

Visualizing the rapidly-vanishing signal using ultra-short echo time MRI: techniques and applications.

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MRI can provide superior soft tissue contrast with rich information and doesn't involve exposure to ionizing radiation. Therefore, it is the method of choice for many imaging applications. However, tissues with short transverse relaxation times (T_2/T_2^*) such as cortical bone and lung parenchyma are often invisible in conventional MR images. Ultra-short TE(UTE) MRI enables us to capture the rapidly decaying signals from the tissues otherwise invisible and hence has significantly broadened the applications of MRI. In this presentation, we will talk about the basic concepts of UTE MRI, current UTE MRI techniques and some of their applications.

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Education

Ph.D, Biomedical Engineering, University of Wisconsin-Madison, 2004
M.S., Biomedical Engineering, University of Wisconsin-Madison, 2002
M.S., Technical Physics, Peking University, P.R. China, 2000
B.S., Technical Physics, Peking University, P.R. China, 1997

Professional experience

12/2018 - Consultant, Medical Physics, Dept. of Radiology,
Mayo Clinic, Rochester, MN
12/2015 - 11/2018 Senior Associate Consultant, Medical Physics,
Dept. of Radiology, Mayo Clinic, Rochester, MN
02/2015 – 12/2015 Principle Research Scientist, Toshiba Medical Research
Institute USA, Inc. Vernon Hills, IL
06/2012 – 01/ 2015 Senior Research Scientist, Toshiba Medical Research Institute
USA, Inc. Vernon Hills, IL
01/2007 – 05/2012 Research Assistant Professor, Center for MR Research,
Univ. of Illinois at Chicago
01/2005 - 12/2006 Postdoctoral Fellow, Dept. of Radiology, Stanford University
08/2004 - 12/2004 Postdoctoral Research Associate, Medical Physics,
University of Wisconsin-Madison
1/2003 - 05/2003 Teaching Assistant, Biomedical Engineering,
University of Wisconsin-Madison
08/2000 - 07/2004 Research Assistant, Medical Physics,
University of Wisconsin-Madison

Professional activities

Member International Society for Magnetic Resonance in Medicine (ISMRM)
American Association of Physicists in Medicine (AAPM)
Reviewer Magnetic Resonance in Medicine
Journal of Magnetic Resonance Imaging
Journal of Magnetic Resonance
IEEE Transactions on Medical Imaging
Medical Physics
Magn Reson Mater Phy (MAGMA)
NMR in Biomedicine
Abdominal Imaging

Honors and awards

RSNA travel award for young investigators in molecular imaging (2009)
Excellent Academic Scholarship, Peking University (1993-1994)
Outstanding Graduate Student Fellowship, Peking University (1998-1999)
Glory Scholarship, Peking University (1998-1999)

Highlights of Qualifications and Skills

- Solid background in MR physics and engineering
- Extensive experiences in qualitative and quantitative MR imaging techniques, including pulse sequence development, imaging system imperfection correction (eddy currents, gradient timing errors, B0 and B1 inhomogeneities, etc.), image reconstruction, image processing and analysis
- Extensive clinical as well as industrial experiences in applying MR techniques to improve image quality, diagnosis and treatment
- Self-motivated and work well both independently and in a team environment

Peer reviewed papers

1. Carlstrom LP, Perry A, Graffeo CS, Dai D, Ding Y, Jakaitis DR, **Lu A**, Rodgers S, Kreck T, Hoofer K, Gorny KR, Kadirvel R, Kallmes DF. Novel Focal Therapeutic Hypothermia Device for Treatment of Acute Neurologic Injury: Large Animal Safety and Efficacy Trial. *J Neurol Surg B Skull Base*. Doi:10.1055/s-0040-1721818.
2. Mostardeiro TR, Panda A, Witte RJ, Campeau NG, McGee KP, Sui Y, **Lu A**. Whole-brain 3D MR fingerprinting brain imaging: clinical validation and feasibility to patients with meningioma. *MAGMA*. 2021 Oct;34(5):697-706.
3. Thompson SM, Gorny KR, Koepsel EMK, Welch BT, Mynderse L, **Lu A**, Favazza CP, Felmlee JP, Woodrum DA. Body Interventional MRI for Diagnostic and Interventional Radiologists: Current Practice and Future Prospects. *Radiographics*. 2021 Oct;41(6):1785-1801.
4. Suchyta MA, Gibreel W, Sabbagh MD, Hunt CH, Gorny KR, **Lu A**, Mardini S. Using Black Bone Magnetic Resonance Imaging for Fibula Free Flap Surgical Planning: A Means to Reduce Radiation Exposure with Accurate Surgical Outcomes. *Plast Reconstr Surg*. 2021 Jul 1;148(1):77e-82e.
5. Mostardeiro TR, Panda A, Campeau NG, Witte RJ, Larson NB, Sui Y, **Lu A**, McGee KP. Whole brain 3D MR fingerprinting in multiple sclerosis: a pilot study. *BMC Med Imaging*. 2021 May 22;21(1):88.
6. **Lu A**, Favazza CP, Felmlee JP, Welch BT, Mynderse LA, Browne JE, Woodrum DA, Gorny KR. Experimental Investigation of Cryoneedle Heating during MR-Guided Cryoablation in Ex Vivo Tissue Samples at 1.5-Tesla. *J Vasc Interv Radiol*. 2021 May;32(5):721-728.e2.
7. Lomas DJ, Woodrum DA, McLaren RH, Gorny KR, Felmlee JP, Favazza C, **Lu A**, Mynderse LA. Rectal wall saline displacement for improved margin during MRI-guided cryoablation of primary and recurrent prostate cancer. *Abdom Radiol (NY)*. 2020 Apr;45(4):1155-1161
8. **Lu A**, Woodrum DA, Felmlee JP, Favazza CP, Gorny KR. Improved MR-thermometry during hepatic microwave ablation by correcting for intermittent electromagnetic interference artifacts. *Phys Med*. 2020 Mar;71:100-107.
9. Gorny KR, Favazza CP, **Lu A**, Felmlee JP, Hangiandreou NJ, Browne JE, Stenzel WS, Muggli JL, Anderson AG, Thompson SM, Woodrum DA. Practical implementation of robust MR-thermometry during clinical MR-guided microwave ablations in the liver at 1.5 T. *Phys Med*. 2019 Nov;67:91-99.
10. **Lu A**, Atkinson IC, Thulborn KR. Motion reduction for quantitative brain sodium MR imaging with a navigated flexible twisted projection imaging sequence at 9.4 T. *J Magn Reson*. 2019 Oct;307:106582.
11. **Lu A**, Gorny KR, Ho ML. Zero TE MRI for Craniofacial Bone Imaging. *AJNR*

- Am J Neuroradiol. 2019 Sep;40(9):1562-1566.
12. Koo CW, **Lu A**, Takahashi EA, Simmons CL, Geske JR, Wigle D, Peikert T. Can MRI contribute to pulmonary nodule analysis?. *J Magn Reson Imaging*. 2019 Jun;49(7):e256-e264.
 13. Thulborn KR, **Lu A**, Atkinson IC, Pauliah M, Beal K, Chan TA, Omuro A, Yamada J, Bradbury MS. Residual Tumor Volume, Cell Volume Fraction, and Tumor Cell Kill During Fractionated Chemoradiation Therapy of Human Glioblastoma using Quantitative Sodium MR Imaging. *Clin Cancer Res*. 2019 Feb 15;25(4):1226-1232
 14. McDonald JS, McDonald RJ, Ekins JB, Tin AS, Costes S, Hudson TM, Schroeder DJ, Kallmes K, Kaufmann SH, Young PM, **Lu A**, Kadirvel R, Kallmes DF. Gadolinium-enhanced cardiac MR exams of human subjects are associated with significant increases in the DNA repair marker 53BP1, but not the damage marker γ H2AX. *PLoS One*. 2018;13(1):e0190890.
 15. Ohno Y, Koyama H, Yoshikawa T, Matsumoto S, Seki S, Takenaka D, Yui M, **Lu A**, Miyazaki M, Sugimura K. Pulmonary Thin-Section MR Imaging with Ultra-Short TE: Comparison with Thin-Section Standard- and Low-Dose CT for Assessment of Radiological Findings for Patients with Various Pulmonary Parenchyma Diseases. *J Magn Recon Imag*. 2015 Jul 30.
 16. **Lu A**, Atkinson IC, Xiaohong Joe Zhou, Thulborn KR. PCr/ATP Ratio Mapping of the Human Head by Simultaneously Imaging of Multiple Spectral Peaks with InterLeaved Excitations and Flexible Twisted Projection Imaging Readout Trajectories (SIMPLE-TPI) at 9.4 Tesla. *Magn Reson Med* 2013. 69:538-44.
 17. Atkinson IC, **Lu A**, Thulborn KR. Preserving the accuracy and resolution of the sodium bioscale from quantitative sodium MRI during intrasubject alignment across longitudinal studies. *Magn Reson Med*. 2012. 68:751-61.
 18. **Lu A**, Atkinson IC, Vaughn JT, Thulborn KR. Impact of gradient timing error on the tissue sodium concentration bioscale measured using flexible twisted projection imaging. *J Magn Reson* 2011;213:176-81.
 19. **Lu A**, Daniel BL, Kaye E, Butts Pauly K. MRI of frozen tissue demonstrates a phase shift. *Magn Reson Med* 2011; 66:1582-9.
 20. Atkinson IC, **Lu A**, Thulborn KR. Clinically constrained optimization of flexTPI acquisition parameters for the tissue sodium concentration bioscale. *Magn Reson Med*. 2011; 66:1089-99.
 21. **Lu A**, Atkinson IC, Claiborne T, Damen FC, Thulborn KR. Quantitative Sodium Imaging with a Flexible Twisted Projection Pulse Sequence. *Magn Reson Med* 2010; 63:1583-93.
 22. Kaye EA, Josan S, **Lu A**, Rosenberg J, Daniel BL, Butts Pauly K. Consistency of Signal Intensity and T2* in Frozen ex vivo Heart Muscle, Kidney and Liver Tissue. *J Magn Reson Imaging* 2010; 31:719-24.
 23. Thulborn KR, **Lu A**, Atkinson IC, Damen FC, Villano JL. Quantitative sodium MR imaging and sodium bioscales for the management of brain tumors. *Neuroimaging Clin N Am*. 2009 Nov;19(4):615-24.
 24. Atkinson IC, **Lu A**, Thulborn KR. Characterization and Correction of System Delays and Eddy Currents for MR Imaging with Ultrashort Echo-time and Time-varying Gradients. *Magn Reson Med* 2009; 62:532-7.
 25. Jung Y, Samsonov AA, Block WF, Lazar M, **Lu A**, Liu J, Alexander AL. 3D Diffusion Tensor MRI with Isotropic Resolution using a Steady-state Radial Acquisition. *J Magn Reson Imaging* 2009; 29:1175-84.

26. **Lu A**, Daniel BL, Pauly JM, Butts Pauly K. Improved Slice Selection for R2* Mapping during Cryoablation with Eddy Current Compensation. *J Magn. Reson Imaging* 2008; 28:190-8.
27. Kijowski R, **Lu A**, Block WF, Grist TM. Evaluation of the Articular Cartilage of the Knee Joint with Vastly Undersampled Isotropic projection reconstruction Steady-State Free precession (VIPR-SSFP) Imaging. *J Magn Reson Imaging* 2006; 24:168-175.
28. **Lu A**, Grist TM, BlockWF. Fat/water Separation in Single Acquisition Steady-State Free Precession Using Multiple Echo Radial Trajectories. *Magn Reson Med* 2005; 54:1051-7.
29. Liu J, Redmond MJ, Brodsky EK, Alexander AL, **Lu A**, Thornton FJ, Schulte MJ, Grist TM, Pipe JG, Block Generation and Visualization of Four Dimensional MR Angiography Data Using an Undersampled 3D Projection Trajectory. *IEEE Trans Med Imaging*. 2006;25:148-57.
30. **Lu A**, Broadsky E, Grist TM, Block WF. Rapid Fat Suppressed Isotropic Steady-State Free Precession imaging Using True 3D Multiple-half-Echo Projection Reconstruction. *Magn Reson Med* 2005; 53:692-9.
31. Du J, Carroll TJ, Brodsky E, **Lu A**, Grist TM, Mistretta CA, Block WF. Contrast Enhanced Peripheral Magnetic Resonance Angiography Using Time-Resolved Vastly Undersampled Isotropic Projection Reconstruction. *J Magn Reson Imag* 2004; 20:894-900.
32. Du J, **Lu A**, Block WF, Thornton FJ, Grist TM, Mistretta CA. Time-resolved Undersampled Projection Reconstruction MR Imaging of the Peripheral Vessels Using Multi-Echo Acquisition. *Magn Reson Med*. 2005 Mar;53:730-4.
33. **Lu A**, Barger AV, Grist TM, Block WF. Improved Spectral Selectivity and Reduced Susceptibility in SSFP Using a Near Zero TE Undersampled Three-Dimensional PR sequence. *J Magn Reson Imaging* 2004; 19:117-123.
34. **Lu A**, Cai J. The Design of a Digital Energy Window for γ -Cameras. *Nuclear Electronics & Detection Technology* 2000; 20:211-213.
35. Cai J, Yan H, **Lu A**. Principle and Application of Field Bus Communication Controller FB3050. *International Electronic Elements* 2000; 20:5-11.
36. Cai J, **Lu A**, Song X. X-Ray Source in Dual Energy X-Ray Bone Density Measurement. *Nuclear Electronics & Detection Technology* 1999; 19: 185-187.
37. Cai J, **Lu A**, Jiang X. The Design of the Control Board of an Intelligent Transmitter. *Measurement & Control Technology* 1999; 18:49-51.
38. Cai J, **Lu A**. Performance and Application of the Smart Sensor Signal Processor TSS400-S2. *Application of Electronic Techniques* 1997; 8:45-48.

Peer reviewed conference proceedings

1. **Lu A**, Felmlee J, Gorny K, Kallmes D, Kollash P, Carr C. "Feasibility of bright-bone cervical spine MRI using Zero TE sequence at 3T". ISMRM 27th Annual Meeting & Exhibition, Montreal, CA. 2019.
2. **Lu A**, Favazza CP, Woodrum DFelmlee JP, Browne JE, Welch BT, Gorny KR. Investigation of RF heating risk during MRI-guided cryoablation at 1.5T. ISMRM 28 Annual Meeting & Exhibition.
3. **Lu A**, Woodrum D, Favazza CP, Felmlee JP, Browne JE, Welch BT, Gorny KR. Investigation of the impact of RF heating on the treatment temperature during MRI-guided cryoablation at 1.5T ISMRM 28 Annual Meeting & Exhibition.

4. **Lu A**, Gorny KR, Favazza CP, Felmlee JP, Woodrum DA. Improved MR thermometry during Microwave ablation by correcting for sporadic electromagnetic interference. 2018 ISMRM
5. **Lu A**, Gorny KR, Felmlee JP, Broski SM, Howe BM. Comparison of cortical bone visualization in the hip using ZTE and in-phase 3D gradient echo MRI sequences at 3T. 2018 ISMRM
6. Shu Y, Trzasko JD, **Lu A**, Felmlee JP, Port JD. In vivo Phosphorus Metabolite Imaging on a 3 Tesla MRI Scanner in a Clinically Feasible Scan Time. 2018 ISMRM
7. Koo CW, **Lu A**, et al. Magnetic Resonance Imaging of Pulmonary Nodules: Updates, Pearls and Pitfalls. 2018 ISMRM.
8. Favazza CP, **Lu A**, Anderson AG, Felmlee JP, Rabin Y, Mynderse LA, Woodrum DA and KR Gorny. Towards MR-Thermometry during MRI-guided Cryoablations: Measuring sub-zero temperatures with ultra-short-TE MRI. 2018 AAPM.
9. Long Z, Yu L, Bruesewitz M, Favazza C, **Lu A**, Kaufmann T, Gorny K. Effects of CT exam protocols on skull-density-ratio calculations performed for MRgFUS Brain treatment planning. 6th International Symposium on Focused Ultrasound. 2018 Reston, Virginia.
10. Gorny K, Favazza C, **Lu A**, Felmlee J, Hangiandreou N, Hanson P, Bourcy J, Williams S, Anderson A, Mynderse L, Callstrom M, Woodrum D. MR-safety within the Interventional MRI suite. 12th Interventional MRI Symposium, Boston, MA.
11. **Lu A**, KR Gorny, Favazza CP, Felmlee JP, Woodrum DA. Improved MR thermometry during microwave ablation by correcting for electromagnetic interference. 12th Interventional MRI Symposium, Boston, MA.
12. Woodrum D, Kinsman K, McLaren R, Lomas D, Gorny K, Favazza C, Felmlee J, **Lu A**, Mynderse L. Magnetic resonance imaging-guided, salvage, percutaneous cryoablation of recurrent prostate cancer after radical prostatectomy: 24 month follow-up. 12th Interventional MRI Symposium, Boston, MA.
13. Knavel A, Gorny K, Favazza C, **Lu A**, Felmlee J, Bjarnason H, Bendel E, Welch B, Tollefson M, Woodrum D. MRI-guided cryoablation of pedal artero-venous malformations. 12th Interventional MRI Symposium, Boston, MA.
14. Mynderse LA, **Gorny KR**, McLaren R, Lomas D, Felmlee JP, **Lu A**, Woodrum DA. MRI guided trans-rectal focused ultrasound as focal therapy for intermediate grade prostate cancer: single center preliminary biopsy results. 12th Interventional MRI Symposium, Boston, MA.
15. JA Bourcy, CP Favazza, KR Gorny, **A Lu**, JP Felmlee, PL Hanson, SL Williams, WS Stenzel, AG Anderson, LA Mynderse, DA Woodrum. Considerations for design of interventional MRI environment to optimize workflow and procedure times. 12th Interventional MRI Symposium, Boston, MA.
16. Shanblatt E, Nelson BJ, Leng S, Favazza CP, **Lu A**, Gorny K, McCollough CH. Pre-Clinical Demonstration of Grating-Based Phase Contrast X-Ray Imaging for Cryoablation Therapy. 2018
17. Kristin K, Mynderse L, et al. Magnetic Resonance Imaging-Guided Cryoablation of Recurrent Prostate Cancer After Radical Prostatectomy: PSA Response Over 24 Month Follow Up. Proc. 11th Interventional MRI Symposium 2016. P940.
18. **Lu A**, Gorny KR, et al. Improved delineation of air-bone interface in in-vivo high-resolution bright bone ZTE MRI at 3T. Proc 25th ISMRM 2017. P5109

19. **Lu A**, Gorny KR, et al. Utilization of phase data to improve image contrast in UTE MRI at 3T. Proc 25th ISMRM 2017. P5050.
20. Favazza CP, Gorny KR, **Lu A**, Howell BD, Felmlee JP, Ormsby T, Woodrum DA. Improving MR image quality and temperature monitoring during MR-guided microwave ablations, 2017 RSNA, Chicago
21. **Lu A**, Zhou X, Miyazaki M, et al. Investigation of the Multiple T2* Compartments in Lung Parenchyma Using a 3D Multi-Echo Radial Sequence. Proc. 24th ISMRM 2016. P1611.
22. **Lu A**, Zhou X, Miyazaki M, et al.. Multiple T2 Environments in Lung Parenchyma using a 3D Multi-echo Radial Sequence. Proc. 43rd JSMRM 2015.
23. Ohno Y, Seki S, Koyama H, **Lu A**, Yui M, et al., Pulmonary Thin-Section 3D MR Imaging with Ultra-Short TE: Comparison of Capability for Radiological Findings Assessment with Thin-Section CT. Proc. 23rd ISMRM 2015, p1036.
24. Zhou X, Ouyang C, **Lu A**, Miyazaki M. ECG Gated 3D Single Shot Fast Spin Echo with Variable TR for Non-Contrast Peripheral MR Angiography at 3T. Proc. 23rd ISMRM 2015, p4507.
25. **Lu A**, Miyazaki M, Umeda M, Yui M, Koyama H, Ohno Y. Respiration Effects on Ultra-short TE(UTE) Pulmonary MR Imaging. Proc. 42nd JSMRM 2014. O-1-110.
26. **Lu A**, Miyazaki M, Ouyang C, Zhou X. Fusion of Magnitude and Phase Images and Its Applications in Ultra-Short TE MR Imaging. Proc. 22nd ISMRM 2014, P4233.
27. Ouyang C, **Lu A**, Zhou X, Miyazaki M. Time-Resolved Non-Contrast Fresh Blood Imaging MRA Using Compressed Sensing Reconstruction. Proc. 22nd ISMRM 2014, P2700.
28. Ouyang C, **Lu A**, Zhou X, Miyazaki M. Single-Artery Pseudo-Continuous Arterial Spin Labeling with Off-Resonance Correction. Proc. 22nd ISMRM 2014, P2700.
29. Zhou X, Ouyang C, **Lu A**, Miyazaki M. Double Background Suppression in Quiescent Inflow Single-Shot Imaging at 3T. Proc. 22nd ISMRM 2014, P3879.
30. **Lu A**, Atkinson IC, Thulborn K. Navigators Improve Accuracy of Quantitative Sodium MR Imaging Compromised by Head Motion During with Long Acquisition Times. Proc. 21st ISMRM 2013, P3742.
31. Thulborn KR, Atkinson IC, **Lu A**, Jamil S, et al. Tissue Cell Fraction (TCF) from Quantitative Sodium MR Imaging Measures Real-Time Tumor Response to Fractionated Radiation Therapy. Proc. 21st ISMRM 2013, P3625.
32. Thulborn KR, Jamil S, **Lu A**, Atkinson IC. Tissue Cell Fraction (TCF) from Quantitative Sodium MR Imaging Does Not Change with Age in Cognitively Normal Subjects. Proc. 21st ISMRM 2013, P2874.
33. **Lu A**, Atkinson IC, Thulborn K. Improved PCr/ATP Ratio Mapping of the Human Head by Simultaneously Imaging of Multiple Spectral Peaks with InterLeaved Excitations and Flexible Twisted Projection Imaging Readout Trajectories (SIMPLE-flexTPI) at 9.4 Tesla. Proc. 20th ISMRM 2012. P4421.
34. **Lu A**, Atkinson IC, Thulborn K. Comparison of Two Fast MR Acquisition Strategies for Simultaneously Imaging of PCr and γ -ATP in the human brain at 9.4T. Proc. 20th ISMRM 2012.p4427.
35. Liu C, **Lu A**. Probing Intra- and Extracellular Magnetic Susceptibility in the Brain. Proc. 20th ISMRM 2012.
36. **Lu A**, Thulborn KR. Characterizing Cerebral Blood Volume and Permeability with a Undersampled Multiple-Echo 3D Projection Reconstruction Sequence and a Fast T1 Mapping Method. Proc. 19th ISMRM 2011. p2062.

37. Atkinson IC, **Lu A**, Thulborn KR. Clinically-Constrained Resolution-Optimized FlexTPI Acquisition Parameters for the Tissue Sodium Concentration Bioscale. Proc. 19th ISMRM 2011. P1494.
38. Atkinson IC, Fleischman D, **Lu A**, Shah R, Thulborn KR. Feasibility of Detecting Preclinical Hippocampal Neuronal Cell Loss in Subjects Destined to Develop Alzheimer's Disease. Proc. 19th ISMRM 2011. P2237.
39. **Lu A**, Atkinson IC, Thulborn K. In Vivo Brain Sodium T2* Mapping with a Multiple-Echo Flexible TPI Sequence. Proc. 19th ISMRM 2011. P3504.
40. **Lu A**, Atkinson IC, Zhou XJ, Thulborn KR. Initial Experience with 31P Imaging of Human Brain Using a Multi-resonance, Spectral-selective Sequence at 9.4Tesla. Proc. 18th ISMRM 2010. p980,
41. **Lu A**, Thulborn KR. High-resolution Non-contrast Enhanced Dark Blood Brain Vessel Imaging Using a Balanced Steady State 3D Projection Reconstruction Sequence. Proc. 18th ISMRM 2010, p4427.
42. Atkinson IC, **Lu A**, Thulborn KR. Classification Of Metabolic Parameters by Anatomically Superimposed Scans (COMPASS). Proc. 18th ISMRM 2010, p4427.
43. Atkinson IC, **Lu A**, Thulborn KR. Flyback Twisted Projection Imaging for Fast Quantitative Sodium Imaging Demonstrated on the Human Brain at 9.4 Tesla. Proc. 18th ISMRM 2010.
44. Thulborn KR, **Lu A**, Atkinson IC, Claiborne T, Ganin H, Stainsby JA. Precision and Accuracy of Two Projection-Based Pulse Sequences for Measurement of Brain Cell Fraction and Tissue Sodium Concentration Bioscales with Quantitative Sodium MR Imaging. 48th Annual Mtg, American Society of Neuroradiology (ASNR), Boston 2010, p154.
45. **Lu A**, Atkinson I, Damen F, Thulborn KR. Improved Quantitative Sodium Imaging. Proc. 95th RSNA 2009.
46. **Lu A**, Damen FC, Atkinson IC, Claiborne T, Thulborn KR. Improved Quantitative Sodium Imaging with a Flexible Twisted Projection Design and B0 Inhomogeneity Correction. Proc. 17th ISMRM, 2009. p2472.
47. **Lu A**, Thulborn KR. Inherent Insensitivity to B1 Field Inhomogeneity Using Regularized Nonlinear Inversion Reconstruction. Proc. 17th ISMRM, 2009. p2795.
48. Elena K, **Lu A**, Alley M, Butts Pauly K. PRF Shift in Frozen Tissue at 3T. Proc. 17th ISMRM, 2009. p448.
49. Thulborn KR, Atkinson IC, **Lu A**, Claiborne T, Flannery MP, Zhou XJ, Haldar J, Liang Z-P. "Metabolic MR Imaging of Human Brains at 9.4 Tesla." University of Minnesota High Field Workshop. 2009 .
50. **Lu A**, Atkinson IC, Zhou XJ, Claiborne T, Thulborn KR. Preliminary Results of 31P MR Imaging at 9.4T Using a RARE Sequence. Proc. 16th ISMRM, 2008.
51. Atkinson IC, Thulborn KR, **Lu A**, Haldar J, Zhou XJ, Claiborne T, Liang Z-P. Quantitative 23-Sodium and 17-Oxygen MR Imaging in Human at 9.4T Enhanced by Constrained K-space Reconstruction. Proc. 16th ISMRM, 2008.
52. Thulborn KR, Damen KR, **Lu A**, Atkinson I, Villano J, Halpern H, Aydogan B, Flannery M, Ganin H. Monitoring Brain Tumor Response to Radiation by Sodium MR Imaging. Proc. 16th ISMRM, 2008.
53. Atkinson IC, **Lu A**, Haldar JP, Liang, Z-P, Thulborn KR. Human 17-Oxygen Imaging at 9.4T and Enhanced Reconstruction using 23-Sodium. American Society of Neuroradiology (ASNR), 2008.
54. **Lu A**, Villano J, Damen F, Flannery MP, Atkinson I, Thulborn KR. Quantitative Metabolic MR Imaging Monitors Early Brain Tumor Response to Radiation. University of Illinois College of Medicine Research Day, February 2008.

55. **Lu A**, Daniel BL, Butts Pauly K. Investigation of Temperature Dependent Phase Shift in Frozen Tissues During Cryoablation. Proc. 15th ISMRM 2007, p163.
56. Thulborn KR, Atkinson IC, **Lu A**, Claiborne T, Flannery MP, Zhou XJ, Haldar J, Liang Z-P. "Metabolic MR Imaging of Human Brains at 9.4 Tesla". 7th University of Minnesota High Field Workshop, 2007.
57. **Lu A**, Daniel BL, Butts Pauly K. A Simple Approach to Measure and Correct for B₀ and Linear Eddy Currents. Proc. 14th ISMRM 2006, p2378.
58. **Lu A**, Daniel BL, Butts Pauly K. Improved Slice Excitation for Ultra-short TE Imaging with B₀ and Linear Eddy Current Correction. Proc. 14th ISMRM 2006, p2381.
59. **Lu A**, Daniel BL, Butts Pauly. K Improvements in R₂* Mapping during In Vivo Cryoablation. Proc. 14th ISMRM 2006, p1424.
60. Josan J, **Lu A**, Pauly JM, Daniel BL, Butts Pauly K. Double Half RF Pulse for Reduced Sensitivity to Linear Eddy Currents in Ultrashort T₂ Imaging. Proc. 14th ISMRM 2006, p3004.
61. **Lu A**, Daniel BL, Kaye EA, Butts Pauly K. Improved *In Vivo* MRI temperature mapping during cryosurgery. Cryobiology 2006; 53:437-438.
62. Josan S, **Lu A**, Pauly JM, Daniel BL, Butts Pauly K, Kaye EA. Reducing Eddy Current Sensitivity in R₂* Mapping during Cryosurgery. Cryobiology 2006; 53:438.
63. Kaye EA, Josan S, **Lu A**, Butts Pauly K. Consistency of MR parameters in frozen porcine heart muscle, liver and kidney. Cryobiology 2006; 53 385.
64. Jashnani Y, **Lu A**, Jung Y, Kijowski R, Block WF. Linear Combination SSFP at 3T: Improved Spectral Response Using Multiple echoes. Proc. 14th ISMRM 2006, p3607.
65. Moran CJ, **Lu A**, Jung Y, Kelcz F, Brodsky E, Grist TM, Fain, SB, Block WF. Simultaneous Acquisition of Fat and Water Volume Images of the Breast with T₂-like Contrast Using Vastly Undersampled Isotropic Projection (VIPR) SSFP. Proc. 14th ISMRM p2868 , 2006
66. Jung Y, **Lu A**, Grist TM, Block WF. Non-Contrast-Enhanced SSFP MRA with Improved Consistency and Fluid Suppression. Proc. 13th ISMRM 2005, p1712.
67. Liu J, **Lu A**, Brodsky EK, Block WF. Improved Coverage and Fewer Artifacts through Oversampling in Non-cartesian Scans. Proc. 13th ISMRM p2292, 2005
68. Takahashi M, **Lu A**, Brittain JH, Hinks RS, Shimakawa, A. Johnson JW, Cunningham CH, Block WF, Pauly JM, Bydder JM. Ultra Short TE (UTE) Imaging at 8 μ sec with 3D Vastly Undersampled Isotropic Projection Reconstruction (VIPR). Proc. 13th ISMRM 2005, p2405.
69. Arunachalam A. **Lu A**, Brodsky EK, Block WF. GRAPPA for the 3D Radial Trajectory (VIPR). Proc. 13th ISMRM 2005, p2674.
70. Unal O, Block WF, Korosec FR, **Lu A**, Grist TM. Technique for Myocardial Viability Imaging using Radial Sampling. Proc. 11th ISMRM 2004, p1604.
71. **Lu A**, Rowley HA, Grist TM, Block WF. Fat Suppression in Single Acquisition Steady-State Free Precession Using Multiple Echo Radial Trajectories. Proc. 12th ISMRM 2000, p264.
72. Liu J, **Lu A**, Alexander A, Pipe JG, Brodsky EK, Seeber D, Grist TM, Block WF. Temporal Filter Design for Time-resolved VIPR Using an Iterative Density Compensation Algorithm. Proc. 12th ISMRM 2004, p264.
73. Arunachalam A, **Lu A**, Brodsky EK, Fain SB, Block WF. Parallel Imaging for 3DPR (VIPR). Proc. 12th ISMRM 2004, p2246.
74. Donald BM, Aexander AL, Brodsky EK, **Lu A**, Block WF. VIPR Steady state imaging with diffusion sensitivity. Proc. 12th ISMRM 2004, p2108.
75. Brodsky EK, **Lu A**, Thorton FJ, Grist TM, Block WF. Using Multiple Half-

- Echos to Improve Sampling Efficiency and Fat Suppression in Time-Resolved MRA. Proc. 11th ISMRM 2003, p322.
76. **Lu A**, Grist TM, Thornton FJ, Block WF. Non-contrast Enhanced Dual Half Echo VIPR Angiography with Fat and Water Separation. Proc. 11th ISMRM 2003, p320.
 77. **Lu A**, Wieben O, Grist TM, Block WF. Vastly undersampled Isotropic Projection Reconstruction Imaging with Multi-half-Echo (VIPR ME). Proc. 11th ISMRM 2003, p210.
 78. Du J, Block WF, Carroll TJ, **Lu A**, Grist TM, Mistretta CA. Peripheral Angiography with a Time-Resolved VIPR Sequence. Proc. 10th ISMRM 2002, p216.
 79. **Lu A**, Grist TM, Block WF. Improved Spectral Selectivity and Reduced Susceptibility in True-FISP Using a Near Zero TE Undersampled 3D PR Sequence. Proc. 10th ISMRM 2002, p470.

Book chapters:

- **Lu A**, Daniel BL, Butts Pauly K. "Ultrashort TE Imaging of Cryotherapy" in Encyclopedia of Magnetic Resonance. In: MRI of Tissues with Short T2s or T2*s. eds Bydder GM, Fullerton GD, Young IR, United Kingdom. John Wiley & Sons. Chichester, West Sussex : Wiley, 2012.
- Atkinson IC, **Lu A**, Thulborn KR, "Quantitative Metabolic MR Imaging of Human Brain Using ¹⁷O and ²³Na". In: MRI of Tissues with Short T2s or T2*s. eds Bydder GM, Fullerton GD, Young IR, United Kingdom. John Wiley & Sons. Chichester, West Sussex : Wiley, 2012.
- **Lu A**, Atkinson IC, Thulborn KR. Sodium Magnetic Resonance Imaging and its Bioscale of Tissue Sodium Concentration. In Encyclopedia of Magnetic Resonance. Hoboken, NJ: John Wiley & Sons. 2010. DOI: 10.1002/9780470034590.emrstm1171.pub2.
- Thulborn KR, Atkinson IC, **Lu A**. Metabolic Magnetic Resonance Imaging: A Case for Bioscales in Medicine. *In: Functional Neuroradiology: Principles and Clinical Applications*. Eds. Scott Faro, Mohamed FB. Springer Science + Business Media, NY, NY. 2010.

Patents

- No. 6, 794, 867: Isotropic Imaging of Vessels with Fat Suppression
Block WF, Grist TM, **Lu A**
- No. 7,148,685: Magnetic resonance imaging with fat suppression
Block WF, **Lu A**

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