EPI based quality assurance on Siemens linear accelerators

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Introduction
For quality assurance (QA) in radiotherapy generally radiographic films are used. The workflow of radiating and analyzing the films is time-consuming and cost-intensive. In this work parts of the QA were performed with an electronic portal imager (EPI) instead of film. For the analysis of the measured data, generated with the EPI, an efficient workflow concept was developed. The results of the analysis were compared to those of film based QA-data.

Material and Methods
The EPI Rid1640 AL1 (Perkin Elmer) on a 6 MV Siemens Linac (equipped with the MLC “Optifocus”) was positioned in a way, that the imaging layer lies coplanar in the isocenter plane, perpendicular to the central beam. To simulate the same assembly, films were placed according to the EPI imaging layer. RW3-plates with a build-up depth, equivalent to the material covering the EPI imaging layer, were put on the films. Following QA-tests were evaluated:

1. MLC positions ("garden fence test")
Five stripes of 2cm width were applied at different x-leaf positions and afterwards analyzed.

2. beam profiles
Because of the specific signal interpretation of the EPI, the data required correction to analyze the field characteristics.

3. field alignment
The penumbra area was marked with steel spheres. Then the radiation field was overlaid. The adjustment of light to radiation field was analyzed with the Siemens COHERENCE Physicist Workspace software.

4. star shots
Couch and collimator star shots were performed. The analysis of star shots was also carried out with the software denoted above.

For film measurements Kodak X-Omat V films and an Epson Expression 10000XL 1.0 scanner were used.

Results
1. Table 1 shows the results of the MLC positions test for EPI and film. Deviation single gives the average deviation of the right and left leaf bank from the predefined positions. Deviation center shows the average deviation from the predefined center position for each of the five stripes. Field size gives the average deviation from the predefined field size given by the two leaf bank positions.

<table>
<thead>
<tr>
<th></th>
<th>deviation single [mm]</th>
<th>deviation center [mm]</th>
<th>field size [mm]</th>
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<tbody>
<tr>
<td>EPI</td>
<td>0.7 ± 0.2</td>
<td>0.7 ± 0.1</td>
<td>0.9 ± 0.2</td>
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<tr>
<td>film</td>
<td>0.6 ± 0.2</td>
<td>0.7 ± 0.1</td>
<td>0.5 ± 0.2</td>
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Tab. 1: Analysis of leaf positions for EPI and film data

2. The penumbra of EPI profiles are 1.3% larger than those obtained with films. This is due to the fact that detectors of the EPI do not process the evolving light signal independently but neighbouring detectors are also influenced. Field size values are 0.3% larger than those measured with films.

3. Steel spheres with a diameter equal to or greater than 2.5mm could be well distinguished (Fig. 4a). Nevertheless the adjustment of the steel spheres is subject to setup errors of approximately 1mm.

4. Collimator star shots achieve comparable results for EPI and film: 0.9 ± 0.2mm. Couch star shots with film show about 1.6mm higher values (Fig. 4b).

Discussion
With an EPI constancy checks can be performed effectively, presumed that reference images have been generated before. Tests for MLC positions and beam profiles work well in above described manner. The significance of the field alignment test must critically be reviewed because of setup errors and the size of the steel spheres. Star shots can be easily and objectively analyzed with the Siemens COHERENCE Physicist Workspace software. Deviations for couch star shots must be verified. Though further measurements containing dose information are needed, for relative QA the EPI gives a reasonable alternative.

References