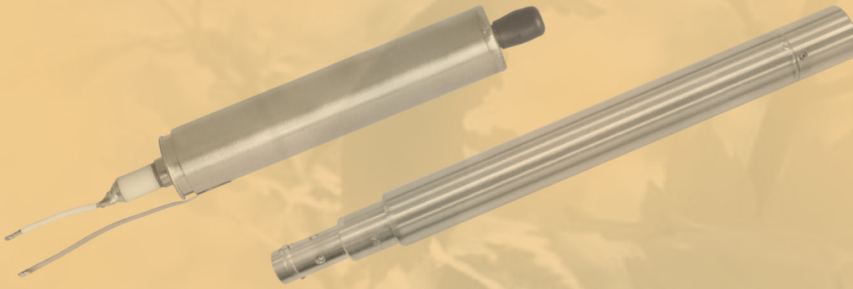




VACUTEC



## He-3 Neutron Detectors

### General Considerations, Applications

He-3 filled proportional counters are standard neutron detectors and are most suitable 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 field of applications for He-3 proportional counters, for the monitoring of natural neutron radiation, for homeland security, for industrial applications in the range of nuclear technologies, in measurement methods for humidity, in oil, gas and mineral exploration, and in material research.



### Some Basics

He-3 is an isotope of the noble gas helium. It is stable, nonradioactive, inert and nontoxic. The natural abundance of He-3 in helium is very low, only 0.00014%.

He-3 is a strong absorber of neutrons. The neutrons are captured by the reaction  $\text{He } 3 (n, p) \text{H-3}$  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.

The thermal neutron sensitivity data of the VacuTec He-3 Neutron detectors are based on measurements at the PTB\* Thermal Neutron Calibration Facility. The neutron reference field of this facility is at a 30 cm distance in front of a 50 x 50 cm<sup>2</sup> window as the neutrons are escaping from the graphite moderator surface.

\*Physikalisch-Technische Bundesanstalt (PTB), Braunschweig

### Construction

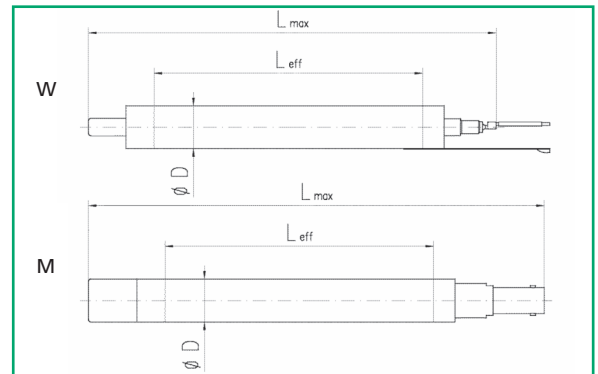
The VacuTec He-3 proportional counter tubes consist of welded stainless steel with an alumina ceramic insulator and a pump port made of copper. By default, the connectors are short solderable leads into axial / radial direction for counter types with small dimensions. Types of larger dimensions are equipped

with a coaxial MHV connector. Other types of connectors may be ordered on demand. The counter tube is filled with a defined amount of He-3 gas and a small amount of CO<sub>2</sub> quenching gas for the operation of the proportional counter.

## Definitions

Neutron fields are characterized by the neutron flux density. The unit of neutron flux density is defined by the number of neutrons crossing an area of 1 cm<sup>2</sup> 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 density in the unperturbed neutron field. This results in 1/s / (1/cm<sup>2</sup> 1/s) = cm<sup>2</sup> or cps / (cm<sup>2</sup> s<sup>-1</sup>). The historical unit cps/nv for the sensitivity is also quite common, it is equivalent to cps / (cm<sup>2</sup> s<sup>-1</sup>).



Order number	Dimensions						Gas pressure/bar	Order number	Operating voltage/V		
							1.95	4	6	8	10
	Tube diameter (D)	Max. length (L <sub>max</sub> ) mm	Weight g	Capacitance pF	Active length (L <sub>eff</sub> ) mm	Active volume cm <sup>3</sup>	7x	9x	6x	8x	1x
							Thermal neutron sensitivity cps/nv				
<b>060 00</b>						<b>490</b>	<b>680</b>	<b>800</b>	<b>910</b>	<b>1010</b>	
x6	1/2 inch/12.7 mm	81 W	30	3	40	2.8	0.4	0.8	1.0	1.3	1.5
x2	1/2 inch/12.7 mm	94 W	35	3.1	50	3.5	0.5	1.0	1.3	1.6	1.9
x3	1/2 inch/12.7 mm	144 W	60	3.6	100	6.9	1.2	2.1	2.9	3.5	4.1
x4	1/2 inch/12.7 mm	194 W	80	4.1	150	10.4	1.8	3.2	4.4	5.4	6.2
x5	1/2 inch/12.7 mm	244 W	105	4.5	200	13.9	2.4	4.4	6.0	7.3	8.4
<b>061 00</b>						<b>520</b>	<b>720</b>	<b>840</b>	<b>960</b>	<b>1070</b>	
x2	5/8 inch/15.88 mm	101 W	50	3.4	50	6.2	0.9	1.7	2.2	2.6	3.0
x3/7	5/8 inch/15.88 mm	151 W / 169 M	80	3.9	100	12.4	2.0	3.6	4.7	5.7	6.4
x4/8	5/8 inch/15.88 mm	201 W / 219 M	110	4.3	150	18.6	3.1	5.5	7.3	8.7	9.8
x5/9	5/8 inch/15.88 mm	251 W / 269 M	140	4.8	200	24.8	4.2	7.4	9.8	12	13
<b>062 00</b>						<b>540</b>	<b>760</b>	<b>870</b>	<b>1000</b>	<b>1100</b>	
x2	3/4 inch/19.05 mm	101 W	60	3.3	50	9.7	1.4	2.4	3.2	3.7	4.1
x3/7	3/4 inch/19.05 mm	151 W / 169 M	100	3.7	100	19.5	3.1	5.3	6.8	8.0	8.8
x4/8	3/4 inch/19.05 mm	201 W / 219 M	130	4.2	150	29.2	4.7	8.1	10	12	13
x5/9	3/4 inch/19.05 mm	251 W / 269 M	170	4.6	200	39	6.3	11	14	16	18
<b>063 00</b>						<b>590</b>	<b>760</b>	<b>910</b>	<b>1050</b>	<b>1160</b>	
x3	1 inch/25.4 mm	153 M	200	4.7	100	35.2	5.1	8.4	11	12	13
x4	1 inch/25.4 mm	203 M	260	5.1	150	52.9	7.9	13	16	18	20
x5	1 inch/25.4 mm	253 M	322	5.5	200	70.5	11	18	22	25	27
<b>064 00</b>						<b>600</b>	<b>830</b>	<b>980</b>	<b>1100</b>	<b>1240</b>	
x4	1.5 inch/38.1 mm	203 M	420	4.9	150	136.2	19	29	33	35	37
x5	1.5 inch/38.1 mm	253 M	505	5.3	200	181.6	26	38	44	47	49
<b>065 00</b>						<b>680</b>	<b>860</b>	<b>1010</b>	<b>1160</b>	<b>1260</b>	
x4	1.97 inch/50 mm	203 M	590	4.9	150	249.3	32	43	48	50	50
x5	1.97 inch/50 mm	253 M	710	5.3	200	332.4	42	58	64	66	67

W = wire M = MHV

Corresponding to customer requirements it is possible to realize also other dimensions and gas pressures.

We reserve the right to alter the specifications.