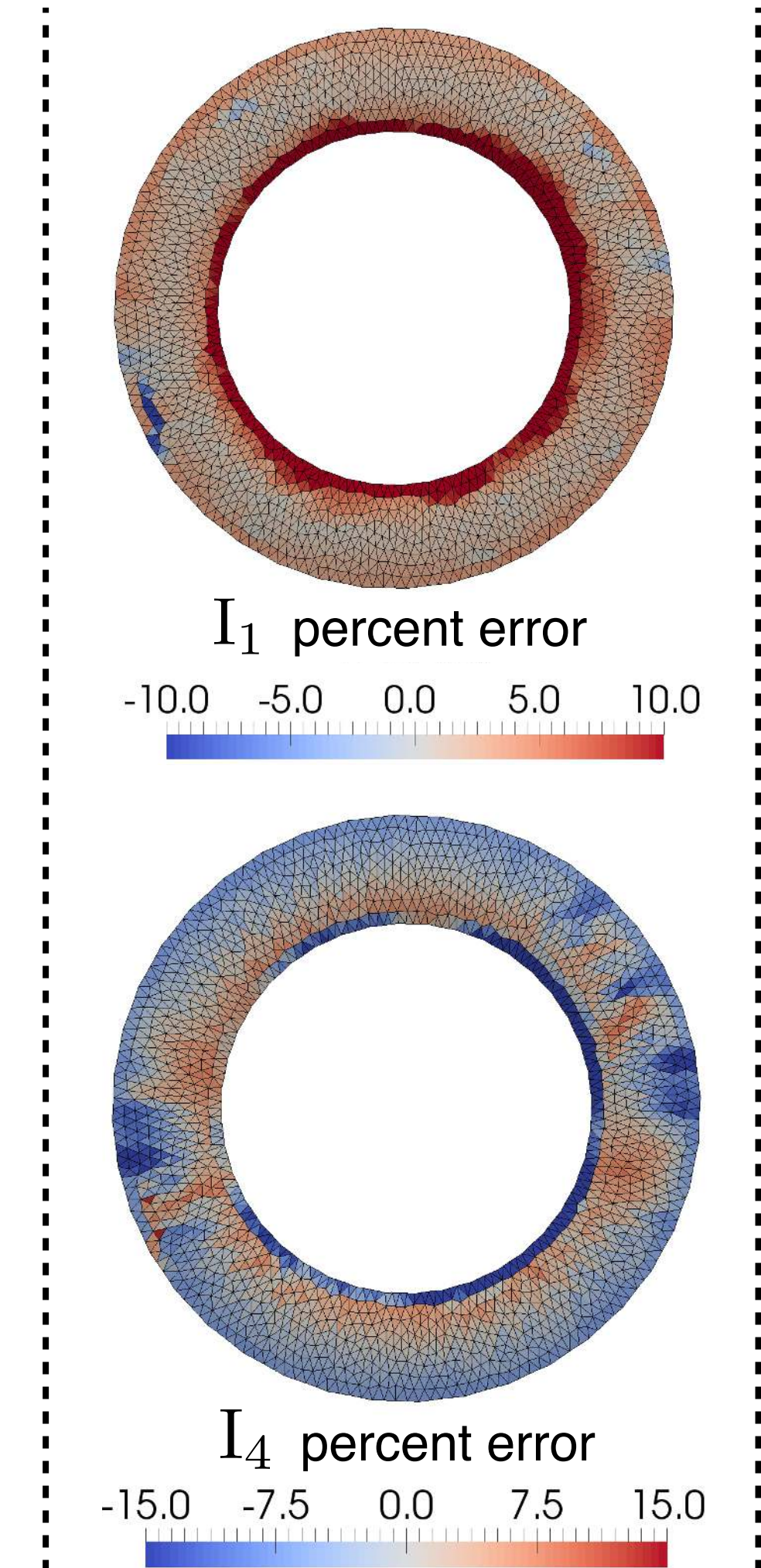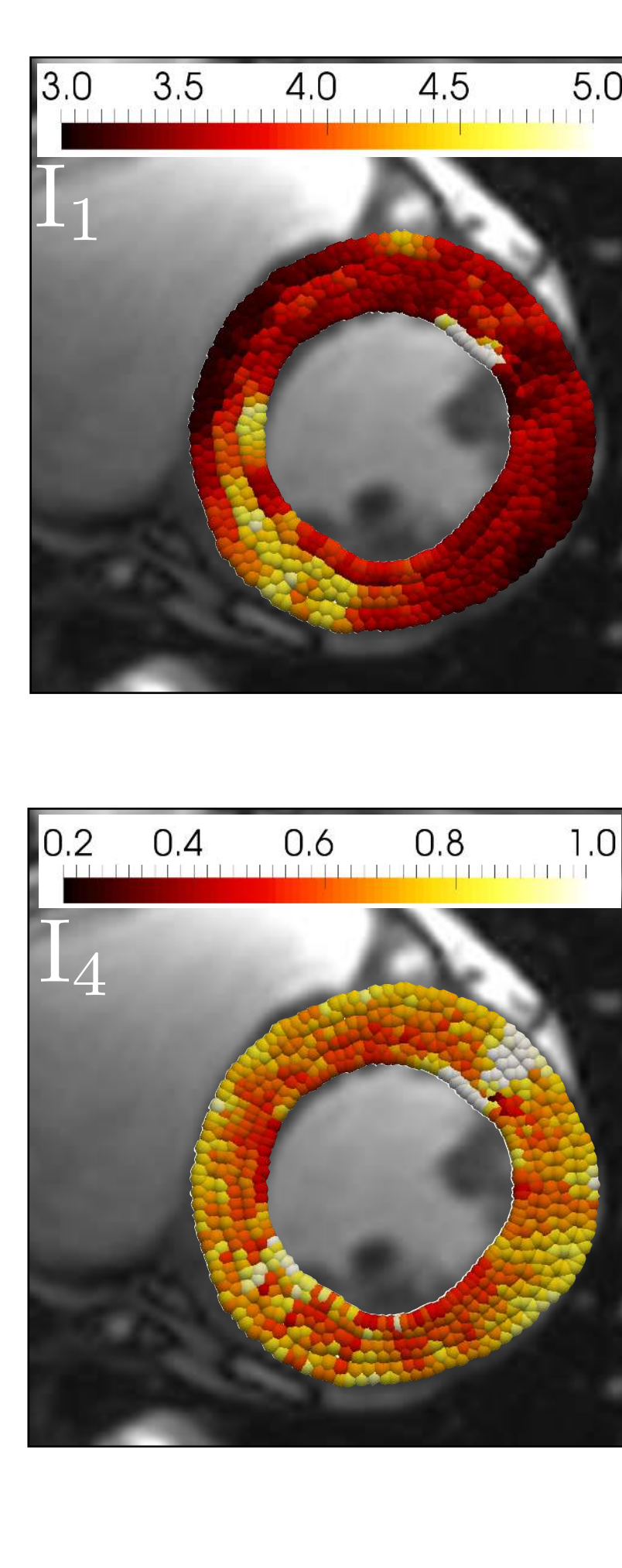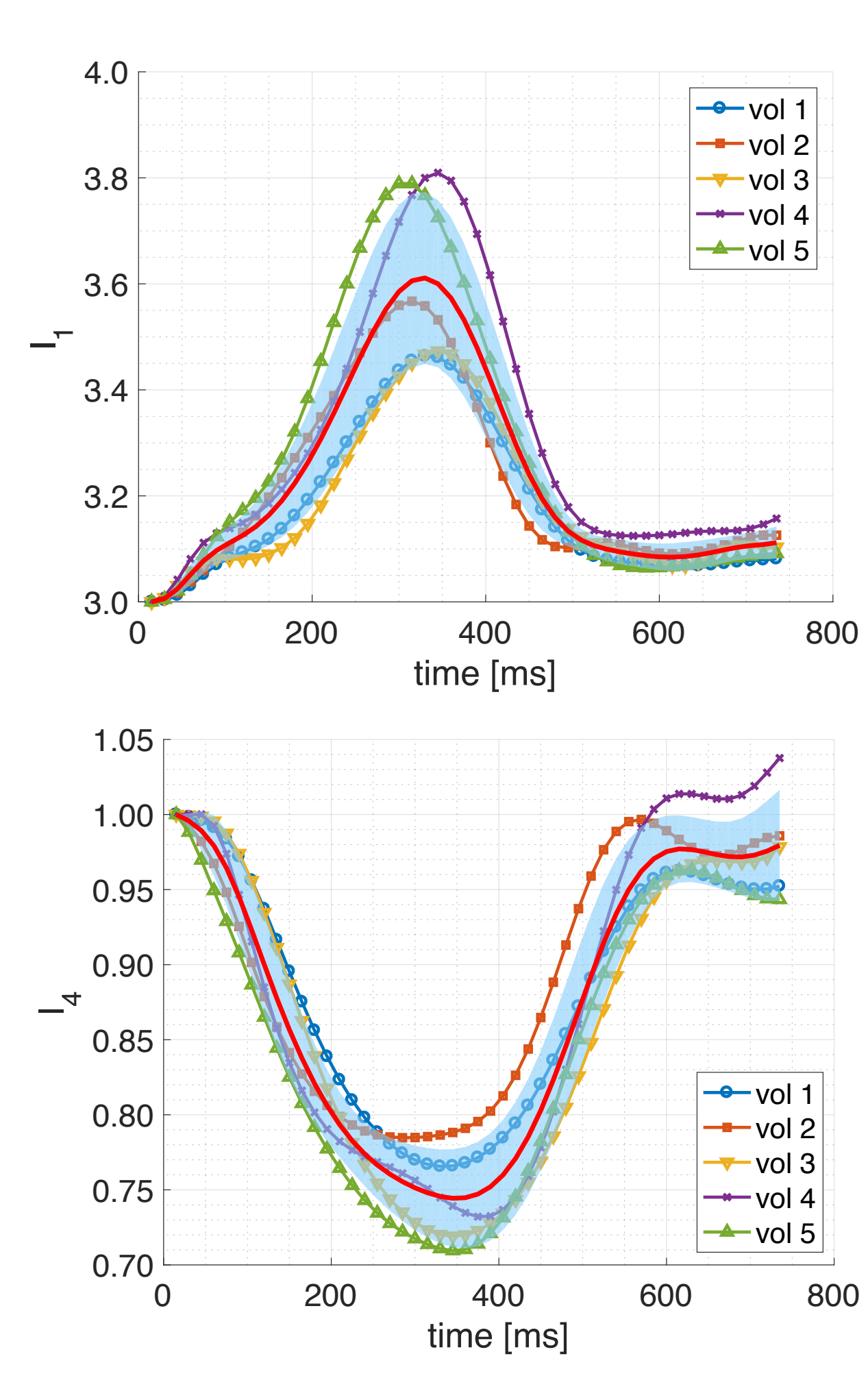**Model Construction**: LV short-axis single-slice (top) including cardiomyocyte preferential orientations (principal eigenvectors) from cDTI and Lagrangian displacement vectors from beginning to end systole from DENSE.

Pointwise error for I1 and I4 computed with the analytical phantom and using the single slice model with DENSE simulated data.

Peak systolic deformation invariants I1 and I4 in a healthy volunteer at end systole.

Time evolution of averaged I1 and I4 in N=5 healthy volunteers - intersubject mean (red line) and standard deviation (blue shaded region).