EZFluence
by Radformation Inc.

WHITE PAPER

Automation of Field in Field Planning with EZFluence Software

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Difficulties in Breast Cancer Treatment Planning

Manual forward planning in radiation therapy consists of a trial-and-error technique that requires physicists and dosimetrists to endure a tedious, time-consuming process day after day, patient after patient. Moreover, plan quality is highly dependent on both the skill of the treatment planner and the time available to create the plan.

While IMRT is commonly employed to treat many types of cancer, forward planned field-in-field is still used far more often in breast cancer treatment[1]—especially in early stages. Great strides in automation are being actively implemented for IMRT plans, but forward planning has not seen the same kind of development attention or innovative leaps.

EZFluence is software designed by treatment planners, physicists, and engineers to automate the field-in-field and electronic compensator technique, bringing a new level of innovation to forward planning.

Such automation is timely since physical and enhanced dynamic wedges are no longer standard solutions and custom plans have come to be expected. Such patient-tailored plans come with a level of complexity that necessitate expending time and effort by professionals in the clinic whose time is far too valuable to waste.

Breasts are inherently one of the most challenging 3D conformal radiation treatment sites due to their irregular surfaces. In the most common planning workflow, the treatment planner will first set up the nearly-opposing tangent fields to cover the breast as desired and then calculate the open field dose. From this point, the treatment planner applies either a field-in-field or electronic compensator technique to achieve the desired homogeneous dose distribution.

Without EZFluence, the field-in-field technique requires iteratively adding field apertures by manually adjusting MLC leaf positions and/or field weights until the desired dose is achieved, and the electronic compensator technique

[1] Kisling, K. D., Ger, R. B., Netherton, T. J., Cardenas, C. E., Owens, C. A., Anderson, B. M., ... & He, Y. (2018). A snapshot of medical physics practice patterns. *Journal of applied clinical medical physics.*

requires manually and iteratively adjusting fluence intensities on a fluence map. Both techniques require full dose calculations for each iteration. Electronic compensators can achieve more homogeneous dose distributions relative to field-in-field, but many clinics[1] do not utilize the technique due to the challenging and time-consuming manual fluence adjustment and the extra quality assurance that the resulting sliding window treatment plans may require.

"EZFluence reduced our clinic's planning time from thirty minutes to under four. That is an 85% reduction in planning time, while preserving all of the dosimetry."
Todd Yoder, MS, CMD
Stony Brook University Hospital

Both techniques have historically required significant time—anywhere between 15 minutes and several hours depending on the complexity of the patient geometry and skill of the treatment planner—to produce, with the resulting dose distribution being highly dependent on both the amount of time spent and the skill of the treatment planner.

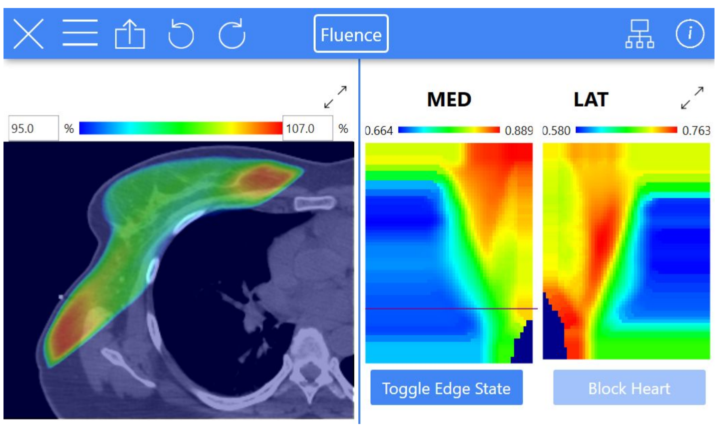

Figure 1: *Fluence Plan Executed by EZFluence*

The optimization process in EZFluence begins with identifying well-behaved points in the center of the breast or near the surface of an organ-at-risk (e.g. lung) where the goal is to achieve 100% of the prescription dose. The fluence intensity maps are iteratively modulated in order to achieve this goal in a way that ensures that the hot spots are balanced on both sides of the breast. EZFluence then ensures that the maximum dose is reduced to a specific maximum dose goal.

EZFluence also identifies regions of the field that do not intersect the patient (i.e. "flash") and automatically extrapolates fluence intensities so as to minimize the negative effects of small setup errors.

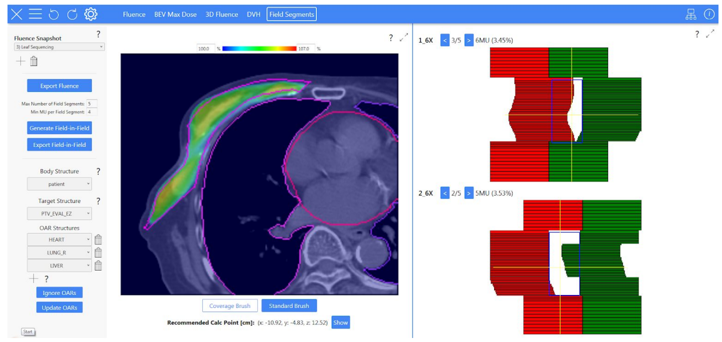

Figure 2: *Field in Field Plan Executed by EZFluence*

The fast dose calculation speed makes it possible for EZFluence to produce multiple fluence-based plan options with varied maximum dose limit goals in order to allow the user to simply choose the plan that fits their clinical preferences. This is an essential feature because clinically acceptable dose metrics vary from clinic to clinic[1].

The user can then decide whether they want to generate an electronic compensator or a field-in-field plan.

Clinicians See Results in Seconds

EZFluence is able to generate a user-specified number of field-in-field apertures in seconds. These apertures are generated with dose distributions similar to that of the fluence-based optimization. EZFluence does this by making use of an in-house graph algorithm along with machine- and site-specific heuristics. Aperture intensities are then optimized with dose voxel-based penalty functions.

This is a better technique because existing general leaf sequencing methods don't explicitly take the strict aperture cardinality constraint into account (i.e., a hard aperture limit isn't part of the sequencing algorithm). Such consideration is necessary as limiting the number of apertures greatly complicates the sequencing of non-homogeneous fluence patterns versus IMRT-style sequencing with far more apertures. Because each aperture greatly impacts the quality of the plan, high-quality automated field-in-field algorithms must make good use of all degrees of freedom.

EZFluence seamlessly integrates with the Varian Eclipse™ Treatment Planning System (TPS). The user simply launches the software from within the TPS and then directly imports the optimal fluence files and field-in-field plans generated by EZFluence into Eclipse.