Validation of Delta^4 for clinical use

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Introduction.

The Delta^4 system (Scandidos AB, Uppsala, Sweden) is designed to check a complete treatment plan in one single measurement. We intend to use the system for routine QA of IMRT treatment plans.

The aim of this work was to evaluate the system with respect to dosimetric properties, before taking it in clinical use.

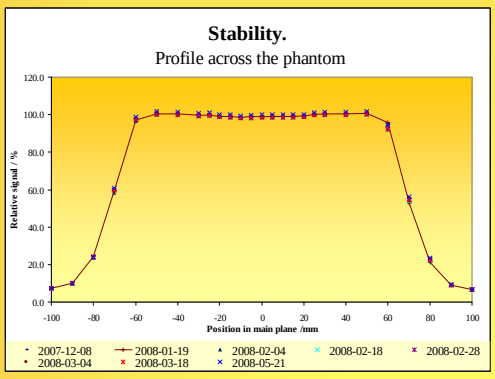
Material and methods.

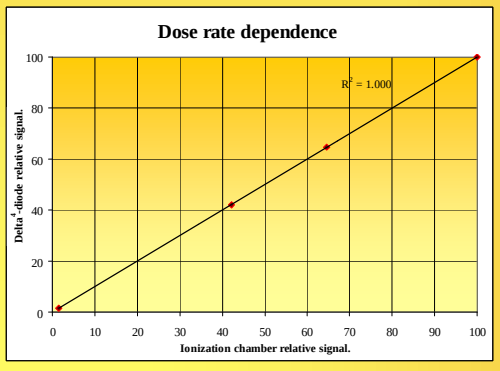
The Delta4-system is a cylindrical PMMA-phantom with two perpendicular detector planes. The 'main unit' is made in one piece and the crossing plane is divided in two 'wing units'. The detectors are p-type Si diodes covering a 20x20 cm^2 area on each plane.

Simple static beam arrangements with 6MV photons were used for the evaluation. A selection of 4 diode lines, parallel to the phantom axis, were studied. One line was located on each wing unit and two on the main unit.

Stability.

A four field box plan was measured 8 times during a 5 month period. The diode signals was corrected for fluctuations in accelerator ouput.
The standard deviation was 0.5% of the central dose for all diodes studied, except in the penumbra.



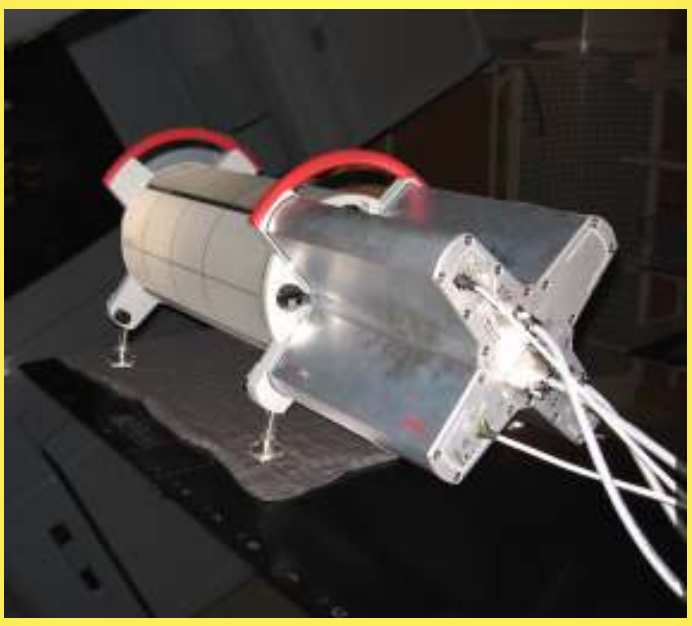


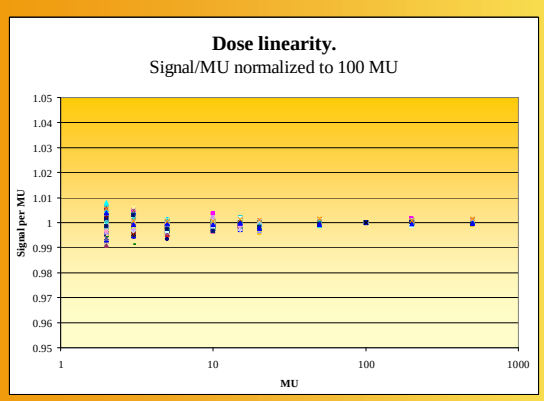
Dose rate dependence.

The dose rate was varied by varying the focus-detector distance. The lowest dose rate was achieved by shielding the entire field with MLC. The diode signals were compared to ion chamber measurement under the same conditions.
The correlation was very good.

Dose linearity.

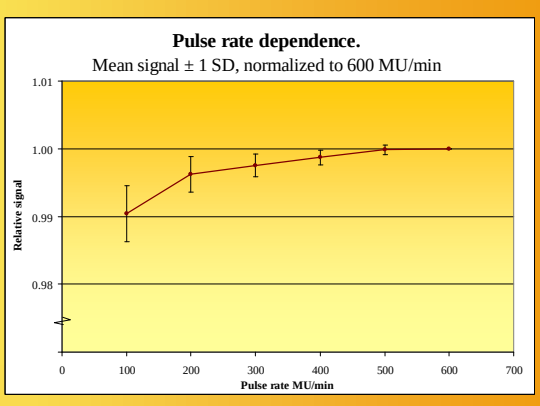
Dose linearity was studied using one single field irradiated with varying number of monitor units, from 2 MU to 500 MU. The result for each detector was normalized to 100 MU. Signal per MU varied less then 1% for all diodes inside the field.





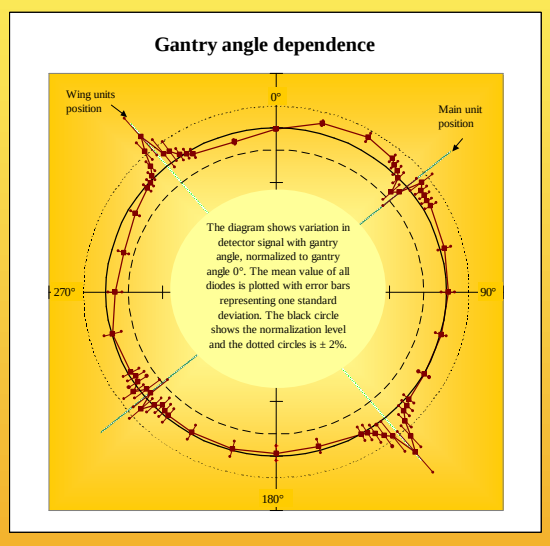
Pulse rate dependence.

A 10 x 10 cm^2 field was measured with pulse rates from 100 to 600 MU/min. The accelerator output was monitored using a external ion chamber. We found a tendency that the detector signal decreases with lower pulse rate. The average of all diodes inside the field is about 1% lower for 100 MU/min compared to 600 MU/min.



Gantry angle dependence.

The response of the diodes along the phantom axis was studied for different gantry angles from 0º to 360º. For angles close to parallel to any of the detector planes the detector response differs from other angles. Outside ± 5º from the detector planes the standard deviation of the diode signals were 0.8%.



Short term reproducibility.

One 10 x 10 cm^2 field irradiated with 100 MU was used, resulting in isocenter dose of 0.74 Gy. The irradiation was repeated 10 times. The relative standard deviation was less than 0.1% for all detectors inside the field.

Discussion.

The parameter with largest impact on measurement results is the angular dependence. The diodes studied for this parameter are mounted on the main unit and the signal peaks parallel to the wing unit is probably due to differences in attenuation in the crossing detector plane and should be less pronounced for off-axis detectors. Still we recommend to avoid using gantry angles close to parallel to the detector planes.
No studies of data calculated in the Delta^4 software have been made in this work.

Conclusion.

The Delta4 system is well suited for measurement of individual patient plans.
The parameters studied result in an overall uncertainty of 1.2% (1 sd), but the variations with gantry angle and pulse rate have a systematic component.