MYRRHA

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

October 9-10,2014

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

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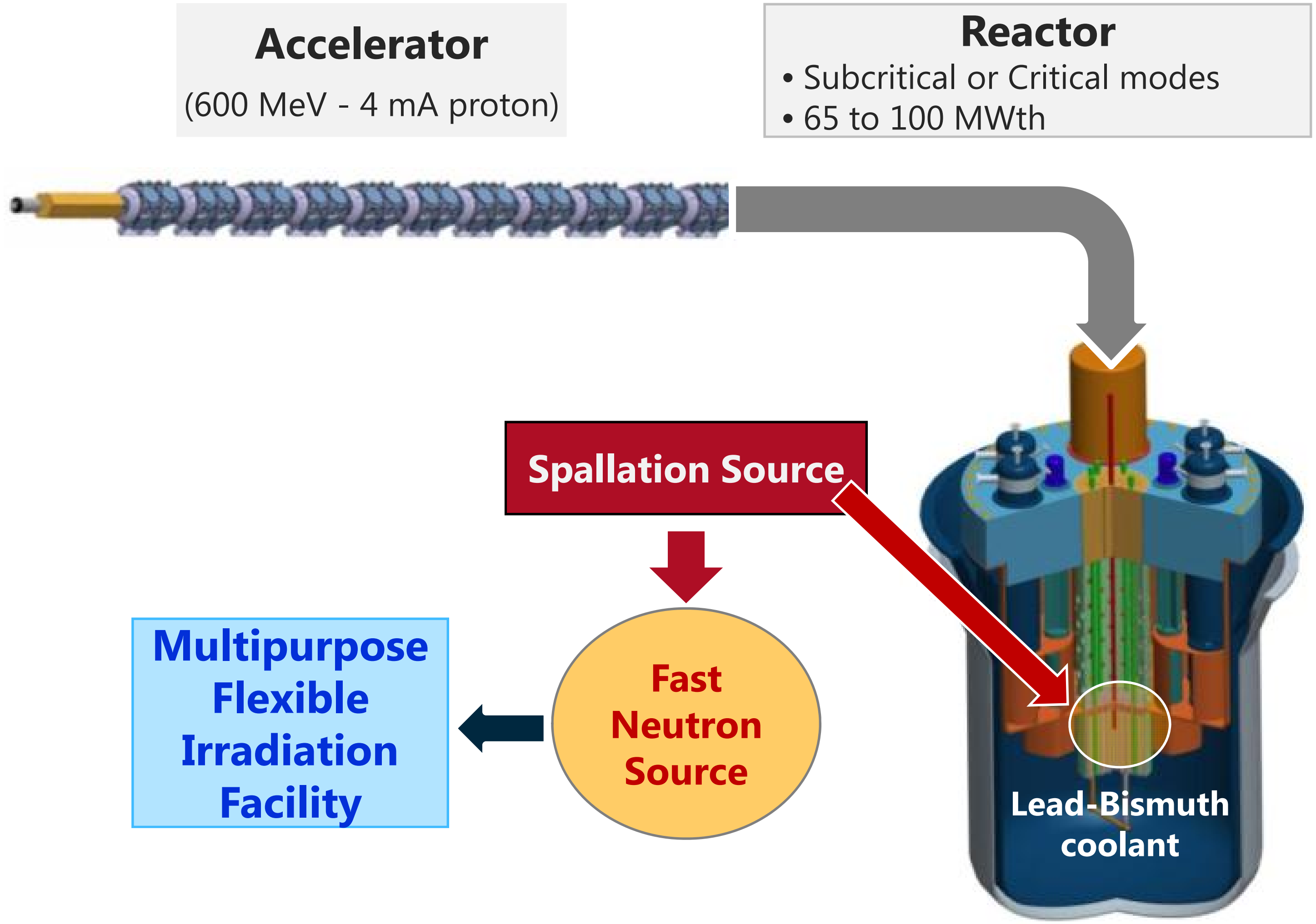
MYRRHA

Multipurpose h**Y**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

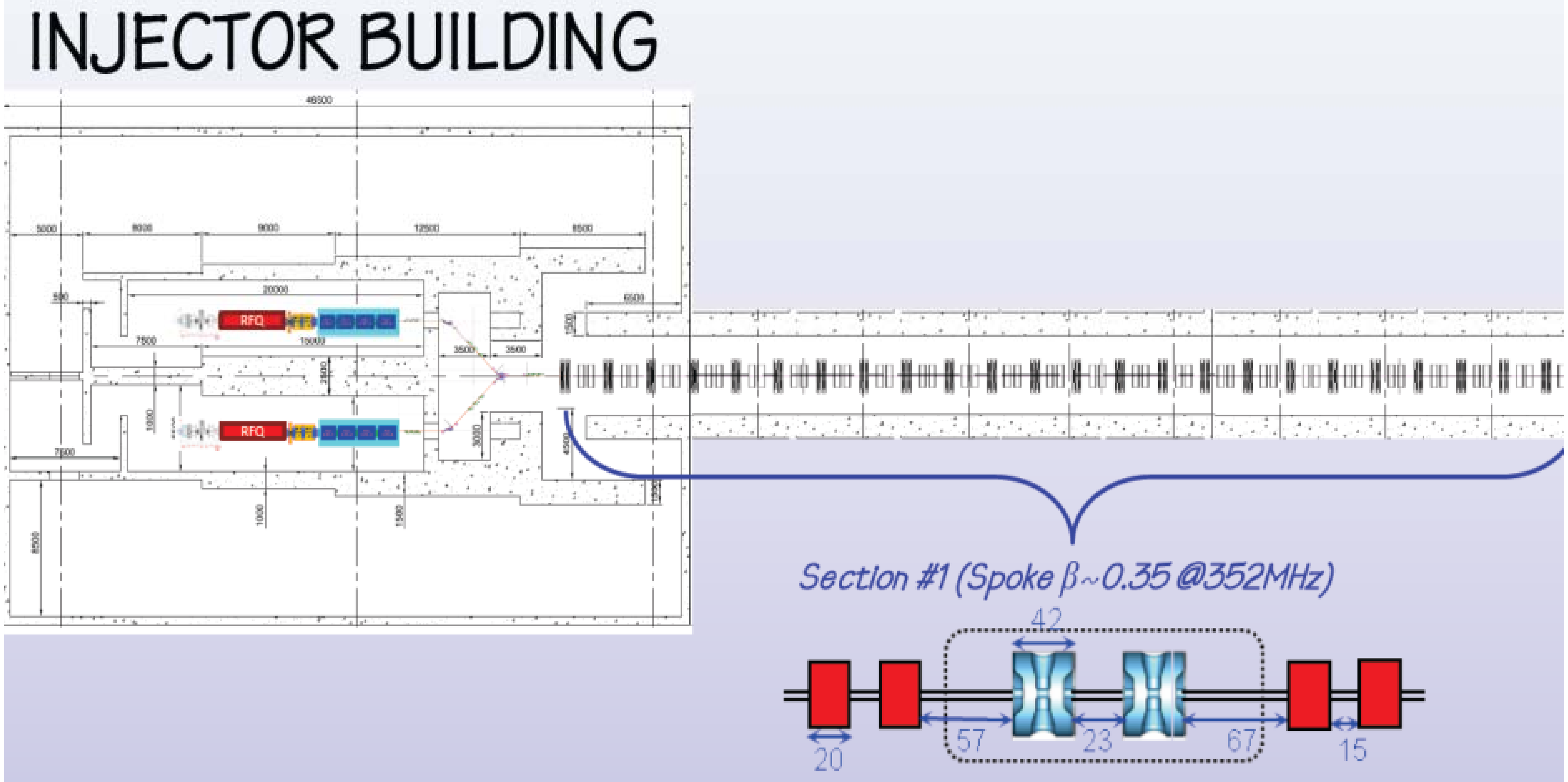
fundamental parameters (ADS)	
particle	p
beam energy	600 MeV
beam current	4 mA
mode	CW
MTBF	> 250 h

challenge !

failure = beam trip > 3 s

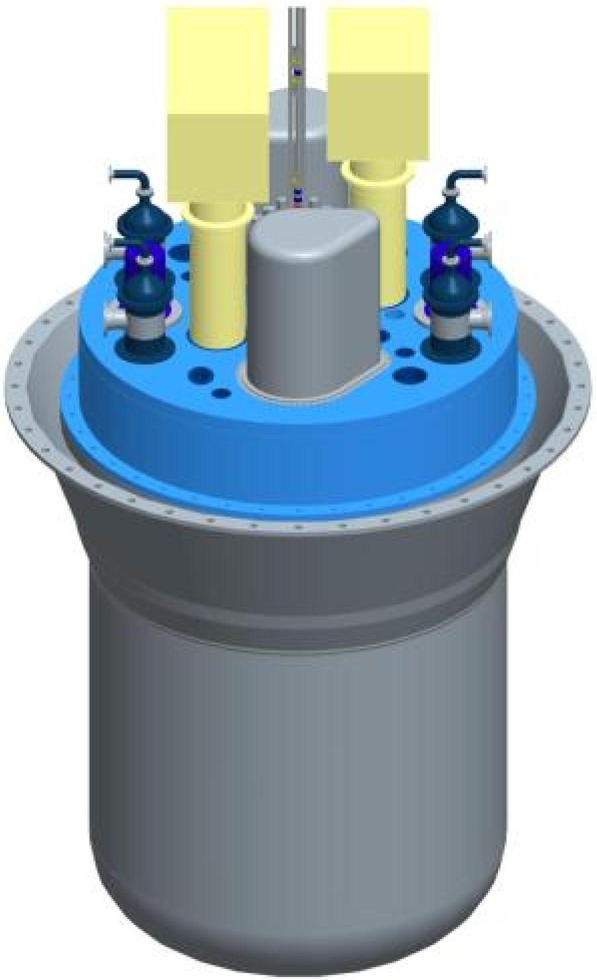
implementation	
superconducting linac	
frequency	176.1 / 352.2 / 704.4 MHz
reliability = redundancy	double injector
	“fault tolerant” scheme

MYRRHA linac



Reactor layout

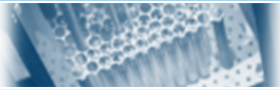
- Reactor Vessel
- Reactor Cover
- Core Support Structure
  - Core Barrel
  - Core Support Plate
  - Jacket
- Core
  - Reflector Assemblies
  - Dummy Assemblies
  - Fuel Assemblies
- Spallation Target Assembly and Beam Line
- Above Core Structure
  - Core Plug
  - Multifunctional Channels
  - Core Restraint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



Multipurpose facility

Material research
Φ_{Fast} = 1 to 5.10^{14} n/cm^2.s
(En>1 MeV) in large volumes

Fuel research
Φ_{tot} = 0.5 to 1.10^{15} n/cm^2.s



Fission GEN IV

Fusion

Φ = 1 to 5.10^{14} n/cm^2.s
(ppm He/dpa ~ 10)
in medium-large volumes

50 to 100 MWth
Φ_{Fast} = ~10^{15} n/cm^2.s
(En>0.75 MeV)

Waste

Multipurpose
h**Y**brid
Research
Reactor for
High-tech
Applications

High energy LINAC
600 MeV – 1 GeV
Long irradiation time

Fundamental research

Φ_{th} = 0.5 to 2.10^{15} n/cm^2.s
(En<0.4 eV)

Radio-isotopes

Silicon doping

Φ_{th} = 0.1 to 1.10^{14} n/cm^2.s
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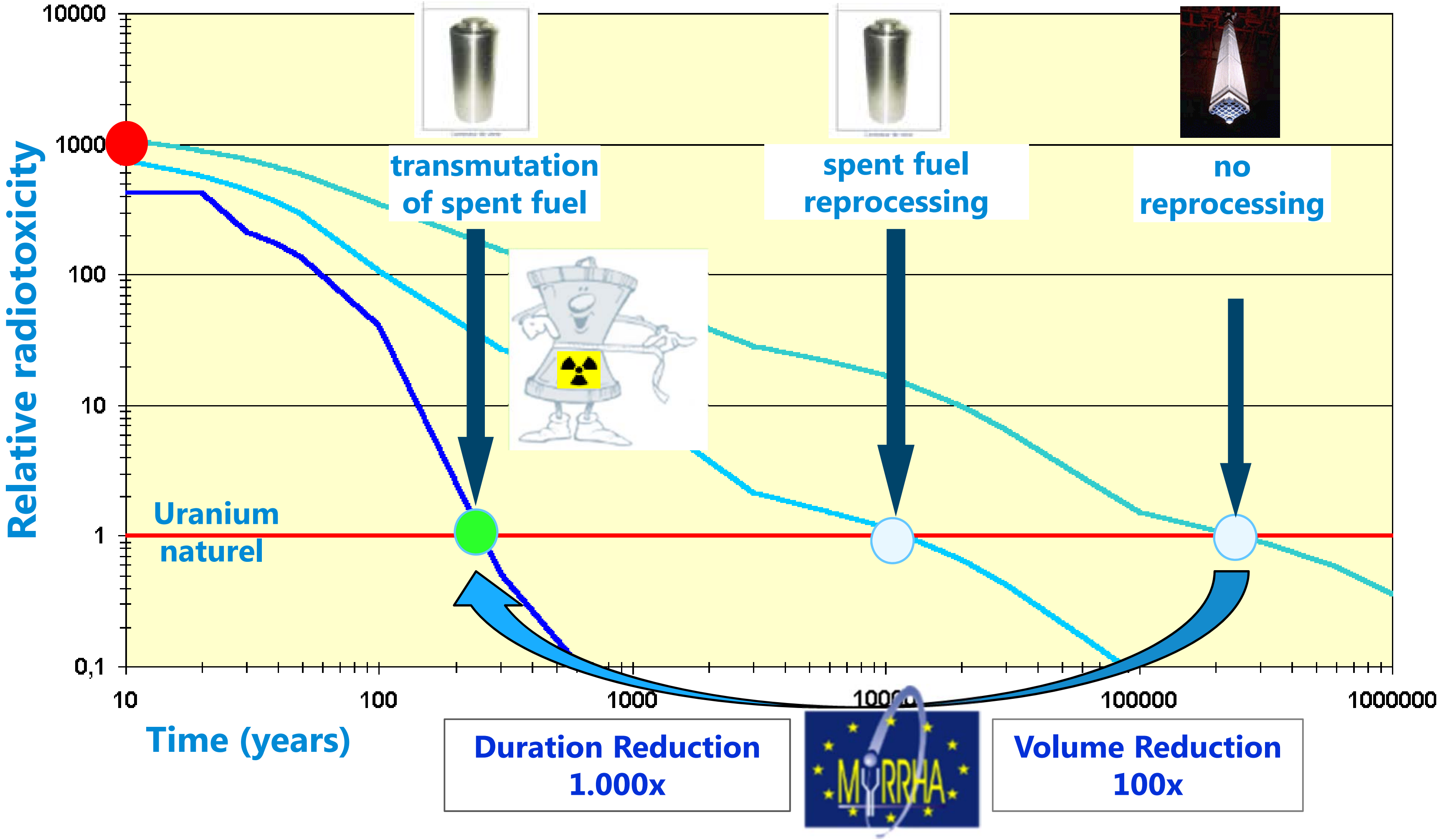
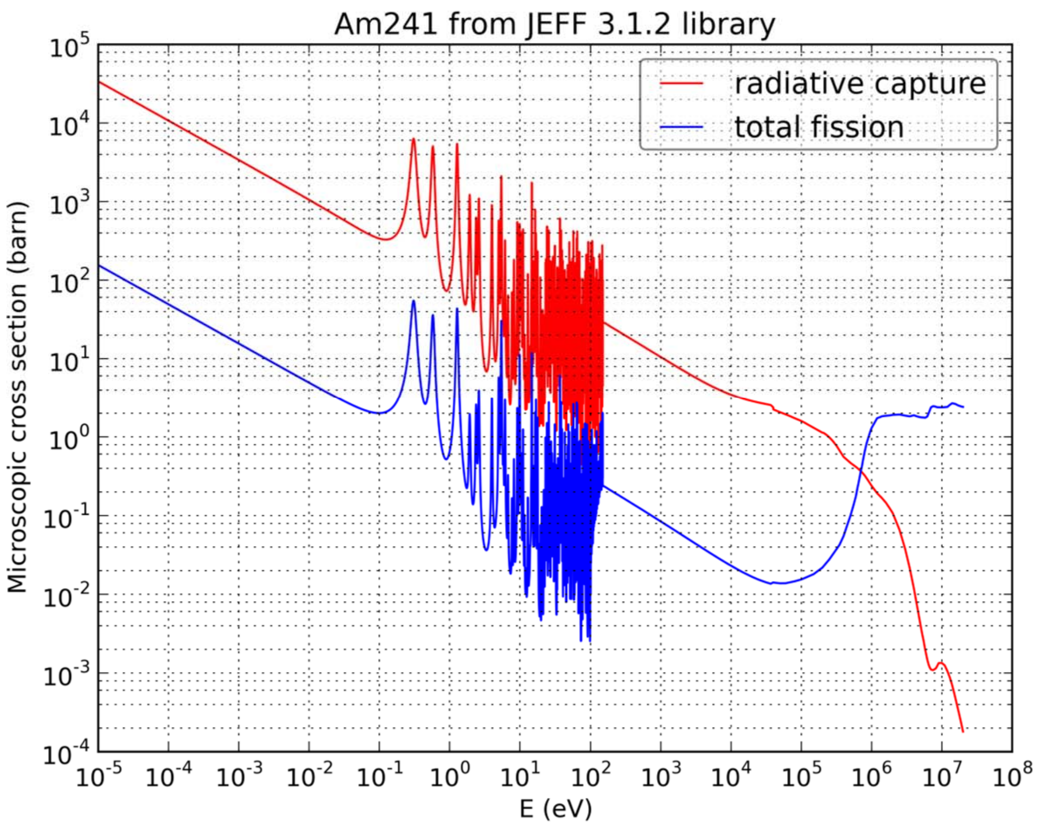
Motivation for transmutation



Fast Neutron 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.**

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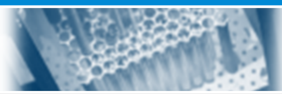

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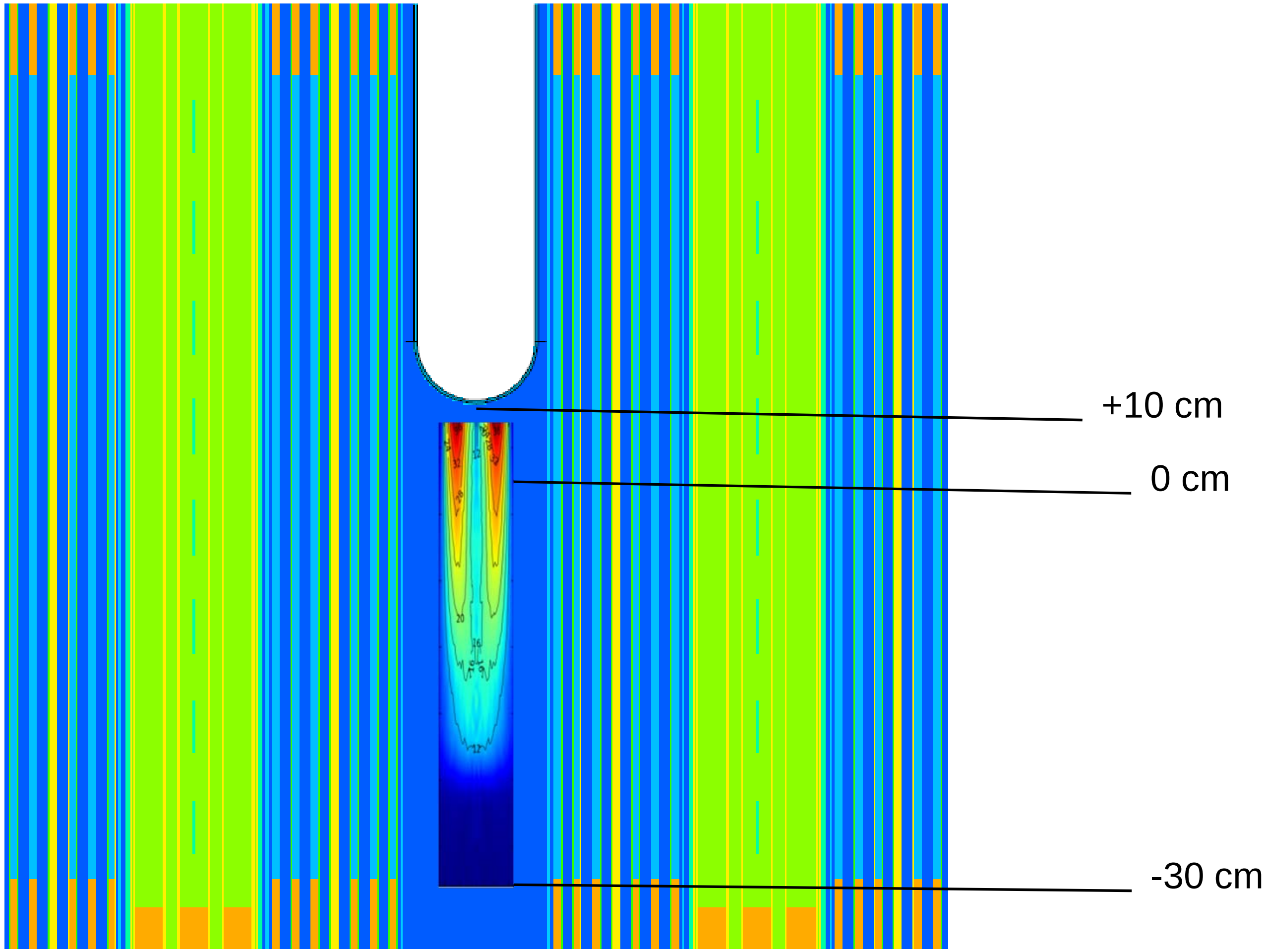
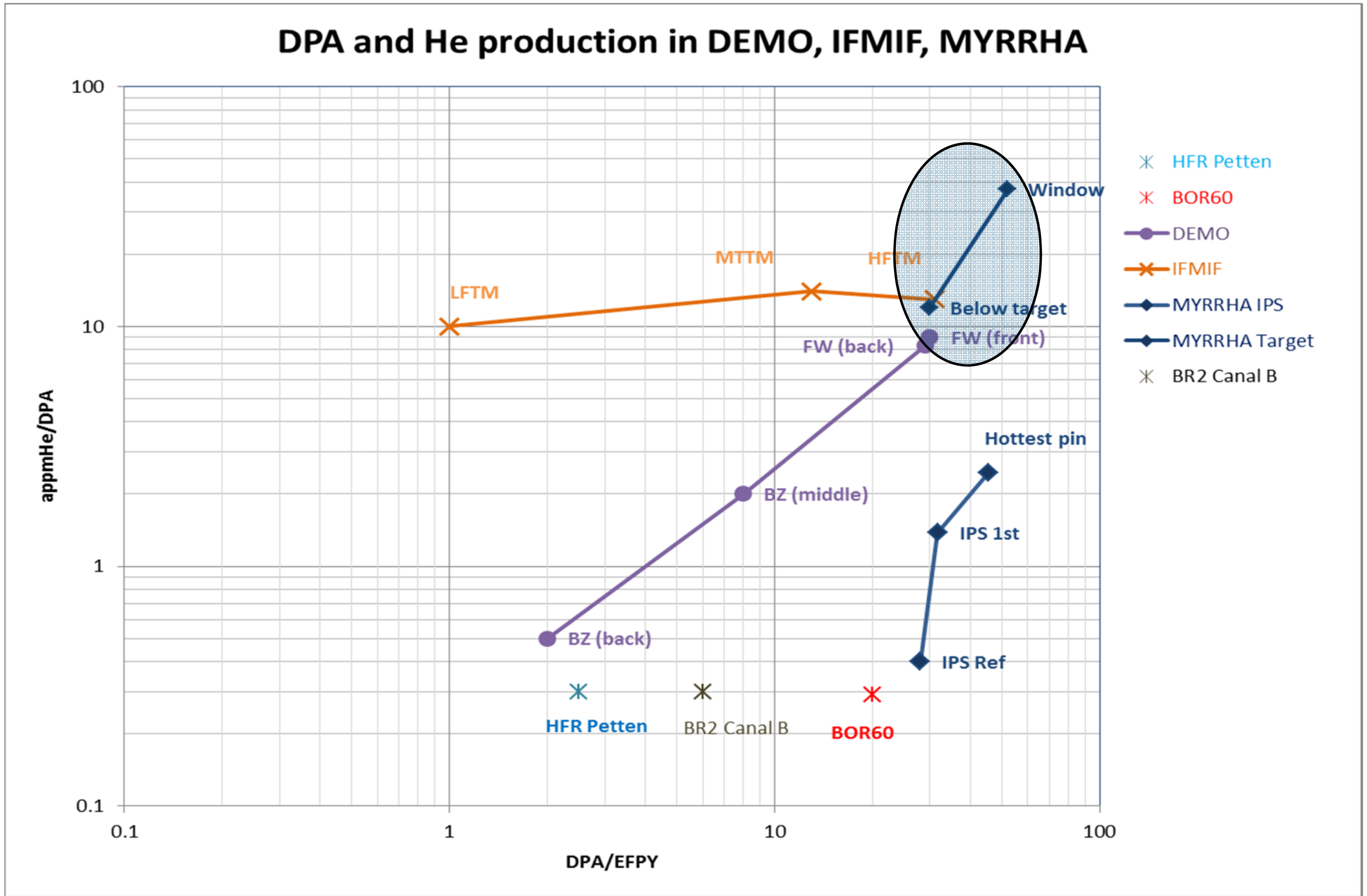
Prepare the path for Fusion DEMO
Irradiation capabilities under the spallation target



MYRRHA for fusion irradiations



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

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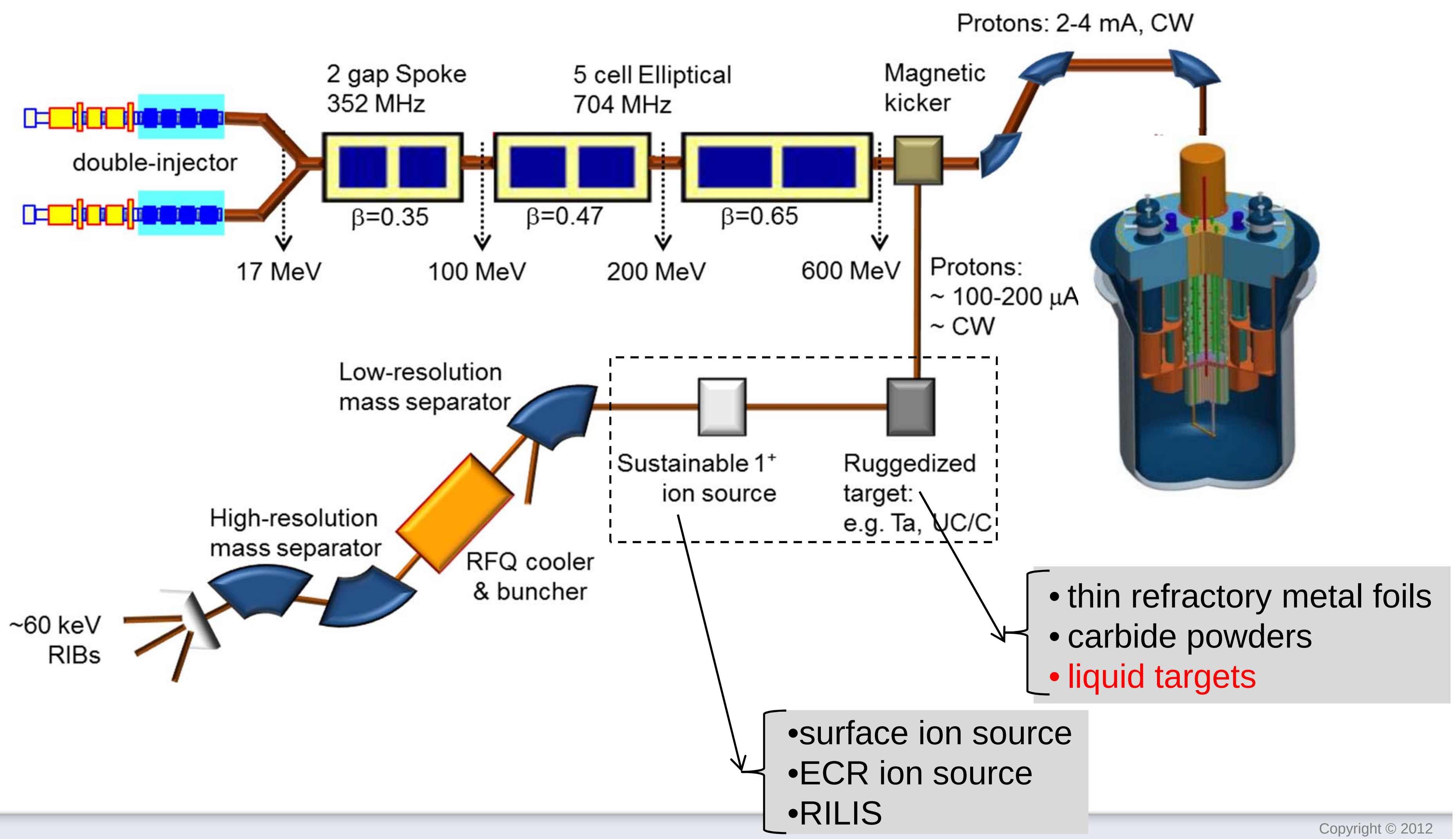
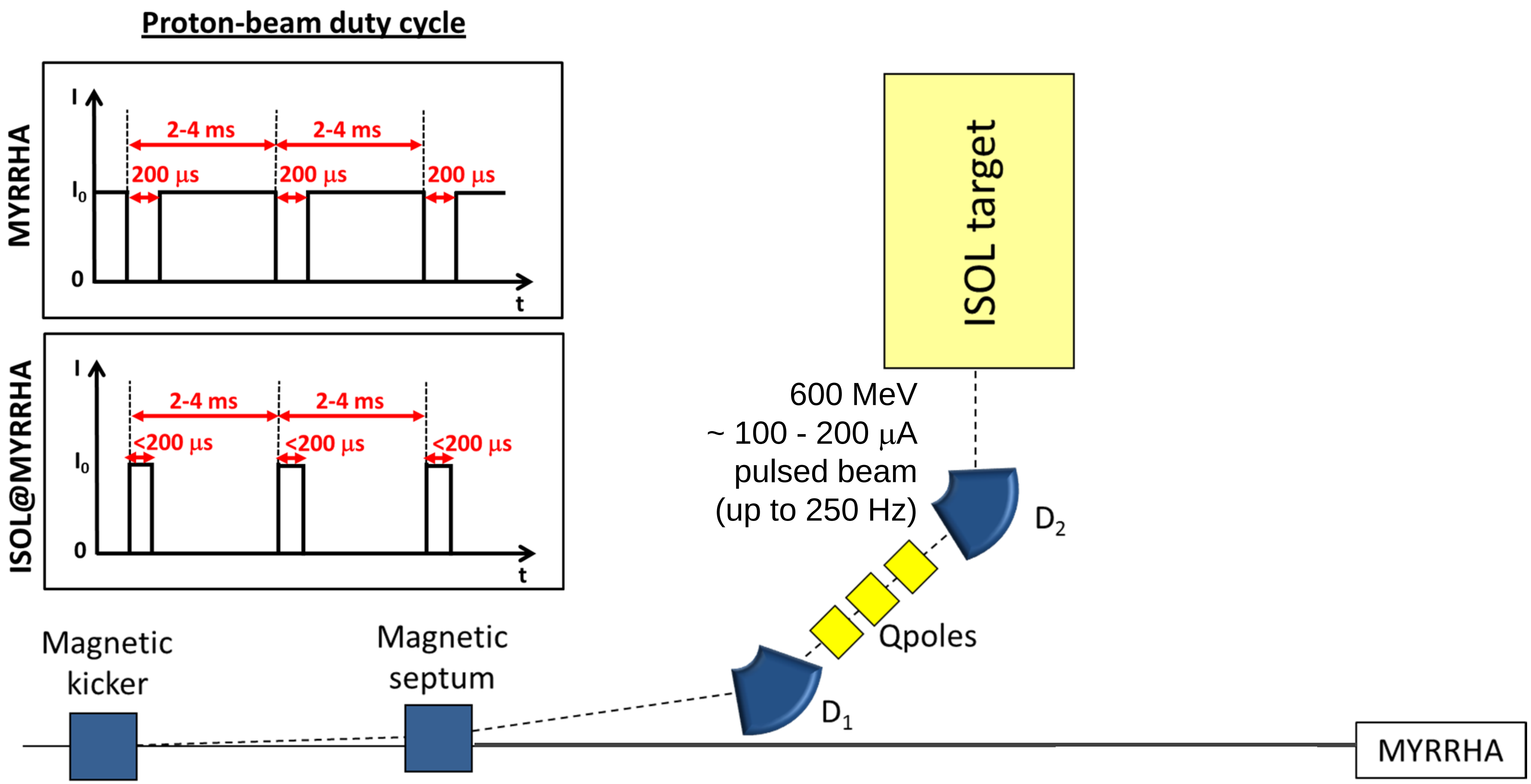
ISOL@MYRRHA - Concept



Beam-Splitting System (Concept)



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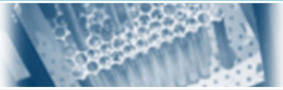

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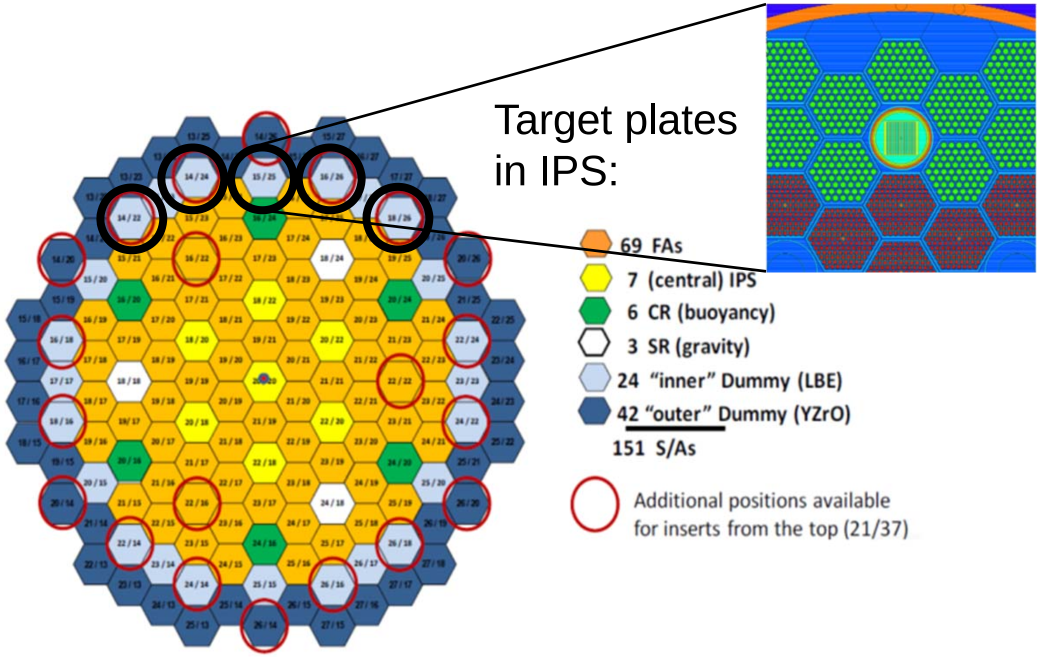
Silicon doping

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**

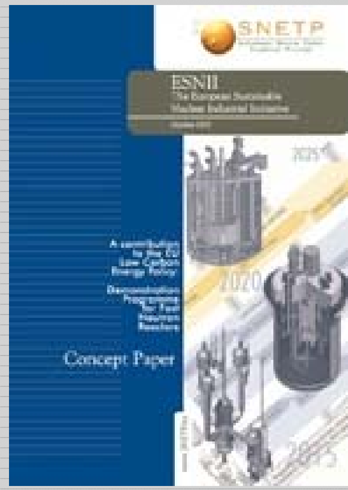
European Context

ESFRI
European
Strategic
Forum for
Research
Infrastructure

SET Plan
European
Strategic
Energy Plan

Knowledge Economy

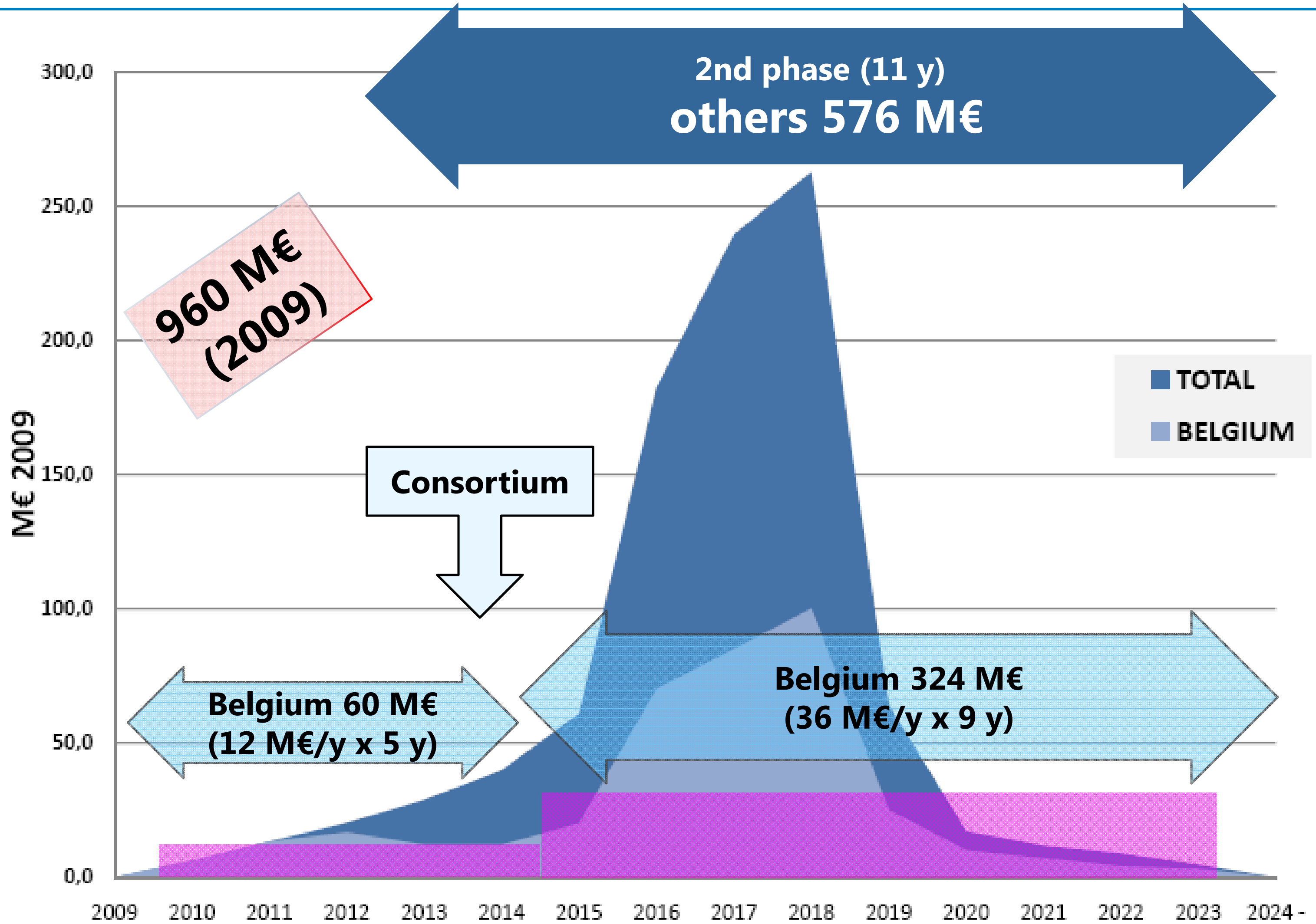
Energy Independence



27.11.2010
Confirmed on ESFRI priority list projects

15.11.2010
in ESNII
(SNETP goals)

Belgian commitment: secured
International consortium: under construction



The project schedule

2010-2014	2015	2016-2018	2019	2020-2022	2023	2024-
Front End Engineering Design	Tendering & Procurement	Construction of components & civil engineering	On site assembly	Commissioning	Progressive start-up	Full exploitation

Minimise technological risks

Accelerator x Spallation target x Sub-critical reactor

Secure the licensing

PDP preliminary dismantling plan

PSAR preliminary safety assesment

EIAR environmental impact assesment

Secure a sound management and investment structure

Central Project Team

Owner Consortium Group

Owner Engineering Team

FEED (Front End Engineering Design)

2010-2014

MYRRHA international network

VERI LUX TAS MEA
JAEA
DEPARTMENT OF ENERGY UNITED STATES OF AMERICA
中國科学院
CHINESE ACADEMY OF SCIENCES
NATIONAL NUCLEAR CENTER OF THE REPUBLIC OF KAZAKHSTAN
KAZATOMPROM
НАЦИОНАЛЬНАЯ АТОМНАЯ КОМПАНИЯ

AnsaldoNucleare
Una Società Finmeccanica
EMPRESARIOS AGRUPADOS
AREVA
iba
OXFORD TECHNOLOGIES
TRACTEBEL Engineering
GDF SUEZ
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Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
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in der Helmholtz-Gemeinschaft
FZR
Forschungszentrum Rossendorf
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CRS4

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KATHOLIEKE UNIVERSITEIT LEUVEN
GSI
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Universidad Politécnica de Madrid
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AGH
uned
Universidad Nacional de Educación a Distancia

International Members Consortium - Phase 2

«ERIC» (*)

CLOSED/ SHARED INFORMATION

for MoC

Members of Consortium **~25%**

- Individual research of a member of Consortium
- Collaborative research amongst members of Consortium
- 3 years program commitment

OPEN INFORMATION

Open User Facility **~25%**

- Governments funding
- Criteria of research excellence
- Independant program access committee (PAC)

SHARED INFORMATION

for participants

Collaborative research **~25%**

- Distribution of information to participants

CLOSED INFORMATION

for participants

Contract research
Commercial services **~25%**

- RI
- NTD Silicon

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)

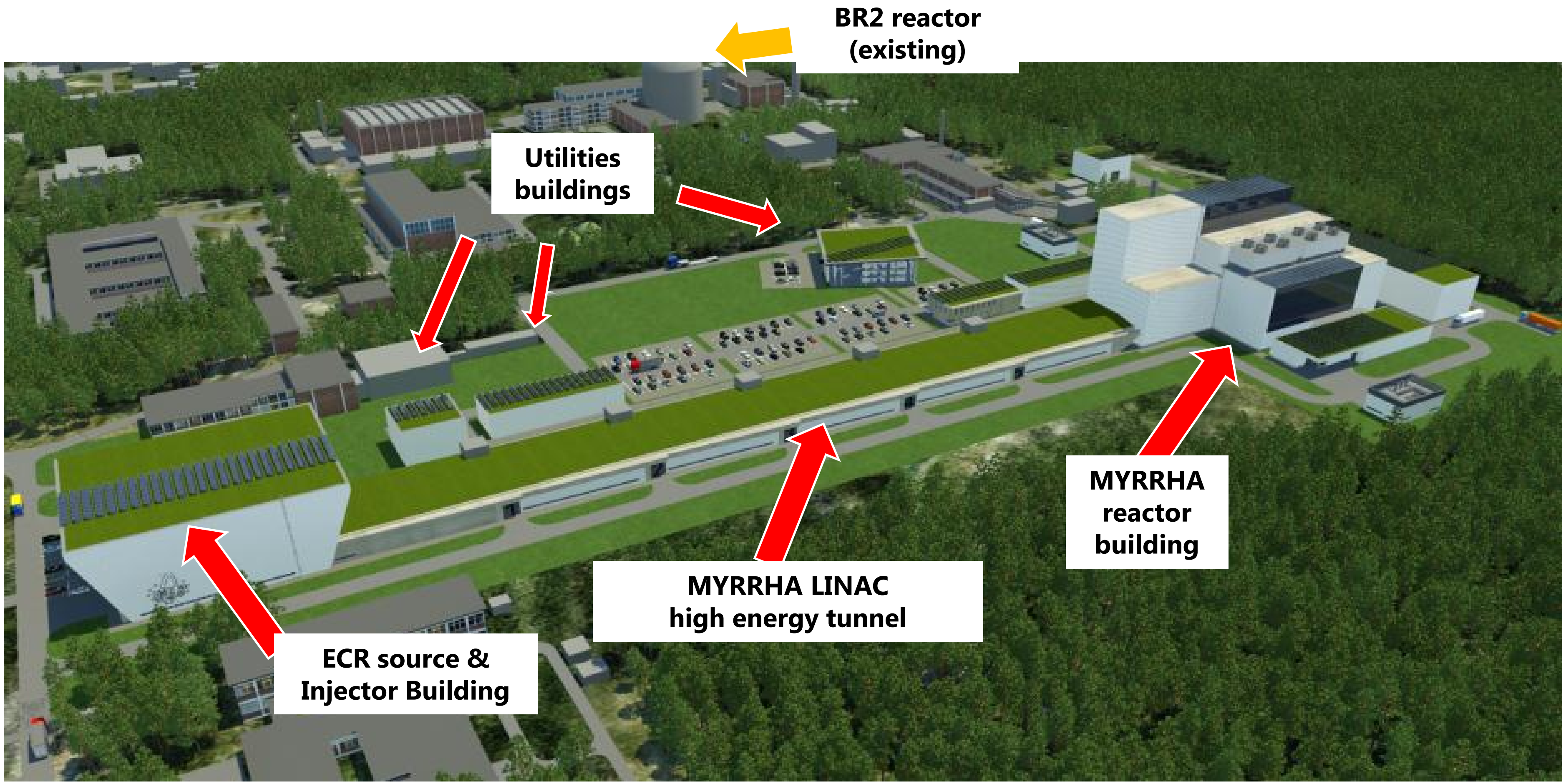
SCK•CEN
as qualified and licenced operator of the MYRRHA infrastructure under contractual arrangement with ERIC

(*) European Research Infrastructure Consortium

Conclusions

- **MYRRHA As a Multipurpose Fast Spetrum 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 materia**l research community towards the DEMO construction
  - **Secure society needs** for RI for medical applications and Dopped-Si for renewable Energy

MYRRHA: EXPERIMENTAL ACCELERATOR DRIVEN SYSTEM
A pan-European, innovative and unique facility at Mol (BE)



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Centre d'Etude de l'Energie Nucléaire
Belgian Nuclear Research Centre

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

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