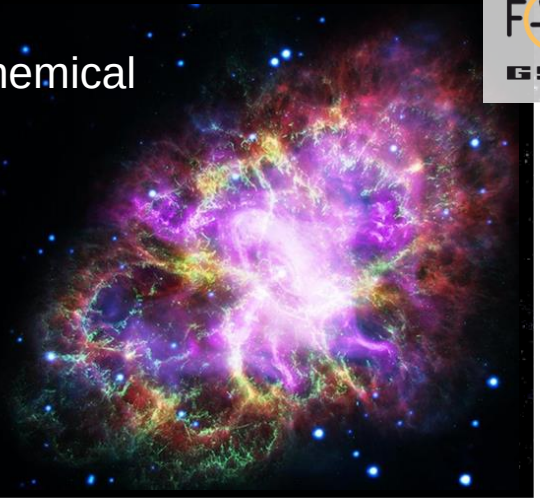
Introduction to GSI and FAIR

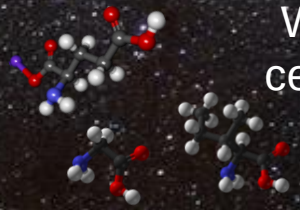
Dr. Arjan Vink
Head of GSI/FAIR Grant Office
October 17, 2022

Photo: G. Otto/GSI

Where are chemical elements produced?



What does matter look like in the most heavy objects of our universe, the neutron stars?



What happens to human cells on the way to Mars?

How are complex molecules formed?

How do materials behave under high pressure?

Fobos, Uranus, Jupiter, Erde Quelle: http://de.wikipedia.org

Cosmic matter can be produced with particle accelerators in the lab.

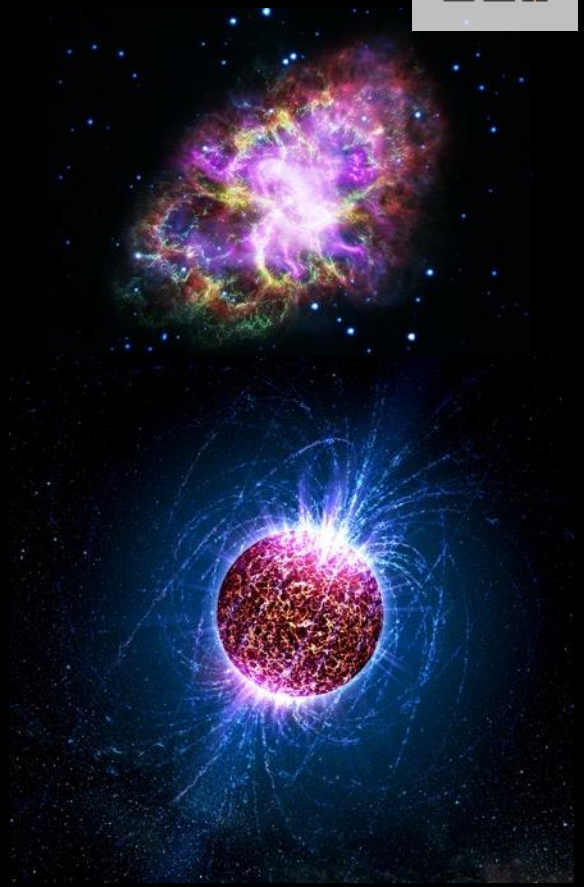


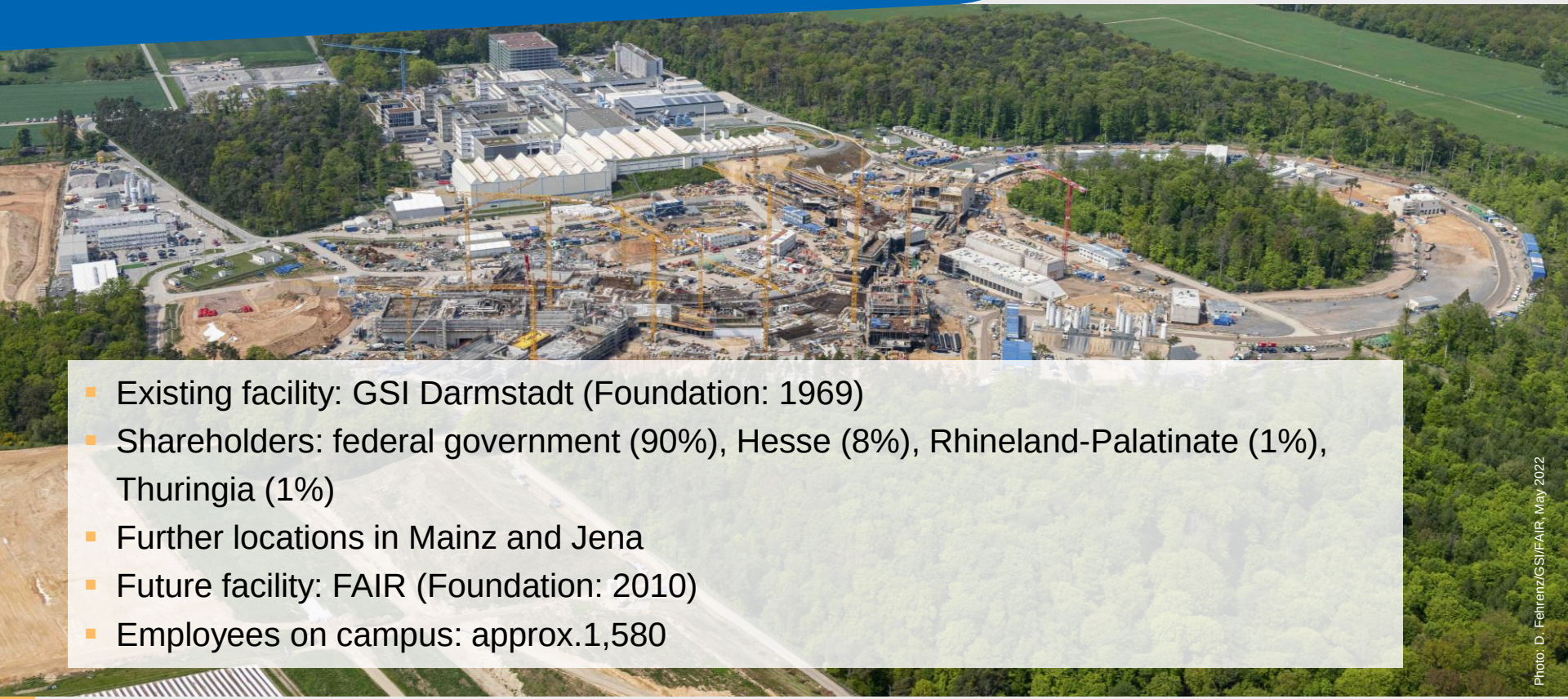
Photo: NASA, ESA, G. Dubner (IAFE, CONICET-University of Buenos Aires) et al.; A. Loll et al.; T. Temim et al.; F. Seward et al.; VLA/NRAO/AUI/NSF; Chandra/CXC; Spitzer/JPL-Caltech; XMM-Newton/ESA; and Hubble/STScI (oben), Penn State University (unten)

We explore the universe…

…in the lab.

Photo: J. Hosan/GSI/FAIR, "NASA, ESA, the Hubble Heritage Team (STScI/AURA), A. Nota (ESA/STScI), and the Westerlund 2 Science Team"

GSI GmbH – Helmholtzzentrum für Schwerionenforschung
FAIR GmbH – Facility for Antiproton and Ion Research



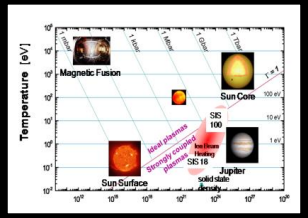
- Existing facility: GSI Darmstadt (Foundation: 1969)
- Shareholders: federal government (90%), Hesse (8%), Rhineland-Palatinate (1%), Thuringia (1%)
- Further locations in Mainz and Jena
- Future facility: FAIR (Foundation: 2010)
- Employees on campus: approx.1,580

Photo: D. Fehrenz/GSI/FAIR, May 2022

Research themes at GSI and FAIR

APPA

atomic physics,
biophysics,
plasma physics,
material research



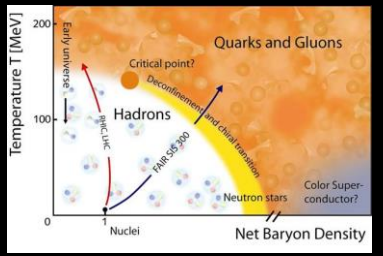
TECH

scientific computing

accelerator science

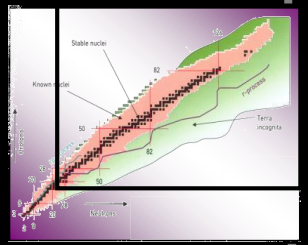
CBM

Properties of nuclear and Quark matter



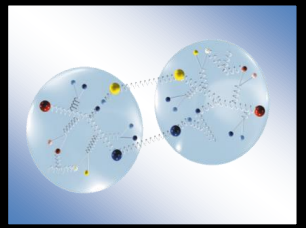
NuSTAR

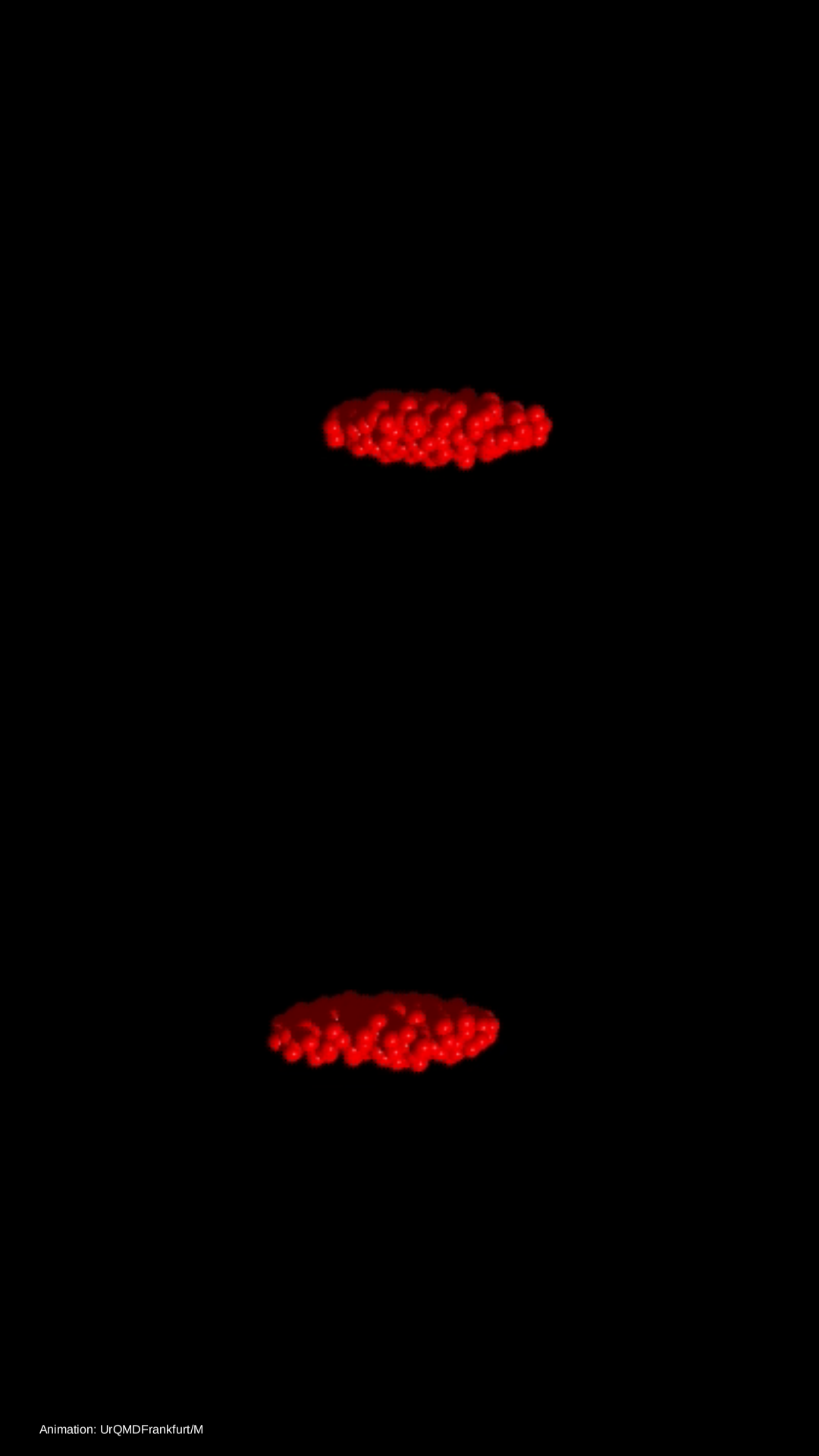
nuclear structure and nuclear astrophysics



PANDA

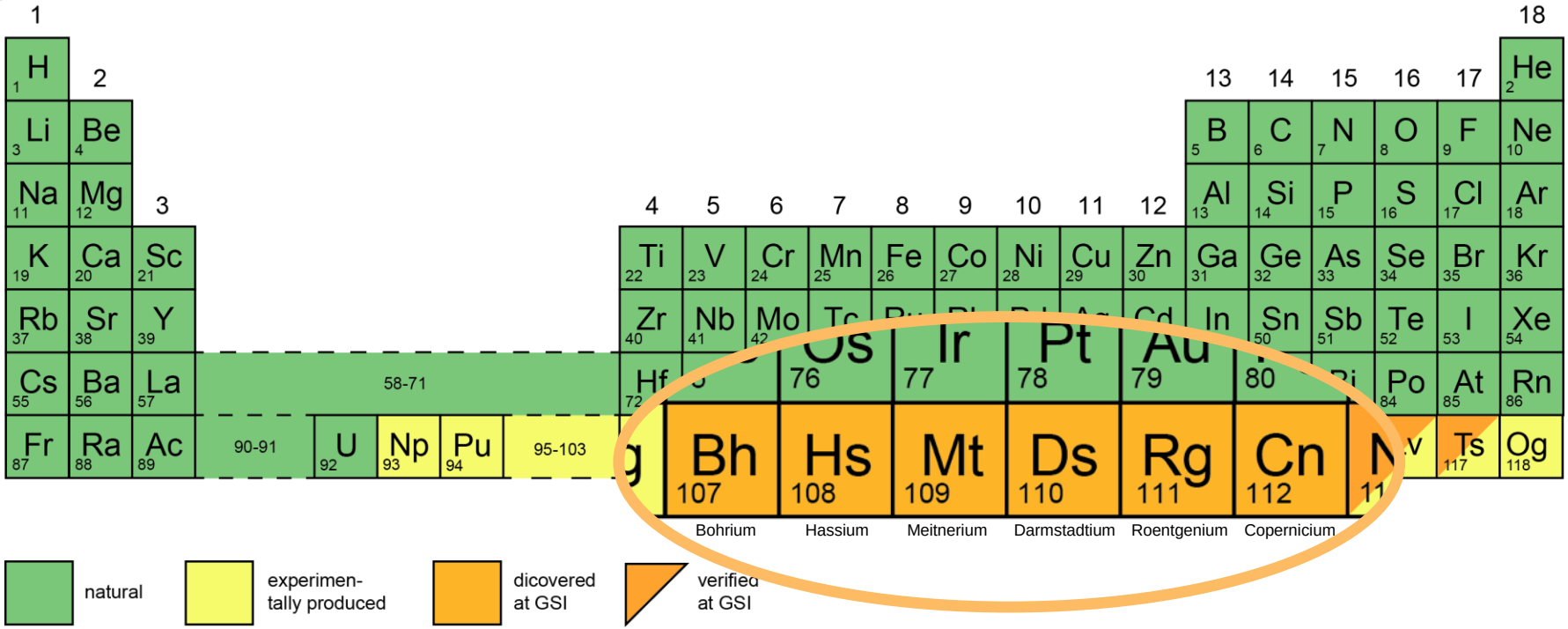
hadron structure and dynamics





Animation: UrQMDFrankfurt/M

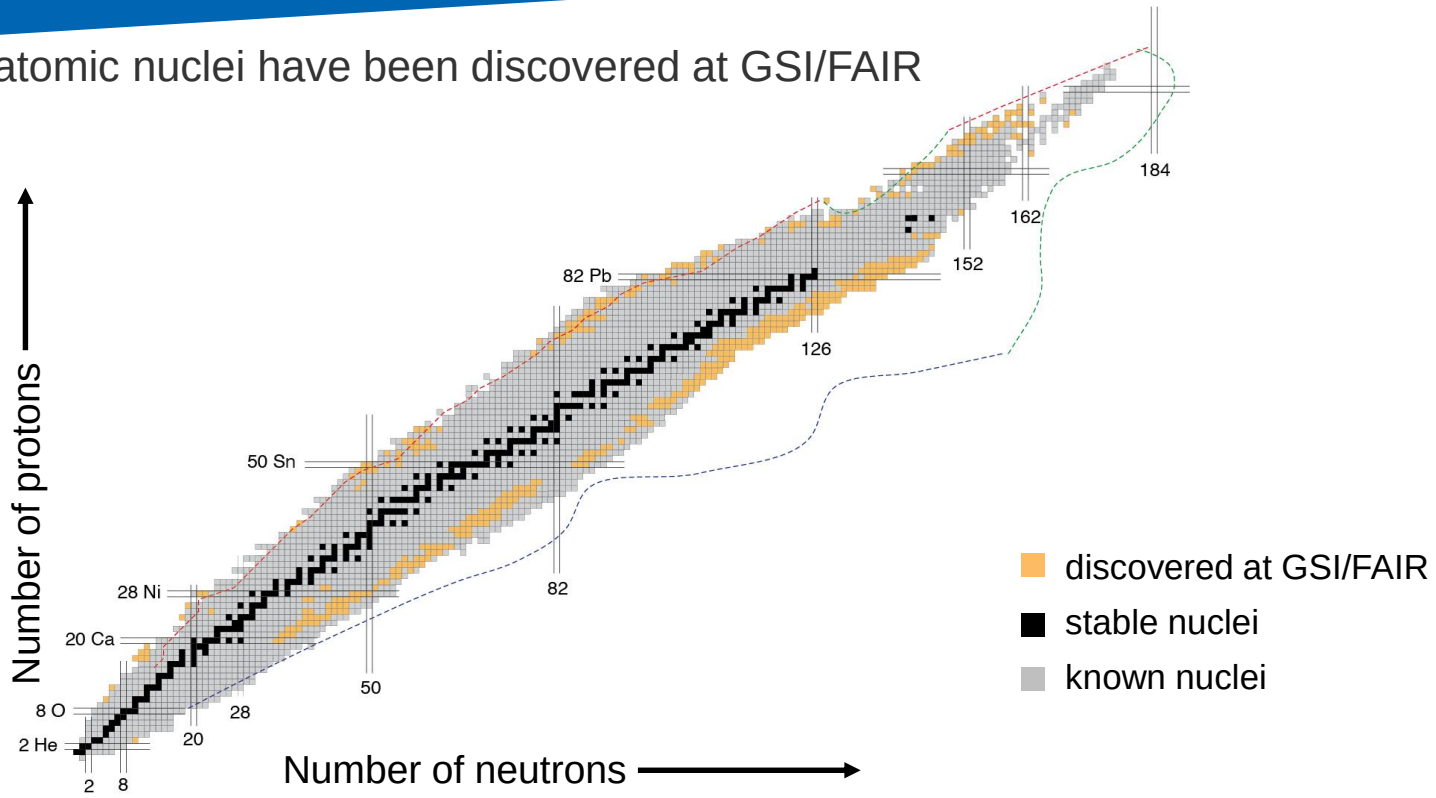
Discovery of new elements



Graph: GSI/FAIR

Discovery of new atomic nuclei

- 445 atomic nuclei have been discovered at GSI/FAIR



Application: cancer therapy with heavy ions

- Precise, gentle and very successful
- Treatment of 440 patients at GSI
- By now established and in clinical operation, among others in Germany (Heidelberg and Marburg), Austria and Italy
- At GSI: Research and further development

Photo: A. Zschau/GSI

FAIR Darmstadt

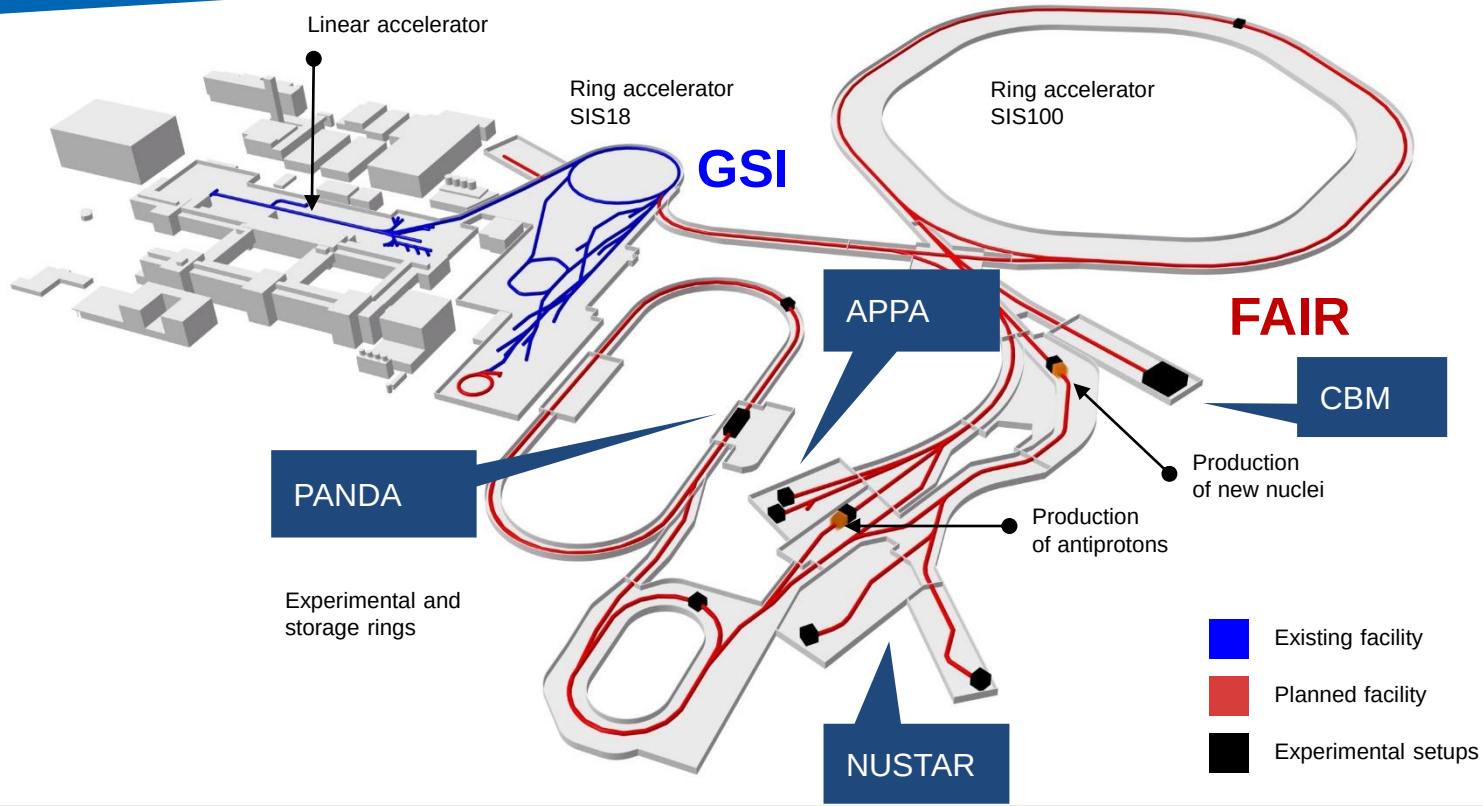
Graph: ion42/FAIR

- **25 accelerator and experimental structures,** labs and other operation and supply structures
- **Underground accelerator ring** with a circumference of approx. 1,100 m
- **Around 150,000 m²** of total area

- World-leading accelerator laboratory for decades
- Unique research in physics and applications

- Landmark in the European research roadmap (ESFRI)
- Top priority in the European nuclear physics community

The Facility



Construction volumes

2 million m³
of soil

to be moved

600,000 m³
of concrete

to be used

65,000 tons
of steel

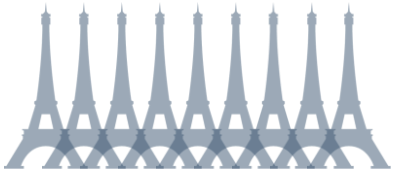
to be utilized

status October 2022 : more than 50 % completed

– as much as for 5,000 single-family homes.

– as much as eight Frankfurt football stadiums.

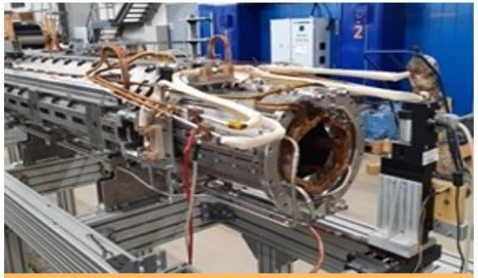
– as much as nine Eiffel Towers.



FAIR facility - worldwide production and delivery of accelerator components and experiments

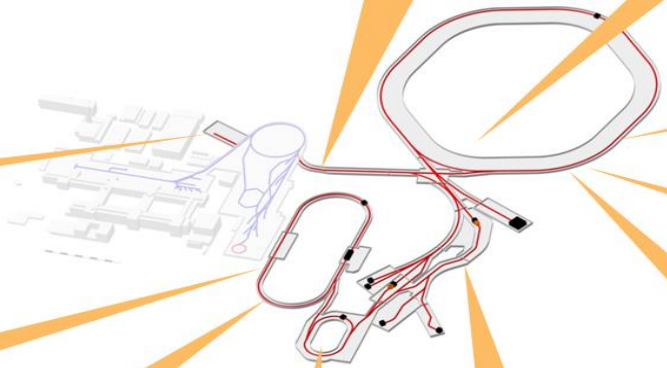
HEBT: Dipole-Magnets

Power Converters



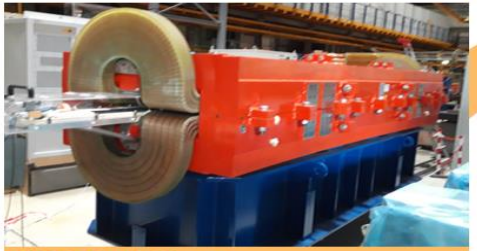
SIS100: Quadrupol-Magnet

p-Linac: RFQ- Development



SIS100: Vacuum Chambers

HESR: Quadrupol-Magnets



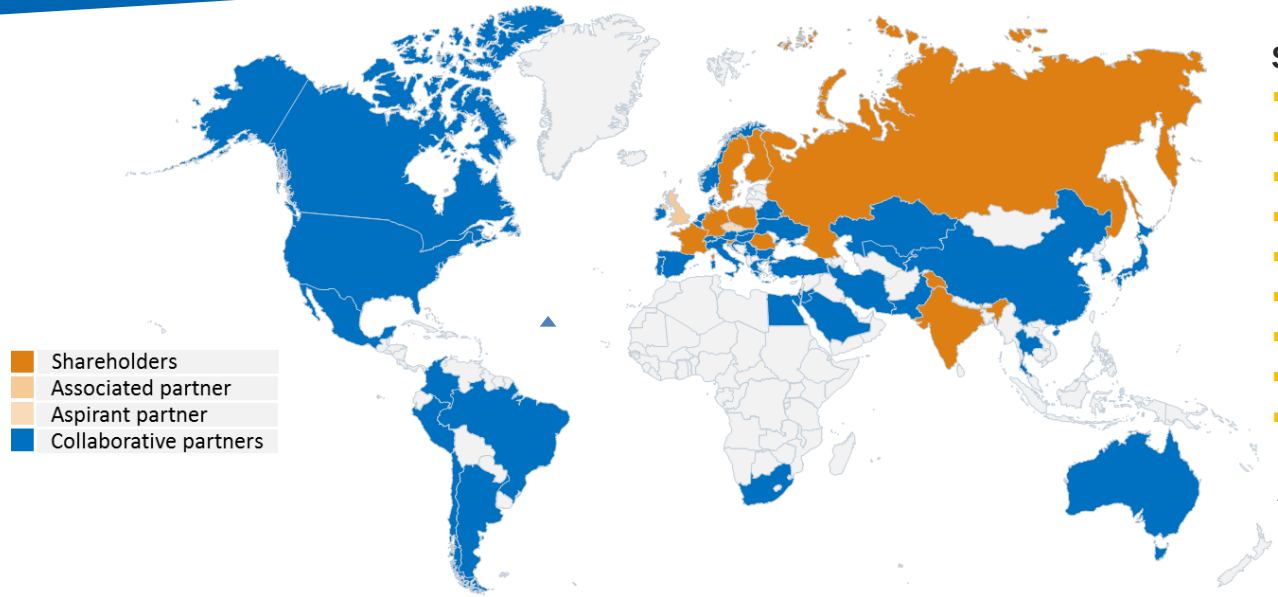
HESR: Dipole-Magnet

CR: Dipole-Magnet

SFRS: Multiplet-Magnet CERN test facility

SIS100: Dipole-Magnet

Shareholders and scientific partners worldwide



Shareholders

- Germany (70,2%)
- Finland (0,5%)
- France (2,7%)
- India (3,5%)
- Poland (2,3%)
- Romania (1,2%)
- Russia (17,4%)
- Sweden (1,0%)
- Slowenia (1,2%)

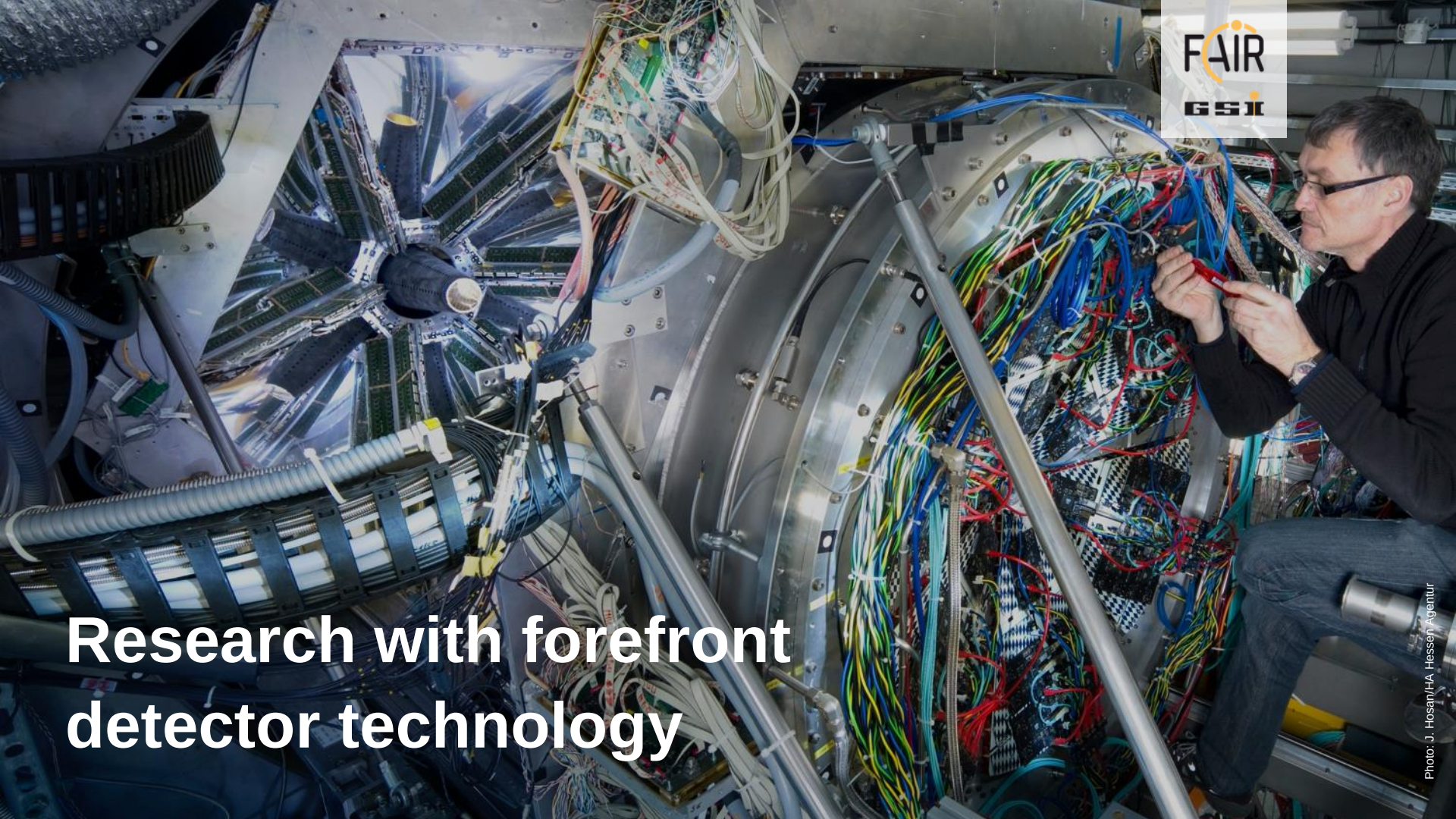
Associated

- United Kingdom

Aspirant

- Czech Republic

- Realization and operation with international cooperations
- Cooperation with around 400 institutes in more than 50 countries
- Expected that up to 3000 scientists per year will use FAIR facility

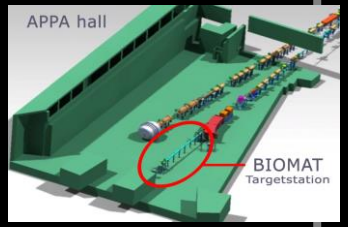


Research with forefront detector technology

Contributions of the CZ Republic to FAIR

APPA

vacuum stations for BIOMAT beam line



TOTAL

2016-2019

k€ 864

2020-2022

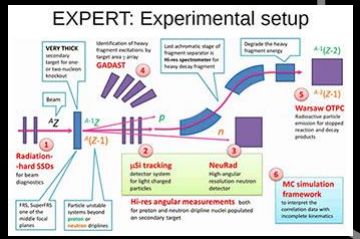
M€ 1.6

CBM

Electromagnetic Calorimeter (ECAL)
Projectile Spectator Detector (PSD)

NuSTAR

scintillator crystals for GADAST detector (Super-FRS)



PANDA

$PbWO_4$ scintillator crystals for Electromagnetic Calorimeter

GSI as a talent factory

- A unique capability to attract and create talent and know-how on-campus and at surrounding universities
- Training and education of the next generation of scientists, engineers and computing experts from all over the world:
  - Tenure track positions
  - Young Investigator Groups
  - Graduate School (HGS-HIRe) with currently more than 300 doctoral students from all over the world and offering multiple training programs for students
  - Internships
- Many now in important positions in academia, research and even in government

Outreach activities at GSI

For the general public:

- Events/exhibitions
  (Open House, Highlights der Physik, …)
- Guided tours of the facility
- Lecture series „Wissenschaft für Alle“

For high-school students:

- Saturday Morning Physics
- IPPOG-Masterclasses (ALICE data analysis and particle therapy)
- Girls'Day
- “Brückenschlagen” – lectures in schools
- “meet a scientist” – online meetings with scientists

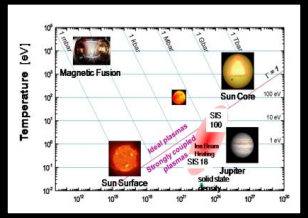
For university students/post-graduates:

- Summer Student Program
- GET_INvolved

EU Projects at GSI and FAIR

APPA

atomic physics, biophysics, plasma physics, material research



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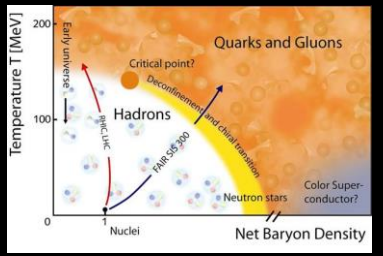

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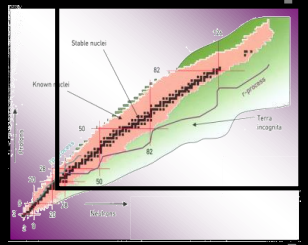

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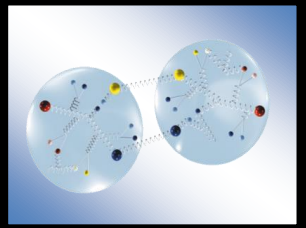

EU Projects at GSI and FAIR

- **APPA:** *Research Infrastructures:* INSPIRE, HITRI/PLUS, PRISMAP, RADNEXT, LASERLAB EUROPE, THRILL, HEARTS, ERC Consolidator Grant, ERC Advanced Grant
- **NUSTAR:** *Research Infrastructures:* EUROLABS, *EURATOM:* ARTIMIS, 2 ERC Starting Grants, EU Advanced Grant, ERC Synergy Grant
- **CBM:** *Research Infrastructures:* EURIZON, STRONG-2020
- **PANDA:** *Research Infrastructures:* STRONG-2020
- **Scientific computing:** *Research Infrastructures:* ESCAPE, EGI-ACE, *EFRD/REACT-EU:* technology marketing, construction Green IT Cube, *Digital Europe:* EDITH
- **Accelerator science:** *Research Infrastructures:* ARIES, I.FAST
- **Miscellaneous:** *ATTRACT:* CASEIA, *Widening:* Policy Answers

Sustainable technology: Green IT Cube

Water-cooled high-efficient computer centre (2 Megawatt cooling capacity per floor) with up to 100 Petabyte of storage capacity (up to 300.000 nodes)

GSI/FAIR Digital Open Lab

Realtime environment for High-Performance-Computing with industry applications (including for SMEs) :

- **Joint R&D projects** – develop green technology, HPC, big data and software
- **Collaborations** – access to HPC-systems and –projects
- **Make rackspace available** – offer of services

Collaborations Darmstadt University of Applied Sciences, Technical University Darmstadt, hessian.AI (planned)

Projects: Technology transfer, construction, regional connectivity

h_da
HOCHSCHULE DARMSTADT
UNIVERSITY OF APPLIED SCIENCES

TECHNISCHE UNIVERSITÄT DARMSTADT

hessian.AI

Finanziert von der Europäischen Union
NextGenerationEU

Dieses Projekt wird aus Mitteln des Europäischen Fonds für regionale Entwicklung als Teil der Reaktion der Union auf die COVID-19-Pandemie finanziert.


FAIR
GSI
Thank you for your attention!
Graph: ion42/FAIR