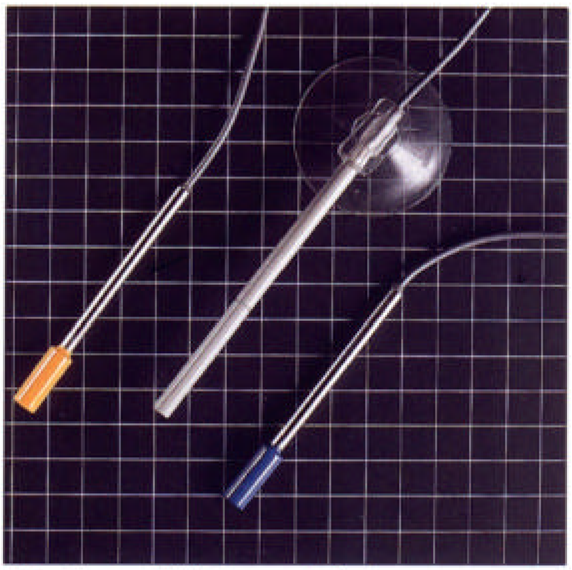
Radiation Field Detectors based on Hi-pSi Semiconductors



PFD – Photon Field Detector (yellow)
EFD – Electron Field Detector (blue)
RFD – Reference Field Detector (gray)

SFD – Stereotactic Field Detector (green)

Radiation Field Detectors from Scanditronix based on Hi-psi semiconductors Is an excellent choice in relative field analyses as well as output factor measurements. The high doped p-type silicon detector chip (Hi-psi), designed specifically for Radiation Therapy applications. has replaced the Ionization Chambers in many clinics since their introduction in 1992. The accuracy and lifetime of the Hi-pSi detectors are unsurpassed in the field of Radiation Therapy today and you benefit with a 3 year warranty!

The main benefits in using Hi-pSi field detectors am:

Direct Dose-measurement in electron beams
no need for ionization to dose conversion

Measurement of output factors in small fields
 the only solution for today's needs

High and uniform sparial resolution in beam plane
accurately shaped penumbras in the whole beamplane using the same detector

Precise deflnition of measurement point and high spatial resolution in beam direcrion
correct depth interpretation, accurate and easy surface measurements.

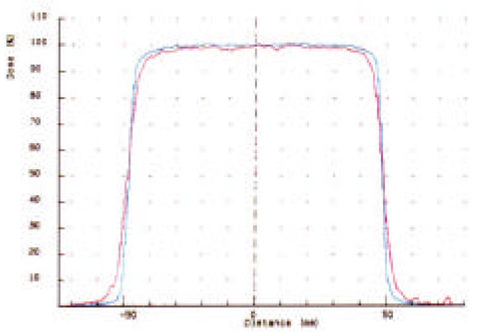
Easy to use:
independent or bias, pressure and moisture
very robust - always reliable
no "warn-up" time

High durability - 3 year warranty
Low lifetime cost

Features of Hi-pSi field.detectors

Proven Dose Rate Independence
One of the premier features of the Hi-pSi detectors is the proven dose rate independence[1]. Even after receiving over 200 kGy of absorbed dose using high photon energies where there is significant neutron contribution, the Hi-psi detectors continue to measure accurately .This feature gives the possibility to pre-irradiate the detectors and thereby minimize the sensitivity decrease with absorbed dose The resuit is not only detectors far superior to other Si detector but also detectors unsurpassed for use in most Radiation Therapy applications.

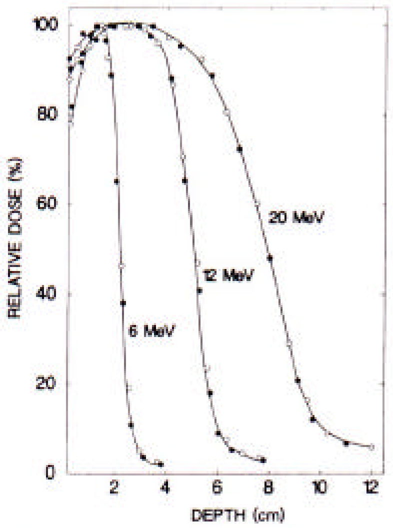
Spatial Resolution
The active volume can be kept very small due to the high efficiency of detection in Si. This feature is used to achieve a high uniform spatial resolution in the beam plane, and a precise definition of the measurement depth. The active volume positioned close to the tip of the detector ensures accurate measurements in the build-up region



A profile measured with PFD and IC. The penumbra (R20-R80) is 5.8 resp. 5.3 using an IC and 3.0 resp. 2.9 mm using a PFD.

Direct electron depth dose

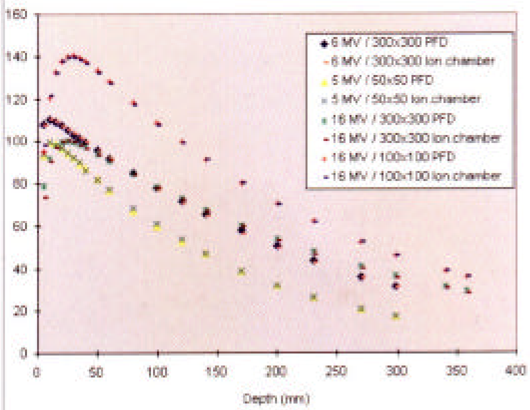
The constant relation of stopping power Si/water in the range 4 to 50 MeV eliminates the need for ionization to dose conversion for a Hi-pSi detector. This is specially imponant in small fields and for profiles where no accurate ionization to dose conversion needed for ionization chambers, is available



Direct depth doses in electron fields using the EFD and ionization to Dose corrected depth doses using NACP chamber.

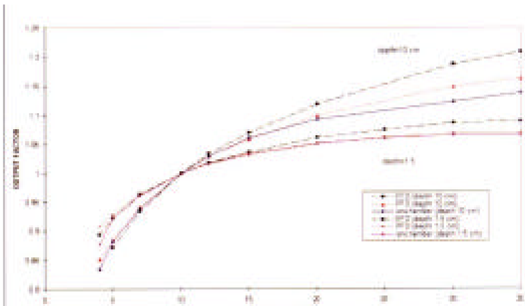
Energy independence

Dose delivered to water is constant for photon-en ergies above 300 Kev Dose contribution from scattered photons (<300 KeV) is insignificant in small fieldsizes (<10 cm) The Photon Field Detector (PFD) is the choice for measuring depth doses arid TMR in large fleld sizes (E>10 cm) The PFD is specially designed and manufactured to compensate for the energy dependence.Because of this any residu al energy dependence is clinically irrelevant.



Depth doses in photon beams using Ionization chamber and Hi-pSi detectors.

Output faetors In small photon beam.
The small size of the stereotactic detector, the "energy independence" in fields less than 10 cm and the low impact of non Electron-equilibrium, makes it the choice for measuring output factors.



Output factors in a 6 MV beam at two depths using IC, PFD and the EFD [2]

Applications for Hi-pSi detectors

Depth doses In water
The most demanding relative measurements are depth dose and TMR measurements in water. Because both the dose rate and the energy spectra change wit depth, the Hi-pSi detectors arc designed to be independent of these effects. The detectors of choice for measuring electron fields and small photonflelds(<lOcm)are the Electron Field Detector (FFD) or the Stereotactic Field Detector (SED). This is because the SFD has the superior spatial resolution specially required in sniall fields (<10cm) and the EFD has a larger collection volume, useful to speed-up electron dosimetry in normal field sizes. The PFD has been optimized for those larger photon fields(>10cm) allowing it to give a true depth dose or TMR scan.

Output factor measurement
Absolute dosimetry should be done using a long term stable detector e.g an ionization chamber. Howeven the relative output ractors in small fields (E< 10cm) are preferably measured using Hi-pSi detectors [2] Any of the three detectors can be used. In very small field sizes, <2cm, the SFD is preferred due to the small dimension.

Profiles in water
The most important feature of a detecton measuring proriles in photon or electron beams, is spatial resolution in the penumbra regionE Hi-pSi detectors have a distinct advantage in this application when compared to JCE The uniform detection area of the Hi-pSi detector is also an important benent when compared to IC No reorientation needs to be done for the Hi-psi to achieve required spatial resolution.
The FFD and the LDA-detector are optimized to compensate for the scattering outside the geometric field and is the best choice in conventional photon beams.

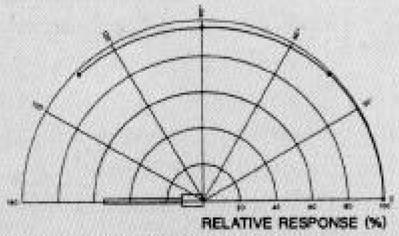
In electron beams it is preferable to use the FFD However,the FED and LDA can also be used if the profiles are re-normalized using a depth dose curve.

In air
Relative measurements in air are much less demanding using miniphantoms. Either of the three types or Hi-pSi detectors can be used with no limitation in field size

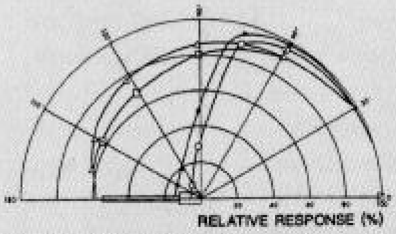
[1] Erik Grusell End Goran Rikner: "Linearity with dose rate of low resisvity p-type silicon semiconductors" Phys Med, Bid. Sb (1993) 785-79

Technical data

Type of detector	**Photen PDF**	**Electron EFD**	**Stereotactic SFD**
Energy range (MV/ MeV)	1-50	1-50	1-50
Field size range (mm)	50-400	10-400	2-100
Dose-rate dependence(0.1 to 0.6 mGy / pulse)	<1 %	<1 %	<1 %
Encapsulation diameter (mm)	7	7	5
Effective measurement point (mm)	0.5 +- 0.15	0.45+-0.1	0.5 +- 0.15
Tot length (mm)	75	75	75
Cable length (m)	2	2	2
Stem material	Stainless steel	Stainless steel	Stainless steel
Stem diameter (mm)	4	4	4
Chip size (side/thickness, mm)	3.5/0.5	3.5/0.5	0.95/0.5
Geometric form of active area(mm)	circled	circled	circled
Diarmeter of active area (mm)	2.5	2.5	0.6
Thickness of active volume (mm)	0.06	0.06	0.06
Pre -irradiation level (kGy)	8 (16/ LDA)	8	8
Sensitivity (nC I Gy)	140	90	6
SVWT (% I 0C)	0.3 + 0.1	0.3 + 0.1	0.3 + 0.1
Collection time	5 misec	5 misec	5 misec
Impedance at zero bias (MOhm)	>150	>150	>150



The directional dependence of a Scanditronix electron field detector, measured at a depth of 2 cm in a 20 x 20 cm field of 20 MeV electrons.



The directional dependence of a Scanditronix photon field detector in radiation of a different qualities.
(□) ^{60}Co (○) 40 kV (x) 75 kV (△) 8 MV