Bruce Eric Hammer, Ph.D.
Professor of Radiology & Adjunct
Professor of Entrepreneurial Studies
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Brief Description of Research and Interests

Design and development of magnetic resonance instrumentation. Research areas include biotechnology, MR safety/compatability of medical devices and industrial process monitoring.

Research and Expertise

Primary Research Interest and Area of Expertise

NMR, MRI, medical electronics, instrumentation development, nuclear magnetic resonance imaging, radiofrequency circuits, magnet design, biomedical engineering, positron emission tomography

Educational Background

B.S., Biology/Physics, State University of New York, Albany, NY, 1974
M.S., Biomedical Engineering, Northwestern University, Evanston, IL, 1976
Ph.D., Biomedical Engineering, Northwestern University, Evanston, IL, 1981

Professional Background

Project Scientist. Integrated system components and developed imaging applications., Intermagnetics General Corp., Guilderland, NY, 1981 – 1984

Senior Scientist. Developed NMR applications for in vivo 1H, 13C, 31P and 19F spectroscopy and imaging, MR microscopy and flow imaging., Intermagnetics General Corp., Guilderland, NY, 1984 – 1989

Manager. Defined program for government and industrial magnetic research applications. Coordinated the R&D activities of a team of research professionals. Intermagnetics General Corp., Latham, NY, 1989 – 1990

Assistant Professor, Department of Radiology. Director, Magnetic Resonance Section of Radiological Physics, University of Minnesota, 1990 - 1997

- Constructed 5.0 T NMR research system/laboratory
- Applied NMR to biotechnology and porous media applications

Associate Professor, Department of Radiology, University of Minnesota, 1997 – 2007, Adjunct Associate Professor of Entrepreneurial Studies, Carlson School of Management, University of Minnesota 2001-2006.

- Director, Center for Interdisciplinary Applications in Magnetic Resonance (CIA-MR).The CIA-MR mission is to apply MR technology to fundamental problems in the engineering and physical sciences.
- Constructed 1.5 T/68mm whole body imaging system
- Developed a 17 T/50mm magnet system as a NIH shared instrument resource. Applications include MR microimaging and magnetic levitation to simulate orbital freefall, lunar and Martian gravitational force.

Professor, Department of Radiology, University of Minnesota, 2007 – present, Adjunct Professor of Entrepreneurial Studies, Carlson School of Management, University of Minnesota 2007 - present.

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- Active areas of research include:
  - Developing NMR hardware for organ viability assessment
  - NMR spectrometer on a chip
  - Magnetic levitation as a simulation of orbital freefall

- NMR metabolomics of osteoblasts and osteoclasts
- NMR imaging and spectroscopy of engineered tissues
- MR compatibility of medical devices

- Past areas of research included:
  - Development of hybrid MR-PET tomographic scanner
  - NMR quantum computing
  - Development of MR for industrial applications

Courses Taught

Rad 5101 Diagnostic Radiology
1991 - 1997
Taught MR physics to medical students

Cell & Tissue Reactor Engineering
1993 - 1998
Co-Lecturer - annual short course offered by Department of Chemical Engineering at University of Minnesota. Lectured on biotechnology applications of magnetic resonance.

BPhys 8147 Advanced Physics of Magnetic Resonance Imaging
1 semester, 3 credits, 1995 – 2003.
Primary lecturer and laboratory supervisor. This is a laboratory-based course supported by formal lectures. NMR (nuclear magnetic resonance) and MRI physics, spatial selection and encoding, imaging hardware and system engineering. Imaging sequences, associated contrast/resolution. Recent developments in MRI.

BPhys 8148 Advanced Digital Imaging Science
1 semester, 3 Cr, 2002.
Co-lecturer. The objectives of this course are to introduce students to state-of-the-art digital processing techniques for image acquisition and quality assessment, reconstruction, 3D image processing and analysis, display, archiving and communication in the field of medical imaging.

BMEN 8401-8402 New Product Design and Business Development
(also identified as ME 8221-8222, ENTR 6041-6042,OMS 6061-6062)
2 semesters, 4 Credits/semester, 2001 – present.
Teams of graduate engineering and business students and faculty along with marketing and engineering representatives from the company work over nine months to develop a working prototype of a new product , a business plan and a patent application. The company then completes the process to product launch. Teams I led did product design for Comedicus, Boston Scientific, Venturix, Starfire, St. Jude Medical , Aeromix, Boston Scientific and VivoSense.

Professional Honors

Biomedical Engineering Fellowship, NIH, 1974 - 1977
Argonne National Laboratory Fellowship, Argonne National Laboratory, 1977 - 1981
Best paper award for presentation "MRI and Micro-X-Ray CT Based Three Dimensional Analysis of Polyurethane Foams", Fundamentals Session, Polyurethanes Expo 98, Dallas., Polyurethane Expo 98 , 1998
Chair of Advanced Imaging Technologies, “Design of Medical Devices”, Minneapolis, MN, April 26 -27, 2001.
Chair of Imaging/Radiology Session “Design of Medical Devices”, Minneapolis, MN, April 24 -25, 2003.

Consulting Activities

Radiation Safety Services, Inc., Evanston, IL (1978-1981)
Intermagnetics General Corporation (1991 – 1992)
Medtronic, Minneapolis, MN (2000)
Bosch TL Systems, Minneapolis, MN (2000-2002)
Boston Scientific, Plymouth, MN (2002-present)
Bresagen, Athens, GA (2000 – 2001)

Comedicus, Columbia Heights, MN (2001 – 2002)
Anulex, Minnetonka, MN (2005)
AGA Medical, Golden Valley, MN (2005-2007)
St. Jude Medical, St. Paul, MN (2007)

Community and University Service

Full Graduate Faculty Member of Biophysical Sciences 1991 - present
- Served on Graduate Admissions Committee 1993 - present

Full Graduate Faculty Member of Biomedical Engineering 1998 - present
- Served on Graduate Admissions Committee 1997 -2000

Adjunct Professor of Entrepreneurial Studies, Carlson School of Business, 2001 - present
Full Graduate Faculty Member of Electrical Engineering 2002 - present
NSF Major Research Instrumentation Panel, Member of Panel, 2002
NIH Shared Instrumentation Review Panel, Member of Panel, 2002, 2004, 2005, 2006.
Research Safety Officer for Department of Radiology, 2002 – 2003
Student Grievance Committee, 1998 - present

Publications

1. Irving, C.S., Hammer, B.E., Danyluk, S.D., Klein, P.D., "13C Nuclear Magnetic Resonance Study of the Complexation of Calcium by Taurine", Journal of Inorganic Biochemistry, Vol.13, pp.137-150, 1980.
2. Hennessy, M.J., Hammer, B.E., Butler, D.M., House.W.V., "T1(f) Studies in Brain Tissue," Medical Physics 10(5) 735, 1983.
3. Hennessy, M.J., Hammer, B.E., Butler, D.M., House, W.V.,"Field Dependence of T1 in Human Heads from .05 to 1 Tesla," Magnetic Resonance in Medicine 1 (2),:281, 1984.
4. Hammer, B.E., Hennessy, M.J., Carr, S.L., "In Vivo Study of Chick Embryological Development by Proton and Phosphorous NMR at 2.1 Tesla", Proceedings from the First Congress of the European Society of Magnetic Resonance in Medicine and Biology, p. 42 - 50, Montreux, 1985.
5. Hack, S.N., Hammer, B.E.,"Site Planning for Clinical NMR Systems", Magnetic Resonance in Imaging, Vol.4, pp.525-537, 1986.
6. Hammer, B.E., "Proton Decoupled 13C NMR Imaging", Magnetic Resonance in Medicine, Vol. 7, pp.235-240, 1989.
7. Woods, R.T., Hennessy, M.J., Kwok, E., Hammer, B.E., "NMR Microscopy - A New Biological Tool", Bio Techniques, Vol.7, pp.616-622, 1989.
8. Heath, C.A., Belfort, G., Hammer, B.E., Mirer, S.D., Pimbley, J.M., "Magnetic Resonance Imaging and Modeling of Flow in Hollow-Fiber Bioreactors", American Institute of Chemical Engineering Journal, Vol.36, pp.547-558, 1990.
9. Hammer, B.E., Sacks, W., Bigler, R.E., Hennessy, M.J., Sacks, S., Fleischer, A., Zanzonico, P.B., "Design of a 13C{1H} RF Probe for Monitoring the In Vivo Metabolism of [1-13C]Glucose in Primate Brain", Magnetic Resonance in Medicine, Vol.13, pp.1-5, 1990.
10. Hammer, B.E., Heath, C.A., Mirer, S.D., Belfort, G., "Quantitative Flow Measurements in Bioreactors by Nuclear Magnetic Resonance Imaging", BIO/TECHNOLOGY, Vol.8, pp.327-330, 1990.
11. Oliveira, R.J., Hammer, B.E., Stillman, A., Holm, J. Jons, C., Margolis, R.H.,"A Look at the Ear Canal Changes with Jaw Motion", Ear and Hearing, Vol. 13:6, pp. 464-466, 1992.
12. Hammer, B.E., Christensen, N.L., Heil, B.G., "Use of a Magnetic Field to Increase the Spatial Resolution of Positron Emission Tomography," Medical Physics, vol. 21, no. 12, 1917 - 1920, 1994.
13. Graham, P.H., Draeger, K.J., Ferrey, M.L., Conroy, M.J., Hammer, B.E., Martinez, E., Aarons, S.R. Quinto, C., "Acid pH Tolerance in Strains of Rhizobium and Bradyrhizobium, and Initial Studies on the Basis of Acid Tolerance of Rhizobium Tropici UMR1899", Can. J. Microbiol, Vol 40:3, 198-207, 1994.
14. Hammer, B.E., Christensen, N.L., "Use of Strong Magnetic Fields to Limit Positron Range in Matter," IEEE Transactions on Nuclear Science, IEEE Transactions on Nuclear Science, vol. 42, no. 4, 1371-1376, 1995.
15. Christensen, N.L., Hammer, B.E., Heil, B.G., Fetterly, K., "Positron Emission Tomography within a Magnetic Field Using Photomultiplier Tubes and Lightguides", Physics and Medicine in Biology, vol. 40, 691-697, 1995.
16. Kutsovsky, Y.E., Alvarado, V., Scriven, L.E., Davis, H.T., Hammer, B.E., Dispersion of Paramagnetic Tracers in Bead Packs by T1 Mapping, Mag. Res. Imag., 14(7-8):833-839, 1996.

17. Hammer, B.E., Engineering Considerations for a MR-PET Scanner, Physica Medica , Vol. XII, Supplement 1, pp. 69 - 76, 1996.
18. Raylman, R.E., Hammer, B.E., Christensen, N.L., MRI-PET Scanner Design: The Effect of Magnetic Fields on the Intrinsic Resolution of PET Scanners, IEEE Trans. Nucl. Sci., Vol 43 (4), pp. 2406 - 2412, 1996.
19. Hammer, B.E., Magnetic Field Mapping with an Array of NMR Probes, Rev. Sci. Inst. Vol. 67 (6), pp. 2378-2380, 1996.
20. Kutsovsky, Y.E., Scriven, L.E., Davis, H.T., Hammer, B.E., "NMR Imaging of Velocity Profiles and Velocity Distributions in Bead Packs", J. Phys. Fluids, vol. 8(4), pp. 863 - 871, 1996.
21. Haak, G.M., Christensen, N.L., Hammer, B.E., Experimental Studies on the Angular Distribution of Scintillation Light from Small BGO Crystals, Nucl. Instr. Meth. A., 390:191-197, 1997.
22. Haak, G.M., Christensen, N.L., Hammer, B.E., Coupling Scintillation Light into Optical Fibre for Use in a Combined PET-MRI Scanner, Nucl. Instr. Meth. A, vol. 399: 455-462, 1997.
23. Hammer, B.E., "Two Images are Better than One", Phys. World, 10 (12), pp.23-24, 1997.
24. Kutsovsky, Y.E., Alvarado, V. Davis, H.T., Scriven, L.E., Hammer, B.E., Paramagnetic Tracer Concentration Evolution by NMR Relaxation Time Mapping: Application to Aris-Taylor Dispersion, Mag. Reson. Imag., 16(1): 63- 71, 1998.
25. Pangrle, B.J., Hammer, B.E., Bidault, N.P., Listemann, M.L. Stevens, R.E., Zhang, X.D., Macosko, C.W., Magnetic Resonance Imaging and Micro-X-Ray CT Based Three Dimensional Analysis of Polyurethane Foams, Polyurethanes Expo98, p.247 – 252, September 17-20, 1998, Dallas, TX.
26. Hammer, B.E., "Industrial Applications of Nuclear Magnetic Resonance", Sensor Review, 18(4), 1998.
27. Schueler, B.A., Parish, T.B., Lin, J-C., Hammer, B.E., Pangrle, B.J., Ritenour, E.R., Kucharczyk, J. , Truwit, C.L., "MRI Compatibility and Visibility Assessment of Implantable Medical Devices", J. Mag. Res. Imag., 9:596-603 ,1999.
28. Gramer MJ. Poeschl DM. Conroy MJ. Hammer BE. Effect of harvesting protocol on performance of a hollow fiber bioreactor. Biotechnology & Bioengineering. 65(3):334-40, 1999
29. Bidault, N.P., Hammer, B.E., "Rapid MR Imaging of Cryoprotectant Permeation in an Engineered Dermal Replacement", Cryobiology, 40:13-26 , 2000.
30. Beilman, G.J., Meyers, D., Cerra, F.B., Lazaron, V., Dahms, R.A., Conroy, M.J. and Hammer, B.E., Near-Infrared and Nuclear Magnetic Resonance Spectroscopic Assessment of Tissue Energetics in an Isolated Perfused Canine Hind Limb Model of Dysoxia, Shock, 15:5, 392-397, 2001
31. Bidault, N.P., Hammer, B.E., Hubel, 'Water Content in an Engineered Dermal Replacement During Permeation of Me2SO Solutions Using Rapid MR Imaging, Biotechnology Progress. 17(3):530-6, 2001
32. Taylor JH, Mulier KE, Conroy MJ, Myers D, Hammer BE, Beilman GJ. Tissue energetics as measured by nuculear magnetic resonance spectroscopy during hemorrhagic shock. Shock, 21(1):58-64, 2004.
33. Taylor JH, Beilman GJ, Conroy MJ, Mulier KE, Hammer BE. Phosphomonesters Predict Early Mortality in Porcine Hemorrhagic Shock. Journal of Trauma, 56(2):251-258, Feb. 2004.
34. Beilman GJ, Mulier KE, Conroy MJ, Taylor JH, Hammer BE. Hemodynamics and Tissue Energetics During Resuscitation of Porcine Hemorrhagic shock with hextend or lactated ringers solution. Surgery, Feb. 2004.
35. Beilman G, Taylor J, Conroy MJ, Hammer BE. Hextend Resuscitation of Hemorrhagic Shock is Associated with Improved Hemodynamics but not Tissue Energetics. Accepted for presentation and publication in proceedings of the HFM Symposium on Combat Casualty Care in Ground Based Tactical Situations: Trauma Technology and Emergency Medical Procedures, August 2004
36. Kalambur, V.S., Han, B., Hammer, B.E., Shield, T.W., Bischof, J.C., In Vitro Characterization of Movement, Heating and Visualization of Magnetic Nanoparticles for Biomedical Applications. Nanotechnology 16, 1221–1233, 2005.
37. Siskind, L.C., Hammer, B.E., Christensen, N.L., Yepez, J, Multiple RF Coil Nuclear Magnetic Resonance Quantum Computing, Journal of Quantum Information Processing, 4(6), 433 – 455, December 2005.
38. Bauhs, J., Hammer, B.E., Ferrous-Ferric Ion Exchange Dosemeter, Journal Radiation Protection Dosimetry, 120, 140-143, September 2006.
39. Scott III, W.E., Matsumoto, S., Tanaka, T., Avgoustiniatos, E.S., Graham, M.L.,Williams, P.C.,Tempelman, L.A., Sutherland, D.E., Hering, B.J.,Hammer, B.E., Papas, K.K., Real-time non-invasive assessment of pancreatic ATP levels, Transplantation Proceedings, Vol. 40(2), p403-406 March 2008.
40. Hammer, B.E., Kidder, L.S., Williams, P.E., Xu, W., Magnetic Levitation of MC3T3 Osteoblast Cells as a Ground-Based Simulation of Microgravity, Microgravity Sci. Technol., 21:311–318 2009.

41. Harjani, R., Kim, J., Patnaik, S,, Hammer, B., Implantable CMOS Tissue Monitoring NMR Spectrometer (invited paper), IEEE Circuits and Systems for Medical Environmental Applications Workshop, Merida, Mexico, December 2009.
42. Kim, J., Hammer, B., Harjani, R., A Low Power CMOS Receiver for a Tissue Monitoring NMR (paper) Spectrometer IEEE VLSI Circuits Symposium, June 2010.
43. X. Yuanyuan, Zeng, P., Siegel, R.A., Wiedmann, T.S., Hammer, B.E., Longes, P.W.,Magnetic Deposition of Aerosols Composed of Aggregated Superparamagnetic Nanoparticles, Pharm. Res., 27(5), 855 – 865, May 2010.
44. Scott WE 3rd, O'Brien TD, Ferrer-Fabrega J, Avgoustiniatos ES, Weegman BP, Anazawa T, Matsumoto S, Kirchner VA, Rizzari MD, Murtaugh MP, Suszynski TM, Aasheim T, Kidder LS, Hammer BE, Stone SG, Tempelman LA, Sutherland DE, Hering BJ, Papas KK., Persufflation improves pancreas preservation when compared with the two-layer method. Transplant Proc. 42(6):2016-9, 2010.
45. Scott WE 3rd, Weegman BP, Ferrer-Fabrega J, Stein SA, Anazawa T, Kirchner VA, Rizzari MD, Stone J, Matsumoto S, Hammer BE, Balamurugan AN, Kidder LS, Suszynski TM, Avgoustiniatos ES, Stone SG, Tempelman LA, Sutherland DE, Hering BJ, Papas KK., Pancreas oxygen persufflation increases ATP levels as shown by nuclear magnetic resonance. Transplant Proc. 42(6):2011-5, 2010.

Patents

Issued:

Hammer, B.E., "NMR-PET Scanner Apparatus", U.S. Patent number: 4,939,464: July 3, 1990
Hammer, B.E., Conroy, M.J., "Catheter for Cell Delivery in Tissue", U.S. patent: number 6,758,828July 6, 2004
Zhong, S-P, Helmus, M.N., Smith, S.R., Hammer, B.E., "Magnetic Resonance Imaging of a Medical Device and Proximate Body Tissue," US Patent Number, 7,483,732: January 27, 2009.

Pending:

Churchwell, S.D., Hammer, B.E., et al., "Aneurysm Treatment Devices" US Application No. 11/276,244 filed Feb 17, 2006 based upon 11/275,455 filed January 5, 2006 & U.S. Provisional application filed March 12, 2005.

Book Chapters

Sacks, W., Hammer, B., Bigler, R.E., Cowburn, D., Sacks, S., Fleischer, A., Zanzonico, P.B., "The Use of 13C Glucose and NMR to Study Cerebral Metabolism in Vivo in Rat and Rhesus Monkey", PET and NMR: New Perspectives in Neuroimaging and Clinical Neurochemistry, pp.283-302, Alan R. Liss, Inc., 1986.

Miscellaneous Publications

Hammer, B.E., "Two Images are Better than One", Physics World, December 1997.

Hammer, B.E., Christensen, N.L., Heil, B.G., "Use of a Magnetic Field to Increase the Spatial Resolution of Positron Emission Tomography," Medical Physics, vol. 21, no. 12, 1917 - 1920, 1994; abstracted with a figure in Year Book of Nuclear Medicine, Mosby-Year Book, Inc., (1996).

Kutsovsky, Y.E., Hammer, B.E., Scriven, L.E., Davis, H.T.,"Flow Imaging in Porous Media", Tecmag updates, vol. 4, No. 6, June 1993.

Presentations and Published Abstracts

1. Bauhs, J.A., Hammer, B.E., Higgins, P.D., Micro Fricke Dosimeters Composed of Cation Exchange Resin Beads, Health Physics Society, June 2010.

2. Ramesh Harjani, Jaehyup Kim, Satwik Patnaik and Bruce Hammer (invited), Implantable CMOS Tissue Monitoring NMR Spectrometer, IEEE Circuits and Systems for Medical Environmental Applications Workshop, Merida, Mexico, December 2009.

3. Jaehyup Kim, Satwik Patnaik, Ramesh Harjani and Bruce Hammer, Implantable Wireless NMR Spectrometer, U Medical & Engineering Showcase, Tuesday 9/22/09

4. Weegman, BP, Scott, WE, Anazawa, T, Avgoustiniatos, ES, Yuasa, T, Ferrer-Fabrega, J., Hammer, BE, Loughnane, MH, Hering, BJ, Kandaswamy, R, Sutherland, DER, Suszynski, TM, Papas, KK, Continuous, real-time viability assessment of kidneys based on oxygen consumption, Xenotransplantation, 16(5), 432 - 433, 2009. 432-433.

5. Weegman, Bradley P., Ferrer-Fabrega, Joana, Scott, William E. III, Anazawa, Takayuki, Avgoustiniatos, Efstathios S., Yuasa, Takeshi, Hammer, Bruce E., Loughnane, Michael H., Hering, Bernhard J., Kandaswamy, Raja, Sutherland, David E. R., Thomas, Suszynski M., Papas, Klearchos K., Continuous, real-time viability assessment of pancreata based on oxygen consuption, Xenotransplantation, 16(5), 421, 2009.

6. Scott, William E. III, Balamurugan, Appakalai N., Ferrer-Fabrega, Joana, Anazawa, Takayuki, Weegman, Bradley P., Hammer, Bruce E., Matsumoto, Shuichiro, Avgoustiniatos, Efstathios S., Maynard, Kristen S., Sutherland, David E. R., Hering, Bernhard J., Papas, Klearchos K., MRI as a novel tool to develop new methods of pancreas distension to enable homogeneous enzyme distribution for successful islet isolation, Xenotransplantation, 16(5), 420 - 421, 2009.

7. Scott, William E. III, Theisenger, Bastien, Weegman, Bradley P., Stein, Sam, Brandhorst, Heide, Hammer, Bruce E., Avgoustiniatos, Efstathios S., Maynard, Kristen S., Korsgren, Olle, Papas, Klearchos K., Brandhorst, Daniel, One-layer method with novel compound perfluorohexyloctane increases levels of ATP relative to perfluorodecalin as shown by 31P-NMR spectroscopy, Xenotransplantation. 16(5), 2009.

8. Scott, William E. III, Ferrer-Fabrega, Joana, Anazawa, Takayuki, Weegman, Bradley P., Stein, Sam, Matsumoto, Shuichiro, Stone, Jay, Balamurugan, Appakalai N., Hammer, Bruce E., Avgoustiniatos, Efstathios S., Maynard, Kristen S., Stone, Simon, Tempelman, Linda, Sutherland, David E. R., Hering, Bernhard J., Papas, Klearchos K., Pancreas oxygen persufflation increases ATP levels as shown by NMR, Xenotransplantation. 16(5), 319-320, 2009.

9. Scott, William E., Ferrer-Fabrega, Joana, Avgoustiniatos, Efstathios S., Anazawa, Takayuki, Weegman, Bradley P., Matsumoto, Shuichiro, O'brien, Timothy D., Murtaugh, Michael, Hammer, Bruce E., Yu, Ivy, Kidder, Louis S., Maynard, Kristen S., Stone, Simon G., Tempelman, Linda, Sutherland, David E. R., Hering, Bernhard J., Papas, Klearchos K., Pancreas persufflation for 6 h and 24 h improves viable islet yields compared with the two-layer method, Xenotransplantation. 16(5). 319, 2009.

10. Scott, WE, Ferrer, J., Chamberlain, R ., Anazawa, T., Weegman, BP, Matsumoto, S., Hammer, BE, Balamurgan, AN, Avgoustiniatos, ES, Maynard, KS, Sutherland, DER, Hering, BJ, Papas, KK, MRI as a novel tool to optimize enzyme distribution and pancreas distension for successful islet isolation, Pancreas, 37 (4): 495, 2008.

11. Hammer, B.E., Kidder, L.S., Willams, P.C., Hammer, L.E., Seghal, H.S., Xu, W., Long-Duration Magnetic Levitation of MC3T3 Osteoblast Cells as a Ground-Based Simulation of Microgravity, ESA Symposium on Technology for Artificial Gravity and Microgravity Simulation 10 - 12 December 2007, ESTEC, Noordwijk, The Netherlands.

12. Watanabe, Y. and B. Hammer, *Designing a multiple spin-echo pulse sequence optimized for polymer gel dosimetry.* Medical Physics, 2007. **34**(5): p. 2432-2433.

13. Bauhs, J.A, Hammer, B.E., Measurement of MRI image degradation in a three-dimensional dosimeter made of ion exchange resin beads labeled with ferrous ions, AAPM 49th Annual Meeting, Minneapolis, MN, July 22 -26, 2007.

14. Bauhs, J.A. Hammer, B.E., Higgins, P.D., Dose Response of Ion Exchange Resin Beads SU-FF-T-236, AAPM 47th Annual Meeting, Seattle, WA, July 24 – 28th, 2005.

15. Hammer, B.E., MRI Compatibility Testing of Medical Devices for Research and Development Engineers, 4th Annual Design of Medical Devices, University of Minnesota, April 14, 2005.

16. Siskind, L.C., Hammer, B.E., Christensen, N.L., Multiple RF Coil NMRQC, Quantum Computation for Physical Modeling (QCPM) Workshop 2004, Air Force Research Laboratory, September 13-15, 2004, Martha's Vineyard, MA.

17. Bauhs, J.A., Hammer, B.E., Fricke Ion Exchange Dosimeter, 14th International Solid State Dosimetry Conference for June 27-July 2 in New Haven, CT, 2004.

18. Hammer, B.E., Christensen, N.L., King, W., Conroy, M.J., Pogue, N., Integration of a 6 MeV Electron Beam LINAC with a 1.5 T MRI Scanner, ISMRM 12th Scientific Meeting, Kyoto, Japan, May 15 -21, 2004.

19. Hammer, B.E., Engineering and Medical Applications of Magnetic Fields, 3rd Annual Design of Medical Devices, Session F2, University of Minnesota, April 9, 2004.

20. Hammer, B.E., Design and Characterization of Medical Devices by MRI , 1st Annual Design of Medical Devices Session B1, University of Minnesota, April 26, 2001.

21. Hammer, B.E., Christensen, N.L., Raylman, R.R., "MR-PET: Sub-millimeter MR and PET images in the Same Scanner", Proceedings of the 6th Meeting of the International Society of Magnetic Resonance in Medicine, April 18 – 24, 1998, Sydney, Australia, p. 256.

22. Bidault, N.P., Hammer, B.E., Hubel, A., Use of a Combined C4S-Keyhole Imaging Technique to Study the Dynamics of Cryoprotective Agents in Engineered Tissue, Proceedings of the 6th Meeting of the International Society of Magnetic Resonance in Medicine, April 18 – 24, 1998, Sydney, Australia, p. 1455.

23. Schuler, B.A., Hammer, B.E., Parish, T., Lin, J., Pangrle, B., Heruth, K., Schultz, B.K., Elsberry, D.E., Kucharczyk, J., Truwitt, C., "MR Compatibility and Visibility Assessment of Implantable Medical Devices", A Workshop on Advances in MR Safety and Compatability: Implications for Interventional and Functional MRI, ISMRM, June 9 - 11, 1996, McLean, Va.

24. Beilman, G.J., Meyers, D., Cerra, F.B., Hammer, B.E., Conroy, M.J., Reynolds, D.G., "Tissue Energetics during Variation of Oxygen Delivery in an Isolated , Perfused Hind-Limb Model", Society of Critical Care Medicine, New Orleans, LA, February 1996.

25. Kutsovsky, Y.E., Alvarado, V., Davis, H.T., Scrivem, L.E., Hammer, B.E., "Dispersion of Paramagnetic Tracers in Bead Packs by T1 Mapping: Experiments and Simulations", 3rd International Meeting on Recent Advances in Magnetic Resonance Applications to Porous Media", Louvain la Neuve, Belgium, September 1 - 5, 1995, p. C7.

26. Hammer, B.E., "One-Shot Field Mapping with an Array of Chemically Shifted Nuclides", 3rd Meeting of Society of Magnetic Resonance, Nice, France, August 19 - 25, 1995, p. 929.

27. Kutsovsky, Y.E., Hammer, B.E., Scriven, L.E., Davis, H.T., "Velocity Vector Imaging in a Single Sequence", Proceedings of 3rd Meeting of Society of Magnetic Resonance, Nice, France, August 19 - 25, 1995, p.591.

28. Conroy, M.J., Hammer, B.E., Amiot, B. P., Gramer, M. J.,"Characterization of a Large Scale Commercial Hollow Fiber Bioreactor Using Multinuclear NMR Spectroscopy and Imaging", 3rd Meeting of Society of Magnetic Resonance, Nice, France, August 19 - 25, 1995, p. 1197.

29. Hammer, B.E., Christensen, N.L., "Detection of Positron Annihilation in Strong Magnetic Fields: The Foundation for Developing an MR-PET Scanner", IEEE Nuclear Science Symposium and Medical Imaging Conference, Norfolk, VA, October 30 - November 5, 1994.

30. Hammer, B.E., "Simultaneous Measurement of NMR and Positron Annihilation in a Magnetic Field", 2nd Meeting of Society of Magnetic Resonance, San Francisco, CA, August 6 - 12, 1994, p. 749.

31. Hammer, B.E., Christensen, N.L., Heil, B.G., "Experimental Verification that a Magnetic Field Increases the Spatial Resolution of PET Images: The First Step Toward Developing a Hybrid MR-PET Scanner", 36th Annual Meeting of the American Association of Physicists in Medicine, Anaheim, CA, July 24-28, 1994. Abstract in Medical Physics, vol.21(6), p.932, X10, 1994.

32. Hammer, B.E., "Magnetic Field Mapping with an Array of NMR Probes," 35th Experimental Nuclear Magnetic Resonnace Conference, Pacific Grove, CA, April 10 - 15, 1994.

33. Hammer, B.E., Ong, H.S., Amiot, B., "NMR Imaging and Spectroscopy of a Large Scale Cell-Loaded Hollow Fiber Bioreactor", Paper No. 161h in session on Immobilized and Perfused Eucaryotic Cell Cultures, American Institute of Chemical Engineers Annual Meeting, Miami Beach, FL., November 1-6, 1992.

34. Cousins, J.P., Hammer, B.E., Lee, K.J., Andrjuk, T., Ptak, T. Goldfard, R.D., "Non-Ischemic Myocardial Injury Observed In Vivo in Chronically Instrumented Pigs Under Continuous Endotoxin Challenge", 9th Meeting of the Society of Magnetic Resonance in Medicine, p.252, New York, 1990.

35. Hammer, B.E., Mirer, S.D., Heath, C.A., Belfort, G., "Quantitative Flow Measurements in Bioreactors by NMR", 30th Experimental Nuclear Magnetic Resonance Conference, Pacific Grove, CA, April 1989.

36. Hammer, B.E., "New Horizons for Medical Resonance Imaging and Spectroscopy Instrumentation", 23rd Annual Meeting-Association for the Advancement of Medical Instrumentation, Washington, D.C., 1988.

37. Hammer, B.E., Sacks, W., Hennessy, M.J., Bigler, R.E., Sacks, S., Fleischer, A., Zanzonico, P.B., "In Vivo Metabolism of 1-[13C]-Glucose in Monkey Brain by 13C NMR Spectroscopy", Physiological NMR Spectroscopy:From Isolated Cells to Man: New York Academy of Sciences, New York, September 1986.

38. Hammer, B.E., Sacks, W., Hennessy, M.J., Bigler, R.E., Sacks, S., Fleischer, A., Zanzonico, P.B., "In Vivo Metabolism of 1-[13C]-Glucose in Monkey Brain by 13C NMR Spectroscopy", works in progress, 5th Annual Meeting, Society of Magnetic Resonnace in Medicine, p.166-167, August 1986.

39. Hammer, B.E., "13C Imaging by Selective and Non-Selective Excitation", works in progress, Society of Magnetic Resonance Imaging, Philadelphia, PA, March 1986.

40. Hammer, B.E., Sacks, W., Hennessy, M.J., Bigler, R.E., Sacks, S., Fleischer, A., Zanzonico, P.B., "In Vivo 13C NMR of Glucose Metabolism in Monkey Brain", 3rd Meeting of the Society of Magnetic Resonance Imaging, San Diego, CA, March 1985.

41. Hennessy, M.J., Gramm, J.J., Hammer, B.E., "A Multi-Purpose Rat Probe for In-Vivo Spectroscopy", Abstract p. 178, 3rd Meeting of the Society of Magnetic Resonance Imaging, San Diego, CA, March 1985.

42. Hammer, B.E., "Applications of Small Bore Magnets in NMR Imaging and Spectroscopy", invited paper at the Annual Meeting of the Society of Photographic Scientists and Engineers, Atlantic City, NJ, May 1985.

43. Hammer, B.E., Hennessy, M.J., House, W.V., Butler, D.M., "Field Dependence of T1 in Human Heads from 0.05 to 0.1 Tesla", 25th Annual Meeting of the American Association of Physicists in Medicine, New York, NY, July 1983.

Invited International Seminars

1. Hammer, B.E., "Engineering Considerations for a MR-PET Scanner", European Scientific Institute, International Seminar on Medical Imaging and New Types of Detectors, Archamps, Haute-Savoie, France, May 15 -19, 1995.

2. Hammer, B.E., "NMR Applications in Biotechnology", University of British Columbia, Department of Chemical Engineering, Vaccouver, B.C., Canada, May 10, 1996.

Invited National Seminars

1. Hammer, B.E., Bernhardt, A., Malba, V., Massively Parallel NMR Spectrometers for Quantum Computing Applications, Quantum Computation for Physical Modeling (QCPM) Workshop, Air Force Research Laboratory, September 27, 2000, Martha's Vineyard, MA.

2. Conroy, M.J., Hammer, B.E., Bioreactor Structure and Function Studied by NMR, Biosym 96, International Symposium on Hollow Fiber Bioreactor Technology,, Boston, MA, November 3-6,1996.

3. Hammer, B.E., "Non-Biomedical NMR Imaging Applications"; 3M Technical Forum, 3M Corporation, St. Paul, MN., July 29,1991.

4. Hammer, B.E. "Magnetic Resonance Imaging of Flow in Hollow Fiber Bioreactors"; Midwest Biotechnology Symposium, Madison, WI., May 30, 1991.

5. Hammer, B.E. "Bioreactor Characterization Using NMR Imaging and Spectroscopy"; Biological Process Technology Institute NIH Seminar, St. Paul, MN., May 10, 1991.

6. Hammer, B.E. "Flow Visualization by Nuclear Magnetic Resonance Imaging"; Naval Underwater Systems Center, Newport, RI., January 10, 1991.

Invited Local Seminars

1. Hammer, B.E., Medical devices and MR compatibility: *What to test and how to test*, Life Science Alley, St. Louis Park, MN, September 28, 2010.

2. Hammer, B.E., Advances in MRI, Tech Tune-Up: Innovative and Disruptive Technologies, University of Minnesota, Department of Electrical Engineering, June 2 – 4, 2008.

3. Hammer, B.E., Magnetic Levitation, MRI and the NMR Chip, Magnetic Seminar Series, May 2, 2008.

4. Hammer, B.E.., Magnetic Levitation of MC3T3 Osteoblastic Cells as a Ground-Based Simulation of Microgravity, Minnesota Orthopaedic Research Foundation, Minneapolis, MN, March 25, 2008.

5. Hammer, B.E., Magnetic Levitation as a Surrogate for Orbital Free-fall Experiments, Bone/Cartilage Data Club Meeting, UMN, May 24, 2006.

6. Hammer, B.E., Applications of Magnetism in the Biomedical Sciences, Physics Colloquium, UMN, January 25, 2006.

7. Hammer, B.E., Beyond MRI, BMEI Biomedical Imaging Seminar, UMN, November 18, 2005.

8. Hammer, B.E., Accessing MRI for your Research, Lillehei Heart Institute, UMN, November 9, 2005.

9. Hammer, B.E., MRI Compatibility Testing of Medical Devices: What the R&D Scientist/Engineer Needs to Know, Medical Alley, Double Tree Park Place, St. Louis Park, MN , January 25, 2005.

10. Hammer, B.E., The Attraction and Repulsion of Magnetism in Medicine, National Academy of Engineering, Technical Innovation in Medical Devices, University of Minnesota, March 31, 2005.

11. The Outer Limits of Magnetism in the Biophysical Sciences, U of MN Biomedical Engineering Institute, January 26, 2004.

12. Hammer, B.E., Spins, Magnets and Chemistry: The Ingredients for NMR Imaging, Chemical Biology Colloquia, Department of Medicinal Chemistry Smith 117, April 21, 2004.

13. Baus, J.A., Hammer, B.E., Properties of Ion Exchange Resin Beads Incorporating Iron Ions for Use in a Three-Dimensional Ionizing Radiation Dosimeter, North Central Chapter American Association of Physicists in Medicine, Mayo Clinic Rochester, Rochester, MN, November 19, 2004.

14. Hammer, B.E., Non-Clinical MRI and other Bizarre Magnetic Projects, North Central Chapter American Association of Physicists in Medicine, Gundersen Lutheran Hospital, La Crosse, WI, May 4, 2004.

15. Hammer, B.E., Development of a Multimodality MR-PET Scanner, BMEn seminar, Univ of Minn. Sept 7, 1999.

16. Analytical Chemistry Seminar: NMR Imaging Applications for the Applied Sciences - May 8, 1994

Active funding for Bruce Hammer:

2R44DK069865-03/(subcontract PI=Kleachos Papas) 09/30/2006-09/30/2009 20%
Islet Culture, Shipping, and Infusion Device
Goal for Hammer component: To develop MRI techniques to verify islet culture shipping and infusion device is functional.

Completed:

University of Minnesota (PI=Hammer, Mantell) 07/01/2008 – 06/30/2010 3%(unpaid)
Center for Nanostructure Applications Seed Grant $80,000
Magnetic Susceptibility of Subcellular Organelles

Semiconductor Research Corp (PI=Hammer, Harjani) 09/01/2008 – 08/30/2009 3% (unpaid)
Wireless implantable NMR spectrometer $40,000 (gift)

University of Minnesota (PI=Hammer, Harjani) 07/01/2007 – 06/30/2009 5% (unpaid)
Institute for Engineering in Medicine $161,000
Wireless implantable NMR spectrometer on a chip

2 U42 RR016598-06 (PI=Hering) 09/2006 – 09/2012 15%
NIH $5,584,374
Human Pancreatic Islet Cell Resources
Goal for Hammer component: Characterize pancreatic islets for transplantation via NMR spectroscopy

W81XWH-07-1-0216 / Mod P00001 (PI=Slaton) 03/05/2007 - 04/04/2010 8%
USDOD ARMY $535664
Development of nanoencapsulated prostate cancer specific contrast agent for MRI
Goal for Hammer component: Develop MRI protocols, acquire data and analyze.

1R21EB003947-01A2 (Hammer) 09/15/2006 – 08/31/2008 25%
NIH/NIBIB $225,000
Magnetic Levitation of Osteoblasts
Microarray study of Osteoblasts in simulated orbital freefall.

Pending:

Minnesota Medical Foundation 07/01/2010 – 09/30/2010 2%(unpaid)
Effect of Gravity on Osteoblast Genomics and Metabolomics requested amount = $15,000

Declined:

1R01EB012513-01 (PI = Hammer) 12/01/2010 to 11/30/2015 40%
NIH/NIBIB requested amount = $ 2,912,026
Implantable Wireless NMR Spectrometer

1UH2AR059661-01 (PI = Hammer) 07/01/2010 to 6/30/2015 40%
NIH/NIAMS requested amount = $1,809,386
Gravitational Regulation of Osteoblast Genomics and Metabolism

Nugen Corp. 06/01/2010 – 05/31/2011
Gravitational Regulation of Osteoblast Genomic Expression on Earth and in Space
Requested amount = $10,000 in supplies

UofM IEM, Requested amount Implantable Wireless NMR Spectrometer on a Chip,	1/1/2010 – 12/31/2010 $50,000	
NIH RFA-0D-09-003 (PI=Hammer) Requested amount Wireless implantable NMR spectrometer on a chip	10/01/2009 – 09/30/2011 $1,000,000	25%
NIH RFA-0D-09-003 (PI=Simha) Requested amount In vivo imaging of cartilage biomarker molecules by Nanoprobe-based MRI	10/01/2009 – 09/30/2011 $1,000,000	8%
NIH RFA-0D-09-003 (PI=Simha) Requested amount Non-Invasive Magnetic Resonance Elastography to Stage Intervertebral Disc Disease	10/01/2009 – 09/30/2011 $998,803	17%
NIH RFA-0D-09-003 (PI=Papas) Requested amount Real-time assessment of pancreas quality via NMR	09/30/2009 – 09/29/2011 $1,000,000	5%
NIH RFA-0D-09-003 (PI=Panyam) Requested amount Multi-Modal Targeting For Lung Tumor Specific Drug Delivery and Imaging	09/30/2009 – 09/29/2011 $ 999,365	15%

OVERLAP: None