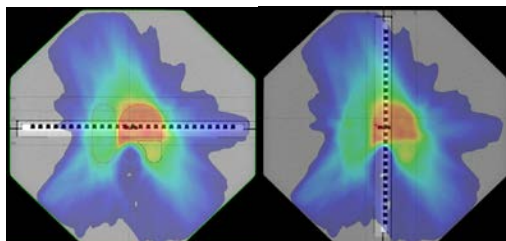


Effective and efficient radiotherapy dosimetry audit: Where to next?

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Dosimetry audit

- Important role in the quality and safety of radiotherapy both for established and new technologies and techniques.
- Helps to reduce delivered dose variability and is mandatory in many multi-institutional trials.
- National and large scale audits are able to:
 - set, maintain and improve standards
 - identify issues which may cause harm to patients



Dosimetry audit

- Support implementation of complex techniques
- Benchmark centres with similar equipment
- However they can also be costly and time consuming
- Important that:
 - design is efficient and effective
 - groups work together to maximise the benefit to the user.

Challenges in dosimetry audit

- Ever expanding horizon: new techniques, new equipment, do the same things still need auditing in the same way?
- Different types of audit have different advantages and disadvantages. What is appropriate for what we need to do?
- Very little or no funding
- What is it we actually need to check?
 - IROC review of poor performance indicators
 - Carson et al Med Phys Dec 2016





ESTRO support for dosimetry audit

- Strategy review identified as an important topic
- Workshop at ESTRO office in January 2017
- Discussion of future of dosimetry audit
- Role ESTRO could play to support

Attributes of ideal dosimetry audit

- Provides 3D dose distribution with high spatial resolution
- In a patient-like geometry/ medium
- Follow patient radiotherapy care-path
- Efficient (*easy to use the equipment/ requires minimum time/ automated?*)
- Real time results
- Cheap (*manpower/ equipment*)
- Independent
- Relevant



Approaches to dosimetry audit

- Postal
 - Suitable phantoms
 - TLD/OSLD/alanine/film
 - Local chamber
- Site visit
 - More complex phantoms
 - Arrays
 - Discussion
- Remote
 - Collect local planned and delivered data



Traditional detectors and phantoms

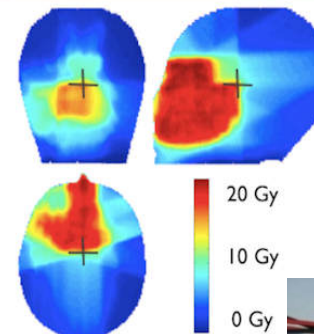
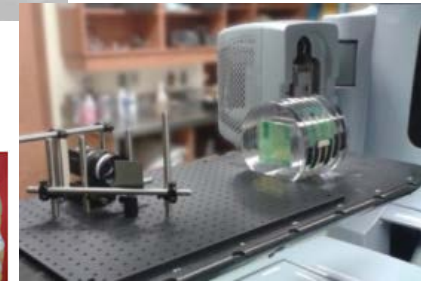
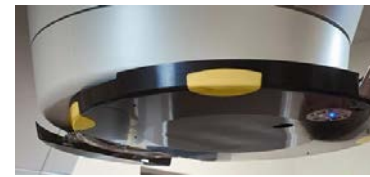
- TLD, OSLD, alanine, film
- IC, semiconductors, MOSFETs
- Wet or solid water or plastics
- Commercial anthropomorphic



Alternative detectors



- Pre-treatment QA devices
- On line dose monitoring devices
- Scintillators
- Portal image devices
- Gel dosimetry
- Graphite calorimetry



Alternative phantoms

- 4(5?)D phantoms
- 3D printing

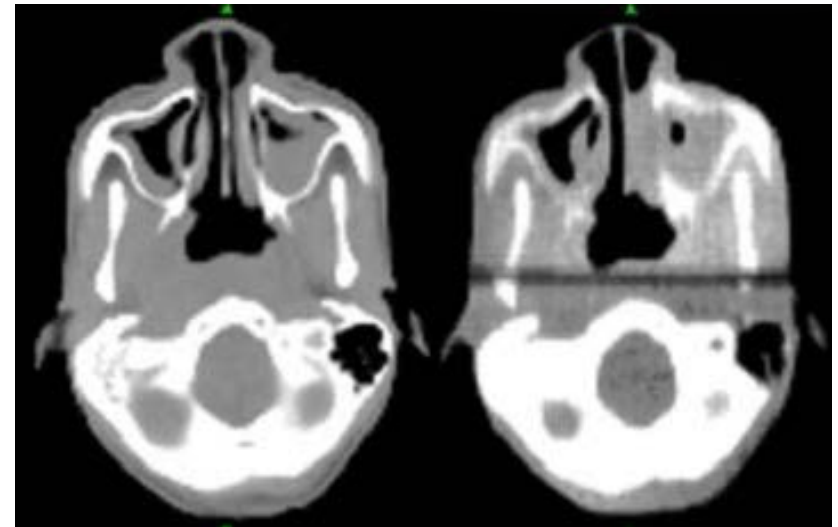


Dynamic Thorax phantom, CIRS Inc.



3D model

Phantom



Patient CT

Phantom CBCT

Virtual methods for audit

- Could we check the plan and/or delivery remotely?
- Could the centre make the measurements themselves?
- How could this maintain independence?
- Efficient (cheaper)?
- As effective?





Virtual methods: Auditing the plan

- How good is the plan?
- Does it achieve what we want?
- Could it be (even) better?
- How should we rank plans?
- Against clinical constraint goals achieved?
 - Usual answer Yes/No (binary)

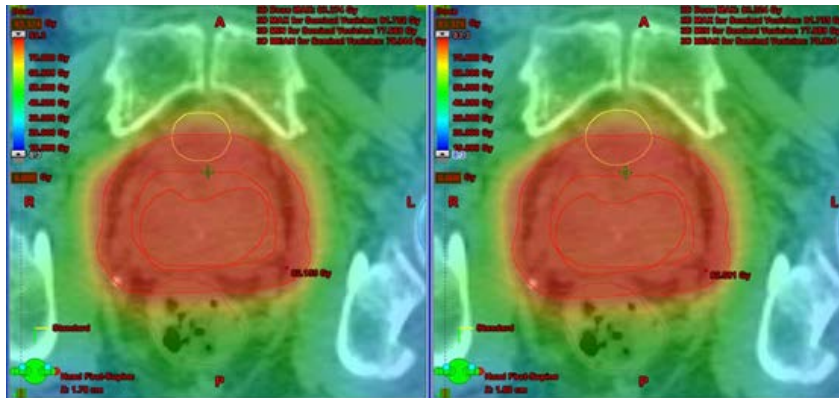


Virtual methods: Auditing the plan

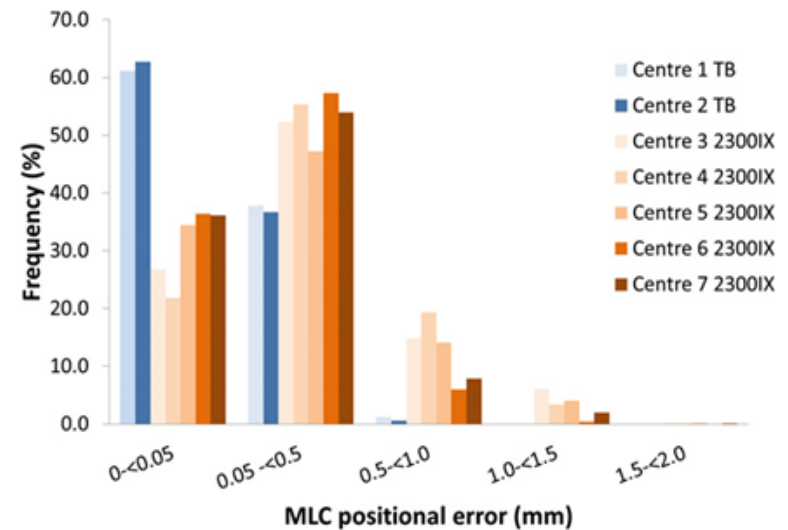
- Plan quality depends on more than DVHs
 - plan complexity, robustness and deliverability.
- In depth plan analysis can provide useful information in comparisons, especially when multiple vendors are involved.
- Plan analysis could be incorporated in dosimetry audits and also in clinical trials.
- Identify plans which need measurement

Virtual methods: Auditing the delivery

- Log files
- Recording data – MLC, jaws, dose, gantry.....
- Delivery performance
- Actual dose recalculation



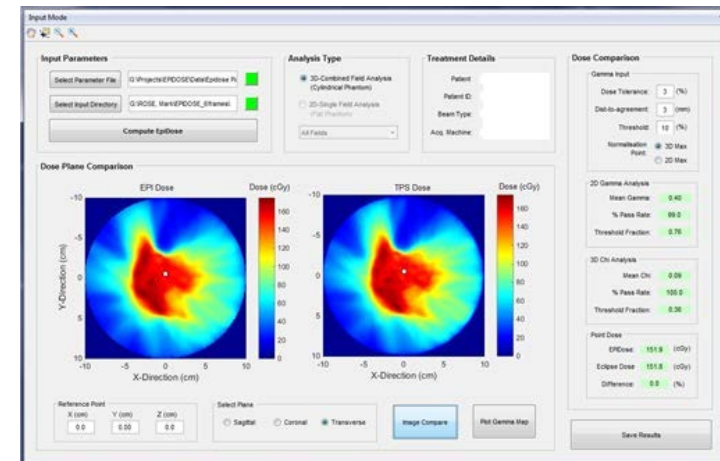
Schreibmann et al. Med Phys 2009



McGarry et al. BJR 2016

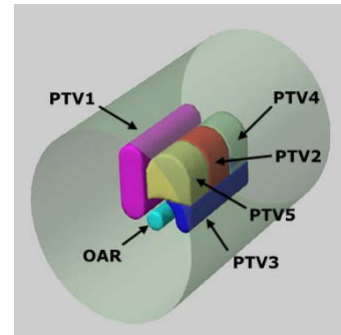
Virtual delivery methods: EPID

- eg VESPA Greer et al. ESTRO 2017
- TPS and EPID data transferred to audit group for dose reconstruction on virtual phantom comparison
- Planar or cylindrical virtual phantoms
- TPS dose vs dose reconstruction
- Proposed for a remote auditing method



Virtual methods: Virtual / local phantoms

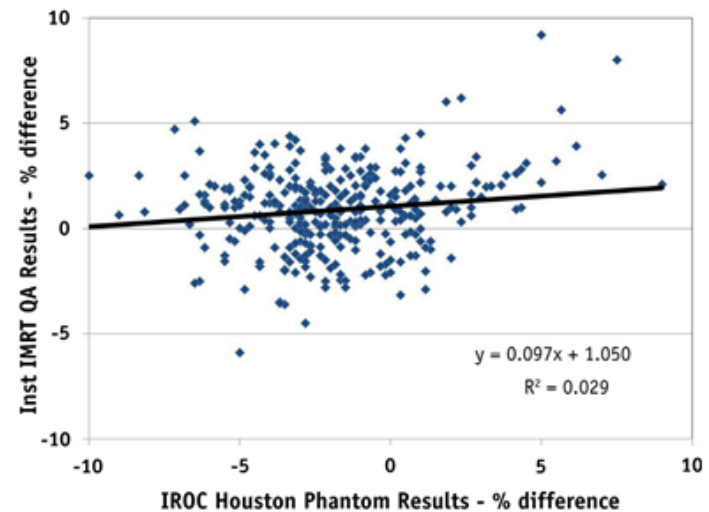
- Virtual phantom
- Local QA
- Weber et al 2014: EORTC “virtual phantom project” in-house QA vs. RPC anthropomorphic audit phantom
- Kry et al 2014: Institutional patient-specific IMRT QA does not predict unacceptable plan delivery



3DTPS test



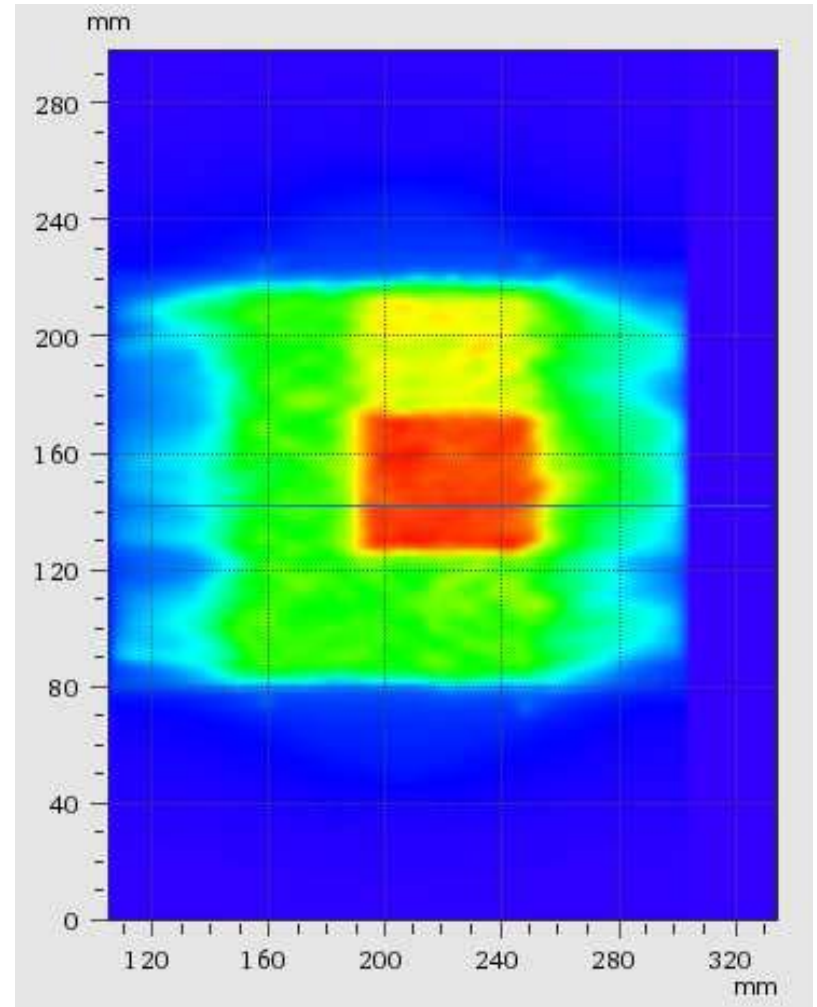
Octavius II & 2D Array
Hussein et al. RO 2013



Kry et al. IJROBP 2014

Virtual dosimetry audit: intercomparison

- Calculated 'measured' dose distribution
- Comparison of 6 international clinical trial QA groups
- Aim towards mutual understanding and acceptance



Hussein et al ESTRO 2017

How could ESTRO support dosimetry audit?

- Guidelines / recommendations for setting up audits in collaboration with IAEA
- Sharing solutions developed by members
- Support large scale participation in testing tools for auditing
- Help lobby EU regarding auditing need in RT - quality



Next steps

- Future workshop
 - November 17th-18th Glasgow
 - Special issue of Physics and Imaging in RO
- Task force
 - Aim of further exploring how ESTRO could contribute to this important field.
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