Slow neutron facilities at the National Physical Laboratory, UK

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Bushy House

NPL was founded in 1900 in a former royal residence

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New laboratories

Completed in stages between 2000 and 2009

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Neutron facility

Chadwick Building

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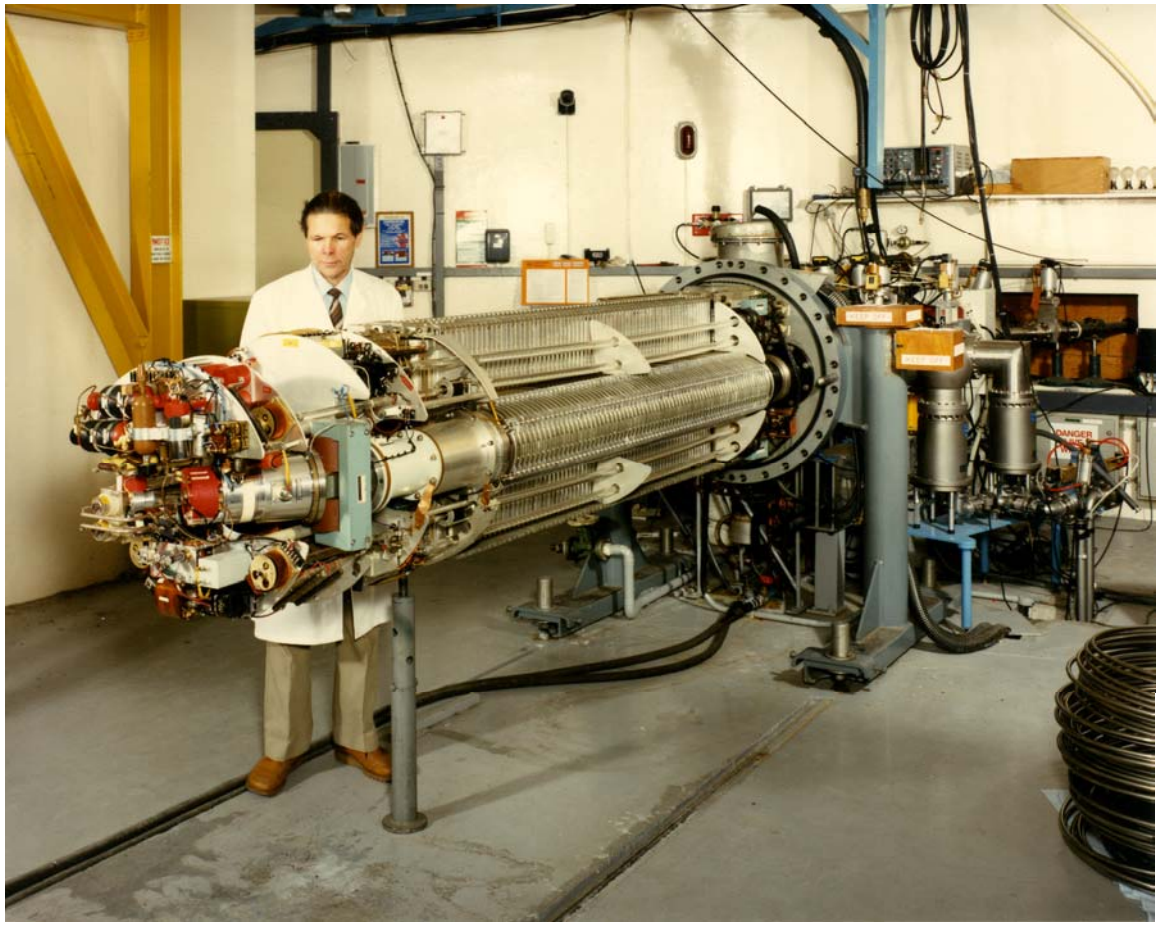
3.5 MV Van de Graaff accelerator



Showing ion source, pulser and accelerator tube

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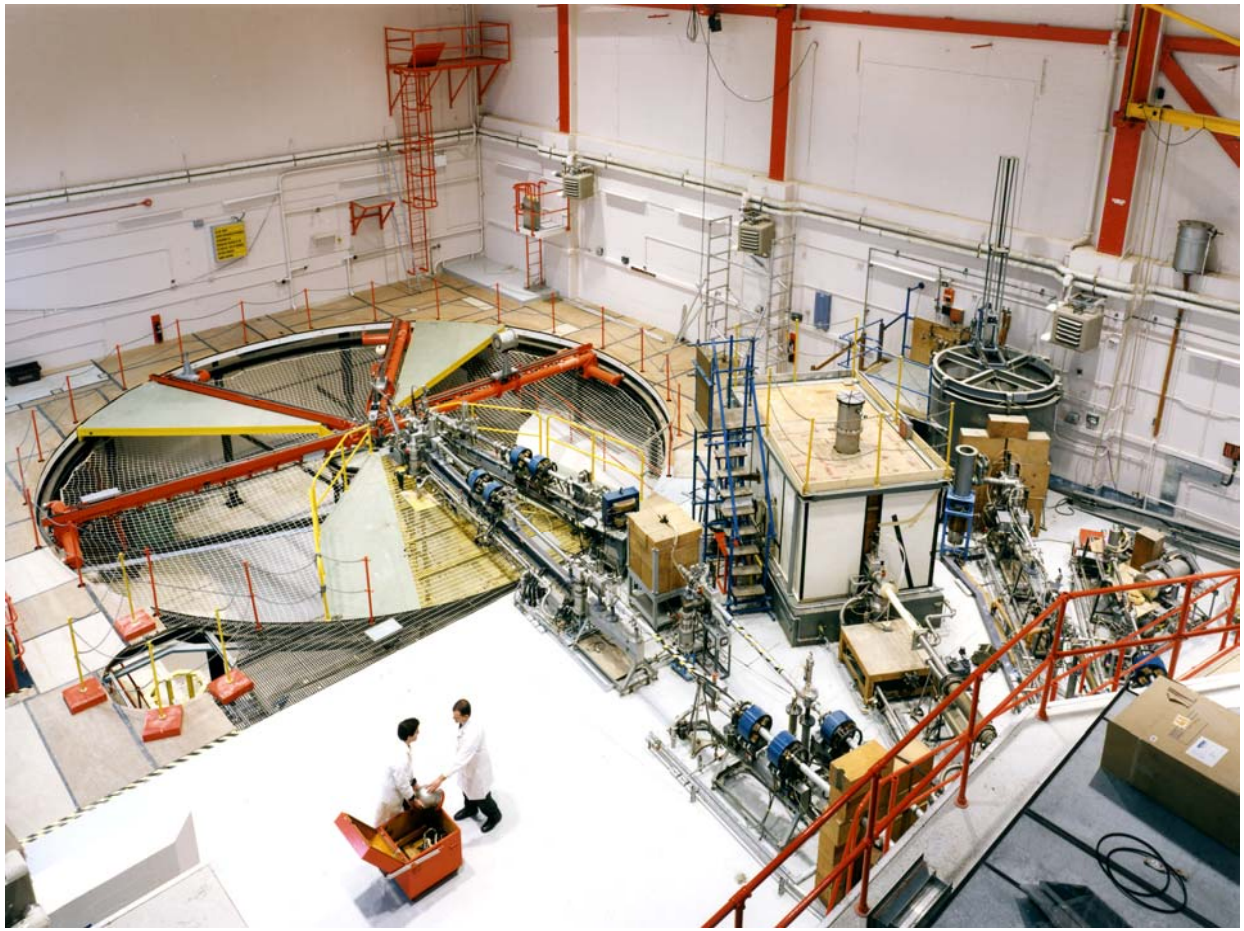
Experimental area



Showing low scatter area, thermal pile and water bath

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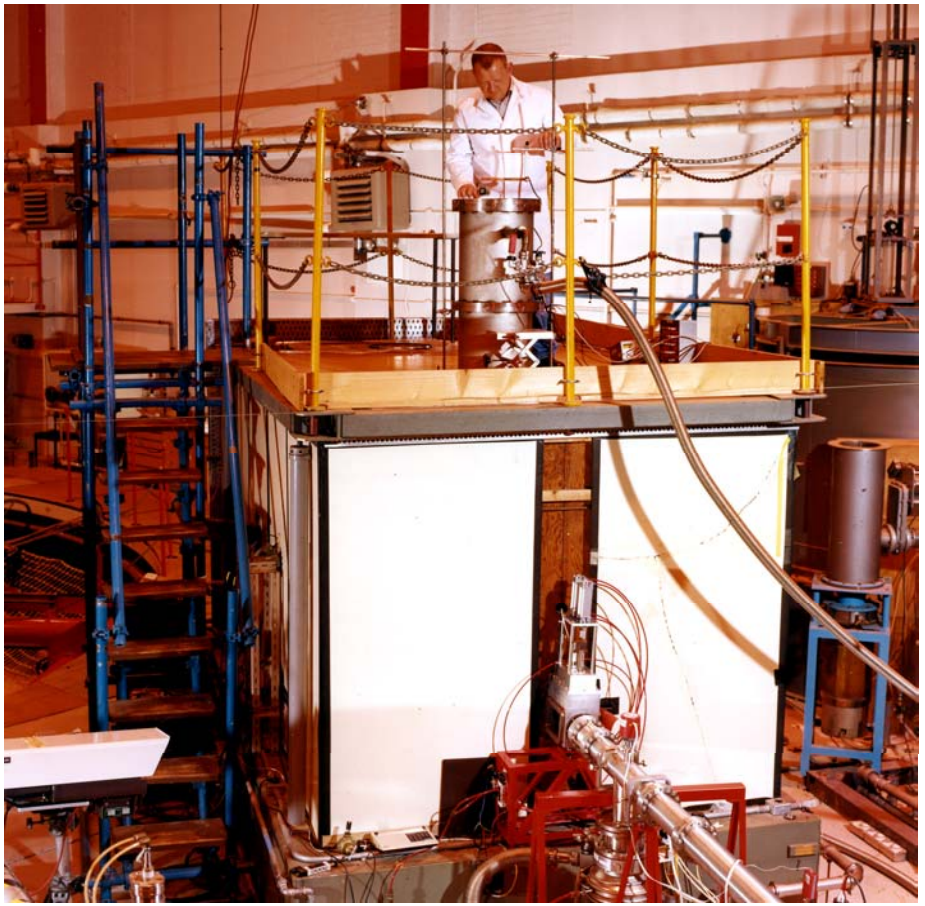
Thermal Pile



Graphite block about 2.8 m long by 1.4 m wide by 1.6 m high

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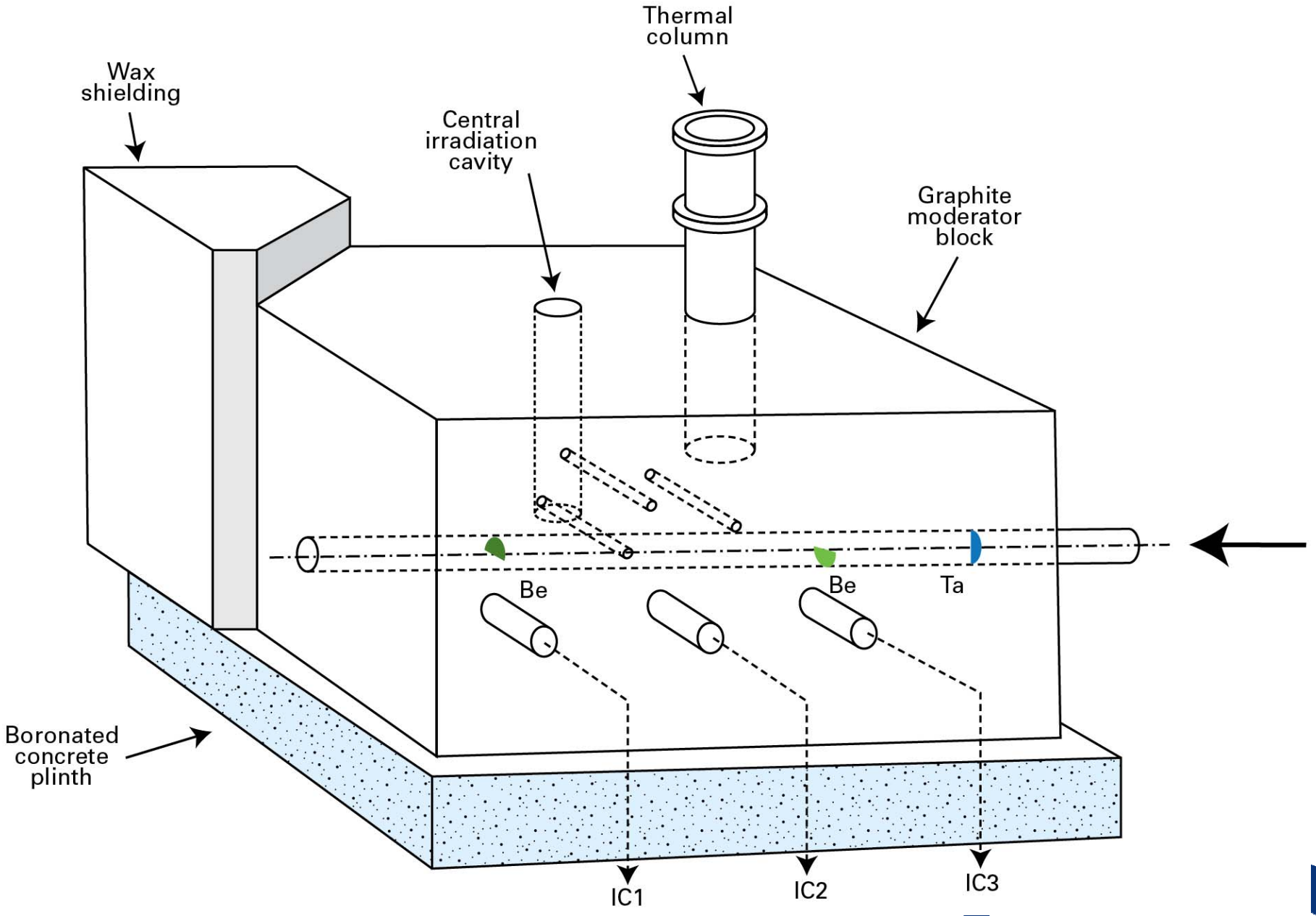
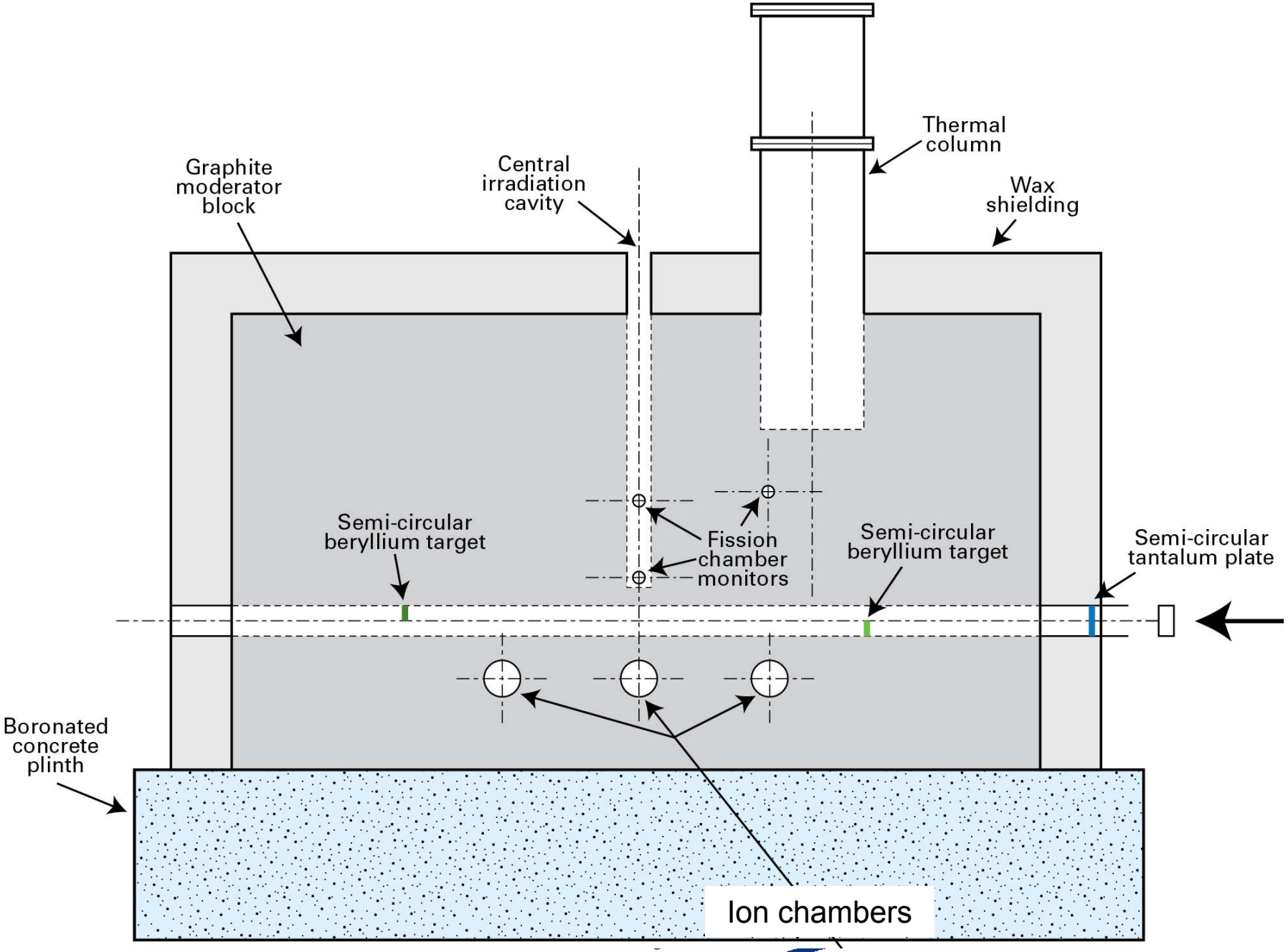
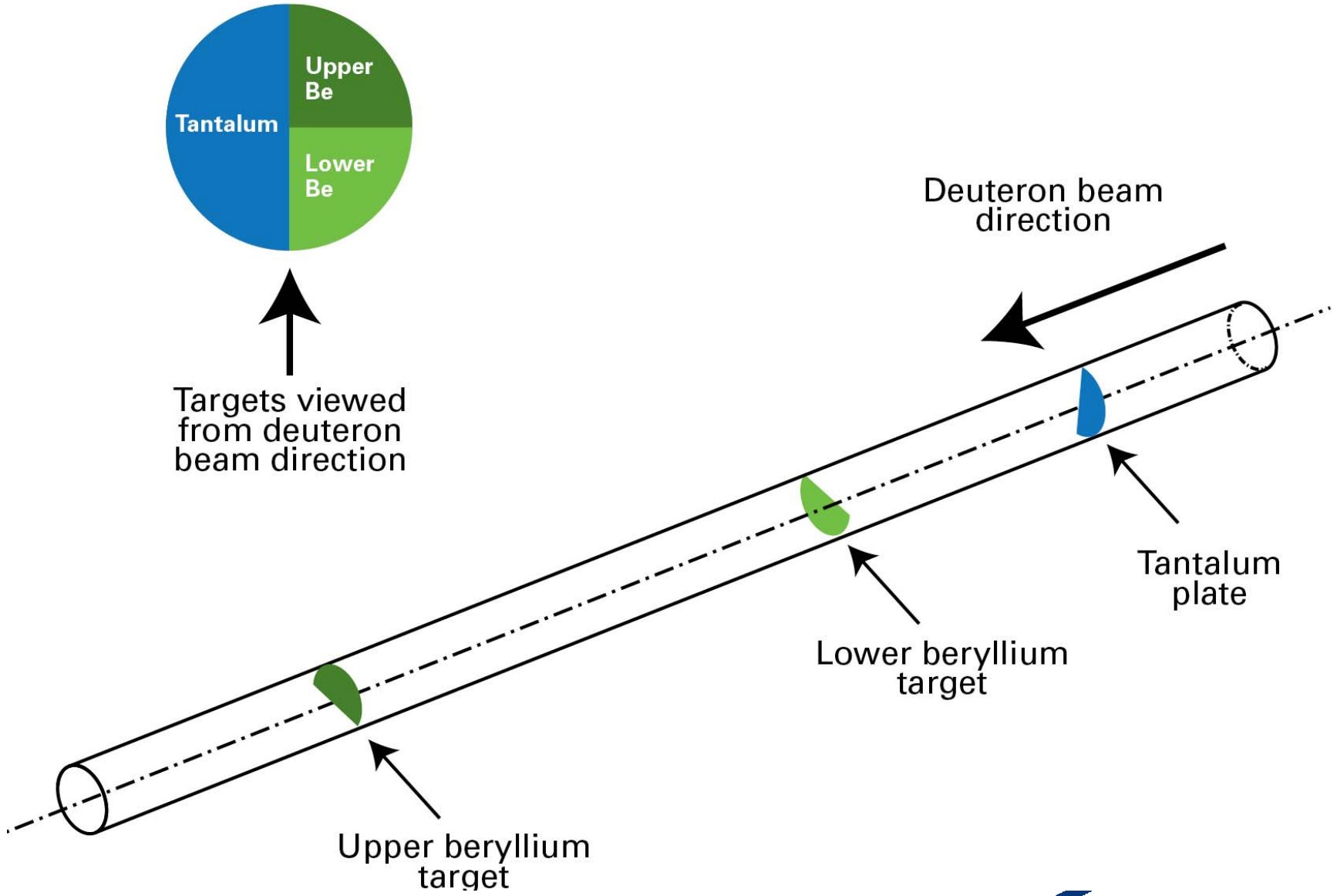


Ion chamber signals to servo


Graphite moderator block
Central irradiation cavity
Thermal column
Wax shielding
Semi-circular beryllium target
Fission chamber monitors
Semi-circular beryllium target
Semi-circular tantalum plate
Boronated concrete plinth
Ion chambers


Tantalum
Upper Be
Lower Be
Targets viewed from deuteron beam direction
Deuteron beam direction
Tantalum plate
Lower beryllium target
Upper beryllium target

Data for NPL Thermal Pile

Central cavity:

- Isotropic field
- Up to 1.2 x 10^7 cm^{-2} s^{-1} (research reactor: 10^{12} cm^{-2} s^{-1} or more)
- Max. dia. of object: 119 mm
- Typical Cd ratio 33

Thermal column:

- Beam geometry
- Up to 4 x 10^4 cm^{-2} s^{-1} (1 mSv h^{-1})
- Column dia. 300 mm (larger objects can be placed on top)
- Typical Cd ratio 6.5

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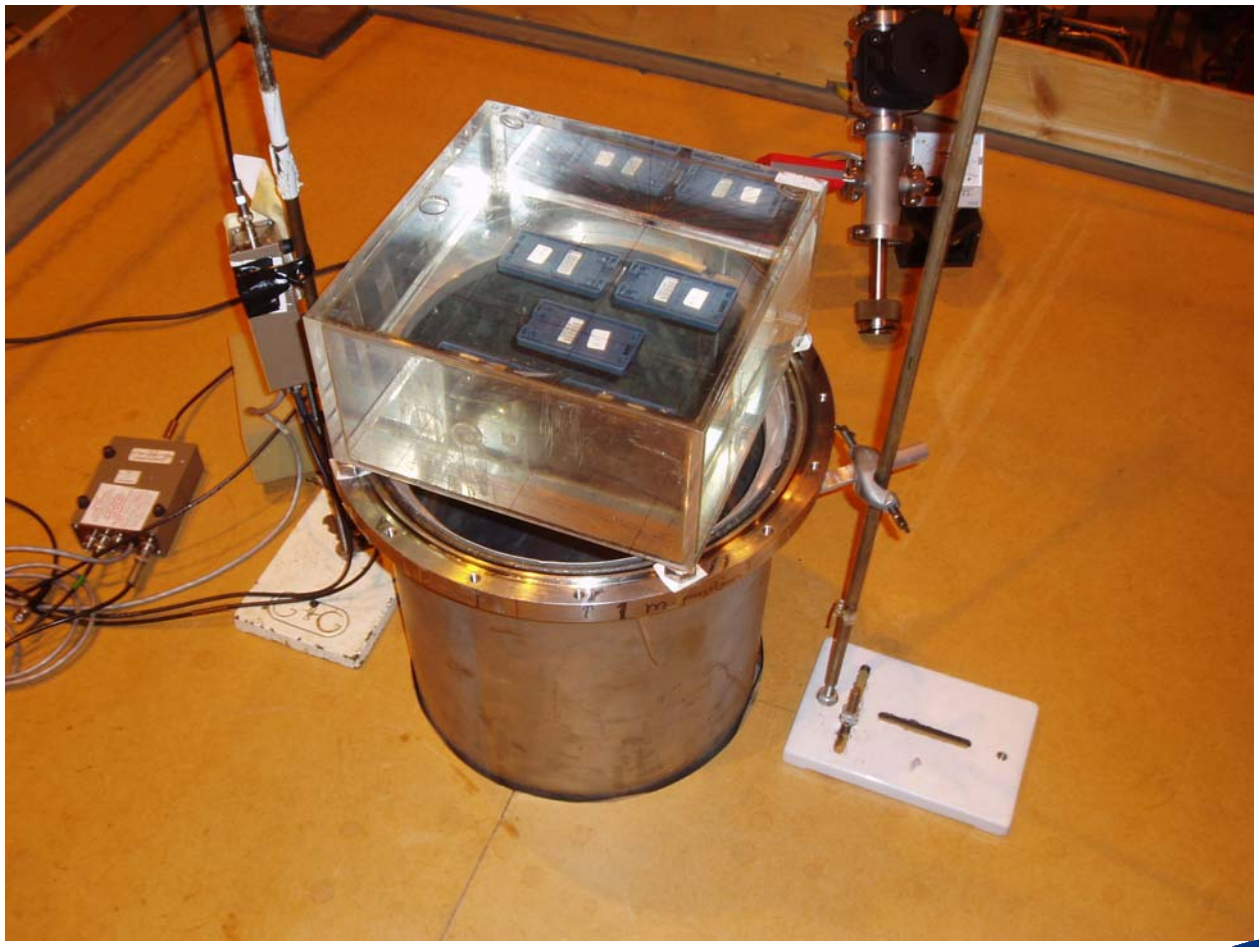
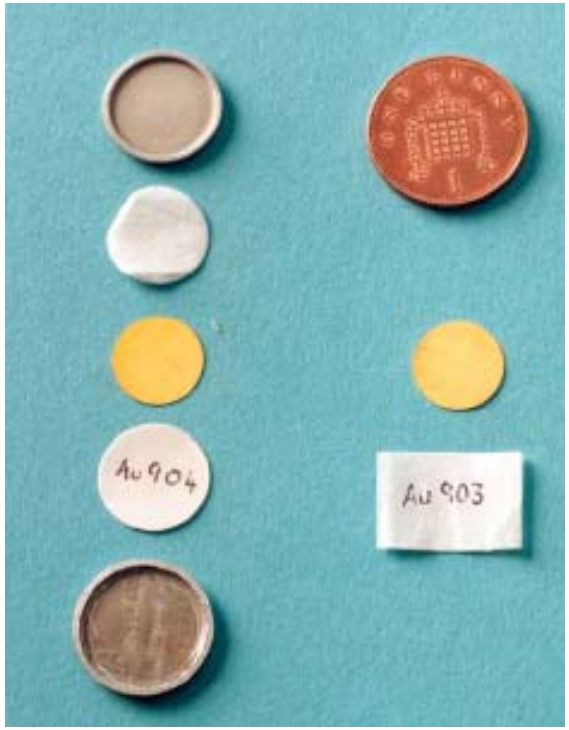
Measurement on thermal column



Monitoring the fluence delivered

- Fission chambers are built in to the pile, but are only used as an indication.
- Precise measurement is by gold foil activation followed by off-line β– counting in a 4π low background β–counter



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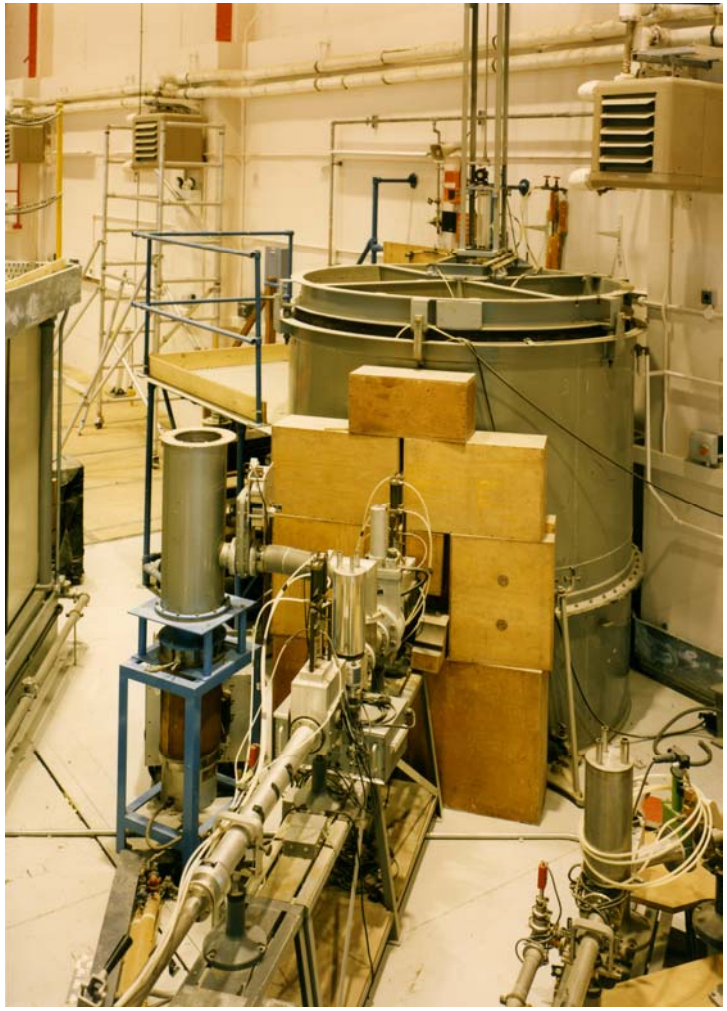
Water bath



- Cylindrical body of water, 2.4 m high by 2 m diameter.
- Liquid more difficult to build with, and flux depression effects larger.
- But epithermal field follows 1/E dependence more closely than Thermal Pile ($1/(E^{1.05})$).

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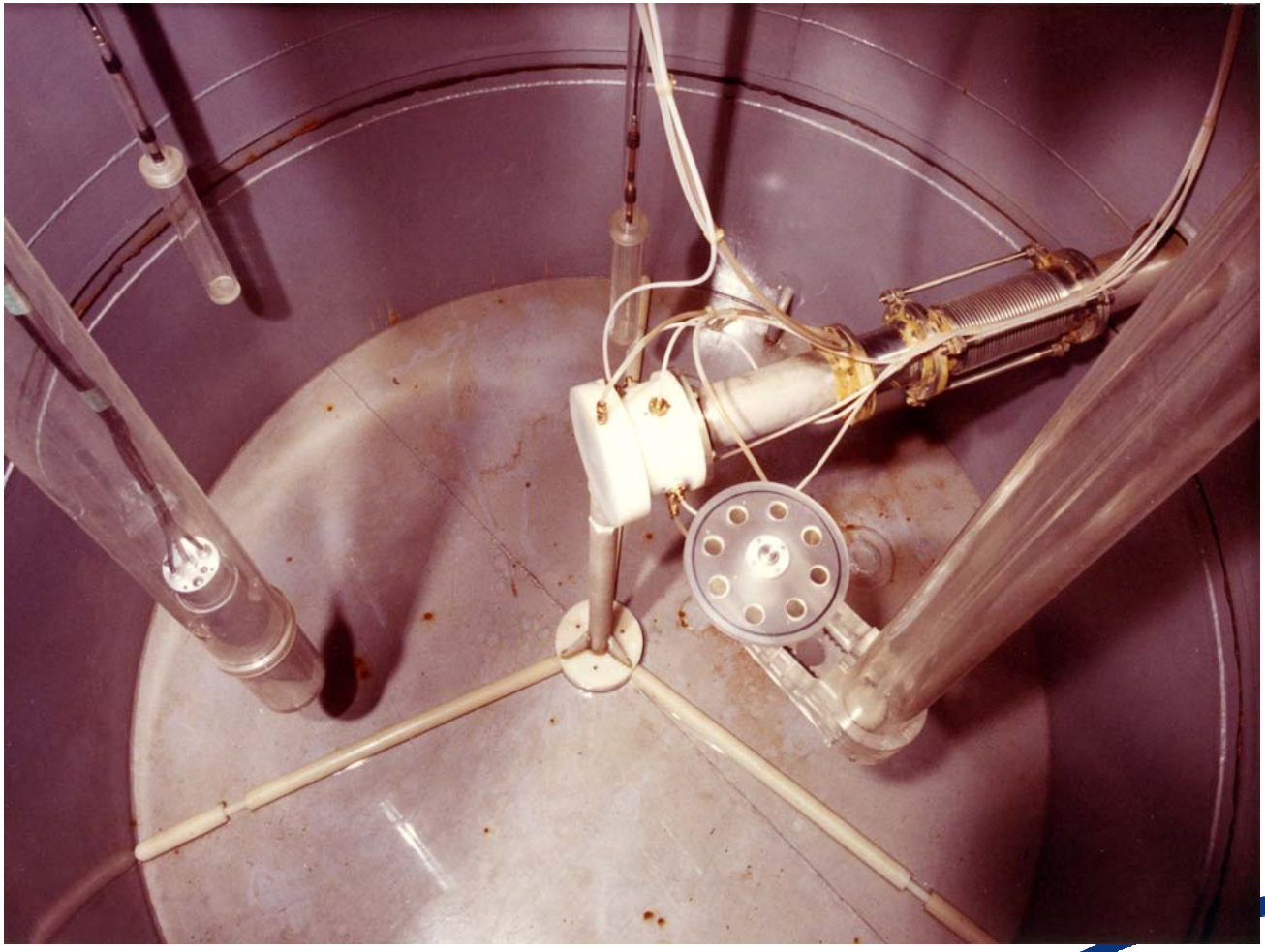
Inside the water bath



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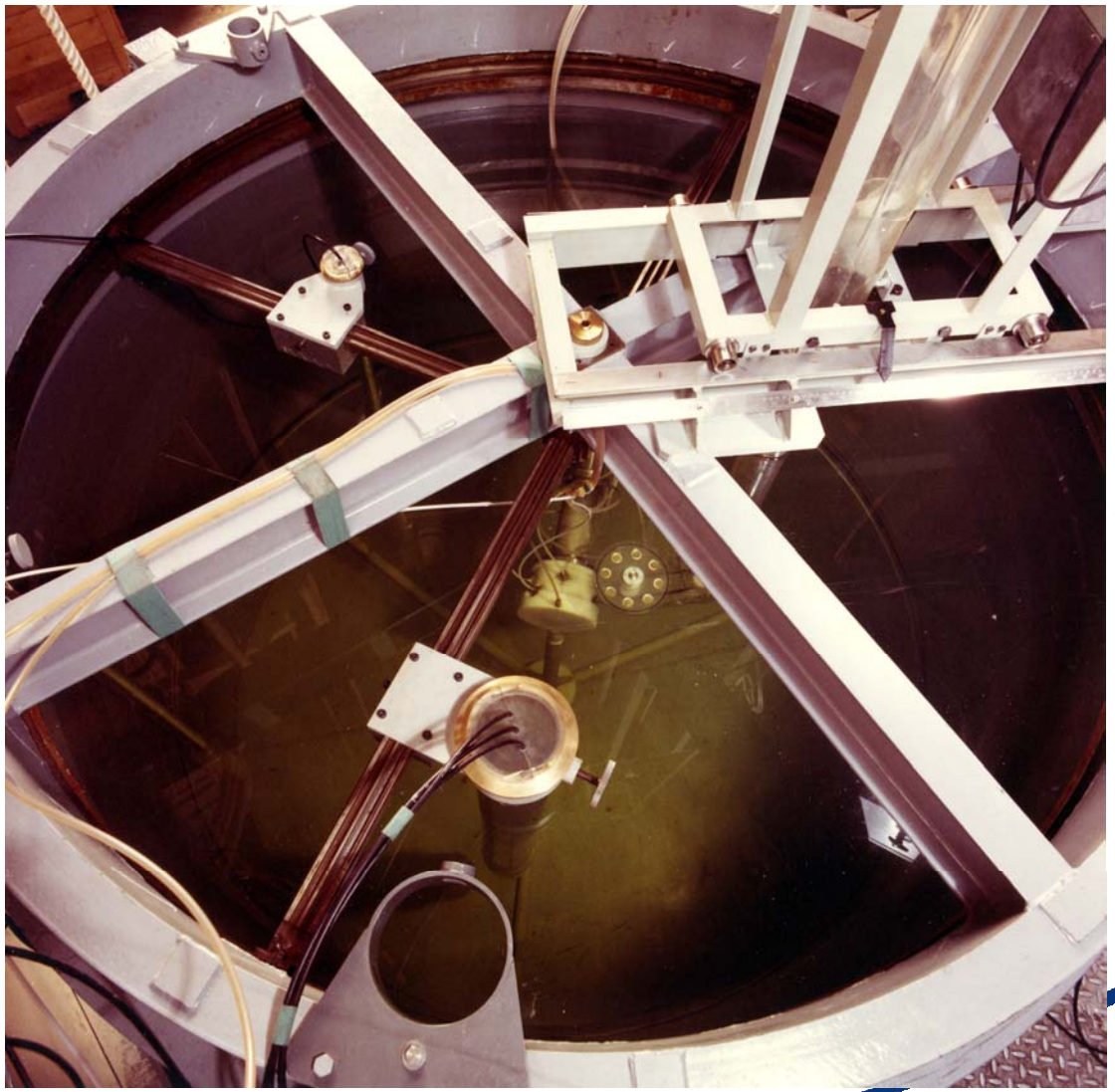
Inside the water bath



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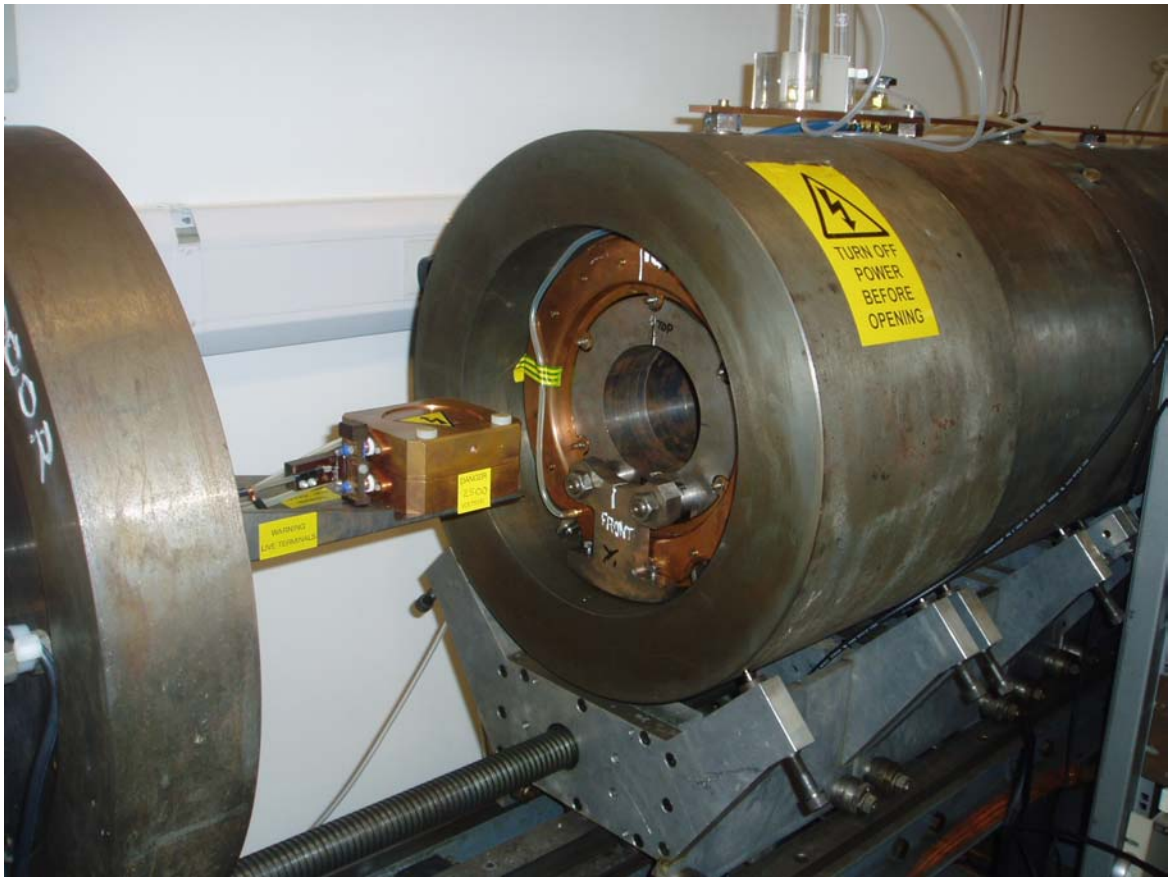
Previous nuclear data measurements

Between 1970 and 1974 these facilities were used to measure thermal neutron capture cross sections and / or resonance integrals of: ^{107}Ag, ^{109}Ag, ^{27}Al, ^{75}As, ^{37}Cl, ^{63}Cu, ^{65}Cu, ^{164}Dy, ^{151}Eu, ^{69}Ga, ^{71}Ga, ^{165}Ho, ^{139}La, ^{23}Na, ^{93}Nb, ^{196}Pt, ^{198}Pt, ^{159}Tb, ^{51}V, ^{89}Y.

Activity measurement



Where β counting efficiency of sample is known:

4π low-background windowless β counter.

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Activity measurement

Where the induced activity is high enough:

$4\pi\beta$-γ counting.

Activity measurement

- The laboratories of the NPL Radioactivity Group are close by. They have specialised facilities that can help with non-standard or difficult measurements.

Conclusions

- The NPL Neutron Metrology Group has a 3.5 MV Van de Graaff accelerator and a range of experimental facilities.
- Well-characterised neutron fields can be produced in the fast, epithermal and thermal energy regions.
- These can be used for calibrations, activations, reactor instrument testing, and cross section measurements.

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