Path to effective reactor power monitoring: equipment, qualification, operation

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Abstract

- Securing a reliable measurement of the neutron flux and reactor power is a multi-step process, starting with the development of a set of relevant requirements and ending with the final commissioning and testing of the entire chain of monitoring equipment to ensure that the requirements have been met.
- This presentation focuses on the proTK™ series of neutron flux monitoring systems and Mirion's approach when supplying systems, as well as the support that is provided.

Neutron Flux Monitoring – Operation Mode

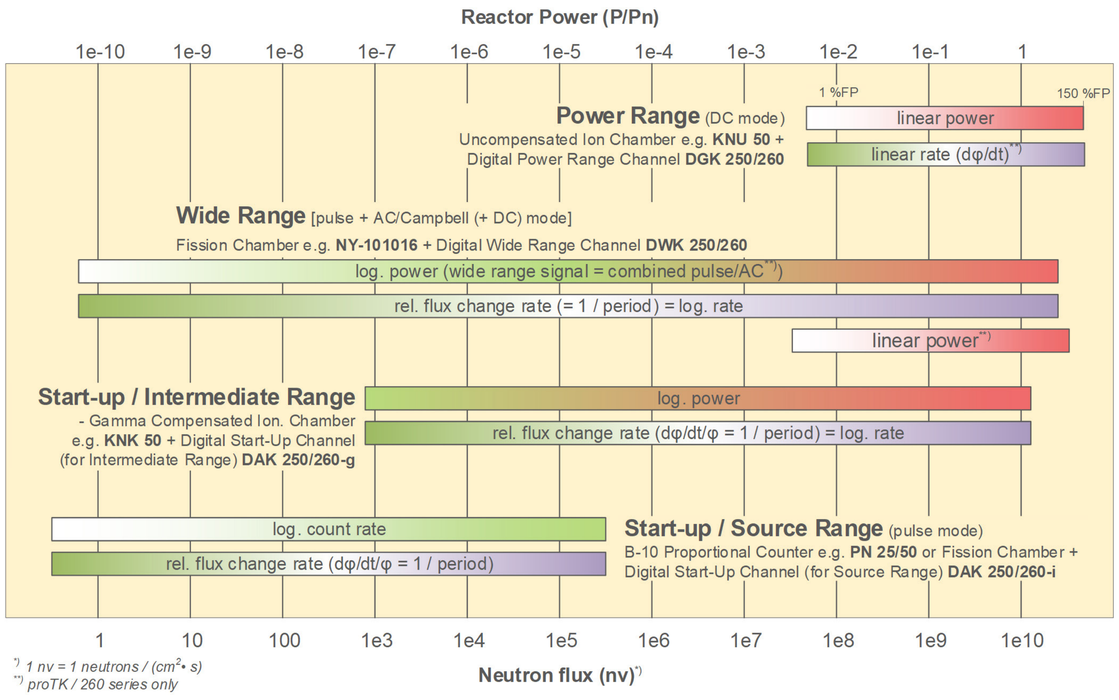
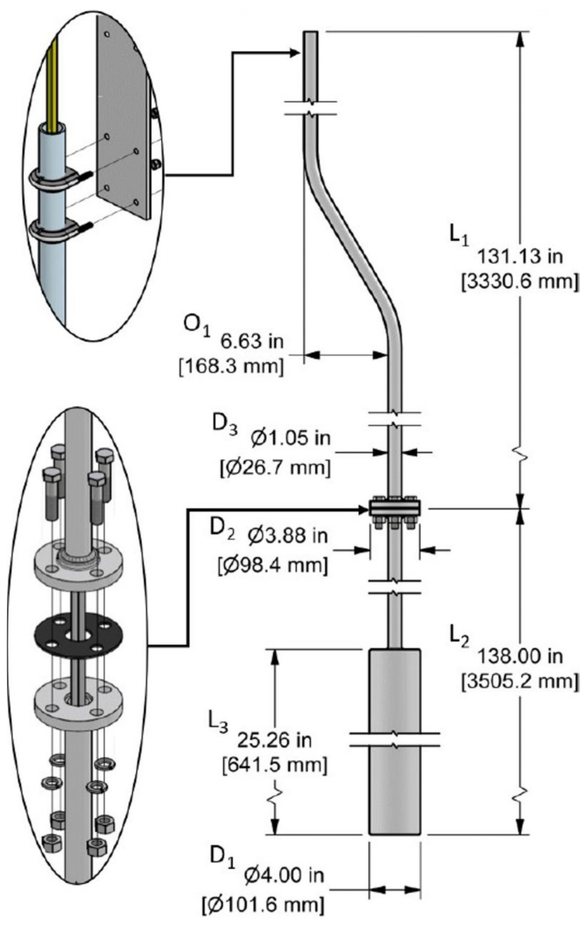


Figure 1: General chart for proTK neutron flux instrumentation, showing the modes of operation and the proTK detectors and signal processing units that can be used for covering 10 or more decades of neutron flux or reactor power.

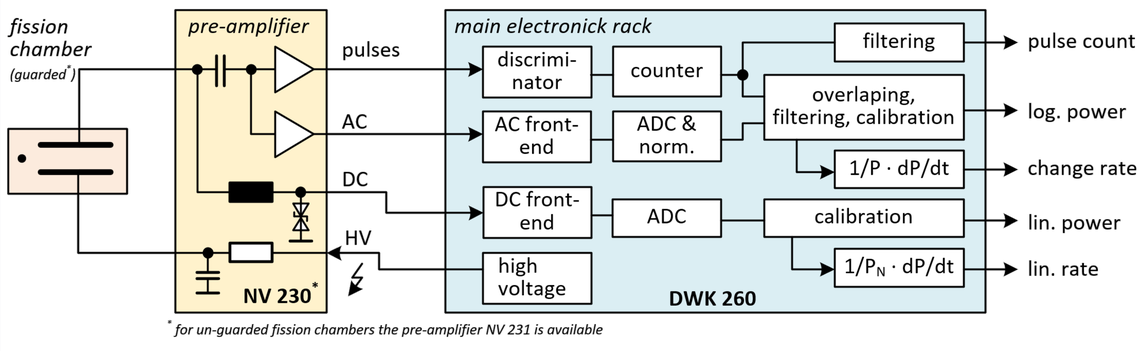
Standard Solution for Research Reactors (e.g., TRIGA)

Mirion has configured a standard set of equipment for neutron flux monitoring in a pool-type research reactor (e.g., TRIGA), consisting of the following components:

- Detector assembly with a wide range guarded fission chamber (Detector and cables are mounted in a water-tight housing and conduit).
- Field cable protection.
- Signal processing;
  - Wide range pre-amplifier of type NV 230
  - DWK 260™ Signal processing channel



- Basic signal flow diagram of wide range neutron flux monitor with guarded fission chamber, pre-amplifier and DWK 260 signal processing unit for pulse, AC and DC processing.



Mirion Project Approach

- Mirion is supporting modernization projects with state-of-the-art equipment and with services (including requirements engineering, qualification, installation, commissioning and operation).
- By using the V model it is ensured, that the requirements of the system and its components, which are specified in the first phases, will be verified and validated by corresponding reviews or tests in the later phases.

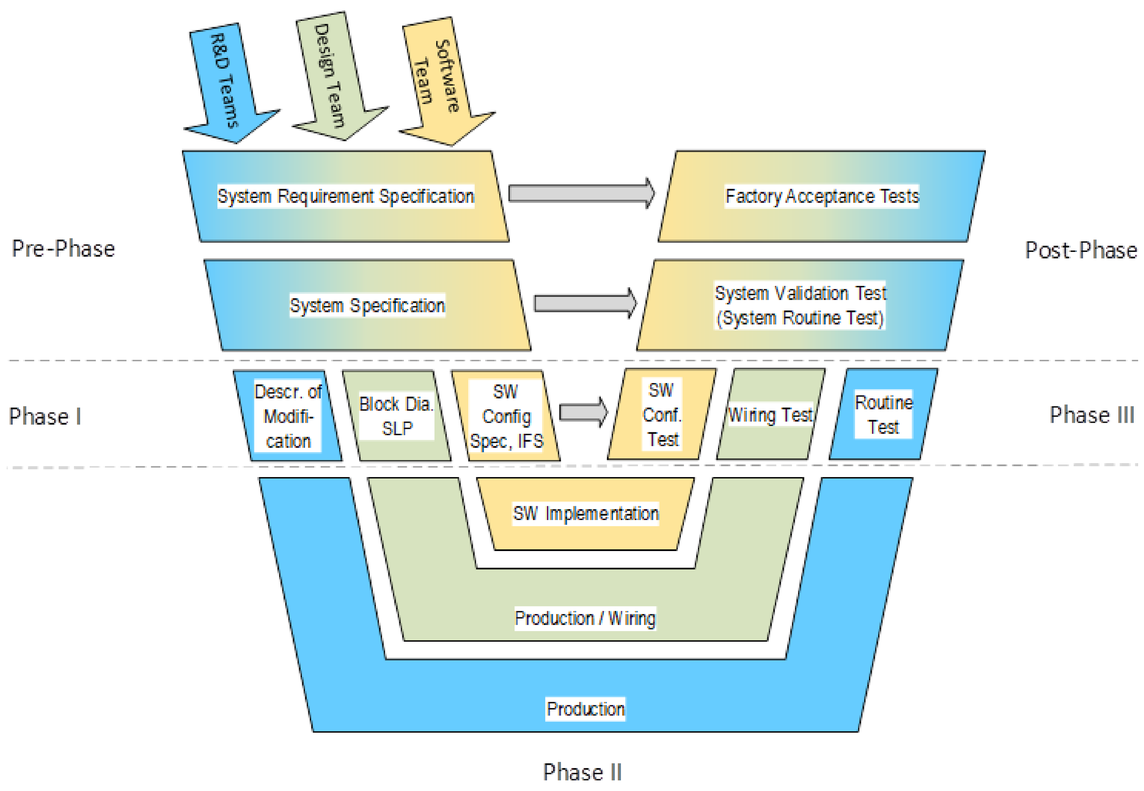


Figure 2: Example of V model for a specific Mirion project.

Calibration

- Information needed for calibration of the nuclear instrumentation based on neutron flux data consists of a mix of data.
- Parts of the data can be provided by the supplier of the monitoring system, e.g., the sensitivity of the detector to neutrons with a certain energy spectrum (typically given e.g., as sensitivity for thermal neutrons).
- Other information though is closely linked to the reactor facility, e.g., the thermal power of a reactor cannot be derived only from the specifics of the detection system and providing this information is the responsibility of the operator.

Conclusion

- Monitoring the neutron flux in a reactor is essential for the safe, reliable and efficient operation.
- Mirion provides complete neutron flux monitors for all modes and ranges of operation. For research reactors, Mirion is offering Wide Range Neutron Flux Monitors that cover the complete range from reactor start-up to power operation with just one wide range fission chamber.
- Complementary to the supply of the equipment, Mirion offers services for supporting the operator during all stages of the product's lifetime.

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