# Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II)

## Status and Outlook

IGORR 2025

Axel Pichlmaier – Florian Jeschke – Roland Schätzlein

# Sad fact:

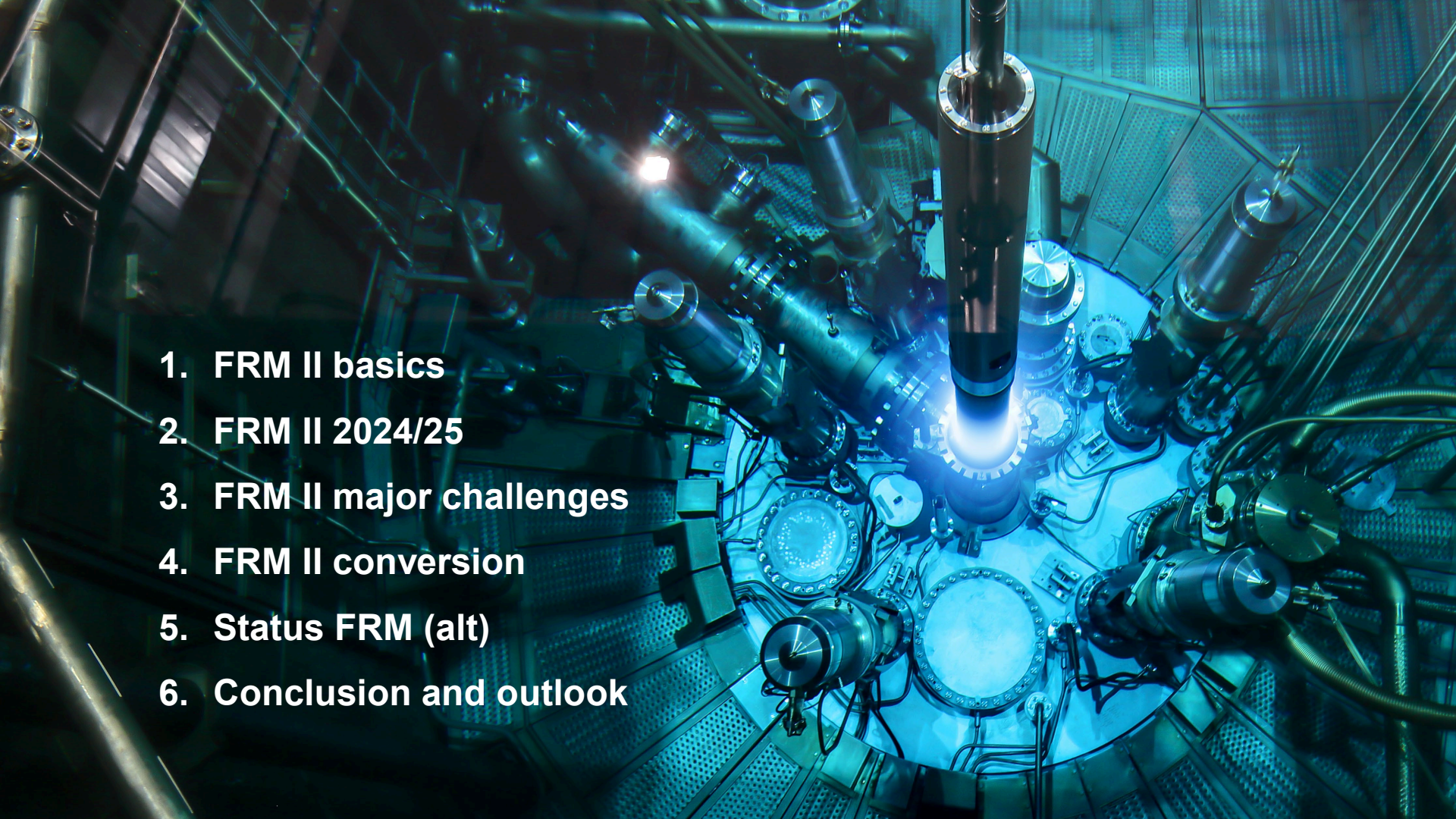
Since 16.03.2020: no more power operation

# Carsten Schneider, Federal Minister for the Environment,

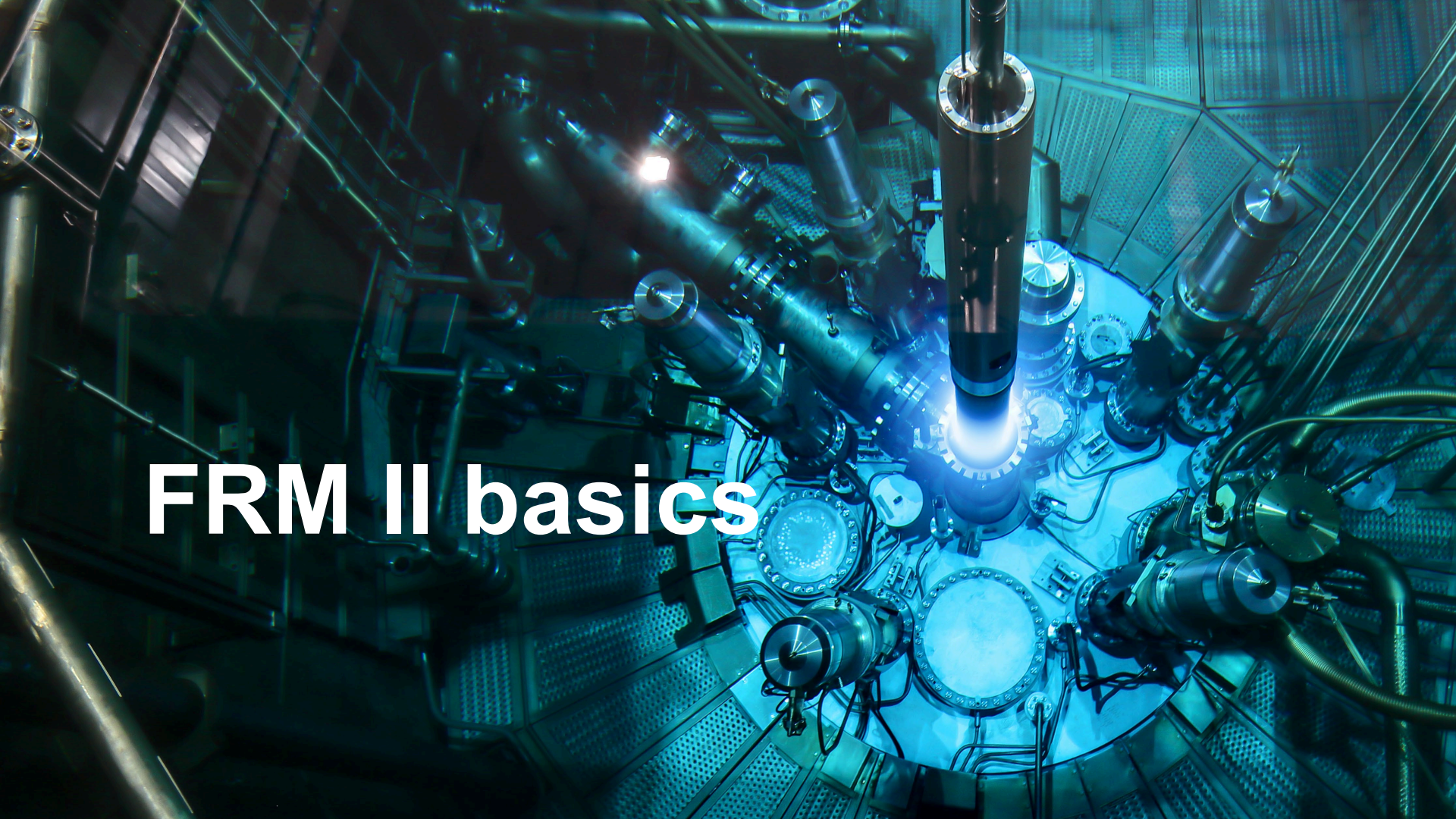
23.05.2025 (early statement after election and installation in office)

Germany has opted for an energy system without nuclear power for good reasons. [price, nuclear safety risks, safeguards]. I cannot seriously describe such a technology as sustainable. We respect the decision of other member states [of the EU] to use nuclear energy as long as these plants do not pose a risk to the German population. […]. The Federal Government has not taken such a position [classifiation of nuclear as sustainable and federal support for nuclear] and will not do so in future with [my party as coalition partner …].”

Who said the tide had changed with the new government?



1. FRM II basics
2. FRM II 2024/25
3. FRM II major challenges
4. FRM II conversion
5. Status FRM (alt)
6. Conclusion and outlook



# FRM II basics

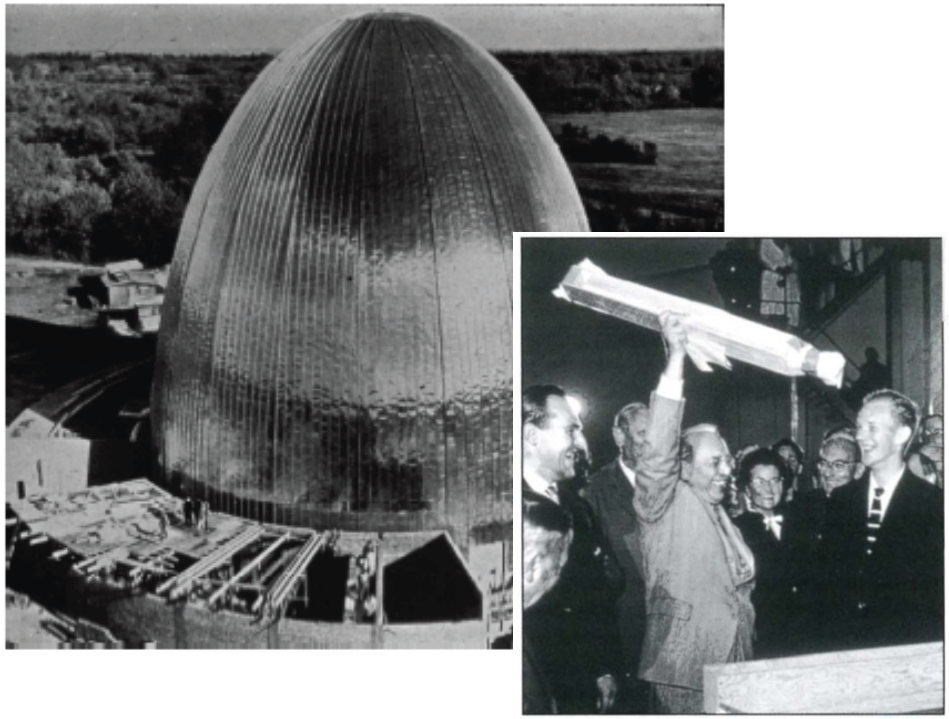

Munich 15 km
Garching 2 km
N
FRM II / FRM

# FRM is The Heart of the Research Campus Garching

**Campus Garching 1957**

**Campus Garching today**

# The FRM

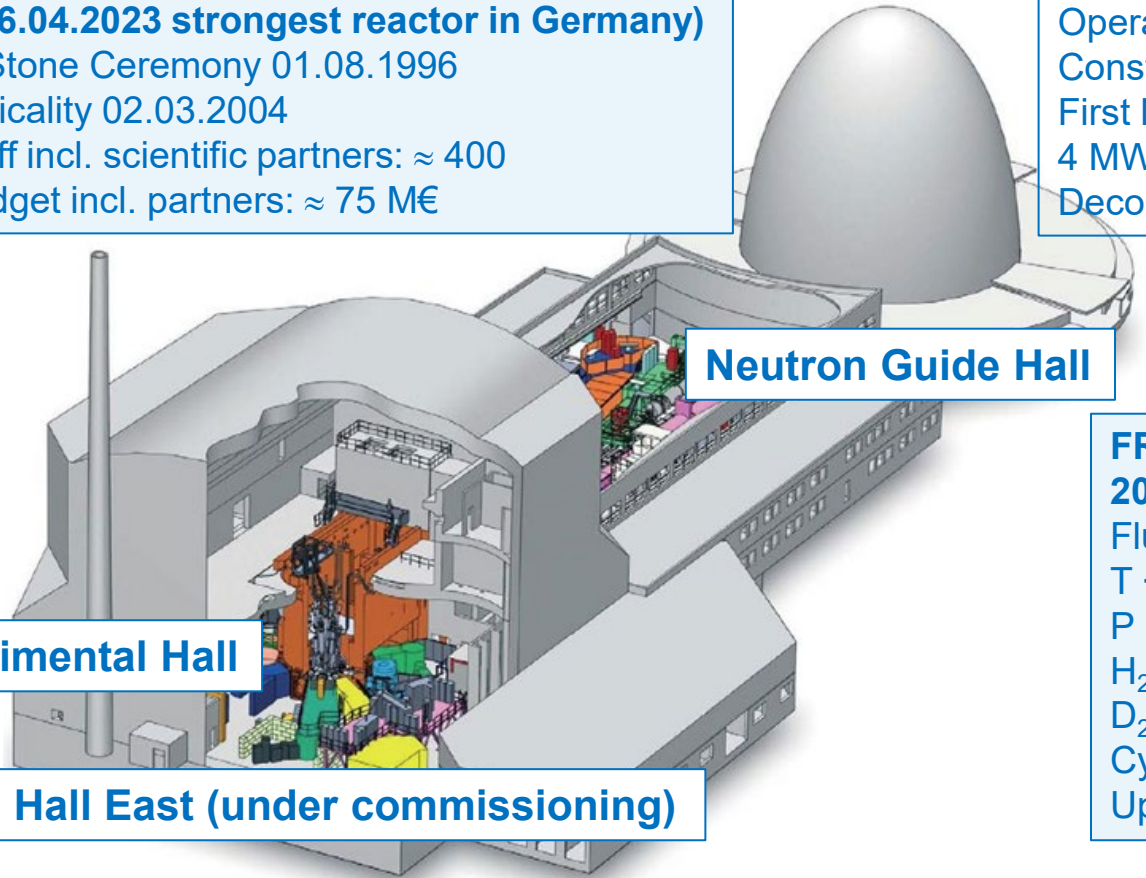


*Bavaria's Prime Minister Högner shows the first fuel element.*

- The decision to build the FRM was made by the Bavarian Council of Ministers on June 06, 1956 – 12 years to the day after D-Day.
- The FRM went into operation on October 31, 1957, after only two months of planning and eleven months of construction.
- It was the first nuclear facility in Germany.
- The Garching research campus was built around the FRM.

**FRM II**
**(since 16.04.2023 strongest reactor in Germany)**
Corner Stone Ceremony 01.08.1996
First Criticality 02.03.2004
Total staff incl. scientific partners: ≈ 400
Total budget incl. partners: ≈ 75 M€

**FRM** („Atomic-Egg“)
Operational 1957 – 2000
Construction 1956/57
First Nuclear Installation in D
4 MW MTR reactor by AMF
Decommissioning license 03.04.2014



**Neutron Guide Hall**

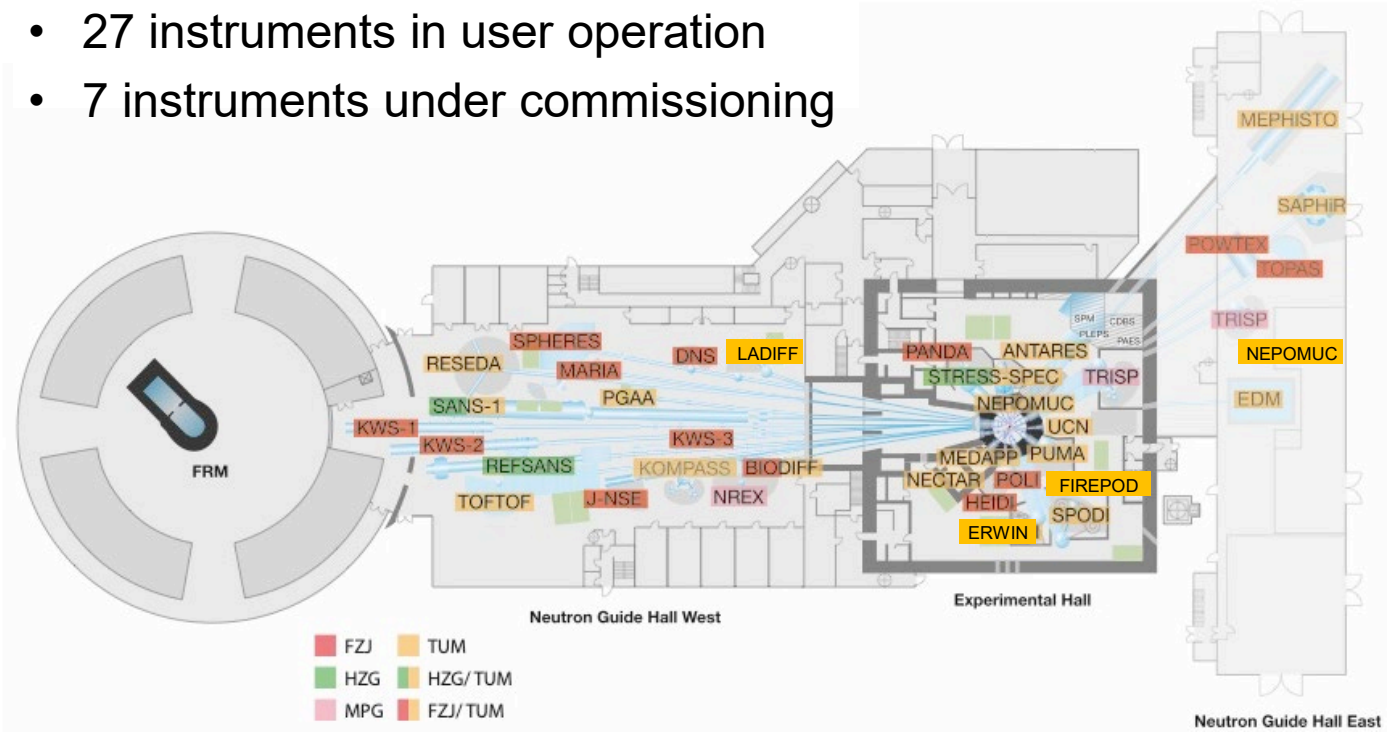
**Experimental Hall**

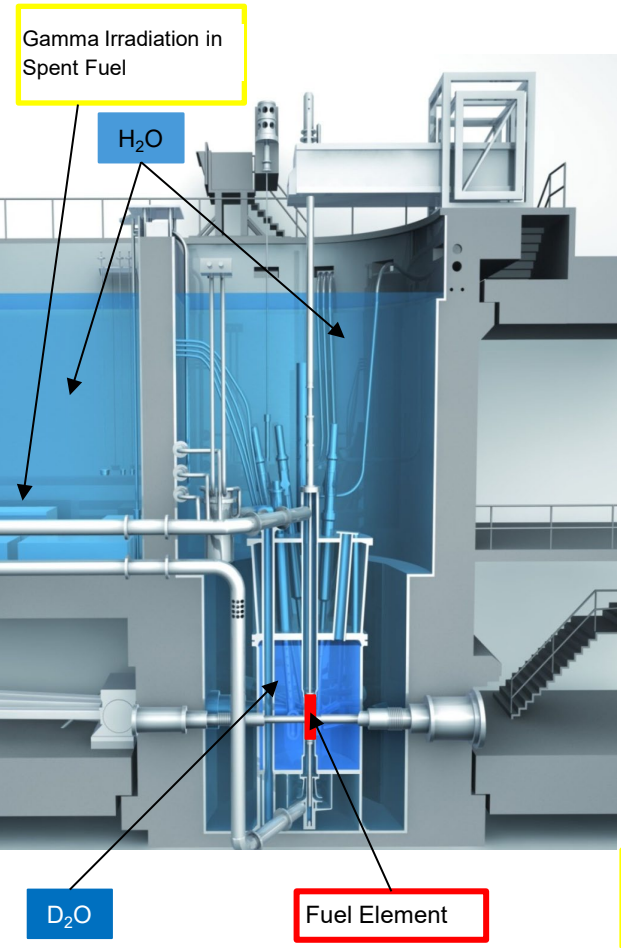
**Guide Hall East (under commissioning)**

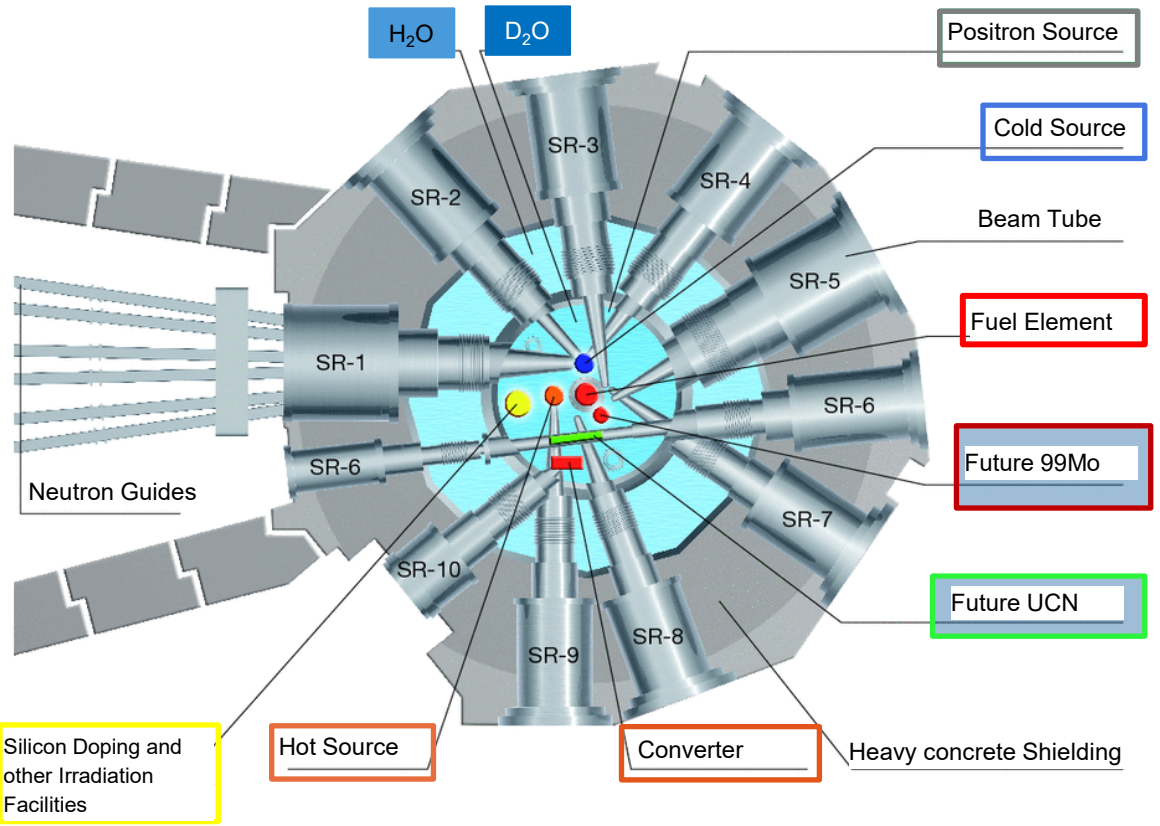
**FRM II**
**20 MW** thermal Power
Flux up to **$8*10^{14}$ neutrons/cm²/s**
T < 50 °C
P < 10 bar
$H_2O$ cooling
$D_2O$ moderation
Cycle length **60 days**
Up to 4 cycles per year

# Scientific Instruments

- 27 instruments in user operation
- 7 instruments under commissioning

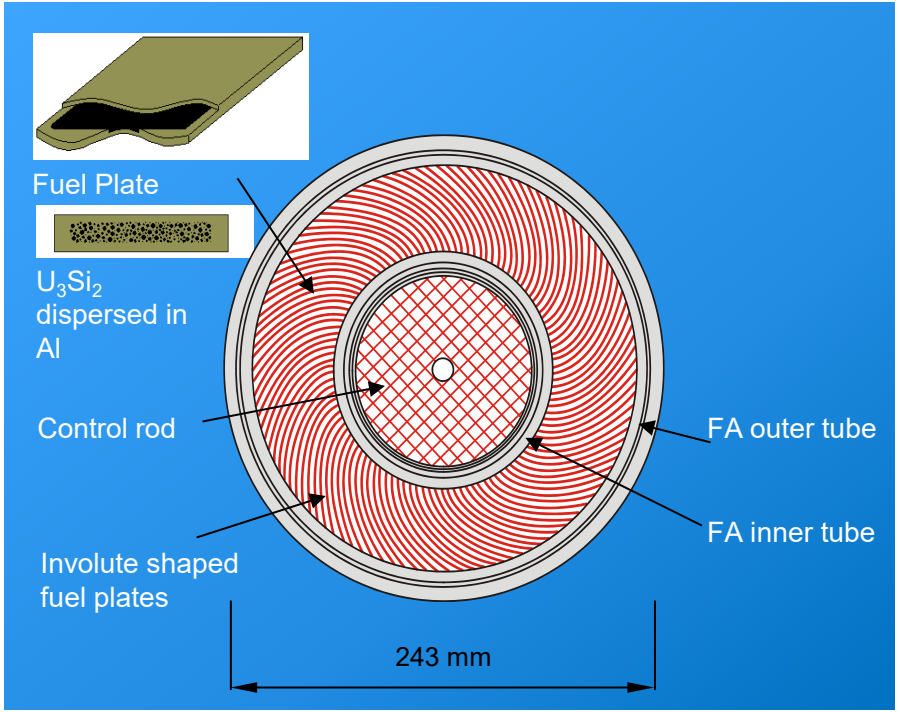




Gamma Irradiation in Spent Fuel
$H_2O$
$D_2O$
Fuel Element


$H_2O$
$D_2O$
Positron Source
Cold Source
Beam Tube
Fuel Element
Future 99Mo
Future UCN
Heavy concrete Shielding
Converter
Hot Source
Silicon Doping and other Irradiation Facilities
Neutron Guides
SR-1
SR-2
SR-3
SR-4
SR-5
SR-6
SR-6
SR-7
SR-8
SR-9
SR-10

# FRM II Fuel

- One fuel assembly at a time in the core
- 60 day cycle, up to 4 cycles/yr
- ≈ 8 kg U (≤ 93 % U-235)
- Hollow cylinder
  - ≈ 1,3 m length,
  - ≈ 24 cm diameter,
  - ≈ 53 kg total weight
- Fuel: $U_3Si_2$ in Al dispersed
- Involute shape, similar to HFIR, Oak Ridge and RHF, ILL
- Conversion to LEU ongoing



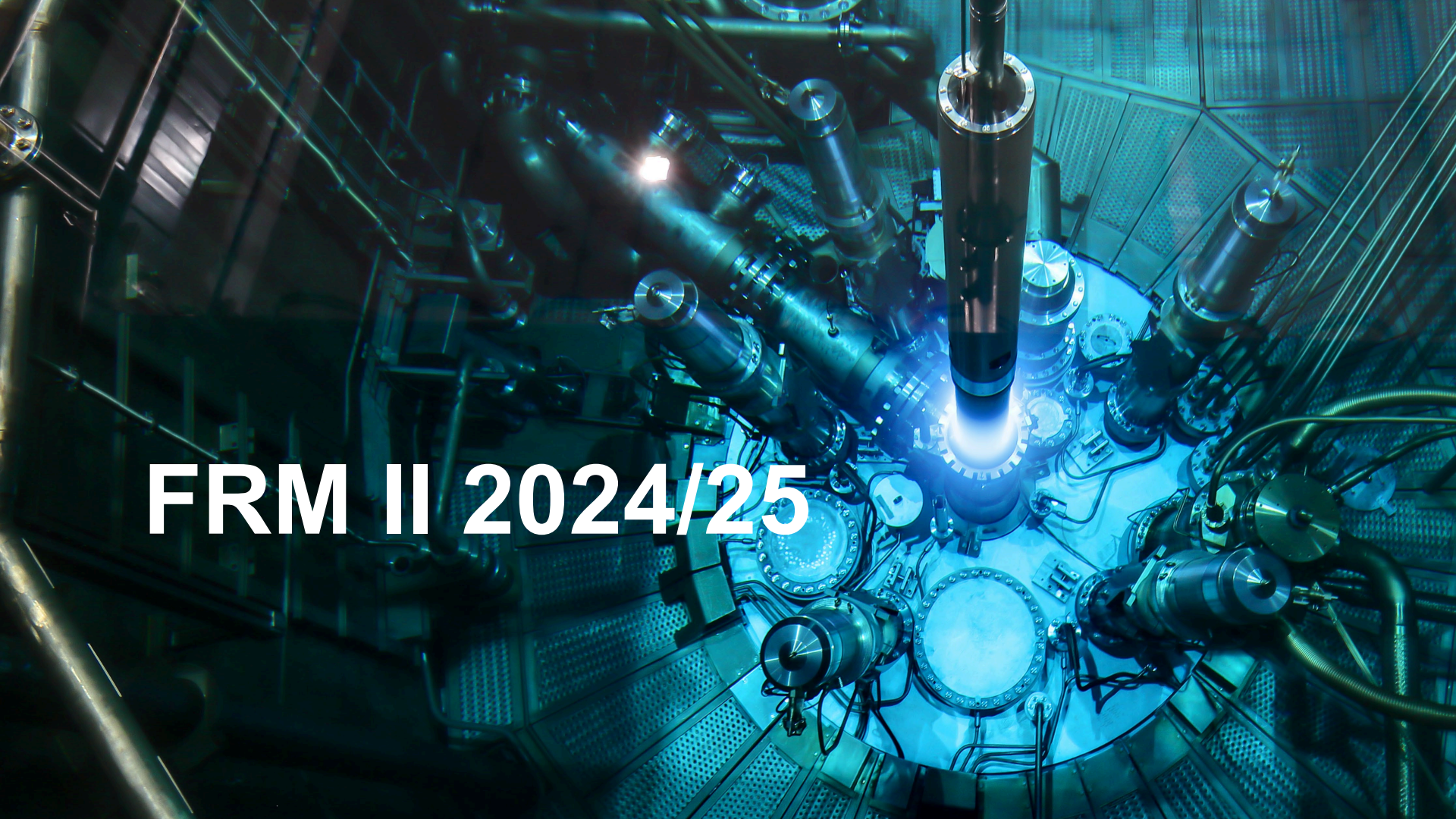

**At ILL and FRM II: > 240 FA used**

# Conversion of FRM II from HEU to LEU

- The project is on schedule.
- TUM and Framatome as well as other project partners (ANL, BR2 and others) are investing considerable resources.
- FRM II activities are currently primarily aimed at submitting the conversion license application at the end of 2025.
- Work relating to the
  - Technical qualification,
  - manufacturing,
  - reactor physics

  are well underway.


Milestone: 25.02.2025 at Framatome. Final inspection of the FUTURE-MONO 1 fuel plates. These are HALEU U10Mo, monolithic with 20 µm Zr (PVD coated), manufactured as part of the EU QUALIFY program entirely in Europe!


FRM II 2024/25

# Some Major Accomplishments

- Renovation of the primary and tertiary cooling loop, including water treatment facilities and instrument cooling system
- Upgrade of the cranes in the reactor hall (ongoing) and experimental hall (completed): complete replacement of I & C systems, adaptation of brakes → cf. presentation D. Schneider, this conference
- Overhaul of parts of the ventilation systems
- Refurbishment of $D_2O$ circulation pump, progress towards new $D_2O$ resin purification system
- Upgrades of irradiation facilities → cf. presentation V. Hutanu, this conference,
- Renovation of the reactor protection system and I & C systems (TXP no longer supported, compatibility to TXS to be maintained), in preparation
- Progress towards new UPS and batteries (seismic qualification, electromagnetic compatibility)
- Periodic safety review (PSR) 2024, due date April 30, 2025 including DSA (deterministic security analysis) in time submitted to the regulator.
- Preparation for installation of the new central channel, progress in its manufacturing
- Progress towards transport of spent fuel

# FRM II major challenges

# Spent fuel shipment

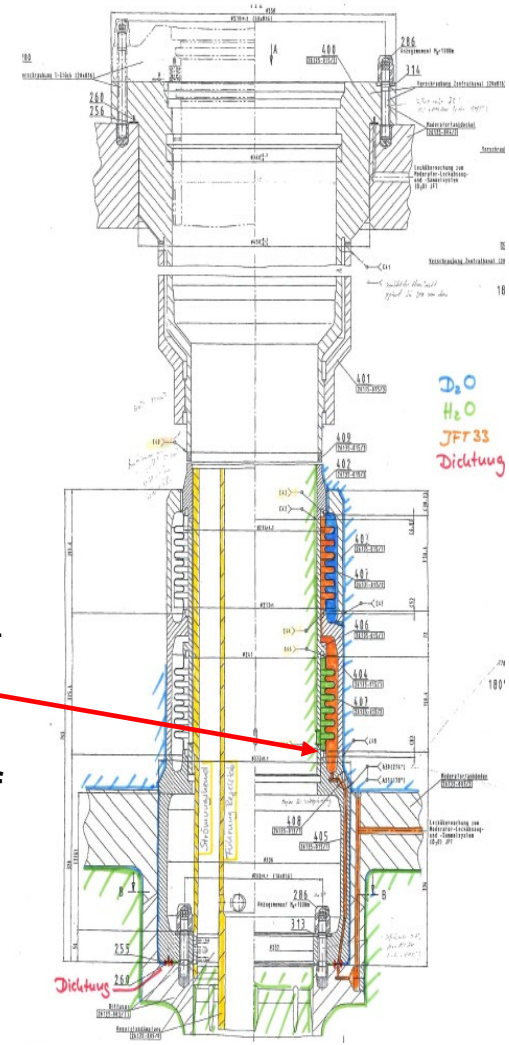
**According to the FRM II license, spent fuel is to be stored in Ahaus, NW Germany. The Transport requires several licenses:**

(1) Transport license for CASTOR® MTR3 (granted 2019).
(2) Transport license § 4 AtG (applicant: Orano NCS).
(3) Storage license § 6 AtG for storage of spent fuel (applicant: BGZ).
(4) FRM II is technically ready and awaiting the licenses.
Favorable conditions in 2025:
no more federal nor state elections in 2025
no large events (Olympics, Soccer Championship …)
(5) Issue of licenses may happen in 2025. They likely will be challenged in court.

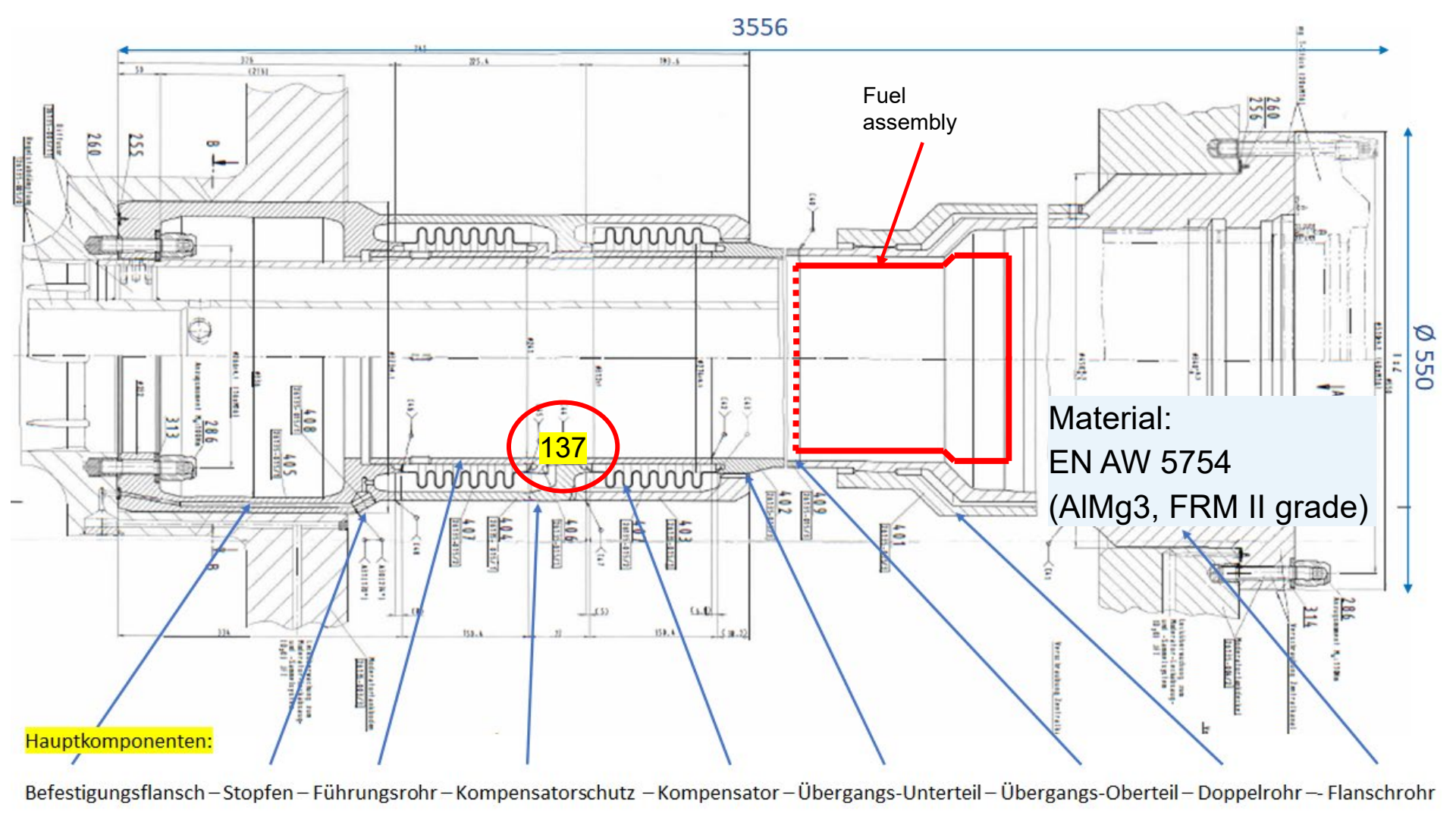
**The licenses are dearly needed. 48/50 places taken in spent fuel pool.**

# 2022 ff: Central Channel (“Zentralkanal”)

- The central channel is one of the most important components of FRM II. It serves as
  - Enclosure of the cooling medium ($H_2O$)
  - Separation of cooling and moderating media ($H_2O$/$D_2O$)
  - Coolant guide for cooling the fuel element
  - Positioning of the fuel element
  - Support of the control rod (without drive)
  - […]
- A tiny leak (1 drop/3 minutes) was discovered by the leak detection system.
- No (other) effects on FRM II, persons or the environment.
- Planned and only remedy: installation of a new “Zentralkanal”.
- Construction of new “Zentralkanal” technically demanding, AND **number of contractors to be coordinated**, the rapid **decrease of knowledge in nuclear after the German phase-out** and the **lack of skilled labor**.




**A new „Zentralkanal“ will replace the old one.**

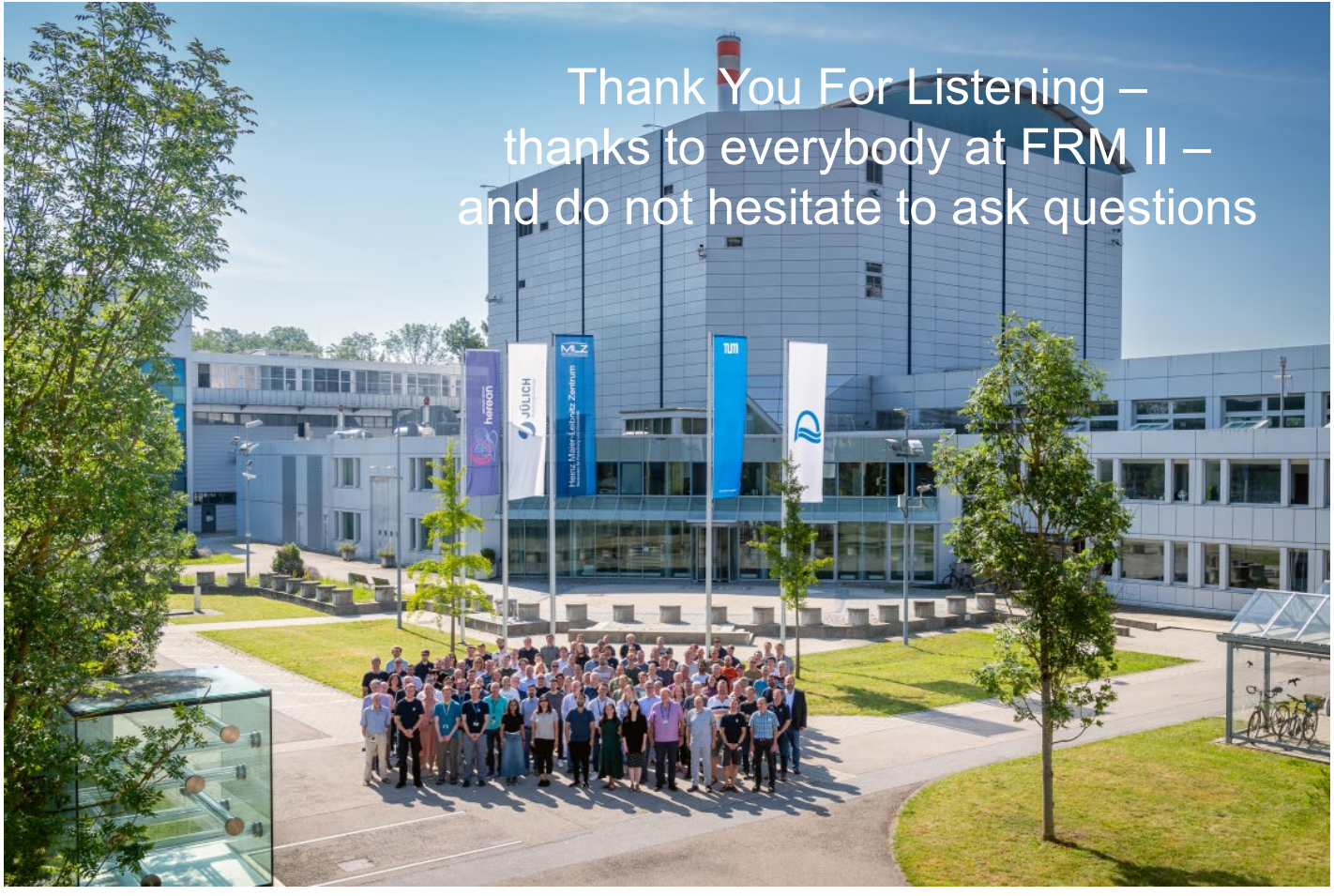

3556
Fuel assembly
Ø 550
137
Material:
EN AW 5754
(AlMg3, FRM II grade)
Hauptkomponenten:
Befestigungsflansch – Stopfen – Führungsrohr – Kompensatorschutz – Kompensator – Übergangs-Unterteil – Übergangs-Oberteil – Doppelrohr – Flanschrohr

# Conclusion and Outlook

# Conclusion and Outlook

- FRM II is a versatile machine of world class quality for
  - neutron scattering,
  - neutron imaging,
  - positron applications,
  - NTD-Si and RI-production –

  in a challenging situation.
- Back to normal operation is foreseen after all technical and administrational conditions will be met, probably in early 2026.
- The time without neutrons is demanding for everybody in the team (including scientists and external stake holders!), but it is used for general refurbishment projects and inspections.


Thank You For Listening –
thanks to everybody at FRM II –
and do not hesitate to ask questions
Helmholtz
JÜLICH
Heinz Maier-Leibnitz Zentrum