Contribution of EURATOM in Fast Reactor R&D

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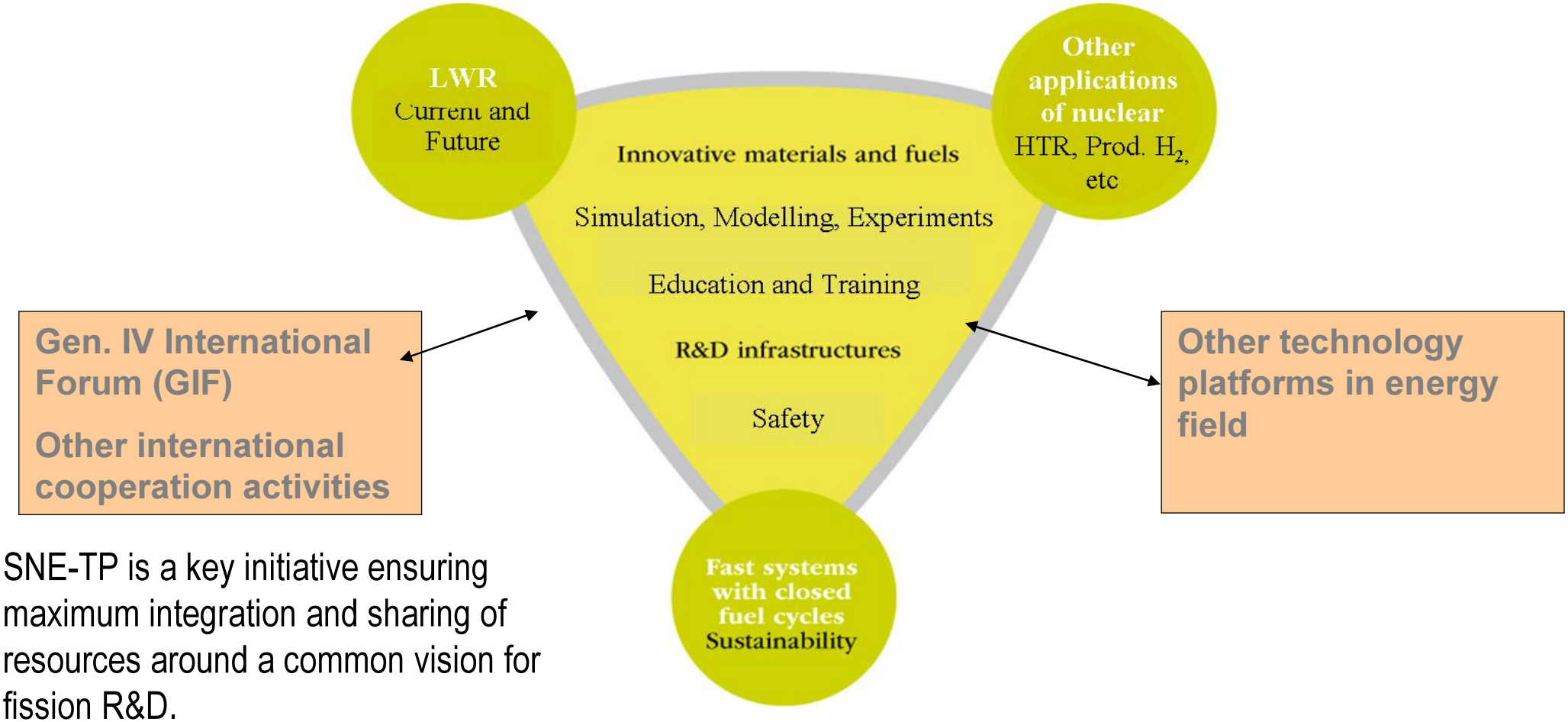
JRC
EUROPEAN COMMISSION

Outline of the presentation

- **Fast Reactor development in Europe:**
  - the Sustainable Nuclear Energy Technology Platform (SNE-TP)
  - the Strategic Energy Technology Plan (SET Plan)
- **The European Sustainable Nuclear Industrial Initiative (ESNII)**
- **International collaboration**
- **Role of EURATOM in support of R&D**
- **Conclusion**

Fast Reactor development in Europe (1)

The Strategic Research Agenda (SRA) of the European Sustainable Nuclear Energy Technology Platform (SNETP)



SNE-TP is a key initiative ensuring maximum integration and sharing of resources around a common vision for fission R&D.

Fast Reactor development in Europe (2)

SRA Reactor Technology Road-Maps

- **Current and future Light Water Reactors**
  - Plant life Management, material ageing issues
  - Advanced modelling tools & intelligent plant monitoring systems

Maintain competitiveness in **fission technologies**

- **Generation IV Fast Neutron Reactors**
  - Innovative fuels (incl. MA-bearing for transmutation) and core performance
  - Improved materials
  - Advanced instrumen-tation, in-service inspection systems

Demonstration of a **new generation (Gen-IV) of fission reactors** for increased sustainability

- **Other applications of nuclear energy:**

Optimization of reactor design (LWR, HTR, FNR) and heat process applications for production of:

  - H_2
  - synthetic fuel (2^{nd} gen. biofuels, CtoL)

Nuclear as a **low carbon energy supply** to other industries

Base load electricity

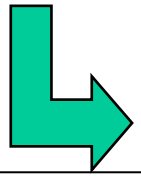
New applications

Fast Reactor development in Europe (3)

EU Energy Policy Initiative

March 2008: The «European Strategic Energy Technology Plan» (SET Plan) was endorsed by the European Council

- Need for R&D and Innovation in low carbon energy to implement the EU Energy policy
- Need for more research integration: i.a. European Energy Research Alliance
- Six European initial Industrial Initiatives: Wind, Solar, CCS, Biofuels, Grid, **Nuclear Fission**
- Communication on the Financing of the SET plan adopted on Oct. 7th, 2009



Increased public and private investment needed for the development of low carbon technologies

SET-Plan and Nuclear Fission

- **Key EU technology challenges** for the next 10 years

  … to meet 2020 targets:

  - ***"Maintain competitiveness in fission technologies, together with long-term waste management solutions"***

  … to meet 2050 vision:

  - ***"Complete the preparations for the demonstration of a new generation (Gen-IV) of fission reactors for increased sustainability"***

- **Task Force launched in 2009 to prepare the first nuclear European Industrial Initiative:**

  - ***"Sustainable nuclear fission initiative: focus on the development of Generation-IV technologies": ESNII (European Sustainable Nuclear Industrial Initiative)***

Fast Reactor development in Europe (5)

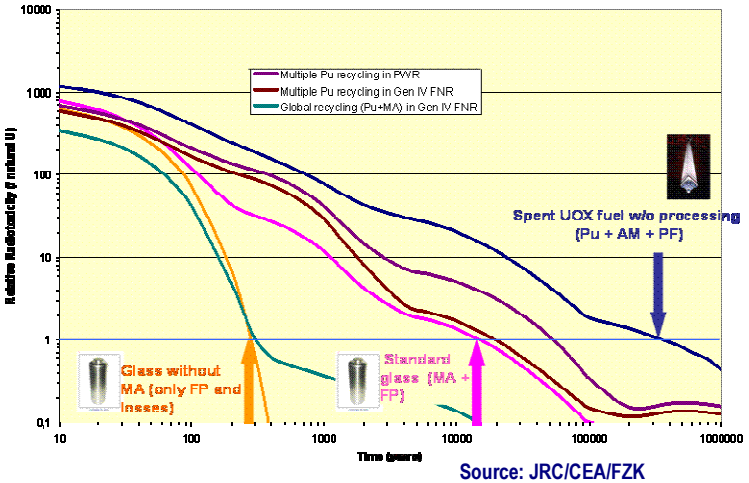
Why to create an Industrial Initiative on Generation IV Fast Reactor Systems ?

Technology	Identified reserves ~4.7 MtU	Total conventional resources ~14.8 MtU	Total conventional resources + phosphates ~36.8 MtU
LWRs once through	85	270	675
Introduction of FBRs*	4 250	13 500	33 750

Source: NEA Redbook 2008

Uranium resources and expected years of availability

- Fast Neutron Reactors (FNRs) have been operated in the past (including in Europe), but today's safety, operational and competitivity standards require the design of a new generation of fast reactors
- The main goals are to ensure long-term resources availability (multiplication by a factor of at least 50 of the energy produced by a given amount of uranium), and to increase the waste management efficiency (volume, heat load and toxicity reductions)
- R&D on 4 fast neutron systems is currently being implemented, cordination is ensured through SNETP in Europe and GIF at international level
- A framework for industrial implementation need to be set up



Source: JRC/CEA/FZK

European Sustainable Nuclear Energy Industrial Initiative (ESNII) (1)

Objective

• To demonstrate the sustainability of Generation IV Fast Reactors (exploit full energy potential of uranium and minimization of waste) and its industrial and economic viability to ensure that nuclear energy remains a long-term contributor to the low-carbon economy.

Sector target

• Commercial deployment of Generation IV from 2040 while retaining at least 30% share of EU electricity with an expansion towards cogeneration of process heat for industrial applications

Suggested required investment by the sector

• 6 -10 billion €

European Sustainable Nuclear Energy Industrial Initiative (2)

Participants to the ESNII Task Force (October 2009)

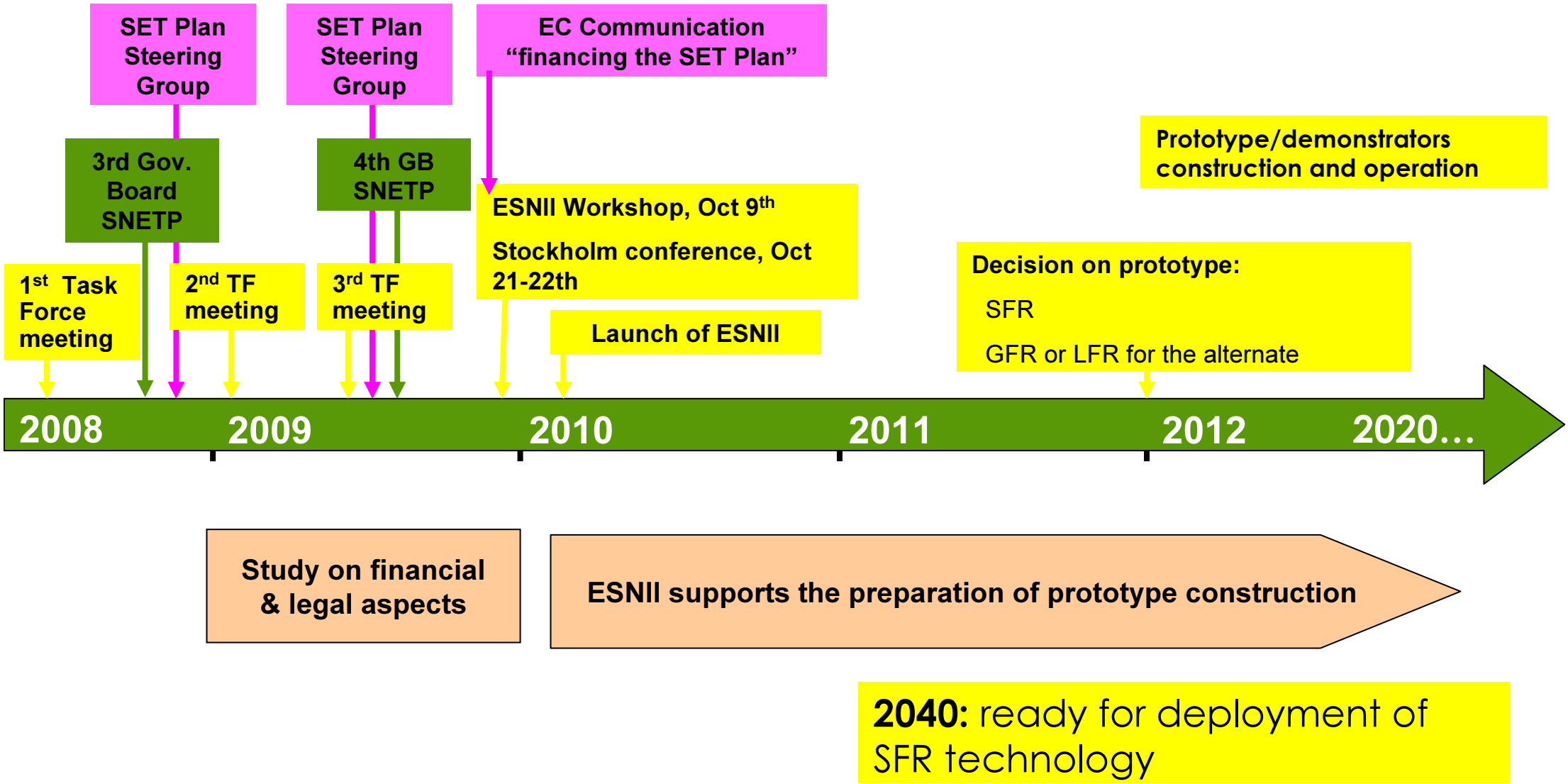
- Industry

- and R&D organisations

From 7 European countries

- This group is open to new members

European Sustainable Nuclear Energy Industrial Initiative (3)



Ref: CEA

European Sustainable Nuclear Energy Industrial Initiative (4): Indicative content and cost

2008 2012 2020

SFR — Reference proven technology

LFR — Alternative technology

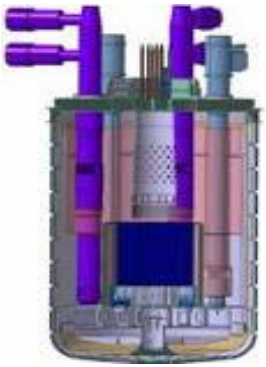
GFR — Alternative technology

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

600 M€

750 M€ - 1 G€

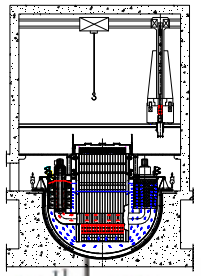
600 + (250-450) M€



2040: Target for deployment of Gen-IV Fast Neutron Reactors

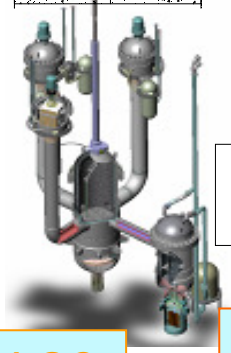
SFR PrototypeASTRID operated by 2020 (France)

2-4 G€



ETPP European Technology Pilot Plant (LFR)

600-800 M€



ALLEGRO experimental reactor (GFR)

R&D (15 years) 1,5 - 3 G€

Total 6 - 10 G€

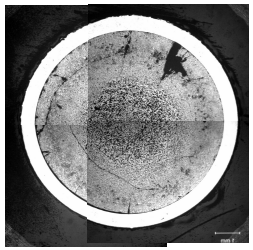
Ref: CEA

International collaboration (1)

EURATOM contribution to Generation IV International Forum: achievements

Sodium Fast Reactor

- Launch of a new project (European Sodium Fast Reactor – FP7)
- Hot cells analysis of Pu carbide fuels irradiated in Phenix
- Advanced structural materials project (GETMAT-FP7)
- Support to the design of the SFR European prototype



JRC/ITU Pu carbide fuel analysis

Gas Fast Reactor

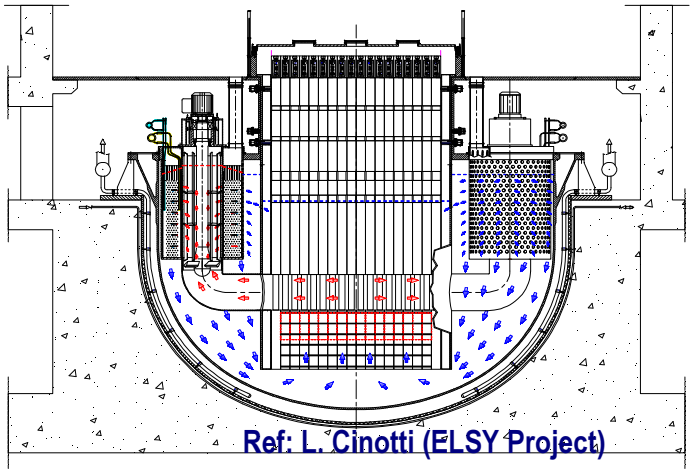
- Completion of GFR design comparisons (GCFR Project-FP7)
- Minor Actinides oxide and nitride fuel fabrication developments

International collaboration (2)

EURATOM contribution to Generation IV International Forum: achievements

Lead Fast Reactor

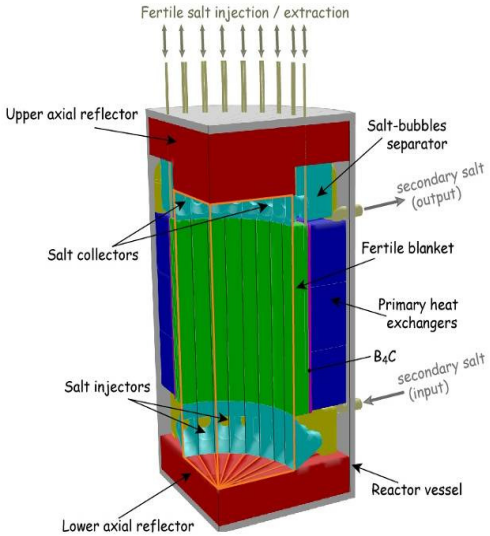
- 600 MWth LFR preliminary design (ELSY-FP7)
- Advanced structural materials project (LFR optimisation)



Ref: L. Cinotti (ELSY Project)

Molten Salt Fast Reactor

- Design of a MSR fast reactor
- MSR fluoride fuels property determinations



Ref: C. Renault

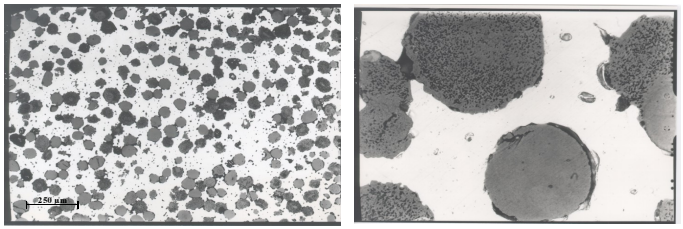
International collaboration (3)

Bilateral and Trilateral collaborations (examples)

CENTRALE PHENIX CEA-EDF

METAPHIX: CRIEPI-CEA-JRC metallic minor actinides fuels irradiation in Phenix
Irradiation completed up to 10 at%, examinations underway

FUTURIX: DOE-CEA-JRC oxide Am CERMET fuel pins irradiation in Phenix
Irradiation completed, examination underway



CERMET Am, Pu oxide in Mo matrix

DOE-EURATOM collaboration:

- INERI project on advanced cladding materials welding
- Reserach on nitride fuels

T91 end cap welded with magnetic pulse method

Role of EURATOM in support of R&D (1)

Total EURATOM Contributions to fast reactors research: 30 M€/year

- **EU Framework Programme Projects (Indirect Actions)**
  - Fast Reactor R&D performed by European Consortia (with external contributions)
    - ***Community funding: generally 50%***
- **JRC direct contribution**
  - JRC contributes to Fast Reactor R&D through its Work Programme
    - ***Community funding 100%***
- **Direct contributions of R&D organisations and/or industry** from EU or Associated Member States from their own funding
    - ***no Community funding***

Role of EURATOM in support of R&D (2)

EURATOM Indirect Actions on Fast Reactors Development

Project	Period	Total budget M€	Topics
ESFR	2009-2012	11.5	SFR design and safety
GCFR	2006-2009	3.6	GFR design and safety
ELSY	2006-2009	6.5	LFR design and safety
ACSEPT	2008-2012	23.8	FR fuel reprocessing
GETMAT	2008-2013	14.0	FR advanced structural materials
F-BRIDGE	2008-2012	10.2	FR innovative fuels research

Total of running projects: 70 M€ over 3-4 years (with 50% community funding)
New proposals processed on Lead and Gas Fast Reactors

EURATOM

Role of EURATOM in support of R&D (3)

The JRC: providing robust science for policy makers
7 Institutes in 5 Member States

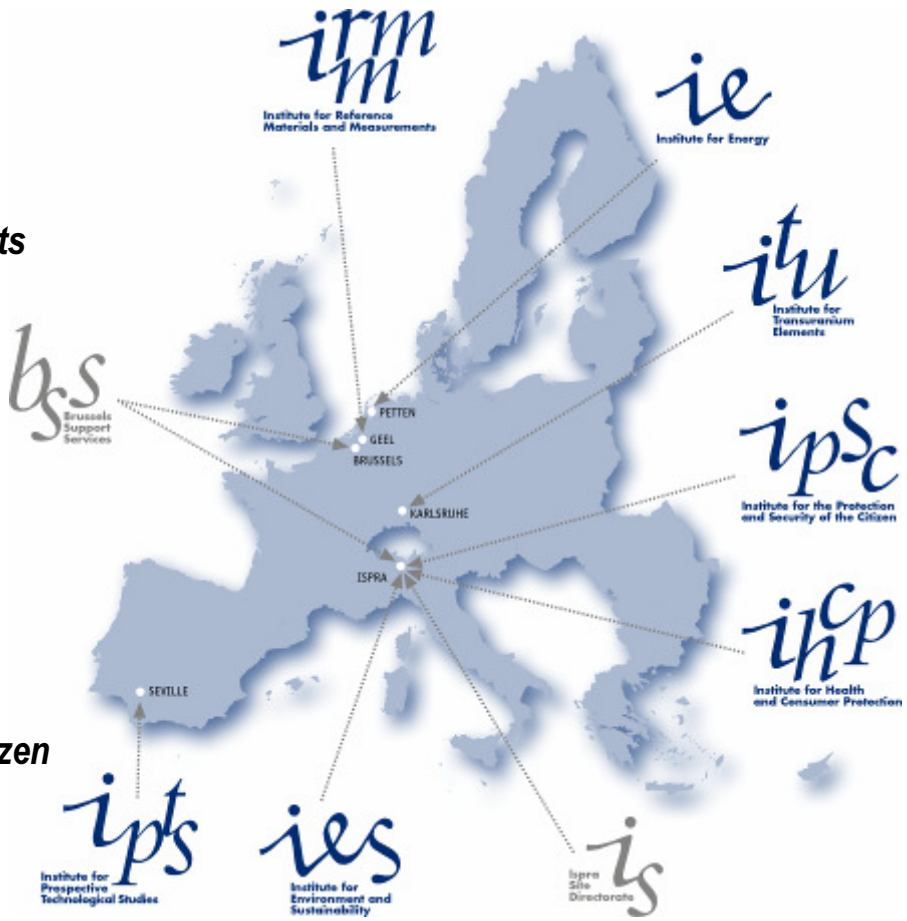
IE - Petten The Netherlands
-Institute for Energy

IRMM - Geel Belgium
- Institute for Reference Materials and Measurements

ITU - Karlsruhe Germany
- Institute for Transuranium Elements

IPSC - IHCP - IES - Ispra Italy
- Institute for Environment and Sustainability
- Institute for Health and Consumer Protection
- Institute for the Protection and Security of the Citizen

IPTS - Seville Spain
- Institute for Prospective Technological Studies

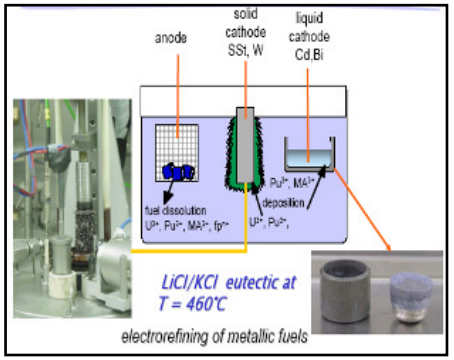


Role of EURATOM in support of R&D (4)

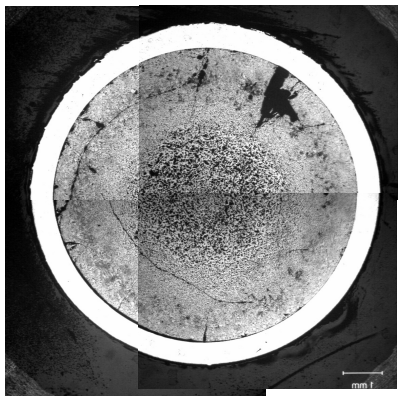
JRC Contribution to Fast Reactors Development

- Involved in research on all 4 fast systems (no detailed design work)
- Focus on safety and security research fields
- Particular research topics (to be described in another paper at this Conference) are:
  - Fuel fabrication and properties including post-irradiation
  - Advanced fuel reprocessing experiments
  - Fuels and structural materials research
  - Reactor design and safety comparisons
  - Proliferation resistance and physical protection evaluations
- JRC is the implementing agent for EURATOM in GIF

Budget: about 10 M€/y



Reprocessing: Aqueous & Pyro



Carbide Pu fuel irradiated in Phenix FR

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Conclusions

- In Europe, nuclear fission R&D is coordinated through SNETP
- Three R&D pillars have been identified: safety of existing reactors, development of a new generation of fast reactors, heat-related applications of nuclear energy
- Long-term resources availability and reduction of waste hazards favour the development of fast reactors;
- The launch of an European Industrial Initiative will support the construction by 2020 of a sodium- cooled fast neutron reactor in France
- The European Commission, through its EURATOM fission programme, is a major contributor to the R&D programme, either through « Indirect Actions » financed by RTD or by « Direct Actions » implemented in JRC
- The R&D international dimension is of primary importance. This is reflected through the active participation of EURATOM in GIF, and through a number of bilateral collaborations