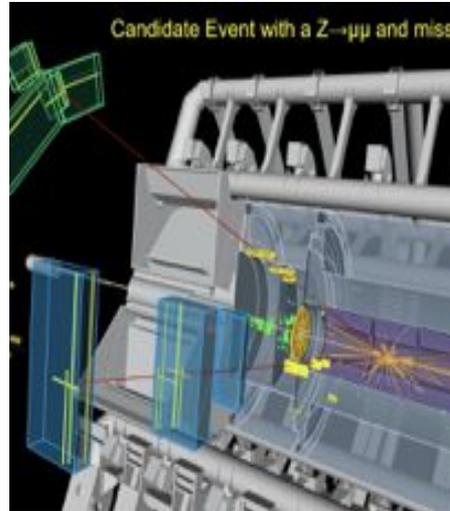


# Helmholtz.AI

Judith Katzy (DESY)



# Research Field Matter & AI



Research domains with large data sets and advanced data mining techniques  
-> many applications for AI

# Helmholtz Incubator Platforms

## The context

Special activities financed by Initiative and **Networking** Fund

5 incubator platforms for **innovative projects in data science**:

**Helmholtz.ai**

HelmholtzFederatedITServices (HIFIS)

Helmholtz Imaging

HelmholtzInformationAndDataScienceAcademy (HIDA)

Helmholtz Meta Data (HMC)

Implementation since ~2019

Yearly volume ~50 Mio, **Helmholtz.ai 12 Mio**

# Helmholtz.ai

## The task

“[Helmholtz AI] will significantly enrich Helmholtz in terms of applied AI. It will bring together scientists from all centres, provide support in their needs and thereby will foster transdisciplinary and ground-breaking research.”

*(quote from the original HAICU concept)*

# Helmholtz.ai

## The organisation

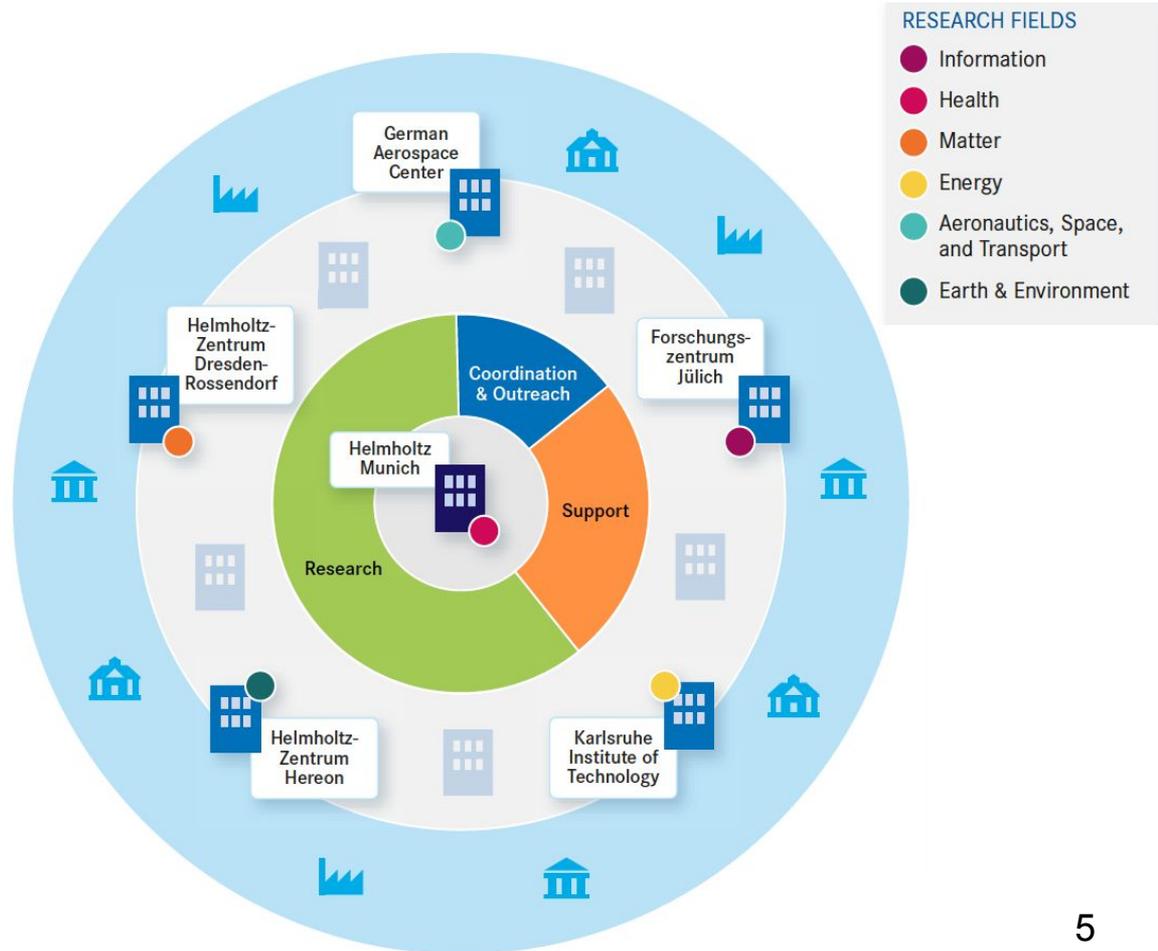
- 1 central unit (Munich)
- 5 local units:  
one per research field
- 12 Helmholtz centers without unit

### Each Local Unit:

Research group (YIG)  
Support Team (Consultants)

### Central Unit:

Research group (YIGs, senior)  
Support Team (Consultants)  
Management of the incubator



# Helmholtz.ai

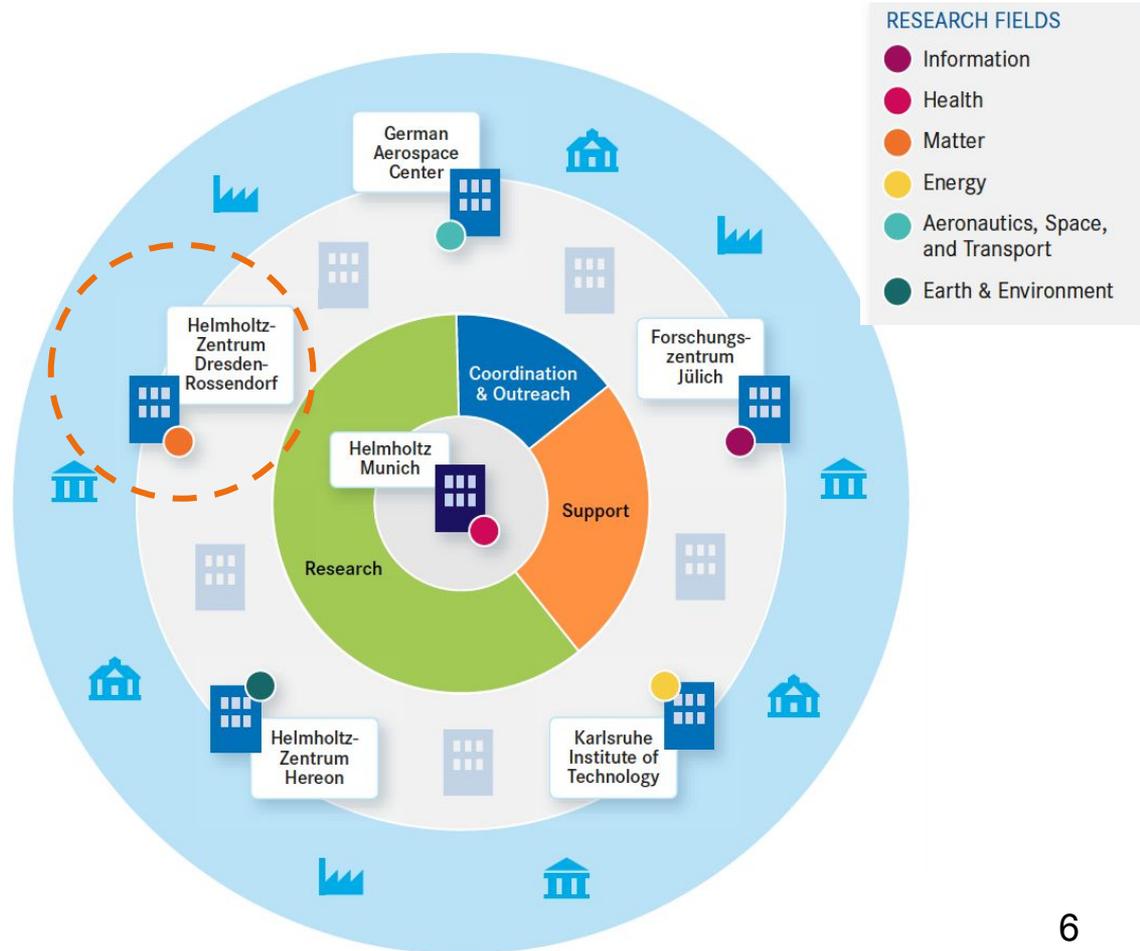
## The organisation

- 1 central unit (Munich)
- 5 local units:
  - one per research field
  - Matter: Dresden Rossendorf**
- 12 Helmholtz centers

**Matter:**  
**Young Investigator Group:**  
“Artificial Intelligence for the Future  
Photon Science”  
Nico Hoffmann (HZDR)

**Consultant Team:**  
Leader: Peter Steinbach (HZDR)

Involvement of “Matter and the Universe”:  
**Steering board member** (Judith Katzy)



# Helmholtz.AI research network involvements

## Democratising AI for a data driven future

### Example applications in Helmholtz.ai

Health:	highest resolution 3D maps of human cortical areas
Energy:	probabilistic forecast to stabilise energy systems
Earth:	analysis of aerial photos for the inventory of urban trees (to analyse urban forests for heat island mitigation)
...	

### Example involvement in networks

**OpenGPT-X** large language model for use and share data and services free of charge, in multiple languages and according to the highest European data protection standards

**HBP** human brain project

European Laboratory for Learning and Intelligent Systems (**ELLIS**) - the European excellence network in ML

...

# Helmholtz.ai Conference 2023

Hosted by DESY



HELMHOLTZ AI ARTIFICIAL INTELLIGENCE COOPERATION UNIT | HELMHOLTZ IMPROVING FUTURE CHALLENGES | HZDR HELMHOLTZ-ZENTRUM FÜR DURCHFÜHRENDE MATERIEFORSCHUNG | HELMHOLTZ MUNICH | hereon | DESY | KIT | DLR | JÜLICH FORTH AND CENTER FOR ENERGY

Next edition: 12-14 Juni 2024 Düsseldorf

- 300 participants at DESY, 70 virtual
  - “real lab experience”
- 450 participants on joint day with Helmholtz Imaging
- 2 keynote talks
  - Max Welling
  - Zeynep Akata
- 63 talks, 80 posters
- a panel discussion on **Foundation Models** (Zeynep Akata, Max Welling, Fabian Theis, Wolfgang Hildesheim, Jenia Jitsev)
- **Special session on ML at Quantum computing**

# Helmholtz.ai Conference 2023

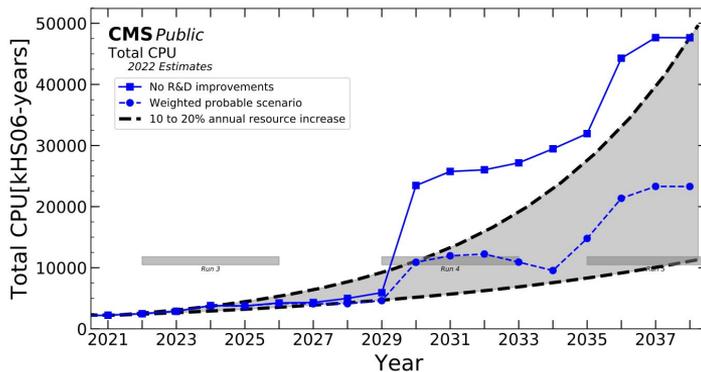
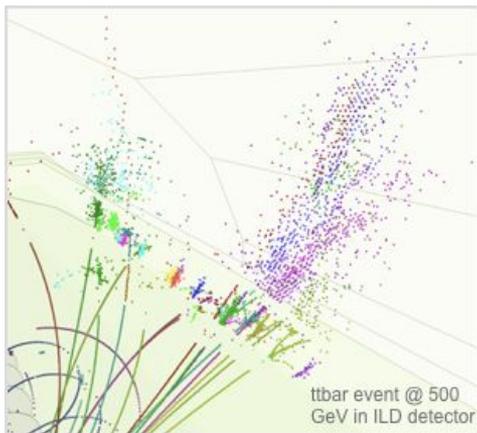
Joint Day with Helmholtz imaging

- Explore common topics on AI
- High level speakers
- **Unconference**
  - New format to enhance discussion among participants



# AI @ Particle Physics

## Generative models for Fast Simulation in highly granular calorimeters



Work for ILD,  
CMS, ATLAS

### ML Challenges:

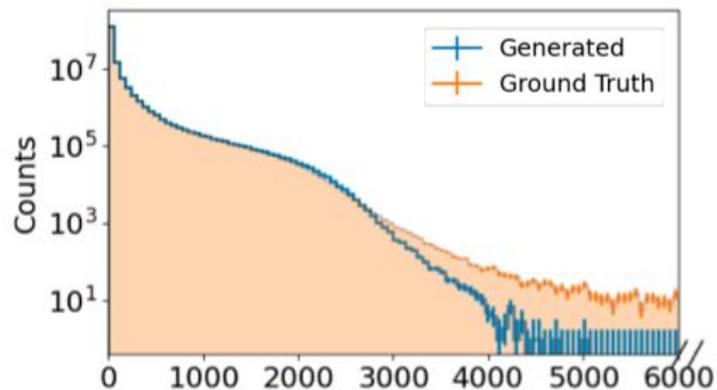
Generate tails of the distributions and sparse detector signals

### ML implementations:

Particle clouds to represent detector hits

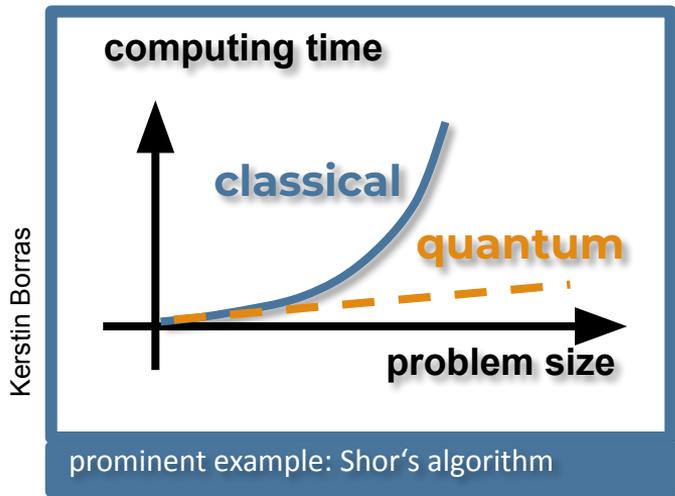
Tree-based Graph-NN for simulations

Diffusion models

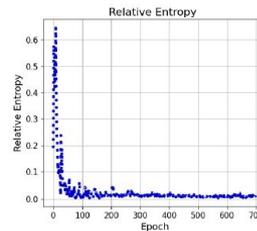
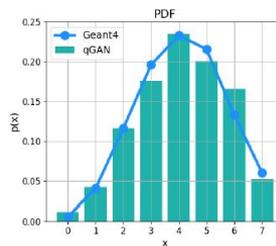


# AI and Quantum Computing

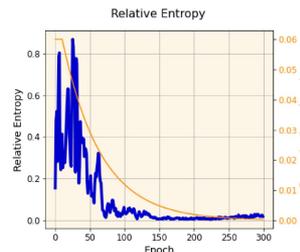
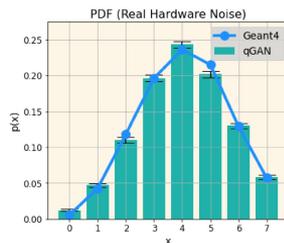
## Early examples in Experimental Particle Physics



### Q-GAN simulations for detectors



readout  
noise



full noise  
real hardware

Work for CMS and LUXE

Kerstin Borrás, Dirk Krücker,  
Federico Meloni

# Matter and Universe: Helmholtz.AI ongoing projects

## ■ SynRap: Machine-learning based synthetic data generation for rapid physics modeling (DESY + HZDR)

SynRap investigates the generation of simulated (“synthetic”) data using surrogate models, which will be used in a second step for efficient training of neural networks. A unified surrogate model framework will be developed and used to tackle common challenges in two different research areas – high-energy physics (HEP) and high energy-density (HED) phenomena.

*Contact: Isabell-Alissandra Melzer-Pellmann, isabell.melzer@desy.de (DESY)*

2 out of 56 funded projects from the period  
2019-2022

- Known difficulties to find partners
- Strong networks at CERN
- More issues?

## ■ DeGeSim: Deep Learning for most precise high-energy particle physics at the Large Hadron Collider (DESY + FZJ)

Scientific simulation calculations are often limited by their high demand for computing capacity. Generative Deep Neural Networks offer an efficient way to replace complex models and enable fast and precise simulations for the CMS and ATLAS experiments at the Large Hadron Collider (CERN). [More information.](#)

*Contact: Dr. Dirk Krücker, dirk.kruecker@desy.de (DESY)*

# AI @ Particle Physics

## Unique challenges

### ML challenges - tricky details:

Statistical nature of the objects - data labeling difficult to impossible

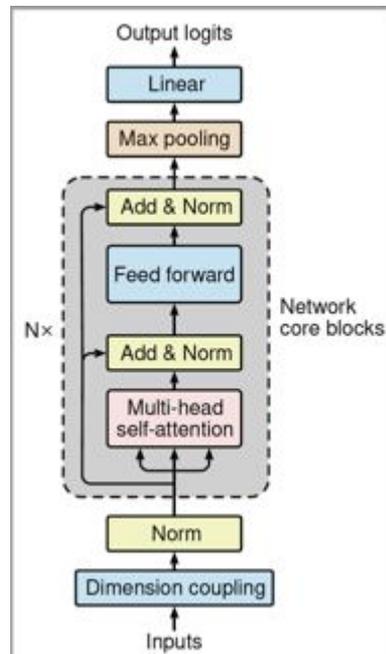
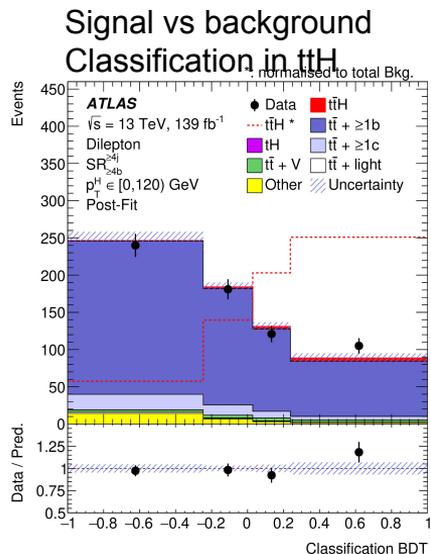
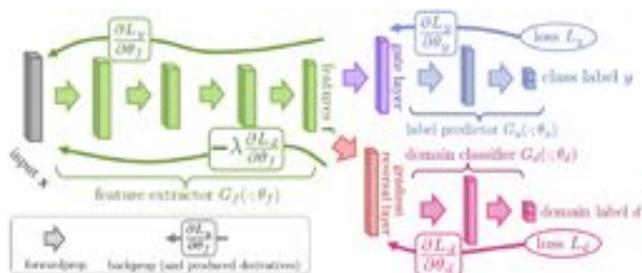
Negative weighted instances (“events”) for training

Potential bias due to training on simulations - uncertainty estimate difficult

### Use of the art ML methods outside Helmholtz.ai

Attention based transformers, GNN, XGBoost

Adversarial training



# Helmholtz.ai Project Calls

A possibility for you to get a ML project financed

[Project call 2023](#)

Information meeting  
10.10. at 10 am

## General goal:

- exploit ML methods in applicants' research field
- have the potential to quickly generate larger follow-up projects
- address cross-center ML challenges and methods

deadline  
1.12.2023

## Concrete project requirements:

- high risk high gain (innovation, long term impact)
- at least 2 Helmholtz centers involved
- Matched funding

## Special calls (changing focus every year):

- 3 projects reserved for special focus
- This year: **generating AI-related use cases for quantum computing**

## What you can get:

- up to 250k over max. 3 years (+250k from home institute)
- example: 1PhD student per institute or postdocs for a shorter time

# Vouchers

## Possibility to get help from an Helmholtz.AI consultant

### Exploration voucher

- You have data and an idea but are unsure about methods, potential solutions and the effort required?
- Work with an AI consultant for up to two weeks to develop a plan

### Realisation voucher

- You have a good idea about the method but need help
- Work with an AI consultant for two weeks up to 6 months

### Application:

Every research of a Helmholtz center can apply for voucher projects

Vouchers are fully funded by Helmholtz.AI - no matching necessary

Fill out this [voucher form](#) any time, processing takes only 3 weeks

### Voucher example use cases:

selecting, testing and implementing machine learning methods

enabling researchers through training and workshops

support in creating and advertising high impact benchmark datasets.

# HAICORE

## Easy GPU access

### Ad-hoc usage

- Up to 10 GPU/h per day
- GPUs at KIT

### Lightweight projects

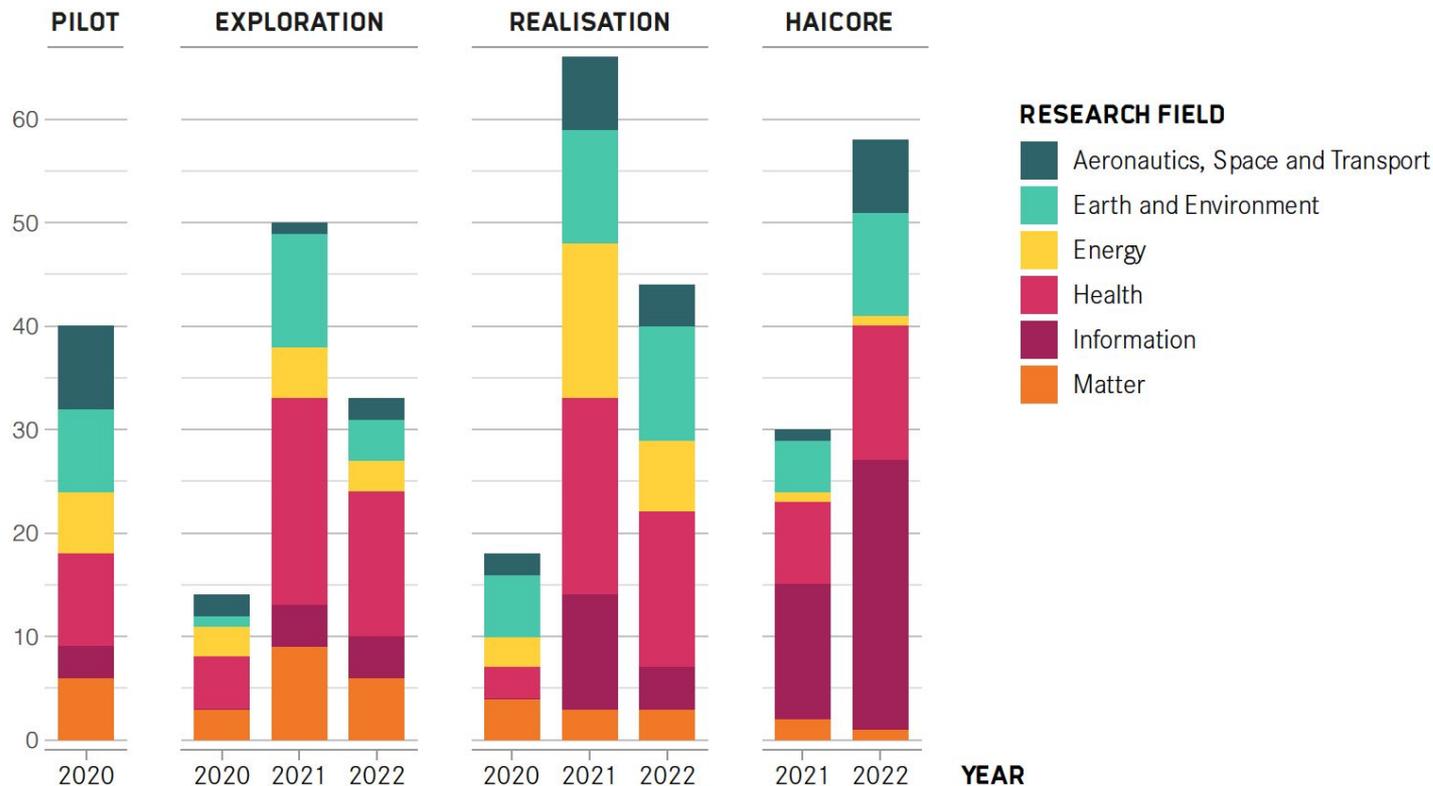
- Up to 5000 GPU/h per half year
- GPUs at FZJ, access to Juwels Booster possible

Check out the details [here](#)



# Usage of vouchers & haicore

## Matter compared to the rest



# Summary

Helmholtz.AI covers a large variety of ML methods and applications in all Helmholtz research domains

- Helmholtz.AI conference gives a good overview of (academic) ML projects in Germany

Helmholtz.AI provides support for ML projects with funding, consultant support and GPU access

Matter and Universe involvements are limited sofar

- Hope to increase visibility with ML@Quantum projects

**back-up**

# Helmholtz.ai

## Steering Board



**FABIAN THEIS**  
Scientific director,  
Helmholtz AI,  
Helmholtz Munich



**GUIDO JUCKELAND**  
Helmholtz-Zentrum  
Dresden-  
Rossendorf



**JUDITH KATZY**  
Deutsches  
Elektronen-  
Synchrotron



**ANDREAS KOSMIDER**  
Helmholtz  
Association



**FLORIAN GRÖTSCH**  
Helmholtz  
Association



**TIMO DICKSCHEID**  
Forschungszentrum  
Jülich



**MARIO FRITZ**  
Helmholtz Center  
for Information  
Security



**RALF MIKUT**  
Karlsruhe Institute  
of Technology



**CORINNA SCHRUM**  
Helmholtz-Zentrum  
Hereon



**OLIVER STEGLE**  
German Cancer  
Research Center



**FREDERIK TILMANN**  
German Research  
Centre for  
Geosciences