Introduction and Overview

Ralph Engel

German Research Landscape

Incomplete overview

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Fraunhofer

Universities

MAX PLANCK
GESELLSCHAFT

Leibniz
Association

Many other research institutions (including industry)

Max Planck Society

Overview

Kaiser Wilhelm Society (1909): “The Institutes to be established should not be restricted in advance in their area of research. Instead, they should develop their particular focus from the personality of the scholar leading each Institute and from the course of science. The Director heading the Institute should have proved himself through great success as a researcher. As many temporary positions as possible should be created for young scholars at the Institutes.”

86 research institutes and facilities (five institutes and one research facility outside Germany)

Almost 24,000 employees, including 6,700 researchers, 2,500 visiting researchers and approx. 520 scholarship holders

More than half of the researchers come from outside Germany

Annual budget: approx. 2.3 billion euros (2021)

www.research-in-germany.org

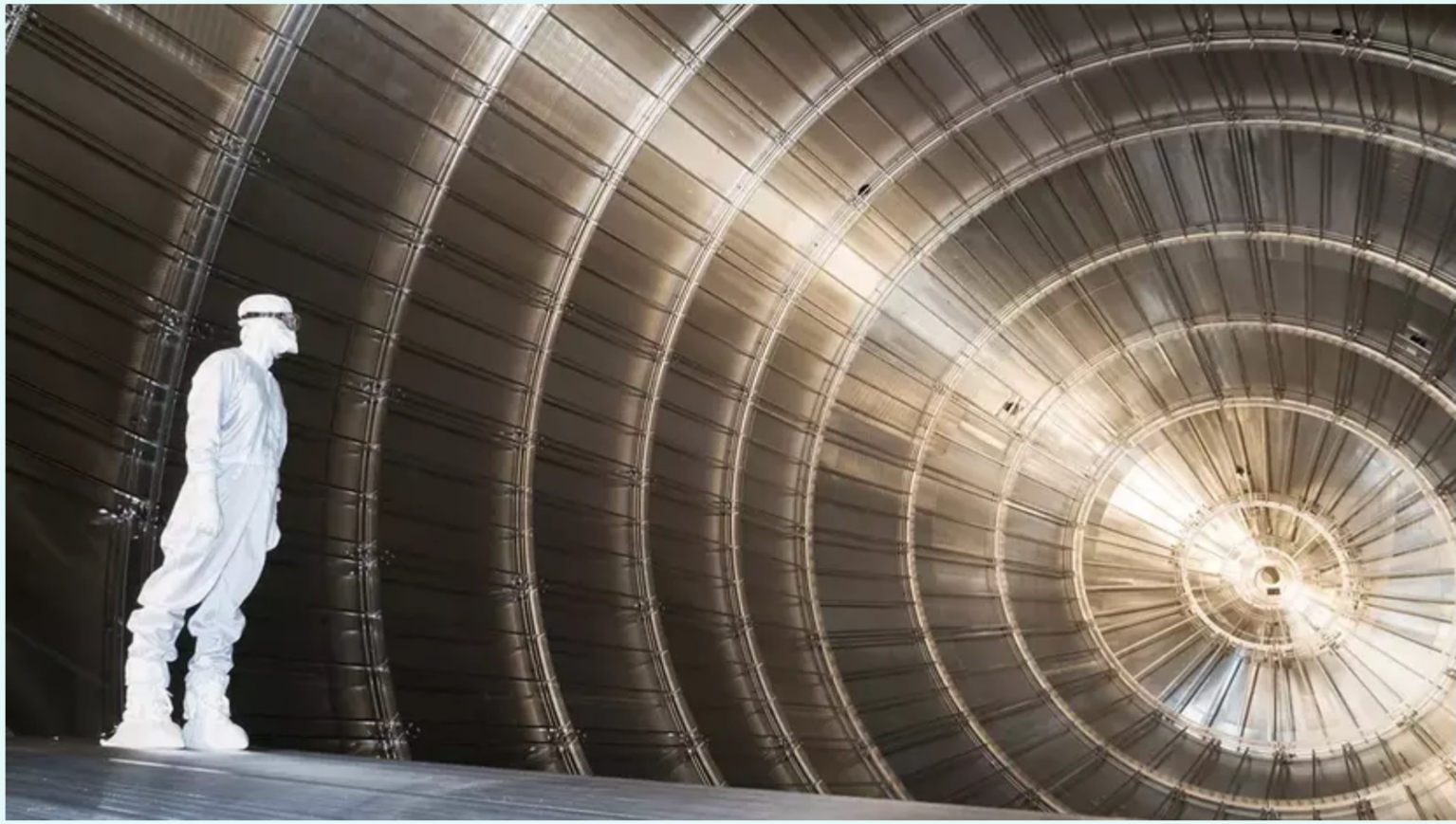
Helmholtz Association

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Mission

The Helmholtz Association contributes to solving grand challenges facing society, science and industry by conducting top-rate research in the fields of Aeronautics, Space and Transport; Earth and Environment; Energy; Health; Matter; and Information.

Learn more →

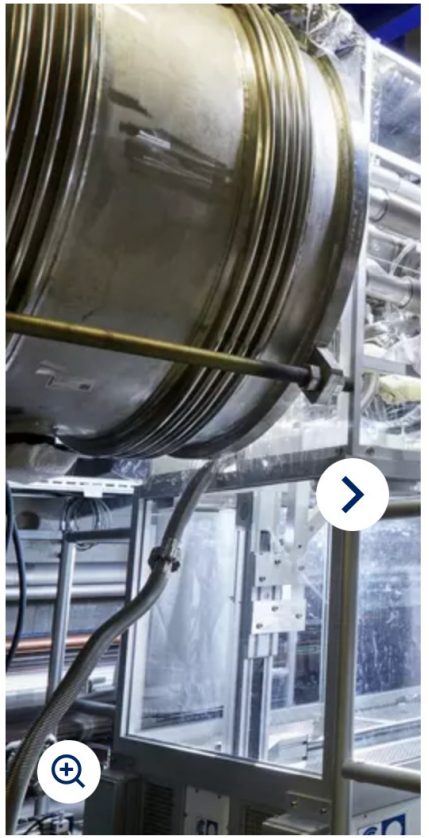


What we research

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

First-class research needs unique infrastructures. We develop, build and operate powerful research facilities such as the world's most powerful X-ray laser, research vessels, supercomputers and accelerator facilities. They are used by thousands of researchers from all over the world every year.

IceCube is the world's largest particle detector designed to detect neutrinos from galactic or extragalactic objects. It is located at the Amundsen-Scott South Pole Station. IceCube/NSF, Martin Wolf



The European XFEL is the most powerful X-allows completely new experiments. Image

Helmholtz Association

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RESEARCH FOR GRAND CHALLENGES

Overview

Helmholtz addresses major and pressing questions from science, industry and society. To this end, we arrange our long-term cutting-edge research in six strategic areas. It sets up and operates unique research infrastructures and large-scale facilities, such as particle accelerators, research vessels or earth observation satellites. Its facilities are made available to researchers from universities and non-university research institutes both within Germany and abroad.

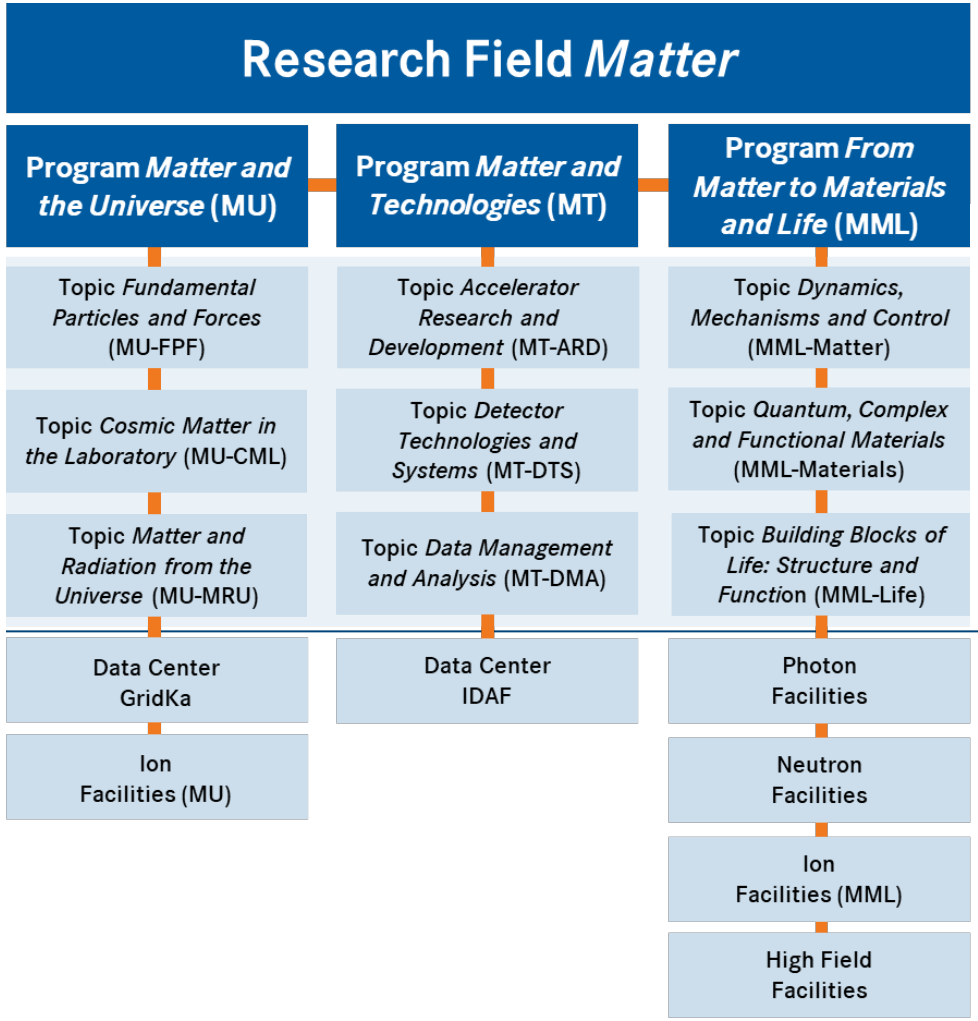
18 scientific-technical and biological-medical Helmholtz Research Centres

Approx. 44,000 employees, including roughly 16,000 research staff; 6,200 PhD students and almost 11,000 visiting scientists from all over the world

Annual budget: 5.4 billion euros (2021)

Partnerships with institutions and organisations all over the world, international collaborative research projects in many countries

Research Field Matter



LK I
Leistungskategorie I
Research

LK II
Leistungskategorie II
User Service

Helmholtz Association

Program-oriented Funding (PoF)

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The Helmholtz Association does not invest its resources in individual institutions, but in **cross-center research programs that compete with one another for funding**.

By **pooling the diverse resources** of its various research centers, Helmholtz is in the unique position of not only being able to offer solutions to individual problems, but also to comprehensively address the complex issues facing science, society, and the economy and to develop system solutions.

The program-orientated funding is based on a two-step system: The first step is a **scientific evaluation** of the centers and the existing programs at the level of the individual centers. The second step is a **strategic evaluation** of the programs planned for the future at the level of the areas of research.

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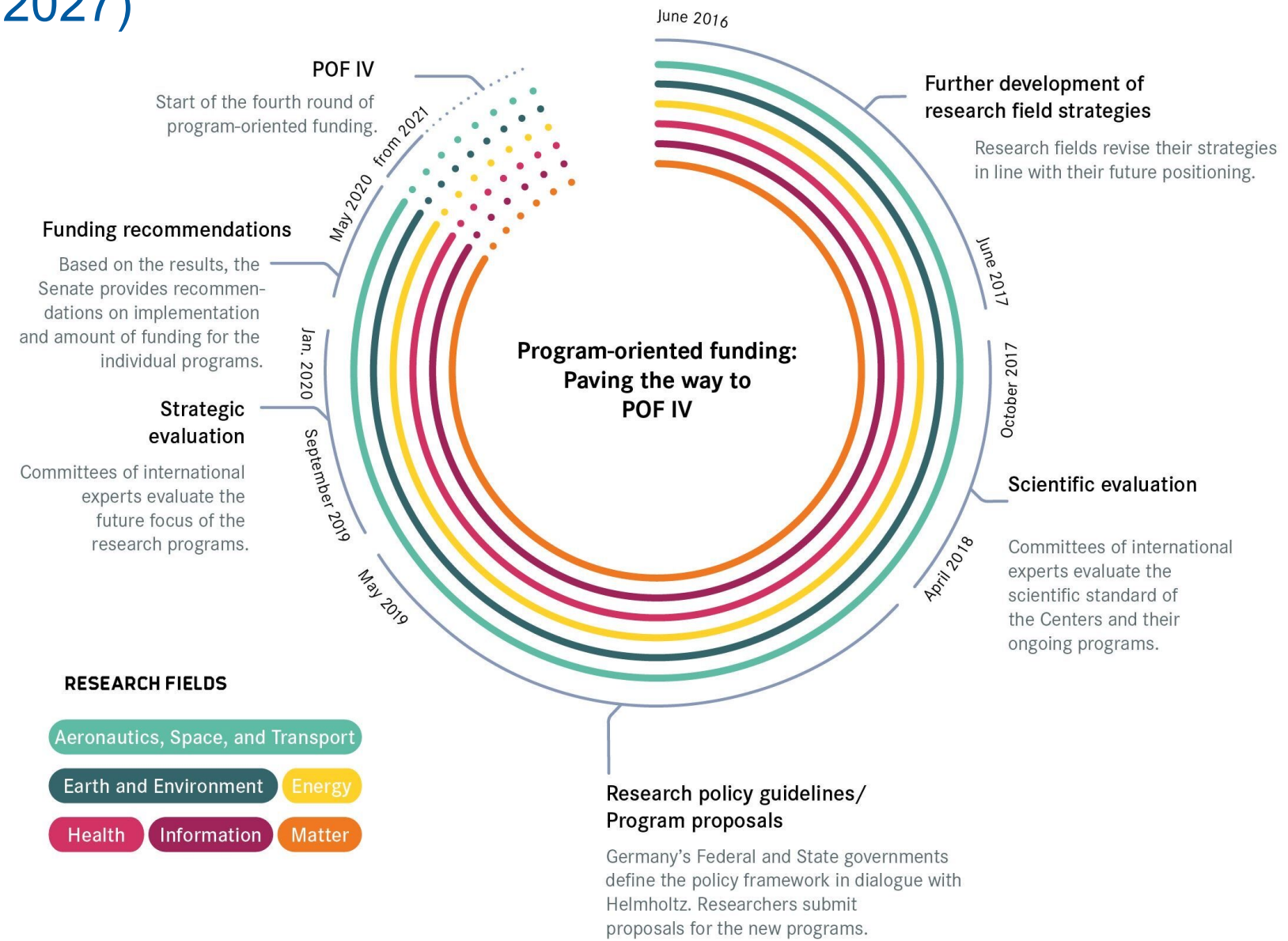
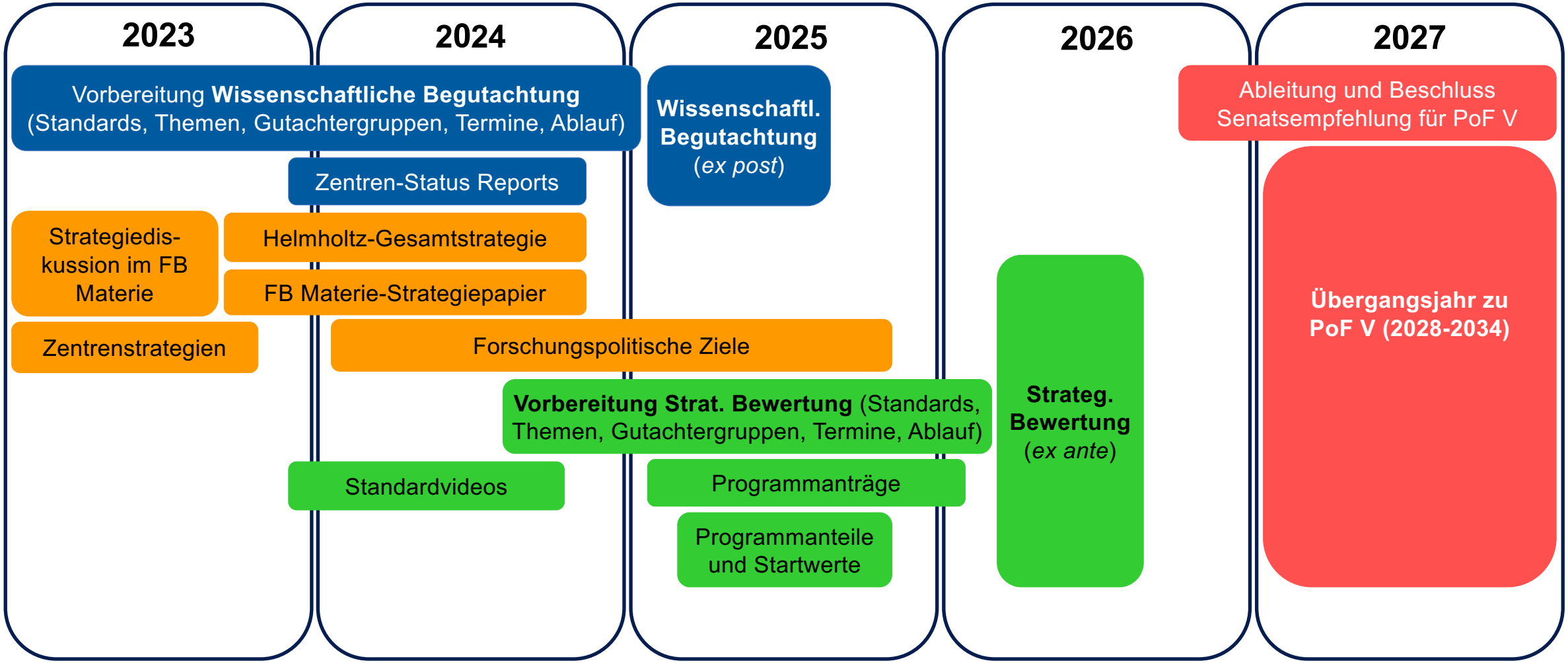
Example: PoF IV (2021 – 2027)

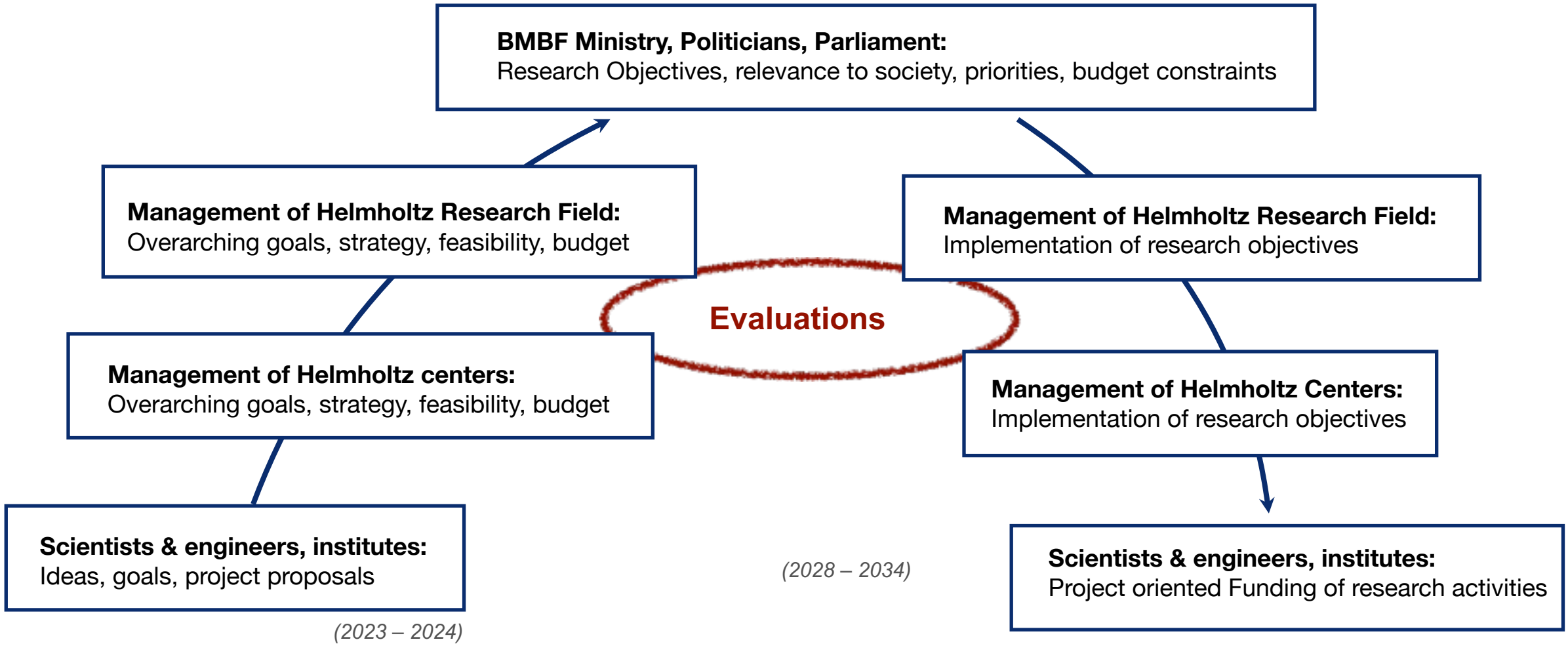


Timeline Preparation PoF V (2028 – 2034)

- „Iterativer Prozess“
- Elemente bedingen sich gegenseitig
- Frühzeitige Abstimmung mit ZWG
- Reduktion Paralleldiskussionen



Why should we discuss our strategy already now?



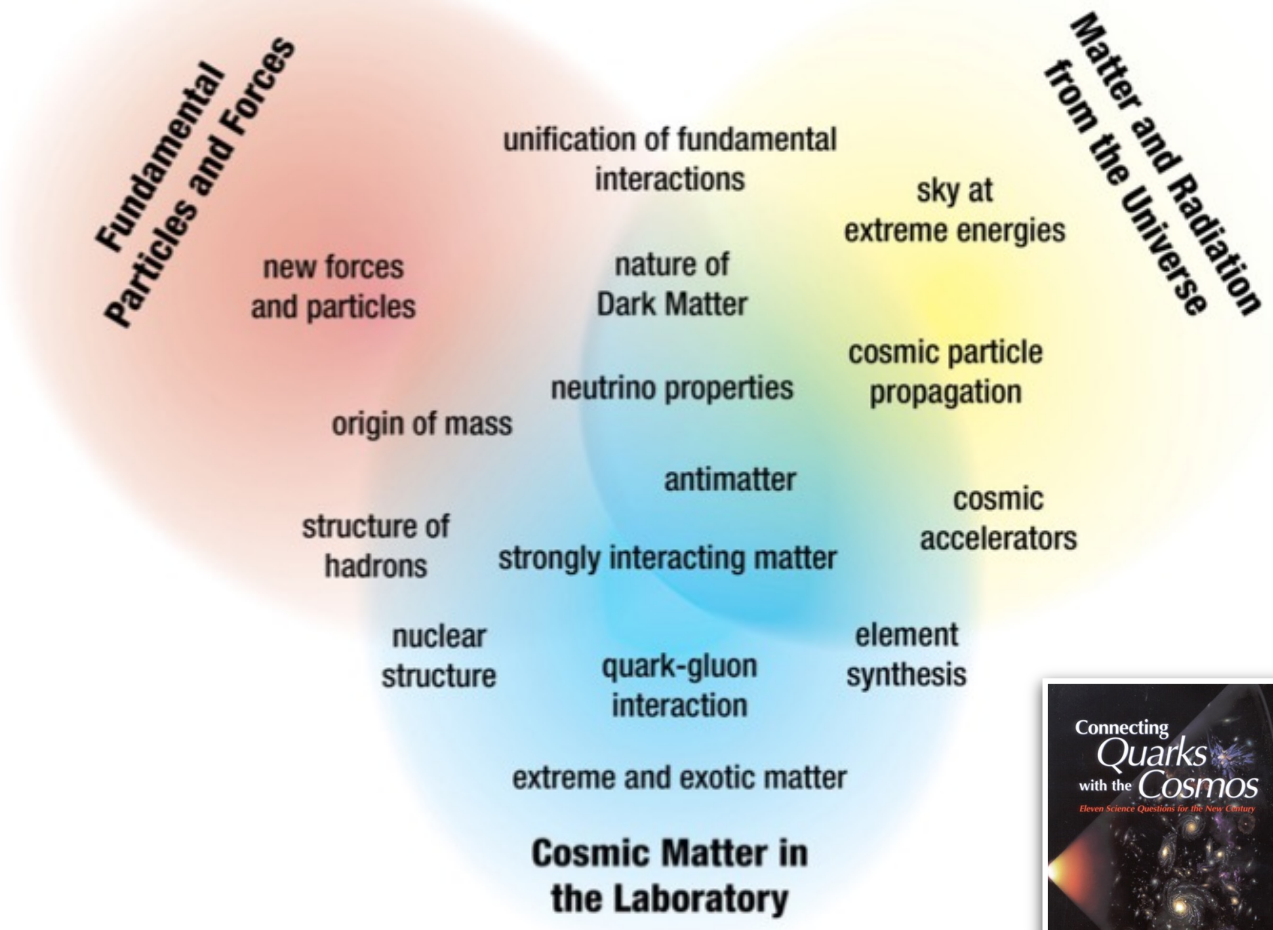
Program Matter and the Universe

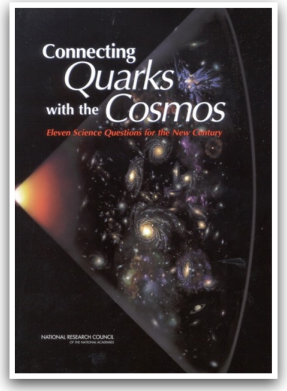
Overall aims and strategy

MATTER AND THE UNIVERSE

Coherent picture of the microcosm and a detailed idea of the evolution of our universe

- to identify the fundamental particles and their interactions as well as to obtain an exact understanding of the structure of the vacuum
- to understand the structure and dynamics of hadrons, nuclei and nuclear matter and their role in the astrophysical formation of chemical elements
- to understand the nature of Dark Matter (and Dark Energy) and of the Universe at high energies





National Research Council, USA

The Program Matter and the Universe (MU)

MATTER AND THE UNIVERSE

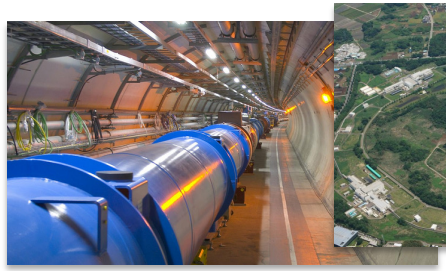
Matter and the Universe

- **Fundamental Particles and Forces** — 40%
  - DESY 95% – KIT 5%
- **Cosmic Matter in the Laboratory** — 20%
  - GSI
- **Matter and Radiation from the Universe** — 40%
  - DESY 45% – KIT 55%

LK II Research Infrastructures

- GridKa — KIT
- GSI MU Ion Facilities — GSI

> 650 FTE
> 90 MEUR/yr



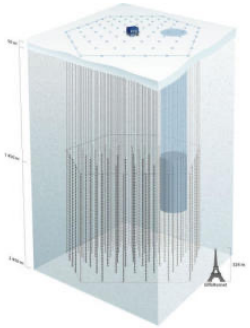
ATLAS, CMS, ALICE

Belle II

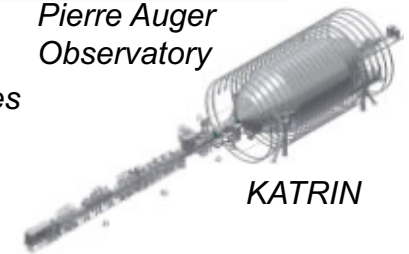
GSI & FAIR: CBM, NUSTAR, PANDA

Cherenkov telescopes (CTA)

Pierre Auger Observatory



IceCube

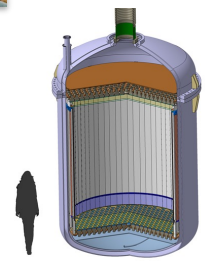


KATRIN

XENONnT

LUXE

ALPS-II



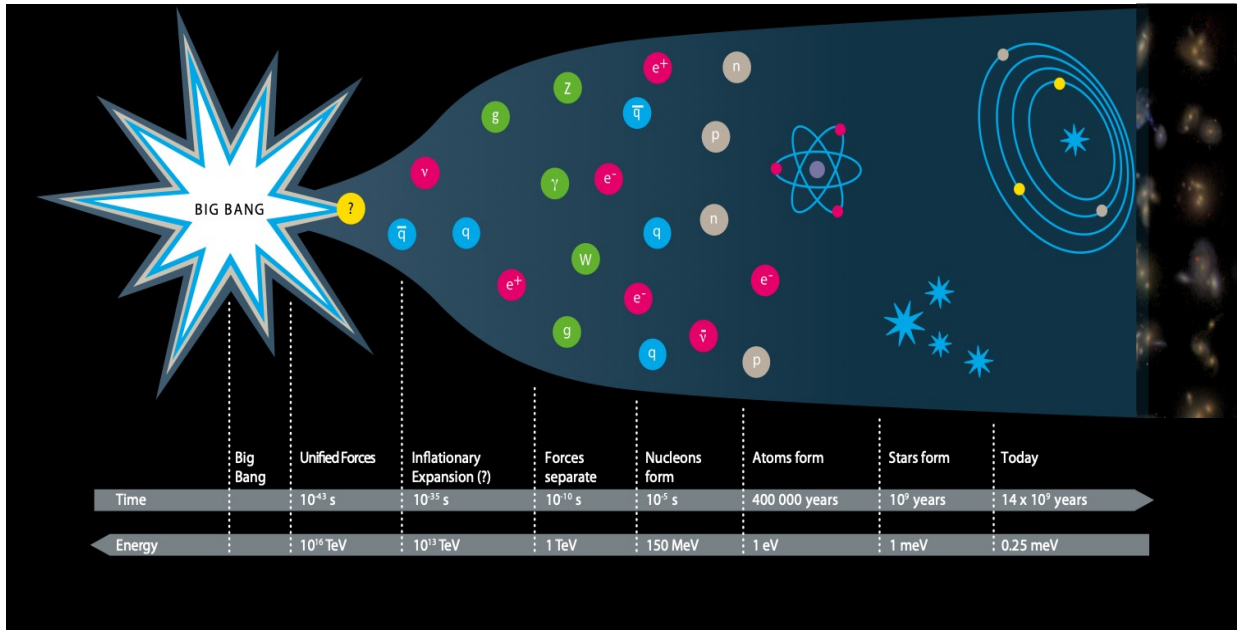
DARWIN

HELMHOLTZ

Topic 1 – Fundamental Particles and Forces (FPF)

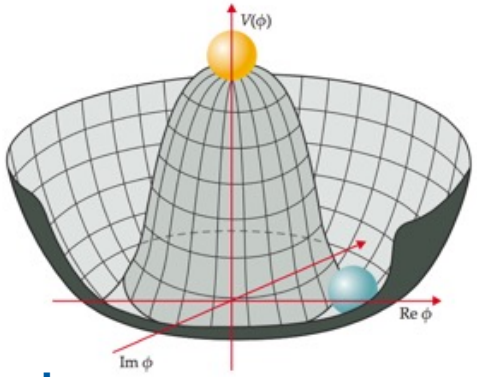
MATTER AND THE UNIVERSE

Study the fundamental laws of Nature in our universe, governed by quantum physics and the dynamics of space-time



Particle physics aims at understanding the basic processes that govern the early universe (< 1 ns)

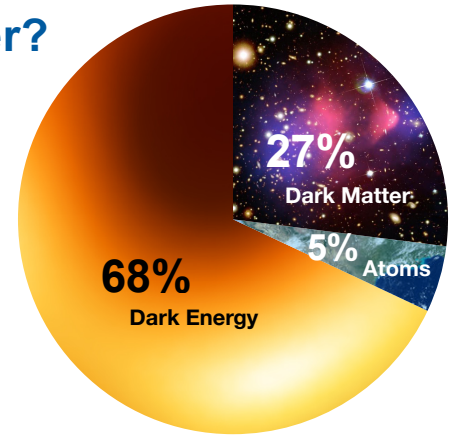
Science drivers

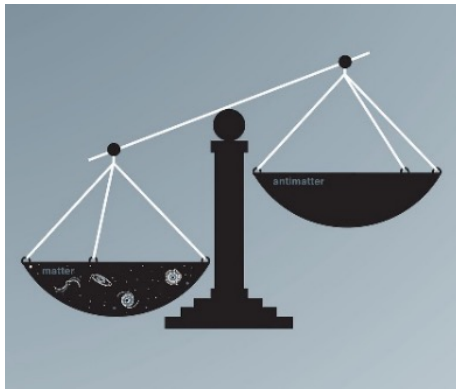


What is the structure of the vacuum?

Where did the anti-matter go?

What is dark matter?



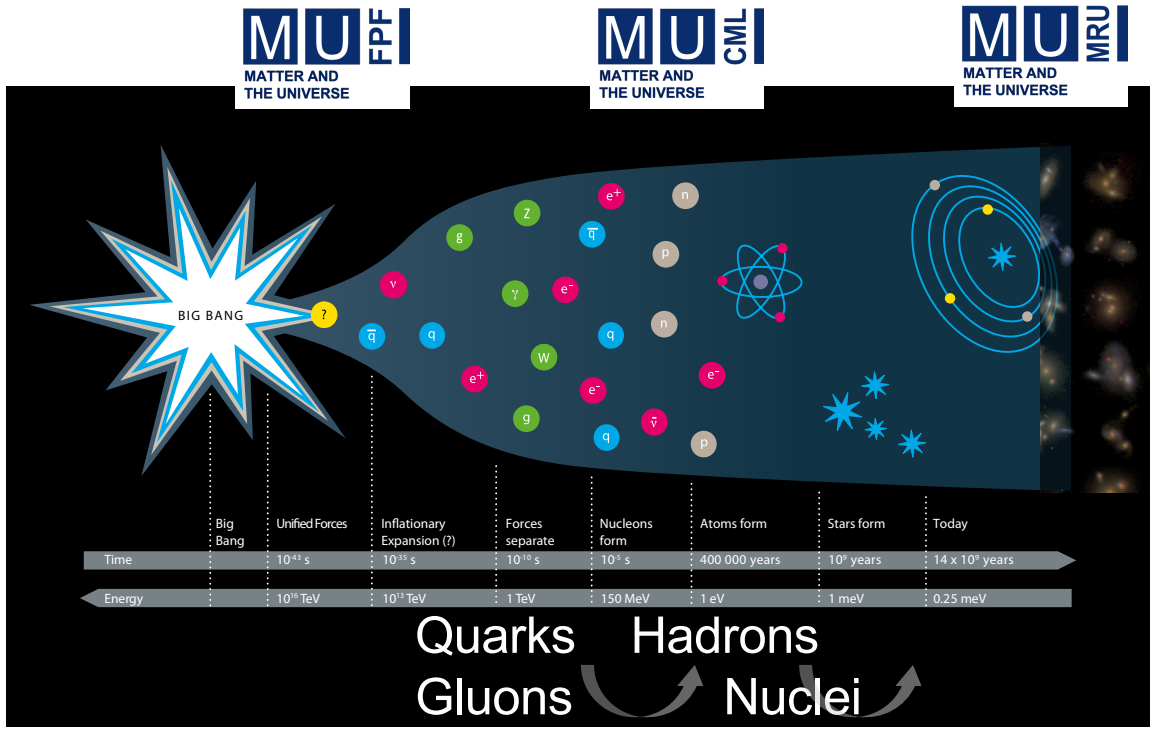


Topic 2 – Cosmic Matter in the Laboratory (CML)

Mission to understand

Emergence of complex phenomena in strong interaction

Role of the strong interaction in the evolution of our universe



Aims

- Unravel the properties of hadrons; access and understand the QCD spectrum
- Explore strongly interacting systems under extreme conditions of temperature, density, isospin

Strategy

- Study cosmic matter in the laboratory
- Use primary and secondary ion beams from (anti-)protons to uranium
- Apply forefront technologies

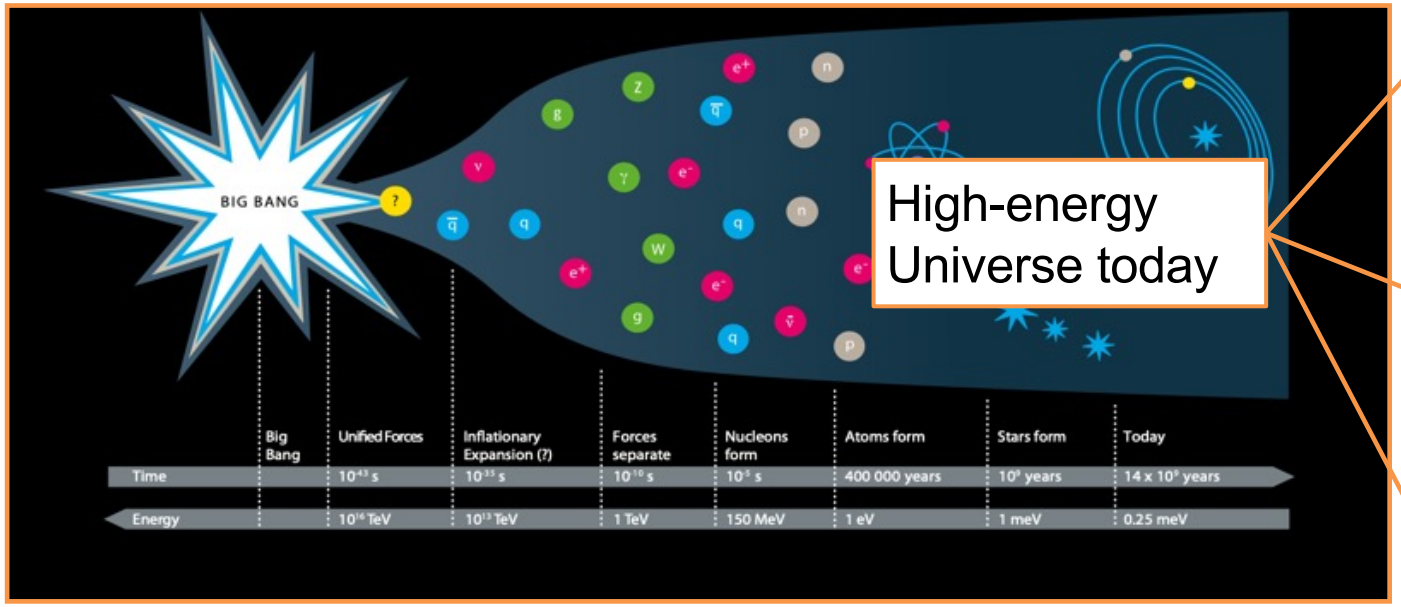
Uniqueness

- Relativistic ion beams of highest intensities
- Storage rings for cooled (secondary) beams
- Innovative experiment instrumentation

Topic 3 – Matter and Radiation from the Universe (MRU)

Understanding the high-energy Universe and its constituents

A broad but coordinated research program with observatories and in laboratories – a growing field of science



High-energy Universe today

Multi-messenger view of the cosmos

- Gamma-ray astronomy
- Neutrino astronomy
- Cosmic rays
- Gravitational waves

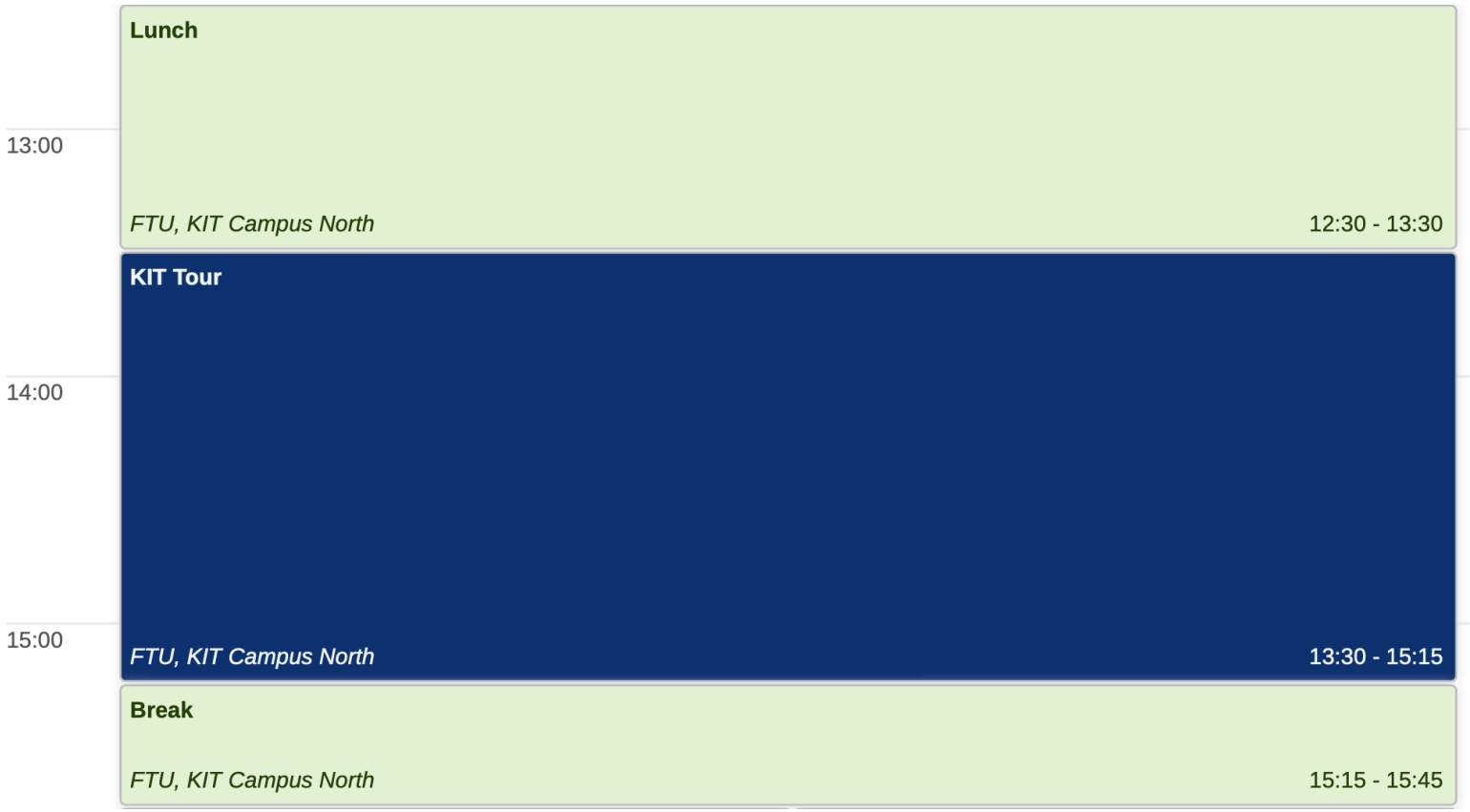
Understand the role of **neutrinos** in the Universe

Search for new physics and **Dark Matter**

Strong interplay between experiments and theory

Thursday

09:00	**Welcome**	*Beate Heinemann et al.*
	Aula, FTU	09:00 - 09:10
	Overview PoF and MU	*Ralph Engel*
	Aula, FTU	09:10 - 09:30
	Fundamental Particles and Forces	*Kai Schmidt-Hoberg*
	Aula, FTU	09:30 - 09:48
	Cosmic Matter in the Laboratory and GSI LKII	*Frank Maas et al.*
10:00	*Aula, FTU*	09:48 - 10:06
	Matter and Radiation from the Universe	*Kathrin Valerius*
	Aula, FTU	10:06 - 10:24
	GridKa LKII	*Andreas Petzold*
	Aula, FTU	10:24 - 10:42
	Discussion/Buffer	
	Aula, FTU	10:42 - 11:00
11:00	**Break**	
	FTU, KIT Campus North	11:00 - 11:30
	Physics Highlight: Daniel Heuchel - Searching for axions and ALPs at DESY: why, how and how to go beyond discovery?	
	Aula, FTU	11:30 - 12:00
12:00	**Physics Highlight: Oliver Just - Using simulations of colliding neutron stars to investigate the origin of the heaviest elements**	
	Aula, FTU	12:00 - 12:30


13:00
14:00
15:00
Lunch
FTU, KIT Campus North
12:30 - 13:30
KIT Tour
FTU, KIT Campus North
13:30 - 15:15
Break
FTU, KIT Campus North
15:15 - 15:45

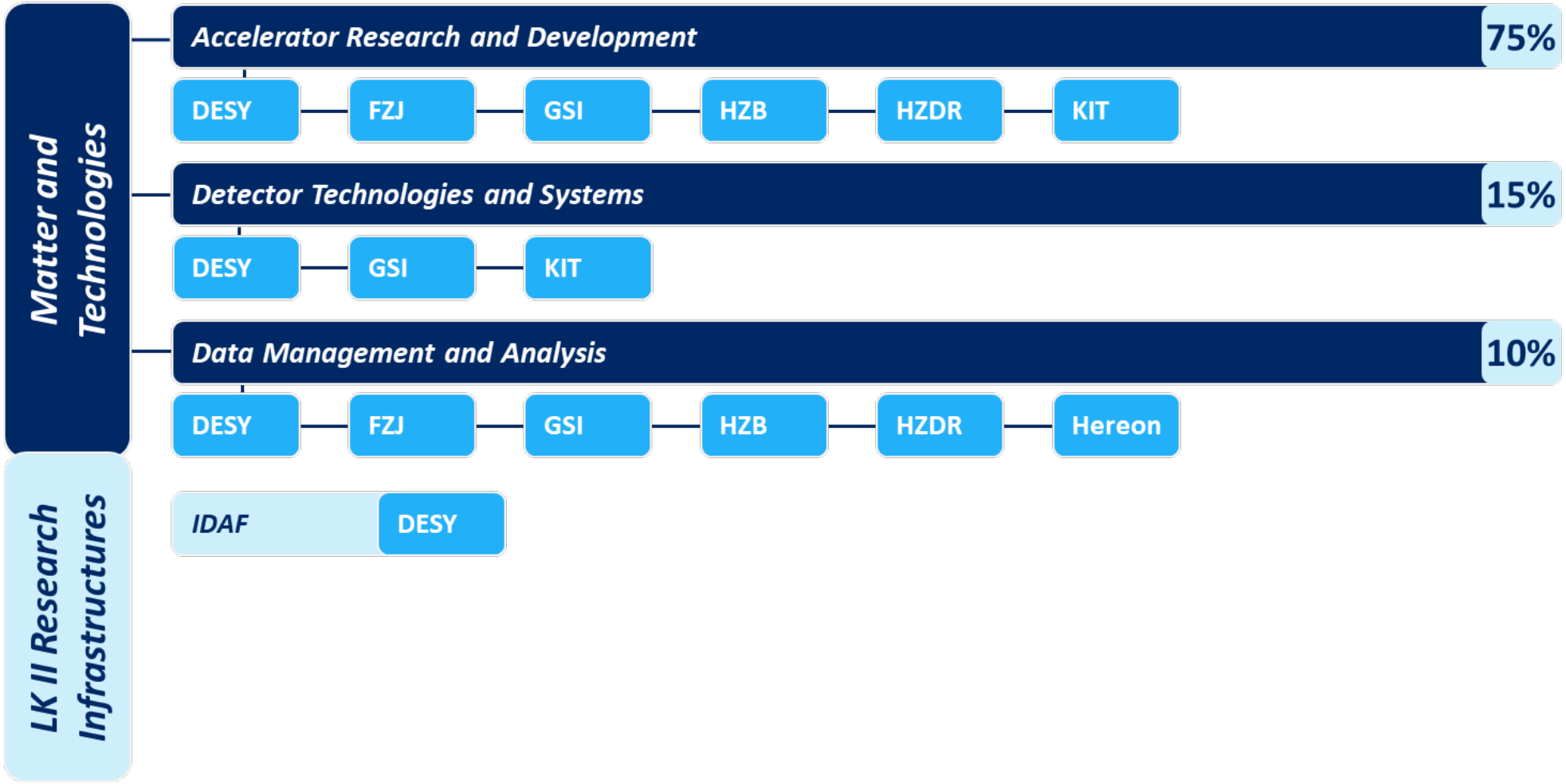
	Dark matter simplified models *Tomas Gonzalo* *Room 236, Mittlerer Hörsaal, FTU* 15:45 - 16:00	**Recent news on the R(D(*)) anomaly** *Monika Blanke et al.*
16:00	**First data-taking with ALPS II** *Henry Frädrich* *Room 236, Mittlerer Hörsaal, FTU* 16:00 - 16:15	**Search for generalized neutrino interactions at KATRIN** *Caroline Fengler*
	NanoGrav & primordial black holes *Virgile Dandoy* *Room 236, Mittlerer Hörsaal, FTU* 16:15 - 16:30	**Solar neutrinos - CNO measurement by Borexino and sensitivity for JUNO** *Luca Pelicci*
	Axion Searches at Cooler Synchrotron COSY *Prof. Joerg Pretz*	**Heavy-quark hadronization at LHC: status and future perspectives** *Andrea Dubla*
	ML / AI: Helmholtz Platform *Judith Katzy* *Aula, FTU* 16:45 - 17:00	**Decoding the EOS of neutron star-like matter via flow patterns of nuclear cluster ...** *Behruz Kardan*
17:00	**Sustainablility** *Kollegger Thorsten* *Aula, FTU* 17:00 - 17:15	**Impact of pions on BNS mergers** *Vimal Vijayan* *Room 236, Mittlerer Hörsaal, FTU* 17:00 - 17:15
	Examples for work on modern data management - PUNCH4NFDI use cases and ... *Achim Geiser*	**Searching for the missing duo: coincident gravitational-waves and high-energy neu...** *Doga Veske*
	Computing: Use of federated infrastructures in MU *Manuel Giffels*	**The Transient and Variable Gamma-ray Sky with CTA** *Gernot Maier*
18:00	**Poster Session** *FTU, KIT Campus North* 17:45 - 19:00	

Friday

09:00	**Fundamental Particles and Forces**	*Isabell Melzer-Pellmann*
	Aula, FTU	09:00 - 09:18
	Cosmic Matter in the Laboratory	*Yvonne Leifels*
	Aula, FTU	09:18 - 09:36
	Matter and Radiation from the Universe	*Christian Stegmann*
	Aula, FTU	09:36 - 09:54
10:00	**GridKa LKII**	*Max Fischer*
	Aula, FTU	09:54 - 10:12
	Discussion/Buffer	
	Aula, FTU	10:12 - 10:30
	Foto	
	FTU, KIT Campus North	10:30 - 10:40
	Break	
	FTU, KIT Campus North	10:40 - 11:00
11:00	**Physics Highlight: Graeme Stewart - Computing**	
	Aula, FTU	11:00 - 11:30
	Physics Highlight: Marc Schumann - Dark matter (and more) with DARWIN/XLZD	
	Aula, FTU	11:30 - 12:00
12:00	**Plenary session: Discussion and Conclusion**	
	Aula, FTU	12:00 - 12:30

Backup slides

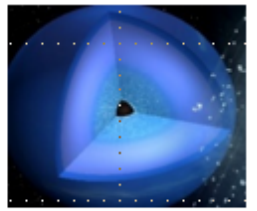
The Program Matter and Technologies (MT)

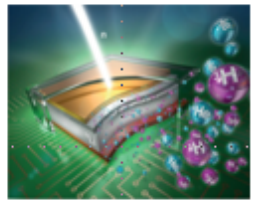


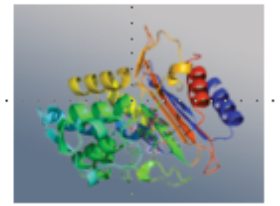
The Program From Matter and Materials to Life (MML)

From Matter to Materials and Life

- **Matter – Dynamics, Mechanism and Control** — 33%
  - DESY — GSI — HZB — HZDR
- **Materials – Quantum, Complex and Functional Materials** — 50%
  - DESY — FZJ — GSI — HZB — HZDR — Hereon — KIT
- **Life – Building Blocks of Life: Structure and Function** — 17%
  - DESY — GSI — HZB — Hereon — KIT







LK II Research Infrastructures

Photon Facilities	FLASH	DESY	PETRA III	DESY	BESSY II	HZB	XFEL	DESY	
Neutron Facilities	JCNS	FZJ	GEMS	Hereon					
Ion Facilities	GSI MML Ion Facilities	GSI	IBC	HZDR					
High-Field Facilities	HLD	HZDR	ELBE	HZDR					

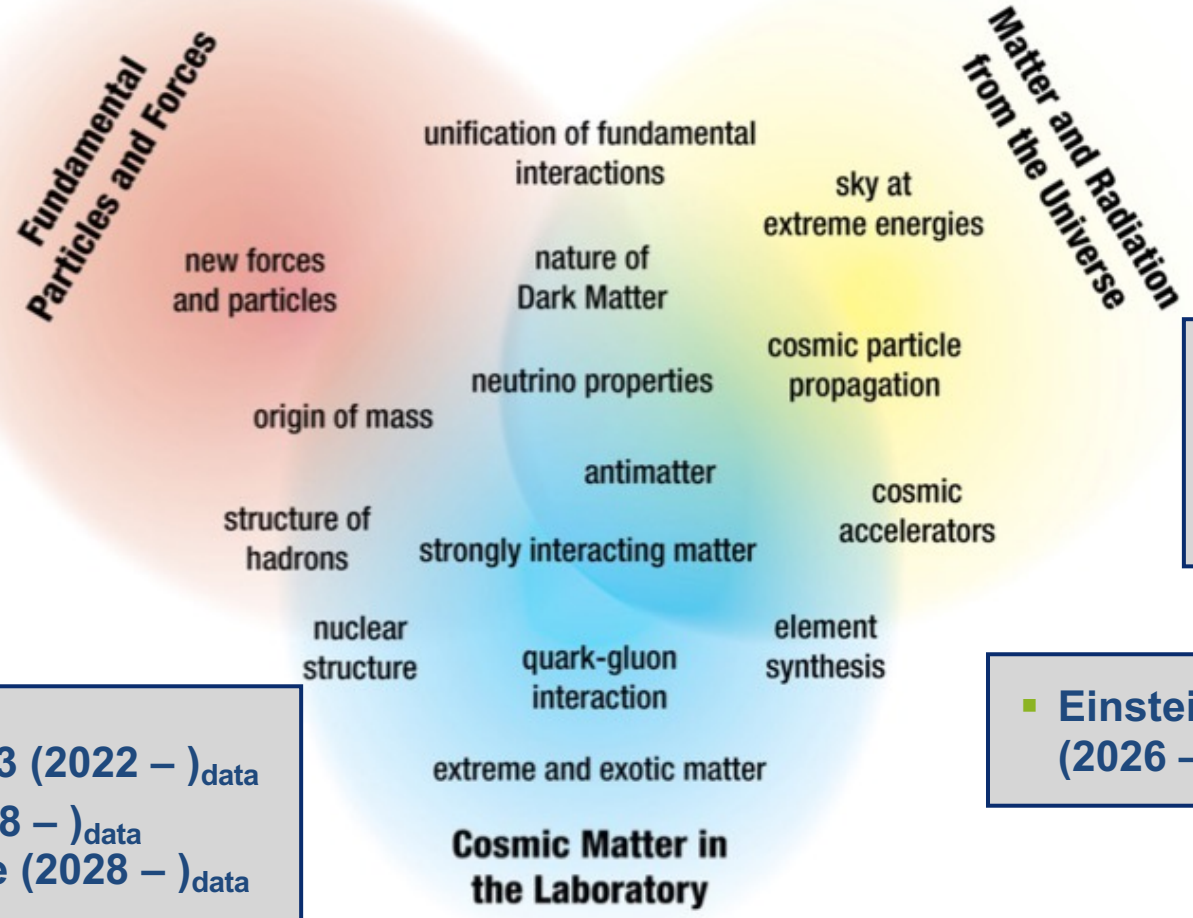
Overview of major facilities in PoF V

MATTER AND THE UNIVERSE

- ALPS II (2022 –)$_{data}$
- DARWIN/XLZD (2025 –)$_{inv}$
- Baby-IAXO (2027 –)$_{inv}$

- LUXE (2027 –)$_{data}$

- LHC Run 3 (2022 –)$_{data}$
  → HL-LHC (2029 –)$_{data}$
- Belle 2 (2023 –)$_{data}$



- Computing: GridKa, Green Cube, (IDAF)$_{MT}$ (2027 –)$_{inv}$

- AugerPrime (2024 –)$_{data}$
- CTA (2029 –)$_{data}$
- IceCube-Gen2 (2026 –)$_{inv}$

- ALICE@LHC Run 3 (2022 –)$_{data}$
- FAIR Phase 0 (2018 –)$_{data}$
  First Science (2028 –)$_{data}$

- Einstein Telescope (2026 –)$_{inv}$

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