Performance-based QA for Radiotherapy: TG 135
QA for Robotic Radiosurgery

Sonja Dieterich, Ph.D
Stanford University
- Chair, AAPM TG 135
Status of TG 135

- Writing cut-off for final editing in Oct 2008
- Original Draft submitted to AAPM Quality Assurance Subcommittee (QASC) for ASTRO 2008
- Revised Draft submitted to QASC in early July
- At the time of submitting this slide: ...
- Review by TPC, comments from Professional Council
- Submission to Medical Physics
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  - Robot & Room
  - Accelerator
  - Software
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  - Overall Accuracy (all subsystems)
- Summary & QA tables
TG-135 does not contain:

- Instructions for commissioning
- Recommendations on specific detectors
- Recommendations on technology implemented widely in clinics after October 2008

TG-135 is:

- A fast-track TG giving basic recommendations until switching to TG-100 style QA
- Pointing out areas where we need to develop QA
QA for Individual System Components: Accelerator

- Obvious differences to regular linac:
  - No flattening filter
  - Fixed & IRIS collimators
  - X-band
  - No bending magnet
- QA is straightforward, follow TG-40, TG-42 and TG-45
- Small field dosimetry (to be found in TG-155):
  - Practical Aspects of CK Small Field Dosimetry, WE-213A-2, 4pm, Room 213A
QA for Individual System Components: Software

- TG-53 gives excellent guidelines
- CK software is integral part of system
- Topics not covered by TG-53:
  - Data security: who can change data, and how?
  - Custom CT density model
  - Checking accuracy of inhomogeneity calculations
    - With ray-tracing algorithm
    - With MC
- Patient or patient-like QA (more later)
QA for Individual System Components: Imaging System

- Stability of Geometry
- Generators and Sources
- Amorphous Si detectors
- Patient dose from image guidance (TG-75)

### Table 1: Imaging System Related Quality Assurance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Tolerance</th>
<th>Suggested Frequency</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtration</td>
<td>First Half Value Layer</td>
<td>≈ 21 CFR, 1020.30</td>
<td>Annually</td>
<td>AAPM Report 14, Part 3, page 85; AAPM Report 74, Section 5.2.1</td>
</tr>
<tr>
<td>kVp Accuracy</td>
<td>Non-Invasive kVp meter</td>
<td>+/- 5% or = or better than manufacturers specifications</td>
<td>Annually</td>
<td>AAPM Report 74, Section 5.3.1</td>
</tr>
<tr>
<td>mA Station Exposure Linearity</td>
<td>Diagnostic Ionchamber</td>
<td>Adjacent mA stations within +/- 20%</td>
<td>Annually</td>
<td>AAPM Report 74, Section 5.3.3; AAPM Report 14, Part 3, p 84</td>
</tr>
<tr>
<td>Exposure Reproducibility</td>
<td>Diagnostic Ion chamber</td>
<td>Coefficient of variation &lt; 0.10</td>
<td>Annually</td>
<td>AAPM Report 74, Section 5.3.3; AAPM Report 14, Part 3, p 84</td>
</tr>
<tr>
<td>Focal Spot Size</td>
<td>Slit Camera or star pattern</td>
<td>NEMA Standard XR 5-1992 (R1999)</td>
<td>At ATP then as required</td>
<td>NEMA Standard, AAPM Report 74, Section 5.2.6</td>
</tr>
<tr>
<td>Imager Position Reproducibility</td>
<td>Isopost tip</td>
<td>+/- 2 pixels</td>
<td>Quarterly</td>
<td>Accuracy test procedures in conjunction with field service</td>
</tr>
<tr>
<td>Bad Pixel Statistics</td>
<td>Accuracy Field Service</td>
<td>Bad Pixels less than max limit, number and position</td>
<td>Quarterly</td>
<td>Accuracy test procedures in conjunction with field service</td>
</tr>
<tr>
<td>Other predictive Imager Tests, SNR, CNR, Gain Stability</td>
<td>To Be Determined</td>
<td>Reproducible</td>
<td>Monthly, TBD</td>
<td></td>
</tr>
</tbody>
</table>
Which image artifacts have what effect on tracking algorithm?

QA is usually done in good alignment – SHIFT your E2E phantom!

Phantoms are easier to track than patients
QA for Integrated Systems: Imaging/Software

- Essential to ensure accuracy of image guidance
- Available Resources:
  - Reports #14 and #74 of TG 12 on diagnostic imaging QA
  - AAPM TG 75
- Obvious challenges:
  - Training in diagnostic imaging QA
  - Availability of diagnostic tools
  - No manufacturer recommendations
- That we do not know how to do it now does NOT mean we can ignore the issue!
QA for Integrated Systems: Accuracy of Radiation Delivery

1. Robot Mastering (by manufacturer)
2. 1\textsuperscript{st} order: uses beam laser on isocrystal
3. 2\textsuperscript{nd} order: fine-tunes 1\textsuperscript{st} order calibration
4. Commissioning document specifies <0.5mm average rms error per path (~40 nodes)
5. Robot pointing has been shown to be stable by repeated use of srch2 for up to 2 years (longer data not available)
6. Problems:
   - laser as a substitute for beam (SU-FF-T-299)
   - Calibration check to users except visual BB check
Overall System QA: Patient-Specific/Like QA: Why?

- It is the only non-isocentric QA test
- It tests all aspects of technical delivery
- Develop pass/fail criteria:
  - What is your case mixture: trigeminals, prostates ...
  - RTOG protocols for SRS/SBRT are good guidance
  - Your own expectations
- AND it tests your complete clinical process
Overall System QA: Patient-Specific/Like QA: How?

Take anthropomorphic phantom and run a mock treatment, including all processes:

1. RTT does simulation
2. Plan non-isocentric
3. In “Patient” mode
4. Have MD approve
5. Do documentation
6. Have RTT treat
7. Analyze film (gamma-index)
This is Overall System QA:
Implementation of TG-135

- Technology changes since editing “lockdown”:
  - IRIS collimator
  - MC for IRIS collimator
  - InTempo (change of prostate imaging)
  - Major database/software change
  - ...

- Report should serve as Guideline, adapt to clinic
- Keep up with the literature on QA
- TG 100: Database? Process maps?