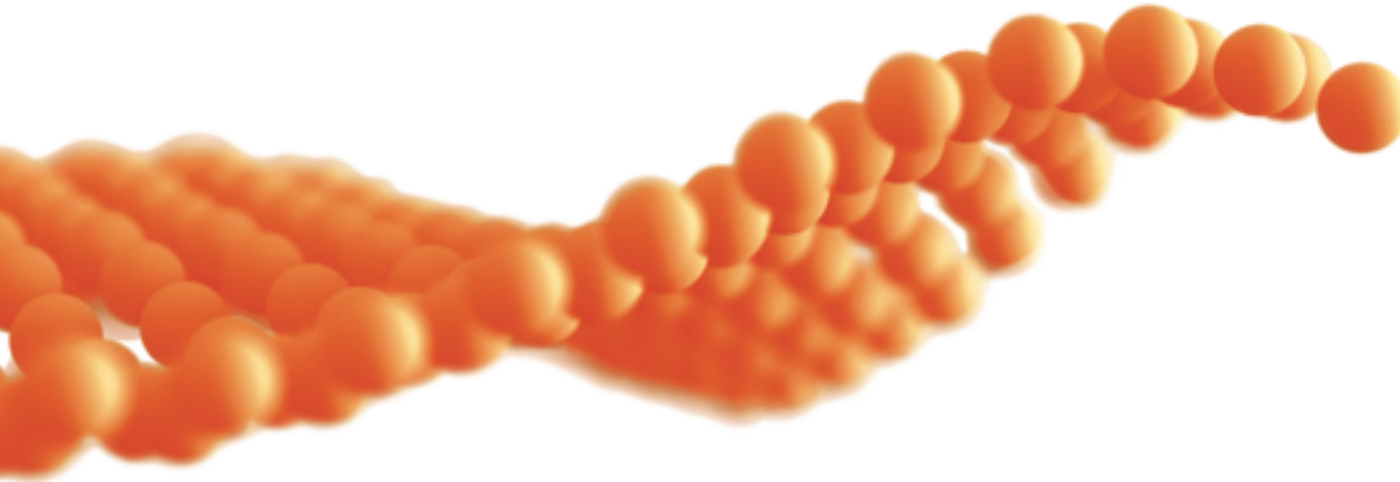


AWSensors
Scientific Technology

CATCH-U-DNA 1st Review Meeting

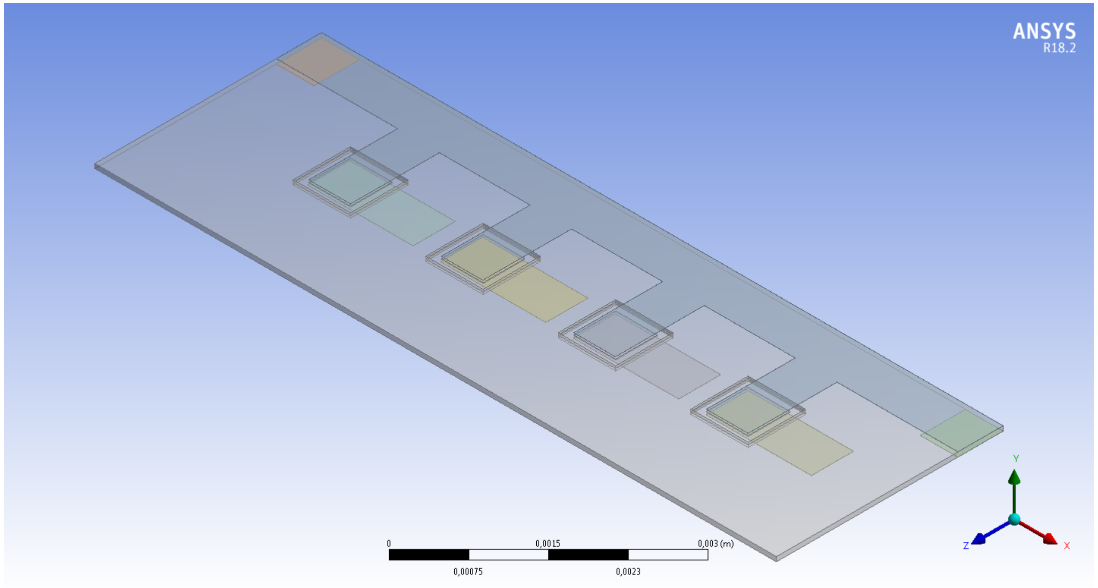
26th June 2018, Brussels, Belgium

WP1. Acoustic wave devices and measurement control unit

Objectives and current results

1. Objectives

- Chip containing an array of TSBAR sensors



Requirements

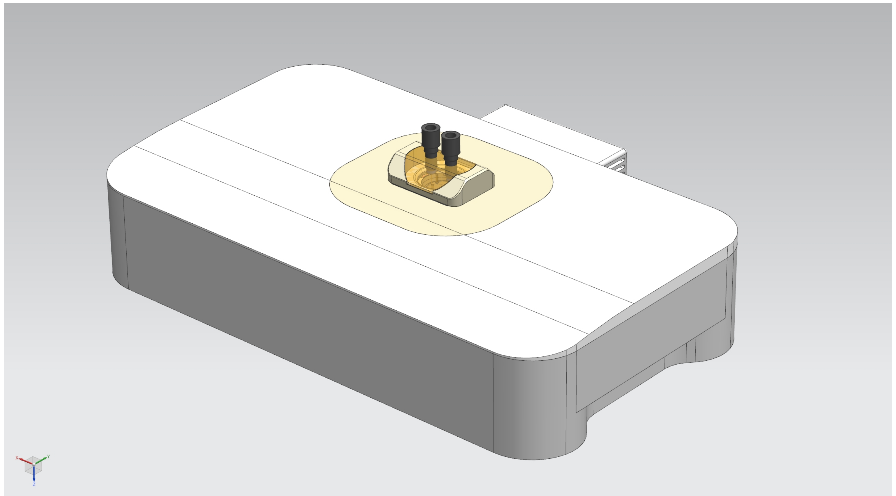
- Size < 6 cm2
- Cost < 2€ (mass production)
- Op. frequency between 150 MHz and 2GHz

1. Objectives

- Measurement system

Requirements

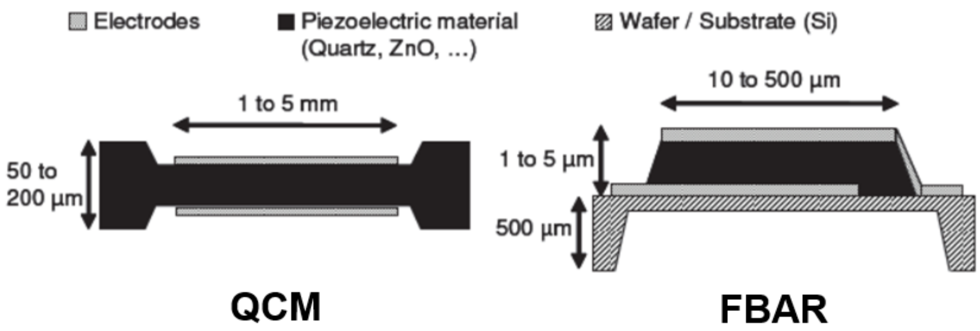
- High resolution
- Stability in the ppt range
- Real time (for arrays)



2. Main achievements

SENSOR DESIGN AND MODELING
Task 1.1
(M1-M15)

Sensor Array Design



- Operating frequencies (30- 700 MHz)
- AT-cut quartz
- Integration capability (0.5 mm)
- High Q factor
- Low complexity
- Low cost

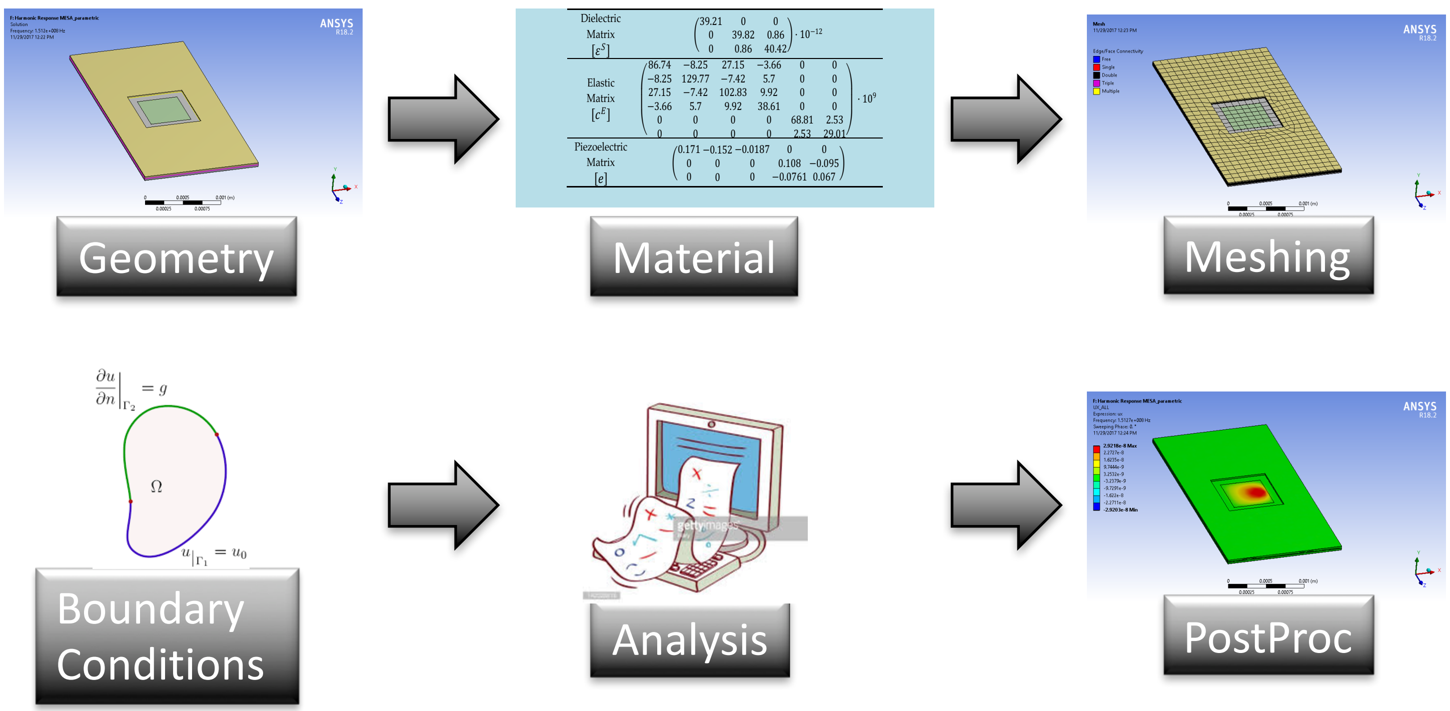
HFF-QCM → ← FBAR

- Operating frequencies (1- 2 GHz)
- ZnO or AlN
- Integration capability (0.1 mm)
- CMOS standard
- Medium/High Complexity
- Low cost

2. Main achievements

SENSOR DESIGN AND MODELING
Task 1.1
(M1-M15)

Sensor Numerical Models



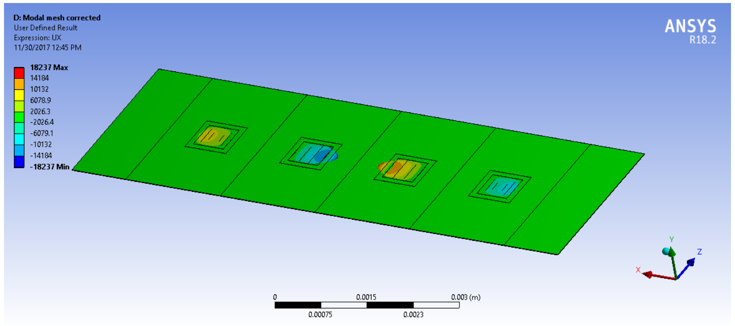
2. Main achievements

AWSensors
Scientific Technology

SENSOR DESIGN AND MODELING
Task 1.1
(M1-M15)

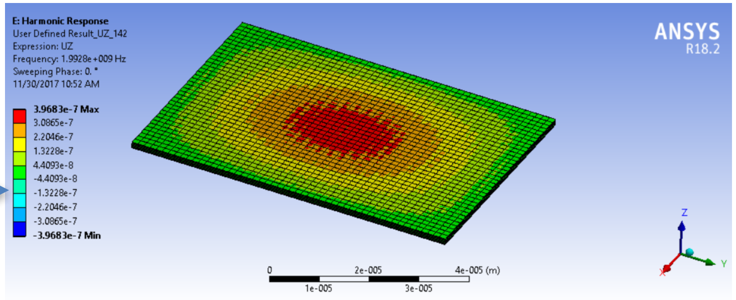
Sensor Numerical Models

HFF-QCM

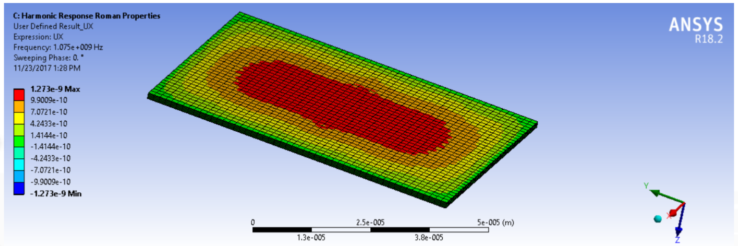


FBAR

FBAR



S-FBAR



2. Main achievements

AWSensors
Scientific Technology

SENSOR DESIGN AND MODELING
Task 1.1
(M1-M15)

Sensor Numerical Models

Analysis performed

- Modal
- Harmonic
- Harmonic (considering damping)
- Parametric

Main Conclusions

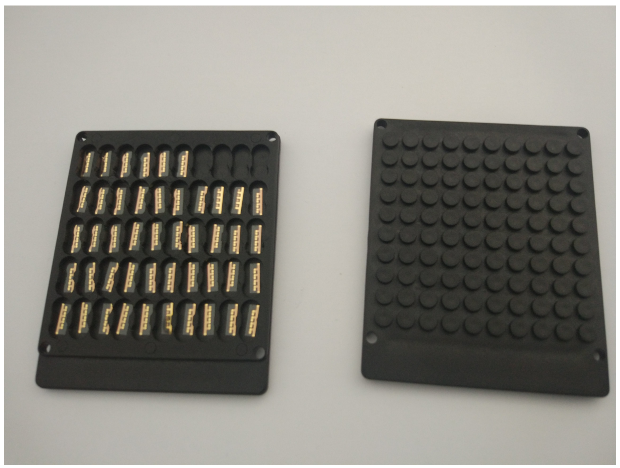
- It is possible to change ZnO substrate deposition angle to obtain a S-FBAR to be used in liquids
- Surface Acceleration (sensitivity) is of the same order of magnitude in HFFQCM (@150 MHz) and in S-FBAR (2GHz)
- Considering damping, Q exhibited by the HFFQCM is far better than the S-FBAR configuration.
- Interferences in HFFQCM arrays are lower than 50 dB when spacing 1.7 mm

2. Main achievements

AWSensors
Scientific Technology

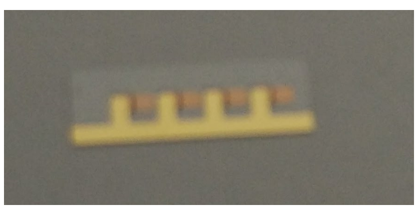
SENSOR FABRICATION
Task 1.2
(M4-M18)

4 sensor HFFQCM array Fabricated (single-side inverted mesa)

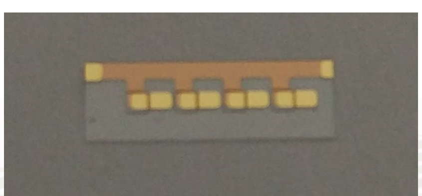


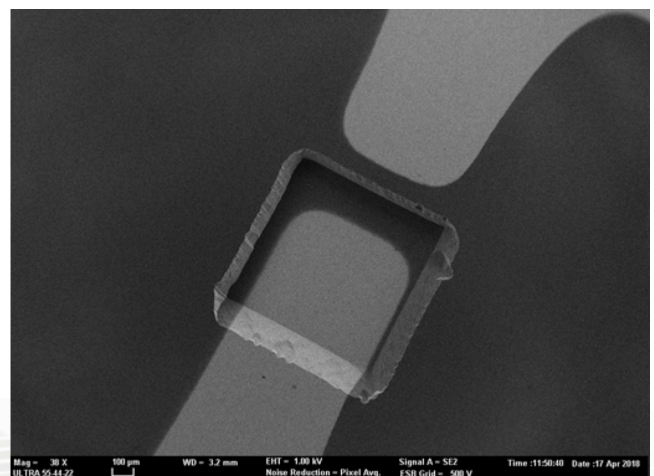
- Microfabrication process (etching, electrode sputtering, electrode wrapping) defined and tested
- Tooling developed
- 4 sensor array implemented
- SEM characterized
- Electrical characterization is ongoing

Top



Bottom

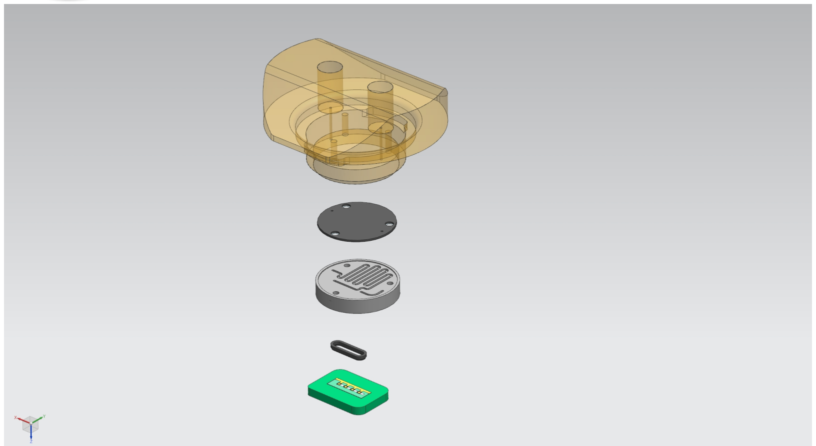




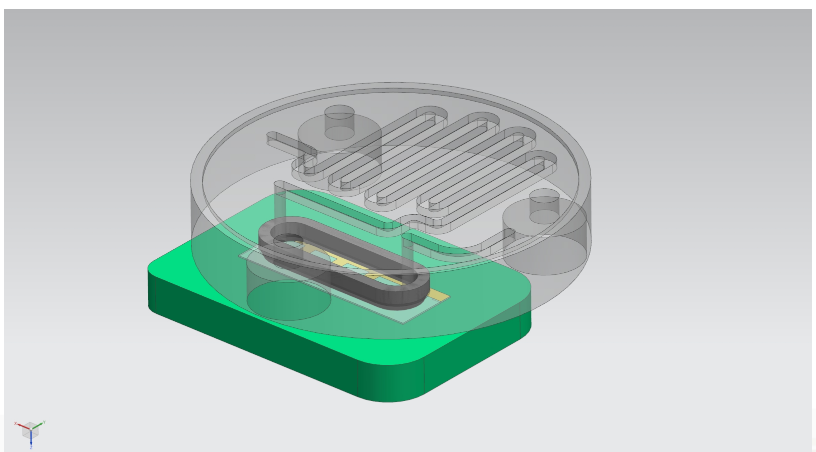
2. Main achievements

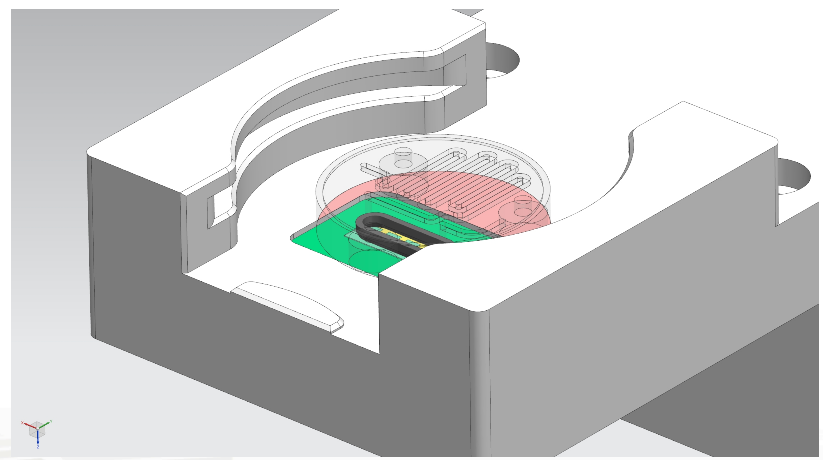
SENSOR FABRICATION Task 1.2 (M4-M18)

Sensor packaging designed



- Heat exchanger designed
- PCB support designed
- Sealing gasket designed
- Fluidic, thermal and electric requirements have been considered





2. Main achievements

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method

Why?

- Objective: Measure multiple sensor responses simultaneously
- Accurate measurement of the acoustic ratio
- Calibration issues (complex electronic interface)
- High stability/Low noise
- Wide operation range (Liposomes)

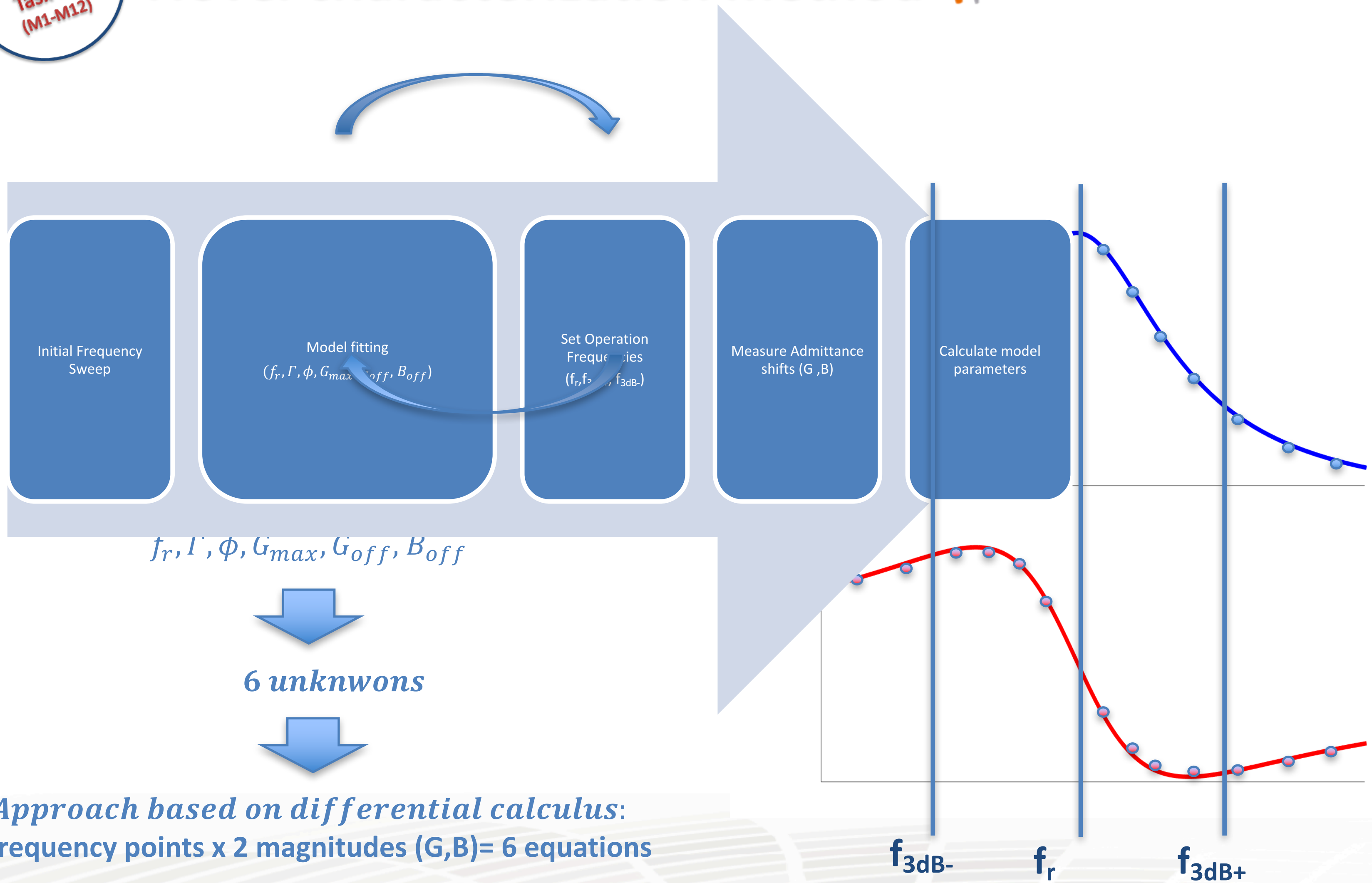
Characteristics & Benefits

- Mixed (Tracking- Fixed frequency) characterization algorithm
- Fast (Multiplexing)
- Accurate
- Wide operation range
- Electrical artifacts considered
- Patent evaluation

2. Main achievements

MEASURING TECHNIQUE Task 1.3 (M1-M12)

Novel characterization method



$f_r, \Gamma, \phi, G_{max}, G_{off}, B_{off}$

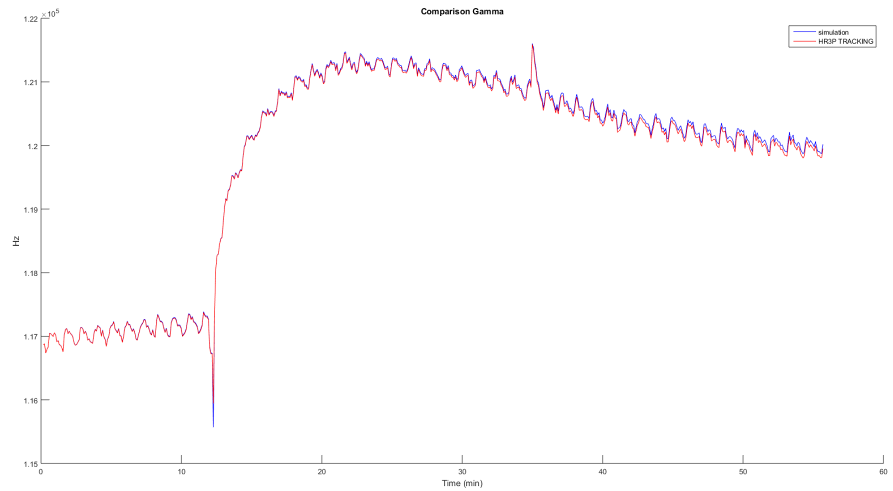
6 unknwons

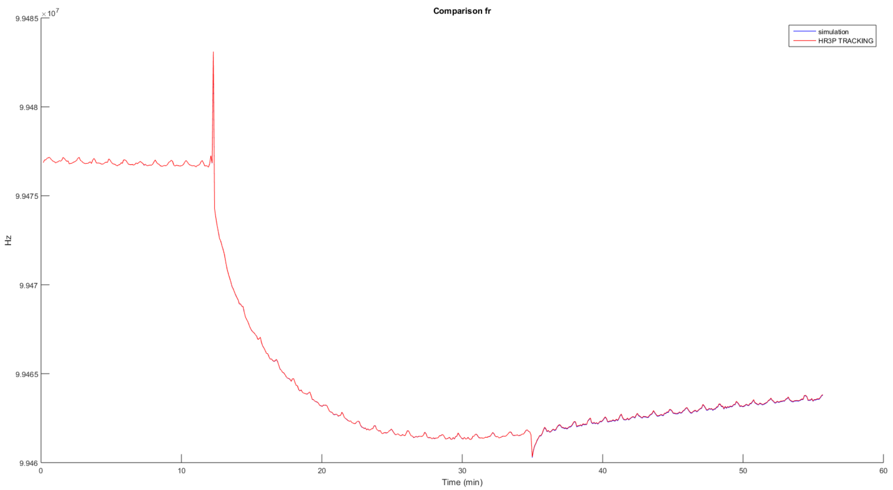
Approach based on differential calculus:
3 frequency points x 2 magnitudes (G,B)= 6 equations

2. Main achievements

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method

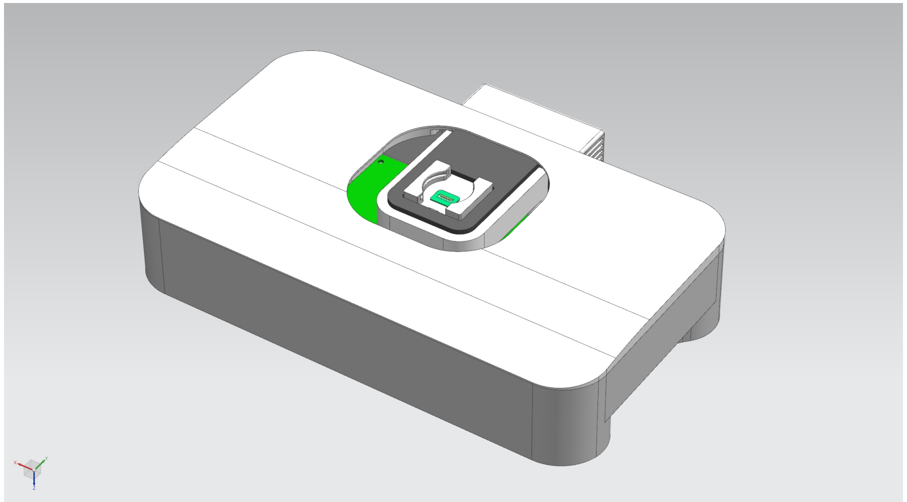


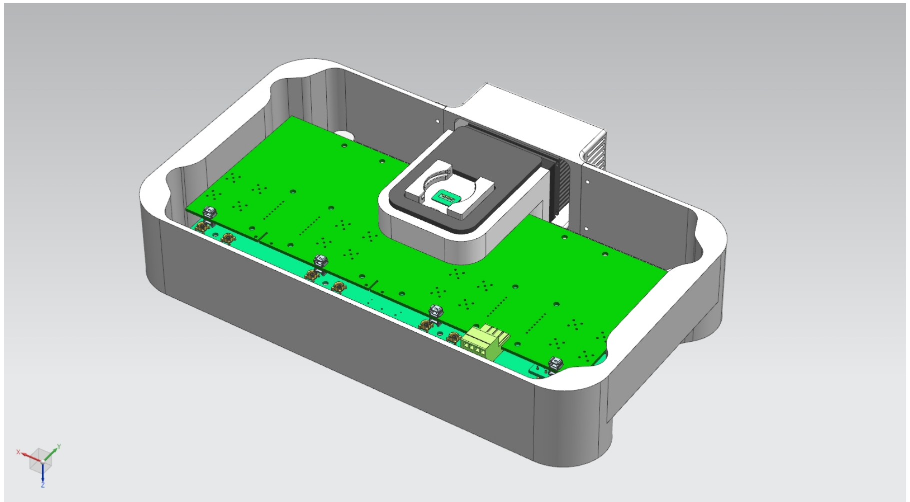


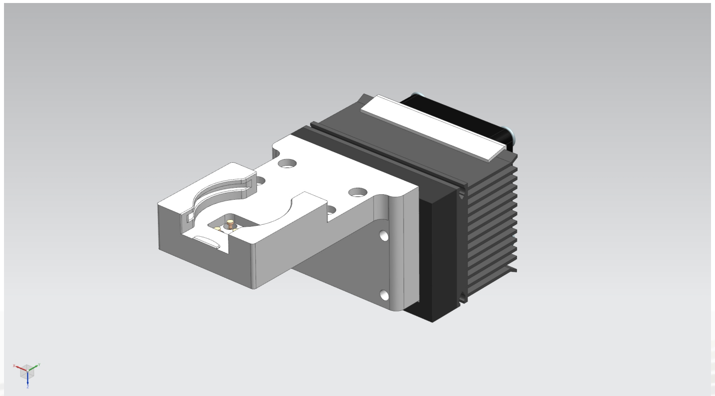
2. Main achievements

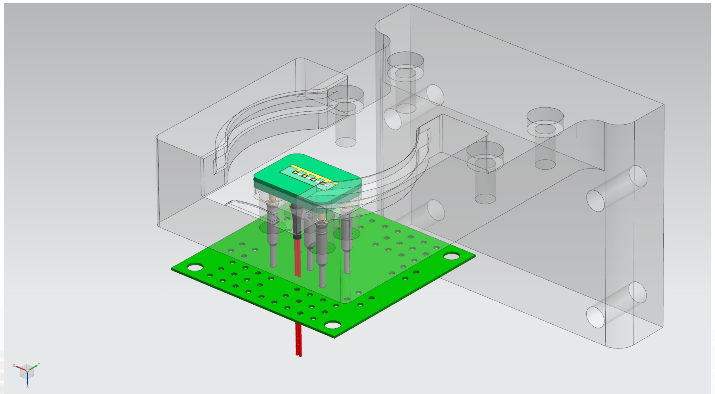
MEASURING TECHNIQUE
Task 1.3
(M1-M12)

X400 Instrument design (Electrical /mechanical interface)







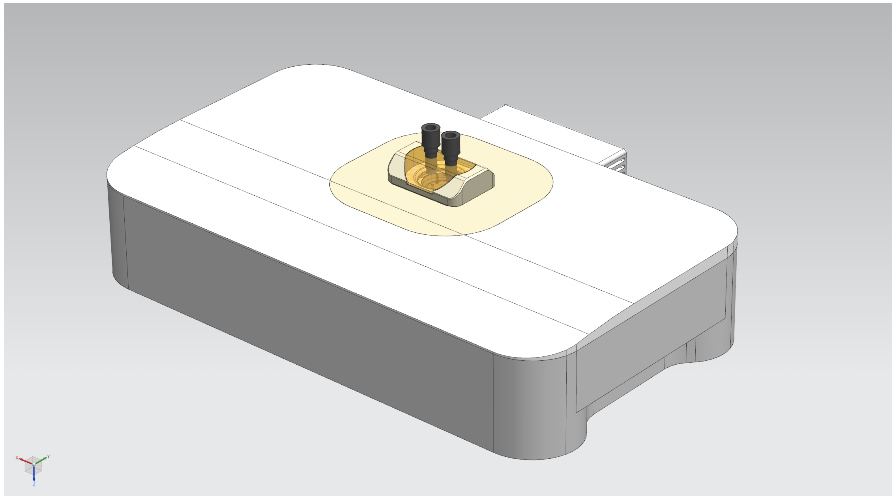


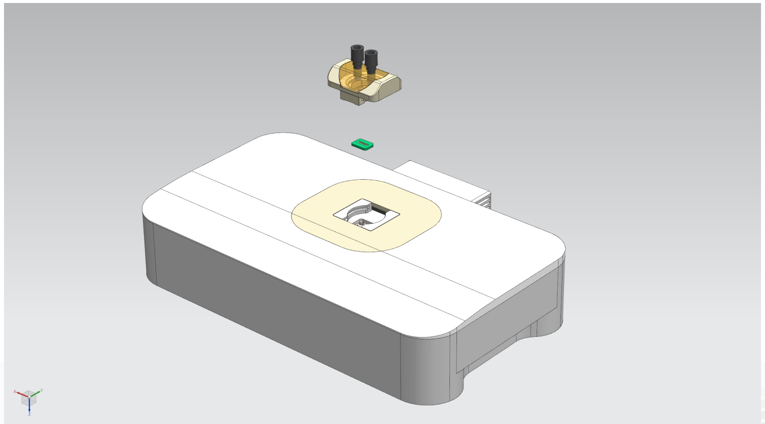
2. Main achievements

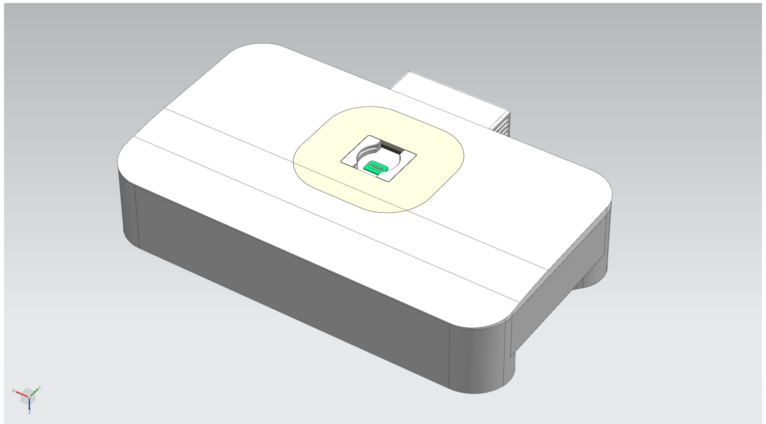
AWSensors Scientific Technology

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

X400 Instrument design







3. Future plans

AWSensors
Scientific Technology

SENSOR DESIGN AND MODELING
Task 1.1
(M1-M15)

- Design of the final CUDNA array
- Optimization re-design loops

SENSOR FABRICATION
Task 1.2
(M4-M18)

- Implementation of the packaging designed
- Sensor surface cleaning protocol
- Sensor surface modification
- Preliminary testing with bio-samples
- Implementation of final CUDNA array

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

- Hardware/Firmware implementation of the novel characterization method
- Delivering a preliminary instrument prototype to test CUDNA overall concept

4. Deviations, delays and problems

- No significant problems/delays detected
- Technical modifications: 24 sensors required per array
- New timeline proposed to allow re-design loops: array optimization will continue until M28 to consider Consortium proposal/results

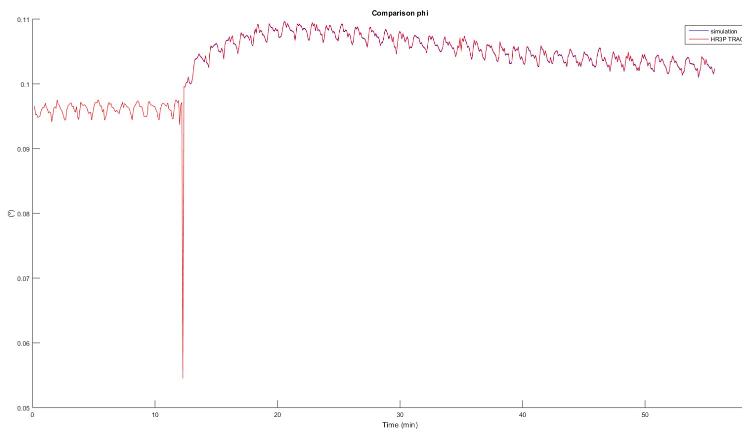
5. Questions

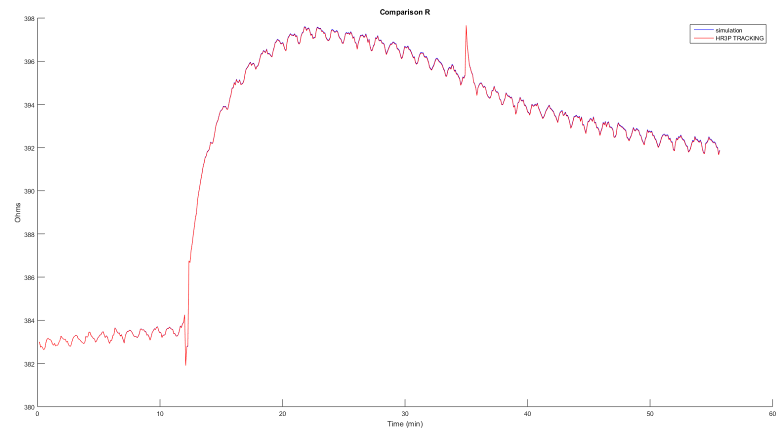
Thank you!

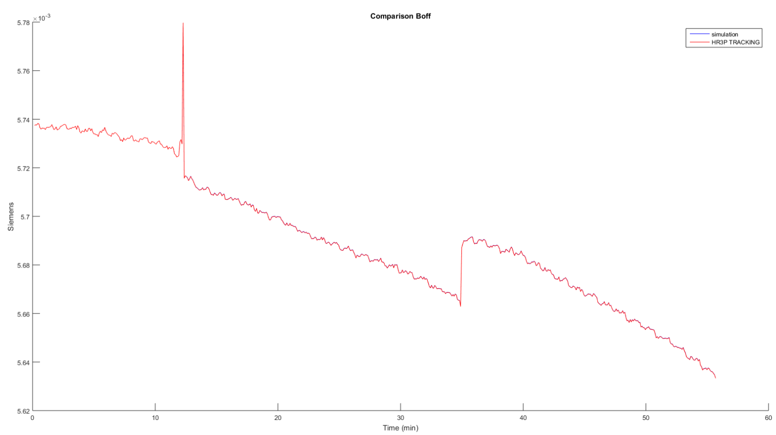
2. Main achievements

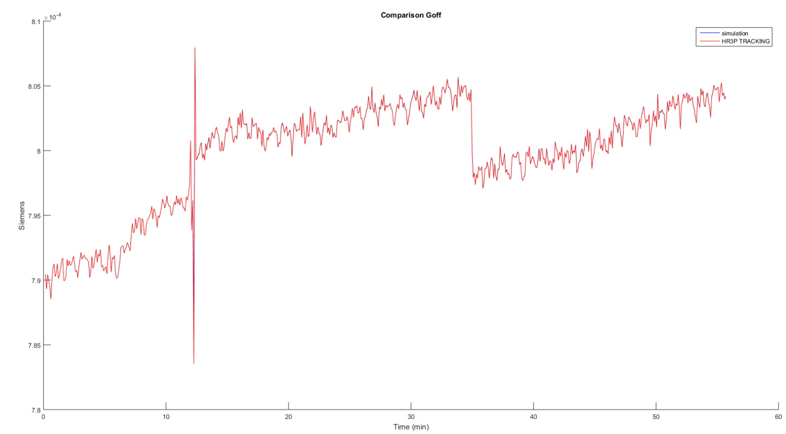
MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method







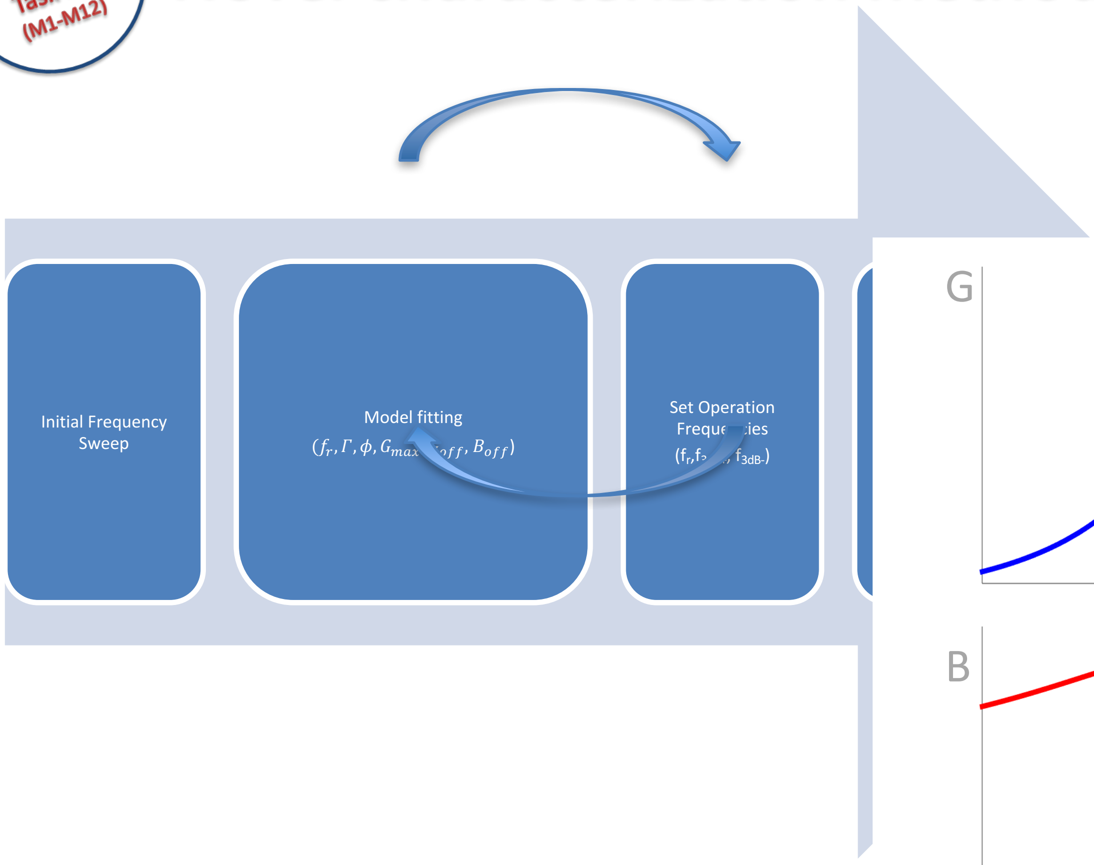


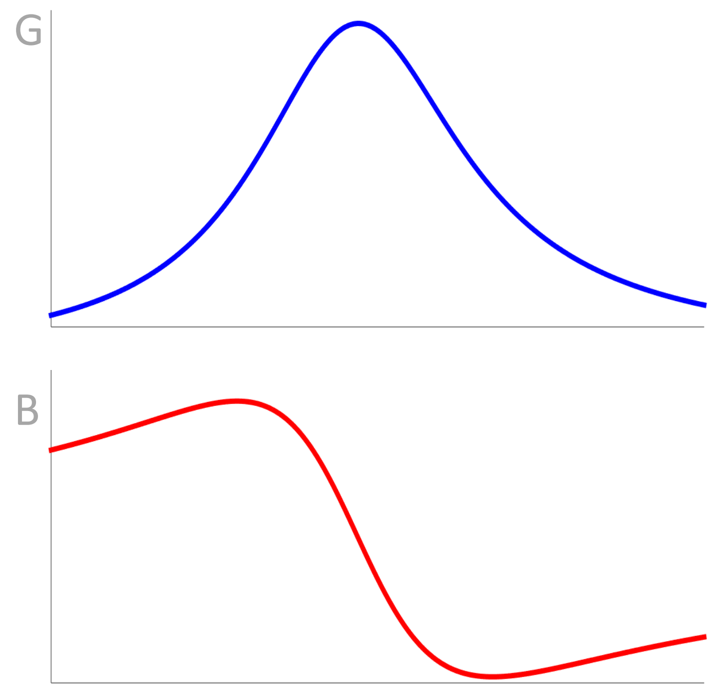
2. Main achievements

AWSensors
Scientific Technology

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method



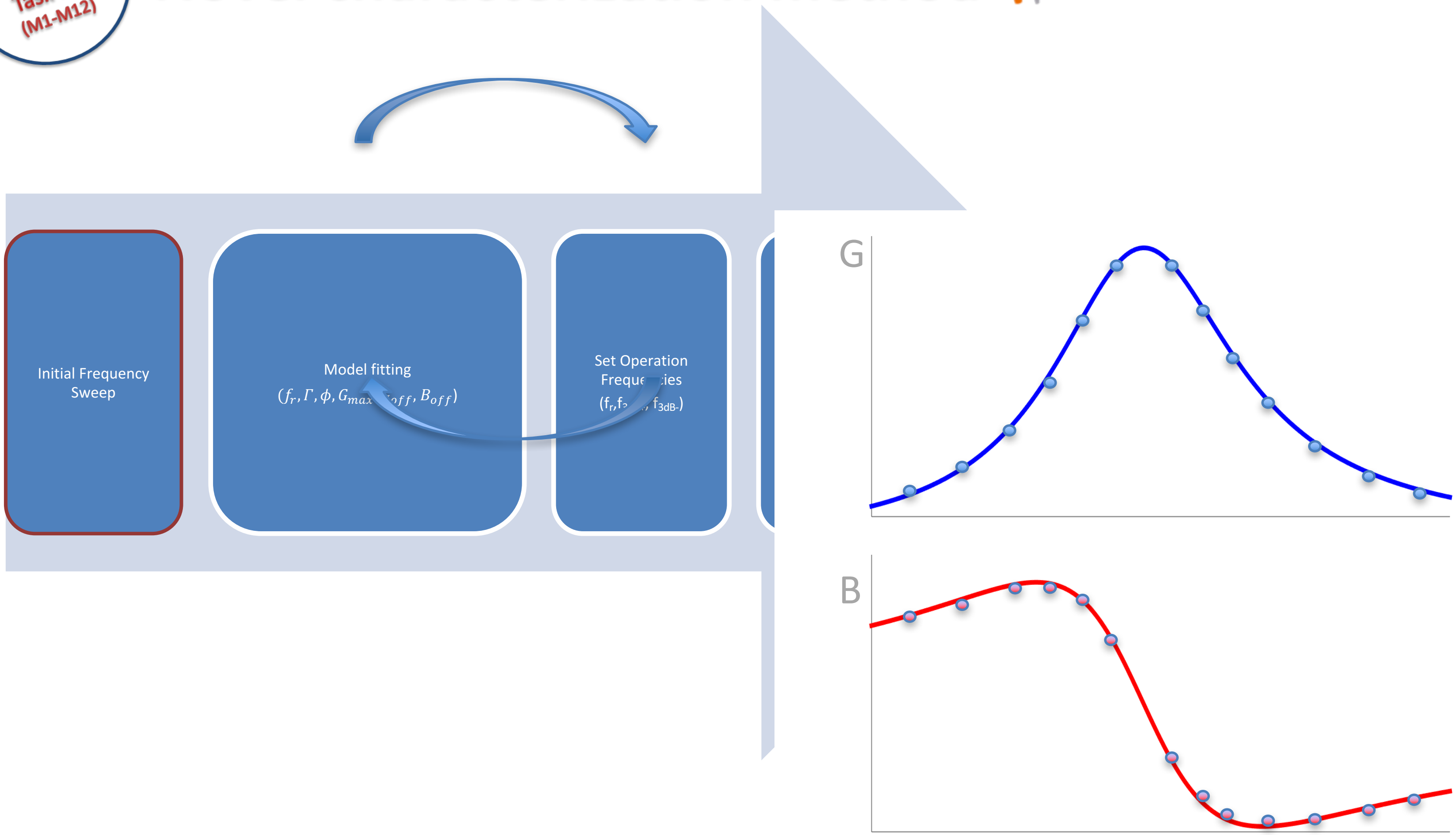


2. Main achievements

AWSensors
Scientific Technology

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method

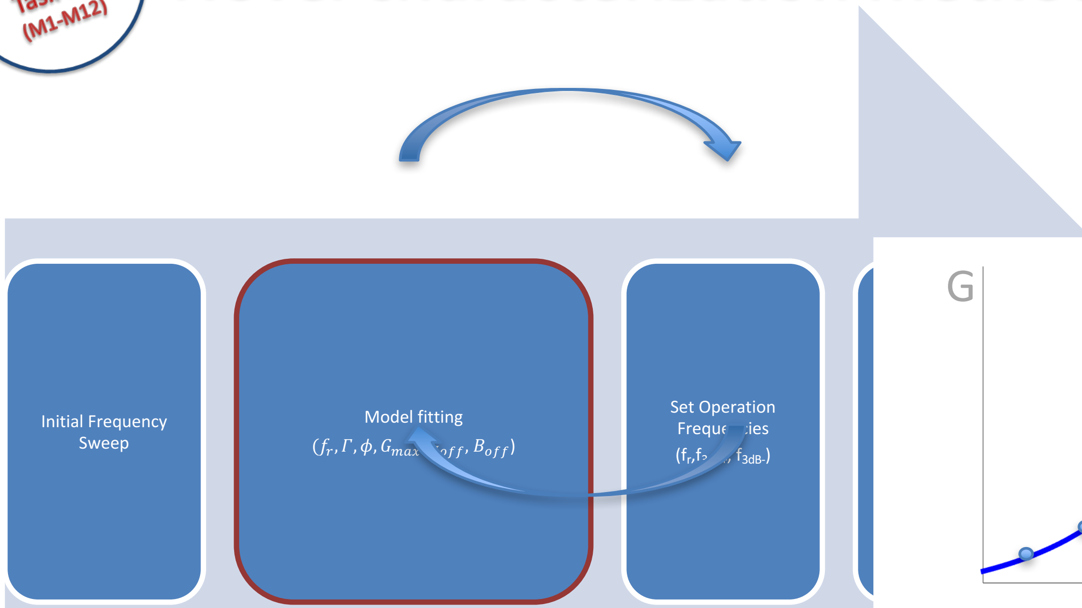


2. Main achievements

AWSensors Scientific Technology

MEASURING TECHNIQUE Task 1.3 (M1-M12)

Novel characterization method

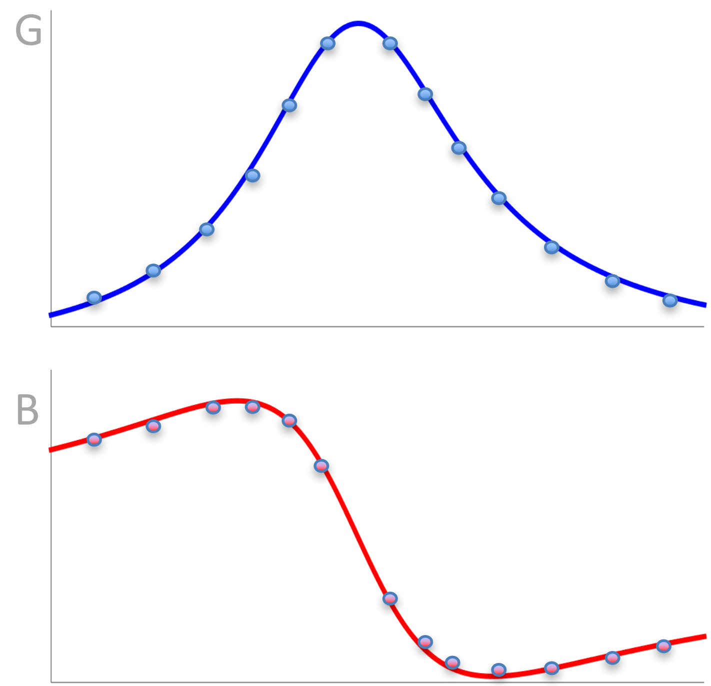


Model Parameters:

$f_r, \Gamma, \phi, G_{max}, G_{off}, B_{off}$

$$G(f) = G_{max}\left(\frac{f^2(2\Gamma)^2}{(f_r^2 - f^2)^2 + f^2(2\Gamma)^2}\cos\phi - \frac{f(2\Gamma)(f_r^2 - f^2)}{(f_r^2 - f^2)^2 + f^2(2\Gamma)^2}\sin\phi\right) + G_{off}$$

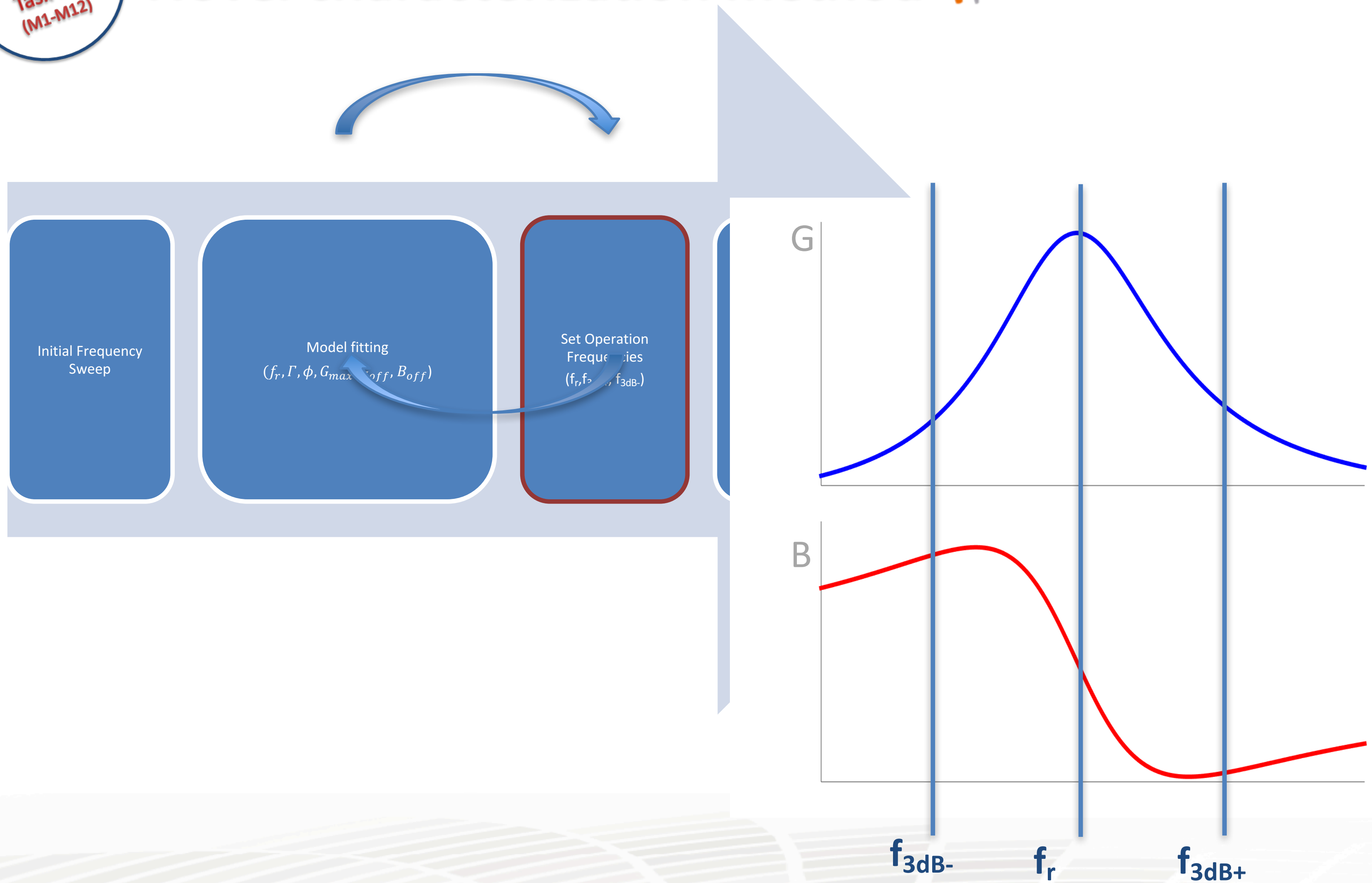
$$B(f) = G_{max}\left(\frac{f^2(2\Gamma)^2}{(f_r^2 - f^2)^2 + f^2(2\Gamma)^2}\sin\phi + \frac{f(2\Gamma)(f_r^2 - f^2)}{(f_r^2 - f^2)^2 + f^2(2\Gamma)^2}\cos\phi\right) + B_{off}$$



2. Main achievements

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

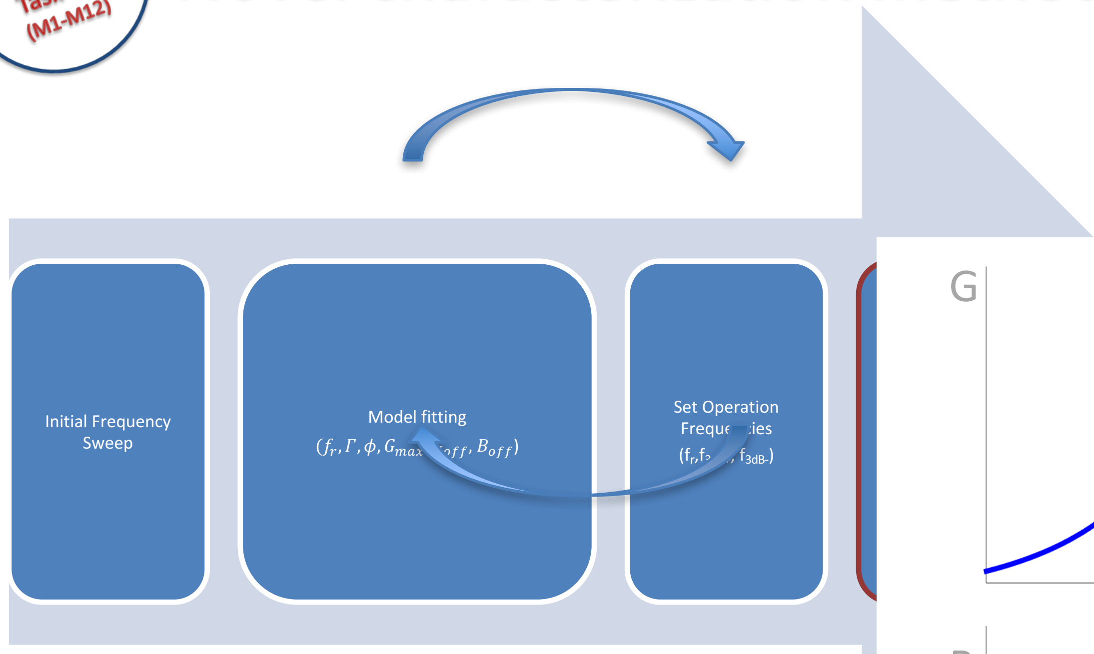
Novel characterization method



2. Main achievements

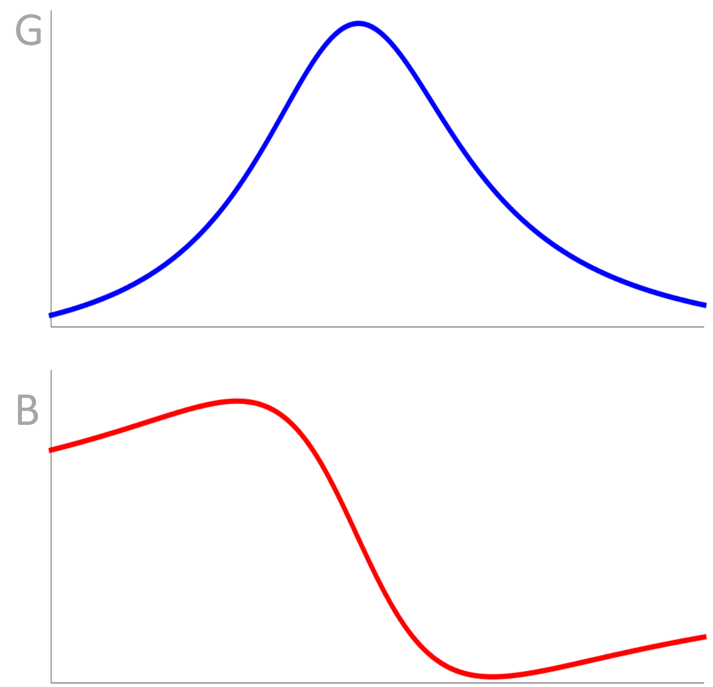
MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method



$$\Delta G_{corr} = \Delta G - \frac{\partial G(f_m)}{\partial f}\Delta f = G(f_n)_{t1} - G(f_m)_{t0} - \frac{\partial G(f_m)}{\partial f}\Delta f$$

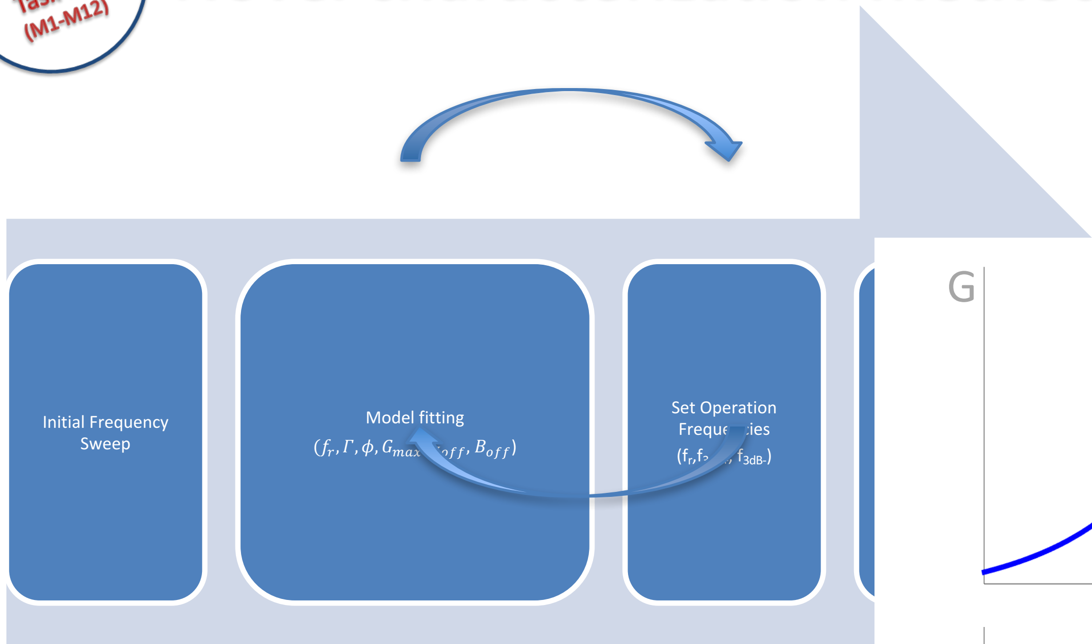
$$\Delta B_{corr} = \Delta B - \frac{\partial B(f_m)}{\partial f}\Delta f = B(f_n)_{t1} - B(f_m)_{t0} - \frac{\partial B(f_m)}{\partial f}\Delta f$$

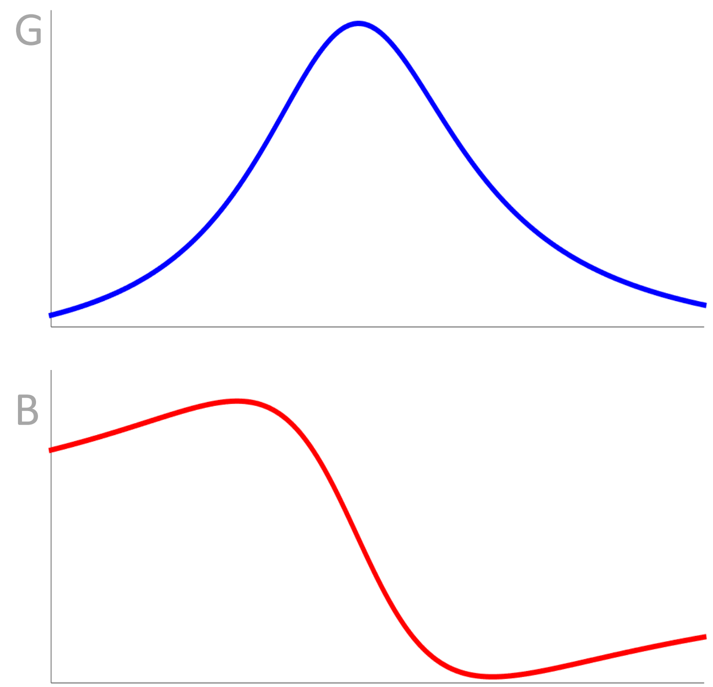


2. Main achievements

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method





$$\Delta G = \frac{\partial G(f_m)}{\partial f_r}\Delta f_r + \frac{\partial G(f_m)}{\partial G_{max}}\Delta G_{max} + \frac{\partial G(f_m)}{\partial \Gamma}\Delta \Gamma + \frac{\partial G(f_m)}{\partial \phi}\Delta \phi + \frac{\partial G(f_m)}{\partial G_{off}}\Delta G_{off} + \frac{\partial G(f_m)}{\partial B_{off}}\Delta B_{off} + \frac{\partial G(f_m)}{\partial f}\Delta f$$

$$\Delta B = \frac{\partial B(f_m)}{\partial f_r}\Delta f_r + \frac{\partial B(f_m)}{\partial G_{max}}\Delta G_{max} + \frac{\partial B(f_m)}{\partial \Gamma}\Delta \Gamma + \frac{\partial B(f_m)}{\partial \phi}\Delta \phi + \frac{\partial B(f_m)}{\partial G_{off}}\Delta G_{off} + \frac{\partial B(f_m)}{\partial B_{off}}\Delta B_{off} + \frac{\partial B(f_m)}{\partial f}\Delta f$$

2. Main achievements

MEASURING TECHNIQUE
Task 1.3
(M1-M12)

Novel characterization method

Admittance shift peaks.
Lack of accuracy of the derivatives!!!!