# CEIDEN: La Plataforma Tecnológica de I+D de Energía Nuclear de Fisión

**CEIDEN-NNL UK**

**1-2 February 2016**

**Topic 1: Fuel Fabrication**

# Topic 1: Fuel fabrication

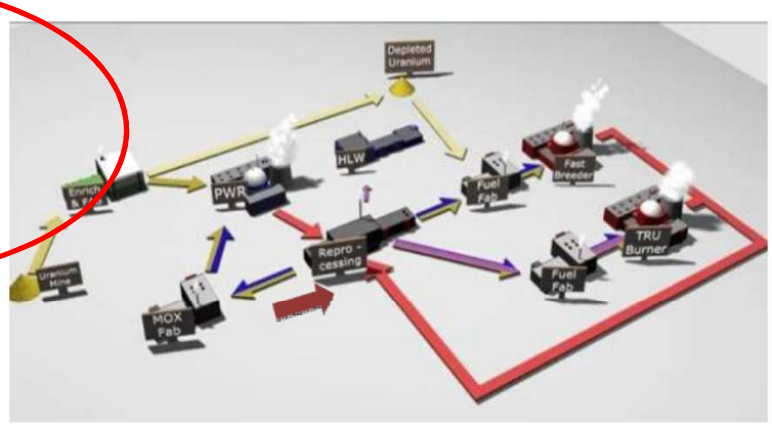
- Participants: IDOM, ENSA, CSN, CIEMAT, ENUSA

## Strategic Projects

NATIONAL NUCLEAR LABORATORY

**Fuel Fabrication:**

- Accident Tolerant Fuel
- 3D Printing




**Waste Management & Decommissioning:**

- Thermal Treatment of ILW
- Remote Characterisation (Photonics)
- Colloid Behaviour
- Biogeochemical Research
- C-14 in Reactor Graphite

**Thermal Reactor Operations:**

- Plant Lifetime Extension & Degradation of Cladding
- Spent Fuel Storage & Disposal

**Advanced Separations & Recycle:**

- Aqueous
- Pyrochemical

**Fast Reactor:**

- PIE Methods
- Fuel Performance Modelling

**Cross-cutting:** Immersive and Augmented Design Modelling

# Topics included in NNL presentation

- Accident Tolerant Fuels: fuel and cladding alternatives
- Fuel performance modelling, international road-mapping exercises
- 3D printing as a development of a new approach to fuel manufacturing

## Accident Tolerant Fuels (ATF) (Dave Goddard)

NATIONAL NUCLEAR LABORATORY

Vision: To establish NNL Nuclear Fuel Centre of Excellence as a major participant in international efforts to develop fuels for LWRs with enhanced accident tolerance.

First priority: Novel routes for manufacture of uranium silicide fuels (with USDOE/WEC) – direct route from $UF_6$ and $SiH_4$

- Second Priority: Waterproofing of uranium nitride fuel (EU FALSTAFF project) – direct route from $UF_4$
- Alternative cladding options (e.g. SiC composites, MAX phase ceramics) through collaboration with UK academics (Manchester, Sheffield, Imperial).
- Links with fuel performance modelling activities and international road-mapping exercises (IAEA, OECD-NEA)

## Additive Manufacturing (3D Printing) (Pete Morris)

NATIONAL NUCLEAR LABORATORY

Vision: Development of a New Approach to Fuel Manufacturing

- Installation and commissioning of a metallic 3D selective laser melting machine (3D Printer, see image on right) at the Preston Lab.
- Aim to develop the ability to produce complex metallic items in a single piece (e.g.. patterned cladding tube, fuel assembly components etc).
- Stainless Steel is the current focus until expertise is developed
- Other non-reactive or reactive metals are printable at this time (e.g. Gold, Titanium and its alloys etc)
- Ultimately NNL will attempt a 3D print of metallic Uranium into a pellet form.
- Other material print explorations will follow (i.e. alloys of U relevant for accident tolerant fuels for example).

# Additional suggested topics:

- Fabrication of advanced fuel for new Gen III & IV reactors, as MOX
- Fabrication of the simulated spent fuel at long aging conditions:
  - Identification of the altered spent fuel (porosity, chemical compositions, RIM, etc).
  - Stability studies of the spent fuel under repository conditions.
  - Effect of the cladding in the corrosion of the spent fuel under storage conditions.
- Characterization method/techniques applied to the spent/irradiated fuel
- Safety of advanced fuels
- Fuel Licensing process in UK: design basis, process, documentation, schedule, …
- Fuel surveillance: inspection, characterization, failure modes, repair…