MYRRHA status

EUCARD Workshop

7 February , 2017, Geneva

MYRRHA in the 2014 BE Gov. Declaration

De regering zal het behoud van excellentie in het onderzoek naar de nucleaire veiligheid en informatie voor de burger, de omgeving en nucleaire infrastructuren op Belgisch grondgebied nastreven.

Ze zal het MYRRHA-project of evenwaardige projecten van het SCK progressief ondersteunen om het noodzakelijke onderzoek naar innovatieve oplossingen voor hoogradioactief afval, naar de kwalificatie van fusiereactormaterialen, naar het behoud van de medische radio-isotopenproductie in ons land en naar fundamenteel kernfysisch onderzoek optimaal verder te zetten in een internationale context, in samenwerking met universiteiten, onderzoekscentra en zusterorganisaties van het SCK.

Le gouvernement visera le maintien de l'excellence dans la recherche dans les domaines de la sûreté nucléaire et de l'information du citoyen, de l'environnement et des infrastructures nucléaires sur le territoire belge.

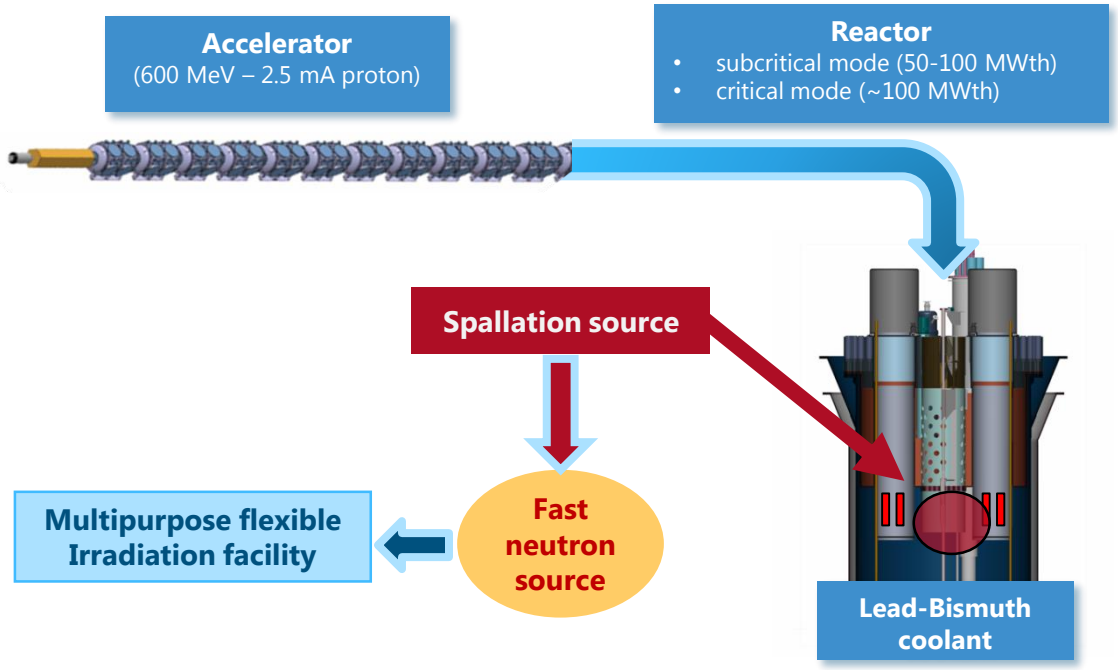
Il soutiendra progressivement le projet MYRRHA ou des projets équivalents du CEN en vue de poursuivre de manière optimale, dans un contexte international, les recherches nécessaires concernant des solutions innovantes pour les déchets hautement radioactifs, la qualification des matériaux des réacteurs à fusion, le maintien de la production de radio-isotopes médicaux dans notre pays et de recherche nucléaire fondamentale, en collaboration avec les universités, les centres de recherche et les organisations sœurs du CEN.

The Belgian Government will support in a progressive way the MYRRHA project or any equivalent project at SCK•CEN aiming to continue the needed research for innovative solutions for High level waste, qualification of materials for fusion, the production of radioisotopes for medical applications in our country and fundamental nuclear research in collaboration with the universities and sister organisation of SCK•CEN

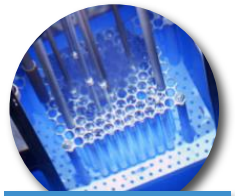
Key objective of the MYRRHA-programme

Construction of an Accelerator-Driven System (ADS) as a Large Research Facility consisting of

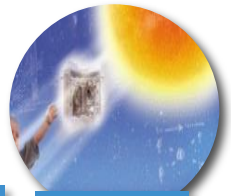
- A 600 MeV – 2,5 mA proton linear accelerator
- A spallation target/source
- A lead-Bismuth Eutectic (LBE) cooled reactor able to operate in subcritical & critical mode



MYRRHA multipurpose facility: application portfolio 2014



Fission GEN IV

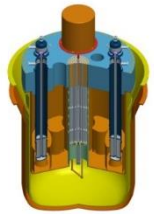


Fusion

Fundamental research

Multipurpose h**Y**brid **R**esearch **R**eactor for **H**igh-tech **A**pplications

Waste: Primary goal



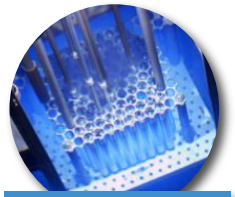
LFR European Technology Pilot Plant (ETPP)

Radio-isotopes: Priority

Silicon doping

Source: MYRRHA ad hoc Group (MAHG), SCK•CEN MYRRHA Project Team, MYRRHA Business Plan

MYRRHA application portfolio 2016: Silicon doping is not economically attractive for MYRRHA



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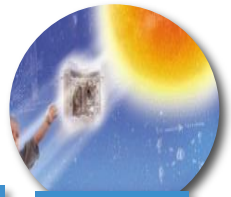


Fusion

Fundamental research

Multipurpose h**Y**brid **R**esearch **R**eactor for **H**igh-tech **A**pplications

Waste: Primary goal

Radio-isotopes: Priority

Silicon doping

SMR LFR: Valorisation only

Source: SCK•CEN MYRRHA Project Team, MYRRHA Business Plan

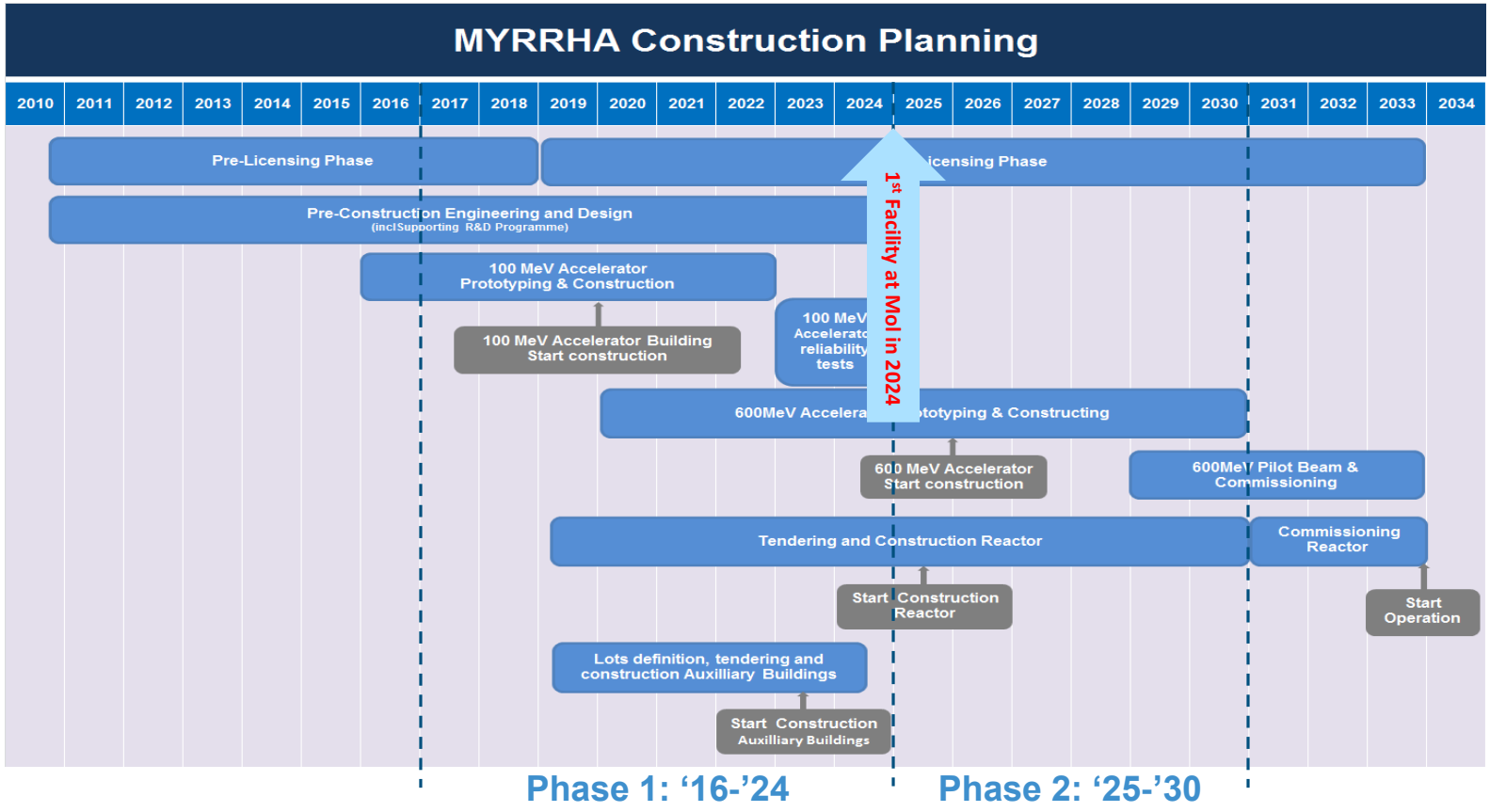
New implementation approach

- **In 2015, SCK•CEN investigated three scenarios for the implementation of MYRRHA:**
  - SC1: Accelerator first + Reactor later
  - SC2: Reactor first + Accelerator later
  - SC3: Accelerator and Reactor all together

- **In December 2015, SCK•CEN Board selected Scenario one (SC1) as the most appropriate approach for the realisation of MYRRHA. This scenario consists of a phased approach (Phase 1 = 2016-2024)**
  - Eliminating the technical risks
  - Spreading the investment cost
  - Allowing first R&D facility available by 2024

Source: SCK•CEN MYRRHA Project Team

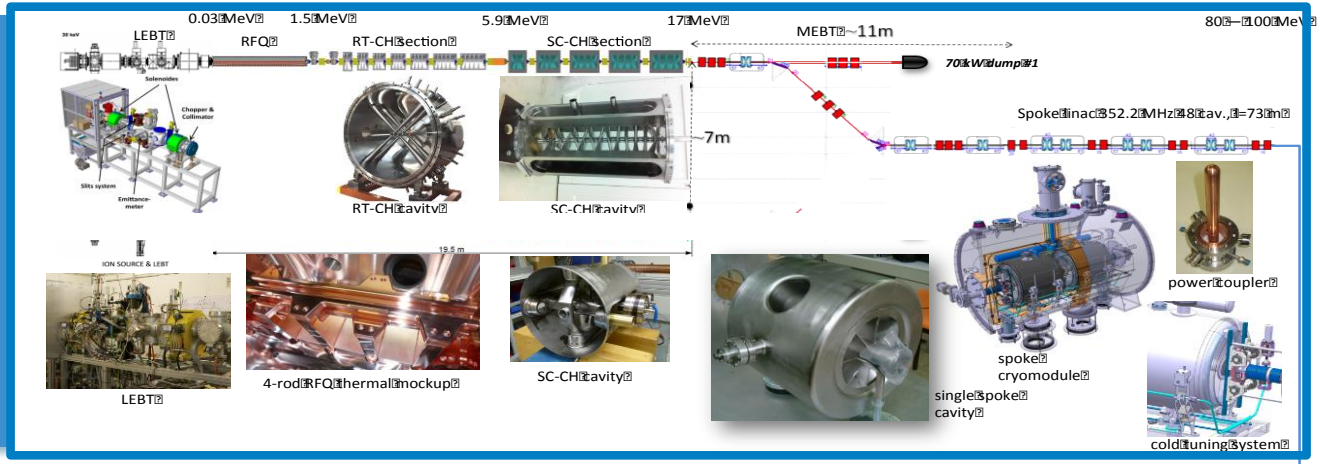
Global high-level planning MYRRHA Project (2016-2030)

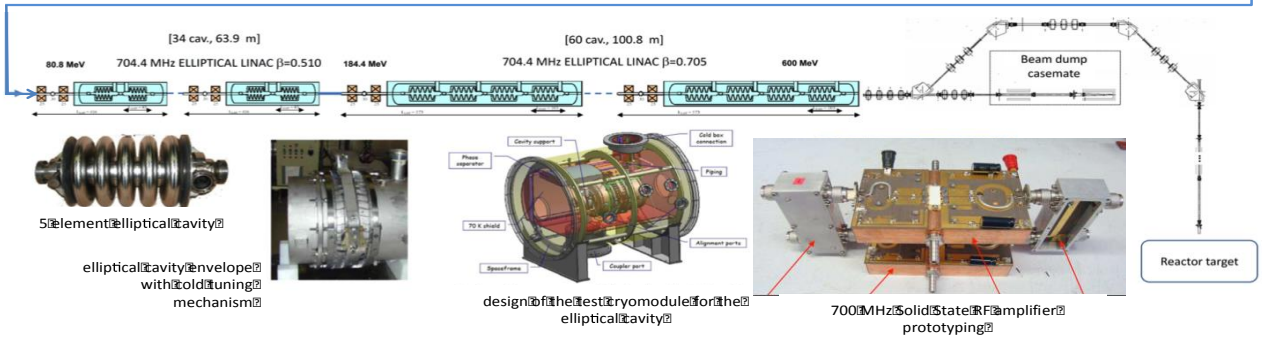


Source: SCK•CEN MYRRHA Project Team

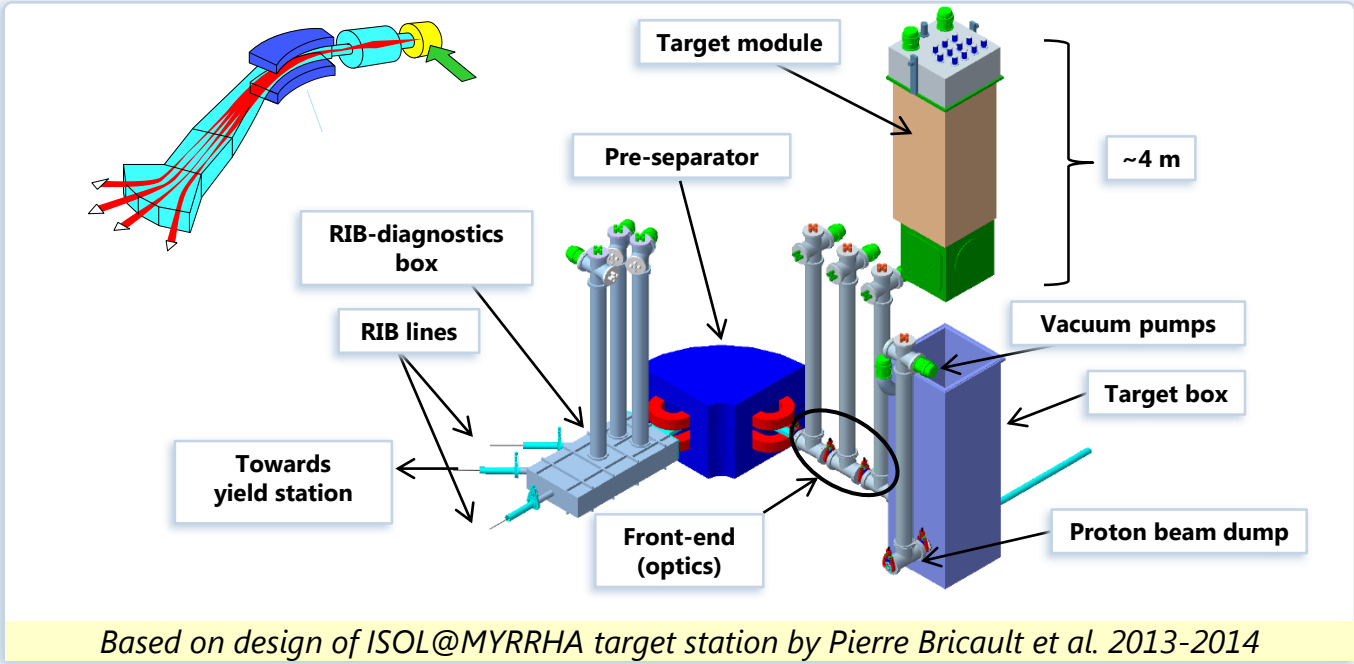
MYRRHA accelerator design

MYRRHA accelerator 0 – 100 MeV section



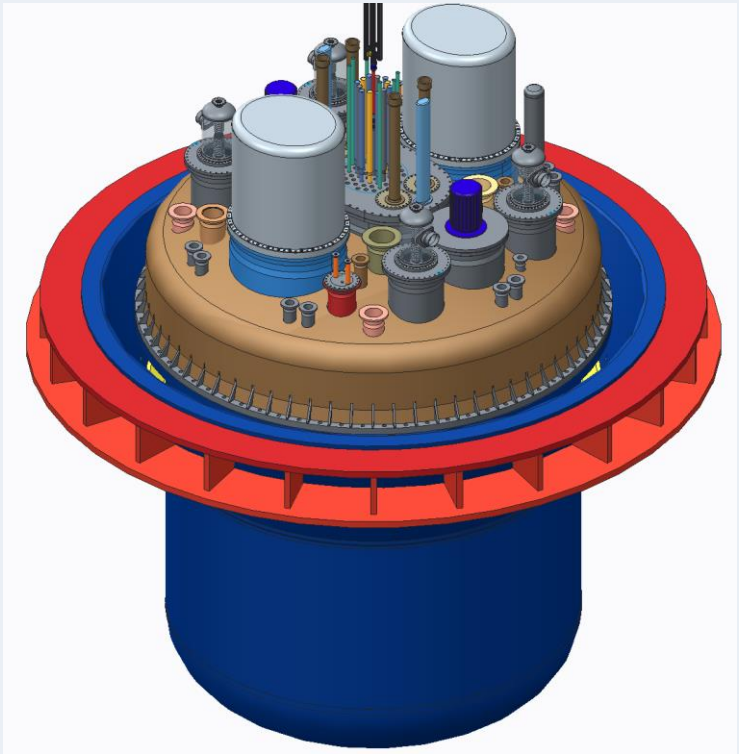


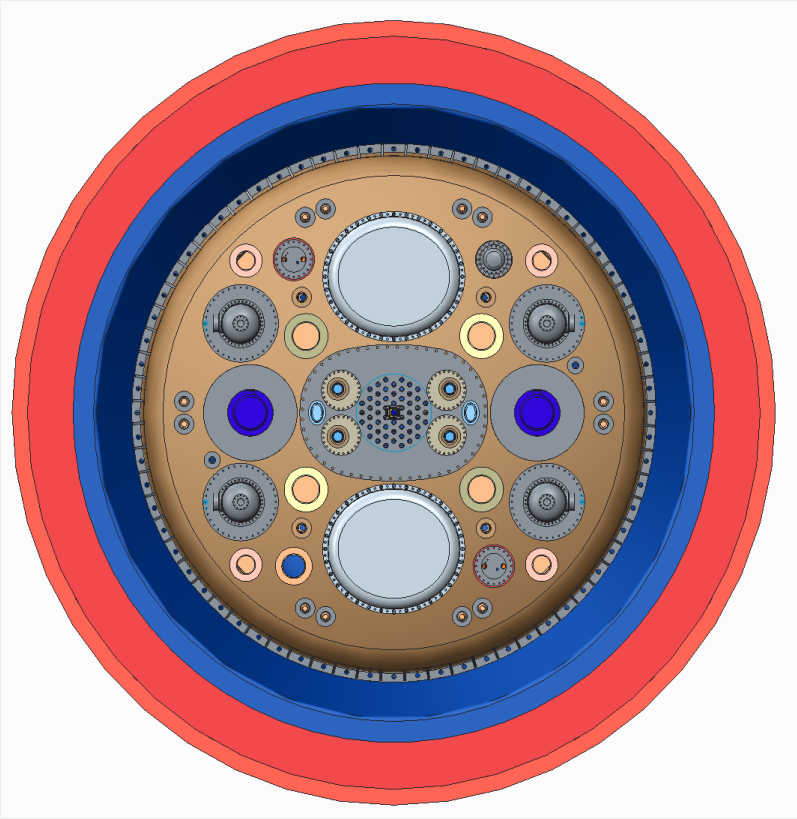
Proton Target Facility- Conceptual Design



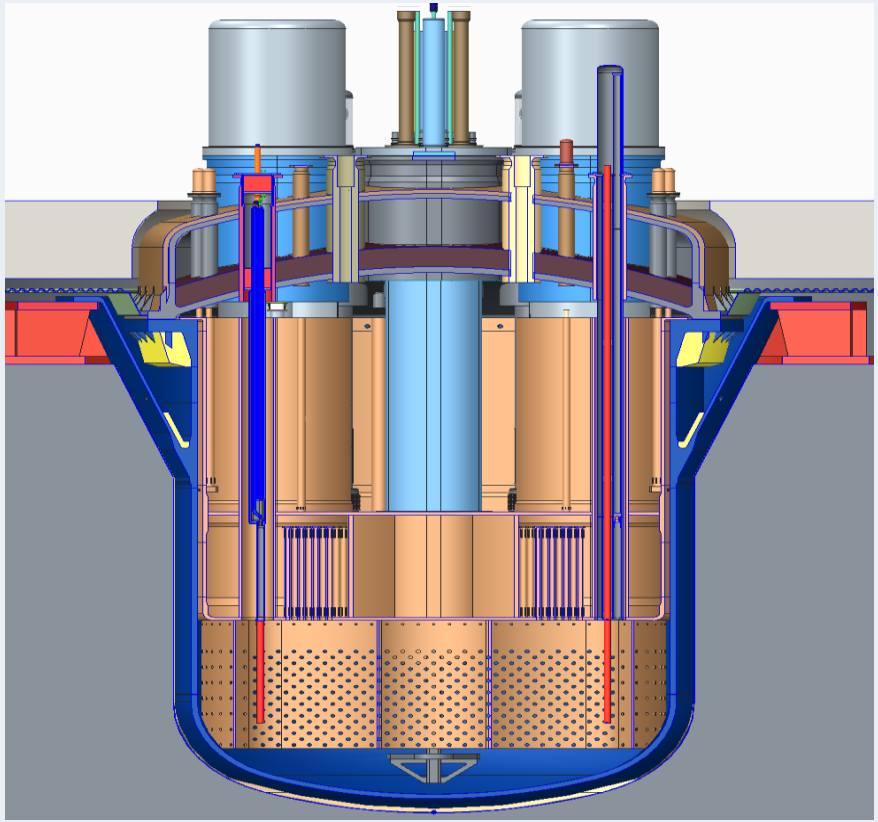
Based on design of ISOL@MYRRHA target station by Pierre Bricault et al. 2013-2014

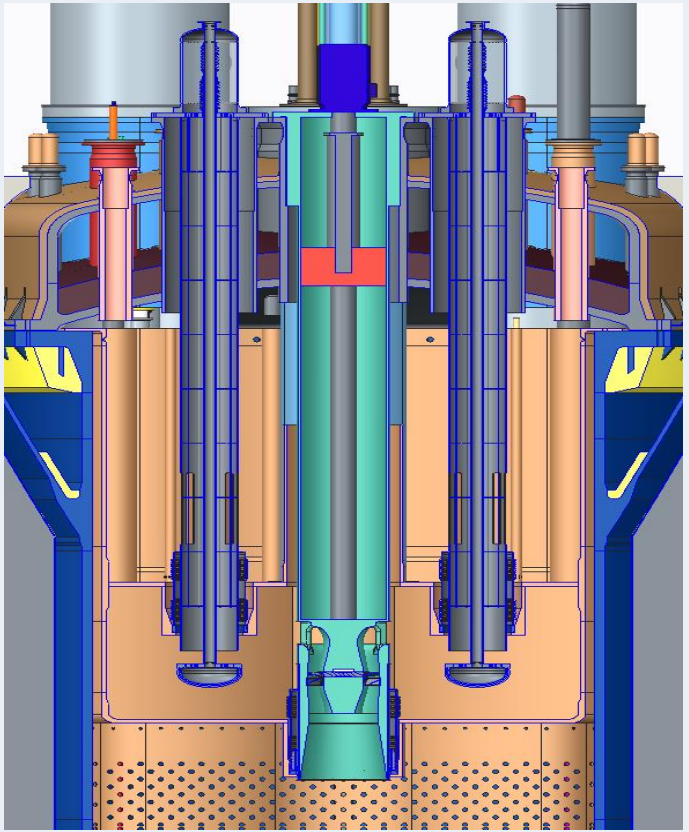
MYRRHA rev. 1.6





MYRRHA rev. 1.6





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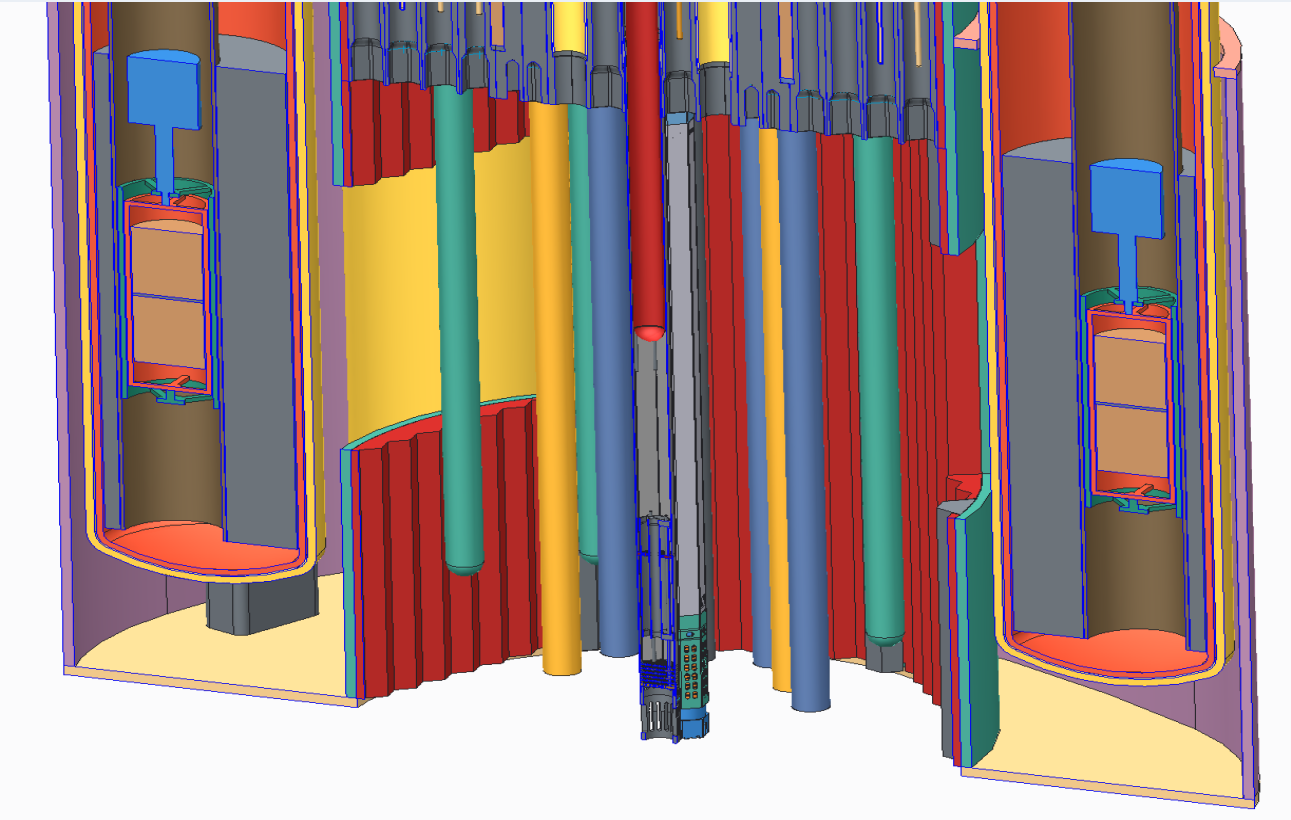
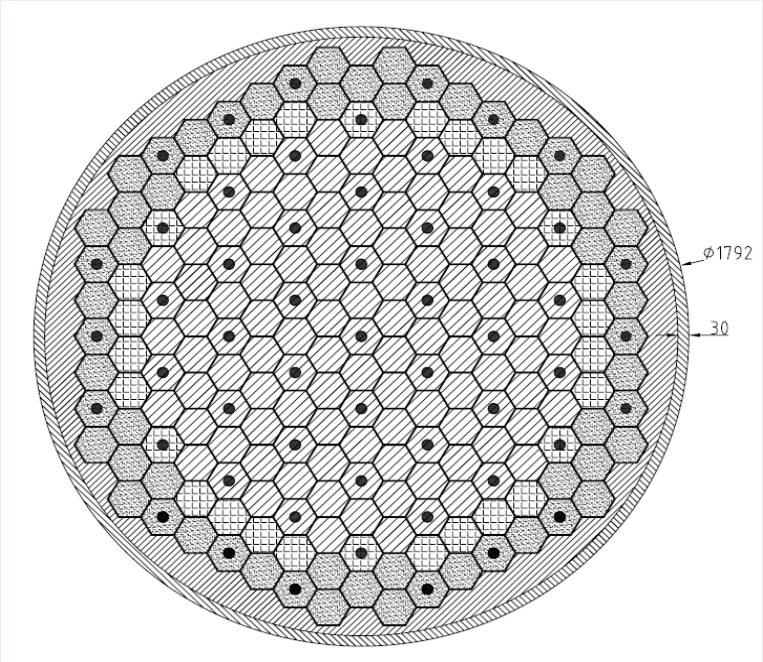


Fuel Assembly and Core



- Core
  - 211 positions
    - 108 FA in critical core
  - 55 MFC
  - Mass flow rate
    - 13800 kg/s
      - Ti: 270°C
      - To: 325°C

Confirmation innovative design components

- **Mechanical design of the primary pump**
  - Mechanical architecture defined
  - Bearing types identified
  - Mechanical analysis in progress

- **Innovative double wall heat-exchanger**
  - Test module for COMPLOT is designed
  - Design under review by the industrial partner
  - Construction of module in 2017

Source: MYRRHA ad hoc Group (MAHG), SCK•CEN MYRRHA Project Team

Confirmation innovative design components

- **In-Vessel Fuel Handling Machine with an additional articulation**
  - Concept development of the additional articulation in a second revision
  - Engineering design of gripper on-going
  - Start of manufacturing of gripper components in 2017
- **Diaphragm**
  - Analysis lay-out on-going
  - New conceptual design in development
  - Concept review planned in January 2017
- **Reactor vessel**
  - Reactor Vessel with integrated Safety Vessel designed
  - Mechanical analysis being finalised
  - Start of licensability analysis in January 2017

Source: MYRRHA ad hoc Group (MAHG), SCK•CEN MYRRHA Project Team

Elements of the Pre-Licensing Phase

- There are two main elements that form part of the pre-licensing phase process
  - Focus Points
  - The Design Options and Provisions File (DOPF)

- Focus Points address specific issues/topics that are considered important to be addressed in the pre-licensing phase. These are the fundamental important points that can influence the licensability of the project

- The DOPF works on a slightly higher level, though it will finally incorporate many of the aspects of the focus points. The document outlines the safety approach of the facility as well as the options and provisions taken to meet the safety objectives.

Focus Points Overview

- Focus Points address specific topics of importance that meet the three following conditions:
  - New or not mature enough
  - Specific to MYRRHA
  - Has an impact on the safety of the facility
- Focus Points are defined by FANC/Bel V
- Focus Points may be added or removed as the project progresses, however this has to be done with approval from FANC
- Focus Points are grouped into Focus Point Themes, each theme can have several specific Focus Points associated with it

Focus Point Themes

- External Hazards
- LBE Issues
- Criticality
- Fuel Qualification Program
- Decay Heat Removal
- Confinement
- I&C
- Management of gases
- In-Vessel Fuel Storage
- In-Vessel fuel manipulation and recovery
- Radiological safety
- Licensing of codes, standards and methodologies
- Accident analysis
- Severe accidents
- Experimental devices
- Accelerator

LBE R&D programme

- LiLiPuTTeR-II
- HELIOS 3
- Heavy Liquid Metal Lab
- MEXICO
- CRAFT
- LIMETS 3
- RHAPTER
- COMPLOT
- ESCAPE
- US lab

LBE conditionning

Materials

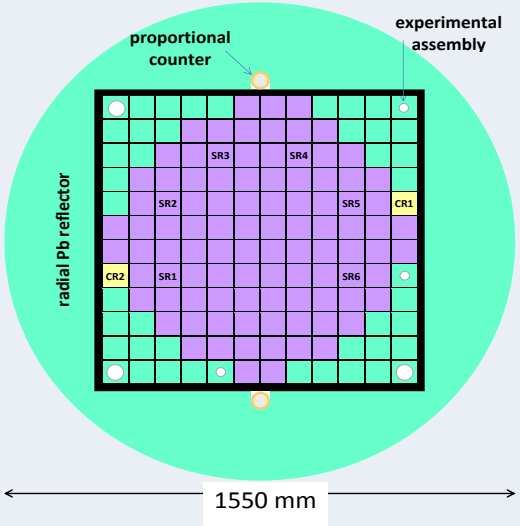
Component testing & TH

Instrumentation

Democritos (VKI) + European platforms (ENEA, KIT, KTH) + JAEA

VENUS-LFR critical facility (2010-2018)

- First licensing of lead reactor outside Russia (2007-2010…2013)
- Core design consolidation - Code validation
- Subcritical approach procedures



MYRRHA 2017 objectives towards the Belgian Government
11 High-Level-Deliverables (HLDs)

	Technical deliverables
1	Technical Design Report (TDR) for **full accelerator**
2	Conceptual design of 100 MeV **accelerator building**
3	Prototyping of all 100 MeV **accelerator components**
4	Confirmation of innovative **reactor design components**
5	**Licensibility statement** on MYRRHA from FANC/AFCN
	Non-technical deliverables
6	Total **budget** consolidation for **Phase 1**: Investment (±25%), OPEX & revenues
7	A **fuel cycle scenario** study including transmutation and impact on the geological disposal for the Belgian scenario
8	Consolidation of the SC1 implementation plan & associated **financing plan**
9	**Risk** assessment & mitigation **methodology**
10	**Commitment** of major **stakeholders** for **Phase 1** (investors, scientific & technological users)
11	Update of 2010 MYRRHA **socio-economic study** in Belgium and its regions (incl. broader EU dimension)

Source: MYRRHA ad hoc Group (MAHG), SCK•CEN MYRRHA Project Team

MYRRHA

A pan-European, innovative and unique facility at Mol (BE)