CNI User Meeting

OCTOBER 14, 2022

CNI

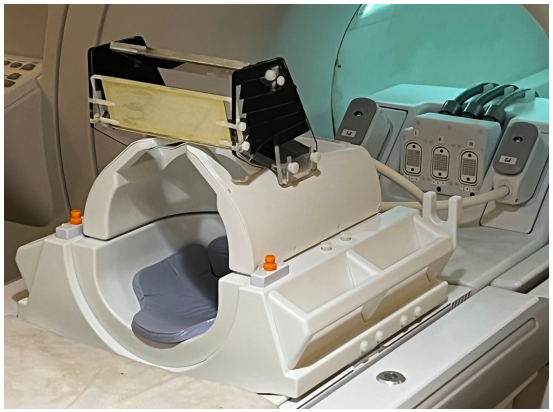
User Meeting Agenda

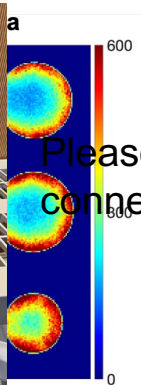
Oct. 14, 2022

- Technology developments
- Flywheel update
- Future system upgrade
- C-ShARP RFP & Experiential Learning
- Friendly reminders

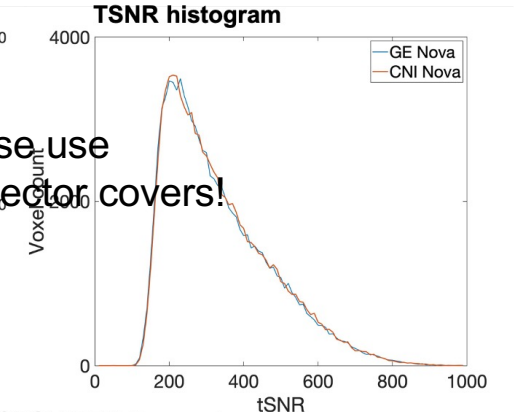
Technology – New Nova Coil

- New Nova 32-channel installed
- No meaningful differences with previous Nova coil borrowed from GE



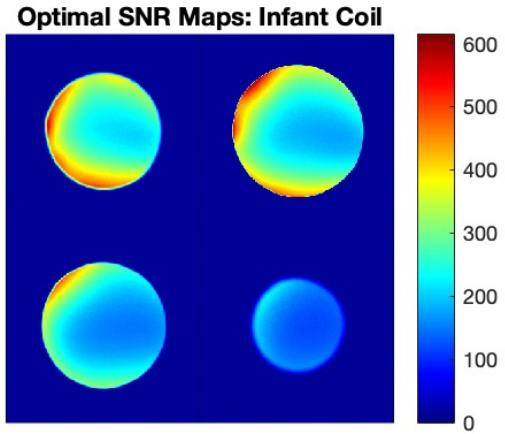


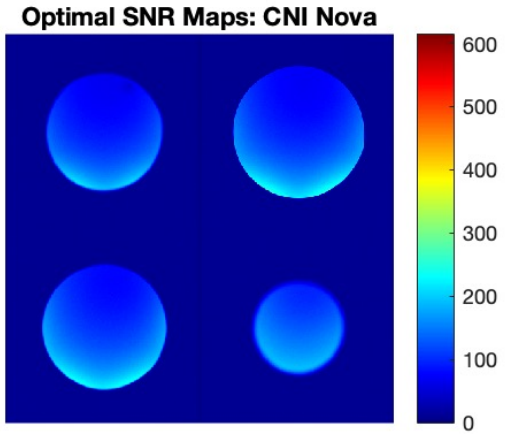
Please use connector covers!



Technology – New Infant Coil

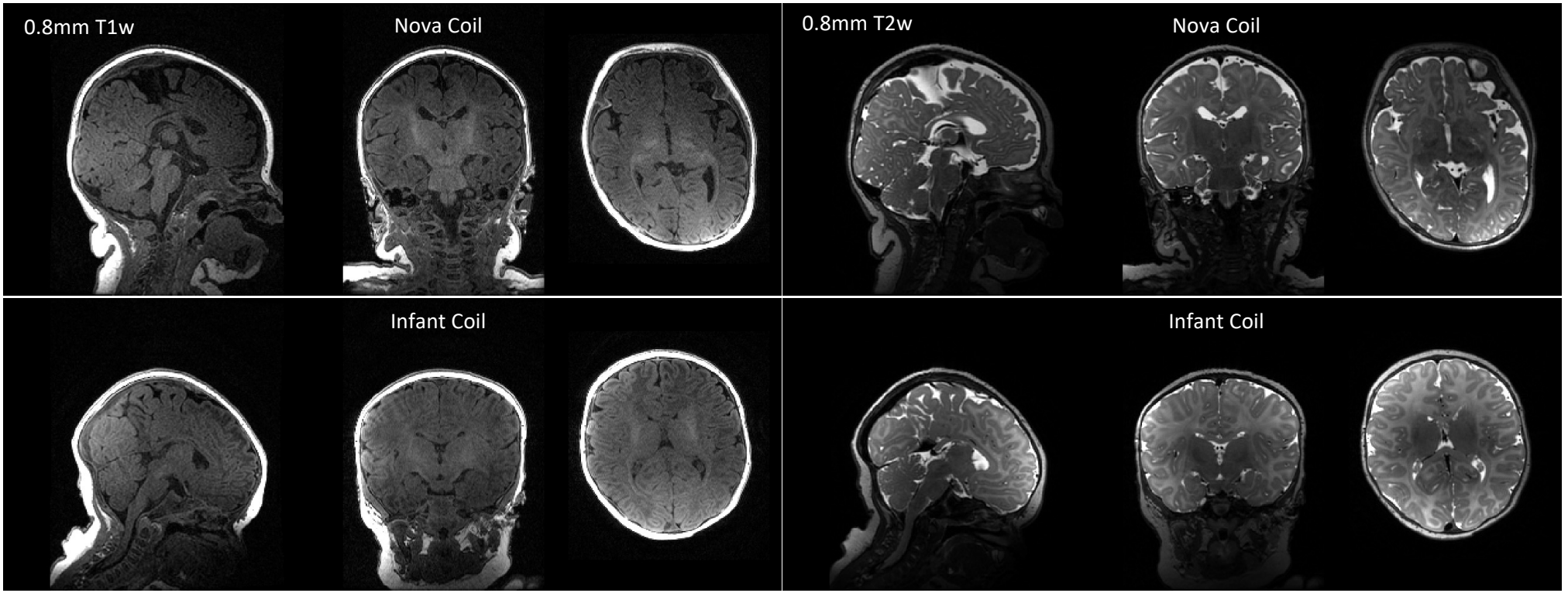
- Custom 32-channel coil sized for infants 0-1 years old, Boris Keil THM[1]
- Funded by Prof. Kalanit Grill-Spector
- Equivalent FDA safety testing for GE commercial coils, but still an investigational device
- Improves SNR compared to 32-channal Nova adult coil, especially anterior
- Contact us if you're interested in using



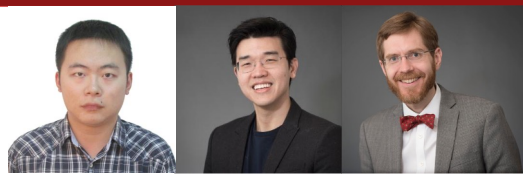


[1] Ghotra *et al*. *MRM* 86.3 (2021): 1773-1785.

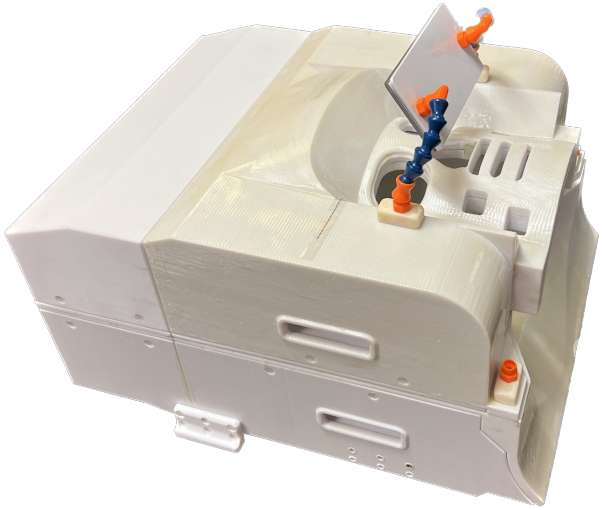
Technology – New Infant Coil

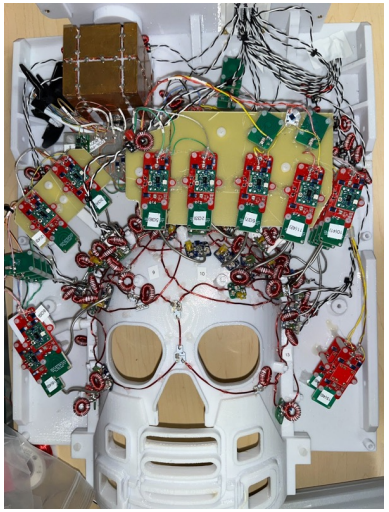


Technology – AC/DC Coil



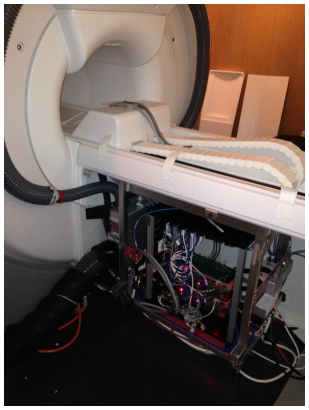
- Collaboration with C. Liao & K. Setsompop (Stanford EE/Radiology) and J. Stockmann (Radiology, Harvard/MGH)
- Developing 48-channel RF receive coil, with receive coils also providing local shim control

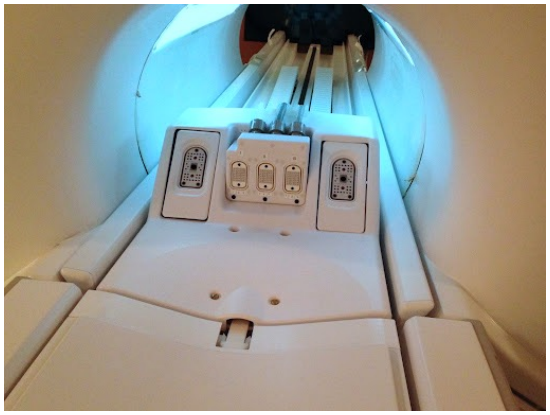


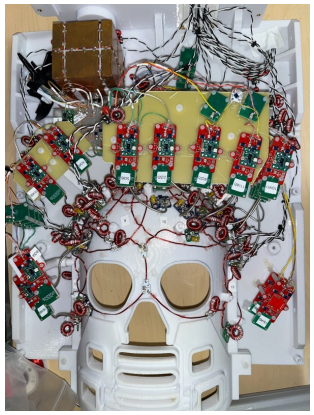


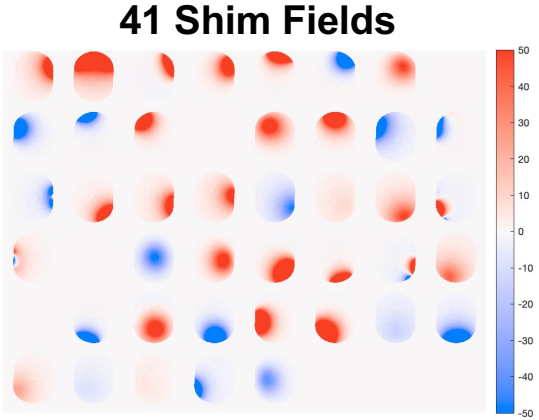
Technology – AC/DC Coil

- Tightly integrated with CNI Scanner
  - Shim amplifier in rear pedestal, coupled to GE coolant system
  - Shim coil cables incorporated in GE cable management system
  - Provides DC shim currents to 41 of 48 receive coils



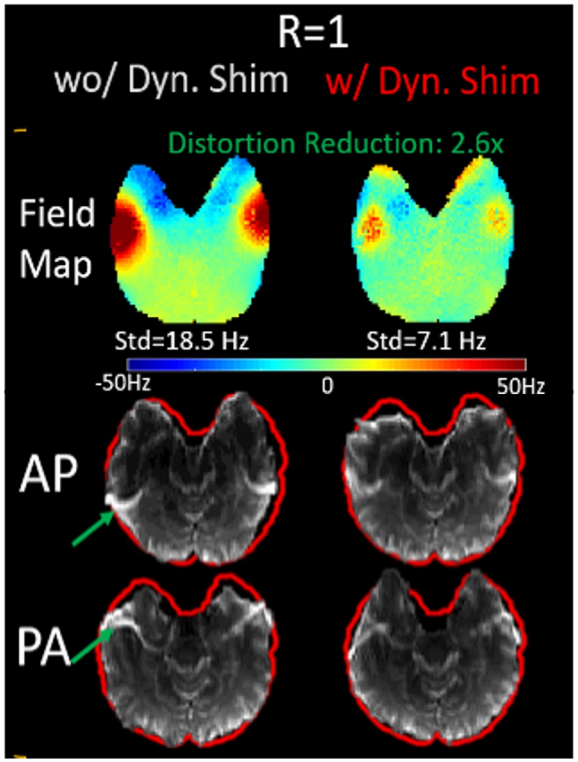






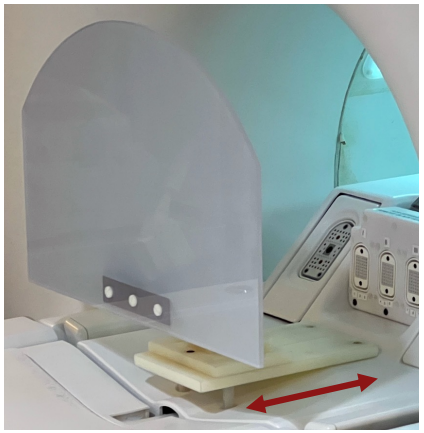
Technology – AC/DC Coil

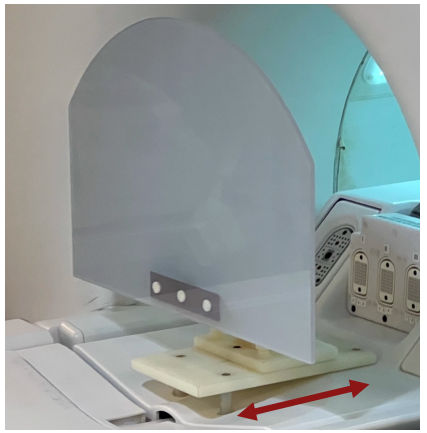
- Current status
  - Workflow process still in development
  - Scanner operation causing unintended interaction with shim control
  - Expect first *in vivo* images by early November
- Applications
  - Improving quality in MRI and MRSI
  - Enabling FMRI and diffusion in regions of high B0 inhomogeneity
  - Enabling new types of MR sequences



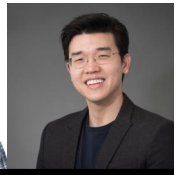
Technology – Projector Screen

- Universal screen holder built to work with all coils
- Permanent base near coil ports
- Screen can be installed with just two thumbscrews, adjustable S/I
- Will safely traverse entire scanner bore including rear air vent

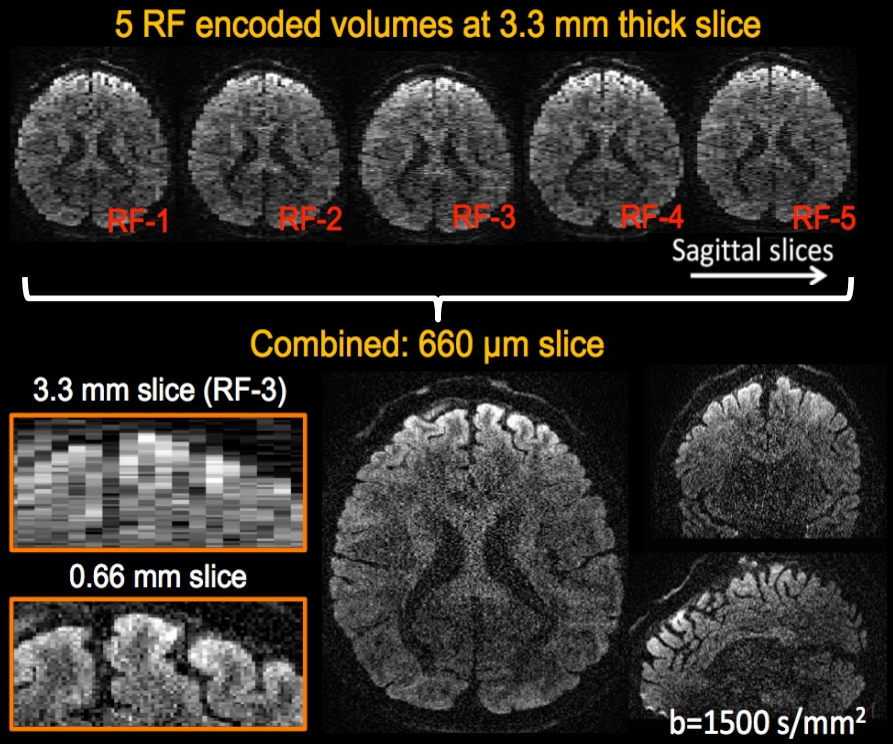




Ultra-High-Resolution Diffusion: gSlider-SMS[1-2]

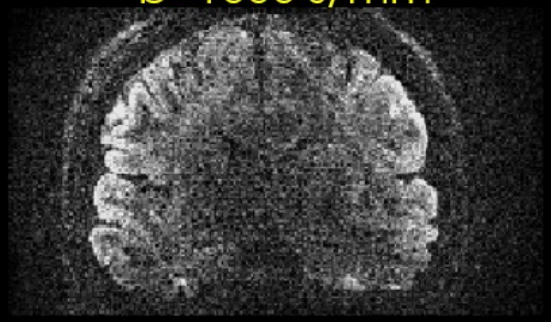
gSlider-SMS *(Generalized SLIce Dithered Enhanced Resolution Simultaneous multiSlab)*



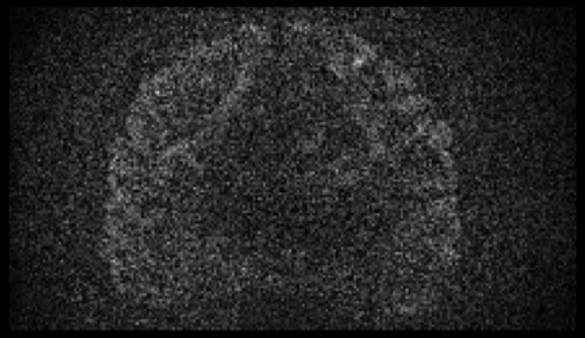
 1. Setsompop K. et al, MRM 2018 2. Liao C. et al, MRM 2020

SNR Improvement of gSlider

standard EPI: 1mm iso
b=1000 s/mm^2

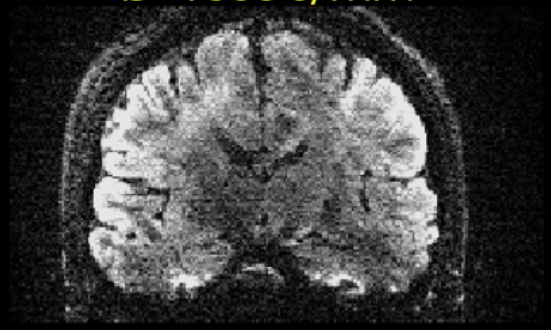


b=2500 s/mm^2

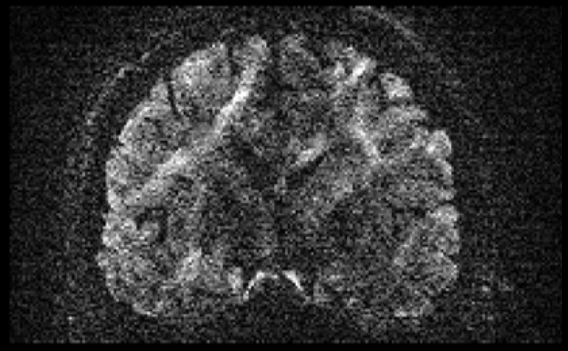


TA: 20 sec

gSlider: 1mm iso
b=1000 s/mm^2



b=2500 s/mm^2

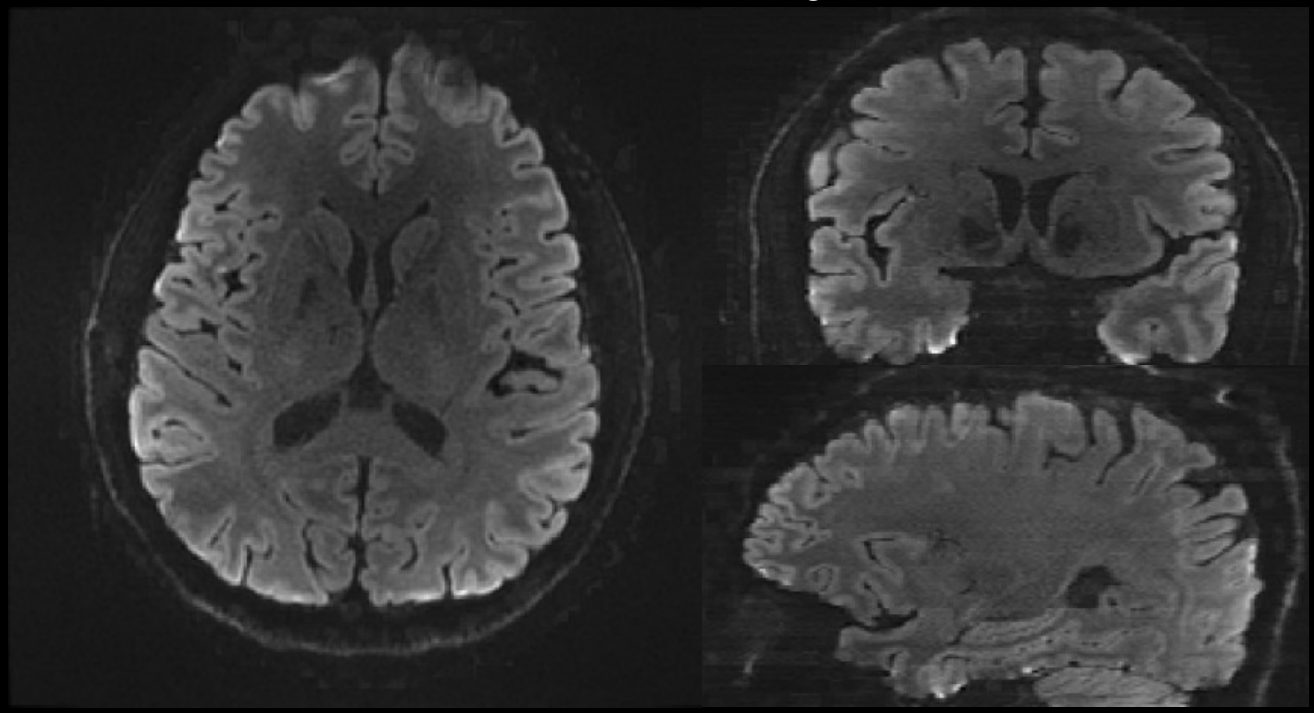


TA: 17.5 sec
(TR 3.5×5 RF-encodings)

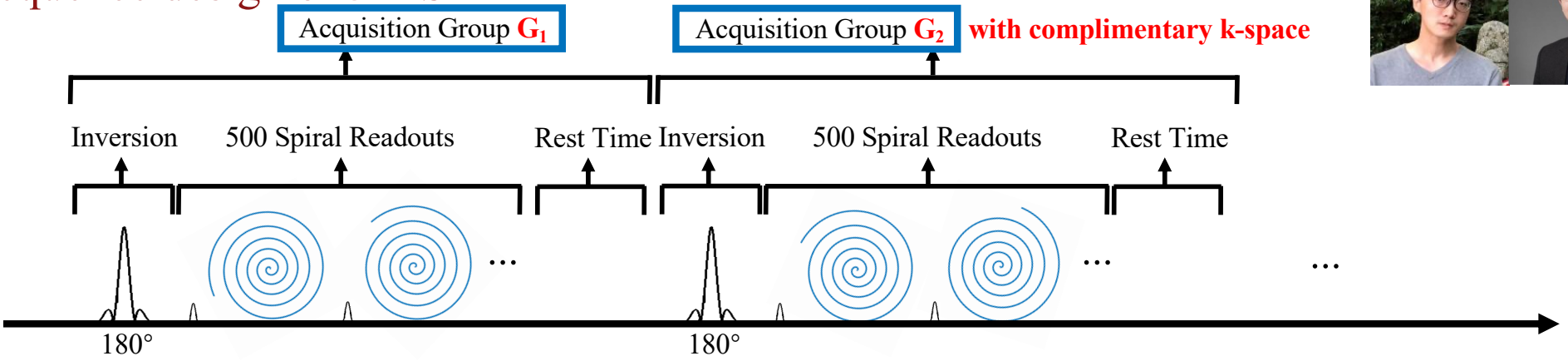
Whole-Brain 1-mm DWIs in 10 Minutes

30 directions
b-value=1000s/mm^2
TR/TE =3500/75ms
Partial Fourier 6/8
FOV = 220 mm
Total acquisition time: 9min 24s
Reconstruction ~35min

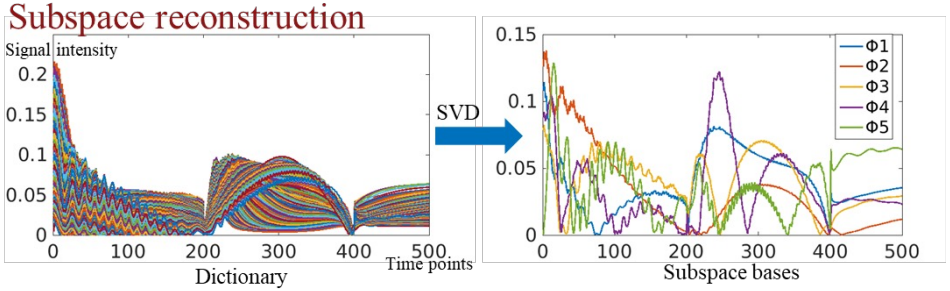
30 diffusion-direction averaged DWIs



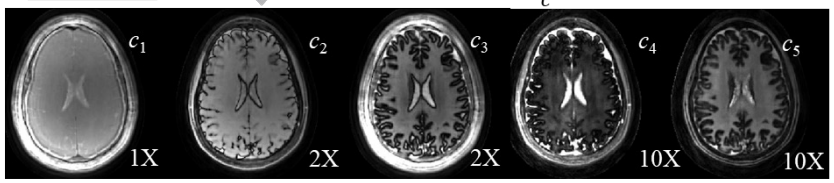
Sequence design of 3D-SPI-MRF



Subspace reconstruction

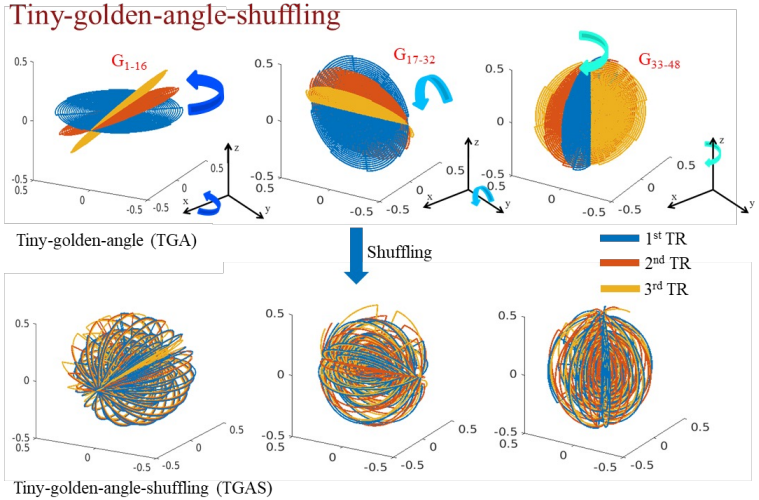


Subspace recon w/ LLR $\min_c \|PFS\Phi c - y\|_2^2 + \lambda R_r(c)$



Subspace recon w/ LLR

Tiny-golden-angle-shuffling



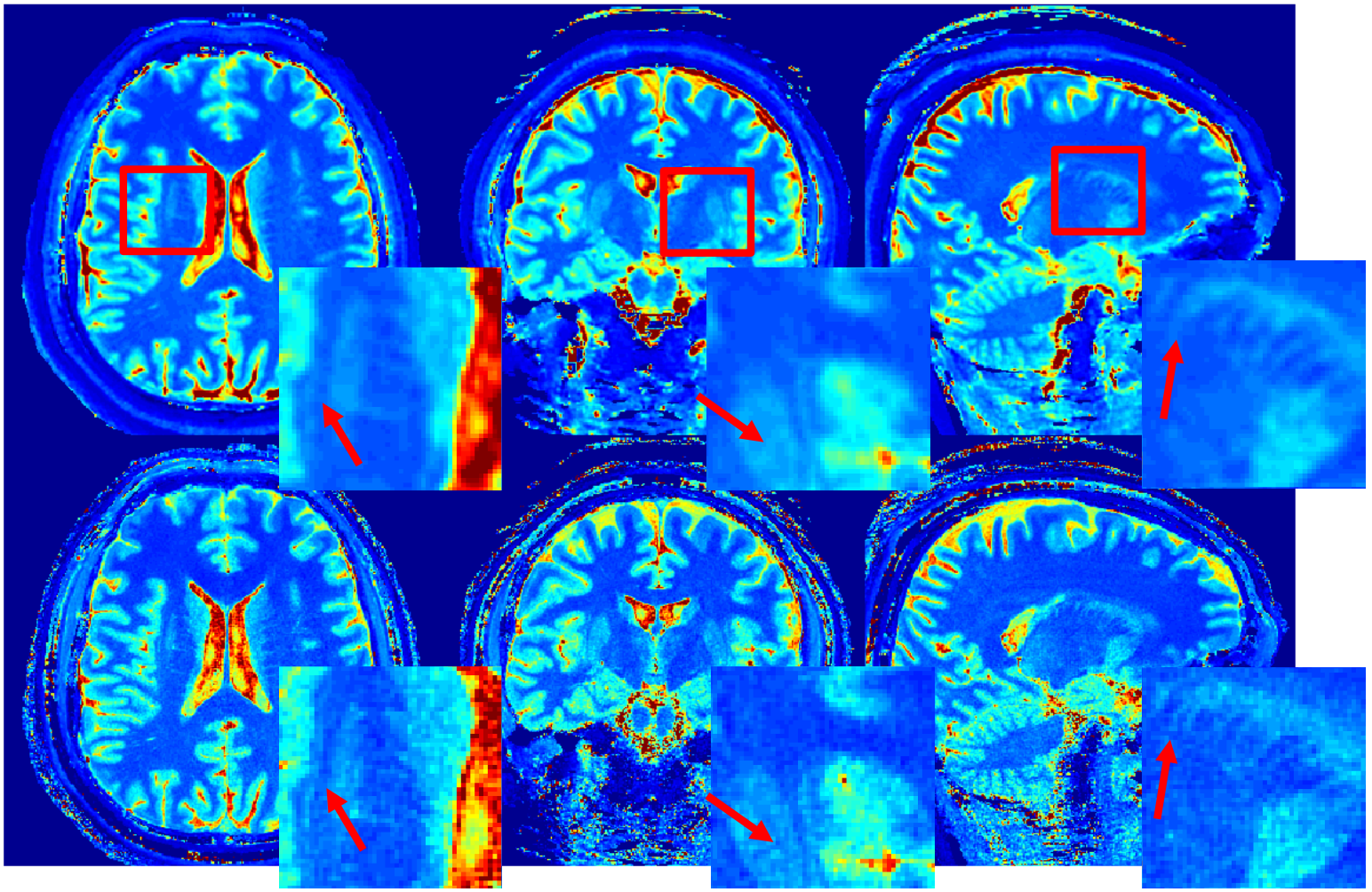
Optimized SPI trajectory

[1] Cao X, MRM 2022

Results from GE 3T UHP scanner

Resolution:1-mm iso
FOV: 220mm iso
Acquisition: 2 min
Max Slew raw: 100 T/m/s
Recon time: ~0.5H

Resolution:0.66-mm iso
FOV: 220mm iso
Acquisition: 4 min
Max Slew raw: 100 T/m/s
Recon time: ~4H

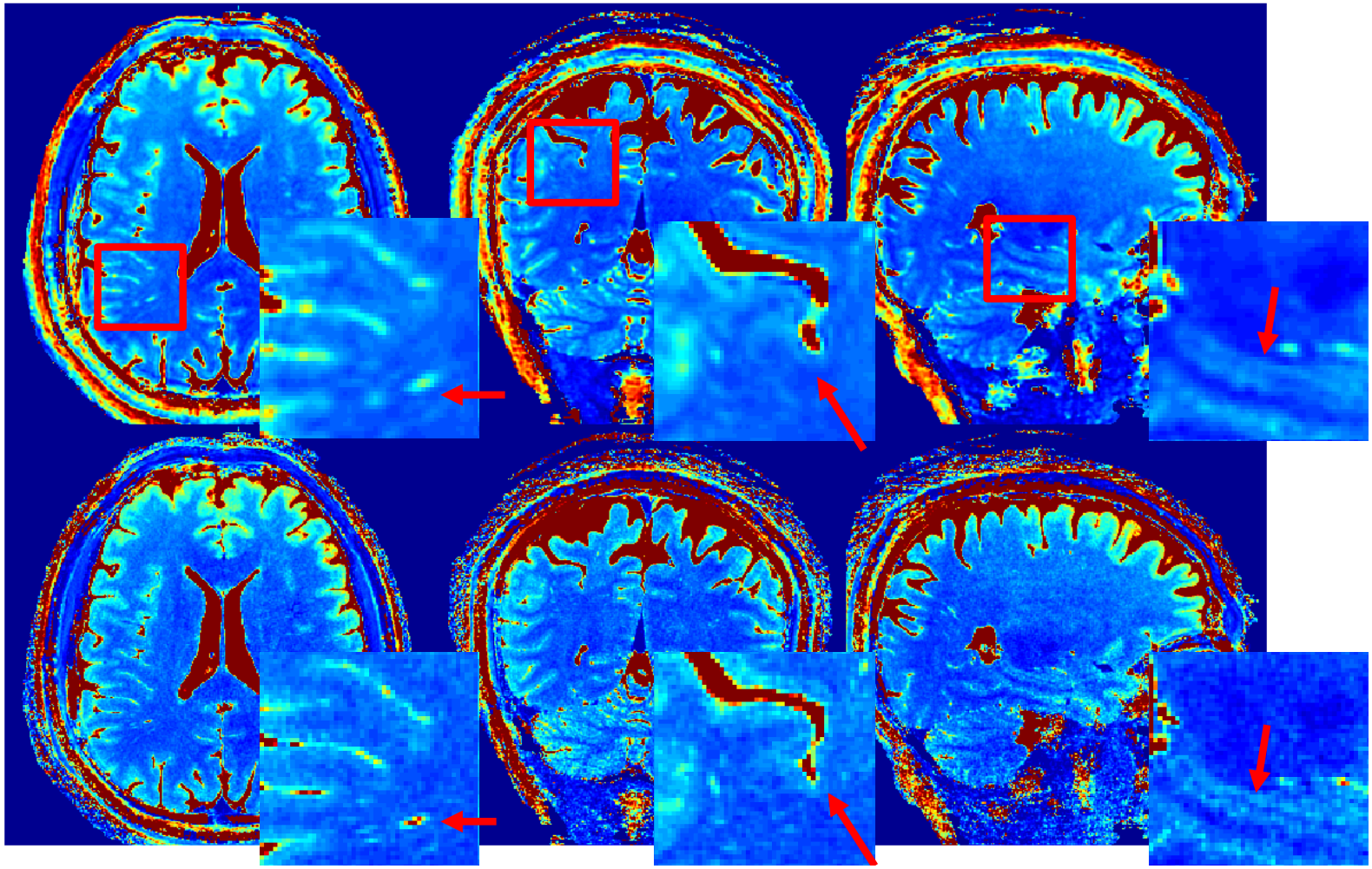


Results from GE 3T UHP scanner

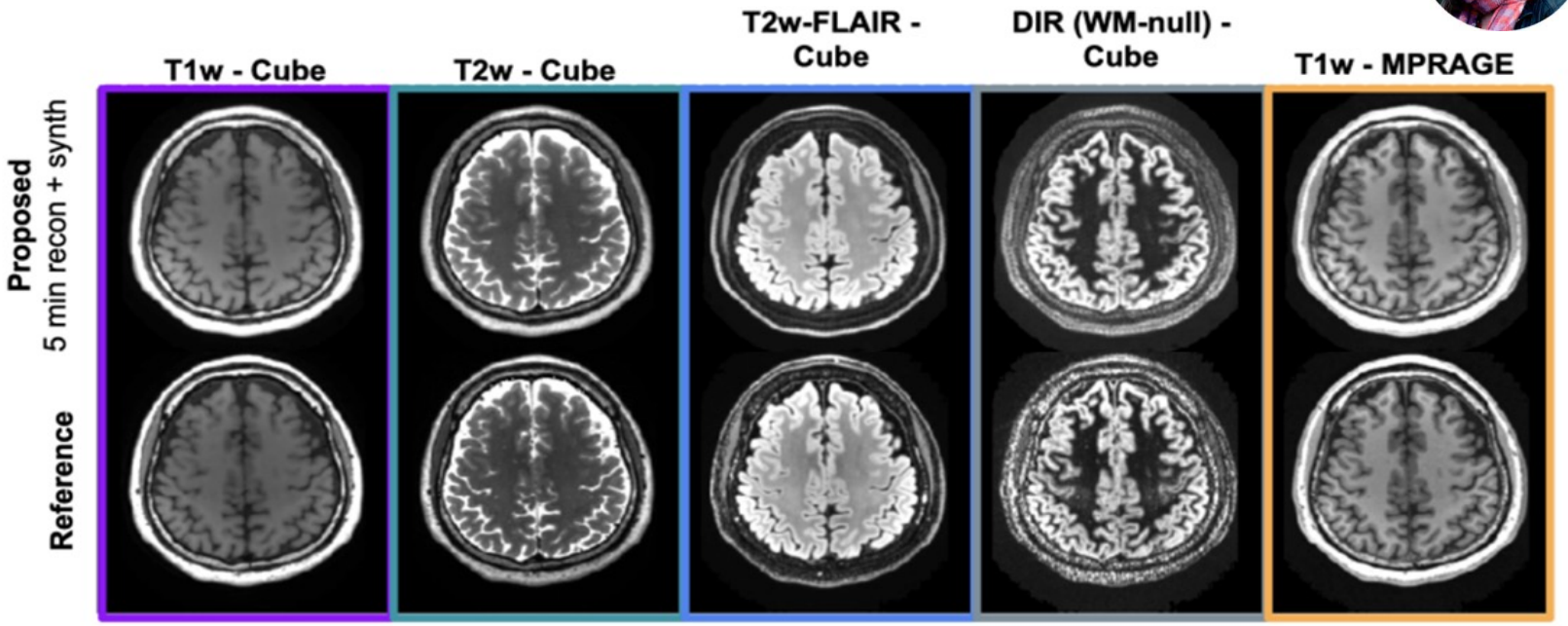
On GE 3T UHP scanner

Resolution:1-mm iso
FOV: 220mm iso
Acquisition: 2 min
Max Slew raw: 100 T/m/s
Recon time: ~0.5H

Resolution:0.66-mm iso
FOV: 220mm iso
Acquisition: 4 min
Max Slew raw: 100 T/m/s
Recon time: ~4H



Towards clinical application using MRF



Using deep learning to synthesize T_1w/T_2w images with MRF results

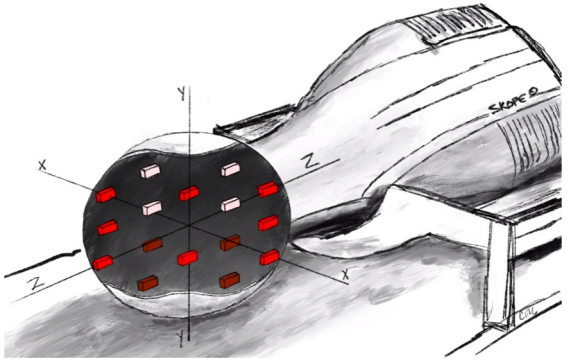
Synthesized MPRAGE offered high-quality brain segmentation

This 3D-SPI-MRF sequence has been deployed on CNI, Lucas Center, Stanford Hospital and Stanford Children Hospital with collaborators. Automatic data transfer and reconstruction scripts have also been well developed.

[1] Schauman S, ISMRM 2022 [2] Iyer S, ISMRM 2022

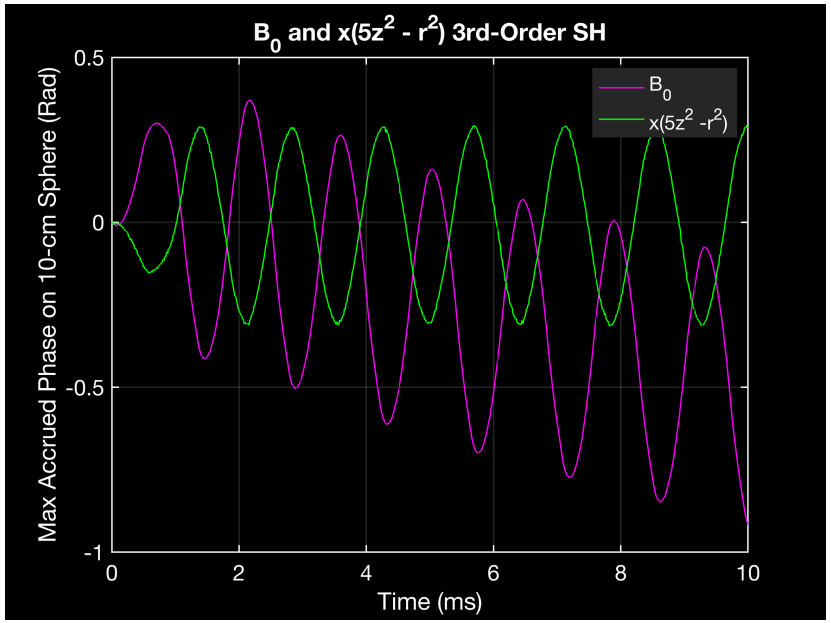
Technology – Skope Field Camera

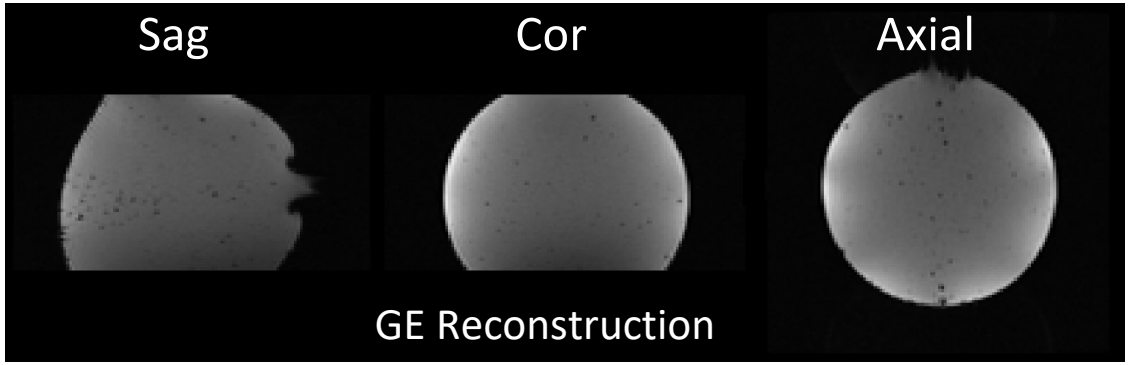
- Internal Stanford award (Kerr, Pauly, Wandell - $438K) to improve quality and precision of MRI at Stanford:
  - 3T dynamic field camera providing 1us resolution of up to 3rd order spherical harmonic model of field perturbations
  - 7T system extension
  - High bandwidth data storage
  - Image reconstruction software

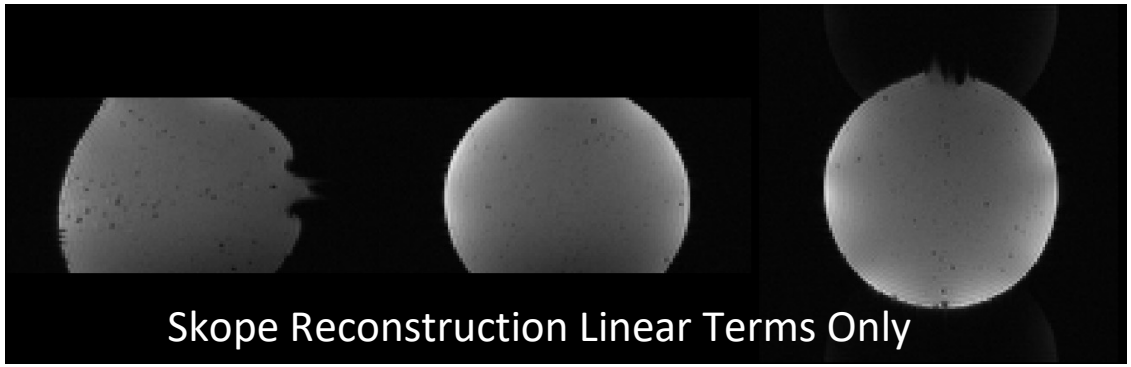


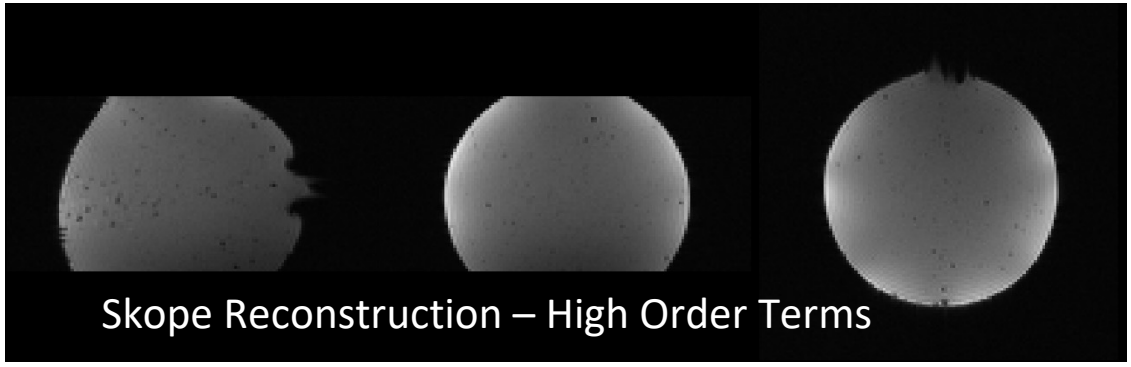
EPI R1 Acquisition

R=1
25.6-cm FOV
60 slices
2-mm iso resolution
128x128 matrix
TE = 42.0ms



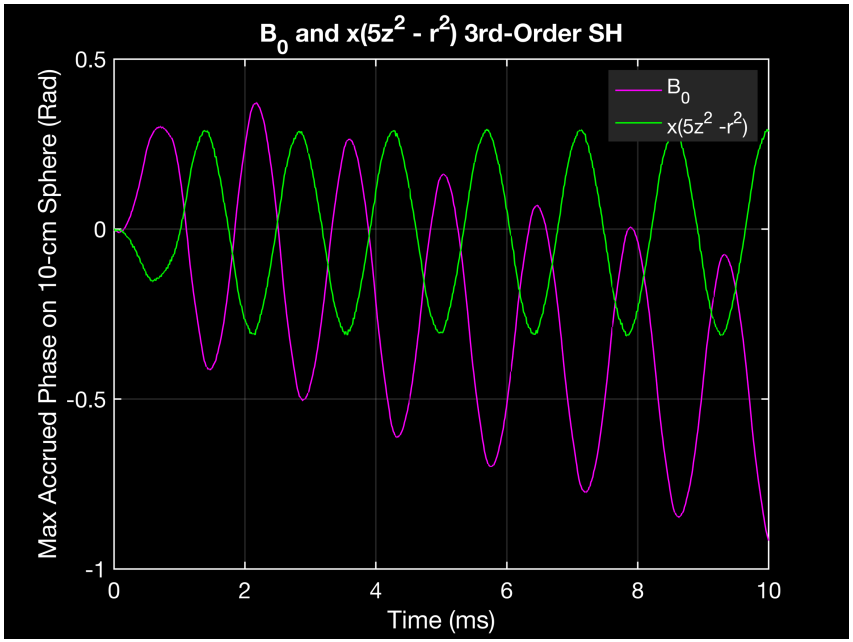


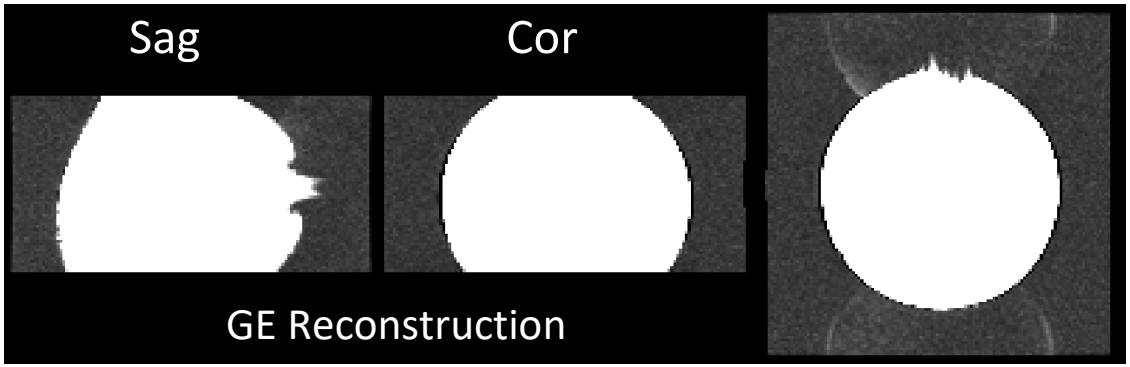


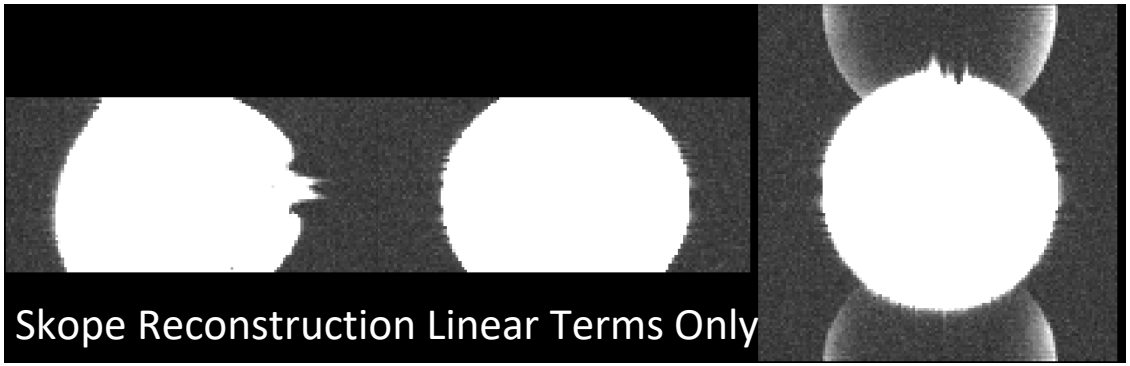


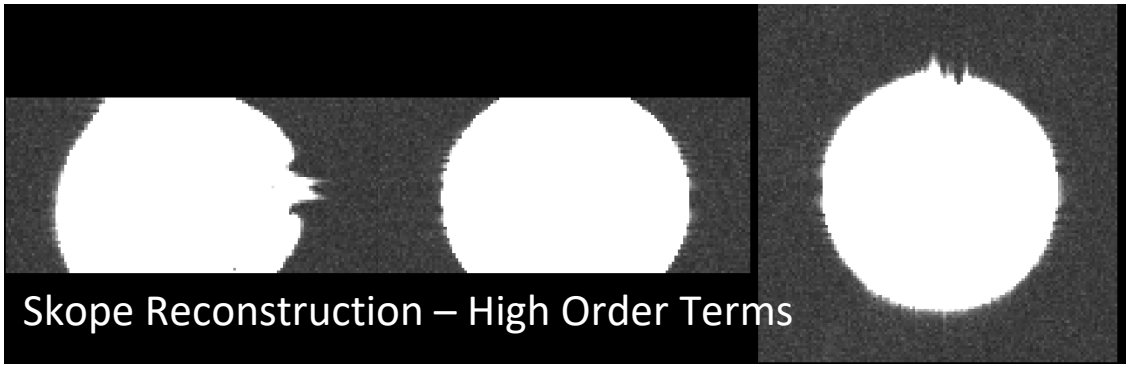
EPI R1 Acquisition (Windowed)

R=1
25.6-cm FOV
60 slices
2-mm iso resolution
128x128 matrix
TE = 42.0ms





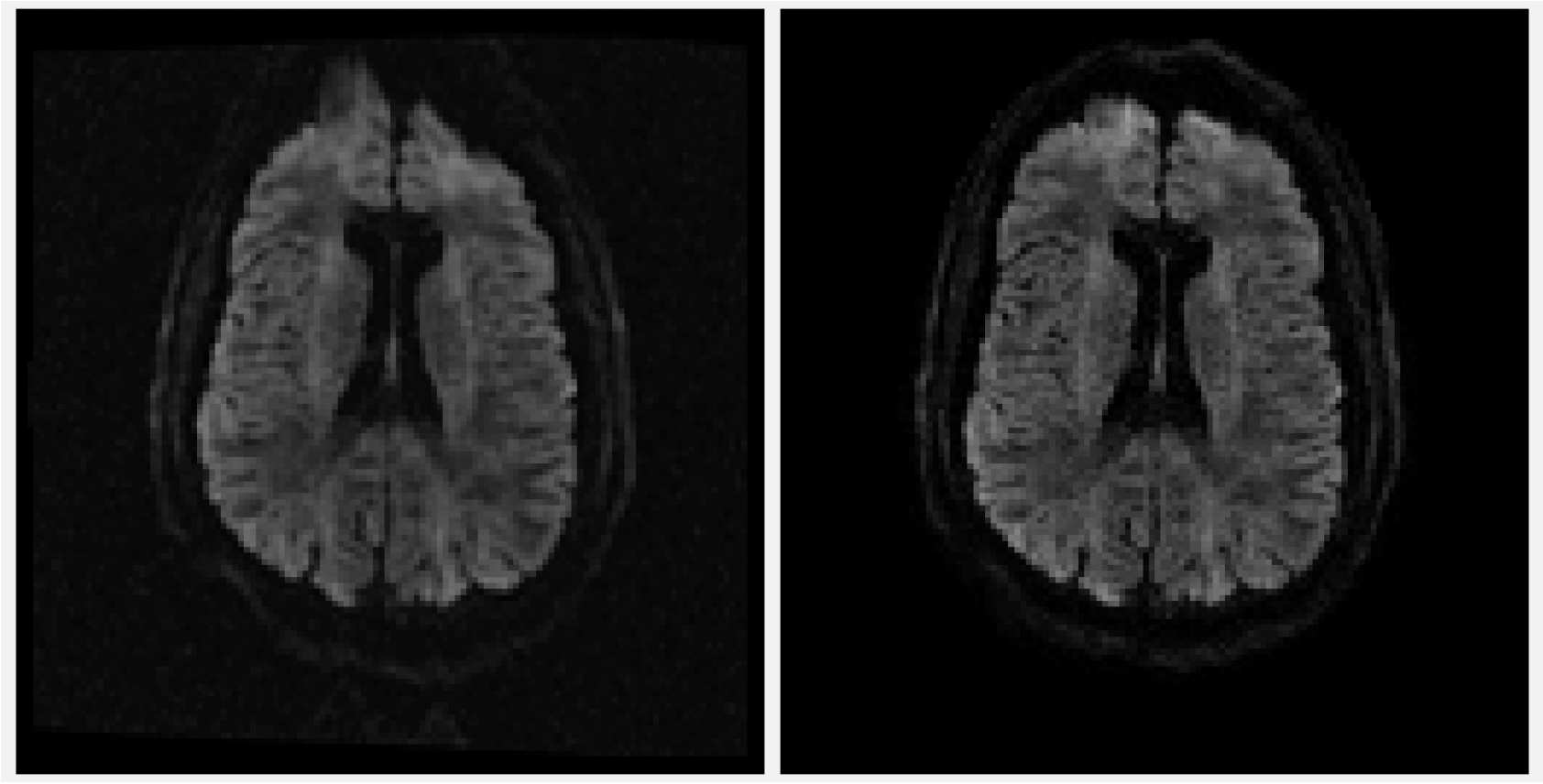


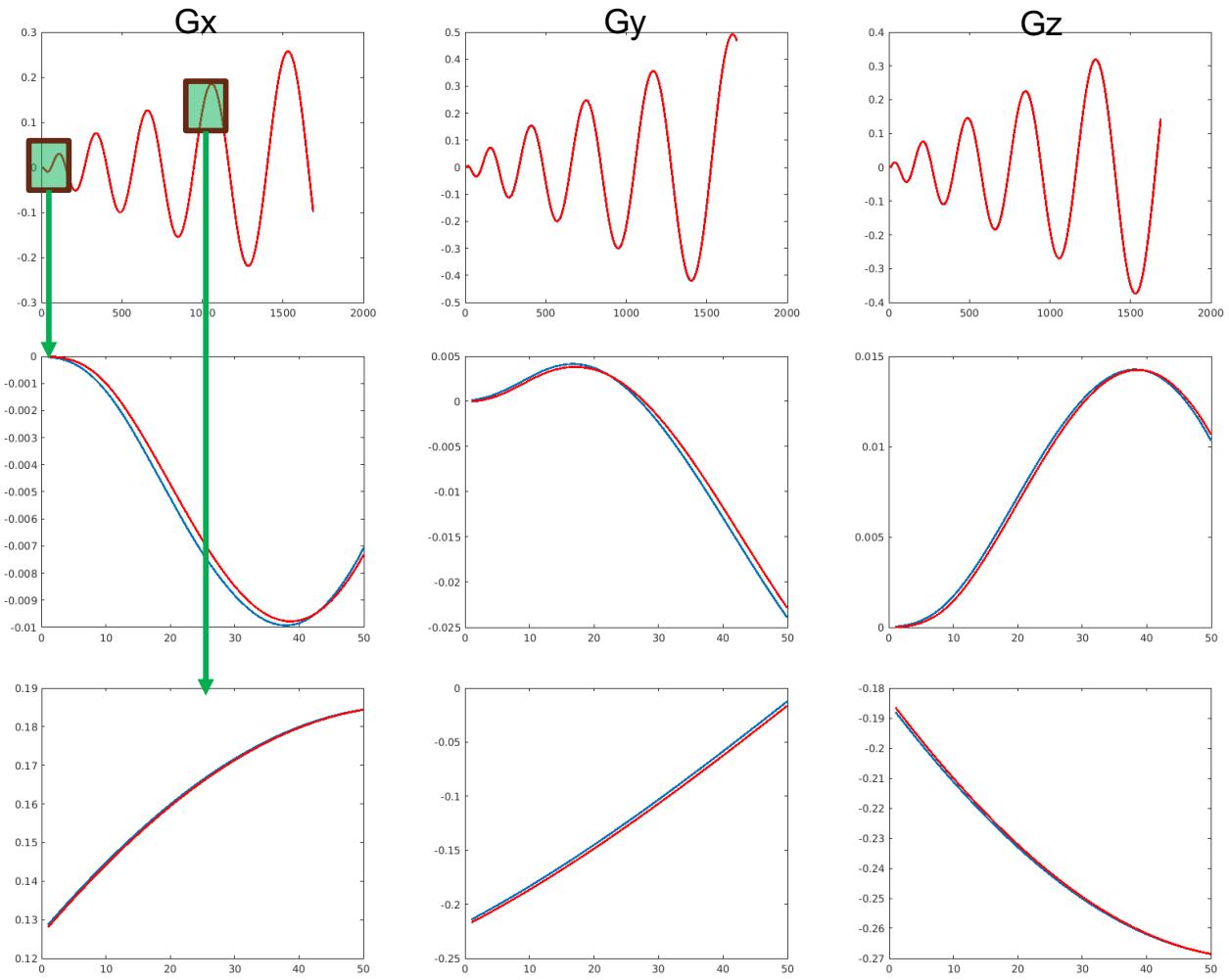


DWI R1 Acquisition, Diffusion Weighted Volumes

GE reconstruction without B0 correction

Skope reconstruction with B0 correction



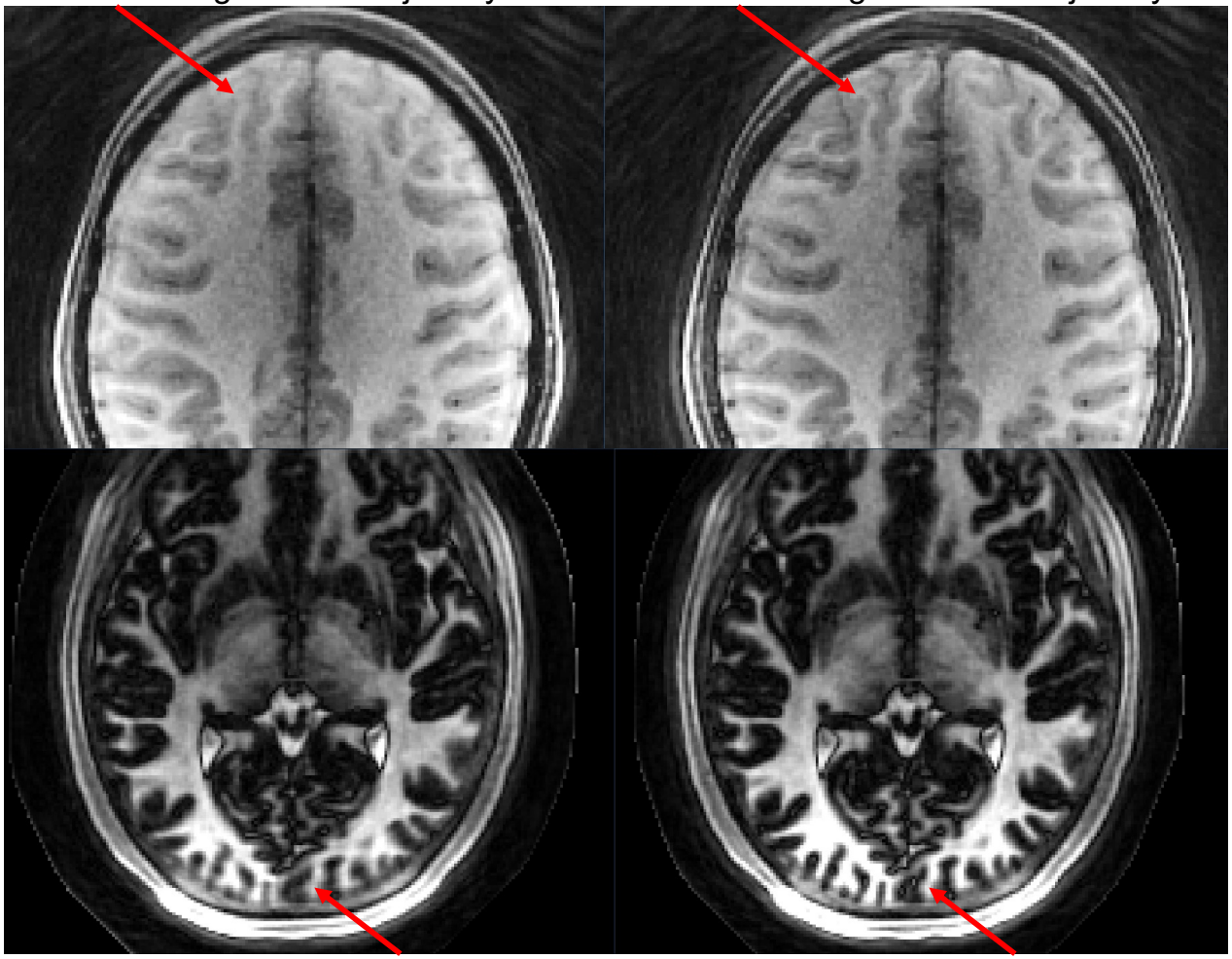


Nominal trajectory

Measured trajectory using Skope

Recon using nominal trajectory

Recon using measured trajectory



NUFFT

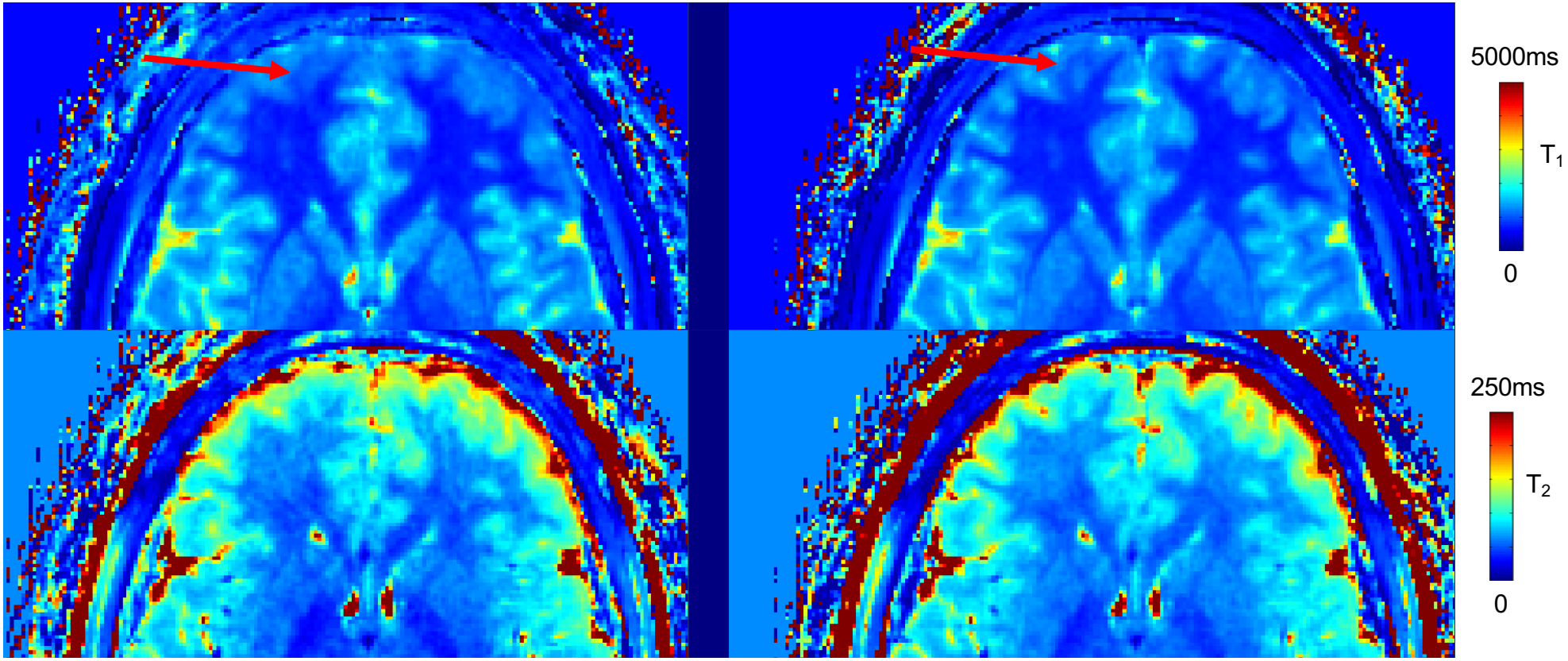
Subspace reconstruction with locally low rank

Max slew rate: 100 T/m/s
Max gradient amplitude: 30 mT/m

Resolution: 1-mm isotropic
FOV: 220-mm isotropic
Acquisition time: 1m 56s

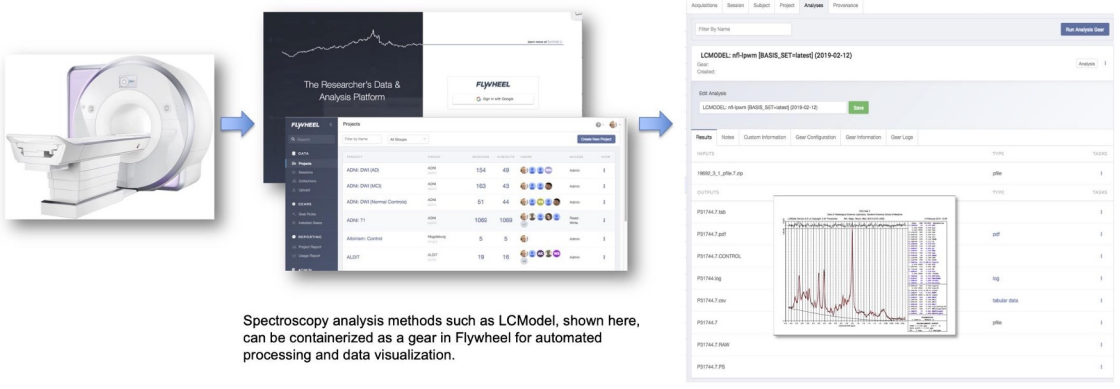
MRF using nominal trajectory

MRF using measured trajectory



Technology – Spectroscopy

Interest in measuring metabolic changes via MRS techniques and combining that information with functional MRI measurements continues to grow. CNI continues to support the research of its user community by providing state of the art data acquisition and data processing techniques in spectroscopy.

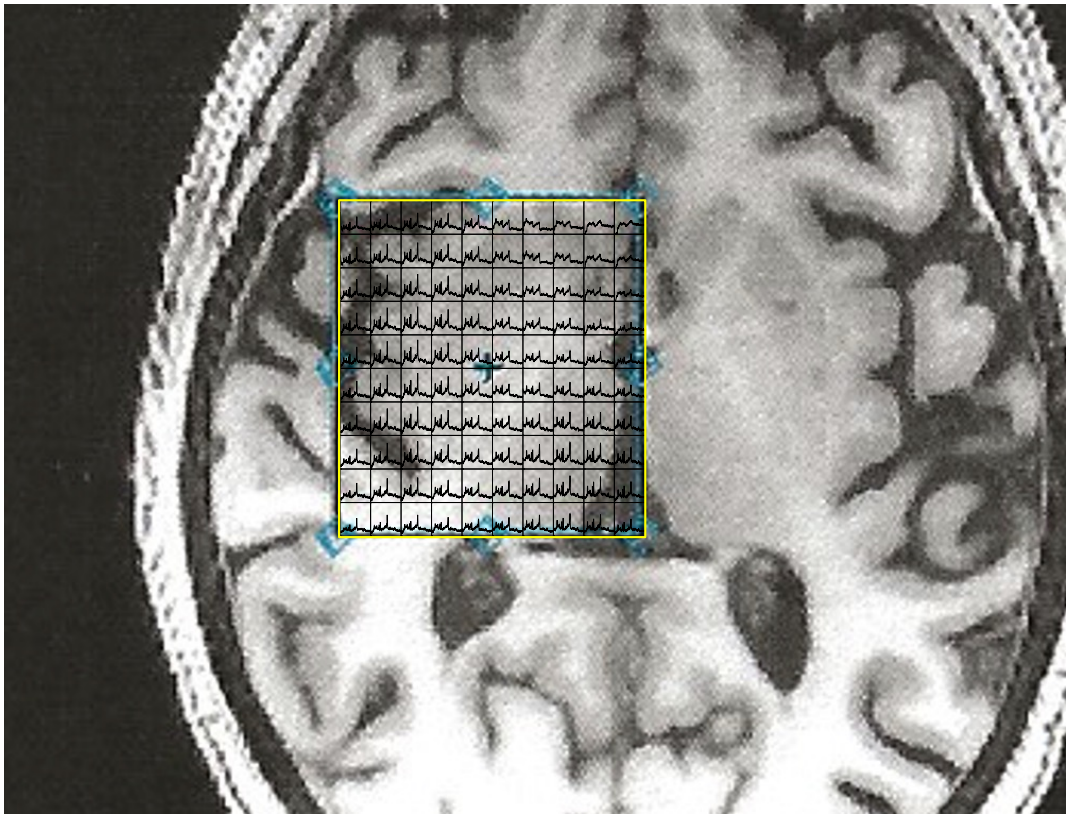


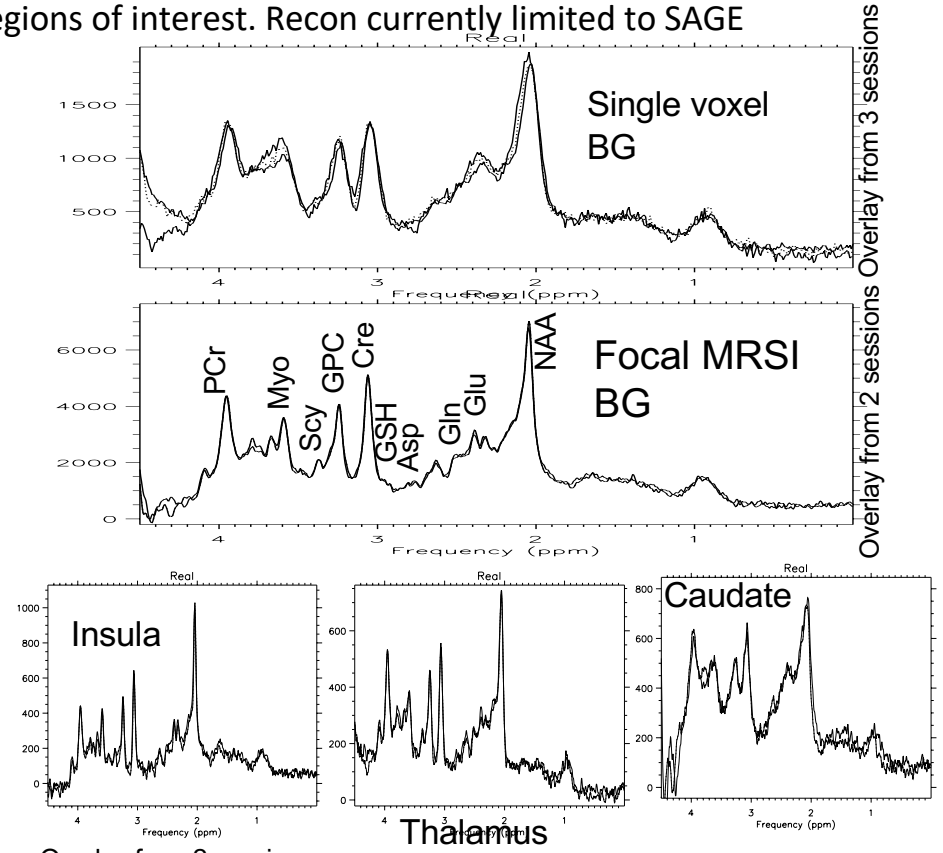
Spectroscopy analysis methods such as LCModel, shown here, can be containerized as a gear in Flywheel for automated processing and data visualization.

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]

Technology – Spectroscopy

GE WIPs (s-Laser sequence) allow focal MRSI acquisitions. Application to difficult Basal Ganglia region demonstrates improved repeatability plus the flexibility to separate different BG regions of interest. Recon currently limited to SAGE





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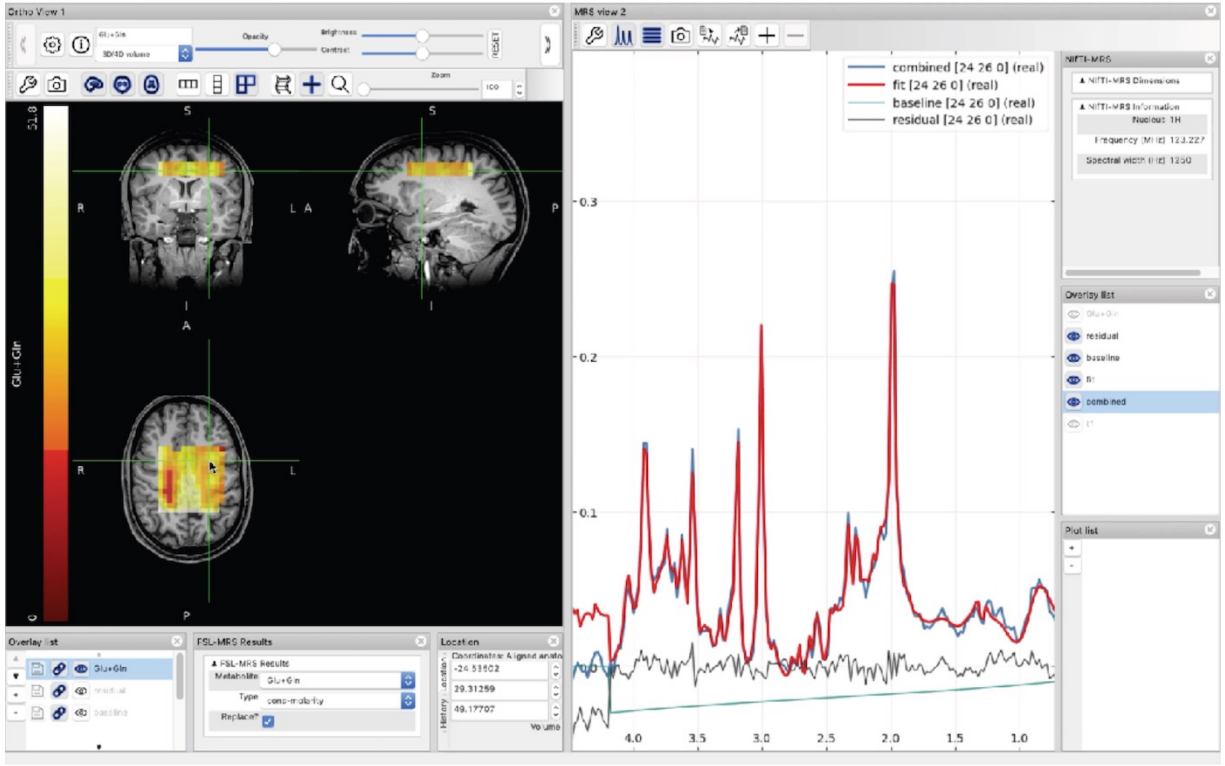
Stanford University

Technology – Spectroscopy

Spectroscopy data processing capabilities for single voxel and MRSI are currently being evaluated for optimally combining open-source processing packages such as FSL-MRS (using FSLeyes (MRS plugin)) with Flywheel gears.



Technology – Spectroscopy

- CNI Spectroscopy resources
  - Spectroscopy Wiki page (literature references, data acquisition and data processing tools) https://cni.stanford.edu/wiki/GABA_spectro
  - Spectroscopy special interest group meetings
    - to support CNI users with ongoing spectroscopy projects
    - to evaluate and implement new spectroscopy methods for data acquisition (example: GE WIP's) and processing (example: FSL-MRS) particularly in challenging areas of the brain
  - Contact Laima if you'd like to find out more

Technology – Compute & Data Resources

- NIH management plans require *keeping data for as long as useful to research community*
  - All acquired data preserved in Flywheel in an appropriate repository
- Increasing compute demands
  - Increasing load on Flywheel reaper
  - Increasing demand for offline reconstruction capabilities
- Plan for new servers
  - Funded by C-ShARP service center refreshment grant
  - New Flywheel reaper expected by December
  - Massively powerful compute server order in preparation

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

Flywheel

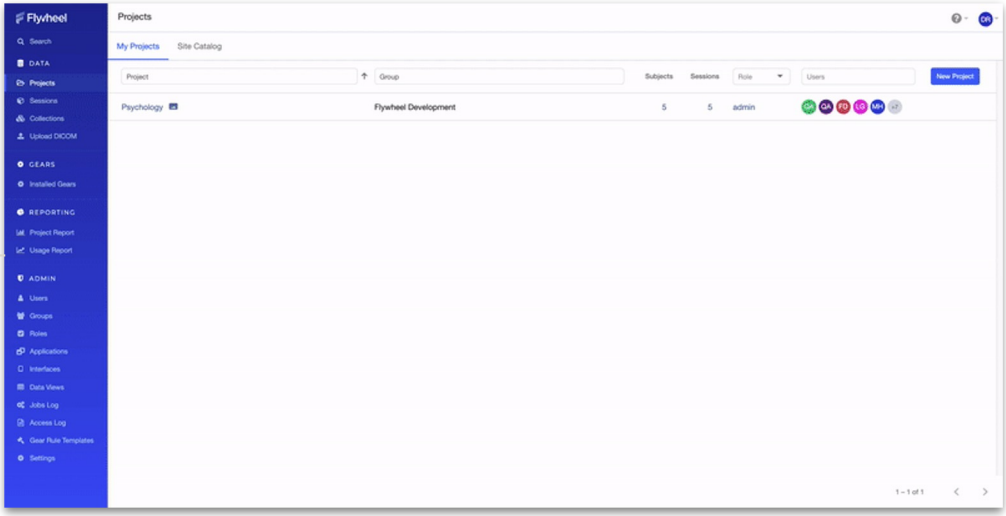
Welcome to 16.10!

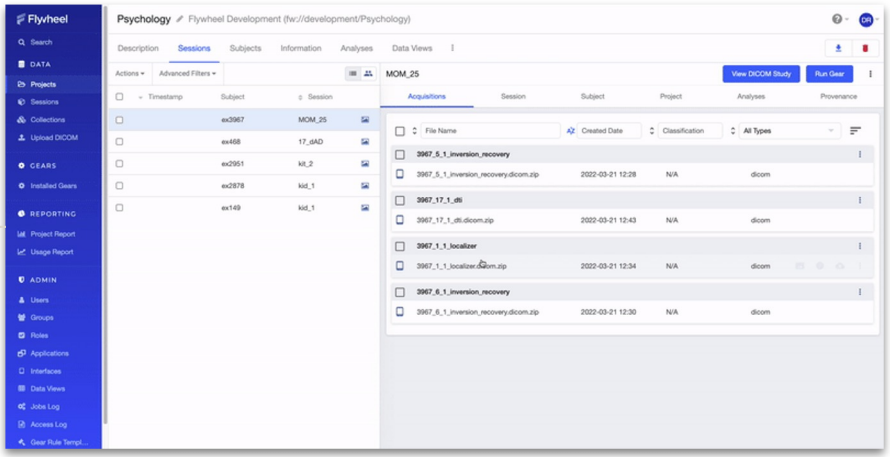
Upgraded Wednesday 10/12

- At CNI: some issues have been noted. Initial site slowness, issues with analysis gear outputs. FW team is working to remedy.

New features include:

- **Project Catalog (doc)**
  - Projects with re-usable data can be found and shared
- **File enhancements**
  - Rename Files
  - Change file type
  - Move files across containers
- **Site wide Jobs Log (doc)**
  - Now YOU can see your jobs all in one place
- **Data Views (doc)**
  - Filtering, Grouping, Aggregation

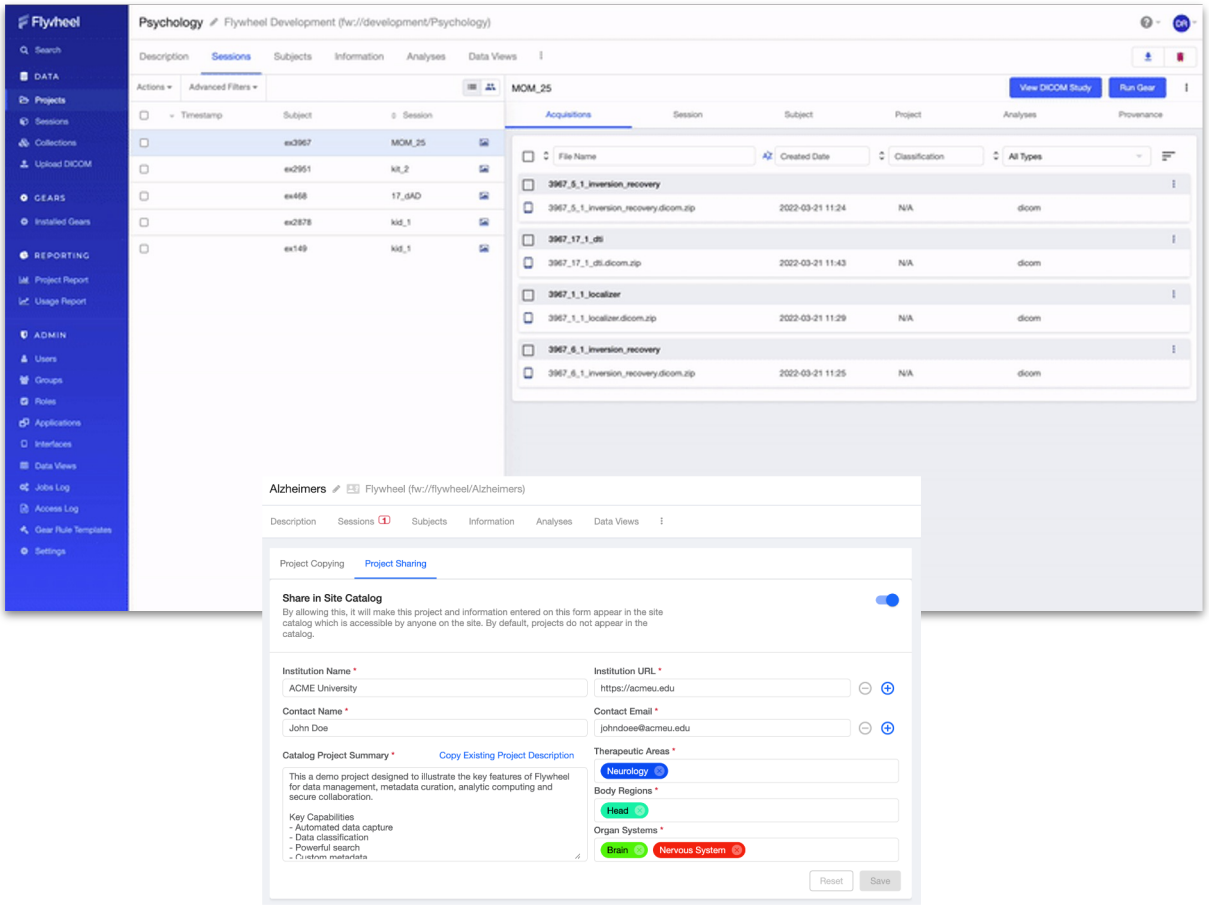




Flywheel

Project Catalog (doc)

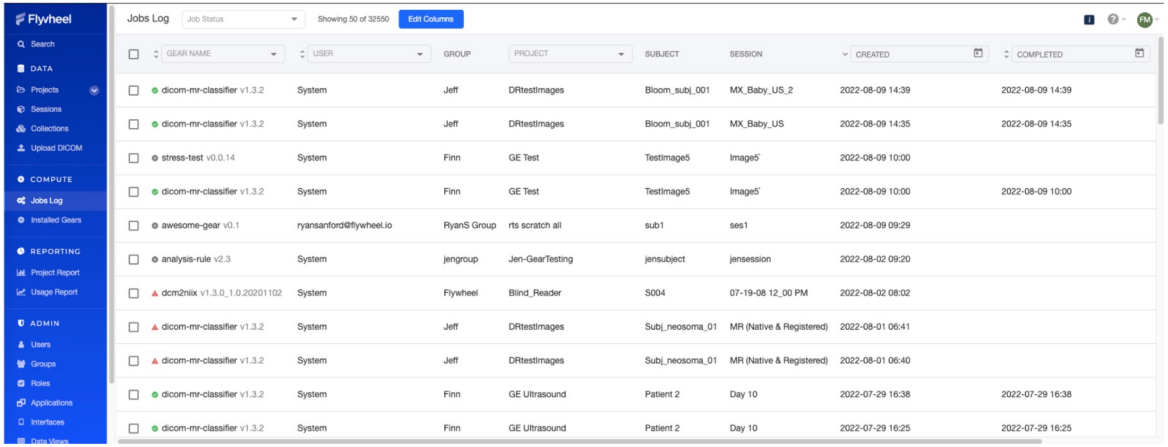
- Projects with re-usable data can be found and shared
- By default, your project is not shared on the catalog
- In order to share it, a user with the right permissions must go into project “Settings” and “Project Sharing”
- There they can toggle sharing “on” or “off” and add pertinent catalog details for their project
- Multiple options are presented for users to easily navigate to projects of interest in the catalog
- Can be used with Smart Copy to provide a “zero-footprint” copy of project to another group.

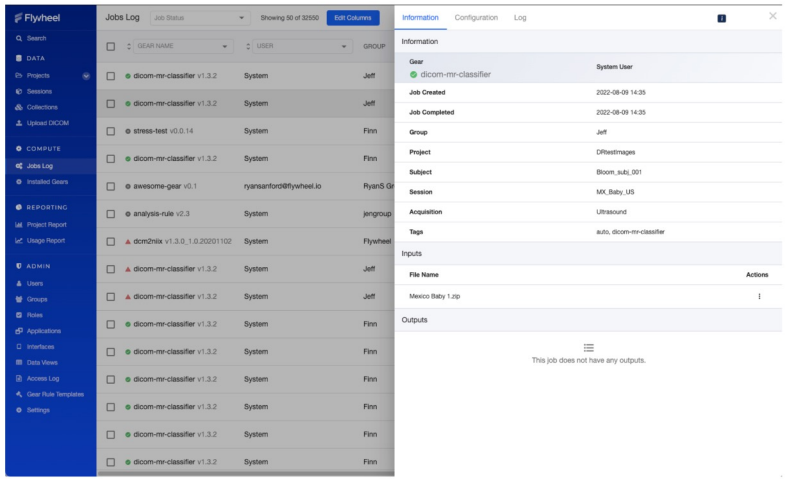


Flywheel

Jobs Log Page (doc)

- Previously this was an administrator task… now every user can manage their jobs
- Any user can manage their jobs
  - View logs
  - View inputs
  - View outputs
  - Download files
  - Cancel running jobs





Flywheel

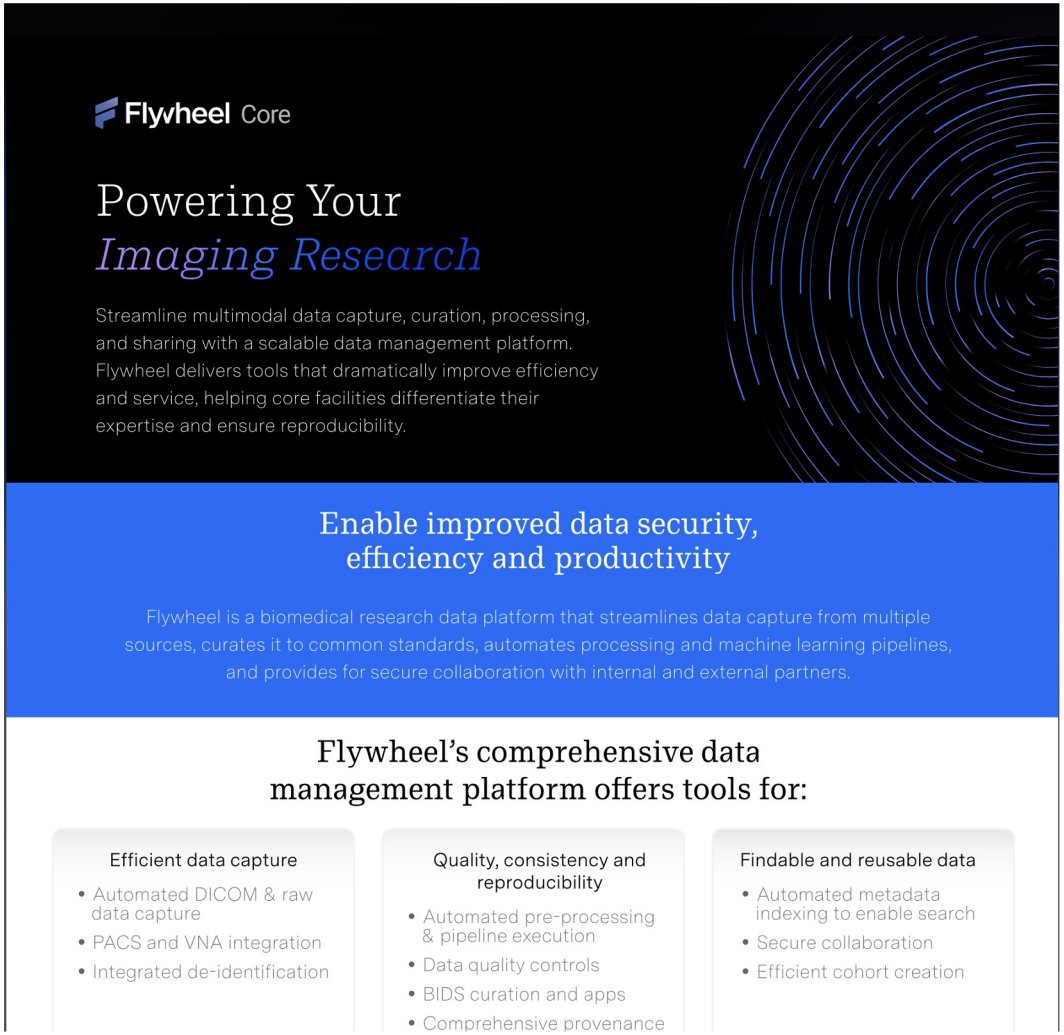
Lab Edition Upgrade

Increased functionality

- Upload, manage, and analyze retrospective data
- Analyze data directly in Flywheel via Gears
  - Gear Exchange Access
  - Data provenance
  - Reproducibility
  - Cloud scalability
- Run analyses locally and store outputs directly in Flywheel for secure, permissions-based sharing
- Develop and upload custom Gears

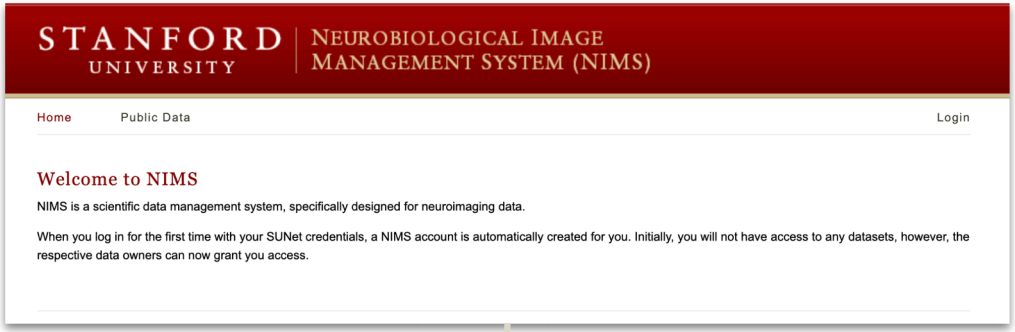
Available to groups at Stanford at discounted rates

- Contact Flywheel for more information and pricing



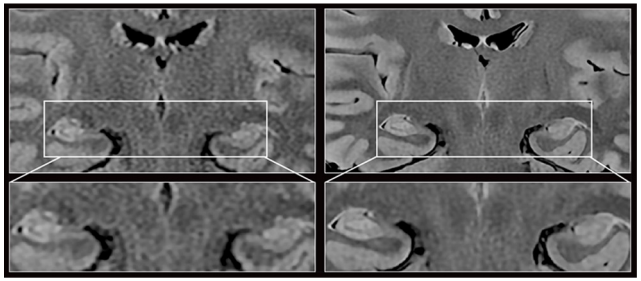
NIMS DATA

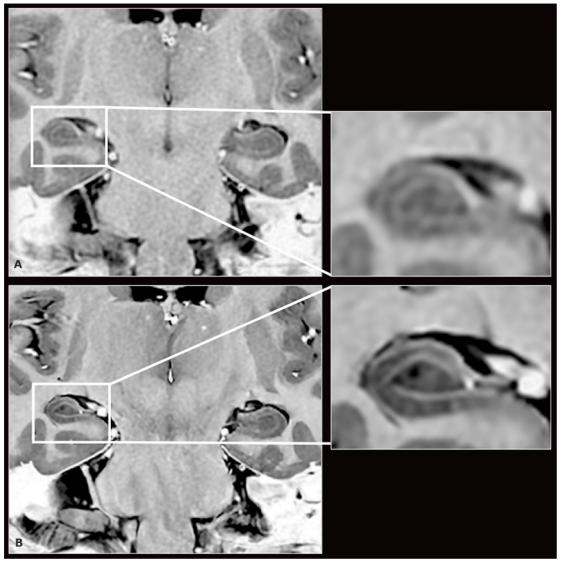
- Over the years we have migrated the majority of the data from our legacy image management system - NIMS
- If your group has data on NIMS you would like migrated on priority to Flywheel please reach out to Michael Perry
- NIMS will eventually be retired, though our goal is to transfer (almost) everything

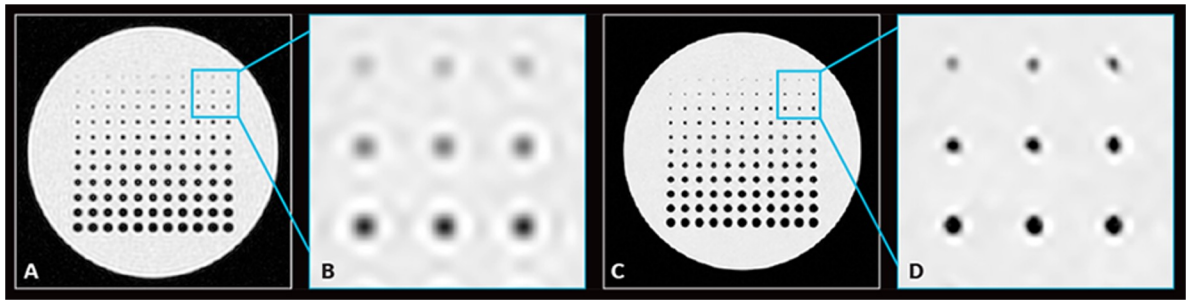


GE System Upgrade

- Will move from RX28 to RX30 Q1/2023
  - 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
  - Possibility new hardware will come in advance







C-ShARP RFP & Experiential Learning Grant

- Community of Shared Advanced Research Platforms formed 2020
  - Re-imagining shared facilities
  - Bridging Departmental and School boundaries
  - Annual RFP to support service center missions, next RFP due Jan. 2023
- CNI has $23K grant to support experiential learning in FY23
  - Class tours/demos
  - Class projects using CNI
  - Contact Adam if you are interested in participating

Friendly Reminders

- CNI uniquely welcoming and pleasant research MRI space
  - Use all organizational bins
  - Think wilderness trip – *Leave No Trace*
- Please following scheduling policies
- Respect other group's space / subjects
- Always open to suggestions on how to improve

Questions?