# Improving the QA for geometric accuracy for stereotactic radiotherapy with a Linac

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## Introduction

Cranial Stereotactic irradiation using an add-on micro-MLC was introduced at the Universitätsspital Basel in 2009. From the beginning irradiation of very small lesions (<1cm) was intended. Introducing the QA program it turned out soon, that accuracy and reproducibility of QA procedures used so far were not sufficient to fulfil the needs for stereotactic treatment, i.e. submillimeter accuracy. Therefore developments to improve the geometrical accuracy had to be introduced.

## Material and Methods

1) First the fixation procedure of the add-on micro-MLC (DMLC, ELEKTA) was modified. Additionally to the delivered screws appropriate alignment pins are used to reduce the tolerance of the position of the micro-MLC versus the head of the linear accelerator (ELEKTA Synergy Platform). Reproducibility of fixation is reduced from about 0.4 to below 0.2 mm.
2) Star Films
Primary need of the stereotactic irradiation is the perfect coincidence of laser and radiation field at any possible gantry, collimator and table angle. Therefore the quality of star films is of great concern. Radiographic films are used, laser position is marked by a needle. Marking the laser line several pinpricks are done using a magnifying glass (magnification 3x). After development and scanning of the film, the image file is imported to a free-ware image manipulation program (GIMP, version 2.6; www.gimp.org). Using this program lines indicating the central beams can easily be drawn and repositioned; the maximum zoom factor of 1600% allows very precise evaluation of the position and dimension of the centre of the star films.
3) Winston Lutz Test
The usual regular QA process in stereotactic irradiaton is the Winston-Lutz Test. A radio-opaque ball is aligned to the laser coordinate system. A small field is irradiated and the relative position of the ball to the field boundaries is assessed for different angles of gantry, collimator and table. The point limiting the precision of this test, is the alignment of the Winston- Lutz tool to the laser, which is done by manually moving the table to the desired position. High quality images of a digital camera allow to determine the alignment of ball and laser to 0.1 mm. Misalignment during the test can be corrected in the subsequent analysis.

## Results

The improved techniques lead to a more accurate determination of the geometric QA parameters. Using image manipulation software the process can be redone by one or several operators. Reproducibility of the single processes is 0.2 mm or lower. Reproducibility of the entire QA is 0.3 mm or lower.

## Discussion

Improvements of QA processes lead to highly reproducible results with maximum uncertainty of 0.3 mm. Therefore deviations can be reliably detected at an early stage. Using these methods, irradiation of very small fields can be done with high geometrical accuracy, limiting factors are the positioning of the linear accelerator (i.e. gantry sag) and of the patient.