

Technical report for "?", 6,580 characters, 4 pictures

Enormous progress made in tumour radiation therapy

Before the introduction of computerised radiation machines, head and neck tumours could not be safely treated with radiation without the high risk of damaging organs, the spinal cord or salivary glands or patients suffering paralysis. Spinal column tumour treatments ran similar risks. However, patients often had very little choice: either they underwent radiotherapy despite these risks, or they did nothing and allowed the cancer to spread further throughout their body.

The computerised radiation machine Millennium MLC made by Varian Medical Systems now provides a reliable process for treating tumours safely and minimising damage to healthy tissue. The so-called collimator can optimise and accurately direct doses of radiation, even to a small or irregularly shaped target area. One further advance is the MLC's dynamic radiation technique. Particularly critical areas can be treated efficiently and specifically with varying dosage within the tumour volume. This means better radiation results are achieved, with far fewer complications for patients.

Radiation can be delivered using a segmental or dynamic approach or a combination of both. Furthermore, the MLC is able to show the tumour as a three-dimensional anatomical image with different views from various angles. These views allow complex radiation treatments to be planned in great detail. One course of treatment is normally delivered in a 10 - 15 minute time slot. The process is further streamlined through automation and the ability to save and repeat processes. This means that tumours can not only be targeted more securely and accurately, but also much quicker.

The Millennium MLC is a multileaf collimator made by Varian Medical Systems. It comprises 120 parallel, individually adjustable tungsten leaves which block or redirect an x-ray beam towards the target. The leaves of the MLC are therefore adjustable apertures through which the radiation is directed at the patient's tumour. By correctly positioning the leaves, the radiation area can be adjusted to exactly match the shape of the tumour. The radiation produced by a linear accelerator can be delivered from various angles. The X-ray beam can therefore very closely approximate the tumour contour.

As already mentioned, the MLC provides a basis for heterogeneous and therefore intensity-modulated radiation therapy. The adjustable leaves mean that the radiation can be accurately controlled, i.e. it can be delivered to various points of the tumour with an adjusted intensity. Consequently, the dose can be higher in more aggressive areas of the tumour, and lower around sensitive healthy tissue. Before multileaf-collimators were developed, hospitals used to use lead and zinc to accurately shape the beam. To protect surrounding organs, casts in the negative

shape of the tumour were placed between the radiation source and the tumour. By deflecting the beam however, surrounding tissue was damaged. As a tumour looks different from every angle, four or five such casts were produced for each patient. This was a time-consuming and expensive process. In addition, these heavy die-cut parts had to be loaded in and out of the treatment machines by hand. The introduction of multileaf collimators with tungsten leaves solved all these problems and also created a variety of new treatment shapes.

maxon motors integrated with gearhead and encoder

The leaves of the Millennium MLC were optimised in shape and design to enable them to fit precisely into the system. If the leaves are too tightly packed, this could hamper certain movements or make the leaves jam. However, if they are not accurate enough, radiation from the subsequent gaps could escape and damage healthy tissue. To minimise such leakage, the leaves must be moved as accurately as possible. This task is performed by 120 compactly built-in maxon motor drives. The brushless motors, 10 or 13 mm in diameter respectively and comprising motor, planetary gearhead and encoder, move the leaves into the correct position. maxon motors are guaranteed to have a long service life because of their unique design and the use of the worldwide patented ironless winding. But even more important is the fact that the 120 motors can fit into an area measuring 40 cm x 40 cm. In other words, the size of the motor is a key factor. By using maxon motor drives, the engineers were able to fit the 120 tungsten leaves into the available space.

The Millennium MLC is capable of treating a tumour in 150 different ways, assuming that the opening for the radiation protection can be adjusted quickly and automatically using pre-programmed data. Consequently, the motors must deliver high torque and be extremely dynamic in order to adjust the leaves quickly and accurately. The synchronous adjusting of these leaves, against the subsequent friction that could occur, places an even greater demand on the torque.

The use of powerful neodymium magnets in maxon motors generates a high power density, even in compact designs. The patented rhombic winding guarantees a long service life, fast acceleration and high efficiency. Thanks to the use of ironless rotors, maxon motors have no magnetic detent which means they can be controlled and positioned extremely accurately. The precision drive systems are between 17 and 24.6 mm long. The performance range lies between 0.75 and 1.5 watts, and the nominal torque goes up to 1.61 mNm.

The drives' maximum efficiency is 76% and the temperature range -20 to +65°C.

According to the speed or voltage required, various windings are available.

Matching gearheads with reduction ratios from 4:1 to 1024:1 can increase torque to 200 mNm.

Due to their high performance and small size, maxon motors are also suitable for a variety of other applications, such as medical miniature pumps, surgical devices, air samplers and laser measuring equipment.

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Figure 1: the Millennium MLC made by Varian Medical Systems.

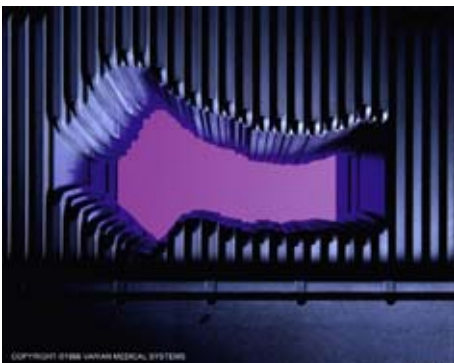
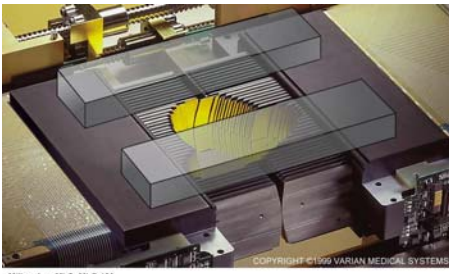


Figure 2: illustration of the leaves.



Figure 3: 13 mm diameter drive unit, comprising RE 13 motor, GP 13 planetary gearhead and MR encoder.



Millennium MLC: MLC-120
"The design of the Millennium MLC reduces out-of-field leakage."

Figure 4: the Millennium MLC minimises leakage.