ArcCHECK® & 3DVH®

The Benchmark for 3D VMAT QA
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The ArcCHECK® is the world’s most selected independent 4D measurement array. Simply connect the single cable which supplies both power and data, and start to measure. No background measurements, no warm-up, no separate inclinometers, no additional hardware accessories.
**Volumetric Measurement QA for Patient Plan, Dose and Machine Testing**

ArcCHECK is the only true 4D array specifically designed for QA of today’s modern rotational deliveries. Its more than 1,300 SunPoint® Diode Detectors provide consistent and highly sensitive measurements for all gantry angles, with no additional hardware required. Independent absolute dose measurements enable the gold standard for stringent and efficient patient plan and machine QA testing.

**Patient Plan QA**
Stringent, fully independent measurement QA of patient plan and delivery with SNC Patient™ software

**Dose and DVH QA**
Full 3D Dose reconstruction for target and OAR DVH QA with 3DVH® software

**Machine QA**
Dynamic machine QA testing routines are provided for a wide variety of tests with SNC Patient software

**Hardware**
ArcCHECK embodies the spirit of independent Medical Physics measurement.
- 1,386 SunPoint Diode Detectors (0.019 mm³)
- Consistent Beams Eye View (BEV) for all gantry angles measuring entrance and exit dose
- Real-time electrometer measures every pulse, as well as composite and sub-arcs
- Interior cavity allows for a wide range of detector and tissue equivalent inserts
See the Entire Picture
An Ideal Geometry

Phantoms are ideally shaped like a patient. The cylindrical design of ArcCHECK intentionally simulates patient geometry to better match reality.

Because ArcCHECK detectors always face the delivery beam regardless of gantry angle, detection of very small gantry angle errors are possible. In contrast, when a 2D array is irradiated obliquely, the geometry collapses to 1D. Even when there is no detector shadowing effect, significant information is lost on a 2D array, and errors up to 10° are missed 75% of the time.¹

With ArcCHECK, gantry angle, leaf-end position, absolute dose, and time (4D) are measured and correlated to identify sources of error. Dose accuracy is improved and errors can be traced to the treatment planning system, the delivery system, or the imaging system.

What You See with a 2D Array

What You See with ArcCHECK

2D Array Measurement
An inherent limitation of 2D arrays is an inability to capture all of the dose information for rotational deliveries.

ArcCHECK Measurement
ArcCHECK displays BEV dose distribution throughout the entire arc delivery. More data is available to perform a more thorough QA analysis.


“Significant information is lost on a 2D array, and errors up to 10° are missed 75% of the time.”
Measuring completely around the isocenter in a uniform manner for each angle is a more stringent measurement than a simple composite dose at the isocenter. Errors visible in the isocenter are also visible in the surrounding dose measurements, but in more detail.

ArcCHECK measures entry and exit dose for every angle. For each beam angle, ArcCHECK measures high dose regions at the entrance and low dose regions at the exit, detecting potential delivery and TPS modeling errors for both high and low dose levels. For those who would like to measure the dose at isocenter or elsewhere within the cavity, Sun Nuclear offers the versatile MultiPlug™ and CavityPlug™ with detector insert capabilities.

- Hounsfield Unit (HU) conversion testing
- Tissue equivalent inserts:
  - Brain
  - Bone
  - Breast
  - Liver
  - Lung
  - Muscle
  - Apidose
  - Titanium
  - Water/Air
- Dose in up to 25 locations
- Film cassette insert
- Bezel angle indicator for rotation within cavity
- Precision milled detector holder included
  - Solid insert included to achieve solid cavity

- Precision fitted to ArcCHECK cavity
- Measure dose in cavity center
- Precision milled detector holder included
  - Solid insert included to achieve solid cavity
Helical Detector Grid
Detectors are arranged on a HeliGrid™ which increases the sampling rate and reduces BEV detector overlap and shadowing.

- An ArcCHECK 10 x 10 cm² area contains 221 detectors; equivalent to the detector density in a MapCHECK® 2
- Entrance and exit dose are measured, effectively doubling the detector density in the measurement field

Virtual Inclinometer™
ArcCHECK calculates gantry angle independently using entrance and exit dose.

- Virtual Inclinometer is accurate to ±1°
- System design eliminates the need for additional inclinometer cables and mounting to the delivery system

Easy Setup
ArcCHECK contains a sophisticated yet easy to use leveling system that ensures quick and accurate setup.

- With integrated rotation and tilt inclinometers, the leveling LEDs relay setup status in real-time

Large Fields
Two ArcCHECK measurements can be combined in SNC Patient software for larger field sizes.

Small Fields
Merge feature provides 442 detectors within a 10x10 field

2D Dose Analysis
With a single mouse click, SNC Patient software compares measured ArcCHECK dose points to planned dose points. Compare normalized data or absolute dose data using Distance to Agreement (DTA), Gamma (γ), and Gradient Compensation.

VMAT / Control Point Analysis
Individual control points and user-defined arc sections can be analyzed for a full arc or sub arc. A 360° presentation of pass, low, and high dose summary for the defined control point range and sub arcs is presented.

MLC Analysis
Evaluate the difference between the planned and delivered MLC pattern, and identify leaves that may indicate required service. Additional machine QA tests are also included.
3DVH®
Clinically Relevant Patient Specific QA

Phantom Evolution
3%/3mm criteria showing 99.2% passing rate, a good test of deliverability and machine performance.
3DVH uses ArcCHECK QA measurements to estimate 3D dose to the patient geometry.

- Perform 3D dose and DVH QA analysis on patient – not phantom – geometry
- Identify TPS and beam delivery errors
- Supports coplanar and non-coplanar beams

Sun Nuclear’s 3DVH software offers a unique quality assurance tool for patient specific IMRT QA. Testing was conducted for IMRT plans where we introduced known errors in both absolute dose and geometry of the delivered fields. These differences were accurately detected and reported by 3DVH and gave us a high degree of confidence in the system’s ability to detect treatment delivery errors. The system also revealed that where beams may “pass” in a 2D analysis, regions of failure and match were more clearly revealed in a 3D analysis.

Kym Rykers, Ph.D.
Chief Radiation Oncology Physicist, Austin Health, Australia

Clinical Evaluation
Evaluating the same plan, 3DVH shows substantial target underdose, indicating that although the plan was properly delivered, the clinical impact was below expectations.
Respiratory MotionSim™

Simulate the dosimetric impact of target motion with proven accuracy.

- Evaluate motion impact on 3D Dose and DVH
- Determine if motion management is necessary, and subsequently perform QA on QA motion management plans
- Use existing QA measurements and avoid bulky mechanical motion phantoms

Machine QA Analysis

Use ArcCHECK for a wide variety of machine QA tests in dynamic and rotational mode.

- Dynamic Gantry Rotation QA*
- Dynamic Gantry Angle QA*
- Dynamic Gantry Speed QA
- Dynamic Symmetry and Flatness*
- MLC QA
- Treatment Reproducibility QA

*Also available with static angles
Selected Publications

ArcCHECK® Accuracy Studies
Commissioning Monte Carlo algorithm for robotic radiosurgery using cylindrical 3D-array with variable density inserts
Dechambre et al., Liege University Hospital, Belgium, European Journal of Med Physics, 33 (152-158) (2017)

Filmless methods for quality assurance of Tomotherapy using ArcCHECK
Yang et al., Hong Kong, Med. Phys., 44 (7-8) (Jan 2017)

A comparison of the gamma index analysis in various commercial IMRT/VMAT QA systems
M. Husseina et al., Radiotherapy and Oncology 109 (3), (2013)

ArcCHECK-MR® Studies
Performance of a cylindrical diode array for use in a 1.5 T MR-linac
Houweling A. et al., Physics in Medicine and Biology, 61 (3) (2014)

Patient-specific quality assurance for the delivery of (60)Co intensity modulated radiation therapy subject to a 0.35-T lateral magnetic field.

3DVH® Studies
VMAT QA: Measurement-guided 4D dose reconstruction on a patient

Using a Novel Dose QA Tool to Quantify the Impact of Systematic Errors Otherwise Undetected by Conventional QA Methods: Clinical Head and Neck Case Studies
M. Chan et al., Technology in Cancer Research & Treatment 13 (1), (2014)

Learn more at sunnuclear.com/publications

Integration with the SunCHECK™ Platform
The SunCHECK Platform has direct device integration to ArcCHECK for array-based Pre-Treatment QA support, complementing phantomless offerings -- and providing optimal, unmatched flexibility for Patient QA.

Smarter Pre-Treatment QA
Directly connect your ArcCHECK to review full Pre-Treatment QA results, including absolute dose calibration and import of array calibration data, and measurements for composite results and per beam deliveries. Templates are provided by modality and can be easily customized to fit your needs.
Specifications

1,386 SunPoint Diode Detectors

Central Cavity

Helical Grid (HeliGrid) Geometry

1.0 cm Detector Spacing

21.0 cm Array Length

21.0 cm Array Diameter

2.9 cm Physical Detector Depth

Optional ArcCHECK Trolley can help ensure smooth transport of array and cradle. Narrow 18” width fits tight spaces, and shelf has been designed to slide away when cradle feet are positioned on the treatment couch.

Detector Type: SunPoint® Diode Detectors

| Detector Quantity: | 1,386 |
| Detector Spacing (cm): | 1.0 |
| Array Diameter (cm): | 21.0 |
| Array Length (cm): | 21.0 |
| Cavity Diameter (cm): | 15.0 |
| Inherent Buildup (g/cm²): | 3.3 |
| Inherent Backscatter (g/cm²): | 3.3 |
| Detector Physical Depth (cm): | 2.9 |
| Array Geometry: | Helical Grid (HeliGrid) 1 cm offset |
| Phantom Material: | PMMA (Acrylic) |
| Active Detector Area (mm²): | 0.64 |
| Detector Sensitivity (nC/Gy): | 32.0 |
| Max Dose/Pulse (Gy): | 0.003 |
| Detector Volume (mm³): | 0.019 |
| Detector Stability: | 0.5% / kGy at 6 MV |

Dose Rate Dependence: ± 1%, 75 - 250 cm SSD

Update Frequency (ms): 50

Number of Connection Cables: Single power/data cable

Dimensions (Total Length)(cm): 44.29

Weight (kg): 15.4

System Requirements (SNC Patient, 3DVH)

- Operating System: Windows 10 (Professional), Windows 8.1 or Windows 7
- CPU: Recommended 2.4 GHz or better, multi-core (2 or more cores)
- RAM: Recommended 4 GB or more
- Hard Drive Space: Recommended 5 GB or more

Compatibility

- FFR: Yes
- MR: Yes (ArcCHECK-MR®)
- SunCHECK: ArcCHECK measurements for composite and per beam deliveries