# Mapping of Myocardial ASL Perfusion and Perfusion Reserve Data

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## INTRODUCTION:

Arterial spin labeling (ASL) is an emerging tool for the assessment of myocardial perfusion and perfusion reserve in humans. This technique requires registration of multiple images and suffers from low signal-to-noise ratio (SNR) [1-4]. In this work, we present a novel approach for mapping perfusion and perfusion reserve based on ASL data. Unregistered spatial data is transformed into a polar coordinate frame and then simultaneously filtered and re-sampled onto a polar grid to boost SNR while generating useful visualizations [5]. This approach is tailored to the formation of quantitative maps from unregistered low-SNR data, and is not specific to ASL.

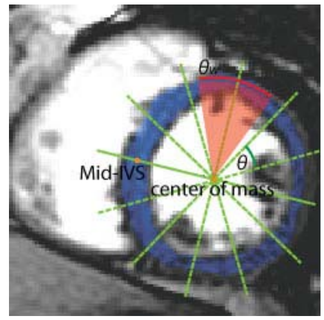


*Figure 1: Manually segmented LV ROI (blue). All LV samples are transformed to polar coordinates relative to the center of mass and the mid-interventricular septum.*

## METHODS:

Mid-short-axis slices were imaged, and regions of myocardium were manually segmented. All data were transformed to a polar coordinate frame based on the segmented contours, the center of mass, and the mid-interventricular septum (see Figure 1), leading to irregularly spaced data in the new frame. These data were then resampled at uniformly spaced intervals around the circumference of the left ventricle where each resampled data point, was computed as a weighted average of sample values within its neighborhood, using a truncated Gaussian as the weights: $W(\Delta\theta) = e^{-\frac{\Delta\theta}{2\sigma^2}} \sqcap (\Delta\theta/\theta_w)$. The standard deviation of the Gaussian, $\sigma$, and the window width, $\theta_w$, are free parameters. This approach allows for straightforward computation of noise power in the new coordinate frame. Myocardial blood flow (MBF), thermal noise, and physiological noise were then estimated from ASL signals as described in Ref. [1], and were plotted onto the polar coordinate frame.

## RESULTS:

Data from twenty-nine patients were analyzed. Figure 2 shows data from a representative patient with a total occlusion of the left anterior descending (LAD) coronary artery, confirmed by X-ray angiography. When increasing the window size, $\theta_w$, from π/6 to 2π, the average thermal noise across all patients decreased from 0.060 to 0.020 ml/ml/min, while the average physiological noise decreased from 0.70 to 0.46 ml/ml/min. This indicates that physiological noise is spatially correlated. As shown in Figure 3, the use of broader filters reduces both thermal and physiological noise at the cost of decreased angular resolution, which hinders assessment of individual segments.

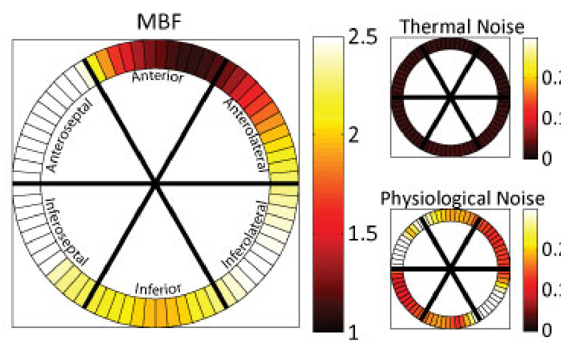


*Figure 2: Maps of MBF, thermal noise, and physiological noise from a patient with a total LAD occlusion, during adenosine infusion. All quantities are in ml/ml/min.*

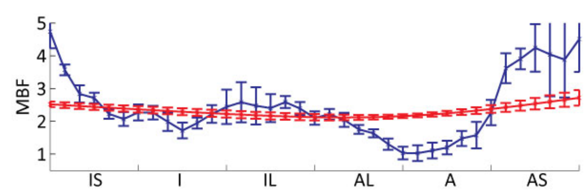


*Figure 3: Regional MBF using filter widths of π/6 (blue) and 2π (red). Bars represent physiological noise. Notice the tradeoff between SNR and angular resolution. All quantities are in ml/ml/min. IS:Inferoseptal, I:Inferior, IL:Inferolateral, AL:Anterolateral, A:Anterior, AS:Anteroseptal.*

## DISCUSSION:

The proposed approach enables mapping of myocardial ASL perfusion and perfusion reserve in a polar space. Next steps include consideration of myocardial layers and optimization of imaging protocols, segmentation approaches, and polar space spatial filters to provide clinically valuable assessment of perfusion reserve.

## REFERENCES:

[1] Zun, et al. MRM, 62:975–983, 2009. [2] Wang, et al. MRM, 64: 1289–1295, 2010. [3] Poncelet, et al. MRM, 41:510-519, 1999. [4] Wacker, et al. JMRI, 18:555-560, 2003. [5] Cerqueira, et al. *Circulation*, 105:539–542, 2002.