BIOGRAPHICAL SKETCH

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NAME: Henning U. Voss

eRA COMMONS USER NAME (credential, e.g., agency login): HUVOSS

POSITION TITLE: Associate Professor of Physics in Radiology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Potsdam, Potsdam, Germany	MS	03/1995	Physics
University of Potsdam, Potsdam, Germany	PHD	10/1998	Physics
University of Potsdam, Potsdam, Germany	Max-Planck-Society postdoc fellowship	03/1999	Physics
Georgia Institute of Technology, GA	Visiting postdoctoral fellow	06/1999	Physics
University of Surrey, UK	Visiting postdoctoral fellow	11/1999	Physics

A. Personal Statement

My research focuses on the development of advanced neuroimaging MRI approaches and their clinical and pre-clinical application. Generally, with my background in physics and dynamical system modeling I work in collaboration with biomedical and clinical scientists. My current research projects are: 1. Applying concepts of the physics of dynamical systems to novel imaging approaches of the human brain. 2. Imaging network integrity in subjects with severe brain lesions caused by traumatic brain injury and stroke. 3. Pre-clinical functional MRI studies in small animal models for neuronal circuitry, development, and plasticity.

B. Positions and Honors

Positions and Employment

1999 – 2003	Assistant Professor, University of Freiburg, Freiburg, Germany
2003 – 2009	Assistant Professor of Physics in Radiology, Weill Cornell Medical College, New York, NY
2008 -	Faculty Director of the Pre-Clinical Imaging Division at the Citigroup Biomedical Imaging Center, Weill Cornell Medical College, New York, NY
2010 -	Adjunct Associate Professor, Columbia University, New York, NY
2009 – 2015	Nancy M. and Samuel C. Fleming Research Scholarship, Cornell University, NY
2009 -	Associate Professor of Physics in Radiology, Weill Cornell Medical College, New York, NY

Other Experience and Professional Memberships

1989 – 2003	Member, Deutsche Physikalische Gesellschaft
2005 -	Member, ISMRM
2005 -	Member, New York Academy of Sciences
2008 -	Member, Society for Neuroscience
2012 -	Member, IEEE

Honors

1995	Diploma thesis: Summa cum laude, University of Potsdam, Germany
1998	PhD thesis: Summa cum laude, University of Potsdam, Germany
1999	Otto-Hahn-Medal, Max-Planck-Society
2006	US patent 7,642,781 B2, High-pass two-dimensional ladder network resonator

C. Contribution to Science

1) Mathematical modeling of dynamical systems with application to the biomedical sciences

The mechanisms behind fast and efficient neuronal information processing are an active area of research. Sixteen years ago I found a dynamical coupling scheme for nonlinear oscillators, the building blocks of computational models in neuroscience, that can explain how two spatially separated processing units can synchronize without a time delay, and how naturally occurring signal transmission time delays can be overcome and even utilized for prediction. Impact: Although abstract in its conception, research groups around the world independently have been finding widespread applications of this concept in real natural phenomena and engineering; for example, in physics, it can explain time shifts in coupled lasers (Tang & Liu, Phys. Rev. Lett. 90, 194101, 2003; Chiarello et al., IEEE Photonics Technology Lett. 23, 564 (2011)). In robotics, it is used to enable real-time response to the environment (Kojima et al., 8th IFAC Symp. on Nonlinear Control Systems, 167 (2010)). In biology, it can be used to model coupled molecular motors (Kostur et al., Phys. Rev. E 72, 036210 (2005)). In the neurosciences, this concept has been first used in models of coupled neurons (Ciszak et al., Phys. Rev. E 79, 046203 (2009)). Very recently this concept has been used to resolve a longstanding apparent paradox in the timing of EEG signals of nonhuman primates, with profound implications about cortical information processing (Matias et al., NeuroImage 99 (2014) 411).

- H.U. Voss & N. Stepp, A negative group delay model for feedback-delayed manual tracking, Journal of Computational Neuroscience 41, 295 – 304 (2016).
- H.U. Voss, The leaky integrator with recurrent inhibition as a predictor, Neural Computation 28, 1498 – 1502 (2016).
- H.U. Voss, Signal prediction by anticipatory relaxation dynamics, Physical Review E 93, 030201(R) (2016).
- H.U. Voss, Anticipating chaotic synchronization, Physical Review E 61, 5115 – 5119 (2000). PMID: 11031554.

2) Algorithms to model complex spatiotemporal signals

In order to understand complex systems such as the brain, I have been publishing methods for the estimation of parameters from spatiotemporal data that can be modeled by nonlinear differential equations, for example neuronal models and pattern forming systems. These methods have been applied by me for the first time to model neuronal dynamics, which inspired further research in this field; for example, the algorithms developed by me were used to control cortical dynamics in the book "Neural control engineering: The emerging intersection between control theory and neuroscience", MIT Press, 2011, by Steven Schiff. An early impact on science was the inference of a metabolic network for an individual's response to a smallpox vaccine from longitudinal cytokine protein concentration data (McKinney et al. Phys. Rev. E 73, 921912 (2006)). My present research in this field concerns modeling of the BOLD response in functional MRI and of cerebral hemodynamics in general on the basis of these algorithms.

- H.U. Voss, J.P. Dyke, K. Tabelow, N.D. Schiff & D.J. Ballon, Magnetic resonance advection imaging (MRAI) of cerebrovascular pulse dynamics, Journal of Cerebral Blood Flow & Metabolism, in press, DOI: 10.1177/0271678X16651449.
- H.U. Voss, J. Timmer & J. Kurths, Nonlinear dynamical system identification from uncertain and indirect measurements, International Journal of Bifurcation and Chaos 14, 1905 – 1933 (2004).
- A. Sitz, U. Schwarz, J. Kurths & H.U. Voss, Estimation of parameters and unobserved components for nonlinear systems from noisy time series, Physical Review E 66, 016210 (2002).

3) MRI techniques to image structure and function of the brain with clinical applications

I have been developing tools to improve MRI anatomical as well as functional and diffusion tensor imaging, and devised novel functional MRI protocols to image subjects in the minimally conscious state: Early on I developed MRI techniques to overcome the typical image distortions occurring during ultra-fast imaging protocols. The figure to the right shows the pulse sequence and postprocessing algorithm at work. In a long-term collaboration with mathematicians, I developed procedures for the analysis of functional and diffusion tensor MRI data. Together with my collaborator Dr. Dyke, I developed a model to overcome partial voluming effects in white matter brain imaging, which was applied to study the progression of late infantile neuronal ceroid lipofuscinosis. In an ongoing collaboration with Nicholas Schiff we apply advanced MRI imaging techniques to image residual cognitive capacity in subjects with severe brain injury caused by stroke or brain trauma.

- J.C. Bardin, J.J. Fins, D.I. Katz, J. Hersh, L.A. Heier, K. Tabelow, J.P. Dyke, D.J. Ballon, N.D. Schiff & H.U. Voss, Dissociations between behavioural and functional magnetic resonance imaging-based evaluations of cognitive function after brain injury, Brain 134, 769 – 782 (2011). PMID: 3044833.
- K. Tabelow, J. Polzehl, A. M. Ulug, J. P. Dyke, R. Watts, L.A. Heier & H.U. Voss, Accurate localization of brain activity in presurgical fMRI by structure adaptive smoothing, IEEE Transactions on Medical Imaging 27, 531 – 537 (2008). PMID: 18390349.
- H.U. Voss, R. Watts, A.M.Ulug & D. Ballon, Fiber tracking in the cervical spine and inferior brain regions with reversed gradient diffusion tensor imaging, Magnetic Resonance Imaging 24, 231 – 239 (2006). PMID: 16563951.
- K. Tabelow, J. Polzehl, H.U. Voss & V. Spokoiny, Analyzing fMRI experiments with structural adaptive smoothing procedures, Neuroimage 33, 55 – 62 (2006). PMID: 16891126.

4) Preclinical functional and neurophysiological MRI

In collaboration with biologists, I developed an experimental procedure for functional MRI in songbirds, a model for neuronal plasticity and complex neuronal information processing, and could find new insights into the processing of complex auditory stimuli. The methods developed for this project have been used for auditory fMRI in the common marmoset, too, yielding new insights about tonotopic representations that were not known before and provide a pathway for studying vocal perception in these animals, providing an alternative to studies with larger non-human primates. In collaboration with researchers studying stroke and other neurological diseases, I perform imaging studies of physiological signals such as the local cerebral blood flow, and induced neuronal activation by optogenetic fMRI. In this research, it is often necessary to build advanced technological equipment; in my research I am focusing on radiofrequency resonators for MRI, a collaboration with Douglas Ballon.

- S. Sadagopan, N.Z. Temiz & H.U. Voss, High-field functional magnetic resonance imaging of vocalization processing in marmosets, Scientific Reports 5, 10950 (2015).
- A.I. Domingos, J. Vaynshteyn, H.U. Voss, X. Ren, V. Gradinaru, F. Zang, K. Deisseroth, I.E. de Araujo & J. Friedman. Leptin regulates the reward value of nutrient, Nature Neuroscience 14, 1562 – 1568 (2011). PMID22081158.
- K.K. Maul*, H.U. Voss*, L.C. Parra, D. Salgado-Commissariat, D. Ballon, O. Tchernichovski & S.A. Helekar (*the first two authors contributed equally to this study), The development of stimulus-specific auditory responses requires song exposure in male but not female zebra finches, Developmental Neurobiology 70, 28 – 40 (2010). PMID19937773.
- H.U. Voss, K. Tabelow, J. Polzehl, O. Tchernichovski, K.K. Maul, D. Salgado-Commissariat, D. Ballon & S.A. Helekar, Functional MRI of the zebra finch brain during song stimulation suggests a lateralized response topography, PNAS 104, 10667 – 10672 (2007). PMID17563380.