POF V.

Kick-off for FH in MU-FPF

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DESY

20 May 2025

HELMHOLTZ

DESY.

Timeline for submission of the strategy report

- **Beginning of June 2025**
  Receiving Templates and official start of drafting the application
- **Summer 2025 (not yet defined further)**
  Definition of the "Startwerte" by the DESY directorate
- **19 September 2025**
  Meeting of the Lenkungsausschuss Materie (HZDR)
- **15 December 2025**
  Handing in of the report; then discussion in the MB, layout and proof-reading
- **17 March 2026**
  Final version has to be handed in
- **March 2026**
  Receiving Templates and official start of drafting the presentations
- **13-17 April 2026**
  "Hauptprobe" (MDC, Berlin Buch)
- **4-8 May 2026**
  Dress rehearsal (MDC, Berlin Buch)
- **26-29 May 2026**
  Strategical evaluation (MDC, Berlin Buch)

Internal timeline before submission

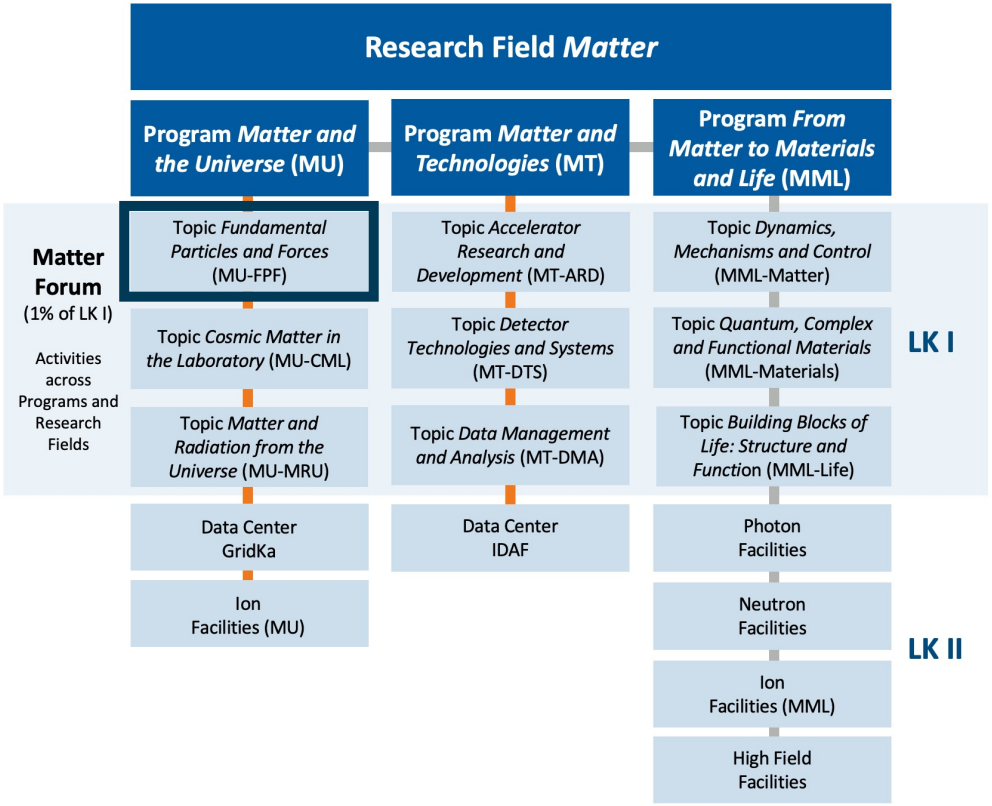
- **Today:**
  start of bi-weekly meetings of the writing team – will continue until draft is ready
- **19-20 June:**
  FH MU-FPF retreat to collect input for the writing team
- **21 July:**
  Present first summary of the strategy (including inputs from retreat) at the FH retreat

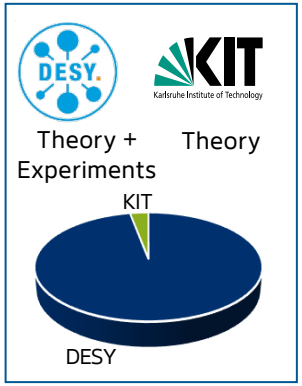
What happened so far?

- **In 2023, we had started the discussion, but stopped at some point**
- **Now we need to speed up quickly**
- **The following pages present a summary of where we stood at that time**

Reminder: FPF in MU

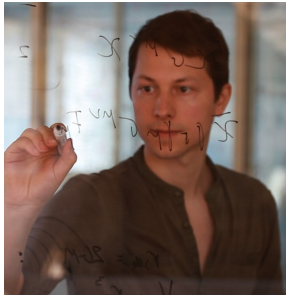
Particle physics at DESY and KIT (theory)





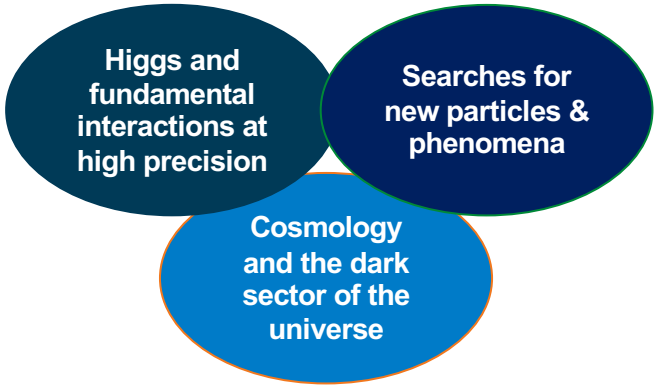
- 2 Helmholtz centers
- 3 locations
- 158 scientists
- 78 Ph.D. students
- 34 MEUR costs / a
- 42 nationalities

Topic spokespersons:
Isabell Melzer-Pellmann, Kai Schmidt-Hoberg



Changes from PoF IV to PoF V

Foreseen change / adaption of subtopic structure



PoF IV → PoF V

Pushing the limits of our understanding of fundamental interactions

The origin of mass, the flavour puzzle, and the imbalance between matter and anti-matter

The evolution of the early universe and the nature of the dark sector

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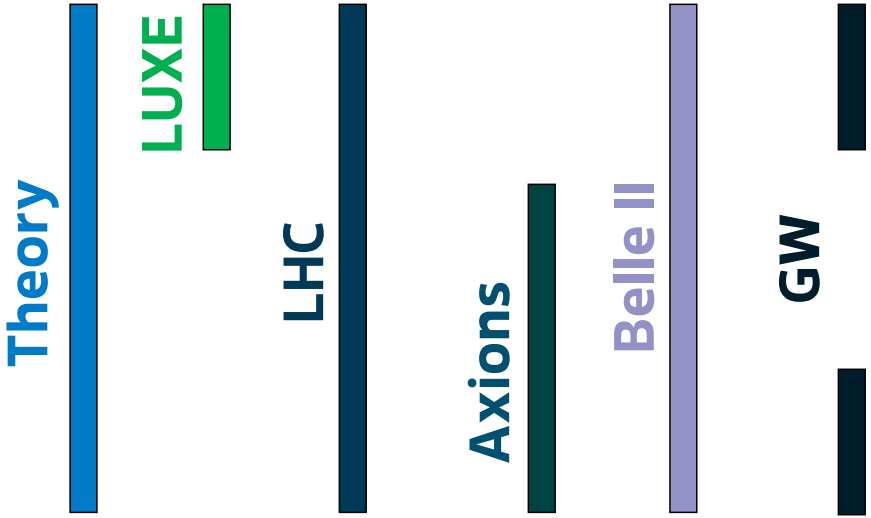

Pushing the limits of our understanding of fundamental interactions

The origin of mass, the flavour puzzle, and the imbalance between matter and anti-matter

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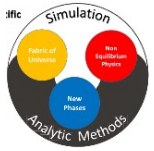
Testbeam Facility (DESY)

Detector Assembly Facility (DAF, DESY)

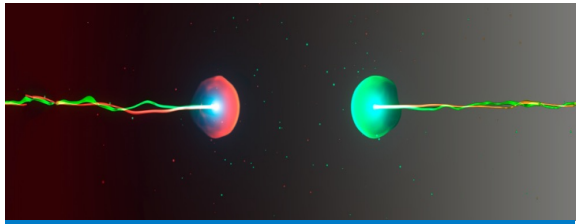
Computing Centres GridKa and IDAF

Wolfgang Pauli Centre



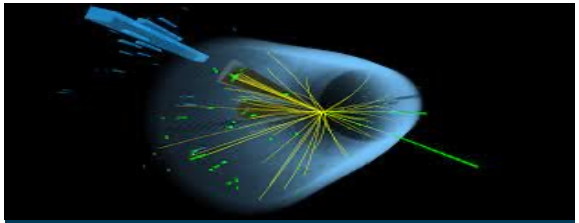
PoF V Subtopic Structure and Science Drivers

Our science drivers address the big questions of nature: Understanding the quantum universe



Pushing the limits of our understanding of fundamental interactions

- Strong-field QED
- Strong interactions, QCD
- Lattice QCD
- g-2



The origin of mass, the flavour puzzle, and the imbalance between matter and anti-matter

- Higgs boson
- Top and B physics
- Charge-parity violation
- Lepton flavour universality

The evolution of the early universe and the nature of the dark sector

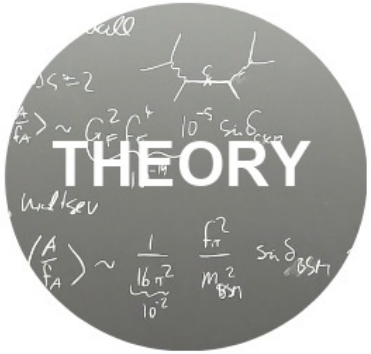
- Cosmology
- Axions, ALPs
- Gravitational waves
- Dark matter

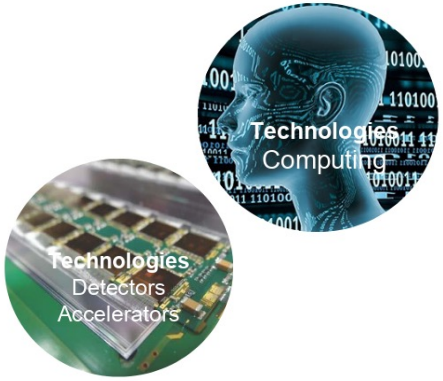
Fundamental curiosity-driven science

- Development of cutting-edge technologies (detectors, computing, accelerators, lasers, …)
- Very attractive for young high-potentials
- High potential for disruptive technology development important for society, e.g. WWW, imaging technologies, cloud computing, …

Particle Physics at DESY: the Next 10-15 Years

Specific focus areas





Key contributions to global projects at CERN and KEK
- HL-LHC preparation and running in 2029 onwards
- Belle II: expect ~50/ab by 2034

Engage in planning and preparation for future projects (EPPSU decision by 2028)

Maintain broad and world-leading portfolio.

Establish WPC as world-leading interdisciplinary center for theoretical physics

Theory as "Idea factory"

ALPS II: first science run started running in May 2023.
BabyIAXO, LUXE: Solve challenges & find financial resources for PoF V
MADMAX: proof concept in prototyping phase & find financial resources
New ideas, e.g. HF GW local experiments (complementing ET)

~50% of topic resources go into technical work!

Strengthen innovation in detectors and computing

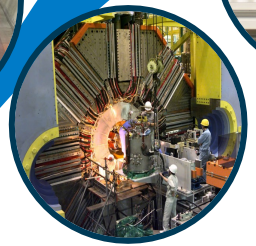
Increase 3rd party funding

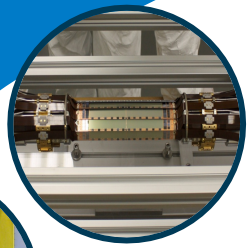
Strengthen exchange across divisions

Mid- and Long-Term Strategy

Fundamental Particles and Forces

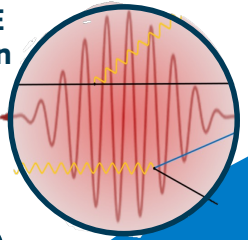
LHC and Belle II



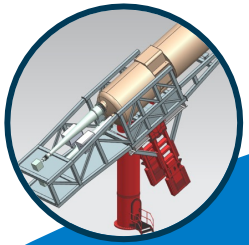


2023: Belle II PXD 2
later: Belle II upgrade

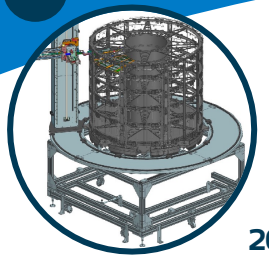
2023: ALPS II



2025: LUXE construction

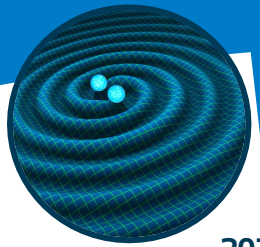


2025++: BabyIAXO

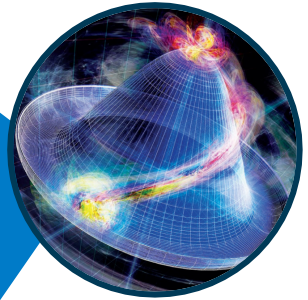


2028: HL-LHC upgrades

2025++: MADMAX



203X: Local GW experiments



2040+: Next collider?

Strategy paper from in 2024

MU and MT: List of grand challenges

The research field Matter has cast its ambitions into a list of grand challenges, structured along the programs of the research field.

Matter and the Universe

- Understanding of the nature of dark matter, the origin of the matter-antimatter asymmetry in the universe, and the properties of neutrinos
- Studying hadronic matter under extreme conditions in the laboratory, which is essential for unraveling the origin of heavy elements in the universe
- Understanding the connection of particle physics with the processes in the universe and how the most extreme events shape our universe

Matter and Technologies

- Meeting the demands for ever more powerful accelerators and detectors, generated within the research in Matter, including the strategic development of potentially disruptive technologies, the exploration of new and emergent ideas, and moving them from the realm of pure research into the application in Matter.
- Answering to the enormous increase in data recorded in Matter and, more generally, in research, and developing efficient ways to turn data into knowledge
- Making fundamental research technologically viable in times of energy and climate crisis.

Strategy paper from in 2024

MU: Mission

The mission of the research field is to explore the structure and properties of matter and the universe as well as the data-based molecular design of new material functions and biological systems, utilizing large-scale research facilities for investigations across all relevant length and time scales.

A key part of its mission is to make the unique analytical potentials of its infrastructures accessible to a wide range of users from the academic and industrial sectors.

Through its contribution to the national technological sovereignty and the broad participation in cutting-edge technology for science and society, the research field significantly strengthens Germany's position as “Wissenschafts- und Innovationsstandorts”.

The research field Matter stands in for a world-open international and diverse research environment.

Matter and the Universe

Our mission is to understand the Universe on all energy, length and time scales, and to connect the evolution of the cosmos and its phenomena to the fundamental physics of the microcosmos and the basic constituents of matter.

We strive to enable an optimal knowledge gain through the development, construction, operation, and efficient utilization of cutting-edge research and computing infrastructures in an international environment. These encompass world-leading high-energy accelerator experiments and large-scale particle astrophysics observatories. Furthermore, we develop theoretical foundations and analytical methods employing modern computing technologies like Artificial Intelligence. We will ensure that Germany will benefit in the long term from this knowledge gain, fostering the education of young high-potentials and advancing sustainable practices, particularly in fields such as computing.

Strategy paper from in 2024

MT: Mission

Matter and Technologies

Our mission is to conceive enabling research technologies which are “driven by science and driving science”.

We leverage emergent and sustainable technologies in an integrative approach in accelerator, detector and data sciences to create new opportunities for sustainable cutting-edge research in Matter and beyond. We push technologies for accelerators and detectors and we develop schemes to efficiently and safely store data and make them accessible to science and to provide low-carbon footprint and resource responsible systems.

We strengthen research in technology as a field, train the next generation of engineers and scientists in our field and link into areas such as energy-, information-, and health-science, and society at large.

Strategy paper from in 2024

MU: Scientific positioning

Matter and the Universe

We strive to identify the most fundamental matter constituents, to study the forces that act between them at the highest possible precision, as well as to understand the influence of these fundamental building blocks and forces on the evolution of the universe.

- Pushing the limits of our understanding of fundamental interactions – strong, electroweak and gravitational – through precision measurements at large particle collider experiments and at novel medium-scale experiments at DESY.
- Understanding the origin of mass, the flavour puzzle, and the imbalance between matter and anti-matter through analyses at large particle collider experiments and theory developments related to Higgs bosons, top and bottom quarks, and tau leptons.
- Understanding the evolution of the early universe and the nature of the dark sector through theoretical developments and through experimental searches for new particles at large particle collider experiments, and at novel medium-scale experiments at DESY with a focus on searches for axions and high-frequency gravitational waves.