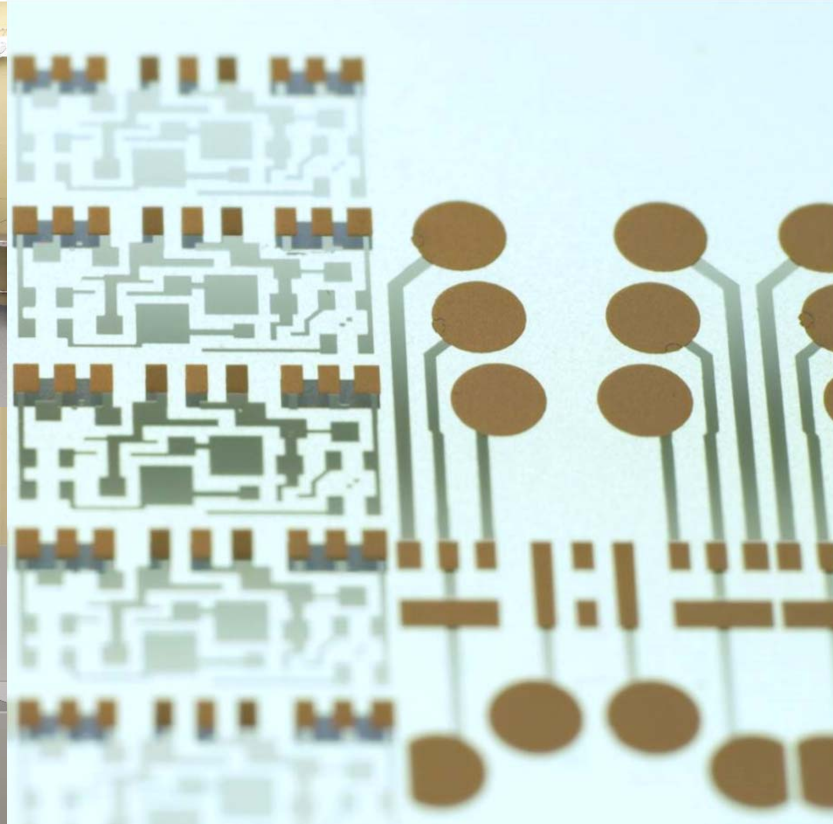
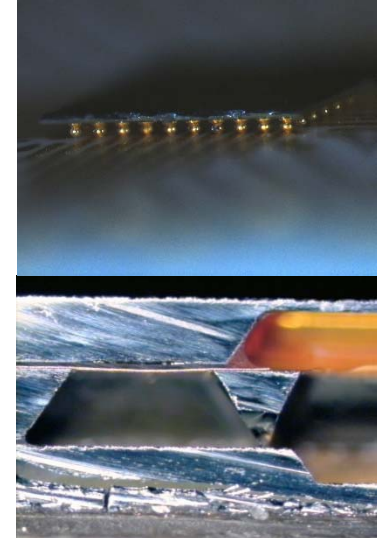
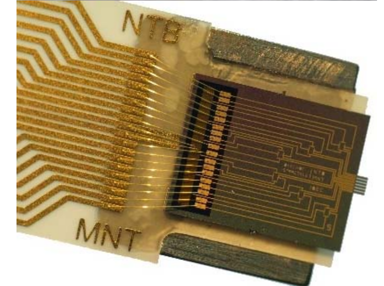
NTB

Interstaatliche Hochschule
für Technik Buchs

FHO Fachhochschule Ostschweiz

Institute for Micro- und Nanotechnology

Industry-Driven Packaging

Solutions for delicate devices in harsh environments

Näher dran
am System
der Technik
der Zukunft

NTB / MNT: Our point of view for packaging

- Typical industrial projects
  - The industrial partner typically would like to do things using his own capabilities, equipment and expertise
  - The innovation has to come from an optimised, modified or newly combined process. New processes should only be used when it is absolutely necessary
- Start thinking about dicing, packaging and capsulation before you start
- Optimisation and unusual combination of "known" processes and / or materials as key issues
- Deep understanding of the processes and materials in use including the machine park
- Think about thermal issues (hierarchy, max temperatures…) and environmental issues (humidity, corrosive atmosphere, temperature…)
- …and finally pushing process limits (ask the engineers / operators what is still practicable)

Common sense in packaging?

- Surfaces are responsible for bond ability.
- When using thin films the bulk has to be taken into account.
- Thin films can be consumed during some of the bonding processes (eg. soldering)
- When using different joining partners the CTE's have to be adjusted / matched, or tensions have to be taken into account
- The thermal hierarchy has to be maintained / secured
- Layers on Chips:
  Al, AlSi, TiPt, WTiAu, WTiCu, TiAgAu, TiCu, WTiNiAu,...
- Layers on PCBs:
  Cu, CuSn, Sn, CuNiAu, CuNiPdAu, Au, ASiG, ENIG, NiPIG,...

Applicable technologies for bonding

Welding
- WIG TIG MIG ~ melting temp.
- Electron / Laser Beam ~ melting temp.

Reactive Foils ~ melting temp.

Soldering
- Brazing ~ 500 – 1300°C
- Soldering ~ 120 – 400°C
- Glas solder ~ 350 – 800°C
- Thin film solder ~ 120 – 1300°C

Anodic bonding ~ 400°C
- Thermo compressive bonding
- Anodic bonding

Fusion bonding > 400°C

Ultrasonic bonding
- Wire bonding
- Thermo sonic bonding

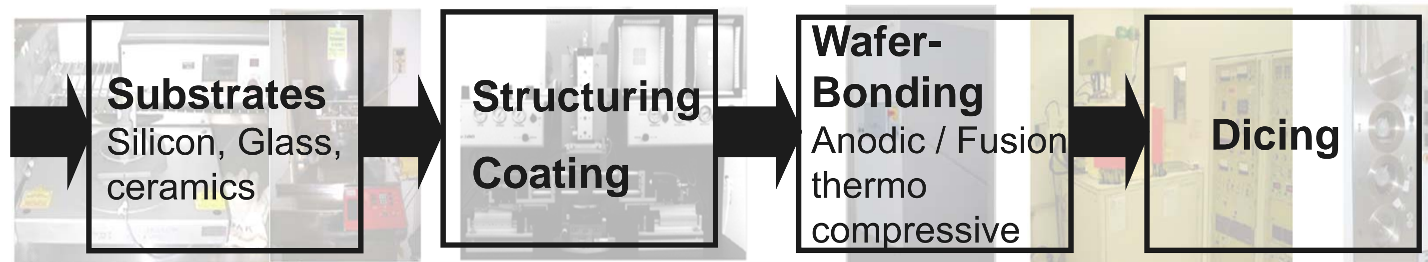
Electroplated growing

Adhesive bonding: RT – 600°C
- Epoxies / Acrylates
- Silicones
- Cements

Mechanical joints
- Screws
- Bolts / Rivets
- Clamping

First, second, third, ... – level packaging

1st Level Packaging

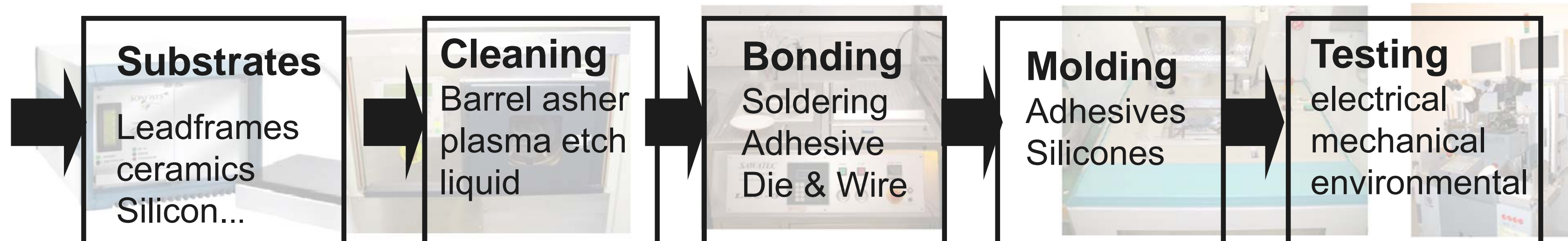


Analytics

REM & EDX | Cross sectional preparations | X-Ray | Profilometry

Shear & tensile strength | Electric testing | XRD / HRXRD

2nd , 3rd ,… Level Packaging



Optical pressure gauge @ high temperatures (I)

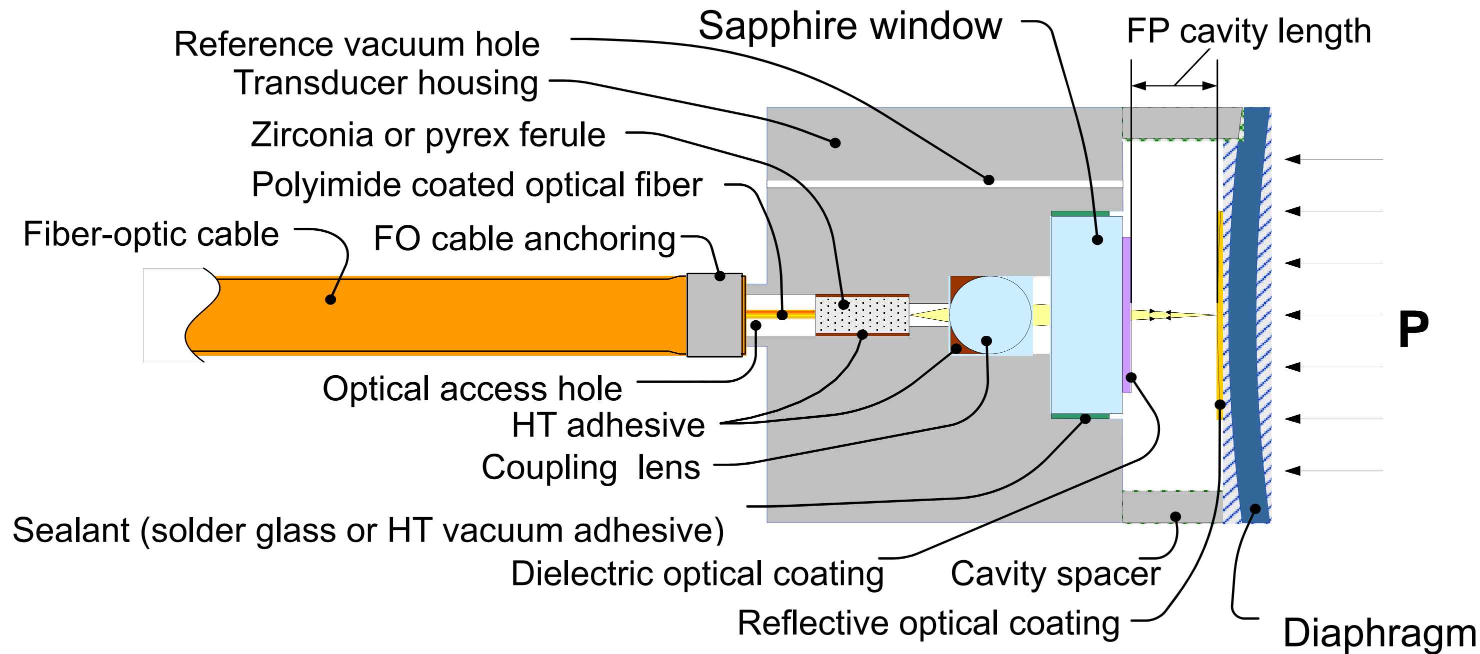
Specifications:

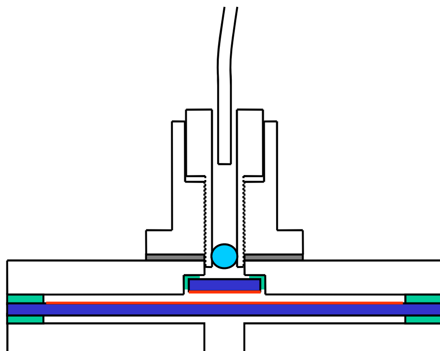
Measurement Range:	1..1000 Torr
Accuracy:	0.25% of reading
Temp. effect on zero:	0.005 % of F.S./°C
Sensor Temp.:	max. Sensortemp. +50°C
Resolution:	0.0005 % of F.S.
Operating Temp.:	150ºC .. 300ºC
Warm-up Time:	<180 Min

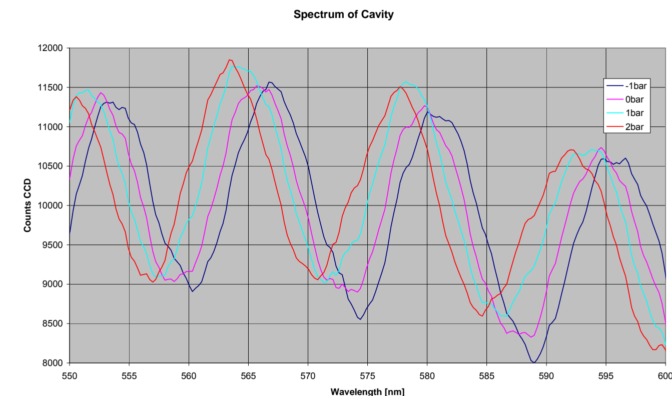
CDG gauge

Use base technologies from the CDGs.
If possible also a similar design.

Optical pressure gauge @ high temperatures (II)



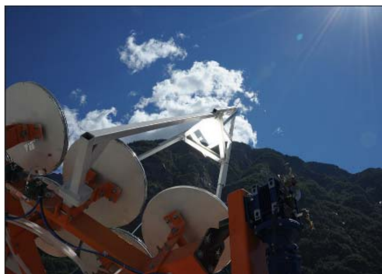


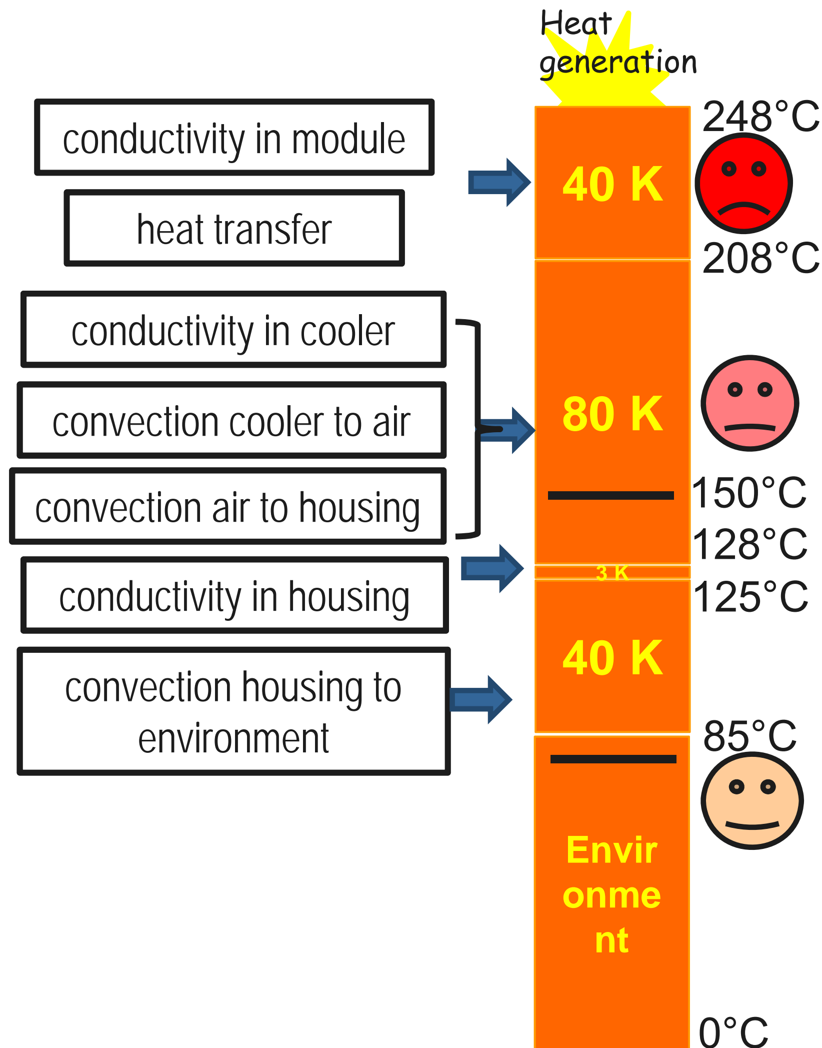


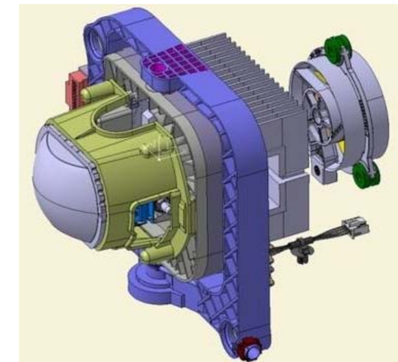
Why thermal management

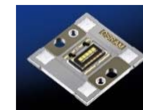
Solar Cells

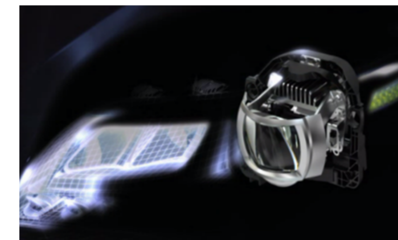
LEDS





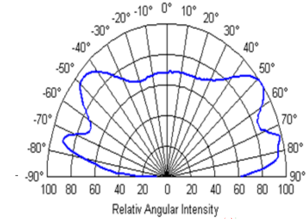


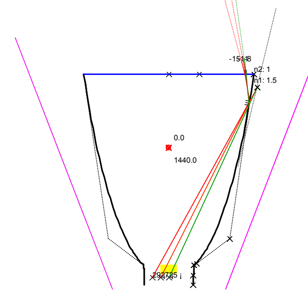


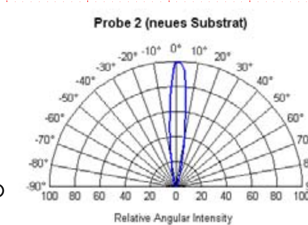


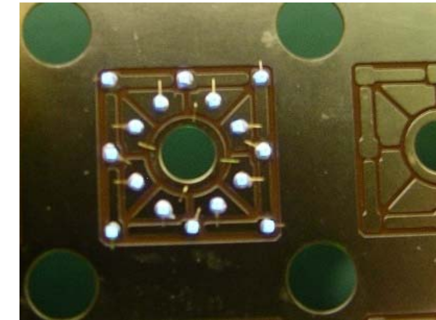
LED Panel I

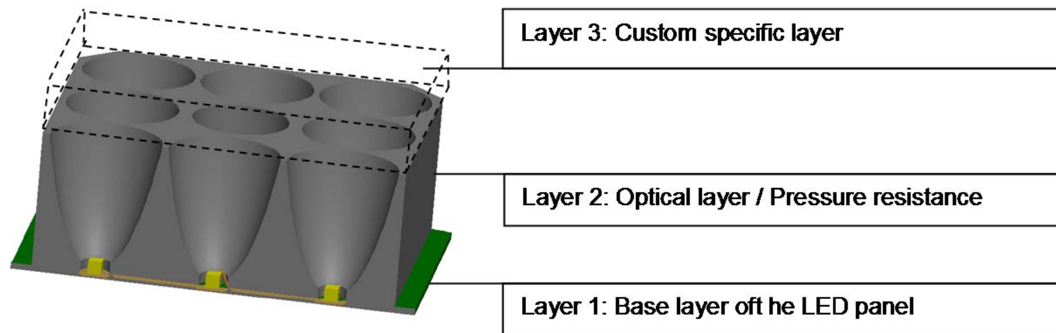
Max. thickness:	<5mm
Pressure resistant:	min. 15 N/mm^2
Max. temperature:	100°C (continuous)
Min. temperature:	-40°C
Sealed package:	hermetic (gas-, water)
Power supply:	<50V DC
Isolation:	isolation using cover
connection:	simple cable...
Optical characteristic:	no bundling up to ± 10°
Bending of panel:	0 to 90°

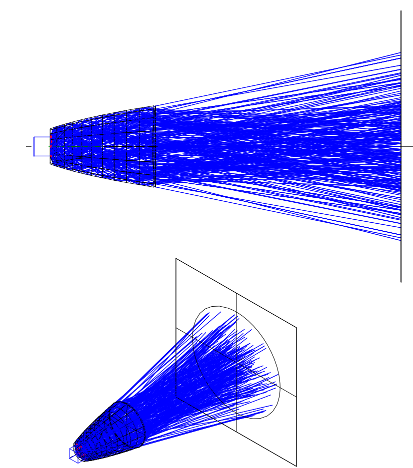




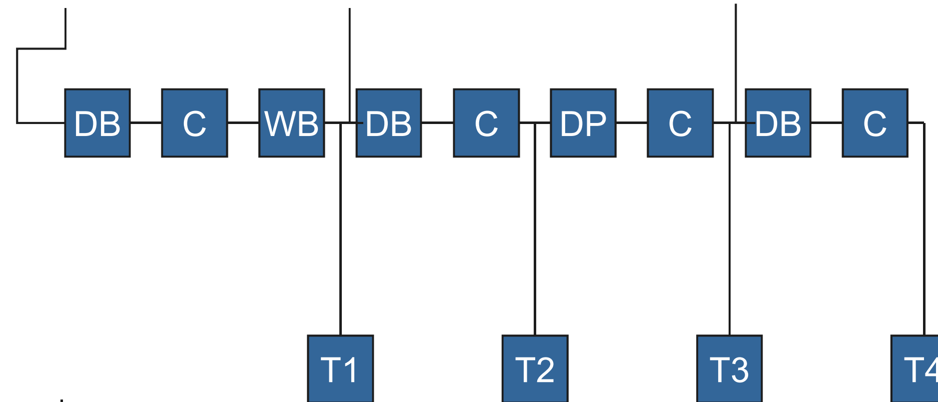


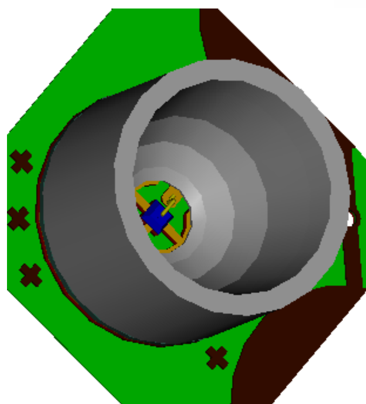


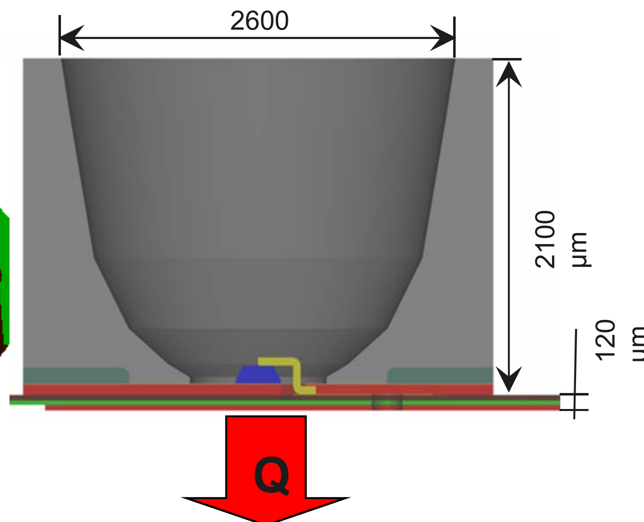




LED Panel II





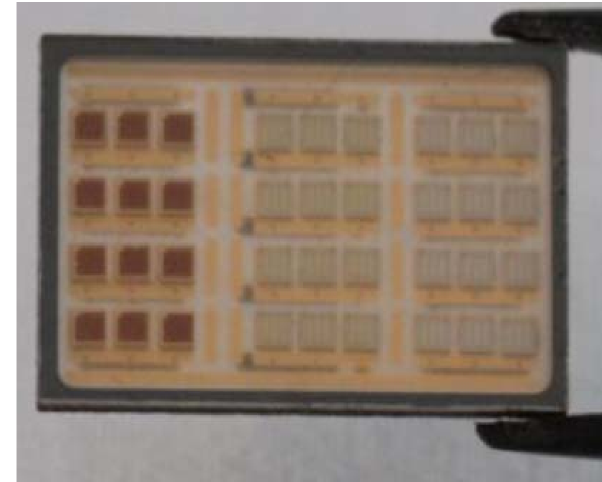


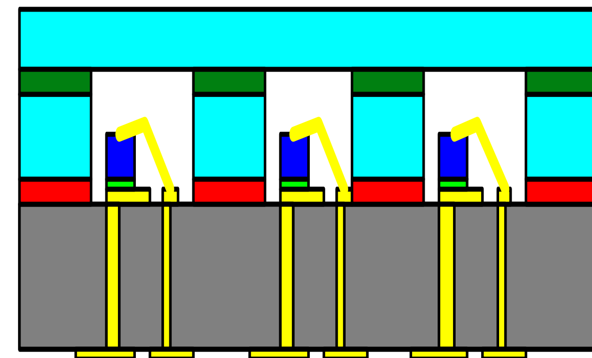
DB	**Die Bonding**
WB	**Wire Bonding**
C	**Curing/Soldering & Cleaning**
DP	**Dispensing**
T1-4	**Testing**

Altatec Microtechnologies AG I

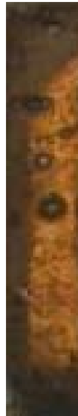
- Hermetical, autoclave able, package for LED bare dies.
- Repeated temperature cycles to 134 °C ; pressure 0.3 to >2.5 bar @ 100% humidity.

Specifications	
Autoclave cycles	Up to 2000cycles @ 134 °C pressure >2 bar 100% humidity
Dimensions (l x b x h)	<3mm x <3mm x <2.5 mm
Biocompatibility	No toxic substances
Optical Transparency	>90 %
Thermal coupling of the LED to the substrate	
Mass production must be possible	
SMD process has to be possible	Soldering 220°C for 30 sec.
Package shall allow other devices than LEDs	Temperature sensors, different colored LEDs, photo sensors, camera chips, ...



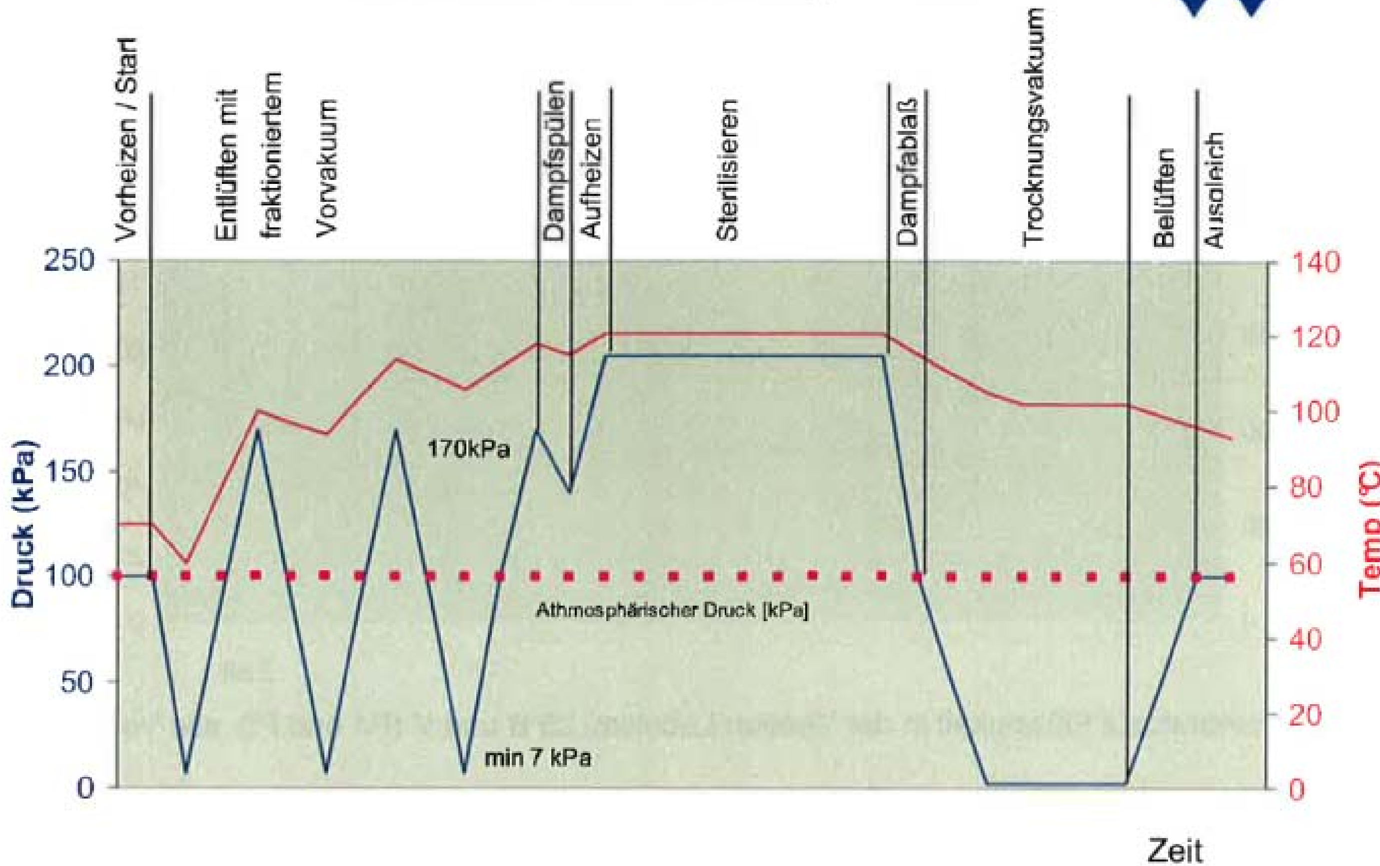


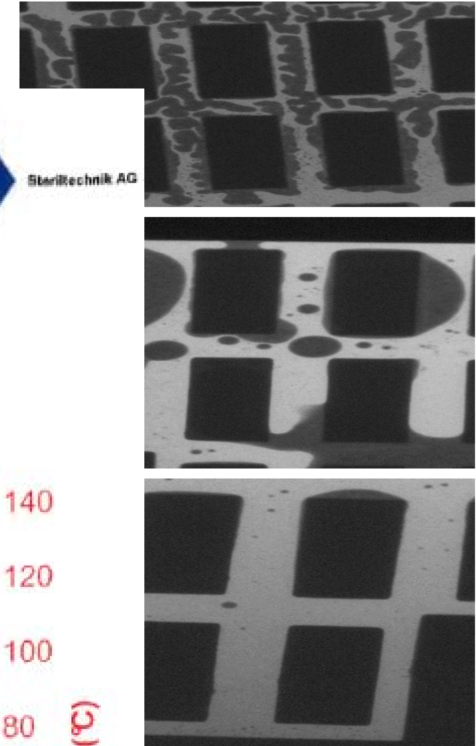
Altatec Microtechnologies AG II

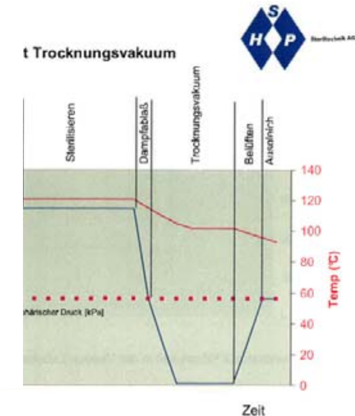


No
de

OK
cavity after 4250 cycles

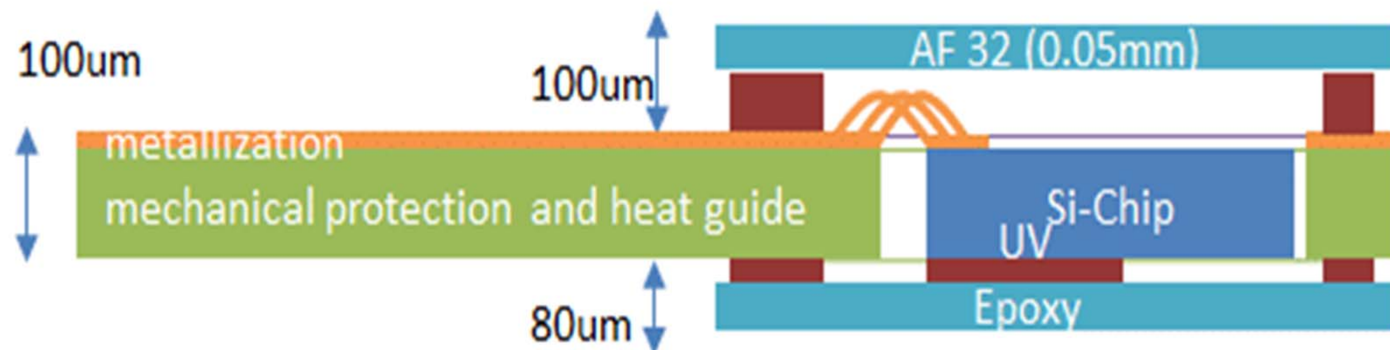




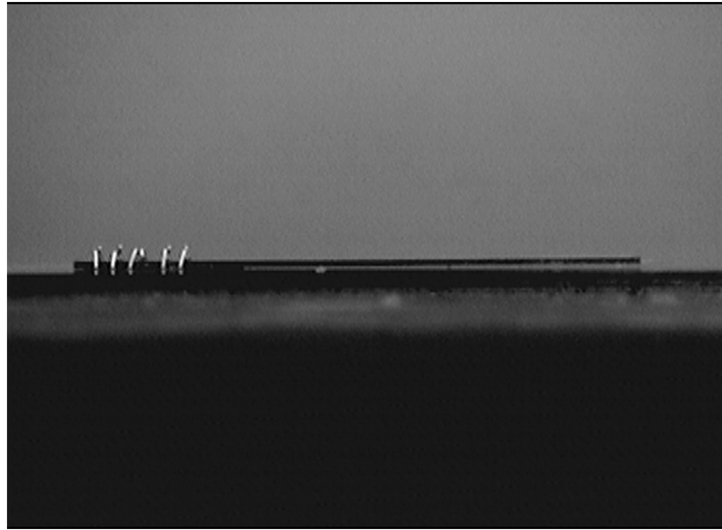


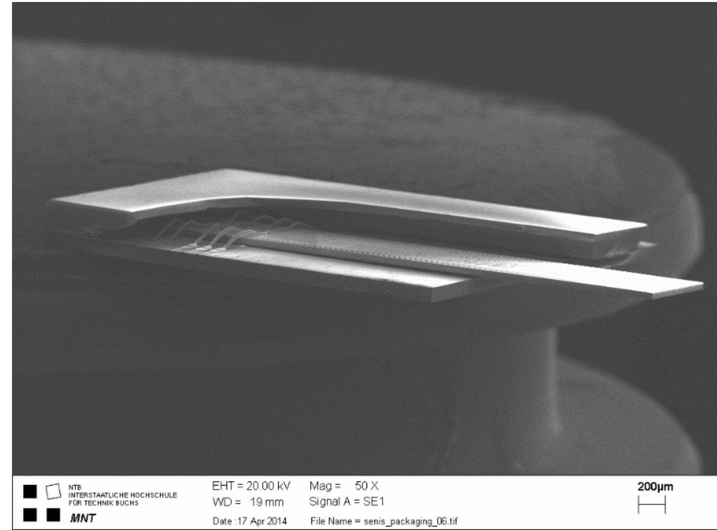
Thin hall Sensor I

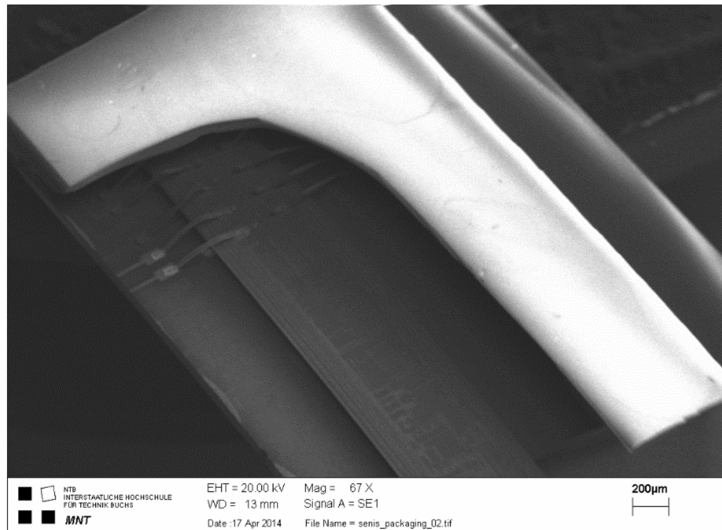
- Thickness ≤ 0.3mm, width ≤ 2mm, length (of the stiff part) ≤ 15mm;
- Thermal conductivity sensor chip – environment, power dissipation of about 60mW with a smallest possible temperature increase of the sensor chip
- Relative permeability of materials: 1+/-10^{-5}(max) ➔ no ferromagnetic material
- Minimize bonding stress and thermally induced stress in the transducer
- Probe body and support as stiff and strong as possible
- Thermal range: at least -40°C to 85°C

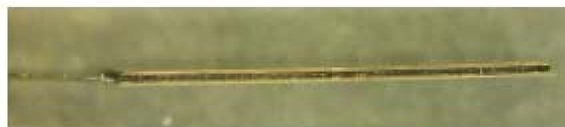


Thin hall Sensor II









Optical Titration Sensor I

- Usage of known EOCB-Technology for sensor application
  - Cheap
  - Easy to use
  - Automated manufacturing
  - LEDs: usage of large light guides with big cross section (400 x 500 µm²) ➔ no discrete modes
- Hermetically closed housing (glass cylinder)
  - Recess for measurement cavity
- Compatible to already enabled lab instruments (holders etc.)
- Optical and electronic systems on one board
  - compact
  - fast

NTB
Interstaatliche Hochschule für Technik Buchs
FHO Fachhochschule Ostschweiz

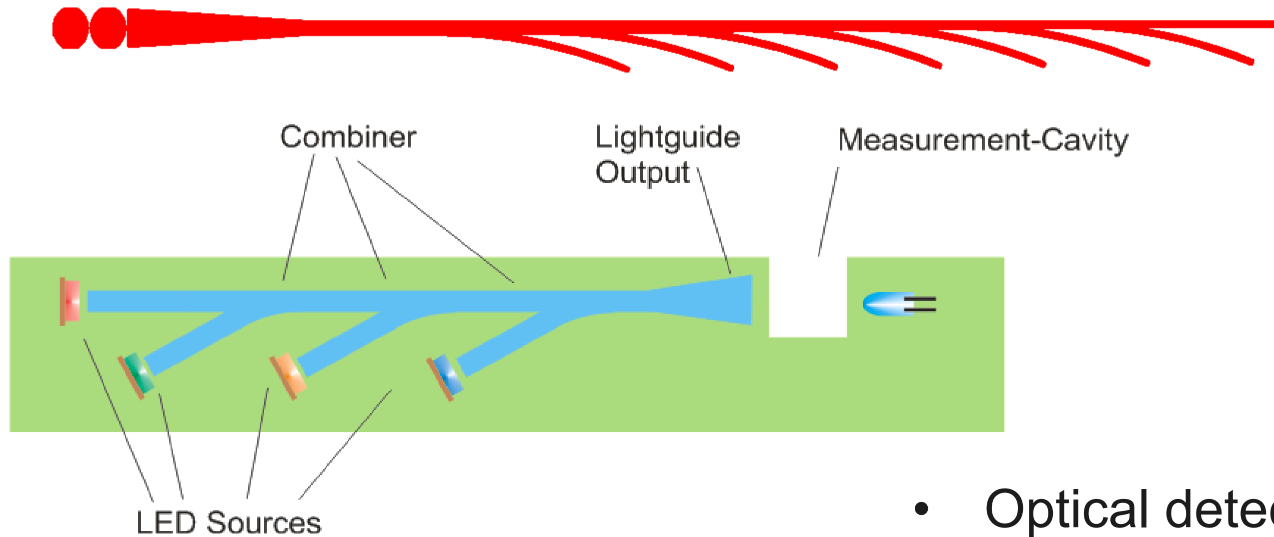
vario-optics ag

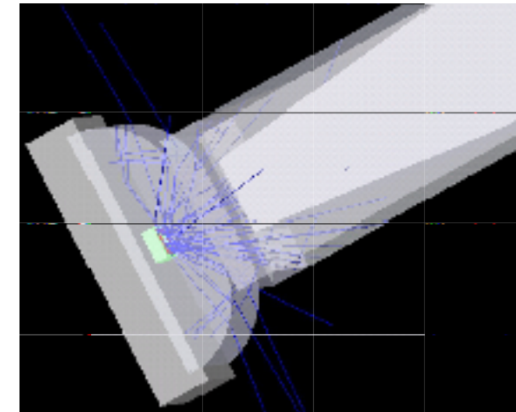
Metrohm

MNT
Institut für Mikro- und Nanotechnologie

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Förderagentur für Innovation KTI

Optical Titration Sensor II



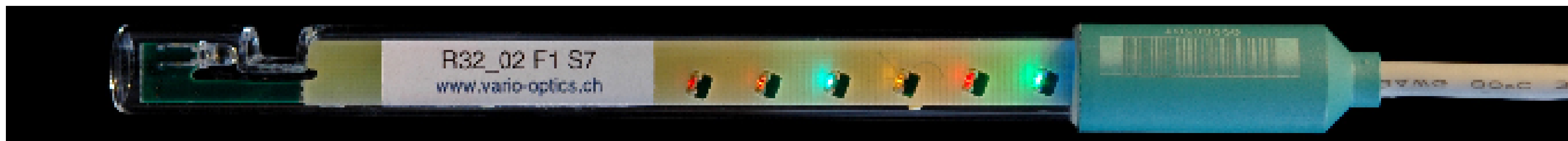


Product application:

Fast pH measurement

Measuring of coloration of fluid

- Optical detection of color change
- 8 different wavelength in one path
- Light guide embedded into PCB
- Measuring cavity 7 mm

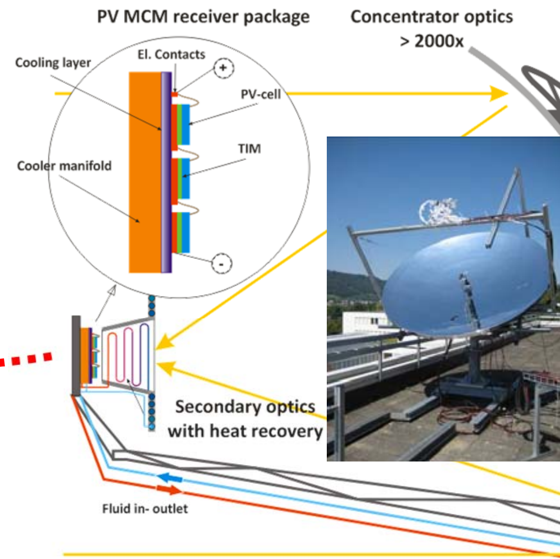


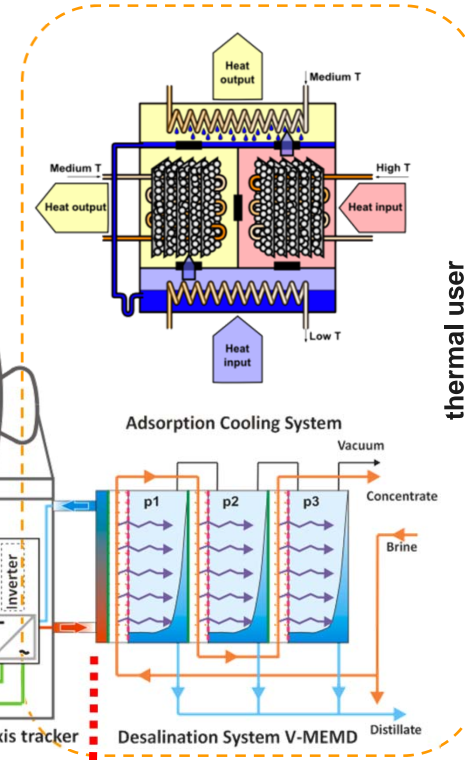
HPCVT I

Overall System Yield 80%

Exergy recovery fraction from sunlight 50%

Radiation input
850 W/m²
for 7.1h / day





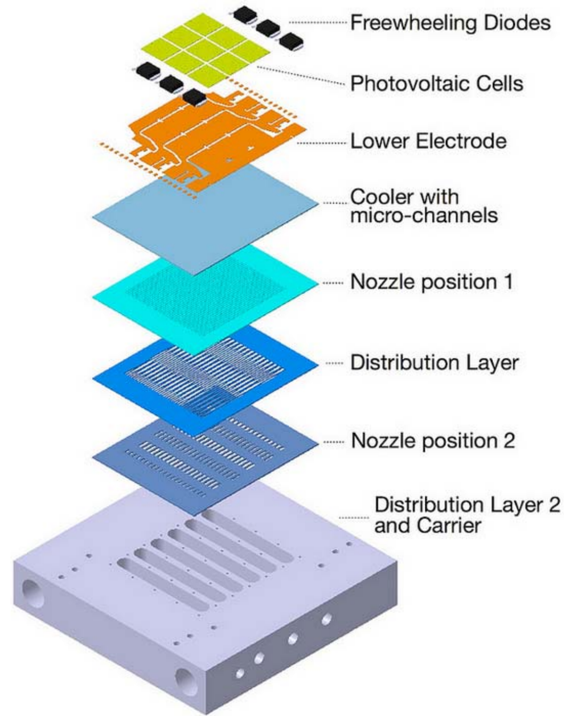
Receiver technology:
Multichip package with 10x lower thermal resistance concentration up to 5'000x and improved lifetime of >25 years

Loss in optics 20%

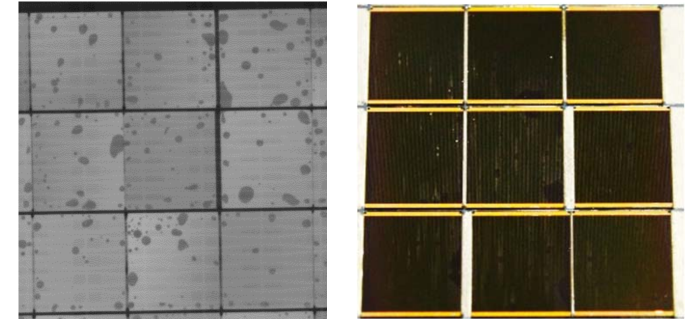
Electrical yield 25%
204 W/m² using triple junction chip
Potential for long-term improvement to 35%

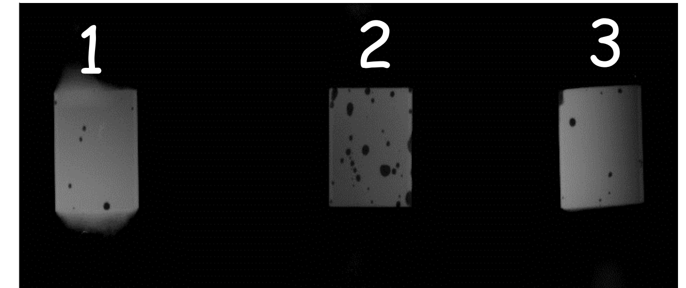
Thermal yield: 55% 460 W/m² converted to:
Cooling **yield of 1.3 kWh/(m² day)** with a COP of 0.6
Desalination **yield of 30 l/(m² day)** with GOR of 7

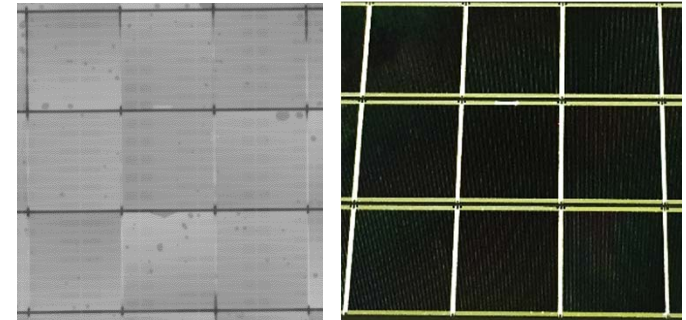
HPCVT II

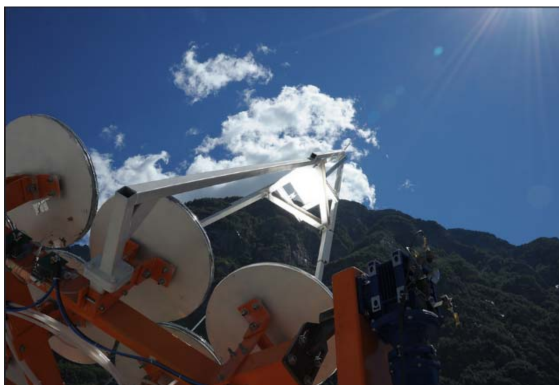


Progress









Conclusion

- Innovation can come from optimization and combination of “well-known” processes
- Keep systems simple (as long as you can ☺)
- Try to stick to established processes
- Think about the *packaging* of parts when you start designing (this can save you a lot of money ☺)