PREMIUM Analyse

Improved monitor design and configuration for reducing reported tritium discharges from the Orphée research reactor

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- Overview of the Orphée Research Reactor
- The requirement
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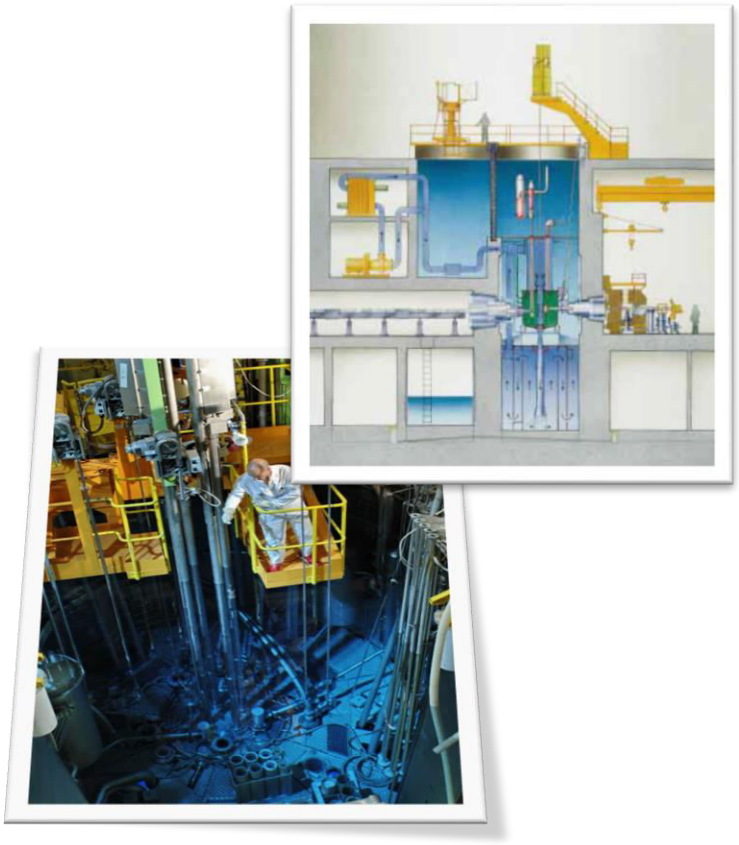
ORPHEE RESEARCH REACTOR

- CEA Saclay Facility, located near Paris.
- Provides neutron beams for fundamental research.
- First Criticality : 19th December 1980.
- Every year it receives around 500 scientific visitors from around the world.

ORPHEE RESEARCH REACTOR



- « pool » type PHWR reactor.
- Thermal power of 14 MWth
- Thermal neutron flux of $3x10^{14}$ neutrons per cm^2 per second.
- The reactor has 9 horizontal channels and 9 vertical channels (including 4 pneumatic channels for activation analysis).
- Monitoring includes:
  - 8 Tritium activity monitors
  - 8 Noble Gas monitors

ORIGINALS MONITORS

- 2 cabinets : 1 for HTO & 1 for Noble Gases
- 8 points of measurement = 16 cabinets + spares
- Limit of detection for HTO : 31uCi/m^3 - 1.16 MBq/m^3
- Very long response time (10s of mins)
- Use Silica gel for HTO measurement = radioactive waste to recycle (plus an inert delay bed)
- Not compliant with seismic specifications
- Obsolete components

REQUIREMENT

- Replace the orignal system by a new one, more compact
- Increase the sensitivity of the measurement
- Reduce response time
- Reduce the volume of radioactive waste
- Offer a solution which is seismically compliant
- Able to communicate with the reactor information systems

THE SOLUTION
- One Compact Unit -

- 1 Mobile unit
- 2 derived channels.
  - HTO real time measurement
  - Noble gases real time measurement.
- From 4 independent measurements.

THE SOLUTION

- Improved Limit of Detection -

With our 180cc ionization chambers and ultra low noise preamplifiers we are able to achieve a minimum detectable activity of :

1uCi/m³ (40kBq/m³) for HTO !
0.5uCi/m³ (20kBq/m³) for Noble gases !

THE SOLUTION

- Improved Response Time -

- Proven 180cc ionization chambers and ultra low noise preamplifiers combined with:
- Our new SAM – HTO separator which achieves very high efficiency separation of HTO and Noble Gases in <1 second.
- Response times < 1 minute to 90% of full value

THE SOLUTION

- Reduce Radioactive Wastes -

- Our new SAM – HTO separator employs a reuseable membrane requiring limited maintenance.

- No Silica Gel = No radioactive waste.

THE SOLUTION

- Plus -

- Qualified to the necessary Seismic requirements.
- Communicates with the existing plant computer systems via a standard protocol: Modbus.

SUMMARY

REQUIREMENT		Original	New	Improvement
Limit of Detection for HTO	kBq/m3	1160	40	Factor of 29
Response time	seconds	~1800	<60	Factor of 30
Radioactive Waste generated		Yes	No	☺
Seismically qualified		No	Yes	☺
Modbus communication to existing plant systems		No	Yes	☺

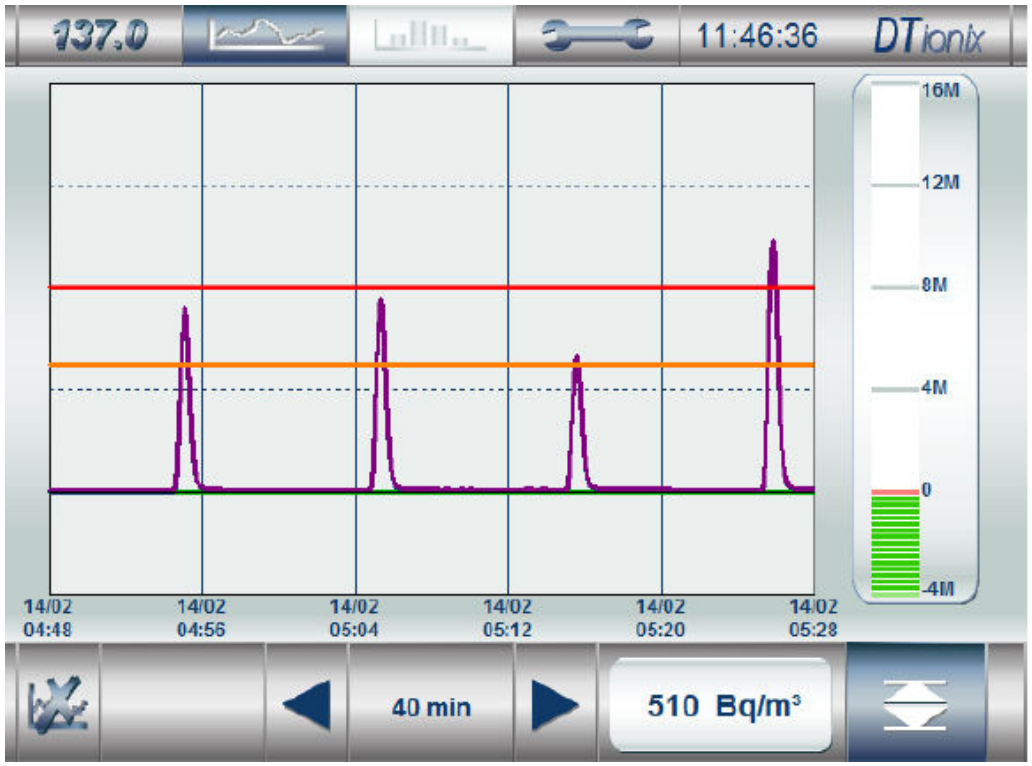
But what does this mean in the real world on plant

A LITTLE STORY

- The reactor has 4 pneumatic tubes for activation analysis.

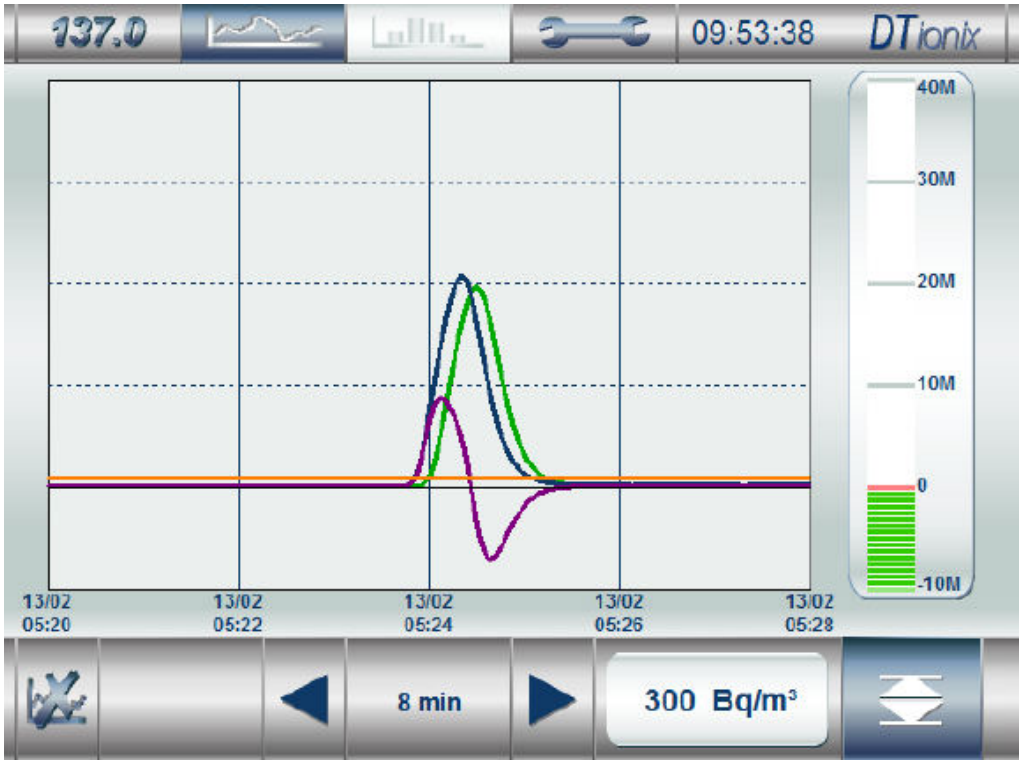
- Each morning these tubes are vented under the site discharge regulations.

^{41}AR VENTS AS SEEN BY THE NOBLE GAS CHANNEL

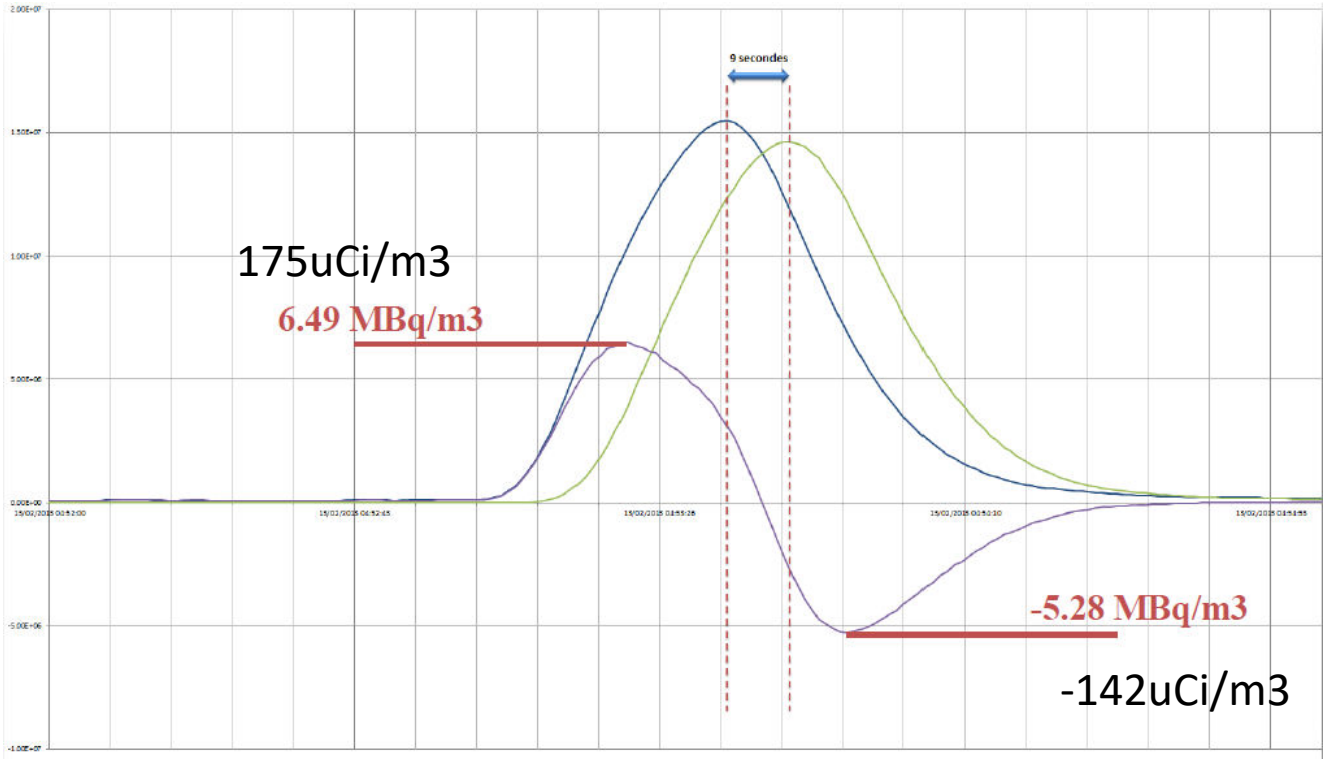


^{41}AR VENTS AS SEEN BY THE HTO CHANNEL

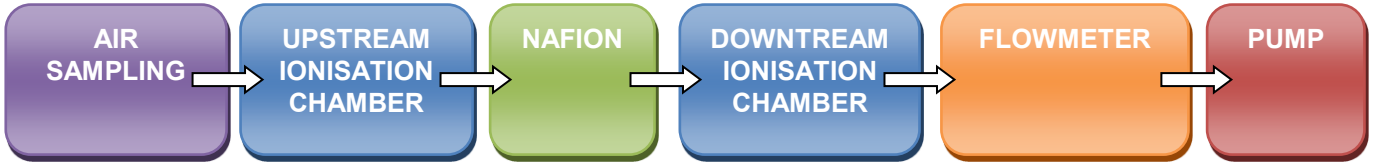
^{41}AR VENTS AS SEEN BY THE TWO HTO CHANNEL



IN A BIT MORE DETAIL



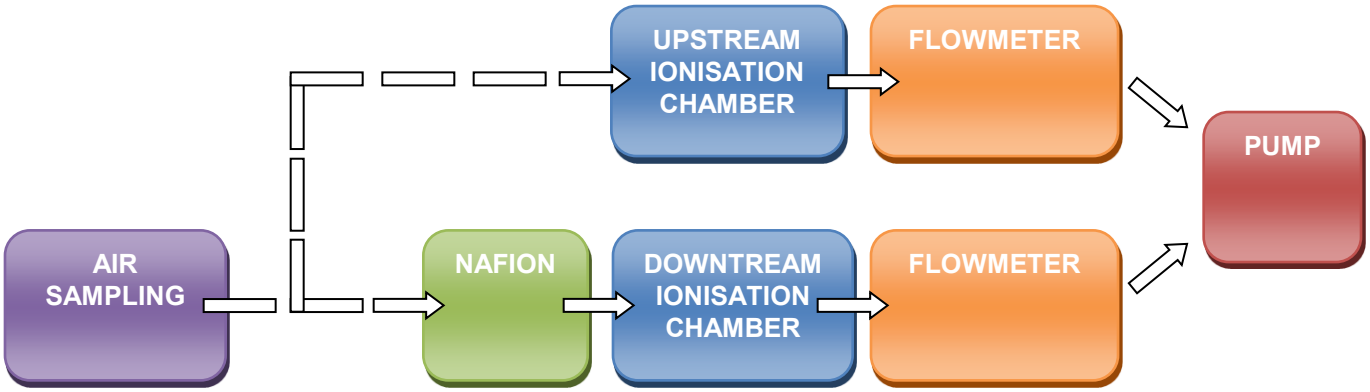
9 SECONDS – WHERE FROM?



- Fill 1st chamber
- Pass NAFION
- Fill 2nd chamber

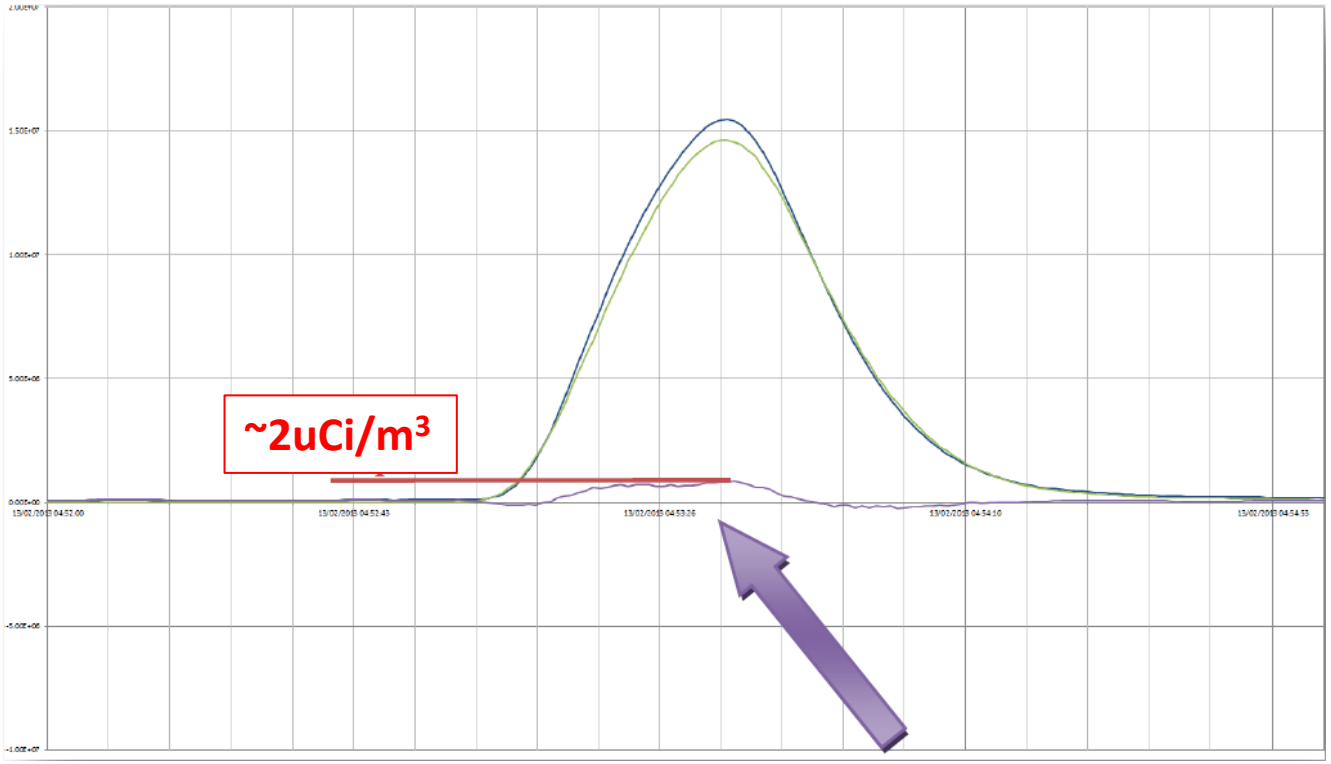
= 9 seconds delay

SLIGHT MONITOR MODIFICATION



- As the transition time for the noble gases through the Nafion is minimal
- By adjusting the flow in each leg
- Can sychronize the measurements

IN A BIT MORE DETAIL



CONCLUSION

- A basic measurement response for the derived measurement improved by nearly 30x
- HTO Limit of detection of the system improved by a factor of ~30.
- Accurate quantification of ^{41}Ar even for very short duration releases.
- Limited effect on the HTO measurement capability during these ^{41}Ar releases.