

# Neutron detector

# CFUC07

## High-temperature fission chamber

### Application

- ✓ Detection of neutrons at temperature up to 600°C

### Features

- ✓ High sensitivity
- ✓ Very high immunity against interferences
- ✓ Very short collection times in pulse mode

| Nuclear characteristics at 20°C                |                               |                        |  |
|--|-------------------------------|------------------------|--|
| Sensitivity to thermal neutrons <sup>1</sup> : | Pulse mode                    | 1                      | $\text{c.s}^{-1}/\text{n.cm}^{-2}.\text{s}^{-1}$           |
|  | Fluctuation mode              | $4 \times 10^{-26}$    | $\text{A}^2.\text{Hz}^{-1}/\text{n.cm}^{-2}.\text{s}^{-1}$ |
|  | Current mode                  | $2 \times 10^{-13}$    | $\text{A}/\text{n.cm}^{-2}.\text{s}^{-1}$                  |
| Neutron flux range:                            | Pulse mode <sup>2</sup>       | 1 - $10^6$             | $\text{n.cm}^{-2}.\text{s}^{-1}$                           |
| Gamma sensitivity:                             |                               | $7 \times 10^{-9}$     | $\text{A}/\text{Gy}.\text{h}^{-1}$                         |
| Exposure limits:                               | Thermal neutrons <sup>3</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>4</sup> : | Between signal and outer shell | min $10^{12}$ | $\Omega$ |
|  | Between HV and outer shell     | min $10^{12}$ | $\Omega$ |
|  | Between signal and HV          | min $10^{13}$ | $\Omega$ |
| Operating voltage:                           | Nominal up to 600°C            | 400           | V        |
|  | Maximum at 20°C                | 600           | V        |
|  | Limit with no radiation        | 1300          | V        |
| Charge collection time <sup>5</sup> :        |                                | 100           | ns       |
| Cable:                                       | Capacitance                    | 170           | pF/m     |
|  | Characteristic impedance       | 50            | $\Omega$ |
|  | Attenuation                    | 0.34          | dB/m     |

### Mechanical and physical characteristics

|                                     |  |  |   |
|-------------------------------------|--|--|---|
| Detector:                           | Materials:   | Case, electrodes<br>Insulator<br>Brazing     | Inconel (Co<0.05%)<br>$\text{Al}_2\text{O}_3$<br>NiCuAu |
|                                     | Sensitive layer:                                     | Uranium enriched in $^{235}\text{U}$<br>Mass | >90%<br>1.4 $\text{mg.cm}^{-2}$                         |
| Filling gas <sup>6</sup> (pressure) |  |  | Argon + 4% nitrogen<br>(at 400 kPa)                     |
| Dimensions:                         | Nominal diameter                                     | 48   | mm  |
|                                     | Detector length                                      | 372  | mm  |
|                                     | Overall length, on request <sup>7</sup>              | max 12                                       | m   |
|                                     | Sensitive length                                     | 230  | mm  |
| Cable:                              | Type <sup>8</sup> : high immunity, mineral insulator | 6 coax                                       |   |
|                                     | External diameter                                    | 6 mm   |   |
|                                     | Insulator<br>Curvature radius <sup>9</sup>           | MgO<br>min 60 mm                             |   |
| Connector:                          | Type <sup>10</sup>                                   | HN, watertight                               |   |
|                                     | CFUC07/F <sup>7</sup>                                | female                                       |   |
|                                     | CFUC07/M <sup>7</sup>                                | male   |   |
|                                     | Insulator  | $\text{Al}_2\text{O}_3$                      |   |

### 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 c.s<sup>-1</sup>.

<sup>2</sup> Pulse mode operating range for a measurement equipment with a resolution shorter than the collection time of the detector.

<sup>3</sup> Flux corresponding to a 1% sensitivity loss of the detector.

<sup>4</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>5</sup> Charge collection time: the measured value depends on the electronics and on the cable capacitance.

<sup>6</sup> The use of a gas mixture (Ar + N<sub>2</sub>) increases the electron velocity and therefore favours a short collection time.

<sup>7</sup> The type of connector (male or female) and the overall length (detector + cable + connector) constitute the version code to be mentioned in the detector reference after the basic type number. For example CFUC07/F5 indicates a detector with a female connector and a 5 m overall length.

<sup>8</sup> Our "6 coax" cable is the 1 Zs FCAc 60 referenced cable from Thermocoax.

<sup>9</sup> This is the smaller curvature radius allowing one reversible deformation.

<sup>10</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. To be required when ordering.

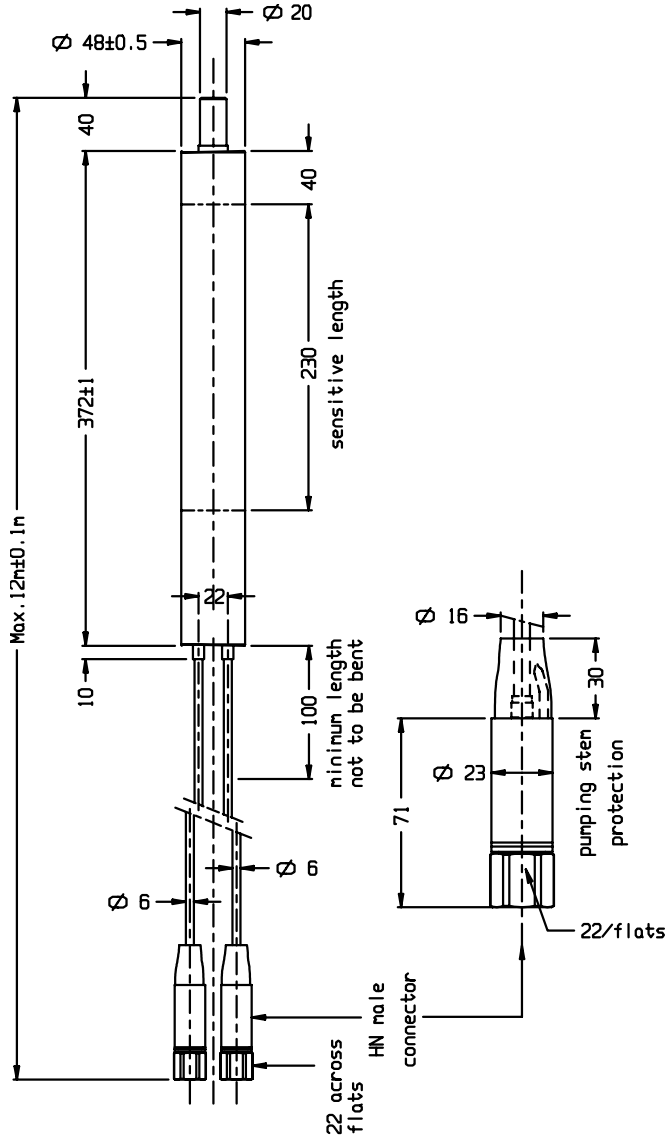
<sup>11</sup> Including temperature increase due to gamma radiation (effective above  $10^4 \text{ Gy.h}^{-1}$ ). The maximum operating temperature is indicated for pulse operating mode. The leakage current in the cables increase rapidly with temperature. It is therefore necessary to take into account this characteristic, which limits the maximum temperature so that the ratio of wanted signal/parasitic signal remains acceptable.

<sup>12</sup> Vibration test conditions: frequency 60 Hz, amplitude  $\pm 1.5 \text{ mm}$ .

# Neutron detector

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Outline (dimensions in mm)



| Limiting values                     | Max                   |
|-------------------------------------|-----------------------|
| Operating temperature <sup>11</sup> | 600 °C                |
| Vibration (any axis) <sup>12</sup>  | 200 m.s <sup>-2</sup> |
| Shock (perpendicular axis)          | 500 m.s <sup>-2</sup> |