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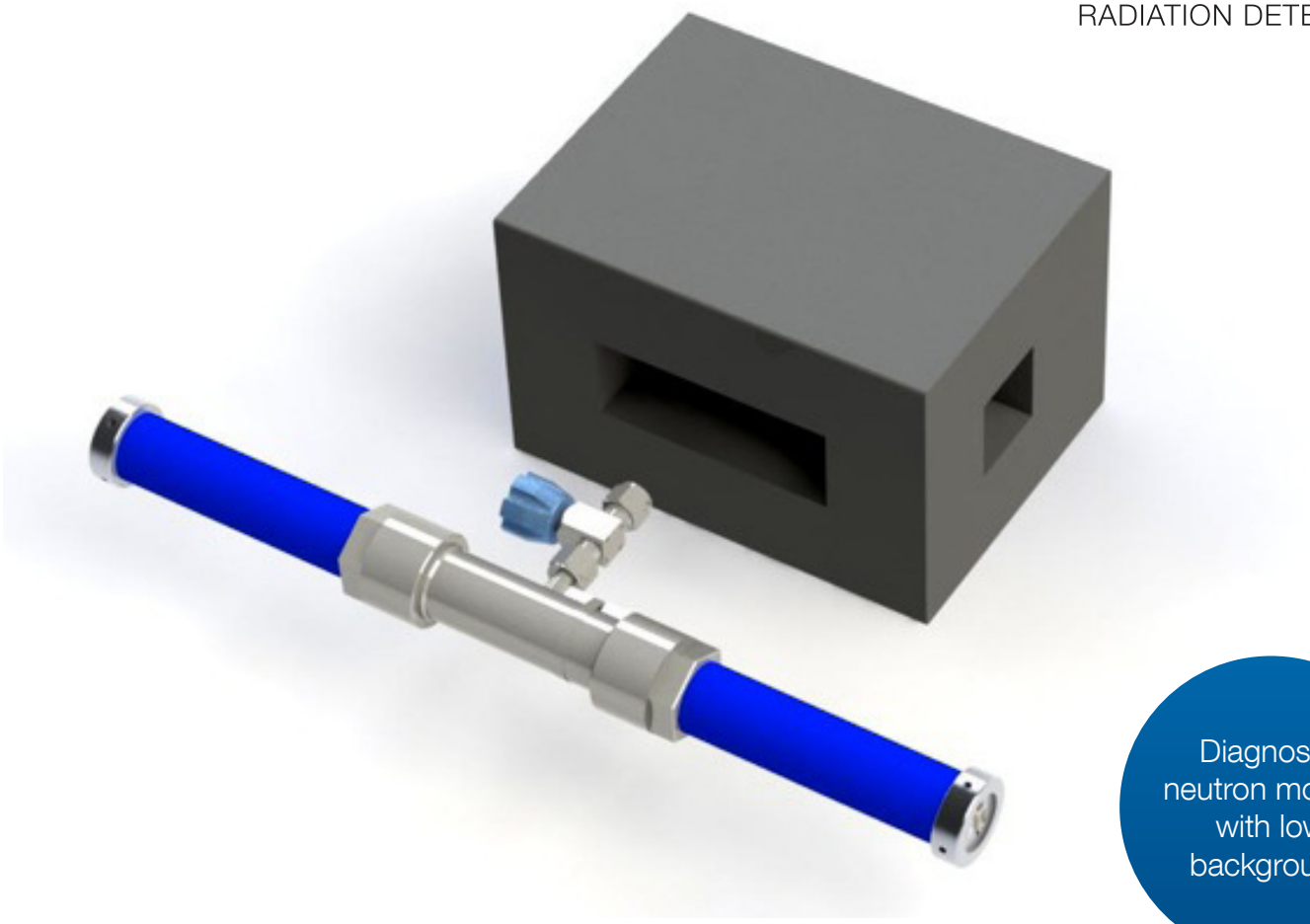
RADIATION DETECTORS



Diagnostic neutron monitor with low background

Neutron Spectral Monitor

Real-time fast neutron monitoring tool

The Neutron Spectral Monitor is a diagnostic tool that enables measuring, monitoring and analyzing fast neutron fluxes.

Key Features

- Directional and isotropic measurements of fast neutron fluxes
- Neutron source identification
- Neutron rate above a given configurable energy threshold
- Low background operation
- Operation even in gamma fields up to and beyond 400 µSv/hr
- Configurable trigger logic

Capabilities & Applications

- Monitoring and identifying neutron background
- Measure fast neutron background rates, for example in underground physics environments
- Measure neutron rates above configurable threshold
- Measure time correlation between fast neutron events to identify cosmic spallation events
- Assess fast neutron flux and obtain fast neutron spectrum through spectral unfolding
- Suited for fast neutron dosimetry, combined with gamma dosimetry
- Time-of-Flight measurements with TTL external trigger

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System

The Neutron Spectral Monitor consists of the following components

- Up to four Arktis ^{4}He fast neutron detectors including high voltage power supply
- Polyethylene collimator for each detector
- Arktis WaveDREAM B-8 high-speed digitizer
- Laptop computer running Arktis' N-Monitor control software, including Graphical User Interface and analysis tools

The Neutron Spectral Monitor is available with one, two or four detectors. As an example see Figure 1, which consists of two fast neutron detector systems with removable collimators.

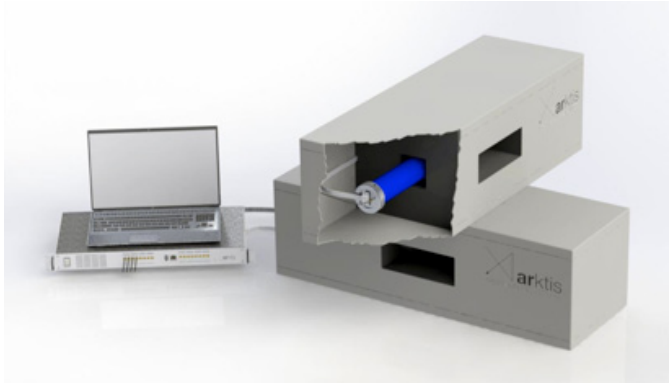

Figure 1: A full system of two fast neutron detectors with collimators, pointing in two directions.

Description

The Neutron Spectral Monitor can perform both isotropic as well as directional fast neutron flux measurements. Directional measurements are made possible by the supplied polyethylene collimators. The user controls the measurement from the laptop based N-Monitor control software, which allows to monitor fast neutron count rates and study the response spectra. The software is configured to accommodate up to four detectors that all plug into the common digitizer. The WaveDREAM B-8 offers nanosecond time synchronization between detectors. Exploiting this functionality, the operator can use the N-Monitor analysis software to study time correlation and identify correlated effects such as ship effect neutrons, or monitor fission multiplicities. Users can access the measurement data to perform spectral unfolding and further offline analysis on signals.

The Neutron Spectral Monitor uses scintillation detectors based on ^{4}He. Neutrons are detected via elastic scattering interactions causing helium recoils. Helium is well-suited for this application: due to its low charge density, gamma interactions are unlikely. Furthermore, the gas offers powerful pulse shape discrimination against the remaining gamma background. As opposed to thermal neutron detectors, no moderator is needed. Not only does this enable obtaining timing precision of the order of nanoseconds, it also allows using a collimator for directional measurements and to obtain spectral information. In the experiments performed, the scintillation light yield was found to be a linear function of the energy deposited, and the same yield was obtained for neutron and gamma events. Enabled applications that exploit neutron rates above a given threshold are described in reference [1] and [2].

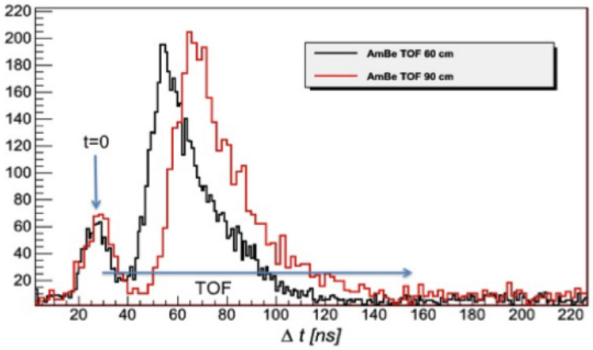

Figure 2: The Time of Flight (TOF) spectra of an AmBe source at different distances are shown. Fast response gamma detectors plugged in the WaveDREAM digitizer are used to tag the gamma in coincidence with the AmBe (alpha,n) reaction. The time difference between the detection of the gamma and the neutron in the ^{4}He detector defines the TOF and velocity of the neutrons.

[1] D. Murer et al. 2011 He-4 detectors for mixed oxide (MOX) fuel measurements, IEEE Nucl. Sci. Conf. R. 4858
[2] U. Gendotti et al. 2012 Active SNM detection with He-4 scintillators, SORMA WEST 2012. 5P-24

Specifications	
Arktis ^{4}He Fast Neutron Detector	Length: 71 cm, Diameter: 5.2 cm Sensitive Volume: 4.4 cm diameter x 19 cm length, Weight: 6 kg
8 cm Thick Polyethylene Collimator	Length: 35 cm, Height: 23 cm, Width: 23 cm, Weight: ~15 kg
Arktis Wave-DREAM B-8 Digitizer	Width: 270 mm, Height: 60 mm, Length: 489 mm Maximum cable length to detectors: 25 m
Laptop, Software	Lenovo™ with Ubuntu 12.04, running N-Monitor software

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