



# Small Field Dosimetry for RapidArc SRS-SBRT Quality Assurance of the Varian Edge™ Radiosurgery System using Gafchromic™ EBT3 Radiochromic Films

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## Small Field Dosimetry is still a BIG Problem.....

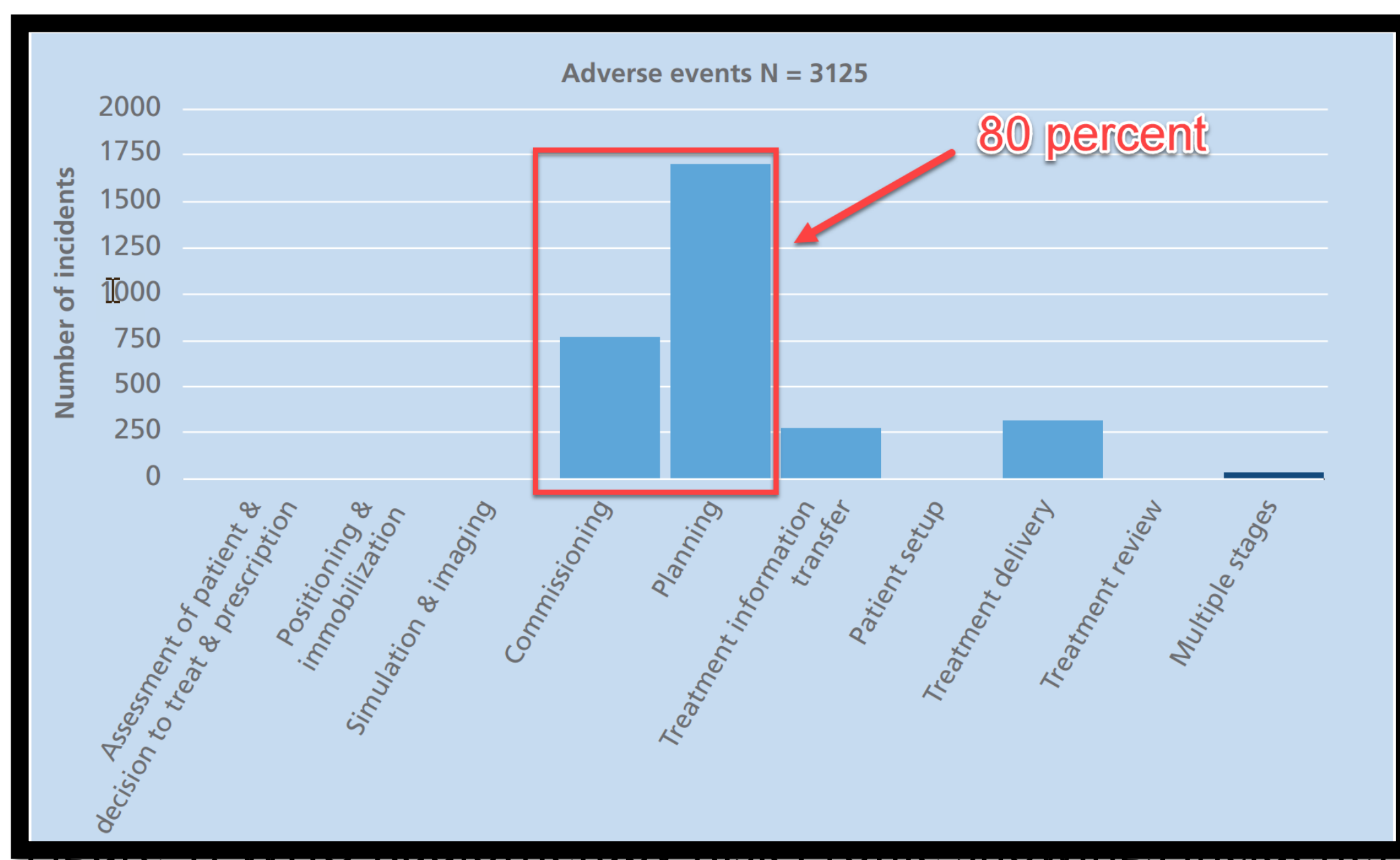
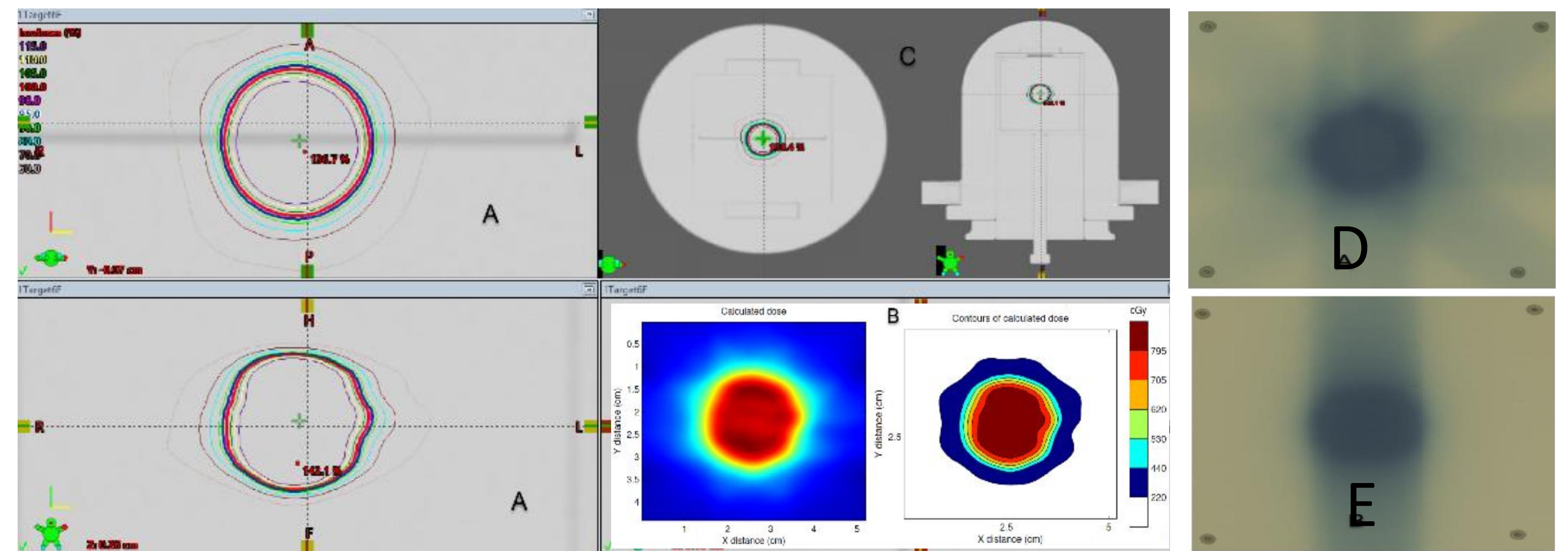


Figure 2. The radiotherapy work process showing adverse events (1976-2007) by the stages of treatment process.

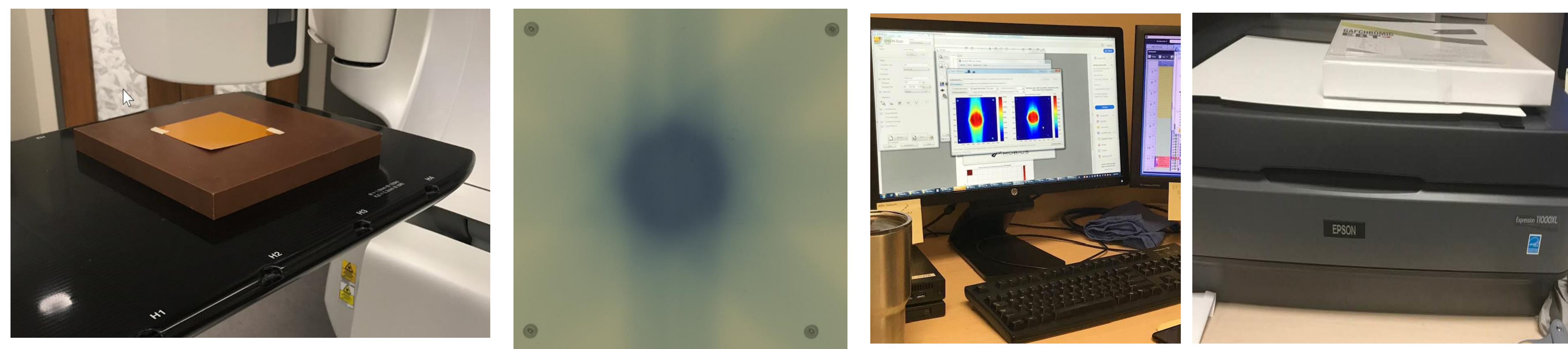
1. Commissioning Errors (25 percent)
  1. Small Field Measurements
  2. Small Field Absolute Dose Calibrations
2. Treatment Planning Errors (55 percent)
  1. SRS/SBRT Cones
  2. Wrong Side/site of treatments
3. Small Field Dosimetry is Still challenging due to:
  1. Occlusion of the direct photon beam source
  2. Drop in output and overlapping penumbræ
  3. Lateral electron disequilibrium
  4. Widening of FWHM of the dose profile
  5. Volume average due to large Detector size

## RapidArc Treatment Planning and Calculated Dose Distribution



RapidArc treatment phantom plans for multiple energies (6 FFF, 6, 10 FFF, 10MV photon beams), single target and multitarget were developed with the Eclipse planning system (TPS). (A) Treatment plans developed on StereoPHAN phantom CT scans using the Eclipse TPS, (B) Calculated dose distributions for a 1Target 6 MV multiarc plan (C) BB target localization on the CT scans (D) and (E) are exposed EBT3 films for 1 target 6X FFF multiarc and 1 target 10 FDCA plans.

## Gafchromic EBT3 Radiochromic Film Calibration and Irradiation



The Correlation curve of Optical Density (OD) vs Absorbed dose (in Gy) is determined through Film Calibration.

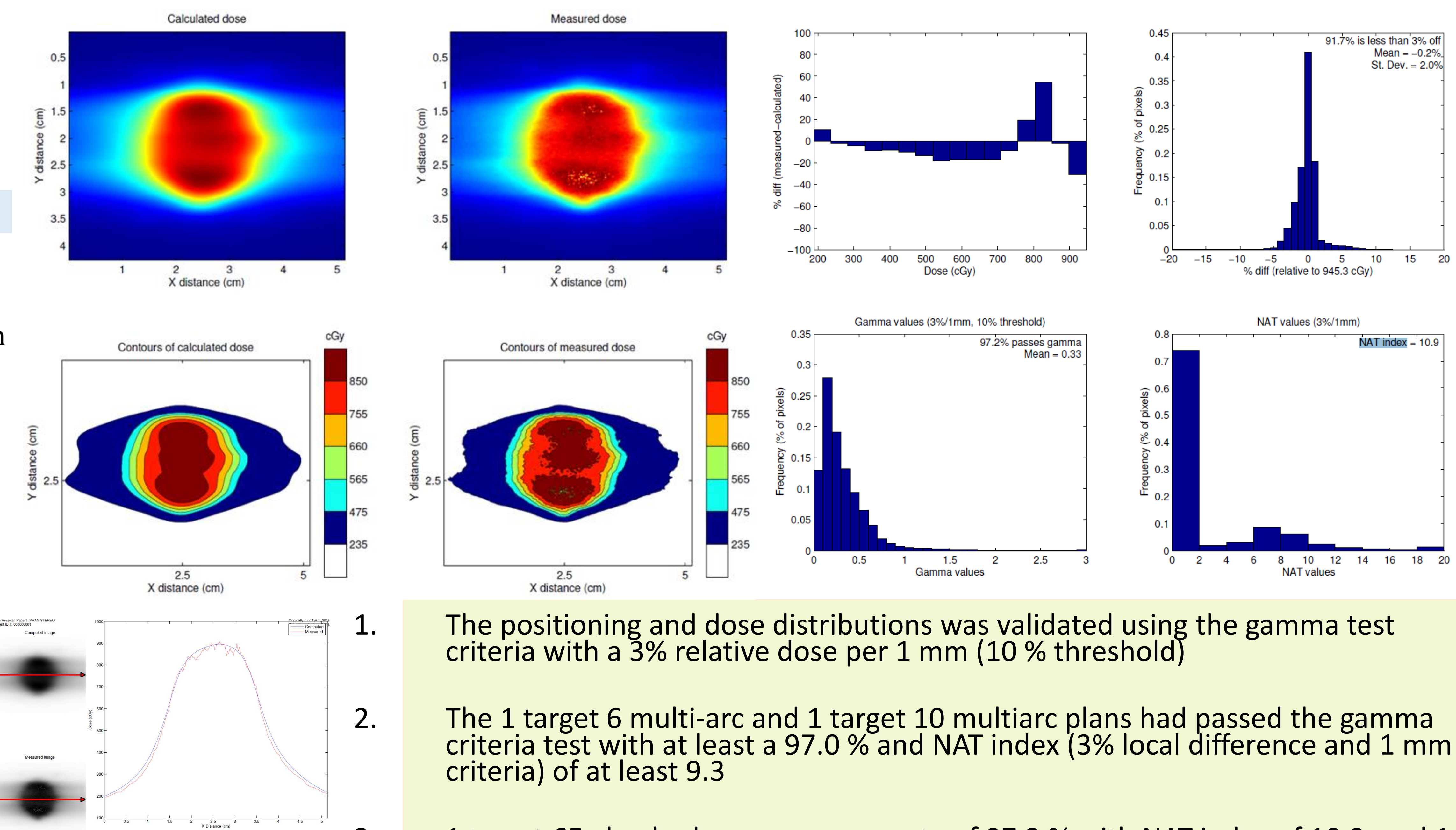
Films were exposed in a solid water phantom (PTW, Freiburg, Germany) composed of 30 × 30 cm<sup>2</sup> with 10 cm of the buildup material above and below the film. The source-to-film distance was 100 cm. Film samples were cut and irradiated perpendicularly to the 6 MV photon beam from a Varian Edge™ Radiosurgery System (Varian Medical Systems, Palo Alto, CA) equipped with Extra-fine 2.5mm MLC at 2400MU/min Dose Rate

## End to End Testing: Phantom Irradiation



The Prepared and unexposed film is scan for bad pixels using Epson 11000 XL flat bed scanner (Seiko Epson Corporation, Owa, Japan) and then inserted into the cube insert inside the stereoPHAN (Sun Nuclear Corp, Melbourne, FL, USA) and the various plans delivered

## Results and discussion



### Selected References:

1. Benedict SH, Yenice KM, Followill D, et al. Stereotactic body radiation therapy: The report of AAPM Task Group 101. Med Phys. 2010;37(8):4078-4101. doi:10.1118/1.3438081
2. Seuntjens J. TH-EF-204-02: Small Field Radiation Therapy: Physics and Recent Recommendations From IAEA and ICRU. Med Phys. 2016;43(6Part47):3893-3893. doi:10.1118/1.4958242

1. The positioning and dose distributions was validated using the gamma test criteria with a 3% relative dose per 1 mm (10 % threshold)

2. The 1 target 6 multi-arc and 1 target 10 multiarc plans had passed the gamma criteria test with at least a 97.0 % and NAT index (3% local difference and 1 mm criteria) of at least 9.3

3. 1 target 6F plan had a gamma pass rate of 97.2 % with NAT index of 10.9 and 1 target 10F plan with a gamma of 98.8 % and NAT index of 5.9.