Enabling of high Q Micromachined Planar Filter Components

Part I

ESA GSTP- 4 Program:

ESTEC Contract No. 19621 / 06 / NL /PA

Dr. Wolfgang Tschanun MBA, RMT

www.reinhardt-microtech.ch

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Content

- introduction + basics

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Introduction (I / VI)

Basic Project's requests:

- Transform an academic design / process flow into an industrial whole wafer process
- including packaging of the devices wafer level
- show first environmental tests

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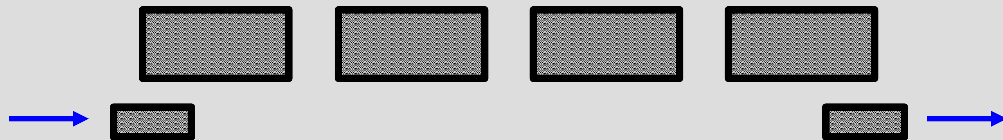
Introduction (II / VII)

- basics I

The incoupled EM – wave passes the λ / 2 designed electrode structure and comes to resonate at the selected frequencies.



To increase the Q – figure the wave is enclosed at an Au coated cavity.

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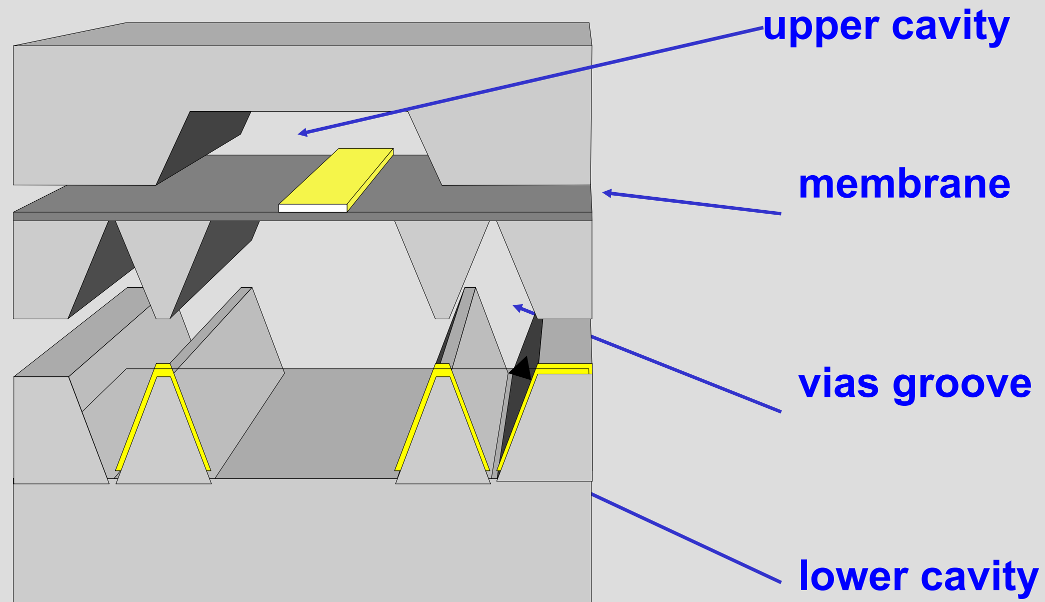
Introduction (III / VII)

- basics II



Q – figures up to 600 can be realised

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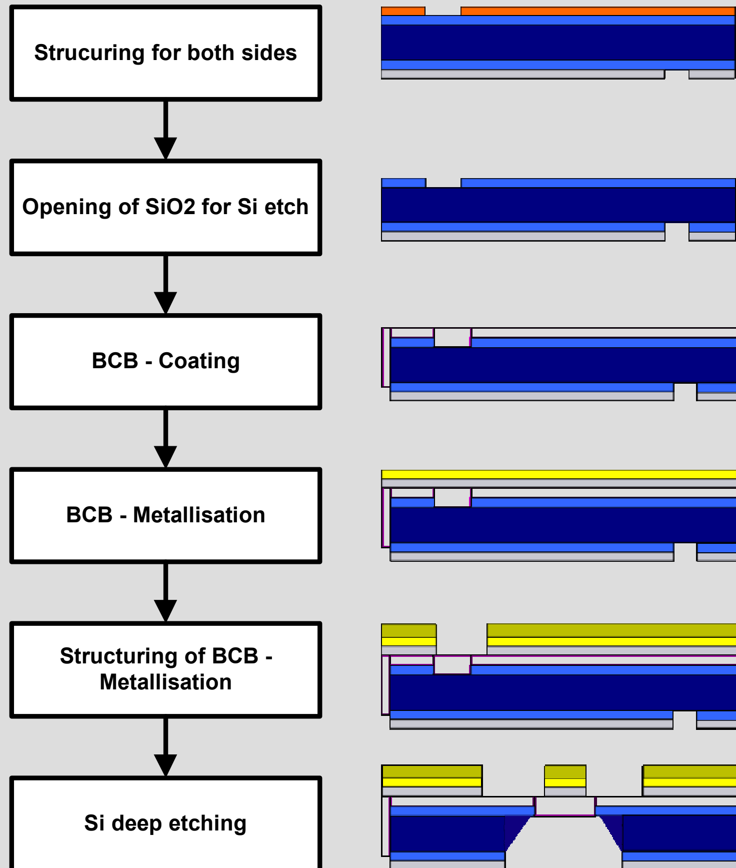
Introduction (IV/ VII)



- Transform an academic design / process flow into an industrial whole wafer process

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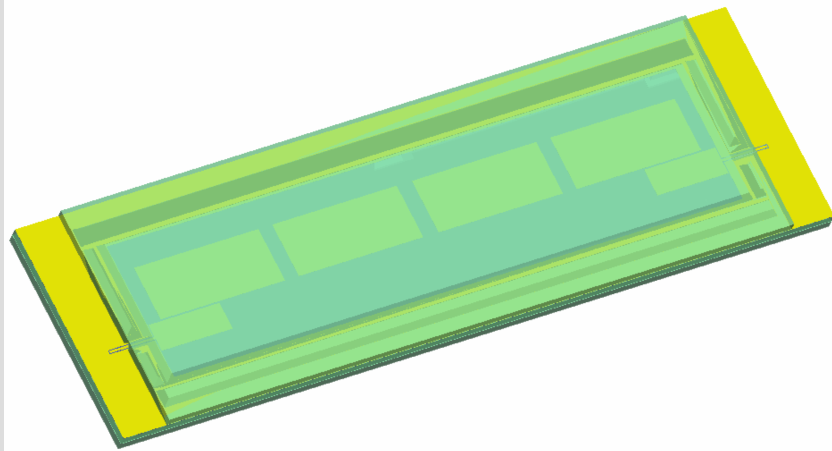
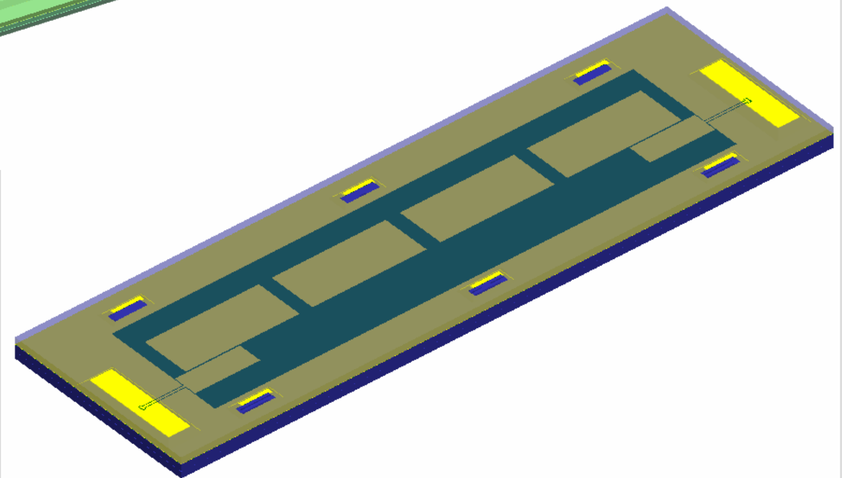
Introduction (V / VII)

- including packaging of the devices

  wafer level





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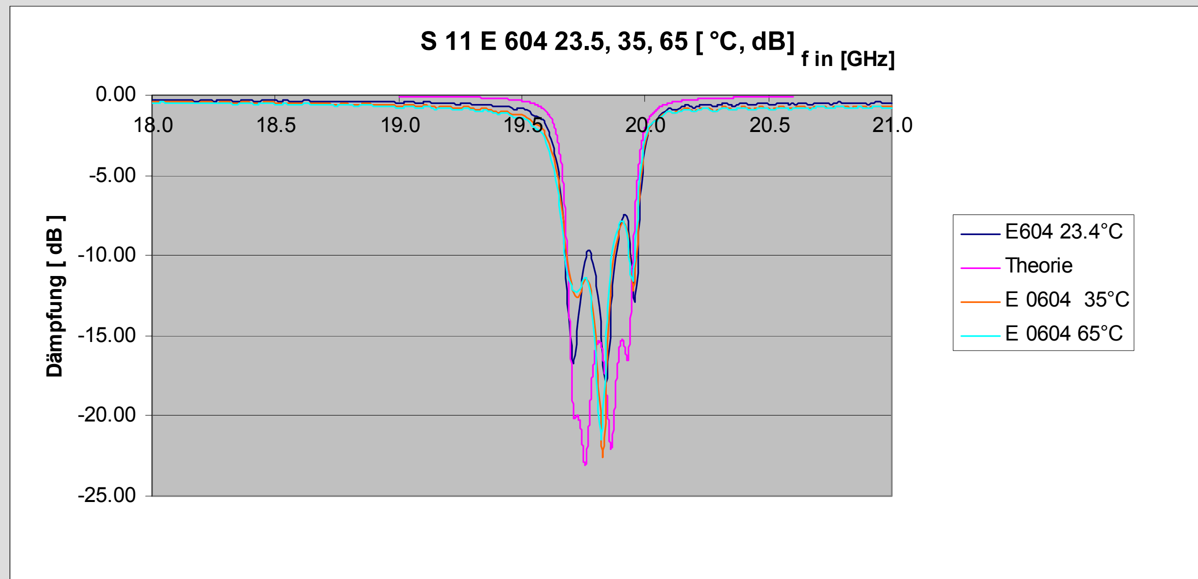
Introduction (VI / VII)

- show first environmental tests



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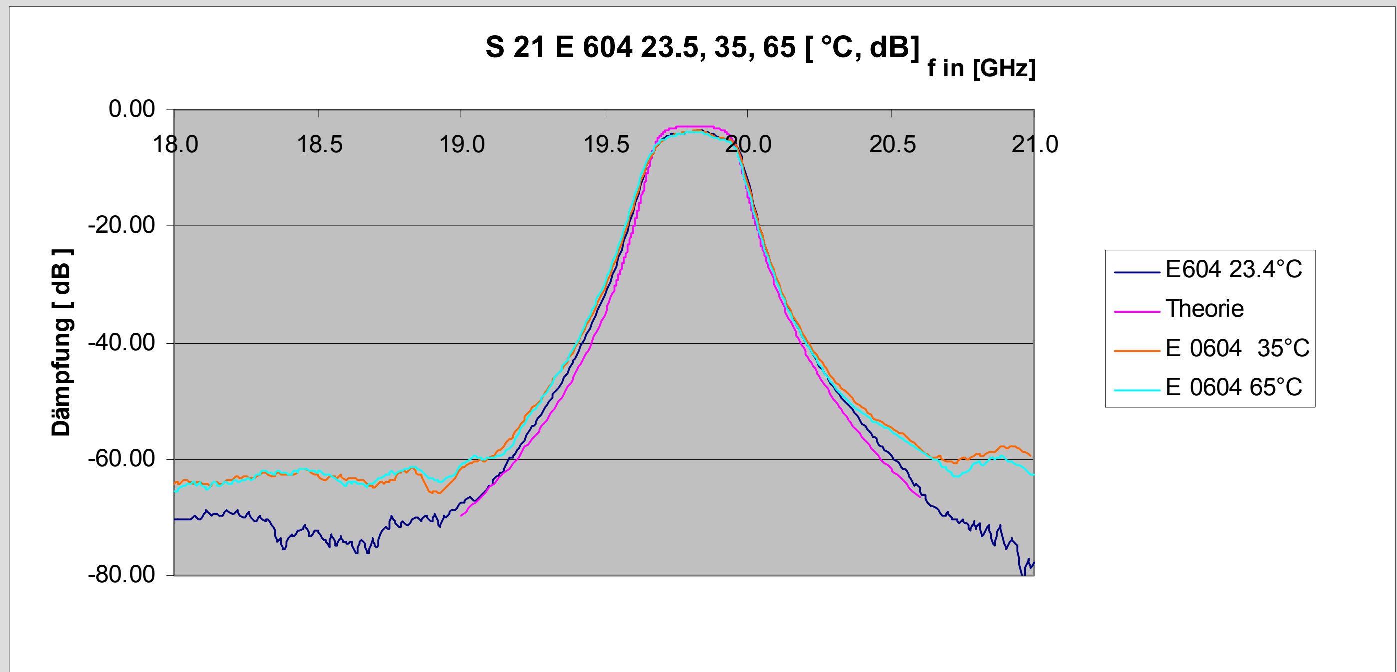
Introduction (VII / VII)

- show first environmental tests



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END

of part I

introduction and basics

Enabling of high Q Micromachined Planar Filter Components

Part II

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Content (part II of final presentation)

- specification
- theory and design
- device overview
- processes on wafer level
- development of packaging design
- processes for packaging
- realised filters measurements
- outlook

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Specifications

Technical specification:

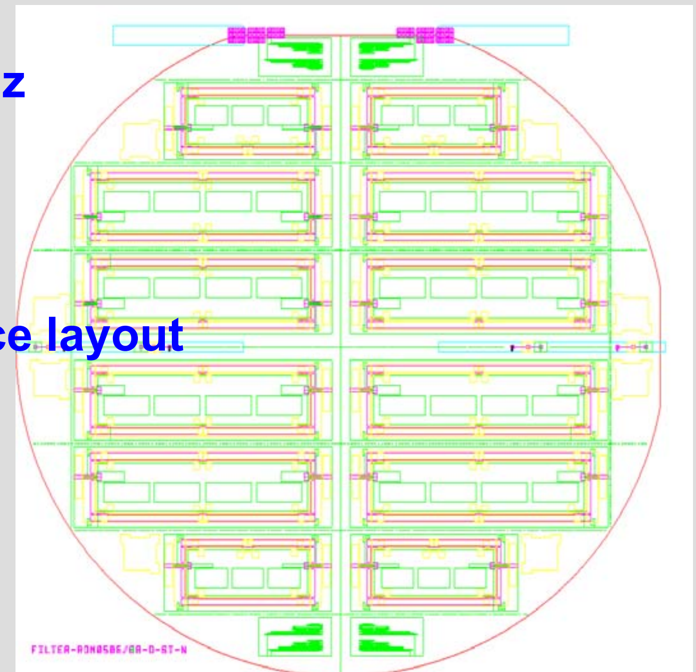
down - converter filter at K_a - band

f_0 = 19.825 GHz

Initial bandwidth ~ 0.75 GHz

min. loss at f_0 ~ - 3 dB etc.

given: electrode and device layout



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Theory and Design (I)

Theory:

was covered throughout the project by Xlim:

- basic layout (pre - given, not altered)
- failure budgets (tolerances)
- design checks
- practical proof of new packaging design

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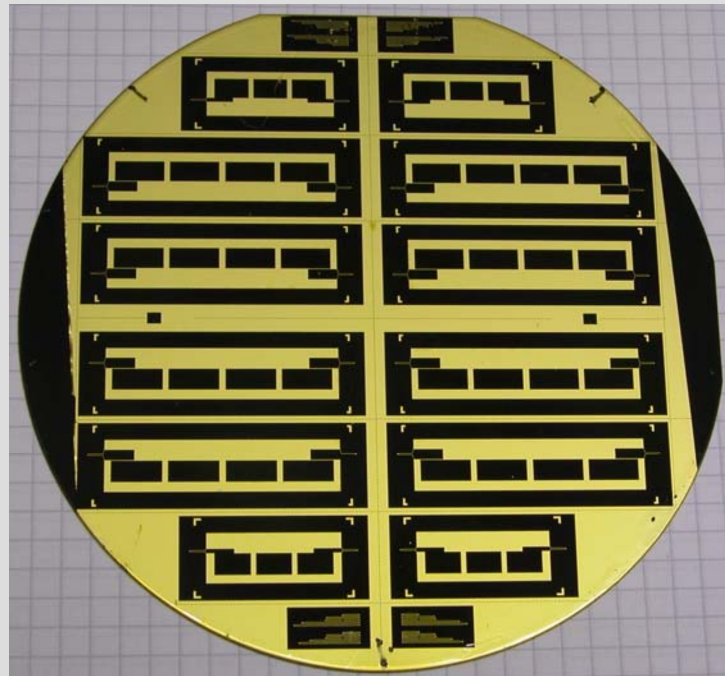
Theory and Design (II)

Design:

changed to practical waver level stacking



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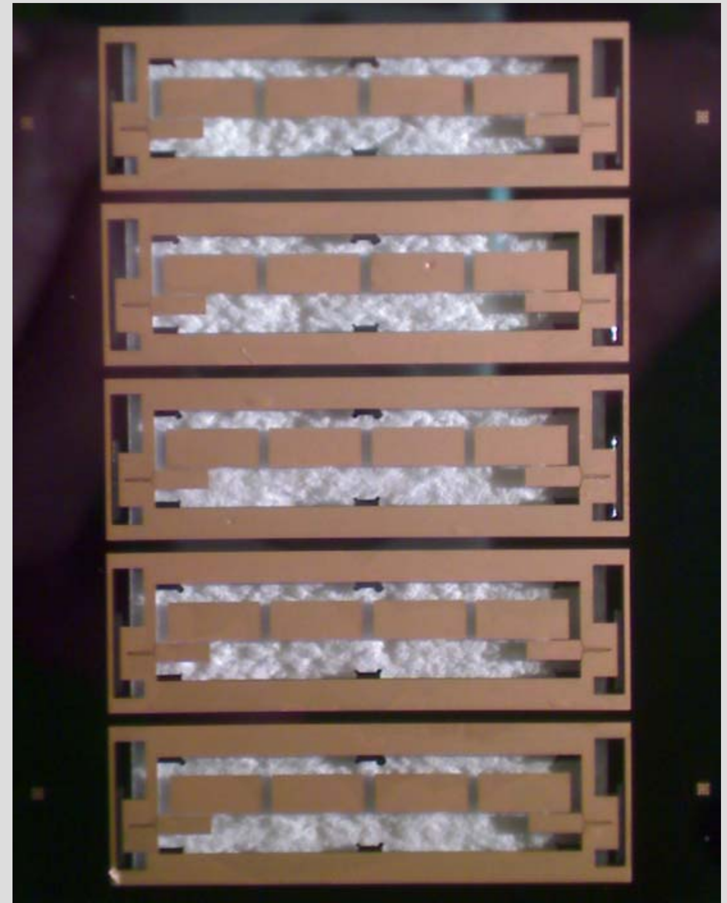
Theory and Design (III)

Design:

changed to practical

waver level stacking



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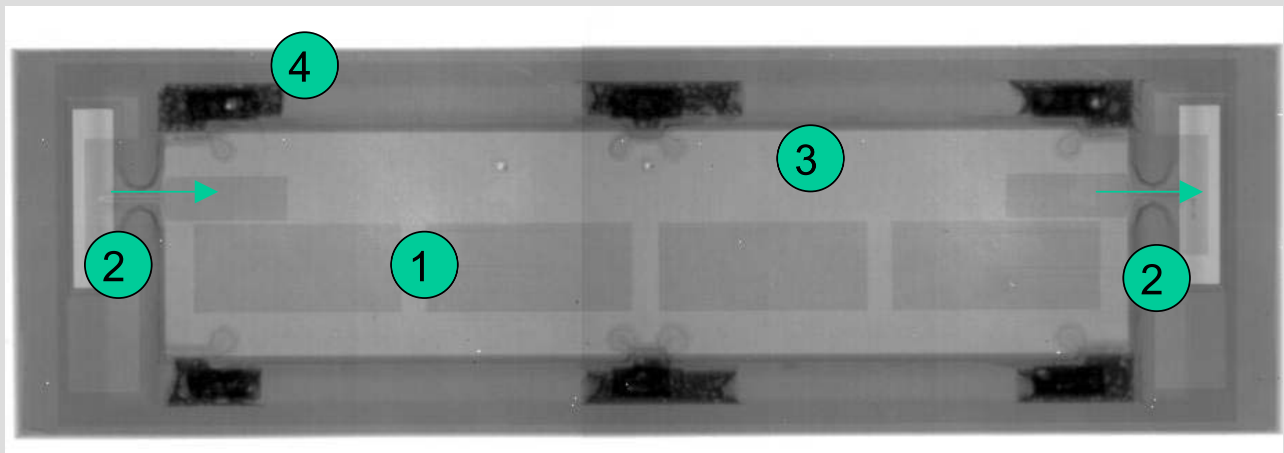
Device overview I

The devices are built up out of 3 stacked wafers

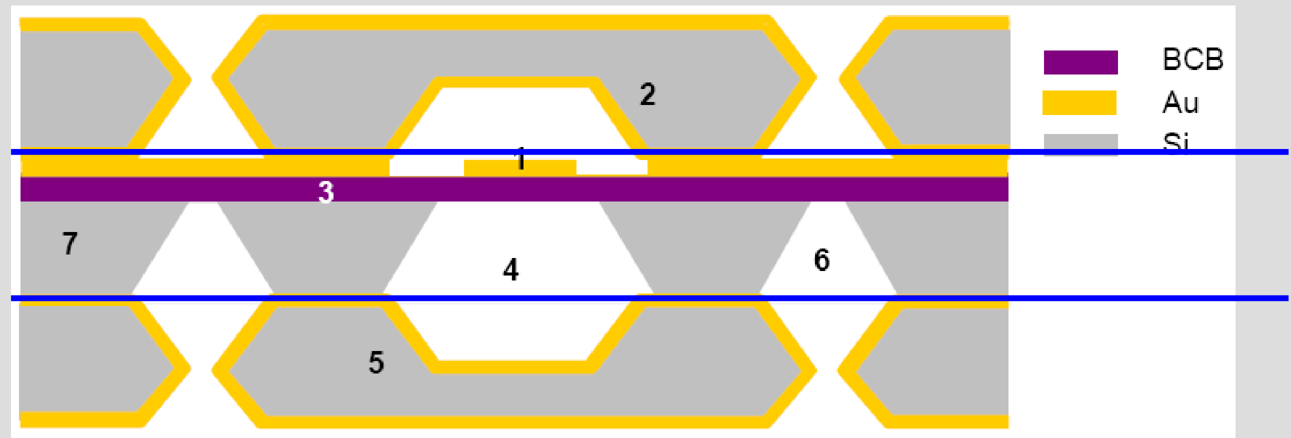
X –ray picture:



1. *microstrip Line (waveguiding part)*
2. RF - input output
3. BCB membrane
4. conducting adhesive

Device overview II

The devices are built up out of 3 stacked wafers forming a resonating cavity:



1. *microstrip Line (waveguiding part)*
2. ground metallisation *top wafer*
3. BCB membrane
4. cavity divided by BCB membrane
5. ground metallisation *bottom wafer*
6. area for electromagnetic shielding
7. high ohmic Si

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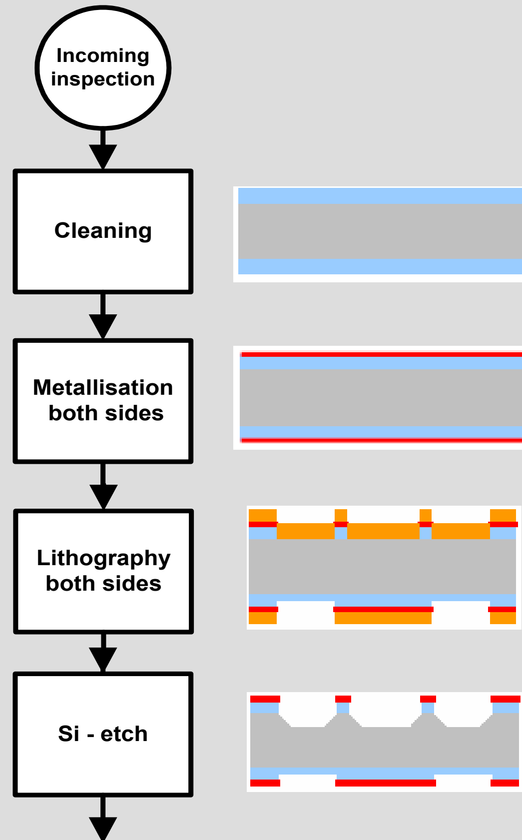
Wafer Processes I



Process follow up for Bottom wafer (I):

- cleaning
- metallisation (both sides)
- lithography (both sides)
- Si - etch

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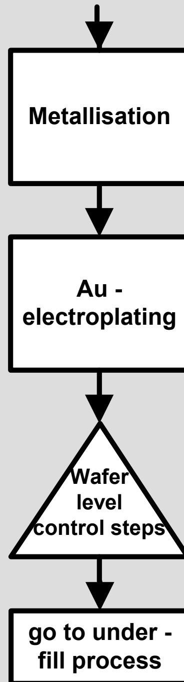
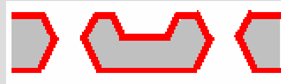
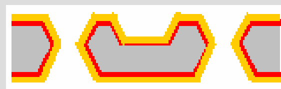
Wafer Processes II

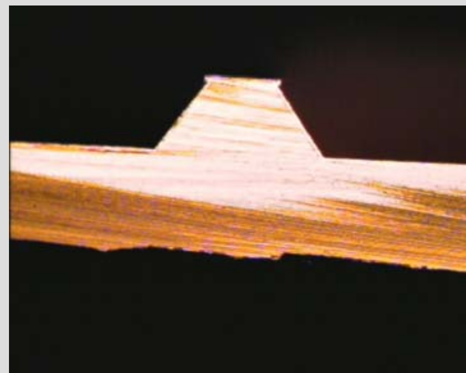






Process follow up for Bottom wafer (II):

- 2nd metallisation
- electroplating (top 8.5; slope 7, bottom 6.7 µm Au)



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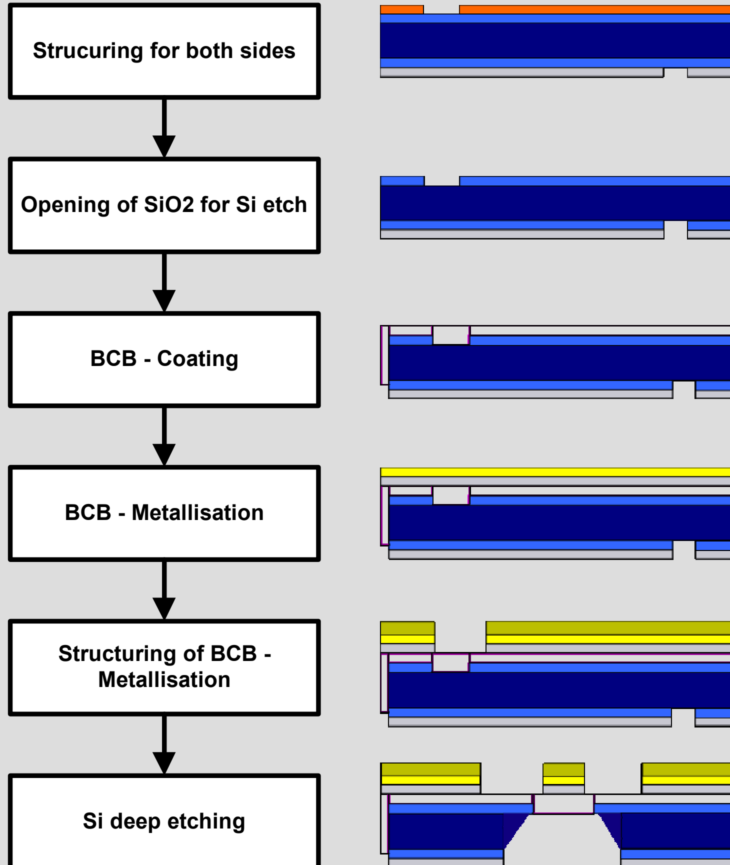
Wafer Processes III



Middle wafer key processes:

- BCB – Processing
- Si – etch simultaneously
- handling of thinned wafers

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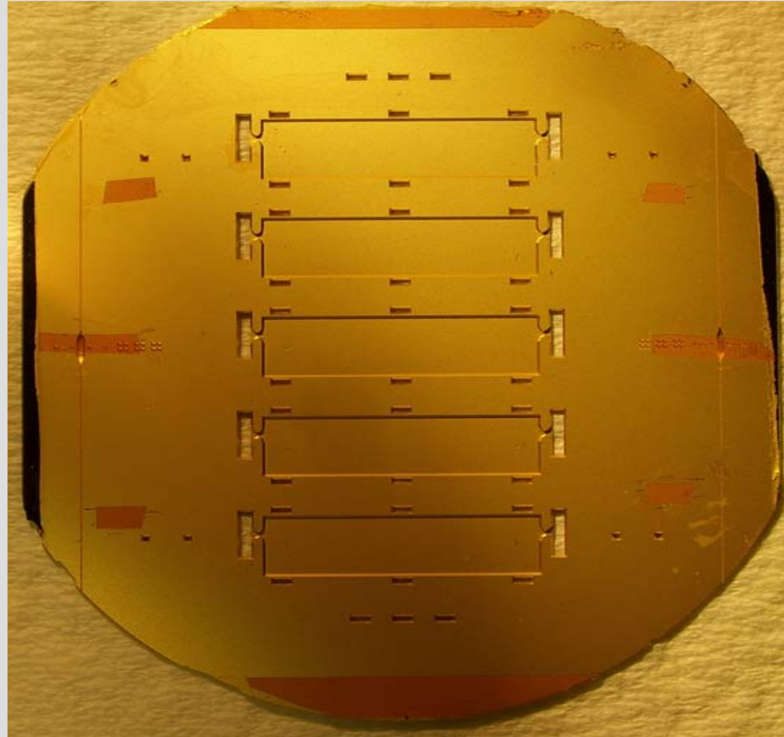
Wafer Processes IV



Top wafer:

- prepared for underfill

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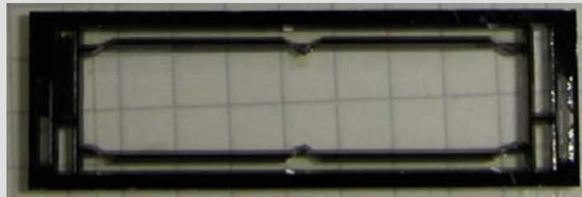
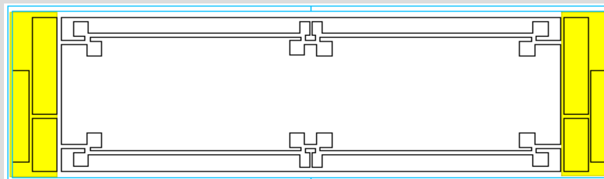
Development of the Packaging Design I





initial design:

- manual gluing of 3 parts
- complicated single alignment
- cumbersome handling

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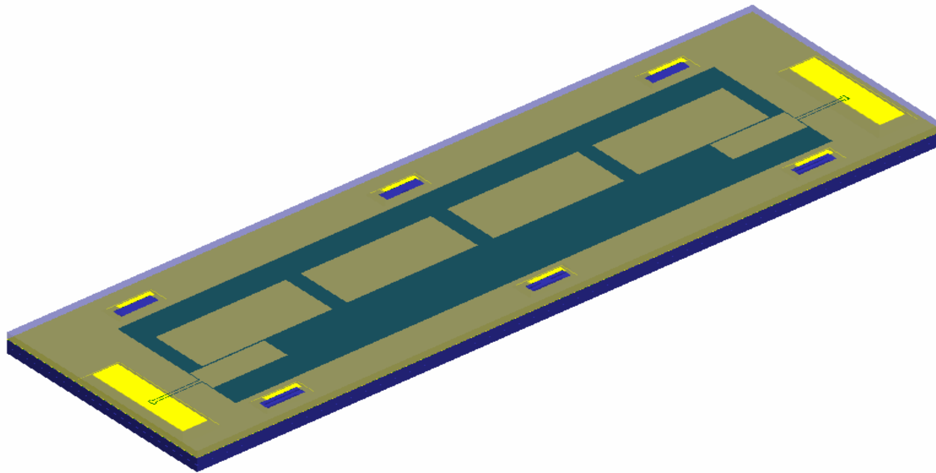
Development of the Packaging Design I



new design considerations:

- partially etched openings
- a single wafer alignment system

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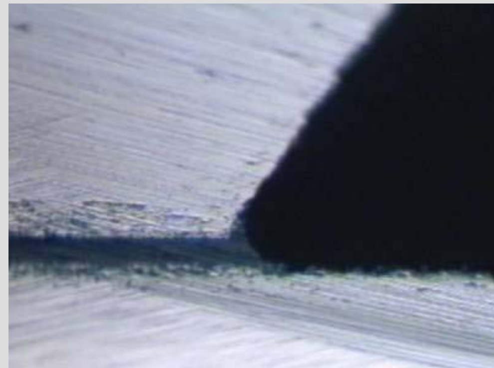
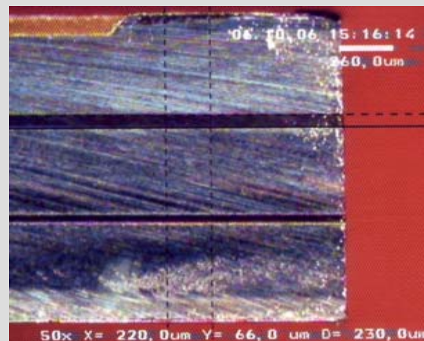
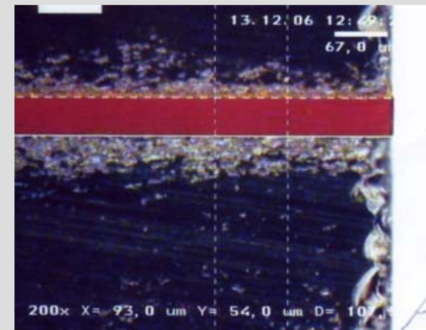
Processes Packaging I

Complete Underfill Process:



by selecting proper process parameters a well defined flow of underfill can be achieved





complete / non - complete fill of device edges

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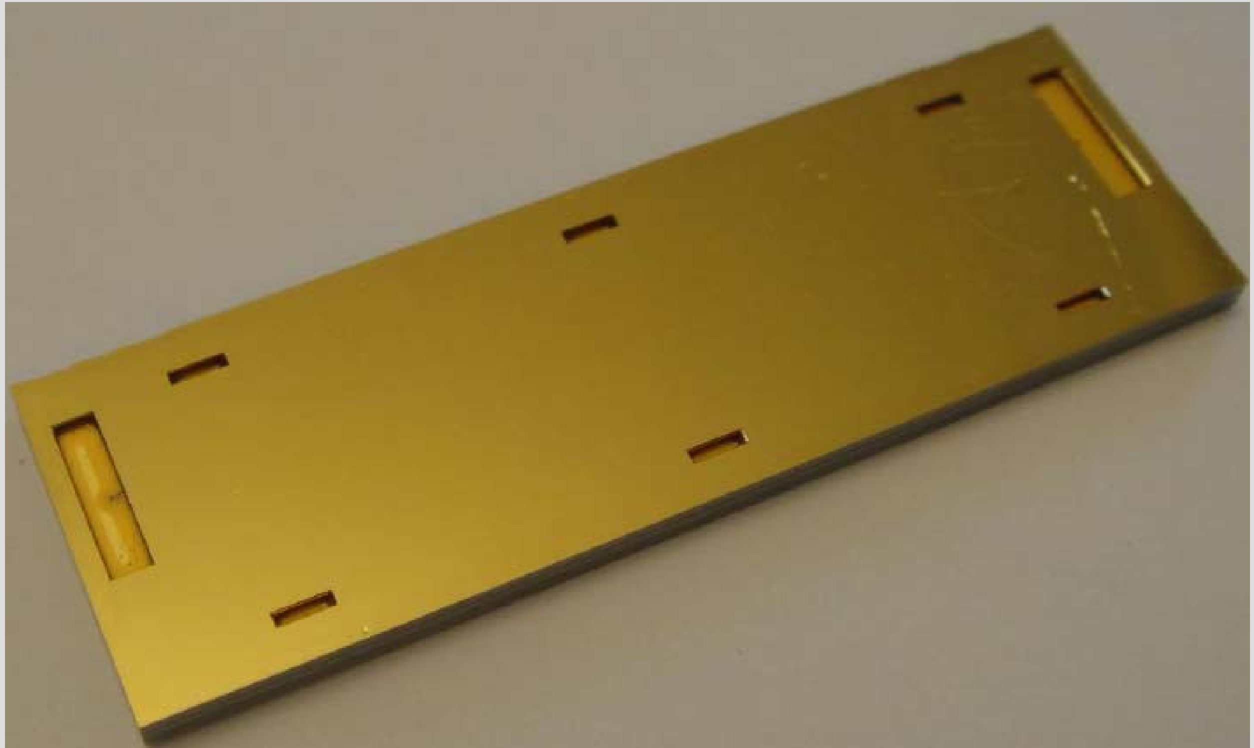
realised filter

- device picture



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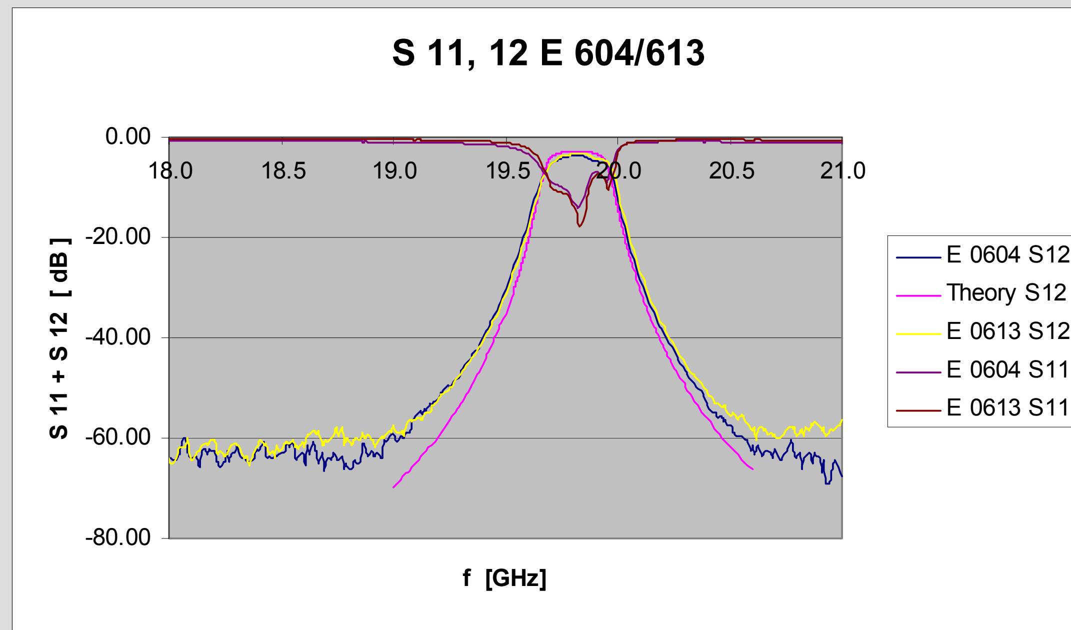
realised filter (I / IV)

- RF – Measurements I (overview)



2 golden samples

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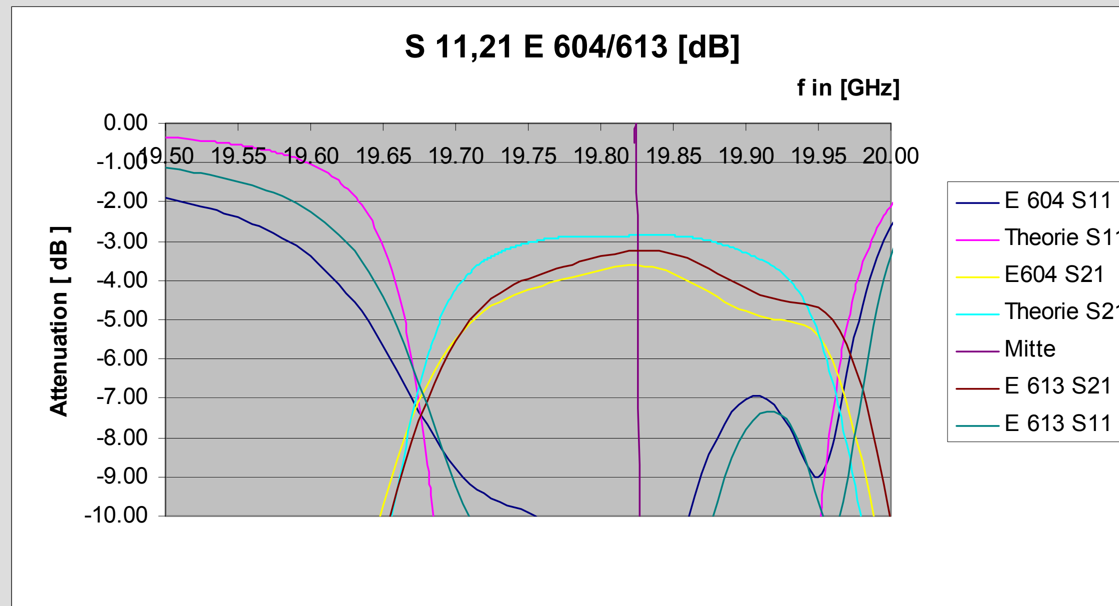
realised filter (II / IV)

- RF – Measurements II (detail)



2 golden samples; enlargement

compare theory and practical measurements

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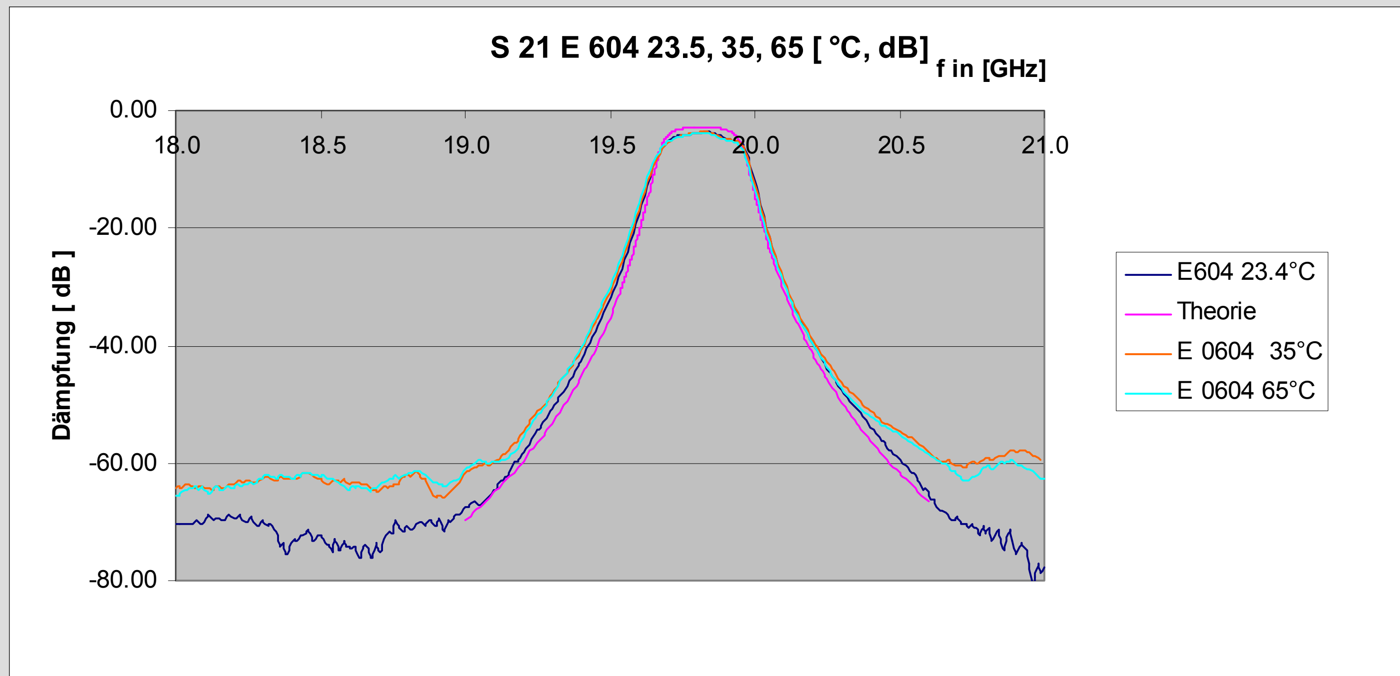
realised filter (III / IV)

- RF – Measurements temperature dependant



S_{21} of E 0604 temperature dependant

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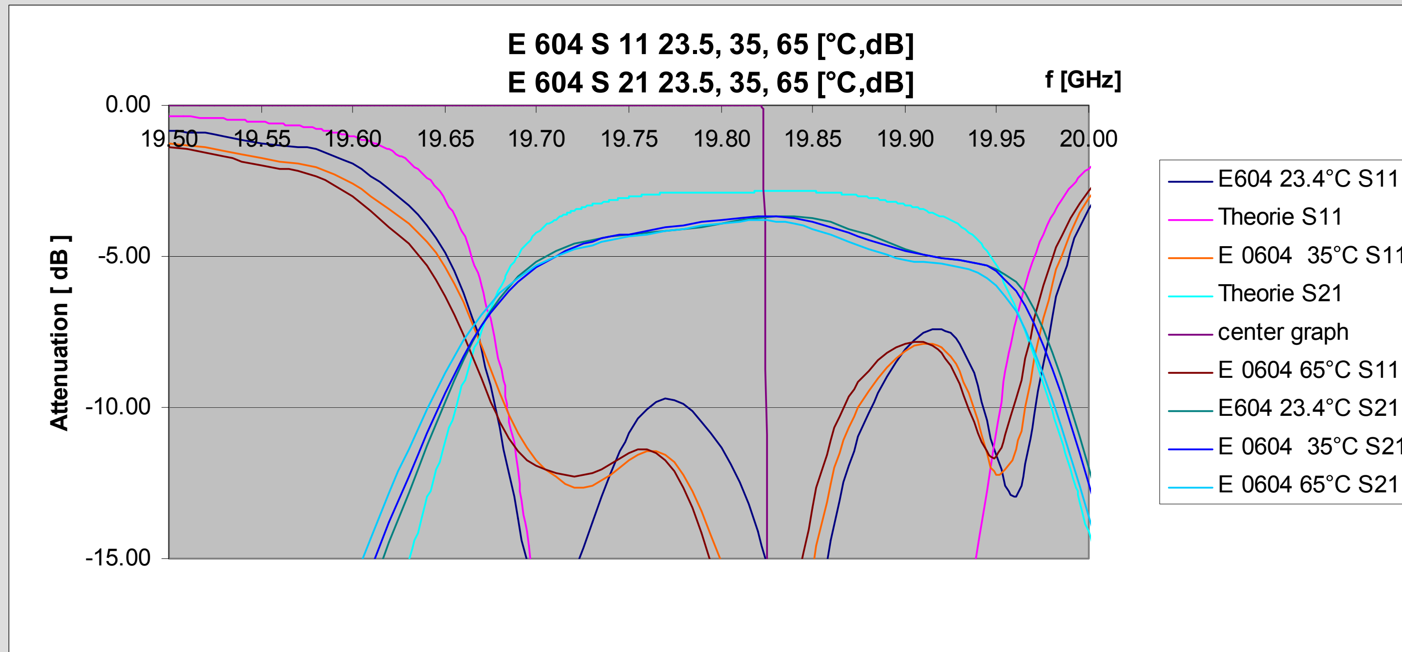
realised filter (IV / IV)

- RF – Measurements temperature dependant



E 0604 enlargement S_{11} + S_{21}, 3 temperatures

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Outlook I

The success story of this project was guided by:

- good theoretical investigations
- step by step development of packaging
- mutual help of all project partners

Outlook II

The success story of this project was guided by

(non technical view)

- a personal frictionless working together
- a successful teamwork
- resulting in sound friendship

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