**Comparison of three Array Calibration Methods of MapCheck for Elekta Beam Modulator**

**Purpose:**
To compare three array calibration methods of MapCheck for an Elekta Beam Modulator LINAC.

**Introduction:**
MapCheck is a 2D Diode array. Before the MapCheck can be used, both an array calibration and a dose calibration need to be performed. The array calibration is to ensure that all diode detectors have a uniform response. The best result can be achieved if the array calibration is performed with the radiation beam used.

In MapCheck array calibration procedure provided by the manufacturer, a field size of 26 x 26cm$^2$ is recommended if it is calibrated at 100cm SSD. It is a challenge to calibrate MapCheck for a limited field size linear accelerator, e.g., an Elekta Beam Modulator with the maximum field size of 21 x 16 cm$^2$. First, the maximum field size of a Beam Modulator LINAC is not only limited but also in a rectangular shape. In treatment plans, the treatment fields are delivered at any collimator angles. Second, the diode detectors have a slight energy dependence and an energy spectrum can be changed by both SSD and field size. It is unclear what the best way is to calibrate the MapCheck array for an Elekta Beam Modulator LINAC.

**Methods:**
We have tested three methods regarding the array calibration of MapCheck for Beam Modulator: 1) calibrate with Elekta Synergy; 2) calibrate with Beam Modulator at an extended SSD (135cm); 3) calibrate with both Elekta Synergy and Beam Modulator, and combine the calibration files.

For the third method, the MapCheck was first calibrated with Beam Modulator at both collimator angle 0 (file 1) and 90 degrees (file 2) at 110cm SSD. Then the MapCheck was calibrated with Elekta Synergy (maximum FS 40 x 40 cm$^2$) using the standard method at 100cm SSD (file 3). The three array calibration files were then combined with proper normalization to generate the final array calibration file. The array calibration files were combined such that it best describes the response of MapCheck detectors to Beam Modulator and all the detectors are covered. The following schematic drawing shows how the final array calibration is generated from the three original array calibrations.

| | | |
|---|---|---|
| ③ | ② | ③ |
| ① | ① | ① |
| ③ | ② | ③ |

①= From BM at Collimator Angle 0

②= From BM at Collimator Angle 90

③= From Elekta Synergy

After calibrating the MapCheck detector array with the three methods, the Gamma Index (Gamma Index < 1) pass rates with a criterion of 3% and 3mm from all the three calibration methods were compared. The null hypothesis is that there is no difference among the 3 methods of array calibration for Beam Modulator.

**Results:**
The pass rates of Gamma Index from the three methods are close to each other. A statistical analysis shows that the null hypothesis cannot be rejected with p-value greater than 0.1.

**Conclusions:**
For the testing cases, no significant difference was found among the three array calibration methods in term of Gamma Index pass rate. The array calibration of MapCheck can be performed in any of three methods in this study for a Beam Modulator LINAC.