



Enabling of high Q Micromachined Planar Filter Components

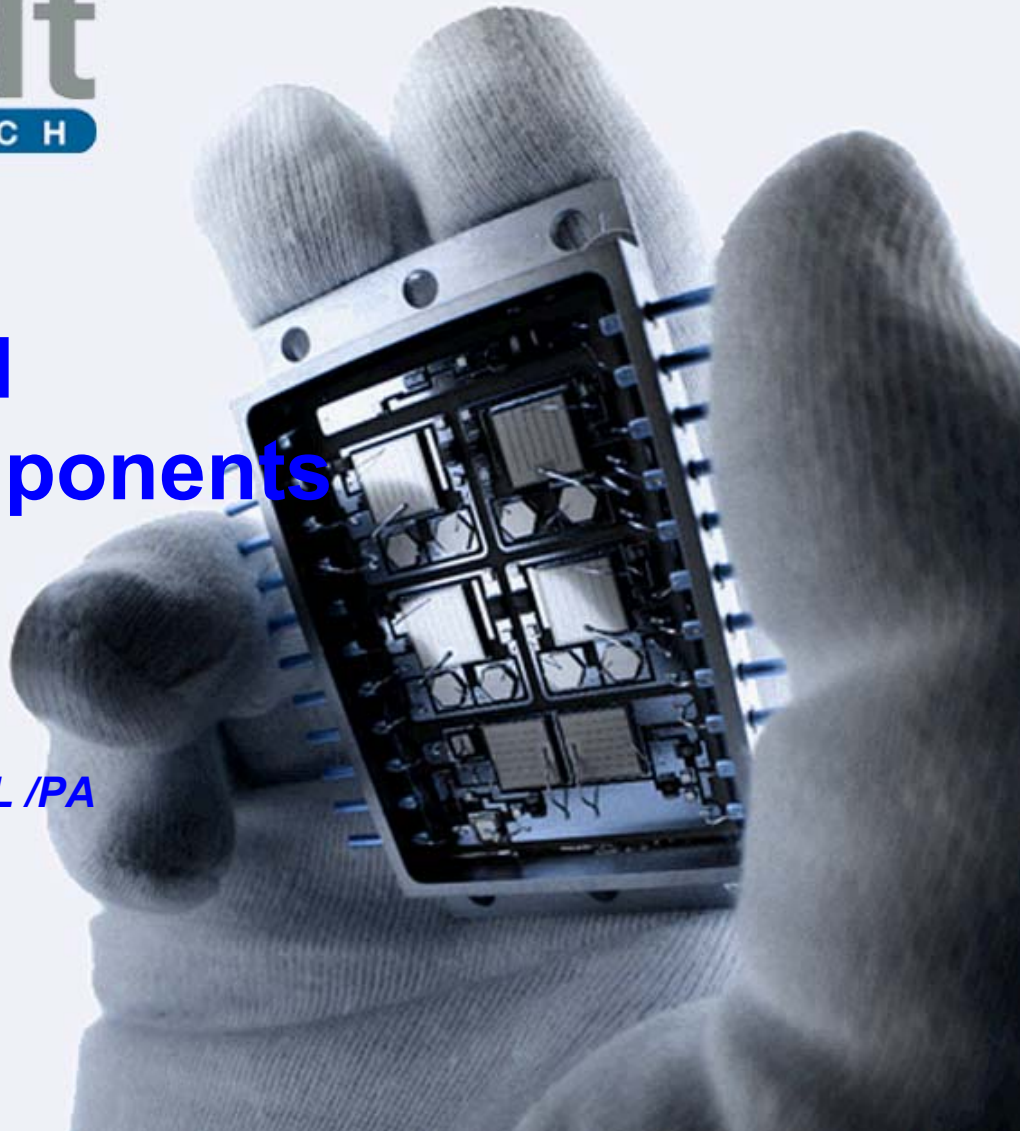
Part I

ESA GSTP- 4 Program:

ESTEC Contract No. 19621 / 06 / NL / PA

Dr. Wolfgang Tschanun MBA, RMT

www.reinhardt-microtech.ch



Content

- introduction + basics

Introduction (I / VI)

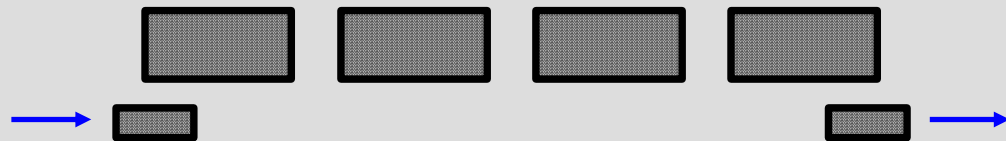
Basic Project's requests:

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

Introduction (II / VII)

- basics I

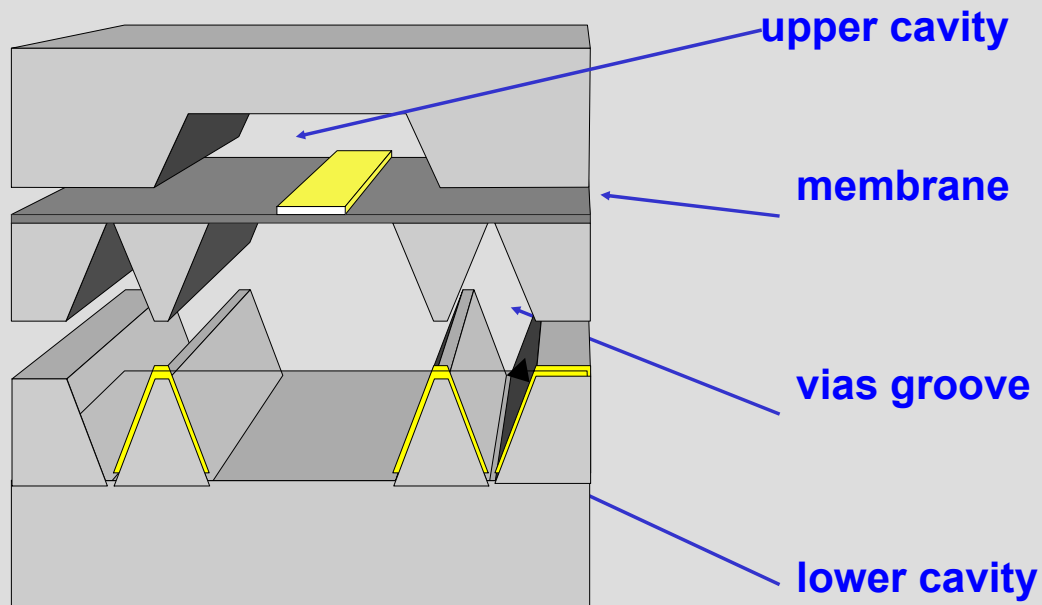
The incoupled EM – wave passes the $\lambda / 2$ designed electrode structure and comes to resonate at the selected frequencies.



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

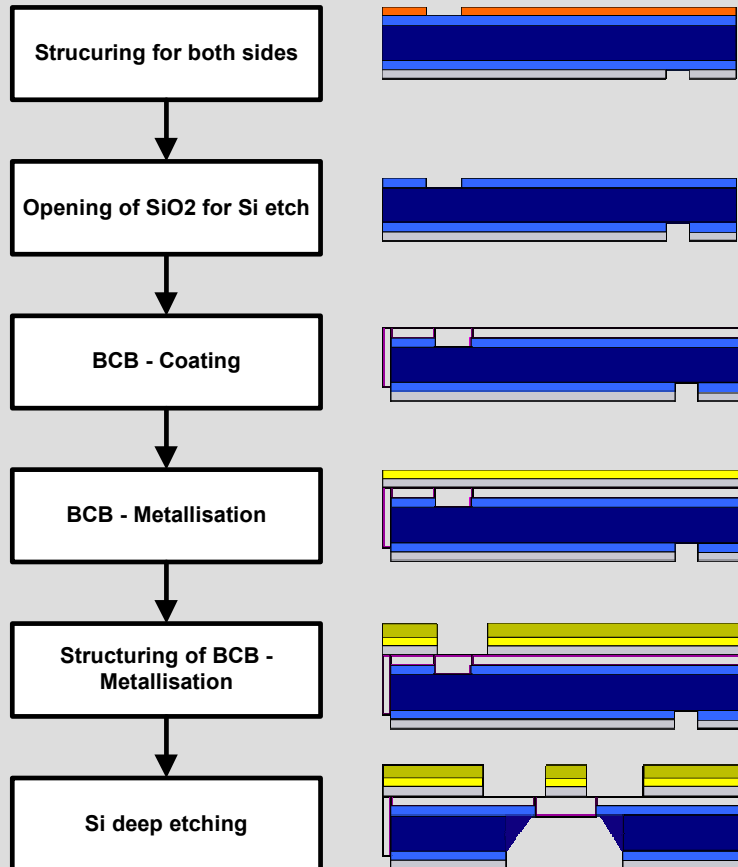
Introduction (III / VII)

- basics II



Q – figures up to 600 can be realised

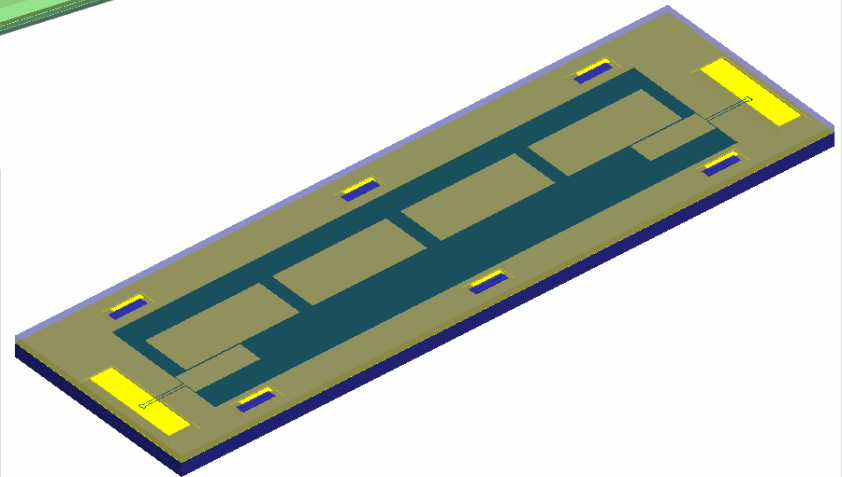
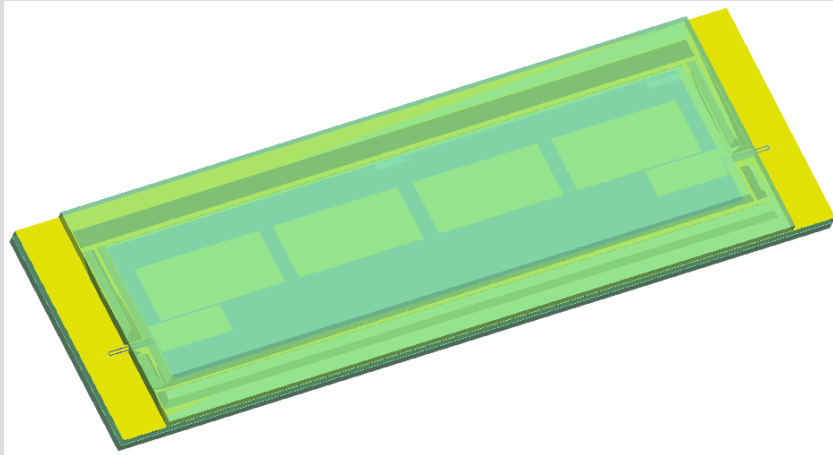
Introduction (IV/ VII)



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

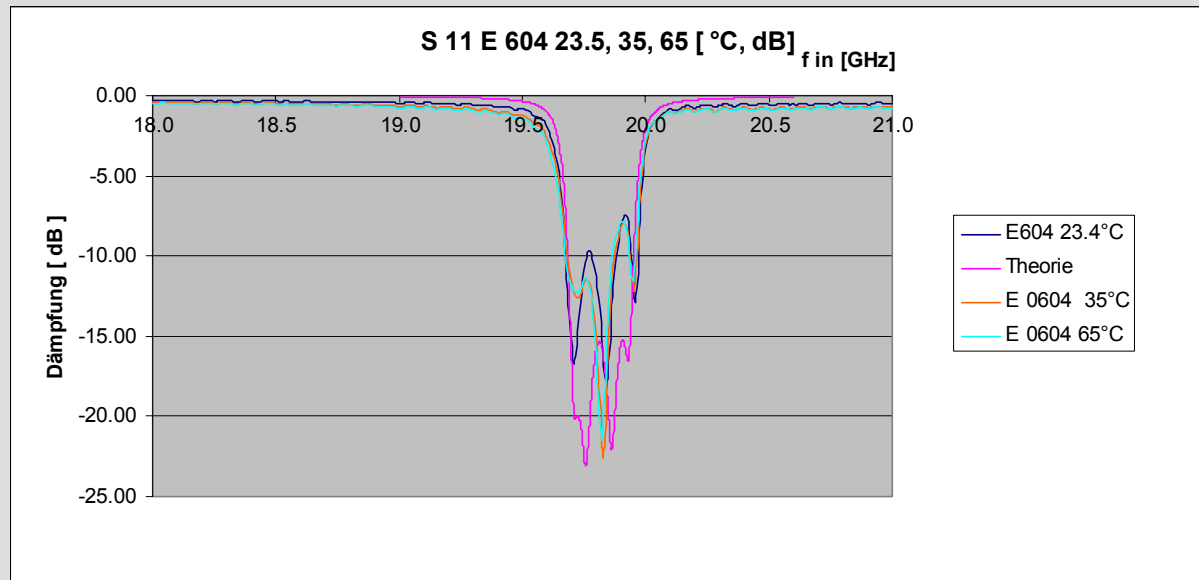
Introduction (V / VII)

- including packaging of the devices
wafer level



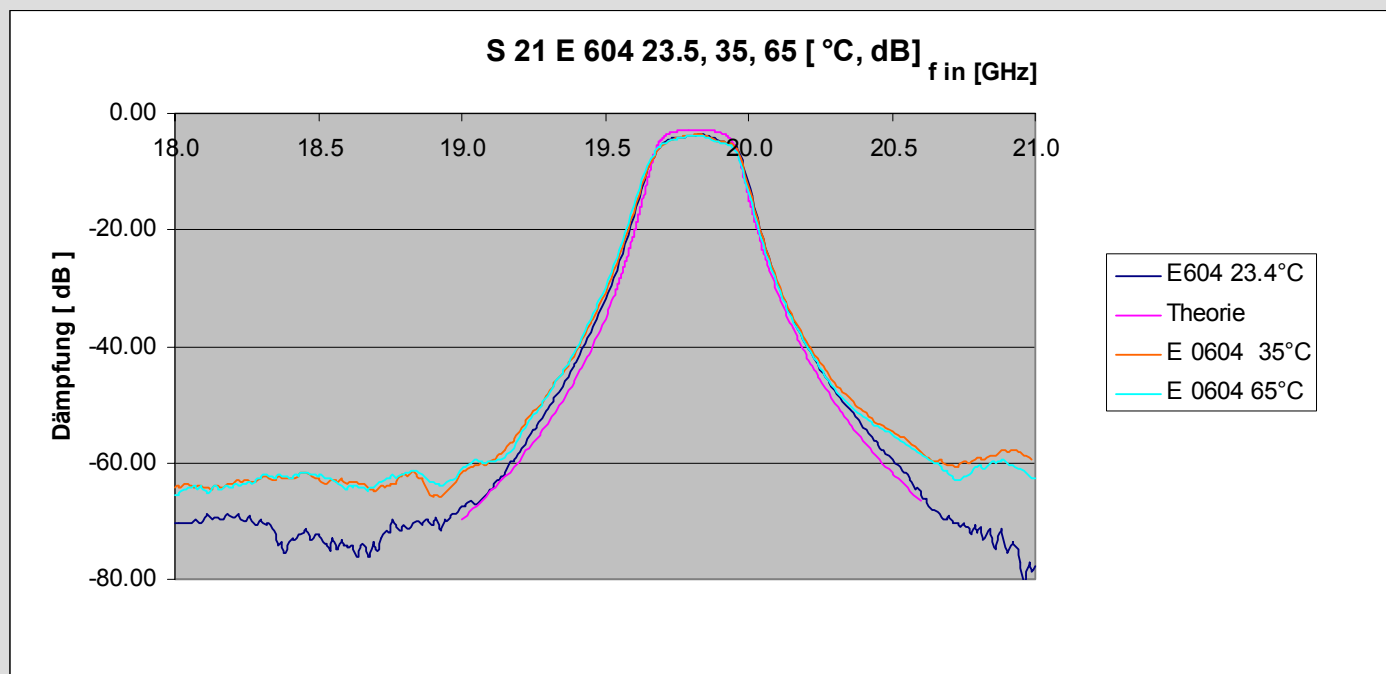
Introduction (VI / VII)

- show first environmental tests



Introduction (VII / VII)

- show first environmental tests



END

of part I

introduction and basics



Enabling of high Q Micromachined Planar Filter Components

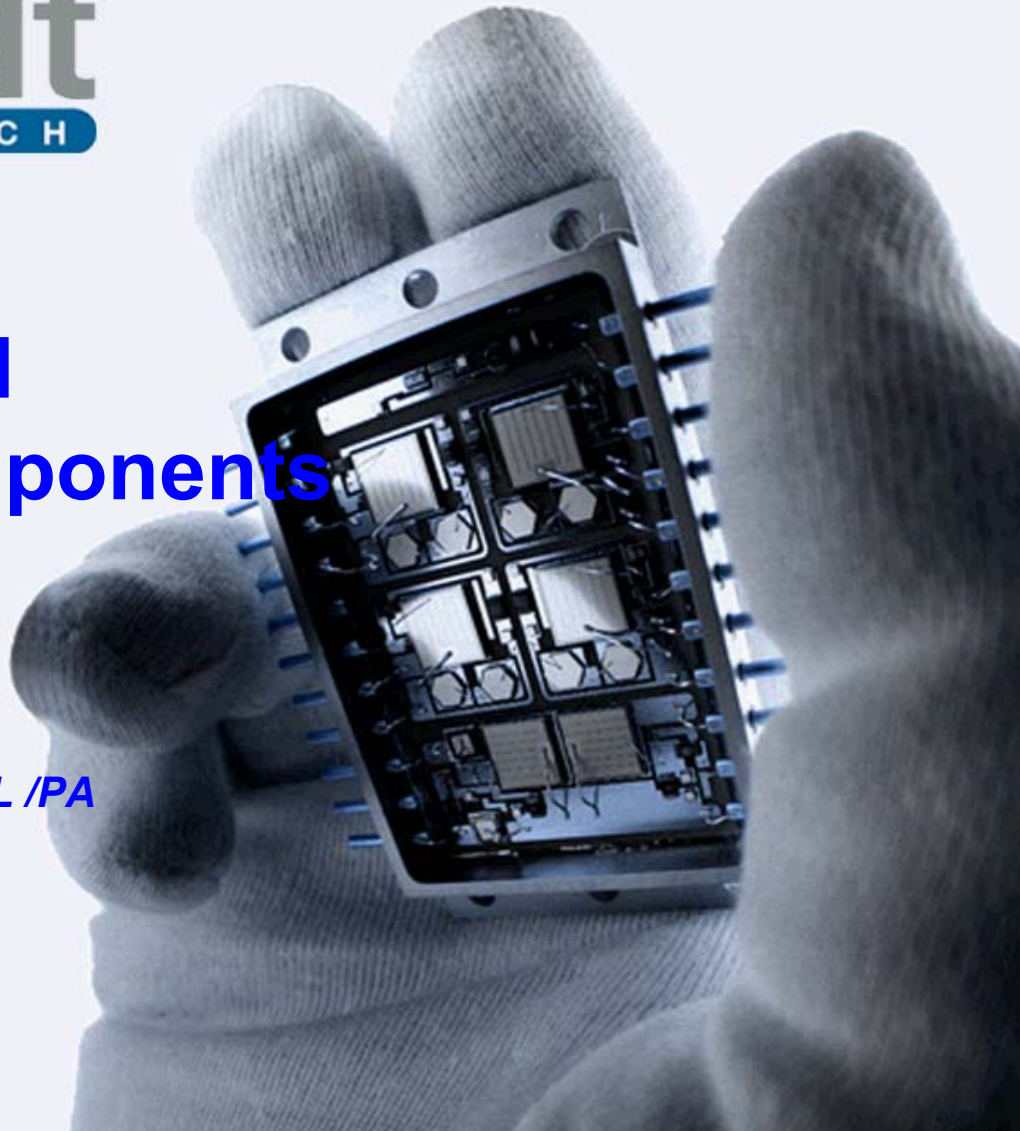
Part II

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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

Specifications

Technical specification:

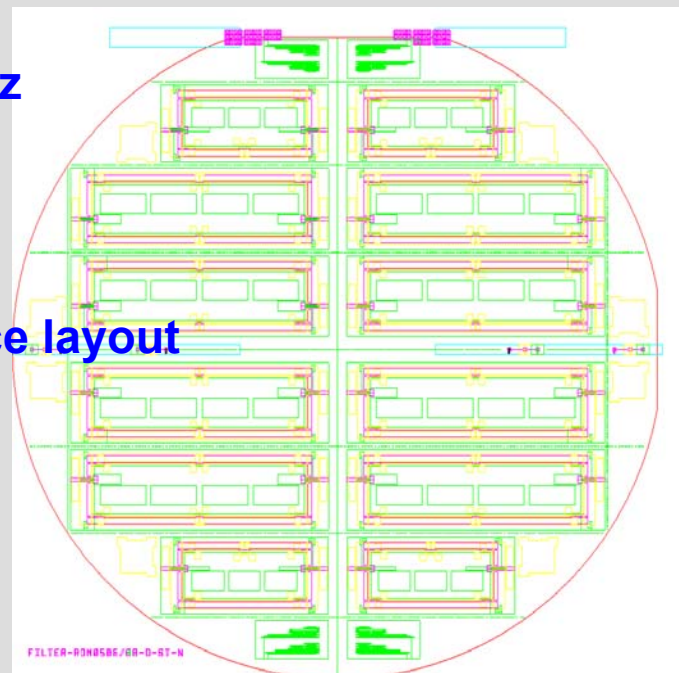
down - converter filter at K_a - band

$f_0 = 19.825$ GHz

Initial bandwidth ~ 0.75 GHz

min. loss at $f_0 \sim -3$ dB etc.

given: electrode and device layout



Theory and Design (I)

Theory:

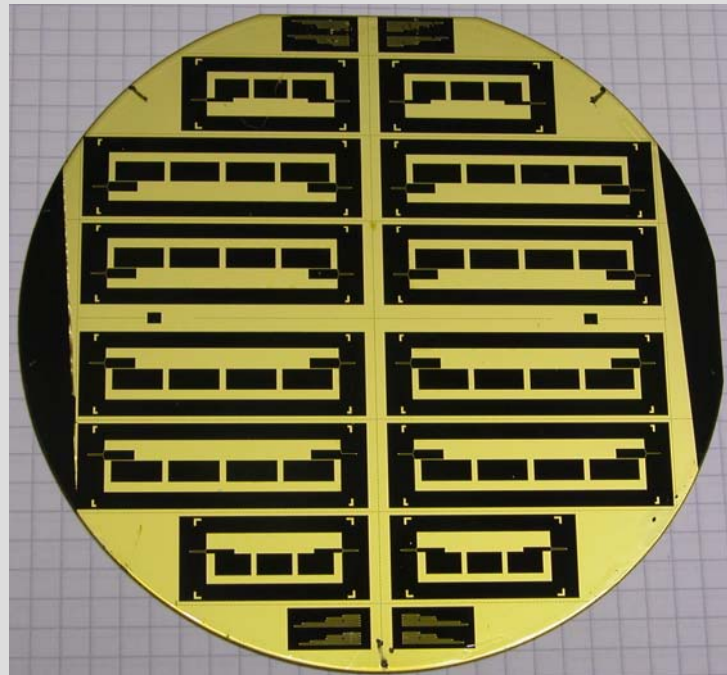
was covered throughout the project by Xlim:

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

Theory and Design (II)

Design:

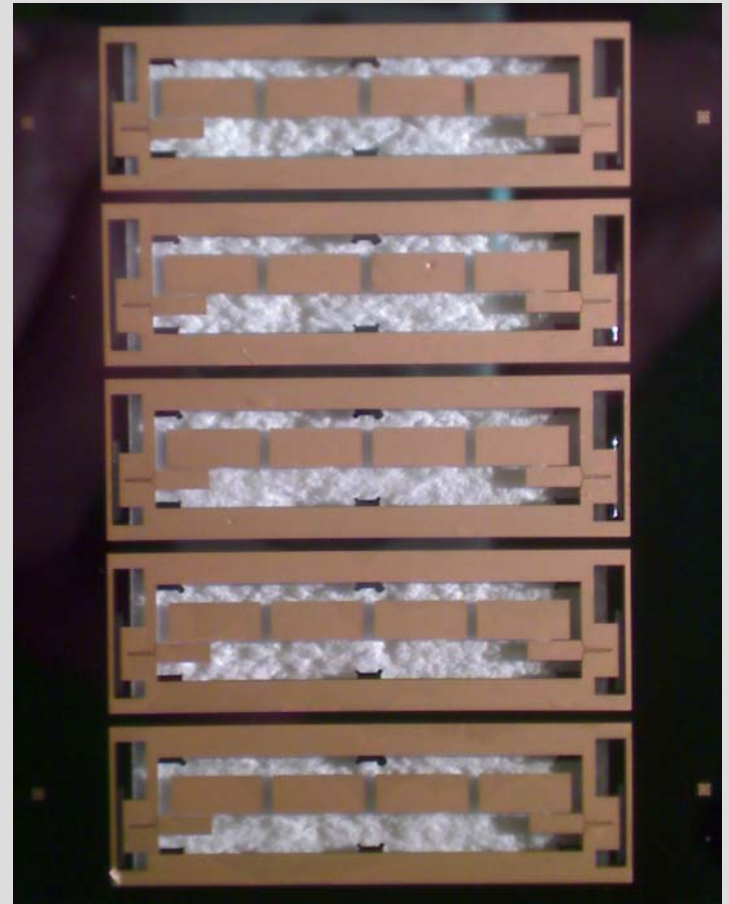
changed to practical waver level stacking



Theory and Design (III)

Design:

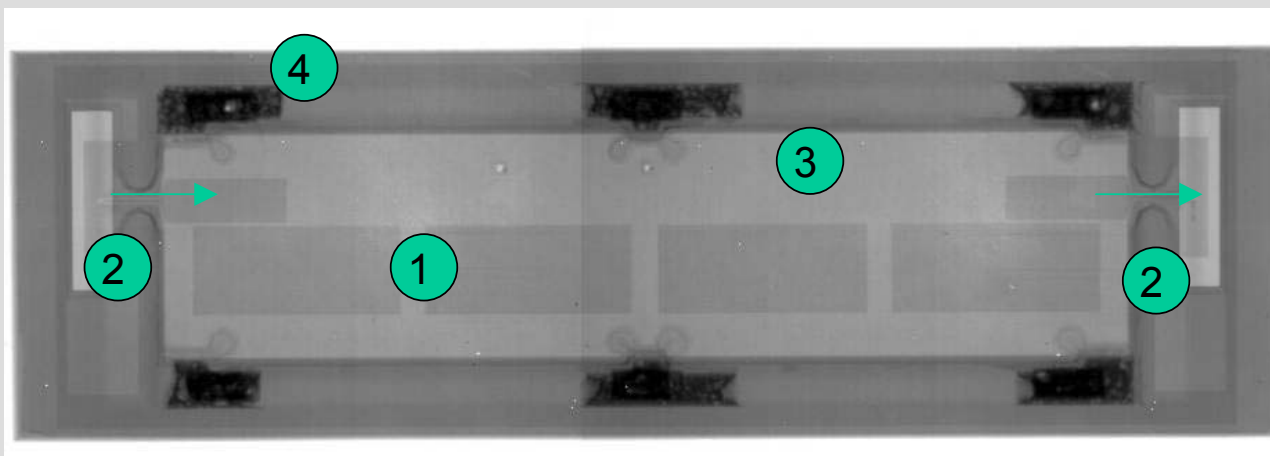
changed to practical
waver level stacking



Device overview I

The devices are built up out of 3 stacked wafers

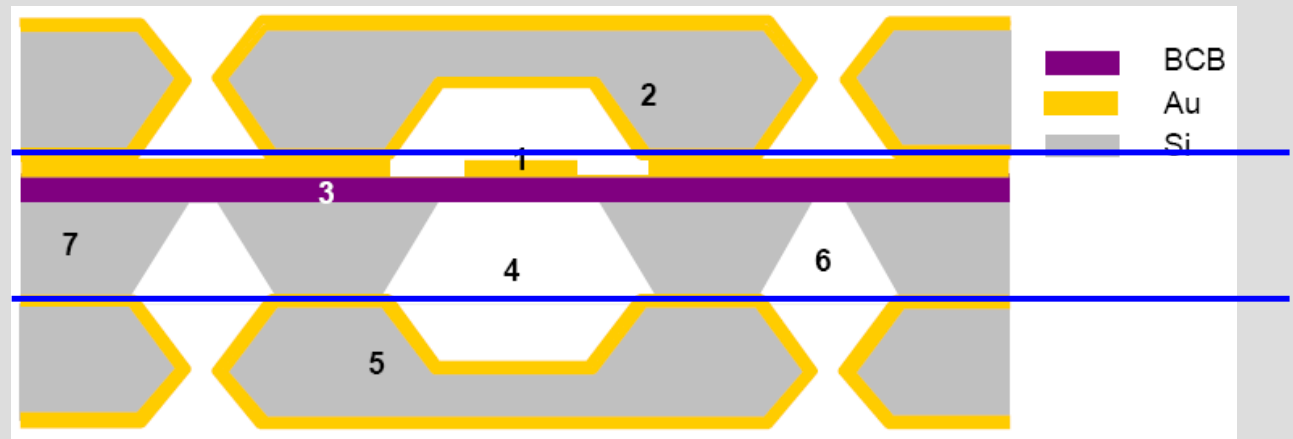
X-ray picture:



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

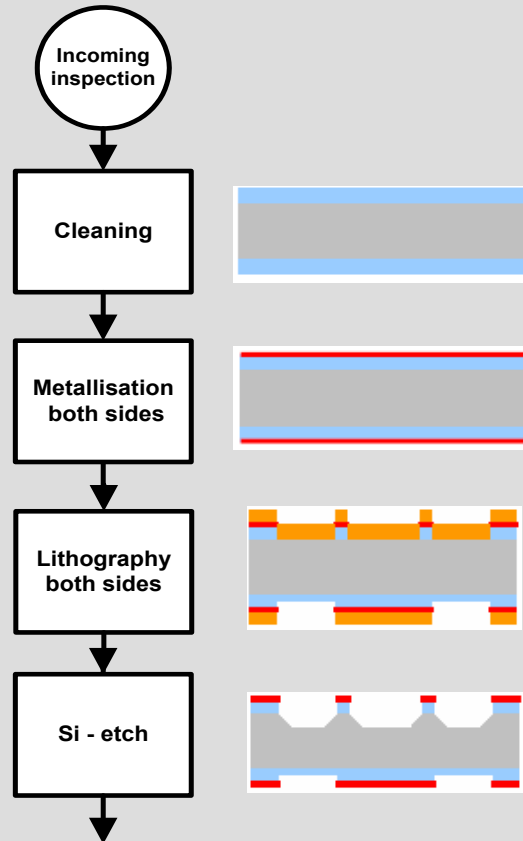
Device overview II

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*

Wafer Processes I

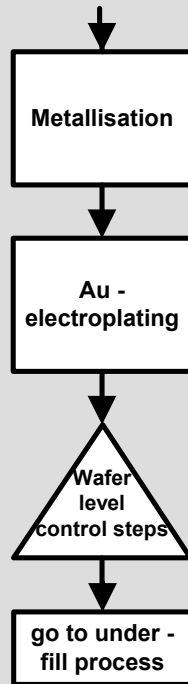


Process follow up for
Bottom wafer (I):

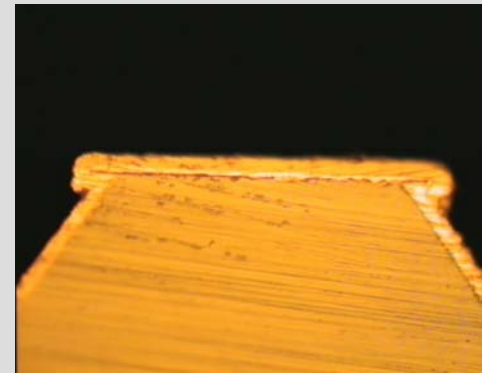
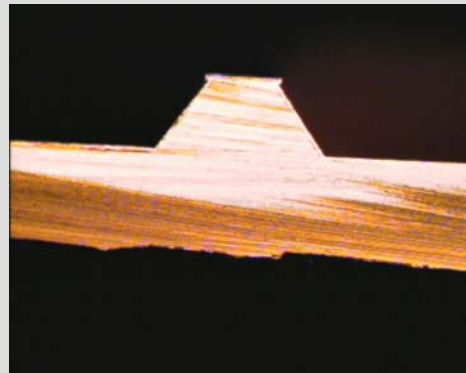
- cleaning
- metallisation (both sides)
- lithography (both sides)
- Si - etch

Wafer Processes II

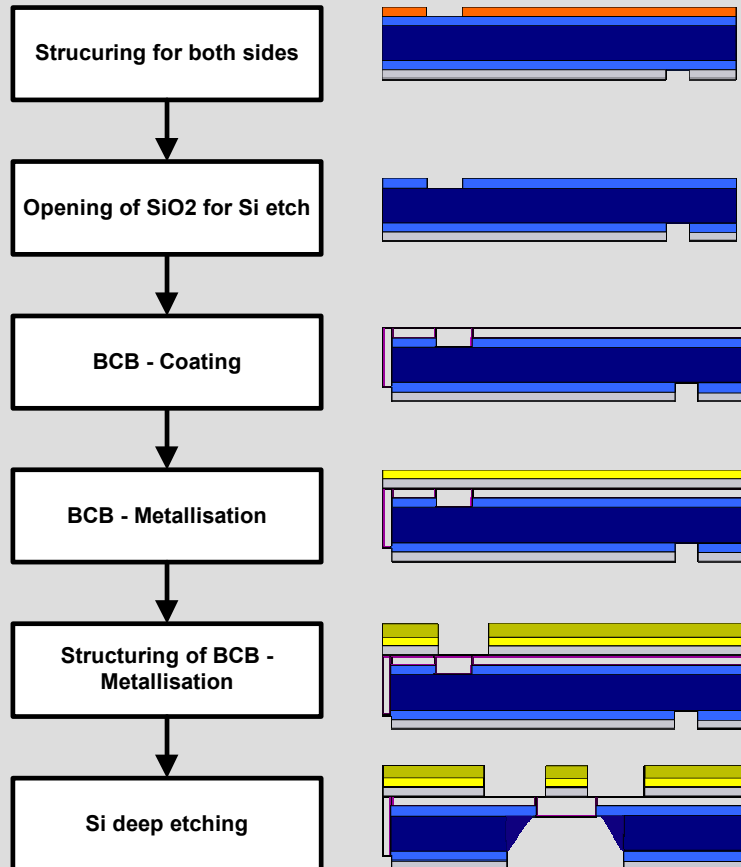
Process follow up for
Bottom wafer (II):



- 2nd metallisation
- electroplating (top 8.5;
slope 7, bottom 6.7 $\mu\text{m Au}$)



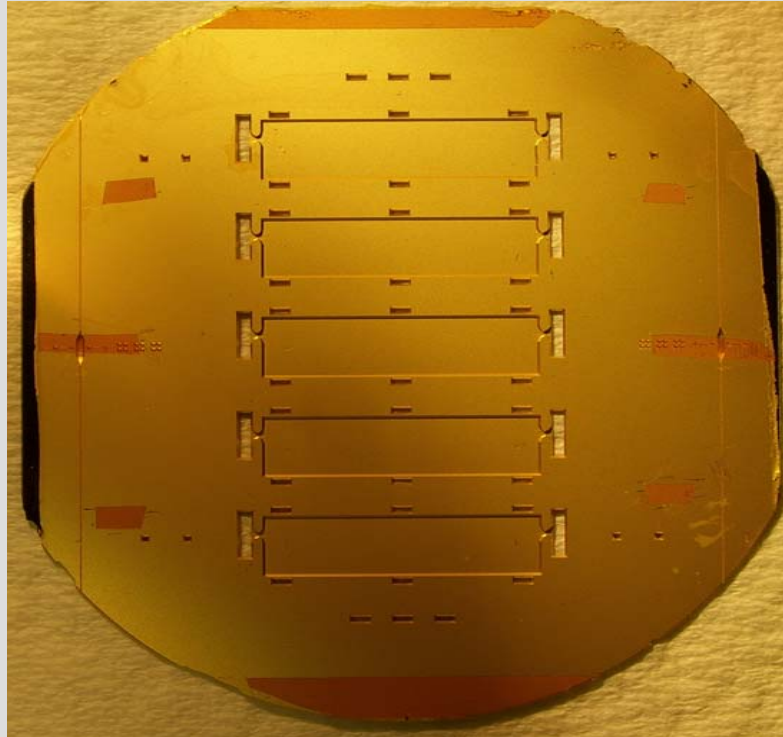
Wafer Processes III



Middle wafer key processes:

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

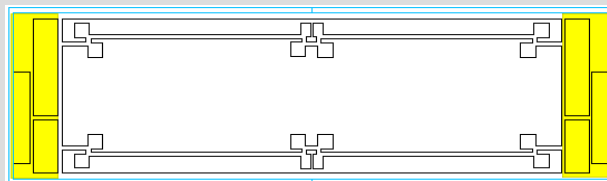
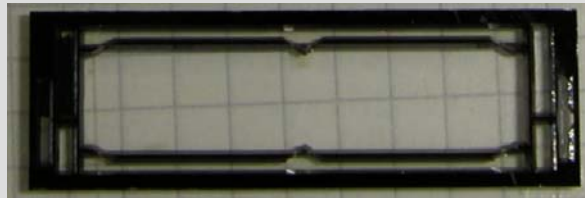
Wafer Processes IV



Top wafer:

- prepared for underfill

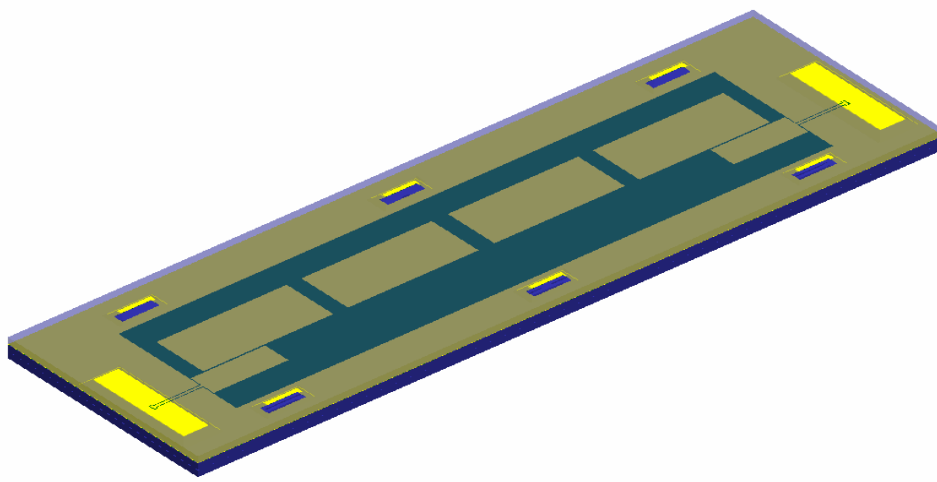
Development of the Packaging Design I



initial design:

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

Development of the Packaging Design I

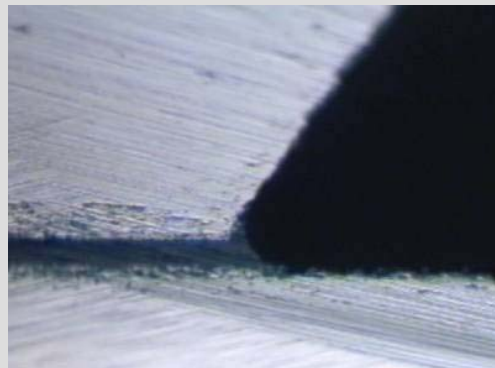


**new design
considerations:**

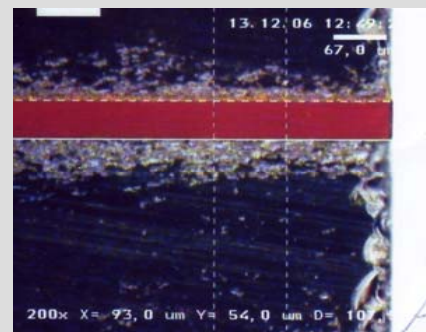
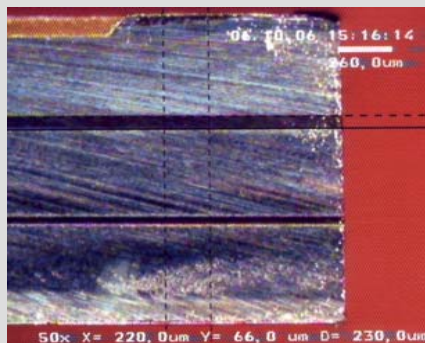
- partially etched openings
- a single wafer alignment system

Processes Packaging I

Complete Underfill Process:



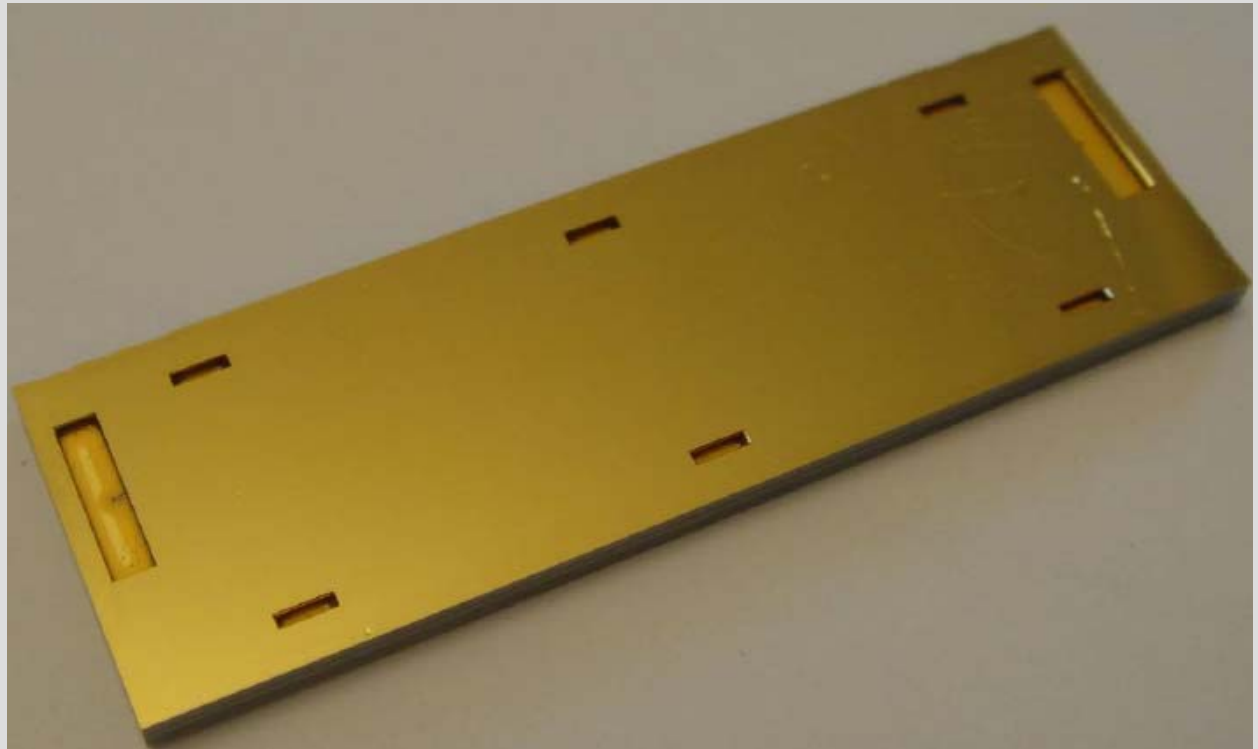
by selecting proper process parameters a well defined flow of underfill can be achieved



complete / non - complete fill of device edges

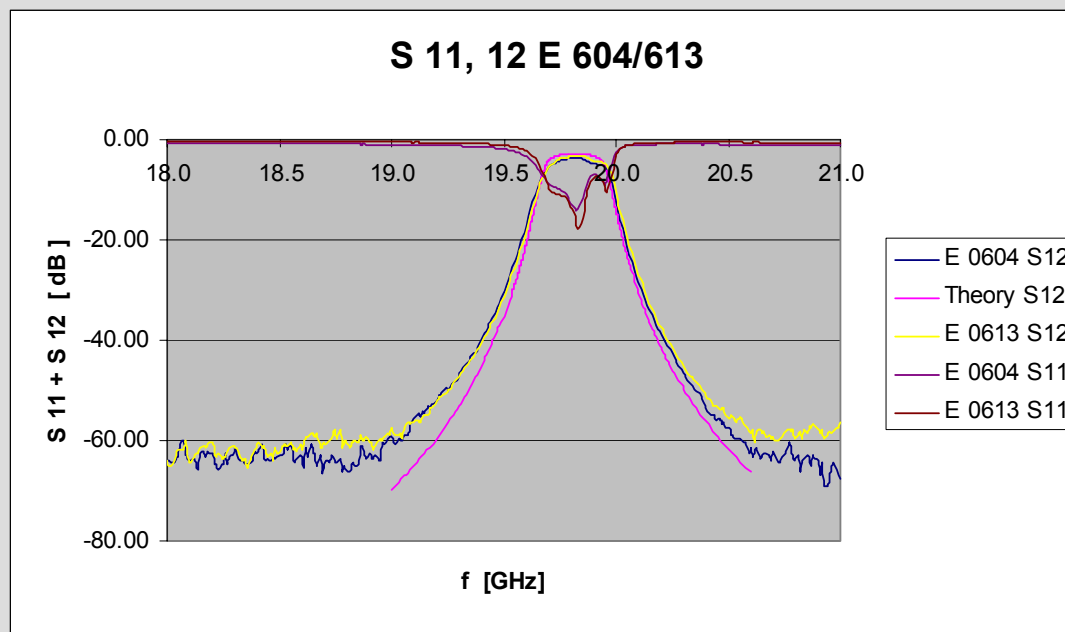
realised filter

- device picture



realised filter (I / IV)

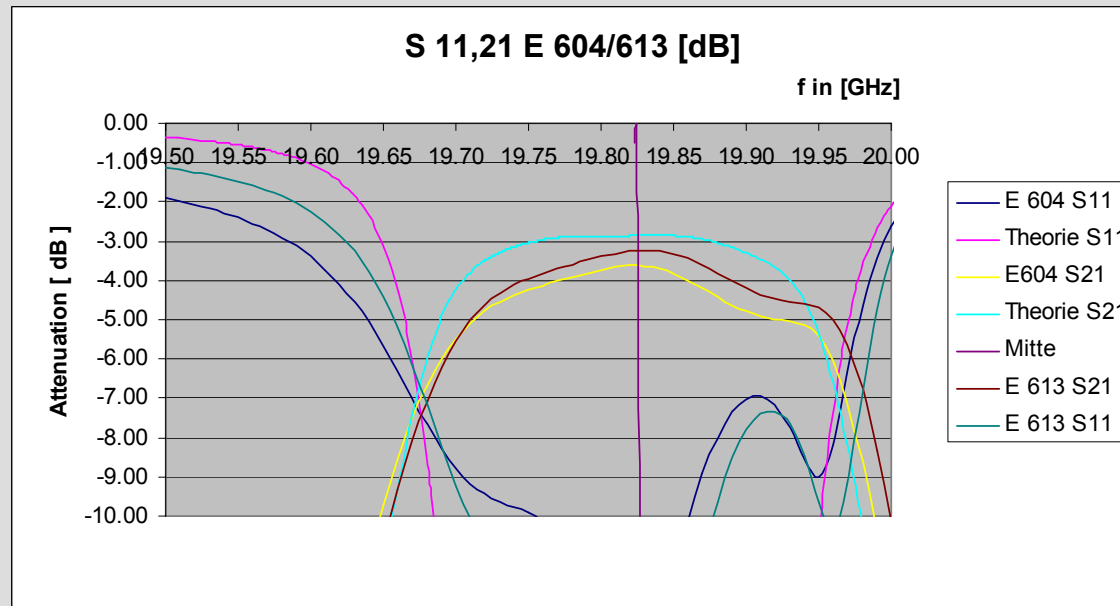
- RF – Measurements I (overview)



2 golden samples

realised filter (II / IV)

- RF – Measurements II (detail)

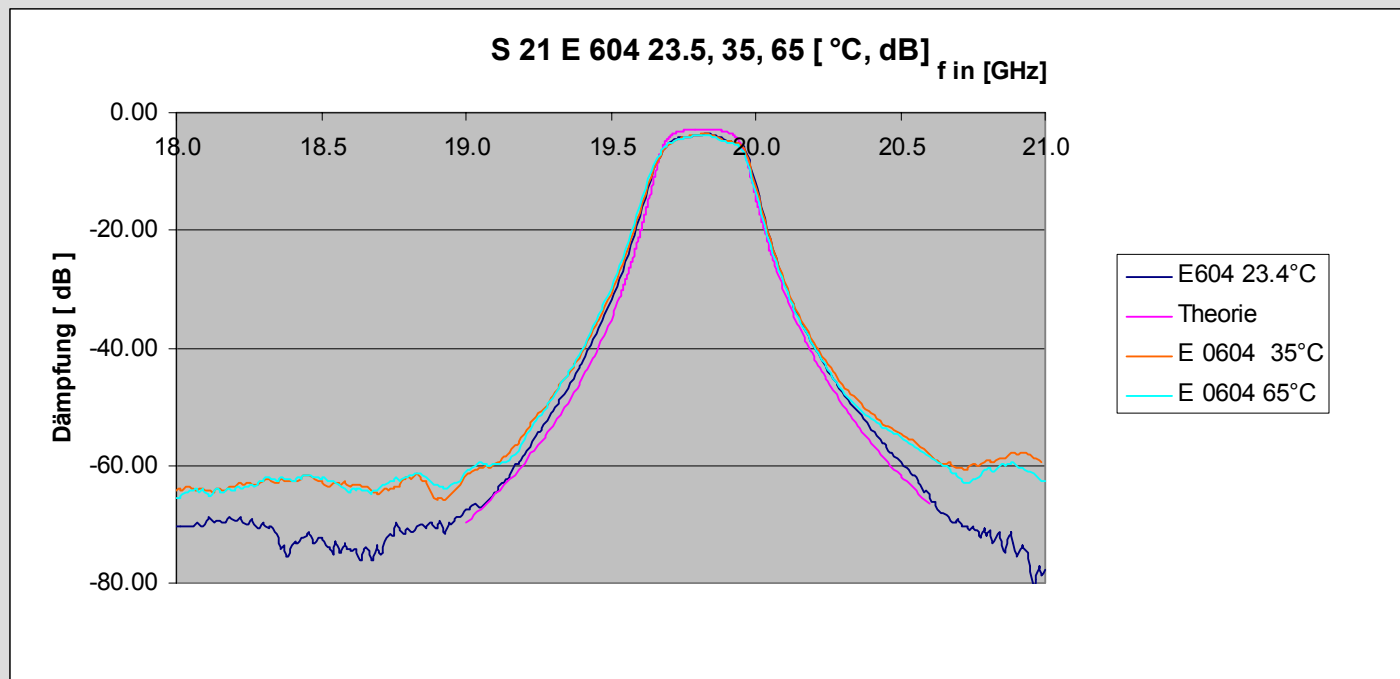


2 golden samples; enlargement

compare theory and practical measurements

realised filter (III / IV)

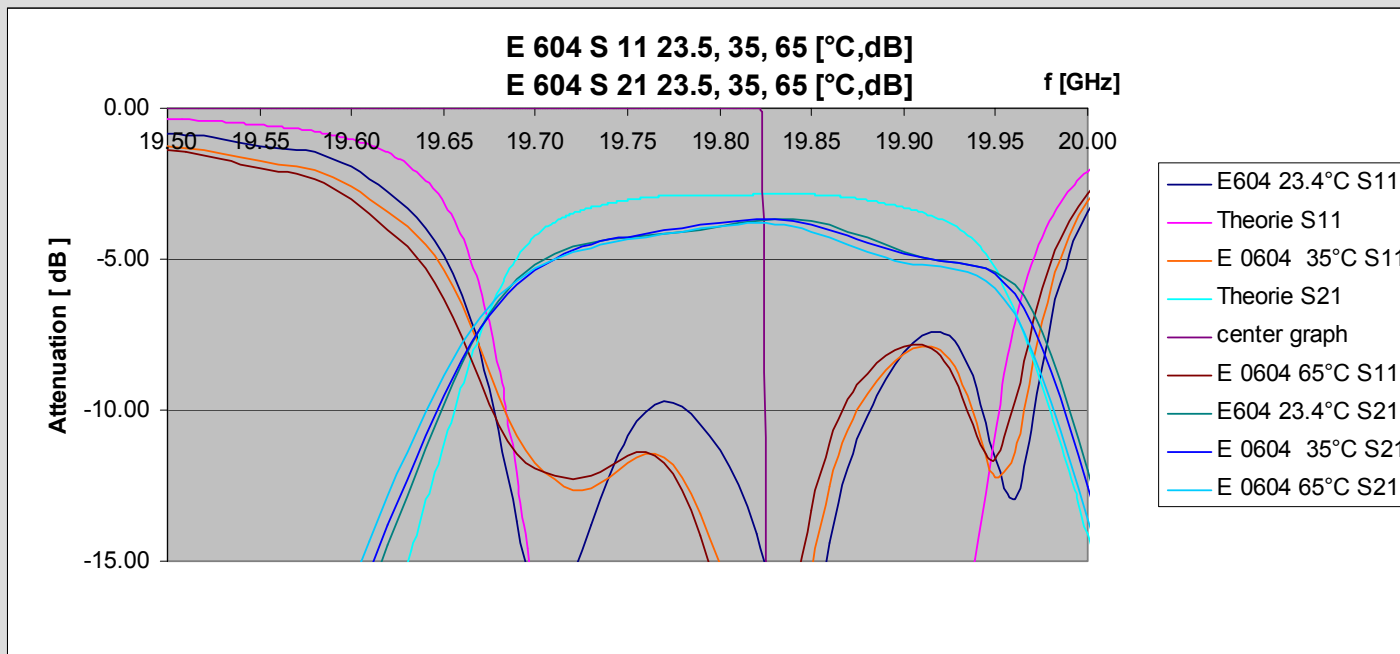
- RF – Measurements temperature dependant



S₂₁ of E 0604 temperature dependant

realised filter (IV / IV)

- RF – Measurements temperature dependant



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

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

END