

# Accelerated diffusion-weighted MRI at 7T: Joint reconstruction for shift-encoded navigated interleaved echo planar imaging (JETS-NAVIEPI)

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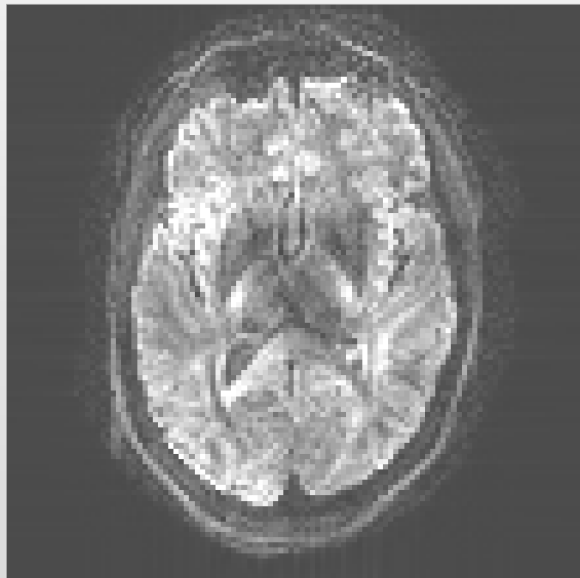
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# Motivation

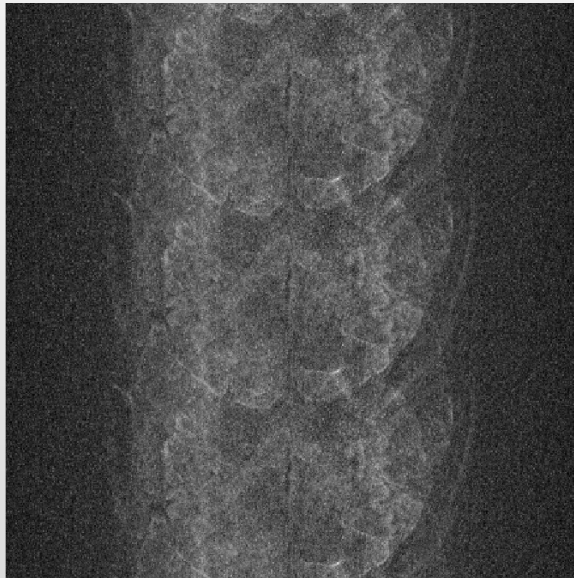
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Diffusion-weighted MRI (DWI) suffers from:

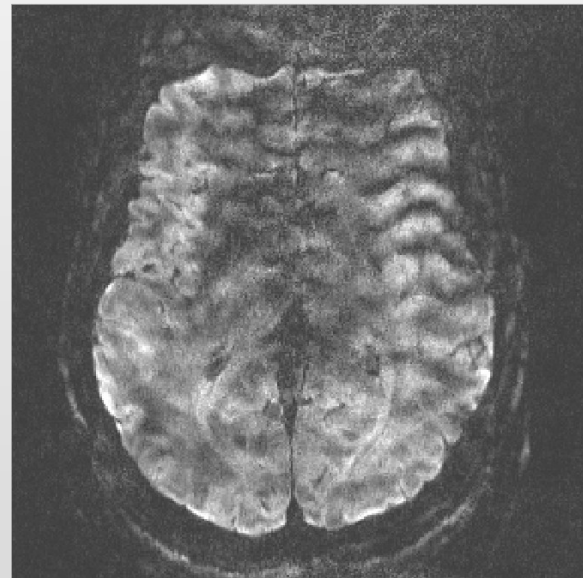
Limited spatial resolution  
& poor SNR



Shot-to-shot  
phase variation



Motion



# Goal

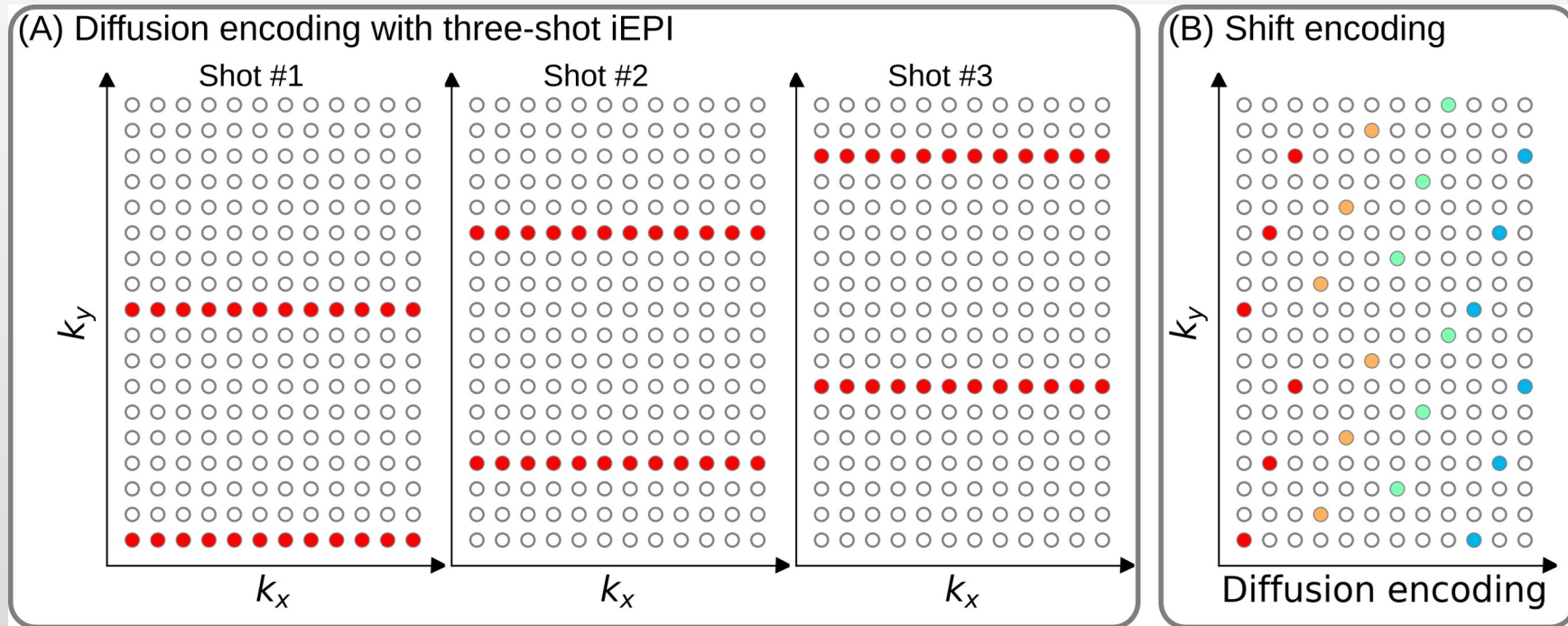
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To develop high spatial-angular-temporal resolution DWI at 7 T.

- ✓ Sub-millimeter spatial resolution
- ✓ Multi-shell q-space sampling
- ✓ Undersampled complementary k-space acquisition

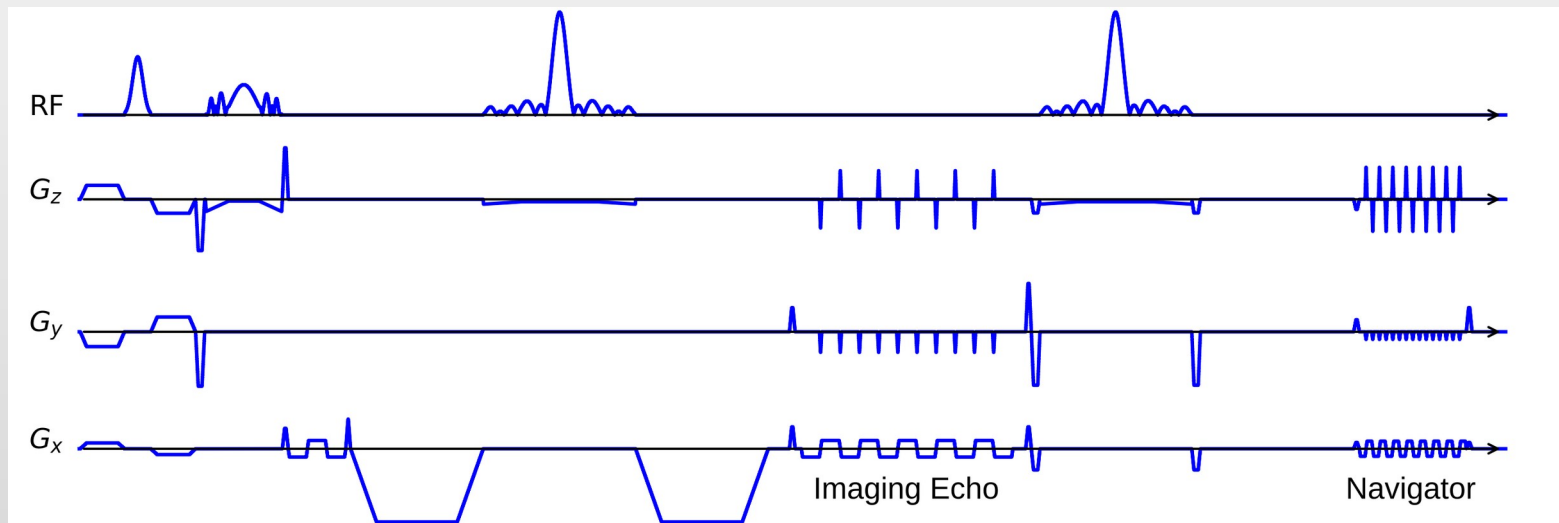
# Approach: Shift Encoding

- Enables complementary k-q-space sampling

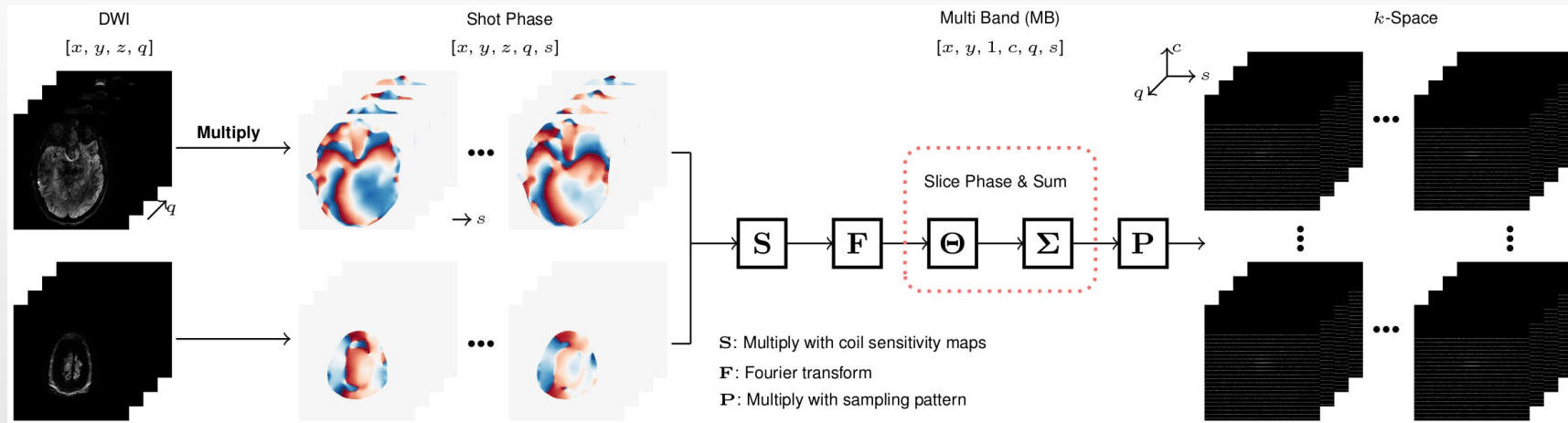


# Approach: NAViEPI – iEPI Meets rsEPI

- Consistent echo spacing between imaging and navigator echoes
  - Minimal distortion mismatch between echoes
  - Flexible number of shots for high spatial resolution
  - Reliable shot-to-shot phase estimation



# Approach: Joint Reconstruction



$$\operatorname{argmin}_x \|Y - \mathbf{A}(x)\|_2^2 + \lambda R(x)$$

$Y$  : measured  $k$ -space data;

$x$  : diffusion-weighted images (DWI);

$\mathbf{A}$  : the above forward model;

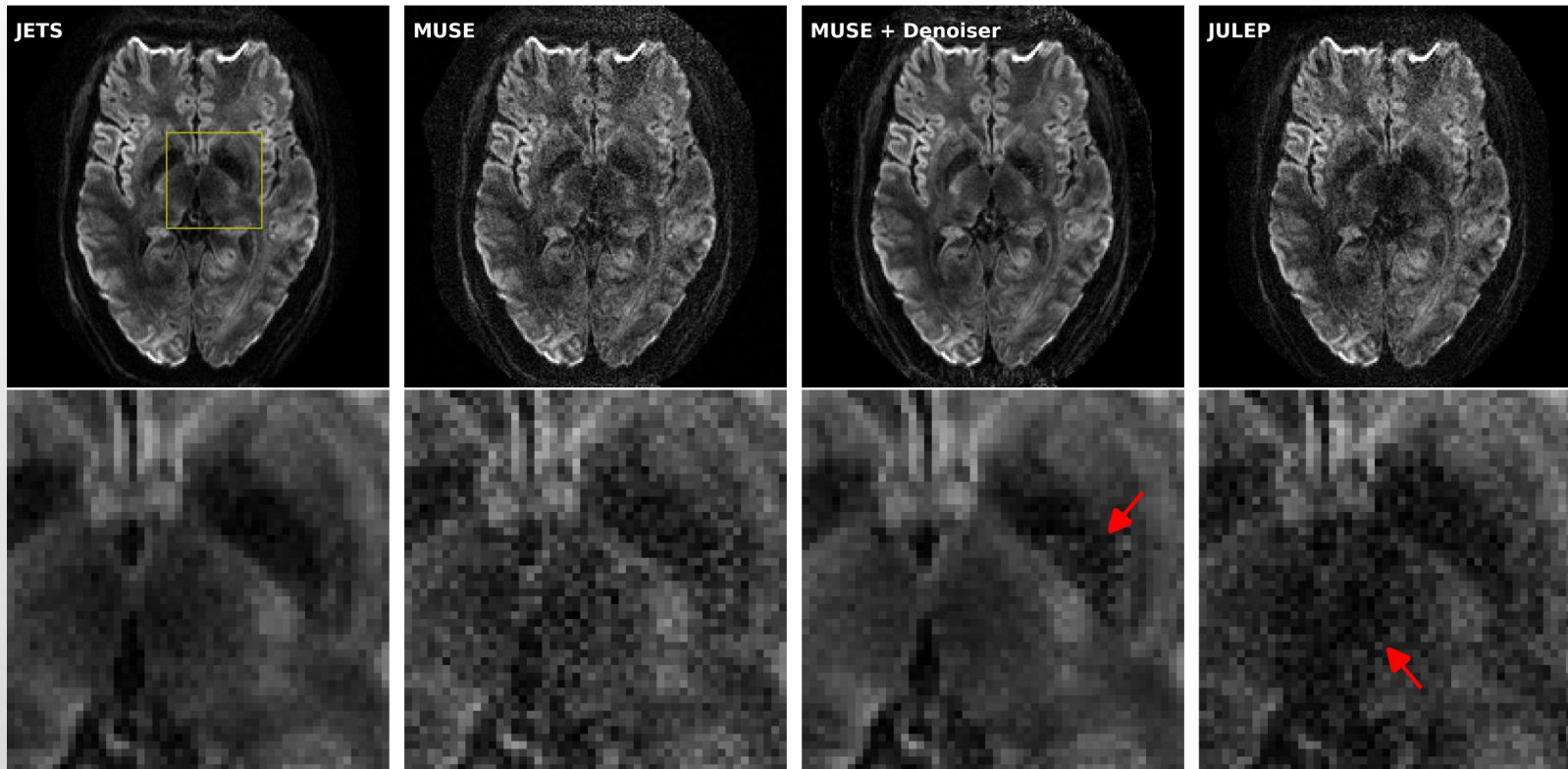
$R(x)$  : regularization function.

# Experimental Setup

Experiment	#1	#2	#3
Spatial resolution	1.0 mm ISO	0.5 x 0.5 x 2.0 mm <sup>3</sup>	1.0 mm ISO
Shots	4	5	2
Diffusion directions	20	3	126
b-values (s/mm <sup>2</sup> )	1000	1000	1000, 2000, 3000
Acceleration	1 x 3	3 x 2	3 x 3
Scan Time (min)	10:42	1:38	22:25

# Result: Effective JETS Reconstruction

8th DW image from 4-shot iEPI @ 1 mm ISO





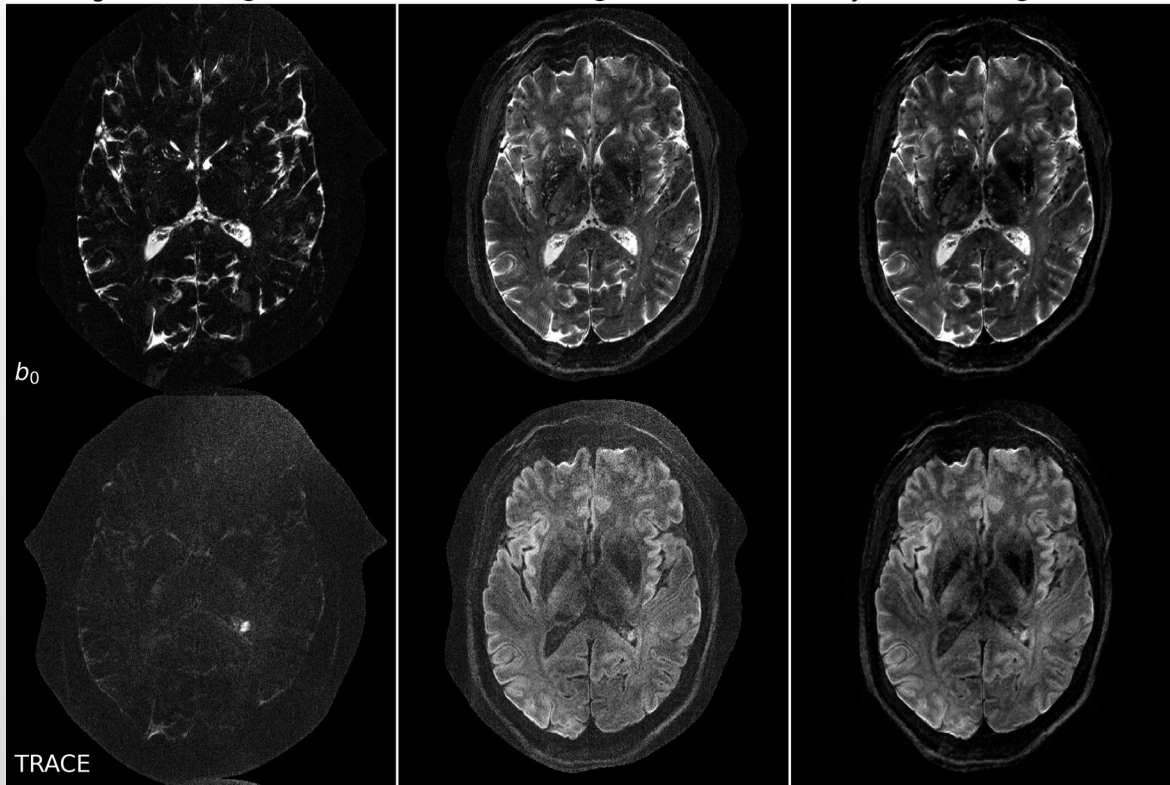
# Result: Efficient NAViEPI Sampling

3-scan trace acquisition with voxel size 0.5 X 0.5 X 2.0 mm<sup>3</sup>

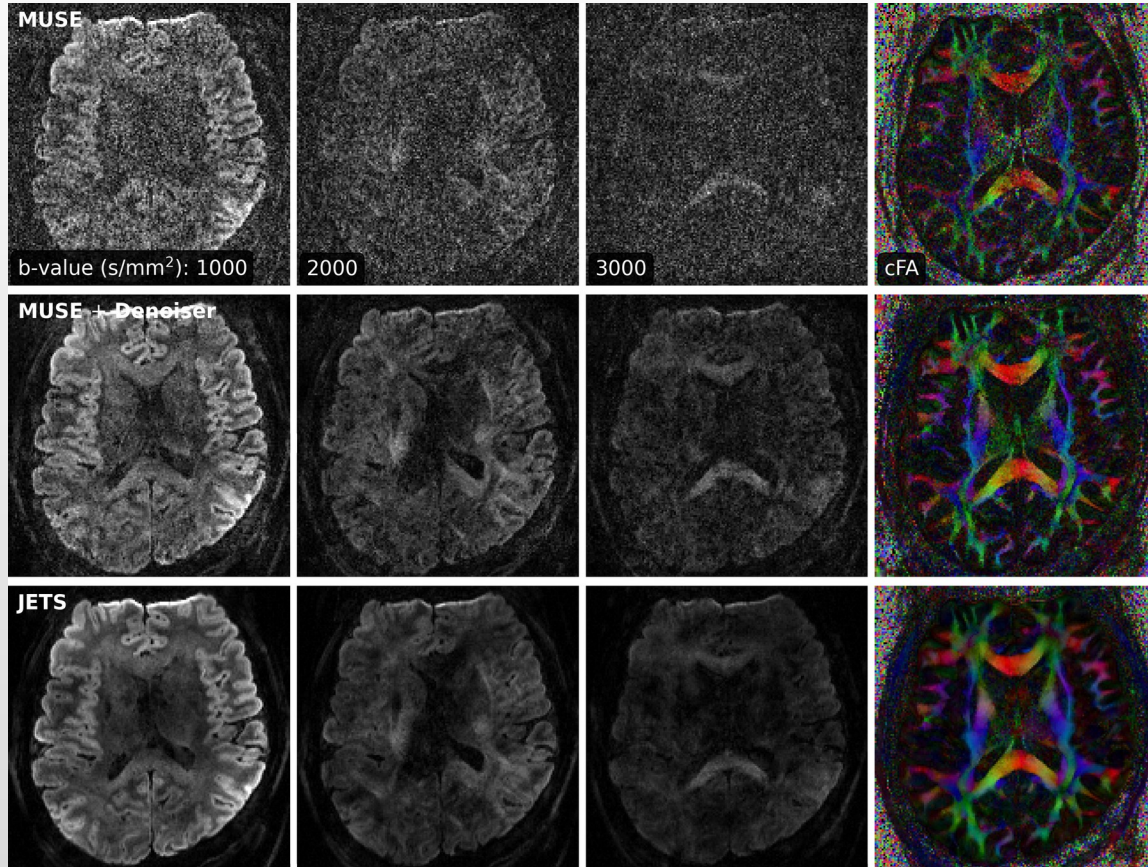
single-shot EPI @ 46 sec

NAViEPI @ 98 sec

JETS-NAViEPI @ 98 sec



# Result: 3-Shell DTI



# Open-Source Codes

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- Accepted by *Imaging Neuroscience*:  
[https://doi.org/10.1162/imag\\_a\\_00085](https://doi.org/10.1162/imag_a_00085)
- Codes & Data:  
<https://github.com/ZhengguoTan/NAVIEPI>

# Impact

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JETS-NAViEPI enables

- ✓ accelerated sub-millimeter resolution brain DWI at 7T;
- ✓ clinically relevant 3-scan trace and neuroscientific DTI protocols.

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