



# MYRRHA

*International Symposium on  
Present Status and Future Perspective for Reducing Radioactive waste  
Tokyo, Japan*

*October 9-10, 2014*

Marc Schyns

SCK•CEN, Boeretang 200, 2400 Mol, Belgium

[mschyns@sckcen.be](mailto:mschyns@sckcen.be) or [myrrha@sckcen.be](mailto:myrrha@sckcen.be)



STUDIECENTRUM VOOR KERNENERGIE  
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE



STUDIECENTRUM VOOR KERNENERGIE  
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

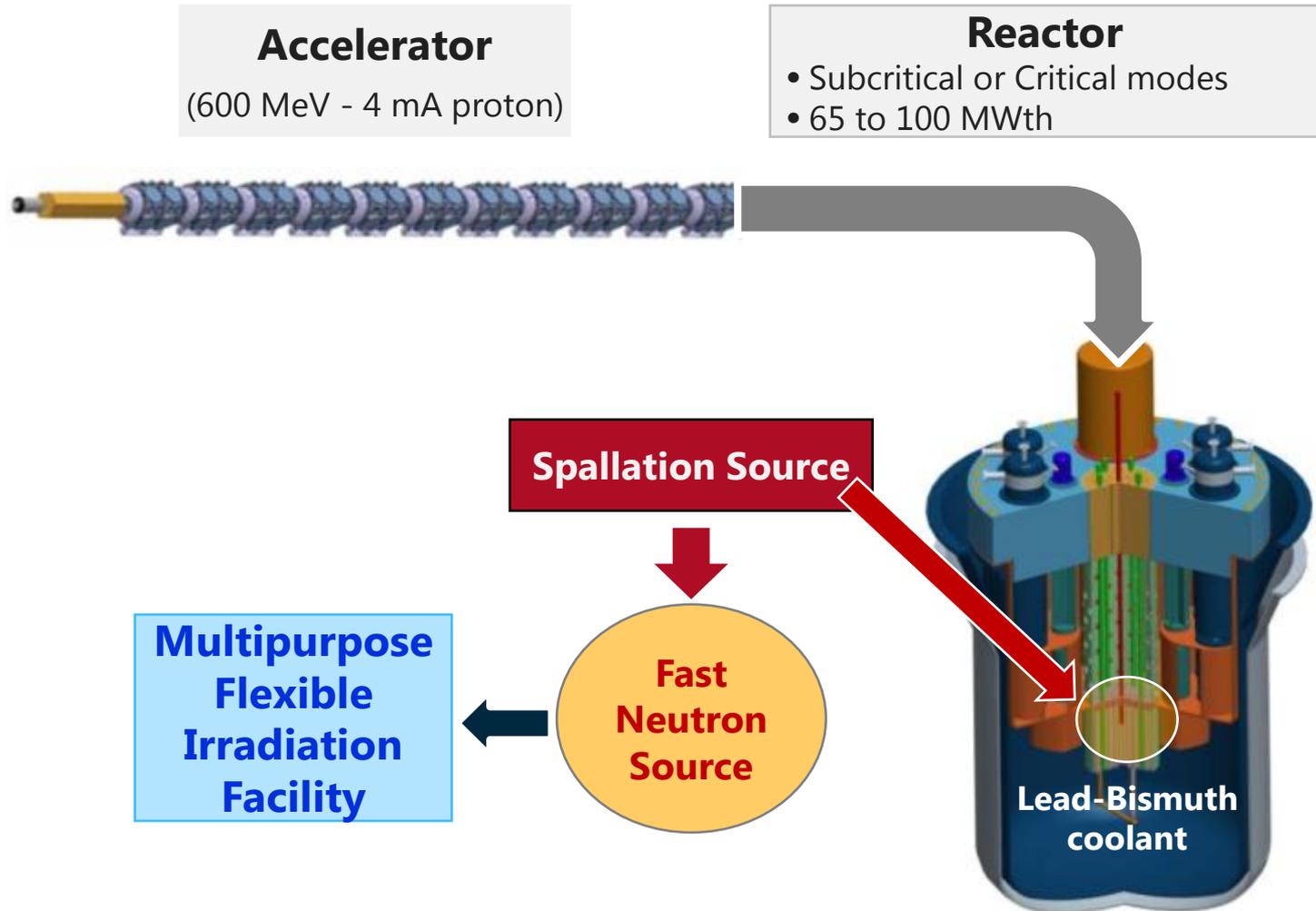
## MYRRHA

**M**ultipurpose **hY**brid **R**esearch **R**eactor for **H**igh-tech **A**pplications

Contributing to the European Strategy for P&T



# MYRRHA - Accelerator Driven System



# MYRRHA Accelerator Challenge

fundamental parameters (ADS)	
particle	p
beam energy	600 MeV
beam current	4 mA
mode	CW
MTBF	> 250 h

challenge !

failure = beam trip > 3 s

implementation	
superconducting linac	
frequency	176.1 / 352.2 / 704.4 MHz
reliability = redundancy	double injector
	"fault tolerant" scheme



# Reactor layout

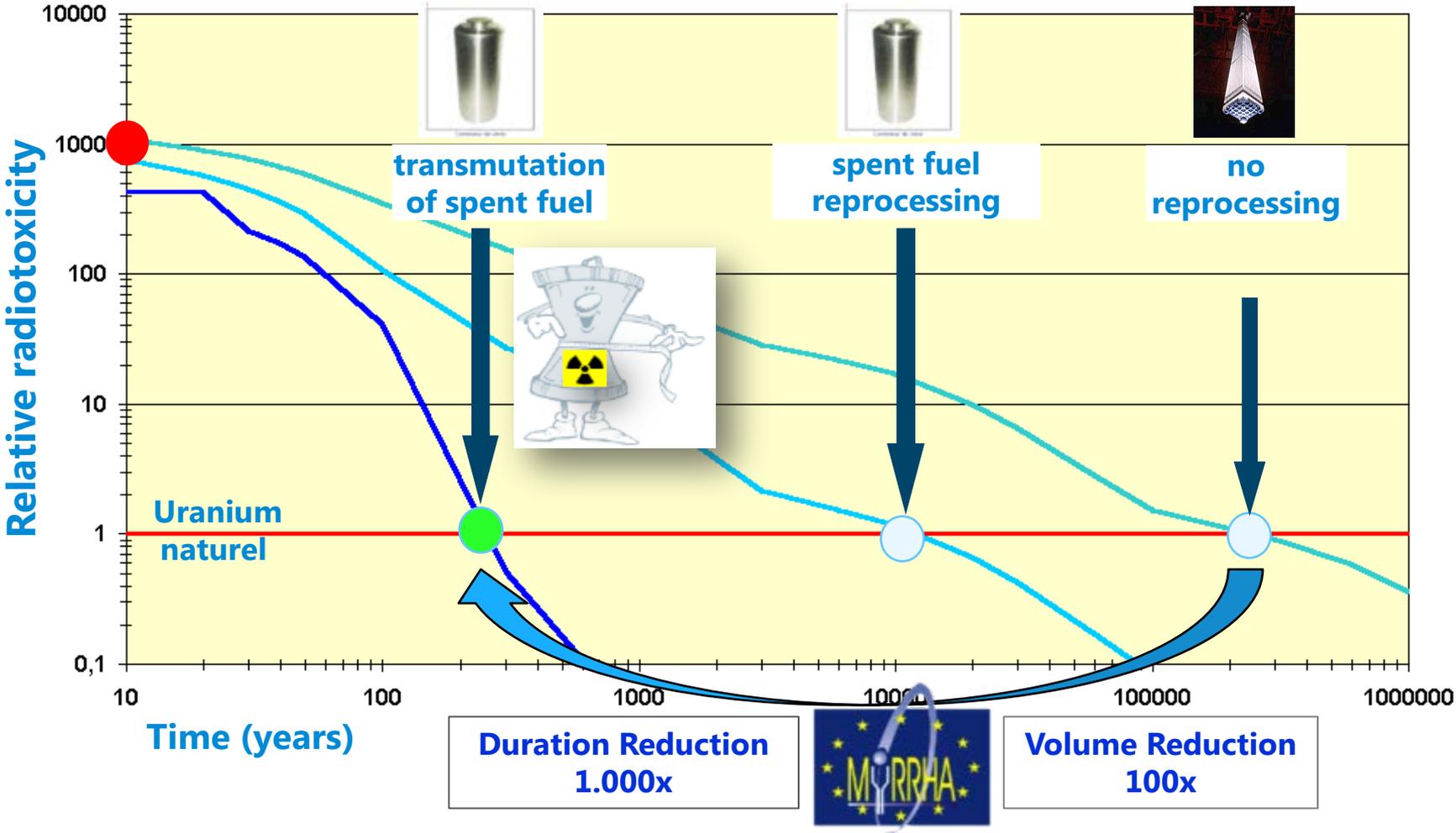
- Reactor Vessel
- Reactor Cover
- Core Support Structure
  - Core Barrel
  - Core Support Plate
  - Jacket
- Core
  - Reflector Assemblies
  - Dummy Assemblies
  - Fuel Assemblies
- Spallation Target Assembly and Beam Line
- Above Core Structure
  - Core Plug
  - Multifunctional Channels
  - Core Restraint System
- Control Rods, Safety Rods, Mo-99 production units
- Primary Heat Exchangers
- Primary Pumps
- Si-doping Facility
- Diaphragm
  - IVFS
- IVFHS
  - IVFHM



# Multipurpose facility

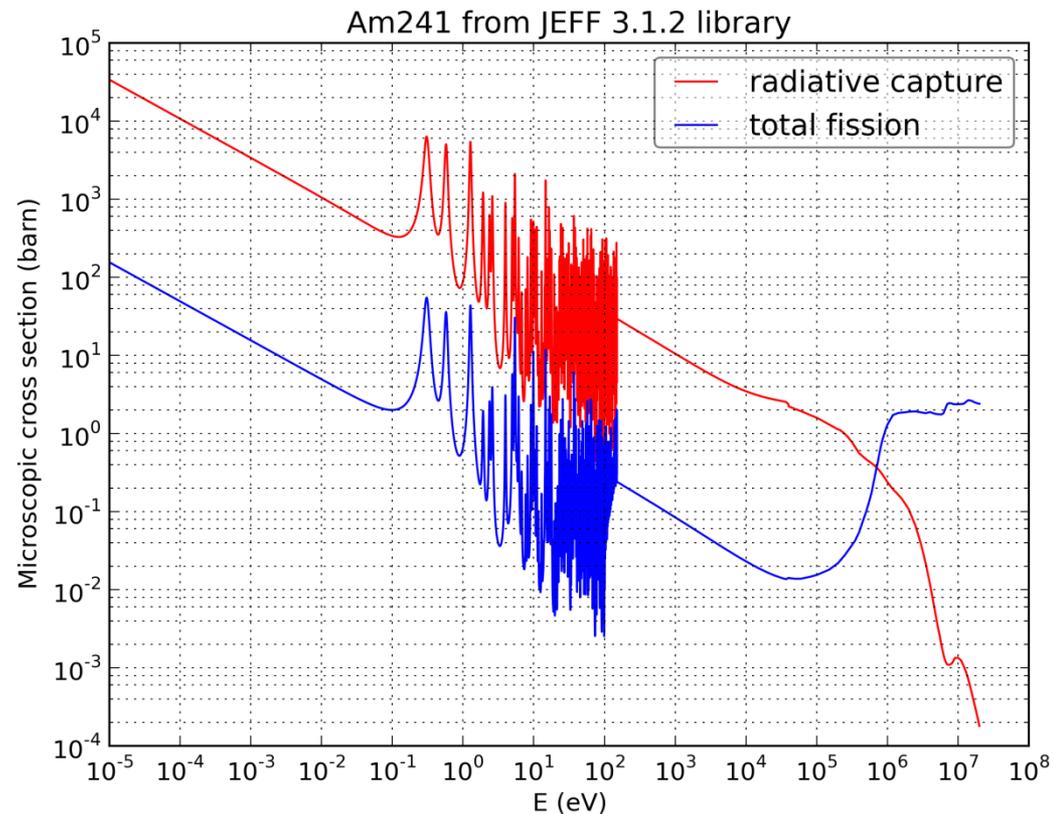


# Motivation for transmutation



# Fast Neutrons are unavoidable for transmutation

- To transmute MAs, we need to fission them
- The ratio Fission/Capture is more favorable with fast neutrons



# Is sub-criticality a luxury?

---

Both **Critical reactors** as well as **ADS** can be used as Minor Actinides transmuters.

**Critical reactors**, heavily loaded with MAs, can experience severe safety issue due to reactivity effect induced by a smaller fraction of delayed neutrons.

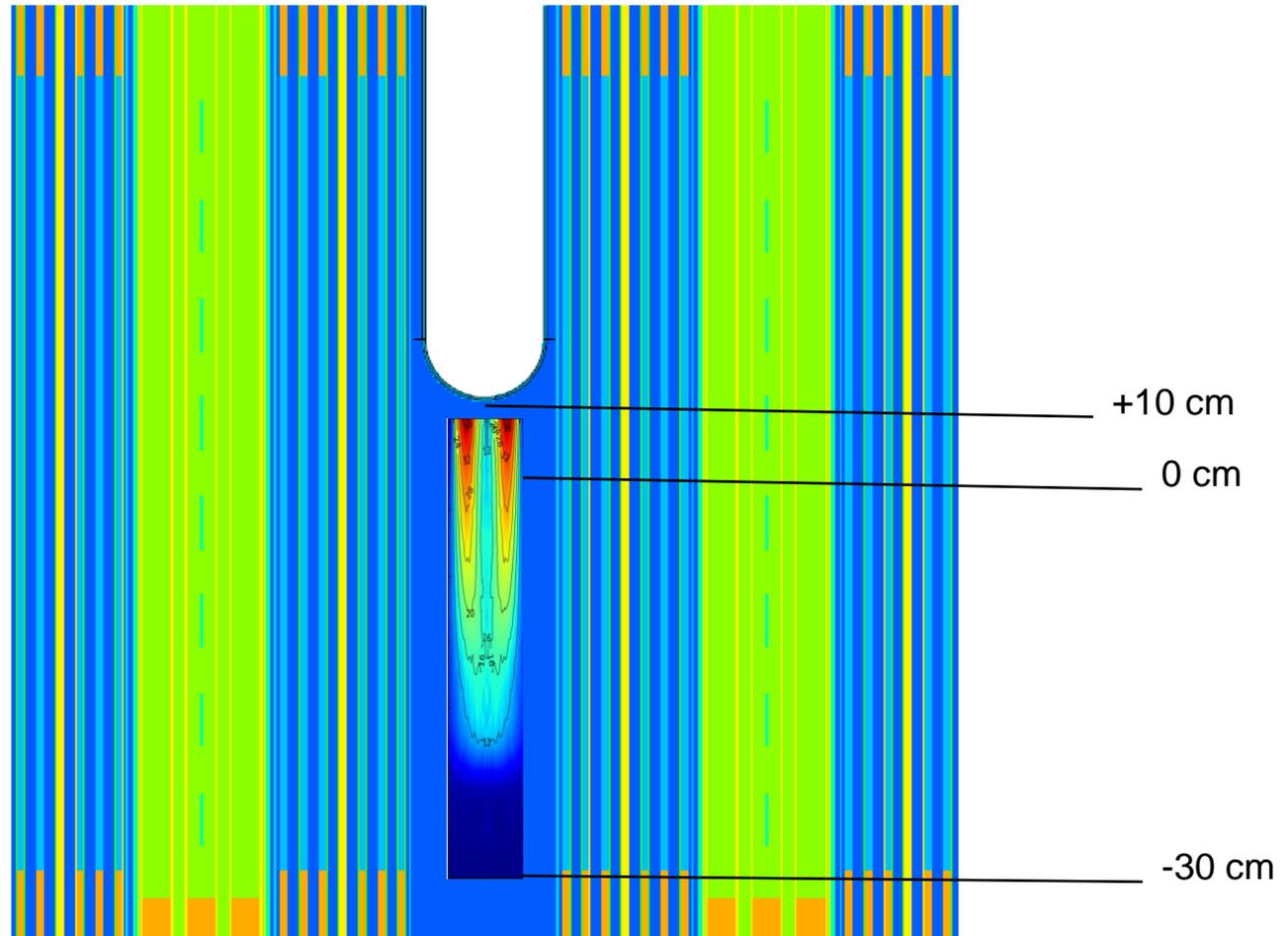
**ADS** can operate in a more flexible and safer manner even if **heavily loaded with MAs** hence leading to efficient transmutation.

Therefore we say that **sub-criticality is not a luxury but a necessity.**

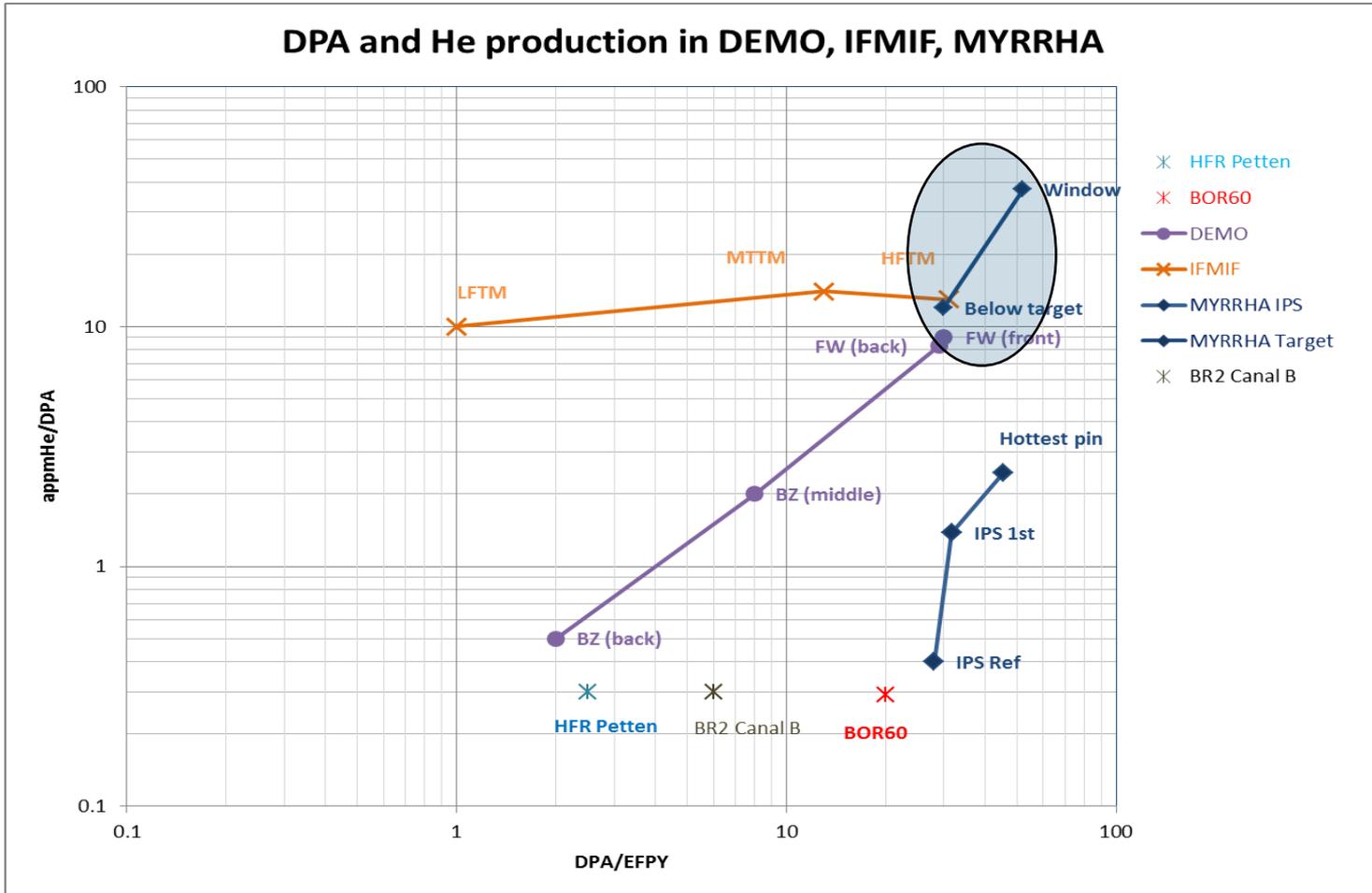
# Multipurpose facility



# Prepare the path for Fusion DEMO Irradiation capabilities under the spallation target



# MYRRHA for fusion irradiations

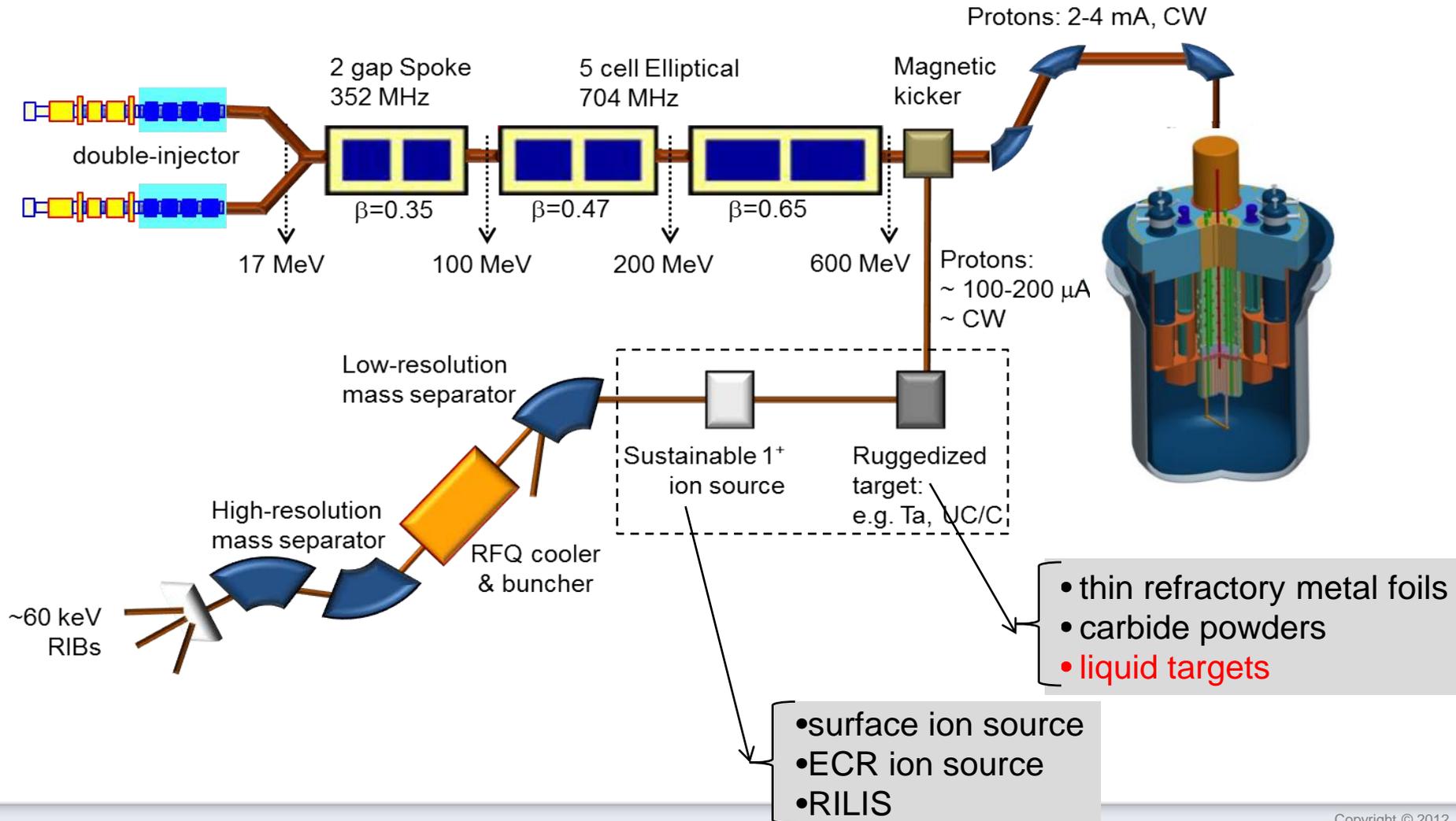


Estimated damage induced in DEMO and proposed irradiation conditions in IFMIF and MYRRHA-IMIFF

# Multipurpose facility

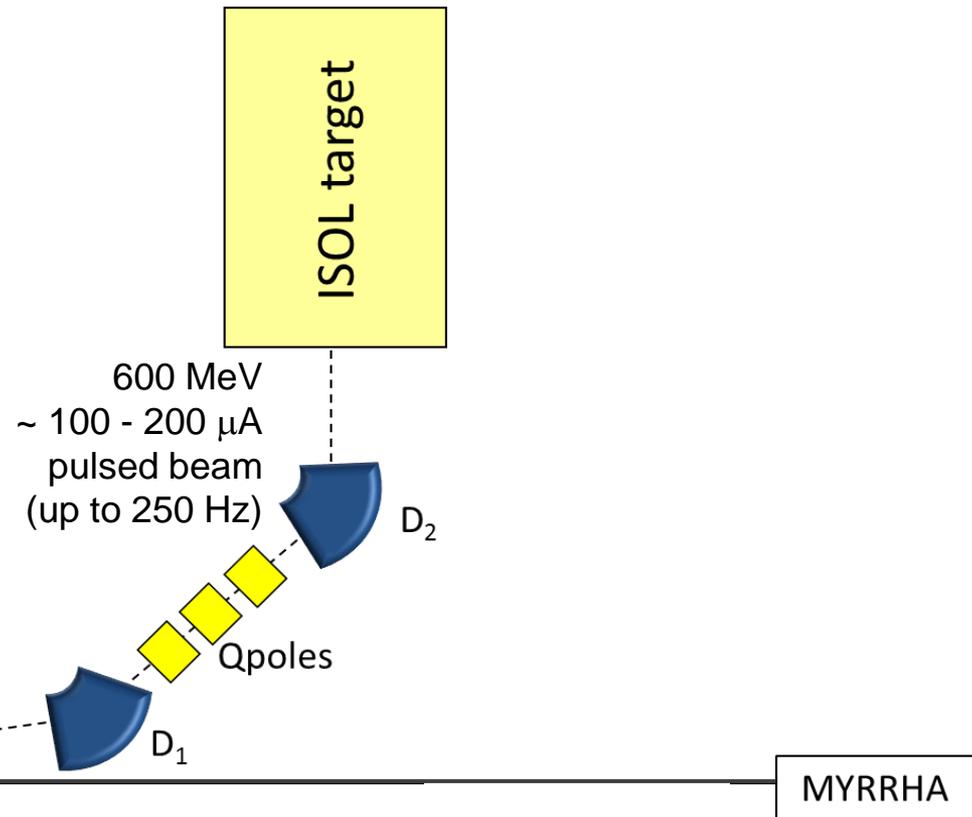
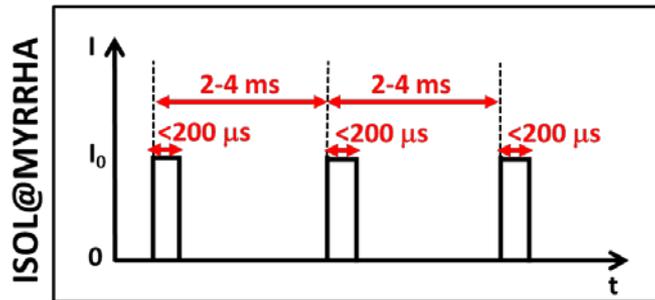
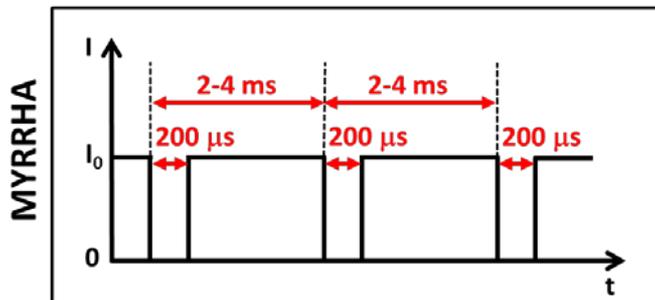


# ISOL@MYRRHA - Concept



# Beam-Splitting System (Concept)

Proton-beam duty cycle



Magnetic  
kicker



Magnetic  
septum



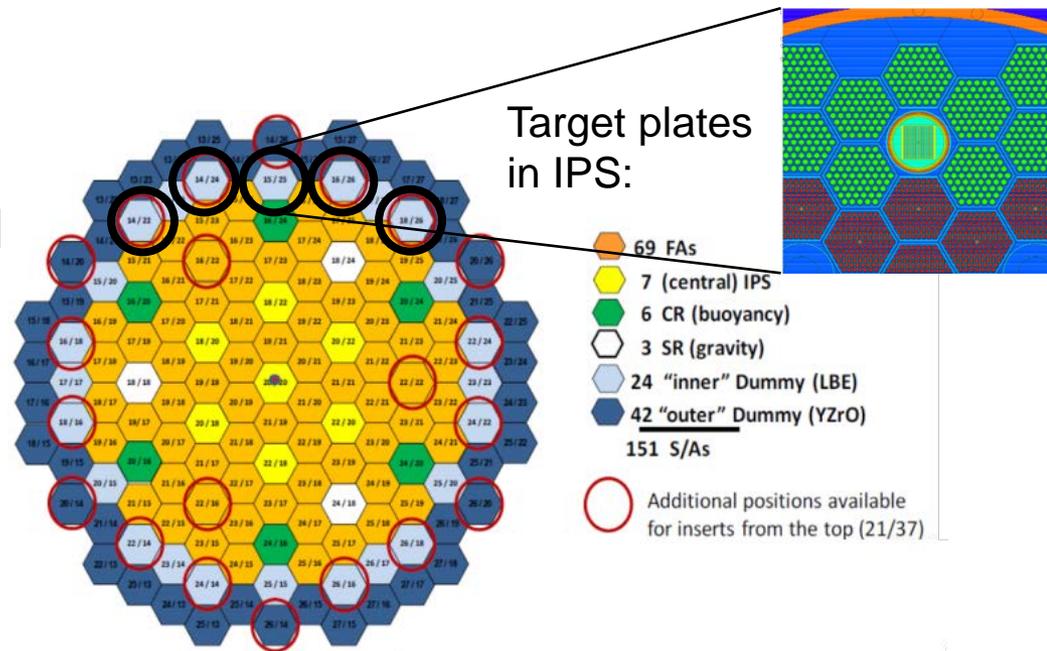
# Multipurpose facility



# Production of radioisotopes in MYRRHA thermal neutron flux-traps

## Core lay-out:

- In reflector positions
- Cooled by water
- In thermalized neutron field
- Transport by rabbit system
- Positions also usable for testing of materials in thermal field!



=> **Both are possible in MYRRHA:**

- **Testing of materials/fuels in fast (core) field**
- **Testing of materials/fuels in thermalized (peripheral) field**

# European Context

**ESFRI**  
European  
Strategic  
Forum for  
Research  
Infrastructure

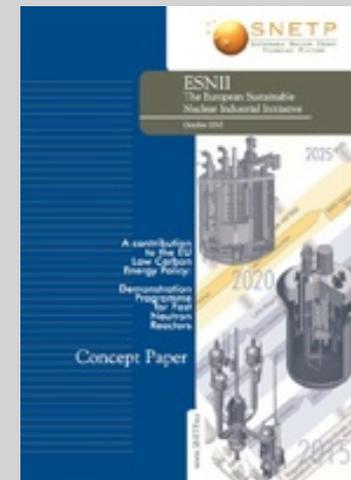
**SET Plan**  
European  
Strategic  
Energy Plan

## Knowledge Economy



**27.11.2010**  
Confirmed on ESFRI  
priority list projects

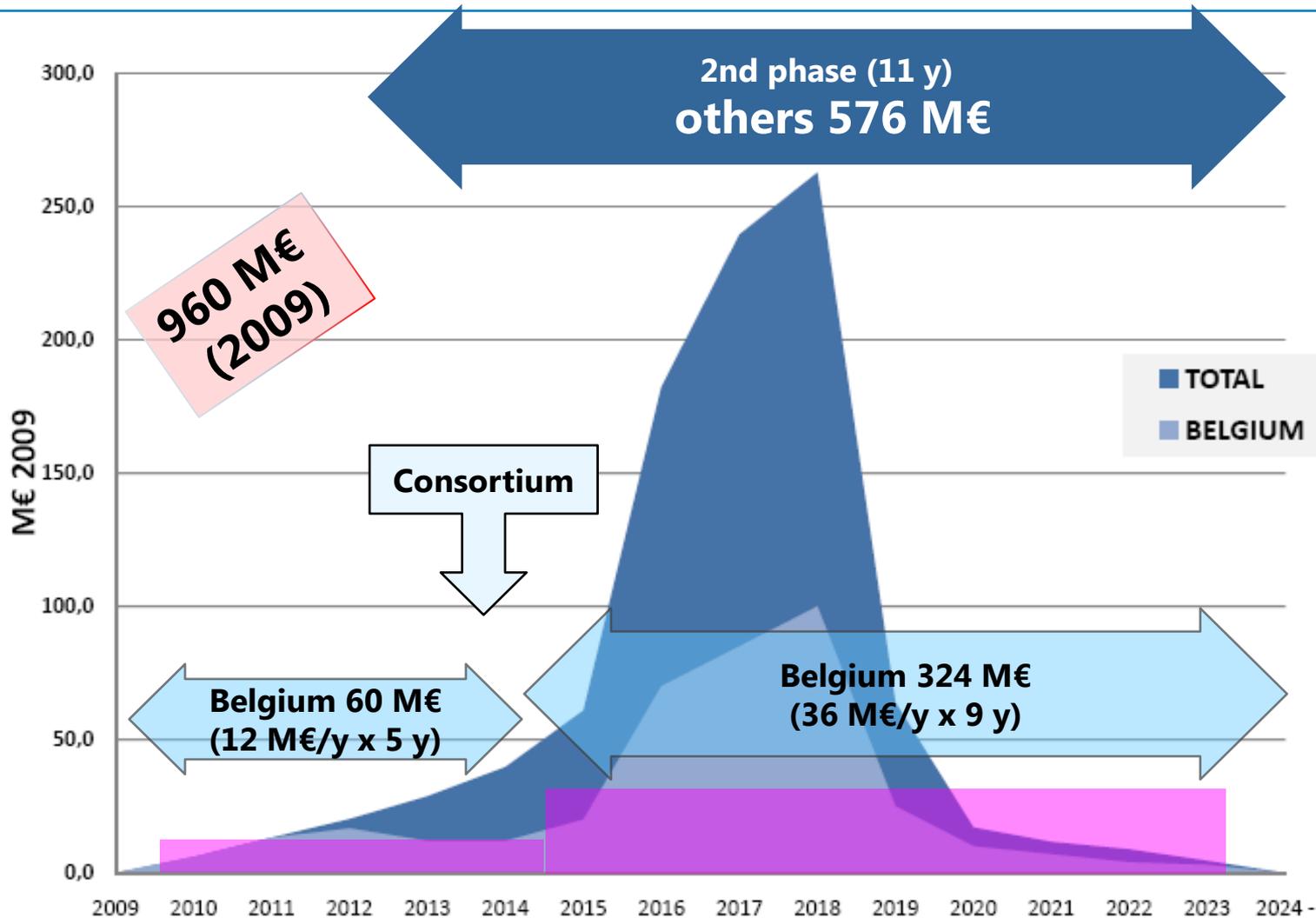
## Energy Independence



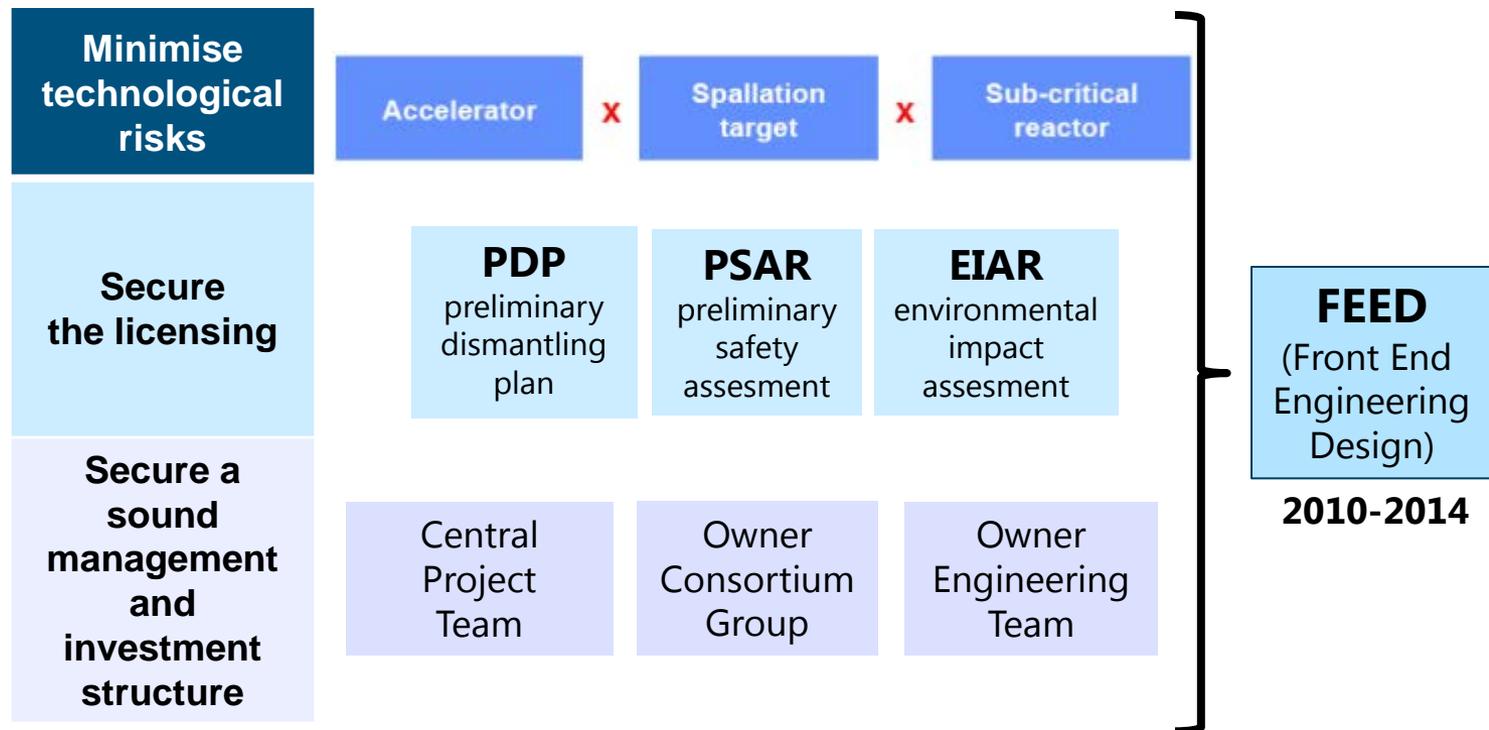
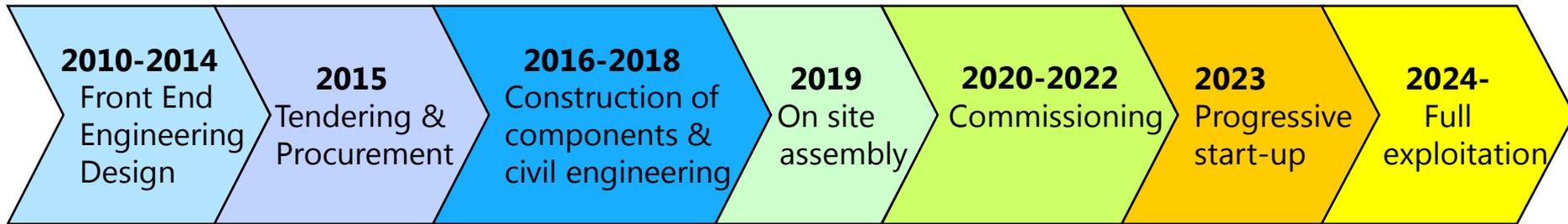
**15.11.2010**  
in ESNI  
(SNETP goals)

# Belgian commitment: secured

## International consortium: under construction



# The project schedule





# International Members Consortium - Phase 2

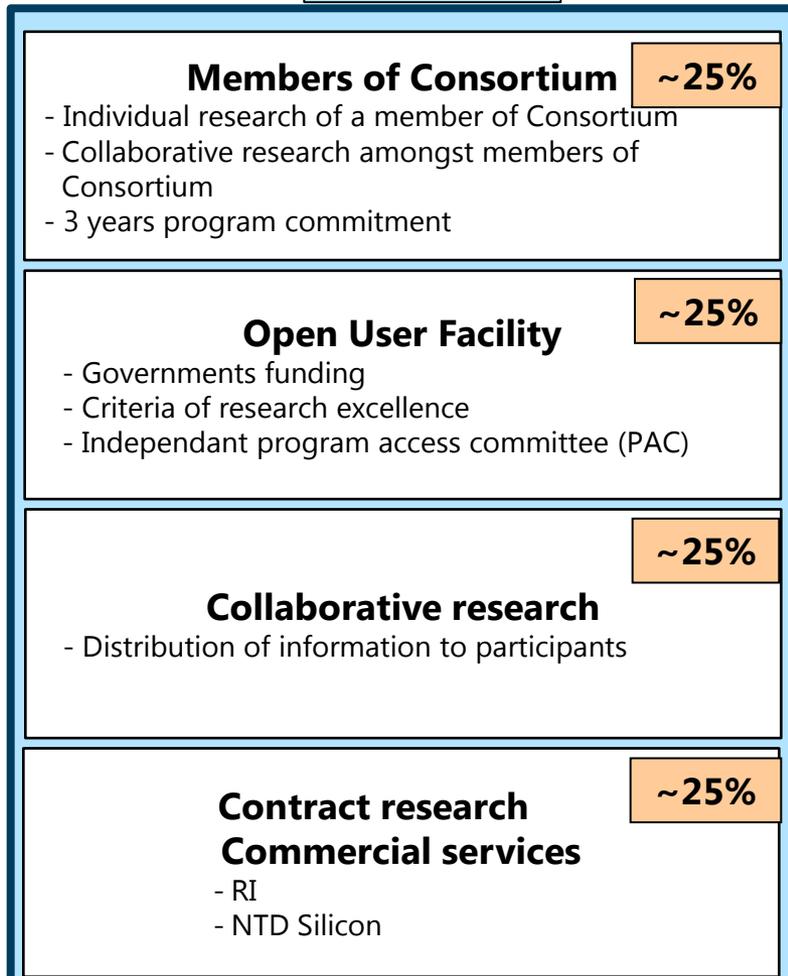
«**ERIC**» (\*)

**CLOSED/  
SHARED  
INFORMATION**  
  
for MoC

**OPEN  
INFORMATION**

**SHARED  
INFORMATION**  
  
for participants

**CLOSED  
INFORMATION**  
  
for participants



- BENEFITS for Members of Consortium**
- Board position to control overal operation
  - Priority of access
  - Potential benefit of low price (compensation profit from commercial revenues)
  - Capacity transfer flexibility (rules tbd)

**SCK•CEN**  
as qualified and licenced operator of the MYRRHA infrastructure under contractual arrangement with ERIC

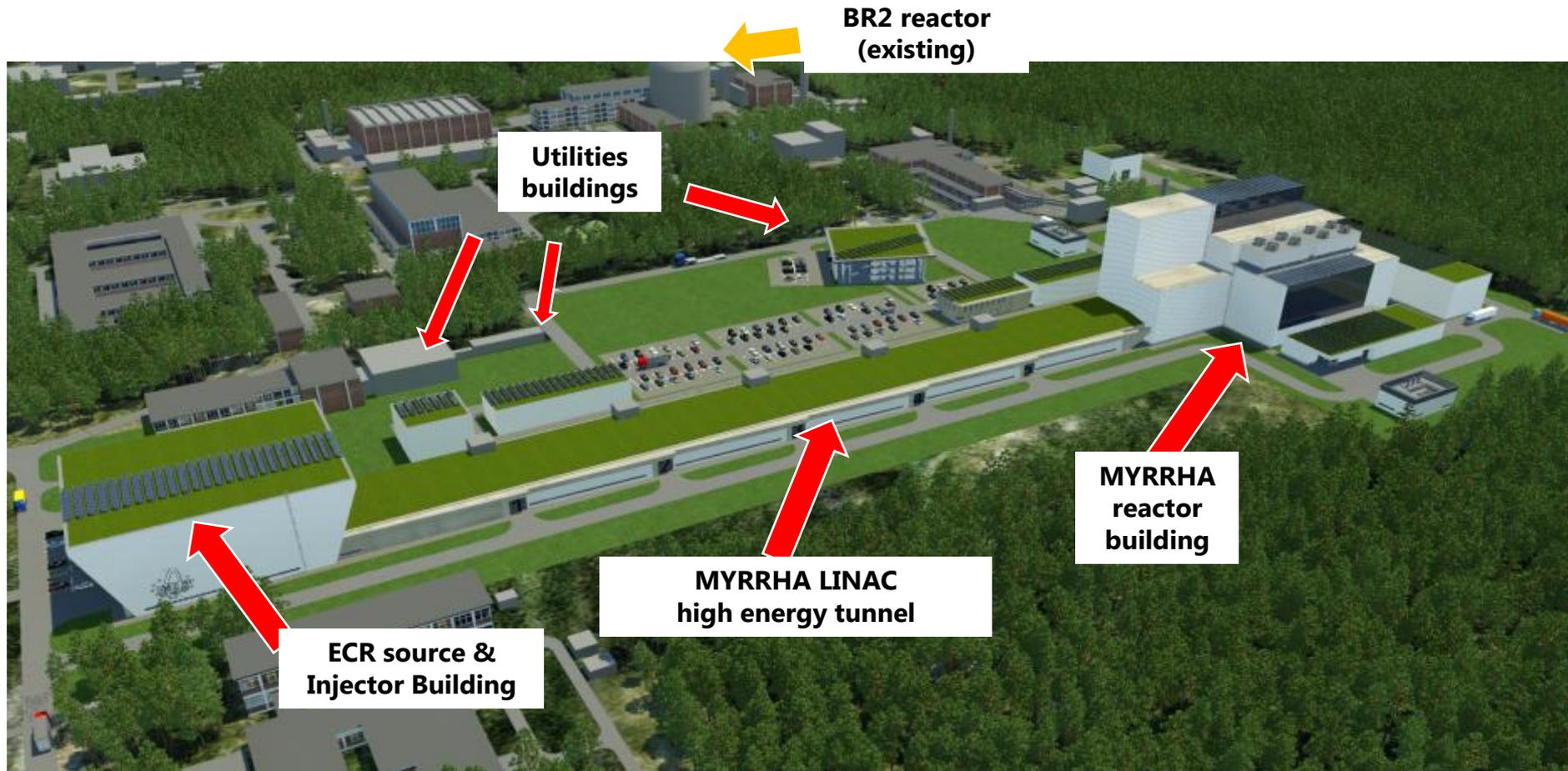
(\*) *European Research Infrastructure Consortium*

- **MYRRHA As a Multipurpose Fast Spectrum irradiation facility selected by ESFRI, is responding to:**
  - The issue of addressing the nuclear waste legacy of present reactor technology through advance options (**ADS, P&T**)
  - The SNETP need for a **multipurpose research infrastructure** expressed in its Strategic Research Agenda whatever the considered technology for Gen.IV systems
  - The Objective of Belgium and SCK•CEN to **maintain a high level expertise in the country** in the nuclear safety, nuclear technology and nuclear competencies independently of the future of NE
  - The objective of the European Commission to make available a series of **relevant irradiations facilities for the fusion material** research community towards the DEMO construction
  - **Secure society needs** for RI for medical applications and Doped-Si for renewable Energy

# MYRRHA: EXPERIMENTAL ACCELERATOR DRIVEN SYSTEM

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

---



**Copyright © 2013 - SCK•CEN**

PLEASE NOTE!

This presentation contains data, information and formats for dedicated use ONLY and may not be copied, distributed or cited without the explicit permission of the SCK•CEN. If this has been obtained, please reference it as a "personal communication. By courtesy of SCK•CEN".

**SCK•CEN**

Studiecentrum voor Kernenergie  
Centre d'Etude de l'Energie Nucléaire  
Belgian Nuclear Research Centre

Stichting van Openbaar Nut  
Fondation d'Utilité Publique  
Foundation of Public Utility

Registered Office: Avenue Herrmann-Debrouxlaan 40 – BE-1160 BRUSSELS

Operational Office: Boeretang 200 – BE-2400 MOL



STUDIECENTRUM VOOR KERNENERGIE  
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE