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CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

SIXTH FRAMEWORK
PROGRAMME

From MYRRHA to XT-ADS: lessons learned and towards implementation

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On behalf of the EUROTRANS DM1 partners

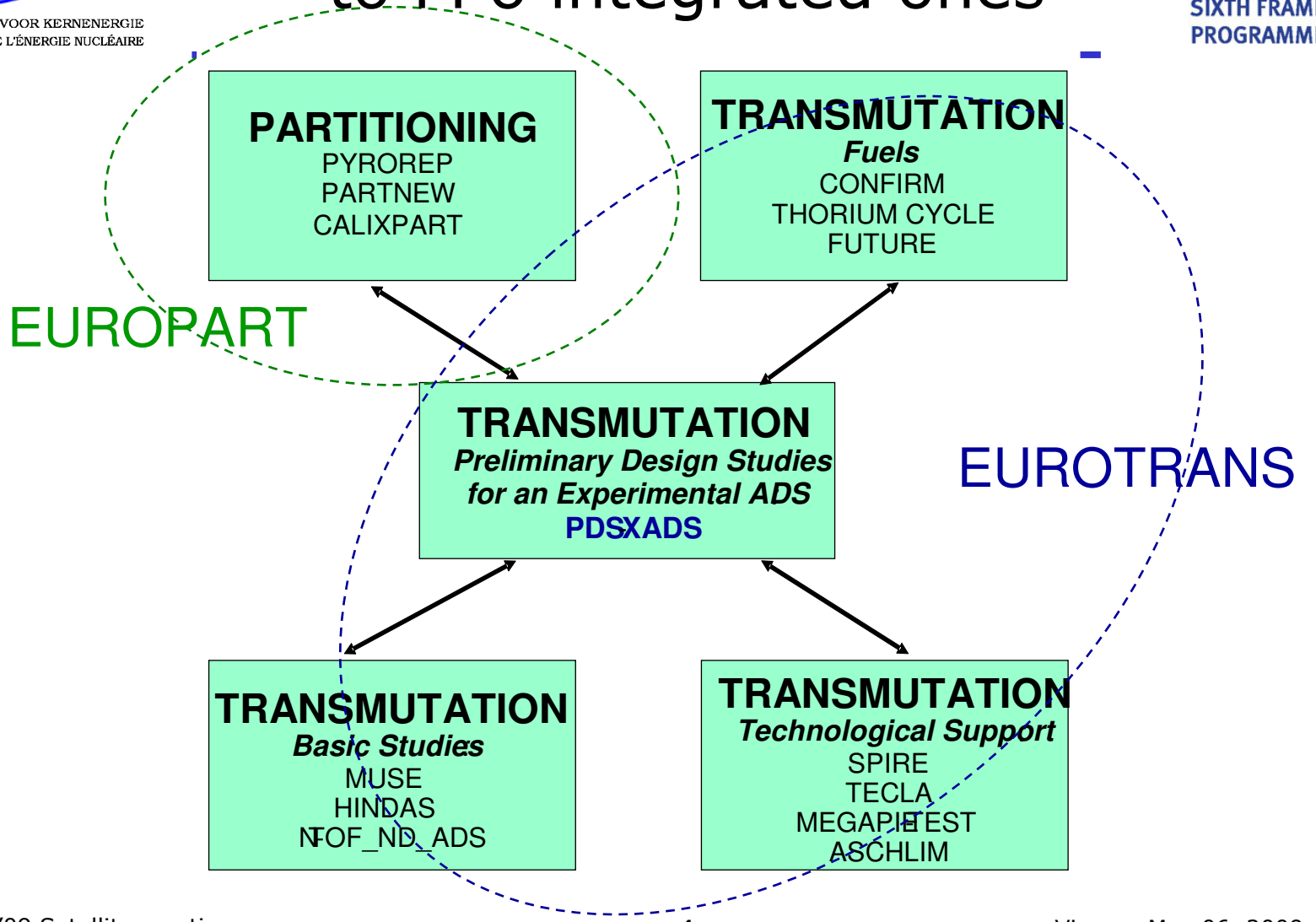
Summary

- More than 40 partners have started the FP6 IP_EUROTRANS project in April 2005;
- It was the continuation of several FP5 projects;
- For the design activities, SCK•CEN has proposed the existing MYRRHA design file as a starting basis;
- MYRRHA has evolved into XT-ADS;
- And is going to further evolve in the coming years.

What is MYRRHA going to be ?

- A flexible neutron irradiation testing facility as successor of the SCK•CEN MTR BR2 (100 MW)
- An attractive fast spectrum testing facility in Europe for Gen.IV and Fusion
- A full step ADS demo facility and P&T testing facility
- A technological prototype as test bench for LFR Gen.IV
- An attractive tool for education and training of young scientists and engineers
- A medical radioisotope production facility
- A fundamental research facility at the accelerator

From FP5 separate projects to FP6 integrated ones



The Design Concepts – FP5 PDS-XADS project

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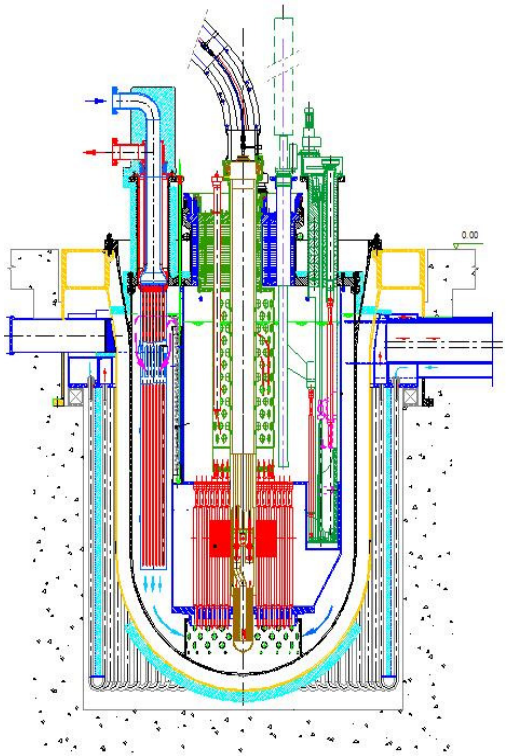
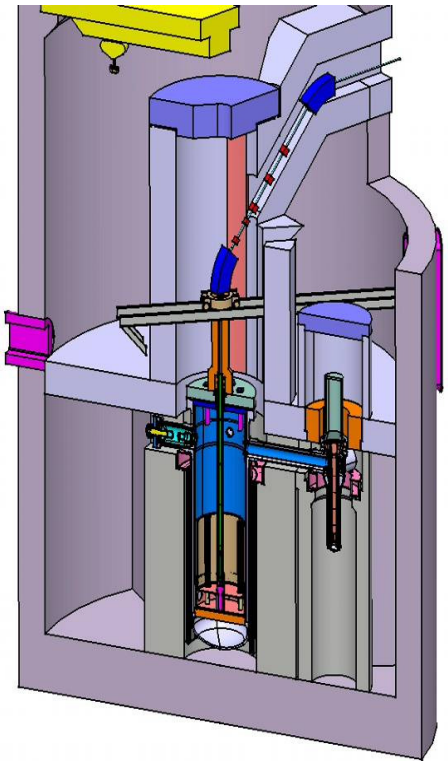
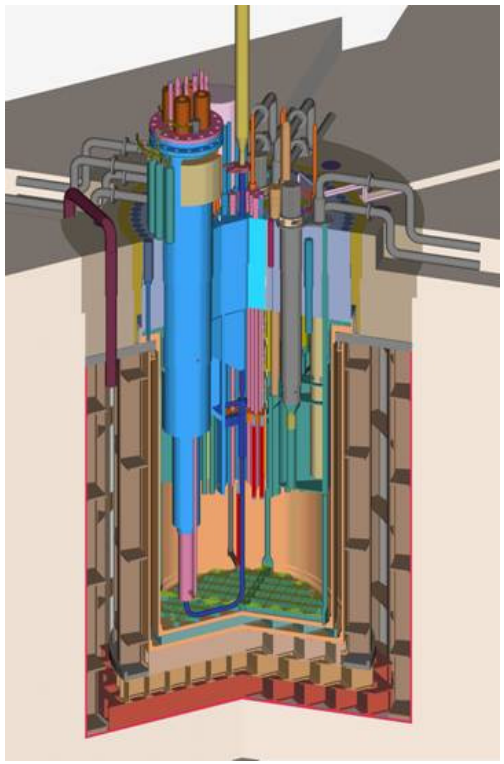
80MWth Pb-Bi cooled XADS	80MWth Gas-cooled XADS	50MWth Pb-Bi cooled MYRRHA
		
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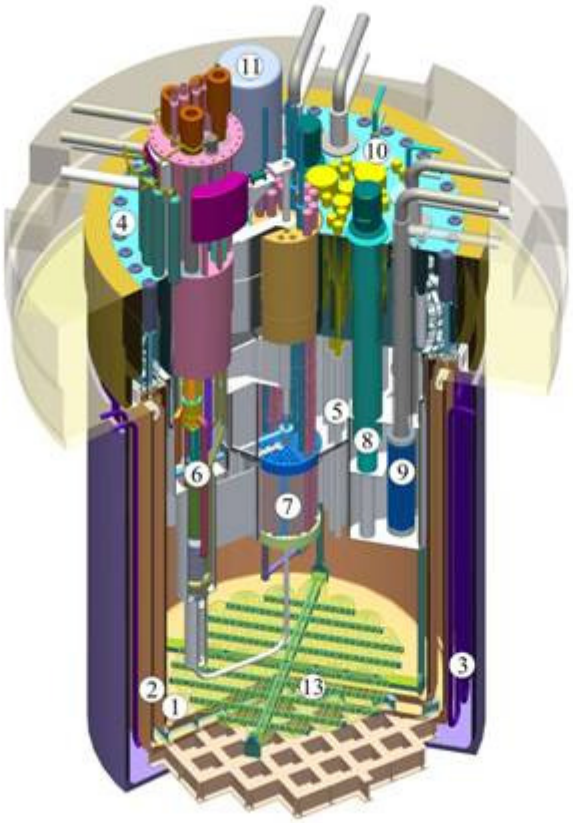
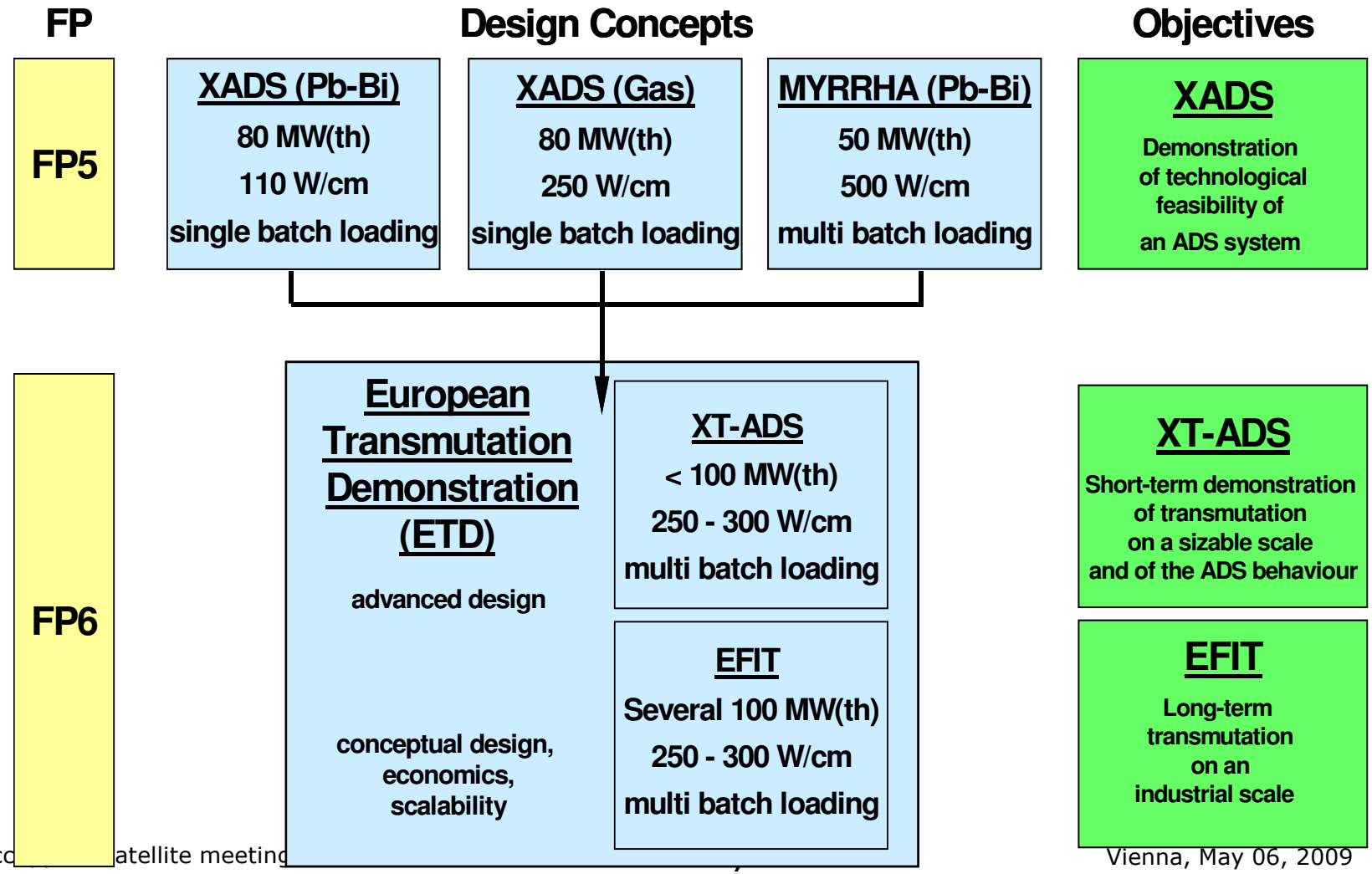
The MYRRHA 2005 overall configuration



1. inner vessel
2. guard vessel
3. cooling tubes
4. cover
5. diaphragm
6. spallation loop
7. sub-critical core
8. primary pumps
9. primary heat exchangers
10. emergency heat exchangers
11. in-vessel fuel transfer machine
12. in-vessel fuel storage
13. coolant conditioning system

From FP5 separate projects to FP6 integrated ones



The IP_EUROTRANS Objectives

- First, to define a long-term European Transmutation Demonstrator (ETD) of several hundred MWth called EFIT (for European Facility on Industrial scale Transmuter) able to transmute nuclear waste on a industrial scale; EFIT will be cooled either with Lead or with Helium.
- Then, to design a short-term eXperimental Transmuter based on ADS concept (ETD/XT-ADS) able to demonstrate both the feasibility of the ADS concept and to accumulate experience when using dedicated fuel sub-assemblies or dedicated pins within a MOX fuel core.
- Both plants will rely in a LINAC accelerator (although of different sizes) since it is the only type able to achieve the requested reliability.

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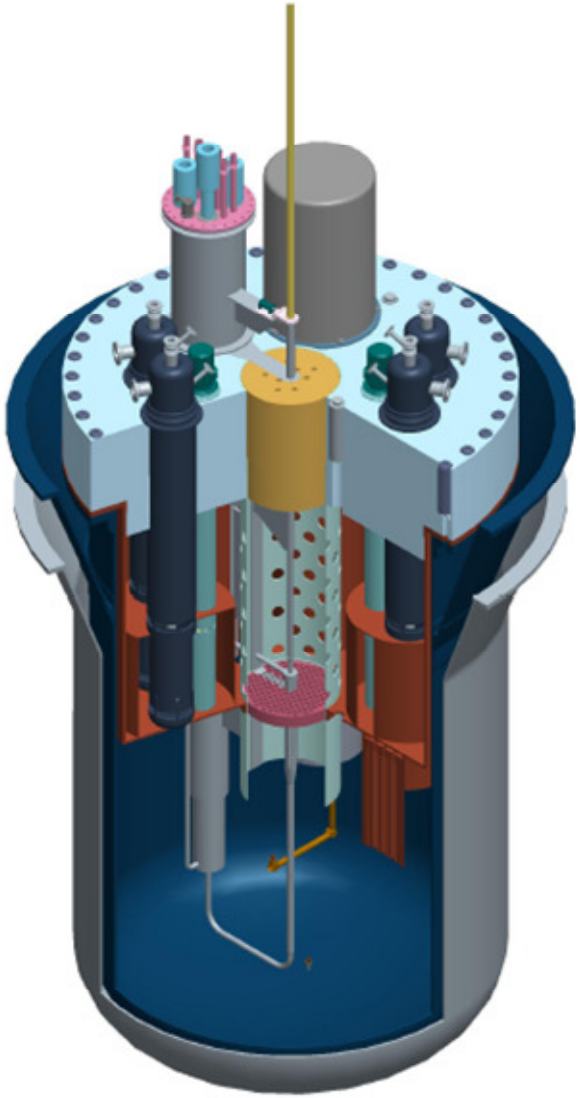
The XT-ADS machine

- MOX-fueled, Pb-Bi cooled
- MYRRHA Draft-2 served as input
- Accelerator
  - 600 MeV x 2.5 mA
- Spallation target
  - Windowless
- Subcritical
  - k_{eff} ≈0.95
- Power
  - 50-100 MWth



XT-ADS (2009) versus MYRRHA (2005) (1/3)

	XT-ADS	MYRRHA
Design level	Advanced design	Conceptual design
Coolant	Pb-Bi	Pb-Bi
Primary System	Integrated	Integrated
Core Power	57 MWth	~50 MWth
Core Inlet Temp	300℃	200℃
Core Outlet Temp	400℃	340℃
Target Unit interface	Windowless	Windowless
Target Unit geometry	Off-center	Off-center
Fuel	MOX (accept for a few MA Fuel Assemblies)	MOX (accept for a few MA Fuel samples)
Fuel Power density	700 W/cm^3	~1000 W/cm^3
Fuel pin spacer	Grid	Wire
Fuel Assembly type	Wrapper	Wrapper
Fuel Assembly cross section	Hexagonal	Hexagonal

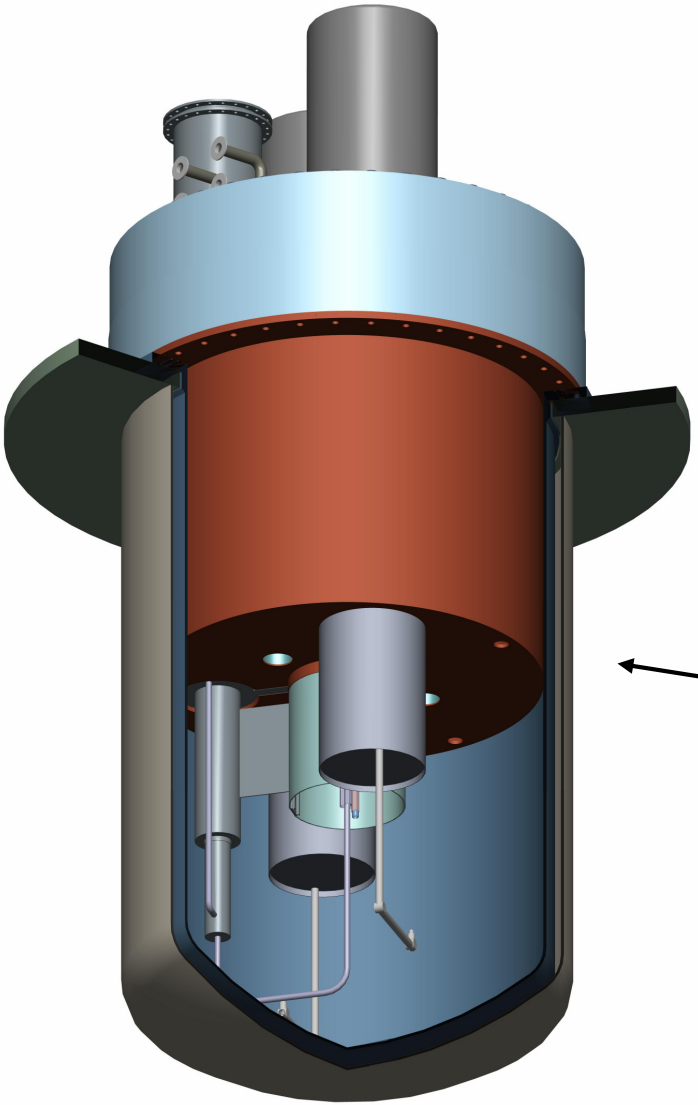
XT-ADS (2009) versus MYRRHA (2005) (2/3)

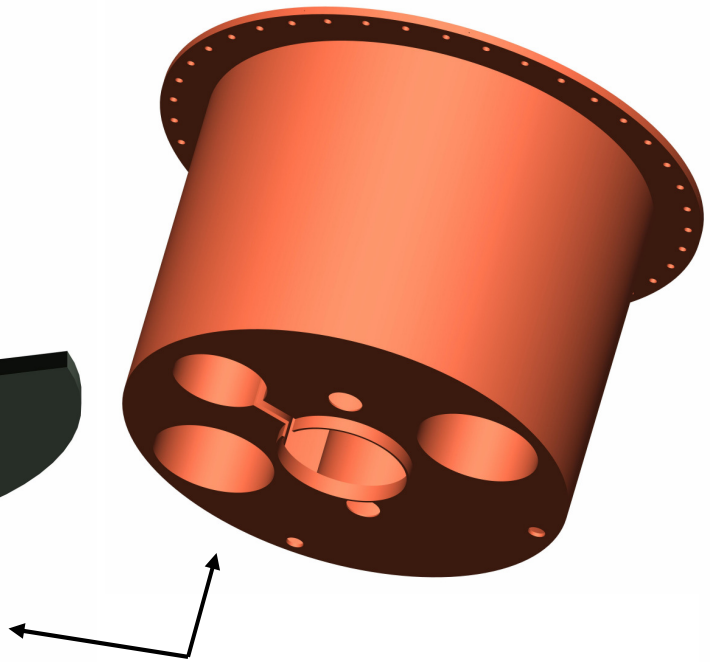
	XT-ADS	MYRRHA
Fuel loading	Bottom (top was studied)	Bottom
Fuel monitoring	T and FF (per FA)	T and FF (per FA)
External fuel handling	RH oriented	RH oriented
Primary coolant circulation in normal operation	Forced with mechanical pumps	Forced with mechanical pumps
Primary coolant circulation for DHR	Natural + Pony motor	Natural circulation
Secondary coolant	Low pressure boiling water	High pressure water / Low pressure boiling water
Reactor building	Below grade	Below grade
Seismic design	was studied; is ok	TBD (site specific)
Structural Material	T91 and A316L	T91 and A316L
Accelerator	LINAC (600 MeV*2.5 mA or 350 MeV*5 mA)	LINAC (350 MeV*5 mA)
Beam Ingress	Top	Top

XT-ADS (2009) versus MYRRHA (2005) (3/3)

	XT-ADS	MYRRHA
MOX Fuel type	from reprocessing	reactor grade
Fuel pin hole	yes (Φ=1.6 mm)	no
Pu content	~35%	20 & 30%
Fuel Assembly centre – to centre	96.2 mm	87.0 mm
FA in core	75	45
number of possible IPS	8	17
Vessel type	hanging	standing
Vessel bottom	elliptical	flat
Number of groups HX + PP	2	4
ultimate decay heat removal	vault cooling system	emergency cooling loops

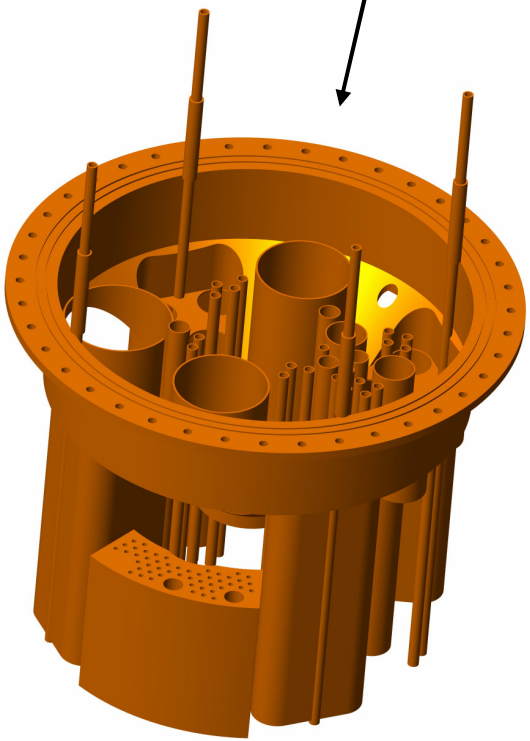
XT-ADS new configuration: the simplified diaphragm





XT-ADS

MYRRHA



XT-ADS Reactor Assembly

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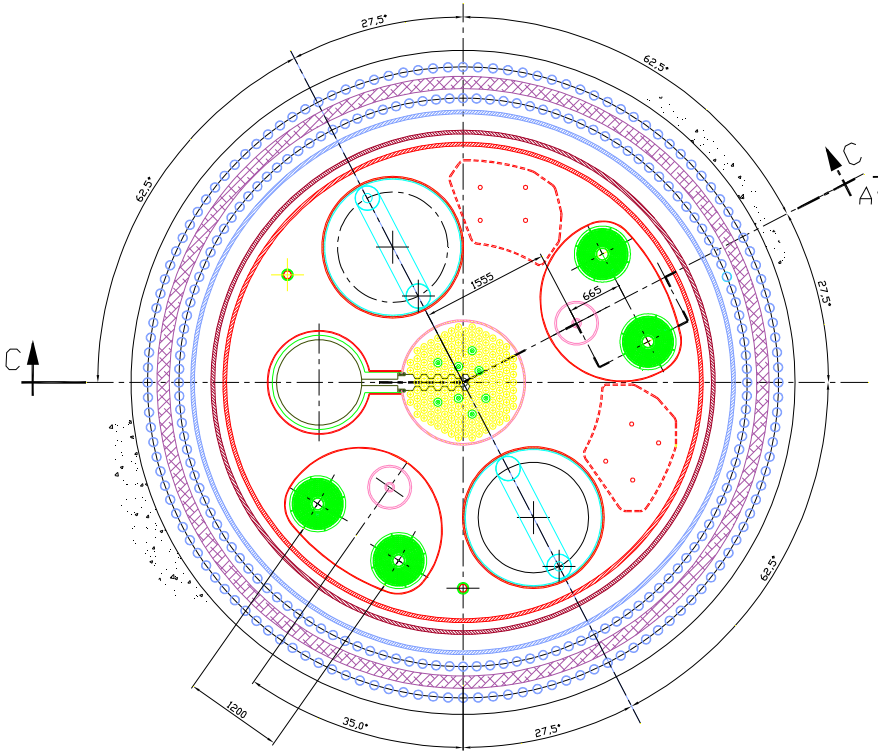
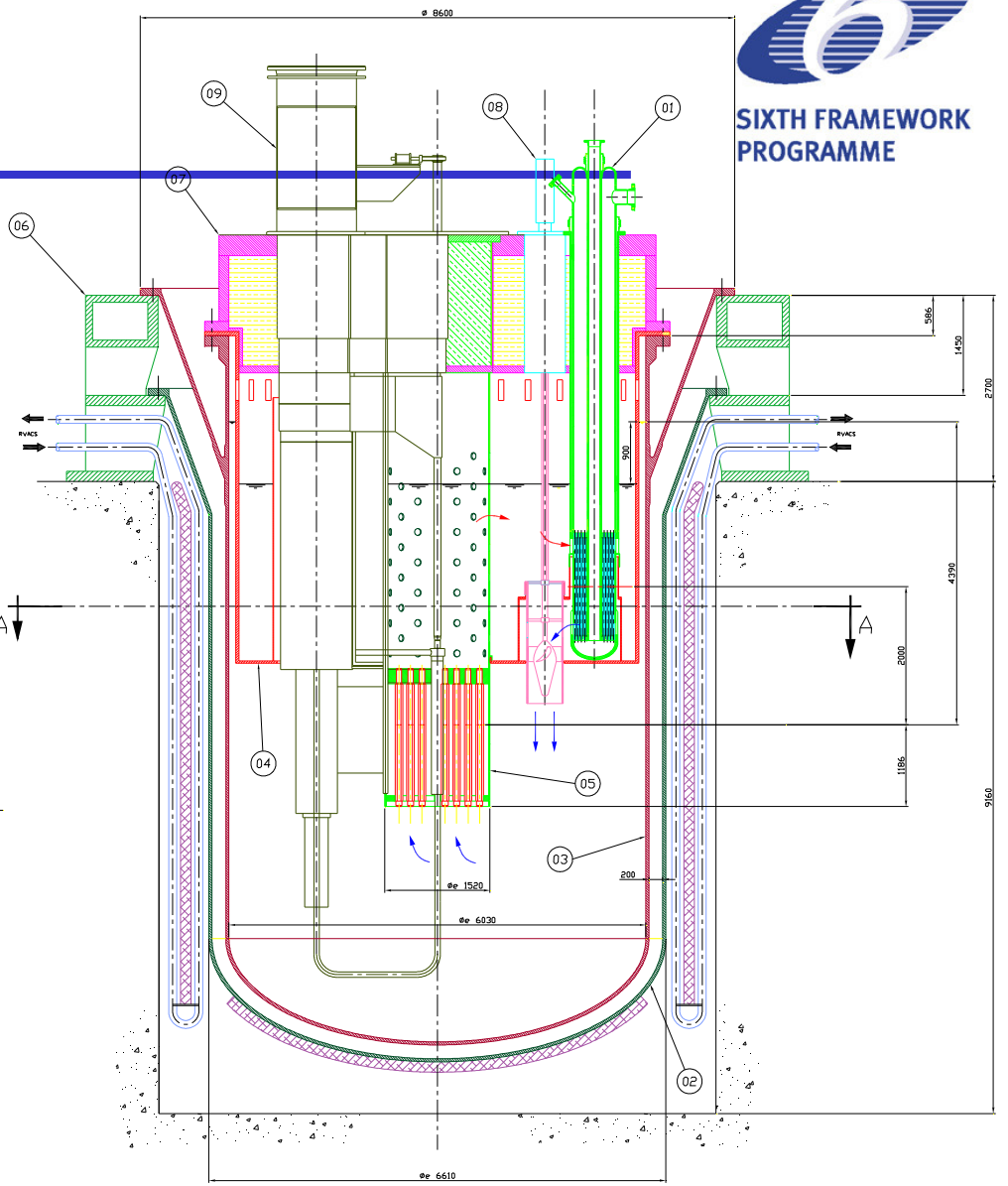
1. PHX (2X2)
2. Safety Vessel
3. Reactor Vessel
4. Inner Vessel
5. Core Barrel
6. Support
7. Reactor Cover
8. Primary Pumps (2X1)
9. Spallation loop





Conclusions and perspectives (1/2)

- For XT-ADS we have been using the MYRRHA Draft-2 file (version 2005) as a starting sheet;
- The EUROTRANS partners have issued now (2009) a revised sheet;
- The most important revision concern the size of the plant with
  - Power to be evacuated by the HEX: 75 MWth
  - Accelerator: 600 MeV x 2.5 mA
- And a simplification of the internals (HEX, diaphragm)
- While other assumptions have been confirmed, among others:
  - Spallation target: Windowless one
  - Subcritical core: k_{eff} ≈0.95
  - MOX-fueled, Pb-Bi cooled
  - Fuel loading from the bottom

Conclusions and perspectives (2/2)

These characteristics give to the plant :

- More flexibility to the irradiation performance of the plant
- An improved Safety
  - reduced damage to core barrel and cover plate;
  - better transient behaviour

The plant will require further analysis within IP_EUROTRANS

- to finalize documentation (design, safety, cost evaluation)
- ⇨ trying to get financial support to build it is the final aim

While remaining topics will be studied in the next programmes

- see last presentation of this satellite