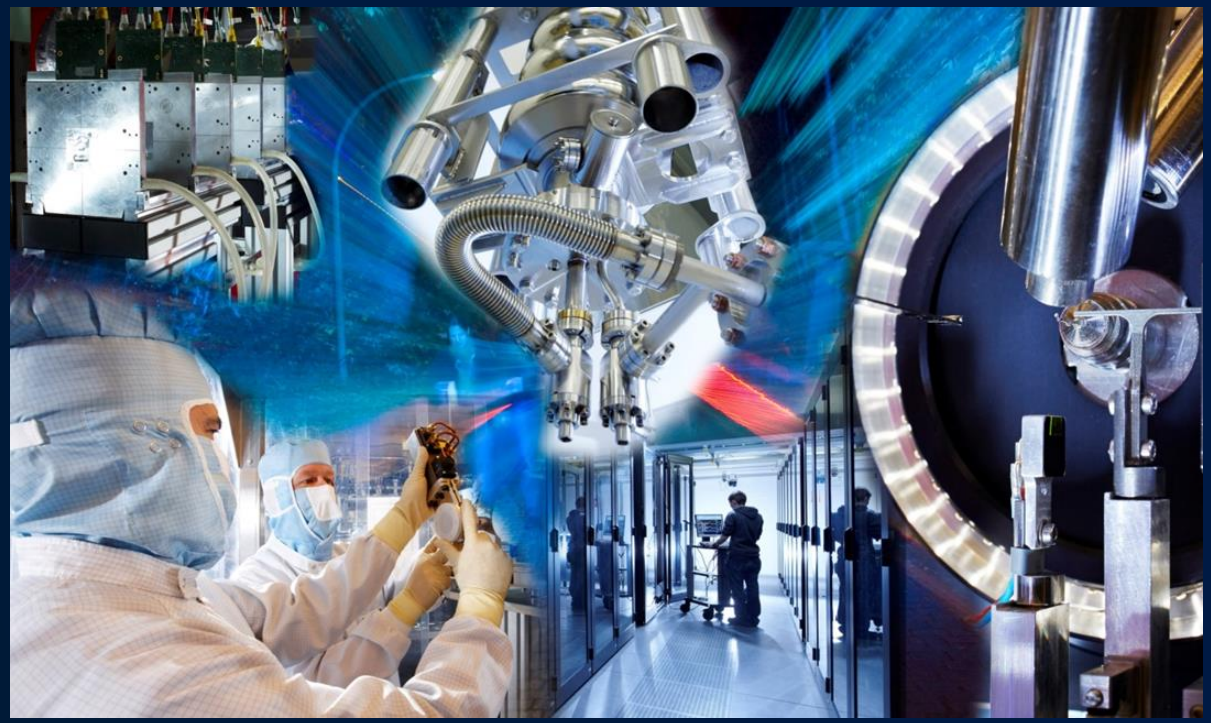
Accelerating Science – an Overview of DESY

65th Anniversary of DESY's Foundation: Ankara University – DESY Relations

Bilimi hızlandırmak



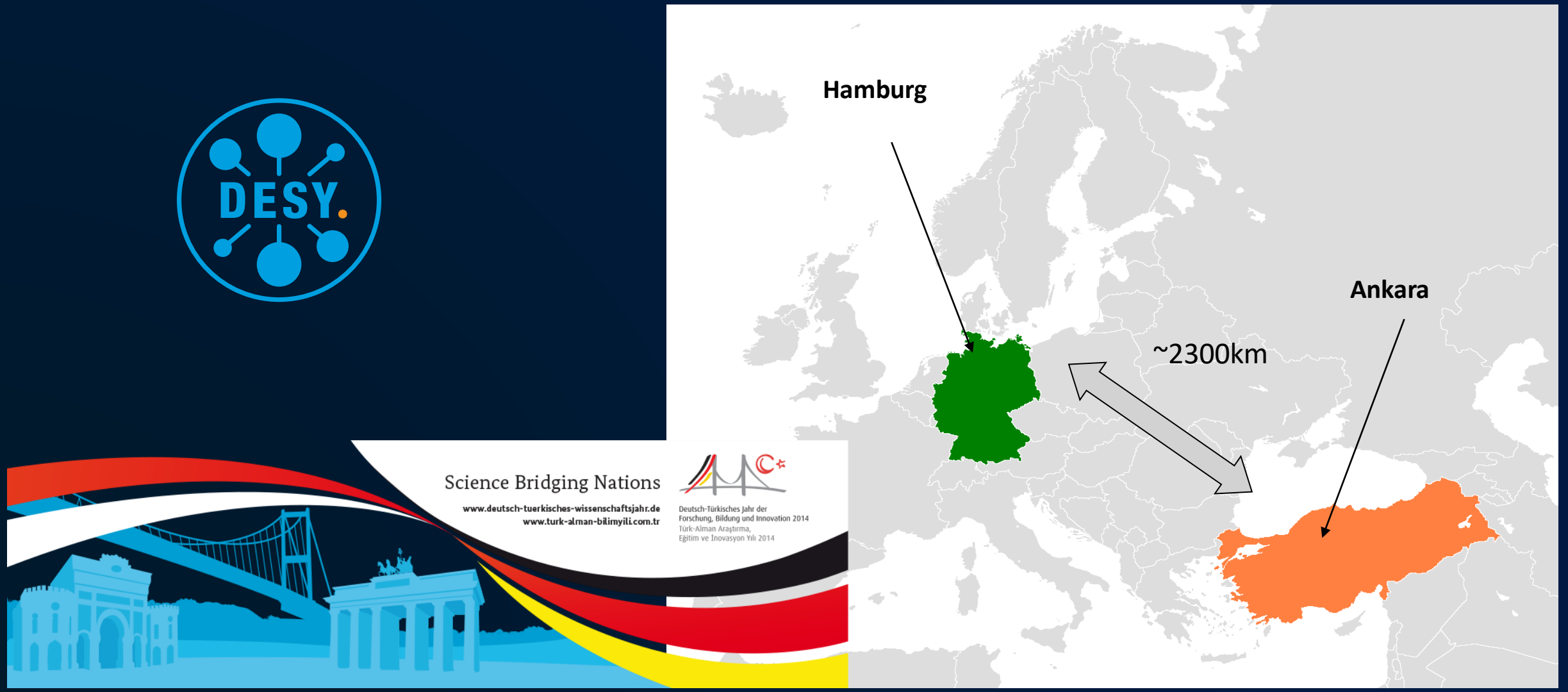
Frank Lehner

Head of the Directorate's Office, DESY

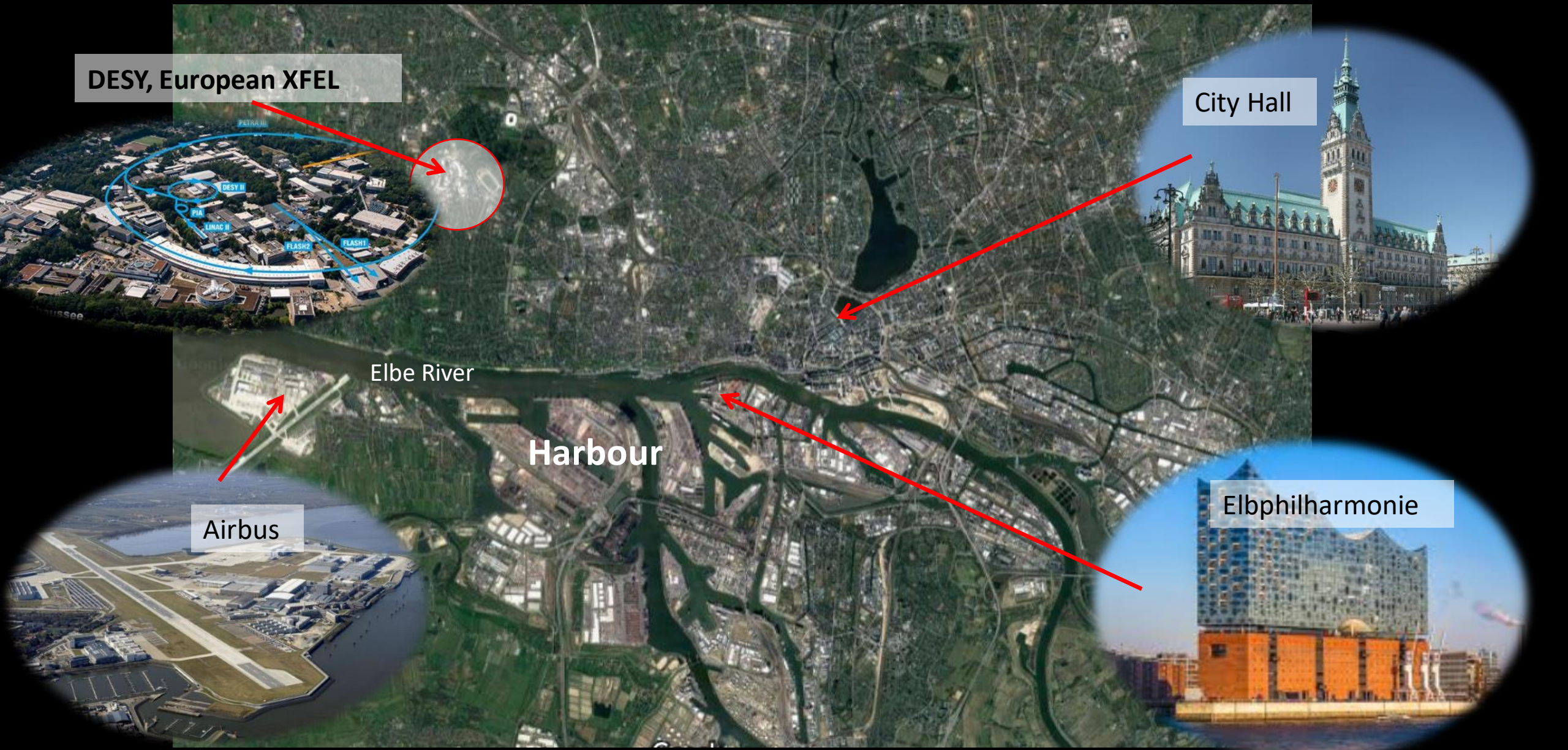
www.desy.de

26 February 2025

Where is DESY?



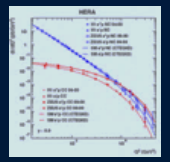
Where is DESY?



DESY. 1959-2025 „The Decoding of Matter“

Werner Heisenberg

Gluon



Electeoweak Unification

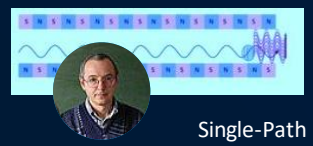
Proton Structure

TESLA Technology

XFEL LINAC

XMCD Effect

Schütz



Single-Path X-ray Laser

Saldin

Ribosom Struktur

Yonath

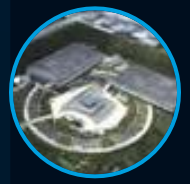
SFX

Chapman

Plasma-Accelerators

Leemans

DESY



DORIS

PETRA

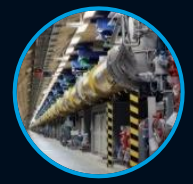
DORIS-SR

HERA

FLASH

PETRA III-SR

XFEL



1991 Zeuthen

1959 1971 1974 1981 1993 2000 2009 2025

W. Jentschke

W. Paul H. Schopper

V. Sörgel

B. Wiik

A. Wagner

H. Dosch

B. Heinemann

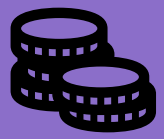
DESY – Facts & Figures

Foundation:
1959 as national lab

Member of Helmholtz Assocation

Employees:
~3.000 staff
~350 PhDs

More than 3000 international guest scientists



Budget:
240M€ annual
90:10 federal:state

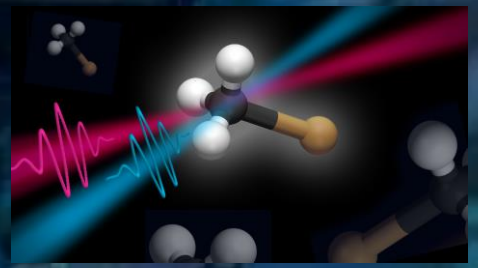
Sites:
Hamburg and Zeuthen (south of Berlin)

Research Areas:
Particle Physics
Astroparticle P.
Photon Science
Accelerators

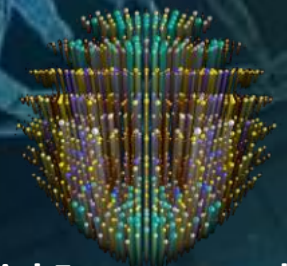
DESY´s. Mission

Exploration of Matter at the Highest Level

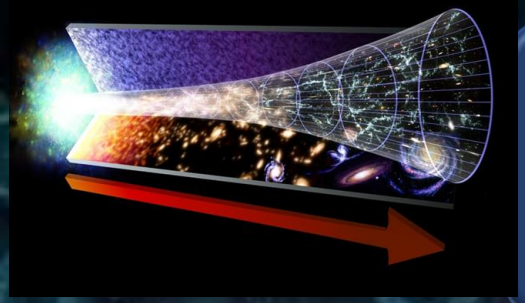
Advancing Knowledge for Science, Industry and Society



Light-Matter Interaction



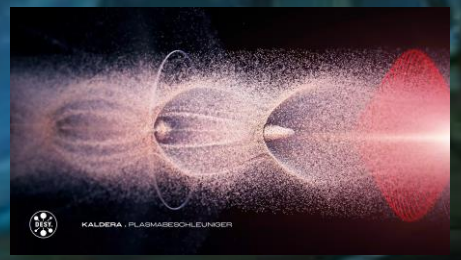
Serial Femtosecond
X-Ray Crystallograpy



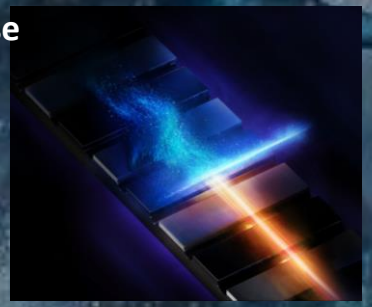
Fundamental Particles
and Nonthermal Universe

World-Class Research Facilities for Global Collaboration

Advancing and operating cutting-edge Infrastructures for Research Innovation and Education



Laser-Plasma - ultimate acceleration



TESLA – Attosec Pulses

Key Actor in Regional and Global Ecosystems

Strengthening science and innovation ecosystems through strategic cooperation

DESY.

World largest X-ray Machines

Modern large-scale research facilities & technologies @DESY.

The complementary use of unique research facilities in close proximity creates synergies

PETRA III World's largest synchrotron radiation source

FLASH World's first Free Electron Laser

EU-XFEL World's most powerful free electron X-ray laser

Large data storage

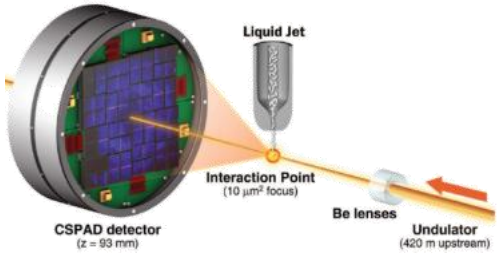
Test facilities for new detector technologies

Interdisciplinary centres

DESY. Interdisciplinary research platforms PETRA III, FLASH, XFEL

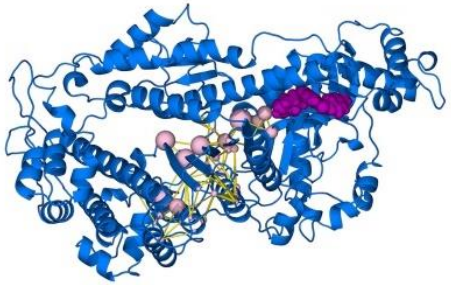
in concrete planning

Quantum materials
FEL Research



DESY
Max-Planck Society
University Hamburg

Structural Biology
Infection Research

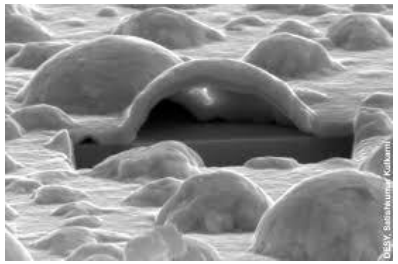


CSSB Centre for Structural Systems Biology

DESY
EMBL
HZI, FZJ
BNITM, LIV
UKE, MHH
UHH

*) DZIF Members

Nanotechnology
Nanomaterial Design



cXNs
Center for
X-ray and Nanoscience

DESY
University Kiel
Hereon
Technical University
Hamburg-Harburg

Theory
Interdisciplinary Concepts

WPC
Wolfgang Pauli-Centre

DESY
University Hamburg

Water
Molecular Water Research

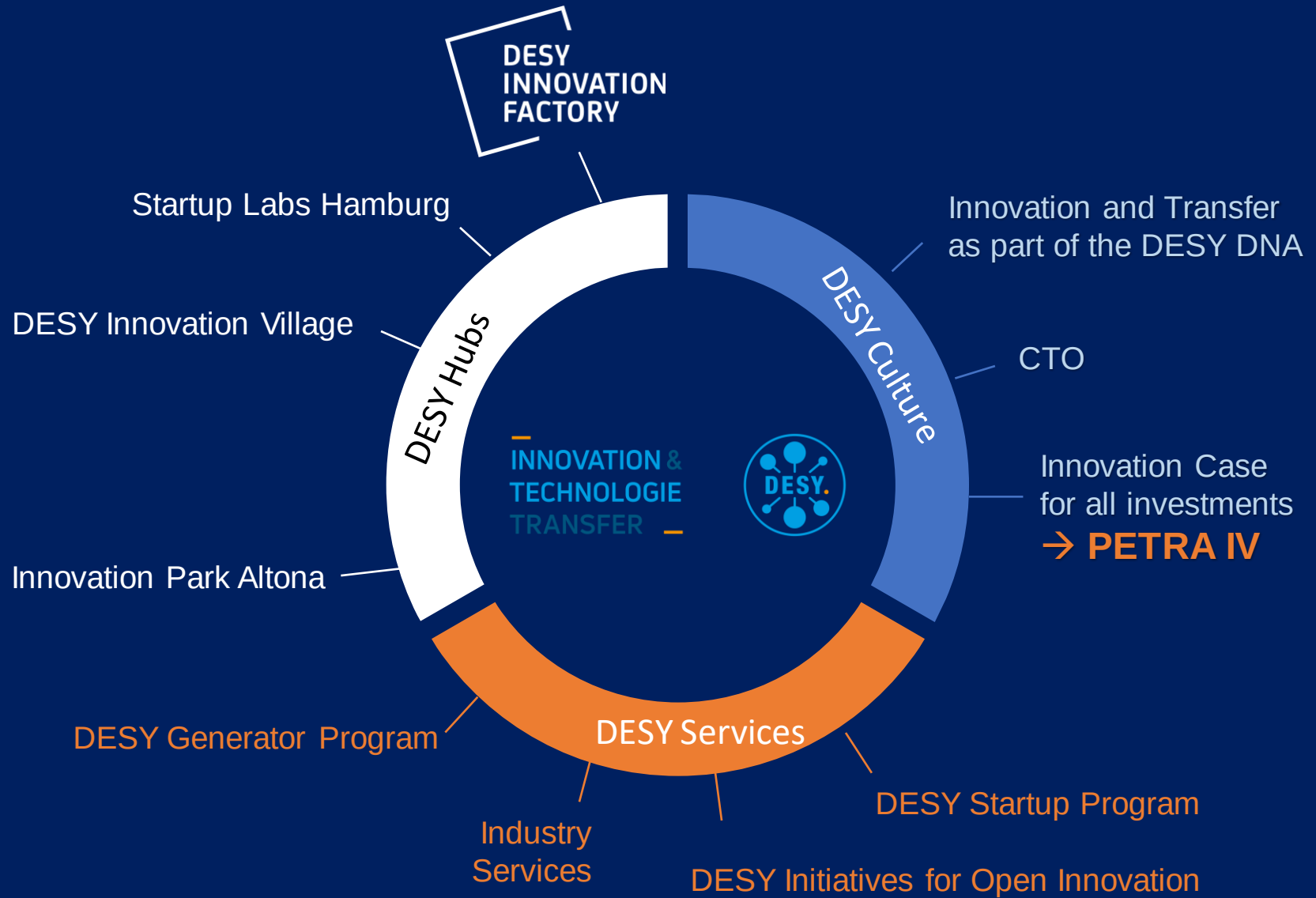
CMWS
Centre for Molecular Water Science

DESY
European Consortium

UFZ, GFZ
HZB

DESY. Significant momentum in innovation activities in the DESY ecosystems in Hamburg and Zeuthen.

Startup Labs Hamburg
Start 2019
DESY-UHH-FHH



PETRA III fact sheet

DESY's Brilliant Synchrotron Radiation Source

Timeline of PETRA:

1978: **PETRA I** for particle physics (gluon discovery)

1988: **PETRA II** as pre-accelerator for HERA

2010: **PETRA III** as 3. generation synchrotron radiation source (High Brilliance X-ray Source for Nano Science)

2029 (planned): **PETRA IV** as 4. generation synchrotron radiation source (Ultimate 3D X-ray Microscope)

DESY is collaborating with several strong partners

EMBL

Helmholtz-Zentrum hereon

MAX-PLANCK-GESELLSCHAFT

Röntgen Ångström Cluster

Fraunhofer

INDIA @ DESY

electron energy	**6 GeV**
stored current	**100 / 120 mA** (1% top-up)
emittance (h × v)	**1.3 nmrad × 20 pmrad**
circumference	**2304 m**
photon energy range	**4-40eV, 250 eV - 200 keV**
beamlines in operation	**25**
beamlines under construction	**1**
beamlines in planning	**1**
user operation (hours/year)	**5000**
bunch separation	**192 ns or 16 ns**

DESY.

PETRA III. was never in lockdown during the pandemic

Operation (on-site under strict access and hygienic rules or remote) during COVID-19 has enabled key research

S. Günther *et al.*, Science (2021), DOI: 10.1126/science.abf7945

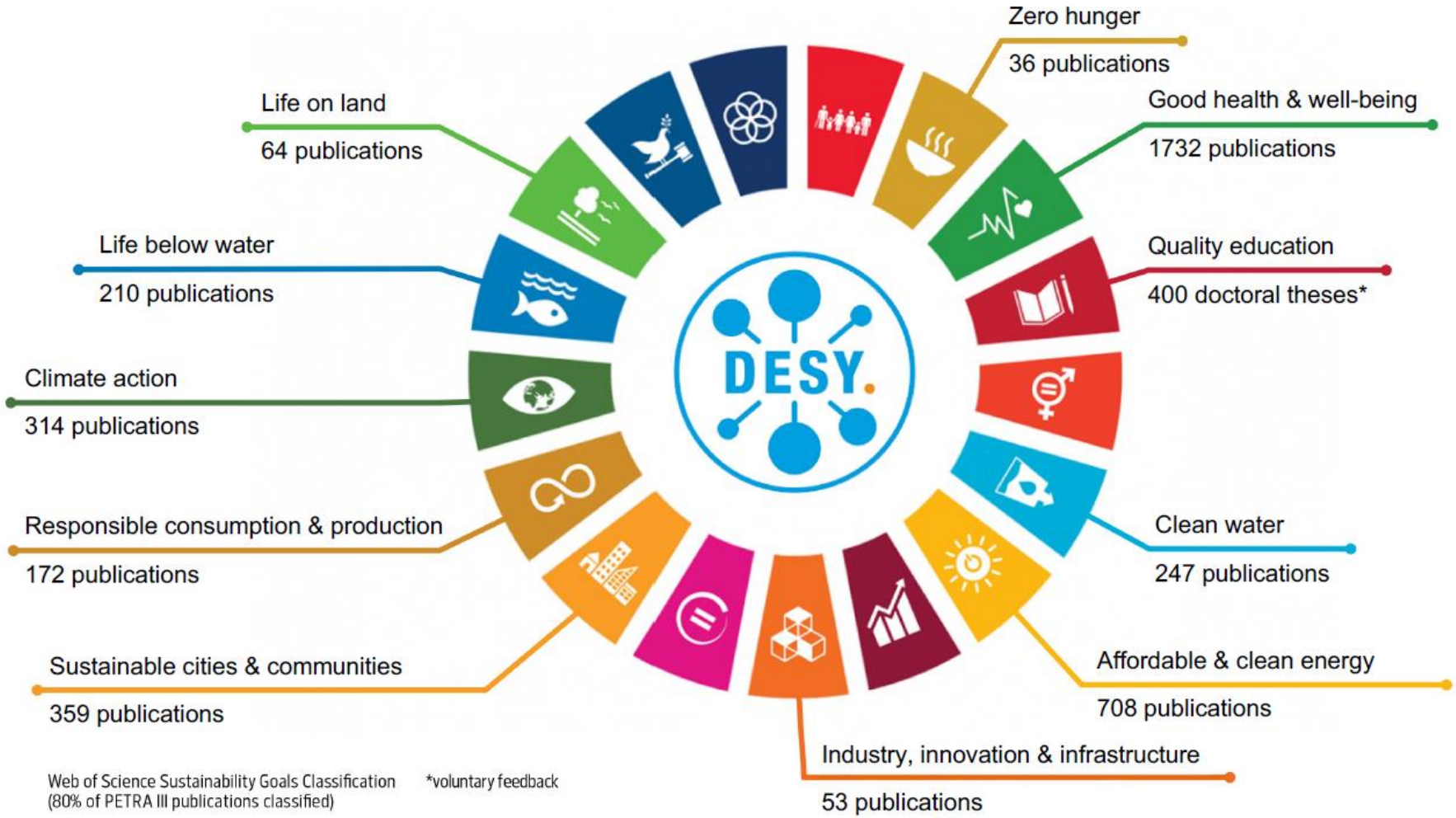
J. Qiao *et al.*, Science (2021), https://doi.org/10.1126/science.abf1611

S. de Munck *et al.*, Nature (2021), https://doi.org/10.1038/s41586-021-03959-5

C. D. Siewert *et al.*, Cells (2020), https://doi.org/10.3390/cells9092034

Our users make an impact

Analysis for PETRA III: Contribution to the UN sustainable development goals



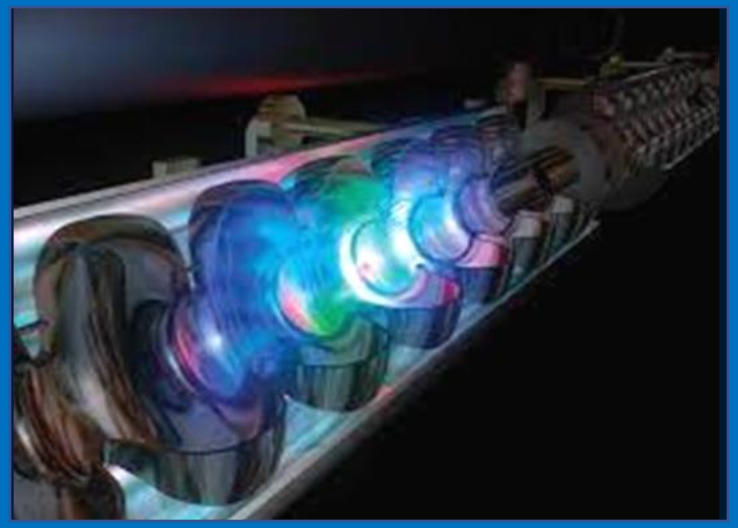
Web of Science Sustainability Goals Classification
(80% of PETRA III publications classified)

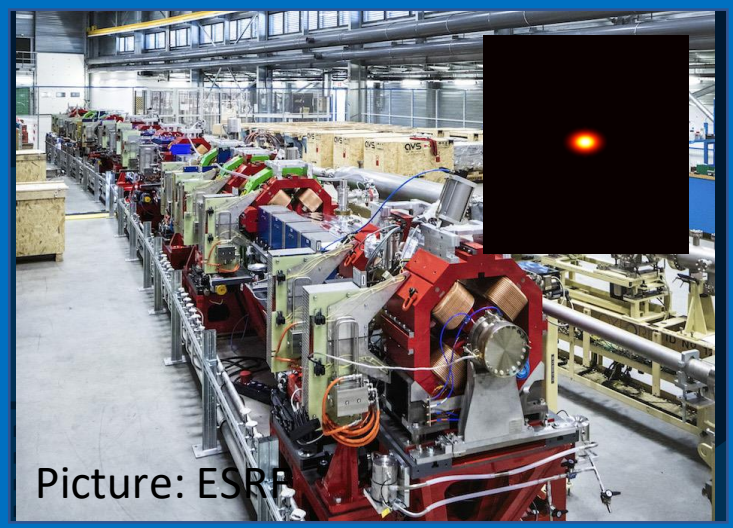
*voluntary feedback

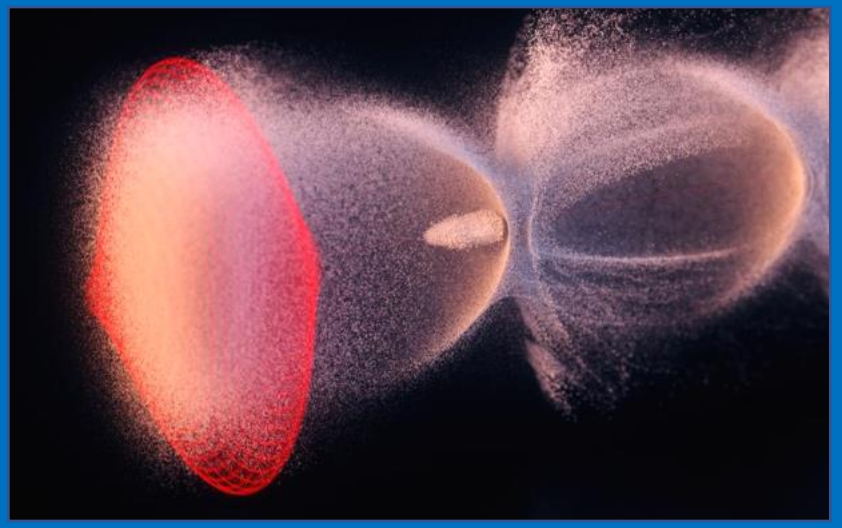
Clarivate™ InCites

DESY. R&D in new accelerator technologies for high-brilliance sources

World-leading technologies







Superconducting technology
Moonshot FLASH
Mars shot XFEL, LCLS2

Multibend Achromat technology
PETRA IV H6BA
developed in cooperation with ESRF
Build all (!) worldwide upgrades
to the disruptive European technology

Plasma technology
Moonshot: PETRA IV plasma injector
Translation in market

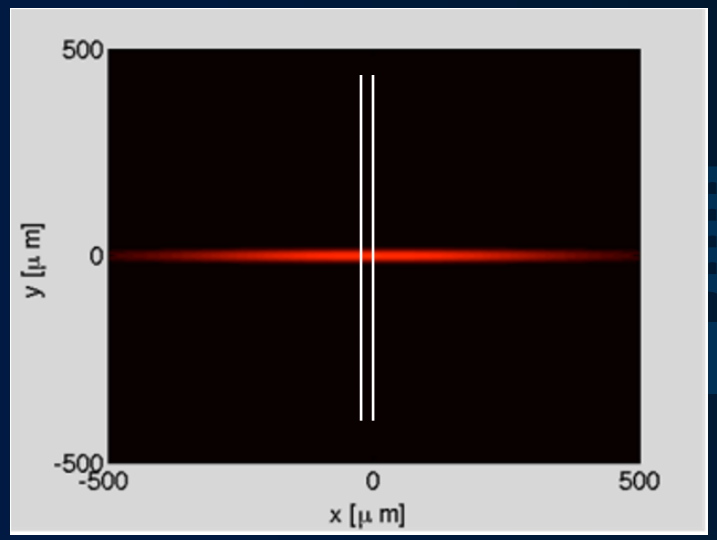
LASER R&D @ DESY

DESY. PETRA IV - Exploring the quantum world

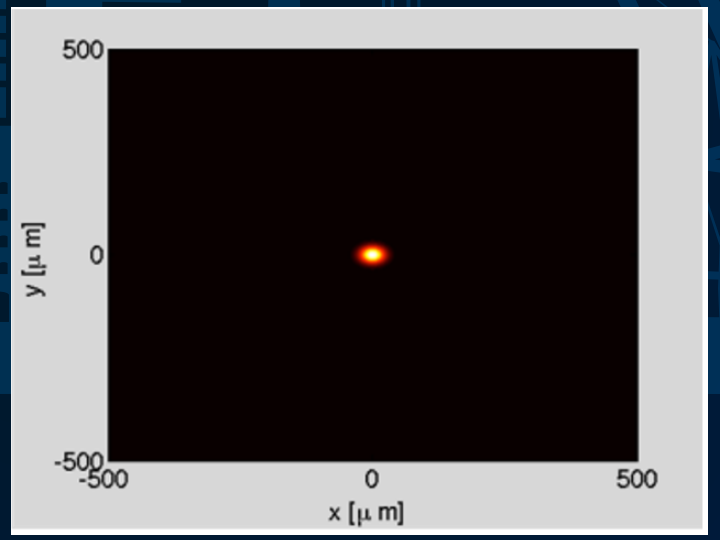
PETRA III
the best X-ray source for more than a decade
but no suitable microscope
for
Investigations on the quantum scale

PETRA IV
World-leading X-ray microscope
for
Design and control of materials
on the quantum scale

National roadmap process
Submission of the PETRA IV application October 25, 2024



Electron beam
in the PETRA III ring



Electron beam
in the PETRA IV H6BA ring

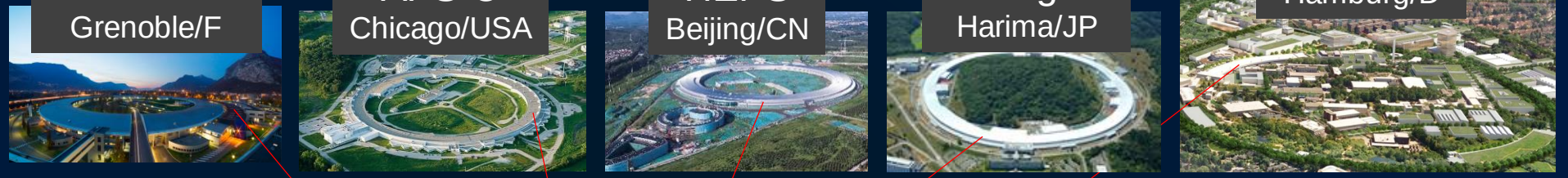
500-fold (!)
Increased performance

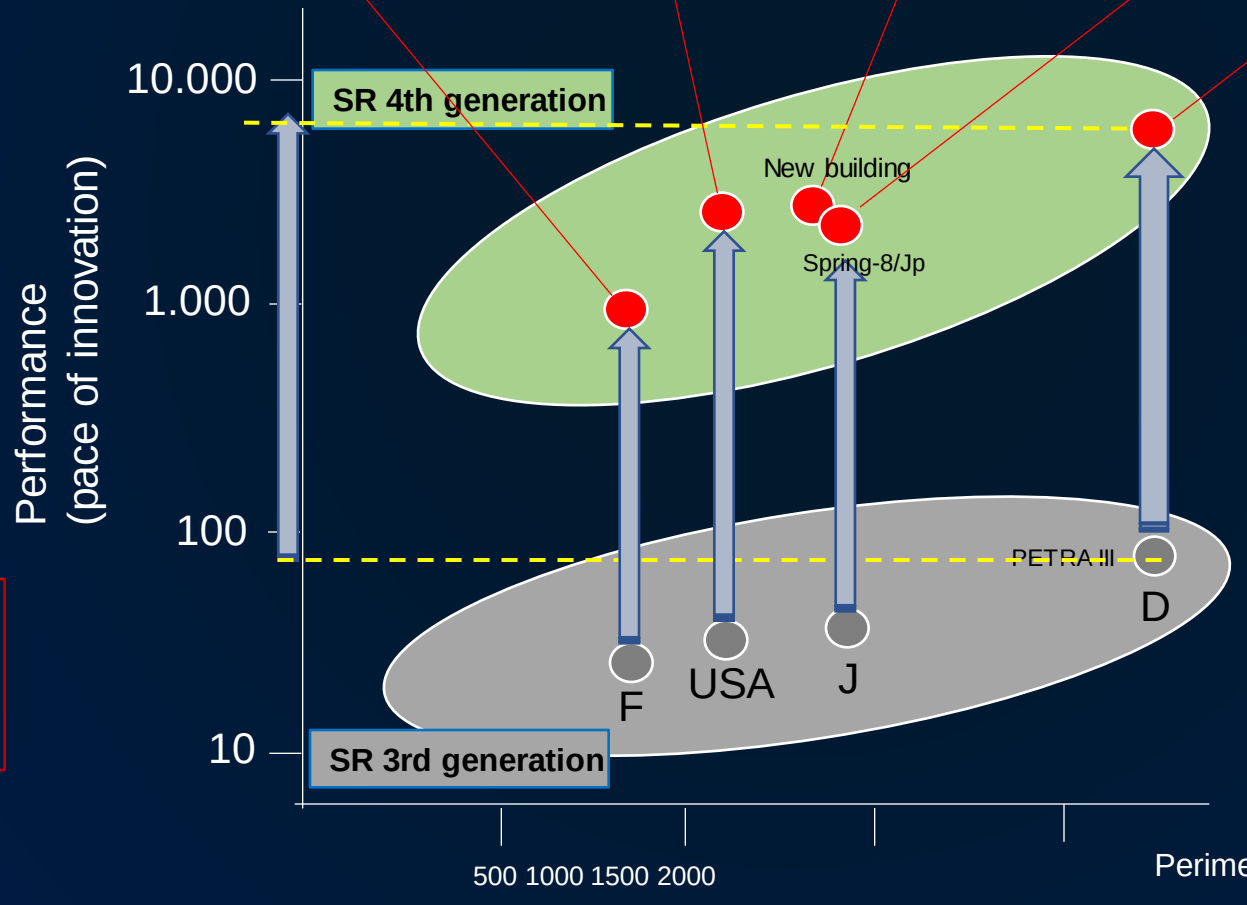
→ Disruptive new Insights
→ Innovations on the Nano scale

DESY. The international competition .... never sleeps!

The future „Big 5"

2020	2024	2025	2028	2029
ESRF-EBS Grenoble/F	APS-U Chicago/USA	HEPS Beijing/CN	SPring8-II Harima/JP	PETRA IV Hamburg/D





phys:
diffraction limited
maximum
Photon energy (eV)

4th generation based on European development:

Hybrid Multibend Achromat Technology (HMBA)

Global competition
for the best radiation source

→ Innovation machines for High-tech developments

APS-U and HEPS overtake all European SR sources in terms of performance in 2025

→ **PETRA IV** confidently secures the gloabl leadership !!!

Cooperation counts

Visits ot Turkish Delegation January 2014 at DESY/XFEL
Workshop in Istanbul July 2014
Public Roadshow Event at Turkish Universities May 2015
- initiated during the Turkish-German Year of Science (2014)

Deutsch-Türkisches Jahr der
Forschung, Bildung und Innovation 2014
Türk-Alman Araştırma,
Eğitim ve İnovasyon Yılı 2014

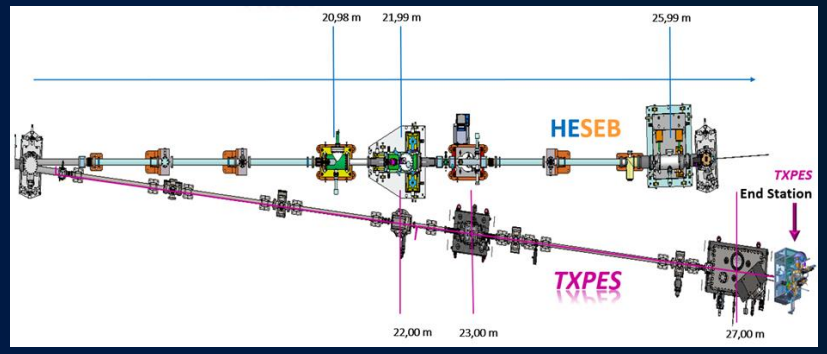
Cooperation counts

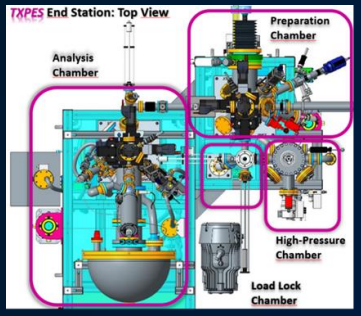
Public German-Turkish Science Day in Hamburg in Dec 2015
Workshop DESY/XFEL-Turkish Science Community – January 2016

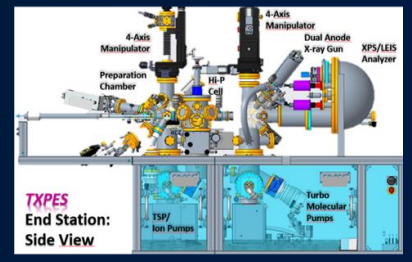
Deutsch-Türkisches Jahr der Forschung, Bildung und Innovation 2014
Türk-Alman Araştırma, Eğitim ve İnovasyon Yılı 2014

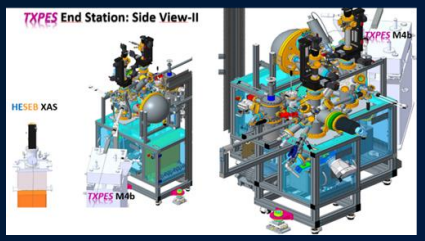
SESAME - a special place for cooperation

- SESAME - Synchrotron-light for Experimental Science and Applications in the Middle East, Jordan
- Türkiye – Member of SESAME / Germany (through DESY) is observer
- Helmholtz Soft X-Ray Beamline (HESEB) – Turkish Soft X-ray Photoelectron Spectroscopy (TXPES) Cooperation - cooperation DESY-Ankara





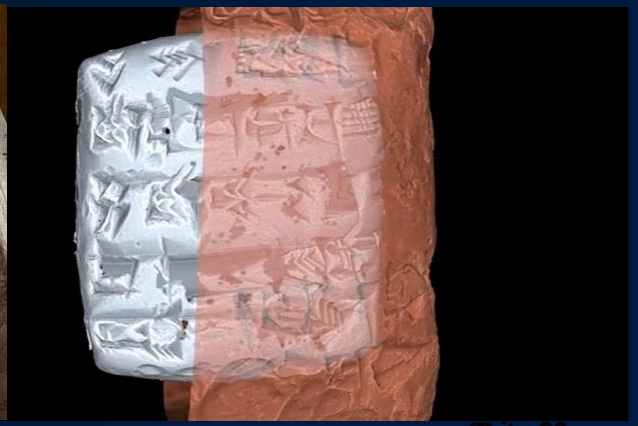




Cultural Heritage

- Cuneiform writing believed to be invented by Sumerians ~middle 4th millennium BCE
- Many clay cuneiform tablets enclosed / sealed in a clay envelope
- Museum of Anatolian Civillisation in Ankara has outstanding collection of clay tables of Assyrian cuneiform
  => a huge treasure of cultural heritage
- ENCI - mobile CT scanner for analysing cultural heritage objects – developed by DESY
- Specialized for closed cuneiforms
- Reveal the “hidden”

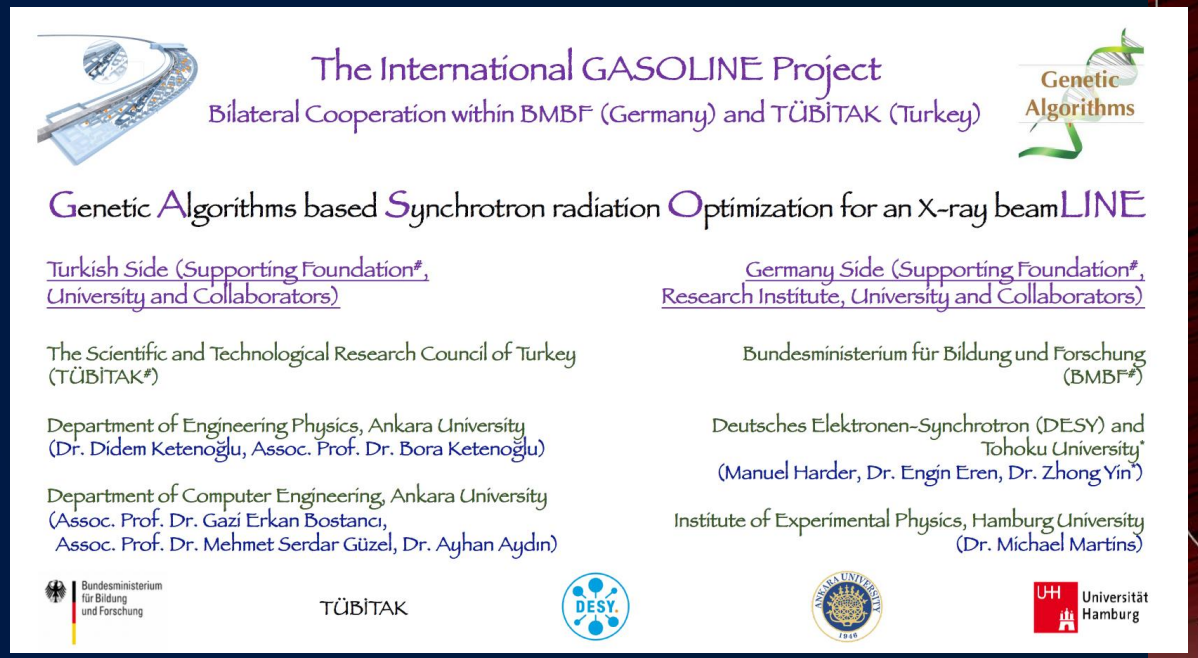
Musuem Director Yusuf Kıraç and the ENCI team at the Museum of Anatolian Civilisations in Ankara.



Thanks to Avni Aksoy / U Ankara for his great help

GASOLINE Project

- A TÜBİTAK-BMBF funded collaboration between U Ankara and DESY using genetic algorithms to optimize synchrotron and FEL beamlines
- two Workshops in 2022 and 2024
- organized by B. & D. Ketenoğlu et al.



DESY. – now 65 years and full in (E)motion

The place to be …
and for future DESY-Ankara cooperation

Thank you - Teşekkür ederim

HELMHOLTZ

DESY. fosters global Collaboration in pioneering large-scale Research Projects.

1 - 5
6 - 50
> 50

Europe

European XFEL

SLAC

CTAO

BELLE II

LEAPS

ESRF

LHC@CERN

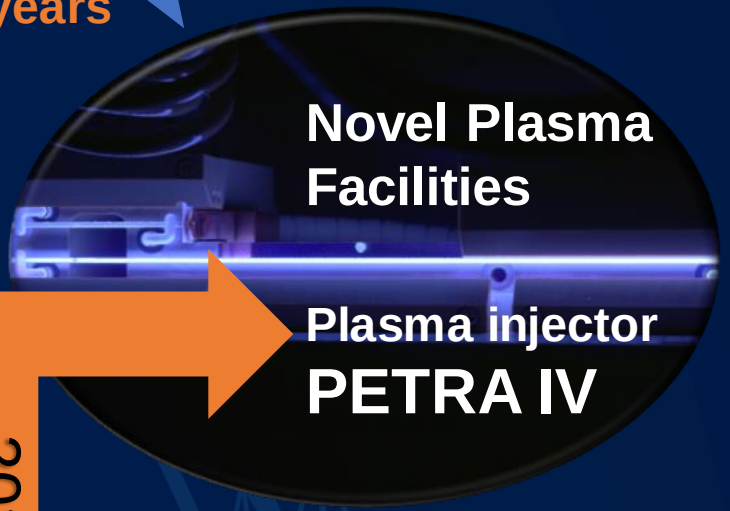
ICECUBE

DESY. is pioneering the Accelerators of tomorrow.

10-20 years

2000

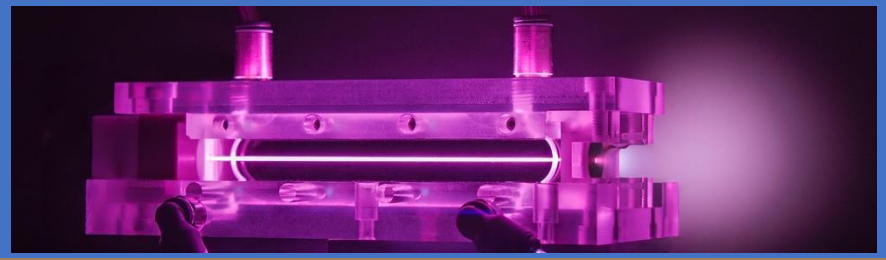
10-20 years



2028

Cold Technology „TESLA“

Plasma Technology



DESY Accelerator R&D