VivID AS
ID system
MMS and Ultrasound

- Technology and possible applications -

The company VivID AS

- Founded year 2000
- Supported by the Forny program
- 4 entrepeneurs
- Grant from NFR 2002
- Proof of concept 2003
- Akershus Næringsfond July 2004: direct placement 450.000 NOK ; share rate 10 x pari
- Offered IFU agreement from Innovasjon Norge April 2004 (Marine Harvest – Aquaculture)
- Finalist in the DnBNOR innovation contest August 2004

Organization

- Man.dir./leader of board/owner:
  - John Brungot, M.Sc./economist
- Board:
  - Sverre Holm, Prof. UiO, owner
  - Ivar Wergeland, M.Sc/consultant
  - Lars Hoff, ass.prof. HiVe, owner (reserve member)
- Also owner:
  - Arne Rønnekleiv, Prof. NTNU
- Co-innovators:
  - Ralph Bernstein, dr. ing
  - Dr. Dag T. Wang, dr ing., Sintef

ID method

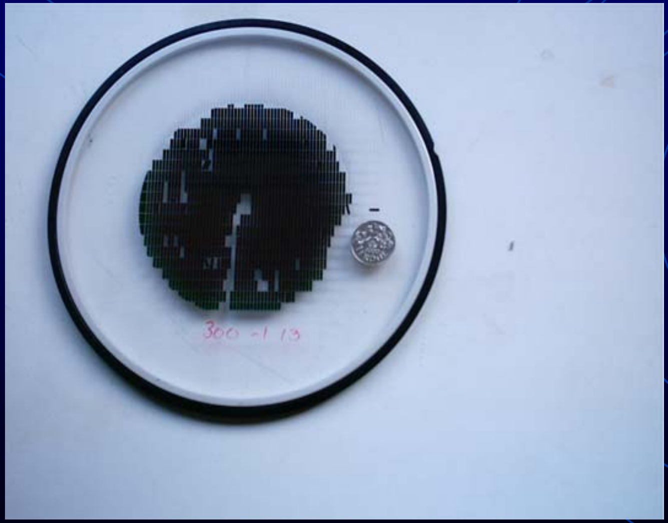
Identification in liquids

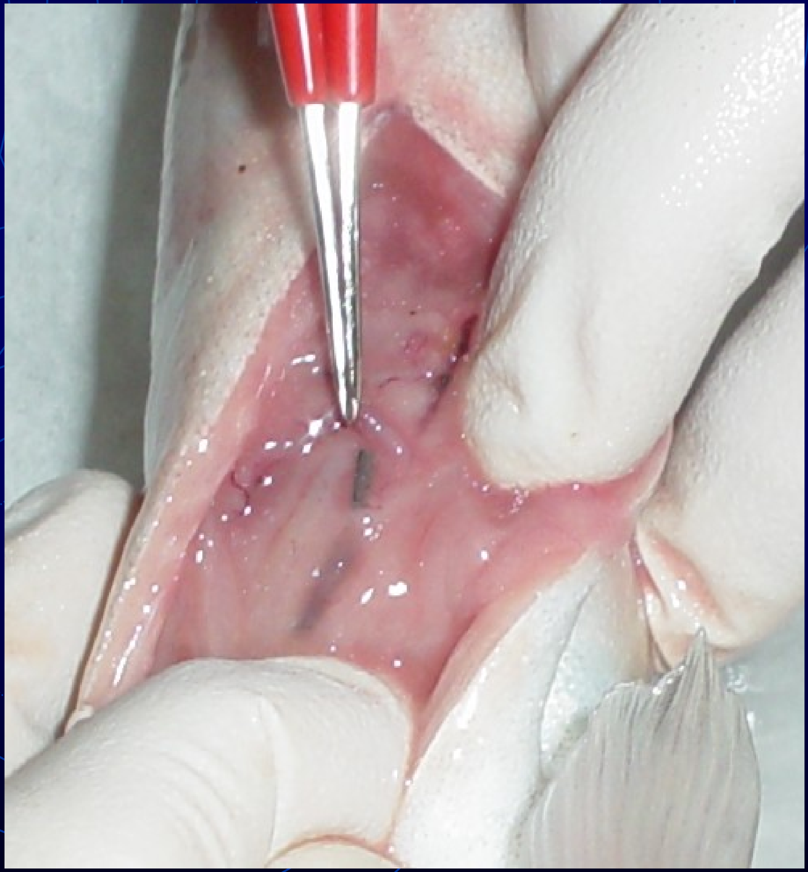
- Reasonable cost acoustic system based on MMS(Micro Mechanical System) ID chips and ultrasound signal measurements and readings
- Also applicable for living objects

Silicon/glass ID chip

Present chips (for fish) :

- Cross section ca. 1,5 mm x 1,5 mm
- Length ca. 4 mm



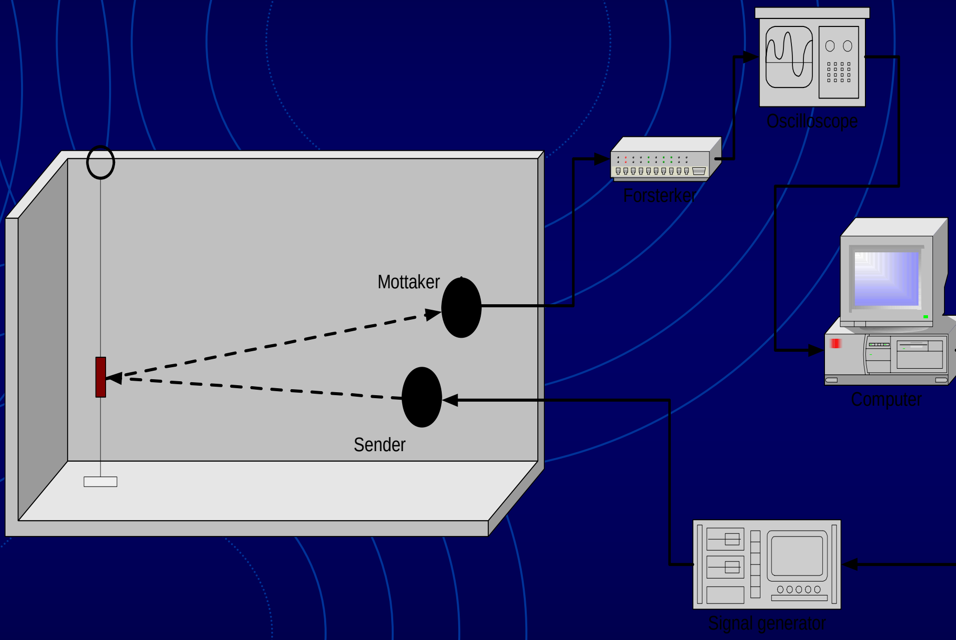


State of development

- Development since 2001
- Designed ID chip in MMS (Micro Mechanical System) – technology
- Manufactured by SINTEF microsystems/Sensonor AS
- ‘Proof of concept’ 2003 after testing of
  - Chip in water
  - Chip in fish meat
  - Chip in fish in water
- Norw. patent NO 315396, granted July 2003
- PCT (Patent Cooperation Treaty): USA, China and Japan, Europatent (EP) granted 2005

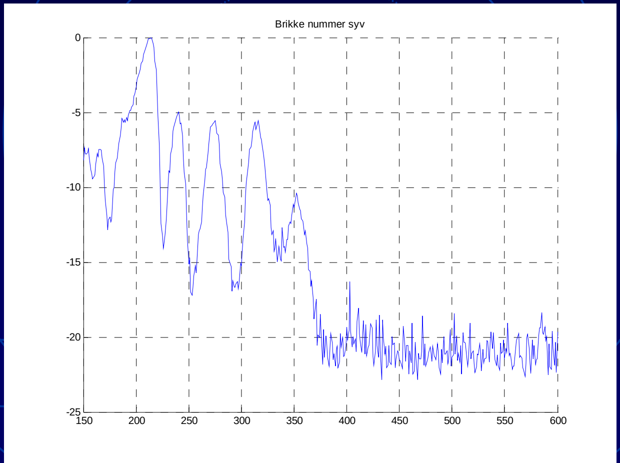
Test layout

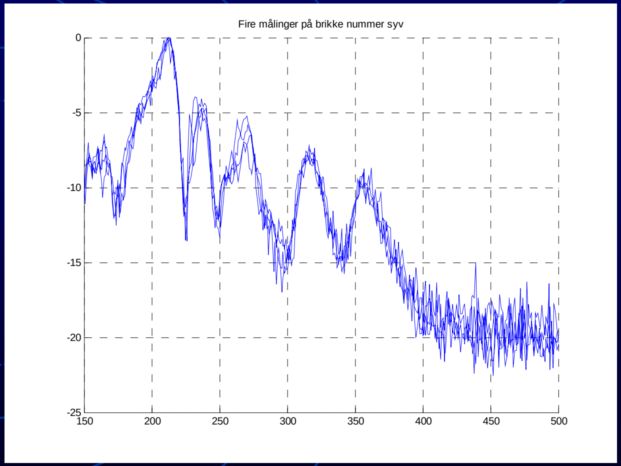
- Test equipment: PC, signal generator, two 250 kHz transducers, one amplifier and a scope
- A scope is not needed for a commercial system



Results – measurements on chip

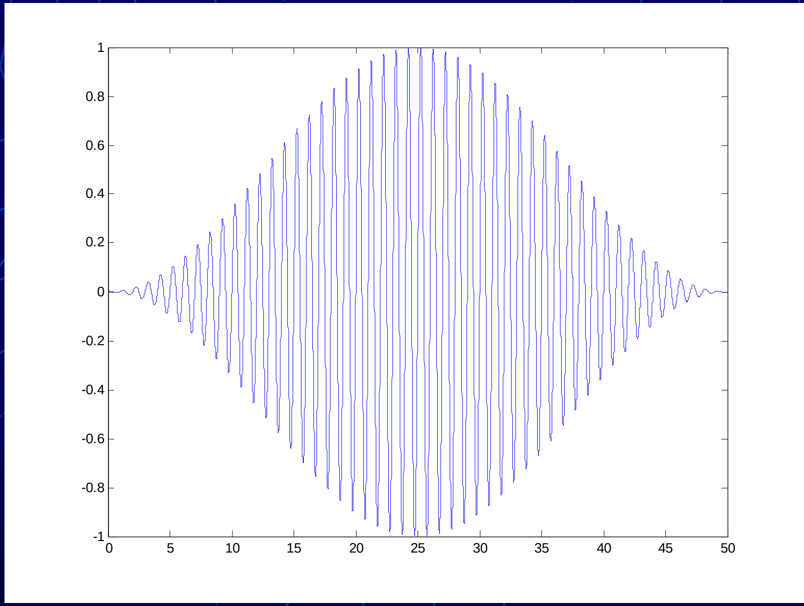
- Sharp resonance peaks
- Measurements of the same chip at approx. same position shows good repeatability





Transmit pulse

- Pulses at frequencies between 180 and 600 kHz
- The transmit pulse consisted of 25-50 periodes and was weighted by a Hanning envelope



Measurements on chip in fish I

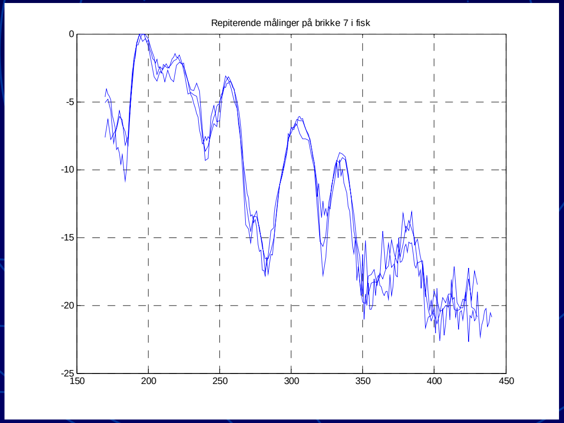
- The chips were mounted inside the anestetized fish applying an injection needle
- The fish was left to rest at least one day before measurements

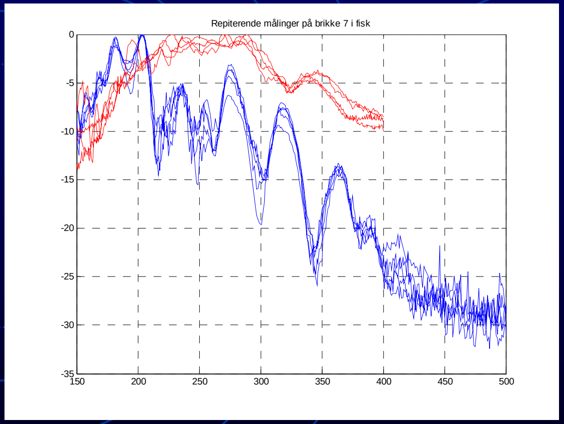
Measurements on chip in fish II

- The fish was anestetized in a solution with MS222 for appr. 5 minutes
- Then it was positioned in the beam from the emitting transducer

Results – chip in fish

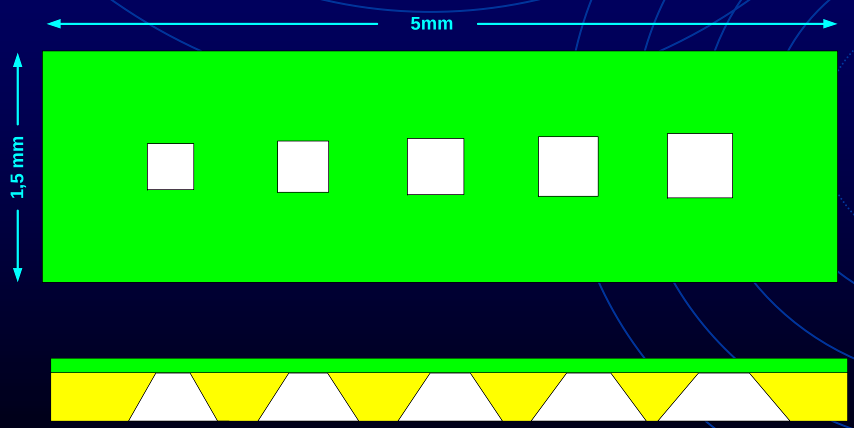
- Quite clear resonance peaks
- The combination of resonances in accordance with the chip ID
- Comparison with measurements on fish without chip (red curve) shows the difference

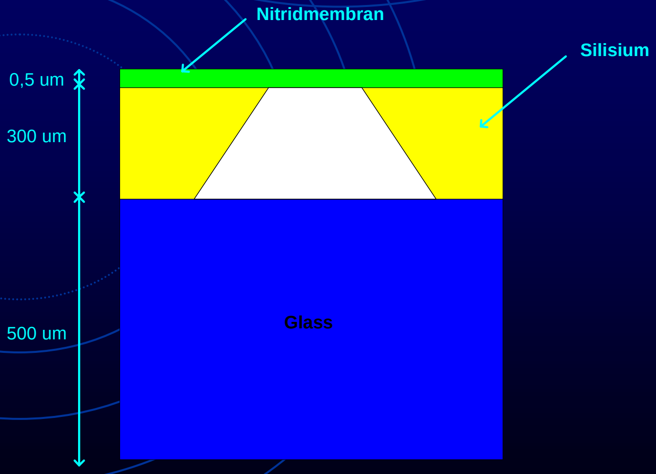




MMS: Micro Mechanical System

- Present ID chips made of silicon with bonded nitride membranes under tension
- The cavities are made by wet-etching through a silicon wafer to the membrane
- The wafer is then fastened to a glass wafer by anodic bonding

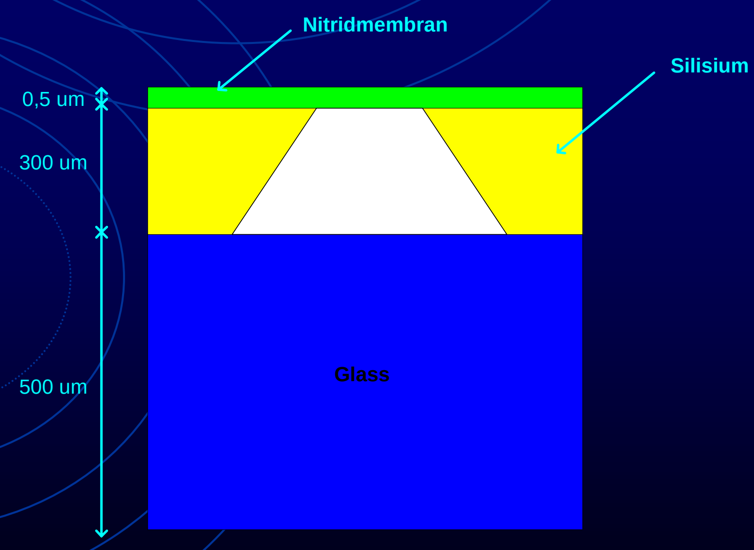




Resonator design

Cavity + membrane => resonance frequency
Prototype series: 17 selected frequencies in 7 different combinations (chips)
Possible combinations (IDs), F frequencies ands R resonators:
N = F! / (R!*(F-R)!)
F=17, R=5 => N=6188 combinations. One extra resonator for calibration

Membrane dimensions, µm					
195,0	189,8	184,7	179,7	174,9	170,3
165,7	161,3	156,9	152,7	148,6	144,7
140,8	137,0	133,3	129,8	126,3	
Calculated resonance frequencies, kHz					
400,0	383,0	366,8	351,3	336,4	322,1
308,4	295,4	282,8	270,9	259,4	248,4
237,8	227,8	218,1	208,9	200,0	



Publications

- A. Rønnekleiv, J. Brungot, D. Wang, R. Bernstein, V. Jahr, K. Kjølerbakken, L. Hoff, and S. Holm, **Design of Micromachined Resonators for Fish Identification,** in Proc IEEE Ultrasonics Symposium, Rotterdam, Netherlands, Sep. 2005.
- S. Holm, J. Brungot, A. Rønnekleiv, L. Hoff, V. Jahr, K. M. Kjølerbakken, **Acoustic passive integrated transponders for fish tagging and identification,** submitted to Aquacultural Engineering, Feb. 2006.

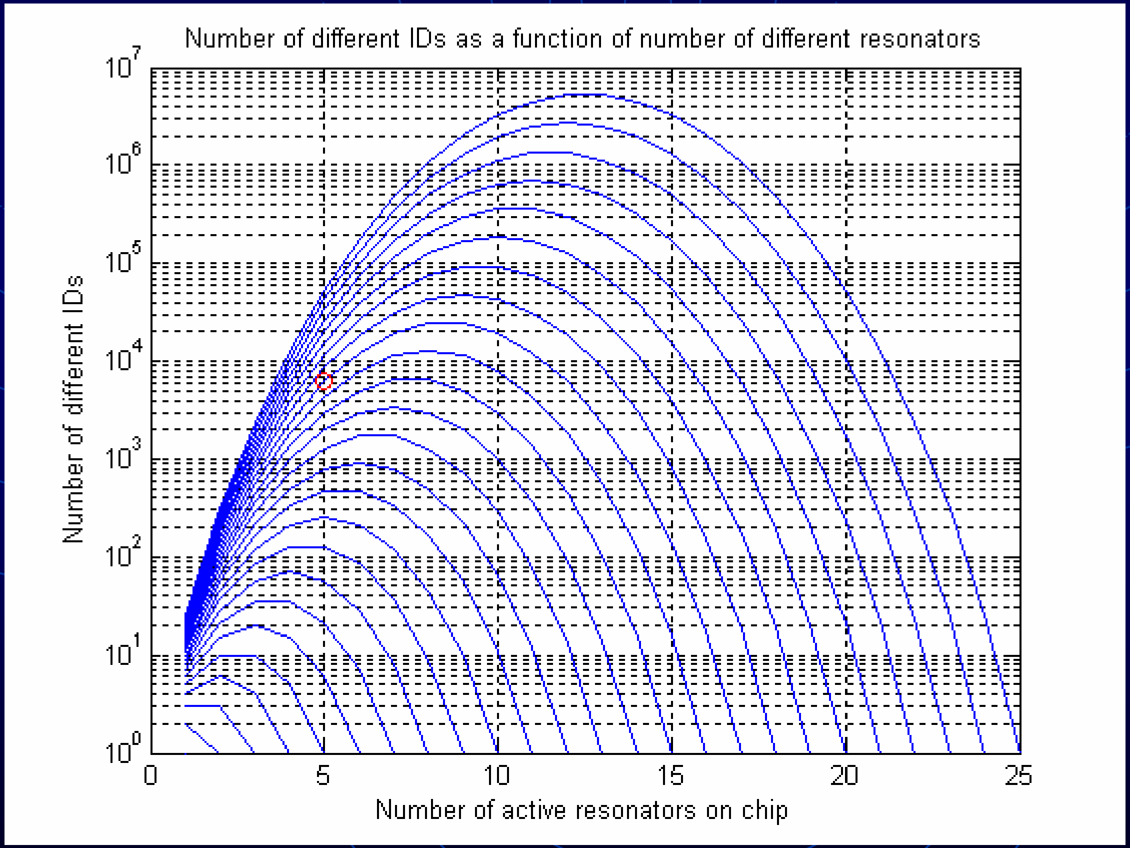
New applications – scaling down

Demands:

- Increased number of IDs
- New square chip sized approx. 0,4xo,4x0,3 mm3
- Ultrasound frequency 3-5 MHz
- May be mounted inside PEG beads (patented method) for applications within biotech industry
- Reading distance ~1 mm

Distribution - number of IDs

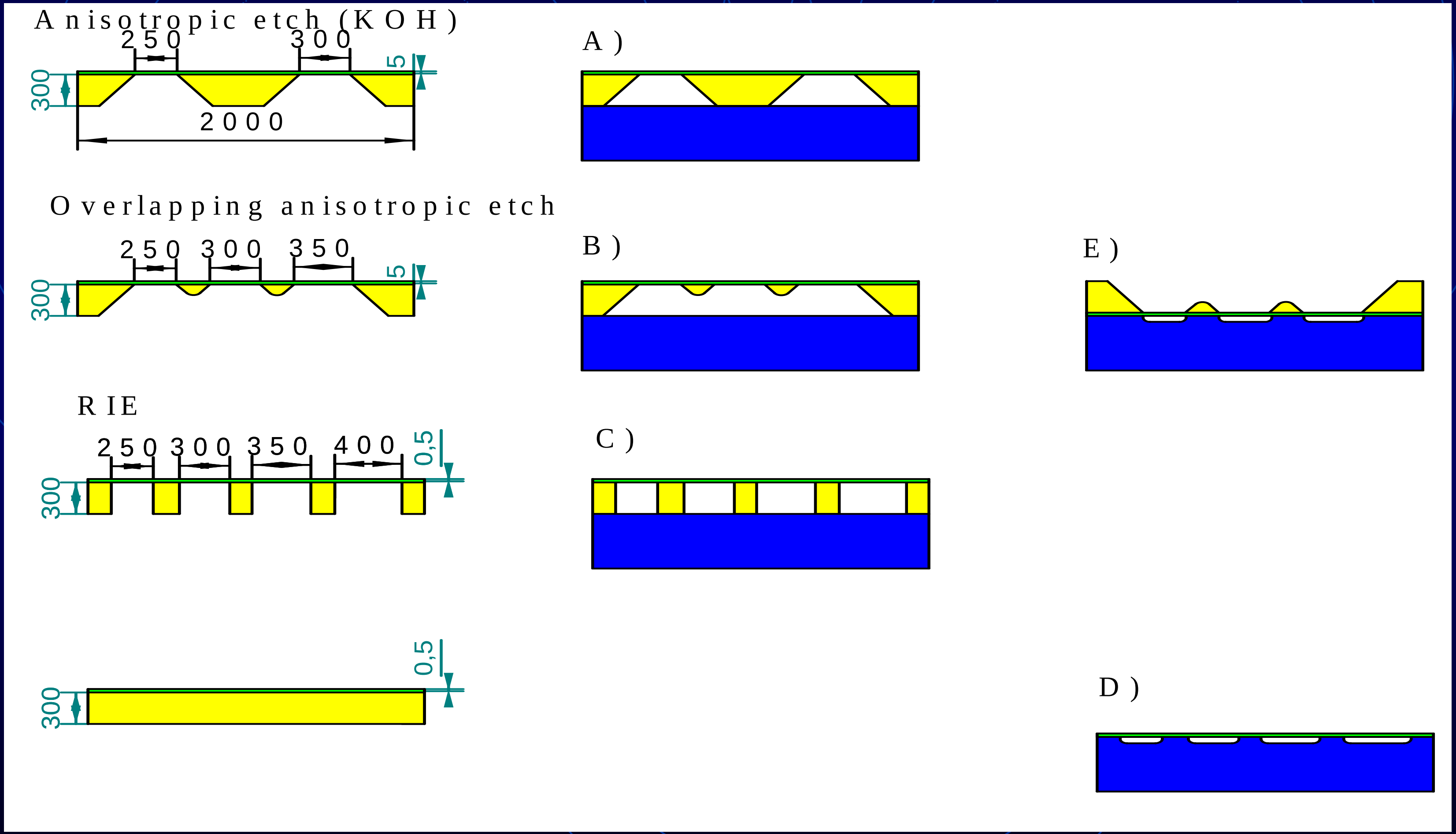
N = F! / (R!*(F-R)!)



Solution - chips

- Examples:
  - 4 to 7 resonances, chosen from 16 availible gives 25.600 IDs
  - 4 to 10 resonances, chosen from 15 gives 30.000 IDs
- Additionally one or two resonators with fixed and known resonance frequencies as references for calibration
- Need: 15 to 20 possible resonance frequencies and deployment of appr. 10 different resonators on each chip

Alternatives – chip design



Solution - frequency

- Chip diameter at least ¼ wave length at lowest resonance frequency gives lowest resonance frequency at appr. 0,75 MHz and the upper resonances at 3 to 5 MHz
- If the liquid has acoustic properties comparable to water, the signal losses will be low, giving Q values of appr. 100 at 5 MHz, which is excellent
- But 10 % of some unknown substance in the liquid may notably increase the losses. This must probably be tested by experiments for each liquid

Solution - reader

- 15 to 20 frequences means a frequency span with a proportion of 4.0 - 6.7 between the lowest and highest frequencies
- The resonance frequencies will cover a span of 120 % to 150 % of relative bond width
- This is difficult to achieve for single transducers when also demanding high sensitivity
- However, due to a short reading distance ID detection may prabably be achieved for such applications

IFU partners - biotech industry applications