

## HIGH BRILLIANCE NEUTRON SOURCE (HBS)

The next-generation neutron facility for science and industry

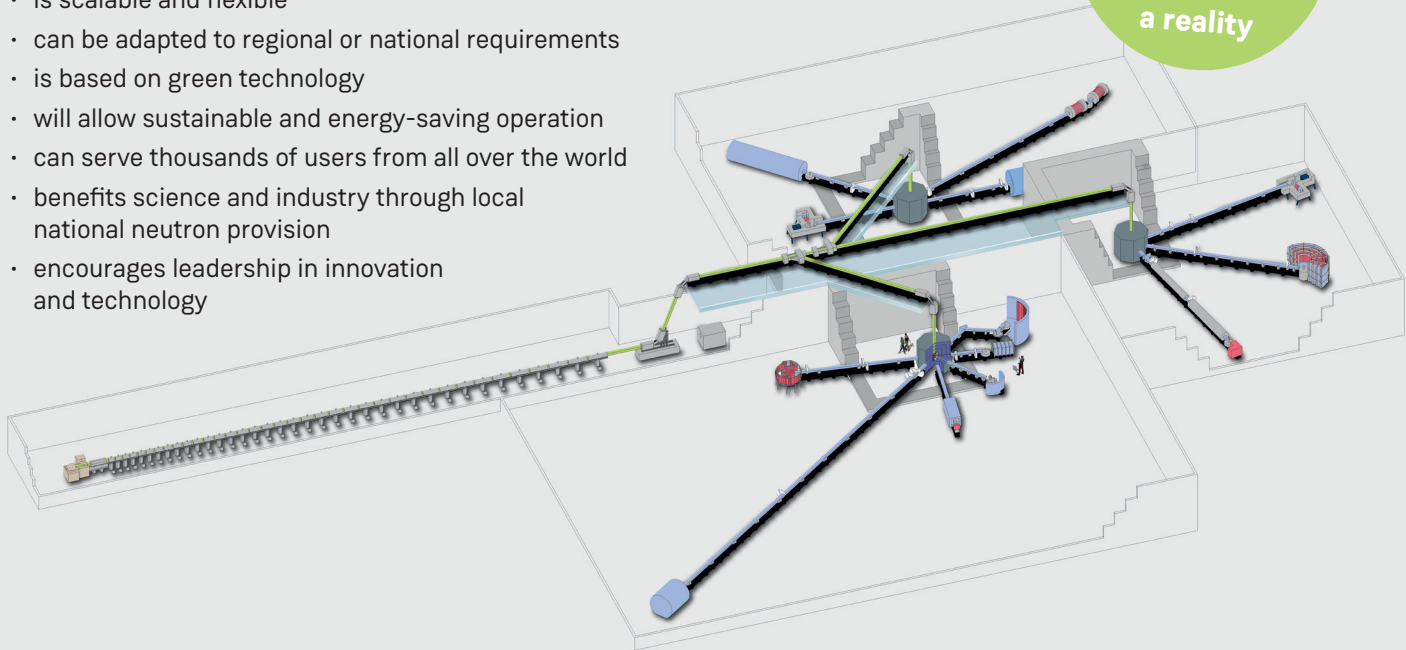
Mitglied der Helmholtz-Gemeinschaft

# The High Brilliance neutron Source (HBS)

## A project for a next-generation neutron facility which

- changes the paradigm of neutron facilities
- is driven by a low-energy proton accelerator
- offers cost-efficient neutron production
- is scalable and flexible
- can be adapted to regional or national requirements
- is based on green technology
- will allow sustainable and energy-saving operation
- can serve thousands of users from all over the world
- benefits science and industry through local national neutron provision
- encourages leadership in innovation and technology

A green European neutron ecosystem can become a reality



# HBS – A Change of Paradigm

- **Optimize source brilliance**

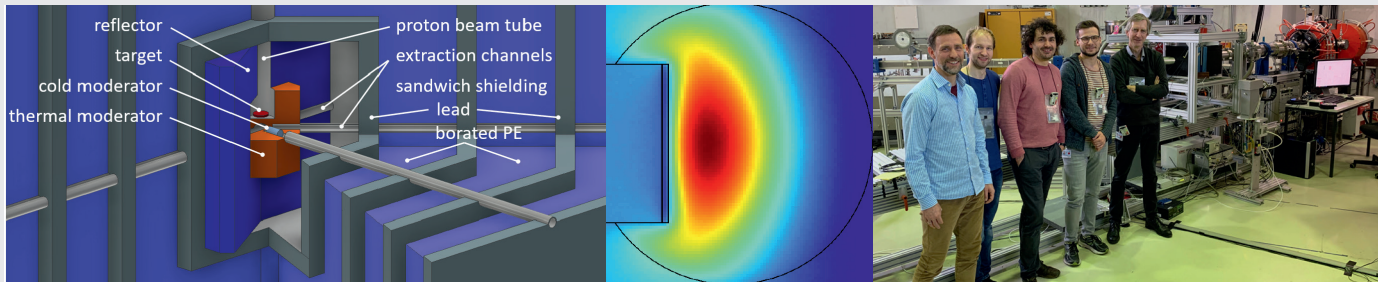
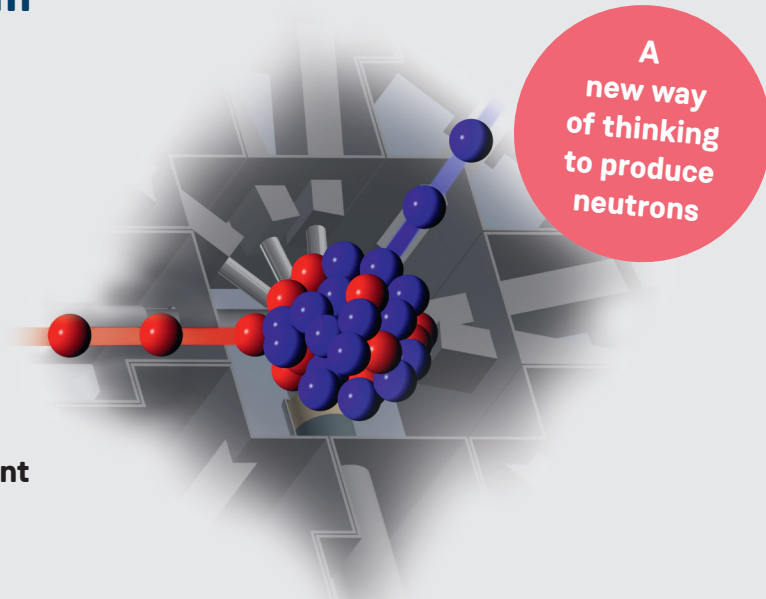
intense, fine, collimated beams  
for novel applications

- **Produce less, use efficiently**

a nuclear reaction at low proton energy  
leads to minimum unwanted radiation and  
radioactive waste, efficient beam extraction  
and cost savings

- **Source as integral part of the instrument**

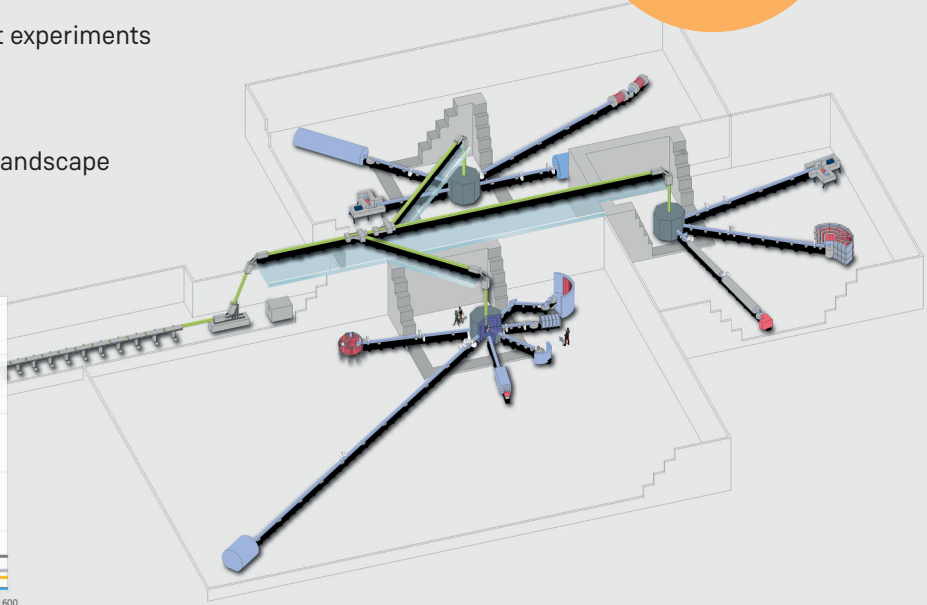
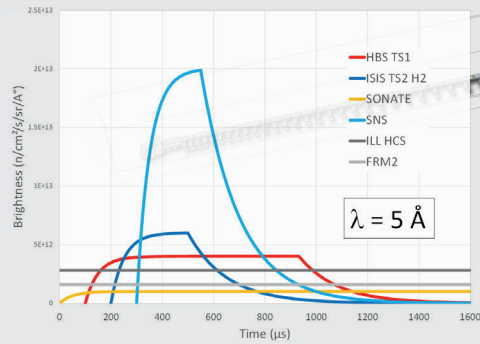
neutron beams tailored to fit application



# HBS – Performance through Brilliance

- **Several target stations**  
adapted to the scientific needs offering optimized neutron flux
- **High brilliant neutron beams**  
for competitive instrumentation for best experiments
- **Versatile novel facility**  
complementary and competitive in the landscape of neutron sources

Adapt  
the neutron  
source to the  
specific  
needs



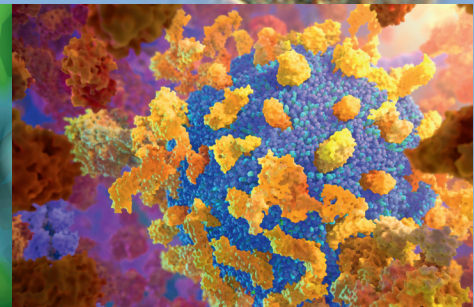
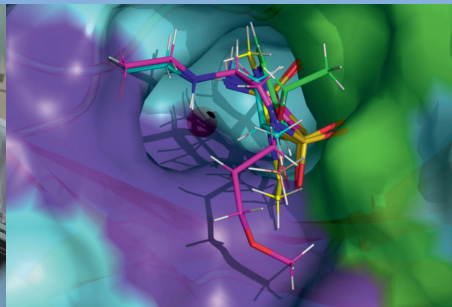
# Mastering Complexity

**Neutrons are** ideal microscopic probes for **entire complex biological matter and organisms.**

## **Neutrons are**

- smart and gentle on protein crystals or biological samples
- can locate hydrogen atoms functioning in biochemical processes
- can demask drugs, enzymes or subunits of complex proteins in their environment via H/D contrast matching
- can capture the movement and dynamics of functional units of proteins
- can detect the structure and function of proteins and enzymes in the crowded environment in living cells

The  
gentle  
life science  
microscope



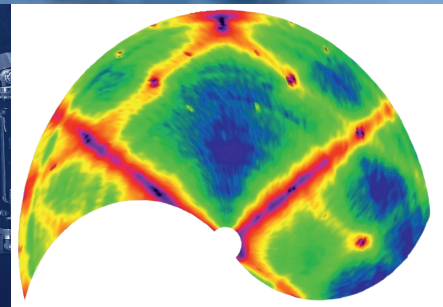
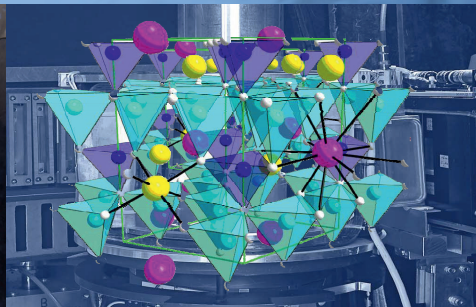
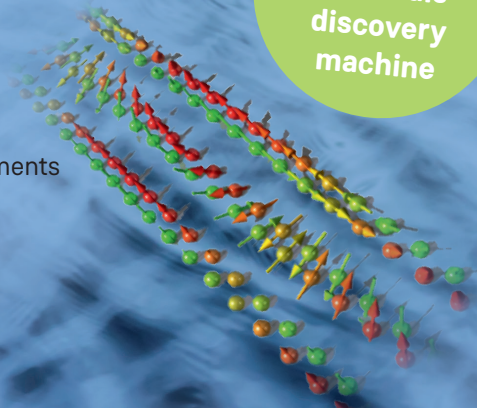
# Mastering Complexity

**Neutrons are** ideal microscopic probes for **complex topological quantum materials and quantum systems.**

## Neutrons probe

- quantum states through interaction with polarized neutron beams
- penetrate through complex sample environments, allowing measurements in the true quantum regime, at low temperature and high fields
- discover novel entangled quantum states in materials relevant to the second quantum revolution
- discover novel topological quantum states of matter relevant for future spintronics, such as skyrmions or magnetic monopoles

The  
quantum  
materials  
discovery  
machine



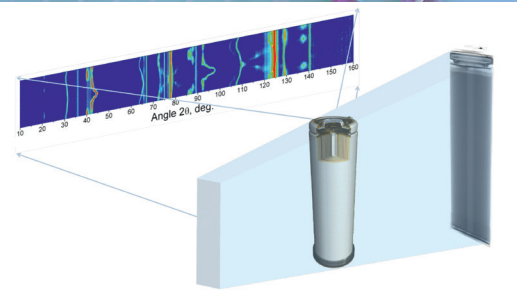
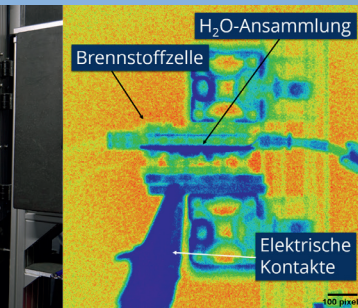
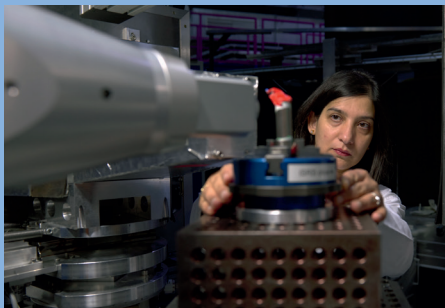
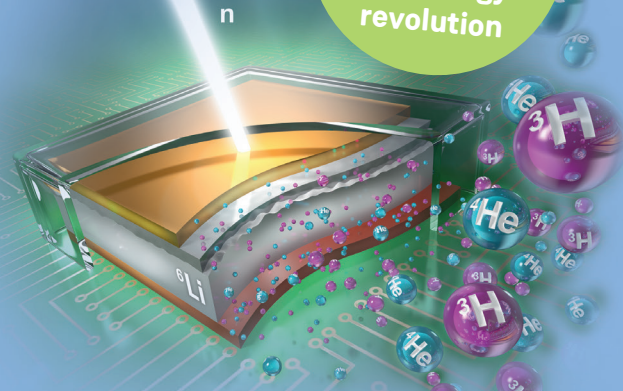
# Mastering Complexity

**Neutrons can** ideally probe **entire real energy engineering systems** as neutrons see where atoms are and how they move.

## Neutrons can

- see light elements such as hydrogen and lithium, which are at the very heart of the energy revolution
- allow the operando study of real, entire energy storage or energy conversion devices with their penetration ability
- follow the movement of Li in Li ion batteries
- show function and structure of liquids in membranes for fuel cells

The innovation-enabler for the energy revolution



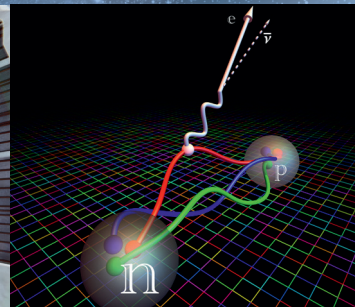
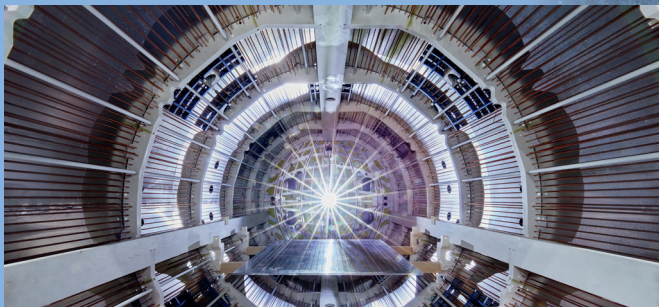
# Mastering Complexity

**Neutrons provide answers to fundamental questions about our existence** through extreme precision measurements.

Hunting  
for the  
origin of our  
universe

## Neutrons provide

- stringent tests of the standard model of physics via high-precision measurements of their lifetime
- could solve the riddle of why we exist by searching for an electric dipole moment (EDM) in an attempt to explain the disequilibrium of matter to antimatter
- can test Newton's law on otherwise inaccessible length scales through the observation of quantum states in the earth's gravitational field





# Societal Impact

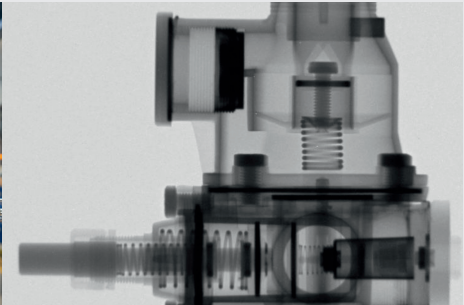
An  
opportunity  
for bussiness  
and  
employment

## Regional impact

- 2000 – 3000 users/year provide opportunity for local business for service and infrastructure including transportation, accommodation and leisure
- regional companies benefit from contracts for construction and maintenance work
- high-tech companies for advanced technological components (accelerator systems, cryo-technology, mechanical and electrical engineering, neutron optics) will benefit and provide employment for the region

## Innovation impact

- scientific and technological service for industry
- high level analytical platform for quality assurance and product development

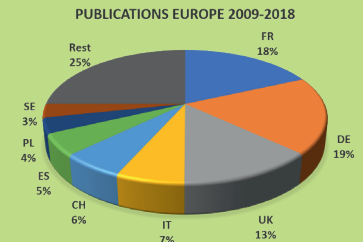
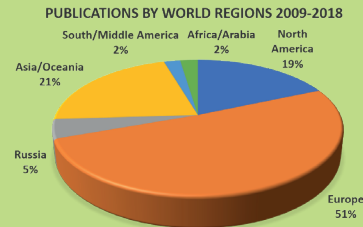


# Serving a Productive National Community

## German neutron users

- there are 1900 registered users in KFN database of the Komitee Forschung mit Neutronen (KFN)
- are scientists working in many areas and disciplines
- are the largest user group at national (MLZ) and international sources (ILL, SINQ, ISIS)
- have an outstanding publication record over many years

World-leading research with neutrons



# A Fit-for-purpose Location

## A neutron facility

- energy-efficient and climate-neutral embedded in local environment and infrastructure
- the architecture combines functionality and flexibility
- an open, green architecture to provide scientists with a creative environment
- a location to attract the best and brightest talent in science and engineering

Innovative  
architecture for  
an innovative  
facility



# Building a Green Neutron Landscape

## High brilliance accelerator-driven neutron sources

- will revolutionize the neutron landscape in Europe
- green neutrons with climate-neutral accelerator technology
- requires no nuclear license and produces no waste from nuclear fission
- the HBS project has aroused significant international interest and created a network of projects in Europe and world-wide for access to neutrons in the future

A green European neutron ecosystem can become a reality

Cooperation within LENS:  
League of advanced European Neutron Sources.

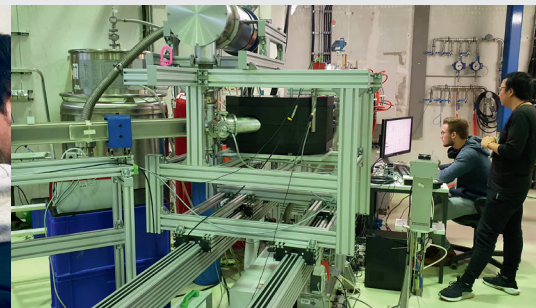
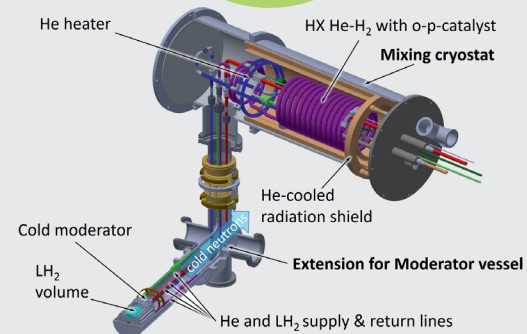


# A Driver for Innovation and Technological Leadership

## The high brilliance accelerator-driven neutron source HBS

- fosters high tech engineering
- serves as a driver for innovation e.g. in cutting-edge optics
- stimulates leadership in accelerator technology
- pushes back limits in material science and engineering
- explores high-end cryo-technology for cold moderator systems
- exploits efficient and sustainable energy management
- secures reliable operation
- pushes forward digitalisation, automation, and artificial intelligence at all levels in both technology and facility operations

Driving digitalization, automation and innovation



# Making a Vision come True

## Preparing the ground

- since 2015, the annual “Unkel” Workshop has become an international incubator for the development of low-energy, accelerator-driven neutron sources

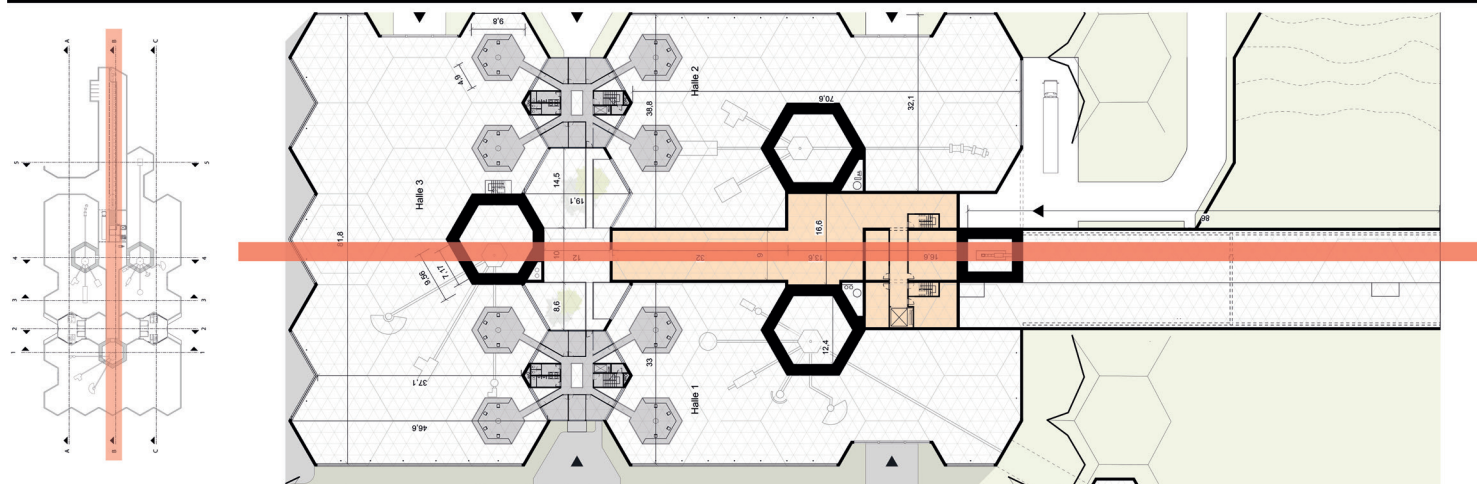
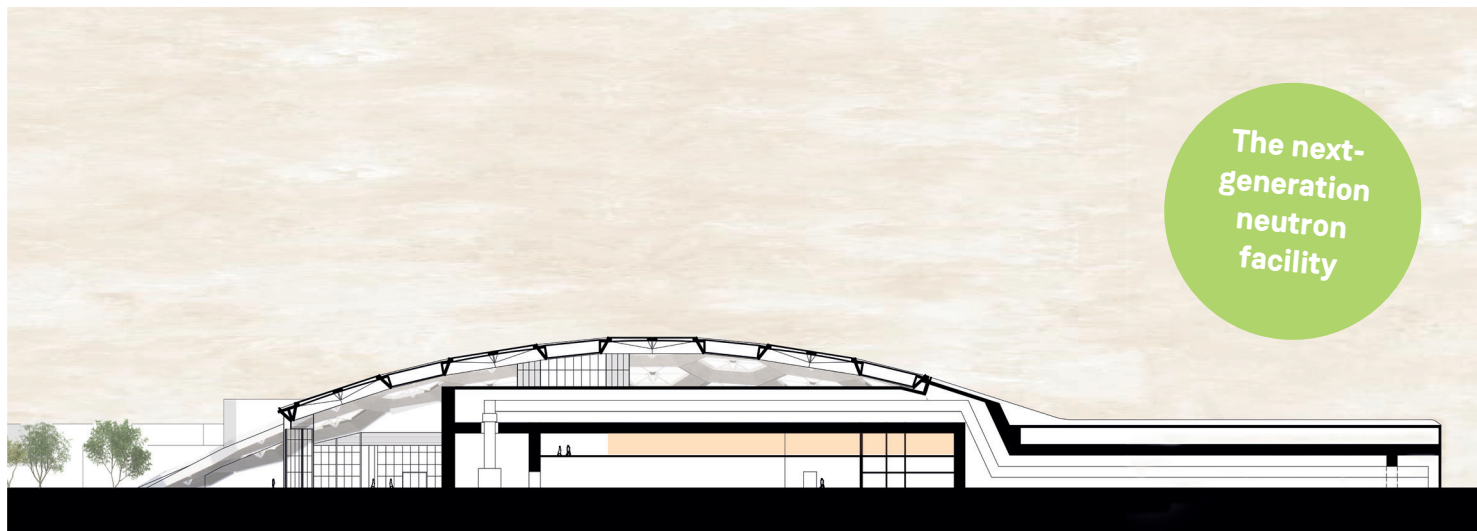
## Shaping the vision

- in 2020, the Conceptual Design Report CDR was finished
- work on the Technical Design Report is ongoing, different funding sources are being explored

A  
vision for  
the future with  
neutrons



The next-generation neutron facility



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