

Multi-Slice Single-Breath-Hold Cardiac CINE with Slice and Time-Dependent Deep Image Prior at 1.5T and 0.55T

Rafael de la Sotta[1], Tabita Catalán[1,2], Francisco Sahli[1,2,3], *René Botnar[1,2,3,4] and *Claudia Prieto[1,2,3]

[1]*Millenium Institute for Intelligent Healthcare Engineering, Santiago, Chile*
[2]*School of Engineering, Pontificia Universidad Católica de Chile, Santiago, Chile*
[3]*Institute for Biological and Medical Engineering, Pontificia Universidad Católica de Chile, Santiago, Chile*
[4]*School of Biomedical Engineering, King's College London, London, United Kingdom*

ISMRM & ISMRT
ANNUAL MEETING & EXHIBITION
Honolulu, Hawai'i, USA 10-15 MAY 2025

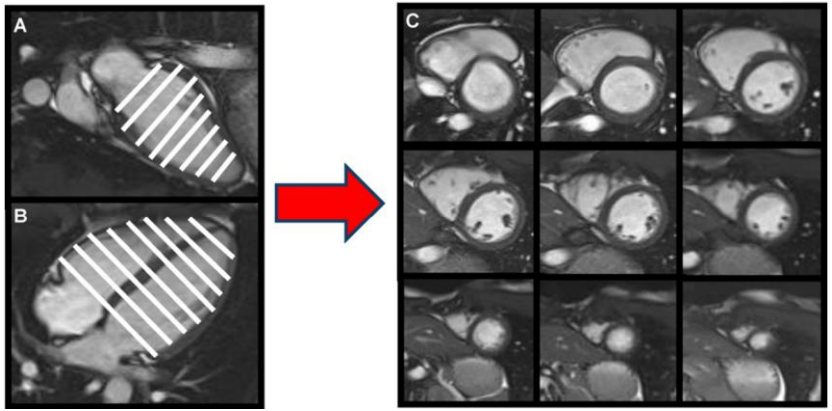
Declaration of Financial Interests or Relationships

Speaker Name: Rafael de la Sotta

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Motivation

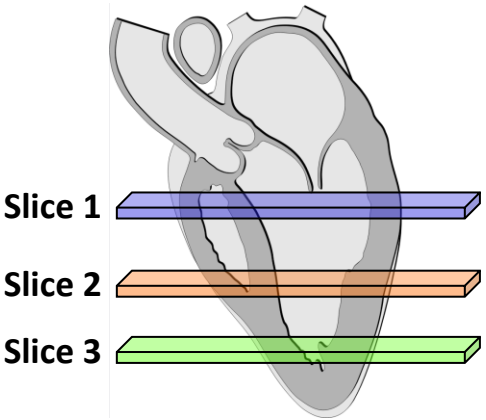
- Cardiac CINE MRI is the **gold standard** for the assessment of cardiac function.
- Conventional cardiac CINE MRI requires multiple slices and breath-holds, leading to **long scan times** and to **potential slice-misalignment**.
- Also, **multiple breath-hold can be challenging** for some patients.



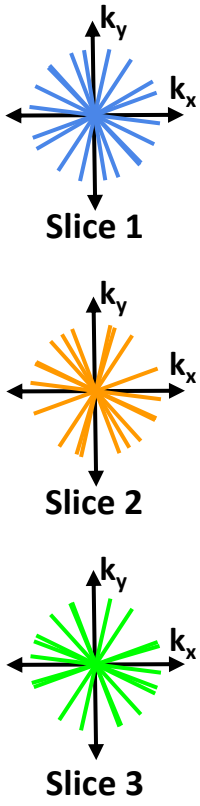
Objective

To perform a **multi-slice single-breath-hold** cardiac CINE, reconstructed by a **slice and time-dependent deep image prior (ST-DIP)** network.

Method Overview



Sequential single-breath-hold acquisition



Simultaneous reconstruction by **ST-DIP**

Slice and Time Dependent Deep Image Prior (ST-DIP)

In our **loss function** all slices (s) and frames (t) are reconstructed simultaneously.

$$\arg\min_{\theta} \sum_{s=1}^{N_s} \sum_{t=1}^{N_t} (||W \cdot (EG(s,t;\theta) - K_{s,t})||_2^2 + \lambda \cdot TV(G(s,t;\theta)))$$

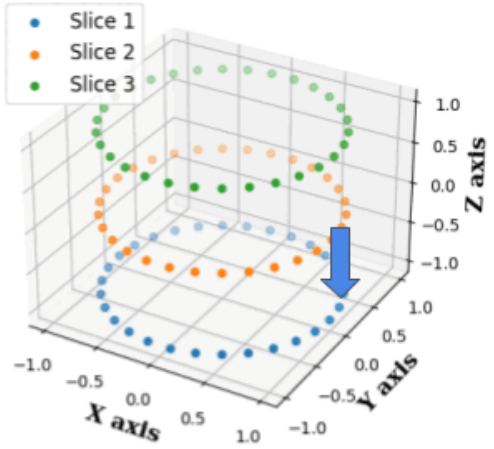
Frequency-weighted consistency loss

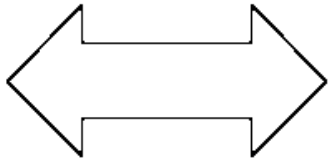
Regularization

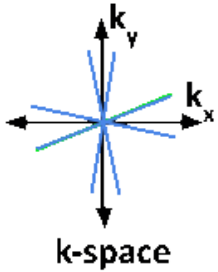
G: Neural network
θ: parameters
K: Acquired data
E: Encoding operator (Coil sensitivities, Fourier Transform, Undersampling)
W: Frequency weighting
TV: Total variation
N_S: Number of slices
N_T: Number of frames

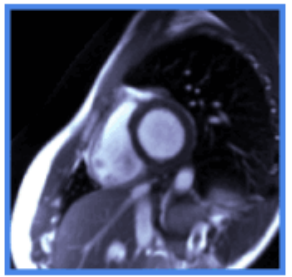
Slice and Time Dependent Deep Image Prior (ST-DIP)

We use a **Fixed latent representation** for multi-slice cardiac CINE

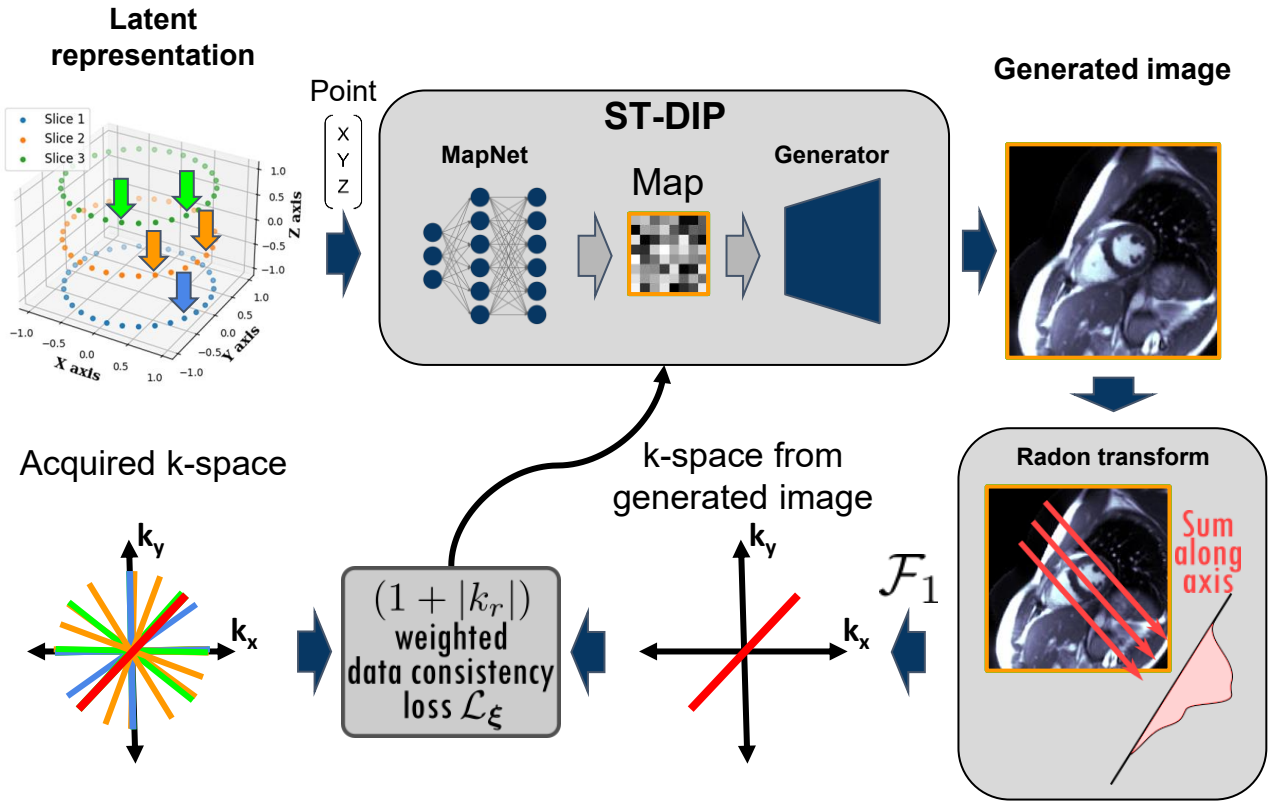








Slice and Time Dependent Deep Image Prior (ST-DIP)

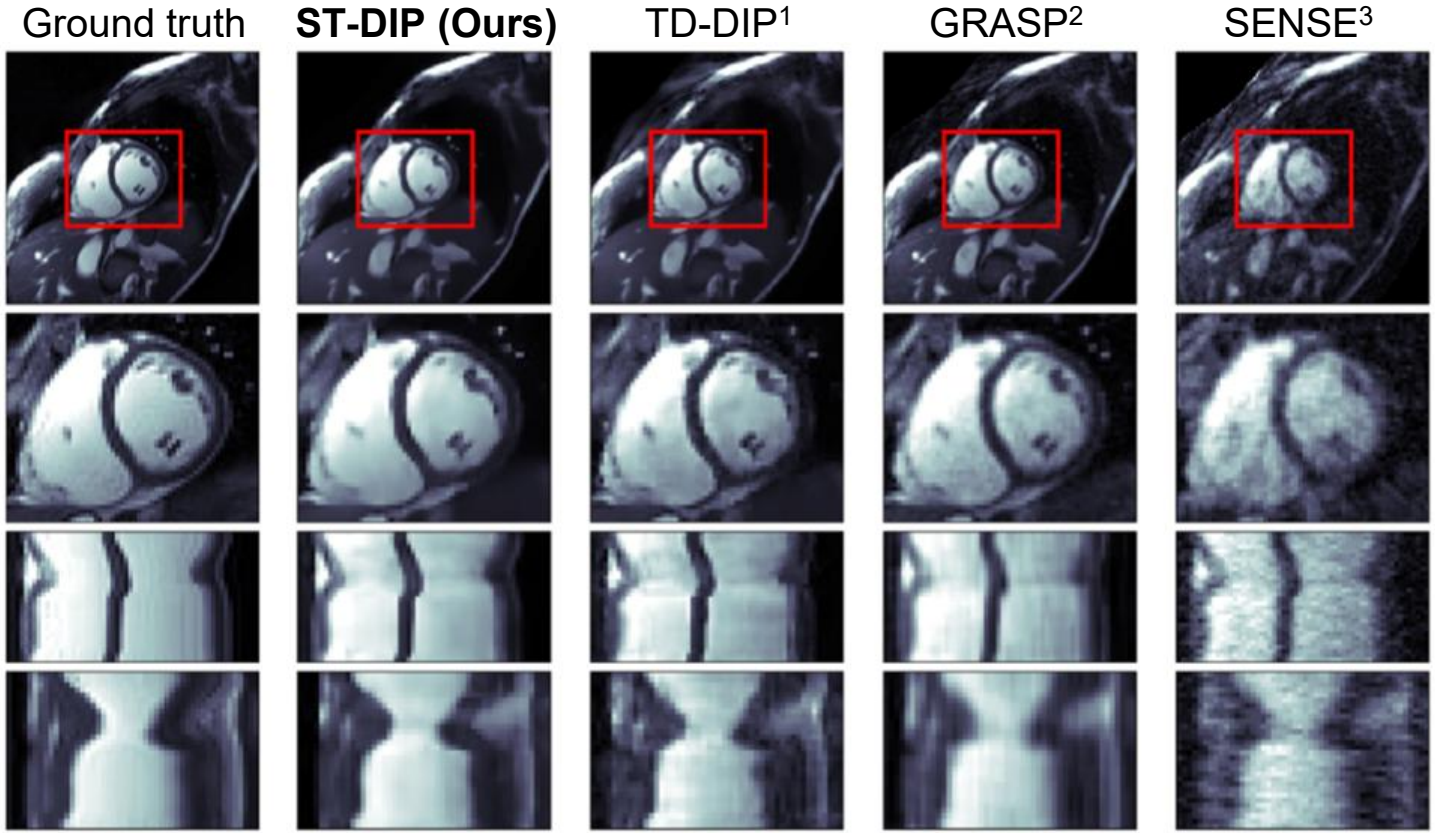


In-vivo experiments

We tested our method at 0.55T and 1.5T.

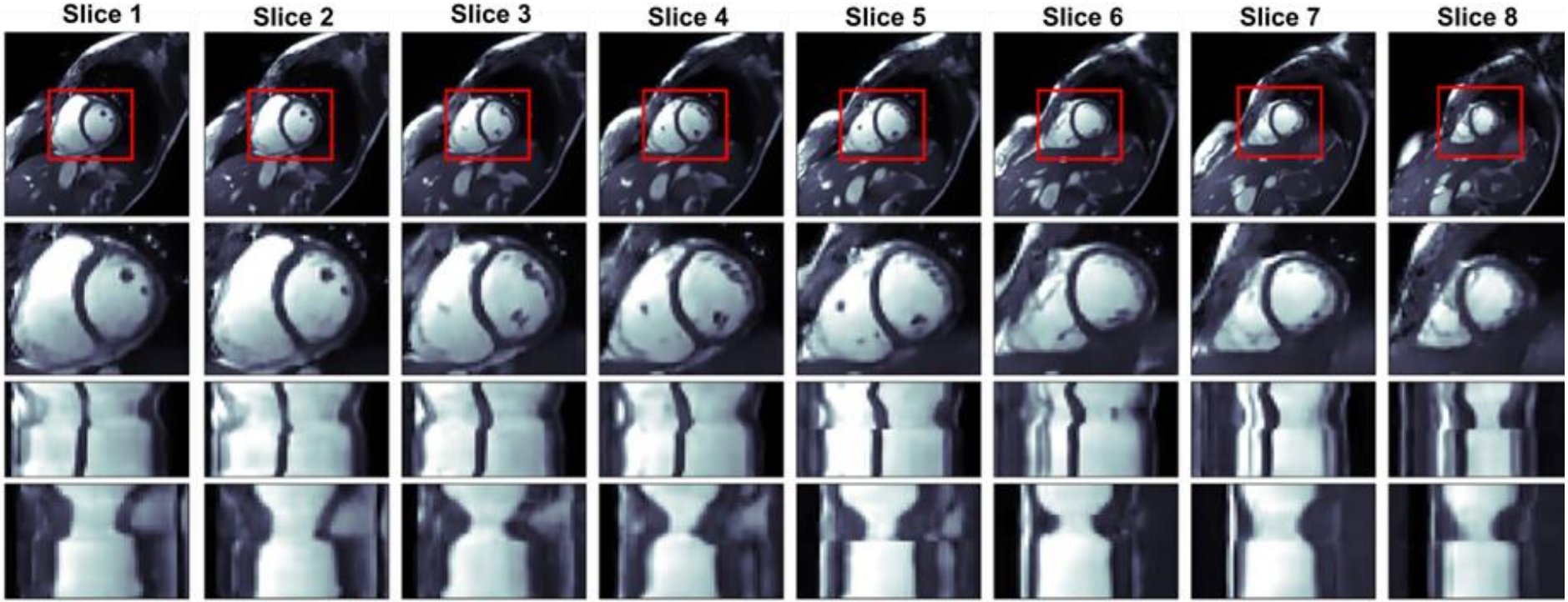
		1.5T	0.55T
Acquisition	FOV (mm)	256 x 256	256 x 256
	Resolution (mm)	2 x 2	2 x 2
	Thickness (mm)	8	10
	TE / TR (ms)	1.16 / 2.3	2.85 / 5.7
	FA (°)	60	78
	Number of slices	**8**	**8**
	Acquisition time per slice (s)	**1**	**1.5**
Reconstruction	Cardiac phase bins	30	30
	Undersampling factor / bin	**17**	**32**

Results: High-quality images at 1.5T

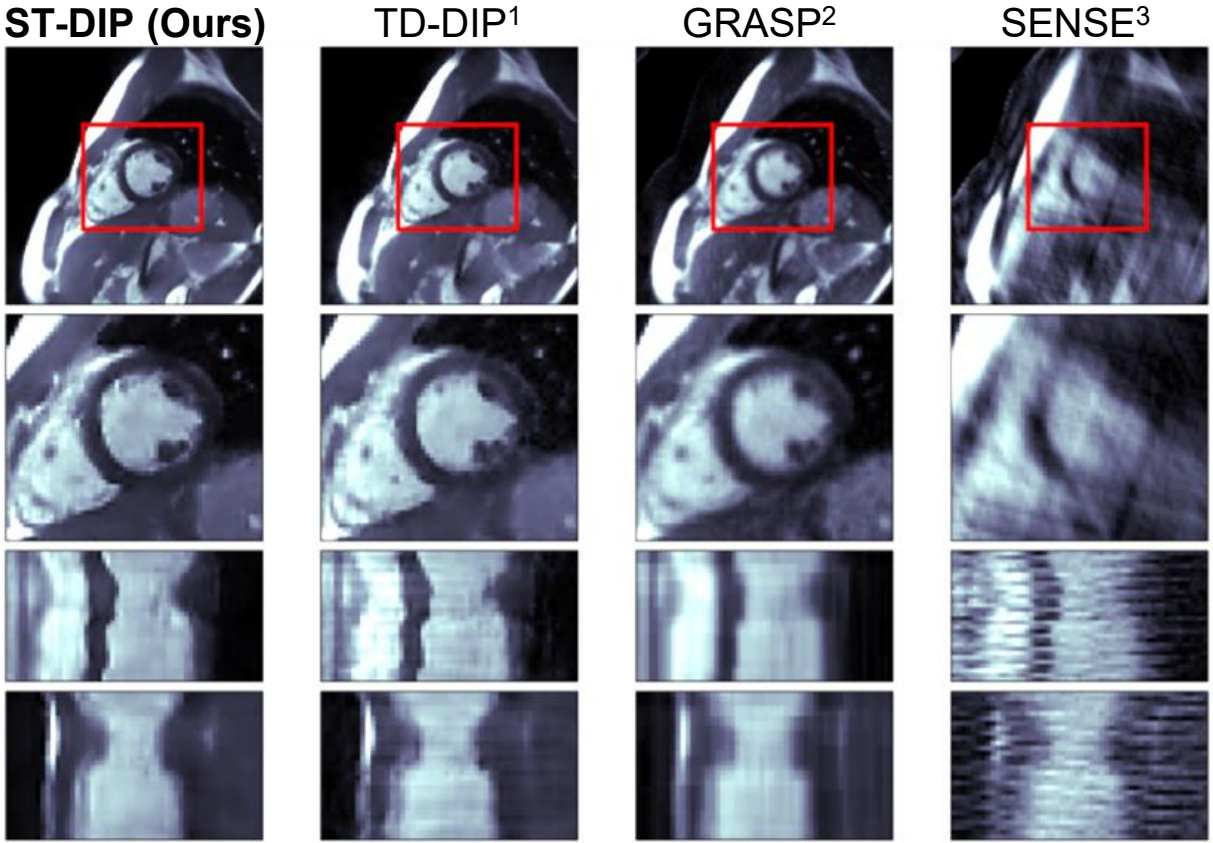


[1]Yoo, Jaejun, et al. IEEE Trans Med Imaging. 2021. [2]Feng, Li, et al. Magn Reson Med. 2014. [3]Pruessmann, Klass, et al. Magn Reson Med. 1999

Results: High-quality images at 1.5T

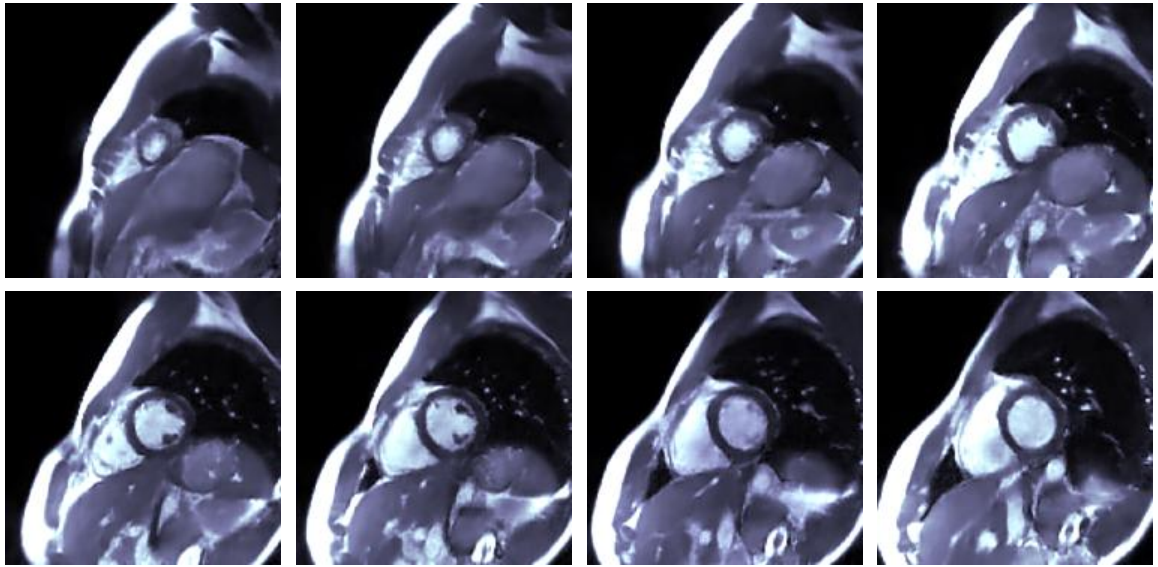


Results: High-quality images at 0.55T



[1]Yoo, Jaejun, et al. IEEE Trans Med Imaging. 2021. [2]Feng, Li, et al. Magn Reson Med. 2014. [3]Pruessmann, Klass, et al. Magn Reson Med. 1999

Results: High-quality images at 0.55T

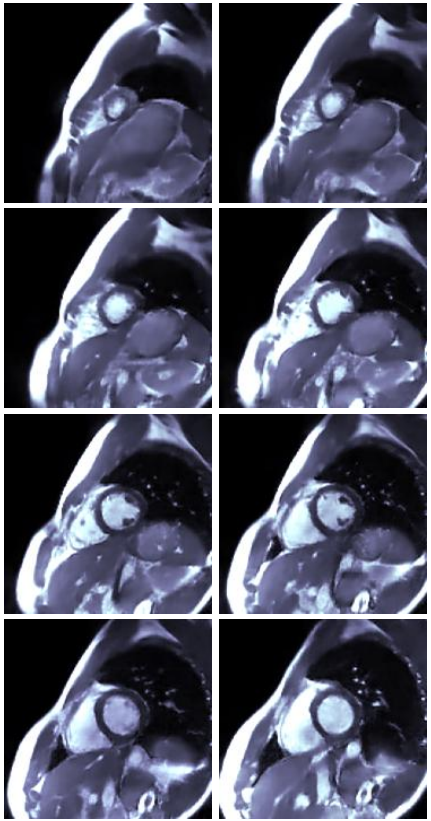


Conclusions

- 8 cardiac cines in a single breath-hold at 1.5 and 0.55 T.
- Slice and time-dependent DIP method.
  (see #2629 for a motion corrected approach)
- Outperform conventional reconstruction approaches and TD-DIP.

Future work

- Validation with patients.



Acknowledgements

ihealth | Millennium Institute for Intelligent Healthcare Engineering

https://i-health.cl/

@iHEALTHMilenio

@KCL_CardiacMR

This work was funded by ANID - Millennium Science Initiative Program - ICN2021_004