

## 3D Display of ECG Signals

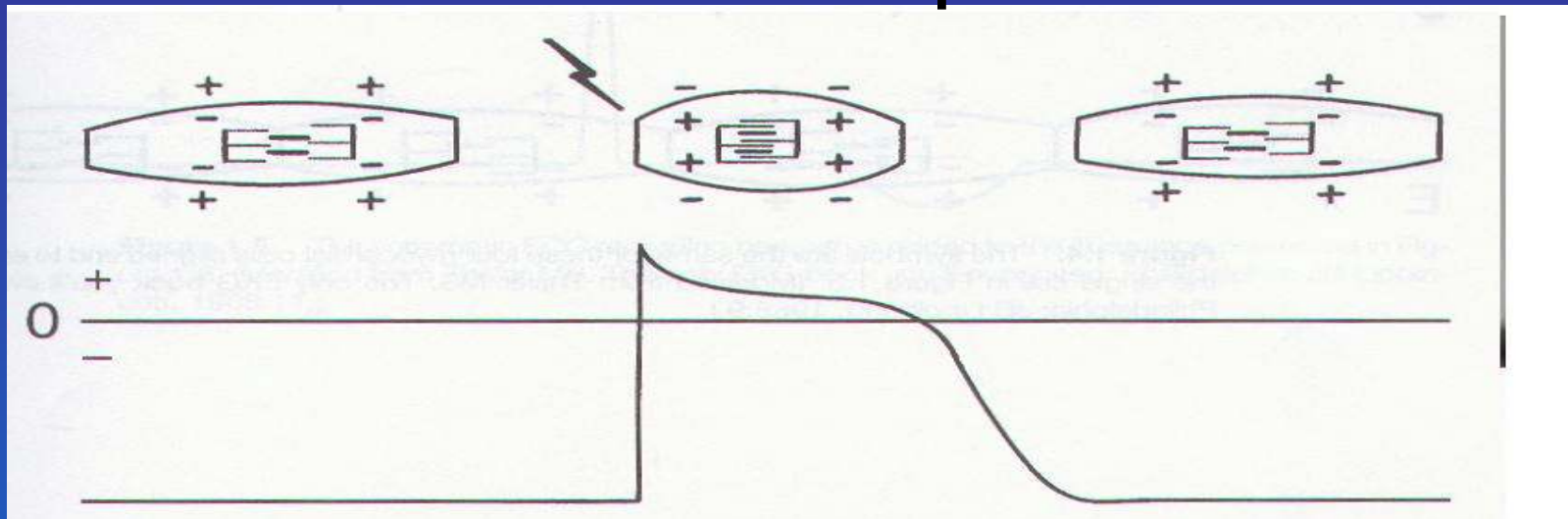
- Understanding the way that the ECG signal is generated.
- Using 3D presentation methods to enhance diagnosis
- Improved diagnosis of the patient with chest pain



# Heart cells and their polarization

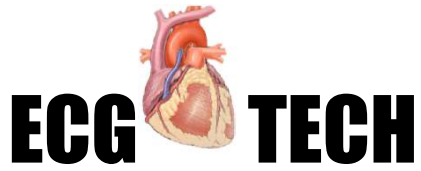
## Heart Cells and their Polarization and dePolarization

### And depolarization

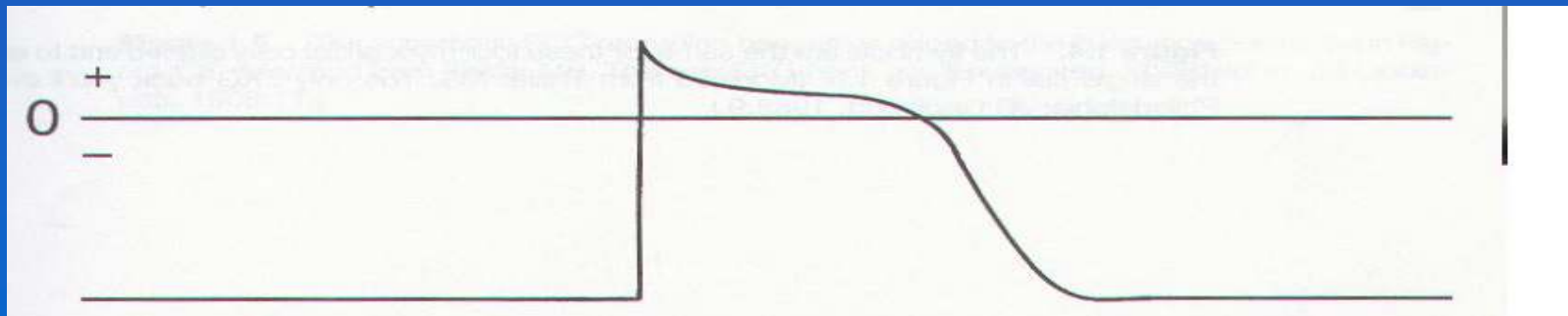
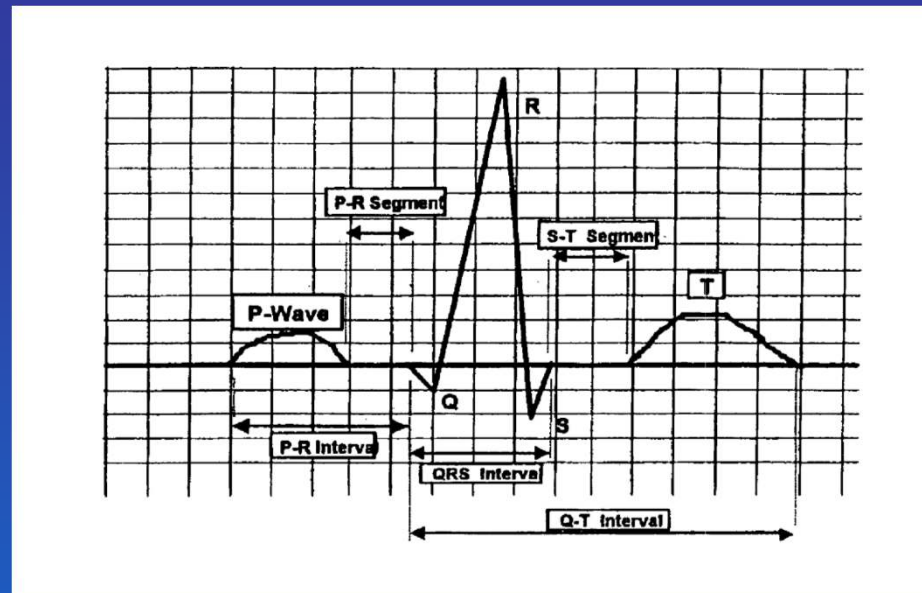


At the top a single cardiac cell is shown at three points in time:

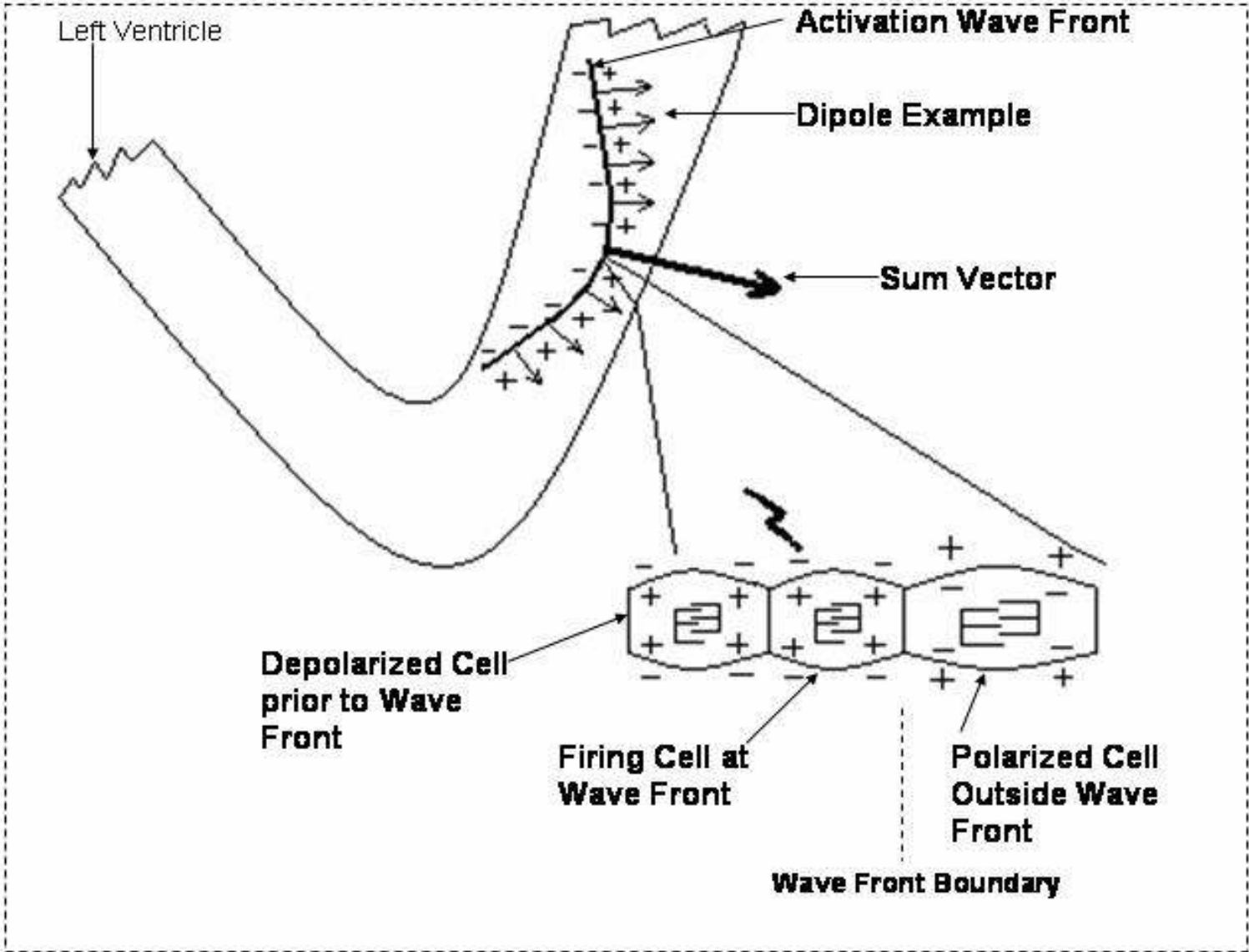
1. initially relaxed and polarized;
2. firing (lighting bolt) by impulse from adjacent cell causing positive (+) ions to enter the cell – depolarization;
3. relaxed again after polarization. At the bottom the electrical potential inside the cell is shown.

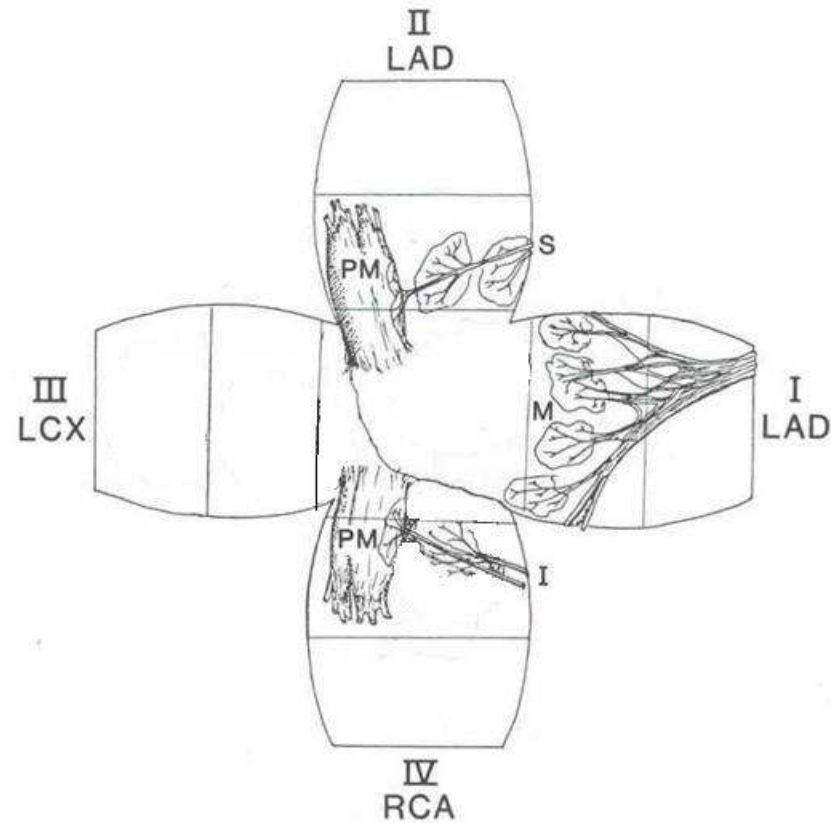


# The ECG Waveform



**Cross section of the Left Ventricle showing the Activation Wave Front and the cells that are at the boundary between the depolarized cells and the polarized cells.**





The distribution of the attachment of the Purkenje fibers to the endocardium of the Left Ventricle. The 4 quadrants of the heart model are spread around the apex and are assigned as follows:

I LAD is the Anteroseptal quadrant.

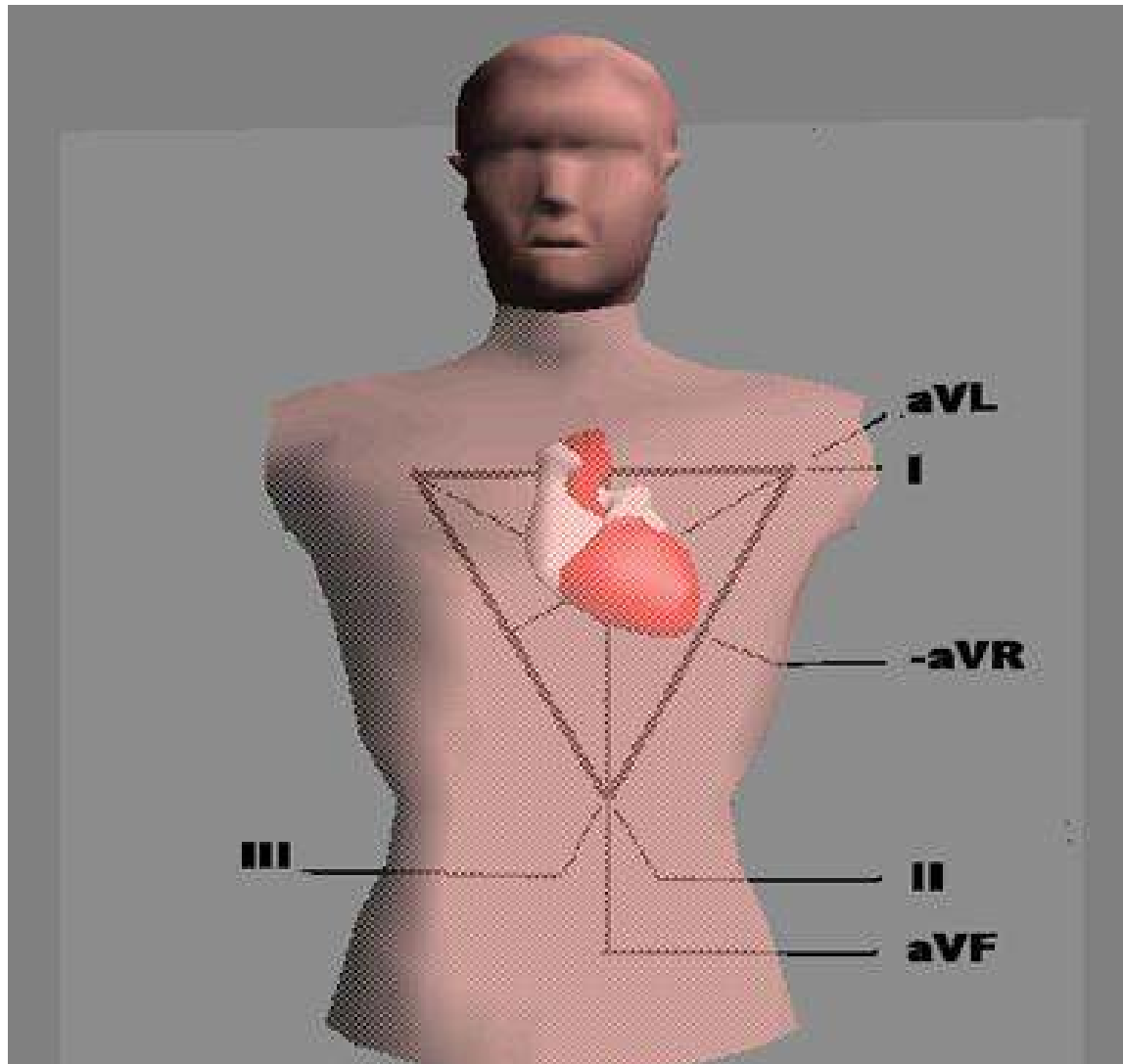
II LAD is the Anterosuperior quadrant

III LCX is the Posterolateral quadrant

IV RCA is the Inferior quadrant.

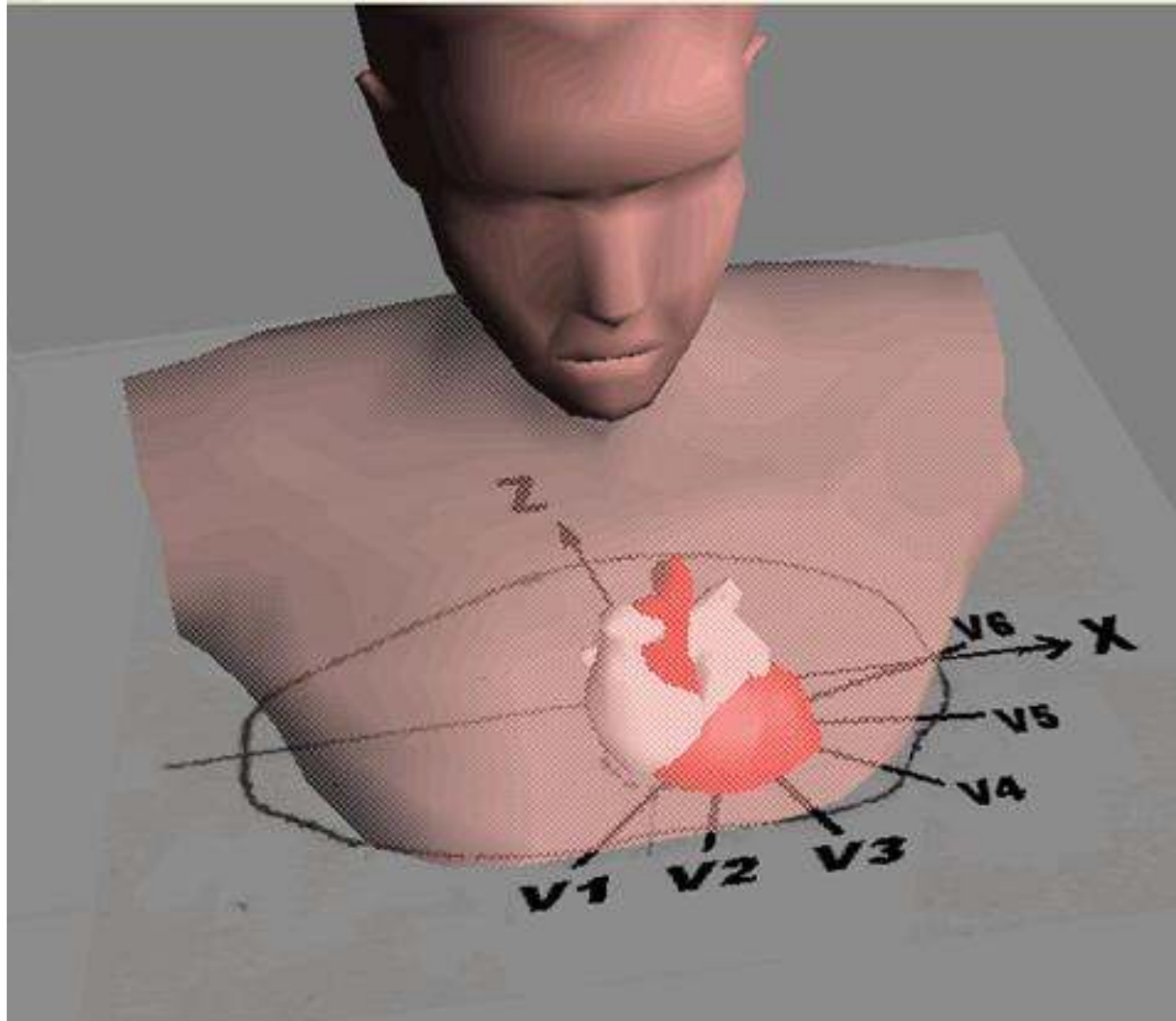
The initial excitation points shown in this model are used in the simulation.

## Limb Leads as they relate to the Heart and the Human Torso



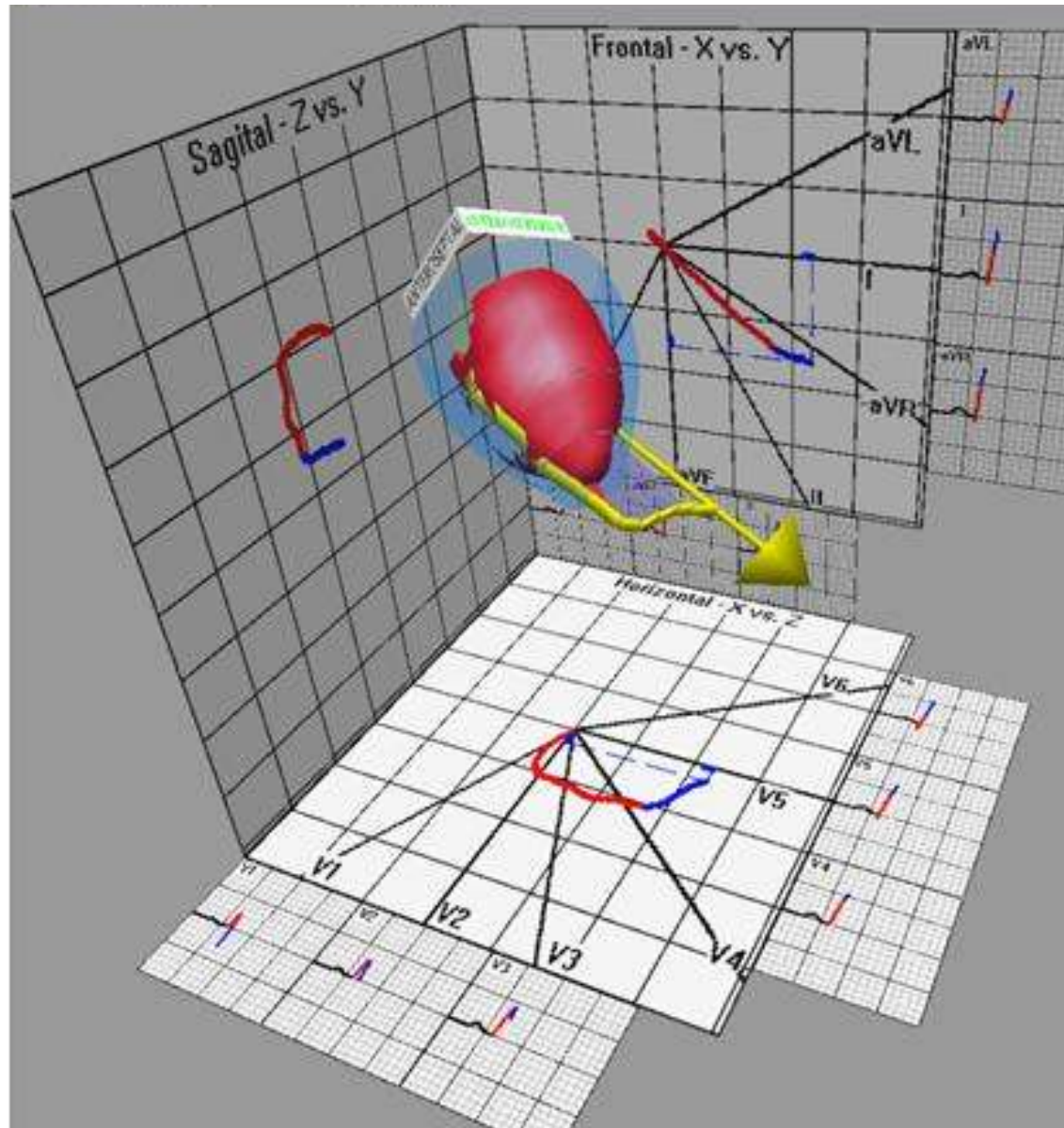
Limb leads shown in relation to the heart in the human torso. These lead vectors are useful for predicting the amplitude of the signal that is projected from the heart dipole sum vector on to each of the leads.

## Precordial Leads are sensitive to vectors in the Horizontal Plane



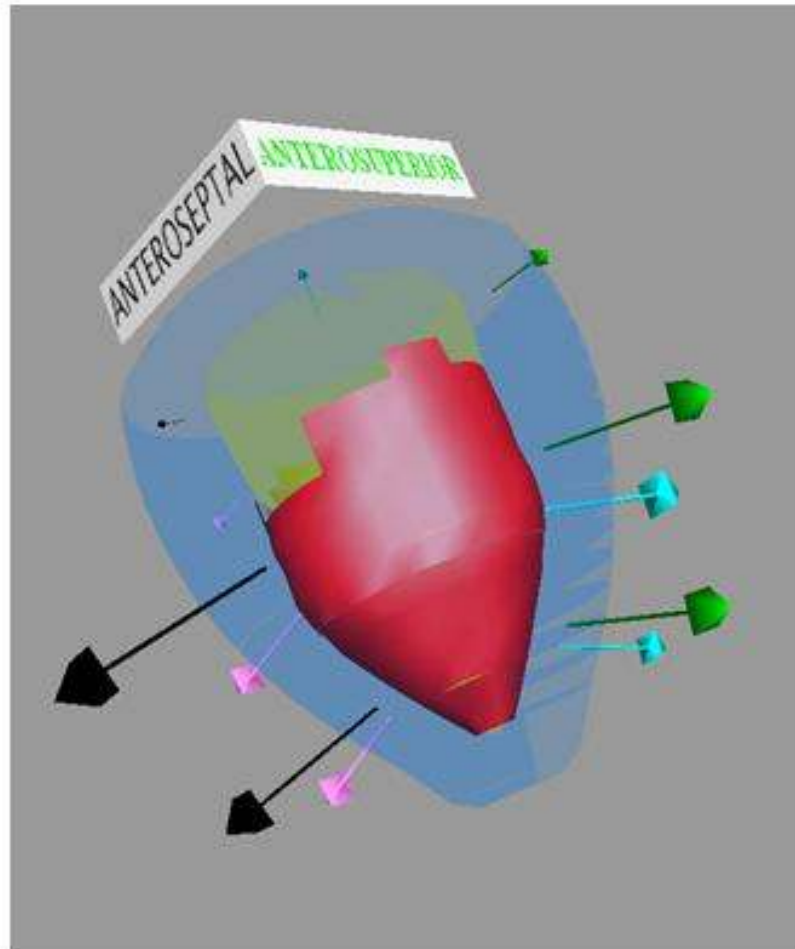
Precordial leads are shown in relation to the human torso. Lead vectors project from the electrical center of the heart. These lead vectors in the horizontal plane may be used to predict the signals received by these leads in relation to the sum vector.

The 3D heart program shows how the electrical signals generated by the wavefronts are converted to vector loops and the 12 Lead ECG.

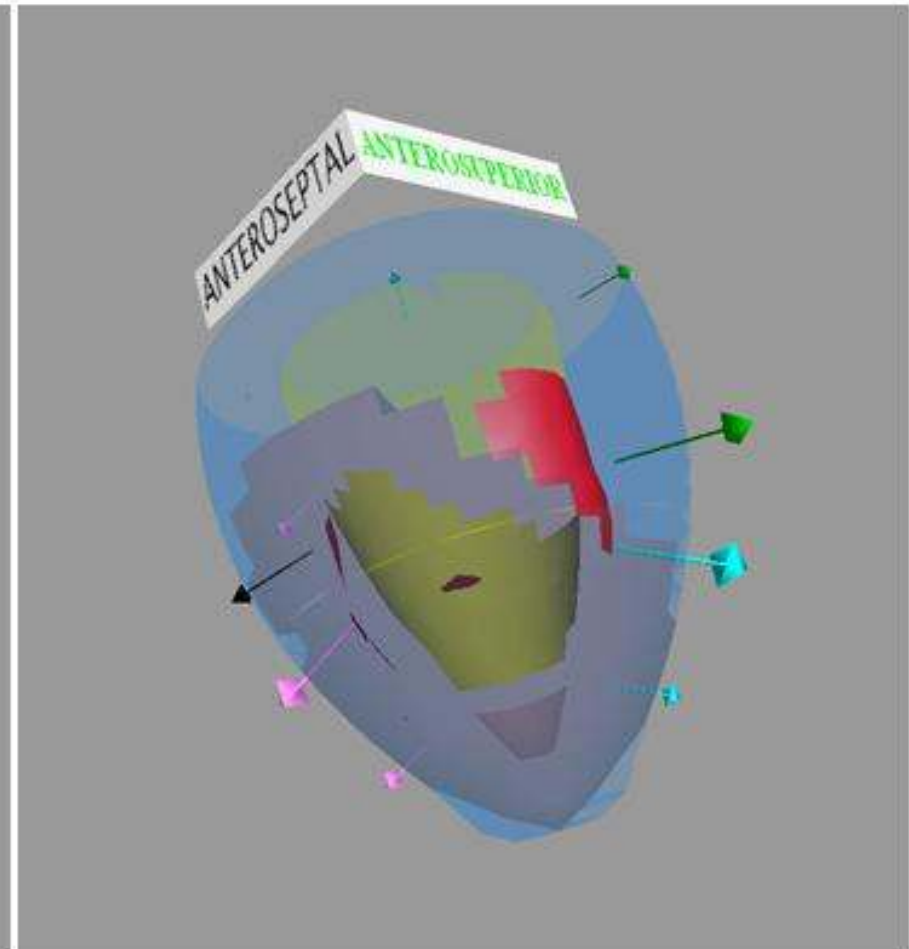




This snap shot shows the cardiac excitation process in terms of the active surface shown in bright red and the vectors (indicated by arrows) that emerge from the activation of the 12 divisions: superior, middle, and apical sectors of each of the 4 quadrants: 1. Anteroseptal, 2. Anterosuperior, 3. Posterolateral, 4. Inferior.

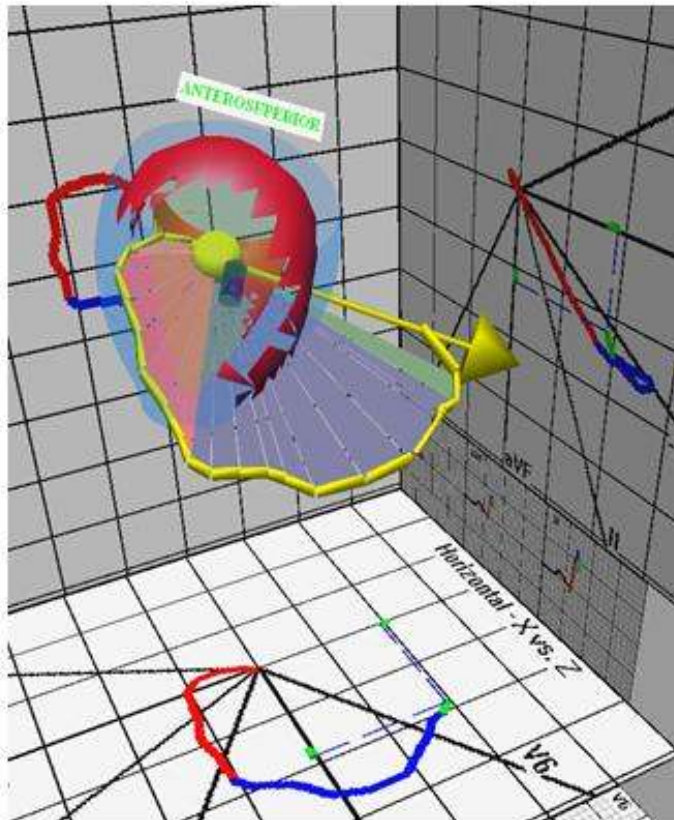


**Normal Heart**

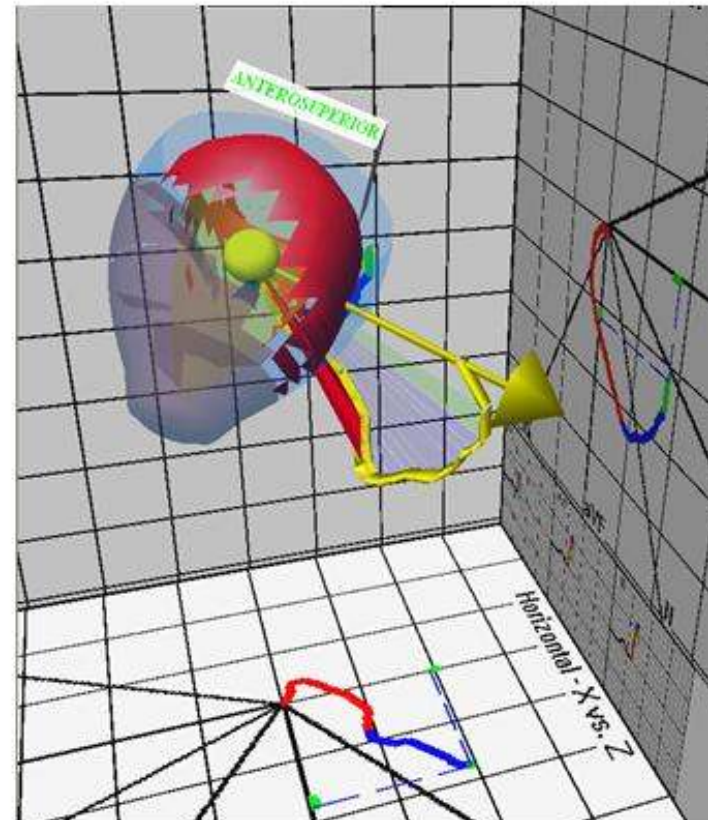


**Medium Anterior MI**

The vector loops from the normal heart and from the heart with the medium sized anterior MI presented below are shown for comparison. The yellow arrows represent the summation vectors at 55 msec in both conditions. The effect on the body surface electrical signals of the elimination of the anterior vectors by the MI appears as a distortion of the initial 40 msec of the vector loop.

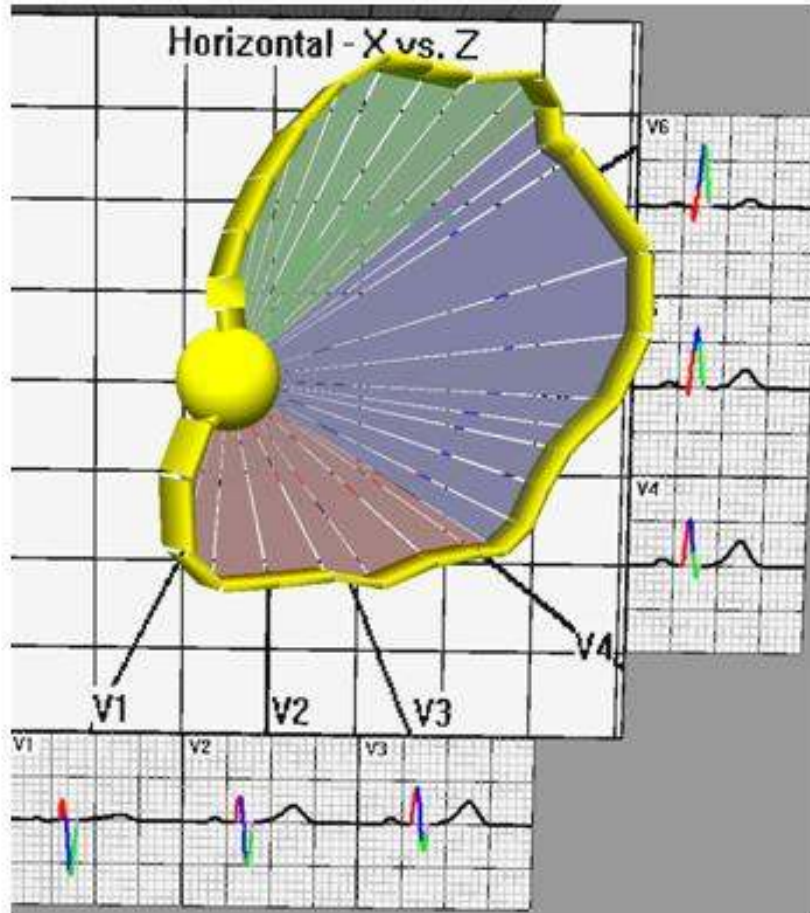


Normal Heart

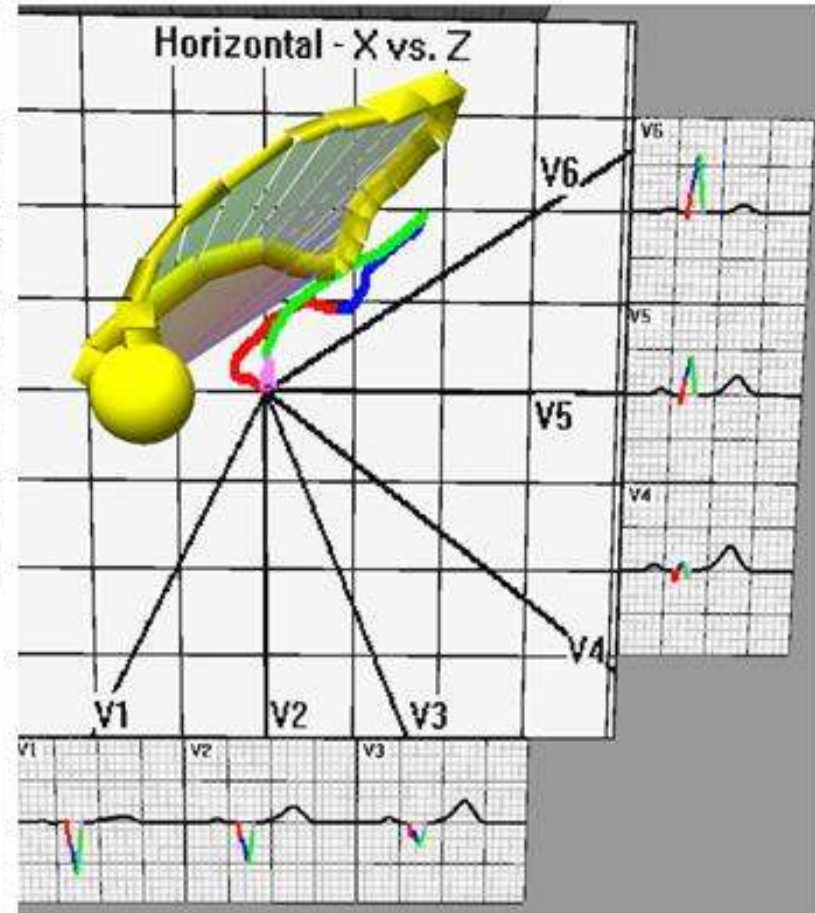


Medium Anterior MI

The presentation of the vector loops by themselves for the normal heart and the Medium Anterior MI in the horizontal plane show the tell tale loss of initial anterior vectors and their posterior direction as well as the resultant Q waves in V1, V2 and V3 unmistakably flagging Anterior MI.



Normal Heart



Medium Anterior MI

# ECG Simulations Covered

- normal activation
- large, medium, and small anterior MI
- large, medium, and small postero-lateral MI
- large, medium, and small inferior MI
- LBBB, RBBB, LAFB, LPFB

- **“The best way to interpret tracings is to learn basic principles of electrocardiography, including vector concepts, and apply them to each tracing that is being interpreted. Without such an approach people who memorize are helpless when they see tracings that they have not seen previously.”**
- From “Current Status of Clinical Electrocardiography with Suggestions for the Improvement of the Interpretive Process by J. Willis Hurst, MD, MACP in The American Journal of Cardiology Vol 92 November 1, 2003