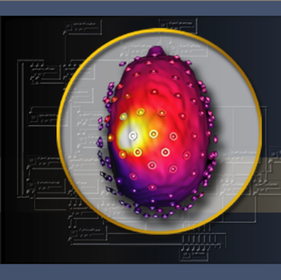
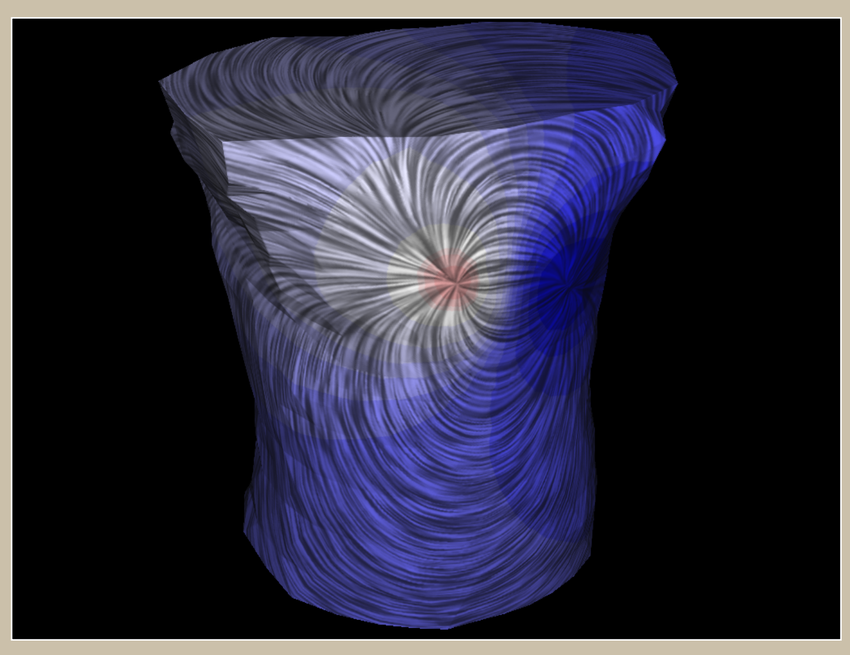


VISUALIZATION OF FLOW PATTERNS IN BIOELECTRIC CURRENT

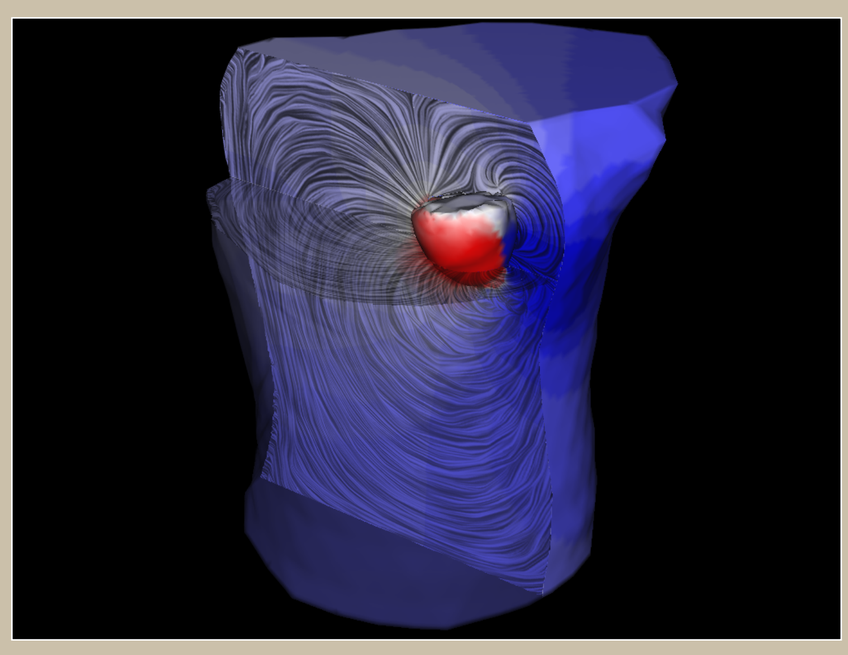
XAVIER TRICOCHE, BRUNO TACCARDI, FRANK SACHSE, ROB MACLEOD, CARSTEN WOLTERS

Electric and magnetic fields are vector fields that represent bioelectric activity in the human body, however, their interpretation has been limited by the challenges of visualizing them in meaningful ways. One result has been that visualization and analysis have focused on the scalar potentials (electric and magnetic), for which mature visualization strategies exist. Our past and ongoing research concentrates on methods that generate a global depiction of the continuous vector flow fields underlying the discrete information in numerical data sets. Our preliminary results show that visualizations combining a depiction of the bioelectric current combined with related scalar attributes like potential and current amplitude permit a deeper understanding of the three-dimensional shape of the bioelectric sources and their fields. They also offer new insight into the impact of tissue characteristics, e.g., anisotropy, on the resulting bioelectric fields.

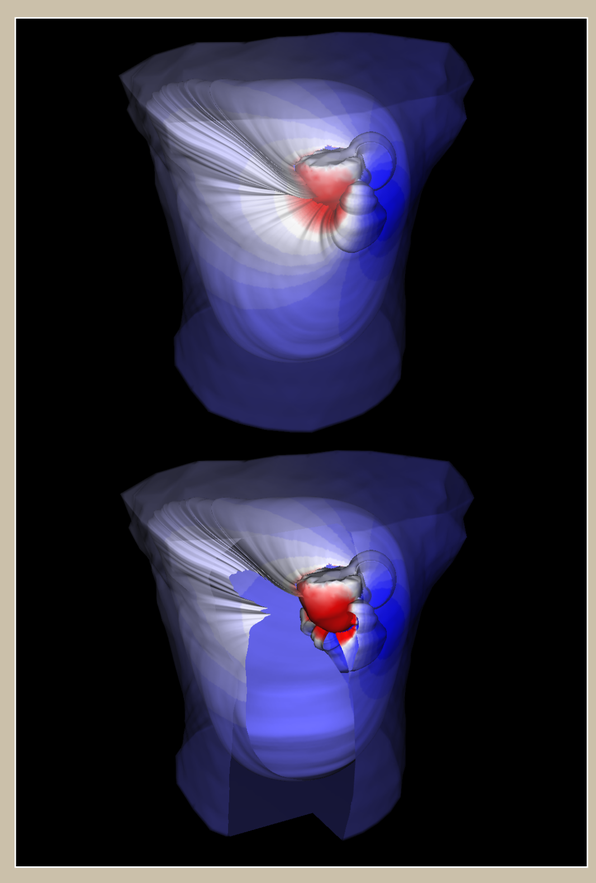
Flow Visualization Samples for Cardiovascular Research



This picture shows the extracardiac current as it arises on the outer surface of the torso. The directional information of the flow is conveyed by means of a Line Integral Convolution (LIC) technique. The visualization is enhanced by improving the contrast between individual streamlines and combining the streamline texture with a color coding of the potential values on the surface. The dipolar shape of the equivalent cardiac source is clearly visible as a source and sink pair on the surface.

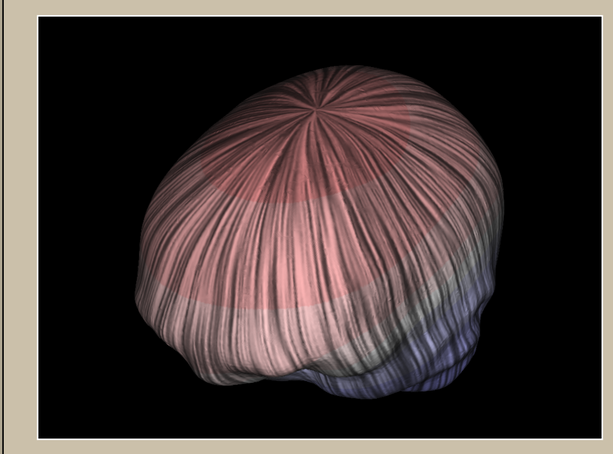


To gain insight into the volume flow patterns within the torso we use two cutting planes that intersect at the approximate location of the source and sink on the heart surface and are oriented to best capture the symmetry of the resulting electric current. Transparency of one of the cutting planes and part of the boundary helps to avoid occlusion. Again, color coding represents the electric potential on both the cardiac surface and the torso boundary.

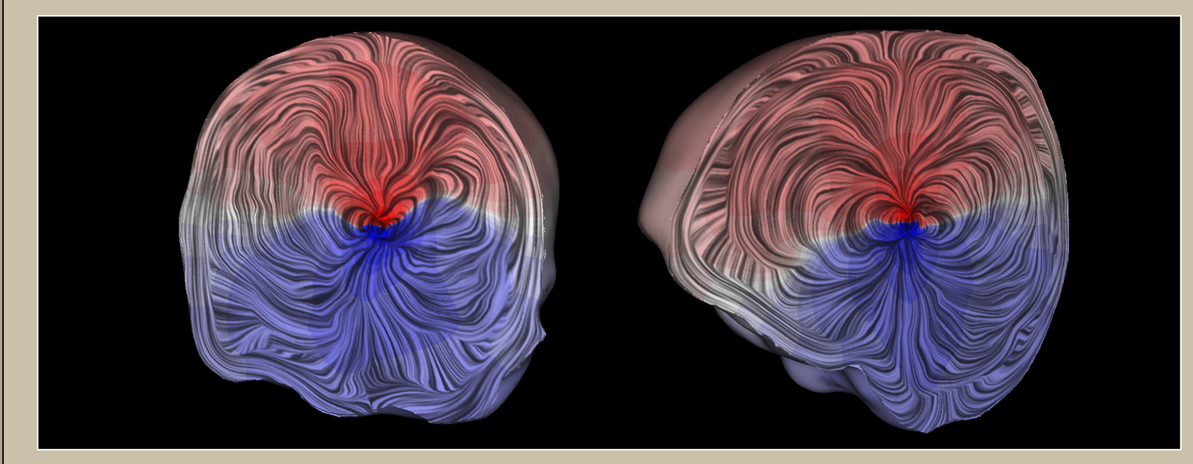


These two images illustrate the utility of stream surfaces that follow the three-dimensional electric current inside the torso.

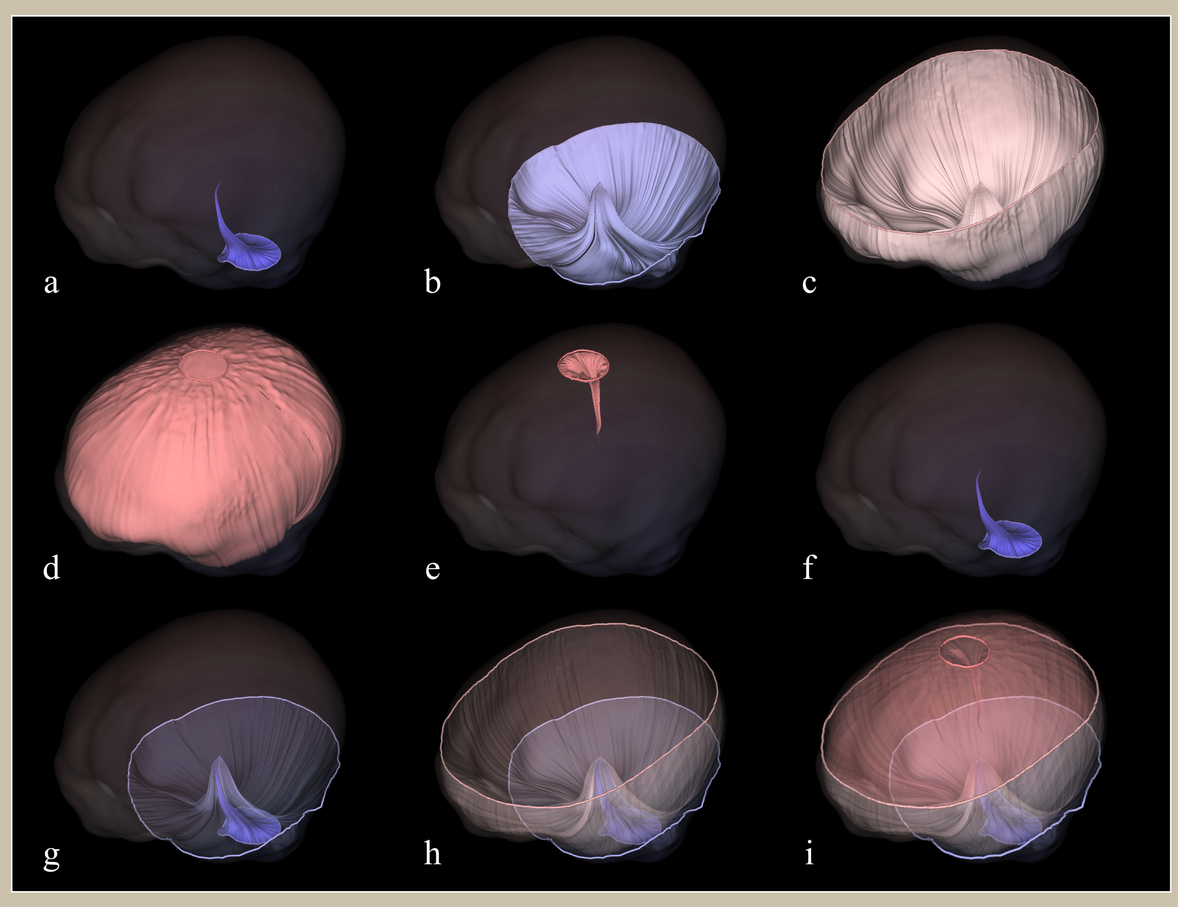
Flow Visualization Samples for Brain Research



LIC texture visualization of the bioelectric current tangential to the head surface. The color coding corresponds to the electric potential. Combined with the texture of the flow, the image clearly shows the position of the current as it emerges from the deeper source and projects onto the surface.



The same technique applied to coronal and coronal-saggital clipping planes reveals more details of the dipolar source and its interaction with the surrounding anisotropic tissue. Rather than a typical smooth, symmetric dipolar pattern, the electric current is clearly diverted by the presence of white matter tracts that lie close to the source. The field also changes direction very rapidly as it approaches the skull just beneath the surface of the head.



Figures **a** through **i** show a sequence of stream surfaces, each seeded from a different isocontour of electric potential from the scalp surface to reveal the path of current from that part of the head back to the source. The color coding of each stream surface corresponds to the associated value of potential and we make use of transparency to facilitate visualization.

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