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# European Spallation Source

# Experts from Poland are involved in designing and building the world's strongest pulsed neutron source for investigating the properties of condensed matter

ESS


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Fig. 1
Waveguide installation in the accelerator tunnel

Fig. 2
Completed installation of waveguides in the tunnel of the ESS accelerator

Fig. 3, 4
Preliminary installation of STUB waveguide system

The European Spallation Source (ESS), under construction in Lund, Sweden, since 2014, will be one of the largest research facilities in the world. It has the status of a European Research Infrastructure Consortium (ERIC), with Poland among its 15 founding members. The budget of this project is 1.85 billion euro. Experts from over 100 leading research centers, including Poland, are involved in the construction of the neutron source itself and developing the top-class instrumentation.

The ESS will be the world's strongest pulsed neutron source for investigating the properties of condensed matter in the broadest sense – from fundamental physics and materials engineering on the nano- to macro--scales, through new materials for energy generation and storage, medicinal substances and their carriers, the physics and chemistry of soft matter, all the way to non-destructive, revealing scrutiny of otherwise invisible features of works of art. Intense neutron beams can be used to experiment on very small samples, as well as to study physicochemical processes in real time.

A linear accelerator, the most powerful ever built, will supply a pulsed beam of protons to induce spallation processes in a helium-cooled tungsten target. As part of the Polish in-kind contribution, engineers from the Institute of Nuclear Physics PAS in Kraków, the National Centre for Nuclear Research in Świerk, Warsaw University of Technology, Lódź University of Technology and Wrocław University of Technology are involved in its construction. Some of the Polish design, construction and technical efforts are supported by Polish industry. The launch of the ESS is foreseen for 2023.

Further reading:

www.europeanspallationsource.se

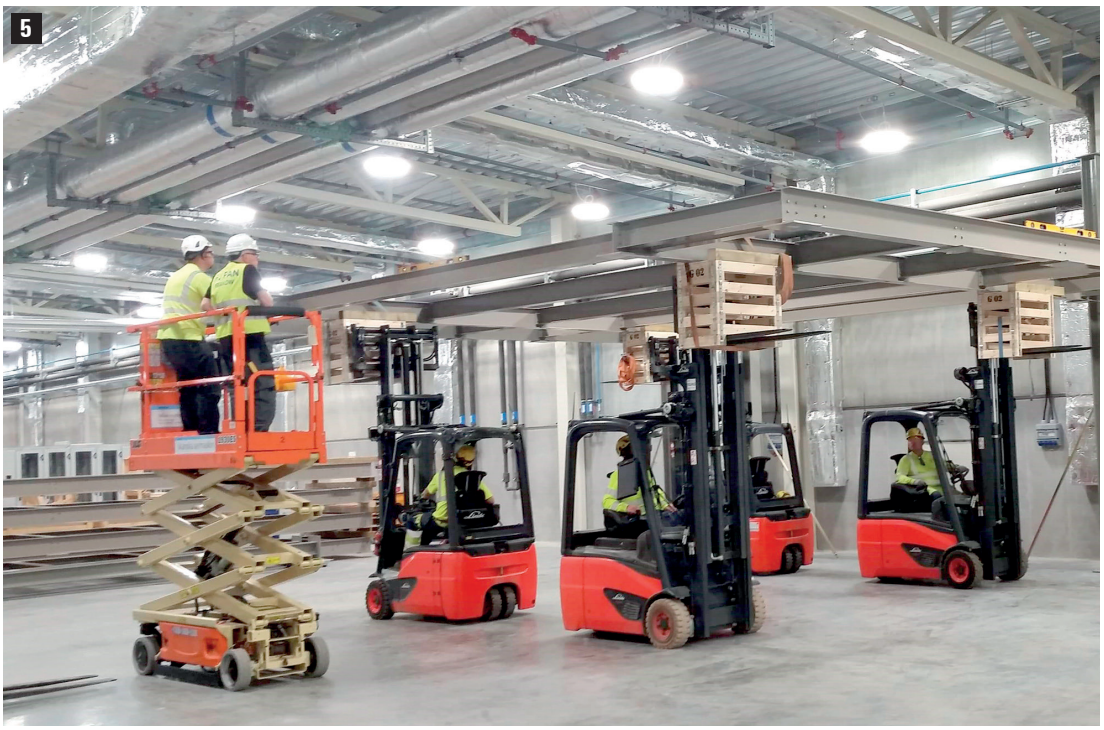

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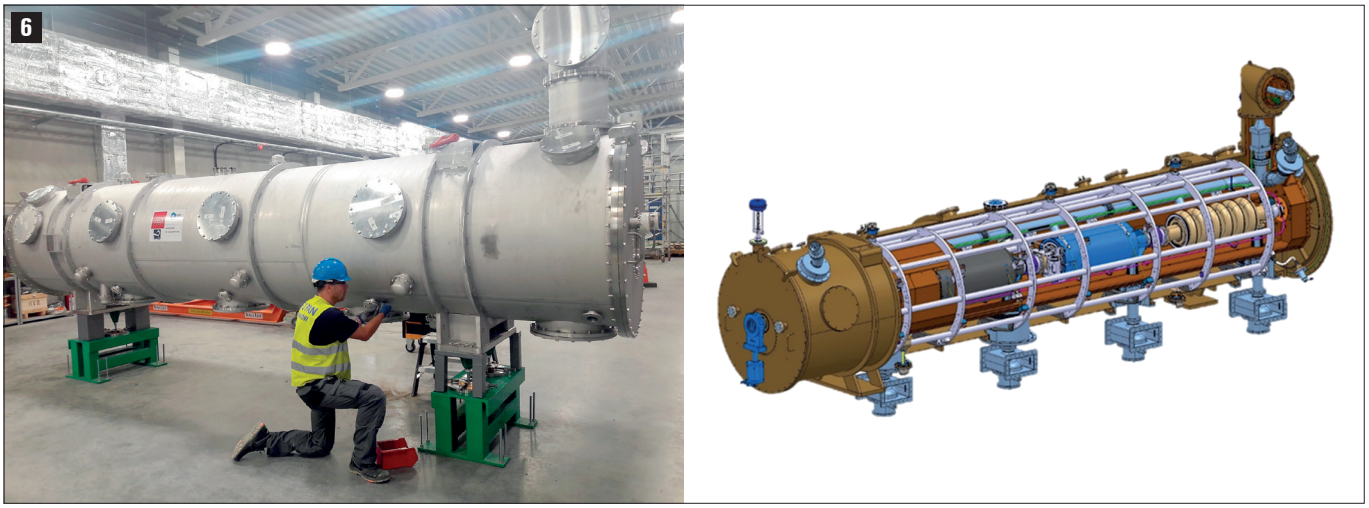
Fig. 5
VNA test and installation of 27 loads 352 MHz and 82,704 MHz

Fig. 6
Preliminary tests of the ESS cryomodule installation



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Spallation is a process in which a heavy atomic nucleus is bombarded with protons with energy of about 1 GeV, leading to a cascade of internal reactions and the emission of a large number of neutrons and other nucleons, nuclear fragments and γ-rays. As a result, the atomic mass of the bombarded nucleus decreases


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Fig. 7
VNA test and installation of 26,352 MHz circulators


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Fig. 8
Power distribution system – waveguides 704 MHz ready for tuning

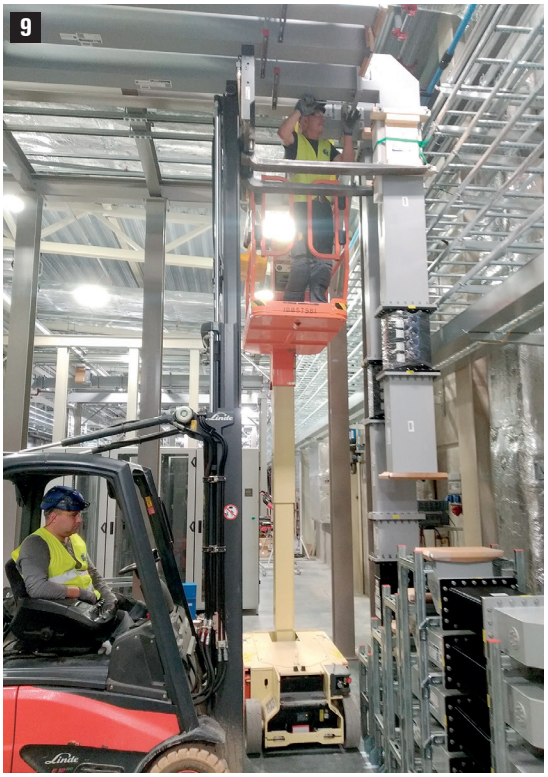


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Fig. 9
Installation of vertical wave elements

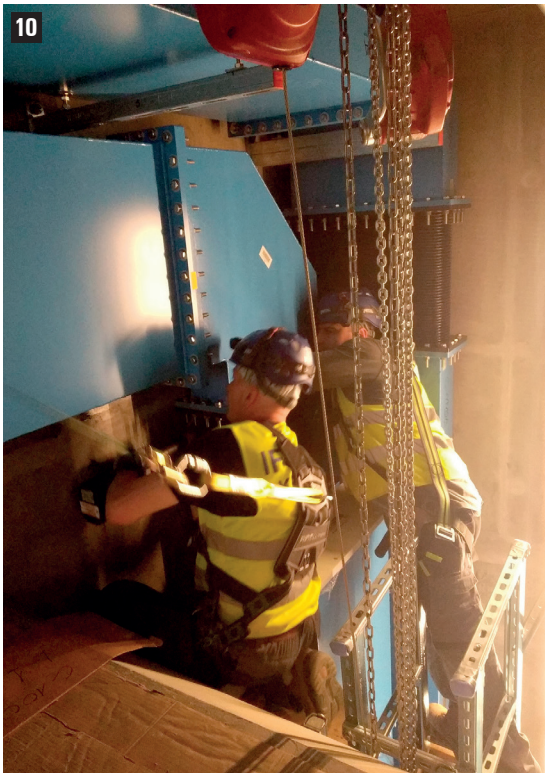


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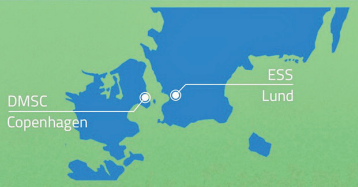
Fig. 10
Challenging installation of waveguides of the RQF section in the STUB transition

# European Spallation Source

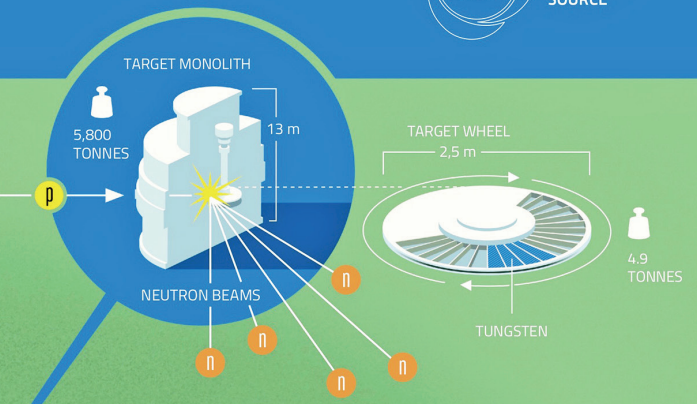
EUROPEAN SPALLATION SOURCE

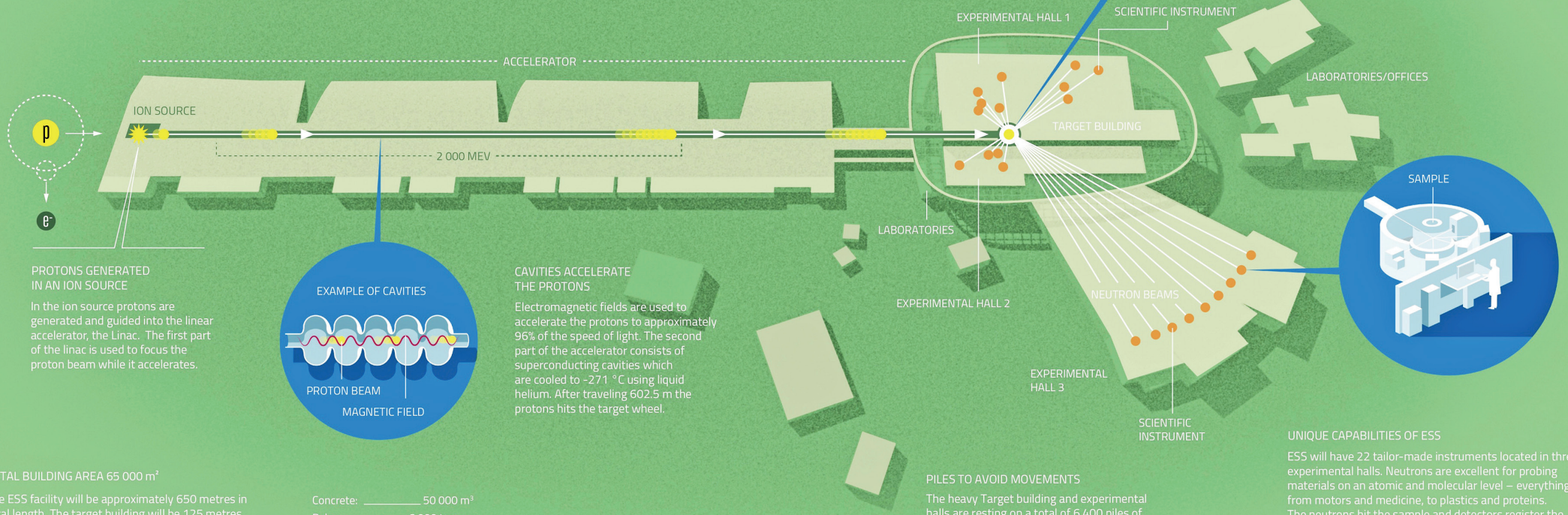
The European Spallation Source (ESS) is a multi-disciplinary research centre based on the world's most powerful neutron source. ESS will give scientists new possibilities in a broad range of research, from life science to engineering materials, from heritage conservation to magnetism. ESS is a pan-European project, with Sweden and Denmark serving as host countries. The main research facility is being built in Lund, Sweden, and the Data Management and Software Centre (DMSC) is located in Copenhagen, Denmark.




## THE TARGET IS THE NEUTRON SOURCE

When the accelerated protons hit the rotating tungsten target wheel spallation occurs and neutrons are scattered from the tungsten nucleus. The more neutrons produced and collected in the target, the "brighter" the neutron source. The neutrons are directed through moderators and neutron guides to the scientific instruments where they are used for experiments. The Target monolith consists of the Target wheel, moderators, cooling systems and shielding and weighs approximately 5,800 tonnes.




## PROTONS GENERATED IN AN ION SOURCE

In the ion source protons are generated and guided into the linear accelerator, the Linac. The first part of the linac is used to focus the proton beam while it accelerates.




## CAVITIES ACCELERATE THE PROTONS

Electromagnetic fields are used to accelerate the protons to approximately 96% of the speed of light. The second part of the accelerator consists of superconducting cavities which are cooled to -271 °C using liquid helium. After traveling 602.5 m the protons hits the target wheel.

## TOTAL BUILDING AREA 65 000 m²

The ESS facility will be approximately 650 metres in total length. The target building will be 125 metres long, and about 30 metres high. The 537-meter-long accelerator tunnel is built underground and will be covered with soil.

| | |
|---|---|
| Concrete: | 50 000 m³ |
| Rebar: | 6 000 tonnes |
| Pipes: | 40 km |
| Cables: | 2,000 km |
| Total volume: | 400,000 m³ |


## PILES TO AVOID MOVEMENTS

The heavy Target building and experimental halls are resting on a total of 6,400 piles of different types, in order to avoid unwanted movements in the structure.

## UNIQUE CAPABILITIES OF ESS

ESS will have 22 tailor-made instruments located in three experimental halls. Neutrons are excellent for probing materials on an atomic and molecular level – everything from motors and medicine, to plastics and proteins. The neutrons hit the sample and detectors register the neutron scattering, giving precise information about the material's structure and dynamics.