



NUI Galway
OÉ Gaillimh



Investigation of Frequency Spacing for Dielectric Measurements

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in collaboration with Prof. Paul M. Meaney

The Lambe Medical Device Research Group

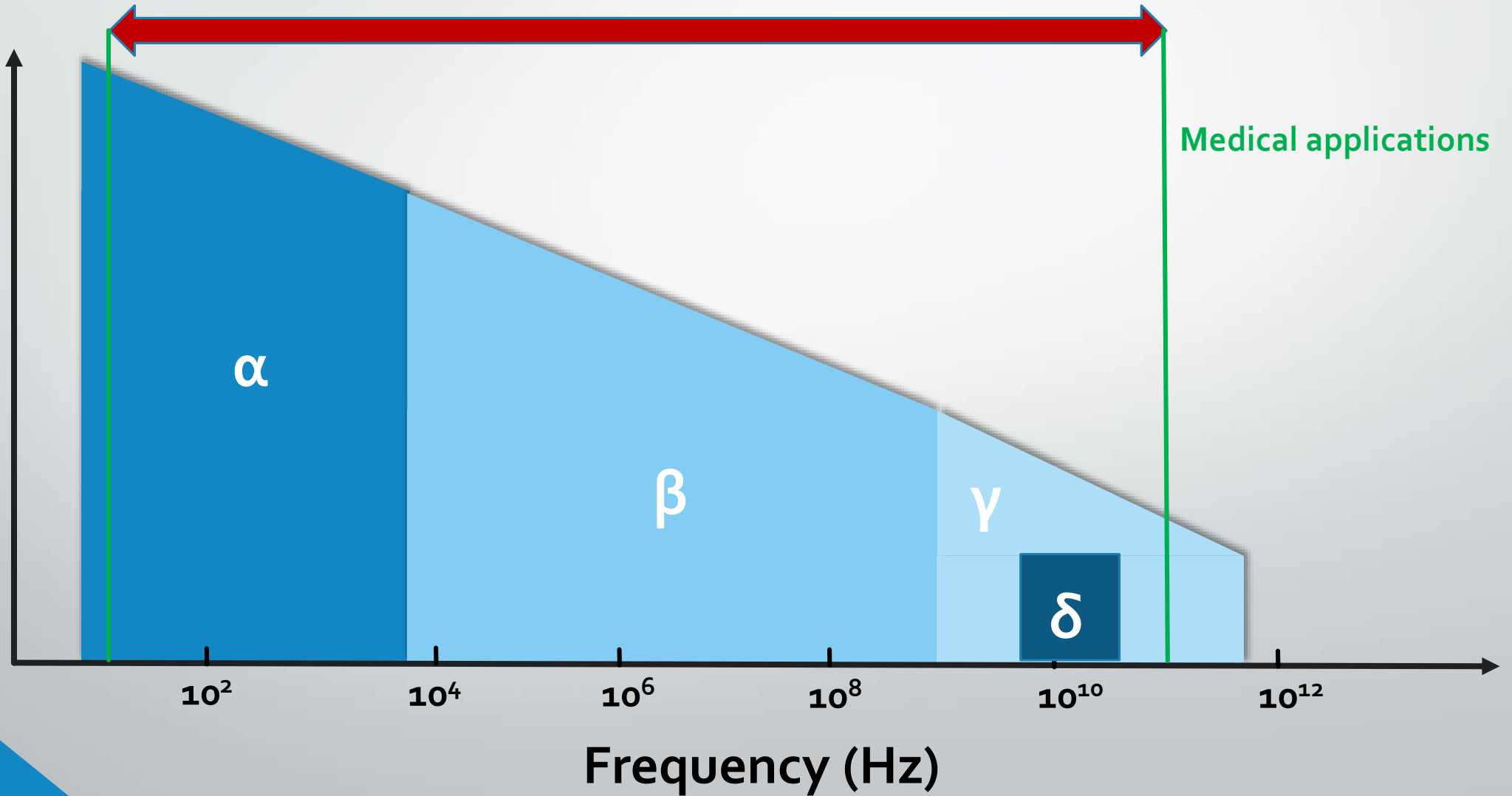
Outline

- Brief introduction of dielectric properties and dispersion regions
- Data fitting and frequency spacing
- Quality metrics used to assess the fitting results
- Experimental results
- Conclusion

Introduction

- Dielectric properties are the response of biological tissues in EM
- Biological tissue show strong dispersive behavior
- Various biophysical factors contribute towards the dispersion
- Each factor typically responds to specific region in frequency spectrum

Dispersion Regions

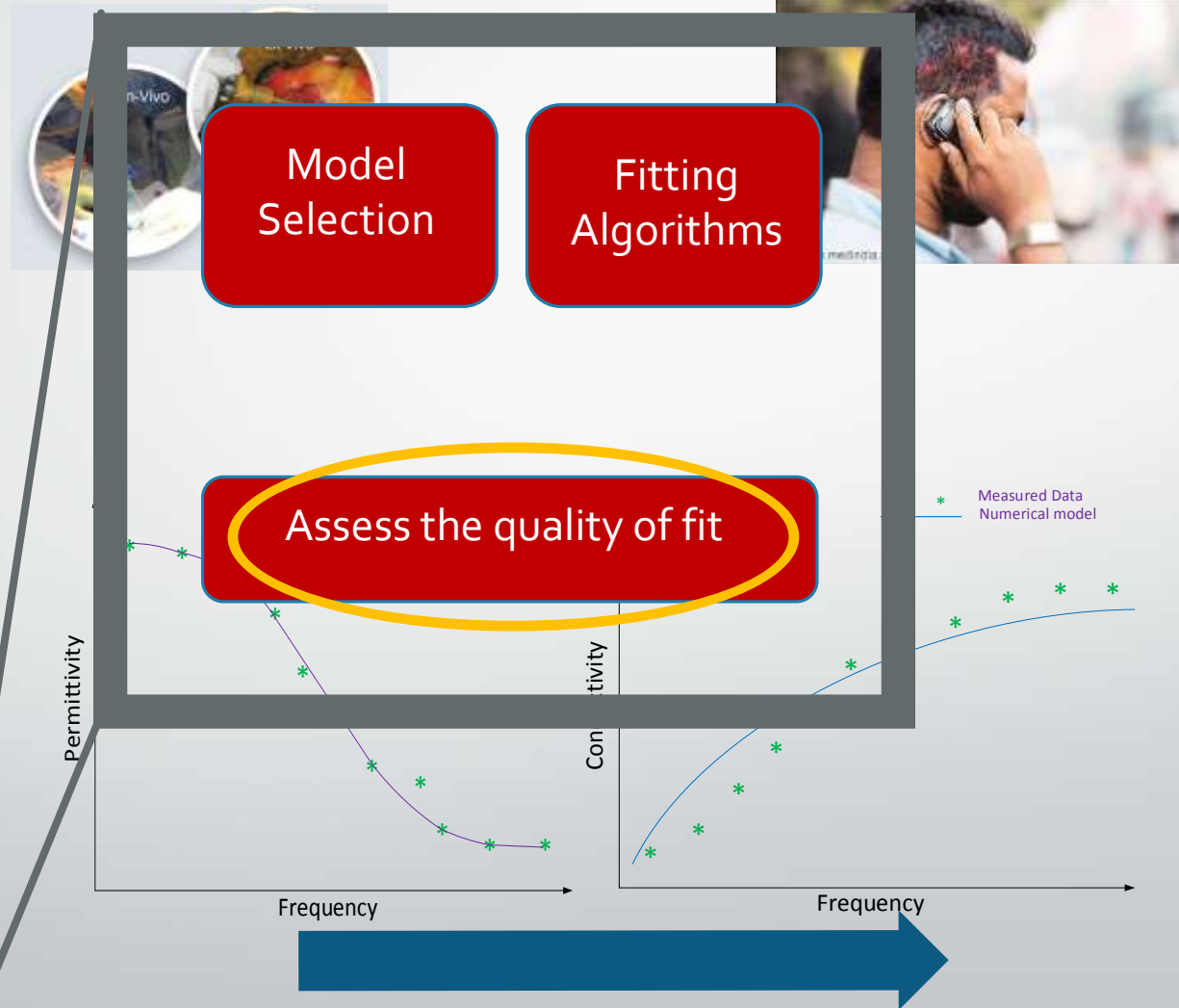


Development Process

Dielectric Measurements



Parametric Models

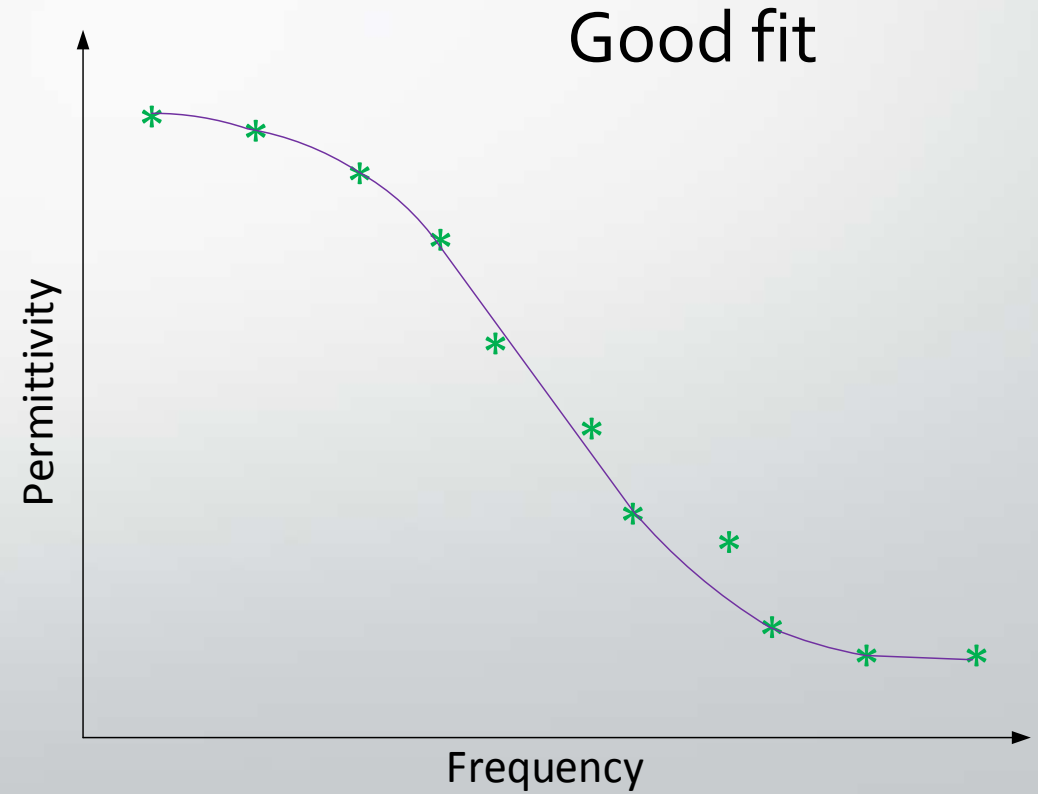
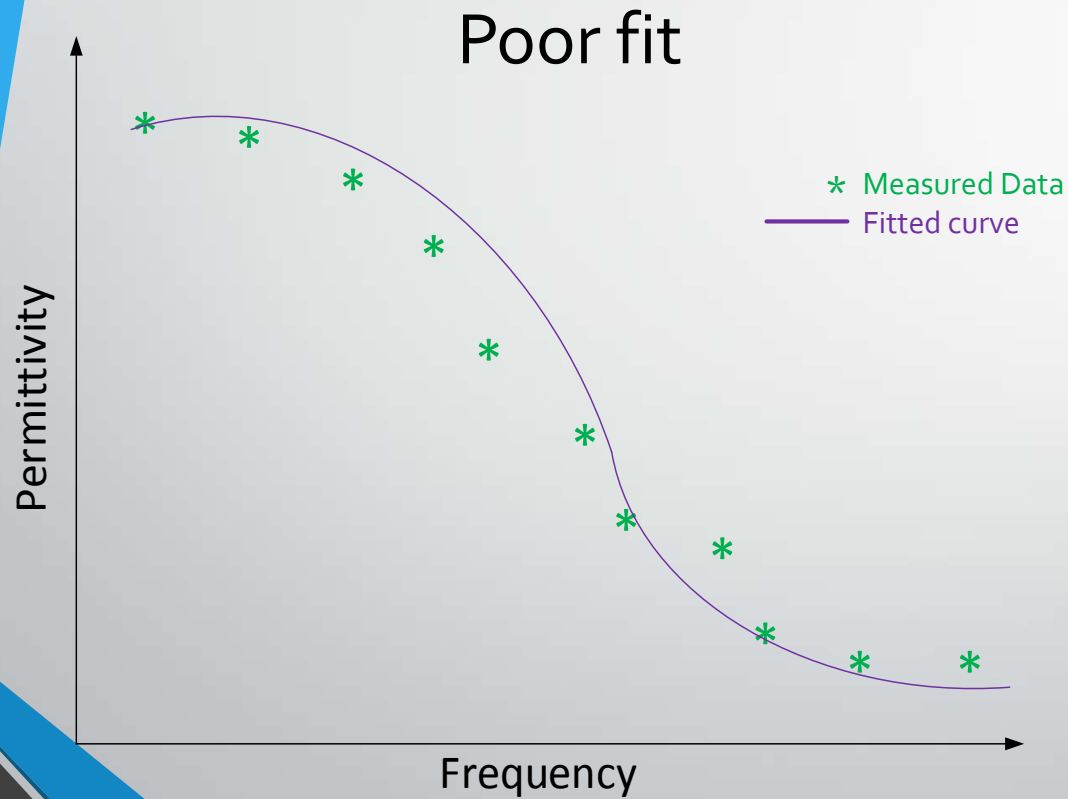


Medical devices/safety

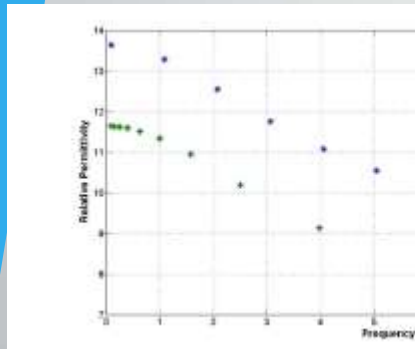


Simulation & Design

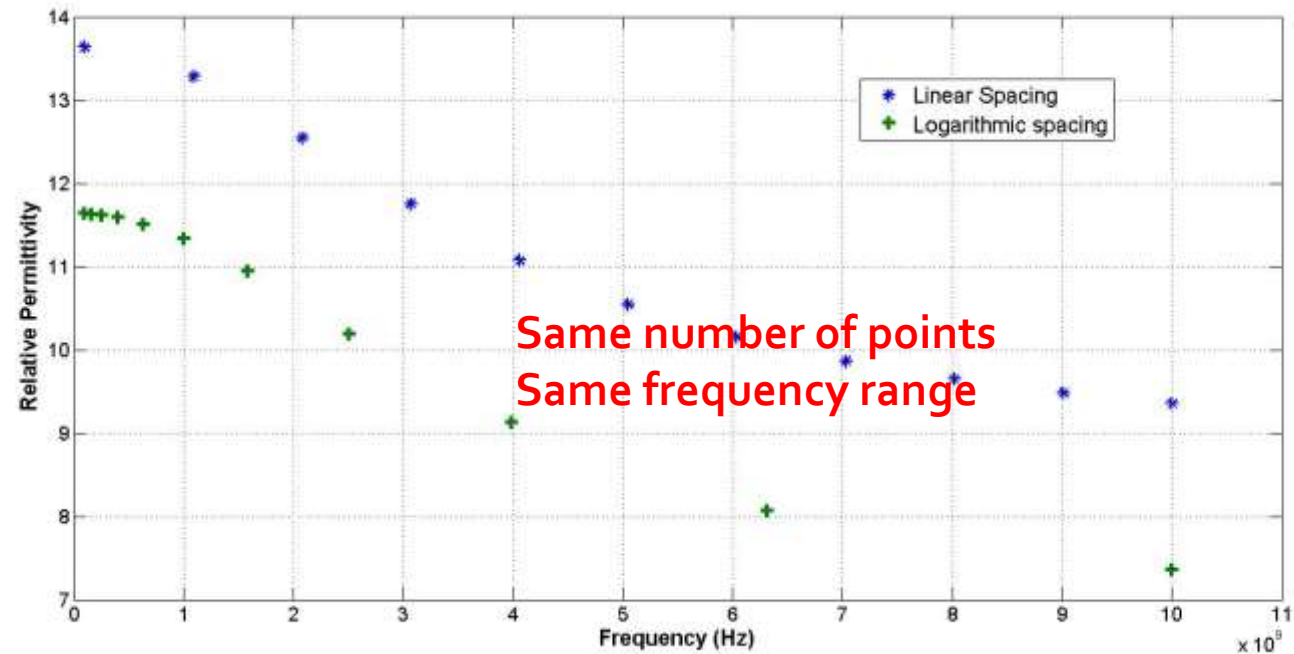
Fitting Example



Frequency Spacing



Sample data points



Sample data points Cole-Cole plot

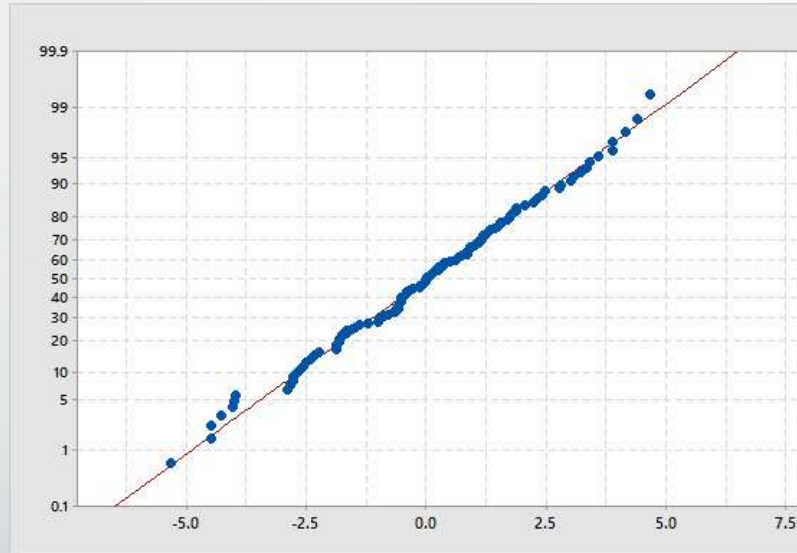


Fit Quality Metrics

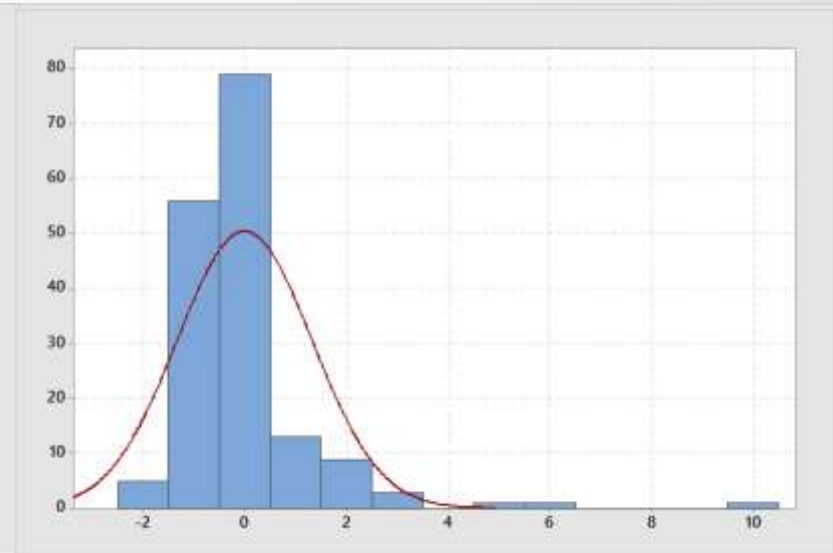
- Normally used metrics to assess the quality of the fitted data
 - Average fractional error
 - Average absolute error
 - Sum of squared errors
- Well known statistical methods
 - Residual analysis
 - Goodness of fit

Statistical Analysis

- Residual Analysis
 - Normality
 - Independence
 - Randomness
- Goodness of fit
 - Chi-squared test



Distribution is normal

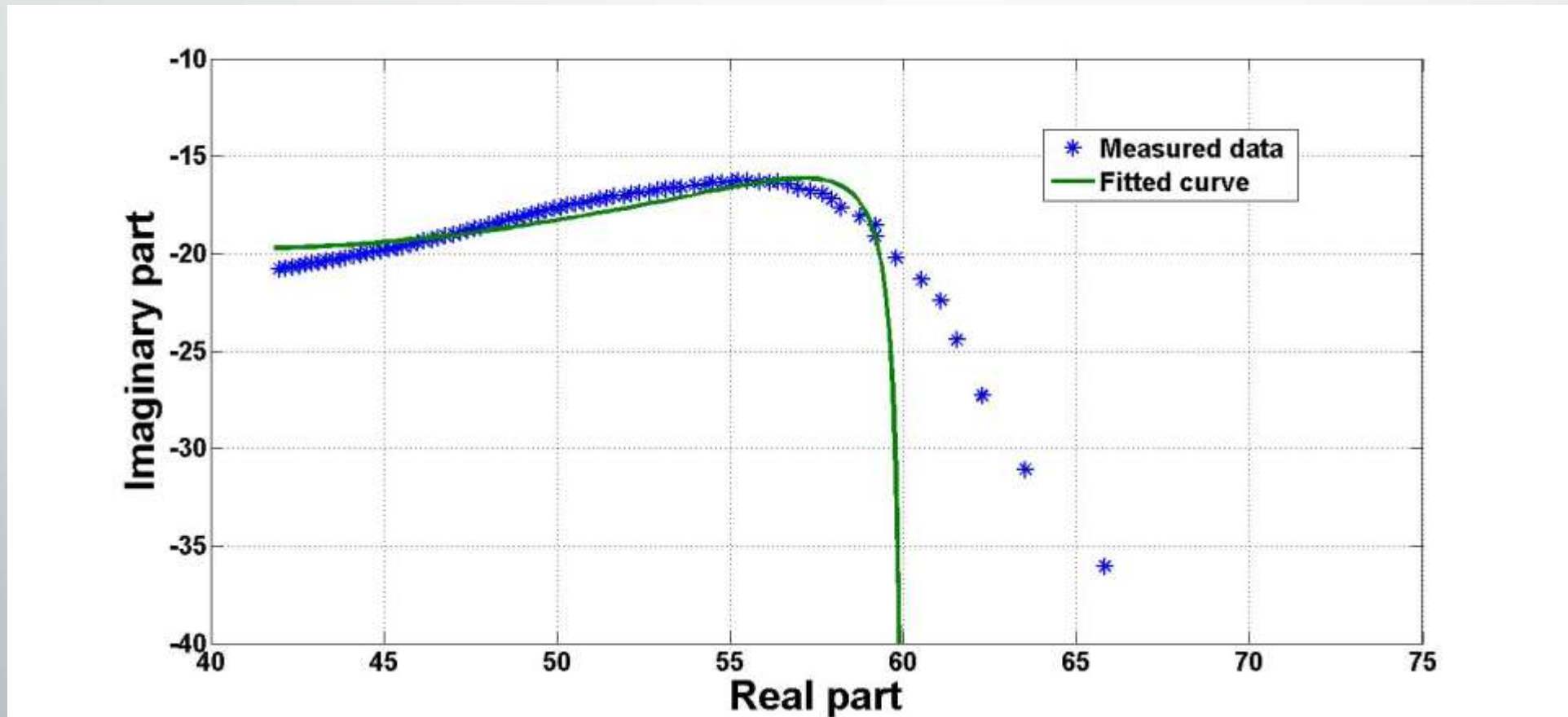


Distribution is not normal

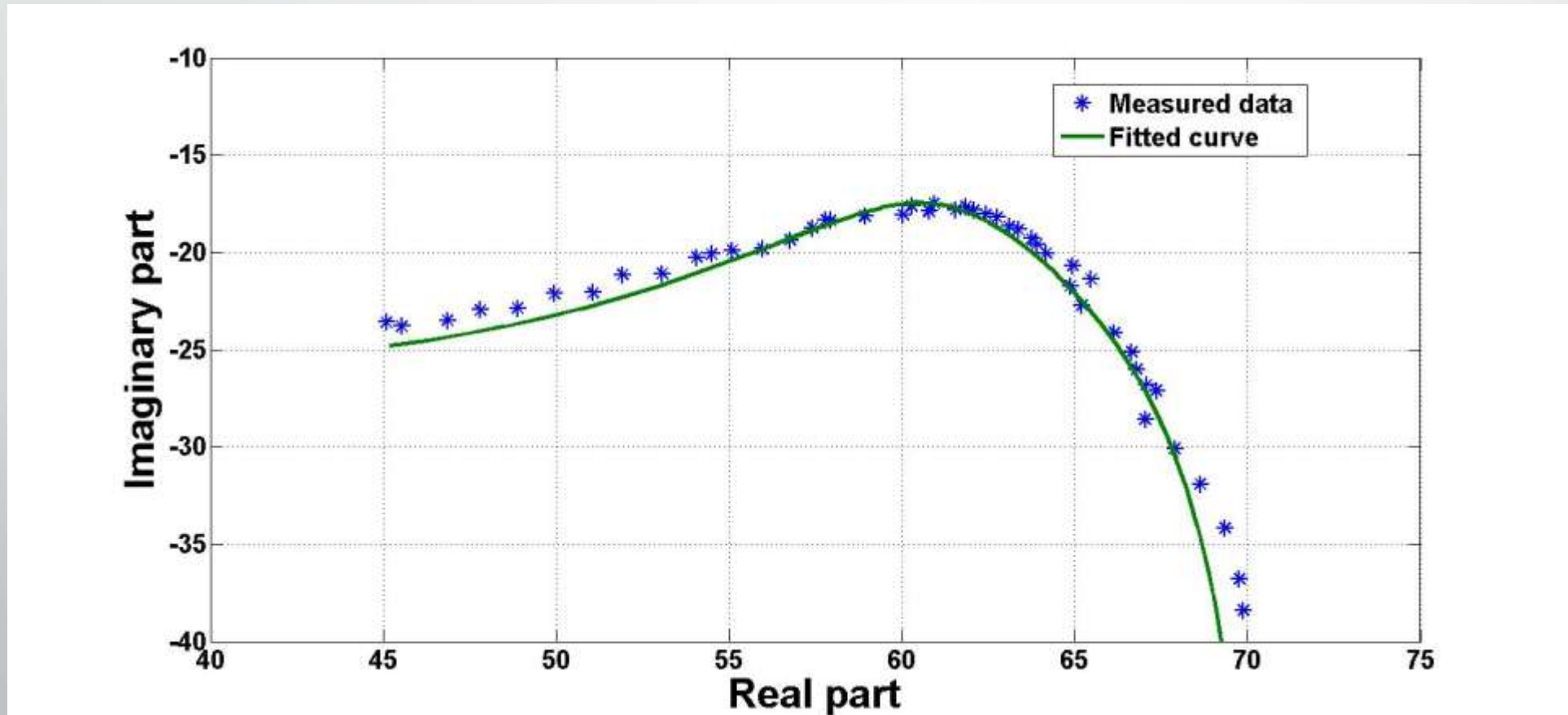
Experimental Design

- Aim: quantitatively assess the impact of quality metrics and frequency spacing
- Collaboration with Prof. Paul M. Meaney, Dartmouth College, USA
- Bovine muscle tissue at room temperature
- Linear and log frequency spacing over 200 MHz – 8.5 GHz

Cole-Cole plot using Linear Frequency spacing

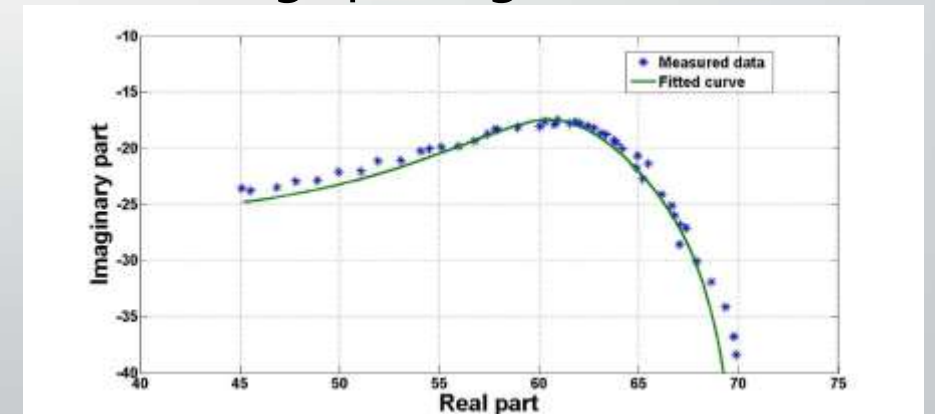
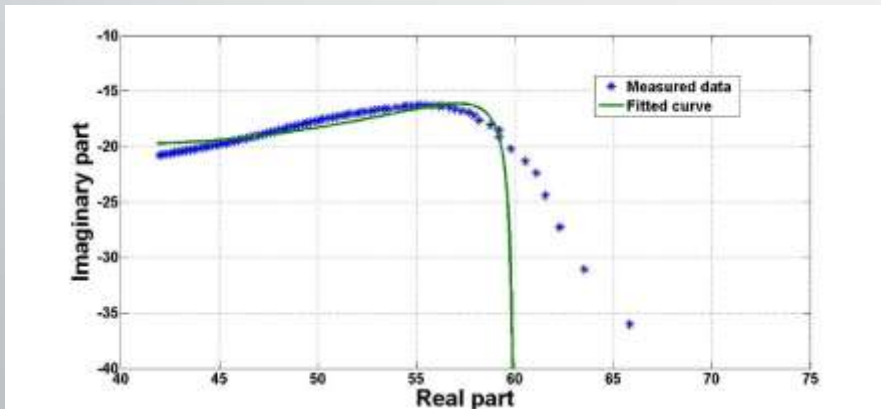


Cole-Cole plot using Log Frequency spacing



Conclusion

- Statistical methods are better metrics to assess the quality of the fitted data
- One relaxation
Linear spacing is better
- More than one relaxation
Log spacing is better





Thank You!

