**"*MOX FUEL FOR FAST REACTORS : high level of flexibility towards plutonium management and minor actinide transmutation”***

**By Nathalie Chauvin, CEA**

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 **About the lecture**

All Within the GENERATION IV initiative, several reactors have been selected : sodium fast reactor SFR, lead or lead-bismuth fast reactor LFR, advanced driver system ADS, gas fast reactor GFR, very high temperature reactor VHTR and molten salt reactor MSR.
Innovative fuels have been selected especially for the fast neutron reactor (SFR, LFR and GFR) : it’s ceramics like oxide mixed (U,Pu)O2 or mixed nitride (U,Pu)N or mixed carbide (UPu)C and also metal fuel UPuZr.

There is a long experience on fast reactors since the 50’s, of using oxide fuel.

Now the Fast reactors in operation are mainly loaded with oxide fuel : in Russia with BOR60, BN600, BN800, in Japan with JOYO, in India with FBTR and in China with CEFR and CFR600.

The performances for the evaluation are focused on the capability to reach high burn-up and the flexibility towards various operating conditions : this means for example the ability to operate at lower power or lower temperature ranges.
Secondly the behavior in case of transients up to severe accidents are the most important factors to take into consideration.

Criteria related to the fuel cycle are the cost of fabrication and reprocessing, which will make the difference. In the case of closed fuel cycle, the ability to manage the plutonium and to burn minor actinides  is very important.

Fast reactors are flexible towards the cycle and the associated scenarios with different assumptions of the nuclear park. This is the unique system that can offer this.

The ability of MOX fuel in FR to burn, to breed or to multirecycle plutonium have been demonstrated. The European project PuMMA has recently provided data towards the impact of Pu management on the whole fuel cycle.

Towards transmutation of minor actinides and for heterogeneous fuel, with Inert Matrix Fuels  a comprehensive database thank to ~35 experiments have been achieved in MTRs & PHENIX with promising results . Now there is less interest due to transmutation performances reduced. As inert matrices are very difficult to be reprocessed, a once-through strategy is adopted and the transmutation rate in one way remains lowest compared to the performances obtained with homogeneous mode transmutation or minor actinides bearing blankets.

Minor Actinides Bearing Blanket is  a promising solution but at an early stage of development. Analytical irradiations, fabrication R&D and adapted fuel design should progress in the coming years for a future evaluation. Front end and back end of the fuel cycle are strongly affected by MABB Sub Assembly composition. An adapted and probably innovative design of the fuel Sub-Assembly and of the fuel element should answer to these technological aspects.

On the homogeneous mode of transmutation, fuel performances seem to be not affected by americium loading but a full demonstration is still needed with representatives Linear Heat Rate, high burn up and the final fuel element design.

**About the lecturer**

Nathalie Chauvinis working at CEA Cadarache IRESNE in the fuel Studies Department International Expert on fuels for fast reactors.

She worked for a long time on the minor Actinides transmutation program, participating to the optimization of the fuel design, the irradiation experiments and the synthesis reports.

Then she was project manager for the development of very innovative fuels for the Gas cooled Fast Reactor with oxide/carbide fuels, refractory cladding including ceramic composites one for pin or plate type fuel element.

She is now in charge of international cooperations devoted to fast reactor fuels development as –

* Chair of the Working Party on the Fuel Cycle at OECD/Nuclear Science Committee;
* Chair of the Expert Group on Innovative Fuel Element at OECD/NSC/WPFC;
* Coordinator of PUMMA project at EURATOM H2020
* French representative in the CRP on Fuels and Materials for Fast Reactors at the IAEA.

She is also participating in several activities in different scientific committees of international conferences (IEMPT, Fast Reactor, GLOBAL), and she is the CEA counterpart in several bilateral collaborations with other international scientific organizations devoted to MOX fuel.