



Review of potentially new products

Contract 4000117402/16/F/MOS
Finnish technological capacities with
regard to ESA opportunities

Products

- Coating at Diarc Technology Oy
- ALD coating at Picosun
- Grating plates for UV-X-rays by using e-beam lithography at Finnlitho Oy
- Optical film at HS Foil Oy
- Advanced optical sensor at Pixpolar Oy
- “Black silicon” company
- Timegate Instruments Oy
- Radiation sensors (Medipix) at Advacam Oy
- Debris monitor at Ruag, SSF and OIA
- Low power processor at Minima Processor Oy
- SI based MEMs oscillator at Tikitin Oy
- CubeSat at Reaktor Space lab Oy



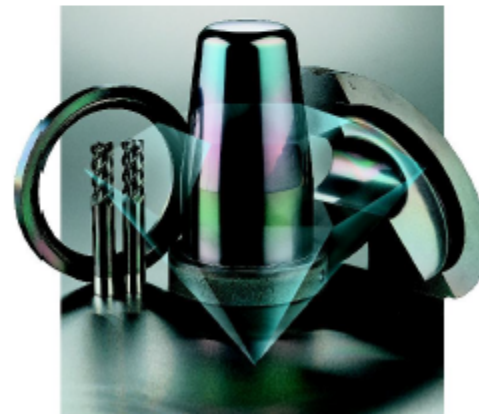
smart surface solutions

DIARC-Technology

DIARC-Technology Oy is specialized in manufacturing of thin film coatings based on DIARC's unique FCAPAD method. Since 1993 it has been successfully applied on several customer applications.

The success is based on smart surface solutions which directly improve competitiveness of our customers.

Active research and development together with our customers keeps us in the front line of thin film material development.



FCAPAD = Filtered Cathodic Arc Plasma Accelerator method

Diarc Technology Oy

- Company: SME, 15 people
- Strength: Unique coating technology, plasma assisted coating. Company's in house developed reactors.
- Markets: Multiple industries
- Application areas: components, tools, functional (adaptation, joining, intelligence surfaces, protection), decoration, energy technology
- Experience in space: Regular deliveries to Patria for special coatings to improve adhesion between titanium and carbon fiber in solar panels in satellites

Diarc Technology Oy

- Potential space applications in places where
 - strong coatings on components,
 - antistatic or high thermally conductive surfaces,
 - protection against ESD,
 - adhesive bonding,
 - intelligent surfaces or
 - surface protection is needed
- TRL 9 for one technology
 - Others 3-6



Adhesive bonding of Ti parts in satellites

Picosun ALD Solutions

Company



Locations



Mission



Technology



**60+ personnel,
estimated 70 - 80
by 2017**

**110+ incl.
outsourced**

**30 – 40% annual
turnover growth**

HQ/factory: Finland

**Local offices: USA,
Europe (Germany),
Japan, China,
Singapore and
Taiwan**

**30+ distribution
partners on 6
continents**

**Cutting edge ALD
solutions for the
industry leaders**

**Focus on pilot/mass
production**


**Global leaders in
ALD know-how**

**Sophisticated 15th
generation design**

**Seamless transition
from R&D to
production**

**Wide installation
base of R&D and
production systems**

Single wafer to particle coating




Single wafer



Batch



Large area/3D substrates



Roll-to-roll



Particle coating

Up to 12" (upscale to 18" in process)
Nanolaminates
Pinhole free films on porous/HAR
substrates

Air and vacuum loading
Cluster compatibility
Excellent non-uniformity/particle count

Large flat substrates or 3D items in
batch

Tested up to 400x600 mm²

Up to 300mm wide
Same flow design as for single wafers
Conformal also on through-porous

Down to nanoscale powders
Fully conformal coating
Batches up to 1 kg

ALD for PCBA Industry

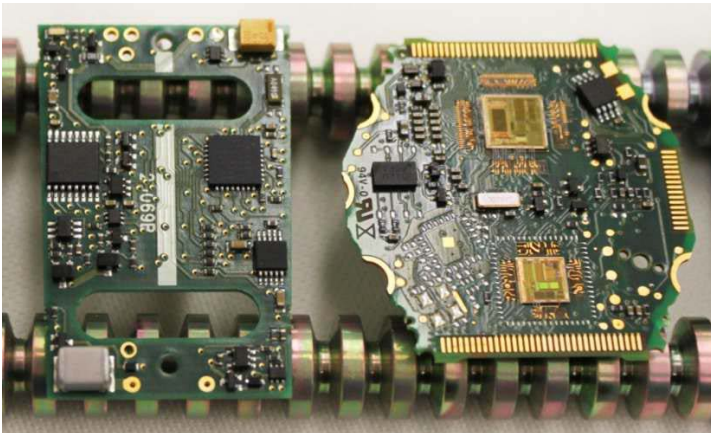
What: New conformal coating for electronics assemblies

Why: ALD offers new reliable and cost effective options for PCBA industry
Lower cost of chemicals than in Parylene coating!

Applications: Protection, passivation, prevention of tin whiskers growth
Enhancement of polymer packages
Replacing Parylene CVD with better capability and reduced cost

Space applications: protection of electronic boards for space industry
TRL depends on technology (application,) can be from 3 to 9

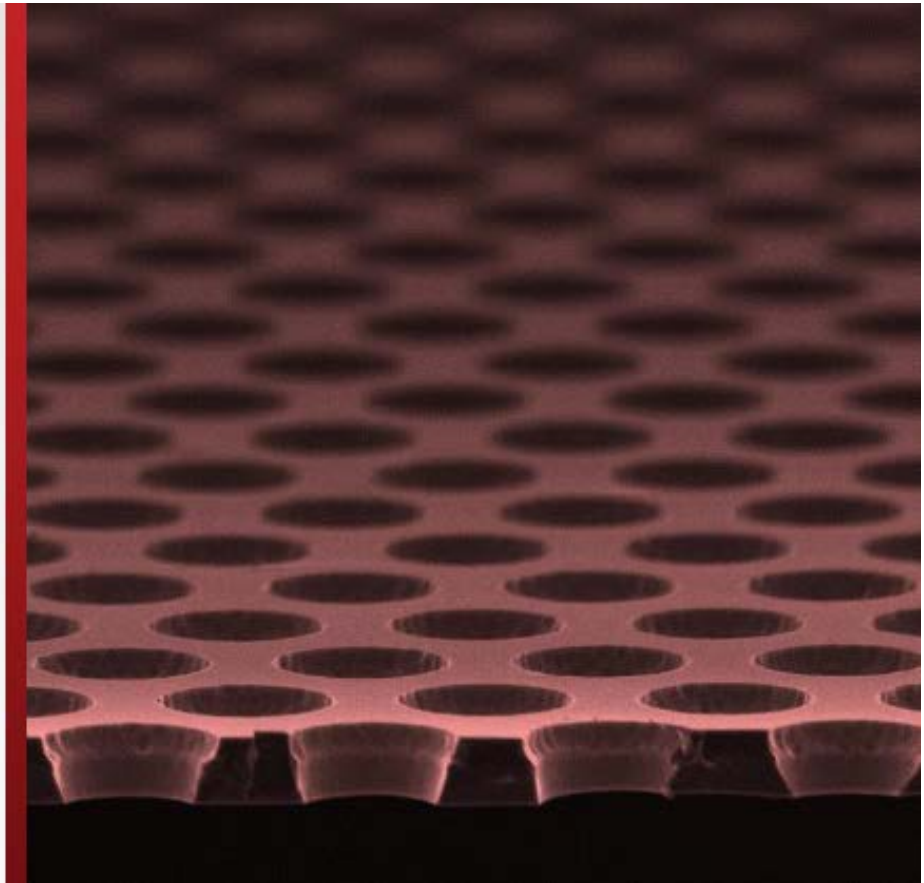
To whom: High reliability electronics
Long term environmental protection
Value added devices



- Picosun has been conducting ESA funded research program to mitigate corrosion and tin whisker growth on printed circuit board assemblies
- ESA was very satisfied with first phase results, continuation project with more focus for space applications approved
- ESA project has proven ALD to be an attractive option for the protection of electronic assemblies when extremely thin, re-workable, transparent and inert coatings are preferred

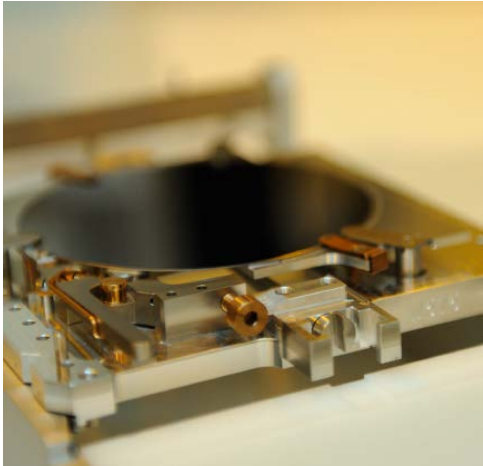


CUSTOM NANOSTRUCTURE
FABRICATION AND R&D SERVICES

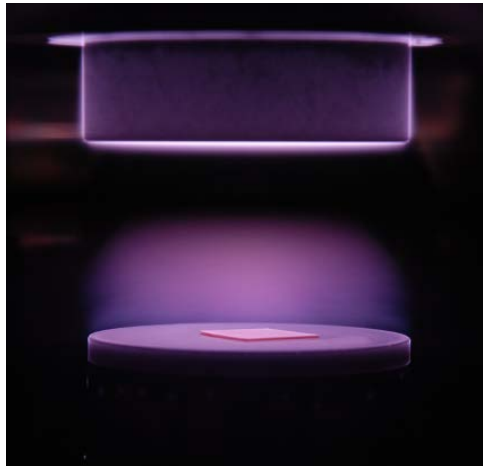


Finnlitho Ltd in short

- Based in Joensuu, **Finland**, and operating since 2014.
- Offers nanolithography services from R&D and prototyping to production of small series.
- Specialized products and processes related to diffractive X-ray optics and optical nanostructures in general.
- Utilizes the modern cleanroom facilities and equipment of the Institute of Photonics, University of Eastern Finland (UEF).
- For production reliability reasons also has access to similar facilities and equipment at Micronova, Espoo, Finland.



Electron beam lithography



Thin film deposition



Characterisation

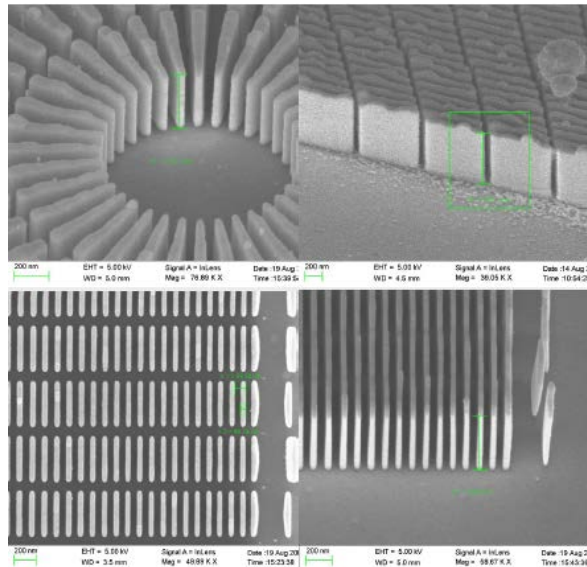


Reactive ion etching

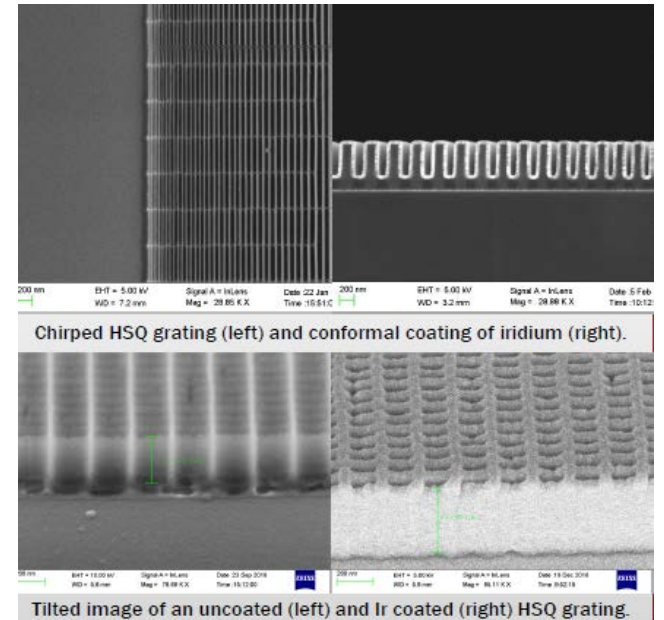


Replication

Grating structures for X-rays



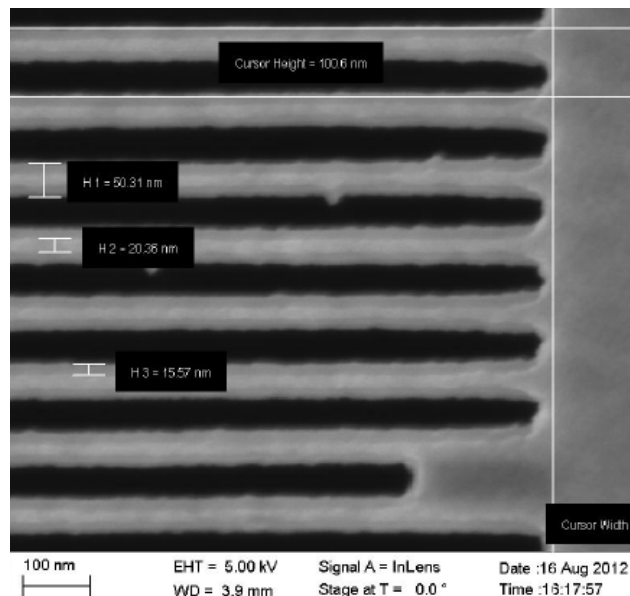
High aspect ratio Au structures



Chirped HSQ grating (left) and conformal coating of iridium (right).

Tilted image of an uncoated (left) and Ir coated (right) HSQ grating.

Iridium zone-doubled gratings



Freestanding gratings

Finnlitho Oy

- Potential space applications
 - Diffractive x-ray spectrometer for the range 50 eV to 200 eV, science applications
 - Inductive filters
- TRL 6



unique components for X-ray
spectroscopy applications,
also in space

HS

f ● i l s

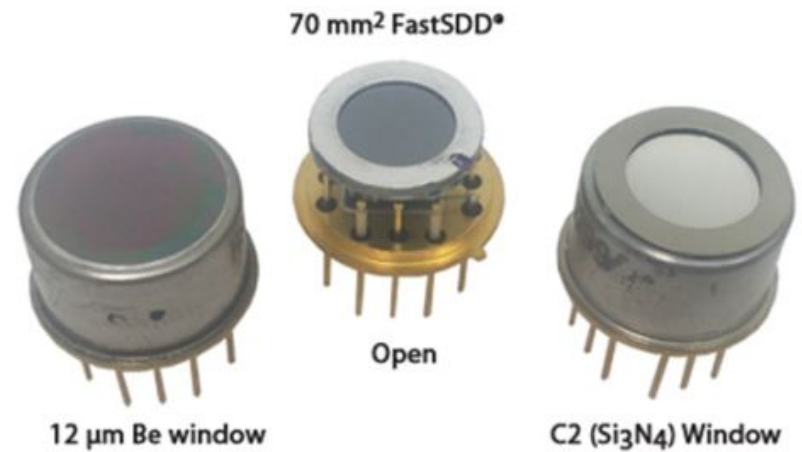
AMETEK[®]
MATERIALS ANALYSIS DIVISION

HS Foils products

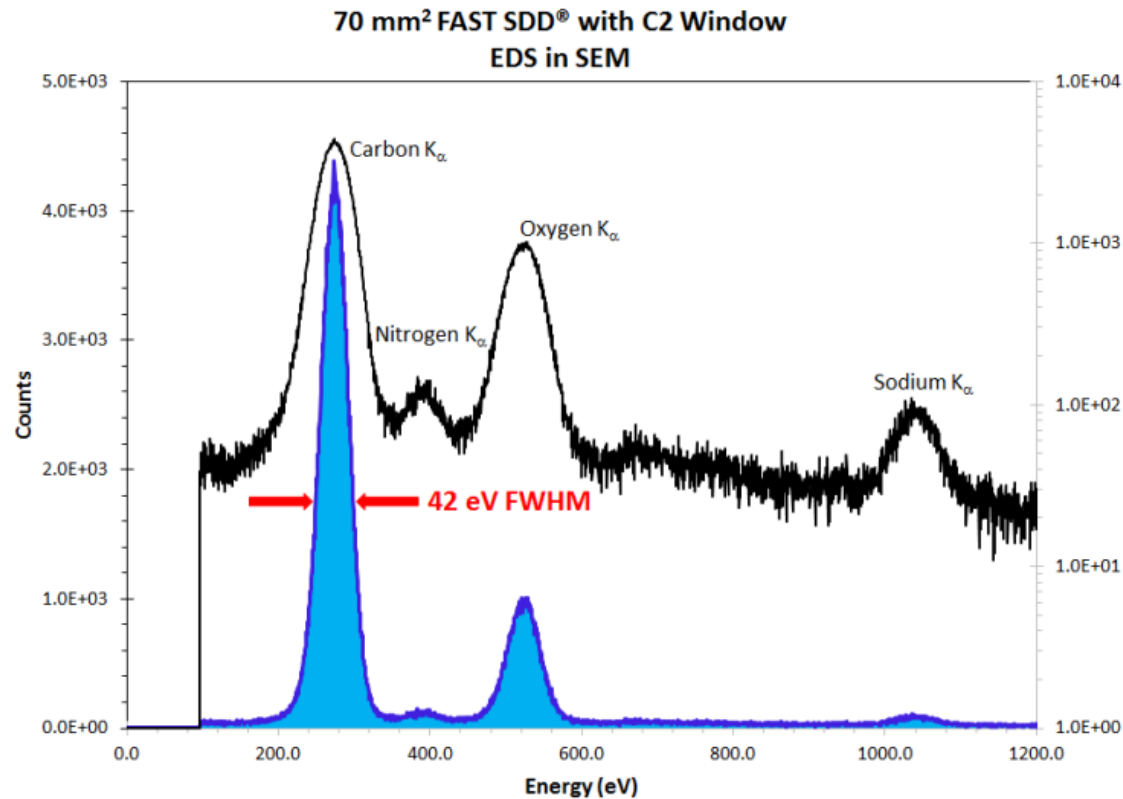
X-ray windows and filters



Silicon X-ray detectors



Carbon spectrum taken with the 70 mm² FAST SDD and a SiN window



HS Foils Oy

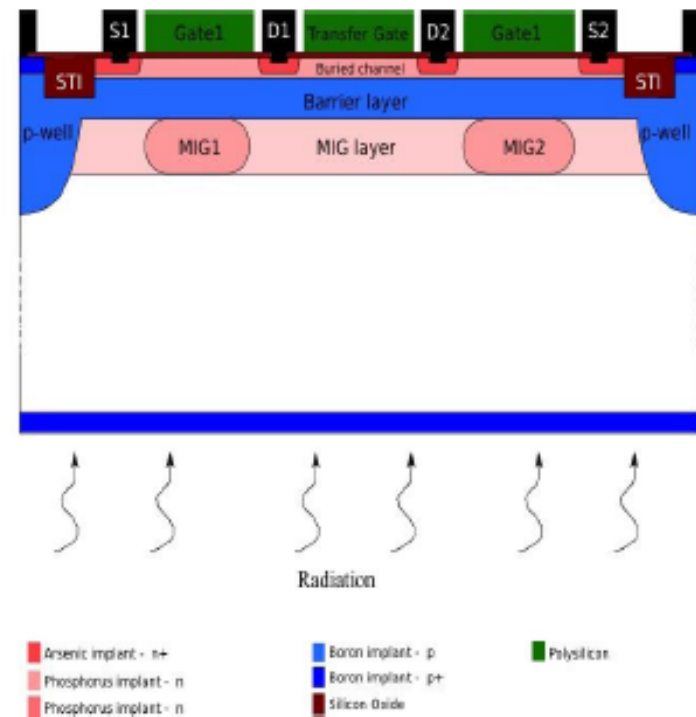
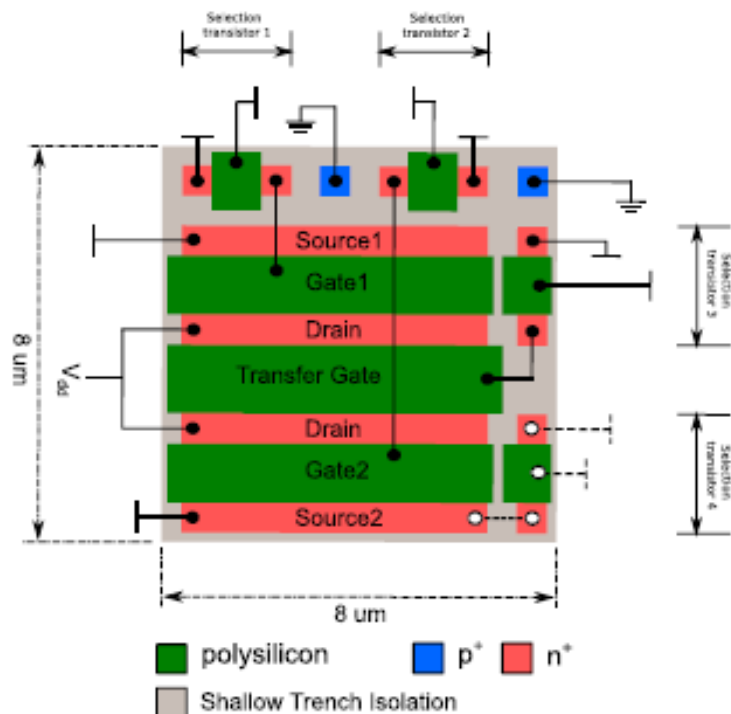
- Potential space applications
 - X-ray filters and detectors
 - Interest to expand detector activity to UV detectors and apply "black silicon" surface to detectors
- TRL 5-8 (depends on the product)



- Company: SME, two full time people, four consultants, VTT facilities
- Strength: radiation hard imaging sensor design; active pixel, low light applications
- Space applications: the technology can be applied also to Germanium; IR imaging

MIG = Modified Internal Gate

MIG pixel / 0.18 μm 5 V CMOS: top view & cross-section





MIG image sensor technology is a perfect fit for space applications:

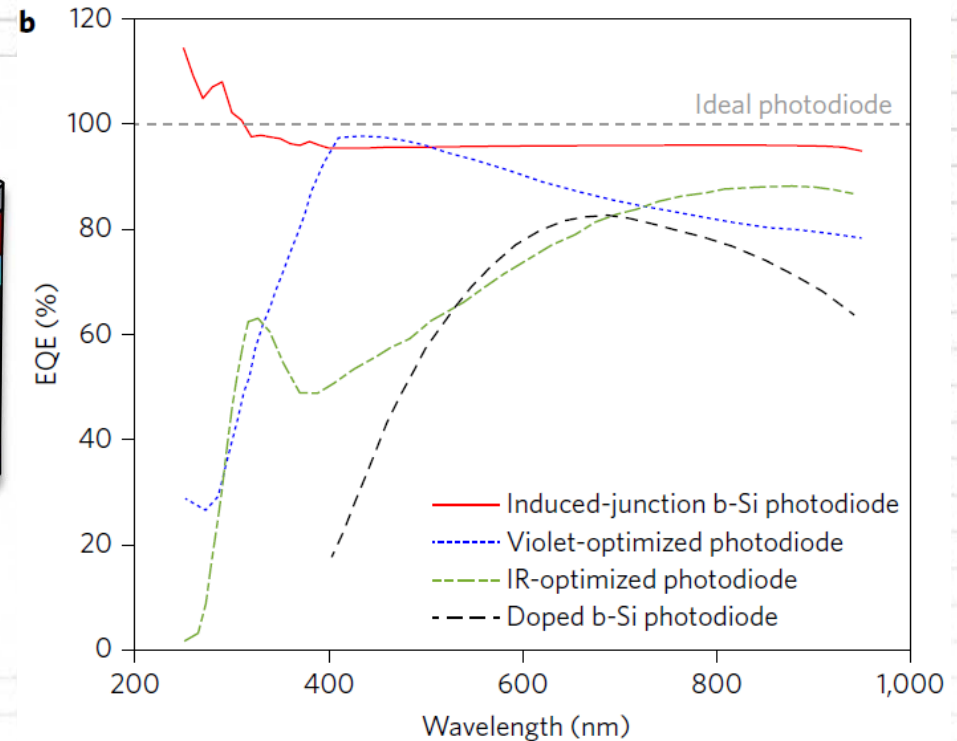
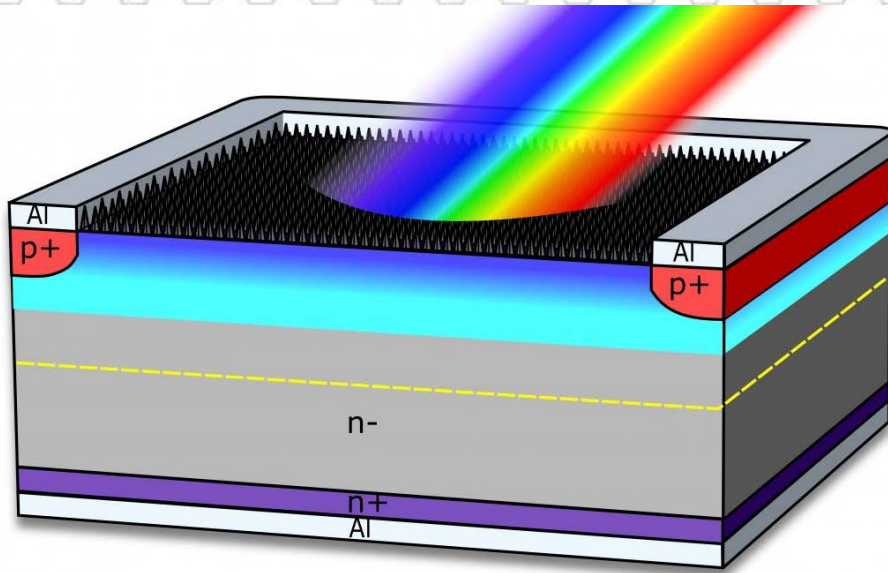
- Enables simultaneously asteroid tracking as well as direct detection of planets around stars through continuous readout
 - Increasing the frame rate does not increase the noise
- No interface issues
 - Tolerant to radiation damage
 - Low noise image sensors can be made also from other semiconductor materials than Silicon (e.g. SiGe, Ge)

TRL 3

Black silicon photodiodes with an induced junction

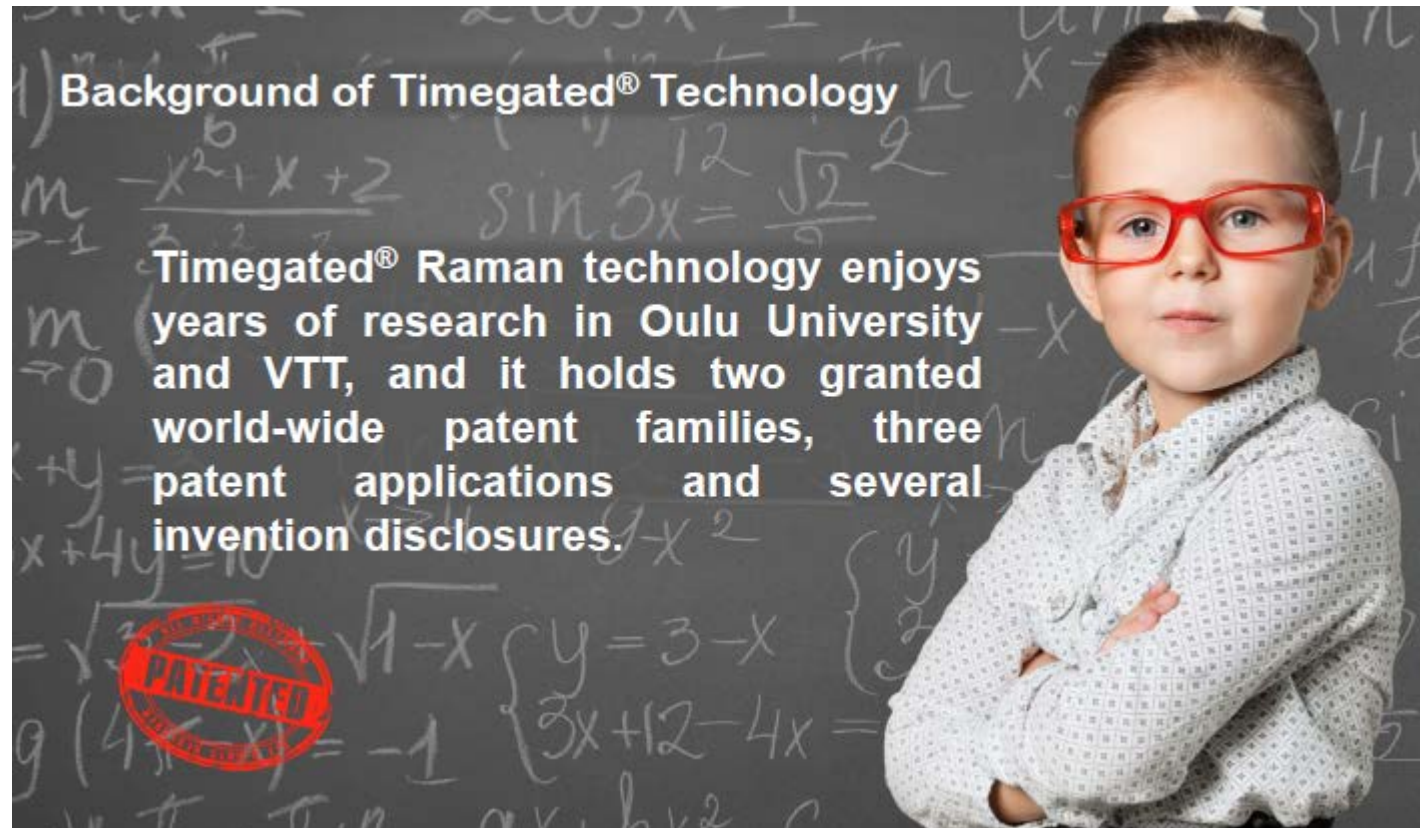
Hannu Laine, Mikko Juntunen, Juha Heinonen, Ville Vähänissi,
Päivikki Repo, Hele Savin
Electron Physics group

Black-silicon + induced junction = record EQE



Black Silicon Spin-off Company

- Potential space applications
 - Improved UV to IR sensor
 - Applications for imaging sensors
- TRL 4

The slide background features a chalkboard with various mathematical equations and a young girl with red glasses and a white patterned shirt standing with her arms crossed. A red circular stamp with the word "PATENTED" is visible in the lower-left corner of the image area.

Background of Timegated® Technology

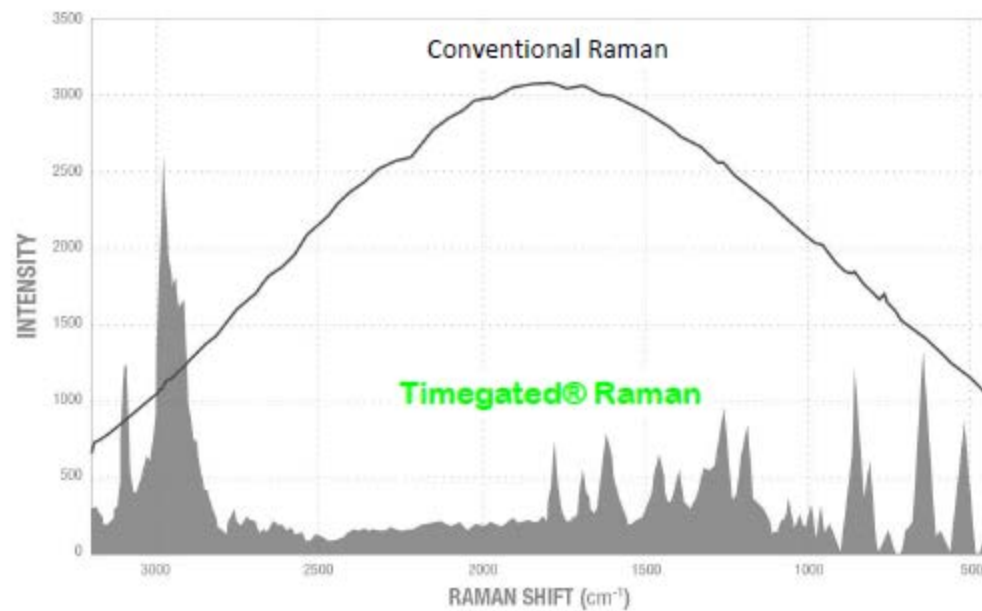
Timegated® Raman technology enjoys years of research in Oulu University and VTT, and it holds two granted world-wide patent families, three patent applications and several invention disclosures.

SME; six (6) people

Raman Spectrum Fingerprint of Material



timegate | ahead of time



Sample: amoxicillin tablet

Raman Instrument Market

Raman spectrometer market is expected to grow from more than \$1.0 billion in 2015 to **\$1.8 billion in 2021** with (CAGR) of 9.9% from 2016 through 2021¹.

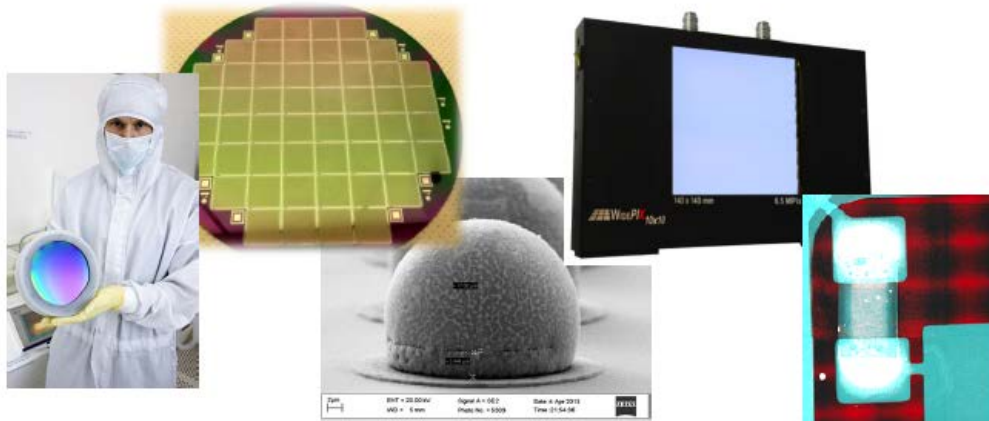
Timegate Instruments Oy is the **FIRST and ONLY** company worldwide having brought to the market the new and affordable **Timegated®** Raman spectrometer solution.

Our goal is to solve the most important problem in Raman spectroscopy: Fluorescence signal dominating and covering the Raman signal. This opens up new markets where Raman has not been applicable before.

¹ BCC Research, GLOBAL MARKETS FOR RAMAN SPECTROSCOPY, Sept., 2016, ISBN: 1-62296-361-X

- Potential space applications
 - Planetary missions: mineral point analysis from rovers
 - TRL 4

ADVACAM company and technology presentation



ADVACAM consists of two units:

- Advacam Oy, Espoo: semiconductor sensors & modules (since 2012)
 - Spin-off from VTT Technical Research Centre of Finland
- Advacam s.r.o, Prague: imaging cameras and solutions (since 2013)
 - Spin-off from Institute of Experimental and Applied Physics, Prague

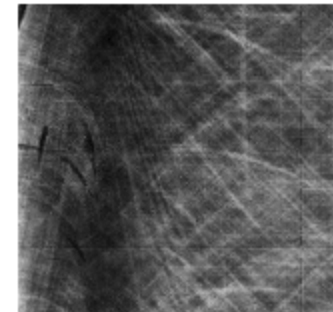
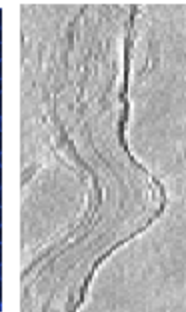
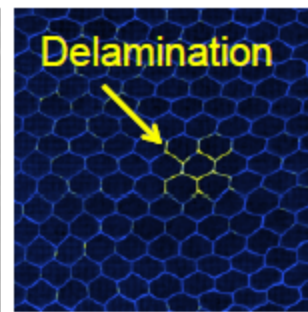
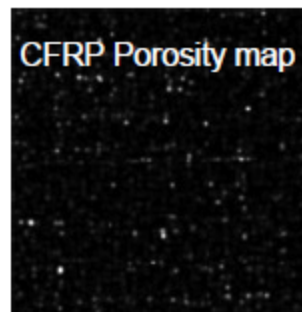
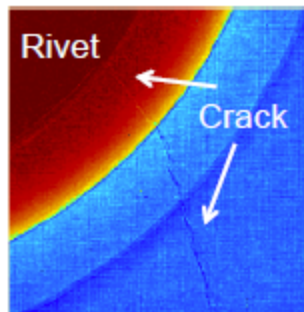
ADVACAM employs 18 people full time:

- 7 founders and 11 employees (+ 2 USA representatives)



NDT in aero-space industry

- **Problem:** Inspection of light-weight composite materials is difficult using regular X-ray imaging systems (ultra-sound used)
- **Solution:** Radically new X-ray imaging solutions optimized for testing composite materials such as CFRP
- **Value:** Automated manufacturing process control and savings in costs. Laminate wrinkles, kissing-bonds, delaminations, porosity, foreign objects and micro-cracks in the soft materials can be detected instantly with high resolution
- **Customers:** LM Windpower, GE global research, MFG, Owens Corning





International Space Station



Miniaturized Particle Telescope (Miniaturized Particle Telescope) - 11.22.16

[Overview](#) | [Description](#) | [Applications](#) | [Operations](#) | [Results](#) | [Publications](#) | [Imagery](#)

ISS Science for Everyone

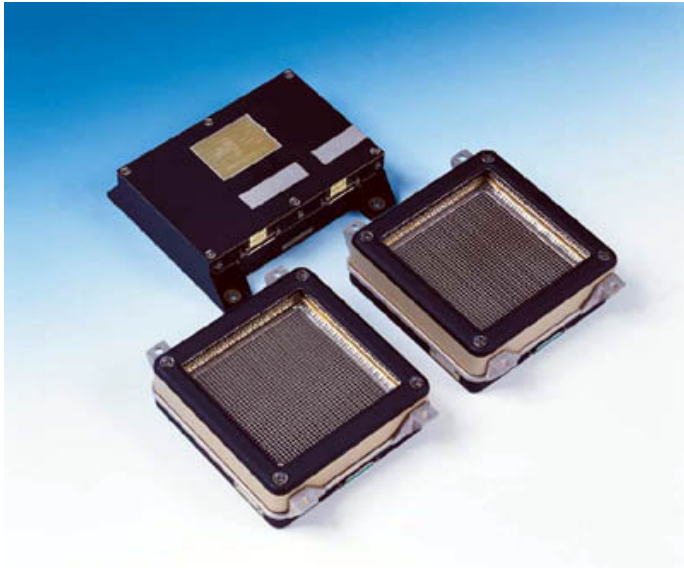
Science Objectives for Everyone

The Miniaturized Particle Telescope (MPT) is a two-element radiation detector that builds on the Radiation Environment Monitor (REM)/Timepix technology. REM units are already being flown as a technology demonstration on the International Space Station (ISS). The entire detector assembly is roughly the size of the palm of your hand. All power/data is done through two USB connections directly to a laptop. The MPT is a Commercial Off-the-Shelf (COTS) product, manufactured by Advacam. Timepix detectors are USB-powered particle trackers based on Medipix technology developed at the European Organization for Nuclear Research (CERN).

Advacam Oy

- Potential space applications
 - Imaging XRF in planetary missions
 - Solar activity detector
 - Particle background in space
- TRL 8

Debris Monitor



Debie-1 (DEBris In orbit Evaluator)
-> PROBA satellite 2001

Consortium

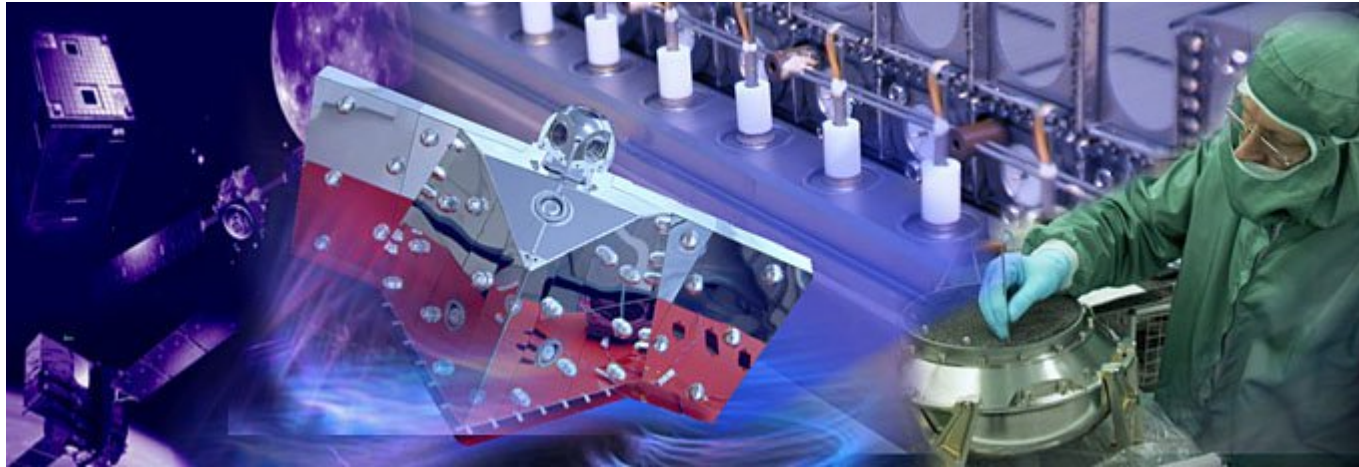
- Oxford Instruments: sensor
- Ruag: electronics and central unit
- SSF: software



Debie-2 -> International Space Station 2008

TRL 7

Oxford Instruments Analytical Oy Space



- Expertise in X-ray and gamma-ray detector technology and spectral analysis used in the demanding environment of space exploration and research.
- OIA has designed, developed and produced customized instruments and components, such as position sensitive proportional counters, solid-state spectrometers and detector arrays, ultra-thin X-ray windows and filters. In addition sub-mm bolometer technology and space debris sensors have been developed.

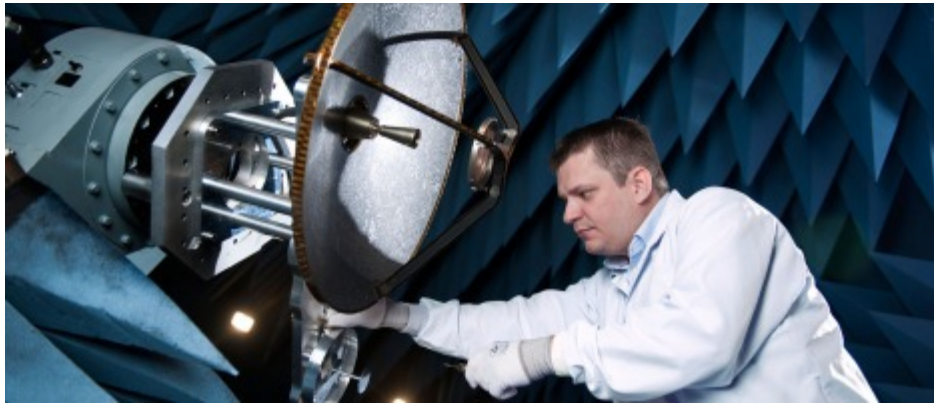
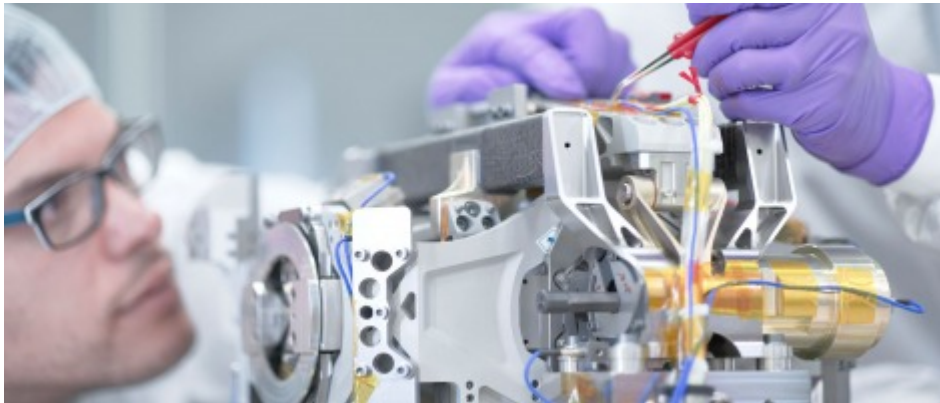
SSF (former Space Systems Finland) Oy

- Started from a space mission, now widened to other areas of secure software:



RUAG Space Finland Oy

- was space department of Patria company. Sold 2014 to the Swiss space company RUAG
- launcher & separation structures, satellite structures and mechanisms, digital electronics, satellite communication





LESS ENERGY MORE PERFORMANCE

Minima Processors' technology enables **up to 20x** **energy efficiency improvement** in digital processors as compared to legacy solutions.

LOW POWER ELECTRONIC APPLICATIONS



CONSUMER
ELECTRONICS



SENSORS &
COMMUNICATION



MEDICAL
APPLICATIONS



COMPUTING DEVICES
& SYSTEMS

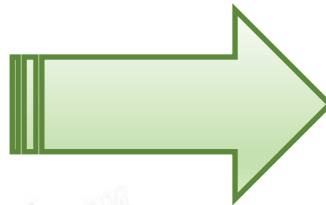
1,6 M€ equity funding from institutional and private investors in 2016
1,7 M€ funding from Horizon 2020 program for commercialization and piloting

Minima processor Oy

- Potential space applications
 - Processors for e.g. CUBE satellites
 - Ready to deliver components, but not act as prime contractor
- TRL 4

Tikitin Ltd - The MEMS Resonator & Oscillator Company

The mission of Tikitin is to replace quartz crystals in frequency control products with its innovative MEMS resonators





- ❑ The mission of Tikitin, a privately held Finnish company founded in May 2016, is to disrupt the frequency control industry with its innovative MEMS resonators
- ❑ Tikitin commercializes the 17-yrs long R&D work on MEMS resonators carried out by VTT
- ❑ Tikitin has shown, for the first time, that performance similar or better than that of quartz resonators can be reached with MEMS resonators
- ❑ Tikitin is making its own manufacturing in the clean room of VTT team by operating the processing tools under a separate rental agreement
- ❑ Assets of Tikitin include its unique knowhow in design and manufacturing MEMS resonators as well as the access to the state-of-art manufacturing environment with the investment cost on the order of 100 M€

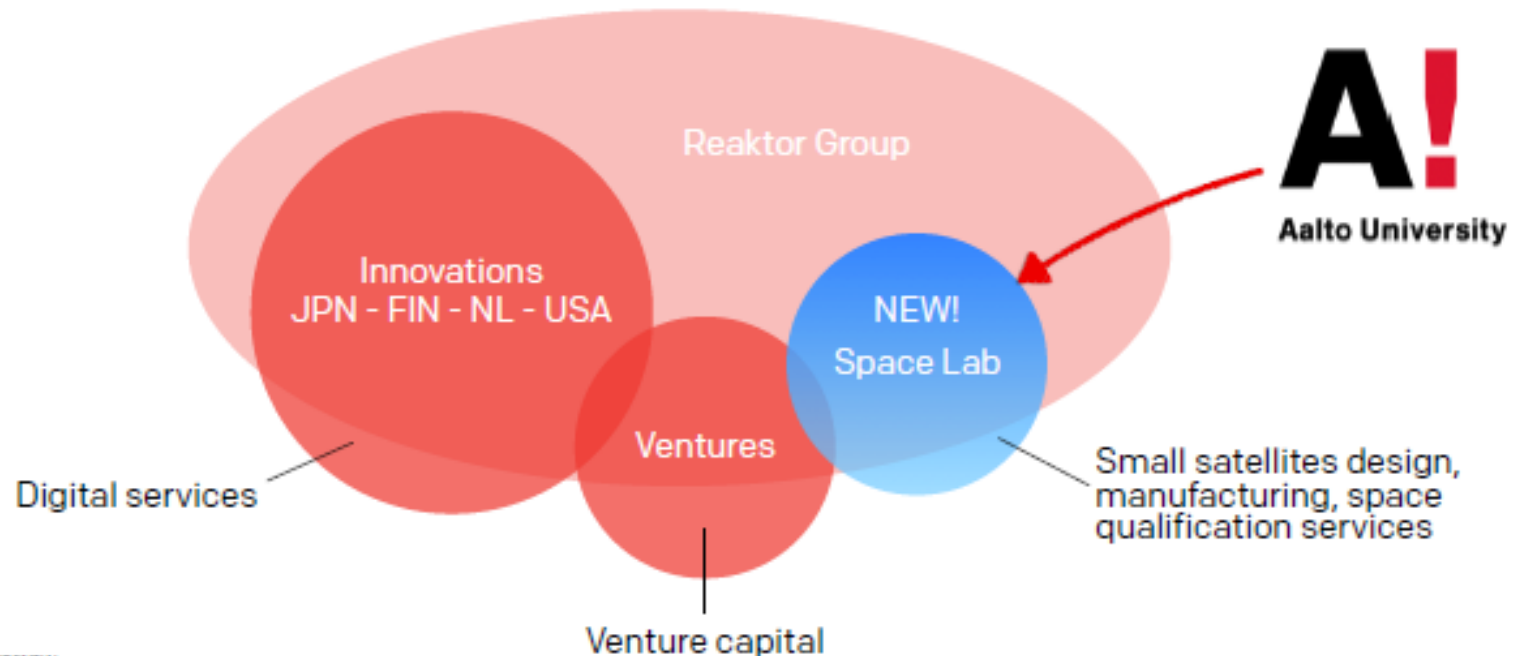
Tikitin Value Proposal for Space Applications

- ❑ Tikitin MEMS resonators
 - ❑ Suitable for high-performance oscillators
 - ❑ Low sensitivity to vibrations
 - ❑ High operation temperature range
- ❑ Tikitin proposes a high-performance oven-controlled MEMS oscillator for harsh environments ("Super OCMO")
 - ❑ Low sensitivity to vibrations
 - ❑ High temperature range
 - ❑ Small size 5 x 4 x 3 mm³
 - ❑ Low power consumption <50 mW
 - ❑ Super-OCMO is seen as a solution for high performance timing in harsh environments superior to competing technologies such as quartz-OCXO, atomic clock, miniaturized atomic clocks (MAC)
- ❑ Tikitin is interested in becoming a manufacturer and supplier of space-qualified MEMS resonators and oscillators
 - ❑ Tikitin is looking for development partners and funding

TRL 3

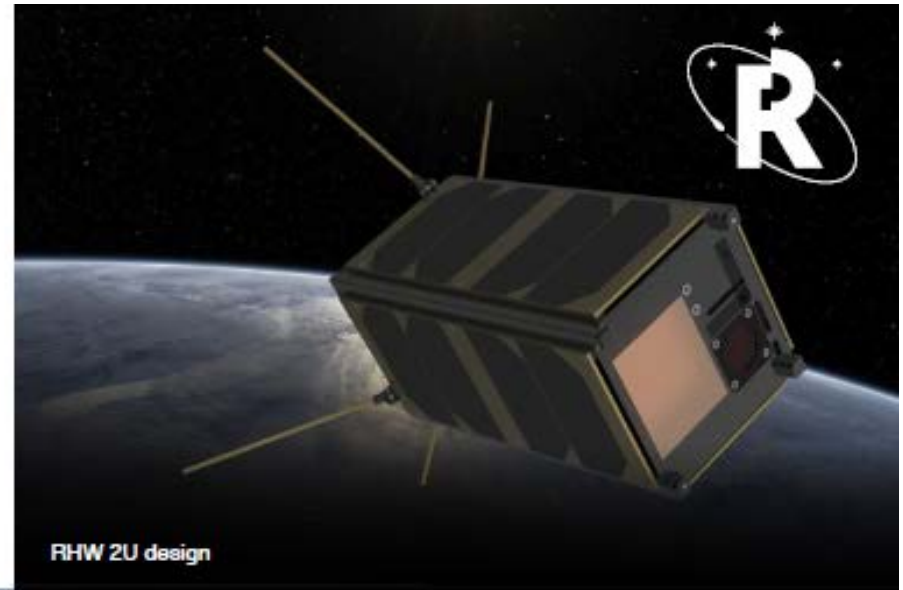
About Reaktor

Established in 2000, revenue 2016 €53M, operating in Tokyo - Helsinki - Amsterdam - New York, 400 specialists. We build exceptional digital services and help our customers to grow their business.



RSL team track record

The team has been designing nanosatellites since 2010, built Aalto-1 & Aalto-2 in Aalto University, and designed the ASPECT deep space mission nanosatellite. CEO Tuomas Tikka also participates in ISO small satellite testing standardization.



Reaktor Space

1. Small satellites
2. Reusable mission platform
3. 400 designers & developers supporting the satellite team

Together we provide **turn-key small satellite mission services** to LEO and beyond.

TRL 7