MIRION Connect AMERICAS 26

Annual Users' Conference

ADVANCING RADIATION SAFETY. EMPOWERING PROGRESS.

M Resort, Henderson, NV | June 15 – June 18

MIRION TECHNOLOGIES

Advancing Radiation Safety.
Empowering Progress.

TUESDAY

June 16

NIS & I&C

MIRION Connect 26
AMERICAS
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7:30–9:00 AM	*Registration & Breakfast*
9:00–10:15 AM	**proTK Digital Neutron Instrumentation: Research Reactors, Advanced Nuclear & Retrofit** *Jörg von Loeben — Mirion*
10:15–10:30 AM	*Break*
10:30–11:15 AM	**I&C & Neutron Instrumentation in Westinghouse Design Plants** *Lou Gaussa & Jay Rotondo — Westinghouse*
11:15–12:00 PM	**Analog Neutron Instrumentation Solutions with CoreVision System** *Yvotte Brits · John Portillo — Paragon*
12:00–1:00 PM	*Lunch*
1:00–2:00 PM	**HIPS Safety I&C Platform: Architecture & Real-World Applications** *Tighe Smith — Mirion*
2:00–2:30 PM	**Showcasing 10 CFR 50.59 Licensing Success: Duke Oconee (AFIS)** *Tighe Smith — Mirion*
2:30–2:45 PM	*Break*
2:45–3:30 PM	**Antares — NMS & Reactor Trip System (4th of July Reactor)** *Brad Rearden — Antares*
3:30–4:00 PM	**ARCADE – Risk Informed Design** *Andrew Hahn — Sandia National Labs*
4:30–5:00 PM	**Reactor Simulation & Operator Training Solutions** *Yvotte Brits — Paragon*

Digital NFMS

with proTK

Jörg von Loeben

VP I&C “Safety, Protection & Control”

Mirion Connect | Annual Users’ Conference 2026

Henderson, NV

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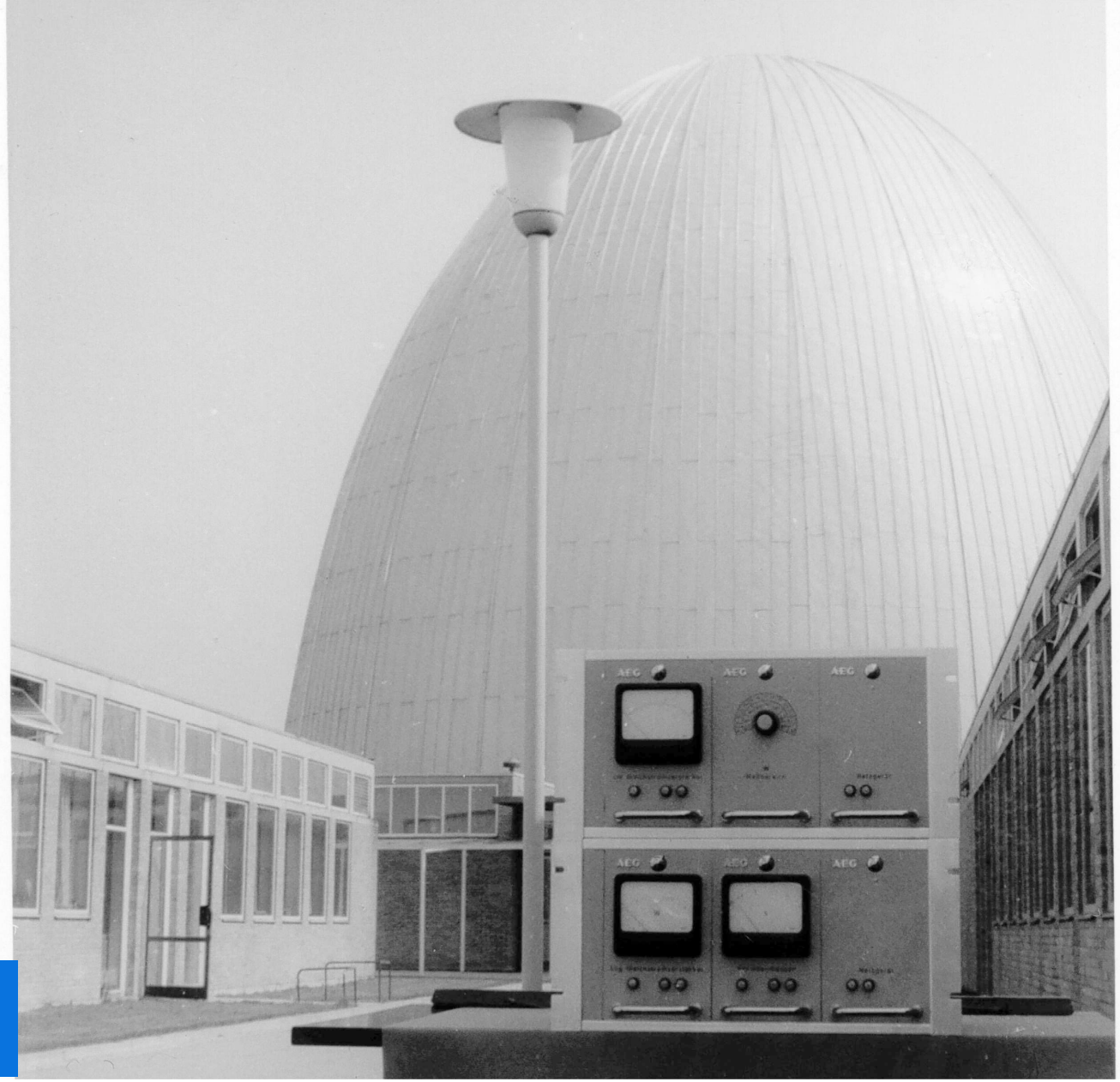
Introduction
A Brief History

1955

1. *Abolition of Occupation Statute – Paris Agreements (05/1955)*
2. *Civilian nuclear energy authorized – 1st Geneva Conference (08/1955)*

- *Decision to build first research reactor*
- *AEG: construction & instrumentation supply*
- *Construction start: Nov 6, 1956*
- *Commissioning: Oct 31, 1957*

- *1 MW pool reactor, upgraded to 4 MW*
- *Applications: research and medical*



First research reactor in Germany:
Begin of construction to start of operation: 11 months

[40 Jahre Atom-Ei Garching.](#) (PDF) TU München, Oktober 1997

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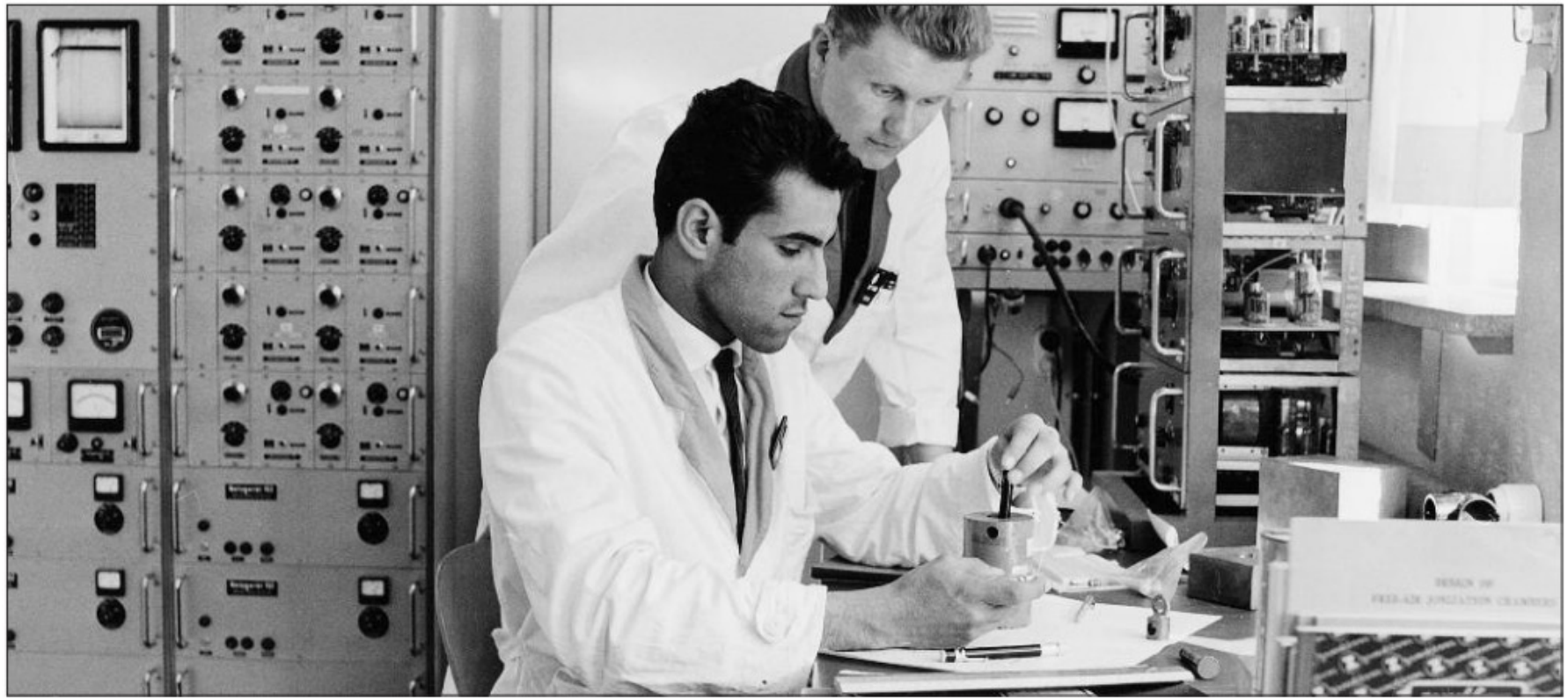
Bavaria's Minister-President presents the first fuel element, 1957

[40 Jahre Atom-Ei Garching.](#) (PDF) TU München, Oktober 1997



Radiation monitoring systems in air lock („Reaktorschleuse“)

Reator control panel

40 Jahre Atom-Ei Garching. (PDF) TU München, Oktober 1997

KG 80

KNK 50 u. 80

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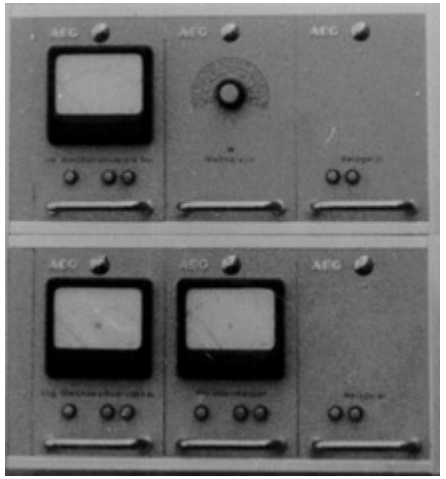
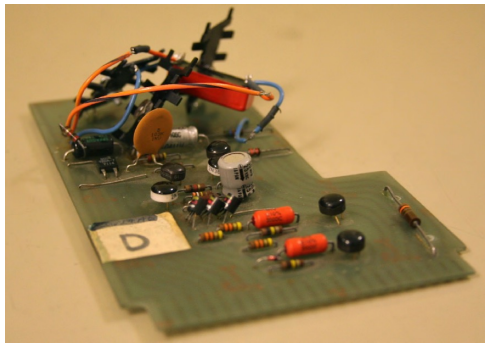
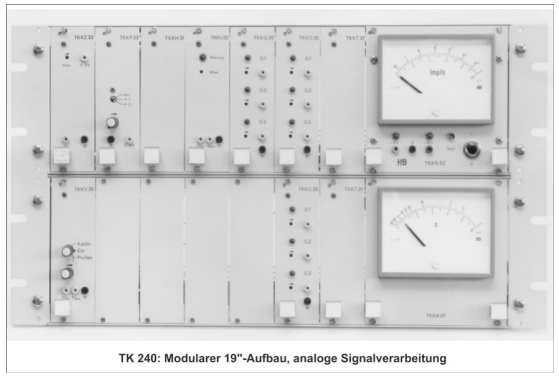
Analog to Digital

1950ies

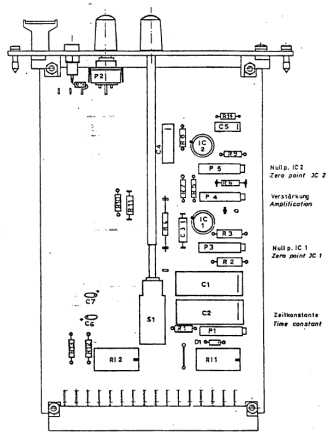




1970ies

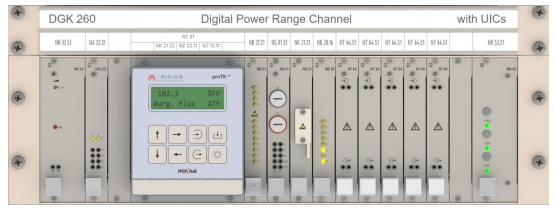


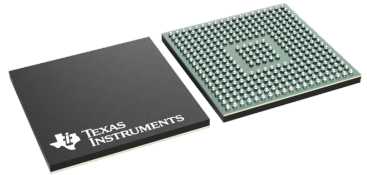
TK 240: Modularer 19"-Aufbau, analoge Signalverarbeitung



1990ies

2020ies





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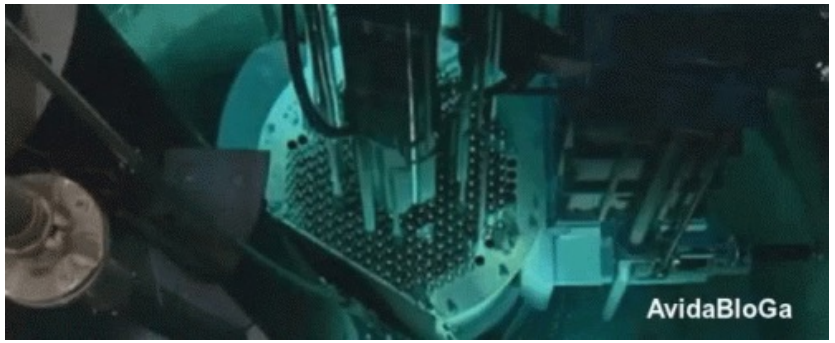
NFMS and proTK

Neutron Flux Density …



What is it?

- *A direct and fast measurement of the reactor power*
- *Reactor “off” to 100 % full power: >10 orders of magnitude*

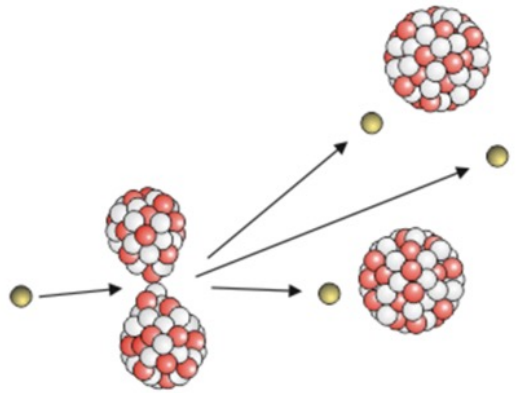
Why measure it?

- *Too many neutrons = reactor might overheat; too few = not enough power*
- *Too fast increase = chain reaction might get out of control*

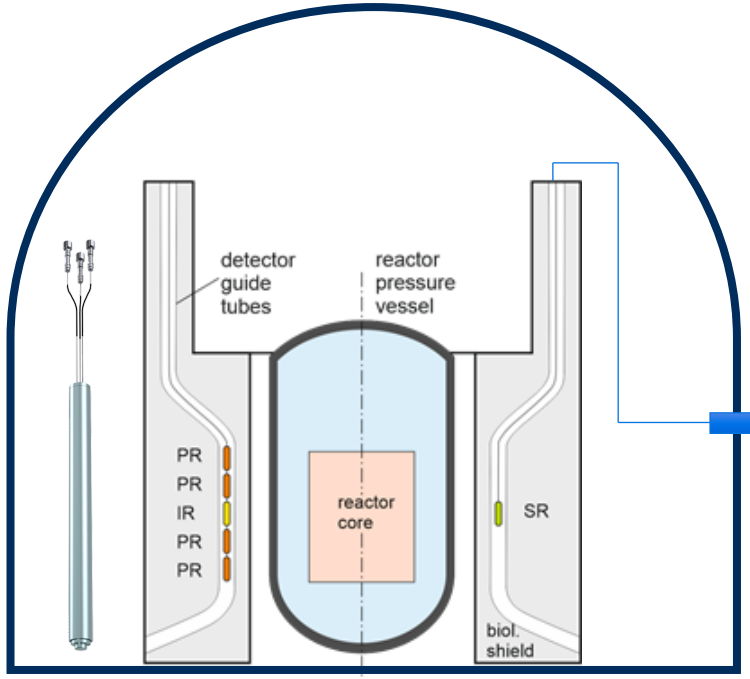
→ *The Neutron Instrumentation System helps control the reactor power*

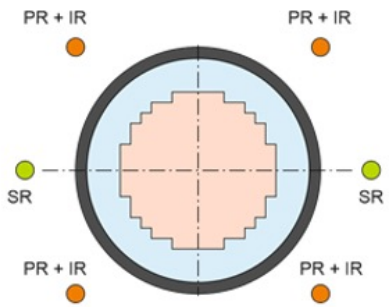
→ *It shuts down the reactor if something goes wrong (→ Safety Relevant)*

→ *It helps balance the fuel and keep operation safe and efficient*



Typical NIS (NFMS) of a PWR





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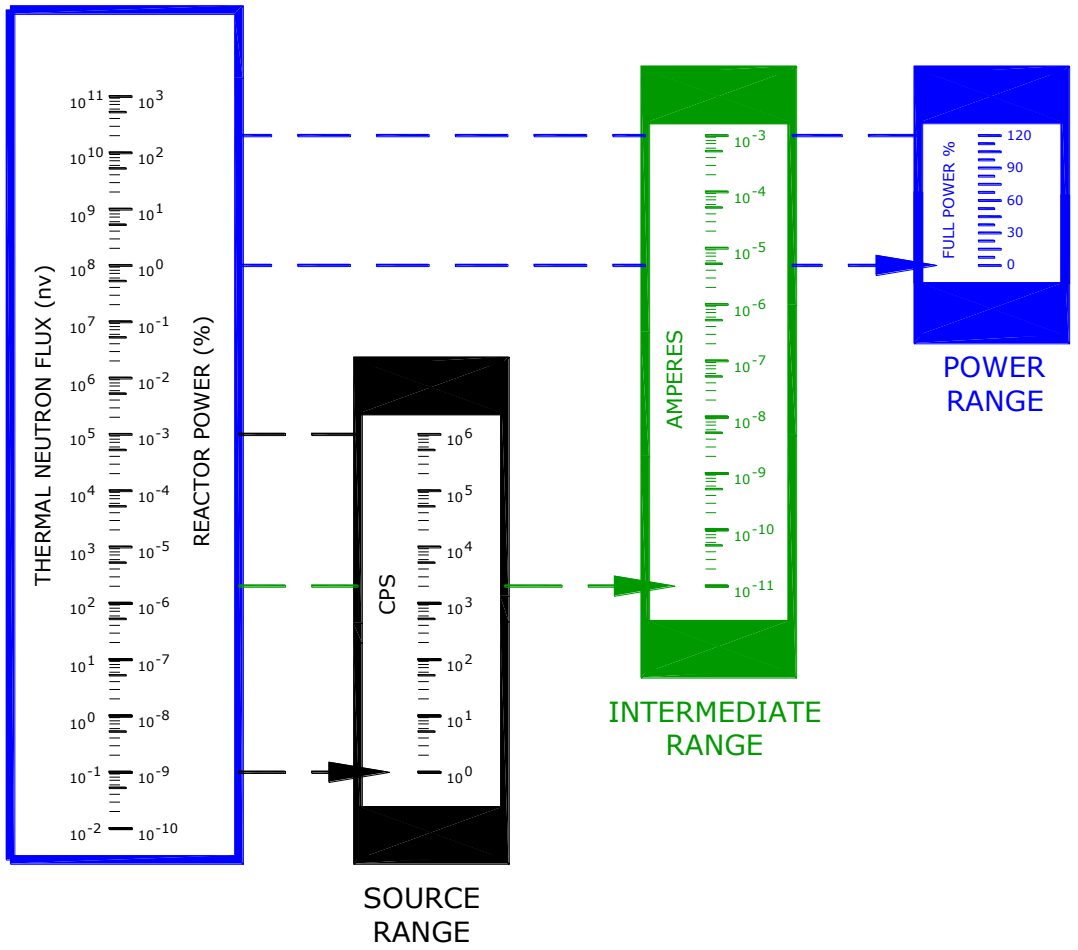
NFMS - The Challenge

- Reliable and accurate determination of the reactor power, expanding over 10-12 orders of magnitude
- Integration in existing I&C infrastructure; compatibility
- Provide reactor trip safety signal (SCRAM)
- Withstand harsh environments and high radiation (detectors + cables)
- Compliance to a variety of strict nuclear standards
- Qualification and life cycle for 40+ years of operation
- Fast response times comparable to Analog Systems (milliseconds)
- Convincing strategy to improve trust in digital safety systems



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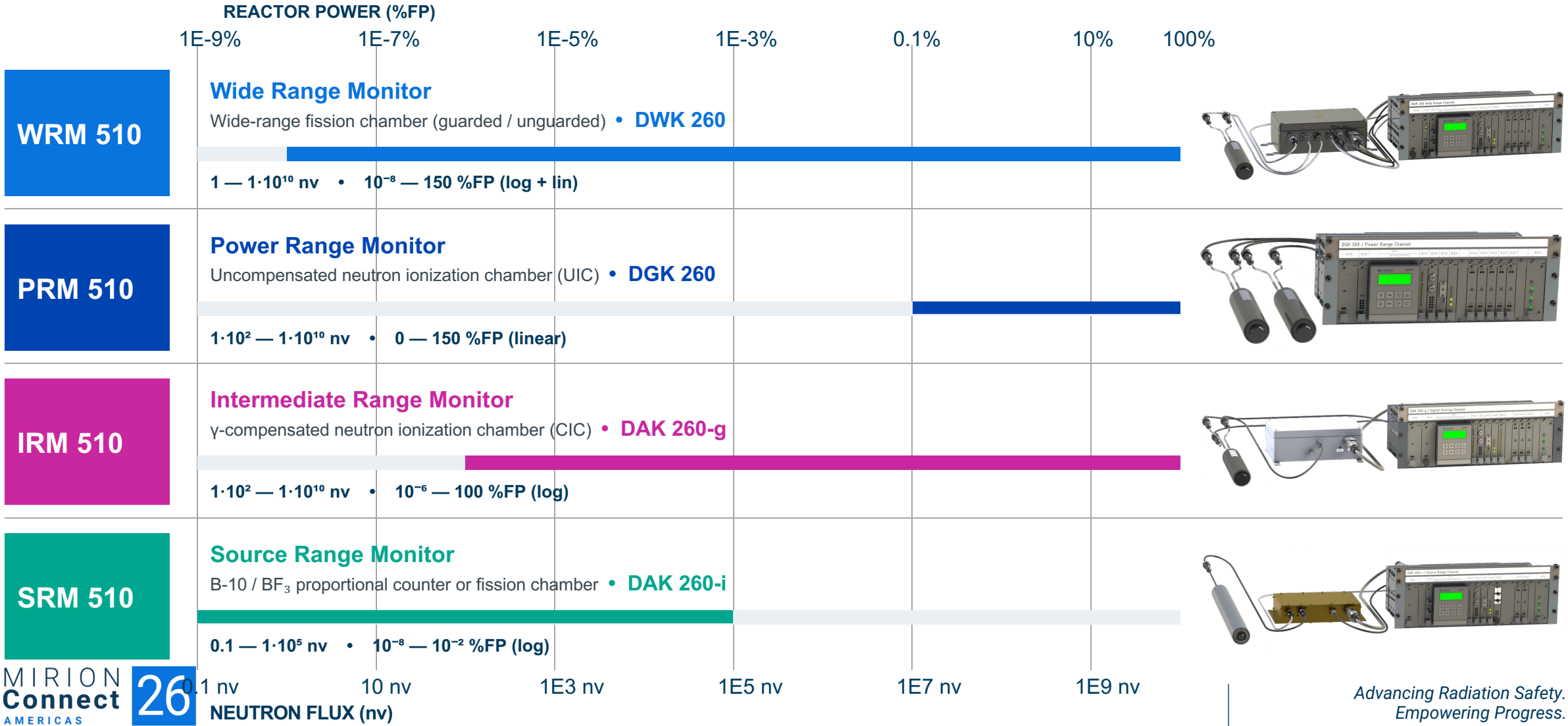
Measurement Ranges

Complete neutron flux coverage from reactor start-up to full power — four monitors, one integrated proTK™ solution.



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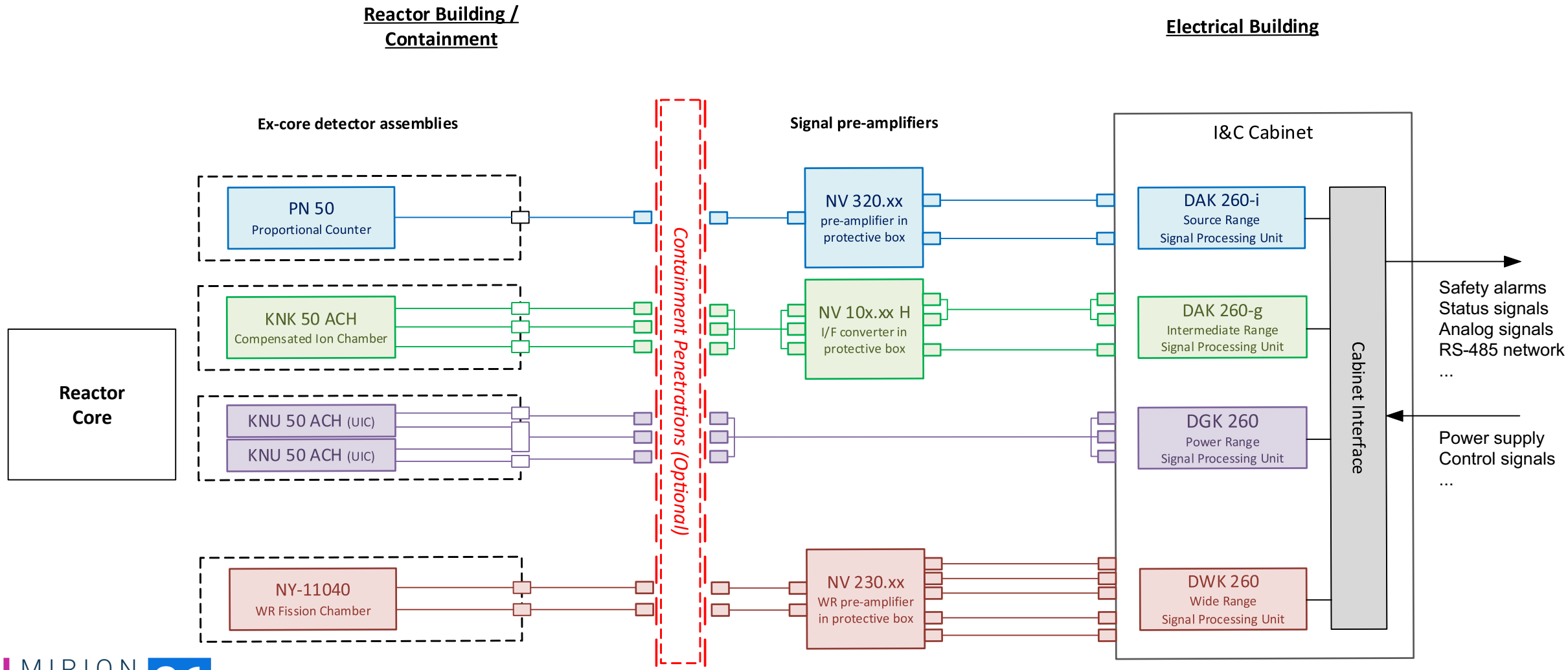
proTK™ - Typical Implementation



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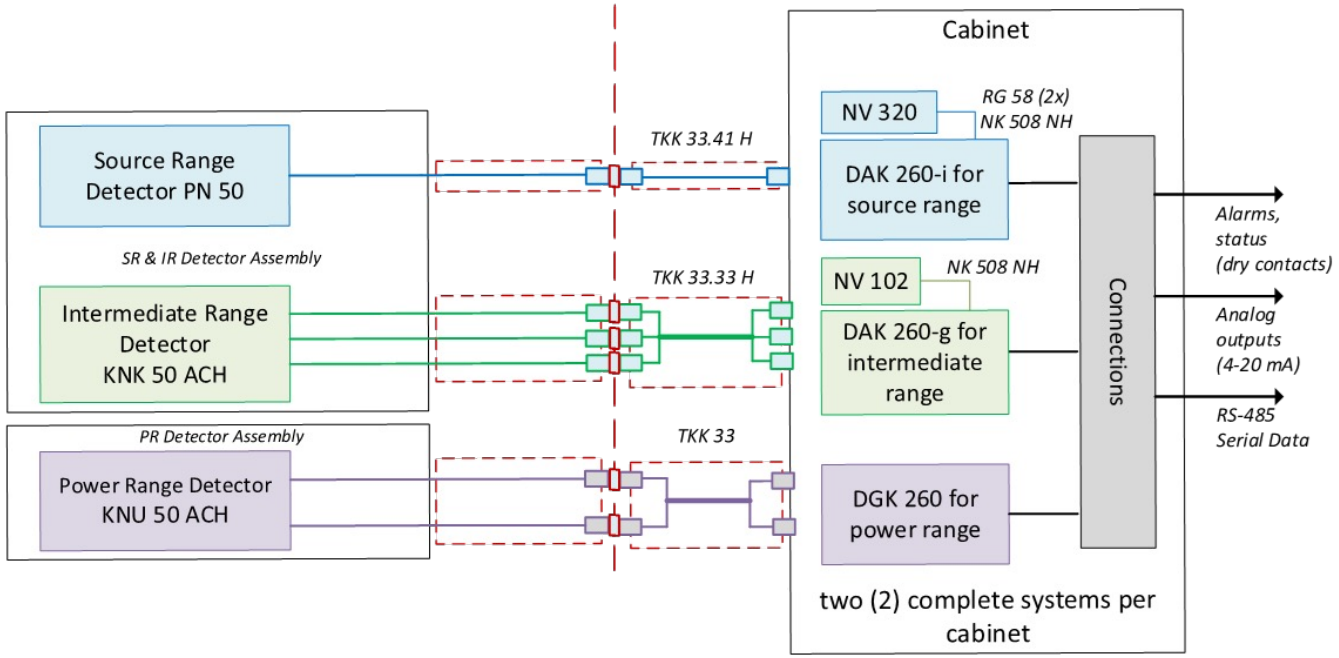
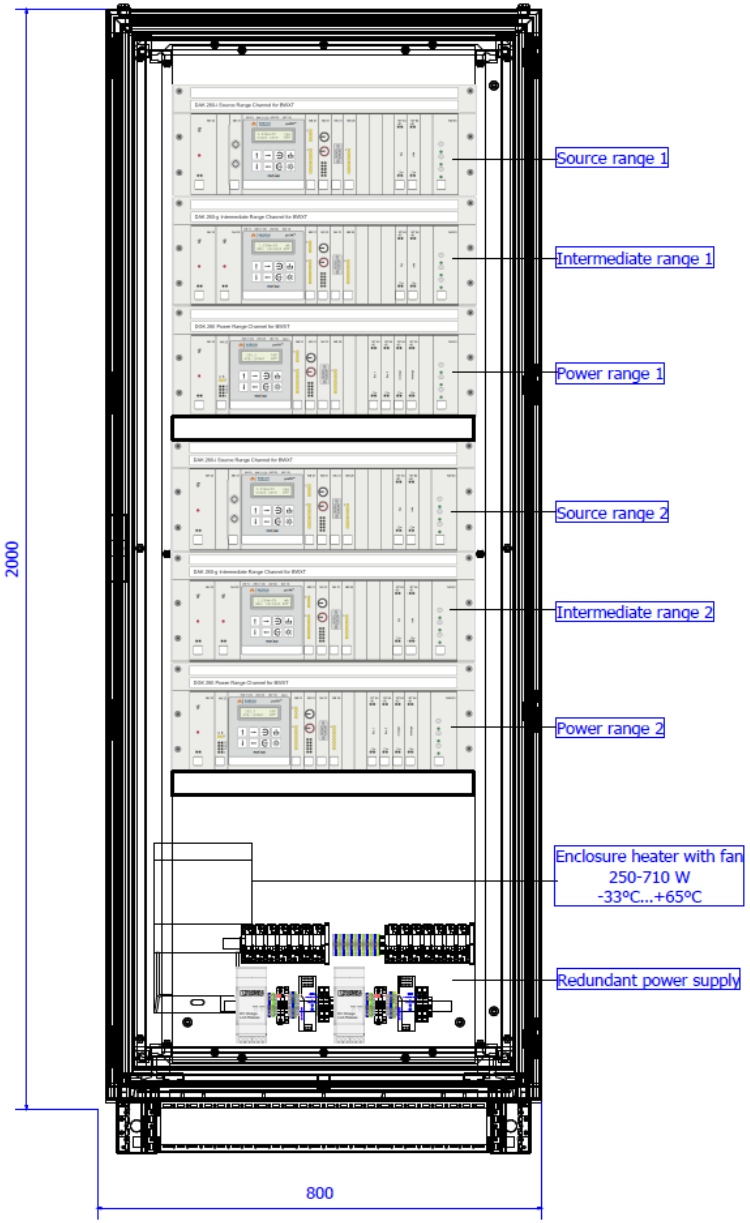
Example of NFMS Solution with proTK

- *Multiple SMR projects have been awarded in the US*
- *Customers show strong interest in digital NFMS*
- *Mirion has received highly favorable feedback as a comprehensive NFMS service provider*





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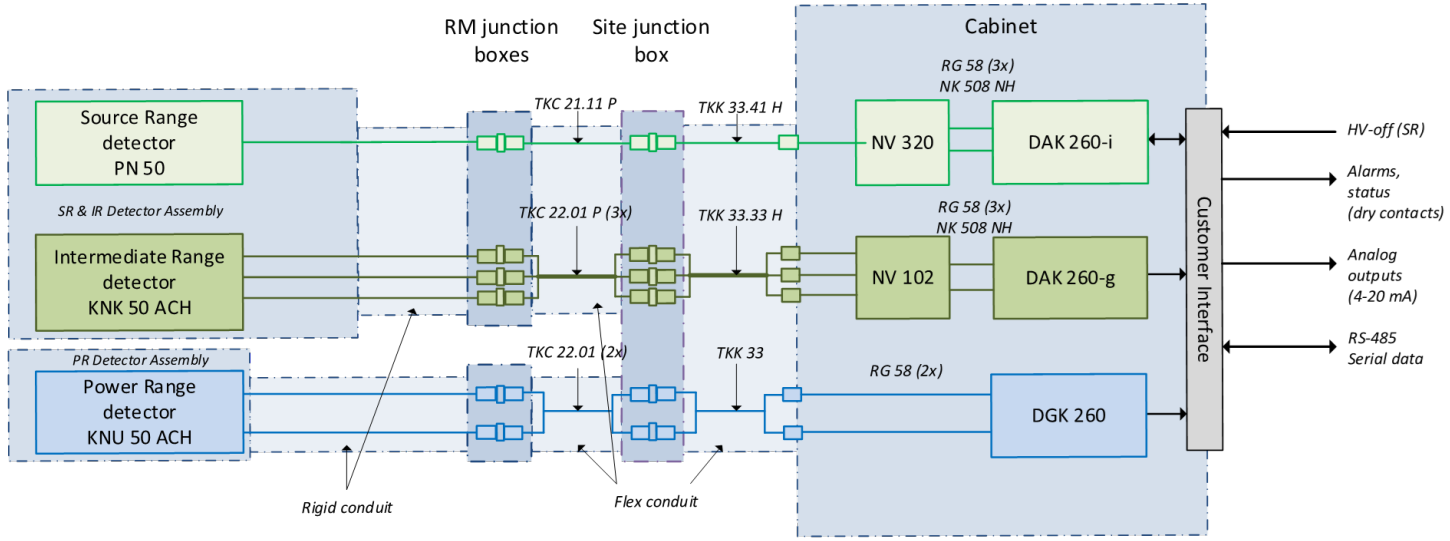
EMI/EMC Design Considerations

- *Detection assembly & cable routing with EMI shields*
- *System grounding concept*
- *EMC protection for cabinet and feedthrough:*
  - *EMC seals*
  - *Metallic separation of EMI/EMS components in cabinet*
  - *Potential equalization*
- *Power supply*
  - *HF filter*
  - *Surge and burst protection*
- *In-/output isolation*
- *…*

Applicable Standards

- *RG 1.180:2003*
- *IEC 61000 series*
- *IEC 62003:2009*
- *EPRI-TR-102323:2013*



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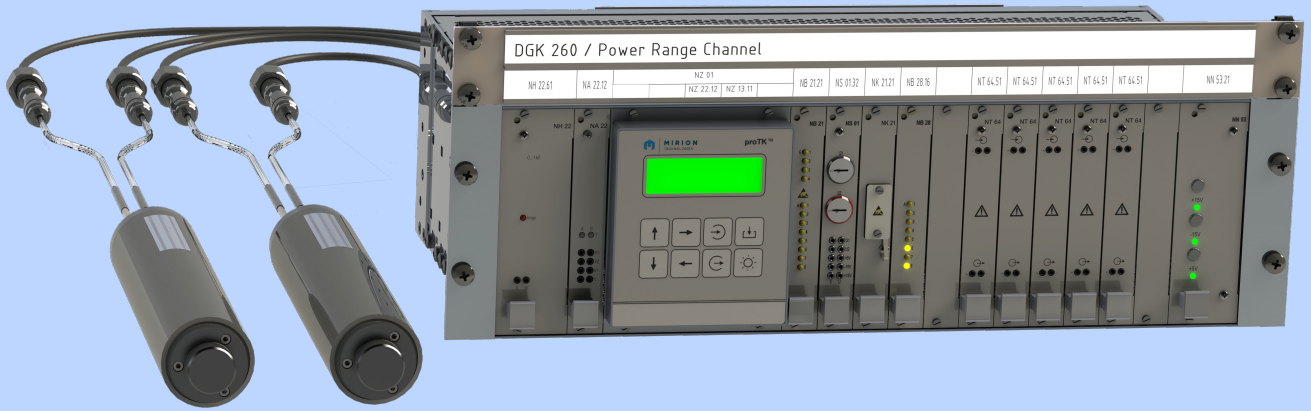

proTK™ Platform

Digital, modular, accurate, fast, testable and reliable NIS

- *Scalable 19” rack-mounted multiprocessor platform for Radiation and Process Monitoring and Neutron Flux Measurement*
- *Highly customizable to meet functional, normative and customer requirements*
- *Perfect for Retrofit, Advanced Nuclear, new Builds and Research Reactors*
- *Recently upgraded to modern µControllers*

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proTK™ – Main Features

- Fast response time due to a cycle time of 5 ms (2.5 ms power range)
- Adaptive signal filtering / time constant over the complete dynamic range
- Signal processing and calculation of linear and/or logarithmic neutron flux signal
- Seamless determination of the change rate
- Isolated analog and binary output signals (SW configurable) for the reactor protection syste
- Up to 8 adjustable trip thresholds (=safety alarms) for the RPS
- User adjustable parameter, locked by a key switch, non-volatile
- Elaborated testing concept based on
  - ✓Remote controlled test generators in the input module, for both signal paths
  - ✓Simulation of measurement values, analogue and binary outputs
- Operation and monitoring via serial interface, RS-232 or RS-485 (optional)
- Continuous functional self-monitoring

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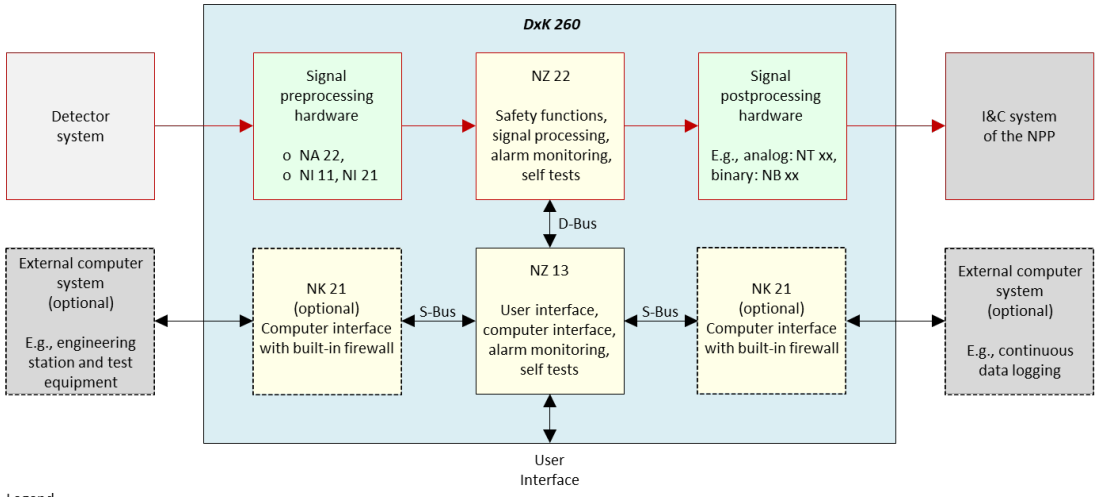
proTK™ - Digital NIS

Digital, modular, accurate, fast, testable and reliable

Software Architecture & Key Features

- *SW is pre-developed, V&V'ed and certified*
- ***Common** base SW across the proTK™ platform*
- *Project-specific configuration with user-adjustable parameters*
- *Continuous self-diagnostic; redundant intrinsic design*
- *Structured test strategy for simplified maintenance*



Field Proven Experience

- *35 years of digital safety systems in the field*
- *3500+ operational years across 400+ safety critical systems*
- *5x Westinghouse-designed European NPPs operating with proTK*

proTK™ delivers all the benefits of digital signal processing with proven reliability

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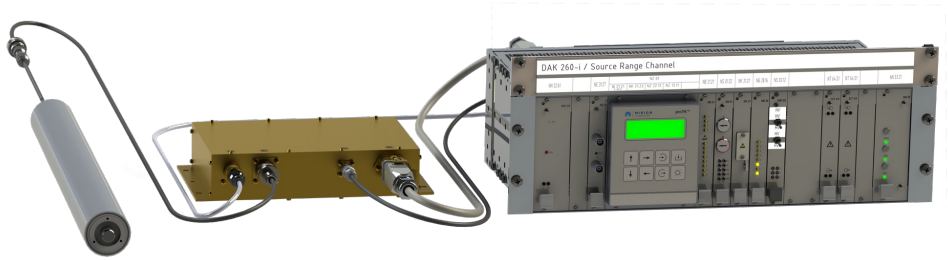
proTK™ — Reactor Start-up Range

SRM 510™ Source Range Monitor



Signal processing / pre-amplifier
DAK 260-i / NV 320

Detector type
B-10 / BF3 proportional counter · Fission

Neutron flux range
0.1 … 1E5 nv

Typical output / scaling*
0.1 … 1E5 cps

1E-8 … 1E-2 %FP

−1.25 … 0 … +12.5 %/s (-0.33 … 0 … +3.3 DPM)

IRM 510™ Intermediate Range Monitor

Signal processing / pre-amplifier
DAK 260-g / NV 102

Detector type
γ-compensated neutron ionization chamber (CIC)

Neutron flux range
1E2 … 1E10 nv

Typical output / scaling*
1E2 … 1E10 nv

10E-6 … 100 %FP

−1.25 … 0 … +12.5 %/s (-0.33 … 0 … +3.3 DPM)

**) All output scalings are fully configurable — tailored to customer requirements and the specific application and implementation*

proTK™ — Wide Range & Reactor Power Operation

WRM 510™ Wide Range Monitor

Signal processing / pre-amplifier

DWK 260 / NV 230 or NV 231

Detector type

WR fission chamber (guarded or unguarded)

Neutron flux range

1 … 1E10 nv

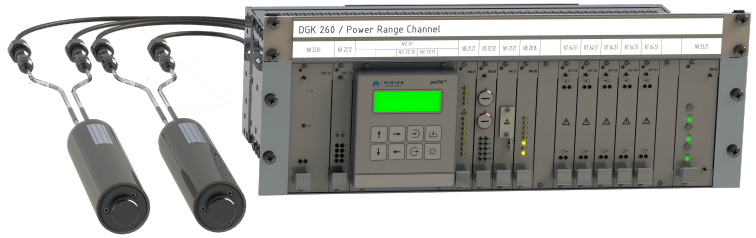
Typical output / scaling

1 … 1E6 cps & 1 … 1E10 nv

10^{-8} … 150 %FP (log) & 0 … 150 %FP (lin)

−1.25 … 0 … +12.5 %/s (-0.33 … 0 … +3.3 DPM)

PRM 510™ Power Range Monitor



Signal processing / pre-amplifier

DGK 260 (no pre-amplifier)

Detector type

(1 or 2) uncompensated neutron ionization chamber (UIC)

Neutron flux range

100 … 1E10 nv (course gain adjustment at input module)

Typical output / scaling

0 … 150 %FP (avg)

−10 … 0 … +10 %FP/s

−30 … +30 %FP (axial deviation)

**) All output scalings are fully configurable — tailored to customer requirements and the specific application and implementation*

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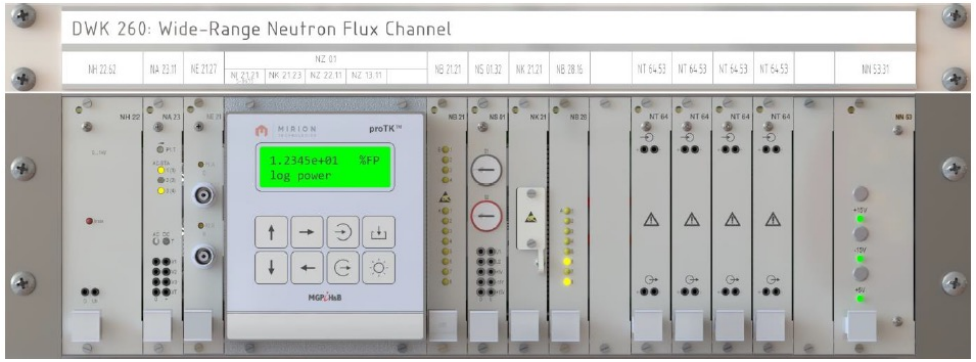
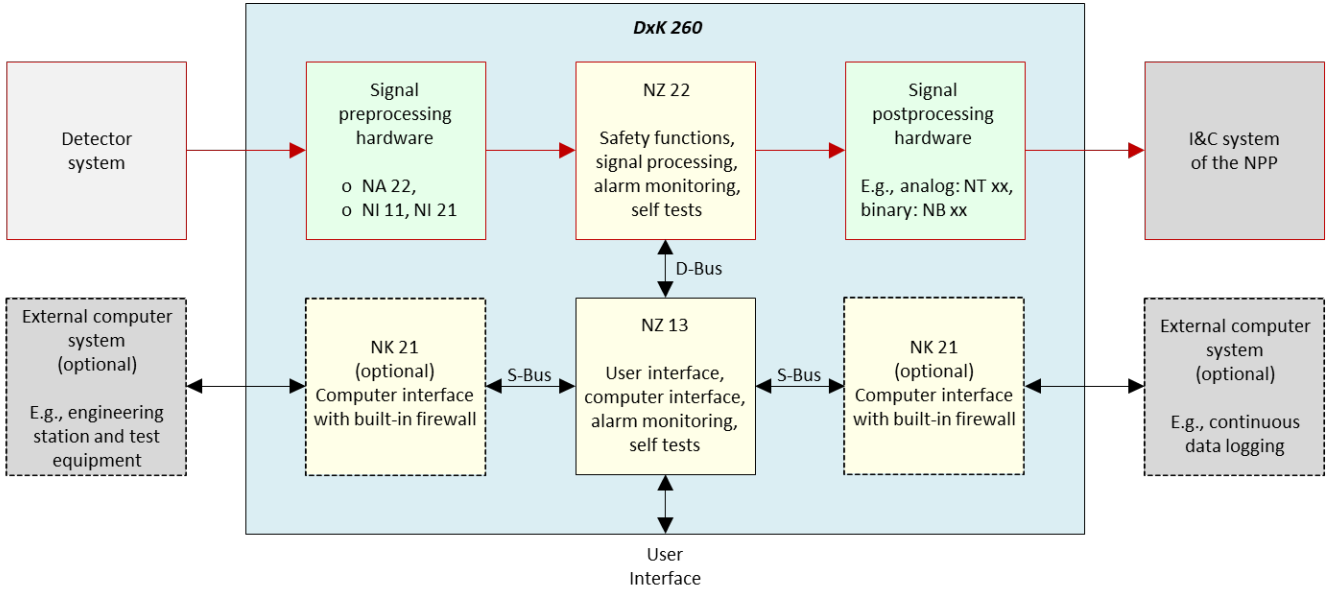
proTK™ - Basic Architecture

Neutron Flux



Reactor Power / Change Rate

Alarm / SCRAM



Legend

Equipment performing safety functions

- Processor board performing safety functions (NZ 22)
- Signal pre-processing hardware
- Detector system
- External NPP I&C systems performing safety functions (not part of the DxK 260)

Equipment not performing safety functions

- Processor board without safety function (mandatory)
- Processor board without safety function (optional)
- External systems that are not part of the DxK 260 (optional)

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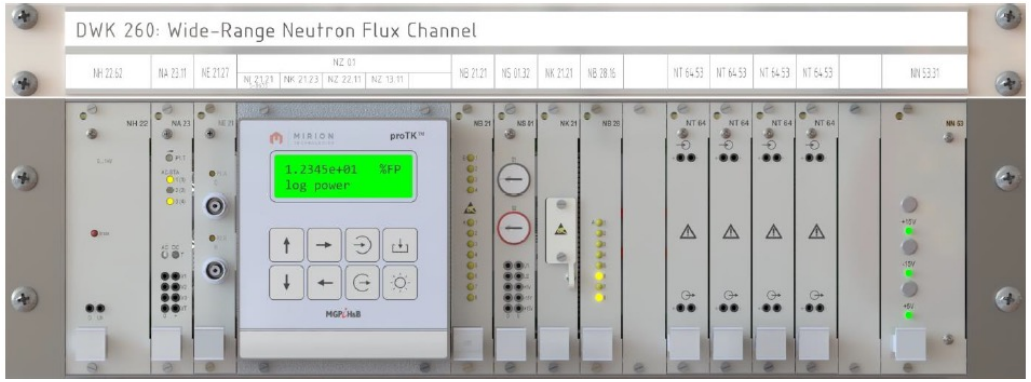
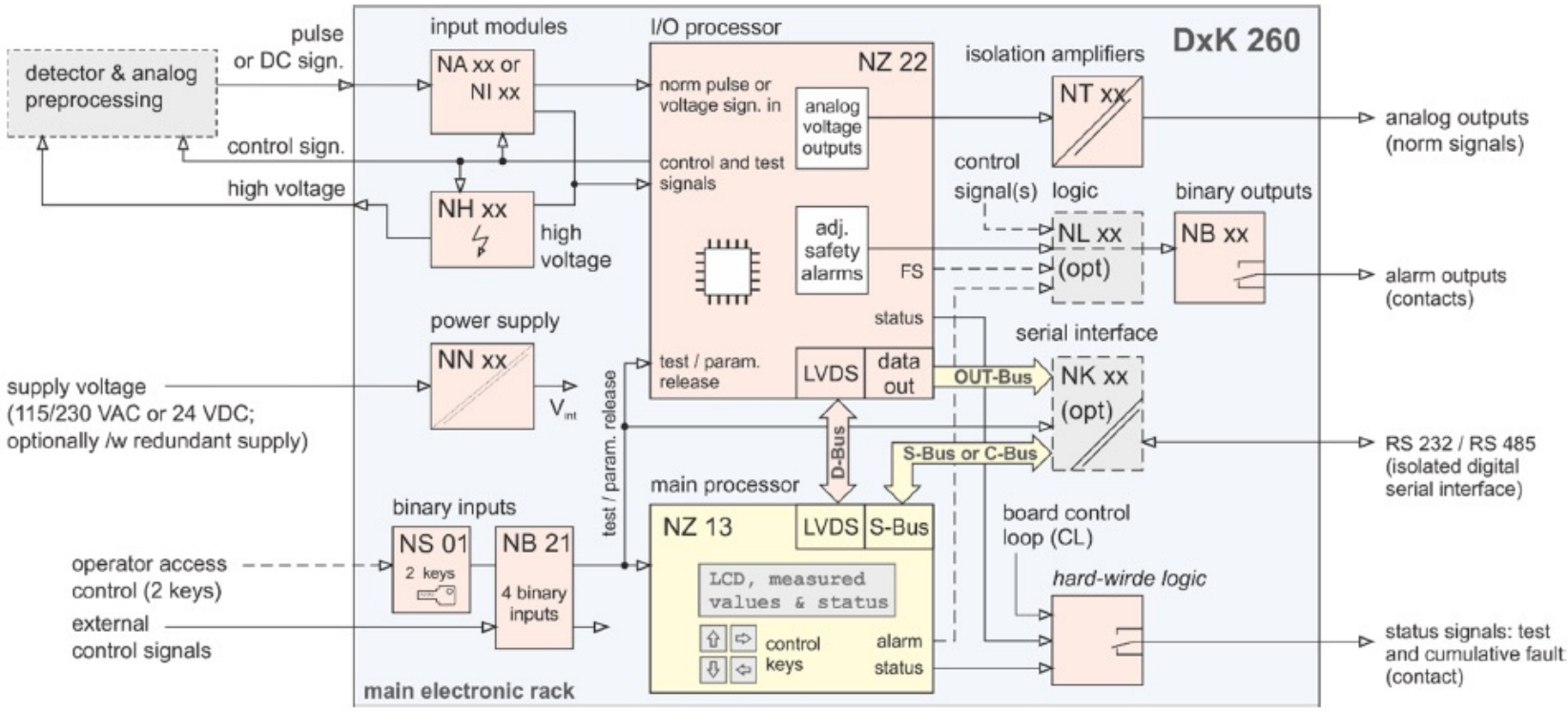
Basic Architecture of the proTK™ / 260 series





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proTK™ - Reactor Start-up Channels

DAK 260-i

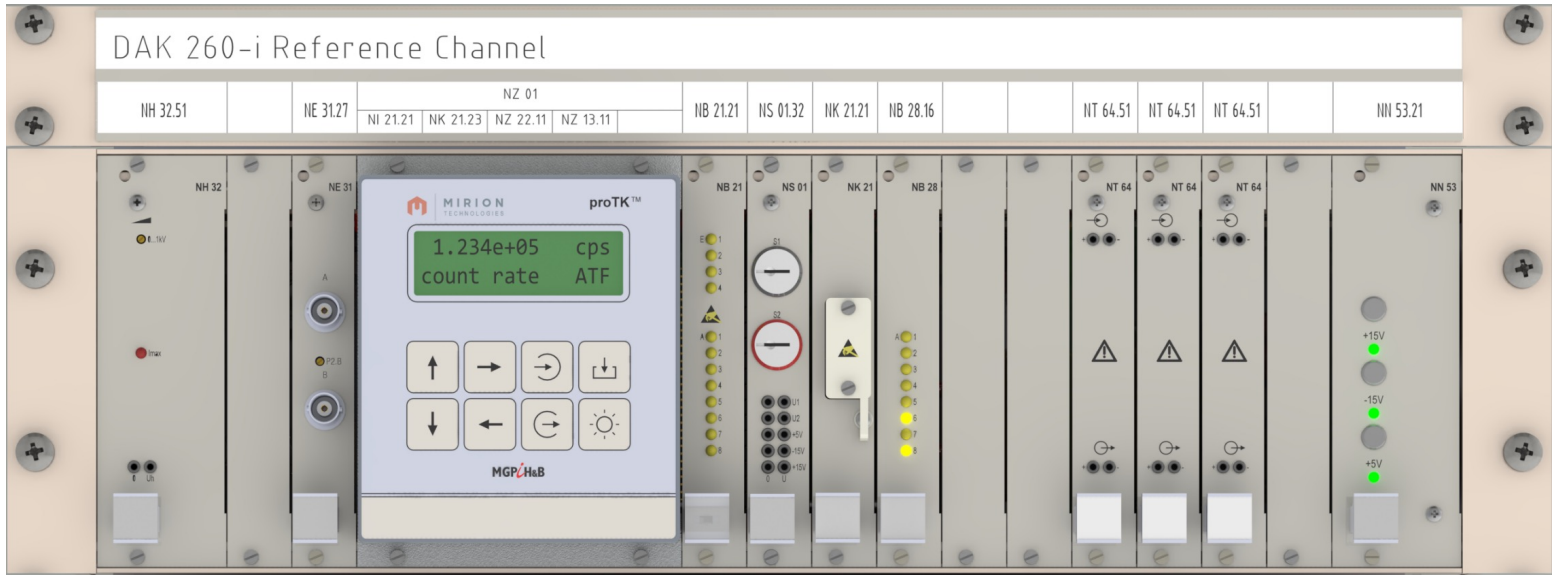
Source Range Channel

Start-up/pulse range, **with pulse pre-amplifier** for proportional (B-10, BF3, He-3) & fission counters (U-235)

DAK 260-g

Intermediate Range Channel

With current-to-frequency converter for DC current measurement from gamma compensated or un-compensated neutron ionization chambers (CIC, UIC)



Note: DAK-260-i, DAK 260-g and DGK 260 share one system plattform with identical base SW.
They differ in analog input modules (HW) and SW Configuration, only.

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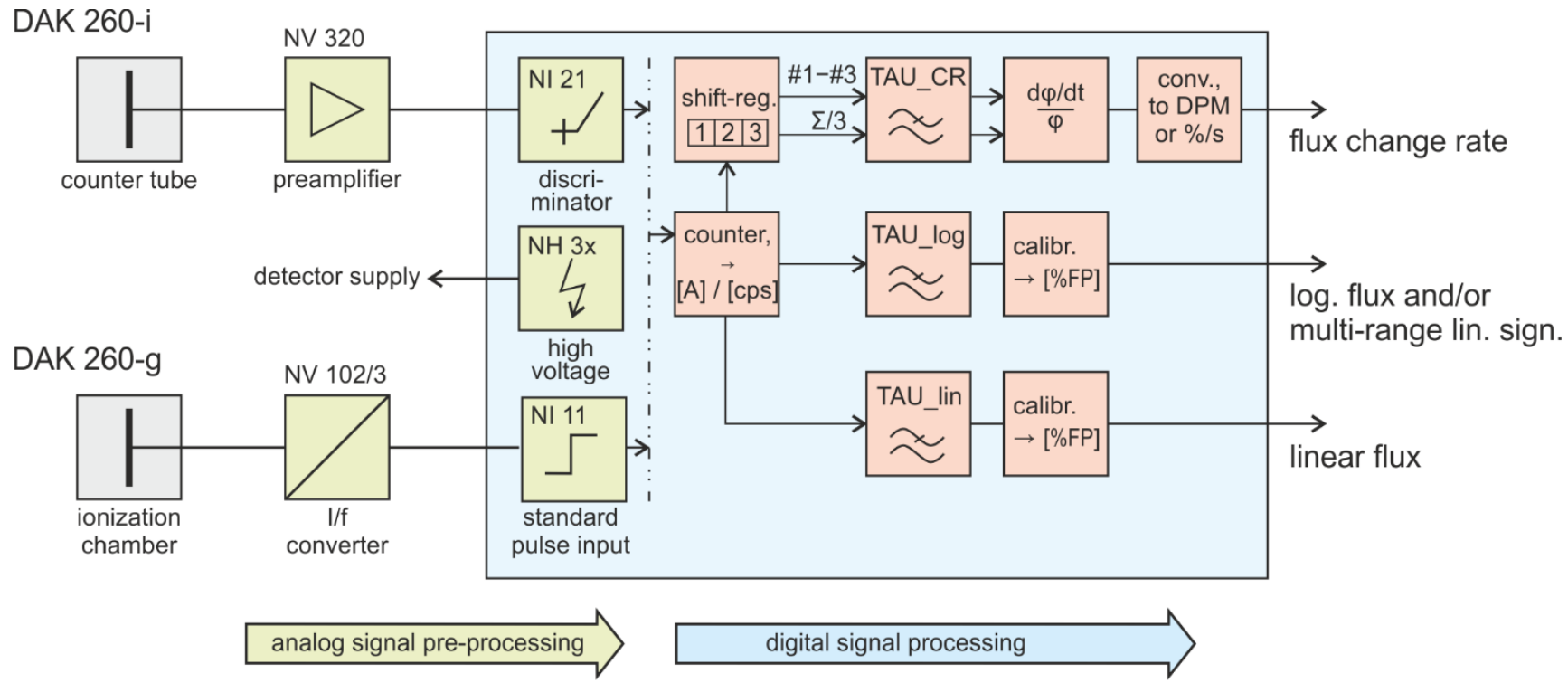
proTK™ - Reactor Start-up Channels



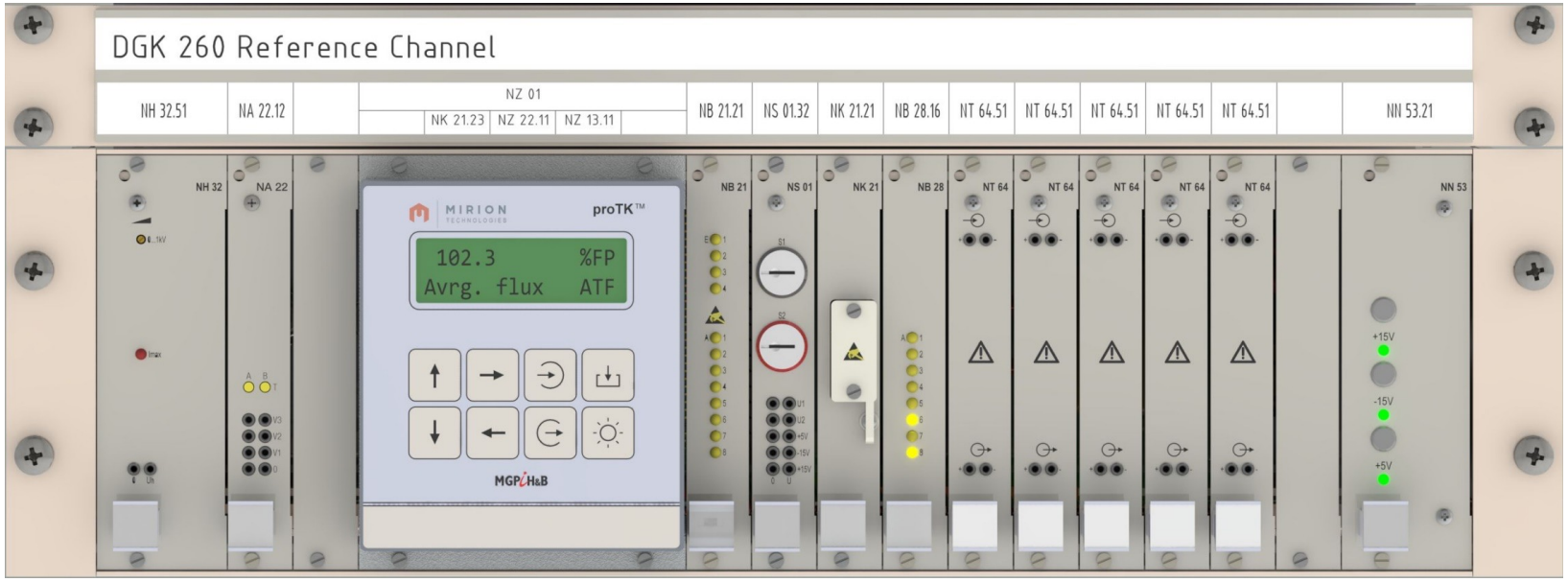
- 5 ms cycle time
- Many different configuration options to comply to project demands

proTK™ - Reactor Power Range Channels

DGK 260

Power-Range Channel

Linear channel for DC current measurement from gamma compensated or un-compensated neutron ionization chambers (UIC)



Note: DAK-260-i, DAK 260-g and DGK 260 share one system platform with identical base SW.
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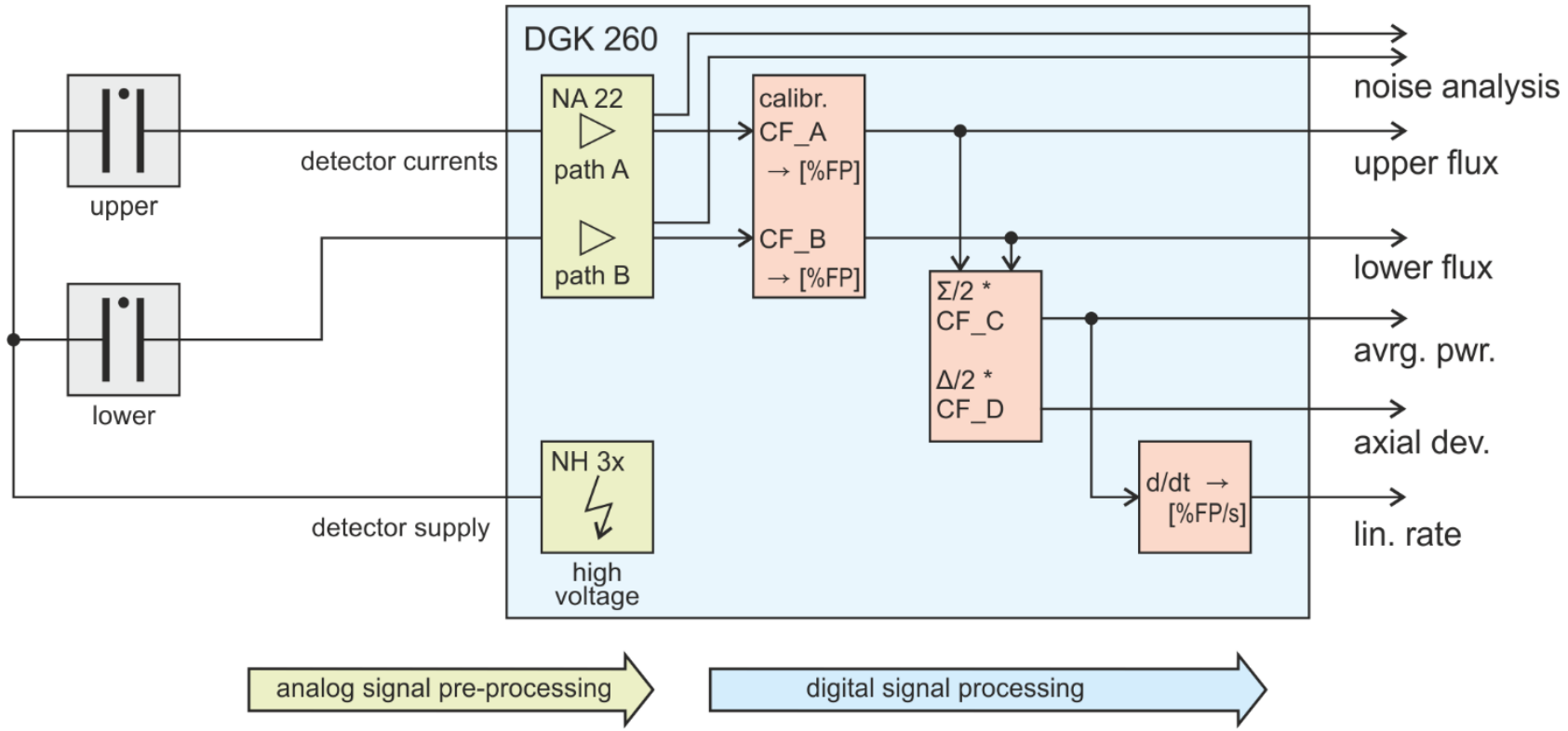
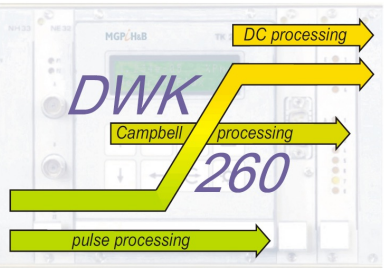
proTK™ - Reactor Power Range Channels



- Two separate adjustable signal paths for connection of one or two neutron-ionization chambers with individual calibration
- Configurable lin power outputs with different ranges (e.g. 0…120 % and 0…200 % in parallel)
- 2.5 ms cycle time

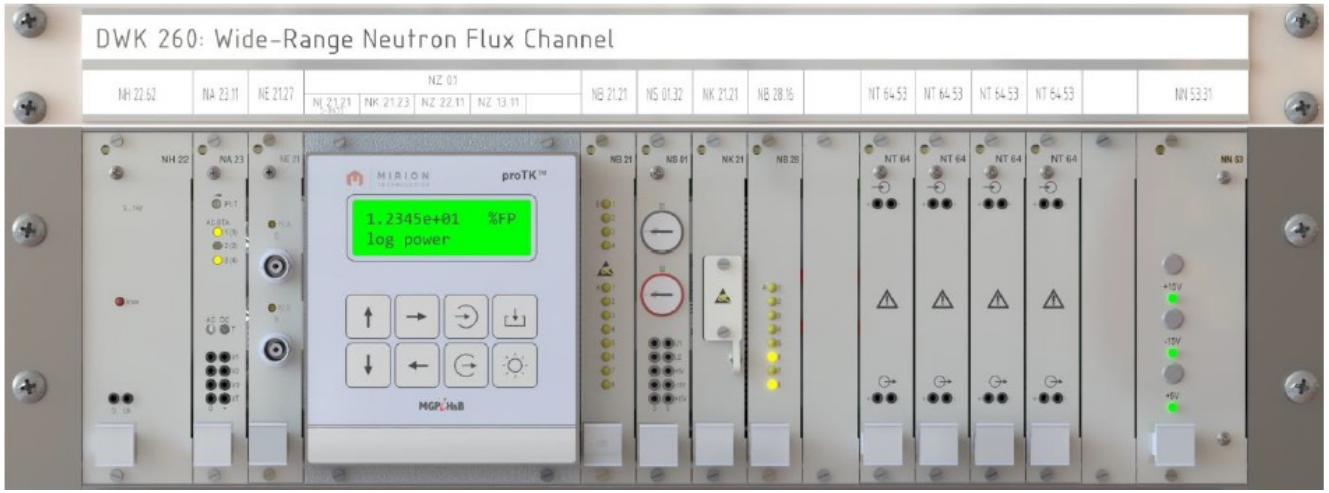
proTK™ - Wide Range Channel



DWK 260

Wide-Range Channel

Pulse, Campbell (AC) and DC processing and combined wide range lin./log. signals, for wide-range fission chambers



Note: DWK 260 shares most of the HW with DAK 260 and DGK 260, but has ist own base SW

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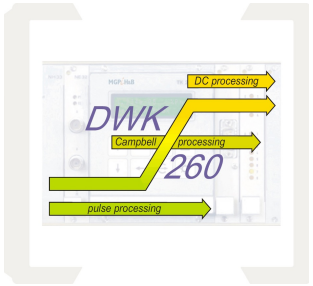
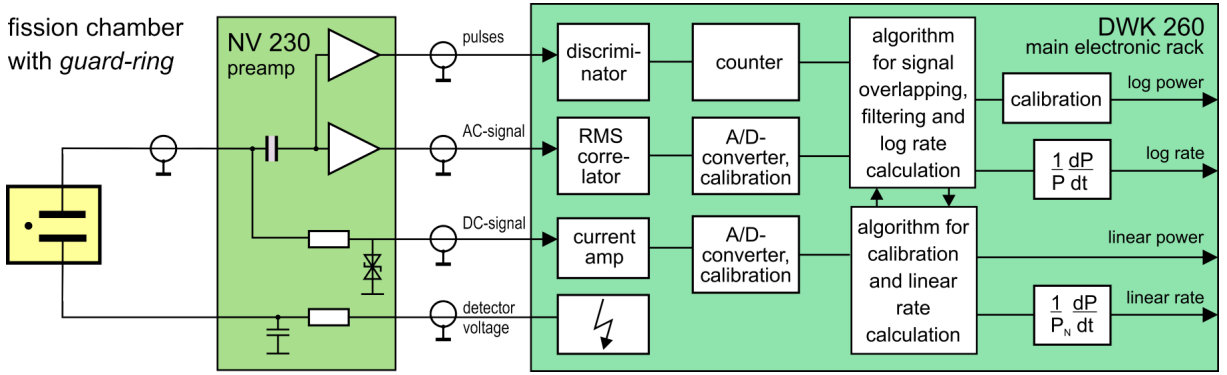
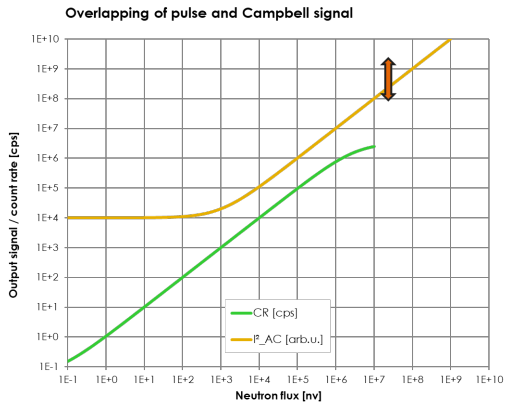
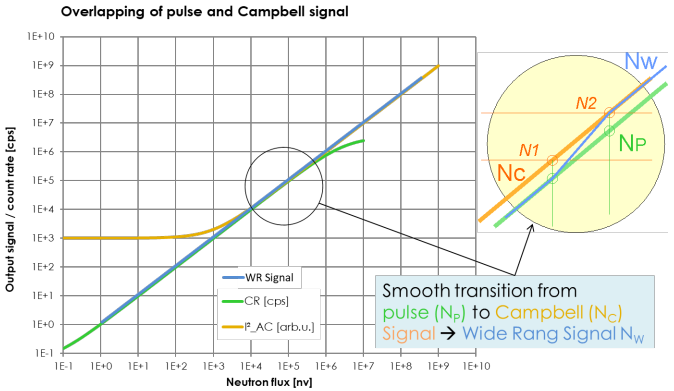
DWK 260



- *Works with wide-range fission chambers (with or without guard-ring design)*
- *Can potentially cover all relevant measurement ranges with one detector*
- *Combines Pulse, Campbell (AC) and DC signal*
- *Seamless transition due to digital calibration*
- *Tested with high-temperature fission chamber*







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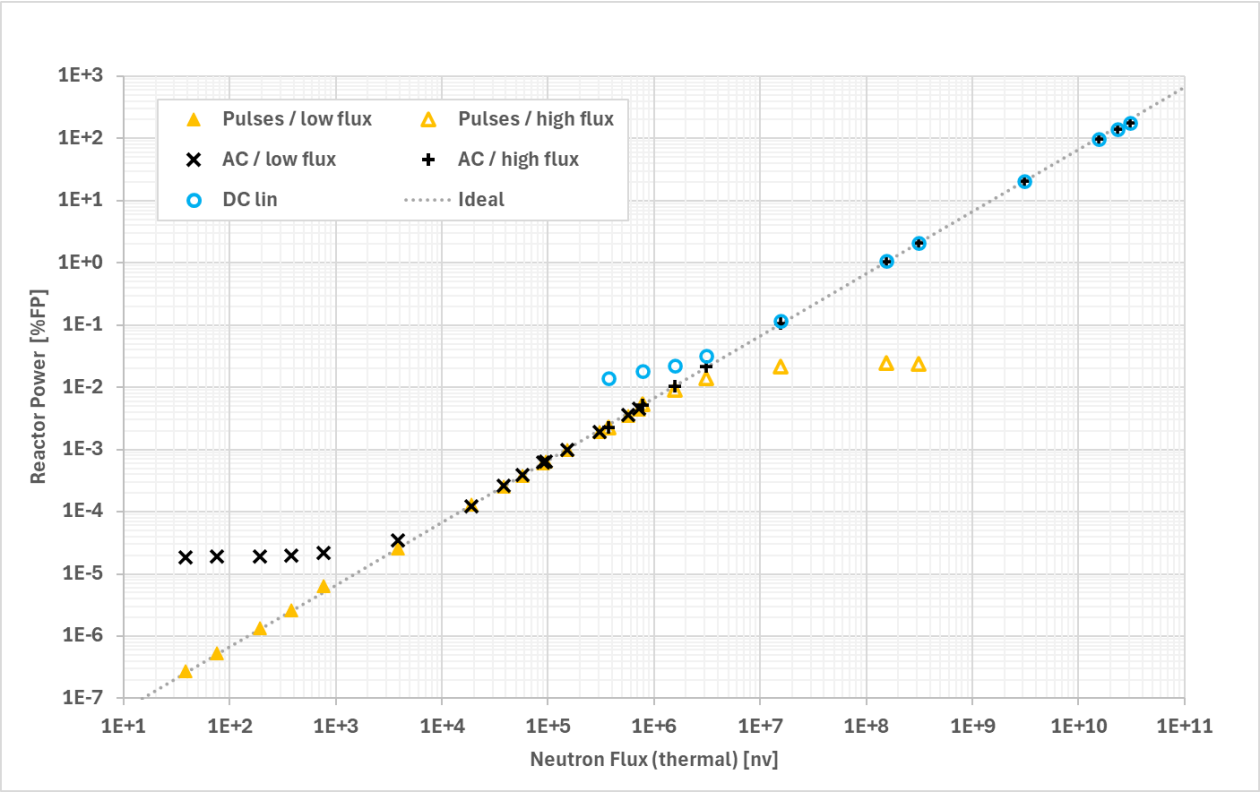
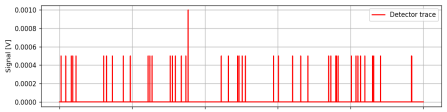
DWK 260

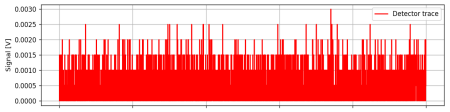
- *Works with wide-range fission chambers (with or without guard-ring design)*
- *Can potentially cover all relevant measurement ranges with one detector*
- *Combines Pulse, Campbell (AC) and DC signal*
- *Seamless transition due to digital calibration*
- *Tested with high-temperature fission chamber*



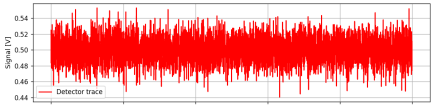
Pulse



Campbell



DC



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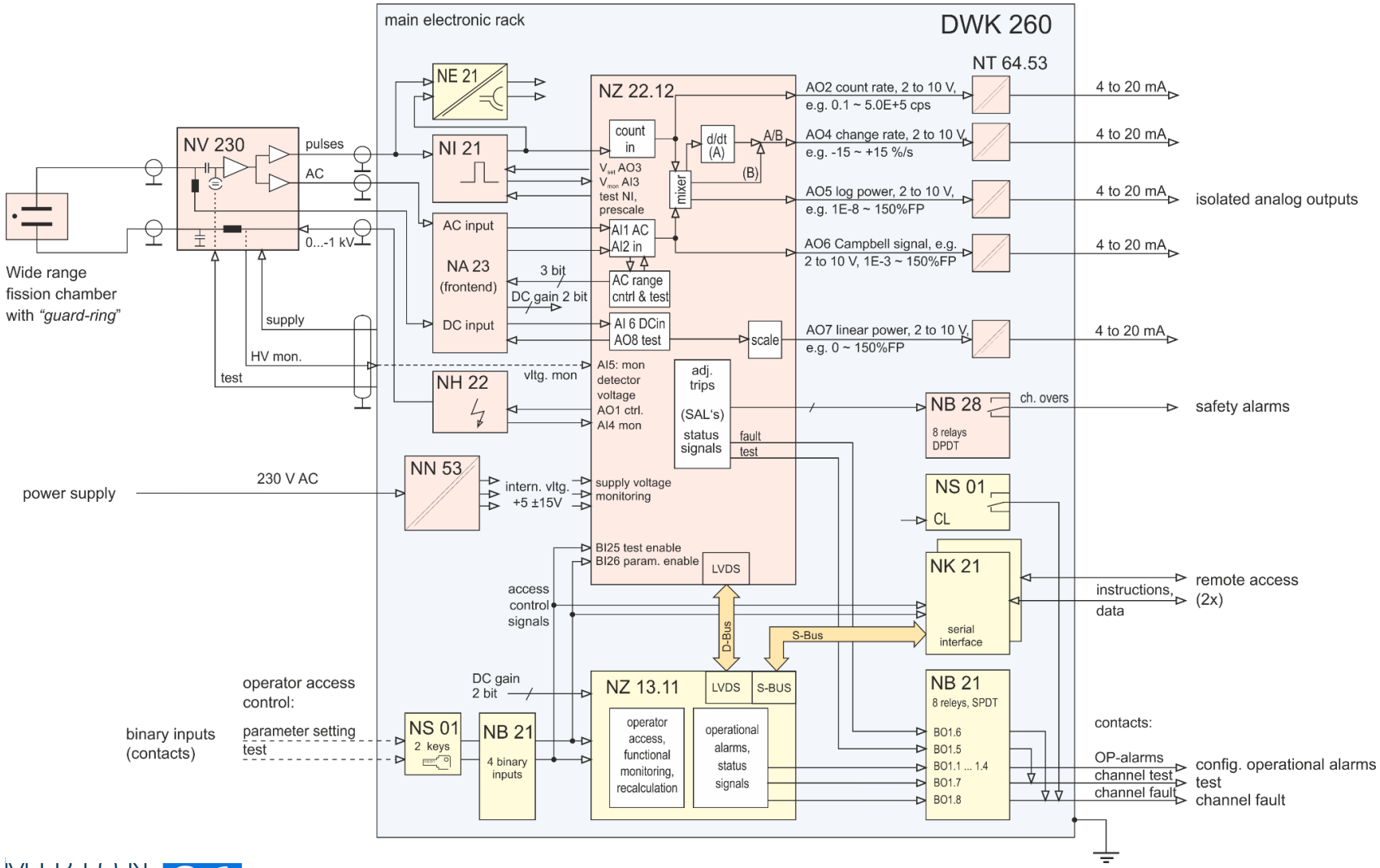
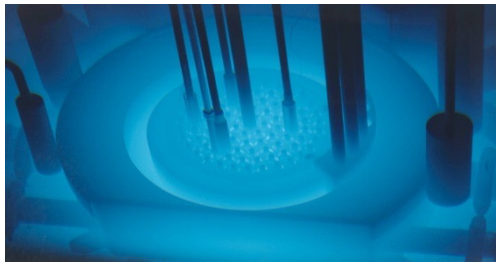
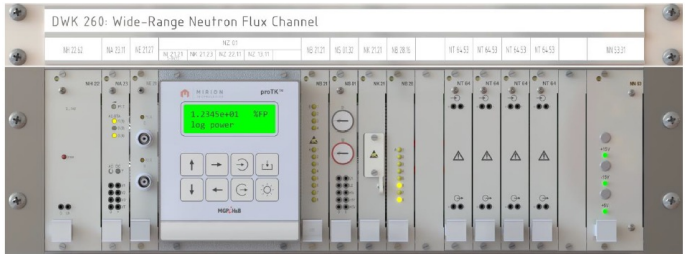
Functional Diagram of DWK 260







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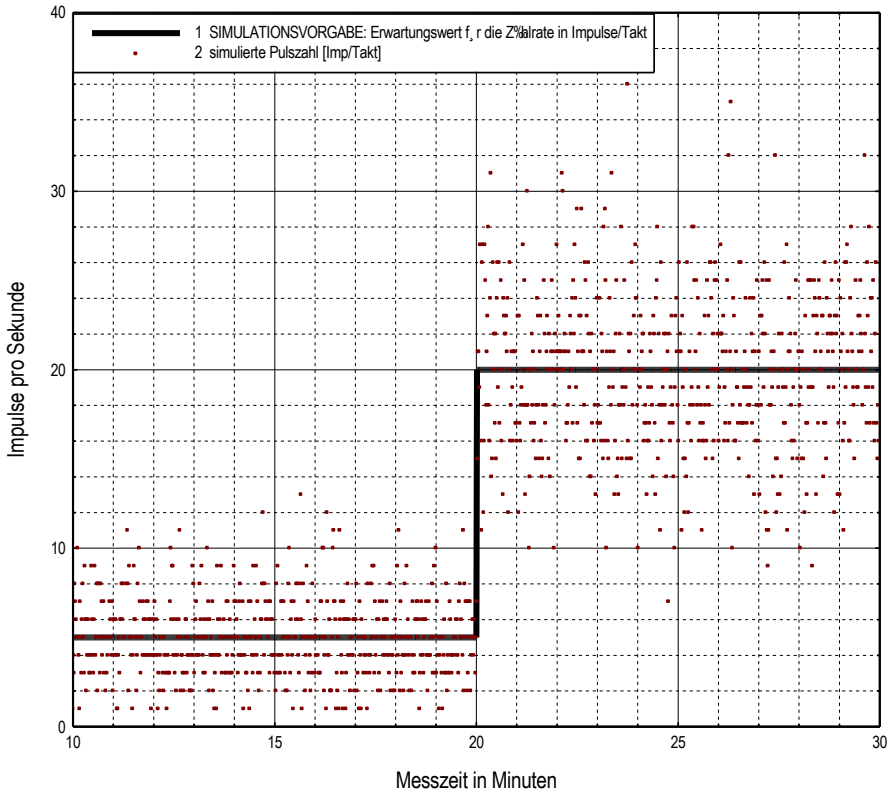
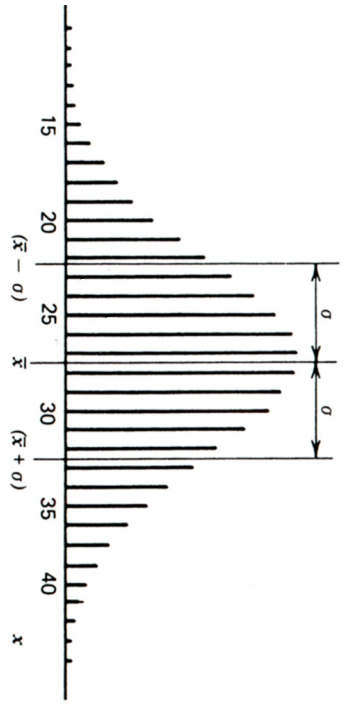
Breakout – Counting Statistics and Response Time

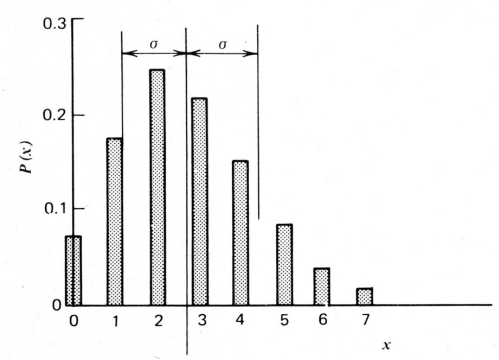
Why do we need Filters?

Source Range:

- *The count rate signal of the source range detector as statistical fluctuation (Poisson, Gauss)*
- *Can we determine a count rate increase from 5 cps to 6 cps?*







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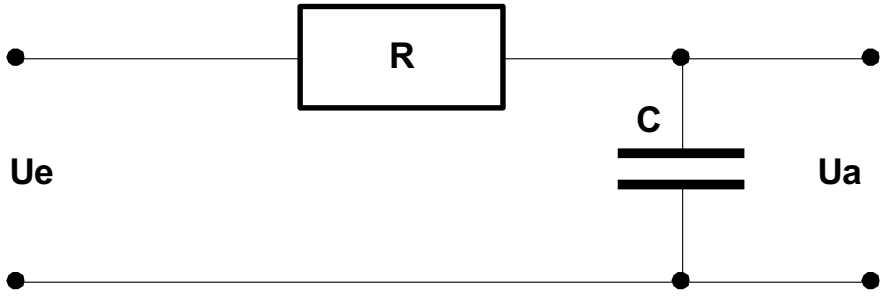
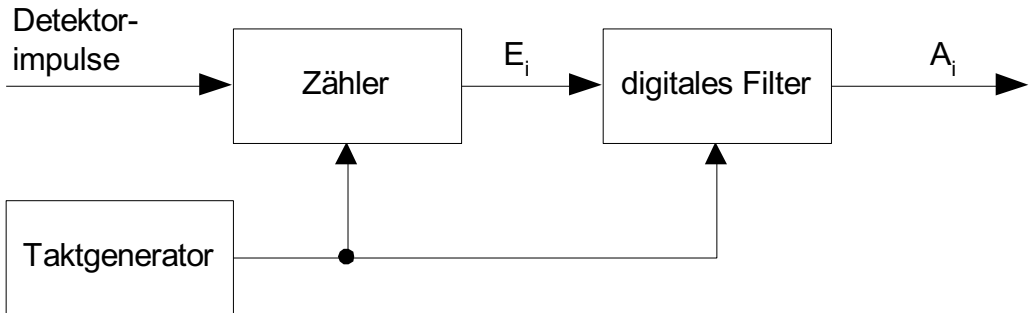
Smoothening / Filtering the Signal

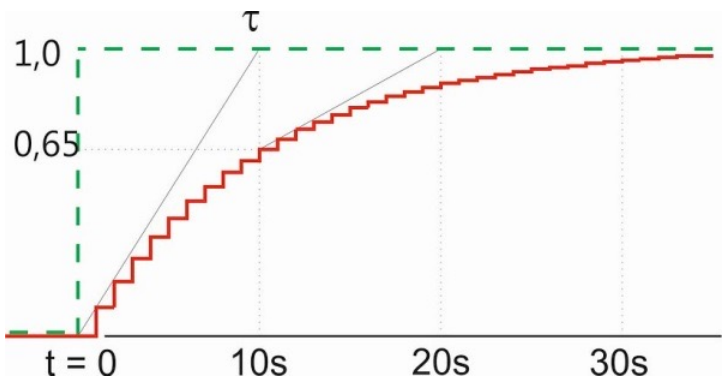
analog:



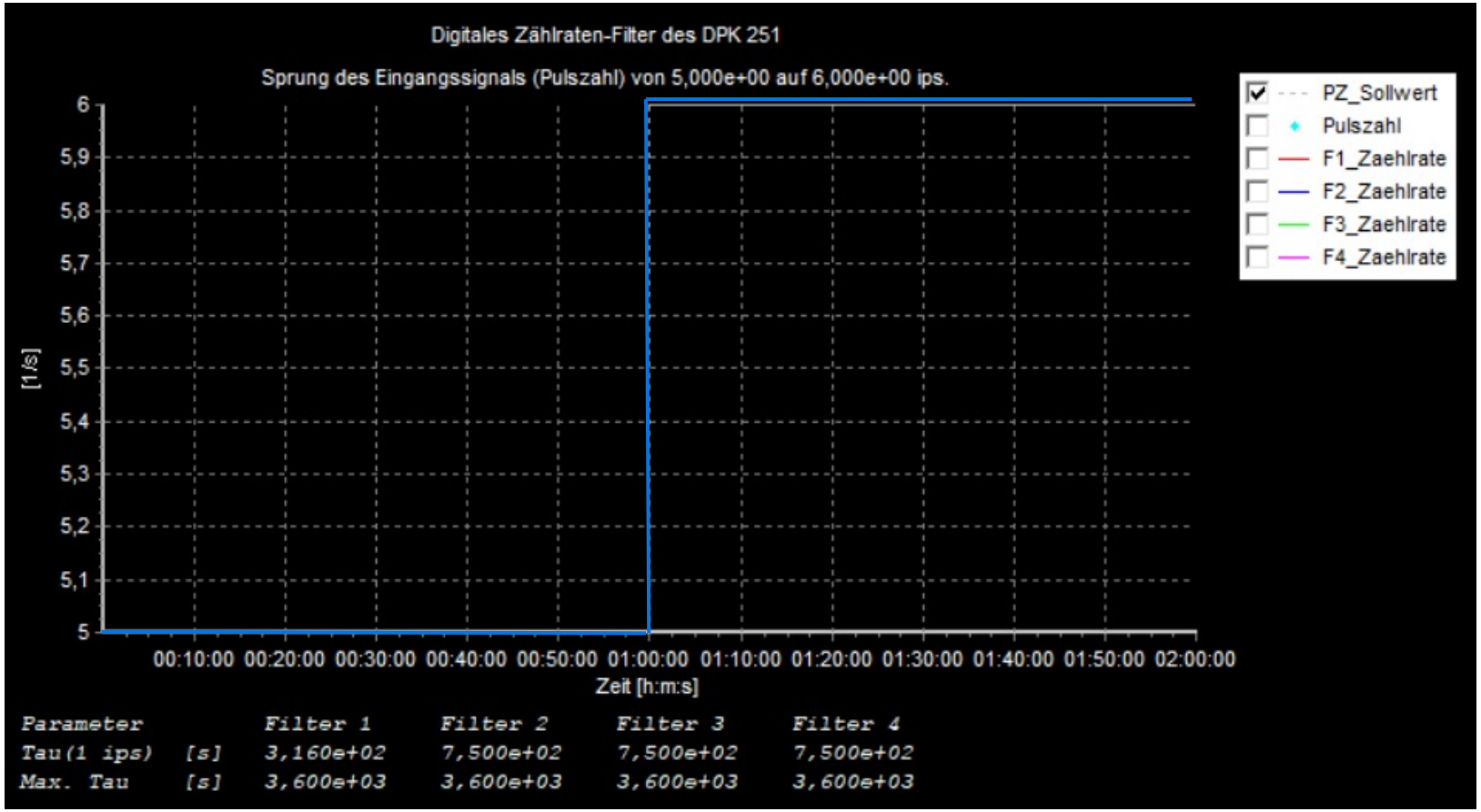
Example t = 1 s; ε = 0,1; d.h. τ ~ 10 s

digital:



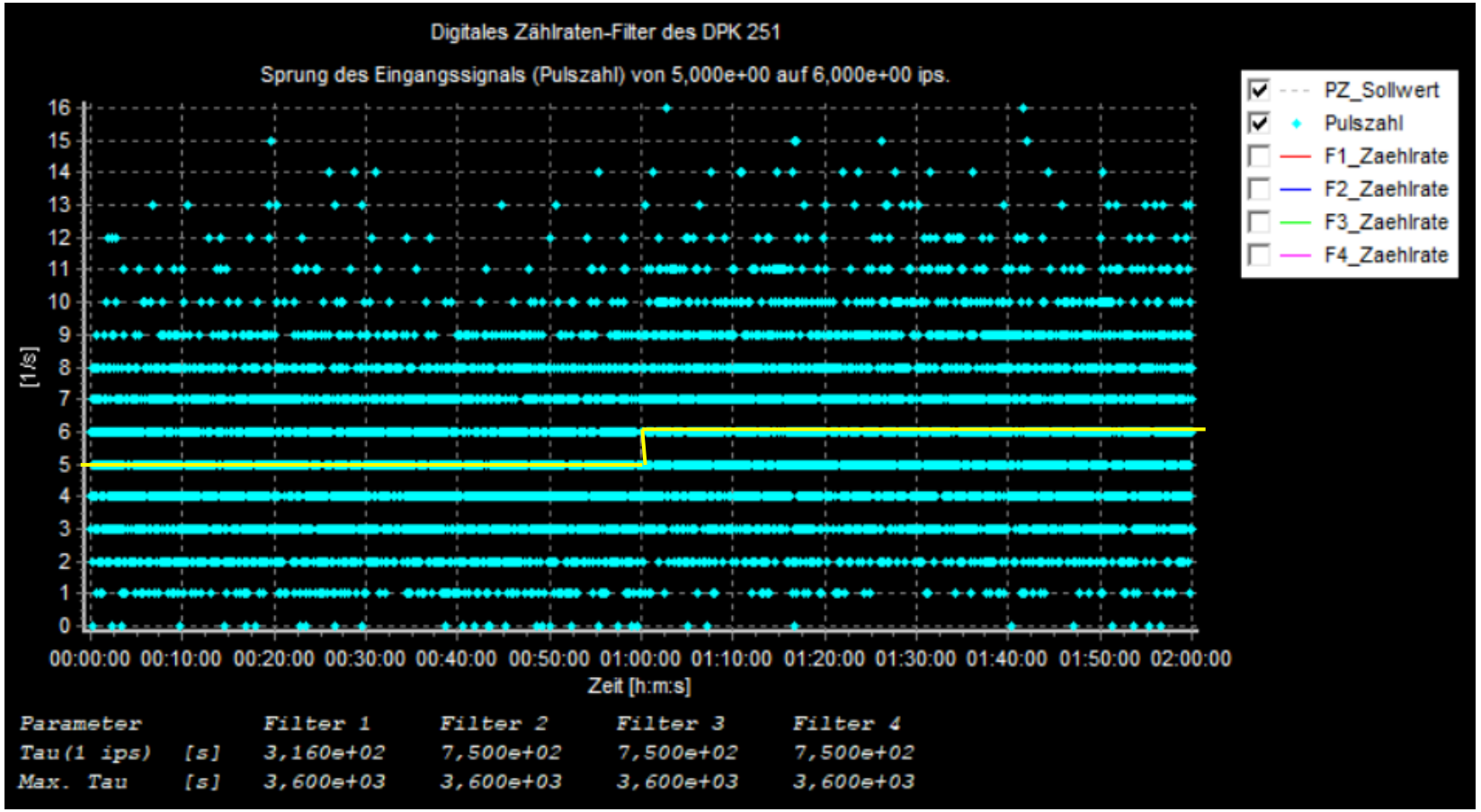


Example: Signal Filtering



t=0 bis t=3600 s : count rate = 5 cps
t > 3600 s: count rate = 6 cps

Example: Signal Filtering



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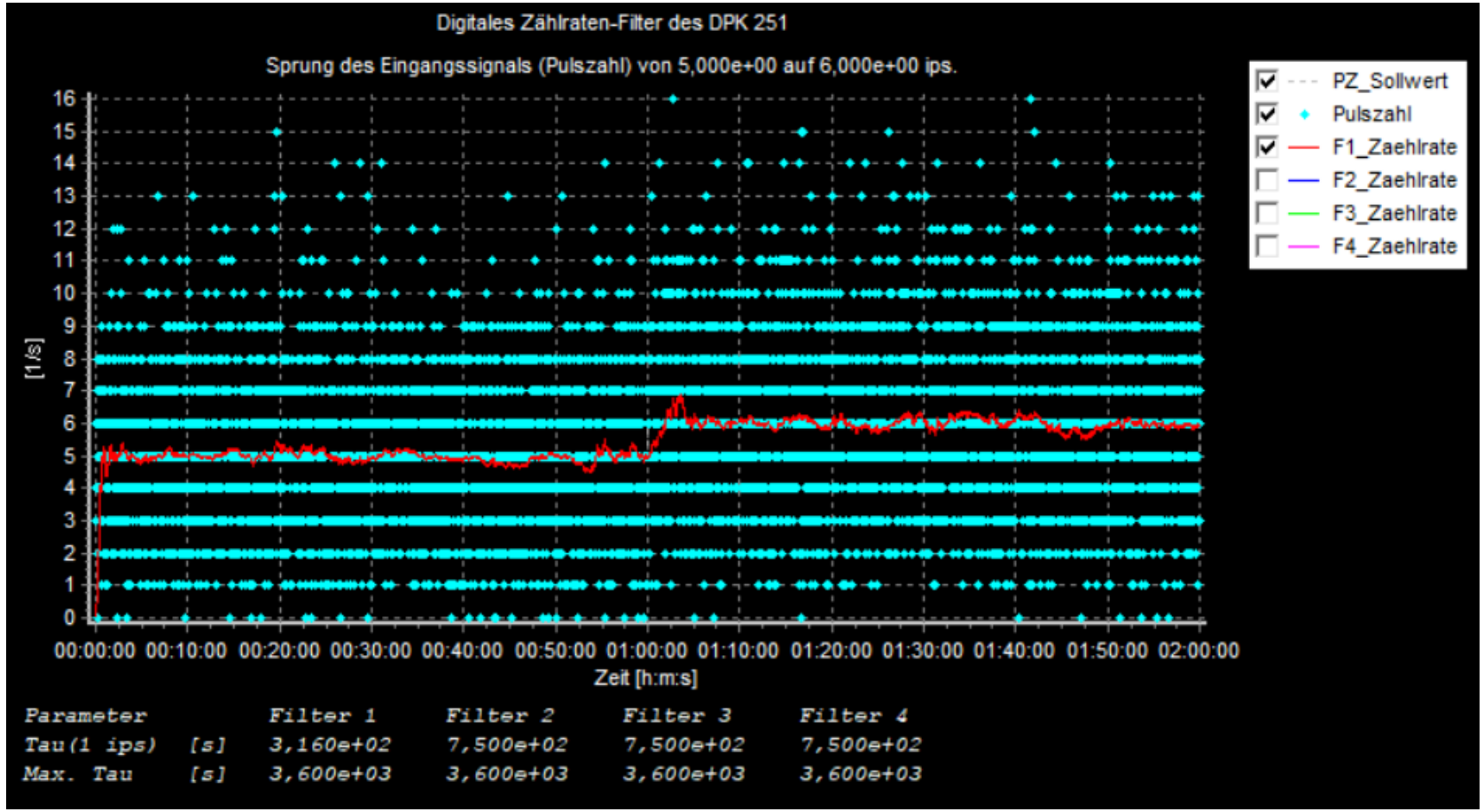

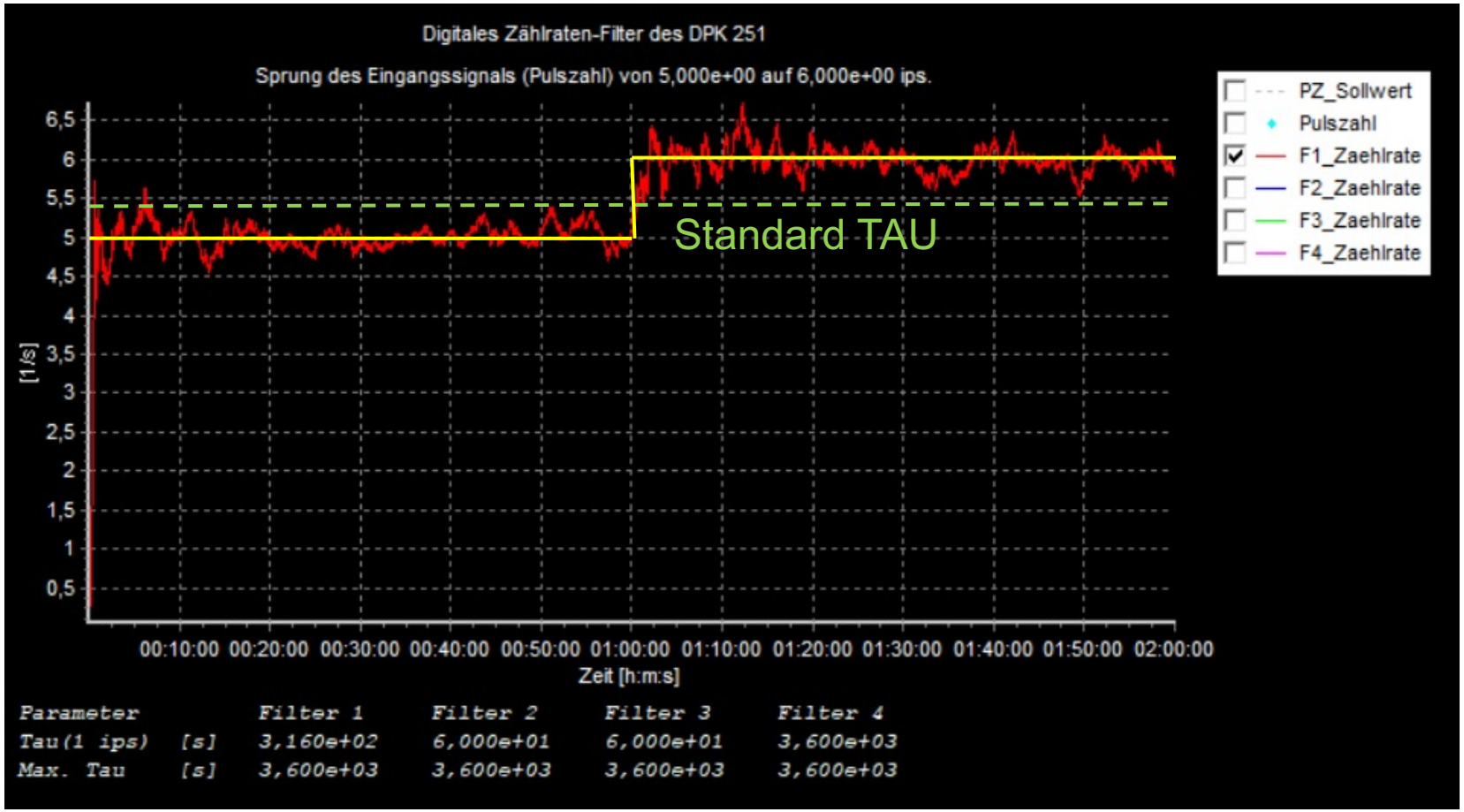

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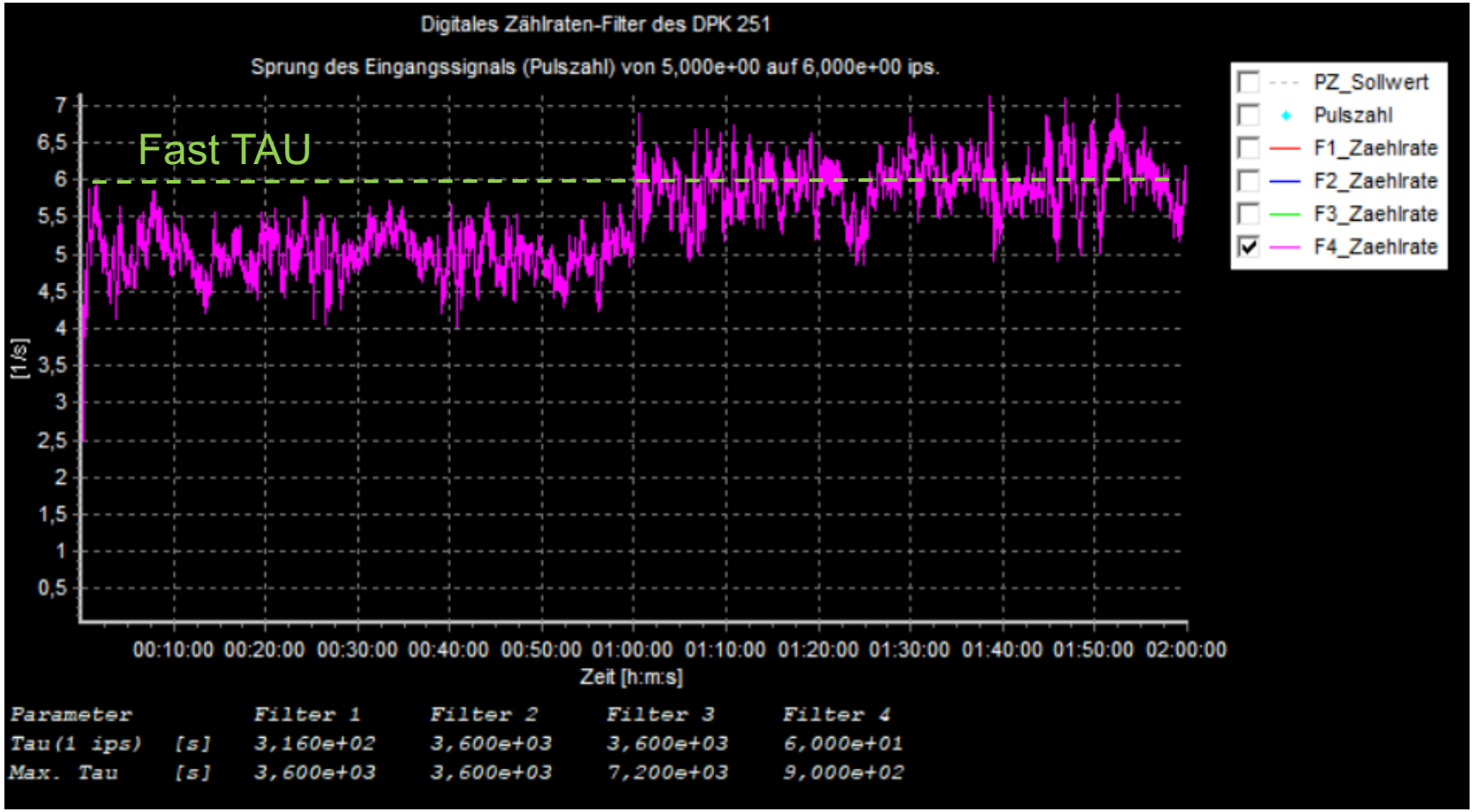

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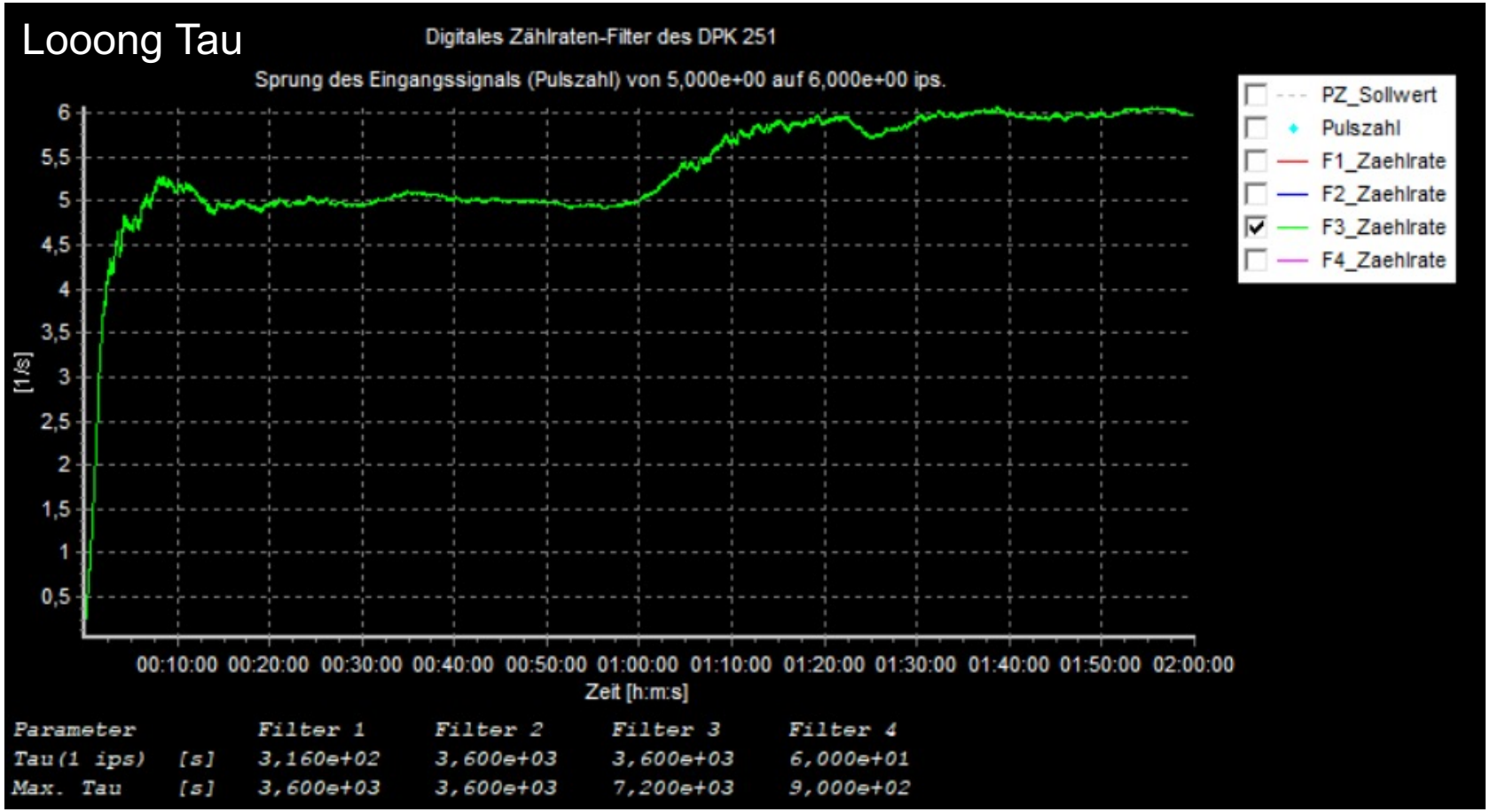
Looong Tau



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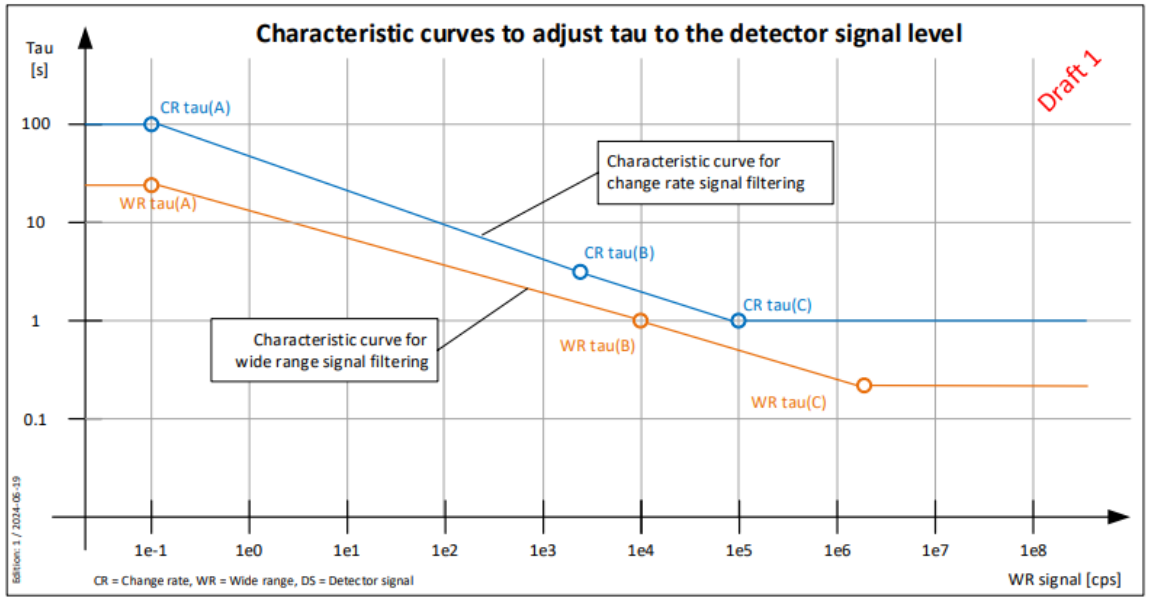
DWK 260 – LOG Signal

- *Cycle time 5 ms; 100 ms averaging*
- *Response time ≤ 60 ms + 0.7 · TAU_{WR}*
  (Log signal, symmetric step)
- *Change rate (CR):*
  Response time dependent on
  - *signal amplitude (neutron flux)*
    at start of transition,
  - *nature and characteristics of input transient*
    - *step change:*
      → approx. 1.66 · TAU_{CR} + 60 ms
    - *log-ramp:*
      → approx. 0.2 · TAU_{CR}

DWK 260 – DC LIN Signal

- *Cycle time 5 ms*
- *Response time* ≤ 15 ms + 0.7 · TAU_{LIN}
- ≤ 22 ms (for TAU_{LIN} = 10 ms)



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Projects & Achievements

proTK™ Installed Base

Safety channels	DAK – Startup and IR	DGK - Power	DWK - Wide
NPPs & Research Reactors	Germany, Netherlands, Belgium, Jordan, Switzerland, USA, Finland, China, Brazil	Germany, Netherlands, Belgium, USA, Jordan, Bangladesh, Brazil	Germany, Netherlands, Switzerland, USA, Jordan, Bangladesh
Total installations	262	63	57
Available since	1994	1996	1988
Channels x Years	>2000	603	750

plus >500 non-safety installation for RMS applications

NIS Only	No of Drawers	No of Reactors	Projected
Total	381	36	+9
Large NPPs		21	+0
Research Reactors		15	+3
Advanced Nuclear & SMR		0	+6

Average MTBF > **170 000 hrs (20a)**

Failures due to SW = **0**

Total proTKs

In the News

Westinghouse

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- AP1000 (6)
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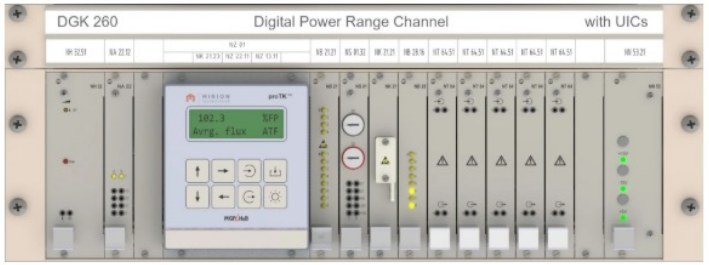
- Instrumentation & Control (2)
- Leadership Insights (4)
- Legacy (10)
- Microreactors (5)



Westinghouse is Partnering with Mirion Technologies

June 25, 2025 by Westinghouse Electric Company

Categories: Blog

Westinghouse and Mirion Technologies Inc. are collaborating to supply advanced digital Excore Nuclear Instrumentation Systems (NIS), leveraging the state-of-the-art Mirion proTK™ product line to upgrade the aging NIS which exist today in operating nuclear power plants.

Mirion Technologies
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3 Wochen •

We are honored and excited to share that we've been awarded the contract to supply the Radiation Monitoring System (RMS) and the Nuclear Instrumentation System (XIS) for the Natrium Reactor ... mehr

Übersetzung anzeigen

TerraPower
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🎉 Procurement Milestone 🎉 TerraPower has awarded contracts to three additional suppliers for the Natrium® Reactor Demonstration Project, completing 100% of the long lead procurements necessary for ... mehr

Übersetzung anzeigen

TerraPower Awards Another Round of Vendor Contracts for Natrium® Reactor, Completes...

terrapower.com

November 16, 2023

MIRION

Mirion Technologies Signs Agreement with TerraPower for Molten Chloride Reactor Experiment

Contract to provide Nuclear Instrumentation System Design and Fabrication that will Advance the World's First Critical Fast-Spectrum Salt Reactor

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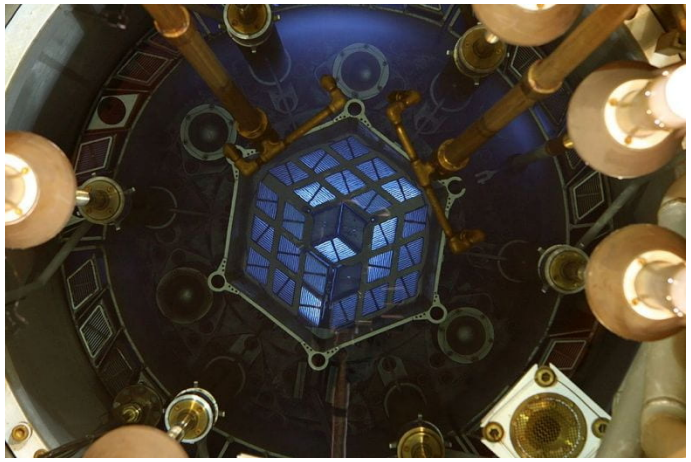
Example – MIT Reactor



Purdue Research Reactor

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US research reactor goes digital in licensing 'first'

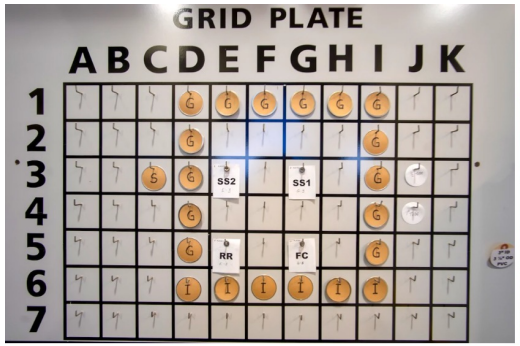
10 July 2019

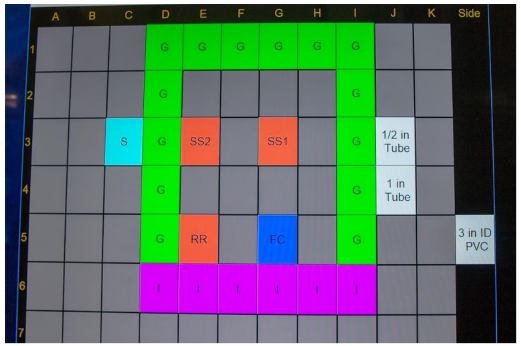
Share

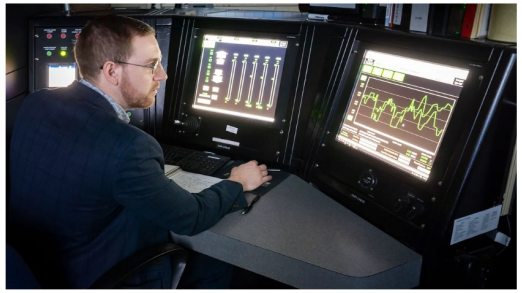
The US Nuclear Regulatory Commission (NRC) has licensed the first entirely digital nuclear reactor instrumentation and control (I&C) system in the USA, at a university-based research reactor originally built in 1962. The NRC licence also for the first time covers parts certified under standards laid down by a non-US regulatory body.

PUR-1 (Image: Vincent Walter)

Purdue University Reactor Number One (PUR-1) and its associated research facility have undergone a digital conversion which began in 2012, when the US Department of Energy awarded the university a grant under its Nuclear Energy University Program to replace reactor equipment with a state-of-the-art instrumentation and control system. The fully digital system was developed by the university in collaboration with Mirion Technologies and the Curtiss-Wright Corp.







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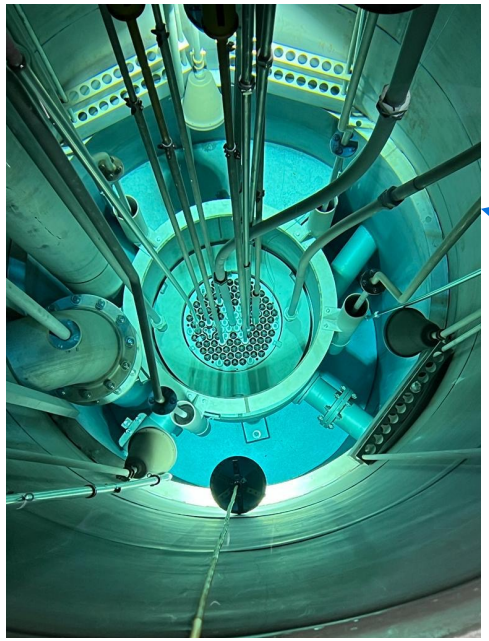
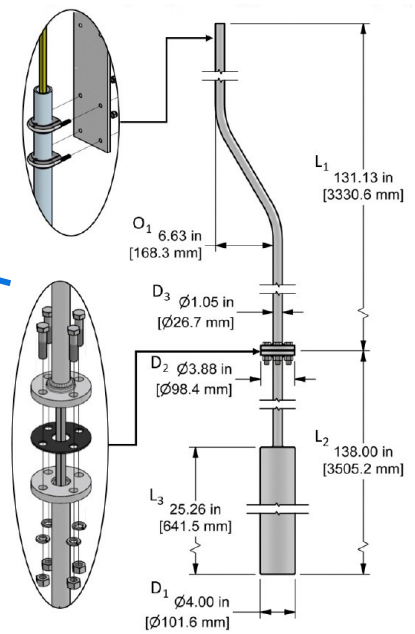
Bangladesh (BTRR)

BAEC TRIGA Research Reactor (BTRR)





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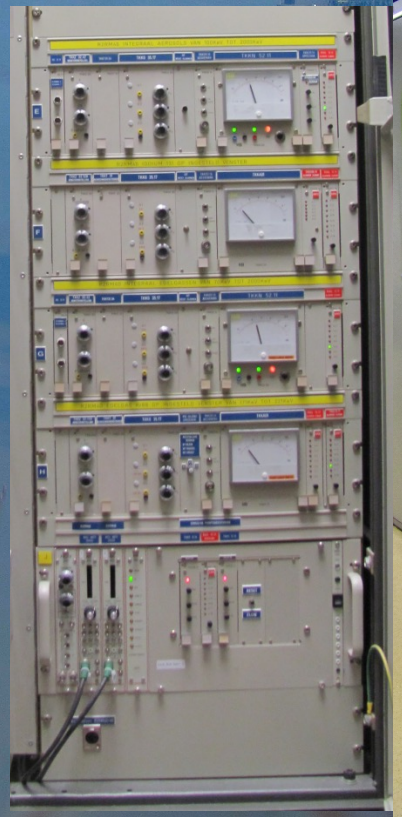
Full digital NIS upgrade of the Belgium Fleet (Doel & Tihange)

RMS Upgrade for Doel 1,2 and 4



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Thank you !

You're Invited

Join Us for a Pre-NECX Open House

Paragon, Certrec, and Mirion Technologies—the companies behind Mirion Nuclear Solutions—invite you to an open house at Paragon's Fort Worth headquarters ahead of the NECX opening reception in Dallas.

Join us for:

- Facility tours showcasing advanced capabilities and innovation, including seismic testing tables, loss-of-coolant accident (LOCA) simulation, electromagnetic interference and radio-frequency interference (EMI/RFI) testing, and a real-time reactor simulation environment
- A hands-on look at solutions supporting today's operating fleet and advanced reactors, including MCCs, plantwide modernization, digital upgrades, HVAC systems, and radiation monitoring technologies
- Insights into I&C repair and reverse engineering as a bridging solution
- Licensing support services
- Conversations with the Mirion Nuclear Solutions team on unified I&C approaches and the future of nuclear operation
- Lunch and refreshments

WHAT	**An Open House before NECX**
WHERE	**Paragon Headquarters** 7410 Pebble Drive, Fort Worth, TX
WHEN	**Monday, August 24** Drop in between 10:00 a.m – 4:00 p.m.
RSVP	Scan QR code to **register by August 7th**

Transportation between the Hilton Anatole (NECX headquarters in Dallas) and Paragon will be available throughout the day.

SHUTTLE SCHEDULE

Departure times from Hilton Anatole to Paragon:
9:30 a.m.; 11:30 a.m.; 1:30 p.m.

Departure times from Paragon to Hilton Anatole:
12:30 p.m.; 2:30 p.m.; 4:00 p.m.

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Your Voice Matters

2026 Customer Satisfaction Survey

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M Resort, Henderson, NV | June 15 – June 18

MIRION TECHNOLOGIES

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Thank you

Why is it usefull?

Source Range:

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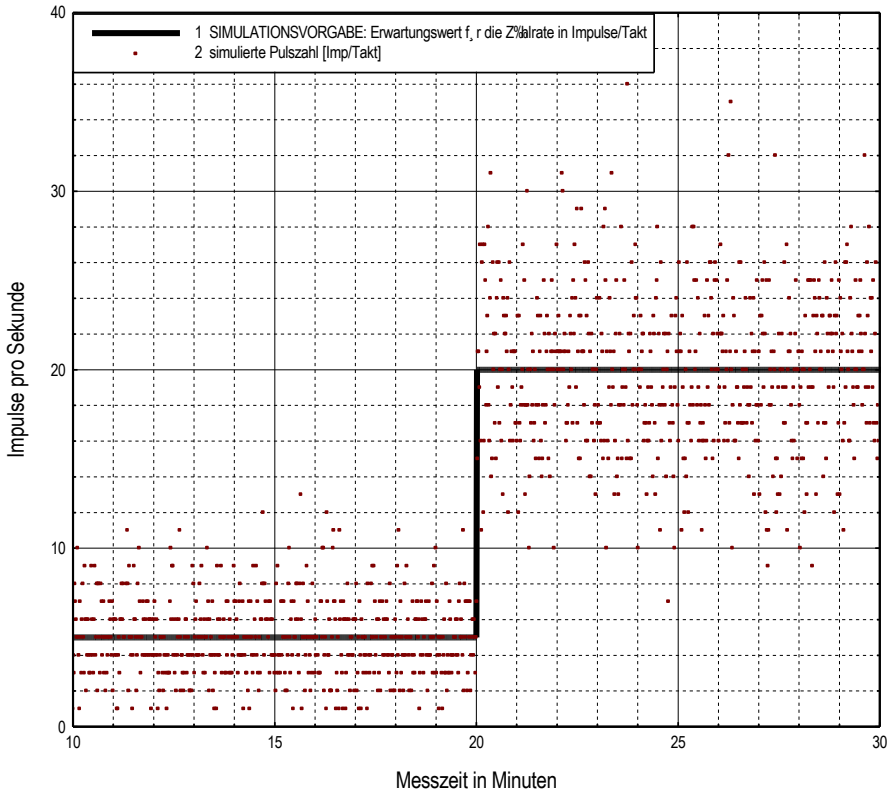
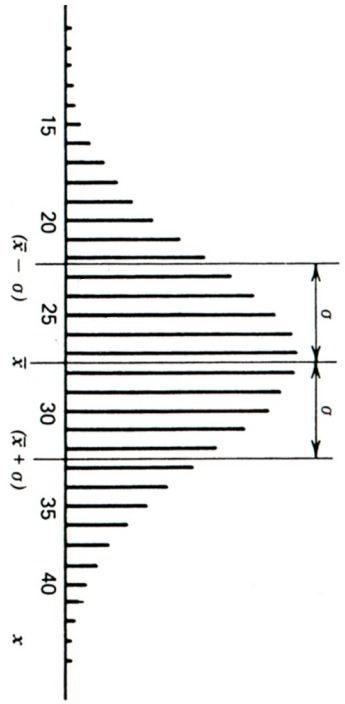
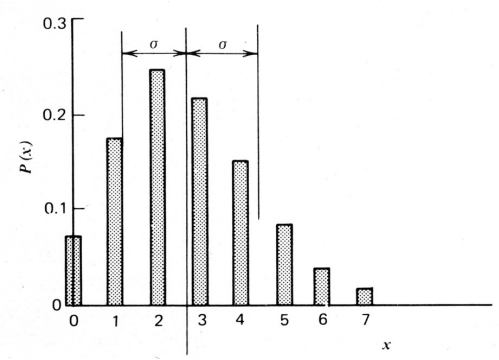
- *Can we determine a count rate increase from 5 cps to 6 cps?*







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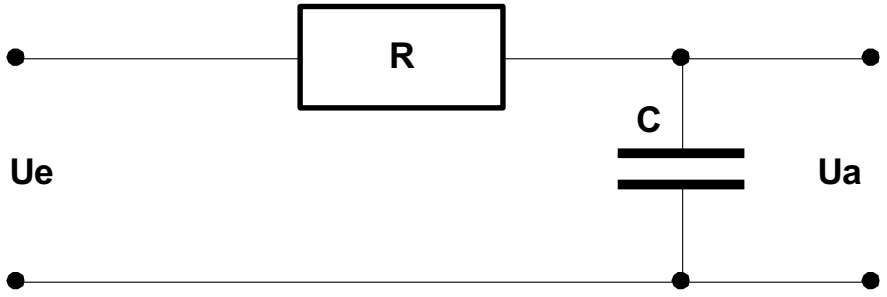
Smoothening / Filtering the Signal

analog:



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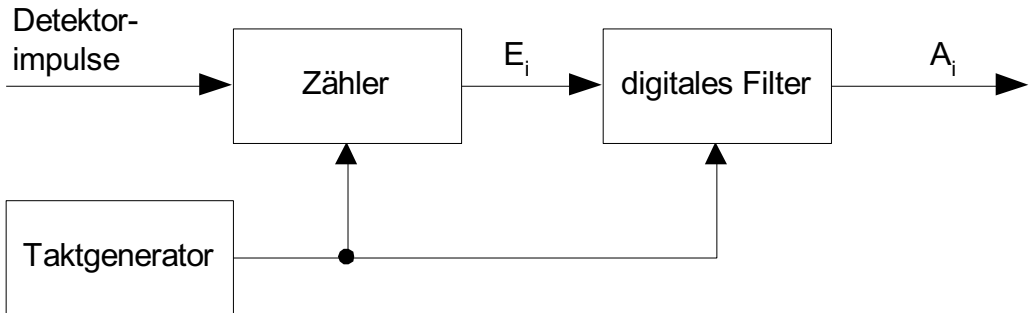
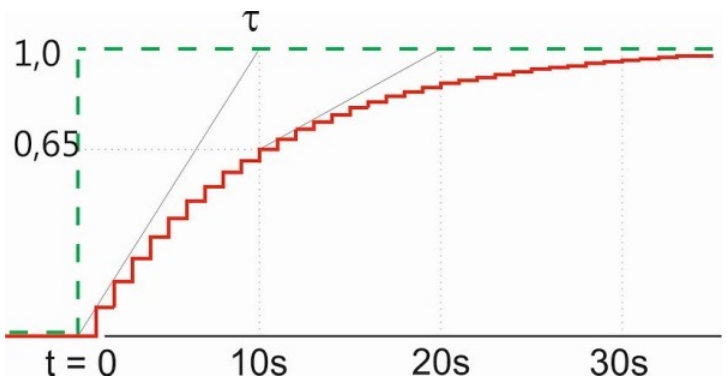
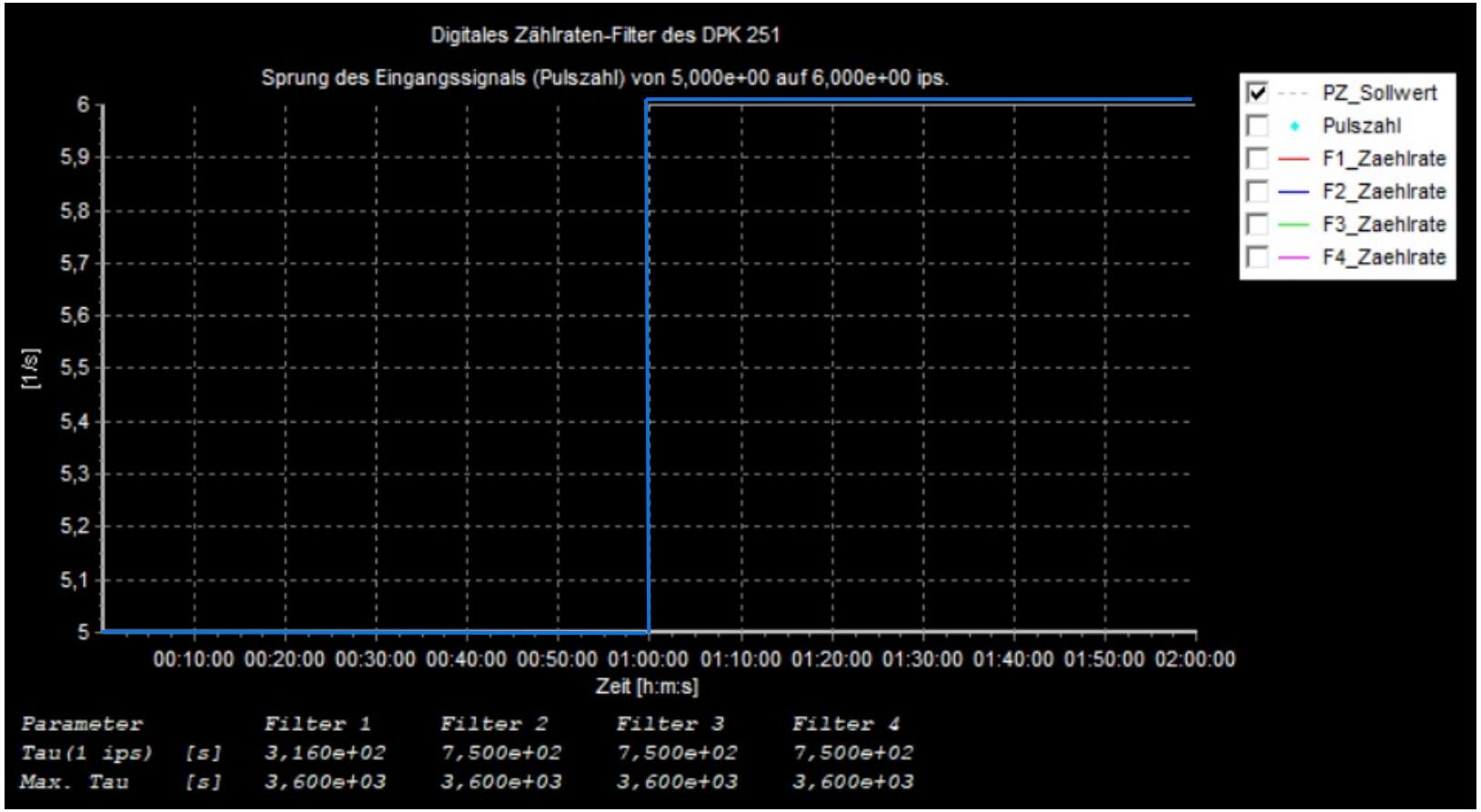
digital:





Example: Signal Filtering



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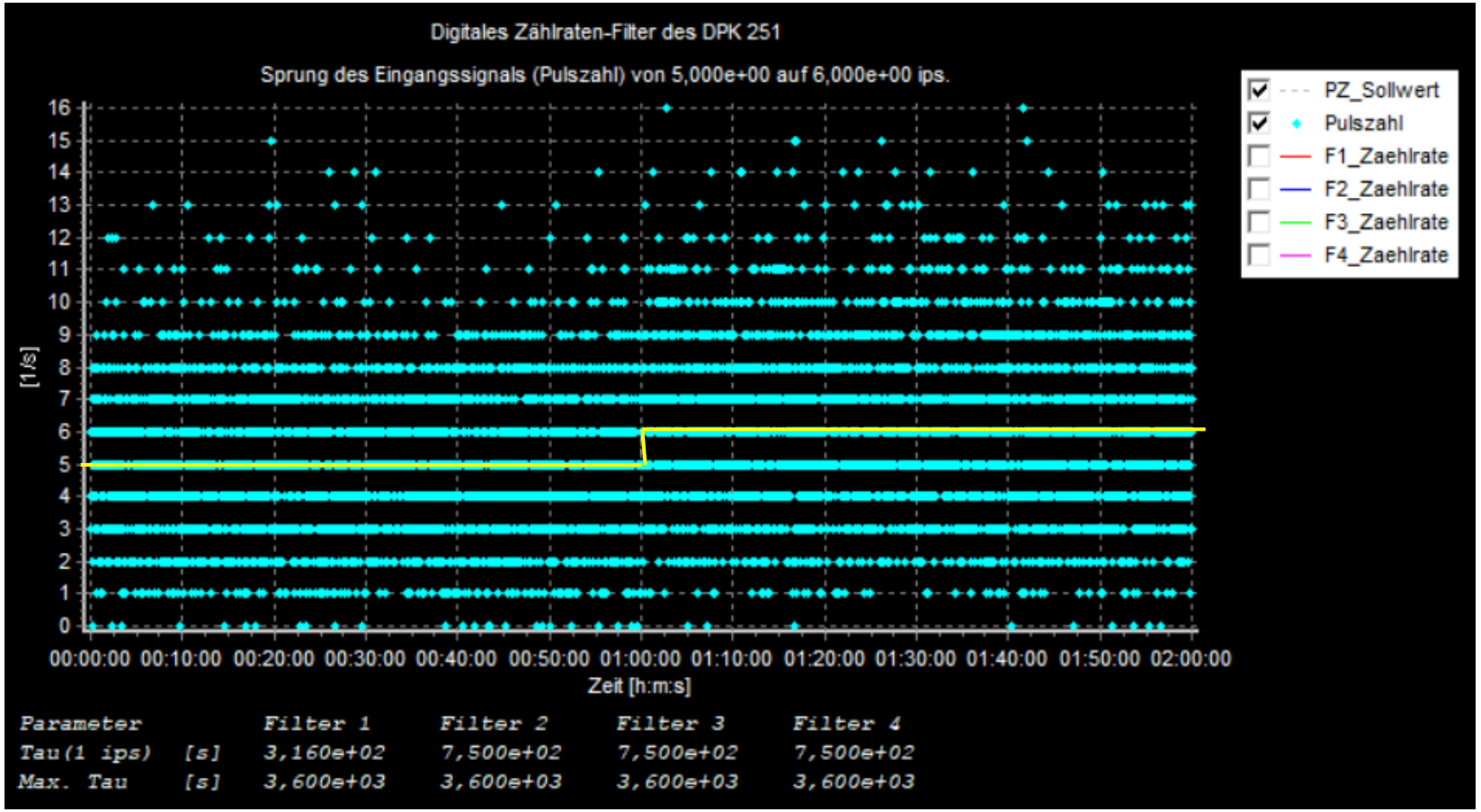

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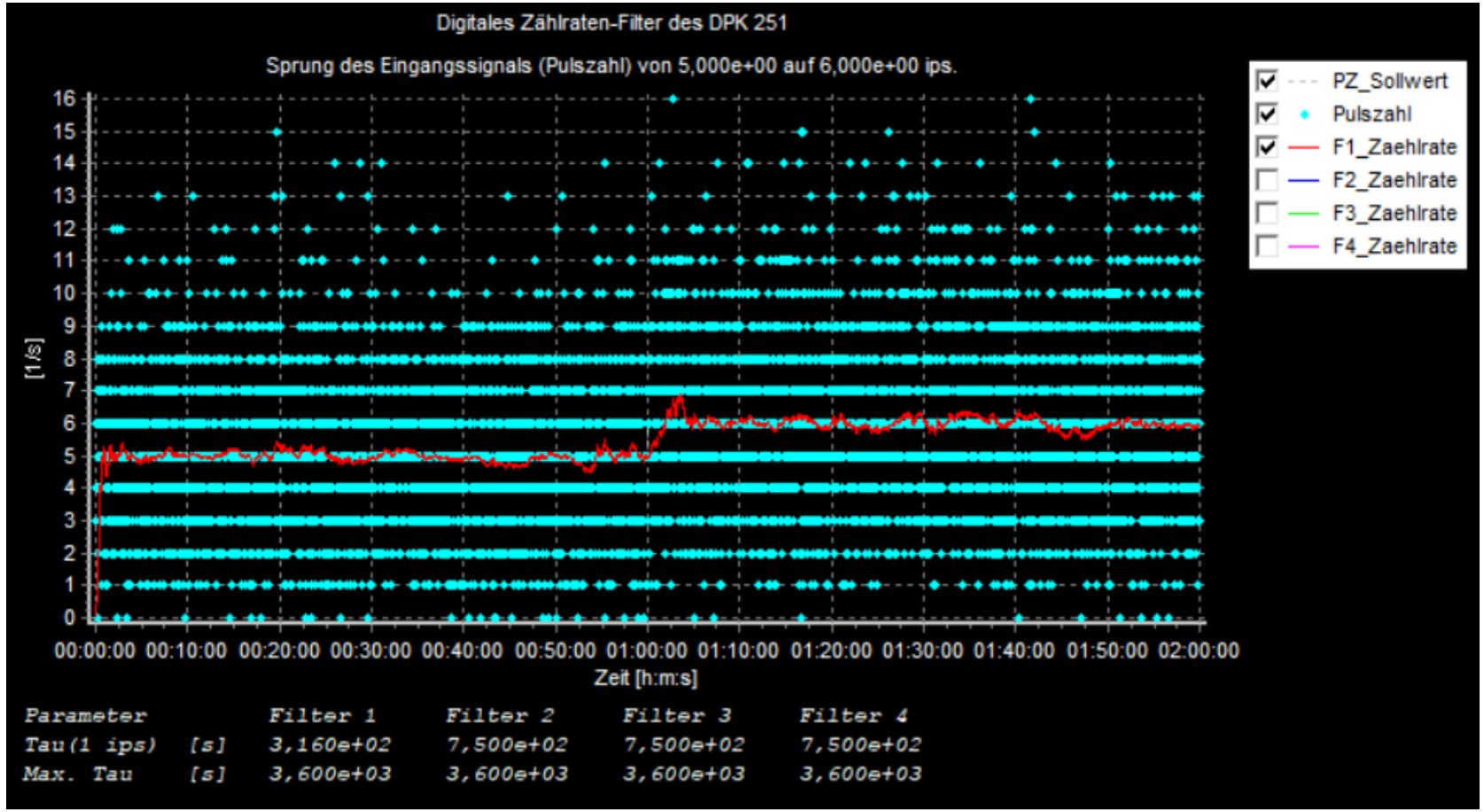
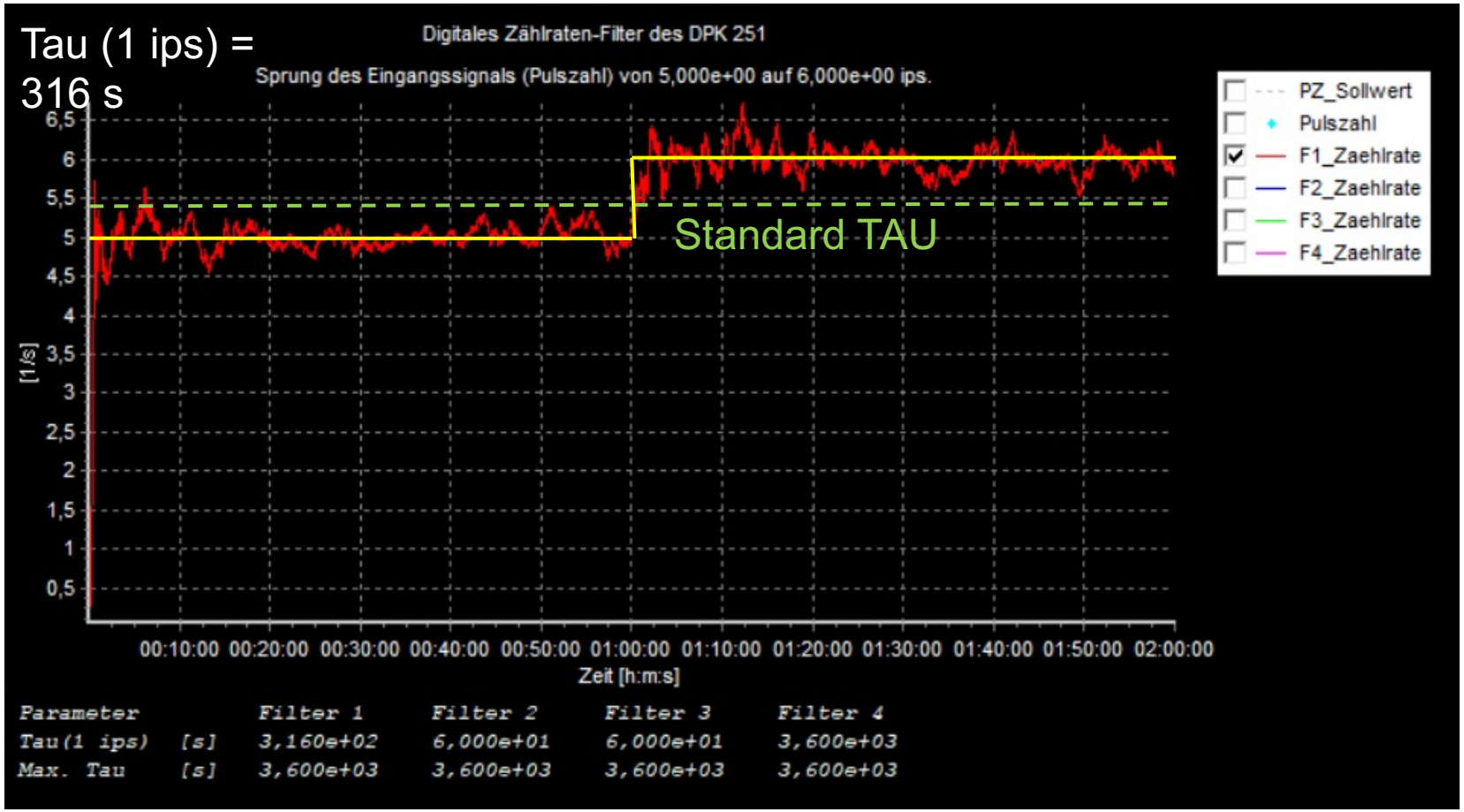
t > 3600 s: count rate = 6 cps





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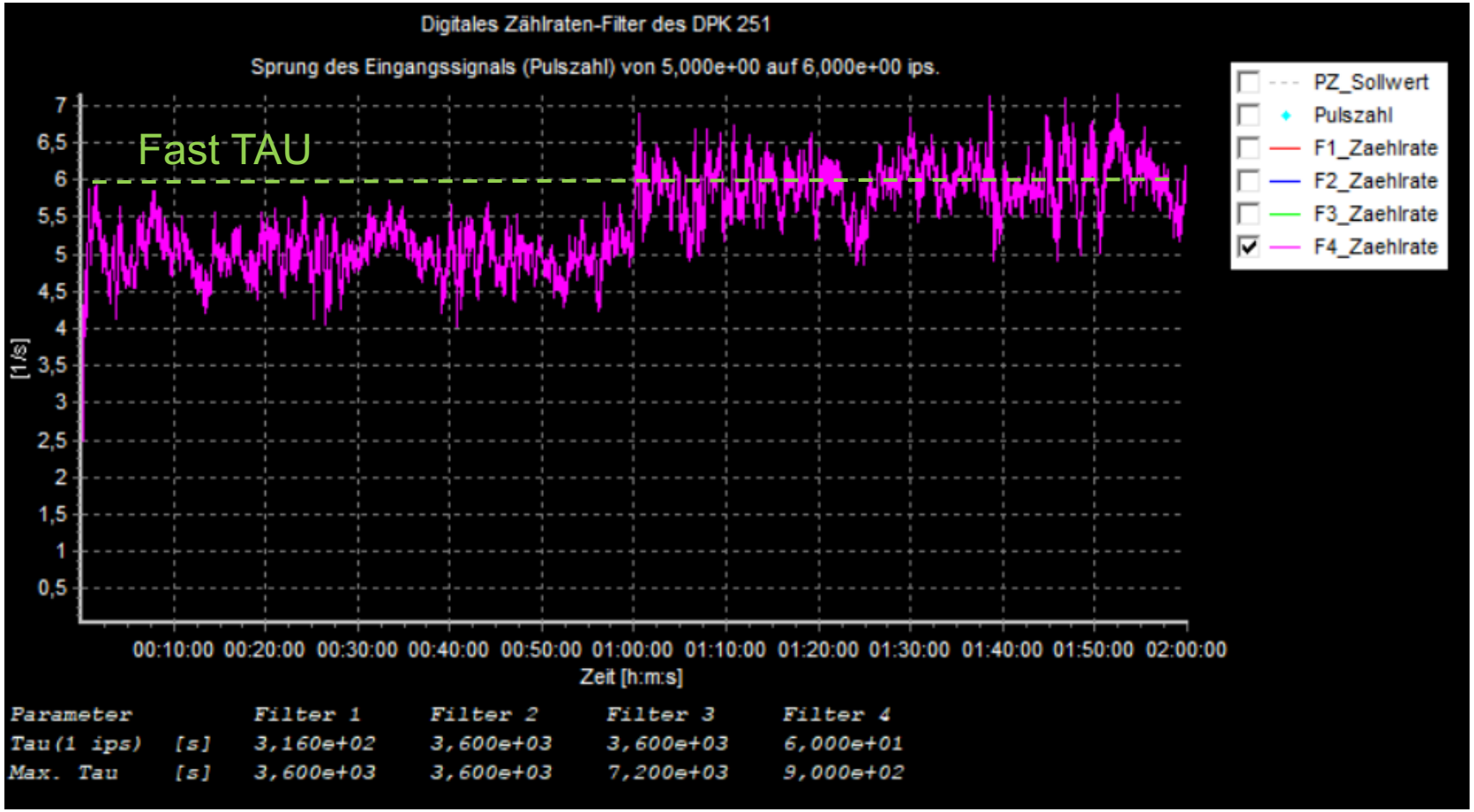

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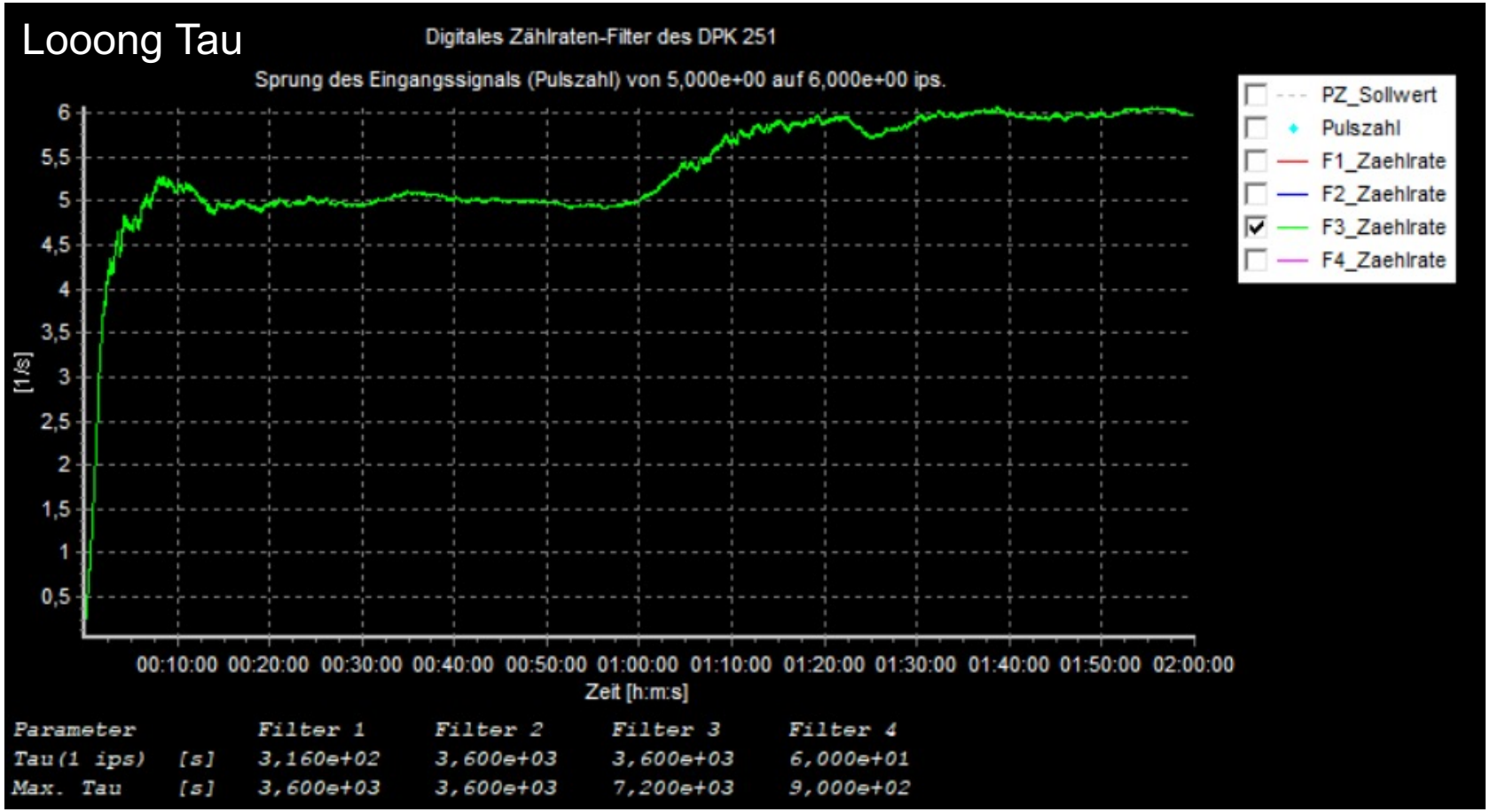
Looong Tau



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