MINERVA accelerator has grown metres

At the Cyclotron Resource Centre in Louvain-la-Neuve, SCK•CEN is in the midst of building the first part of the particle accelerator that will drive the MYRRHA research reactor. This part (with an energy of up to 100 MeV), the corresponding injector and irradiation stations are a stand-alone project: MINERVA. With MINERVA, SCK•CEN can test the reliability of the particle accelerator, produce new medical radioisotopes and carry out fundamental research.

Thanks to a financial injection from the Belgian government, MYRRHA becomes a reality. MYRRHA is the world's first prototype of a reactor driven by a particle accelerator. The specificity of this configuration – Accelerator Driven System (ADS) – is the sub-critical core of the reactor. The core does not contain enough fissile material to sustain a spontaneous chain reaction and must therefore be fed continuously by an external source of neutrons. "This is where the particle accelerator comes in", explains Dirk Vandeplassche, physicist and specialist in particle accelerators.

"In the MYRRHA design, we opted for a linear accelerator (linac)", says Dirk. "This is to ensure the greatest reliability. Indeed, a linac produces fewer interruptions of the proton flow in the beam than a cyclotron." MYRRHA's particle accelerator consists of an injector with an ion source and a Radio Frequency Quadrupole (RFQ), and a chain of magnets and cavities. The proton beam will be accelerated in order to be fired at a spallation target at the heart of the reactor core. "Upon impact, neutrons are released, which will maintain the fission reaction", explains Dirk.

Accelerator bearing European colours

In 2018, MINERVA – the particle accelerator up to 100 MeV – took shape nicely. "Meanwhile, the first metres can be seen at the Cyclotron Resource Centre in Louvain-la-Neuve. The ion source and different components of this accelerator were first tested in Grenoble and have now been moved to Belgium. It doesn't stop at the Belgian border; it brings together several European partners and this accelerator therefore bears European colours", winks Dirk Vandeplassche. The accelerator team put the components back together and installed the complete wiring. Ultimately, the MINERVA accelerator will produce 100 MeV protons, but the installation in Louvain-la-Neuve is limited to 5.9 MeV. Dirk: "The low-energy part is extremely important and critical for the behaviour of the proton beam during the whole follow-up of the acceleration. Therefore, we are very focused on its extensive testing. We want to make as many proton beams as possible and characterise them." During the first half-year of 2019, high-performance tests will follow and the RFQ will be coupled to the accelerator. "This will be a magical, but exciting moment", exclaims Dirk. "Well, exciting… I would be surprised if it didn't work." The RFQ is a fundamental link in achieving the paramount reliability for MYRRHA.

Dirk Vandeplassche and **Jeroen Engelen,** collaborators for the particle accelerator

In a later phase of the MINERVA project, the capacity of the particle accelerator will be increased gradually up to an energy level of 100 MeV. In 2026, MINERVA will be brought on-line. From then on, the particle accelerator and its two corresponding irradiation stations will be used to produce medical radioisotopes and to carry out fundamental research in physics and material research – more specifically in the field of nuclear fusion. But first, the particle accelerator must be moved to Mol.

Transfer to Mol

Preparations for the building that will house MINERVA are in full swing. “The actual construction will start in 2022 and the buildings should be ready one and a half years later for the installation of the systems”, explains Jeroen Engelen, who works at the Balance of Plant within SCK•CEN and is in charge of design and implementation. “We are talking about a 150-metre long tunnel for the accelerator and, parallel to this, a large technical hall. At the head of the accelerator, there will be a building housing workshops, offices and labs. Once the structural works are completed, we will start installing the particle accelerator and the ion source.”

“Currently, we are building the first part of the particle accelerator in Louvain-la-Neuve for MINERVA and by extension therefore also MYRRHA.”

The last challenge is to crank up the energy level to 600 MeV. “This energy is required to carry out all the planned activities, in particular transmutation”, says Jeroen. To reach that energy level, the accelerator must be extended by 250 metres. “Then, we extend the accelerator to the reactor building housing MYRRHA, which will also be built in the next phase.” The total length of the setup – main building, injector, accelerator tunnel up to the impressive reactor building – will then be close to 500 metres. For the planned works, there will be a European tender procedure. “We appeal to all parties in Belgium and abroad to take part”, concludes Jeroen. As regards employment opportunities – both in Mol and beyond – this can count. On average, around 700 people will work on MYRRHA each year, both during the construction phase and during the operational phase of the infrastructure.

A COOL 2 KELVIN

Superconductivity is the phenomenon whereby the electrical resistance of certain materials disappears below a certain temperature. “The temperature we require is 2 Kelvin. This is close to the absolute zero, rather cool”, winks Dirk Vandeplassche.