

The background features a large, light gray watermark of the Stanford University seal. The seal is circular and contains the text "LELAND STANFORD JUNIOR UNIVERSITY" around the top edge and "1891" at the bottom. In the center of the seal is a redwood tree with the motto "DIE LICHT DER FREIHEIT" (The Light of Freedom) written above it. There are also several stars around the inner circle of the seal.

CNI User Meeting

MARCH 6, 2020

CNI

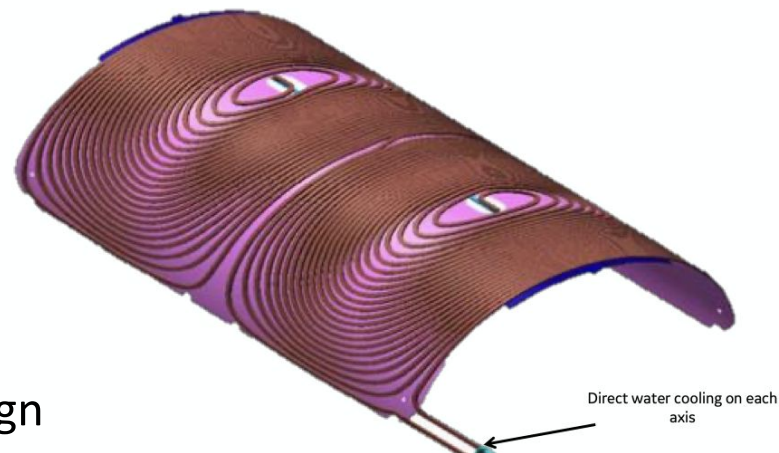
**User
Meeting
Agenda**

Mar. 6, 2020

- What is the UHP?
- Ups & downs of the UHP upgrade
- New CNI features
- Initial results
- Getting ready to scan on the UHP
- Flywheel updates
- Laima's corner
- One more thing

What is the UHP?

- Ultra-High Performance 3T
- Blend of two systems:
 - GE Premier electronics
 - SuperG amplifier technology (2400V, 1000A)
 - 2x35kW RF amplifiers
 - 64 receiver channels
 - GE Signa 7T gradients
 - HRMB 60-cm coil
 - Hollow gradient conductors
 - Force and torque-balanced design



What is the UHP?

Specification	Discovery MR750
Bore Diameter	60cm
Peak Gradient*	50 mT/m
Peak Slew**	200 mT/m/ms
Rx Channels	32
Comment	Prior CNI System

SIGNA Premier	Discovery MR750 UHP
70cm	60cm
70 (80) mT/m	100 (110) mT/m
200 mT/m/ms	250 mT/m/ms
140	64
Main product roadmap	Very stiff coil (7T) Force-balanced minimal vibration

*Peak gradient that is sustainable. Systems may have higher gradient strength, but only for limited duty cycle.

**Peak slew rate generally limited to 150 mT/m/ms for whole-body systems.

What is the UHP?

- UHP sites

- Prototype at Duke University (Allen Song)
- U. Michigan Center for FMRI (Doug Noll) to install
- Lucas Center migrating one 750 to UHP
- Porter Drive planning for UHP
- GE expectation is to sell 4-8 systems in next year - possible sites:
UCSD Center for FMRI, University of Toronto - Sunnybrook

What is the UHP?

- New equipment room electronics and cabling
- Scan room looks unchanged (don't judge a book)
- New receive coils



What is the UHP?

- GE operating system
 - Currently running DV27R01 patch
 - Will catch up to current commercial release (DV28) in 6 months
 - DV28 harmonization will add features and enable use of AIR surface coils

Ups and Downs of UHP Upgrade

- GE Waukesha trip (12/9/19-12/10/19, Hua & Adam)
 - 1½ days scanning on UHP
 - Able to compile and scan with our research sequences
 - System had a fault that resulted in all bad data



Ups and Downs of UHP Upgrade

- UHP acquisition initially structured as a loan from GE HEF
 - Approved through Randy Livingston, Stanford CFO
 - Boggled down in problems with how to track by PMO and Capital Accounting
- Restructured as a 5-year lease to own
 - Includes 7-year service agreement with technology refreshment
 - Signed last day before winter shutdown

LESSEE: THE BOARD OF TRUSTEES OF THE LELAN UNIVERSITY



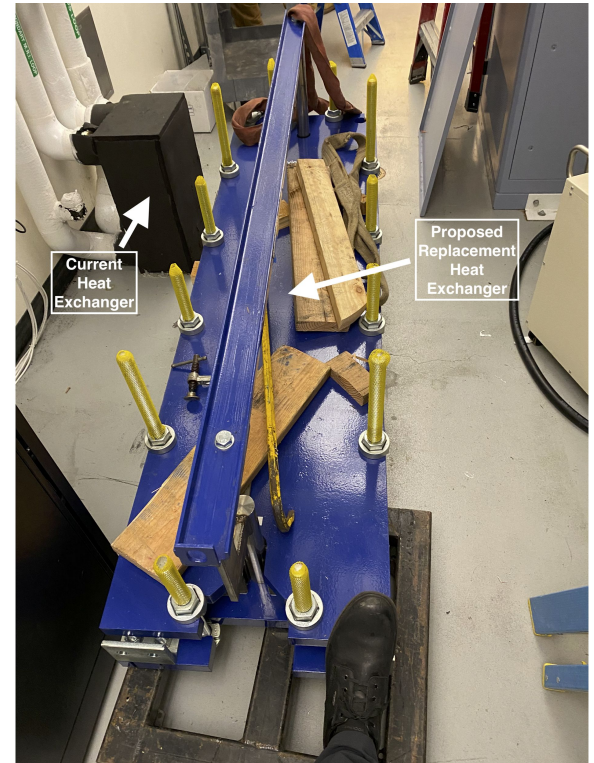
Authorized Signature: 
Cindy Wilkinson (Dec 20, 2019)

Printed Name: Cindy Wilkinson

Title: Assistant Vice President of Procurement Services

Ups and Downs of UHP Upgrade

- Heat exchanger debacle
 - UHP increases heat load to 94kW from 70kW
 - Expectation of modest increase in heat exchanger capacity
 - “Big Blue” showed up instead
 - Two months later CNI scores a win with a credit of \$26,400
 - Plans are to install only slightly larger HX than current on May 4



Ups and Downs of UHP Upgrade

- Smooth deinstall



Ups and Downs of UHP Upgrade

- Always remember to wand!



Ups and Downs of UHP Upgrade

- Smooth equipment room install (minus Laima barricade)



Ups and Downs of UHP Upgrade

- “The Incident”



0630 Hours



0920 Hours

Ups and Downs of UHP Upgrade

- “The Incident”



0927 Hours



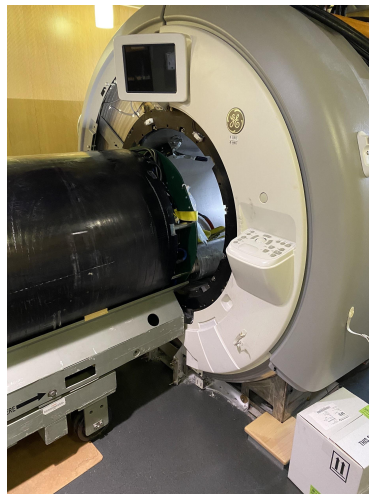
0929 Hours

Ups and Downs of UHP Upgrade

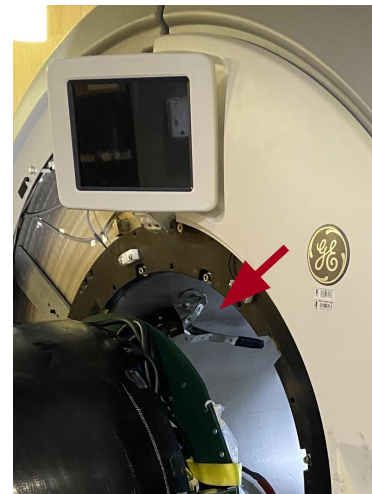
- “The Incident”



0931 Hours

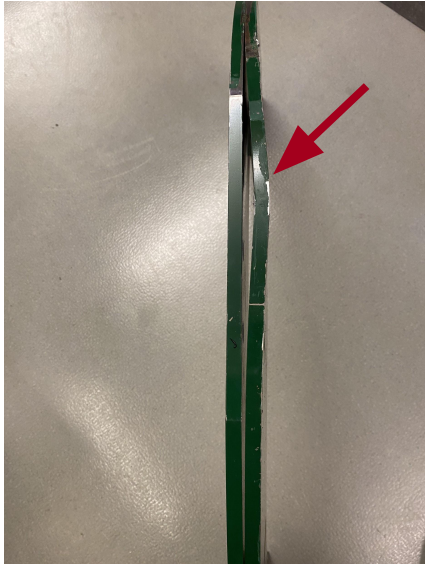


1220 Hours



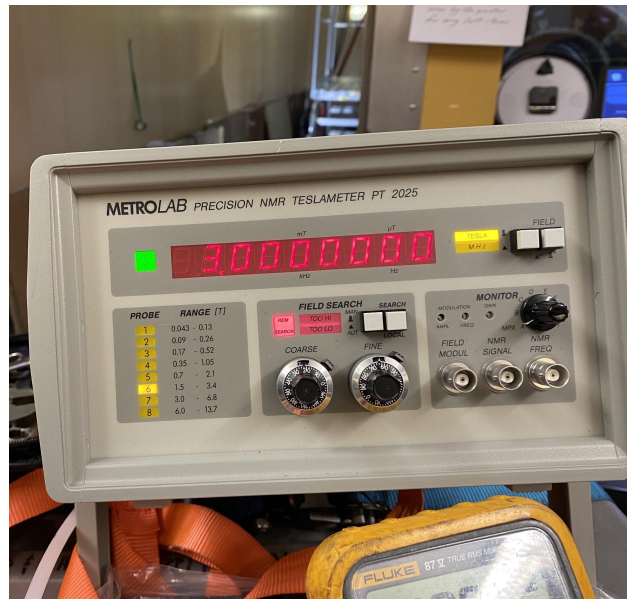
Ups and Downs of UHP Upgrade

- Two days later at 0.3T



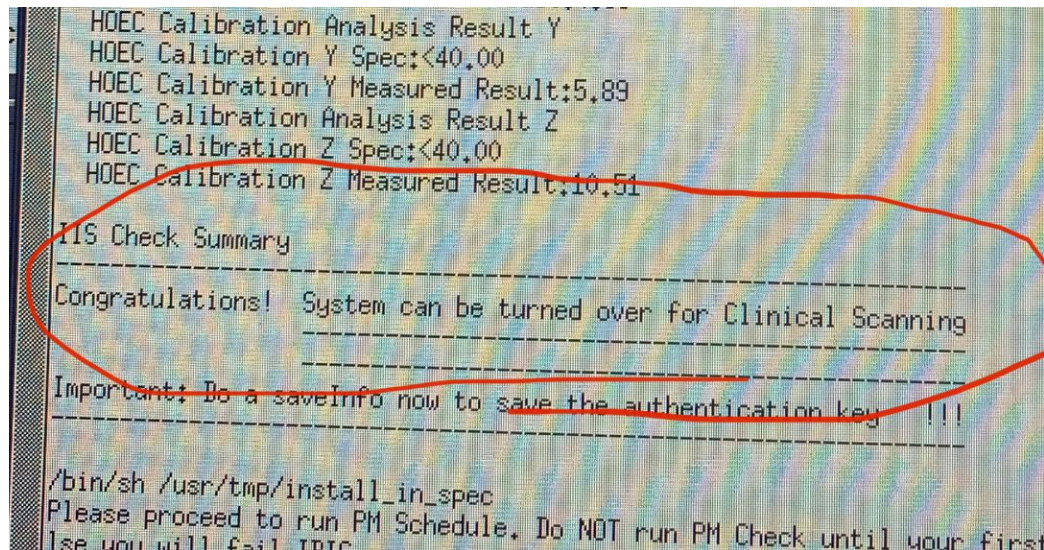
Ups and Downs of UHP Upgrade

- Finishing mechanical install and ramping back to 3T



Ups and Downs of UHP Upgrade

- First image and clinical test pass Feb. 14 👍
- All research and option keys only restored by Mar. 3 🙄



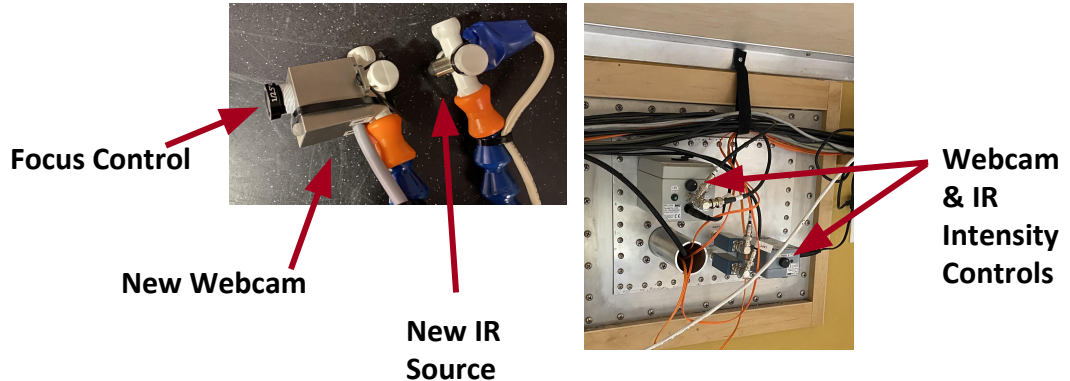
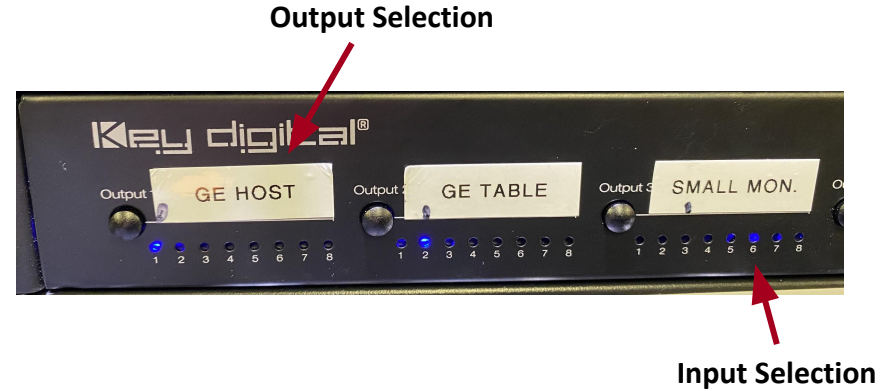
New CNI Features

- New receive coils
 - 48-channel GE head coil
 - Can operate as posterior 24-ch coil
 - EEG cable entry
 - HNU (head neck unit) (3-in-1)
 - Different anterior sections
 - Varies between 21 and 18 coil elements

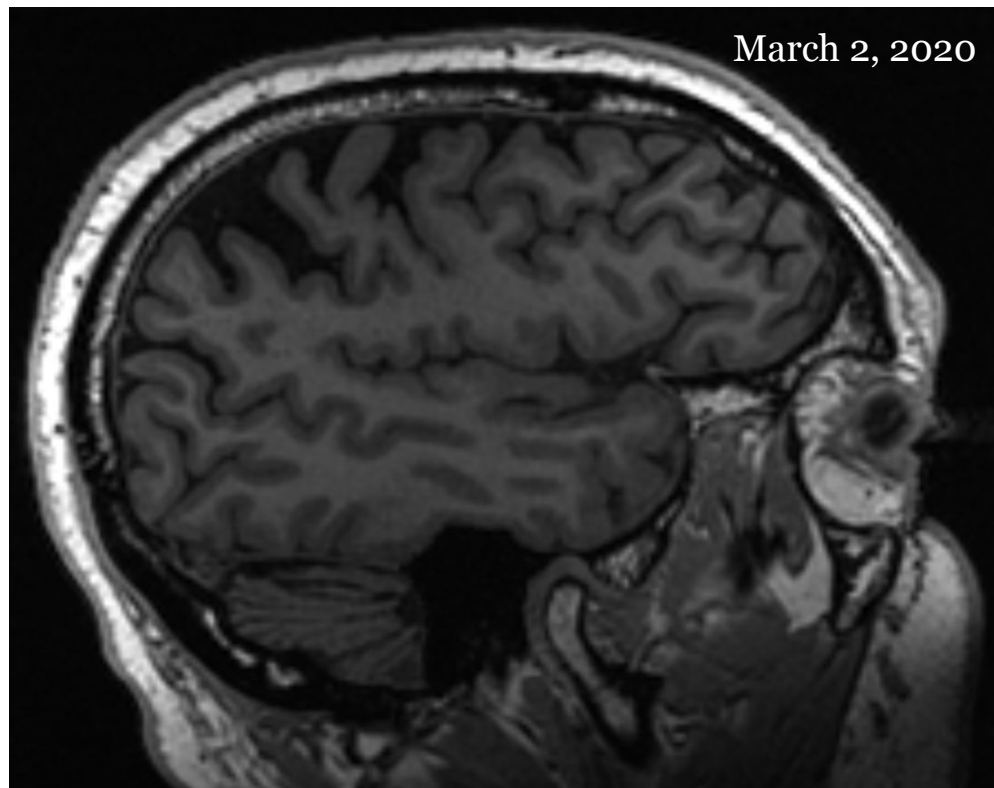


New CNI Features

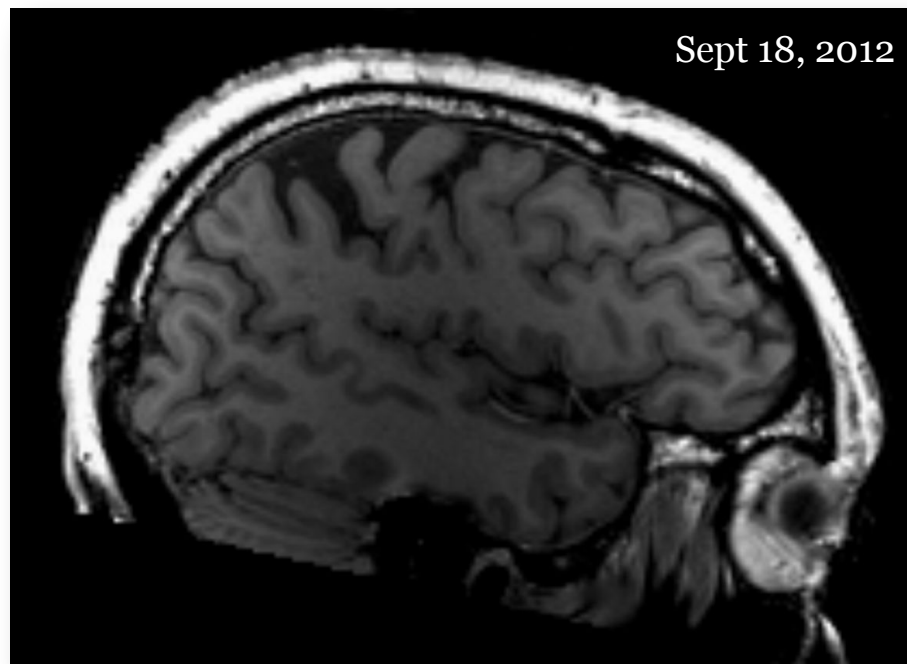
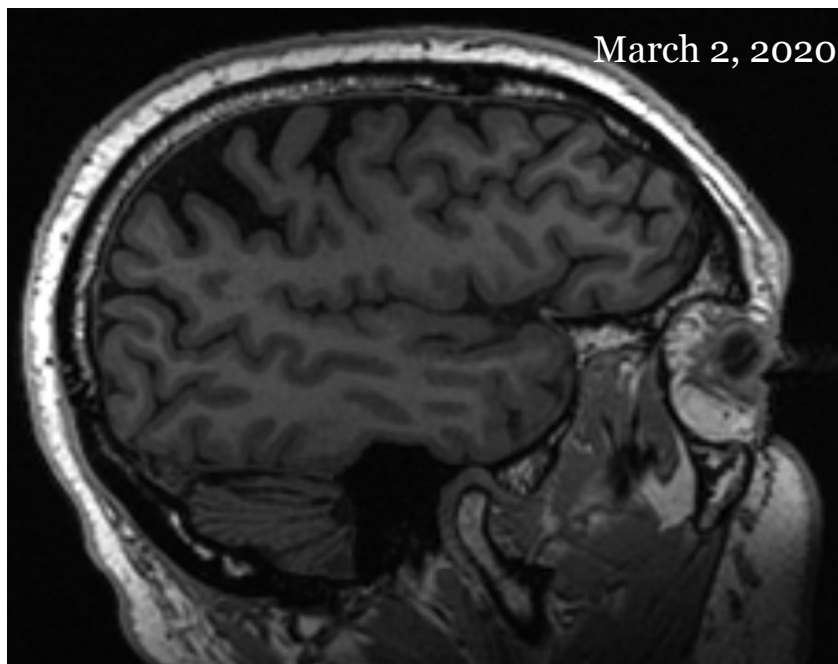
- New accessories
 - HDMI Switch
 - Webcam / integrated IR
 - New IR source
 - Old IR source still required for Eyalink



First T1-Weighted on the New UHP

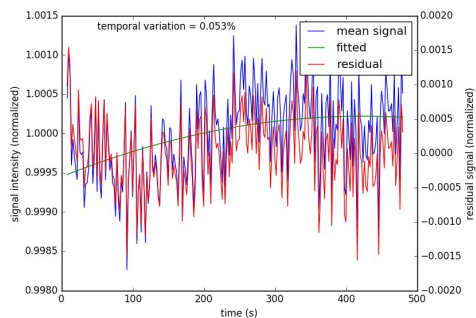


Data management: Same subject



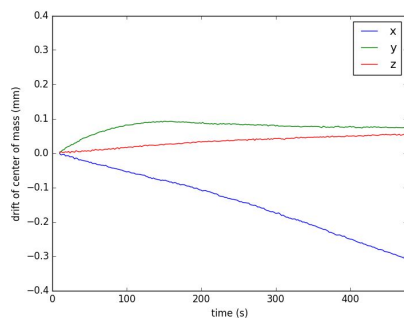
Initial Results - EPI temporal stability

Signal intensity variation

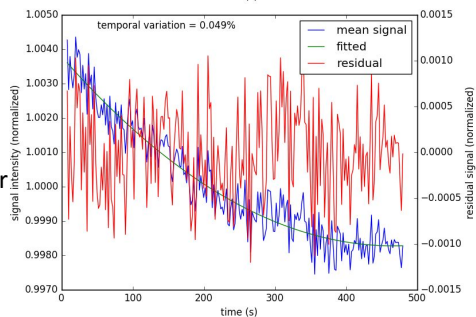
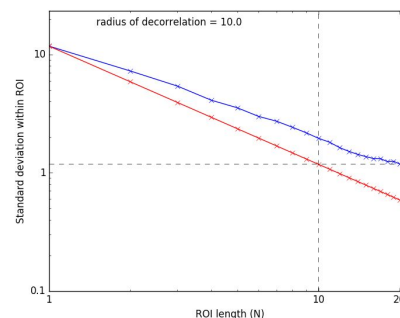


MR750

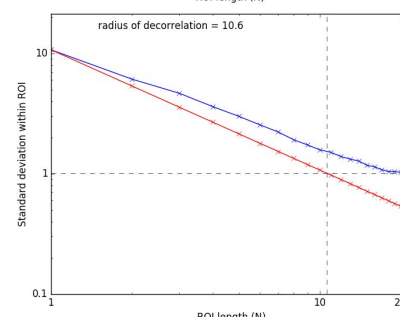
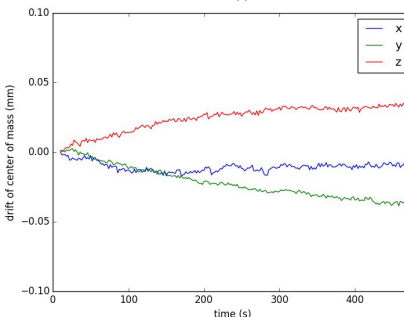
Center frequency drift



Signal decorrelation radius

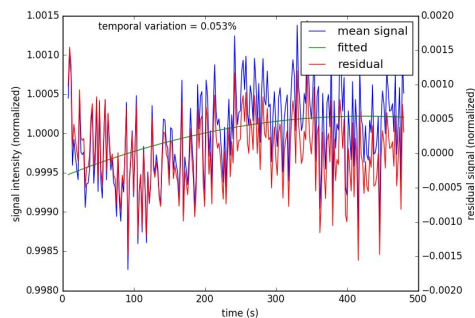


UHP
full flow
chilled water



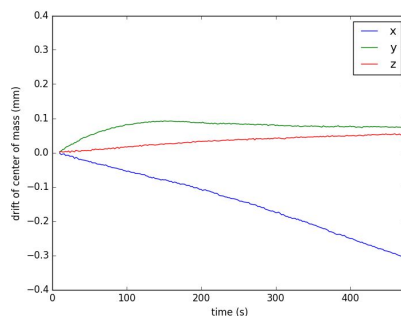
Initial Results - EPI temporal stability

Signal intensity variation

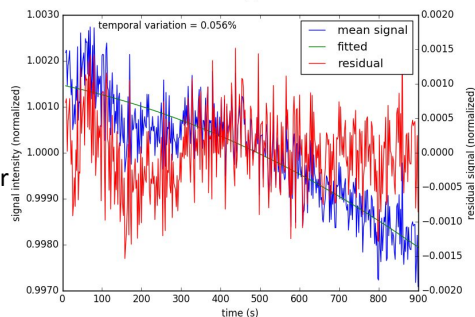
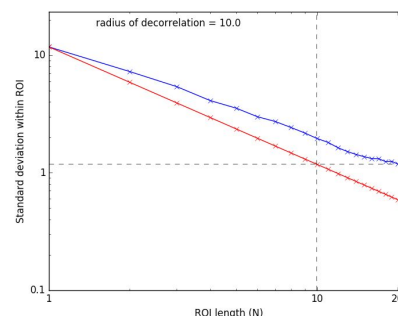


MR750

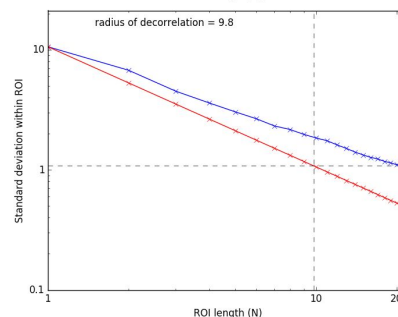
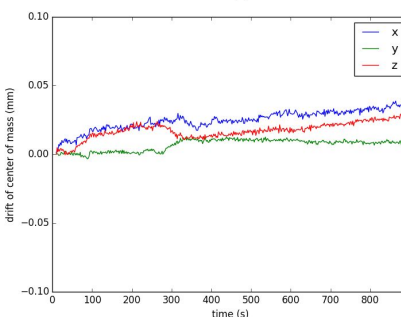
Center frequency drift



Signal decorrelation radius

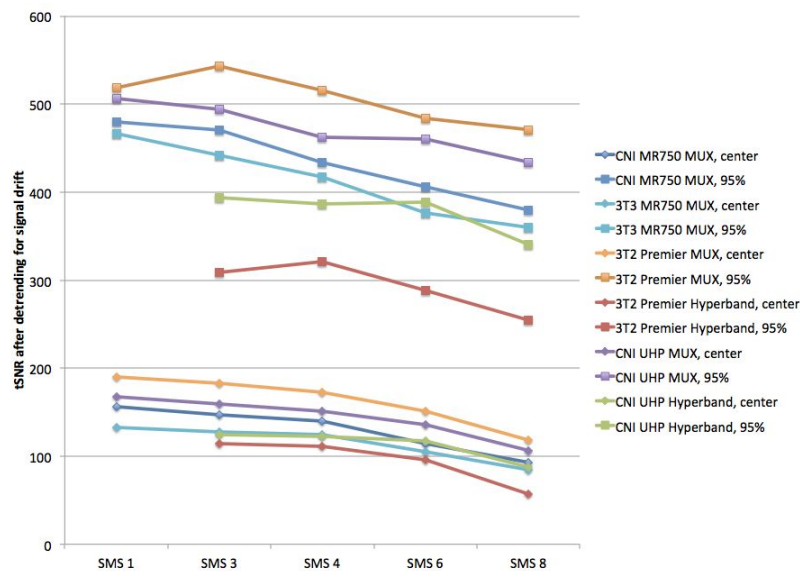
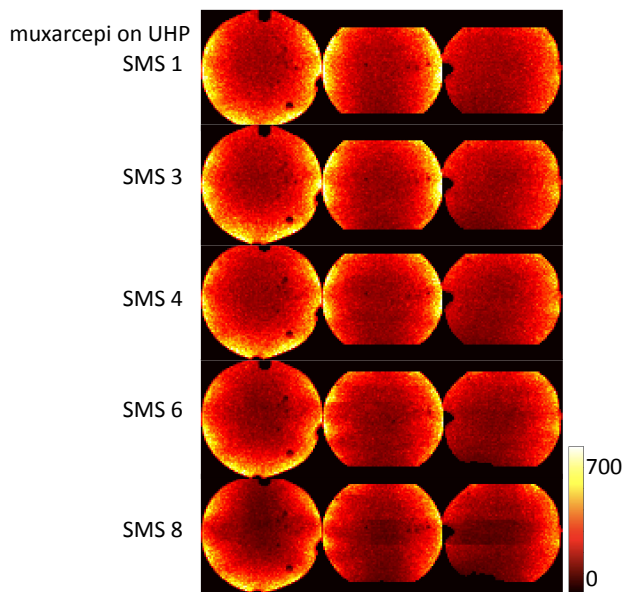


UHP
controlled
chilled water



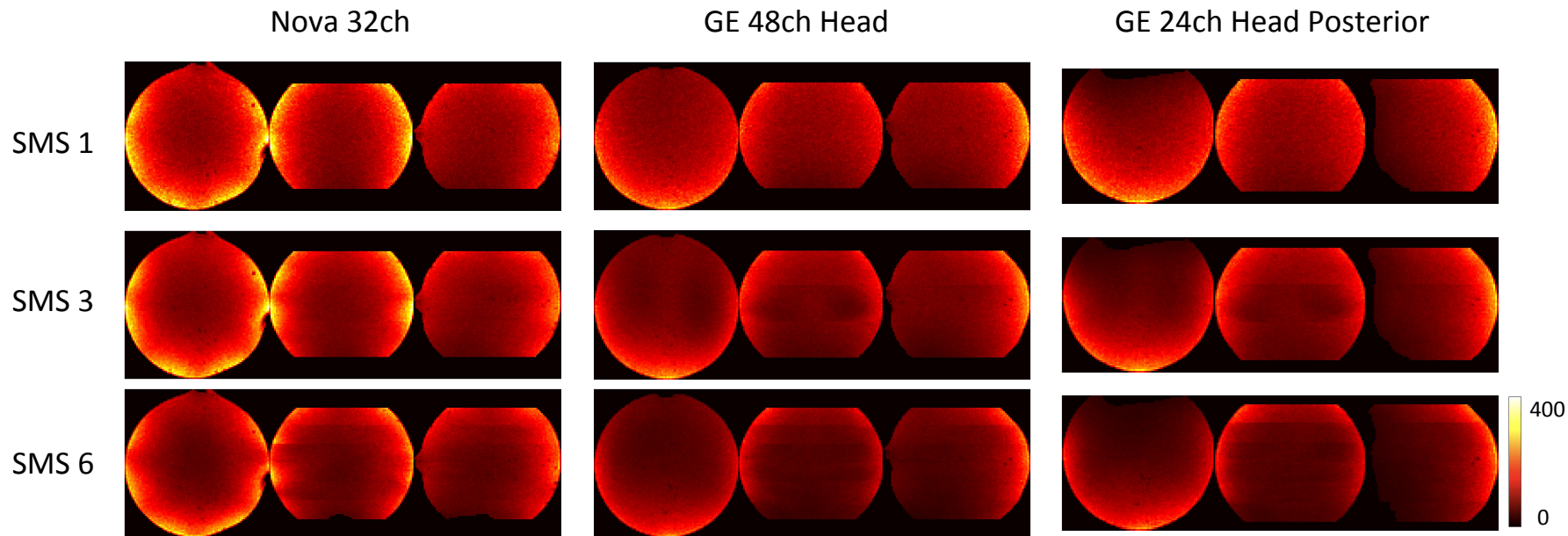
Initial Results - tSNR comparison

- Sequences
 - muxarcepi on CNI MR750, Lucas 3T3 MR750, Lucas 3T2 Premier, CNI UHP
 - GE Hyperband on Lucas 3T2 Premier, CNI UHP
- SNR measured at center of mass & 95% for through-plane acceleration factor of 1, 3, 4, 6, 8



Initial Results - testing GE coils

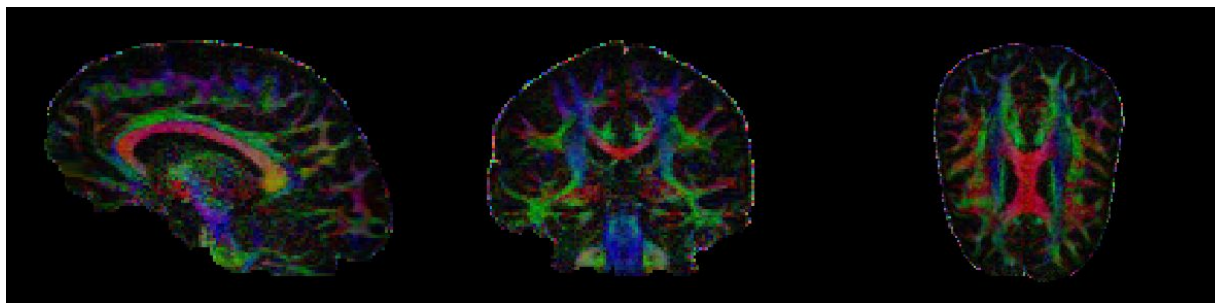
- SNR for muxarcepi at different SMS factors



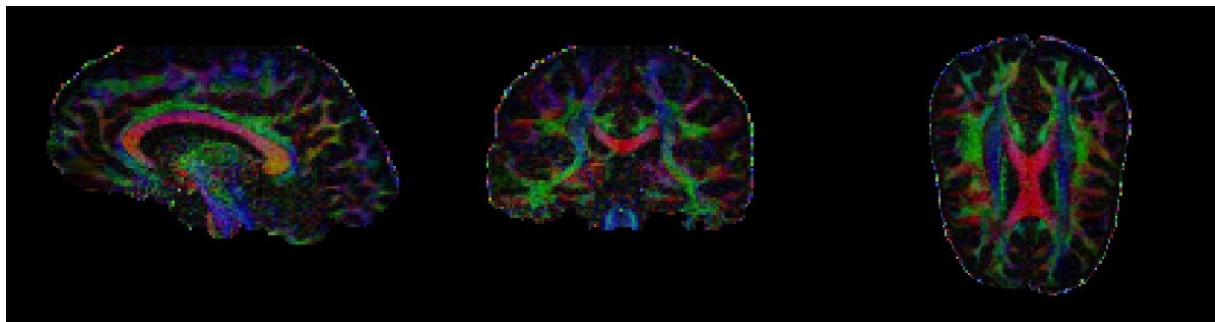
Initial Results - diffusion

- TE on UHP very similar to MR750 at derated diffusion gradient amplitude

CNI MR750



CNI UHP



Initial Results - Flywheel Project

- Storing scanner comparison data and sharing on Flywheel
- Will continue to update
- Link and description will be sent out in blog post

Scanner comparison

In preparation for the upgrade of the scanner we are comparing measurements at the Lucas (3T3) and CNI scanner. In the next few months we plan to add additional data from the Connectome Plus (UHP) system at GE in Milwaukee.

The project will contain scans from different sites and different subjects and phantoms. We have organized the data into different collections. These are named

- scanner_comparison - in-vivo
- scanner_comparison - phantom

Phantom collection

Substrate

We used three separate phantoms that are listed in the 'Subject' field. Originally we scanned with the phantomOrig, which was a bit old. The T1 value had shortened up make it imperfect for assessing brain sequences.

So, we updated our phantoms to include two newer agar phantoms (phantomA, phantomB) which have T1 values that are close to the white matter.

Scanners

We measured on three scanners (CNI, Lucas3T2, Lucas 3T3 and UHP at Milwaukee). The session label includes a string that identifies the scanner.

The UHP data collected on the December 9 and 10 were problematic. We keep them here, but we are not analyzing them. We are waiting for new data from the UHP when it comes up at the CNI.

Acquisition sequences

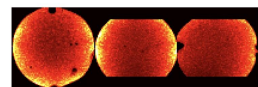
The impact of SMS (mux-factor) on temporal SNR (tsnr)

The color here indicates the voxel-wise temporal SNR measurement. Each value is the mean divided by the standard deviation across the temporal sequence. Scale bar at the right. The SNR is higher for voxels at the surface of the spherical phantom. The three images show three orthogonal slices through the center of the phantom.

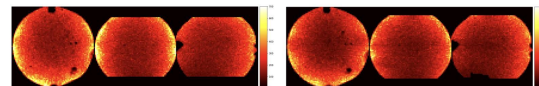
- fMRI - CNI sequence at different mux factors.

CNI MR750 (2011-19)

MUX 1



MUX 3, MUX 6



3T3 MR750

Scanning on the UHP

- CNI scan calendar opening for March 9-15
 - Protocol development time only
 - For this week only - OK to book out beyond 48-hours
 - Labs should limit themselves to 2-3 hours
 - OK to book more if schedule is still open on Monday, but be considerate
- Update your IRB
 - The UHP is an investigational device
 - See <https://cni.stanford.edu/wiki/IRB>
- Still to be completed:
 - BIOPAC connection
 - External trigger to scanner
 - Projector connection to HDMI matrix switch
 - Mirror and projection screen support for new coils




Flywheel Updates

- Platform upgrades
 - Flywheel v11 - March 13: <https://docs.flywheel.io/>
 - V3 infrastructure + Integrated “Lab” Support: Multi-Project
- Reminders
 - PHI
 - Use subject codes: If none is provided `ex<exam_number>` is used
 - Flywheel Connector will strip some PHI fields:
 - PatientID, Patient Name, Patient Date of Birth
 - Usage of the string in the PatientID field
 - `<subject_label>@<group>/<project>`
 - Flywheel Usage info: <https://cni.stanford.edu/wiki/Flywheel>

Laima's Corner


- Laima out March 9-13 at ENC presenting spectroscopy methods in use at CNI
 - See https://cni.stanford.edu/wiki/GABA_spectro
 - More updates soon
- Please review important updates on https://cni.stanford.edu/wiki/Getting_Started
 - New online forms for orientation registration
 - New information and form to be completed for groups conducting CLIA-waived testing (urine tests)



MRS in Neurosciences:
In-vivo spectroscopy methods and applications at the Stanford Center for Cognitive and Neurological Imaging (CNI)

Laima Baltula*, Mang Gu†, Ralfat Hus†, Michael Perry†, Matthew Sacconi†, Hua Wu†, Tim Durazzo†, Claudia Padula†, Donna Murray†, Daniela DeSouza†, Katy Blomquist†, Megan Holt, Ehsan Ghassemi, Hannah Fragner†, James Blang†, Ined Hassani†, David Steiner†, Brian Wanders†

*Center for Cognitive and Neurological Imaging, Stanford University, CA, USA, †Radiology Department, Stanford University, CA, USA, ‡Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, CA, USA, §Department of Psychology, Stanford University, CA, USA, ¶Department of Neurology and Neurological Sciences, Stanford University School of Medicine, CA, USA



Introduction

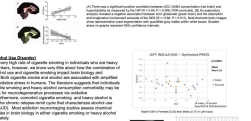
Discovers about the brain have implications for fields ranging from Business, Law, Psychology, and Education. The Stanford Center for Cognitive and Neurological Imaging (CNI) has research services across various domains to help meet the experimental needs of the human neuroimaging community. CNI develops and disseminates cognitive and neuroimaging analysis tools to the human neuroimaging community. We work closely with a researcher community of CNI's former members with a goal of disseminating research findings for neuroimaging studies.

The mission of researching methods involves an MRS technique and combining that information with related MRS measurements to give CNI a unique role in support for research of its user community by providing state-of-the-art data acquisition and data post-processing and analysis capabilities for in-vivo spectroscopy. Through collaborative efforts the special interest spectroscopy group at CNI has created education, participated in experimental design, and guided acquisition and interpretation of results.

Representative research studies

Researchers at CNI are using in-vivo spectroscopy to measure brain metabolism of individuals. However, magnetic resonance spectroscopy (MRS) measurements are contaminated by non-target metabolites, and therefore, data analysis and interpretation is challenging. This is especially difficult in the presence of overlapping metabolites.

Example: We have been studying glutathione levels in a group of patients with a history of alcohol use disorder. The goal of the study was to determine whether CNI's in-vivo MRS could measure glutathione levels from the GABA-MRS signals. We found that glutathione levels were significantly lower in patients with alcohol use disorder compared to controls. This finding is consistent with previous research showing that glutathione levels are lower in patients with alcohol use disorder.



Data acquisition and processing tools

The Research Center for Cognitive and Neurological Imaging (CNI) provides a variety of software tools for data acquisition and processing. These tools are designed to be user-friendly and easy to use. They include:

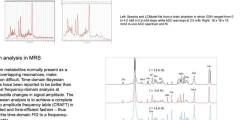
Software	Platform	Analysis Methods
SPIN-ECHO	Windows	SPIN-ECHO
MRS-FAST	Windows	SPIN-ECHO
MRS-FAST	Windows	SPIN-ECHO
SPIN-ECHO	Windows	SPIN-ECHO
SPIN-ECHO	Windows	SPIN-ECHO
SPIN-ECHO	Windows	SPIN-ECHO

Users can also use our online registration and orientation forms to get started with our tools. For more information, please contact the CNI staff.

New methods and techniques

The CNI continues to support the research of its user community by developing and incorporating for general use new data acquisition and data analysis capabilities. Representative examples include:

Improved analysis of metabolites in in-vivo MRS studies: Quantification of GABA levels. The CNI has developed a new method for quantifying GABA levels in in-vivo MRS studies. This method involves the use of a GABA-MRS signal and a GABA-MRS reference signal. The CNI has also developed a new method for quantifying GABA levels in in-vivo MRS studies. This method involves the use of a GABA-MRS signal and a GABA-MRS reference signal.



References


This document provides a list of references for the research conducted at CNI. These references are intended to provide a starting point for further research. The references are listed in alphabetical order by author name.

1. Laima Baltula, et al. (2018). In-vivo MRS of glutathione levels in patients with alcohol use disorder. *Journal of Magnetic Resonance Imaging*, 48(4), 1015-1025.

2. Laima Baltula, et al. (2019). Improved analysis of metabolites in in-vivo MRS studies. *Journal of Magnetic Resonance Imaging*, 50(2), 315-325.

Data Management

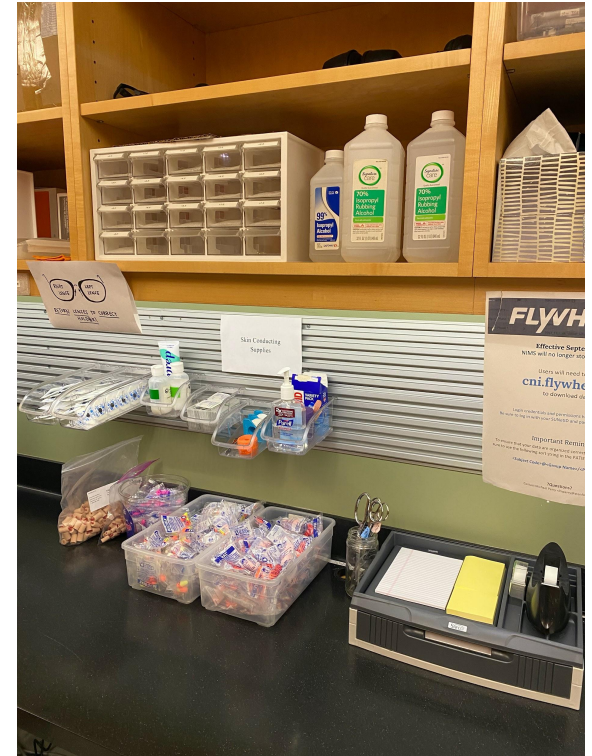
The CNI provides a variety of software tools for data management. These tools are designed to be user-friendly and easy to use. They include:



Users can also use our online registration and orientation forms to get started with our tools. For more information, please contact the CNI staff.

Laima's Corner

- Start and **stop** your scan session on time
- Please return all supplies and equipment to the proper locations
- Tidy up after yourself and your subject
- Parking changes
 - Q passes continue to be available
 - A parking scratchers not available
 - <https://transportation.stanford.edu/parking/purchase-a-parking-permit/visitors>
- Incidental findings procedure
<https://cni.stanford.edu/wiki/Operations>



One More Thing

- New sequences in development from GE:
 - HyperMEPI - SMS EPI acquisition with multiple echoes
 - MBMS - SMS multishot EPI diffusion-weighted acquisition using a sparse image reconstruction
 - ABCD protocol using HyperBand extension
- CNI goals:
 - Improve product HyperBand performance so as to translate off research SMS sequences
 - Exploit UHP capabilities to improve diffusion imaging resolution
 - CODE - optimization of diffusion encoding
 - Gradient system calibration for improved eddy current distortion direction
 - Multishot spiral diffusion

Questions?