INDEPENDENT DOSIMETRY AUDIT BASED ON END-TO-END TESTING IN PROTON BEAM THERAPY

A. Carlino¹, H. Palmans¹,², C. Gouldstone², P. Trnkova³, G. Bosmans⁴, G. Vilches Freixas⁴, I. Rinaldi⁴, O. Noerrevang⁵, H. Nyström⁵, A. Vestergaard⁵, S. Lorentini⁶, C. Algranati⁶, M. Schwarz⁶, S. Vatnitsky¹, M. Stock¹

¹ MedAustron Ion Therapy Center, Marie Curie-Straße 5, Wiener Neustadt, Austria.
² National Physical Laboratory, Hampton Road, TW11 0LW Teddington, United Kingdom.
³ HollandPTC, Huismansingel 4, Delft, The Netherlands
⁴ Zuid-Oost Protonen Therapie Centrum (ZON-PTC), Maastricht, The Netherlands
⁵ Dansk Center for Partikelterapi (DCPT), Aarhus Universitetshospital, Palle Juul-Jensens Boulevard 99, Aarhus, Denmark
⁶ Centro di Protonterapia, APSS, Via al Desert 14, Trento, Italy
• nothing to disclose
Outline

- MedAustron&NPL Audit service
- Participants of audit: facilities audited
- Phantoms & Detectors
- End-to-end test procedures
- Results
- Conclusion
Dosimetry audit service

Service provided by MedAustron in collaboration with the NPL (UK):

- **On-site support in performing full dosimetric end-to-end tests by a MedAustron delegate.**

- Measurements performed with ionization chamber, alanine pellets and EBT3 films in customized anthropomorphic phantoms.

- Farmer ionization chamber and alanine pellets calibrated in $^{60}\text{Co}$ at NPL (UK).

- Provision of a final audit report - Alanine pellets dose values certified by NPL (UK).
“GEOGRAPHY” OF AUDIT
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<th>Facility /when</th>
<th>Beam Line</th>
<th>S/C/SC* - Vendor</th>
<th>OIS</th>
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<td>S - In-house</td>
<td>In-house</td>
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*S/C/SC = Synchrotron (S) or Cyclotron (C) or SynchroCyclotron (SC)  
**HBL = fixed Horizontal Beam Line  
***VBL = fixed Vertical Beam Line
Phantoms & detectors (1)
Homogeneous phantom

- Homogenous Polystyrene phantom (1.06g/cm$^3$)
- Seven plates, each with a size of 20x20x3 cm$^3$
- Customized to allocate different detectors:
  - Farmer chamber (PTW 30013)
  - 20 Alanine pellets
  - 2 EBT3 Films

Phantoms & detectors (2)  
Head phantom

- Customization of head phantom in collaboration with CIRS (Tissue Simulation & Phantom Technology):
  - 3 EBT3 films in the head-neck region
  - 2 Ionization chambers (Farmer PTW 30013)
  - 22 Alanine pellets

Mevion – ZON-PTC (NL)

End-to-end test procedures

End-to-end test of the entire logistic chain of radiation treatment starting from CT scanning, treatment planning, monitor calibration, patient positioning and beam delivery. The whole clinical workflow was reproduced as during patient treatment.

CT data → OIS data → TPS data

Head phantom

Pelvis phantom
End-to-end test procedures

OIS → RVS → Accelerator

In room Imaging

Image registration

IBA Gantry 2 (Trento, IT)
End-to-end test procedures

1. **OIS**
2. **RVS**
3. **Accelerator**

**In room Positioning** (HBL, MedAustron)

- **Head phantom** – Loaded with alanine
- **Pelvis phantom** – Loaded with Farmer ionization chamber
- Box shaped target (8x8x12 cm$^3$ - 768 cc)
- Beam arrangement: Gantry 90°, Couch 270°
- 20 alanine pellets in the target volume – Farmer chamber at center of the target
- Prescribed dose 11 Gy(RBE)
Results for all facilities – Homogeneous phantom

- Average deviation over 20 alanine pellets at each beam line
- Average deviation of alanine overall beam lines $-0.1 \pm 1.0\%$ (k=2 is 2.0%)
- Cylinder shaped target (230 cc)
- Beam arrangement: Gantry 90°, Couch 0°
- 22 alanine pellets in the target volume – Farmer chamber at center of the target
- Prescribed dose 11 Gy(RBE)
Results for all facilities – Head phantom

- Average deviation over 22 alanine pellets at each beam line
- Average deviation of alanine overall beam lines $-0.2 \pm 1.2\%$ ($k=2$ is 2.4%)
Results for all facilities – Alanine vs Farmer chamber

- Alanine and Farmer chamber agrees on average -0.5 ± 0.6% in the homogenous phantom
- Alanine and Farmer chamber agrees on average -0.4 ± 0.5% in the head phantom
- Largest deviation -1.2% in both phantoms
Take home message

- An innovative dosimetry audit service (MedAustron&NPL) has been offered to the proton therapy community based on the experience gained at MedAustron.

- Dosimetry audit based on end-to-end testing has been successfully performed at 5 proton therapy centers (IBA, Varian, MEVION, MedAustron) in Europe.

- PTCOG granted the audit for one facility within the IPACS collaboration.

- Development of dosimetry audit based end-to-end testing for carbon ion beams is on going at MedAustron.
Acknowledgments:

- MedAustron medical physics team

- Colleagues from NPL (UK):
  Ana Lourenco
  Russell Thomas
  Catharine Clark

The audit at the proton therapy facility in Trento (IT) was fully financially supported by a project fund from the PTCOG (as part of the IPACS collaboration)

Contact email: antonio.carlino@medaustron.at

Thank you!