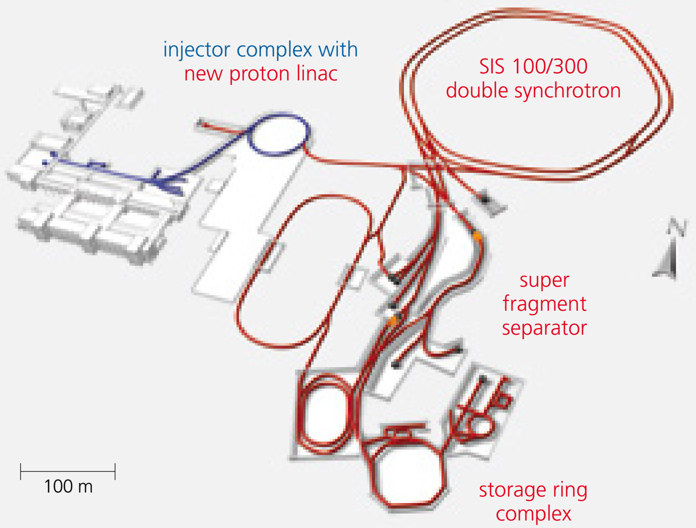
Facility for Antiproton and Ion Research

The UNILAC and the SIS 18-ring of the existing facility (blue) serve as injectors for the new facilities of the FAIR complex (red), such as the SIS 100/300 accelerator rings (double synchrotron), the super fragment separator, the storage rings and the various experimental areas.



Realization of the facility

FAIR is being constructed in several stages. The modularized start version is being financed by Germany together with partner states and costs more than 1 billion euros (price level 2005). Additional partial systems are still being researched and developed, and still have to be financed. The start version in itself, however, does allow all the FAIR scientific collaborations to conduct unique research and offers considerable potential for ground-breaking discoveries.

More than 3,000 scientists from about 50 countries in Europe and overseas will use the facility for their experiments.

International cooperations

Europe is seeing the establishment of a significant research site at FAIR. One at which the worlds of science and education are able to network at international level, thus also fostering a global cultural exchange. More than 3,000 scientists and engineers from all over the world already work at FAIR.

NUSTAR Collaboration

SPARC Collaboration

CBM Collaboration

HEDgeHOB Collaboration

PANDA Collaboration

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FAIR

GSI

Facility for Antiproton and Ion Research

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FAIR – A unique new accelerator facility

… with its vast research program will serve to further investigate key issues such as the evolution of the universe and the origin of matter found in planets and in our surroundings on earth.

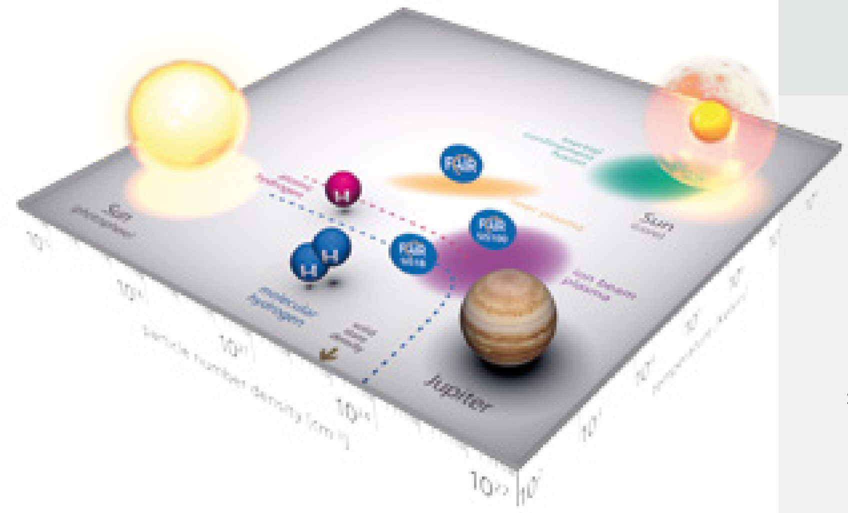
FAIR – Particular features

- High-precision and high-intensity primary and secondary beams of stable and unstable ions of unprecedented quality
- Parallel beam performance from protons to uranium beams, as well as antiproton beams
- Rapidly cycling superconducting magnets

FAIR Partner Countries

Finland	France	Germany	India	Poland
Romania	Russia	Slovenia	Sweden	United Kingdom

What happens in the interior of planets?



Atomic, Plasma and Applied Physics at FAIR

Physicists call the fourth state of aggregation plasma. This is a gas made of electrically charged particles.

Hot plasmas at low pressure are already well-known. Plasmas at high pressure and low temperatures as they exist in the interior of large planets, for example, still require investigation on a wider scale, however. Plasma physics experiments at FAIR will provide the latest findings in this field.

The heavy ions available at FAIR will also be used to investigate the impact of cosmic radiation on inter-planetary flights for both astronauts and spacecraft components.

Ultra-strong electromagnetic fields occur in highly-charged heavy ions and can be further increased in experiments with fast heavy ions passing each other. The new project will open up unique opportunities for these areas of research and for quantum electrodynamics tests at ultra-strong fields.

What holds the world together?

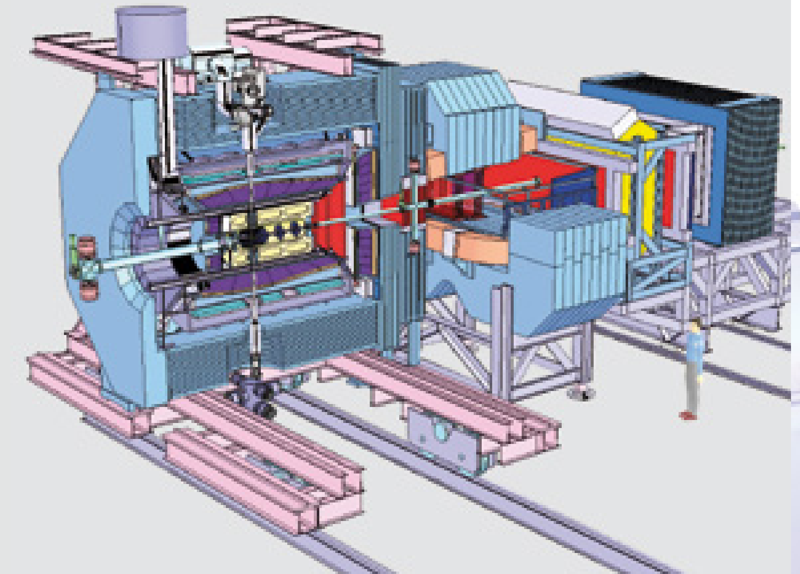
Protons and neutrons in the atomic nuclei are called hadrons. Their building blocks are quarks, which are kept together by the strong force. Gluons, which take their name from the word „glue", are identified as mediators of the strong force.

Questions to be solved are:

- How do quarks interact?
- Which combinations of quarks exist?
- Why are hadrons heavier than the sum of the masses of their constituents?

Experiments at FAIR in the fields of hadron and nuclear physics such as PANDA (anti**P**roton **AN**ihilation at **DA**rmstadt) with high precision antiproton beams will help to find answers.

The PANDA detector at FAIR



What are the properties of nuclear matter?

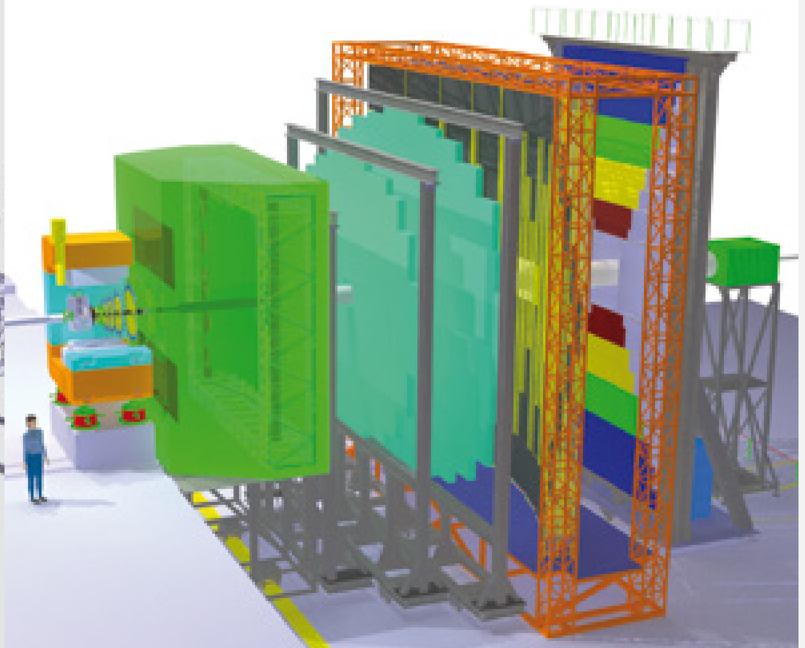
The cores of neutron stars contain - as was also the case in the early universe - matter at extreme energy densities. Here quarks and gluons are not expected to be confined in hadrons but to move freely in a so-called quark-gluon plasma.

Key questions are:

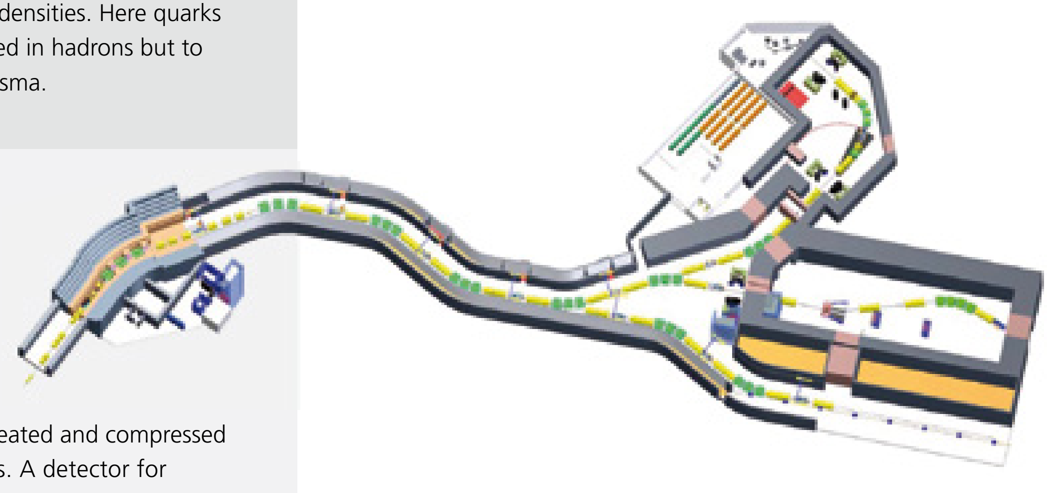
- To what extent can nuclear matter be compressed?
- At which densities and temperatures will hadrons dissolve into quarks and gluons?

In the laboratory, nuclear matter can be heated and compressed via high-energy nucleus-nucleus collisions. A detector for measuring particles emerging from this extremely hot and dense matter (CBM-**C**ompressed **B**aryonic **M**atter) will help to tackle these fundamental questions.

The CBM detector at FAIR



How are the heavy elements made?



The NUSTAR facility at FAIR

It is assumed that chemical elements heavier than iron originate from collapsing stars or stellar collisions. The underlying processes depend on the nuclear forces and symmetries in rare isotopes.

To investigate the **NU**clear **ST**ructure, **A**strophysics und **R**eactions (NUSTAR) with intensive secondary beams of such rare isotopes experiments using the Super-Fragment-Separator (FRS) and a series of complimentary detector set-ups are foreseen. They should clarify relevant details of the nuclear configuration of the various isotopes. In addition, a better understanding of the abundance of the heavy elements, new knowledge about the interior of neutron stars and other unsolved astrophysical puzzles are expected.