



# HiLASE Centre of Excellence – Synergy project

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# Outline

1. HiLASE Centre introduction
2. HiLASE Centre of Excellence – Synergy project
3. HiLASE CoE project objectives – Use of synergies
4. HiLASE Centre – Synergies in practice

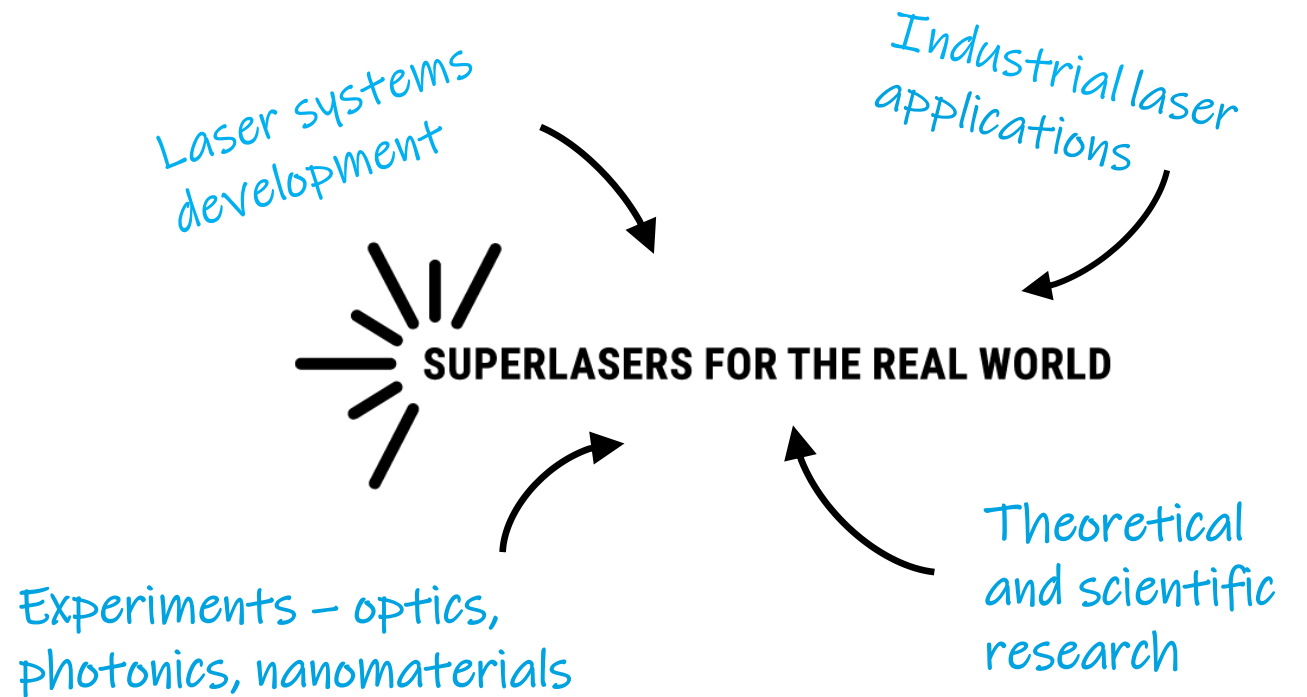
# HiLASE Centre Profile



High average power pulsed **LASE**rs

High energy & high repetition rate DPSSLs

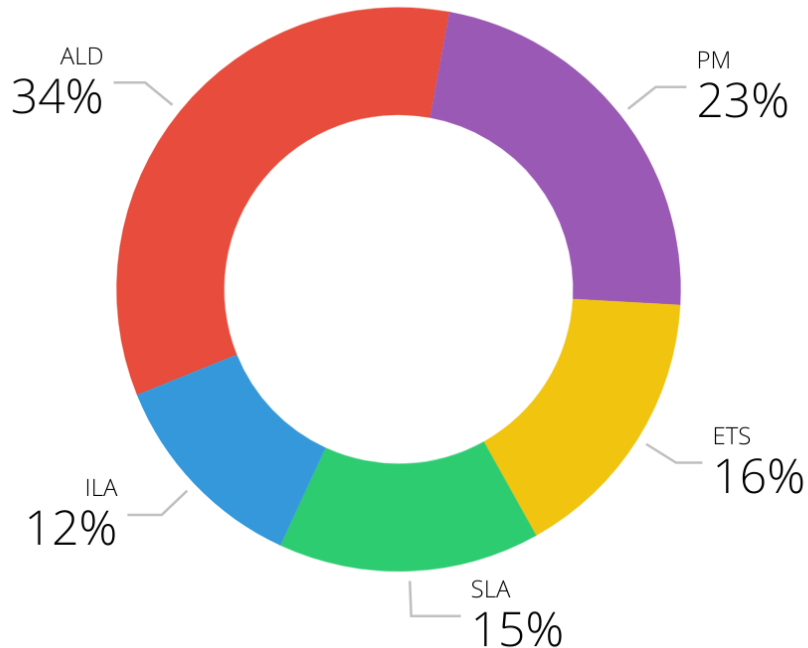
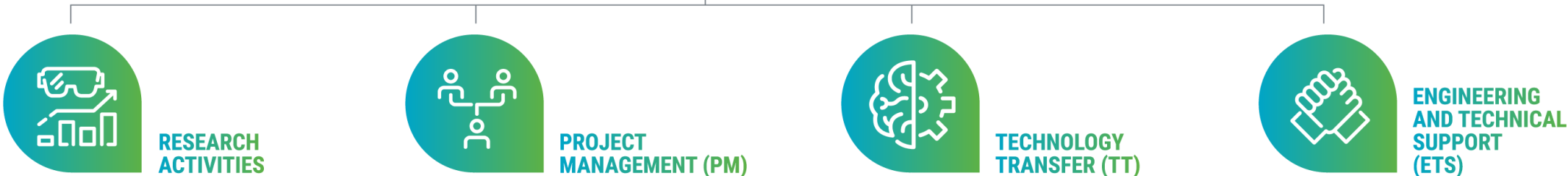
Key technological infrastructure for laser development and  
Next generation lasers for hi-tech industrial applications



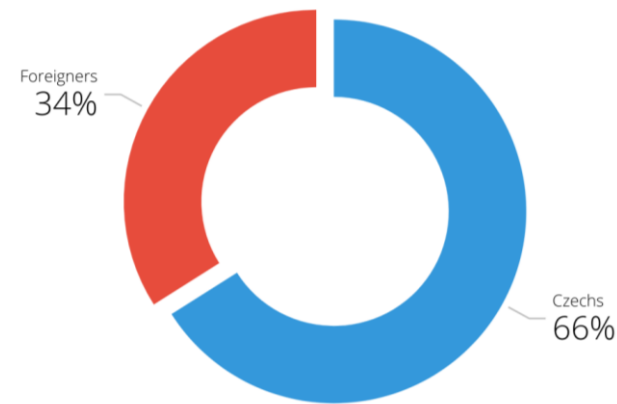
# HiLASE virtual tour video YouTube



# Organization

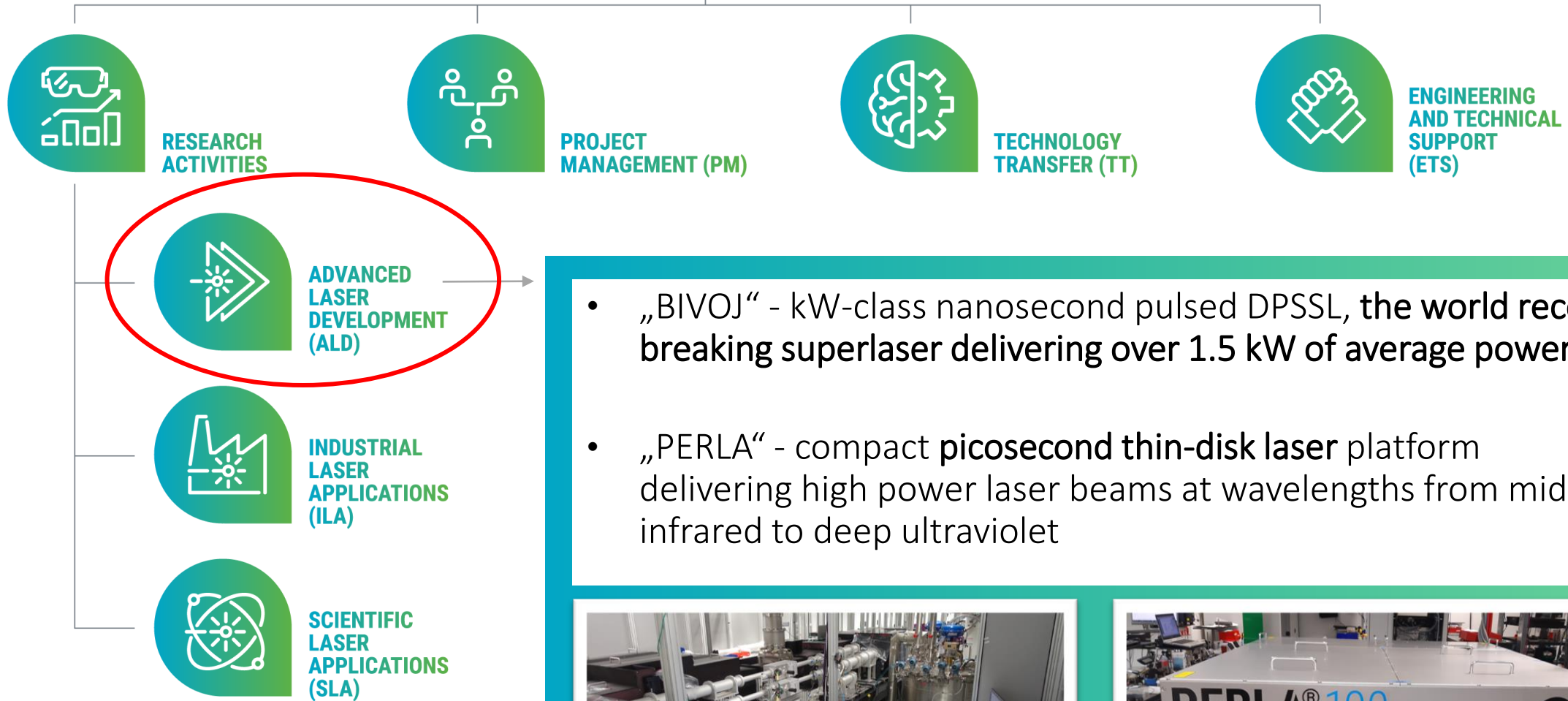


ALD, ILA and SLA Depts.

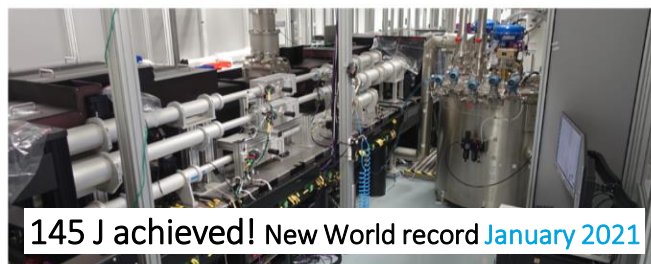




# ALD Team

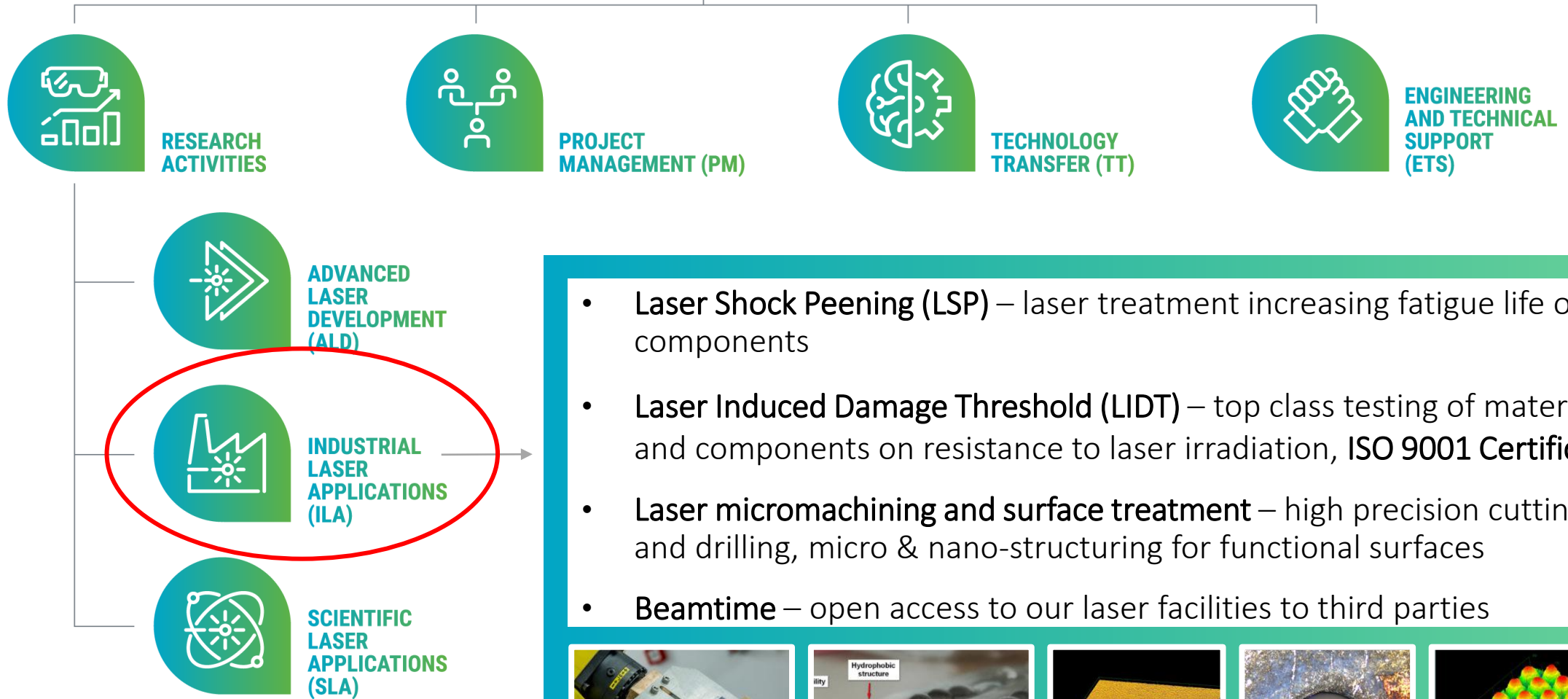


- „BIVOJ“ - kW-class nanosecond pulsed DPSSL, the world record-breaking superlaser delivering over 1.5 kW of average power
- „PERLA“ - compact **picosecond thin-disk laser** platform delivering high power laser beams at wavelengths from mid-infrared to deep ultraviolet

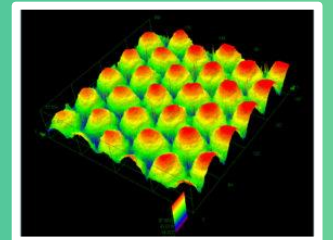
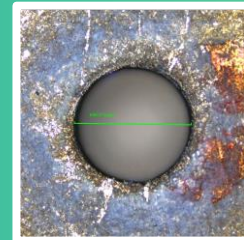
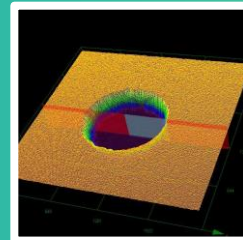
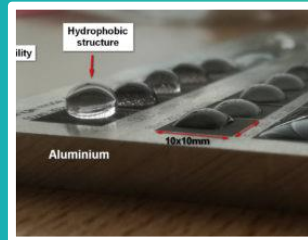
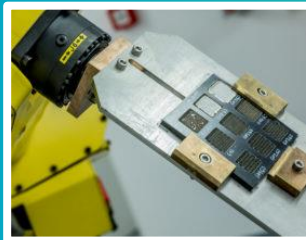


# ILA Team

hila<sup>se</sup>

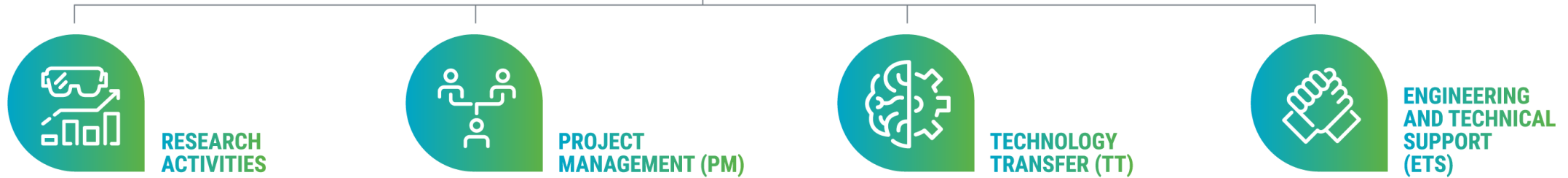


- **Laser Shock Peening (LSP)** – laser treatment increasing fatigue life of components
- **Laser Induced Damage Threshold (LIDT)** – top class testing of materials and components on resistance to laser irradiation, **ISO 9001 Certificate**
- **Laser micromachining and surface treatment** – high precision cutting and drilling, micro & nano-structuring for functional surfaces
- **Beamtime** – open access to our laser facilities to third parties

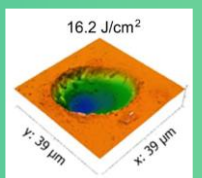
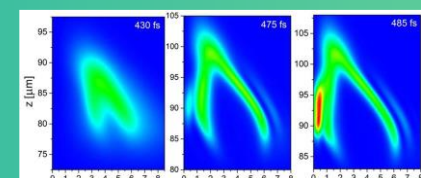
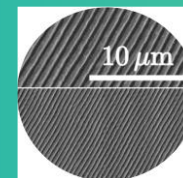
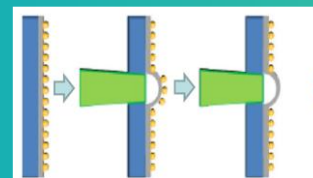


# SLA Team

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- **Laser-matter interaction-** Modelling of laser tailoring of materials properties, surface modification and synthesis of new materials
- **Laser Material Processing-** Laser writing of photonic structures in bandgap materials; Surface and volumetric processing of materials
- **Nanomaterials-** Nanoparticles, 2D materials and their transfer by Blister-Based Laser-Induced Forward Transfer; Ablation dynamics study
- **Mid-IR and bio-applications-** Laser therapeutics; Laser interaction with biological tissues; Nanoparticles for theranostics
- **Ultrafast photonics-** band structure computation from first principles, plasmonics





# Teaming with STFC-UKRI

## HiLASE CoE project - Teaming with STFC-UKRI (CLF)

- Horizon 2020 + OP RDE = 45 mil. EUR
- Implementation: **04/2017 - 11/2023**
- Preserve **technological leadership** by Upgrades
- Transfer best practises on **Commercialization**
- Create a “**Facility of Choice**” for Users



Science and  
Technology  
Facilities Council



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 739573 (HiLASE CoE)



The Horizon 2020 Spreading Excellence and Widening Participation programme celebrates new excellent research partnerships across Europe.

Following evaluation by an International panel of Independent experts the European Commission awards €10 million to

**HiLASE**

2016 Teaming Phase 2 project

coordinated by **Czech Academy of Sciences** in partnership with  
**Science and Technology Facilities Council (UK)**

to develop a **Centre of Excellence** in Czech Republic.

Congratulations on this outstanding initiative and your contribution to bridging the Research & Innovation divide in Europe.

Brussels, 16 February 2017

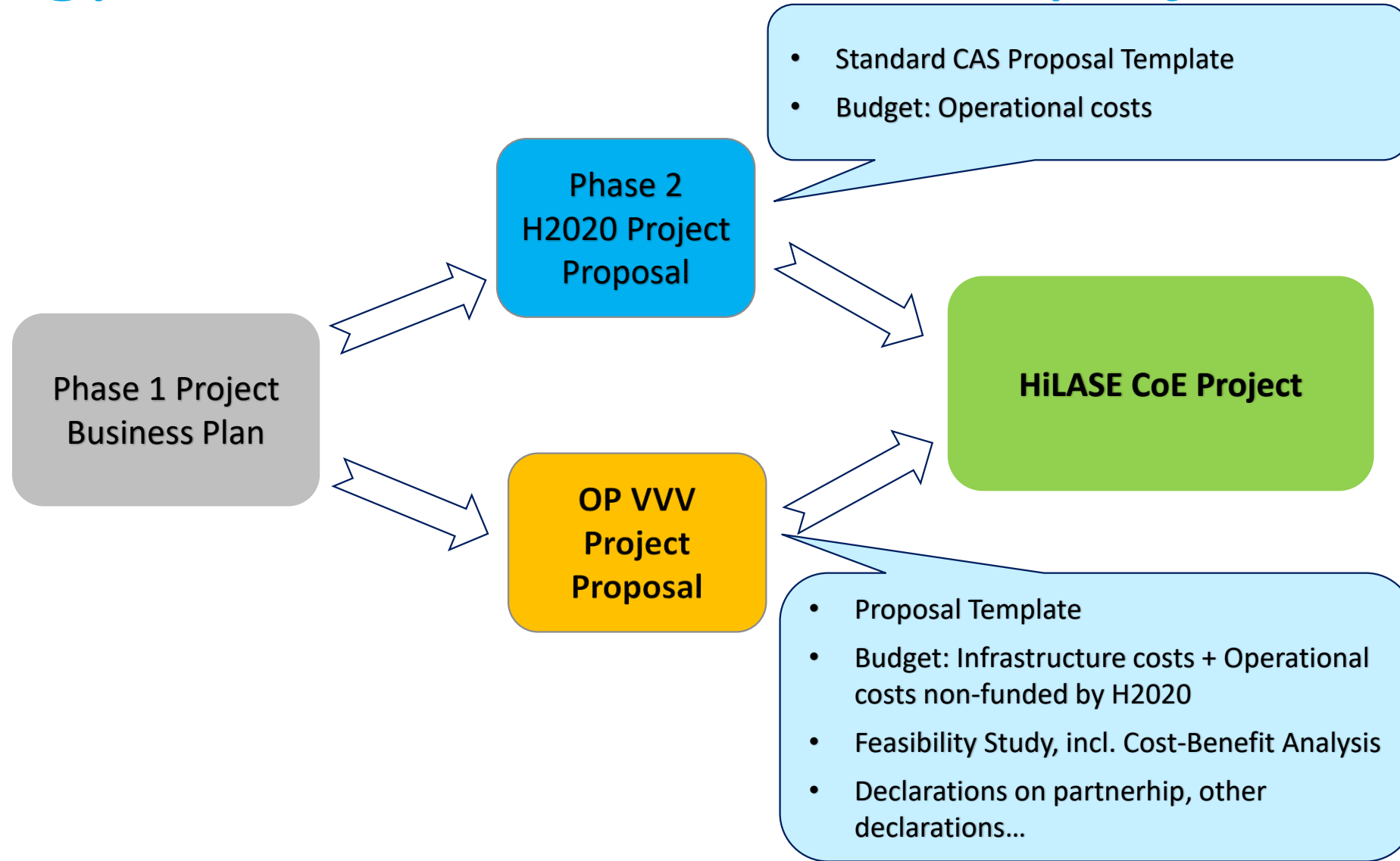


Robert-Jan Smits,  
Director General for Research  
and Innovation

Tomas Mocek,  
On behalf of the project

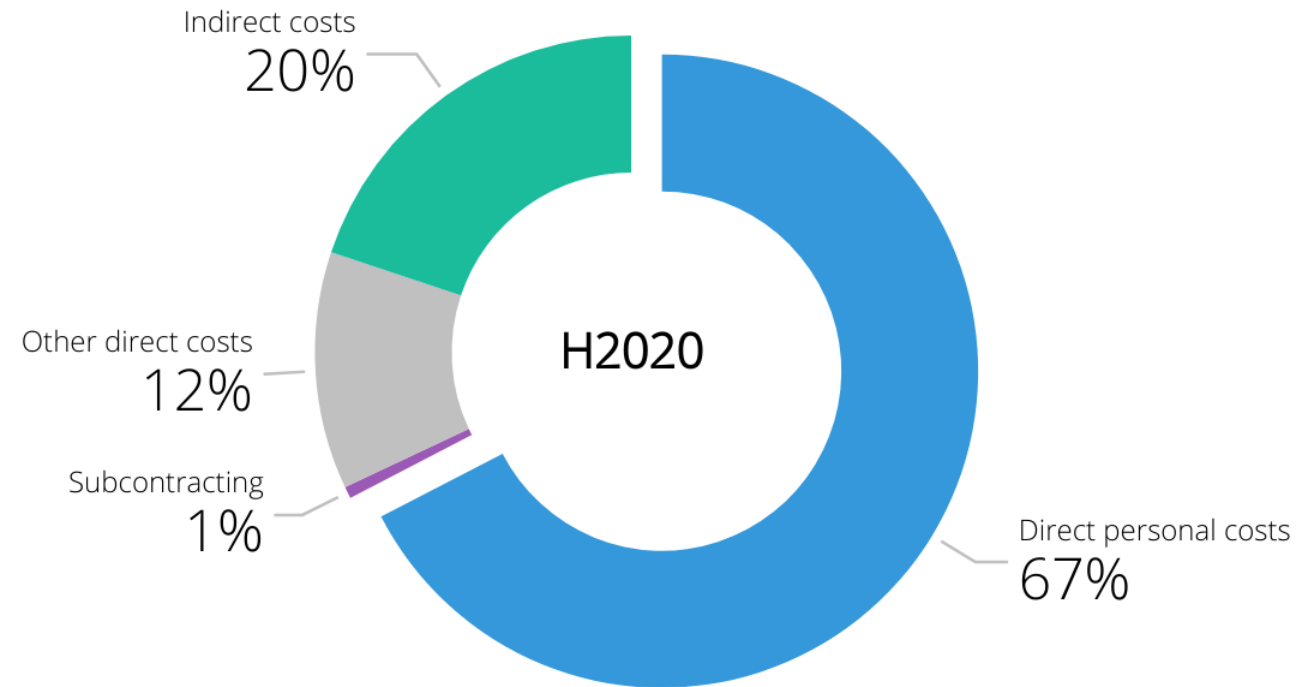
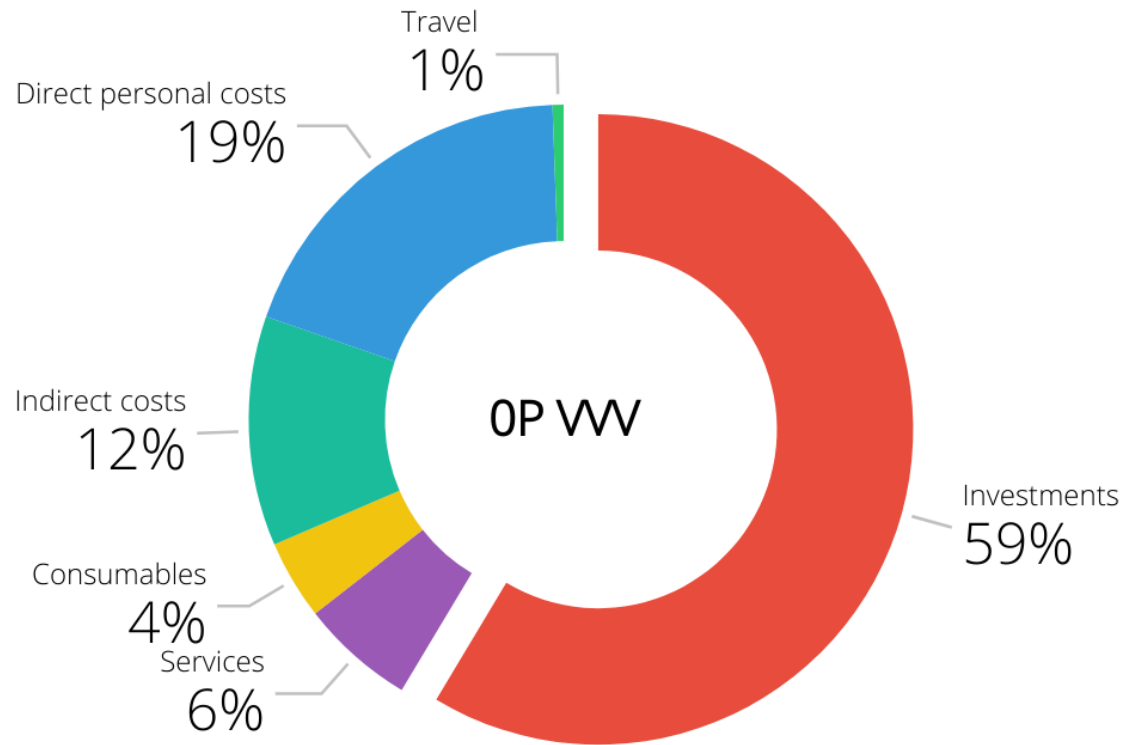


# Synergy of H2020 and ESIF – two projects



# Synergy of H2020 and ESIF – budget structure

OP VVW (35 mil. EUR) + Horizon2020 (10 mil. EUR) + = 45 mil. EUR



# Project Objectives – Use of Synergies

1. Drive **improvements in the innovation performance** of the Czech Republic
2. Establish and grow a global user community, delivering a programme of **scientific excellence through the exploitation of the CoE**
3. Raise **the profile of the Czech Republic in laser - driven materials processing**
4. Further **develop STAR, the existing regional cluster**, providing an innovation friendly environment
5. **Enhance the "Day 1" capability** by technology development to underpin future competitiveness
6. Establish the **academic autonomy** of the CoE
7. Establish a strategy to underpin the **CoE's self - sustainability** into the future
8. **Promote science and innovation** in laser technology & applications to the wider community including schools, colleges and the general public

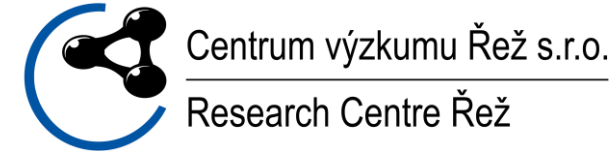
# 1. Improving innovation performance

- Completion of customized station for advanced laser processing of dielectric materials (200 kHz, 0.5 mJ, 100 W, 1030 + 532 nm)
- Collaborative research and licence agreement on commercialization of PERLA 100 laser platform with European and Czech hi-tech partners.
- Closer cooperation with Czech companies through joint projects / contract research





# Partnership with Industry



# Spin-off with industry



+



INDUSTRIAL  
PVD COATINGS

=

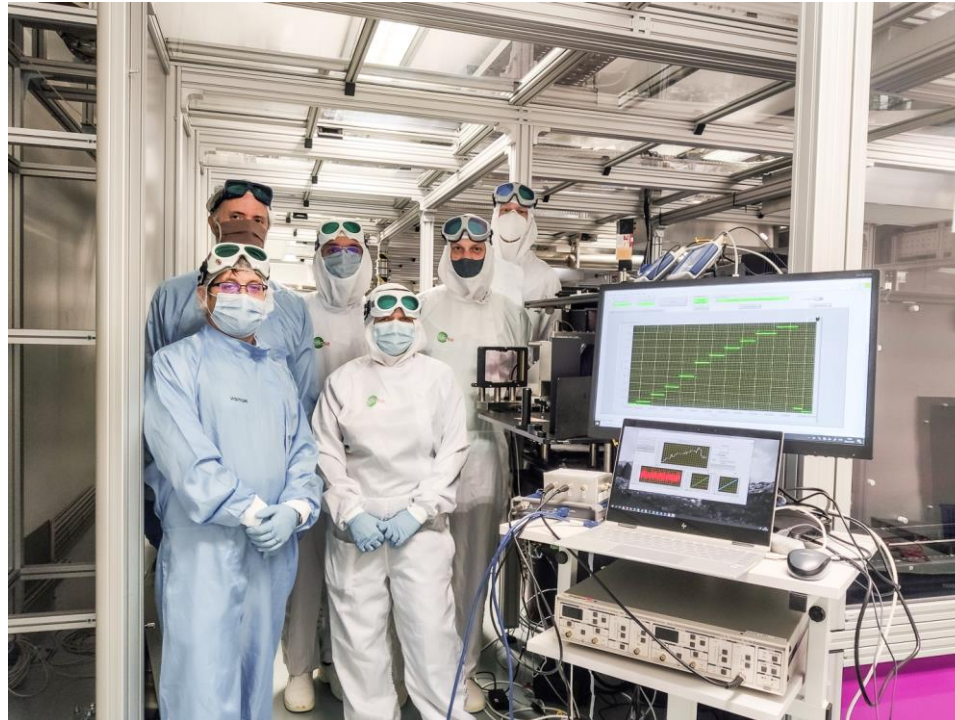
-Hi-BEAMS



## 2. Scientific excellence

- In the framework of HiLASE Open Access program, users from the National Institute of Standards and Technology (USA) demonstrated an alternative method of SI-traceable non-destructive measurement of individual laser pulse energy
- This is the first time that the absolute energy of laser pulses (pulse-by-pulse) generated by the Bivoj laser at full performance (100 J / 10 Hz) was directly measured

**NIST**  
National Institute of  
Standards and Technology  
U.S. Department of Commerce



# Partnership with Academia



Agenzia nazionale per le nuove tecnologie,  
l'energia e lo sviluppo economico sostenibile



한국기초과학지원연구원  
KOREA BASIC SCIENCE INSTITUTE



"Ingeniamos el futuro"



전자부품연구원  
Korea Electronics Technology Institute

# 3. Raising profile in laser-driven material processing

## World records in multi-beam nanostructuring:

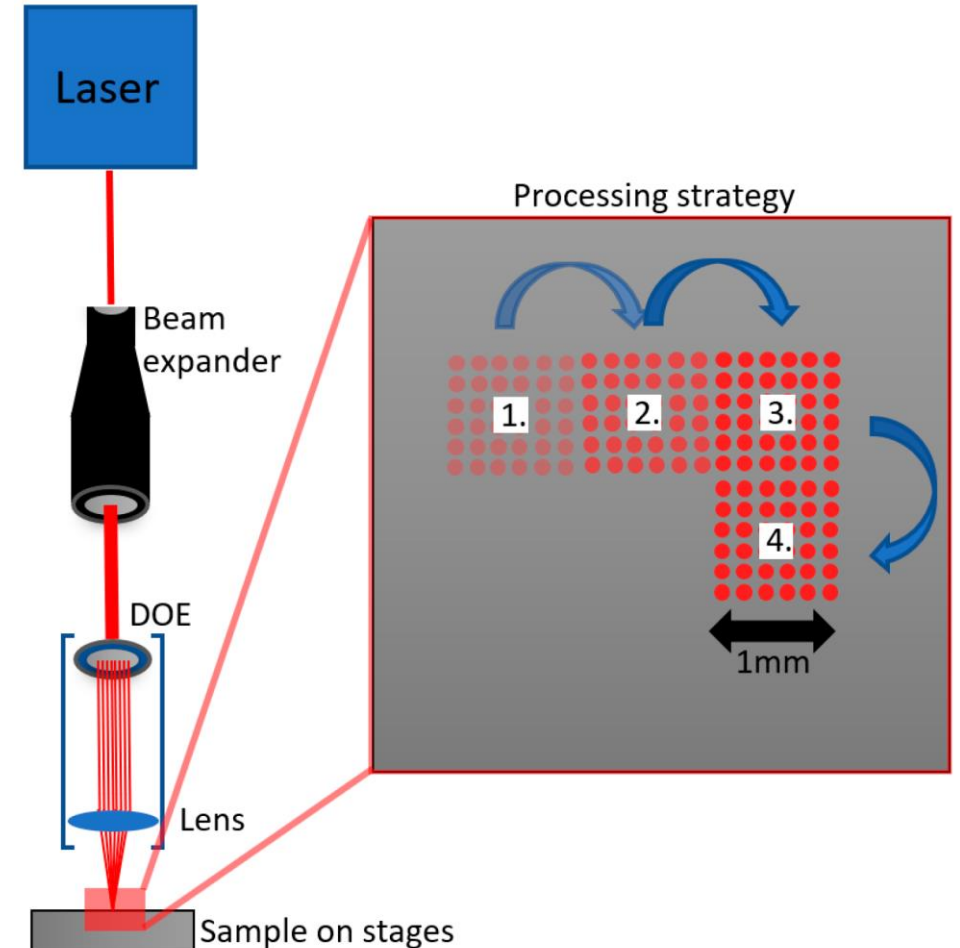
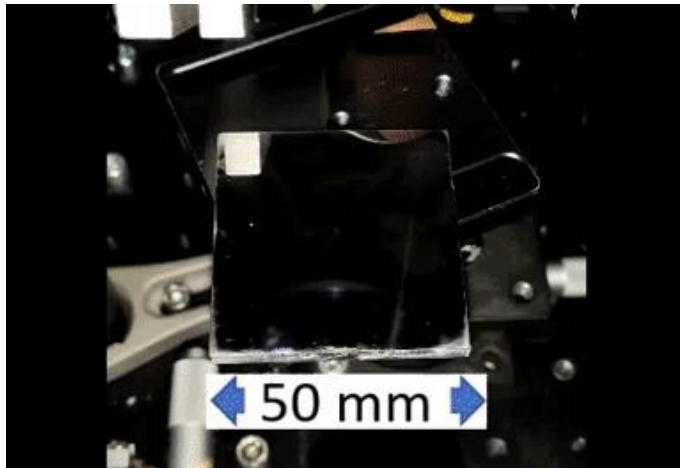
### 1. Simultaneous nanostructuring with 40 401 beams



Communication

#### Towards Rapid Fabrication of Superhydrophobic Surfaces by Multi-Beam Nanostructuring with 40,401 Beams

Petr Hauschwitz <sup>1,\*</sup>, Radka Bičštová <sup>1</sup>, Alexander Brodsky <sup>2</sup>, Natan Kaplan <sup>2</sup>, Martin Cimrman <sup>1,3</sup>, Jaroslav Huynh <sup>1,3</sup>, Jan Brajer <sup>1</sup>, Danijela Rostohar <sup>1</sup>, Jaromír Kopeček <sup>4</sup>, Martin Smrž <sup>1</sup> and Tomáš Mocek <sup>1</sup>





# 4. Support and development of STAR region

- Brain4Industry (B4I), consortium led by FZU among the winners of the national and DEP round of the European Digital Innovation Hub call for proposals
- B4I focuses on the digitalisation of small and medium enterprises, application of artificial intelligence (AI) in manufacturing processes, and offers expertise in advance manufacturing technologies
- HiLASE is contributing by connection our laser technologies with 3D printing methods



Center of Applied  
Research and Development  
for Additive Manufacturing



INSTITUTE OF THERMOMECHANICS  
CZECH ACADEMY OF SCIENCES

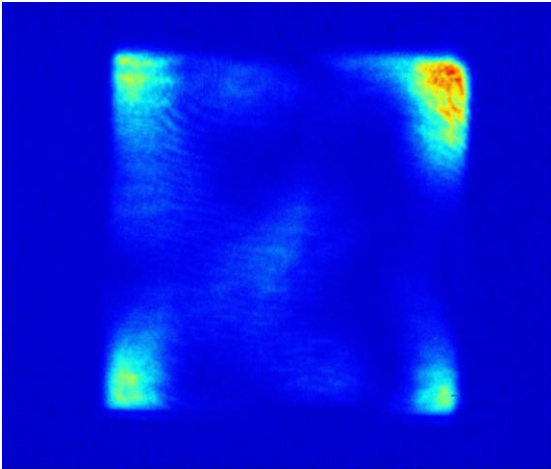


# 5. Enhance the "Day 1" capability

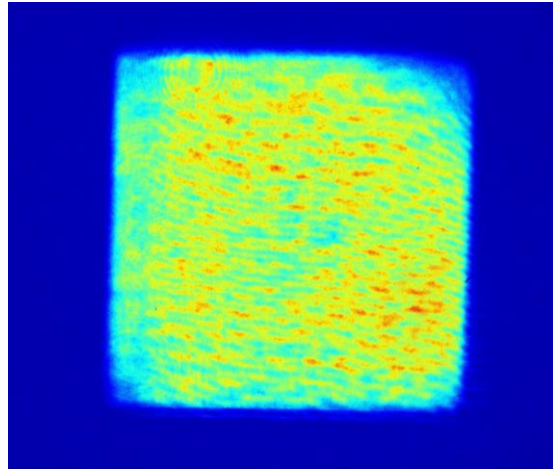
**A new world record on the BIVOL laser system achieved at 515 nm (01/2022)**

- Input to SHG 121 J
- Depolarization 2.5 %
- Convertible energy 118 J
- 515 nm energy 95 J at 10 Hz
- Efficiency 80%

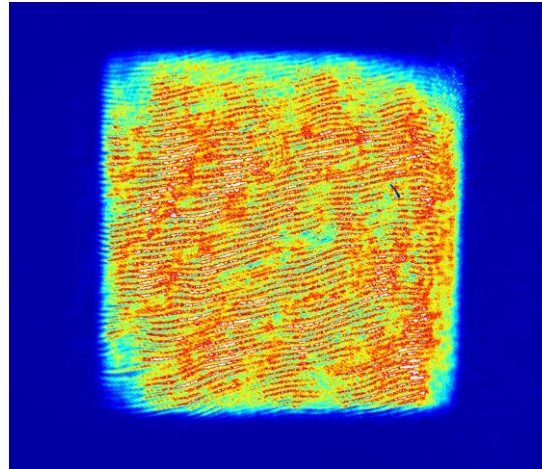
Input P



Input S



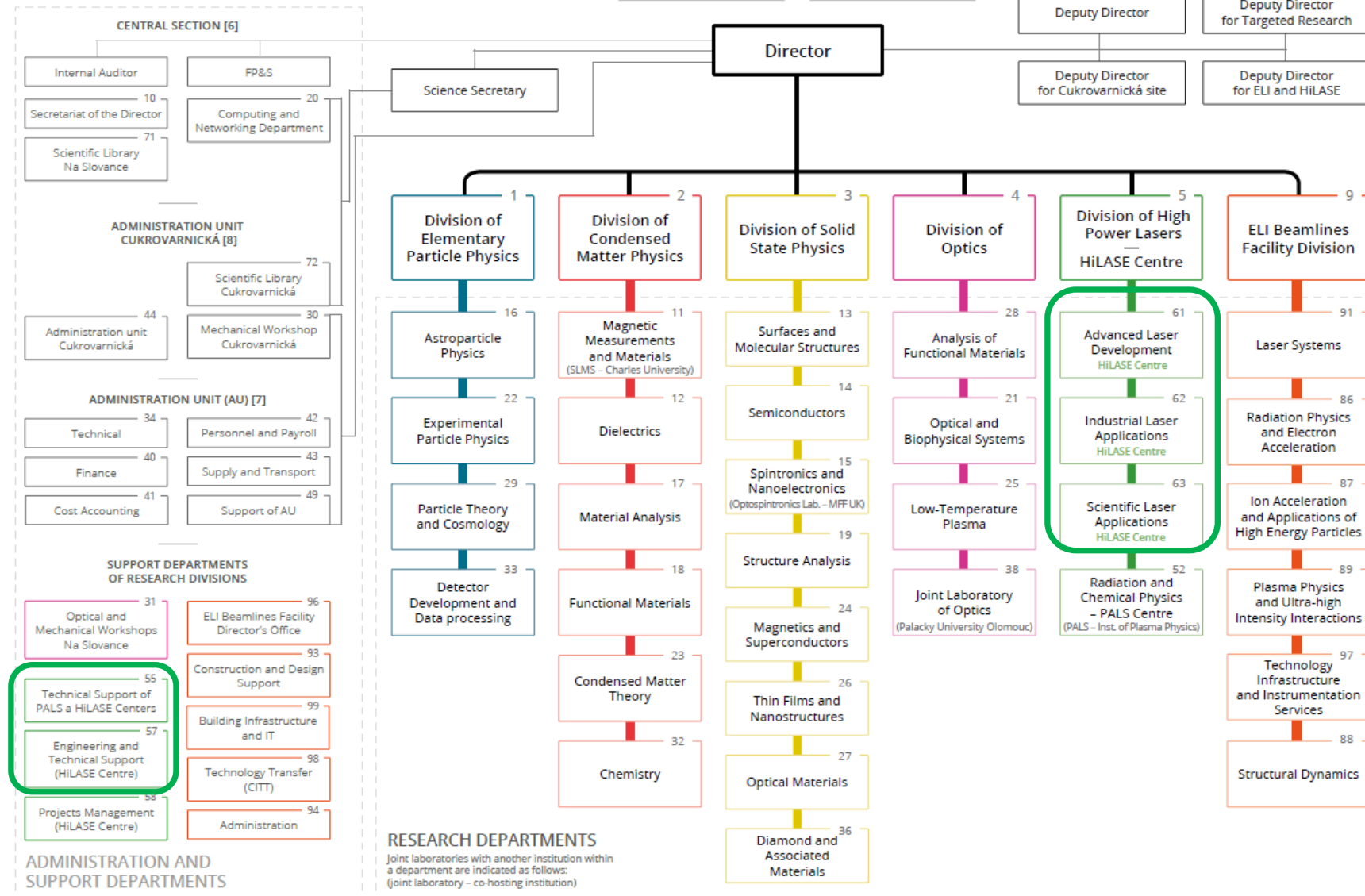
Output P





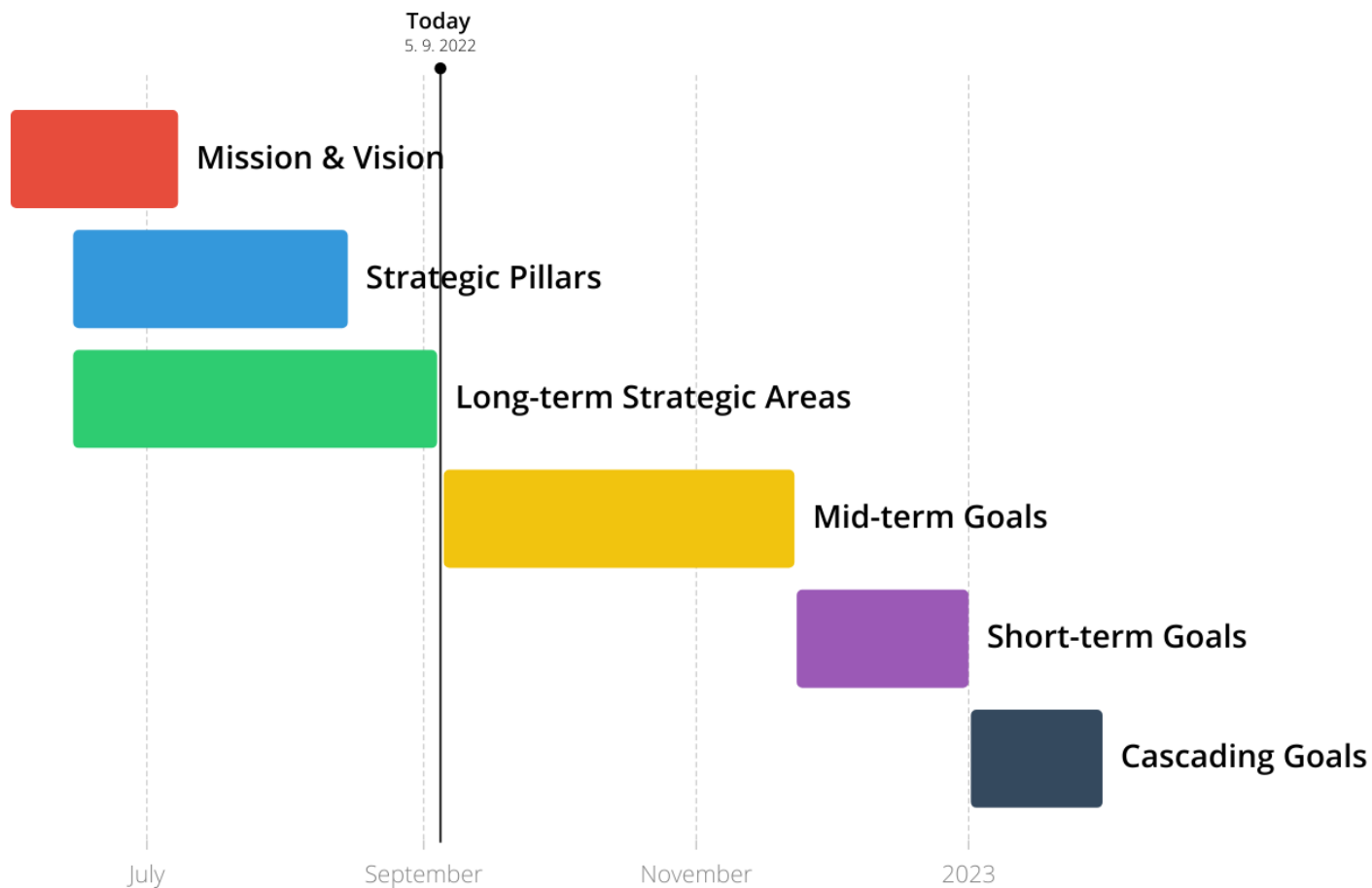
# 6. Autonomy obtained & enforced

Příloha č. 2b Organizační řád  
Organizační schéma FZÚ AV ČR, v. v. i. (EN)

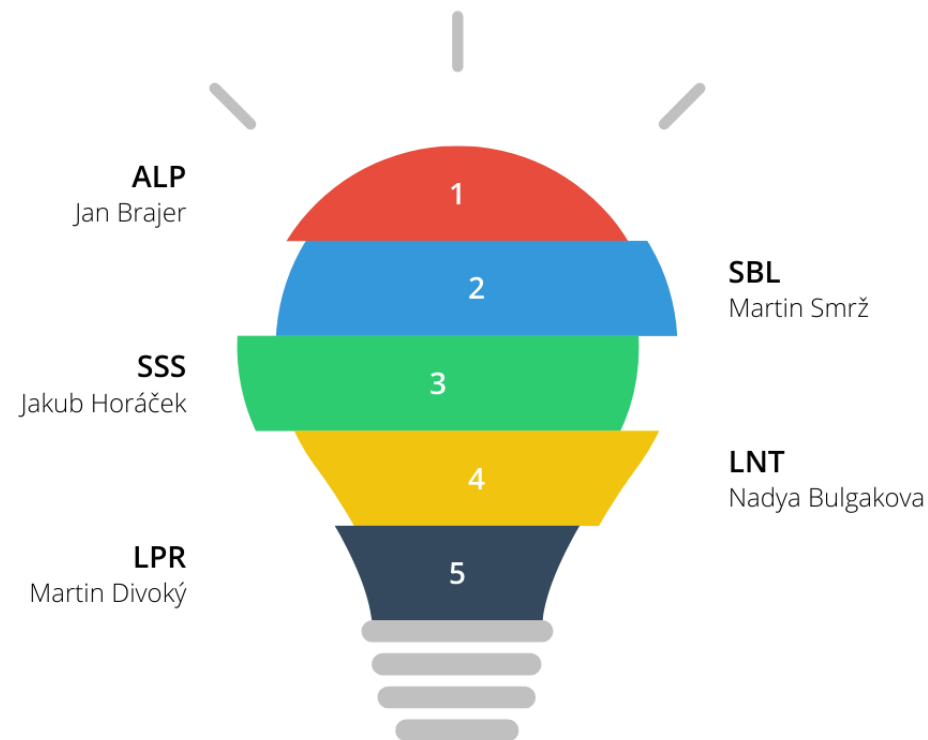


# 7. Strategy for self-sustainability

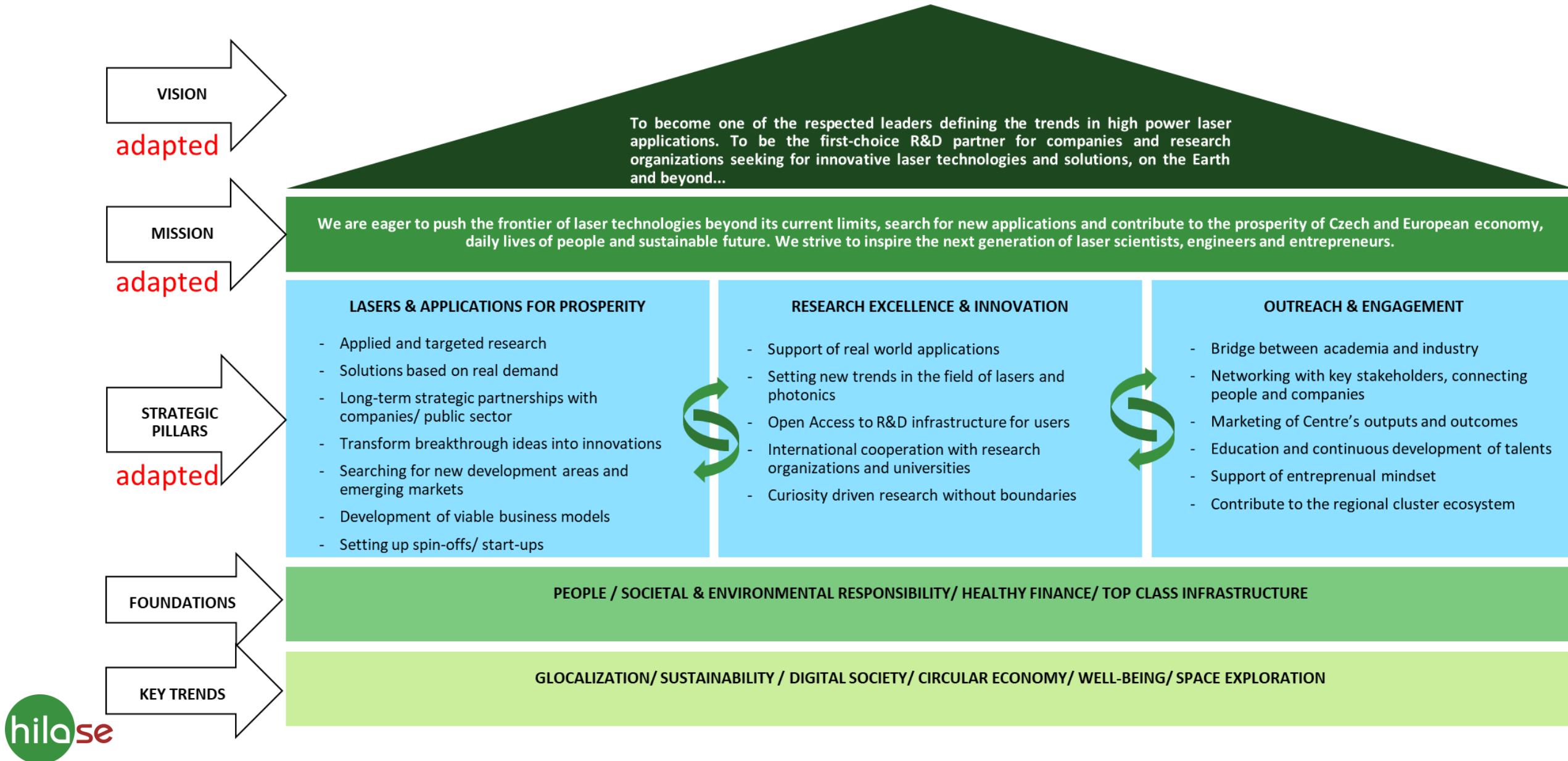
## Strategic Planning Timeline



## Strategic Areas



# The new “House concept” of HiLASE



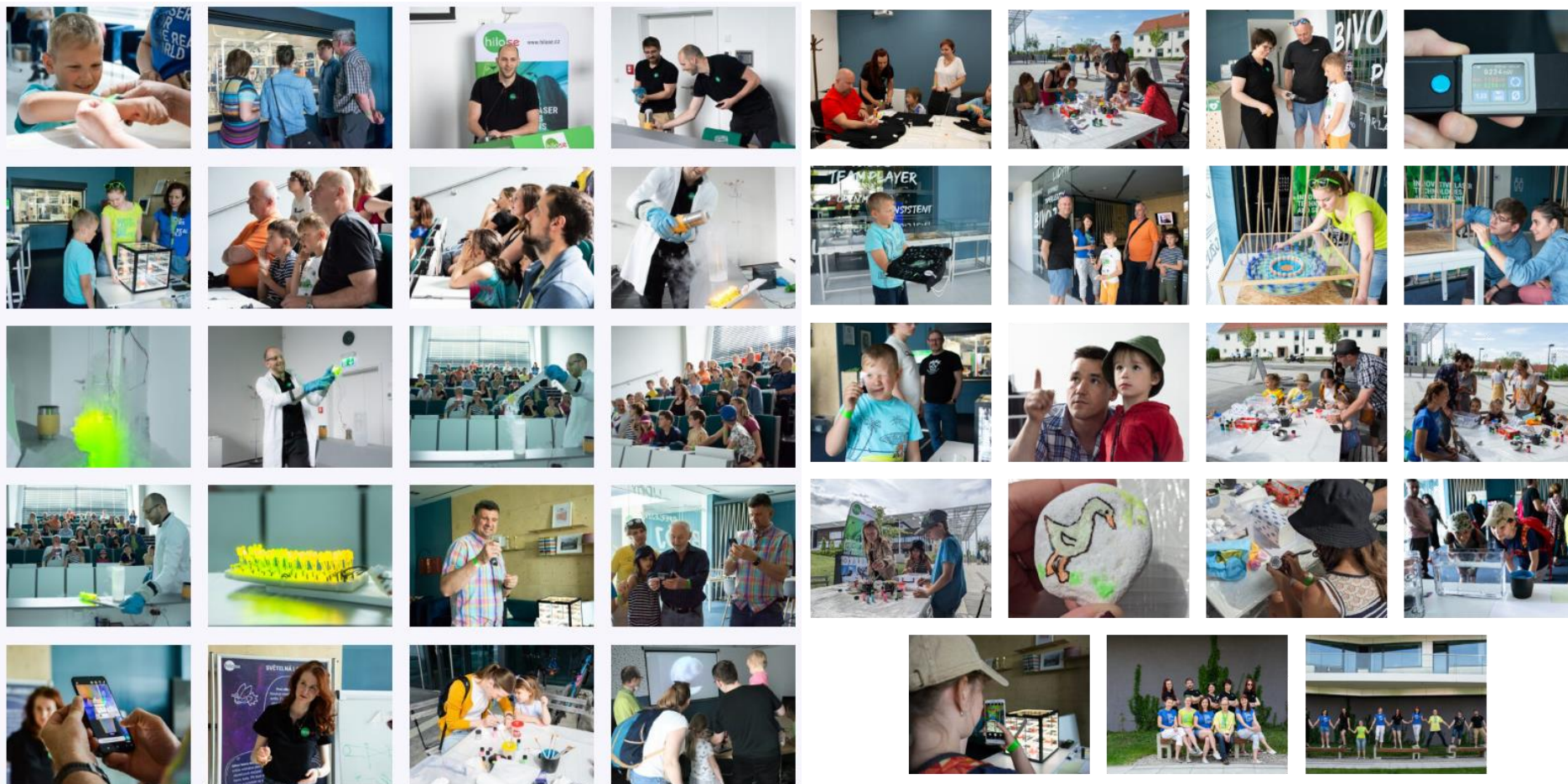


# Strategic Areas for the Next Decade

- **Advanced Laser Processing & production technologies (ALP)**
  - laser surface treatment, laser micro/nanomachining, industrial process development support and diagnostics, laser-created biofilms, antibacterial surfaces,...
- **Space-Borne Laser technologies (SBL)**
  - laser technologies qualified for space applications – asteroid mining, optical communication, satellite protection, defence applications, space debris removal, laser propulsion
- **Smart & Safe Solutions for laser systems and applications (SSS)**
  - testing of materials and components on resistance to laser irradiation, laser safety assessment & training, laser device safety, laser mass spectrometry for environmental safety,...
- **Laser Nano-Technology (LNT)**
  - pulsed laser deposition of 2D materials, laser-annealing synthesis of 2D materials from liquid precursors, laser direct printing of 2D materials, 2D material functionalization,... non-invasive laser theranostics, laser surgery with tailored laser beams, pulsed laser fabrication of biocompatible interfaces,...
- **Laser technologies for compact Particle and Radiation sources (LPR)**
  - High-power laser sources, adaptive optics, design and optimization of laser systems, predictive thermo-optical modelling, laser beam engineering, laser pulse shaping (temporal/spatial), non-linear optics, laser drivers for EUV and mid-IR sources, pump systems for PW-class lasers

# 8. Promote science and innovation

HiLASE EVENTS | **International Day of Light** | May 14, 2022 - Attendees:  $\geq 200$



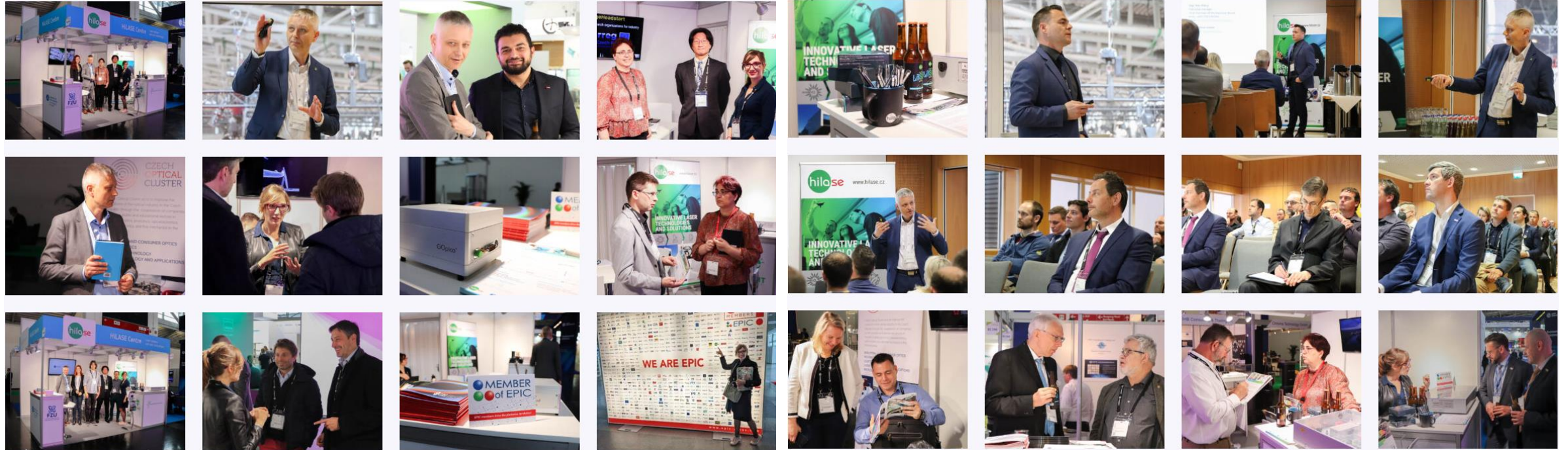
## PROGRAMME:

- From candle to laser light
- Laser safety workshop
- Workshop – painting on fabric
- Painting on pebbles
- Interactive exhibits
- A brief guided tour of the lobby with a glimpse into our laboratories
- Schlieren system – how to see the invisible
- Science lab – interactive science experiments for children
- Geocaching

<https://www.hilase.cz/en/v-centru-hilase-jsme-oslavili-mezinarodni-den-svetla/>



# Communication & Dissemination

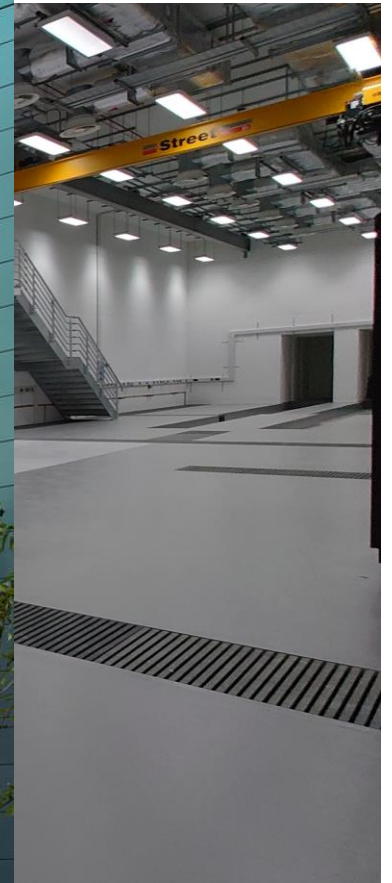
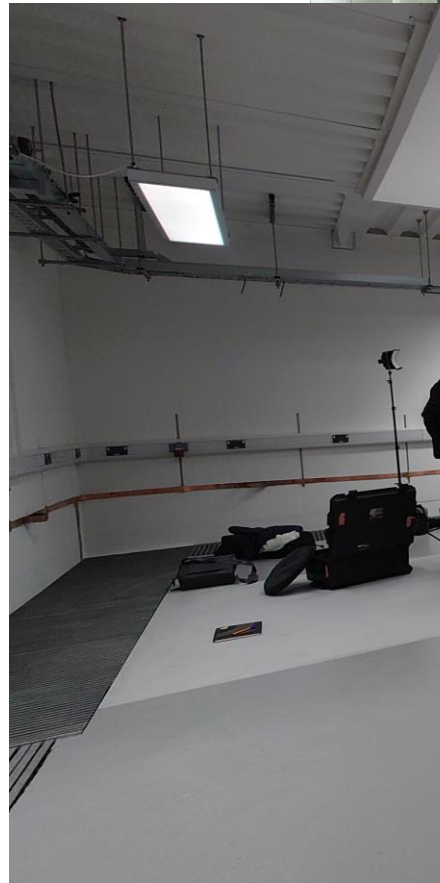


[www.hilase.cz/en/events/hilase-centre-at-the-laser-world-of-photonics-2022-trade-fair/](http://www.hilase.cz/en/events/hilase-centre-at-the-laser-world-of-photonics-2022-trade-fair/)

# Benefits of the HiLASE CoE Project to STFC / CLF

## Extreme Photonics Applications Centre (EPAC)

- 2018: STFC / CLF awarded £82M to construct a new, laser-driven source facility: X & gamma rays, ions, muons, THz, etc.
- EPAC exploitation is critically dependent on all 3 STFC / CLF CoE strategic objectives!





# HiLASE Centre – Synergies in practice

- Cooperation with Czech/ foreign companies through joint projects – complementary funding from TA ČR (TREND, GAMA & DELTA projects)
- Cooperation with Czech/ Foreign companies – complementary contract research revenues
- Brain4Industry (B4I) – National funding + National Recovery Plan + Digital Europe Programme
- Seal of Excellence OP JAK – MSCA Fellowships CZ





# Extension of synergies

- Extension of existing instruments, in particular, Seal of Excellence at the level of Horizon Europe and ESIF
- e.g. ERA-Chairs projects:
  - Widening instrument
  - Mono-beneficiary action
  - Budget per project: M€ 1,5 – 2,5
  - Project duration: up to 5 years



**Operační program  
Jan Amos Komenský**

THANK  
YOU!

Lukáš Masopust, MBA  
Deputy Head of Centre



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EUROPEAN UNION  
European Structural and Investment Funds  
OP Research,  
Development and Education



Science and  
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