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Contrast-to-Tissue Ratio Improvement by Transmitted Optimized Binary Signal in Ultrasound Pulse Inversion Imaging

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1. Introduction & Background

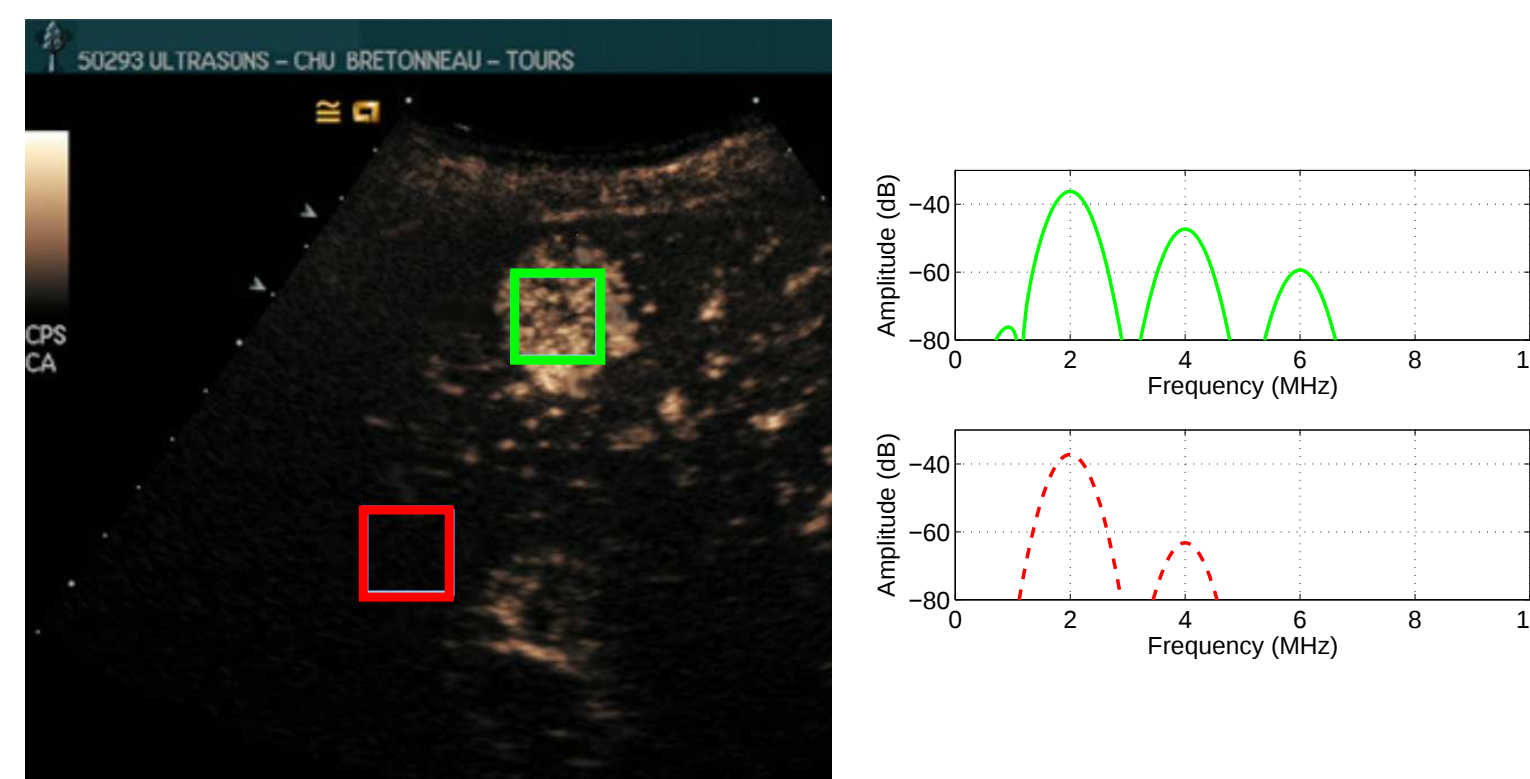
A. Ultrasound Contrast Imaging

- Injection of encapsulated microbubbles
- High nonlinear behaviour
- Contrast-to-Tissue Ratio

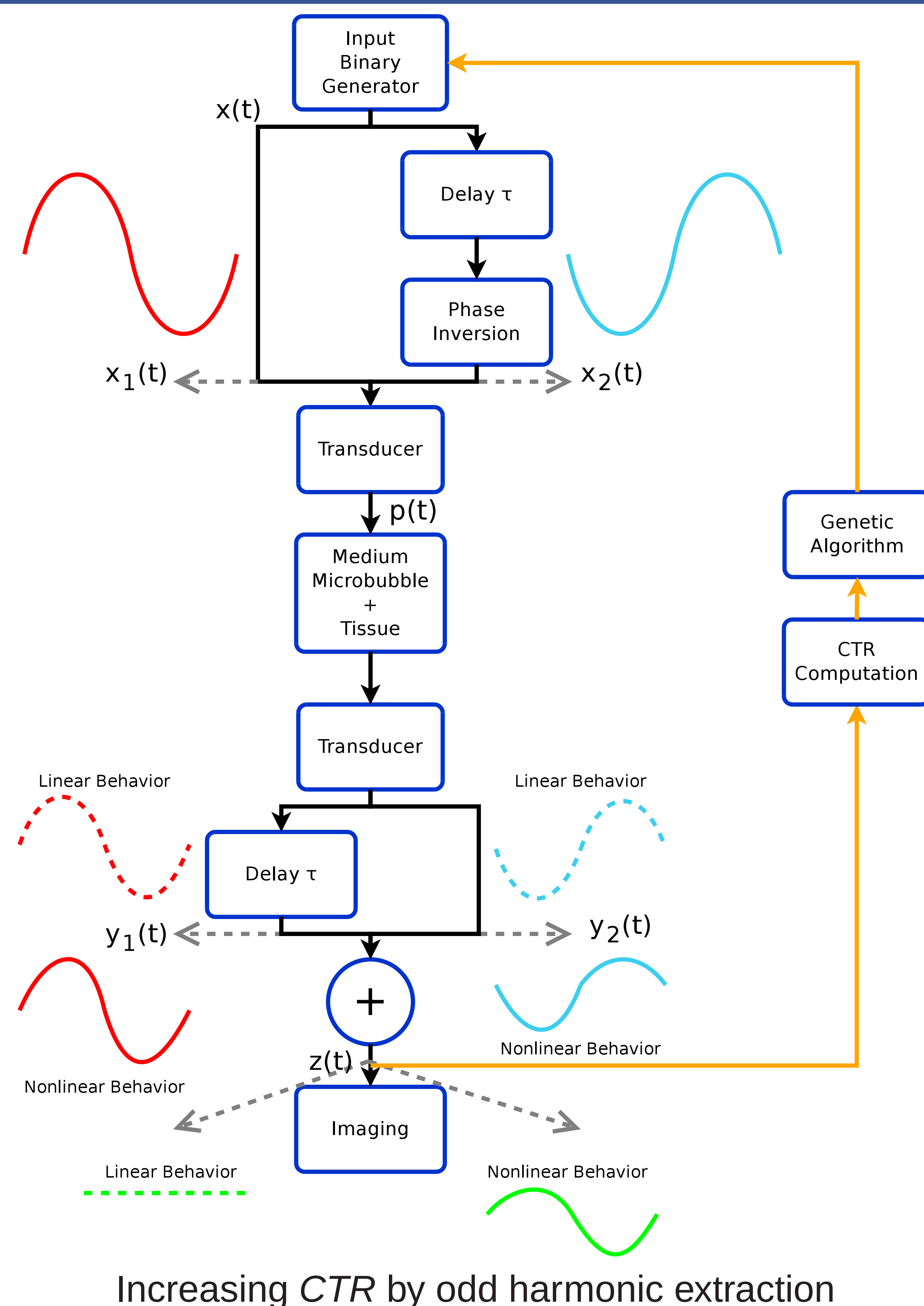
$$CTR = \frac{E_{\text{microbubbles}}}{E_{\text{tissue}}}$$

B. Simulation

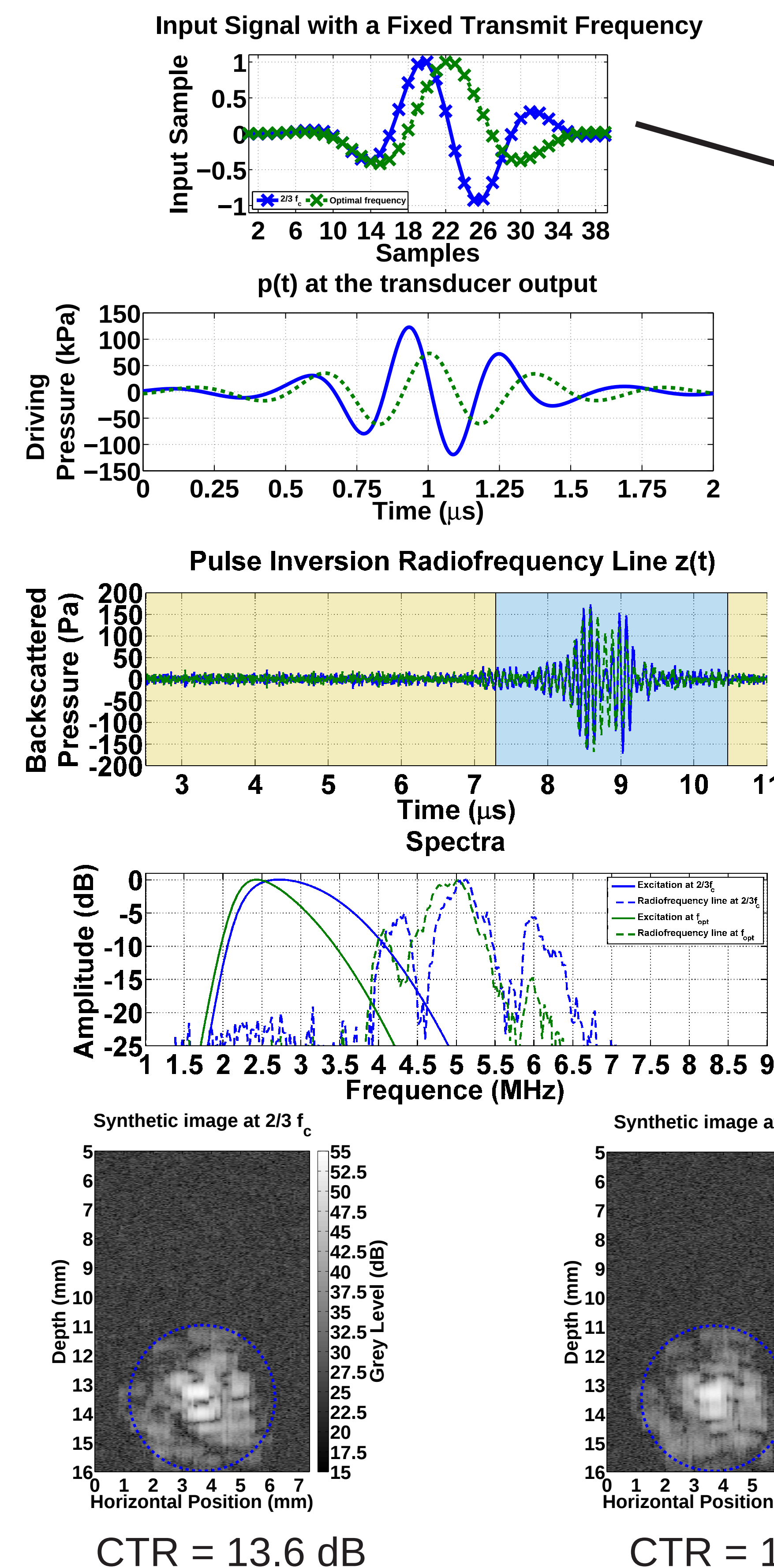
- Marmottant model for a 2.5 μm microbubble
- Nonlinear propagation in tissue by Anderson's model
- Transducer: 4 MHz - 75%



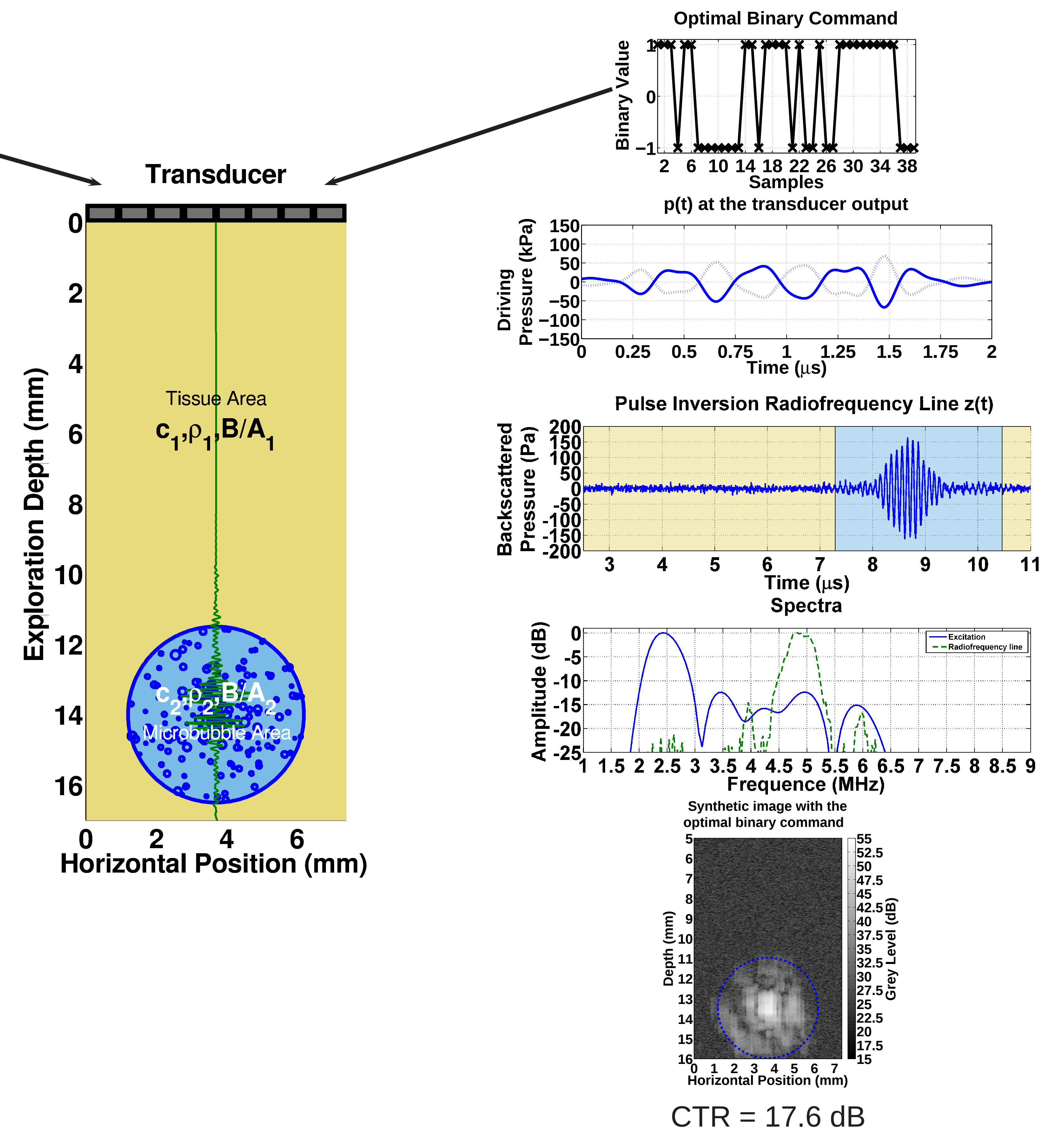
2. Pulse Inversion Ultrasound Imaging with Feedback



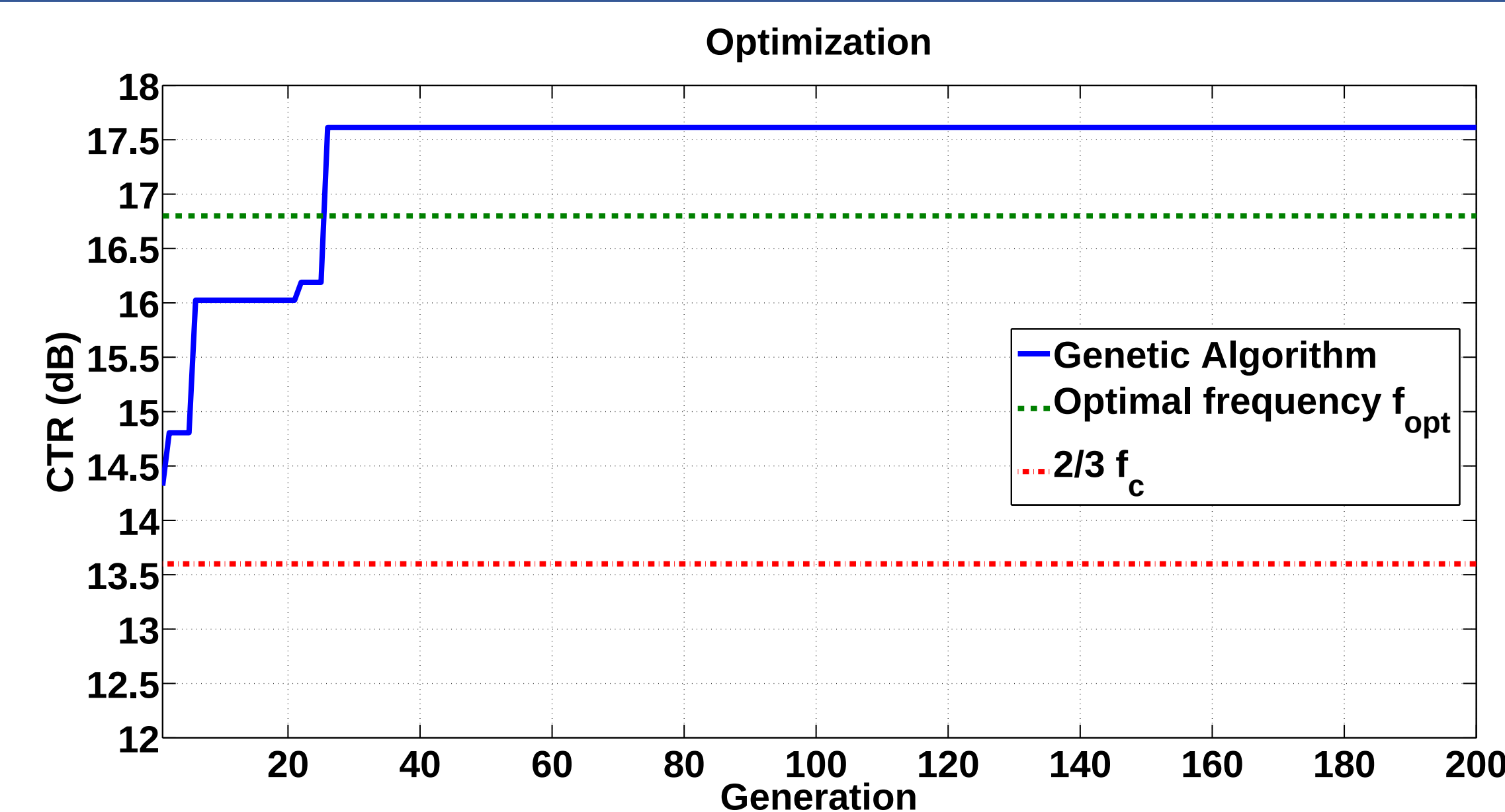
3. Usual Transmitted Pulse



4. Optimal Binary Command



5. Optimization Process by Binary Genetic Algorithm



6. Discussion

- Automatic optimization of CTR
- Gain
 - 4 dB in comparison with an excitation at $2/3f_c$
 - 0.8 dB in comparison with an excitation at the optimal frequency
- Stochastic excitation combined with genetic algorithm $\rightarrow$ Nonlinear
- Nonlinear backscattered components only due to medium nonlinearities
- Prospects
 - Implementation on ultrasound scanner
 - Using programmable analogue transmitter

Ménigot et al., Optimization of Contrast to Tissue Ratio by Frequency Adaptation in Pulse Inversion Imaging, IEEE T UFFC, 59(11), 2012