

# Orbit Designs for Image Quality Improvement

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# **Orbit Design - Neuroimaging Design space** $(\theta, \phi)$ at fixed $\theta$ (1°~360°) **Embolization coil** $-50^{\circ} \le \phi \le 50^{\circ}$ Image quality metric detectability index of spherical stimuli 30 stimulus locations on ellipsoid surrounding coil Predictive image quality model For penalized likelihood reconstruction with quadratic penalty Fast prediction of noise, resolution, and d' based on the object and imaging task Stayman et al., Task-driven source-detector trajectories in cone-beam computed tomography: I. Theory and methods, 2019, JMI Capostagno et al., Task-driven source-detector trajectories in cone-beam computed tomography: II. Application to 13 neuroradiology, 2019, JMI

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# **Universal Orbit Design**

## Patient-specific designs

Advantages for imaging performance Logistic challenges with calibration, quality assurance

## Universal orbit for metal artifact reduction

Does not require prior information Robust against arbitrary metal shapes/positions Easy to calibrate, quality assurance

### Data through metal as missing data

Introduce missing sampling/frequencies Orbit design to acquire complete data for all locations

Gang et al., Non-circular CT orbit design for elimination of metal artifacts, SPIE 2020

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# Summary & Discussion Ffects of orbit on image quality Objective image quality metric (noise, resolution, bias) Composite metrics (detectability index) Dependence of optimal orbit Object, location, imaging task, General procedures and different implementations for orbit design Objective function: detectability index, spectral shift, sampling completeness Optimization algorithm: greedy, non-greedy Patient-specific, task-specific vs. universal Implementation Challenges Calibration for irreproducible orbits Self/online calibration Reconstruction speed Analytic, Deep learning

# References

# **Patient-specific**

### **Task-driven Design**

Stayman, Fully 3D, 2015 Stayman, JMI, 2019 Capostagna, JMI, 2019 Fischer, Scientific Report, 2016

# **Kinematic Constraints**

Hatamikia, MedPhys, 2020 Hatamikia, Plos One, 2021

Online Design Thies, IJCARS, 2020

Metal Artifact Avoidance Wu, PMB, 2020

# **No prior information**

Metal artifact Gang, SPIE, 2020

Space filling trajectory Kingston, IEEE Comp Imaging, 2018

# **Self Calibration**

Muders, IEEE Trans Nuclear Sci, 2014 Ouadah, PMB, 2016

DL recon for arbitrary geometry Russ, CT Meeting, 2021

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