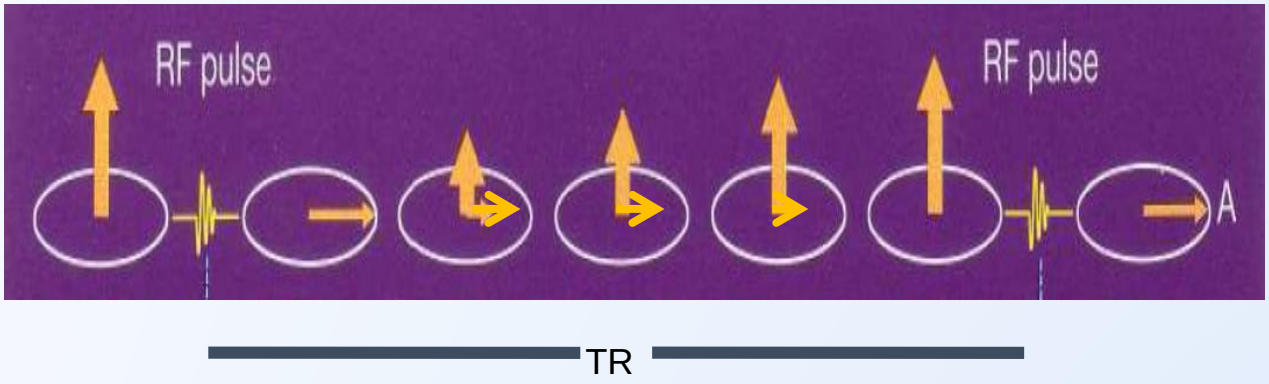
Lesson 5 (A): TR and TE

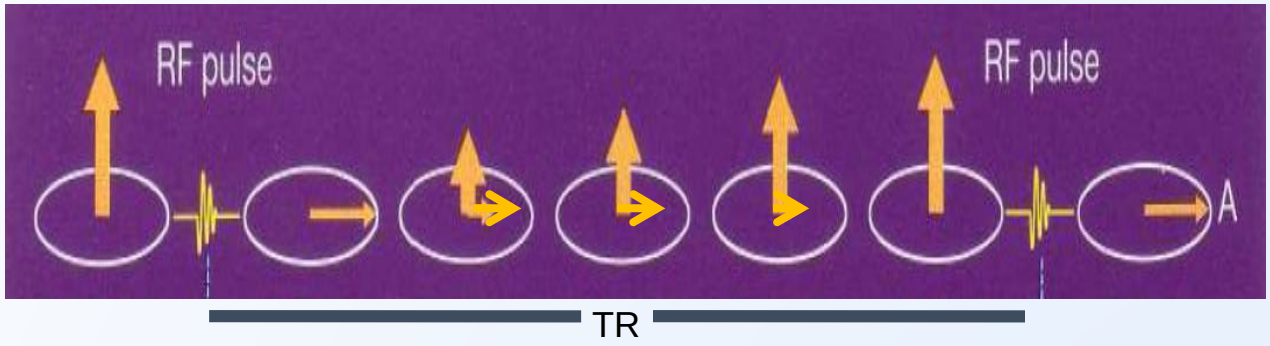
Aims

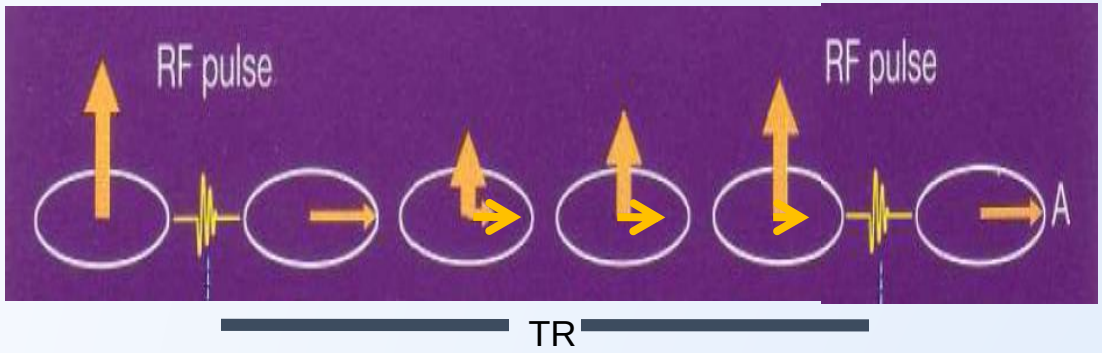
- Learning the following topics about TR and TE parameters:
- Definition of TR
- Received signal and TR
- Definition of TE
- Received signal and TE

Repetition time (TR)

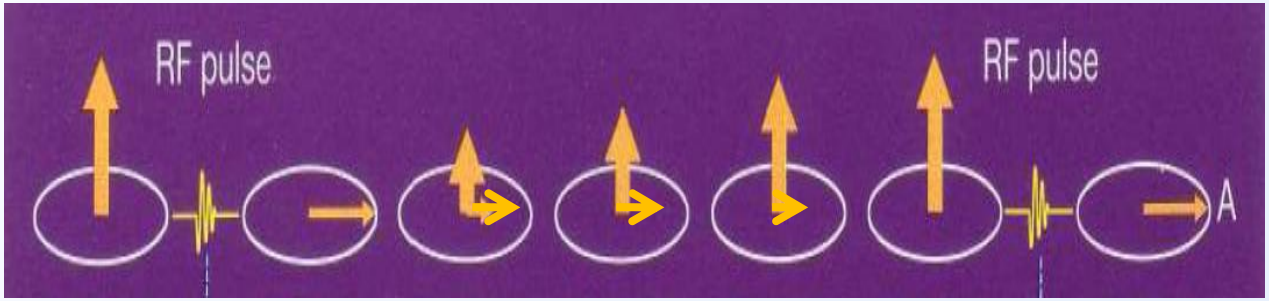


Repetition time (TR)





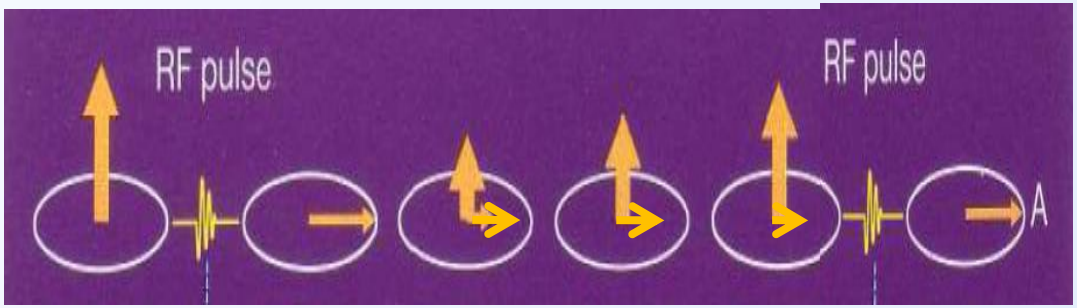
Repetition time (TR)



TR

Mz=M0

Mz max



TR

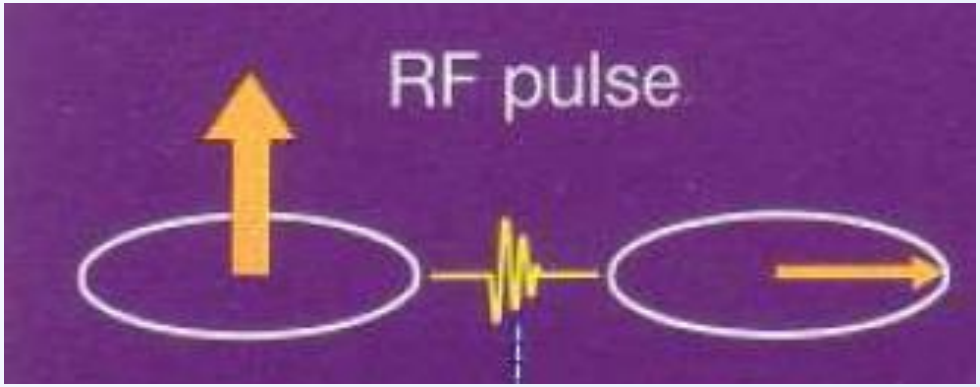
Mz=M0

Mz < M0

Mz and TR

- What is the magnitude of the magnetization vector Mz at the time TR?
- Because $Mz(t) = M0 (1 - e^{-t/T1})$
- at $t = TR$
- $Mz (TR) = M0 (1 - e^{-TR/T1})$

Mz and Mxy



Received Signal and TR

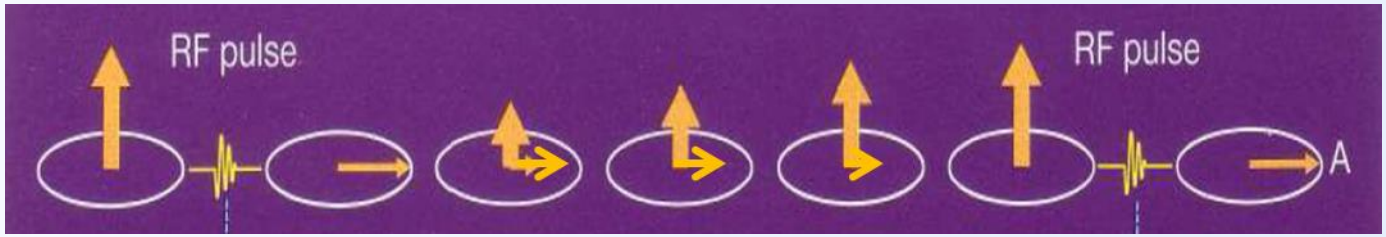
- Longer TR → ……. signal
- stronger

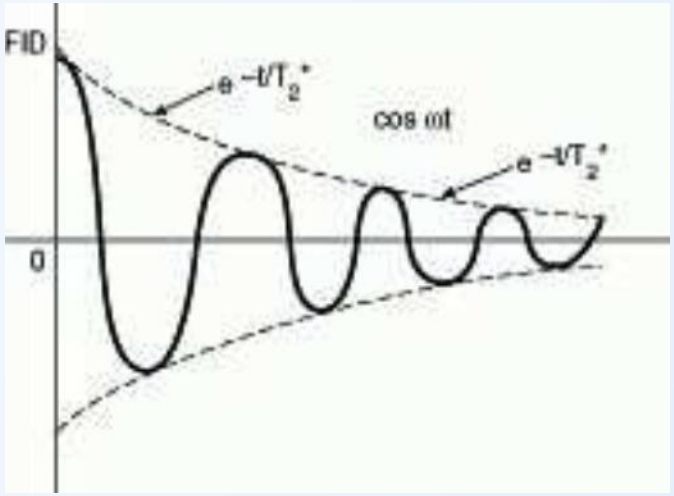
Received Signal

- $S \propto N(H)\ (1 - e^{-TR/T1})$
- S: signal
- N(H): proton density
- TR: repetition time
- T1: longitudinal relaxation time
- For a given tissue, the T1 and the proton density are constant.

Received Signal

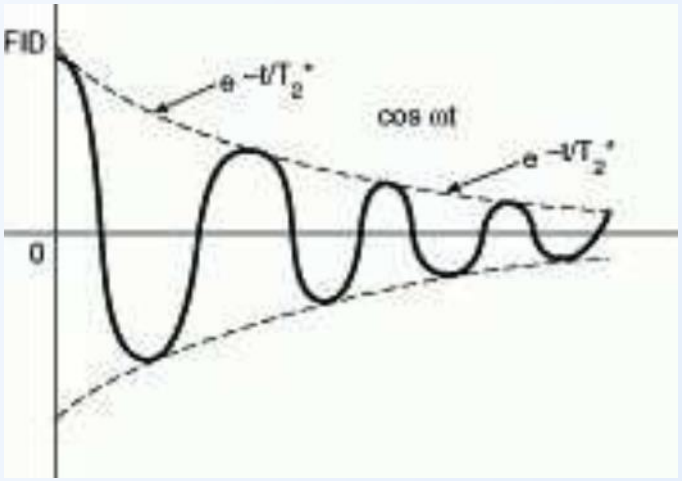
- If we measure the FID at time TR immediately after the application of the second 90° RF pulse, it will be .....
- maximum.





Received Signal

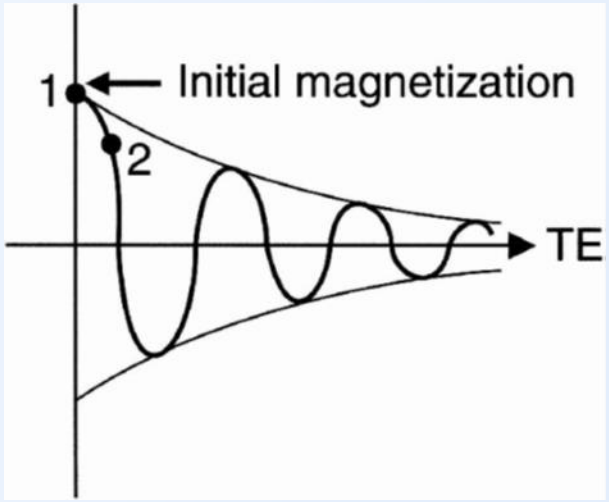
- Can we measure the maximum FID?
- In reality, we have to wait a certain period until the system electronics allows us to make a measurement.



TE

- Instead of making the measurement immediately after the RF pulse (which we could not do anyway), we wait a short period of time and then make the measurement.
- This short time period is referred to as TE.

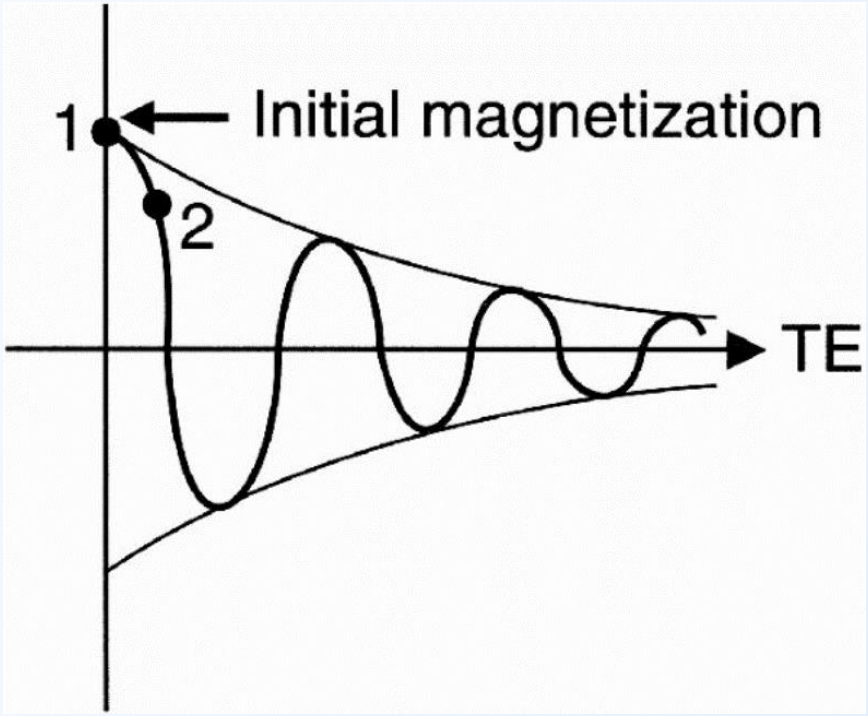
- TE:
- Echo Delay Time
- Time to Echo
- Echo Time



- TE and minimum TE

TE

- Longer TE → …… signal
- weaker



Signal intensity

- $S \propto M0\ (1 - e^{-TR/T1})\ (e^{-TE/T2})$
- Since M0 is proportional to the number of mobile protons, i.e., $M0 \propto N(H)$ →
- The signal intensity we measure is given by:
- $S \propto N(H)\ (1 - e^{-TR/T1})\ (e^{-TE/T2})$

Summary

- TR
- TE
- Received signal, TR and TE

Reference

- Hashemi, RH and Brandy, WG. MRI the Basics, Second Edition