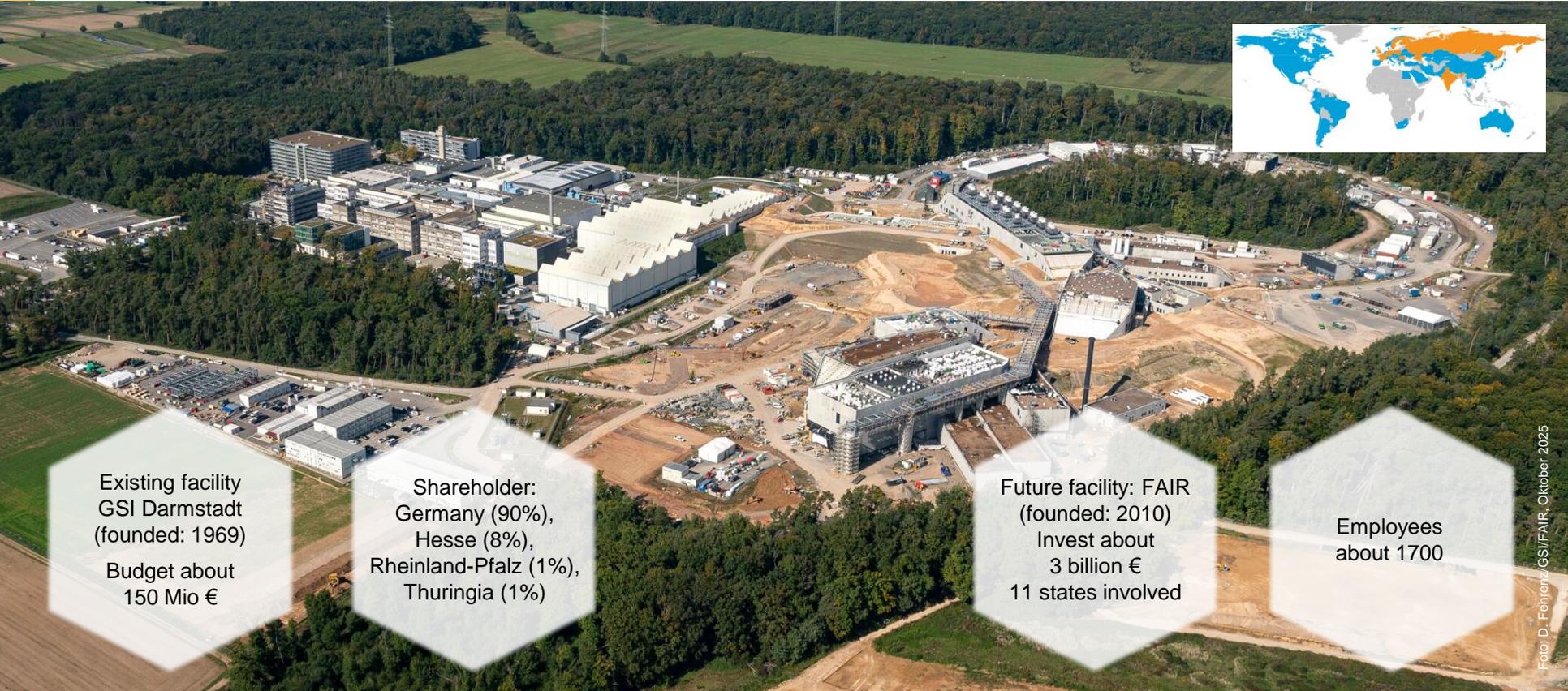# Data Center Challenges around FAIR Green IT Cube

Energy efficient - sustainable - resource saving

Data-Center Technology & Business Opportunities

GSI & FAIR Project

Existing facility
GSI Darmstadt
(founded: 1969)

Budget about
150 Mio €

Shareholder:
Germany (90%),
Hesse (8%),
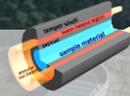Rheinland-Pfalz (1%),
Thuringia (1%)

Future facility: FAIR
(founded: 2010)
Invest about
3 billion €
11 states involved

Employees
about 1700

Foto: D. Fehrenz/GSI/FAIR, Oktober 2025
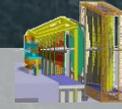
GSI & FAIR

FAIR - New Heavy-Ion Accelerator

CBM
Compressed Baryonic Matter
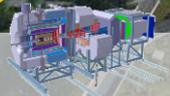compressed core matter

APPA
Atom-, Plasma Physics

Computing
Green IT Cube

- **25 Accelerator and Experimental Facilities**
  laboratories, and other operational and utility buildings

- **Underground accelerator ring**
  with a circumference of approx. 1.100 m

- **total area of approx. 150.000 m²**
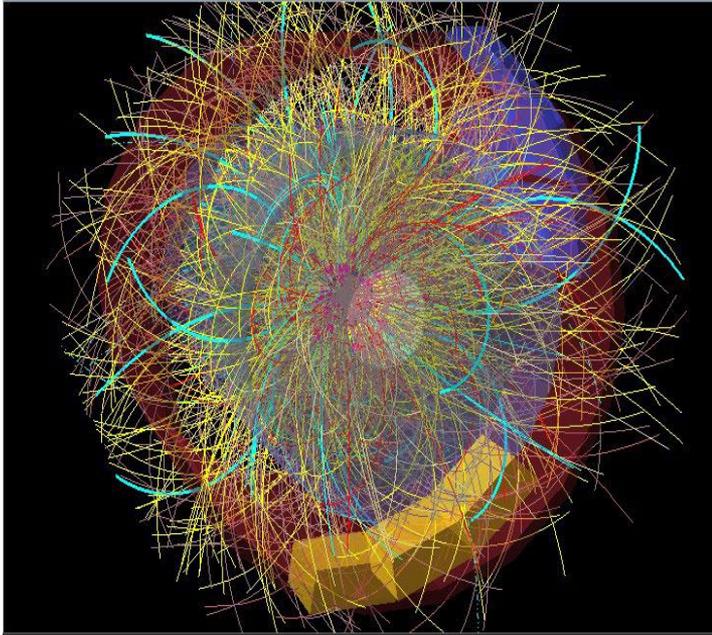
PANDA
Nuclear structure physics

NUSTAR
Nuclear structure, astrophysics and reactions

© GSI/FAIR, Zeitrausch

Computing at FAIR: Big Data

© J. Hosan, GSI/FAIR

FAIR GSI

Pb-Pb collision (ALICE-Detector)   Source: CERN

Data Center Green IT Cube

High data rates (Streaming):
> 1 TByte/s in online farms

Large data volumes:
- up to 250 petabytes online
- up to 50 petabytes per year on disc

High computing capacities:
~>200.000 Cores

High performance Network

High value:
scientific results

Need for an on-site, highly scalable, and energy-efficient computing infrastructure → Green IT Cube

Green IT Cube – Efficient Data Center

➤ Datacenter

- ➤ **compact cubic with 6 floors, 20 m high**

  high-bay warehouse structure

- ➤ **128 racks per floor**

- ➤ **design 2 MW electrical/thermal power per floor**

- ➤ **short cable runs, reduced electrical power loss**

  small latency for high-performance network

- ➤ **passive rack based heat exchanger**

- ➤ **evaporative cooling tower**

- ➤ **design PUE < 1.07**

Foto: H. Kreiser/GSI

© GSI

Green IT Cube – Efficient Data Center
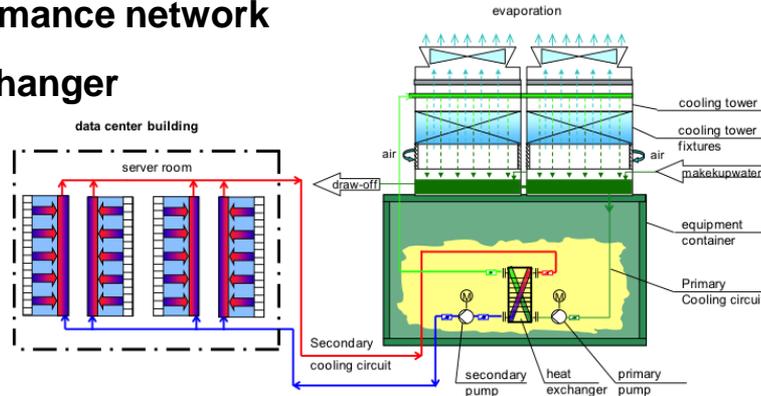
- **Digital open laboratory (living data center laboratory)**
  - **Research & Development with research partners (academic/industry)**
    on compute topics of relevance to GSI/FAIR
  - **vertical stack from datacenter up to HPC-applications**
- **Funding program „hpc_Gateway"**
  - strengthening knowledge transfer between GSI and industry,
    promoting innovation ecosystems using AI and HPC.
    Providing system access for common research work.
    Typical setup: research entity at GSI and industrial partner.
- **Data analyses for GSI + FAIR**
- **Focus on datacenter relevant topics**

R&D Focus: Data center technologies

Topics	Why important?	Planned measures / aim
Airflow-Modelling	Optimization of cooling performance & energy consumption Fan speed varies with load and power consumption → not constant	AI-based models instead of full CFD simulations + In-situ sensor fusion (temperature, pressure) Challenge: dynamical fan-speed of the servers
Dynamic optimization	Change of cooling relevant parameters Real-time adjustment required	Maximum efficiency Minimizing energy consumption and operating costs
Increased Cooling Requirements of modern chips	Reduces fan energy, increases density	Cooperation testing of direct-liquid-cooling systems heat-over-coolant loops
Power distribution	Power for high density server systems connected with DLC	

Project DLC - GSI & Rittal

1 MW full rack based Cooling Distribution Unit
suppy up to 10 racks with DLC-Systems

**Design – 2-Level-Liquid-Cooling-Loop
(CPU- und GPU-Block)**

Prototyp – 2 Rack-units in the Living Lab
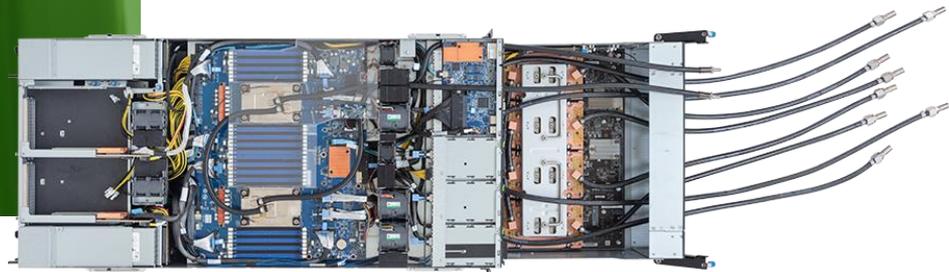
Fotos: Firma Gigabyte - https://gigabyte.com

- start up in Darmstadt

- develop an AI-based system to analyse infrastructure cooling parameter

- digital twin of a datacenter cooling infrastructure

- calculate and optimize cooling set points based on operating-, load- and surround-data

- reduce energy consumption

- optimized waste heat utilization

Green IT Cube & potentiell Business-opportunities

Topic	Possible Partners
Data center technology (DLC, airflow, modular power)	Cooling system manufacturers, Energy system manufacturers
Building structures (thermal integration, heat recovery)	Civil engineers, Architects
Waste heat utilization (district heating, process heat)	Municipal utilities, Energy suppliers
Electrical engineering (AC/DC distribution, smart PDUs)	Manufacturers of power supply systems
Living Lab Services (Test-as-a-Service, Validierung)	Start-ups, Research institutes

Digital Open Lab – Forstering Innovation

The Digital Open Lab within the Green IT Cube provides an environment for developing, testing, and scaling up energy-efficient, high-performance computing to the scale of industrial demonstrators.

Such a "**living lab**" enables the collaborative use of various R&D opportunities with industry.

➢ Real-world environment for testing innovative technology
➢ Simple and convenient testing
➢ Space for experimentation & learning
➢ Create space for new innovation ideas and develop better data centers.
➢ Open innovation approach to collaboration with industry and other companies

✓ Technology demonstrator – testing new cooling/power solutions
   (e.g., heat exchangers, high-voltage DC distribution)

✓ Co-development – Joint development of AI-based control algorithms

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Thank you very much for your attention.

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