Scripps Proton Therapy Center: Configuration and Implementation

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Proton Symposium
2013 Annual AAPM Meeting
Indianapolis, Indiana USA
Facility Configuration
Scripps Proton Therapy Center

***All Rooms : PBS Only

360° Gantry

Fixed Horizontal Beamline

Cyclotron
Max E : 250 MeV
Scripps Proton Therapy Center

- Gantry-mounted dual x-ray imaging system
- Full CBCT function
- Internal and external imaging console
- TrueBeam-like treatment console
- Robotic, 6-degree of freedom patient positioner
Scripps Proton Therapy Center

• Designed treatment capacity: 2400 pts per year
• Planned patient mix:
  – Prostate Cancer: 800 patients/year
  – Lung Cancer: 200 patients/year.
  – Head & Neck Cancers: 200 patients/year
  – Pediatric Cancer: 100 patients/year
  – Breast Cancer: 200 patients/year
  – CNS Tumors: 400 patients/year
  – Other tumor sites
Scripps Proton Therapy Center

- Physicians (4)
  - Carl Rossi
  - Huan Giap, Ryan Grover, Andrew Chang
- Physicists (7)
  - Lei Dong
  - Annelise Giebler, Anthony Mascia, Yongbin Zhang, Franko Piskulich, Richard LePage, Luis Perles
- Physicist Assistants
  - To be hired: January 2014
- Dosimetrist (2)
  - First cohort started: July 2013
- Radiation Therapists (5)
  - First cohort started: August 2013
Quality Assurance
Daily Machine QA

- Duration 15 minutes; performed by RTTs
- In short, an end-to-end test using daily QA detector
- Rotate proton energy daily, Monday Through Friday
- PBS volumetric irradiations (i.e. not single spots)

Weekly Machine QA

Summary

- Comprehensive spot pattern tests
  - Initially performed: weekly
- Deliver a fixed spot pattern at two gantry angles, two energies
- This spot pattern is benchmarked at commissioning
- The physical measurement results and their comparison to benchmark are recorded
- 30 minutes per room

Test Parameters

- Position – location of spot on Lynx versus planned location
- Shape – ratio of x-axis and y-axis
- Size – sigma of x-axis and y-axis
- Output – output constancy

Courtesy IBA Dosimetry
Monthly Machine QA

- The Daily + Weekly QA programs are comprehensive and reviewed daily/weekly; detailed trend analysis performed as part of monthly QA
- Monthly QA tests a wider spectrum of the beam delivery system in one session (e.g. more ranges, more doses, etc)
- Precise quantification of the treatment couch using Winston-Lutz style tests performed at cardinal gantry angles
- Image quality assessment of the imaging system
Annual QA

• As opposed to constancy measurements, the annual QA re-measures / re-validates baseline/commissioning data using commissioning caliber equipment

• Detectors:
  – Water tank + Bragg peak chamber
  – Water tank + Farmer chamber
  – Lynx or Logos scintillator detectors
  – OctaviusXDR ion chamber array

• Absolute Calibration: IAEA TRS 398
Patient Specific QA

• Every field for every patient undergoes quality assurance procedure prior to treatment

• Procedure highlights:
  – For each field, three transverse profiles, each at different depth, measured with 2D ion chamber array; compared to calculation in Eclipse
  – For each field, at least one point dose measurement is made using cross-calibrated ion chamber (i.e. IBA Dosimetry CC04)
  – Measurement setup:
    1. Gantry 0 degrees: all field recalculated to 0 degrees; all fields measured at 0 degrees
    2. Planned Gantry Angle: all fields measured at planned gantry angles and compared to calculation

• Passing criteria is being developed
  – Starting point: 3% / 3mm with 90% passing
  – Evaluate and determine during commissioning and validation
Novel Monthly Machine QA Technique

- Use OctaviusXDR or StarCheckMaxi + BQ Check phantom
- Using single detector, measure: spot position, dose constancy, proton range/energy, field uniformity (symmetry/flatness)
- Additional setup (e.g. imaging bb + Lynx mounted to gantry) required for Winston Lutz tests

Testing/development with Varian, Rinecker Proton Therapy Center and Scripps Proton Therapy Center
Novel QA Implementation

- Logos Systems Inc XRV device:
  - Conical scintillator-based detector
  - Alignment: laser, imaging device, and beam isocenter.

<table>
<thead>
<tr>
<th>Isofocus Beam Summary</th>
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<tbody>
<tr>
<td>Beam Center</td>
<td>X</td>
<td>Y</td>
<td>Z</td>
</tr>
<tr>
<td>Average:</td>
<td>0.22</td>
<td>0.09</td>
<td>75.71</td>
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<tr>
<td>Max:</td>
<td>0.49</td>
<td>0.41</td>
<td>76.33</td>
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<tr>
<td>Min:</td>
<td>-0.03</td>
<td>-0.23</td>
<td>74.84</td>
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<tr>
<td>StDev:</td>
<td>0.18</td>
<td>0.23</td>
<td>0.43</td>
</tr>
</tbody>
</table>

- Laser @ 0.64 of DE:
  - Laser @ 0.64 of DE: 75.8464

- Laser Error:
  - Laser Error: 0.22 X (mm), 0.09 Y (mm), -0.14 Z (mm)
Novel Patient QA Technique

- Aluminum mount interfaces to Varian nozzle
- OctaviusXDR array rigidly held in place
- 4 x Slide Nuts securely hold up to 25.0cm of solid water in front of the ion chamber array
- Allows transverse plane at any water equivalent depth (up to 25.0cm)
- Because Varian nozzle holder translates, also allows measurements upstream and downstream of isocenter

Thanks to Glen Mounce, machinist
Acknowledgements

• SPTC Colleagues, especially the physics group:
  – Lei Dong
  – Franko Piskulich
  – Richard LePage
  – Annelise Giebler
  – Yongbin Zhang
  – Luis Perles

• Our partners at Advanced Particle Therapy (APT)
• Our partners at Varian Medical Systems, Particle Therapy Group
Thank you!