MYRRHA, the Belgian Prototype that fascinates the World
Outline

• Context – What is MYRRHA?
• A Non Profit Organisation exists now!
• Our implementation strategy
• Recent update on the reactor part of the installation.
MYRRHA: ACCELERATOR DRIVEN SYSTEM

**Phase 1**
- Linear Accelerator
- 100 MeV

**Phase 2**
- Phase Three
- 600 MeV

- Transmutation Demonstration
- ADS at Pre-Industrial Scale
- Flexible Irradiation Facility
MYRRHA’s phased implementation strategy

Phased approach benefits:

- Reduced technical risk
- Spreading investment cost
- First R&D facility available in Mol end of 2026

Source: SCK CEN MYRRHA Project Team
<table>
<thead>
<tr>
<th>Applications</th>
<th>Description</th>
<th>MYRRHA phase 1</th>
<th>MYRRHA phase 2</th>
<th>MYRRHA phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spent fuel transmutation</td>
<td>&gt;&gt; Reduce radio-toxicity:</td>
<td>✗</td>
<td>✗</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• in volume (factor 100)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• in duration (factor 1,000 from 300,000 years to 300 years)</td>
<td></td>
<td></td>
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<tr>
<td>Innovative radioisotopes</td>
<td>Produce new diagnostic and therapeutic medical isotopes for research and</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>clinical use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundamental research</td>
<td>A landmark project on the ESFRI high priority list contributing a.o. to</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td></td>
<td>fundamental research in nuclear physics science and nuclear medicine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fusion energy</td>
<td>Conducting advanced materials research, qualification and testing for</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td></td>
<td>fusion energy</td>
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Belgian Government decision of 7 September 2018

Decision to build MYRRHA as large new research infrastructure in Mol, Belgium

Belgium allocates €558 m for 2019-2038
- €287 m for 2019-2026: construction of MINERVA (linac 100 MeV + PTF & FTS)
- €115 m for 2019-2026: design, R&D and licensing for Phases 2 (extended linac 600 MeV) & 3 (reactor)
- €156 m for 2027-2038: MINERVA operations (linac 100 MeV)

Establishment of international non-profit organisation
MYRRHA AISBL/IVZW

Government support for establishing MYRRHA partnerships
Belgium appoints cabinet ministers to promote and negotiate international partnerships

Source: Belgian minister of Energy, Environment & Sustainable Development
Belgian Government decision of 7 September 2018
Confirmed on 23 July 2021 (+ creation of MYRRHA NPO)

Decision to build MYRRHA as large new research infrastructure in Mol, Belgium

Belgium allocates € 558 m for 2019–2038
• 2019–2026: construction of MINERVA (linac 100 MeV + PTF & FTS)
• 2019–2026: design, R&D and licensing for Phases 2 (extended linac 600 MeV) & 3 (reactor)
• 2027–2038: MINERVA operations (linac 100 MeV)

Establishment of international non-profit organisation
MYRRHA AISBL/IVZW
Decided 23.07.2021
Created 17.09.2021

Government support for establishing MYRRHA partnerships
Belgium appoints tutorship ministers to promote and negotiate international partnerships

Source: Belgian minister of Energy, Environment & Sustainable Development
MYRRHA AISBL is a separate legal entity needed to find external partners/investors

Responsibilities:

- For SCK CEN
  - Design & build MINERVA (phase 1)
  - Conduct R&D for phases 2 (Accelerator - 600 MeV) & 3 (MYRRHA Reactor)
  - Obtain licenses for Phase 1 and later on for Phases 2 & 3
  - Being the nuclear operator of MYRRHA/MINERVA

- For MYRRHA AISBL
  - Establish the MYRRHA International Consortium
  - Guarding the overall scope of MYRRHA programme
The AISBL has been set up: MYRRHA welcomes international partners

"MYRRHA AISBL is a reality!", enthuses Hamid Ait Abderrahim, Deputy Director-General of SCK CEN and Director of MYRRHA. The deed of incorporation was signed on Friday. "17 September therefore marks the start of a new era for MYRRHA. One in which we can officially join forces with international partners to achieve our ambitions and goals!"

MYRRHA will become the world’s first research reactor powered by a particle accelerator, and will tackle societal challenges that confront all countries. "This includes nuclear waste treatment or the fight against cancer with a new generation of medical radioisotopes, or fundamental materials research for nuclear fusion, among other things. International cooperation is essential if we are to come up with"
MYRRHA REACTOR: IMPLEMENTATION IN 2036

OBJECTIVES = TRANSMUTATION + RADIOISOTOPES + FUSION MATERIAL R&D + TECHNOLOGY PLATFORM
MYRRHA reactor primary design Rev. 1.8, frozen end 2020

- Integrated Pool-type concept with LBE coolant
- Fuel assemblies: hexagonal bundles of cylindrical wire-spaced fuel pins (MOX fuel 30wt.% Pu)
- 4x heat exchangers: double-walled with leak detection; water/steam on secondary side
- 2x primary pumps: vertical shaft mixed-flow design
- Bottom core loading: single in-vessel fuel handling machine (IVFHM)
- Safety vessel integrated into the primary vessel

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
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<tbody>
<tr>
<td>Maximum core power</td>
<td>MW$_{th}$</td>
<td>64</td>
</tr>
<tr>
<td>Maximum heat sink rated power</td>
<td>MW$_{th}$</td>
<td>70</td>
</tr>
<tr>
<td>Shutdown state LBE temperature</td>
<td>°C</td>
<td>200</td>
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<tr>
<td>Maximum core inlet LBE temperature</td>
<td>°C</td>
<td>220</td>
</tr>
<tr>
<td>Maximum average hot plenum LBE temperature</td>
<td>°C</td>
<td>270</td>
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### Revision 1.8 in numbers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Rev. 1.6</th>
<th>Rev. 1.8</th>
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<td>Max. Core Power</td>
<td>MW&lt;sub&gt;th&lt;/sub&gt;</td>
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<td>64</td>
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<tr>
<td>Design power</td>
<td>MW&lt;sub&gt;th&lt;/sub&gt;</td>
<td>110</td>
<td>70</td>
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<tr>
<td>Vessel diameter</td>
<td>m</td>
<td>10.2</td>
<td>8.3</td>
</tr>
<tr>
<td>Vessel height</td>
<td>m</td>
<td>15.9</td>
<td>11.9</td>
</tr>
<tr>
<td>Total reactor height</td>
<td>m</td>
<td>20.2</td>
<td>16.3</td>
</tr>
<tr>
<td>Longest component length (Pump)</td>
<td>m</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>LBE inventory</td>
<td>m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>725</td>
<td>525&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total mass</td>
<td>ton</td>
<td>10000</td>
<td>6682&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

1. 2000 ton reduction in LBE coolant for the LBE coolant compared to Rev. 1.6
2. 1300 ton reduction in steel mass
### MYRRHA reactor, Planning

**2020**
- Description of Rev. 1.8 concept, including the reactor building
- Final report of the pre-licensing phase
- R&D Status report

**2022 – Stage-Gate**
- Conceptual design
- Commitment of consortium partner

**2024 – Stage-Gate**
- Feasibility of conceptual design
- Positive advice from safety authorities

**2026**
- Basic design with consortium partner

**2030**
- Building permit
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