Simplified Enhanced Dynamic Wedge Profile Measurements Using Two Commonly Available Detector Arrays

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Presentation Outline

- **Introduction**
  - What is EDW? Benefits?
  - Previous Related Research
  - The novelty of this research

- **Methodology**
  - Equipment used
  - Setup of the Experiment

- **Results and Analysis**
  - Comparison of data in regards of accuracy
  - Time efficiency of the data collection

- **Conclusions**
Introduction - EDW

1996 Varian implementation of improved version of dynamic wedge
Wedge-shaped dose distribution by sweeping one of the upper collimator jaws
from open to closed position dose rate and jaw speed is constantly changing
A single pre-defined golden segmented treatment data STT data is provided by
the vendor for each photon energy

Advantages:

- Many different combinations of FS and wedges
- Reduction of peripheral dose
- No beam hardening effect
- Reduction of workload of the therapists
- Reduction of the treatment time of the patient
- Minimizing the skin dose to the patient

Introduction – Previous Research

6, 10 MV, 5, 10, 15 cm depth
FS - 5,10,15,20 cm²
IF – 2%, P - 2mm

6 and 18 MV, 15 cm depth
FS - 5,10,15, 20 cm²
2.8% difference with Eclipse

15 MV, dmax, 5, 10 & 20 cm
FS - 4x4, 10x10, 15x15,20x20 cm²
EPID focus 100 cm, CA 24 - 5%

6, 10 MV, 4,6,8,10,12,16,20 cm²
Dmax, 5,10, 20 cm
IF - 5%, M- 10% 60°, 20 cm
> 20% for larger angles and deeper 15 cm

15 MV, Dmax, 5, 10, 20 cm
5x5, 10x10, 15x15 cm²
IF: 2.5%, M-4.5%, 5cm, 15x15,45°
OF: 2%, M-3.6%,5cm, 15x15,60°
P: 12%, M-26%,20 cm15x15, 60°

15 MV, dmax, 5, 10 & 20 cm
4x4, 10x10, 15x15,20x20 cm²
4% difference with TPS

2. Gossman M S. et al. Med Dosim 2007;32(3);211-215
5. Fontanarosa D. et al. Med Phys 2009;36(10),4504
Introduction – Novelty

- Utilizing the Largest Field Size
- Comparison of ion chamber and diode array
- Time analysis of various methods
## Methodology - Equipment

### Varian Truebeam
- 6, 10 and 18 MV
- Largest FS 30x30 cm²
- Dmax, 5, 10 & 20 cm
- 200 MU
- LDA99 SSD = 100 cm
- Arrays SSD = 78 cm

### Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>LDA-99</th>
<th>IC Profiler</th>
<th>MapCheck 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Detectors</td>
<td>Hi-pSi diode</td>
<td>Modified PP IC</td>
<td>SunPoint Diode</td>
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<tr>
<td>Number of Detectors</td>
<td>99</td>
<td>251 (x-63, y-63)</td>
<td>1527</td>
</tr>
<tr>
<td>Detectors Spacing</td>
<td>5 mm (min 1 mm)</td>
<td>5 mm</td>
<td>10 mm (min 5 mm)</td>
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<tr>
<td>Size of Detector</td>
<td>2.45mmx2.45 mm</td>
<td>Width 2.9 mm</td>
<td>0.64 mm x mm</td>
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<tr>
<td>Field Size</td>
<td>40 cm</td>
<td>32x32 cm²</td>
<td>32.0x26.0 cm²</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>35 Gy/nC</td>
<td>14.4 nC/Gy</td>
<td>32.0 C/Gy</td>
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<tr>
<td>Effective Pond of Measurements</td>
<td>&lt;0.1 mm</td>
<td>0.9 cm</td>
<td>2.0 ± 0.1 g/cm²</td>
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</table>
Methodology – Experimental Setup

**Varian Truebeam**
6, 10 and 18 MV, 30x30 cm², Y2 out

**LDA 99:** 0.5 cm resolution
(1 run, no couch shift)

**IC Profiler:** 0.5 cm resolution
(1 run, no couch shift)

**MapCheck 2:** 1 cm resolution
(2 runs, couch shift - 0.5 cm)
0.5 cm resolution after the couch shift
Results – Profile Comparison

18 MV 5 cm depth

LDA 99 vs IC Profiler

LDA 99 vs MapCheck 2

Tatsiana Reynolds  04/17/2015
### Results - Accuracy

#### In Field (within 80% of FS), 5 cm depth

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<th>LDA 99 vs IC Profiler</th>
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<td></td>
<td>10°</td>
<td>15°</td>
<td>20°</td>
<td>25°</td>
<td>30°</td>
<td>45°</td>
<td>60°</td>
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<tr>
<td>6 X</td>
<td>-0.49</td>
<td>-0.49</td>
<td>-0.50</td>
<td>-0.47</td>
<td>-0.54</td>
<td>-0.34</td>
<td>-0.38</td>
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<td></td>
<td>3.15</td>
<td>3.18</td>
<td>3.05</td>
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<td>2.85</td>
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<td>-0.30</td>
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<td>-0.38</td>
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<tr>
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<th>LDA 99 vs MapCheck 2</th>
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<td>60°</td>
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<tr>
<td>18 X</td>
<td>0.14</td>
<td>0.22</td>
<td>0.30</td>
<td>0.24</td>
<td>0.17</td>
<td>0.18</td>
<td>0.31</td>
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<td>2.52</td>
<td>2.63</td>
<td>2.50</td>
<td>2.48</td>
<td>2.12</td>
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# Time Efficiency

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</table>
| **Initial Setup & Break down** | 150 min\(^1\)  
90 min – BP, 60 min–LDA99 | 5 min                                     | 5 min                                     |
| **Data acquisition time** | 180 min  
15 min (7 A) x 3 E x 4 D               | 180 min  
15 min (7 A) x 3 E x 4 D                | 360 min  
2 x 15 min (7 A) x 3 E x 4D             |
| **Additional Setup Time** | 10 min                                      | 36 min  
3 min x 3 E x 4 D                      | 36 min  
3 min x 3 E x 4 D                      |
| **Data Analysis & Conversion** |                                             |                                           |                                           |
| **Total Time**            | 400 min                                     | 473 min                                    | 905 min                                   |

Conclusions

<table>
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<tr>
<th></th>
<th>In Field</th>
<th>Penumbra</th>
<th>Out of Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDW(^1,2)</td>
<td>4 %</td>
<td>3 mm or 15%</td>
<td>5 %</td>
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</tbody>
</table>

- **IC Profiler as accurate as LDA 99**
- **Most clinics don’t have LDA but have some other type of array detectors**
- **Overall, time expenditure is a slightly less with LDA (assuming user proficiency)**
- **But, LDA 99 requires more machine time than array detector**
- **The data conversion could be automated, hence, decreasing the time for data analysis and conversion with the array detector**

Questions???