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Euratom Research in Fission & Fusion
– what does the future hold?

Simon WEBSTER
HoU Fusion Association Agreements
Acting HoU 'Fission'
DG Research & Innovation
European Commission

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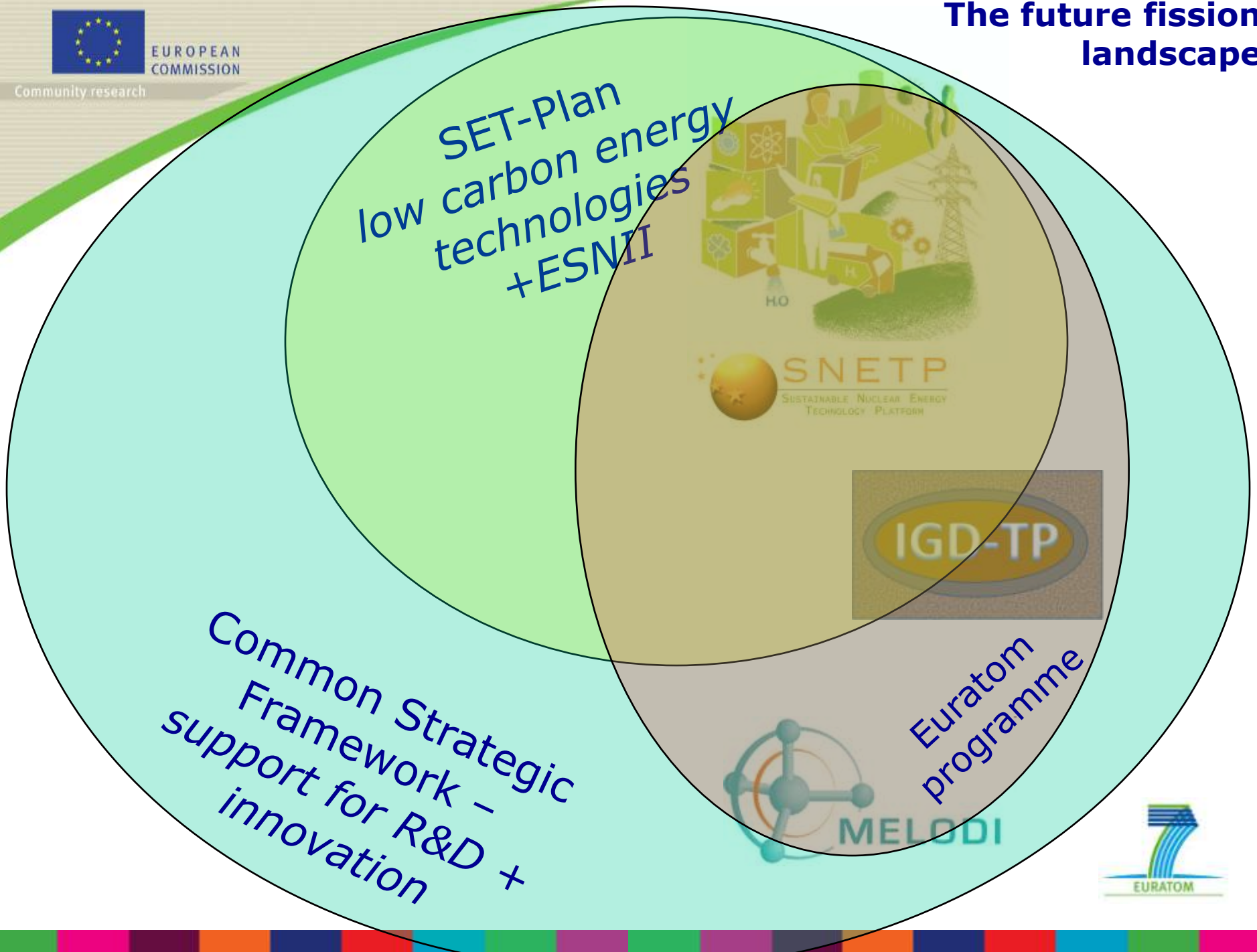
The future fission landscape



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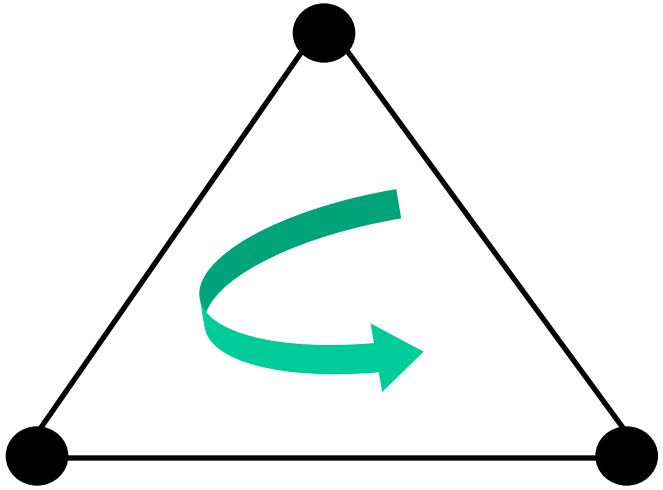
European Nuclear Energy Forum
Bratislava - Prague

2009: EU Directive on nuclear safety
2011: EU Directive on management of radwaste



SNETP
Sustainable Nuclear Energy Technology Platform

ENSREG
European Nuclear Safety Regulators Group

IGD-TP

MELODI

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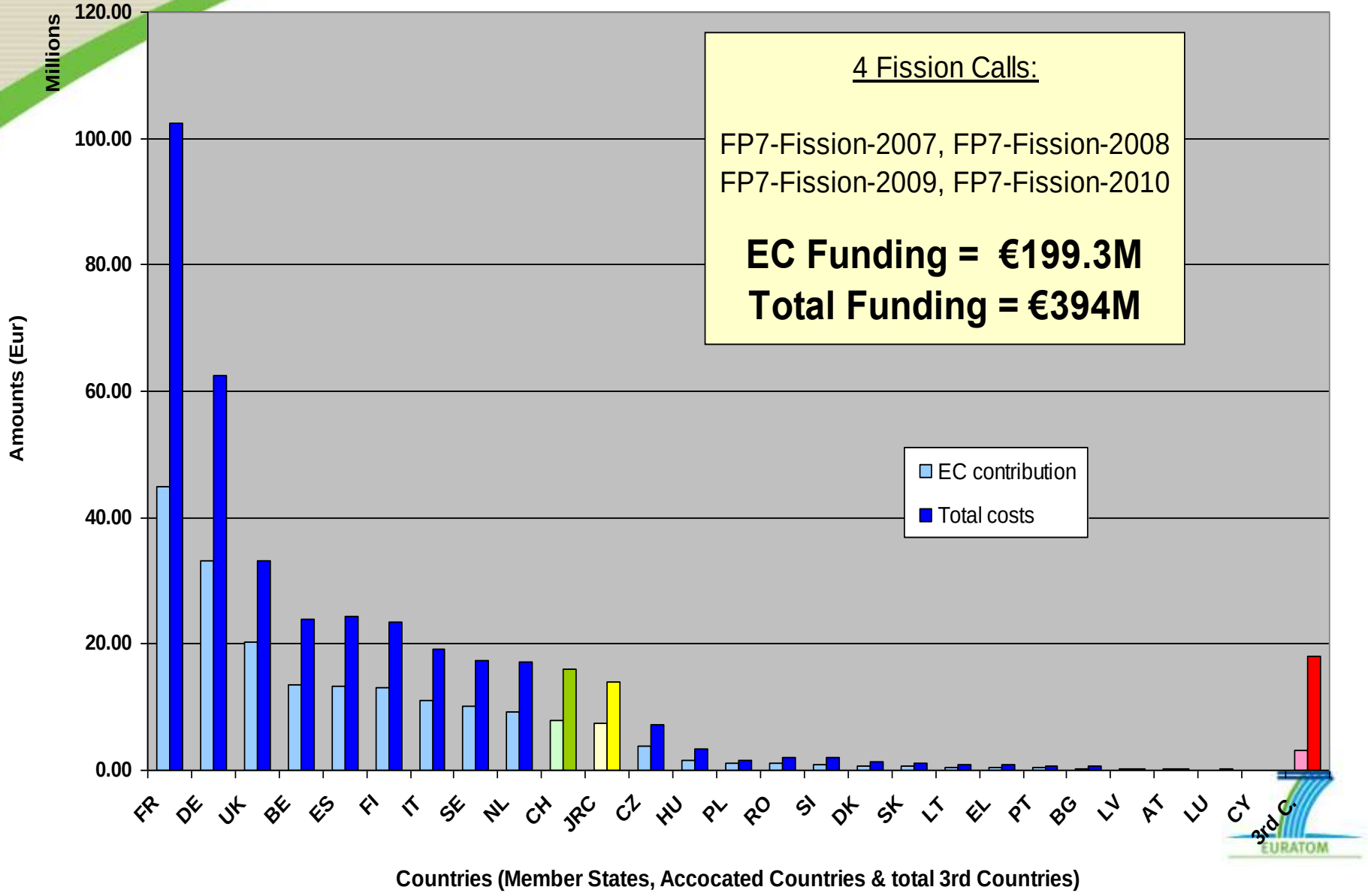
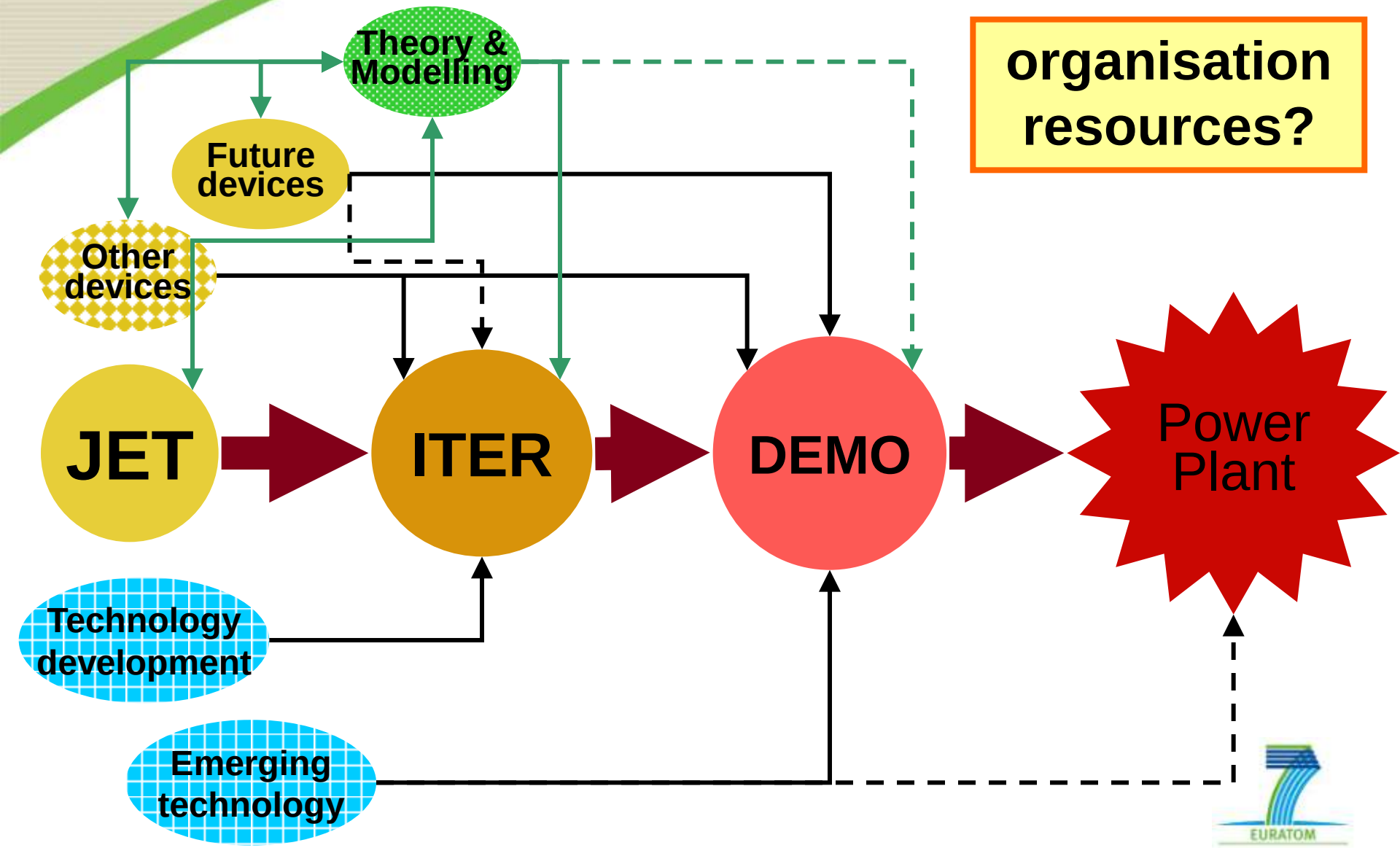
Participation in Euratom FP7 'Fission' Programme



Fusion – how do we get there?

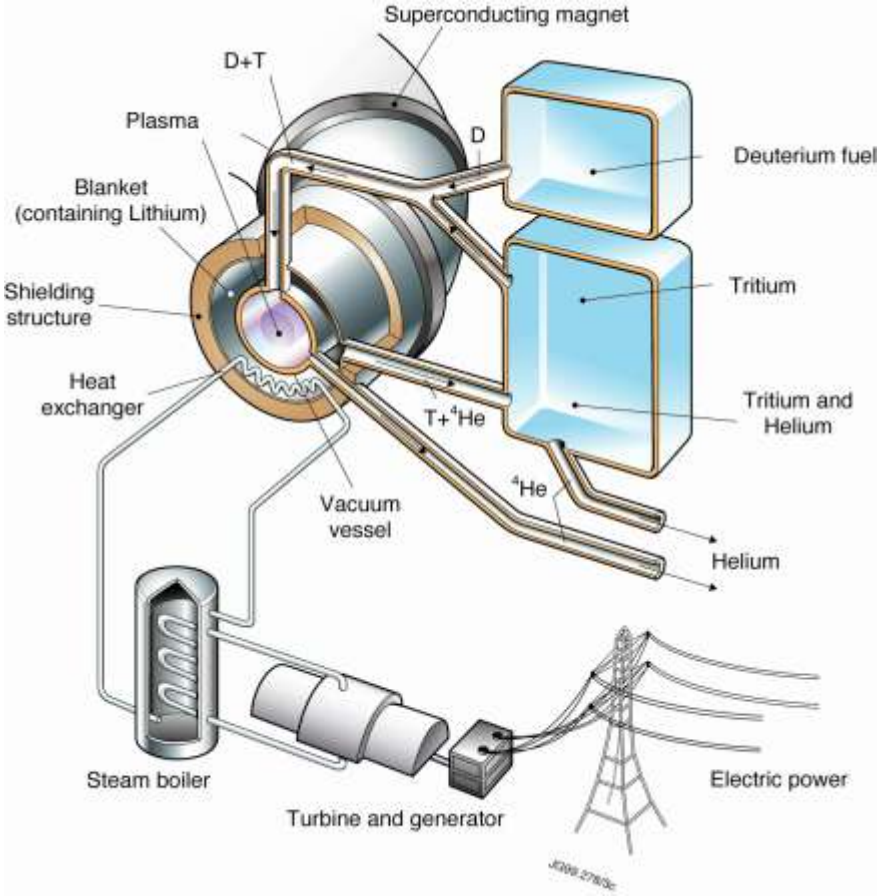


The European Fusion Programme
Objectives

- **<u>The long term objective:</u> Create the conditions for the construction of a fusion reactor for the generation of electricity**

7th Euratom Framework Programme:

"Developing the knowledge base for, and realising ITER as the major step towards, the creation of prototype reactors for power stations which are safe, sustainable, environmentally responsible, and economically viable"



The path towards DEMO

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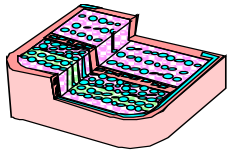
Fusion Engineering Research

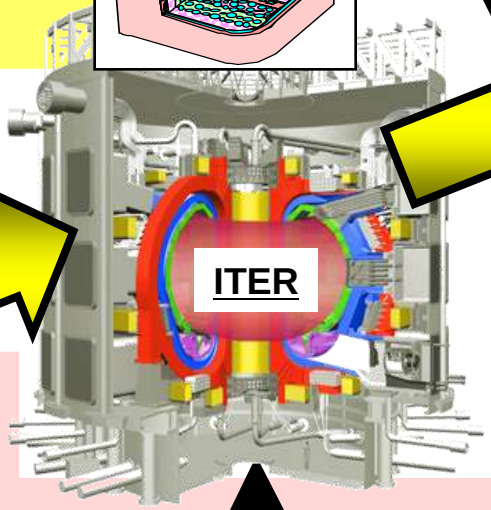
- Structural Material Dev.
- Structure Development
- Blanket technology
- Component Technology

Heavy Irradiation

Test Blanket Module

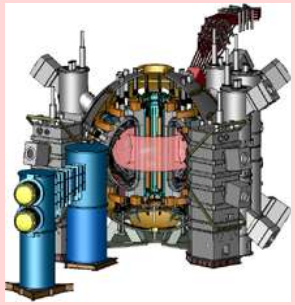


Tokamak DEMO Reactor



Fusion Plasma Research

JET



JT-60 SA

ITER & DEMO Physics Support Activities

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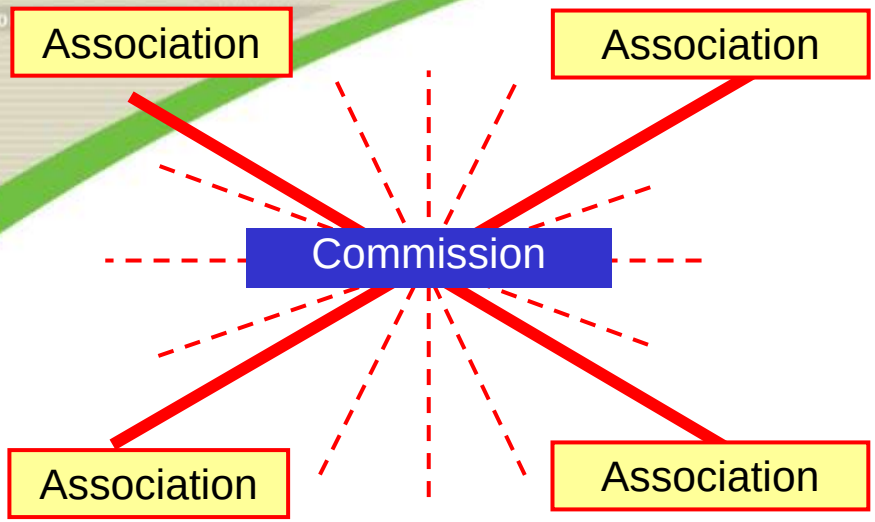
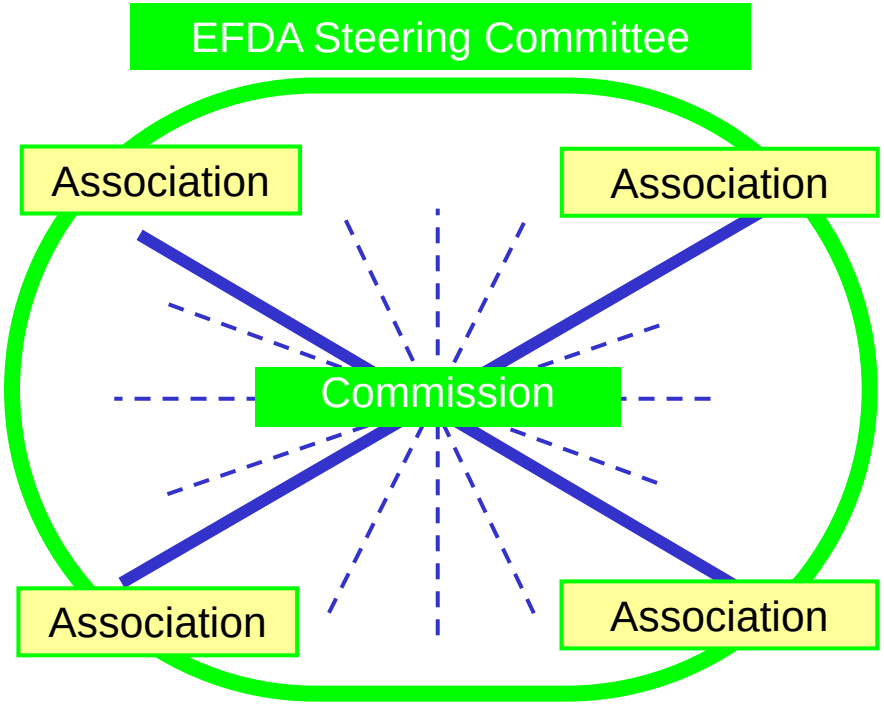
The European Fusion Programme
The European Dimension/1



Contract of Association with each institute active in fusion research and the Commission



EFDA (European Fusion Development Agreement) between all the Associations together and the Commission

Activities of EFDA:

- Emerging technologies
- Research programme of JET
- International collaborations outside of F4E
- Education and training

The Framework Programme
(EC-FP7 2007-13, Euratom-FP7 2007-11)

• **Cooperation** – Collaborative Research (health, food, IT, nanotech, **energy**, environment, transport, space and security)	€ 32,413 M
• **Ideas** – Frontier Research	€ 7,510 M
• **People** – Marie Curie Actions	€ 4,750 M
• **Capacities** – Research Capacity	€4,097 M
	€ 48,770 M
• Joint Research Centre (nuclear and non-nuclear research)	€ 2,268 M
• **Euratom (2007-2011)**:	
- nuclear fission (systems & safety, radwaste, RP)	€ 287 M
- **fusion energy research***	€1,947 M
	€2,234 M

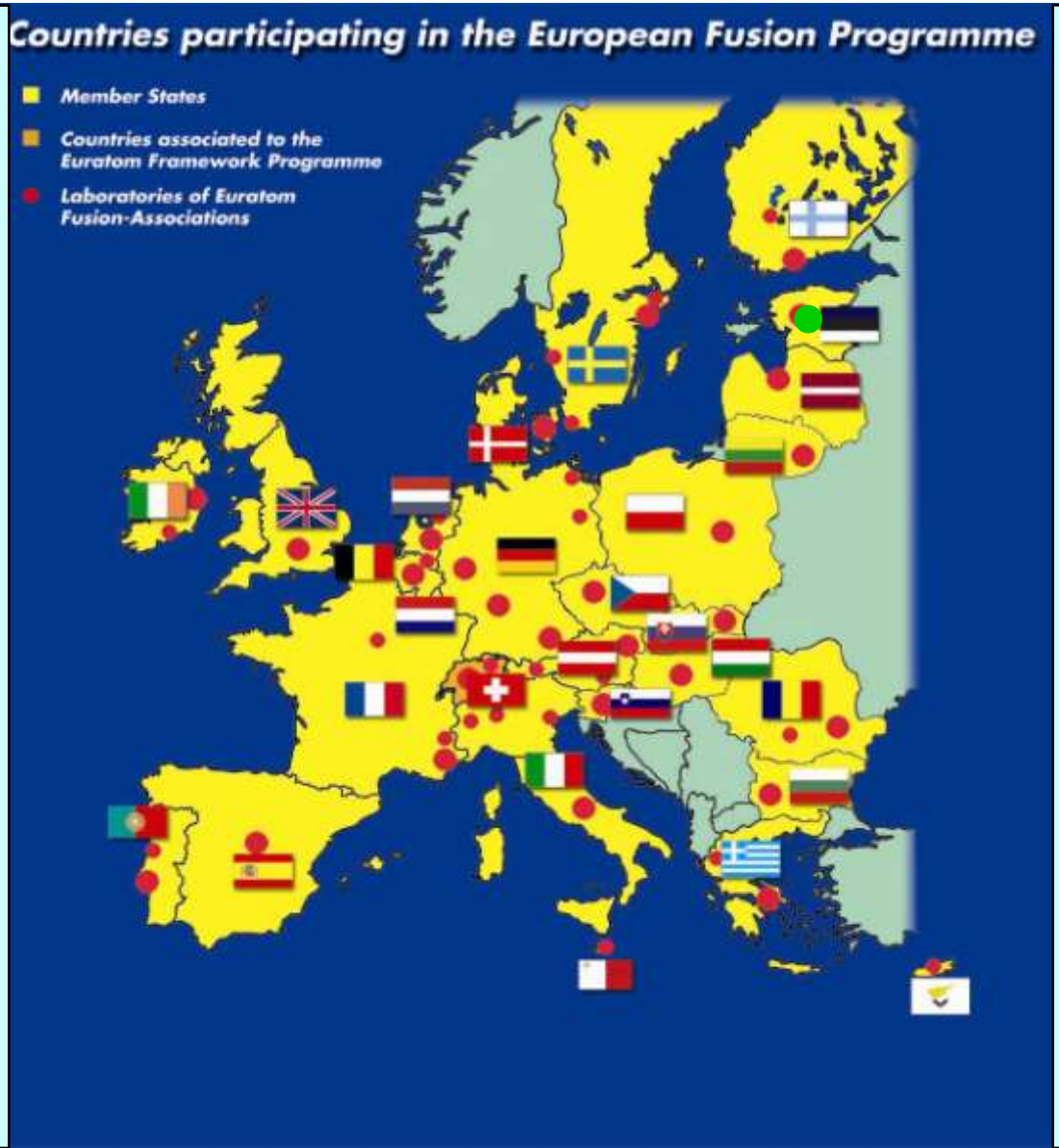
Typically ~5% of total R&D funds

~54% of total spending

* with at least € 900 M for activities other than ITER construction

Distributed R&D 26 Associations in an Integrated Programme

- **Euratom - CEA** (1958) France
- **Euratom – ENEA** (1960) Italy (incl. Malta)
- **Euratom - IPP** (1961) Germany
- **Euratom - FOM** (1962) The Netherlands
- **Euratom - FZJ** (1962) Germany
- **Euratom - Belgian State** Belgium (1969) (incl. Luxembourg)
- **Euratom - RISØ** (1973) Denmark
- **Euratom – UKAEA** (1973) United Kingdom
- **Euratom - VR** (1976) Sweden
- **Euratom - Conf. Suisse** Switzerland (1979)
- **Euratom - FZK** (1982) Germany
- **Euratom –CIEMAT** (1986) Spain
- **Euratom – IST** (1990) Portugal



- **Euratom - TEKES** (1995) Finland (incl. Estonia)
- **Euratom - DCU** (1996) Ireland
- **Euratom - ÖAW** (1996) Austria
- Eur-Hellenic Rep. (1999) Greece (incl. Cyprus)
- **Euratom - IPP.CR** (1999) Czech Rep.
- **Euratom - HAS** (1999) Hungary
- **Euratom – MEdC** (1999) Romania
- **Euratom – Univ. Latvia** Latvia (2002)
- **Euratom - IPPLM** (2005) Poland
- **Euratom - MHEST** (2005) Slovenia
- **Euratom – CU** (2007) Slovakia
- **Euratom – INRNE** (2007) Bulgaria
- **Euratom – LEI** (2007) Lithuania

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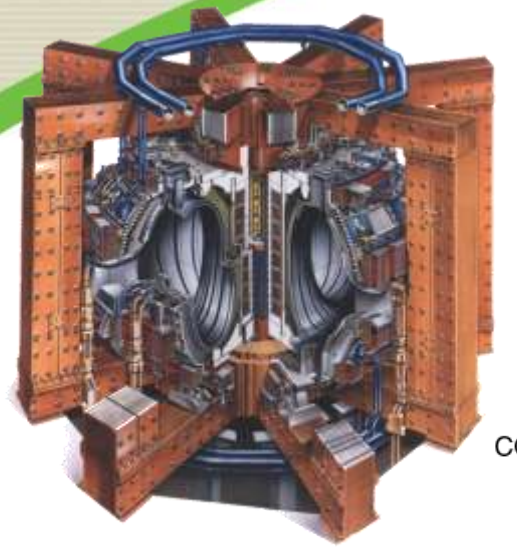
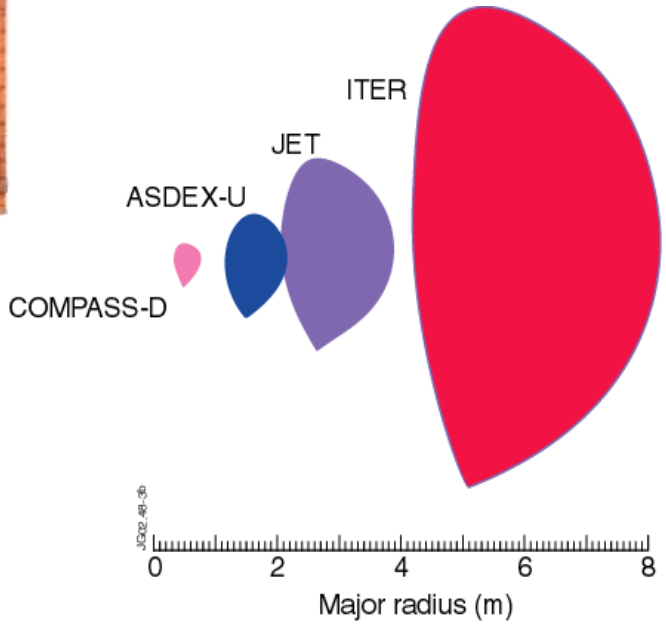
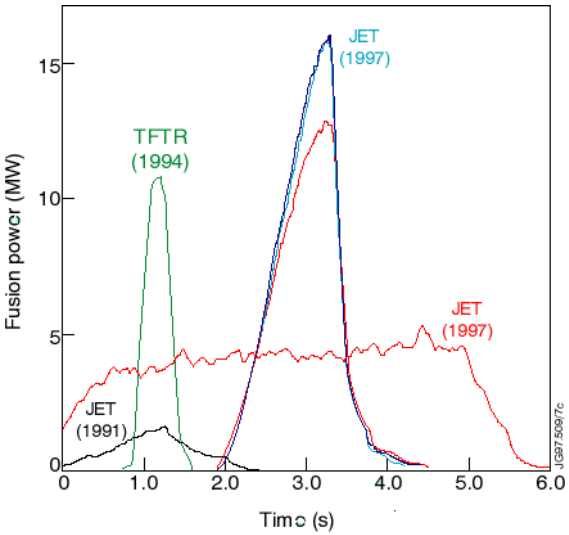
JET, the Joint European Torus







- JET is closer in size to ITER than any other tokamak
- It has a plasma shape similar to ITER
- It is the only tokamak in the world able to operate with tritium

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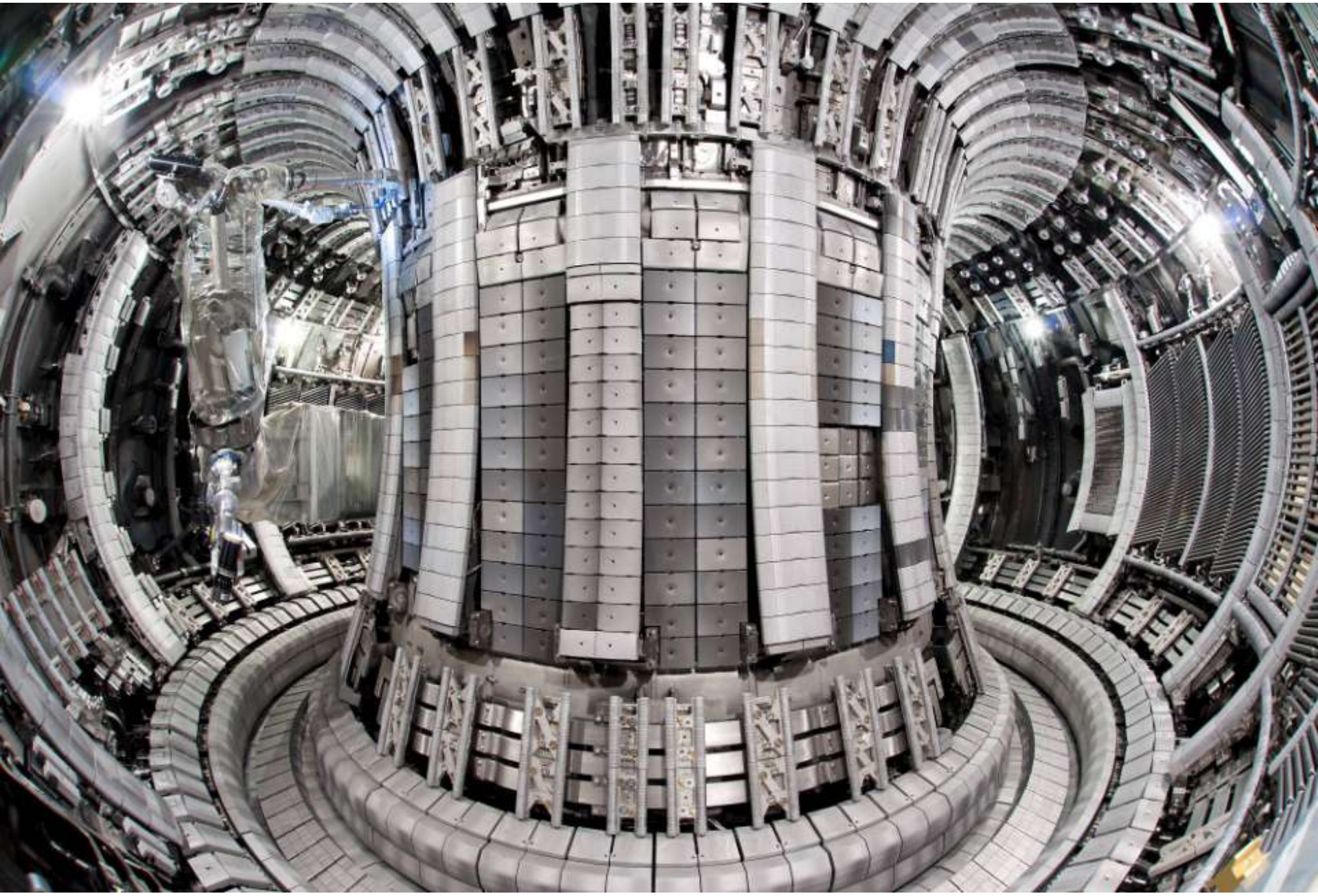

The European Fusion Programme
The European Dimension/2

- **"F4E" - the European Joint undertaking for ITER and the development of fusion energy -** ***Members are Euratom, represented by the Commission, the Euratom Member States + the countries Associated to Euratom (CH) in the field of fusion***

- **F4E carries out the following tasks:**

1. **Delivers Europe's obligations to the ITER Agreement;**
2. **Delivers Europe's obligations to the Broader Approach Agreement;**
3. **Prepares and coordinates the programme of activities required for the timely construction of the first demonstration fusion reactor.**

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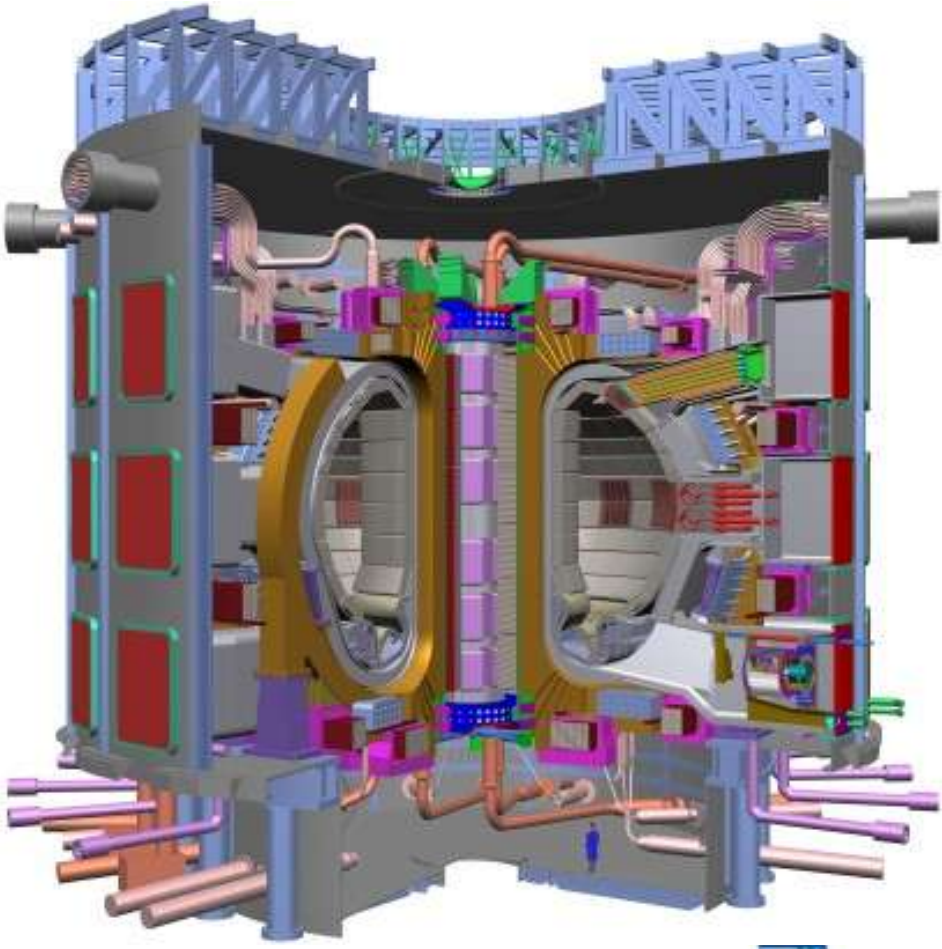
The ITER Project

- **The largest energy research project in the World**
- **Essential part of the EU and world strategy for the development of fusion**
- **Scope : demonstrate the scientific and technical feasibility of fusion energy**



Distribution of cost:

- **EU: 45.46% (1/5th from France)**
- **Other ITER Partners: 9.09% each**

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Current status of the ITER and F4E project

- Contracts: ~€1000M committed in construction contracts Including
  - Magnet
  - Buildings
  - Vacuum Vessel

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Fusion and Industry

- **The "*Fusion Industry Innovation Forum*" formed in 2010:**
  - **Define and implement, in conjunction with the research centres, a technology roadmap to a fusion power plant**
  - **Define and implement a technology transfer programme**
  - **Define and implement, in conjunction with the Commission and the fusion programme, skills development initiatives**
  - **Provide input for consideration in the FP8 Commission proposals**
  - **Report to the CCE-FU**
- **The membership consists of:**
  - **Sixteen Industrial Members on the FIIF Management Board, 2 Experts from the Associations, one expert from EFDA and one from Fusion for Energy.**
- **Current activities:**
  - **working with EFDA PPP&T department on pre-conceptual design definition.**
  - **Drafting report on the implementation of a technology transfer programme in fusion research**
  - **Reviewing the required future skills in industry**

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FIIF Management Board Members

IBERDROLA

AnsaldoNucleare
Una Società Finmeccanica

Fortum

amec

iter-nl

DANFYSIK

EMPRESARIOS AGRUPADOS

AREVA

SCIENTIFICA

ASTRIUM
AN EADS COMPANY

DSi
Delta Services Industriels

SIEMENS

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Fusion devices in the European programme

JET	Tokamak	Culham, UK	1983
ASDEX Upgrade	Tokamak	IPP Garching, Germany	1991
COMPASS	Tokamak	IPP.CR Prague, Czech Rep	2008 (transferred from UKAEA)
EXTRAP–T2R	Rev. Field Pinch	VR Stockholm, Sweden	1994 (2000)
FTU	Tokamak	ENEA Frascati, Italy	1990
ISTTOK	Tokamak	IST Lisbon, Portugal	1992
MAST	Sph. Tokamak	UKAEA Culham, UK	1998
RFX	Rev. Field Pinch	ENEA Padova, Italy	1991 (2000)
TCV	Tokamak	CRPP Lausanne, Switzerland	1992
TEXTOR-94	Tokamak	FZJ Jülich, Germany	1981 (1994)
TJ-II	Stellarator	CIEMAT Madrid, Spain	1997
TORE SUPRA	Tokamak	CEA Cadarache, France	1988
Wendelstein 7-X	Stellarator	IPP Greifswald, Germany	in construction

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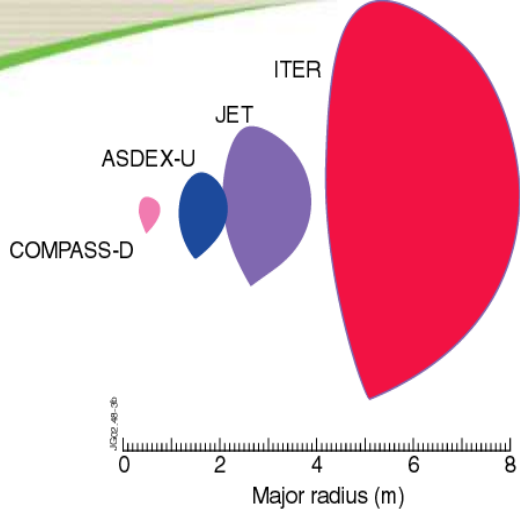
ITER Parameters (2001 design)



Parameter	Value	Parameter	Value
Minor radius (a)	2.0 m	Installed additional heating and current drive (P_{add})	73 MW
Major radius (R_0)	6.2 m	Plasma pulse length (inductive drive)	400 s
Plasma elongation (κ)	1.85	Average electron density $\langle n_e \rangle$	1.1×10^{20} m^{-3}
Toroidal magnetic field (B_T) at R_0	5.3 T	Average ion temperature $\langle T_e \rangle$	8.9 keV
Nominal plasma current (I_P)	15 MA	Peak fusion power	500 MW

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Summing up…

- Imminent / urgent actions
  - Agree 2-yr extension to Euratom FP7
  - Resolve ITER funding issue for 2012&13
  - Finalise Euratom proposal for programme post-2013 as part of CSF and the next Multi-annual Financial Framework
    - *Fission:* SET-Plan & Gen-IV, Fukushima?
    - *Fusion:* ITER, strategic roadmap, funding schemes, future of JET?
- Needed over medium / longer term
  - *Fission:* Increasing role of SNETP / IGDTP / MELODI & hopefully SET-Plan (strategic agendas for R&D, increased integration & cooperation, nuclear R&D fully part of policy on low-carbon technology)
  - *Fusion:* improved management of IO & F4E / construction of ITER / possible evolution of EFDA / extended operation of JET (D-T phase)
  - *Euratom:* increasing integration of the fission & fusion programmes in key areas (esp. materials) and with CSF instruments in general

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Thank you for your attention!

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