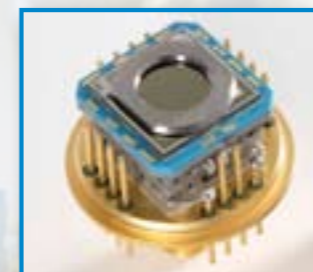


Silicon Drift Detector

Product Brochure

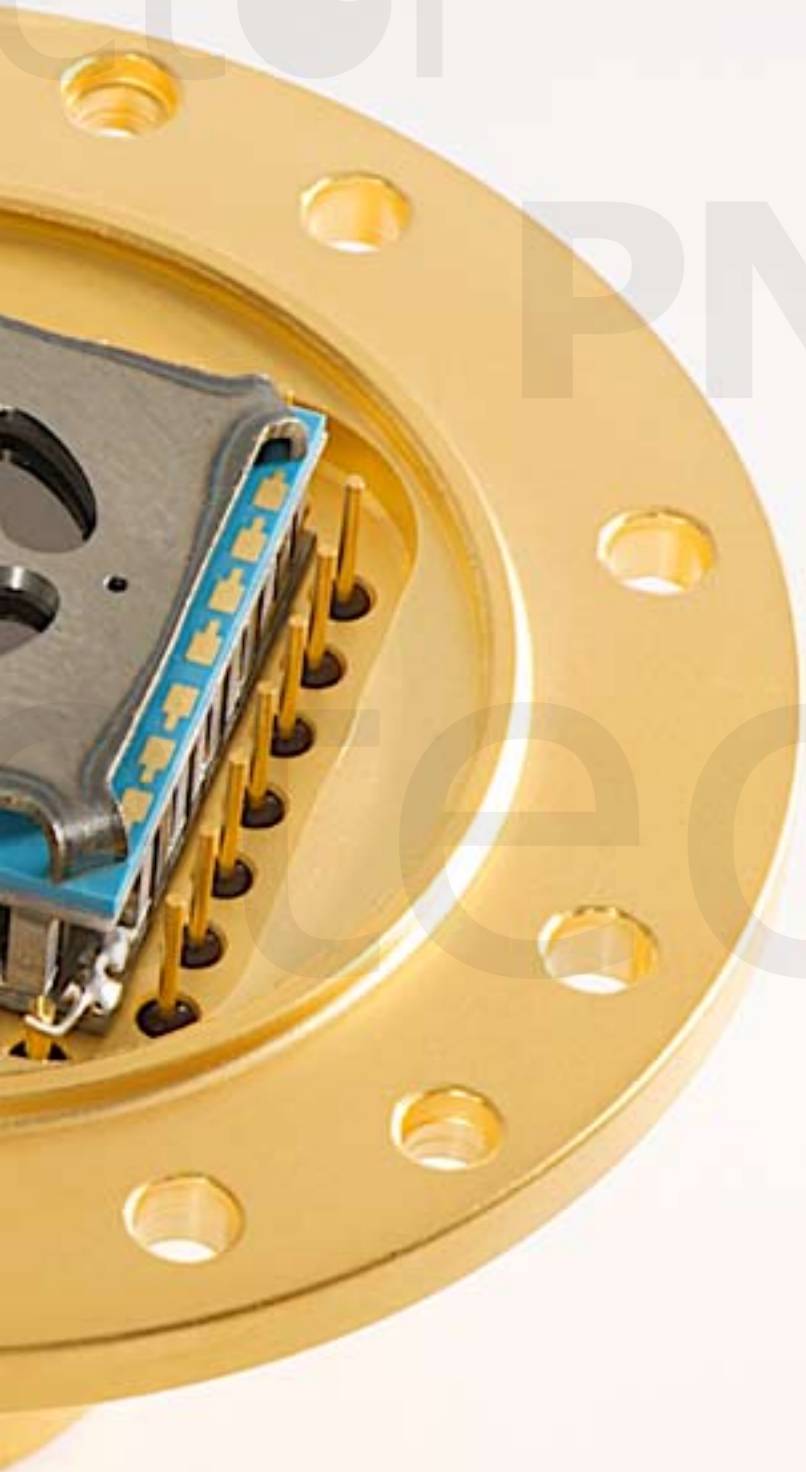
Update 2011



PN▶Detector

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PN▶Detector



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-  *Classic Silicon Drift Detector*
-  *High Resolution Silicon Drift Detector*
-  *Multielement Silicon Detector*
-  *Extra Large Detector Series*

PN▶Detector

Detector

About Silicon Drift Detectors

The vision of modern silicon radiation detectors is closely correlated to the basic principle of the Silicon Drift Detector (SDD) which has been proposed in 1983 by Emilio Gatti and Pavel Rehak. The authors presented a paper at the 3rd European Symposium of Semiconductor Detectors in Munich introducing the concept of “**Silicon Drift Chamber**” – a semiconductor variation of the well-known gas proportional counter used for position sensing.

The SDD working principle is based on the sideward depletion technique which allows the depletion of a large volume of high-resistivity silicon bulk by a **small anode** receiving a minimum signal capacitance. By that, the SDD overcomes the major problem of a classical semiconductor detector where the input capacitance is directly proportional to the active area. Figure 1 shows a schematic view of the silicon drift detector in its standard configuration.

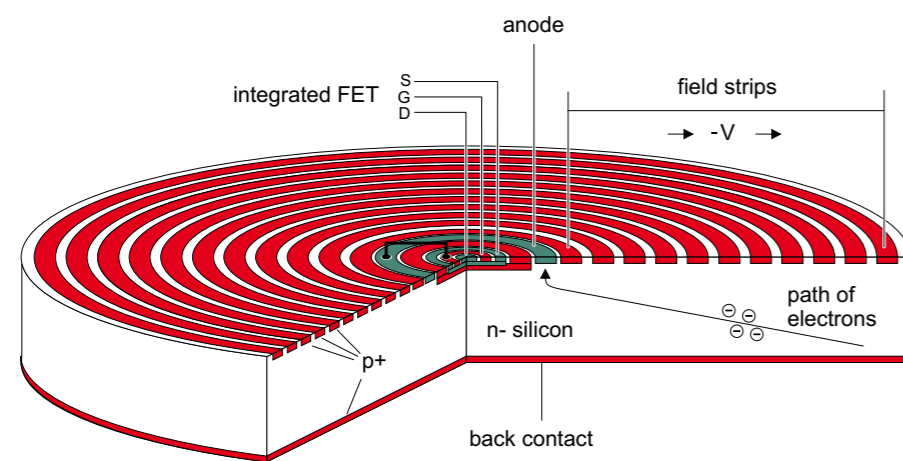


Fig. 1: Schematic 3-D view of a Silicon Drift Detector.

The detector consists of a large volume of n-type silicon bulk depleted from both sides: a homogeneous, shallow p⁺-n junction on the side where the incoming radiation enters the detector and a structure of circular p⁺ drift rings on the opposite side. By applying a negative voltage on the **homogeneous back side** (radiation entrance window) and an increasingly negative voltage on the drift rings, a potential field distribution is created inside the detector such that the electrons generated by the absorption of ionizing radiation drift towards a small sized collecting anode situated in the center of the device.

An important step in additionally improving the detector spectroscopic performance has been achieved by the **integration of the first amplification step** (a JFET transistor as shown in Fig. 1) directly into the sensor. The connection of the anode to the transistor gate is reduced to a small metal strip of a few tens of microns length. By this

approach parasitic capacitances related to large connection pads and long bonding wires are avoided. Unwanted effects like pick-up noise or microphony are suppressed. The SDDs developed and fabricated by the Semiconductor-Laboratory of the Max-Planck Institutes for Physics and Extraterrestrial Physics in Munich, together with the companies **PNSensor** and **PNDetector**, are characterized by the following features:

Due to the elaborated fabrication technology, featuring the **polysilicon** and **pnWindow** process, the leakage current level is so low that the SDD can be operated with moderate cooling by means of a single stage Peltier element. The SDD's optimum energy resolution (FWHM down to 123 eV @ Mn_K and 45 eV @ C_K) is already achieved at -20°C and 1 μs shaping time. At -10°C an energy resolution down to 126 eV is achieved respectively down to **135 eV at 0°C**.

In order to take the full advantage of the small anode, for PN-SDDs the **front-end JFET** of the amplifying electronics is integrated into the detector chip and directly connected to the anode resulting into a **total signal capacitance** down to 80 fF. This feature allows measuring much better energy resolution at shorter shaping times compared to conventional PIN diodes, Si(Li) detectors and SDDs without integrated FETs,

recommending the PN-SDD for high count rate applications up to **1 Mcps**. The system can be operated in a continuous reset mode (no detector dead time at all) making use of the self adapting reset mechanism present in the transistor channel. Alternatively, the integrated reset diode allows a pulsed-reset operation mode which makes the detector performance **independent on the count rate**.



Fig. 2: Insight into cleanroom and bonding area at PNDetector.

About PNDetector

The company **PNDetector GmbH** was founded in the year 2007 as a spin-off of the company PNSensor GmbH. It is situated on the technology campus of Siemens in Munich together with **PNSensor** and the Semiconductor Laboratory of the Max-Planck-Institutes for Physics and for Extraterrestrial Physics.

The company is fabricating and developing advanced radiation detectors with emphasis on **Silicon Drift Detectors** with **integrated FET**. Our customers use the expertise of our employees in dealing with Silicon Drift Detectors and in developing advanced packaging designs.

PNDetector distributes its products worldwide to **OEM customers** as a leading company that supports the

field of **Micro-Analysis** and **XRF-Analysis** with their highly performed detector modules.

PNDetector provides **serial production** as well as the competence for individual solutions – reliably high quality guaranteed. Ideas, development, production and sales all fulfil PNDetector's sophisticated demand on quality. Our experienced staff takes care of it.

PNDetector's access to various projects in well-known **research institutes** assures continuous work on new developments.

Classic Silicon Drift Detector

The **Classic Silicon Drift Detector (SDD)** chip is round structured with the first amplification step (JFET) monolithically integrated into the center of the device. It shows good energy resolution and high count rate capability due to the small signal anode, the integrated JFET and the ultrapure fabrication process which is established at the Semiconductor Laboratory of the Max-Planck-Institutes.

The active sensor areas vary from **5 mm²** and **10 mm²**, **20 mm²**, **30 mm²** and **60 mm²** up to **100 mm²**. Most of the

detectors provide excellent light element capability due to the integration of the **pnWindow**.

The detectors are well suited for all kinds of Energy Dispersive Spectroscopy (EDS) specifically in **X-ray Fluorescence Analysis (XRF)**. The detector modules are robust – leakage tightness, radiation hardness and peak stability are continuously proven and adapted to state-of-the-art development. As the detectors are generally operated at -20°C they need minimum cooling power only.

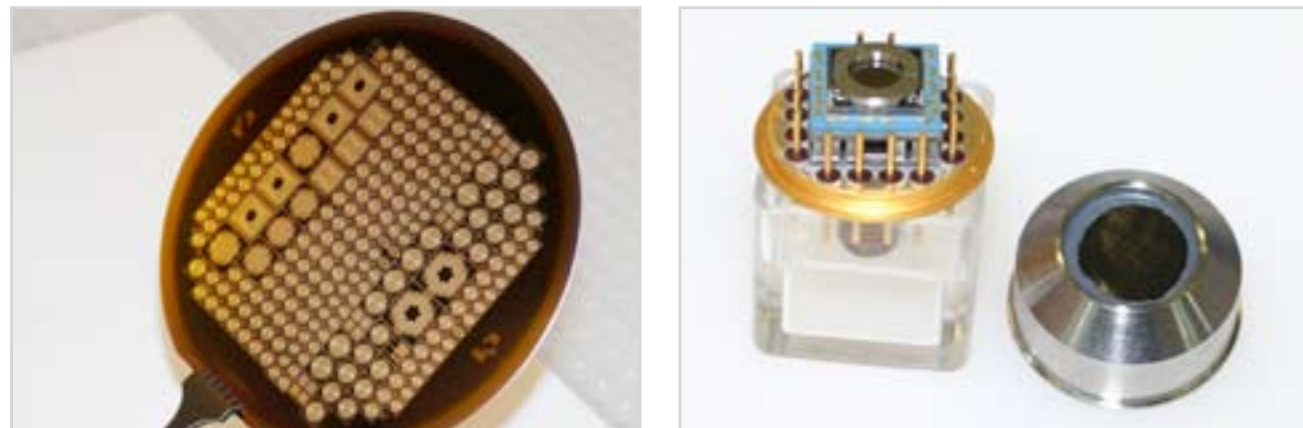


Fig. 3: High ohmic silicon wafer processed with a recent SDD layout and a SDD detector module with the sensor chip mounted onto substrate, peltier cooler and TO8 socket with cooling stud and electrical pins. The module is typically closed under nitrogen atmosphere by a non-magnetic steel cap with a thin Beryllium or Polymere Window.

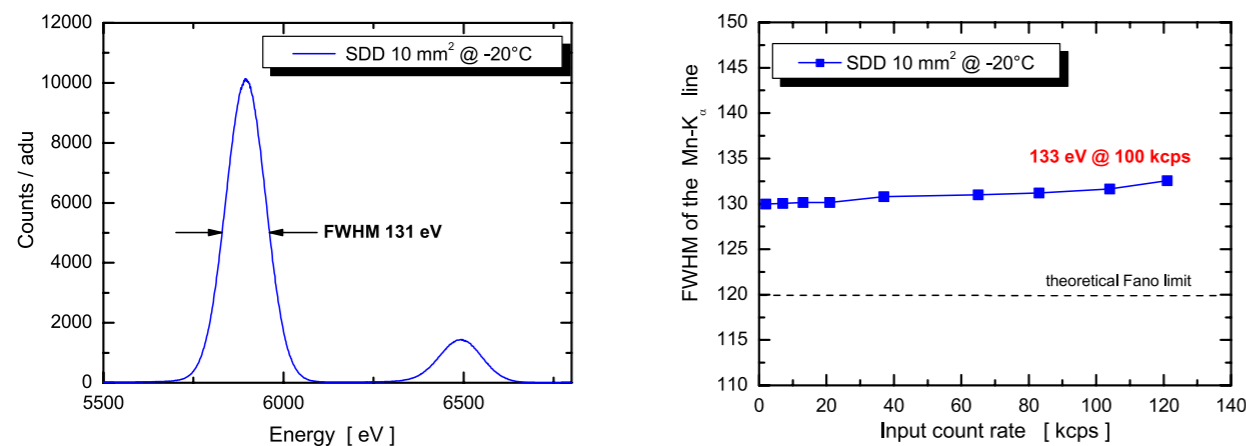


Fig. 4: The energy resolution of the Classic Round SDDs varies **between 130 and 135 eV** depending on area and count rate. The operation temperature is -20°C.

Sensor Description Module Design Performance Parameter

Standard

SDD-05-130 BeW ic

| | | |
|--|--|---|
| 5.0 mm ² x 450 μm round design polysilicon technology | round TO8 housing outer diameter 15 mm Ø 2.2 mm Zr collimator 1-stage peltier cooler 8 μm Beryllium window | typ. 130 eV FWHM @ MnK, -20°C, 10 kcps typ. 132 eV FWHM @ MnK, -20°C, 100 kcps P/B typ. 1,500 @ MnK |
|--|--|---|

low cost



SDD-10-130 BeW ic

| | | |
|---|--|---|
| 10.0 mm ² x 450 μm round design polysilicon technology | round TO8 housing outer diameter 15 mm Ø 3.2 mm Zr collimator 1-stage peltier cooler 8 μm Beryllium window | typ. 132 eV FWHM @ MnK, -20°C, 10 kcps typ. 133 eV FWHM @ MnK, -20°C, 100 kcps P/B typ. 2,500 @ MnK |
|---|--|---|

XRF



SDD-10-130pnW UTW ic

| | | |
|--|--|---|
| 10.0 mm ² x 450 μm round design polysilicon technology pnWindow | round TO8 housing outer diameter 15 mm Ø 3.2 mm Zr collimator 1-stage peltier cooler thin polymere window | typ. 132 eV FWHM @ MnK, -20°C, 10 kcps typ. 133 eV FWHM @ MnK, -20°C, 100 kcps typ. 62 eV FWHM @ C_K, -20°C, 10 kcps P/B typ. 5,000 @ MnK |
|--|--|---|

low cost SEM



Large Area

SDD-20-135 BeW ic

| | | |
|---|--|---|
| 20.0 mm ² x 450 μm round design polysilicon technology | round TOX housing outer diameter 16 mm Ø 4.6 mm Zr collimator 1-stage peltier cooler 8 μm Beryllium window | typ. 135 eV FWHM @ MnK, -20°C, 10 kcps typ. 137 eV FWHM @ MnK, -20°C, 100 kcps P/B typ. 3,500 @ MnK |
|---|--|---|

20 mm²



SDD-30-135pnW BeW ic

| | | |
|---|--|---|
| 30.0 mm ² x 450 μm round design polysilicon technology pnWindow | round TOX housing outer diameter 16 mm Ø 5.8 mm Zr collimator 1-stage peltier cooler 8 μm Beryllium window | typ. 135 eV FWHM @ MnK, -20°C, 10 kcps typ. 137 eV FWHM @ MnK, -20°C, 100 kcps P/B typ. 7,500 @ MnK |
|---|--|---|

30 mm²



SDD-100-130pnW BeW ic

| | | |
|---|--|--|
| 100.0 mm ² x 450 μm round shaped design polysilicon technology pnWindow | round TOX housing outer diameter 23 mm Ø 9.6 mm Zr collimator 2-stage peltier cooler 8 μm Beryllium window | typ. 135 eV FWHM @ MnK, -30°C, 10 kcps typ. 137 eV FWHM @ MnK, -30°C, 100 kcps P/B typ. 10,000 @ MnK |
|---|--|--|

100 mm²



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