Additional Material

The DAVID multi-wire chamber is placed in the upper slot of the accessory holder, close to the cross-hair reticle. Each of the parallel wires is positioned exactly in the projection of the midline of a MLC leaf pair, so that the signal from each wire is proportional to the line integral of the ionization density over its length and thereby to the opening width of the associated leaf pair (Fig 1). The sum of all wire signals is a measure of the total radiant energy administered to the patient. The DAVID system has been designed to detect decalibrated MLC leaves by comparing the signal profile measured during each patient fraction with a reference profile measured for instance during IMRT plan verification or accelerator maintenance. However, as Fig. 1 shows, the signal channels at the field edges are influenced by the positions of the field limiting block-jaws. If during patient treatment the calibration of these jaws is suddenly lost due to a machine related problem, each field size deviation would result in a signal profile change in these channels. The sensitivity towards these calibrations is even higher than for the MLC leaf position detection. The reason is that a decalibrated block-jaw influences the wire signal along its whole irradiated length, whereas a MLC position error only influences a fraction of the wire length. We will discuss the functional relationship between the positions of decalibrated jaws and the DAVID chamber signal profiles and will report on clinical examples and long term performance.

Figures 2 and 3 are showing the sensitivity with respect to decalibrated jaws for the examples of an open 10 cm × 10 cm field and a single field of an IMRT prostate plan (both irradiated with 15 MV, SIEMENS Artiste). As clearly visible, already decalibrations of 0.5 mm are detectable. In the talk, these example DAVID signal profiles, taken without the deconvolution software, will be upgraded by deconvolved examples with even higher sensitivity to jaw decalibrations.

Figure 1: Typical signals of the David chamber and illustration of the situation at the edges of an IMRT field (insert). The field limiting jaws (here at the midlines of channels -10 and 0) are influencing the signal wire across the whole length. By comparison to the reference signal profile, small position errors are therefore detectable. Shown are the signals for a segment measured with a chamber designed for a collimator with 1 cm leaf width (27 signal channels) in the case of correct jaw position.

Figure 2: DAVID chamber signal profile for a 10 cm × 10 cm reference field S(x) and in the presence of a 1mm decalibrated jaw pair, Ŝ(x). The small deviations at the field edges are clearly visible. The relative signal change for a 0.5 mm difference in jaw position is approximately 5% and thus clearly detectable. The figure shows the result of a measurement with a chamber designed for a MLC with 80 leaf pairs (80 signal channels) and 5 mm leaf width.

Figure 3: DAVID chamber signals for a single segment of an IMRT plan. Shown are the reference field S(x) and a measurement with a 1mm decalibrated jaw pair Ŝ(x). The small deviations at the field edges are clearly visible. As in Fig. 2, measurements have been performed with a DAVID chamber with 80 signal channels.

Literature:

