

# Modulated Electron Bolus (MEB)

Adaptiiv’s MEB solution allows single-beam electron treatments to deliver modulated electron radiation therapy (MERT) dose distributions that conform to an irregular distal PTV surface. Our regulatory cleared software, backed by patented algorithms, automates the design and fabrication of patient-specific and plan-specific modulated thickness electron bolus. Custom modulated thickness bolus, designed and fabricated with Adaptiiv’s MEB solution, has been shown to result in MERT dose distributions that provide superior sparing of healthy tissues and distal OARs compared to uniform thickness bolus electron plans (Figures 1A & 1B).

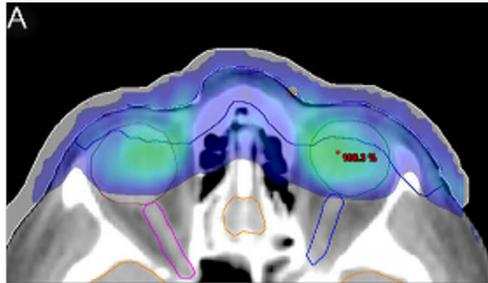


Figure 1A. Patient with mycosis fungoides of the forehead, eyelid and nose. Uniform thickness bolus provides coverage of the PTV, however, a high dose to underlying healthy tissue and OARs is evident.

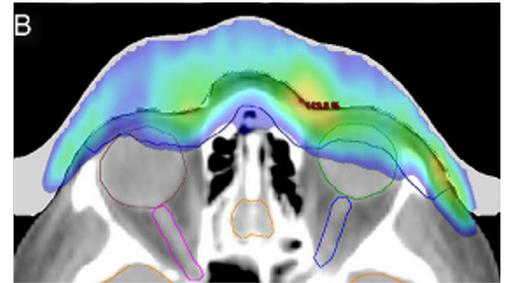


Figure 1B. Adaptiiv’s Modulated Electron Bolus is customized, changing the surface shape to allow for tailoring of dose distribution.



*“Without Adaptiiv’s MEB, it is often difficult to develop a plan that tailors the prescribed dose to the tumor volume, resulting in overexposure to underlying healthy tissue.”*

## Key Benefits

- Adaptiiv’s MEB automates modulated bolus thickness optimization and fabrication. The software takes a few minutes to determine optimal shape and 3D printing can be done in a matter of hours, producing a bolus with spatial accuracy on the order of 1mm. In one case, MEB design time was reduced from 30+ hours of manual tuning within the TPS to under 2 minutes with Adaptiiv’s MEB module.
- 3D printed bolus improves the following: integrity of the bolus (compared to wax), reproducibility of patient setup, and the accuracy of treatment delivery through a better, more consistent fit to the patient surface.
- Adaptiiv’s patented hotspot correction algorithm allows users to determine the appropriate balance of dose homogeneity versus conformity. No other commercial solution provides this capability.
- Adaptiiv provides the only regulatory cleared solution allowing users to customize a bolus, seamlessly export the modified bolus structure back into their TPS, and use their clinically commissioned TPS to calculate dose.
- Adaptiiv’s solution replaces the need to use multiple versions of open source software when transforming a structure within the TPS into a 3D printed accessory. Using multiple versions of open source software requires excessive design time, treatment plans can’t be easily verified in the TPS, and they do not have regulatory clearance.
- MEB plans created in Adaptiiv’s software demonstrate superior sparing of healthy tissues and distal OARs while significantly reducing hotspots compared to photon IMRT delivery, i.e. VMAT (Figures 2A, 2B, and 2C).

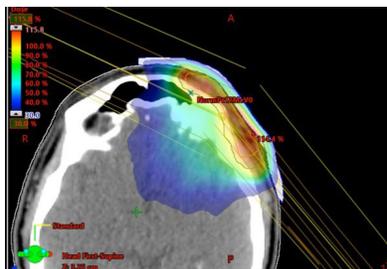


Figure 2A. Treatment plan using VMAT was rejected due to splay of intermediate dose.

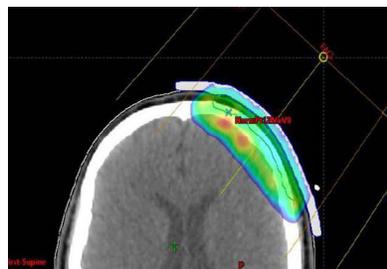


Figure 2B. Standard electron field with uniform thickness bolus delivers a high dose to underlying healthy tissue and has a high presence of hotspots.

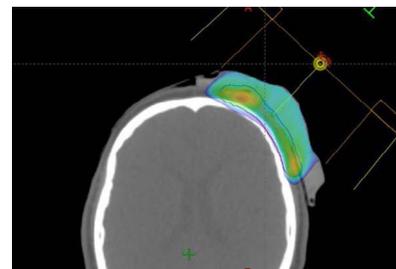


Figure 2C. Same electron field as center image - however, using Adaptiiv’s MEB spares underlying healthy tissue and significantly reduces hotspots.

# Clinical Benefits

	Radiation Oncologist	Medical Physicist	Radiation Therapist / Dosimetrist	Administrator
<b>Patient Consult</b>	<ul style="list-style-type: none"> <li>- Improve treatment quality through OAR sparing.</li> <li>- Improve reproducibility and accuracy during treatment.</li> </ul>			<ul style="list-style-type: none"> <li>- Provide an improved standard of care.</li> <li>- Use of innovative, regulatory cleared technology.</li> </ul>
<b>CT Simulation</b>	<p>Improve patient comfort through simplified setup during CT simulation and treatment.</p>		<p>Increase efficiency and confidence. Manual bolus fabrication is replaced by a simplified, objective, and automated 3D printed bolus workflow.</p>	<ul style="list-style-type: none"> <li>- 3D printed bolus meets requirements for existing billing codes - can be billed as a patient-specific complex device.</li> <li>- Eliminate the need to fabricate bolus in the CT suite, thereby increasing throughput.</li> </ul>
<b>Image Contouring / Bolus Design</b>	<p>Use standard TPS contouring/structure generation tools to generate a uniform bolus covering the desired treatment area on the CT scan. This will be input into Adaptiiv's MEB module for customization.</p>			
<b>Treatment Planning</b>	<ul style="list-style-type: none"> <li>- Final MEB structure is exported back to the TPS for dose calculation.</li> <li>- Final MEB structure will translate into a 3D printed patient-specific bolus with spatial accuracy on the order of 1mm.</li> </ul>	<ul style="list-style-type: none"> <li>- Use standard TPS process to generate a simple electron plan using the uniform bolus structure.</li> <li>- Seamlessly export plan, structure set, and CT into Adaptiiv's software and automatically optimize bolus thickness in just a few minutes.</li> <li>- Further customize the bolus using post-processing tools (patient ID label, cropping, smoothing, etc.).</li> <li>- Known bolus shape during treatment planning accurately reflects bolus shape during treatment delivery. This may not be true of conventional methods, such as wax and Superflab.</li> </ul>		<ul style="list-style-type: none"> <li>- Seamlessly integrate final bolus structures into existing TPS workflow following a regulatory cleared process.</li> <li>- A faster, cheaper commissioning and QA process.</li> </ul>
<b>Patient-Specific Quality Assurance</b>		<ul style="list-style-type: none"> <li>- Simple pre-Tx bolus QA (CT scan of accessory).</li> <li>- Verification of placement on patient need not impact patient workflow (CBCT).</li> </ul>		<p>Little overhead required for patient-specific accessory QA, without any impact on patient workflow.</p>
<b>Patient Setup at Tx Unit</b>	<p>Setup is simplified and objective versus manual bolus, provides increased confidence in accurate plan delivery, and can result in less consult calls to the unit.</p>	<p>Increase RT confidence as a result of simplified setup. This can result in less consult calls to the unit.</p>	<ul style="list-style-type: none"> <li>- Decrease setup time for complex cases by as much as 30%.</li> <li>- Increased efficiency and confidence. Setup is simplified and objective vs. manual bolus fabrication.</li> </ul>	<ul style="list-style-type: none"> <li>- Decrease need for extended treatment delivery time slots.</li> <li>- Increase setup efficiency and reproducibility.</li> <li>- Increase treatment efficiency, throughput, and capacity.</li> </ul>
<b>Image Guidance</b>	<p>CBCT assessment of conformity demonstrates reduced frequency and volume of air gaps and improved reproducibility.</p>			
<b>Treatment Delivery</b>	<p>Improved confidence in the accuracy of dose delivery both superficially (due to improved bolus fit, reduced air gaps, setup reproducibility) and at depth due to improved bolus integrity and spatial accuracy achieved during 3D printing fabrication (vs. manual wax bolus).</p>		<p>Improved patient and staff experience:</p> <ul style="list-style-type: none"> <li>• Eliminate wax and wet gauze.</li> <li>• Reduce need for tape.</li> <li>• Increased setup efficiency.</li> <li>• Increased confidence as a result of simple workflow.</li> </ul>	<ul style="list-style-type: none"> <li>- Reduce risk of compromised delivery due to use of unverified accessories during treatment.</li> <li>- Reduce risk of inaccurate bolus fabrication through use of regulatory cleared processes.</li> </ul>

# Why Adaptiiv?

---

Adaptiiv offers an advanced 3D printing software solution designed specifically for radiation therapy. Our solution integrates fully with existing TPS and clinical workflows. This enables users to create patient-specific accessories on demand and provides the following advantages over traditional methods and alternate commercial solutions:

1. The only turn-key commercial solution for in-house MEB-MERT.
2. Adaptiiv's MEB module enables a new standard of care for electron treatment quality, sparing underlying healthy tissues and reducing hotspots.
3. Improved accuracy and reliability in treatment delivery versus traditional methods.
4. An integrated commercial solution that allows users to view the newly designed patient-specific bolus in their TPS to verify the plan prior to plan sign-off.
5. The only turnkey 3D printing software solution backed by a regulatory cleared QMS. Radiation therapy accessories are created on demand without the need for a highly dedicated staff skill-set or the assumed risk associated with use of multiple versions of open source software.
6. Adaptiiv's software facilitates and amalgamates multiple radiation therapy-specific post-processing features which saves time and eliminates the need for multiple versions of open source software.
7. Adaptiiv is an in-house solution that gives users greater control over commissioning and QA processes compared to external solutions used to design/fabricate medical accessories.
8. Reduced long term cost of fabrication with no shipping costs or delays in treatment when compared to outsourcing.