

# INTELLIGENT DOSE RATE DETECTORS FOR RADIATION MONITORING IN AUTOMATIC MEASURING NETWORKS

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## ABSTRACT

Several gamma and neutron doserate detectors have been recently developed which are specially designed for the application in networks: All the electronic components which are necessary for an automatic measurement mode are integrated inside the detector. This also includes a microprocessor and a serial interface. On request the probe transmits the complete measurement information. Up to 32 probes can be operated in one network.

A newly developed PC program (MRP = Monitoring Radiation Program) allows to handle, present, and store the data of up to 32 intelligent probes additionally to the data of other radiation monitors.

## INTRODUCTION

Automatic ambient radiation measurements require the periodic acquisition and evaluation of signals. For this purpose in conventional systems the detector signals have to be amplified, computed and translated into a computer readable format. The new FHZ 601 A intelligent dose rate detectors perform all these steps of signal processing itself by its integrated microprocessor and analogue devices. The detector delivers completely calibrated digital data via a serial interface.

## DETECTOR EXAMPLE

The FHZ 601 A intelligent probe combines the advantages of modern microprocessor electronics with the excellent properties of the FHZ 600 A proportional detector [1] which is successfully in use in several measurement networks and monitoring stations. The high sensitivity and the wide measuring range have as well been fully retained as the typical angular and energy response (see fig. 1). For the FHZ 600 A proportional

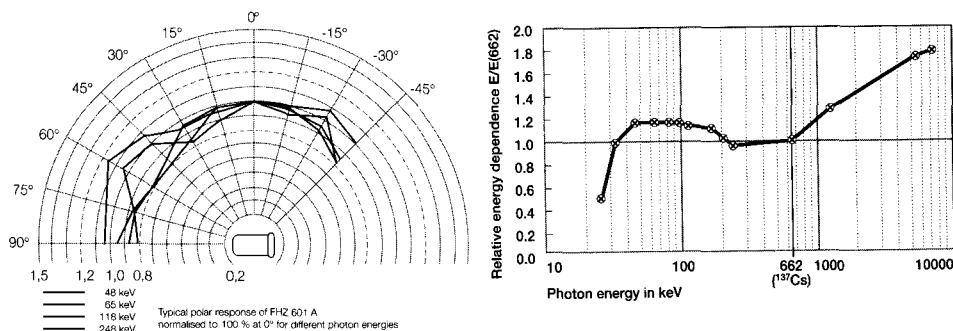


fig. 1: typical angular and energy response of the FHZ 601 A

detector as well as for the FHZ 601 A intelligent detector the approval for official calibration by German authority has been given /2/. The individual correspondence of a probe and its measuring and display instrument in a calibrated system is no longer necessary. Intelligent probes are calibrated as an independent system and can be substituted by any other one by chance without losing the calibration of the system.

#### THE ELECTRONICS

Modern technologies such as SMD technics, flexible printed circuits, and ASIC devices were used to build up the intelligent probe. It contains the energy filtered proportional counter, the high voltage supply, preamplifier, the whole counting electronics and an integrated microprocessor with a serial interface RS 485. The microprocessor controls the whole measurement and transmits a calibrated measuring value to the serial interface. Additionally it permanently performs self-tests for all devices and measures the operating and ambient conditions. The results are transmitted to the RS 485 interface as a status information.

The probe does not require any special display unit. For data acquisition and display a standard PC can be used. A software program for data handling in the PC is available (see below).

#### THE FHZ 601 A IN NETWORKS

The RS 485 interface permits the construction of local measuring networks, in which up to 32 probes can be operated from a central control station in a simple twisted pair bus system. Each probe can individually be addressed (0...31). Data transmission takes place at 2400 or 9600 bit/s via cables which may exceed even a length of 1000 m. Data transmission over distances of 3 km has successfully been tested /3/.

The measurement information is transmitted by a level 2 protocol (ISO/OSI) listed in DIN 66348 to protect data against transmission errors. The data telegram contains not only the measured value but also an identification parameter and various status information. This telegram permits

- the identification of the source i.e. the transmitting probe
- a check of the data transfer
- a permanent control of the operating conditions and the status.

The permanent self-tests detect any ambient or operating conditions out of the normal range and report them as a status information. These tests include:

- measurement of the supply voltage for the digital electronics
- measurement of the temperature
- control of the detector amplification
- preamplifier tests by permanently injecting sets of test pulses
- control of the minimum countrate (detector failure)
- watchdog routines

Further the calibration and measuring parameters can be read out by the user and a plateau measuring routine is available that can be operated on request.

A built-in history memory stores up to 256 measuring values including time and status. The measurement is therefore independent of the connection to a central computer. On request the history data can be read out without disturbing the actual measurement.

## CALIBRATION

All the calibration parameters (including two correction factors and the intrinsic background) and related information such as serial number, detector type, and software version are stored in the permanent memory (EEPROM) of each probe. The probe is calibrated at three dose rate levels. This calibration takes place once before delivery. After this initial calibration the calibration data are locked and can not accidentally be changed. For recalibration a hardware switch inside the probe has to be manipulated. Therefore by sealing the detector housing the calibration data are protected against any unauthorized changes.

## THE INTELLIGENT PROBE'S FAMILY

The electronics of the FHZ 601 A is also integrated into other proportional detectors.

The probe FHZ 621 A covers the middle and high dose rate range from 50 nSv/h to 25 mSv/h. The FHZ 621 A is also PTB approved. The BIOREM FHT 750 neutron detector which uses a  $\text{BF}_3$  proportional detector has been combined with the intelligent electronics and thus represents an intelligent neutron detector. This development allows the parallel integration of neutron and gamma detectors in the same network.

For further applications the intelligent electronics has been integrated into an ion chamber which can therefore also be used in a network together with the other detectors of the intelligent family.

## MRP MONITORING RADIATION PROGRAM

As a powerful tool for analysing and interpreting the measured values a special PC-program has been designed. It allows the acquisition, storage and presentation of the measurement results from up to eight stand alone radiation monitors e.g. aerosol monitors or from up to 6 radiation monitors plus 32 dose rate probes such as e.g. the FHZ 601 A (fig. 2). According to their interactive communication with the user 3 groups of routines can be found:

1. Automatically running routines without interactive control.

These routines are automatically executed after program start up:

- The measuring values of the connected monitors and detectors are periodically acquired. Depending on preset parameters the chart of the last 1 to 31 days of the measured values is graphically displayed. Additionally another set of measured values may be displayed numerically. Fast changing values may also appear in an analogue display as a bargraph.

- Error messages from the remote monitors and exceeded alarm levels as well as transmission failures are signaled optically and acoustically.

## 2. Routines requiring user dialogue

Using the function keys explained on the monitor the following operations may be executed:

- Change of the time and measured value scale of the graphic display.
- Selection of the measured values to be displayed.
- Display of measured values from any time period during the last 10 months and calculating the average values of selectable regions.
- Numerical output of a complete data set for any selected time.
- Display of a protocol file containing error messages from the remote monitors and exceeded alarm levels as well as transmission failures together with the time they occurred.
- Execution of special functions e.g. control of a multi channel analyser.

All these functions do not affect the permanent data acquisition of the actual measured values.

## 3. Configuration Files

The preset values for the complete program (such as time period of the data acquisition, number of the monitors and detectors, scale and colours of the graphic display and many more) are stored in external ASCII files. This allows the user to modify these parameters and thus to adapt the program to new hardware configurations or to modified requirements.

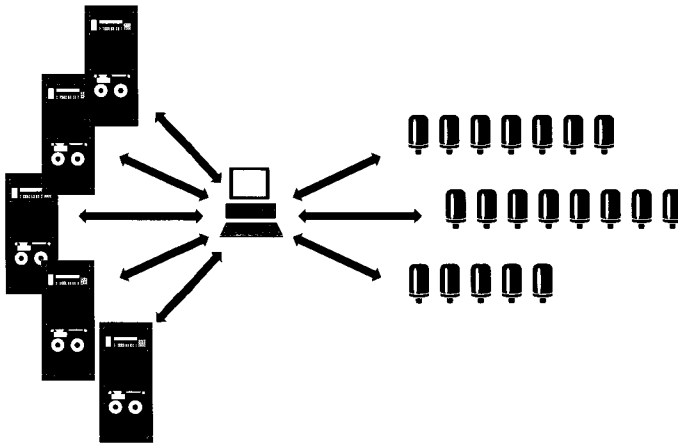


fig. 2:

Local network consisting of aerosol monitors and intelligent probes linked to a PC via MRP

- /1/ Fischer, U.: Hoheempfindlicher Proportionaldetektor zur Messung und Überwachung der Umgebungsstrahlung; Detektor FHZ 600 A im natürlichen Strahlungsfeld; FAG Erzeugnisbereich Strahlenmeßtechnik, Betriebsinterner Bericht (1989)
- /2/ Innerstaatliche Bauartzulassungen: PTB Nr. 6.41-06/89 B and PTB Nr. 6.41-17/90 B
- /3/ B. Hoffmann et al.; Intelligente Sonde FHZ 601 A für die Ortsdosimetrie; Jubiläumstagung des Fachverbandes für Strahlenschutz e.V.; Aachen (1991)