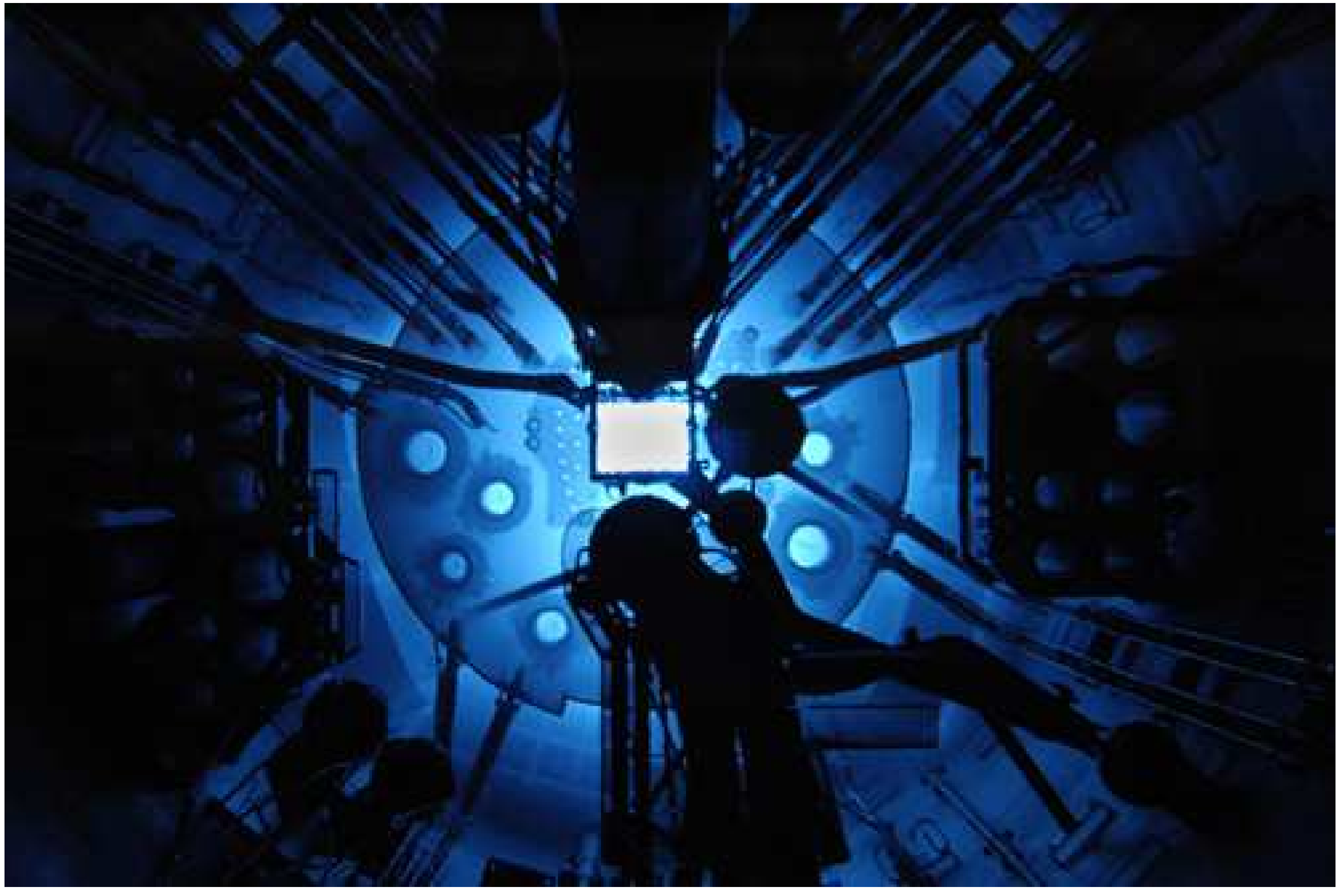
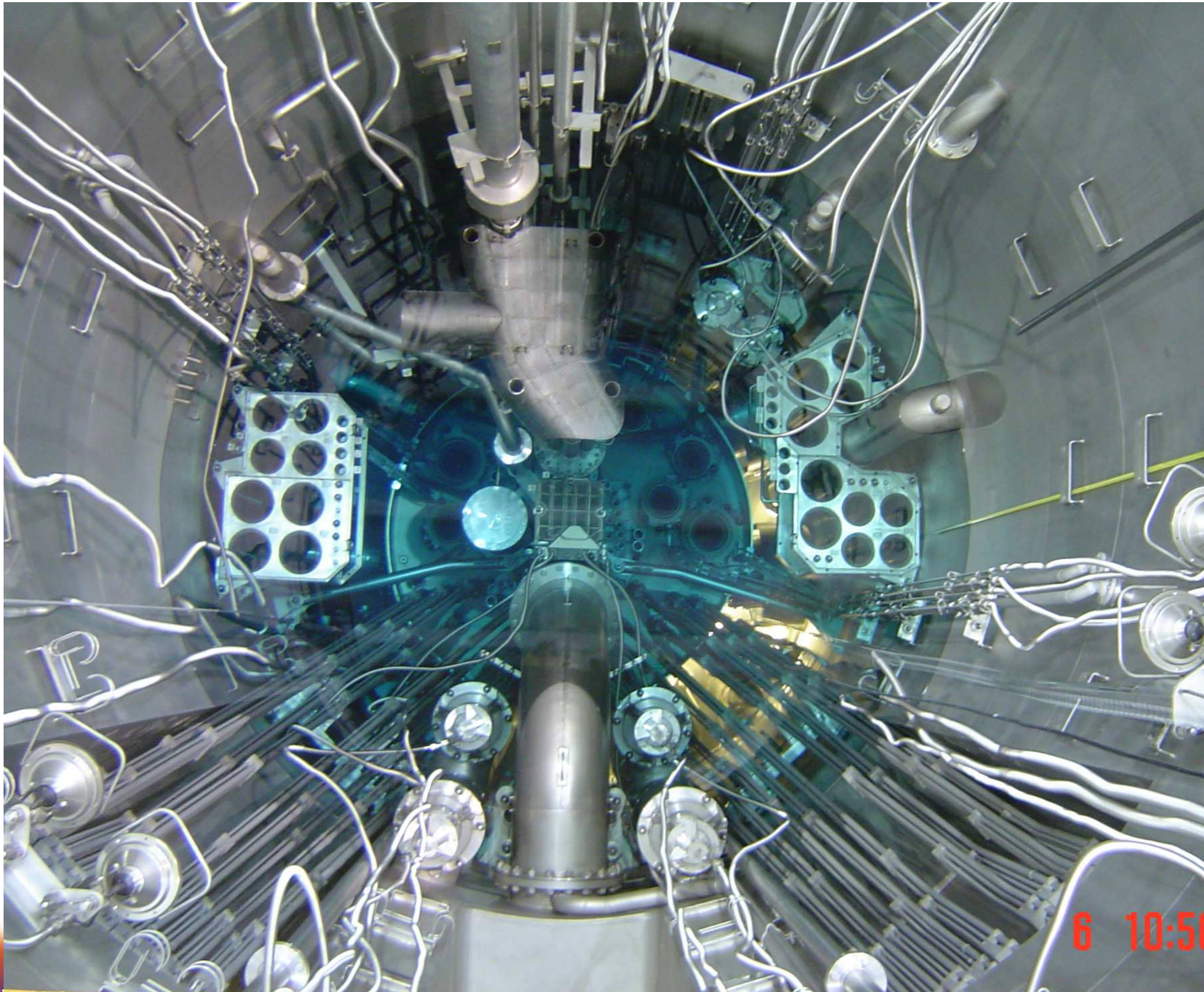
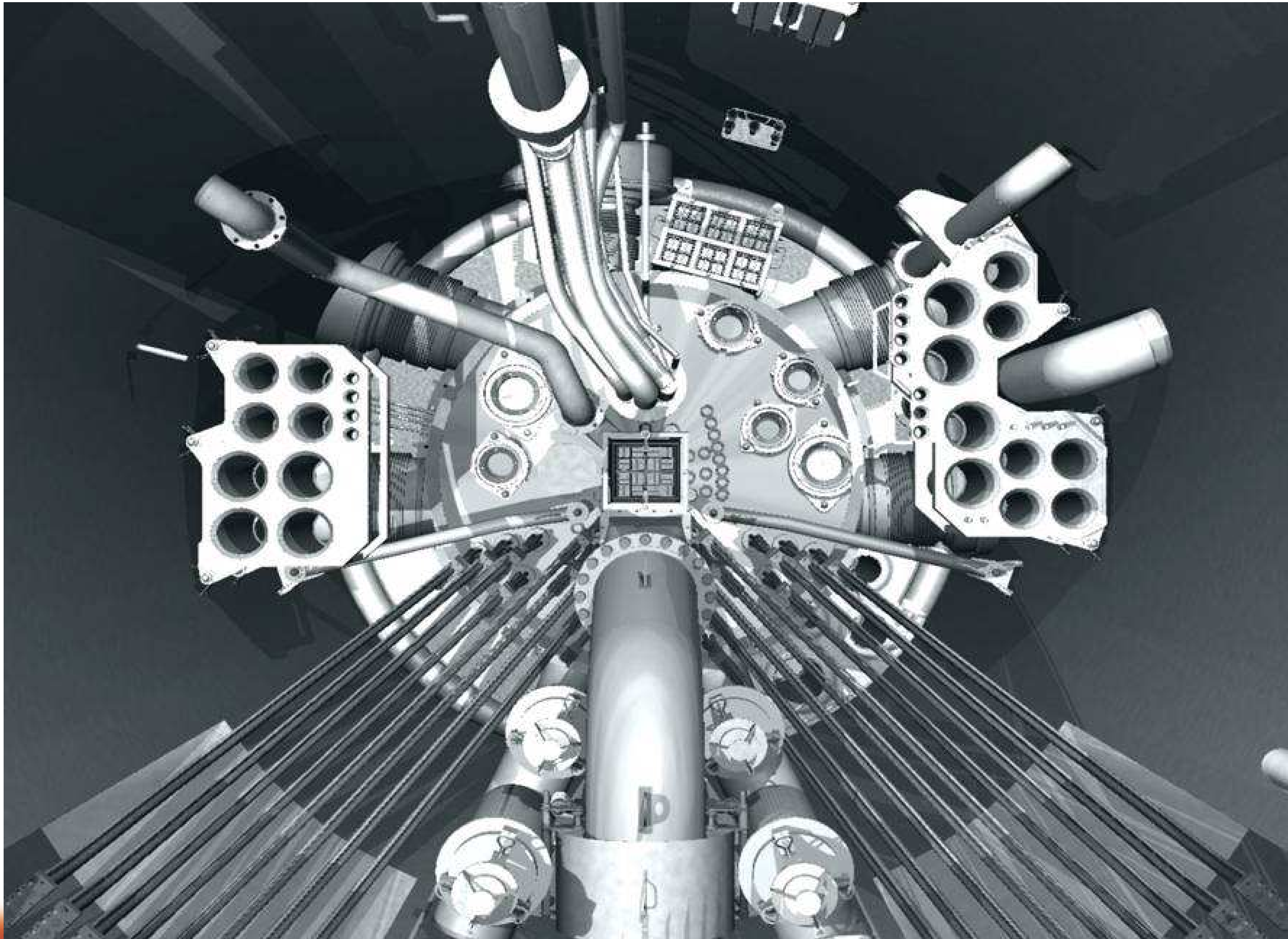
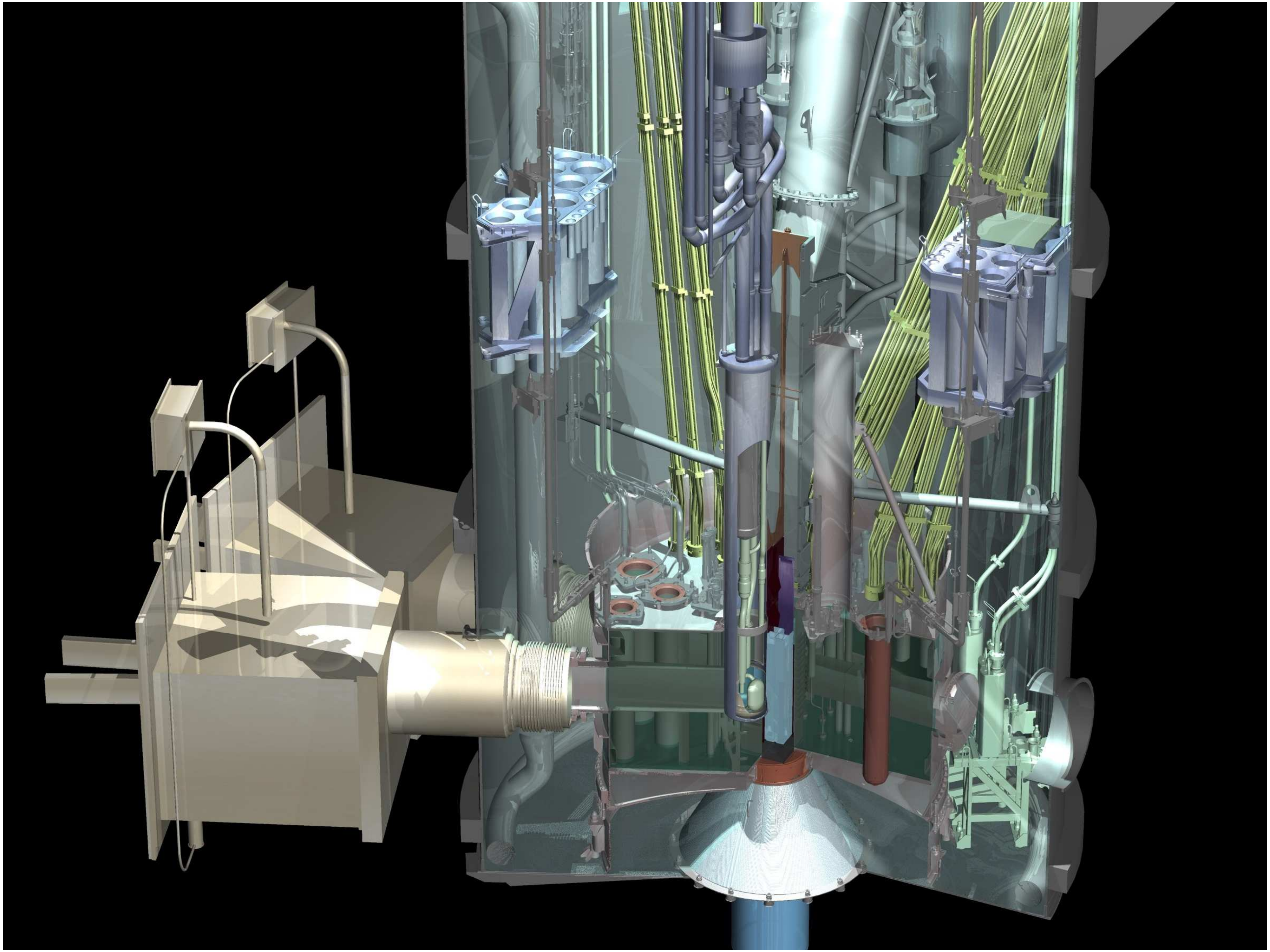
OPAL Reflector Vessel & leak mitigation

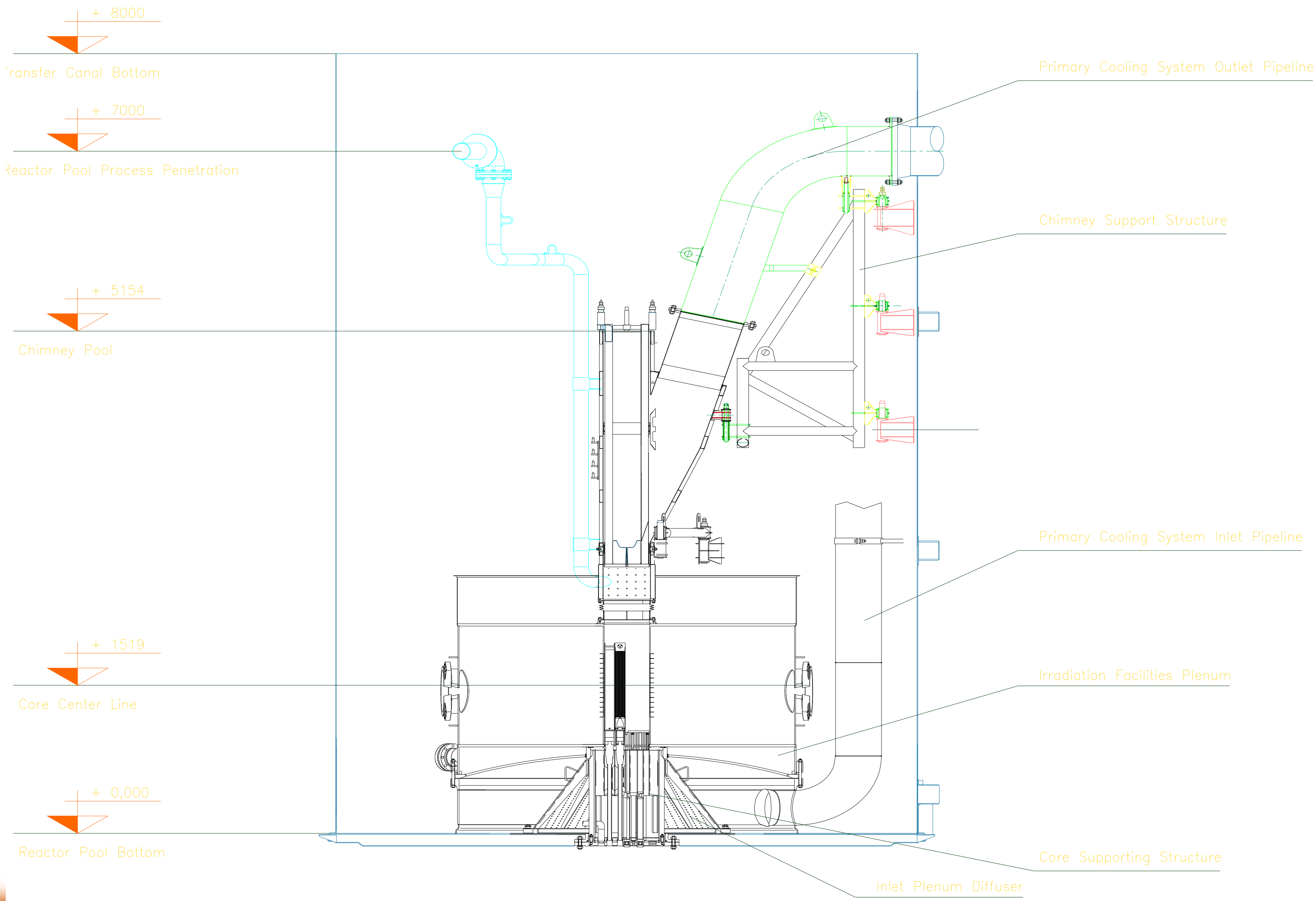



6 10:5






DANGER
WORKERS
BELOW


+ 8000
ransfer Canal Bottom
+ 7000
eactor Pool Process Penetration
+ 5154
Chimney Pool
+ 1519
Core Center Line
+ 0,000
Reactor Pool Bottom
Primary Cooling System Outlet Pipeline
Chimney Support Structure
Primary Cooling System Inlet Pipeline
Irradiation Facilities Plenum
Core Supporting Structure
Inlet Plenum Diffuser

Timeline of Events

Jan 2007
Reduction in D2O purity observed

Feb 2007
Leak test confirms leaks

Mar 2007
Pressure Increase #1

Apr 2007
Pressure Increase #2

May 2007
Repair options design review

Sep/Oct 2007
Micro-particle injection

Feb 2008
HW isotopic purif. design review

June/July 2008
Reactor S/D
Leak tests

November 2008
Heavy Water Inventory replaced
INVAP/ANSTO planning

Construction of HW isotopic purif. plant

Reactor shutdown
Testing clamps

Nov/Dec 2009
4 Clamps applied

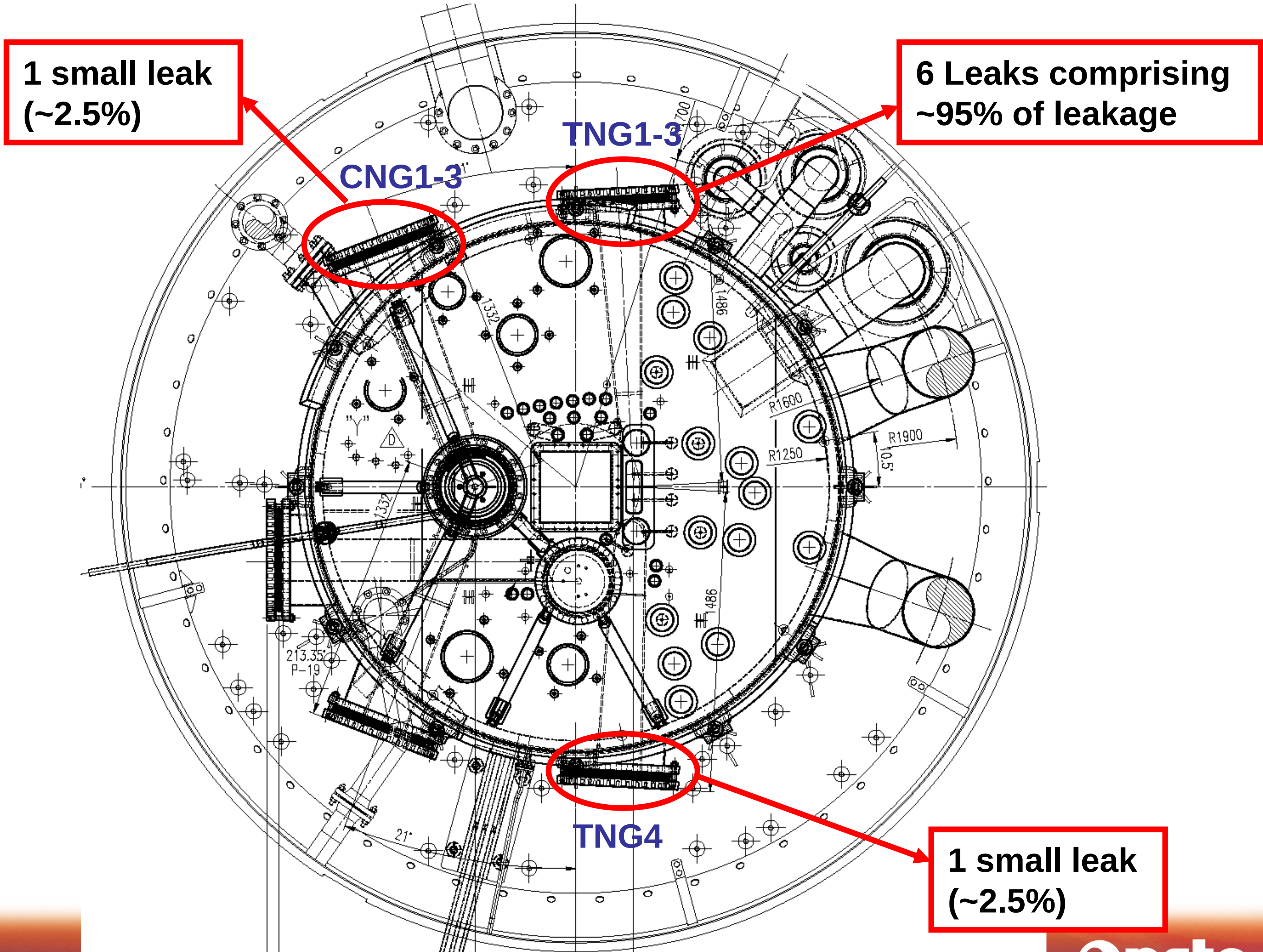
2011
HW isotopic purification system

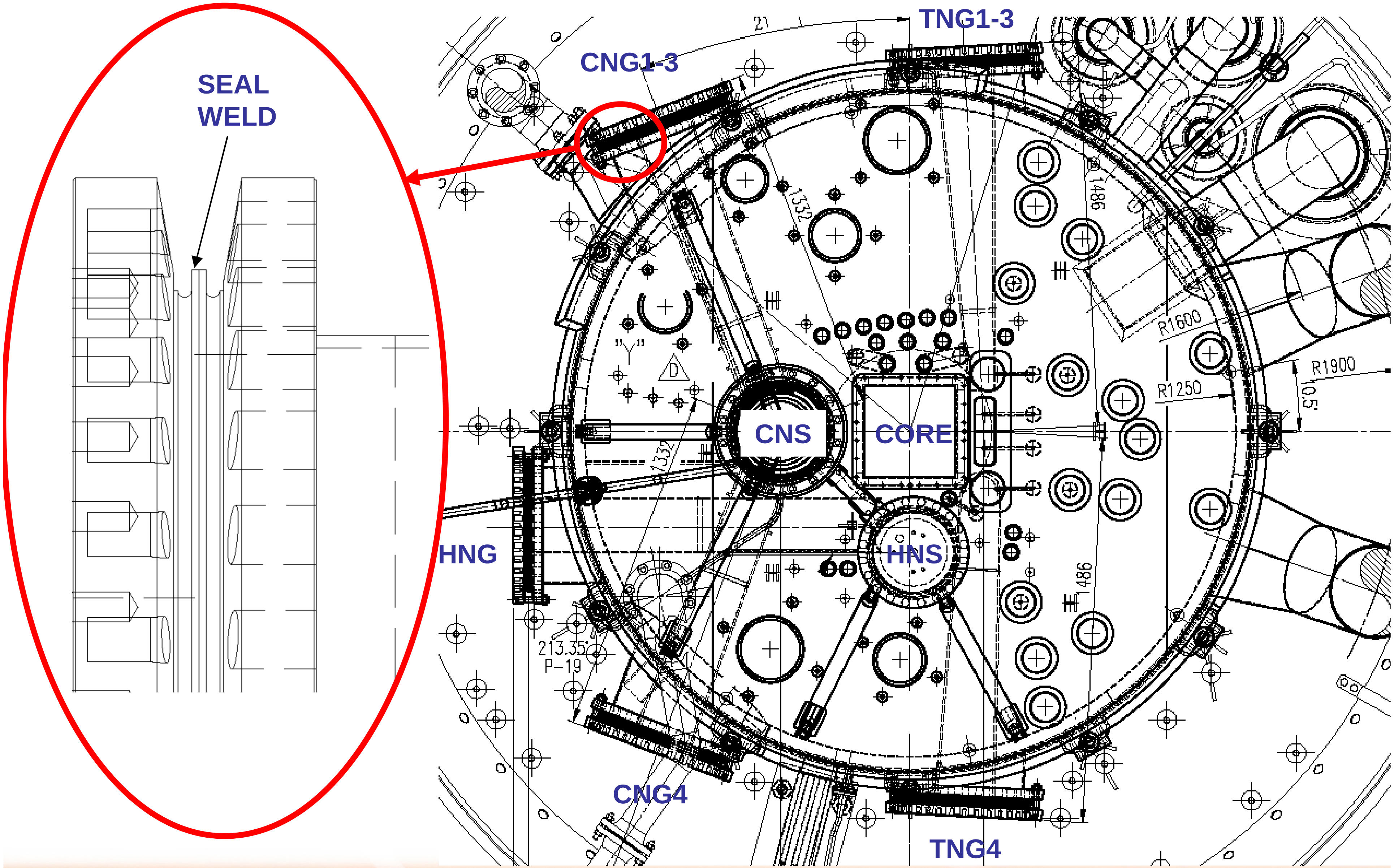
RVE He Leak Test - Method

- Reactor Pool drained to 7m (normal level 12.6m)
- RVE completely drained of heavy water
- Helium gas injected into RVE to a maximum pressure of 97kPa providing a DP of 40kPa (max. DP was limited by pressure rating constraints of CNS equipment)
- All RVE flanges and penetrations carefully checked for leakage, particularly the neutron beam flanges

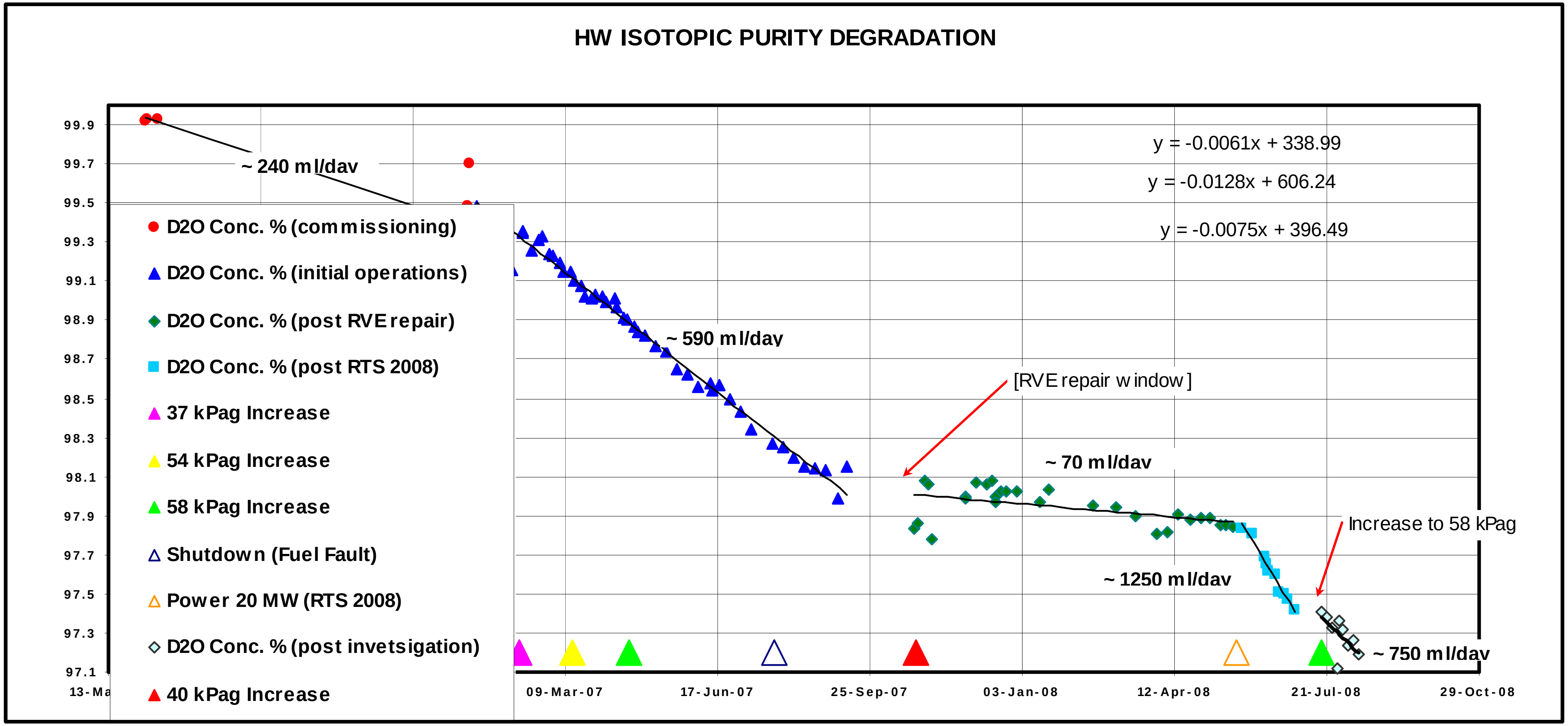
RVE He Leak Test - Results

- First helium bubbles were observed 3 hours into the test from the TNG1-3 flange
- Smaller helium bubbles were observed on day 4 from CNG1-3 and TNG4
- No other leakages observed
- Collection of bubbles from the TNG1-3 leaks showed a leak rate consistent with the isotopic purity degradation

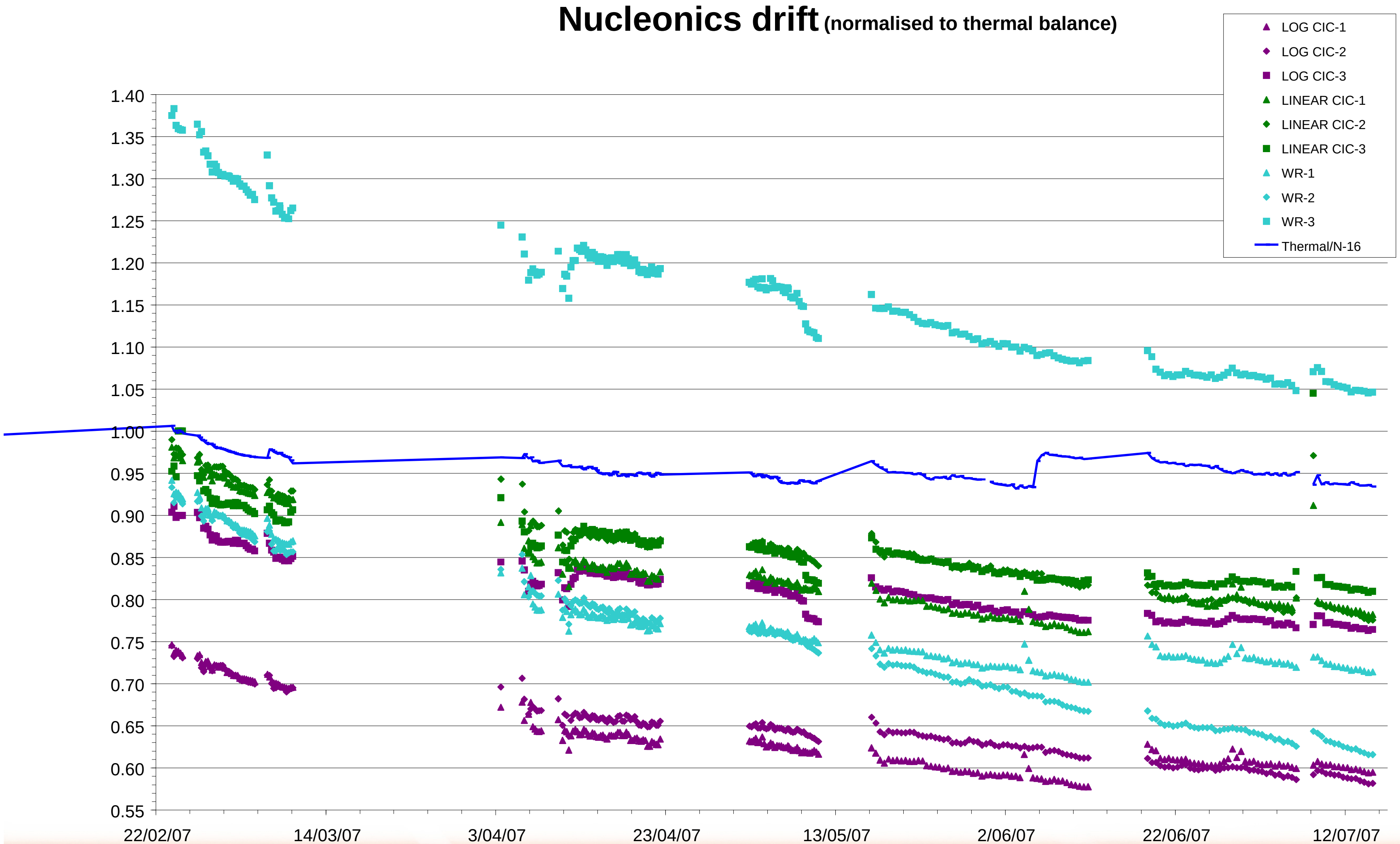

1 small leak
(~2.5%)
6 Leaks comprising
~95% of leakage
TNG1-3
CNG1-3
TNG4
1 small leak
(~2.5%)
R1600
R1250
R1900


SEAL
WELD
CNG1-3
TNG1-3
CNS
CORE
HNS
HNG
CNG4
TNG4
R1600
R1900
R1250
1332
1486
213.35
P-19

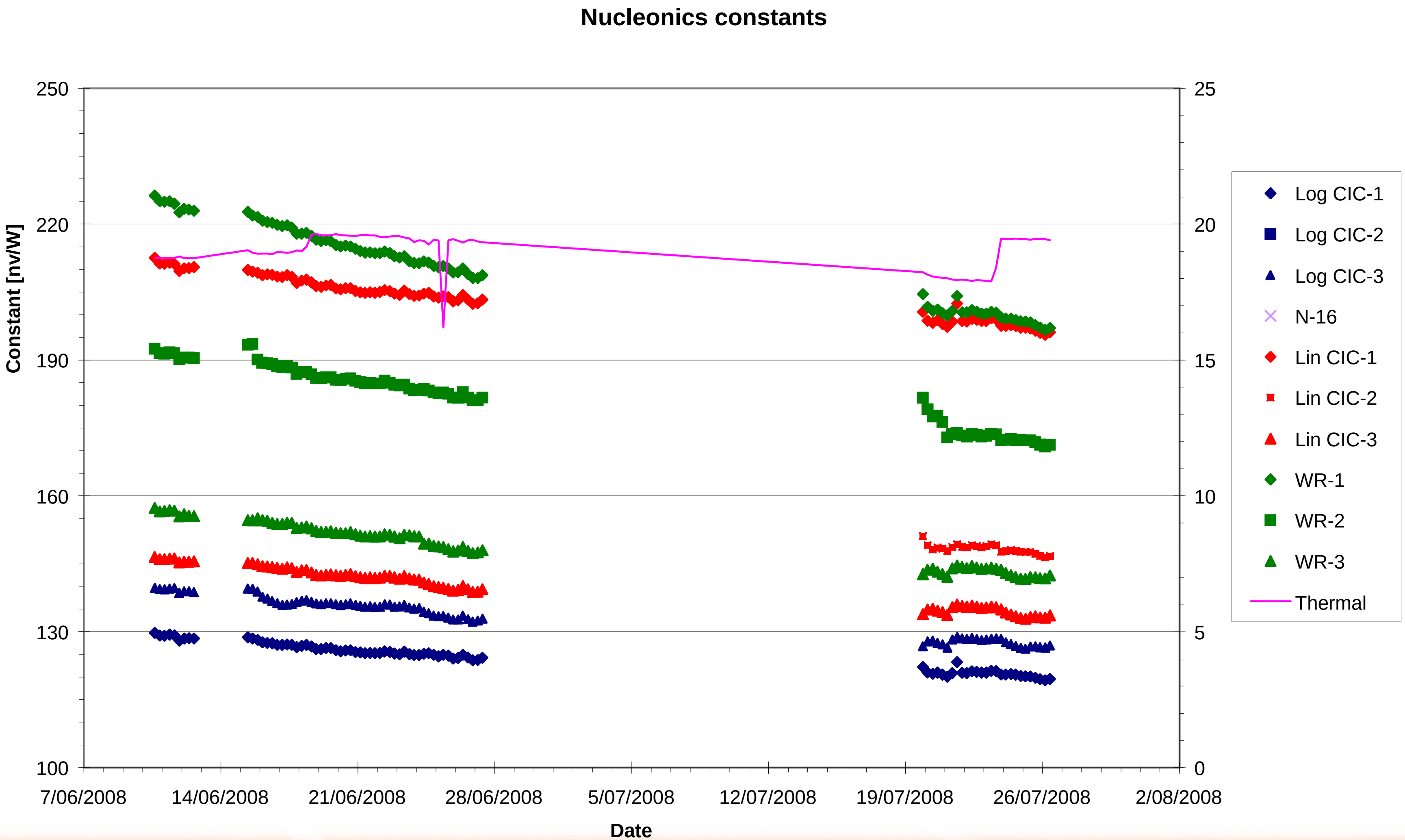
D2O Purity 2006-2008

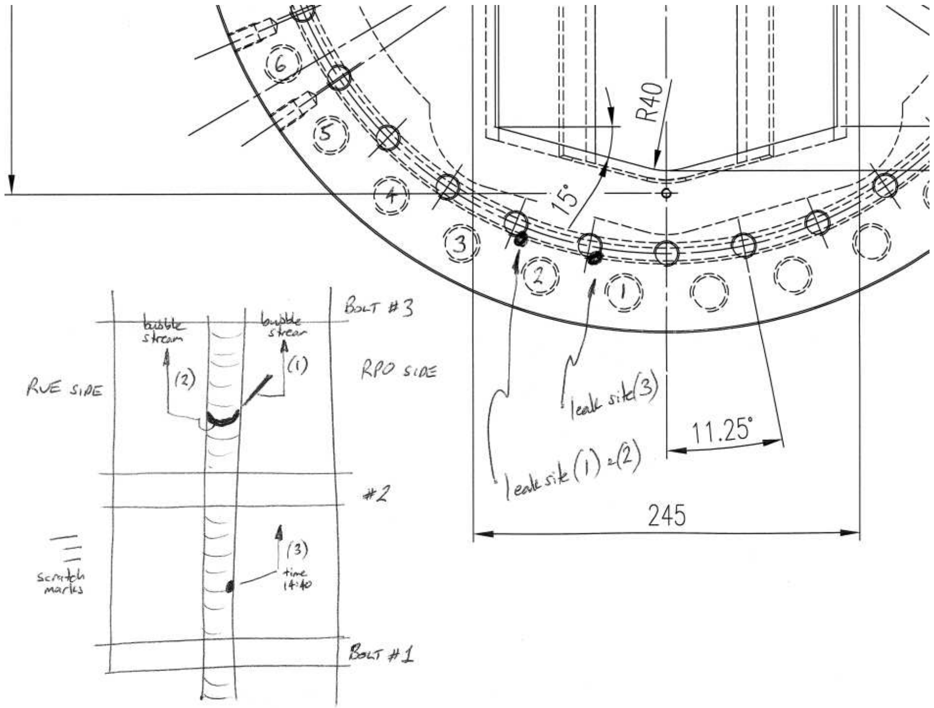


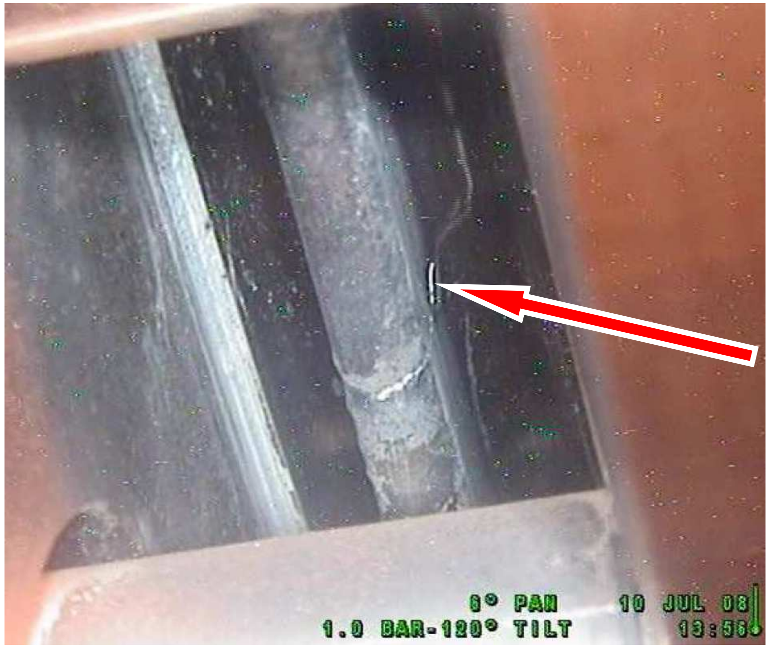
Nucleonic channels data - 2007



Nucleonic channels data - 2008




R40
15°
11.25°
245
leak site (1) + (2)
leak site (3)
BOLT #3
bubble stream
bubble stream
(1)
(2)
RVE SIDE
RPO SIDE
#2
scratch marks
(3)
time 14:40
BOLT #1


6° PAN 10 JUL 08
1.0 BAR-120° TILT 13:56


28° PAN 09 JUL 08
1.0 BAR-123° TILT 14:23


35° PAN 09 JUL 08
1.0 BAR-118° TILT 16:14

Analysis

- No new leak sites identified
- Estimated leak site diameter ~20 micron.
- Estimated leak site length of 20-200 micron.
- Temperature effect may be due to variation in water viscosity
- Alumina injection now largely ineffective

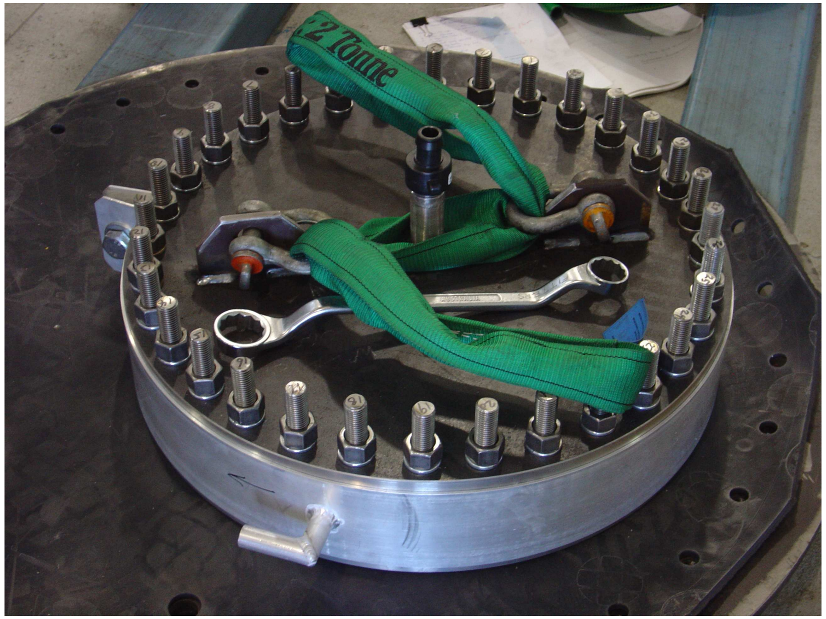
Requirements

- Understand the defects on RVE
- Protect integrity of RVE
- Optimise reactor operation time and performance
- Minimise leak-rate prior to HWU plant installation
- Monitoring of D20 purity
- Control leak-rate

Options for mitigation of leaks

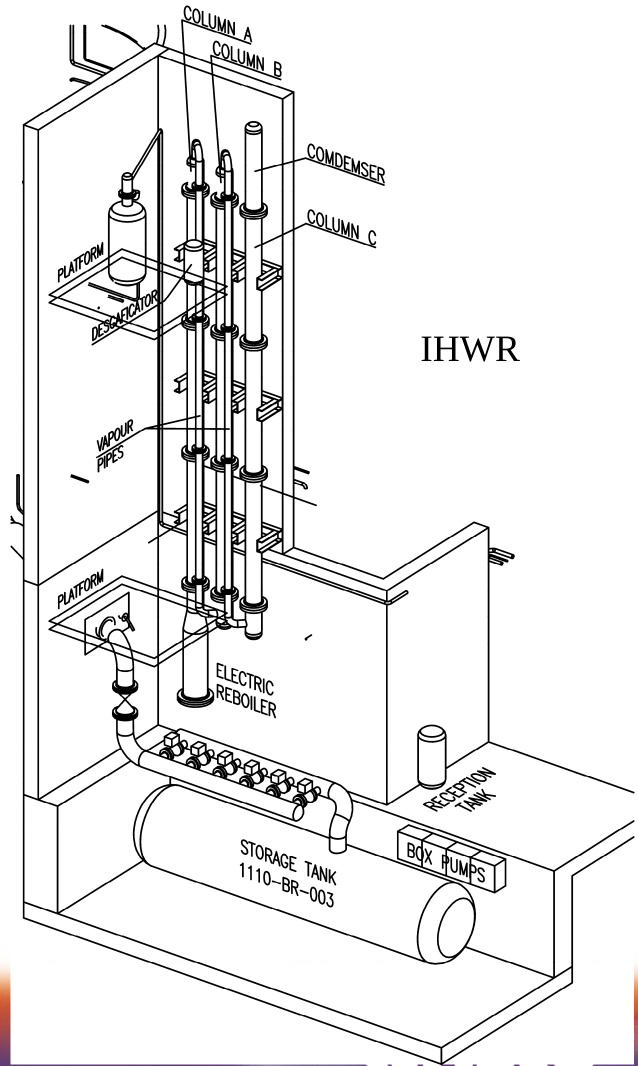
- Heavy water replacement
  - Allows operation to continue and major projects to progress
- Global pressure control
  - Increase cover gas pressure
  - Safety submission likely – increased risk of tritium in RPO
- Local pressure control
  - Flow loop around beam flanges
  - Mock up tested – may require ARPANSA approval
  - Ready in ~1 month
- Leak-site clamp (leak-site “epoxy”)
  - Local and no moving parts
  - Ready in 1-2 months
- Temperature adjustment
  - Requires safety analysis and submission
- Particle re-injection
  - Not favoured

Mock-ups



Heavy Water Enrichment

- Distillation is feasible
- Mature technology
- A significant height of distillation column is necessary (20 to 30 m)
- Not energy efficient
- Long lead time
- Reactor down time

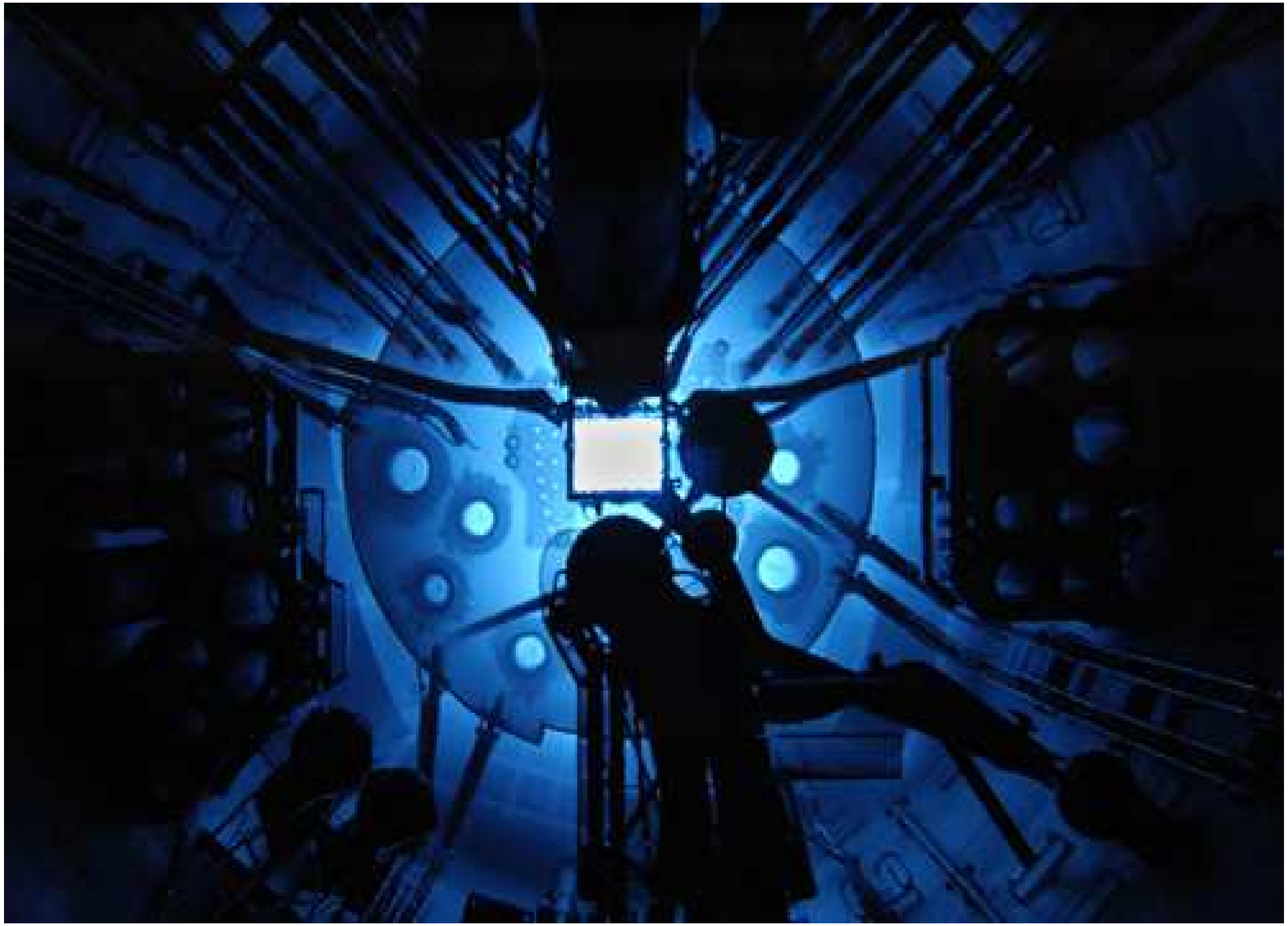


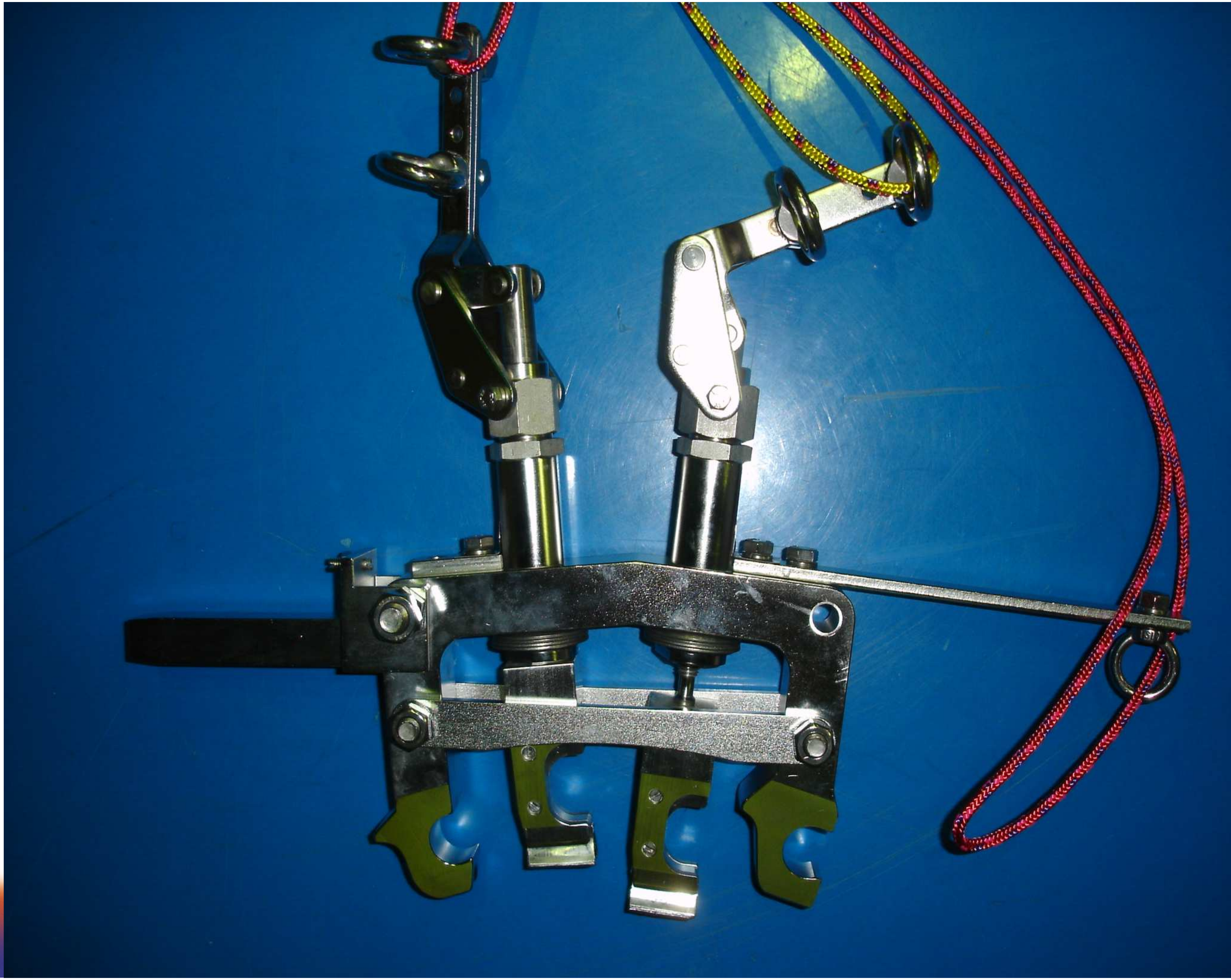
IHWR

HW Isotopic Purification

- HW isotopic purification plant designed
- Detailed engineering design review undertaken
- Preferred option is a separate building for the distillation columns will permanent connection to the reactor heavy water system
- Safety submission prepared, submitted and approved to construct and “cold commission”
- Plant construction is being completed now

Still Operating

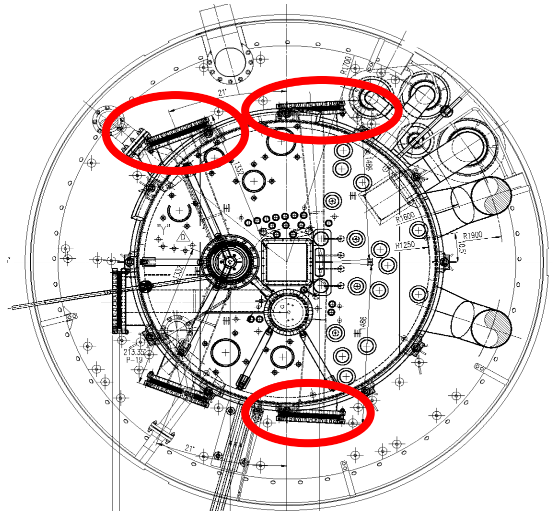


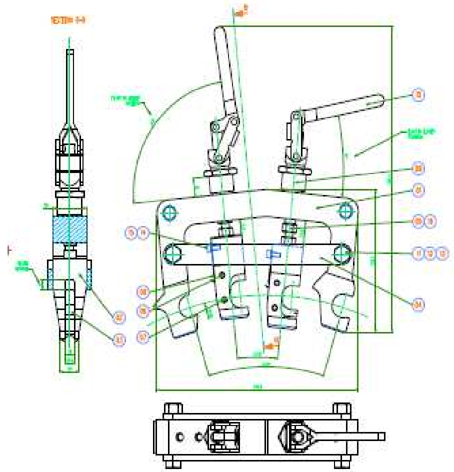


Reflector Vessel Trial Repair

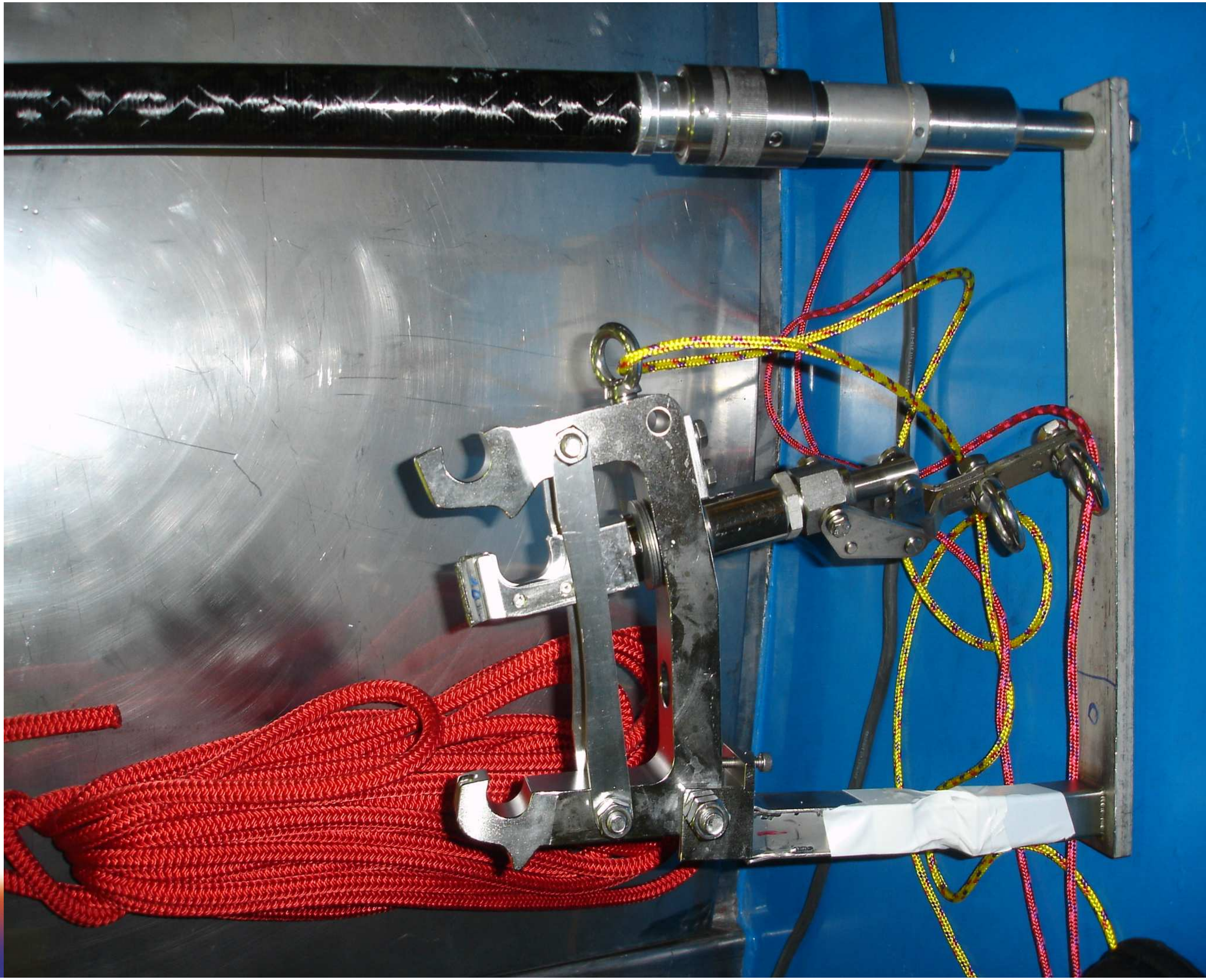
Application of Clamps

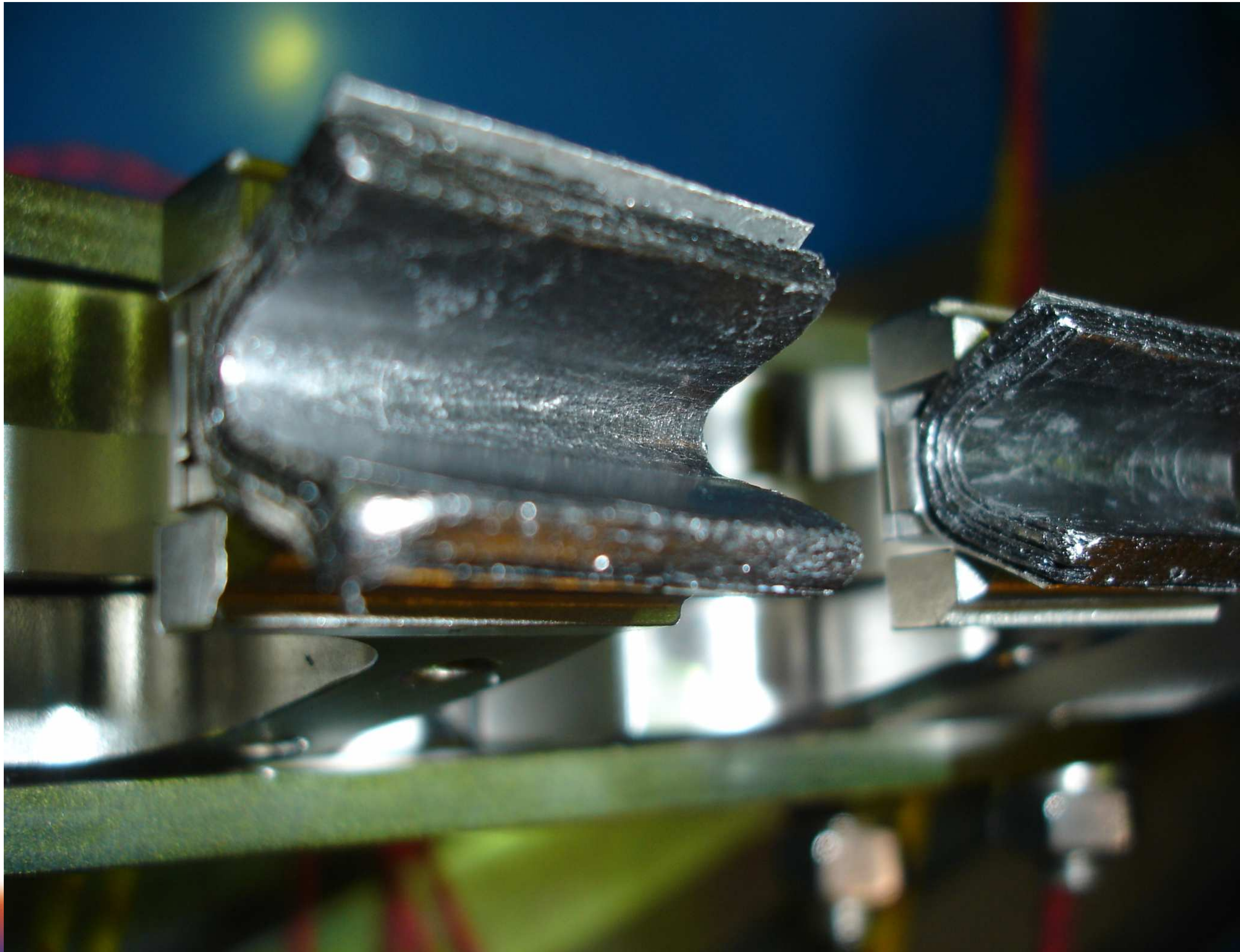
Nov – Dec 2009



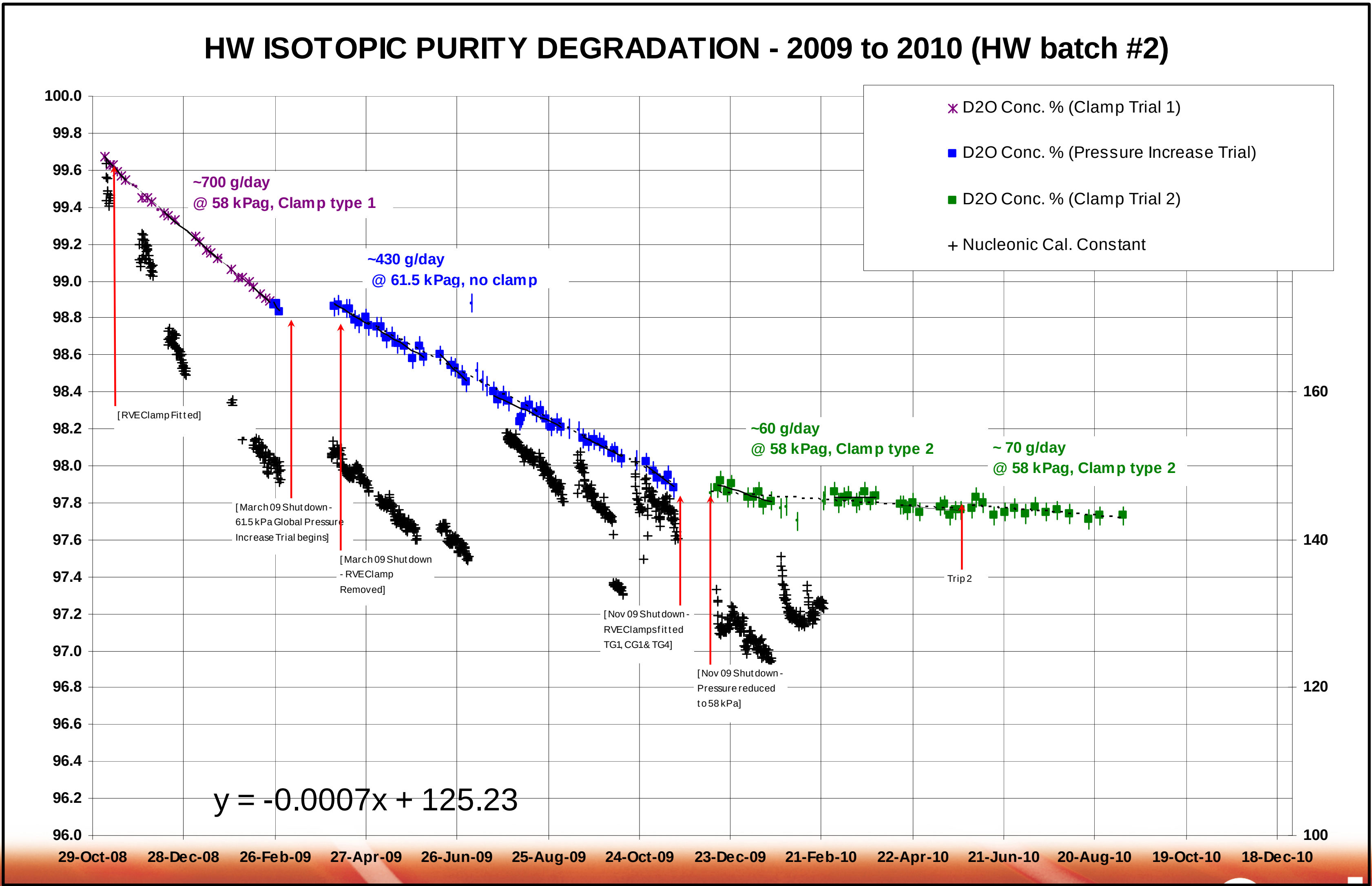


- Remove fuel
- Lower Reactor Pool water
- Drain RVE
- Over-pressurise – He bubbles
- Apply clamps – graphite pads
- Bubbles halted on major leak sites
- Return to service
- Measured D2O purity





Latest Heavy Water Purity Data



Current & next steps

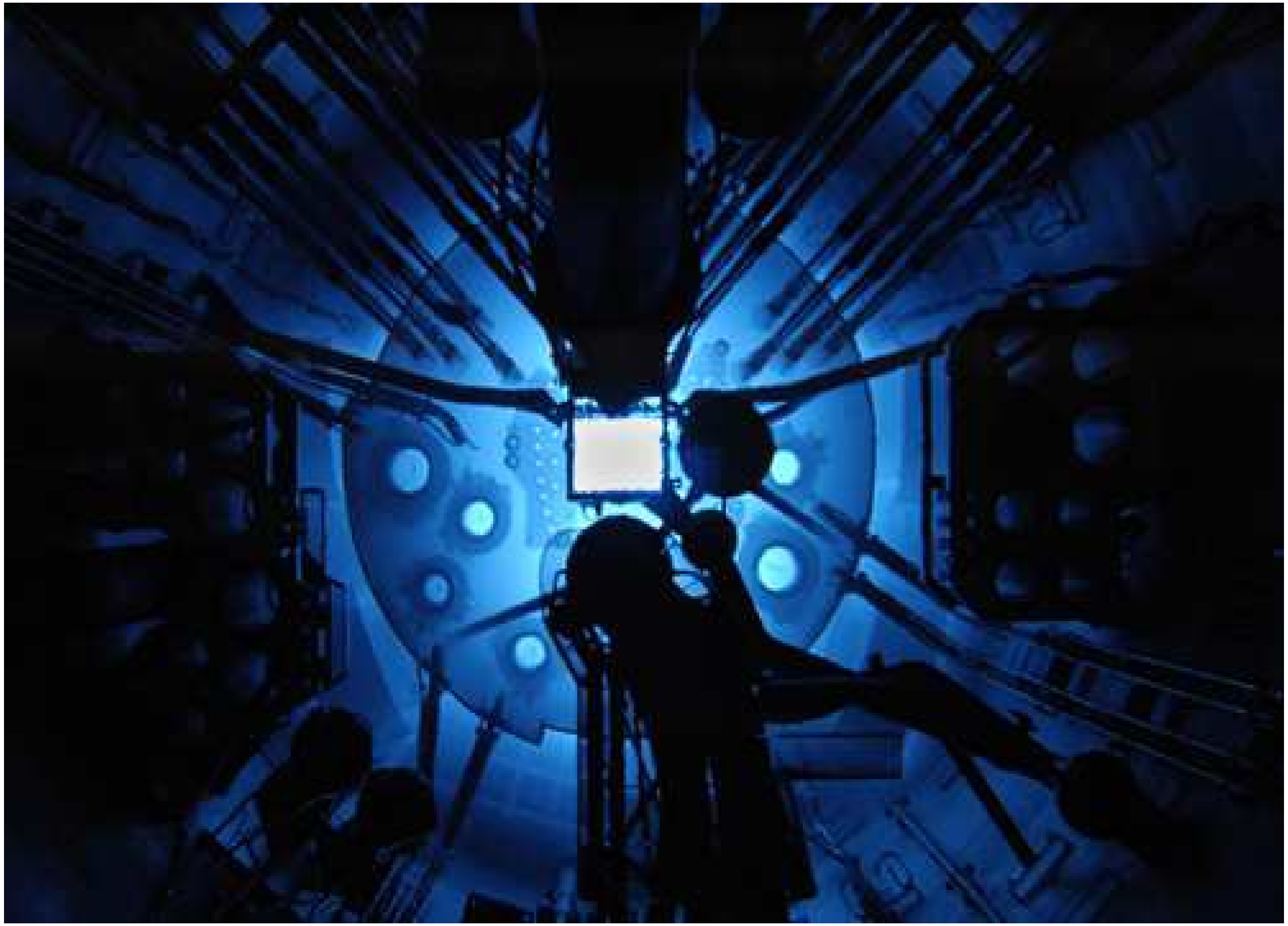
- Maintain clamps in position
- Manufacturing spares
- Visual monitoring
- Measuring D2O purity – once per week
- Monitoring nucleonics channel responses
- Keep extant other engineering projects with long-term promise
- Heavy Water Isotopic Purification System constructed and commissioned in 2011

Root Cause

- Defects caused by delayed hydride cracking
- Stress analysis has shown that there is no significant residual stresses in the weld


OPERATIONS BRIDGE 244/80

Still Operating



ansto

Nuclear-based science benefiting all Australians