ALVIN

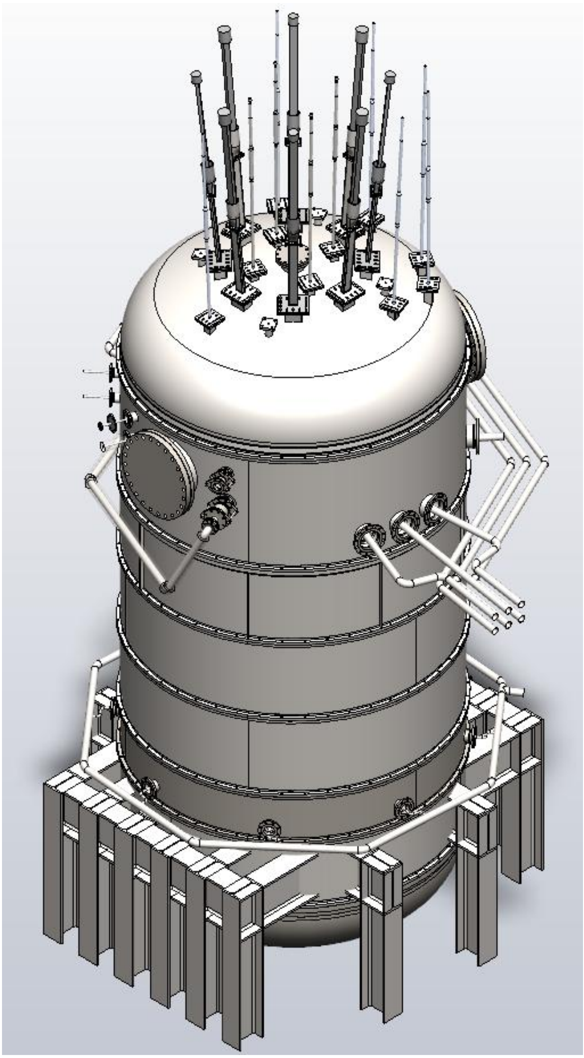
Stellaria’s Molten Salt Nuclear Experimental Reactor

200 kW_{th}

Hamza Ghninou, Georges Gay, et al.

PLAN

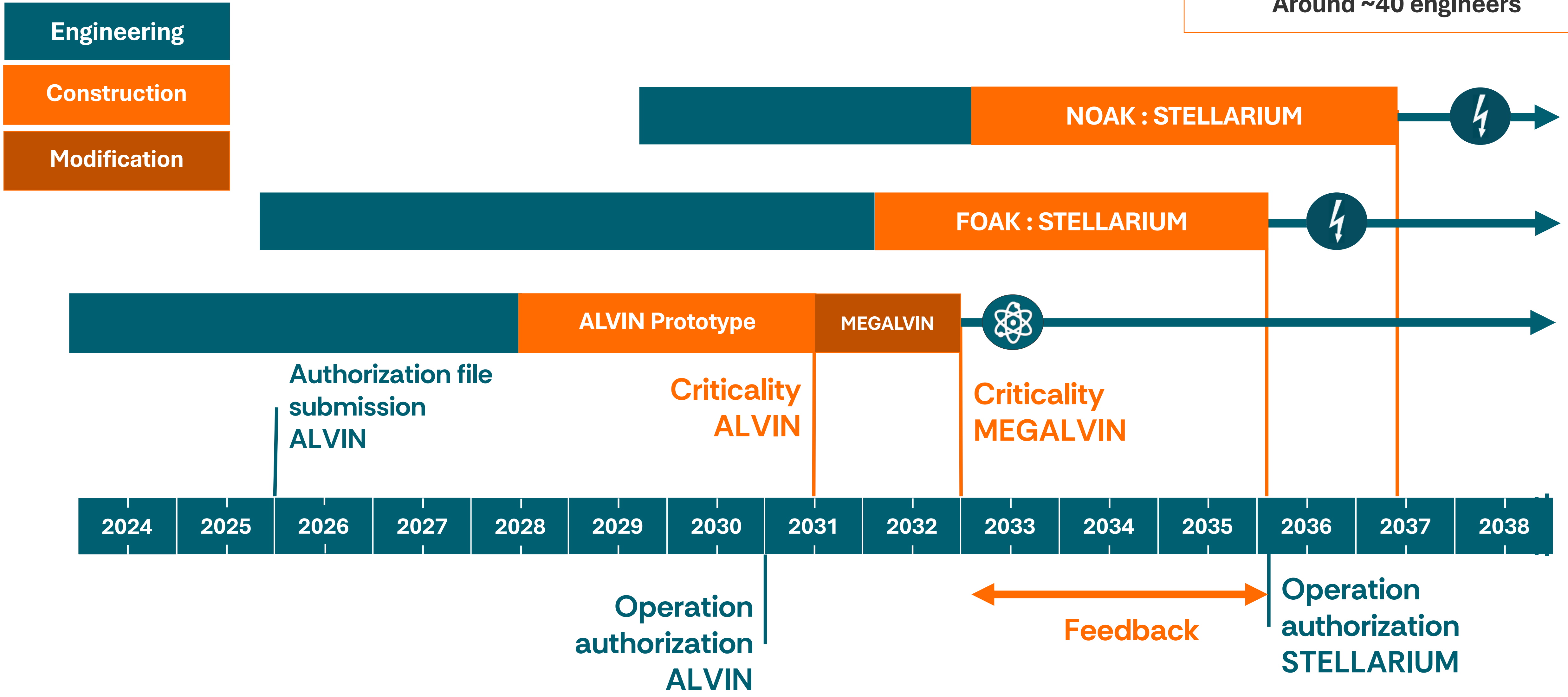
- **Overview of the ALVIN Reactor**
  - Main Objectives
  - Reactor Design
    - Preliminary Design Phase
    - Neutronic Feedback
    - Thermal-hydraulic Feedback
- **Potential for Neutron Noise Measurements**
  - Neutron Noise Analysis
    - Challenges and Limitations for ALVIN
    - In-Pile Oscillations



Reactor Core System Architecture

Stellaria in Quick words

Around ~40 engineers

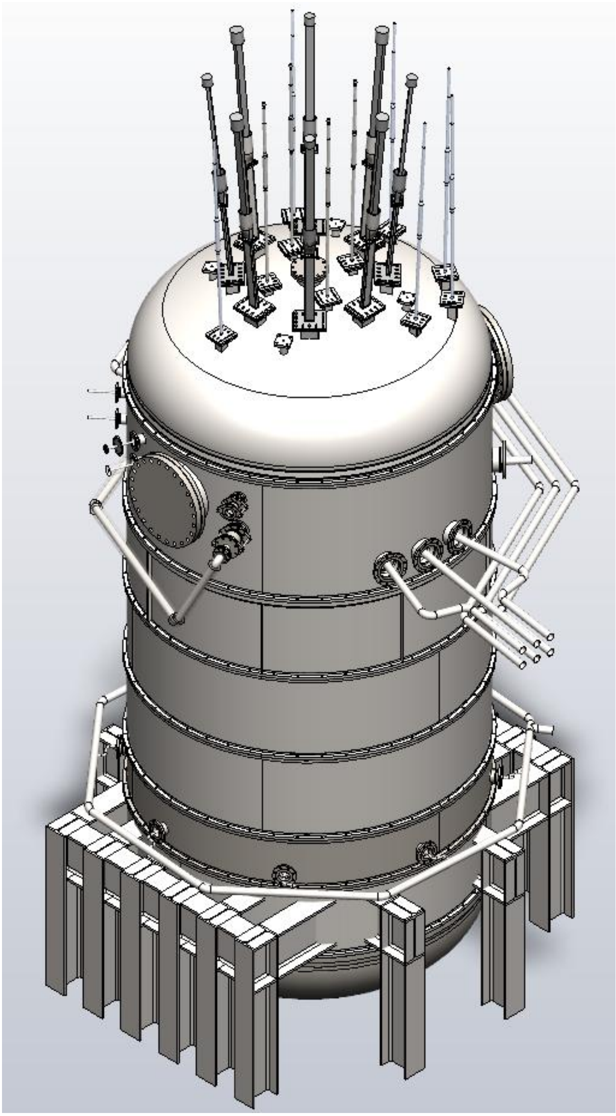


Overview of the ALVIN Reactor

Main Objectives

ALVIN is :

- A **Fast Neutron** Molten Salt Experimental Reactor
- Using **Liquid Fuel** (Chloride based Salt)
- Operating at a Nominal Power of **200 kW** (Steady-state)
- Operating by **Natural Convection**



Overview of the ALVIN Reactor

Main Objectives

ALVIN is dsigned to meet a set of objectives

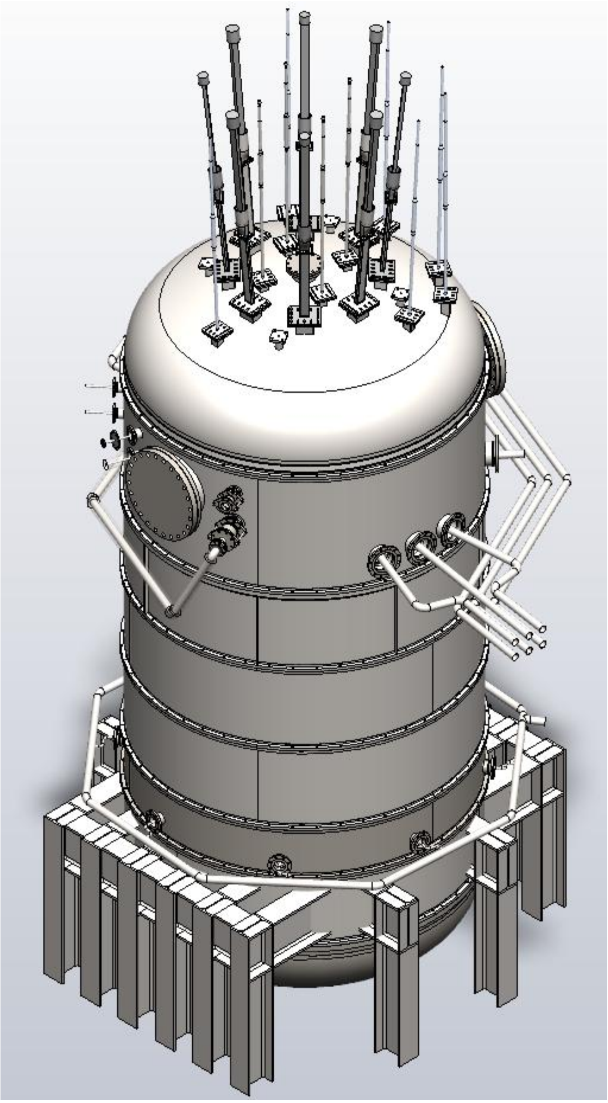
Objective 1 — Successfully **Achieving Criticality** with a Fast-Neutron Molten Salt Reactor
Through a serie of startup tests and experiments during the reactor's approach to criticality

Objective 2 — **Validation** and **Qualification** of **Modelling** and **Simulation Tools** for a Fast-Neutron MSR
Carrying out a serie of Neutron, Photon and Thermal-hydraulic measurements (Uncertainty Reduction)

Objective 3 — **Safety Demonstration** and **Neutron Reactivity Control**
Dynamic Reactivity Experiments via a Fast Neutron Reactivity Insertion

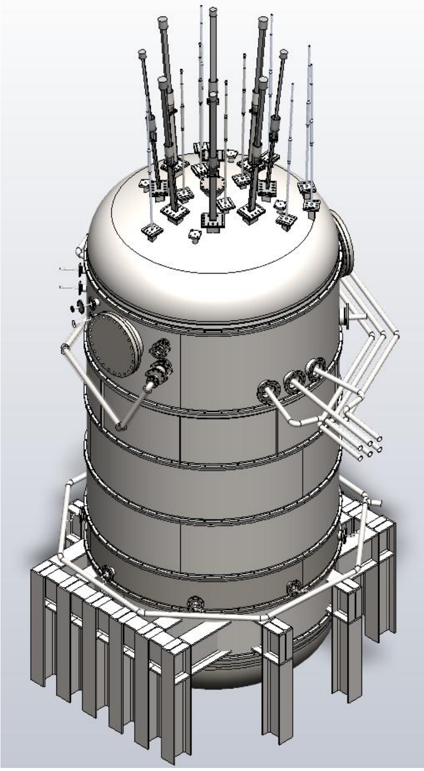
Objective 4 — **Reactor Operations** and **Demontration** of the **« Cooling Control »** Safety Function
Reactor Control via Extracted Power and Experimental Validation of the Reactor's Transient Response

Objective 5 — **Demonstration** of Chloride Fuel Salt **Handling, Loading** and **Offloading Strategy**
Systems and Equipment testing, Instrumentation Testing, and Qualification for Molten Salt Reactors

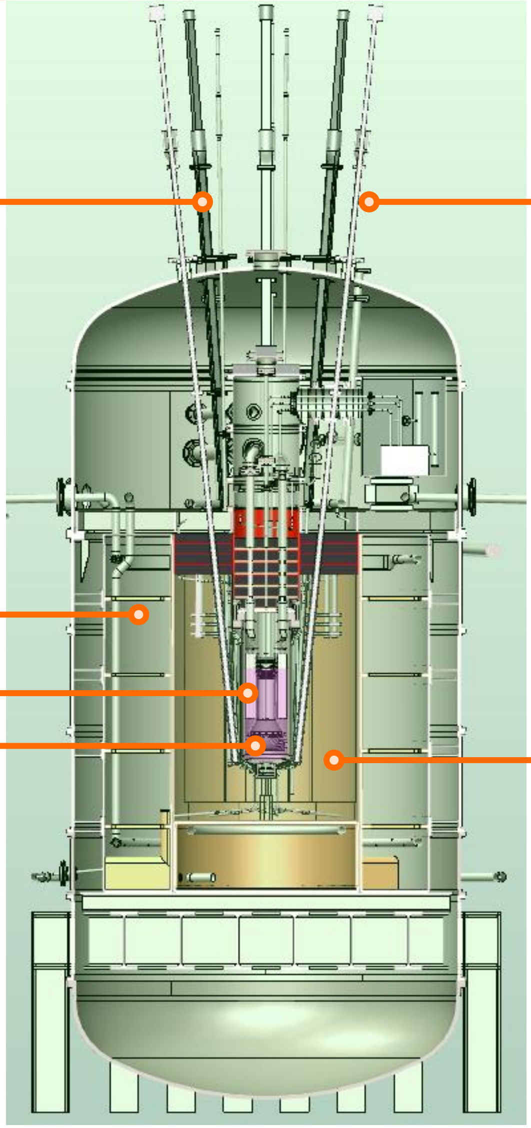


Overview of the ALVIN Reactor

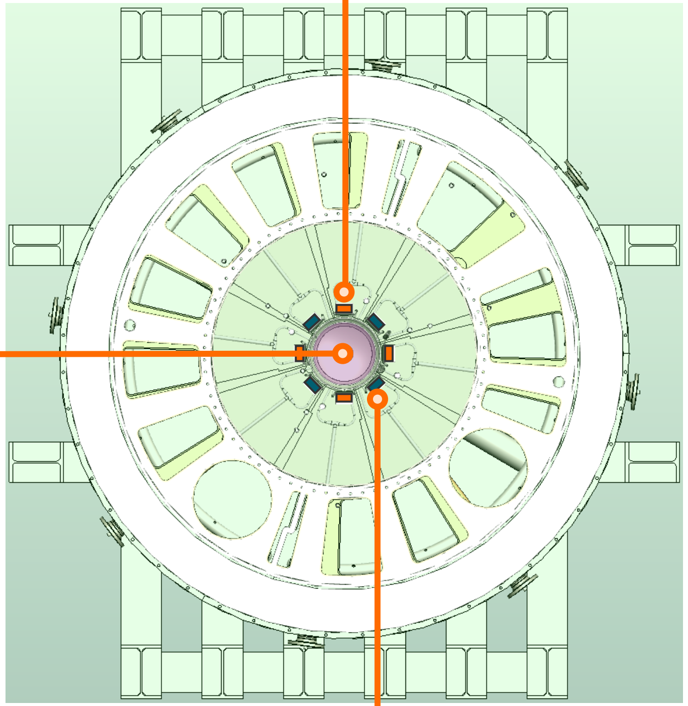
Preliminary Desing Phase



Reactor Core System Design and Architecture



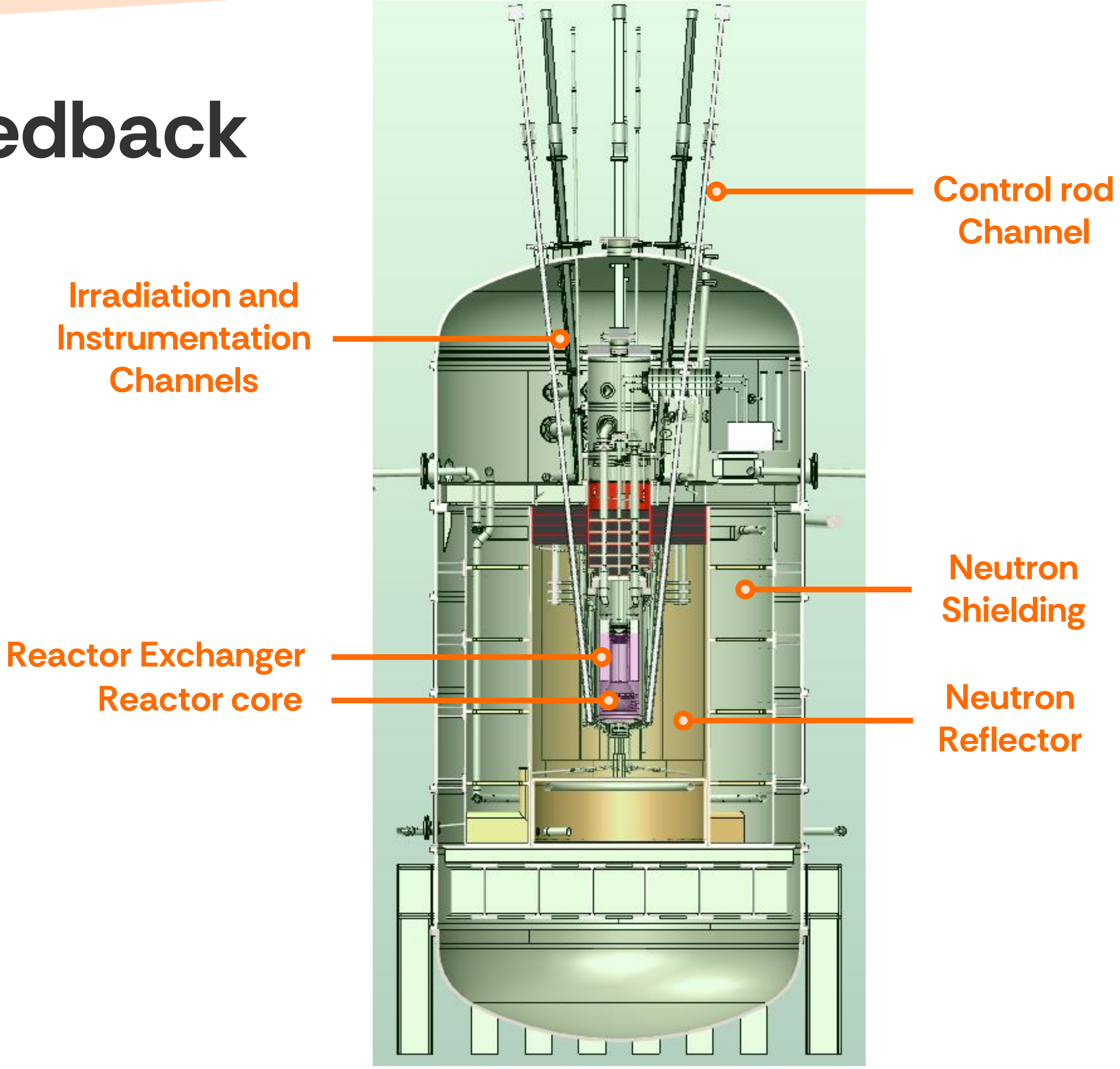
Side View of the Reactor Core



Radial View of the Reactor Core

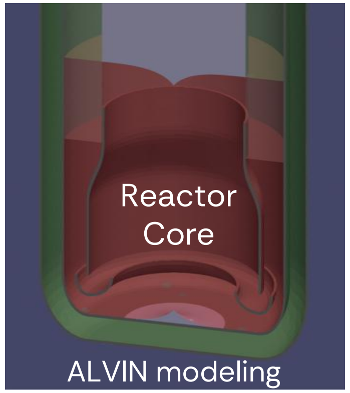
ALVIN's Neutronic Parameters Feedback

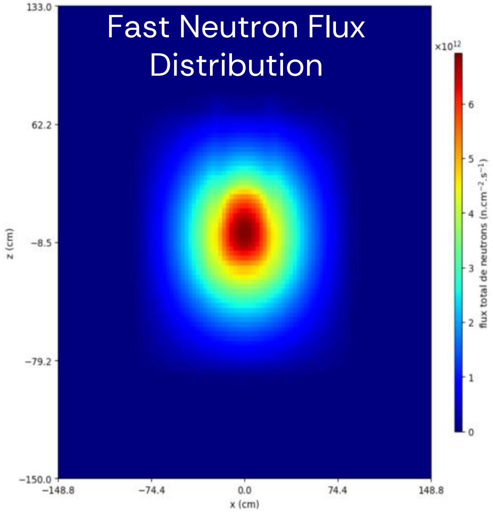
Parameter	Value
Thermal Power (steady State)	200 – 1000 kW
Delayed Neutron Fraction β_{eff}	222 pcm
Generation Time Λ_{eff}	0.9 µs
Negative Thermal Feedback α_{dil}	-20 pcm/°C
Core Average Fast Neutron Flux (at 200 kW)	~10^{12} n.cm².s^{-1}
Core Average Photon Flux (at 200 kW)	~10^{12} γ.cm².s^{-1}
Reactor Core Dimensions	50 Ø50H H = ccm = 55 cm
Reactor Core Volume	~100 L
Reactor Core Fuel Salt Composition	NaCl-$PuCl_3$
Neutron Reflector Material	Lead
Reactivity Control System	4 B_4C Rods

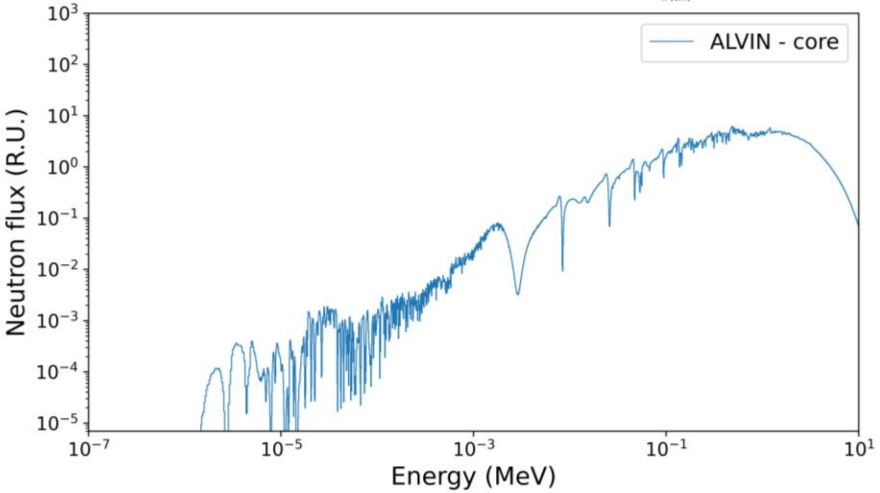


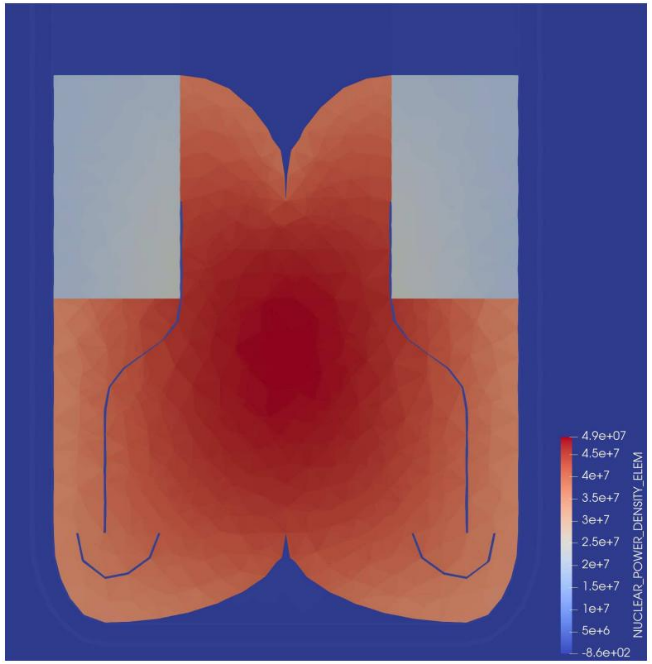
Side View of the Reactor Core

ALVIN’s Neutronic and Thermal-Hydraulic Coupling Simulations

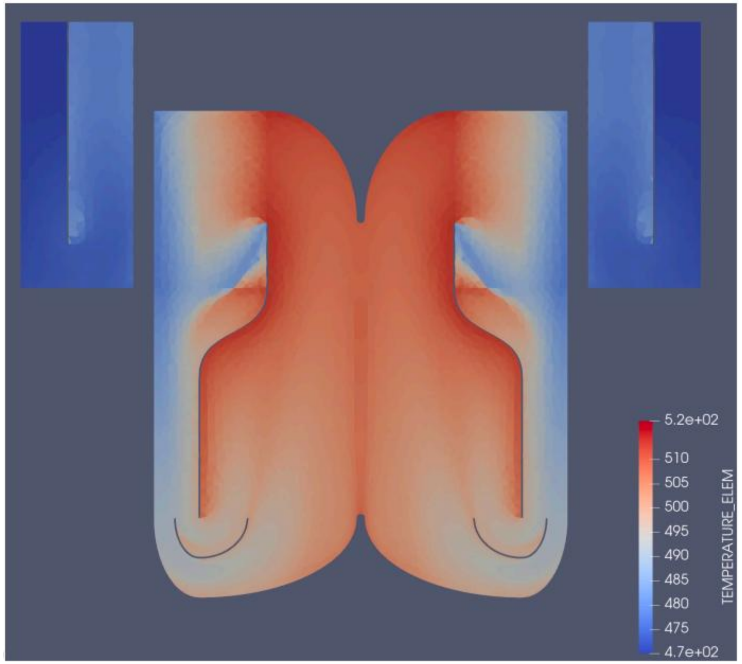








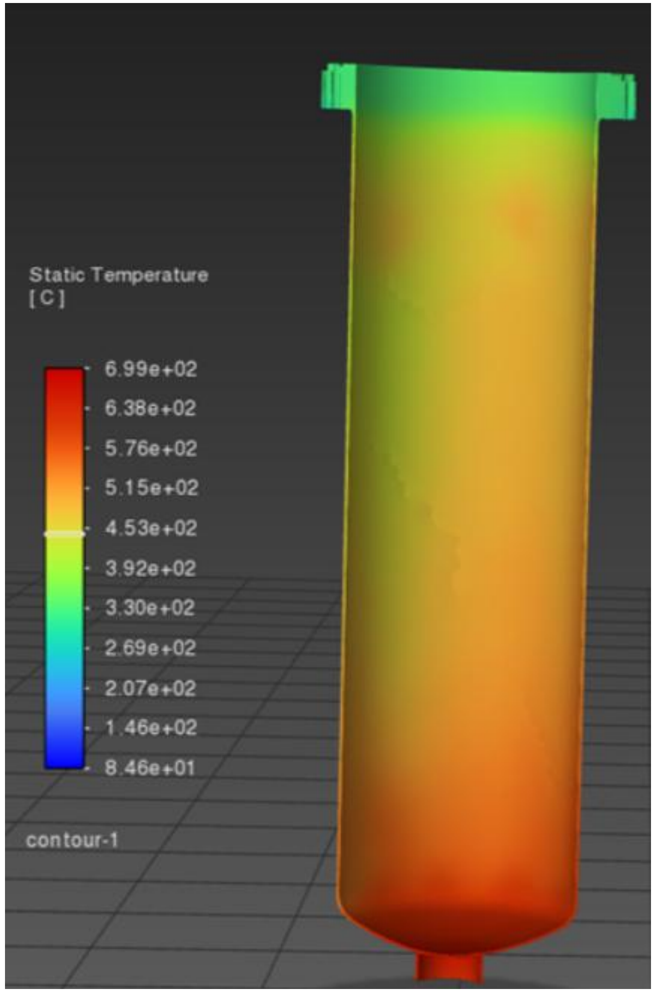
ALVIN’s Core Power Distribution



ALVIN’s Core Temperature Distribution

Potential for Neutron Noise Measurements

Challenges and limitations



Neutron noise measurement problematic at 0 power

- The vessel is maintained above fusion temperature with **hot gas flow**
  - → **Strong temperature** gradient in the salt
  - → Temperature fluctuations

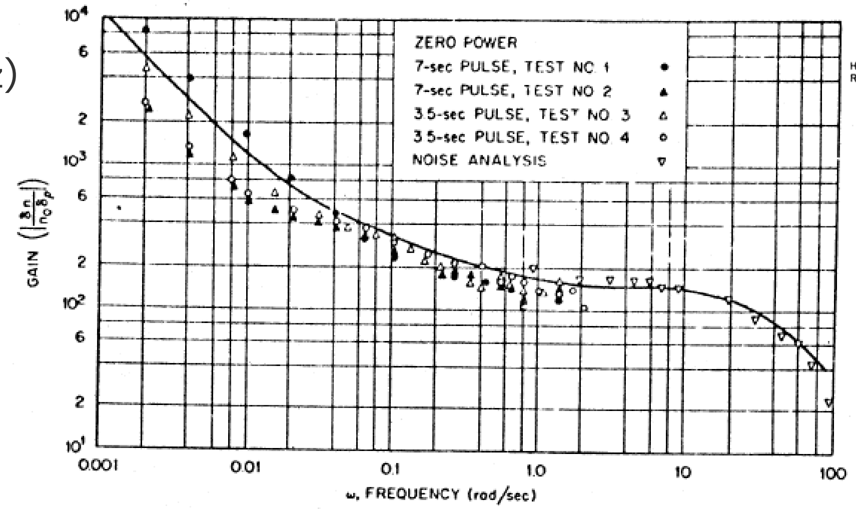
Reactivity Oscillation Measurements
In-pile oscillations

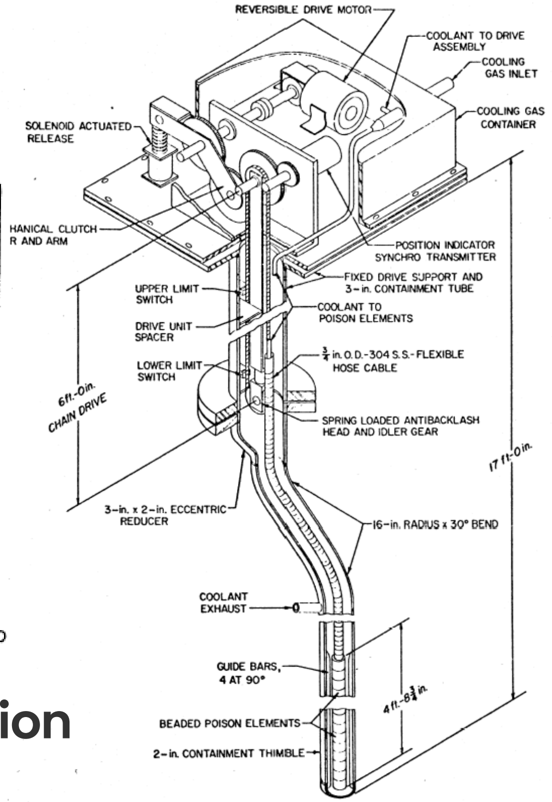
Dynamic Neutron Measurements (Reactivity Oscillation)

Reactor Transfer Function Measurement

Reactivity Oscillation and Reactor Transfer Function Measurement

- Use of a **Reactivity Oscillation System**
  - → Placed in an Irradiation Channel in the Reflector
  - → Oscillation with a Variable Frequency (1 mHz – 100 Hz)
  - → Reactor Transfer Function Measurement
  - → Kenetic Parameters Prediction





Control Rod Oscillation System - MSRE

KEEP IN TOUCH:

Georges Gay, Neutronic Engineer
Georges.gay@stellaria.fr

Hamza Ghninou, Neutronic Engineer
Hamza.ghninou@stellaria.fr

www.stellaria.fr

THANK YOU