**Supporting Material: Online dose verification with gafchromic film for fixed-gantry and rotational intensity modulated radiation therapy: a phantom study**

**Background:** The fixed-gantry intensity-modulated radiotherapy (IMRT) and volumetric modulated radiotherapy (VMAT) require the patient-specific quality assurance (QA) measurements to verify the accuracy of the treatment plans, and to determine the possible discrepancies between the prescribed and the delivered doses. However, the patient specific QA is usually performed on a homogeneous phantom prior to the treatment. This type of QA approach does not take into account the patient heterogeneity and the treatment delivery associated uncertainties such as setup error, intrafraction motions and machine related variations [1].

Gafchromic film such as EBT2 has been used for patient specific pretreatment QA in IMRT and VMAT. Compared to the 2D diode or ion chamber arrays, EBT2 film offers very high spatial resolution for dose verification [2]. The purpose of this study is to investigate the feasibility of using EBT2 for online dose verification during the treatment.

**Method and Materials:** An anthropomorphic (Rando) head phantom was immobilized in treatment position with a thermoplastic mask to simulate a real patient. A sheet of gafchromic film (EBT2) was sandwiched between a 1-cm-thick solid water slabs, which was fixed to the Type-S extension, and a patient head hold (a pillow was used in this study). The detail is shown in the Fig.1. The solid water slab used for dose buildup was placed directly under the patient’s head holder. The Rando phantom was set up to mimic the actual patient CT simulation and treatment. The CT images were export to the treatment planning systems (Eclipse, version 8.6.17, Varian Medical Systems, Palo Alto, CA and Pinnacle, v8.0m, Philips Medical Systems, Milpitas, CA). One step-and-shot plan fixed-gantry IMRT plan was generated on Pinnacle planning system, and one RapidArc plan was generated on Eclipse workstation for this patient (Rando phantom). The dose distributions on the film plane were calculated. The two plans were delivered to the phantom in the treatment position on a Varian Trilogy linear accelerator with two new films for dose deposits. The films were scanned, and the measurements were compared with the planned doses.

![Fig.1: The Rando phantom was immobilized in treatment position with a thermoplastic mask to simulate a real patient. A sheet of gafchromic film (EBT2) was sandwiched between a 1-cm-thick solid water slab and a pillow.](image)

**Result:** The composite dose distributions measured on the film plane were the actual delivered dose for the treatment. The data analysis was performed using FilmQA and Matlab softwares. The comparison of the treatment plan dose distribution and the film measurements are shown in Fig.2 (for IMRT plan) and Fig.3 (for RapidArc plan). The measured and the planned dose profiles were in agreement of within 3% in both high dose (>100cGy) and low dose (<50cGy) regions. Using 3mm and 3% criteria Gamma pass rates for the IMRT and RapidArc plan were found to be 95% and 94%,
respectively.

Fig. 2. The dose comparisons for the step-and-shot IMRT plan and the film measurement.

Fig. 3. The dose comparisons for the RapidArc plan and the film measurement.

Conclusions: The phantom study has demonstrated the feasibility of using gafchromic film for online dose verification. This simple method takes into account the patient heterogeneity and the treatment associated uncertainties such as setup error, intrafraction motions and machine related variations. It can be implemented as a physics and/or clinical QA tool. This method is performed during the treatment delivery and no additional machine time is required. Although gafchromic film was used in this study, other QA measurement devices such as diode array or ion chamber array can be easily utilized in the online dose verification.

References: