

Fusion Neutronics Meeting 2025: ITER and beyond

Neutron-Based Characterization of the KATANA Activation Loop Using JSI TRIGA Reactor Pulsed Operation

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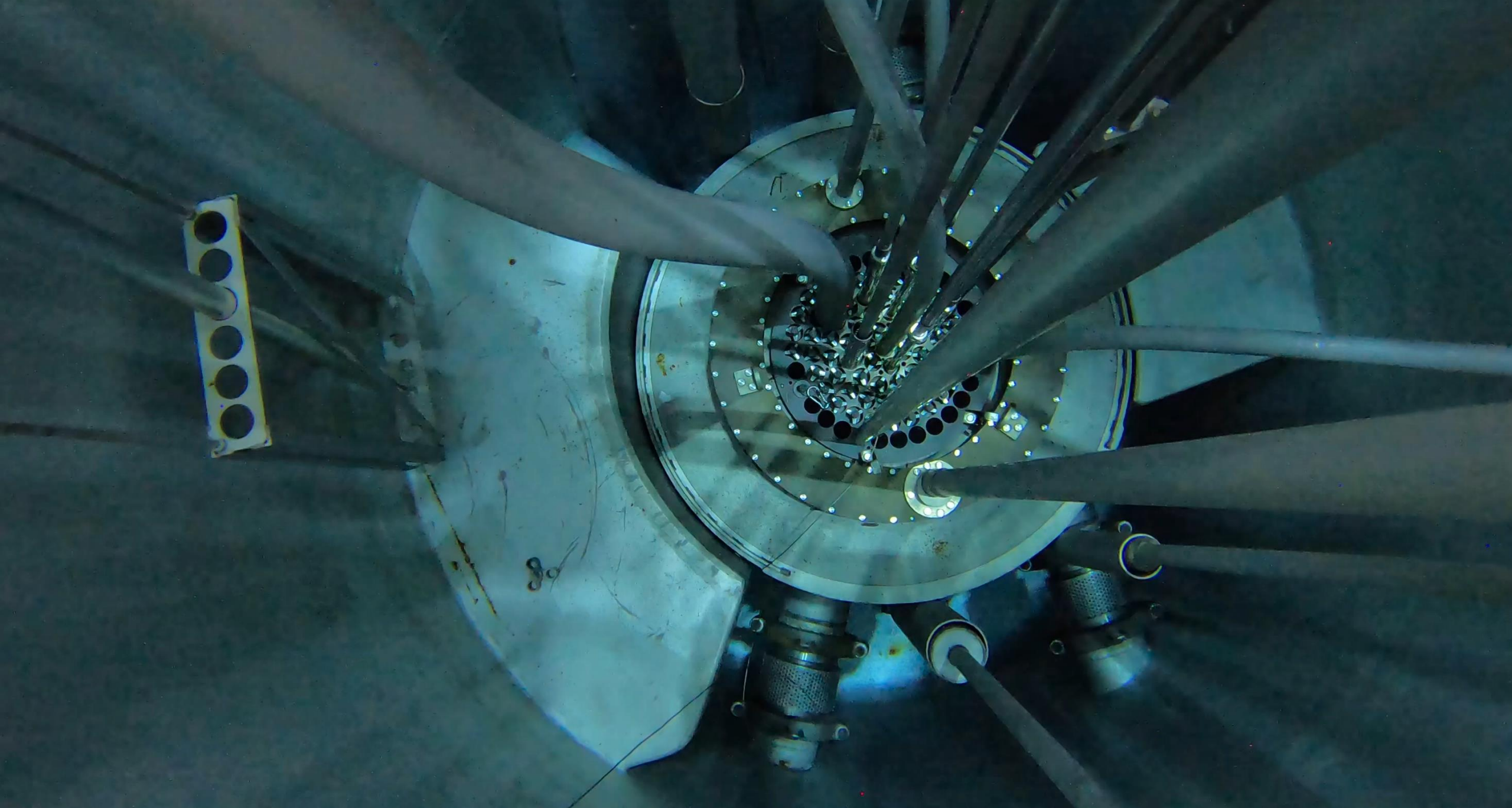
Introduction

Water activation process

- Short – lived radioisotopes
 - High energy gamma and neutrons
- Water activation in fusion devices several orders of magnitude higher than in nuclear fission reactors

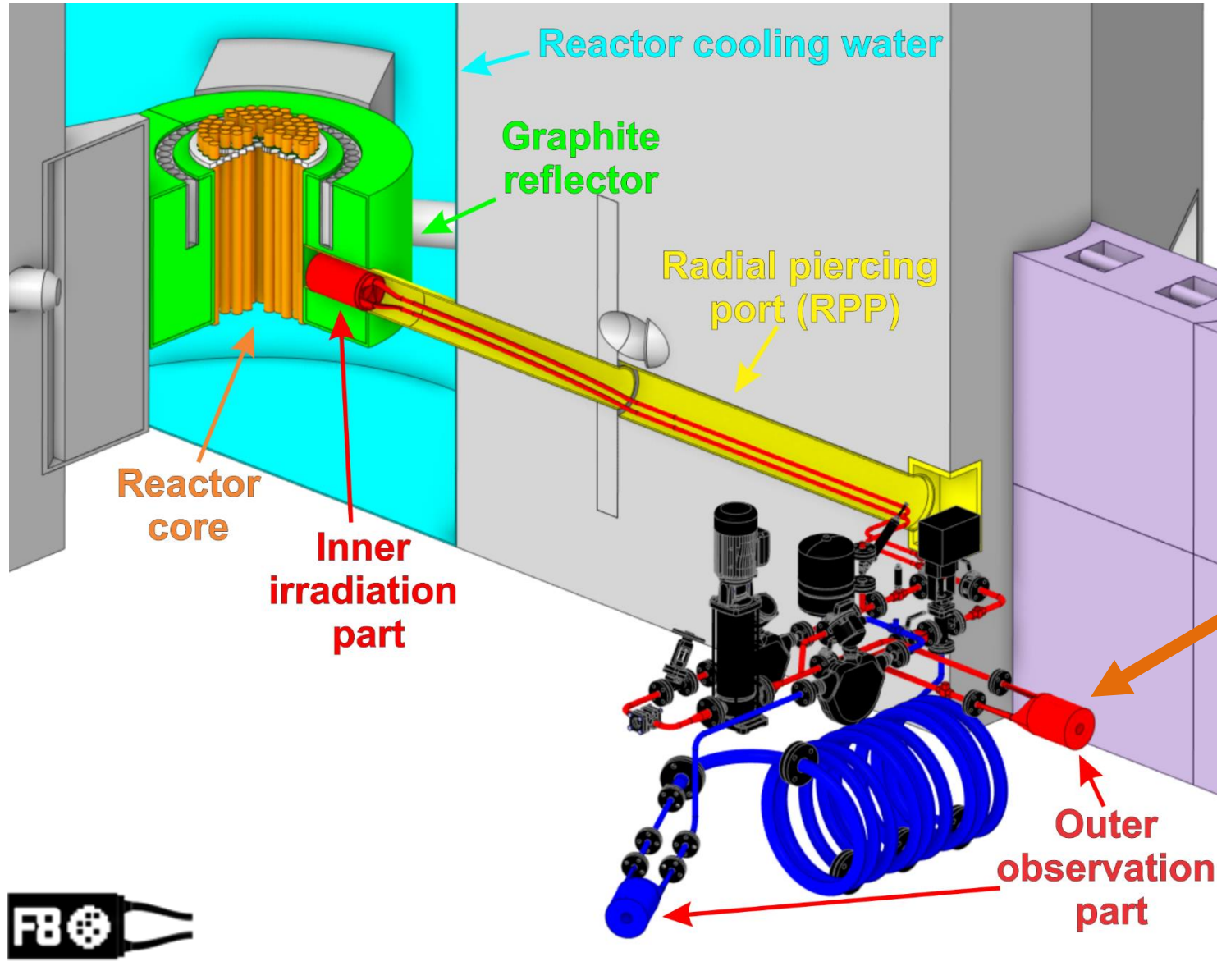
Reaction	$t_{1/2}$	Major decay products	Threshold energy	Natural abundance
$^{16}\text{O}(n, p)^{16}\text{N}$	7.13 s	γ : 6.13 MeV (67%) γ : 7.12 MeV (5%)	≈ 10 MeV	99.76%
$^{17}\text{O}(n, p)^{17}\text{N}$	4.17 s	n: 0.38 MeV (35%) n: 1.17 MeV (53%)	≈ 8 MeV	0.04%
$^{18}\text{O}(n, \gamma)^{19}\text{O}$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



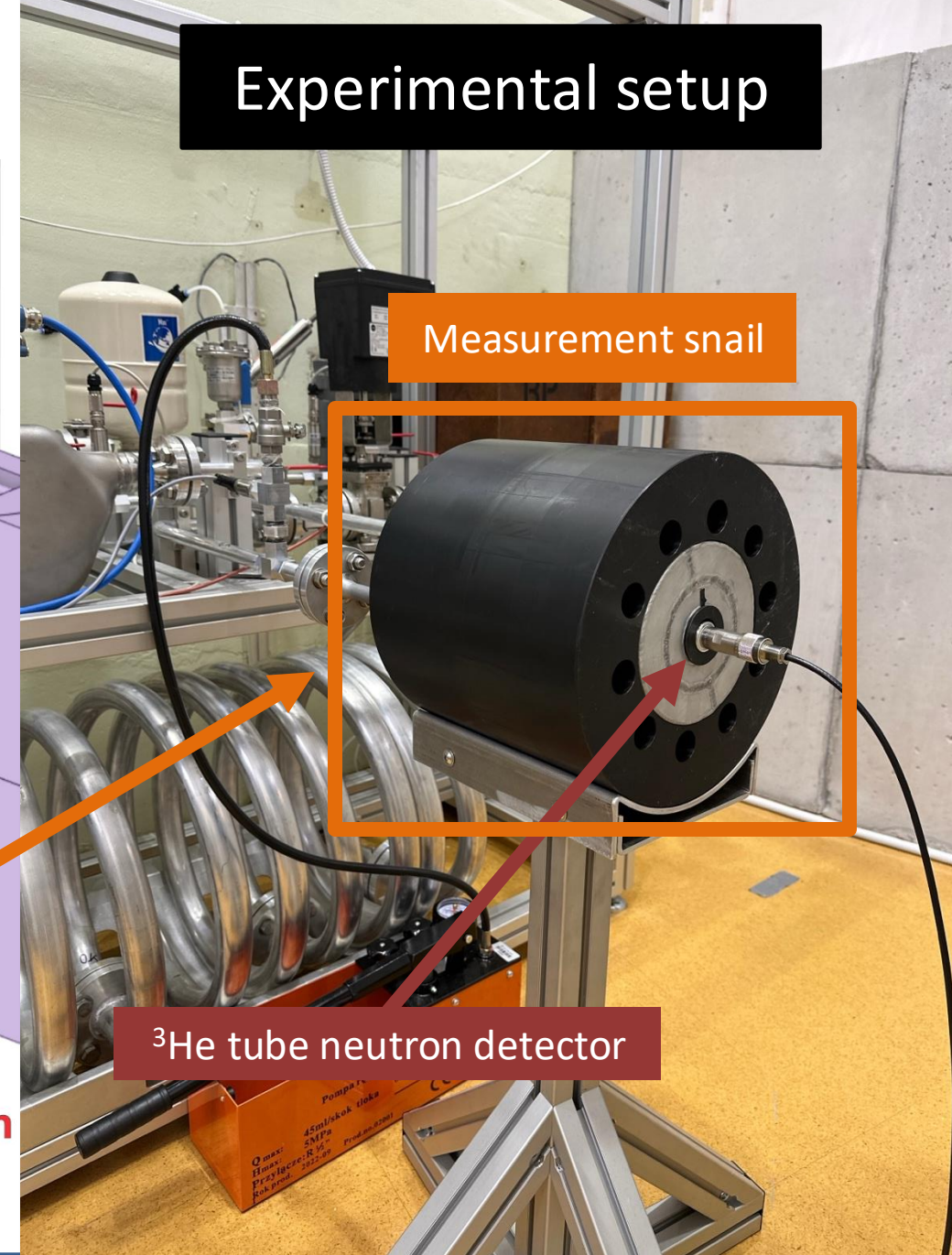




KATANA water activation facility



Experimental setup





KATANA response to reactor pulse

JSI TRIGA pulse recorder

- Uncompensated ionization chamber

Constant flow rate (FLW1)

- Coriolis flow meter

Neutron measurement system

- LND ^3He tube detector
- CAEN Preamplifier (A1422)
- CAEN MCA (V1782)

KATANA simulation

- Analytic approach – uniform volume elements ($V = 21.65 \text{ ml}$)
- Specific activity calculated at every time step
- Discrete step transport

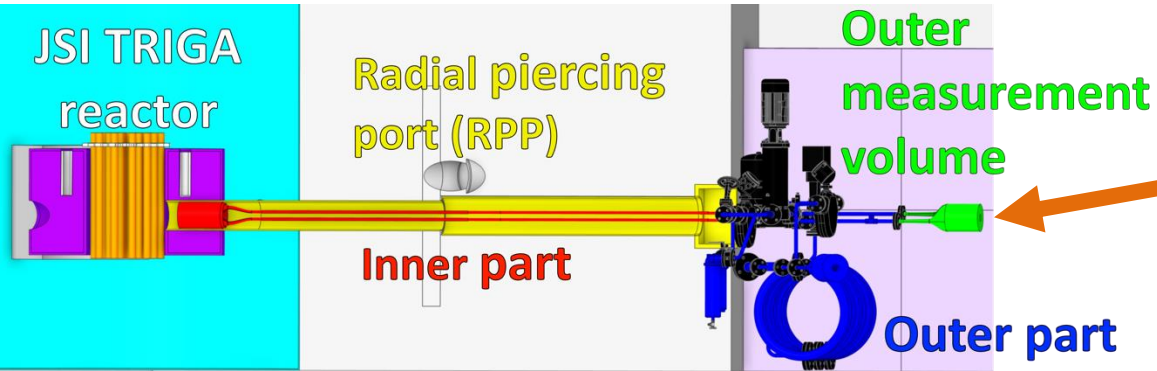
$$A'_{t+\Delta t} = A'_t e^{-\lambda \Delta t} + R(1 - e^{-\lambda \Delta t})$$



JSI TRIGA MCNP model: $R = \int \Phi(E) \sigma(E) N dE$



KATANA response to reactor pulse



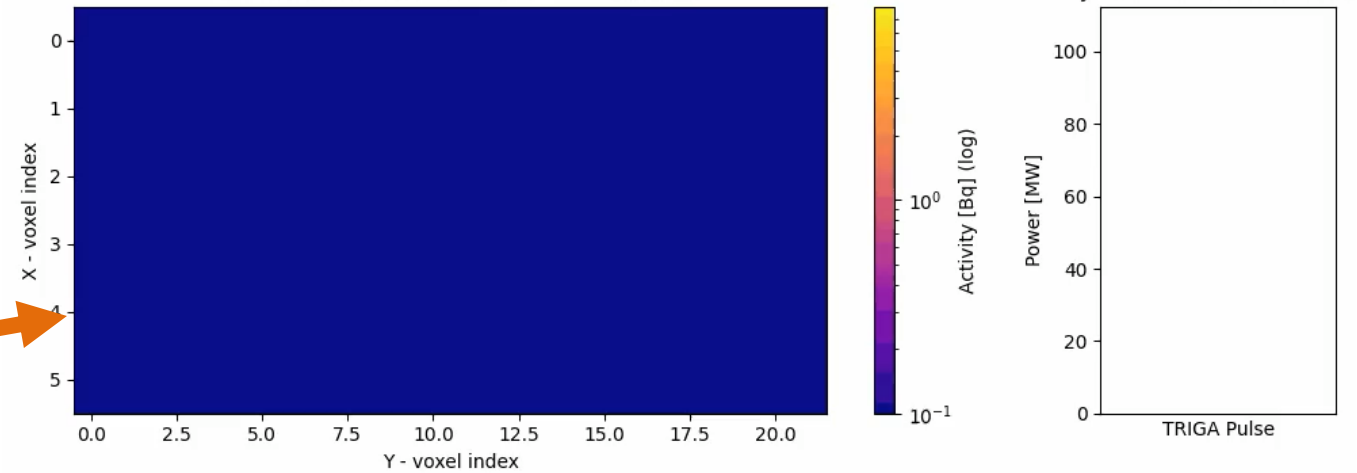
Measurement snail

- 2D top view representation of the Outer measurement volume used for the simulation

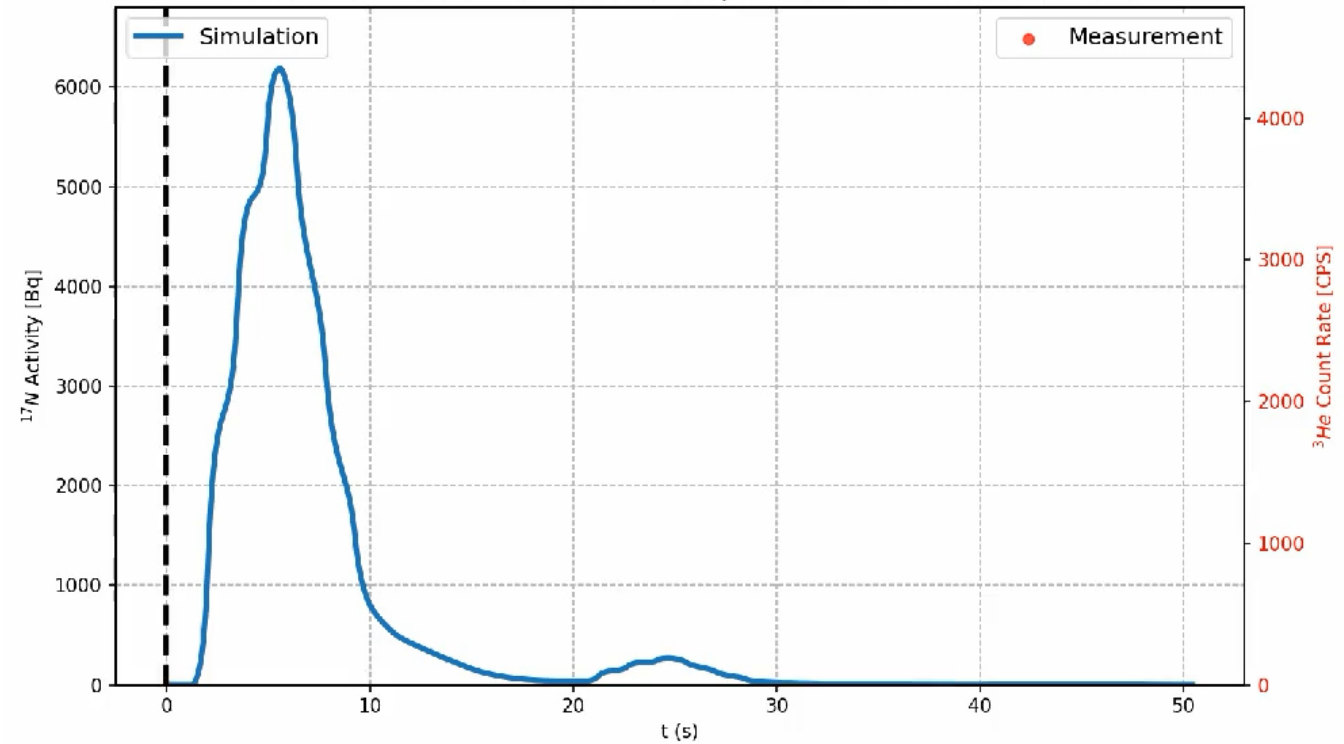
JSI TRIGA Pulse recorder signal used as an input for the simulation



Measurement snail: ^{17}N @ $t = 0.00$ s



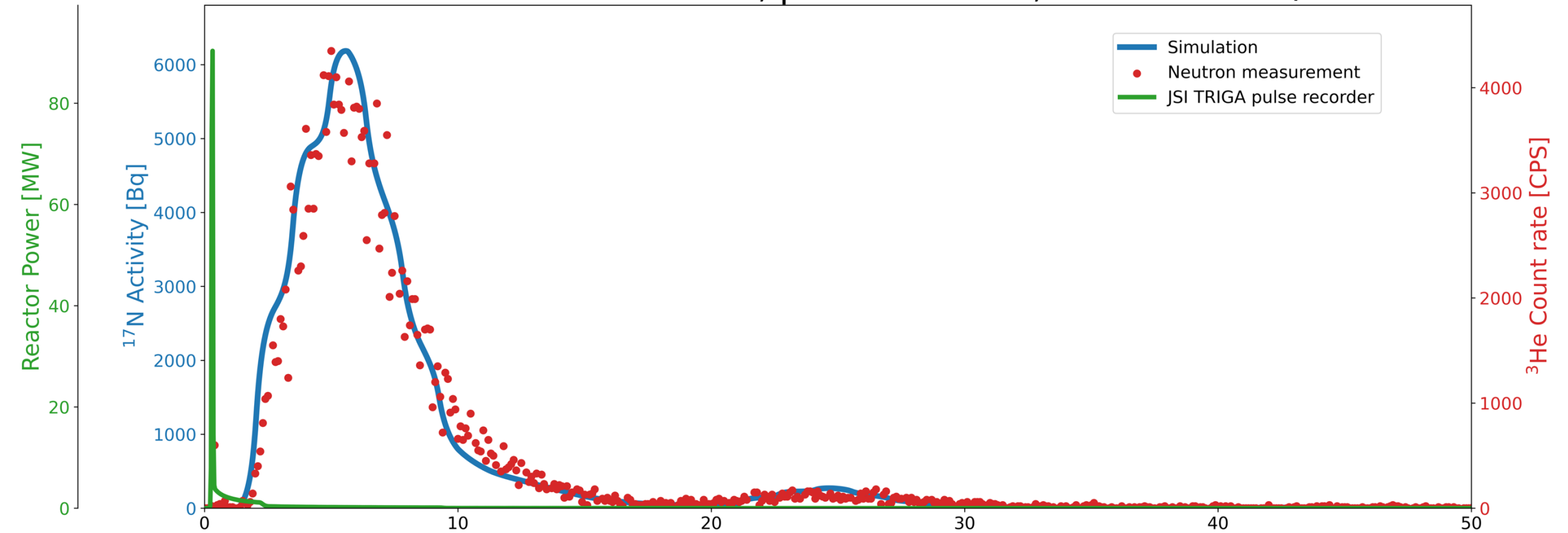
Measurement snail: ^{17}N @ $t = 0.00$ s, pulse ID = 774, FLW1 = 0.66 l/s





KATANA response to reactor pulse

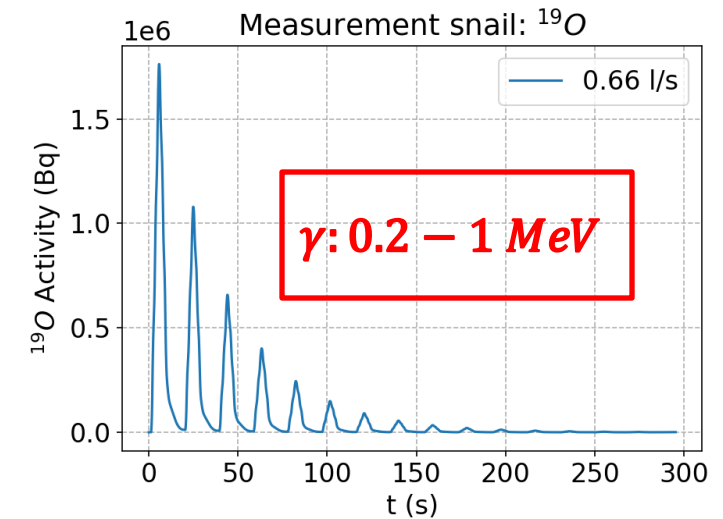
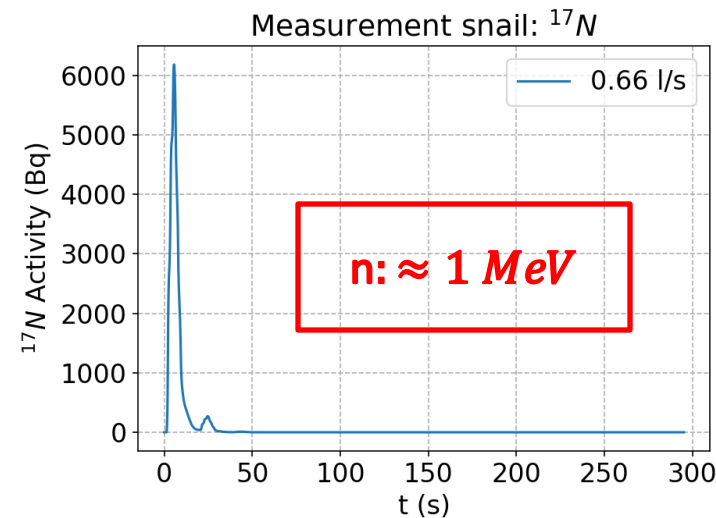
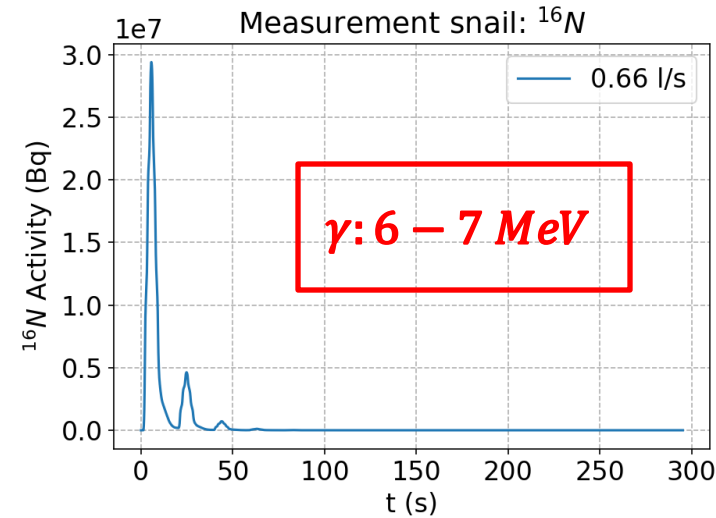
Measurement snail: ^{17}N , pulse ID = 774, FLW1 = 0.66 l/s





Conclusions

- KATANA simulation tool can predict the response of the system
- Neutron measurements match the simulation
- KATANA is volumetrically well characterized
- FUTURE:
 - Compare the KATANA simulation tool with ^{16}N and ^{19}O gamma signal
 - Compare presented results with computational tools developed for ITER





Cutting the boundaries between fission and fusion