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He-3 NEUTRON DETECTORS

General Considerations, Applications

He-3 filled proportional counters are standard neutron detectors and are best suited for the detection of thermal neutrons. Larger types are also used for spectroscopy of epithermal and fast neutrons by pulse height spectroscopy. This type of detector is very insensitive to photon radiation, and the remaining amount may be well discriminated by electronic means.

There is a wide range of applications for He-3 proportional counters. This includes the measurement of natural neutron radiation, industrial applications in the range of nuclear technologies or measuring tasks in oil and natural gas extraction.

Basics

He-3 is an isotope of the noble gas helium. It is stable, non-radioactive, inert and nontoxic. The natural occurance of He-3 in helium is very low, only 0.00014 %. He-3 is a strong absorber of neutrons.

Neutrons are captured by the reaction He-3 (n, p) H-3 building a proton and a triton with a reaction Q-value of 764 keV. The energy dependent cross-section of this reaction is one of the well-known standards in neutron measurement.

Both the proton and the triton are charged ions and are registered by the proportional counter.

Definitions

Neutron fields are characterized by the neutron flux. The unit of neutron flux is defined by the number of neutrons crossing an area of 1 cm^2 per 1 second. The sensitivity of the He-3 proportional counter is determined by the rate of counted pulses (measured in the unit counts per second, 1/s or cps) per neutron flux (nv) in the unperturbed neutron field.
This results in 1/s / (1/cm^2 1/s) = cm^2 or cps / (cm^{-2} s^{-1}). The historical unit cps/nv for the sensitivity is also quite common, it is equivalent to cps / (cm^{-2} s^{-1}).

Construction

The VacuTec He-3 proportional counter tubes are made of welded stainless steel with an alumina ceramic insulator and a pump connector made of copper. Electrical connectors can be of short, solderable leads (Wire) with the types 70 060 and 70 061 or coaxial MHV connector (MHV) for types 70 063 - 70 065. We provide options with different filling pressures between 1.95 and up to 10 bar and effective lengths of maximum 200 mm.

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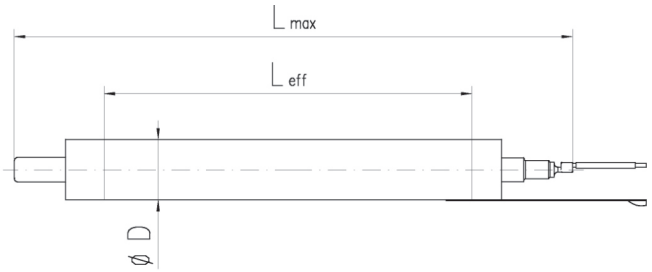

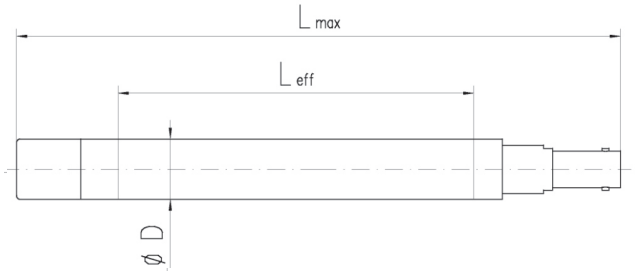

Type	Tube diameter (D)	Effective length (L_{eff}) (mm)	Filling pressure (bar)	Operating voltage (V)	Thermal neutron sensitivity (cps/nv)	Connection
70 060	1/2 inch / 12.7 mm	40	10	1010	1.5	Wire
	1/2 inch / 12.7 mm	50	8	910	1.6	
	1/2 inch / 12.7 mm	100	10	1010	4.1	
70 061	5/8 inch / 15.9 mm	50	10	1070	3.0	
	5/8 inch / 15.9 mm	100	8	960	5.7	
	5/8 inch / 15.9 mm	200	4	720	7.4	
70 063	1 inch / 25.4 mm	100	1.95	590	5.1	MHV
	1 inch / 25.4 mm	100	4	760	8.4	
	1 inch / 25.4 mm	200	1.95	590	11.0	
	1 inch / 25.4 mm	200	4	760	18.0	
70 064	1½ inch / 38.1 mm	200	1.95	600	26.0	
70 065	2 inch / 50.0 mm	200	1.95	680	42.0	

Upon request, all detectors are available with filling pressures of 1.95, 4, 6, 8 and 10 bar.
Detectors with wire connection can be offered in 50, 100, 150 and 200 mm effective length and detectors with MHV connection in 100, 150 and 200 mm length.

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