

# Neutron detector

# CFUG08

## Out-core fission chamber with integral cable

### Application

- ✓ Detection of thermal neutrons in a wide flux range of  $0.2$  to  $7 \times 10^{10}$   $\text{n.cm}^{-2}.\text{s}^{-1}$

### Features

- ✓ High sensitivity
- ✓ Also available in a LOCA-proof (Loss Of Coolant Accident) version

| Nuclear characteristics at 20°C                |                               |                                    |  |
|--|-------------------------------|------------------------------------|--|
| Sensitivity to thermal neutrons <sup>1</sup> : | Pulse mode                    | 4                                  | $\text{c.s}^{-1}/\text{n.cm}^{-2}.\text{s}^{-1}$           |
|  | Fluctuation mode              | $1.6 \times 10^{-25}$              | $\text{A}^2.\text{Hz}^{-1}/\text{n.cm}^{-2}.\text{s}^{-1}$ |
|  | Current mode                  | $8 \times 10^{-13}$                | $\text{A}/\text{n.cm}^{-2}.\text{s}^{-1}$                  |
| Neutron flux range:                            | Pulse mode <sup>2</sup>       | $0.2 - 2 \times 10^5$              | $\text{n.cm}^{-2}.\text{s}^{-1}$                           |
|  | Fluctuation mode <sup>3</sup> | $2 \times 10^3 - 7 \times 10^{10}$ | $\text{n.cm}^{-2}.\text{s}^{-1}$                           |
|  | Current mode <sup>4</sup>     | $10^5 - 7 \times 10^{10}$          | $\text{n.cm}^{-2}.\text{s}^{-1}$                           |
| Gamma sensitivity:                             |                               | $3.4 \times 10^{-8}$               | $\text{A}/\text{Gy}.\text{h}^{-1}$                         |
| Exposure limits:                               | Thermal neutrons <sup>5</sup> | max $2 \times 10^{19}$             | $\text{n.cm}^{-2}$   |
| Gamma radiation:                               | Exposure                      | max $10^9$                         | Gy   |
|  | Dose rate                     | max $10^4$                         | $\text{Gy.h}^{-1}$   |

### Electrical characteristics

|  |                           |               |          |
|--|---------------------------|---------------|----------|
| Insulating resistance at 600V <sup>6</sup> : | Nominal at 20°C           | min $10^{12}$ | $\Omega$ |
| Operating voltage:                           | Nominal up to 250°C       | 600           | V        |
|  | Maximum at 20°C           | 800           | V        |
|  | Limit with no radiation   | 1300          | V        |
| Charge collection time <sup>7</sup> :        |                           | 150           | ns       |
| Detector:                                    | Capacitance               | 1200          | pF       |
| Cable:                                       | Capacitance               | 170           | pF       |
|  | Characteristics impedance | 50            | $\Omega$ |
|  | Attenuation               | 0.34          | dB/m     |

### Mechanical and physical characteristics

|                                     |   |  |  |
|-------------------------------------|---|--|--|
| Detector:                           | Materials:  | Case, electrodes<br>Insulator<br>Brazing     | Aluminium<br>$\text{Al}_2\text{O}_3$<br>AgCu |
|                                     | Sensitive layer:                                      | Uranium enriched in $^{235}\text{U}$<br>Mass | >90%<br>1.8 $\text{mg.cm}^{-2}$              |
| Filling gas <sup>8</sup> (pressure) |   |  | Argon + 4% nitrogen<br>(at 250 kPa)          |
| Dimensions:                         | Nominal diameter                                      | 80   | mm   |
|                                     | Detector length                                       | 419  | mm   |
|                                     | Overall length, on request <sup>9</sup>               | max 12                                       | m  |
|                                     | Sensitive length                                      | 220  | mm   |
| Cable:                              | Type <sup>10</sup> : high immunity, mineral insulator | 6 coax                                       |  |
|                                     | External diameter                                     | 6  | mm   |
|                                     | Insulator<br>Curvature radius <sup>11</sup>           | MgO<br>min 60                                | mm   |
| Connector:                          | Type <sup>12</sup>                                    | Watertight, HN                               |  |
|                                     | CFUG08/F <sup>9</sup>                                 | Female                                       |  |
|                                     | CFUG08/M <sup>9</sup><br>Insulator                    | Male<br>$\text{Al}_2\text{O}_3$              |  |

### Notes.

*Unless otherwise stated, all characteristics are given at 20°C*

<sup>1</sup> Values depending on the characteristics and the calibration of the measurement equipment. The pulse sensitivity is calculated from the ( $\alpha$ -neutron) discrimination curve for a discriminating threshold corresponding to a counting rate of  $1 \text{ c.s}^{-1}$ .

<sup>2</sup> Fluctuation mode sensitivity is given for a 10 to 100 kHz pass band.

<sup>3</sup> Pulse mode operating range for a measurement equipment with a resolution shorter than the collection time of the detector.

<sup>4</sup> Current mode operating range: the lower limit of the current mode operating range depends on the electronics (especially on the input amplifier) and on the signal / parasitic current ratio (parasitic current = leakage current + gamma current +  $\alpha$ -current). The upper limit is depending both on the detector and electronics (loss of linearity).

<sup>5</sup> Flux corresponding to a 1 % sensitivity loss of the detector.

<sup>6</sup> For sensible fission chambers ( $s > 0.1 \text{ c.s}^{-1}/\text{n.cm}^{-2}.\text{s}^{-1}$ ), the  $\alpha$ -current is predominant in relation to the leakage current from the insulators. The insulating resistance is then measured by the ratio  $\Delta U/\Delta I$  of the  $I=f(U)$  curve determined without any ionizing radiation.

<sup>7</sup> Charge collection time: the measured value depends on the electronics and on the cable capacitance.

<sup>8</sup> The use of a gas mixture ( $\text{Ar} + \text{N}_2$ ) increases the electron velocity and therefore favours a short collection time.

<sup>9</sup> The type of connector (male or female) as well as the overall length (detector+cable+connector) constitute the version code to be mentioned in the detector reference after the basic type number. For example CFUG08/F5 indicates a detector with a female connector and a 5 m overall length.

<sup>10</sup> Our "6 coax" cable is the 1 Zs FCAc 60 referenced cable from Thermocoax. The "4 coax" cable is the 1 Zs FCAc 40 referenced cable from Thermocoax.

<sup>11</sup> This is the smallest curvature radius allowing one reversible deformation.

<sup>12</sup> In order to avoid humidity penetration during storage, the connector is closed with a cap to be removed just before use. As a general rule, prevent any humidity penetration at the connection level (refer to "Instructions for use and handling" in the package). Other connector types are possible on special request.

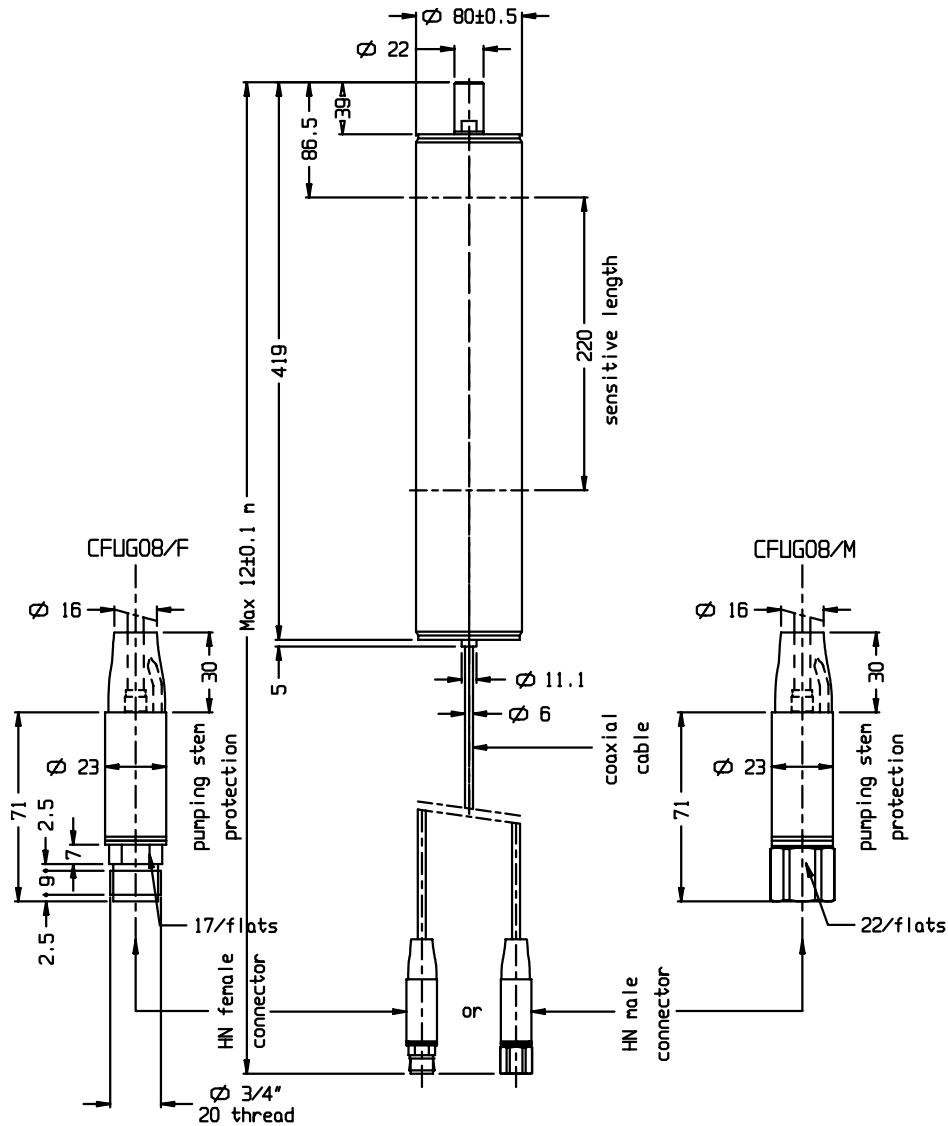
<sup>13</sup> Including temperature increase due to gamma radiation (effective above  $10^4 \text{ Gy.h}^{-1}$ ). The maximum operating temperature is indicated for pulse operating mode. The leakage current in the cable increases rapidly with temperature. It is therefore necessary to take into account this characteristic, which limits the maximum temperature so that the ratio of wanted signal/parasitic signal remains acceptable.

<sup>14</sup> Vibration test conditions: frequency 60 Hz, amplitude  $\pm 1.5 \text{ mm}$ .

# Neutron detector

# CFUG08

Outline (dimensions in mm)



| Limiting values                     | Max                   |
|-------------------------------------|-----------------------|
| Operating temperature <sup>13</sup> | 250 °C                |
| Vibration (any axis) <sup>14</sup>  | 200 m.s <sup>-2</sup> |
| Shock (perpendicular axis)          | 500 m.s <sup>-2</sup> |

The information furnished is believed to be accurate and reliable, but is not guaranteed and is subject to change without notice. No liability is assumed by PHOTONIS for its use. Performance data represents typical characteristics as individual product performance may vary. Customers should verify that they have the most current PHOTONIS product information before placing orders. No claims or warranties are made as to the application of PHOTONIS products. Pictures may not be considered as contractually binding. This document may not be reproduced, in whole or in part, without the prior written consent of PHOTONIS.