Leibniz Universität Hannover

PhoenixD

Photonics · Optics · Engineering
Innovation Across Disciplines

Forschungsdatenmanagement im Exzellenzcluster PhoenixD

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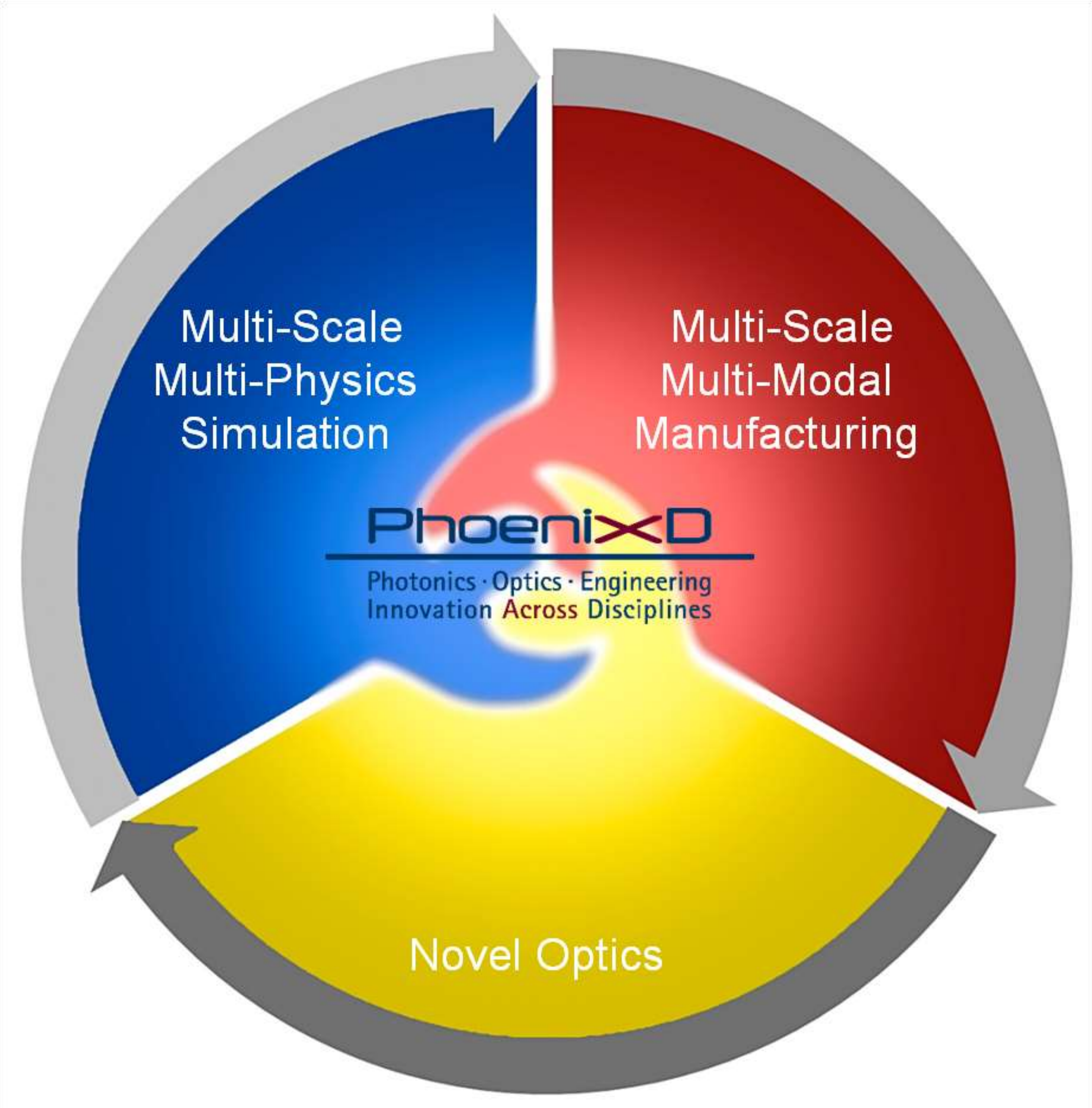
Uwe Morgner

Cluster of Excellence PhoenixD - The Vision



Across disciplines

Engineering Science

Physics

Chemistry

Computer Science

PhoenixD

Photonics · Optics · Engineering
Innovation Across Disciplines

Simulation

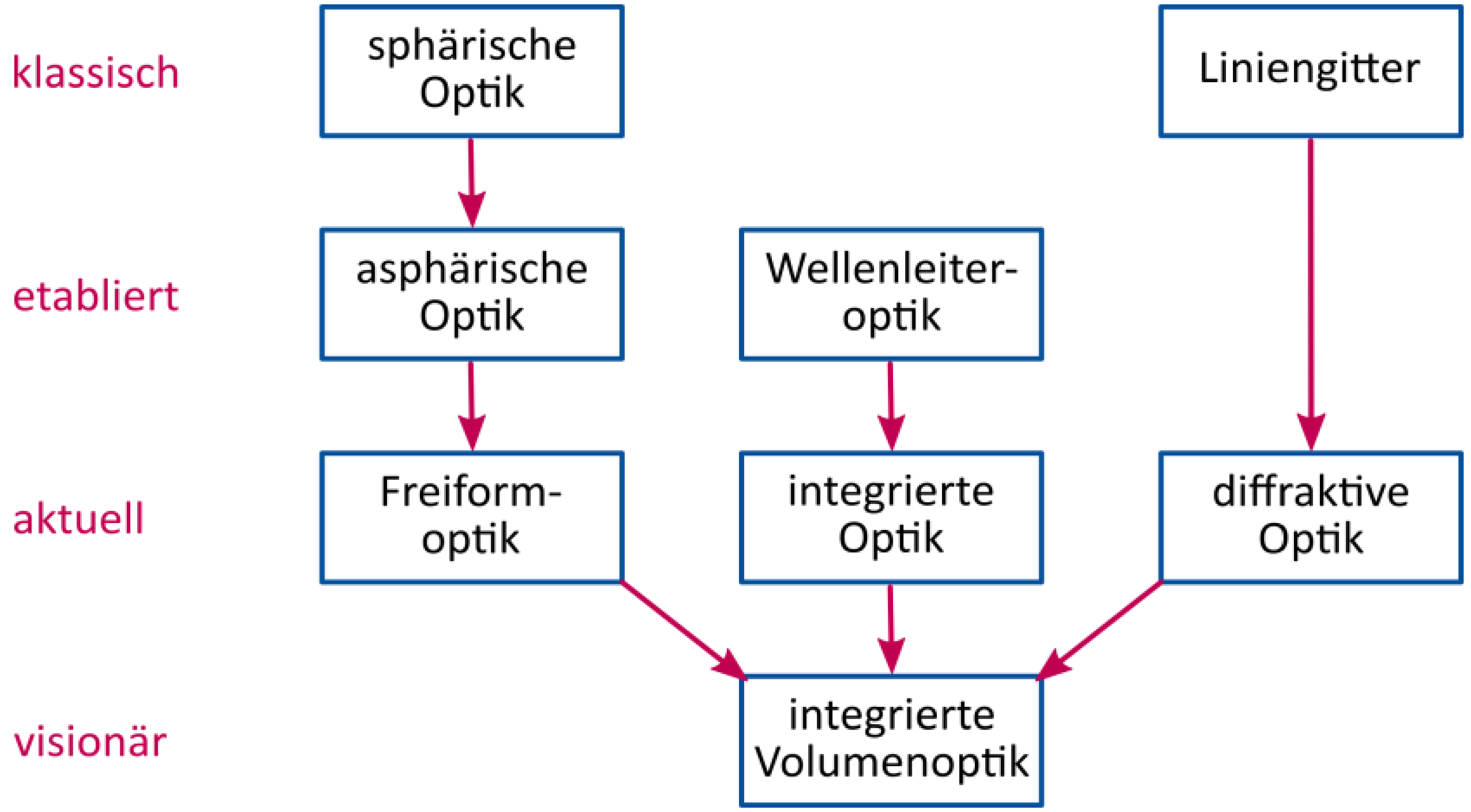
Metrology

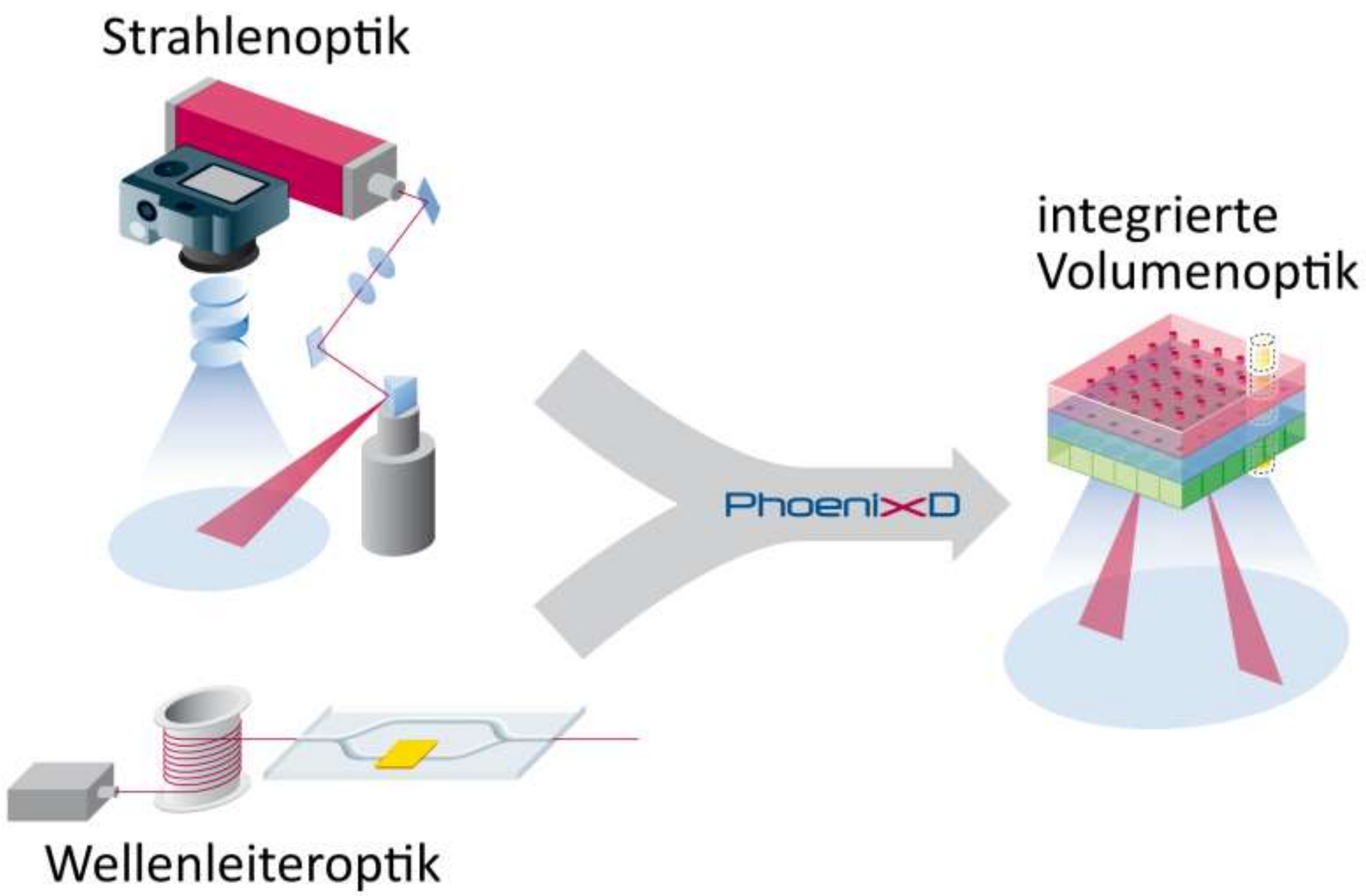
Manufacturing

Materials

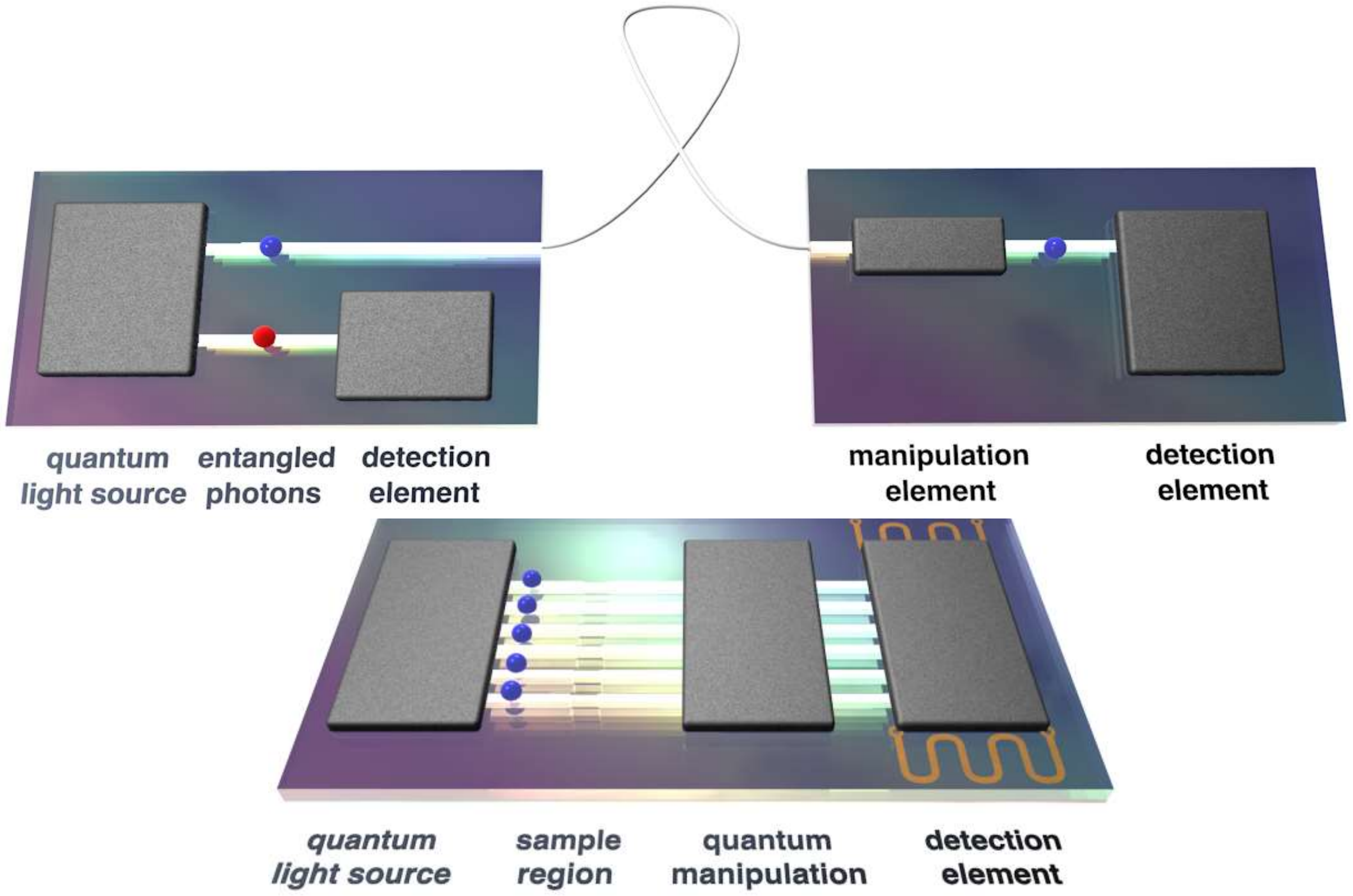
Novel Optics: Digital, integrated, individual, adaptive

Historical Development





Quantum communication / quantum sensor

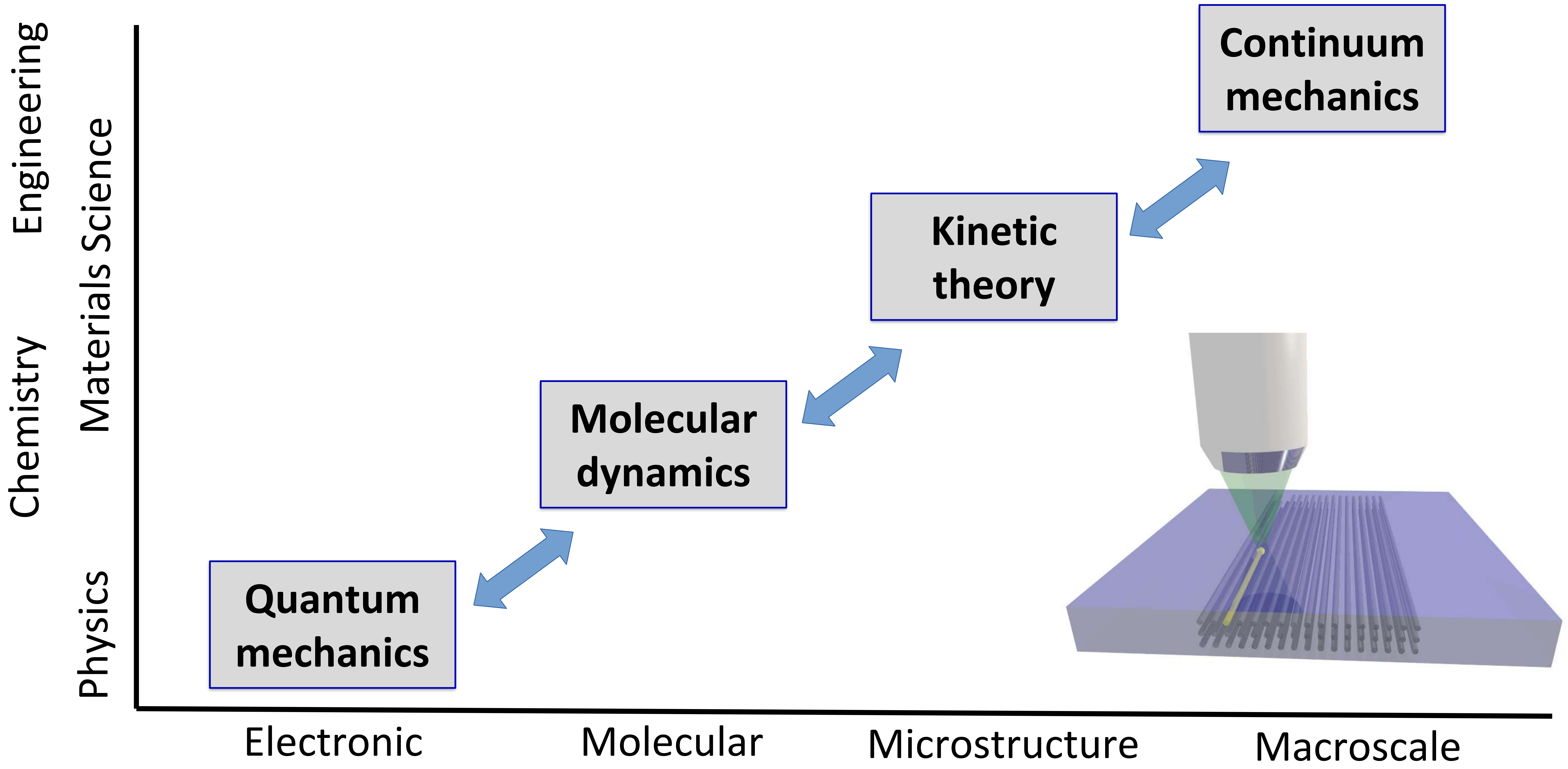


- Design and simulation of integrated optics
- Sensitive, selective and stable materials for light sources and sensors
- Multi-scale manufacturing

The virtual lab - simulation and design

Domain decomposition
Services and orchestration
Discontinuous space-time Galerkin methods
Evolutionary development
RCWA GPGPU
Model reduction
Meshfree method
Forcefield methods
SPH Split Step (FFT)
FDTD Raytracing Beam analysis
Monte Carlo FEM
Mesoscale modeling
Discrete dipole approximation

Multi-scale simulation chain



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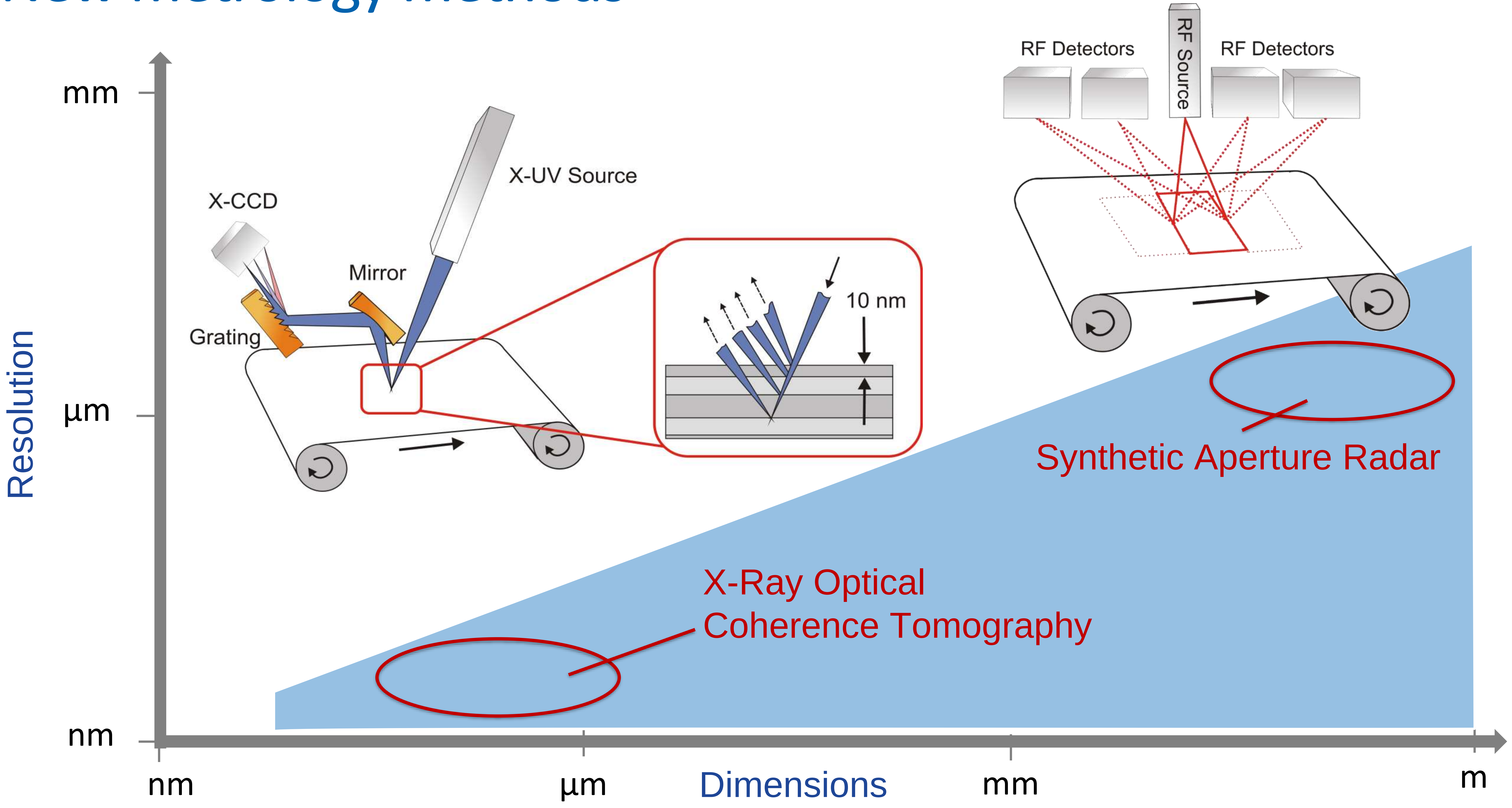
Metrology

Multi-beam OCT
X-ray interferometry
Light microscope SAR XPS AFM
X-ray microtomography
VCSEL near field sensor
Structured light 3D scanner
Micro-computed tomography
SEM X-ray OCT TEM
Laser scanning microscope
Fiber ellipsometer
UV scatterometer
Wavefront sensor

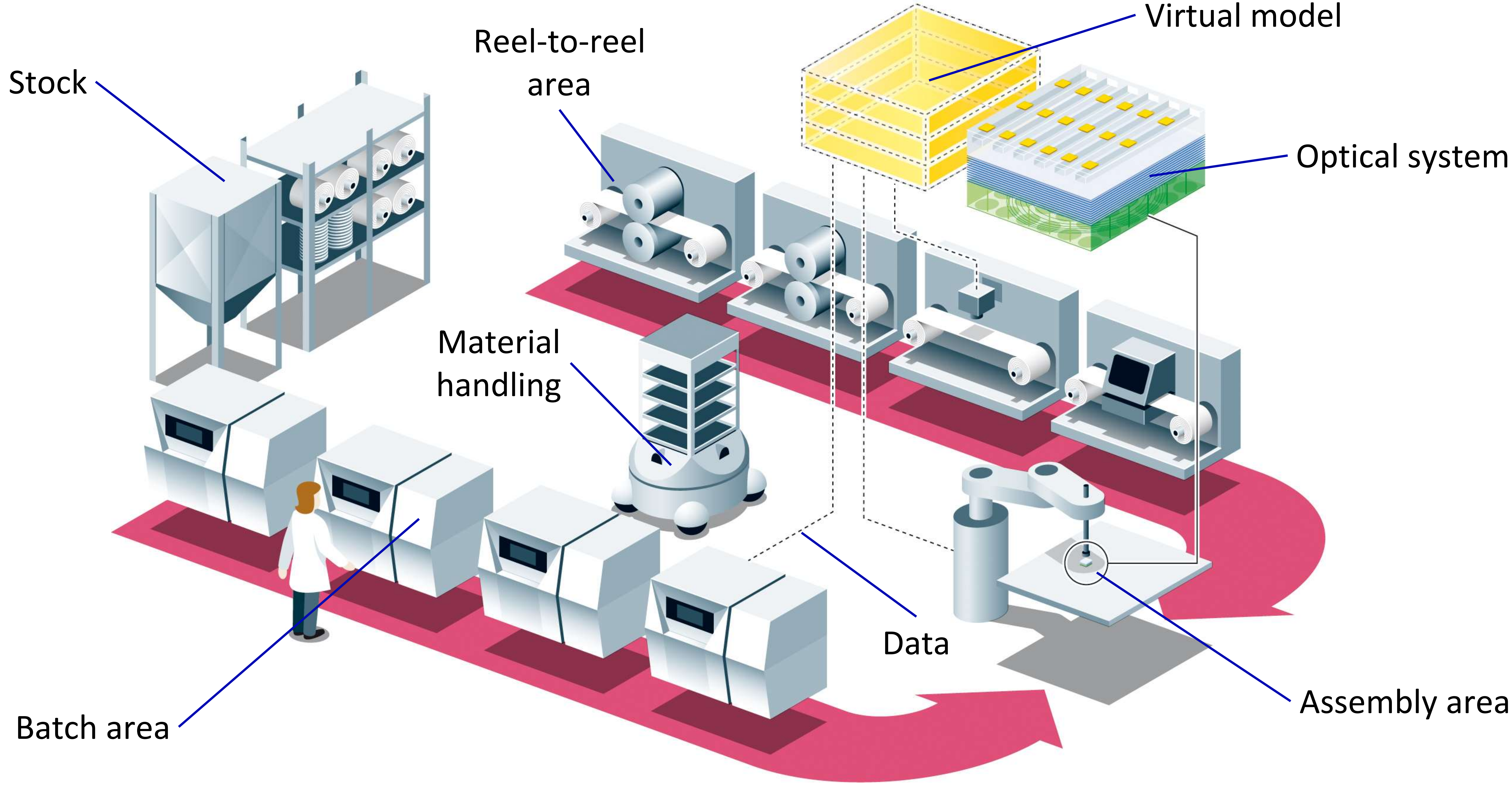
New metrology methods



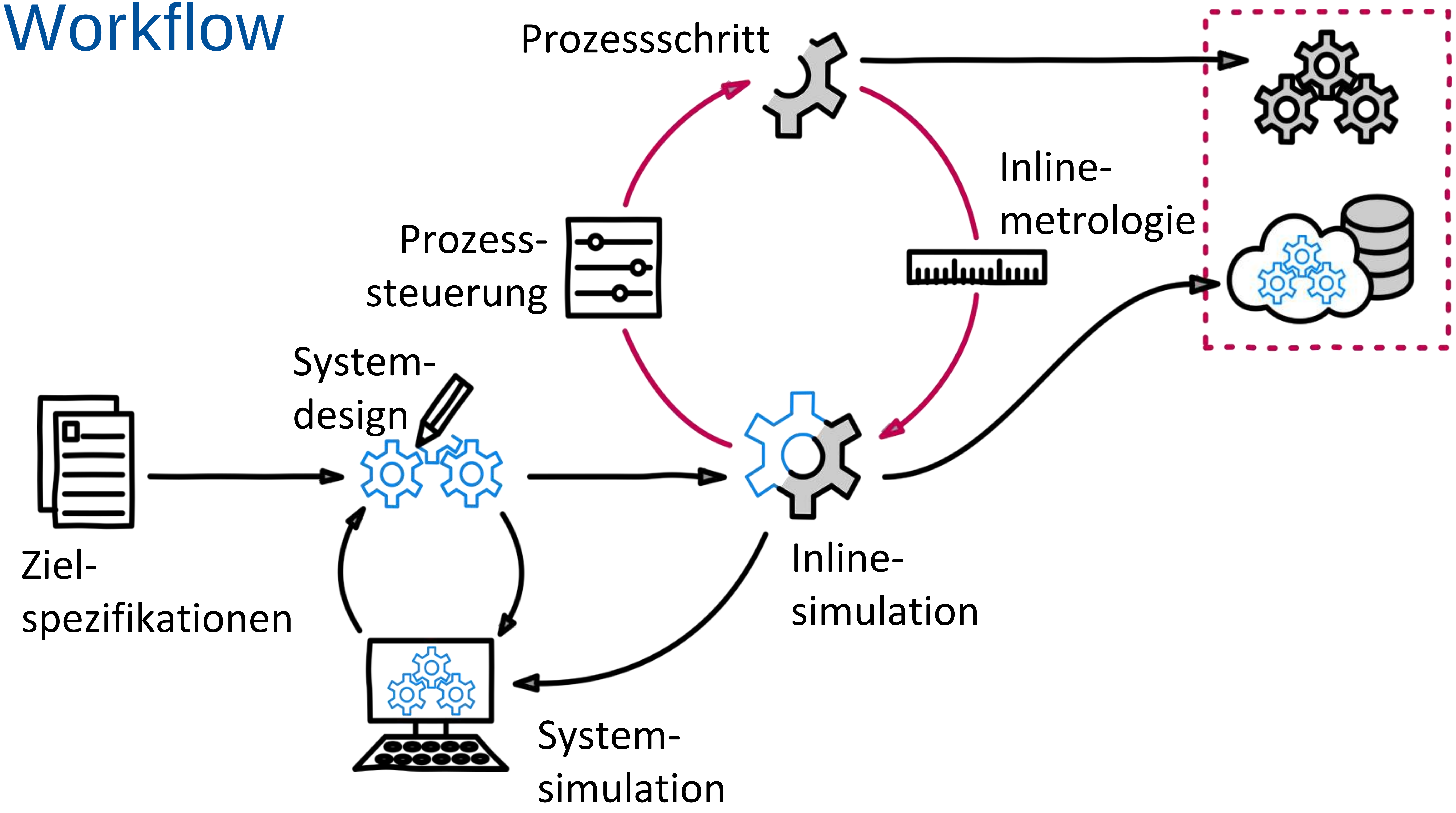
Manufacturing of Optics Components

Substrate handling UV /IR curing
3D μ-Writer Component handling
Aerosol jet printing Material handling
Plasma cleaning 2PP Robot Inkjet printing
LS
AGV Self-assembly E spray
Flexographic printing Slot die coating
Laser induced forward transfer
Femtosecond laser structuring
LGD Vacuum deposition Cutting shee
Bonding LMD SLM Lamination
HMM Pick & Place & Dispenser Fiber reel-to-reel
Lithography Micro embossing
Powder handling Roll-to-roll modules

Manufacturing grid

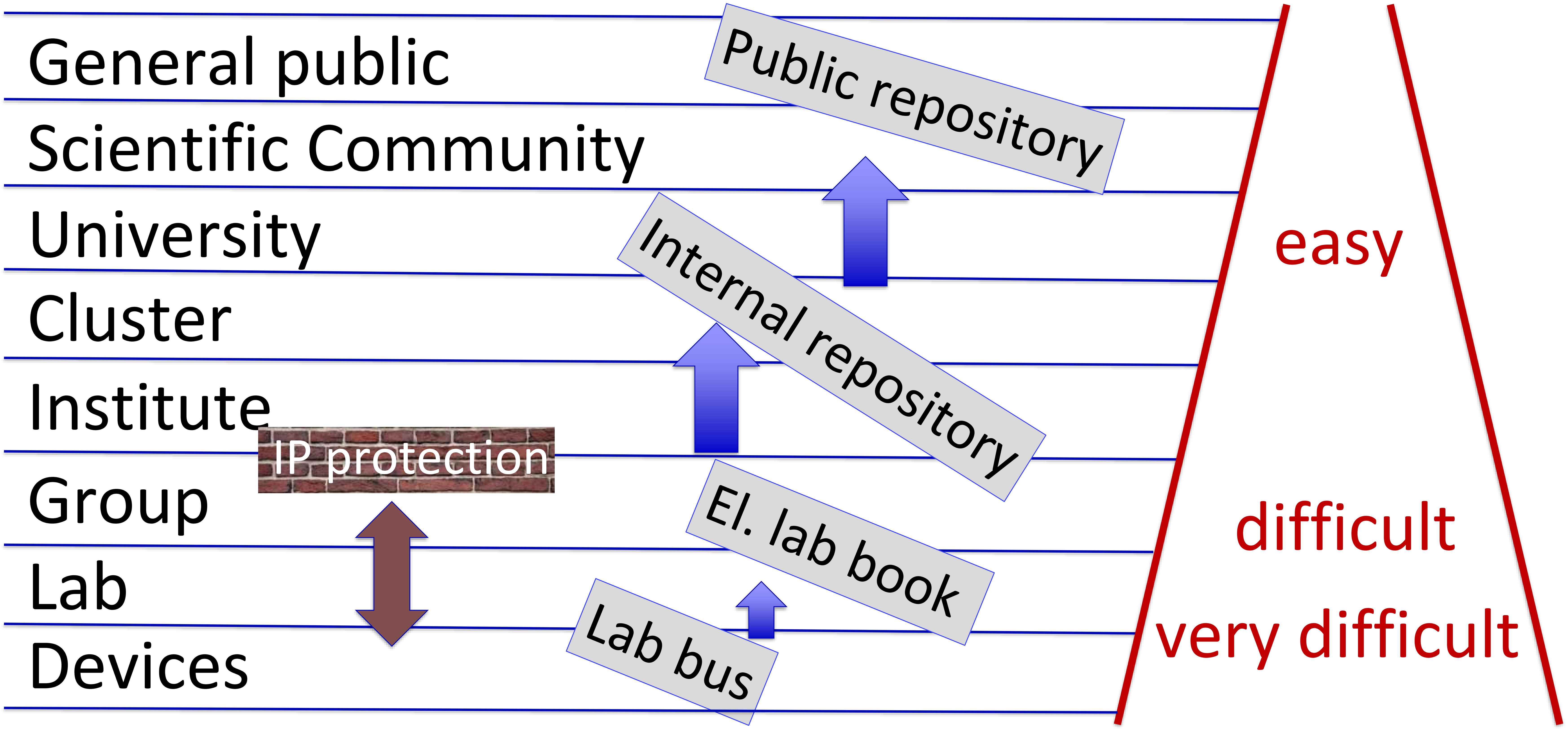


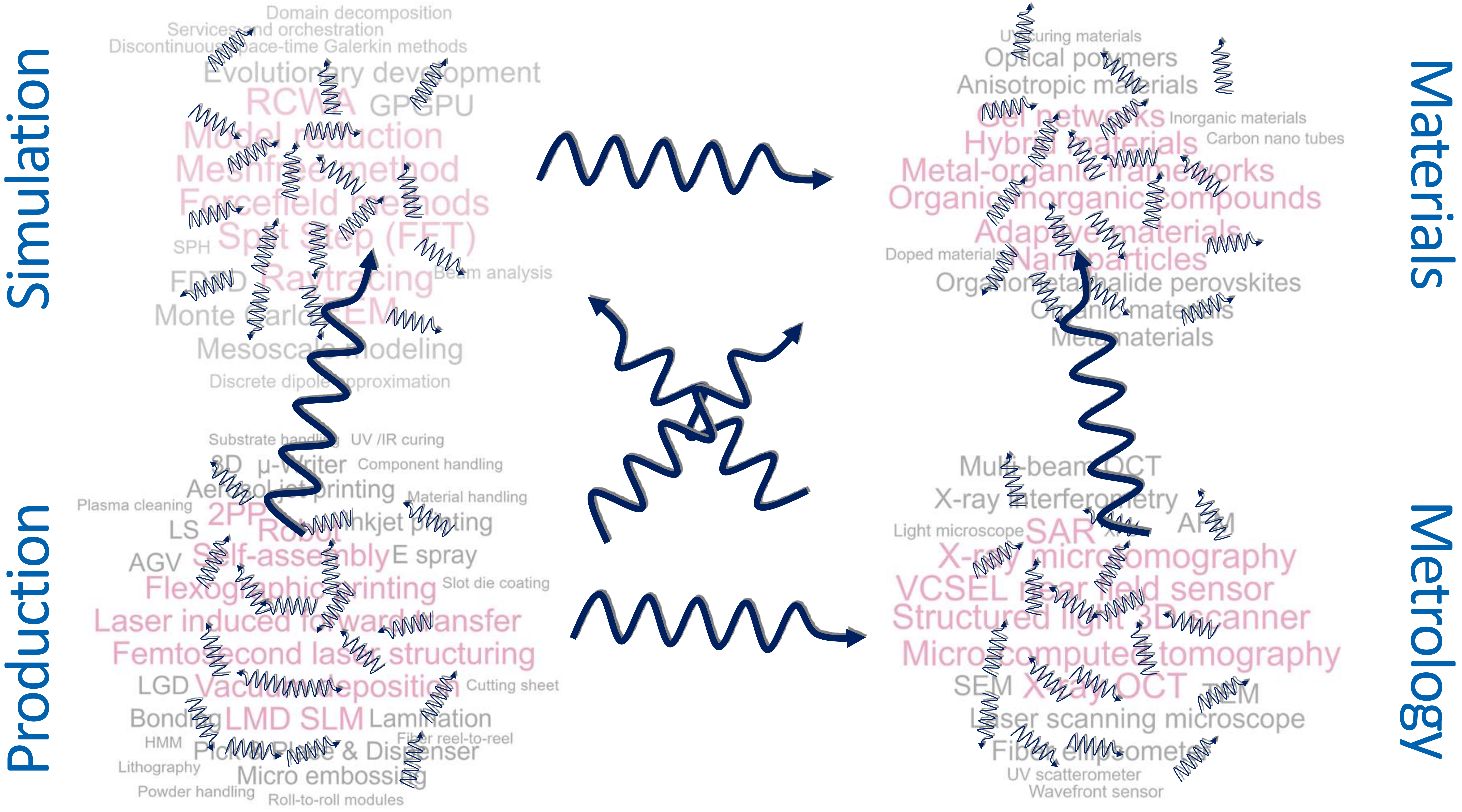
Workflow



Prozessschritt
Inline-
metrologie
Prozess-
steuerung
System-
design
Ziel-
spezifikationen
Inline-
simulation
System-
simulation

Data control

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Discrete dipole approximation
Materials
UV curing materials
Optical polymers
Anisotropic materials
Gel networks
Inorganic materials
Carbon nano tubes
Hybrid materials
Metal-organic frameworks
Organic-inorganic compounds
Adaptive materials
Doped materials
Nanoparticles
Organometal halide perovskites
Organic materials
Metamaterials
Production
Substrate handling
UV /IR curing
3D µ-Writer
Component handling
Aerosol jet printing
Material handling
Plasma cleaning
2PP
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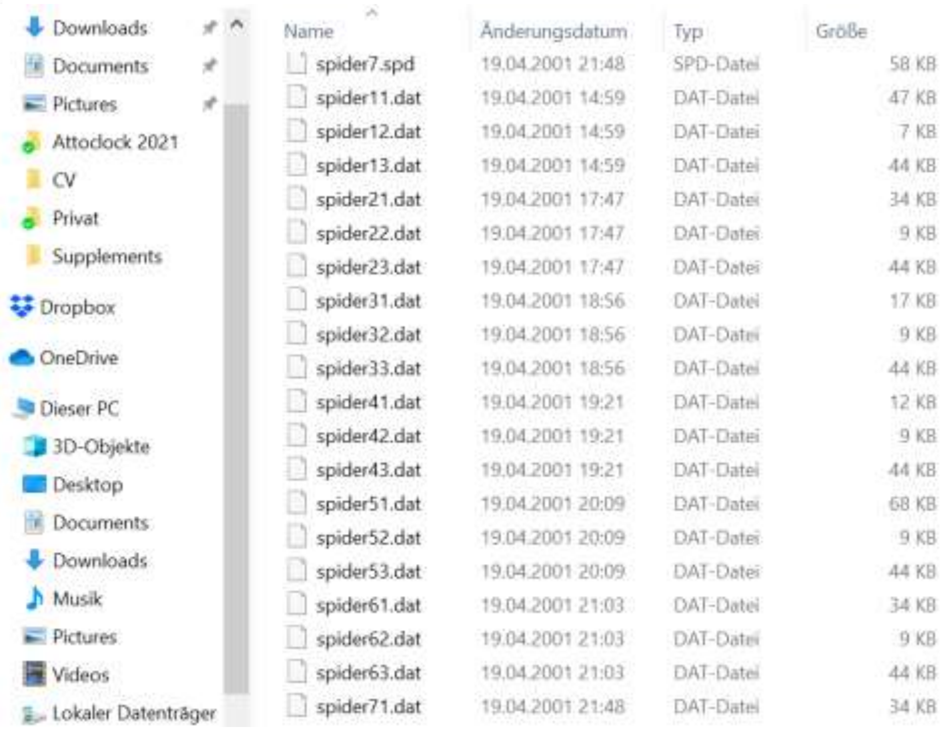
Research data management (RDM) today

Research data management (RDM) today

- Flexible individual components – arranged differently every day
- Many home-built components
- Various measurement devices → Multiple Research Data

Meta data - Lab book



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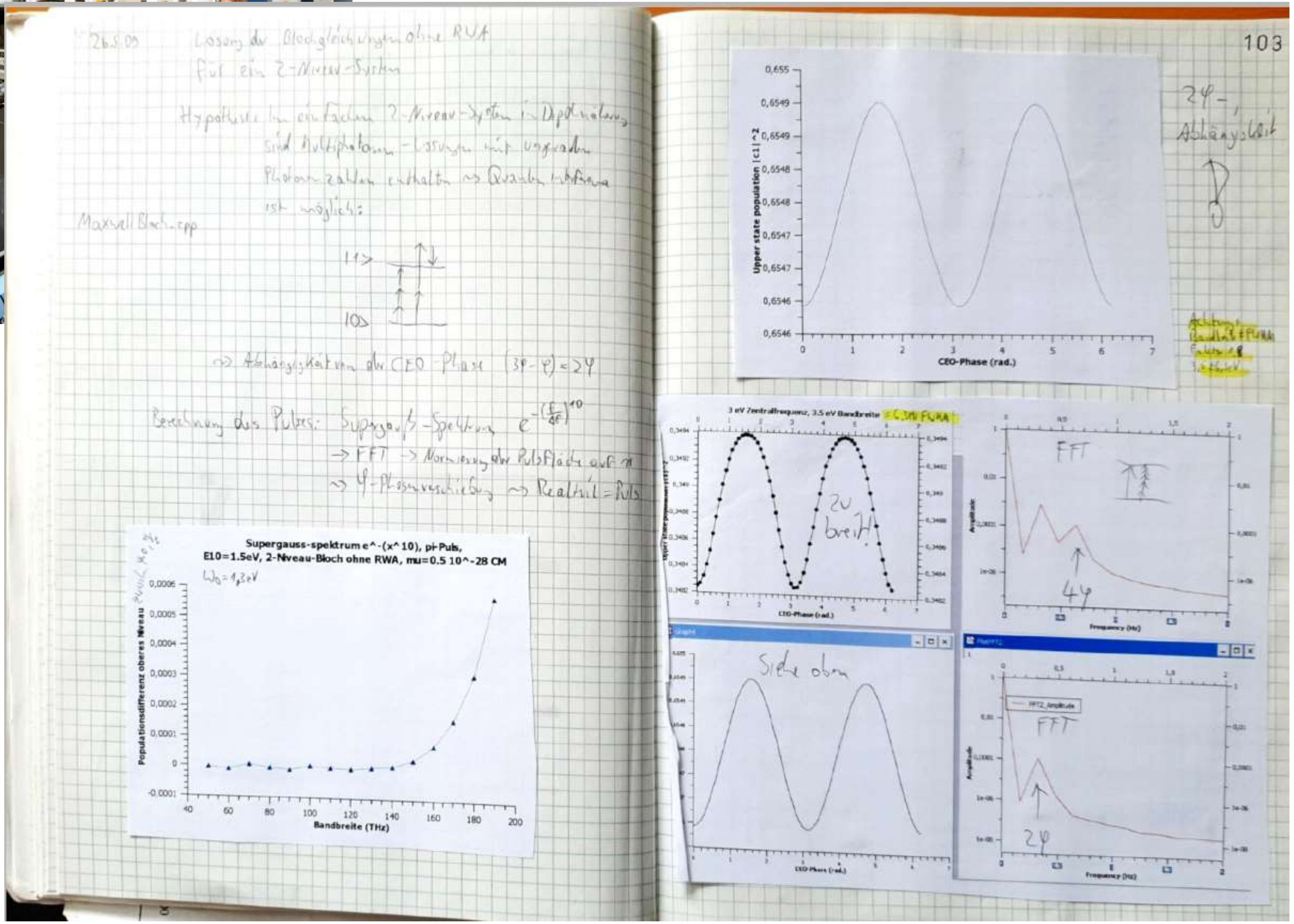

Challenges in Optics Labs

- Babylonian language confusion:
  - Simulation:
    - Commercial software (Zemax, JCMwave, Comsol, Lumerical, etc.)
    - Simulation code (Matlab, Python, LabView, Mathematica, Fortran, C++, etc.)
    - Software libraries
  - Lab:
    - Control software for commercial devices (translation stages, power meters, etc.)
    - Self-written measurement, conversion and post-processing scripts or tools (Matlab, Python, LabView, Mathematica, Fortran, C++, etc.)
  - Proper metadata standards and aquisition

Lab bus / simulation bus

- Unified machine descriptor
- continuous status reports
- Unified sensor output

- Unified multi-scale object descriptor:
  - 4D Geometry
  - 4D Material distribution
  - 4D Index of refraction
  - 4D Charge distribution
  - 4D Temperature distribution
  - 4D Stress distribution
  - …

Lab book

- Visualization tools
- Group sharing
- Hierarchical data protection
- Water-proof time stamp
- Forgery-proof

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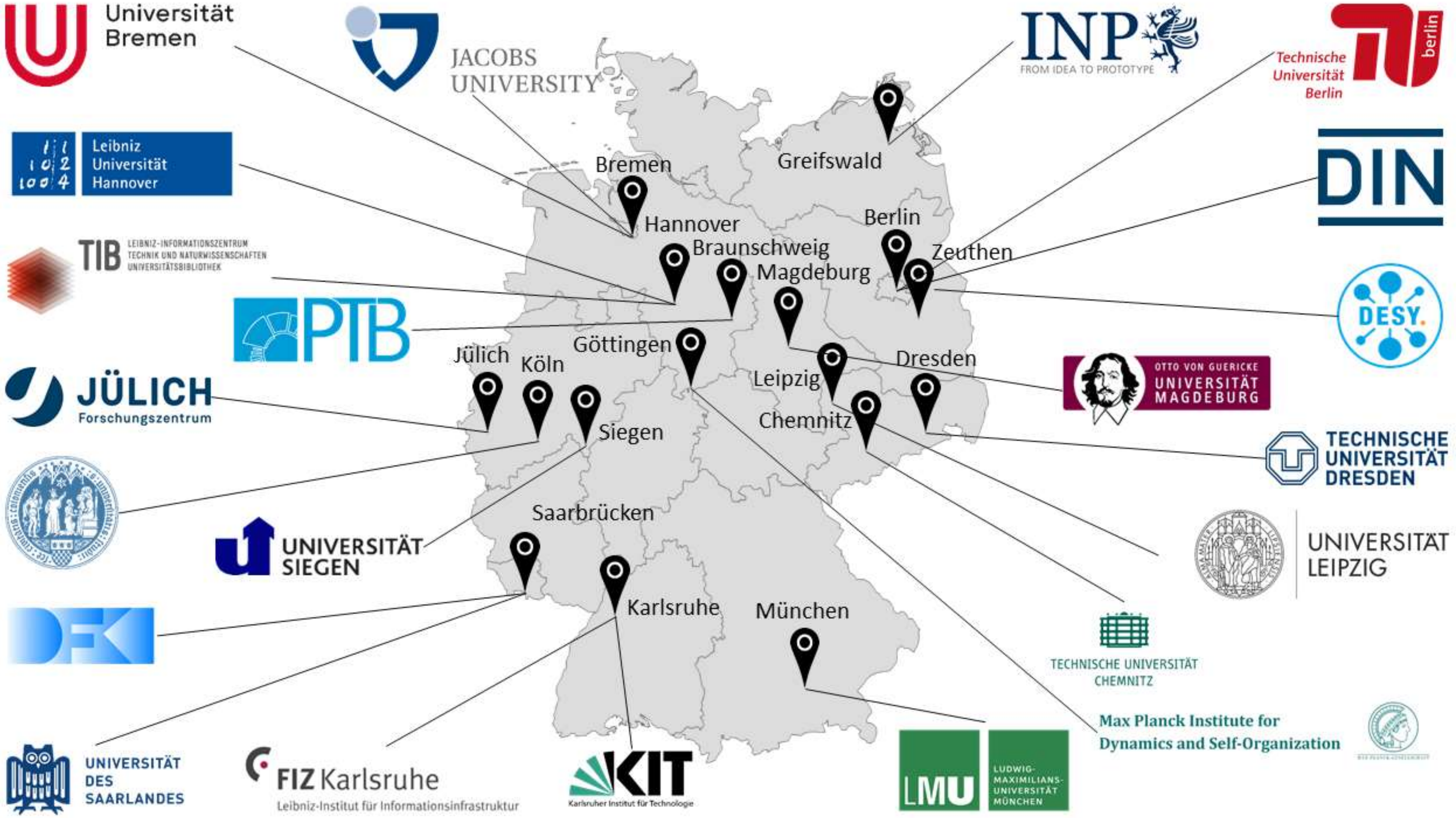
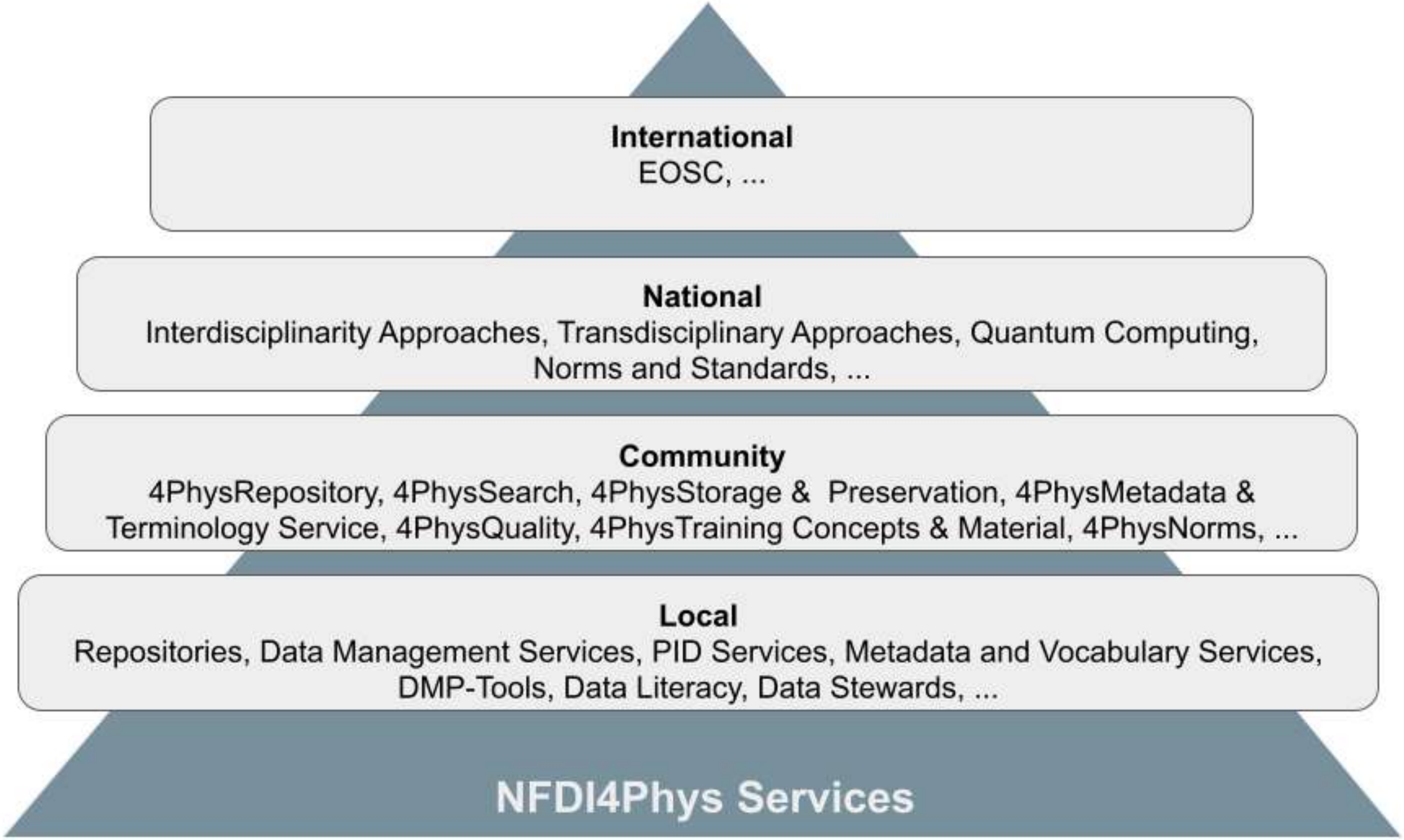
NFDI4Phys 2022



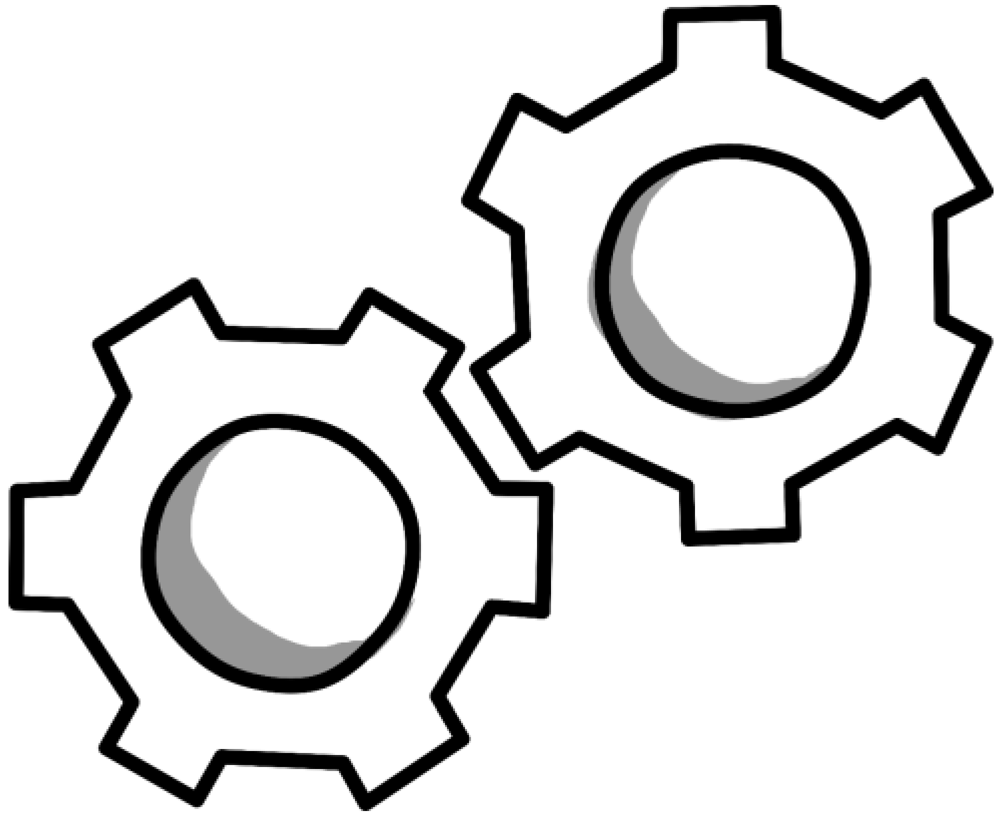
NFDI4Phys 2022



NFDI - Main challenges

- **Leave no one behind** – integrate all different areas of physics into a NFDI
- **Avoid patchwork of solutions** – coordinate different data infrastructures
- **Handle heterogeneity** – with intelligently chosen basic concepts
- **Create acceptance** – include the concerns of the reseachers
- **Facilitate exchange** – learn from each other through different practises
- **Ensure international connectivity** – a national data infrastructure only makes sense when compatible with international infrastructures.
- **Train young researchers** – incorporate data management in curricula

How do we get started in PhoenixD



- Networking: RDM@LUH, NFDI4Ing, (NFDI4Phys)
- Identification of first low-threshold steps (partly FAIR)
- Research data management plans
  - Electronic Lab book
  - Data exchange between researchers
  - Overarching storage of project data
  - Data → repository
- Support standardization activities in NFDI

Does RDM improve research?

- Data security/transparency
- Time saving
  - during data entry,
  - during documentation,
  - during evaluation,
  - during publication,
  - during archiving,
  - during transfer.
- Many new functionalities

Thank you!