SUNRISE-LFR: The new Swedish reactor

Fredrik Dehlin
Nuclear Engineering
KTH Royal Institute of Technology
fdehlin@kth.se
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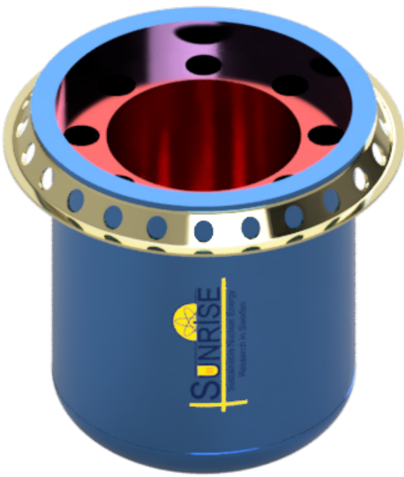
SUNRISE-LFR/ SEALER-D

SUNRISE
Sustainable Nuclear Energy Research in Sweden



SMR AB

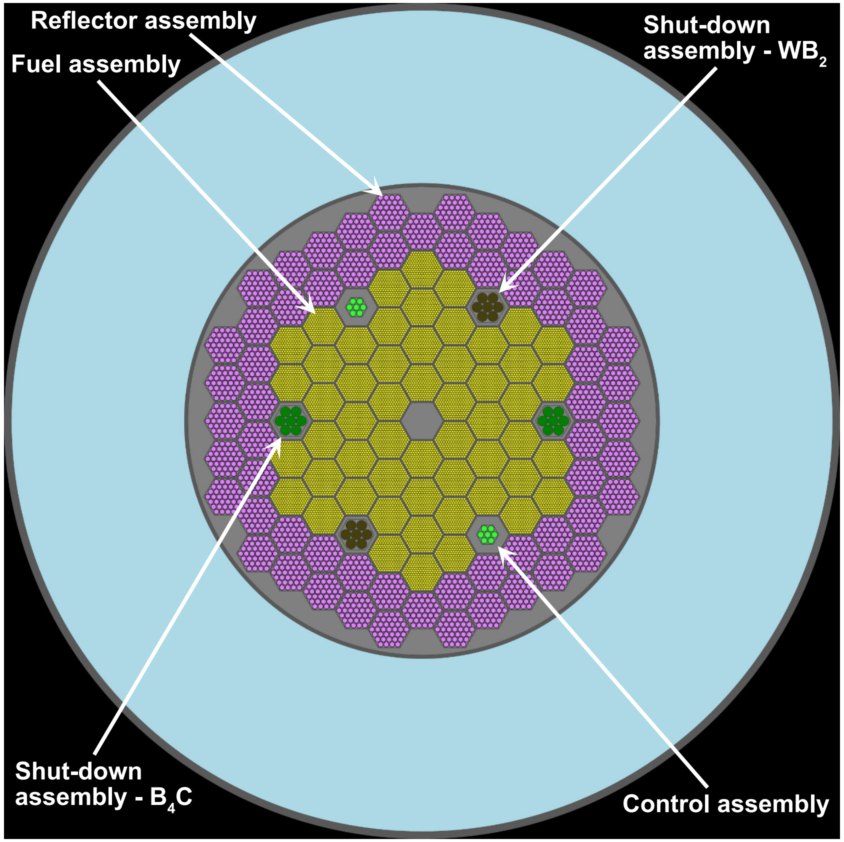
- 80 MWth research & demonstration reactor
- Used to verify irradiation performance of UN fuel, demonstrate safety concept, corrosion control and materials, operation and maintenance procedures.
- Location: Simpevarp
- Cost: ≈ 1 500 MSEK
- Licensing based on IAEA guidelines, four stages:
  - Government permissibility
  - Permission to construct
  - Permission for trial operation
  - Permission for regular operation

Design goals

- The goals of SUNRISE-LFR research and demonstrator reactor are:

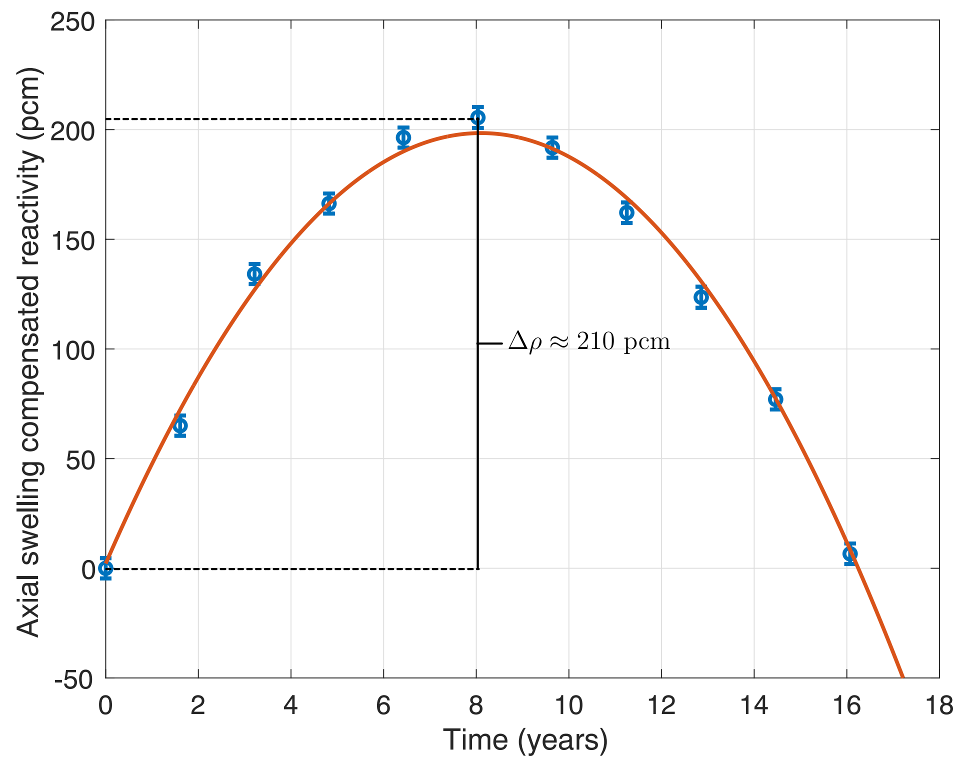
1. To demonstrate and validate the ability to operate a LFR in a commercial fashion prior to starting a commercial program.
2. To act as a neutron source available to academic and commercial entities with the purpose of performing fuel testing and validation.
3. To be suitable for education of university students and commercial operators.
4. To perform at the highest safety standard to ensure the safety of staff, visitors and the general public.
5. To minimise the impact on the local environment caused by the operation of the reactor.

Core design and layout



Core map of SUNRISE-LFR

- **54** UN fuel assemblies
- **60** ZrO_2 reflector assemblies
- **2** Nat-B_4C control rod assemblies
- **2** 96%-B_4C shutdown rod assemblies
- **2** WB_2 shutdown rod assemblies



Reactivity evolution during the fuel cycle of SUNRISE-LFR.

- **^{235}U enrichment of 12 at-% yields a minimal reactivity swing.**
- **Few control rod assemblies with low reactivity worth necessary to compensate swing.**
- **No possibility of prompt criticality in the event of unwanted control rod extraction.**

About SUNRISE-LFR

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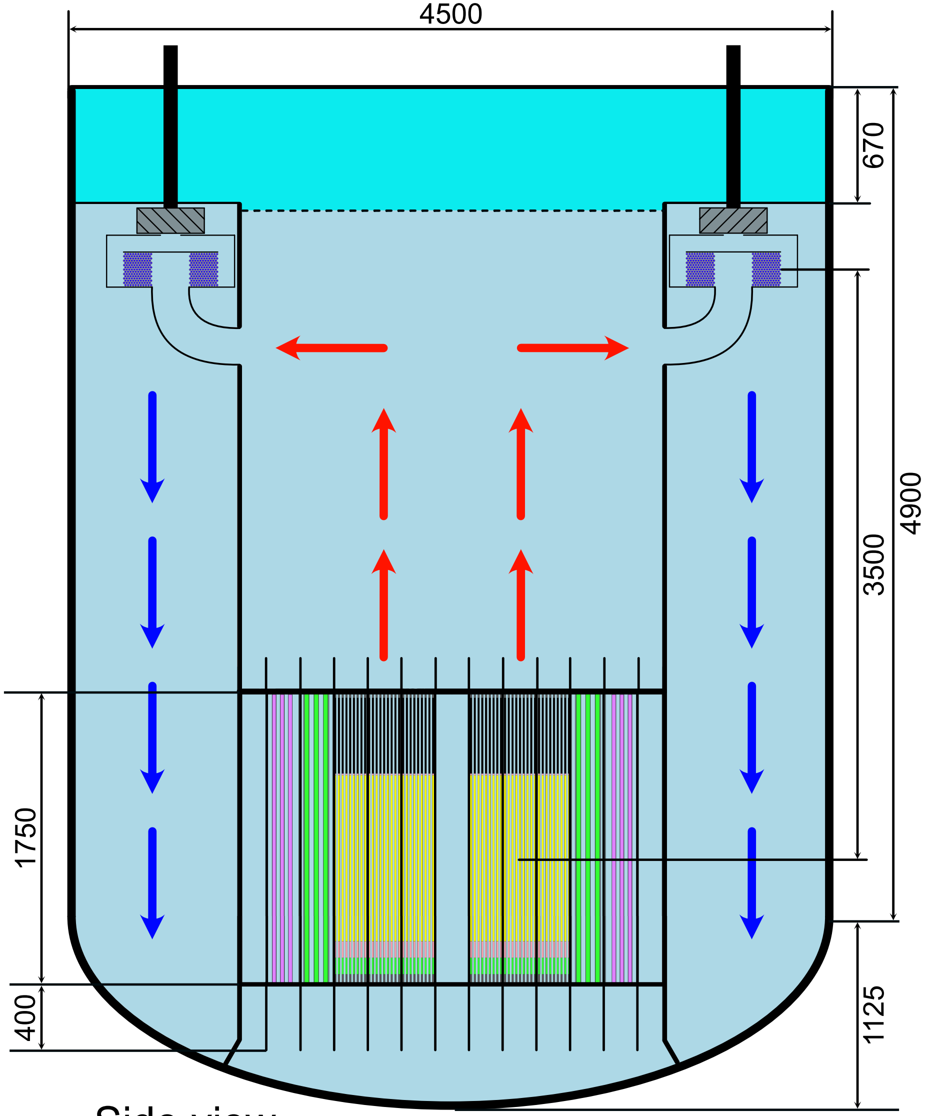
- Fueled by almost 13 ton of 12 at-% enriched uranium nitride (UN).
- Cooled by liquid lead (420/550 °C).
- Be capable of facilitating transient experiments (extra large safety margins incorporated in the design)
- Operate for 16 years on one fuel loading to demonstrate commercial operation.
- Demonstrate production of carbon neutral energy carriers, e.g., bio-fuels or hydrogen
- First criticality planned early 2030s.



Side view

KTH VETENSKAP OCH KONST

Potential applications

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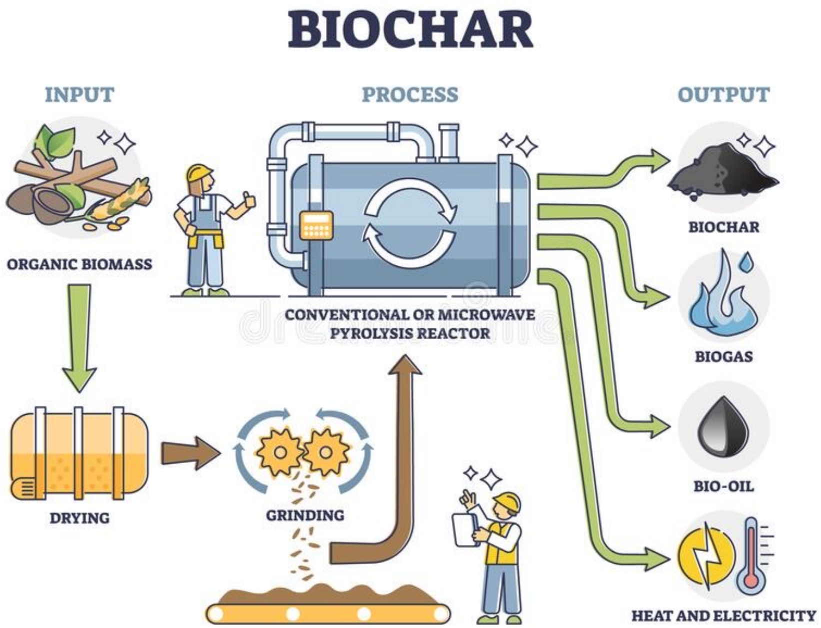
A reactor produces 2-3 times more heat compared to electrical energy!

- ## Steam pyrolysis of bio-mass:
  - Residue from the forest industry can be converted into bio-char, bio-oil and bio-gas.
  - Potential for both Bio-CCS and Bio-CCU.



- ## High temperature electrolysis:
  - Efficiency of the electrolysis process is increased at higher temperatures.
- ## Process heat to industries:
  - Combine heat and electricity production.
- ## District heating.
- ## Desalination of sea water:
  - Example: A single NuScale VOYGR (77 MWe) reactor can desalinate approximately 300 000 m^3 per day. (Stockholm: ~150 000 m^3 per day.

Published reactor design

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An analytic approach to the design of passively safe lead-cooled reactors

Fredrik Dehlin *, Janne Wallenius, Sara Bortot

KTH, Division of Nuclear Engineering, Albanova University Centre, 10691 Stockholm, Sweden

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A B S T R A C T

A methodology to assist the design of liquid metal reactors, passively cooled by natural circulation during off-normal conditions, is derived from first principle physics. Based on this methodology, a preliminary design of a small LFR is accomplished and presented with accompanying neutronic and reactor dynamic characterizations. The benefit of using this methodology for reactor design compared to other available methods is discussed.

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Thank you for your attention!