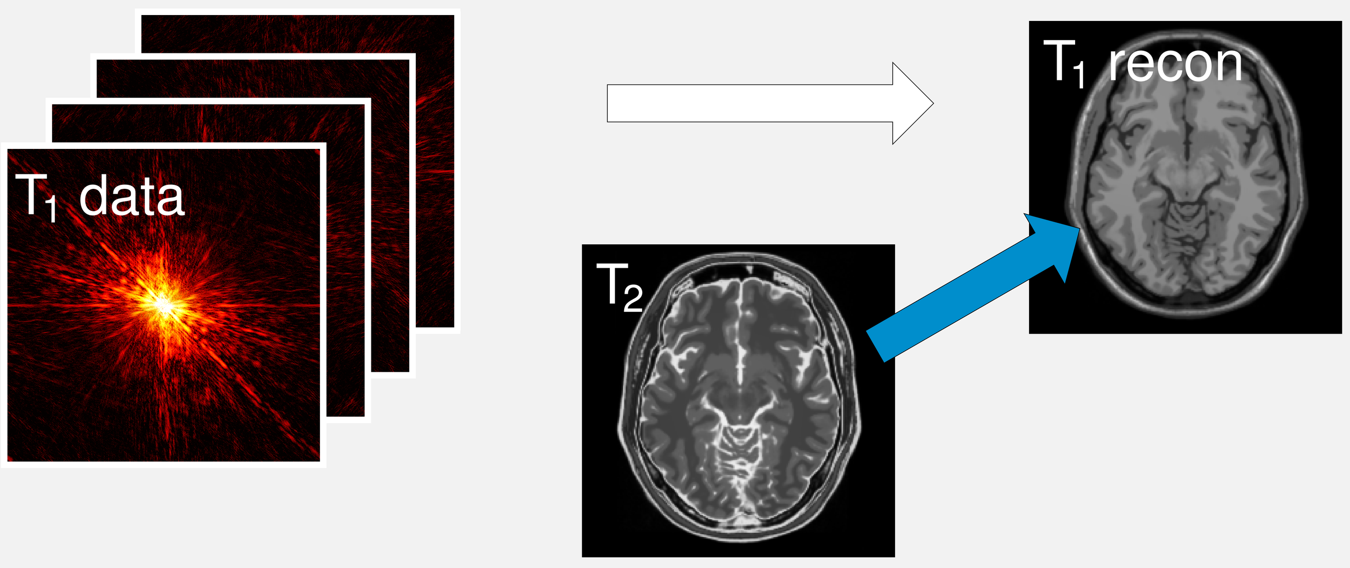
# Mathematical Innovation for PET and MRI Imaging

M. J. Ehrhardt[1], M. M. Betcke[2], P. Markiewicz[2], J. Schott[2] and C.-B. Schönlieb[3]
1 University of Bath 2 University College London 3 University of Cambridge
**contact:** m.ehrhardt@bath.ac.uk

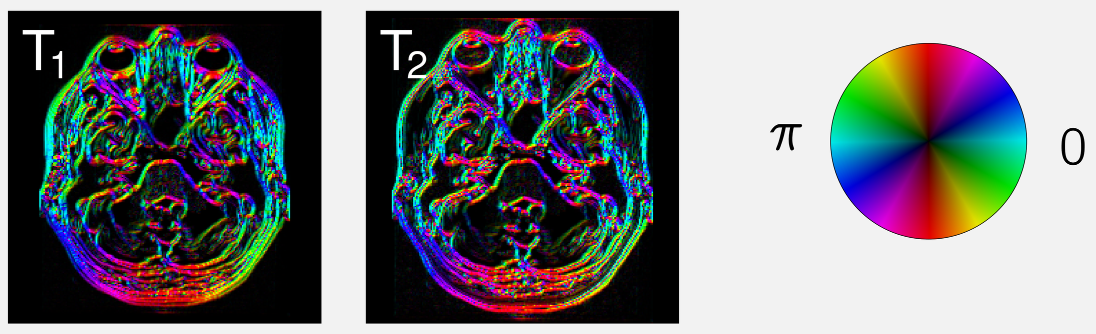
## Multi-Contrast MRI

Magnetic resonance imaging (MRI) is a versatile technology with many **different contrasts**, e.g. $T_1$ and $T_2$. MRI contrasts show **similar structures** due to same anatomy.

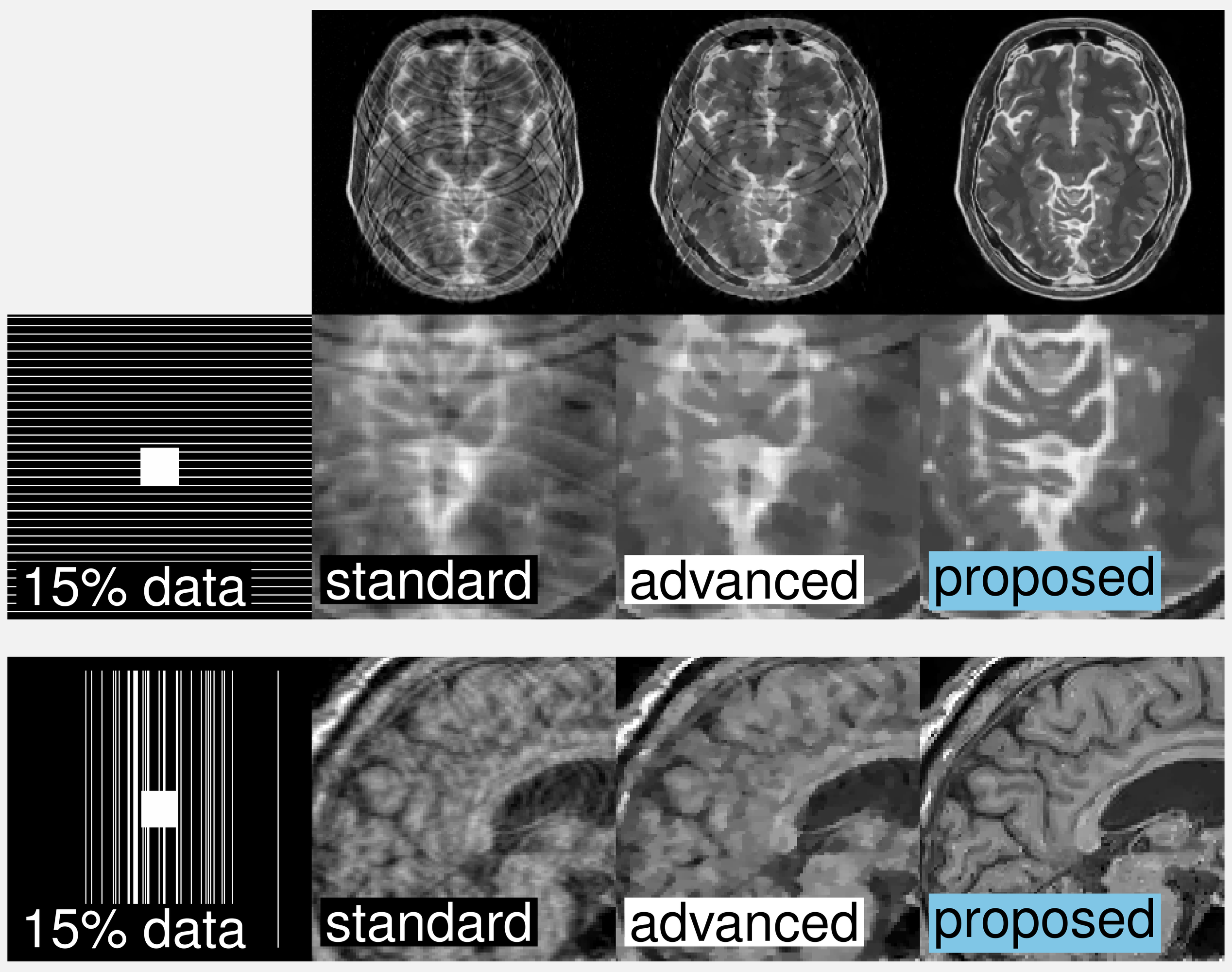
**Research hypothesis:** Can we **exploit redundancy**, transfer structure from one contrast to another and reconstruct from less data? This directly leads to **shorter scan** times (patient comfort, save time/money, dynamic imaging).



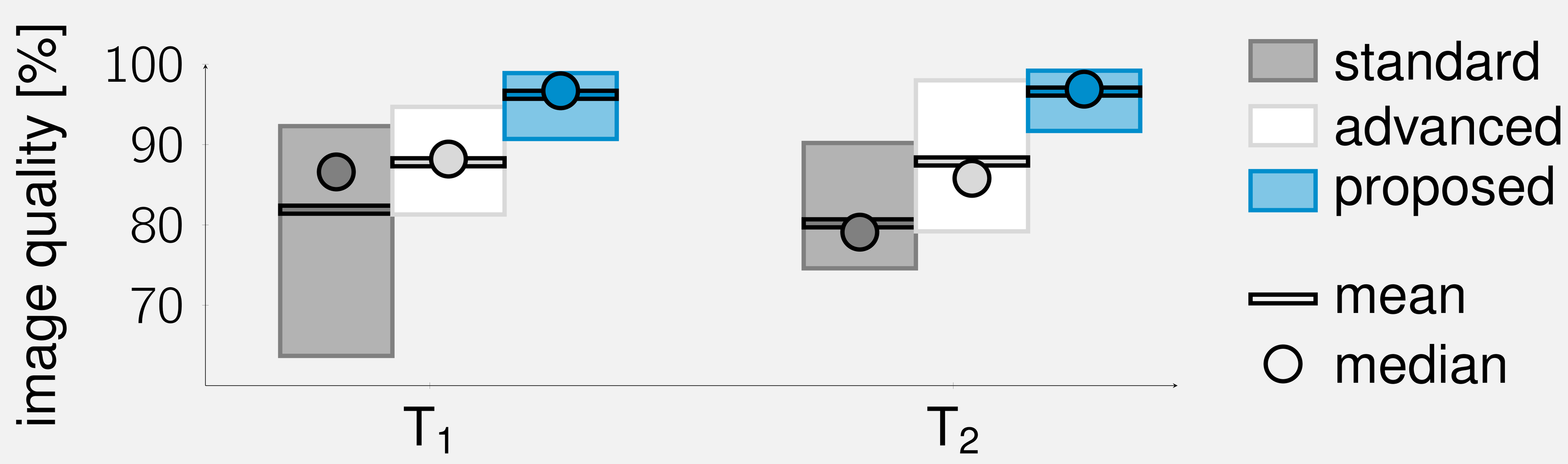

Difficult to compare images of different contrasts. **Define structure** on location and direction of contrast changes




## Qualitative Results [1]




## Quantitative Results [1]

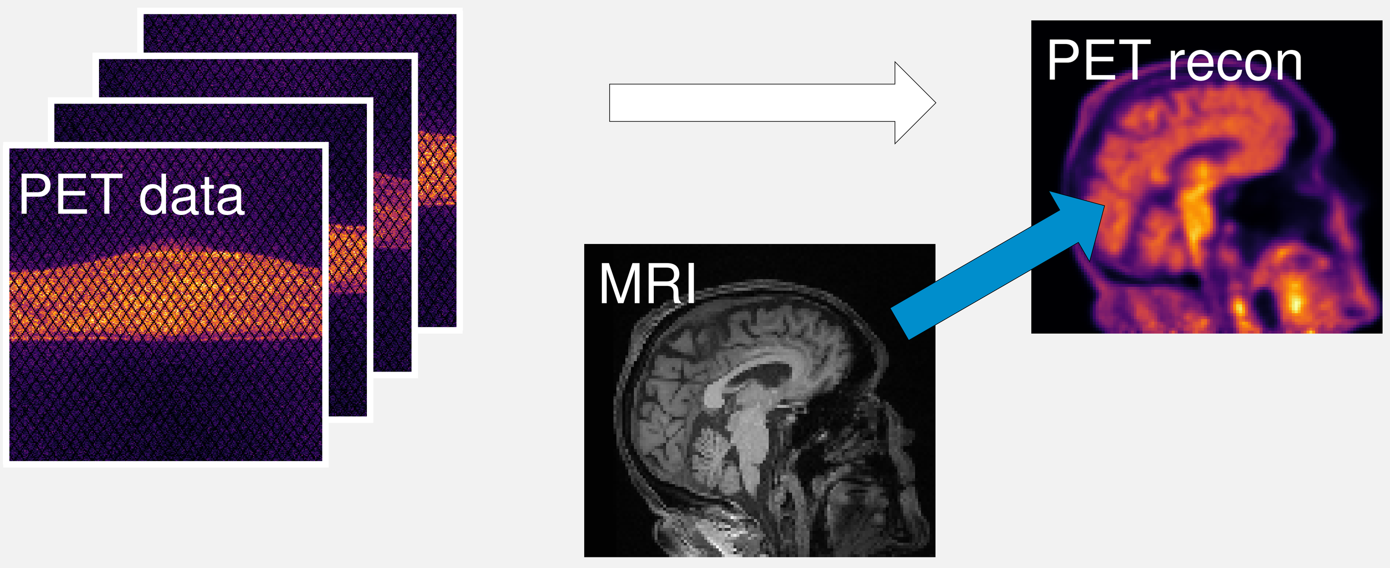



Range (min to max), mean and median over 12 data sets.

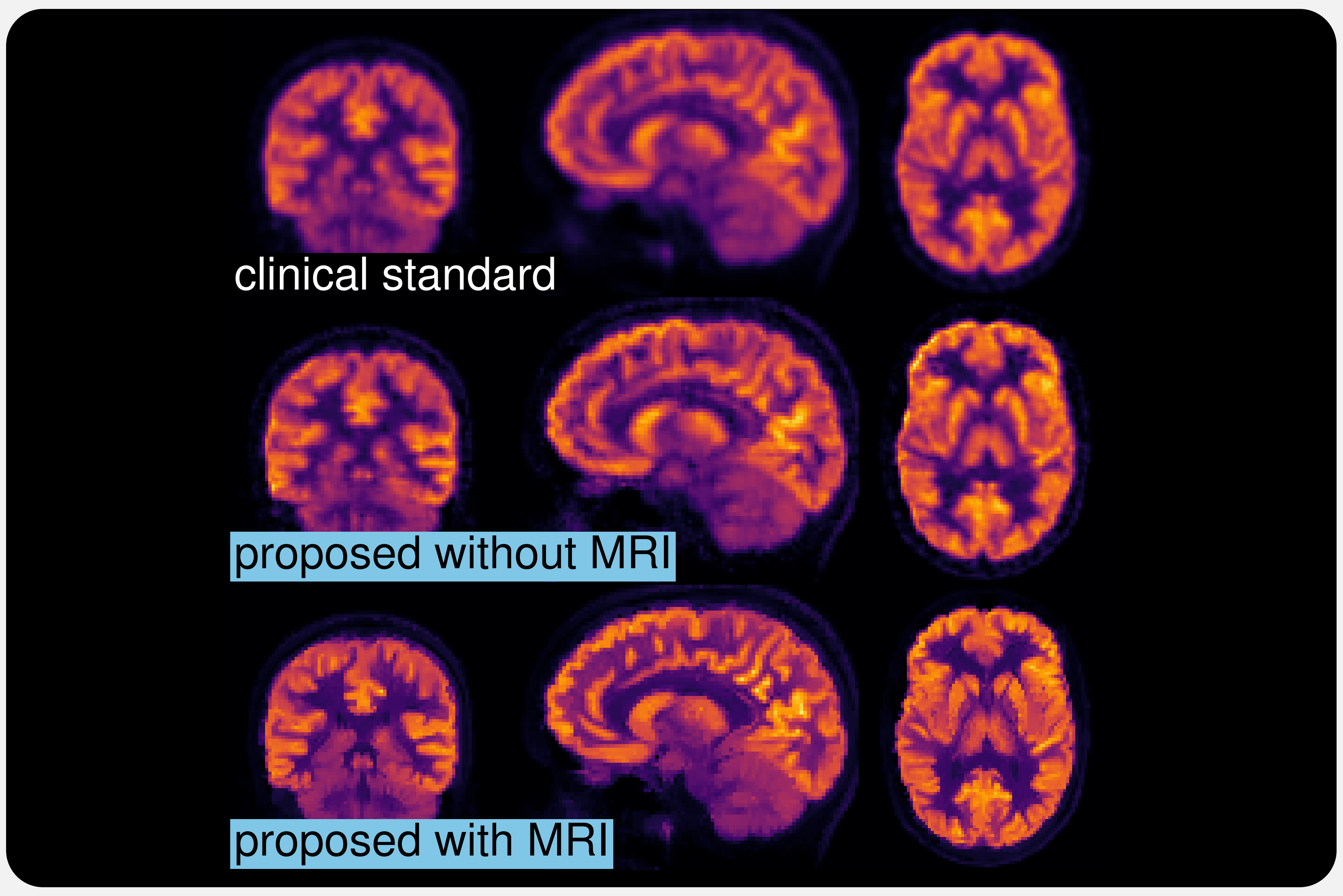
## PET-CT and PET-MR

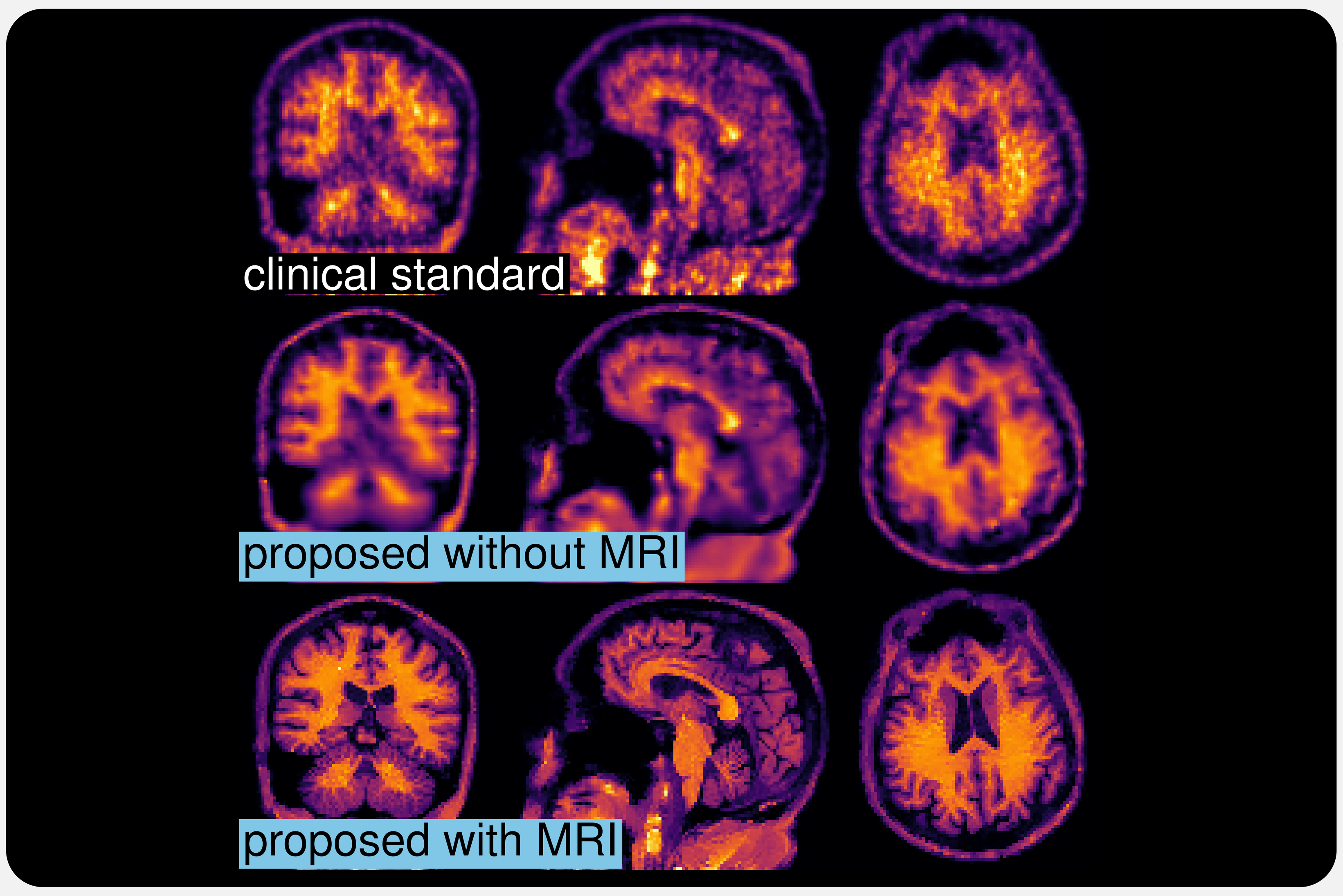
Positron emission tomography (PET) uses radioactive tracers (e.g. [$^{18}$F]FDG or [$^{18}$F]florbetapir) for functional imaging. Typical PET images are of low resolution, partly due to high noise in the data.

**Research hypothesis:** Can we enhance PET imaging (e.g. higher resolution) by **advanced mathematical models**? These models may or may not include anatomical MRI information. This may lead to: **better localisation, better quantification, lower dose**.




## Results: FDG and florbetapir [2, 3]




**References:**
[1] Ehrhardt, Betcke, Multi-Contrast MRI Reconstruction with Structure-Guided Total Variation, SIAM Journal on Imaging Sciences, 2016
[2] Ehrhardt, Markiewicz, Richtárik, Schott, Chambolle, Schönlieb, Faster PET Reconstruction with a Stochastic Primal-Dual Hybrid Gradient Method, Proc. SPIE, 2017
[3] Ehrhardt, Markiewicz, Schönlieb, Faster PET Reconstruction with Non-Smooth Priors by Randomization and Preconditioning, `arxiv.org/abs/1808.07150`, 2018

Institute for Mathematical Innovation
UNIVERSITY OF BATH