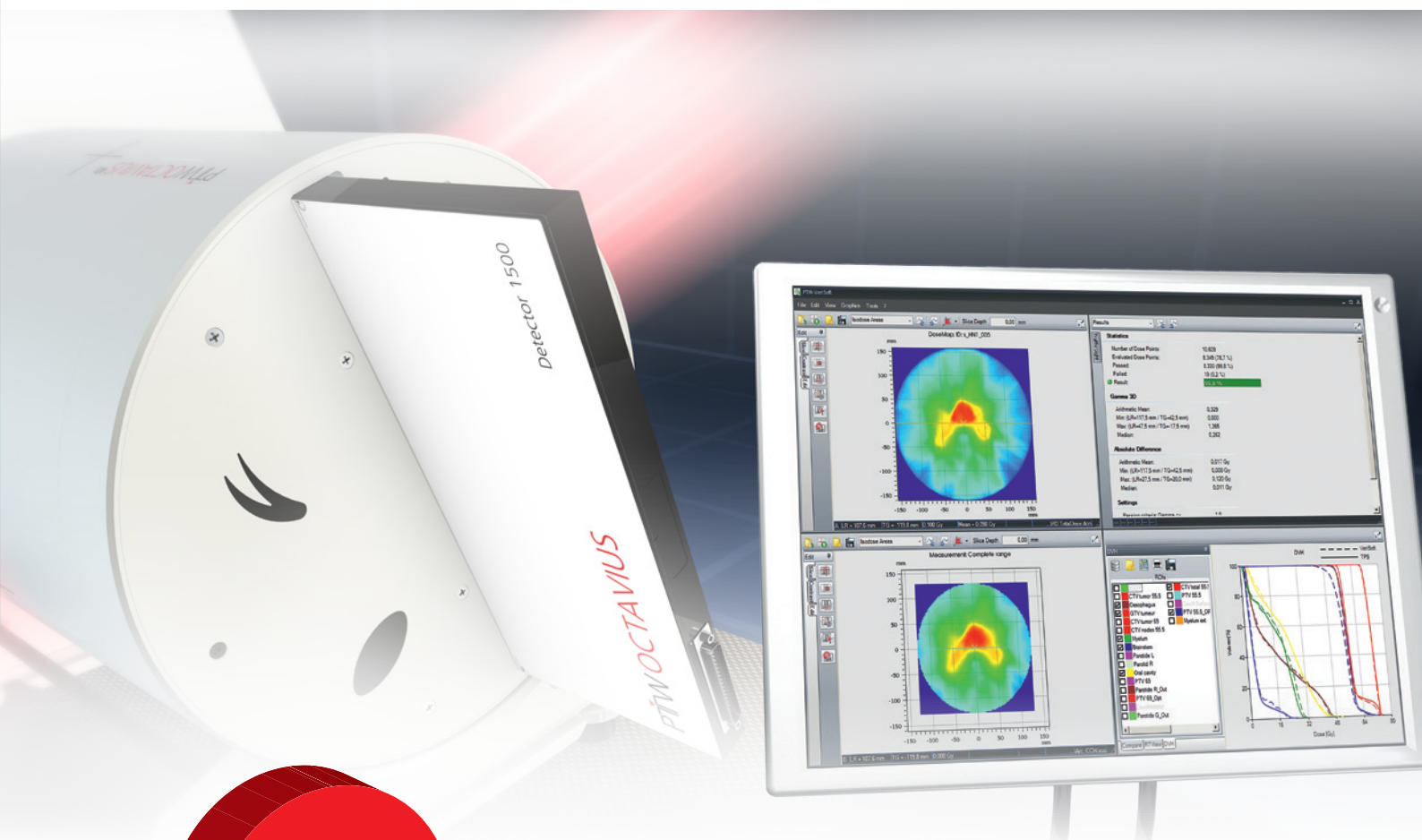


4D in Motion



Smarter.
Faster.
Easier.

OCTAVIUS

Turnkey Solution for
4D Patient Plan Verification



OCTAVIUS 4D

When form follows function in 4D patient plan verification.

Following the rotation of the gantry, OCTAVIUS® 4D acquires thousands of measurement points over the entire phantom volume, including the clinically relevant target volume around the isocenter.

With its modular design and cutting-edge detector technology, OCTAVIUS 4D provides you with a complete solution for patient- and machine-specific quality assurance of all major radiotherapy techniques. As a true 3D system, it measures the dose in a volume, entirely independently from the treatment planning system.

Measurements are performed with a high-resolution OCTAVIUS ionization chamber array with 729, 977 or 1405 ionization chambers, which is inserted into a motorized cylindrical phantom. The unique OCTAVIUS 4D phantom is controlled by a wireless inclinometer attached to the gantry. Reading the inclinometer's output, it rotates the OCTAVIUS detector synchronously with the gantry, allowing you to collect thousands of measurements points, thus covering the entire phantom volume.

As the OCTAVIUS detector is always aligned perpendicular to the beam, OCTAVIUS 4D requires no angular corrections or calibrations, making it your perfect choice for rotational delivery techniques and easy-to-use in clinical routine.

The intuitive, feature-rich VeriSoft software with its independent, patient-based DVH calculation and patient CT overlay helps you to assess target coverage better. Versatile in use, OCTAVIUS 4D can be upgraded to machine QA, enabling you to quickly perform routine quality assurance checks on your LINAC at all gantry angles without gantry mounts.

With OCTAVIUS® 4D, patient plan QA is advancing into a new dimension of patient safety and clinical efficiency.

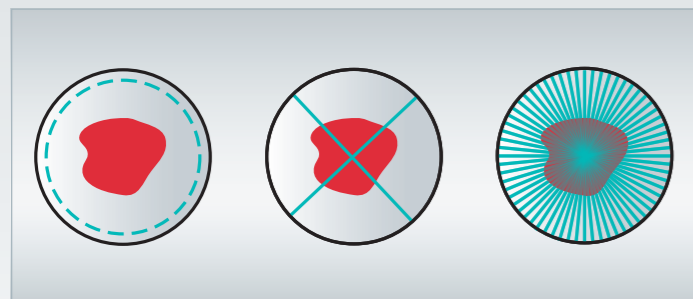


Fig. 1: Measurements inside the entire phantom volume
Simplified illustration showing measurement positions (blue) obtained with OCTAVIUS 4D (right) compared to other dosimetry systems which measure either outside the target volume in the low dose area (left) or far fewer measurement planes (center).

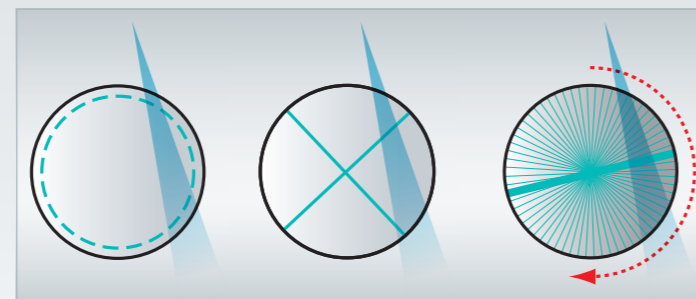
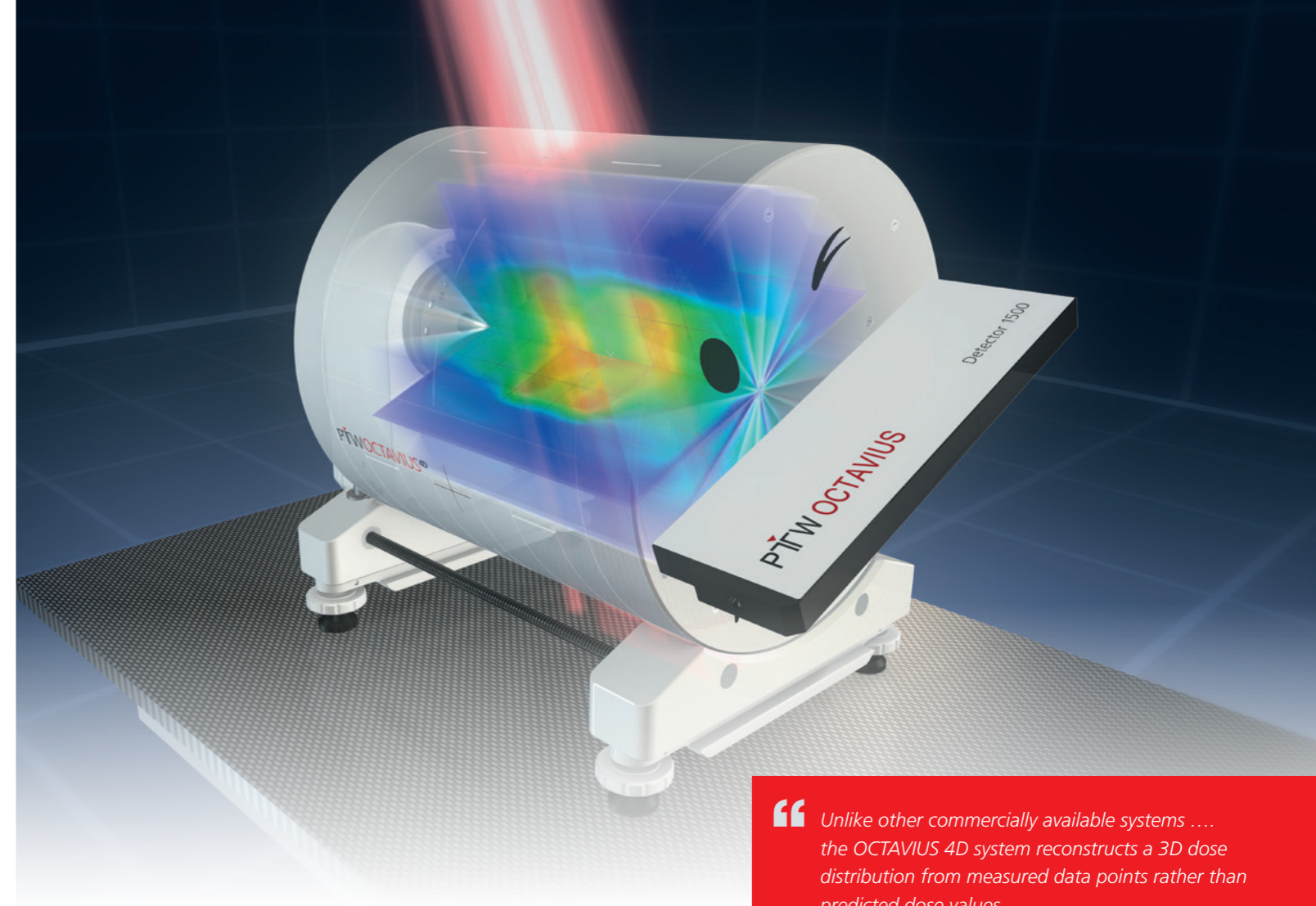


Fig. 2: Detector always perpendicular to the beam
Unlike other dosimetry systems where inclined beam vectors result in a varying angular response of the diodes (left, center), the OCTAVIUS detector always remains perpendicular to the beam, providing truly isotropic, angle-independent dose measurements.



“ Unlike other commercially available systems the OCTAVIUS 4D system reconstructs a 3D dose distribution from measured data points rather than predicted dose values.

Stathakis et al.: Characterization of PTW OCTAVIUS4D for patient-specific VMAT QA; Med. Phys. 40 (7), July 2013



OCTAVIUS® 4D Highlights

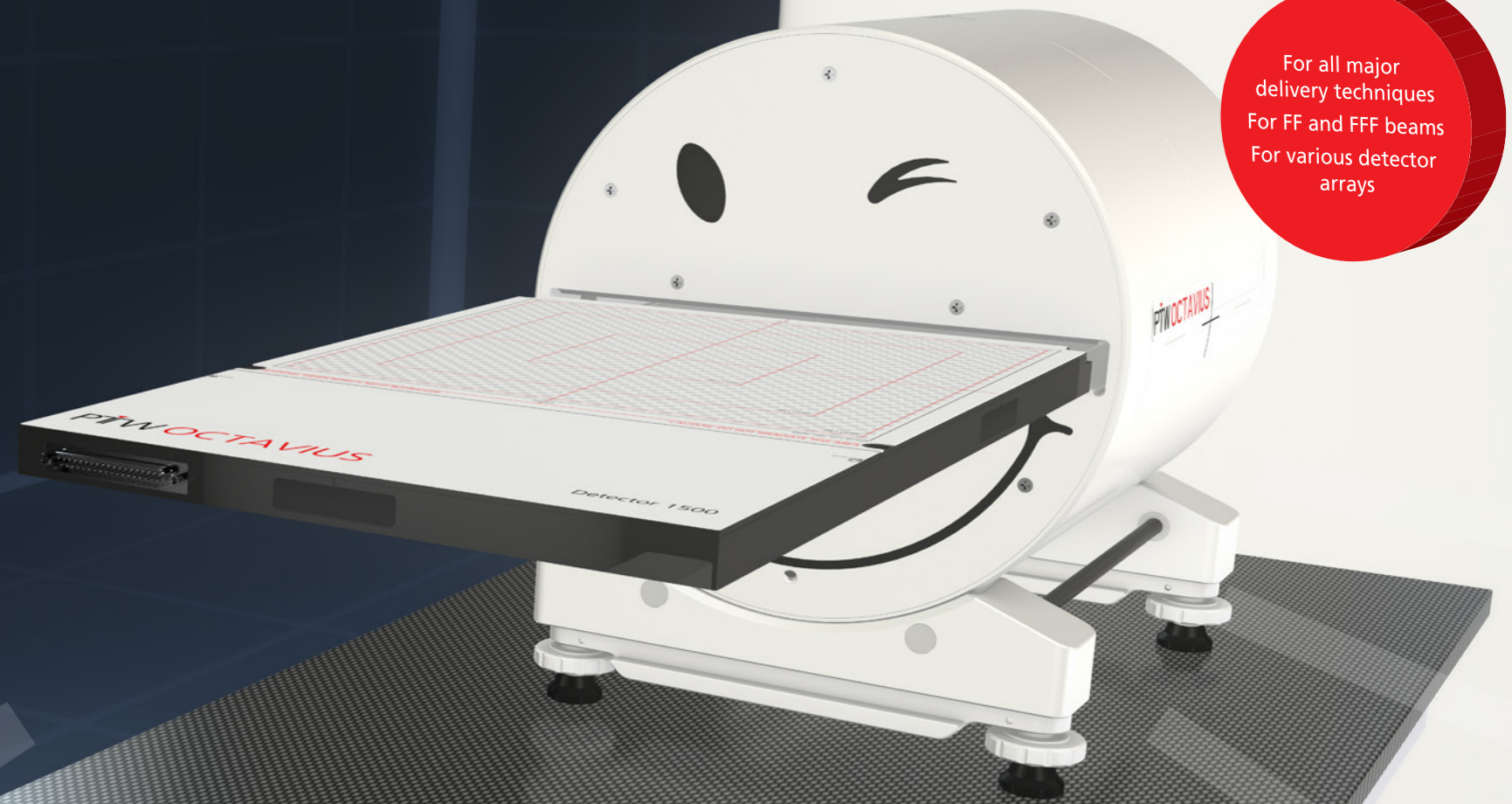
Smarter. Faster. Easier.

- ▶ **Modular – truly flexible**
OCTAVIUS 4D can be used with various detector arrays depending on your application or budget. Enhance or simply upgrade to the next-generation PTW detector as and when needed.
- ▶ **Independent – truly measured, not predicted**
OCTAVIUS 4D is the only 4D QA device that calculates the 3D dose and patient DVHs based on truly measured data, entirely independent of the treatment planning system (TPS).
- ▶ **True 3D – inside the entire volume**
Rotating the detector synchronously with the gantry, OCTAVIUS 4D measures the dose in the entire phantom volume, including the clinically relevant target volume around the isocenter (Fig. 1). Unlike other 4D QA devices, it does not need additional hardware or software for 3D dose calculation.
- ▶ **Outstanding detectors – better results**
OCTAVIUS detectors use Gold Standard ionization chambers known for their outstanding stability. With the highest detector density and largest field coverage of available 4D QA devices, OCTAVIUS 4D 1500 allows you to detect dose errors and deviations much more easily and faster than before.
- ▶ **True isotropic geometry**
The unique rotating phantom always aligns the detector perpendicular to the beam. OCTAVIUS 4D therefore requires no angular corrections or calibrations for dosimetric accuracy (Fig. 2).
- ▶ **Clinically relevant dose analysis**
Easy-to-use VeriSoft software provides you with multiple, versatile tools for an efficient dose evaluation, including 3D volume analysis, patient CT overlay and a truly independent, patient-based DVH analysis.
- ▶ **Machine QA with FFF analysis**
Used with the optional LINAC QA package, OCTAVIUS 4D makes it possible to check key beam parameters at all gantry angles with one single measurement – without gantry mounts.

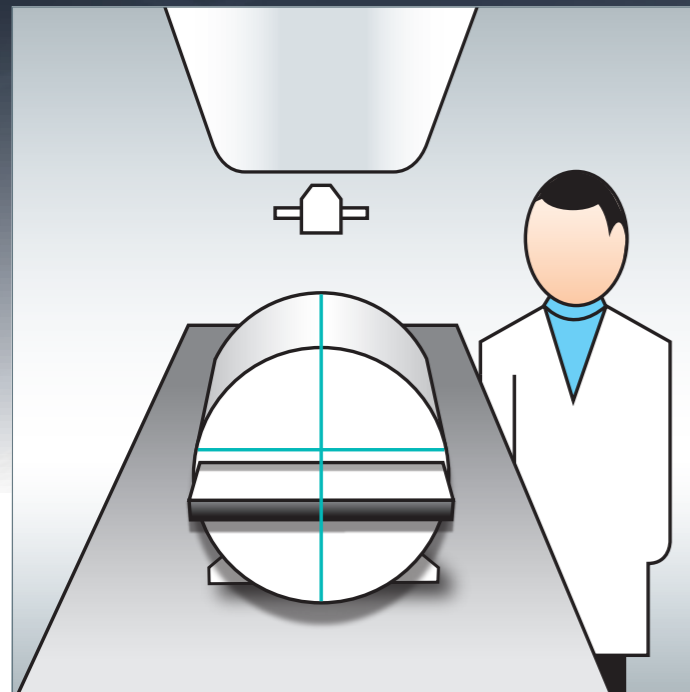
OCTAVIUS 4D

Four simple steps is all it takes.

For all major delivery techniques
For FF and FFF beams
For various detector arrays

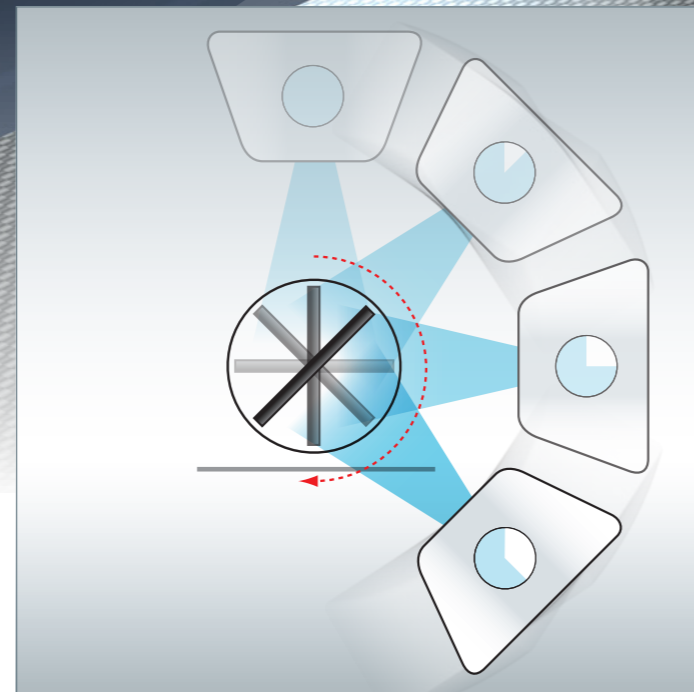


QA Device Setup



OCTAVIUS 4D system is set up and aligned on patient couch. Wireless inclinometer is attached to vertical part of gantry.

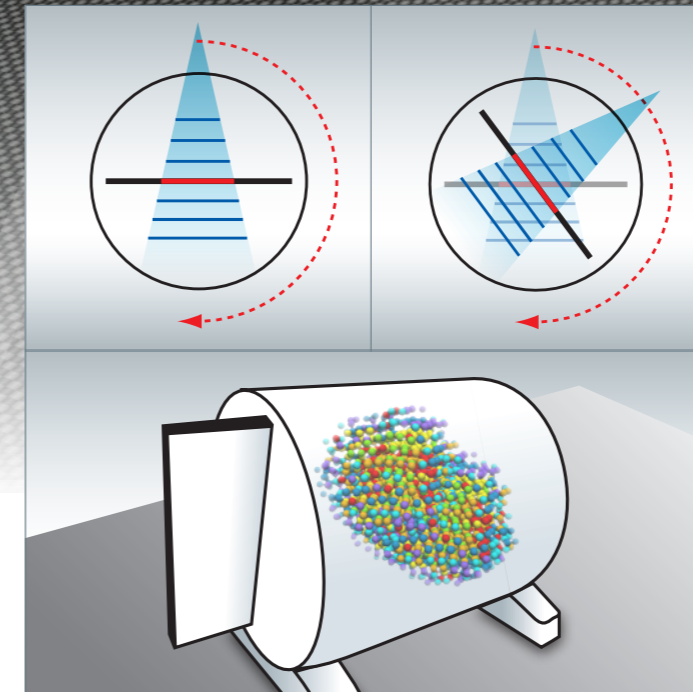
Measurement



Measurement is started in VeriSoft.

Reading the inclinometer's output, the motorized OCTAVIUS 4D phantom rotates synchronously with the gantry. The OCTAVIUS detector, which remains aligned perpendicular to the incident beam, measures a dose plane for each gantry angle.

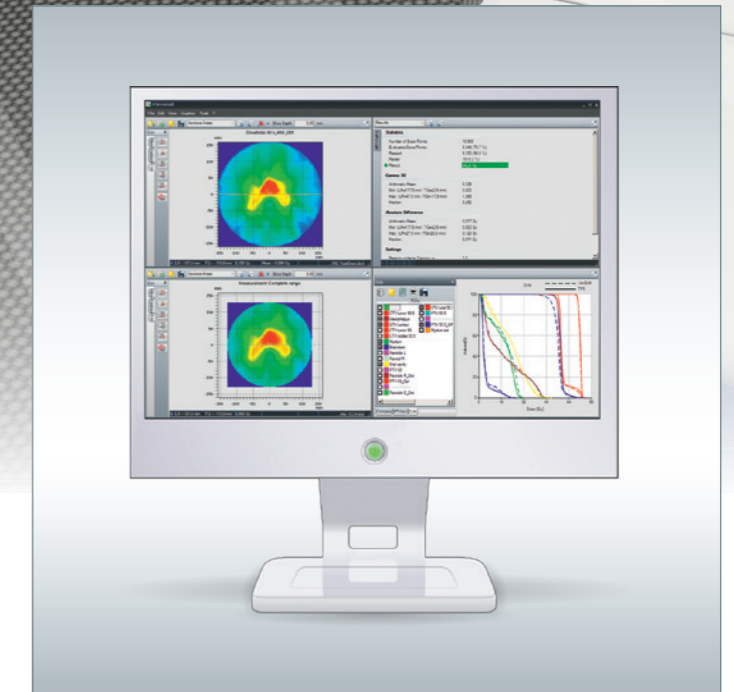
Calculation



The measured dose plane for each gantry angle is used to determine the dose values along the source-detector rays. To calculate these values, OCTAVIUS 4D applies a sophisticated algorithm developed by the DKFZ Heidelberg which is based on PDD curves measured for different field sizes for the accelerator and energy in use. All dose points measured are then added up, finally obtaining a 3D dose volume with a user-selectable resolution of typically 2 mm.

— measured dose plane — calculated values along the source-detector rays

Evaluation



Calculated DICOM RT dose cube from TPS is imported into VeriSoft.

Sets of transverse, sagittal and coronal planes can be extracted for direct comparison to the calculated TPS dose planes in VeriSoft. Advanced evaluation tools, including patient CT overlay and patient-based DVH analysis, assist you to make better assessments of dose delivery to critical structures and organs at risk (OAR).

YouTube See how it works.
Watch the OCTAVIUS® 4D video on our official YouTube channel "PTW Dosimetry".

Which detector is best for you?



The Checkerboard Detector

OCTAVIUS[®] 1500

For rotational QA

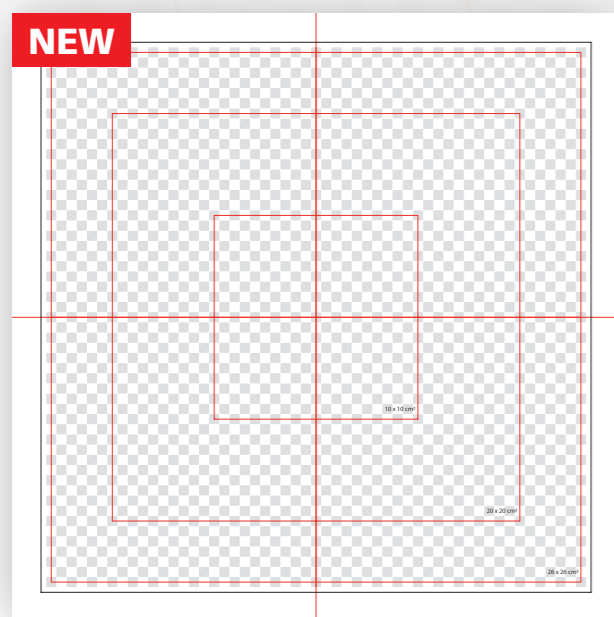
Highlights

- ▶ Highest detector density and largest field coverage of available arrays
- ▶ Resolution nearly doubled – 1405 vented ionization chambers on 27 cm x 27 cm
- ▶ Unique checkerboard detector layout – no leaf undetected
- ▶ 100% field coverage with two measurements via simple couch shift
- ▶ Gold Standard ionization chambers as detectors – no ageing, no response degradation
- ▶ Extended dose rate range for FFF beams

Basics

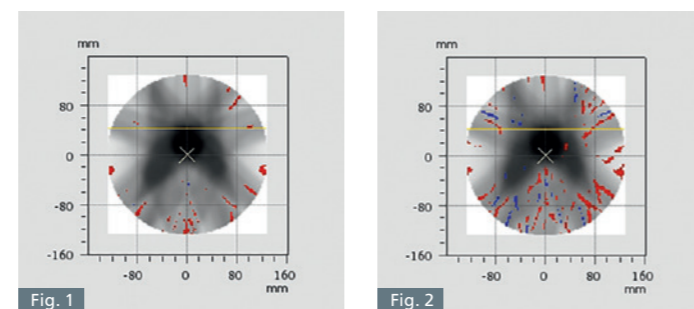
1405 detectors • size 4.4 x 4.4 x 3 mm³ • spacing 7.1 mm center-to-center • max. field size 27 x 27 cm² • max. dose rate 48 Gy/min

NEW

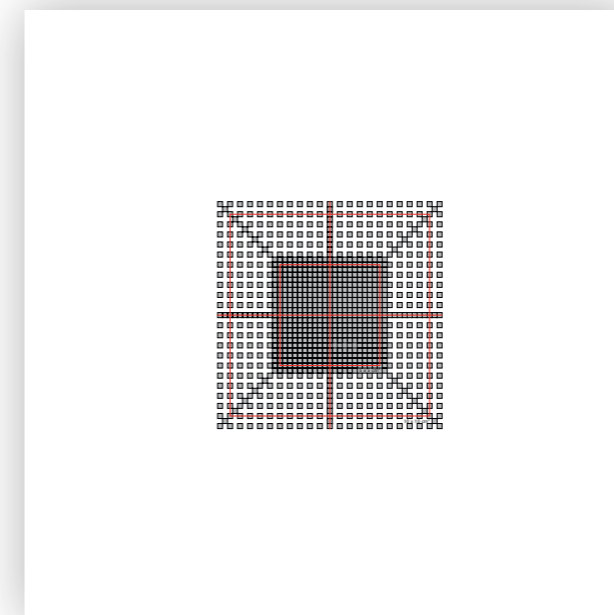


OCTAVIUS[®] 1500: Highest detector density – better error detection

With the detector density nearly doubled, the new OCTAVIUS Detector 1500 (Fig. 1) significantly reduces the number of failed points compared to its predecessor OCTAVIUS Detector 729 (Fig. 2), helping you to identify clinically relevant dose errors and deviations much more easily and faster than before.



Fewer false-positive errors: Failed points (red) obtained with OCTAVIUS Detector 1500 (Fig. 1) compared to OCTAVIUS Detector 729 (Fig. 2)



OCTAVIUS[®] 1000 SRS

For small-field IMRT and SRS/SBRT QA

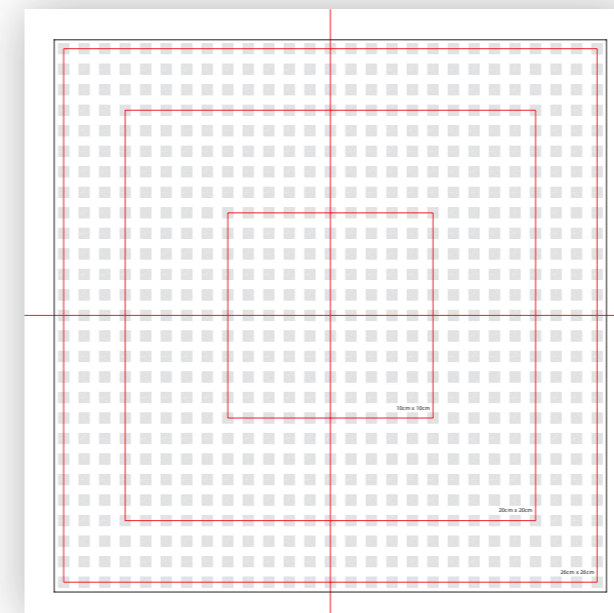
Highlights

- ▶ The first two-dimensional detector array based on liquid-filled ionization chamber technology – high spatial resolution, minimal energy dependence
- ▶ Smallest detector size (0.003 cm³) with highest spatial resolution (2.5 mm) of available arrays
- ▶ 977 liquid-filled ionization chambers on 10 cm x 10 cm
- ▶ Full field coverage on 5 cm x 5 cm
- ▶ Excellent sensitivity – measures single MUs
- ▶ Suitable for high-definition MLC QA
- ▶ Extended dose rate range for FFF beams

Basics

977 detectors • size 2.3 x 2.3 x 0.5 mm³ • spacing 2.5 mm center-to-center* • max. field size 10 x 10 cm² • max. dose rate 36 Gy/min

*in center area



OCTAVIUS[®] 729

For standard IMRT and conventional delivery techniques

Highlights

- ▶ Large field coverage – cubic detector design, uniform detector spacing (5 mm edge-to-edge)
- ▶ 729 vented ionization chambers on 27 cm x 27 cm
- ▶ Gold Standard ionization chambers as detectors – no ageing, no response degradation
- ▶ Extended dose rate range for FFF beams

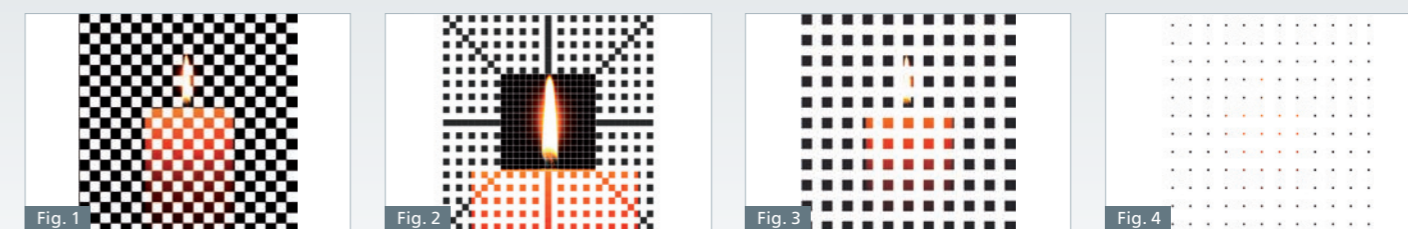
Basics

729 detectors • size 5 x 5 x 5 mm³ • spacing 10 mm center-to-center • max. field size 27 x 27 cm² • max. dose rate 48 Gy/min

OCTAVIUS[®] Detectors: Largest field coverage – better detection of hot spots

In IMRT and IMAT QA, large field coverage is of greater importance than detector size, since it significantly increases the chance of detecting a hot spot or measuring dose at steep gradients.

With their high detector density and unique detector layout, OCTAVIUS detectors offer the best field coverage of available commercial arrays, giving you the most detailed picture of the dose delivered to the patient.

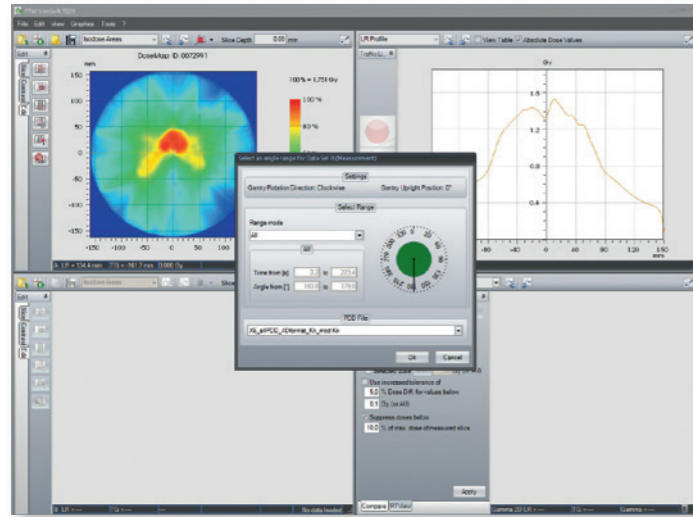


Simplified illustration showing maximum field coverage achieved by OCTAVIUS ionization chamber arrays with a single measurement (Fig. 1 OCTAVIUS 1500: 50% coverage; Fig. 2 OCTAVIUS 1000 SRS: 85% coverage in center area,

Fig. 3 OCTAVIUS 729: 25% coverage) compared to diode array of the same detector spacing (Fig. 4 0.64% coverage), even though the actual information is one dose value per single detector for all array types.

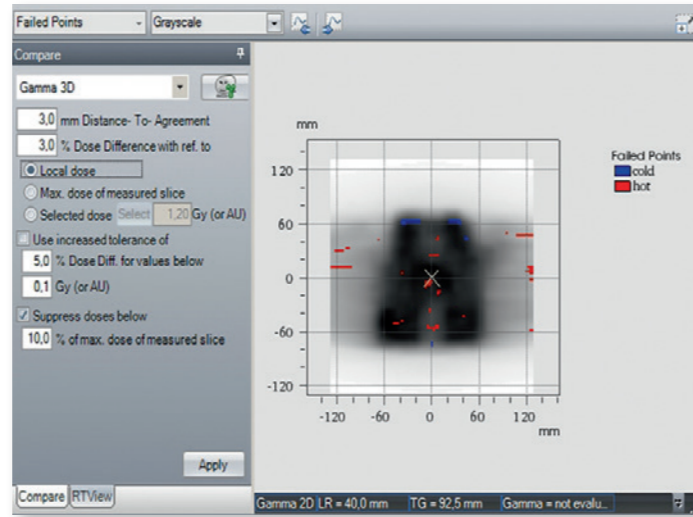
VeriSoft® Patient Plan Verification

Does it agree or not?



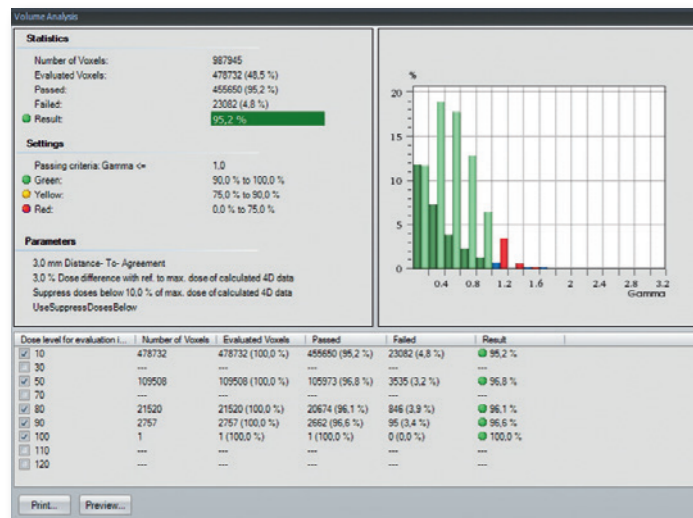
Composite or Control Point Analysis

Load the complete measurement or select gantry angle segments ("control points") for analysis. Scroll through the slices to compare the dose at relevant phantom depths in all three planes (transverse, coronal or sagittal).



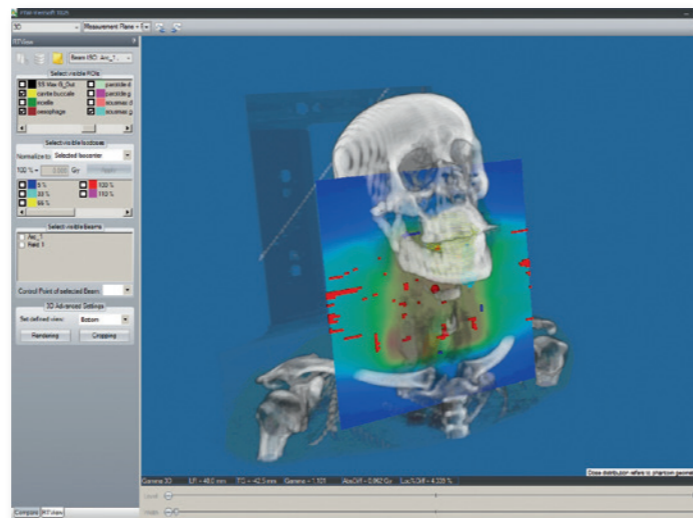
3D Gamma Index Analysis

Using all three spatial dimensions for data comparison, a 3D Gamma Index analysis may reduce the number of failed points in high dose gradients. If this method is applied in combination with the local dose chosen as reference value, it allows you to detect overdosage in low dose regions which may be overseen when using the maximum dose level as reference value.



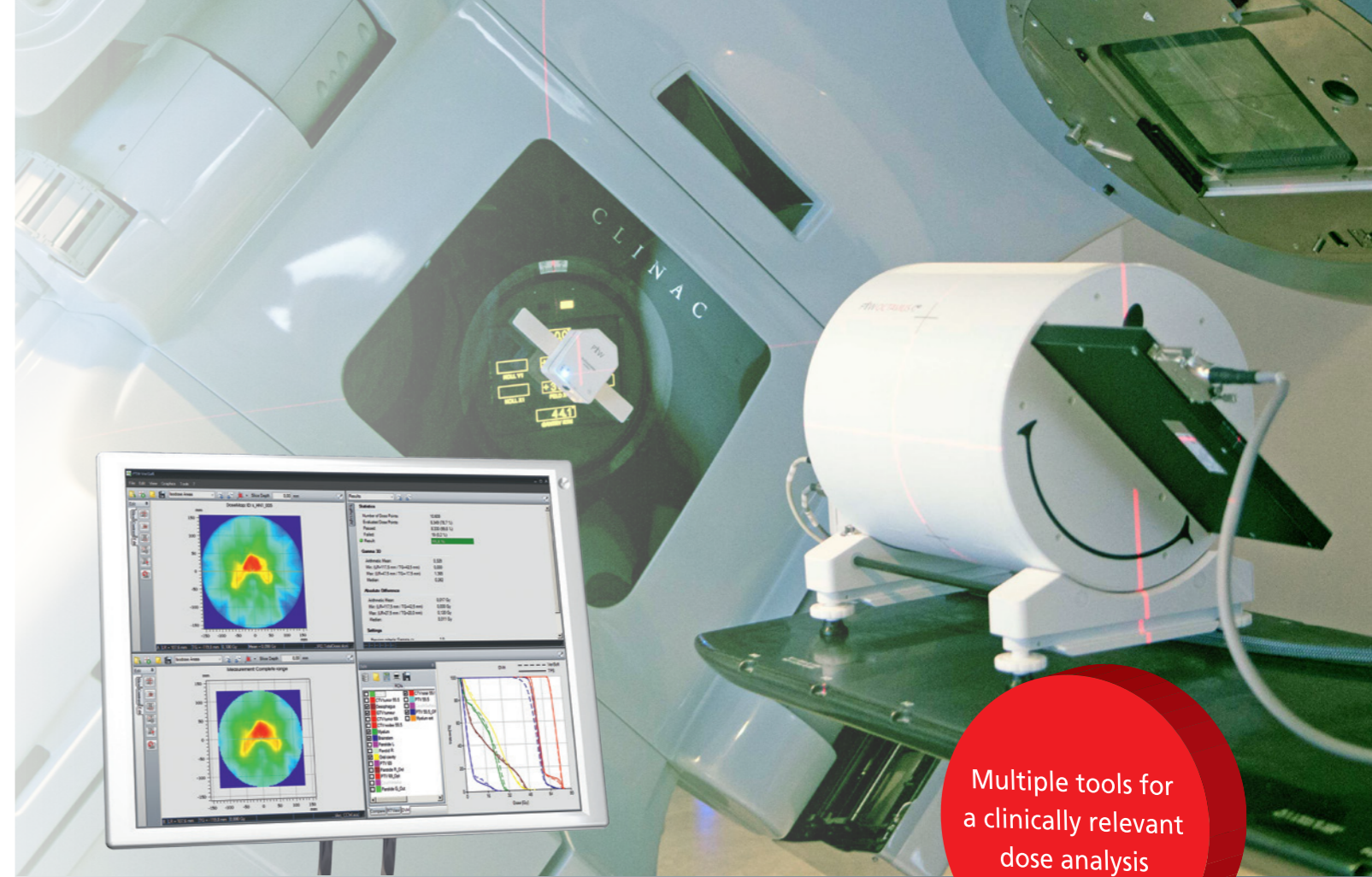
3D Volume Analysis

Gain more confidence in the accuracy of your results. The unique 3D volume analysis compares the dose measured inside the entire volume, using multiple parameters and automatically calculating all slices of the dose cube.



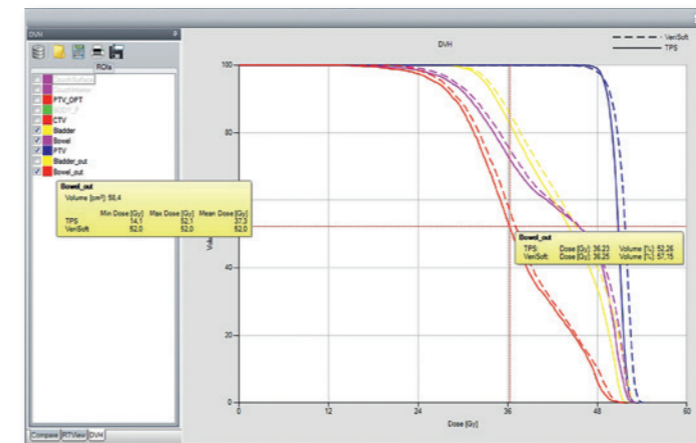
CT Overlay

Failed points, measured isodoses, contours of the CTV, PTV and organs at risk can be overlaid onto the patient's CT image to support you in your evaluation of the accuracy of dose delivery.



Multiple tools for a clinically relevant dose analysis

DVH 4D



Select from a wide range of standard and advanced dose comparison and evaluation tools:

- ▶ Profile and dose distribution overlays
- ▶ Dose-difference distributions
- ▶ Results summary with "traffic light" indicator
- ▶ Gamma histograms
- ▶ 2D/3D Gamma Index analysis
- ▶ 3D volume analysis
- ▶ Patient CT overlay
- ▶ Independent, patient-based DVH calculation

Calculate patient dose-volume histograms (DVHs) for selected structures in only a few minutes and compare them with the DVHs calculated by the TPS using optional DVH 4D for VeriSoft.

Unlike other QA devices, which require TPS dose data for DVH calculation, DVH 4D performs its calculations truly independently from the TPS, entirely based on OCTAVIUS 4D measurement data and the patient's anatomy, using density values from the patient's CT scan.

i How are dose and patient DVHs calculated in OCTAVIUS 4D?

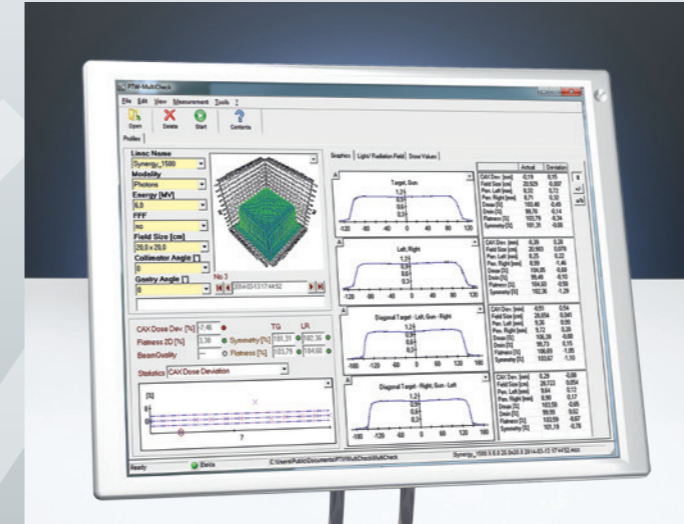
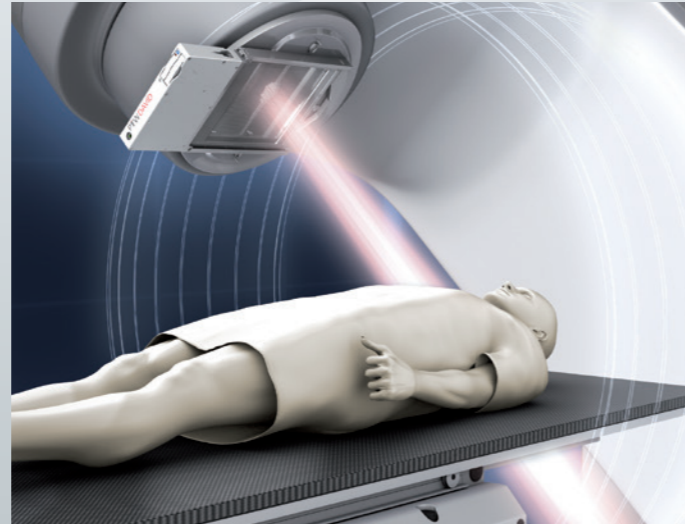
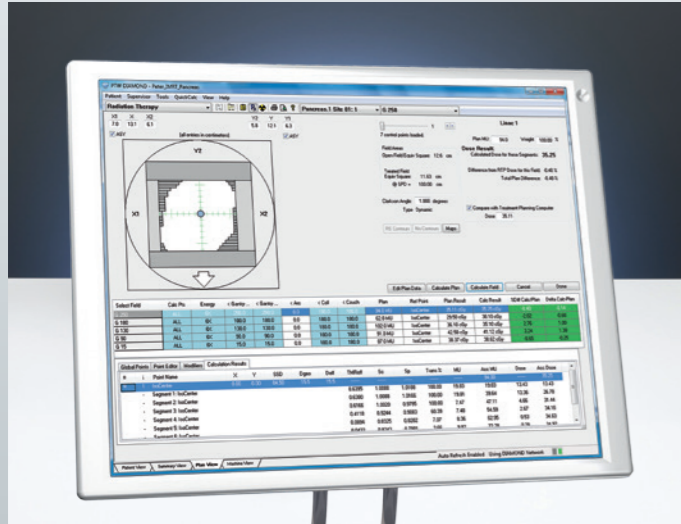
For more information, please read our application note "Dose reconstruction in the OCTAVIUS 4D phantom and in the patient without using dose information from the TPS; B. Allgaier, E. Schüle, J. Würfel, White Paper, D913.200.06/00 (2013)".

Points selected. Plan verified.

Closing the Gap in IMRT QA.

All parameters in one go.

4D in Motion.



DIAMOND®

Secondary check software for independent dose or MU verification

Key Features

- ▶ Clinically established solution for precise, independent verification of point dose or MU calculations
- ▶ Fast and simple – no LINAC time or phantom setup required
- ▶ Dose comparisons at one or multiple points (field-by-field, composite)
- ▶ Advanced calculation capabilities, e.g., wedge support, corrections of “flash” in breast treatments, fluence/dose mapping
- ▶ Multiple treatment techniques supported, including IMRT, RapidArc®, VMAT

DAVID®

In vivo verification of dose delivery during patient treatment

Key Features

- ▶ Independent verification and documentation of dose delivery and MLC accuracy during each patient treatment
- ▶ Immediate detection of errors or malfunctions (e.g., lost MLC positions)
- ▶ In vivo measurements not limited to single points
- ▶ Wireless operation and data transfer
- ▶ Supports conformal, dynamic and rotational IMRT delivery techniques (RapidArc®, VMAT, IMAT)

LINAC QA for OCTAVIUS®

LINAC QA Upgrade Package

Key Features

- ▶ Complete package for routine machine QA in combination with an OCTAVIUS detector and MultiCheck LINAC QA software
- ▶ Fast, efficient check of beam profile and output constancy at all gantry angles in one shot – without gantry mounts
- ▶ FFF analysis
- ▶ Record and playback function for a quick assessment of the LINAC startup behavior
- ▶ Trend display

Supported QA Procedures

- X-ray/electron output constancy
- Photon/electron beam profile constancy
- Electron beam energy constancy
- X-ray/electron output constancy vs. gantry angle
- X-ray/electron off-axis factor constancy vs. gantry angle
- Check of wedge angle for 60°
- Segmental IMRT (step and shoot) test
- Moving Window IMRT (four cardinal gantry angles)
- Dose rate and symmetry over time

OCTAVIUS® 4D Upgrade

The easiest way to 4D dosimetry

Key Features

- ▶ Budget-friendly solution for users of PTW two-dimensional detector arrays who wish to upgrade to 4D dosimetry
- ▶ Package includes: OCTAVIUS 4D phantom, wireless inclinometer, electronics, VeriSoft upgrade with Navigator single user interface
- ▶ Supported detector arrays: OCTAVIUS® Detector 1500, OCTAVIUS® Detector 1000 ^{SR5}, OCTAVIUS® Detector 729, 2D-ARRAY seven29®

OCTAVIUS 4D

Quick Overview



Description	4D dosimetry system for patient- and machine-specific quality assurance in radiation therapy	
How it works	Rotates with the gantry and measures the dose in the entire phantom volume as a function of time or gantry angle	
Use	Verification of IMRT, IMAT and SRS/SBRT treatment plans; LINAC QA (optional)	
Supported Detectors	OCTAVIUS® Detector 1500; OCTAVIUS® Detector 1000 SRS; OCTAVIUS® Detector 729; 2D-ARRAY seven29®	
Supported Applications		
Pre-treatment – field-by-field		■
Pre-treatment – composite plan		■
In vivo – dose delivery QA		□
LINAC QA		□
Supported Techniques		
2D/3D		■
Step & Shoot		■
Sliding Window		■
Arc IMRT/IMAT (RapidArc®, VMAT)		■
SRS/SBRT		■
FF/FFF beams		■
Helical TomoTherapy®		- 1
CyberKnife®		- 1
Options		
LINAC QA for OCTAVIUS®	L981295	□
DVH 4D for VeriSoft®	S070009.001	□
DIAMOND® Secondary Check Software	S070020	□
DAVID® Dose Delivery QA System	L981390	□
OCTAVIUS® 4D Upgrade Package	L981324	□
OCTAVIUS® 1500 Upgrade Package	L981452	□
Accessories		
Phantom Chamber Plate Semiflex 0.125 cm³	T40056.1.002	□ 2
Phantom Chamber Plate PTW Farmer®	T40056.1.003	□ 2
Phantom Chamber Plate PinPoint® 3D	T40056.1.006	□ 2

■ supported □ optional - currently not supported

¹ recommended system OCTAVIUS II ² Insert plate for cross calibration of detector array against single ionization chamber

Turnkey Solutions – best suited for any application

OCTAVIUS 4D comes complete in three ready-to-use solutions. Select the package with the detector that is best for your application or budget, and get started. Enhance or upgrade your OCTAVIUS system as and when needed.

OCTAVIUS® 4D 1500

Turnkey solution for 4D patient plan verification in IMRT, IMAT, RapidArc®, VMAT

Includes rotating OCTAVIUS 4D phantom with wireless inclinometer, OCTAVIUS Detector 1500, VeriSoft software and trolley. Part No. L981438

OCTAVIUS® 4D 1000 SRS

Turnkey solution for 4D patient plan verification in small-field IMRT and SRS/SBRT

Includes rotating OCTAVIUS 4D phantom with wireless inclinometer, OCTAVIUS Detector 1000 SRS, VeriSoft software and trolley. Part No. L981429

OCTAVIUS® 4D 729

Turnkey solution for 4D patient plan verification in IMRT, IMAT and conventional delivery techniques

Includes rotating OCTAVIUS 4D phantom with wireless inclinometer, OCTAVIUS Detector 729, VeriSoft software and trolley. Part No. L981398

Selected References

The Octavius 1500 2D ion chamber array and its associated phantoms: Dosimetric characterization of a new prototype

A. van Esch et al., Med.Phys. **41**, 091708 (2014)

Characterization of a novel 2D array dosimeter for patient-specific quality assurance with volumetric arc therapy

S. Stathakis et al., Med. Phys. **40**, 071731 (2013)

Octavius 4D characterization for flattened and flattening filter free rotational deliveries

C. K. McGarry et al., Med. Phys. **40**, 091707 (2013)

Octavius 4D 1000 SRS, a new instrument for SBRT VMAT IMRT verification, commissioning and clinical implementation

J. Gimeno-Olmos et al., Poster Presentation, ESTRO 22 (2013)

Dose reconstruction in the OCTAVIUS 4D phantom and in the patient without using dose information from the TPS

B. Allgaier, E. Schüle, J. Würfel, White Paper, D913.200.06/00 (2013)

Dosimetric Properties of the OCTAVIUS Detector 1500

T. Stelljes et al., Poster Presentation, AAPM (2014)

Characterization of a two-dimensional liquid-filled ion chamber detector array used for verification of the treatments in radiotherapy

M. Markovic et al., Med. Phys. **41**, 051704 (2014)

Performance parameters of a liquid filled ionization chamber array

B. Poppe et al., Med. Phys. **40**, 082106 (2013)

Two-dimensional ionization chamber arrays for IMRT plan verification

B. Poppe et al., Med. Phys. **33** (2006)

“

While showing equally good dose linearity and dose rate independence, the Octavius1500 outperforms the previous models because of its instantaneous measurement stability and its twofold active area coverage.The beneficial impact of the detector density is most prominent in the Oct4D system, for which the average pass rate (PR) is now nearly 100% (99.31 ± 0.37) when using gamma criteria of 2%G,2 mm (10% dose threshold)...

”

Van Esch et al.: The Octavius 1500 ion chamber array and associated phantoms; Med.Phys. **41** (9), September 2014

“

The Octavius 4D phantom with associated Octavius detector 729 ionization chamber array is a dosimetrically and mechanically stable device for pretreatment verification of FF and FFF RapidArc treatments ...

”

McGarry et al.: Octavius 4D for FF and FFF rotational deliveries; Med. Phys. **40** (9), September 2013

“

The OCTAVIUS 4D system ... was found to be very suitable for patient-specific QA. No angular dependence correction is necessary ... The dose rate dependence was measured to be less than 0.5% and the MU to dose response (MU linearity) was found to be very linear for the range of 2-600 MU. Output factors ... were found to match within 1% ...

”

Stathakis et al.: Characterization of PTW OCTAVIUS4D for patient-specific VMAT QA; Med. Phys. **40** (7), July 2013

Dosimetry Pioneers since 1922.

It all started with a brilliant invention – the revolutionary Hammer dosimeter in 1922. Ingenuity coupled with German engineering know-how shaped the company's history, leading to innovative dosimetry products that later became an industry standard. Over the years, PTW has maintained its pioneering spirit, growing into a global market leader of dosimetry and QA solutions well known for its product excellence and innovative strength. Today, PTW dosimetry is one of the first choices for healthcare professionals in radiation therapy, diagnostic radiology, nuclear medicine and health physics.

For more information on OCTAVIUS QA Systems and other PTW products, visit www.ptw.de or contact your local PTW representative:

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