Purpose: Charged particle therapy, especially proton therapy is a growing treatment modality worldwide. A direct transfer of the MLC technology to proton therapy seems intuitively straightforward as leakage radiation is not a concern. On the other hand, neutron production and induced radioactivity in tungsten MLC are critical issues that are the subjects of the present study.
Methods: We have performed a study with FLUKA Monte Carlo simulation, of the neutron generation, ambient dose equivalent (H*(10)), and activation of a typical tungsten MLC and compared with those obtained from a brass aperture used for proton therapy.
Results: With the tungsten MLC, the secondary neutron dose to patient is at least 1.6 times higher than that from the brass aperture. This may lead to an increase on the risk of secondary cancer. The buildup of activity in MLC (30 patients per day) is about 3.4 times higher than that for the brass aperture at the end of 40-day treatment. The residual activity decreases by a factor of 2 after 40 days of MLC cooling, but still is about 7600 times higher than the activity for the brass aperture. The utilization of the MLC at the end of the operation cycle will require prolonged storage for cooling due to W-181 and Ta-179. There are also risks of MLC electronic malfunctioning associated with the soft error caused by secondary neutrons. The tritium production in tungsten MLC as a result of its daily use in the clinic is also estimated.
Conclusions: MLC could be an efficient way for beam shaping, an efficient cost reduction option for proton therapy. However, tungsten MLC does not seem to be suitable for proton therapy. Usage of tungsten MCL in clinic will create unnecessary risks associated with the secondary neutrons and induced radioactivity for patients and staff.