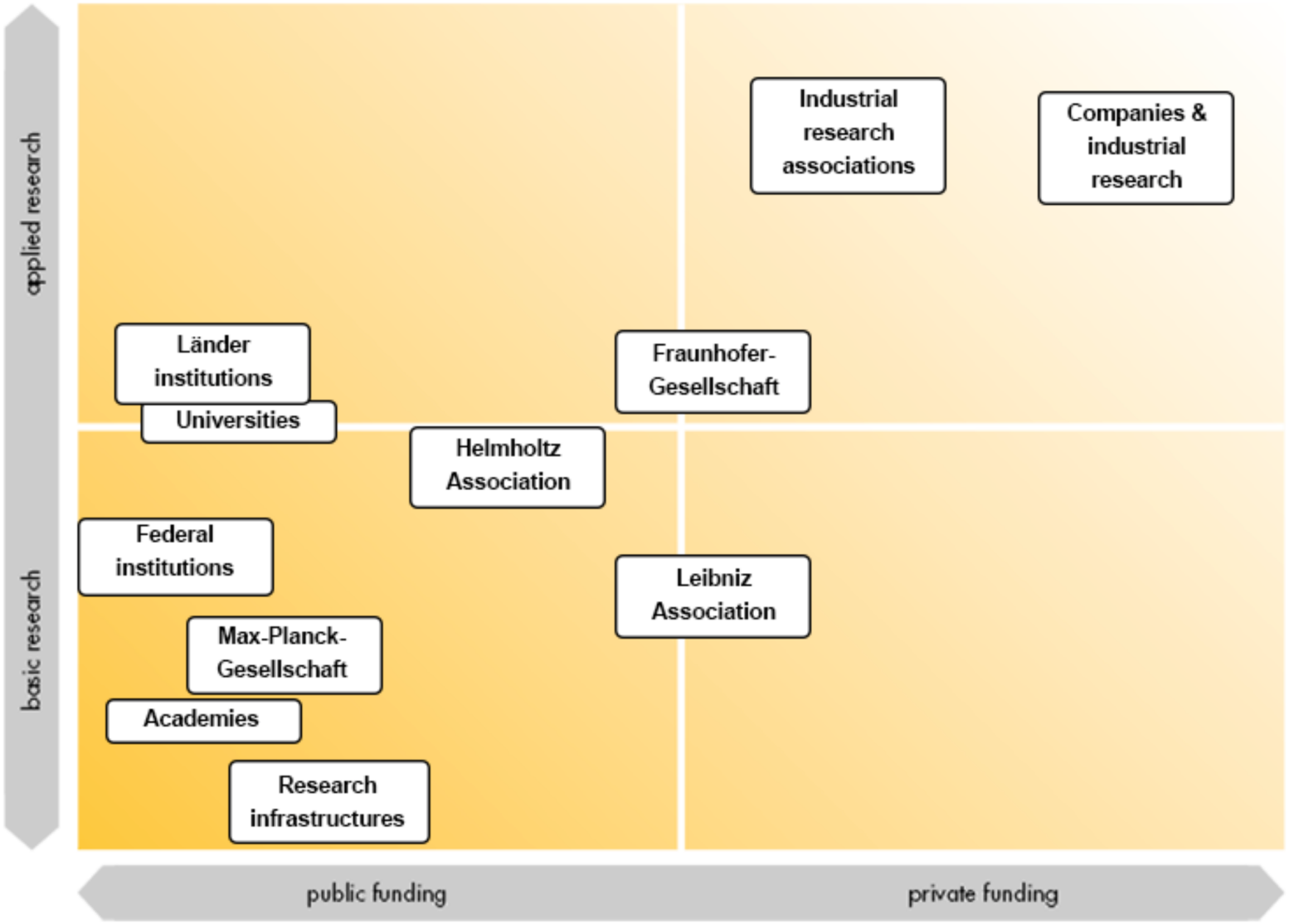
Introduction and Overview

Beate Heinemann and Ralph Engel

German Research Landscape

Overview and funding



www.research-in-germany.org

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

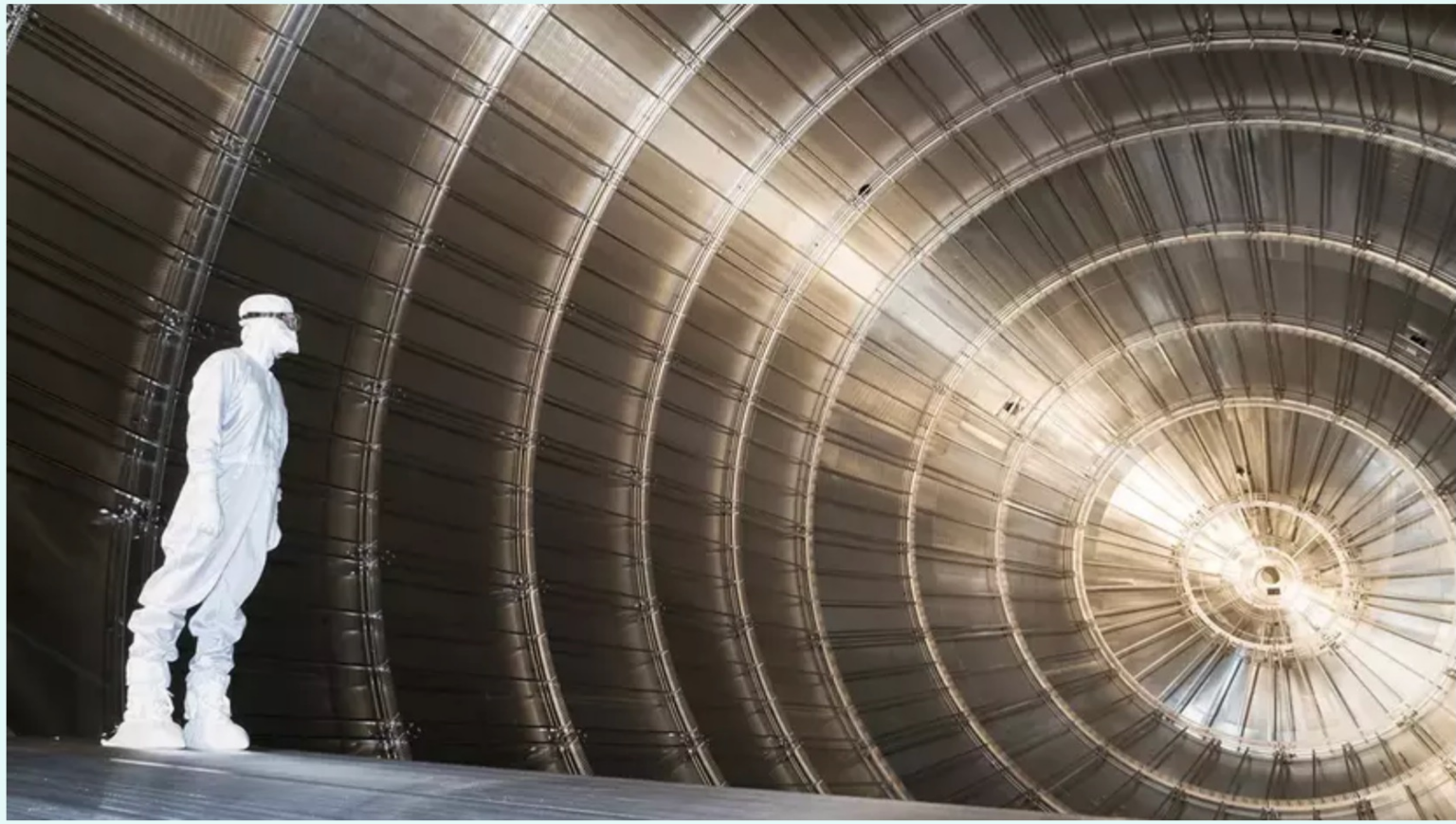
Helmholtz Association

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 →

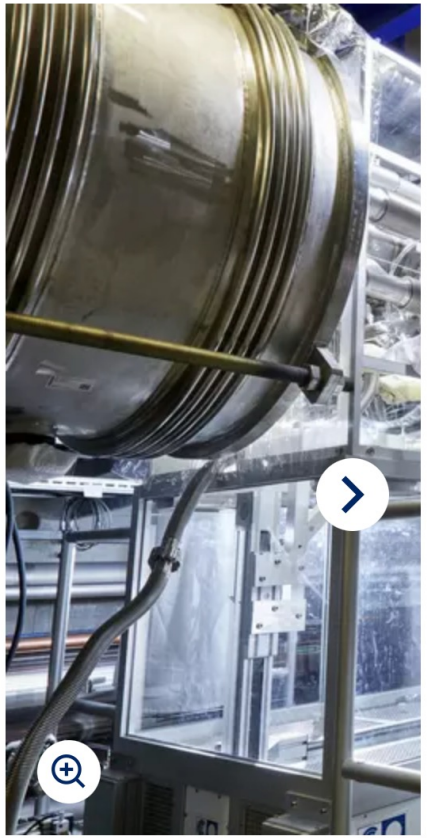


What we research

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

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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

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Research Field Matter

Research Field *Matter*

Program *Matter and the Universe* (MU)	Program *Matter and Technologies* (MT)	Program *From Matter to Materials and Life* (MML)
Topic *Fundamental Particles and Forces* (MU-FPF)	Topic *Accelerator Research and Development* (MT-ARD)	Topic *Dynamics, Mechanisms and Control* (MML-Matter)
Topic *Cosmic Matter in the Laboratory* (MU-CML)	Topic *Detector Technologies and Systems* (MT-DTS)	Topic *Quantum, Complex and Functional Materials* (MML-Materials)
Topic *Matter and Radiation from the Universe* (MU-MRU)	Topic *Data Management and Analysis* (MT-DMA)	Topic *Building Blocks of Life: Structure and Function* (MML-Life)
Data Center GridKa	Data Center IDAF	Photon Facilities
Ion Facilities (MU)		Neutron Facilities
		Ion Facilities (MML)
		High Field Facilities

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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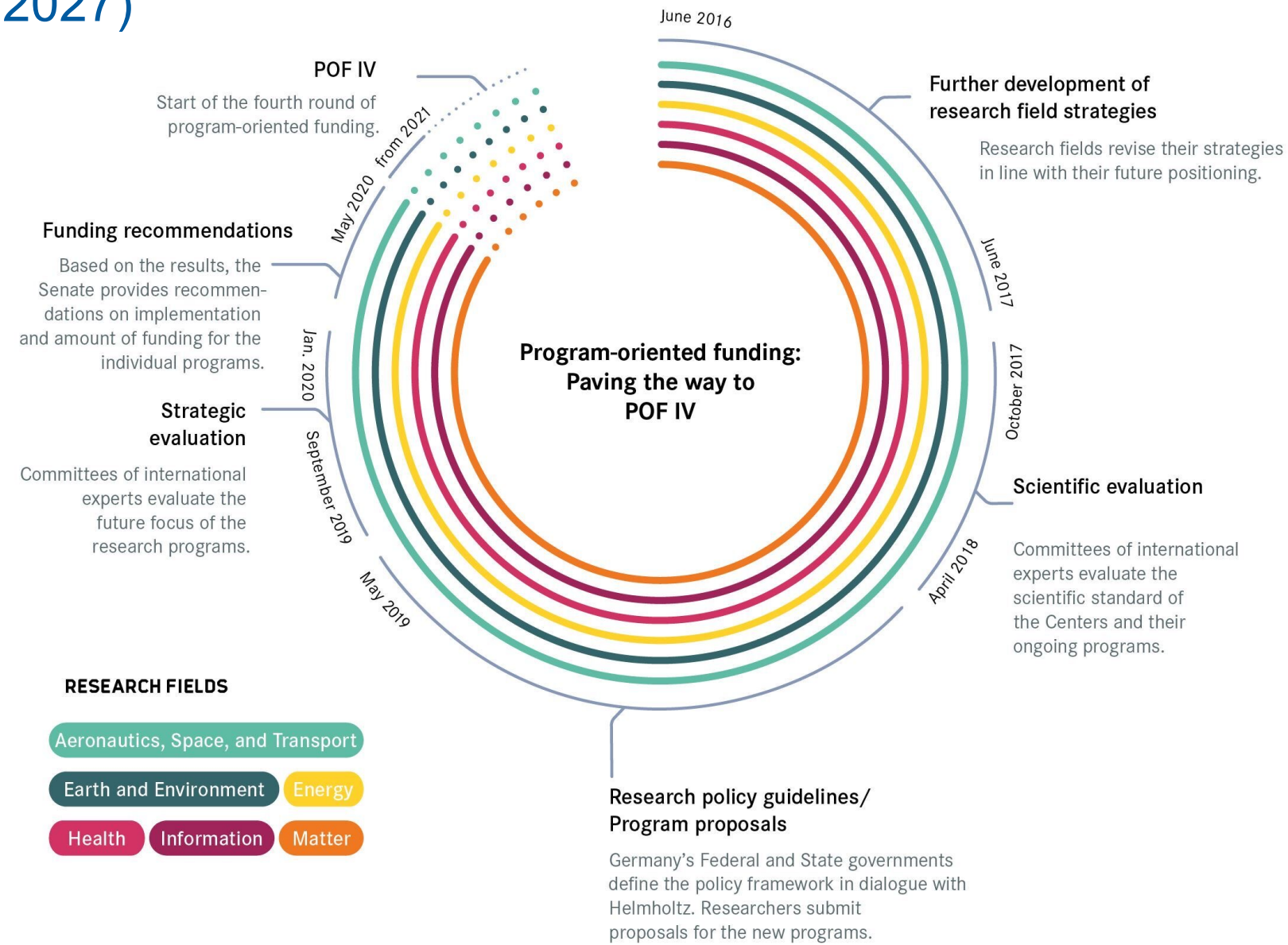
Example: PoF IV (2021 – 2027)



The Program Matter and the Universe (MU)

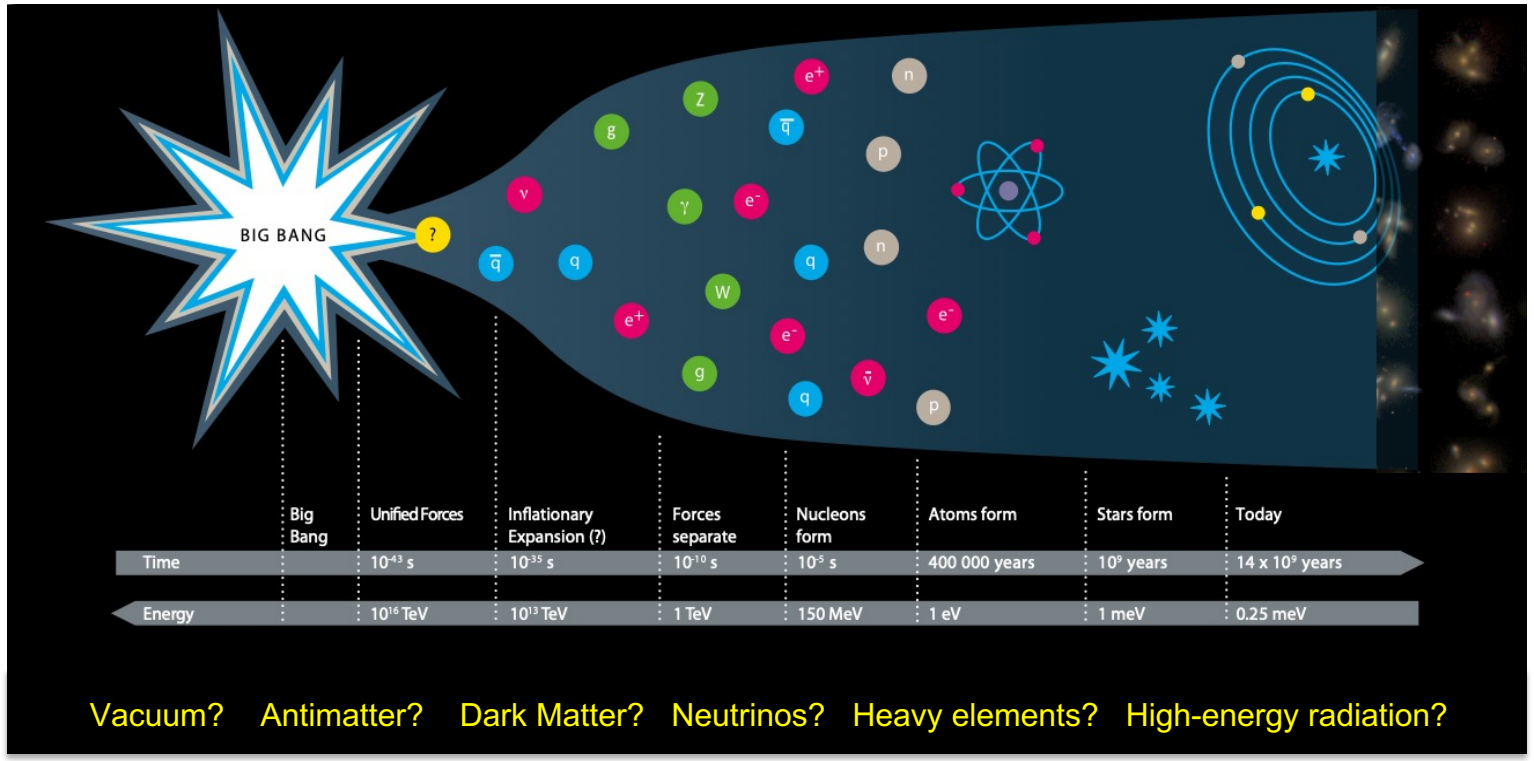
MATTER AND THE UNIVERSE

aims at building the foundations of our understanding of the world

1. Particles and forces

2. Quarks, hadrons and nuclei

3. Messengers from the Universe



Strategy

Coherent approach:

hadron/lepton/ion accelerators, experiments, observatories, theory

System competence:

large-scale and long-term, international, off-site and on-site projects

Research: 650 FTE + 95 M€/yr **Facilities: 150 FTE + 30 M€/yr**

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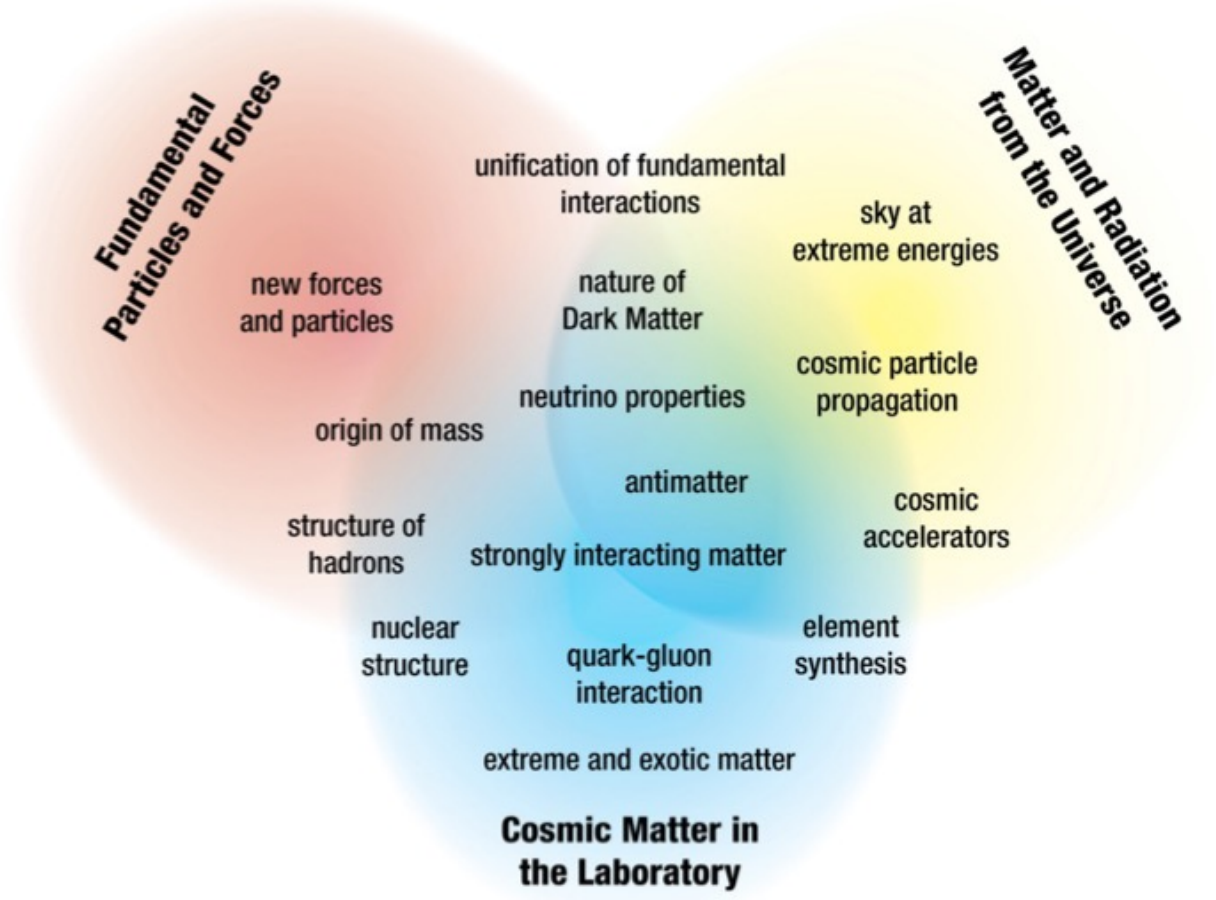
The Topic Structure

follows from the scientific questions and approach



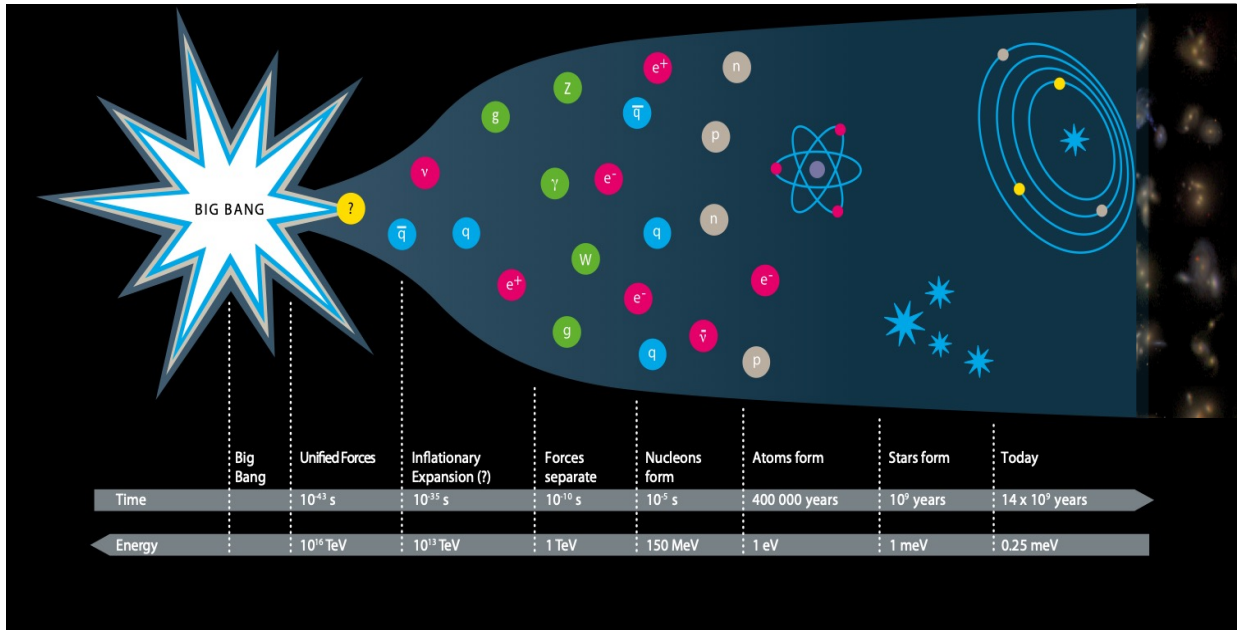
	Fraction of program	Centers
Topic 1: **Fundamental particles and forces**	**39%**	**97% DESY** **3% KIT**
Topic 2: **Cosmic matter in the laboratory**	**20%**	**100% GSI**
Topic 3: **Matter and radiation from the Universe**	**41%**	**60% KIT** **40% DESY**

Theory: integral part of all Topics

Topic 1 – Fundamental Particles and Forces (FPF)

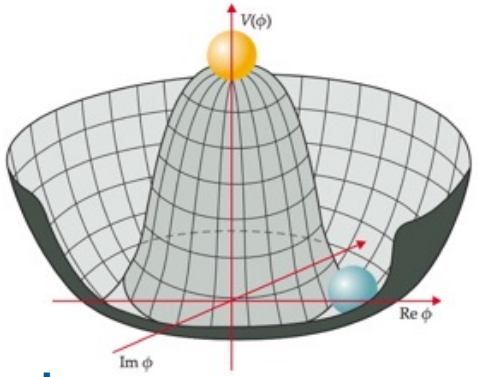
MATTER AND THE UNIVERSE

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)

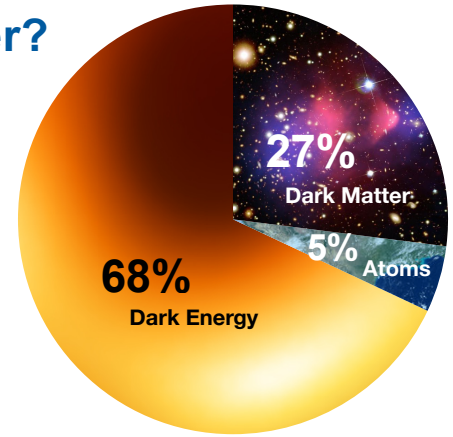
Science drivers

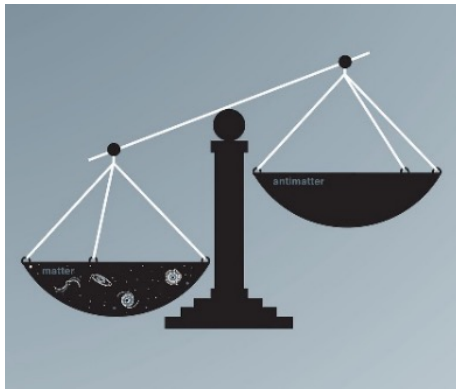


What is the structure of the vacuum?

Where did the anti-matter go?

What is dark matter?



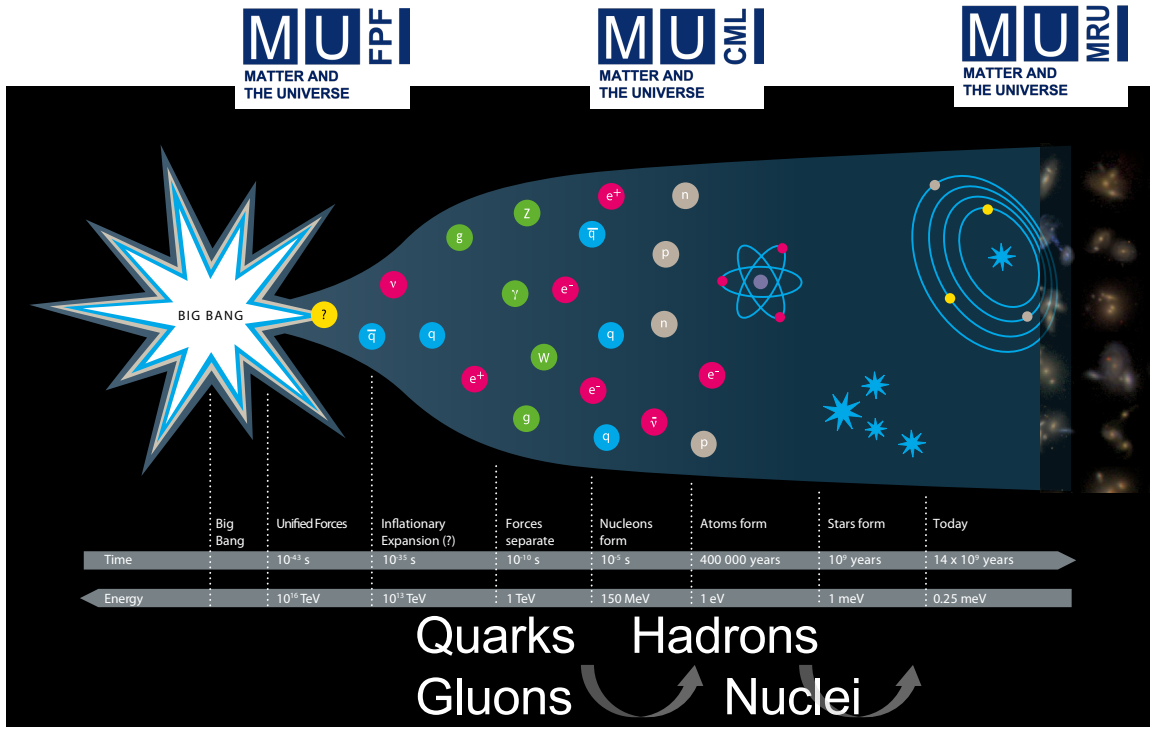


Topic 2 – Cosmic Matter in the Laboratory (CML)

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

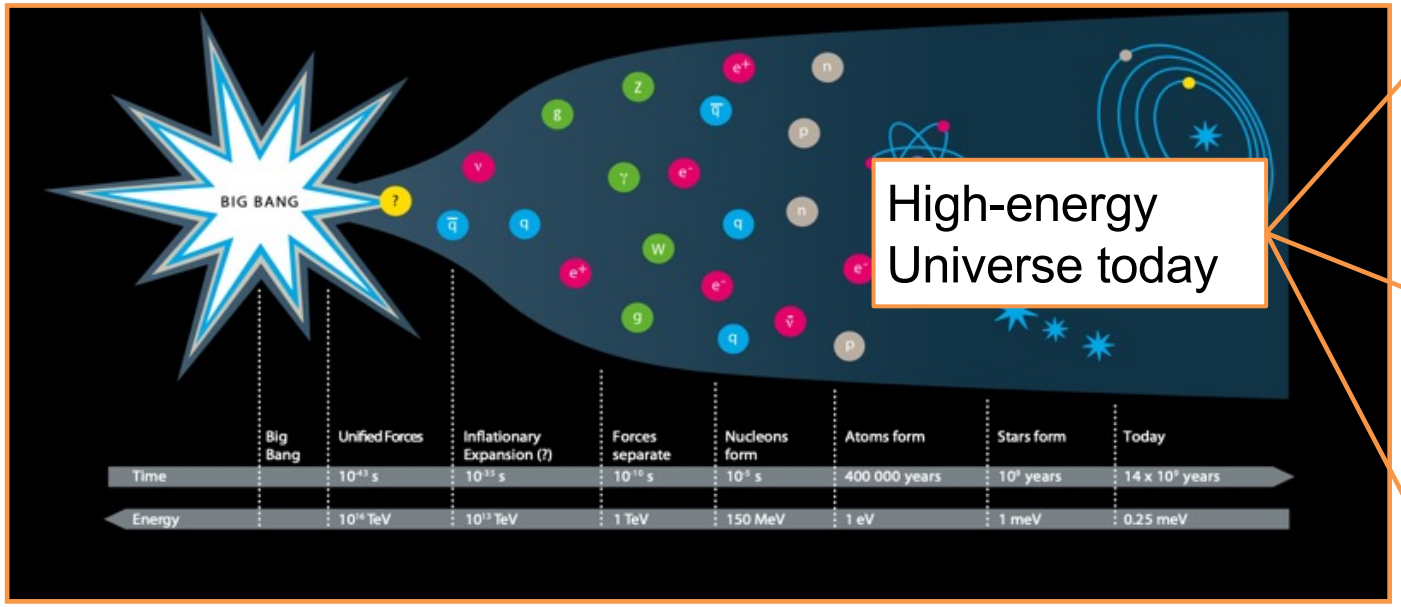
Uniqueness

- 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

Program Matter and the Universe (MU)

Summary of Topics and Research Objectives

Topic 1: Fundamental Particles and Forces (FPF)	Topic 2: Cosmic Matter in the Laboratory (CML)	Topic 3: Matter and Radiation from the Universe (MRU)
Pushing the limits of our understanding of fundamental interactions	Hot and dense matter	Dark Matter
Origin of mass, flavour puzzle, and imbalance between matter and anti-matter	Nuclear structure, nuclear reactions, and superheavy elements	Neutrino properties
Evolution of the early universe and the nature of the dark sector	Properties of hadrons and their excitation spectrum	Multi-messenger view of the high-energy universe

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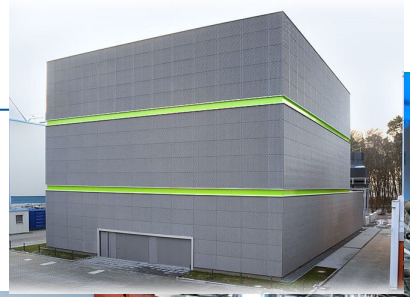
Large Facilities are a central element

to enable ambitious research program

MATTER AND THE UNIVERSE

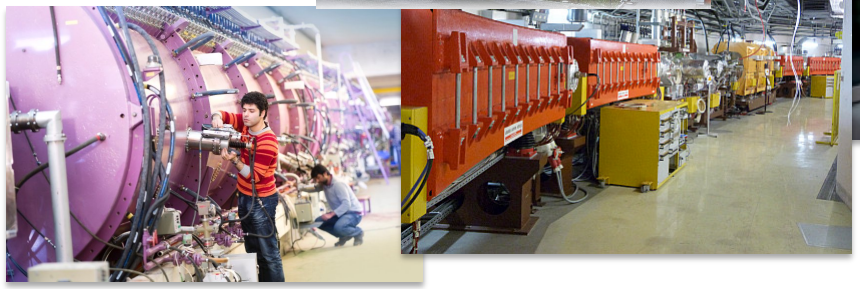
Helmholtz Facilities	Full cost	FTE
User Facility: GridKa	**7.3 M€/yr**	**20**
User Facility: GSI-MU Facilities	**23.6 M€/yr**	**130**

Green IT Cube



Largest Tier-1 (CPUs)

UNILAC



International projects

ATLAS, CMS, ALICE

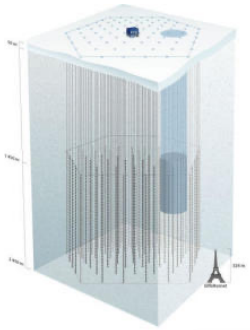
Belle II

GSI & FAIR: CBM, NUSTAR, PANDA

Cherenkov telescopes (CTA)

Pierre Auger Observatory

KATRIN

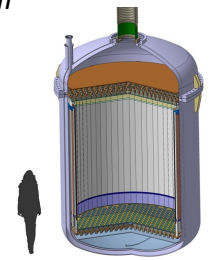


IceCube

XENONnT

BabyIAXO

ALPS-II



DARWIN

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Thursday

09:00	**Welcome and introduction to PoF and MU** *Auditorium*	*Beate Heinemann et al.* 09:00 - 09:20
	Highlights from the Topic FPF *Auditorium*	*Kai Schmidt-Hoberg* 09:20 - 09:40
	Highlights from the Topic CML *Auditorium*	*Frank Maas* 09:40 - 10:00
10:00	**Highlights from the Topic MRU** *Auditorium*	*Christian Stegmann* 10:00 - 10:20
	Highlights of GridKa *Auditorium*	*Dr. Max Kühn* 10:20 - 10:40
	Highlights of GSI MU facilities *Auditorium*	*Yvonne Leifels* 10:40 - 11:00
11:00	**Coffee break**	11:00 - 11:30
	Status of neutrino parameters and cosmological constraints *Auditorium*	*Thomas Schwetz-Mangold* 11:30 - 12:00
12:00	**Charge radii of fermium isotopes and reduction of shell effects in heavy nuclei** *Auditorium*	*Jessica Warbinek* 12:00 - 12:30

Thursday

Note: no credit/EC card payment possible in DESY canteen

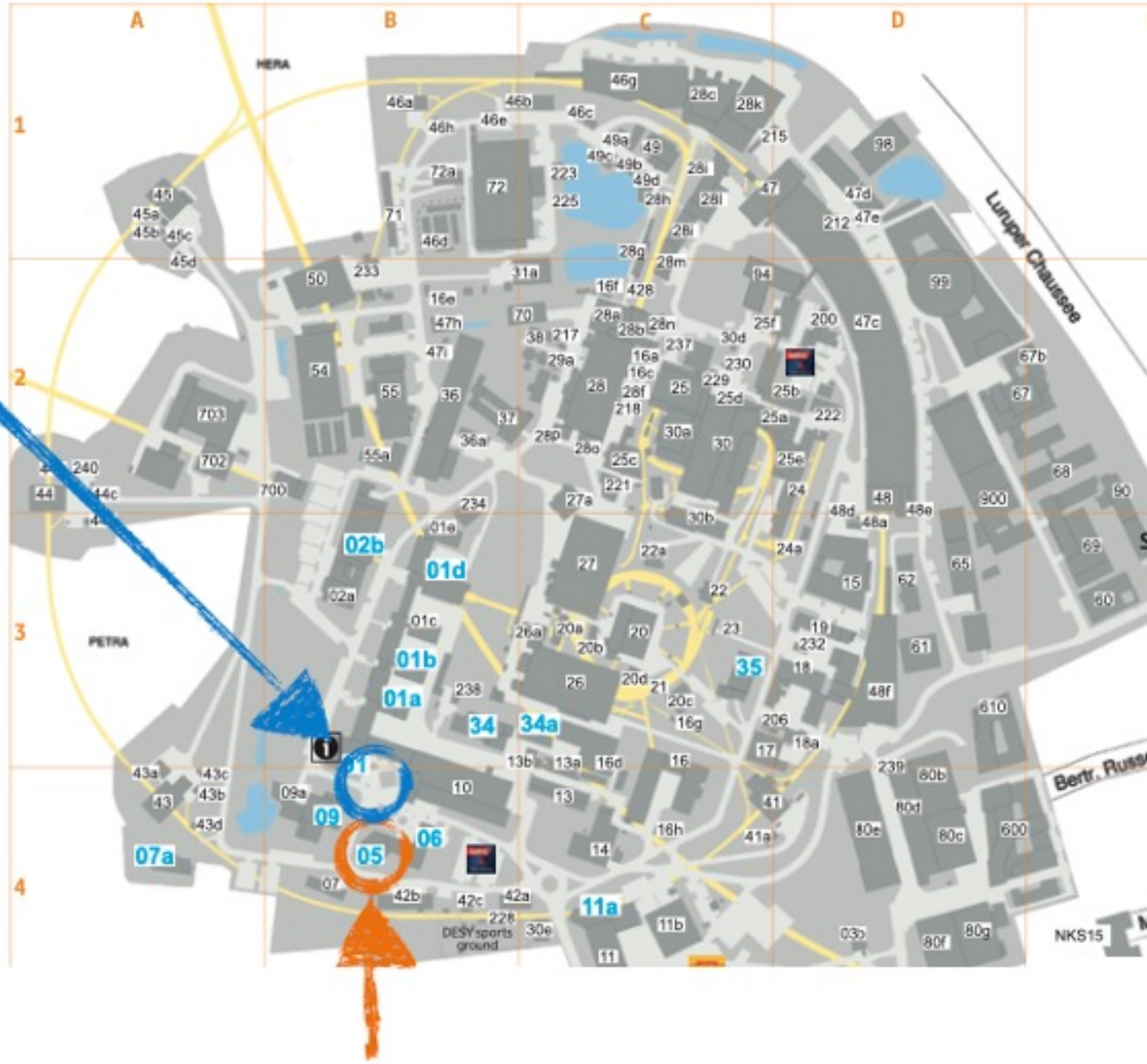
Guided tours to DESY facilities/experiments

Meeting point of all: In front of Building 1

13:30-15:15

Campus Tour: 4 guided groups

ALPS Tour: Organised transfer by car



Thursday

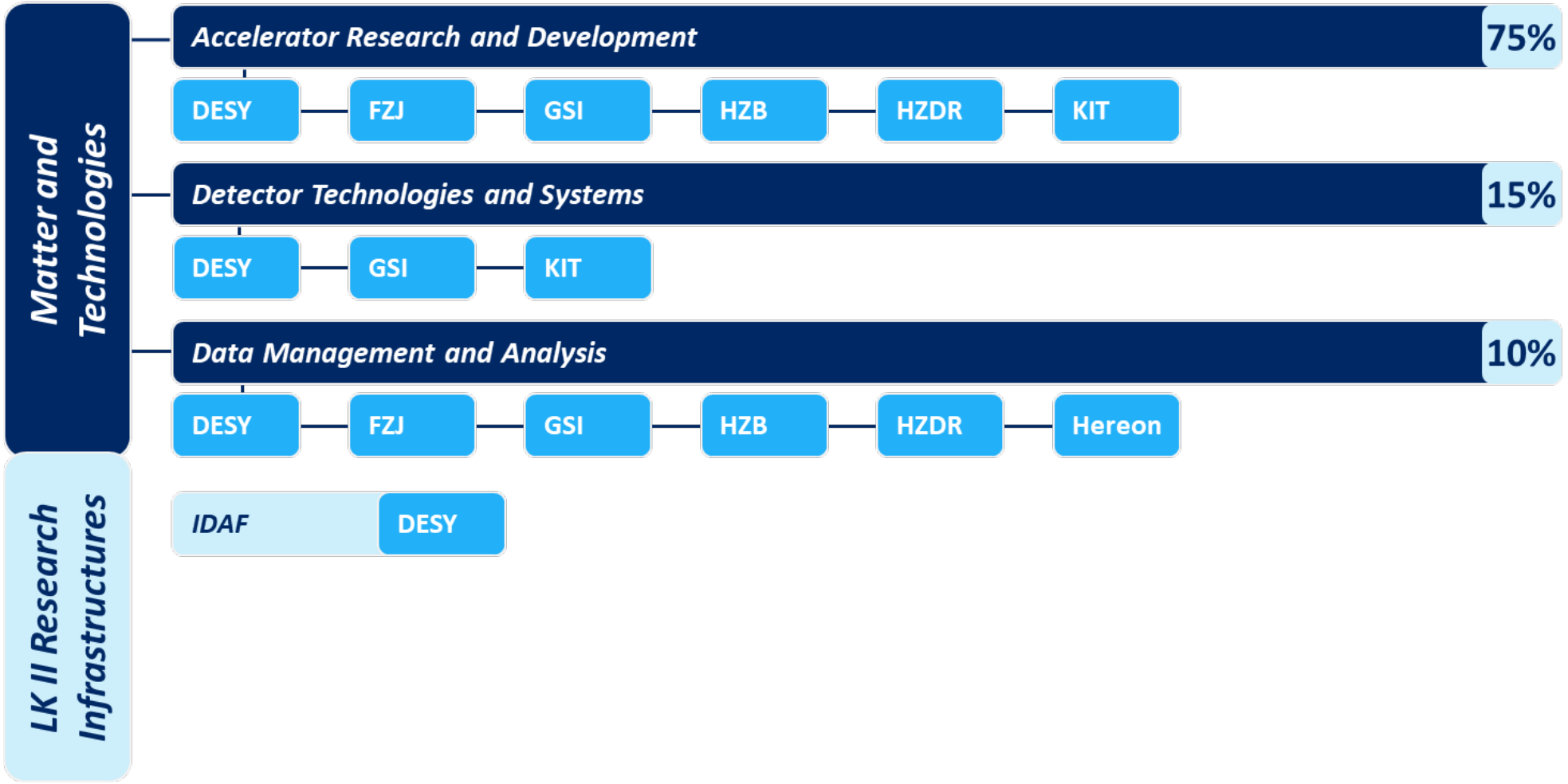
	Probing the BSM landscape through … *Lukas Allwicher*	**Modeling radio and X-ray afterglows …** *Chengchao Yuan*	**First searches for axion and dark ph…** *David Leppla-Weber*
16:00	**Model independent Time Violation st…** *Kiran Sharma*	**Calibrated Atomic Data and 3D Radia…** *Andreas Floers*	**XLZD - Towards the Ultimate Liquid-…** *Alexey Elykov*
	The JUNO experiment: current progr… *Cristobal Morales*	**Impact of neutrino oscillations in nu…** *Heamin Ko*	**Large neutrino mass in cosmology …** *Cristina Benso*
	Higher-order corrections for Higgs p… *Marco Vitti*	**Studying hadron production mechan** *Saket Kumar Sahu*	**Looking for a SFOEWPT in the RxS…** *Alain Verduras Sc…*
	The PUNCH4NFDI Consortium *Christiane Schneide*	**Towards solving the muon problem i…** *Tanguy Pierog*	**Highlights from Auger and AugerPri…** *Dr. Darko Veberic*
17:00	**AI agents for ground-based gamma …** *Dr. Dmitriy Kostunin*	**High precision measurement of the …** *Malte Christian Wi…*	**The parsec-scale jets of the SS 433 …** *Michelle Tsirou*
	Precise quantum angle generator de… *Saverio Monaco*	**Measurement of the pion transition f…** *Oliver Noll*	**The astrophysical impact of 205Tl b…** *Thomas Neff*
	Finding excesses in model paramete… *Kierthika Chathirat…*	**KATRIN++ - Development of New Det…** *Neven Kovac*	**Long-term data preservation for the …** *Gernot Maier*
18:00	**Poster session: Poster session** Poster session in canteen extension *Canteen extension* 17:45 - 19:00		
19:00	**Dinner** Dinner in DESY canteen		

Friday

09:00	**The Detector Upgrades for HL-LHC** *Auditorium*	*Doris Eckstein* 09:00 - 09:15
	FAIR and Its Experiments - Status and Plans *Auditorium*	*Yvonne Leifels* 09:15 - 09:30
	Neutrinos in Greenland - RNO-G *Auditorium*	*Anna Friederike Nelles* 09:30 - 09:45
	From KATRIN to KATRIN++ *Auditorium*	*Markus Steidl* 09:45 - 10:00
10:00	**Strategy of the Program MU for PoF V** *Auditorium*	*Ralph Engel et al.* 10:00 - 10:15
	Discussion time *Auditorium*	10:15 - 10:30
	Workshop photo	10:30 - 11:00
11:00	**Coffee break**	11:00 - 11:30
	Highlights from the Program "Matter and Technologies" (MT) *Auditorium*	*Friederike Januschek* 11:30 - 12:00
12:00	**Accelerating Scientific Discovery with AI** *Auditorium*	*Gregor Kasieczka* 12:00 - 12:30
	Plenary session: Conclusions and farewell *Auditorium*	12:30 - 13:00
13:00		

Backup slides

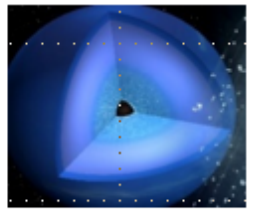
The Program Matter and Technologies (MT)

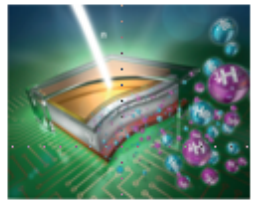


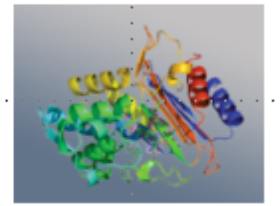
The Program From Matter and Materials to Life (MML)

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				