

MU Days 2026 – Introduction and Overview

The background is a complex, abstract composition. It features a dark blue, starry space-like texture. Overlaid on this are several scientific motifs: a large green sine wave curves from the bottom left towards the top right; a blue arc with a white dotted line runs across the middle; a red sine wave is visible in the upper left; a series of vertical blue and white spheres are in the upper center; a complex, multi-layered circular structure with red and blue lines is on the right; and a faint, large-scale spiral is in the bottom right.

Ralph Engel, Elisabetta Gallo & Bianca Keilhauer

Helmholtz Mission

Sustainable research shapes the future

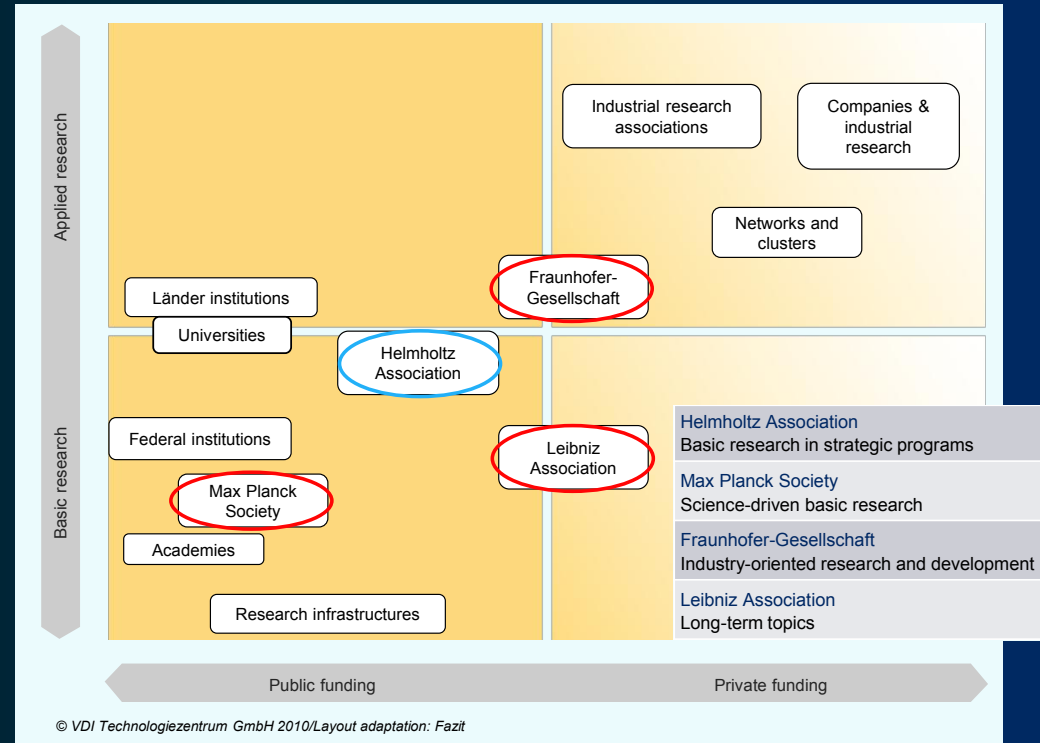
We are shaping the world of tomorrow. We provide answers to the big questions of our time and develop solutions for the future. We conduct research in the fields of energy, earth & environment, health, information, aeronautics, space & transport and matter.

We work in a networked manner with a clear focus. Our overarching research programs connect the 18 Research Centers. Our partners are leading experts and institutions from Germany and abroad. Independent experts review our long-term research programs. Their judgment determines whether and how we use funding.

We disseminate our knowledge to society. Our researchers take a holistic approach to complex challenges: They engage in basic research, but also quickly bring innovative solutions into practice. We make our knowledge freely accessible to the general public as well as to interested parties from science and industry.

We rely on cutting-edge technologies. We develop and operate a network of large-scale equipment and test facilities that is unique in the world. It is open to scientists from all over the world.

We promote talent worldwide. Our employees form the basis for our cutting-edge research. We support them at every stage of their scientific development. Diversity, equal opportunities and the compatibility of career and family are a matter of course for us.



(shown by Martin Keller at Strategic Evaluation)

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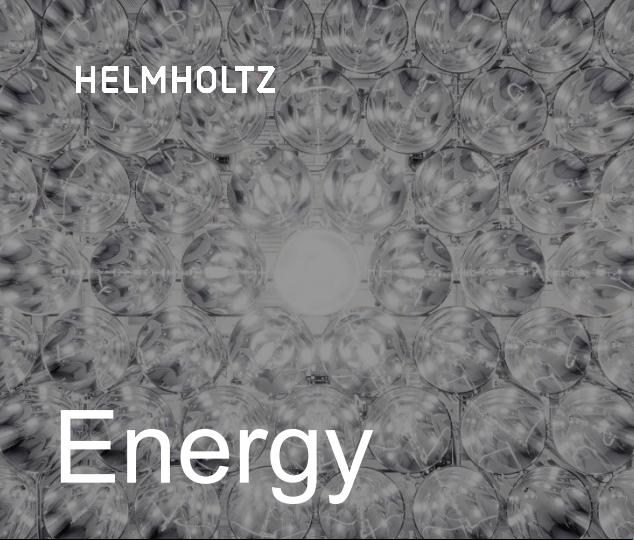
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18 Centers
47,500 employees
9,000 PhD students
6.3 billion euros



HELMHOLTZ

Energy



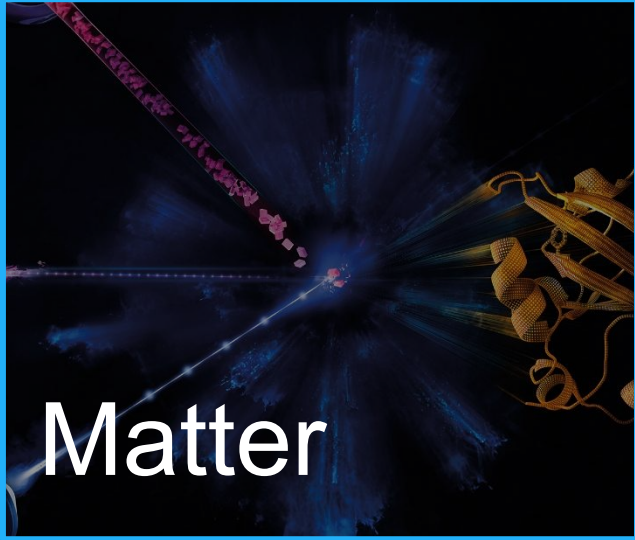
Earth and
Environment



Health



Aeronautics,
Space and
Transport



Matter



Information

Research Field Matter

Addressing challenges of the next decades

Exploring Matter & Universe:

From quantum to cosmos

Use-inspired Basic Research:

From invention to innovation and impact

Operating Unique Infrastructures:

For science, industry & partners

Fostering Partnerships & Talent:

Collaborations, alliances, outstanding people

Technology Independence:

Sovereignty, resilience, sustainability

(shown by Sebastian Schmidt at Strategic Evaluation)



7 Centers and
2 Institutes
14 Facilities

2,750 FTE
650 PhD students
8,000 users/yr
770 million euros

Research Field Matter

Organizational structure – Helmholtz Programs

Exploring Matter & Universe:

From quantum to cosmos

Use-inspired Basic Research:

From invention to innovation and impact

Operating Unique Infrastructures:

For science, industry & partners

Fostering Partnerships & Talent:

Collaborations, alliances, outstanding people

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(shown by Sebastian Schmidt at Strategic Evaluation)



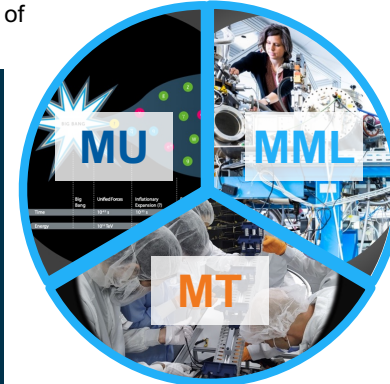
MATTER AND
THE UNIVERSE

Addressing most fundamental
questions on the nature of
matter and the structure of
the universe



FROM MATTER TO
MATERIALS AND LIFE

Ranging from curiosity-
driven to application-driven
research in new materials
and bio-structures

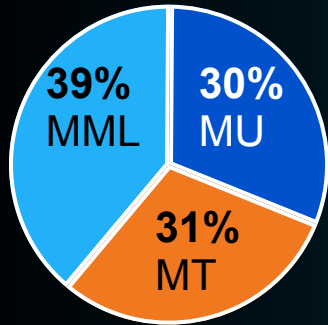


MATTER AND
TECHNOLOGIES

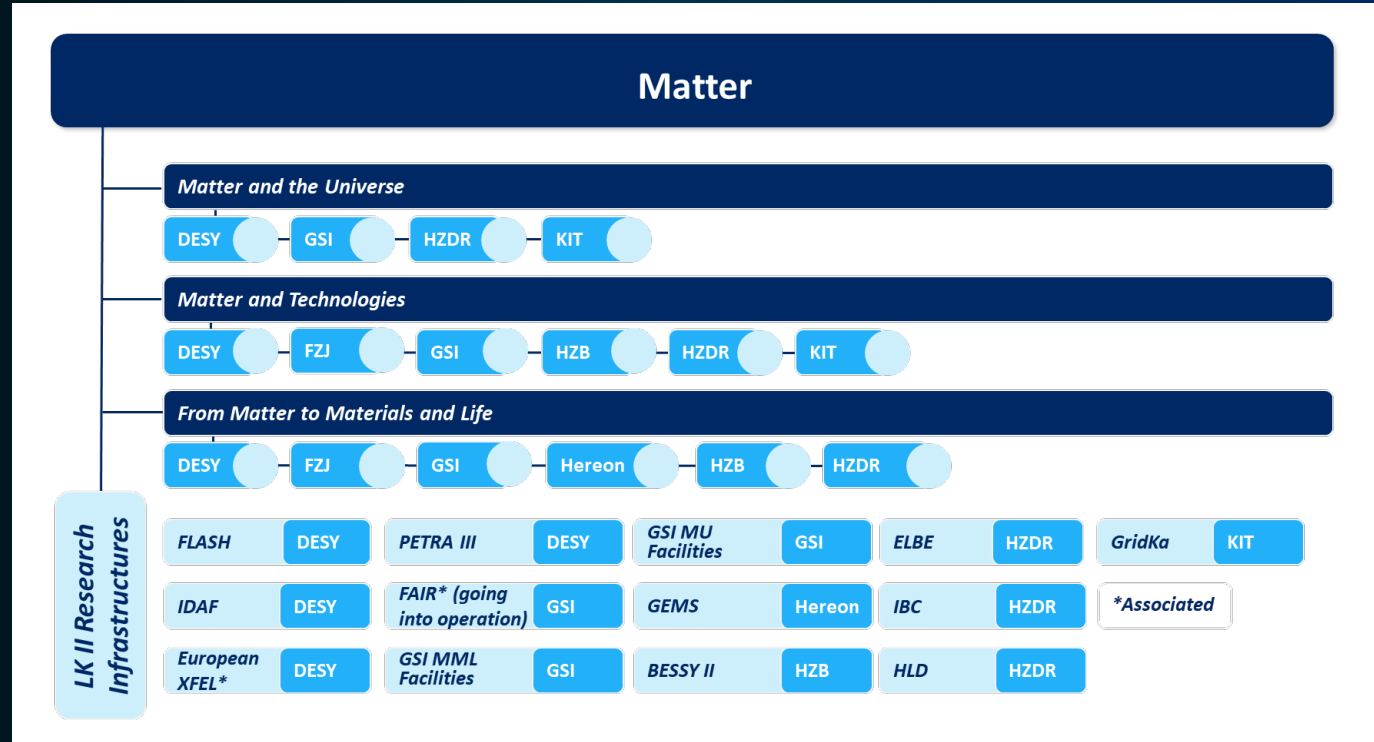
Delevoping advanced technologies
for accelerators, detectors
and data/computing systems

Research Field Matter

Organizational structure – Programs, Centers, and Facilities



Current budget
distribution



Matter and the Universe

SPOKES-
PERSONS



Ralph
Engel



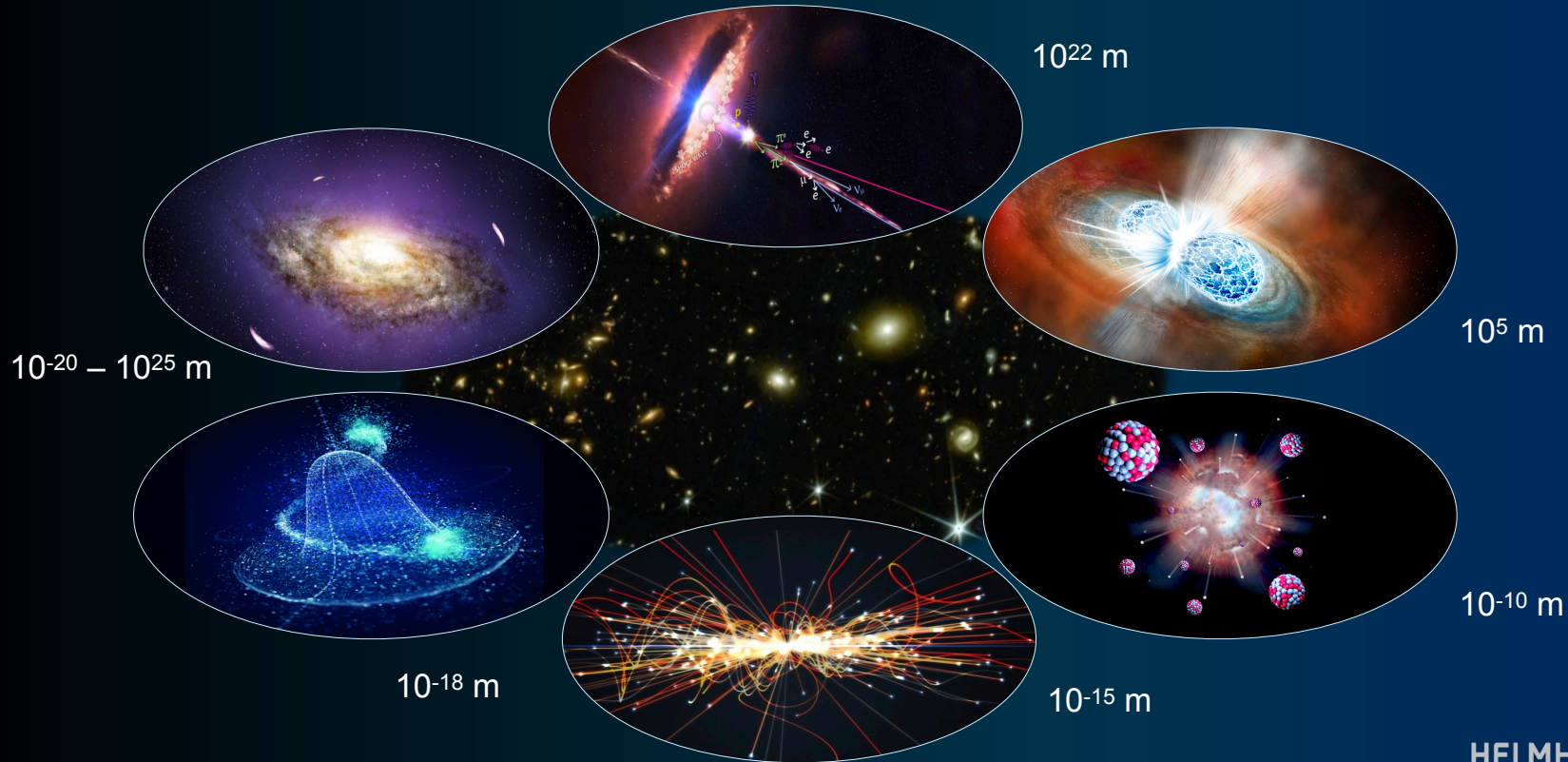
Elisabetta
Gallo



Research for grand challenges.

Connecting the quantum world with the universe

Building the foundations of our understanding of the world



Connecting the quantum world with the universe

Building the foundations of our understanding of the world

Properties of neutrinos

Role of axions

Nature of
Dark Matter

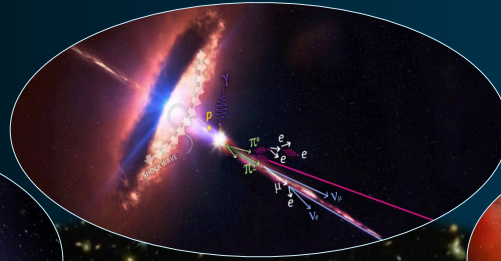
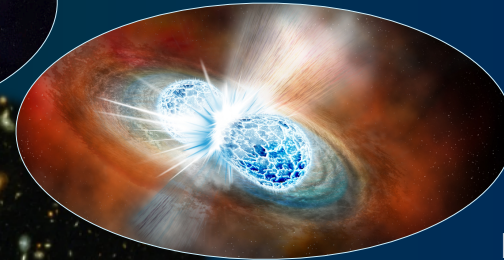
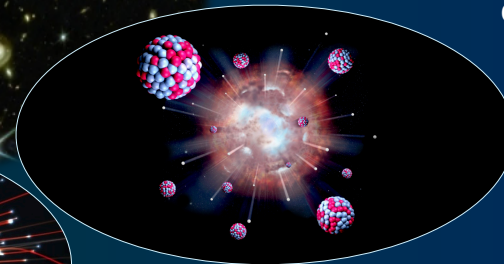
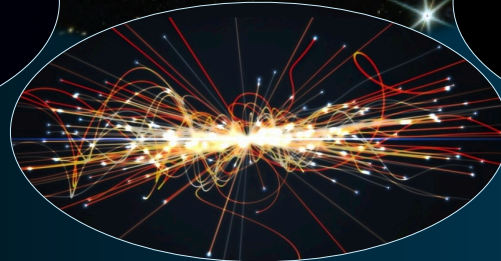
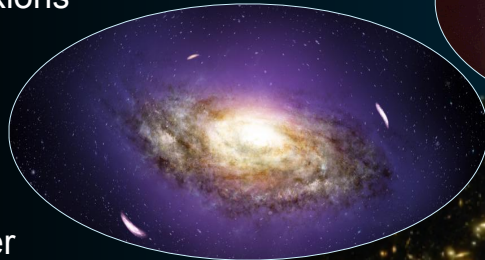
Vacuum
and Higgs

Matter-antimatter
asymmetry

Extreme processes and
multi-messenger radiation

Matter under
extreme conditions

Production of
heavy elements



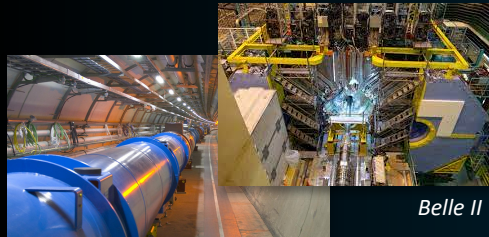
Organizational structure and methods follow from physics questions and scientific approach

Topics

- Fundamental Particles and Forces (FPF)
- Cosmic Matter in the Laboratory (CML)
- Matter and Radiation from the Universe (MRU)

User Facilities

- GSI MU Facilities
- GridKa



ATLAS, CMS, ALICE

Belle II



GSI & FAIR: CBM,
NUSTAR, PANDA

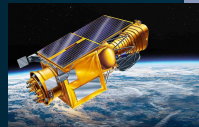


Felsenkeller



Pierre Auger
Observatory

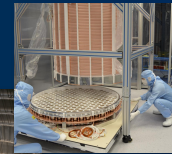
ULTRASAT



Cherenkov telescopes



KATRIN



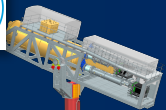
XENONnT



XLZD



ALPS-II



BabyIAXO



IceCube



GridKa



SIS-18

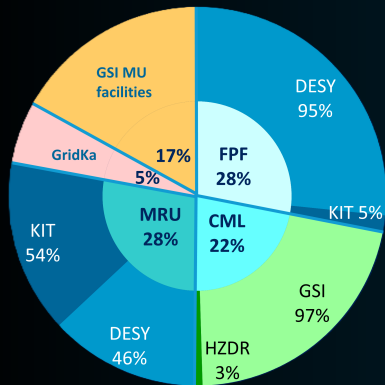


Green IT Cube



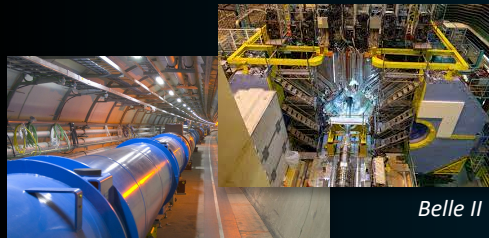
Organizational structure and methods

follow from physics questions and scientific approach



366 scientists, 148 PhD students,
177 support personnel, 138 M€/yr

(plan for 2028)



ATLAS, CMS, ALICE

Belle II

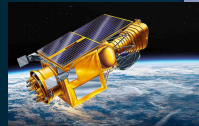


GSI & FAIR: CBM,
NUSTAR, PANDA



Felsenkeller

ULTRASAT



Cherenkov telescopes



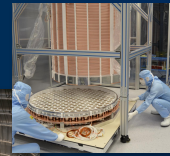
Pierre Auger
Observatory



KATRIN



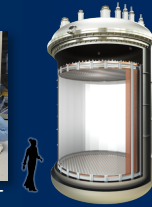
IceCube



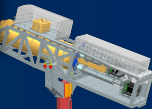
XENONnT



ALPS-II



XLZD



BabyIAXO



GridKa



SIS-18

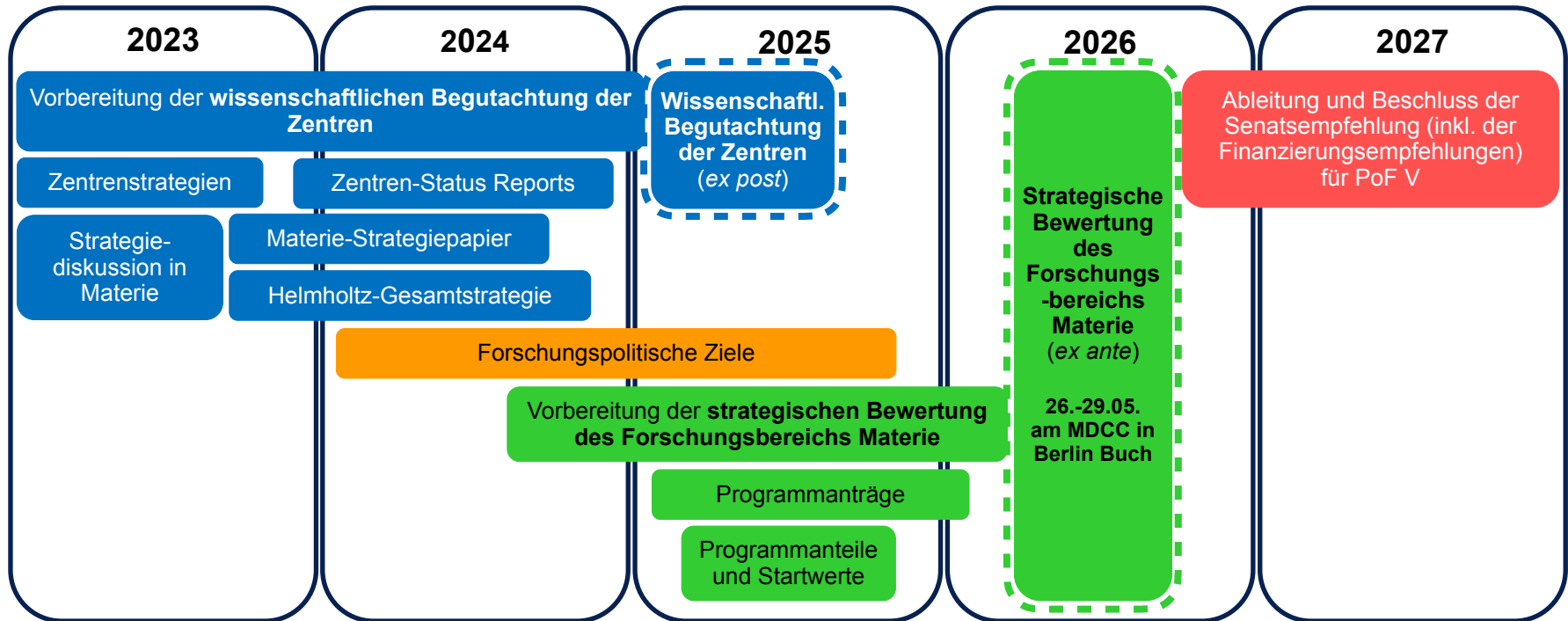


Green IT Cube



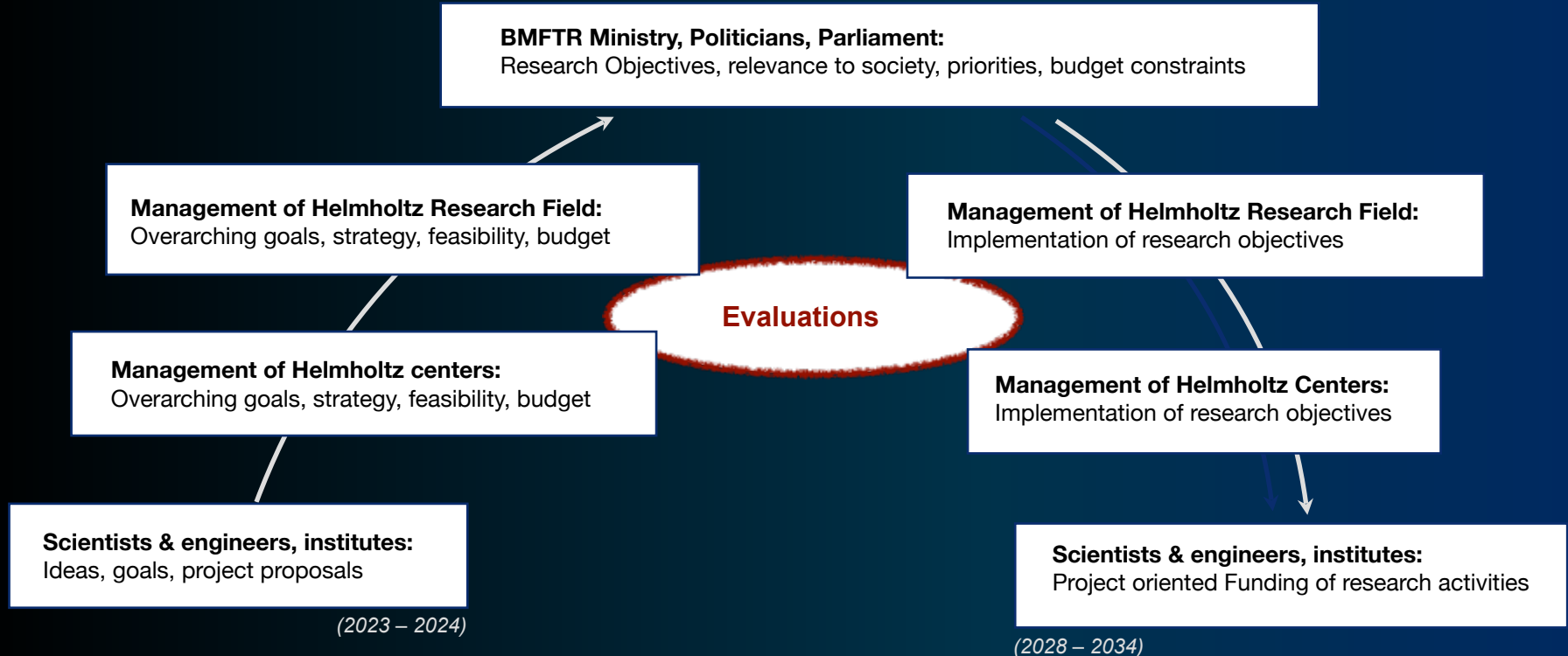
Program-oriented Funding (PoF)

Schedule from PoF IV (2021 – 2027) to PoF V (2028 – 2034)



Transition from PoF IV to PoF V

Process of defining strategy, setting priorities, and allocating funds



Preparation of PoF V

Research Policy Objectives (Forschungspolitische Ziele)

Topic Fundamental Particles and Forces (FPF)

The general objective of the Topic FPF is to gain new fundamental insights into the nature of dark matter and the Higgs boson, as well as the origin of the matter–antimatter asymmetry in the universe. The focus is to be on fundamental experimental work as well as theoretical and phenomenological work. The experimental activities will be based on a portfolio of leading participations in world-class experiments in an international environment, such as the experiments at the LHC and at a future flagship project at CERN, as well as complementary experiments carried out at the participating Helmholtz centers. The Helmholtz centers DESY and KIT contribute to this Topic.

*Final version of
Research Policy Objectives for PoF V*

- **Objective 12:** The upgrades of the ATLAS and CMS detectors for the HL-LHC are to be carried out and commissioning is to be performed. The aim is to carry out initial physics analyses with the new data.
Target date: 2032
Center responsible for achieving the objective: DESY
- **Objective 13:** The BabyIAXO experiment is to be set up and commissioned. The aim is to carry out initial physics analyses with the new data.
Target date: 2034
Center responsible for achieving the objective: DESY

Preparation of PoF V

Research Policy Objectives (Forschungspolitische Ziele)

Topic Cosmic Matter in the Laboratory (CML)

In this Topic, research is to focus on unraveling the secrets of strongly interacting matter under extreme laboratory conditions in order to understand, among other things, the microscopic properties and phase structure of QCD matter and the formation of heavy elements in our universe. The complexity of matter will be studied on all length scales, from the behavior and composition of hadrons made up of quarks and gluons as well as the dynamic generation of their mass, to the complex and diverse structures of atomic nuclei and nuclear matter and their significance for the evolution of our universe. The CBM and NUSTAR experiments at the future FAIR accelerator complex and ALICE at the LHC at CERN will serve as central foundation for new scientific discoveries.

*Final version of
Research Policy Objectives for PoF V*

- **Objective 14:** Initial physics analyses will be carried out using new data from the NUSTAR experiment at the International FAIR Facility.
Target date: 2030
Center responsible for achieving the objective: GSI
- **Objective 15:** The CBM detector at the SIS100 accelerator at the International FAIR Facility is to be set up and put into operation.
Target date: 2031
Center responsible for achieving the objective: GSI

Preparation of PoF V

Research Policy Objectives (Forschungspolitische Ziele)

Topic Matter and Radiation from the Universe (MRU)

The general objective of the Topic MRU is to determine the nature and properties of dark matter and neutrinos and to investigate high-energy particles and processes in the universe. Dark matter is being searched for using xenon-based detectors, and the properties of neutrinos, in particular their mass, are being determined using the KATRIN experiment, for which the follow-up experiment KATRIN++ is planned. Work on high-energy particles and processes in the universe is to focus on fundamentally expanding our understanding of these events through observation with the world's most sensitive observatories as well as through theoretical consideration of cosmic particle signals using multimessenger analyses. The synergies between particle and astroparticle physics and the physics of hadronic matter under extreme conditions will be exploited to the full. The Helmholtz centers DESY and KIT contribute to this Topic.

*Final version of
Research Policy Objectives for PoF V*

- **Objective 16:** For the KATRIN++ experiment, key components for the atomic tritium source and the quantum detector for electrons are to be built as prototypes and tested intensively.
Target date: 2035
Center responsible for achieving the objective: KIT
- **Objective 17:** Contributions to CTAO include the construction and commissioning of telescopes for the observatory. The focus is to be on computing and contributions to the Mid-Sized Telescopes (MSTs). The aim is to obtain initial scientific findings from the new data.
Target date: 2034
Center responsible for achieving the objective: DESY

Preparation of PoF V

Proposal for the research programs (strategic proposal)



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*Proposal for Strategic Evaluation
(368 pages, submitted December 2025)*

Preparation of PoF V

Strategic Evaluation (May 26 – 28, 2026)

9:00 am	Program Matter and the Universe (Axon I)
9:00 am 10'	Results of the Scientific Evaluation of the Program Daniel Zajfman
9:10 am 10'+10'	Program Overview Ralph Engel
9:30 am 15'+ 15'	FPF – Fundamental Particles and Forces Isabell Melzer-Pellmann
10:00 am 15'+ 15'	CML – Cosmic Matter in the Laboratory Tetyana Galatyuk
10:30 am 15'+ 15'	MRU – Matter and Radiation from the Universe Kathrin Valerius, Christian Stegmann
11:00 am 10'	Coffee Break (Foyer)
11:10 am 8'+7'	User Facility GridKa – Computing and Data Center Achim Streit
11:25 am 8'+7'	User Facility GSI MU Facilities Yvonne Leifels
11:40 am 30'	Summary Discussion Program Matter and the Universe
12:10 pm 50'	Closed Session (Axon II)
1:00 pm 30'	Remaining Questions

Chair of the panel

First name	Family name	Affiliation	Country
Daniel	Zajfman	Israel Science Foundation	Israel

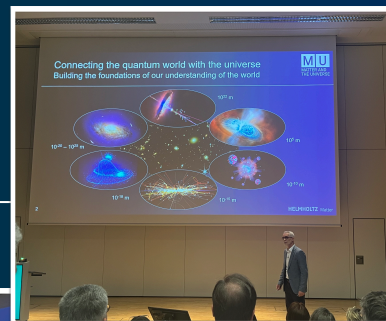
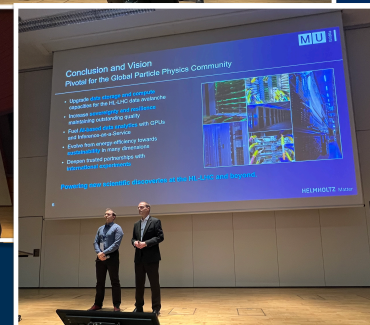
Members of the panel

First name	Family name	Affiliation	Country
Klaus	Blaum	Max Planck Institute for Nuclear Physics	Germany
Pascale	Ehrenfreund	George Washington University	USA
Trevor	Forsyth	Lund Inst. of adv. Neutron & X-ray Science	Sweden
Ora	Furman	Hebrew University of Jerusalem	Israel
Giovanna	Fragneto	European Spallation Source	Sweden
Rolf	Heuer	Formerly CERN	Switzerland
Patrizia	Rossi	Jefferson Laboratory	USA
Berthold	Schmidt	TRUMPF	Germany
Christian	Rüegg	Paul Scherrer Institute	Switzerland
Francesco	Sette	European Synchrotron Radiation Facility	France

Preparation of PoF V

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1:00 pm 30'	Remaining Questions



Two rehearsal meetings,
two very intense days of evaluation

Preparation of PoF V

Strategic Evaluation – initial notification

Program Matter and the Universe (MU) Topic 1: Fundamental Particles and Forces (FPF)

Observations:

- fully aligned with international and European research priorities in particle physics
- excellent scientific relevance, strong international visibility and the potential to contribute significantly to future developments in particle physics, detector technologies and advanced scientific computing
- scientific competence of the participating teams is outstanding
- exceptional infrastructures

Strategic Recommendations:

- Maintain the complementary balance between international flagship experiments and unique in-house experiments at DESY
- Continue strengthening preparation for the next European flagship collider programme
- Further leverage synergies across Helmholtz programmes.
- Sustain investment in talent development, theory-experiment integration and international collaborations

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Program Matter and the Universe (MU) Topic 2: Cosmic Matter in the Laboratory (CML)

Observations:

- The **highest-caliber scientific objectives** lead international hadron and nuclear physics, bridging fundamental interactions with macroscopic cosmic evolution and search for physics BSM.
- The work plan is **well synchronized** with the **strategic objectives of the Helmholtz Matter research** built around the construction and milestone execution of FAIR.
- Helmholtz **scientists exercise international leadership** across major facilities, demonstrating **excellent capabilities** in advancing the research field.

Strategic Recommendations:

- Management must **prioritize transitioning** from legacy GSI setups (SIS18) to FAIR capabilities (SIS100, Super-FRS) by maximizing Phase-0 scientific output.
- To bridge the HESR antiproton timeline, management should **formally integrate QCdatFAIR**, anchoring hadron physics expertise and early-career scientists to **FAIR infrastructure**.
- Where possible, **profit aggressively on the conclusion of RHIC operations** to establish GSI/FAIR as the premier destination for the high-net-baryon-density physics community.

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Program Matter and the Universe (MU)

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

Observations:

- MRU presents a roadmap for multi-messenger astrophysics that advances neutrino physics, dark matter searches, and gravitational-wave science, through the operation, upgrading, and contributing to the construction of world-leading international research infrastructures.

- The MRU work plan is very ambitious: DESY and KIT should follow closely the cooperation planning process

Strategic Recommendations:

- Given the number of infrastructure projects and system upgrades underway and planned, the teams should incorporate a formal risk management exercise into planning and governance for POF V to improve coordination across initiatives and stabilize the workforce as multiple projects progress simultaneously.
- Another critical component will be retaining highly specialized personnel and attracting top new talent to sustain international competitiveness and secure third-party funding for shorter science projects

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Research Field MATTER

	Funding categories
	A/B/C
Matter and the Universe	
Fundamental Particles and Forces	A
Cosmic Matter in the Laboratory	B
Matter and Radiation from the Universe	A
Matter and Technologies	
Accelerator Research and Development	A
Detector Technologies and Systems	A
Data Management and Analysis	B
From Matter to Materials and Life	
Matter – Dynamics, Mechanism, and Control	B
★ Materials – Fundamentals, Function, and Processes	B
Life – Structure, Function, and Regulation Across Scales	A

Julich/Neutron
Research

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HELMHOLTZ Matter

Preparation of PoF V

Strategic Evaluation – report and recommendations

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Research Field Matter Evaluation Report

May 26 - 29, 2026

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Content

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1 Research field Matter	
2 Programme "Matter and the Universe" (MU)	
2.1 Topic "Fundamental Particles and Forces" (FPF)	
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2.3 Topic "Matter and Radiation from the Universe" (MRU)	
3 Programme "Matter and Technologies" (MT)	
3.1 Topic "Accelerator Research and Development" (ARD)	
3.2 Topic "Detector Technologies and Systems" (DTS)	
3.3 Topic "Data Management and Analysis" (DMA)	
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Ilja Bohnet

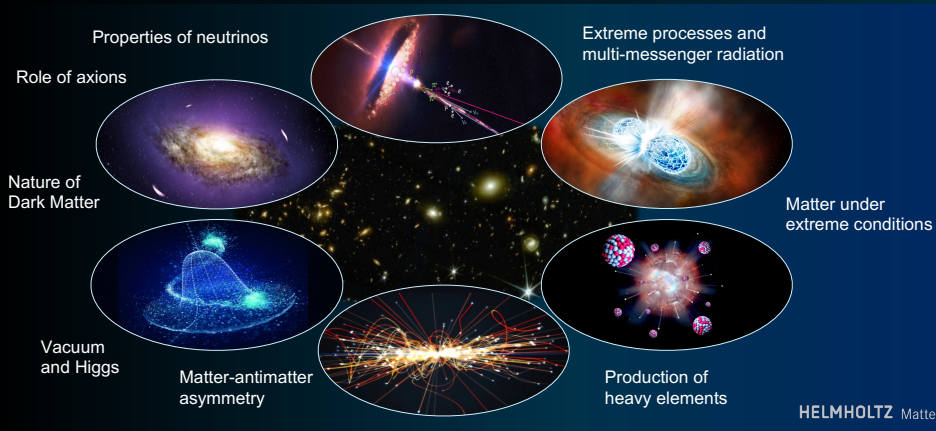
Maïke Kohlmorgen, Sylke Selzer,
Margaux Köhler, Nicolas Villacorta,
Sören Wiesenfeldt, Harald Buddeweg,
Viktoria Güldner, Sandra Hamann,
Petra Engelbert and many others

Reviewing Matter:
often particles, perhaps dark, mostly condensed,
sometimes even alive

Thank you

Strategic Evaluation

Remarks on strategy of the Program MU



- Highly coherent and scientifically ambitious
- Exceptionally well aligned with the mission of the Research Field and Research Policy Objectives
- Fostering innovation through large-scale collaborative research
- Impressive commitment to training and attracting young scientist

Resource planning is generally appropriate to the scale and ambition of the program

A major strength lies in the scientific competences and world-leading infrastructures

Recommendation: continue to capitalize on its unique balance of international projects and strong in-house capabilities

Selected specific recommendations to the Topics

Fundamental Particles and Forces (FPF)

- Maintain the complementary balance between international flagship experiments and in-house experiments at DESY and continue strengthening preparation for the next European flagship collider

Cosmic Matter in the Laboratory (CML)

- Prioritize transitioning towards FAIR capabilities while maximizing First Science (+) programs and maximize the impact of FAIR2028 facilities

Matter and Radiation from the Universe (MRU)

- Incorporate a formal risk management exercise into the planning, retain highly specialized personnel and attract top new talents

Remarks on LKII

- Strong support to **GridKa** as outstanding user facility and of the TIER upgrade for HL-LHC
- Mitigations are underway for the UNILAC fire at **GSI**, with minor impact on the long term core program of these unique facilities **for ion beam research**

Rating topic Fundamental Particles and Forces				
Scientific goals and strategic relevance				
X Outstanding	☐ Excellent	☐ Very good	☐ Good	☐ Fair
Scientific competence				
X Outstanding	☐ Excellent	☐ Very good	☐ Good	☐ Fair
Implementation				
☐ Outstanding	X Excellent	☐ Very good	☐ Good	☐ Fair

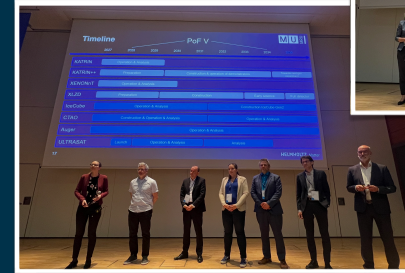
Rating topic Cosmic Matter in the Laboratory				
Scientific goals and strategic relevance				
X Outstanding	☐ Excellent	☐ Very good	☐ Good	☐ Fair
Scientific competence				
☐ Outstanding	X Excellent	☐ Very good	☐ Good	☐ Fair
Implementation				
☐ Outstanding	X Excellent	☐ Very good	☐ Good	☐ Fair

Rating topic Matter and Radiation from the Universe				
Scientific goals and strategic relevance				
X Outstanding	☐ Excellent	☐ Very good	☐ Good	☐ Fair
Scientific competence				
X Outstanding	☐ Excellent	☐ Very good	☐ Good	☐ Fair
Implementation				
☐ Outstanding	X Excellent	☐ Very good	☐ Good	☐ Fair

Lessons learnt

- Timely realization of large international infrastructures (FAIR, HL-LHC, astrophysical observatories...) will be crucial for the success of the program
- Further strengthen integration between theoretical, experimental, computational and technology activities, while ensuring flexibility to adapt to new developments
- Continued strategic coordination among the centers and prioritization of resources is needed to maximize the impact on international level and a risk-management framework is recommended

"Overall, the Programme represents an internationally leading and scientifically compelling research portfolio with outstanding long-term potential."

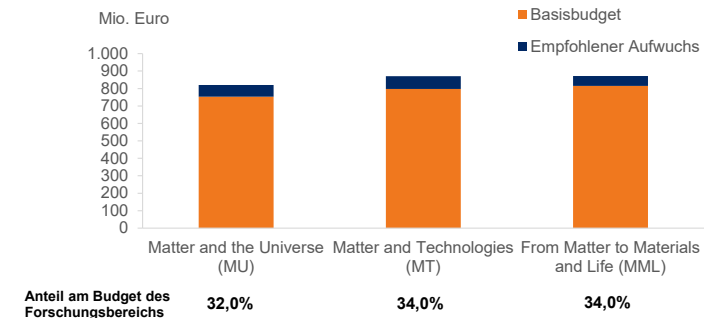


Great team work and an occasion to discuss our program all together

Strategic recommendations at the level of the entire research field “Matter”:

- The combination of highly qualified scientists, sustainable resources, and large-scale facilities for long-term research and development within the research field is truly unique worldwide. So, continue investments in highly qualified personnel, instrumentation, facility upgrades, software sustainability, and advanced computing. In particular, empower the strategic opportunities within the programmes by
 - strengthening the area of artificial intelligence across all programmes & topics with priority; future incremental investments should preferentially target AI-driven science and infrastructure, quantum technologies & sensing, software sustainability, advanced computing, neutron-based research capabilities, and interdisciplinary initiatives that connect the three programmes;
 - provide a natural bridge between the three programmes with quantum technologies and quantum sensing by corresponding investments, and
 - increase the convergence of R&D activities in fundamental physics, materials science, biology, computation, and engineering.
- Strengthen mechanisms that promote crosstalk and synergy (including shared facilities, cross-center collaborations, joint technology development, common data infrastructures, and interdisciplinary scientific networks) through targeted cross-programme funding, shared personnel initiatives, coordinated strategic planning, and common technology platforms.
- Ensure that research and development priorities remain strongly aligned with the implementation timelines and technical requirements of the national roadmap projects and major infrastructures, see recommendations for the Large-scale Research Infrastructures below. Formal risk-management processes for major infrastructure projects should remain central priorities.

Funding recommendations PoF V



Preparation of PoF V

Draft of Senate Recommendations – Program MU

Strategic recommendations at the level of the programme “Matter and the Universe”:

- A central priority for the coming funding period should be the successful transition toward the next generation of planned experiments and research infrastructures.
- Particular attention should be devoted to coordinated strategic planning and proactive risk management across the major infrastructure projects of the program and upgrades currently underway involving complex timelines, distributed collaborations, and substantial technological dependencies (for instance “Early Science” and “First Science” at FAIR).
- The programme should further strengthen integration between theoretical, experimental, computational, and technology-development activities, while ensuring sufficient flexibility to adapt to delays or changing international conditions.
- In parallel, workforce development should remain a strategic priority, including sustained support for graduate training, early-career scientists, and targeted short-term scientific initiatives that can rapidly exploit new opportunities.

Compliance with these recommendations will be checked every year

Preparation of PoF V

Large-scale investment planning (Category A, 15 – 50 M€)

Antrag	Zentrum	Einreichung	Projektdauer	Kommentar
TIER-Upgrade	KIT (DESY, GSI)	2025	2027-2032	Zur Förderung ausgewählt
HELIAC	GSI (HIM)	2026	2028-2033	Durch FBP beschlossen
Data Center Berlin	HZB (MDC)	2027	2029-2032	In Vorbereitung
CMWS	DESY (HZDR, HZB, Hereon)	2028	2030-2035	In Vorbereitung
LAB4Nano	HZDR	2029	Ab 2031	In Vorbereitung
KATQuAt	KIT	2030	Ab 2032	In Vorbereitung

Current policy: each Research Field can submit one proposal per year in Cat. A for Helmholtz funding

Preparation of PoF V

Large-scale investment planning (Category C, international projects)

Proposed project	Investment in MEUR (project in total)	Time frame of the proposed project	Helmholtz Matter centers	Matter Program s	Project status
IceCube-Gen2 Next-generation neutrino observatory at the South Pole	52 (382)	2029-2038	DESY KIT	MU	prioritized, awaiting evaluation report
XLZD Multi-purpose observatory for dark matter and neutrinos	28 (192)	2028-2035	KIT	MU, MT	in preparation
ET Einstein Telescope gravitational wave detector	Under discussion (2,400)	from 2026	under discussion: DESY, HZDR, KIT, (DZA)	MU, MT	under discussion
Future Flagship Collider preparation DESY preparatory project of the next flagship collider at CERN	3	2028-2034	DESY	MT	under discussion
ALICE3 GSI contribution to the upgrade of the ALICE detector at CERN	5	under discussion	GSI	MT, MU	under discussion
GCOS Global Cosmic Ray Observatory	40 (390)	from 2034	KIT	MU	under discussion