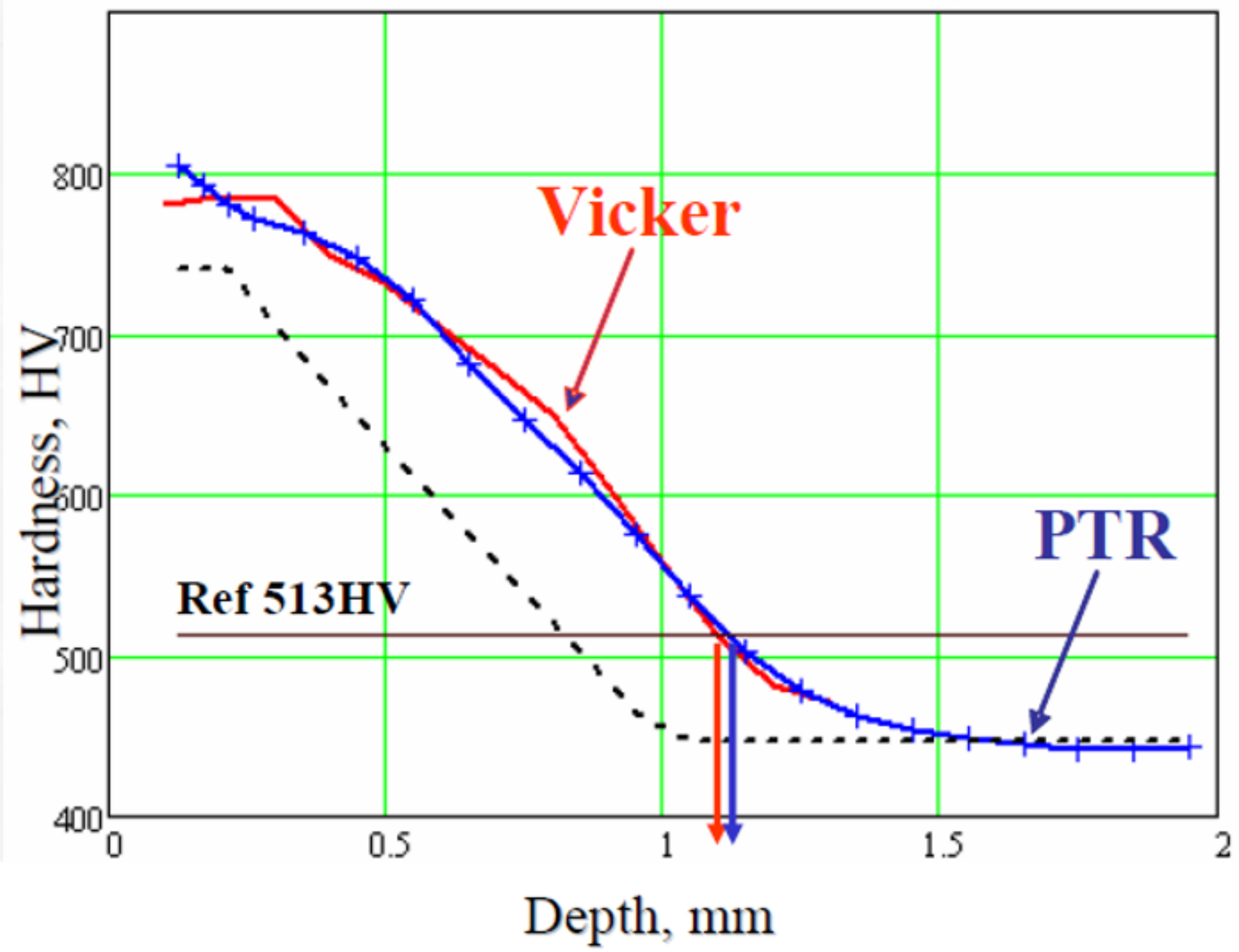
R. Li Voti, G. Leahu, C. Sibilla

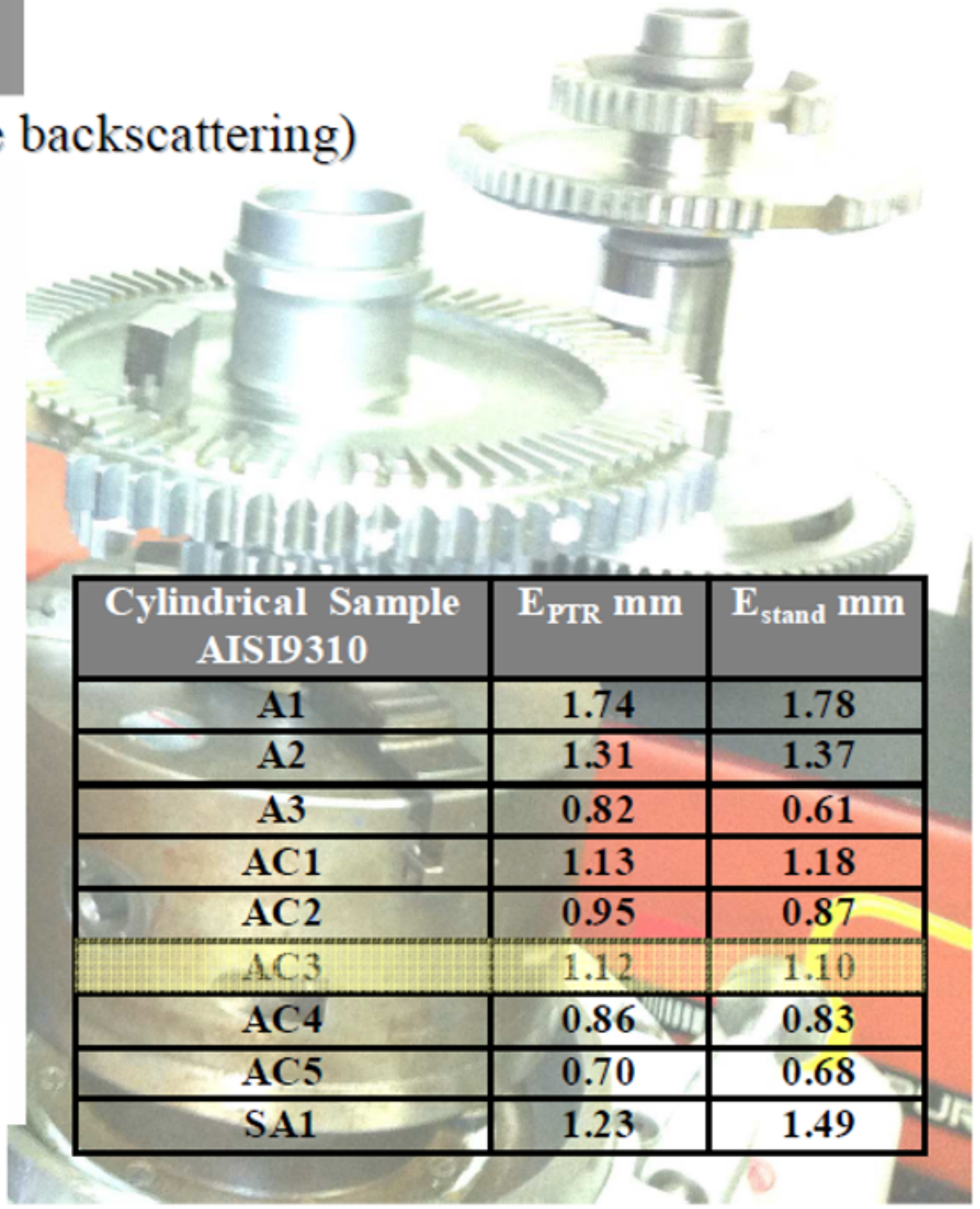
DOI: 10.1007/978-3-319-27896-4_20



Stratigraphy of thermal diffusivity and hardness of steels







Cylindrical Sample AISI9310	E_{PTR} mm	E_{stand} mm
A1	1.74	1.78
A2	1.31	1.37
A3	0.82	0.61
AC1	1.13	1.18
AC2	0.95	0.87
AC3	1.12	1.10
AC4	0.86	0.83
AC5	0.70	0.68
SA1	1.23	1.49

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& Avio propulsione aerospaziale

SURFACE ANALYSIS at ROMA TRE

Stilus Profilometer
- z resolution < 1 nm
- Large area analysis (stitching)

Fourier Transform - IR spectrometer
- Study between 100 cm^{-1} and 2700 cm^{-1}
- Equipped with microscope
- Molecular analysis
- Functional group determination

Low-energy ion beam analysis (ToF-SIMS)
- Three particle guns: Bi+ 30 keV, Cs+ 0.2-11 keV, electron floodgun (20 V)
- Mapping with a lateral resolution < 100 nm
- Depth profiling < 1 nm
- detector range: 1 a.m.u. - 15000 a.m.u.
- detector Time-of-Flight
- Limit of detection ~ ppm

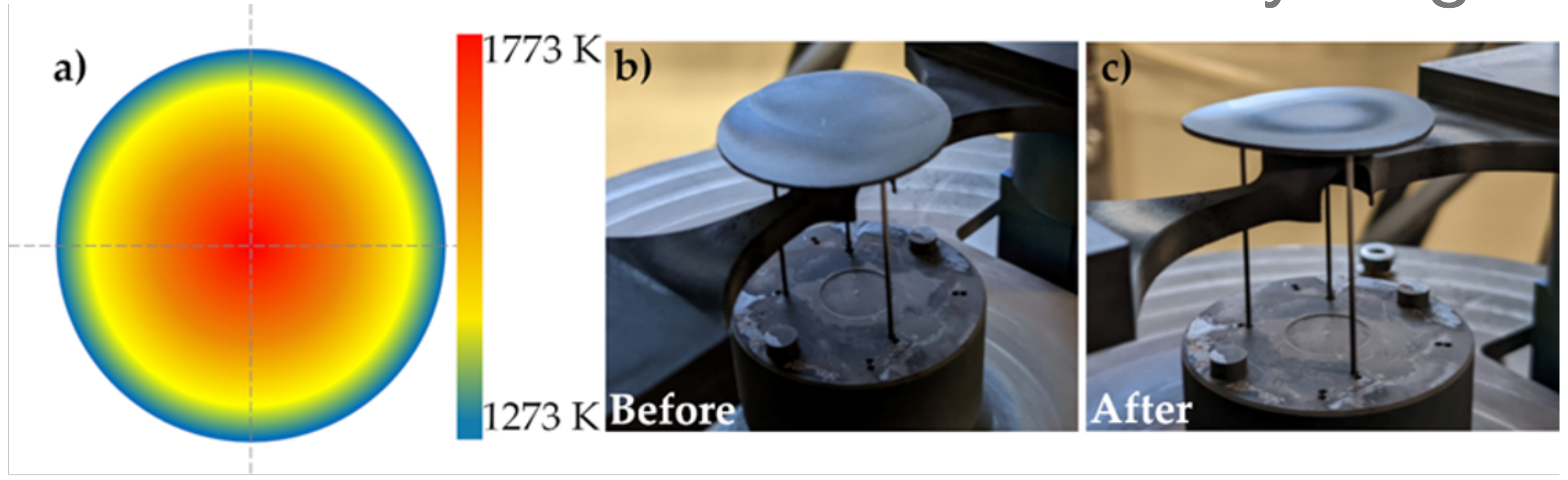
Ref. Publications

FT-IR: *Exploring Manufacturing Process and Degradation Products of Gilt and Painted Leather*, M. Iorio *et al.*, Appl. Sci. 2019 9(15), 3016

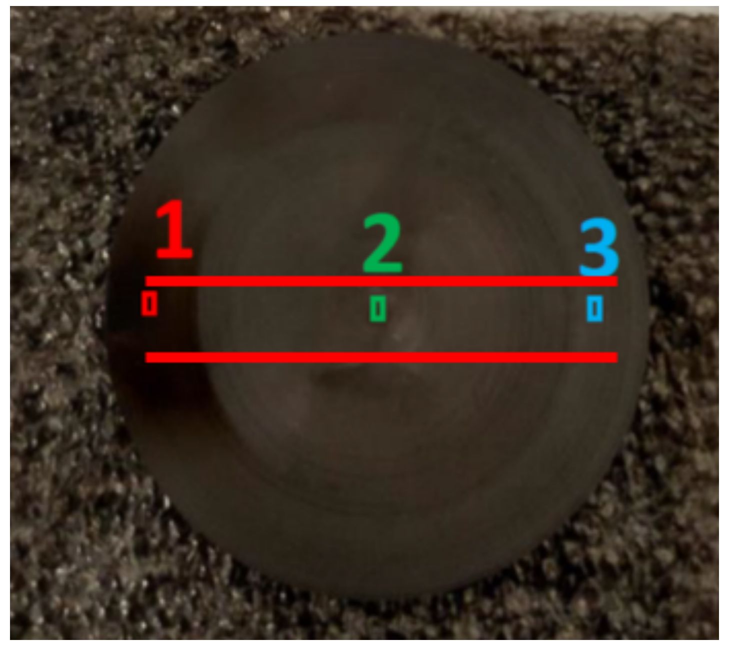
ToF-SIMS: Three-dimensional characterisation of OTFT on modified hydrophobic flexible polymeric substrate by low energy Cs^{+} io sputtering, L. Tortora et. al., Appl. Surf. Science 448 (2018) 628

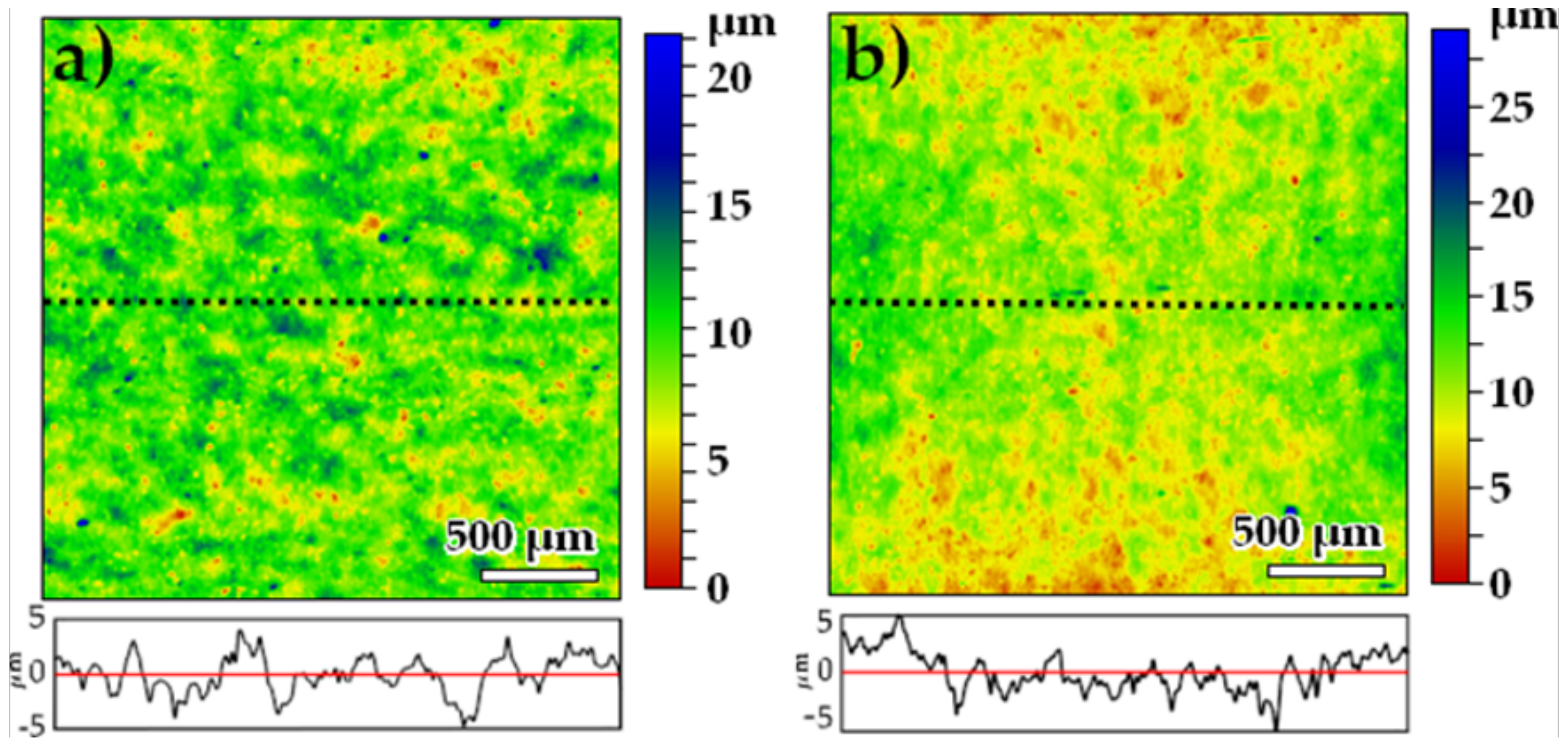
thin Graphite target properties

Graphite HPG59 target sample, tested before and after thermal stress cycling



Detailed profilometry





Surface analysis through ToF-SIMS technique allows to evaluate the composition and impurities variations before and after thermal stress in different target regions