# AI-based Evaluation of cardiac real-time MRI with congenital heart disease

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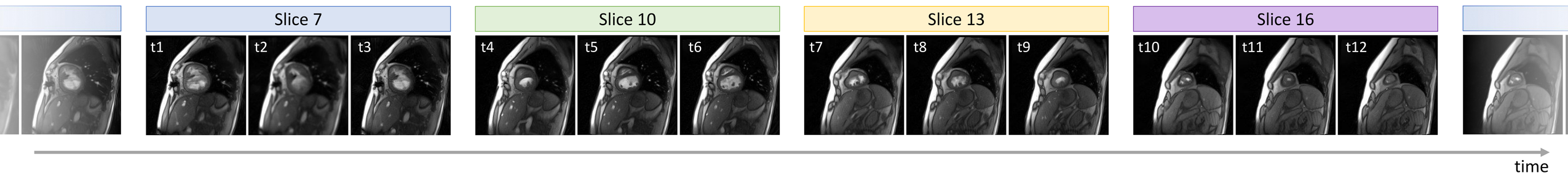
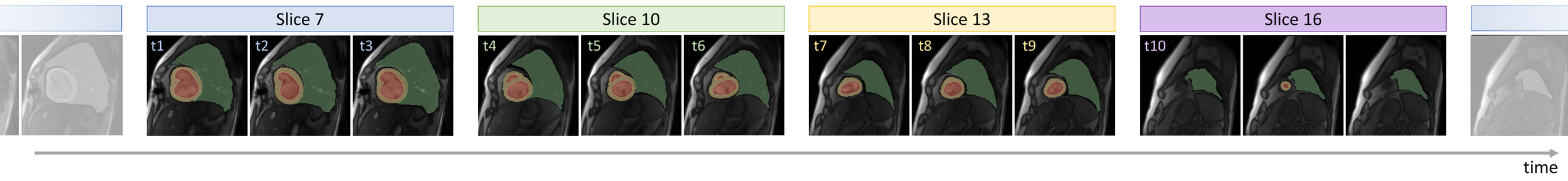
## Real-time Magnetic Resonance Images of a univentricular heart recorded at 30fps

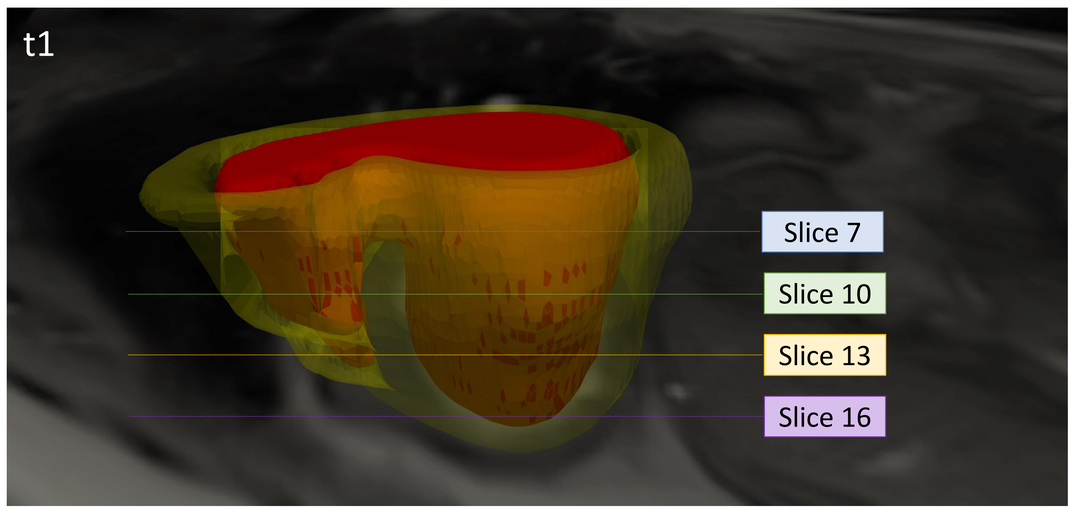



## Automatic Segmentation of the Left Ventricle, Myocard and Lung




## Automatic Synchronization of Respiration and Cardiac Cycle


## Visualization of a beating heart with segmented Left Ventricle and Myocard




## Background

- Cardiac MRI is an important diagnostic tool in heart diseases
- Assessment of **vital parameters like stroke volume or myocardial function**
- Conventional CINE MRI limited in congenital heart diseases due to limited breath hold capabilities and irregular heart beat
- **Real-time MRI** with framerates over 30fps allows **recording during spontaneous breathing**
- High framerates yield large amounts of data that need to be evaluated highly efficiently and with as little manual intervention as possible

## Requirements

- Comprehensible predictions, easy to verify by medical staff
- **Editable interim results**
- **High performance** on standard hardware
- High expendability for further research

## Key challenges

- Deep Learning with **small and noisy data sets**
  - Very specific heart anatomies
  - Anomalies in data due to metal artifacts
  - Limited amount of patients, only few examined with real-time MRI
- **Acquisition of 2D** videos, layer by layer ↔ **Evaluation of 4D** (3D+time) data
- Patients are able to breath freely, respiration dependency
- **Reliability** and Uncertainty Quantification

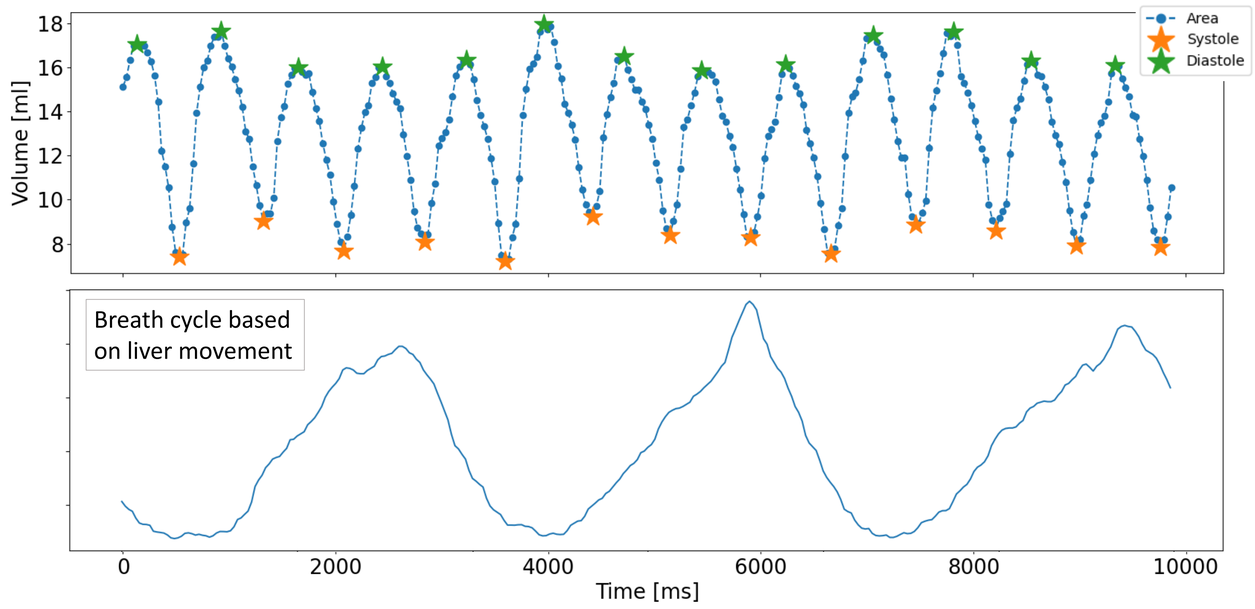
## Methods

- **Semantic Segmentation** of Left Ventricle and Myocard using U-Net architecture
  - Pretrained nnU-net [1] with healthy hearts in short axis view
  - Expert Annotations of CINE and Real-time MRI of univentricular hearts for transfer learning

## Results

- Automatic breath- and cardiac cycle synchronization
  - **Determination of diastolic and systolic phases** based on segmentations
  - **Determination of respiratory phases** based on lung, liver and thorax movements
- Evaluation of vital parameters
  - Computation of stroke volume at various pairs of respiratory and cardiac phases
  - **Influence of respiration on stroke volume and myocardial function**

## Evaluation of vital parameters like the stroke volume subject to respiration




## References

[1] Isensee, F., Jaeger, P.F., Kohl, S.A.A. *et al.* nnU-Net: a self-configuring method for deep learning-based biomedical image segmentation. *Nat Methods* 18, 203–211 (2021).

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