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Is diamond or silicon better for your application?

The tradeoff between using diamond photo-conducting detectors (PCDs) and silicon diodes will depend on the brightness of your x-ray source, its spectral content and perhaps your desired time resolution.

PCDs can claim 200 ps (or better) resolution. Si diodes are typically a factor of 2 (or more) slower depending on their size.

If your source emits P watts (through whatever filtration you may need or want), the detector is at a range R, the detector has an area A and sensitivity S (amps per watt), then the signal level into a 50 ohm load will be:

$$\text{Volts} = 50 * P * A * S / (4 \pi R^2).$$

Typical PCDs have areas of 1x1 to 1x3 mm^2. Typical silicon diodes, sensitive to few keV x-rays, have dimensions of 1x1 mm^2 or less.

A typical diamond (carbon!) PCD is 0.5 mm thick, so it can do a good job of detecting x-rays of energies up to about 5 keV. Thicker diamond PCDs can be made. A typical silicon detector has an effective thickness of 50 to 100 microns which corresponds to good stopping power for x-ray energies up to 6 or 7 keV. Thicker diodes are available but with reduced frequency response.

Typical PCDs have sensitivities of 0.3 mA/W (with a 100 volt bias). Peak signal levels can be up to 10's of volts.

Silicon is about 1000X more sensitive: S is 0.27 A/W. Peak signal level should be kept to under a few volts to ensure linear response.

Both silicon diodes and PCDs must be biased (50 to 100 volts) through a "bias box" with a typical cost of $100.

Every healthy silicon diode will have a sensitivity of 0.27 A/W. Each healthy PCD must be calibrated as the value of S can vary by 2X.

Silicon diodes useful for few keV x-rays are relatively fragile. Diamond is diamond! That is, it is quite rugged.

Silicon diodes useful for few keV x-rays will cost up to $400 per unit. Thicker and larger silicon diodes useful for higher x-ray energies may cost much more. A diamond PCD costs $1500 to $2000 depending on size.

For few keV x-rays and comparable detector sizes and ranges, the silicon sensor will be much more sensitive. If your source is weak, silicon is probably preferred. But if you need to locate the sensor close to the x-ray source, or you need many volt signals to deal with noise, or the source is relatively strong (or emits at higher photon energies), then a PCD may be preferred. The decision will depend on the details of your situation.