

# Uniform Spinning Sampling Gradient Electron Paramagnetic Resonance Imaging

David H. Johnson, Zhiyu Chen, Rizwan Ahmad, Alexandre Samouilov, and Jay L. Zweier.  
Davis Heart and Lung Research Institute, Ohio State University Wexner Medical Center

## Declaration of Relevant Financial Interests or Relationships.

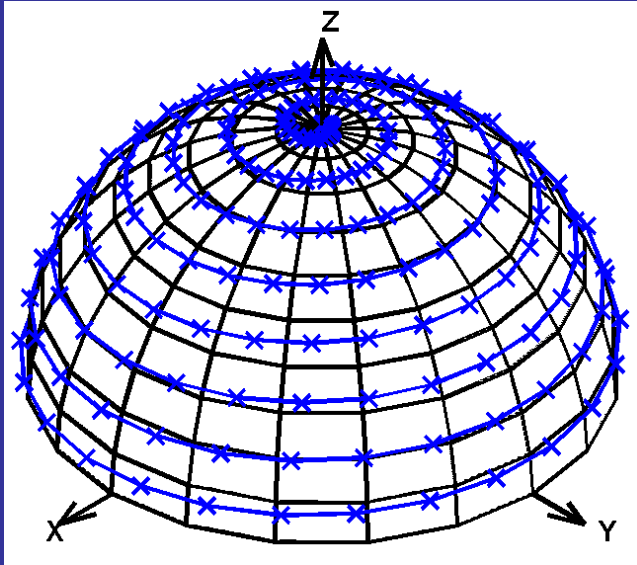
David H. Johnson: I have no relevant financial interest or relationship to disclose with regard to the subject matter of this presentation.



# Motivation

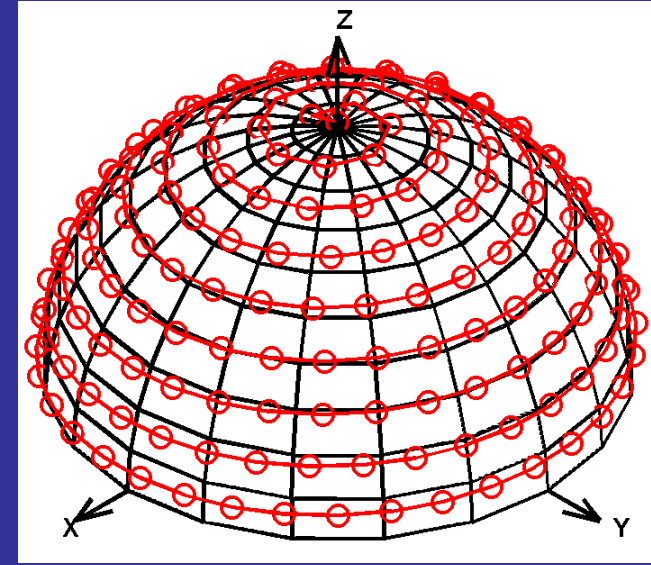
- Electron Paramagnetic Resonance (EPR) Imaging can directly measure free radicals,  $O_2$ , and pH *in vivo*
- Quickly acquiring enough projections to reconstruct a high quality image is a challenge
- Spinning gradient acquisitions can produce thousands of projections rapidly, enabling high quality reconstructions

# Methods



**Equilinear Spinning Sampling  
(ESS)**

- Traditional
- Equal angle increments between adjacent projections
- Many redundant projections



**Uniform Spinning Sampling  
(USS)**

- Novel
- Variable angle increments between adjacent projections
- Every projection contributes new information to reconstruction

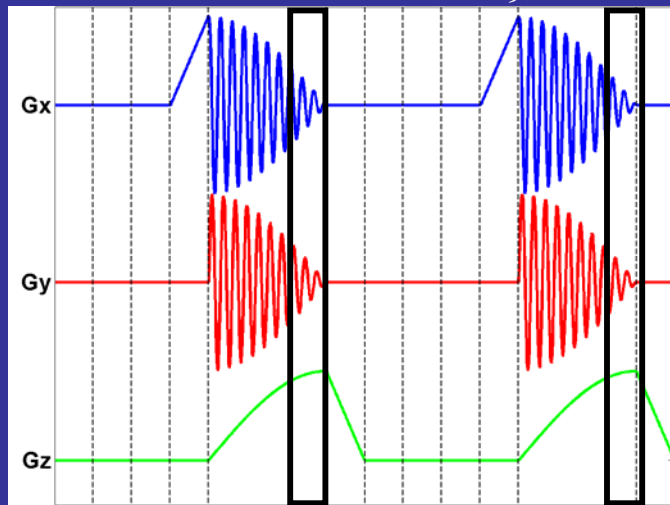
# Redesigning the Acquisition

**ESS:**

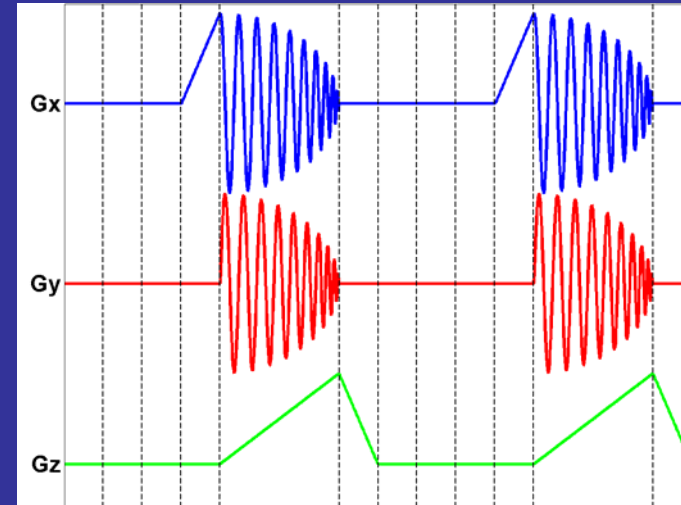
$$\left. \begin{aligned} \varphi_i &= \frac{\pi}{2} \frac{i-1}{N-1} \\ \theta_i &= -4R \left( \frac{\pi}{2} - \varphi_i \right) \end{aligned} \right\} i = [1, \dots, N]$$

**USS:**

$$\begin{aligned} \varphi_i &= \arcsin\left(\frac{i-1}{N-1}\right) \\ \theta_i &= \varphi_i \sqrt{2\pi N} \end{aligned}$$



Wasted acquisition time



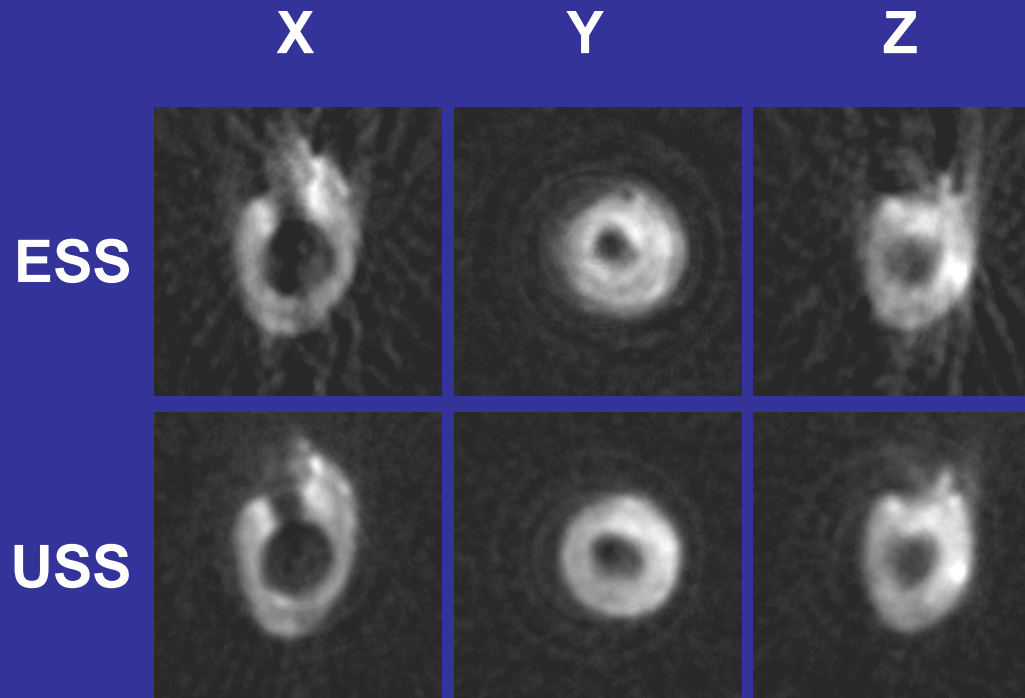
- Arcsin transformation compensates for oversampling near Z axis
- Uniform for any number of projections ( $M$ )
- Same gradient amplitudes

# Experiments

- Isolated rat heart
- Infused with PBS, calcium, and 20 mg/ml Lithium Phthalocyanine (LiPc) suspension through the cannulated aorta
- Balloon inserted into left ventricle
- 4.5 min data acquisition on 1.2 GHz CW EPRI system



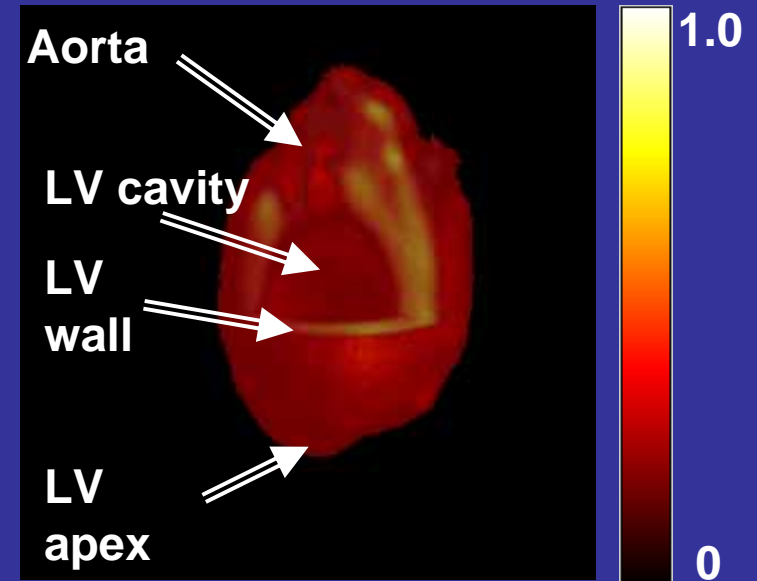
# Results



- Streaking artifacts were suppressed by using USS
- SNR enhanced

# Visualization

- Volume rendering in 3D allows visualization of the heart
- LiPc is perfused throughout the myocardium
- Signal void (balloon) in the LV cavity allows delineation of the LV



# Conclusion

- A novel spinning gradient acquisition was developed and evaluated in an isolated rat heart model
- USS images had higher SNR and lower artifacts than ESS images

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See also recent publication: "Uniform spinning sampling gradient electron paramagnetic resonance imaging. D. H. Johnson, R. Ahmad, Y. Liu, Z. Chen, A. Samouilov and J. L. Zweier. Magn Reson Med. 2013 (in press)."