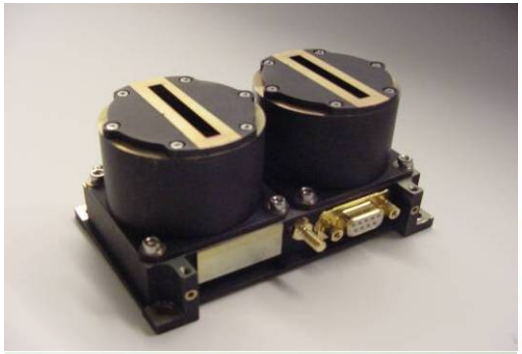
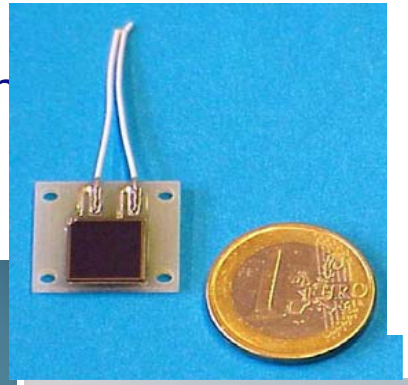
For the mini-DSS it’s the system level that counts

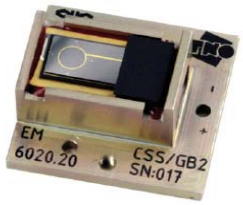
TNO | Innovation for life

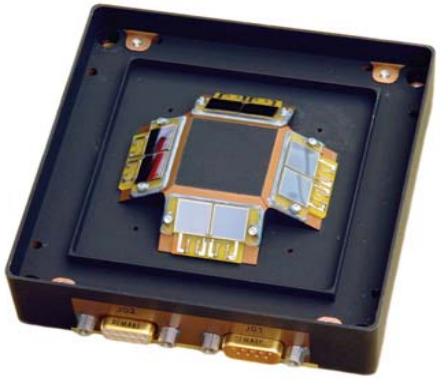
ESA MNT workshop

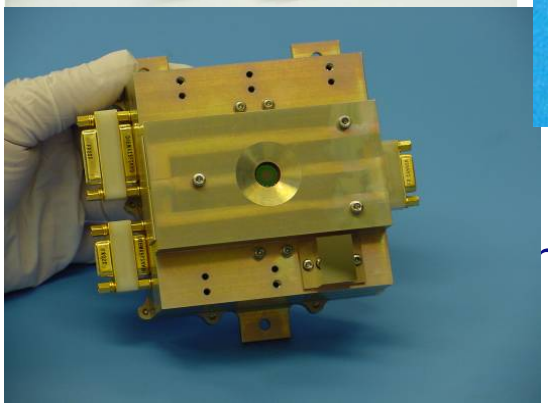
TNO's current portfolio

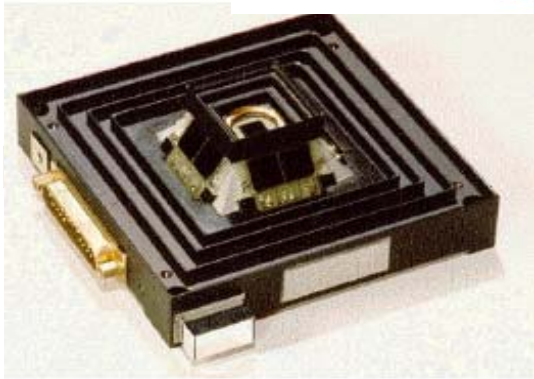




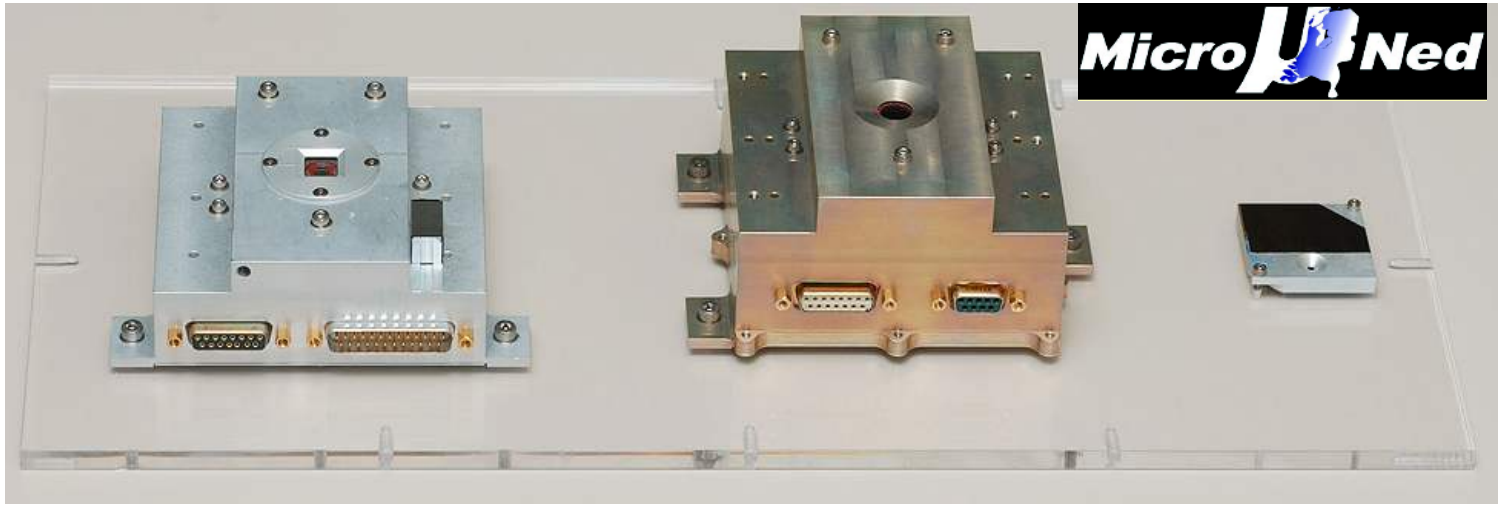




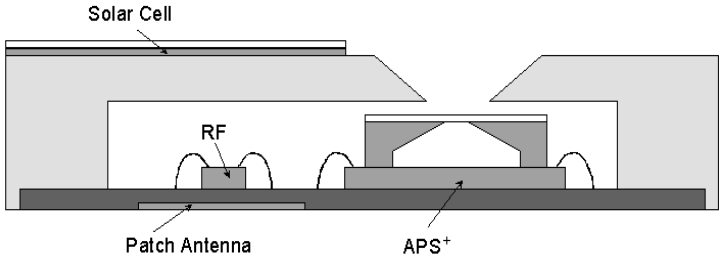




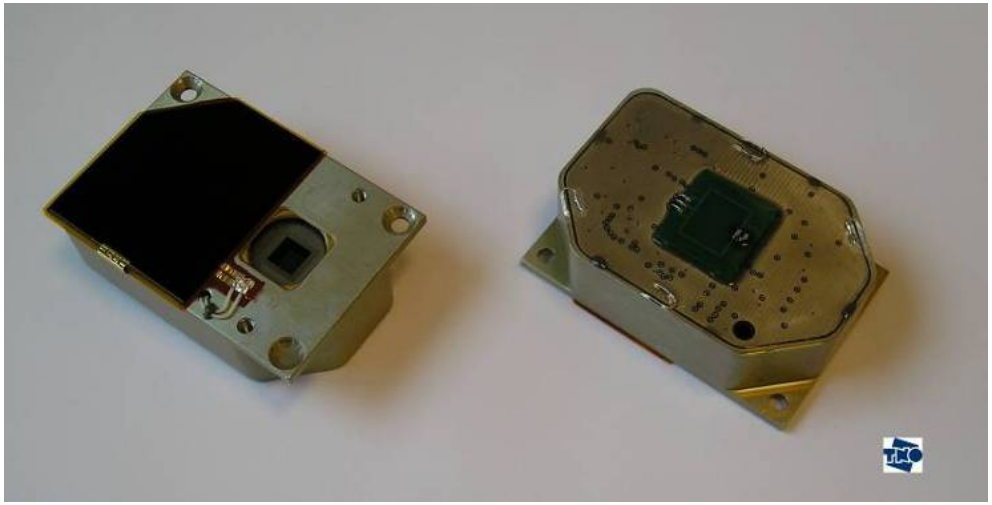
Start of the miniaturisation within Microned



- Autonomous micro-digital sunsensor
  - Autonomous power
  - Wireless link
  - MEMS based



Deliverable 1
Autonomous wireless sunsensor



Flying

Autonomous Wireless sunsensor flying on Delfi-C3 Cubesat from TUD

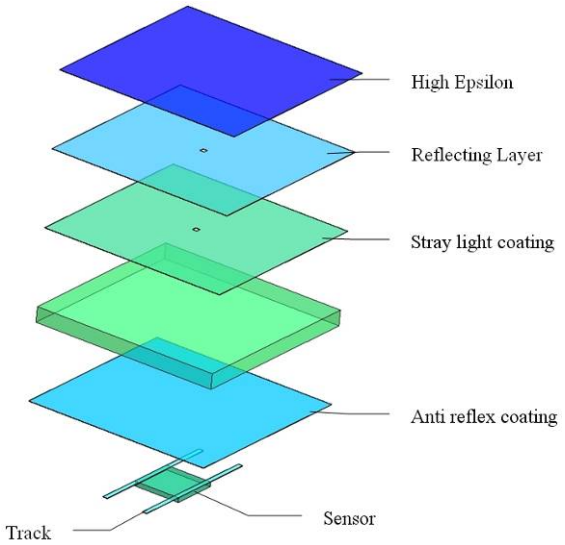
- Weight saving
- Ease of accommodation
- Remote monitoring
- Multiple receivers possible

Deliverable 2
IMMERSED Technology Demonstrator

Ready and working

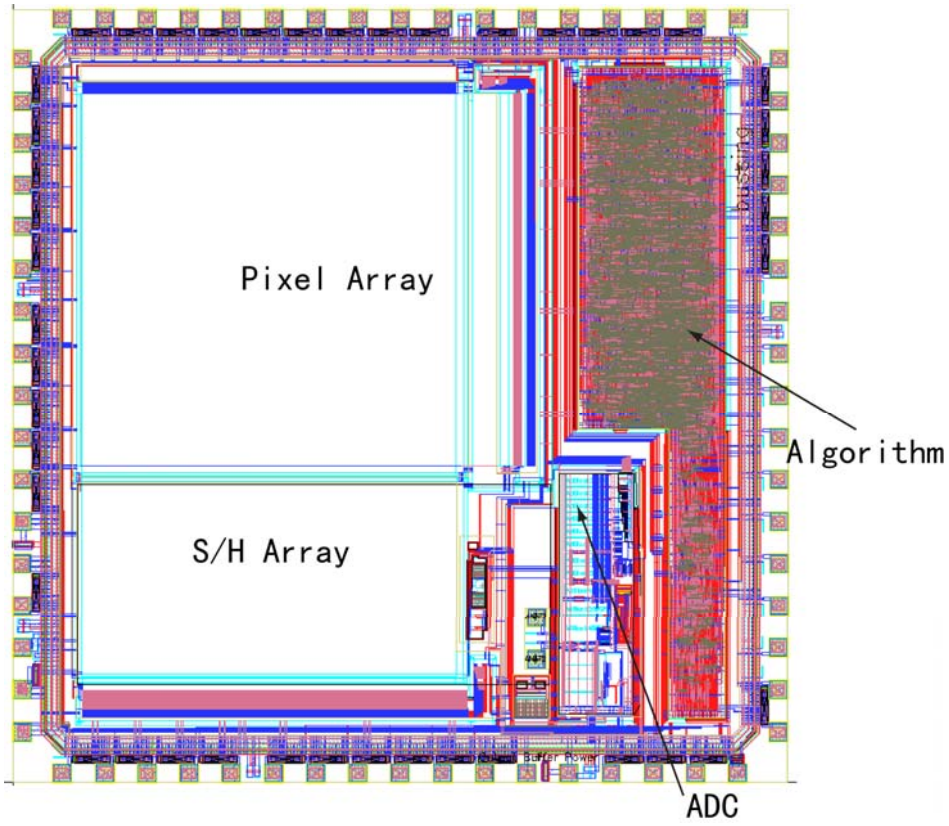
- Motivation: Demonstration of mastery of immersed technology – stepping stone to miniature autonomous SS

- Combination of functionalities
  - Carrier for mask and detector
  - Spacer
  - Radiation shield
- Wafer scale manufacturing



Deliverable 3
APS+ chip

- Single chip sunsensor
- Optimised for low power
- TSMC 0,18 micron process
- Last spin-out 5th May
- Chips received 23th of june
- First results today



Further steps

- Market survey
  - autonomous wireless two bridges to far
  - Add autonomous powering afterwards
  - Wireless nice research topic but not mature enough (yet)
  - No need for the smallest possible sunsensor (yet)

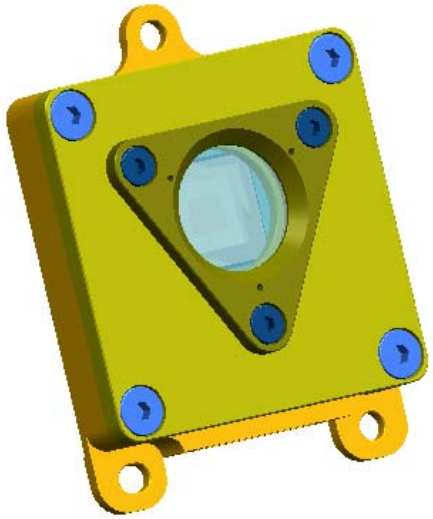
  - **Low cost of prime importance**

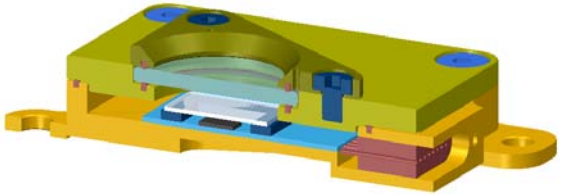
Mini-Digital sunsensor

Future developments : Miniaturisation
NSO ASSET program

- Mini-DSS

- Aluminium housing
- Hermetic
- Automated assembly
- Low power
- ± 47 degrees FOV
- 0,1 degree accuracy goal
- 52*51*14 mm³
- <100mW (est.55mW)





N.B. not autonomous, not wireless
Noise on position measurement measured on APS chip 0.004 degrees

Low power and ±47 degrees field of view

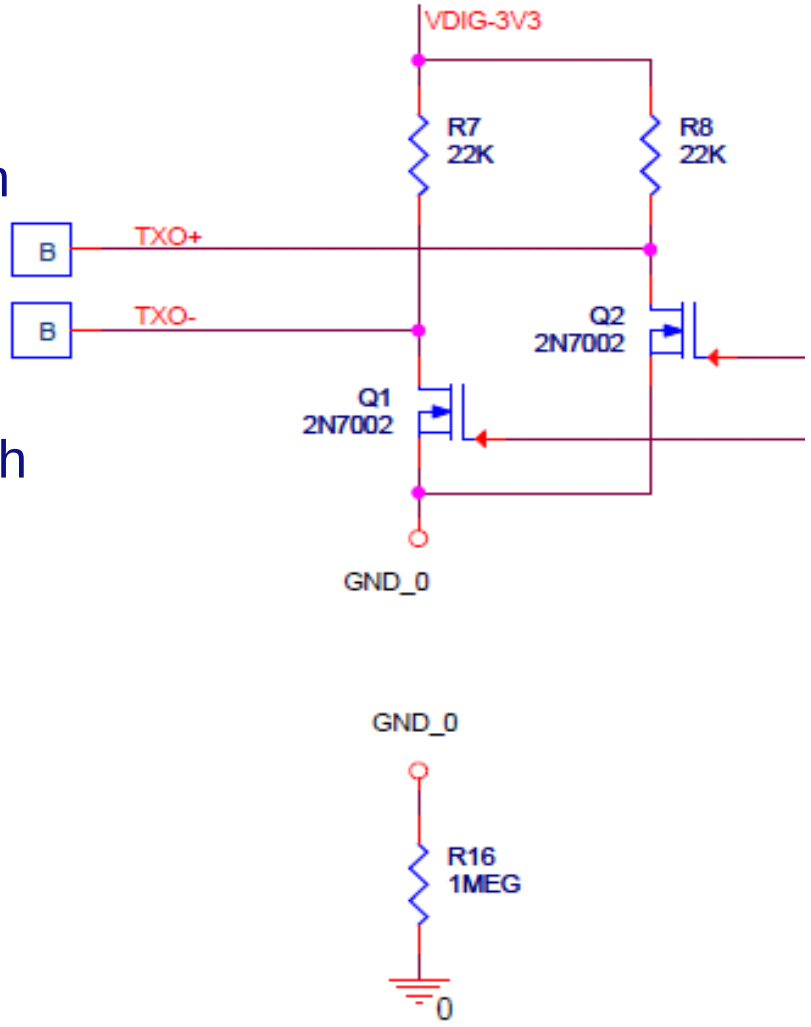
- APS+ power optimised
  - 21.34 mW acquisition mode measured
  - 21.40 mW tracking mode measured
- Support circuits optimised for low power
- DARE without DARE library
- Low power digital interface circuit
- Majority of power consumption in the linear regulators
- ±47 degrees field of view allows solar power supply without large solar cell.

harvest imaging

TU Delft
Delft University of Technology

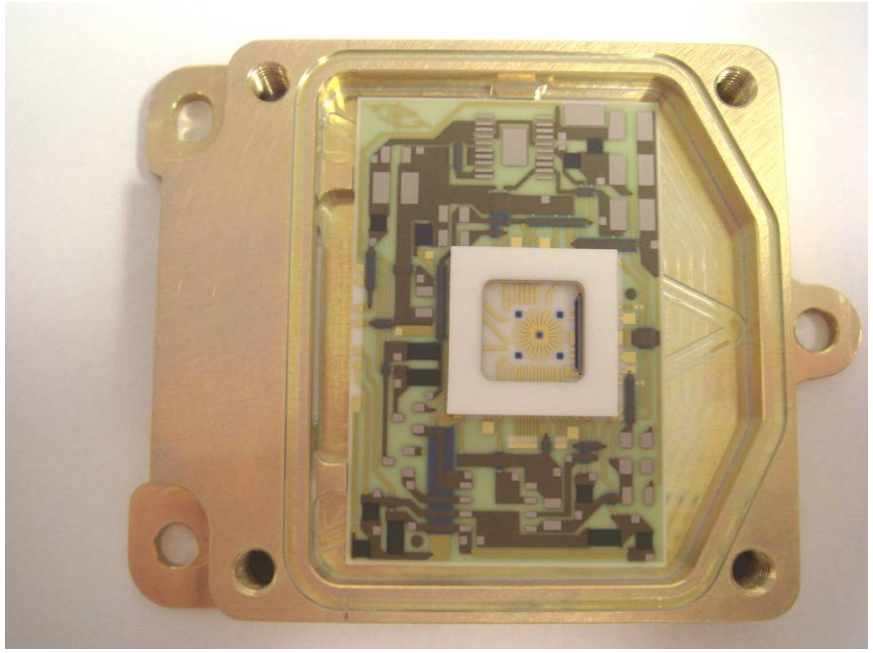
Weak pull up to save power on the interface

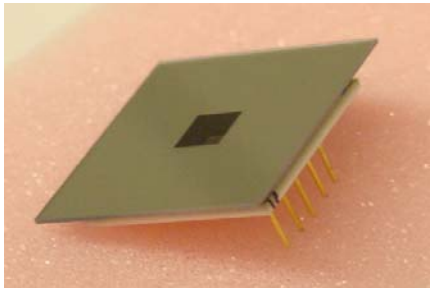
- 3.3V digital output
- Enough pull up to give signal on an oscilloscope or short lines
- Higher current capability with external pull-up for long lines
- Higher current will not give much extra heat in the sensor.
- Sensor floating with respect to housing to allow for SPDG
- 1Meg bleed resistor to avoid charging



Automated assembly

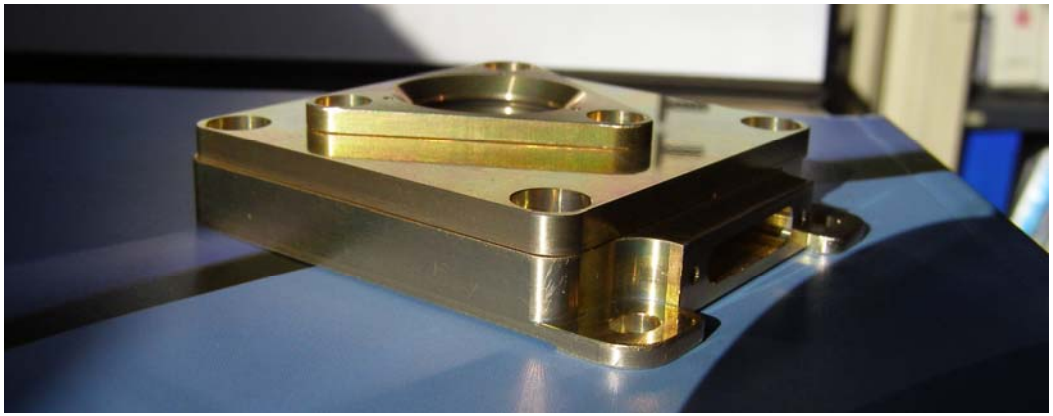
- All Al2O3 sensor core
- Directly referred to reference holes of package
- Allows for simple and cost effective manufacturing
- Vision based pick and place for highest non calibrated accuracy





Aluminium housing

- Semi hermetic through integrated seals
- Integrated connector with single row micro-D pins
  - Bondable pins space qualified for spacewire connectors
  - Grommet material space qualified
  - Less parts
- Non magnetic
- Allows for automated assembly through pick and place
- Easier to machine and therefore more cost effectively produced



Comparison DSS and mini-DSS

	DSS	Mini-DSS	Ratio	remarks
Size	132*110*62mm^3 943,8 cm^3	69*52*14mm^3 50.2 cm^3	18.8	
Weight	475 gram	<50 40	9.5 11.9	
Power	1.4 W	100mW (55 mW)	14 25	DSS at 28V unregulated Mini-DSS @5V
Accuracy	0.02° 3σ	0.1° 3σ	0.2 1	Measured noise mini-DSS 0.004°

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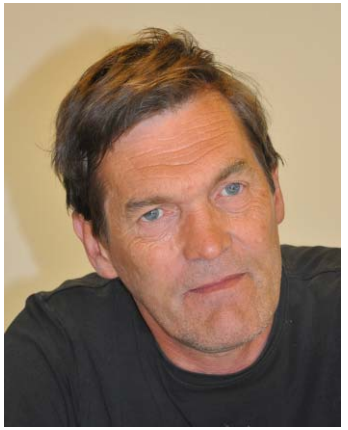

Jacob Jan van der Velden

Conclusions

- MEMS based intelligent sensors offer advantages at systems level but a small sensor doesn't automatically make a small system
- High reliability low power and high rigidity systems can be used for many missions and are bound to change the procurement landscape.
- The mini-DSS is an example of a system optimised sensor which has led to a system which is significantly larger then possible.

What we hope to have proven is:

For small sensors, it's the system level that counts

Thank you for your attention.

For further information

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