FYS-KJM 4740

MR-teori og medisinsk diagnostikk

Kap 6
k-space acceleration

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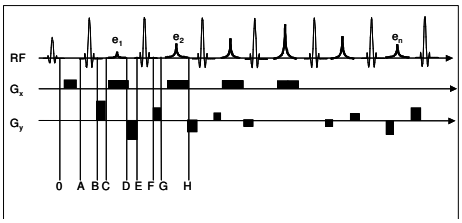
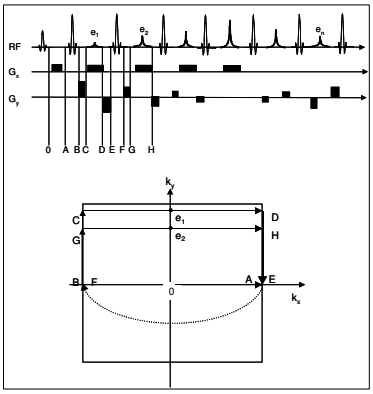
Fast Spin Echo (FSE)

Acquisition of multiple k-lines per TR

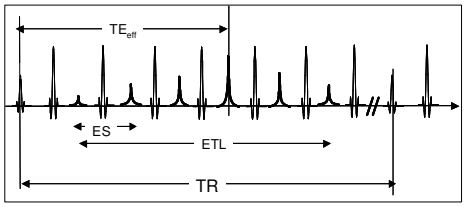
FSE



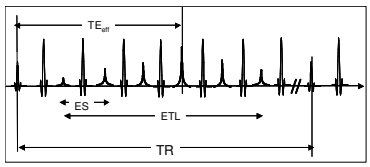
FSE



FSE – effective echo time:



FSE – echo modulation:

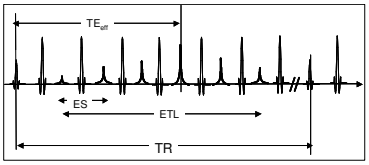


Signal (as fn of k-space line) is modulated by T2-relaxation with point-spread function given by:

$$S(P) = \int_{-k_{max}/2}^{k_{max}/2} P(k_y)\exp(-jk_y)dk_y$$

P(ETL)=exp(-ETL·ES/T2)

FSE – echo modulation:



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FSE – echo modulation:

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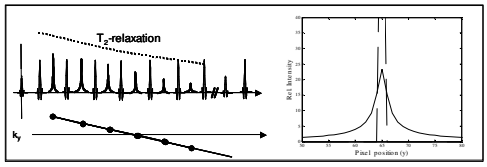
⇩ Exp T2-decay =>Lorentzian kernel

$$S(y,T2) = \frac{1/W}{1+j2y/W}$$ W=δy·2/π (ETL · ES/T2)

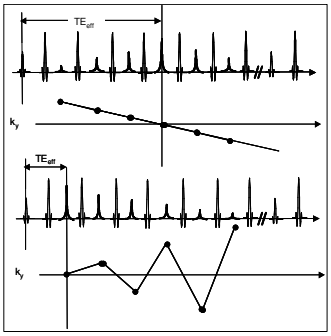
Δy= pixel dim in phase enc-dir



FSE – Different profile orders:

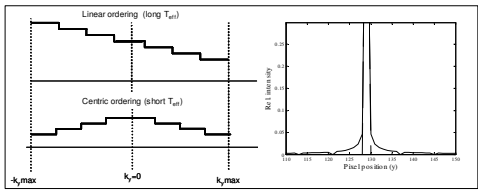
linear

centric

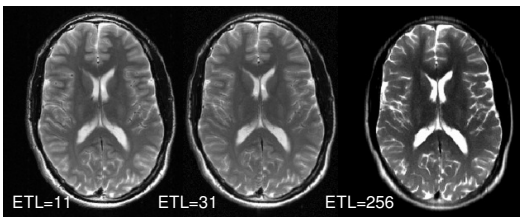


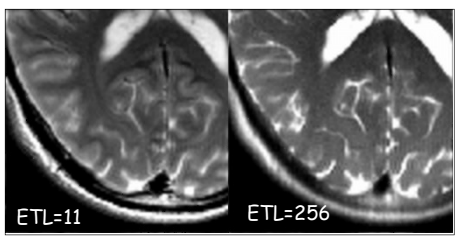
Segmented FSE:
K-space 'raster': minimizing k-space discontinuities

- group together lines with equal attenuation
- minimum step size between adjacent blocks of equally attenuated lines.



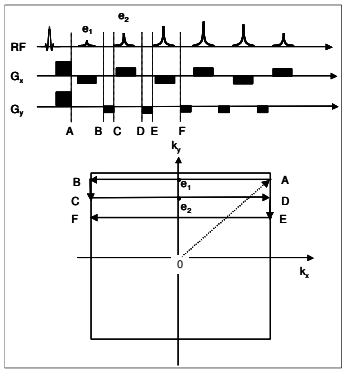
FSE :



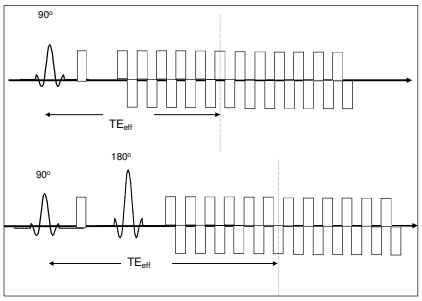


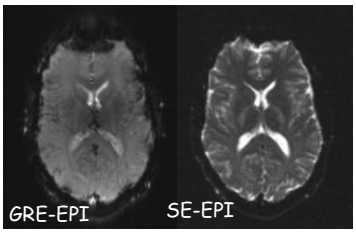
Echo Planar Imaging (EPI)

Similar to FSE but using GRE in stead of SE …



SE or GRE 'preparation'





$$\rho(x,y)=\frac{1}{2\pi}\int\int_{k_x,k_y} M_T(k_x,k_y)\exp\left(j(k_x x+k_y y)\right)\exp(-t/T2^*)\exp(-j\delta B(x,y)t)dk_x dk_y$$

$$\Im^{-1}\left\{\exp(-k/\gamma<G>T_2^*)\right\}=\frac{\gamma<G>T_2^*}{1+j\gamma<G>T_2^* x}$$

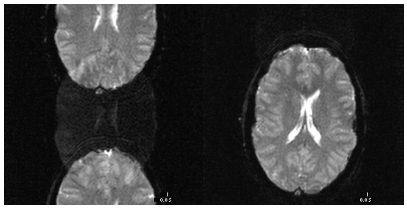
$$\Delta x = 2/(\gamma\langle G\rangle T_2^*)$$

$$\langle G_y\rangle = \langle G_x\rangle / N$$

$$\Delta y = 2N/(\gamma\langle G_x\rangle T_2^*)$$

Eddy currents:

$$B_z \cong B_0\left\{1+\frac{G_x^2 z^2}{2B_0^2}\right\}+G_x x \qquad \Delta y \cong \frac{G_x z^2 N}{2B_0}$$



Spiral imaging

Trajectory for m^{th} segment:

$\mathbf{k}(t) = A\varphi(t)\exp(j\varphi(t) + jm\varphi_0)$; $\varphi(t) = t\pi/N$