

[MO-POS] MEDICAL AND BIOLOGICAL PHYSICS
PHYSIQUE MÉDICALE ET BIOLOGIQUE
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MO-POS-118

Investigation of SNR and SAR for Low-Frequency Polarized Noble Gas MRI of the Lung*, **Erin Chapple**, C.P. Bidinosti, J. Cha, N.A. David, M.E. Hayden, *Simon Fraser University* — Low-field magnetic resonance imaging (MRI) of human lungs using hyperpolarized noble gases has only recently been demonstrated for the first time. As a result there are still a number of surrounding issues that are poorly characterized at low frequencies, such as fundamental signal-to-noise ratio (SNR) limitations and specific-absorption rates (SARs). Here we present the results of an ongoing study that probes SNR and SAR from 100 kHz – 1 MHz, the range of frequencies relevant to this new MRI technique. Resonant coil structures suitable for the study of each property were constructed, and a determination of the effective coil resistance was made with and without a human subject inside each coil type. For the SNR study, rectangular Helmholtz coils (34 x 40 cm) were placed at the front and back of the chest of the subject. At all frequencies the coil resistance is at least an order of magnitude larger than the effective resistance of the subject, implying that optimal SNR might only be achieved with cryogenically cooled coils. For the SAR study, a birdcage-like transmit (B_1) coil which had a homogeneous field map over the volume of the chest was used. An SAR value of $1.5 \times 10^{-5} \int \cdot B_1^2$ W/kg (MKS units) was determined. This result is suitable for any body coil of comparable homogeneity, and is useful for determining limits on RF pulse rates.

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MO-POS-119

A Structural Study of a Myristoylated Membrane Binding Peptide, **T.A. Harroun**¹, K. Balali-Mood², J.P. Bradshaw² and J. Katsaras¹, ¹ *National Research Council* and ² *University of Edinburgh*, - Myristoylation is a common post-transcriptional modification to proteins that confers additional membrane binding affinity. The process involves the attachment of the fourteen carbon saturated acyl-chain of myristic acid to the N-terminus of the protein. Such modified proteins include the adenosine ribosylation factor (ARF) family. Using specific deuterium labeling and neutron diffraction, we previously determined that the 15 amino acid peptide from the N-terminal sequence of ARF1 (pARF1) lies parallel to the membrane interface, in the region of the headgroup. We have repeated this experiment with the myristoylated form of the peptide, and found that the effect of myristoylation is to tighten the helical structure of the membrane-binding domain, forming a new hydrophobic face for the protein, increasing its membrane binding capabilities. These results confirm the theoretical prediction that the effect of myristoylation can extend many residues along the amino acid sequence from the terminus.

MO-POS-120

A Method for Concentrating Nucleic Acids by Synchronous Perturbation of Electrophoretic Mobility, A. Marziali¹, J. Pel¹, E. Holtham¹, **D. Broemeling**¹, R. Coope¹, D. Bizzotto² and L. Whitehead¹, ¹ *Dept. of Physics and Astronomy* and ² *Dept. of Chemistry, University of British Columbia* — Electrophoretic current fields are divergence free, which prevents spatial concentration of DNA by standard electrophoresis in uniform, non-binding media. In this presentation, we demonstrate a general method for achieving electrophoretic concentration of DNA using alternating electric fields and synchronized coefficient of drag alteration. We demonstrate DNA concentration in low (<1%) agarose gel by focussing a uniform DNA solution to a single region in the center of the gel. This is done by applying a mix of dipole and quadrupole electric fields to four electrodes contacting the side of the gel, such that the DNA undergoes oscillatory motion, but its mobility is always higher when moving toward the centre of the gel. Recent results and theory behind this effect will be presented, as well as initial work toward DNA purification applications.

MO-POS-121

Analysis of Nucleic Acid Dissociation Rates using a Trans-membrane Single Molecule Sensor*, **Jonathan Nakane**, M. Wiggin and A. Marziali, *University of British Columbia* — A self-assembling nanosensor for sequence-specific detection of nucleotides across a membrane has been constructed from a single alpha-hemolysin nanopore self-assembled into a lipid bilayer, and a DNA probe tethered to avidin at one end and complementary to the analyte nucleotide at the other end. By monitoring the dissociation rate of single DNA molecules on the trans side of the membrane after binding to the trapped probe strand, we can uncover the energy landscape of these events, allowing us to detect and identify short (14-mer) perfectly complementary strands and localize regions of single base mutations in strands specifically targeted based on the sensor probe sequence. Further analysis of the energy landscapes reveals that several characteristics of the binding interaction, including the length and number of contiguous regions of complementary nucleotides, and the overall free energy of binding between may be used to distinguish populations of different oligonucleotides.

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MO-POS-122

A 3D Ultrasound Scanner for Evaluation of Musculoskeletal Disorders, Andrea Lai², **Daniel W. Rickey**^{1,3,5} and Martin H. Reed^{2,4,5}, ¹ *Medical Physics, CancerCare Manitoba*, ² *Faculty of Medicine, University of Manitoba*, ³ *Dept of Physics, University of Manitoba*, ⁴ *Department of Radiology, Children's Hospital, Winnipeg* and ⁵ *Department of Radiology, Health Sciences Centre* — Ultrasound is a primary imaging technique for diagnosis and assessment of musculoskeletal disorders because it gives excellent visualization of soft tissues and cartilaginous components. The common ultrasound method used is conventional 2-dimensional technology. There is much interest in newer 3-dimensional (3D) ultrasound technology. Although, there are many advantages to 3D methods, it has been weak in scanning over the curved surfaces of the body. The goal of this project is to develop and evaluate a novel 3D ultrasound technique that allows scanning over curved surfaces. In this poster we will show ultrasound images of various musculoskeletal anatomy acquired with a diagnostic ultrasound machine coupled to a system that obtains 3D images over curved surfaces. The usefulness of this 3D technique was evaluated by scanning a number of pediatric patients. The technology was found to easily move over the curved surfaces of the subjects. In addition, the 3D images were tested for geometric fidelity. The scanner reproduced image geometry with a high degree of fidelity, i.e., within 0.3 mm. Motion artefacts could be corrected to a certain degree, however some distortion remained in images acquired from neonates and infants who had been in constant motion during the scan.

MO-POS-123

The Effect of Bone Shape and Orientation in X-Ray Fluorescence Bone Lead Measurement, **A.F. McDonald**, N. Ahmed and D.E.B. Fleming, *Mount Allison University* - Lead is a nonessential trace metal in the human body and has been associated with a variety of adverse health effects. Since the half-life of lead in bone tissue is 10-20 years, measurement of lead concentration in bone allows one to ascertain long-term exposure. Our group uses X-ray fluorescence (XRF) to analyze bone lead levels. This method is performed *in vivo* and is capable of measuring bone lead levels above 5 ppm. The focus of the research project was to investigate some of the factors that may affect precision and accuracy of the technique. The XRF instrument is calibrated using cylindrical bone phantoms doped with known quantities of lead. We constructed additional phantoms of other shapes in order to investigate what effect, if any, bone shape and orientation might have on the technique. Preliminary results are presented and their implications assessed.

MO-POS-124

Localized Ion Depletion And Read Length Degradation In Capillary Electrophoresis For DNA Sequencing*, **Robin Coope** and Andre Marziali, *University of British Columbia* — We have investigated the performance degradation in capillary sequencing of DNA samples that contain slow-moving contaminant fragments such as genomic DNA. Analysis of current and fluorescence data from a 96 capillary electrophoresis instrument has shown that poor reads are primarily due to low capillary current, resulting in a large increase in run length for some capillaries. While the peak shape of different length DNA bands is maintained, simply not enough bands in the affected capillaries reach the detector during the run. While this effect has been observed for years in production DNA sequencing, no satisfactory explanation has been advanced. The mechanism of current reduction has been identified as the catastrophic development of an ionic depletion region downstream of low mobility DNA fragments remaining from the *e-coli* based DNA preparation protocol. The depletion region, with ~5% the conductivity of the background region, grows over time and as a result, the current declines and read length is reduced. We present experimental results showing the growth and propagation of this depletion region, and present analytic and numerical models of this effect.

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