

(1) According to the class content, the magnitude of the signal excited by FLASH at a small angle is related to the T1 value of the tissue and the Flip angle. Please refer to the figure below to **simulate the timing of Mxy and Mz** when changing the flip angle to 15, 30, 45, 60, 75, 90 degrees, TR = 50 ms, T1 = 1000 ms, T2\* = 50ms

事實上信號強度的公式是

$$M_z = M_{z0} \times \frac{(1 - e^{-TR/T1}) \sin \alpha}{1 - e^{-TR/T1} \cos \alpha} e^{-TE/T2^*}$$

• 信號正比於

•  $\alpha$ : 偏折角

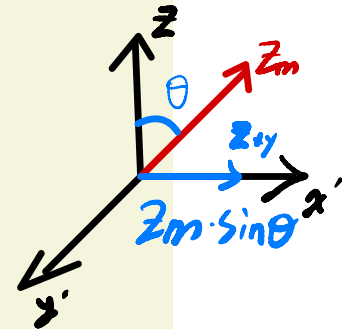
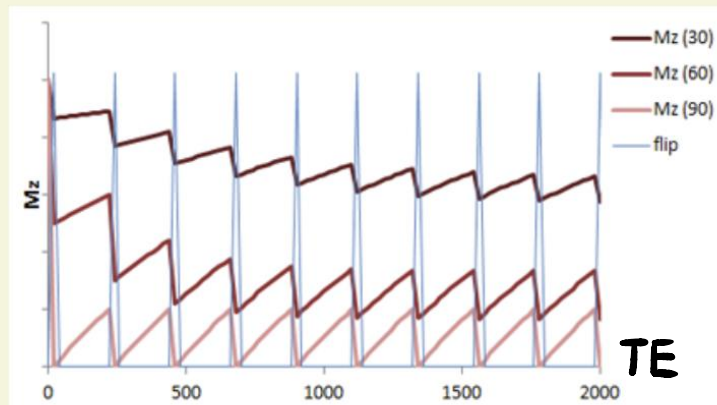


Illustration of the recovery of longitudinal magnetization in a GRE sequence with short TR and varying flip angles over successive applications of the pulse sequence. Given the short TR, there is not much time for the longitudinal magnetization ( $M_z$ , red) to recover. Using small flip angles (e.g. 30 degrees, 60 degrees) allows a larger fraction of the longitudinal magnetization to remain, so recovery is shorter. The 90 degree flip angle gives the lowest amount of signal (light red).

(2) There are two tissues,  $T1 = 1000$  ms,  $1100$  ms,  $T2^* = 50$ ms, in the case of  $TR = 100$  ms, **what flip angle should we choose to use to obtain the maximum MRI image brightness difference between the two tissues?**

(3) 現有一筆實驗資料利用 **MPRAGE** 技術取得 **T1-weighted image**。資料描述如下：<https://brain-development.org/ixi-dataset/>

經過知名軟體 **FreeSurfer** 分析過後，獲得**大腦分區切割**。可經由下列連結下載。[https://mri.ee.ntust.edu.tw/data/IXI\\_aseg.zip](https://mri.ee.ntust.edu.tw/data/IXI_aseg.zip)

而分區資料編碼如下表所示。

(a)

請你計算出這些受試者的**大腦皮質下(Subcortical structures)**部份的**分區體積**。並根據原始網站所提供之受試者資訊(Demographic information)。嘗試探討皮質下**各分區體積與受試者資訊之相關性**。例如 Hippocampus 與受試者年紀是否相關？

(b)

Label No.	Structure Name	Label No.	Structure Name
4	Left-Lateral-Ventricle	50	Right-Caudate
5	Left-Inf-Lat-Vent	51	Right-Putamen
7	Left-Cerebellum-White-Matter	52	Right-Pallidum
8	Left-Cerebellum-Cortex	53	Right-Hippocampus
10	Left-Thalamus-Proper	54	Right-Amygdala
11	Left-Caudate	58	Right-Accumbens-area
12	Left-Putamen	60	Right-VentralDC
13	Left-Pallidum	62	Right-vessel
14	3rd-Ventricle	63	Right-choroid-plexus
15	4th-Ventricle	72	5th-Ventricle
16	Brain-Stem	77	WM-hypointensities
17	Left-Hippocampus	78	Left-WM-hypointensities
18	Left-Amygdala	79	Right-WM-hypointensities
24	CSF	80	non-WM-hypointensities
26	Left-Accumbens-area	81	Left-non-WM-hypointensities
28	Left-VentralDC	82	Right-non-WM-hypointensities
30	Left-vessel	85	Optic-Chiasm
31	Left-choroid-plexus	251	CC_Posterior
43	Right-Lateral-Ventricle	252	CC_Mid_Posterior
44	Right-Inf-Lat-Vent	253	CC_Central
46	Right-Cerebellum-White-Matter	254	CC_Mid_Anterior
47	Right-Cerebellum-Cortex	255	CC_Anterior
49	Right-Thalamus-Proper		