Purpose:

MLC dynamic log files have been clinically used for quality assurance for years. The logged machine parameters and the derived beam 2D fluence maps can be compared to the ones obtained in the treatment plans in order to evaluate the accuracy and consistency of IMRT beam deliveries. In this study, we propose a computationally efficient method, called Direct 3D Fluence Calculation or D3DFC, to extend 2D fluence map derivation to 3D fluence volume computation. The aim is to extend dynalog-based QA from fixed-gantry IMRT to rotational-gantry VMAT.

Methods:

D3DFC calculates the 3D volume of photon fluence distribution directly from the machine parameters (gantry angles, jaw positions, MLC positions, collimator rotation angle, MU) contained in the dynamic log files or DICOM plans, without converting to 2D fluence maps per gantry angle in order to allow higher computation speed and accuracy. For testing, results were verified with film-in-air measurements. 3D fluence volumes computed from VMAT delivery records (with artificially introduced delivery errors) are compared to ones computed from the treatment plans to determine if these delivery errors can be identified.

Results:

D3DFC is implemented in MATLAB and supports the DICOM plans, Varian MLC dynamic logs and Varian Truebeam machine logs. Computation takes 10 to 20 seconds for a single-arc VMAT plan or delivery records. The results showed that 1 mm MLC errors can be clearly detected using delivery-to-plan fluence volume comparison.

Conclusions:

Direct computation from machine parameters allows higher computation speed and accuracy. These advantages are useful for beam delivery verification purposes for which (slower) full patient CT based dose computation is less necessary. The calculated 3D photon fluence volume is useful to detect and visually present the VMAT delivery discrepancies.