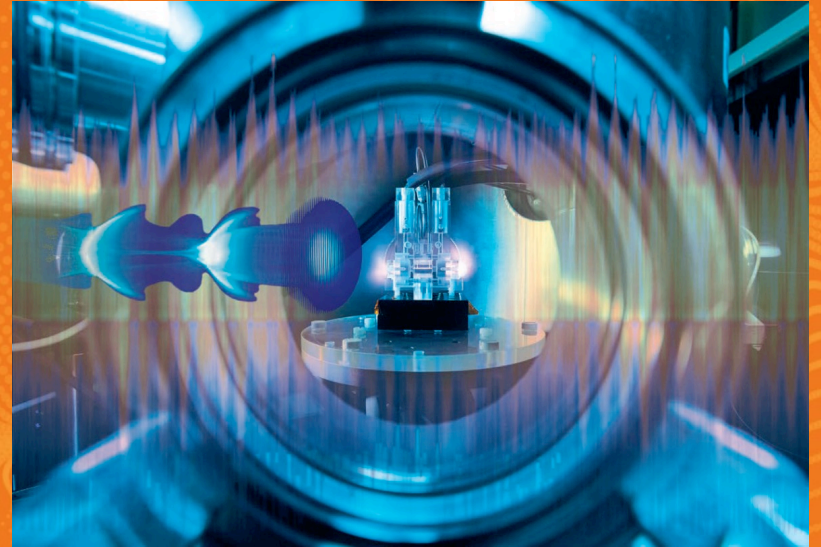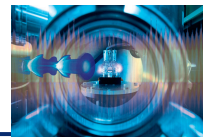# PROGRAM
Matter and Technologies

Research Field Matter


	LK II (User facilities)	International Research Infrastructures	National Research Institutes/ Infrastructures
DESY	FLASH PETRA III IDAF	LHC Belle II CTA (under construction) IceCube European XFEL ESRF	CFEL CSSB NanoLab DESY Test Beams DAF HIB@European XFEL PITZ
FZJ	JCNS (in MLZ)	ESS (under construction) ILL	(FRM-II)
GSI	UNILAC SIS18 ESR	FAIR (under construction) ALICE@LHC	HI Jena HI Mainz
Hereon	GEMS	ESS (under construction)	EMSC
HZB	BESSY II		SupraLab EMIL
HZDR	ELBE HLD IBC	European XFEL EMFL ESRF	HIB@European XFEL DRESDYN
KIT	GridKa	KATRIN Auger IceCube	ATP FLUTE TLK SR Beamlines

- Unique Research Facilities

- Many scientific domains and a diverse user community from university, research institutes and industry

- Digitalisation is important for

  - Efficient and sustainable operation

  - Optimum use of research infrastructures

  - Knowledge extraction from research data

  - Frontier science as a driver of innovation

- Topic DMA established in POF IV

Matter and Technologies
Technologies for Science

ARD DTS
IDAF
MT
DMA
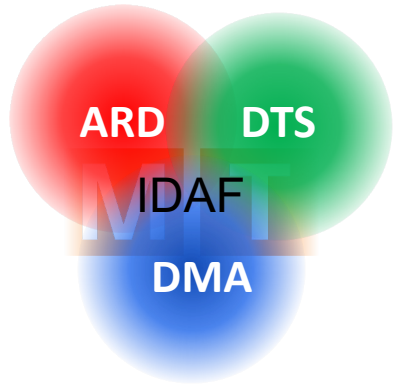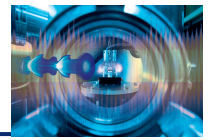
Accelerator science
Detector science
Data analytics

- Research in *Matter* is bold and broad

- It relies on people and on advanced technologies

MT is a program for the future of *Matter* closely intertwined with MML and MU

Matter and Technologies

Other areas
Industry

R&D
- Fundamental R&D
- Research in technologies

Growth
- Prototyping
- Designing systems
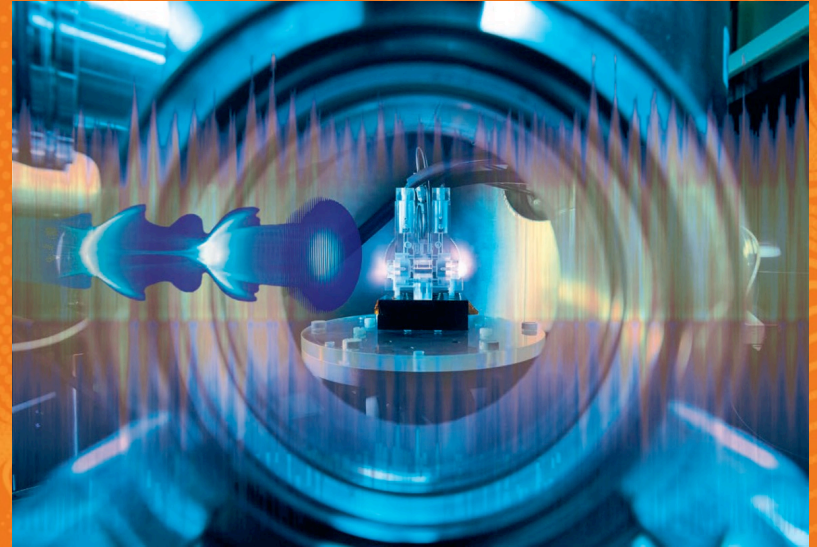- Scalability

Maturity
- Developing facilities
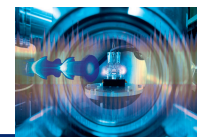- Building infrastructures
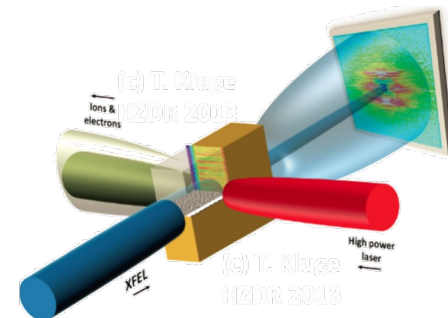- Applications

Decline
- Decommissioning

User communities

Data Management and Analysis (DMA)

DMA — Mission & Goals

**Boosting science** in Matter through **application-driven**, leading edge research in **Computer and Data Science**
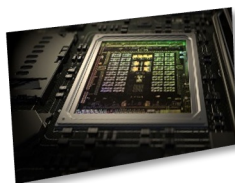
Create a **sophisticated research environment** on **all scales** of research

Develop and apply **new digital methods** and **disruptive technologies** to push science **to the limits**

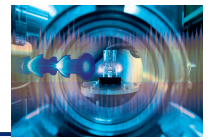**Digital scientific workflows** for **experiments** and **machines** to maximize scientific gain
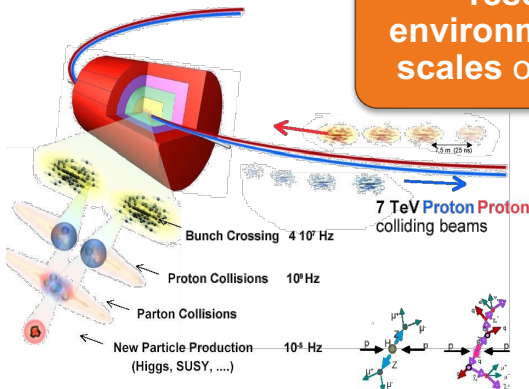
Selection of 1 event in 10,000,000,000,000
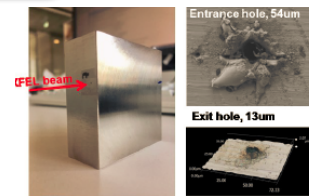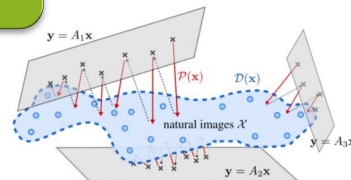
ST1 ─ The Matter Information Fabric

- Exascale Data Management
- F.A.I.R. Data & Meta Data
- Long-term preservation

ST2 ─ The Digital Scientific Method

- Artificial Intelligence
- Exascale Computing
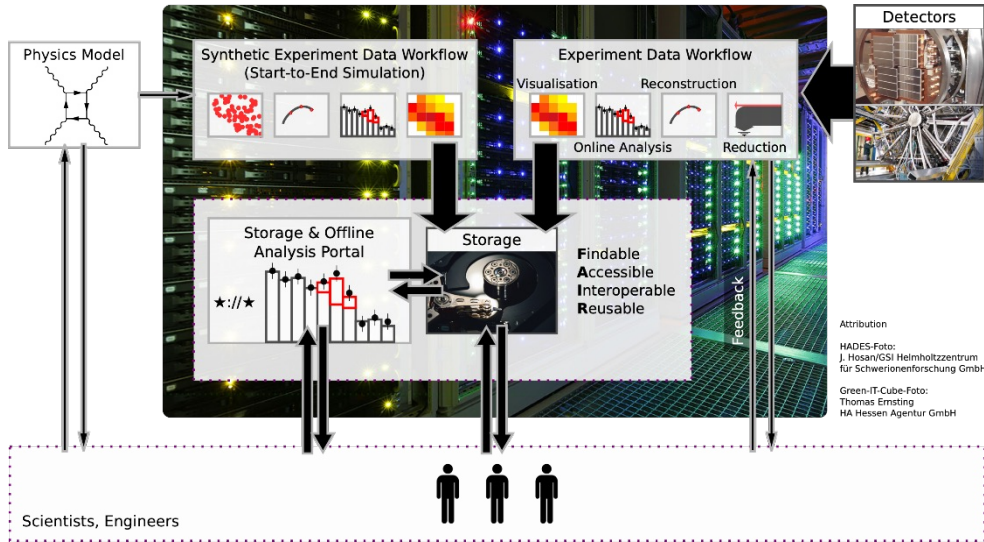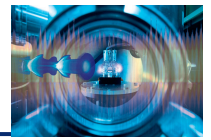- Near-realtime analysis
- Quantum Computing

ST3 ─ The Digital Experiment and Machine

- Exascale Simulations
- In-situ Data Analytics
- Near-realtime feedback
- Machine optimization

regular exchange & common projects

Focus — ST 1 / The Matter Information Fabric

Design & implement **high performance hard- & software infrastructures** for the scientific data lifecycle and machine operation for facilities in Matter

- **Exascale** data ingest, transport, compression, reduction & analysis
- **Meta Data** & **F.A.I.R.** principles
- **Long term** archiving & preservation
- **Portable & modular** solutions

2022: Define needs of the communities → 2024: Design infrastructure prototype → 2027: Review prototype implemented
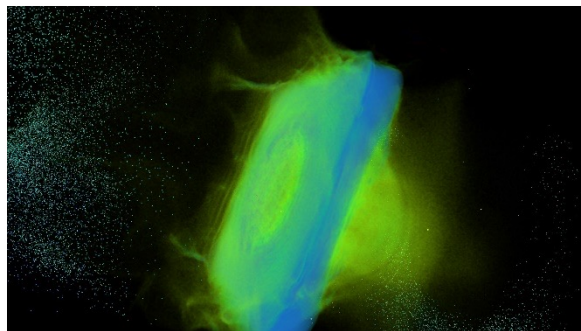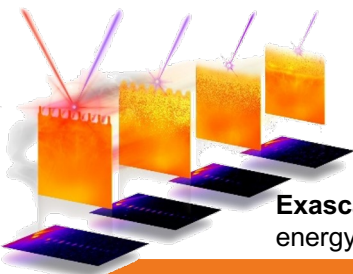
Focus — ST 2 / The Digital Scientific Method

Near real-time **segmentation** of bone implant data by **AI**
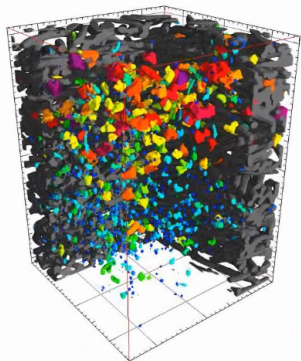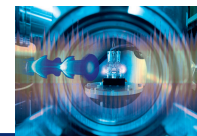
Near real-time **segmentation** of battery electrode data by **AI**

Exascale simulations of high energy density plasmas

Exascale simulations of laser-driven ion acceleration

Develop, apply and share **cutting edge digital methods and frontier technologies** for research in Matter.
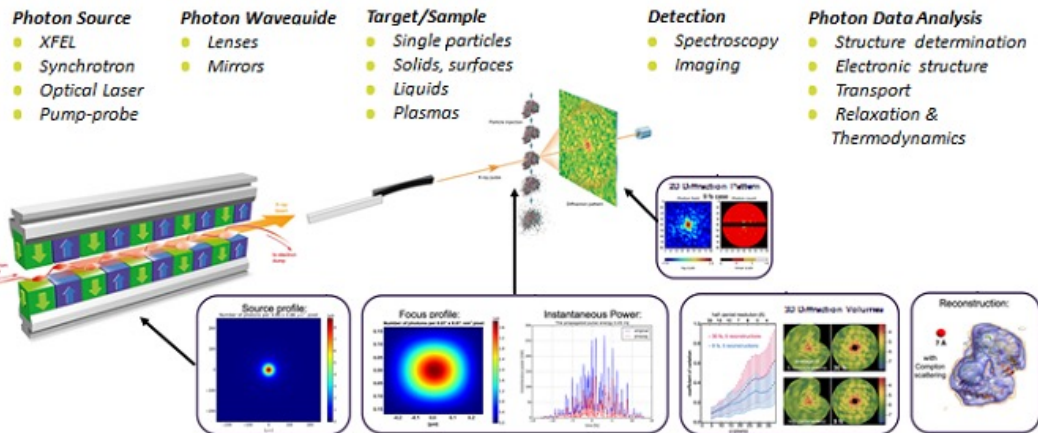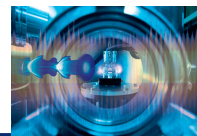
- Artificial Intelligence
- Exascale Computing
- High Throughput Computing
- Quantum Computing
- Near real-time analysis

2023: DMA Open Solutions Toolbox ▶ 2025: Near real-time capabilities ▶ 2027: Surrogate modelling

Focus — ST 3 / The Digital Experiment & Machine

**Full digitalisation of experiments** with feedback and machine control

- Near real-time analysis
- Start-to-end simulations
- Digital Twins of experiments
- Fast feedback
- Machine / experiment optimization
- In-situ / in-operando Visual Analytics
- Open data standards

2024: Near-realtime analysis prototype → **2025: Operation-critical intelligence** → **2027: Digital Twins**

Share — Synergies, Open Science & Education
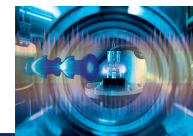
DMA creates **synergies** in Matter between
- Helmholtz Centers & Facilities
- Research Programs (MU,MML,MT)
- Science Domains

DMA develops **open, shareable** solutions for Matter
- **Open Source, modular** solutions, open standards
- Professional, industry-grade software development
- **F.A.I.R.** Data
- **S4M: S**hared, **s**calable **s**olutions for **s**cience in **M**atter

DMA **educates** scientists & fosters **talents**
- **New Formats:** Hackathons, Datathons, Hands-on
- **New Career Paths**: Data Scientist, Software Engineer
- **New Indicators**: Software & Data Citation

General Requirment on HGF side

- **Open Source, modular** solutions, open standards
- **F.A.I.R.** principles
- **S4M:** **S**hared, **s**calable **s**olutions for **s**cience in **M**atter

General requirment on HGF side

- **Open Source, modular** solutions, open standards
- **F.A.I.R.** principles
- **S4M: S**hared, **s**calable **s**olutions for **s**cience in **M**atter

The same requirment as in ESCAPE WP3

Ongoing Work!

- Within the DMA community, a list of projects is being prepared for onboarding

- Requirement to OSSR:
  - Data should only be part of the repository if supporting to software (e.g: Training data sets for ML algorithms)

What is next:

- HIFIS Research Software Directory: highly flexible software directory, but no curation

- Bring together the Helmholtz Research Software Directory and the OSSR. (https://helmholtz.software/)