consuming. There exists a need for a tool that could support and objectify this process.

At present the accuracy assessment is done manually by an experienced observer. As a rule, this tedious procedure is not performed routinely. The wide literature on image registration refers to portal images made with beams generated in accelerators rather than with the cobalt apparata. In Poland more than a half of patients are treated with cobalt. There are numerous references to image registration methods tailored for finding the fitting and non-fitting fragments of the compared edges. The majority of these methods lack generality.

The methodology to be presented is general and requires little user intervention.

- **Features to be matched**: edges of selected anatomical structures, irradiation field and shields, as seen in scanned images.
- Edge detector: zero-second-derivative with scale fitted to noise and scale of edges, separately in portal and reference images.
- **Geometrical transformation**: affine (2 translations, rotation, 2 scalings – along two coordinate axes).
- **Measure of fitting accuracy**: modified Hausdorff distance measure – robust method based on voting. Parts of the contours that do not fit the general tendency are rejected. This is vital if portal images made with cobalt apparata are analysed.
- **Optimisation method** for finding the best transformation: maximum gradient (*chamfer matching*).
- **Final fit** can be calculated with le least squares method for only those pixels which were classified as fitting.
- **Speed-ups**: hierarchical method (pyramid of resolutions); in some cases: pre-calculated virtual transformations.
- **Automatic classification of edges** as belonging to anatomic structures, irradiation field or shields is possible.
- Experiments with enhancing the contrast of portal images using the optical system transfer function concept.

The software tool will be presented which makes it possible to correct the therapeutic system geometry or the location of the patient. Full control of the physician over the measurement process will be maintained, according to the requirement of human decision-making in the therapeutical process. The registration (overlaying) of a portal and a reference image is visualised for verification. Manual corrections of the result will be possible in the final version of the program.

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26.
CHROMOSOMAL DAMAGE AND SURVIVAL OF KERATINOCYTES AND FIBROBLASTS AFTER IRRADIATION WITH 200 kV OR 25 kV X-RAYS

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A relative biological effectiveness of 1 is accepted for soft X-rays (25-30 kV), which are applied in diagnostic radiology (mammography). However, it has been shown that soft X-rays can be more effective in cell killing and chromosomal damage. The present study was initiated to define biological effects of low-energy X-rays in vitro. Experiments were performed with 25 kV X-rays and 200 kV reference X-rays on neonatal human keratinocytes (HEKn), and NIH/3T3 mouse fibroblasts. Cell survival was studied with graded doses in a clonogenic assay, chromosomal damage in a micronucleus (MN) assay. The surviving fraction at 2 Gy for keratinocytes was 46±5% after 200 kV and 33±11% after 25 kV X-rays. Linear-quadratic cell survival analysis yielded α=0.305±0.033 Gy-1 and β=0.048±0.011 Gy-2 for 200 kV and α=0.399±0.103 Gy-1 and β=0.048±0.054 Gy-2 for 25 kV. For 3T3 fibroblasts an SF2 of 53±3% after 200 kV and 61±18% after 25 kV was observed. Values of α=0.24±0.02 Gy-1 and β=0.022±0.002 Gy-2 for 200 kV and α=0.10±0.05 Gy-1 and β=0.070±0.010 Gy-2 for 25 kV were derived. In conclusion, keratinocyte survival was similar for both radiation qualities. For fibroblasts, a reduction in survival at higher doses was observed. Results from MN studies will be presented.