AI for Imaging Metabolic Disorders

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Motivation:

- Metabolic disorders affect multiple organs.
- Our motivation is to identify and quantify changes caused by these disorders.

Goals:

- Create and deploy post processing AI tools for:
  - Adipose tissue quantification.
  - Heart Strain measurement.

Automatic Abdominal Adipose Tissue Segmentation in Cushing Syndrome

Background:

Cushing syndrome:
Cardiovascular complications
Central obesity.

Main Objective:

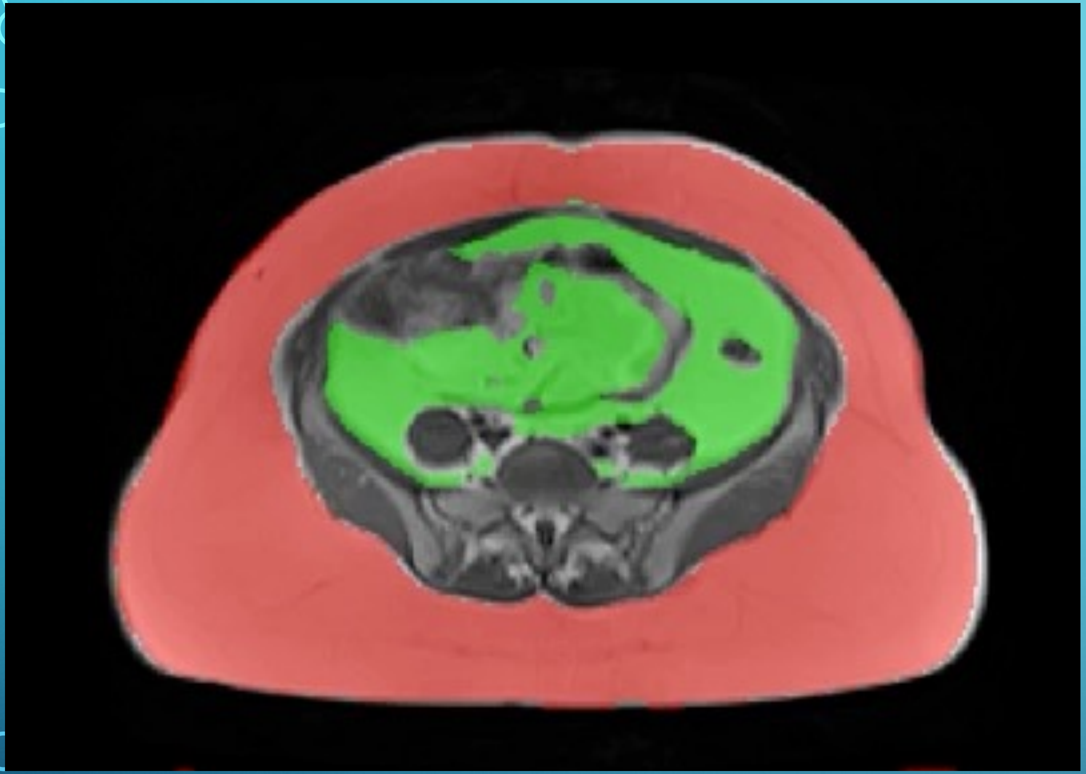
Use AI to monitor obesity after treatment.

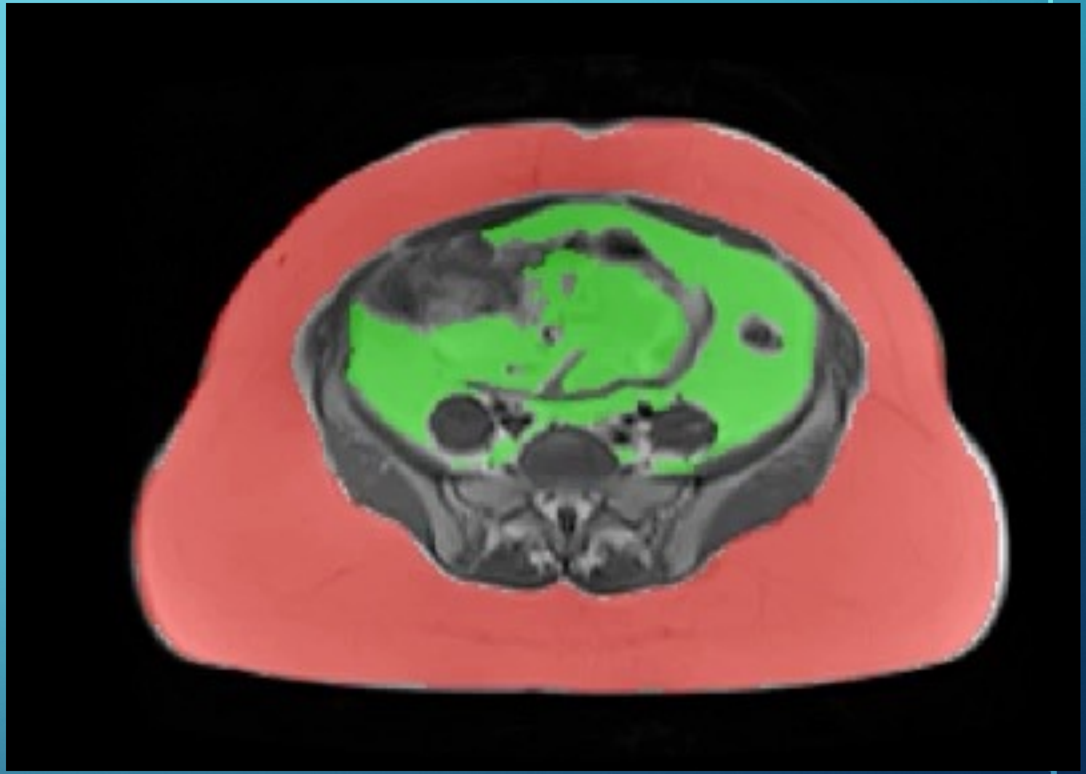
Methods:

- T1-weighted axial images; TR/TE 700/11 ms, flip angle 120˚, matrix size 256 x 180.
- 22 subject volumes out of 91 were chosen as the training dataset;
  3 for validation and 5 for testing.
- Nvidia's Clara Train SDK (ver. 3) ResNet DNN [1] with 4 down blocks and 3 up blocks, dropout of 0.2 and final softmax activation, Adam optimizer, on Nvidia RTX 5000 (2500 Epochs and 7 hours training).

- **This work was published as part of "T**he Improvement in Hepatic Steatosis After Cushing Syndrome Treatment is an Early Sign of Metabolic Recovery" – Under Review.

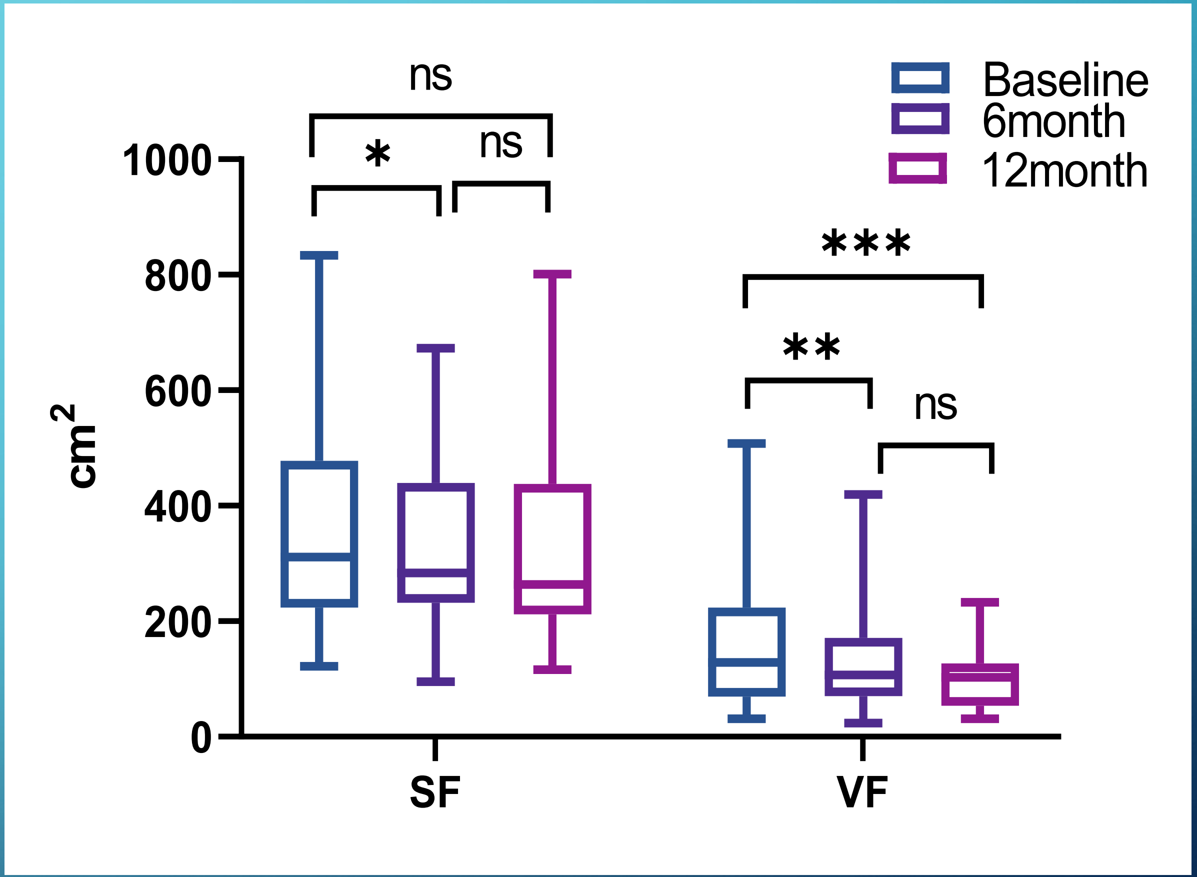
- [1] Myronenko, A., 3D MRI brain tumor segmentation using autoencoder regularization, arXiv:1810.11654.





Average inference time for a single subject volume was ~ 2 seconds.

- Subcutaneous and visceral fat decreased at the 6 month mark.
- Visceral fat remained significantly lower than the baseline.
- Percentage change in fat volume was significantly higher in visceral fat compartment compared to subcutaneous fat.



Direct Pixel to Pixel Principal Strain Mapping from Tagging MRI*

Background:

Conventional strain field mapping techniques are limited in their resolution.
Finer resolution strain mapping still an active area of research.

Main Objective:

Use AI to generate a finer resolution principal strain field mapping for better localization of early-stage tissue strain; i.e. in the myocardium and liver.

Methods:

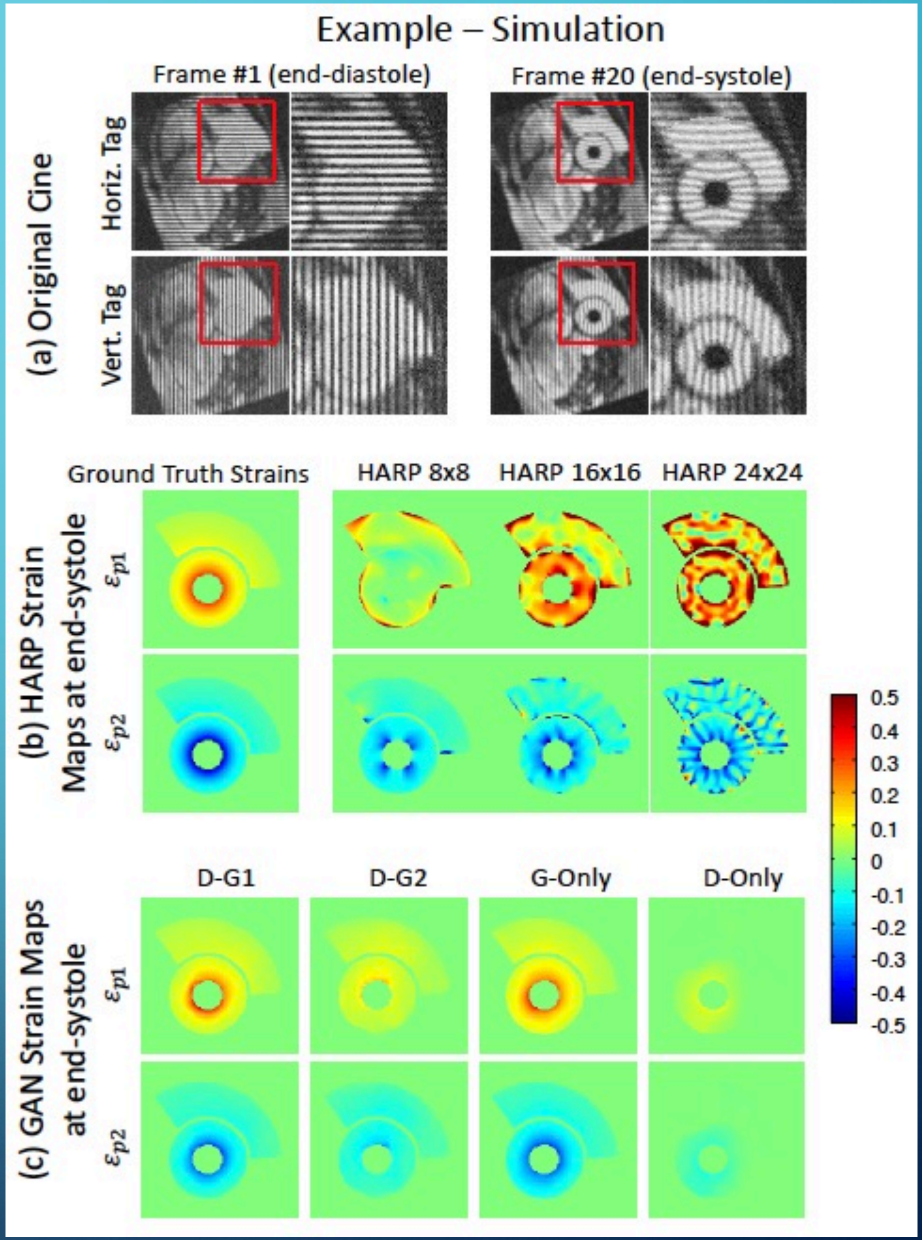
- Computational motion simulator developed in-house to simulate tagging datasets of the myocardial short-axis view.
- Simulator was superimposed on background 3D-TFE or cine bFFE sequences.

* Submitted to Scientific Reports. Under Review.

- 2. Mirza M, Osindero S. Conditional Generative Adversarial Nets. CoRR 2014; abs/1411.1784.

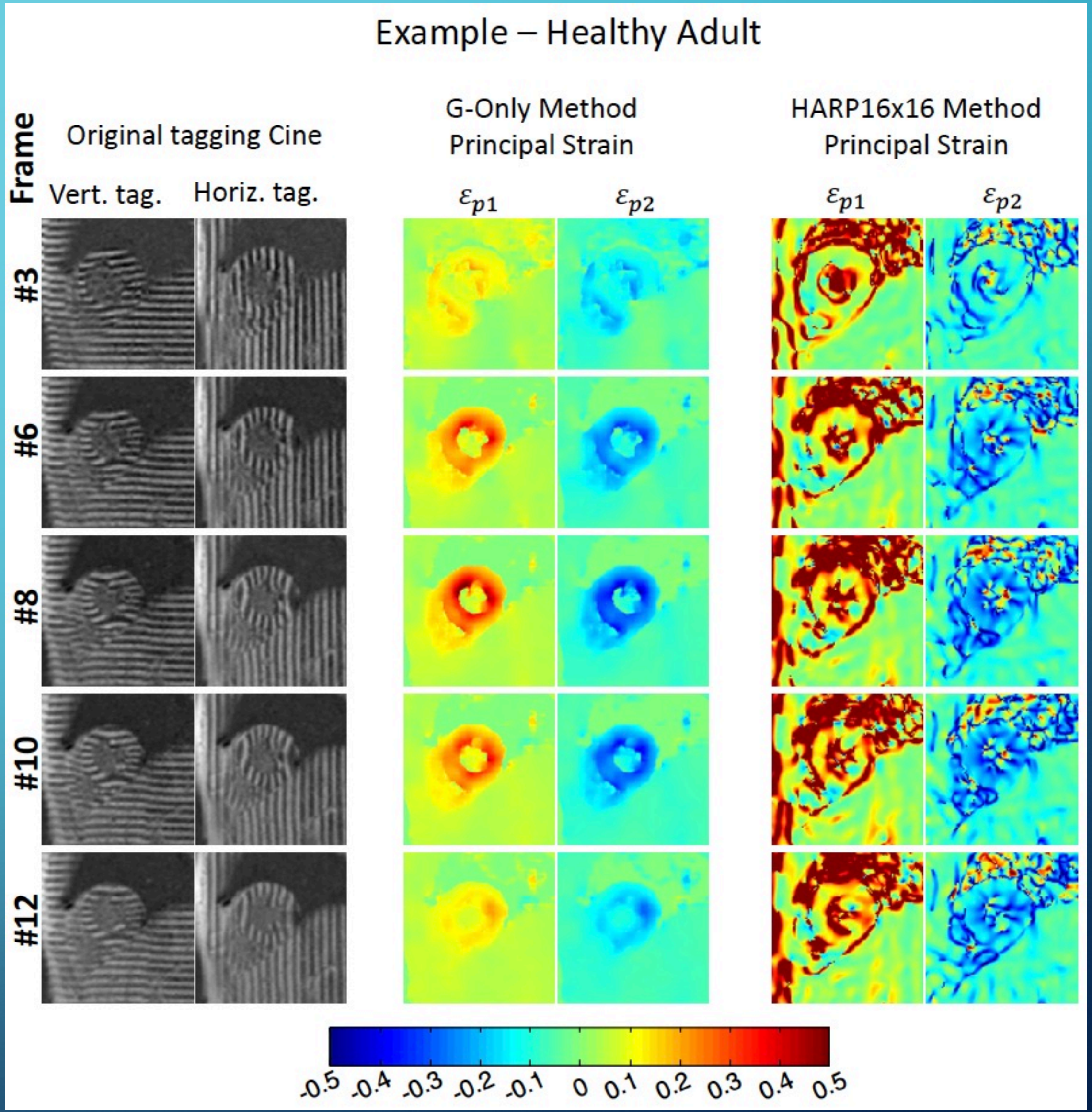
Computational Simulation:

- Motions of the left ventricle and the liver were simulated while a still anatomical image was included as a background (randomly selected and rotated image out of a pool of 250 images).
- Simulations performed in Python.



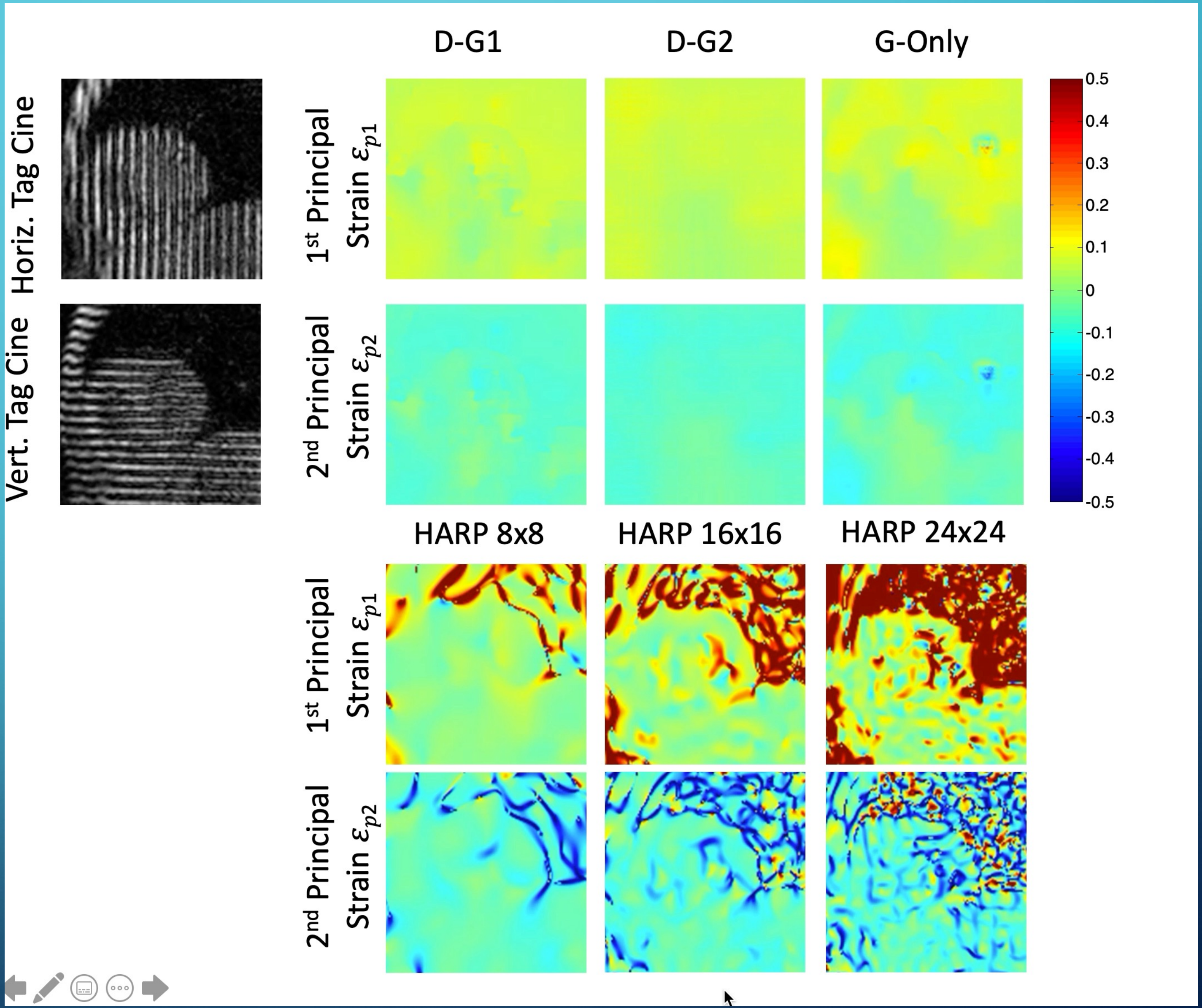
Network Architecture:

- Conditional generative adversarial network (cGAN) [2] with 8 Conv layers down and 8 Conv layers up in the U-net of the generator net and 5 Conv layers in the discriminator net was used for training.
- Adam optimizer was used and training was conducted on an Nvidia RTX 5000 GPU in Python and TensorFlow.
- Training was stopped when the generator pixelwise loss diminished and converged to a plateaued stable minimal value.



2. Mirza M, Osindero S. Conditional Generative Adversarial Nets. CoRR 2014; abs/1411.1784.

PAH Patient:


D-G1
D-G2
G-Only
Horiz. Tag Cine
Vert. Tag Cine
1st Principal Strain ε_{p1}
2nd Principal Strain ε_{p2}
HARP 8x8
HARP 16x16
HARP 24x24
1st Principal Strain ε_{p1}
2nd Principal Strain ε_{p2}
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5