Pressure Sensor Clusters

On the Way to 100 Pressure Sensors on a 1-Euro Coin

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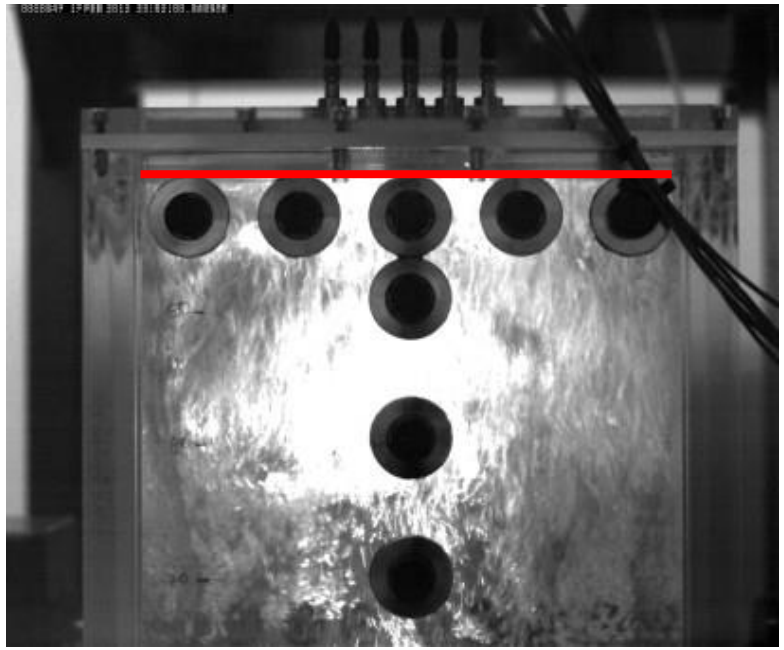
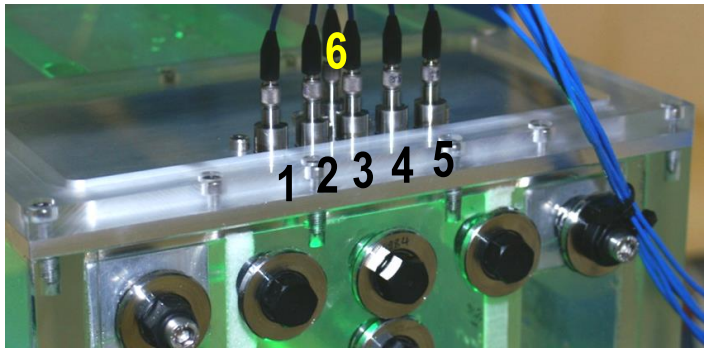
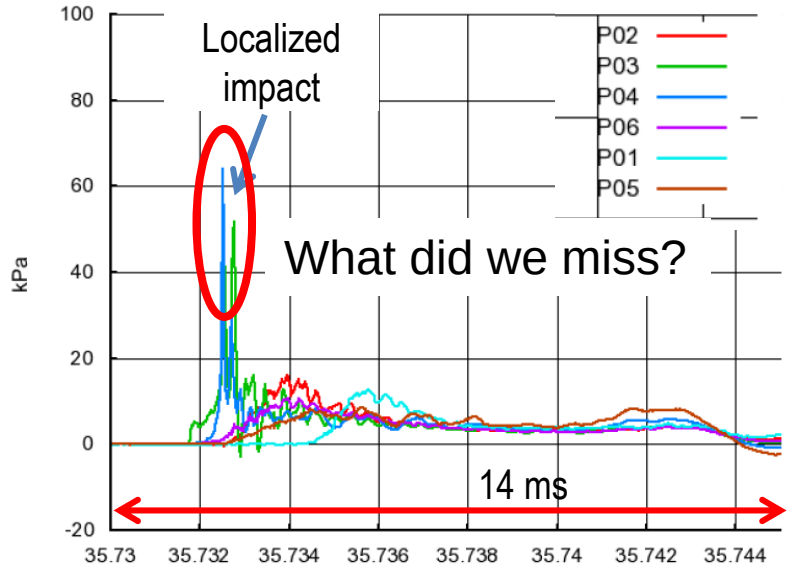
Spatial Distribution of Sloshing Pressures

wide

0.18 s



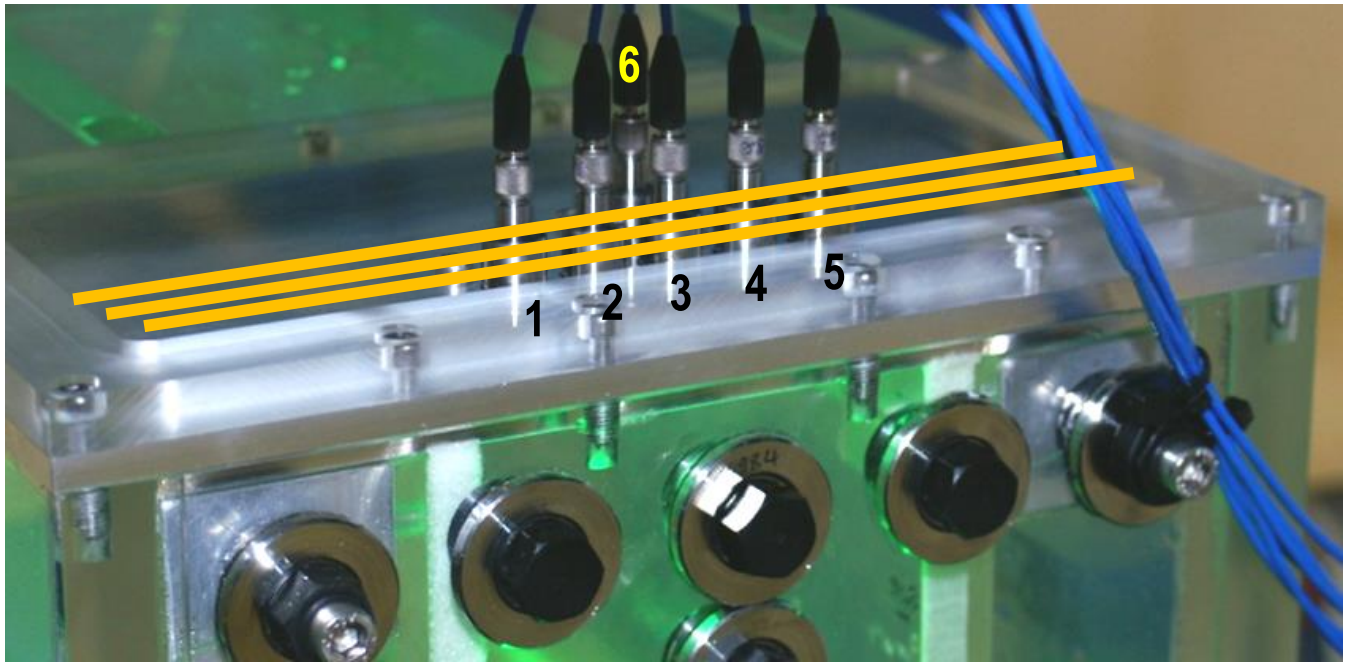




Wide configuration

- Example impacts at 80 % filling
- Tank width 200 mm
- Sensor spacing 14.8 mm

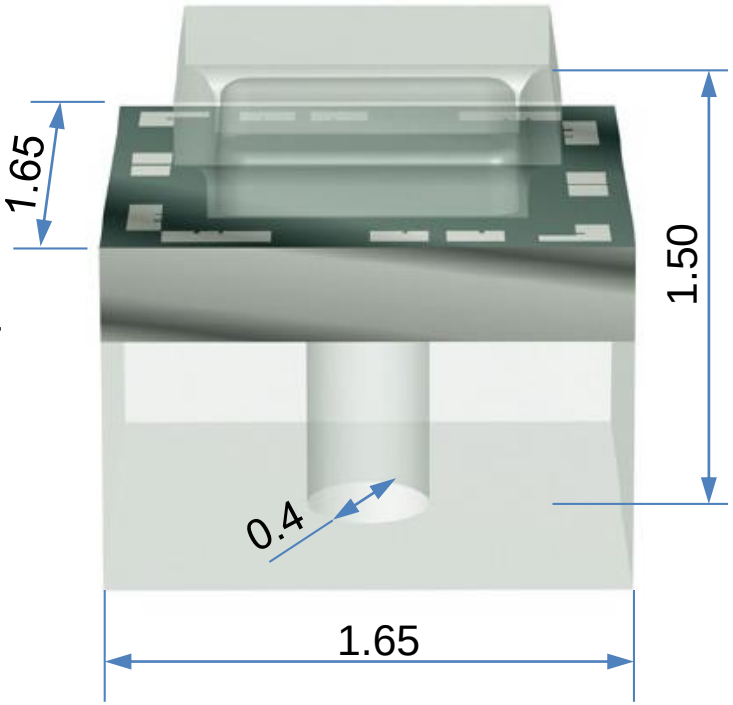
Idea: Very Small Pressure Sensors



- Tank width 200 mm
- > 100 pressure sensors per line?!
- Sensor spacing < 2 mm

EPCOS Pressure Sensor C32 Industrial

- Dimensions: 1.65 x 1.65 x 1.5 mm^3
- Absolute pressure sensor
- Vacuum reference cavity
- Suitable for wet (non-aggressive) media
- Measurement range 0..1.6 bar (10 bar)
- Distributed Wheatstone bridge
- Sensitivity (typ.) 22 mV/V @ 1.6 bar
- Non-linearity (typ.) 0.2%
- Operating temperature -20..85 deg C
  short time (< 15 min): 105 deg C



Engineering Considerations

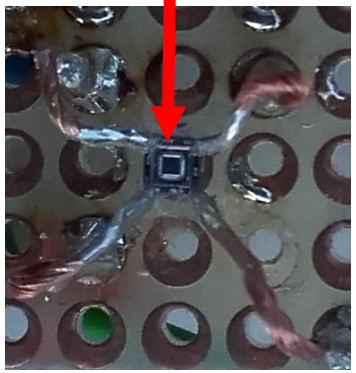
- Air in cavity considered as bubble in water
  - Oscillation frequency 6.6 kHz (isothermal), 7.8 kHz (adiabatic)
- Pressure drop in channel due to surface tension
  - Water/air σ=0.072 N/m → 700 Pa
- Cavity filled with water
  - Time for shock wave to run from opening to membrane and back: 1.5 µs → 670 kHz

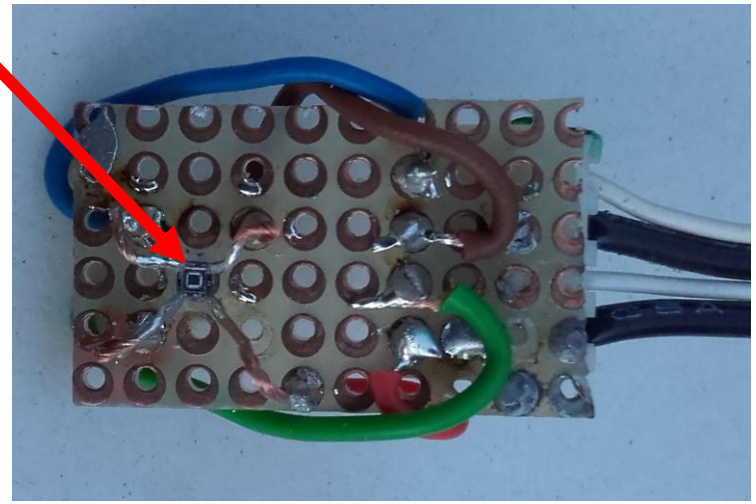
➔ Conclusion: Cavity to be filled with water

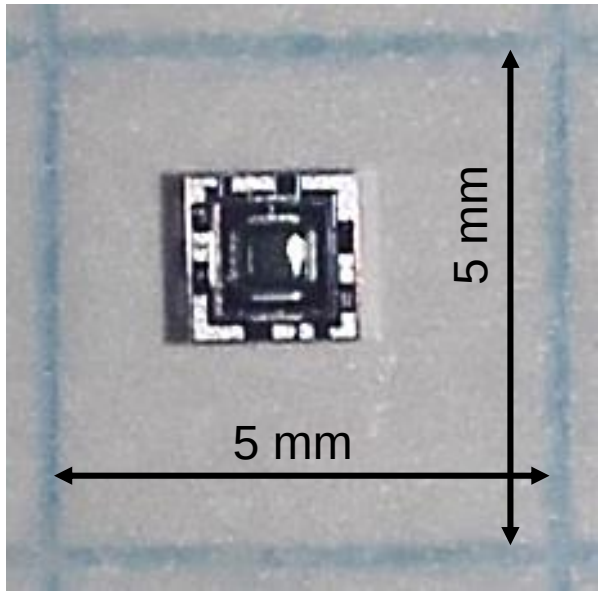
Get Going

- Step 1 → get one to work (!)

1st connected sensor 19.06.2017

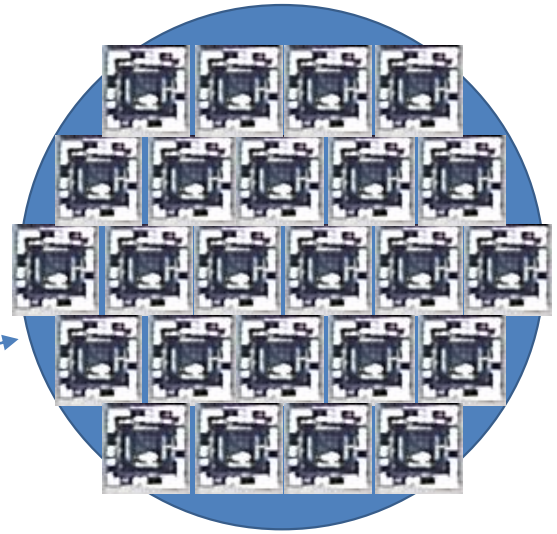






Get Going

- Step 1 → get one to work (!)
- Step 2 → cluster many sensors



Current sensor d = 11 mm
→ 24 new sensors

Challenges

- Micro-electronics world

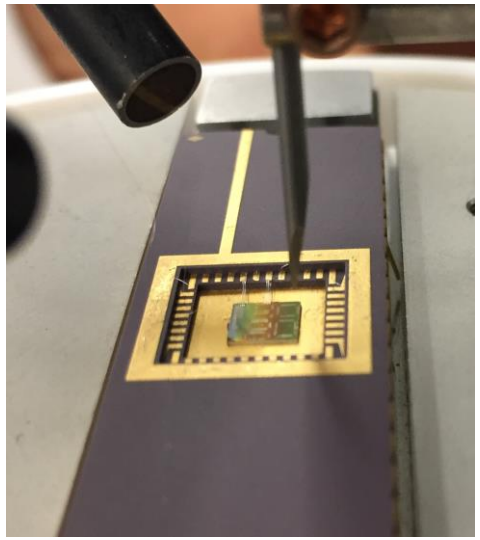
→ Gluing sensors to circuit board

→ Electric connections by wire bonding

→ Water proofing of assembly

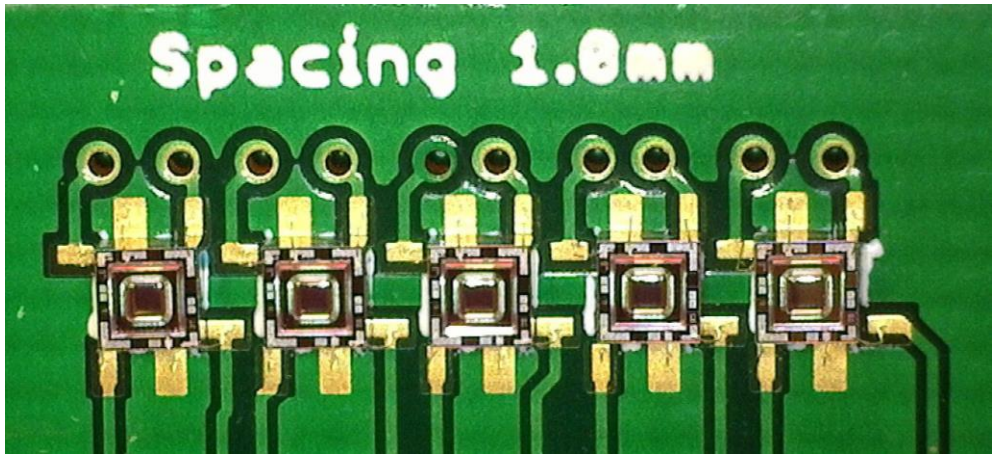
→ High conductor density on circuit board

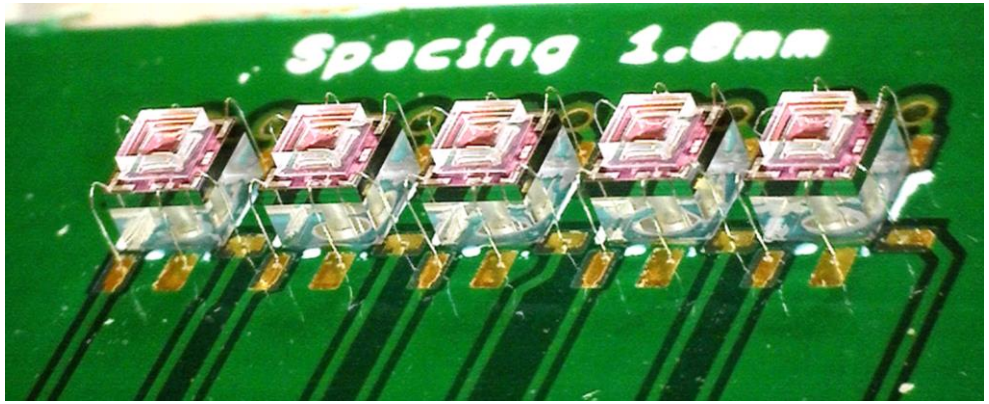
- Overcoming/using surface tension



Current Status

- 1st sensors are glued and bonded (16.10.2017)

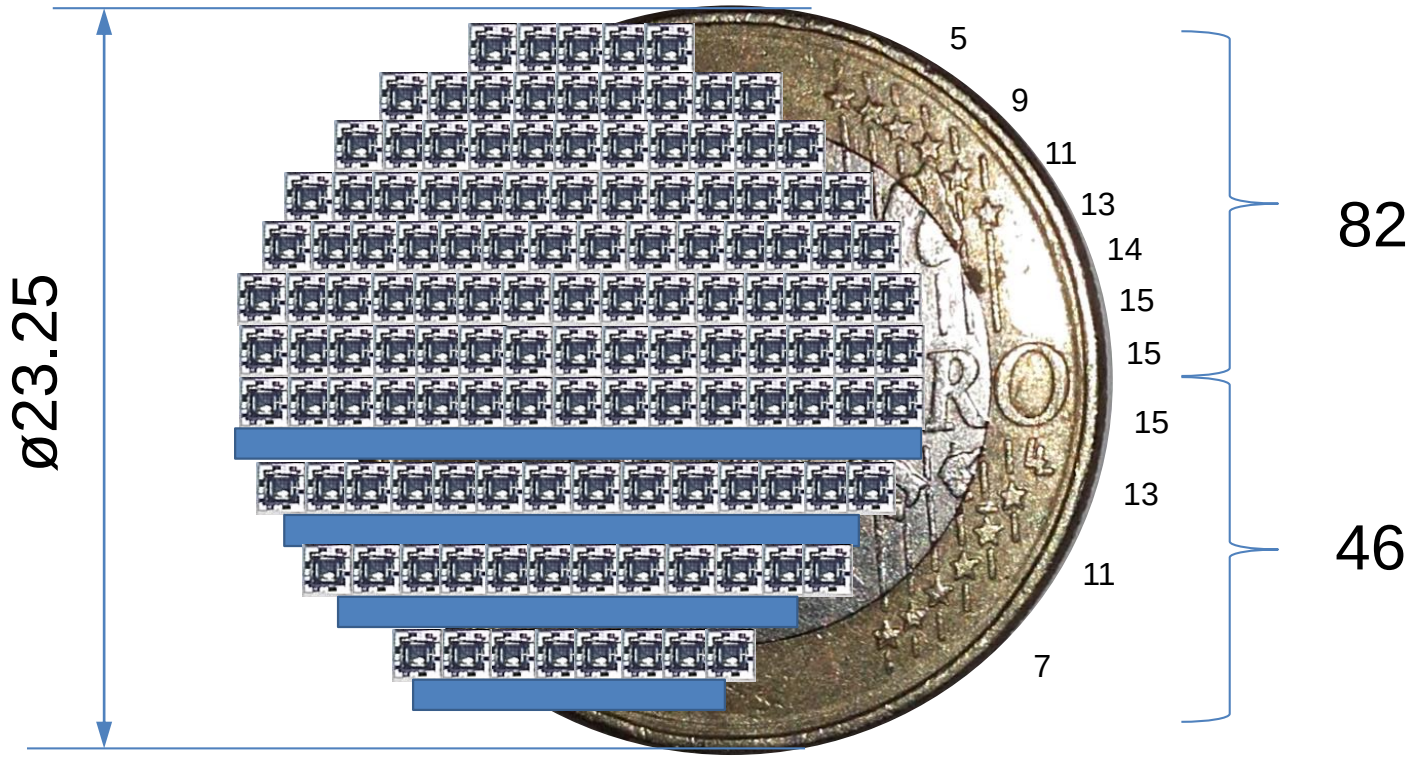




Next steps

- Testing and evaluation of sensors in air
  - 1st static testing
  - 2nd dynamic behaviour
- Try applicability in water
- Testing and evaluation in water
- Proceed to sensor clusters

(Almost) 100 Sensors on a 1-EUR Coin



Acknowledgments

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  - Henk van Zeijl, EWI/EKL for gluing and wire bonding
  - Frits Sterk, 3mE/SHS for electronics support

Thank You for Your Attention!

- What are your ideas for applications?