



### An overview of TG-180:

#### Image Guidance Doses Delivered During Radiotherapy

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2016 AAPM Annual Meeting, SAM Therapy Educational Course,  
TU-B-201-1, Walter E. Washington Convention Center, Room 201, 8:30AM - 9:30AM, August 2, 2016

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### TG-180: Image Guidance Doses Delivered During Radiotherapy: Quantification, Management, and Reduction

Members

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Bruce Curran  
Ryan Flynn  
Michael Gossman  
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X. George Xu  
Timothy Zhu

Consultants

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### AAPM TG-180

- provides typical image doses resulting from different modalities
- recommends a **dose threshold** beyond which imaging dose be accounted for: **5% of therapeutic target dose**
- reviews available techniques for reducing the dose to organs at risk
- provides guidelines for imaging dose dosimetry
- gives guidelines and methods for imaging dose calculations
- describes methods of accounting for imaging dose when it is needed
  - Patient specific imaging dose calculations,
  - Non-patient specific imaging dose estimations

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### Dose from Different Imaging Modalities

- Megavoltage beam imaging
  - 2D: portal images
  - 3D: MVCT, MV-CBCT
- Kilovoltage beam imaging
  - 2D: digital radiograph
  - 3D: kV-CBCT

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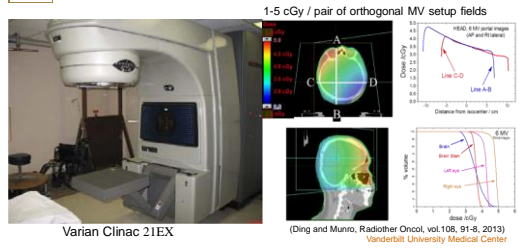
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### Electronic Portal Imaging Device (EPID)




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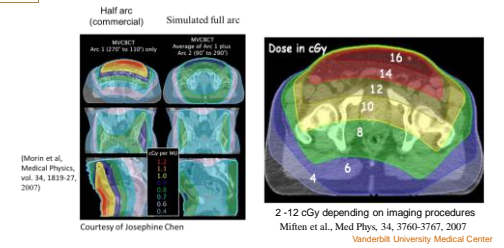
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### Dose to patients: from MV-CBCT




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### MVCT on Tomotherapy unit



Tomos MVCT dose at the center of a 30 cm water phantom dependency on acquisition protocols

| MVCT in Tomo                            |            |
|---|------------|
| Acquisition mode                        | Dose (cGy) |
| Fine pitch (firm couch<br>inversion)    | 2.5 cGy    |
| Normal pitch (firm couch<br>inversion)  | 1.2 cGy    |
| Coarse pitch (120cm couch<br>inversion) | 0.8 cGy    |

Courtesy of Edward Chao, Accuray Incorporated and T. Rock Mackie, UW, Madison, WI

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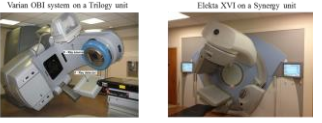
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### Other Imaging Modalities



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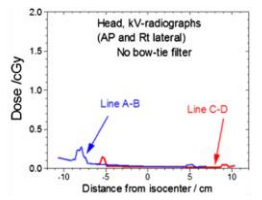
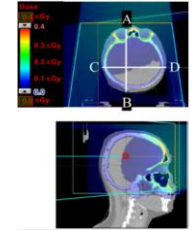
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### Head imaging dose from a pair of kV radiographs (OBI system)



(Ding and Munro, Radiother Oncol, vol.108, 91-8, 2013)

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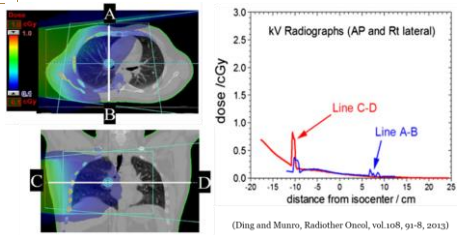
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**Chest imaging dose from a pair of kV radiographs (OBI system)**




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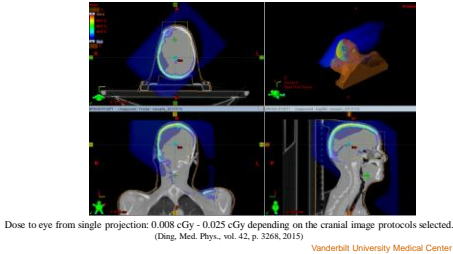
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**Head imaging dose from a pair of kV radiograph (ExacTrac System)**




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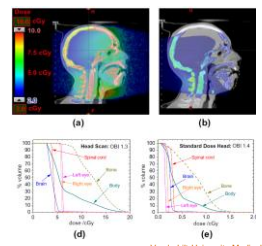
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**Head imaging dose from kV-CBCT**

**OBI 1.3 vs 1.4  
Dose differences  
in Head scan**

(Ding et al., Radiother Oncol, vol.97, 585-592, 2010)




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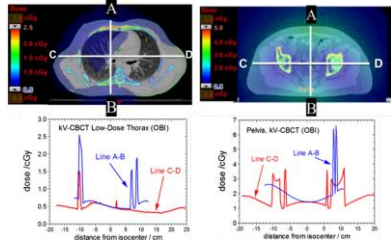
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### Chest and pelvic imaging dose from kV-CBCT



(Ding and Munro, Radiother Oncol, vol.108, 91-8, 2013) Vanderbilt University Medical Center

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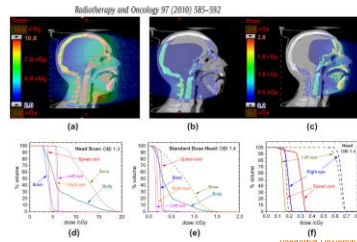
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### Techniques to reduce imaging dose: software upgrade



Radiotherapy and Oncology 97 (2010) 585-592 Vanderbilt University Medical Center

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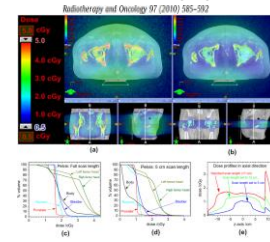
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### Techniques to reduce imaging dose: imaged volume



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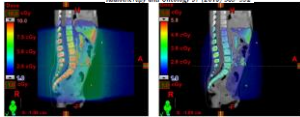
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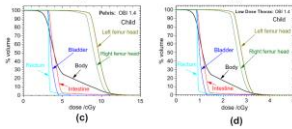


Techniques to reduce imaging dose: select low dose protocol

Vanderbilt University Medical Center, October 30, 2010, 355-367



The image dose can be further reduced by selecting "Low Dose Head" kV-CBCT scan protocol in OBI 1.4 if the diameter of imaged volume is < 25 cm.

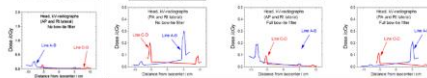
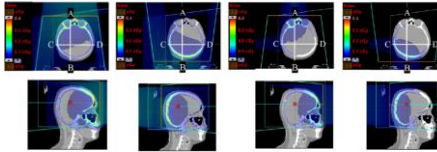


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Techniques to reduce imaging dose: select beam entry angle

Radiotherapy and Oncology 108 (2013) 91-98



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Methods to account for the imaging doses

- Patient specific imaging dose calculations
  - Individual patient CT based imaging dose calculation
  - Accurate organ dose calculations from imaging procedures
- Non-patient specific imaging dose estimations
  - Estimate organ doses from tabulated values based on imaging procedures
  - Dose uncertainty is acceptable

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### Summary of imaging dose

#### MV imaging:

- EPID: 1 - 5 cGy /pair of orthogonal portals
- MVCT (TOMO): 1 - 3 cGy typical
- MV-CBCT: 2- 12 cGy typical

#### kV imaging:

- kV DR: 0.1 - 1.0 cGy /pair of orthogonal beams
- kV-CBCT: Soft tissue: 0.1 - 3 cGy /acquisition Bone: 0.3 - 6 cGy /acquisition
- kV-CBCT(4D): differs from (3D), depends on protocol used

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### Recommendations

#### - ALARA principle should be applied:

- Create local imaging protocols with image modality and techniques
- Develop protocols that are specific for pediatric patients
- Physicists should communicate to the physicians that imaging doses are being delivered to patients
- Use available techniques to reduce dose to organs at risks
- Consider the type of imaging needs (2D vs. 3D).
- kV-imaging dose is much lower than MV imaging dose

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### Recommendations

#### - 5% of the target dose to be the threshold beyond which imaging dose should be accounted for

#### - Methods to account image dose if it is needed:

- Patient specific imaging dose calculations,
- Non-patient specific imaging dose estimations

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Next two talks:

**Parham Alaci, PhD**

Accounting for kV imaging dose

**Ryan Flynn, PhD**

Accounting for MV imaging dose and the future of MV imaging

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