

# Precision and Efficiency: A Clinical Physicist's Workflow for Reliable Beam Data Acquisition with the DoseView™ 3D

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Product **Standard Imaging DoseView™ 3D Water Phantom System**

Keywords **Linac commissioning, water phantom, beam data acquisition, quality assurance, Dosimetric accuracy, medical physics workflow**



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## 1 Abstract

Linear accelerator (linac) commissioning and annual quality assurance (QA) represent two of the most resource-intensive responsibilities in clinical medical physics. These procedures require dedicated vault access — planned in advance, executed within defined windows, and carried out under the dual pressure of dosimetric precision and institutional scheduling constraints.

Contemporary 3D water phantom systems frequently attempt to address setup throughput by incorporating submerged electronic automation such as auto-leveling sensors or by bundling large software ecosystems. In practice, these design choices often introduce additional failure modes, extended troubleshooting procedures, and significant user retraining requirements, without proportionally reducing the physicist's setup burden.

This paper presents an evidence-informed clinical workflow developed at MJS Medical Physics Inc. utilizing the Standard Imaging DoseView™ 3D water phantom system. The described protocol prioritizes mechanical precision and simple software tools to achieve a reliable time-to-first scan, minimize measurement setup errors and uncertainty, and sustain consistent long-term procedures across annual QA cycles. Key operational advantages include an intuitive and fast leveling procedure, a purpose-built data acquisition interface, and a structured setup protocol that enables confident scan-ready positioning within approximately 25 minutes: 15 minutes of setup time, and 10 minutes for water tank filling.

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## 2 Introduction: Operational Context and the Need for Reliable Setup

Linac commissioning and annual QA are planned procedures — they are not executed in the narrow inter-patient gaps that characterize routine daily or monthly QA. They require dedicated vault access, coordinated in advance with clinical scheduling or performed outside clinical operating hours, and they may occupy substantial blocks of time.

Despite the time crunch, the goal in this environment is not speed alone, nor accuracy alone — but precision at speed. A 3D water scanning system must be mechanically stable, setup-reproducible, and software-intuitive to yield sufficient quality beam data within the planned vault window, without requiring excessive time commitments or sacrificing confidence.

Against this background, the selection and configuration of a 3D water phantom system constitutes a clinical decision with downstream implications for data integrity, staff workload, and machine availability. This paper describes a structured, reproducible workflow developed in response to these operational realities.

## 3 Setup and Leveling Workflow: The Primacy of Mechanical Precision

### 3.1 Guiding Philosophy

The author's operational perspective on automated setup may be summarized as: trust but verify. While automation can accelerate routine steps, delicate electronic components submerged in the tank water introduce a class of failure modes that are often difficult to diagnose rapidly under clinical time pressure. Automated leveling algorithms or systems that provide detector alignment using a sensor on the detector carriage in particular may not detect cable tension artifacts, subtle off-axis positioning, or true detector verticality — variables that are immediately apparent upon visual inspection by an experienced physicist.

This is not a philosophical preference for manual work. It is a risk management decision. An automated leveling sequence that completes without error can still yield a subtly unlevel tank, particularly if the water sensor functionality has started to degrade. The physicist must still confirm accuracy at each stage of tank setup to ensure an appropriately high level of confidence in the scan environment before the first measurement is taken.

Accordingly, the DoseView™ 3D workflow described herein is structured around mechanical verification at each critical alignment step. The setup workflow aims to provide the most efficient setup achievable with full confidence in the data. The clinical cost of a short setup that produces asymmetric or offset data — requiring the scan sequence to be repeated — substantially exceeds the time investment of the deliberate manual verification protocol described here.

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## 3.2 Sequential Setup Overview

The following workflow is executed in sequence at each commissioning or annual QA session.

1. **Pre-Session Preparation.** The water storage reservoir is filled several hours prior to vault access to allow water temperature equilibration. This step conserves vault time during the active scan window and reduces measurement uncertainty attributable to thermal non-equilibrium.
2. **System Initialization.** Upon vault clearance, the tank is positioned in rough alignment with the room crosshairs and light field projection. The DoseView 3D motion controller and electrometer are powered on; the detector carriage executes an initialization sequence and moves to the software-defined default position.
3. **Initial Tank Alignment.** With the tank empty, the system is aligned horizontally such that it is approximately centered in the radiation field and rotationally oriented to match the field axes. Vertical height adjustment is made to place the tank in the approximate scanning position, using the room lasers and the targeted fill line marked on the exterior of the tank as a reference. Scanning arm leveling is not performed at this stage because the water weight can cause minor settling of the tank, thereby affecting the scanning arm alignment.
4. **Tank Fill and Leveling Verification.** Auto-fill from the reservoir is initiated while the acquisition software is launched and the pre-loaded scan queue is verified. Upon fill completion, the tank is secured with foot caster locks. The fill level is evaluated using the Optical Distance Indicator (ODI). Scanning arm leveling is then initially set using the system's bubble levels and fine-tuned using the alignment jig to ensure that the scan axes are fully aligned with the water surface.
5. **Detector positioning.** The scanning and reference detectors are set in place, and the scanning detector vertical position is aligned with the water surface. The scanning detector is also approximately centered within the radiation field using the projected crosshairs, and the scanning origin is set. Fine tuning of the detector centering is performed in a later step using the system's Find Center function, so precise centering of the detector is not a concern in the current step.
6. **Visual Confirmation.** Before initiating scanning, a final visual verification step confirms detector vertical alignment and agreement between laser projections and the reference depth indicator. Cables are checked to ensure appropriate length and positioning to allow for the full range of scanning motion. This visual confirmation step is non-negotiable. It is the checkpoint that prevents the most prevalent cause of scan repetition: positional offsets or tilt artifacts that are only discovered after data acquisition is complete.
7. **Final detector centering.** The scanning detector lateral position is evaluated using the Find Center functionality with a 10x10 cm or 20x20 cm field. If a proposed shift is less than 1mm, the shift is applied without additional visual verification. If a proposed shift is greater than 1mm, the shift is applied and centering is visually inspected once again prior to scanning.

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## 4 Detector Selection, Setup, and Alignment

### 4.1 Detector Compatibility and Initial Setup

Appropriate detector selection and robust detector placement is foundational to data integrity. The workflow described here utilizes the Exradin A26 or A28 thimble chambers because their active volume is nearly spherical, so no chamber rotation is required between inplane and crossplane scans. The Exradin A28 has slightly larger volume averaging than the smaller A26, but this difference is balanced by the larger measurement signal of the A28 which enables faster scanning. The Exradin A10 Parallel Plate ionization chamber is used for electron beams when required for specific commissioning or annual QA protocols.

Chambers are initially positioned using the Phantom Alignment Jig external to the tank. The jig enables a detector to be attached to the appropriate holder and roughly aligned prior to placing the combined detector and holder on the detector carriage within the tank. This process ensures that the detector is secure and approximately centered before the chamber is submerged, and it also eliminates a common source of delay associated with in-water detector reconfiguration.

*Note: "Find Center" function: the positioning jig establishes a close approximation of the correct origin, but fine-tuning is typically required. The DoseView 3D "Find Center" function should be used after initial placement to precisely locate the beam axis — this step is expected and should be part of the standard setup routine, not treated as a correction for imprecise jig placement.*

### 4.2 Efficient Leveling and Verification

Before detectors are placed in the tank, an Origin Crosshair Alignment Jig is mounted on the detector carriage. This jig serves two functions: it enables efficient tank arm leveling by providing highly visible indication marks for water surface alignment and it establishes the approximate origin reference used for all subsequent detector positioning.

To level the tank in the most efficient manner possible, the detector carriage with the Origin Crosshair Alignment Jig attached is first driven to the corner of the water tank closest to one of the three leveling screws, and an initial arm leveling is performed using the built-in bubble levels on the arms. The SSD is verified at the center of the tank using a small floating piece of paper and the Optical Distance Indicator (ODI). Height adjustments are made using the tank cart lift. The Origin Crosshair Alignment Jig is then positioned such that it is centered at the water surface, still in the corner of the tank. The carriage is then moved to the adjacent tank corner where the second leveling screw is located. The leveling screw is adjusted by hand until the Origin Crosshair Alignment Jig is again centered at the water surface. The carriage is then driven to the center of the opposite side of the tank, near the third leveling screw. Arm height is adjusted at that third leveling point if needed to bring the jig back into alignment with the water surface. The carriage is then driven back to the center of the tank, where the water alignment with the jig is confirmed. The jig is removed from the carriage, and the detector holder is attached in its place.

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It should be noted that the scanning arms of the DoseView 3D system are independent from the walls of the tank. The three-point leveling system enables the arms to sit securely on the tank even if the tank itself is not perfectly square or perfectly level, and the scanning arms can be aligned easily with the water surface, which is the critical reference plane for scanning. For 3D systems with scanning arms that are rigidly attached to the tank walls or that utilize four-point leveling, leveling becomes more complex due to bowing of the tank walls or torsional strain on scanning arms.

## 4.3 Guidance Note for Newly Certified Physicists

Detector setup is not a mechanical formality — it determines whether the resulting data can be trusted. Establish a personally consistent routine and prioritize reproducibility over speed. Room lasers provide an approximate reference only; always cross-verify with the optical distance indicator and the beam crosshairs along with the Find Center function for detector centering.

The reference detector should be positioned just inside the corner of the field so that the scanning detector never passes directly underneath the reference detector. Double check this positioning any time the field size is changed during scanning.

Small angular errors in scanning detector orientation can produce significant and systematically biased measurement deviations. Apply clinical judgment: no algorithm will detect cable tension artifacts or chamber tilt that causes subtle positioning errors that are apparent to a trained eye.

## 5 Data Acquisition and Software Integration

### 5.1 Software Interface, Scan Queues, and Annual QA Continuity

The most clinically significant feature of the DoseView 3D software is also the simplest to describe: the acquisition interface is purpose-built for beam data collection. It does not bundle unrelated QA modules, legacy analysis functions, or interface conventions inherited from software designed for a different workflow. For a physicist operating under time pressure in a commissioned vault, this focus is not a minor convenience — it is a direct reduction in the cognitive load that contributes to parameter entry errors and setup delays. A clean and intuitive interface like the DoseView 3D software also drastically reduces both the stress and the time involved in re-leaving software that is only used once or twice each year.

The scan queue interface enables rapid assignment of all relevant acquisition parameters such as beam energy, field size, cone configuration, scan direction, step size, and penumbra boundary. During scanning, individual scans may be repeated without reconstructing the full queue, reducing overhead when a single measurement in a multi-energy, multi-field-size sequence requires re-acquisition. Scan queues are saved within the software, so a dedicated annual scanning queue can be created and re-used on subsequent years if desired, or a subset of this queue can be run when needed after linac maintenance or repair. The

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result of having saved queues is a material reduction in interface re-familiarization overhead and a significant decrease in the risk of energy, field size, or scan parameter errors in the annual workflow.

From the practitioner's perspective, this feature converts annual QA from a software re-learning event into a validation event — a meaningful distinction when vault time and staffing time are the constraining resources.

## 5.2 Effective Point of Measurement: Automated Correction

The application of effective point of measurement (EPOM) corrections varies by chamber type and geometry and represents a material source of manual error in beam data acquisition and dose conversion, particularly in time-compressed sessions. The DoseView 3D Dose Convert function automatically retrieves chamber information from the system configuration and applies the appropriate EPOM shift to the acquired data without manual input.

This automated correction reduces a class of systematic errors that disproportionately affect commissioning sessions performed under time pressure or by less experienced practitioners. As with all automated positional operations in this workflow, the applied correction should be confirmed against expected values as part of standard data review — automation reduces the probability of manual entry error; it does not eliminate the physicist's responsibility to verify the result.

## 5.3 Analysis Interface

All data required for commissioning and annual QA evaluation — PDD curves, profiles, output factor data, and acceptance criteria comparisons — are aggregated on a single analysis screen within the DoseView software. This design eliminates the workflow interruption of navigating between multiple software modules during high-pressure clinical sessions and reduces the cognitive load associated with comparing data across multiple application windows. For annual scanning, new scans are compared directly with reference or commissioning scans to enable rapid assessment of any discrepancies.

## 6 Long-Term Reliability, Maintenance, and Service Continuity

### 6.1 Zero-Submerged-Electronics Design

Unplanned system downtime in an active clinical environment is operationally unacceptable. The DoseView 3D architecture maintains all critical drive electronics and motion control components above the waterline. While the mechanical scan arms necessarily operate within the tank environment, the electronics that drive and control them — the components most vulnerable to corrosion and moisture ingress — remain completely dry.

This design eliminates the primary electronics failure mode of some water phantom systems: moisture ingress into submerged control components, which typically requires factory service and produces

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extended scan-unavailability periods. The practical consequence is a materially lower maintenance burden and significantly reduced vulnerability to unplanned commissioning delays attributable to tank-side hardware failures.

## 6.2 Service Contract and Preventive Maintenance

To minimize vault disruption attributable to equipment maintenance, the authors utilize an annual Standard Imaging on-site service contract. A certified technician performs comprehensive integrity checks of the mechanical hardware, motion controller, and electrometer interface. This proactive maintenance cadence has sustained hardware reliability superior to other elements of the clinic's QA instrumentation inventory over the same service period.

## 6.3 Scan Queue Persistence and Annual QA Continuity

The operational benefits of persistent scan queue storage — described in §5.1 in the context of data acquisition — also carry a long-term reliability implication: the workflow does not depend on the physicist's memory of an interface used once per year. The queue is the institutional memory. As long as the queue is validated and stored, the annual QA workflow is reproducible regardless of personnel changes or the time elapsed since commissioning.

## 7 Discussion

The workflow presented here reflects a deliberate prioritization of mechanical precision and carefully designed workflow steps to ensure data are accurate yet still acquired within a minimal timeframe, and it takes advantage of tools within the DoseView software that support and streamline data acquisition and analysis. This combination addresses the two primary operational failure modes in beam scanning: setup-induced artifact requiring scan repetition, and software complexity requiring practitioner retraining.

Automated leveling systems, in the author's clinical experience, do not eliminate the need for manual verification. An automated sequence that completes without an error is not always completed accurately. The practitioner who relies solely on the automated result still risks a setup error. Ensuring that the scanning environment is mechanically correct before any data is collected is a critical step in a scanning workflow. In the author's experience, the protocol described here has yielded a materially lower rate of scan repetition due to setup-induced artifacts, and has not resulted in positioning offsets being discovered post-acquisition.

The software advantages of the DoseView 3D are most practically experienced during annual QA, where the combination of a simple and familiar interface with saved scan queues converts a procedure that might otherwise require interface re-familiarization into a straightforward load-and-validate workflow. This operational efficiency is not visible in a single-session comparison — it accumulates across the commissioning-to-annual-QA lifecycle, and it is most apparent to practitioners who have used alternative platforms with interface conventions that are not recalled reliably on an annual schedule.

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## 8 Conclusion

After several years of clinical use, the DoseView 3D has become the author's preferred beam scanning platform for commissioning and annual QA in community hospital settings — not because it automates the setup process, but because it does not pretend to. The system's design philosophy aligns with the way experienced clinical physicists actually work: verify the mechanical environment deliberately, use software that does exactly what you need without complexity you don't, and maintain a hardware platform that you can trust not to fail during a scheduled commissioning window.

The three operational advantages that have proven most consequential in practice are straightforward: the interface is clear and immediately familiar each time it is used; saved scan queues eliminate the annual relearning overhead that plagues less focused software platforms; and the design has sustained reliable hardware performance across the full service period without tank-side failures.

For newly certified physicists establishing their commissioning and annual QA workflows: invest the time to develop a personal setup protocol with explicit verification at each stage. No sensor replaces the clinical judgment of a physicist who has confirmed the scan environment with their own eyes.

## Acknowledgments

The author acknowledges the clinical physics and dosimetry staff at MJS Medical Physics Inc. for their contributions to workflow validation and ongoing refinement of the protocols described herein.

## Disclosures

The DoseView 3D system described in this paper is a product of Standard Imaging, Inc. (Madison, WI). The author has no financial relationship with Standard Imaging, Inc. Clinical observations and operational conclusions represent the independent professional assessment of the author based on direct clinical use.

## About the Author

Meredith Semon-Pomposelli, M.S., DABR, RSO, AMP is a board-certified medical physicist (DABR) and Radiation Safety Officer practicing at MJS Medical Physics Inc. Her clinical focus encompasses linac commissioning, annual QA, and dosimetric quality management in community hospital environments. She brings a practitioner-centered perspective to equipment evaluation and workflow design, with a particular interest in protocols that sustain data confidence under operationally constrained conditions.