SunPoint™ Diode Detectors ▸▸▸

The Right Detector for the Right Application™

Sun Nuclear manufactures products using diodes and ion chambers. Both offer unique advantages based on the application. Unlike some vendors who insist ion chambers are the only acceptable detector for every application, Sun Nuclear recognizes that diodes offer benefits that are in the best interest of the patient. For this important reason SunPoint Diode Detectors are selected as the dosimeter of choice for many Sun Nuclear products.

These benefits include:

1 ▸ Size.

SRS, IMRT, VMAT deliver small beamlets around critical structures to the target. When millimeters are so critical in the plan and delivery, small detector size during verification is essential for QA accuracy. Measuring $0.64 mm^2$ and $0.000019 cm^3$, SunPoint Diode Detectors are the smallest available detector by orders of magnitude, which results in accurate dose plan QA measurements. Ion chambers may be a gold standard for dosimetry calibration; however this is not the case for patient QA. Ion chambers integrate over a much larger area resulting in a loss of accuracy known as dose volume averaging. Dose volume averaging is a characteristic of ion chambers for small field and gradient measurement which is why Sun Nuclear only uses diodes for such applications.

2 ▸ Sensitivity.

The electron density of silicon is 18,000 times greater than air. Therefore a silicon based diode can be thousands of times smaller than an ion chamber, while its sensitivity can still be 10 times higher. The measurement benefit of this is two-fold. First: a higher signal to noise ratio equals better measurement accuracy and reproducibility. Second: a smaller detector equals better measurement precision. Ion chambers must always be larger than diodes due to their low sensitivity and signal to noise ratio.

3 ▸ Stability.

SunPoint Diode Detectors have insignificant radiation degradation in short term and long term use. In a short term reproducibility test of 15 consecutive 60 MU's measurements, response varied ±0.15%. Quantified over a 261 day (approximately 9 month) period of use, MapCHECK (using SunPoint Diode Detectors) varied ± 0.2%. Both studies indicate SunPoint diode detector based arrays are more stable than ion chamber based arrays. [1,2,3,4,10]

4 ▸ Fast Setup.

SunPoint Diode Detector based instruments do not require warm-up or the application of bias voltage prior to use. Ion chamber arrays can require up to 60 minutes and 10 Gy prior to use. Warm-up is a result of the design of the instrument. Sun Nuclear's ion chamber based products do not require warm-up but do require bias voltage.

5 ▸ Calibration.

The calibration for SunPoint Diode Detector products is very stable. Users typically calibrate every one to three years using Sun Nuclear's patented 15 minute WFC method. Sun Nuclear developed and owns a patent on Wide-Field Calibration (WFC). WFC affords users an easy, accurate, and independent calibration method. WFC is used for ion chamber and diode array products and is a benefit to all Sun Nuclear array product users. Every Sun Nuclear array product receives a factory calibration using Sun Nuclear's in house linear accelerator. WFC provides the user the ability to calibrate their Sun Nuclear product with their own Linac, at any time they wish. This allows users to verify the calibration accuracy themselves, and to perform independent research. The accuracy of Sun Nuclear WFC has been clinically proven worldwide in over 1500 facilities.

SunPoint™

Performance specifications of SunPoint diode detectors are the best in the industry

1 ▶ Sensitivity as a function of accumulated dose.

SunPoint Diode Detectors exhibit consistent sensitivity with accumulated dose. Sensitivity variation is < 0.5%/kGy at 6MV, <1.5%/kGy at 10 MeV. The benefit is infrequent array calibration (< once per year) even when detectors receive different accumulated doses.

2 ▶ Sensitivity as a function of dose per pulse.

Unlike other diodes from different manufacturers, the SunPoint Diode Detector sensitivity only changes about ±1% for 600-fold changes in dose per pulse. Semiconductor diodes can remain linear with dose per pulse after very high accumulated dose. [2,5,6]

3 ▶ n-type and p-type.

Diode performance depends on the individual detector, regardless of n-type or p-type. Several publications demonstrate that n-type diodes can out perform p-type diodes. [2,5,7,8]

4 ▶ Absolute dose.

SunPoint Diode Detector based instruments measure the absolute dose accurately with the dose calibration of the reference detector to the standard accelerator output, exactly as an ion chamber device would do.

5 ▶ Lifetime.

High sensitivity and low change in response give SunPoint Diode Detectors an extremely long life expectancy. The lifetime of Sun Nuclear instrument arrays (ion chamber or SunPoint diode detector based) are a result of changing practices and normal electronic and circuit obsolescence and failure. Life expectancy is at least ten years under normal use. After 100 kGy, Sun Nuclear diode sensitivity is still much higher than that of an ion chamber.

6 ▶ Dependencies.

a Temperature.

Temperature dependence can be compensated by entering a temperature value, or more accurately by calibrating dose before measurement. The temperature coefficient of SunPoint Diode Detectors remains constant with accumulated dose. [7,9]

b Pressure.

Ion chamber response is dependent on temperature and pressure, while diode response is only dependent on temperature.

c Energy.

Energy dependence for SunPoint Diode Detectors is easily managed with calibration files. For example, 6MV will use a 6MV calibration file; 9MeV will use a 9MeV file.

d Field size.

Ion chambers have field size dependence for small and intensity modulated fields. SunPoint Diode Detectors can be used in all field sizes. The Sun Nuclear EDGE Detector, utilizing a single SunPoint Diode Detector, can be used to scan photon (MV) profiles up to 30 x 30cm, and percent depth dose up to 15 x 15cm. For array products using SunPoint Diode Detectors, such as MapCHECK, calibrate the array at the chosen depth if the field size is greater than 25 x 25 cm and deeper than 10 cm. [2]

e SSD and Depth.

SunPoint Diode Detector based arrays are proven to accurately measure dose at different SSD's and depths. MapCHECK IMRT QA depths range from 2-15cm and PROFILER 2 is used at varying depths as a substitute for water phantoms.[6]

Products featuring SunPoint Diode Detectors

ArcCHECK	PROFILER 2	EDGE Detector
MapCHECK 2	SRS PROFILER	IsoRad Detectors
MapCHECK	TomoDose	QED Detectors
In Vivo Solutions	Daily QA 3	

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10 "Comparison of two commercial detector arrays for IMRT quality assurance",
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Corporate Headquarters
425A Pineda Court
Melbourne, Florida 32940
tel: + 1 321 259-6862
web: www.sunnuclear.com