PISTIL, A reactivity modulation device to probe the transfer function of the research nuclear reactor CROCUS

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ABSTRACT
The PISTIL device targets the determination of precursor abundances by reactivity modulation. We here present its design and testing in the CROCUS reactor at EPFL. It is capable of generating periodic modulations between 1 mHz and 200 Hz. The modulation can either be continuous or following a predefined motion profile. Thanks to the mechanical design, its reactivity worth and modulation amplitude are tunable.

MOTIVATIONS

IMPROVED REACTOR KINETIC PARAMETERS
- Uncertainty and bias reduction in delayed neutron parameters for better reactivity estimate in reactor operation and safety studies
- Towards improved knowledge of delayed neutron data and validation of calculation models

ZERO-POWER TRANSFER FUNCTION (ZPTF)
- Reactor response to reactivity perturbations
- Frequency-dependent sensitivity in delayed and prompt neutrons
- Development of a reactivity modulation device to generate controlled modulation covering frequency ranges of interest (<4 mHz to ~100 Hz)
- Mechanical qualification and reactivity calibration
- Fourier analysis of neutron flux variations resulting from modulation

EXPERIMENTAL APPROACH
- Generation of a reactivity modulation device to probe the transfer function of the CROCUS reactor at EPFL. The PISTIL is capable of generating periodic modulations between 1 mHz and 200 Hz. The modulation can either be continuous or following a predefined motion profile. Thanks to the mechanical design, its reactivity worth and modulation amplitude are tunable.

CROCUS REACTOR
- Pool type light water reactor
- Maximum power of 100 W
- Reactivity control by B4C rods or spillway (in-core water level variation)
- Interlocked fuel zones of 1.806 wt.% UO2 lattice and 0.947 wt.% UO2 lattice
- Active core of 86 cm in diameter and 1 m in height
- PISTIL inserted in the core center

PERIODIC REACTIVITY INJECTION SYSTEM TRANSIENT INDUCED LOCALLY (PISTIL)

CONCLUSION AND PERSPECTIVES
- PISTIL: a device allowing controlled and known in-core reactivity modulation for zero-power transfer function measurements
- Contribution to consistent and accurate kinetic parameter evaluation through experimental investigation
- First experimental campaign in CROCUS conducted from May to June 2021, modulation frequency ranging from 1.6 mHz to 200 Hz
- Second experimental campaign planned in Autumn 2021, benefiting from early analysis and using updated neutron detection instrumentation