**Direct 3D Fluence Calculation from Machine Beam Parameters for VMAT Delivery Verification**

For IMRT, verification of delivered 2D fluence maps (derived from dynalog logs) is believed to lead to indirect verification of the 3D composite dose deliveries in target objects. For VMAT, the 2D method is not appropriate anymore because the delivery is in one gantry-rotating 3D beam instead of a number of gantry-fixed 2D beams. 3D fluence verification is therefore necessary. We have developed an efficient photon fluence 3D volume calculation method in study. The most important achievement is the direct calculation from machine beam parameters (conceptually similar to DMPO, or direct machine parameter optimization) therefore has better accuracy and computation speed.

Extracted from MLC dynamic logs, or TrueBeam machine log, or treatment plan in DICOM, machine beam parameters (field by field) used in calculation are gantry angle, collimator angle, X and Y positions, MLC positions, fractional MU, total beam MU. A 3D volumetric fluence is calculated by forward projecting the beam aperture (multiplied by fractional weight of the beam MU) of all beam angles. Beam apertures are directly derived from MLC and jaw positions. The simplified equation is:

\[ I(\hat{x}) = \sum_i F(\hat{x}_p) \times D(t) \times \Delta t \times M \times \frac{100}{|\hat{x} - \hat{s}(t)|^2} \]

Where \( I(x) \) is the 3D fluence intensity at point \( x \), \( F \) is the 2D beam intensity profile in air, \( x_p \) is the projection of \( x \) onto \( F \), \( D(t) \) is the dose rate at time \( t \), \( \Delta t \) is the period of time occupied by the machine log records, \( M = 1 \) if \( x_p \) is inside the beam aperture, \( M = 0 \) otherwise, \( s(t) \) is the MV source position. The last term in the equation is the inverse square correction.

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**Figure:** Results for a prostate plan. Delivery errors (MLC error, or wrong patient/plan) can be easily detected and visually presented.