3DVH transforms the field of per-patient dose QA by generating clinically-relevant and intuitive analyses of complex IMRT and VMAT plans. With proven accuracy, 3DVH estimates the 3D dose to the patient-specific geometry. Powered by the patented Planned Dose Perturbation (PDP™) algorithm, 3DVH uses existing QA measurements. Clinicians can abandon abstract and unpredictable “passing rate” metrics and instead use the same methods to QA treatment plans as those which were used to create them.

**Benefits**

- Transform 2D measurements to 3D dose volume for advanced analysis
- Perform 3D dose and DVH QA analysis on patient – not phantom – geometry
- Supports coplanar and non-coplanar beams
- Identify TPS and beam delivery errors
- Intuitive and familiar presentation of dose and DVH with statistics per anatomical structure
- Fast results with automated tools – Quick Stat Templates, Quick Dose Profiles, DICOM compliant workflow
- No forward dose calculation into the patient CT
- No commissioning
- Uses existing measurements and devices
- With optional Respiratory MotionSim™ module, analyze the dosimetric impact of a moving target

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

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¹ See Publications, Page 8
The Problem: 2D QA is not strongly correlated to actual errors

Actual Errors versus 2D Gamma Passing Rate
Perfect correlation of 2D QA Gamma Passing Rate (%) and Actual Error in DVH Metric is desired.

False negatives: where 2D QA Gamma Passing Rate meets criteria yet actual errors fail criteria.
False positives: where 2D QA Gamma Passing Rate fails criteria yet actual errors pass criteria.

2D: A Lack of Correlation
Commonly accepted 2D QA Gamma Passing Rate lacks significant correlation to actual errors in a patient geometry. While 2D QA techniques are useful for QA, 2D QA Gamma Passing Rates are not reliable as an estimator of actual error in a treatment plan.


3D Volumetric with 3DVH: Significant Correlation
When QA measured errors, large or small, are used to create an estimated 3D dose volume in a patient geometry for QA comparison, significant correlation is achieved.

The Solution: Patient Relevant Dose QA

1 **Structures**
Isolate structures and analyze using Quick Stats. Analyze only what is necessary.

2 **Critical Structure Statistics**
View estimated patient dose in highlighted regions as well as statistics for any structure. Customize desired values in the Quick Stats panel.

3 **Dose Display**
Isolate what is important, whether it be Reference, Comparison or Difference and assign custom colors and opacities to each.

4 **Parameters**
Enter the analysis parameters and get a quick comparison of the results.
False Negative - Conventional analysis indicates no finding of error, but 3DVH® shows substantial target underdose

SNC Patient™ software with 2%/2mm criteria showing 95.3% passing rate

SNC Patient software with 3%/3mm criteria showing 99.2% passing rate

Evaluating the same plan, 3DVH shows substantial target underdose
False Positive - Conventional analysis indicates a finding of error, but 3DVH® shows no clinically meaningful error in planned delivery.

SNC Patient™ software with 2%/2mm criteria showing 85.0% passing rate.

SNC Patient software with 3%/3mm criteria showing 79.7% passing rate.

Evaluating the same plan, 3DVH shows delivery consistent with plan.
## 3DVH® Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>ArcCHECK®</th>
<th>MapCHECK®</th>
<th>EPIDose™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create an estimated 3D or 4D patient dose volume for QA comparison</td>
<td>✔️¹</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>• Use real QA measurements to estimate 3D or 4D patient dose</td>
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<td>• Compare DVH, slice, and absolute point dose of estimate to plan</td>
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<td>• Use DVH for targets and critical structures, instead of 2D gamma passing rates</td>
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<tr>
<td>• Automatically corrects for depth, SSD, and patient geometry</td>
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<tr>
<td>In depth, structure-based (ROI) analysis</td>
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<td>✔️</td>
<td>✔️</td>
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<tr>
<td>• Customize the display of statistics by ROI</td>
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<tr>
<td>• Report the 3D gamma metrics on a per structure basis</td>
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<tr>
<td>• Isolate and analyze only what is necessary</td>
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<tr>
<td>• Create Quick Stat templates for standardization and reuse</td>
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<tr>
<td>• Specify within each template structures and constraints-per-structure; designed to support unlimited configurations</td>
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<tr>
<td>Powerful tools in an intuitive user interface</td>
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<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>• Display Reference Dose, Comparison Dose, or Dose Difference</td>
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<tr>
<td>• Assign custom colors and opacities for clarity and ease-of-use</td>
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<tr>
<td>• View Beams-Eye-View for IMRT treatments</td>
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<tr>
<td>Easily correct for daily output fluctuation</td>
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<td>✔️</td>
<td>✔️</td>
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<tr>
<td>• Daily output correction propagates to the estimated patient dose volume</td>
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<tr>
<td>• Select from multiple default chamber geometries</td>
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<tr>
<td>QA Plan Reporting</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>• Create reports of QA results in PDF format</td>
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<tr>
<td>• Filter report contents to suit clinic requirements</td>
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</tbody>
</table>

¹ Must use a cavity plug with a solid PMMA insert
### 3DVH® Features

**PDP™ for Non-coplanar Beams**
- Compute an estimated patient dose via the ArcCHECK PDP algorithm for a treatment delivery involving non-coplanar arcs

**4D Workspace Tools and Graphics**
- Look at gantry angle and cumulative or differential dose over time
- View cumulative and instantaneous ArcCHECK dose and correlate to gantry angle and MLC position
- Compare MLC measured positions to predicted positions

**VirtualGel™**
- Rapid reconstruction of a high-density, high-resolution 3D phantom dose
- Directly compare ArcCHECK 3D dose volume computed by 3DVH to a TPS-generated dose, without performing the PDP process
- View dose profile along the x, y, or z axis through the origin and along any column of diodes
- Facilitates detection of beam model errors during commissioning
- The benefits of a gel without the extra handling and processing

**Respiratory MotionSim™**
- Quantify and visualize the effects of organ motion on the estimated patient dose distribution
- Uses proven PDP™ measurement-guided reconstruction method to estimate 4D dynamic dose
- Evaluate both 3D Dose and DVH changes caused by motion to determine if motion management is necessary, and to QA motion management plans
- Run simulations virtually without the need for additional hardware
- Separately licensed module
- See Respiratory MotionSim datasheet for more information

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2 Requires the non-DICOM ArcCHECK movie file

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Compatibility

- Hardware: ArcCHECK®, MapCHECK® 2
- Software: SNC Patient™, EPI Dose™
- Rotational Therapy: RapidArc®, VMAT
- Static Gantry: IMRT
- Treatment Planning Systems: Pinnacle®, Eclipse®, and most TPS systems that can export DICOM data (TomoTherapy® coming soon)
- FFF & non-FFF Deliveries

System Requirements

<table>
<thead>
<tr>
<th>System Requirement</th>
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</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>Windows XP, Windows 7</td>
</tr>
<tr>
<td>CPU (GHz)</td>
<td>Recommended 2.4 or better, multi-core (2 or more cores)</td>
</tr>
<tr>
<td>RAM</td>
<td>Recommended 4GB or more</td>
</tr>
<tr>
<td>Hard Drive Space</td>
<td>Recommended 5GB or more</td>
</tr>
</tbody>
</table>

Publications

ArcCHECK, MapCHECK 2 and 3DVH

- “Evaluating IMRT and VMAT dose accuracy: Practical examples of failure to detect systematic errors when applying a commonly used metric and action levels,” B. Nelms et al., Med. Phys. 40 (11), 111722 (2013)

3DVH

- “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 and Treatment (2013)

ArcCHECK PDP™


MapCHECK 2 PDP