

# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM



*Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi*

*Department of Radiation Oncology*

*National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar*

# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

---

## Introduction

NCCCR is amongst the first institutions in Asia and Europe to have the CyberKnife® M6 FIM system (Accuray, Inc., Sunnyvale, CA, USA)

- Fixed Collimators,
- Iris Variable Aperture Collimator and
- InCise™ Multileaf Collimator.



## Purpose

To report the NCCCR commissioning experiences of the CyberKnife M6 InCise™ Multileaf Collimator system.

# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

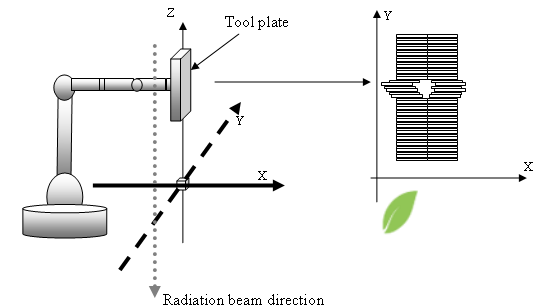
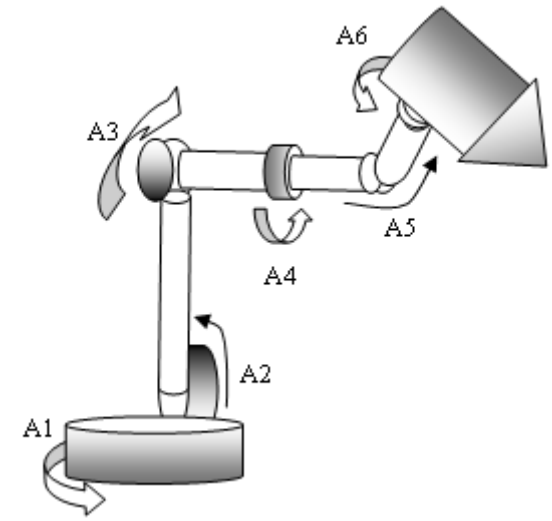
Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

## Materials and Methods

### CK system

- 6 rotational joints with 6 degrees of freedom
  - non-isocentric and non-coplanar treatment beams
  
- LINAC having a precise three dimensional translational movements



# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

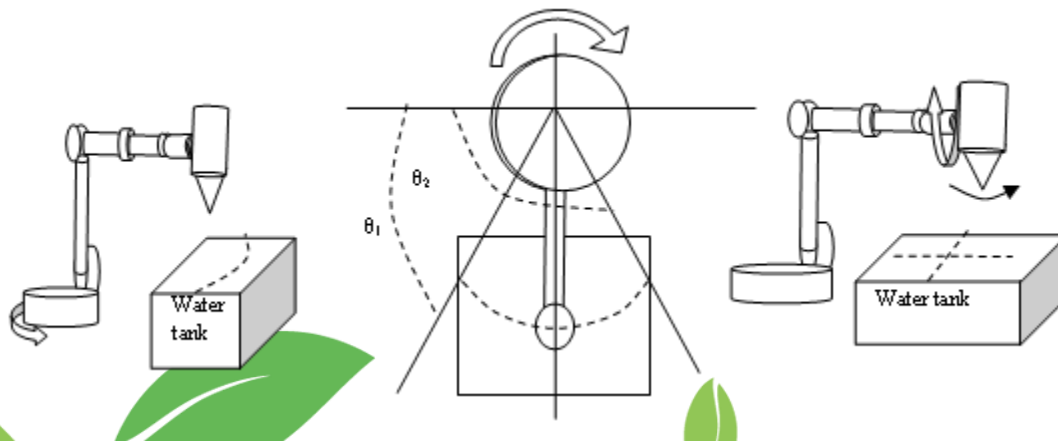
## Materials and Methods

- PTW Freiburg MP3 motorized water tank phantom
- Unidos electrometer (PTW)
- PTW 60018 photon SRS diode (PTW).



### Mechanical check

- LINAC verticality using a cup of water
- Coarse alignment of the LINAC and the water phantom



# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

---

## Materials and Methods

### Beam data collection

- Open Field Profile
- Off Center Ratio (OCR)
- Output Factor (OF)
- Tissue Phantom Ratio (TPR)

### Validation

- Additional measurements for the OCR and OF were conducted using the Sun Nuclear Edge Detector chamber and PTW Unidos-E electrometer.



# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

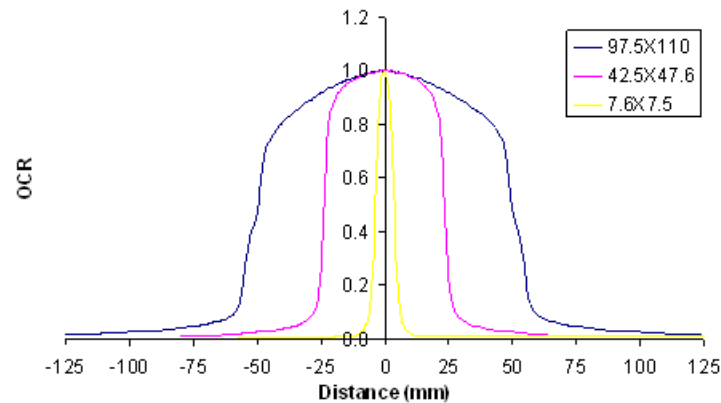
Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

## Results

### Beam data collection

➤ Example of OCR taken at a depth of 100mm for three field sizes.



➤ Variation percentage between our results and those provided by Accuray is 0.19, 0.03, 0.09 and 0.15 mm for depths of 15, 50, 100, 200 and 300 mm respectively.

# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

## Results

### Output factor

| Collimator (mm) | Output factor |
|-----------------|---------------|
| 7.6             | 0.8           |
| 12.6            | 0.91          |
| 17.6            | 0.94          |
| 22.6            | 0.95          |
| 27.6            | 0.96          |
| 32.6            | 0.97          |
| 37.6            | 0.97          |
| 42.6            | 0.97          |
| 47.6            | 0.98          |
| 52.6            | 0.98          |
| 62.6            | 0.99          |
| 82.6            | 0.99          |
| 97.6            | 1             |
| 110             | 1             |

### Tissue phantom ratio

| Depth (mm) | 7.6   | 17.6  | 22.6  | 32.6  | 37.6  | 47.6  | 52.6  | 82.6  | 110   |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|            | X     | X     | X     | X     | X     | X     | X     | X     | X     |
|            | 7.5   | 17.5  | 22.5  | 32.5  | 37.5  | 47.5  | 52.5  | 82.5  | 97.5  |
| 0          | 0.467 | 0.421 | 0.420 | 0.424 | 0.427 | 0.433 | 0.435 | 0.451 | 0.457 |
| 3          | 0.718 | 0.649 | 0.646 | 0.646 | 0.648 | 0.652 | 0.653 | 0.662 | 0.667 |
| 5          | 0.876 | 0.802 | 0.797 | 0.795 | 0.796 | 0.798 | 0.798 | 0.804 | 0.806 |
| 8          | 0.970 | 0.921 | 0.915 | 0.913 | 0.913 | 0.915 | 0.914 | 0.916 | 0.918 |
| 10         | 0.997 | 0.963 | 0.959 | 0.956 | 0.957 | 0.957 | 0.956 | 0.956 | 0.957 |
| 15         | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 20         | 0.984 | 0.999 | 1.001 | 1.003 | 1.004 | 1.006 | 1.006 | 1.005 | 1.006 |
| 50         | 0.842 | 0.873 | 0.882 | 0.894 | 0.900 | 0.908 | 0.912 | 0.924 | 0.930 |
| 100        | 0.651 | 0.683 | 0.693 | 0.710 | 0.717 | 0.731 | 0.736 | 0.763 | 0.775 |
| 150        | 0.502 | 0.535 | 0.544 | 0.561 | 0.568 | 0.582 | 0.588 | 0.618 | 0.635 |
| 200        | 0.391 | 0.422 | 0.432 | 0.444 | 0.450 | 0.462 | 0.468 | 0.497 | 0.514 |
| 250        | 0.311 | 0.337 | 0.345 | 0.356 | 0.361 | 0.371 | 0.376 | 0.401 | 0.415 |
| 300        | 0.248 | 0.270 | 0.276 | 0.286 | 0.291 | 0.299 | 0.302 | 0.324 | 0.338 |

# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

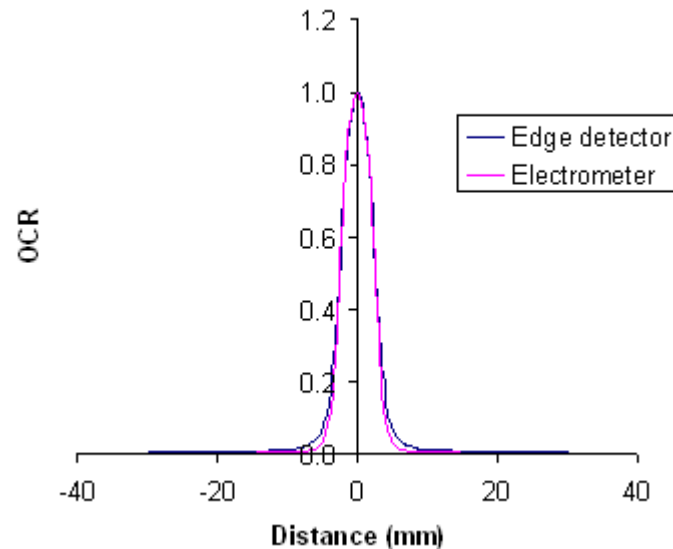
Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

## Results

### Validation

➤ OCR for the fixed 5 mm collimator using edge detector and electrometer



➤ Average of the root mean square deviation between the two detectors is 0.15 mm



# CLINICAL COMMISSIONING OF THE INCISE™ MULTILEAF COLLIMATOR FOR CYBERKNIFE M6™ SYSTEM

Tarek El Kaissi, Tarraf Torfeh, Adam Shulman, Rabih Hammoud, Noora Al-Hammadi

Department of Radiation Oncology, National Center for Cancer Care and Research (NCCCR), HMC, Doha, Qatar

---

## Conclusions

- Our measured data in excellent agreement with the reference data provided by Accuray (within  $\pm 1.5\%$  of the reference data).
  - These results showed that the primary collimator is not centered to neither the fixed collimator nor the MLC.
  - The use of a reference chamber has introduced additional noise for the continuous profiles acquisitions. No reference chamber was used for acquiring continuous profiles.
  - Results presented in this work are amongst the first set of data reported on the InCise™ Multileaf Collimator. These results will be used in order to establish a quality assurance program.
- 