CNI User Meeting

October 15, 2021

CNI

User Meeting Agenda

Oct. 15, 2021

- Update on COVID-19 impact
- Experiential learning grant
- Technology review
- Future upgrade plans
- Friendly reminders

Update on COVID-19 Impact

- Sincere gratitude for institutional support during pandemic
  - CNI generally operates with a positive net balance
  - Pandemic created a significant ongoing financial impact
  - Office of VPDoR (Kam Mohler, Serena Rao) providing significant support to maintain operations and keep user rates stable
- Research Recovery site still primary source for PIs
- To resume research at CNI
  - Approved departmental SOP **OR** IRB protocol including proviso that all subjects are vaccinated or have negative COVID test
  - Complete CNI training as described in CNI Wiki “Getting Started”

Update on COVID-19 Impact

- Anticipate increasing usage at CNI as more projects restart
  - Please remember guidelines for protocol development booking
  - CNI team may reinstitute “Short Term Reserve” slots that free up 2 weeks in advance depending on demand
- Relaxed COVID-19 mitigation measures as of Oct. 1
  - Back-to-back scan sessions (exception for vulnerable subjects)
  - Cleaning only at end of scan for highly-touched surfaces
  - Mask still required for scan subject regardless of county guidelines
  - Stay on time and stay safe!

Update on COVID-19 Impact

- All new user information is on https://cni.stanford.edu/wiki/Getting_Started
  - New user orientation will continue to be on Zoom sessions through the end of this year
  - In-person orientation session will resume in January 2022
  - The updated CNI Canvas module will launched in January 2022 with additional resources for new users

C-ShARP Experiential Learning Grant

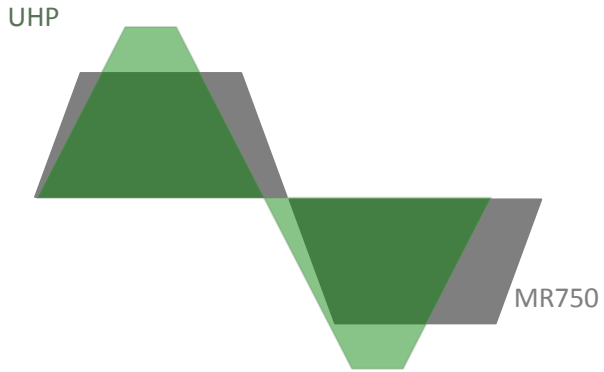
- Community of Shared Advanced Research Platforms formed 2020
  - Re-imagining shared facilities
  - Bridging Departmental and School boundaries
  - Established biannual RFP to support service center missions
- Joint group of service centers successful in application for pilot of educational support (SUMS, CNI, CSIF, SGSC)
- CNI has $28K to support experiential learning in FY22
  - Class tours/demos
  - Class projects using CNI
  - Likely to continue in future years
  - Contact Adam if you are interested in participating

UHP Update: Gradient & PNS Impact

- Updated PNS (peripheral nerve stimulation) assessment
- Best EPI specs for whole-body 3T GE systems

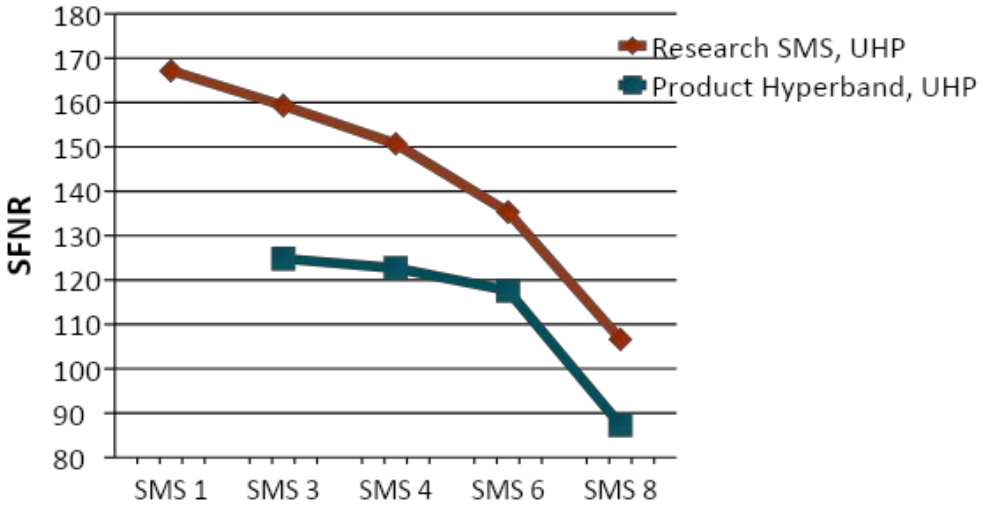
Scan Config Parameters	MR750	UHP
Effective Coil Length (XYZ-axes) (cm)	33.3	37
Rheobase (T/s)	23.4	26.5
Chronaxie (us)	334	359

EPI scan timing (92x92x60, 2.4mm iso, MB 6)	MR750	UHP
echo spacing (us)	572	560
rise time (us)	180	188
plateau time (us)	212	184
plateau amplitude (G/cm)	2.66	2.8
min TE (ms)	16.5	16.4
min TR (ms)	732	728



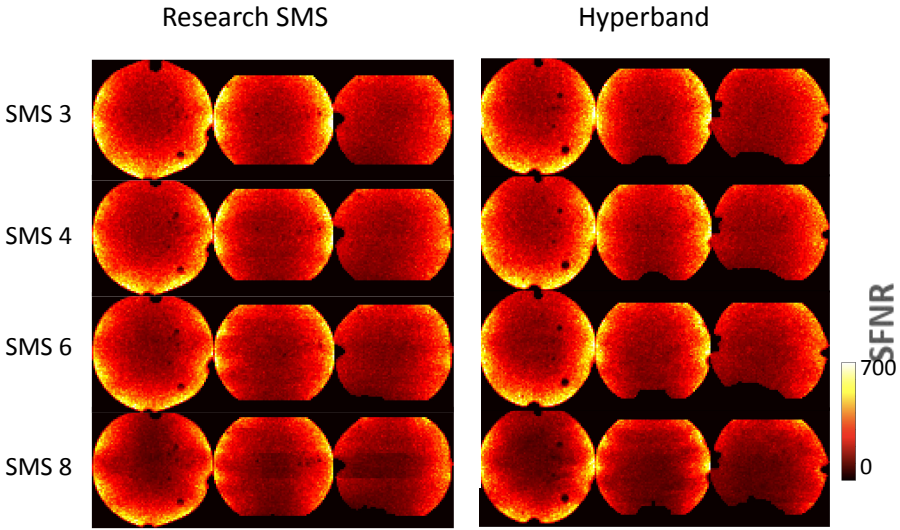
UHP Update: Product SMS (Hyperband)

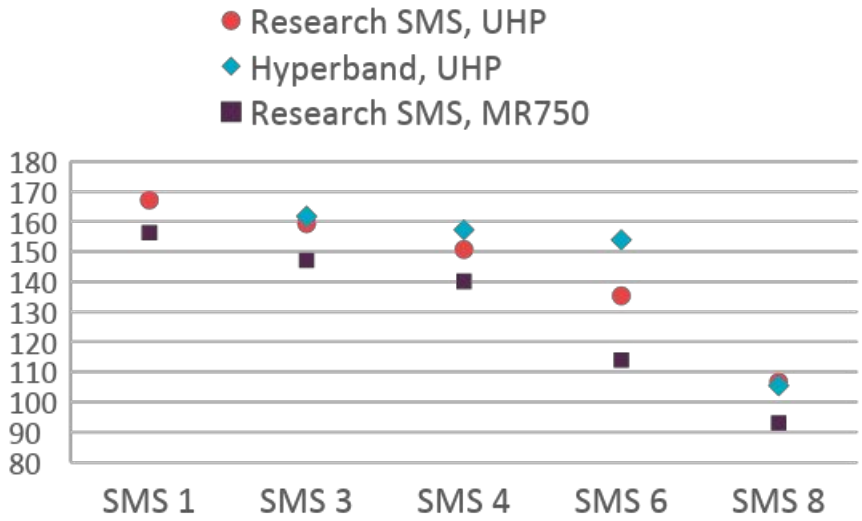
- Product initially could not match CNI research sequence, multiple issues corrected
  - Dynamic phase correction unstable
  - Central brightening TG correction being applied for fMRI
  - Aggressive partial k-space if TE < Min Full TE
  - Reduced long RF excitation duration from 13ms (260lbs, SMS=6) to 4 ms by adding complex modulation technique to the pulse sequence



UHP Update: Hyperband BOLD

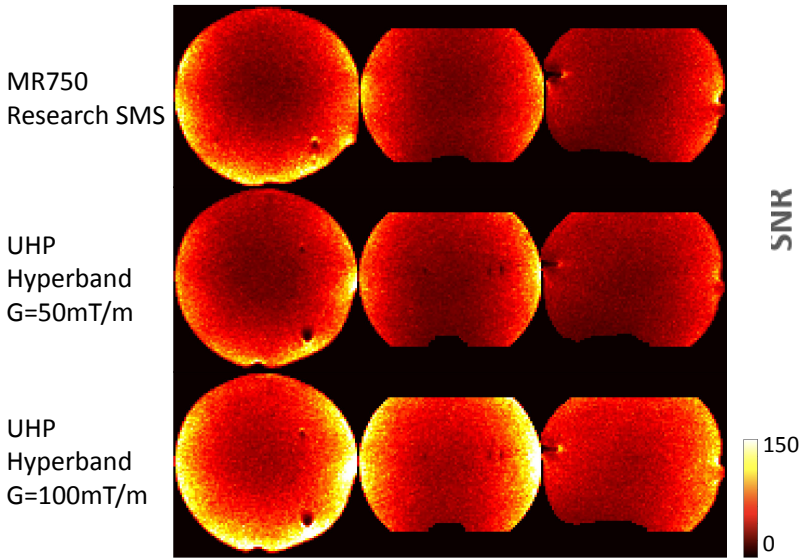
- Updated Hyperband sequence exceeds or matches Research SMS PSD in both SFNR and timing
- Recommended transition from research SMS sequence to Hyperband for all users

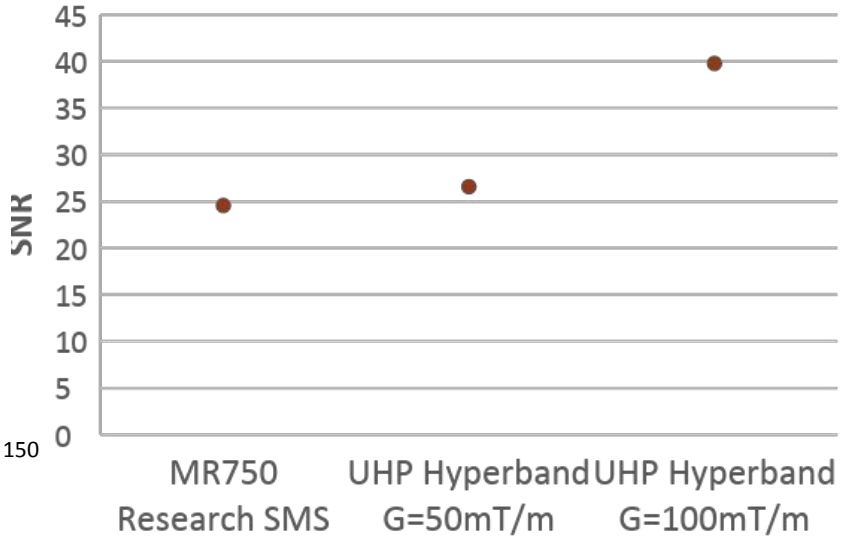




UHP Update: Hyperband DTI

- Similar SNR when peak gradient amplitude is set to match the MR750
- Improved peak gradient amplitude shortens TE, TR and provides SNR benefit





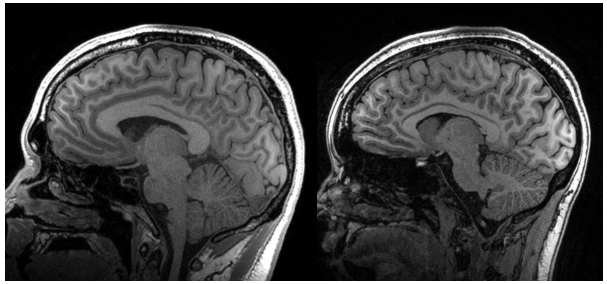
WIP Sequence: MPRAGE+PROMO

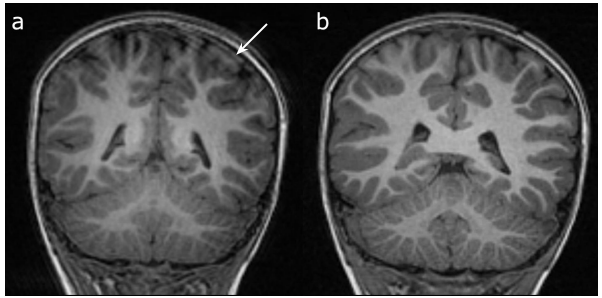
- MPRAGE+PROMO[1]
  - MPRAGE T1w scan with prospective motion correction. Maximum allowed rescan time 300s
  - Provides motion robustness at cost of longer scan times
  - 0.8mm whole brain scan time ~8min
  - Examples:

    MPRAGE: sagittal plane, 0.8mm voxel, FOV 25.6cm, phase/slice acceleration = 2/1.25, scan time 8:56 min

    Compared to BRAVO: 0.8mm, FOV 24cm, phase acceleration = 1.75, scan time 5:29 min
  - (MP2RAGE also available for quantitative T1 measurement)

BRAVO MPRAGE



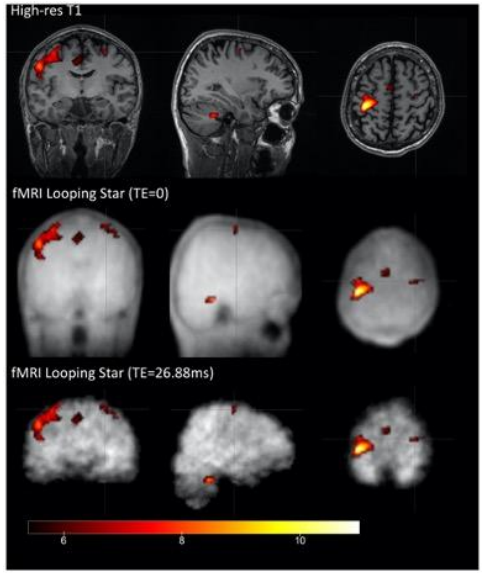


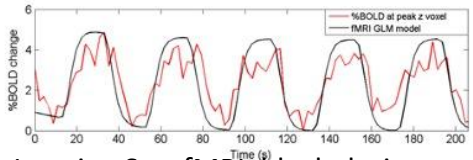
Images from GE 3T MR750W, by Kleingartner, M. et al, University of Iowa

1. White, N., et al. (2010), Magn. Reson. Med., 63: 91-105. DOI: 10.1002/mrm.22176

WIP Sequence: Looping Star

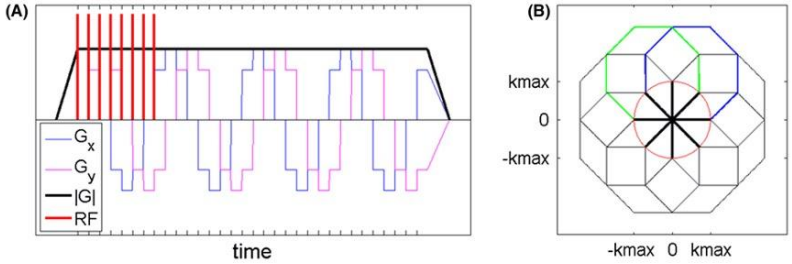
- Looping Star[1]
  - Very quiet multi-echo sequence, 2D & 3D
  - Applications include fMRI, EEG-fMRI, T2* imaging and quantitative mapping
  - Requires GE 48ch head coil
  - Typical scan protocol:
    - fMRI: 3mm, 2-4 echoes, TR 2.5~3s
    - High res: 1/1.2/1.5mm, 2/4/8 echoes, 3-4 min





Looping Star fMRI, block-design, finger-tapping experiment.

Gradient waveforms (A) and k-space trajectory (B) for FID and refocused echoes.

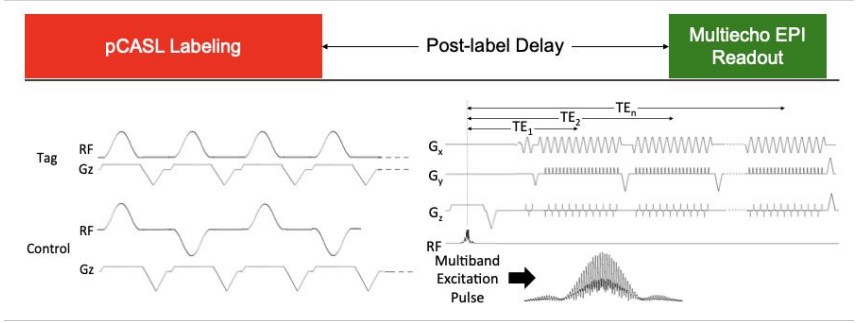


1. Magnetic Resonance in Medicine, Volume: 81, Issue: 1, Pages: 57-68, August 2018, DOI: (10.1002/mrm.27440)

WIP Sequence: Hyperband Multi-echo PCASL

- MBME PCASL[1] measures the temporal dynamics of ASL and BOLD

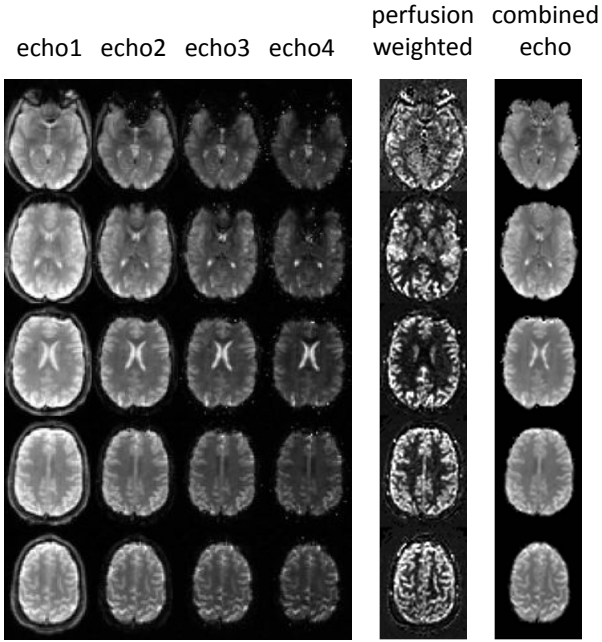
MBME PCASL Sequence Design



** Sequence reconstructs in real-time on the scanner console **

Scan Parameters

TR/TE = 3500/11,30,48,67 ms
MB-factor = 4
In plane acceleration = 2
Voxel Size = 3x3x3 mm
ASL Labeling time = 1500 ms
Post label delay = 1000 ms



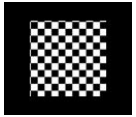
1. Cohen AD, Nencka AS, Wang Y (2018) Multiband multi-echo simultaneous ASL/BOLD for task-induced functional MRI. PLOS ONE 13(2): e0190427 (DOI: 10.1371/journal.pone.0190427)

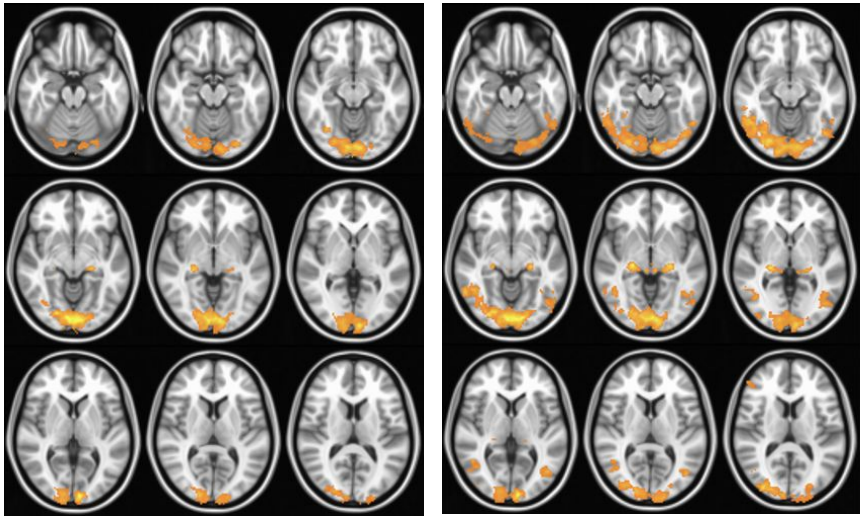
WIP Sequence: Hyperband Multi-echo EPI

- Multiband multi-echo fMRI[1]
- Example scan protocol on UHP:

  TR/TE = 1490/15, 38, 61ms
  voxel size = 2.8mm isotropic
  MB-factor = 3
  phase acceleration = 2

Task Results (data from GE)
Checkerboard, group t-test with 10 subjects
4mm voxel, MB 4, phase acceleration 2





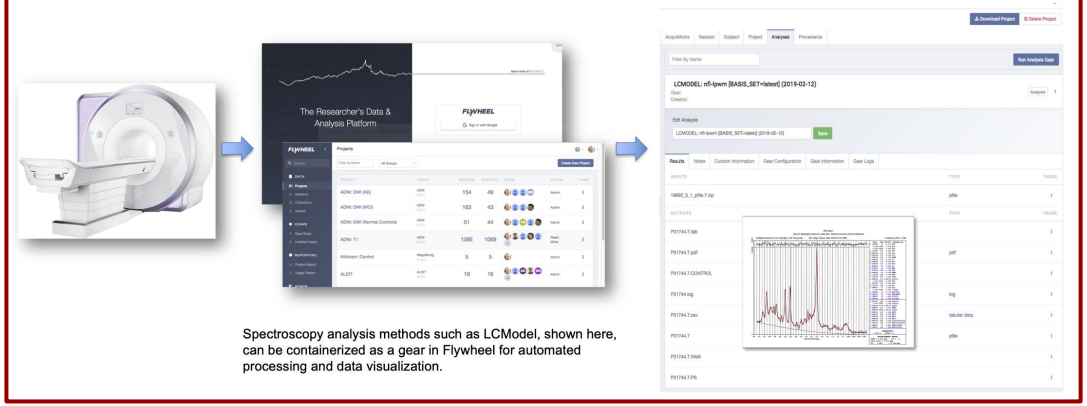
MB: TR/TE = 650/30ms

MBME: TR/TE = 900/11, 30, 48ms

1. Kundu, P. et al, Multi-echo fMRI: A review of applications in fMRI denoising and analysis of BOLD signals. NeuroImage, Volume 154, 2017, Pages 59-80. DOI: 10.1016/j.neuroimage.2017.03.033.

Spectroscopy

- Interest in measuring metabolic changes via MRS techniques and combining that information with functional MRI measurements continues to grow
- GE WIPs installed to standardize and document data acquisition per the ISMRM spectroscopy study group recommendations
  - MEGA-PRESS (for spectral editing)
  - Optimized-PRESS
  - semi-LASER
- Automated data processing for CNI users with Flywheel gears
  - MEGA-PRESS processing with Gannet
  - Optimized-PRESS, semi-LASER with LC-Model



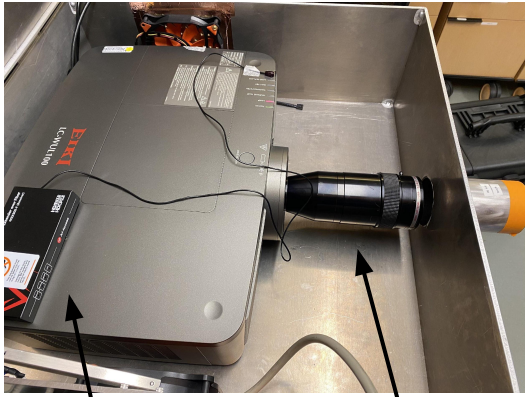
Spectroscopy analysis methods such as LCModel, shown here, can be containerized as a gear in Flywheel for automated processing and data visualization.

Spectroscopy Sequences	*Measured Metabolites*	*Analysis Methods*
MEGA-PRESS[1]	GABA+, Glx (Glutamate, Glutamine)	Gannet[2]
IM-SPECIAL[3]	GABA, Glu (Glutamate), Glx	Sequence specific Matlab code
Optimized-PRESS [4,5,6]	All metabolites	Sequence specific Matlab code, LCModel fitting[7]
semi-LASER [9,10,11,12,13]	All metabolites	Sequence specific Matlab code, LCModel fitting[7]

Spectroscopy

- Spectroscopy resources:
  - Spectroscopy Wiki page updating (literature references, data acquisition and data processing tools) https://cni.stanford.edu/wiki/GABA_spectro
  - Evaluation of additional spectroscopy methods such as CSI
- Monthly CNI spectroscopy users group meetings continue virtually to support CNI users, to review spectroscopy technology trends, and to update the CNI spectroscopy roadmap
- Contact Laima if you'd like to find out more

Projector System Upgrade

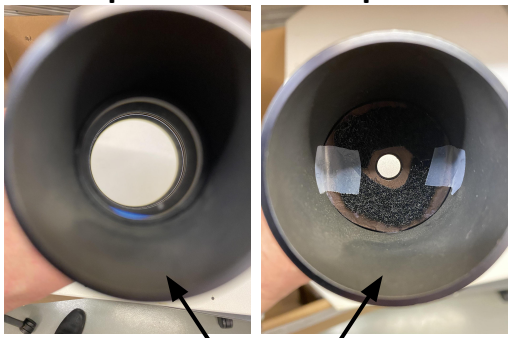


New Fiber-HDMI converter

Filtered power inlet

Navitar MCZ087 lens ($50 eBay)

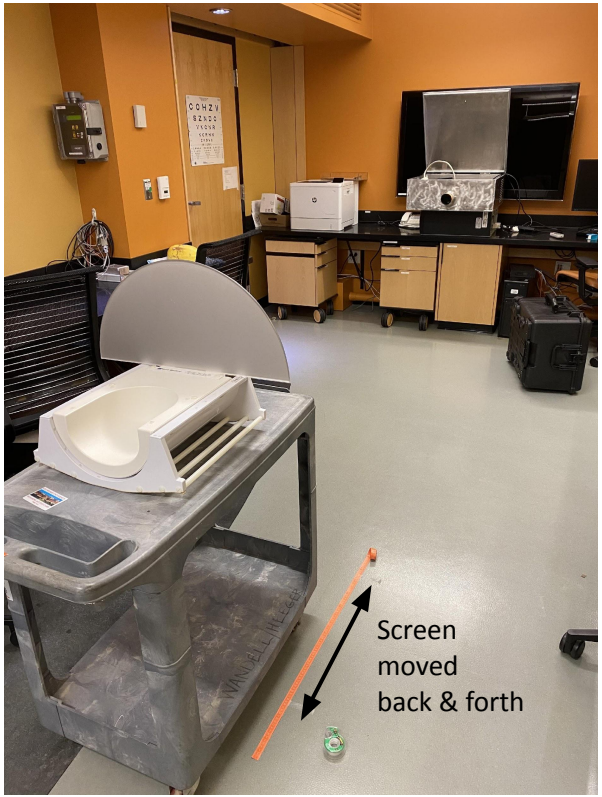
No Aperture **DIY Aperture**



Looking through back-end of lens

- New lens has more usable zoom range and depth of focus
  - Old: 50 x 26cm min image size
  - New: 45 x 24cm – 27 x 14.4cm (screen max: 38 x 20cm)

Depth-of-Focus Test

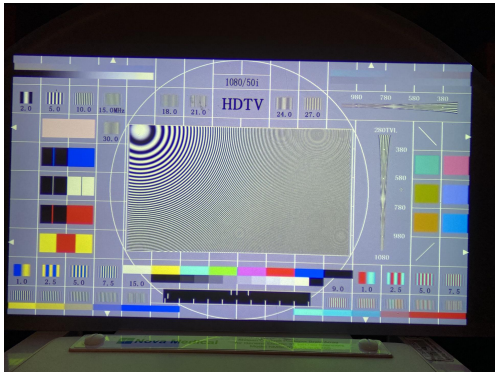


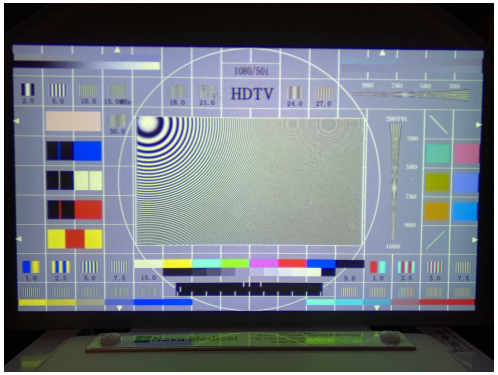
Projector System Upgrade

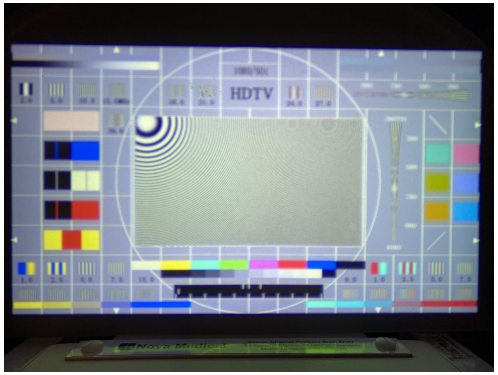
0 cm

+10 cm

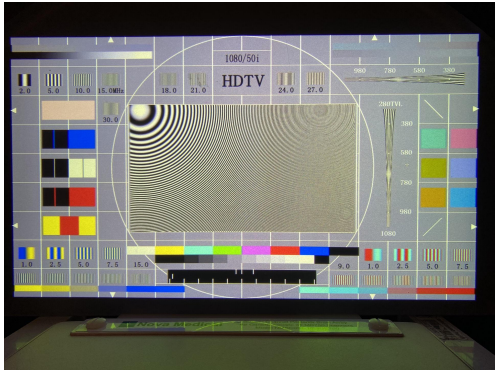
+20 cm

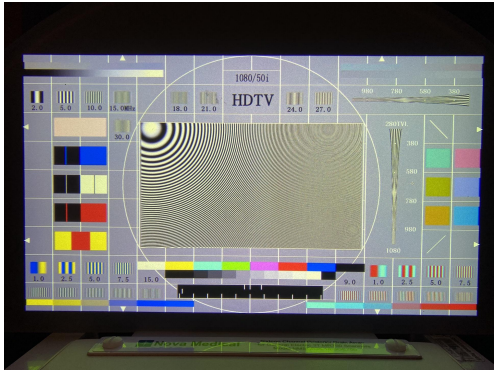


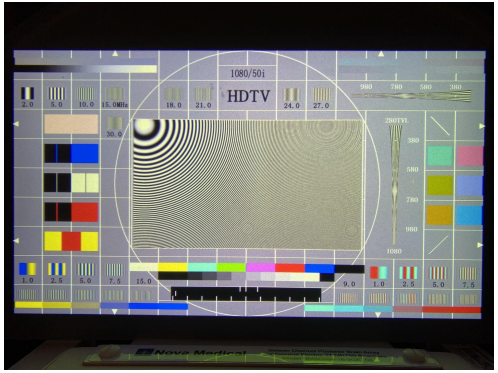




Lens, ND Filters, No Aperture







Lens with DIY Aperture

Monitor Upgrade

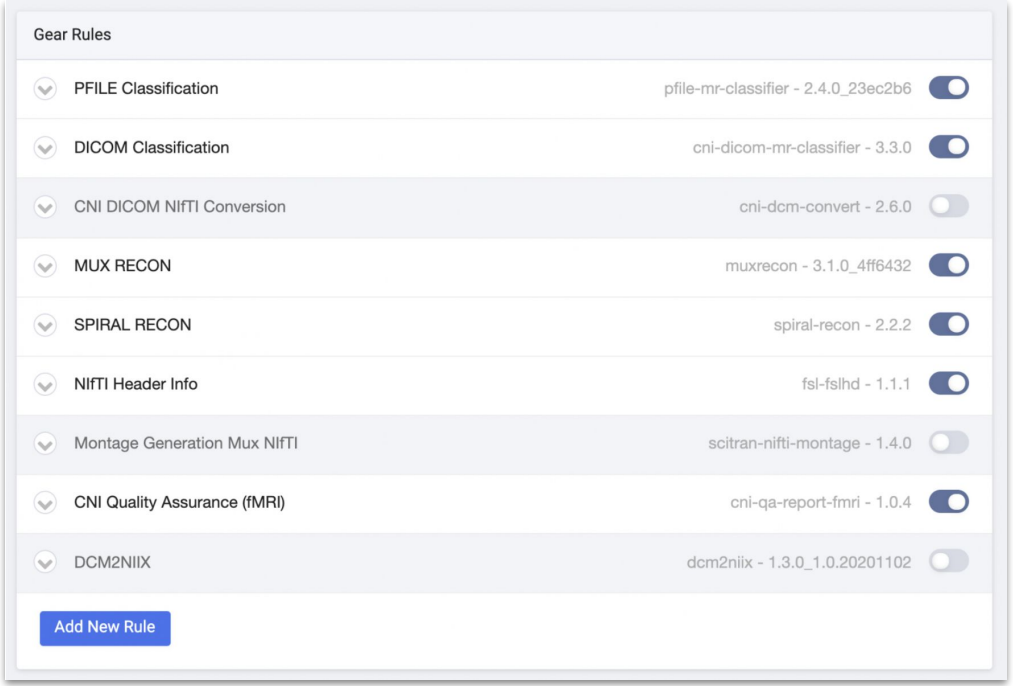
- Updated monitor from Resonance Technology
- 4K resolution, 3D capable
- 49” monitor (2” larger)
- Delivery delayed due to shipping issues (2-6 weeks)
- Real-time signal processor for video flipping will also be available

Flywheel

Gear Rules

- Once data are uploaded to Flywheel those data are automatically processed according to a given Project's "Gear Rules". The Rules define which Gear will be run on a given piece of data when it lands in Flywheel. These rules do everything from metadata extraction from DICOM headers to execution of QA algorithms.

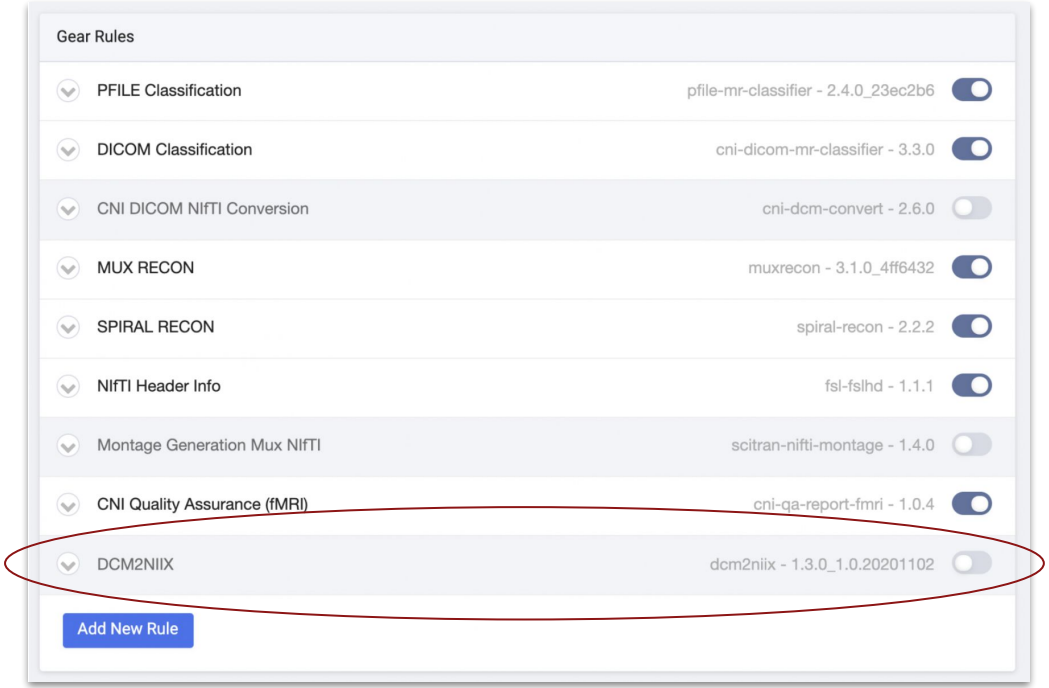
- At CNI we have defined a default set of rules that are applied to every new project. Each rule defines the logic that must be satisfied in order for a given gear to be run on a data file.



Flywheel

DICOM Conversion

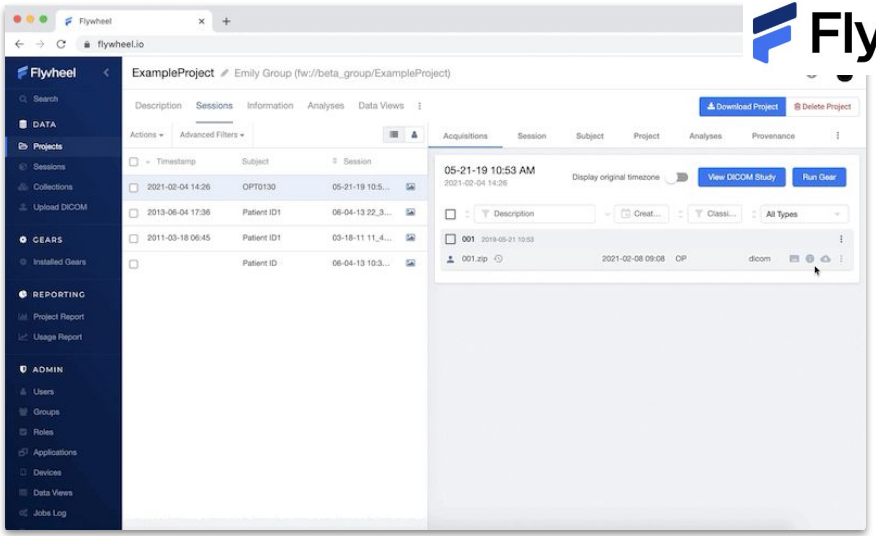
- Flywheel provides a dcm2niix Gear, which we have incorporated into our default rule set.
- As of today the default is still dcm-convert, however for **new projects** you will see this rule available and in a disabled state.
- You can easily enable this rule. However, if you do you should disable the existing dcm-convert rule so that you don't introduce a race condition which would result in a situation where you would not be able to predict which tool would be used to generate the NIfTI data.

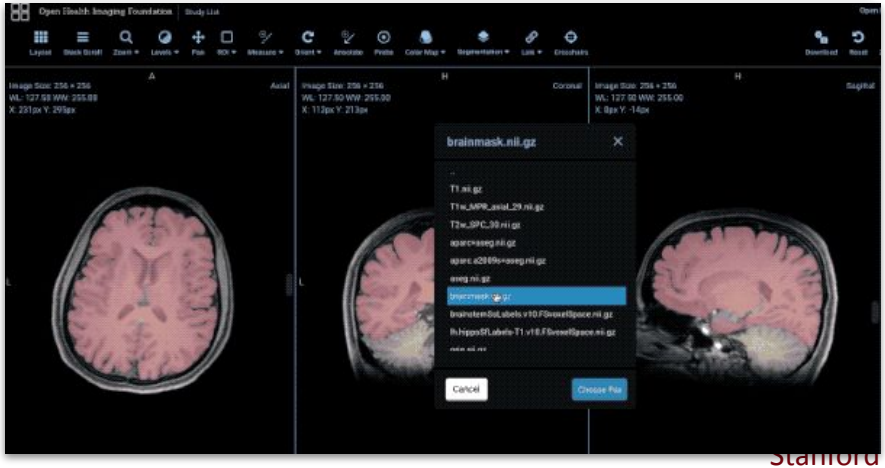


Flywheel

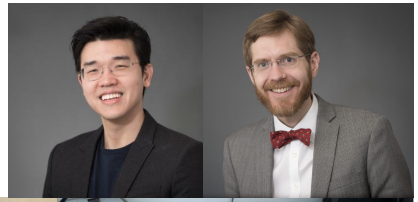
Upgrade to v15

- Coming to CNI late October/early November
- New features include:
  - File Versioning (this is a big one!)
  - New Data Viewer
    - Segmentation Overlay
    - Additional data type support
  - User Interface Enhancements
    - Sorting and Filtering
    - Viewing Timezone Data
    - Data Views Enhancements
  - CLI Improvements and Updates
    - De-Identification



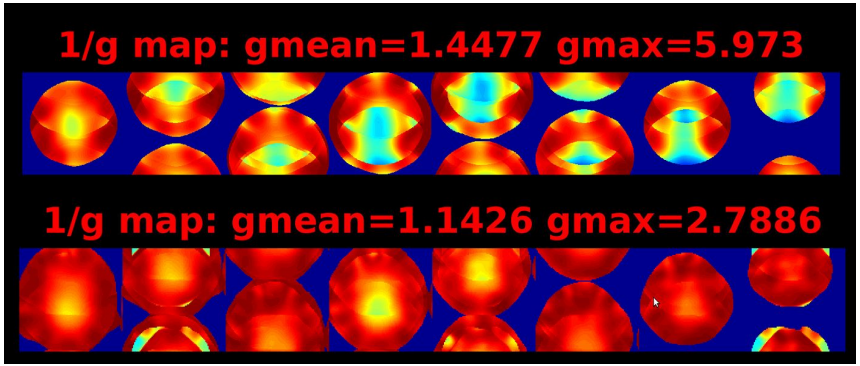


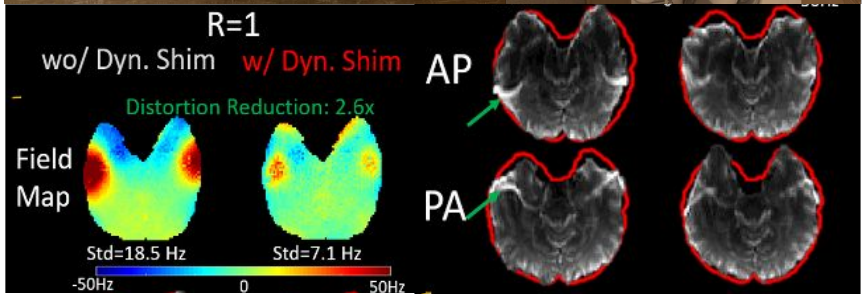
New Technologies: Coils



- 64-channel RF/DC brain coil
  - Collaboration between Kawin Setsompop, Jason Stockmann (Harvard/MGH), GE and CNI
  - Localized shimming with each coil
  - Fast dynamic control; shim can be optimized slice-by-slice
  - Initial testing at CNI in June & August. Expected completion November

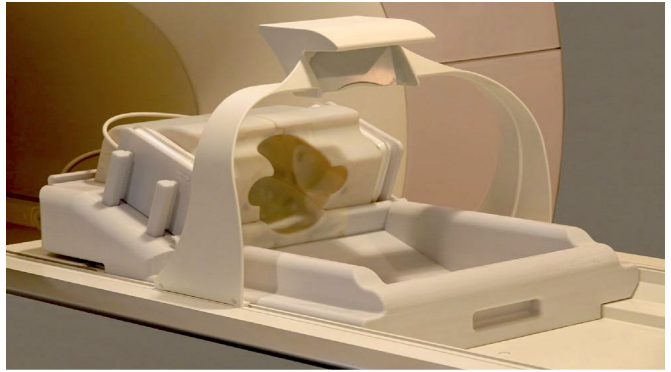
MB8 EPI Simulation

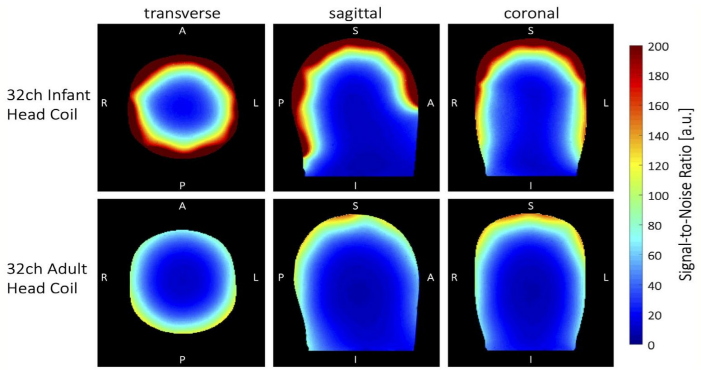




New Technologies: Coils

- 32-channel adaptive infant coil
  - Collaboration between Kalanit Grill-Spector, Boris Keil (THM), GE and CNI
  - Adaptation of Martinos Center custom design [1] to GE platform
  - Built-in earmuff space, adaptive sizing
  - Target delivery EOY

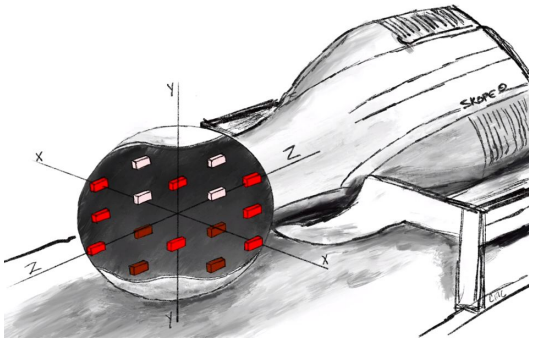




1. Ghotra A, *et al*. Magn Reson Med. 2021 PMID: 33829546.

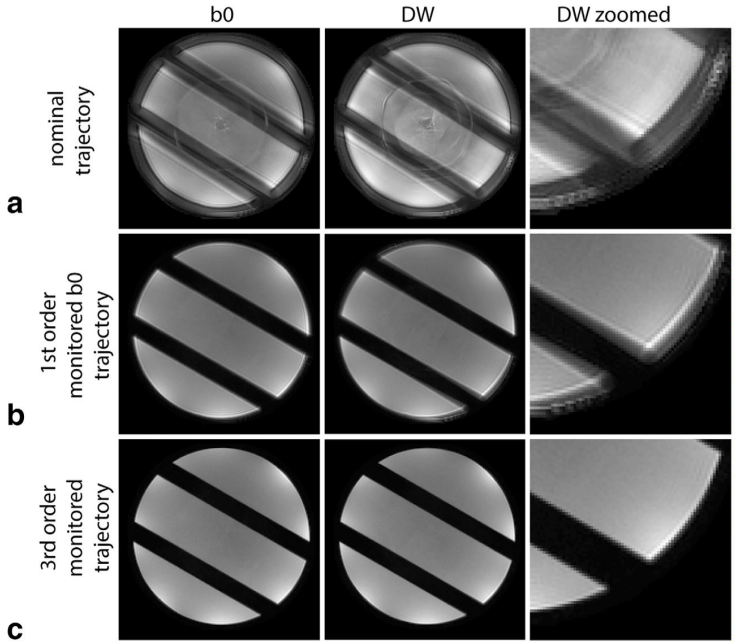
New Technologies: Skope Field Camera

- Internal Stanford award (Kerr, Pauly, Wandell - $438K) to improve quality and precision of MRI at Stanford:
  - 3T dynamic field camera providing 1us resolution of up to 3rd order spherical harmonic model of field perturbations
  - 7T system extension
  - High bandwidth data storage
  - Image reconstruction software
- System will be made available for other 3T scanners on campus
- Installation Nov. 1-2



New Technologies: Skope Field Camera

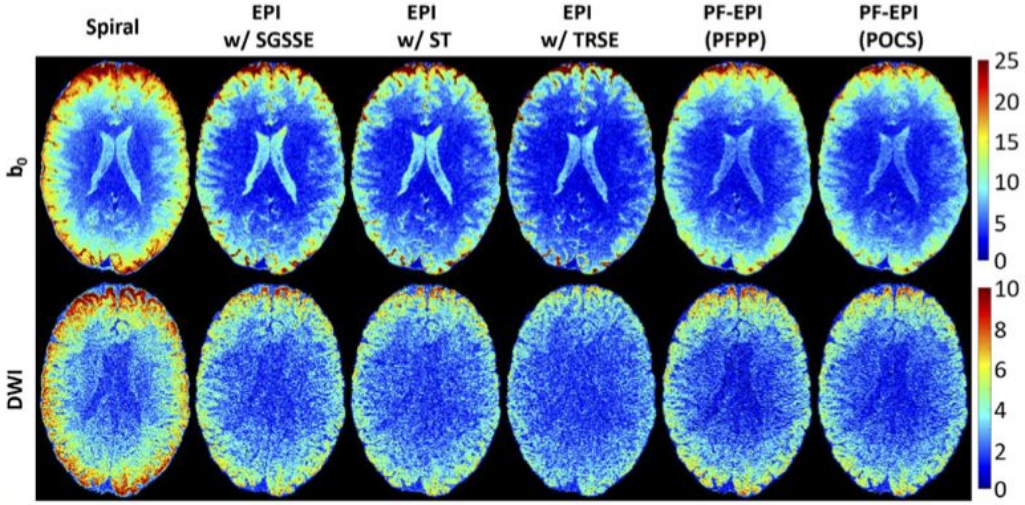
- Project aims:
  - Develop easy-to-use interface for measuring trajectories
  - Assess stability and linearity of gradient system (temperature, gradient amplitude and slew)
  - Develop non-Cartesian acquisitions for efficient fMRI and diffusion imaging with system characterization-based reconstruction
  - Investigate methods for efficient image reconstruction
- Concurrent field monitoring approach will be explored if we are unable to adequately characterize the system



Demonstration of field measurement improvements in image quality for diffusion-weighted single-shot spiral acquisition. From Wilm et al. 2017. Magnetic Resonance in Medicine.

New Technologies: Skope Field Camera

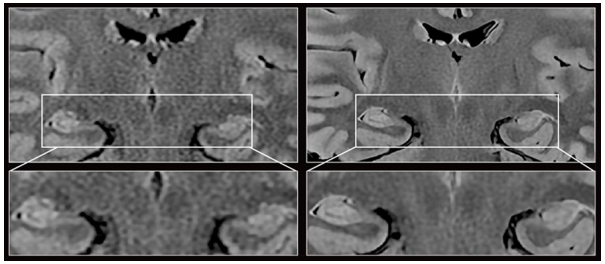
- SNR benefits of spiral diffusion acquisitions are promising and will be examined when using UHP performance levels
- Goal is to leverage SNR benefits to go to higher resolution or dimension diffusion acquisitions

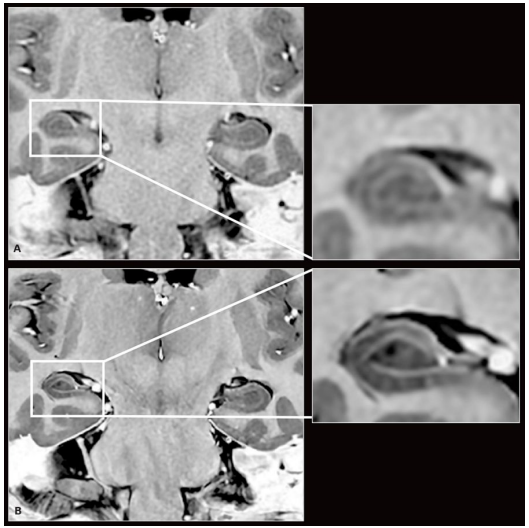


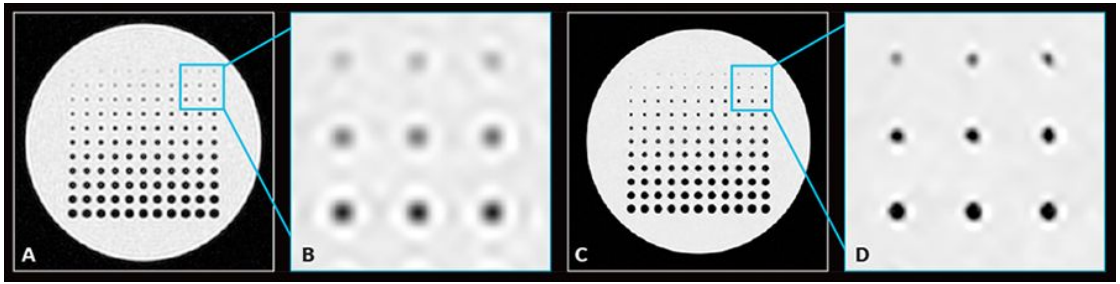
Demonstration of SNR improvement for diffusion-weighted single-shot spiral acquisition compared to various EPI alternatives. Concurrent field monitoring system with 16 RX channels was used. From Lee et al. 2020. Magnetic Resonance in Medicine.

New Technologies: GE System Updates

- Will move from RX28 to RX29 early ‘22
  - New ICN (Image Compute Node) with significant GPU resources to support deep learning applications
  - System will support AIR Recon DL
  - Deep-learning based convolutional neural network for denoising and image sharpening







Managing New Technologies

- CNI is an open-door environment :-)
- We invite groups to request meetings with CNI to review existing protocols and workflow
- As new technologies come on board we'll announce via CNI blog, Slack and host targeted user meetings
- Please share info and questions on our Slack channel

Friendly Reminders

- CNI uniquely welcoming and pleasant research MRI space
- Please help us by maintaining the environment as you found it – please tidy up after your participants as needed
- Take time to use all the organizational bins/etc. to help us help you
- Always open to suggestions on how to improve

Questions?