



**HOTLAB 2009**

**- Future needs for hot laboratories from the GENIV point of view -**

**September 21<sup>th</sup>, 2009**

# **SFR / GFR Hotlabs requirements**

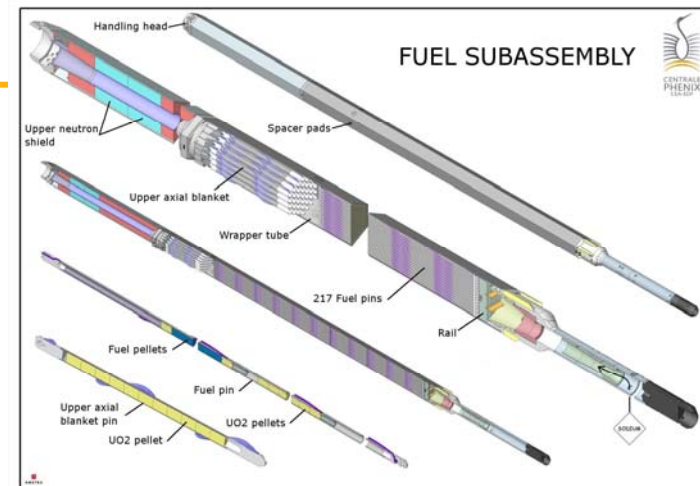
**(french point of view)**

**by Laurent PARET  
Presented by Bernard AUTRAN**

# Different fuels under studies in France (CEA / AREVA / EDF)

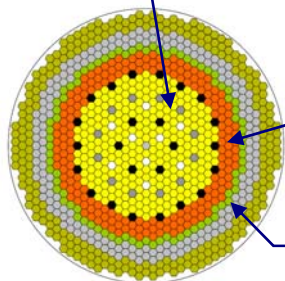


1. **The startup fuel for the prototype :**
  - UPuO<sub>2</sub> with austenitic steel cladding
2. **The final fuel for the prototype**
  - The same with an ODS cladding
3. **The MA bearing fuel for homogeneous transmutation**
  - The same with a lot content of MA (< a few %). All SubAssemblies are charged with this fuel
4. **Two different options for heterogeneous transmutation**
  - MA Bearing Blanket (MABB). UO<sub>2</sub> + MA (10% to 20%) in the radial blanket of the core
  - MA Bearing Fuel (MABF). UPuO<sub>2</sub> + MA (7% as reference). These S/A are taking place in the external core
5. **An advanced fuel**
  - UPuC, no cladding material as reference at this moment



SFR

1  
2  
3  
5

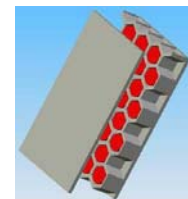


4 - MABF

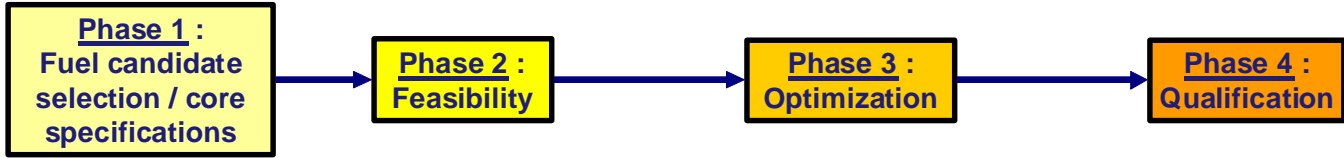
4 - MABB

GFR

1. **Standard fuel : UPuC with a ceramic cladding (pin or macrostructured plate)**



# Fuel qualification : global process



## Phase 1 Phase 2 Phase 3 Phase 4

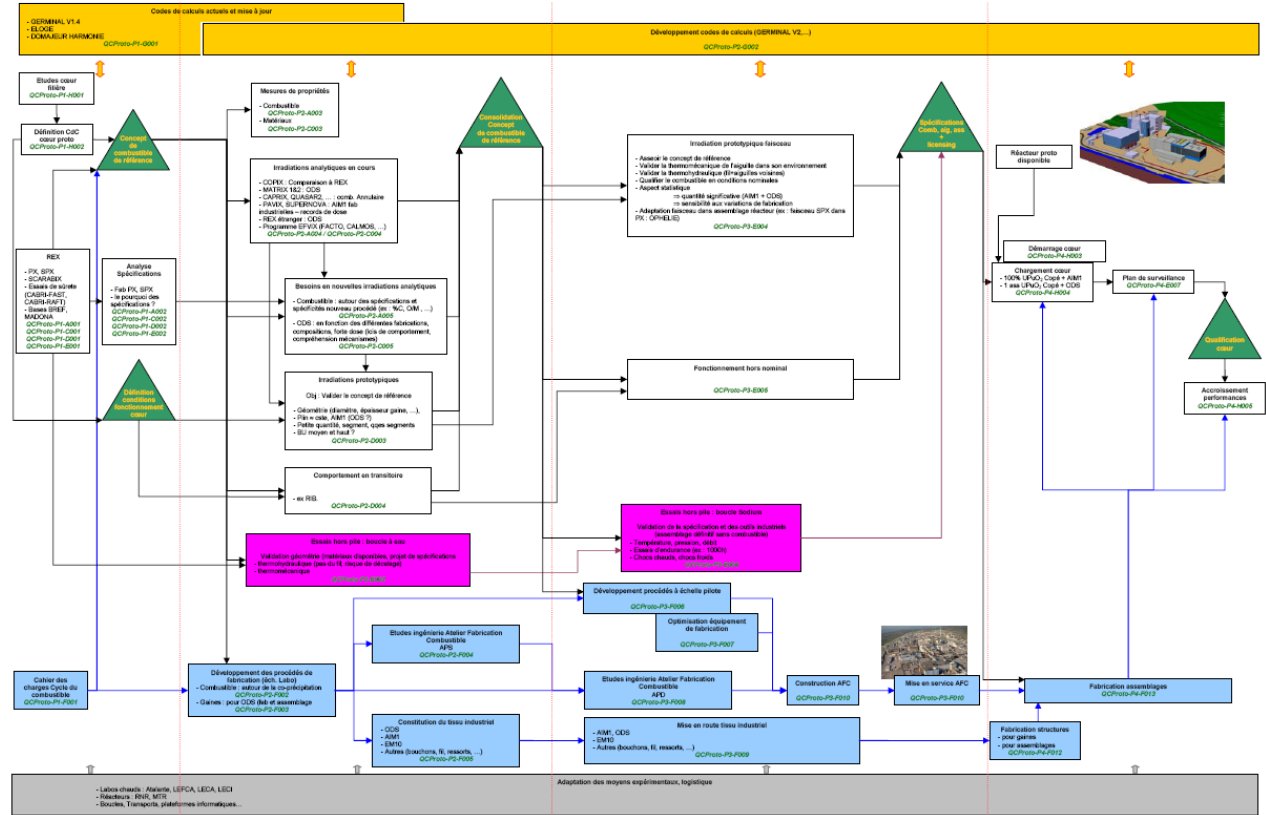
### Fuel codes development

### Irradiations

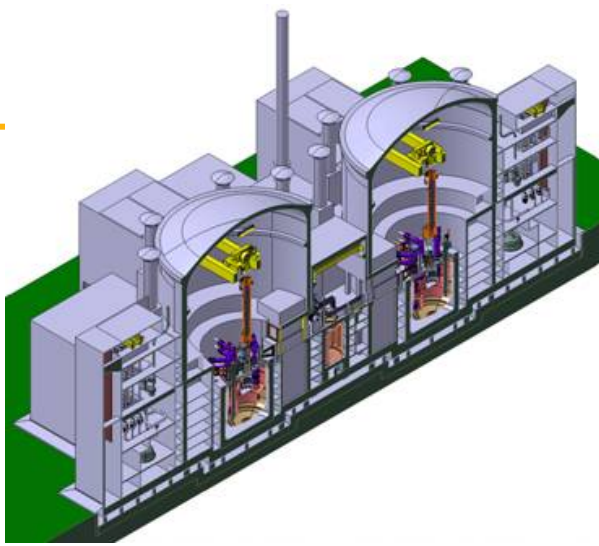
### Out of pile experiments

### Fuel cycle development

### Support activities



### Hotlab requirements



SFR

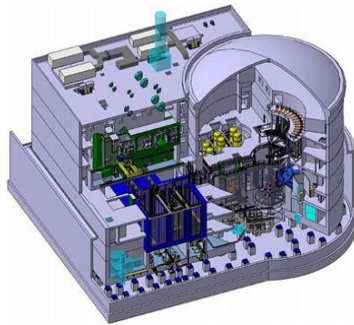


GFR

# Hotlabs and experimental reactors for SFR/GFR development (prototypes and commercial reactors)

## For present and future activities

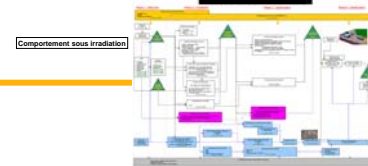
$\alpha, \beta, \gamma$   
labs

**Fast Reactors**  
**Materials Testing Reactors**  
**Reactors for Safety research purposes**

$\alpha$   
labs





# Irradiation behavior



## Fabrication of irradiation devices

### R&D, Fabrication, refabrication

- Fissile compounds
- Fuel elements (pins, ...)
- Capsules and irradiation devices

### Characterization

- Fissile compounds
- Fuel elements (pins, ...)
- Capsules and irradiation devices

Transportation



Post Irradiation Examination

Safety requirements

Fuel R&D

⇒ **UPuO<sub>2</sub>, UPuC, MA bearing fresh fuels**

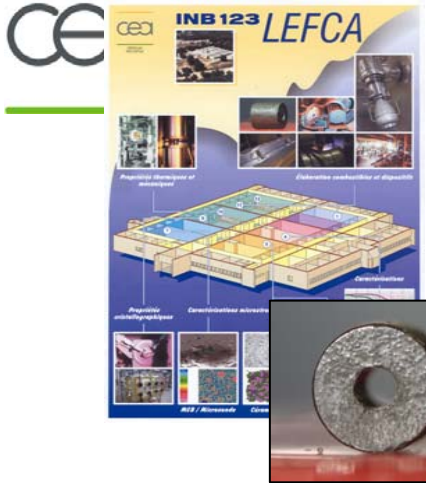
⇒ **Irradiated fuels for specific irradiations (transients, ...)**



# Evaluation of irradiation behavior



## Actual facilities



LEFCA – Cadarache

UPuO<sub>2</sub>  
UPuC

ATALANTE – Marcoule

MA bearing fuels



+ LECA – Cadarache : refabrication with Irradiated fuels

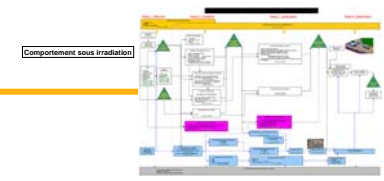
+ International collaboration : ITU (Karlsruhe) for ex.

## Future facilities

- The same  
+ ALFA (Marcoule) : Project in Atalante for a new facility for MA bearing fuels fabrication (pellets, pins and irradiation devices)



- Adaptability to new materials (fissile and inert) and fuel concepts
- R&D on new fabrication processes
- Development of new and more precise characterization methods (in relation with advanced modeling requirements)
- Compatibility with in service reactors (MTR and FR)



## Post Irradiation Examinations



**Non Destructive Examinations**

- Visual inspections,
- Measurements,
- gamma spectrometry
- neutronography,
- ...



**Destructives Examinations**

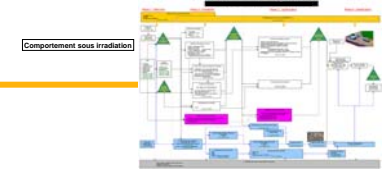
- Microstructures,
- Gases analysis,
- Isotopic analysis
- Mechanical testing
- ...

**Materials and fuels modeling**

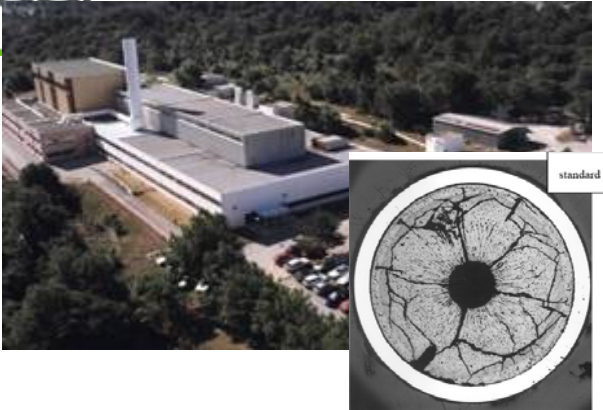
**+ Databases**



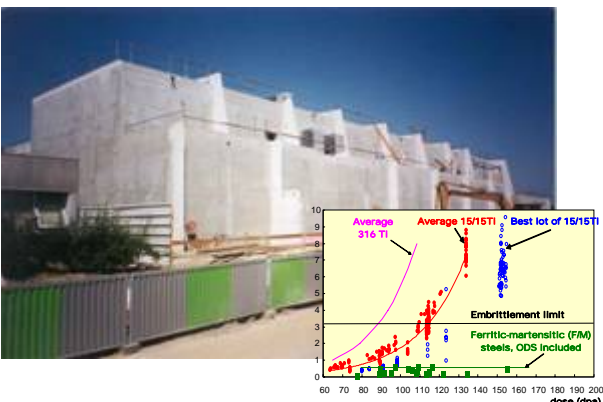
# Evaluation of irradiation behavior



## Actual facilities



LECA / STAR  
- Cadarache  
Fuels PIE



LECI - Saclay  
Materials (and fuels) PIE

- + ATALANTE : Chemical analysis
- + Hot cells on reactors sites for ND PIE
- + International collaboration : ITU (Karlsruhe) for ex.

## Future facilities

-The same  
+ Hot cells on future reactors (ASTRID, JHR, ALLEGRO, ...)



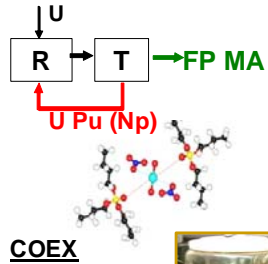
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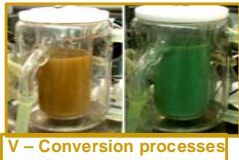
# Fuel cycle development



## Fuels Fabrication : from powder(s) to sub-assembly



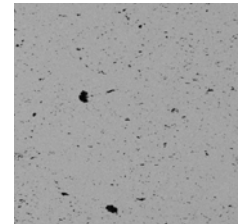
COEX



- Development of a new fabrication process based on a co-precipitated UPuO<sub>2</sub> powder coming from reprocessing

⇒ May simplify process and associated technologies to obtain an homogeneous microstructure

⇒ Increase proliferation resistance



- Development of a fabrication process according to fuels specification (SFR / GFR)

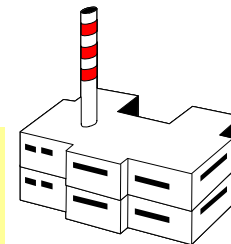


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Current and future R&D facilities



Development and qualification of fabrication process and technology



MOX fuel fab unit for ASTRID driver fuel

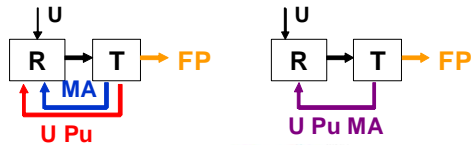
Project in La Hague



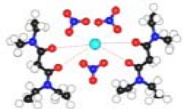
## Fuels Fabrication : from powder(s) to sub-assembly

### MA bearing fuels

- Development of a fabrication processes using MA compounds coming from reprocessing



Heterogeneous recycling  
**DIAMEX-SANEX**



Homogeneous recycling  
**GANEX**

⇒ Challenge for the feasibility of these type of fuels

⇒ Simple processes with very low losses

⇒ Technologies adapted to MA (Thermal power, neutrons emission, ...)



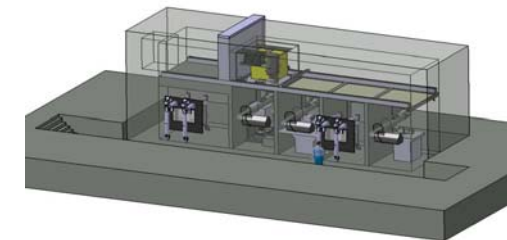
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**Current and future R&D facilities**

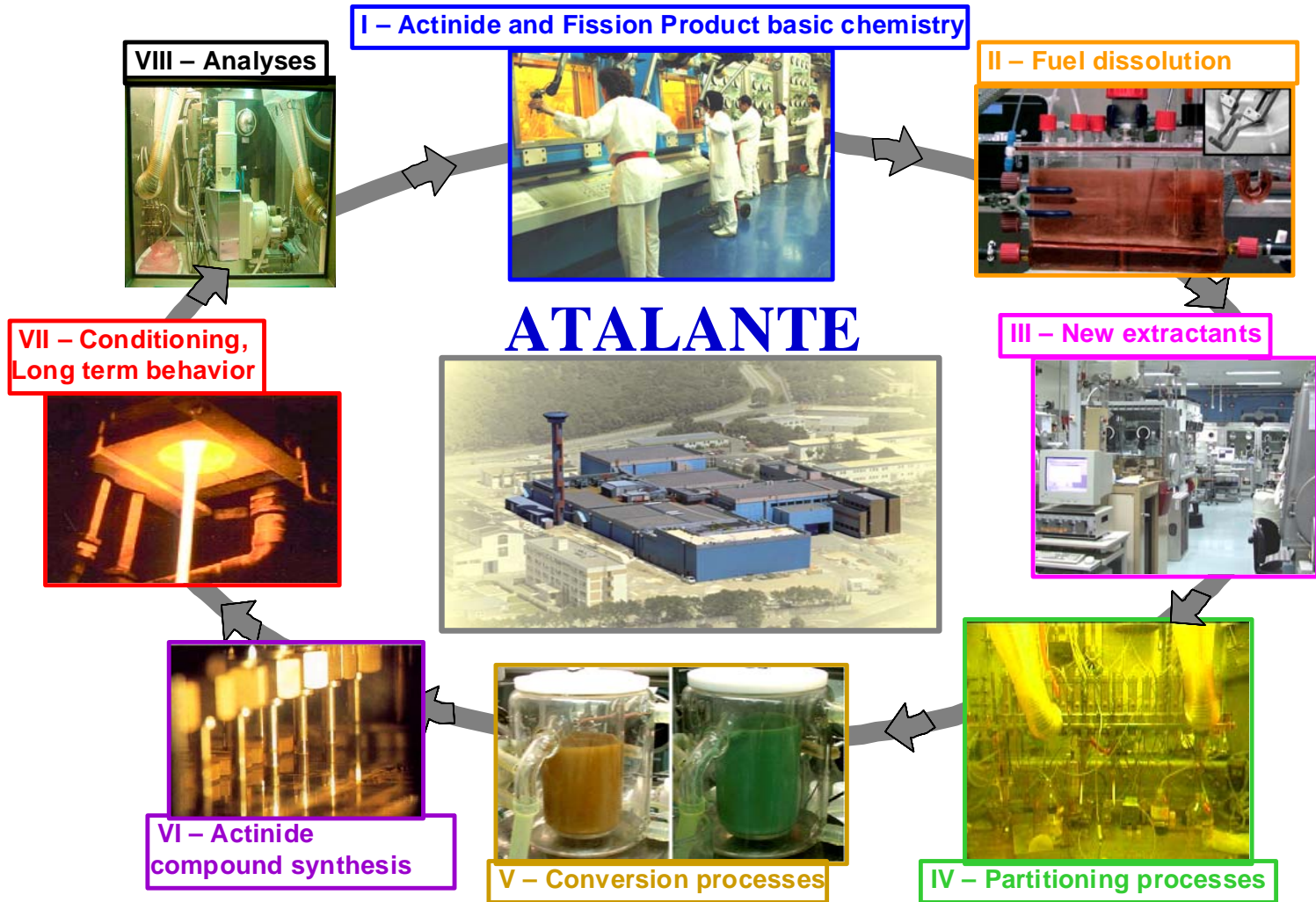


**Development and qualification of fabrication process and technology**



**ALFA facility in Atalante (many pins per year)**

# Fuel cycle development : reprocessing and waste management



- Adapt processes to Fast Reactor fuels specificities (cladding materials, Burn Up, MA and FP content ...)
- Prepare the future plants in La Hague with a co-management of FR and LWR fuels



# Summary



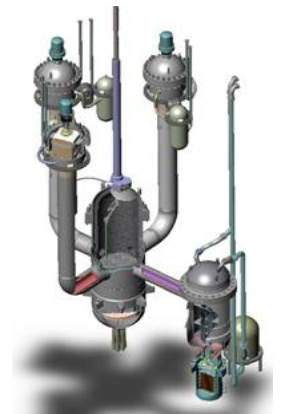
- ✚ SFR and GFR GENIV systems are under studies and two reactors “ASTRID” and “ALLEGRO” could be put in operation by 2020.
- ✚ A good synergy is essential between each activities (simulation codes, experimental irradiations, out of pile experiments and fuel cycle development)
- ✚ All types of hotlabs are essential for fuels qualification, fuel cycle and core materials development.

=> High performance facilities to prepare the future

The **ASTRID** SFR prototype (2020) :  
600-1500 MWt (250-600 MWe)  
→ Precursor of a first of a kind  
→ Irradiation tool



**ALLEGRO**: a GFR demonstration reactor (50–70 MWt), in Europe (2020)







# Additional slides

# CEA Hot labs & MTRs

