# Evaluation of the Sun Nuclear Sunsilicon Diode for Small-Field Dosimetry In 1.5 T and 0.35 T MR-Linacs

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## Introduction

- Achieving accurate small-field dosimetry on MR-linacs is challenging due to magnetic-field-induced dose perturbations and limited availability of MR-compatible detectors[1,2].
- Diode detectors are attractive because they deliver high signal from small sensitive volumes, but their response in a magnetic field depends strongly on detector design.
- **This study characterizes the new Sun Nuclear SunSILICON 1048 unshielded silicon diode for small-field measurements on a 1.5 T and a 0.35 T MR-linac, benchmarked against two established reference detectors.**

## Methods

### Detectors

| Detector | Type | Active Volume (mm³) |
|---|---|---|
| Exradin W2 | Plastic scintillator | 0.790 |
| microDiamond (60019) | Synthetic diamond | 0.004 |
| SunSILICON 1048 | Unshielded Si diode | 0.053 |

### Platforms

Elekta Unity 1.5 T MR-Linac
- PTW BeamScan MR 3D tank; measurements at 10 cm depth, gantry 0°
- Fields: 0.5×0.5 to 10×10 cm², normalized to 10×10 cm²
- Crossline profiles used to convert CAX readings to peak output factors

ViewRay MRIdian 0.35 T MR-Linac
- CNMC WP-3040 1D water phantom; PTW UNIDOS E electrometer
- Fields: 0.83×0.83 to 9.96×9.96 cm², normalized to 9.96×9.96 cm²
- Peak positioning refined via inline/crossline couch steps

### Čerenkov Light Ratio (CLR) Correction

- W2 signals corrected for Čerenkov contamination via the spectral CLR method [3].
- Rectangular field method on MRIdian and Symmetric Profile for Unity

### IAEA TRS-483 Corrections

- TRS-483 $k^{f_{clin},f_{msr}}_{Q_{clin},Q_{msr}}$ were applied to the microDiamond and W2 [4].
- TRS-483-framework corrections were applied to the SunSILICON [5].

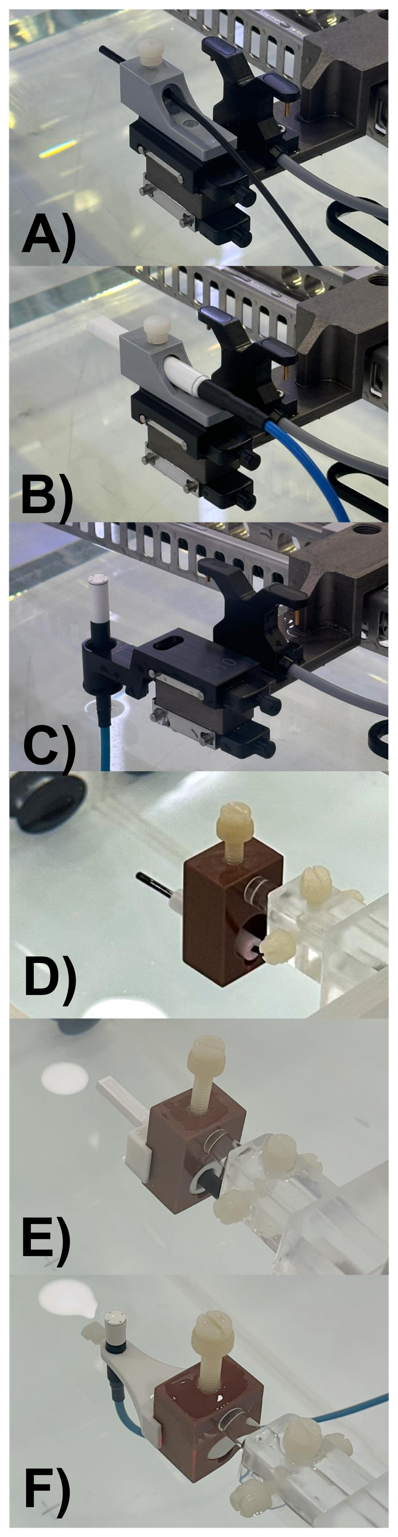


*Figure 1. A–C: Unity setup (W2, microDiamond, SunSILICON). D–F: MRIdian setup.*

## Results

### PDDs and Profiles

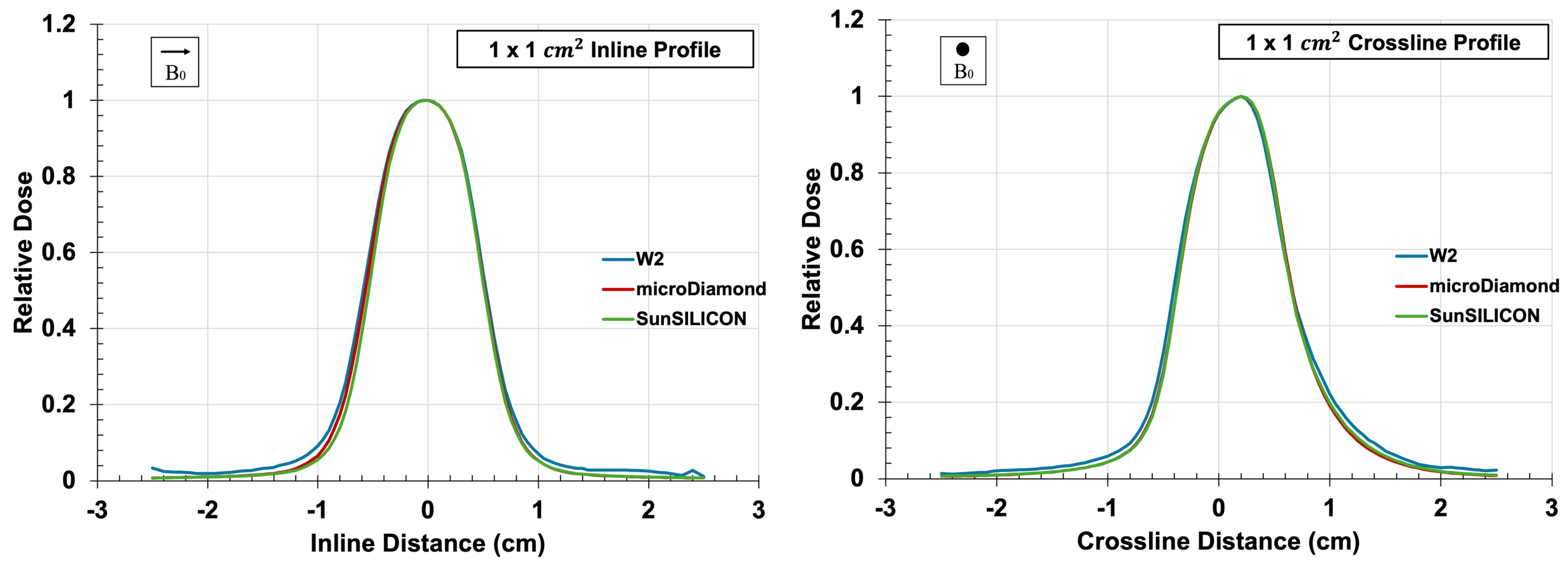


*Figure 2. Inline (left column) and crossline (right column) relative dose profiles for 1×1 cm² square fields on the Elekta Unity 1.5 T MR-linac.*

- PDDs agreed across all three detectors beyond $d_{max}$ within 1.0% (SunSILICON vs. W2) and 1.9% (SunSILICON vs. microDiamond) across all fields.
- Profile FWHM agreed within 0.5 mm across detectors
- PDDs and Profiles were only acquired on the Elekta Unity

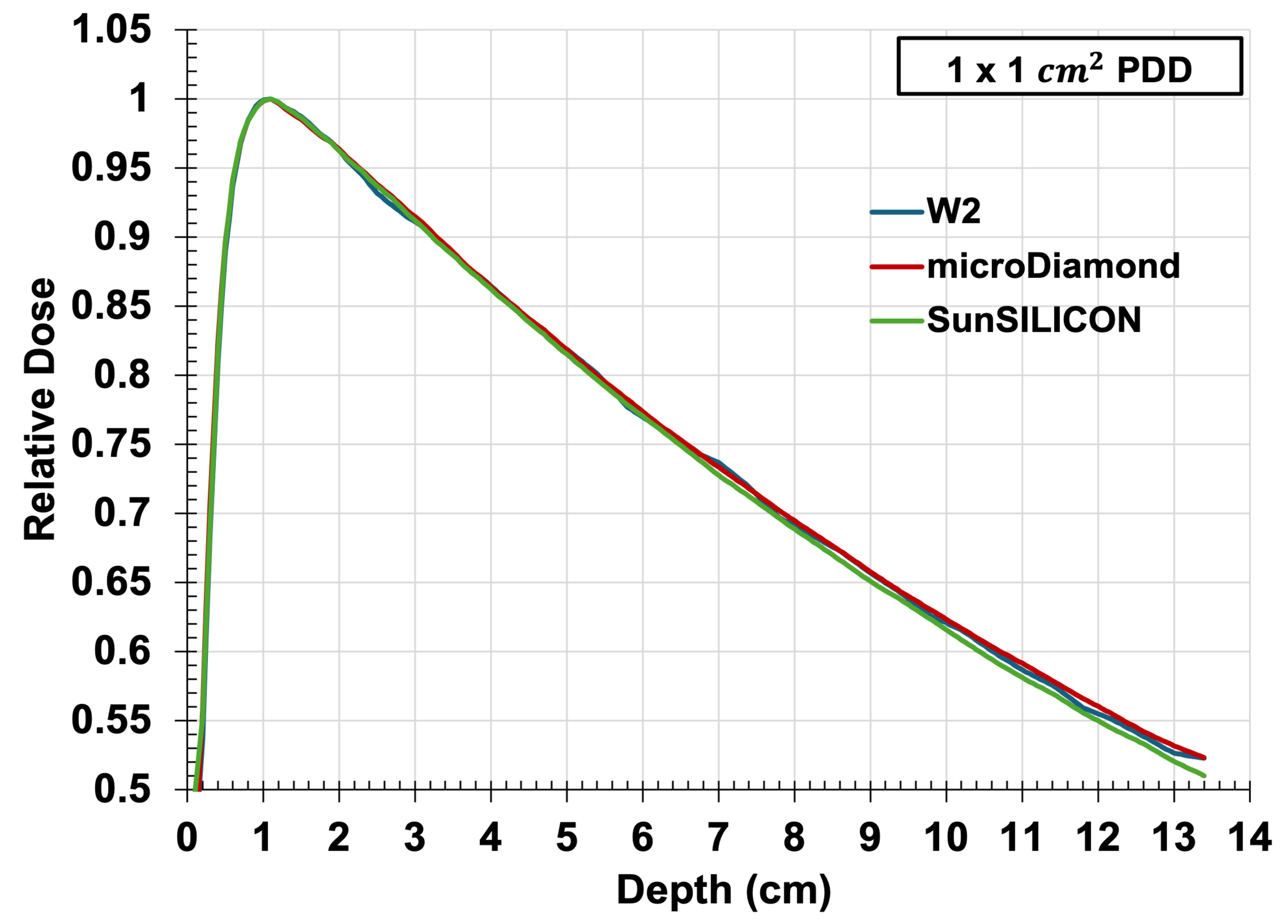


*Figure 3. Percent depth dose curves for 1×1 cm² square fields on the Elekta Unity 1.5T MR-linac. Each PDD is normalized to unity at the depth of maximum dose for that detector and field.*

### Output Factors

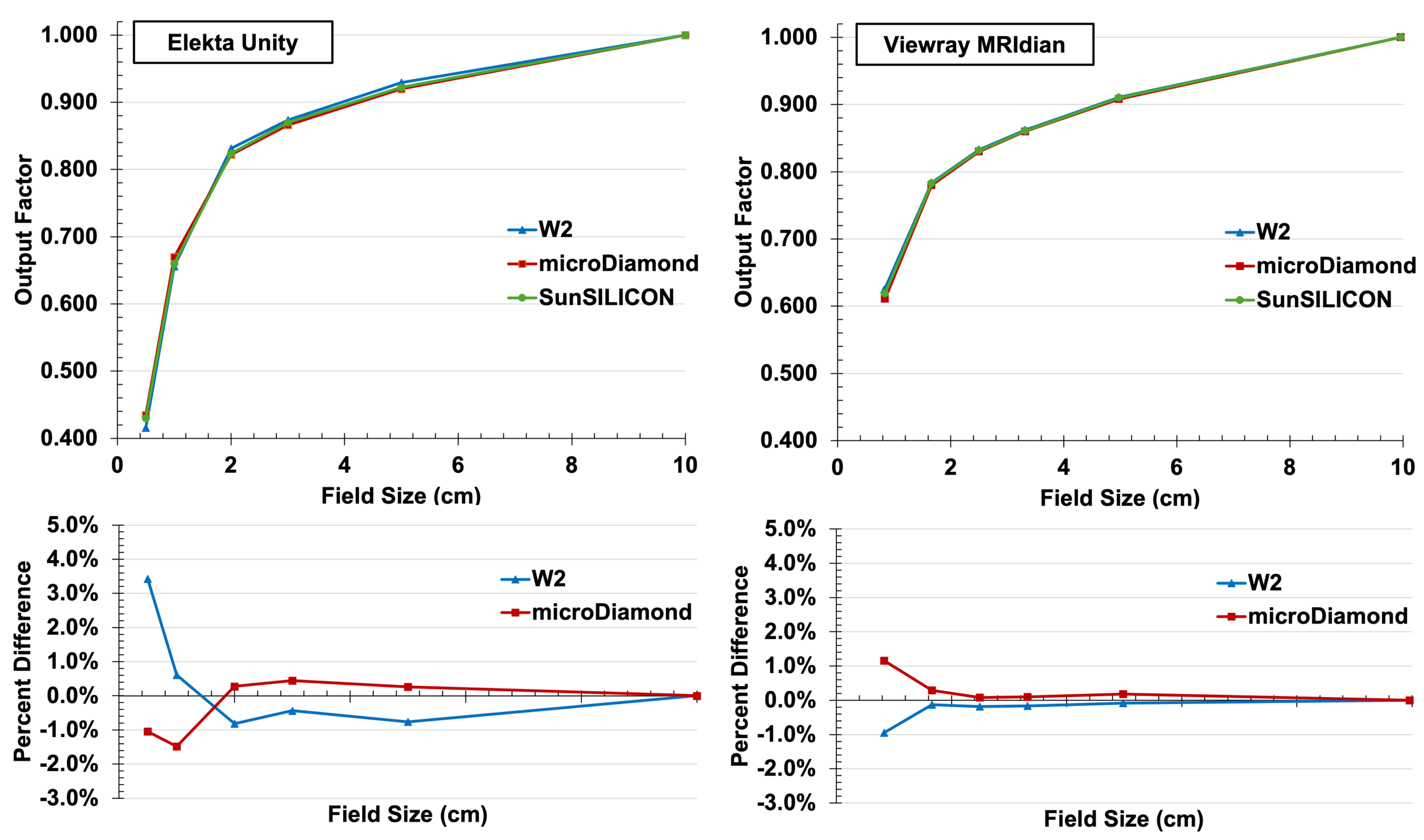


*Figure 4. Output factor vs. field size (top) and SunSILICON percent difference (bottom) for both platforms.*

- For 1.5 T, corrected SunSILICON was within 0.8% of W2 for fields ≥1×1 cm² and within 0.4% of microDiamond for fields ≥2×2 cm² (1.5% at 1×1, 1.0% at 0.5×0.5 cm²)
- The largest deviation at 1.5T was 3.4% at 0.5×0.5 cm².
- For 0.35 T, the SunSILICON was within 1.0% of W2 across all fields and within 0.3% of microDiamond for fields ≥1.66×1.66 cm² (1.2% at 0.83×0.83 cm²)

*Table 1. Output factors for microDiamond, SunSILICON, and Exradin W2 for square fields normalized to the largest field measured on each platform. Square fields normalized to the largest field measured on each platform. Published TRS-483 field-output correction factors (microDiamond) and TRS-483 framework-based correction factors (SunSILICON) were applied to convert uncorrected peak response ratios to corrected peak output factors.*

| | $\Omega_{peak}$ | | | Percent Difference | |
|---|---|---|---|---|---|
| Field (cm²) | W2 | microDiamond | SunSILICON | vs. W2 | vs. microDiamond |
| **Elekta Unity (1.5 T)** | | | | | |
| 10×10 | 1.000 | 1.000 | 1.000 | 0.0% | 0.0% |
| 5×5 | 0.929 | 0.920 | 0.922 | −0.8% | 0.3% |
| 3×3 | 0.874 | 0.866 | 0.870 | −0.4% | 0.4% |
| 2×2 | 0.831 | 0.822 | 0.824 | −0.8% | 0.3% |
| 1×1 | 0.656 | 0.670 | 0.660 | 0.6% | −1.5% |
| 0.5×0.5 | 0.416 | 0.435 | 0.430 | 3.4% | −1.0% |
| **ViewRay MRIdian (0.35 T)** | | | | | |
| 9.96×9.96 | 1.000 | 1.000 | 1.000 | 0.0% | 0.0% |
| 4.98×4.98 | 0.911 | 0.908 | 0.910 | −0.1% | 0.2% |
| 3.32×3.32 | 0.862 | 0.860 | 0.861 | −0.2% | 0.1% |
| 2.49×2.49 | 0.833 | 0.831 | 0.831 | −0.2% | 0.1% |
| 1.66×1.66 | 0.784 | 0.780 | 0.782 | −0.1% | 0.3% |
| 0.83×0.83 | 0.625 | 0.612 | 0.619 | −0.9% | 1.2% |

## Conclusion

This work is the first evaluation of the SunSILICON unshielded diode in MR-linac environments, spanning 1.5 T and 0.35 T platforms.
- All detector agreements fall within the expanded measurement uncertainty (k = 2) of 3.4% (Unity) and 3.6% (MRIdian).
- After TRS-483 corrections [4,5], SunSILICON output factors agreed with the W2 and microDiamond within 1.5% for fields ≥1×1 cm² on both systems, with differences increasing at 0.5×0.5 cm² on the Unity.
- Residual disagreement at the smallest field is consistent with magnetic-field effects not captured by conventional-linac corrections and with sub-mm positioning sensitivity a 0.15 mm W2 peak realignment reduced the 0.5×0.5 cm² difference to 1.4%.

## Acknowledgements

The authors would like to thank:
- Shannon Holmes of Standard Imaging Inc. (Middleton, WI) for technical guidance on W2 measurements
- Standard Imaging Inc. for providing a Exradin W2 on loan for this study.
- UW Accredited Dosimetry Calibration Laboratory customers for their continued support of the UWMRRC research program

## References

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