



## Progress status on pelletized and sphere-packed Am-bearing oxide fuels developments

F. Delage, S. Bejaoui, S. Lemehov, W. Maschek, J. Somers

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F. Delage & S. Béjaoui (CEA), S. Lemehov (SCK•CEN), W. Maschek (KIT), J. Somers (JRC/ITU)

on behalf of the consortium



### Objectives

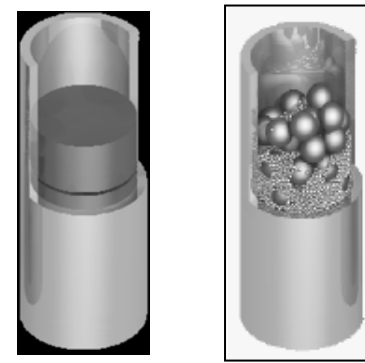
#### Compare spherepacked and pelletized MA-bearing oxide fuels

##### - Fabrication process developments

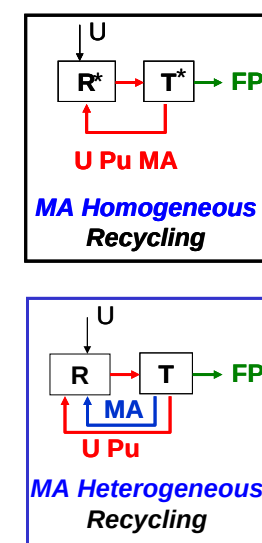
##### - Behaviour under irradiation:

- Post-Irradiation Examinations
- Semi-integral irradiation test
- Modelling and simulation

##### - SFR core preliminary design & safety performance



#### Considering 2 MA-recycling options:



##### - MA homogeneous recycling

→ MA bearing Driver Fuels (MADF):  $(U,Pu,MA)O_{2-x}$ , MA < 5%

##### - MA heterogeneous recycling:

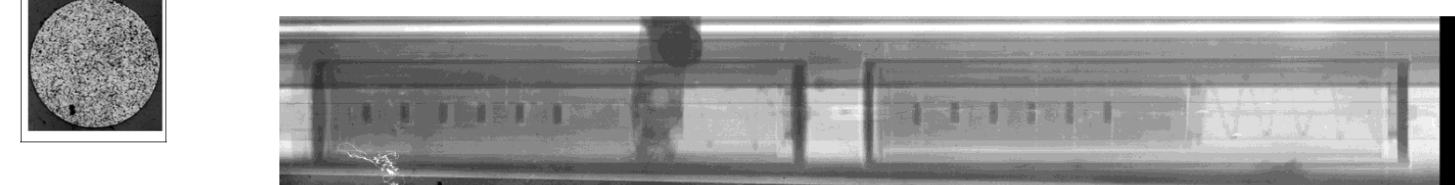
→ MA Bearing Blankets (MABB):  $(U,MA)O_{2-x}$ , MA ~10-20%

### Experiments on (U,Am)O<sub>2</sub> fuels

#### • PIE of MARIOS pins (irradiated in HFR within FP-7 FAIRFUELS)

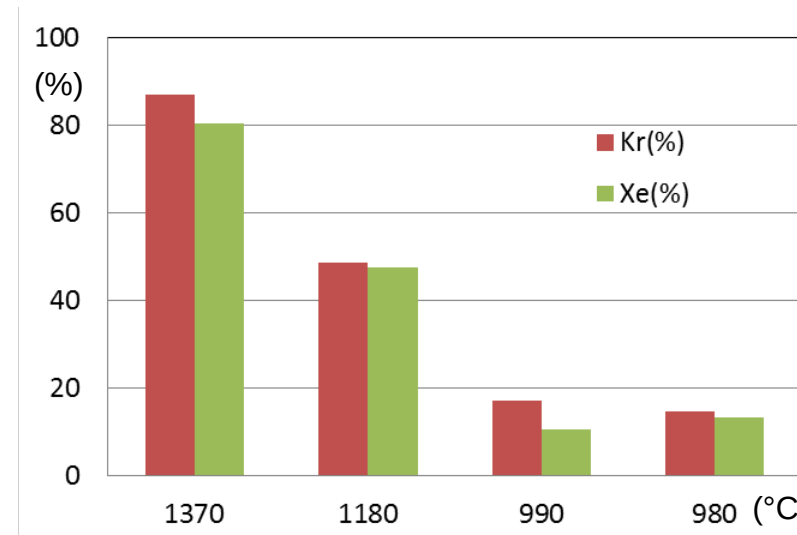
##### → Measurement of He release and U<sub>0.85</sub>Am<sub>0.15</sub>O<sub>2-x</sub> swelling

- Fuel samples kept at constant T° during ~300 EFPD
- 2 microstructures: regular vs tailored porosity



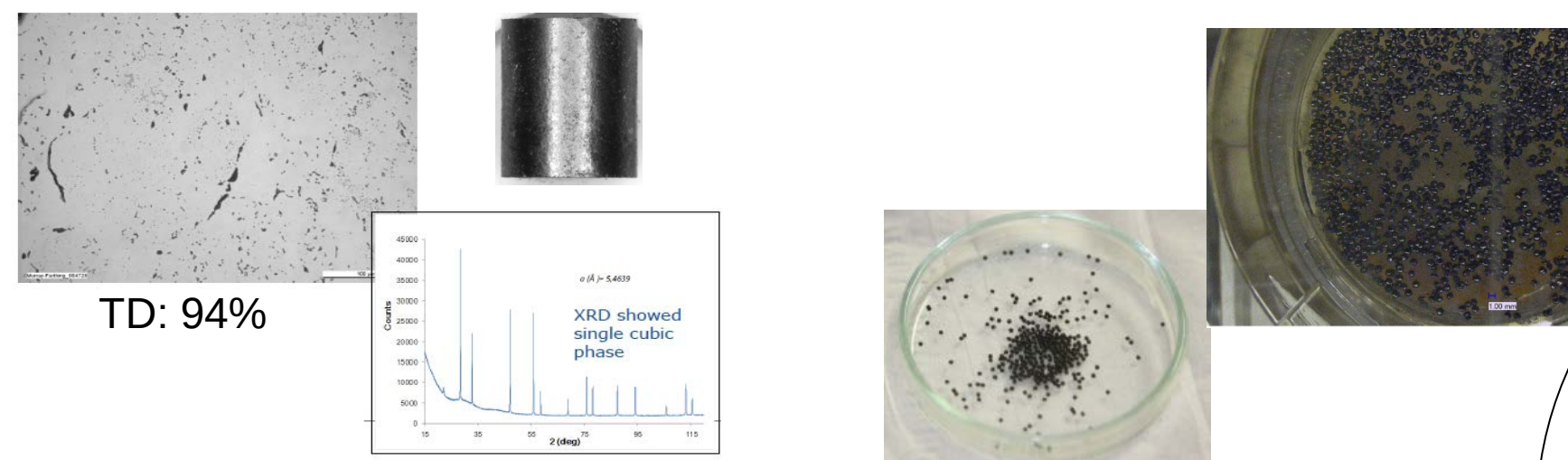
- ~100% helium released
- Strong T° dependence of FG release

##### → Next step: fuel density & microstructure



#### • Design, manufacture and implementation in HFR of MARINE

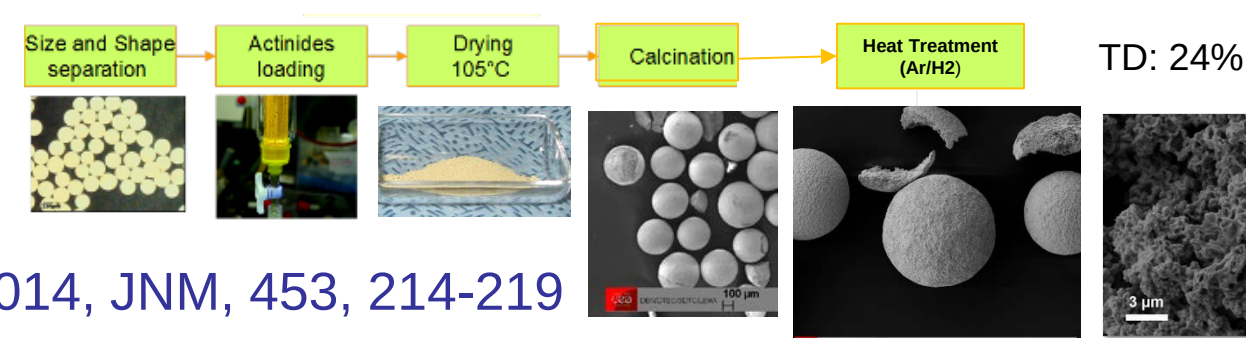
→ 2 stacks of U<sub>0.85</sub>Am<sub>0.15</sub>O<sub>2-x</sub> pellets & beads (800 μm + 50μm) respectively in instrumented pins to be irradiated in HFR under similar conditions (300 EFPD, ~1000°C at EOI)



##### → Irradiation start expected by 4<sup>th</sup> term 2014

#### • Investigation of the Weak Acid Resin route

##### → U<sub>0.9</sub>Am<sub>0.1</sub>O<sub>2-x</sub> beads



→ E. Remy et al., 2014, JNM, 453, 214-219

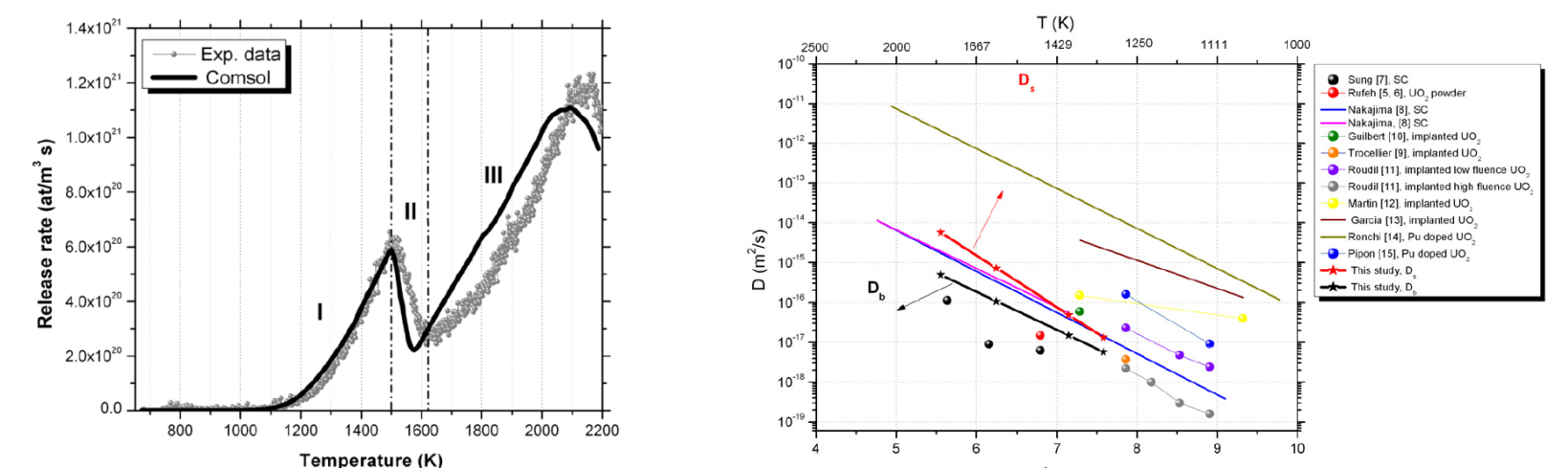
### Modelling & Simulation of fuel behaviour: pelletized & spherepacked MADF & MABB fuels

##### → Upgrades of fuel-performance calculation codes GERMAL(CEA),

MACROS(SCK-CEN), SPHERE/SPACON(PSI) & TRANSURANUS(ITU)

- Collection of experimental data
- Development + implementation in codes of models & correlations describing relevant phenomena

→ ex.: He release mechanisms (Z. Talip et al., 2014, JNM, 445, 117-127)



→ Last step: recalculation of SPHERE irradiation : MADF - pellets & sphere-packs & SUPERFACT-1: pelletized MABB-type fuels irradiated in PHENIX in the 1990's

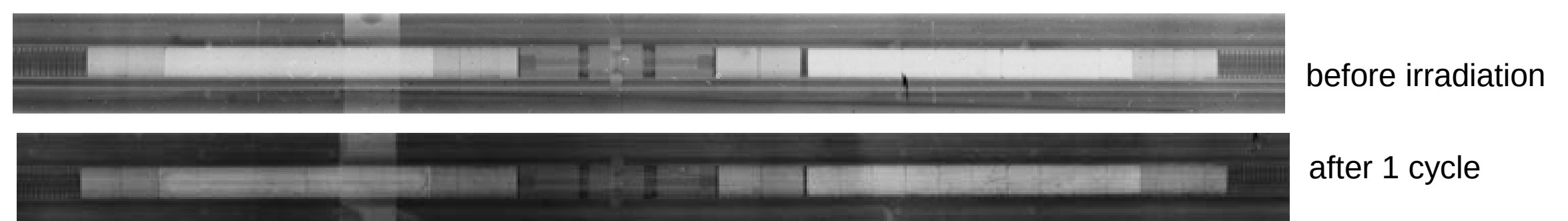
### Experiments on (U,Pu,Am)O<sub>2</sub> fuels

#### • PIE of SPHERE pins (currently under irradiation in HFR within FP7-FAIRFUELS)

##### → Influence of Am on performance of (U,Pu)O<sub>2-x</sub> fuel shaped as pellets & microspheres

- U<sub>0.76</sub>Pu<sub>0.21</sub>Am<sub>0.03</sub>O<sub>1.98</sub> synthesized by sol-gel processes
- 2 stacks : pellets & beads of 2 size fractions (50 & 800μm)
- Tailored spectrum (Hf shielding), ~330 W.cm<sup>-1</sup>, T<sub>clad</sub> ~530°C, up to 5at% (~May 2015)

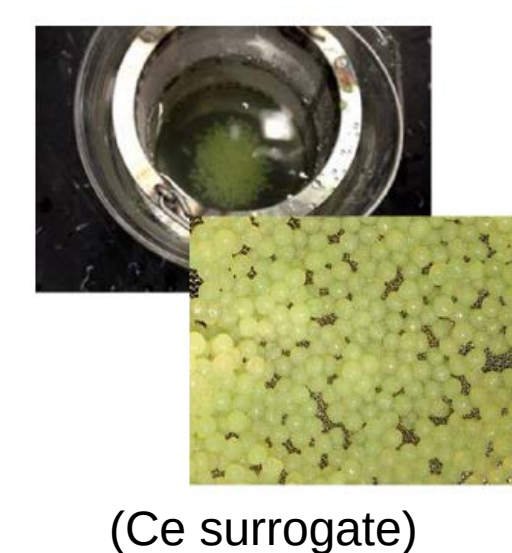
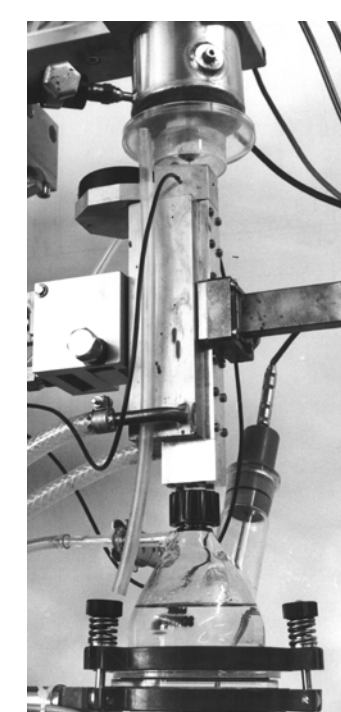
##### → Neutron-radiography results (courtesy of FP-7 FAIRFUELS)



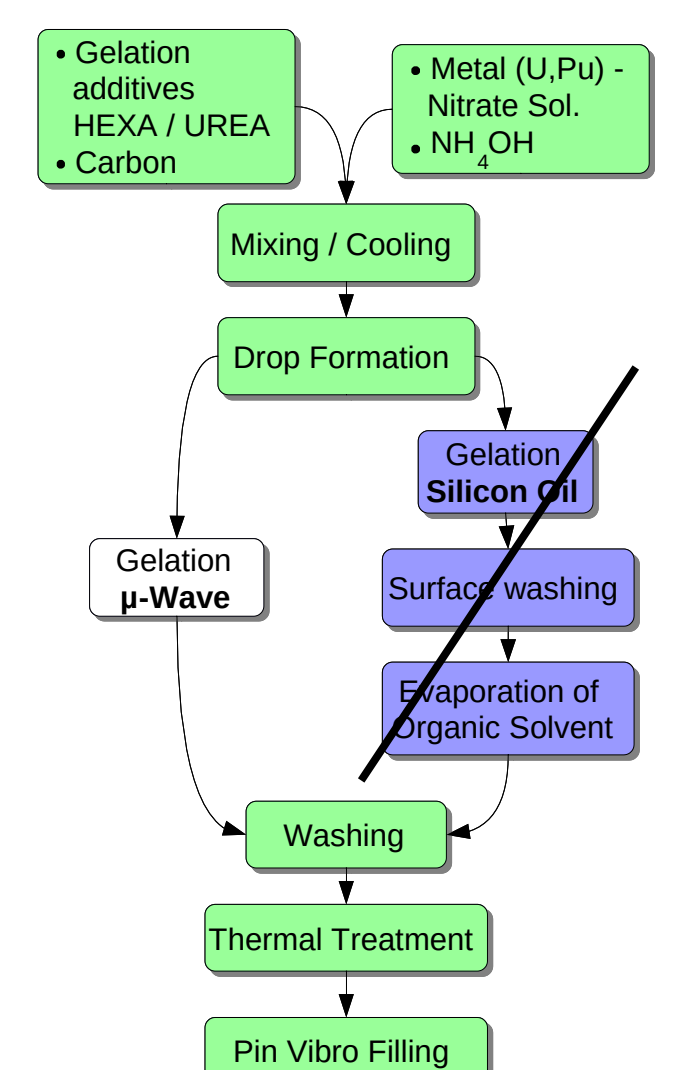
##### → NDE start by 2<sup>nd</sup> semester 2015

#### • Investigation of microwave internal gelation

##### → Simplification of sol-gel fuel fabrication processes



(Ce surrogate)



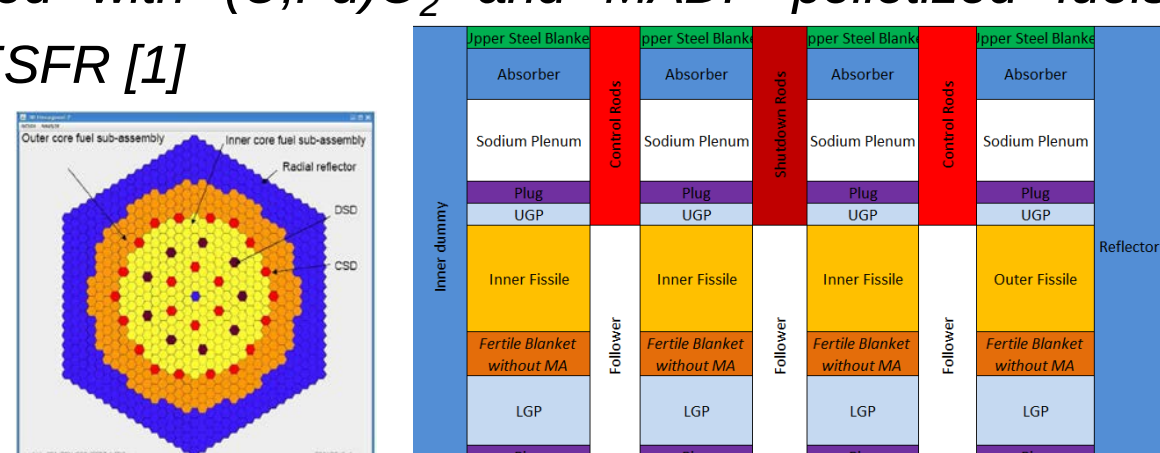
### Pre-design & safety performance of a spherepacked MADF fuelled SFR core

##### → Linking spherepacked shaped fuel fabrication and irradiation behaviour to problematic of core physics, design and safety performance

- Review of core fuelled with (U,Pu)O<sub>2</sub> and MADF pelletized fuels designed in FP-7 CP-ESFR [1]

[1] A. Rineiski et al., 2013, Proceedings conf. FR-13, ref. IAEA-CN-199-399

##### → core OO-ESFR



- Assessment of the sphere-packed fuel impact: fuel density ? Margin to fuel melting ? Thermal conductivity ?

→ L. Andriolo et al, 2013, proceedings conf. INES-4 (Tokyo, 2013)

→ On-going: collection and review of basic data & preparation of safety codes (RELAP5-3D, SIMMER-III, SAS4A, LPS & MAT5DYN)

### Education & training

- Placement of trainees in Master year for 6 months in organisations involved in PELGRIMM

→ 5 internships (year 2014) for contributions to RTD actions related to the project

- Financial support to PhD students & Post-Doctorates to attend summer schools, conferences, workshops, ...

→ 9 grants already allocated (application forms available on <http://www.pelgrimm.eu/>)