BUILDING THE UNIVERSE BELOW GROUND

Cosmic science meets construction

The FAIR Accelerator will send particle beams around a 1.1 kilometer ring at close to the speed of light to help scientists unlock the secrets of the universe.

More than 3,000 scientists from 50 countries will conduct research at FAIR, aiming to achieve breakthroughs in space travel, materials science, cancer therapy, and more.

Billions of years on from the Big Bang, a major build is underway in Germany that is ambitious in terms of both construction and cosmic research. The Facility for Antiproton and Ion Research (FAIR) outside the city of Darmstadt will explore how the universe evolved to give us all the building blocks of matter around us today. Its centrepiece is a 1.1-kilometer-long ring accelerator where beams of electrically charged particles will travel round in a loop at almost 300,000 kilometers per second.

Other ring accelerators exist, including the famous one at CERN in Switzerland. But the FAIR ring will be globally unique in its ability to accelerate ions from every natural element in the periodic table at around 99% of the speed of light – even heavy particles such as gold, lead, and uranium.

Running rings around human knowledge

In laboratories off the ring accelerator, more than 3,000 scientists from 50 countries will carry out experiments. By making the particles collide with fixed targets, the researchers will be able to briefly produce the extreme conditions that otherwise occur only at the core of planets and stars. The resulting breakthroughs in human knowledge could have multiple applications, from protective clothing for astronauts to nuclear fusion technology, and from the detection of new viruses to cancer therapies that use heavy ions to target tumours.

One of the largest scientific construction projects in the world, FAIR is taking shape at the site of GSI, a renowned research facility outside the German city of Darmstadt.

Most of the structure is underground and comprises a winding network of experiment stations and beamline connections branching off the main particle accelerator.

A monumental collaboration
A CHF 3 billion endeavour, FAIR is one of the biggest scientific construction projects in the world. Nine countries and a selected group of companies, including Sika, are working in partnership to complete the work.

The facility's home is a 15-hectare site at the GSI Helmholtzzentrum für Schwerionenforschung. This scientific institute is already world-renowned for its discoveries, which include six new elements.

Here, builders have created a circular underground tunnel to house the new ring accelerator, plus a labyrinthine complex of experiment stations, supply tunnels, and other high-tech buildings.

Waterproofing challenges
Of course, the people tasked with delivering this cosmic construction have been brought down to earth by some very terrestrial challenges, e.g. protecting the interior from water damage.

As Marco Bloch, Product Engineer for Building and Basement Waterproofing at Sika Germany, explains, "FAIR will generate particle beams of a previously unparalleled intensity and quality. At the same time, the facility will contain extremely sensitive equipment, including superconducting magnets cooled with liquid helium. Even the smallest amount of moisture could cause enormous damage and disrupt experiments. So, the waterproofing has to be of the absolute highest quality."

Waterproofing was a particular concern for the accelerator tunnel, due to the massive thickness of the concrete walls and base slab. At 24 meters below the surface, the structure had to withstand enormous groundwater pressure.

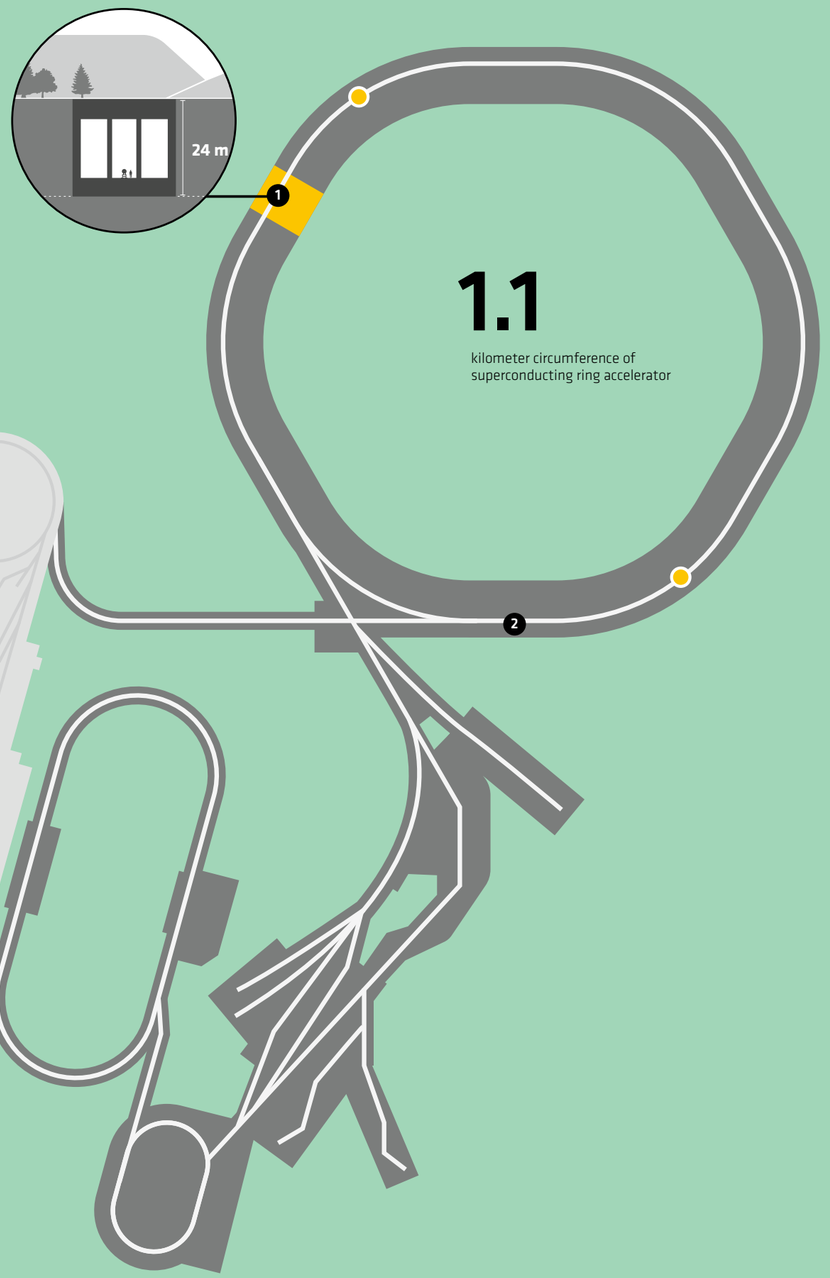
Facts & Figures

2 million
cubic meters of earth excavated – enough to make way for 5,000 family homes

250,000
square meters of Sika waterproofing solutions

85,000
square meters of Sika flooring systems

The FAIR Accelerator is one of the world's largest and most complex scientific construction projects. When it is complete, more than 3,000 scientists from 50 countries will work here on cutting-edge research.



1.1
kilometer circumference of superconducting ring accelerator

Challenges

1. Depth of up to 24 meters, extreme high water and soil pressure

2. High-value underground structure and equipment must be protected from water ingress. Ions of all the natural elements could be accelerated at close to the speed of light. Magnets that keep the ions in their paths are superconducting and cooled to –269 °C by means of liquid helium

3. Extremely high requirements for water vapor diffusion capacity in the system structure of floors and walls due to the massive components, in particular the 2.4-meter-thick floor slab

Sika Waterproofing Solutions

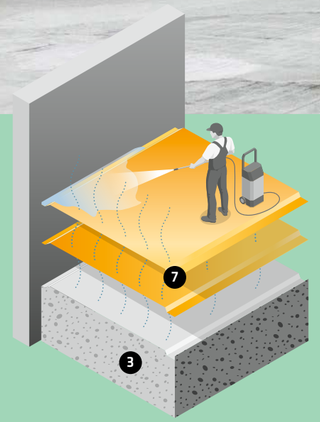
Combination of three Sika solutions in one fully bonded membrane system with high impermeability, crack-bridging ability and protection against lateral water migration, withstanding high water pressure:

4. SikaProof® A pre-installed fully bonded membrane system. The multi-layer structure consists of a highly flexible sealing membrane and a composite layer on the concrete side, creating a permanent, flat bond with the hardening fresh concrete, effectively preventing water ingress in the event of accidental damage

5. SikaProof® P-12 post-applied waterproofing system. This consists of a highly flexible sealing membrane, which is coated with an adhesive and sealant. The membrane is bonded to the existing concrete structure over the entire surface. It is applied cold and is self-adhesive, so it does not require heat or an open flame

6. All types of joints and cracks are sealed with Sikadur-Combiflex®. It allows for three-dimensional joint movement while ensuring a watertight seal. It can be used before and after concreting under the floor slab, on the wall, or in the ceiling area. This makes the sealing system one of the most flexible available

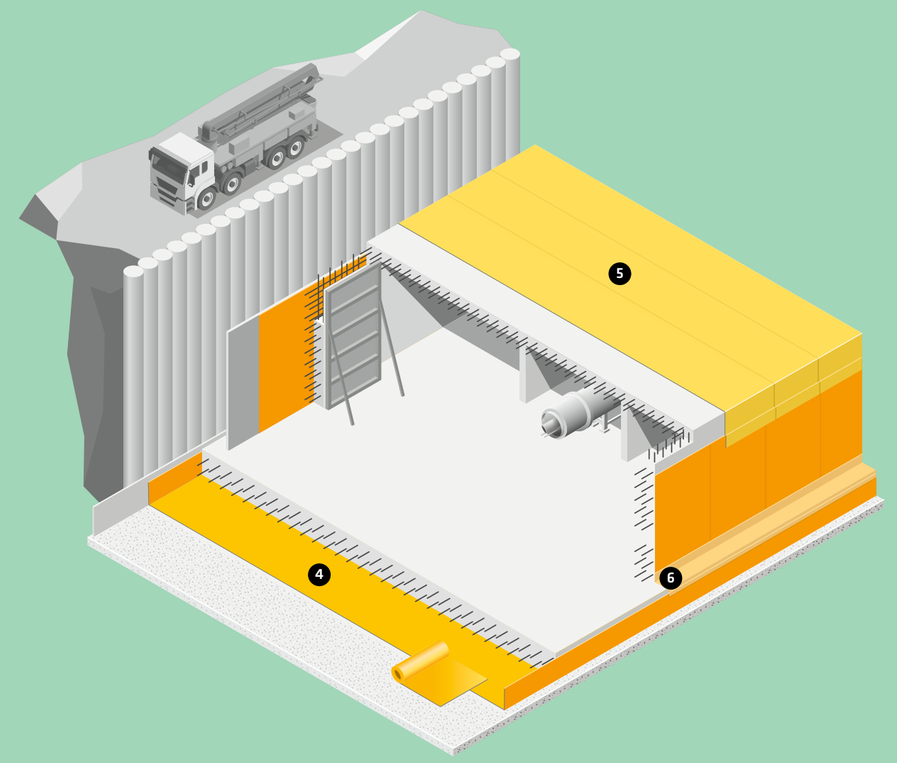
Sika supported the mega project by providing high-performance waterproofing solutions as well as technical know-how.



Sika Flooring Solutions

7. Innovative Sika floor coating system prevents osmotic blistering on damp substrates and offers excellent adhesion to concrete substrates. It is characterized by a particularly high resistance to numerous types of attack.

   Sika's various combinable coating systems were used in conjunction with the epoxy resin-modified self-leveling mortar to meet special requirements like decontamination



3 CHF billion overall investments

150,000 square-meter site

2.4–3.5 meter-thick ground slab

The experts choose Sika

Sika Germany worked closely with FAIR's owners, planners, structural engineers, and physicists, proving that Sika solutions could meet the extreme demands of this mega construction project.

"We showed that all our products could safely withstand the radiation conditions for a minimum 50 years while providing excellent waterproofing protection," says Bloch. "Everything from our waterproofing membranes down to the smallest strip of joint sealing tape and dab of adhesive passed the intensive analysis."

The tunnel walls, floors, and roof were carefully sealed against water ingress using the SikaProof® A and SikaProof® P-12 membranes. Inside the accelerator, the floors and walls were coated with special protective layers that stick firmly to the concrete and stay smooth as they dry. Together, these measures created a strong, flexible, and long-lasting barrier to protect the accelerator from moisture and damage.

Waterproofing know-how

Sika has a wealth of experience in complex underground projects, including hospitals with radiology facilities and museums storing centuries-old treasures. However, a particle accelerator for researching the universe was new territory even for Sika.

"I believe it was our advice and practical support at all phases of the project that made us stand out," says Bloch. "From preliminary planning all the way through to our weekly quality controls during the construction work, we were always on hand to share our know-how and solutions with all teams involved.

"It has been a privilege to play a role in creating a gigantic cosmic laboratory. Even though Sika's contribution will be as invisible as the atoms being researched, our materials will be part of the facility's success."

Thousands of scientists, engineers, builders, and partners have come together to create this universe in a lab. Soon the specialists will arrive who can put it into action.

The facility contains sophisticated components, such as these supply lines that carry liquid helium and electric current between superconducting magnets.

Sika's waterproofing solutions need to shield the highly sensitive equipment from water ingress that could disrupt experiments.