

Lecture 1

Advances in Hyperpolarized MRI for Brain Metabolic Imaging

Pascal WODTKE
Nvision, Germany

Abstract

Hyperpolarized ^{13}C MRI (HP MRI) enables real-time, non-invasive assessment of metabolism. However, broader adoption has been limited by the complexity, duration, and lack of standardization of current hyperpolarization methods. Recent advances have positioned parahydrogen-induced polarization (PHIP) as a rapid, cost-effective approach for producing hyperpolarized ^{13}C -labeled compounds.

The first part of this presentation will focus on recent technological advancements in PHIP, highlighting a fully automated, preclinical PHIP-based polarizer. We will detail a recent multicenter study evaluating this system across eight international research centers, demonstrating the feasibility of standardized, high-throughput metabolic MRI:

- **Rapid Dose Production:** Over 400 injectable hyperpolarized $[1-^{13}\text{C}]$ pyruvate doses were reliably produced in 90 seconds.
- **Broad System Compatibility:** In vivo imaging was successfully conducted across multiple animal models using preclinical MRI systems operating at 1.4, 3, 7, and 9.4 Tesla.
- **Consistent Metabolic Tracking:** Metabolic conversion of pyruvate to lactate and bicarbonate was successfully measured across all sites, demonstrating robust performance across instruments and field strengths.

Transitioning from polarizer technology to preclinical utility, the second half of the talk will explore applications of HP ^{13}C MRI in the brain. We will discuss our latest investigations into metabolic alterations associated with traumatic brain injury (TBI), Alzheimer's disease, and multiple sclerosis. By allowing for the dynamic tracking of regional metabolic dysfunction, HP MRI offers new pathways to detect early disease markers and assess therapeutic interventions in complex neurological disorders.

