The Swedish-French collaboration on the research reactors ASTRID & JHR

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Background – the ESS project

• **ESS**: European Spallation Source – a European Union facility.

• Will be built in **Lund**.

• Participation of France is formalized in a contract between France and Sweden.

• Sweden has to spend 400 MSEK on joint research in subjects relevant to France (energy and environment).

• Out of this, 100 MSEK is devoted to **fission-based nuclear energy**.
Background – the European research program

• Vision: Sustainable Nuclear Energy Technology Platform (SNETP).
• Planned facilities:
  – **MYRRHA** facility in Mol, Belgium, a fast spectrum irradiation facility working as an ADS. Start of operation: ca. 2023.
  – **ASTRID** (Advanced Sodium Technological Reactor for Industrial Demonstration), a prototype Gen-IV sodium-cooled fast reactor to be built in France. Start of operation: ca. 2020.
VR Multi-project Grant in Nuclear Energy Research

- 3 multi-grant projects granted by the Swedish Research Council in the spring of 2012 (projects in collaboration with CEA, France – French Alternative Energies and Atomic Energy Commission):

  - **DEMO-JHR** (coordinator: Prof. Christophe Demazière, Chalmers): 3 PhD projects.

  - **ASTRID core physics and diagnostics** (coordinator; Prof. Imre Pázsit, Chalmers): 4 PhD projects.

  - **ASTRID safety** (coordinator: Prof. Sevostian Bechta, KTH): 1 PhD + 3 post-doc projects.
DEMO-JHR
Deterministic modelling of the Jules Horowitz Reactor

Overview of the CEA Cadarache site, France

© CEA
DEMO-JHR
Reactor under construction

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DEMO-JHR
Unconventional MTR

- Ca 100 MWth
- Core size of ca 60 cm
- Core flow of ca 15 m/s

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Challenging reactor modelling

Spatial distribution of the fast neutron flux (calculations)

Spatial distribution of the thermal neutron flux (calculations)

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DEMO-JHR
Project description

- Aimed at further developing and improving the deterministic modeling of the JHR:
  - development of new computational procedures
  - evaluation of the uncertainty of the results (due to possible uncertainties in input parameters and models)
- Work-packages:
  - Improvement of the nuclear safety CATHARE code based on thermal-hydraulic experiments in the JHR (Chalmers)
  - Development of new procedures for thermal-hydraulic simulations of the JHR (KTH)
  - Uncertainty analysis in depletion calculations for the JHR (Chalmers).
ASTRID
Part of the French program on fast reactor technology

• **July 2005**, the Energy Orientation Act determines the 2015 objectives:
  Maintain nuclear power in the energy mix beyond 2020, and build a first EPR to prepare the French fleet renewal.

• **January 2006**, French President Chirac declaration:
  « I decided to launch, immediately, the design, within the CEA, of a 4th generation reactor, that shall be commissioned by 2020. We will associate the industrial and international partners which would wish to join ». 
ASTRID
Part of the French program on fast reactor technology

- **June 2006**, law on sustainable management of radioactive materials and waste
  « Transmutation of long-lived radioactive elements:
  - Studies and investigations shall be conducted (...), in order to provide by 2012 an assessment of the industrial prospects of those systems and to commission a pilot facility before December 31, 2020 ».

- **May 2008**: Fast Reactor strategy confirmed at Ministry level.

- **September 2010**: Publication of agreement between CEA and French Government: 650 M€ awarded to CEA to conduct design studies of ASTRID prototype and associated R&D facilities.
ASTRID
Part of the French program on fast reactor technology

Rapsodie
1967-1983

Phénix
1973-2010

ASTRID
2020-

Superphénix
1985-1998

© CEA
ASTRID
Characteristics

• **ASTRID** = Advanced Sodium Technological Reactor for Industrial Demonstration.

• Part of EU’s **SNETP** program. Will be the **first Gen-IV reactor worldwide**.

• 250 – 600 MWe.

• 2 Billions €.

• To be built in Marcoule, France, by 2020.
Astrid core physics and diagnostics

Project description

- Aimed at improving the safety of ASTRID (normal operation).

- **Work-packages:**
  - Neutronic aspects of control rod withdrawal in the SFR ASTRID (Chalmers)
  - Acoustic leak detection: contributions of physical modeling and detection methods, application to the steam generator of the SFR (KTH)
  - Advanced neutron monitoring for ASTRID (Chalmers)
  - In-core detection and decision systems (Uppsala University)
Astrid Safety

Project description

- Aimed at improving the safety of Astrid (severe accidents).

- Work-packages:
  - Development and assessment of safety analysis tools for SFR: core catcher design (KTH)
  - Simulation of severe accidents (KTH)
  - Probabilistic Safety Analysis, PSA (KTH)
  - Analysis of severe accident scenarios (KTH)
Conclusions

• First long term direct collaboration between France and Sweden.

• Access for Chalmers, KTH, and UU researchers to CEA infrastructures (facilities and modelling tools).

• Recognition by CEA and VR of the high standard of the research being carried out in Sweden.

• Swedish universities part of the development of Gen-IV technology (reactors meant to be "sustainable", safer, more economical, and more proliferation resistant).