

# OPAL : Commissioning a New Research Reactor



IAEA Conference, Sydney, November 2007

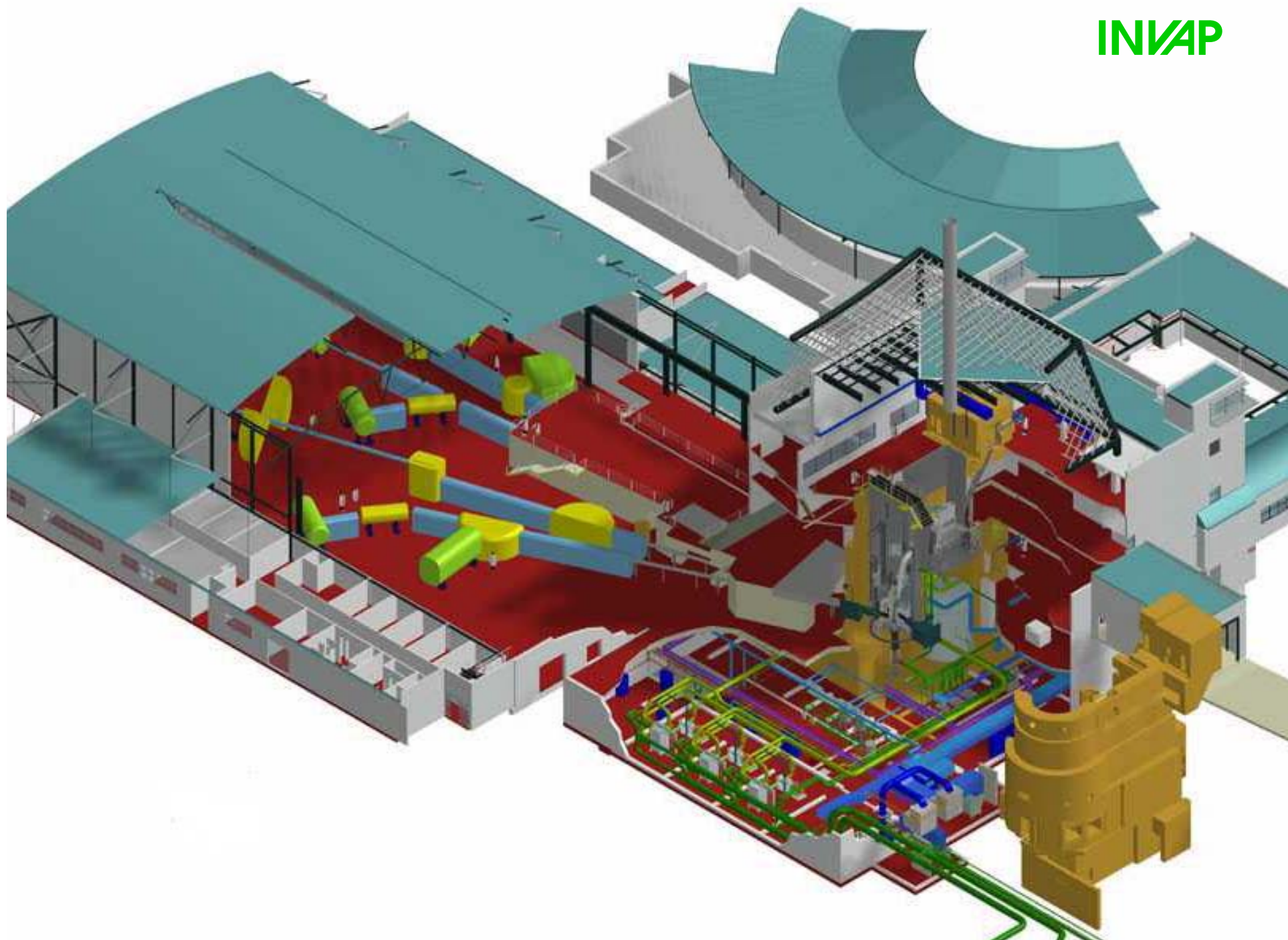
# Project Timeline

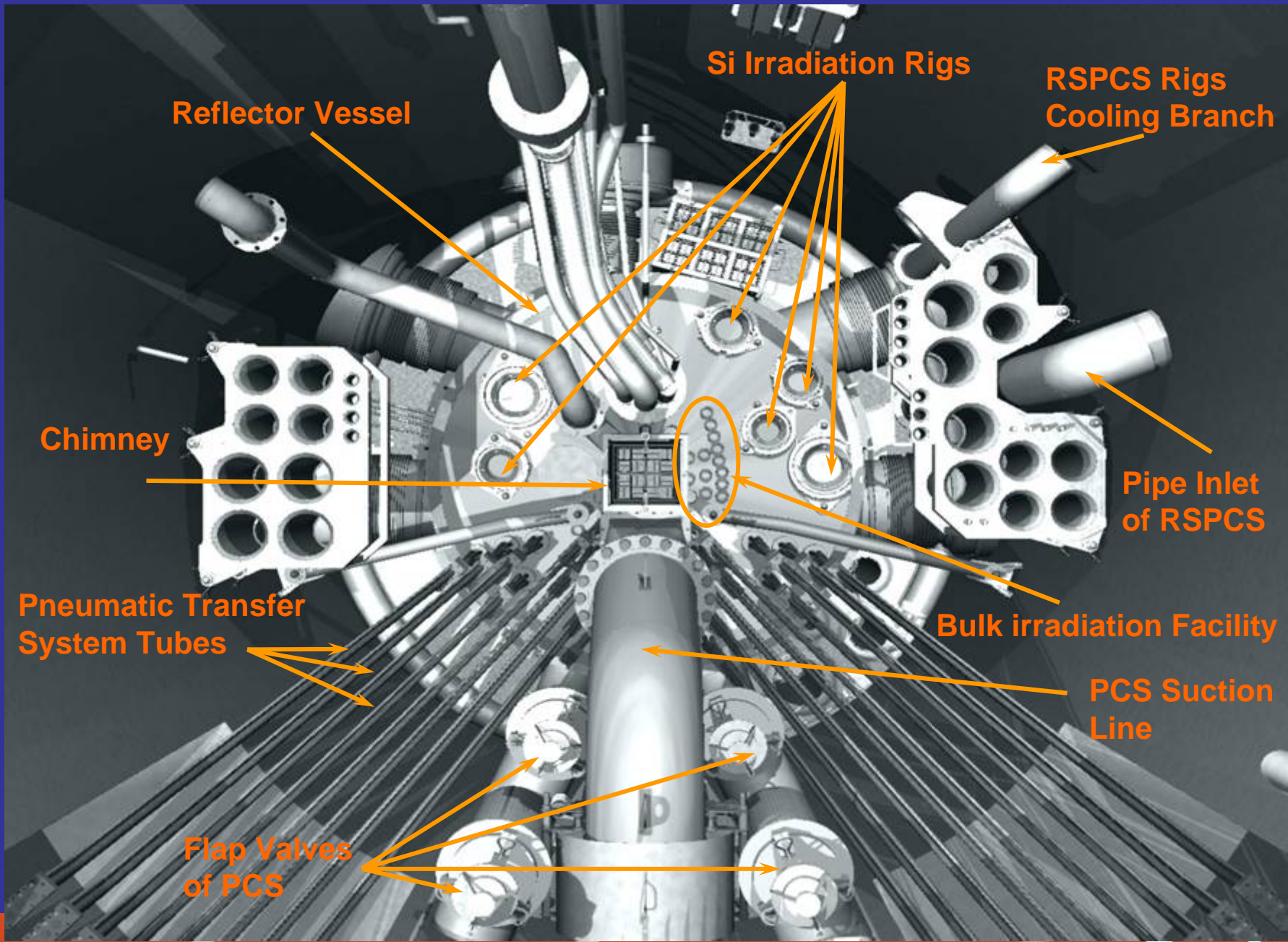
- Government announcement 1997
- Design and licence application 2000/2001
- Construction Licence April 2002
- Construction 2002-2006
- Cold Commissioning Feb-May 2006
- Operating Licence July 2006
- First critical 12 Aug 2006
- Hot Commissioning Aug 2006 – May 2007

# OPAL Reactor

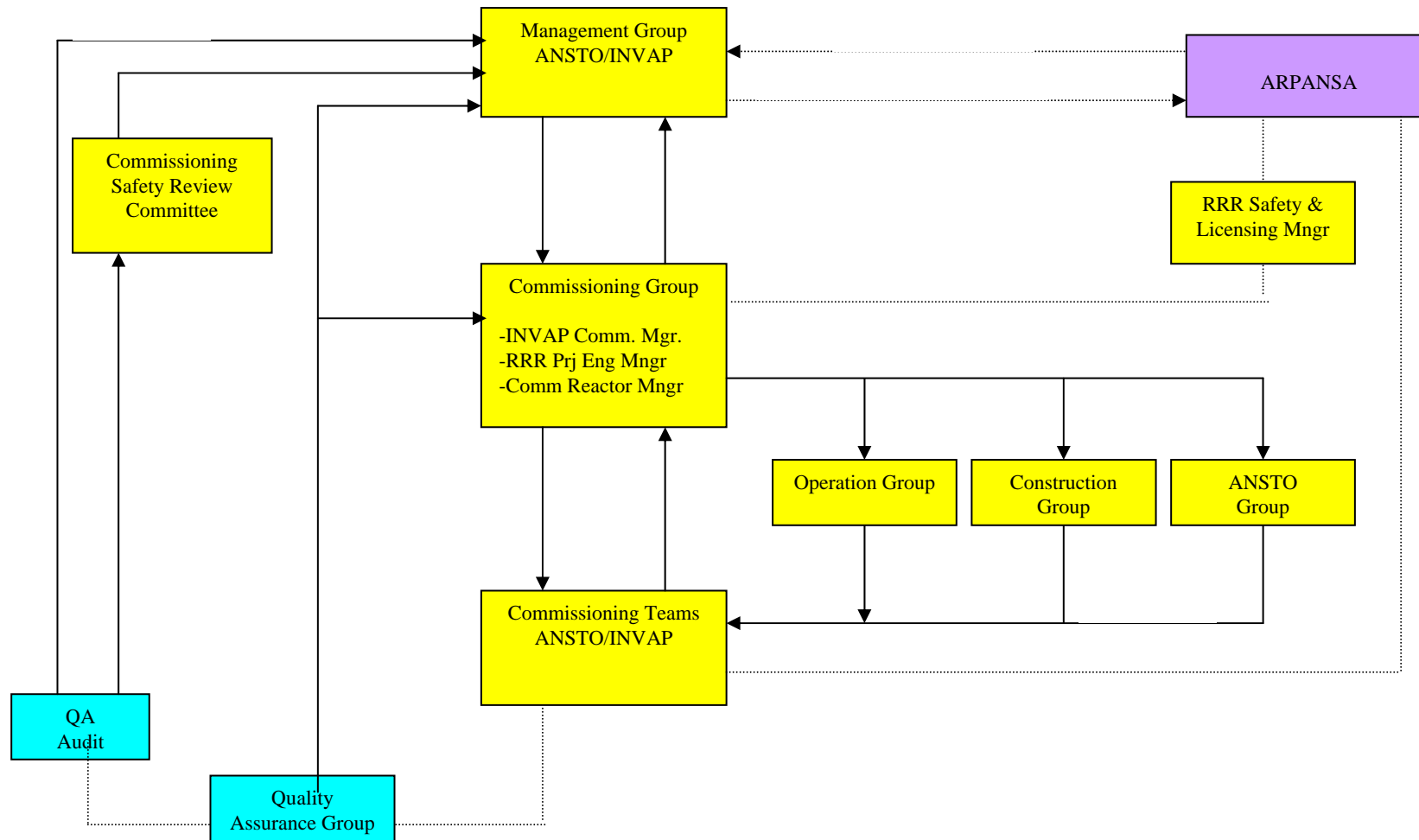
- Multi-purpose facility – neutron beams, radiopharmaceuticals, irradiation of materials
- 20 MW thermal power
- Compact core (~300 kW/L)
- Plate type Low Enriched Uranium fuel
- D<sub>2</sub>O reflector
- Upward coolant flow (light water)
- 2 independent & diverse shutdown systems

INVAP





# Commissioning Organisation



# Staffing and Training

- Experienced HIFAR staff
- Shared HIFAR/OPAL staff
- Staff seconded from within ANSTO
- New recruitment
- Contractors
- Training courses
- Simulator

# Documentation

- Prepared by INVAP, reviewed by ANSTO
  - Commissioning Plan
  - Commissioning Test Procedures
  - Safety Analysis Report
  - Design, Operations and Maintenance Manuals
- Operating Limits and Conditions
- OPAL Business Management System



# Commissioning Stages

- Pre- Commissioning
- Stage A – Cold commissioning
- Stage B1 – First criticality
- Stage B2 – Low power tests
- Stage C – Power ascension and full power tests

# Precommissioning

- Previous tests include:
  - Factory acceptance tests
  - Installation tests
  - Functional tests
- INVAP responsible for all commissioning
- ANSTO project team provides oversight
- ANSTO witness and support precommissioning activities

# Stage A Cold Commissioning

- 47 test procedures completed:
  - Safety system tests (FSS, SSS, Containment)
  - Instrumentation and Control system tests (FRPS, SRPS, PAM, RCMS, RMS)
  - Reactor State tests (Power, Physics Test, Shutdown, Refueling)
  - Plant procedure verification
  - Loss of Normal Power test
  - Emergency drill
  - 36 hr cold run

# OPAL Control Room



# Hot Commissioning

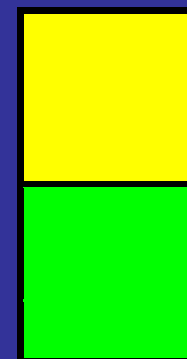
- ARPANSA issued the Operating Licence in July 2006 allowing fuel to be loaded
- Reactor Operations by accredited ANSTO operators under INVAP supervision

# Stage B1

- Start up core with three different uranium loadings.
- First critical 12 August 2006 with 14 fuel assemblies loaded
- First Shutdown System shutdown value measured

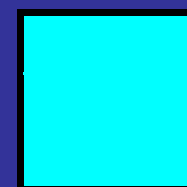
# First Core FA Distribution

A1	B1	C R 1	C1	D1
A2	B2		C2	D2
CR 2		CR5	C R3	
A3	B3	C R 4	C3	D3
A4	B4		C4	D4



~ 212 g U<sup>235</sup> / FA without BP

~ 383 g U<sup>235</sup> / FA with BP



~ 484 g U<sup>235</sup> / FA with BP  
(standard type)







# Stage B2

- Completed loading of full core 16 fuel assemblies
- 22 main tests at powers up to 400kW
- Irradiation of gold wires for determination of power peaking factor, reactivity worth of facilities and calibration of nuclear instrumentation
- All feedback coefficients confirmed negative

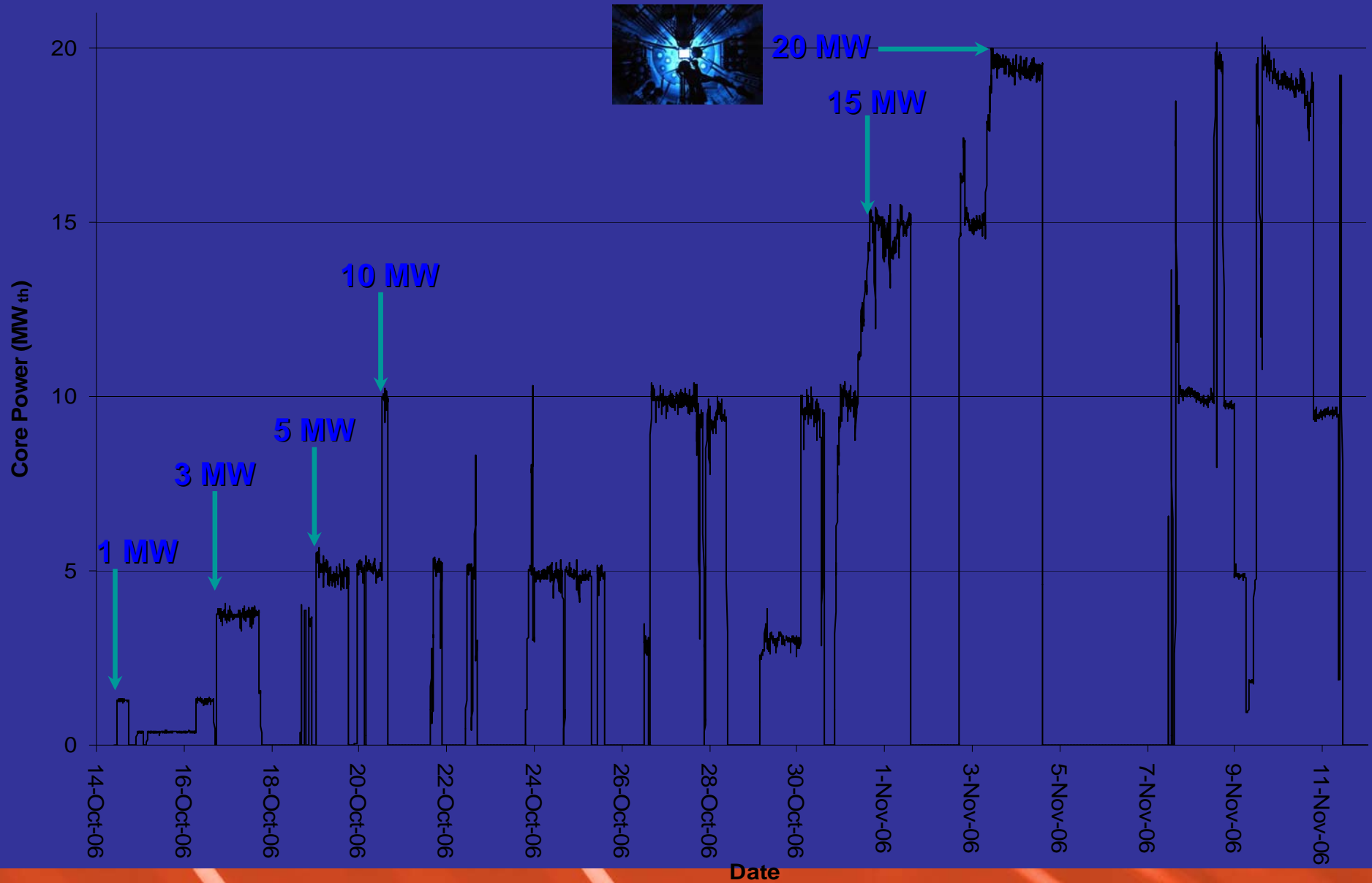
# Stage C

- Reactor power increased in steps to 20 MW
- Nucleonic instrumentation calibration at 3 MW from thermal balance
- Loss of normal electrical supply test from full load
- 20 MW achieved 3 November 2006



# Stage-C Power Profile

— Power Profile (MW)



# Commissioning Issues

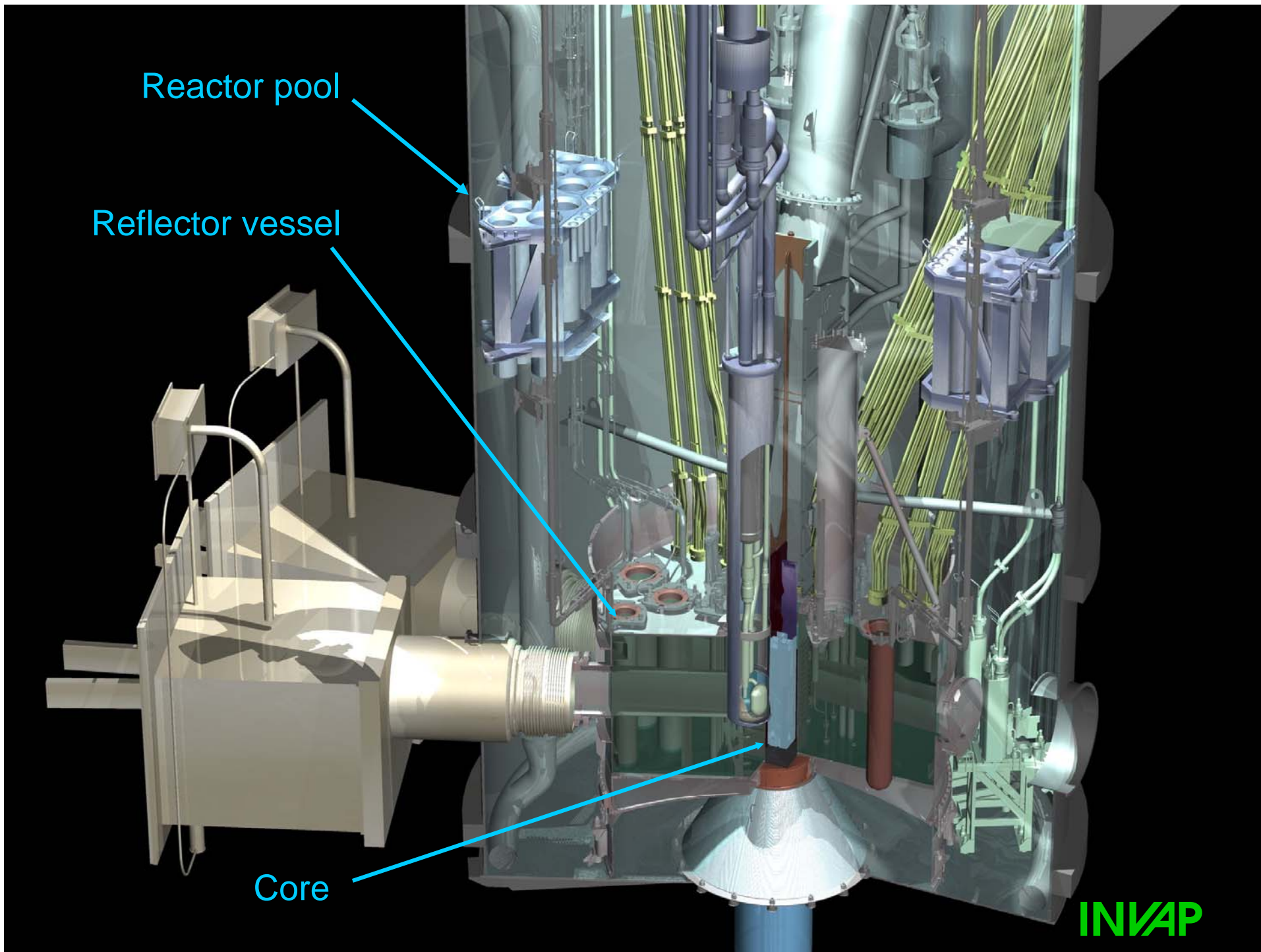
- Noise in nucleonics instrumentation
- Wide range nucleonics detectors change from pulse to Campbell mode
- CNS turbine
- Core outlet temperature sensors
- Cooling tower performance
- Delay in completion of irradiation facilities

Reactor pool

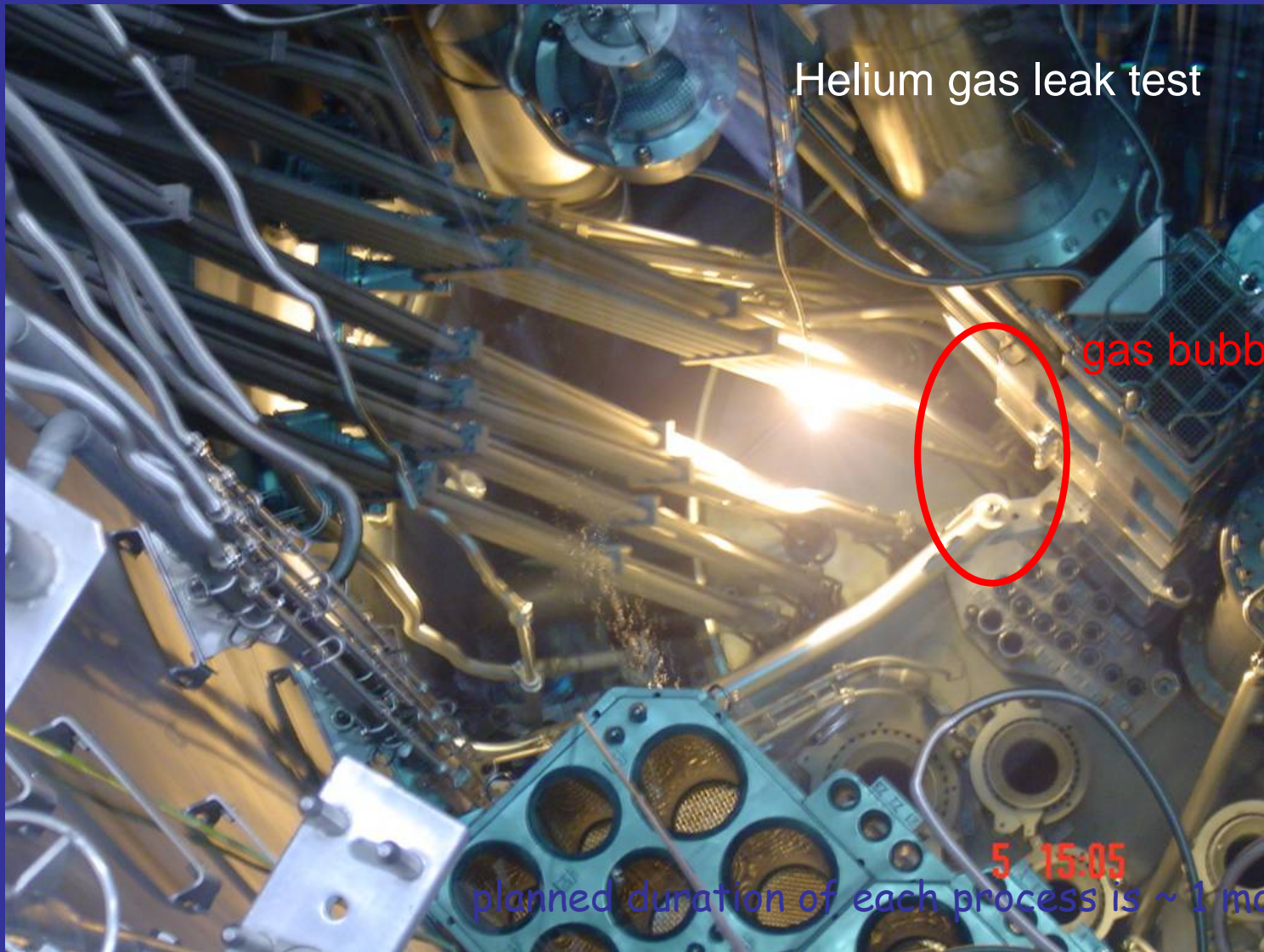
Reflector vessel

Core

INVAP



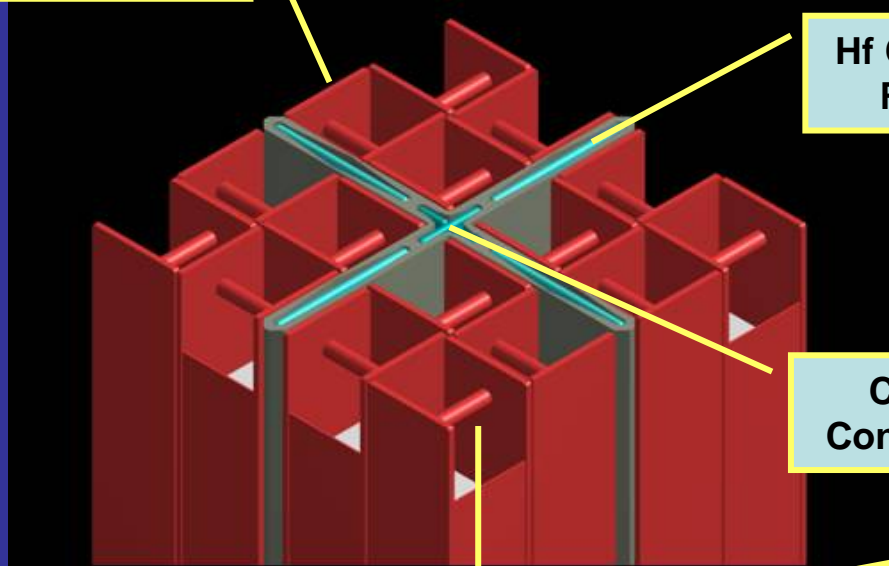
# Repairs to OPAL reflector vessel





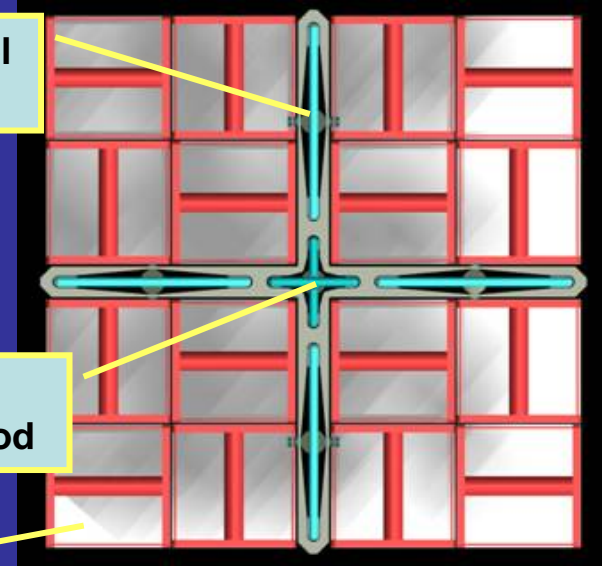
# Reactor Core

Reactor Core

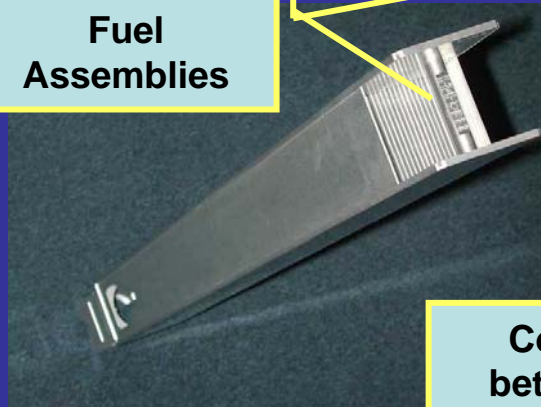


Hf Control Rods

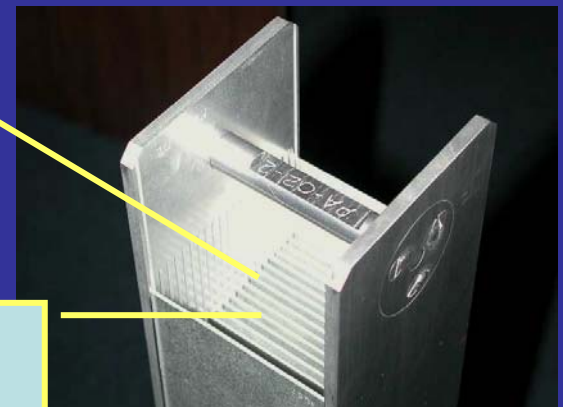
Central Control Rod



Fuel Assemblies



Fuel Plates



Coolant Channels between Fuel Plates

