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# Intensity-Modulated Radiosurgery System

Source: Varian Medical Systems, USA-Palo Alto CA

ponents had to deliver radiation in different modes, including segmental, dynamic, combinations of the two, and 'conformal arc' radiation treatment, all on one treatment machine. A computer system had to be able to translate multiple views of a single tumor into three-dimensional anat-

Source: maxon motor AG.

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Cancer treatment technology from Varian Medical Systems is aimed at being able to 'paint' or conform a radiation dose very tightly to a small or irregularly shaped target. These systems have the ability to minimize hot spots, improve target dose homogeneity, and sculpt dose delivery around critical structures more effectively. These systems are used accurately and repeatedly to treat tumors very close to sensitive structures like optic nerves, spinal columns, and other glands and organs. Despite their complexity, the high-resolution treatments are delivered quickly, fitting into the

### 120 drives on 40 cm x 40 cm

conventional ten to 15 minute time slots generally reserved for such treatments. The process is further streamlined through automation and the ability to customize a process, save it, and repeat it. Varian also provides software that incorporates data analysis and reporting tools.

Varian has received FDA 510(k) clearance for its latest high-definition multileaf collimator (MLC), an ultra-fine beam shaping device for radiosurgery. The HD120 MLC consists of a computer-controlled array of up to 120 parallel, individually adjustable tungsten slats or leaves (Figure 1) that can block the path of an X-ray beam. The MLC is attached to the head of the medical linear accelerator, which generates the beam. The leaves of the MLC are situated in two parallel rows, and can be moved in and out to create an adjustable aperture through which radiation beams are directed at a patient's tumor. The shape of the aperture is dynamically changed as treatment progresses, to match the shape of the tumor as seen from each of the angles from which the beam is being delivered. By using the MLC to precisely shape the beams from multiple angles, it is possible to deliver a radiation dose that closely matches the three-dimensional volume of the tumor. The MLC also facilitates intensity-modulated radiation therapy (IMRT). Using the adjustable leaves of an MLC to shape the beam and by controlling exposure times, clinicians can deliver a different dose to different segments of the tumor, modulating the dose intensity across the entire treatment field. Consequently, the dose can be higher in the most aggressive areas of the tumor and lower in areas where the beam is near or passing through sensitive healthy tissues.

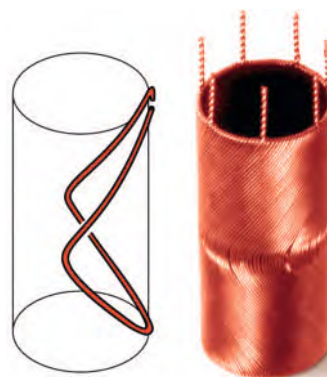
Prior to the new HD120 MLC multileaf collimator, Varian's finest MLC had a central group of beam-shaping leaves that were each 5 mm wide. The HD120 has reduced the width of the central leaves to just 2,5 mm, increasing the beam-shaping precision by 100 percent. Each side of the Varian collimator is configured with 60 leaves distributed in an 8 cm wide central region with 32 x 2,5 mm leaves, flanked by two 7 cm wide outer regions with 14 x 5,0 mm leaves, for a total width of 22 cm. The HD120 MLC was also designed for durability, so that it could be relied upon during continual use in a busy clinic. If the leaves are designed too tightly together, they jam. If the leaves are designed too loosely, radiation leakage occurs. Consequently, careful engineering that optimized how the leaves were packaged into the system was critical. The leaves move in and out through the use of 120 tightly packaged maxon motors.



**2** Drive assembly Ø 13 mm (Motor RE 13), Planetary Gearhead GP 13, MR Encoder

Source: maxon motor AG

The company says, it is known for their long life due to their unique construction, and the fact that they are manufactured on specialized machines. Yet, above and beyond their longevity, the motors offered Varian engineers excellent packaging options. Packing 120 motors into a 40 cm by 40 cm space meant that motor size was almost as critical as motor specifications. Through the use of the RE 8, RE 10 and RE 13 motors (Figure 2), Varian was able to package 120 tungsten leaves into the limited space available. While the motors are small, the truly impressive miniaturization occurred with the required encoder feedback. Each motor has an encoder to close the servo loop that must deliver suitably high resolution while remaining as small as possible in order to meet the packing requirement. Further, these encoders must be modified to be radiation resistant as the high field dose would destroy conventional encoder technology. Varian's radiation system was designed to deliver distinct radiation doses to thousands of different segments per tumor – almost like a free-flowing ▶



Source: maxon motor AG

**3** The patented rhombic moving coil design provides for long life and high efficiency



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- radiation gun. To do this, the multi-leaf collimator reshapes the opening for radiation quickly and automatically according to preprogrammed data. Consequently, each motor must handle high torque and high speed to create the programmed shape changes as quickly and accurately as possible. Motor torque needed to be at a level where the plates could operate in a tightly synched

formation, even against the high friction that could occur. Additional motor features include powerful rare earth magnets to maximize the torque that is available in such a small package. The patented rhombic moving coil design (**Figure 3**) provides for long life, low electrical noise, fast acceleration and high efficiency. An ironless rotor allows for zero cogging and simple accurate control. The motors are rated between 0,5 and 1,5 W, measure Ø8 x 17 mm to Ø13 x 24,6 mm, and offer a maximum continuous torque up to 1,61 mNm (0,23 oz-in).

Motor efficiency is up to 76percent depending on the winding. Ambient temperature range is from -20 to +65 °C. Several different windings are available to match desired speed with available voltage. Matching gearheads are also available with ratios ranging from 4:1 up to 1024:1 capable of delivering up to 200 mNm (28 oz-in) of intermittent torque. Encoders are available down to 8 mm in diameter with resolutions up to 100 lines per turn. Due to this performance and the small size, all motors are suitable for a variety of other medical applications including miniature pumps, surgical devices, air samplers, micro-stages, and laser measuring devices. ■



Improved by revised delivery channels and an active balancing system

## HIGH OUTPUT

**Optimized pump series.** Based on the series SP 500 EC Schwarzer Precision has expanded the pump SP 570 EC by two innovative technologies. First, the delivery channels in the pump head were revised and their flow properties optimized. This was possible because of the NT technol-

ogy (No Turbulence Technology). Second, because of the new IBE active balancing system (Individually Balanced Eccentric) the pump is running extremely quiet. Compared with conventional diaphragm pumps, the SP 570 EC optimally utilizes the installation volume. It delivers maximum pump output even in the smallest space. The modular system allows individual modifications toward the perfect »customized pump«. For example, different valves and diaphragm geometries can be employed to achieve high flow rates, pressures or vacuums. Motors of different manufacturers – from the low-cost to the high-end brushless motor – can be integrated. In addition, components in contact with the flow media can be PTFE-coated (Teflon) at little extra cost to further enhance corrosion resistance. The life of the new miniature pumps is increased by a two-bearing drive shaft and withstands also high pneumatic pressures. Mounting holes at the three sides of the pump permit installation in any position desired.

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Home care applications will be able to contribute to a better quality of life, more individual supplies, and care. While the Home Care segment is still in its infancy, Bühler Motor has already focused upon solutions for this range of application: be it by developing customized complex EEDDs (electronically enabled drug delivery) or by offering development and production of complete systems. As new therapies and medical drugs require new solutions, the development team takes into account that, for example drugs of a high visco-

## SOPHISTICATED DRIVES

sity have to be administered very slowly in order to keep the pain as small as possible. So-called patch pumps permit patients to spend perfectly normal days while undergoing long-term treatment without too much fuss having to be made about it. Smart mobile devices see to it that substances that have to be mixed prior to their administration are indeed mixed and dosed safely. Electro-mechanical actuators trigger the hypodermic needle and make for a safe injection. An ideal needle speed reduces the pain. Competence and experience in the area of drive technology is the base for miniaturized diagnostic and therapeutic applications close to the patient or medical pump systems (such as blood glucose meters, insulin pumps, monitoring devices, medication dosing devices). The company has been certified in accordance with ISO 13485 and develops and produces in accordance with ISO 13485 and FDA 21 CFR Part 820 – process validation in accordance with GMP guideline.

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