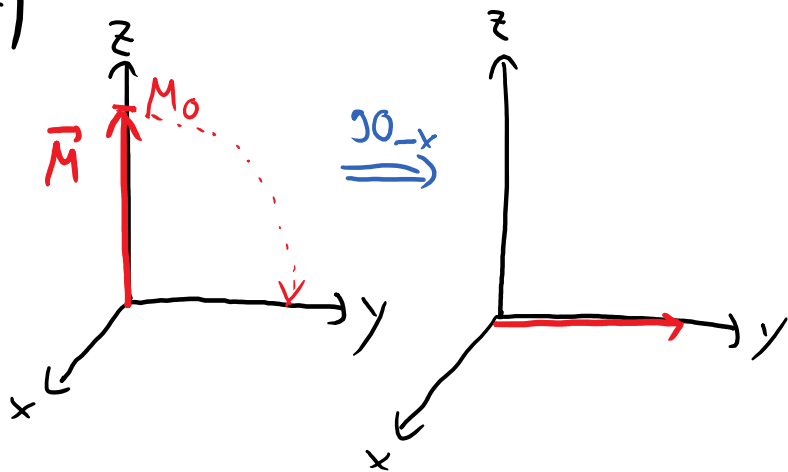


Gezielte Manipulation der Magnetisierung:

90° -Puls ($\frac{\pi}{2}$ -Puls)

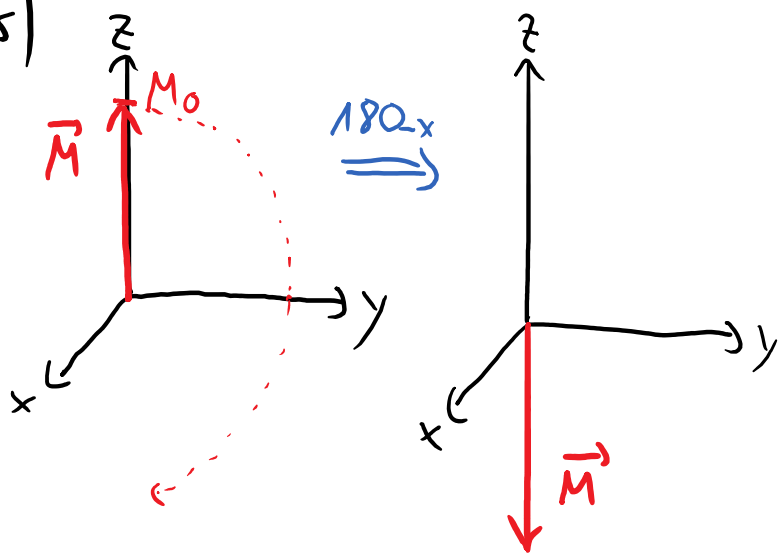
Rotiert \vec{M} 90° um
Pulsachse (hier $-x$)



180° -Puls (π -Puls)

Rotiert 180° um
Pulsachse

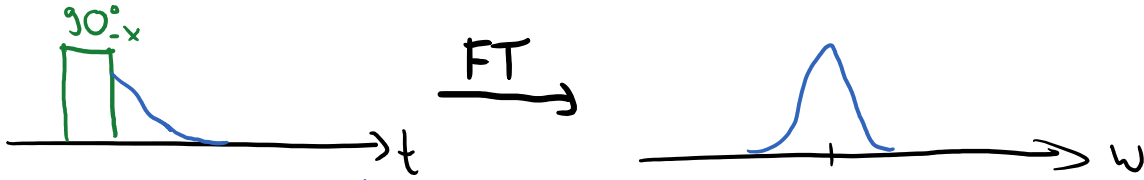
\Rightarrow Inversionspuls



Pulse können kombiniert werden, um komplexe Rotationen innerhalb der "Bloch-Kugel" durchzuführen.

\rightarrow Vielzahl möglicher Experimente.

Das Ein-Puls-Experiment (\rightarrow FID)

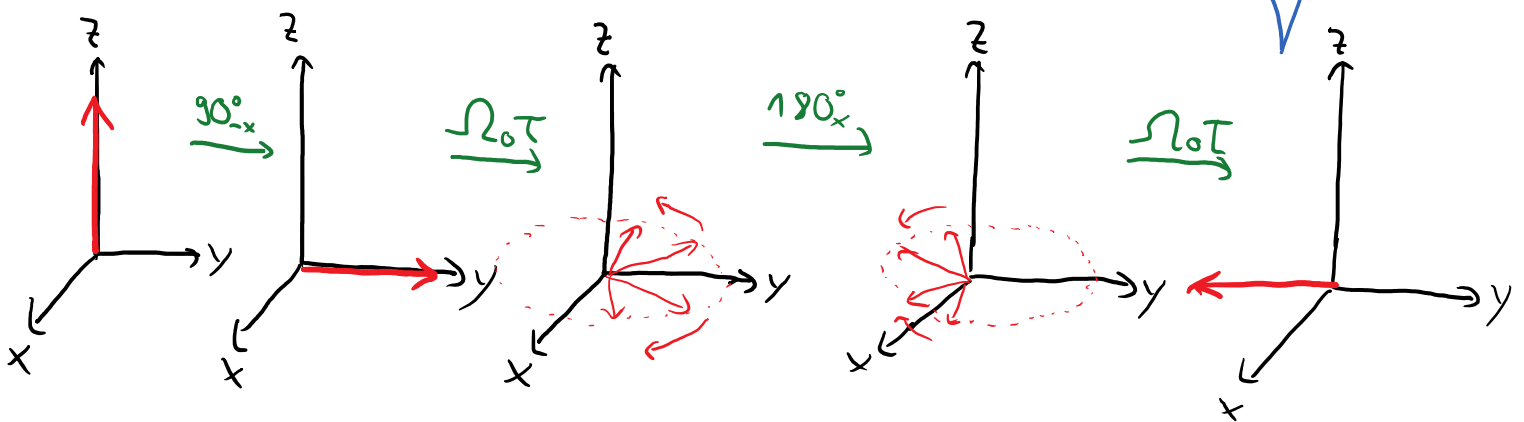
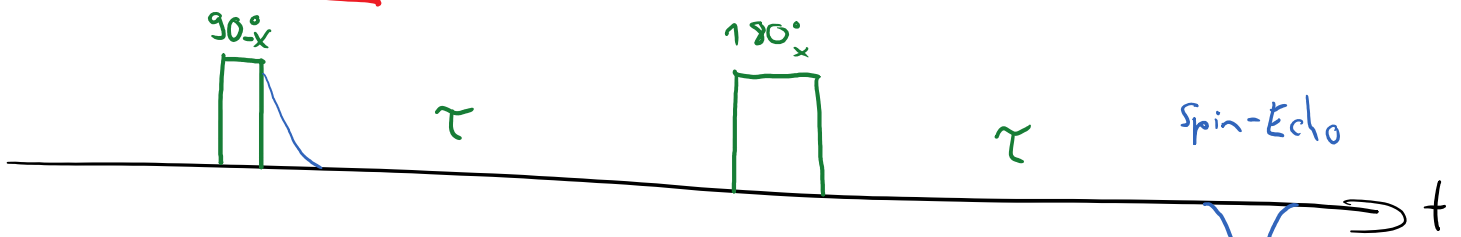


Freie Entwicklung und Zerfall der transversalen Magnetisierung in RKS \xrightarrow{FT} Information über Ω_0

Problem: sehr schneller Zerfall durch Inhomogenität

Detektor muss während Puls und Ring-down geschützt werden \rightarrow blind für FID. (Totzeit ca. 100ns.)

Hahn Echo (Erwin Hahn)



Hahn-Echo refokussiert Inhomogenität

aber: Magnetisierung unterliegt während gesamte Evolutionszeit (d.h. 2τ) transversaler Relaxation!

Relaxation

(ohne μ_w -Feld)

$$\dot{M}'_x(t) = \Omega_0 M'_y - \frac{M'_x(t)}{T_2}$$

$$\dot{M}_z(t) = -\frac{M_z(t) + M_0}{T_1}$$

Lösungen: $M'_x(t) = M'_x(0) \cos(\Omega_0 t) \cdot e^{-\frac{t}{T_2}}$

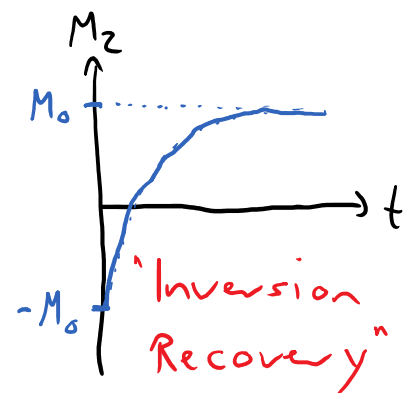
$$M_z(t) = M_0 - [M_0 - M_z(0)] \cdot e^{-\frac{t}{T_1}}$$

2 Szenarien: (für $\Omega_0 = 0$)

- 180°-Puls aus GGLW: $M'_x(0) = 0$
 $M_z(0) = -M_0$

$$\rightarrow M'_x(t) = 0$$

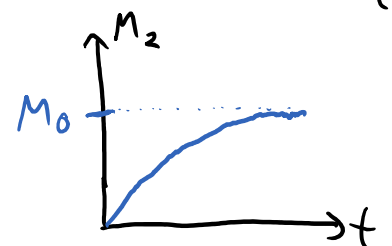
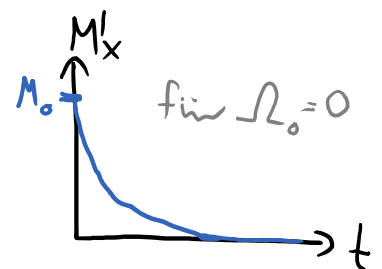
$$M_z(t) = M_0 \left[1 - 2 \exp\left(-\frac{t}{T_1}\right) \right]$$



- 90°-Puls aus GGLW: $M'_x(0) = M_0$
 $M_z(0) = 0$

$$\rightarrow M'_x(t) = M_0 \exp\left(-\frac{t}{T_2}\right)$$

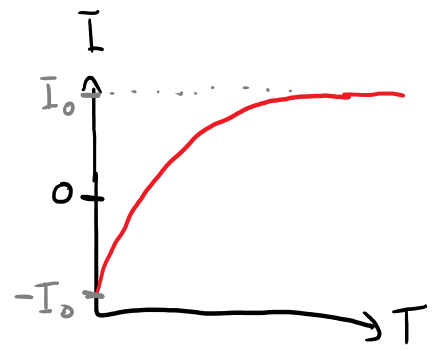
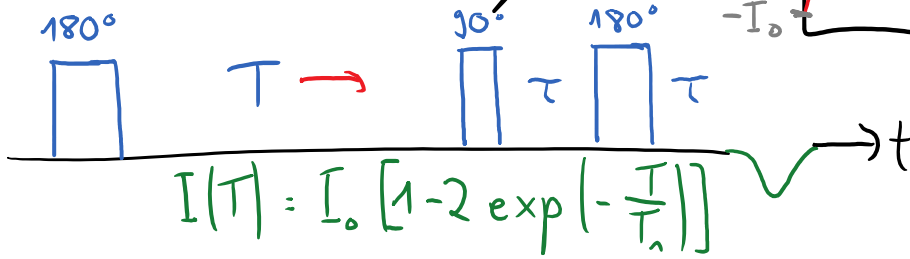
$$M_z(t) = M_0 \left[1 - \exp\left(-\frac{t}{T_1}\right) \right]$$



Messung Relaxationszeiten

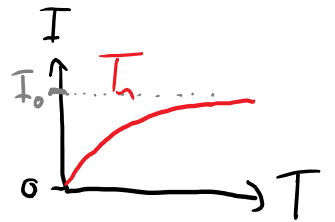
Tuesday, December 19, 2017 11:32 AM

T_1 : Inversion Recovery

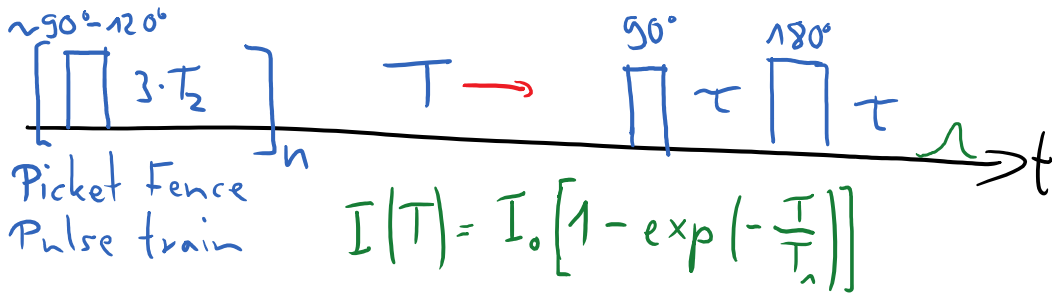


Saturation Recovery

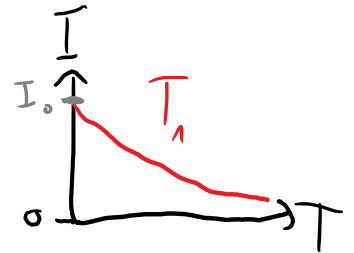
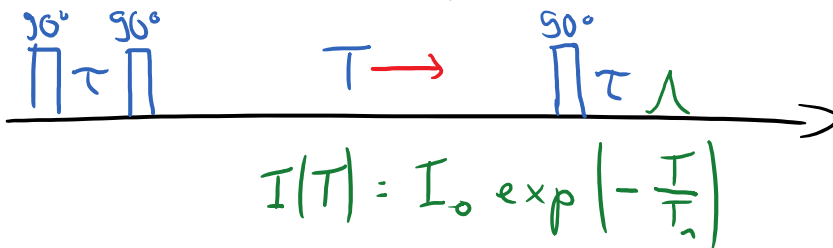
low power pulse
high turning angle (HTA)



$\sim 90^\circ - 120^\circ$
Picket Fence
Pulse train



Stimuliertes Echo



T_2 : Hahn Echo

