# Feasibility Study for Total Body Irradiation at Short Distance Using Sweep Beams and Attachment Free Compensation

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## INTRODUCTION

- In the most standard treatment for TBI, a patient is set up at extended distance several meters away from the isocenter, which makes the cost for such a big shielded treatment room very high.
- This study aims to explore a possible easy planning technique to make TBI deliverable in most of the standard-size clinics.

## AIM

- To deliver a uniform dose in the total body irradiation (TBI) treatment to a phantom or test patient underneath the gantry.
- Using sweep beams were used as a base, together with attachment free compensation beams, including dynamic wedges and/or partial static arcs.

## METHOD

- A rectangular cuboid human size phantom (width 40cm, thickness 25cm, length 170cm) was created in treatment planning system.

- A CT from an anonymized patient with upper and lower body scans was concatenated to form a full body scan from head to toe.

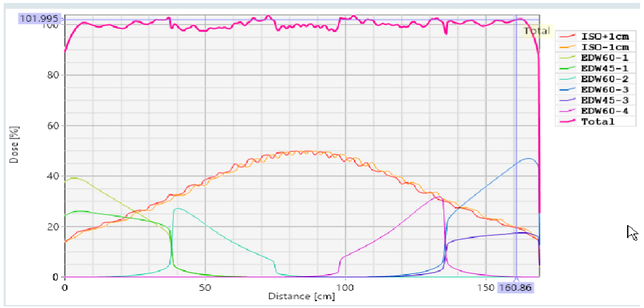
- Test plans using multiple sweep beams and/or dynamic wedges were generated on the phantom and test patient from AP and PA directions.
- The field sizes and relative weighting were adjusted so that the dose to the central axis of the phantom or test patient along the SI direction was within 10% of the prescription.
- The plan sums were created and the dose was evaluated.
- Physical blocks will be used for lung shielding and are not considered in this study.

## RESULTS

- The preliminary feasibility study had been done in the treatment planning system on the **rectangular cuboid human size phantom**.
- using a combination of two sweeping beams and EDW fields of different wedge angles.
- Scheme of AP treatment fields: two sweeping beams with ISOs 2cm apart, four 60 degree EDW fields, including two ins and two outs, and two 45 degree EDW fields (one in and one out), as shown in the following table.

| Field ID | Technique | Field Weight | Gantry Rtn [deg] | Coll Rtn [deg] | Couch Rtn [deg] | Wedge | Field X [cm] | Field Y [cm] |
|---|---|---|---|---|---|---|---|---|
| ISO+1cm | ARC-I | 1.000 | 83.0 CCW 277.0 | 0.0 | 90.0 | None | 40.0 | 40.0 |
| ISO-1cm | ARC-I | 1.000 | 277.0 CW 83.0 | 0.0 | 90.0 | None | 40.0 | 40.0 |
| EDW60-1 | STATIC-I | 0.180 | 310.0 | 90.0 | 90.0 | EDW60OUT | 40.0 | 20.0 |
| EDW45-1 | STATIC-I | 0.130 | 310.0 | 90.0 | 90.0 | EDW45OUT | 40.0 | 20.0 |
| EDW60-2 | STATIC-I | 0.060 | 336.0 | 90.0 | 90.0 | EDW60OUT | 40.0 | 20.0 |
| EDW60-3 | STATIC-I | 0.240 | 52.0 | 90.0 | 90.0 | EDW60IN | 40.0 | 20.0 |
| EDW45-3 | STATIC-I | 0.090 | 52.0 | 90.0 | 90.0 | EDW45IN | 40.0 | 20.0 |
| EDW60-4 | STATIC-I | 0.070 | 26.3 | 90.0 | 90.0 | EDW60IN | 40.0 | 20.0 |

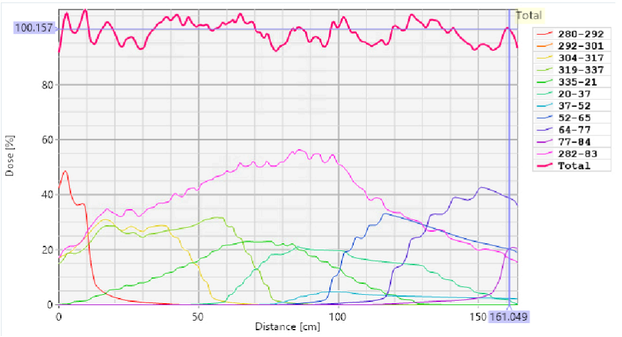
- Along the central axis of the SI direction in the cuboid phantom , the variation of the dose of AP field is shown below.




- The mean, max, min, and stand deviation of the relative dose to the central axis of the cuboid phantom in the **AP field** were 102.1%, 106.5%, 94.4%, and 1.8%, respectively.
- PA treatment was planned in similar way.
- The mean, max, min, and stand deviation of the relative dose to the central axis in the **plan sum** were 102.1%, 105.8%, 94.3%, and 1.5%, respectively.
- The scheme of AP treatment fields to the **full body scan** with full sweeping arc and partial arcs are shown in the following table.

| Field ID | Technique | Machine/Energy | Field Weight | Gantry Rtn [deg] | Coll Rtn [deg] | Couch Rtn [deg] | Field X [cm] | Field Y [cm] |
|---|---|---|---|---|---|---|---|---|
| 280-292 | ARC-I | IUTRILOGY1 - 6X | 1.850 | 280.0 CW 292.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 292-301 | ARC-I | IUTRILOGY1 - 6X | 0.000 | 292.0 CW 301.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 304-317 | ARC-I | IUTRILOGY1 - 6X | 0.280 | 304.0 CW 317.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 319-337 | ARC-I | IUTRILOGY1 - 6X | 0.240 | 319.0 CW 337.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 335-21 | ARC-I | IUTRILOGY1 - 6X | 0.160 | 335.0 CW 21.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 20-37 | ARC-I | IUTRILOGY1 - 6X | 0.130 | 20.0 CW 37.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 37-52 | ARC-I | IUTRILOGY1 - 6X | 0.030 | 37.0 CW 52.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 52-65 | ARC-I | IUTRILOGY1 - 6X | 0.300 | 52.0 CW 65.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 64-77 | ARC-I | IUTRILOGY1 - 6X | 0.610 | 64.0 CW 77.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 77-84 | ARC-I | IUTRILOGY1 - 6X | 1.300 | 77.0 CW 84.0 | 0.0 | 90.0 | 40.0 | 40.0 |
| 282-83 | ARC-I | IUTRILOGY1 - 6X | 0.920 | 282.0 CW 83.0 | 0.0 | 90.0 | 40.0 | 40.0 |

- Along the central axis of the SI direction in the full body scan, the variation of the dose is shown below.




- The average, max, min, and stand deviation of the relative dose to the central axis of the full body test scan in the **AP field** were 99.1%, 107.2%, 91.6%, and 3.6%, respectively.
- The mean, max, min, and stand deviation of the relative dose to the central axis in the **plan sum** were 100.2%, 107.9%, 91.8%, and 4.1%, respectively.
- The mean, max, min, and stand deviation of the relative dose to the central axis of the cuboid phantom in the **AP field** were 102.1%, 106.5%, 94.4%, and 1.8%, respectively.

## CONCLUSIONS

The planning technique of using sweeping beams and/or dynamic wedges to deliver TBI treatment at short distance is promising. The dose calculated to the phantom and test patient is within a reasonable range.

## CONTACT INFORMATION

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