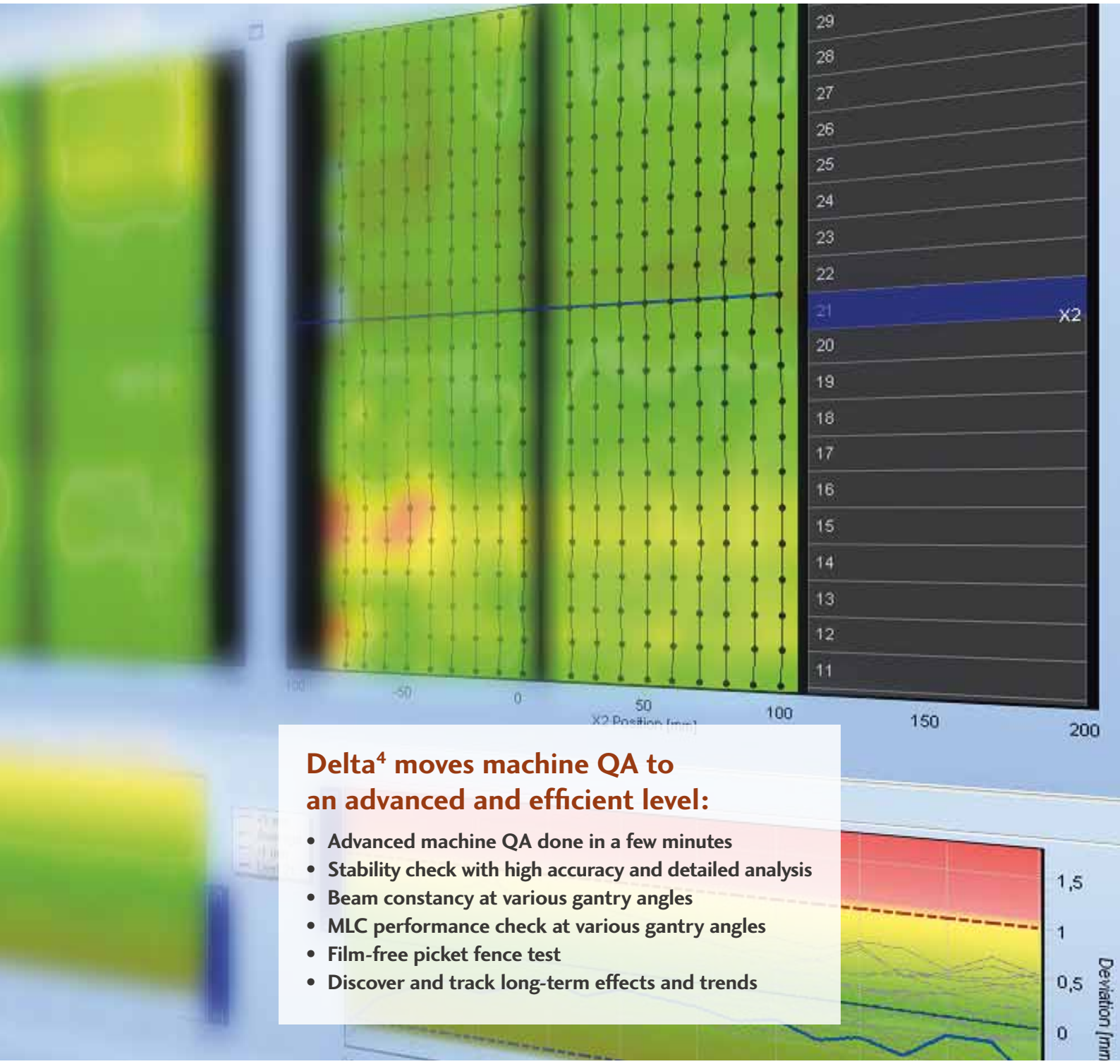
Delta⁴
by ScandiDos

Machine QA



Delta⁴ moves machine QA to an advanced and efficient level:

- Advanced machine QA done in a few minutes
- Stability check with high accuracy and detailed analysis
- Beam constancy at various gantry angles
- MLC performance check at various gantry angles
- Film-free picket fence test
- Discover and track long-term effects and trends

Machine QA

Advanced machine QA done in a few minutes

The Machine QA option for your Delta⁴ system coupled with the advanced hardware of the Delta⁴ system allows the user to perform periodic machine QA and analyze the constancy of therapy machines. At any time, measurements can be compared with TPS data or a reference measurement, typically obtained after maintenance and acceptance of the machine.

The measurement can be run directly in the RT machine's service mode, setting up the configuration directly in Delta⁴. Alternatively, the Machine QA option lets the user create a DICOM RT Plan file including all tests to be performed, profiles, depth doses, and MLC checks – all at the same time! The QA routine can then be stored in the record-and-verify system and run over and over again on demand.

The routine can easily be added and run as part of the pre-treatment verification with Delta⁴ to save time! As always with Delta⁴, analysis can be done at a later time, if preferable.

Stability check with high accuracy and detailed analysis

A unique feature of the Delta⁴ data acquisition is the measurement of each dose pulse individually and with very high accuracy. The unique high accuracy, not possible to achieve with other systems that sample data, provides the basis for the detailed study of the accelerator's start-up behavior, even on a sub-MU level. Delta⁴ integrates one dose pulse (typically 1 mGy) at a time with a resolution of 50 nGy. The total dose is the sum of all the individual doses measured per pulse, with maintained accuracy from the lowest to the highest dose levels.

In the Machine QA option, the time resolution is used to provide freedom to view start-up behavior in various ways. Profiles and depth doses can be extracted from the dataset and parameterized. The shape of the profiles or depth doses and extracted parameters can be viewed in any time or MU interval ranging from a few pulses to the complete delivery. A specific parameter (e.g., symmetry), can be viewed in a time or MU diagram to easily find out when the beam delivery stabilizes, and the stability during the entire delivery can be viewed.

Any measurement point can be selected to view its absolute dose per pulse or any integration of dose pulses against the delivered MU.

Beam constancy at various gantry angles

Traditionally, machine QA is often limited to the upright gantry position. With the Delta⁴ Machine QA option, beam constancy can be checked at various gantry angles (e.g., compare data from four different projections).

MLC performance check in various gantry angles and picket fence test

The picket fence test was originally used to check the reproducibility of leaf gap between opposite MLC leaves using a radiographic film. In Delta⁴, this test is now expanded yet made easy. A DICOM RT Plan file is created in the Delta⁴ software to run the MLC leafs in a specific motion pattern. The leafs makes a major stop along its path every 10mm, starting at one end of the possible opening and moving to the other side. At each major stop, measurements are done at three locations around the diodes and near the 50% level. Thanks to the high spatial resolution (0.05mm) of the diode detectors, the actual leaf position is measured with an accuracy of 0.1 mm. The discrepancy from the planned leaf position is quickly visualized in a graphical presentation where the coloring makes it easy to know if the MLC check has passed or failed. Enhanced analysis can be done utilizing a diagram where the details for each individual leaf along its path can be viewed and compared to the acceptance criteria.

Correct delivered dose depends very much on the field opening or the gap between leafs. The actual gap size can, thereby, be directly compared to the planned gap size. The comparison is done instantly and is clearly visualized in color diagrams.

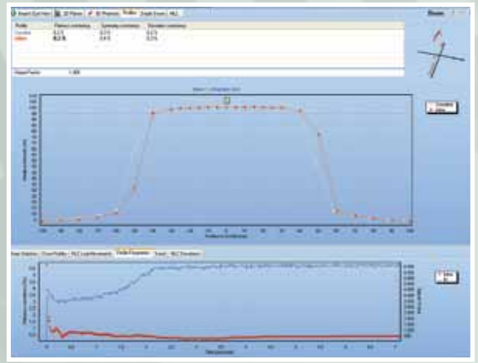
The MLC check can be performed at various gantry angles to verify possible changes in performance due to gravity impact on the mechanics.

Discover and track long-term effects and trends

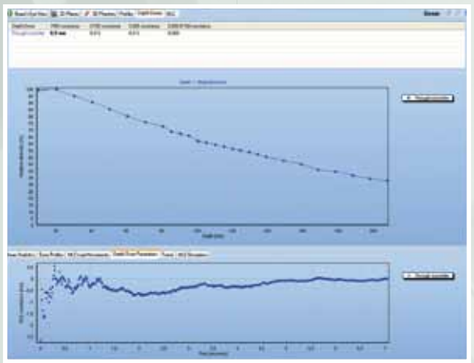
Profiles and depth doses parameterization from periodic machine QA measurements utilizing Delta⁴ can be summarized in a trend diagram. The benefit to the user is easier determination of trends (e.g., continuous degradation in the beam parameters, etc.). The trend diagram is created from measurement taken on various occasions over time. By simply clicking on one data point in the trend diagram, the specific measurement behind that point is displayed in greater detail.

Machine QA for dynamic radiotherapy technology

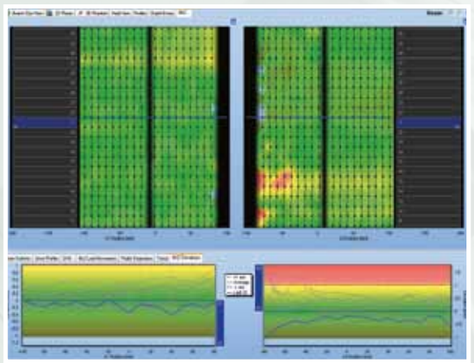
Create a DICOM RT Plan file that includes all QA in one routine, including MLC QA.



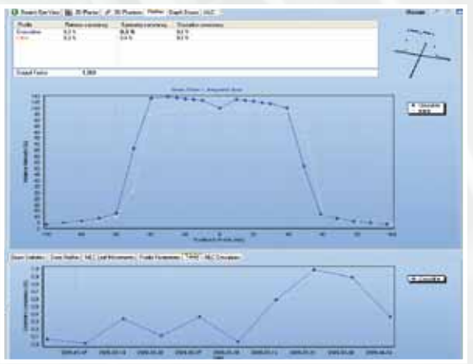
Display the profiles (inline, crossline or diagonal), view the flatness and symmetry parameters – integrated for a few pulses to all pulses, view the parameters in a time diagram. Overlay the time diagram of the parameters with the dose in each pulse in one selected point.



Display depth dose at on- or off-axis position, integrated for a few pulses to all pulses over a certain time or MU. View the time diagram of the R50, D100, D200 and D100/D200 parameters.



The upper part of the screen shows the overview of the picket fence test to get to know if the test passes or fails. The lower part shows the details of each leaf along its path. Left and right leaf banks are presented individually.



The trend over time for the beam parameters can be analyzed. The deviation from the reference measurement or from the TPS is shown in the time diagram. The upper part shows the symmetry measurement for a specific day. Similar trends can be shown for all parameters.

"We had an opportunity to thoroughly evaluate the Delta4 dosimeter prior to clinical use. We have validated it for step-and-shoot IMRT and TomoTherapy, with good results. The design of the device is very clever and a great deal of dosimetric information is available virtually instantaneously after the plan is delivered. The major advantage is the ability to compare dose at the fraction, beam or even individual segment levels, which allows to quickly evaluate and explain any disagreements. The Delta4 helped us to commission new accelerators with a new treatment planning system in a very efficient manner. In addition to IMRT, it provided quick means to verify absolute dose distributions for a variety of conventional beam arrangements. We are looking forward to the next project involving the Delta4 – commissioning and QA of the volumetric arc delivery system."

Vladimir Feygelman, PhD
Assistant Professor
Division of Radiation Oncology
Moffitt Cancer Center
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Delta⁴ is also your ideal solution for pre-treatment verification:

- **VMAT – including Varian RapidArc™**
- **TomoTherapy®**
- **IMRT**

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