# Validation of sub-criticality monitoring techniques for the MYRRHA ADS

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## Abstract

In order to support the development of the MYRRHA ADS, the Belgian Nuclear Research Centre SCK•CEN initiated the GUINEVERE program (2007-2011, within the 6th Framework programme of the European Commission). A zero-power thermal VENUS reactor was transformed into a fast VENUS-F reactor using solid lead as a coolant simulator. The following FREYA project (2011-2016, FP7) was dedicated to the coupling of the VENUS-F reactor to the GENEPI-3C accelerator (developed by the French research centre CNRS) that can be operated in a pulsed, continuous or beam trip mode (i.e. continuous beam with short, regular interruptions). Various techniques for sub-criticality monitoring were extensively investigated in a large number of the VENUS-F reactor core configurations (-4$ to -18$). The source jerk method during the beam trip mode of the accelerator operation has been identified as an appropriate candidate for the sub-criticality level measurement in the MYRRHA core loading/start-up phase. During nominal operation of the MYRRHA ADS the current-to-flux method will be continuously applied for relative monitoring of the sub-criticality level and can be calibrated from time to time applying the source jerk method.

Within the ensuing MYRTE project (2016-2017, Horizon2020) the selected techniques were further refined for the application in MYRRHA by modifying the VENUS-F reactor core to be representative to the latest version of the MYRRHA design (i.e. presence of reflector and In-Pile Sections) and the impact of the instrumentation was investigated (detector deposit and detector positioning in the core and reflector).

In the follow-up SCK•CEN+CNRS MYRACL project (2017-2019), GENEPI-3C was operated in two special regimes. First, random beam trips were added into the regular beam time structure, which simulated short beam intensity variations (~1-100 □s) that can occur rather often with a LINAC such as the one to be used for MYRRHA. The sensitivity of the source jerk technique to such unwanted, aperiodic beam glitches was tested. Second, the accelerator worked in the beam trip mode with a very low duty cycle factor (≈2%), which is planned to be applied during the MYRRHA start-up. For this purpose a deeply sub-critical VENUS-F reactor core was loaded (-30 $), which also served testing the source jerk technique reliability under limit conditions.

Some key results of 2011-2019 activity in the frame of the projects are presented.