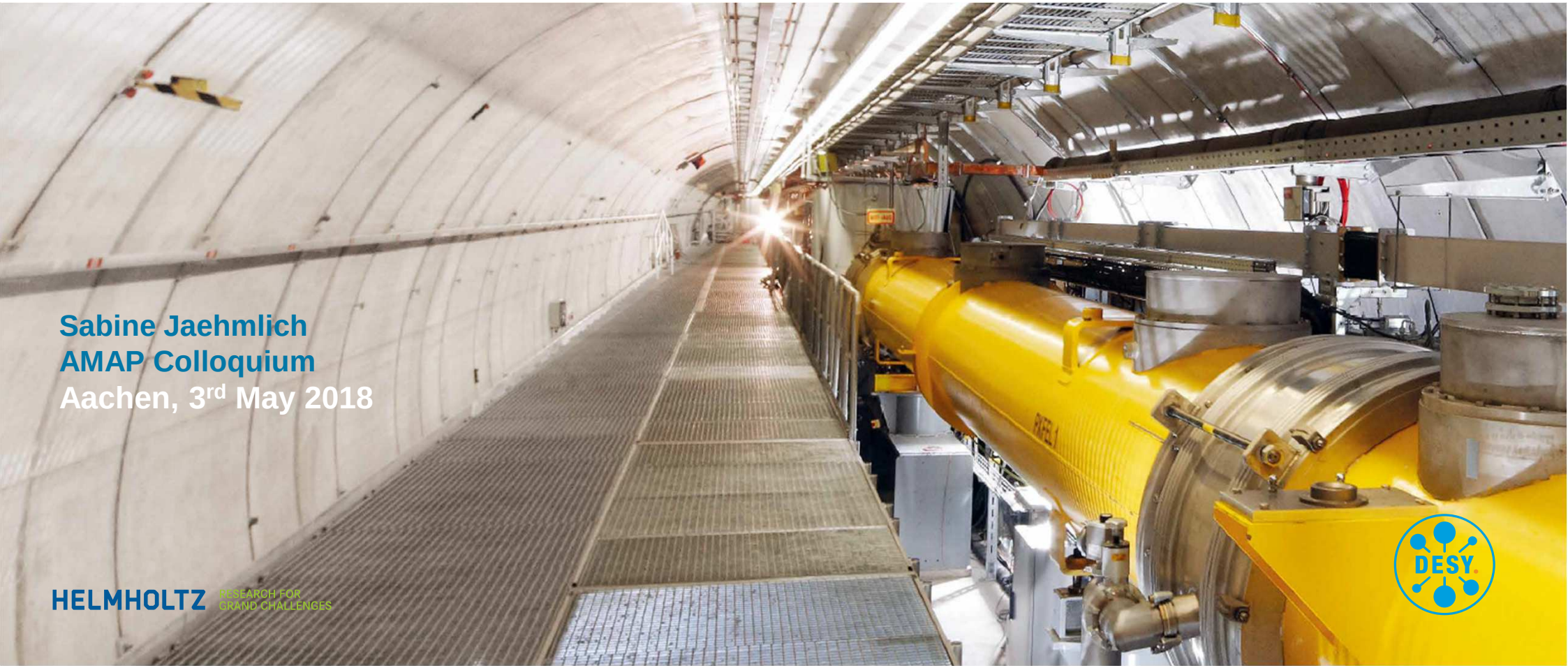
Material characterization at DESY
Best practice, benefits and access.

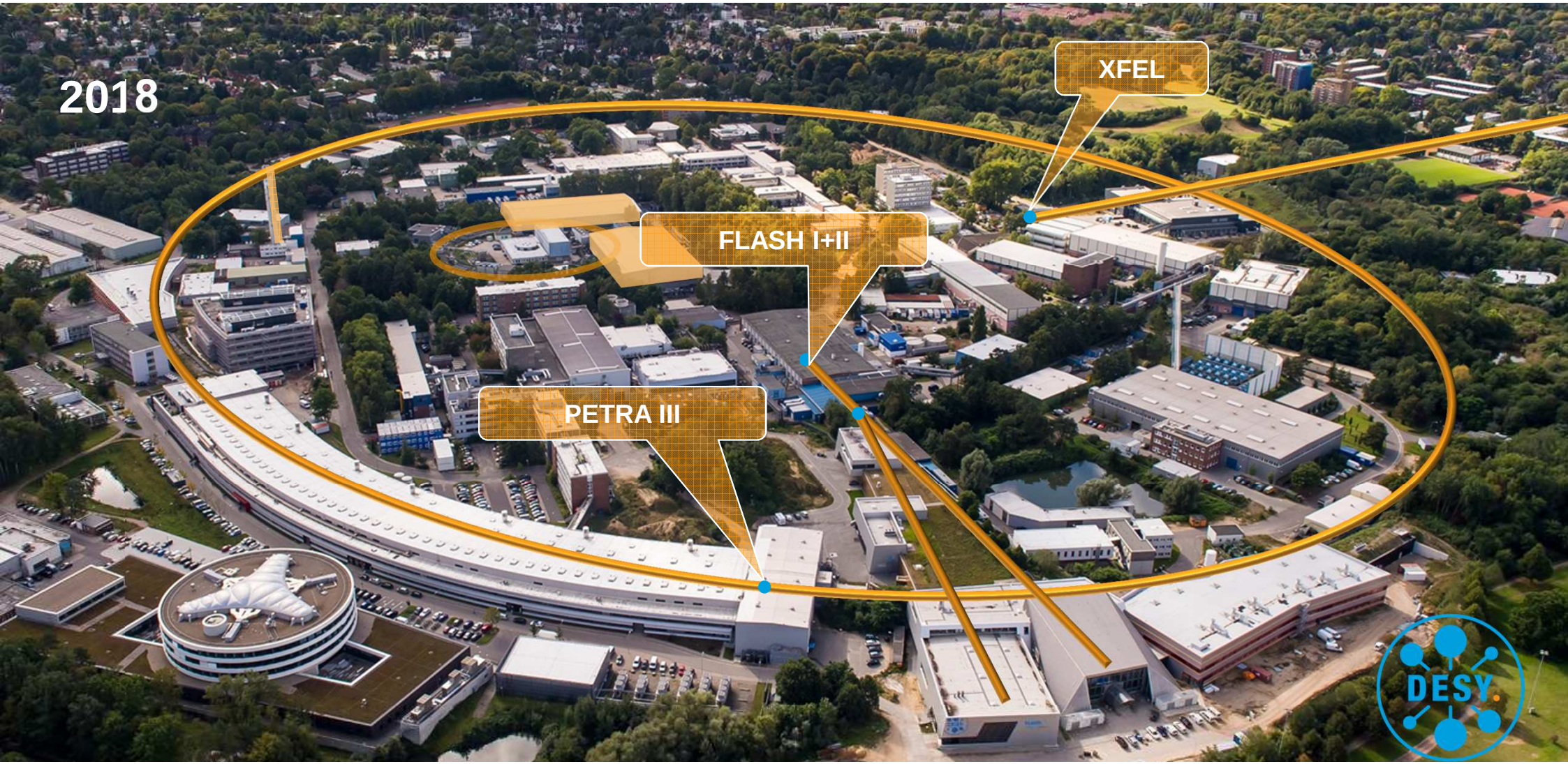


Sabine Jaehmlich
AMAP Colloquium
Aachen, 3rd May 2018

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY

DESY Today.



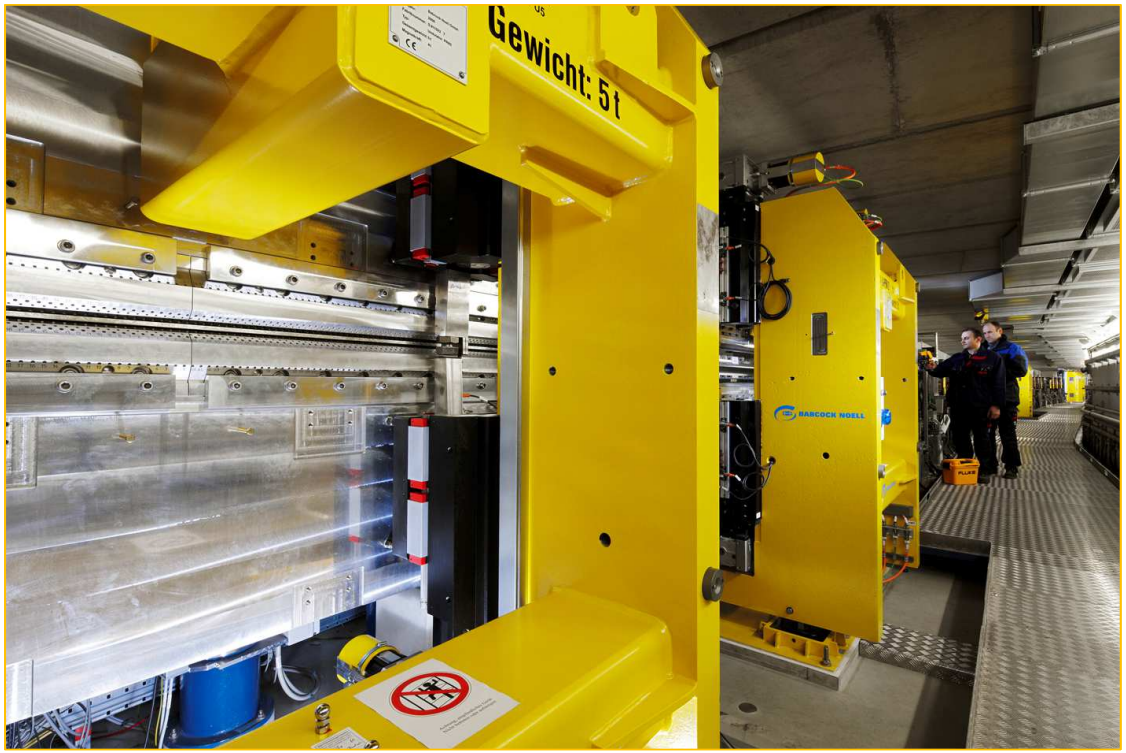
DESY. The most brilliant X-ray light worldwide.

- **ca. 220 Mio. € base budget + 100 Mio. € third party funding**
- **over 400 Mio. € investments p.a. in/around Hamburg in recent years**
- **2.378 employees**
- **more then 3.000 users per year from 45 countries**

Source: EMBL.

PETRA III Beamlines.

19 beamlines for multidisciplinary research.



P01 Dynamics
P02 Hard X-Ray Diffraction Beamline
P03 MINAXS
P04 XUV Beamline
P05 Imaging Beamline
P06 Hard X-Ray Micro/Nano-Probe
P07 High Energy Materials Science
P08 HighRes Diffraction
P09 Resonant Scattering and Diffraction
P10 Coherence Applications
P11 Bio-Imaging and Diffraction
P12 BioSAXS
P13 Macromolecular Crystallography I
P14 Macromolecular Crystallography II
P22 HAXPES
P23 In-situ and Nano Diffraction
P24 Chemical Crystallography
P64 Advanced XAFS
P65 Applied XAFS

Synchrotron research is part of our lives.

New Pharmaceuticals

BIOTECHNOLOGY

Ice cream texture

FOOD INDUSTRY

Suntan cream

PHARMA & COSMETICS

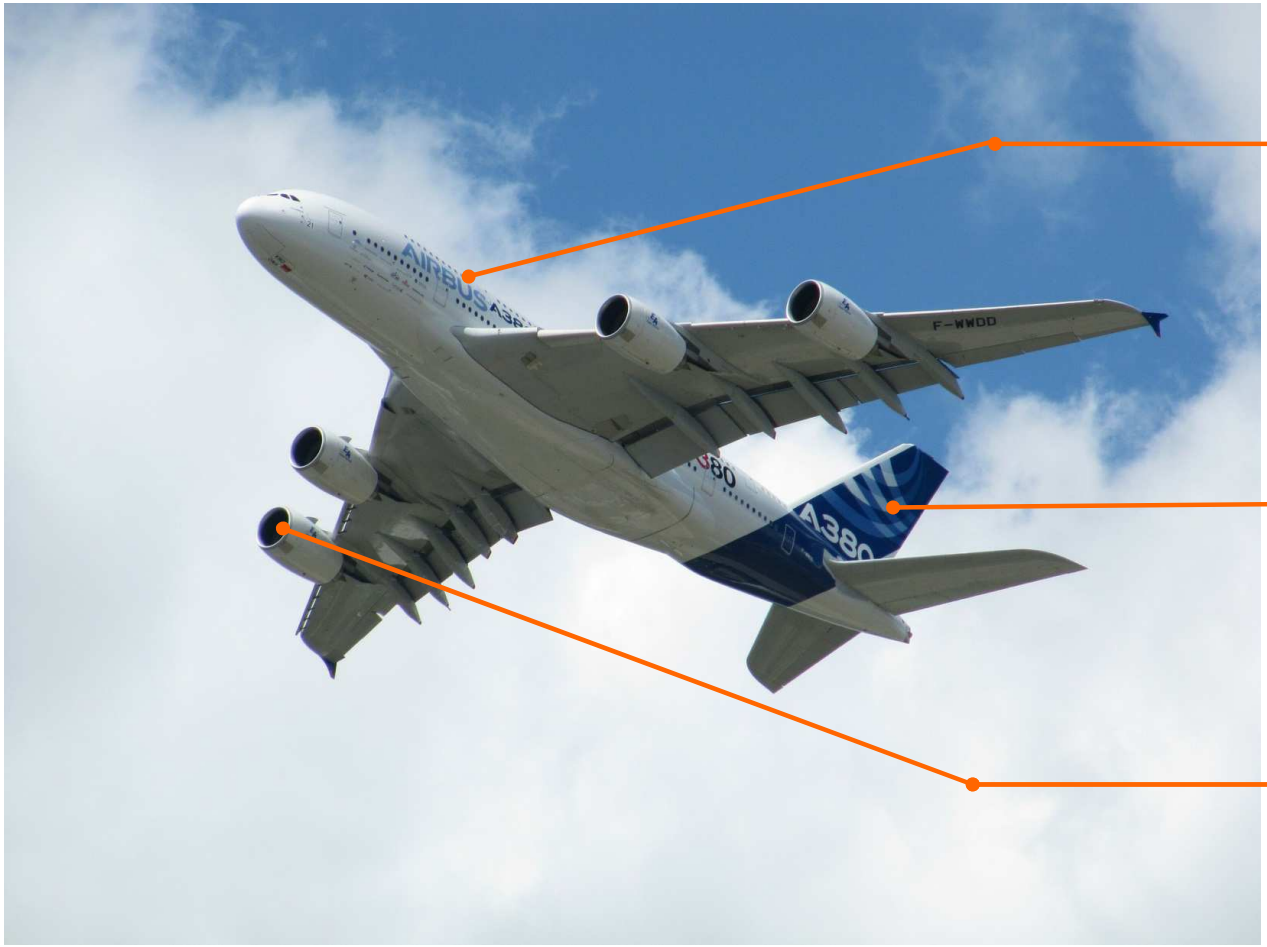
Dye

CHEMICAL INDUSTRY

Adhesives for nappies

MATERIALS SCIENCE

… and can improve our future.



AUTOMOTIVE & AEROSPACE

New alloys & stress tests

CHEMISTRY

Characterization & performance of coatings, paintings & new materials

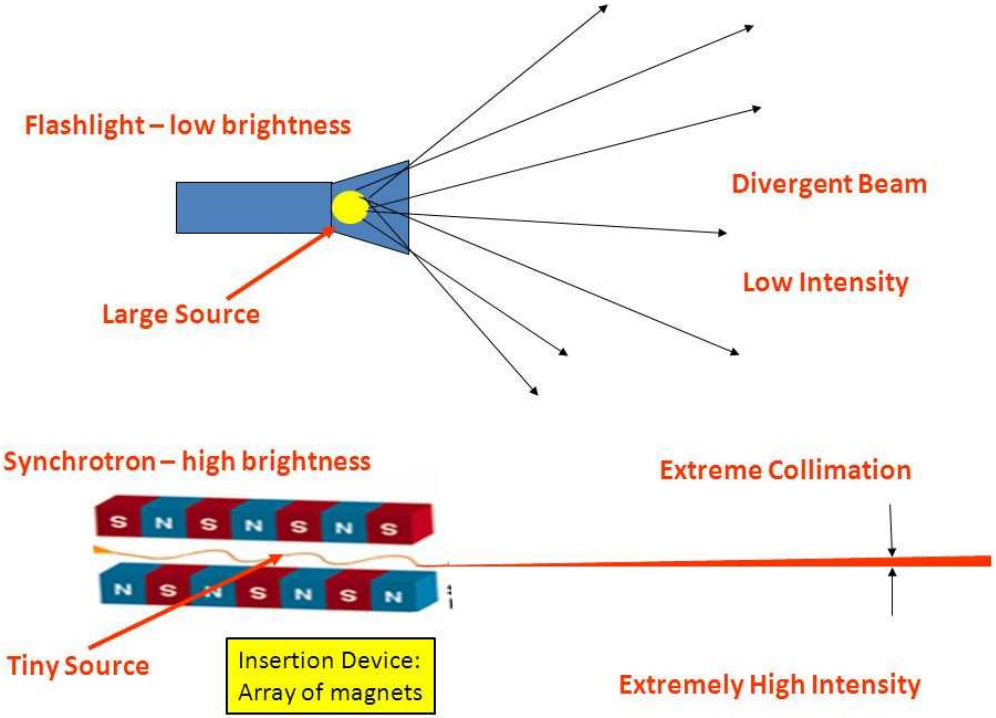
ENERGY & CATALYSIS

Analysis of trace elements in fuels & catalysis performance

Why not a home source?.

What makes synchrotrons special.

and home sources can not achieve.



- **Flux**
- **Collimation**
- **Absorption**

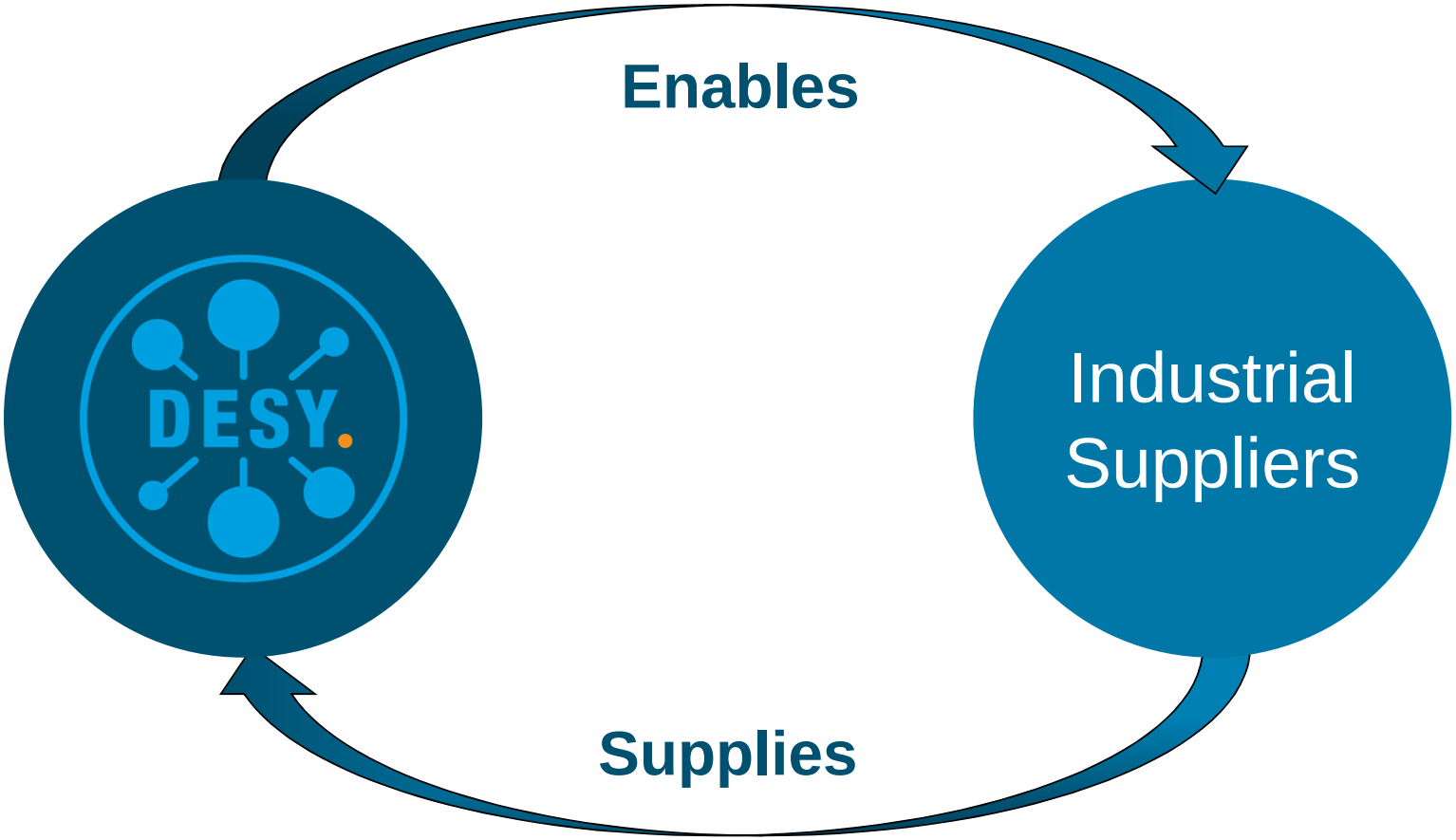
Synchrotron radiation is time-cost effective.

Outsourcing of R&D

Home source	Synchrotron facilities
• Which instrument fit my needs? • Market prospection	✓ 19 state-of-the art stations available ✓ Scientific consultancy services
• Purchase and maintenance • Upgrading & Deprecation costs	✓ Upgrading & New Construction ✓ Hundreds of million investment
• From minutes to hours	✓ From seconds to few minutes

Synchrotron radiation is a non-destructive method

Enabling Innovation together with the Industry



DESY Spin-offs as Suppliers

4 Start-ups – 4 new Suppliers

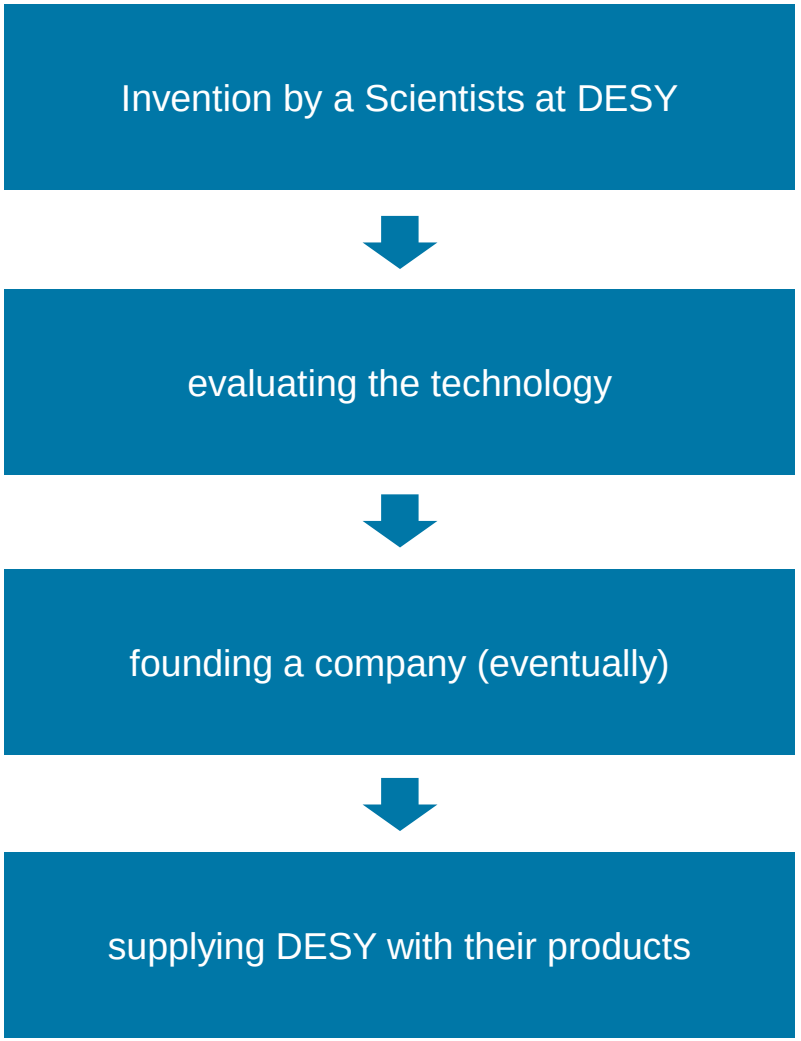
- ideas developed by DESY or with DESY scientist can lead to new companies
- the products then produced by these companies often are needed by DESY
- new supplies come up, but not only for DESY, but also for other institutes
- all of our four spin-offs now supply DESY (and many others) with their products

CLASS 5 Photonics

SUNA PRECISION

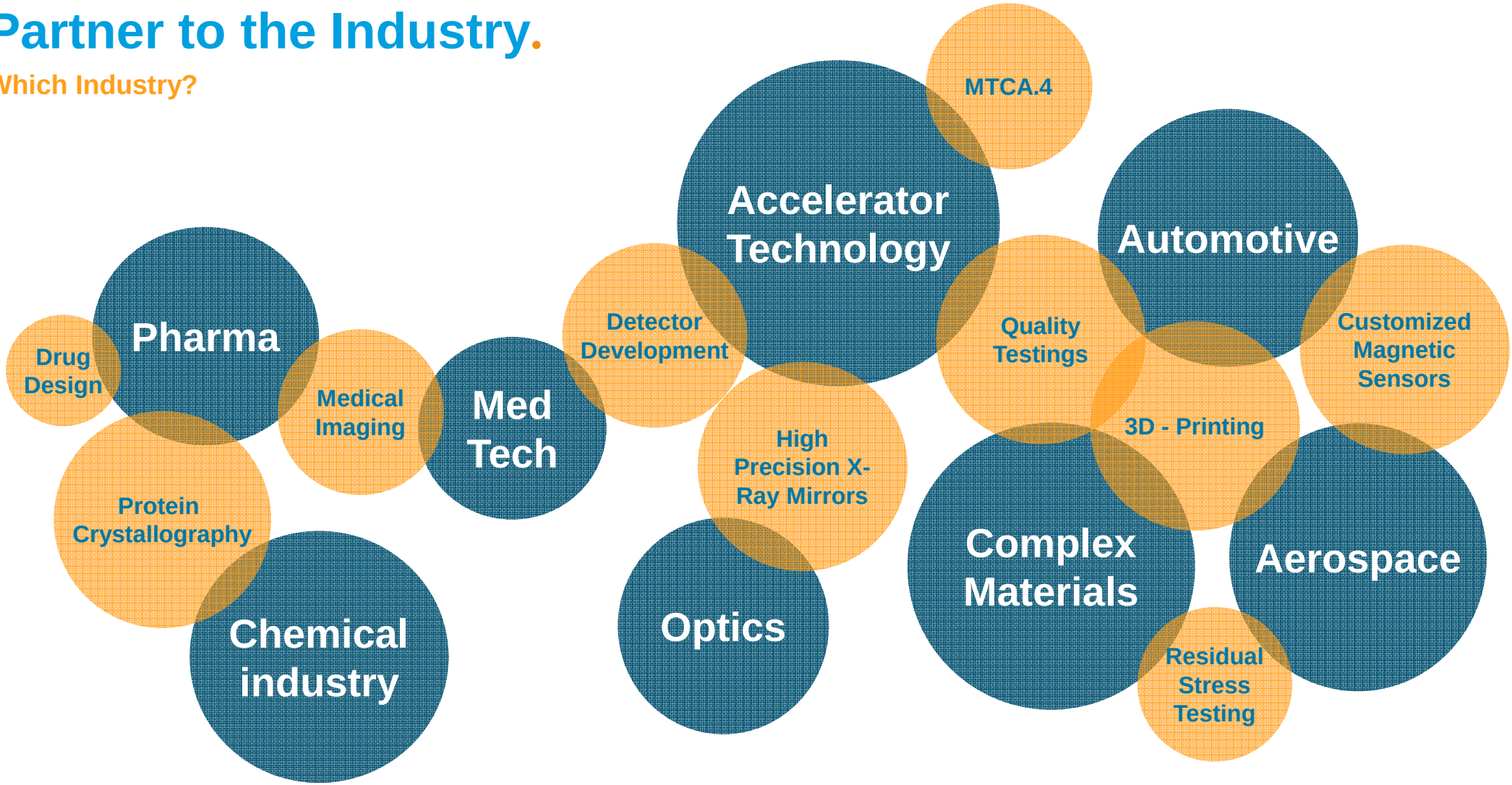
Spectrum

Cycle



Partner to the Industry.

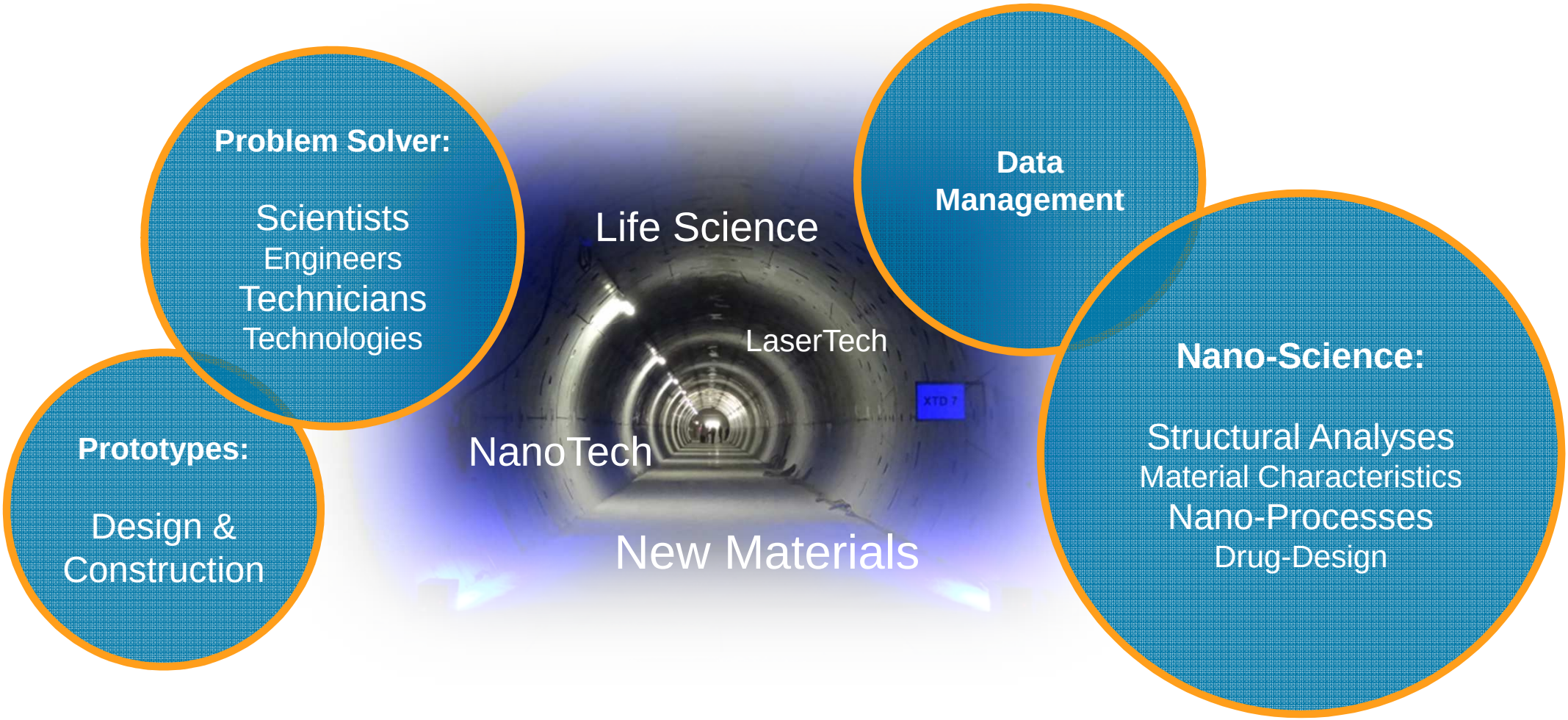
Which Industry?



Partner to the Industry.

Two Access Modes

Perfect Ecosystem for Enterprises.



Cooperation with industry: Magneto Sensors

General Application

Read head in hard disc drivers

Angle sensors for automotive application (motors control / ABS units)

Elec. resistance sensors

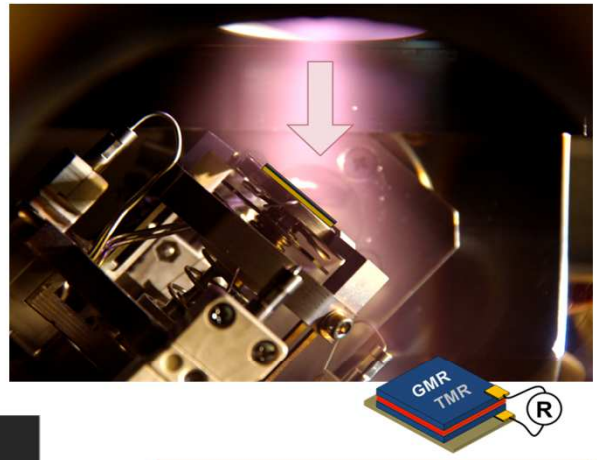
Sensors for micro-position detection and control

3D Magnetometer

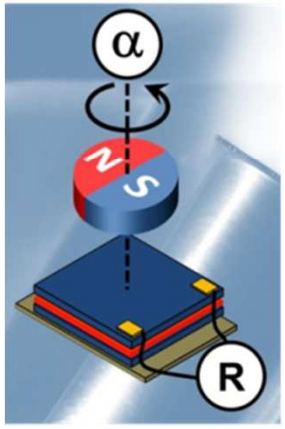
→ **Different measurement possibilities like angle, length, position, speed, magneitc field, current, …**

The Technology.

Thin film deposition in oblique incidence (OID)



Tailoring of angle sensors



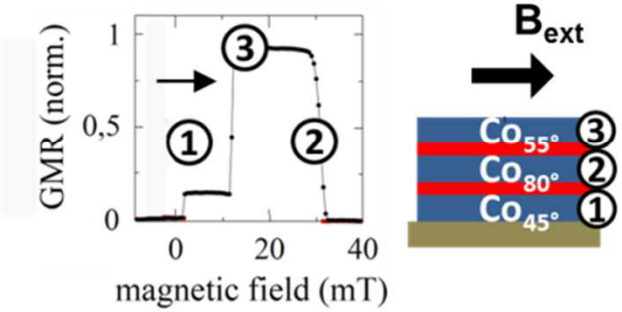
Co/Cu/Co

sinusoidal output signal

periodic peak- or plateau-like output signal

detects rotation sense and frequency

Tailoring of axial sensors



adjustable step-like, sequential output signal

Various new output characteristics obtainable with identical thin-film sequence.

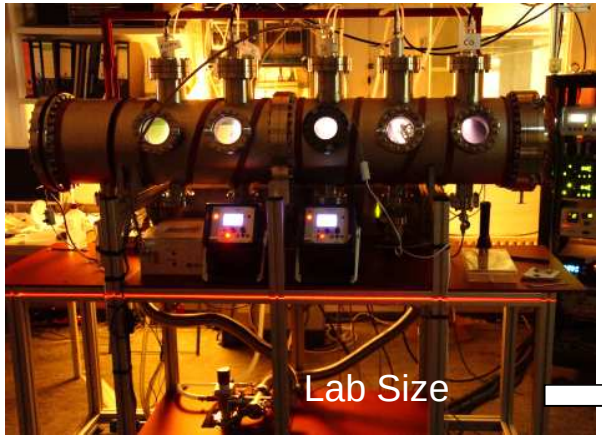
Sensor properties can be precisely tailored to the needs of their application.

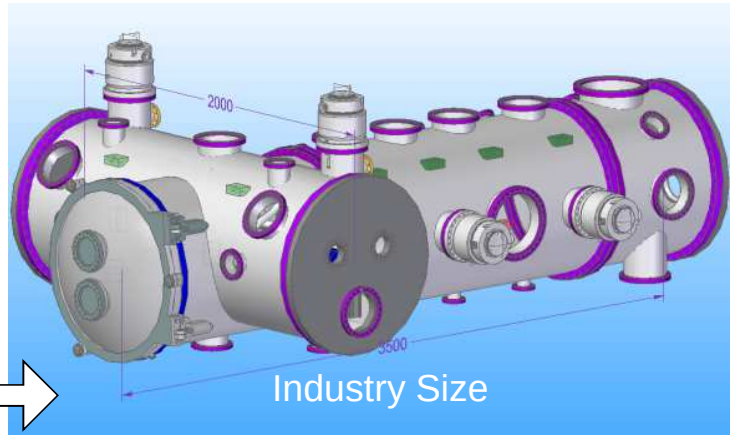
EP 2846334,
US 14/475,800
JP 2016-536799 A

Validation for industrial production

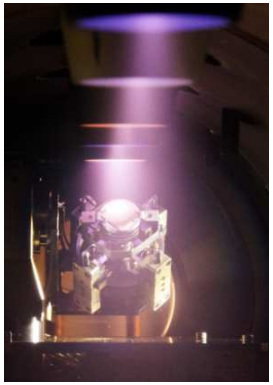
HVF-project

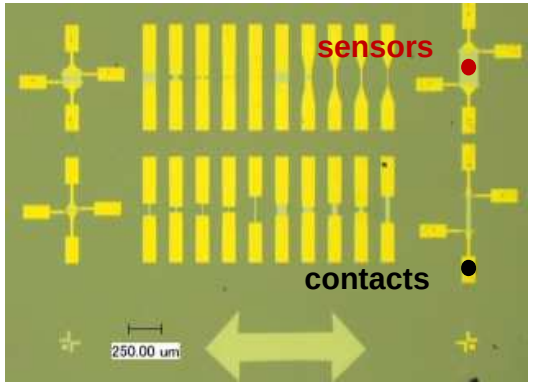
- Helmholtz Validation Project funded by the Helmholtz Association (HVF-0059)
- Budget 1,8 Mio. EUR, 02/2017 – 07/2019
- OID tuning of GMR and TMR sensors
- Validation of 200 mm wafer deposition
- Micro structuring and stress tests
- Integration into ASIC

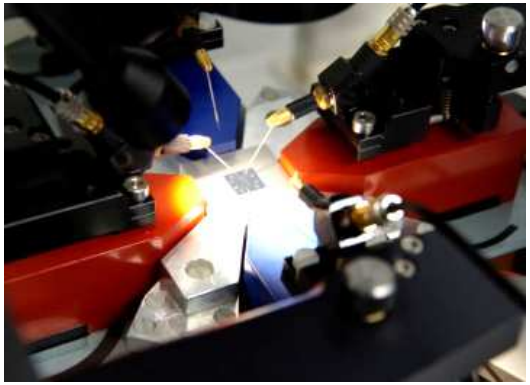




- Goal: Within 2 years - building of an industrial-size UHV deposition test chamber and fabrication of OID-based superior (speed) sensors for automotive applications on 200 mm wafers.







The NanoLab.

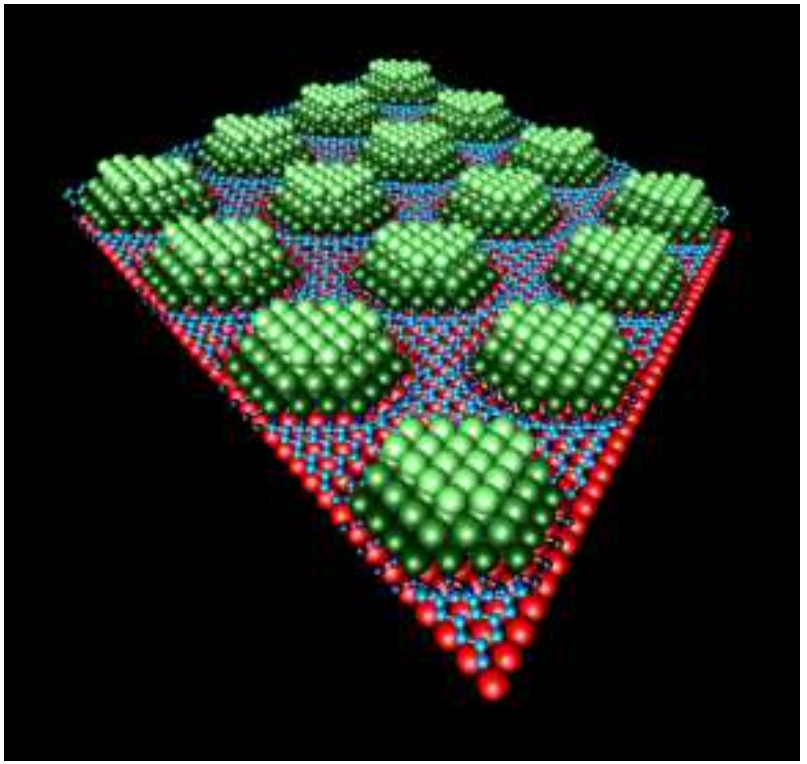
Access and Usage

Open for industrial users

Implementation of

- nano characterization techniques
  (atomic scale structure and chemistry)
- nano structuring techniques
- nano synthesis techniques

- Development of well defined sample transfer protocols between NanoLab and beamlines (nano-PS)



Techniques.

Spectroscopy & Growth (H. Noei)

- UHV sample preparation chamber with LEED / AES
- XPS, FT-IR

X-ray diffraction (V. Vonk)

- Reflectometer
- Six circle diffractometer

Microscopy & Structuring (T. Keller)

- AFM, STM, optical
- SEM + FIB + Lithography (CHyN)

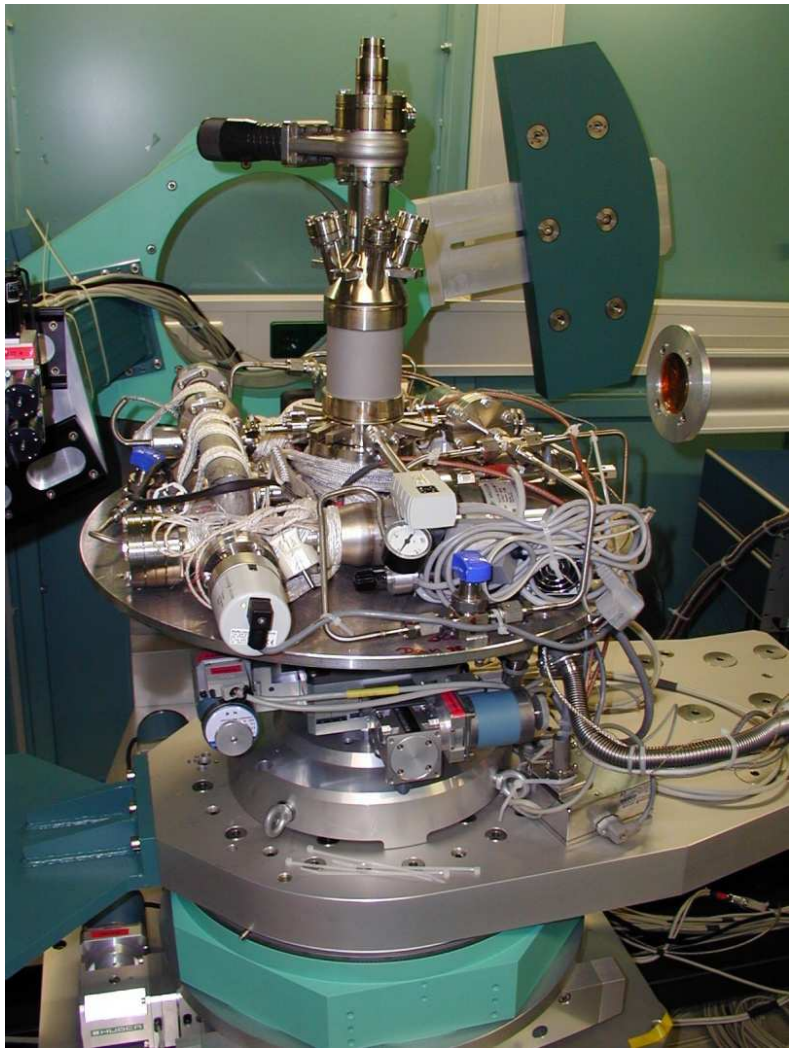
Magnetic Characterization (R. Röhlsberger)

- Physical properties measurement system
- Kerr Microscope

Use Cases from the NanoLab

Operando Studies at the Atomic Scale

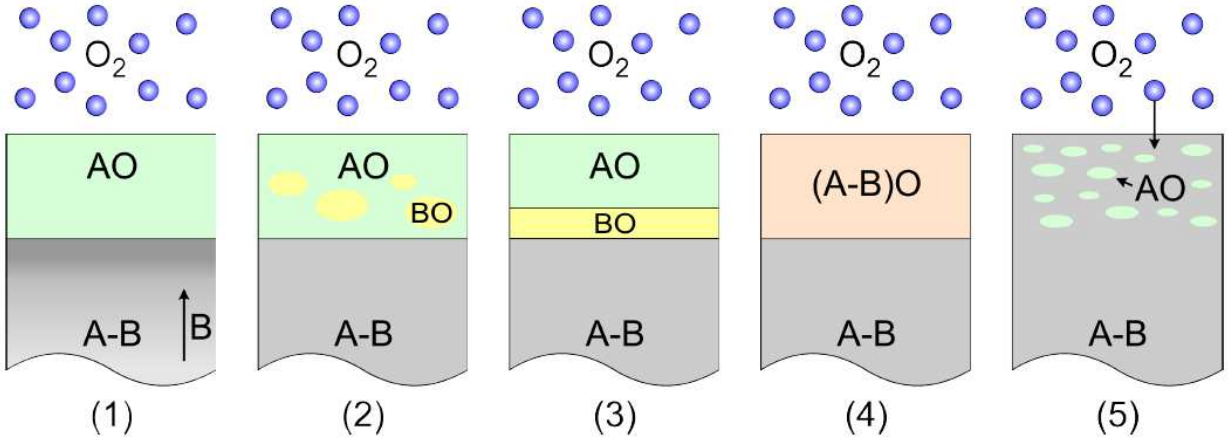
„You follow the oxidation process at the surface“



- UHV, Gas pressures > 1bar, RT- 800° C
- Catalytic flow conditions, operando studies

Use Cases from the NanoLab

Oxidation of Alloys (Scenarios)

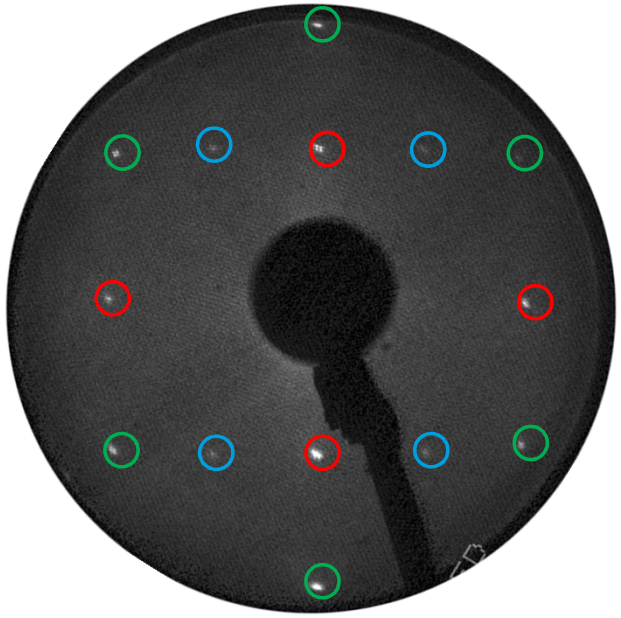


Questions of interest:

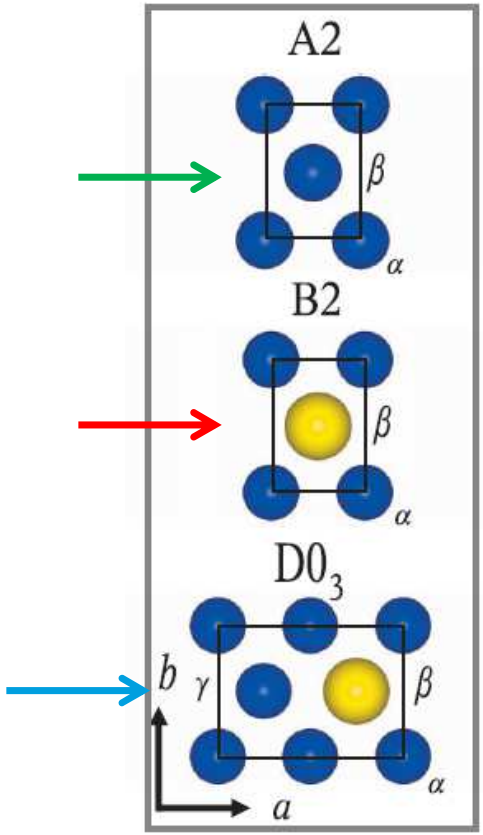
- detailed atomic structure and chemical composition of oxide layer
- transport processes (segregation), rate limiting steps
- interfacial structure / epitaxy
- kinetic behavior (T, p(O2))

Use Cases from the NanoLab

Oxidation of Alloys (Scenarios)

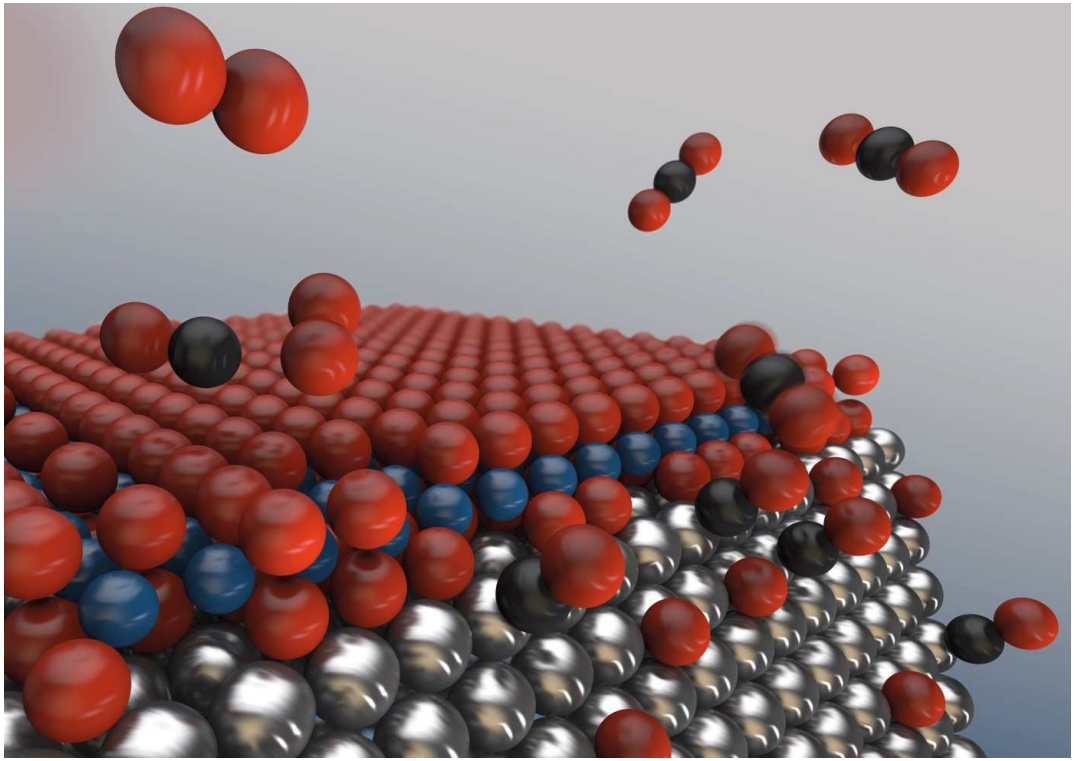


LEED pattern at 78 eV (300 K)



Use Cases from the NanoLab

Edges and corners increase efficiency of catalytic converters



- Platinum-rhodium nanoparticles
- Insitu/in operando measurements (working conditions automotive)
- Different gasous conditions
- PETRA III on P09 (Resonant Scattering and Diffraction beamline)
- Higher effectivity at edges
- Catalytic converters increase efficiency

Reference:
Identification of a catalytically highly active surface phase for CO oxidation over PtRh nanoparticles under operando reaction conditions; U. Hejral, D. Franz, S. Volkov, S. Francoual, J. Strempfer, and A. Stierle; *Physical Review Letters*, 2018; DOI: 10.1103/PhysRevLett.120.126101

See you in Hamburg.
Thank you for your attention.

Accelerators | Photon Science | Particle Physics

Deutsches Elektronen-Synchrotron
A Research Center of the Helmholtz-Association

Dr. Sabine Jaehmlich
Industry Relations Manager