COMPREHENSIVE TG-142 IMAGING AND MACHINE QA

Automate the analysis of over thirty TG-142 recommended QA tasks
The rapid progress of Radiation Therapy has created the need for Quality Assurance testing far greater in scope and effort than in the past. Sophisticated intensity-modulated radiation treatments rely on near-perfect multileaf collimator operation, while advanced imaging technologies for Image-Guided Radiation Therapy rely not only on image quality, but the spatial coincidence of treatment and imaging frames of reference.

TG-142 recommends a suite of daily, monthly, and annual tests to meet the challenge of modern clinical radiation therapy Quality Assurance. In addition to defining the tests for recently-developed technologies, TG-142 identifies the need to test against established baselines and track and trend results. All of these new QA obligations, necessary for a safe and effective clinic, increase physicists’ work load and further strain busy schedules.

PIPSpro efficiently consolidates TG-142 QA workload by incorporating over 30 procedures into one easy-to-use platform. When used in conjunction with specialized phantoms from Standard Imaging, PIPSpro becomes an indispensable part of your QA process, giving you confidence that your clinic is operating within specifications.

“PIPSpro software and phantoms are valuable tools for streamlining over 30 of the TG-142 tests, automating data analysis, and providing documentation of the test results. By providing quantifiable and repeatable results, PIPSpro makes it easier for our center to become compliant with TG-142.”

Rick Baker
Physics Applications Specialist
Iowa Health Des Moines -
John Stoddard Cancer Center
TABLE II

**MONTHLY**

**Mechanical**
- Light/radiation field coincidence
- Jaw position indicators
- Cross-hair centering

TABLE III

**ANNUAL**

**Mechanical**
- Collimator rotation isocenter
- Gantry rotation isocenter
- Couch rotation isocenter
- Coincidence of radiation and mechanical isocenter

TABLE V

**MULTILEAF COLLIMATION**

**Weekly**
- Qualitative test, aka “picket fence”

**Monthly**
- Setting vs radiation field for two patterns
- Travel speed
- Leaf position accuracy

**Annual**
- MLC transmission
- Leaf position repeatability
- MLC spoke shot
- Coincidence of light field and x-ray field
- Segmental IMRT
- Moving window IMRT

TABLE VI

**IMAGING**

**Daily**
- Planar kV and MV (EPID) imaging
- Positioning/repositioning
- Imaging and treatment coordinate coincidence
- Cone-beam CT (kV and MV)
- Imaging and treatment coordinate coincidence
- Positioning/repositioning

**Monthly**
- Planar MV imaging (EPID)
- Imaging and treatment coordinate coincidence
- Scaling
- Spatial resolution
- Contrast
- Uniformity and noise
- Planar kV imaging
- Imaging and treatment coordinate coincidence
- Scaling
- Spatial resolution
- Contrast
- Uniformity and noise
- Cone-beam CT (kV and MV)
- Geometric distortion
- Spatial resolution
- Contrast
- HU constancy
- Uniformity and noise

Film images can be used in all modules with the exception of Imager QA and Stereotactic, where image quality and positioning are critical variables that cannot be maintained using film. DICOM images are supported in all modules. Raw images are supported for ExacTrac and Cyberknife kV planar imager QA.
TG-142 MADE EASY
Designed with a convenient and optimized workflow in mind

Why thousands of users in over 700 clinics choose PIPSpro as their TG-142 software:

- Simple, clean and consistent user interface
- Easy-to-read reports, charts, and graphs
- PDF and comma separated variable (CSV) results export
- Multiple open modules for streamlined workflow
- Physicist-controlled editor for creating testing baselines
- Tracking and trending for test results
- Quick Selects™ for organizing tests and accessing test results
- Automatic image compositing for EPID MLC QA and StarShot images
- Centralized database for easy configuration and accessibility to results

Faster QA with Quick Selects™
In Imager QA, Quick Selects are customizable collections of parameters that allow a variety of machine, imager, phantom, and energy combinations to be saved. Using Quick Selects, one-click activation provides an easy means to recall tests and track your results. Quick Selects are used in the Imager QA and the Logfile-Based MLC QA modules and, because of their power, will be used throughout PIPSpro.

The TG-58 Report encourages users to demand the use of a tool such as PIPSpro QC Software at acceptance to help ensure that the EPID is indeed operating at or above specifications.*


Over 30 TG-142 procedures
POWERFUL IMAGER QA
Consolidated TG-142 QA for volumetric and planar imaging

CT Imaging QA
Using cone beam or diagnostic images obtained with any of the Catphan phantoms (503, 504, 600), PIPSpio automatically finds analysis image slices and performs required TG-142 tests (geometric distortion, spatial resolution, contrast, HU constancy, uniformity and noise). Results are colored green (“Pass”), amber (“Alert”), or red (“Fail”) for easy viewing of status (this scheme is used throughout PIPSpio).

Planar Imaging QA
PIPSpro kV planar imaging QA uses images obtained with Standard Imaging’s QC-kV1 phantom or Leeds Test Objects’ TOR CDR phantom. Testing is supported for kV imagers integrated with linear accelerators as well as images from ExacTrac, Cyberknife, and C-Arms. EPID MV planar imaging QA uses Standard Imaging’s calibrated QC-3 phantom.

Automatic Region Identification Is Key
By automatically identifying analysis regions, subjectivity is reduced and results consistency is improved.

Baseline Editor
Individual baselines can be created for each combination of linear accelerator, imager, phantom, and energy that you test using Quick Selects. This unique and powerful feature allows you to choose representative measurements, combine them, and set alert and warning tolerances for your imaging systems.
**COMPLETE MLC QA**

Cover all TG-142 MLC QA tests with EPID images and logfiles

<table>
<thead>
<tr>
<th></th>
<th>Image-Based</th>
<th>Logfile-Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matched Segments, aka “Picket Fence”</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Setting vs radiation field for two patterns (non-IMRT)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Travel speed – leaf speed loss (IMRT)*</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Leaf position accuracy (IMRT)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Average of leaf and interleaf transmission, all energies</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Leaf position repeatability*</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>MLC spoke shot</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Coincidence of light field and x-ray field, all energies</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Segmental IMRT (step and shoot) test</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Moving window IMRT (four cardinal gantry angles)</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

*With logfile-based analysis, PIPSpro is the only commercial software solution able to measure quantitative leaf speed loss and leaf position repeatability.

PIPSpro MLC QA gives you actionable, quantitative results that allow you to track and trend all TG-142 requirements, delivering critical information that may indicate an impending MLC failure or indicate the need to recalibrate your machine for the best possible clinical outcomes. Step & Shoot and VMAT parameters are tested in any direction using MLC leaf pattern files (*.mlc, *.dva).

PIPSpro is the first commercial machine QA software to determine leaf speed loss. Systems that report only maximum and mean leaf speed cannot be used to calculate leaf speed loss, as required by TG-142,* notes Standard Imaging medical physicist Shannon Holmes, Ph.D.

PIPSpro features automatic compositing of EPID MLC images, so you don’t need to use third-party products to combine individual images.

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In simple leaf speed tests, all leaves travel together

In complex leaf speed tests, every other leaf moves, maximizing inter-leaf friction
PIPSpro is able to measure quantitative leaf speed loss, not just deliver a qualitative result.

Leaf speed status in a repeatability test
**Radiation Light Field Analysis**

PIPSpro uses a single image taken with custom phantoms (FC-2, Center Marker) to calculate:

- Radiation and light field coincidence
- Radiation and crosshair displacement
- Light field and crosshair displacement
- Jaw position measurements
- Light field rotation

*Works for light fields defined by jaws or MLCs.*

**Starshot Analysis**

PIPSpro’s StarShot module uses EPID MV or film images to measure rotational deviations in gantry, collimator, and couch mechanical isocenters. Results are expressed as the minimum diameter containing all spokes at the central point of intersection. Unlike competing software, PIPSpro features automatic compositing of individual EPID spoke images, so you don’t need to use third-party products to combine images.

*Works for spoke images defined by jaws or MLCs.*

**Daily IGRT QA Tracking**

When using Image-Guided Radiation Therapy (IGRT) in the clinic, daily testing is recommended to verify that your imaging coordinate system is precisely aligned with your treatment coordinate system. TG-142 recommends two tests: “Imaging and treatment coordinate coincidence” and “Positioning/repositioning”. Use the Standard Imaging MIMI (Multi-Image Modality Isocentricity) phantom with image registration software to calculate known 3D (x, y, z) and 6D (add couch pitch, yaw and roll) offsets. PIPSpro allows you to record your daily offsets and track and trend your results.

*Simple IGRT trending*
Use Standard Imaging’s Winston-Lutz phantom to measure the difference between the radiation isocenter and the mechanical isocenter for a linear accelerator. A number of images are taken with your portal imager using fixed angles or angles of your choice.

- Automatically load and analyze any images, including DICOM images, for cones or MLC’s.
- Automatically get 2D radiation/mechanical offsets for each image.
- Automatically get an optimal 3D offset to correct patient offset errors.
- 3D analysis with x, y, z results that help you improve patient positioning.
PIPSpro can use a local or centralized database server. As a result, PIPSpro is the choice of small, large and multi-location treatment centers across the world. PIPSpro has the feel of a desktop application using a centralized server, but gives you the power to organize your sites into divisions and departments assigning users permissions to the departments and tasks that they need to do their work.

Features include:

- Single access point controls division, department, linac, and user configuration
- Centralized data access point allows enterprise-wide access to data, results, and trending
- Unparalleled data security
- Citrix server support on enterprise wide systems
- DICOM router offers convenient access and routing of files by constantly listening for new images and automatically sorting them by file type and date into a directory of the users choosing

Centralized Database Management

Simplify your QA by keeping all your data centralized and secure

Thorough service, knowledgeable support
**Phantoms**

**QC-3 Phantom**
- **Calibrated Phantom**
- **ref 71350**
- Used to test the image quality from electronic portal imaging devices (EPIDs).

**QCkV-1 Phantom**
- **Calibrated Phantom**
- **ref 71451**
- Ideal for kV imaging systems, including Varian, Elekta, BrainLAB and Cyberknife.

**FC-2 Phantom**
- **ref 72187**
- For performing the radiation field vs. light field test and jaw position testing.

**Light Field Cross Hair Marker**
- **ref 72247**
- For performing the radiation field vs. light field test and jaw position testing.

**MLC QA Phantom**
- **ref 72277**
- For analyzing individual leaf positions of multi-leaf collimators (MLC).

**Winston Lutz Pointer Phantom**
- **PIPSpro recognizes most ball marker phantoms**
- **ref 72285**
- Expedite and simplify verification of sub-millimeter isocenter treatment setup.

**Winston Lutz Cube Phantom**
- **PIPSpro recognizes most ball marker phantoms**
- **ref 91345**
- Expedite and simplify verification of sub-millimeter isocenter treatment setup.

**MIMI Phantom** (Multiple Imaging Modality Isocentricity Phantom)
- **ref 91240**
- Ensure image guidance accuracy by measuring the coincidence of isocenter prescribed by the lasers, treatment beam and image guidance systems.

**Catphan**
- **purchased through your linac vendor**
- Compatible with model 503, 504, and 600 phantoms.

**Leeds Test Objects**
- **purchased through your linac vendor**
- Routine test objects designed to be used quickly and easily on a regular basis.

 Phantom holders available for CyberKnife and ExacTrac imagers make PIPSpro a complete QA software for all imaging delivery systems.

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**PIPSpro Software Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System</td>
<td>WINDOWS 7 (SP1) or better&lt;br&gt;WINDOWS 8.1 (SP1) or better&lt;br&gt;.NET 4.0 or better</td>
</tr>
<tr>
<td>Processor</td>
<td>Intel® or AMD® 350 MHz or greater</td>
</tr>
<tr>
<td>Memory</td>
<td>1 GB (3 GB recommended)</td>
</tr>
<tr>
<td>Hard Drive</td>
<td>512 MB free space for software installation. Sufficient space to store image data files. 3GB or greater if installing SQL Server Express on the install host.</td>
</tr>
<tr>
<td>Screen</td>
<td>1152 x 864 XGA+(4:3)&lt;br&gt;1600 x 900 (16:9) or higher&lt;br&gt;16 bit HiColor or greater</td>
</tr>
<tr>
<td>CD-ROM Drive</td>
<td>2X speed or greater</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>Must support WMI (Windows Management Instrumentation) Citrix XenDesktop and Citrix XenApp</td>
</tr>
<tr>
<td>Database Management</td>
<td>SQL Server 2008 R2 (or SQL Server Express equivalent) minimum</td>
</tr>
<tr>
<td>Product Standards</td>
<td>Designed to meet IEC 60601-1-4</td>
</tr>
<tr>
<td>Recommended Software</td>
<td>Microsoft Excel</td>
</tr>
</tbody>
</table>

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