



NRC-CNRC

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GBHEC project – modeling update

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National Research
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Conseil national
de recherches Canada

Canada

Modeling variables

- Lift-off
- Probe tilt
- Layers separation
- Edge effects
- Crack length
- Crack width
- Crack depth
- Crack location (first or second layer)
- Crack type: corner crack or mid-bore crack

Role of modeling

- Forward problem (**validation role**):
 - reproduce the experimental signals for known inspection situations
 - establish a consistent (preferably – linear) relationship between the experimental and simulated results
- Backward problem (**numerically generated data**):
 - generate a series of outputs by changing the modeling variables
 - analyze the signals according to the inspectors' criteria and categorize them as “hit” or “miss”, signal amplitude, etc
 - use the numerically generated data in the POD analysis

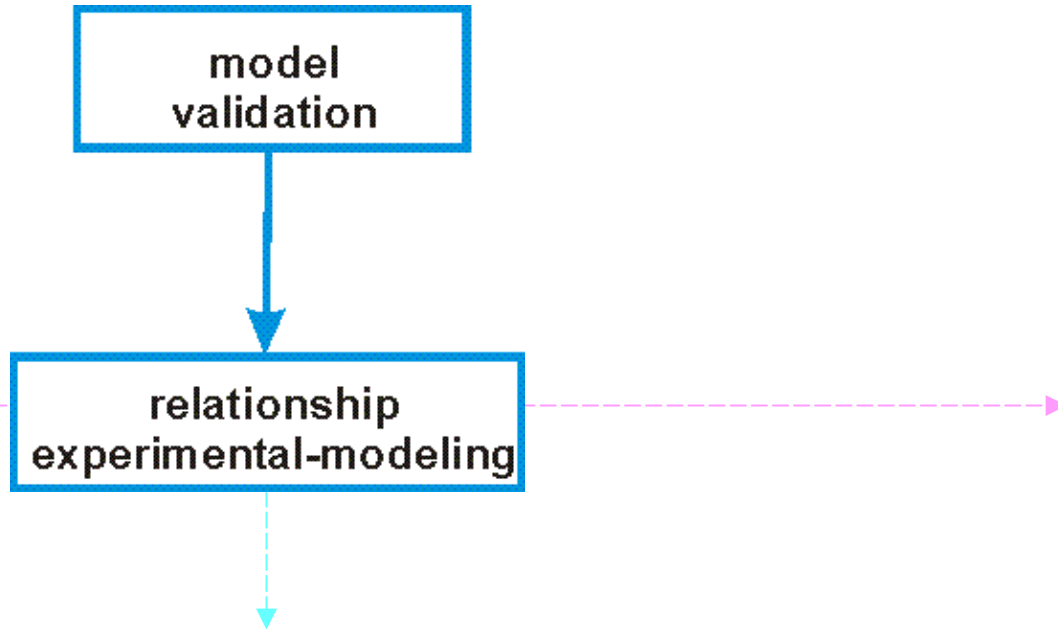
Role of modeling

Experiment

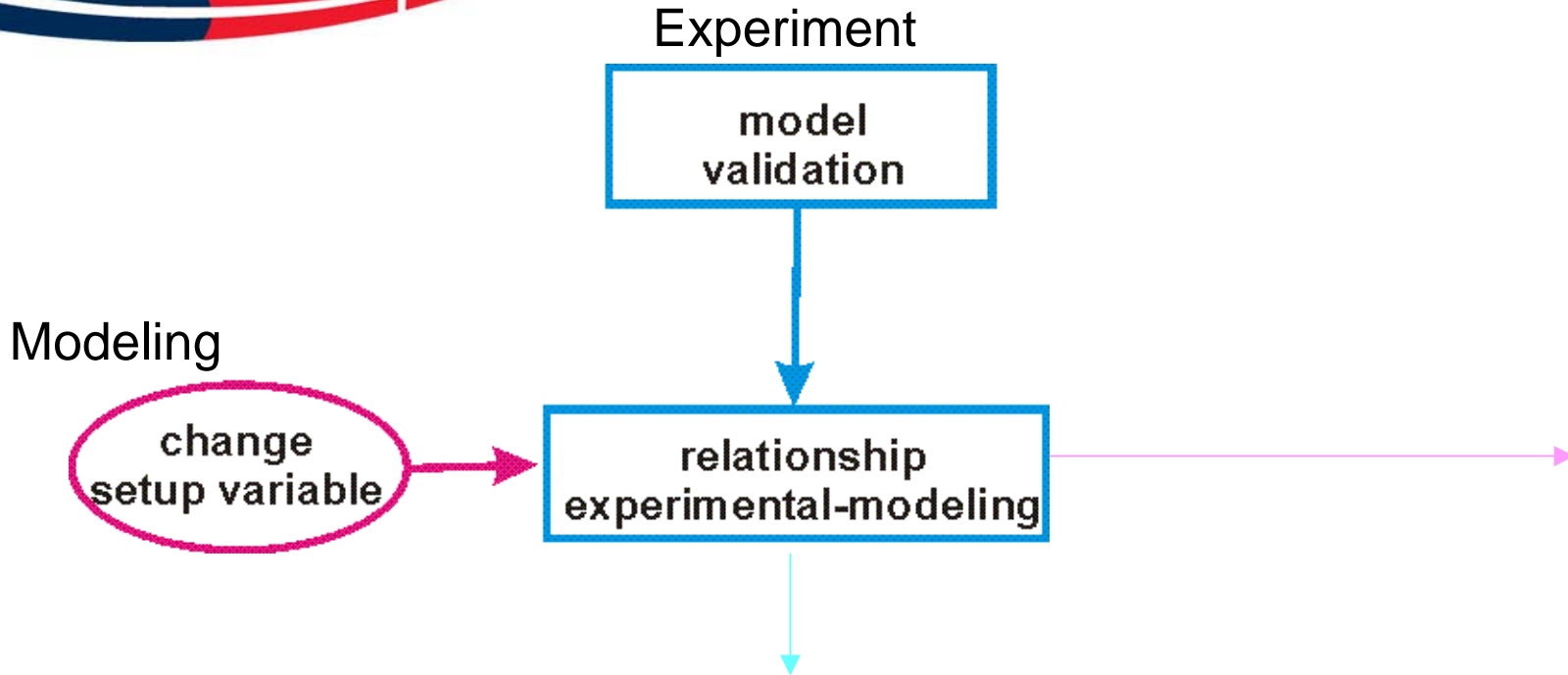
model
validation

relationship
experimental-modeling

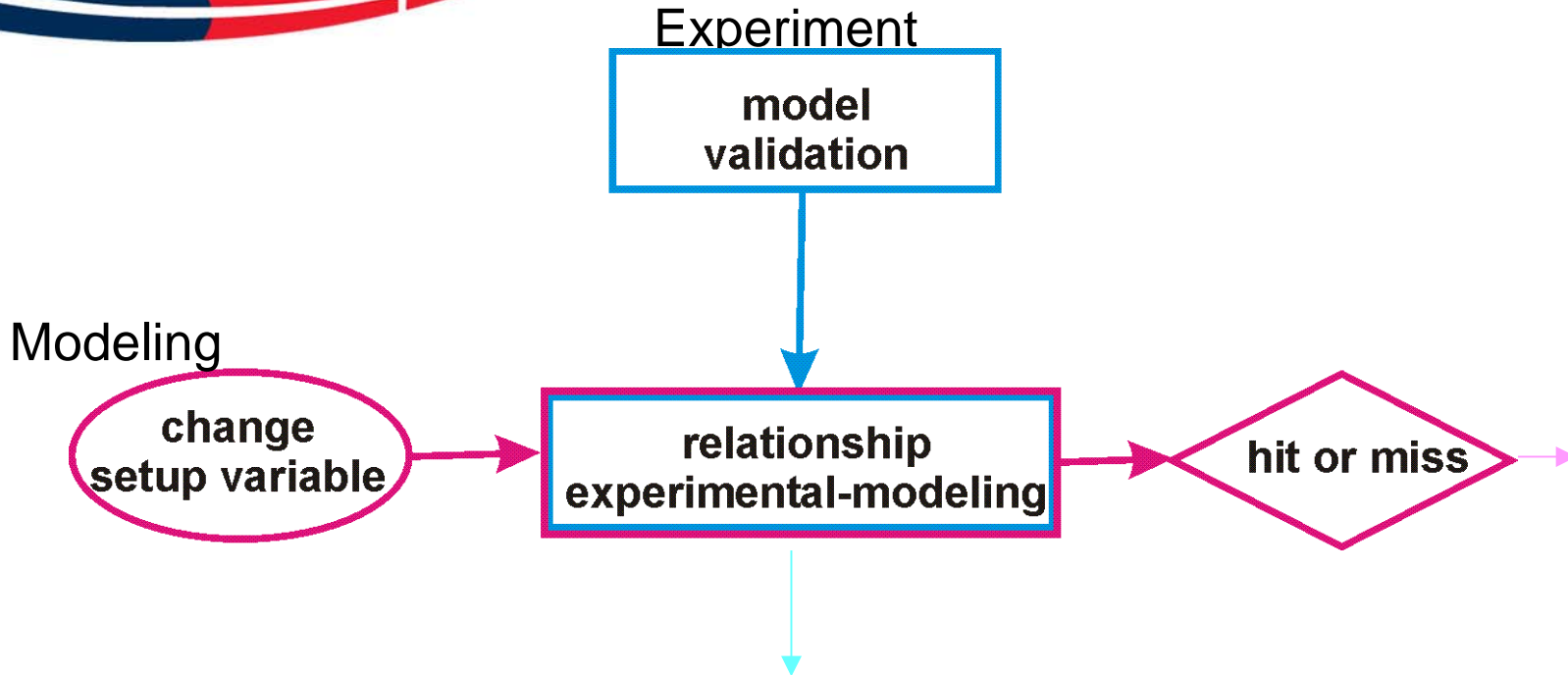
Modeling



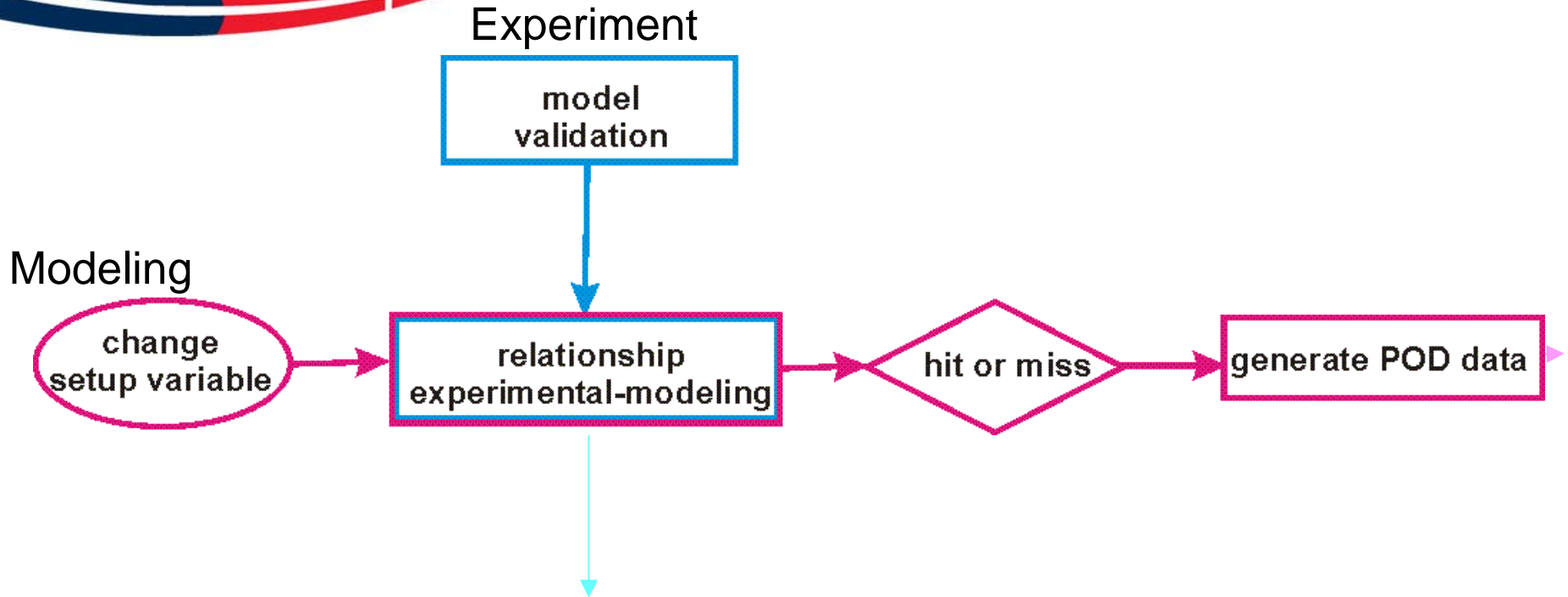
Role of modeling



Role of modeling



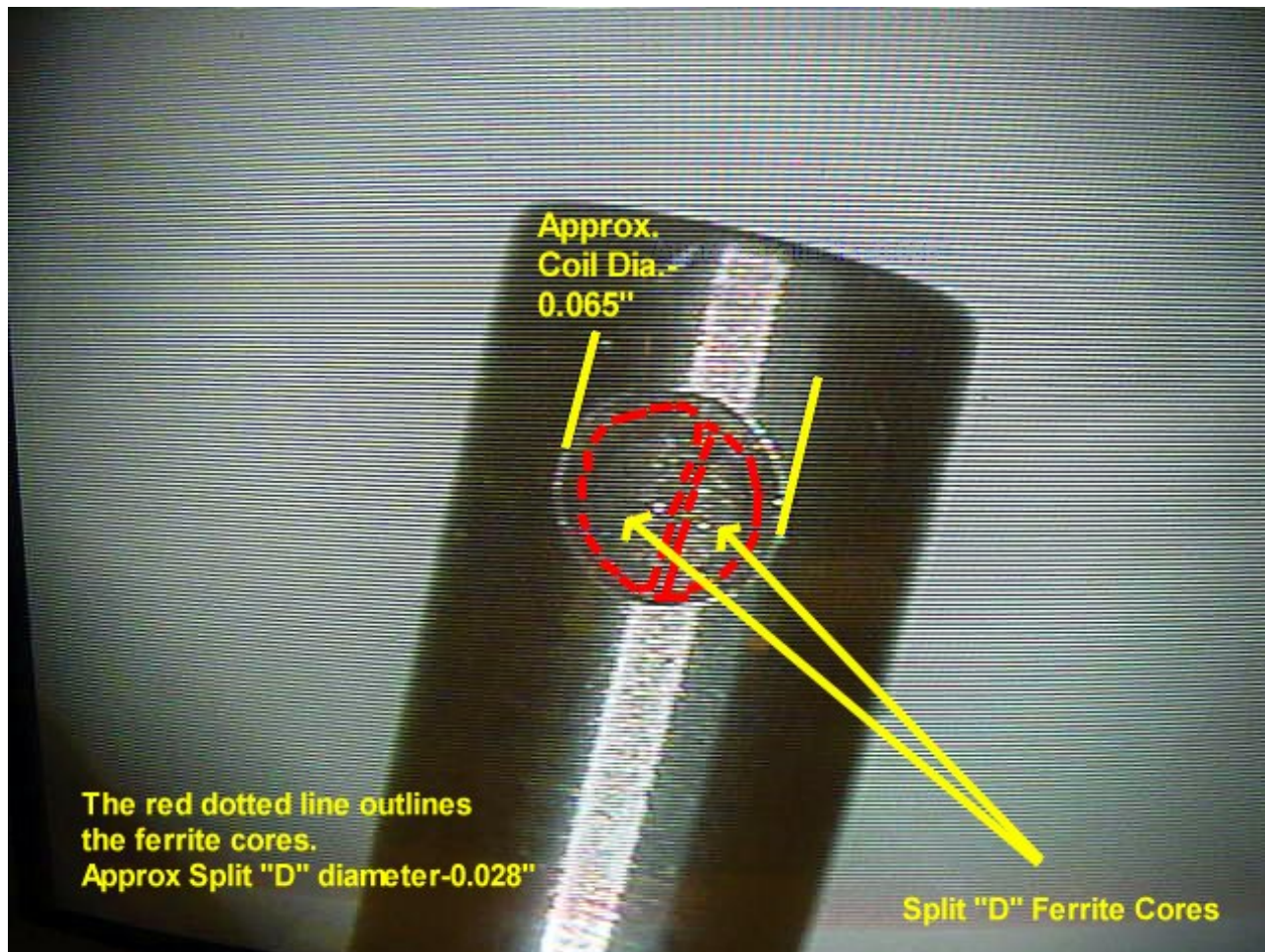
Role of modeling



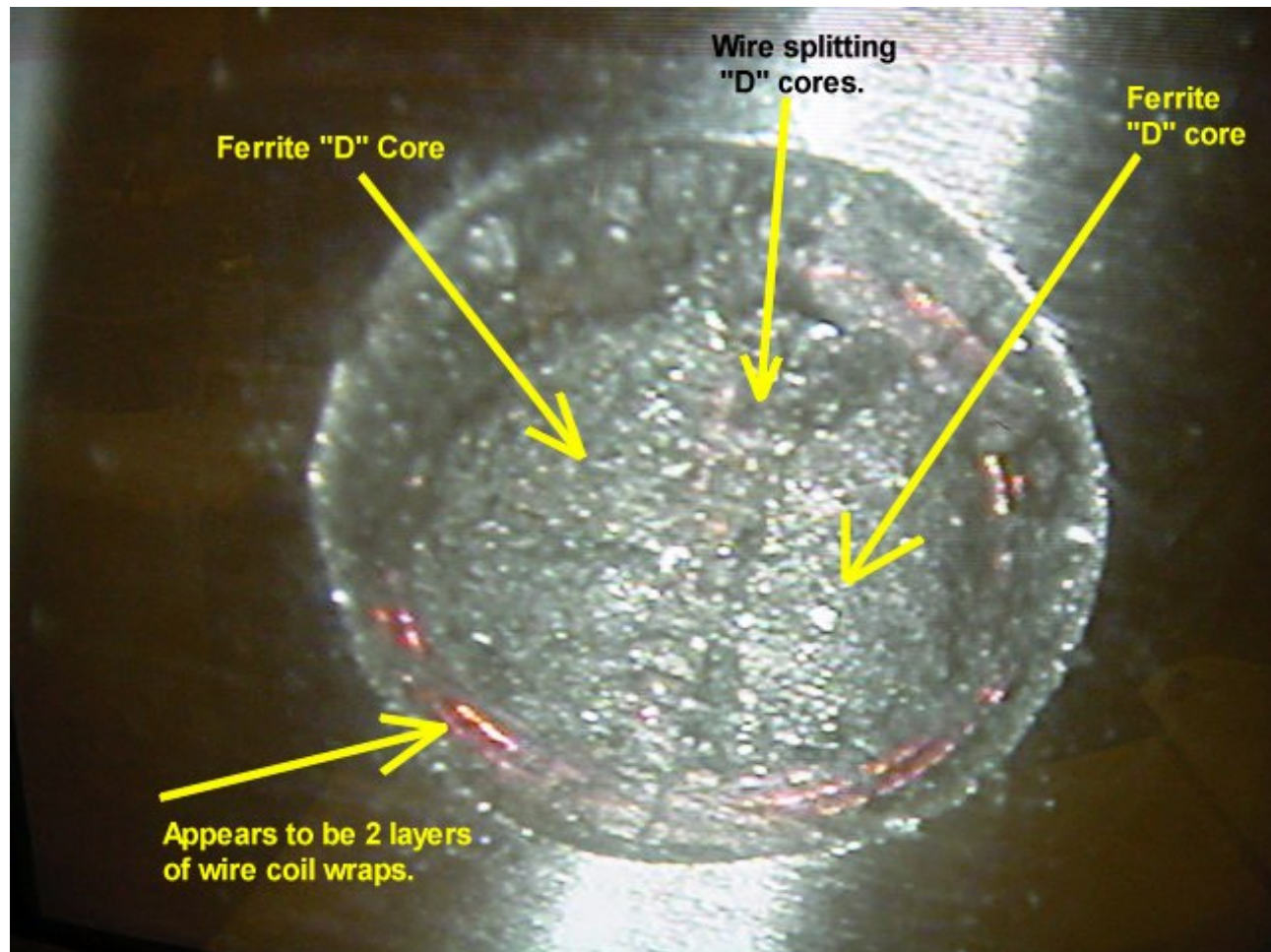
Bolt-Hole ET Probe



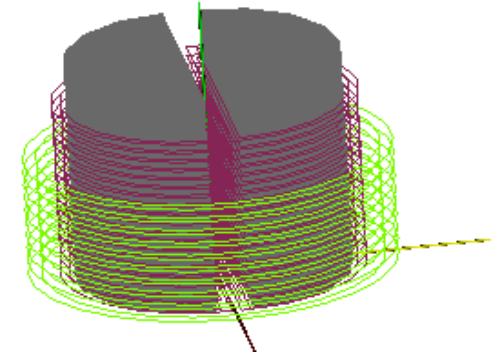
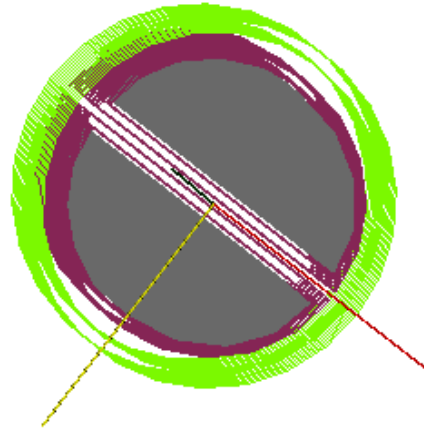
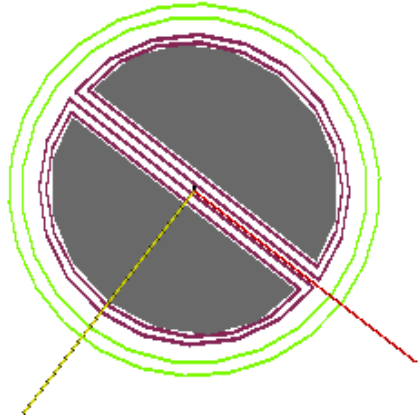
Bolt-Hole ET Probe



Bolt-Hole ET Probe



Bolt-Hole ET Probe



- **Ferrite cores:**

$D=1.5\text{mm}$, $H=1.2\text{mm}$, $\text{Gap}=0.2\text{mm}$, $\mu=200$

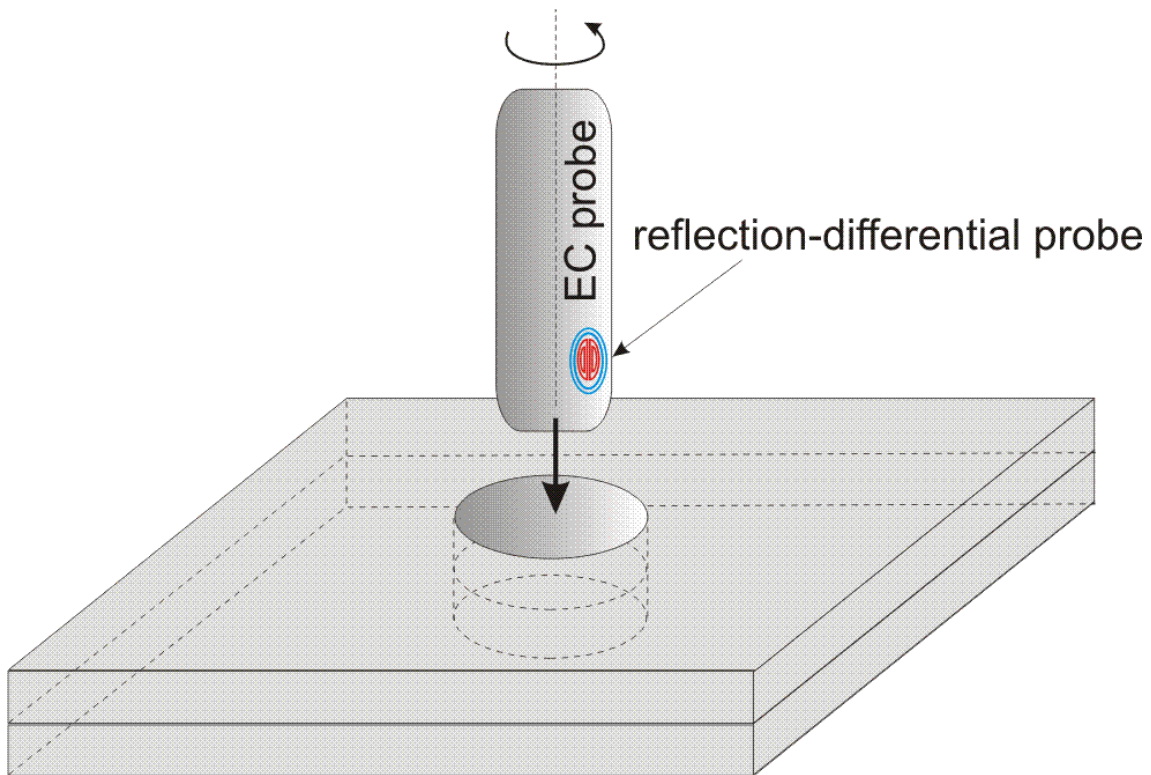
- **Pick-up coils:**

$D=1.5\text{mm}$, $H=1.0\text{mm}$, $t=0.1\text{mm}$, $\text{layers}=2$, $\text{windings/layer}=20$

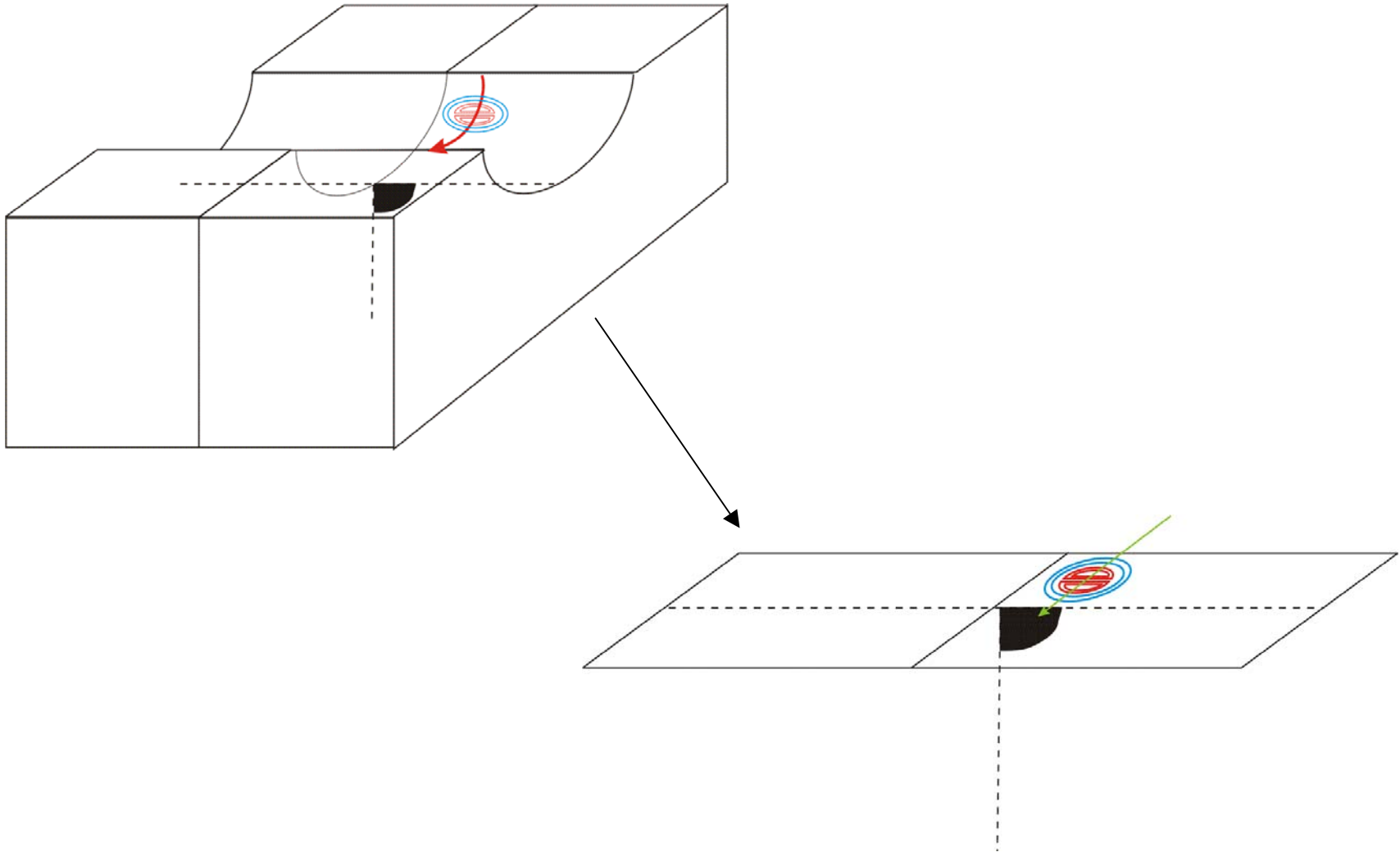
- **Driver coil:**

$D=1.78\text{mm}$, $H=0.7\text{mm}$, $t=0.14\text{mm}$, $\text{layers}=2$, $\text{windings/layer}=10$

Bolt-Hole ET Inspection



Bolt-Hole ET Inspection



- **Modeling variables:**

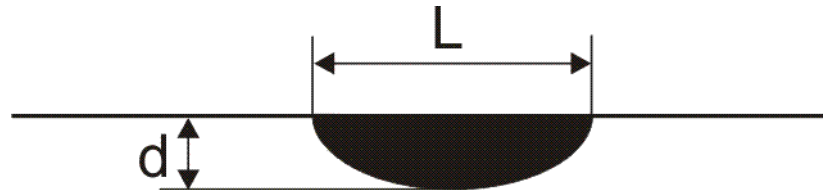
testing frequency, f – default 500kHz

lift-off, l_0 – default 0.2mm

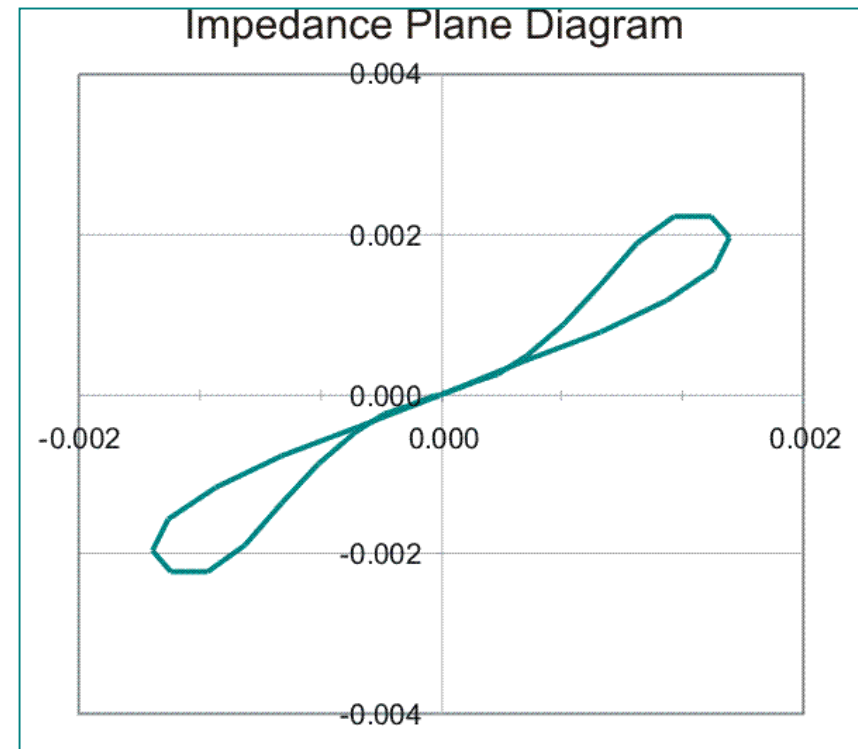
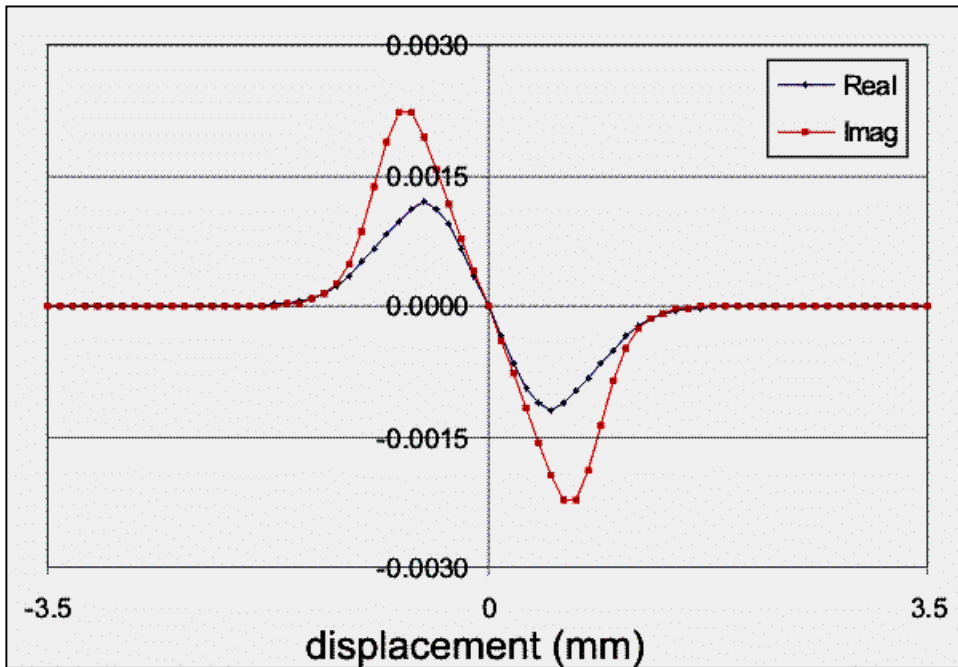
crack length, L – default 1.0mm

crack depth, d – default 1.0mm

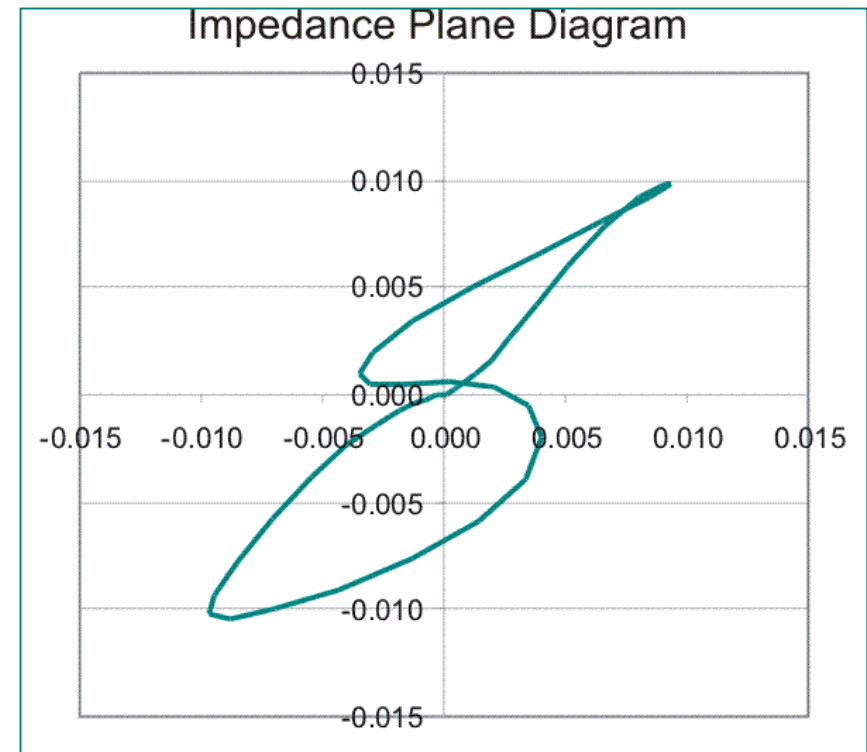
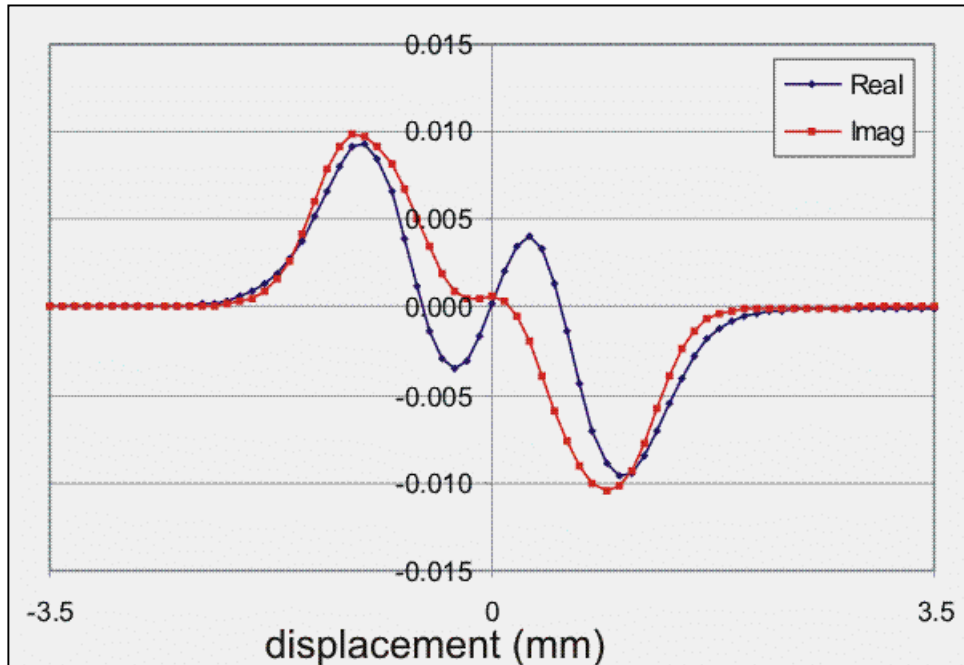
Note: $1\delta=0.22\text{mm}$ for default parameter



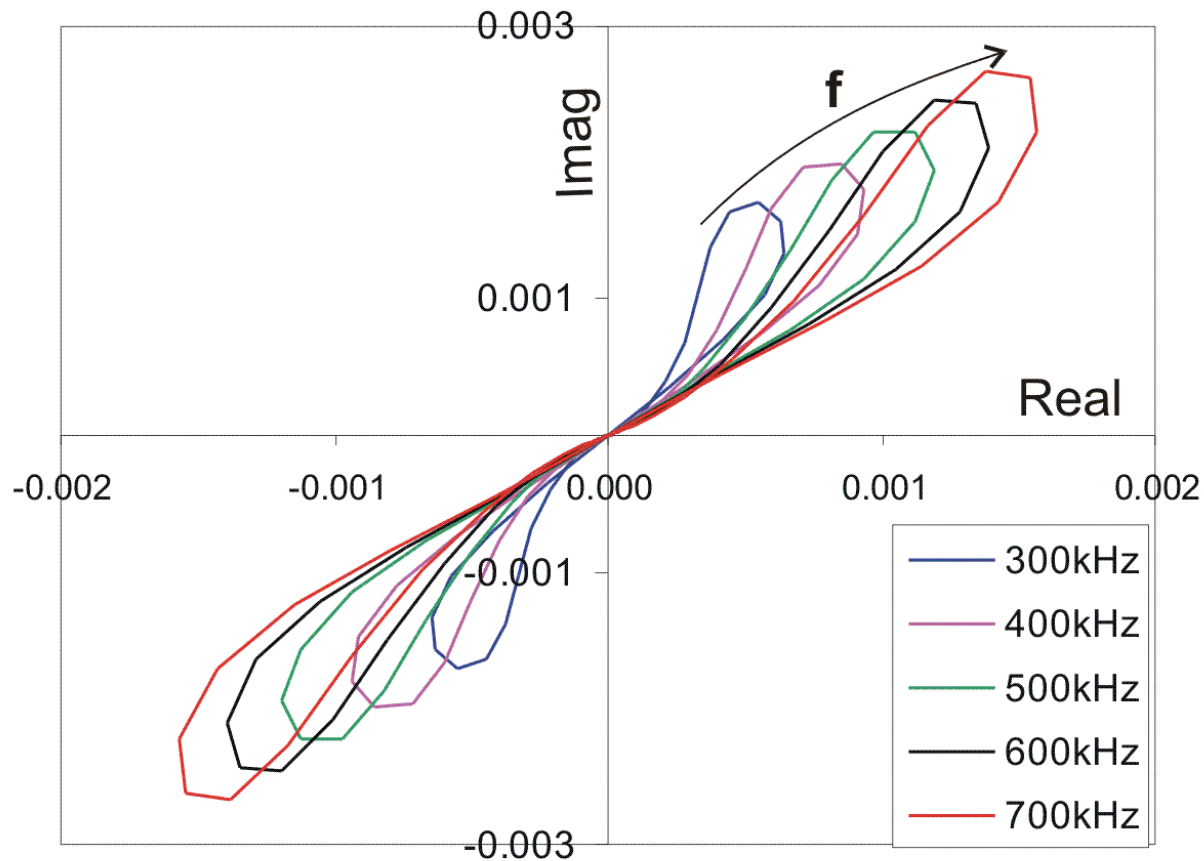
Split parallel to crack - default parameters



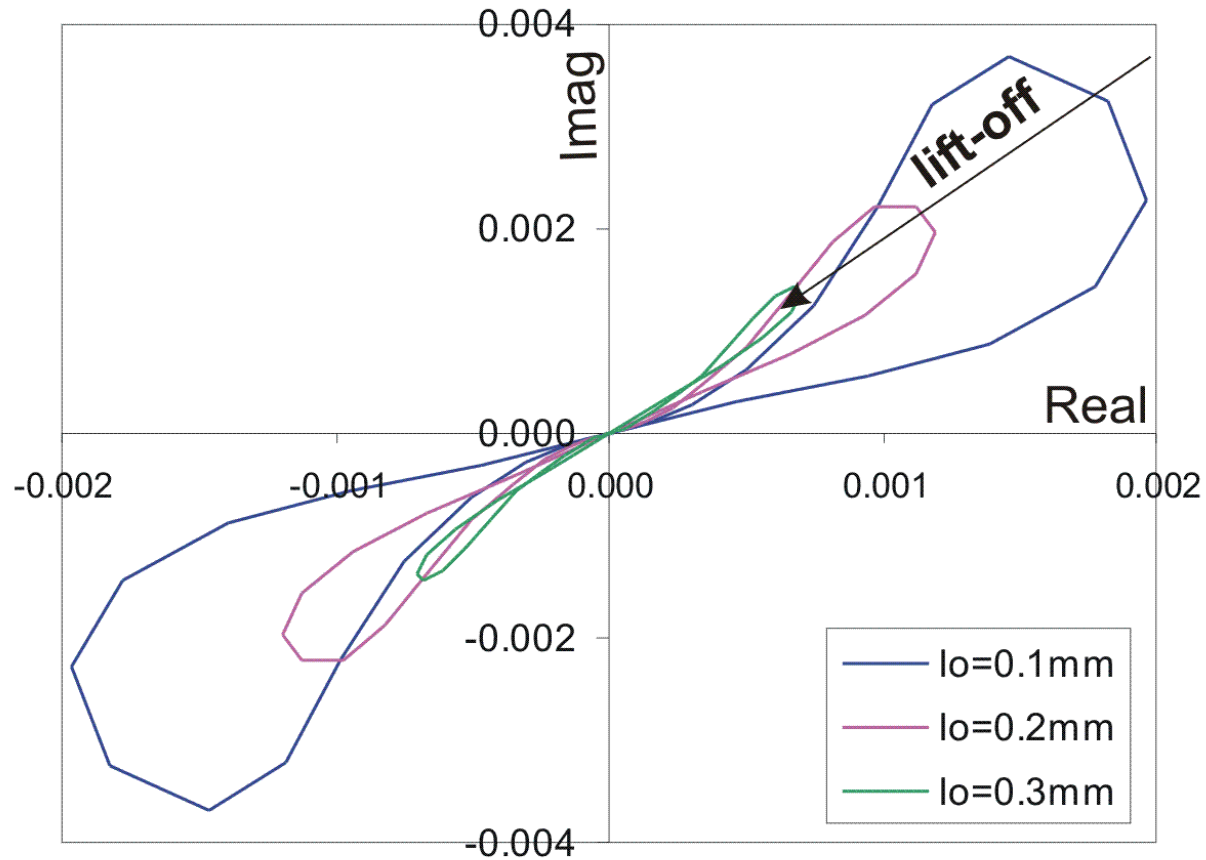
Split perpendicular to crack - default parameters



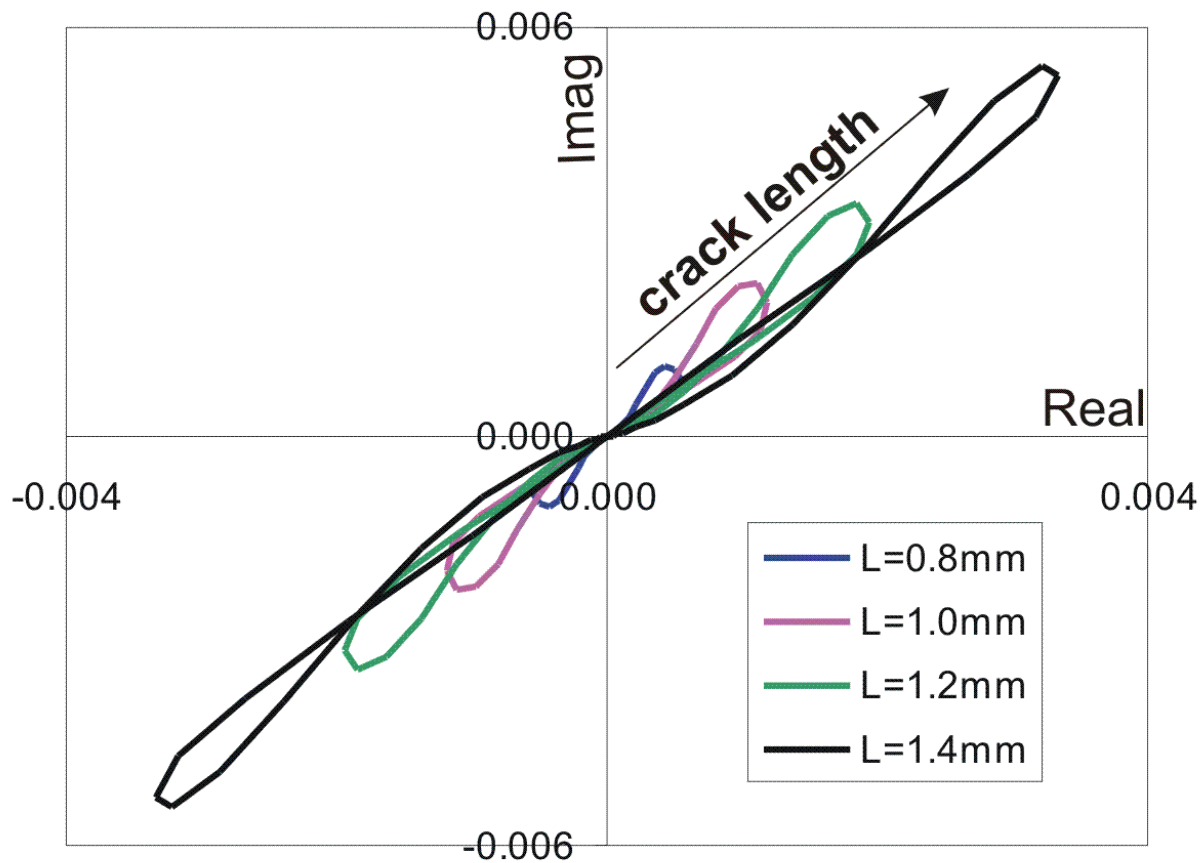
Frequency variation (300, 400, 500, 600, 700) kHz



Lift-off variation (0.1, 0.2, 0.3) mm



Crack length (0.8, 1.0, 1.2, 1.4) mm



Crack depth (0.8, 0.9, 1.0, 1.1, 1.2, 1.3) mm

