From Tokamak to Research Reactor: Replicating JET Water Activation Experiment at KATANA Facility

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CHALLENGE

- Replicate JET water-activation transients at KATANA.

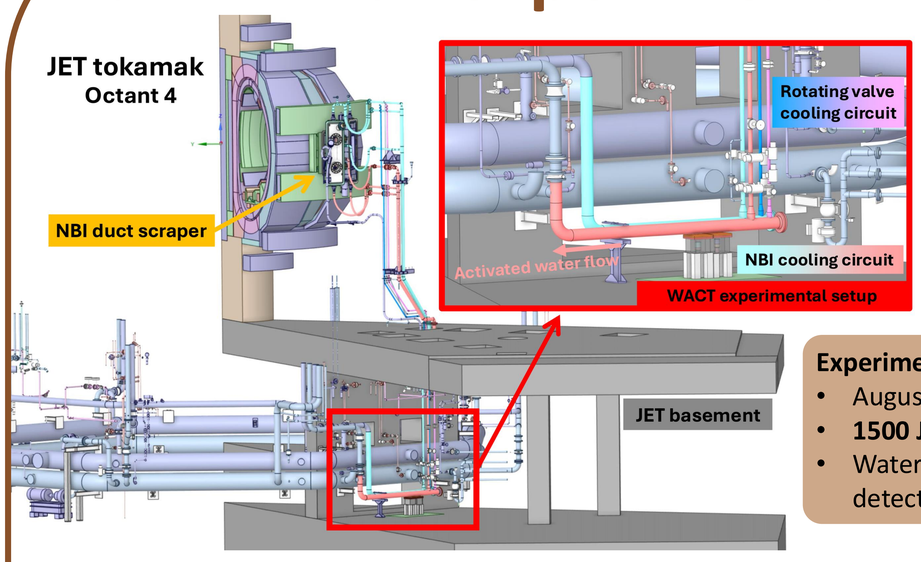
METHOD

- Compare JET and TRIGA pulse shapes and activation responses.

CONCLUSION

- KATANA can support ITER licensing and safe operation.

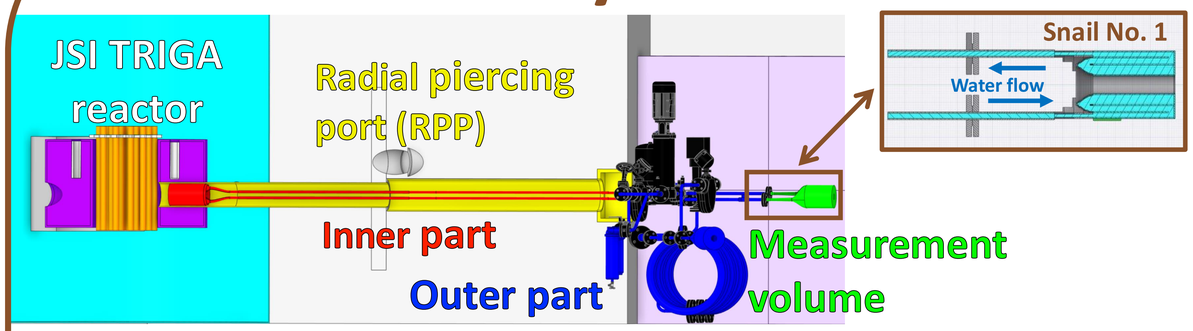
JET WACT experiment



Experiment in numbers:
- August - December 2023
- **1500 JET pulses** recorded;
- Water transit time to the detector ≈ **9.5 s**

DT neutrons primarily activate the cooling water through **^{16}O(n,p)^{16}N**. ^{16}N decays with a **7.13 s** half-life, emitting **6** and **7 MeV** gamma rays.
A **BGO** scintillation spectrometer was installed in the **JET basement**, Octant 4, directly beneath the **NBI water cooling pipe**, inside a 5 cm thick lead chevron enclosure with four 1.3 cm lead collimator plates (2x 5 mm and 2x 30 mm apertures).
The **JET KN1** diagnostic consists of three pairs of $^{235}U/^{238}U$ **fission chambers** and provides the time-resolved **neutron emission rate** during each plasma pulse.

KATANA facility



JSI TRIGA pulsed operation

The JSI TRIGA reactor can produce short, intense power pulses. The pulse profiles are measured using a **Cherenkov power meter**. For this experiment, pulses with inserted reactivities of **1.2 $** and **2.0 $** were used.



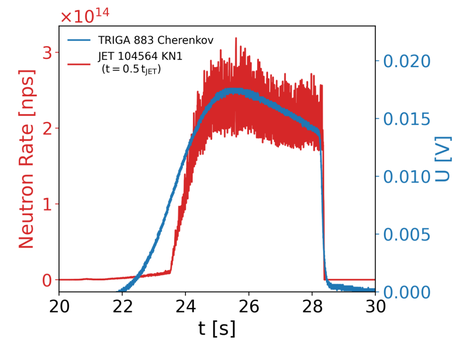
KATANA neutron emission measurement
The experiment was conducted during the stable irradiation scenario of KATANA, with a flow rate of **0.16 l/s**, using the JSI TRIGA reactor in **pulsed operation**. The neutron signal was measured inside Snail No. 1 with **^{3}He detector**.

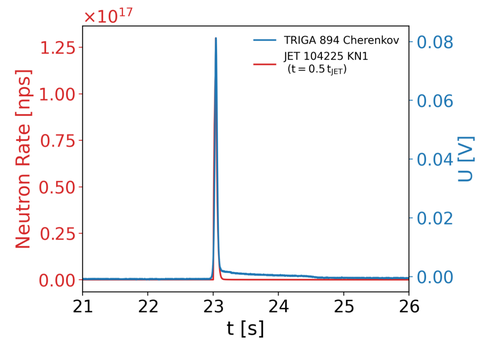
Neutron detector LND 25371	Preamplifier CAEN A1422	Digital MCA CAEN V1782	*Data acquisition CAEN COMPASS*

Experimental setup

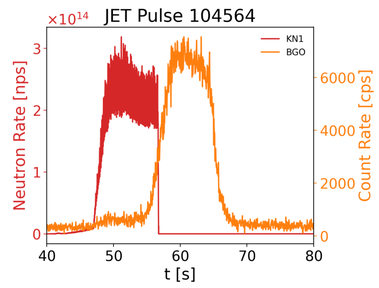
Results

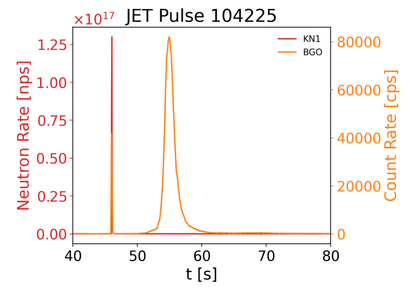
JSI TRIGA and JET pulse comparison
Selected TRIGA pulses reproduce the main temporal features of both short and long JET neutron-emission pulses. The comparison uses the **JET KN1** and the **TRIGA Cherenkov power meter**. The JET time axis was rescaled according to $t = 0.5 \cdot t_{JET}$.

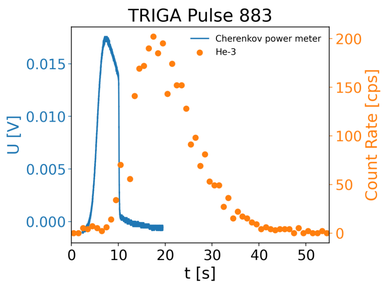


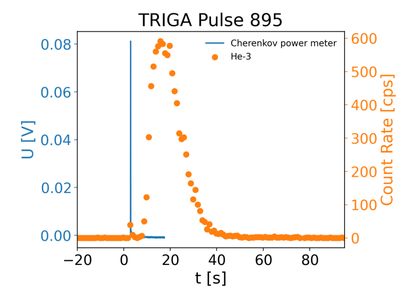


Water-activation response comparison
Both facilities exhibit a delayed water-activation response following the irradiation pulse as activated water reaches the measurement position. **Long and short pulse** show a distinct delayed maximum followed by a decreasing signal. KATANA exhibits a broader and more prolonged response, associated with its **snail-shaped measurement volume**.









Conclusions

- **JET-like water-activation transients can be investigated at KATANA.**
- **Future work will focus on using the same detector as in the JET DTE3 WACT experiment.**
- **KATANA can provide experimental data and validation relevant to the preparation, licensing and safe operation of ITER.**

Acknowledgement

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