




Delta⁴® PT

TRUE VOLUMETRIC
PRE-TREATMENT VERIFICATION

THE DIFFERENCE IS CLEAR



*ScandiDos – innovators
in advanced volumetric
dosimetry solutions*

ScandiDos

ScandiDos is the innovative company that introduced the new QA standard in advanced radiotherapy by moving into the era of 3D and 4D volumetric dosimetry.

Founded in 2002 by a group of highly experienced physicists and engineers, ScandiDos grew out of a recognized need for practical clinical QA solutions for new advanced radiation therapy technologies. Our competence includes the design and development of radiation detectors, electrometers and application software, as well as practical clinical experience in medical physics and radiation measurements.

New solutions

In 2006, ScandiDos was first to introduce a volumetric QA system fully compatible with IMRT and Arc Therapy (IMAT and TomoTherapy). By 2009, the company had sold over 100 Delta^{4PT} (Pre Treatment) systems and had been involved in the validation of new treatment techniques such as Varian's RapidArcTM, Elekta's VMAT, and Philips' SmartArc.

Delta^{4PT} is the first product in the Delta⁴ family of innovations based on the advanced technologies developed by ScandiDos. With the same hardware platform, Delta^{4PT} delivers both the machine-specific and the patient-specific **Pre Treatment QA**.



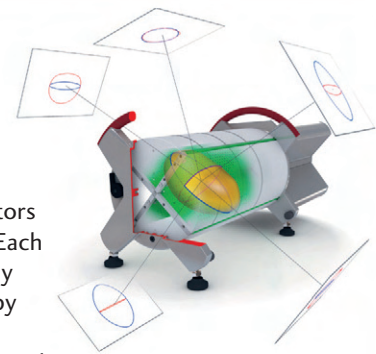
Complete, accurate and fast QA

The Delta^{4PT} patent design is based on two crossing arrays in a fixed cylindrical geometry providing full coverage of the cross-section of any beam direction. Thereby, the intensity modulation can be verified without missing any data.

Delta^{4PT} is the 3D solution that verifies the dose gradients in X, Y and Z directions by real measurement in the target; a completely unique solution on the market, and a necessity if the gradient region is to be verified and the dosimetry task to be completed.

The design with two crossing arrays optimizes the use of a fixed number of detectors in Radiation Therapy. Each detector independently measures dose, pulse by pulse, building the 4D dose-picture, pixel by pixel -

thus, benefiting the user by enabling full flexibility in adaptation to any possible dynamic treatment.



Efficiency, accuracy and clinical relevance at the same time Cornerstones of ScandiDos

INSTANTLY ANALYZE AND APPROVE PLANS

The analysis starts with the Dose - Picture.

QUICKLY AND EASILY FIND THE CAUSE OF DEVIATIONS

If a deviation is noted, the user can easily zoom in on the details.

VERIFY THE DOSE DELIVERY WITHOUT COMPROMISES IN 3D

Reliable QA must be highly accurate and comprehensive. Delta^{4PT} measures the dose with high density in the high gradient region with the resolution of 50nGy.

ANALYZE THE CLINICAL RELEVANCE OF A DEVIATION

The level of importance in discrepancy between delivered and planned dose is determined using patient anatomy (e.g. target and risk structures) to gauge the clinical relevance.

INSTANTLY ANALYZE AND APPROVE PLANS

With Delta^{4PT}, QA can be performed exactly as the plan will be delivered to the patient, with the correct gantry angles – then instantly approved

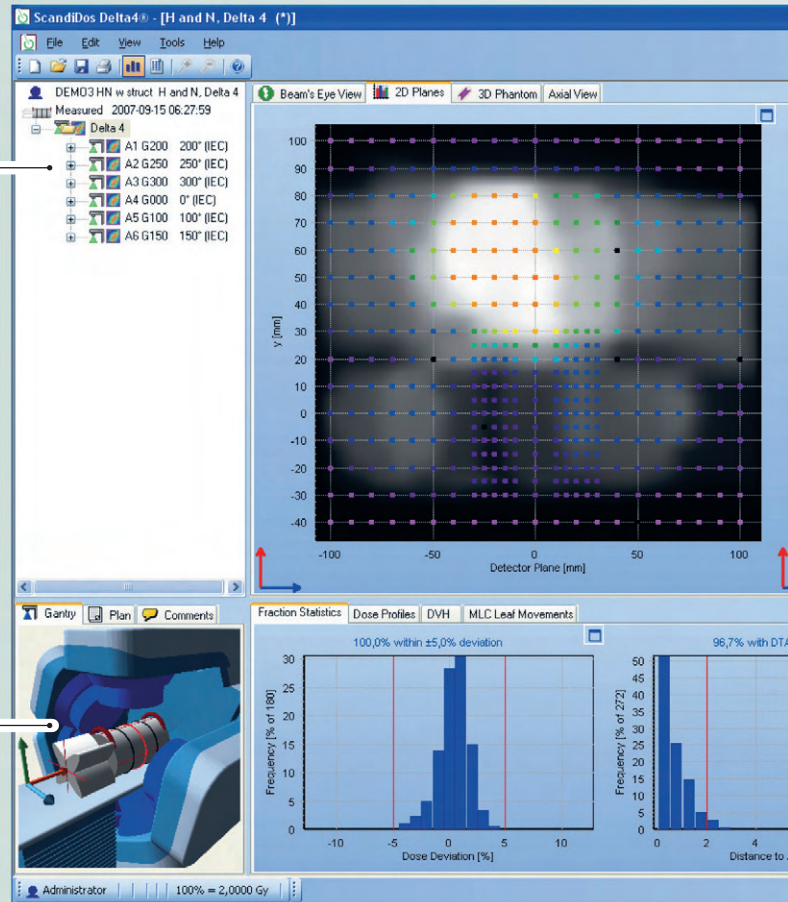
Tree structure from DICOM RT Plan

Selection in the tree structure controls the display

- Fraction level
- Arc level
- Sub-Arc level
- Beam level
- Sub-beam level

Phantom and gantry orientation

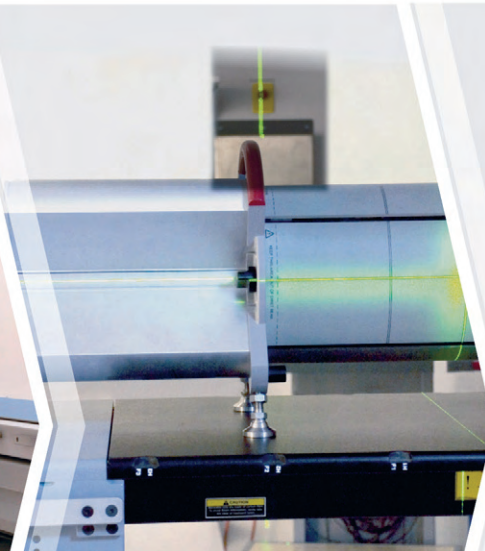
Real-time update



The workflow process



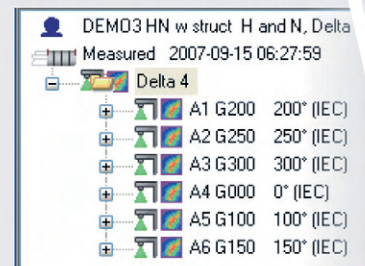
Position Delta^{4PT} on the couch using the specially-designed Trolley, which completely eliminates the need to lift the Delta^{4PT}.



Fast and easy set-up and alignment utilizing lasers, just like positioning a patient.

Normal position (20x20 cm²) or extendable up to 38 cm long fields.

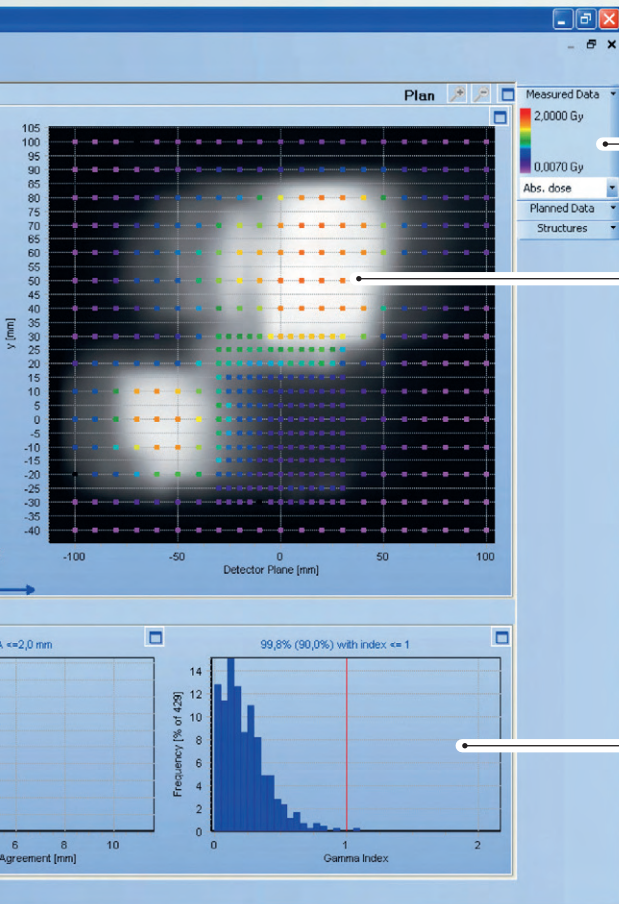
Small longitudinal shifts for extended MLC check.



DICOM RT Plan from TPS defines the tree-structure of the measurement; fraction, Arc, sub-Arc, control point.

3D TPS dose is imported prior to or after measurement for fraction and, if required, for refined beam (Arc) and sub-beam (sub-Arc) analysis.

A green beam-icon indicates that pass criteria were met for that level. Fraction dose can be within criteria although single sub-beams are not.



“ The user friendly software platform of the Delta⁴ system enables the physicist to quickly view and analyze the measurements within seconds after radiation delivery. Quality evaluation of treatment plans can be performed instantaneously using multiple metrics incorporated in the software.

Alonso N. Gutiérrez, Ph.D.
 Assistant Professor
 Dept. of Radiation Oncology &
 Radiology School of Medicine
 Cancer Therapy & Research Center
 at The University of Texas Health
 Science Center at San Antonio,
 San Antonio, TX, USA

Color-scaled measurement points showing

- Absolute dose
- Relative dose
- Dose deviation
- Gamma index
- Distance to agreement

Statistics for all measurement points

- Dose deviation
- Distance to agreement
- Gamma index

Pass / Fail Criteria

Dose Deviation

Pass if 90,0 % have a deviation within \pm 5,0 %

Include detectors in dose range 40 % to 500 %

Distance to Agreement, DTA

Pass if 50,0 % have a DTA \leq 2,0 mm

Include detectors where gradient is \geq 1,0 % / mm

Gamma Index

Pass if 90,0 % have a gamma index \leq 1.0

Max dose deviation \pm 3,0 %

Max spatial deviation \pm 3,0 mm

Include detectors in dose range 20 % to 500 %

MLC Leafs

Overdose Outside Field

Major: \geq 3,0 mm outside and $>$ 40 % of max dose

Minor: 1,5 to 3,0 mm outside and $>$ 60 % of max dose

Underdose Inside Field

Major: \geq 3,0 mm inside and $<$ 60 % of max dose

Minor: 1,5 to 3,0 mm inside and $<$ 40 % of max dose

Normalization Levels

Normalization Level

Level: 100 % (Sub-beam max dose always 100%)

Normalization Dose

Fraction: Iso-center Edited Value 2,0000 Gy, Delta 4 Detector Point

Beam: Iso-center Edited Value 0,3500 Gy, A1 G200 200° (IEI) Detector Point 0,3500 Gy, A2 G250 250° (IEI) Prescribed 0,3500 Gy, A3 G300 300° (IEI)

Sub-beam: Max Dose 0,3500 Gy, A4 G000 0° (IEC) 0,3500 Gy, A5 G100 100° (IEI) 0,3500 Gy, A6 G150 150° (IEI)

For Relative Dose Display, Compare...

Fraction to: Fraction Sub-beam to: Fraction Beam Sub-beam

Beam to: Fraction Beam Sub-beam

20 k18 PTV

Please select status:

Accepted Rejected Measurement failed

OK Cancel

User-defined acceptance criteria for pass or fail. A combination of dose deviation, distance-to-agreement, and/or gamma index can be used. User defined data filtering (e.g. excluding low dose data). Criteria for MLC leaf position accuracy.

3D approach for normalization to make parameterization clinically relevant.

Gamma index, etc. are relative parameters relying on correct normalization.

Select points or levels for normalization and use similar or different methods for fraction, beam and sub-beam.

Easily assign status to the treatment, which can be used to sort and store data logically in the data base.

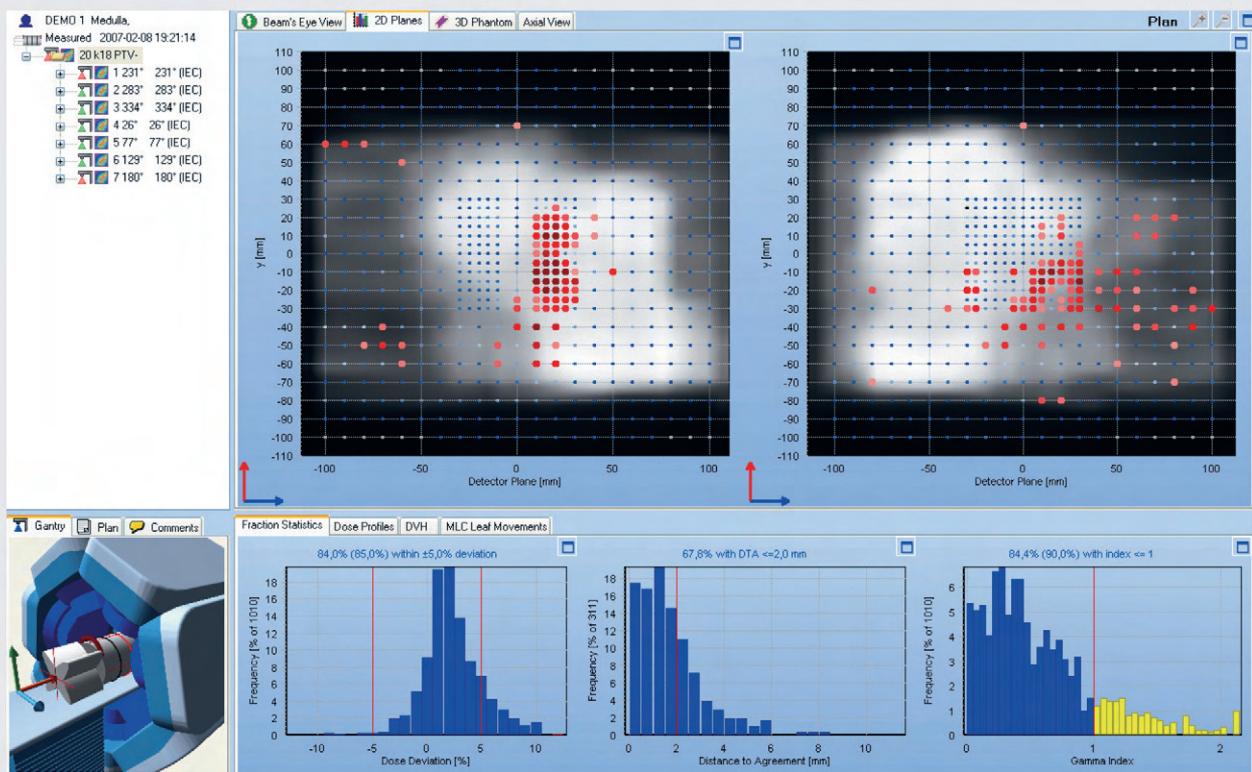
FIND THE CAUSE OF DEVIATION

With Delta^{4PT}, the cause of a discrepancy can be traced and analyzed, utilizing the same measurement.

With the Machine QA option, machine QA can be quickly and easily run during the patient QA session, further expanding analysis to the sub-millimeter level.

START WITH DOSE PICTURE

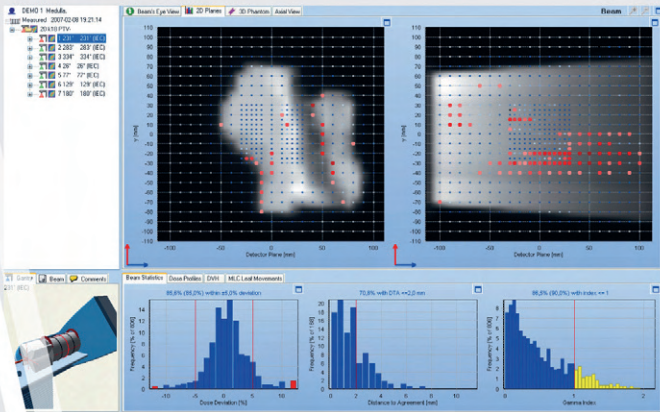
Analyze at fraction level



The procedure starts at the highest level (i.e. fraction dose), and is compared with the TPS data. If further refinement is needed, the beam and control-point level details can be used.

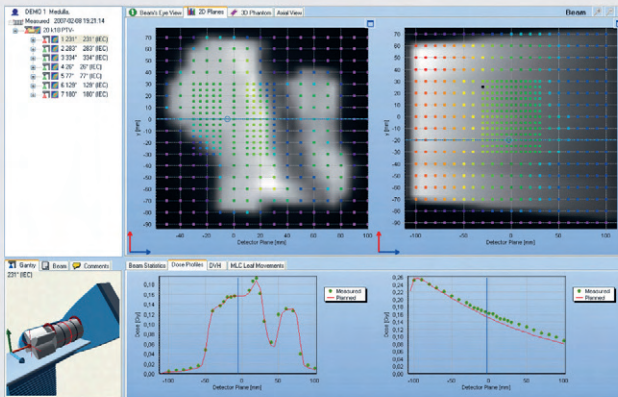
Gamma index outside of the acceptance level is indicated by a red beam icon. Highlighting the bars in gamma index graph enlarges the corresponding points on the planar images for easier analysis.

Analyze at beam level

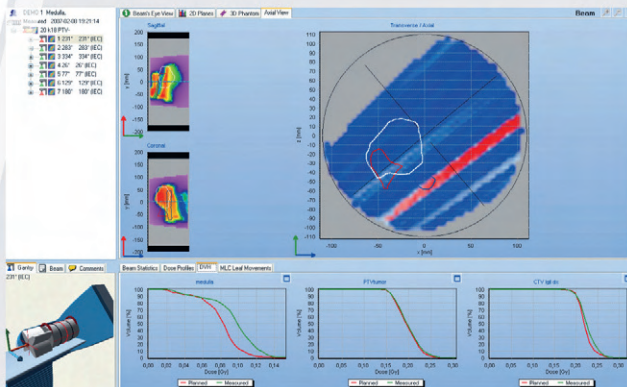


Statistics for the "red beam".

Measurement data presented as absolute dose, dose deviation, gamma index etc.

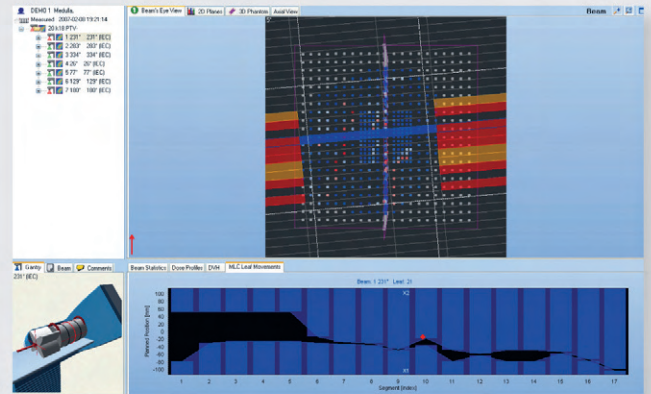


Profiles extracted from the measuring planes, for easy comparison between measured dose and calculation in TPS.



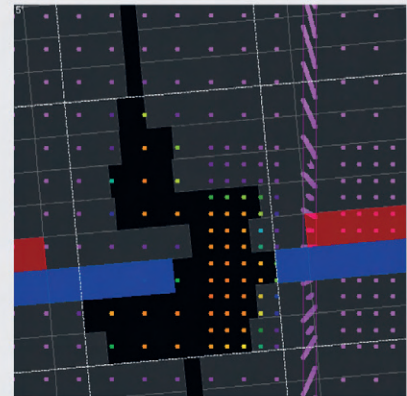
3D dose distribution and DVH at beam level to refine the analysis.

Analyze at control point level



In BEV, dose data per control point is compared with planned MLC path. Major deviating leaves are indicated in red.

Time diagram on the selected leaf pair. Control points with deviations are indicated with red points.



When selecting the control point, the leaf settings are displayed together with the integrated dose for that control point.

Leaves out of tolerance are indicated by flashing measurement points.

When the MLC check indicates error or miscalibration, the analysis can be complemented with the fast, sub-mm MLC check in the Machine QA option, utilizing the Delta⁴PT hardware.

“ We have been using Delta⁴ for over a year now. We have thoroughly validated it for step-and-shoot IMRT, VMAT and helical tomotherapy. It is a powerful and efficient IMRT QA tool. QA plans can be generated, measured, and evaluated in a short period of time. The DVH feature allows to quickly assess the clinical significance of any deviations. The cause of any deviation can be determined by drilling down from the fraction to beam to control point level. The device provides the readout in absolute dose at and around the isocenter – typically the most clinically relevant area.

Vladimir Feygelman, PhD.
Assistant Professor
Division of Radiation Oncology
Moffitt Cancer Center,
Tampa, FL, USA

CLINICAL SIGNIFICANCE

*With Delta^{4PT}, the clinical relevance of a discrepancy can be analyzed and used when evaluating the plan**

Select view as in TPS

- Transverse
- Coronal
- Sagittal

Analyze clinical significance in full 3D

Overlay of patient structures on the full 3D data is used to determine whether hot and cold spots are of clinical significance.

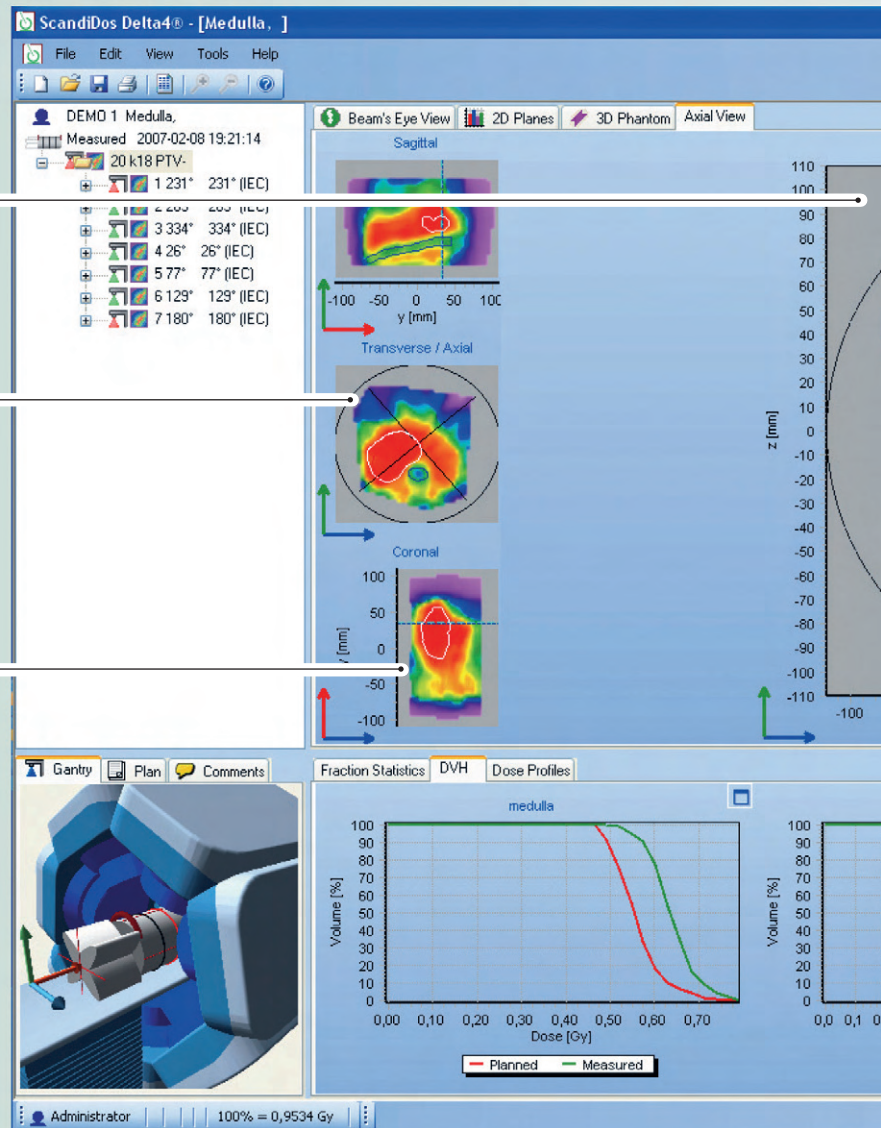
DVH display the discrepancy between planned and measured data in each structure:

- TPS dose and delivered 3D dose in phantom
- Volume of interest based on patient structure

Find out if discrepancy is in clinically important region (patient structure)

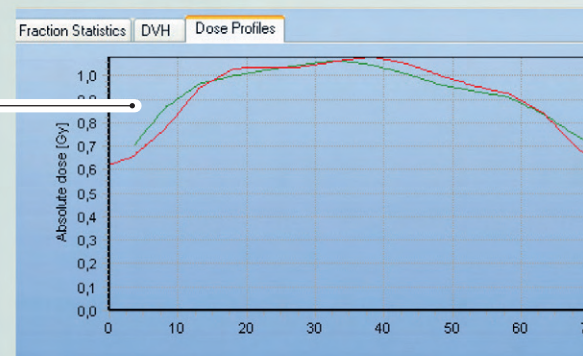
The 3D delivered dose is reconstructed using the measured dose and the TPS calculated dose in a logical and highly accurate way.

Alternatively, when TPS dose is not available, the measured dose together with fully-independent calculations is used.

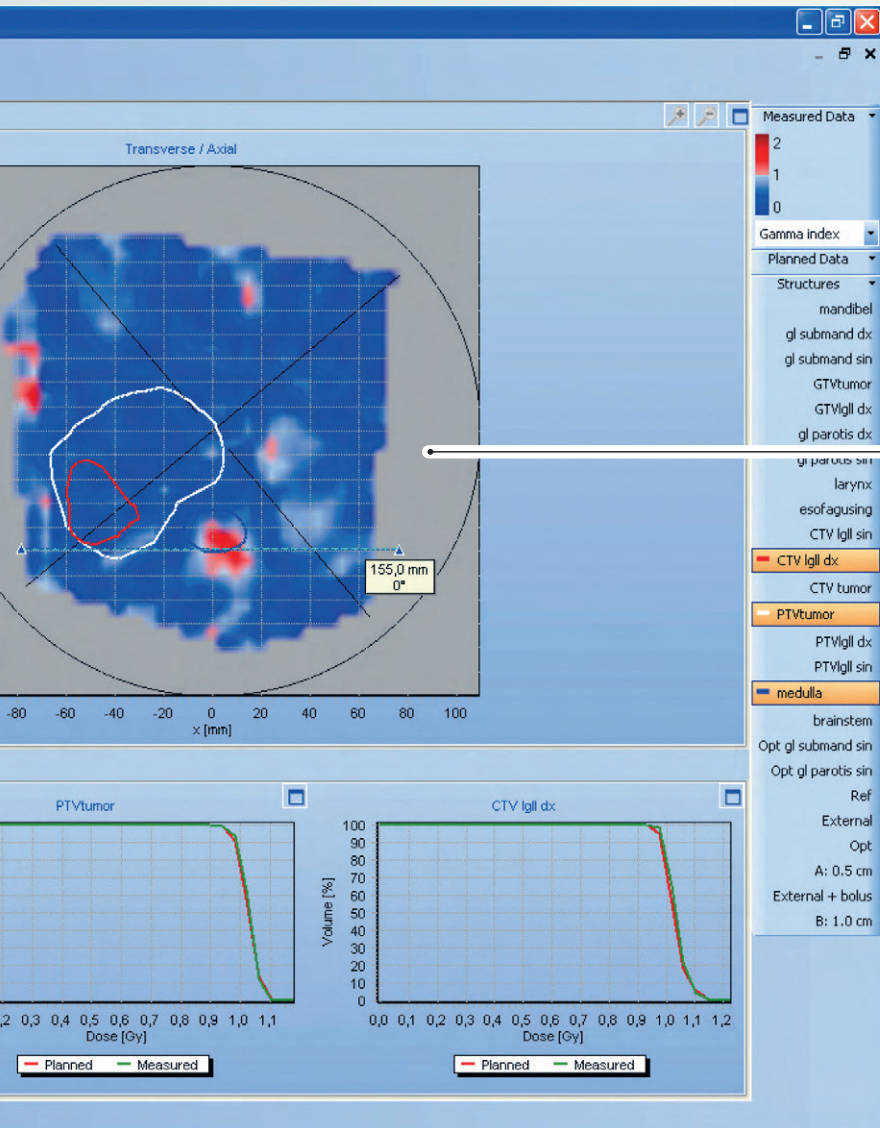


Profiles in 3D

Profiles can be extracted in any of the views; Transverse, Sagittal or Coronal to compare semi-measured data with TPS data.



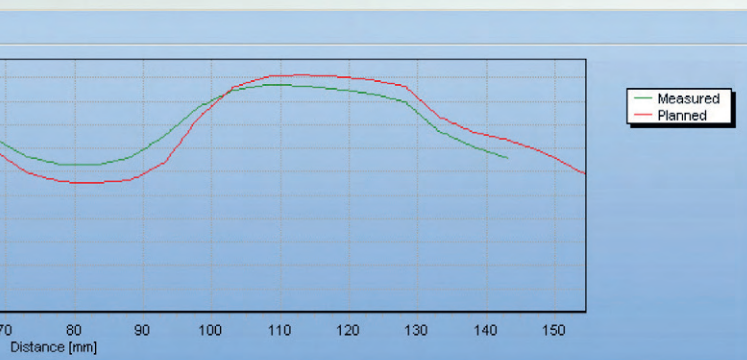
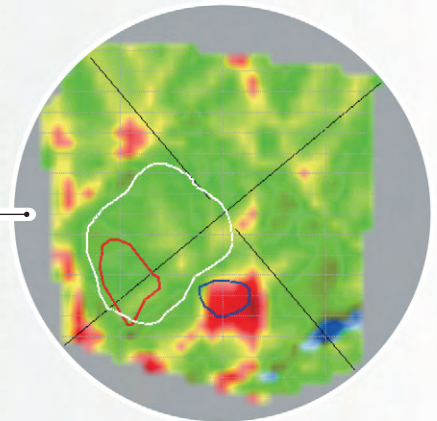
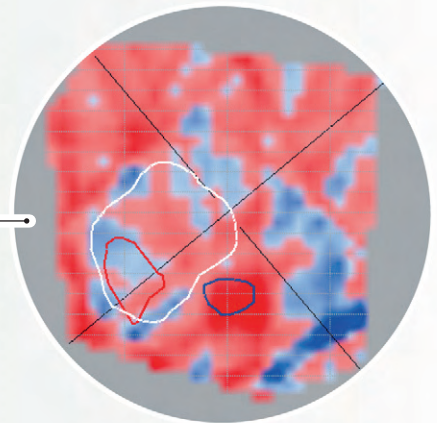
* 3D – DVH is an option in Delta⁴



Display of 3D data

- Gamma index
- Absolute dose or deviation
- Relative dose or deviation
- Distance-to-agreement

Overlay measurement data and patient structure in transverse view.



“ We have been using the Delta⁴ for a year now, and save almost 10 hours per week by performing our Tomotherapy IMRT QA with the Delta⁴ instead of with film and ion chambers. The one-click 3D dose and DVH comparison tools provide immediate, sophisticated clinical analysis of the entire treatment volume and surrounding structures that we have not seen with any other QA system. Regardless of plan complexity or fractionation, we can measure the target dose to within 2% of the prescription. And with one last click of the mouse, your QA documentation is finished. It is fantastic.

Mark Geurts, MS
 Chief Radiation Oncology Physicist
 Caribbean Radiation Oncology Center,
 Bayamón, Puerto Rico

MEASUREMENT ACCURACY

Delta^{4PT} is designed to provide a very high level of inherent accuracy; a basic requirement to enable the highest residual accuracy after applying correction factors.

Inherent accuracy (no correction applied)

Dose linearity better than 99.9%

DPPD (dose per pulse dependency)..... better than 99.5%

Field size dependency better than 97%

Depth dependency better than 98.6%

Out of field dependency better than 99%

Directional dependency better than 97.5%

Total accuracy after applied correction better than 99%

Data from the AAPM 2007 poster: SU-FF-T-135: G. Nilsson "Delta⁴ – A New IMRT QA Device".

CALIBRATION/ ACCESSORIES

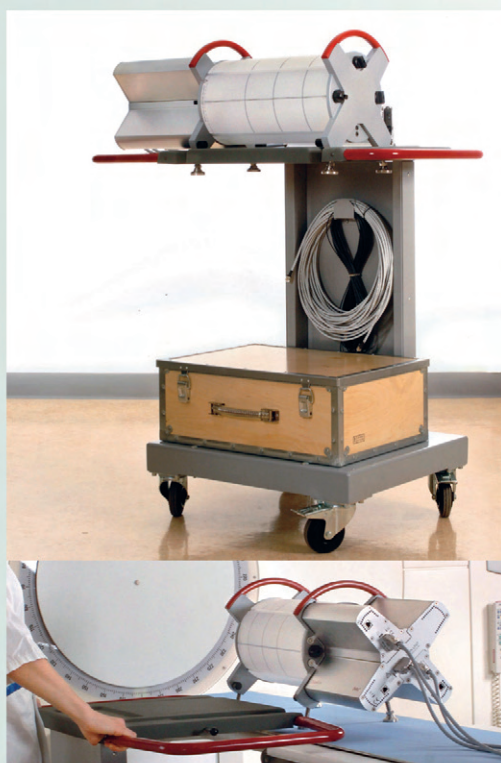


Calibration

Delta^{4PT} is delivered with a dedicated calibration phantom as well as a streamlined calibration process to ensure the highest level of accuracy in the calibration process.

A slab designed specifically for the user's reference IC to cross-calibrate the diode arrays is included as well.

The accuracy in the calibration is within 0.5%. The calibration process incorporates redundant checks to ensure the quality of the calibration.



Trolley

The ergonomic Delta⁴ Trolley eliminates lifting by utilizing the treatment couch.

Furthermore, the Trolley serves as a neat, compact, all-in-one storage platform for the Delta^{4PT}.



Sagittal and coronal support

The optional sagittal and coronal support and software enable measurements to be carried out directly in the sagittal and coronal planes, thus increasing the beam coverage and allowing additional flexibility.

TECHNICAL SPECIFICATION

Cylinder phantom material: PMMA; optional plastic water

Calibration phantom material: PMMA; optional plastic water

Detectors:

Type	p-Si
Total number	1069
Maximum deviation of detection point relative to markings on the phantom	0.5 mm
Detection area per plane	20 x 20 cm
Distance between detectors	
Central area (6x6cm)	5 mm
Outer area (20x20cm)	10 mm
Size (radial x axial)	1 x 0.05 mm ³ = 0.04 mm ³
Shape	Disc
Dose range	1mGy to unlimited
Dose resolution	50 nGy
Sensitivity decrease (6MV beam)	0.8% per kGy
SVWT (Temp. dependency)	0.27% /degree

Compatibility:

TPS import	DICOM RT Plan, Dose and Structure RTOG
Record and Verify	MOSAIQ, ARIA, VARiS, Vision, Lantis

Size and weight Delta^{4PT} unit:

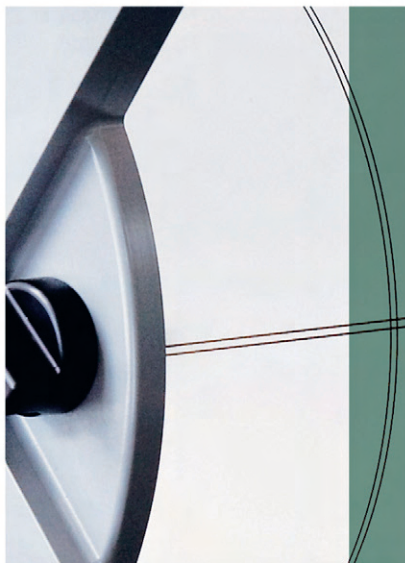
Cylinder diameter	22 cm
Cylinder length	40 cm
Total length	72 cm
Total weight	27 kg

PC recommendations:

Dual core
 Windows XP or Vista
 4GB RAM
 2 Ethernet connectors (one for data acquisition and one for LAN)
 >100GB HDD
 CD ROM drive

Ordering Information:

Part no.	Description
SDOS101-00	Delta ^{4PT} basic system including: <ul style="list-style-type: none"> • 3D detector arrays • PMMA Measuring phantom • PMMA Calibration phantom for cross-calibration with Farmertype chamber (type 2571) • Associated cables • Delta⁴ Basic software for acquisition of data and analyzing functions: Dose, Dose deviation, DTA and Gamma index • DICOM RT Dose and DICOM RT Plan import function
SDOS101-01	VMAT / IMAT and Arc Therapy option
SDOS101-02	4D and Gating option
SDOS101-03	3D-DVH option
SDOS101-04	TomoTherapy Hi-Art option
SDOS101-05	Machine QA option
SDOS102-01	Delta ⁴ Trolley
SDOS102-02	Delta ⁴ cable set
SDOS102-03	Sagittal-Coronal support
SDOS102-11	Ion chamber slab Semiflex
SDOS102-12	Ion chamber slab A1SL
SDOS102-13	Ion chamber slab A12



ScandiDos is an innovative, cutting edge maker of quality assurance solutions and a world leader in dosimetry for radiation therapy. By developing tools for efficient QA, we help to make new and improved treatment techniques available. ScandiDos strives to be at the forefront of technology development to enable the rapid clinical adoption of the latest treatment modalities.

Contact us today, or visit www.scandidos.com for more information.



Delta⁴® is a registered trademark of ScandiDos AB.
RapidArc™ is a trademark of Varian Medical Systems.

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