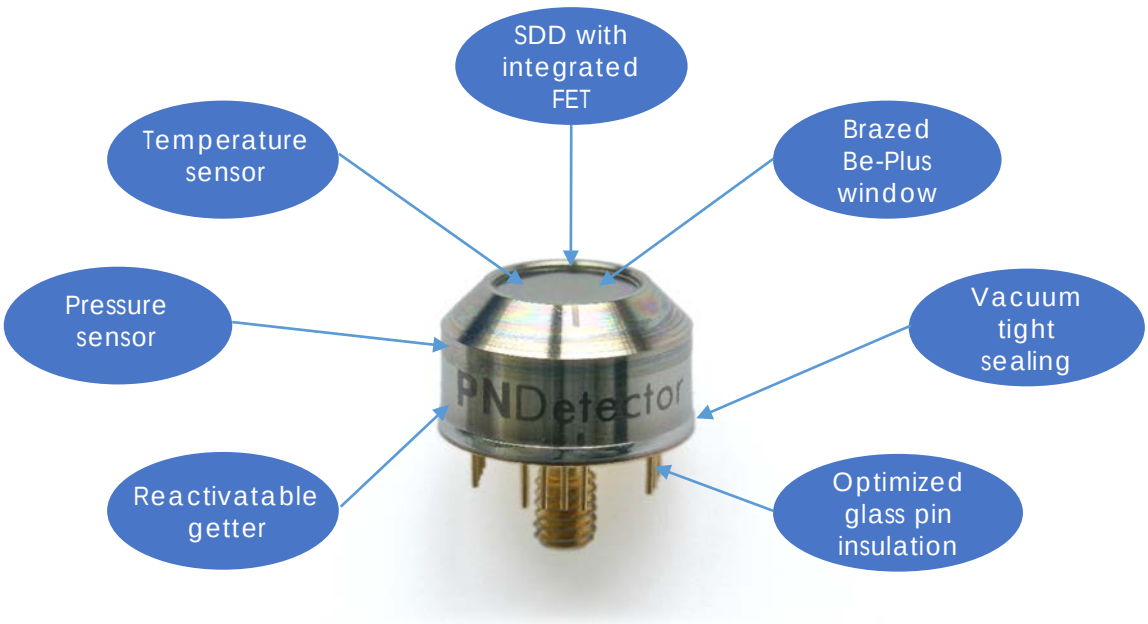
The Complete - Silicon Drift Detector Module

Best chip performance combined with real vacuum housing

SDD chips with integrated FET from PNDetector's production allow us to offer Silicon Drift Detectors with well known spectroscopic performance, excellent energy resolution at moderate operation temperatures and short shaping times.



The real vacuum housing technology

of the Complete Modules leads to a completely controllable, hermetically sealed package. The vacuum tight metallic sealing prevents humidity penetration into the module and heat convection from cooled chip to the window. Results are higher reliability, reduced power loss by peltier cooling and further improved energy resolution.

Internal pressure and temperature sensors

allow the monitoring of the module vacuum. Vacuum values in the optimized range give best performance and reliability.

Vacuum held by reactivatable getter.

The internal getter keeps the pressure of a new module below 0.001 mbar. Though the hermetic sealing has been performed in an optimal way, over its lifetime, the getter surface can become covered with outgassing residues from housing materials or unavoidable leakages. The getter loses functionality, causing the inner module pressure to rise, and over several years, the module will act like a conventional module.

To prevent this, the vacuum of the Complete Module can be refreshed by reactivation of the getter.

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Completely Controlled Vacuum Details

Real vacuum housing with metallic lid-sealing, adapted glass pin insulation as well as vacuum proved housing materials, result in leakage / outgassing rates less than $1 \cdot 10^{-10}$ mbar l/s (see fig. 1).

It would take more than 10 years to reach a pressure of 20 mbar of a standard N_2 filled module even if no getter is activated.

Modern non-evaporable getter techniques reduce the pressure increase in a typical complete module to $1 \cdot 10^{-13}$mbar l/s or 0.0002 mbar per month as long as the getter is active. This keeps the pressure inside the module at a starting value of 0.001 mbar, and it stays less than 0.01 mbar for more than a year.

The integrated pressure sensor allows measurement of the pressure inside the module. It works based on a Pirani principle and is used like a resistive voltage divider. Each Complete Module will be provided with an individual calibration curve (see fig. 2). Together with the on-chip integrated temperature diode, the actual inside pressure of the module can be checked. This feature is unique for PNDetector's SDD modules.

The getter can be reactivated by heating with an electrical current of about 5 A in a defined procedure. In the event that the getter reaches its capacity limit, the pressure increases faster. When the inner module pressure is in the range between 0.02 mbar to 0.1 mbar, PNDetector recommends reactivation of the getter for maintaining the advantages of the vacuum housing. In this range, the first decrease of the Peltier cooling efficiency can be observed (see fig. 3).

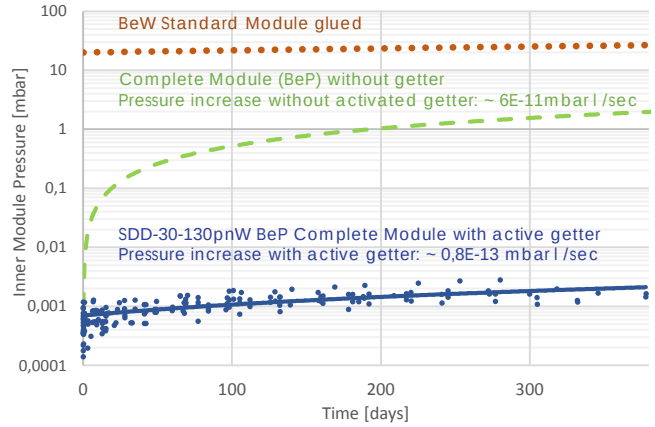


Fig. 1

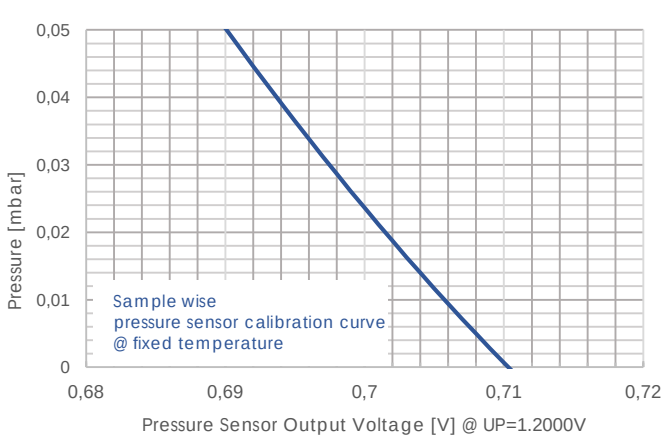


Fig. 2

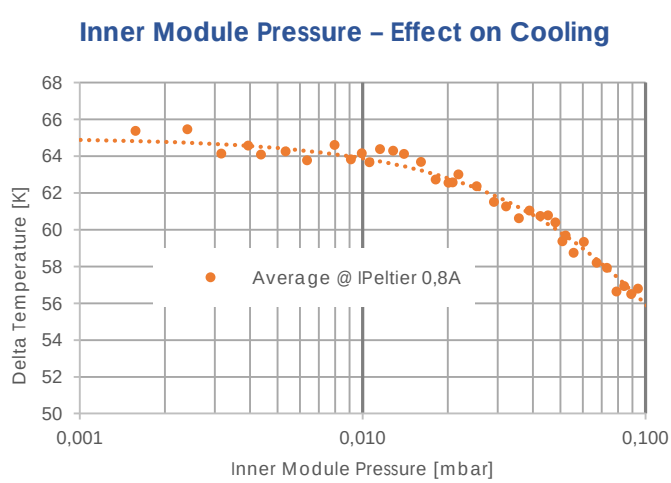


Fig. 3

The Complete - Silicon Drift Detector Module

Benefits of real vacuum housing

Long-term detector stability is ensured by high efficiency vacuum bake-out, optimized module materials and integrated modern non-evaporable getter materials. Minimized humidity prevents condensation and corrosion risk inside the module.

Reduction of the Peltier cooling power by about 50% compared to a standard module with 25 mbar N_2 filling. An operation temperature of -30°C is reached by significantly less than 1 W power consumption (see fig. 4).

Improvement of spectroscopic performance achieved by vacuum conditions inside the module is due to a reduced contribution of the chip surface to the overall signal capacitance. Improved spectroscopic resolution values have been measured on SDD-30-BeP Complete Modules in comparison to standard SDD modules (see fig. 5). All other qualities of the SDD module are kept unchanged.

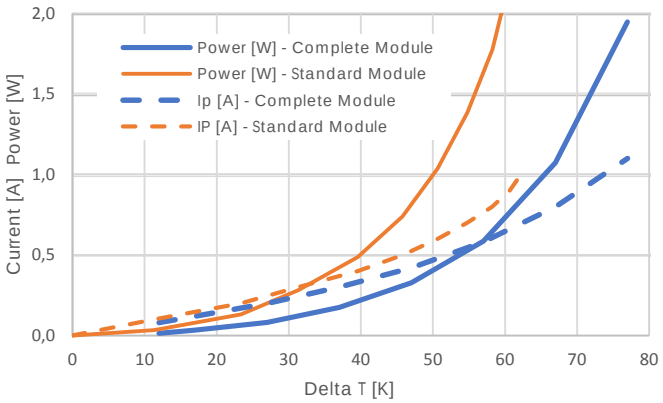


Fig. 4

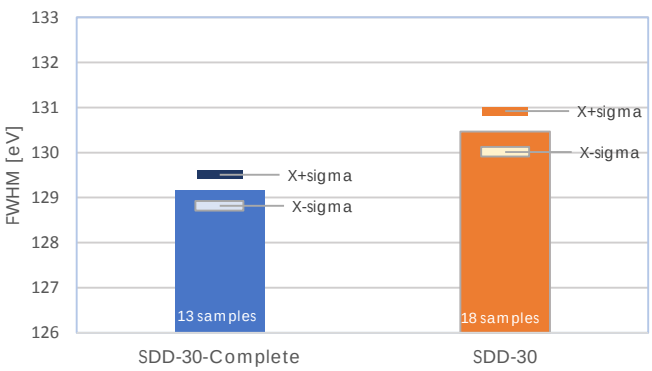


Fig. 5

The Complete – modules ready for test and delivery

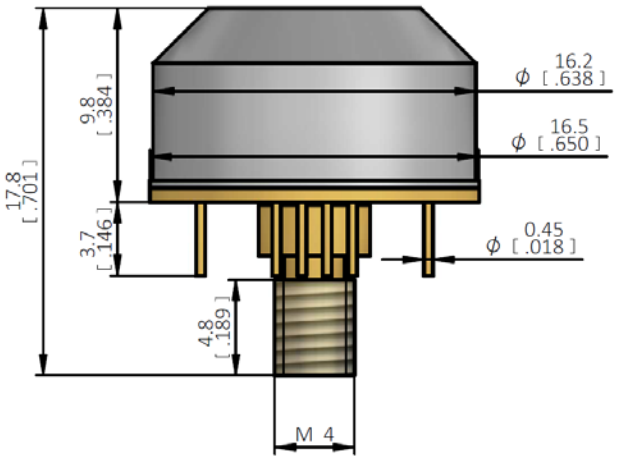
Module	Active Area	FWHM*	Peak-to-Background*
SDD-10-130 BeP Complete	10 mm²	130 eV	4,500
SDD^{plus}-10-128pnW BeP Complete	10 mm²	127 eV	7,500
SD3^{plus}-10-125pnW BeP Complete	10 mm²	124 eV	15,000
SDD^{plus}-30-128pnW BeP Complete	30 mm²	127 eV	12,500
SDD^{plus}-60-128pnW BeP Complete	60 mm²	127 eV	15,000

*) typ. values @ Mn-Kα, -30 °C, input count rates 2-20 kcps, shaping time 1-2 µs

The Complete - Silicon Drift Detector Module

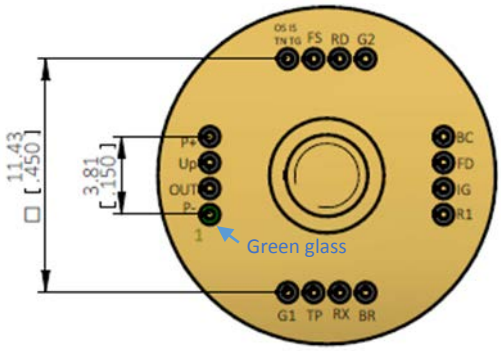
Module dimensions

SDD^{plus}-10-128pnW BeP Complete



Pin layout

SDD^{plus}-10-128pnW BeP Complete



Specifications

SDD^{plus}-10-128pnW BeP Complete

FWHM*	127eV ± 2eV
Peak to Background*	7500 ± 2500
@ -30°C,Mn-Kα, ICR=2-20kcps, tsh=1-2µs	
Active area:	10 mm²
Collimated area:	8.0 mm²
Internal collimator:	Zirconium D=3.2 mm
Module entrance window:	8 µm BePLus
Radiation hardness:	> 10^{12} photons
Temperature diode sensitivity:	-2.78 mV/K @ I=2.7µA
Pressure sensor range:	0.001 ... 0.1 mbar
Cooling power consumption	≤ 1 W ($I_{Peltier}$ typ. 0.6A)
(@ Delta T= 55°C)	

	typical	min	max
Peltier Cooler (P+ - P-)			2.5 V 1.9 A
Current for ΔT=54°C	0.6 A	0.4 A	0.8 A
Pressure Sensor Output (OUT)			
Pressure Sensor Supply (Up)	1200 mV	1199.9 mV	1200.1 mV
Outer Substrate (OS) **Inner Substrate (IS)** **Temperature Diode N (TN)** **Temperature Diode Guard (TG)**	0 V 0 V 0 V 0 V		
FET Source (FS) **Current (FD - FS]**	+5 V 250 µA	+2 V	+8 V
Reset Diode [RD] Off	-13V	-15 V	-1 V
Reset Diode [RD] On **Reset pulse width**	+6 V 0.3...0.5µs	+1 V 0.2 µs	+7 V 1 µs
Getter (G2)	Only for maintenance		
Back Contact (BC)	-100 V	-170 V	-60 V
FET Drain [FD]	+8,3 V	+7 V	+12 V
Inner Guard Ring (IG)	-17 V	-25 V	-5 V
First Ring (R1)	-15 V	-25 V	-5 V
Bias Ring (BR)	-110 V	-180 V	-60 V
Last Ring (RX)	-120 V	-180 V	-100 V
Temperature Diode (TP) **Current TP – TN**	0.4 V 2.7 µA	+0.3 V	+0.6 V
Getter (G1)	Only for maintenance		

Each module is supplied with a specification sheet comprising the optimized parameter values and the detailed performance measurement results.

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October 2018