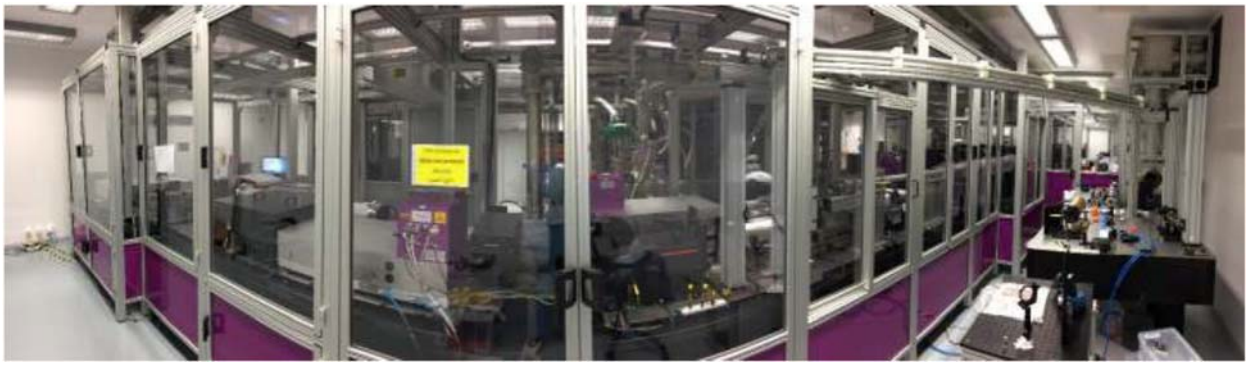
Detailed description of research infrastructure related to Open Access User Programme:

1) <u>High energy nanosecond Bivoj laser</u>



- Repetition rate: 1 Hz and 10 Hz
- Pulse length: 10 ns & 5 ns
- Energy at 1030 nm: 5.5 J and ~ 5.0 J on LSP/LIDT stations @ 10 ns, 4.2 J and ~ 3.8 J on LSP/LIDT stations @ 5 ns (with attenuator and pulse picker)
- Energy at 515 nm: 2.5 J on LIDT station @ 10 ns (without attenuator)
- Beam dimensions: 22 mm x 22 mm (square)
- Wavelength: 1030 nm & 515 nm
- Polarization: linearly polarized
- Availability: 11 am - 6 pm
- Pulse to pulse energy stability: 3% (5% at 515 nm)

Scientist in charge:

Dr. Martin Divoky	
martin.divoky@hilase.cz	
+420 3140077 21	

2a) High repetition rate picosecond Perla B laser

- Repetition rate: 1 kHz
- Pulse length: 1.3 ps
- Energy: 13 mJ

Scientist in charge:

Michal Chyla	
michal.chyla@hilase.cz	
+420 3140077 11	

2b) High repetition rate picosecond Perla C laser

- Repetition rate: 50 kHz or 100 kHz (now optimized for 50 kHz)
- Pulse length: 1.5 ps up to 100 W (6 ps at 250 W)
- Energy: 5 mJ in compressed pulse (50 kHz)
- Beam diameter: approx. 4 mm (it can be modified)

- Wavelength: 1030 nm + 515 nm (up to 30 W/100 kHz/1 ps) + 257.5 nm (up to 4-5 W/100 kHz/1 ps)
- Polarization: linear
- Availability: 8 hours/day
- Long-term power stability: <1.2 % RMS over 6 hours
- Beam quality: M2 = 1.4 – 1.8, depending on output power

Scientist in charge:

Dr. Ondřej Novák	
ondrej.novak@hilase.cz	
+420 3140077 52	

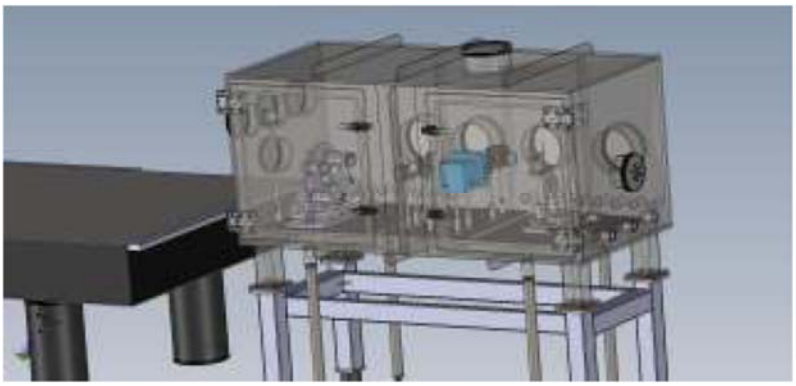
2c) High repetition rate nanosecond DG laser

- Repetition rate: 1 kHz
- Pulse length: 1.4 ns
- Energy: 100 mJ
- Beam diameter: 8 mm (collimated)
- Wavelength: 1030 nm
- Polarization: linear
- Availability: 8 hours/day
- Long-term power stability: <1 % RMS
- Beam quality: M2 <2

Scientist in charge:

Dr. Pawel Sikocinski	
pavel.sikocinski@hilase.cz	
+420 3140077 06	

3) Laser-Induced Damage Threshold (LIDT) target area

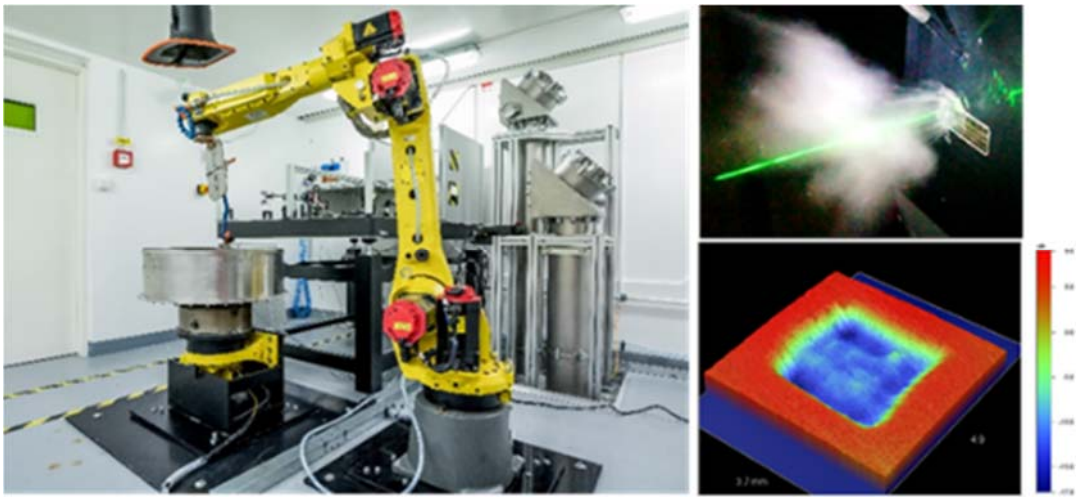


- ISO LIDT tests 1-on-1, s-on-1 type 1 and 2, r-on-1
- ISO 7 clean room environment
- Samples size up to 100x100x100 mm (it can be increased in special cases)
- Samples weight up to 1,5 kg
- Angle of incidence 0° to 60°
- Pulsed laser at 1030 nm and 515 nm, 10 ns, 10 Hz, up to 5 J @ 1030 nm and 2 J @515 nm
- 400 µm spot size round Gaussian or 3x3 mm2 square top-hat
- Pulsed laser at 1030 nm, 1.8 ps, 1 kHz, up to 10 mJ
- Variable spot size, round, Gaussian
- Online fast camera 1000 fps
- Post-test analysis with laser scanning microscope

Scientist in charge:

Dr. Jan Vanda	
jan.vanda@hilase.cz	
+420 3140077 47	

4) Laser Shock Peening (LSP) target area

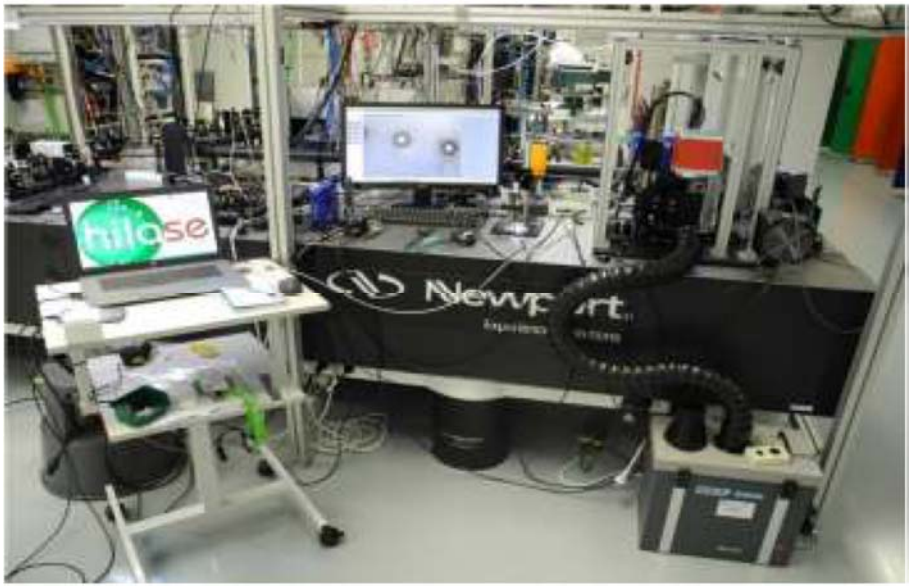


- Load capacity: 20 kg
- Max. workpiece size: 0.5 m
- Experience with these materials: Titanium alloys, stainless steel, aluminum alloys
- Beam size: up to 5 mm x 5 mm
- Productivity: up to 200 cm^2/hour
- Results: uniform strengthening of the surface layer up to depth of 1 mm, extension of the lifetime of the component
- Testing methods: residual stress measurement by X-Ray diffraction and hole drilling (ASTM standard E 837), measurement of fatigue strength and material lifetime

Scientist in charge:

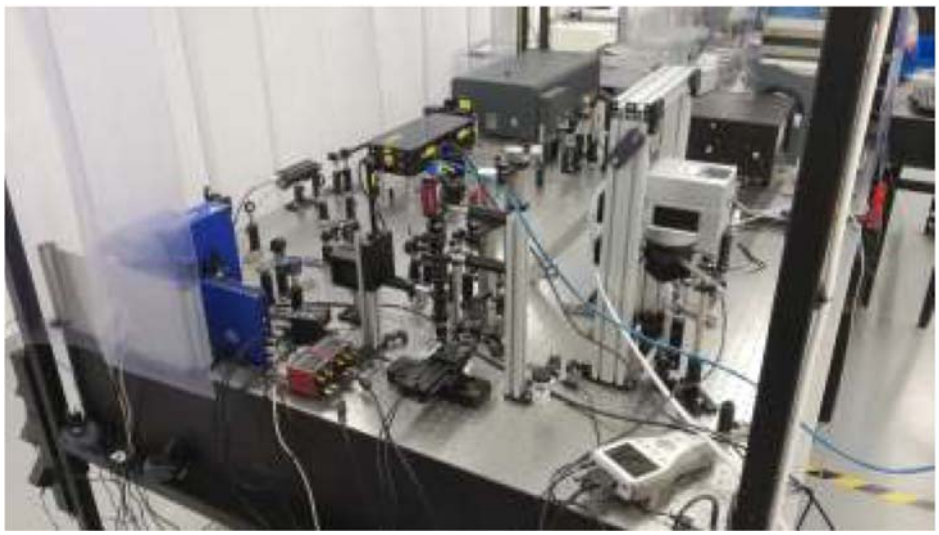
Jan Brajer	
jan.brajer@hilase.cz	
+420 3140077 72	

5) **Laser micro-machining target area with PERLA C**



- Position precision : up to 2 microns
- High precision and sharp edges

6) **Laser micro-processing target area with Pharos laser**



Pharos

- Repetition rate: 1 kHz – 200 kHz
- Pulse length: 250 fs – 10 ps
- Maximal power: 6 W
- Maximal pulse energy: 1 mJ

- Wavelength: 1030 nm
- Beam diameter at 1/e2 of intensity: 5 mm
- M^2: < 1.2
- Polarization: linear
- Harmonics frequencies available (for 2 kHz and 250 fs pulse duration):
    - 2^{nd} harmonic at 515 nm (~ 0.5 mJ @ 2 kHz);
    - 3^{rd} harmonic at 343 nm (~ 0.25 mJ @ 2kHz);
    - 4^{th} harmonic at 257 nm (~ 0.1 mJ @ 2kHz).

Scientist in charge:

Petr Hauschwitz	
petr.hauschwitz@hilase.cz	
+420 3140077 72	

7) Characterization devices

a. Scanning Electron Microscope (SEM)

- Imaging resolution of 1.2 nm
- Accelerating voltage between 200 eV to 30 keV (down to 50 eV with BDT option)
- Multi-Ported large (Ø 230 mm) specimen chamber
- Sputter coater for covering samples with a thin metal film for imaging insulating materials
- Scanning TEM system imaging (STEM) with a resolution down to 0.8 nm
- EDS elemental analysis, imaging and mapping
- Secondary electron detector

Scientist in charge:

Prof. Dr. Alexander Bulgakov	
alexander.bulgakov@hilase.cz	
+420 3140077 33	

b. X-ray Diffractometer (XRD)

- Radiation source: fine focus Cu sealed tube (3kW X-Ray generator)
- Goniometer: 300 mm radius, Eulerian craddle (Theta-Phi)
- Incident optics: CBO, automatic variable divergence slip, monochromators
- Receiving Optics: Ge (220) bounce analyzer, automatic receiving slit
- 5- axis sample stage suitable for 50 mm large and 20 mm thick samples.
- Software with ICSD crystallography database, Suitable for data analysis for Qualitative and Quantitative (RIR) phase analysis, Rietveld analysis, analysis of crystallinity, crystallite size and lattice stress, lattice parameter refinement, X-Ray reflectivity and SAXS.

Scientist in charge:

Dr. Inam Mirza	
inam.mirza@hilase.cz	
+420 3140077 54	

c. Atomic Force Microscope (AFM)

- Direct Raman access from side and top decoupled from AFM laser path.
- Fast Tip Enhanced Raman Spectroscopy alignment
- STM, Conductive AFM. ranges 1 nA, 100 nA, 10 uA.
- Scanning range 100 um x100 um x 15 um
- Vertical resolution: <1nm
- Horizontal resolution: tip curvature dependant.
- Contact mode, Semi contact mode, non contact mode.
- Phase imaging, lateral force microscopy and force modulation.
- Kelvin Probe (surface potential microscopy);
- Nanomanipulation, nanolithography.

d. Raman Spectroscopy Station

- 3 excitation laser wavelengths: 532 nm, 638 nm, 7785 nm.
- 4 gratings 600 gr, 1200 gr, 1800 gr, 2400 gr.
- spectral resolution <1.4 1/cm
- upright confocal microscope
- SWIFT mode scanning for fast mapping
- Lateral resolution: 500 nm
- TERS resolution: 15 nm

Scientist in charge: AFM + Raman spectrometer

Dr. Nathan Goodfriend	
nathan.goodfriend@hilase.cz	
+420 3140077 33	

e. Laser Scanning Confocal Microscope

- Objective lens magnifications: from 5x-100x
- Total Magnification capability: 5x-17,280x
- Color imaging mode: White LED light source with 2 Mega Pixel ccd
- Laser imaging mode: 405 nm laser with photomultiplier detector
- Minimum Z-resolution: 10 nm
- Minimum XY-Resolution 120 nm.

Dr. Jan Vanda	
jan.vanda@hilase.cz	
+420 3140077 47	