

Welcome and digitalDESY Resilience, Efficiency, Sustainability

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A world-leading accelerator lab

DESY's mission



A unique combination of analytical tools

Brilliant X-rays



Overview of our priorities and strategy

Accelerator division is continuing to invest in operating and improving today's machines and carrying out targeted R&D for the future

Top priorities :

- (1) delivering highest quality beams to users with **today's machines**
- (2) upgrading **our machines for tomorrow** to offer performance increase – FLASH, PETRA III, XFEL
- (3) carrying out **foundational R&D** for building the next generation of machines
 - (1) Plasma and SRF
 - (2) Ultra-fast Electron Diffraction
 - (3) Autonomous accelerator/machine learning
 - (4) Medical applications



Key investments:

- **PETRA IV** Technical Design Report (TDR)
- **FLASH2020+** Machine Upgrade
- **KALDERA**: world leading laser for laser plasma accelerators
- **CAST** and **Technicum** building, **space for PETRA IV**
- Potential **PITZ** upgrade for radiation biology



Key challenges:

- **funding** for PETRA IV
- **recruiting** highly skilled technical staff and **increasing** diversity
- **post-pandemic digital DESY**



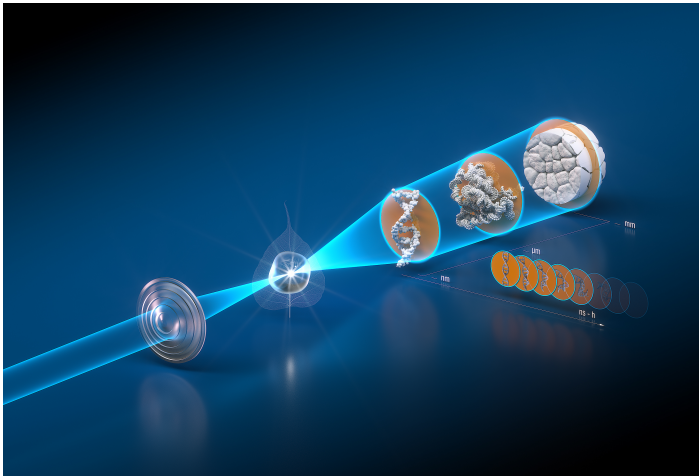
- **Resources for additional projects and staffing**

PETRA IV. X-ray microscope for chemical, biological and physical processes

Scientific excellence in X-ray Analytics to address global challenges



Unprecedented beam parameters



- Significant contributions to major social challenges and to almost all UN sustainability goals
- For a broad national and international user community of universities, research centres and industry

Project partners:

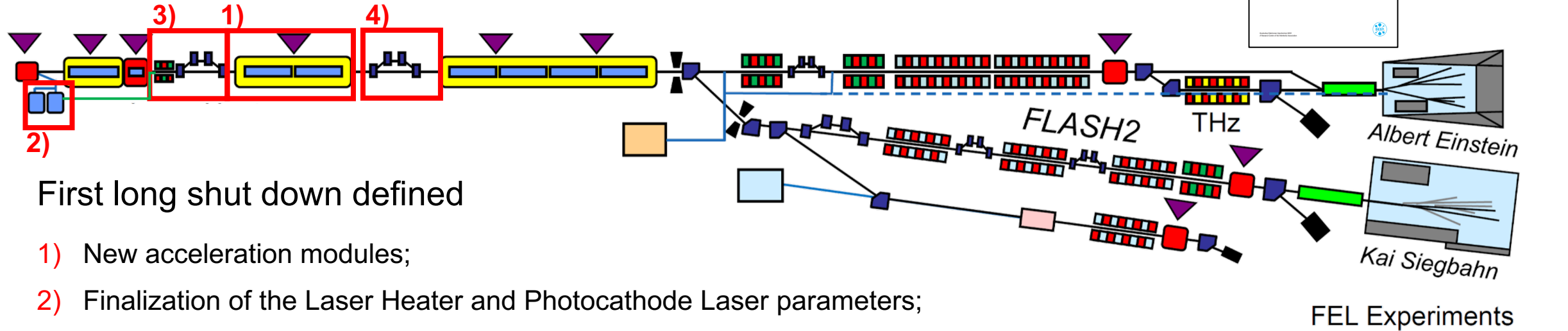


➤ TDR in progress

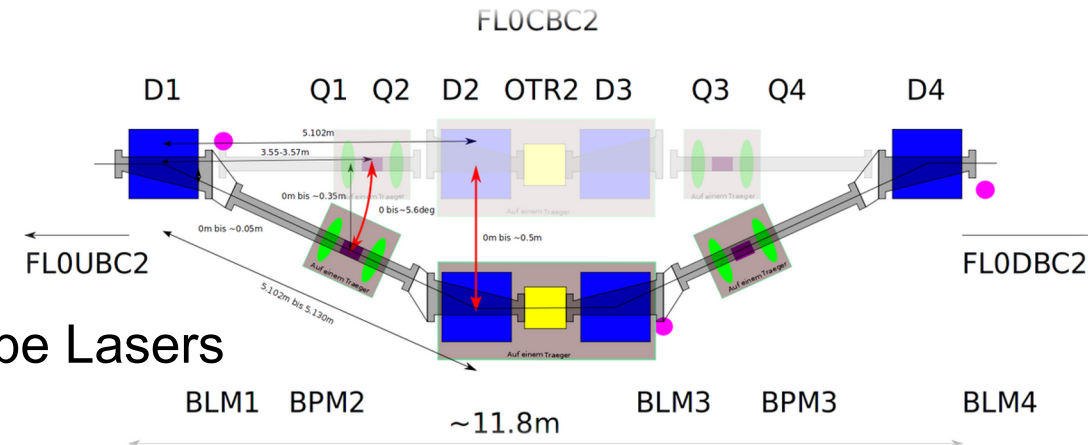


FLASH2020+ Project is progressing on all fronts

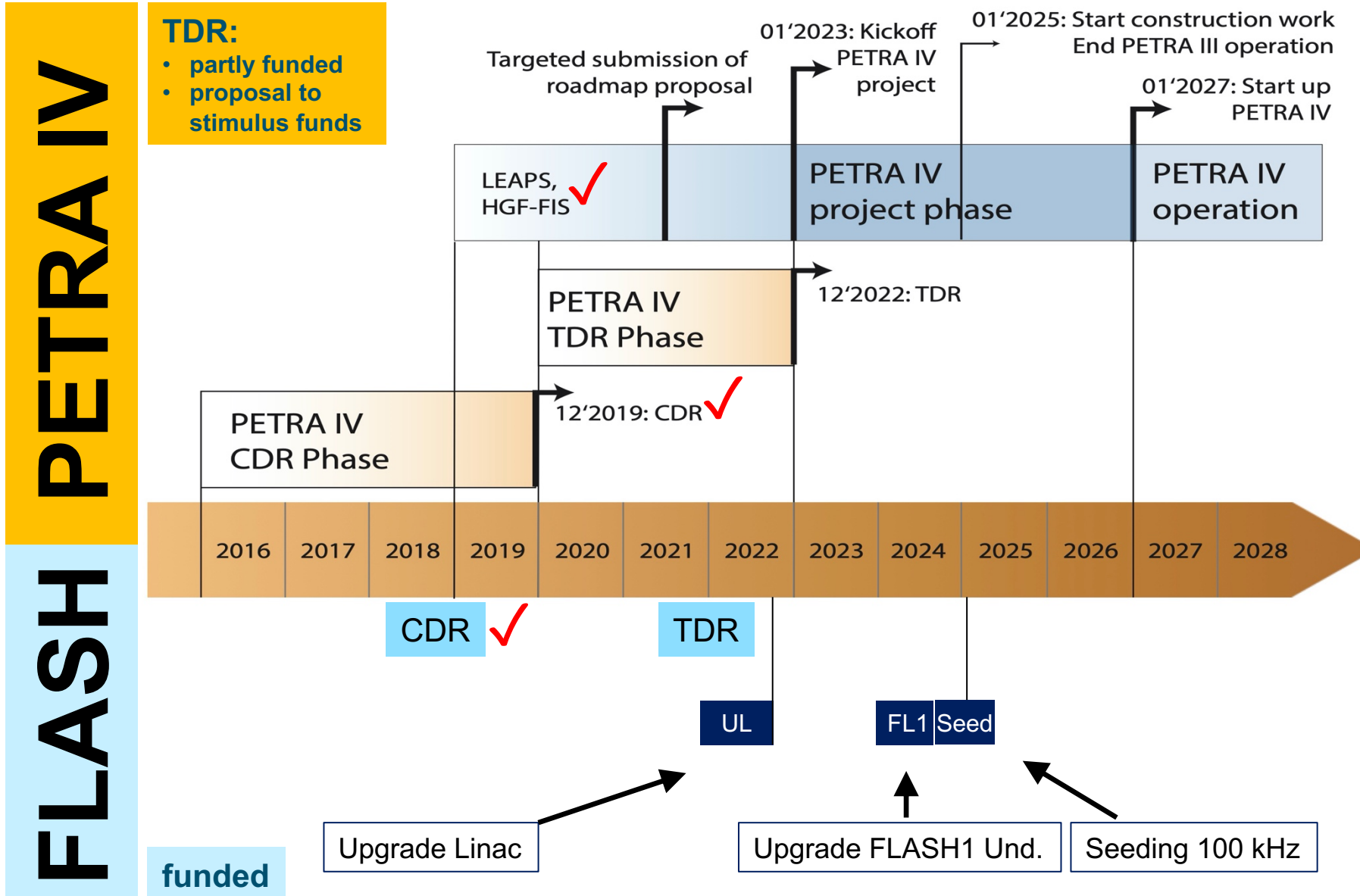
Recent activities and achievements



- First long shut down defined
 - 1) New acceleration modules;
 - 2) Finalization of the Laser Heater and Photocathode Laser parameters;
 - 3) Laser Heater beamline defined and under final revision;
 - 4) Evaluation for BC2 options.
- Definition of general Seed Laser parameters
- Definition of main requirements for new Pump and Probe Lasers



PETRA IV. & FLASH2020+ Upgrade projects are progressing and complementary in timeline



Making DESY a model lab for resilience and sustainability

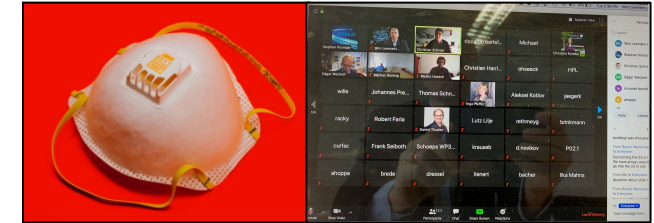
There are global challenges, and we can make a difference, benefit society and be the employer of choice



From providing safe work environments and expanded mobile work to remote user services and controls

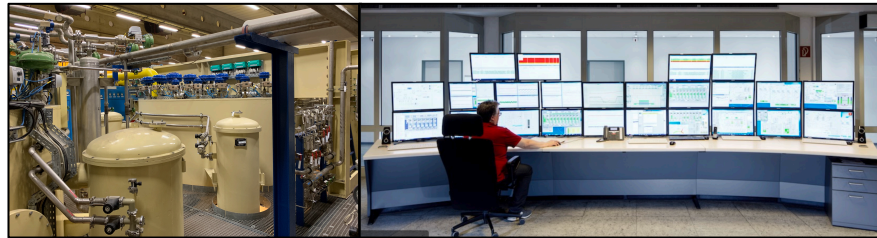
Will require investment, coordination with different DESY divisions, and innovation

- **Safe work environment** and ensure **cyber security**
- **Mobile work** modalities and **paperless processes**



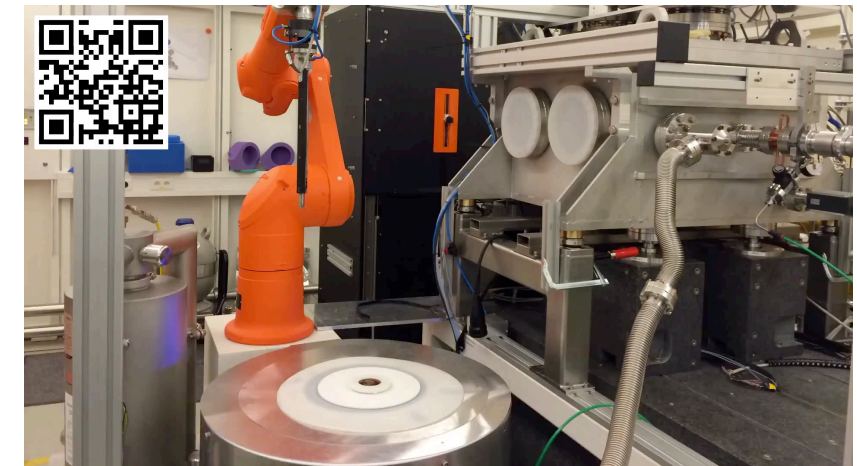
PPE

Video meetings



Remote control of technical infrastructure

- Increase **remote operations capabilities** and **virtual control rooms**
- Assess systems where **remote monitoring** and **control** can be improved
- Establish user modes that **minimize on-site presence**
- Increase **sample mail-in** capacity/capability
- **Autonomous accelerators** integrated with artificial intelligence
- Deploy **robotic technology** and we need to maximize their utility



Enabling a new mode of operation and autonomous accelerator operation through machine learning

➤ Autonomous accelerators

➤ Enable new user modes of operation:

- Experiment drives the machine
- Find new optimized operations by relying on sophisticated search algorithms

➤ Intelligent process control:

- Algorithm and hardware/firmware/software development
- Fault diagnosis and response methods

➤ Reduce night shift crew and its impact on personnel health

■ How:

- Strengthen know-how and expand capabilities at DESY:
 - Build a dedicated team
 - ML already deployed in PETRA IV design, XFEL, laser plasma accelerators
- Build partnerships
- Create an integrated plan and capitalize on new funding opportunities



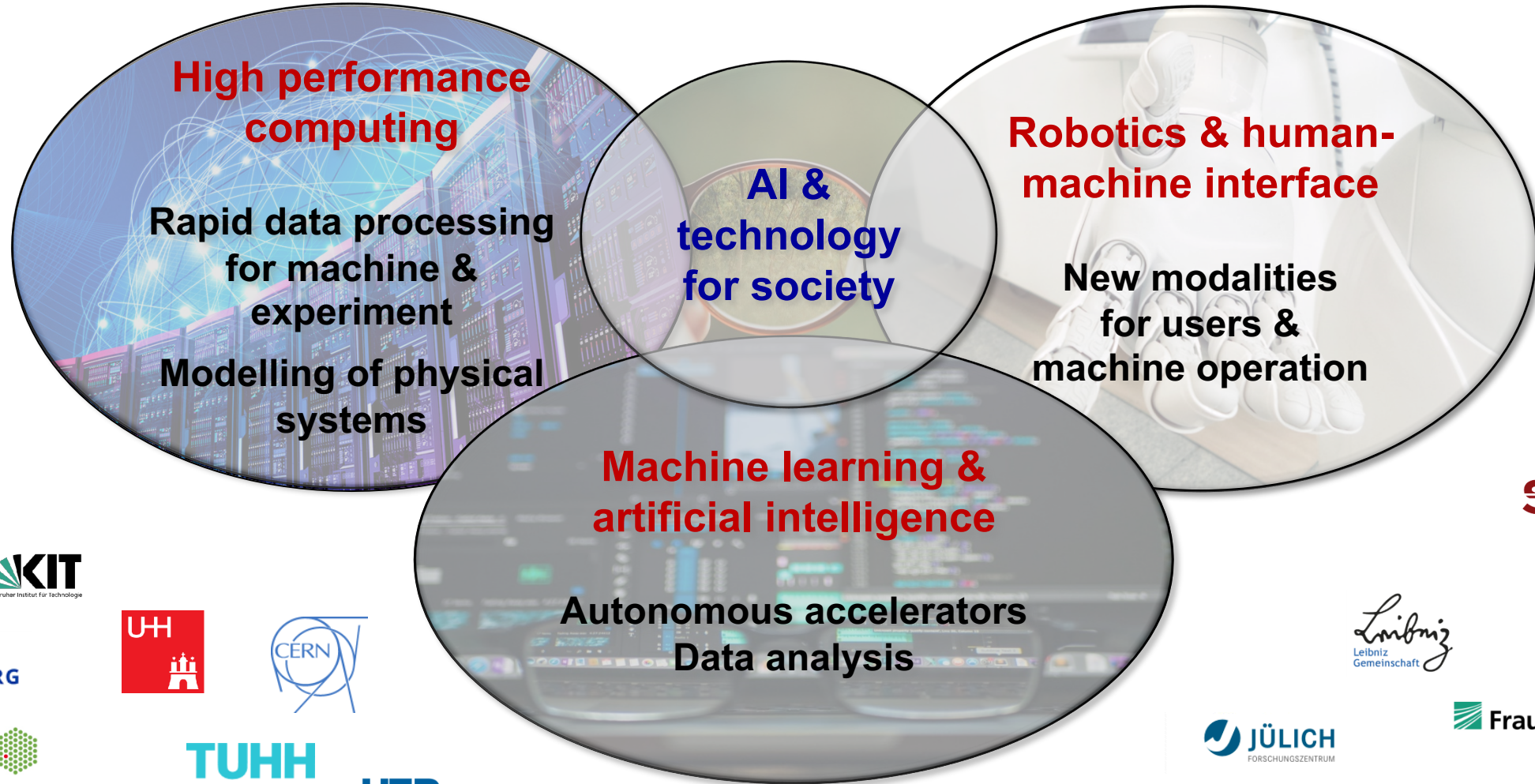
digitalDESY is an umbrella initiative that spans all of DESY

The work packages cover a decade of new developments – all of them already underway



Technology development through partnerships

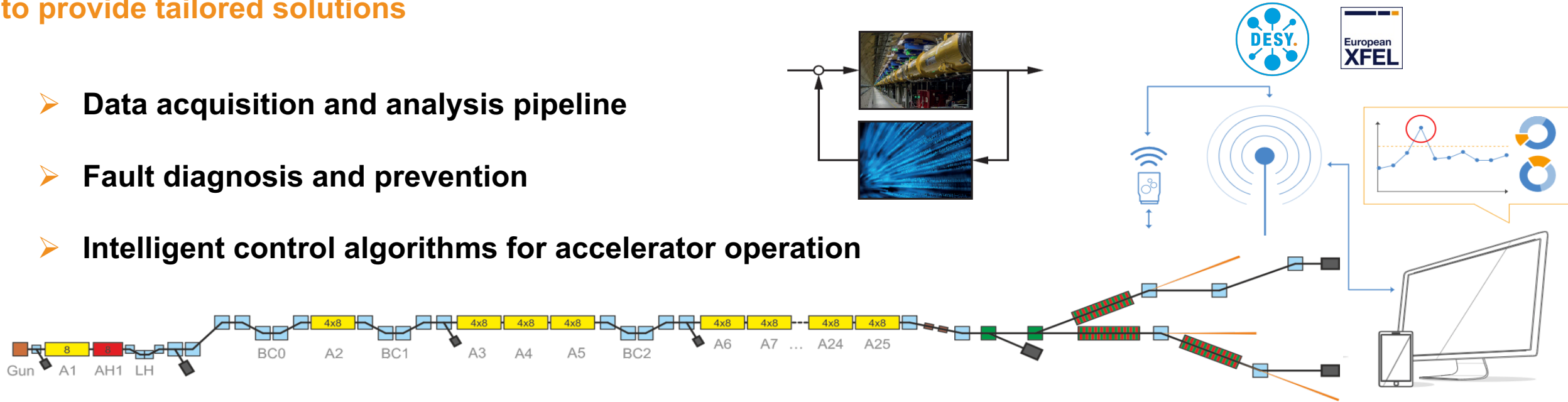
Leverage strengths of Helmholtz, Fraunhofer, Max Planck, Leibniz and all universities and industry to provide tailored solutions



We pursue new funding opportunities and partnerships

Autonomous accelerator operation: Leverage strengths of Helmholtz, partner universities and industry to provide tailored solutions

- Data acquisition and analysis pipeline
- Fault diagnosis and prevention
- Intelligent control algorithms for accelerator operation



Institutes, e.g.:

- Helmholtz institutes: various projects (ARD, DMA)
- SLAC: HIR³X
- CERN: simulation interface for ML
- ESS: Alarms, data sharing, fault diagnosis and protection

Universities



TUHH

HAW
HAMBURG

TUM
TECHNISCHE
UNIVERSITÄT
MÜNCHEN



HELMHOLTZ SPITZENFORSCHUNG FÜR
GROSSE HERAUSFORDERUNGEN

SLAC NATIONAL
ACCELERATOR
LABORATORY

ESS EUROPEAN
SPALLATION
SOURCE

CFEL
SCIENCE

CSSB
Centre for Structural
Systems Biology

MAX-PLANCK-GESELLSCHAFT



KIT
Karlsruher Institut für Technologie

EMBL

Science & Technology
Facilities Council

Fraunhofer

Leibniz
Gemeinschaft

HZB Helmholtz
Zentrum Berlin

HZDR

HZI Helmholtz
Zentrum für
Infektionsforschung

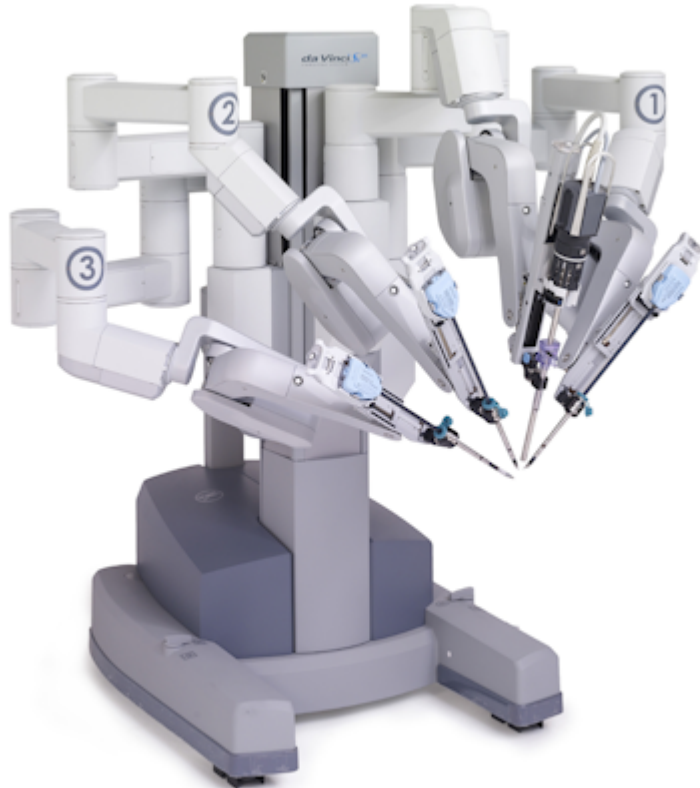
HMGU

JÜLICH
FORSCHUNGSZENTRUM

digitalDESY: can we deploy remotely controlled robot-assisted installation and user operations?

Develop a da Vinci-like robot for assisting users and technical staff

<http://Shadowrobot.com/>



da Vinci Surgical Robot (*Intuitive Inc.*, USA)



VR driven controls Human Machine Interface



Prof. F. Steinicke et al.



Prof. S. Haddadin



Next step

We are planning a workshop

- **Advanced operations of accelerator based light sources**
 - Robotics/antropomatics
 - Virtual reality/augmented reality based advanced human-machine interface
 - Artificial intelligence with focus on autonomous accelerators – machine learning
- **Would take place in Spring 2021**
 - Duration: 2x 3-4 hrs -- virtual
 - Keynote talks
 - What is possible today?
 - What are the challenges?
 - What is on the horizon?
 - Working groups/discussions



Contact

Prof. Dr. Wim Leemans

Accelerator Division

DESY. Deutsches
Elektronen-Synchrotron

www.desy.de