

Estimating Average Dielectric Properties for Microwave Breast Imaging using Focal Quality Metrics

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Overview

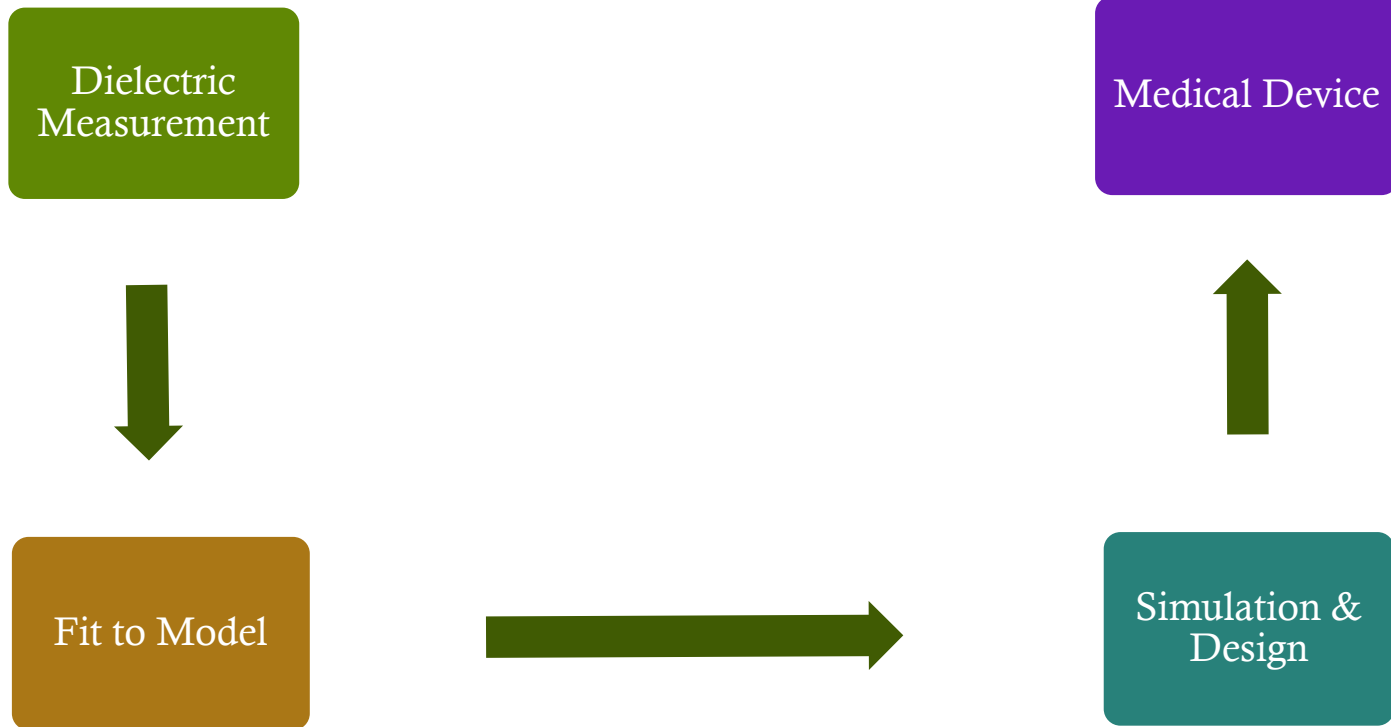
Focal Quality Metrics

MBI Quality Optimisation

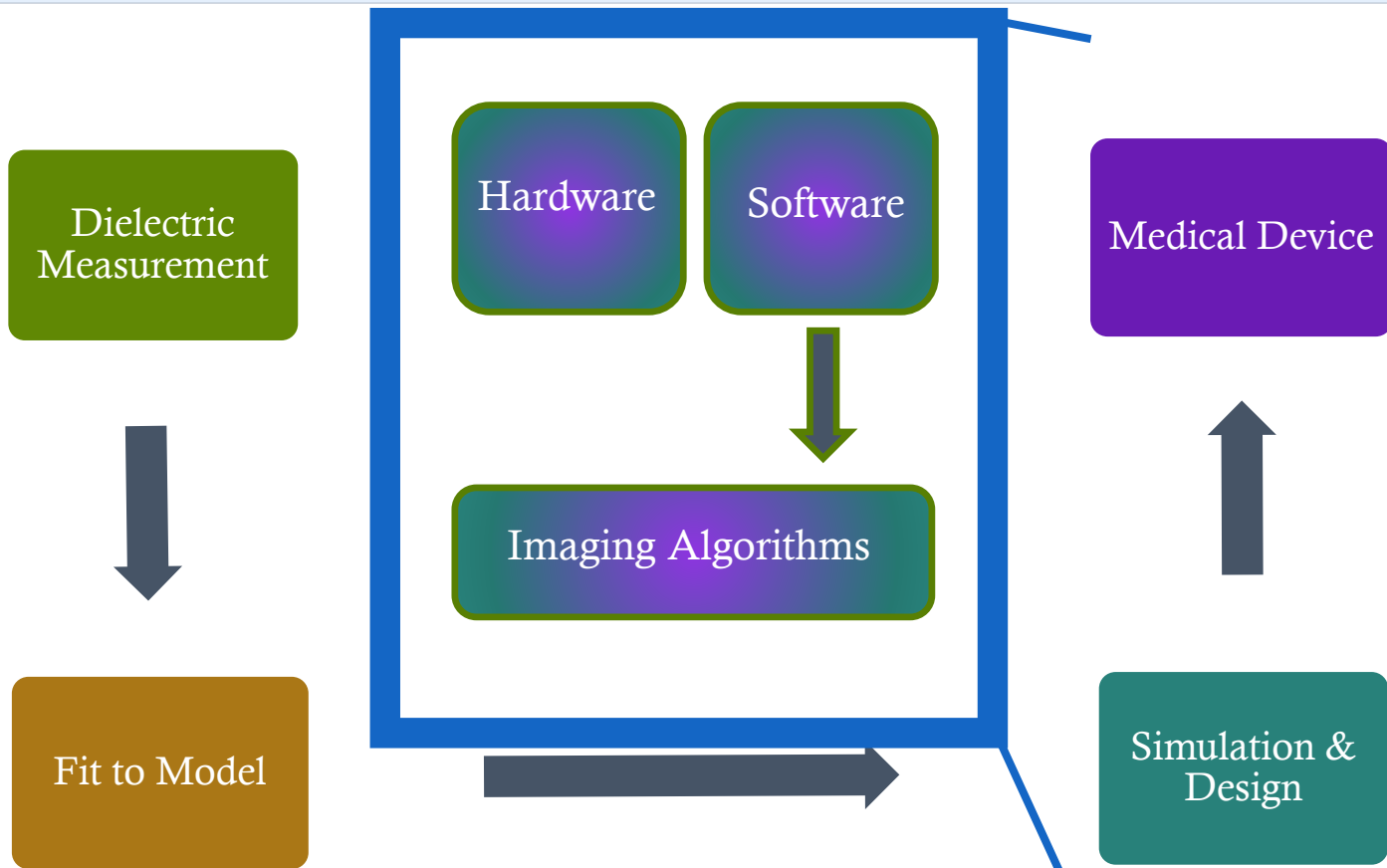
Results

Conclusions and Future Work

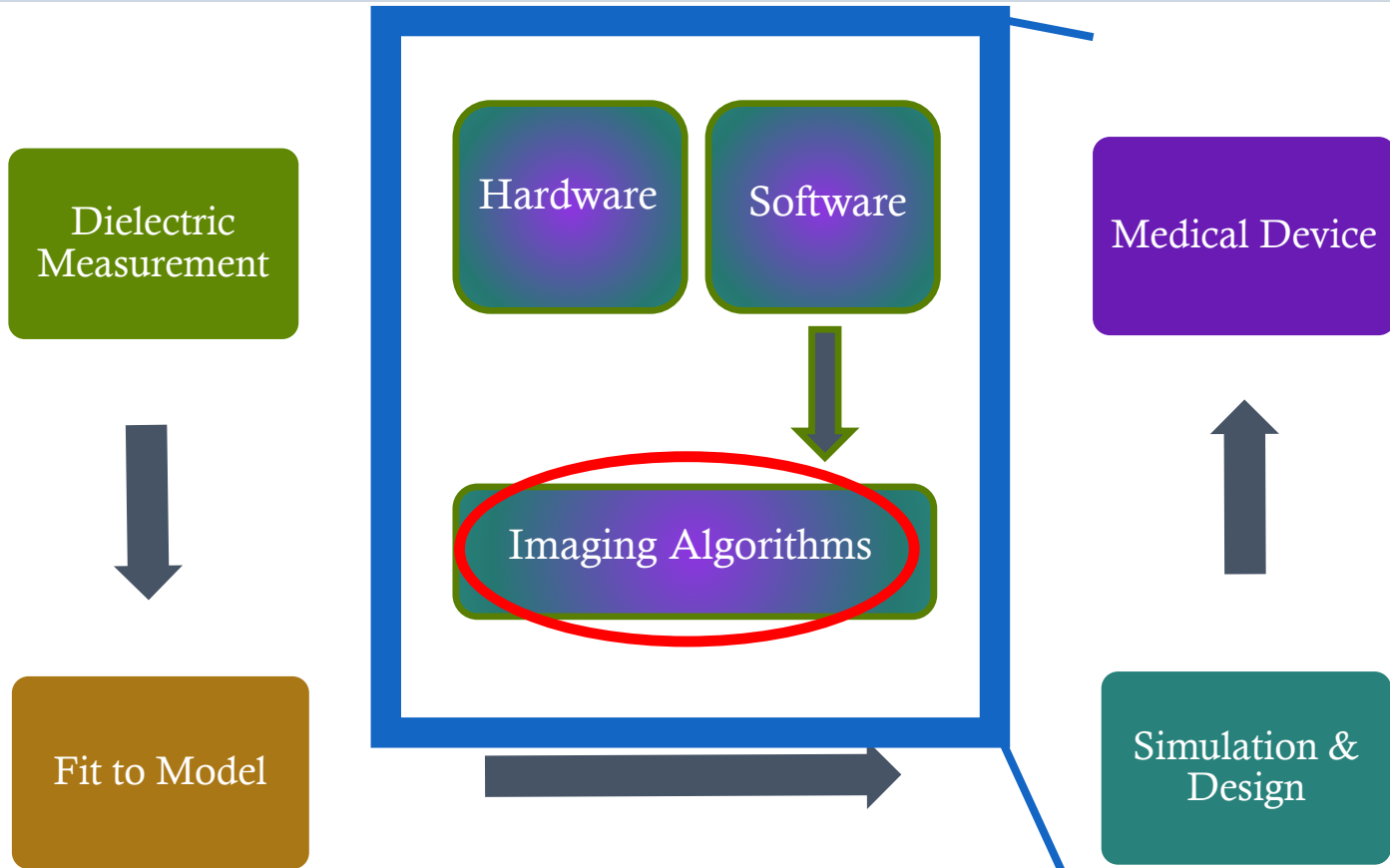
Technology Development Process



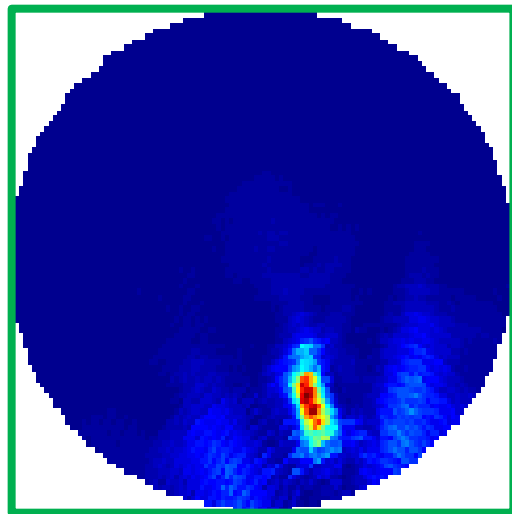
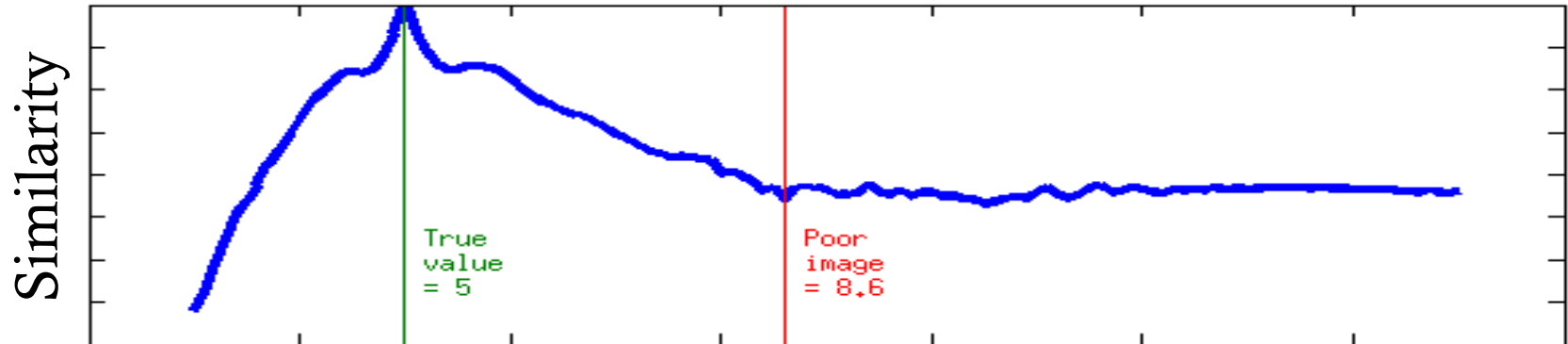
Technology Development Process



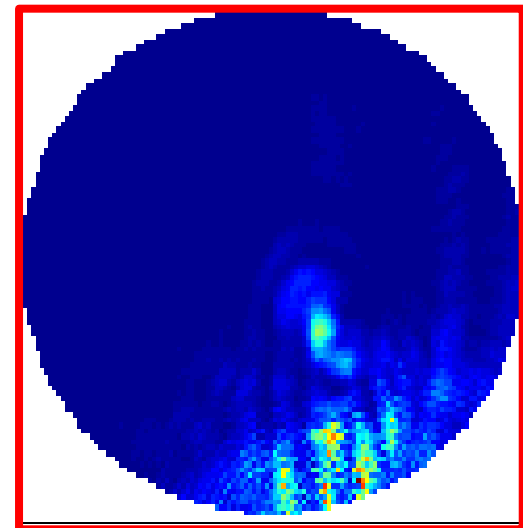
Technology Development Process



Average Dielectric Property Estimation Importance



Average ϵ_r





Existing methods

- Published values
- Considering multiple media (Lim *et al.* 2008)
- Inverse scattering (Winters *et al.* 2006)
- Time-of-flight (Sarafianou *et al.* 2013; Bourqui *et al.* 2015)

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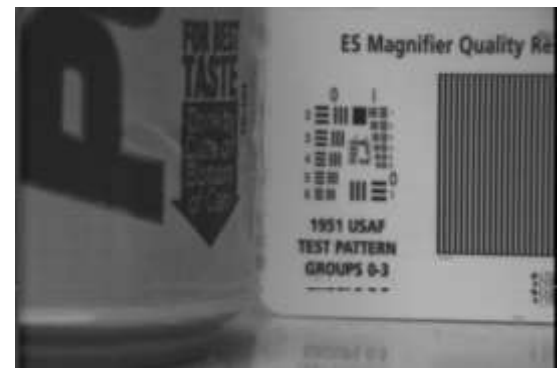
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Conclusions and Future Work

Where used?



For what?

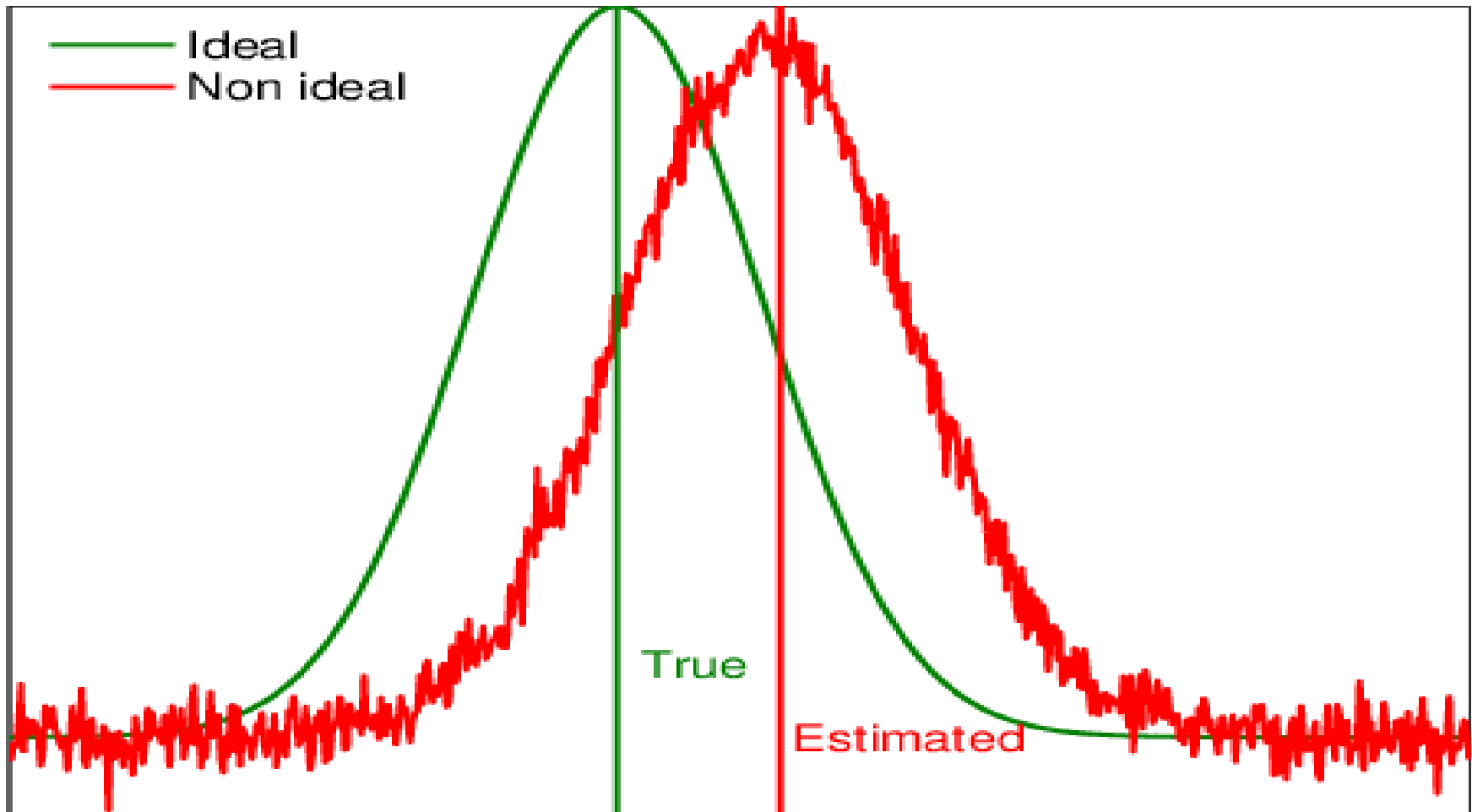


Method of action

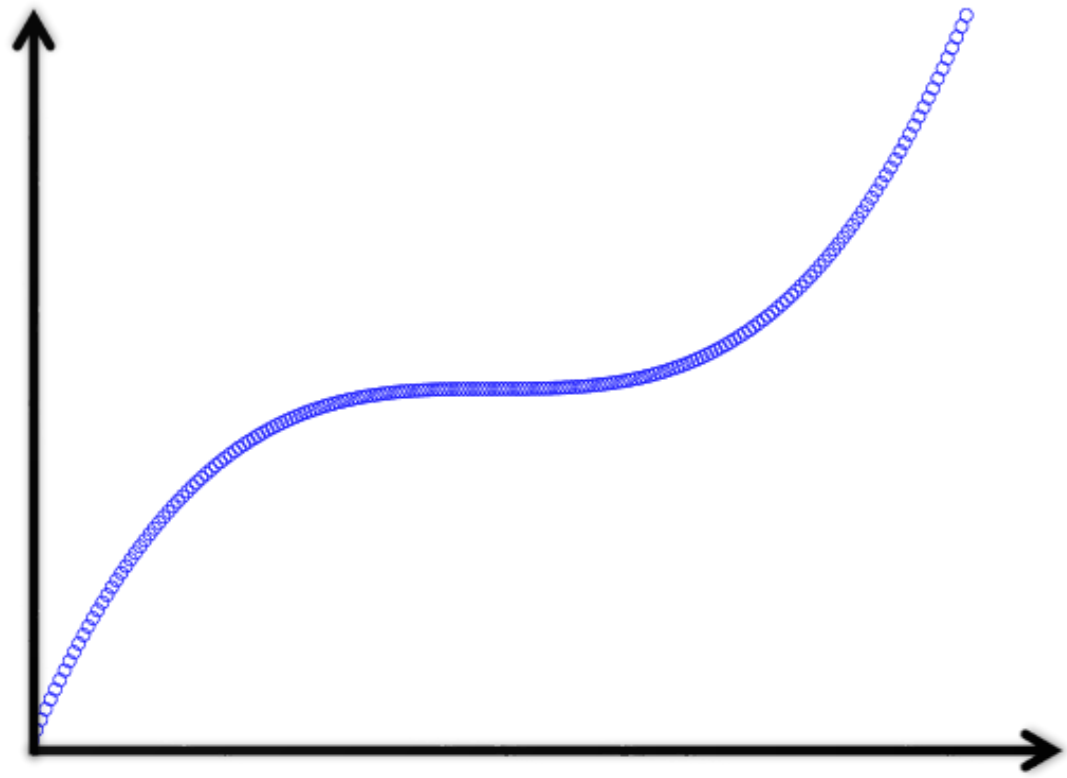


- Estimate high frequency content

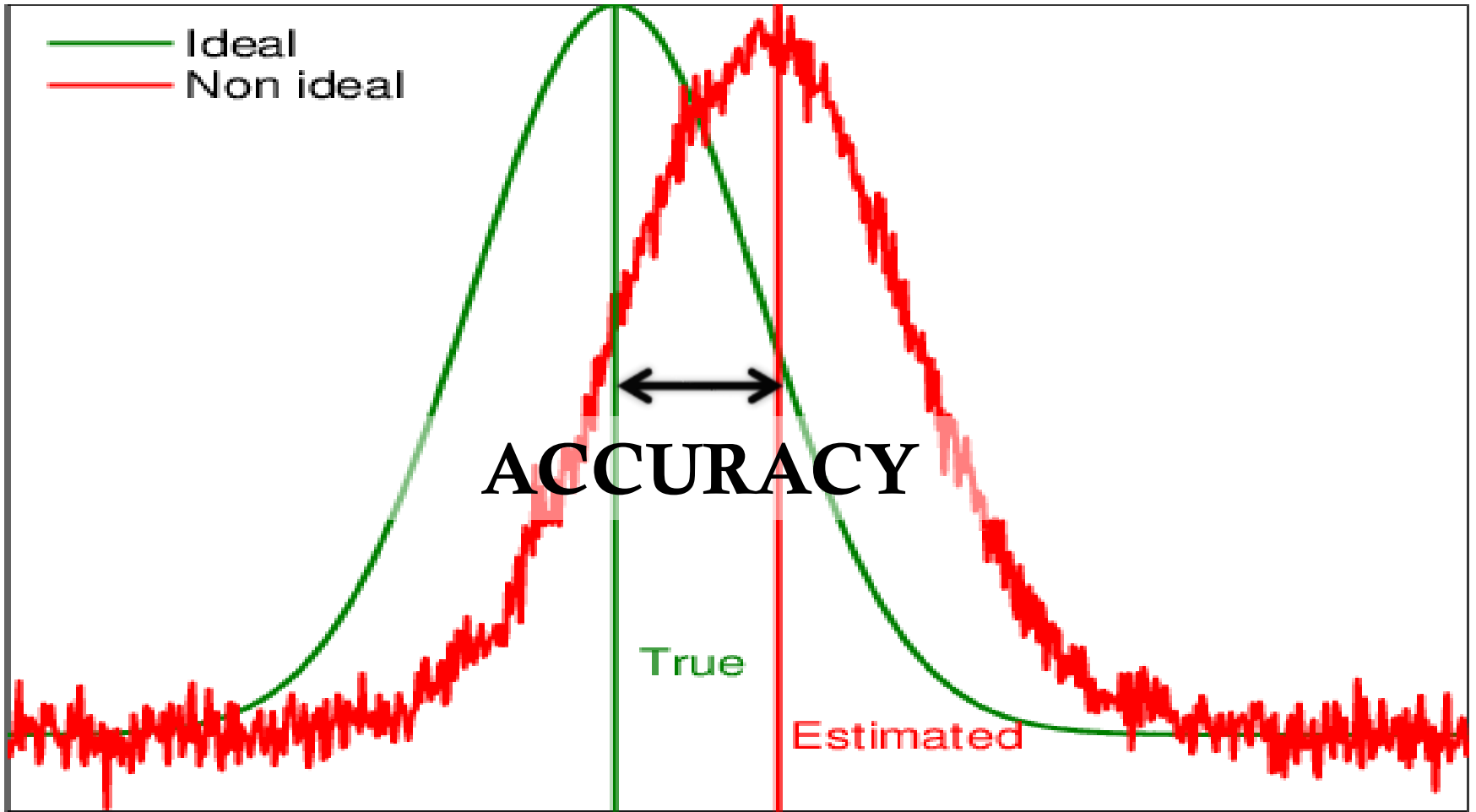
Desirable Properties



Monotonicity



Accuracy



Other properties?

- Width
- Range
- Number of false extrema
- Power of false extrema

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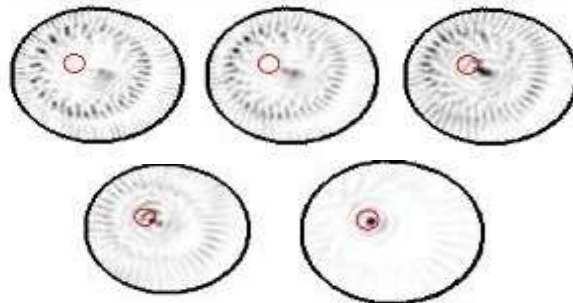
Conclusions and Future Work

Process

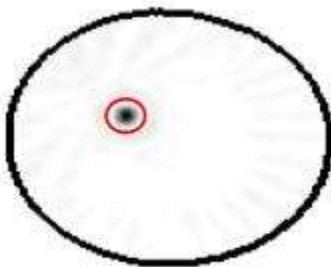
BREAST SCAN (ACQUISITION OF DATA)



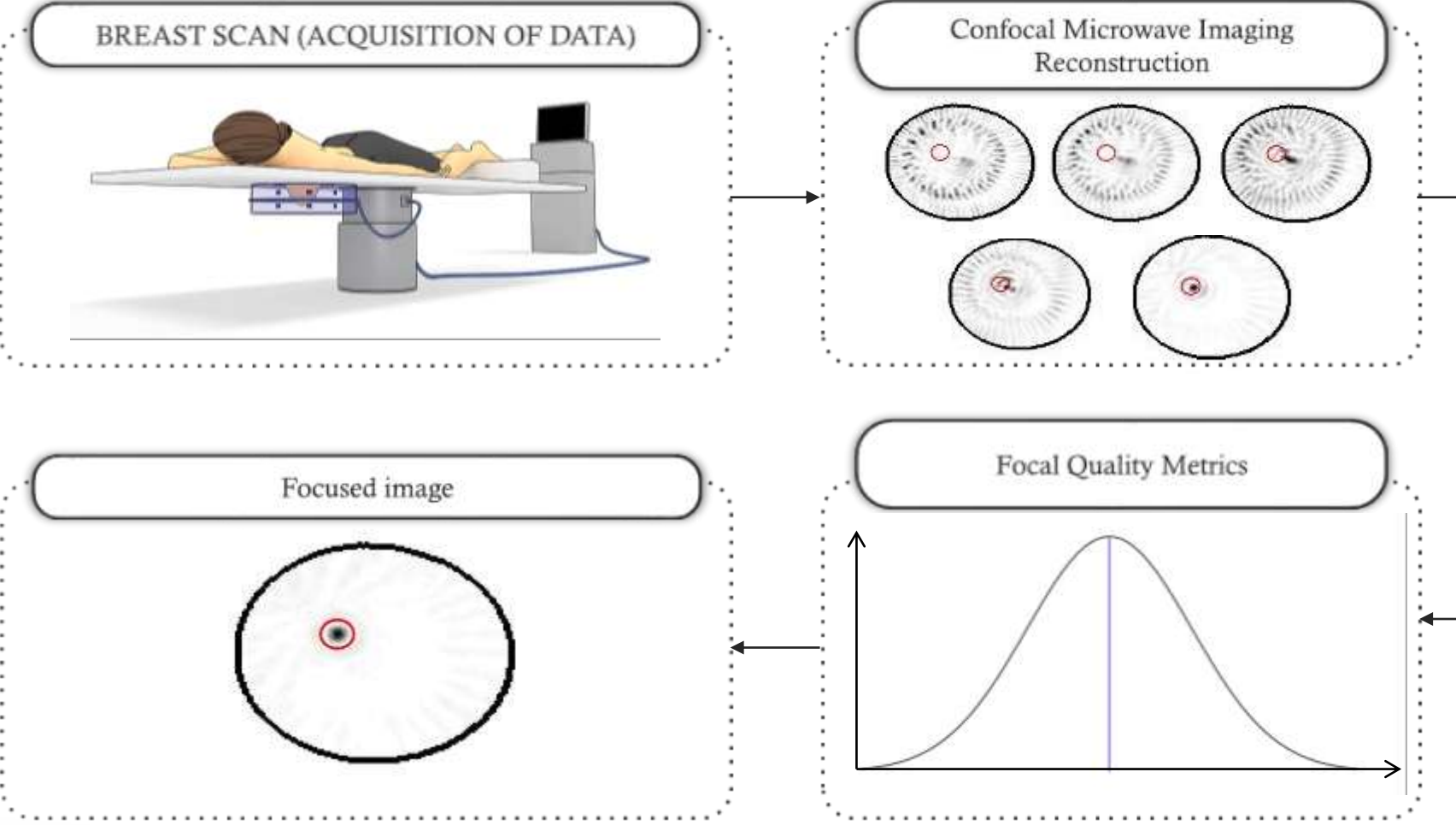
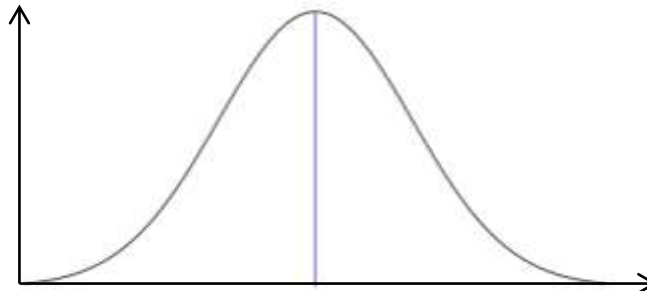
Confocal Microwave Imaging Reconstruction



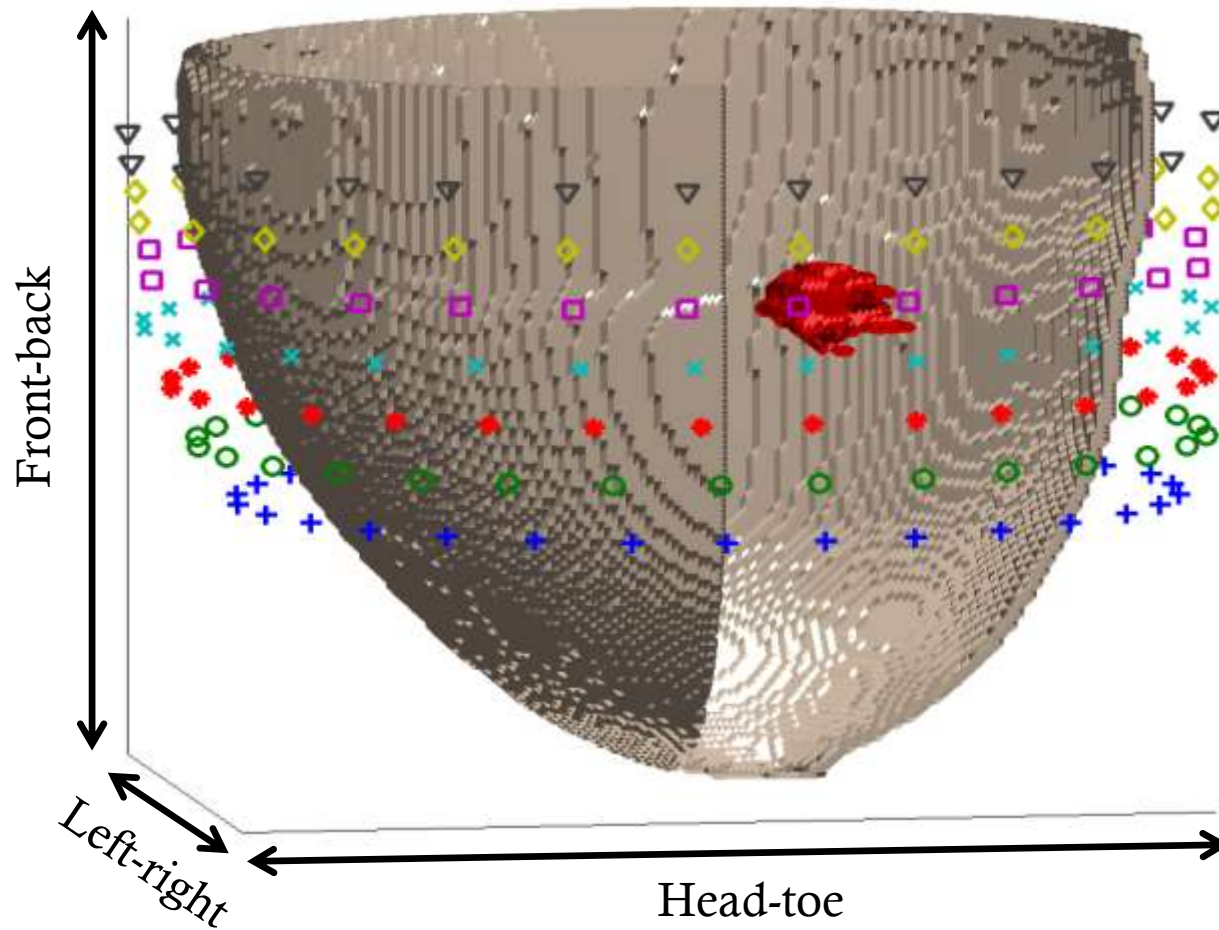
Focused image



Focal Quality Metrics

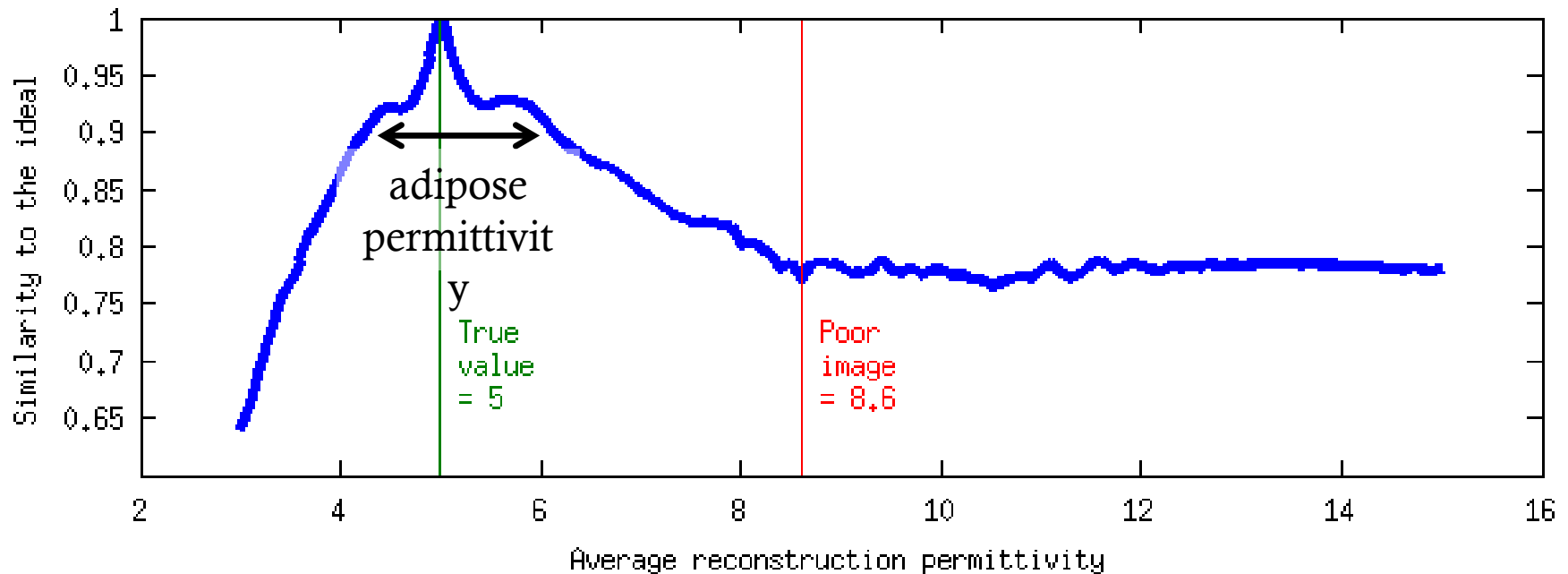


(1) Data Acquisition



(2) Confocal Microwave Imaging

- Delay-and-Sum beamformer
 - Window-length equal to pulse length



(3) Focal Quality Metrics

- Five commonly used metrics analysed

Gradient-based:
$$\Phi_G = \frac{1}{XY} \sum_x \sum_y \max_{D \in \{X, Y\}} |I_D(x, y)|$$

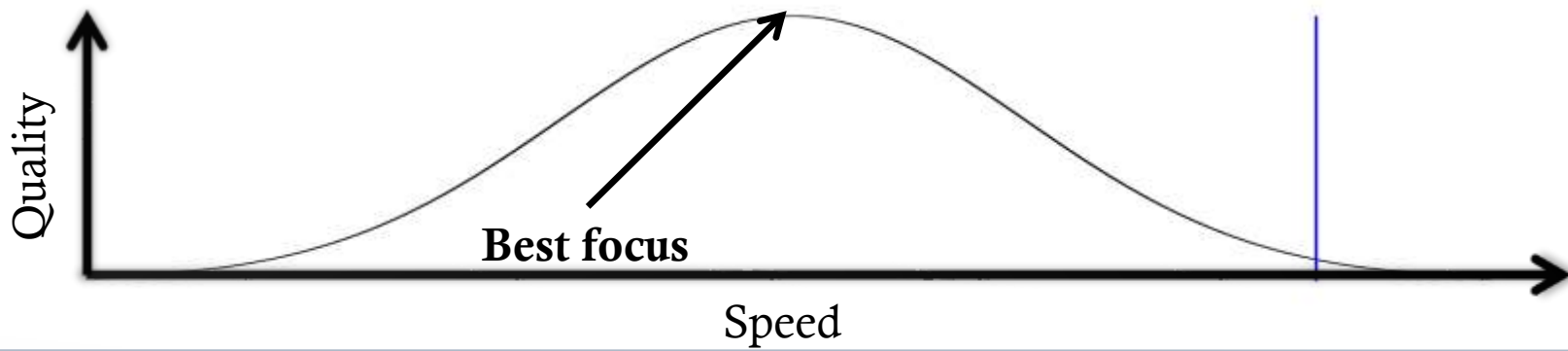
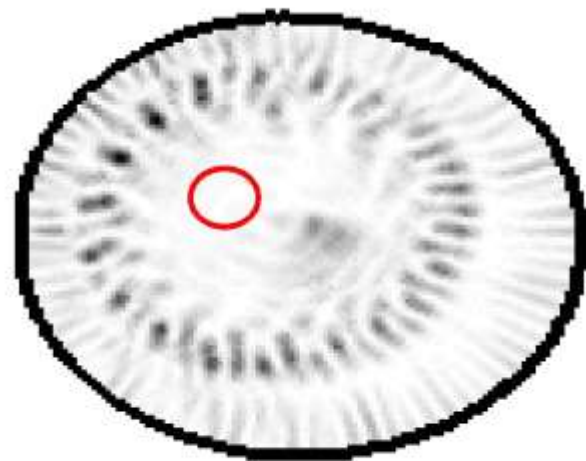
Laplacian-based:
$$\Phi_L = \frac{1}{XY} \sum_x \sum_y (L * I)$$

Wavelet-based:
$$\Phi_W = \frac{1}{XY} \sum_x \sum_y |I_{LH1}(x, y)| + |I_{HL1}(x, y)| + |I_{HH1}(x, y)|$$

Fourier-based:
$$\Phi_F = \frac{1}{XY} \sum_x \sum_y \frac{\sum_{(n,m) \neq (0,0)} F_{x,y}(u, v)^2}{F_{x,y}(0, 0)^2}$$

Statistics-based:
$$\Phi_S = \frac{1}{XY} \sum_x \sum_y (I(x, y) - \bar{I})^2$$

(4) Select best image



Overview

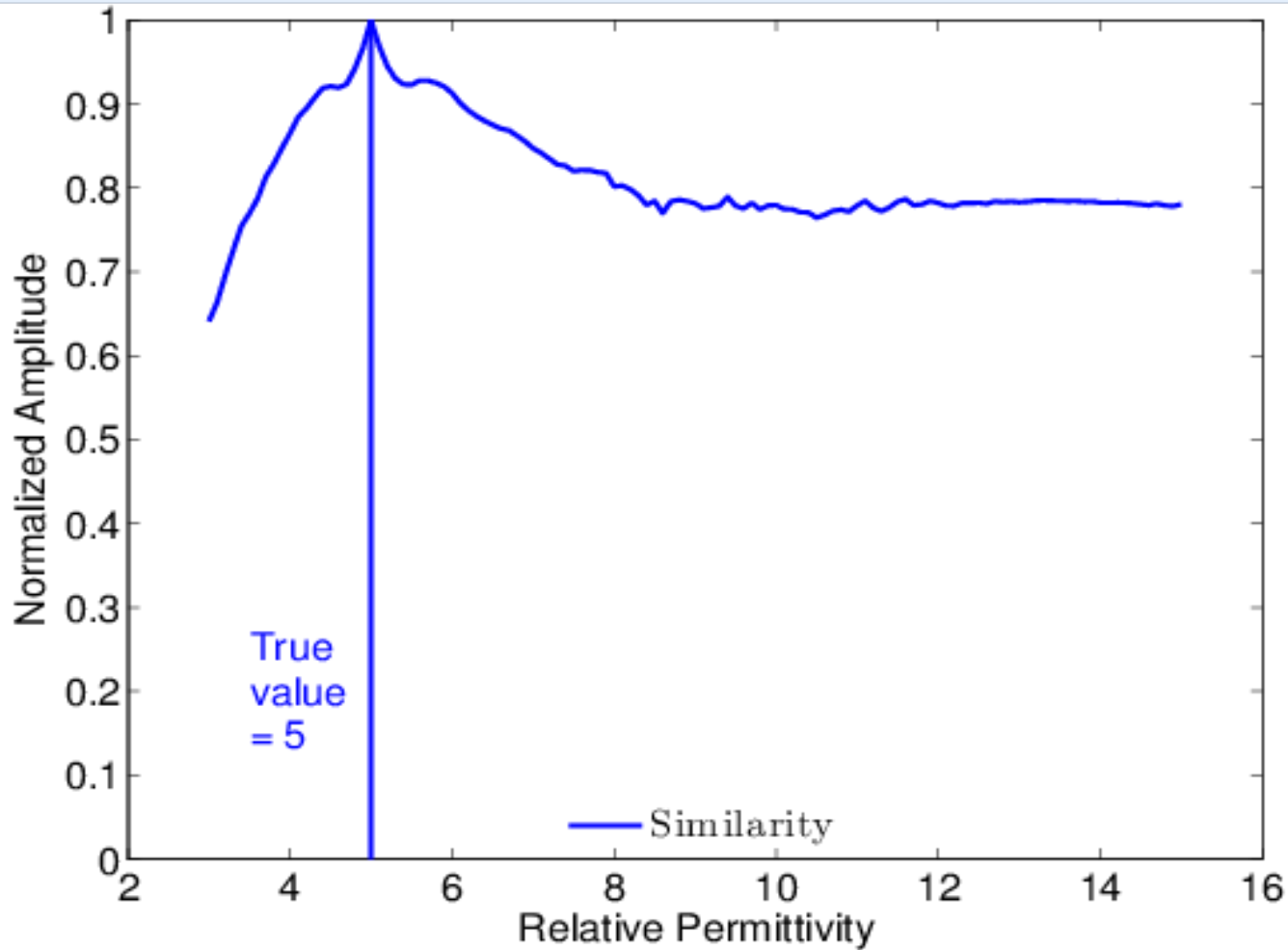
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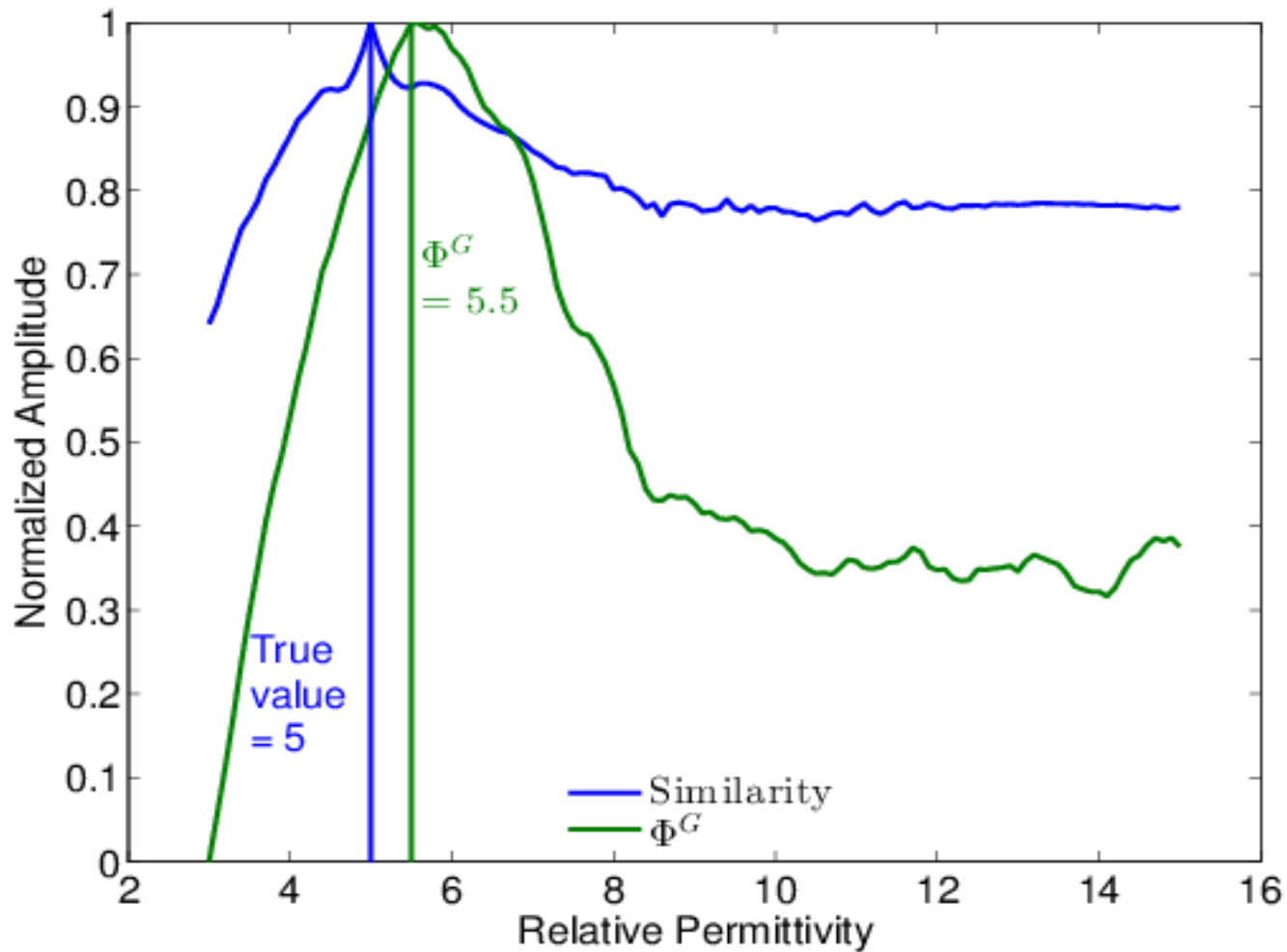
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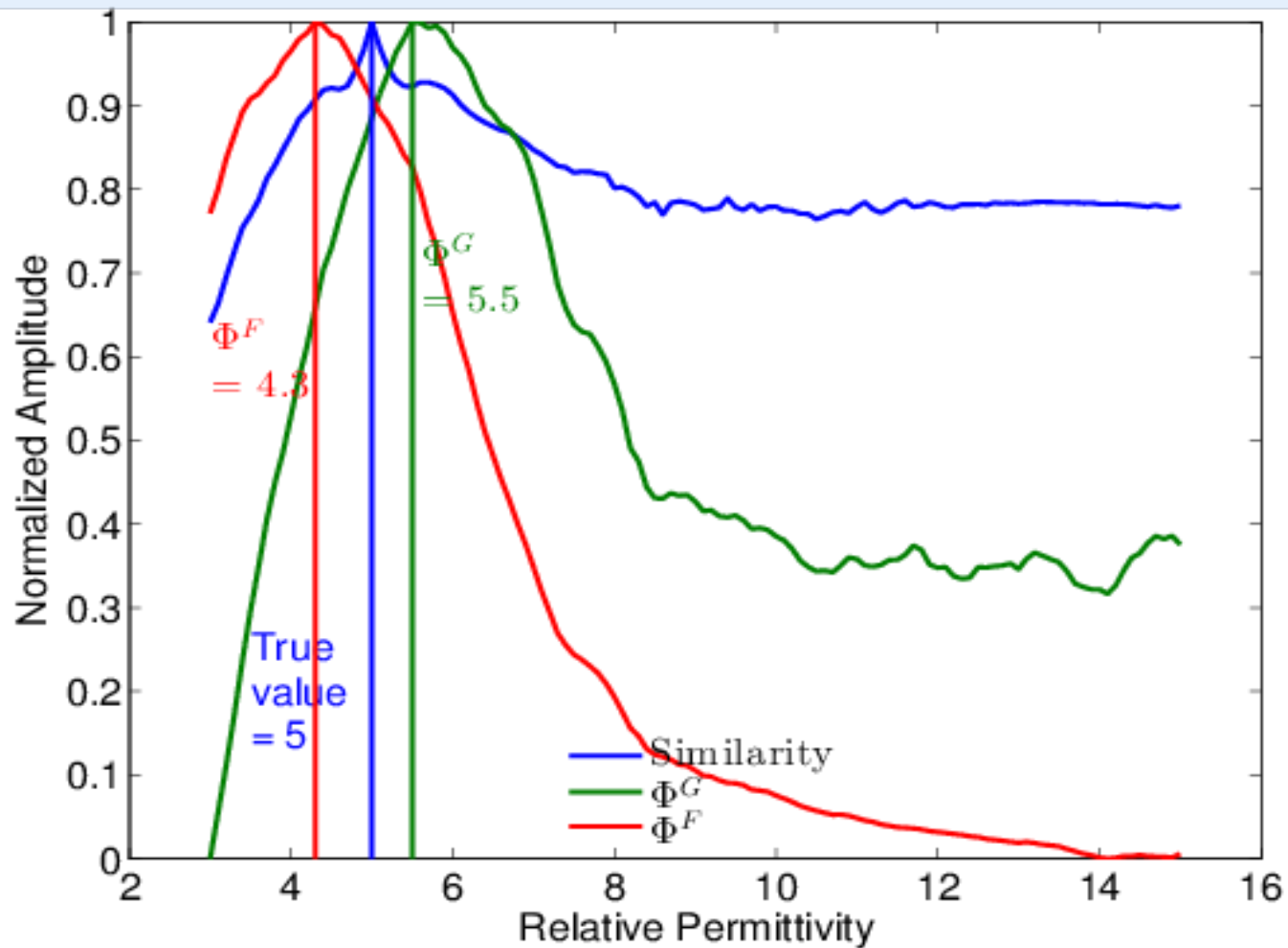
Results



Results

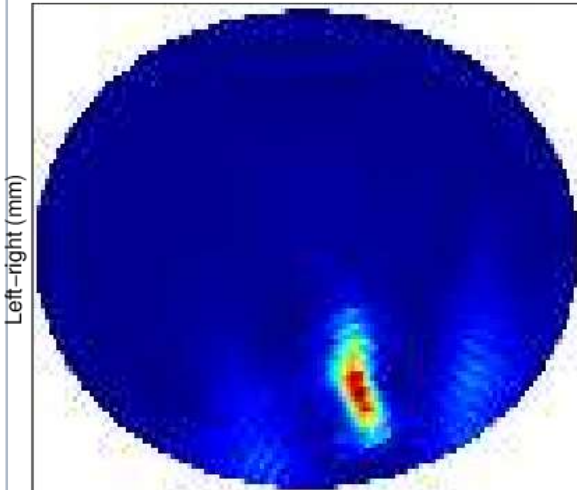


Results



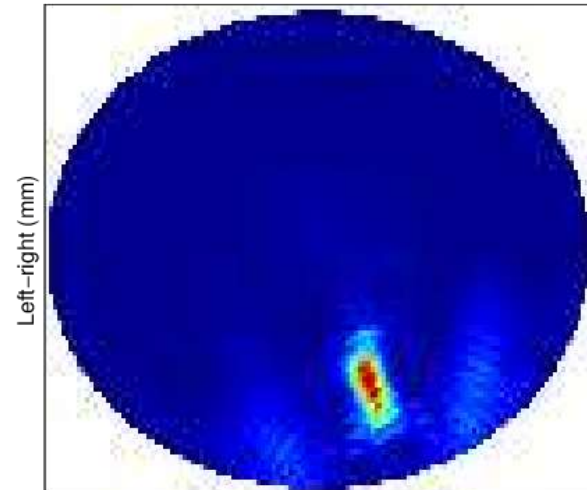
Results

Φ_F



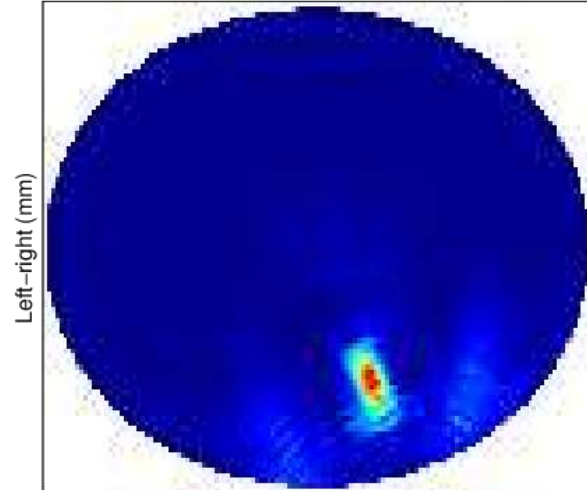
Head-toe (mm)

Ideal



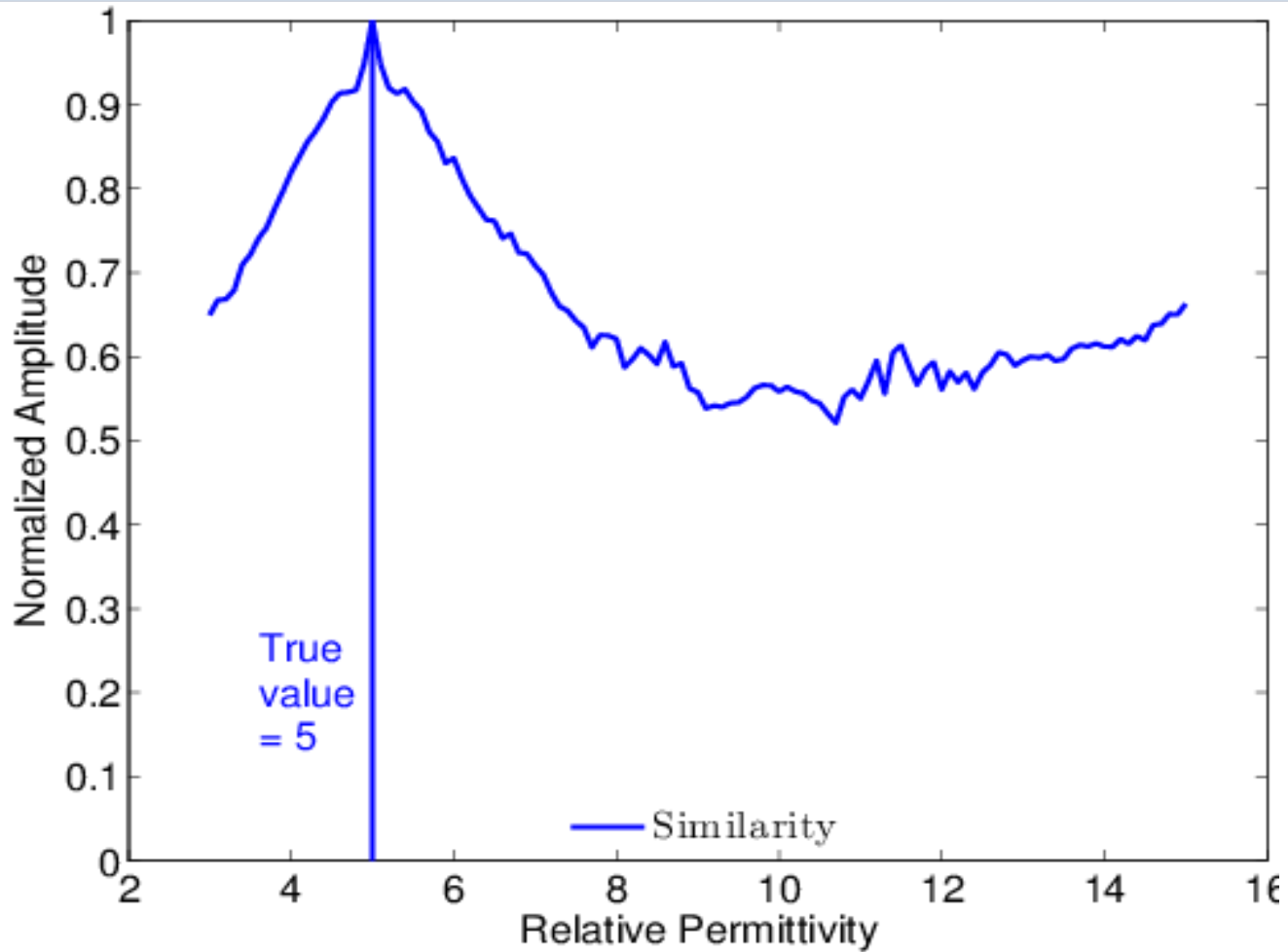
Head-toe (mm)

Φ_G

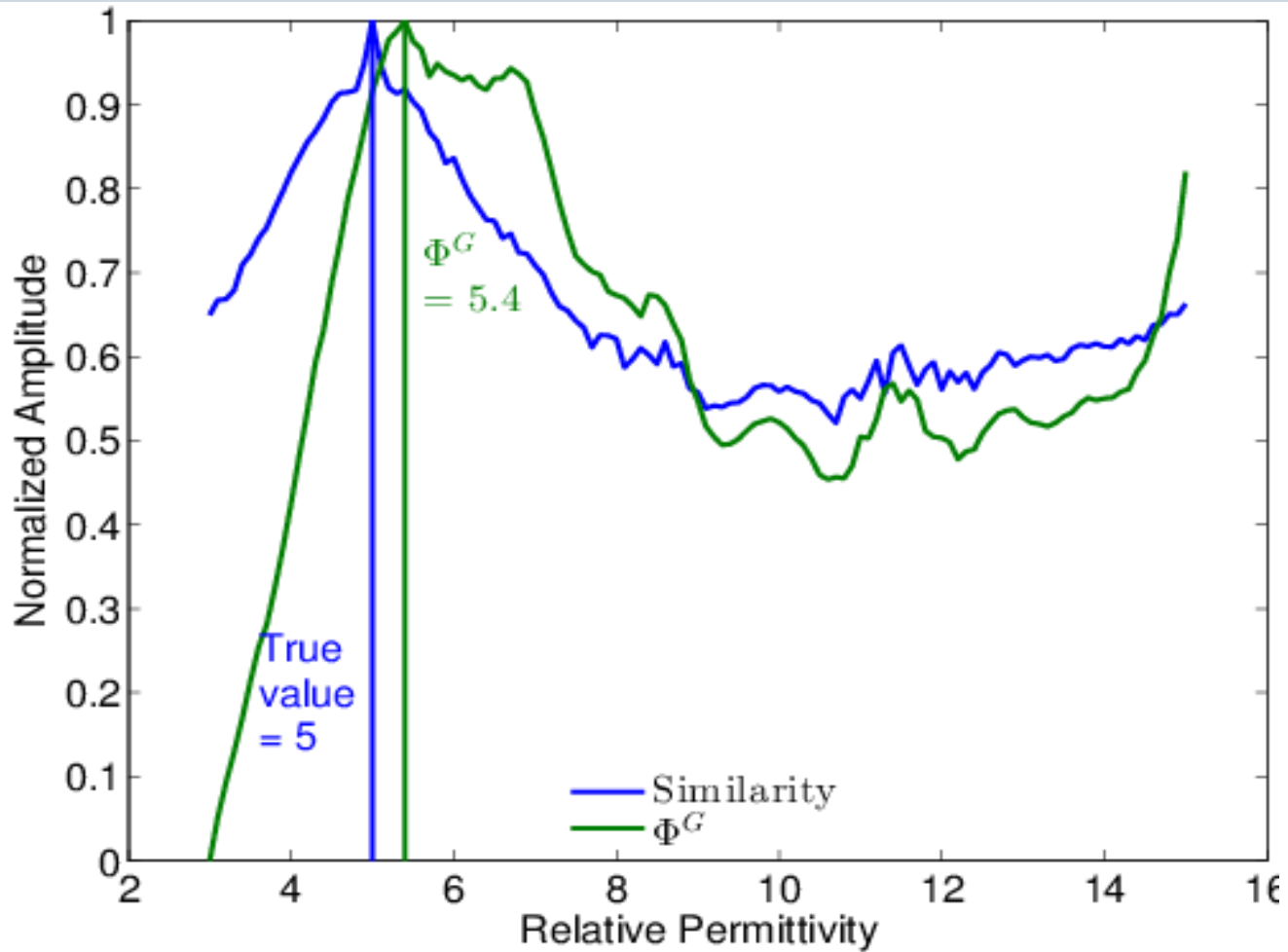


Head-toe (mm)

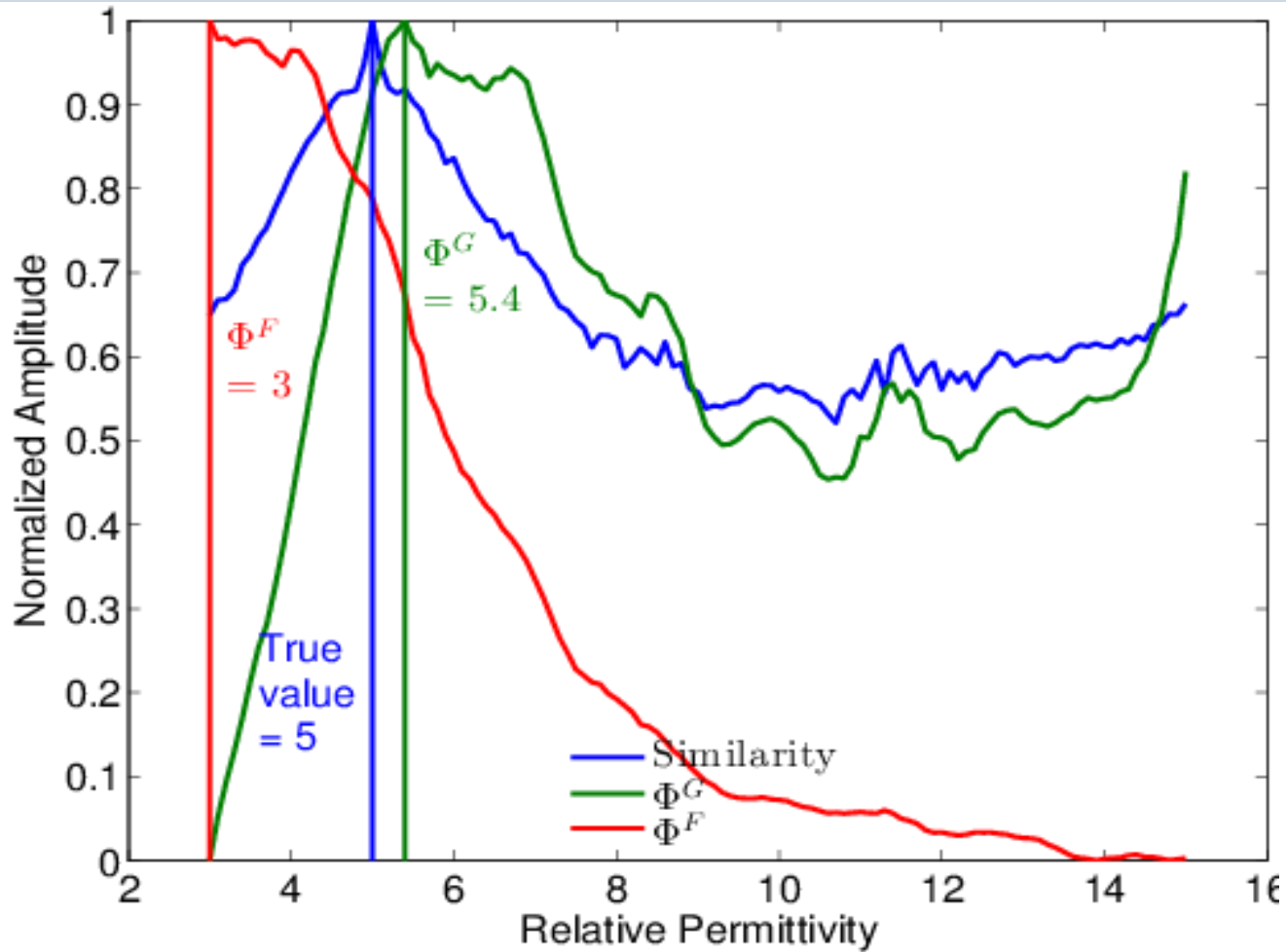
Results



Results

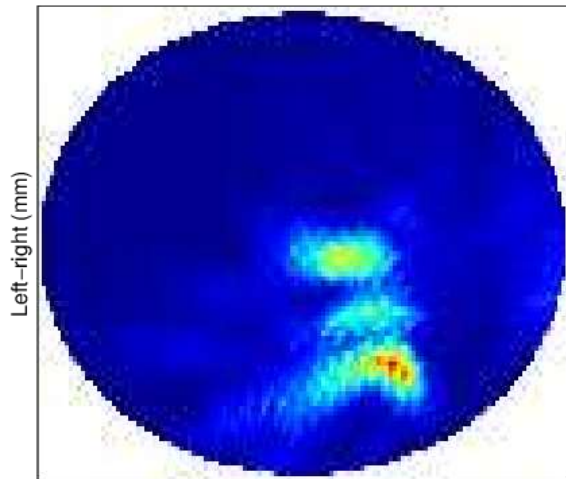


Results



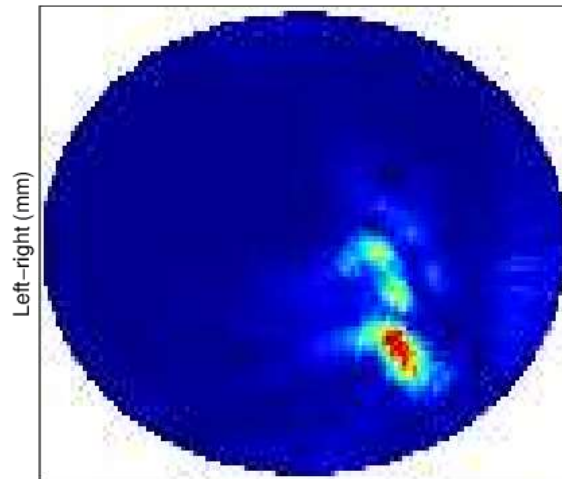
Results

Φ_F



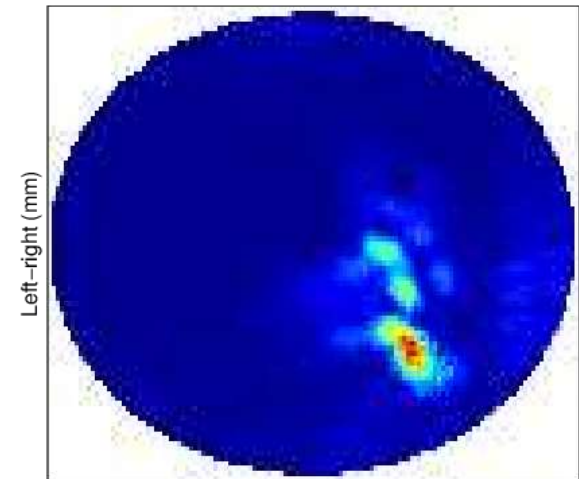
Head-toe (mm)

Ideal



Head-toe (mm)

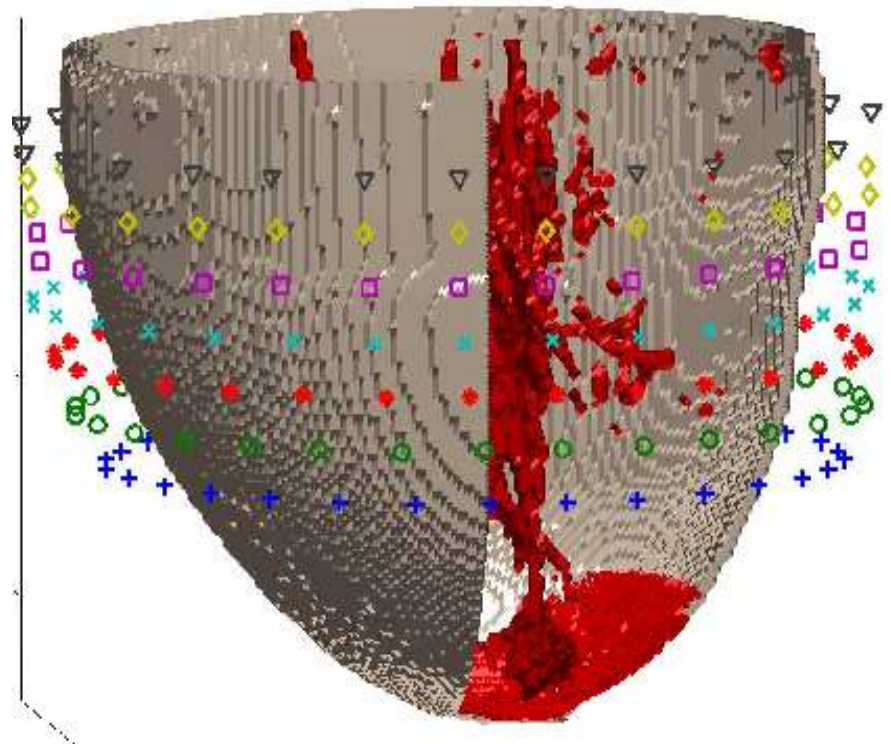
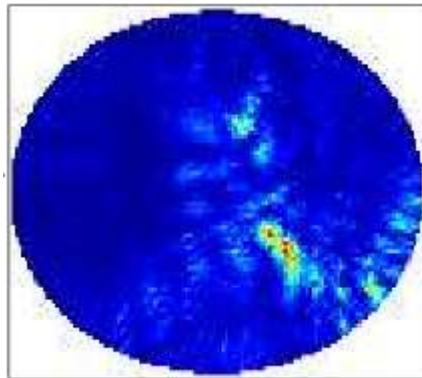
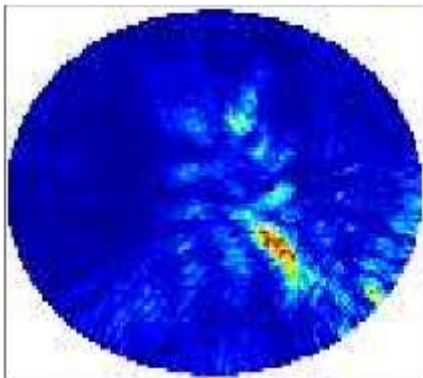
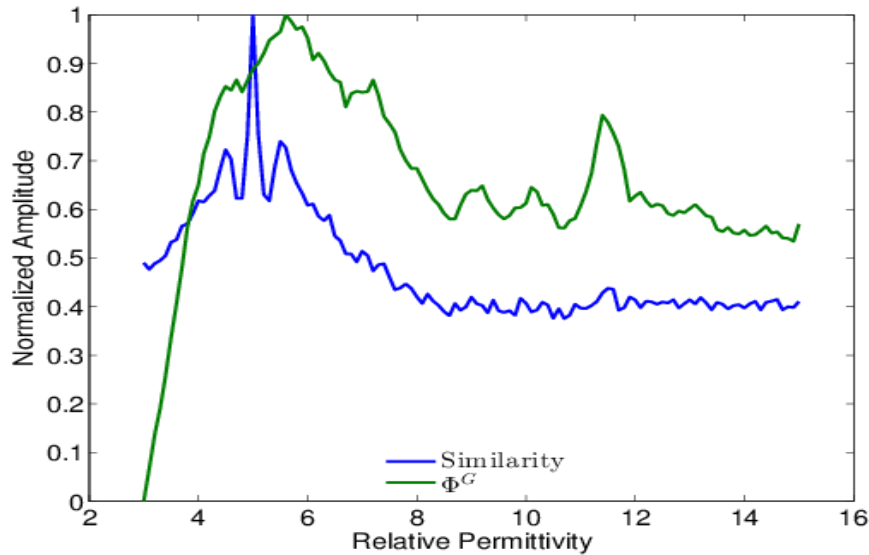
Φ_G



Head-toe (mm)

	Accuracy	Correlation
Φ^G	0.71	0.7
Φ^F	1.02	0.68

Preliminary Heterogeneous Results



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Conclusions and Future Work

- ✓ Dielectric properties key parameter for focused image
- ✓ FQMs can be used to objectively measure quality

- Dielectrically heterogeneous test scenarios
- Extend to volumetric images
- Evaluate optimum FQM

Technology Development Process

