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CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

MYRRHA

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

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Overview

- **Energy Research Infrastructure ?**
- **The MYRRHA Project**
- **International Collaboration**
- **MYRRHA International Consortium**

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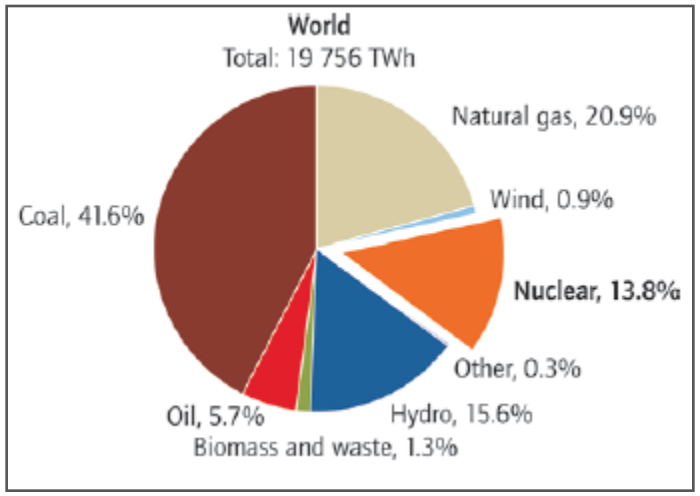
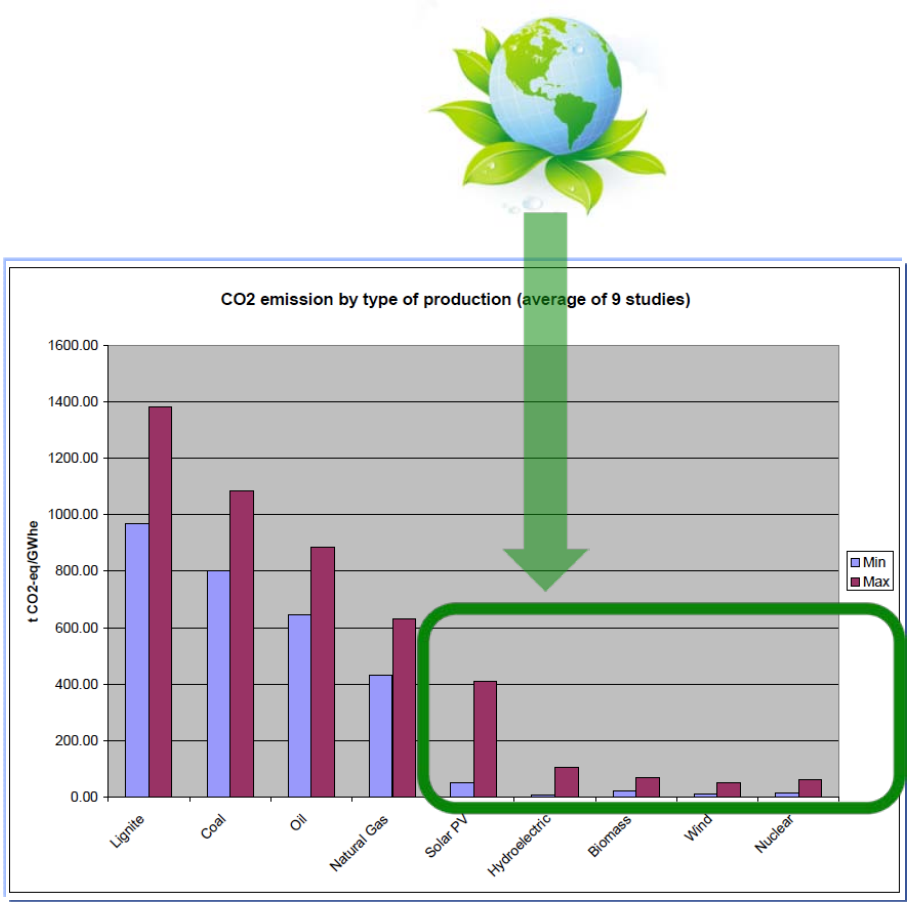
Facing the energy challenge



Electricity generation worldwide
(OECD, 2007)

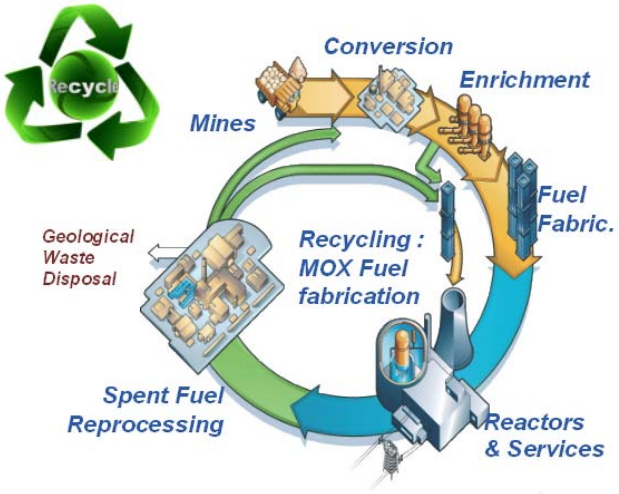


Global issues for nuclear energy

Common needs

Burning legacy of the past

Reducing cost of ultimate waste



Better use of resources

Enhance Safety

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Sustainable nuclear fission

SNETP
SUSTAINABLE NUCLEAR ENERGY TECHNOLOGY PLATFORM

nuclear waste

resource utilisation

Enhanced safety

proliferation risk

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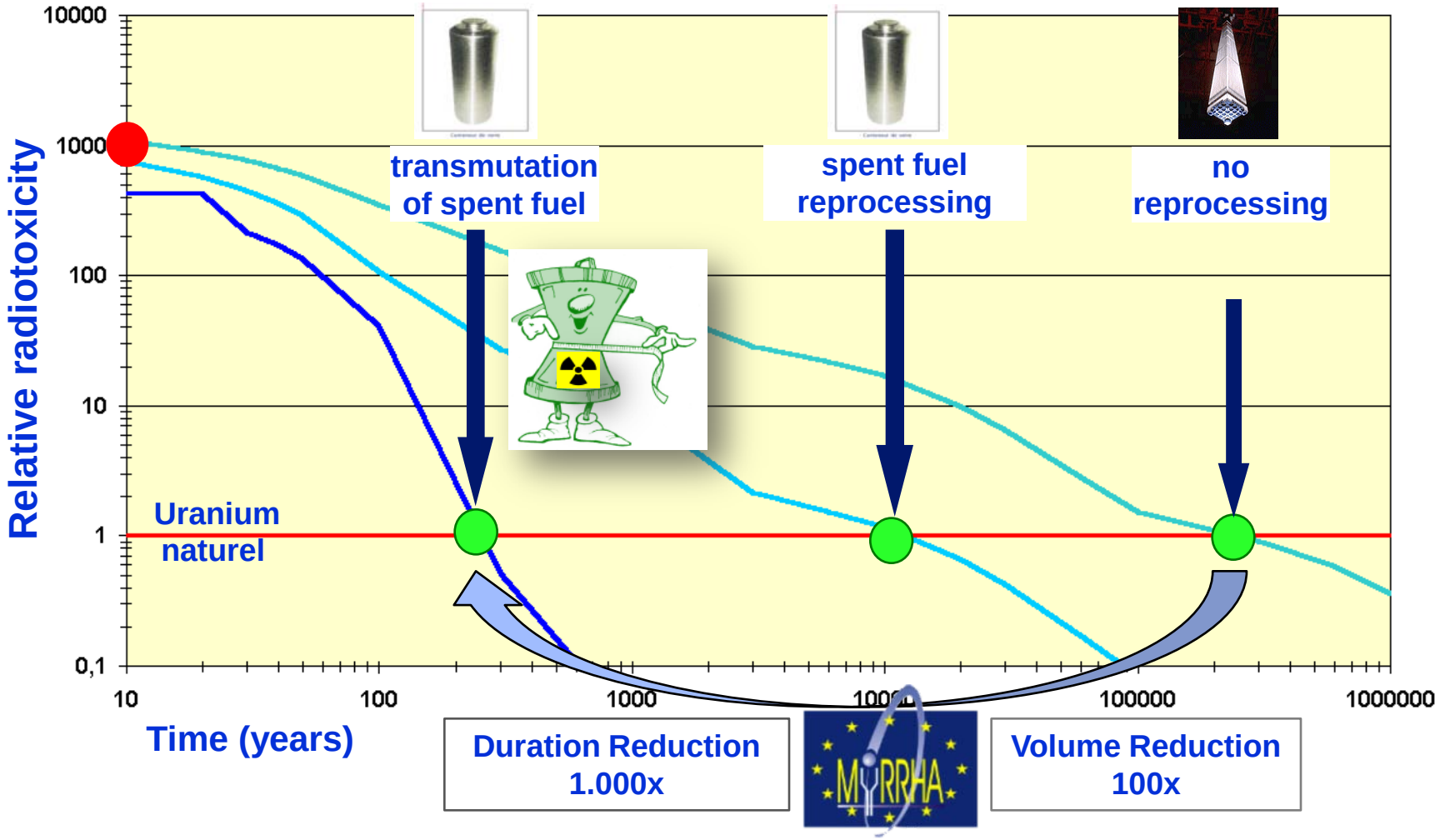
Motivation for transmutation



SCK•CEN : tradition of «first of a kind»

1st pressurized water reactor (PWR) outside of US (BR3)

Inventor of innovative nuclear fuel (MOX fuel)

Highest performing material testing reactor in Europe (BR2)

World first underground laboratory for R&D on HL waste disposal (HADES)

World first lead based ADS (GUINEVERE)

World premiere project for transmutation of nuclear waste

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MYRRHA - Accelerator Driven System

Accelerator
(600 MeV - 4 mA proton)

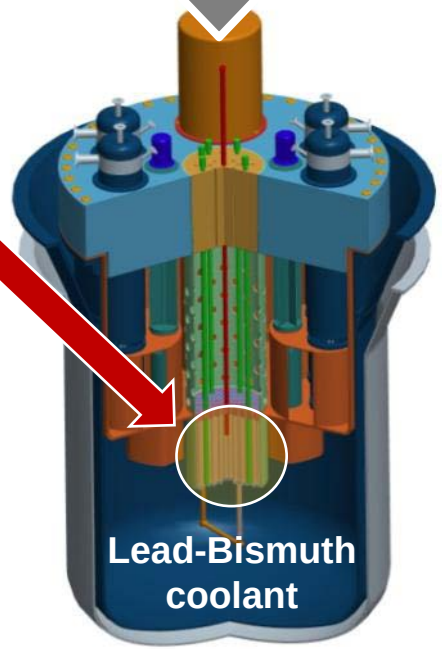
Reactor
- Subcritical or Critical modes
- 65 to 100 MWth

Innovative & Unique

Spallation Source

Fast Neutron Source

Multipurpose Flexible Irradiation Facility



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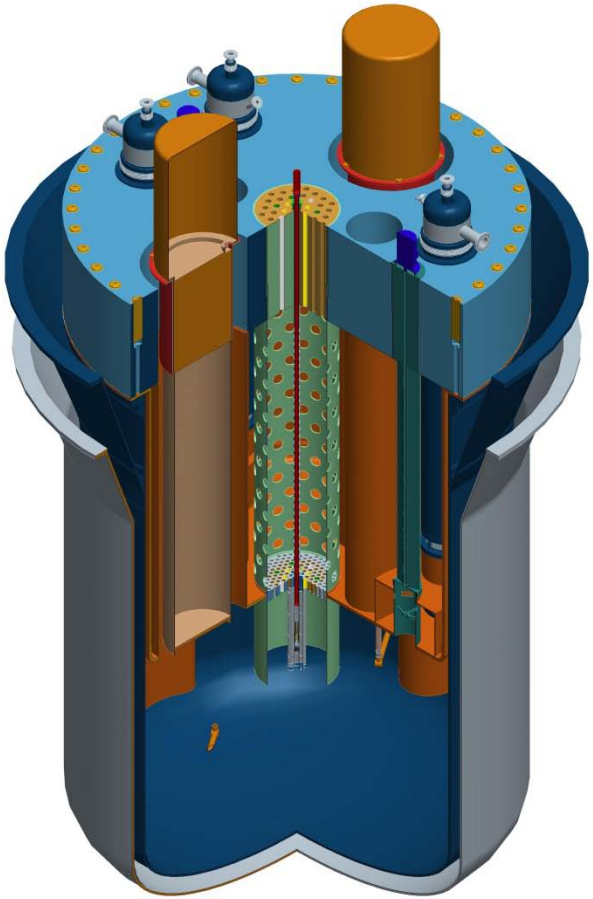
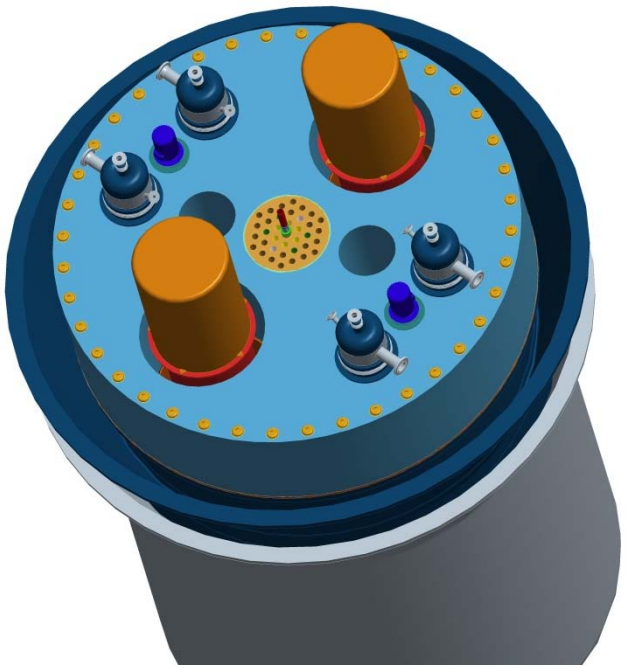
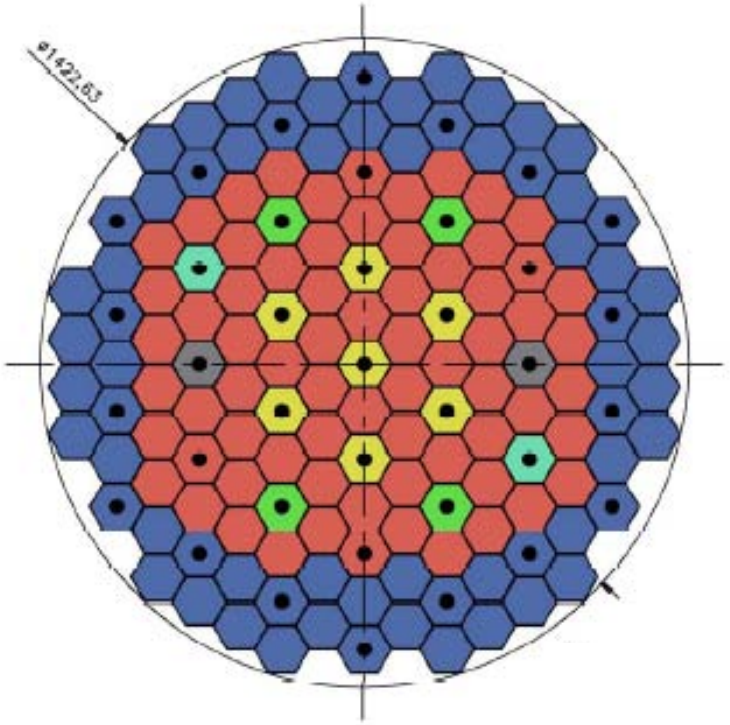
Reactor layout – Updated design

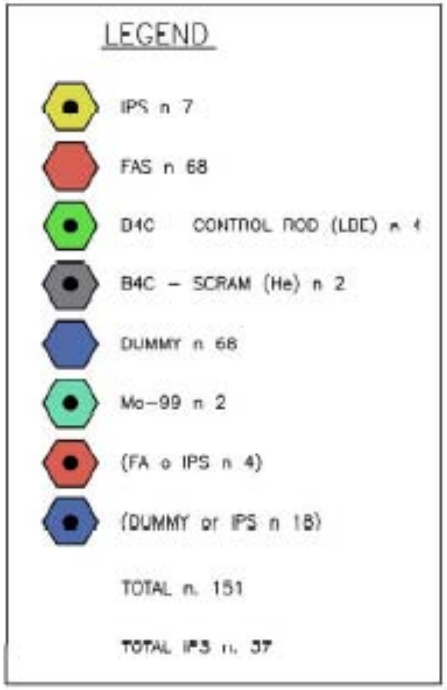


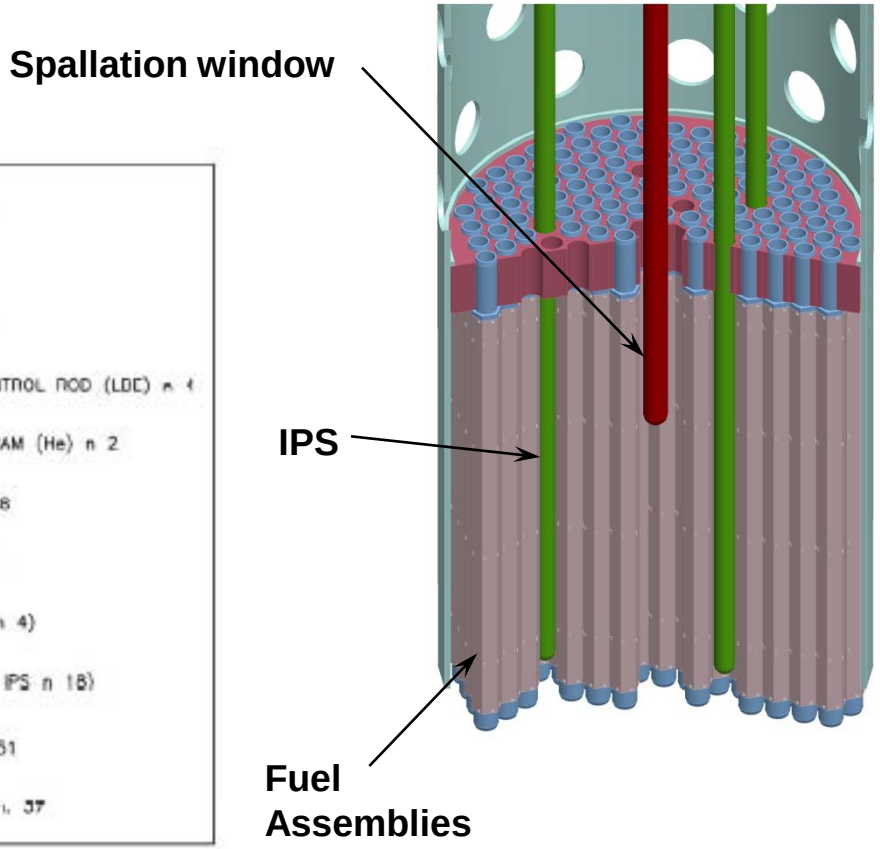


Reactor layout - Core

- k_{eff}≈0.95 (ADS mode)
- 30-35 % MOX fuel
- 7 IPS positions







MYRRHA Accelerator Challenge

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

challenge !

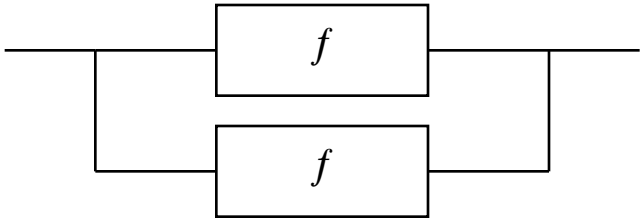
failure = beam trip > 3 s

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

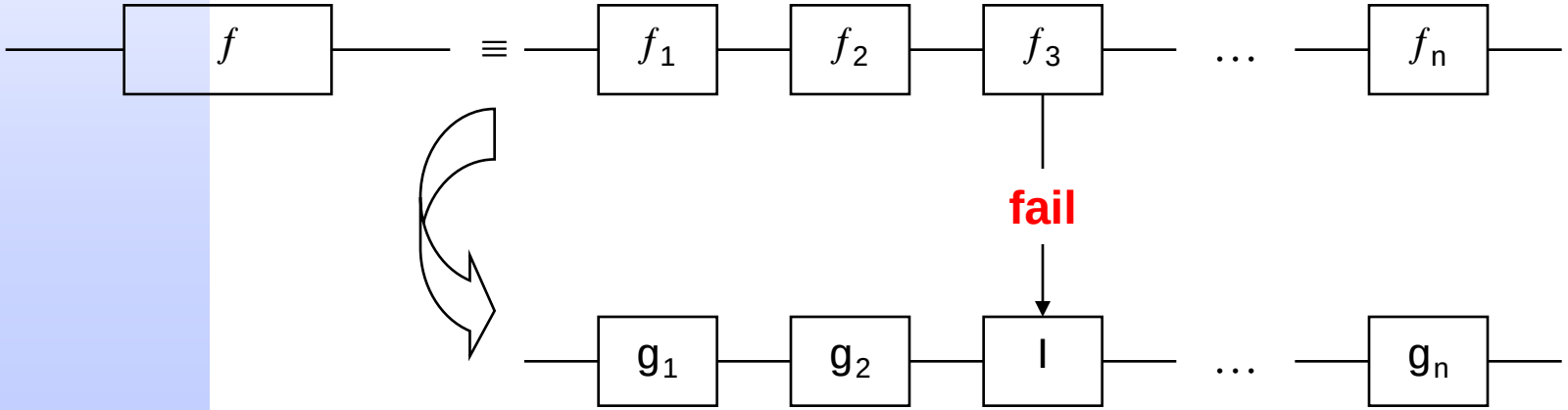
11

Redundancy

parallel scheme

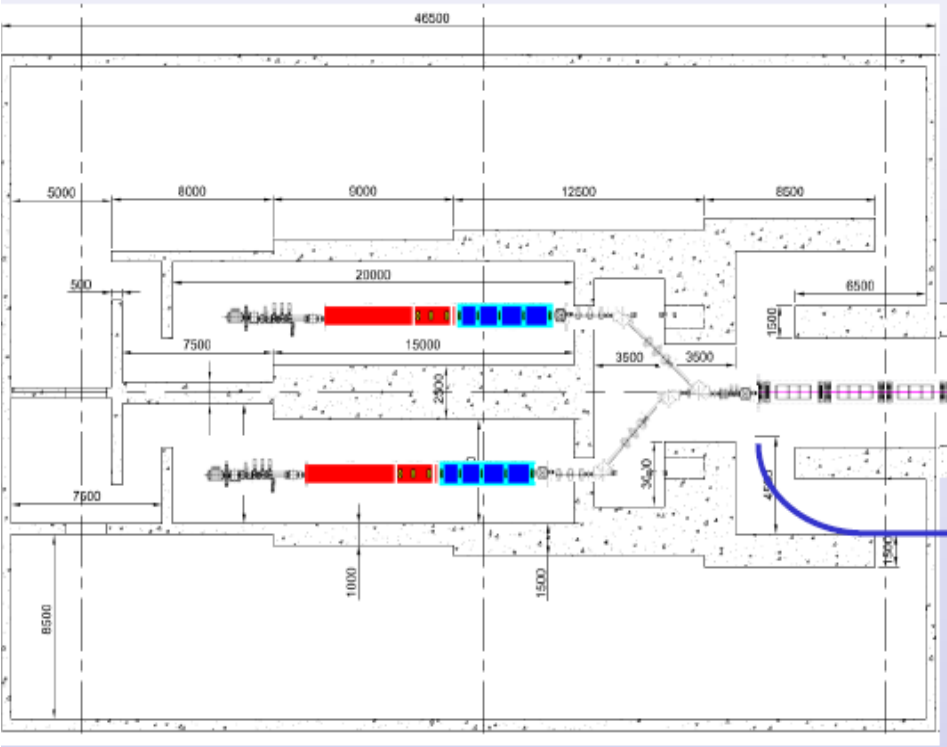


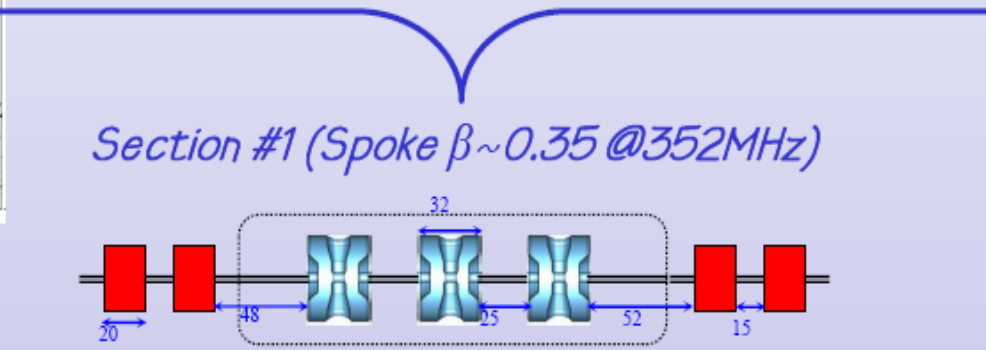
serial scheme: IF



modularity

INJECTOR BUILDING





courtesy J.L. Biarrotte, CNRS/IPN Orsay

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Multipurpose facility

Material research
Φ_{Fast} = 1 to 5.10^{14} n/cm².s
(En>1 MeV) in large volumes

Fuel research
Φ_{tot} = 0.5 to 1.10^{15} n/cm².s

Fission GEN IV

Φ = 1 to 5.10^{14} n/cm².s
(ppm He/dpa ~ 10)
in medium-large volumes

Fusion

50 to 100 MWth
Φ_{Fast} = ~10^{15} n/cm².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/cm².s
(En<0.4 eV)

Radio-isotopes

Φ_{th} = 0.1 to 1.10^{14} n/cm².s
(En<0.4 eV)

Silicon doping

MYRRHA international reviewing

2001: International Strategic Guidance Committee

2002: International Technical Guidance Committee

2003: Review by Russian Lead Reactor Technology Experts (ISTC#2552p project)

2005: Conclusions of the European Commission FP5 Project PDS-XADS (2001-2004)

2006: European Commission FP6 Project EUROTRANS (2005-2009): Conclusions of Review and Justification of the main options of XT-ADS starting from MYRRHA

2007: International Assessment Meeting of the Advanced Nuclear Systems Institute

2008: European Commission FP7 Project Central Design Team (CDT) at Mol for MYRRHA detailed design

2009: MIRT of OECD/NEA on request of Belgian Government

IEA perspective on future nuclear energy

Developing a new generation of nuclear technologies

This roadmap recommends that:

- Governments should continue to support RD&D of advanced nuclear technology to capture its long-term potential to provide sustainable energy with improved economics, enhanced safety and reliability, and stronger proliferation resistance and physical protection.
- The international community should continue to strengthen co-operation on the development of advanced reactor and fuel cycle technologies.
- The nuclear industry and utilities should participate, in co-operation with nuclear research institutes, in the development of next generation nuclear systems to ensure that the designs selected for demonstration are those most suitable for eventual commercialisation.

1. *The demonstration of ADS transmutation could take place in the planned **MYRRHA** facility in Belgium which is scheduled to begin operation by 2023.*
2. *The LFR concept can be technologically demonstrated thanks to **MYRRHA***

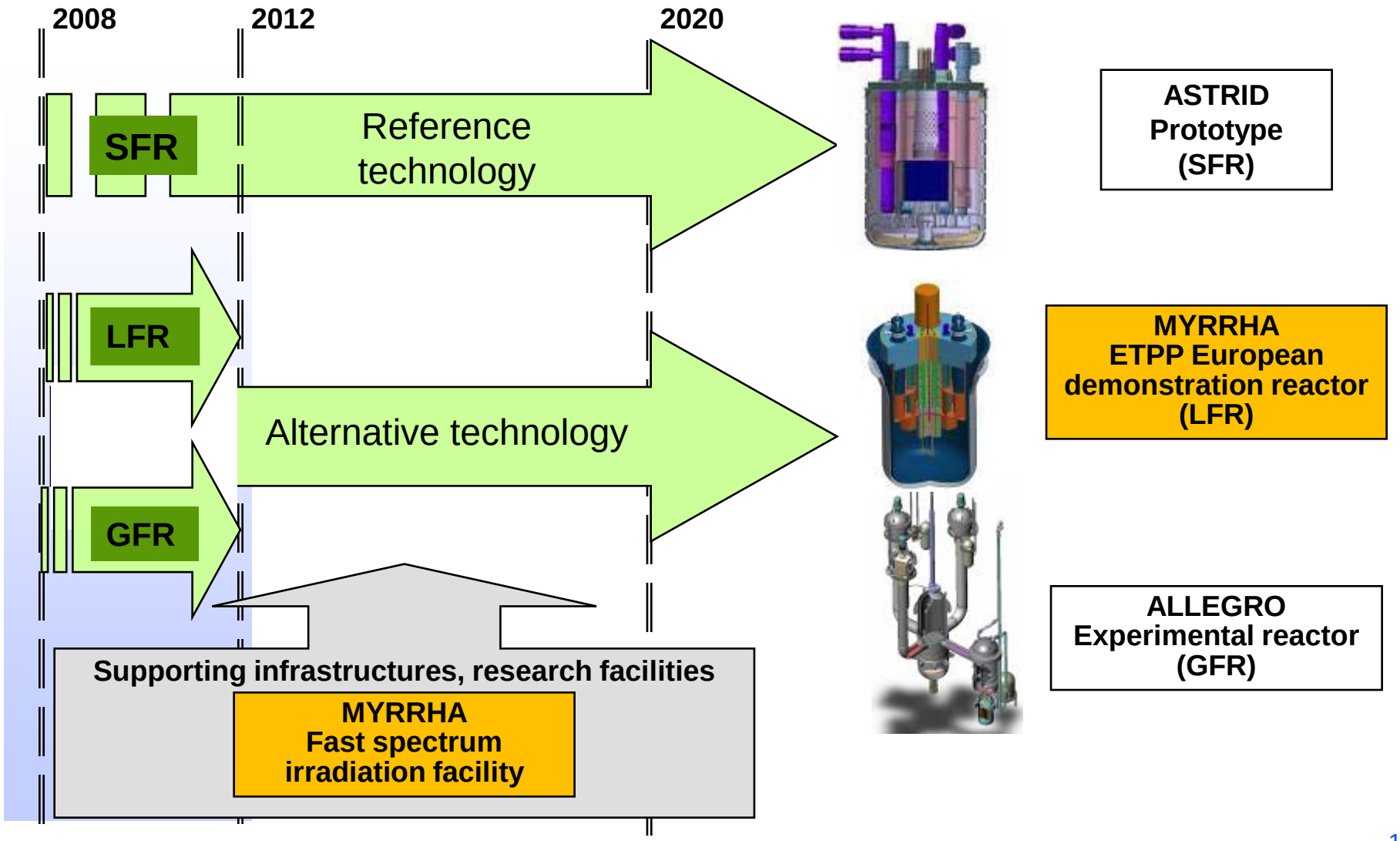
Europe and future nuclear energy

ESFRI
European Strategic Forum for Research Infrastructure

SET Plan
European Strategic Energy Plan

MYRRHA part of ESNII

European Sustainable Nuclear Industrial Initiative



Detailed budget: balancing costs & revenues

2010 - 2023

Investment 960 M€

Building	Equipment	Engineering
196 M€	370 M€	202 M€

Contingencies
192 M€

2024 ~ 2054

Operational Budget

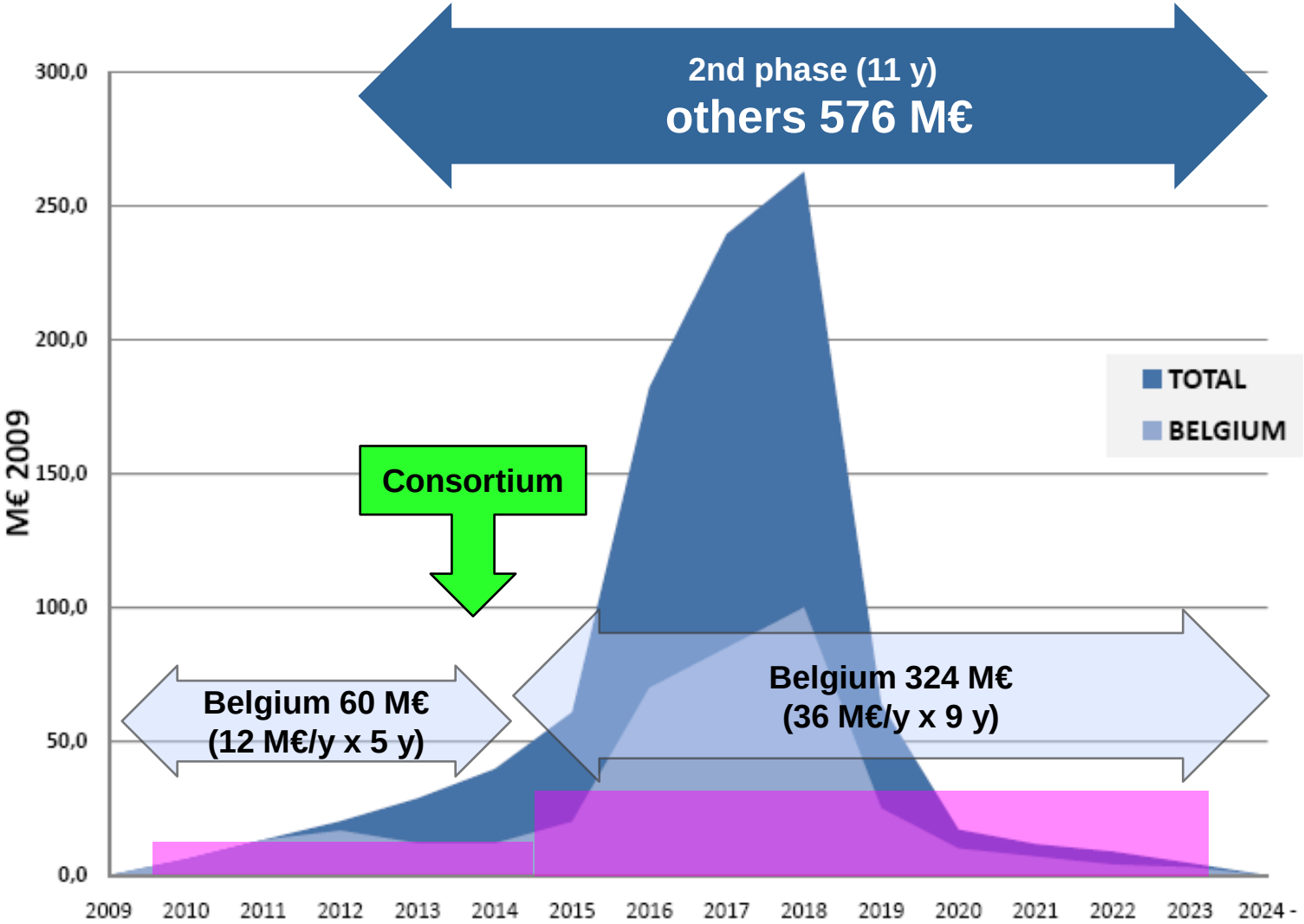
Costs	Revenues
Operational costs 46.6 M€/y	Consortium endowment 25.2 M€/y
	Science & **T**ech. revenues 17.1 M€/y
Organisation reinforcement 14.6 M€/y	**S**ervices revenues >18.8 M€/y

Forging strong partnerships and alliances in Europe and worldwide

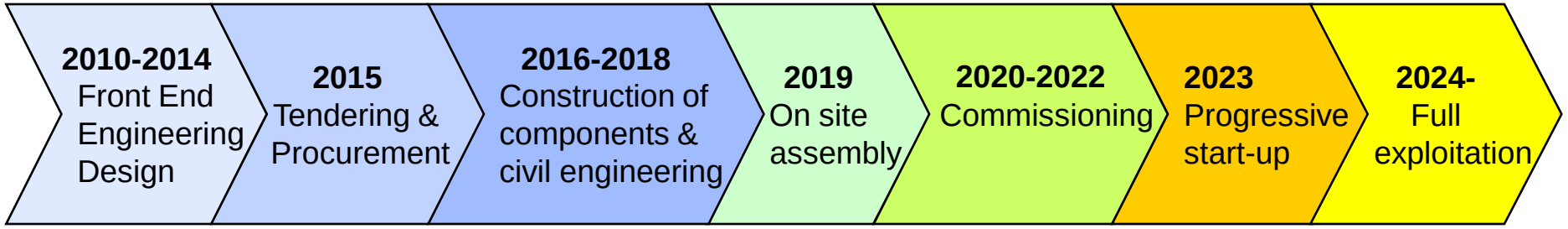
In-cash In-kind FP7 EII	Belgium: 40% (05.03.2010)	Engineering
	EU Member States	Building
	EU	
	ROW	Equipment
loan	EIB	

Owners' Consortium Group	• Co-sharing investment cost • Co-sharing exploitation cost • Privileged access conditions
Alliances	• Securing revenues from Users' Group

Belgian commitment: secured
International consortium: under construction



The project schedule



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: an international project

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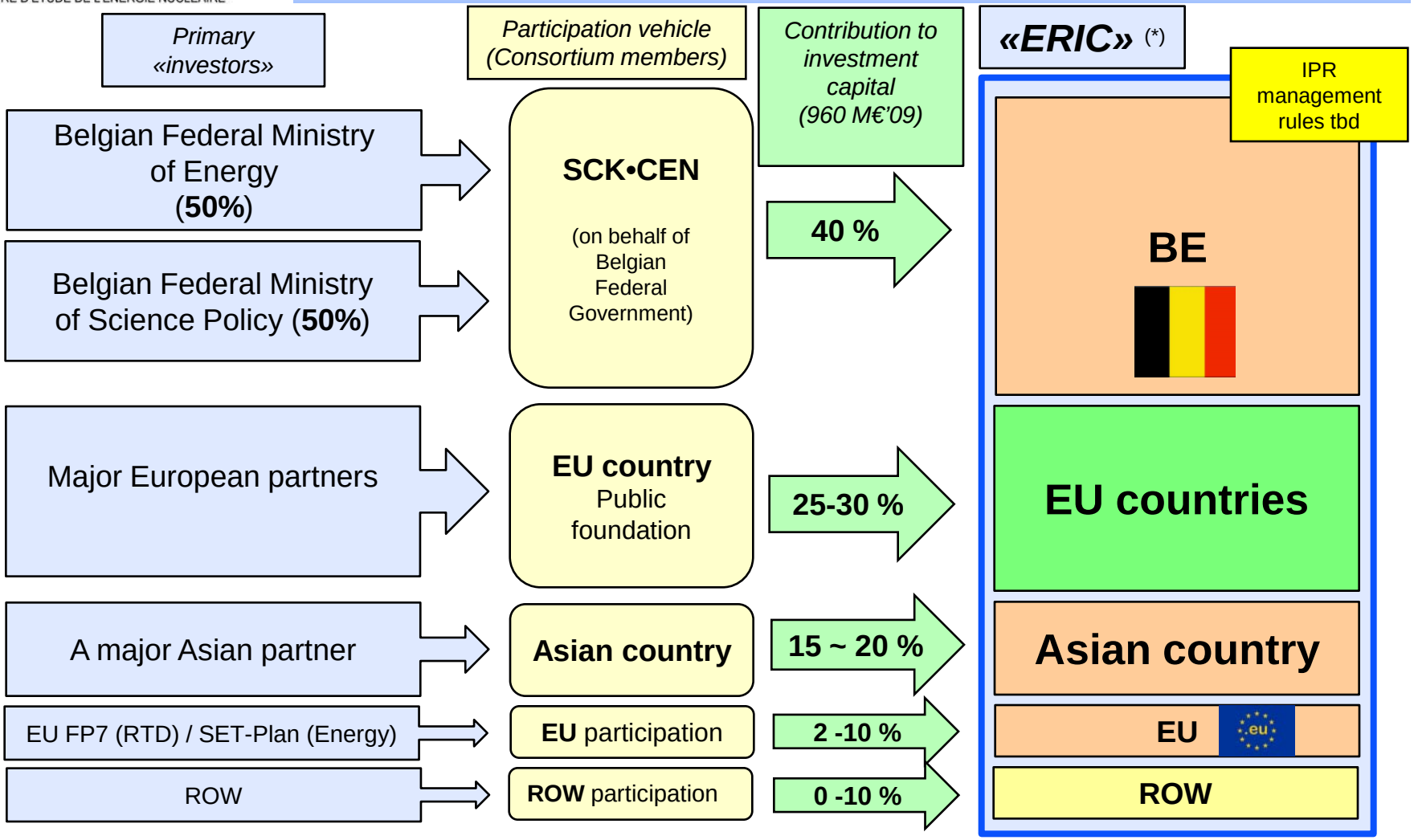
International Members Consortium – Phase 1



(*) European Research Infrastructure Consortium

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International Members Consortium - Phase 2

«ERIC» (*)

CLOSED/ SHARED INFORMATION
for MoC

OPEN INFORMATION

SHARED INFORMATION
for participants

CLOSED INFORMATION
for participants

Members of Consortium — ~25%
- Individual research of a member of Consortium
-Collaborative research amongst members of Consortium
- 3 years program commitment

Open User Facility — ~25%
- Governments funding
- Criteria of research excellence
- Independant program access committee (PAC)

Collaborative research — ~25%
- Distribution of information to 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

Joining the MYRRHA project

- Belgium is welcoming international participation in the MYRRHA consortium
- Membership eligibility for the international MYRRHA consortium is based on a balanced in-cash/in-kind contribution

- Until end 2014, our objectives are:
  - to collect **Letters of Intent** for participation in the MYRRHA International Consortium (deadline mid 2012)
  - to sign **Memoranda of Understanding** for collaboration in MYRRHA with international partners (deadline mid 2014)
  - To finalise the **Consortium legal framework** (deadline end 2014)

MYRRHA: EXPERIMENTAL ACCELERATOR DRIVEN SYSTEM

A pan-European, innovative and unique facility

- Time horizon: full operation ~ 2023
- Costs: ~ EUR 960 million

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