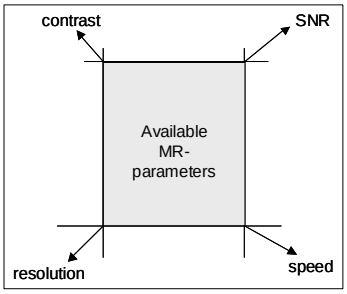
FYS-KJM 4740

MR-teori og medisinsk diagnostikk

Kap 8
Image quality, signal, contrast and noise



Signal induced in received coil with N turns
(ignoring effect of sequence parameters)

$$S(t) = \omega_0 N \int_v M_T(r) \exp(-jk(t)r) dr + n(t)$$

;n(t)=complex noise term

Noise-independent signal from a voxel of volume V_h
(Macovski A. Magn Reson Med 1996)

$$M_{sig} = \omega_0^{\,2} N \chi V_h / \gamma$$

Signal-Noise ratio (single voxel, one measurement)

$$SNR = \frac{\omega_0^{\,2} N \chi V_h}{\sqrt{2kT \cdot R / T_r}}$$

N=No of coil terms, χ=tissue susceptibility, k=Boltzmanns const, T=temp, Tr=read-out time (time to record echo), R=coil resistance,

Does SNR scale with B_o^2 ?
(probably not in reality)

Coil resistance R, complex function of B_o

SNR also function of sequence parameters and Q-factor of coil (Q=ωL/R)

$$SNR = A \cdot \sqrt{\frac{QB_0^{\,3} N_{SA} \cdot N_y N_s}{BW}} V_h \cdot \mathrm{S(TR, TE, \alpha, T1, T2, T2^*, \rho)}$$

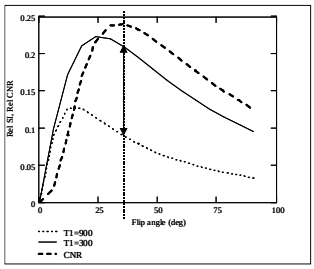
A=constant (susceptibility, temp, object geometry, size etc)
BW=pixel bandwidth=$1/T_r$
NSA=number of averages
Ny=number of phase encoding steps; Ns=number of slice enc steps (=1 for 2D)

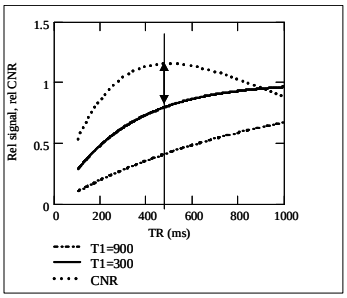
Signal vs contrast

$$CNR = SNR_A - SNR_B = \frac{S(A) - S(B)}{\sigma}$$

σ = image noise (assumed position independent)

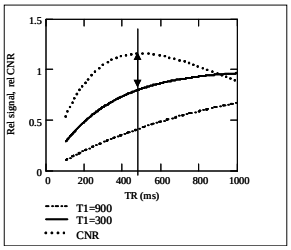
Signal vs contrast (T1.GRE)



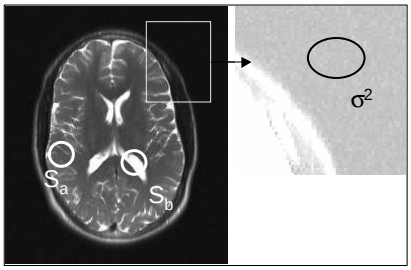


Signal vs contrast (SE)

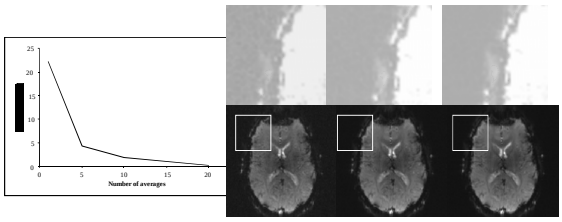
$$TR_{opt} = \frac{T1_1 T1_2}{T1_1 - T1_2} \cdot \ln(T1_1 / T1_2)$$



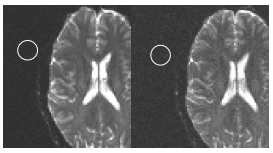
Practical measurement of SNR



Effect of NSA on SNR

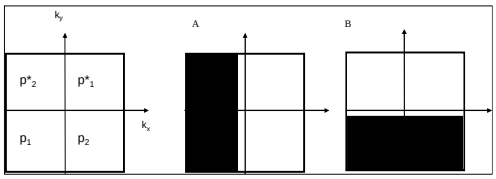


Effect of BW on SNR

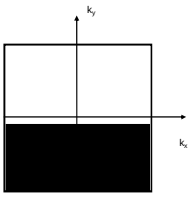


BW=750 Hz BW=2055 Hz

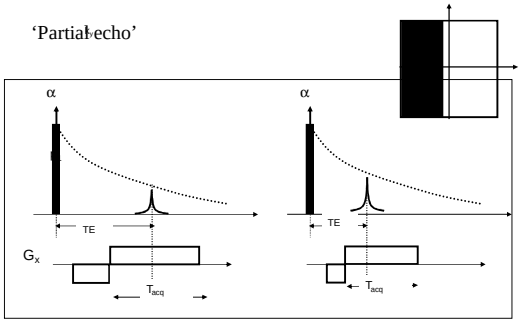
Partial k-space sampling



'Half-scan' (partial Fourier)



'Partial echo'



Rectangular field of view (rFoV)