



MRI pulse sequences for neuroimaging research

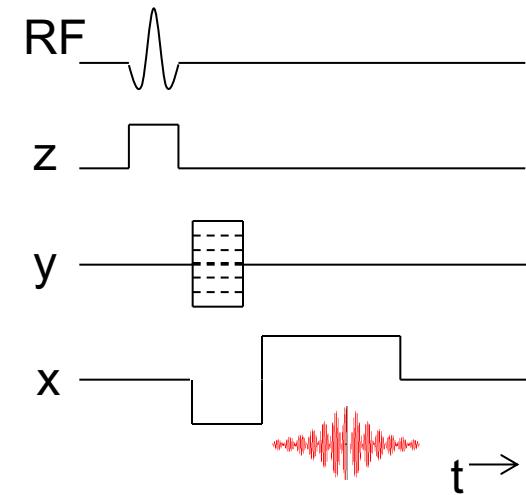
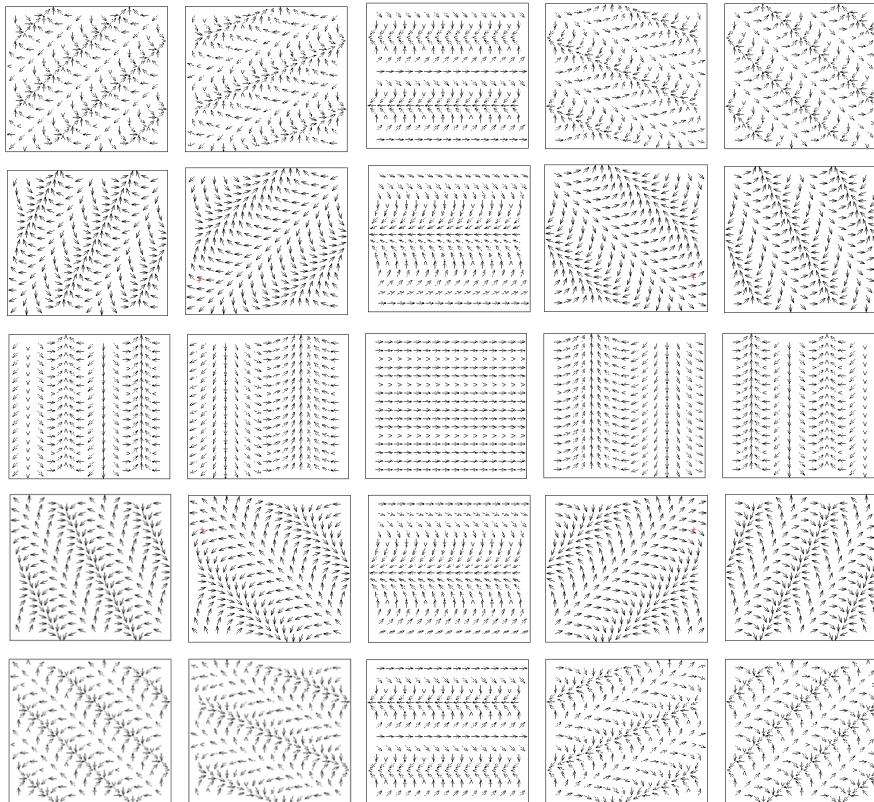
k-space



We acquire spatial frequency information

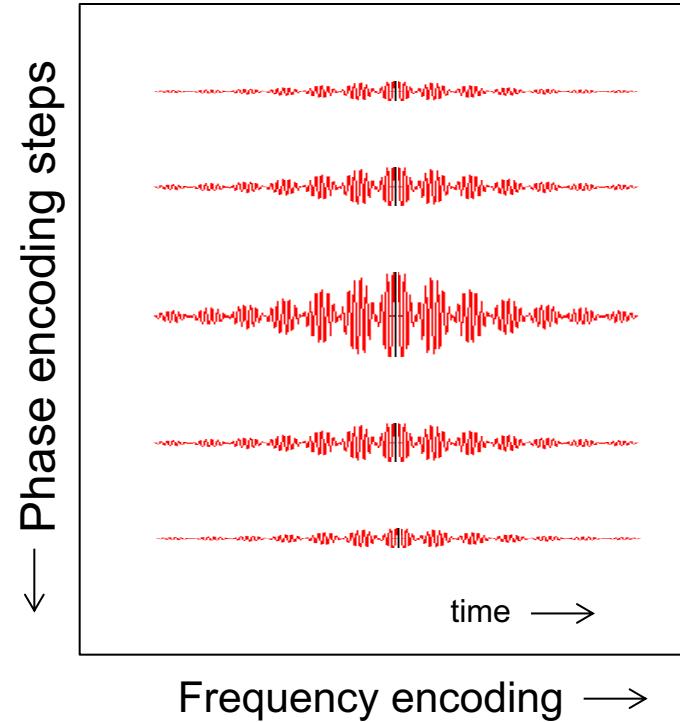
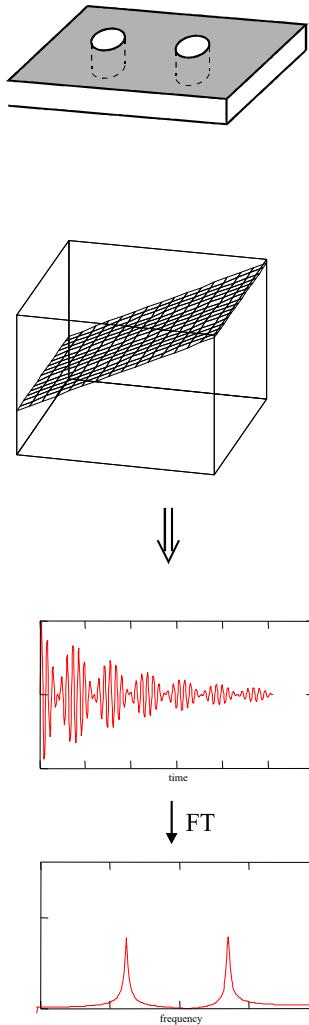
← Phase encoding step

time →





We acquire spatial frequency information





k-space

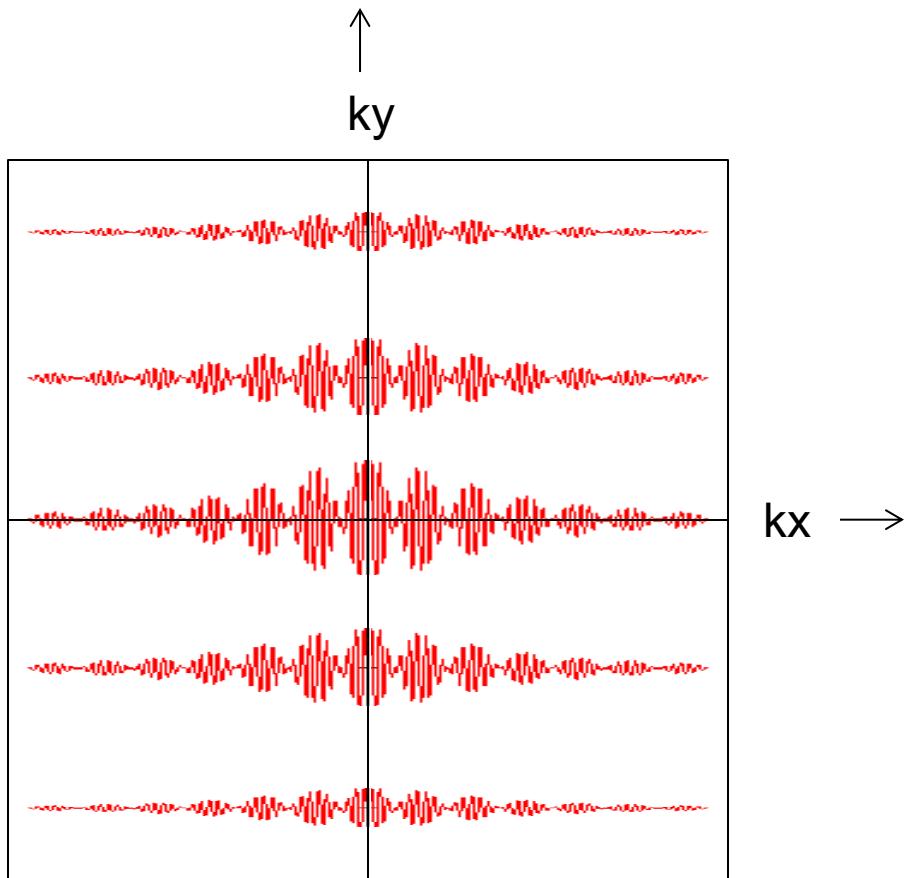
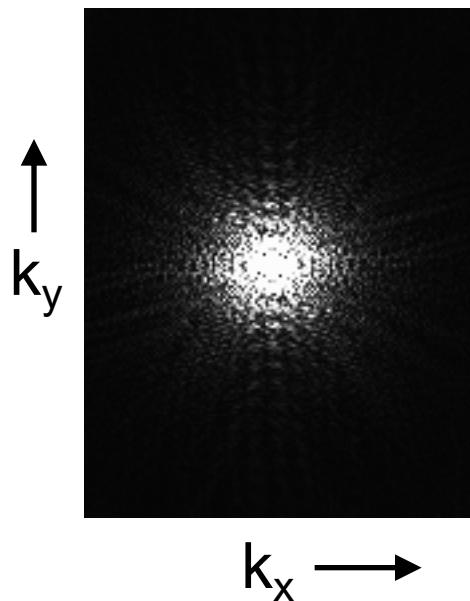




Image (x) space vs. k-space



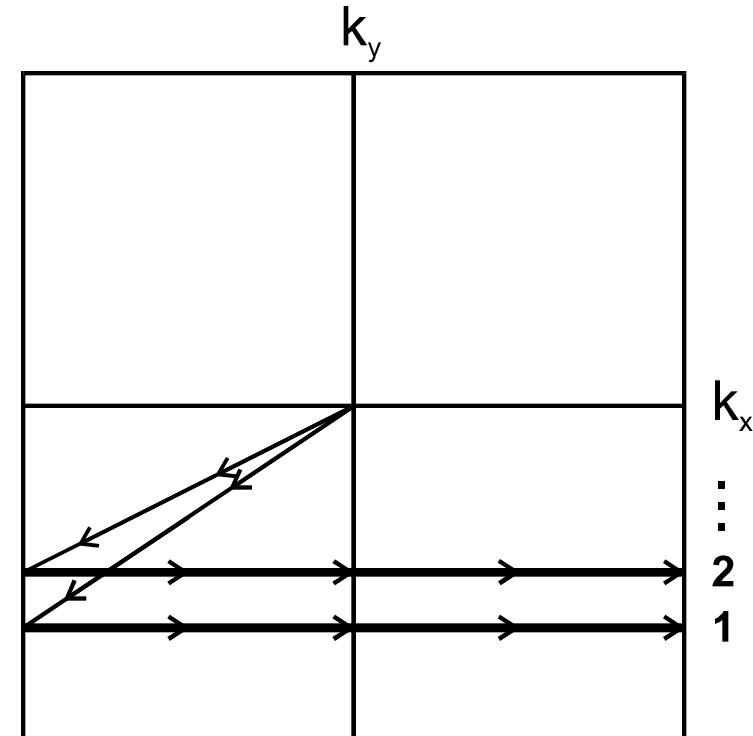
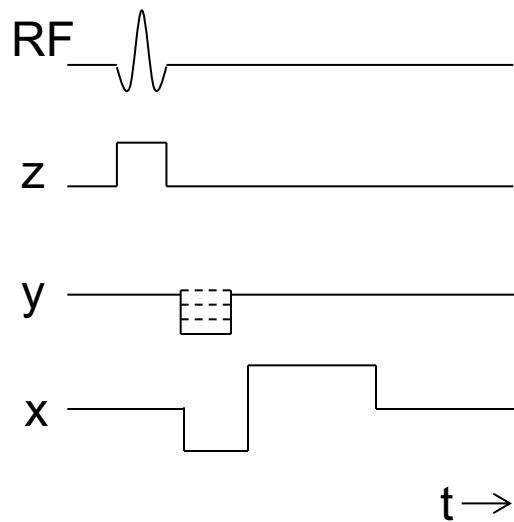
*Fourier
Transform*

A large green double-headed arrow pointing horizontally, indicating the equivalence or transformation between the two spaces.





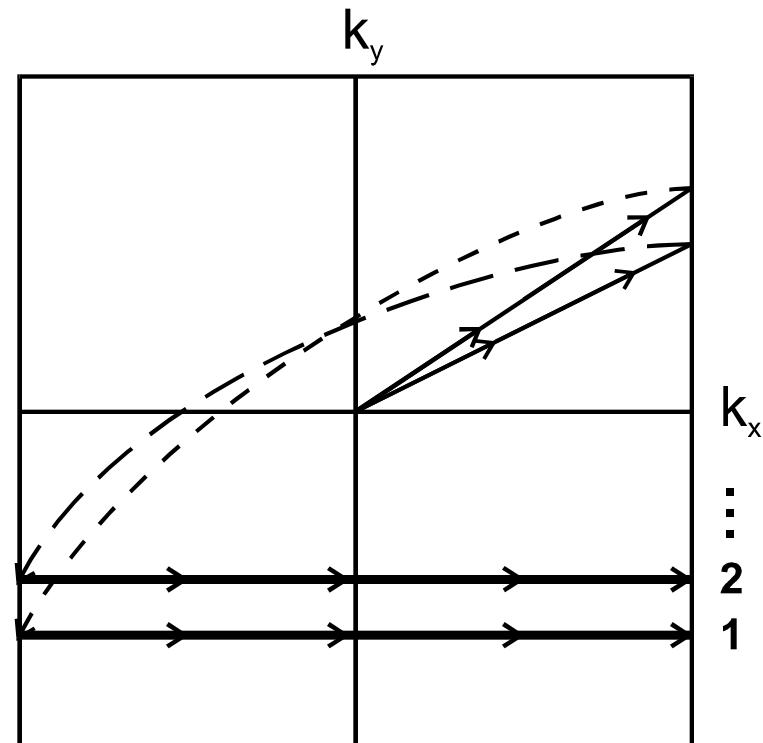
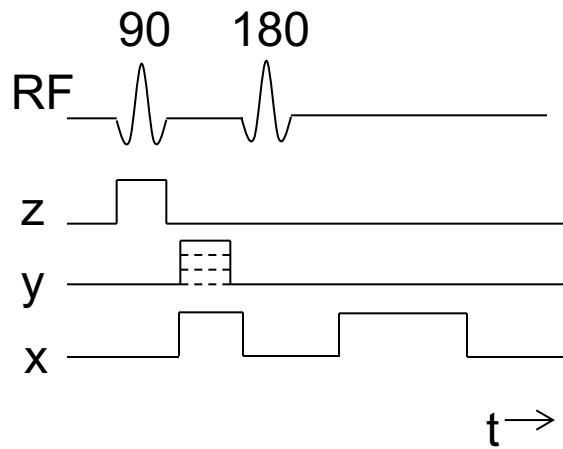
Gradient Echo



$$k = \gamma \int G \, dt$$

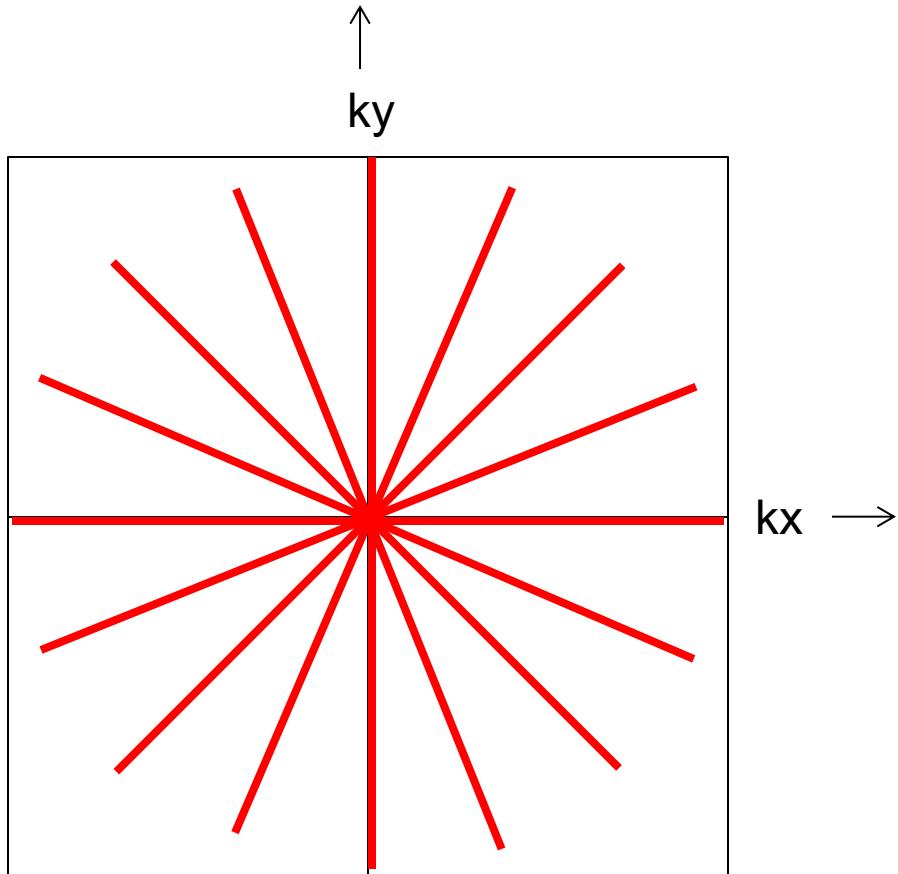


Spin Echo



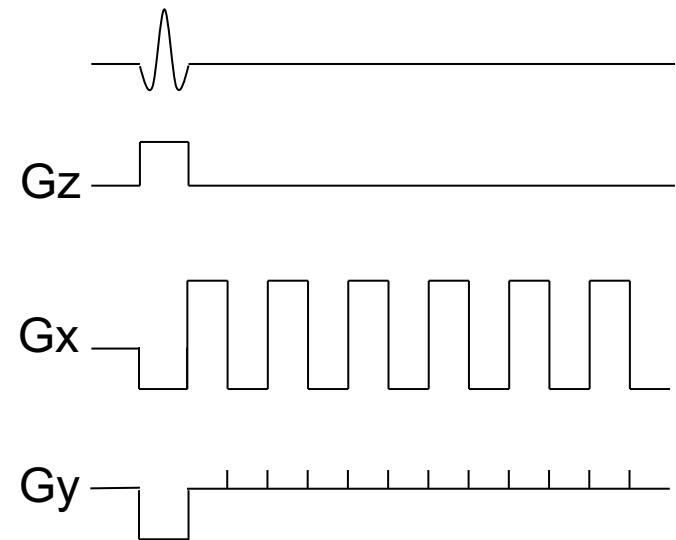
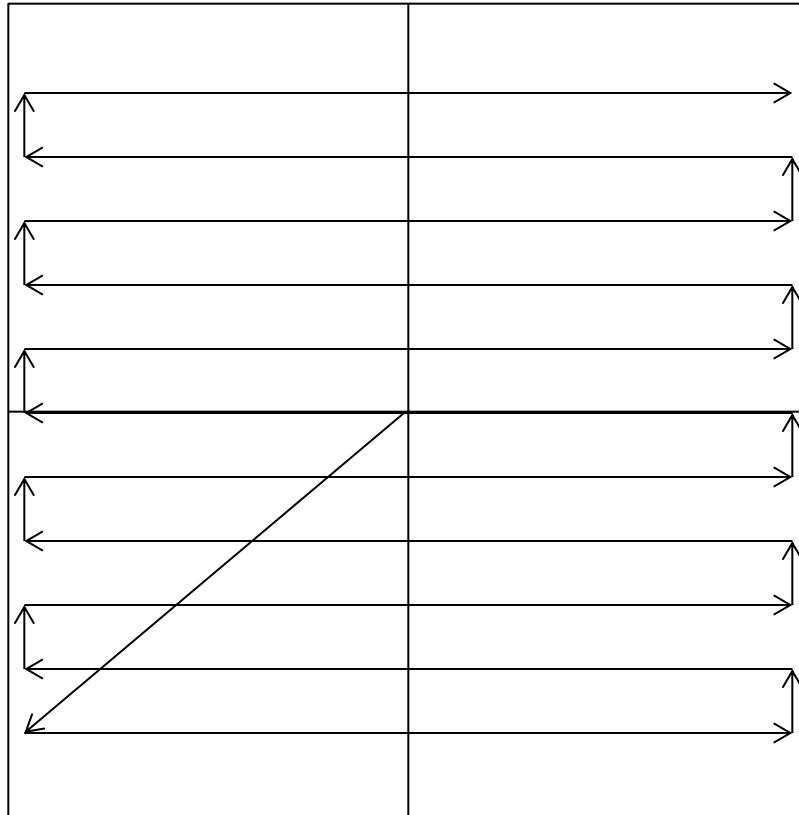


Projection Reconstruction



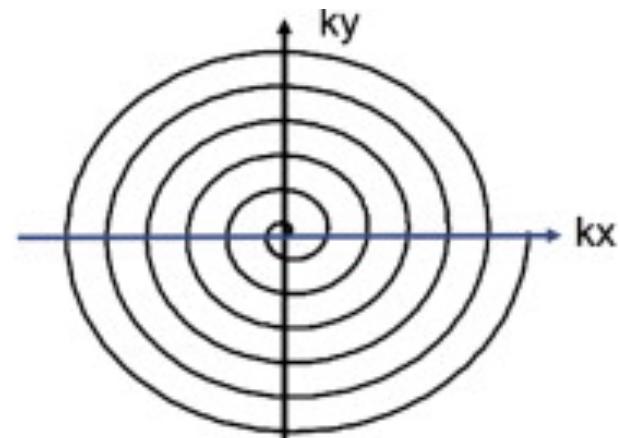
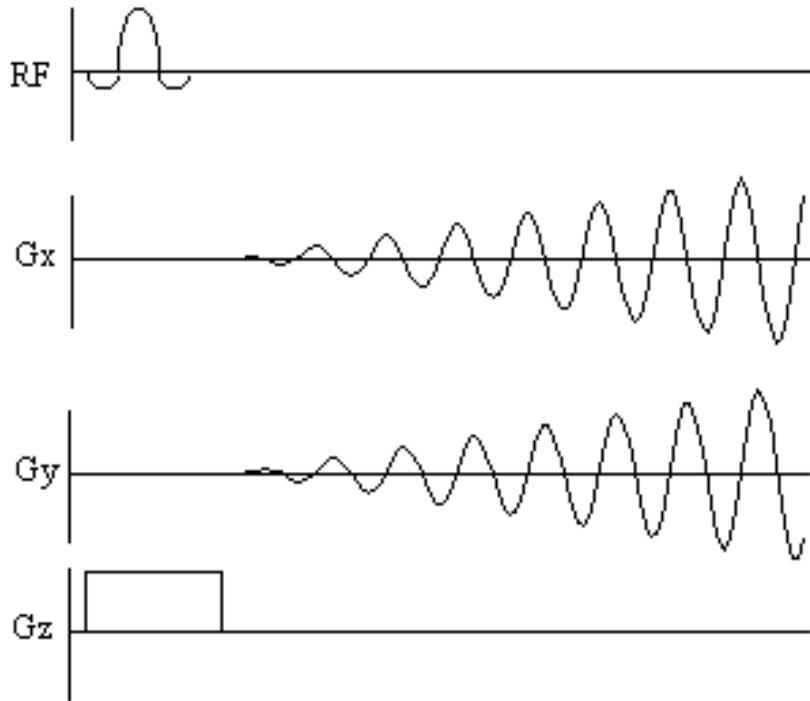


Echo-planar imaging



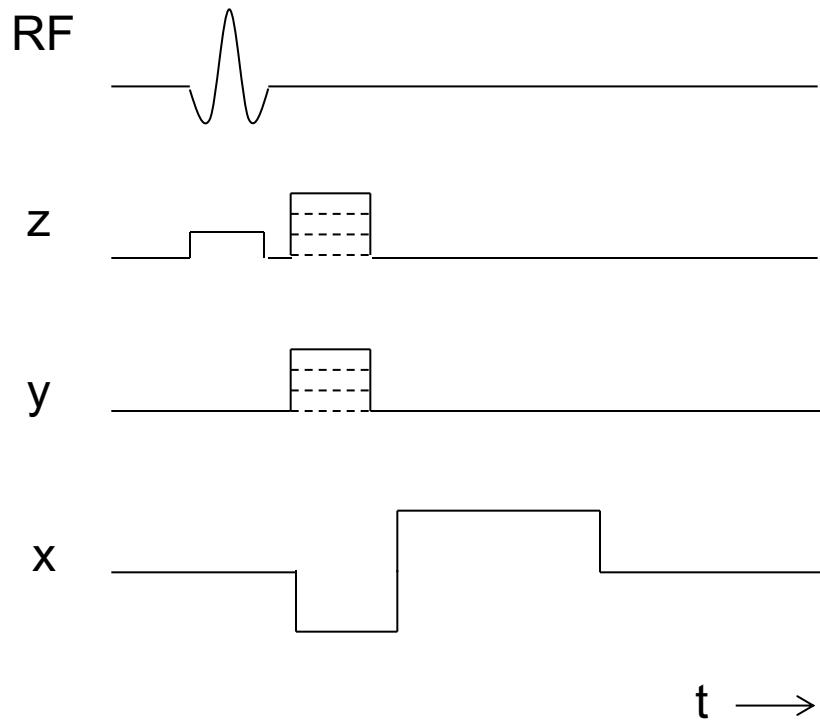


Spiral sequence



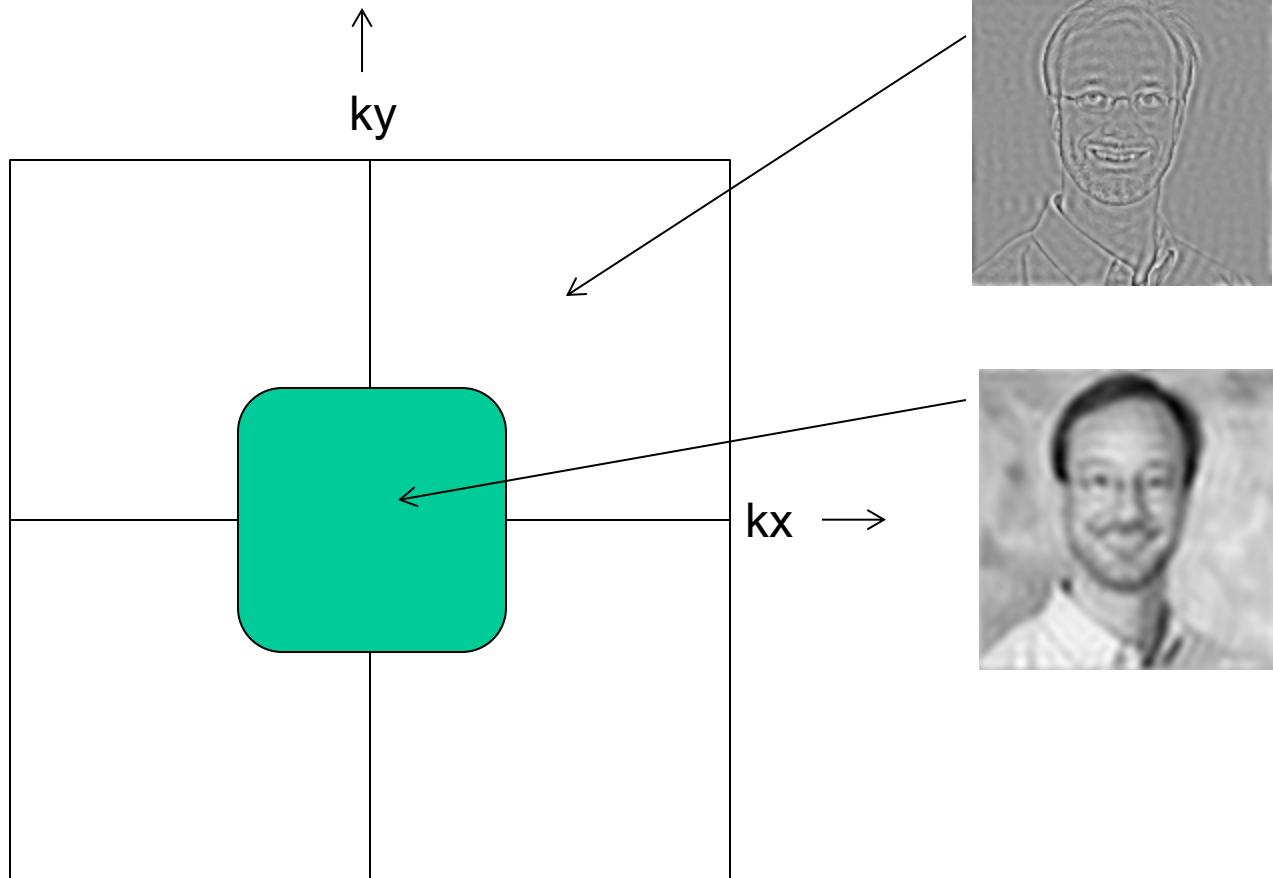


3d imaging sequences



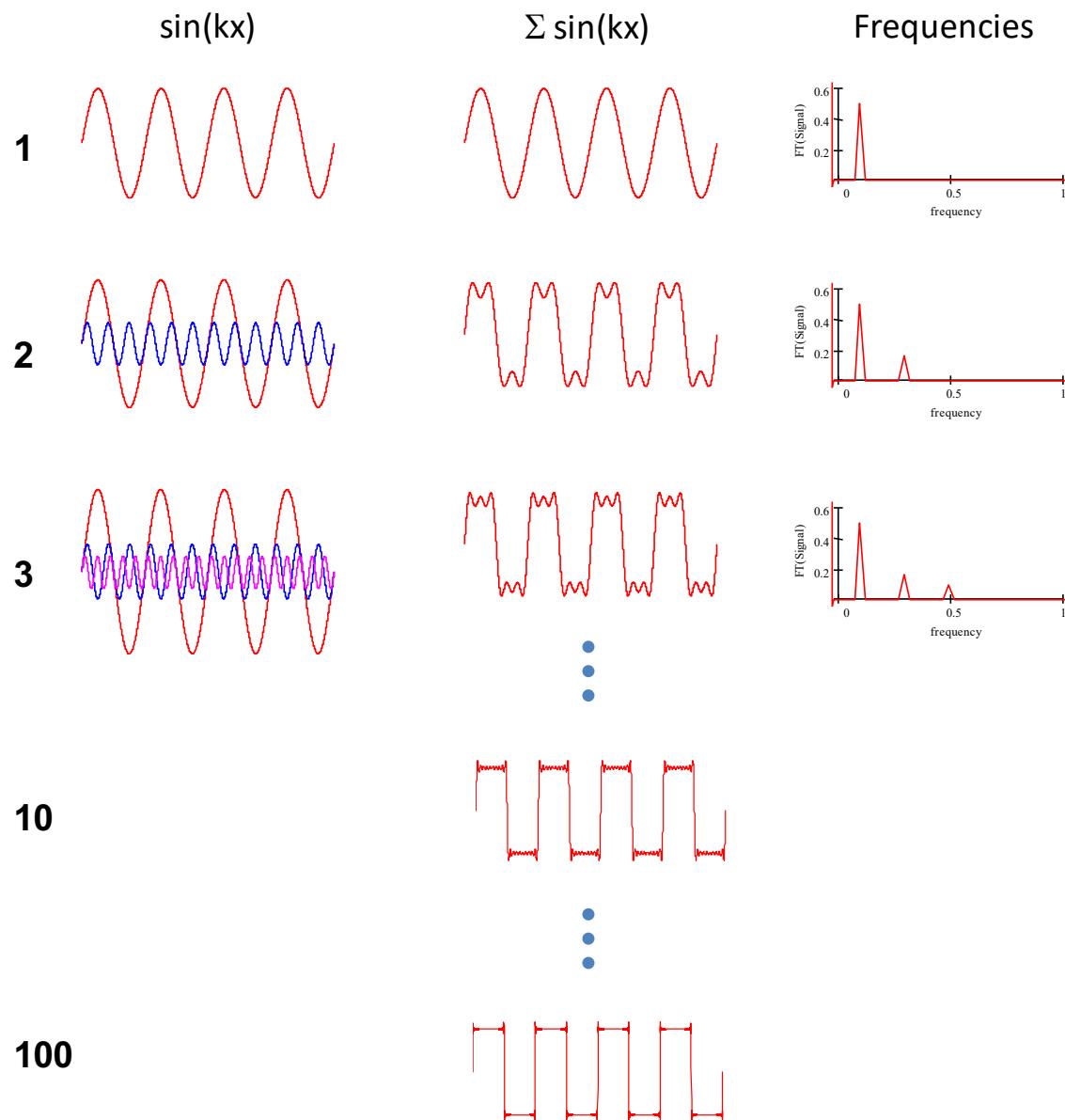


k-space properties



The sum of sines and cosines can create any other function.

For example,
a *square wave*:

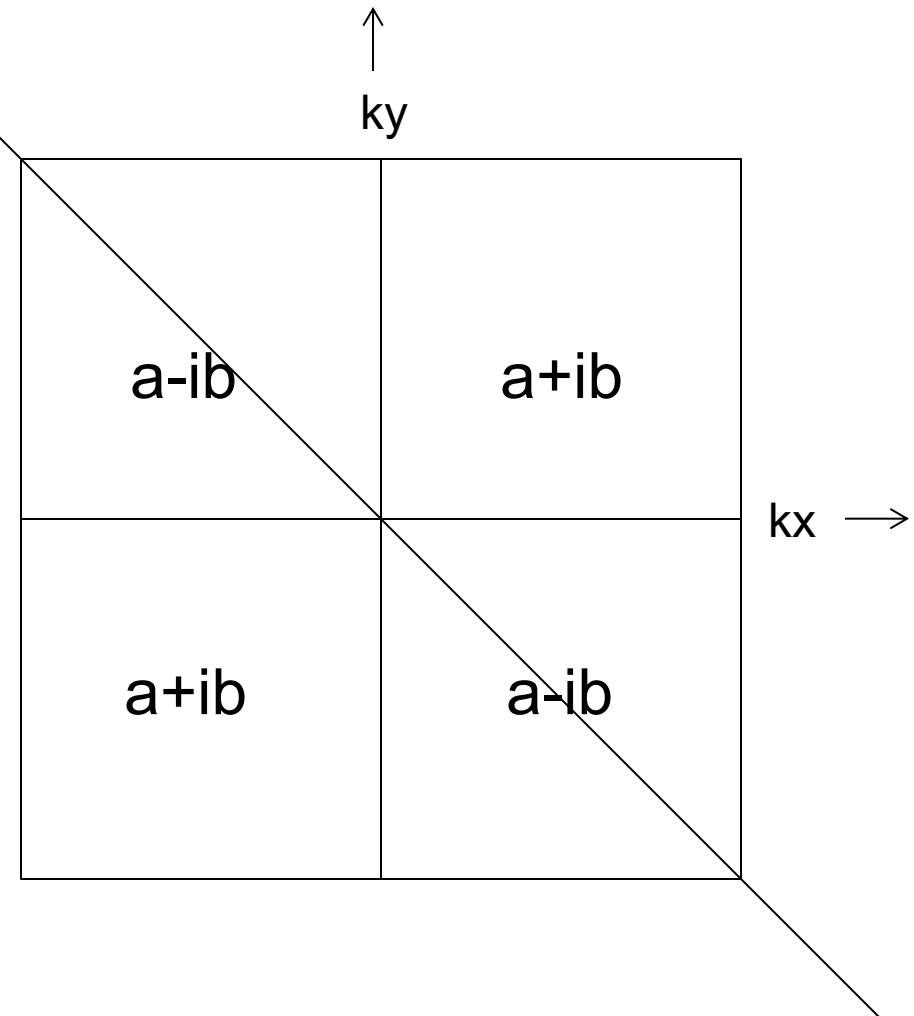
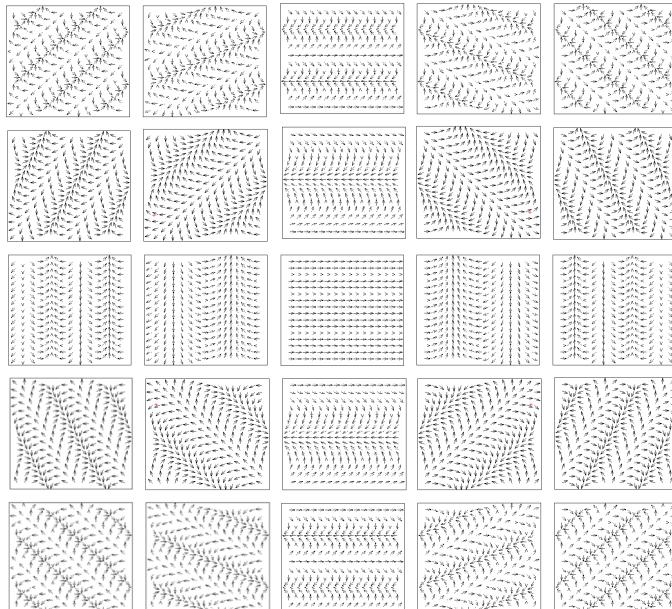


In this way, an
object can be
expressed as the
sum of different
spatial frequencies



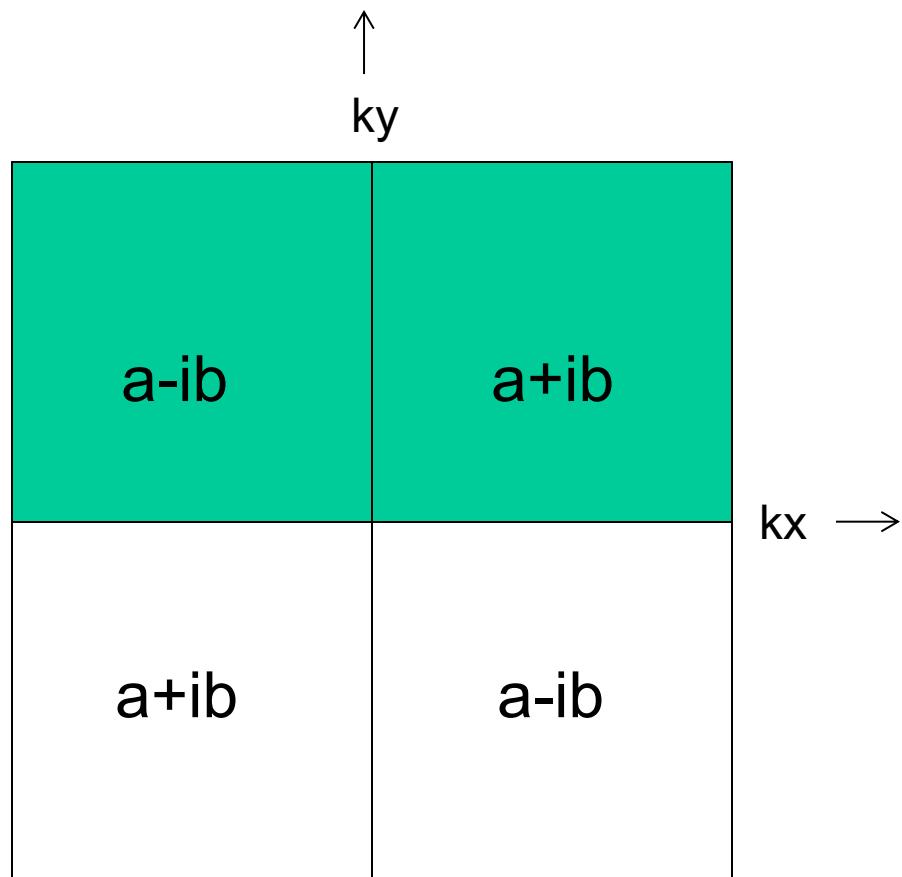
k-space properties

Complex conjugate symmetry



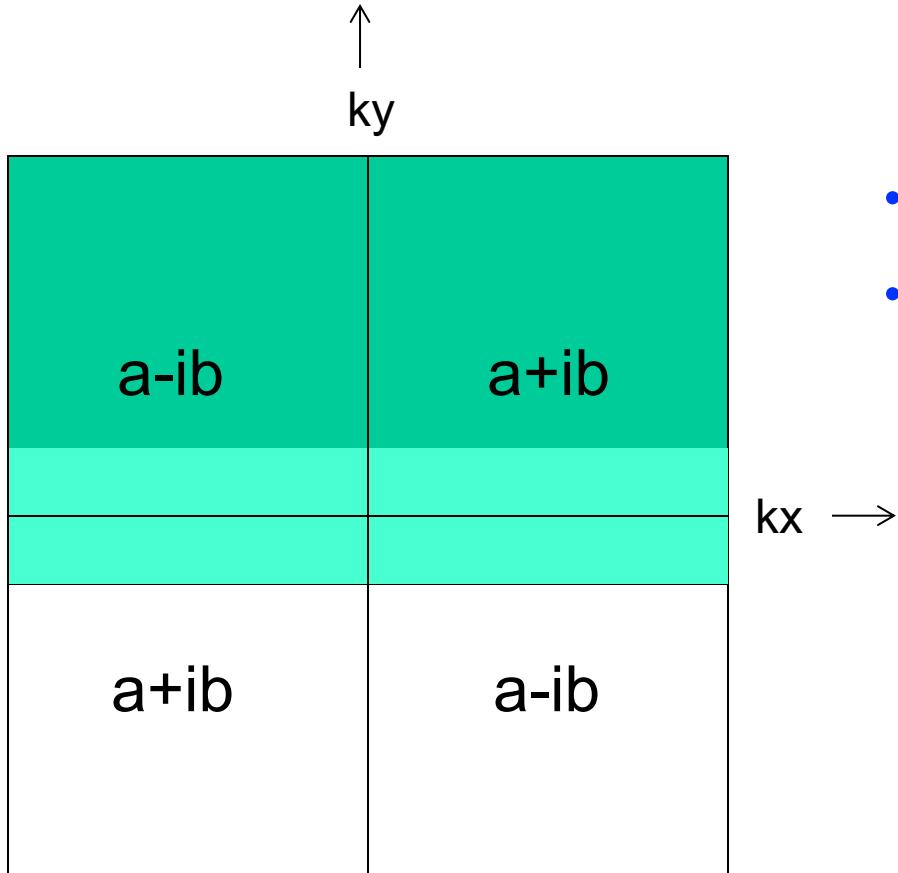


Partial k-space

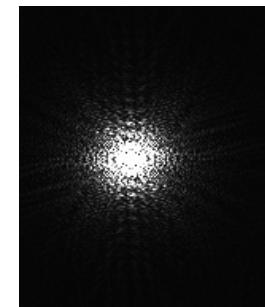




Partial k-space



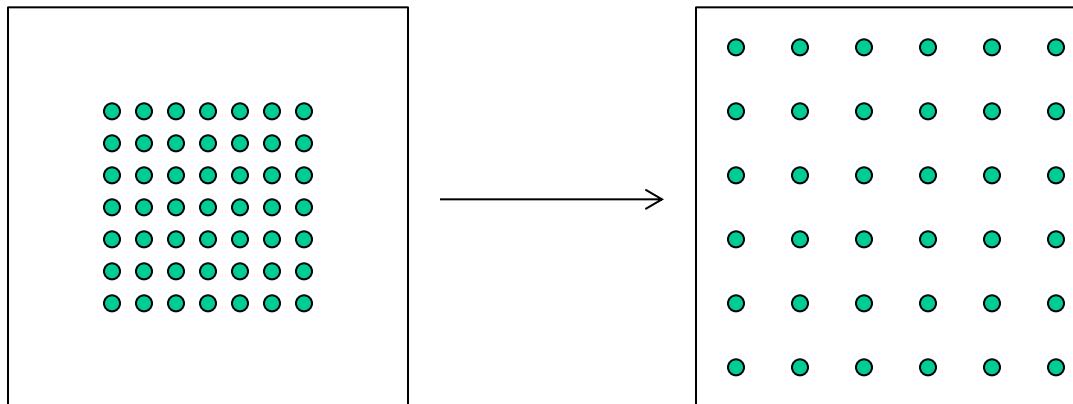
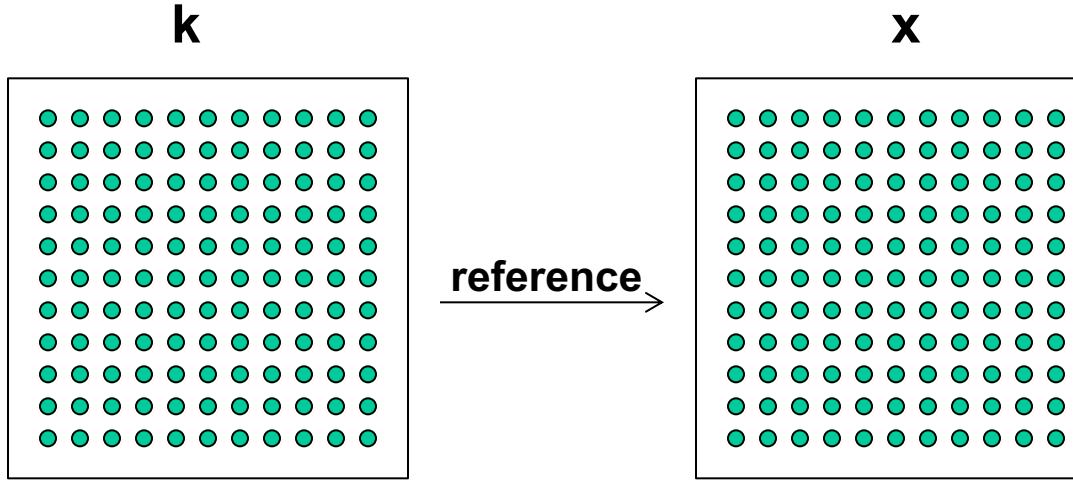
- **Imaging time:** $\downarrow f$
- **SNR:** $\downarrow \sqrt{f}$





Properties of k-space

The extent of k-space you sample determines the image resolution

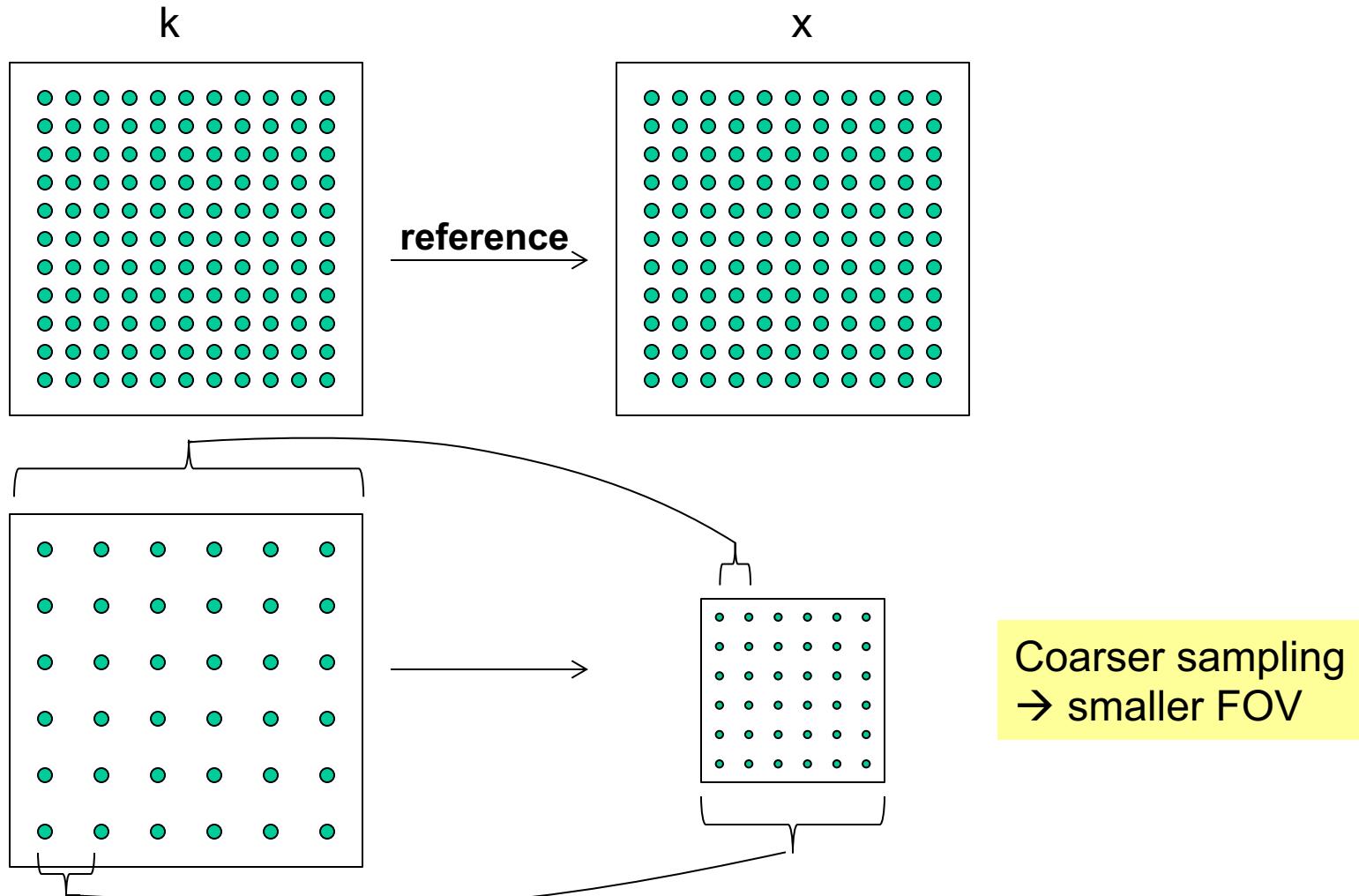


Center of k-space
= lower resolution



Properties of k-space

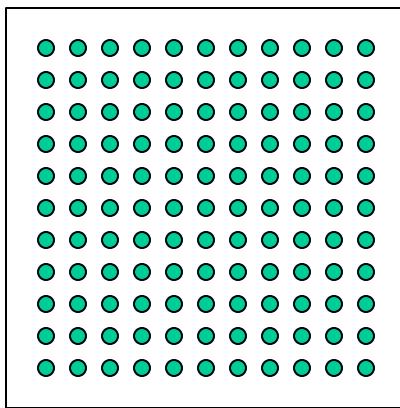
The space between samples in k-space determines the field-of-view



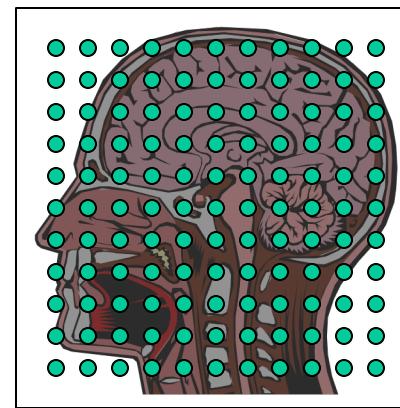


Properties of k-space

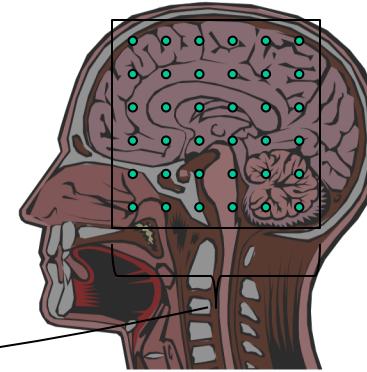
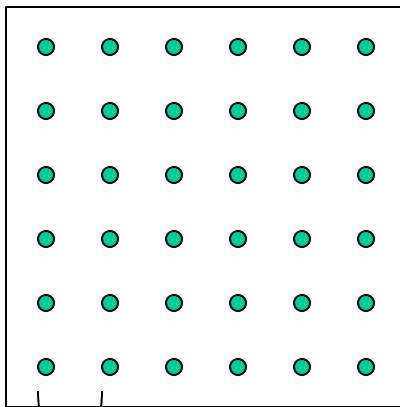
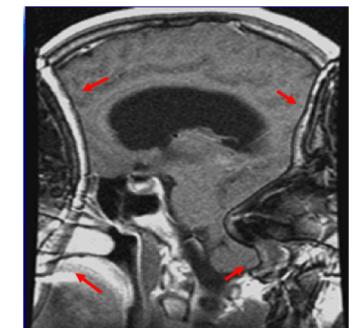
k



x



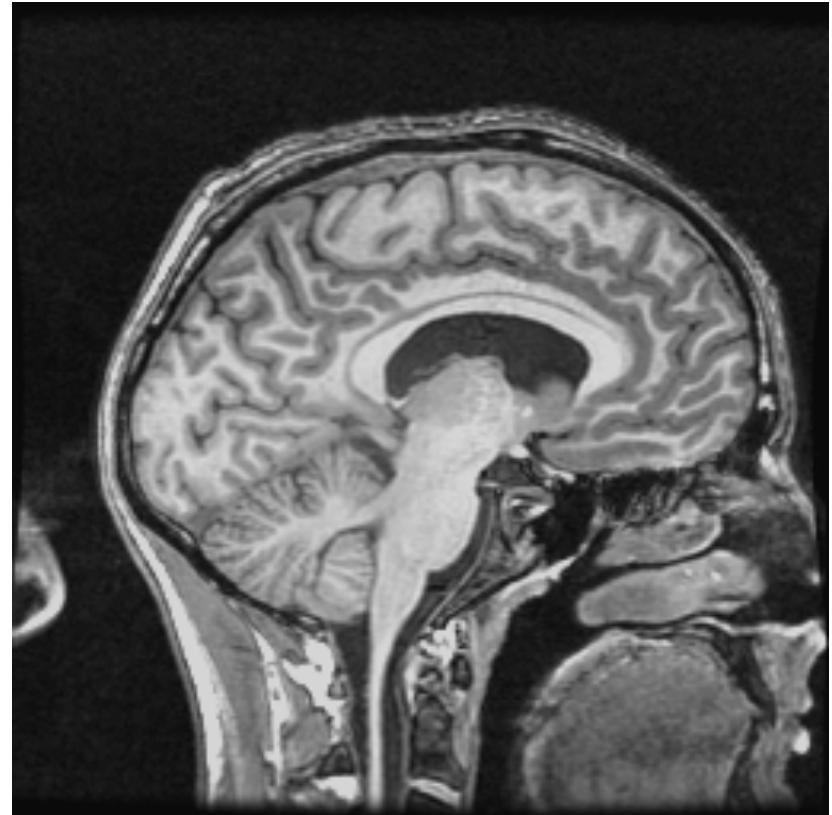
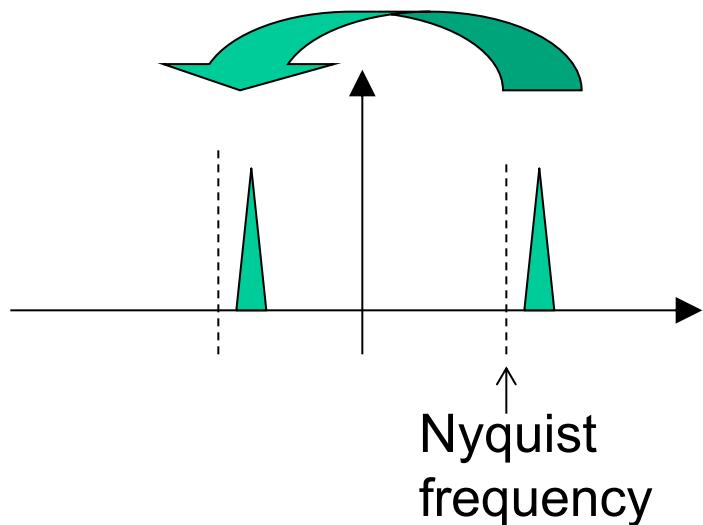
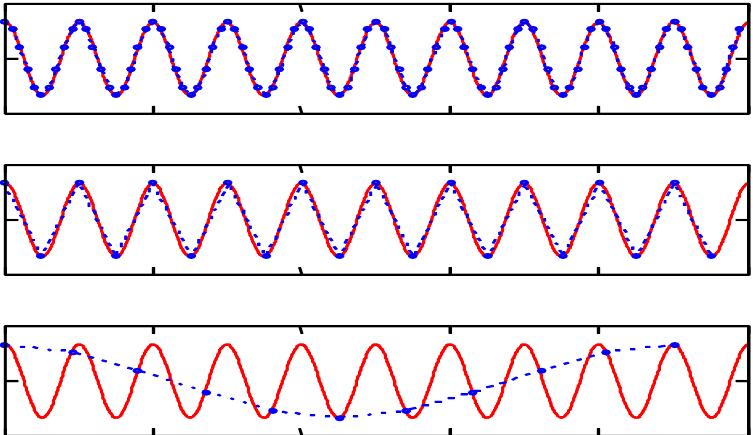
reference



Coarser sampling
→ smaller FOV



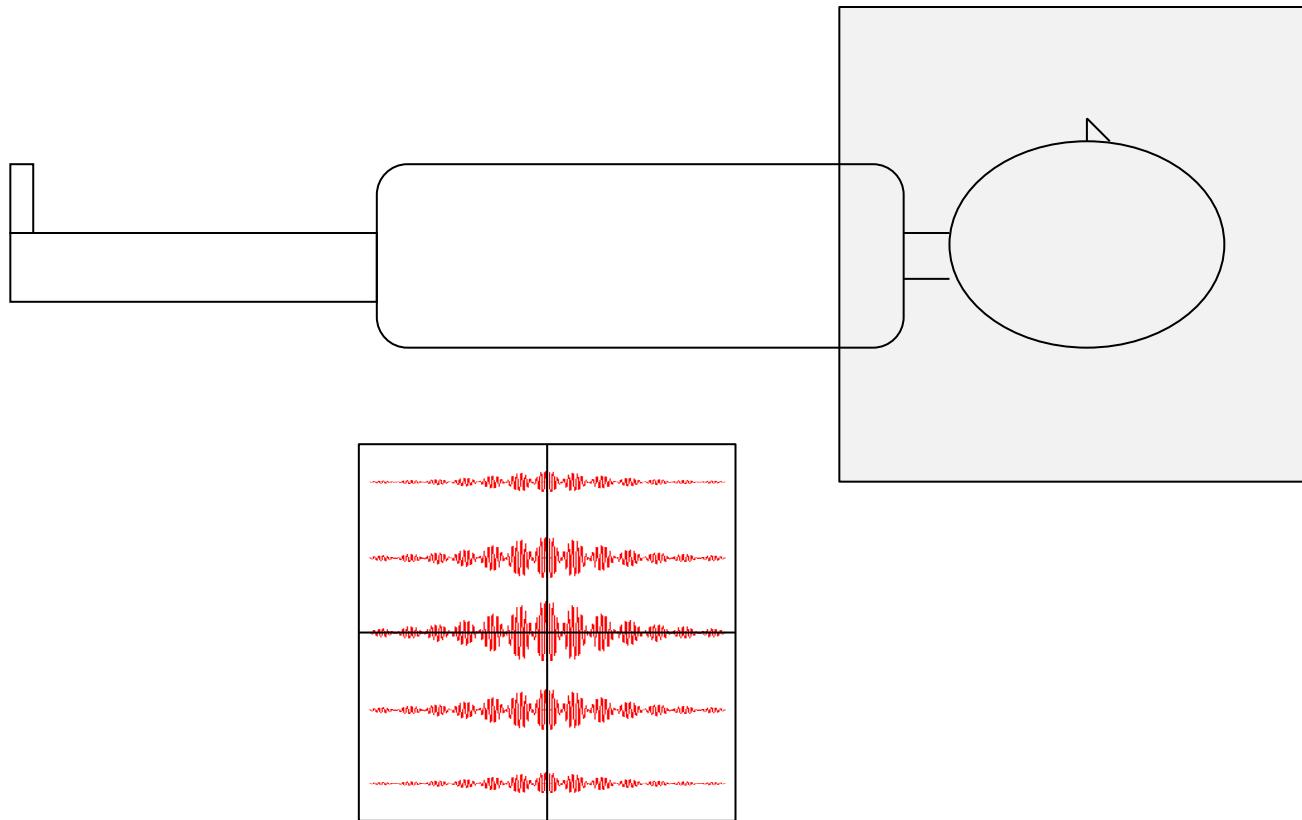
Aliasing





Aliasing

Consider sagittal slice acquisition:





Properties of k-space

