Overview
The purpose of this presentation is to provide an opportunity to survey the advanced MRI methods that currently exist and are on the horizon for assessing the human spinal cord in vivo. We will explore strategies for obtaining high resolution, anatomical information of the gray and white matter, and quantitative techniques such as Diffusion (Tensor and non-Tensor), Magnetization Transfer (MT), and Chemical Exchange Saturation Transfer (CEST). The presentation will dovetail a description of these methods with the implementation in clinically relevant conditions such as multiple sclerosis and traumatic spinal cord injury.

Background
The spinal cord is a small (~1.5cm in diameter), linear central nervous system (CNS) organ that extends from the foramen magnum to the cauda equina and is solely responsible for conducting sensory and motor signals to and from the brain. Most importantly, the spinal cord is indicated in a number of CNS diseases, though the ability to obtain detailed information about the health and welfare of the spinal cord is not trivial. Furthermore, since the spinal cord is somatotopically organized, even very small lesions can have dramatic effects on day-to-day neurological function.

Due to its organization, it is desirable to obtain information about the individual tracts of the spinal cord (ventral, lateral, and dorsal) as well as information about the gray matter, and cord atrophy. However, all spinal cord imaging faces the same set of impediments: 1) voluntary and involuntary motion, 2) the demand for high resolution which impacts the sensitivity to motion and signal to noise ratio, and 3) increased field inhomogeneity due to proximity to large bones and heterogeneous tissues.

In spite of these limitations, the field of advanced spinal cord imaging continues to grow at an exciting rate. Currently, our toolbox of techniques to assess the human spinal cord in vivo is beginning to look very similar to our toolbox for advanced brain MRI. In fact, groups have reported the ability to perform magnetization transfer (MT), diffusion (tensor and non-tensor), quantitative relaxometry, chemical exchange saturation transfer, MR spectroscopy, and fMRI. The highlight of this presentation is to peek inside the MRI toolbox for assessing the human spinal cord in vivo. We will cover the impediments to the imaging method, present the imaging
modalities in detail, and show the relationship between a select set of these methods and clinical evaluation of neurological function.

Outline
1. Overview of Spinal Cord
   a. Anatomy and Function
   b. Impediments to Spinal Cord MRI
2. Description of the Advanced Spinal Cord MRI Toolbox
   a. Anatomical
   b. Diffusion
   c. Magnetization Transfer
   d. CEST
3. Clinical Applications
   a. Multiple Sclerosis
   b. Traumatic Spinal Cord Injury
4. The Horizon – Beyond 3T

Expectation
The take home message from this session should be an increased awareness of the advanced MRI techniques that can be applied to the spinal cord. The focus will be on the application of the techniques to the spinal cord rather than the mechanisms of the individual contrasts. Lastly, we hope that the audience will gain a working knowledge of the future of spinal cord imaging and the impact it may have in the clinic.