Water activation experiments under fusion-relevant conditions at the JSI TRIGA research reactor: design and implementation of the JSI water activation loop systems

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CHALLENGE

- Benchmark quality fusion relevant water activation experiments
- Well-defined gamma source
- iter relevant neutron source

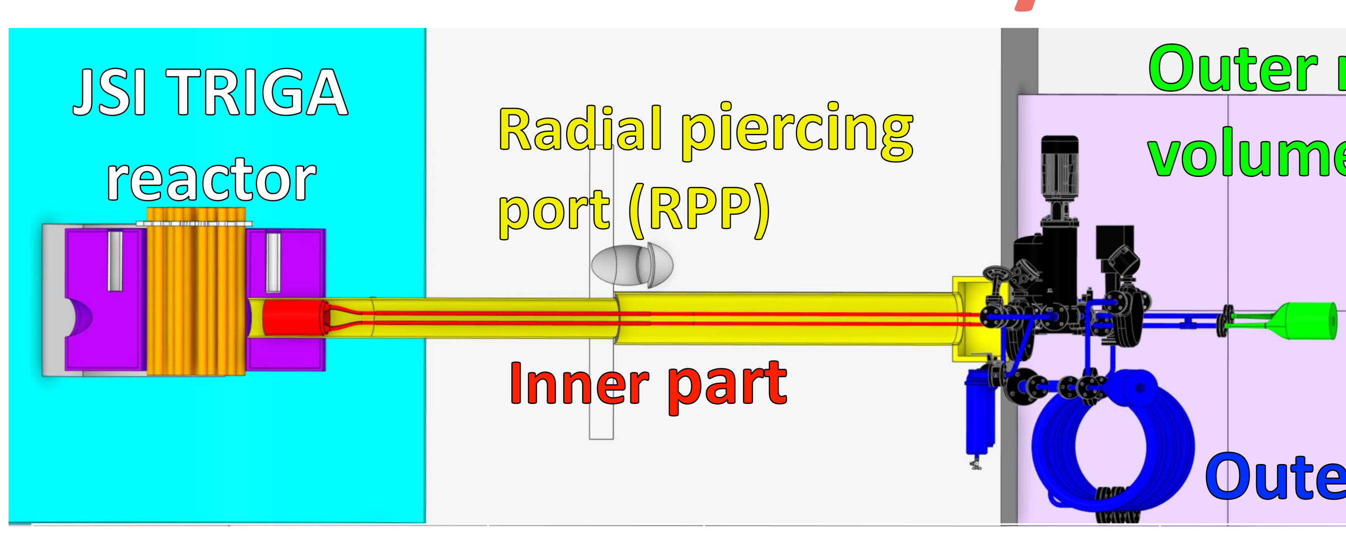
METHOD

- Flexible experimental device
- Precise monitoring and control system
- Two irradiation positions
- Well-defined experimental setup

CONCLUSION

- Fusion-relevant research on water activation
- Controlled experimental conditions
- High flexibility for different experimental setups

KATANA water activation irradiation facility



Reaction	$t_{1/2}$	Major decay products	Threshold energy	Natural abundance
$^{16}O(n, p)^{16}N$	7.13 s	γ: 6.13 MeV (67%) γ: 7.12 MeV (5%)	≈ 10 MeV	99.76%
$^{17}O(n, p)^{17}N$	4.17 s	n: 0.38 MeV (35%) n: 1.17 MeV (53%)	≈ 8 MeV	0.04%
$^{18}O(n, \gamma)^{19}O$	26.9 s	γ: 0.20 MeV (96%) γ: 1.36 MeV (50%)	< 1 eV	0.2%

Water activation in fusion devices several orders of magnitude higher than in nuclear fission reactors. Due to the linearity of the transport equation, the results obtained can be scaled to fusion-relevant conditions.

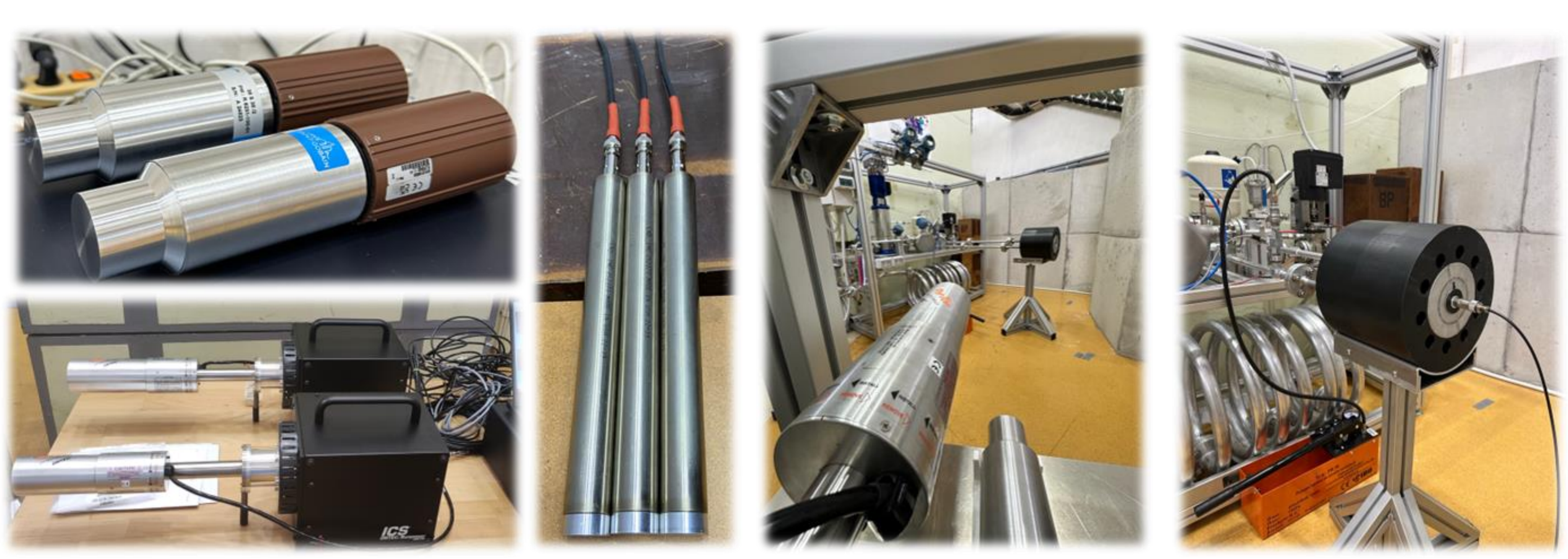
Experimental systems

Gamma detectors

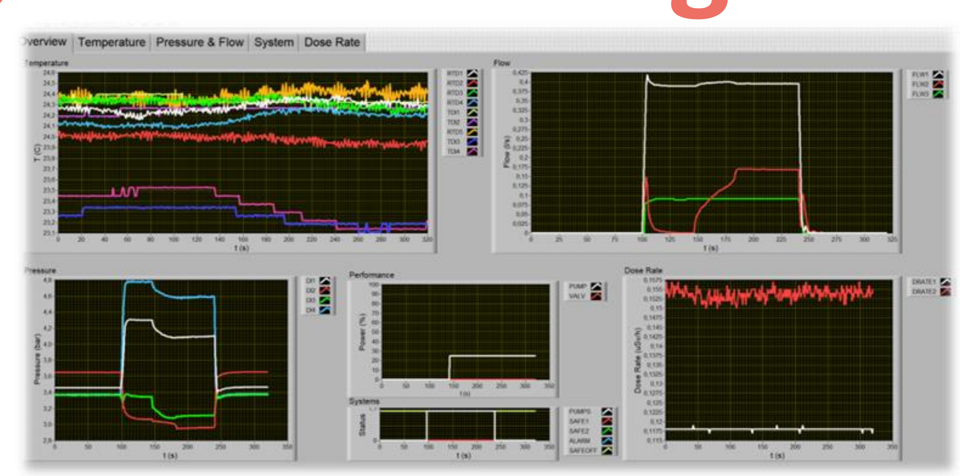
- 2x High Purity Germanium semiconductor detector (HPGE)
- 2x Lanthanum Bromide scintillation detector (LaBr)

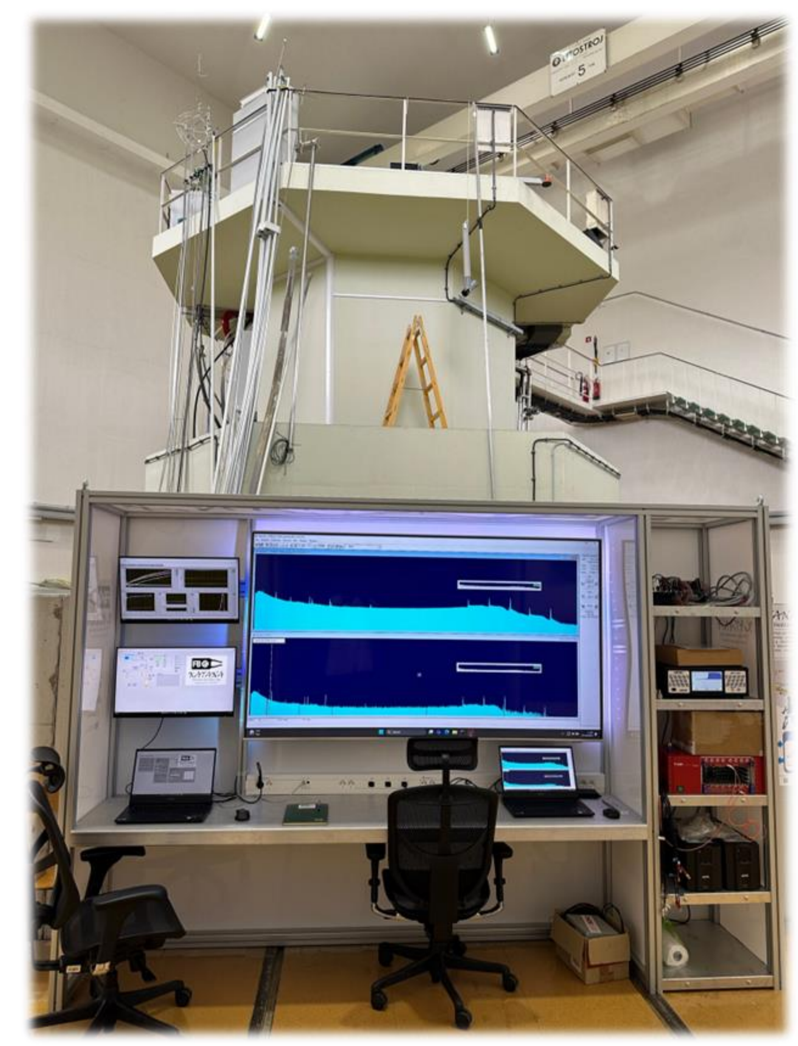
Neutron detectors

- 4x ^{3}He gas filled detector
- 4x BF_3 gas filled detector
- 1x Fission chamber (^{238}U)
- 1x Fission chamber (^{235}U)



Monitoring and control





Diagnostics

- 9 × Temperature sensor
- 4 × Pressure sensor
- 3 × Flow rate sensor
- 3 × TLD passive dose rate monitor
- 1 × Dose rate monitor

- **CompactRIO platform**: Online high-performance control and monitoring system.
- **Integrated sensors:** Monitors temperature, pressure, and flow rate with precision.
- **Flow control:** Adjustable pump and 3-way valve control the circuit flow.
- **Large Experimental Area:** Provides ample space for various experimental set-ups.

Conclusions

- **Water Activation Significance:** Water activation plays a key role in both fission and fusion reactors, leading to the production of short-lived radioisotopes that emit high-energy gamma rays and neutrons.
- **Experimental Flexibility:** The facility supports a wide range of experiments, including detector calibration, shielding studies, and validation of computational models.
- **Impact on Fusion Research:** By providing high-quality experimental data, the facility contributes significantly to the development of safer and more efficient fusion reactor technologies

Acknowledgement

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Contact info: