Weill Cornell Medicine

StaBle: Reducing Aliasing Errors in Doppler Ultrasound for High-Velocity Blood Flow Imaging

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Background & Unmet Need

- Echocardiography is an essential diagnostic and research tool to allow non-invasive visualization of cardiac structures and function
- Doppler ultrasound specifically measures blood flow velocity and can be used to visualize and measure complex flow patterns in the heart, aorta, carotid, and even the urethra
- However, this type of blood flow analysis is often impeded by aliasing artifacts, which occur when the speed of blood is higher than the maximum measurable velocity using ultrasound
- This poses a particular challenge in blood flow analysis in small animal models, as aliasing limits are reduced because of high frequencies
- **Unmet Need:** Improved methods for measuring high velocity blood flow using Doppler ultrasound with fewer aliasing errors for more accurate assessment of cardiac function in humans and animal models, particularly for high-speed plane wave methods

Technology Overview

- **The Technology:** StaBle (Staggered PRF with douBle Transmission), a method to increase the maximum velocity measurement range of Doppler ultrasound
- This technique combines staggered PRF (Pulse Repetition Frequency) and double transmission to detect true velocities from aliased measurements
- **PoC Data:** StaBle is able to achieve a 6-12 times higher velocity limit compared to sequential angle transmission techniques
- In a phantom spinning disc experiment, StaBle demonstrated a 9-fold improvement in detecting peak axial velocity over sequential angle transmission techniques
- *In vivo*, StaBle enabled measurement of an unaliased vector field in the left ventricle of a mouse heart, and consistent measurement of vorticity, kinetic energy, and energy loss

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Patents:
Provisional Filed

Publications:
IEEE-TUFFC – In review
April 2025.

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Technology Applications

- Evaluation of blood flow dynamics in the heart, aorta, or carotid artery
- Improved cardiac flow analysis for cardiovascular research in animal models, such as mice, rats, rabbits, and guinea pigs
- Improved diagnosis and monitoring of cardiovascular disease, such as early-stage heart failure, using Doppler ultrasound methods

Technology Advantages

- Maintains high spatial resolution while increasing the maximum velocity measurement range
- Enables use of high-frequency ultrasound for measurement of small structures, like murine hearts, which have previously been challenging to study
- Reduces data acquisition requirements by enabling high-velocity measurements at lower PRF

Supporting Data / Figures

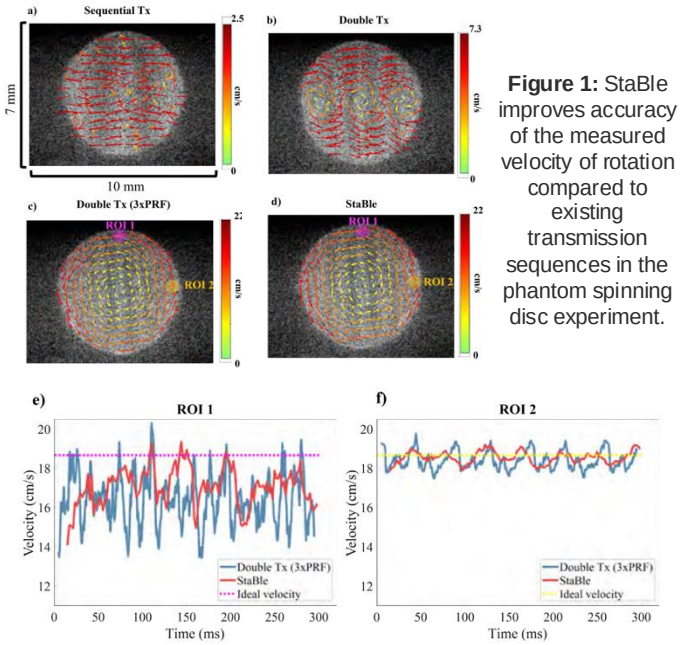

Figure 1: StaBle improves accuracy of the measured velocity of rotation compared to existing transmission sequences in the phantom spinning disc experiment.

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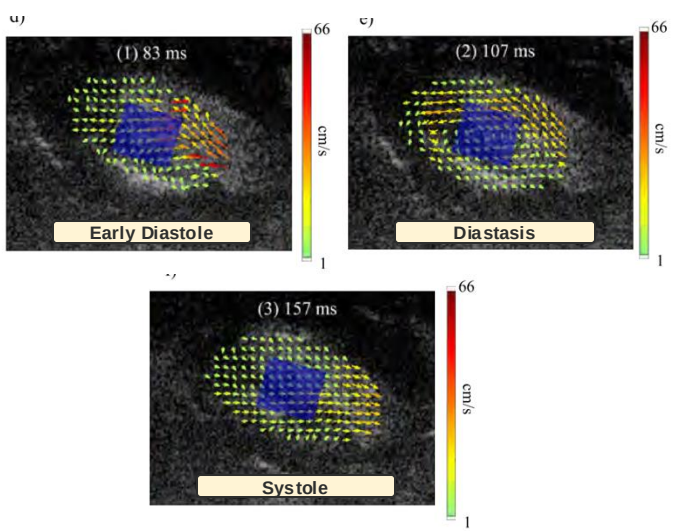
Supporting Data / Figures

Dealiased Doppler Ultrasound with StaBle



Blood Flow Quantification

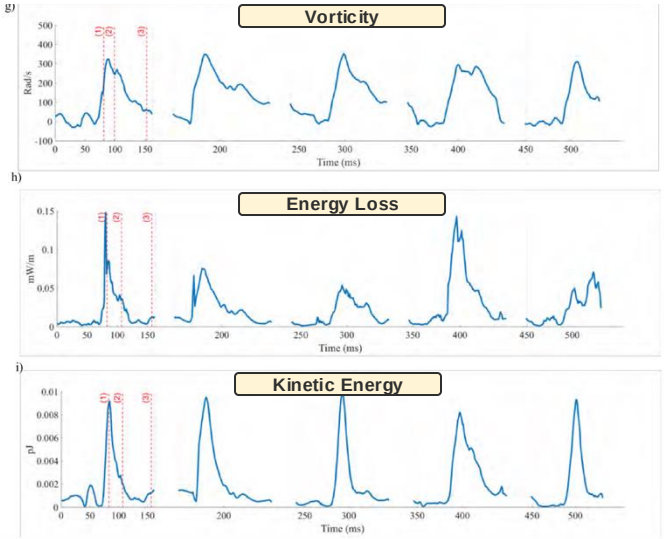


Figure 2: Implementation of StaBle to address Doppler aliasing in a mouse left ventricle and the resulting intracardiac flow quantification.

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