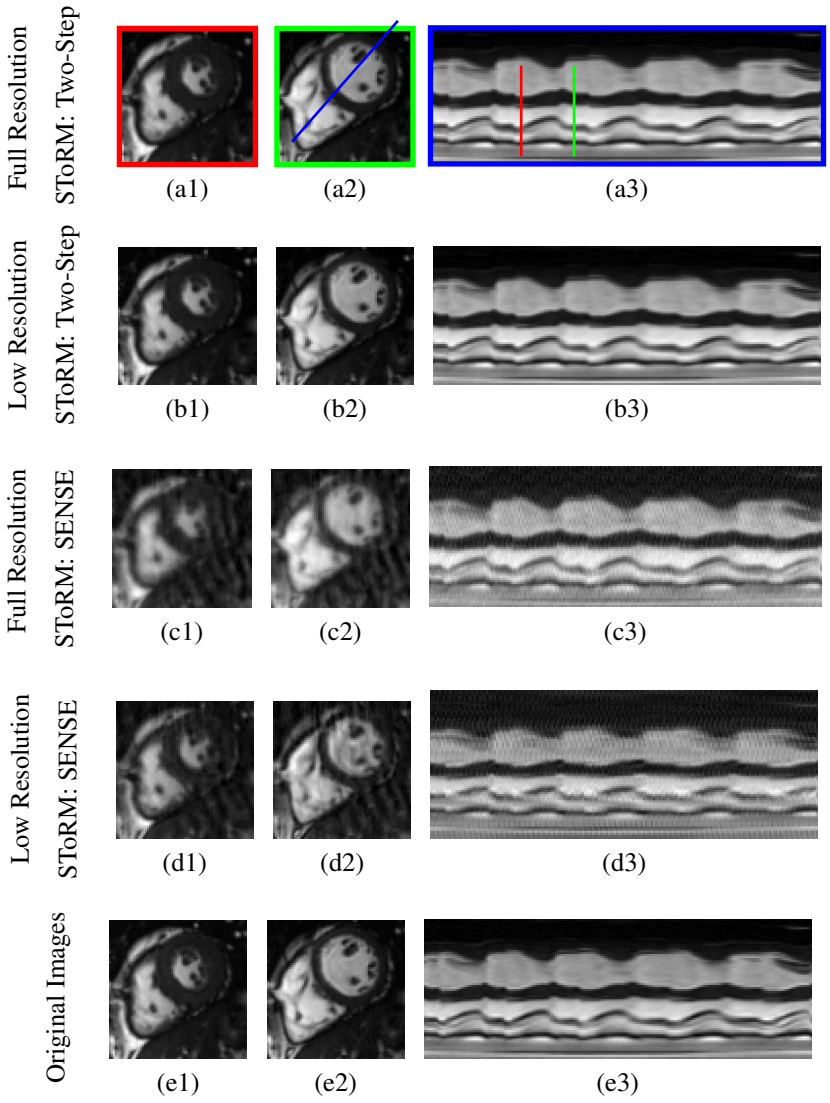
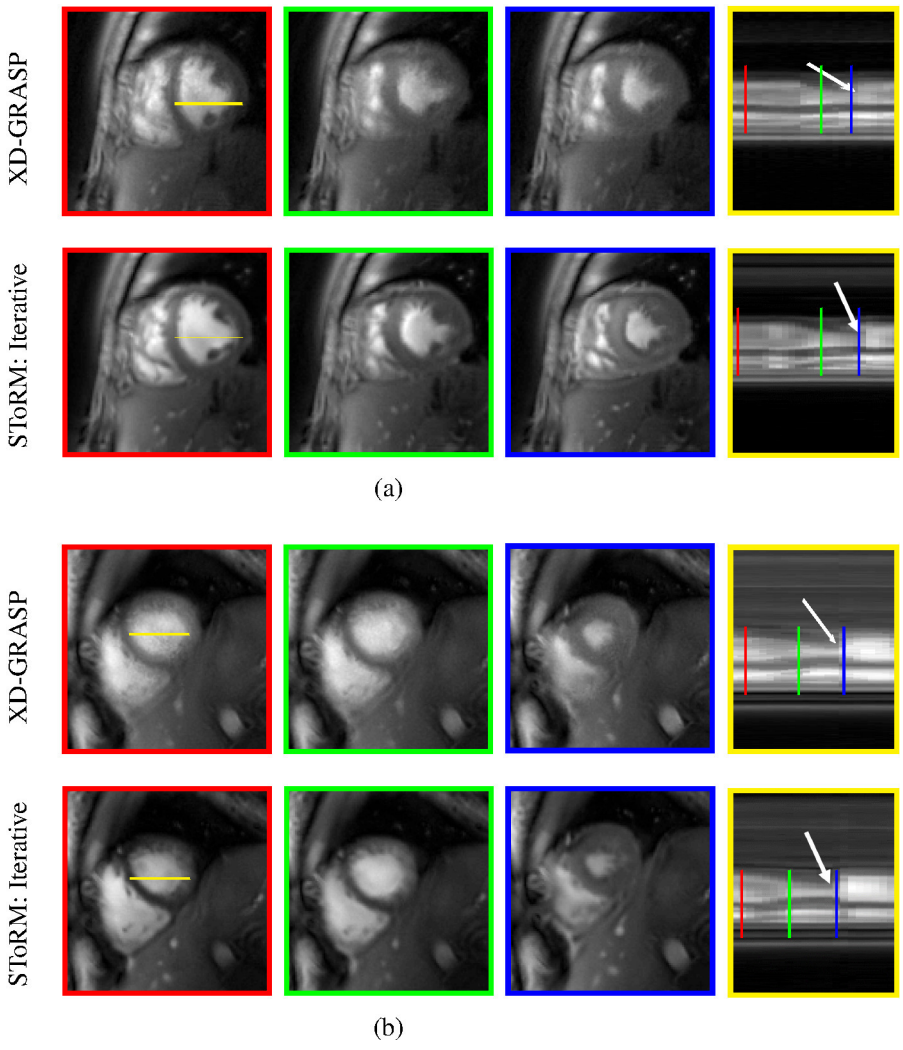
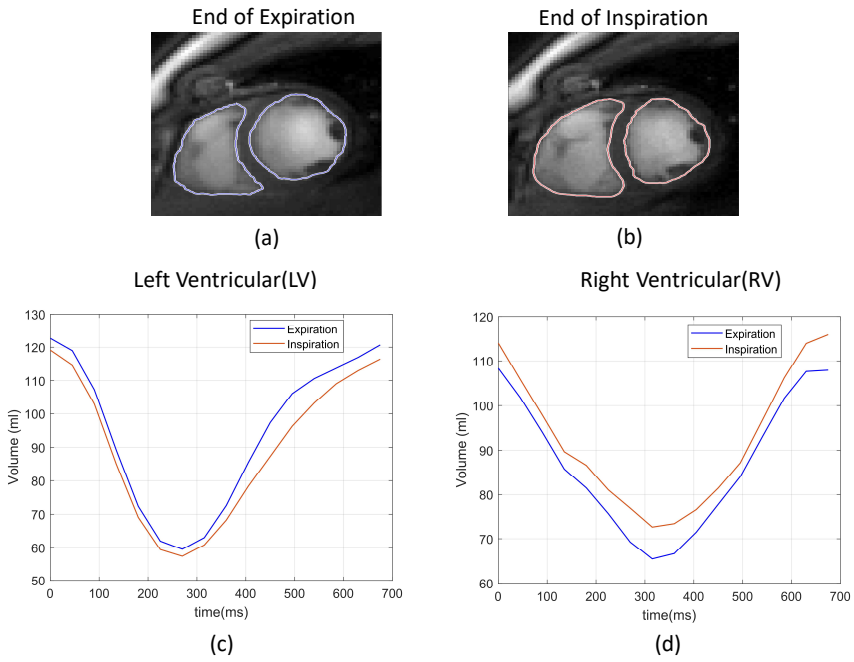


Supplementary Figure S1 . Comparison of Laplacian estimation strategies. Top two rows show the SToRM-Two-Step results, reconstructed from the Laplacian matrices estimated from full-resolution and low-resolution images respectively (a1-b3). Bottom two rows show SToRM-SENSE results. c1-c3 depict the final reconstructed images from the Laplacian matrix estimated from high-resolution images whereas d1-d3 show the results from low-resolution images. The bottom row correspond to the setting where the Laplacian is estimated from the original images (e1-e3). As expected, we obtain slightly improved performance when full resolution reconstructions are used to evaluate the Laplacian matrix using the kernel low-rank method. Specifically, the full resolution reconstructions account for the high spatial resolution information and hence can provide accurate estimates of cardiac and respiratory motion, which translates to improved reconstruction. In addition to the insignificant image quality difference, the computational complexity is higher in the high-resolution based image reconstruction.



Supplementary Figure S2 . Comparison of the proposed scheme against XD-GRASP. We show the frames from our dataset that closely match the ones recovered using XD-GRASP. Note that we do not expect a perfect match in anatomy since XD-GRASP performs an averaging of data within respiratory bins. Three spatial frames are shown, selected from the locations indicated in the temporal profiles with red, green and blue lines. The proposed method results in reconstructions with reduced blurring, compared to XD-GRASP. Since the methods are different we tried to find the best match at particular cardiac respiratory states. Therefore, the first dataset is in the end-inspiration and the second dataset is in the end-expiration. White arrows are used to show the end systole phase, which is well captured by both methods. Contrast changes and the dark rim on the endocardium can be observed, which are due to the cardiac motion and the Gibbs ringing in the variable density spiral based acquisition.



Supplementary Figure S3 . Comparison between right ventricular (RV) and left ventricular (LV) volumes at expiration and inspiratation states (10 slices data from apex to base to cover whole heart) . (a)-(b) show the visual difference between RV and LV areas at end-expiration and end-inspiration, respectively. (c) shows the LV volume at expiration and inspiration states, and it is obervered that the expiration state has higher LV volume as compared to the inspiration state, whereas we have observed opposite trend in RV volume (d). Peak LV volume at expiration =123.1 ml whereas peak LV volume at inspiration = 119.6 ml. Minimum LV values at expiration and inspiration are 57.6 ml and 55 ml respectively (Expiration LV stroke volume= 65.5 ml and Inspiration LV stroke volume= 64.6 ml). Peak RV at expiration = 109 ml and peak RV at inspiration = 115.1 ml. Minimum RV at expiration and inspiration are 65.3 ml and 72.6 ml, respectively.