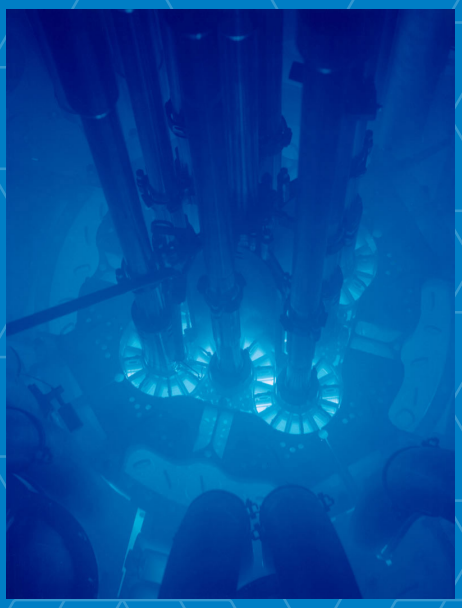
MIRION
TECHNOLOGIES

NEUTRON FLUX MONITORING SYSTEMS

proTK™ RR

Reactor Safety and Control for Research Reactors



Neutron flux monitoring in research and test reactors for all modes of operation.

DESCRIPTION

With the proTK™ product line Mirion is offering state-of-the-art equipment for neutron flux monitoring that is versatile and high performing. Due to its modularity, it can be integrated into nuclear facilities of any size and complexity, including research reactors.

proTK™ neutron flux monitoring channels are providing fast and reliable information on neutron flux levels and trends, therefore allowing the operator to constantly monitor the reactor power and stay ahead of (planned or unexpected) events.

proTK™ RR is Mirion's program for providing reliable and versatile equipment and services to operators of research and test reactors, e.g. the common TRIGA®, to support safe operation while maintaining and improving performance.

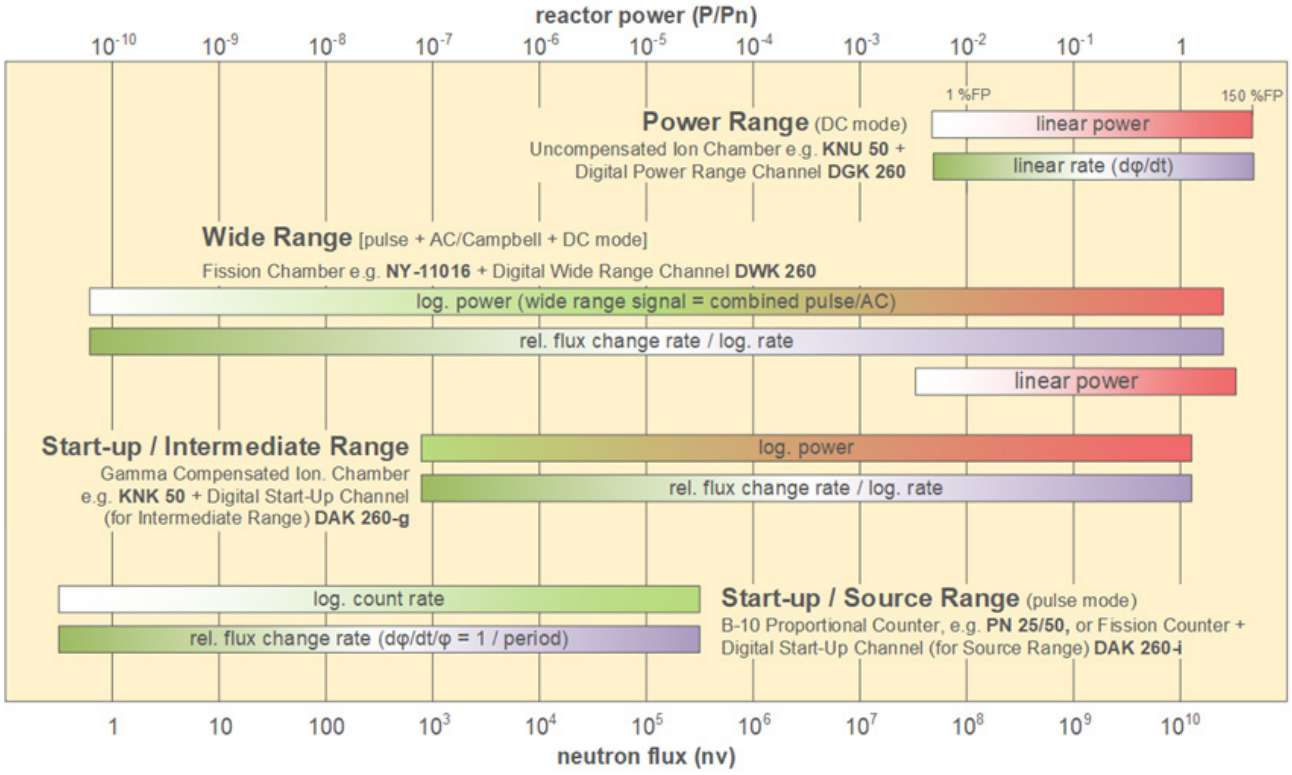
FEATURES

- Comprehensive neutron flux monitoring solutions for research reactors
- Modular design, highly customizable
- Reliable and low maintenance, integrated test functions, continuous self-monitoring
- Large variety of detectors: fission chambers, B-10 proportional counters and ionization chambers
- Water-tight detector housing for in-pool measurement
- Total coverage of neutron flux levels from 0.1 to 1E+11 nv
- 10+ decades of neutron flux with one WR FC and signal processing unit
- Isolated safety signals for RPS
- Optional secured serial interface
- Qualified for Category A functions (Class 1 system) acc. IEC 61226
- Life-time support and services, incl. engineering and licensing support

PROTK™ NEUTRON FLUX MONITORING CHANNELS FOR RR

For measuring the neutron flux and the corresponding reactor power during reactor start-up and power operation, various types of proTK™ neutron flux monitoring channels are available. The table below and the schematic drawing show the coverage by type of proTK™ monitor.

	proTK™ MONITORS	FOR REACTOR POWER OPERATION		
	FOR REACTOR START-UP			
Description	**Source Range Monitor SRM 510™**	**Intermediate Range Monitor IRM 510™**	**Wide Range Monitor WRM 510™**	**Power Range Monitor PRM 510™**
Signal Processing Unit/Pre-amplifier	DAK 260-i/NV 320	DAK 260-g/NV 102	DWK 260/NV 230	DGK 260/-
Detector Type (Example)	B-10 proportional counter (PN 25, PN 50), Fission counter (WL-6376A), BF3 counter (NY-10937)	γ-compensated neutron ionization chamber (KNK 50 ACH)	WR fission chamber (NY-11016, WL-6376A)	(1 or 2) uncompensated neutron ionization chamber (KNU 50 ACH)
Typical Neutron Flux Range (nv)	0.1 … 2 10^5	10^2 … 10^{10}	1 … 10^{10}	10^2 … 10^{10}
Typical Channel Outputs and Scaling	0.1 … 10^5 nv 10^{-8} … 10^{-2} %FP -1.25 … 0 … +12.5 %/s	10^2 … 10^{10} nv 10^{-6} … 100 %FP -1.25 … 0 … +12.5 %/s	1 … 10^{10} nv 10^{-8} … 100 %FP -1.25 … 0 … +12.5 %/s 0 … 150 %FP	0 … 125 %FP −10 … 0 … +10 %FP/s −30 … +30 %FP (axial deviation)



PROTK™ DETECTOR HOUSING FOR RR

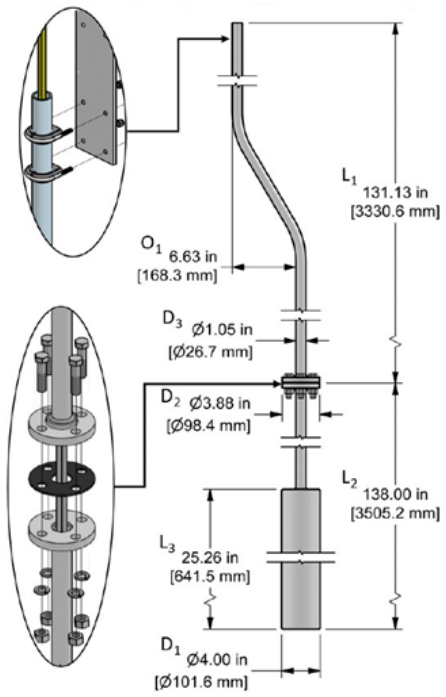
In addition to neutron detectors and suitable signal processing units, Mirion is also offering the mechanical components for mounting and positioning the detectors in suitable locations around the reactor core.

Here an example of a standard housing for mounting detector inside the pool of a research reactor.

The watertight housing shown here is fabricated from aluminum alloy 6061 and delivered in two (2) sections. These sections are joined using a gasket and stainless-steel fasteners.

The upper rigid conduit section features an offset to mitigate streaming. A detector is installed into the lower housing section at the Mirion factory and is not field replaceable. Typically, this watertight housing is used to encapsulate an Ion Chamber, Fission Chamber or Proportional Counter (with BF3 gas or B-10 coated). Dimensions of the housing depending on the detector being housed.

The upper section of rigid conduit is typically secured to the reactor bridge or similar structure using conduit clamps. An optional sealing gland can be added to top of rigid conduit.



PROTK™ SUPPORT AND SERVICES FOR RESEARCH REACTORS

Along with standard or custom state-of-the-art equipment Mirion is supporting research reactors operators throughout the facility's lifetime with services including:

- Preliminary feasibility studies, incl. support for creating a system requirement specification for a modernization project
- Customized design, development and engineering incl. equipment qualification acc. to nuclear standards, especially for safety systems, and support throughout the licensing process
- Installation, commissioning, site acceptance testing and product training for individuals and groups
- Repair and maintenance

Acronyms:
RR = Research Reactor (incl. test and training reactors and other nuclear reactors whose main purpose is not the generation of electrical power)
FC = Fission Chamber; IC = Ionization Chamber; PC = Proportional Counter; SR, IR, PR, WR = Source, Intermediate, Power, Wide Range; I&C = Instrumentation & Control

Units:
1 nv = 1 neutron / (cm² s)
rel. flux change rate = (1/φ) dφ /dt
= 1 / reactor period

Credits (title picture): US NRC (http://www.nrc.gov)

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