NONIUS-Quality Control in Radiation Therapy without Film

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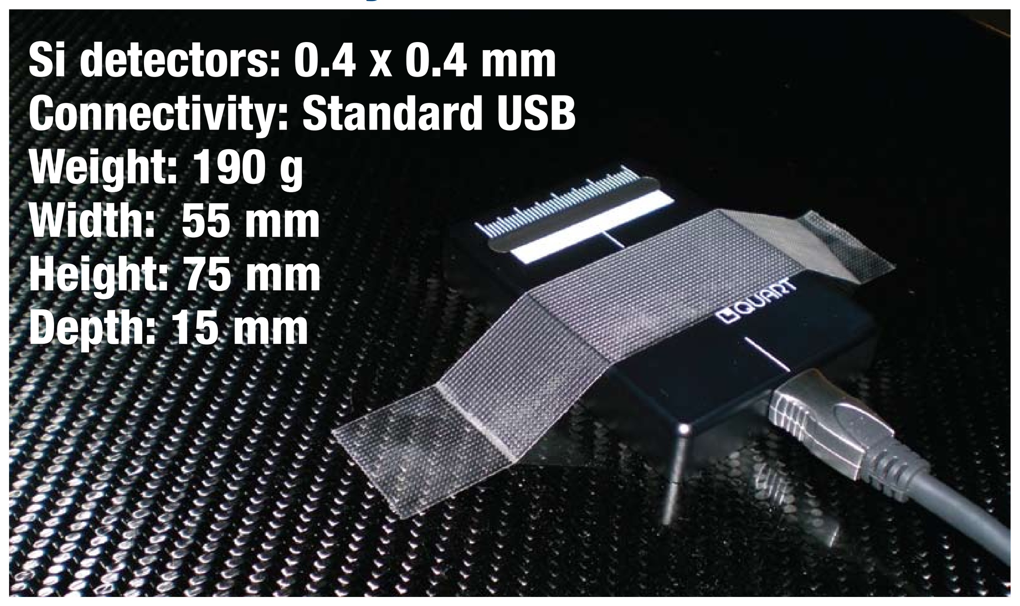
Introduction:

Present a cost-efficient device for the measurement of therapy beam edges as an alternative to the use of conventional, radiochromic or CR films.

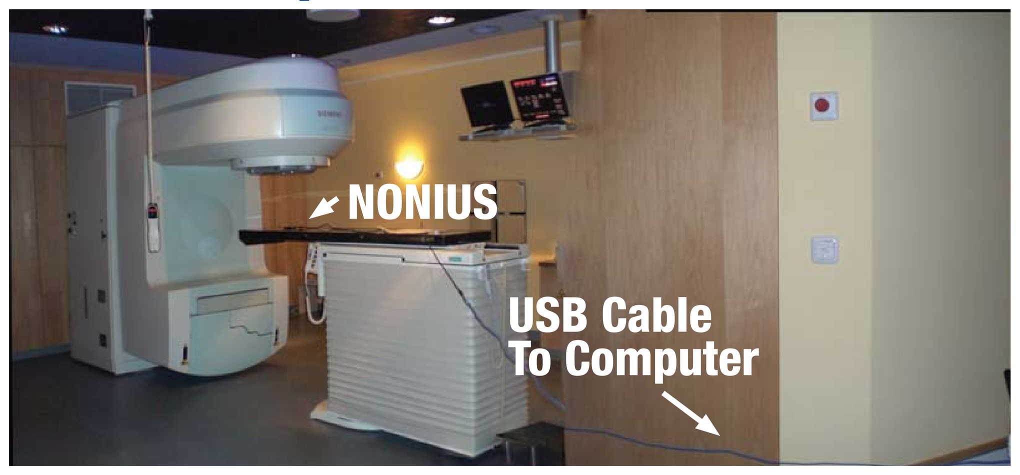
Method:

The NONIUS device consists of a 4 cm ruler located above a radio-sensitive array of 16 photo-sensitive detectors. Each detector is 0.4 x 0.4 mm and separated by 2.56 mm. The NONIUS' ruler is centered on the edge of the light field and then irradiated. A profile along the radiation field edge is displayed and the position corresponding to 50 % decay is automatically compared with the center of the ruler to determine the deviation of the radiation and light fields. NONIUS was irradiated and evaluated using 15MV photons (with a flattening filter), 6-7MV photons FFF (flattening filter free) and 1MV photons (Carbon target) from a linear accelerator. The doses varied between 1 and 10 cGy (1 to 10 monitor units, MU).

The NONIUS consists of 16 Si Detectors in a 4 cm linear array



NONIUS set up

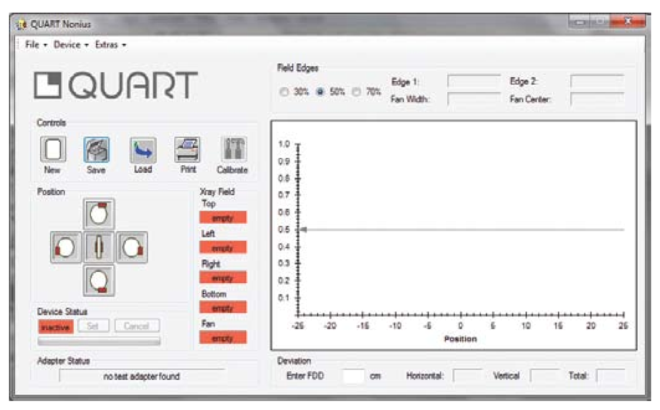


1. Place NONIUS in field of view
2. Connect NONIUS to computer
3. Start Software

Irradiation procedure

Calibration (first-time use only):

1. First time use only
2. Follow software instructions

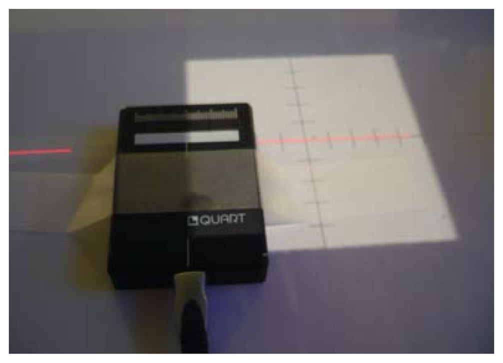


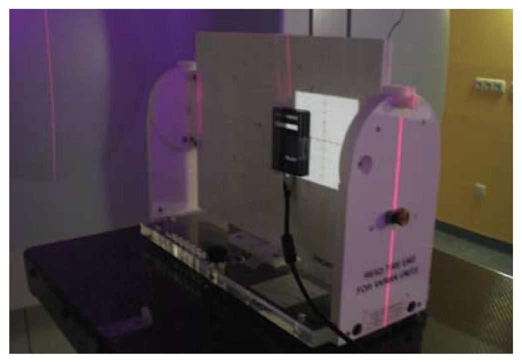
Irradiation procedure

QC/QA Test for each field edge

1. Place NONIUS in light beam edge
2. Click corresponding edge button
3. Irradiate
4. Repeat

QUART NONIUS measurements are independent of gantry angle





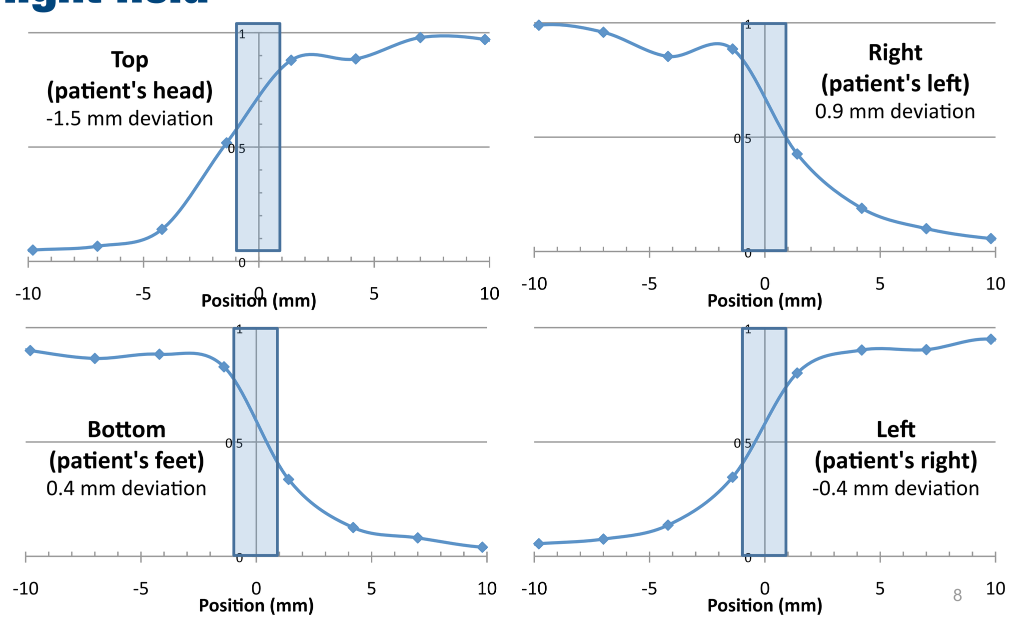
Measurements show an exposure threshold for energies greater than 1MV is at least 2 MU

Energy (MV)	MU	Gantry Angle	QUART NONIUS able to detect beam edge
1	1	0	Yes
7	1	0	No
7	**2**	0	Yes
15	1	0	No
15	**2**	0	Yes
15	2	90	Yes

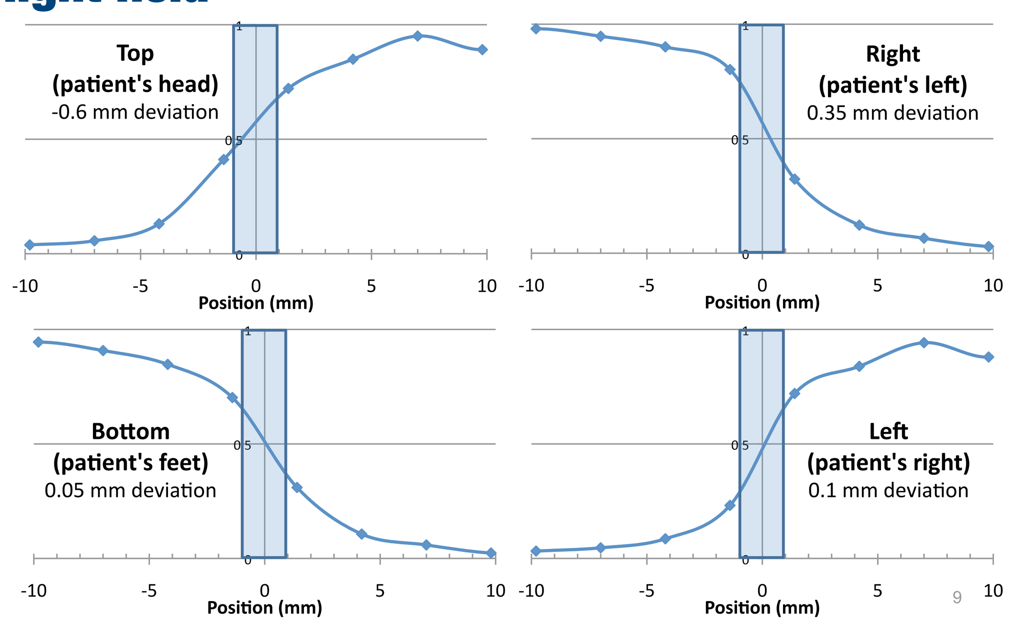
Summary:

- 1 MV (carbon target), threshold is 1 MU,
- 7 MV and higher, threshold is 2 MU,
- Threshold is independent of gantry angle

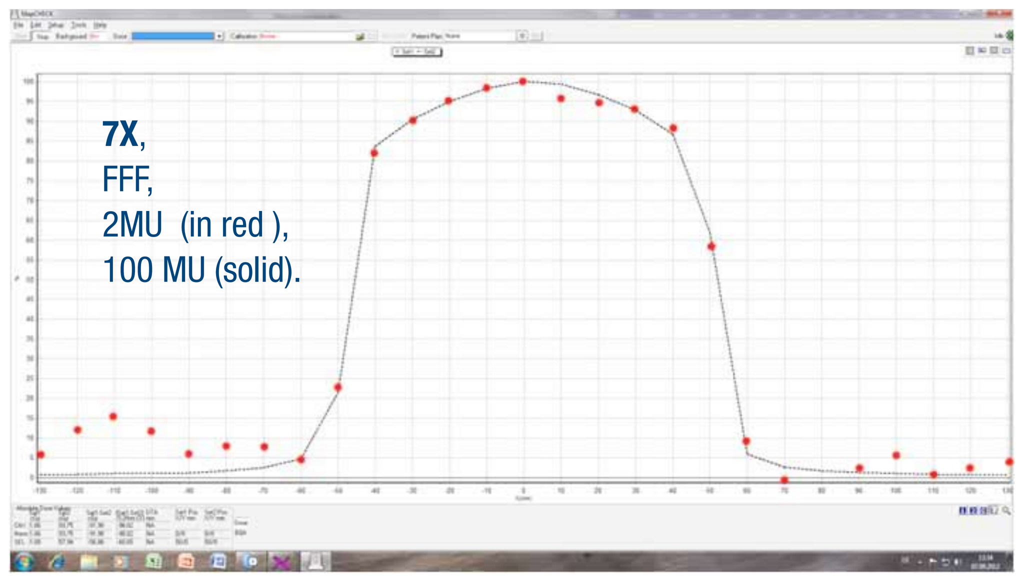
NONIUS 15X-FF measurements showing the deviation between the radiation field and the light field

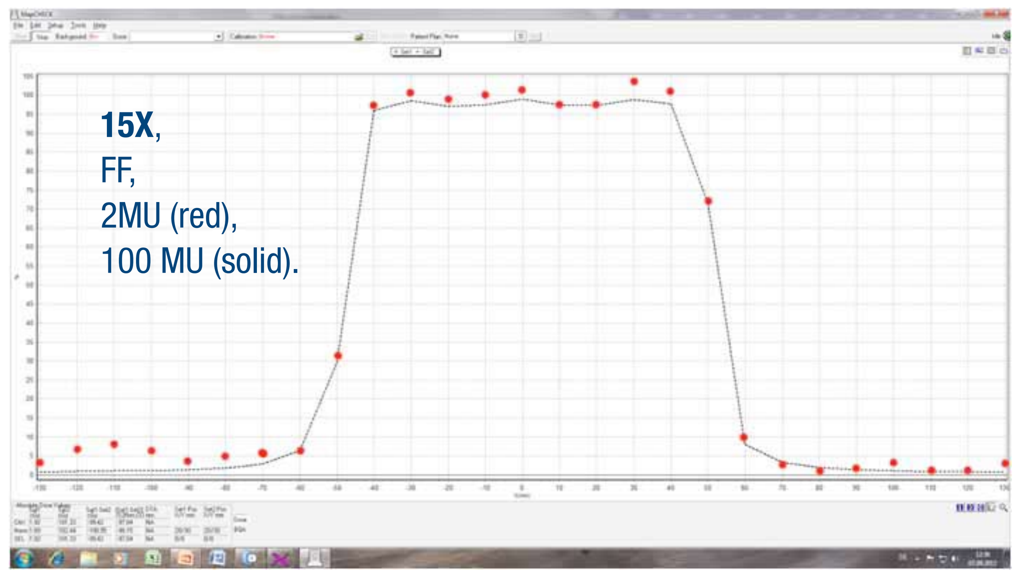


NONIUS 7X-FFF measurements showing the deviation between the radiation field and the light field

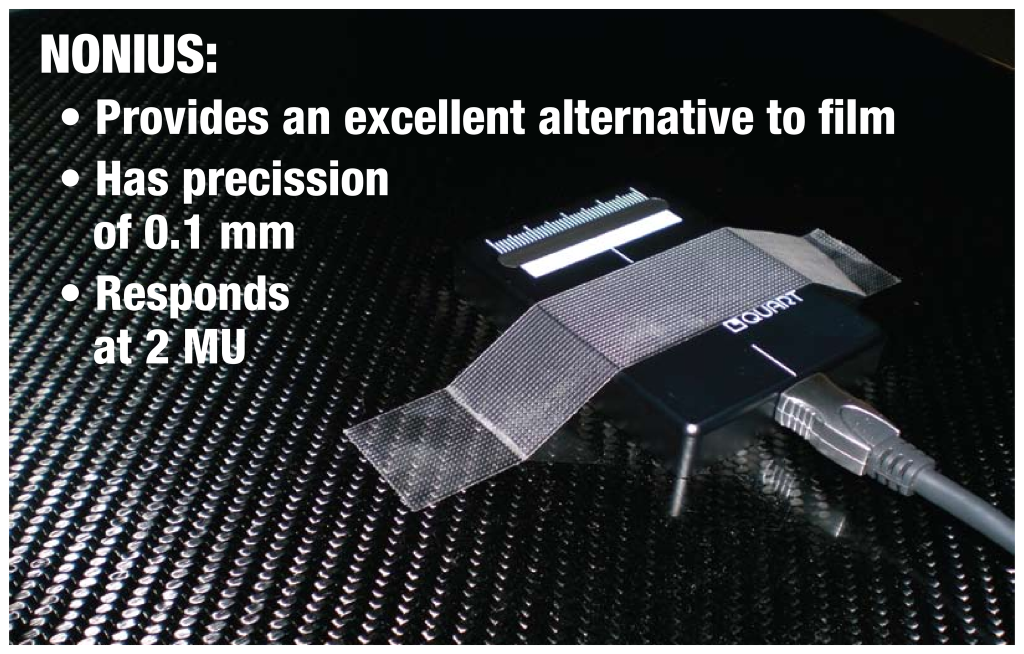


100 and 2 MU diode array profiles showing good light/radiation congruence, array measurements are in good agreement with NONIUS measurement

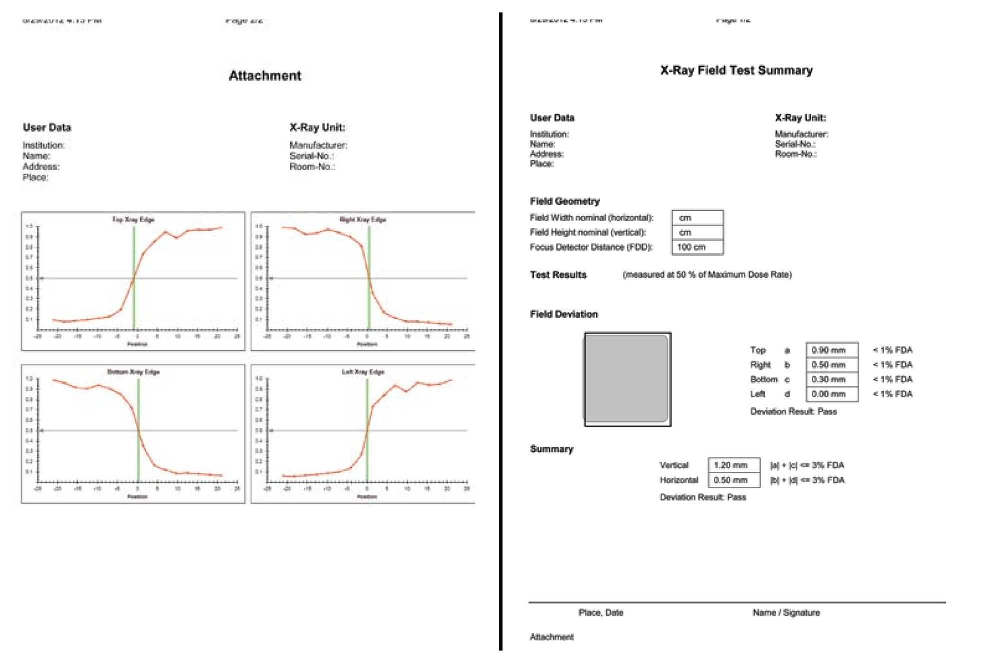




NONIUS can easily and effectively be used for light and radiation field congruence in radiation therapy



NONIUS software easily produces hard copy reports



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Results:

NONIUS is able to measure a useable profile signal with as little as a 2 MU dose. The measured profiles were validated with a conventional diode array. For the case of FFF profiles, the evaluation method should be adapted to determine the edge correctly.

The results, including graphs and all data, can be directly printed from the software or stored. With regard to radiosurgery, preliminary results confirm NONIUS flexibility and show that NONIUS would enable the use of less attenuating materials for the beam alignment.

Conclusion:

The applicability of NONIUS for accurately comparing the coincidence of therapy light and radiation fields was investigated and confirmed. The advantages of using this device in place of film is its ability to automatically and objectively evaluate the coincidence of these fields, the reduced time it takes to make and display measurement results, and the elimination of the repetitive costs and other complications incurred when using various types of film. Thus, a simplification of a necessary and required quality control procedure for linear accelerators and robotic radiosurgery seems to be possible.

Conflict of interest:

H. De las Heras works part time at a consultant for QUART GmbH, F. Schoefer is the scientific leader of QUART GmbH, S. Szeglin and D. Coll Segarra are employed by CNMC Co., a Best Medical International Company, O. Blanck is employed by German Cyberknife Services, and K. Mair has no conflict of interest