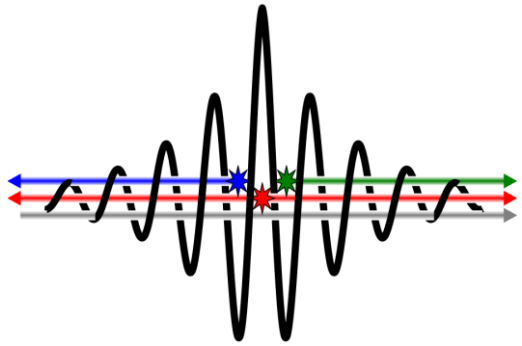

Respiratory motion correction of PET/MR data using SIRF

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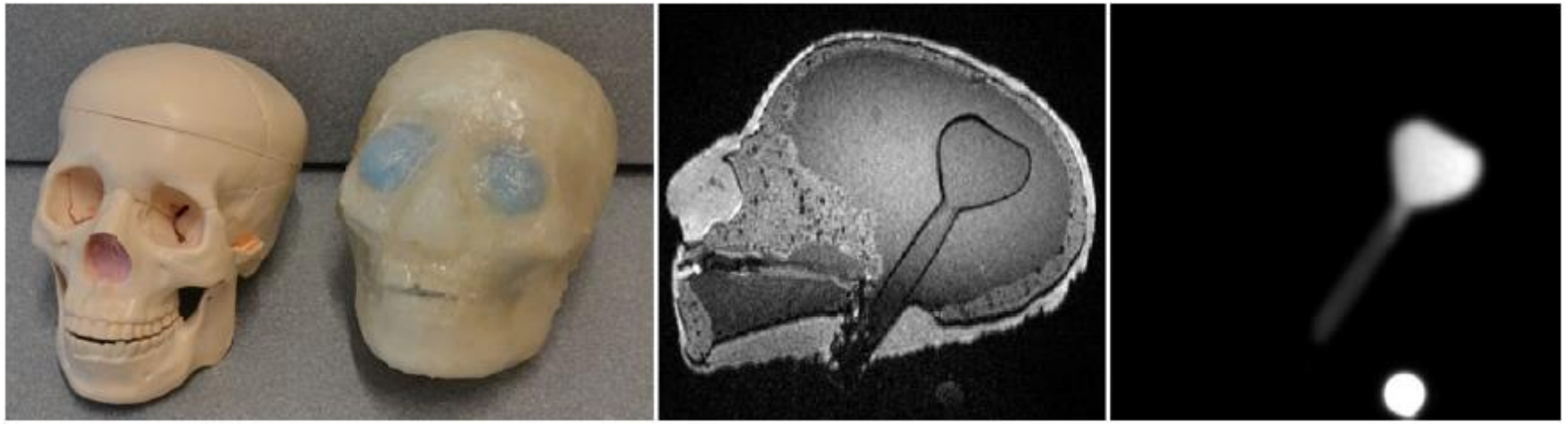
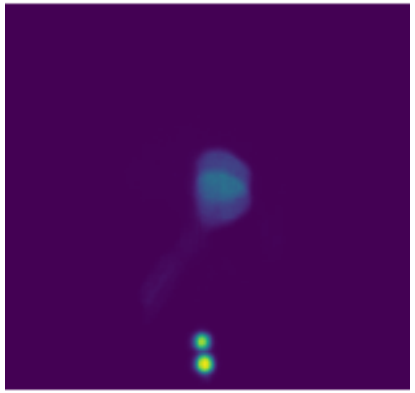
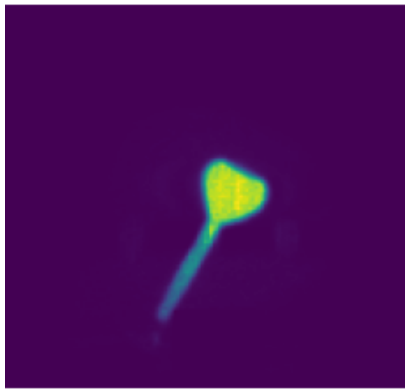
University College London Institute of Nuclear Medicine

The problem

Einspänner *et al. EJNMMI Physics (2022) 9:15*
https://zenodo.org/records/7862046





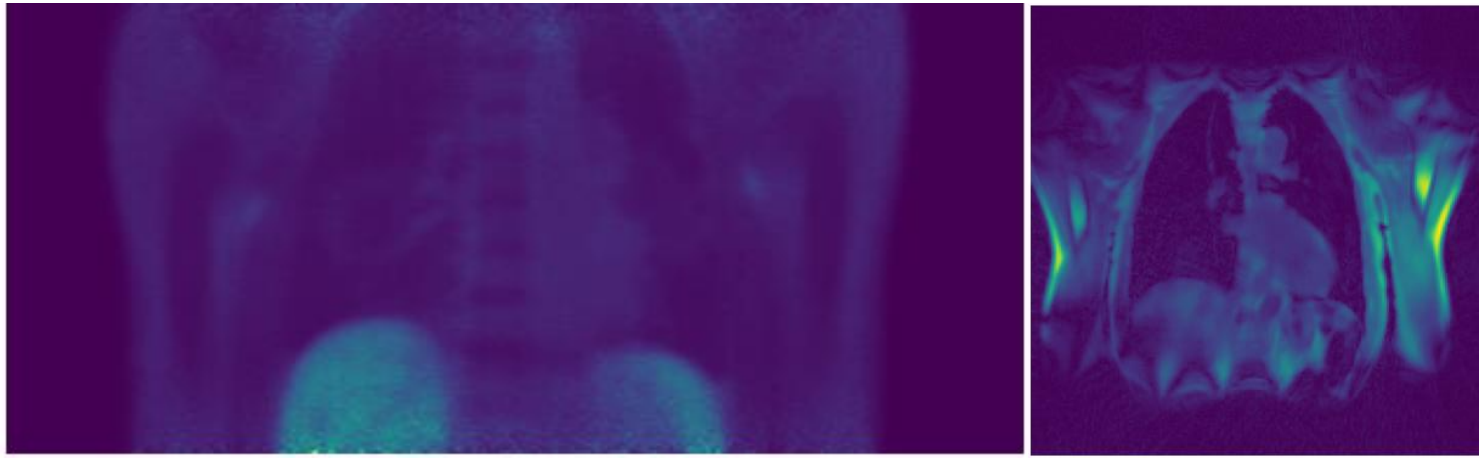


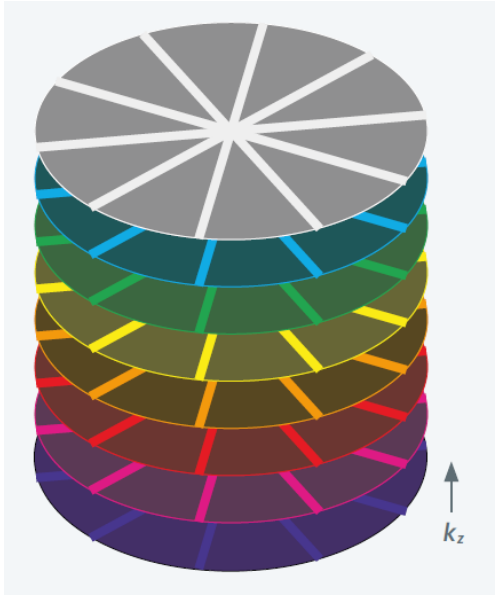
Volumes
Positions
Activities

Are all wrong if you don’t correct motion!

Data + Surrogate

- Here data from cardiovascular patients Siemens Biograph mMR
- 50 min PET scan with Ga-68 FAPI injected 35 min before scan
- Free breathing radial MRI scan lasting 4.1 min

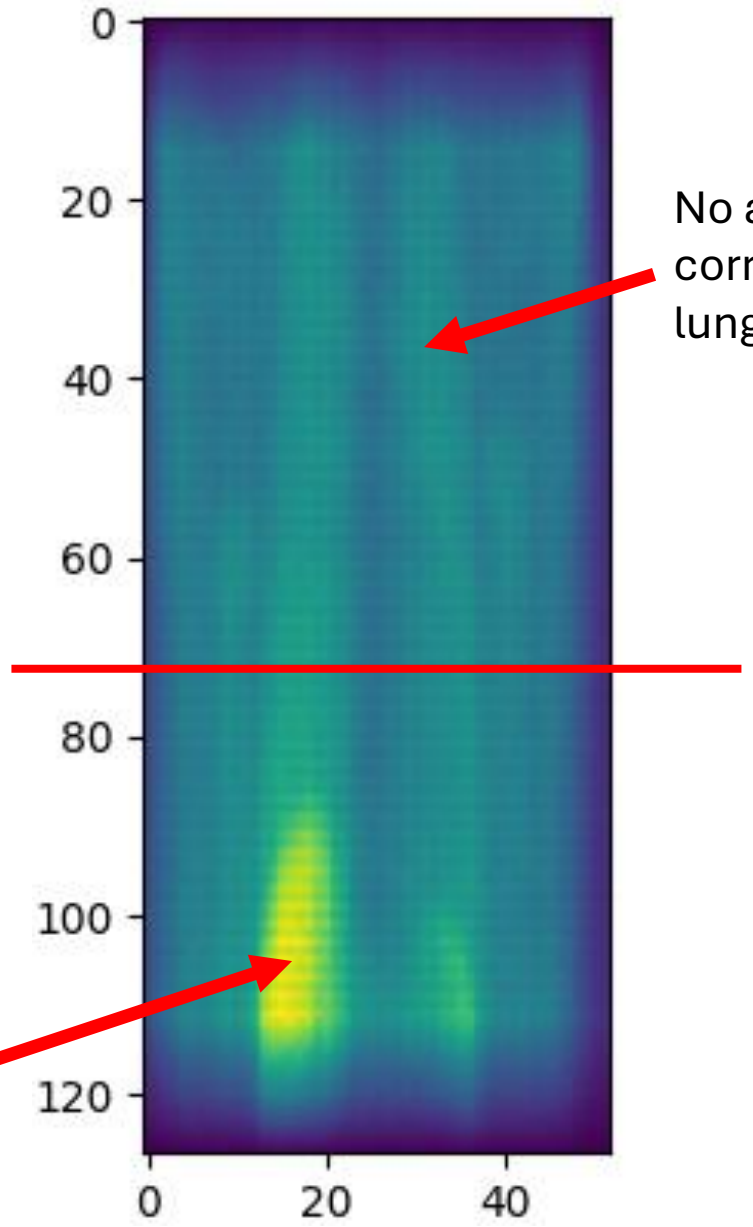




- We require a “surrogate” for the position of the patient
- Here we take surrogates from the raw image data

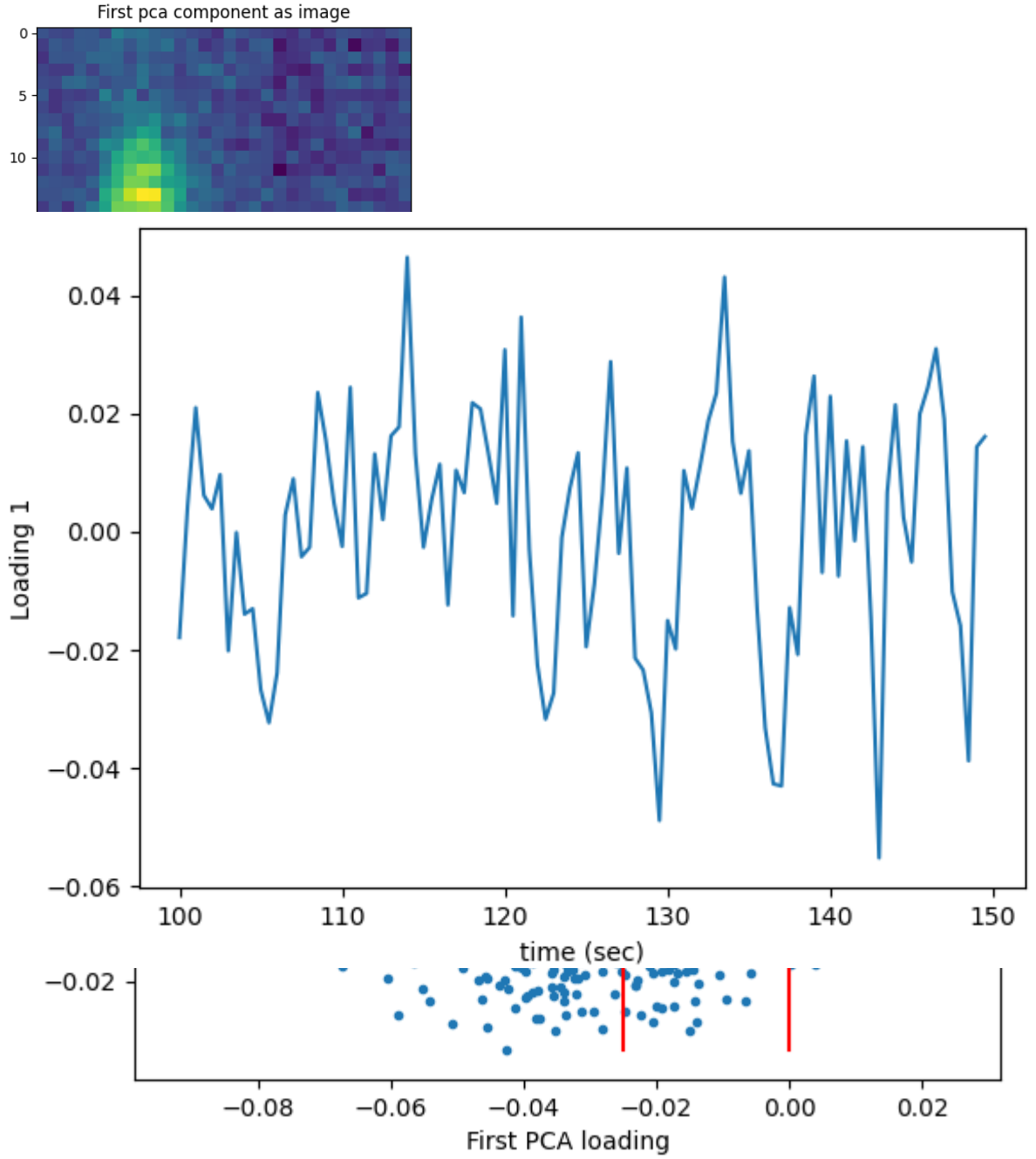
PET and motion

- The PET data is quite noisy
- To extract motion:
  - Unpack listmode data into 0.5 second sinograms
  - Convert sinograms into low-resolution projections through the patient
  - Crop to include primarily the diaphragm
  - Use **principal components analysis** in time



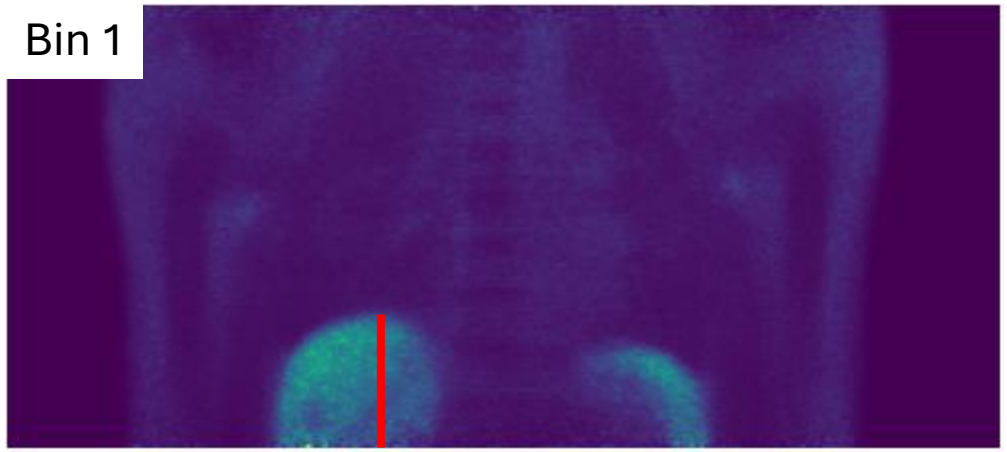
PET and motion

- Using 0.5 sec frames – surrogate is too noisy to use
- Instead use 1.5 sec frames three times
- Start at t = 0, 0.5, 1.0 sec – then create waited sum of **loadings**

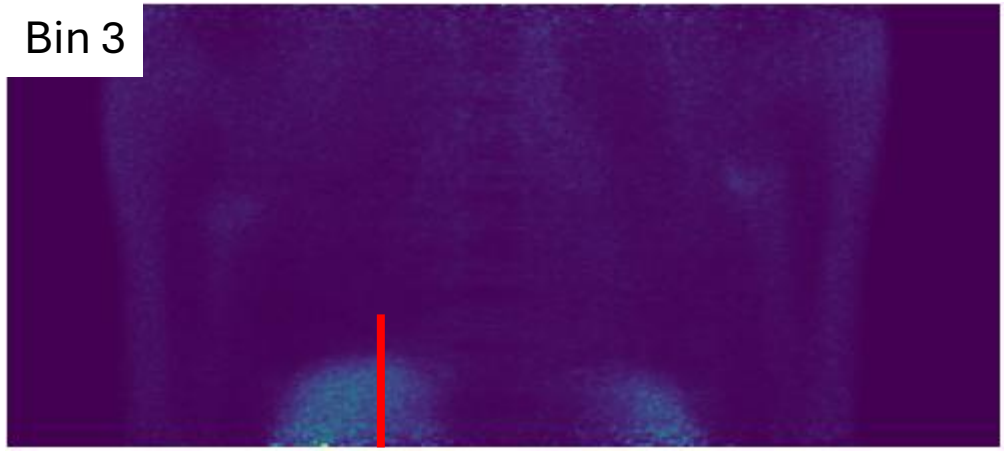


PET and motion

Bin 1

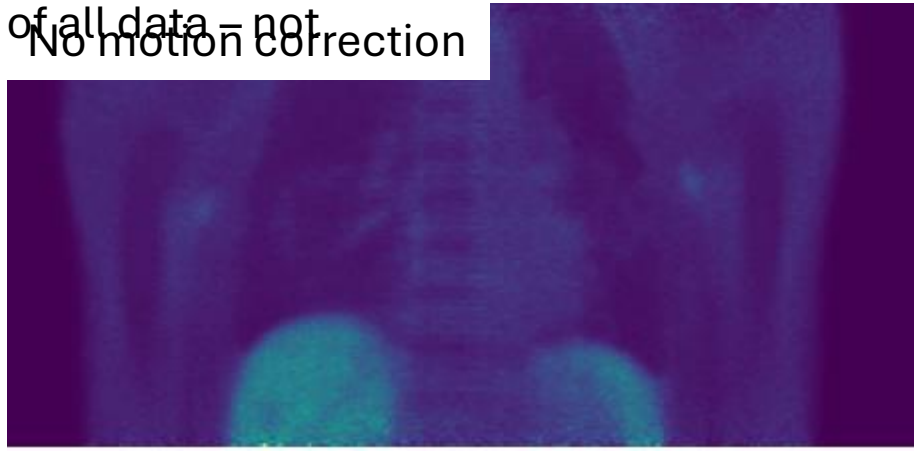


Bin 3

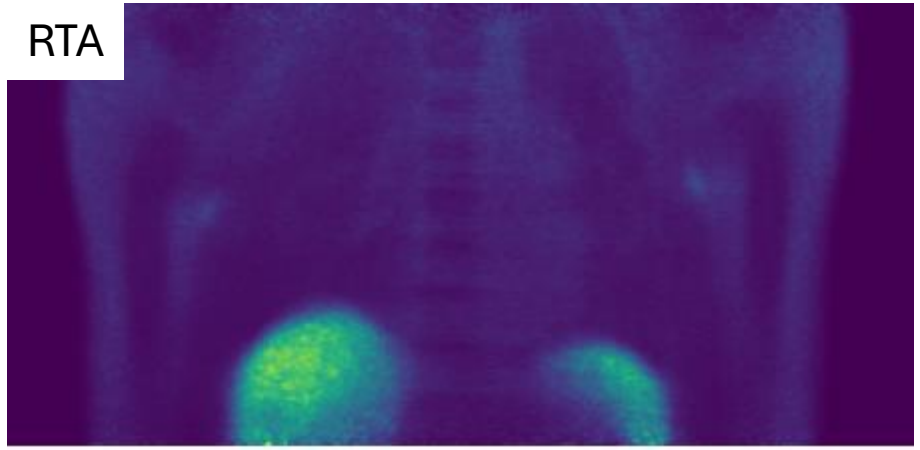


Scatter and randoms estimated from a portion of all data – not for the bin

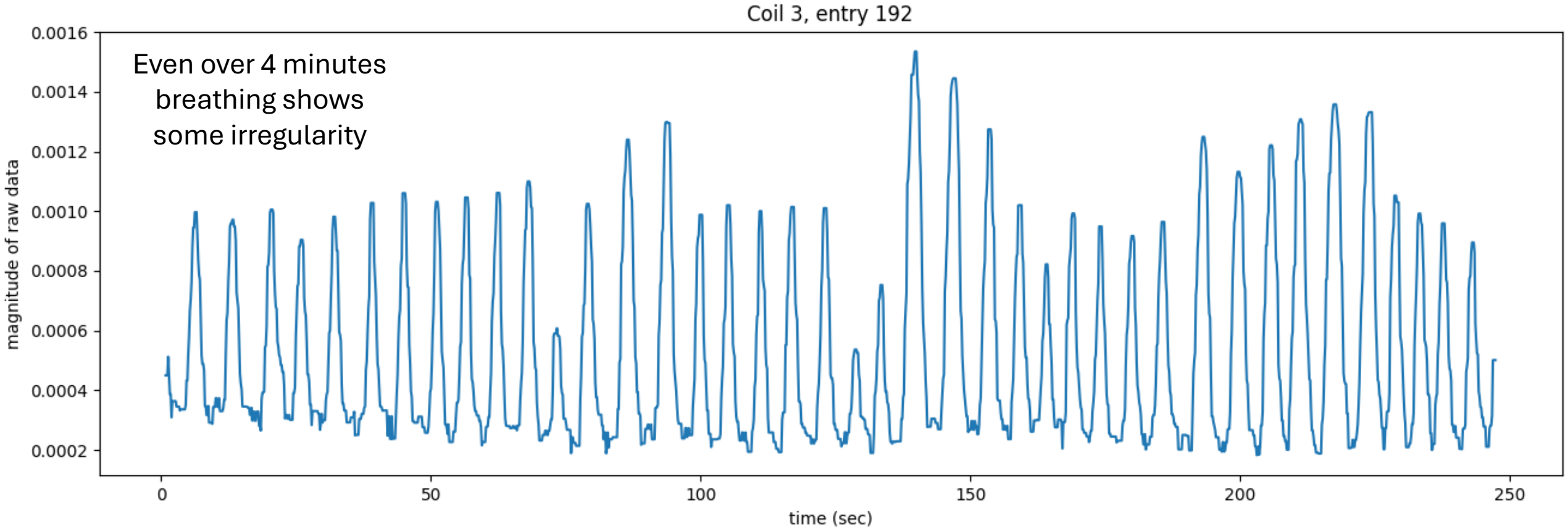
No motion correction



RTA



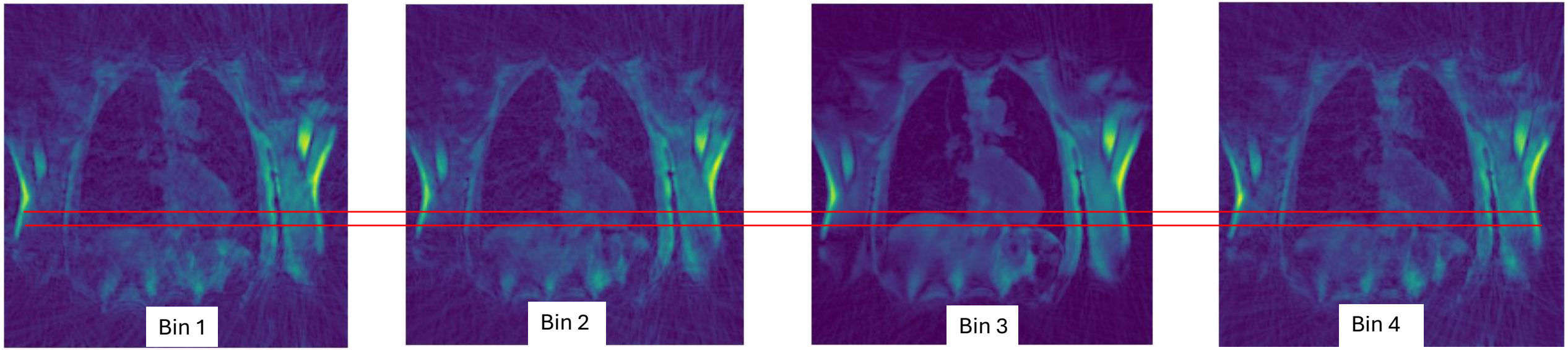
MRI and motion

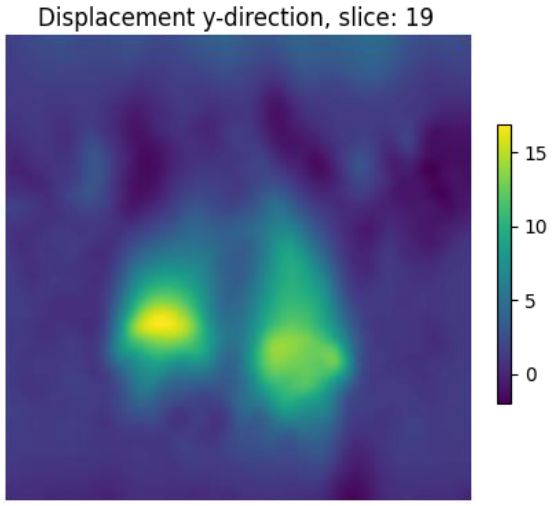


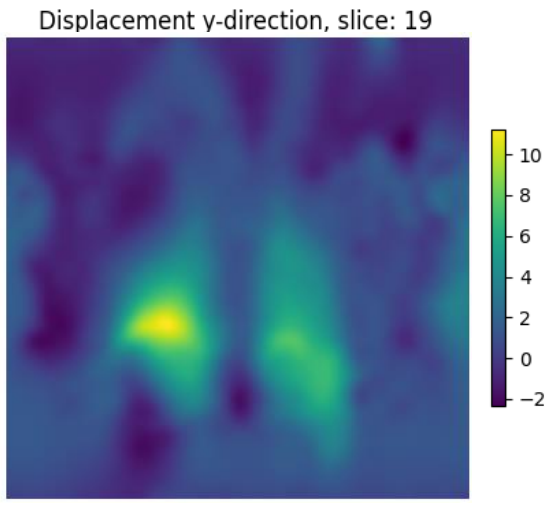
Coil 3 has highest variance of the 18 coils

Value from centre of k-space is a good surrogate for the breathing motion – **PCA isn't required!**

MRI and motion

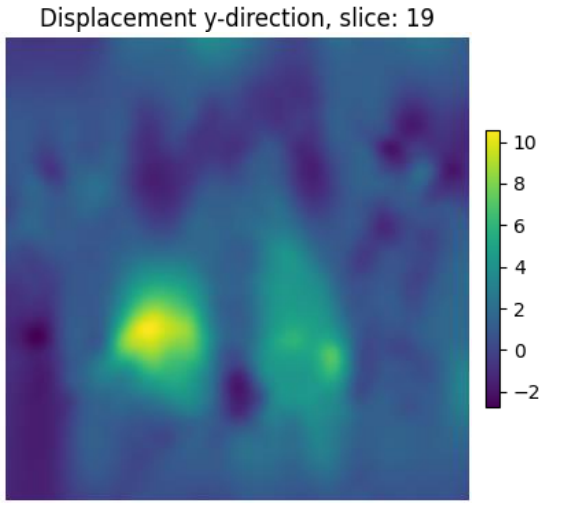




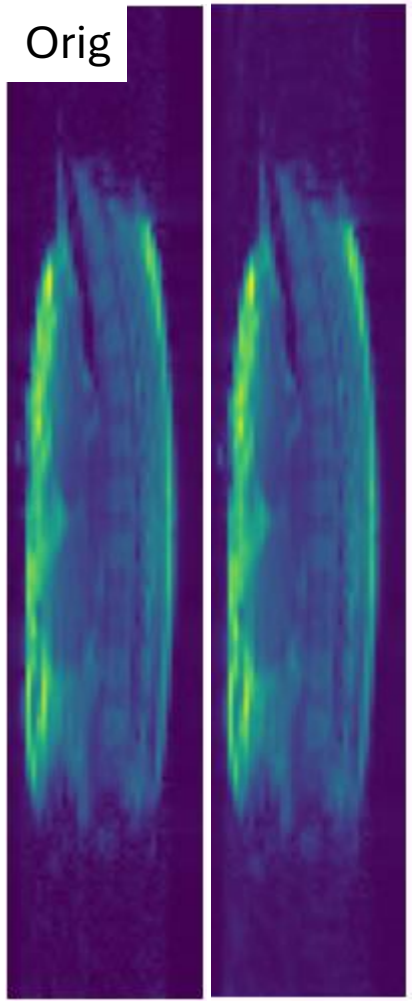


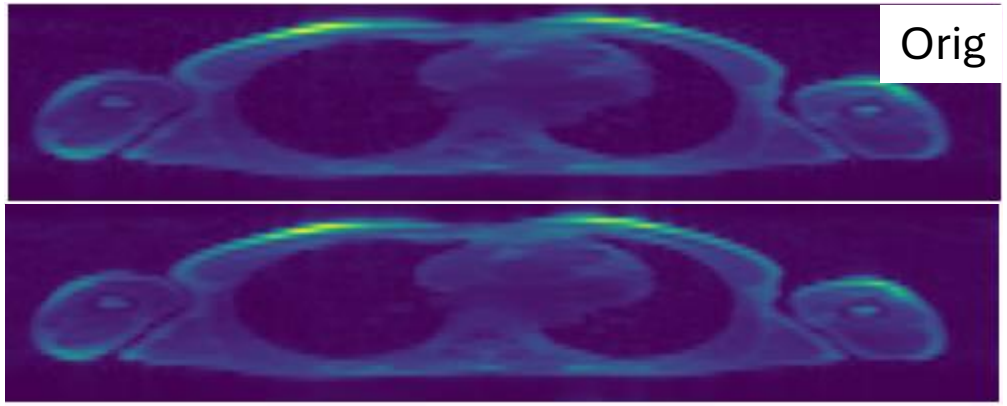
Displacement fields in the SI direction relative to bin 3.

Could use these transformations to warp PET bins



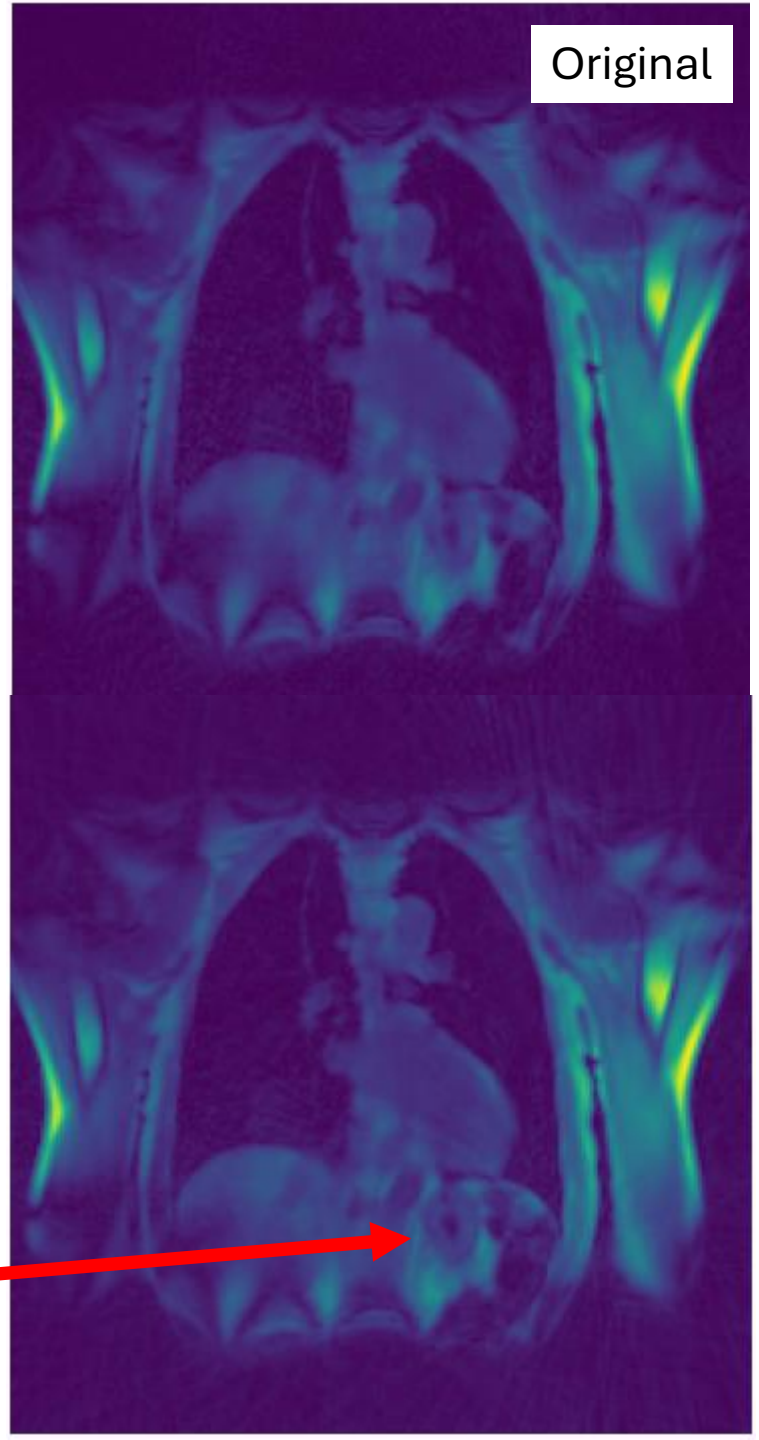
MRI and motion





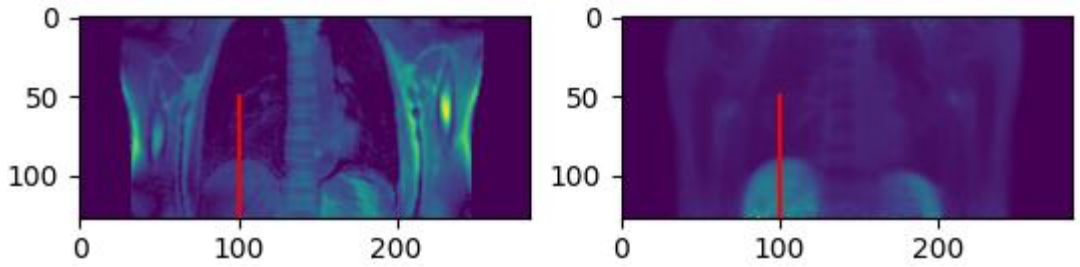
This is register, transform, add (RTA)

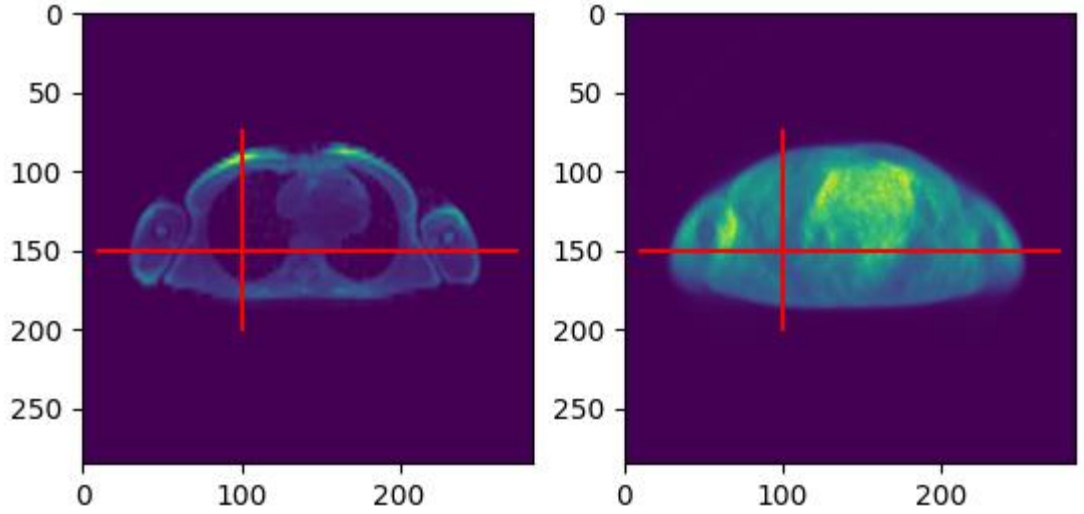
Motion corrected image reconstruction (MCIR) gives improvement around heart

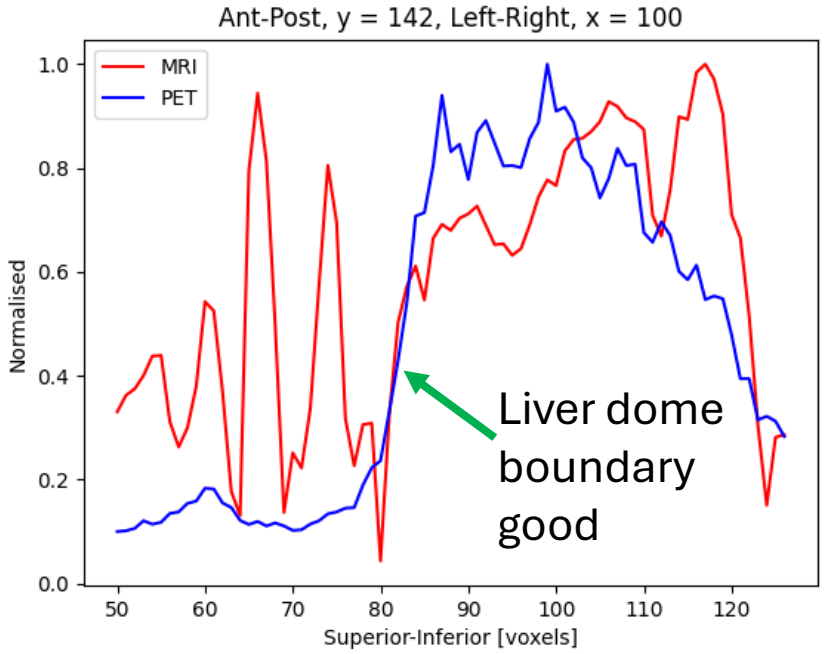


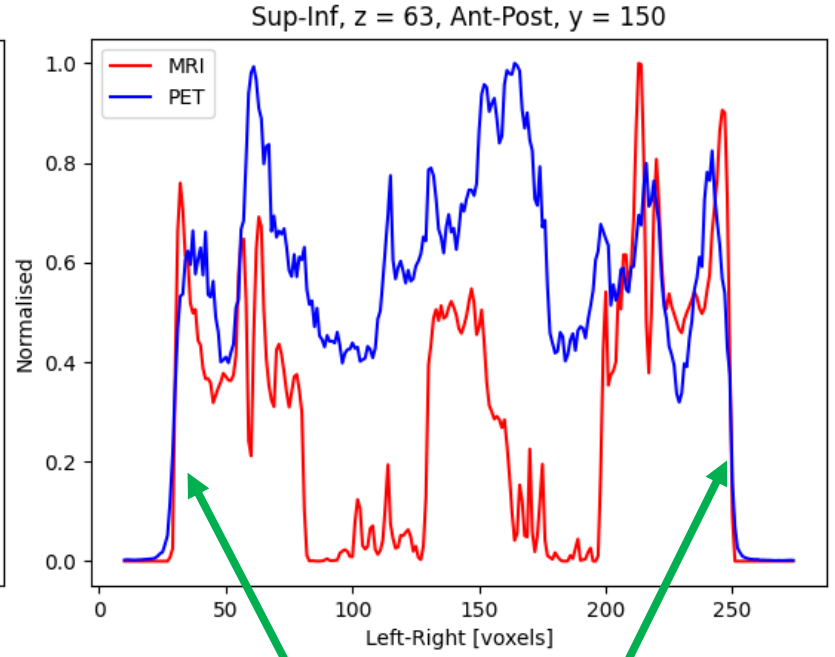
Noticeably sharper

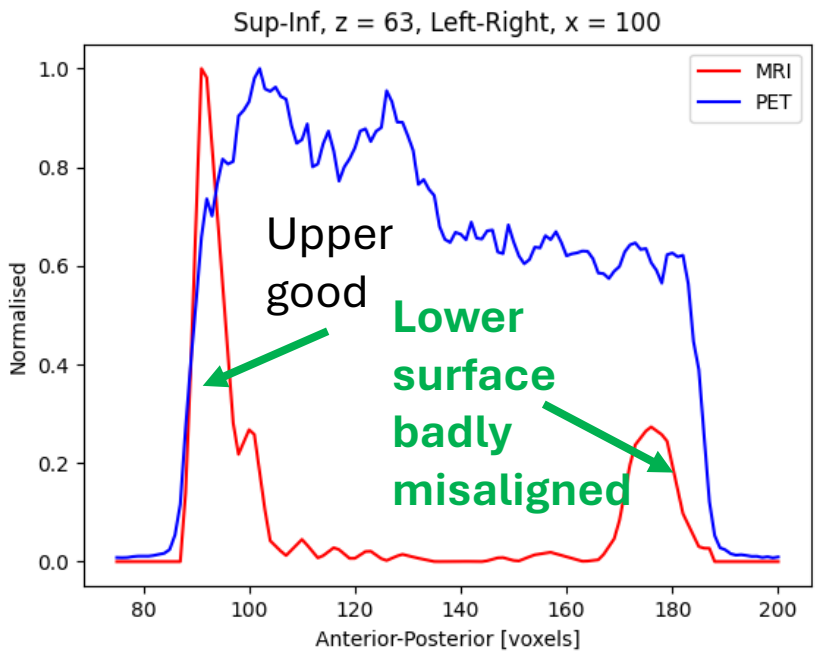
Consistency



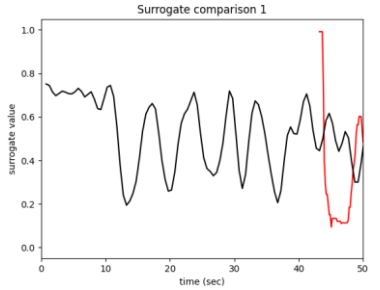


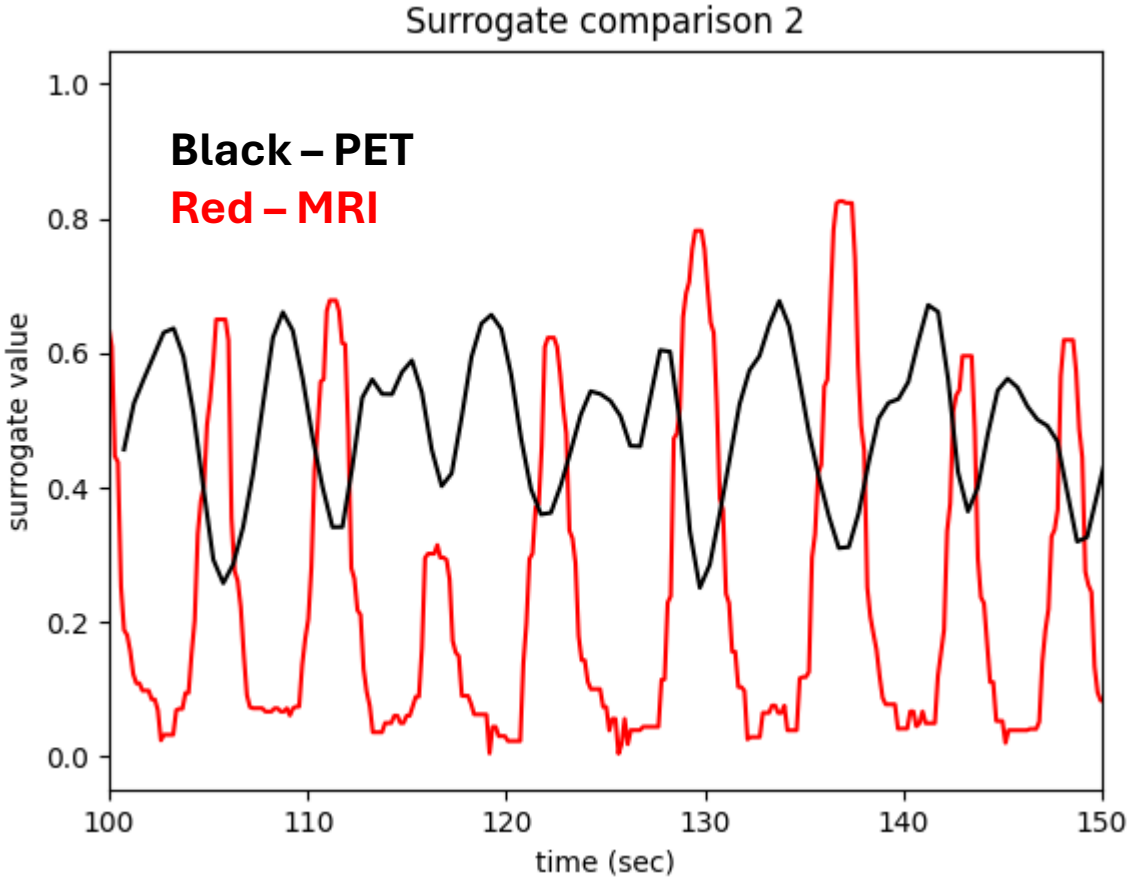


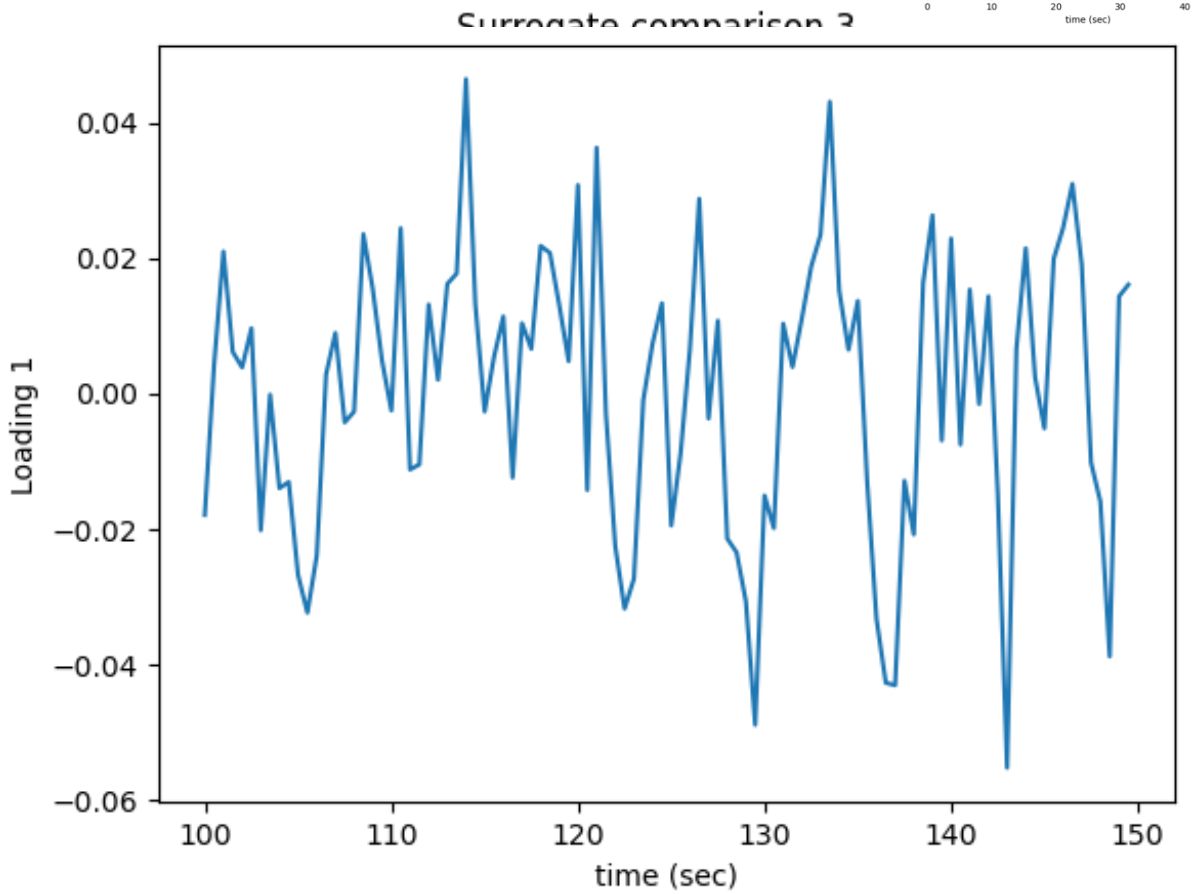




Consistency

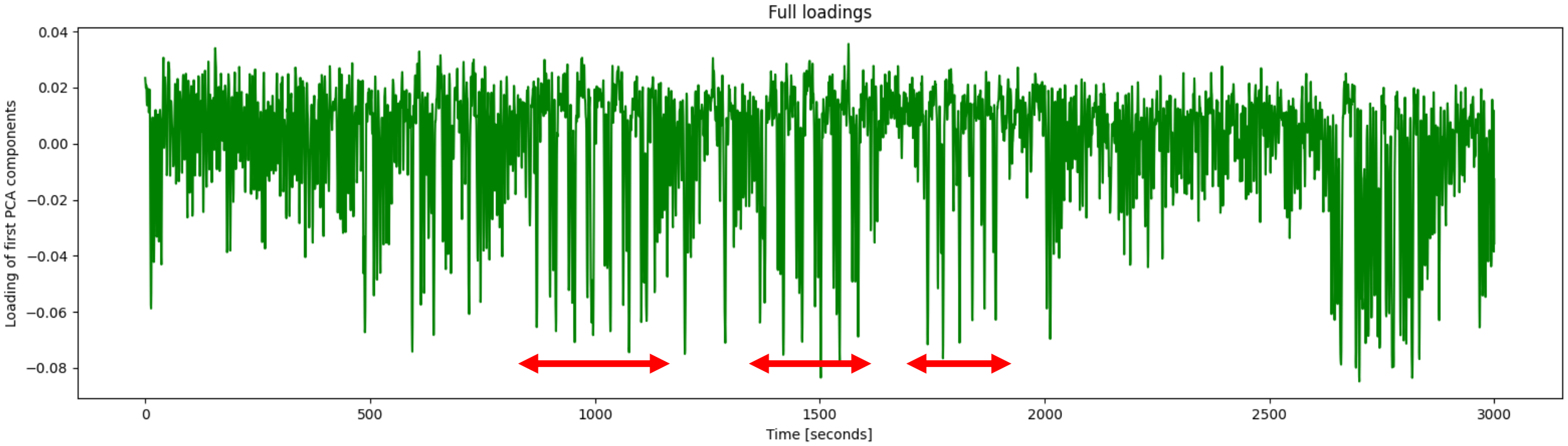






- Independent respiratory surrogates
- Agree perfectly without any adjustment

Breath-hold and the future



- Respiratory pattern far from regular
- Breath-hold protocols particularly challenging
- There is no StarVIBE MRI to accompany these segments

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