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CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

Nuclear technology

and

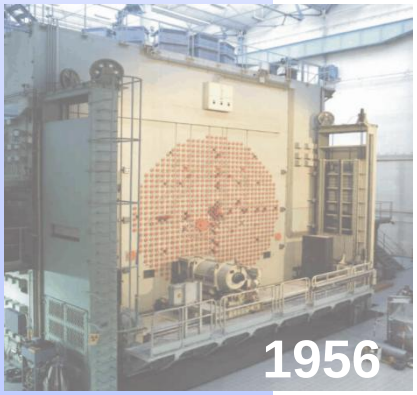
clean

Prof. Dr. Eric van Walle, Director-General

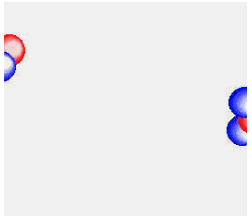
'Gent 175 jaar', Ghent University, Belgium
November 17, 2010

sustainable development energy?

’ a development that meets the needs of the present without compromising the ability of future generations to meet their own needs'(1987, Our Common Future, UNESCO)

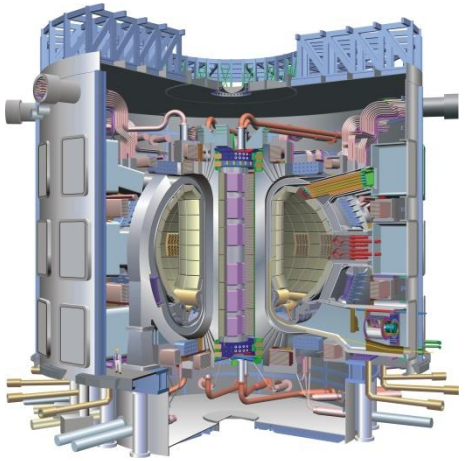


fission



fusion

CLEAN



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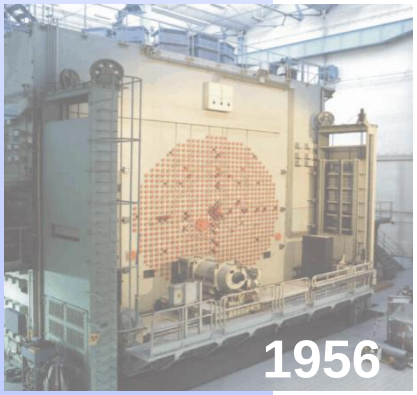
sustainable nuclear energy?

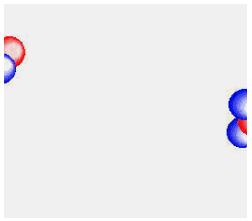
+2100: a development that meets the needs of the future due to efforts of past generations who did not jeopardize their abilities to be creative for the needs of future generations

fusion cannot be established without 'passing by' fission

how clean can fission be?

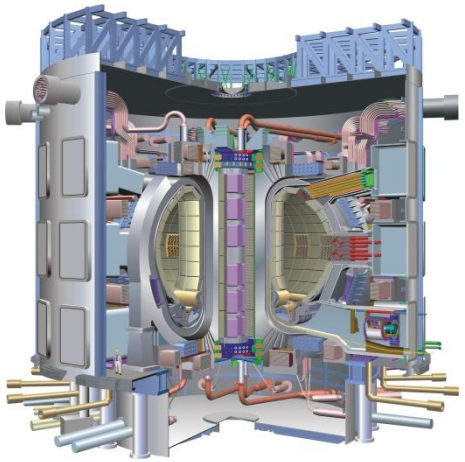


fission



fusion

CLEAN



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research towards 'clean' sustainable nuclear energy

CO_2 free

concentrated

economic

safety

waste

resources

societal aspects

social acceptance

research & development

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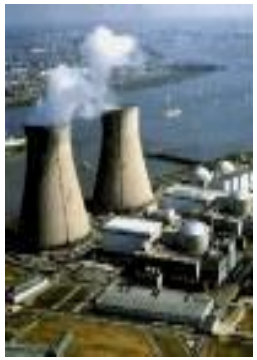
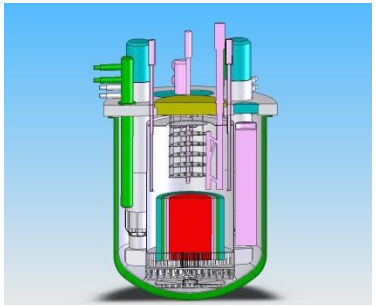
… supports the time evolution of NPP's



1950 1970 1990 2010 2030 2050 2070 2090

Gen I dismantling & storage

Demo
Training
Testing

Gen II lifetime management

Present LWR plants

Gen III passive & efficient

LWR plants under construction

Gen IV sustainable

Design phase

CLEAN

the criteria of GEN IV reactors

CO_2 free

- sustainability:
  - ➔better use of energy vector in nuclear fuel — resources
  - ➔minimisation of the amount and radiotoxicity (lifetime) of used fuel — waste
  - ➔increase the proliferation resistance of nuclear fuel — safety
- safety and reliability:
  - ➔reduced risque for nuclear incidents/accidents by using passive safety systems to increase intrinsic safety — safety
- economy:
  - ➔Optimisation of all components and aspects: from investment to dismantling — economic

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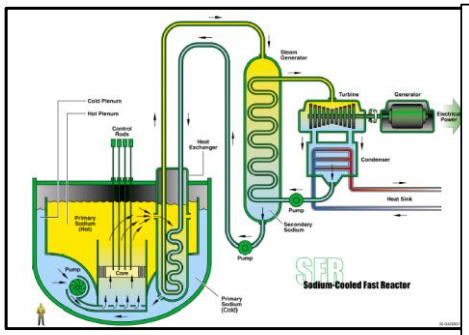
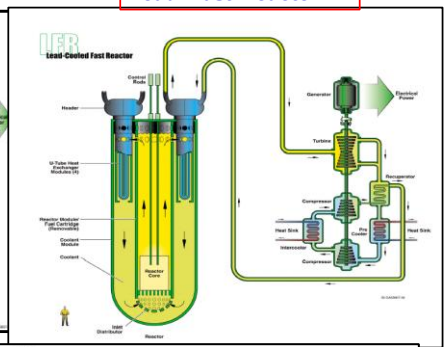
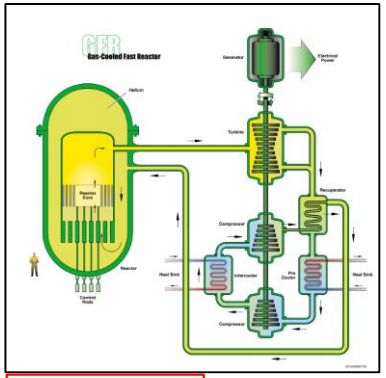
Generation IV selection



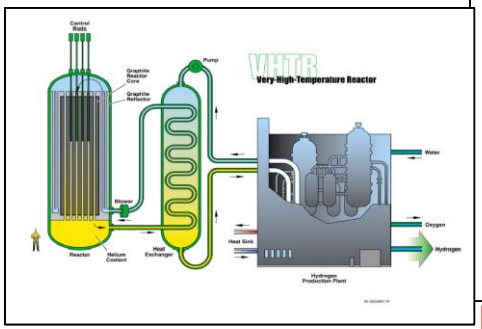
Sodium Fast Reactor

Lead Fast Reactor

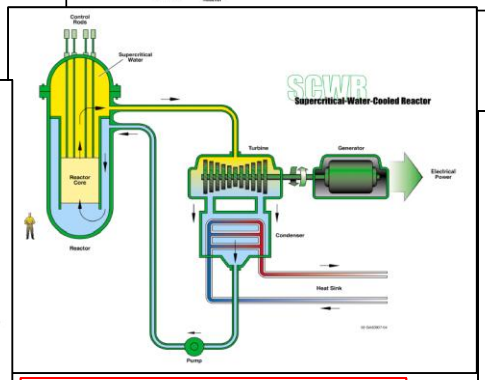




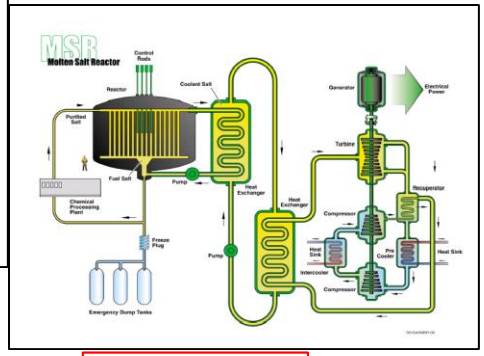
Gas Fast Reactor



Very High Temperature Reactor



Supercritical Water-cooled Reactor



Molten Salt Reactor

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Generation IV research challenges

optimised fuel cycle ↓

	neutron spectrum (fast/ thermal)	coolant	temp (°C)	pressure*	fuel	fuel cycle	size (MWe)	use
Gas-cooled fast reactors	fast	helium	850	high	U-238	closed, on site	288	electricity & hydrogen
Lead-cooled fast reactors	fast	Pb-Bi	550-800	low	U-238	closed, regional	50-150** 300-400 1200	electricity & hydrogen
Molten salt reactors	epithermal	fluoride salts	700-800	low	UF in salt	closed	1000	electricity & hydrogen
Sodium-cooled fast reactors	fast	sodium	550	low	U-238 & MOX	closed	150-500 500-1500	electricity
Supercritical water-cooled reactors	thermal or fast	water	510-550	very high	UO_2	open (thermal) closed (fast)	1500	electricity
Very high temp gas reactors	thermal	helium	1000	high	UO_2 prism or pebbles	open	250	hydrogen & electricity

material compatibility with coolant ↑

high temperature materials ↑

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the answer lies in MYRRHA

- major technological challenges:
  - high temperature materials
  - coolants
  - optimised nuclear fuel cycle
  - instrumentation

need for new advanced research infrastructures

CO_2 free | concentrated | economic

safety | waste | resources

societal aspects

social acceptance

research & development

MYRRHA: innovative and unique

accelerator
(600 MeV – 2.5 mA proton)

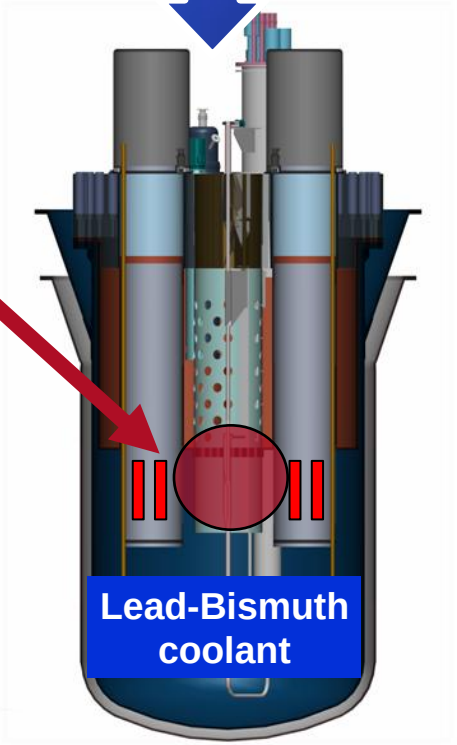
reactor
- subcritical mode (50-100 MWth)
- critical mode (~100 MWth)

Belgian decision in March 2010 to financially support MYRRHA up to 40%

spallation source

fast neutron source

multipurpose fast spectrum irradiation facility



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the tool to pursue sustainability

	Challenge	Solution	MYRRHA contribution
Fission	High radiotoxic level waste	Transmutation	ADS demo
Fission GEN IV	Demonstrate concept	Build demonstrators	LFR technology demo Fast spectrum irradiation facility
Fusion	Extreme operating conditions	Material testing & development	Fast spectrum irradiation facility
Fundamental research	Pushing the limits of knowledge	Access to proton beam	Long term experiments with radioactive ion beams (RIB)
Renewable energies	Efficient power electronics	High efficiency transistors (NTD-Si)	Securing NTD-Silicon production
Healthcare	Ageing population	A long term source of medical radioisotopes	Securing radioisotopes production (existing and new ones)

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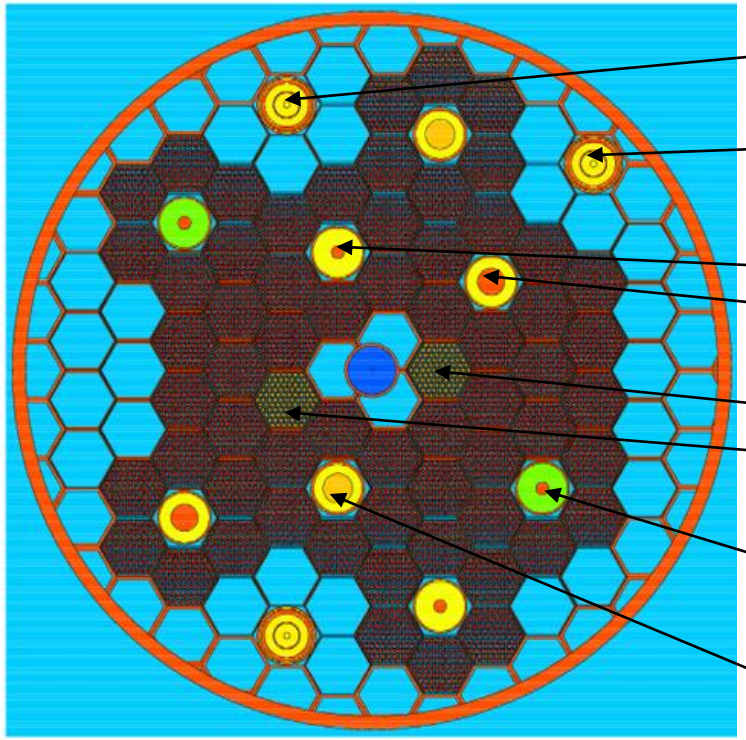
multi-disciplinarity



- thermal island for radio-isotopes
- material studies
- waste reduction
- coolant studies
- fuel studies

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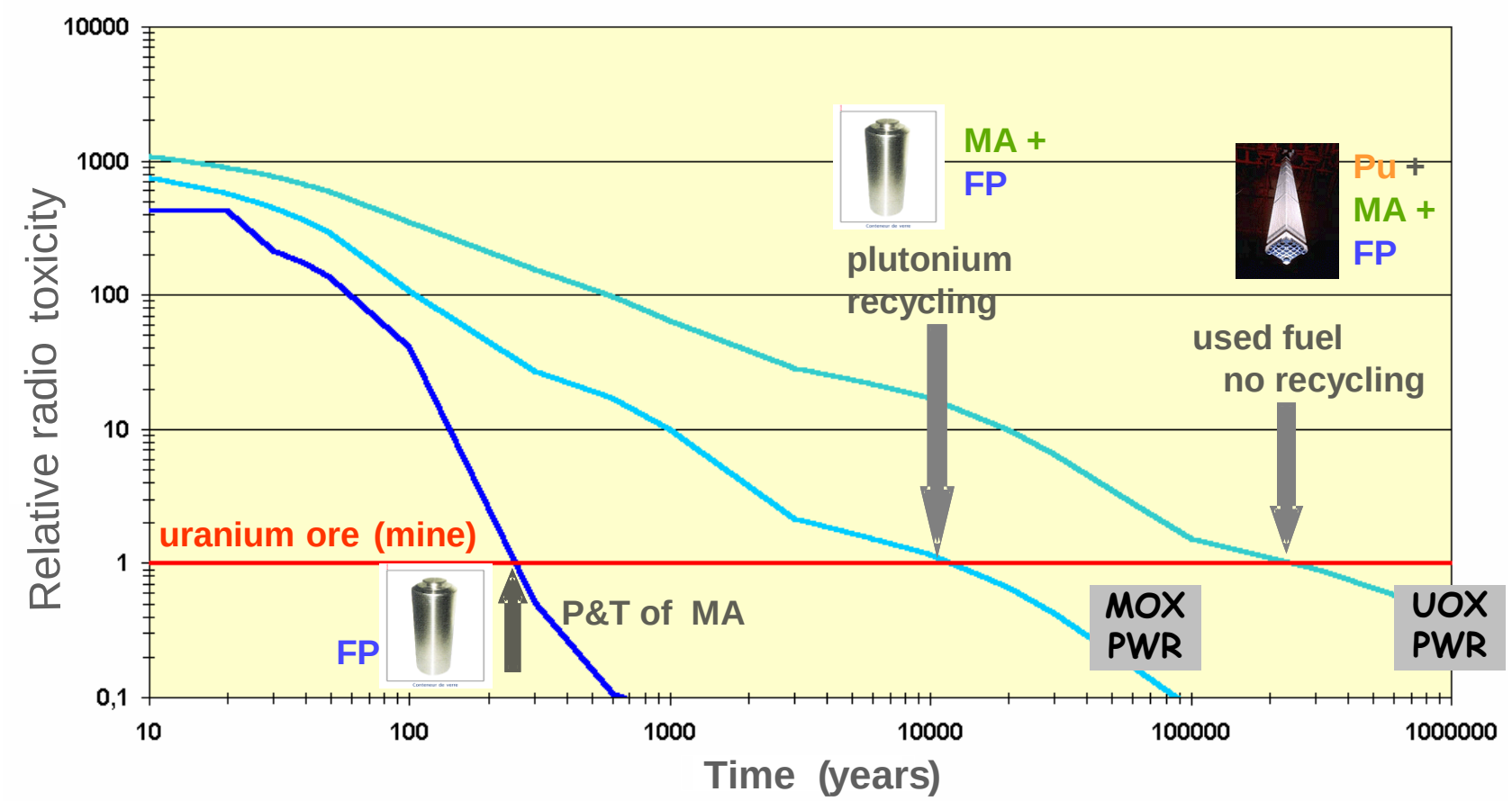
reduction of radio-toxicity and volume of highly activated waste



Dedicated MYRRHA or GEN IV : drastic increase of energy release

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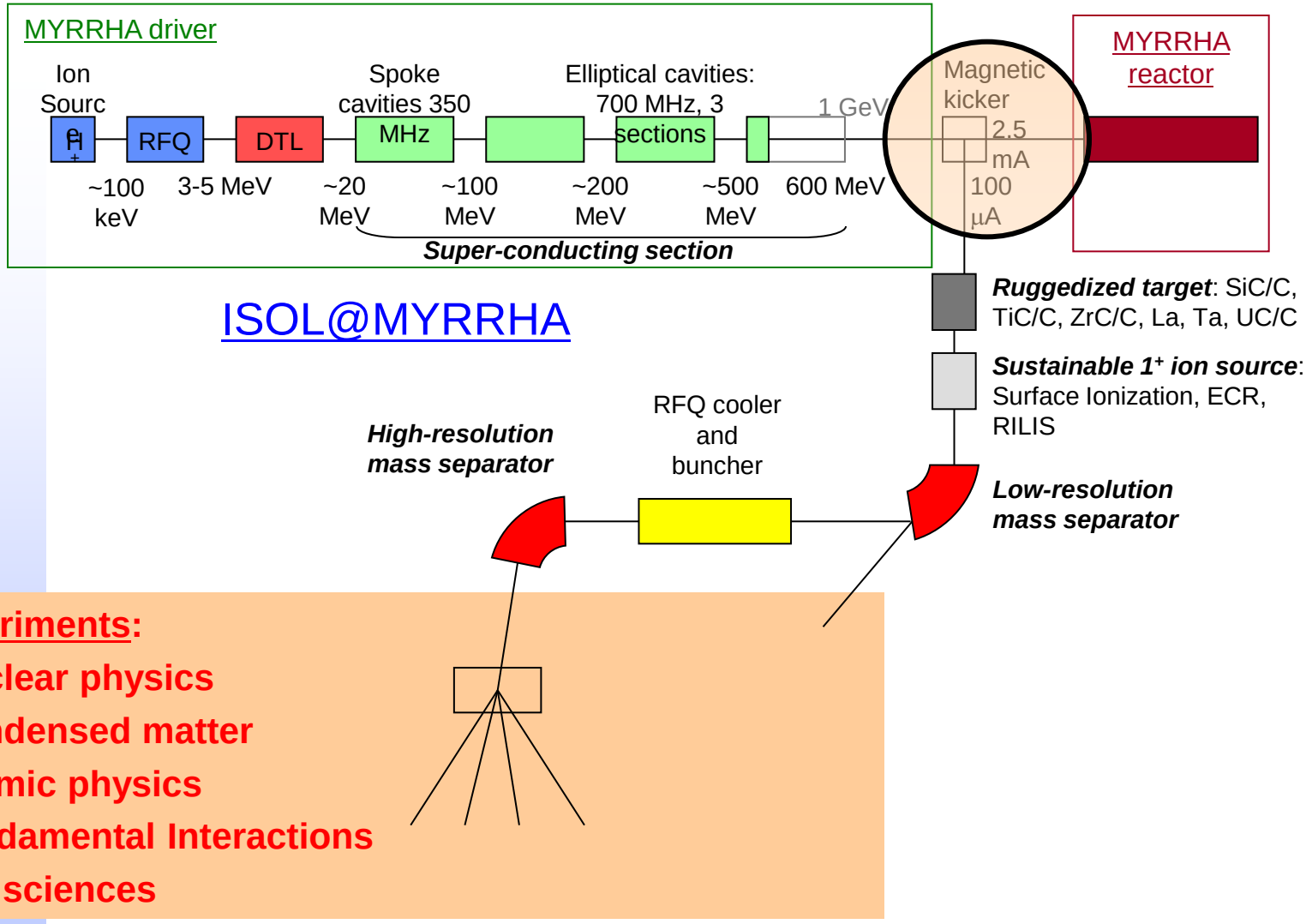
serving the needs of accelerator-based scientific communities



experiments:

- **nuclear physics**
- **condensed matter**
- **atomic physics**
- **fundamental Interactions**
- **life sciences**

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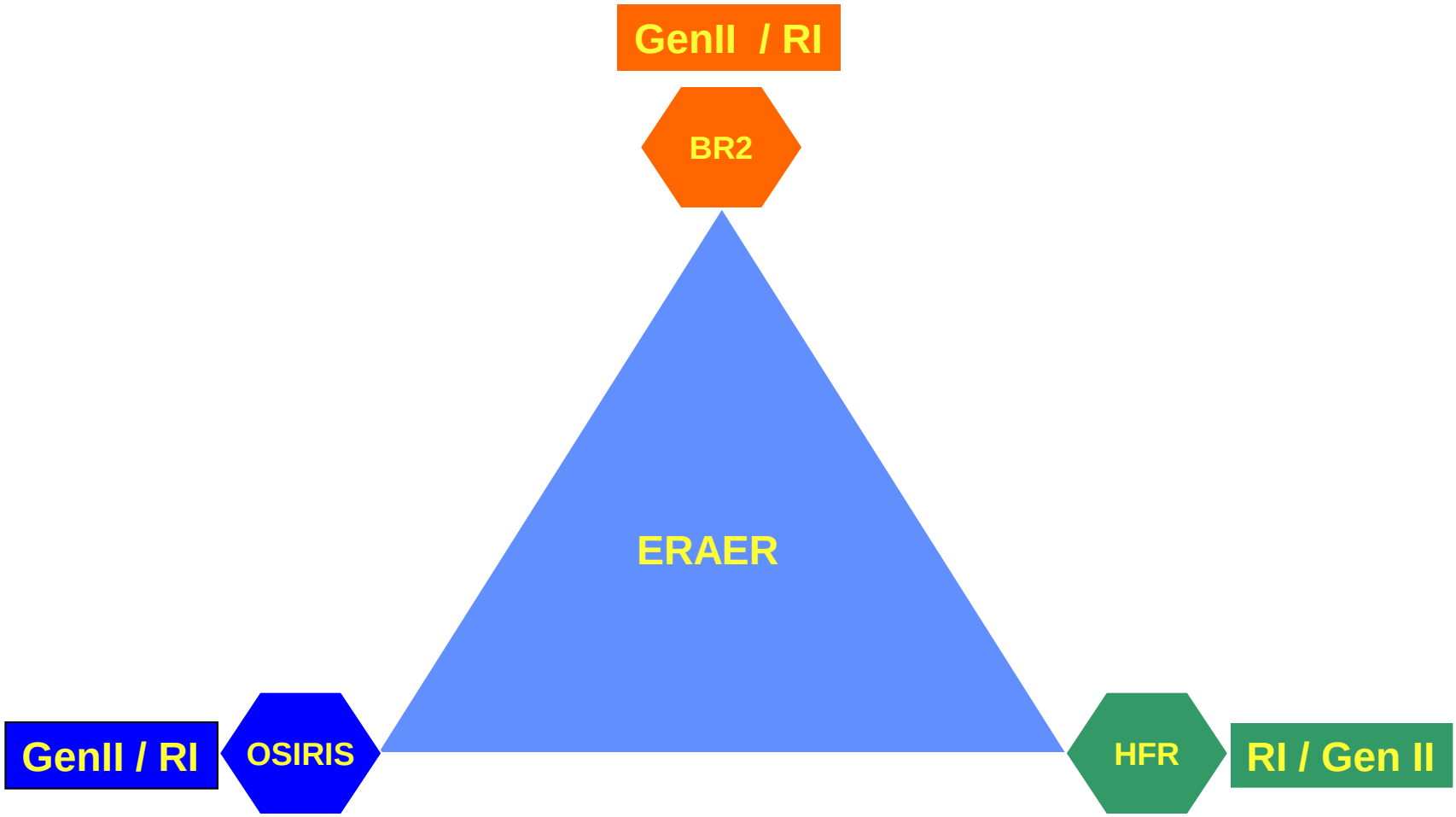
today in Europe



ERAER = European Research Area for Experimental Reactors

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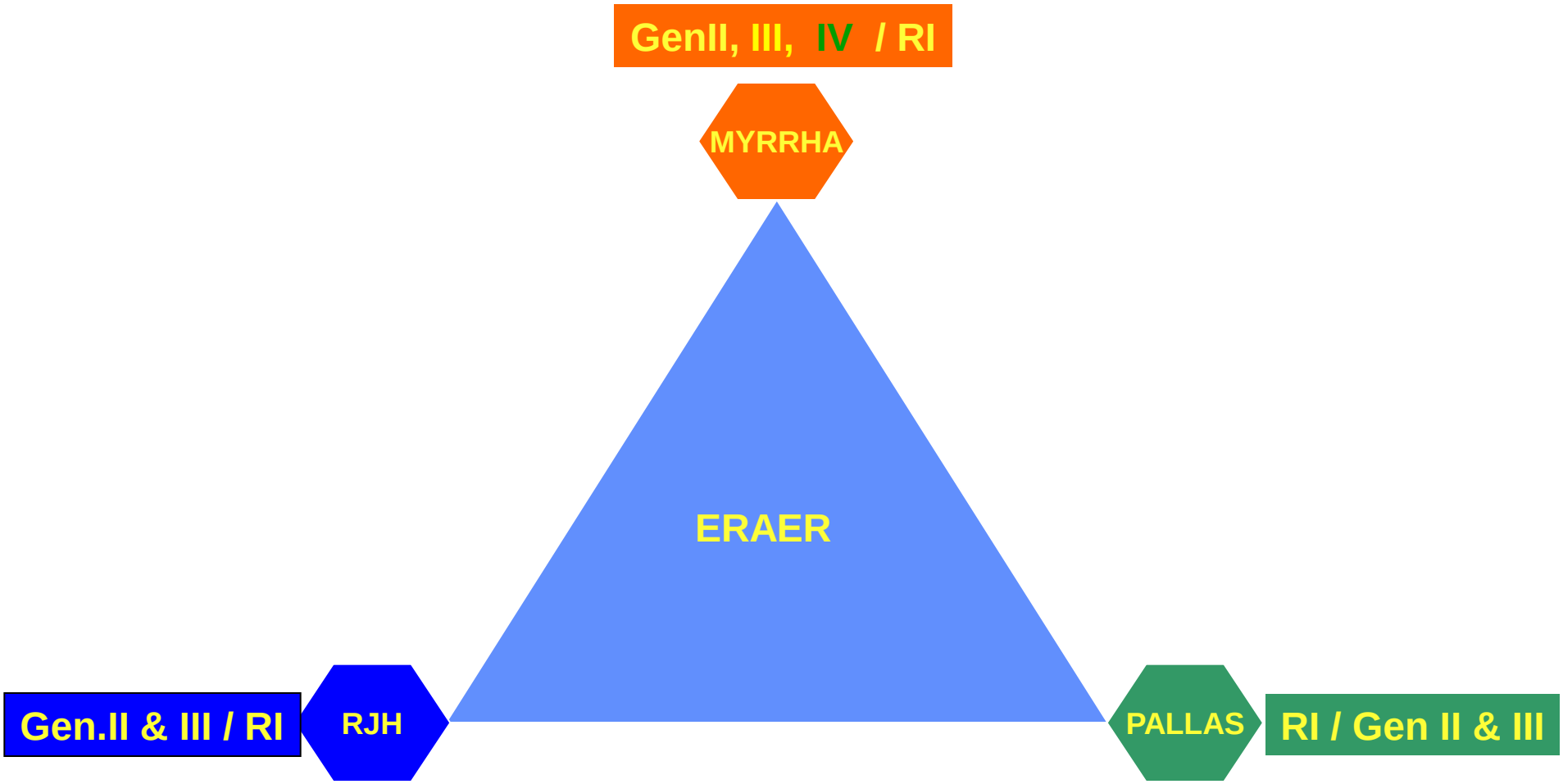
tomorrow in Europe



ERAER = European Research Area for Experimental Reactors

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taking a lead in a European context

Knowledge Economy

Energy Independence

MYRRHA

The only ESFRI project for Belgium

… and worldwide

MYRRHA to contribute to the SNETP goals for GENIV

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2008 2012 2020

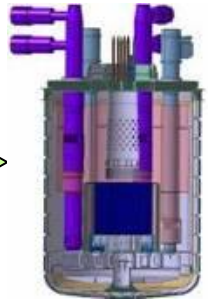
SFR

Reference proven technology

LFR

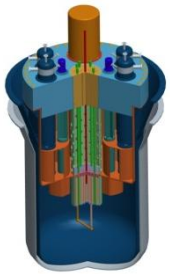
Alternative technology

GFR



ASTRID Prototype (SFR)

CP-ESFR



ETPP European Demonstration Reactor (LFR) (MYRRHA)

LEADER

ALLEGRO experimental reactor (GFR)

GoFastR

Supporting infrastructures, research facilities
loops, testing and qualification benches,
Irradiation facilities incl. fast spectrum facility (MYRRHA)
and **fuel manufacturing facilities**

ADRIANA

CDT

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the final sprint

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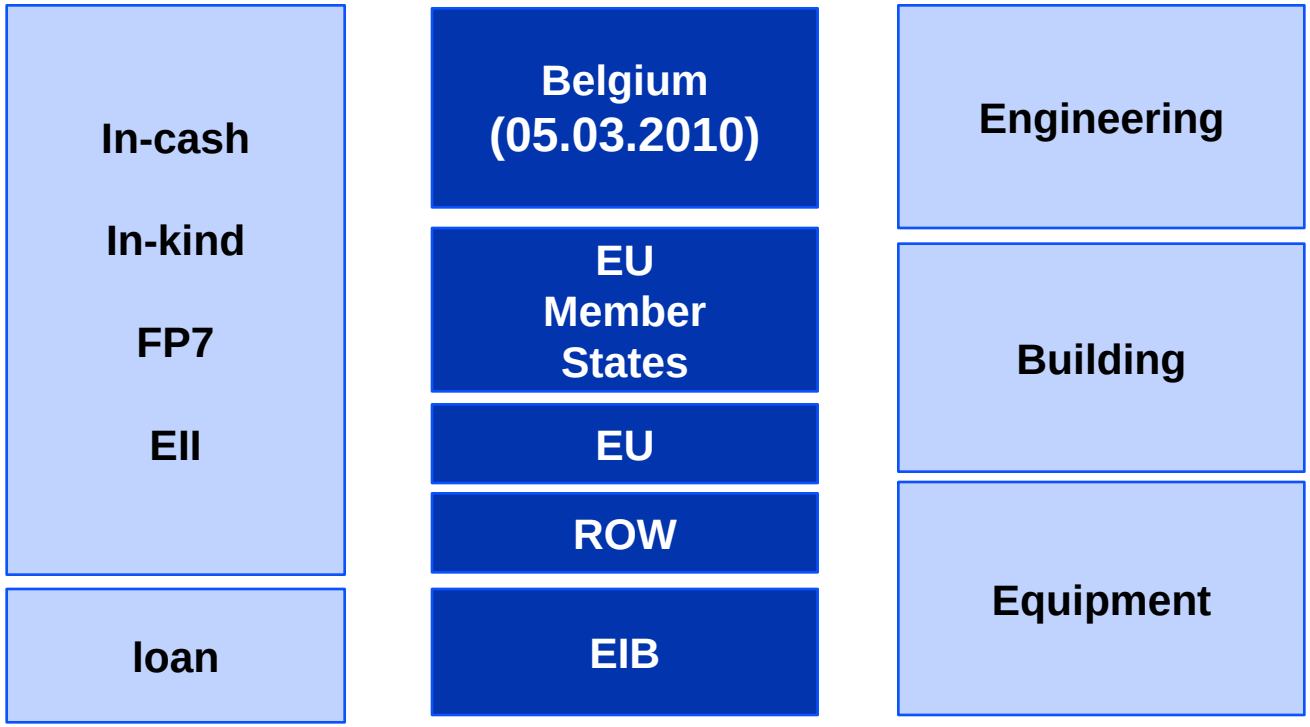
forging strong partnerships and alliances in Europe and worldwide



Owners' Consortium Group

- Co-sharing investment cost
- Co-sharing exploitation cost
- Privileged access conditions

Alliances

- Securing revenues from Users' Group

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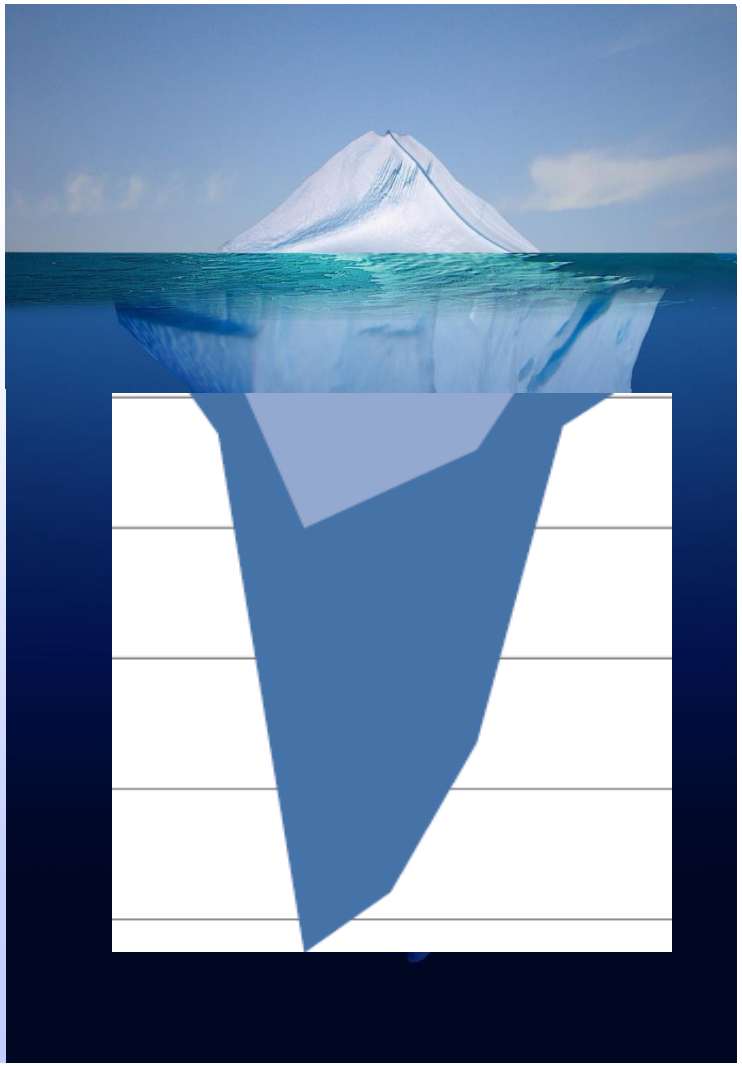
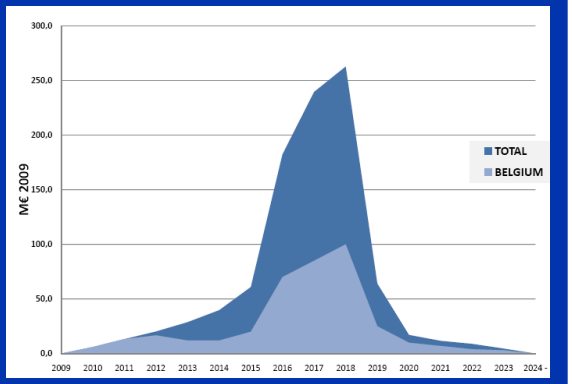
what is left to do?



today

action plan
2010 - 2014

2015 - 2023



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conclusion

- Clean commercial fusion reactors will need support from the development of the next generation of GENIV fission reactors;
- GENIV reactors aim at contributing to large extent to sustainable 'clean' nuclear energy in its applications and consequences;
- Belgium has an international innovative project MYRRHA that is well-embedded in Europe and worldwide;
- MYRRHA is able to contribute to reach the goals of sustainable 'clean' nuclear energy.

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MYRRHA hosted by SCK•CEN

The reality in 2023 !