Simulating dynamic irradiation of complex systems using RayXpert®'s built-in energy-angle spectrum

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Purpose: In the field of radiation processing, simulation of an irradiation process involving moving products is a complex subject, requiring great care in balancing runtime and accuracy. Our aim is to provide an alternative way to simulate this scenario, using a stored energy-angle spectrum, with little to no loss in accuracy and a reduced runtime using only one simulation.

Methods: Using the Monte Carlo software RayXpert®, a first series of 31 unitary calculations, representing 31 steps of movements along a 3 m track was created to be used as a reference point. This reference point includes electron transport and X-ray generation on the conversion target. We then studied the possibility to use a simplified extended representation of the source, and then we developed and studied the use of an energy-angle spectrum to simulate X-ray particles. Absorbed dose rate and kerma water rate (Gy/h) inside a water phantom were compared to evaluate the fit of the two different simulations with respect to the unitary calculations.

Results: The absolute dose rate in the simplified source was overestimated. On the other hand, the energy-angle spectrum yielded less than 5% difference from the reference value in both DUR and absolute dose rate. Calculation time was decreased by a factor of about 100.

Conclusions: This new feature of energy-angle spectrum generation and emission built in RayXpert® allows a user to simulate accurately and quickly a moving X-ray irradiation target, even with a complex source geometry. The energy-angle file hence created can be reused to test various configuration and optimize DUR inside the product as well as absolute dose rate.

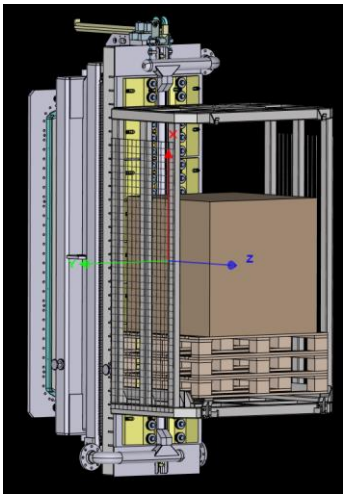

Figure 1. Irradiation setup with IBA Rhodotron.