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CNS In-pile Replacement Project

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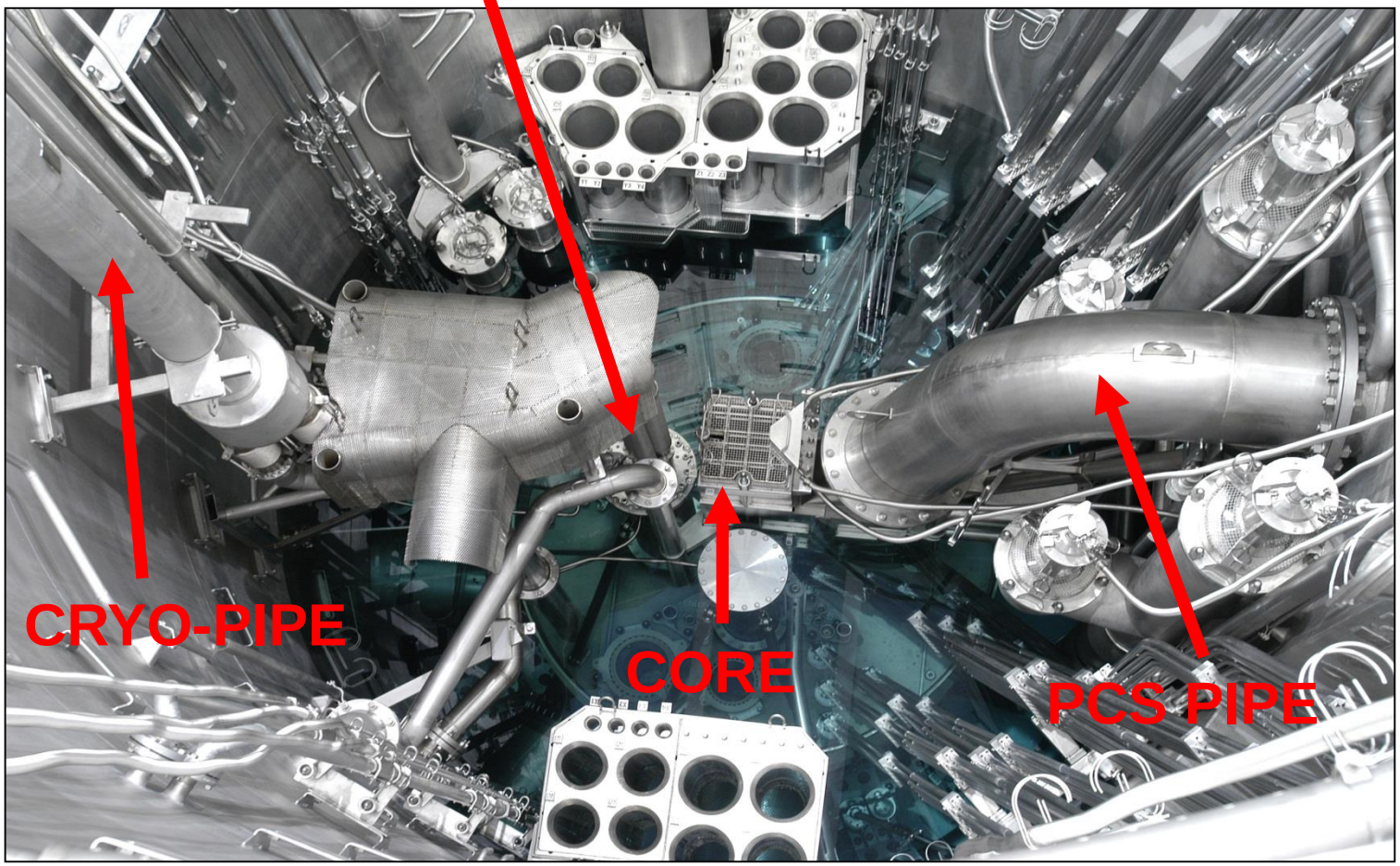
What is the project?

- **To replace the Cold Neutron Source (CNS) as it is approaching the end of its design life.**

The CNS In-Pile is a 3m tall structure and it goes here



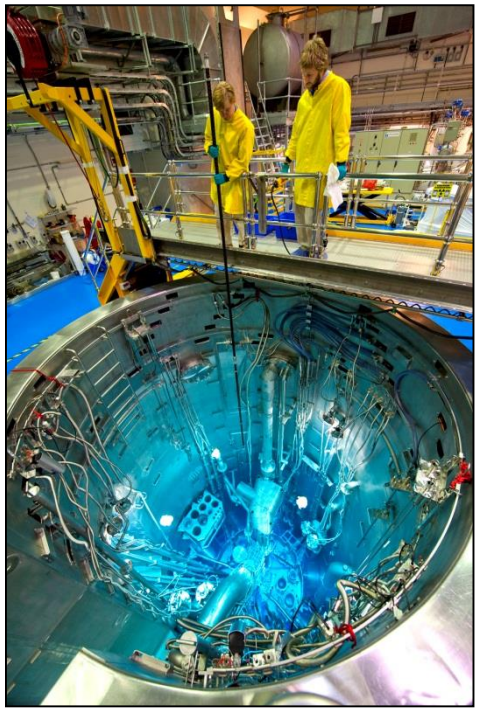
Why do we need to replace it?

- Moderator vessel is made from AlMg5.

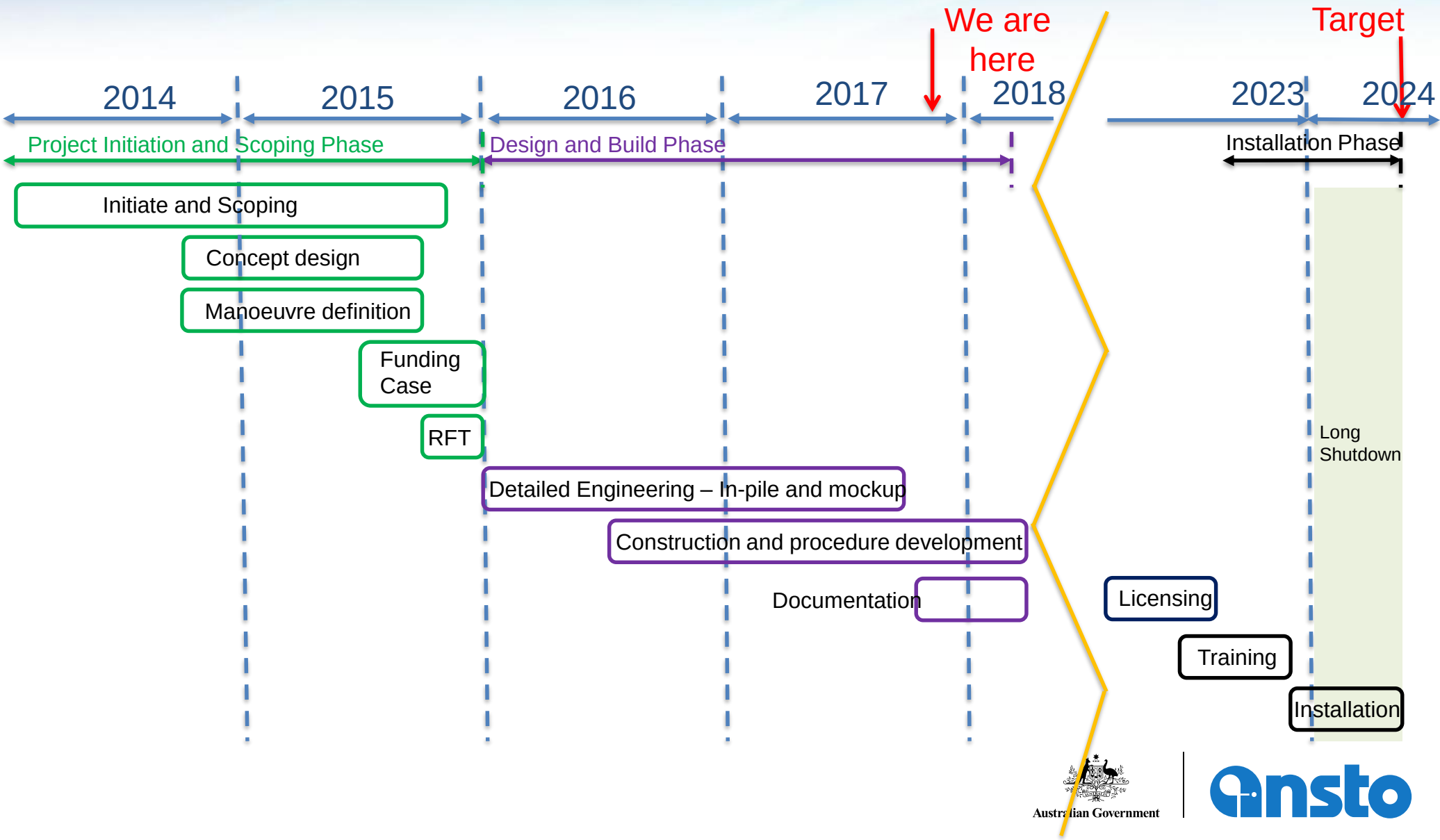
- Thermal neutrons cause damage to Al alloys through transmutation – Al transmuted to Si.
- Si is insoluble in Al and will form particles or potentially Mg2Si particles – solution hardening.
- Fast neutrons displace Al atoms from their initial lattice position => point defects and dislocations => more susceptible to cracking.

Life extension of the CNS In-pile

- **Manufacturer's rated design life is 10 years at full power. This will come in early 2019.**
- **No real data for AlMg5 in this environment for >10 years operation.**
- **NSTLI – Materials - report concluded that manufacturing defects and/or operational defects are not likely to be of sufficient size to result in critical crack instability after 15 years of operation.**
  - *weld residual stress (WRS) and the decreasing irradiation toughness are the major parameters in determining critical crack sizes.*



Installation schedule



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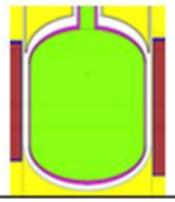
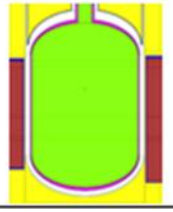
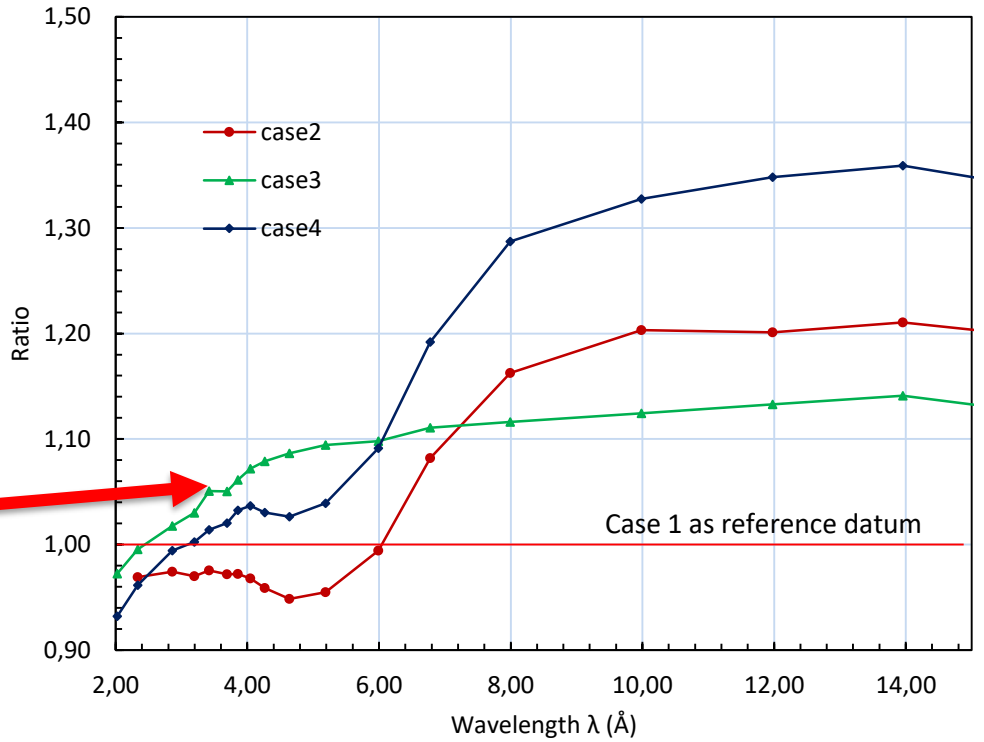
CNS Mk2 – how is it different?

- Conceptual designs based on calculations benchmarked by measurements.
- Possible gains of 11% to 35% in source brightness at the long wavelengths (> 8Å).

Case 1 – As Is	Case 2 – no cavity	Case 3 – moderator chamber height increased by 7 cm	Case 4 - no cavity and moderator chamber height increased by 7 cm (i.e. cases 2 and 3 combined)
			

Case 3 was selected



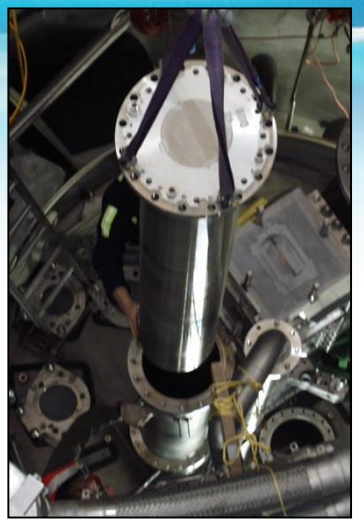
Manoeuvre development - Constraints

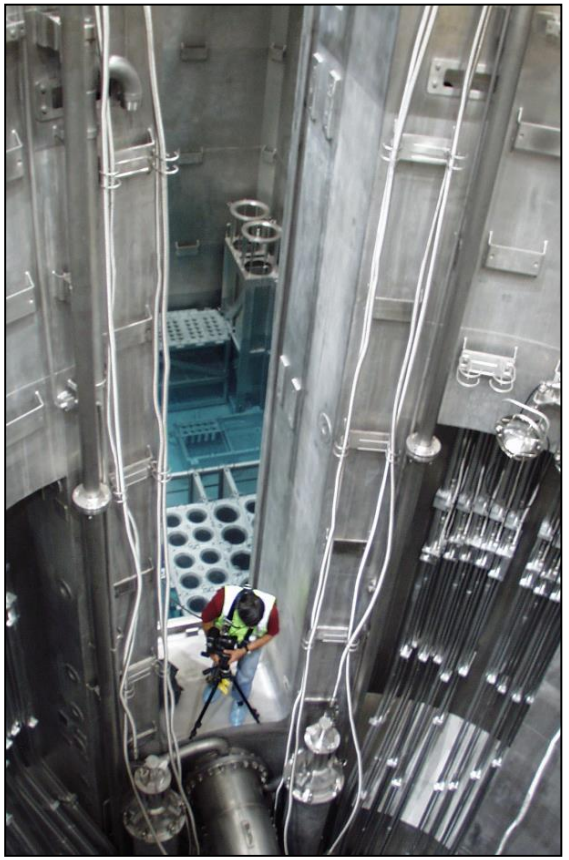
1. ANSTO dose limit – 15 mSv/year per person
2. Project dose constraint – 10 mSv for any individual
3. Project dose target – 5 mSv per person
4. Design target – 2.5 mSv per person

- CNS Replacement project - 25 mSv.man
- Expect to need 9 persons minimum (based on radiation dose). Fatigue, dehydration, etc. may affect this number.
- Expect to operate on 2 extended shifts (10 hours) per day

(this setup was used successfully with Cold Guide 2 installation in 2012).

The original CNS installation





What is different now?

There will be residual heat within the walls

Need to remove all the pipework and support bracket in order to remove the CNS in-pile

Need to remove these nuts 120mSv/hr at contact!

Likely radioactive contamination everywhere!

Background radiation ~100μSv/hr. (Based on previous tasks)

It's a confined space!

Manoeuvre development methodology

1. ALARA
2. High automation (low dose, complexity and cost) vs low automation (higher dose, less complexity)
3. Some tasks would be hard to automate e.g. welding pipes, removing certain nuts with limited access, seal groove preparation, etc.
4. The decision was to automate repetitive tasks and manually perform the complex tasks. This means using distance (long tools), shielding and optimising the duration of the tasks.

Manoeuvre development

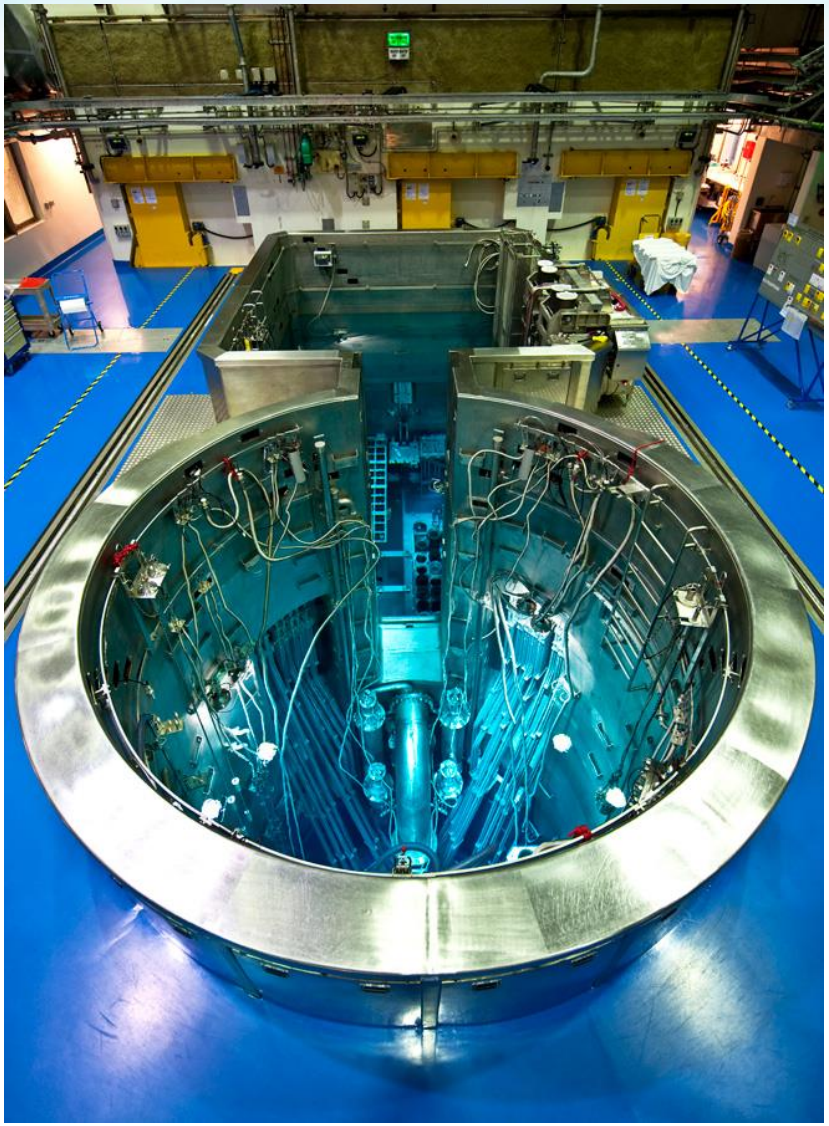
- Manoeuvre development step-by-step in mock-up (no radiation PPE)
- Manoeuvre development step-by-step in mock-up (with radiation PPE)

  (with ANSTO WHS and Radiation protection assistance)
- Abnormal operations and recovery scenarios
- Training before installation

Simulation of rescue scenarios

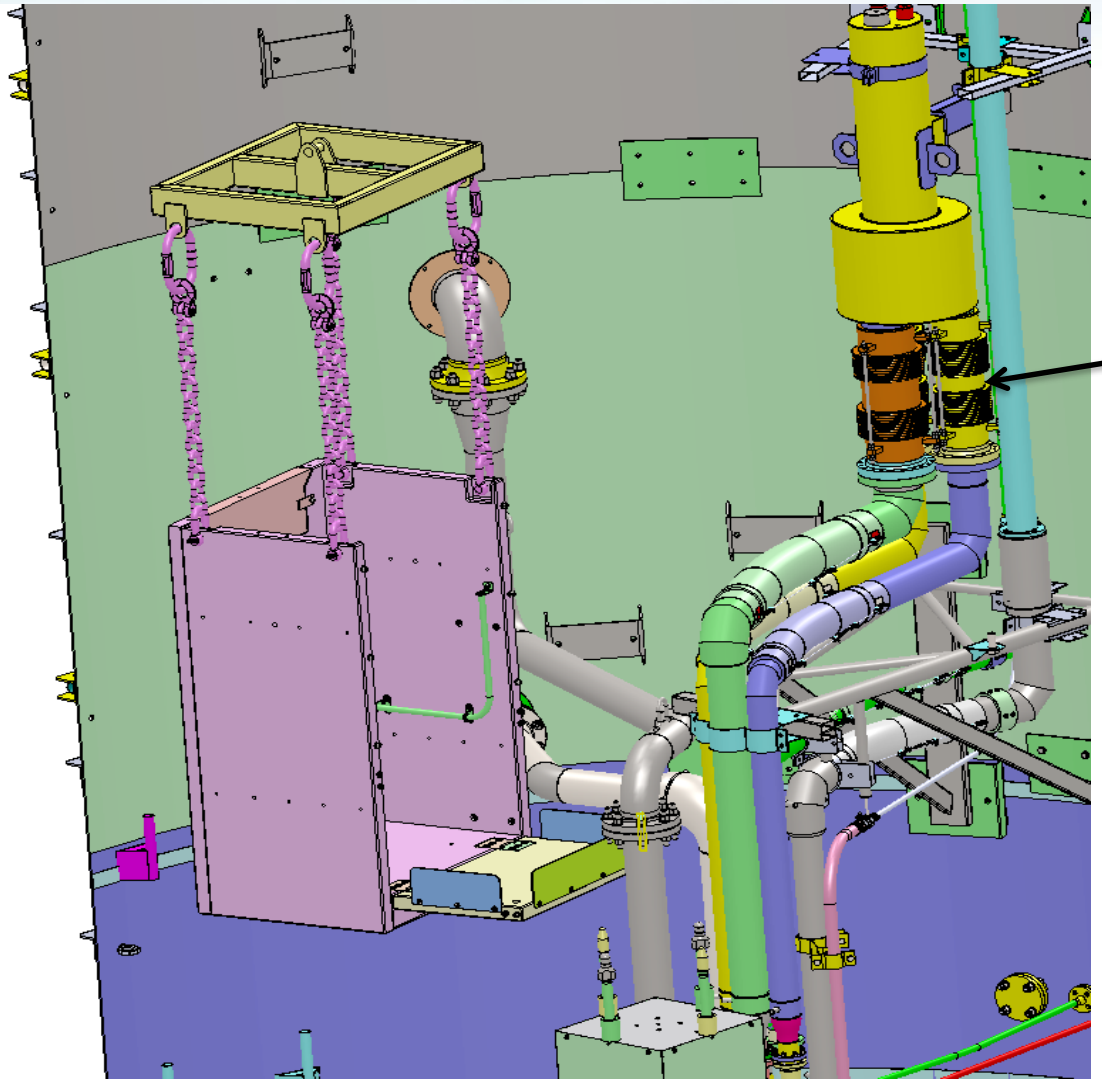
5 main steps to the manoeuvre

1. Reactor shut down, process set up for opening and Level 13 preparation (pool top area)
   - Purge the lines, bring components and tools to Level 13
   - Remove silicon rack, protection covers and other sensitive equipment
   - Line the area with plastic
2. CNS removal, CNS disassembly and final storage
3. New CNS assembly and reactor pool preparation
4. New CNS installation in reactor pool
5. CNS testing, cold and hot commissioning

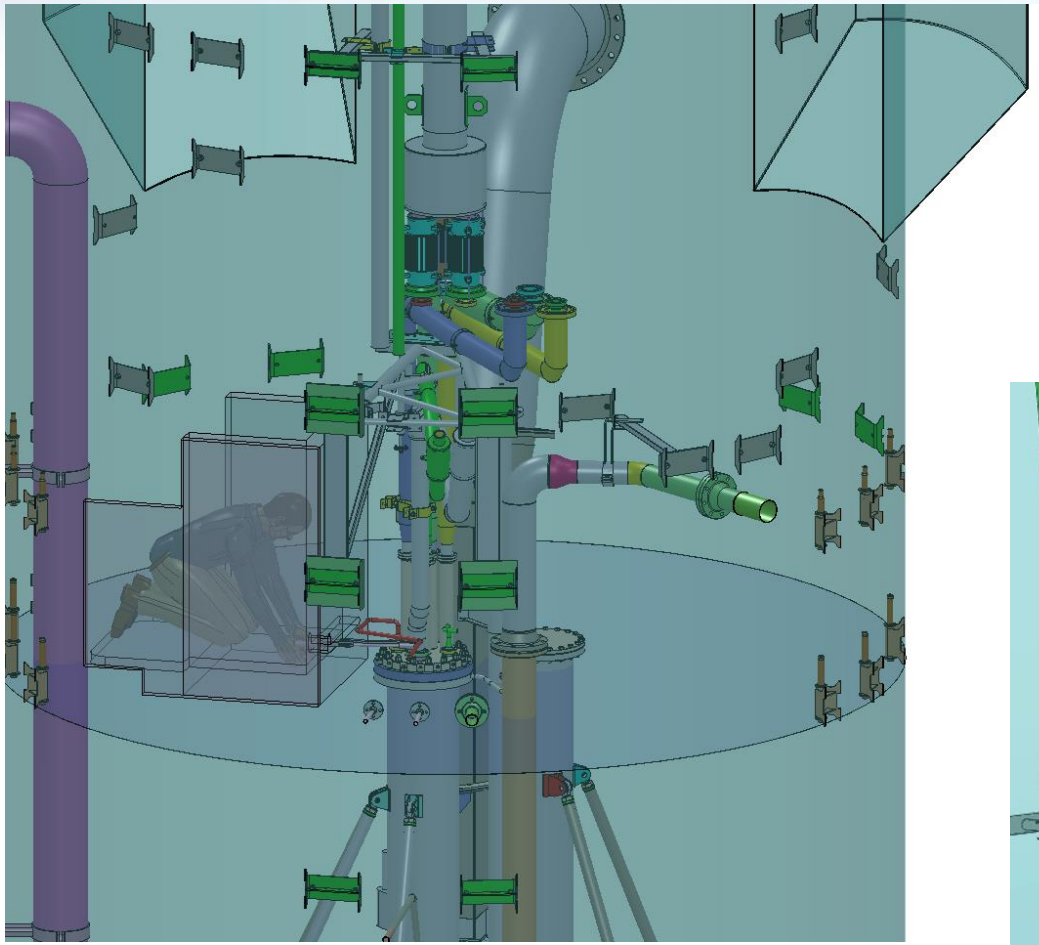


Removal of the existing CNS

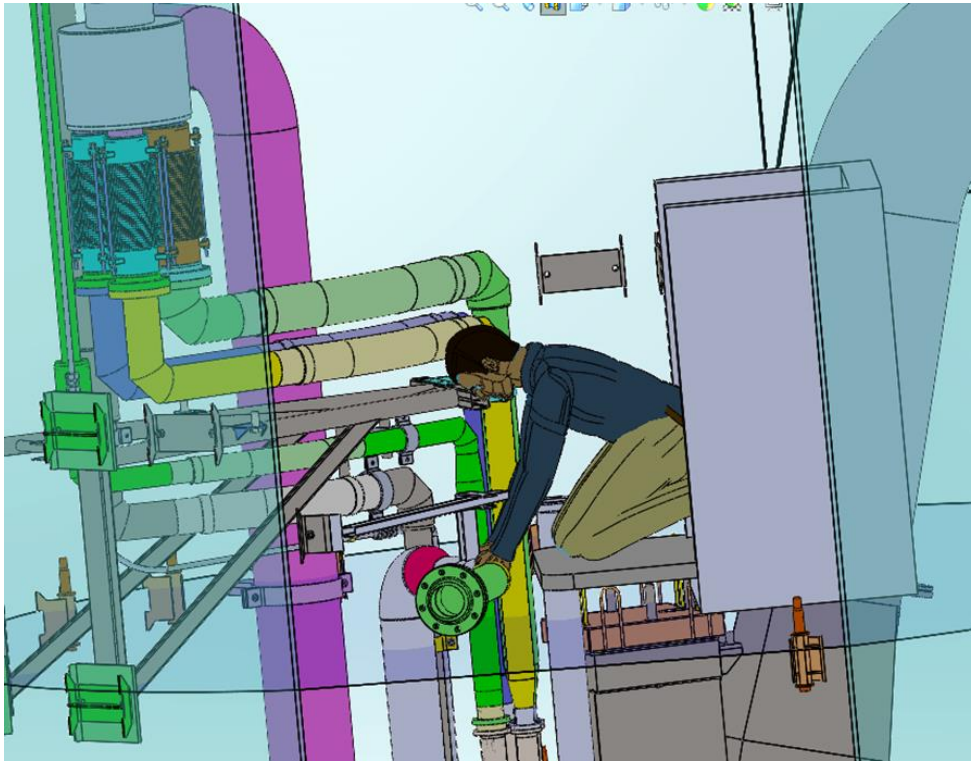
- Shielded workbox for a person to enter the pool.
- Use the water as shielding.
- Drop water level to as low as +4300 (just under the CNS flange) depending on the task.



Removal of the existing CNS

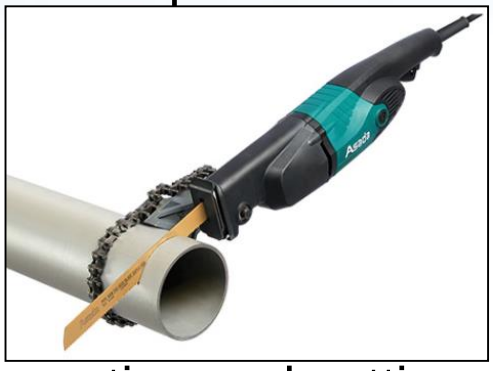


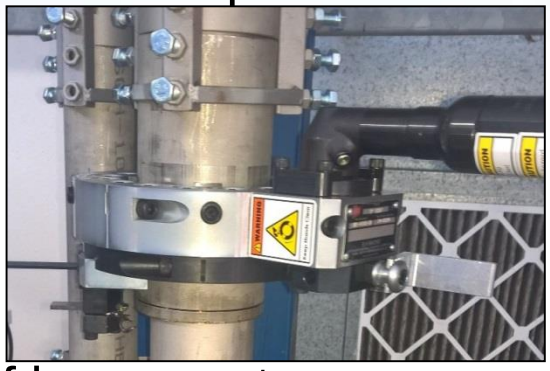
- Shielded workbox can be configured for different tasks.



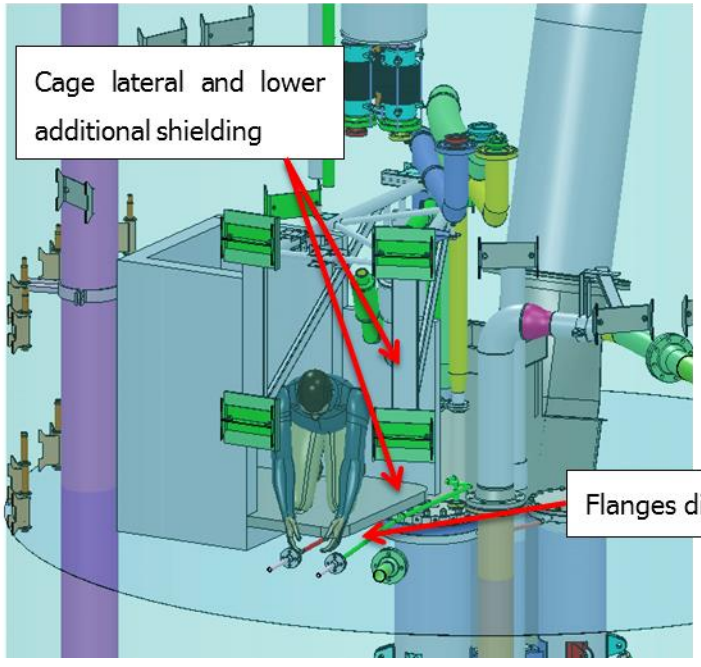
Removal of the existing CNS

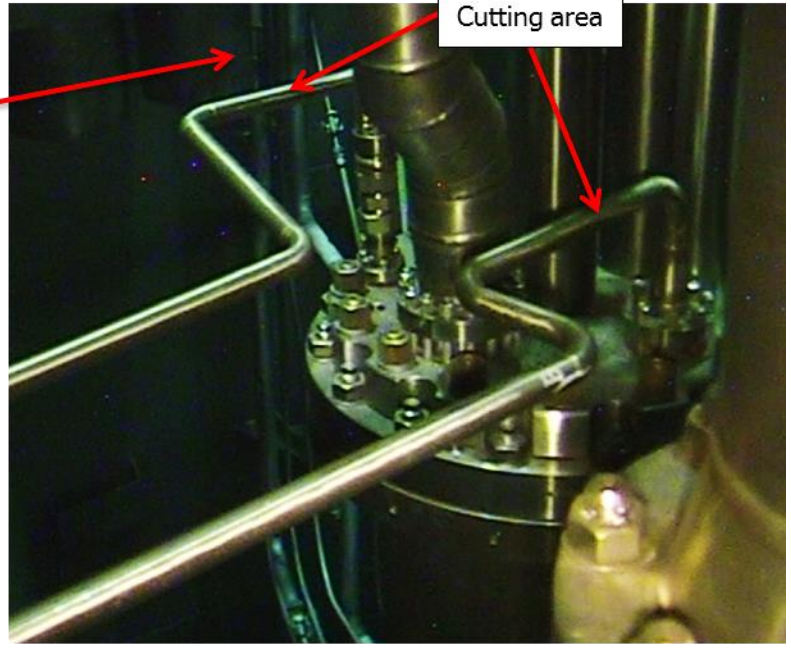
Cutting of vacuum and deuterium lines – improvements for future replacements.





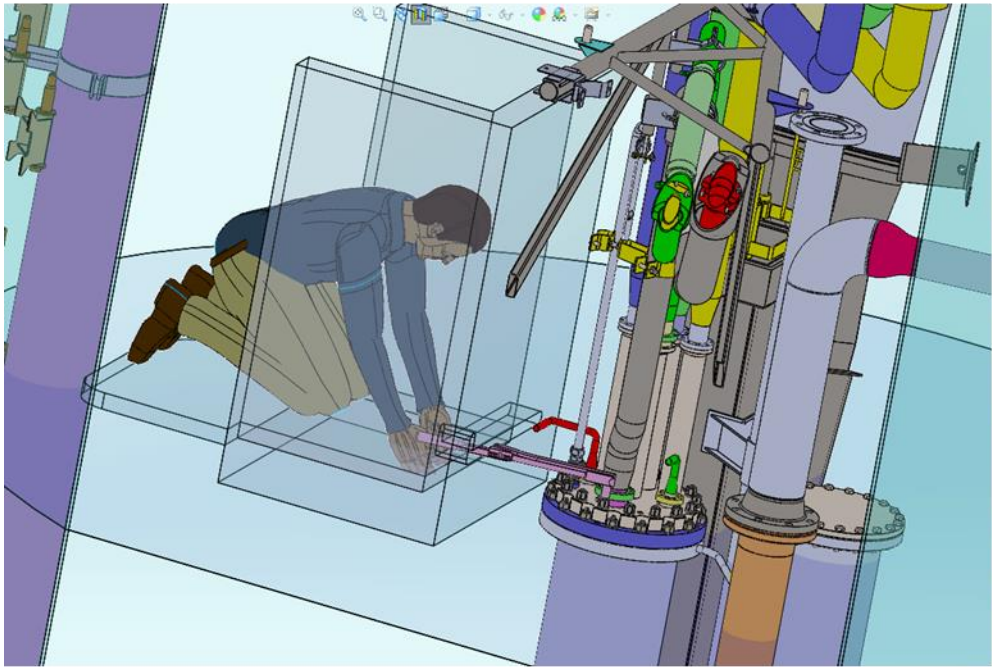
Disconnection and cutting of heavy water lines – improvements for future replacements.

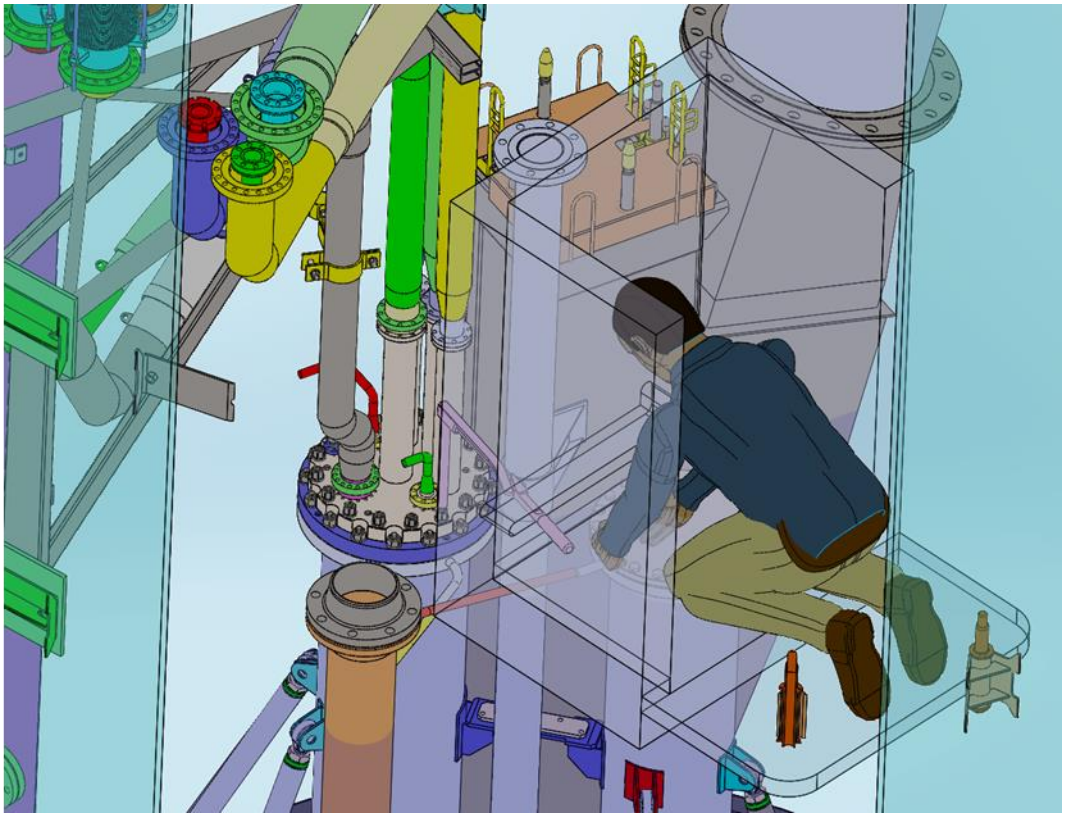




Removal of the existing CNS

CNS flange unbolting/bolting

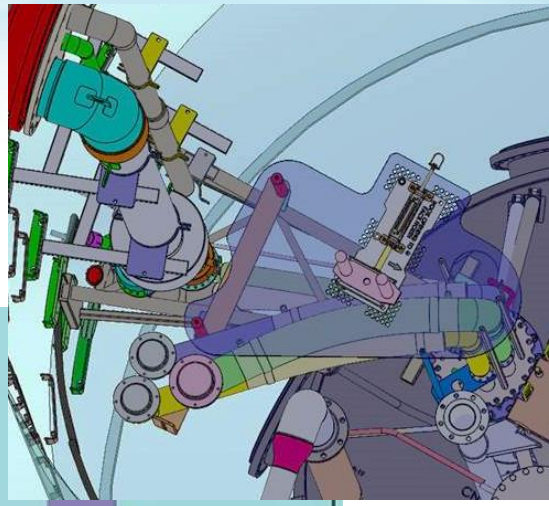


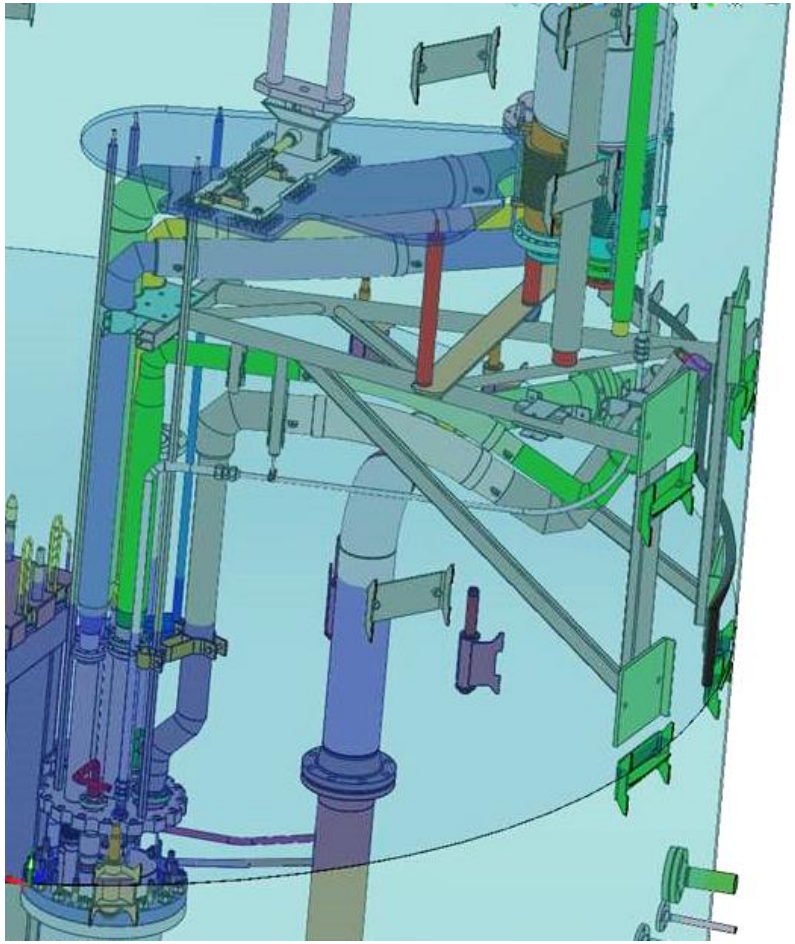


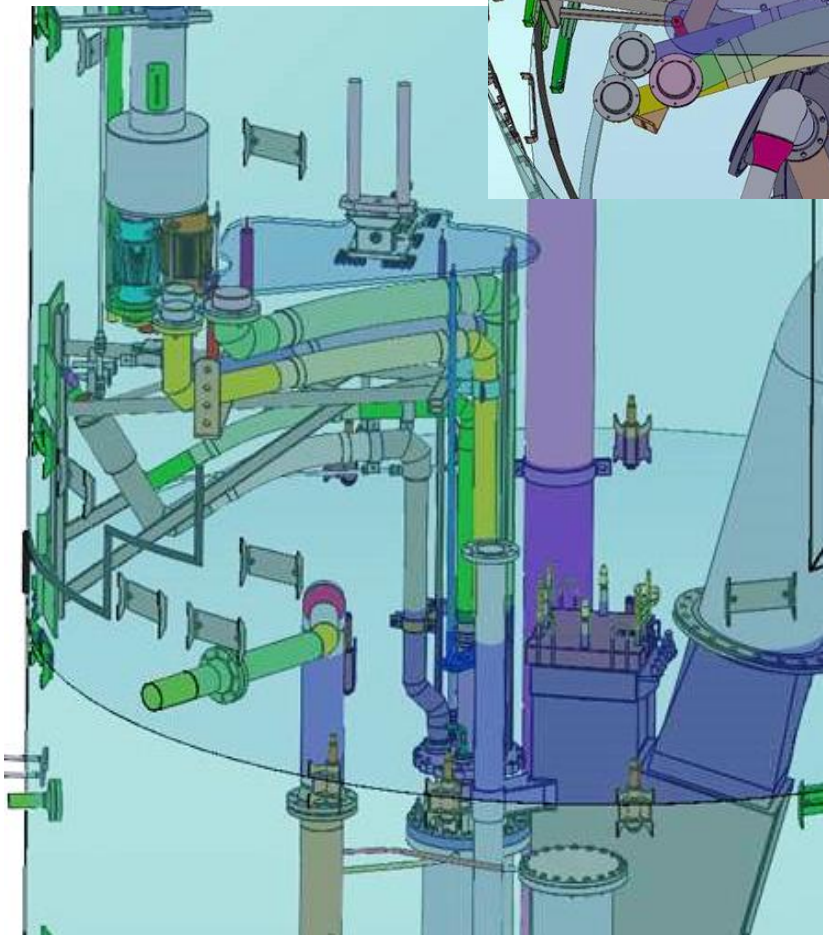
Removal of the existing CNS

Attachment of lifting equipment to CNS

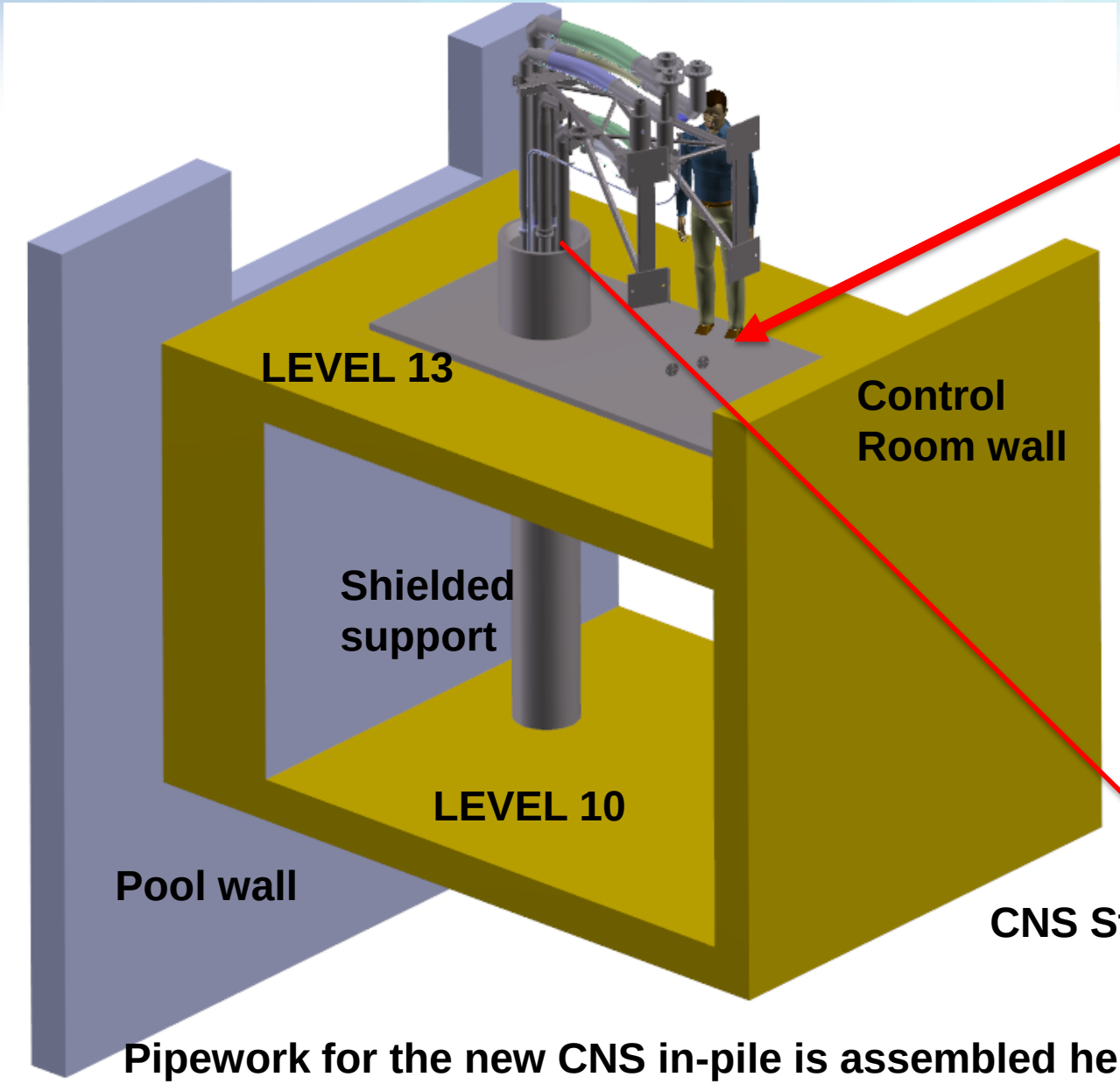
Overall weight of assembly ~600kg

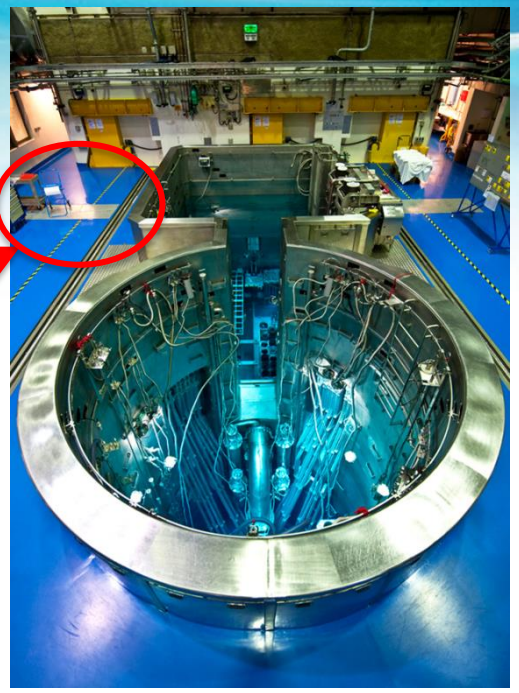


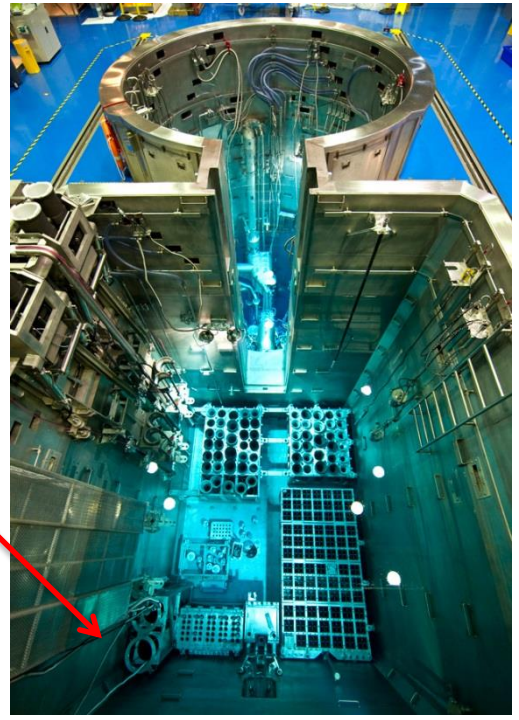




CNS Pipework Disassembly







Pipework for the new CNS in-pile is assembled here too.

CNS Installation – Alignment device

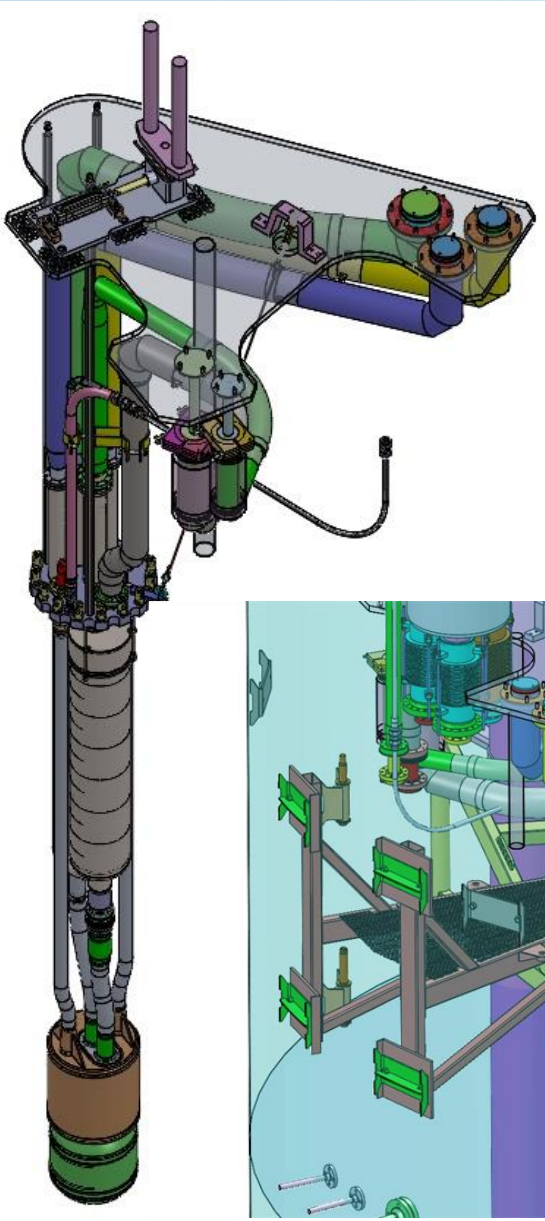
CNS ready for insertion

Electrical cylinder

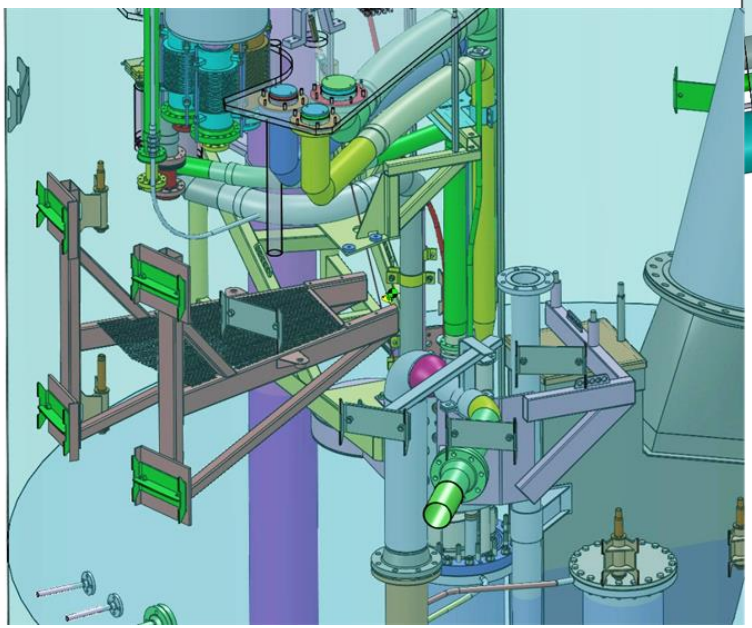
100 mm lead
Shielding ~300 kg

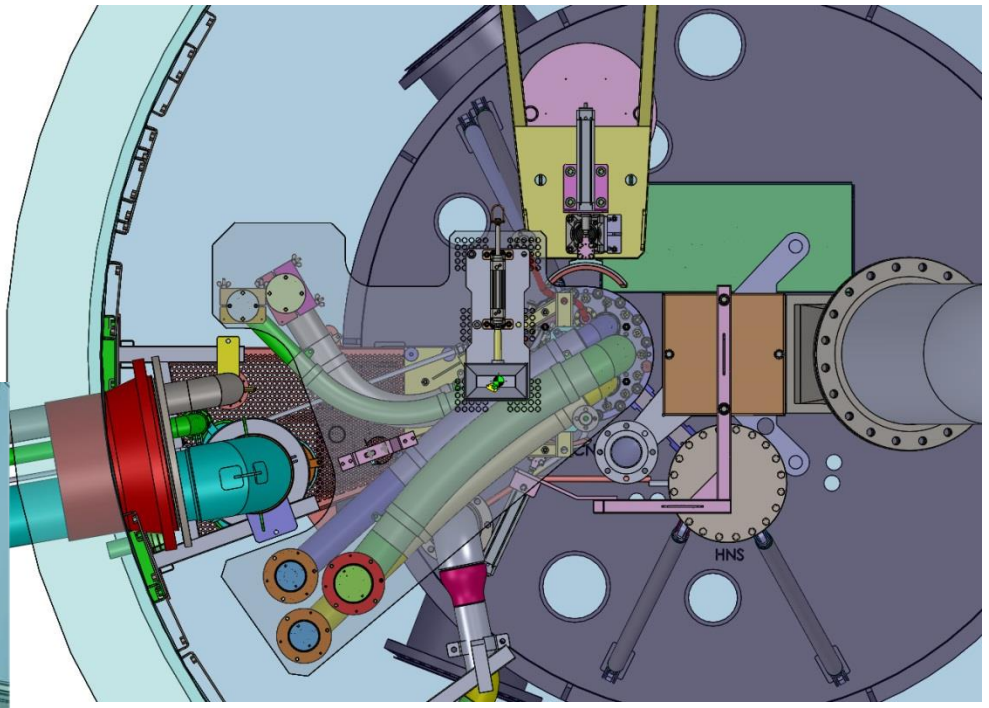
Guides for CNS (polypropylene)

CNS Installation – lifting of new CNS



New pipe support frame and lifting device to allow for one motion insertion.



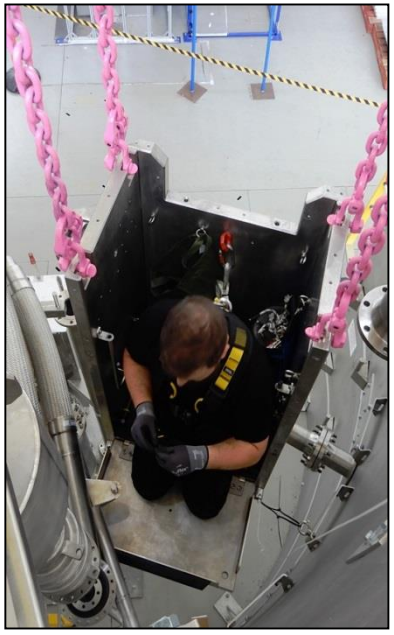


Mock-up of reactor pool and CNS

- **Mock-up built - Full-scale ½ pool**
- **To be used to develop the procedure.**
- **Will be used to train technicians**

Mock-up of reactor pool and CNS

- **Development of the manoeuvre has commenced.**



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Thank you