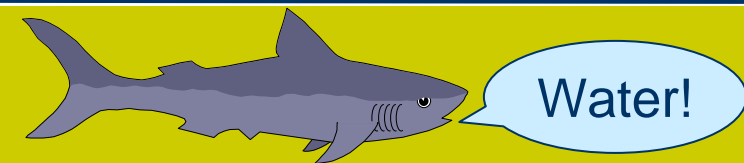
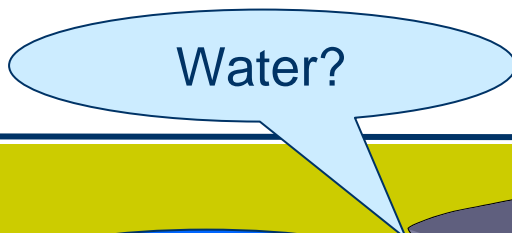


Designing sensors for demanding environments

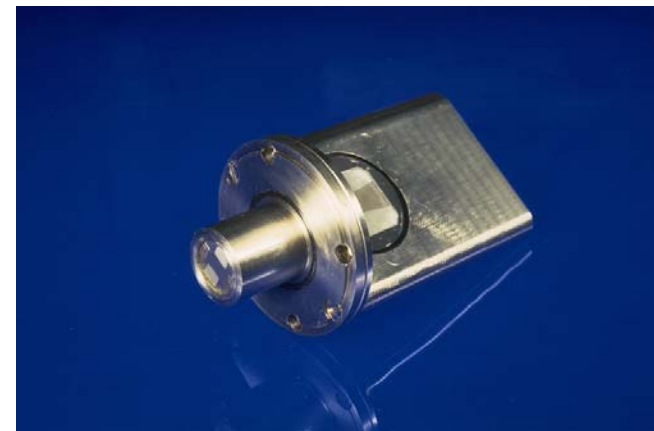
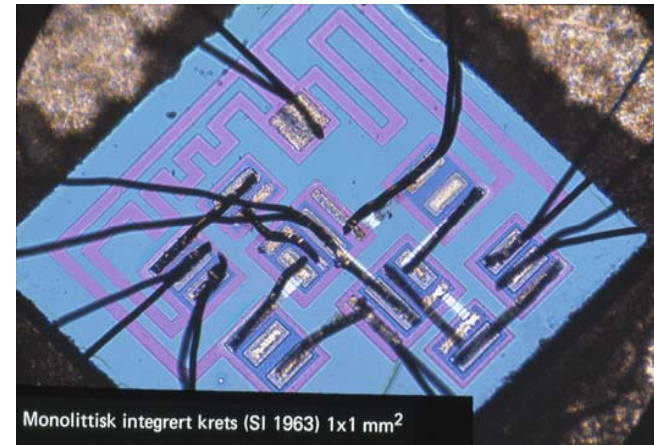
Truls Fallet
SINTEF ICT

What did you find?

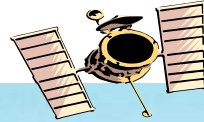


Decades of experience

- The facility in Oslo was founded (1956)
- "NUSSE"- one of the worlds first computers was designed, built and used! (1957-61)
- Several FET-transistors integrated on a common chip (1963)
- "AUTOCON" worlds first CAD system for ship building, later for aircraft and automobile design (1960 – 70)
- "CONDEEP" instrumentation systems for structure surveillence and landing operations (1970-80)
- EM-telemetry from abandoned wells (1986-87)
- Casing strain monitoring at Ekofisk (1987-89)
- HTASIC electronics for 200°C (1990 ---)
- Centrifuge level gauge (1994 – 96)
- Smart well instrumentation (1997 ---)



The petroleum industry offers many challenges



Facilities
Optimised & flexible

Offshore instrumentation

Reservoir Management

Reservoir
Model

Business
Model

Facilities
Model

Intelligent Wells
Monitoring / Intervention

Sensors for process
instrumentation

Control Centre
Decision Support

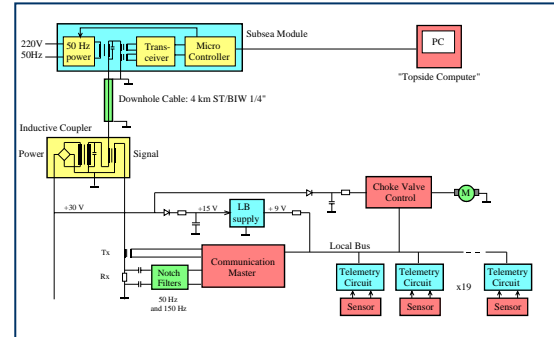
Data storage & Internet

Interdisciplinary creativity

- a must in sensor design

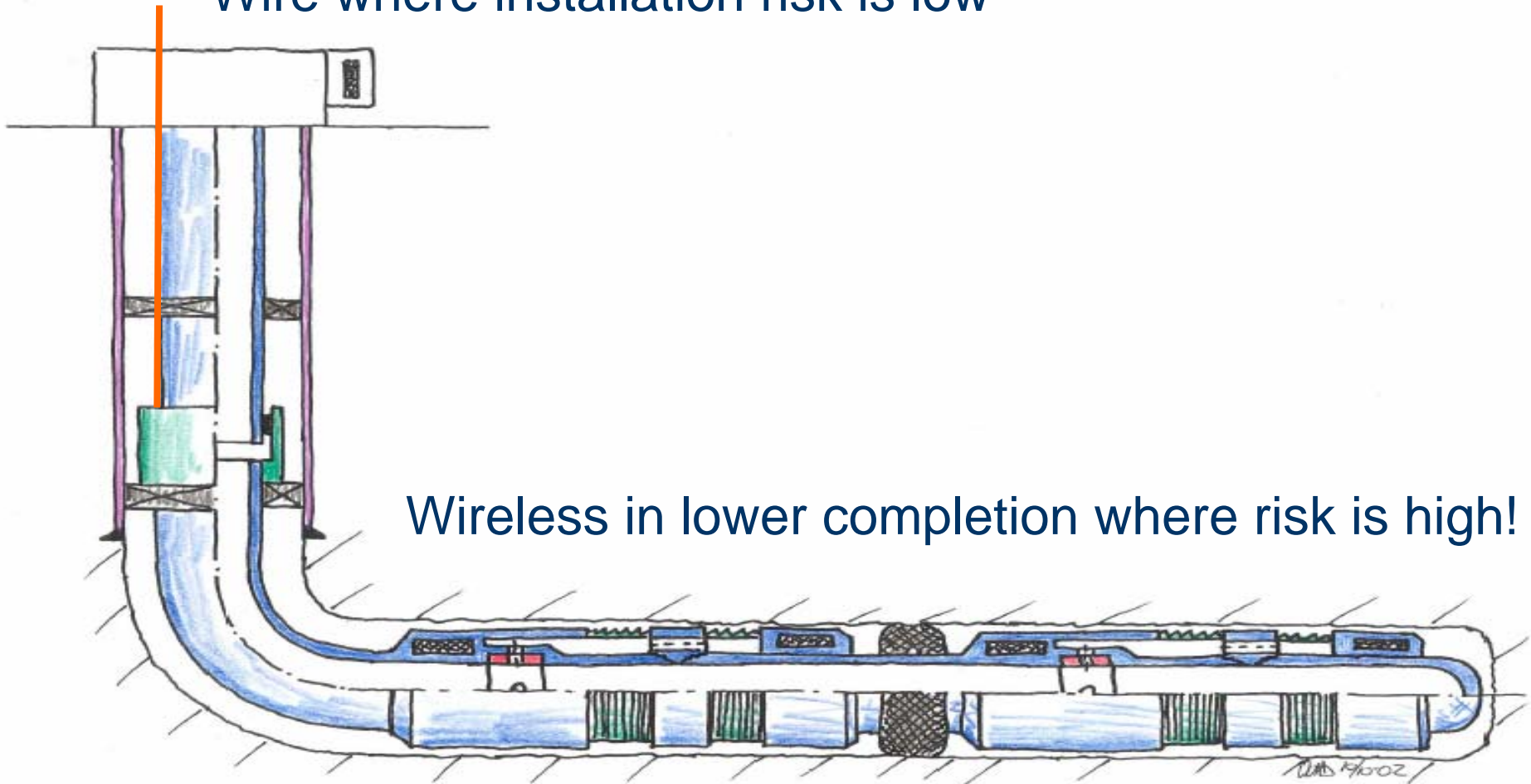
- Measurement physics
- High temperature electronics (200°C)
- Embedded processors, real time software
- Data communication
- Mechanical design, encapsulation, packaging, special materials, heat transfer
- Applications
 - offshore, subsea, oil- and gas wells
 - process industry
 - tilt compensated railway
 - Aerospace and automotive

20 scientists - several disciplines
-large complex projects
-hardware delivery

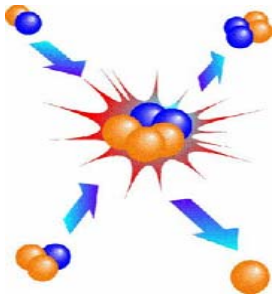


Wireless communication in oil wells

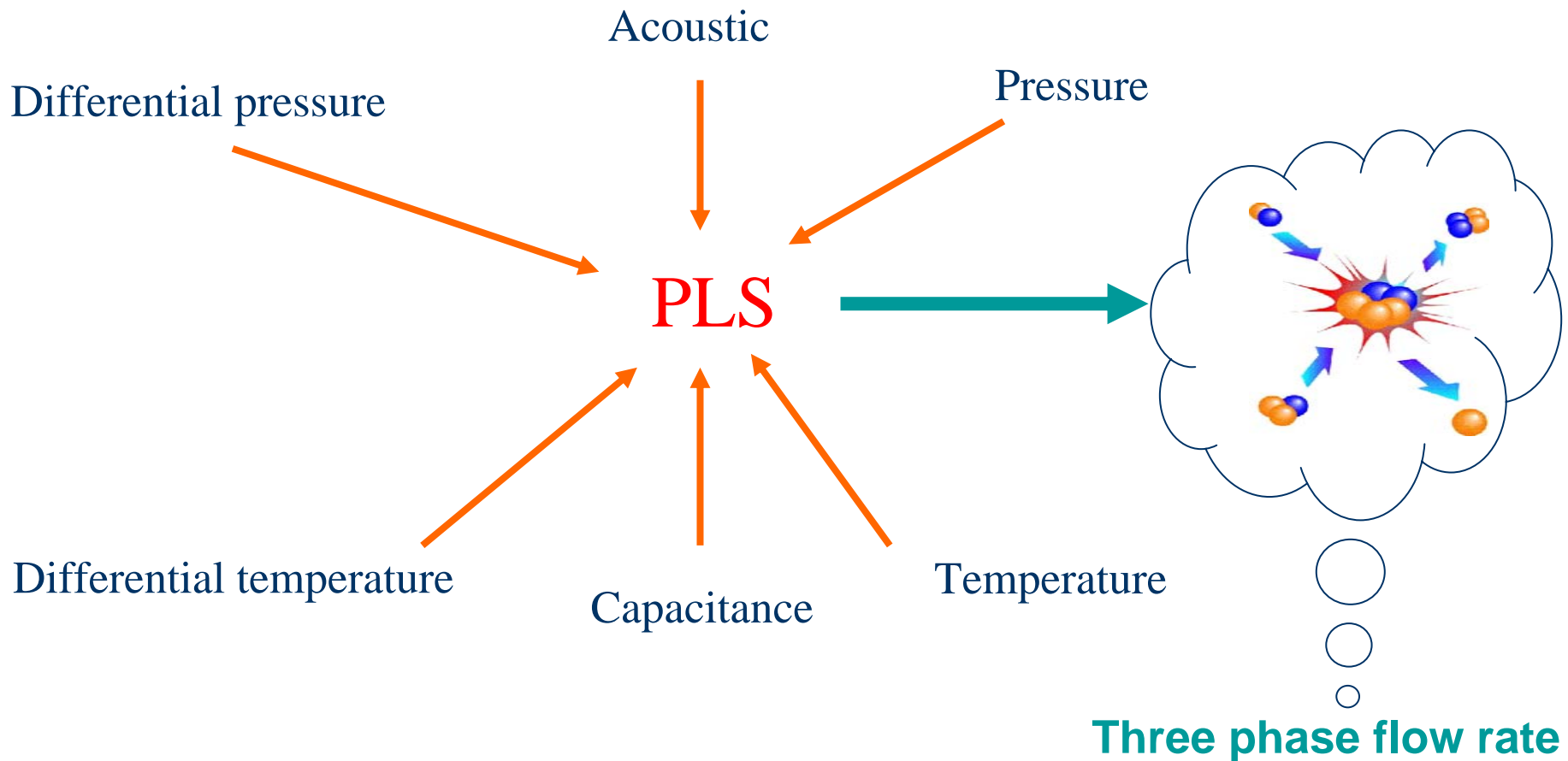
Wire where installation risk is low



Wireless in lower completion where risk is high!



Sensorfusion -for improved reliability



Six sensors with electronics packaged in Inconel and ceramics

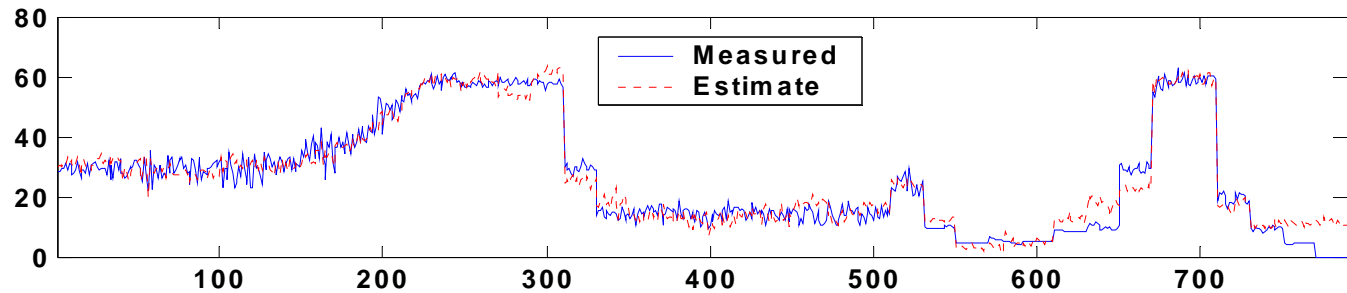
- Pressure
- Diff- pressure
- Temperature
- Diff. temperature
- Capacitance
- Acoustic noise

- 200 x 50Ø
- single wire
- 0 - 200°C
- 0-1000 bar

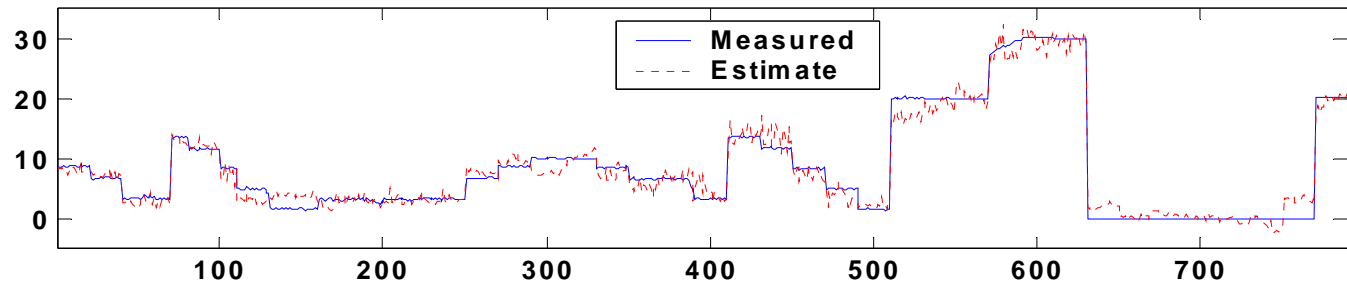


Estimation of 3 phase flow rates with sensorfusion

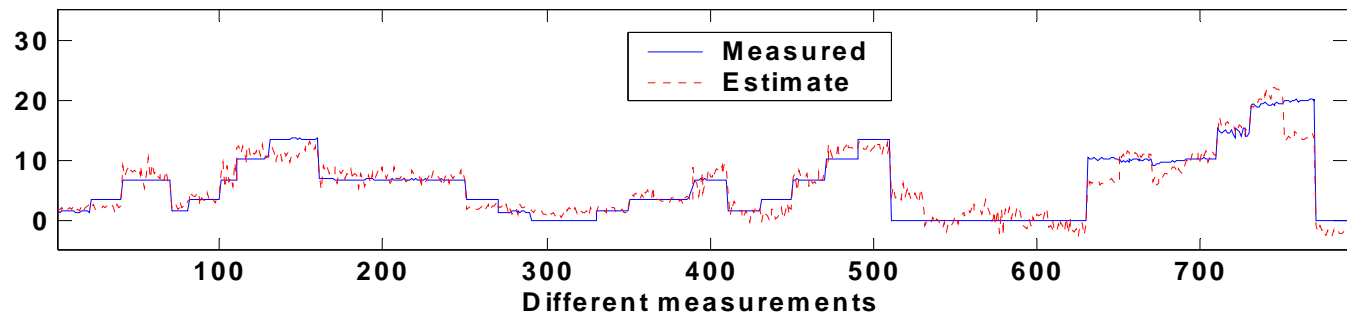
Gas [m³/h]



Oil [m³/h]



Water [m³/h]



Well electronics = HTASIC family

- ❑ Designed for direct sensor integration
- ❑ System on chip solutions
- ❑ Minimum of external components
- ❑ Temperature: 200°C

TTC time multiplexed data transmission

TMM long distance communication

HTP voltage regulator

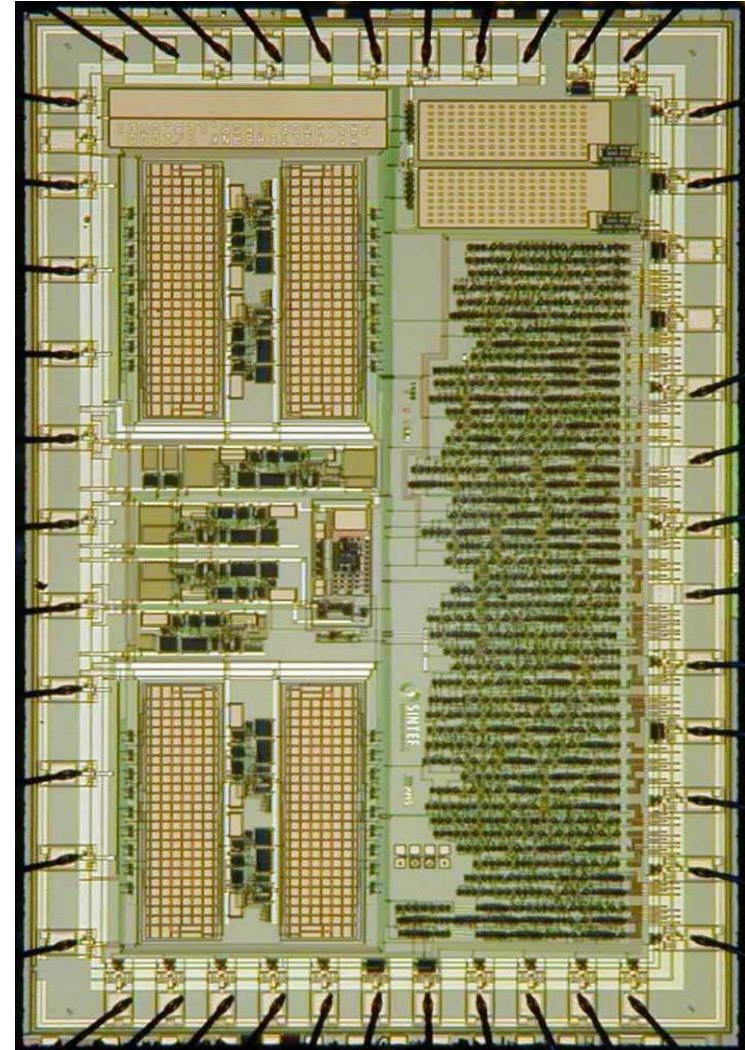
ELS interface to oscillating sensors

CMC measurement of capacitance

Σ/Δ 16-bits A/D-converter

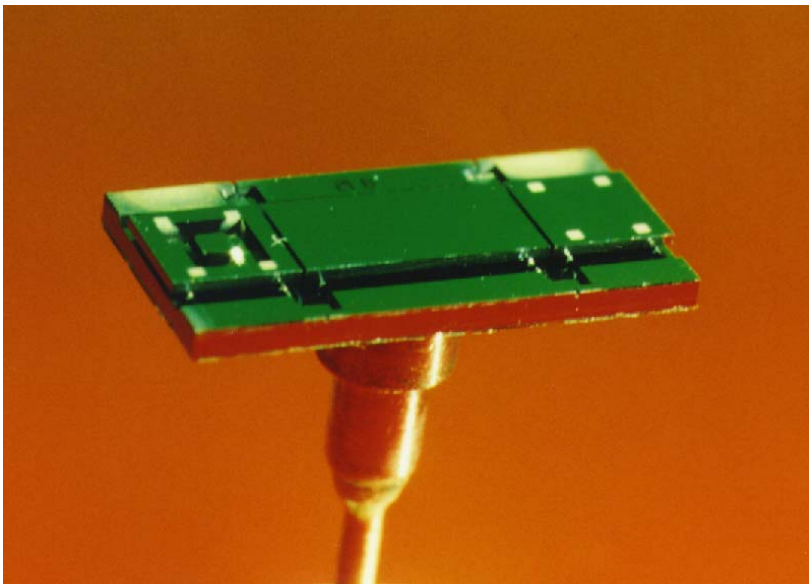
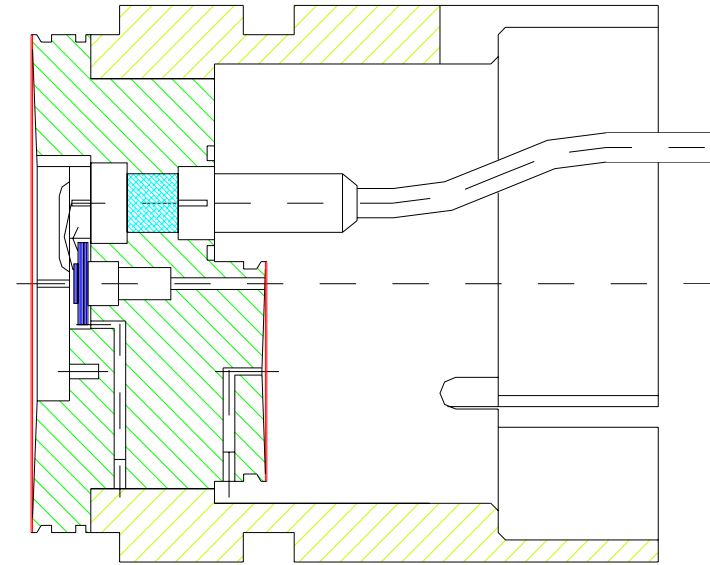
FAC noise analysis

**”System on Chip” leads to minimum
signal connections and maximum
reliability**



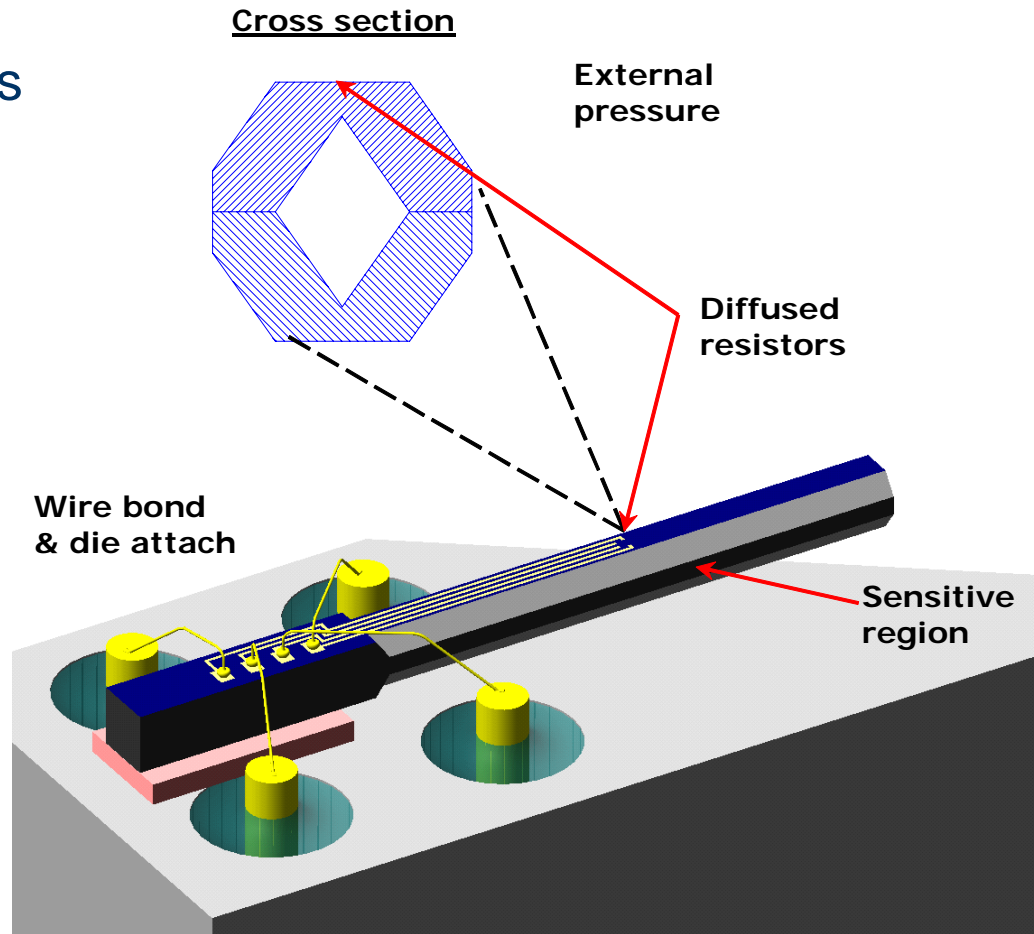
Differential pressure sensor

- A membrane sensor element combined with HTASIC offers mbar resolution at 200°C
- Operates under 1000 bar absolute pressure
- The membrane areas balance the thermal oil expansion



High performance miniature pressure sensor

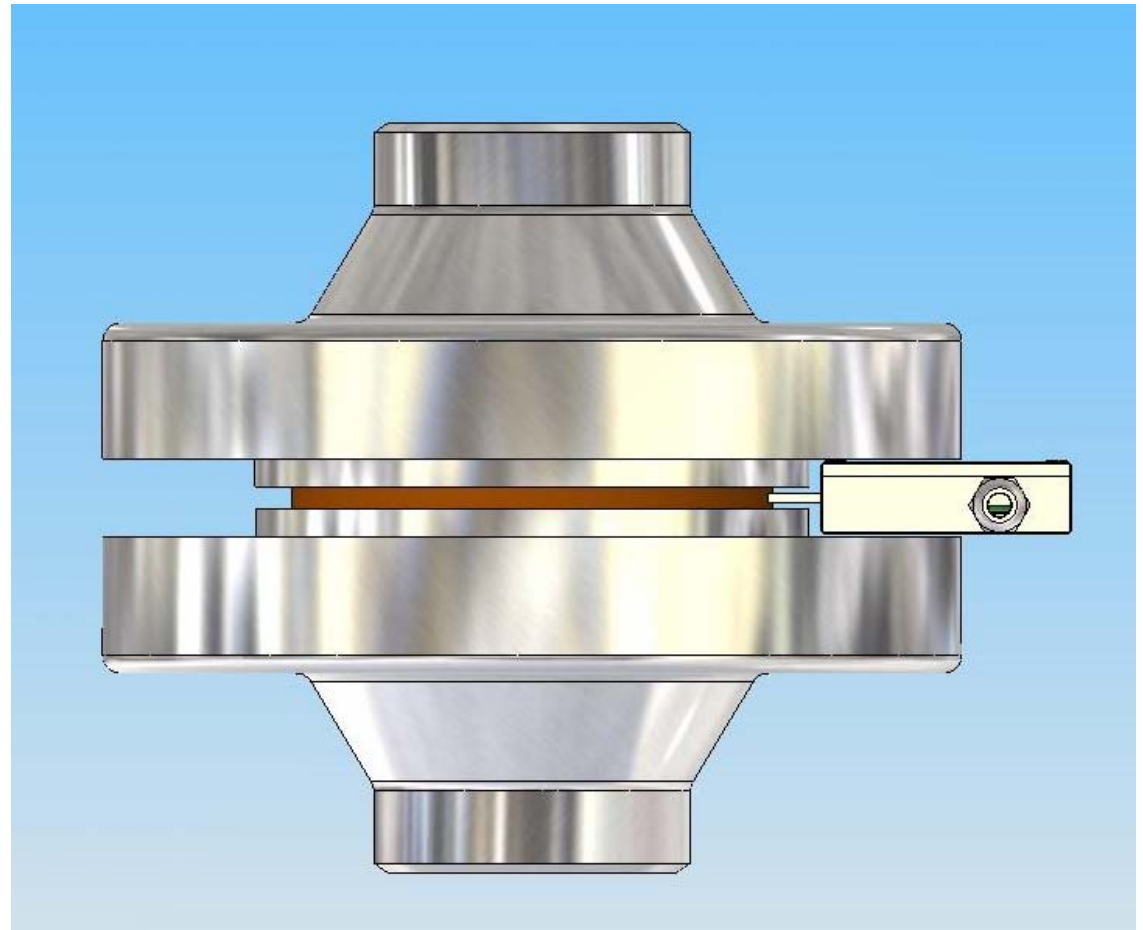
- To be built into small structures
- Low mass leads to high strength
- To be integrated with HTASIC for high temperature performance
- Low power consumption may be realized
- 1000 bar, 200°C
- Accuracy: < 0.01%



Sensor element by Presens A/S

A new pressure/temperature sensor -for the process industry

- High accuracy
- Easy connection
- Gasket replacement
- Compact solution
- Alternative system connections
 - Field bus
 - RS485
 - TCP-IP
 - Wireless LAN
 - 4-20mA
- Sensor element from Presens A/S
- Hydro-patent
(CONFIDENTIAL)

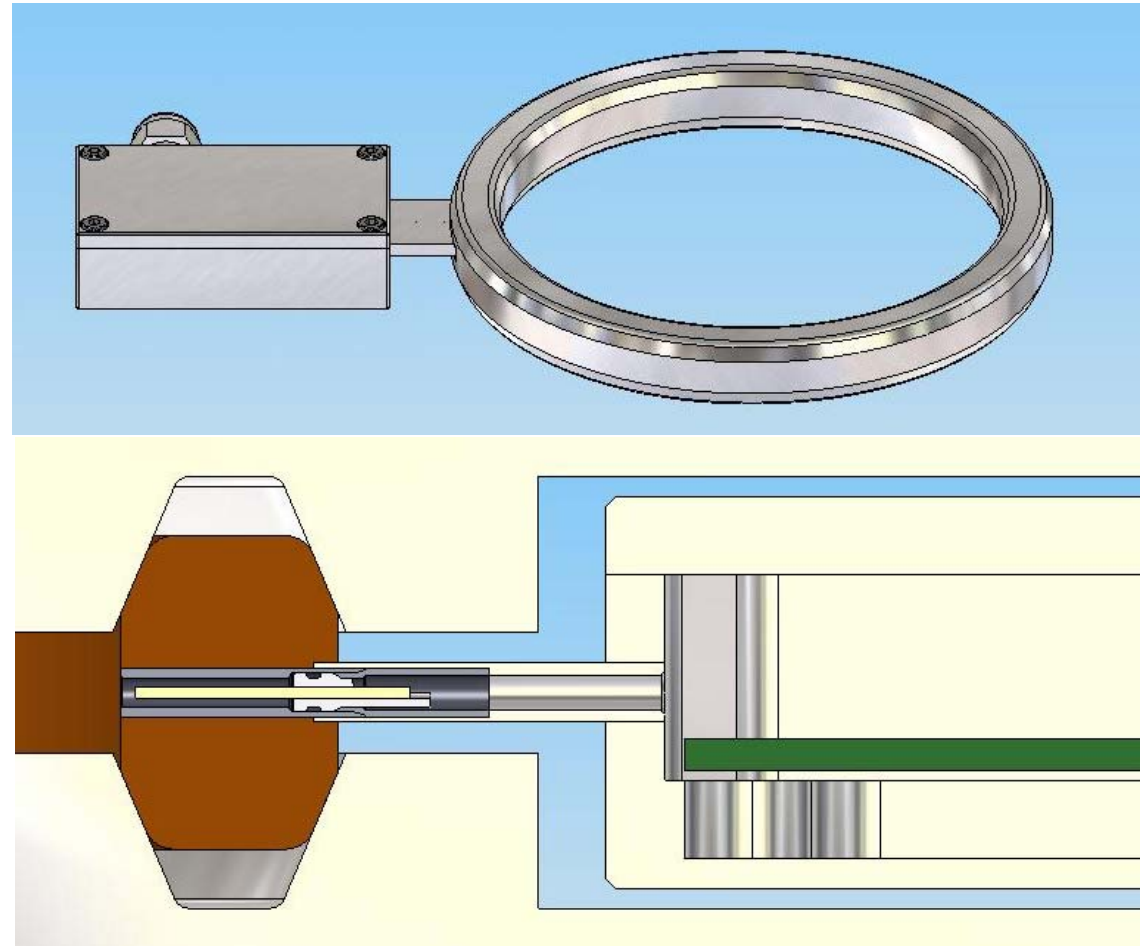


From system design to electronics and packaging (CONFIDENTIAL)

Applications:

Petroleum
Industry

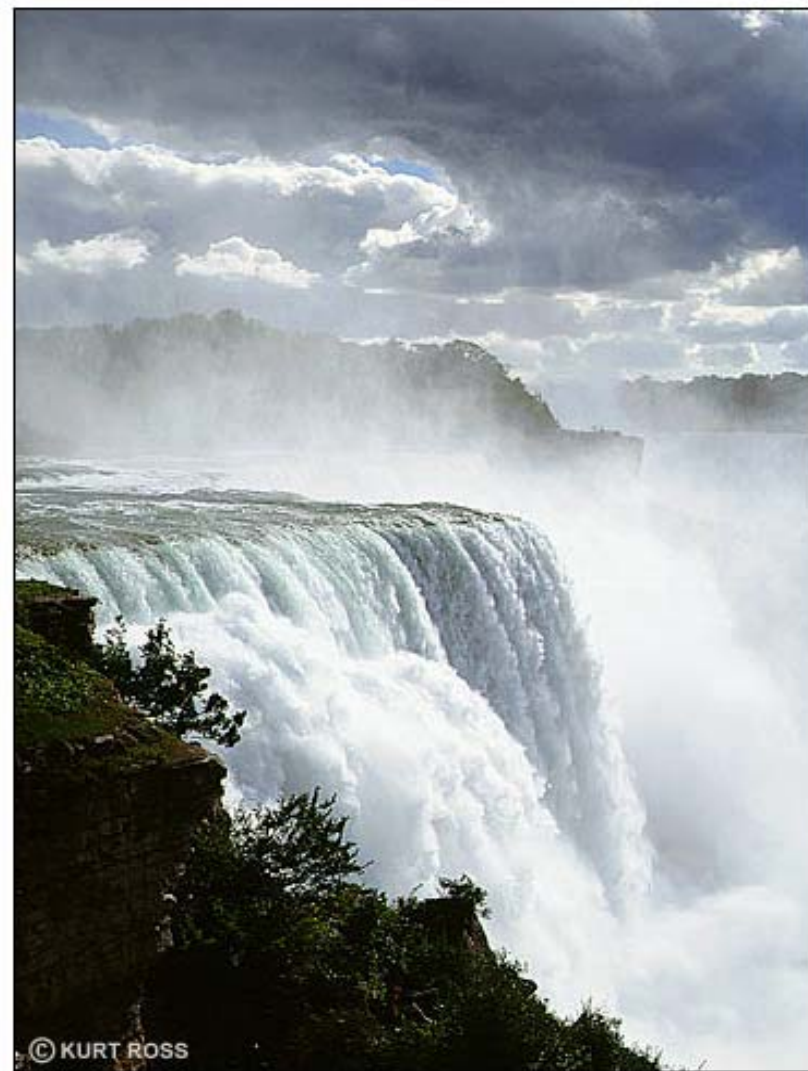
Chemical
Process
Industry



Seeking partners for
international cooperation:
production
sales
and
marketing

Finding power in the well

- Gradients are needed to obtain power
 - temperature differences x heat flow
 - pressure differences x fluid flow
 - natural radiation (very limited energy levels)
- Vibration
 - caused by flow energy loss
 - amplitudes reduce fast when energy is taken out



**Flow energy seems the natural choice: 1litre/sec x 1 bar = 100W
but efficient and reliable energy conversion is needed**

A swimming multi sensor?

A mechanical fish, submarine or well monitoring vehicle, able to move freely in the horizontal part of the well, checking the liquid inflow in several positions. Returning to “base” and reporting the “log” while batteries are charged for a new trip?

