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ACSEPT
PROGRESSES IN ADVANCED PARTITIONING AND CHALLENGES FOR THE FUTURE

Actinide reCycling by SEParation and Transmutation

FP7 EURATOM CP 2007-211267 - (March 2008 – February 2012)

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ACSEPT at a glance

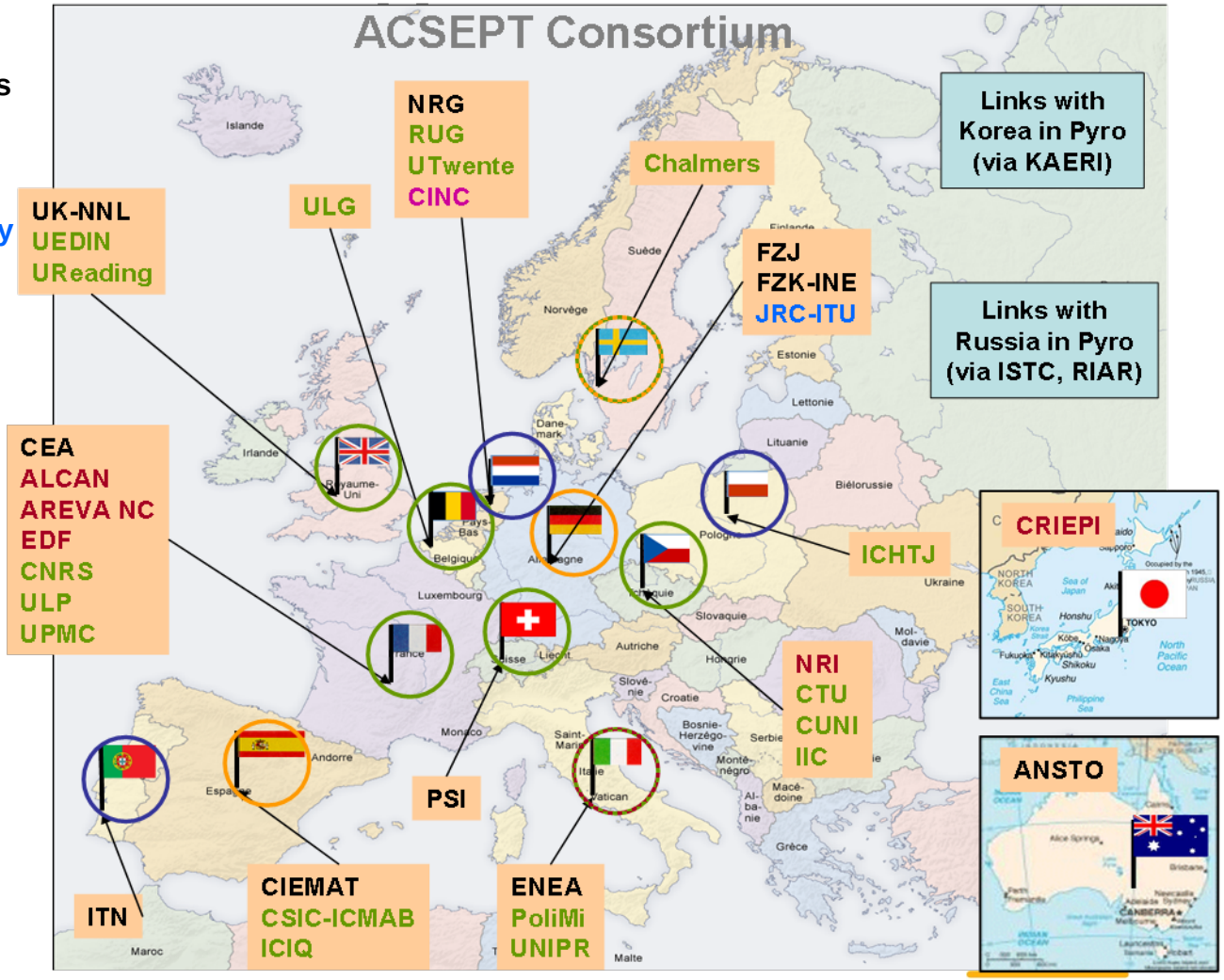
34 partners from
National Nuclear Research laboratories
Nuclear Industrial Companies
Universities and/or National
Fundamental Research Laboratories
European Nuclear Research Laboratory
Small and Medium Size Enterprises

12 European countries
+ Japan & Australia

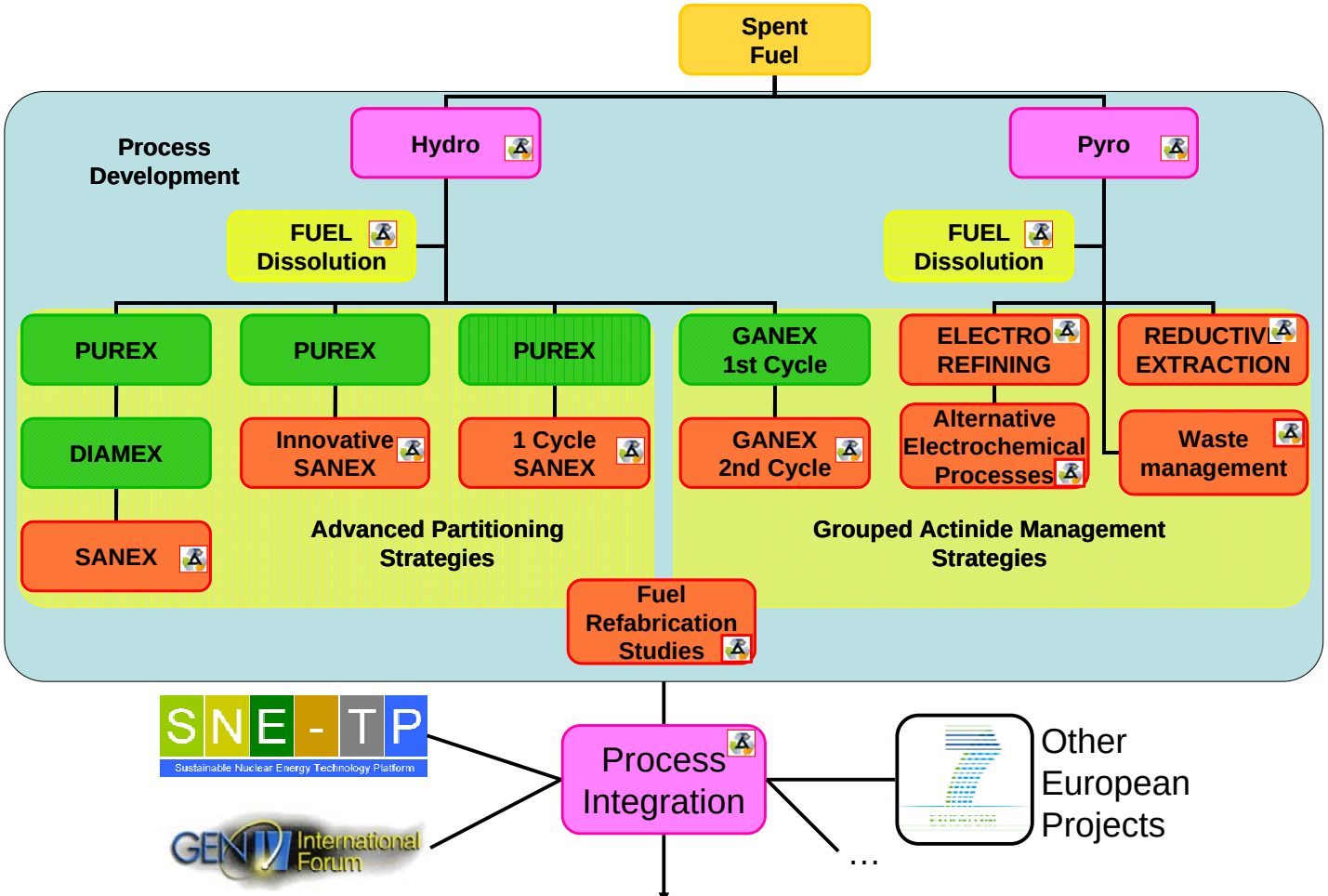
4 years
(2008-2012)

130 men.years
Total budget 24M€
EC Grant 9M€

The biggest FP7
Euratom project



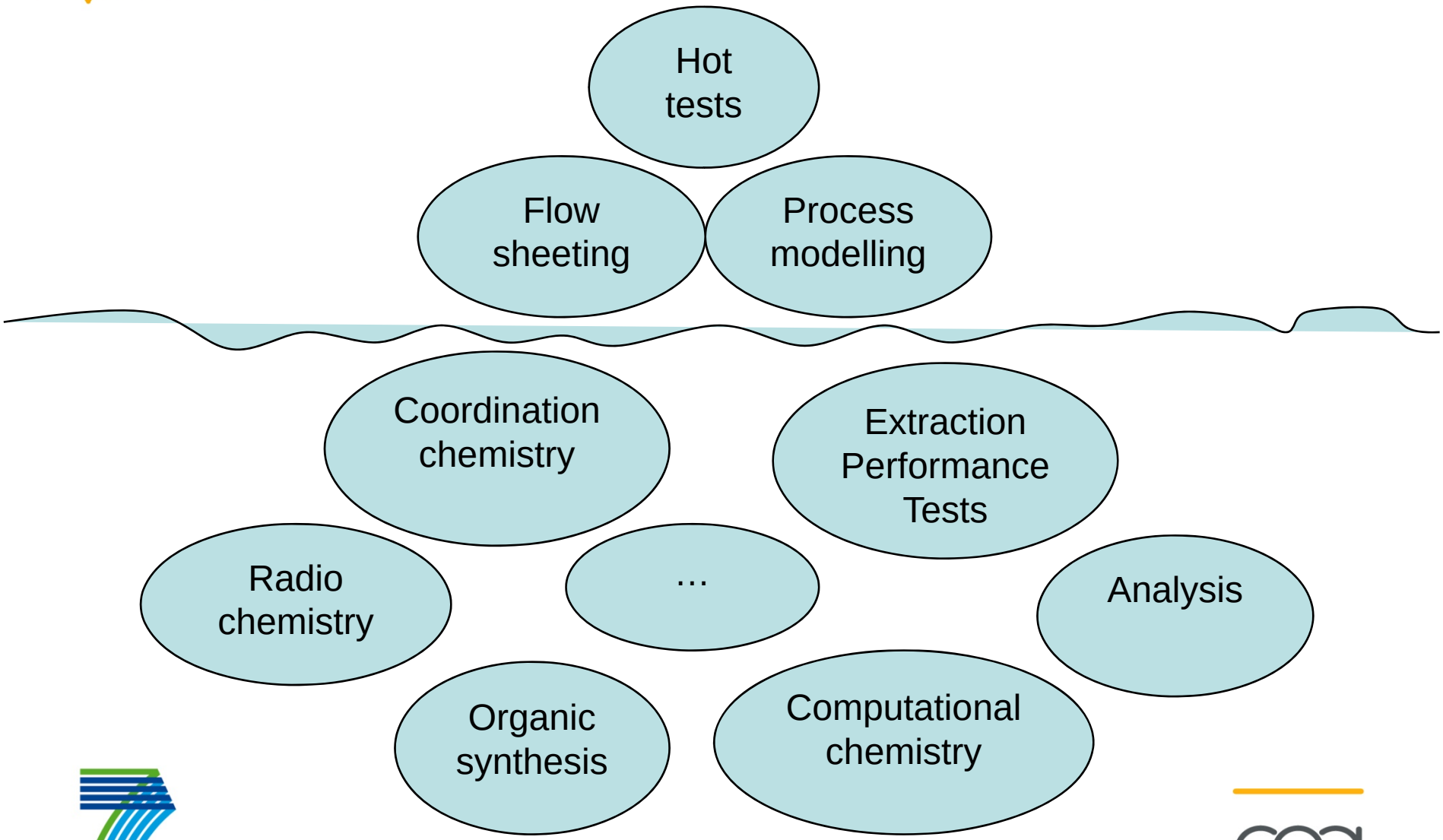
General Objective



Hot Facilities in ACSEPT

+ FZJ, CIEMAT, CRIEPI, NRI

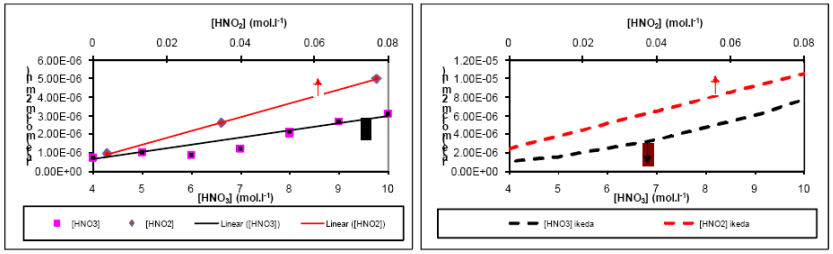
The process development iceberg…



Progres in Hydrometallurgy

Dissolution studies

- $(U,Pu)O_2$ and PuO_2 dissolution studies
  - In warm nitric acid - effect of high and low HNO_2
  - In nitric acid with Ce(IV)/Ag(II) with simulated fission products
- Surface studies of UOx
- U(VI), Pu(IV,VI) – nitrate complexation studies under dissolver conditions



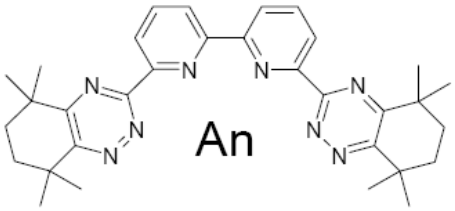
[1] Y. Ikeda , et al., *Kinetic study on dissolution of UO_2 powders in nitric acid*, J. Nuc. Mat., 1995. 224(3): p. 266-272.

Performed at NNL

Heterogeneous recycling

- **"regular" SANEX (on a DIAMEX raffinate), selective actinide extraction**

Two SANEX processes based on BTBP/DMDOHEMA and BTBP/TODGA systems were developed within EUROPART and successfully tested

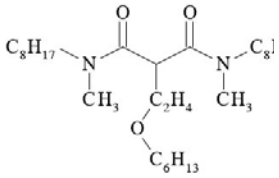


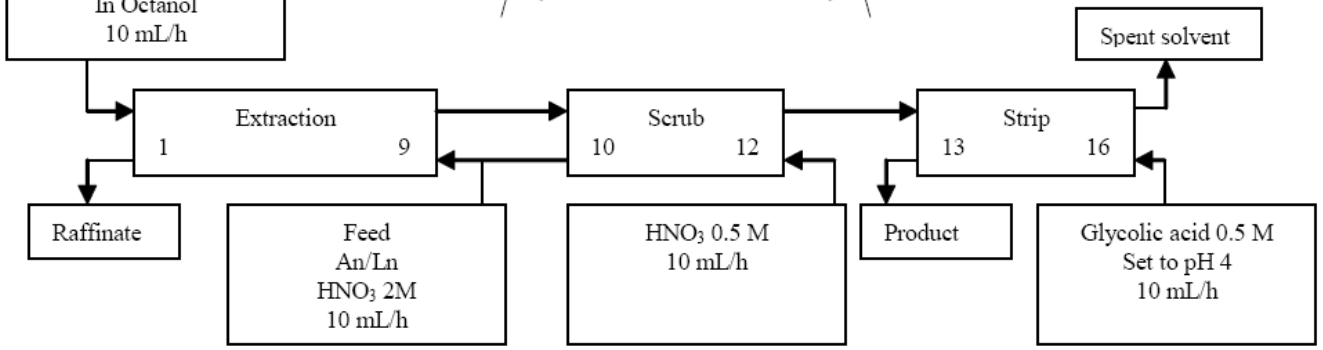
$CyMe_4BTBP$

JRC EUROPEAN COMMISSION

Hot test performed at ITU

DMDOHEMA





Flow-sheet:

- Low flow-rates due to **slow kinetics**
- High feed acidity (2 M) for a more efficient extraction

Results:

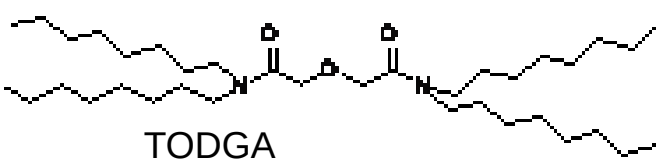
- **>99.9% of the An in the product**
- **Ln remained in the raffinate**
- **Organic phase clean**

BTBP

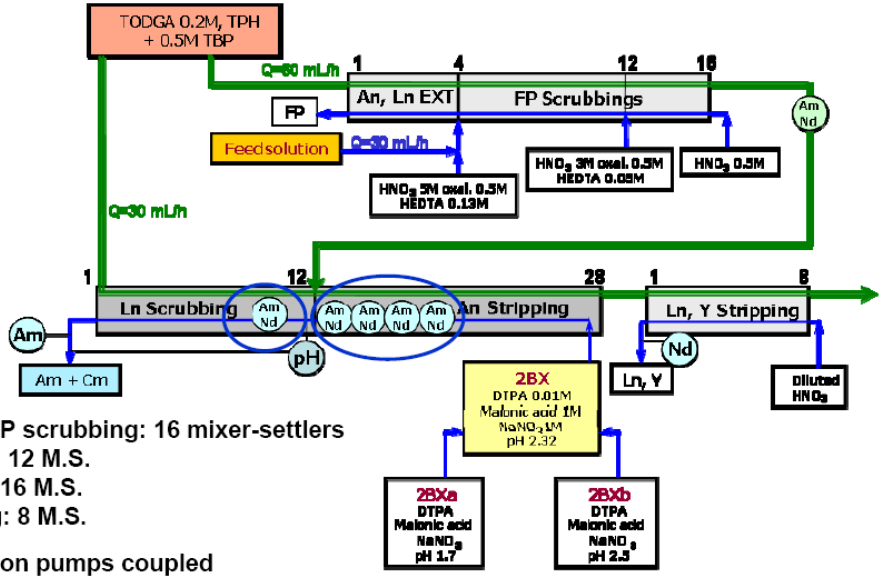
Heterogeneous recycling

- **"innovative" (stripping) SANEX (on a PUREX raffinate), extraction of An, Ln and selective stripping of An.**

One process based on a TODGA system was developed and successfully tested



TODGA



- Extraction – FP scrubbing: 16 mixer-settlers
- Ln scrubbing: 12 M.S.
- An Stripping: 16 M.S.
- Ln/Y stripping: 8 M.S.
- 9 rotating piston pumps coupled with flowmeters
- 7 on-line spectrophotometric measurements for Am – Nd concentrations
- 2 in-line pH controls

D. Warin's lecture at 5:00 PM

Improvements under studies at FZJ and KIT

A. WIlden's lecture at 5:30 PM

A. Geist's poster IV-1

Performed at

Homogenous recycling

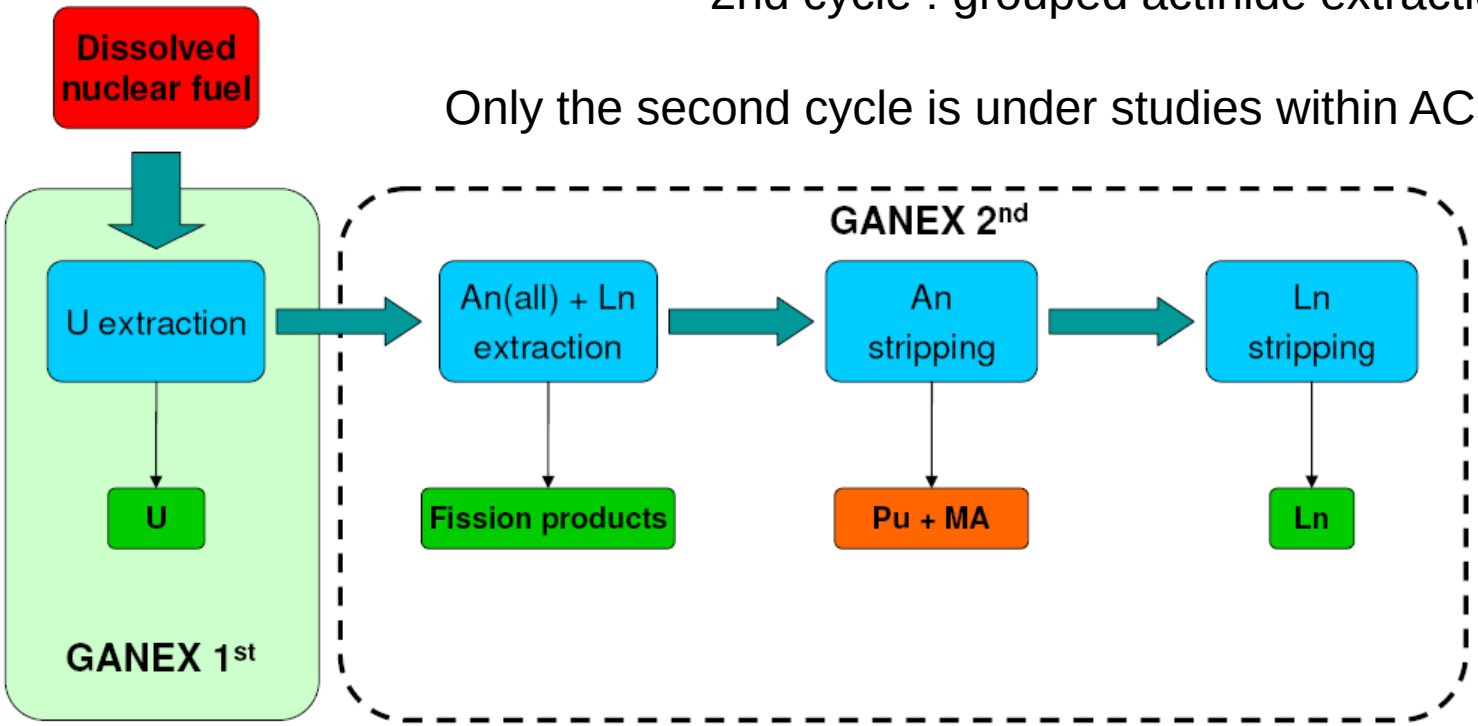
GANEX, grouped actinide extraction

Two cycles:

1st cycle : quantitative Uranium extraction,

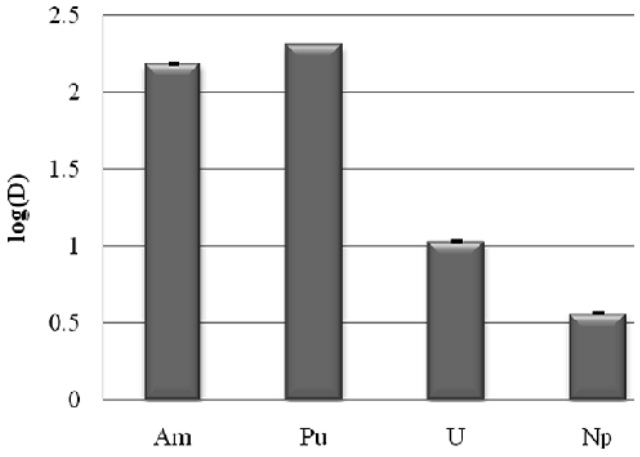
2nd cycle : grouped actinide extraction

Only the second cycle is under studies within ACSEPT



An alternative to the CEA GANEX (D. Warin's lecture at 5:00 PM) based on NEWPART-PARTNEW-EUROPART Systems

Homogenous recycling - CHALMERS

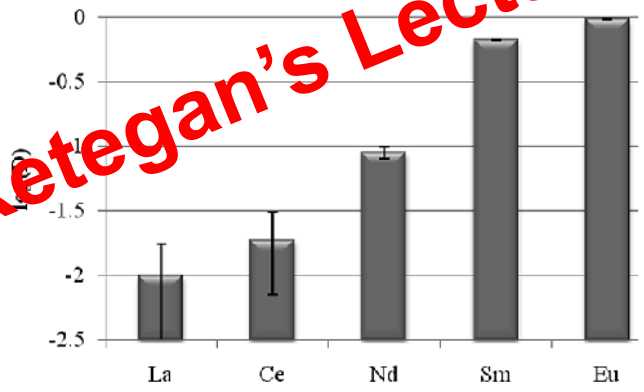


[Enlarge Image]

Figure 5. Extraction of actinides (^{235}U, ^{237}Np, ^{238}Pu, ^{241}Am) from 4 M nitric acid with 0.01 M $CyMe_4$-BTBP and 30% TBP in cyclohexanone.

A TBP/BTBP-based GANEX Separation Process

T. Retegan's Lecture at 6:00 PM !



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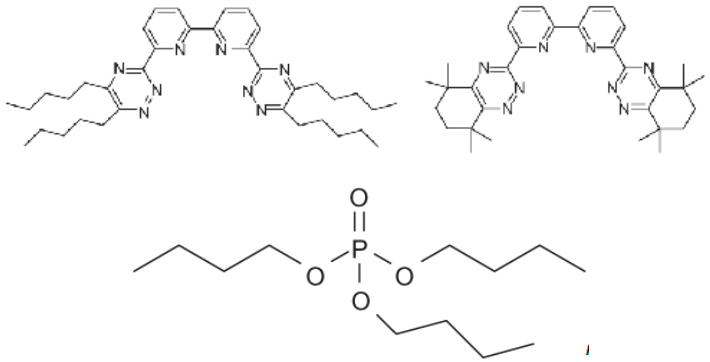
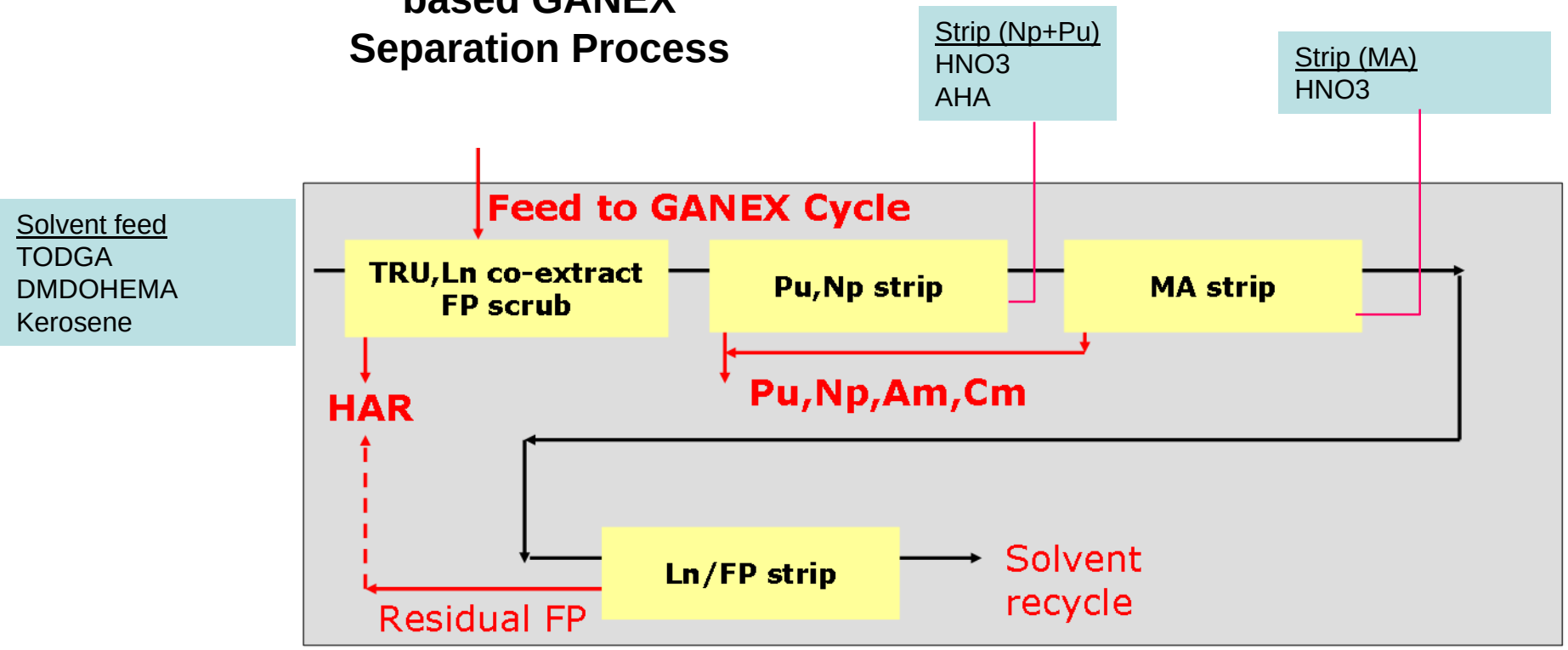


Figure 6. Extraction of lanthanides (^{152}Eu, the rest as non radioactive metal salts) from 4 M nitric acid with 0.01 M $CyMe_4$-BTBP and 30% TBP in cyclohexanone.

Homogenous recycling - NNL

A TODGA/DMDOHEMA-based GANEX Separation Process

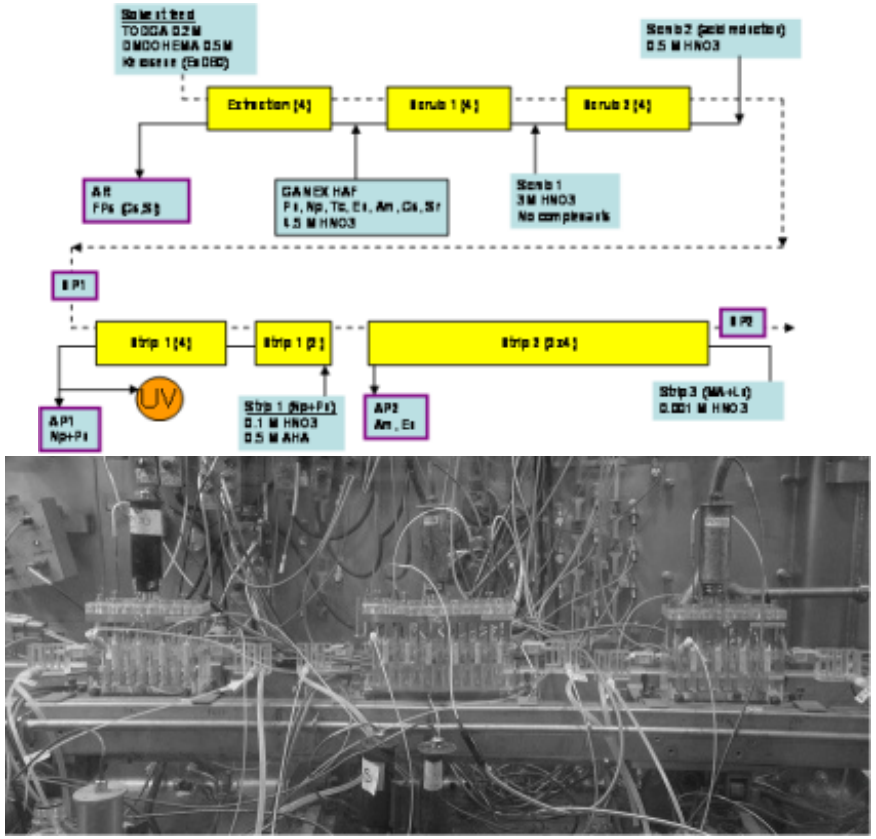


For more information, see R. Taylor at al., Pu Futures 2010

Homogenous recycling – Next Step

Select (at lest) one concept for hot-test demonstration by the end of ACSEPT
Design the flowsheet
Implement the Hot-Test (ITU?)

Challenge



HYDRO - Fuel refabrication

From polyactinide containing solutions to polyactinide containing solids
Basic studies and process orientated studies

Sol gel routes (in Continuation of FP6 EUROPART project)

- **External gelation: some tests, not concluding**
  - Difficulties on Sol-creation (corrosion of stirrer)
  - Kernels stick at phase interface in gelation column
  - Collapsing of many Kernels during drying at RT
  - Sintering-tests not very promising
- **Internal gelation: more efficient, promising results, even if still a lot of work to improve the technique**



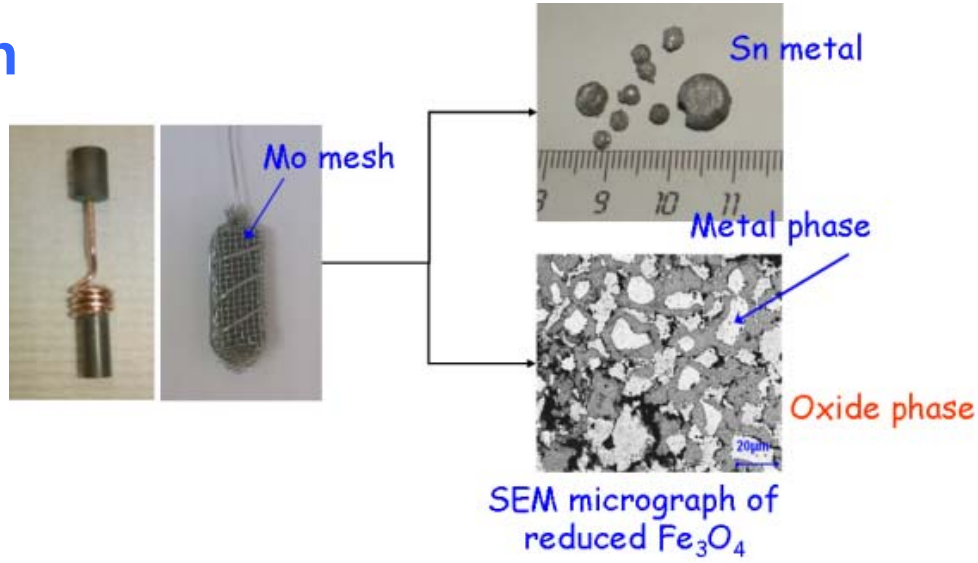
Alternative routes

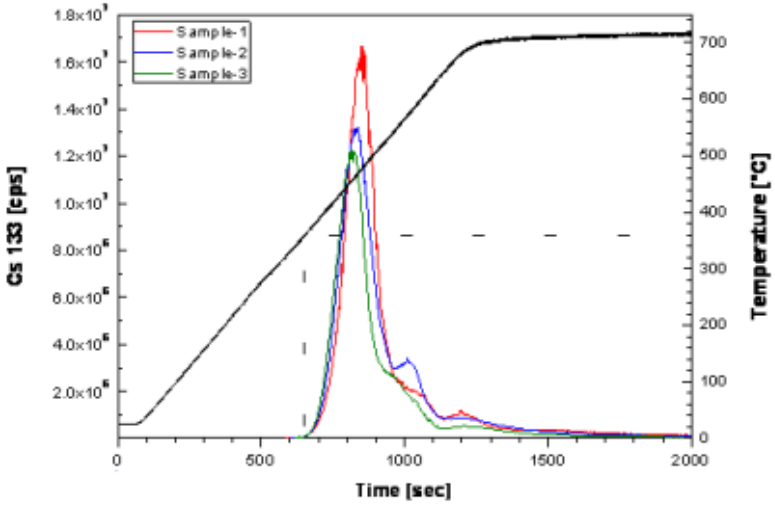
- **Direct thermal denitration/ solid extractants**

Progress in Pyrometallurgy

Direct electrochemical reduction of oxides in molten fluorides

Direct electrochemical reduction of oxides (SnO_2, TiO_2, Fe_3O_4 and UO_2) have been tested in molten fluorides: LiF-LiF-NaF and/or LiF-CaF_2 at 750-850°C.

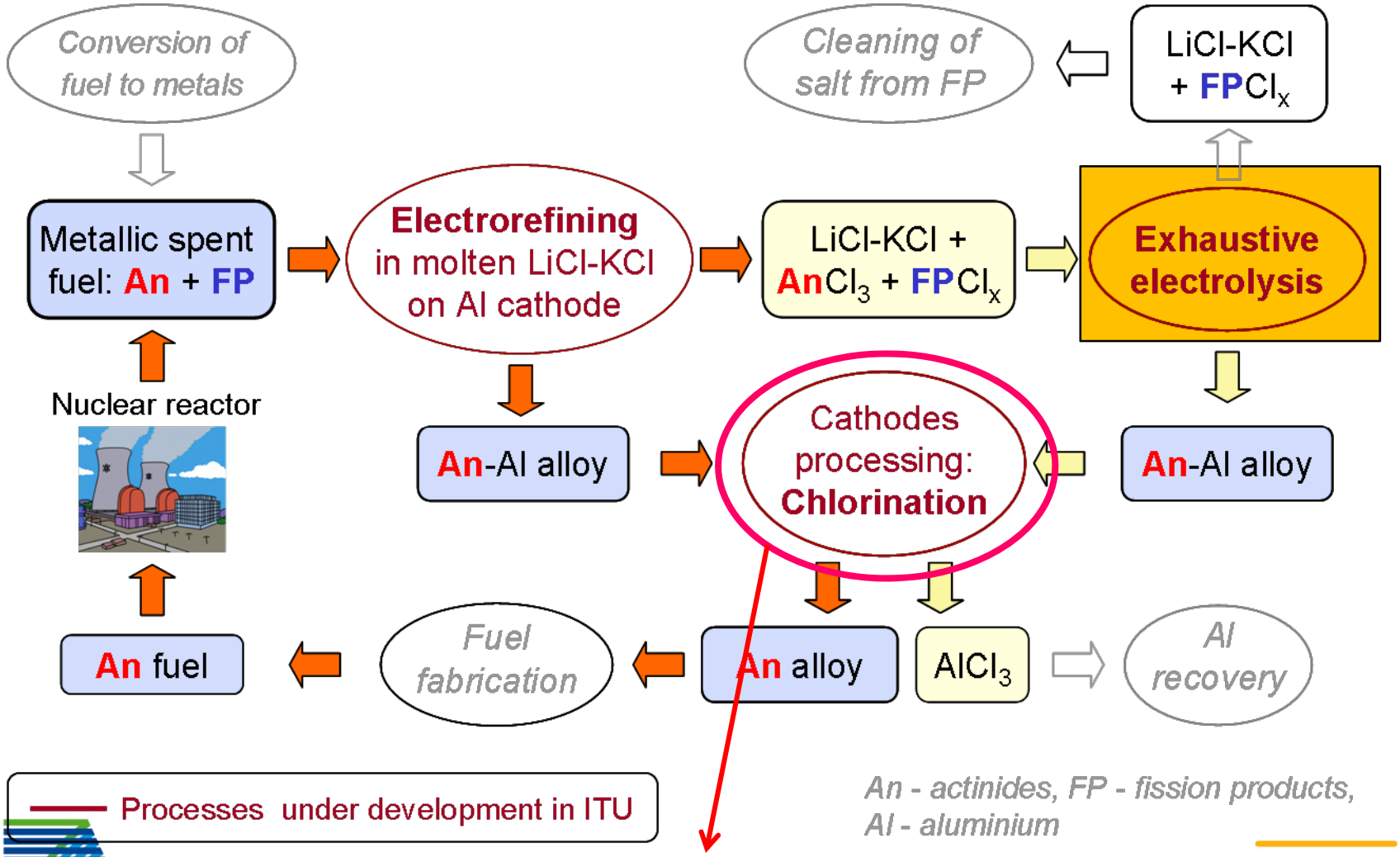




Thermal treatment

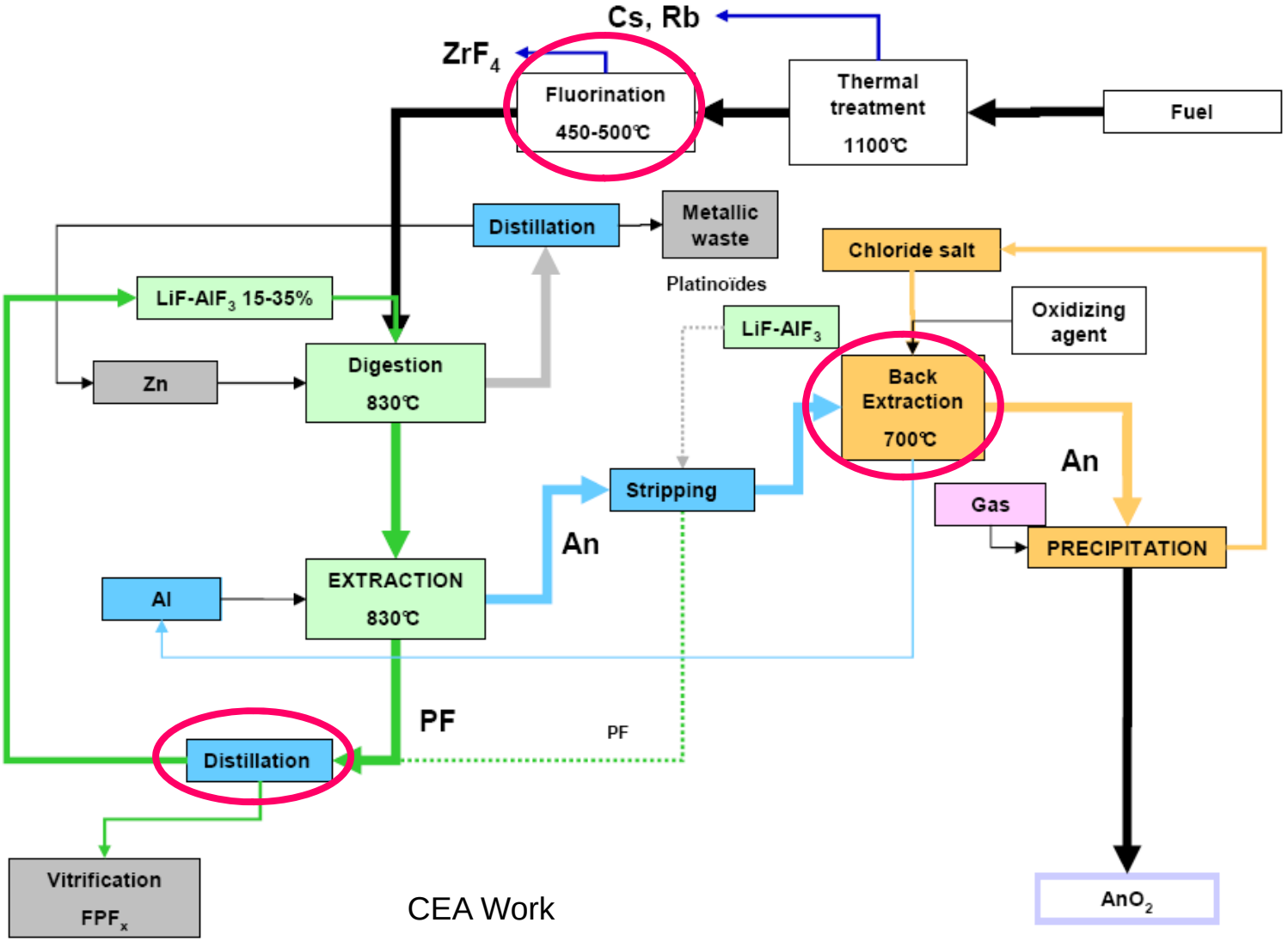
Analytical performance of the **Heated Laser Ablation Cell** in combination with a mass spectrometric detector was tested. Released of Cs measured with IPC-MS from $CsNO_3$ (sol.) and CsCl/NaCl powder allows the determination of the detection limit for this element.

Electrorefining of actinides onto solid aluminium cathode in molten chloride salts



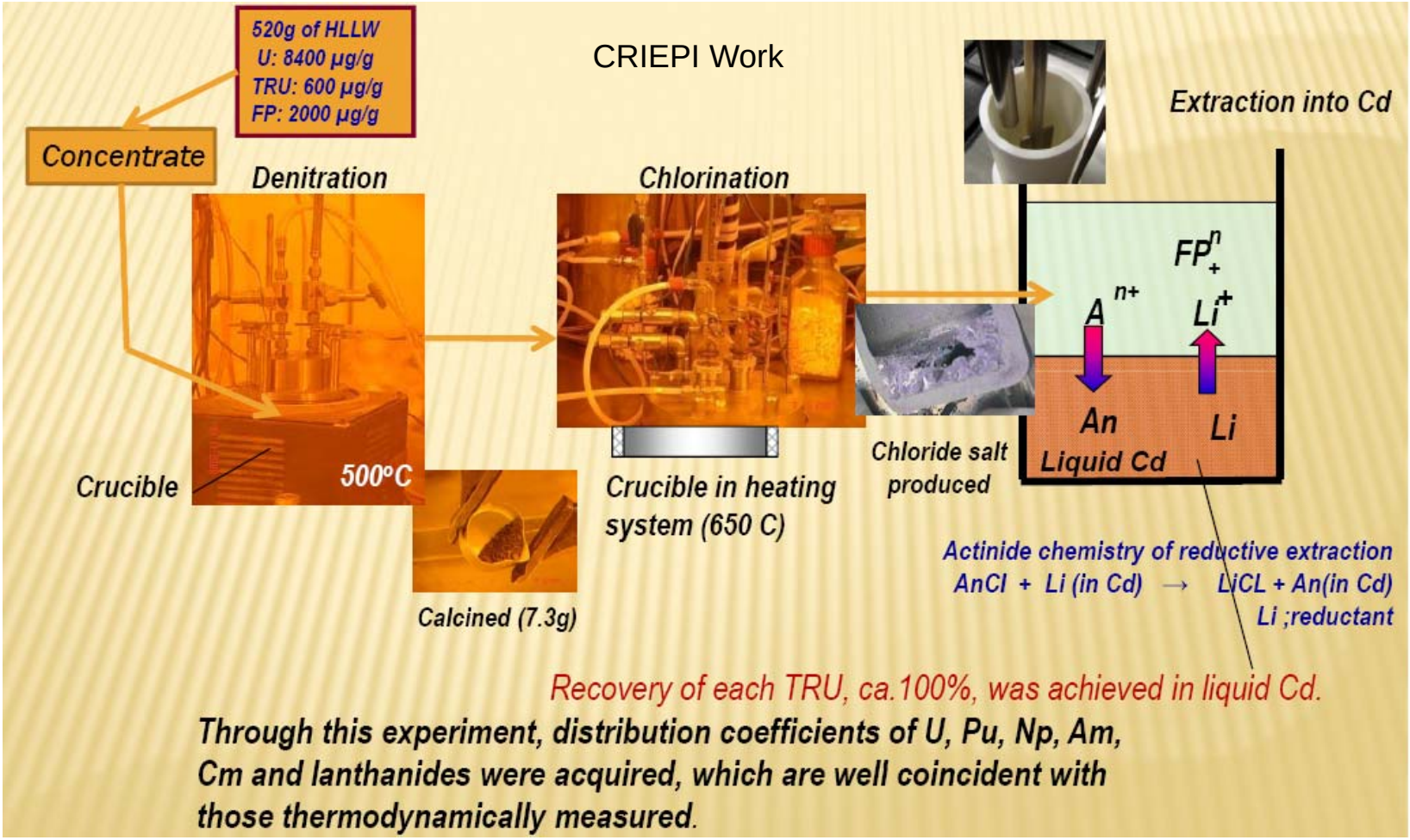
C. Nourry's poster IV-12

Liquid-liquid reductive extraction in molten fluoride salts/liquid aluminium



CEA Work

TRU recovery from genuine HLLW prepared by SF dissolution



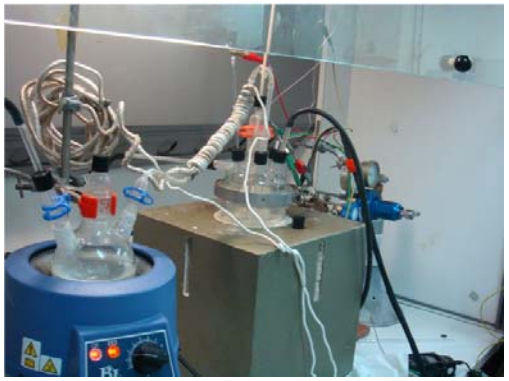
K. Uozumi's lecture, tomorrow, 9:30 AM

Salt recycling - Waste conditioning

FP decontamination in LiCl-KCl molten salt

Precipitation of FP under solid oxide

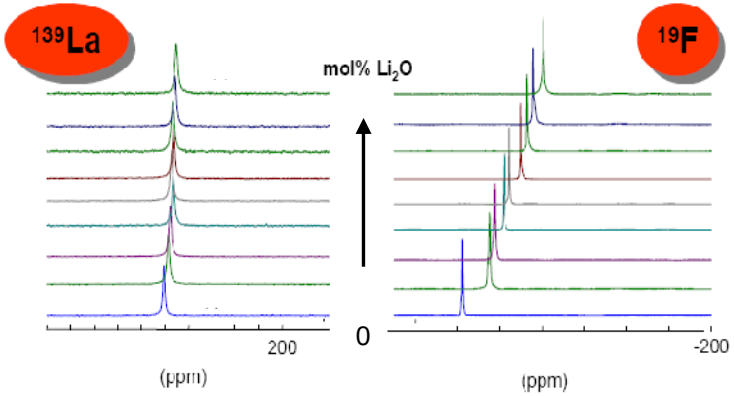
Zeolite Ion-Exchange for Salt Clean-Up



FP decontamination in fluoride molten salt

Distillation of molten fluoride

Decontamination by oxide precipitation



Ceramic waste form for chloride salt

Metallic waste form for the conditioning of metallic FP

Cross-cutting activities

“Brainstorming” Workshops

Two workshops organized in September 2008 during the Prague Meeting.

-Flowsheet calculation requirements

- Cross-Fertilization Seminar In Pyro-Chemistry

Two workshops organized in September 2009 during the Bologna Meeting.

-Requirements to implement a GANEX flowsheet

- Improvement of the electrorefining process flowsheet

-**Two Workshops organized in September 2010 during the Petten Meeting**

-Status on the GANEX Studies

-How to optimize the use of the organic synthesis manpower

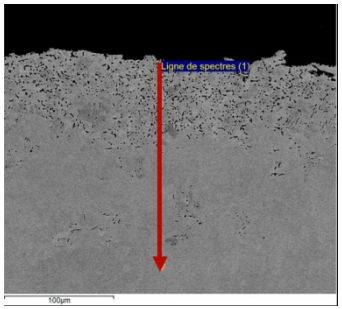
Introductive or illustrative presentation(s) followed
by open discussions and exchanges

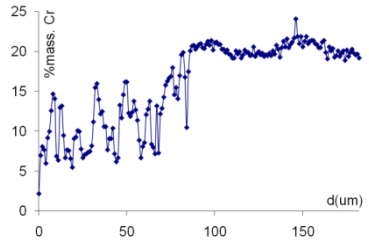
Helps the Project Coordination Committee to take decisions and to reorient/refocus the research program

Engineering studies

Scale-up issues

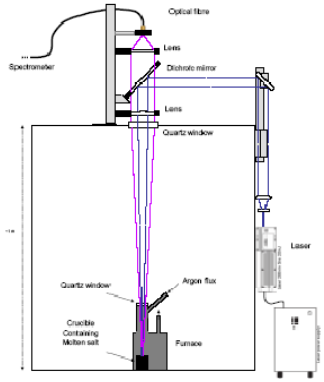
- Development of a device for drop-size measurement in centrifugal extractor in order to prepare the scale-up of this device
- Corrosion studies in molten salts

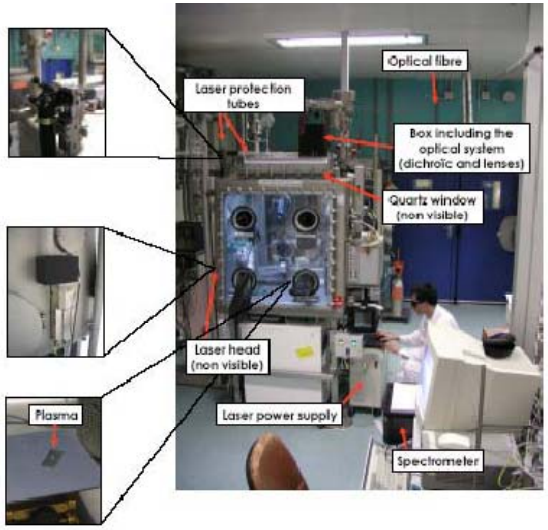




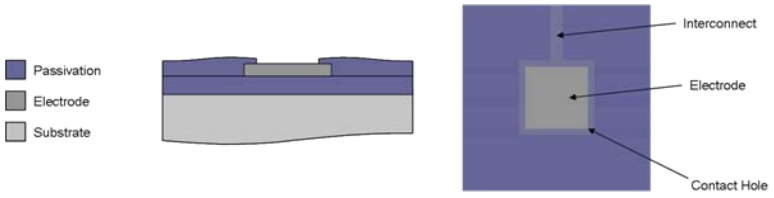
On line monitoring issues in molten salts

- Development of the laser induced breakdown spectroscopy in molten fluoride



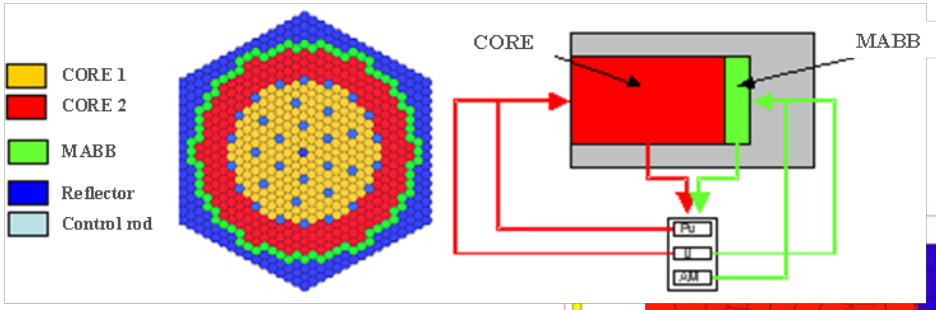


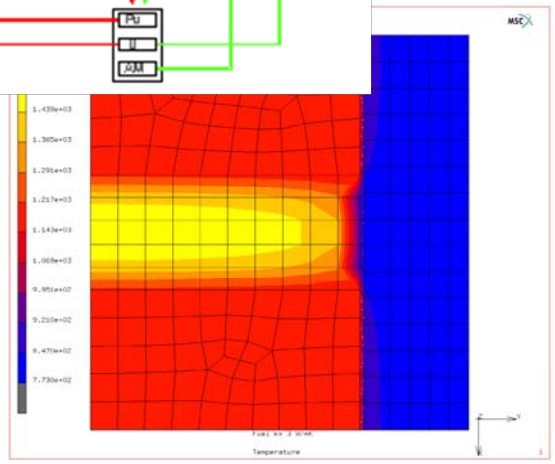
- Development of an electrochemical sensor in molten chloride



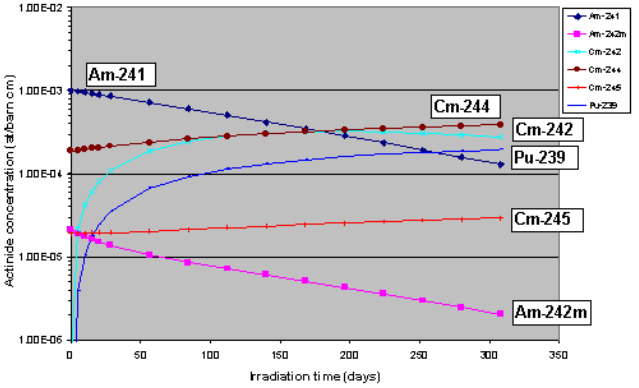
PROCESS – fuel and targets

Definition and design of the MARIOS experiment, now implemented within the FP7 FAIRFUELS Project





Actinide burn-up for $(U_{0.92}(Am,Cm)_{0.08})O_x$



Production of an orientation document on assessment and ranking of inert matrices in term of reprocessing capabilities and waste management.

•Towards an experimental program?

Expected outcome of ACSEPT in 2012

Exploratory Research

here
In pyro

Concepts selected
and validated

Several hundreds of molecules assessed

here
In hydro

Demonstration experiments

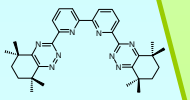
Scale 1/10000

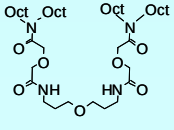
The next
step?

Simplification
« **Consolidation** »

Scale 1/1000

**integration,
long-lasting performance
representativeness,**





Towards potential industrialization

Education and training

Fostering visibility/dissemination

on the 2nd year of the project:

Attending International Conferences
around 40 oral contributions
Global 2009, 238th ACS Meeting, Actinide 2009, 239th ACS Meeting, ICAPP 2009, ACHEMA 2009,MRS'09

Publishing in journals
more than 10 papers (in addition to proceedings)
Radiochimica Acta, Solvent Extraction and Ion exchange, Journal of Nuclear Materials, Dalton Transactions...

Two patents

Investing in people

Attribution of ACSEPT Post-doctoral grants (2 up to now)
(50k€ grant)

Funding mobility of students between Partners (7 up to now)
1 to 3 month periods
(2000€/month)

New!

Dissemination of knowledge

• Promote the participation of students to seminars, scientific workshops or summer schools (contribution to travel and accommodation costs)

•Invite lecturers during ACSEPT meetings.

•Organise specific scientific workshops

Solvent extraction (Jan Olov Liljenzin)
Radiolysis (Bruce Mincher, Steve Mezyk)
Actinide materials (Joe Sommers)
Analysis (Melissa Denecke)
Computational chemistry (Bernd Schimmelpfennig, Enrique Sanchez Marcos)

1st AIWO, March 2010 Lisbon

More than 120 participants

44 oral communications, among them:

12 invited lectures (international experts)

18 contributions from ACSEPT Young Scientists

7 contributions in the ISTC-ACSEPT pyro session

All the sessions chaired by the young generation

All the presentations on our website!

Organized in cooperation with the International Atomic Energy Agency

ACTINET-I3, a tool for networking in actinide sciences

At this occasion:

1st exchanges with J-Actinet

A panel discussion on hot facilities and experimental needs in Europe

Thank you for your attention