DE LA RECHERCHE À L'INDUSTRIE

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Overview of the Main Achievements of the FP7 EURATOM Collaborative Project ACSEPT

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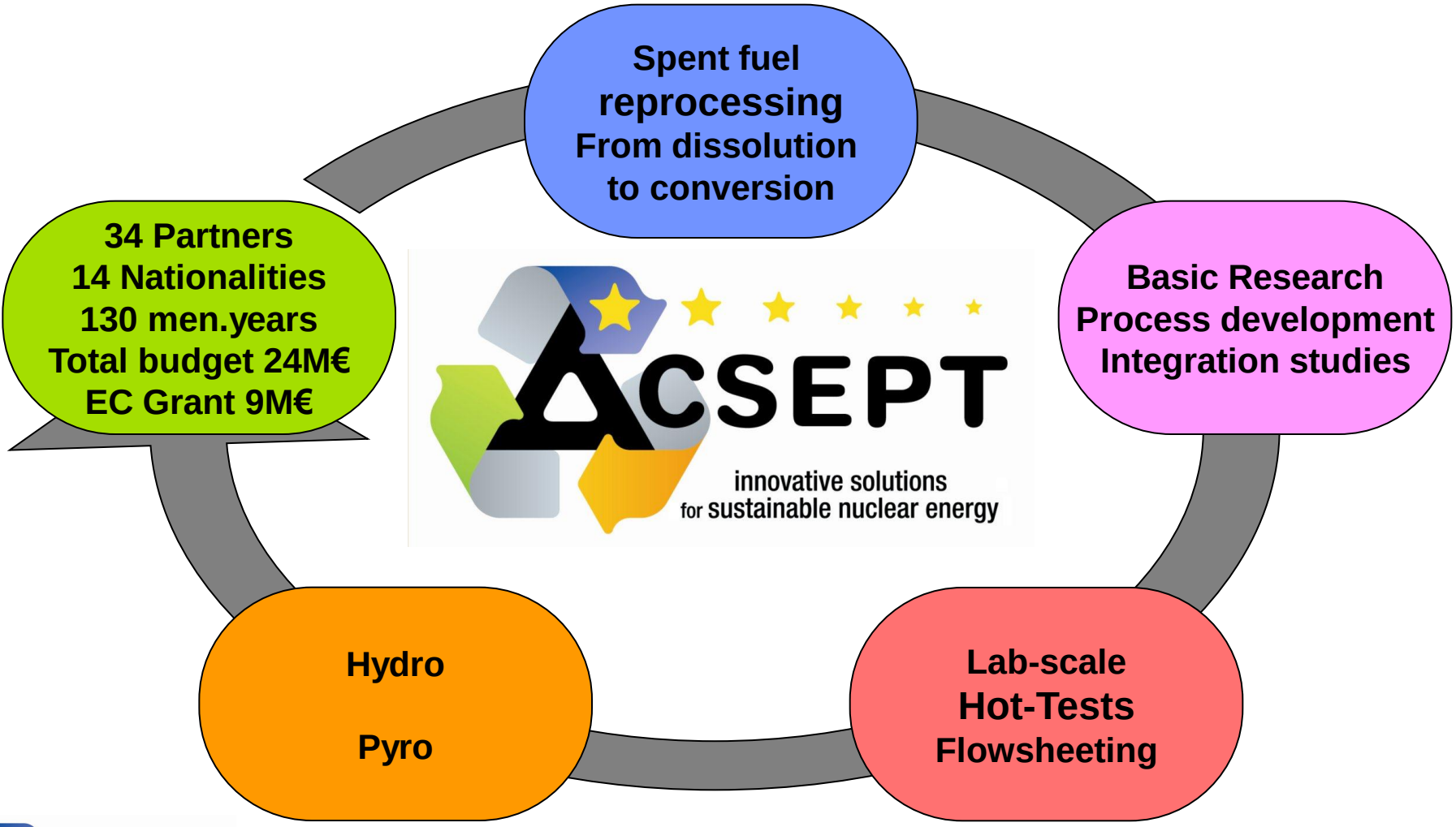
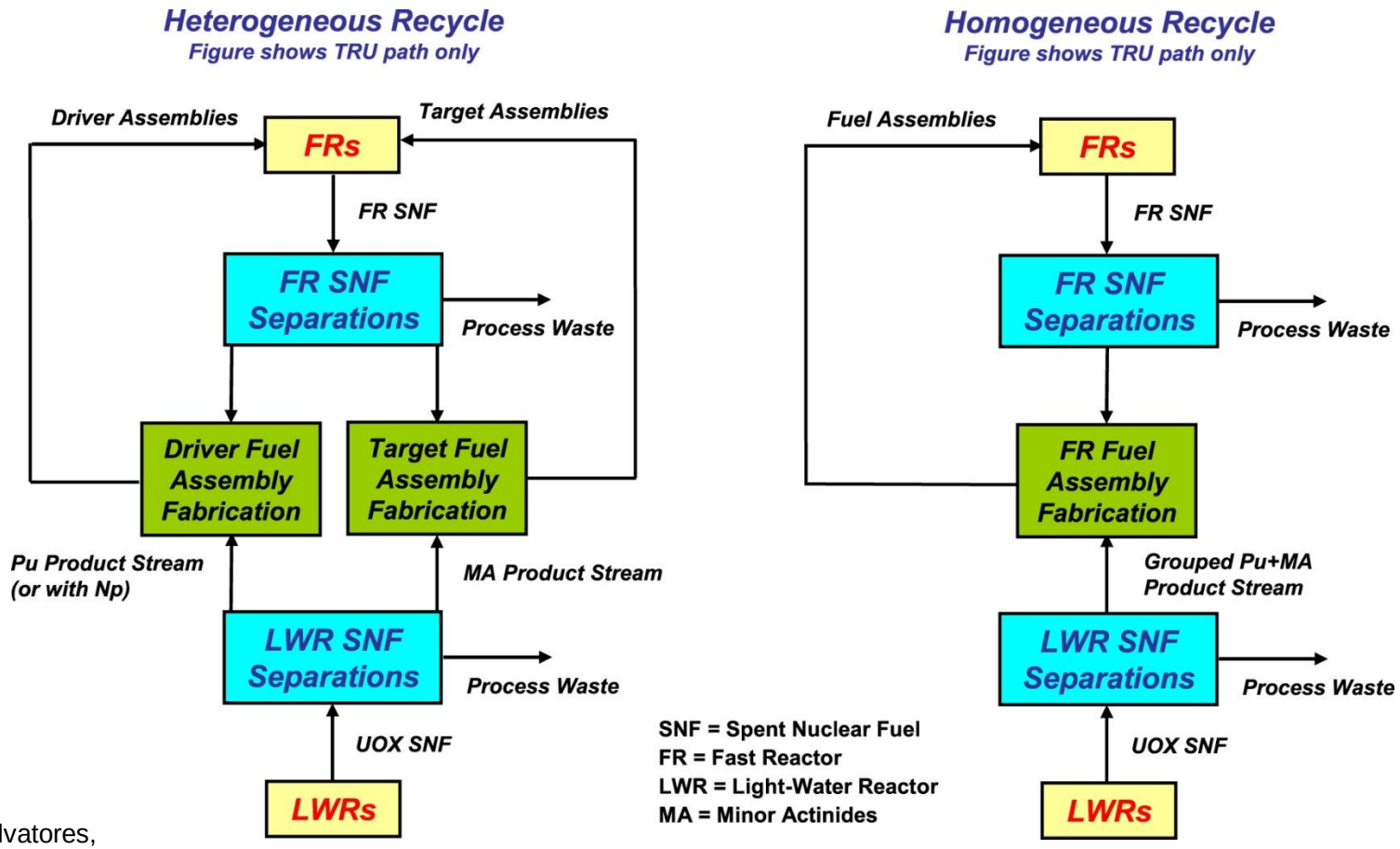
and Collaborators

afaq QSE Qualité Sécurité Environnement AFNOR CERTIFICATION ISO 9001 - OHSAS 18001 ISO 14001

ACSEPT at a glance

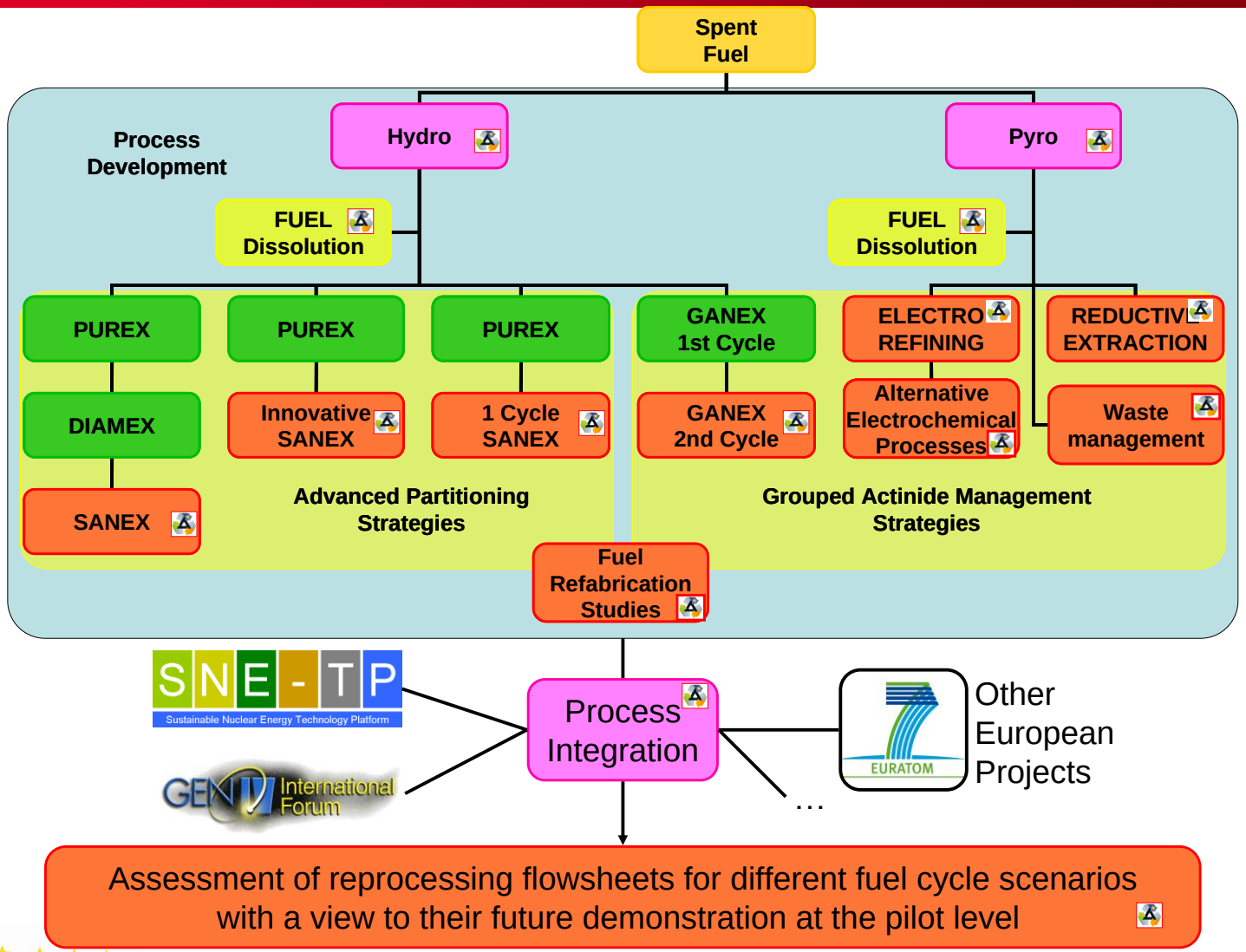


Advanced Fuel Cycles with Minor Actinide Transmutation



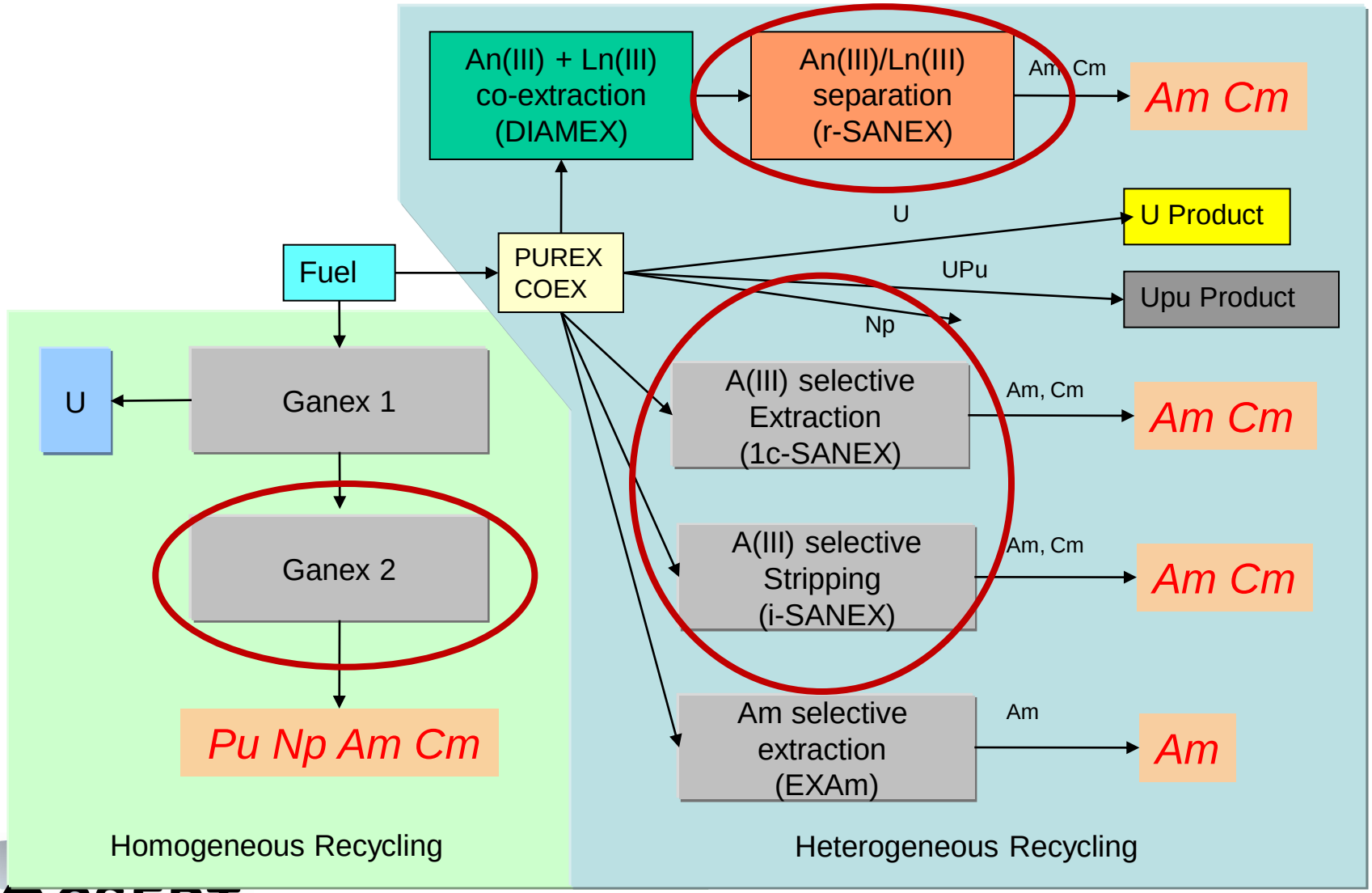
M. Salvatores,

The Objectives



Aqueous Reprocessing

The different reprocessing schemes based on liquid liquid extraction



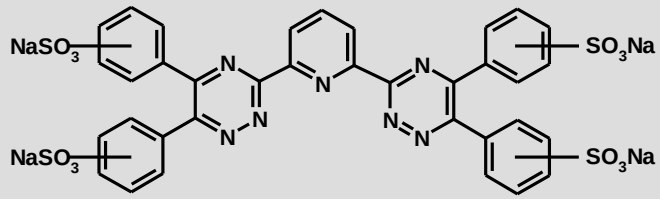
Ligand Design and Assessment

≈ 150 new compounds

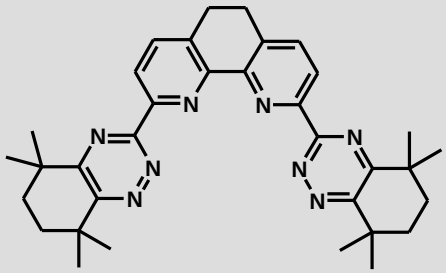
¾ lipophilic extracting agents

¼ hydrophilic complexing agents

Improvements

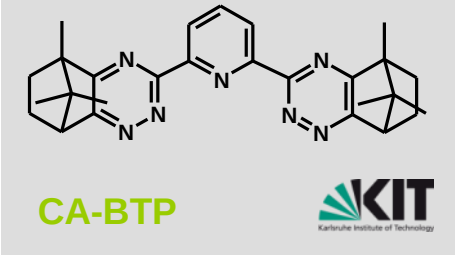


SO_3-Ph-BTP

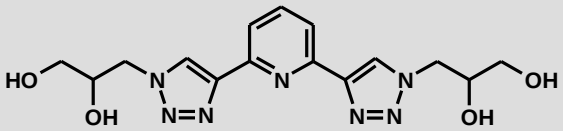


$CyMe_4$-BTPhen

University of Reading



CA-BTP



PyTri-Tetraol

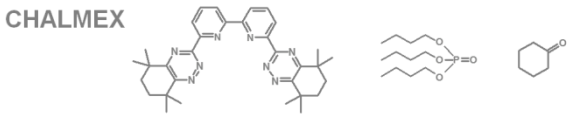
UNIVERSITÀ DEGLI STUDI DI PARMA

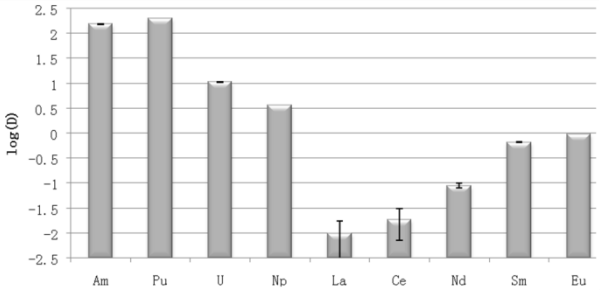
7 teams involved in organic synthesis

ACSEPT innovative solutions for sustainable nuclear energy

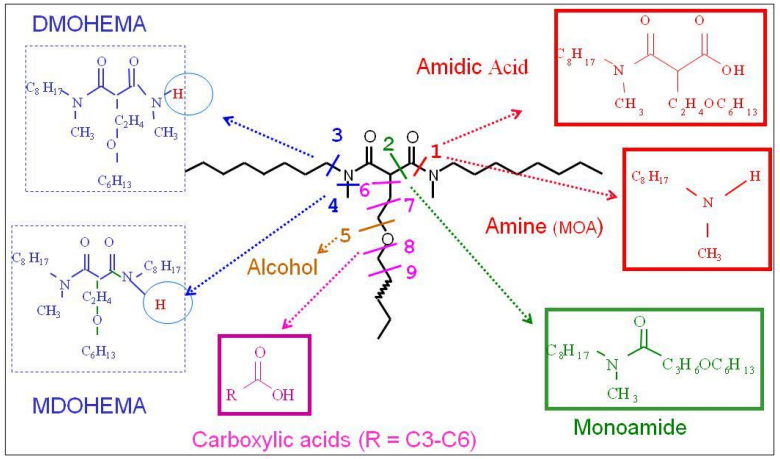
Process development

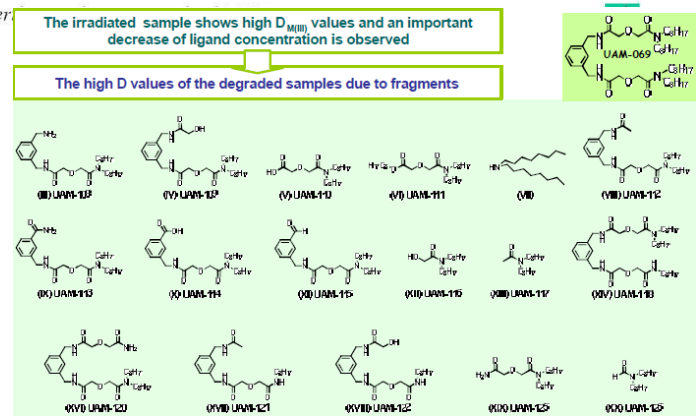
CHALMEX





Solvent design and optimisation





Radiolytic stability

Kinetics

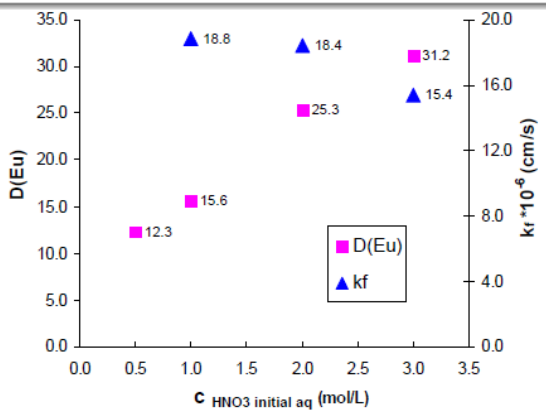


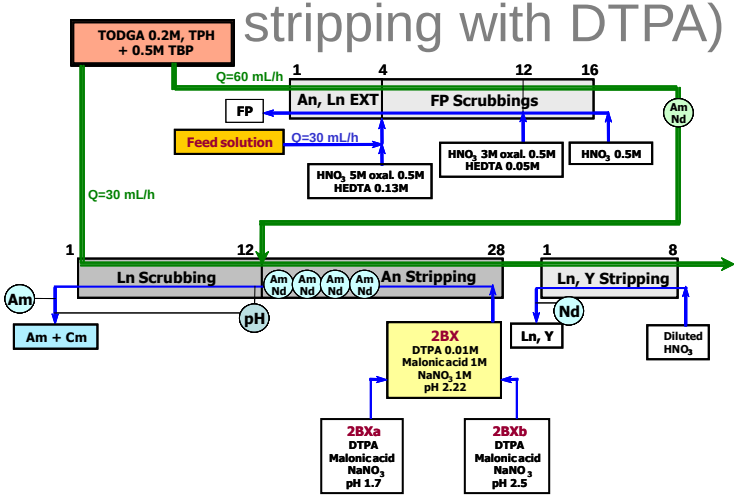
Figure 1: Variation of D and k_f with HNO_3 concentration in the case of 0.01 mol/L $CyMe_4$-BTPhen diluted in 3-methylcyclohexanone (pre-equilibrated).

innovative solutions for sustainable nuclear energy

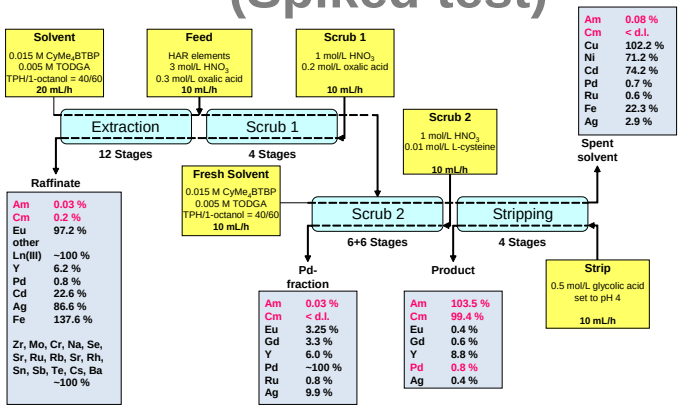
4 Demonstrations (3 hot-tests)

BTBP SANEX At ITU (2008)

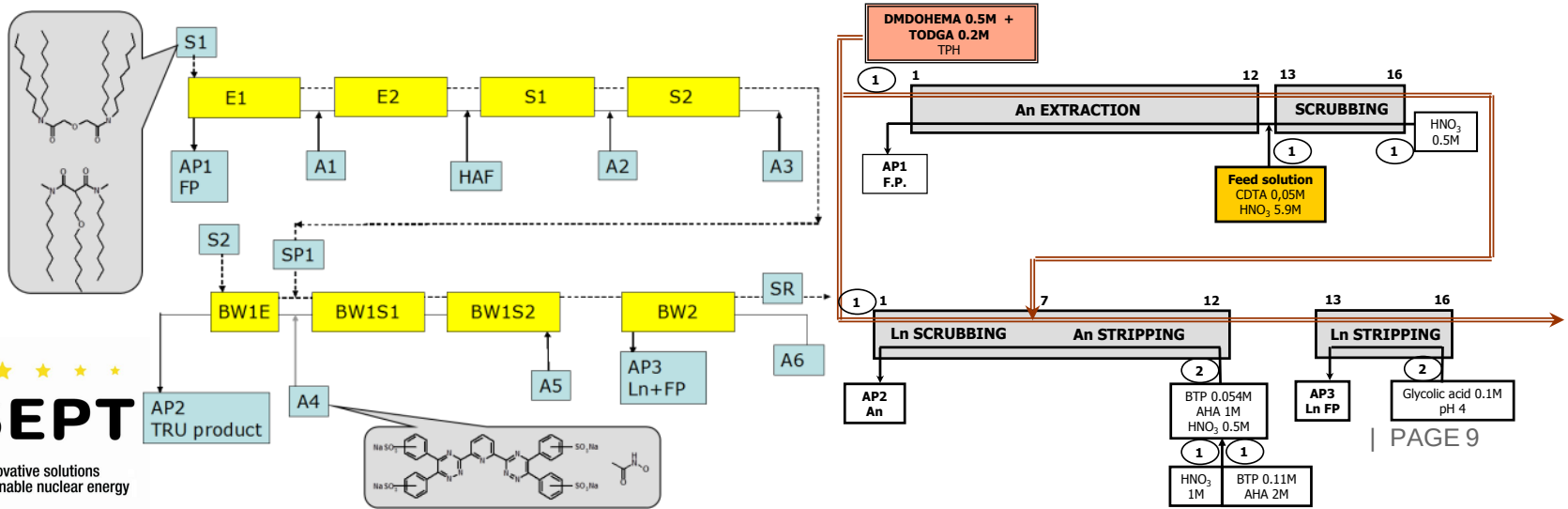
i-SANEX (2009) (selective An(III) stripping with DTPA)



1c-SANEX (2011) (Spiked test)



NNL-GANEX (2012) Flow sheet

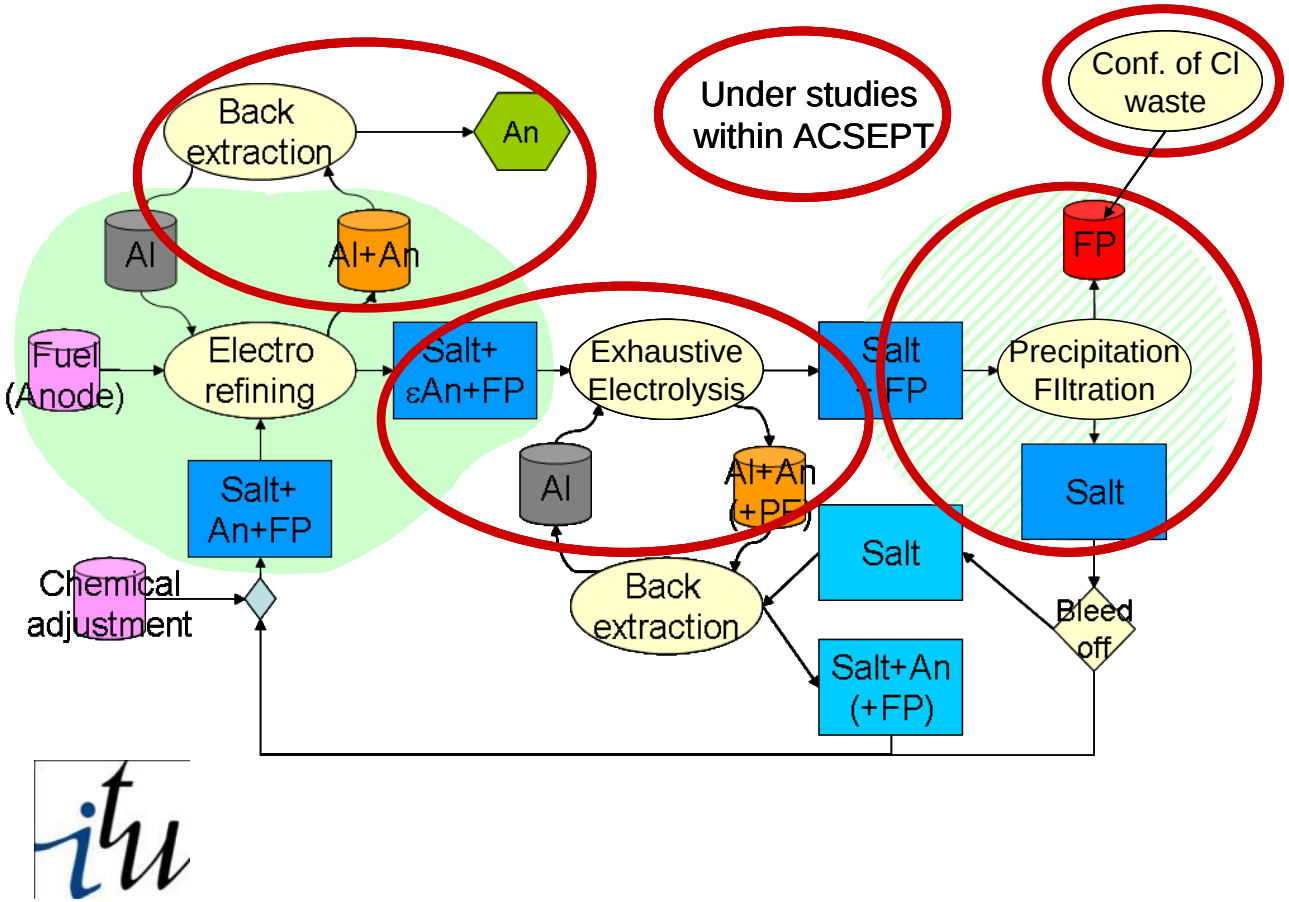


Pyrochemistry

Electrorefining in molten chloride

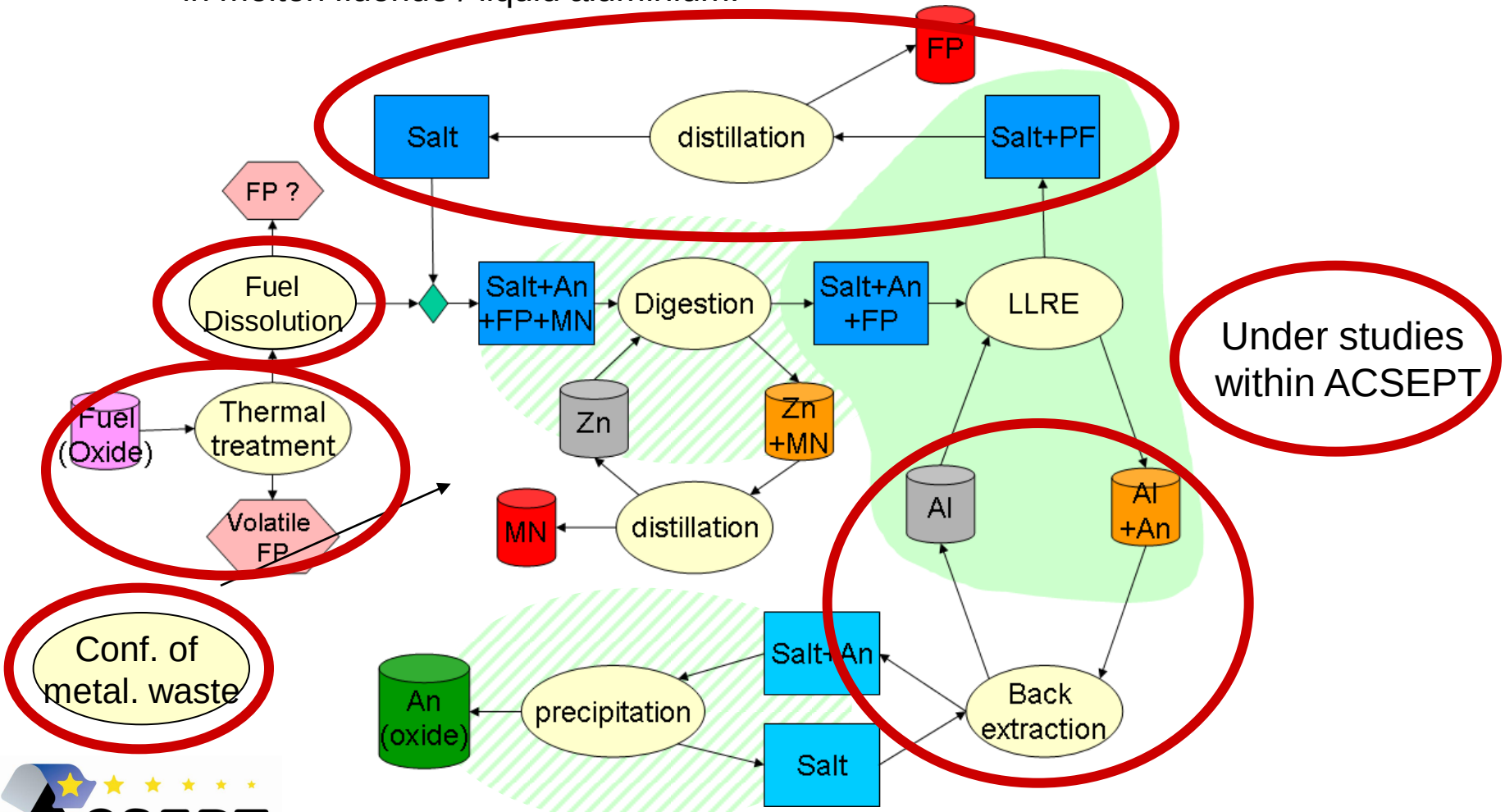
•Based on the IFR concept (USA), the process is centered on the selective electrorefining of An on solid aluminium cathode in molten chloride

- Quantitative recovery not achievable by electrorefining alone
- exhaustive electrolysis step and salt recycling under studies
- Actinide back-extraction from Aluminium is deeply studied



Liquid-liquid reductive extraction

- This process is centered on the selective extraction of An in molten fluoride / liquid aluminium.



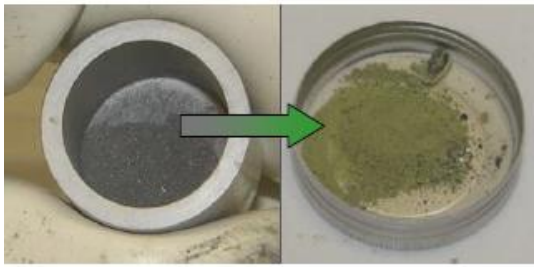
An back-extraction from aluminium

Chlorination process

Distillation
Removal of the remaing salt on the An-Al alloy
1000°C, 10^{-5} bar
Efficicient except for a few FP ($MoCl_2$, $SrCl_2$, $BaCl_2$)

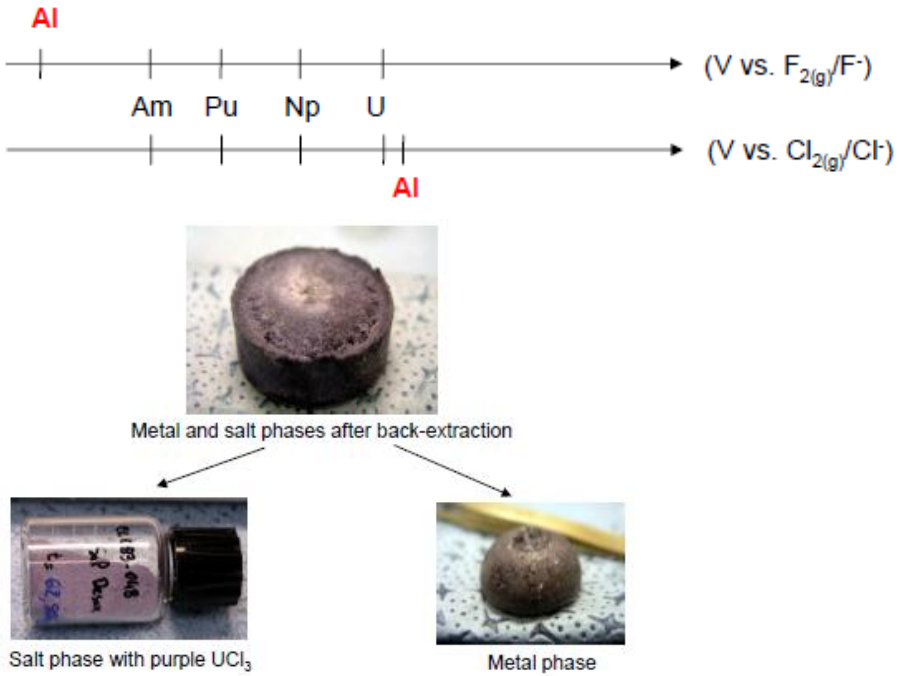
An Chlorination with Cl_2
150-170°C, low (An,Al)/Cl_2 molar ration
Full chlorination, no volatilization of An

Sublimation
Removal of $AlCl_3$
200-400°C, inert atmosphere
Efficient without removal of $AnCl_x$



Liquiq-liquid Oxydative Extraction in molten chloride

Back extraction of An from Al
$AlCl_3$ as oxydant
U: the most difficult An to recover



Salt recycling - Waste conditioning

FP decontamination in LiCl-KCl molten salt

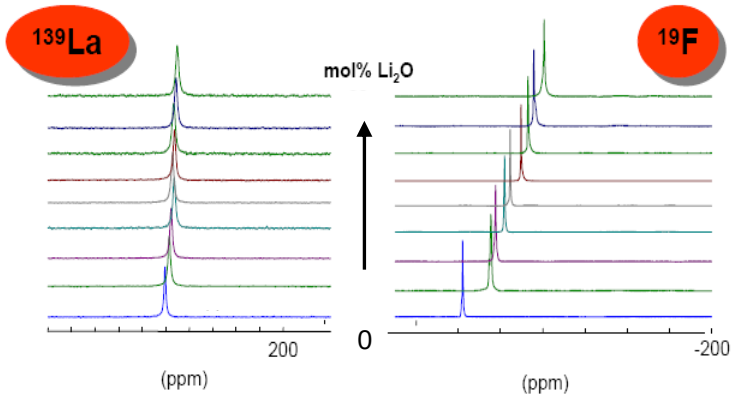
Precipitation of FP under solid oxide with a gaseous reagent

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

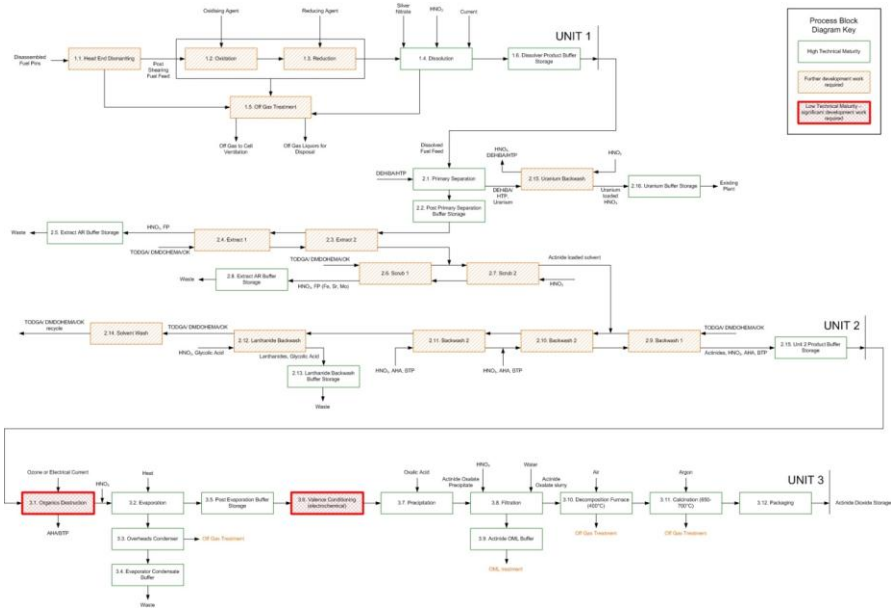
Sodalite not suitable for HLLW
Chloroapathite looks more promising

Metallic waste form for the conditioning metallic FP

Formulation of a Cu-Ni Alloy
First ageing tests promising

Integration studies

Integration studies



state of the art and associated design for the ACSEPT pilot plant which will undertake group actinide separation from GEN IV feed fuels and convert them into new feed fuels for return to the fuel cycle

Estimation of Spent Fuel Burn-up Based on the Plenum Gas Analysis

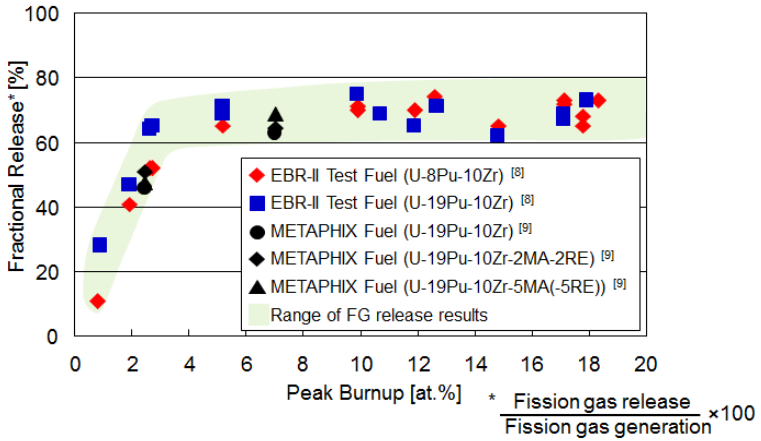


Fig. 8 Burnup dependence of the fission gas release fraction

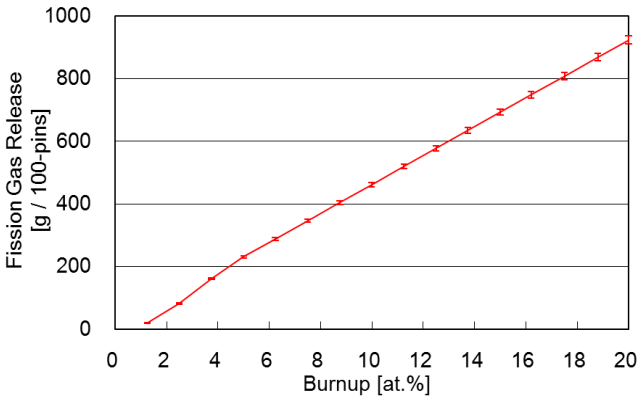
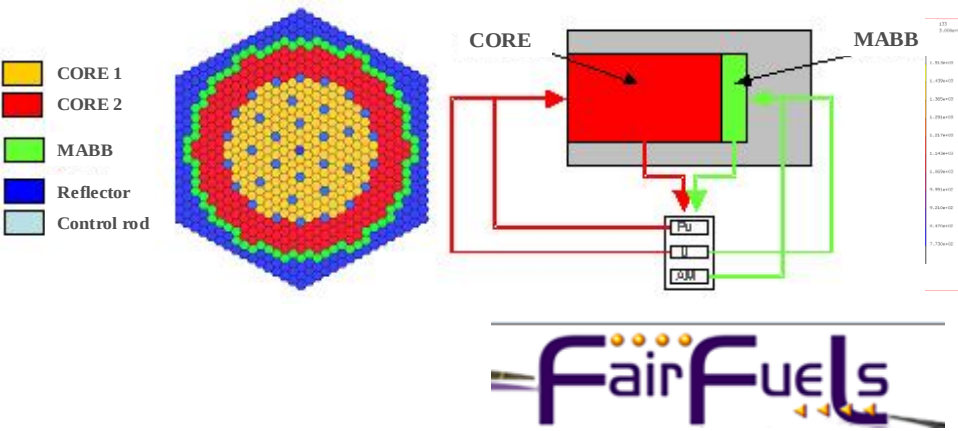
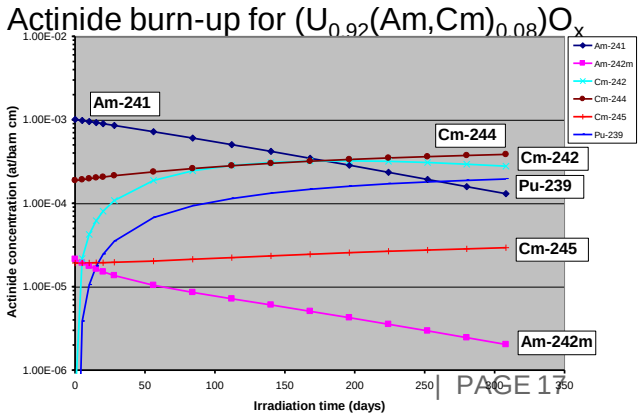


Fig. 9 Burnup dependence of fission gas release from 100 pins of spent fuel

Integration studies

Definition and design of the MARIOS irradiation experiment, to be implemented within FP7 FAIRFUELS





System studies for the treatment of MgO, Mo, UO_2 based actinide bearing matrices: assessment of reprocessing capabilities & waste management

ASGARD
Advanced fuelS for Generation IV reActors: Reprocessing and Dissolution

ACSEPT
innovative solutions for sustainable nuclear energy

Training and Education

Education and training

- More than 30 students contributed to the work (PhD, Post-doc)
- Attribution of two ACSEPT Post-doctoral grants
- Funding mobility of students between Partners (about 15)
- Supporting the participation of ACSEPT students to seminars, scientific workshops or summer schools
- Inviting lecturers during ACSEPT meetings,
- Organising specific scientific workshops (more targeted audience)
- 2 training sessions with ISTC (Madrid – with KAERI - and Dimitrovgrad)

Dissemination

More than **70 papers** in 24 journals with peer review
More than **130 oral presentations** in 35 international conferences
About **50 posters**
About **100 proceedings**

One international workshop (Lisbon 2010) –
“give the floor to the young generation”









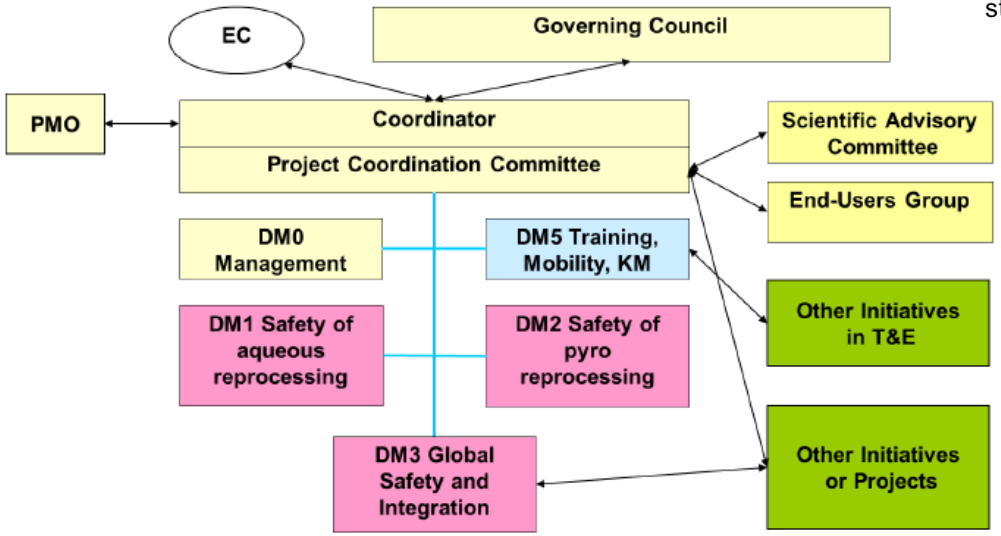

One specific session of Atalante 2012

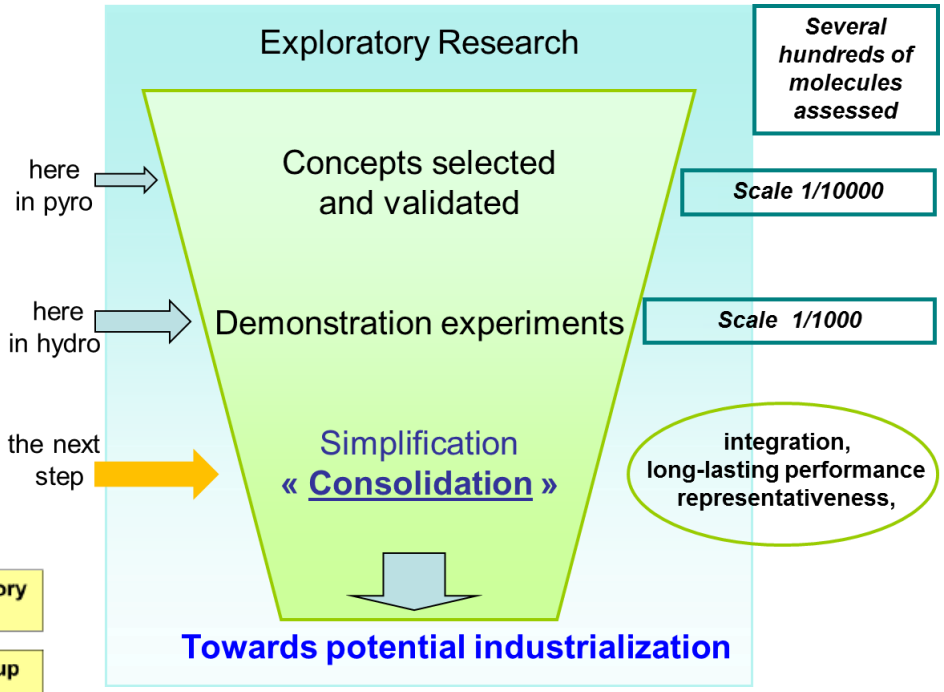
The Future!

Thankfully, the story will continue…

SACSESS

Safety of actinide separation processes

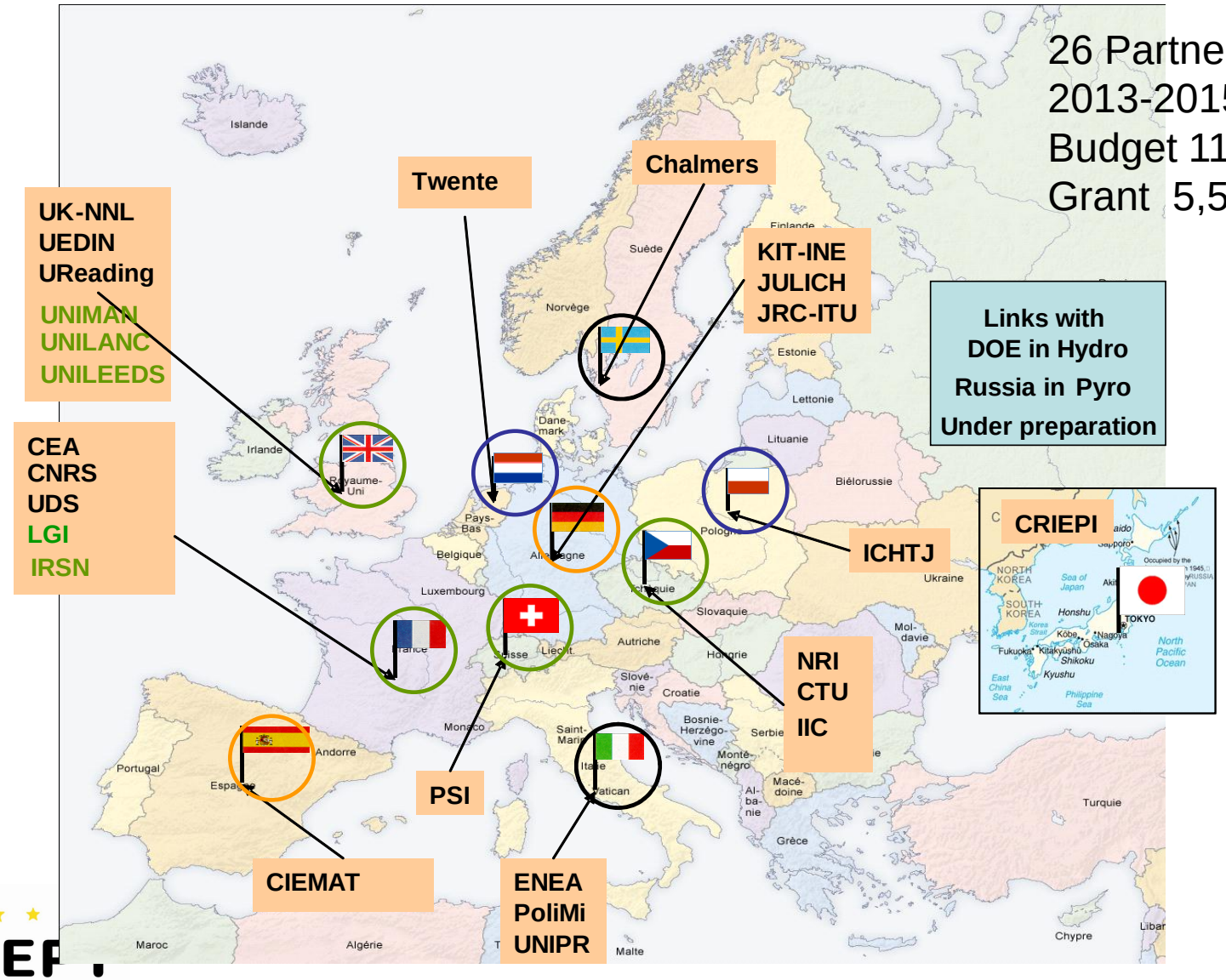




Collaborative project
Safety oriented
Optimisation of selected separation processes

ACSEPT innovative solutions for sustainable nuclear energy

SACSESS Consortium



26 Partners
2013-2015
Budget 11 M€
Grant 5,55 M€

innovative solutions for sustainable nuclear energy

Conclusion

- 4 consolidated flowsheets (r-SANEX, i-SANEX, 1c-SANEX, GANEX2)
- 3 hots-tests, 1 spiked test (hydro)
- A huge amount of work in organic synthesis and screening (hydro)
- The best candidate ligand families considered as identified (hydro)
- Relevant options for exhaustive electrolysis and actinide back-extraction from aluminum identified (pyro)
- Relevant options for salt purification and waste conditioning (pyro)
- Progresses in head-end steps
- Outputs for other FP7 projects
- High involvement in T&E issues
- High level of dissemination

Sylvie Bouvet (ALCAN), Concha Caravaca (CIEMAT), Laurent Cassayre (CNRS), Giorgio de Angelis (ENEA), Christian Ekberg (Chalmers), Amparo Espartero (CIEMAT), Danny Fox (NNL), Andreas Geist (KIT-INE), Philippe Guilbaud (CEA), Mike Harrison (NNL), Clément Hill (CEA), Frodo Klaassen (NRG), Rikard Malmbeck (ITU), Chris Rhodes (NNL), Robin Taylor (NNL), Emmanuel Touron (CEA)

Thank you for your kind attention

SACSESS
Safety of actinide separation processes

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