Basic Pulseq Tutorial

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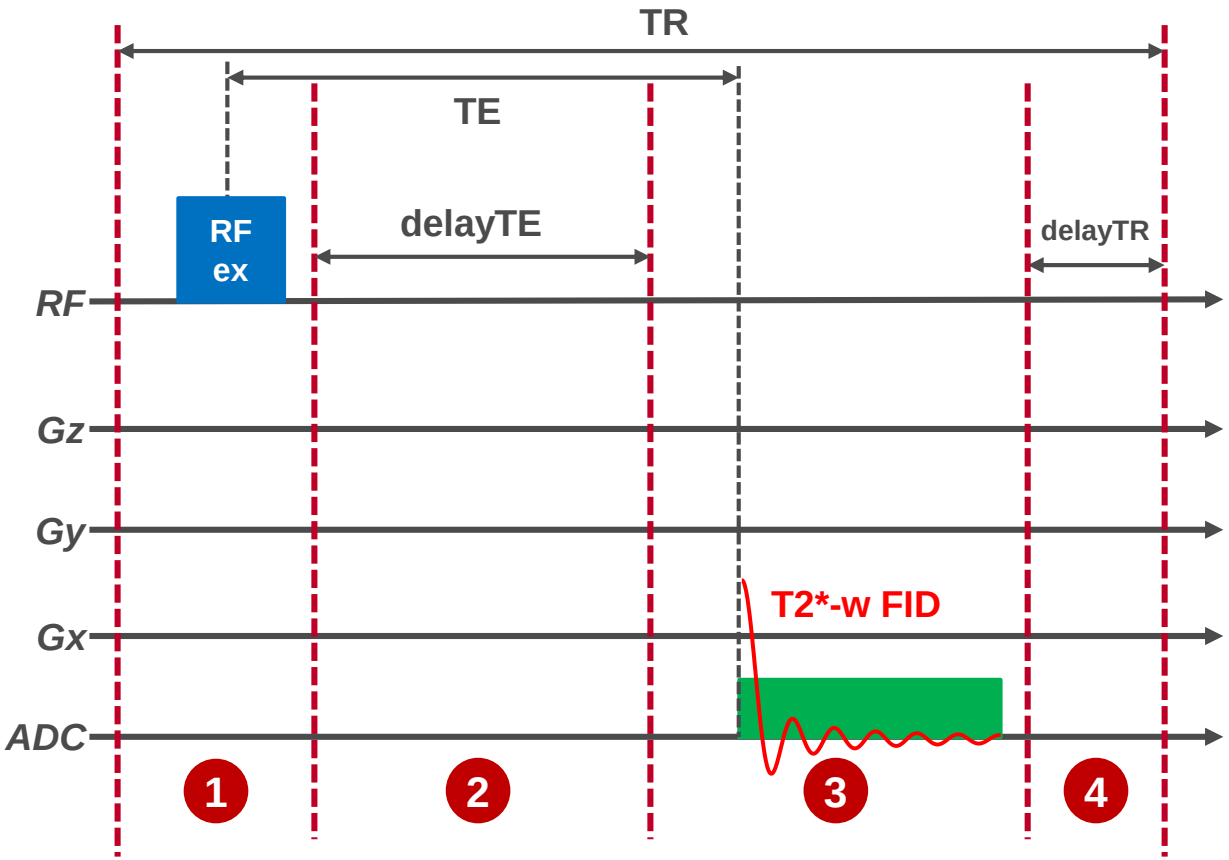
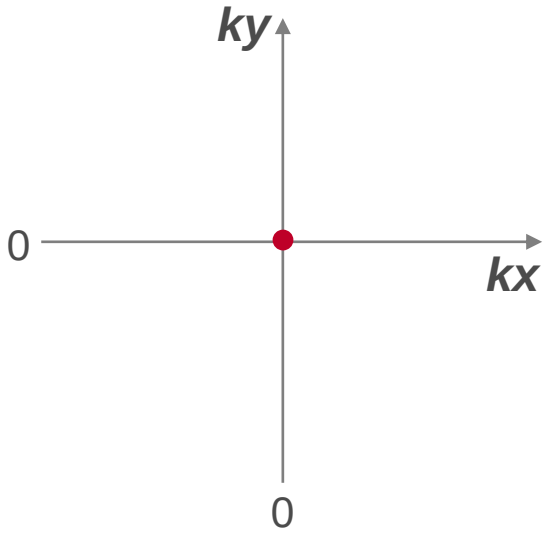
Outline

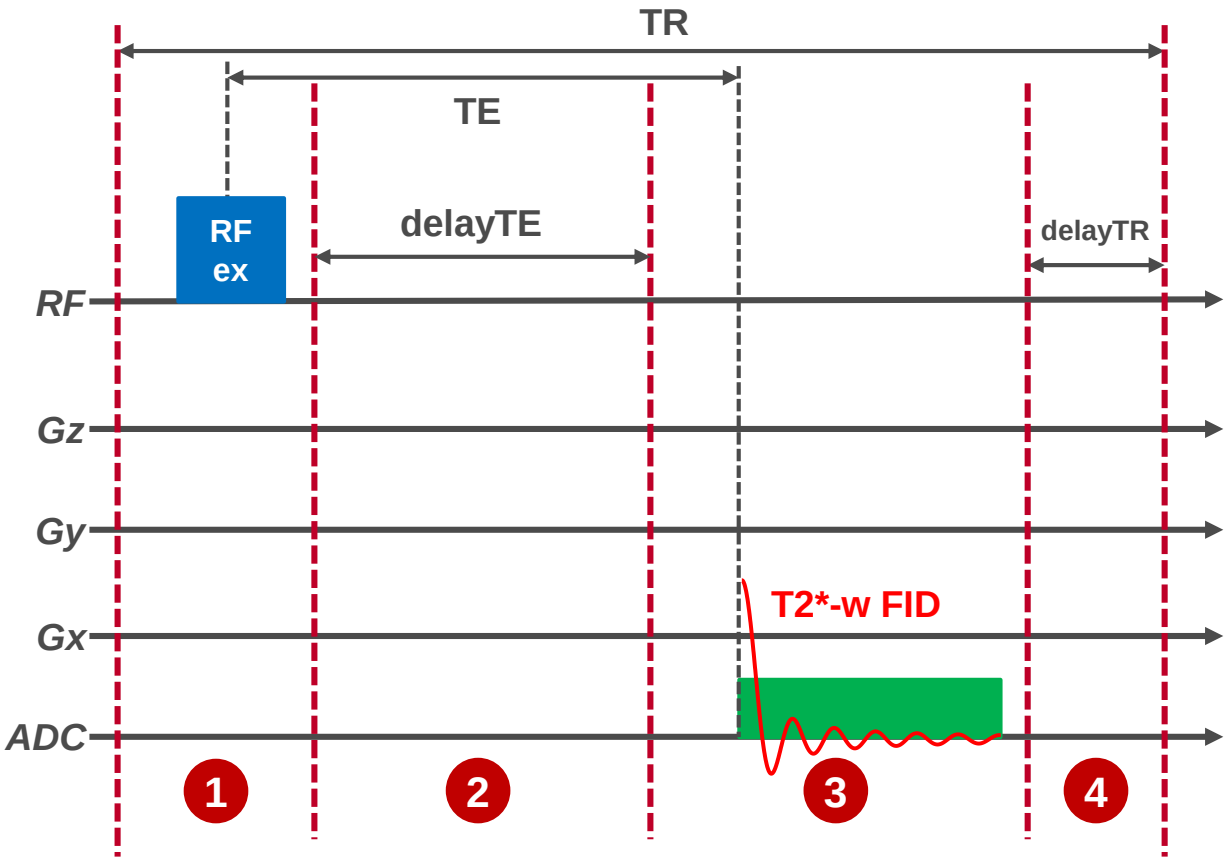
- Basic MR spectroscopy
  - **s01_FID**: Free induction decay (FID)
  - **s02_SE**: Spin echo (SE) without gradients
  - **s03_SE_crushers**: SE with crushers
- Basic MR imaging
  - **s11_GRE2D**: Basic 2D gradient echo (GRE)
  - **s12_GRE2D_optimizedSpoiler**: 2D GRE with time-optimized gradient
  - **s13_GRE2D_acceleratedComputation**: 2D GRE with time-optimized gradient and accelerated computation
- Link to sequence source code, data, and recon scripts:
  - https://github.com/pulseq/ISMRM-Virtual-Meeting--November-15-17-2023/tree/main/basic_pulseq_tutorial

s01_FID





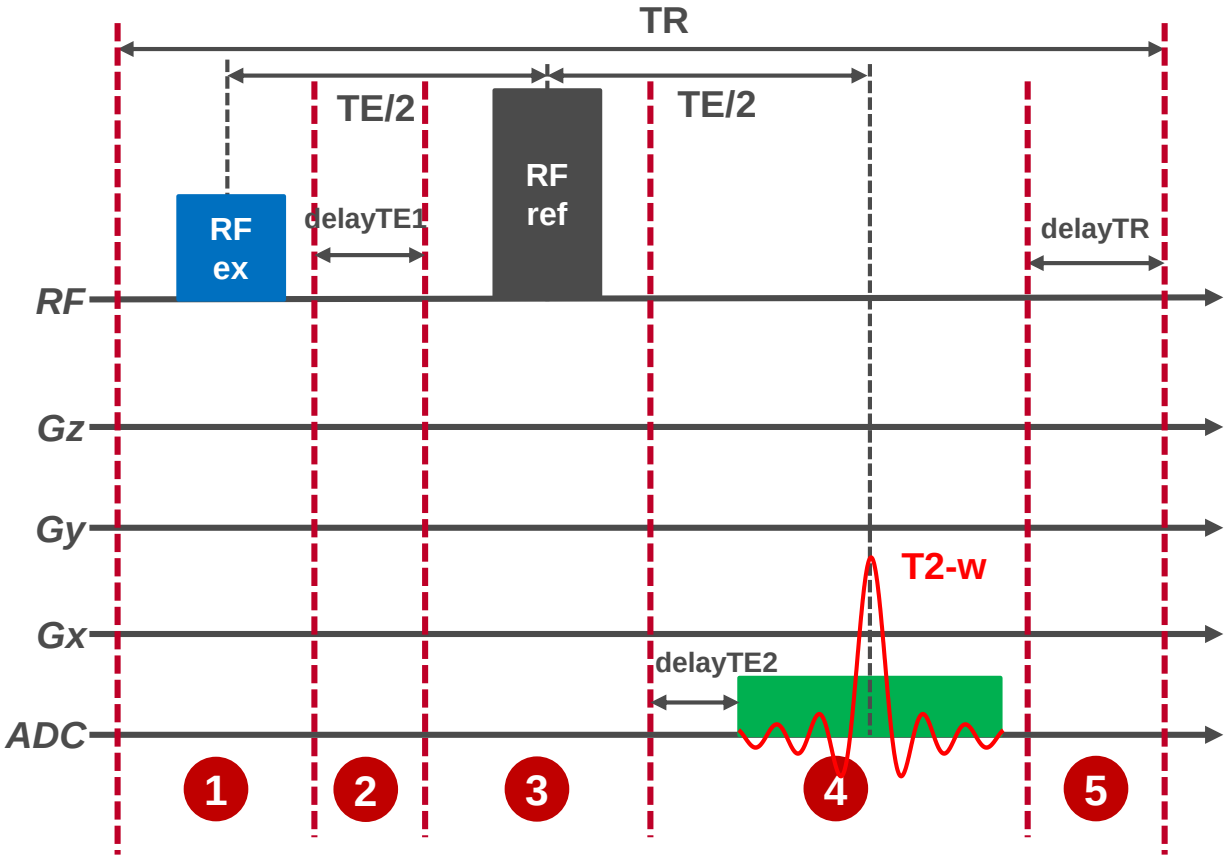
s01_FID

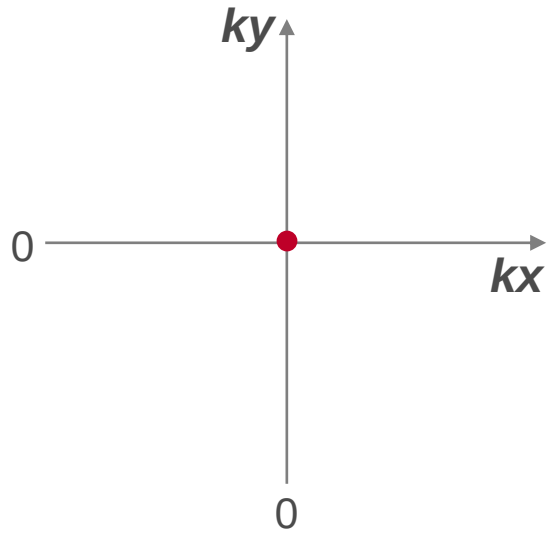


- **T2***: macroscopic and microscopic field inhomogeneity
- **T2**: microscopic field inhomogeneity

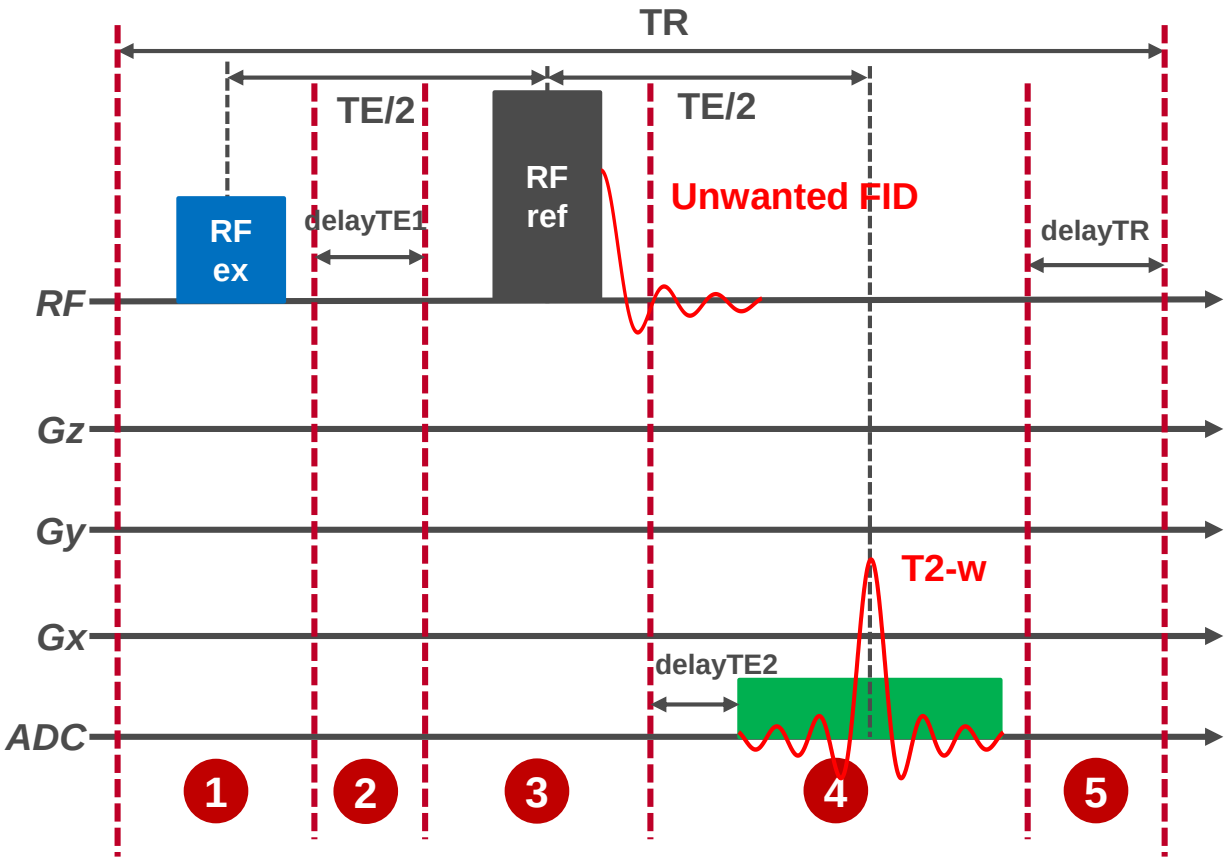
T2 > T2*

s02_SE



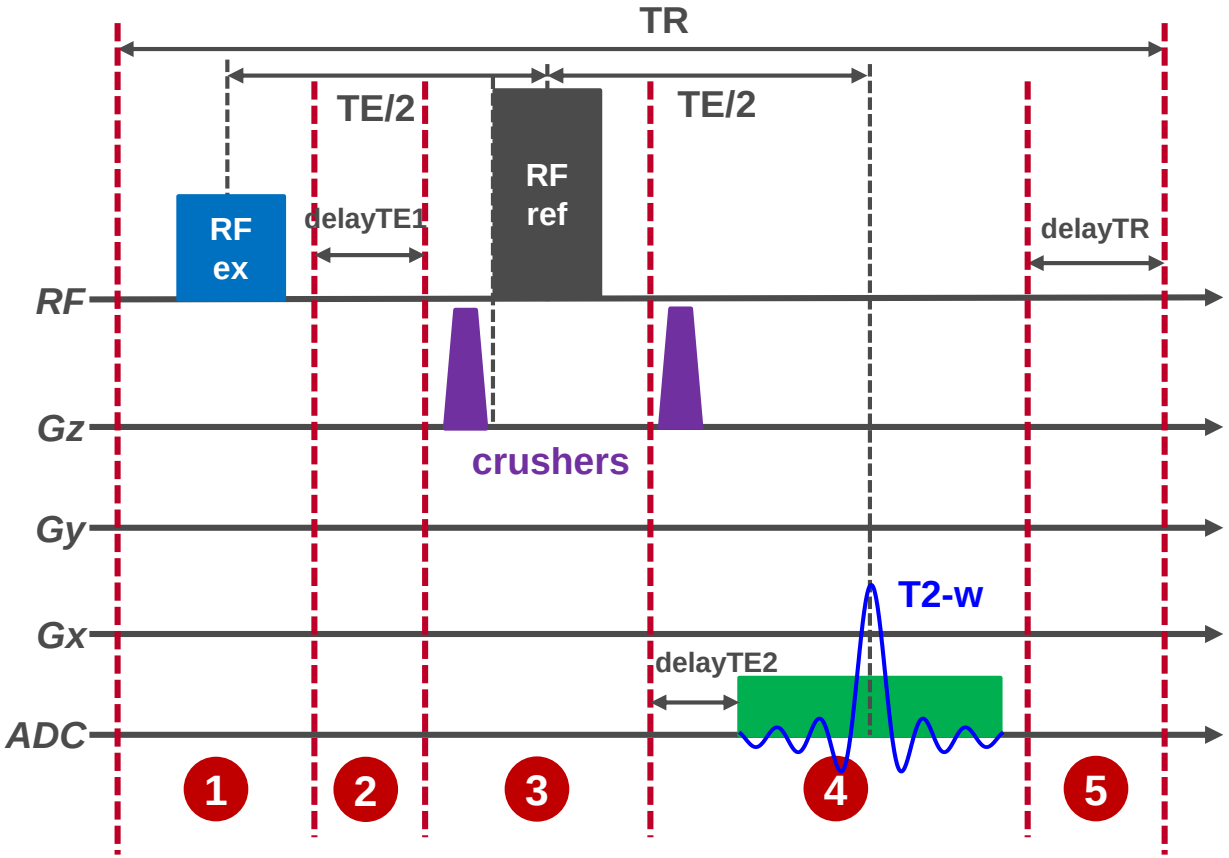


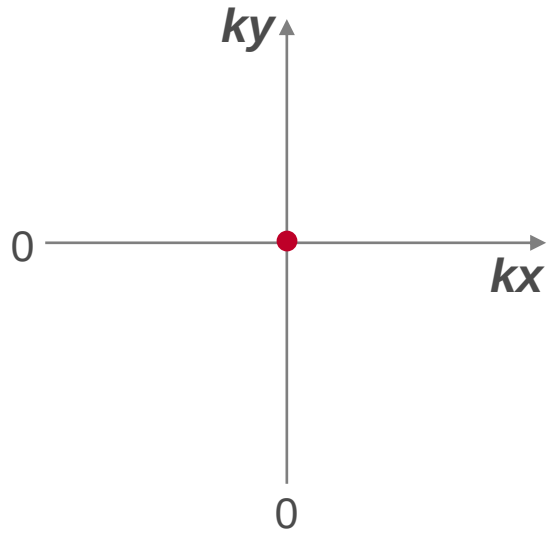
s02_SE



180° pulse is typically **not** perfect. Crushers to suppress unwanted FID

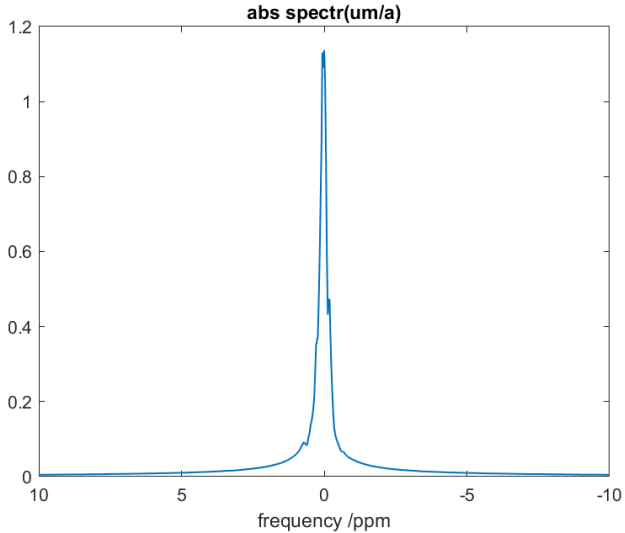
s03_SE_crushers





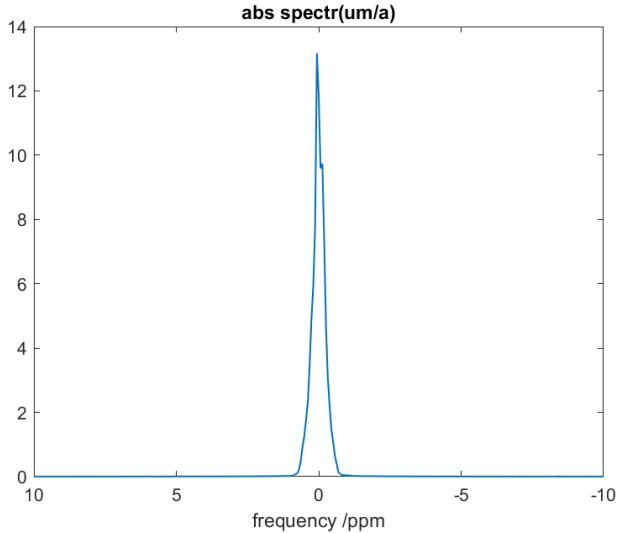
s01 – s03: experiments

s01_FID



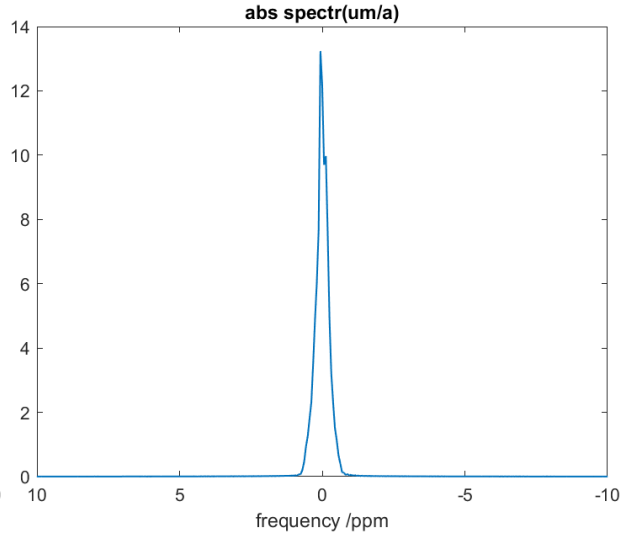
TE = 30 ms

s02_SE



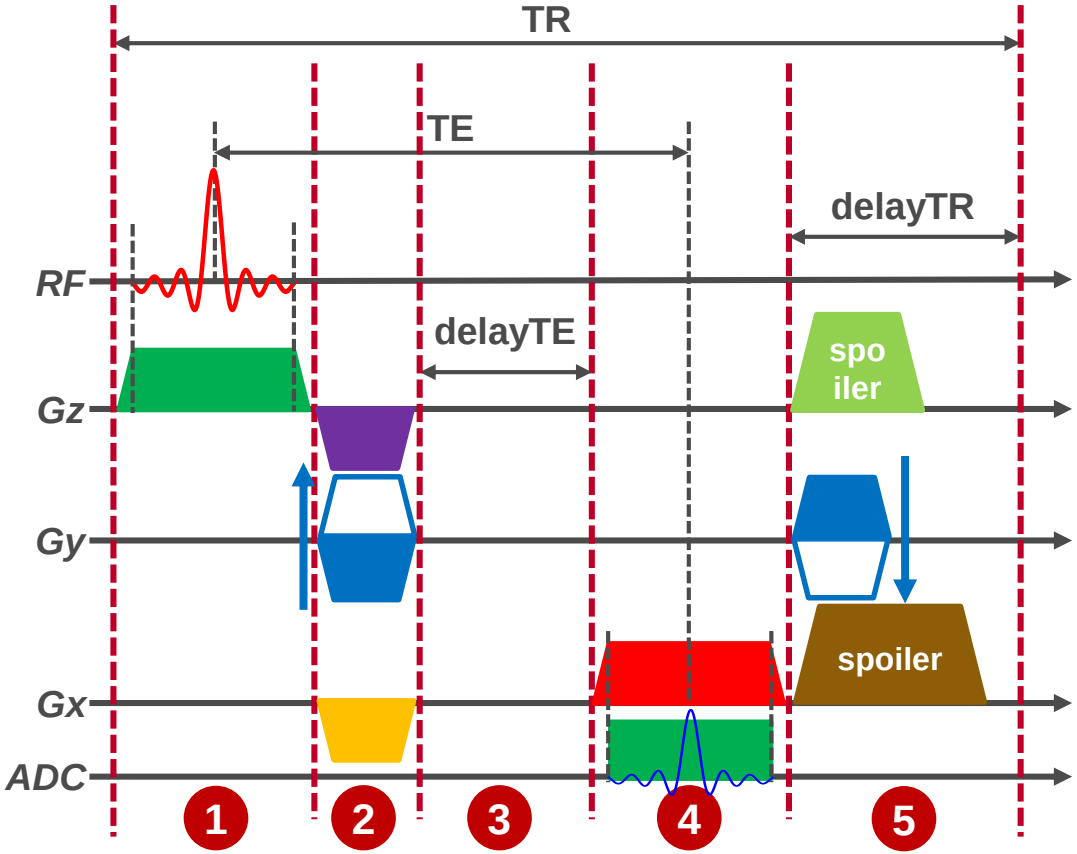
TE = 200 ms

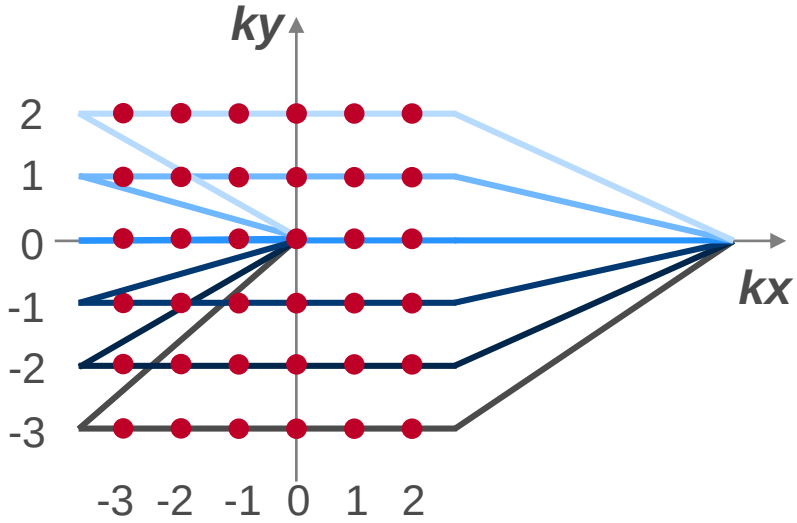
s03_SE_crusher



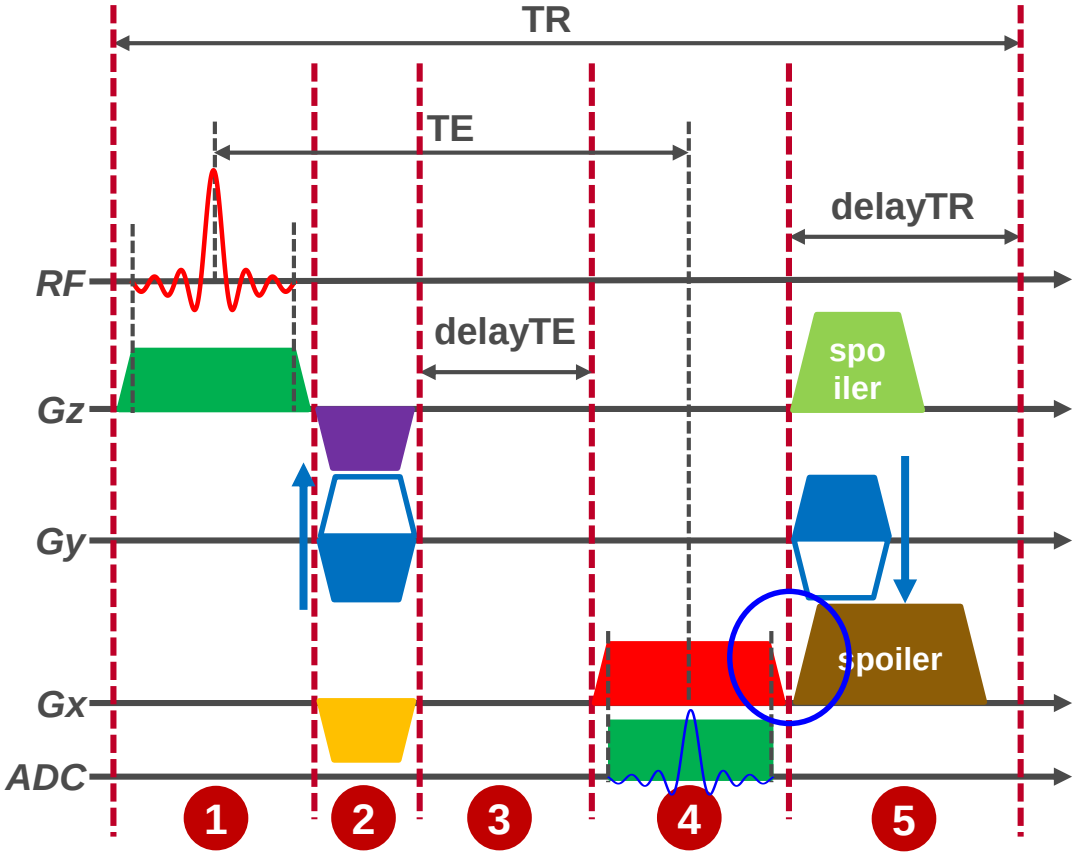
TE = 200 ms

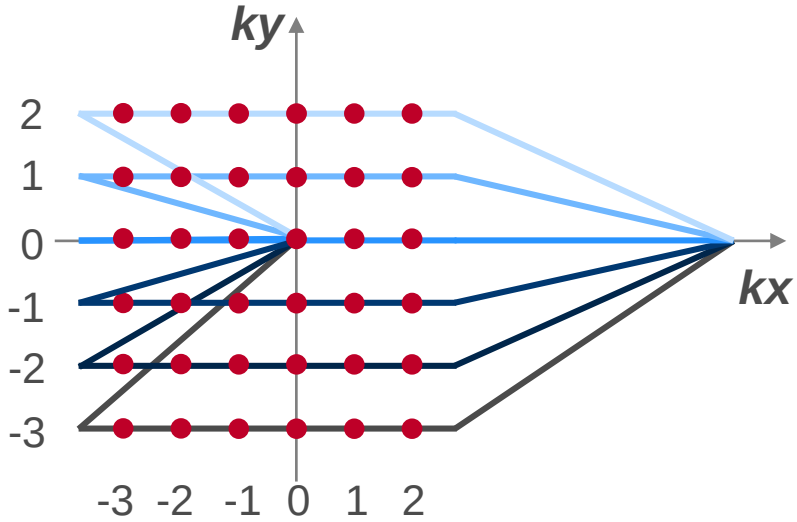
s11_GRE2D


TR
TE
delayTR
RF
delayTE
spo
iler
Gz
Gy
spoiler
Gx
ADC
1
2
3
4
5


ky
2
1
0
-1
-2
-3
kx
-3 -2 -1 0 1 2

s11_GRE2D





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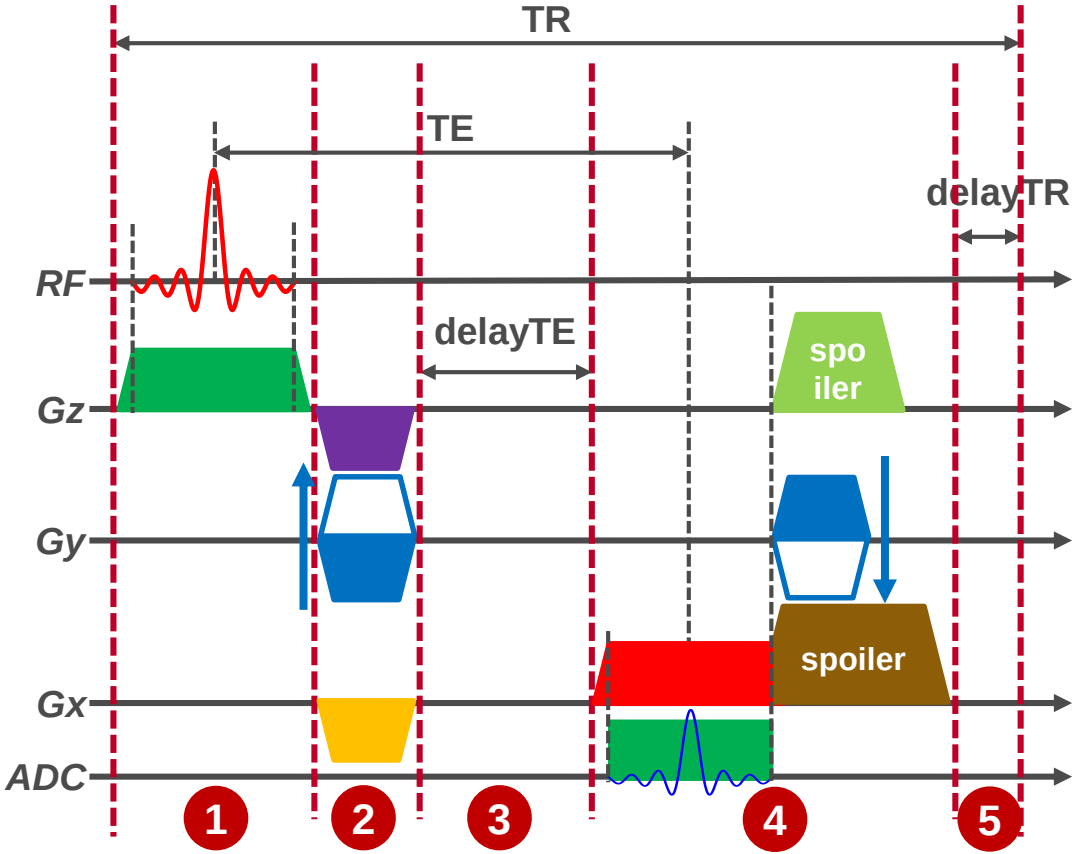
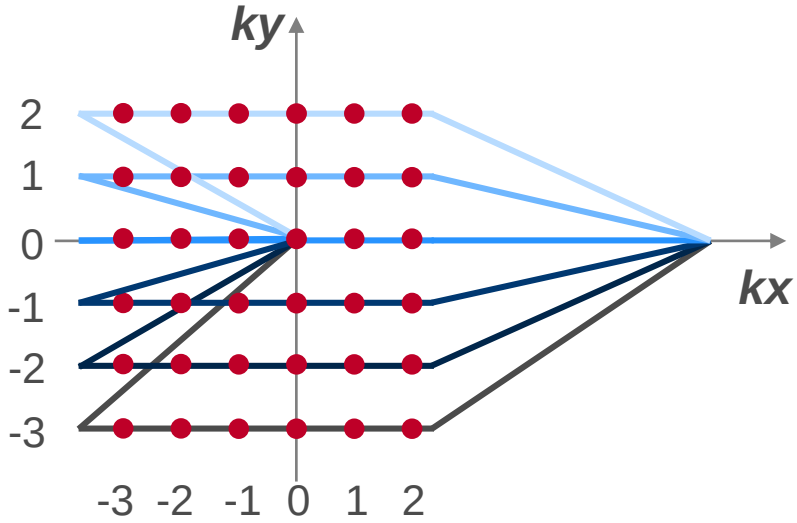
s12_GRE2D_optmizedSpoiler



Gradient “surgery”:

```
mr.splitGradientAt(…)
mr.makeExtendedTrapezoidArea(…)
mr.addGradients(…)
```



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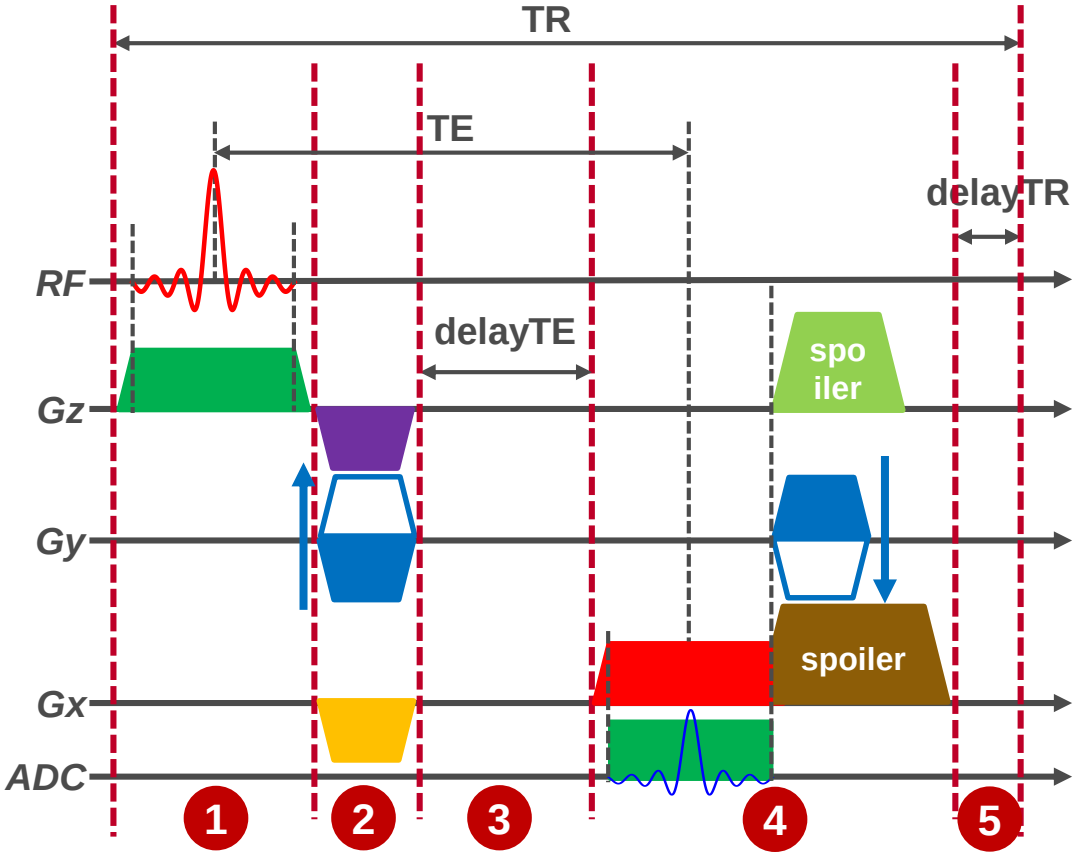
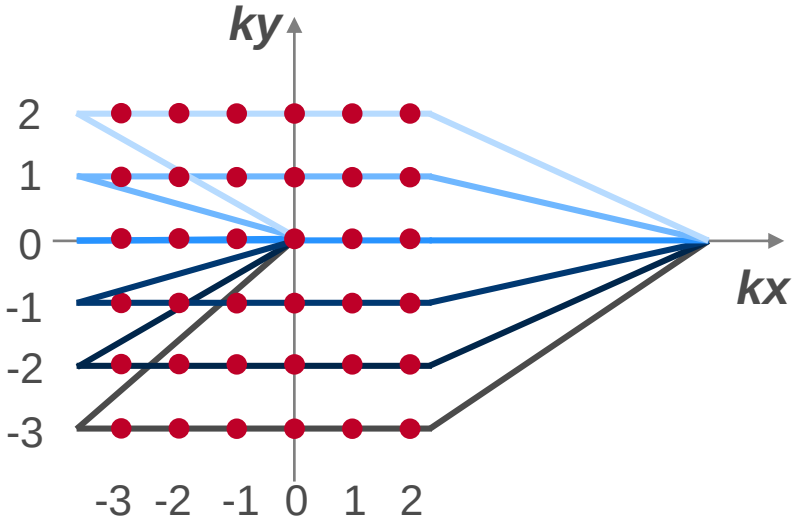
s13_GRE2D_acceleratedComputation



To accelerate seq.addBlock(…):

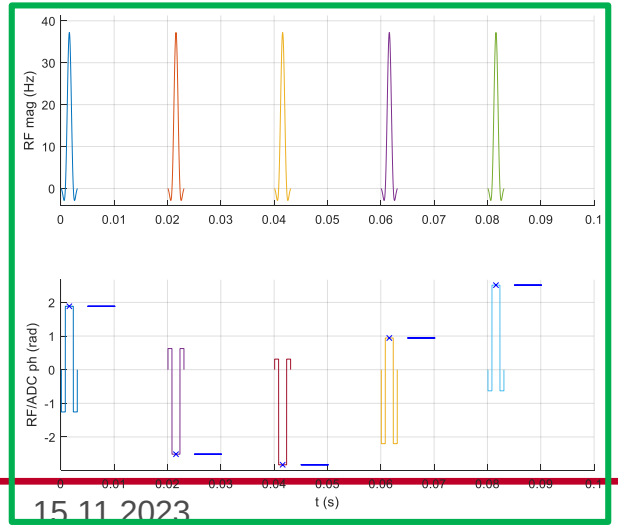
```
seq.registerGradEvent(…)
seq.registerRfEvent(…)
```

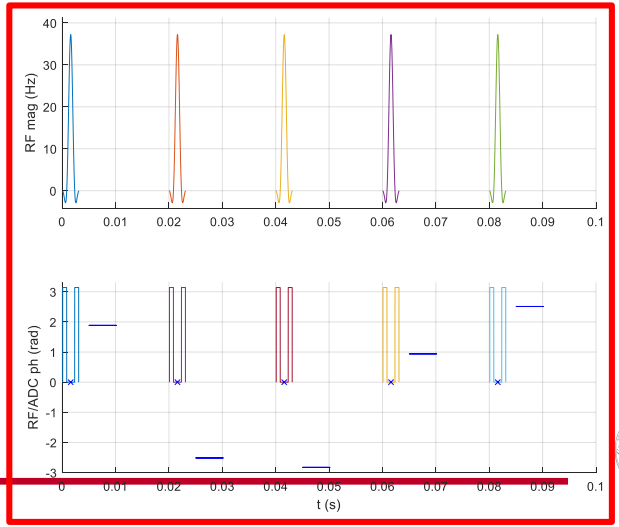


s13_GRE2D_acceleratedComputation

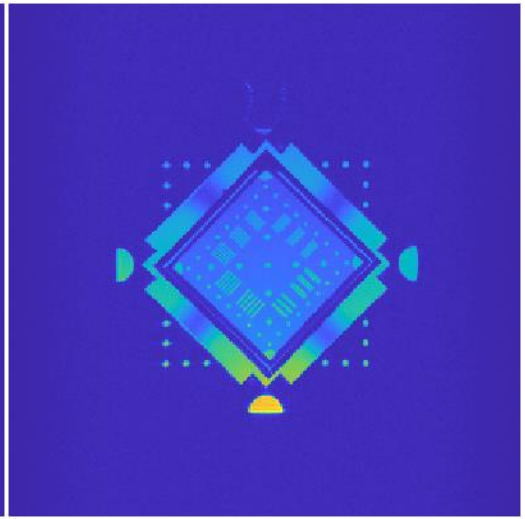
Caution! Possible source of errors!

- After the object is registered, the seq.addBlock(…) will never search the library for consistency.
- RF pulse with changing phase for RF spoiling
- [~, rf.shapeIDs] = seq.registerRfEvent(rf) ;
- rf.id = seq.registerRfEvent(rf) ; % NO GO EXAMPLE!!!





s11 – s13: experiments

s11_GRE	s12_GRE_spoiler	s13_GRE_computation
		
Computation Time: 1.22 s	1.41 s	0.34 s

More information…

A more detailed Pulseq tutorial:

https://github.com/pulseq/tutorials

Sequence library:

https://github.com/pulseq/pulseq/tree/master/matlab/demoSeq

If you have any further questions:

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Thank you for your attention!

Pulseq MATLAB

pypulseq Python

TOPPE

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