Automated Breast Planning in Eclipse
BRAP – Breast Radiotherapy Auto-Planner

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Motivation

Planning breast in Eclipse is **PAINFUL** and **SLOW**. Despite being one of the highest volume sites in RT, planning with the classic opposed tangent technique is onerous and time-consuming. While Eclipse can produce inverse-optimized sliding window IMRT, it is missing many features required for high quality breast planning including robust fluence extension for flash, quality field segment delivery, and optimization preserving shielding for heart and lungs. Janky plugins and expensive commercial solutions just don't cut it. Awkward workflows for target delineation, either contour-based or field placement, require extra hand-offs that lead to compromises in plan quality when changes to beam angle or shielding are required upon iteration.

With patient volume increasing and staffing more challenging than ever, the clinic can be a stressful place. Breast planning should not be a total nightmare. It should be **QUICK**, **EASY** and **FUN**. We owe it to our hard-working dosimetrists. They deserve an **UNDO BUTTON.** We can do better and we want to share it with everyone.

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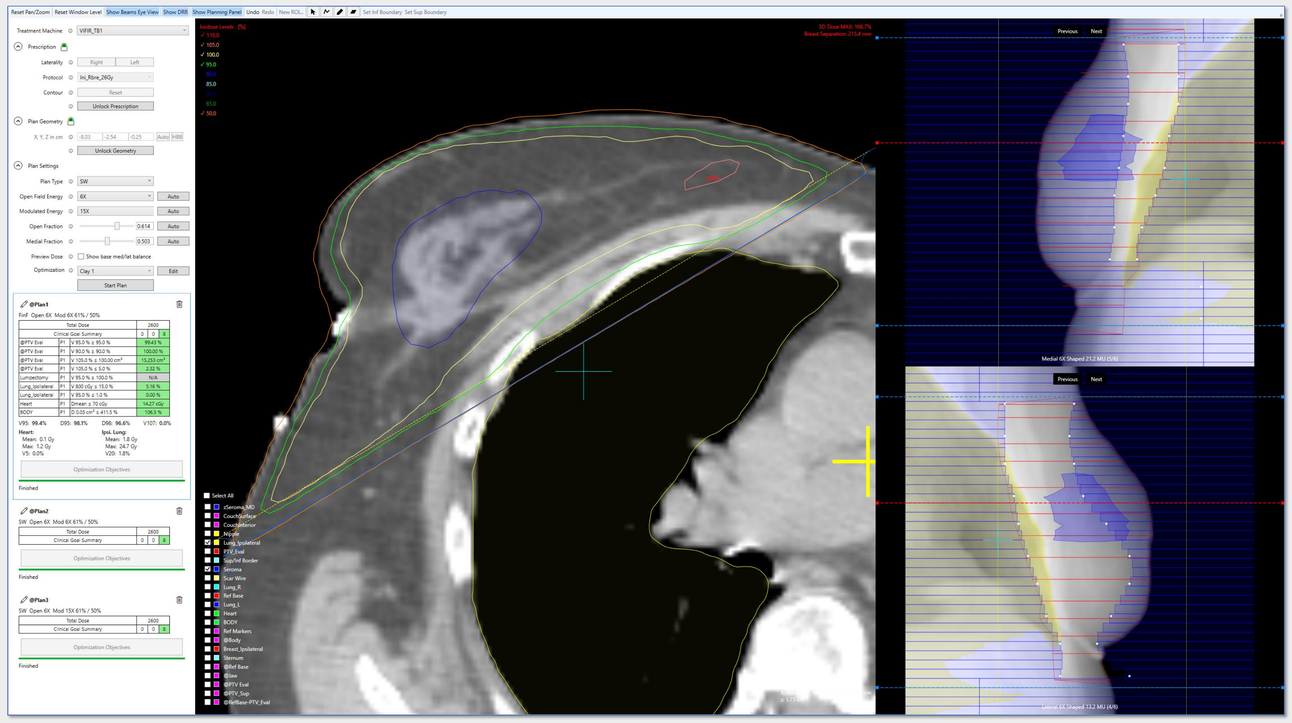
What is BRAP?

BRAP is an open-source, professionally engineered application developed in C# using the Eclipse scripting API. BRAP is launchable as a standalone app, or plugin which is 100% data-backed in Eclipse. Optimization utilizes the Varian Photon Optimizer to generate both sliding window and field-in-field plans.
Features include:

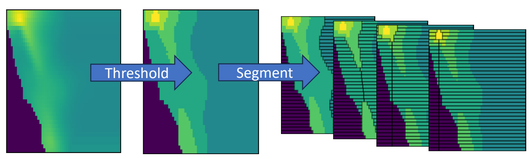
- Contouring GUI for fast field definition
- BEV for aperture-based delineation
- Automated fluence extension for flash
- Automated field setup, energy selection, and field balancing
- Configurable field-in-field LMC
- Seroma auto-segmentation model
- Automated whole-breast field guess
- **Undo/redo functionality**



Field-in-Field LMC

Methods

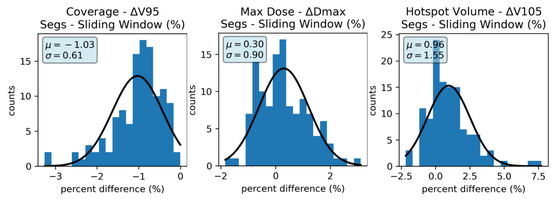
Optimal fluence generated using the Varian photon optimizer was thresholded and discretized into field segments. Smooth leaf adjustments, along with MU's, were then optimized to minimize RMS difference with PO optimal fluence. Resulting segments were corrected for MLC constraints.



A retrospective study of 150 BRAP-generated plans was performed to evaluate plan quality and LMC accuracy. Clinical goals for coverage, hotspots, and OARs were evaluated on sliding window (SW) plans. BRAP generated fluences were then converted to FinF fields via fluence thresholding and tree-search based aperture optimization. Planning metrics compared between FinF and SW plans to assess performance of the LMC.

Results

Conversion of optimal fluences to segments resulted in an average drop in V95% coverage of ~1%, increase in DMax of ~0.3% and increase in V105% of ~1%. The resulting plans, when normalized for equivalent coverage to sliding window plans, all passed clinical goals with a minor degradation in quality consistent with 3rd party segment optimization software.



	Mean	Std.Dev
Mod. MU	-41 %	8.5%
Dmax	+0.3 %	0.9%
V105 %	+1.0 %	1.5%
V95 %	-1.0 %	0.6%
Lung Dmean	-14 %	10 %
Lung V20%	-21 %	16 %
Heart Dmean	-13%	10 %

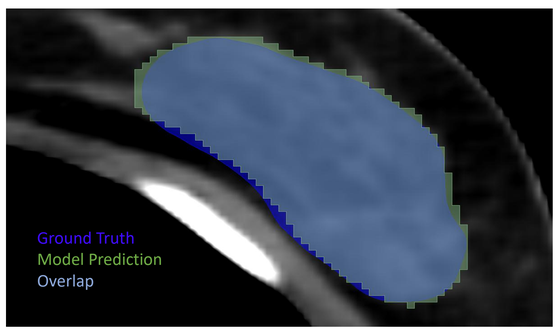
Seroma Auto-Segmentation

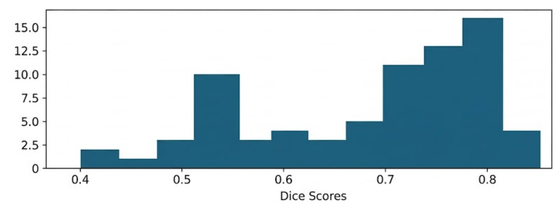
Methods

nnU-Net[1] and 1000 patient breast volumes were used to train a segmentation model to delineate seromas.

Results

DICE scores for 100 test cases ranged from 0.4-0.95. Seromas including surgical clips, and those with proximal scar-wire, yielded significantly improved scores over those without. Resulting volumes serve as a good base guess to guide initial field placement.





CONCLUSIONS

BRAP enables contouring and planning in minutes instead of hours. This software fills missing gaps in Eclipse to make tangent planning quick and easy. Seroma and field auto-guess features provide solid starting points for the integrated contouring GUI. Field-in-field LMC produces quality plans that perform comparably to commercial software.

Future Work

- Open-source release Fall 2026
- Partial breast, mono-isocentric, 5-field, VMAT
- Halcyon & HDMLC support
- Improved seroma model

References

[1] **nnU-Net: Self-adapting Framework for U-Net-Based Medical Image Segmentation** https://doi.org/10.48550/arXiv.1809.10486