

**Purpose:** To perform a comprehensive validation of plans generated on a preconfigured Halcyon 2.0, including evaluations of new features and implementing the PSQA process with multiple detectors.



**Methods:** Ten plans were developed via the AAPM TG-119 test suite with both IMRT and VMAT techniques. Clinically treated plans from 24 patients were re-planned (34 plans) on Halcyon using IMRT and VMAT for a variety of sites including: brain, head and neck, lung, breast, abdomen, and pelvis. Six of those plans were breast VMAT plans utilizing the extended treatment field (ETF) feature available. Another new feature available with Halcyon 2.0, the dynamically flattened beam (DFB), was used for an AP/PA spine and four field box, as well as ten 3D breast plans. All 56 plans were measured with an ion chamber, film, portal dosimetry, MatriXX in a MULTICube phantom, ArcCHECK, and Delta4. Tolerance and action limits were calculated and compared to the recommendations of TG-218.

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**Results:** TG-119 ion chamber and film confidence limits met the limits set by the task group, except for the IMRT target point dose confidence limit. 44 out of 46 clinical plans were within 3% for ion chamber measurements. Average passing rates with 3% dose difference and 2mm distance-to-agreement (global normalization, 10% threshold) for IMRT/VMAT plans were: Film – 96.8%, PD – 99.9%, MatriXX – 91.6%, ArcCHECK – 99.1%, and Delta4 – 99.2%. Calculated action limits were: Film – 86.3%, PD – 98.4%, MatriXX – 71.6%, ArcCHECK – 96.1%, and Delta4 – 95.7%. ETF technique was fully validated and 3D plans with DFB sequence had similar results to IMRT/VMAT plans.

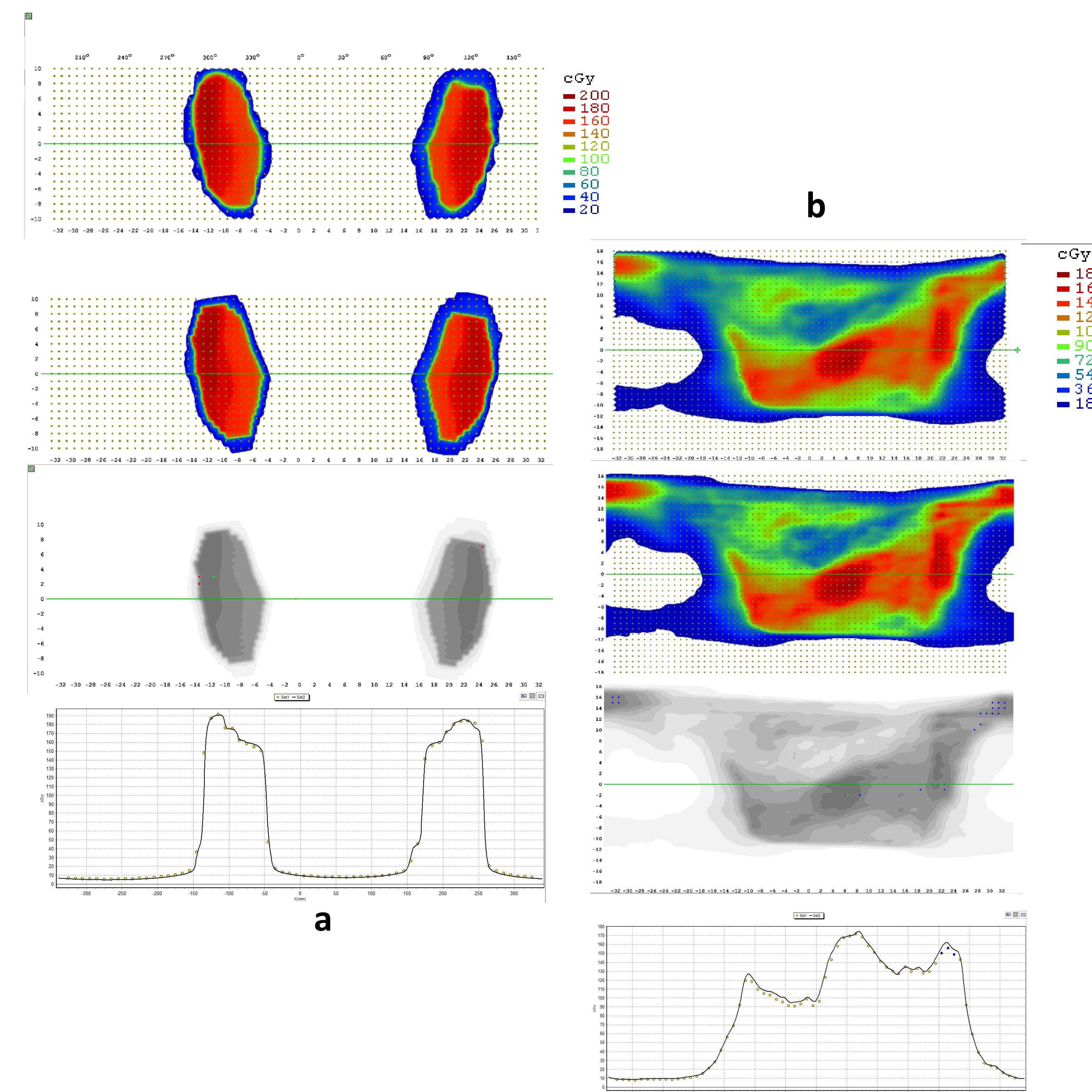


Figure 1: (a) 3D breast tangents using dynamically flattened beam and (b) breast VMAT using extended treatment field measured on ArcCHECK

Table 1: IMRT/VMAT plans 3%/2mm results and calculated tolerance and action limits (as shown in TG-218). IC and film results do not include TG-119 plans.

	IC % diff	Film	MatriXX	Arc- CHECK	Delta4	PD
IMRT	-0.6	98.1	91.2	99.1	99.0	99.8
VMAT	-0.9	96.3	91.9	99.0	99.3	99.9
ALL	-0.8	96.8	91.6	99.1	99.2	99.9
Tolerance Limit		90.3	76.8	96.2	96.8	99.5
Action Limit		86.3	71.6	96.1	95.7	98.4

Table 2: Measured values for plans with DFB fields.

DFB plans	n	IC (%)	MatriXX	ArcCHECK	Delta4	PD
Breast	10	-1.5	89.6	97.3	99.4	100
AP/PA	1	-1.2	87.4	100	96.5	100
4 field box	1	-0.8	90.7	98.6	99.0	100

**Conclusion:** Halcyon plan deliveries including new features, dynamically flattened beam and extended treatment field, were verified with multiple measurement devices. MatriXX results do not include gantry angle correction factors. The process of determining tolerance and action limits flagged the film measurements for extended treatment field plans. From this, it was determined the radiographic film was over-responding due to increased low-energy scatter. After removing those films, the action limit went up from 86.3% to 92.0%.