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Engineering Design of the MYRRHA

Part VI Further Notes

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MYRRHA

From MYRRHA to XT-ADS, the design evolution of an experimental ADS system

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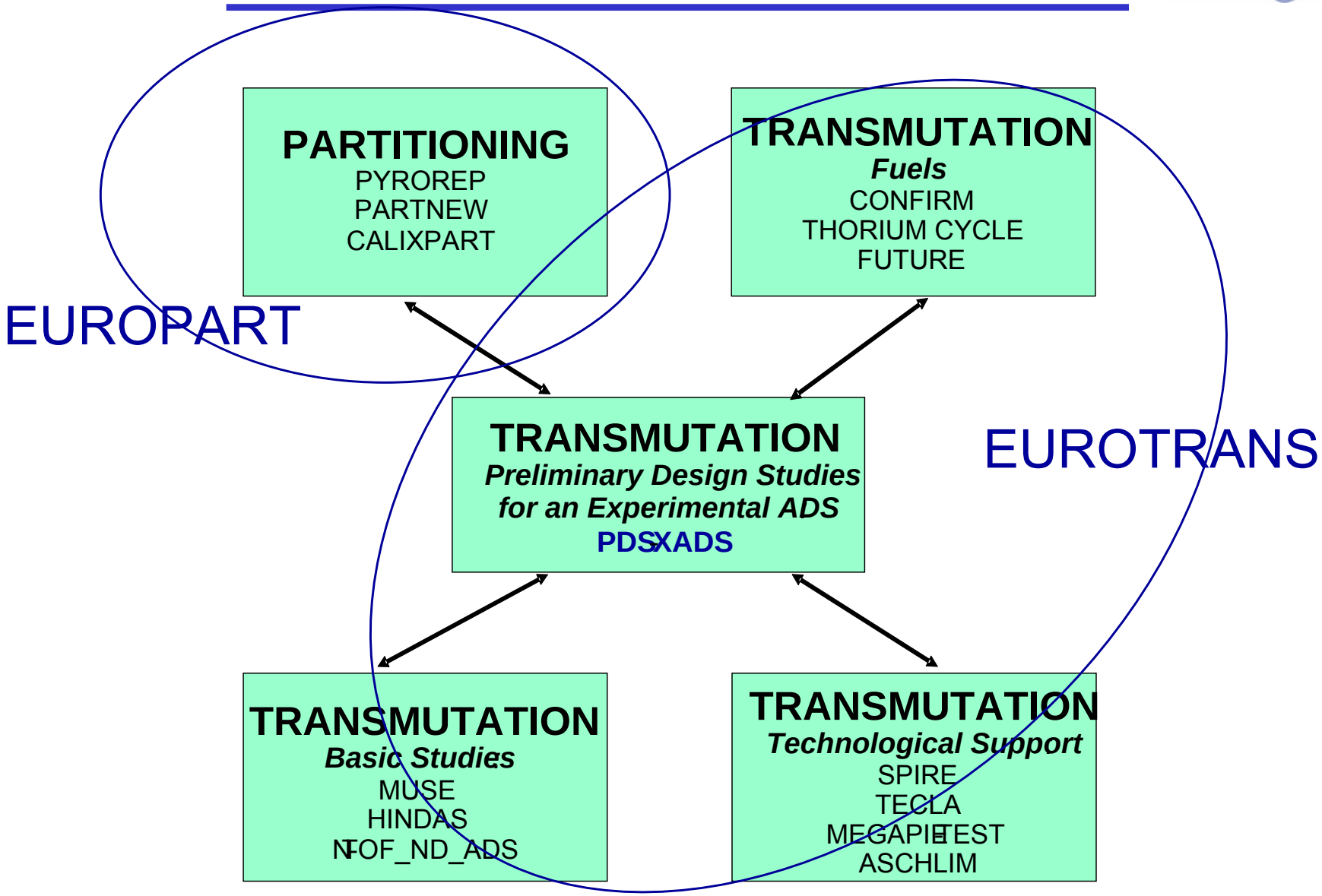
Contents

- The XT-ADS design within the European Commission FP5 & FP6 projects
- The MYRRHA 2005 design file, also called “Draft-2”
- From MYRRHA to XT-ADS and the most recent XT-ADS layout
- A Roadmap for the deployment of XT-ADS in the nearby future
- Conclusions

Introduction (1/4)
XT-ADS in the FP5 & FP6 programmes

- XT-ADS is one of the two designs under study within the EUROTRANS project (European Commission FP6), the other one, EFIT, being presented elsewhere in this conference (sessions 7.2 – Artioli & al – & 10.3 – Mansani & al).
- Other papers related to EUROTRANS are also part of the conference, among others sessions 7.2 & 10.5, (not only mechanical design, but also fuel design, material properties, nuclear data & ADS coupling experiments).
- XT-ADS is the logical continuation of the FP5 PDS-XADS project where three mid-scale systems (50 to 80 MW_{th}) have been studied. One of those three systems, MYRRHA, has been accepted as starting basis for the XT-ADS.

Introduction (2/4)
From separate projects (FP5) to integrated ones (FP6)



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Introduction (3/4)

MYRRHA/XT-ADS is to be:

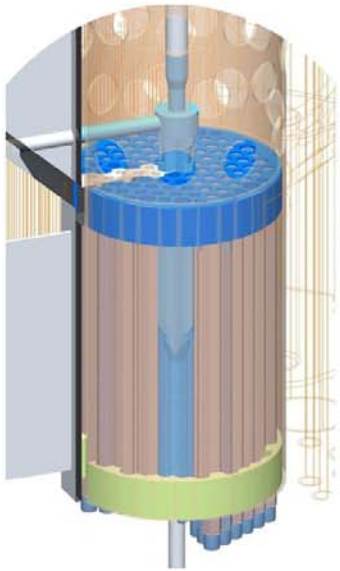
MYRRHA

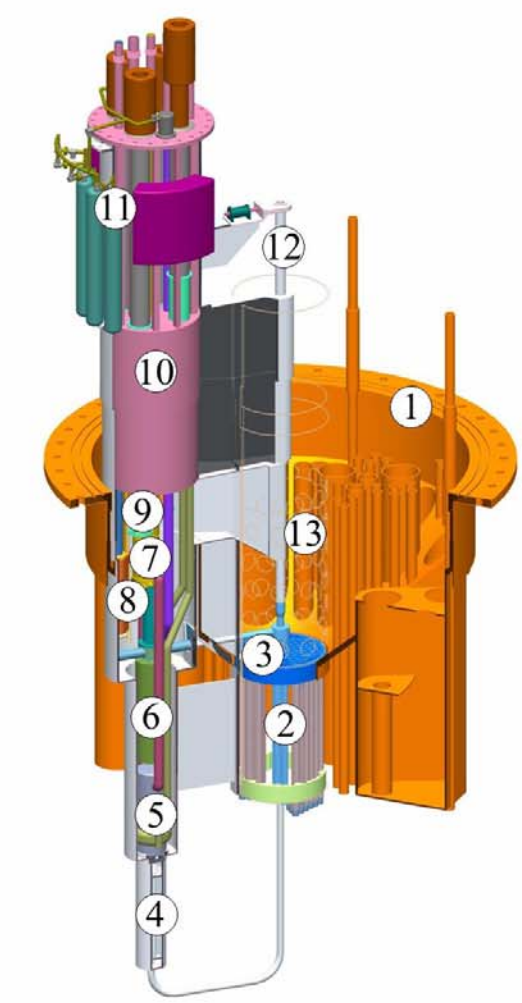
- A full step ADS demonstration facility;
- A P&T testing facility;
- A flexible irradiation testing facility in replacement of the SCK•CEN Material Testing Reactor BR2 (100 MW_{th});
- An attractive fast spectrum testing facility in Europe, beyond 2020, complementary to the RJH facility (F);
- A HLM technological prototype as test bench for LFR;
- An attractive tool for education and training of young scientists and engineers;
- A medical radioisotope production facility.

Introduction (4/4)
From MYRRHA to XT-ADS

- The MYRRHA 2005 or “Draft - 2” design file (~2000 pg) has been made available to the EUROTRANS Community;
- The two next slides illustrate the original “Draft - 2” configuration;
- The modifications needed to optimize & simplify the design have been studied by the EUROTRANS partners in close collaboration; Mol is a candidate site for hosting the XT-ADS;
- SCK•CEN is considering Joint Undertaking for setting up the frame for the realization at European level;
- SCK•CEN has produced very recently (April 2007) a detailed “business plan” (both technical & financial) to discuss with the Belgian authorities.

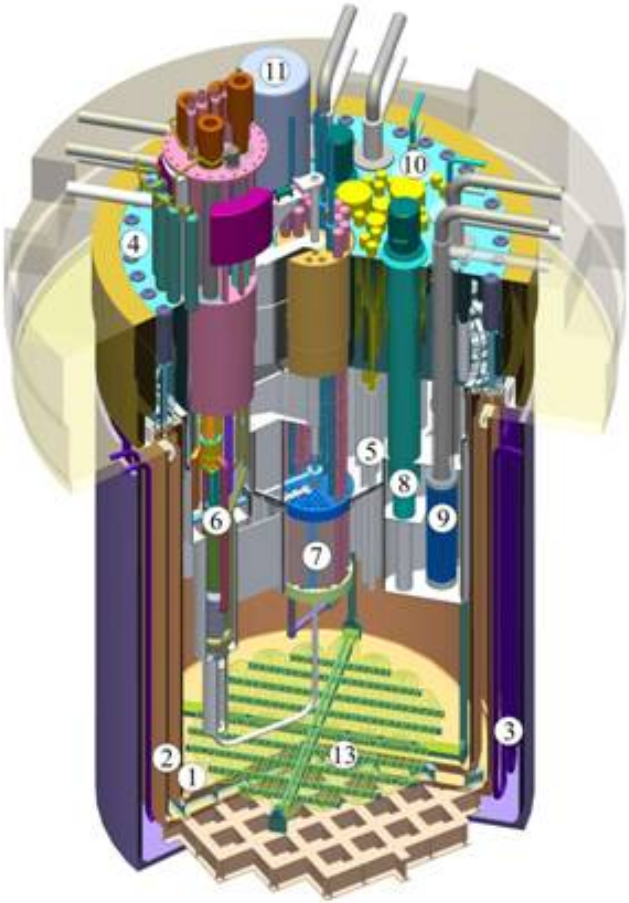
MYRRHA 2005 design (1/2)
Spallation loop





1. diaphragm
2. spallation target
3. core support plate slot
4. heat exchanger
5. turbine & pump
6. electromagnetic pump
7. hydraulic drive
8. Pb-Bi conditioning system
9. vacuum system with cryopumps
10. shielding bloc
11. regeneration circuit with absorber pumps
12. proton beam line
13. core barrel

MYRRHA 2005 design (2/2)
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

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XT-ADS versus MYRRHA (1/3)

	XT-ADS	MYRRHA
Design level	Advanced design	Conceptual design
Coolant	Pb-Bi	Pb-Bi
Primary System	Integrated	Integrated
Power	~70 MWth	~50 MWth
Core Inlet Temp	300°C	200°C
Core Outlet Temp	400°C	340°C
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/cm³	~1000 W/cm³
Fuel pin spacer	Grid	Wire
Fuel Assembly type	Wrapper	Wrapper
Fuel Assembly cross section	Hexagonal	Hexagonal

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XT-ADS versus MYRRHA (2/3)

MYRRHA

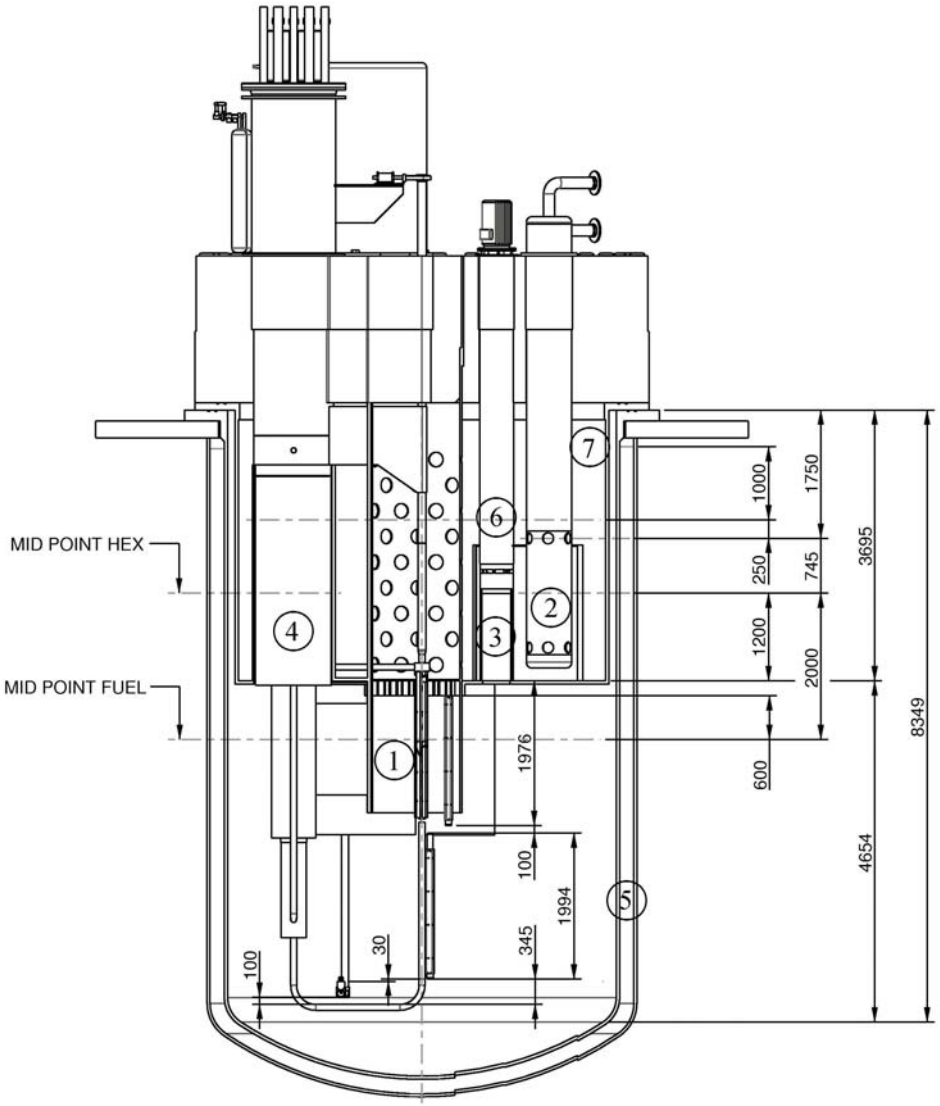
	XT-ADS	MYRRHA
Fuel loading	Bottom (top was studied)	Bottom
Fuel monitoring	T and FF (per FA)	T and FF (per FA)
External fuel handling	RH oriented	RH oriented
Primary coolant circulation in normal operation	Forced with mechanical pumps	Forced with mechanical pumps
Primary coolant circulation for DHR	Natural + 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

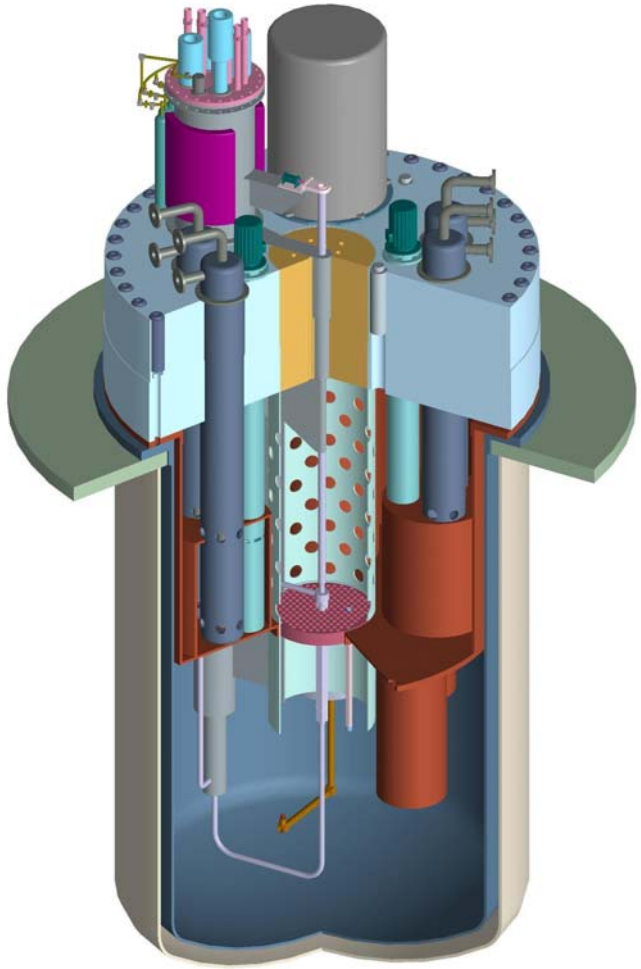
XT-ADS versus MYRRHA (3/3)

	XT-ADS	MYRRHA
MOX Fuel type	from reprocessing	reactor grade
Fuel pin hole	yes (Φ=1.6 mm)	no
Pu content	>31%	20 & 30%
Fuel Assembly centre – to centre	96.2 mm	87.0 mm
FA in core	72	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 (1/3)
Vertical section

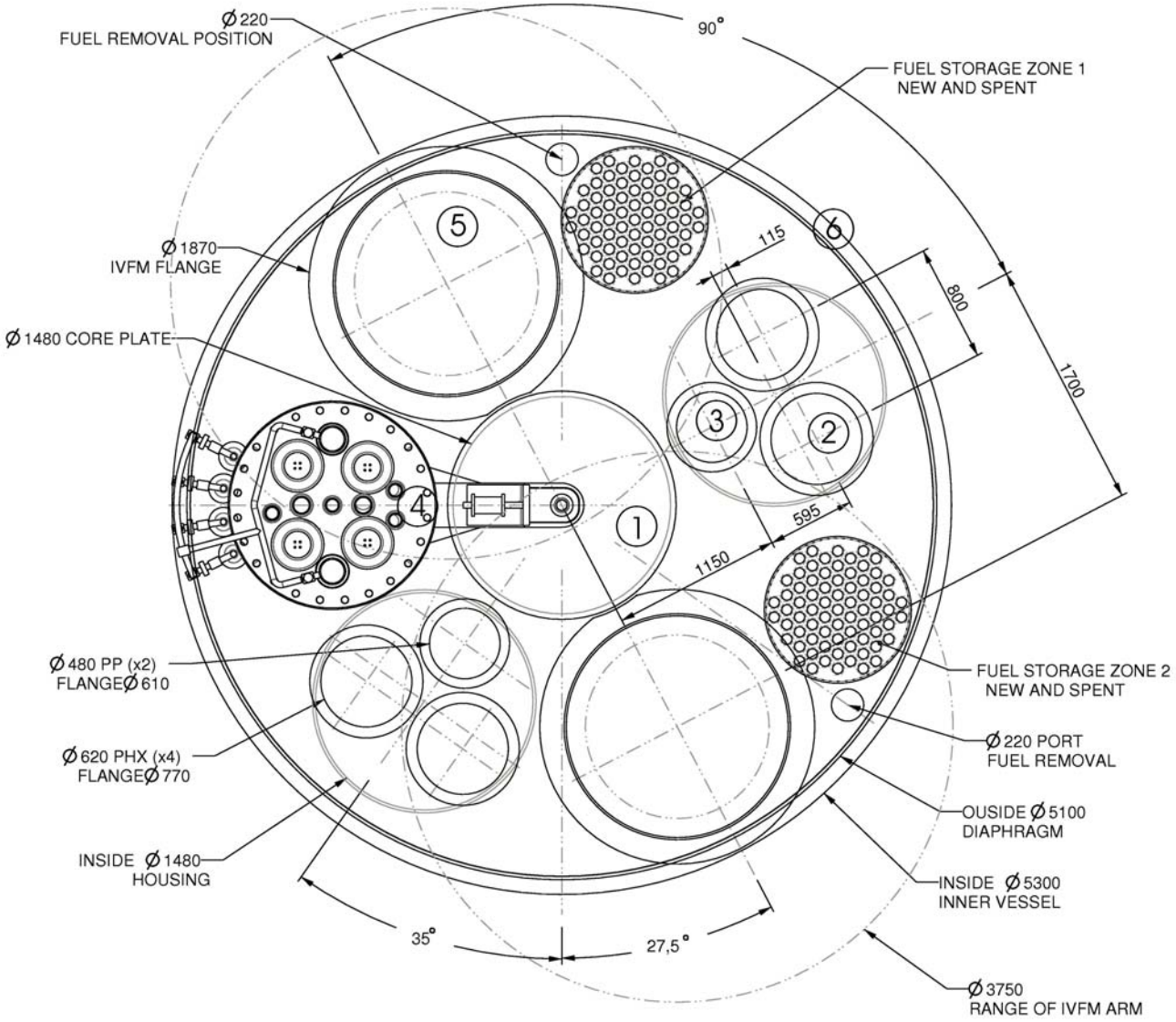
1. Core
2. Heat exchangers (2 x 2)
3. Pumps (2 x 1)
4. Spallation loop
5. Vessels
6. LBE hot level
7. LBE cold level





XT-ADS new configuration (2/3)
Horizontal section

1. Core
2. Heat exchangers (2 x 2)
3. Pumps (2 x 1)
4. Spallation loop
5. Fuel manipulators (2 units)
6. Vessel



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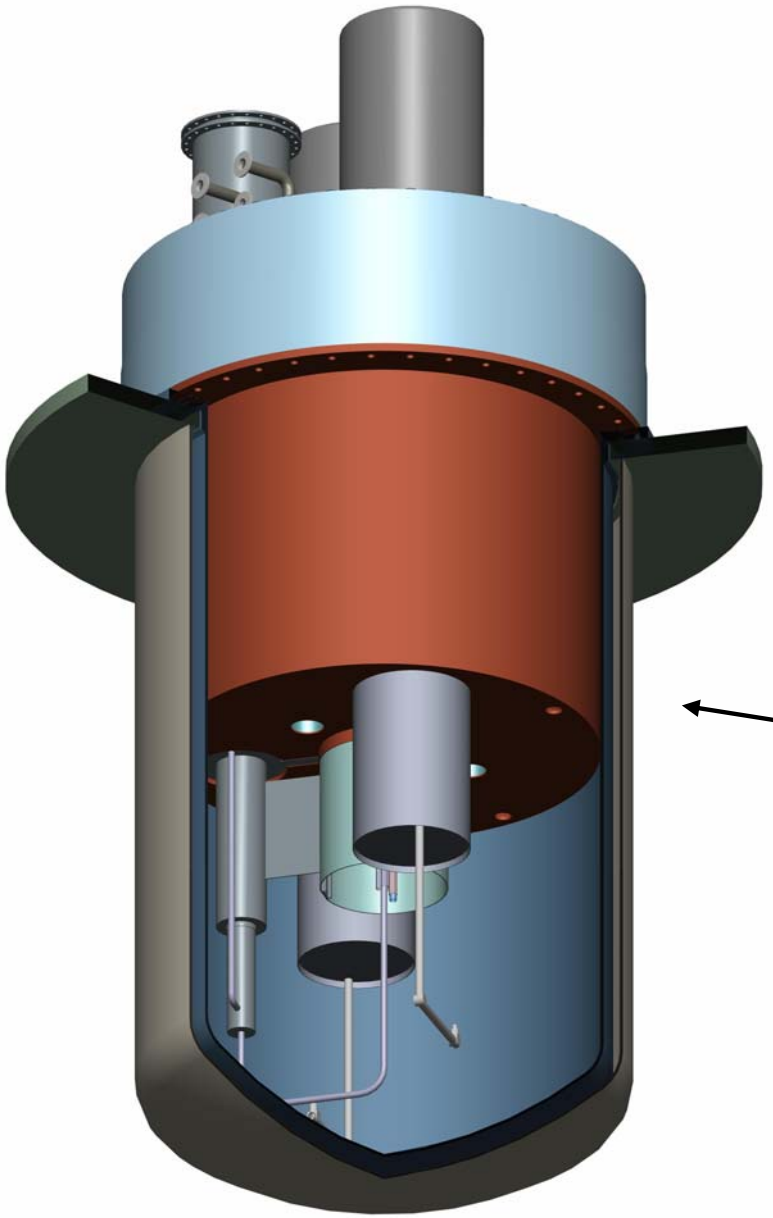
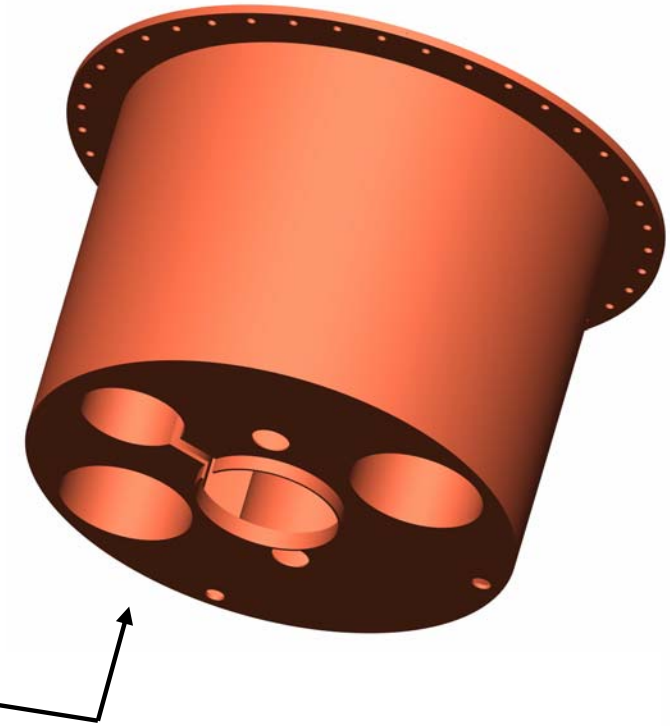
XT-ADS new configuration (3/3)

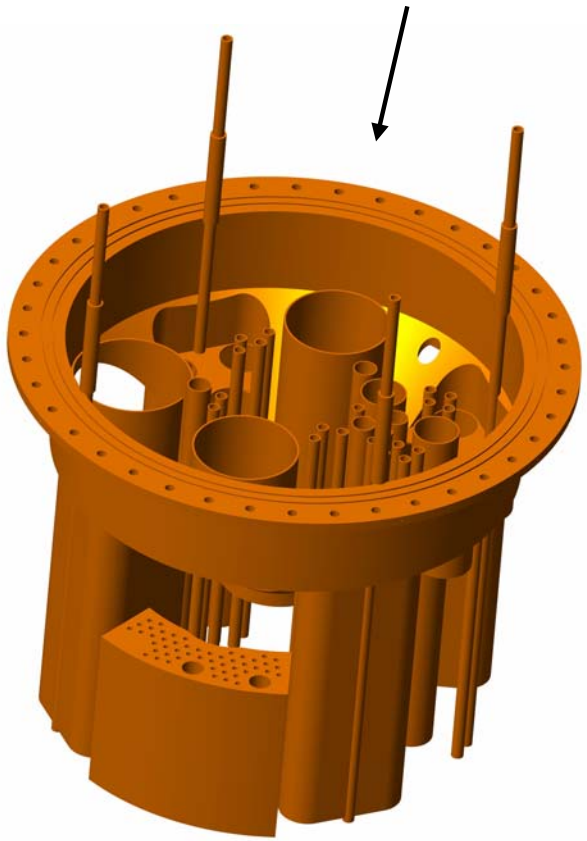
The diaphragm has been simplified

MYRRHA





XT-ADS



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Roadmap for XT-ADS (1/2)

MYRRHA

- 2005-2008 FP6 : EUROTRANS Period
  - Advanced Pre-design File of XT-ADS;
  - Potential show stoppers in Basic Technological research (material, HLM technology, instrumentation) should be answered;
  - Key Accelerator components will be demonstrated;
  - Spallation module hydraulic design will be accomplished;
  - Realise a coupling of the ADS components at realistic power.
- 2009-2013 FP7 : many activities in parallel
  - Detailed Engineering Design (2009-2011);
  - Call for tenders, selection & awarding contracts (2012-2013);
  - Development of key components (2009-2013);
  - Licensing activities (Preliminary Safety Assessment Report; Environment Impact Assessment, Preliminary Decommissioning Programme) with authorities (2008-2013).

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Roadmap for XT-ADS (2/2)

MYRRHA

- 2014-2016 Construction on site of the different components
- 2017 Assembling of components
- 2018-2019 Commissioning at increasing power level
- 2020 Running at full power

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Conclusions

MYRRHA

- SCK•CEN has started the MYRRHA project as a national programme with several national & international bilateral collaboration agreements;
- The project (as XT-ADS) has now evolved as an European integrated project in the frame of IP_EUROTRANS;
- Beyond 2008 (at the end of IP_EUROTRANS) perspectives are under consideration with the Belgian authorities, several EU partners and the EC, for structuring the implementation and deployment of the XT-ADS.

Acknowledgements

We are grateful to several colleagues within our companies (SCK•CEN, Ansaldo, AREVA) and the other EUROTRANS partners for making those advances in the XT-ADS design

and, of course, we are grateful to the European Commission for its financial support through the PDS-XADS FP5 & EUROTRANS FP6 project.