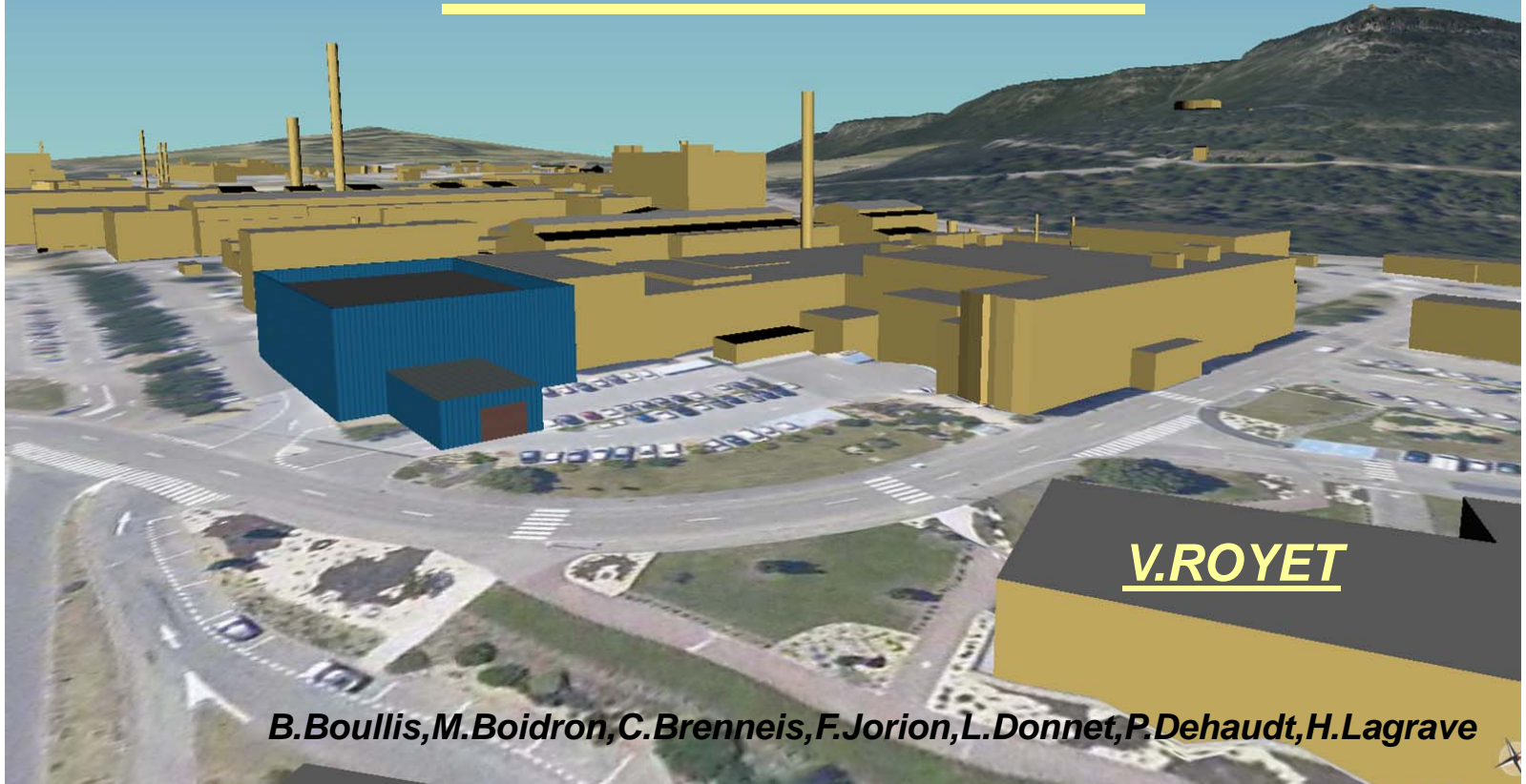




energie atomique • énergies alternatives

PROGRESS FOR THE CEA ALFA PROJECT



**Atalante Laboratory For Actinides bearing fuel
manufacturing**





- 1. Context**
- 2. Atalante facility**
- 3. Main goals for the project**
- 4. Fuel fabrication targets**
- 5. Fabrication process**
- 6. Required shielded lines**
- 7. Progress of design studies**
- 8. Global roadmap**

1.CONTEXT OF THE PROJECT



energie atomique • énergies alternatives

- The 1991 and 2006 french acts: frame of the program
- Three Research thematics for nuclear waste management:
 - **partitioning and transmutation of MA**
 - geological deep repository
 - confinement and interim storage
- A “roadmap”:
 - **2012 : industrial potentialities of the diverse Partitioning and MA transmutation options,**
 - 2015 : repository defined, and operation by 2025



December 30, 1991 and June 28, 2006



2. ATALANTE FACILITY PRESENTATION



VIII – Analyses



I – Actinide and Fission Product basic chemistry



II – Fuel dissolution



ATALANTE



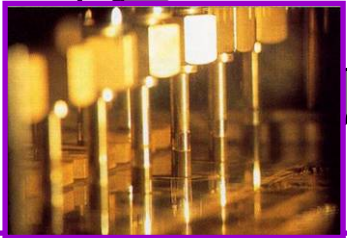
VII – Conditioning,
Long term behavior



III – New extractants



VI – Actinide compound
synthesis



V – Conversion processes

IV – Partitioning processes



3. MAIN GOALS



energie atomique • energies alternatives

- **Produce minor actinides pins for MA bearing fuels development**
 - Irradiation program in ASTRID reactor (Advanced Sodium Technological Reactor for Industrial Demonstration) or through international collaborations.
- **Different steps for the fuel qualification:**

1: fuel design / specifications

2: feasibility: in pile behavior for specifications validation at material scale

3: optimization: validation of technological options at pin scale

4: qualification: full demonstration at assembly scale

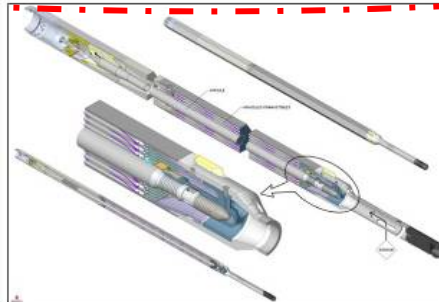
Theoretical studies for fuel definition



ATALANTE TODAY
Few pellets (^{238}Pu , Am, Cm...)
100 g fuel oxyde / year
~ 10 g MA

**Capacity Under evaluation
To be consolidated**

ALFA
Few pins
1 Kg to 5 Kg / year
~ hundred g MA



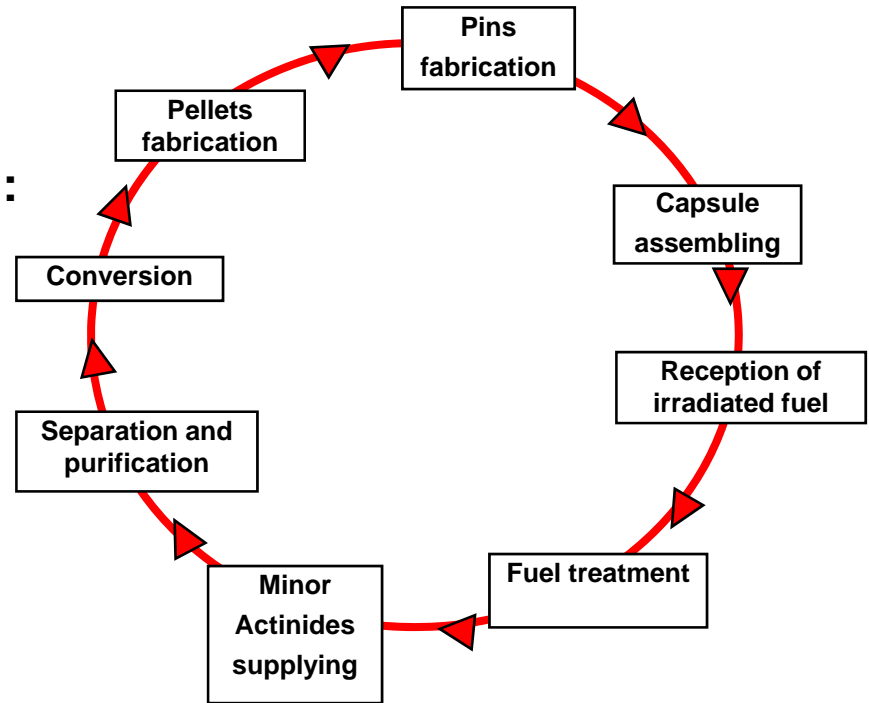
Pre industrial facility
Few assemblies / year
~ tens Kg MA



3. MAIN GOALS



- **A full demonstration of treatment and (re) fabrication:**



- **Flexible fabrication capacity / short production time (a few months)**
- **prefigure the (pre) industrial scale (process, production capacity...)**
- **A demonstration for innovative processes and technologies**



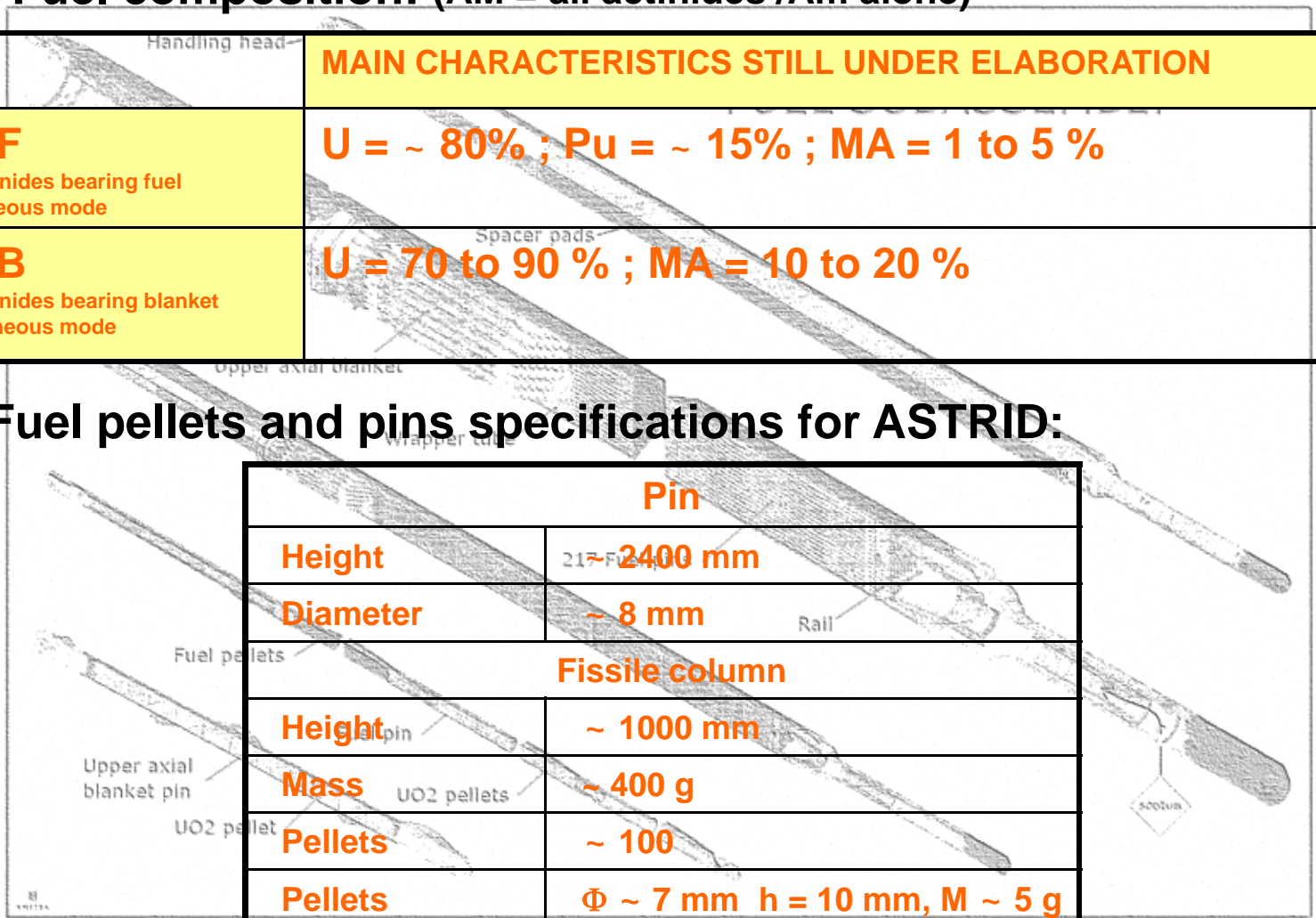
4- FUEL FABRICATION TARGETS



- **Fuel composition: (AM = all actinides /Am alone)**

	MAIN CHARACTERISTICS STILL UNDER ELABORATION
MABF Minor actinides bearing fuel homogeneous mode	U = ~ 80% ; Pu = ~ 15% ; MA = 1 to 5 %
MABB Minor actinides bearing blanket Heterogeneous mode	U = 70 to 90 % ; MA = 10 to 20 %

- **Fuel pellets and pins specifications for ASTRID:**



Pin	
Height	~ 2400 mm
Diameter	~ 8 mm
Fissile column	
Height	~ 1000 mm
Mass	~ 400 g
Pellets	~ 100
Pellets characteristics	Φ ~ 7 mm h = 10 mm, M ~ 5 g



5. FABRICATION PROCESS



énergie atomique • énergies alternatives

- **The selection of the appropriated process must take into account:**
 - MA specific constraints (high activity/ thermal effects/ radiolysis...)
 - Suitable technology regarding exploitation and maintenance for hot cell operation
 - Industrial extrapolation
 - Various products (according to reactors specifications)
 - management of waste and by-product

- ➡ **ALFA is tightly linked to two main R&D programs:**
 1. R&D for process qualification

 2. R&D for technological development :
 - Process equipments adaptation for hot cell environment
 - Innovative hot cells architectures



5. FABRICATION PROCESS



énergie atomique • énergies alternatives

- **On going R&D programs main goals:**
 - demonstrate the MA's fuel fabrication process control at laboratory scale:
 - Heterogeneous fuel (high Ma's concentration)
 - Fuel specifications achievement
 - determine the critical paths in the process
 - identify and evaluate alternative routes to assess the advantages in term of process simplifications (co-converted powder)
 - develop and test innovative technologies
 - evaluate the extrapolation at pilot and industrial scale

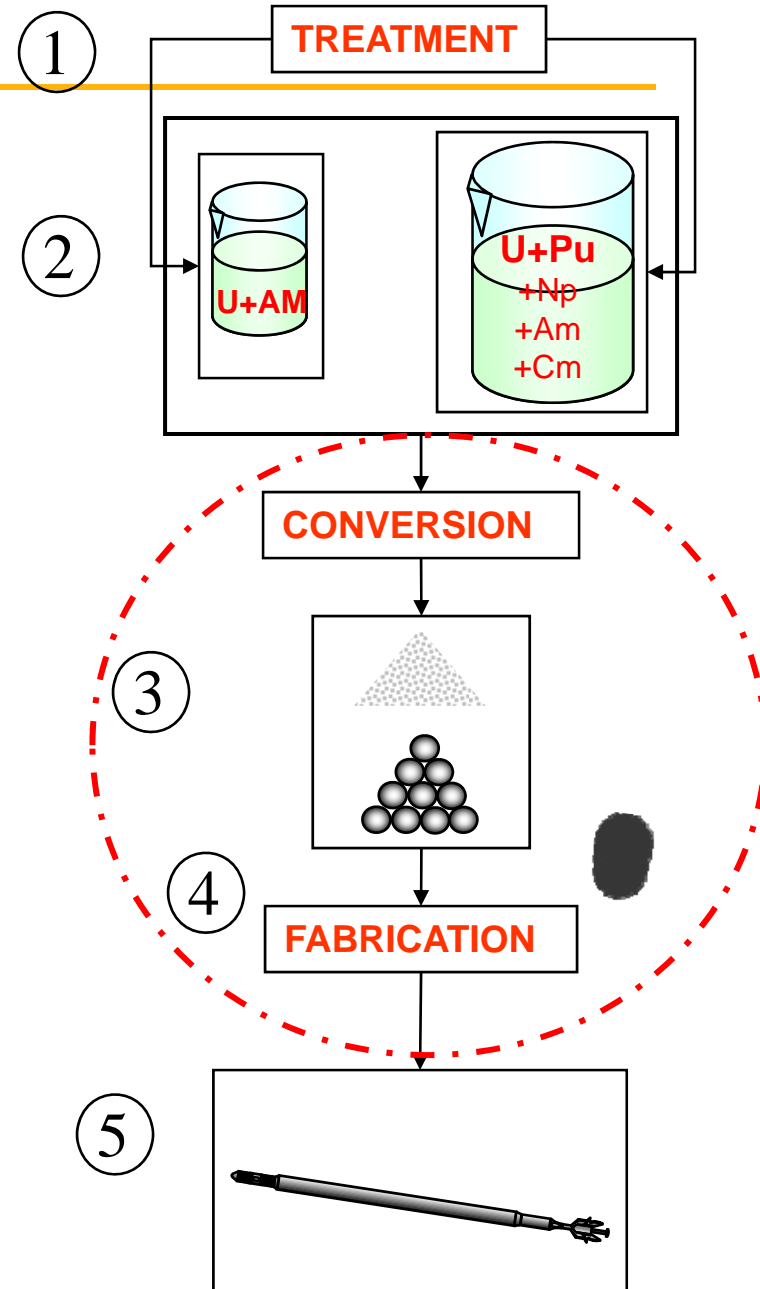


5. FABRICATION PROCESS



The functions to fulfill:

- The MA separation
- The MA solutions preparation
- The conversion
- The pellets fabrication
- The pins fabrication



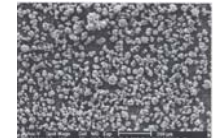
5. FABRICATION PROCESS



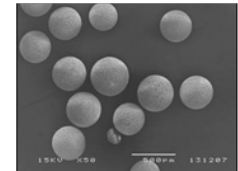
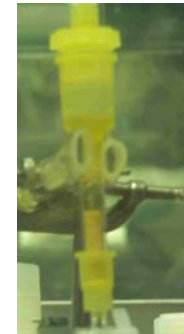
- **Conversion:** different routes already under development (ATALANTE Radiochemistry and processes department):
- **Oxalic co-precipitation + thermal treatment**
- Co-immobilisation in ion exchange resins
- **With significant achievements for MA**
- Sol-Gel + Thermal Treatment (european program)
- Thermal denitration



U(IV)AM(III) (AM=Am,Cm)



S. Grandjean et al,



S.Picart et al



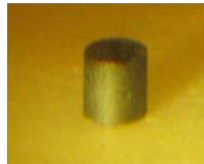
5. FABRICATION PROCESS



energie atomique • energies alternatives

- **Fabrication:** different routes under evaluation (short to long term):

- **Standard Powder metallurgy**
- Significant achievements for experimental irradiations

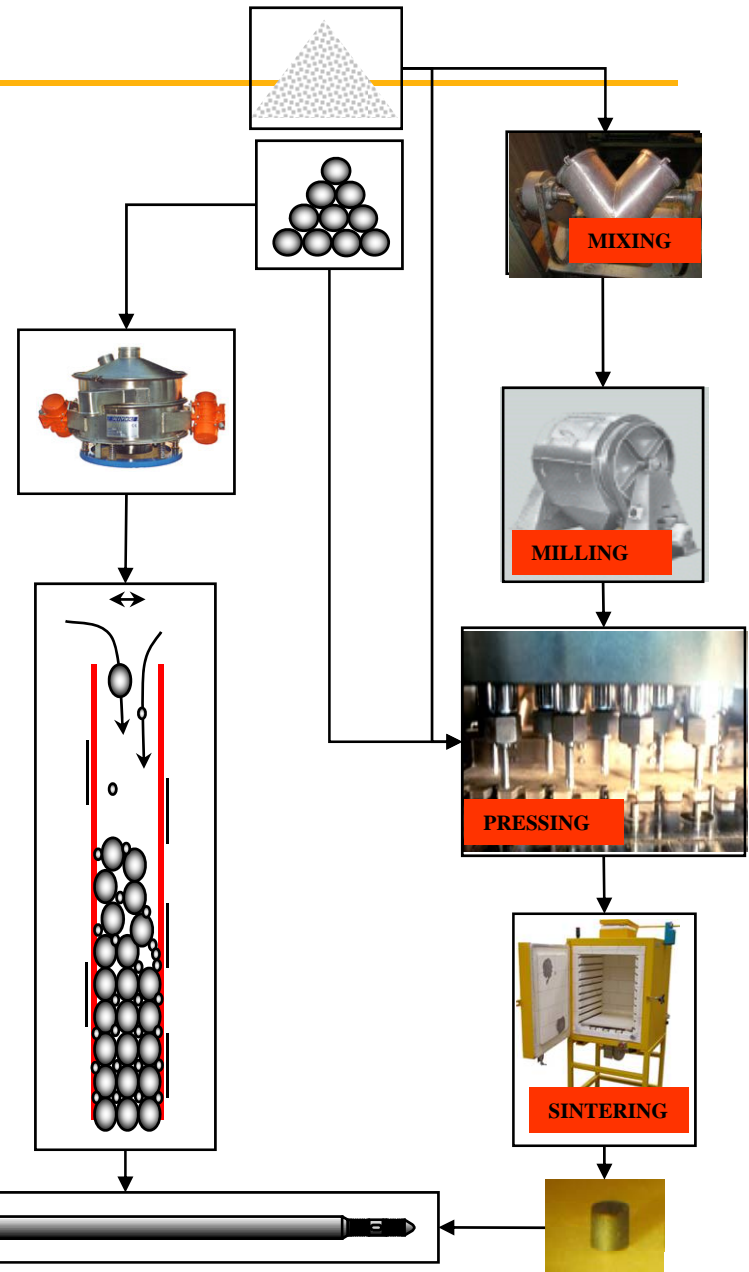


View of a dense UAm 10% pellet after sintering

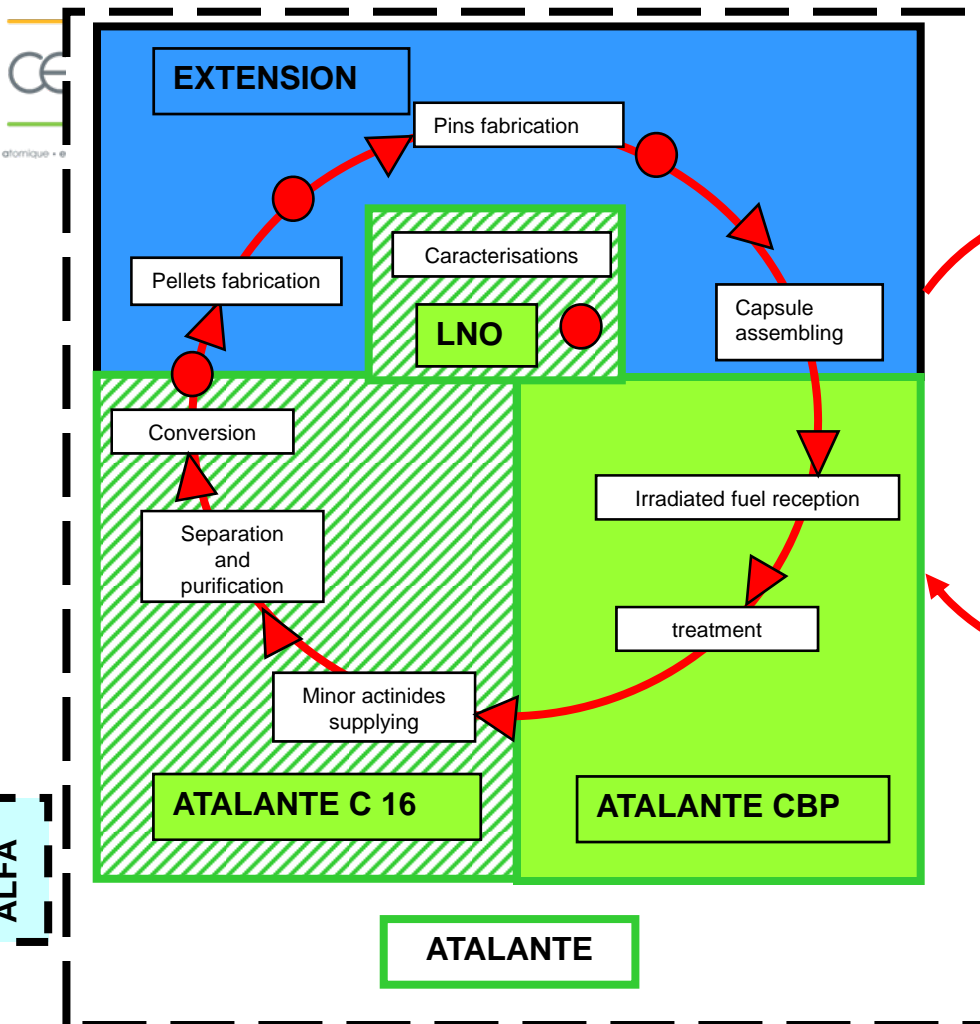
- **Simplified Powder metallurgy:**
 - Function of powder and spheres characteristics




- **Spherepac**

- **Process adaptation during facility lifetime**



6. REQUIRED SHIELDED LINES FOR ALFA



	Empty existing laboratory
	Existing laboratories and shielded cells
	Facility to build

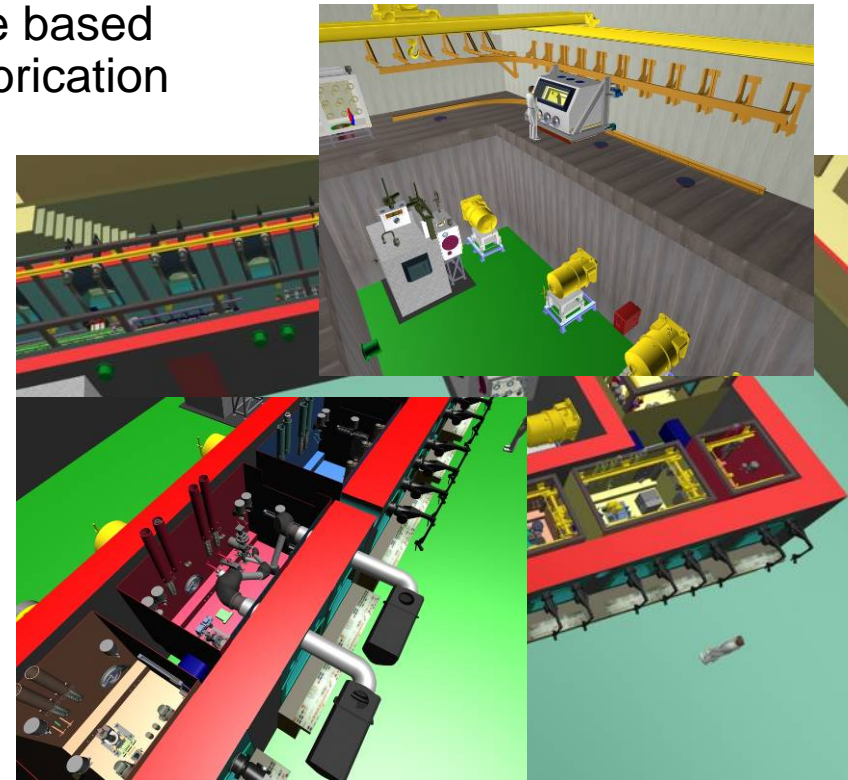
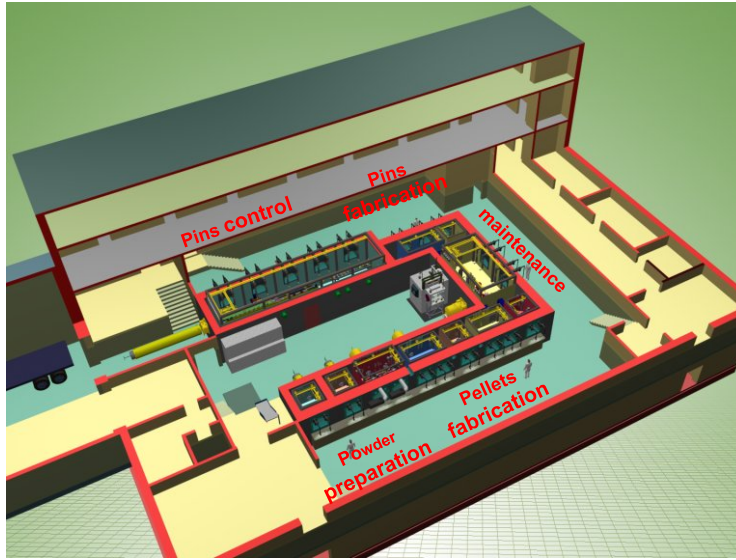


7. PROGRESS OF DESIGN STUDIES



energie atomique • énergies alternatives

- **The first design:** a fabrication line based on well known PWR/SFR MOX fabrication process



- Including some innovations still under evaluation
 - Shuttle for rapid reconfiguration and maintenance of critical equipment
 - Automatic remote handling / robots



7. PROGRESS OF DESIGN STUDIES

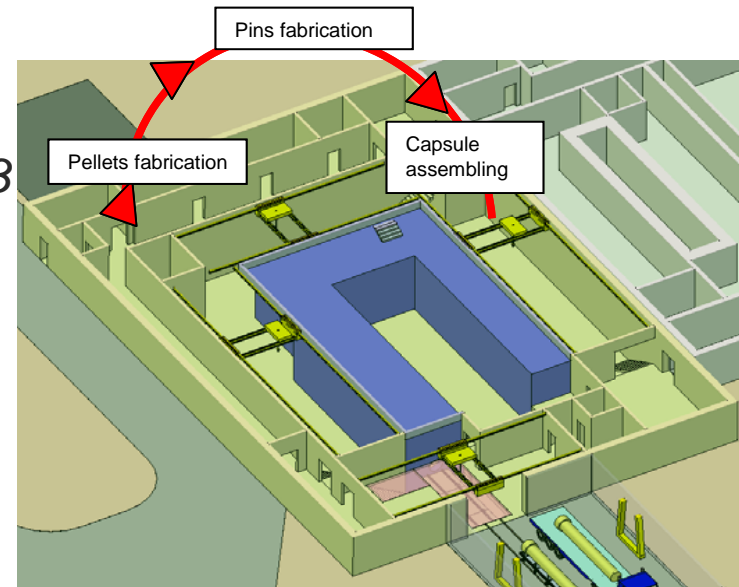
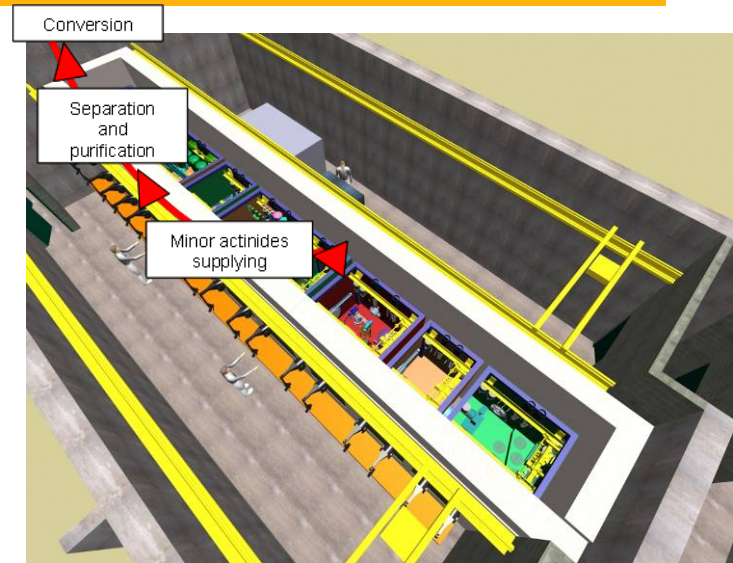


- **Implementation studies in existing laboratories for the chemical process:**

- *a 19m long shielded line and a 10 glove boxes lab.*

- **Design studies of the new building devoted to fabrication process:**

- *41m x 30.7m x 13.7m(H) 21 000m³*
- *4 levels*
- *11 shielded cells / 40m long / 270 m³*
- *Up to date safety requirements*
- *Connected to the existing ATALANTE design facility*



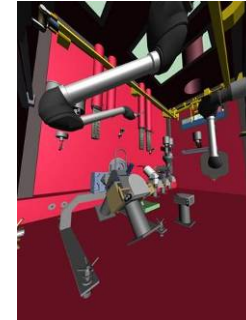
7. PROGRESS OF DESIGN STUDIES



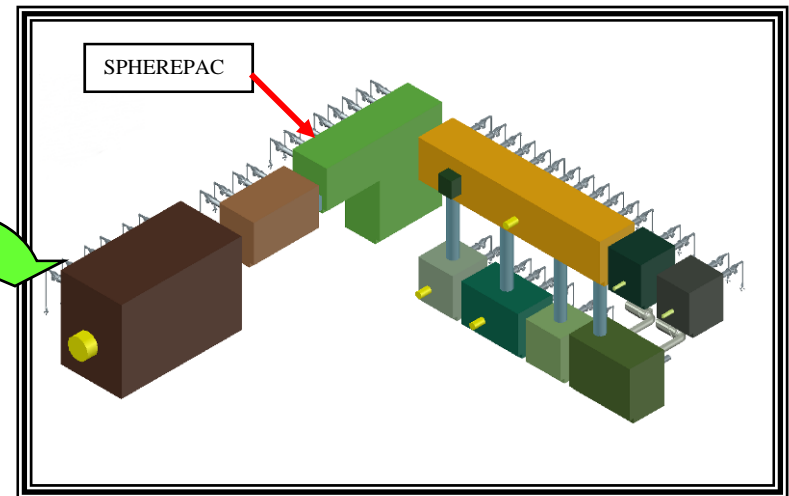
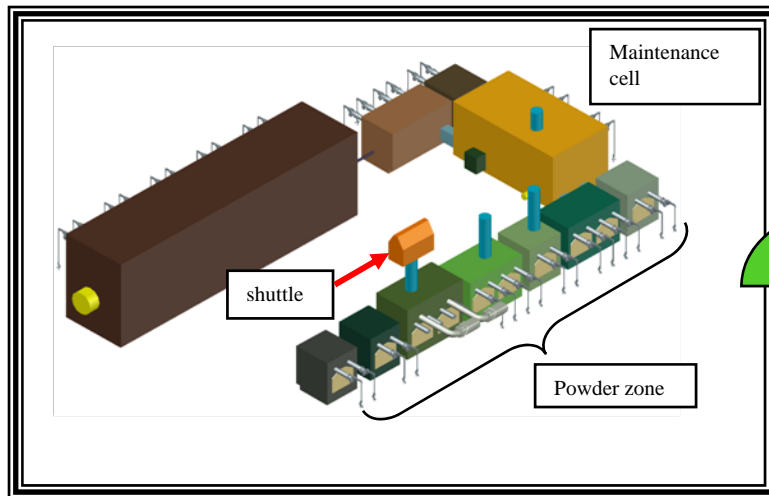
energie atomique • énergies alternatives

- To continue the studies in order to:

- Consolidate the design:
 - Innovations, safety requirements...



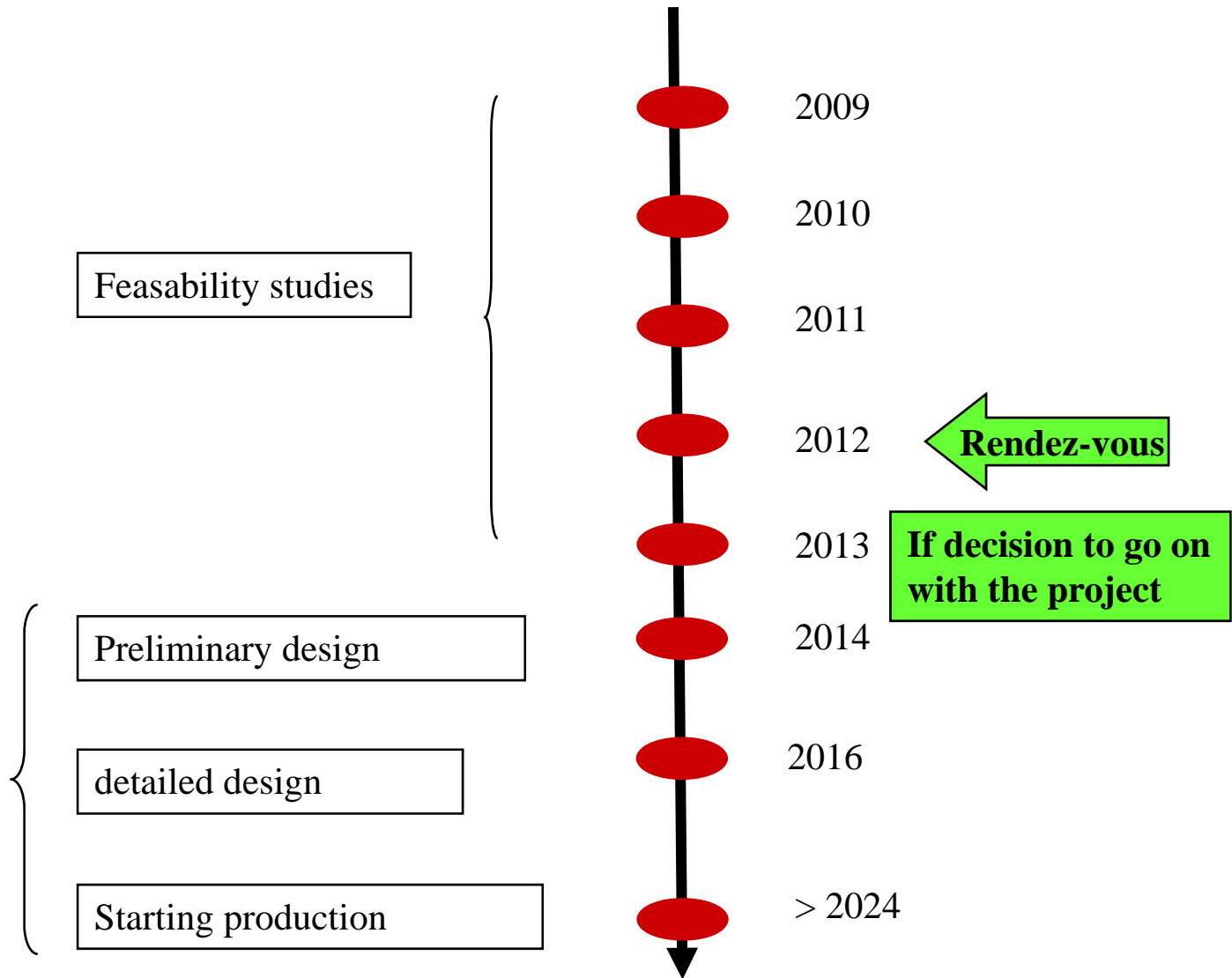
- Assess the impact of different processes on the design



- Optimize the investment cost



8- GLOBAL ROADMAP FOR LONG TERM INVESTMENT PLAN



9. CONCLUSION



énergie atomique • énergies alternatives

- ALFA project calls for the construction of an experimental high activity fuel fabrication facility at a significant scale : ASTRID prototype.
- ALFA will be able to produce various MA bearing fuel and blanket types.
- This new fabrication line will be opened to international collaboration.





energie atomique • energies alternatives

