Intrinsic respiratory motion tracking using ZTE-MRI for PET-MRI

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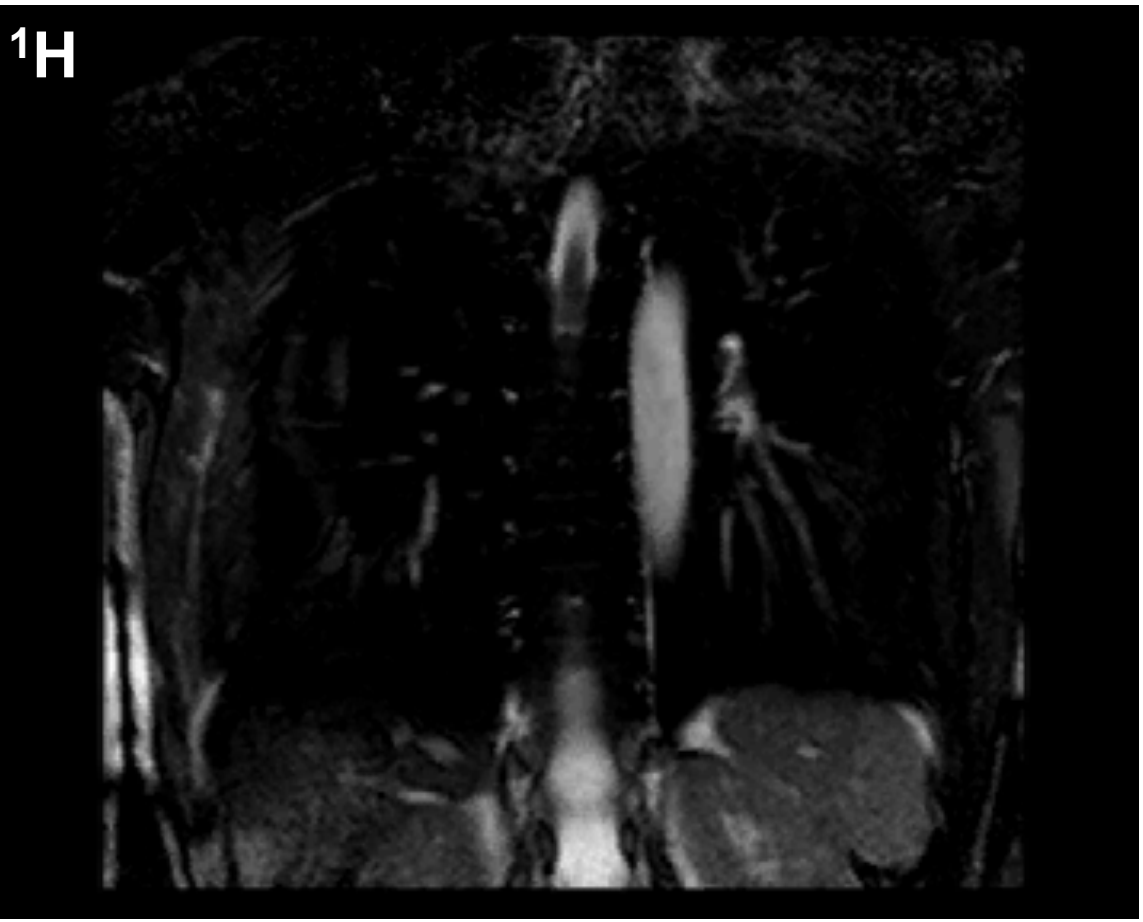
Introduction: What about lung MRI?

hallenging for ^{1}H but possible for other nuclei (^{3}He, ^{129}Xe, ^{19}F, …



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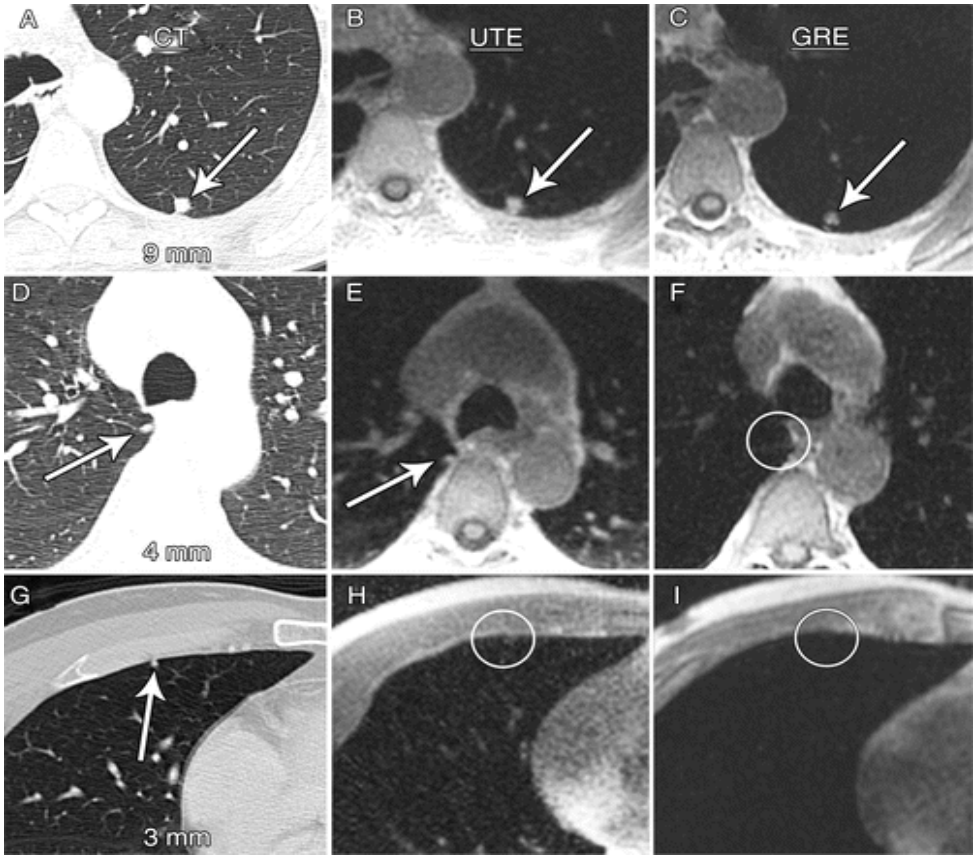
Introduction: ^{1}H lung MRI

Why is it so challenging?

- **Low tissue density**
- **Rapid transverse relaxation** (T_2^* = 1-2 ms)

Consequences:

- **Low SNR**
- **Decrease of spatial resolution** if readout is too long



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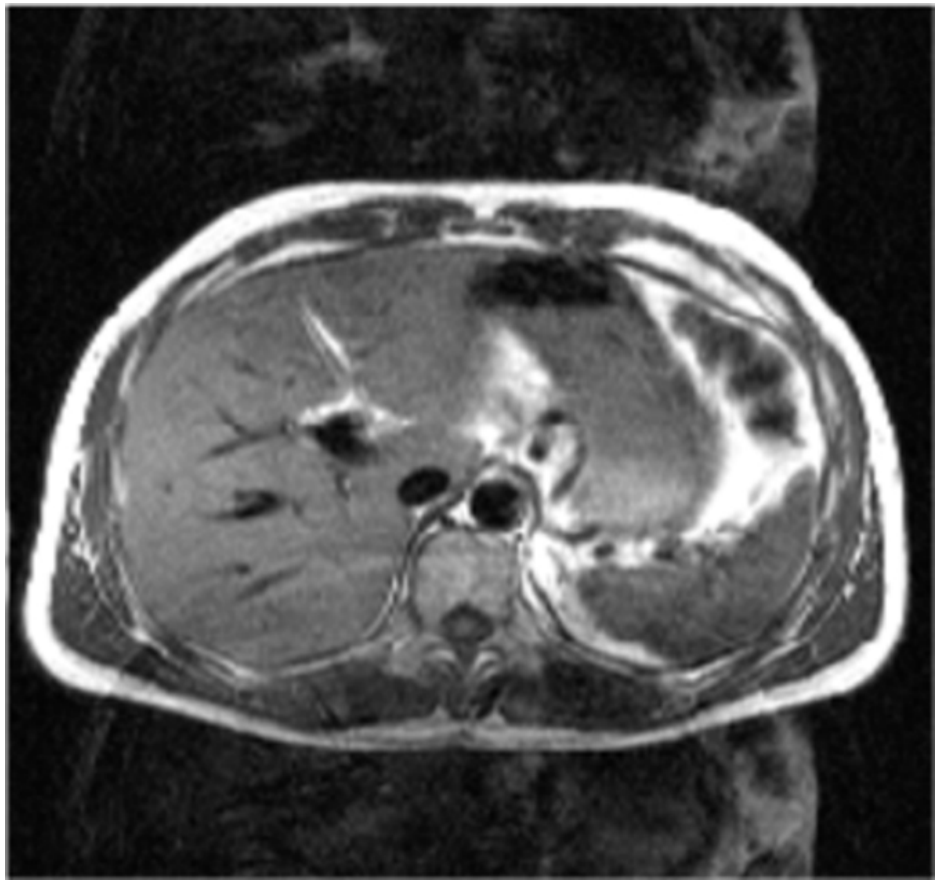
Solution: UTE (Ultrashort Time-Echo) a
ZTE (Zero Time-Echo) pulse sequences

Introduction: Free-breathing MRI

Respiratory motion-related artifacts:



mri-q.com

1st step: Follow respiratory motion

- Abdominal belt
- Navigator echo

2nd step: Suppress motion artifacts on images

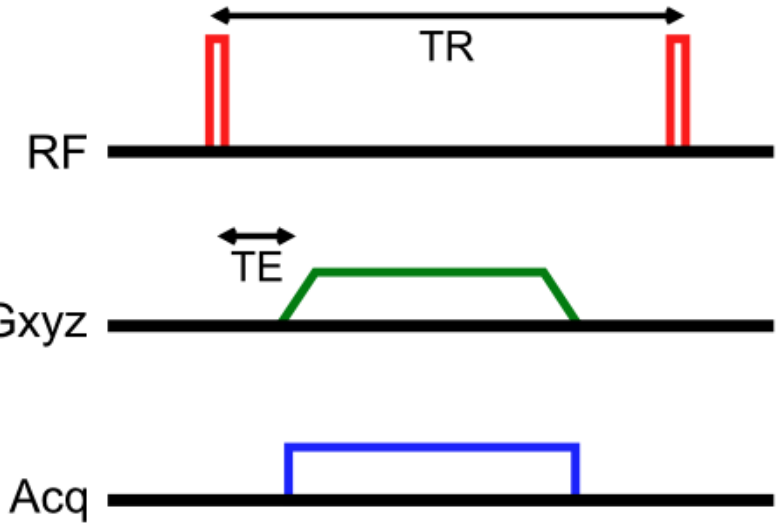
- Prospective gating
- Retrospective gating

New solutions: self-navigation and self-gating

Methods: UTE and ZTE imaging

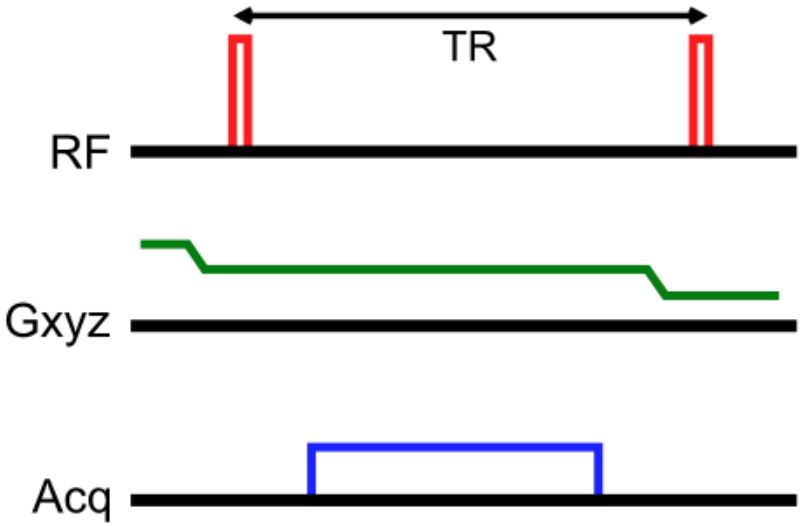
E sequences:

- hort RF pulses for excitation
- igh amplitude readout gradient
- hort radial readout
- **E < 1 ms**



ZTE sequences:

- Short **high BW** RF pulses for excitation
- **Continuous** high amplitude readout gradi
- Short radial readout
- **TE = 0 ms**

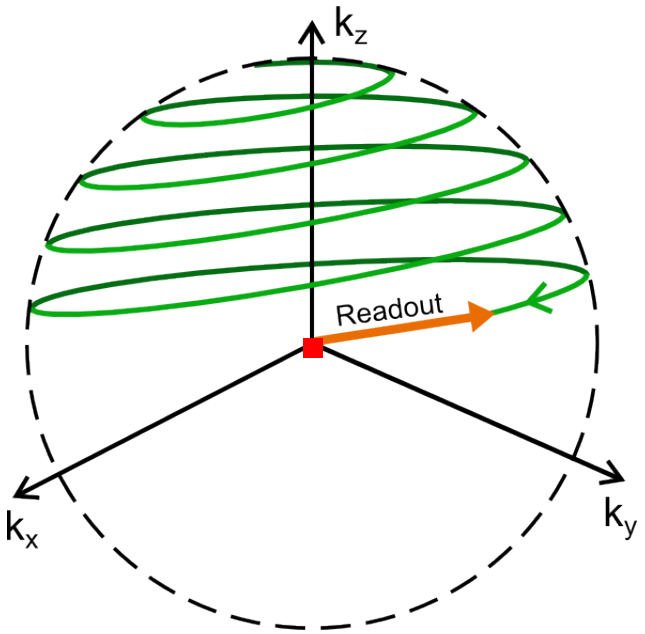


Methods: UTE and ZTE imaging

elf-gating in UTE :

k-space center mesured at each TR (▪)

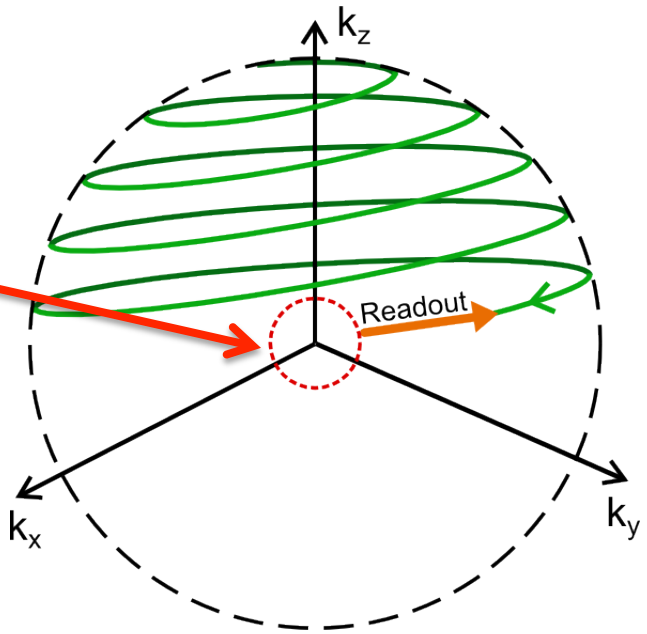
Follow-up of mean intensity over time



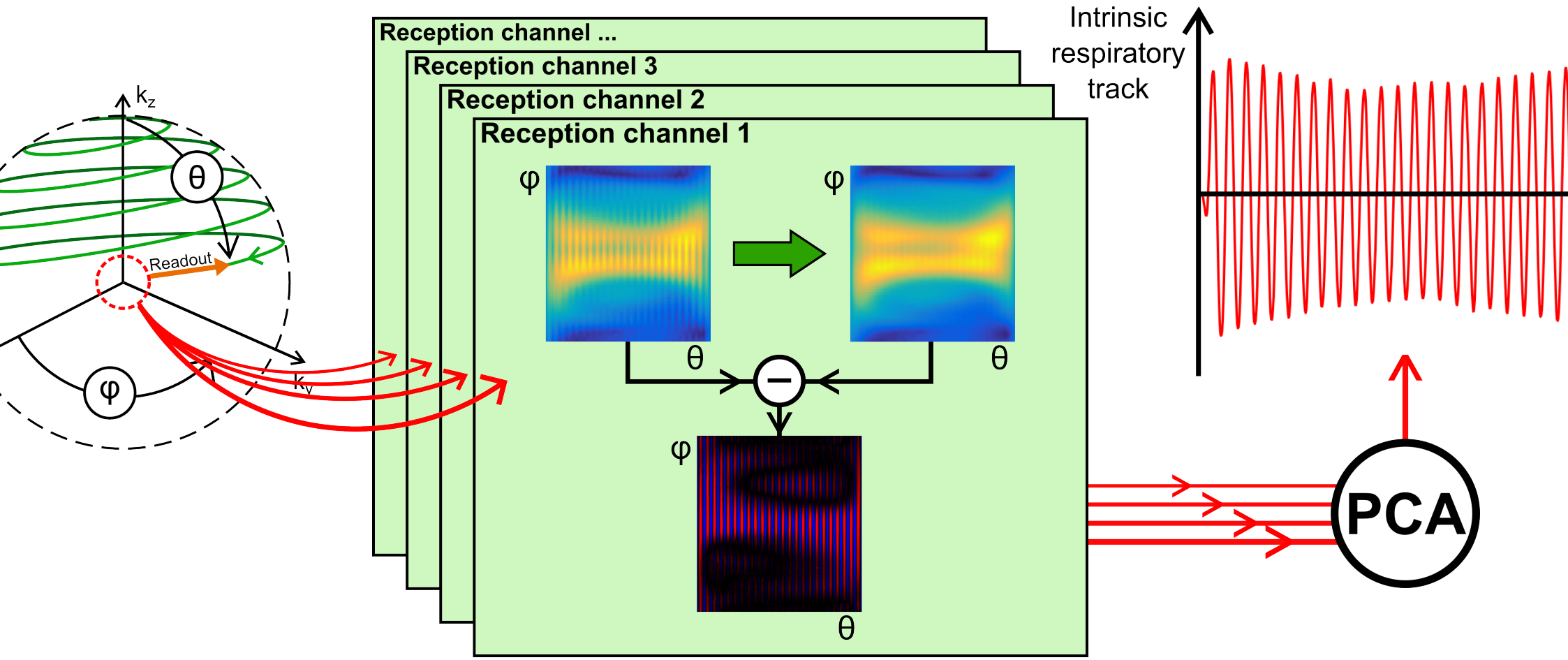
Self-gating in ZTE :

- k-space center **not** mesured at each TR
- **Mean intensity cannot be measured directly**

Can we do something interesting with these measurements?



Methods: Motion follow-up in ZTE



Methods: Motion follow-up in ZTE

ethod tested on:

5 healthy volunteers freely breathing (3 acquisitions for each)

2 lung cancer patients freely breathing (1 acquisition for each)

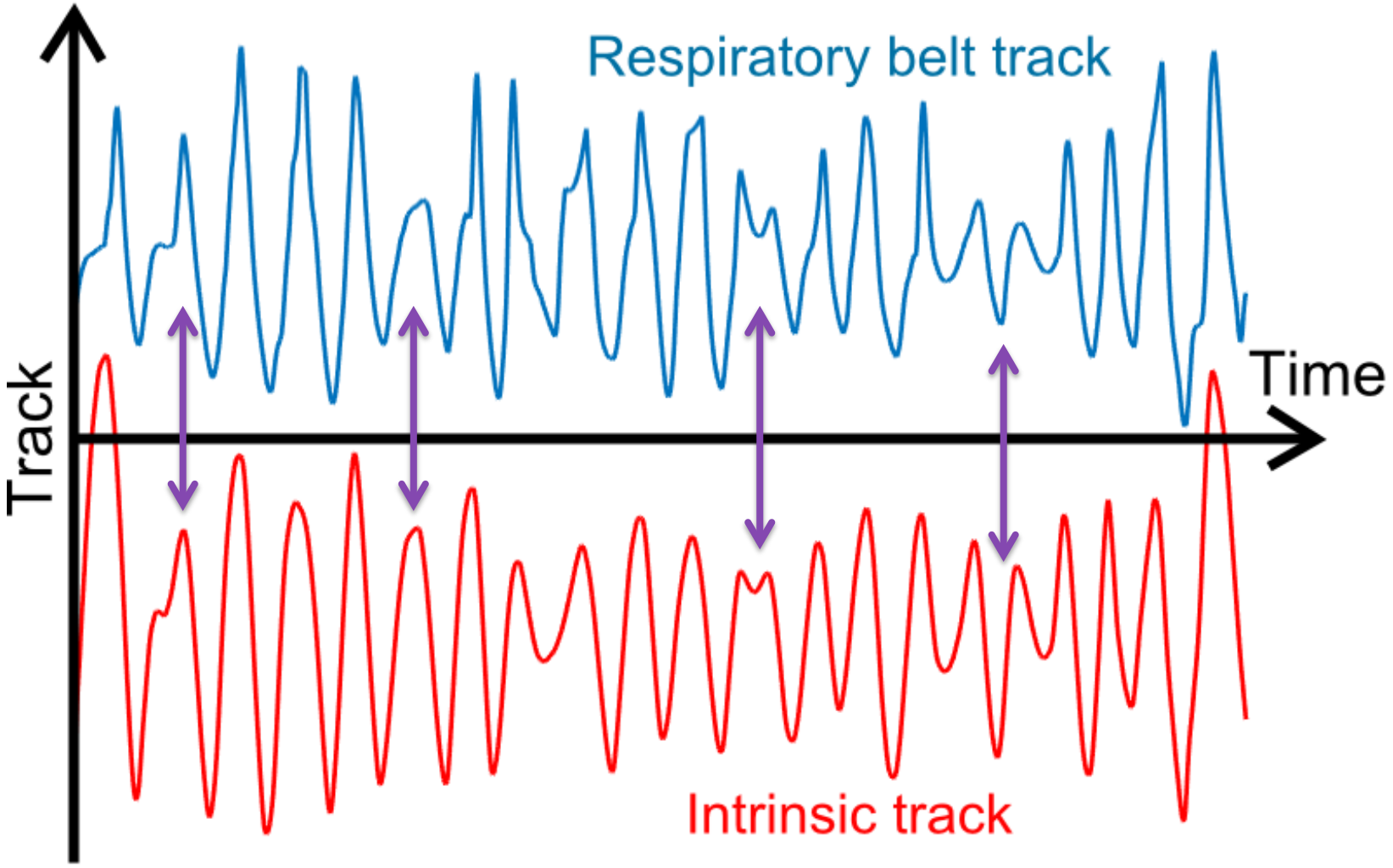
Acquisition conditions:

- **ZTE acquisition** on a GE Signa PET/MR 3.0 T
- Simultaneous respiratory motion follow-up with an **abdominal respiratory belt**.
- 30-channel thorax reception antenna
- Acquisition BW = 62.5 kHz
- Number of spokes = 33792
- FOV = (40 x 40 x 33.6) cm^3
- Nb. of readout points = 218
- **Acquisition time = 1 min 10 s**

Results: Qualitative analysis

For patient 1 :

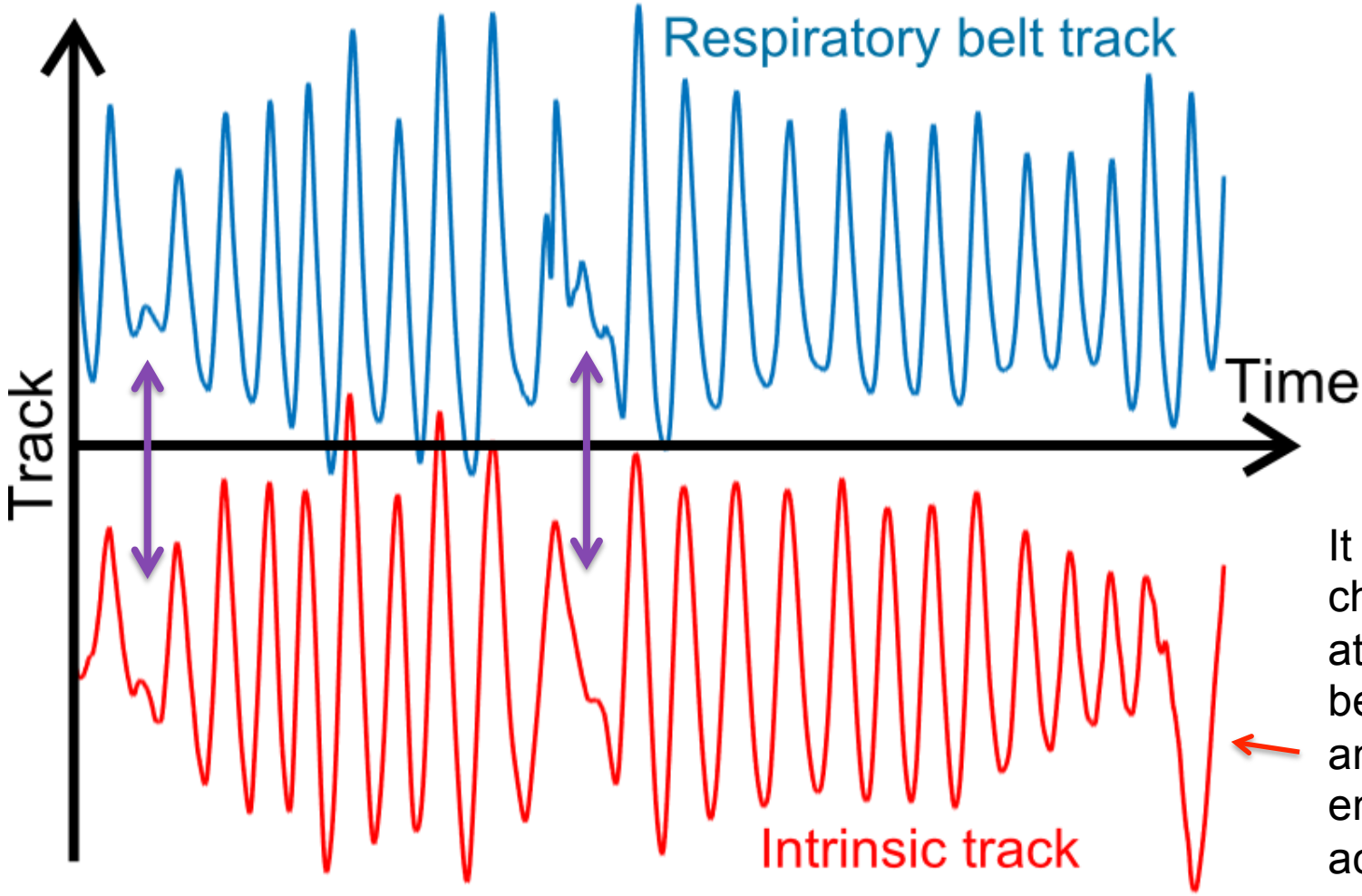
Interesting similarity



Results: Qualitative analysis

For patient 2 :

Interesting similarity



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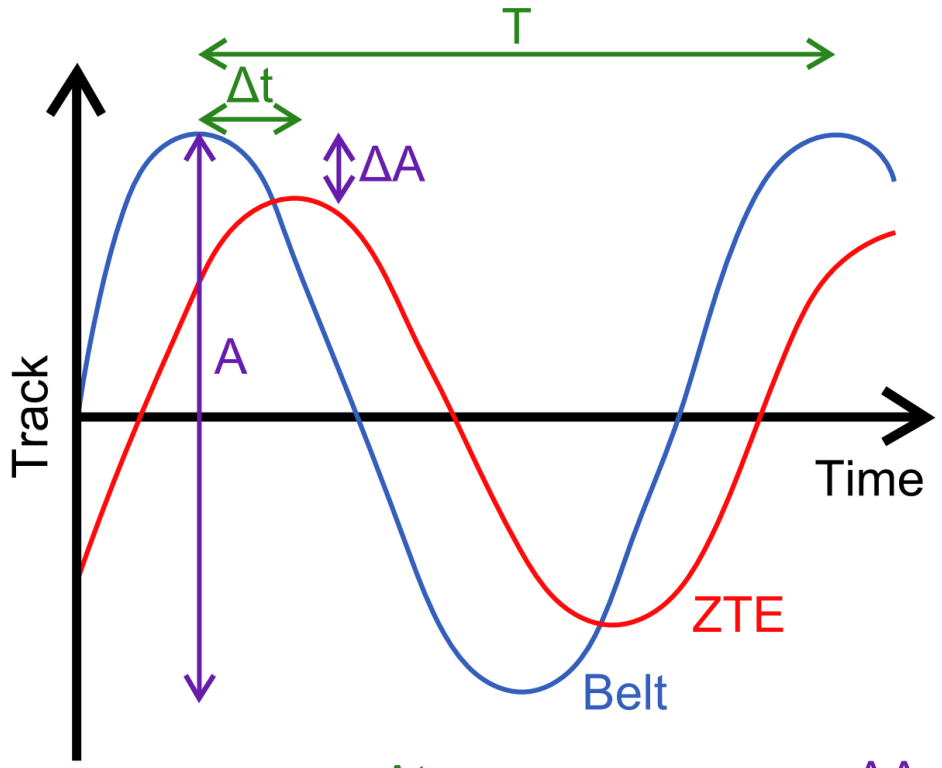
Results: Quantitative analysis



$CST = 1 - \text{mean}(\frac{\Delta t}{T})$ $CSA = 1 - \text{mean}(\frac{\Delta A}{A})$

T: Coefficient of Similarity in Time

A: Coefficient of similarity in amplitude

For the 5 volunteers :

- CST = 0,89 +/- 0,03
- CSA = 0,88 +/- 0,04

For patient 1 :

- CST = 0,84 +/- 0,13
- CSA = 0,79 +/- 0,22

For patient 2 :

- CST = 0,87 +/- 0,10
- CSA = 0,89 +/- 0,08

Discussion and conclusion

- Feasibility of **following intrinsically respiratory motion** in ZTE-MRI.
- This information can be used for **retrospective motion correction** on images.
- Possible **clinical applications**:
  - **Pseudo-CT maps** for attenuation correction in PET-MRI.
  - **Lung density maps** for magnetic resonance elastography.

Acknowledgements

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