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Novel Multiplexing Techniques for Advanced Instruments at Long Pulsed Spallation Source

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Abstract

Novel multiplexing techniques, such as Repetition Rate Multiplication [1] and Wavelength Frame Multiplication [2] help to solve the main challenge in the instrument design at the future European Spallation Source: how to take full advantage of the high neutron peak flux and at the same time provide high instrumental flexibility. The underlying principle of multiplexing techniques is to use a set of monochromatic wavelengths or a set of wavelength bands coming from the same source pulse by means of mechanical chopper system. In this case the instrumental parameters, such as wavelength resolution, wavelength band, repetition rate are not any more determined by the source pulse parameters, but can be flexibly defined by the chopper frequency, speed and chopper pulse. With other words, multiplexing techniques, allow us to create instead of one long pulse a number of mini-pulses with variable frequencies and pulse lengths but with the same peak flux as original pulse.

With the help of unconventional use of existing time-of-flight instruments at continuous reactor sources we have recently experimentally implemented Repetition Rate and Wavelength Frame Multiplication techniques and tested several variants of the multiplexing chopper system. These experiments practically established the basic “quantized” design rules of multiplexing chopper systems and provide full proof of principle of these methods. Repetition Rate Multiplication (RRM) enhanced data collection rates by up to an order of magnitude, including the quality and breadth of the information collected in a single RRM experimental run [3]. Furthermore, it allowed us to select the pulse repetition rate at the sample essentially independently of the frequency of a pulsed source. The Wavelength Frame Multiplication (WFM) variant of the RRM approach was found to provide unrestricted capability for flexible pulse shaping for high and variable resolution diffraction at long pulse sources, overcoming the conventional wavelength band limitations due the source pulse parameters [4],[5]. The results show constant TOF resolution and unperturbed spectral distributions, fully comparable to the common single wavelength frame operation of pulsed source diffractometers, even for every single source pulse. This study also included the first successful experimental realization [5] of phase slewing, asynchronous pulse shaping chopper operation for diffraction work on a pulsed source, which makes a long pulse source to fully behave like an ideal short pulse source with flexibly adjustable and ideally shaped sharp pulses.

References:

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