

JON N. MARSH

7847 Trenton Avenue • University City, MO 63130 • 217-418-4292 • jonnathanmarsh@gmail.com

Professional Profile

Ph.D. ultrasound physicist with over 20 years' experience working in cross-disciplinary environments spanning medicine, biology, basic physics, and engineering. Extensive and diverse background in the fields of signal processing, image processing, molecular imaging, acoustic microscopy, non-destructive testing, and scientific computing. An expert toolmaker and intuitive problem solver.

Work History

Consortium for Translational Research in Advanced Imaging and Nanomedicine (C-TRAIN)

(Washington University School of Medicine)

- 2005-2016: Senior Scientist
- 2002-2005: Research Associate
- 1998-2002: Postdoctoral Researcher

Research Experience

- Designed experiments and oversaw multiple research project teams for in vivo ultrasonic detection and visualization of theranostic nanoparticles targeted to a variety of pathology (e.g., muscular dystrophy, myocardial infarction, angiogenesis, and acute thrombosis) in order to rapidly identify and quantify disease progression and the effects of targeted treatment.
- Participated in development of entropy-based analysis of acoustic waveforms leading to greatly increased sensitivity to subtle changes in scattering architecture of tissue relative to energy-based metrics.
- Conducted in vivo and ex vivo measurements to determine physical basis of acoustic scattering and attenuation in anisotropic tissue such as myocardium and tendon.
- Devised experiments and developed mathematical models for characterization and optimization of acoustic scattering from encapsulated microbubble contrast agents and perfluorocarbon nanodroplet site-targeted ultrasound contrast agents.

Software Development Experience

- Implemented and optimized novel information-theoretic algorithms for detection of acoustic signals in very noisy data for real-time visualization.
- Created software for high-speed data acquisition from acoustic microscopes and modified commercial imaging systems.
- Developed synthetic aperture software to enhance near-field performance of single-element ultrasound probes.
- Independently created large suite of open-source software tools for processing waveform data in ImageJ (https://github.com/JonMarsh/waveform_processing_for_imagej).
- Wrote image segmentation and feature-tracking software for microscopy and cardiac function applications.

Hardware Design Experience

- Designed several high-frequency/high-resolution scanning acoustic microscope systems for ex vivo ultrasound tissue characterization as well as non-destructive testing of carbon-epoxy composites.
- Initiated collaboration with industry partners to modify commercial ultrasound imagers to output radiofrequency data for advanced imaging using novel signal processing algorithms.
- Developed broadband acoustic spectrometer and novel theoretical and experimental techniques suitable for industrial quality control assessment of ultrasound contrast agents.

Languages/Tools

- Proficient in: Java, ImageJ, LabVIEW, GPIB. Experience in: Mathematica, C/C#, OpenCL, Git, Maven, Matlab, Python

Education

- **Washington University in St. Louis:** Ph.D., Physics, 1998
- **Washington University in St. Louis:** M.A., Physics, 1993
- **Western Maryland College:** B.A., Physics, 1990

Affiliations and Awards

- Summa cum Laude, Western Maryland College
- Phi Beta Kappa
- National Need Research Fellowship, Washington University
- IEEE Member (1992–present)

Refereed Manuscripts

- [1] R. U. Palekar, C. Vemuri, **J. N. Marsh**, B. Arif, and S. A. Wickline, "Antithrombin nanoparticles inhibit stent thrombosis in ex vivo static and flow models," *J Vasc Surg*, 2015.
- [2] A. P. Jallouk, R. U. Palekar, **J. N. Marsh**, H. Pan, C. T. N. Pham, P. H. Schlesinger, and S. A. Wickline, "Delivery of a Protease-Activated Cytolytic Peptide Prodrug by Perfluorocarbon Nanoparticles.," *Bioconj Chem*, vol. 26, pp. 1640--1650, 2015.
- [3] M. S. Hughes, J. E. McCarthy, P. J. Bruillard, **J. N. Marsh**, and S. A. Wickline, "Entropy vs. Energy Waveform Processing: A Comparison Based on the Heat Equation.," *Entropy (Basel)*, vol. 17, pp. 3518--3551, 2015.
- [4] M. Hughes, **J. Marsh**, S. Wickline, and J. McCarthy, "Additional results for "joint entropy of continuously differentiable ultrasonic waveforms" [*J. Acoust. Soc. Am.* 133(1), 283-300 (2013)]." *J Acoust Soc Am*, vol. 137, pp. 501, 2015.
- [5] K. P. Bibee, Y.-J. Cheng, J. K. Ching, **J. N. Marsh**, A. J. Li, R. M. Keeling, A. M. Connolly, P. T. Golumbek, J. W. Myerson, G. Hu, J. Chen, W. D. Shannon, G. M. Lanza, C. C. Wehl, and S. A. Wickline, "Rapamycin nanoparticles target defective autophagy in muscular dystrophy to enhance both strength and cardiac function.," *FASEB J*, vol. 28, pp. 2047--2061, 2014.
- [6] H. Pan, J. W. Myerson, L. Hu, **J. N. Marsh**, K. Hou, M. J. Scott, J. S. Allen, G. Hu, S. San Roman, G. M. Lanza, R. D. Schreiber, P. H. Schlesinger, and S. A. Wickline, "Programmable nanoparticle functionalization for in vivo targeting.," *FASEB J*, vol. 27, pp. 255--264, 2013.
- [7] M. Hughes, J. McCarthy, **J. Marsh**, and S. Wickline, "Joint entropy of continuously differentiable ultrasonic waveforms.," *J Acoust Soc Am*, vol. 133, pp. 283--300, 2013.
- [8] H. Pan, **J. N. Marsh**, E. T. Christenson, N. R. Soman, O. Ivashyna, G. M. Lanza, P. H. Schlesinger, and S. A. Wickline, "Postformulation peptide drug loading of nanostructures.," *Methods Enzymol*, vol. 508, pp. 17--39, 2012.
- [9] D. Pan, S. D. Caruthers, A. Senpan, C. Yalaz, A. J. Stacy, G. Hu, **J. N. Marsh**, P. J. Gaffney, S. A. Wickline, and G. M. Lanza, "Synthesis of NanoQ, a copper-based contrast agent for high-resolution magnetic resonance imaging characterization of human thrombus.," *J Am Chem Soc*, vol. 133, pp. 9168--9171, 2011.
- [10] **J. N. Marsh**, G. Hu, M. J. Scott, H. Zhang, M. J. Goette, P. J. Gaffney, S. D. Caruthers, S. A. Wickline, D. Abendschein, and G. M. Lanza, "A fibrin-specific thrombolytic nanomedicine approach to acute ischemic stroke.," *Nanomedicine (Lond)*, vol. 6, pp. 605--615, 2011.
- [11] M. S. Hughes, **J. N. Marsh**, K. F. Agyem, J. E. McCarthy, B. N. Maurizi, M. V. Wickerhauser, K. D. Wallace, G. M. Lanza, and S. A. Wickline, "Use of smoothing splines for analysis of backscattered ultrasonic waveforms: application to monitoring of steroid treatment of dystrophic mice.," *IEEE Trans Ultrason Ferroelectr Freq Control*, vol. 58, pp. 2361--2369, 2011.
- [12] H. Pan, J. W. Myerson, O. Ivashyna, N. R. Soman, **J. N. Marsh**, J. L. Hood, G. M. Lanza, P. H. Schlesinger, and S. A. Wickline, "Lipid membrane editing with peptide cargo linkers in cells and synthetic nanostructures.," *FASEB J*, vol. 24, pp. 2928--2937, 2010.
- [13] **J. N. Marsh**, K. D. Wallace, J. E. McCarthy, M. V. Wickerhauser, B. N. Maurizi, G. M. Lanza, S. A. Wickline, and M. S. Hughes, "Application of a real-time, calculable limiting form of the Renyi entropy for molecular imaging of tumors.," *IEEE Trans Ultrason Ferroelectr Freq Control*, vol. 57, pp. 1890--1895, 2010.
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- [15] M. Hughes, J. McCarthy, M. Wickerhauser, **J. Marsh**, J. Arbeit, R. Fuhrhop, K. Wallace, T. Thomas, J. Smith, K. Agyem, G. Lanza, and S. Wickline, "Real-time calculation of a limiting form of the Renyi entropy applied to detection of subtle changes in scattering architecture.," *J Acoust Soc Am*, vol. 126, pp. 2350--2358, 2009.
- [16] M. Hughes, **J. Marsh**, J. Arbeit, R. Neumann, R. Fuhrhop, K. Wallace, L. Thomas, J. Smith, K. Agyem, G. Lanza, S. Wickline, and J. McCarthy, "Application of Renyi entropy for ultrasonic molecular imaging.," *J Acoust Soc Am*, vol. 125, pp. 3141--3145, 2009.
- [17] N. Soman, **J. Marsh**, G. Lanza, and S. Wickline, "New mechanisms for non-porative ultrasound stimulation of cargo delivery to cell cytosol with targeted perfluorocarbon nanoparticles.," *Nanotechnology*, vol. 19, 2008.
- [18] M. Hughes, S. Caruthers, T. Tran, **J. Marsh**, K. Wallace, T. Cyrus, K. Partlow, M. Scott, M. Lijowski, A. Neubauer, P. Winter, G. Hu, H. Zhang, J. McCarthy, B. Maurizi, J. Allen, C. Caradine, R. Neumann, J. Arbeit, G. Lanza, and S. Wickline, "Perfluorocarbon Nanoparticles for Molecular Imaging and Targeted Therapeutics," *Proceedings of the IEEE*, vol. 96, pp. 397--415, 2008.
- [19] K. D. Wallace, **J. N. Marsh**, S. L. Baldwin, A. M. Connolly, R. Keeling, G. M. Lanza, S. A. Wickline, and M. S. Hughes, "Sensitive ultrasonic delineation of steroid treatment in living dystrophic mice with energy-based and entropy-based radio frequency signal processing.," *IEEE Trans Ultrason Ferroelectr Freq Control*, vol. 54, pp. 2291--2299, 2007.
- [20] T. D. Tran, S. D. Caruthers, M. Hughes, **J. N. Marsh**, T. Cyrus, P. M. Winter, A. M. Neubauer, S. A. Wickline, and G. M. Lanza, "Clinical applications of perfluorocarbon nanoparticles for molecular imaging and targeted therapeutics.," *Int J Nanomedicine*, vol. 2, pp. 515--526, 2007.
- [21] **J. N. Marsh**, K. C. Partlow, D. R. Abendschein, M. J. Scott, G. M. Lanza, and S. A. Wickline, "Molecular imaging with targeted perfluorocarbon nanoparticles: quantification of the concentration dependence of contrast enhancement for binding to sparse cellular epitopes.," *Ultrasound Med Biol*, vol. 33, pp. 950--958, 2007.
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- [24] M. Hughes, J. McCarthy, **J. Marsh**, J. Arbeit, R. Neumann, R. Fuhrhop, K. Wallace, D. Znidarsic, B. Maurizi, S. Baldwin, G. Lanza, and S. Wickline, "Properties of an entropy-based signal receiver with an application to ultrasonic molecular imaging.," *J Acoust Soc Am*, vol. 121, pp. 3542--3557, 2007.

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- [27] M. S. Hughes, **J. N. Marsh**, H. Zhang, A. K. Woodson, J. S. Allen, E. K. Lacy, C. Carradine, G. M. Lanza, and S. A. Wickline, "Characterization of digital waveforms using thermodynamic analogs: detection of contrast-targeted tissue in vivo.," *IEEE Trans Ultrason Ferroelectr Freq Control*, vol. 53, pp. 1609--1616, 2006.
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- [31] **J. N. Marsh**, S. Takiuchi, S. J. Lin, G. M. Lanza, and S. A. Wickline, "Ultrasonic delineation of aortic microstructure: the relative contribution of elastin and collagen to aortic elasticity.," *J Acoust Soc Am*, vol. 115, pp. 2032--2040, 2004.
- [32] **J. Marsh**, K. Crowder, M. Scott, E. Lacy, M. Hughes, G. Lanza, and S. Wickline, "Quantitative Acoustic signatures of ``tissue factor" expression by single smooth muscle cells targeted with liquid perfluorocarbon nanoparticles," *CIRCULATION*, vol. 108, pp. 644, 2003.
- [33] G. Lanza, P. Winter, S. Caruthers, M. Hughes, **J. Marsh**, X. Yu, R. Fuhrhop, H. Zhang, J. Allen, M. Scott, and S. Wickline, "Molecular imaging and targeted drug delivery: A new paradigm in medicine.," *ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY*, vol. 226, pp. U473, 2003.
- [34] S. A. Wickline, M. Hughes, F. C. Ngo, C. S. Hall, **J. N. Marsh**, P. A. Brown, J. S. Allen, M. D. McLean, M. J. Scott, R. W. Fuhrhop, and G. M. Lanza, "Blood contrast enhancement with a novel, non-gaseous nanoparticle contrast agent.," *Acad Radiol*, vol. 9 Suppl 2, pp. S290--S293, 2002.
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- [37] C. Hall, **J. Marsh**, M. Scott, P. Gaffney, S. Wickline, and G. Lanza, "Temperature dependence of ultrasonic enhancement with a site-targeted contrast agent.," *J Acoust Soc Am*, vol. 110, pp. 1677--1684, 2001.
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- [46] A. Klivanov, M. Hughes, J. Wojdyla, **J. Marsh**, C. Hall, J. Miller, J. Wible, JH, and G. Brandenburger, "Targeting of ultrasound contrast material: selective imaging of microbubbles in vitro.," *Acad Radiol*, vol. 5 Suppl 1, pp. S243--S246, 1998.
- [47] **J. Marsh**, C. Hall, M. Hughes, J. Mobley, G. Miller, and G. Brandenburger, "Broadband through-transmission signal loss measurements of Albunex(R) suspensions at concentrations approaching in vivo doses," *JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA*, vol. 101, pp. 1155-1161, 1997.
- [48] A. Klivanov, M. Hughes, **J. Marsh**, C. Hall, J. Miller, J. Wible, and G. Brandenburger, "Targeting of ultrasound contrast material. An in vitro feasibility study.," *Acta Radiol Suppl*, vol. 412, pp. 113--120, 1997.
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Conference Proceedings

- [1] A. J. Li, K. P. Bibee, **J. N. Marsh**, C. C. Weihl, and S. A. Wickline, "Mdx mice have a defect in autophagy that is restored by rapamycin-loaded nanoparticle treatment," in *FASEB Journal*, vol. 26, 2012.
- [2] **J. N. Marsh**, K. D. Wallace, G. M. Lanza, S. A. Wickline, M. S. Hughes, J. E. McCarthy, and M. V. Wickerhauser, "Application of a limiting form of the Renyi entropy for molecular imaging of tumors using a clinically relevant protocol," in *Proc. IEEE Int. Ultrasonics Symp*, 2010, pp. 53--56.
- [3] G. M. Lanza, **J. N. Marsh**, G. Hu, M. J. Scott, A. H. Schmieder, S. D. Caruthers, D. Pan, and S. A. Wickline, "Rationale for a nanomedicine approach to thrombolytic therapy," in *Stroke*, vol. 41, 2010, pp. S42--S44.
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- [13] K. D. Wallace, **J. N. Marsh**, A. M. Connolly, S. A. Wickline, M. S. Hughes, P. A. Brown, and J. E. McCarthy, "Information Theoretic Ultrasound Imaging Differentiates Dystrophin-Deficient and Normal Skeletal Muscle in Humans," in *Proc. IEEE Ultrasonics Symp*, 2006, pp. 1095--1098.
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- [20] M. Hughes, **J. N. Marsh**, A. K. Woodson, E. K. Lacey, C. Carradine, G. M. Lanza, and S. A. Wickline, "Characterization of digital waveforms using thermodynamic analogs: detection of contrast targeted tissue in mda 435 tumors implanted in athymic mice," in *Proc. IEEE Ultrasonics Symp*, vol. 1, 2005, pp. 373--376.
- [21] M. Hughes, **J. N. Marsh**, J. Arbeit, R. Neumann, R. W. Fuhrhop, G. M. Lanza, and S. A. Wickline, "Ultrasonic molecular imaging of primordial angiogenic vessels in rabbit and mouse models with α - β 3-integrin targeted nanoparticles using information-theoretic signal detection: results at high frequency and in the clinical diagnostic frequency range," in *Proc. IEEE Ultrasonics Symp*, vol. 1, 2005, pp. 617--620.
- [22] **J. N. Marsh**, K. C. Crowder, M. S. Hughes, M. J. Scott, E. K. Lacy, G. M. Lanza, and S. A. Wickline, "In vitro acoustic molecular imaging of tissue factor expressed by smooth muscle cells with stable liquid perfluorocarbon nanoparticle contrast agents," in *Proc. IEEE Ultrasonics Symp*, vol. 2, 2004, pp. 1102--1105 Vol.2.
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