ArcCHECK® & 3DVH®

The Ultimate 4D Patient QA Solution

Your Most Valuable QA and Dosimetry Tools
THE 4D QA
GOLD STANDARD

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 rotisseries. It’s that simple, and that powerful.
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. At its heart are over 1300 SunPoint® Diode Detectors providing 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.
- 1386 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 wide range of detector and inhomogeneity 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.

ArcCHECK detectors are always facing the delivery beam regardless of gantry angle. The detector geometry relative to the BEV remains constant. Detection of very small gantry angle errors is 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.

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

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

What You See with ArcCHECK

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

- Hounsfield Unit (HU) conversion testing
- Tissue equivalent inserts:
  - Muscle, Bone, Lung, Adipose, Titanium
- 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

**Beam Delivery**

**ArcCHECK Detector BEV**

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

- Virtual Inclinometer is accurate to ±0.5°
- Avoids additional inclinometer cables and mounting to the delivery system

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

- Built in 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.
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 ($\gamma$), 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.

*Export only. 510(k) pending.
3DVH®
Clinically Relevant Patient Specific QA

Phantom Evolution
3%/3mm criteria showing 99.2% passing rate, a good test of deliverability and machine performance.

• No commissioning
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
- Supports coplanar and non-coplanar beams
- Identify TPS and beam delivery errors

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 impacts on 3D Dose and DVH
- Determine if motion management is necessary, and to 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**

A comparison of the gamma index analysis in various commercial IMRT/VMAT QA systems
M. Husseina et al., Radiotherapy and Oncology 109 (3), (2013)
- "Out of all the systems, ArcCHECK measurements exhibited the closest statistical agreement with the predicted gamma index."

A novel method for routine quality assurance of volumetric-modulated arc therapy,
- Validates ArcCHECK for VMAT QA and Machine QA.

Optimizing the accuracy of a helical diode array dosimeter: A comprehensive calibration methodology coupled with a novel virtual inclinometer,
- Validates ArcCHECK: Field size dependence, angular dependence, dose rate dependence, and intrinsic relative sensitivity (array calibration) factors, along with Virtual Inclinometer.

**3DVH® Accuracy Studies**

VMAT QA: Measurement-guided 4D dose reconstruction on a patient,
- Comprehensive explanation of the AC-PDP algorithm.
- Accuracy study with multiple ion chambers and film planes.

Moving from gamma passing rates to patient DVH-based QA metrics in pretreatment dose QA,
- Evaluation of 3D Gamma as a clinical metric versus 3D volumetric analysis.
- Accuracy study using a white box test.

**3DVH® Clinical Studies**

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)
- Discovered both systematic and patient specific errors using 3DVH that were missed by Gamma QA. Used both EPI Dose and film to verify all 3DVH discovered errors were true.
  - "The authors found that the Gamma criterion of 3%/3mm (or 2%/3mm) was too lenient to detect systematic errors, especially when used in TPS commissioning."
  - "Our study has confirmed the importance of advancing from phantom Gamma-based to patient DVH-based IMRT dose QA. Other researchers have come to this conclusion as well."
  - "Most of these errors would not be discovered in routine QA. Each potential source of error found by 3DVH has been verified to be relevant and true." (Verified with film and EPI Dose)

Evaluating IMRT and VMAT dose accuracy: Practical examples of failure to detect systematic errors when applying a commonly used metric and action levels,
- Four separate hospitals submitted an article on errors they discovered using 3DVH but were missed by conventional planar Gamma analysis.

Sensitivity of volumetric modulated arc therapy patient specific QA results to multileaf collimator errors and correlation to dose volume histogram based metrics,
- Concludes that 5% DVH errors are missed with Gamma only analysis and that volumetric analysis is recommended for VMAT QA.
  - "It is recommended that the sole use of gamma index for Rapidarc QA plan evaluation could be insufficient and a methodology for evaluation of delivered dose to patient is required."

For a complete list of ArcCHECK / 3DVH recommended publications, please request our Recommended Publications document.
Specifications

Detector Type: SunPoint® Diode Detectors
Detector Quantity: 1386
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 (cm²): 27.0 x 43.0
Weight (kg): 16.0

System Requirements (SNC Patient, 3DVH)
Operating System: Windows XP, Windows 7, Windows 8.1
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
FFF: Yes