REACTIVITY MEASUREMENTS IN ACCELERATOR DRIVEN SYSTEMS APPLYING NOISE ANALYSIS TECHNIQUES

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INTRODUCTION

Both pulse counting techniques and continuous current measurements have been applied in the MASURCA subcritical fast reactor driven by the GENEPI pulsed neutron source in order to get the prompt neutron decay constant. The data from the pulse counting experiments were analysed using noise techniques: cross-correlation and Feynman-α. The data from the continuous current measurements were analysed by calculating the Cross Power Spectral Density.

DESCRIPTION

The safe operation of Accelerator Driven Systems (ADS) requires the development of methods to monitor the subcriticality of the reactor. Within the Fifth European Framework Programme, the MUSE project was initiated to investigate the applicability of zero-power noise methods to measure kinetics parameters like the prompt neutron decay constant of a subcritical reactor driven by an accelerator. To this end, at CEA/Cadarache the GENEPI deuterium accelerator developed by CNRS (operating either with a deuterium or tritium target) has been coupled to the MASURCA fast reactor loaded with MOX fuel.

In this new facility measurements were performed at two different subcritical states, depending on whether or not the pilot rod (a polyethylene block) was inserted. The worth of the pilot rod during the measurements was about -124 pcm, and the reactivity value given by CEA at SC0 configuration with the pilot rod inserted (up) was about -455 pcm. The effective delayed neutron fraction β and the neutron generation time Λ used in the analyses were calculated by the FX2 diffusion code and compared with the values giving by others.

In the ADS scenario, new theoretical formulations of the noise techniques has been developed for the Feynman-α, while we derived formulas for the transfer function or the Rossi-α. We compare the three techniques with measurements performed during the MUSE project. The data presented in this paper was measured using the tritium target and a pulsing frequency of 1KHz for the source.

DISCUSSION

The Cross correlation considering only one source pulse per time window reads:

\[
C_{DD}(\tau)d\tau = \frac{\varepsilon_1^2 \varepsilon_2}{\alpha \Lambda} \left( \frac{F_T}{\alpha \Lambda} (\nu - 1) \right) \exp(-\alpha|\tau|) d\tau
\]

The alpha values obtained from this technique were 13598 ± 185 s⁻¹ when the pilot rod was up and 15752 ± 179 s⁻¹ with the pilot rod down. From figure 1 we conclude that using the correlation technique we can easily discriminate reactivity differences of –120pcm.