Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II)

Status and Outlook

IGORR/TRTR 2023

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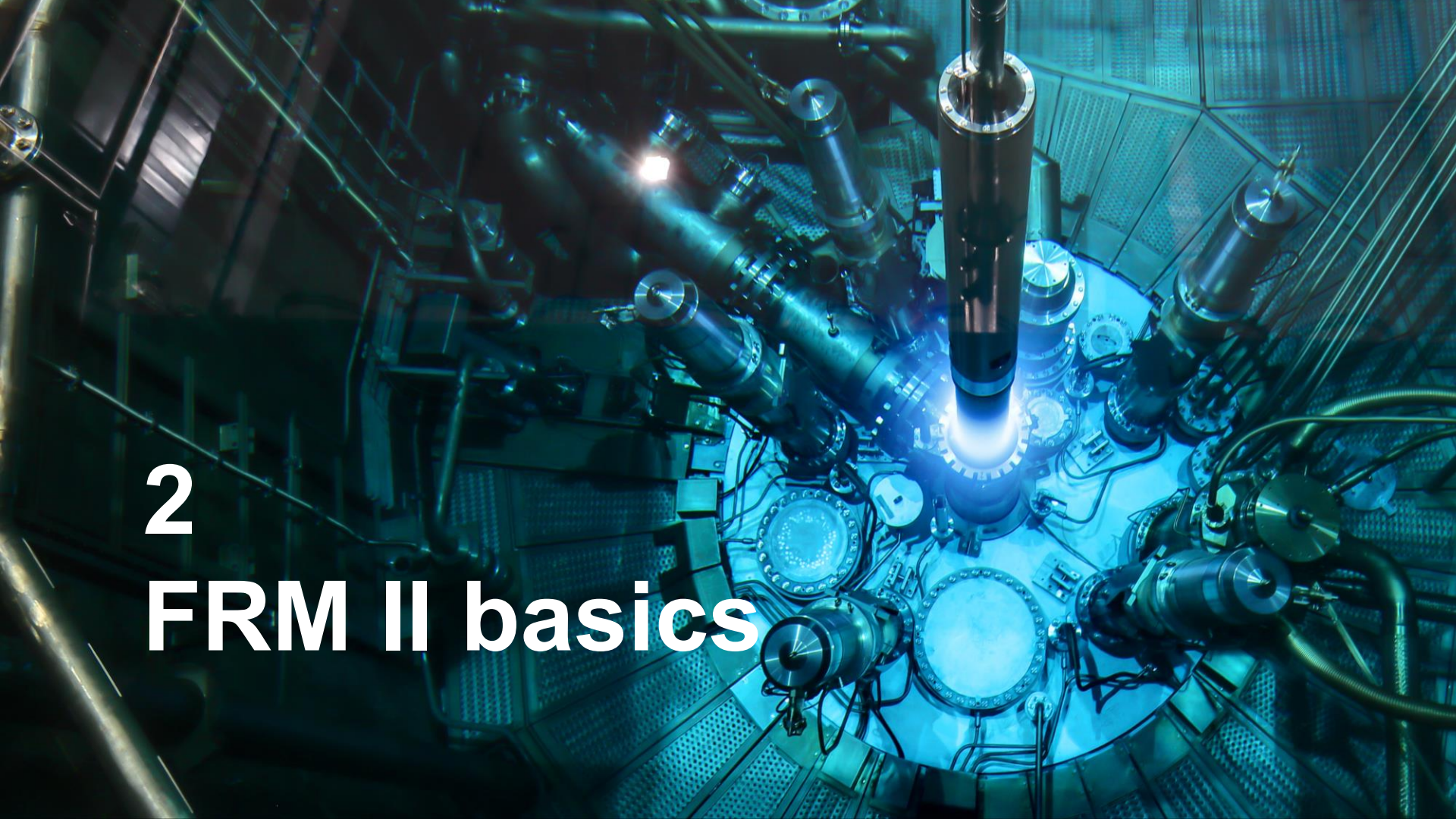
1
FRM II in Garching/Munich


Munich
Garching
N
FRM II/FRM

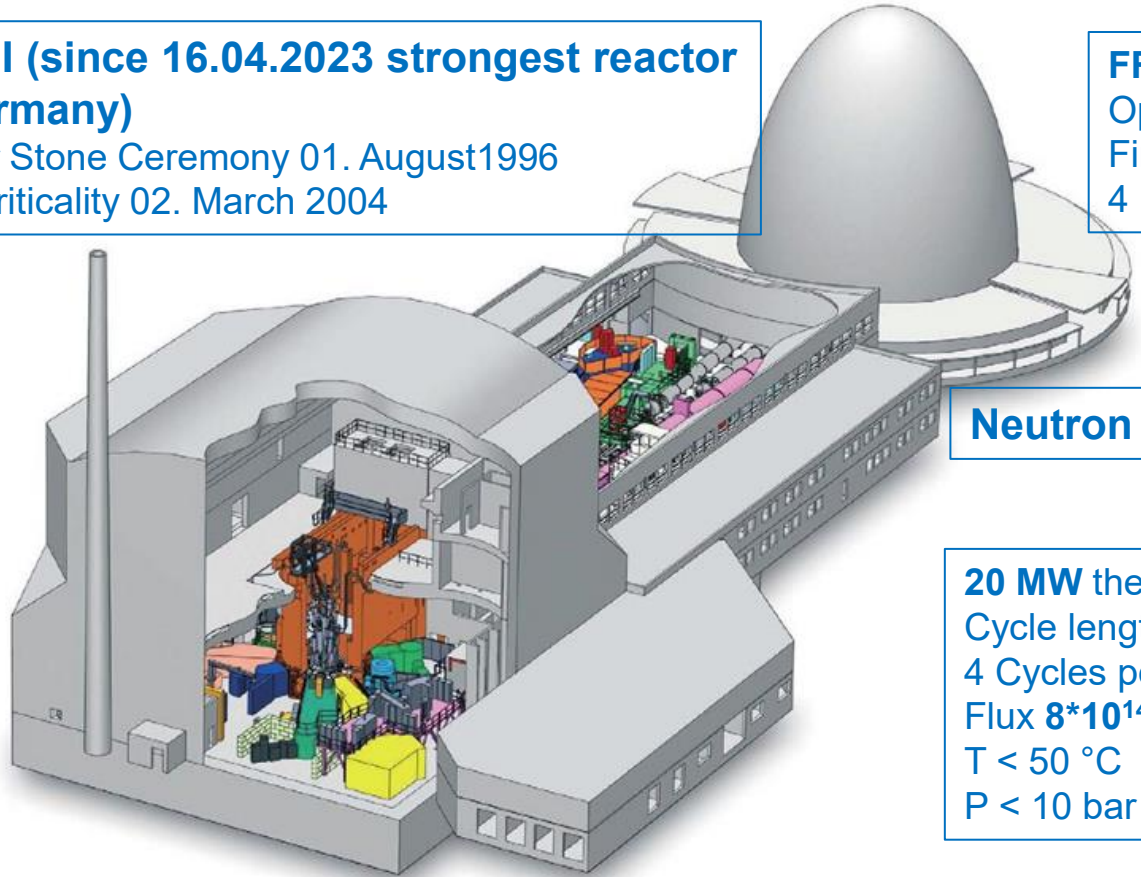


2
FRM II basics

FRM II Basics

FRM II (since 16.04.2023 strongest reactor in Germany)
Corner Stone Ceremony 01. August1996
First Criticality 02. March 2004

FRM („Atomic-Egg“)
Operational 1957 – 2000
First Nuclear Installation in D
4 MW MTR reactor by AMF

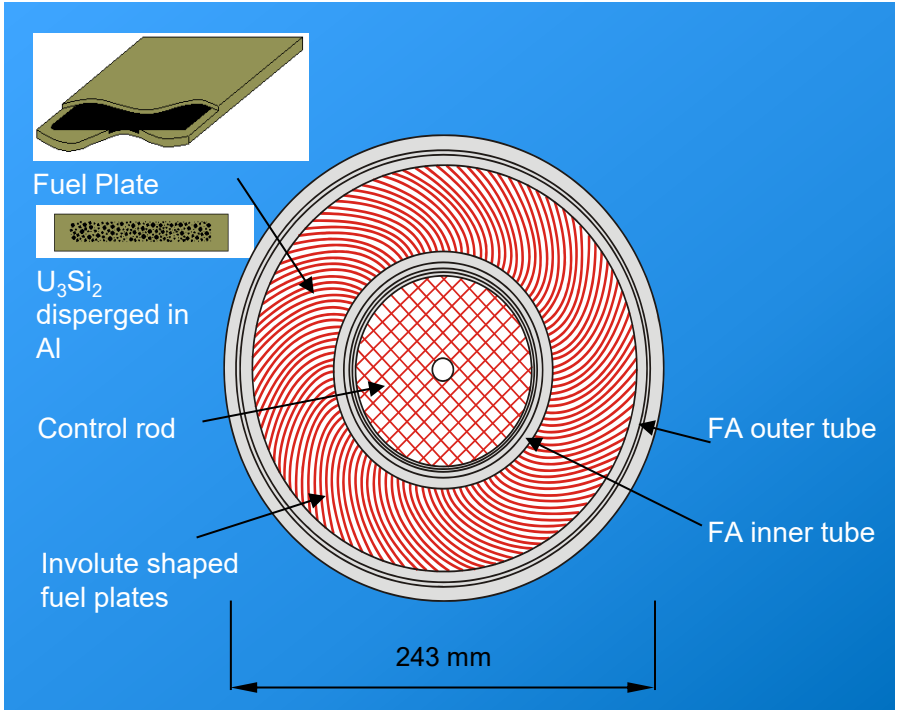


Neutron Guide Hall

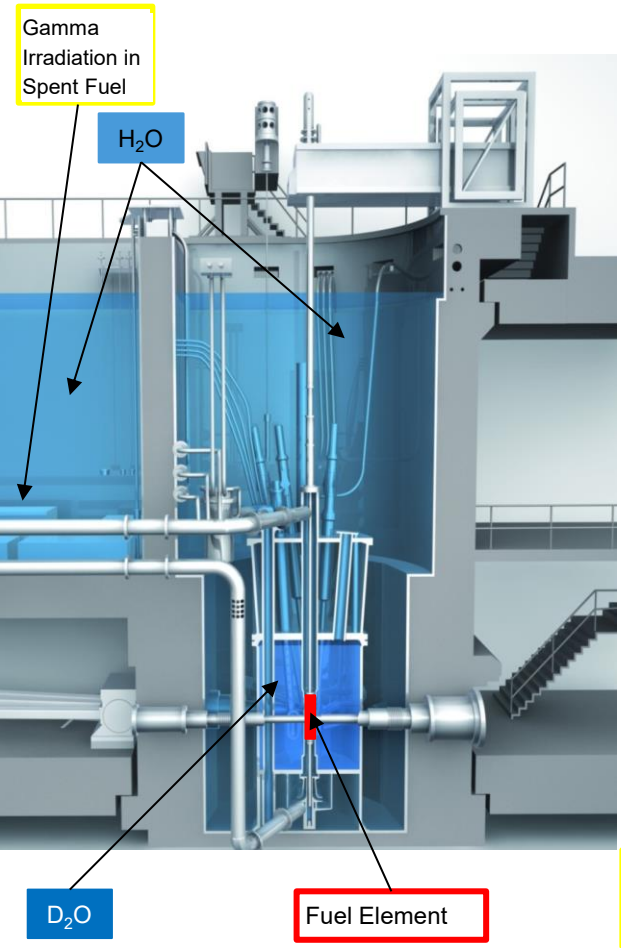
20 MW thermal Power
Cycle length **60 days**
4 Cycles per Year
Flux **$8*10^{14}$ neutrons/cm²/s**
T < 50 °C
P < 10 bar

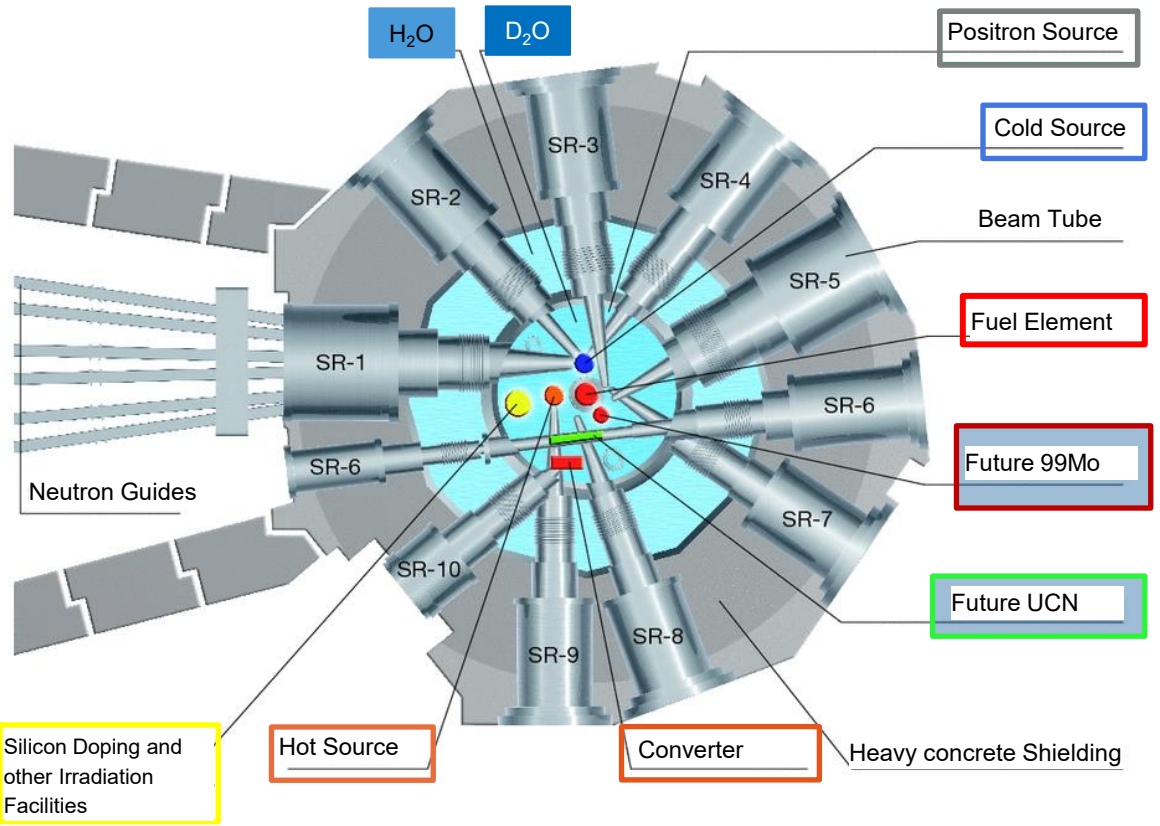
FRM II Fuel

- ≈ 8 kg U (> 90 % U-235)
- Hollow cylinder
  - ≈ 1,3 m length,
  - ≈ 24 cm diameter,
  - 53 kg total weight
  - fuel: U_3Si_2 in Al dispersed
- Similar to Oak Ridge and ILL



At ILL and FRM II: ≈ 240 FA used.


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

Sad fact:

March 31, 2023: 1111 days without neutrons
(and several more to come)

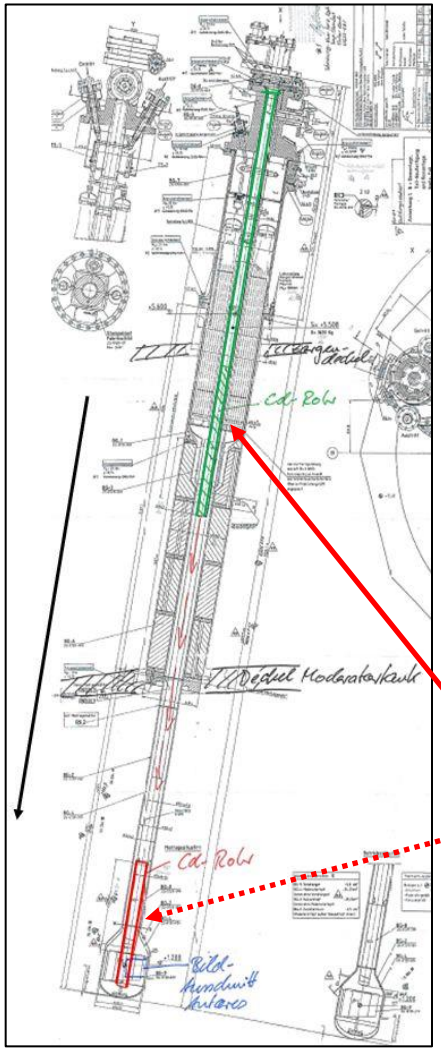
3
FRM II major challenges

Transport of Fresh fuel assemblies (FA)

- Fresh fuel assemblies need to be transported from Framatome/CERCA (France) to FRM II (Germany).
- Several FA are awaiting shipment.
- In Germany, the transport requires a license according to § 4 of the Atomic Energy Act.
  Similar requirements in France.
  BUT: Technical requirements for transportation of such FA are very different in F and D, some even contradictory.
- This license will probably contain further obligations (compensatory measures).

- After years of negotiations with regulating authorities, we have reason for some optimism.

The German licenses will be issued by the BASE (hopefully soon?).



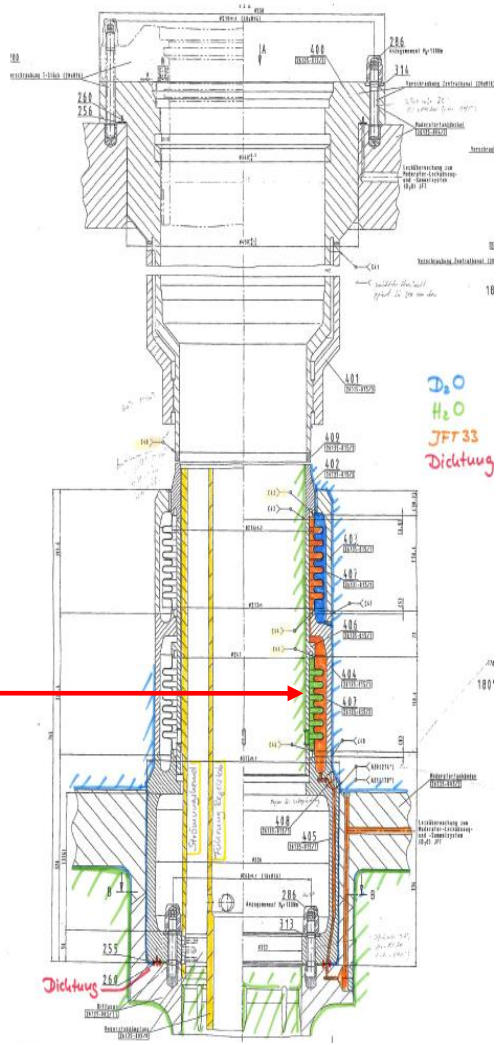
2021: Failure and Subsequent Removal of the Inpile Part of the Cold Source (CNS)

- The CNS is the most important experimental facility at FRM II. Cold neutrons are the "workhorse" of neutron research at FRM II.
- Reactor operation is only permitted
  - with the CNS functioning or
  - with the CNS removed.
- During the reactor restart in 2021, the CNS behaved conspicuously and, by design, led to a reactor shutdown at 10 % PN.
- Diagnosis
- CNS has been removed.
- Construction of new CNS under way but still about two years from completion.

2022: Central Channel (“Zentralkanal”)

- The central channel is one of the most important components with relevance for safety:
  - 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”.

The „Zentralkanal“ will be replaced.



Spent fuel shipment

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

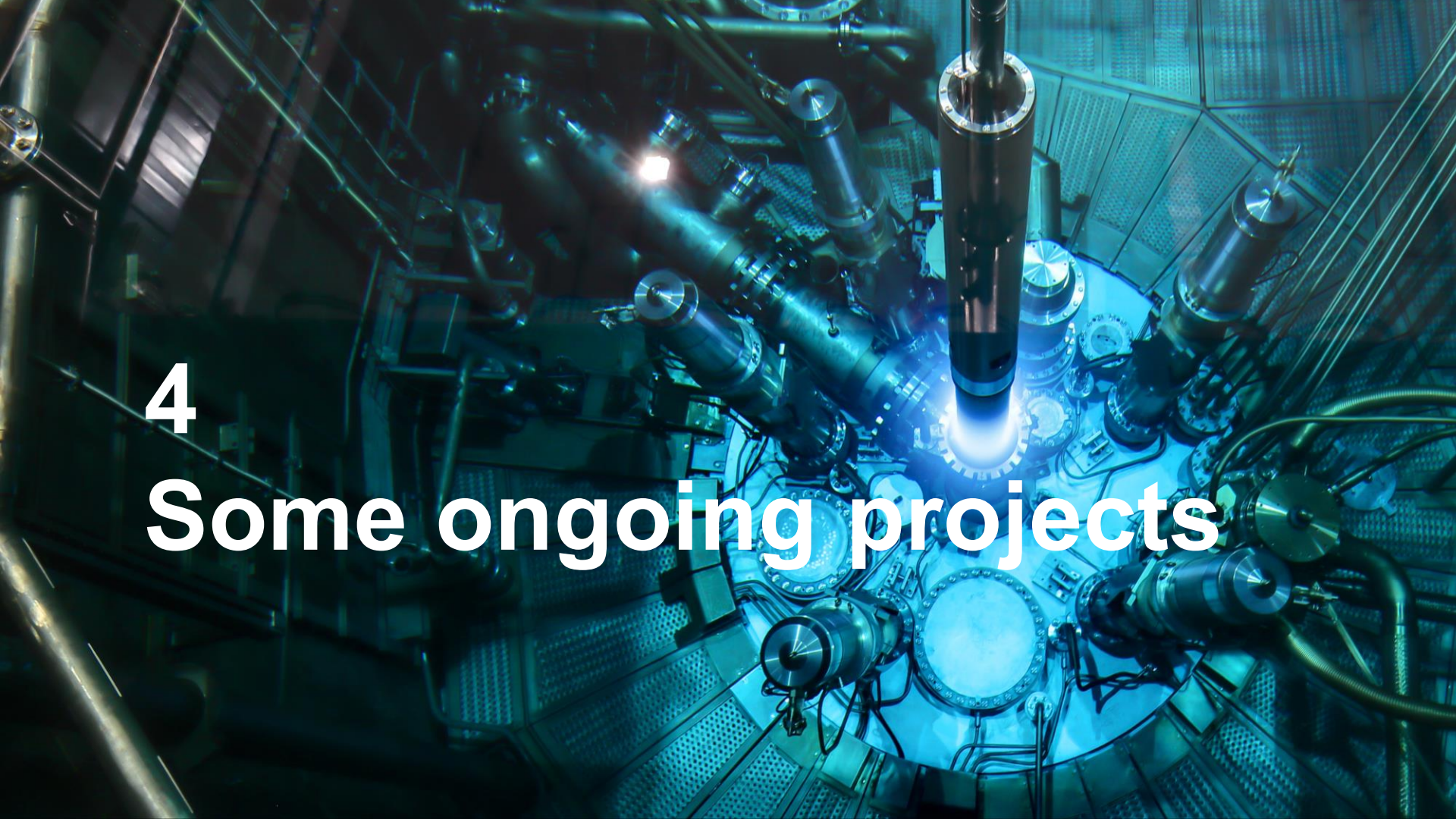
(1) Transport License for CASTOR® MTR3 (granted in 2019)

(2) Transport license § 4 AtG for transport from FRM II to intermediate storage facility in Ahaus

(3) Storage license § 6 AtG for storage of spent fuel in Ahaus.

Cold test 2020 at FRM II

The licenses will be issued by the BASE (hopefully soon?).



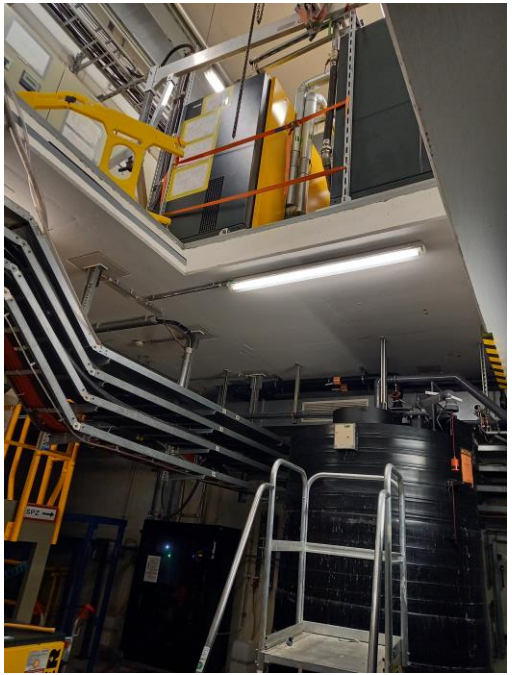
4
Some ongoing projects

Refurbishment of Cranes

- → presentation by Daniel S., this conference

Refurbishments of the Tertiary Cooling Loop

- The tertiary cooling at FRM II is an open loop. It evacuates the reactor power and the heat from other sources.
- Several chemicals are used to condition the water. Most importantly sulfuric acid biocide.
- After about 20 years of operation, the whole conditioning system is being refurbished.
- Next will be ventilators and cooling towers.



Anticipation of 10-year-inspections

- The following groups of components need to be inspected:
  - Beam tubes (pressure test and visual inspection)
  - Different compartments of the hot neutron source (pressure test, visual inspection and compensatory measures)
  - Upper part of central channel (visual inspection)
  - Check valves and rupture disks in the moderator system (general overhaul including pressure test and visual inspection)
  - Moderator tank (pressure test and visual inspection)
- All in all, about 30 inspections were completed on budget and on schedule. All of these were carried out with involvement of the TSO. No deviations with relevance for safety were discovered.
- NDT at primary cooling loop (50 % in five years, foreseen November 2023) still needs to be done.

Conclusion and Outlook

- FRM II is a versatile machine in a challenging situation.
- An intense training program assures continued ability to operate the FRM II.
- The time without neutrons is used for general refurbishment projects and inspections.
- Back to normal operation is foreseen for 2024. In the meantime, scientists
  - have to (re-)analyze existing data
  - go to other neutron sources
  - use the facility for gamma-irradiation in spent fuel

Thank You For Listening
– and do not hesitate to ask questions