Rapid QSM Acquisition with Wave-CAIPI

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- Recent modifications to rectilinear k-space sampling provided more robust reconstructions of highly under-sampled datasets

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Wave-CAIPI Sampling

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- Wave-CAIPI: 2D CAIPI + BPE in 2 directions
- Spread aliasing in 3D to take full advantage of 3D coil profiles

Wave-CAIPI causes voxel spreading in 3 dimensions

- Combination of $G_y$ and $G_z$ gradients with inter-slice shifts yields voxel spreading across three dimensions
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Wave-CAIPI improves parallel imaging

- Voxel spreading increases the distance across aliasing locations
- This increases the variation in coil sensitivity profiles and improves parallel imaging capability

Aliasing voxels are spread out to increase the variation in coil sensitivity profiles.
$R=3\times3$ @ 3 Tesla, 1 mm iso, $T_{acq}=2.3\text{min}$

$k$-space

2D-CAIPI

Recon

$1/G$-factor

$G_{\text{max}}=1.82$

$G_{\text{mean}}=1.22$
R = 3x3 @ 3 Tesla, 1 mm iso, $T_{acq} = 2.3$ min

1. **k-space**
   - 2D-CAIPI
   - Bunch Encoding

2. **Recon**
   - 2D-CAIPI
     - $G_{max} = 1.82$
     - $G_{mean} = 1.22$
   - Bunch Encoding
     - $G_{max} = 1.93$
     - $G_{mean} = 1.38$

3. **1/G-factor**
   - 

$k_{max} = 1.93$

$k_{mean} = 1.38$
R=3x3 @ 3 Tesla, 1 mm iso, $T_{\text{acq}}=2.3\text{min}$

**k-space**

- **2D-CAIPI**
  - $G_{\text{max}} = 1.82$
  - $G_{\text{mean}} = 1.22$

- **Bunch Encoding**
  - $G_{\text{max}} = 1.93$
  - $G_{\text{mean}} = 1.38$

- **Wave-CAIPI**
  - $G_{\text{max}} = 1.08$
  - $G_{\text{mean}} = 1.03$
R=3x3 @ 7 Tesla, 1 mm iso, $T_{acq} = 2.3$ min
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<table>
<thead>
<tr>
<th>k-space</th>
<th>Recon</th>
<th>$1/G$-factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D-CAIPI</td>
<td>$G_{max} = 1.74$</td>
<td>$G_{mean} = 1.19$</td>
</tr>
<tr>
<td>Bunch Encoding</td>
<td>$G_{max} = 2.12$</td>
<td>$G_{mean} = 1.30$</td>
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</tbody>
</table>
R=3x3 @ 7 Tesla, 1 mm iso, $T_{\text{acq}}=2.3\text{min}$
R=3x3 @ 7 Tesla, 1 mm iso, $T_{acq} = 2.3$ min

Wave-CAIPI

Tissue Phase

Susceptibility