Advanced Technology for Space at SRON

Michael Wise
SRON General and Scientific Director

ILO-net Industriedag - June 17, 2022

SRON
Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research (NWO)

SRON Mission

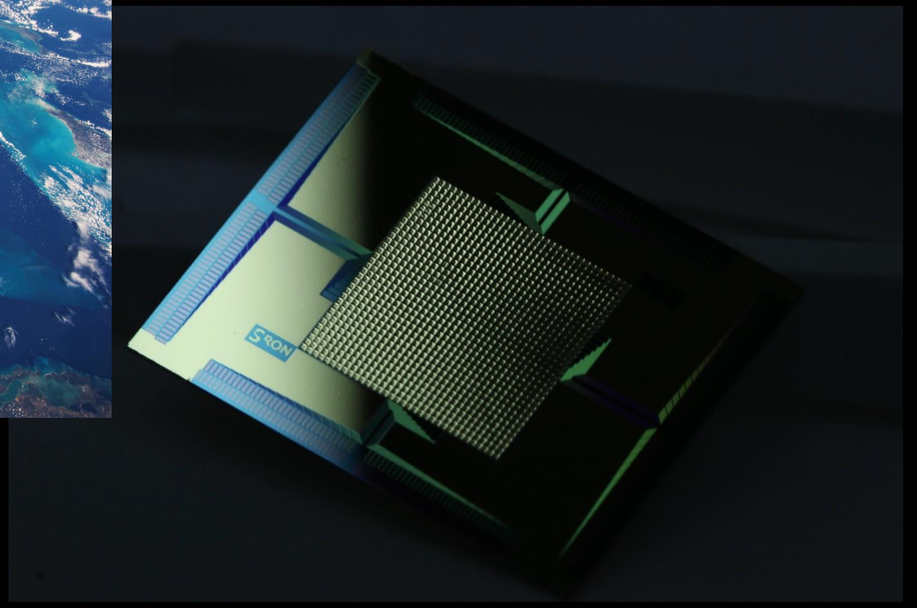
“To enable breakthroughs in space science through pioneering technology, advanced instrumentation, and fundamental research.”

SRON Research Themes

Astrophysics and Exoplanets

Earth Observation and Climate Studies

Technology and Instrumentation



COSMIC OBSERVERS

esa

IN DEVELOPMENT

ACTIVE

LEGACY

microwaves

sub-millimetre

infrared

optical

ultraviolet

x-rays

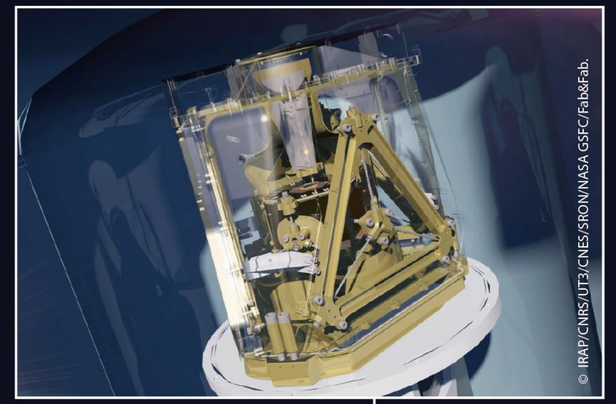
gamma rays

gravitational waves

The *Athena* X-ray observatory

Ariane 6
L1 orbit
4 years nominal mission
+ possible extensions
ToO response ≤ 4 hrs

X-ray Integral Field Unit:
ΔE: 2.5 eV
Field of view: 5 arcmin
Operating temperature: 50 mK



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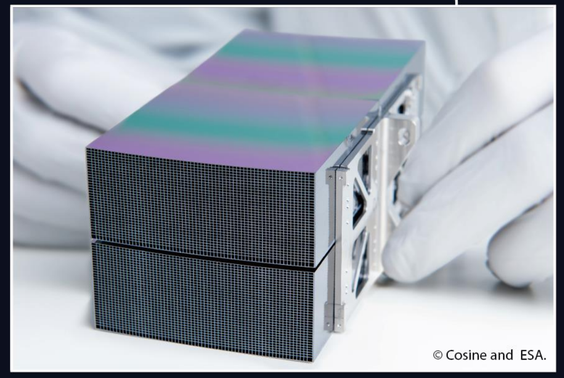
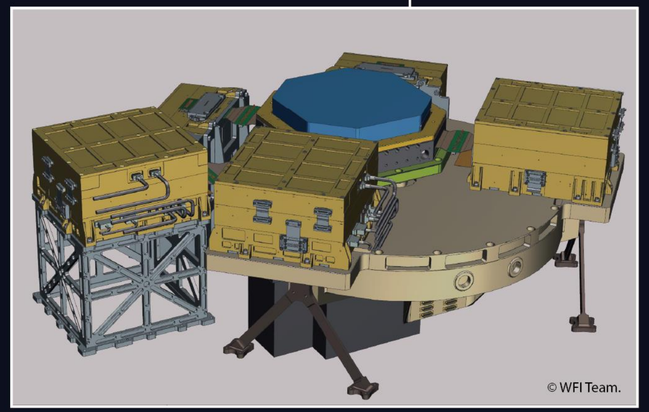
cosine | high energy optics

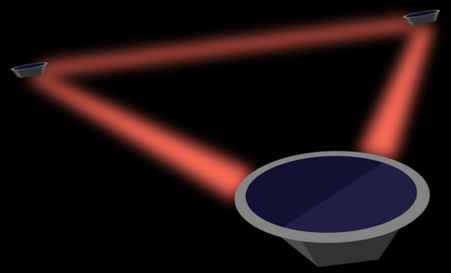
Silicon Pore Optics:
1.4 m^2 at 1 keV
5 arcsec HEW
Focal length: 12 m
Sensitivity: 3 10^{-17} erg cm^{-2} s^{-1}



Wide Field Imager:
ΔE: < 80 eV at 1keV
Field of view: 40 arcmin
Small/Fast detector for bright sources



LISA - Laser Interferometer Space Antenna



3 spacecraft separated by
2.5 million km in triangular formation

Gravitational waves
The first gravitational wave observatory in space

50 million km
from Earth

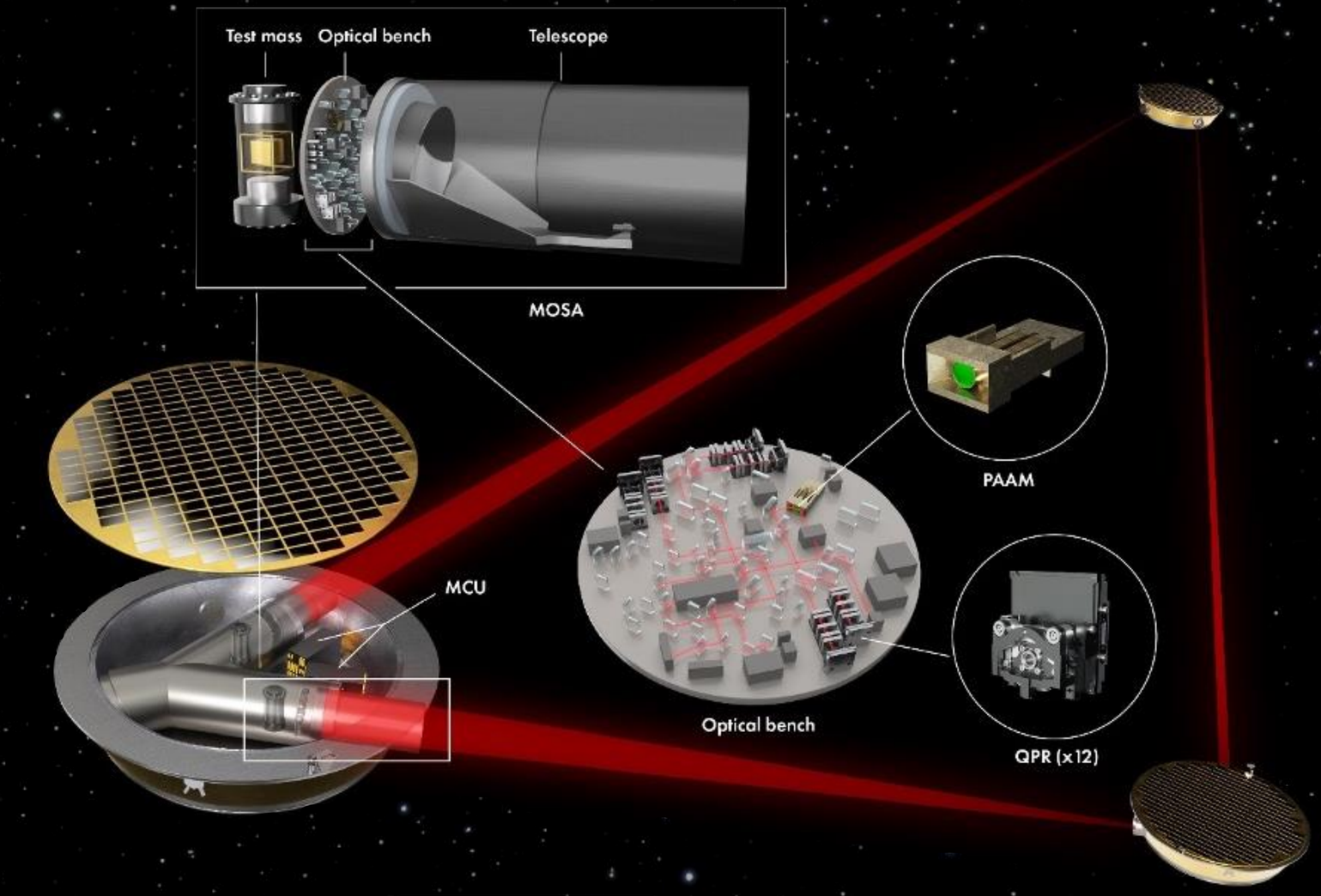
Following Earth in its orbit around the Sun

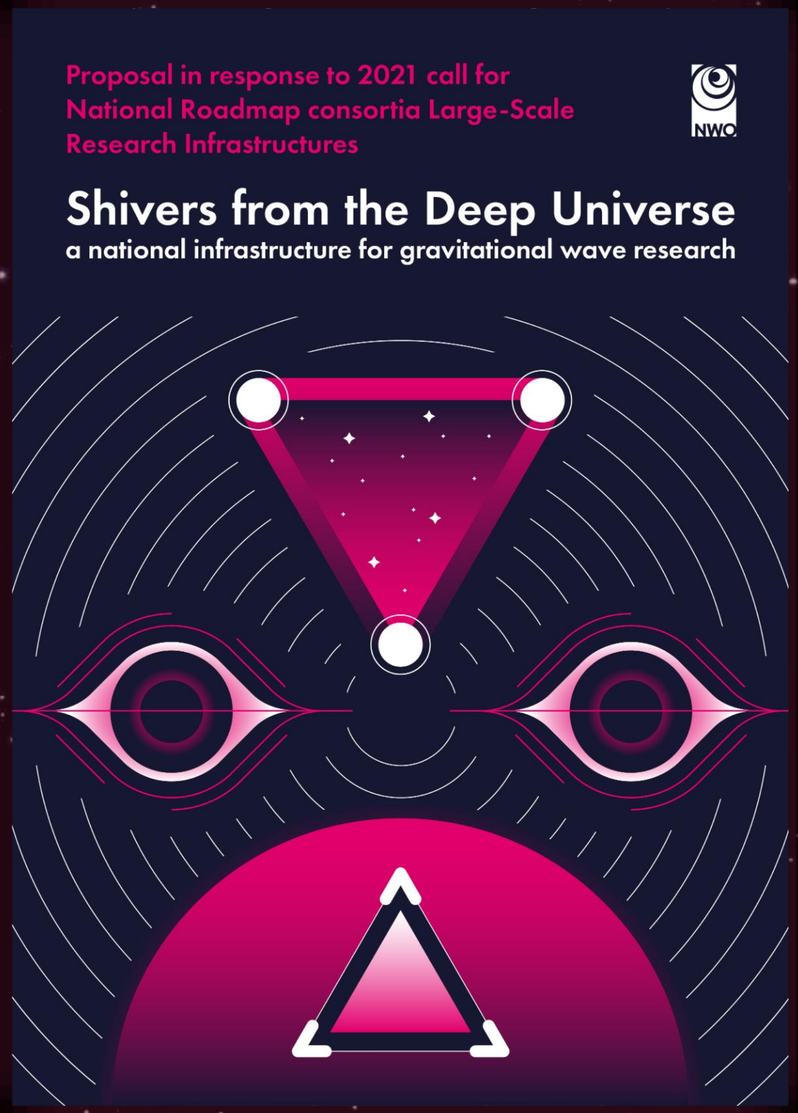
Planned launch in 2037

Core science goals

- **Mergers of supermassive black holes at the centre of galaxies**
- **White dwarf binaries in the Milky Way**
- **Stellar-origin black holes falling into supermassive black holes**

Point-Ahead Angle Mechanism (PAAM)





Nikhef

BRIGHT Integrated PHOTONICS

TNO innovation for life

Voyage 2050 Strategic Objectives

Moons of the giant planets

L4 (+inspirator?)

From temperate exoplanets to the Milky Way

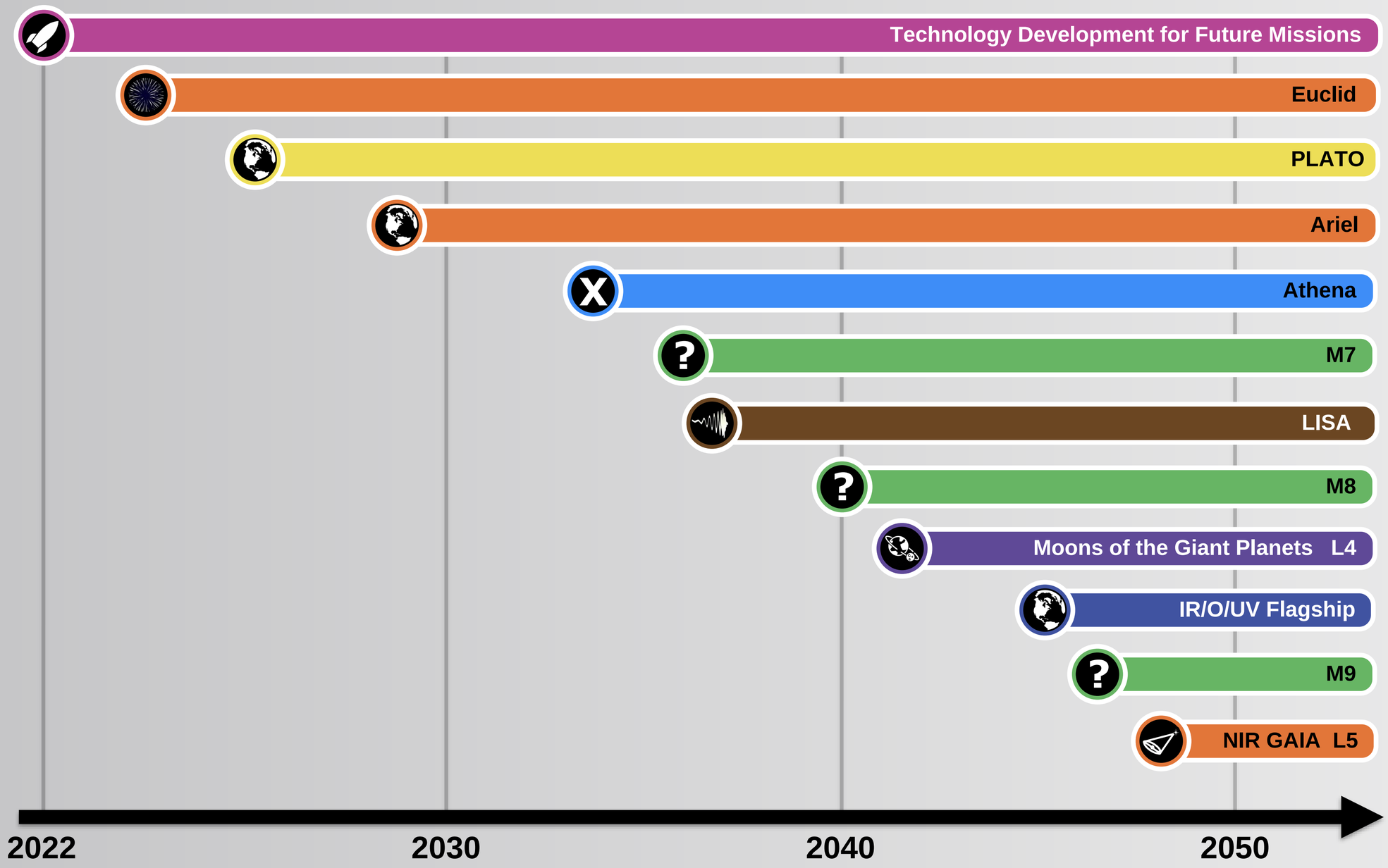
L5
NIR
GAIA

New physical probes of the early Universe

L6 CMB or new GW mission

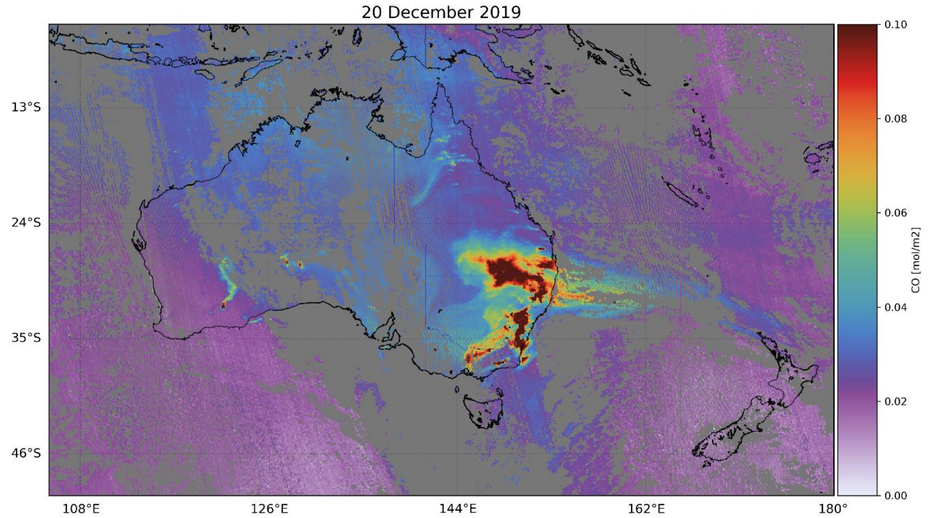
Possible technology development: cold atom interferometry, X-ray interferometry, new power and heat sources, cryogenic sample return, solar sails

Voyage 2050 Mission Timeline



SRON Earth Program - Growing Impact

Ohio blowout, Pandey et al. PNAS 2019



Australian black summer fires, vd Velde et al. Nature 2021

TROPOMI launched 2017, currently our only mission in-orbit

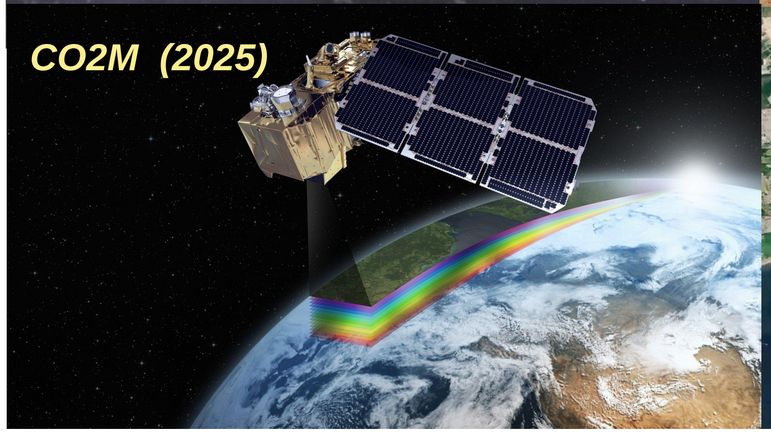
- TROPOMI detects ~10% of worldwide Methane emissions from Oil and Gas (Lauvaux et al. Science 2022)
- Frequent detection of large Methane emissions from Oil and Gas industry, coal mines and landfills
- Significant national and international societal interest (CNN, Bloomberg, COP26, NOS journaal, Atlas, etc.)

Turkmenistan oil fields paper 2019, NOS journaal

Expanded Portfolio of New Missions

EO missions co-led by SRON currently in preparation:

- Sentinel-5 (launch 2023); follow on of TROPOMI mission
- PACE/SPEXone (launch 2024); climate effect of aerosol onboard NASA mission
- CO2M (launch 2025); anthropogenic CO2
- TANGO (launch 2026); zoom-in on greenhouse gas emissions on facility scale



Space-based emission monitoring is a crucial capability for NL national Climate Action

Clear Air Initiative

The Clear Air consortium intends to conduct and promote world leading research and technology for earth observation of the atmosphere.

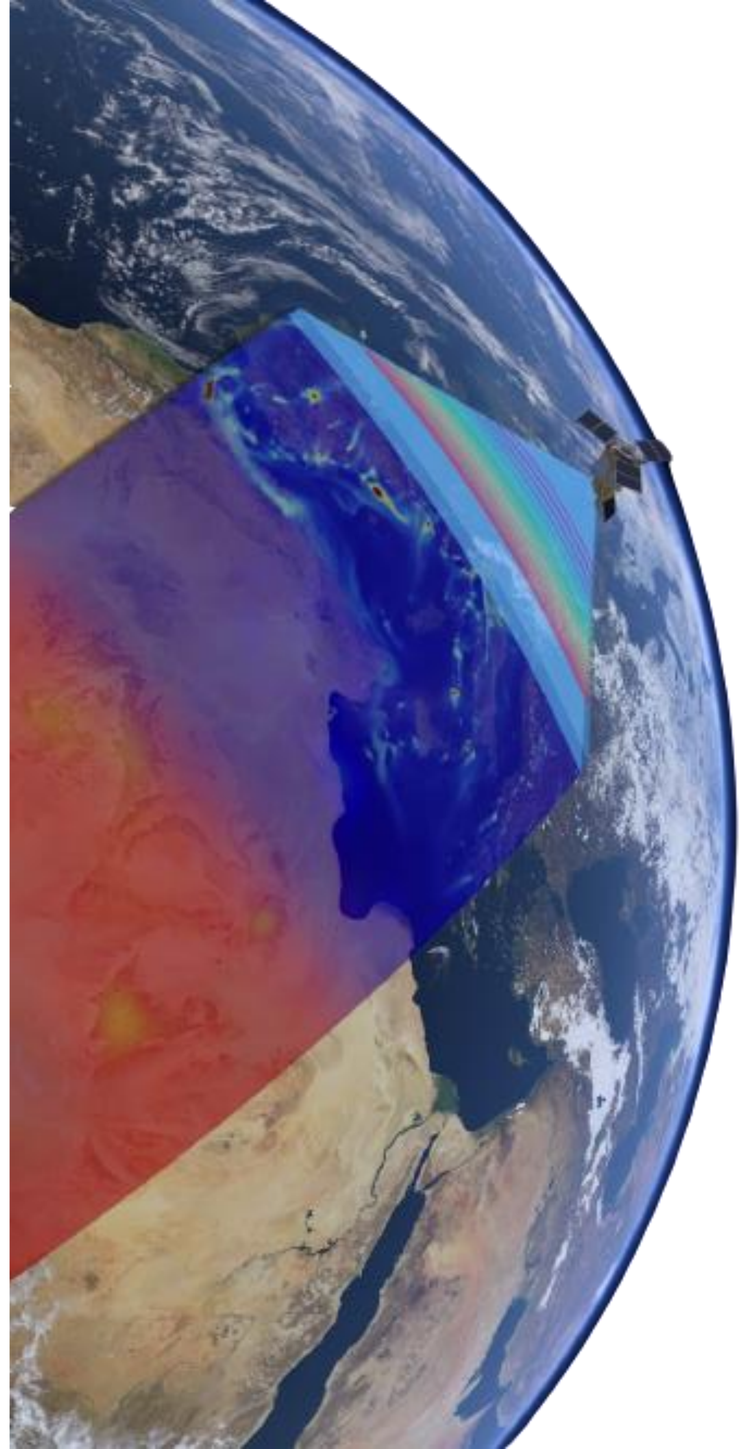
150 M€ Groeifonds proposal to EZK with support of OCW and I&W

Focus on

- Climate agreements & Climate action
- Improve air quality and public health
- Reduce loss of biodiversity due to nitrogen emissions

Impact

- Extend leading Dutch position in climate research
- Support policy making (UN/COP, EU Methane Strategy, IMEO, Stikstofwet, Schone Lucht Akkoord)
- Support the creation of commercial data services in this field (e.g. ISISpace, Airbus, S&T)



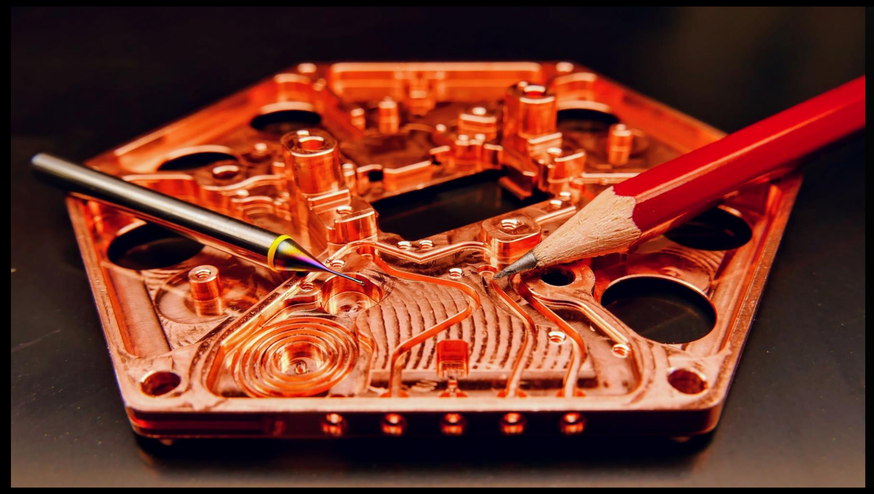
Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

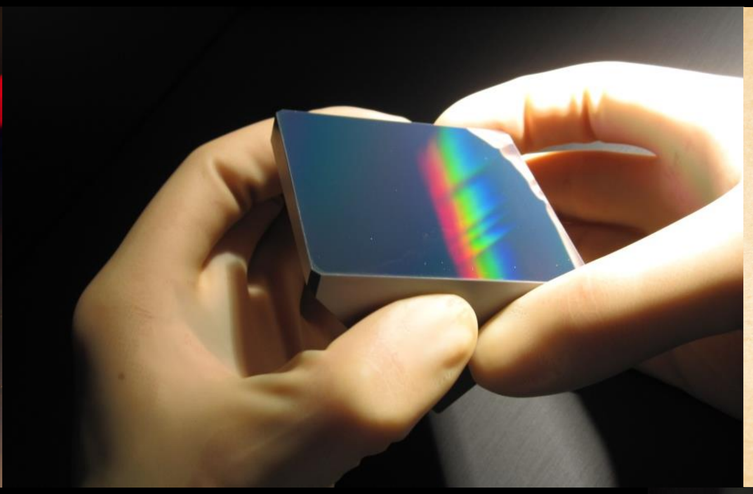
SRON

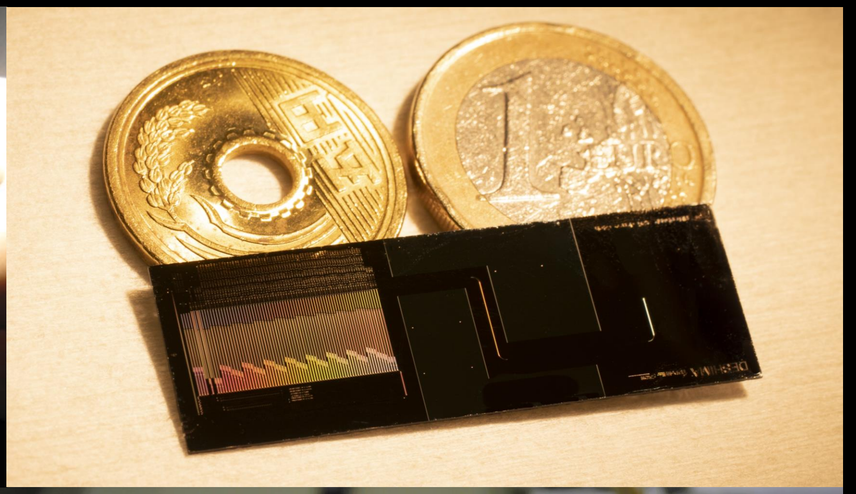
TNO innovation for life

TU Delft

SRON Technology Development







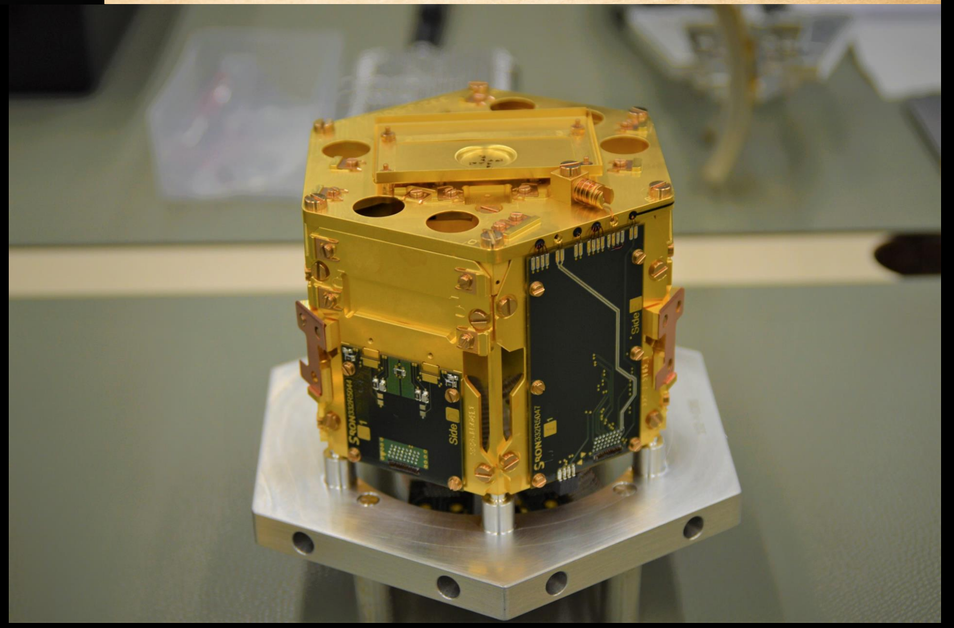
Detectors and spectrographs

Cryogenic sensors and read-out electronics

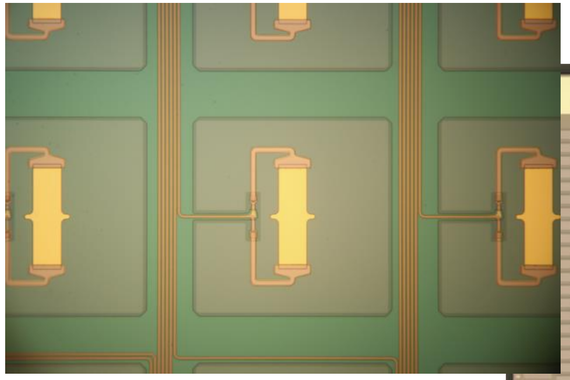
Ultra-high contrast imaging and optics

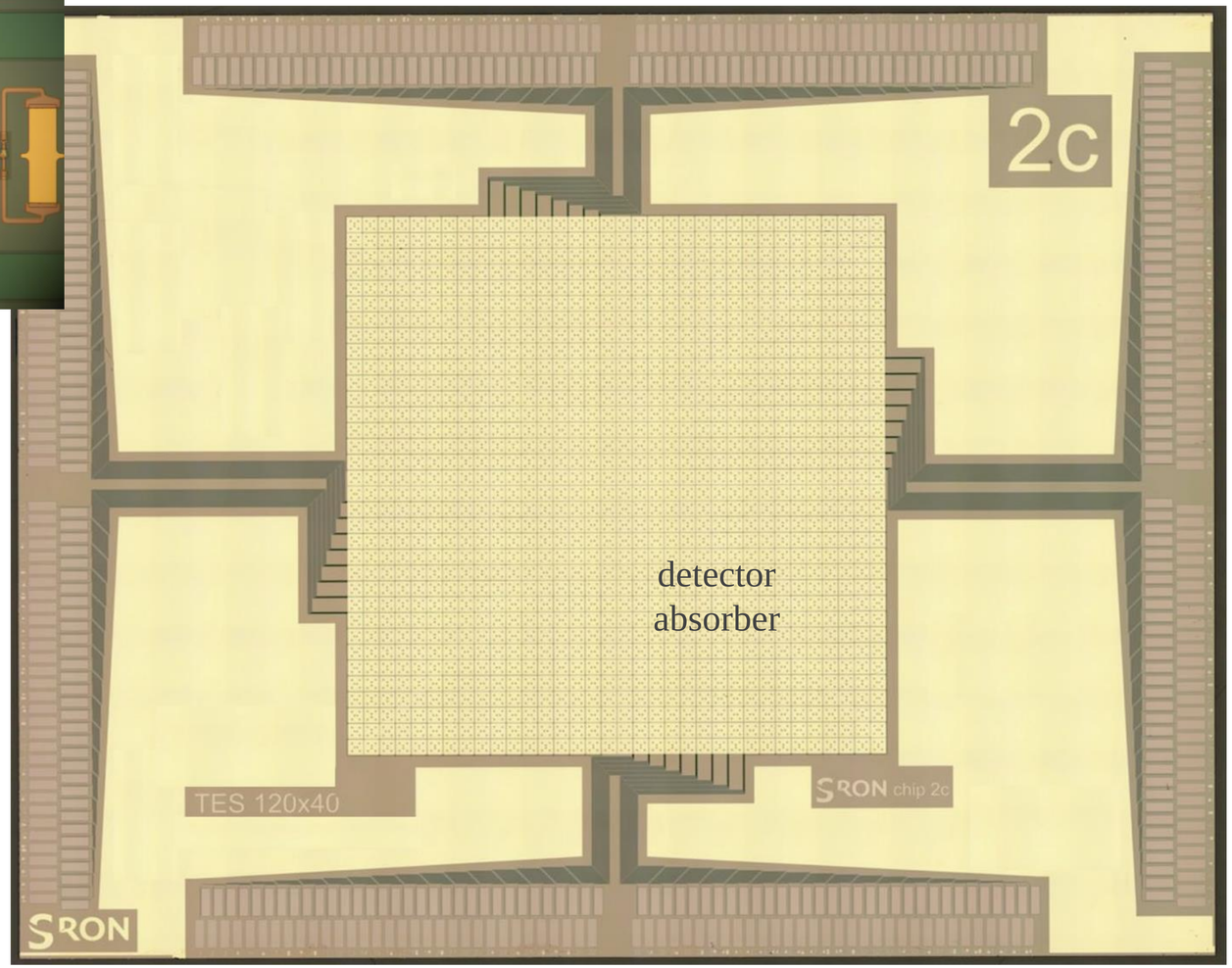
Focal plane manufacture and assembly

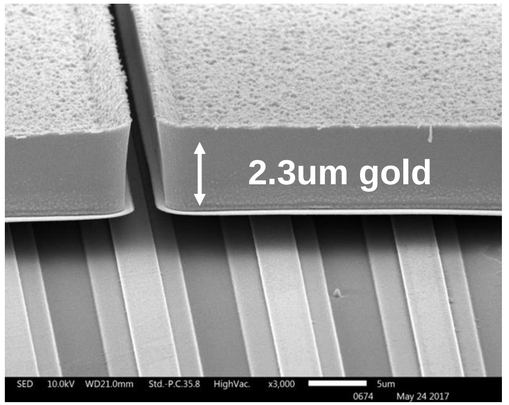
Instrument concepts and demonstrators

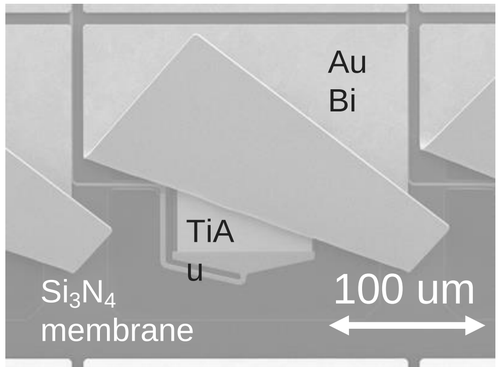


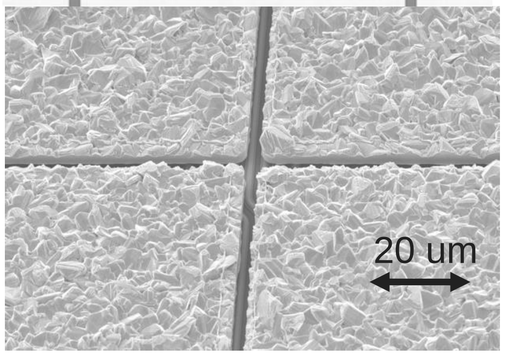
X-ray TES microcalorimeters









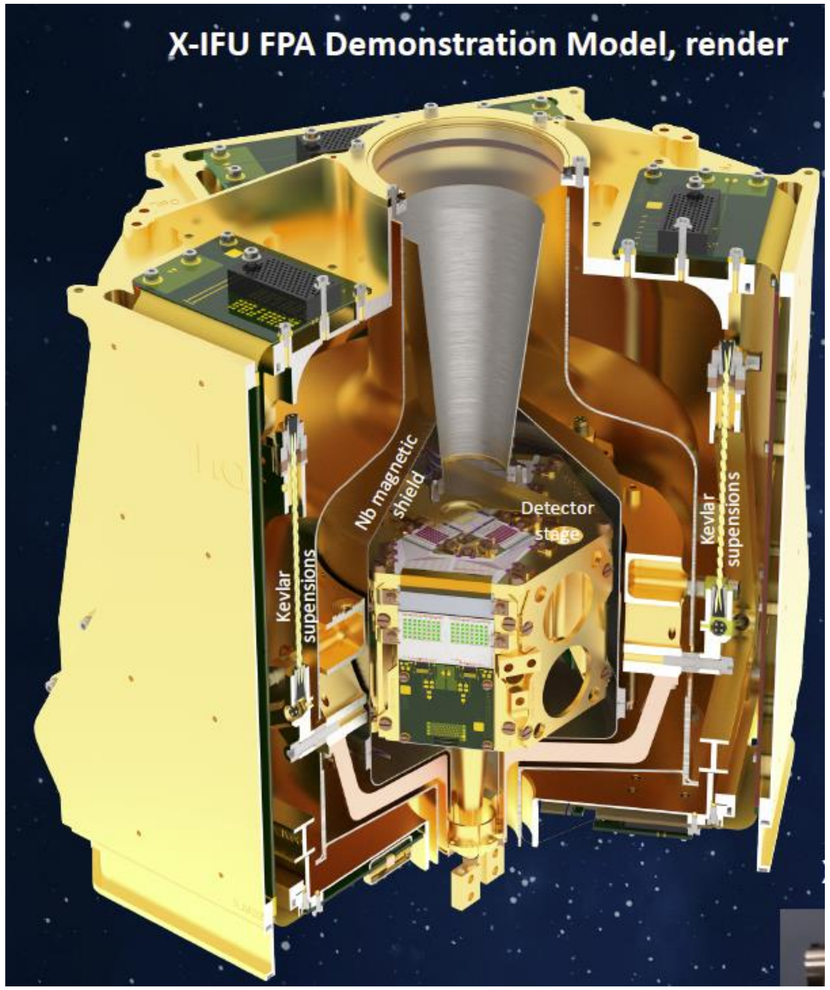


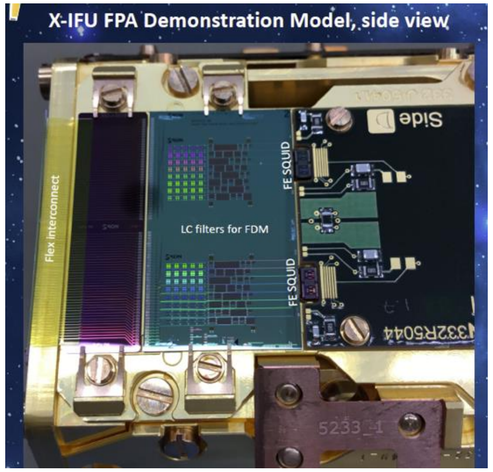
Nagayoshi et al, J. Low Temp. Phys. 199, 2019
M. deWit et al. 2021
L.Gottardi et al. Phys.Rev.Lett. 126(21),217001, 2021
E.Taralli Rev.Sci.Instr. 92 (2),023101, 2021
M. De Wit, et al. J.Appl.Phys. 128(22), 224501, 2021

SRON 32x32 TES pixels array with Au absorbers

Credits; SRON XIFU/FPA team

Athena XIFU Focal Plane Assembly



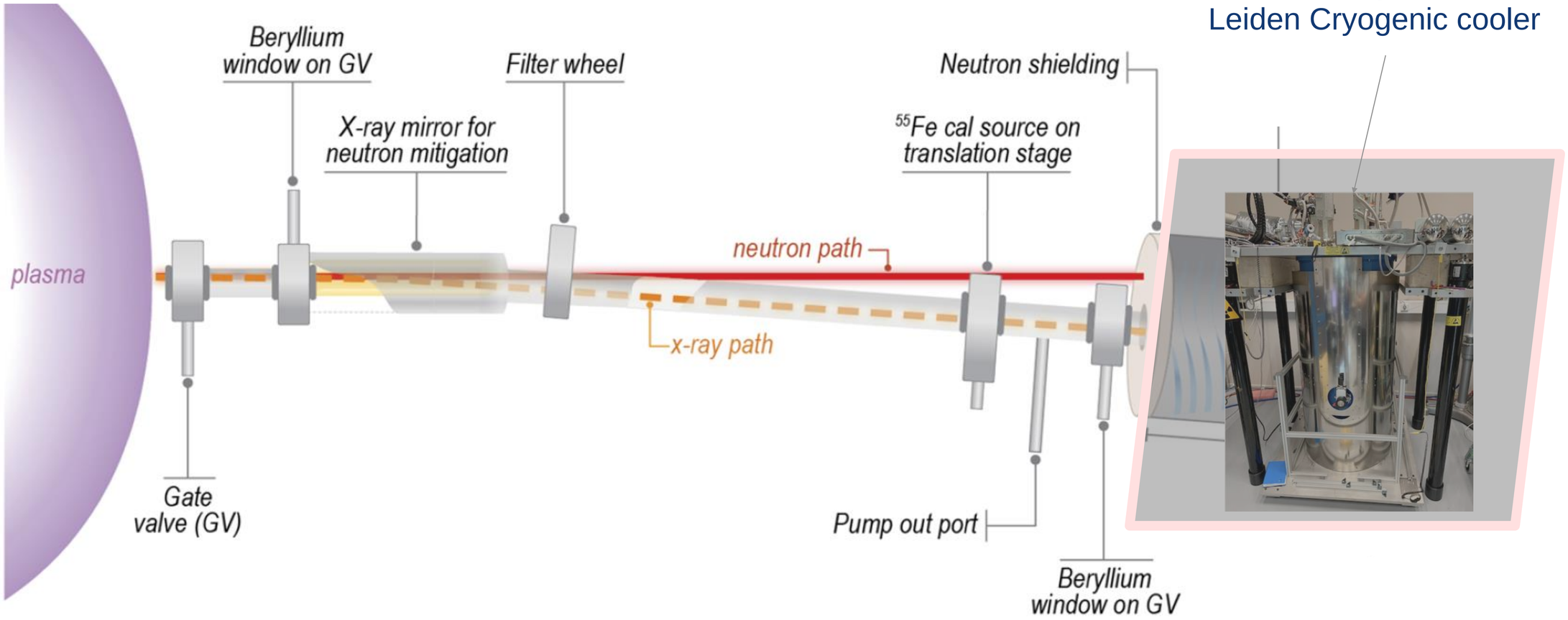


All in-house technology!

SQUID amplifier at VTT(Finland)

Credits; SRON XIFU/FPA team

Concept layout for SRON TES X-ray spectrometer at ITER



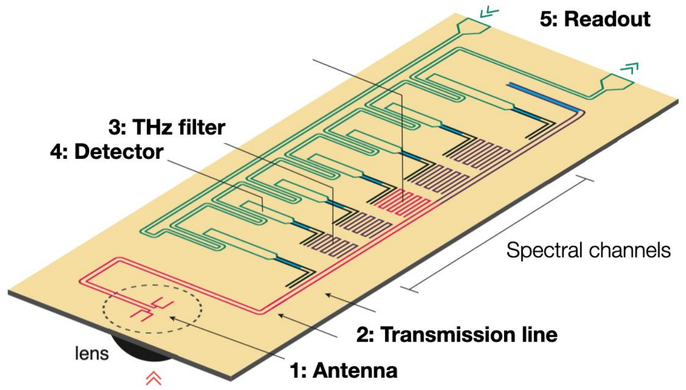
SRON X-ray detectors
Leiden Cryogenic cooler

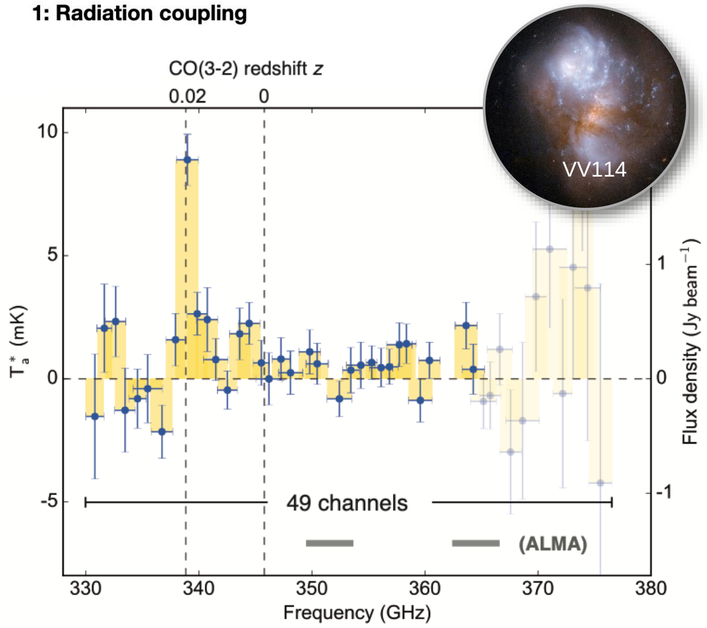
Adapted from M. Eckart et al. Rev. Sci. Instrum., 92, 063520 (2021)

MKIDS (Microwave Kinetic Inductor Detectors)

On-chip spectrometers

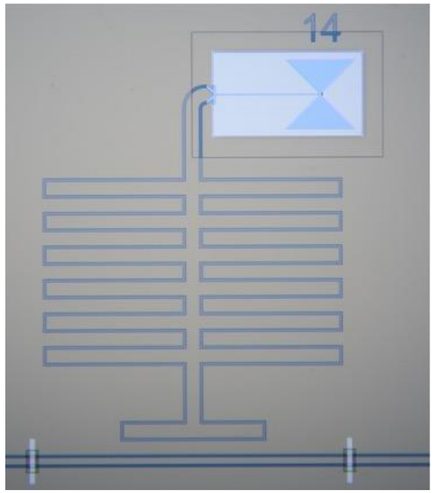
- SRON/TUD invented this technology with Deshima
- And pioneer it on the ASTE telescope

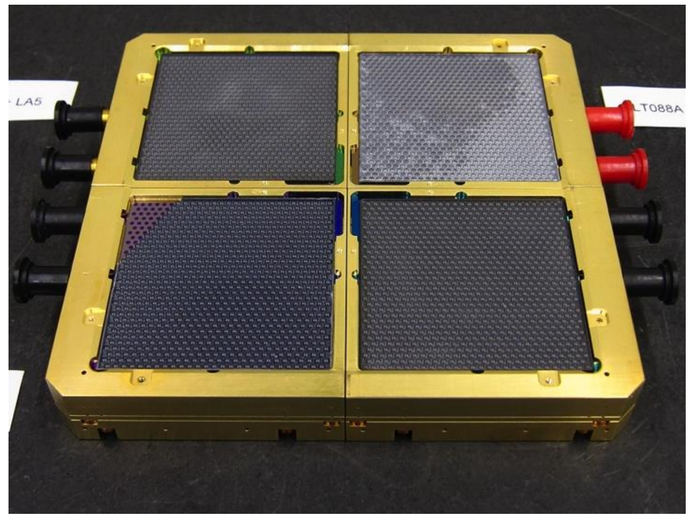




Ultra-sensitive detector arrays

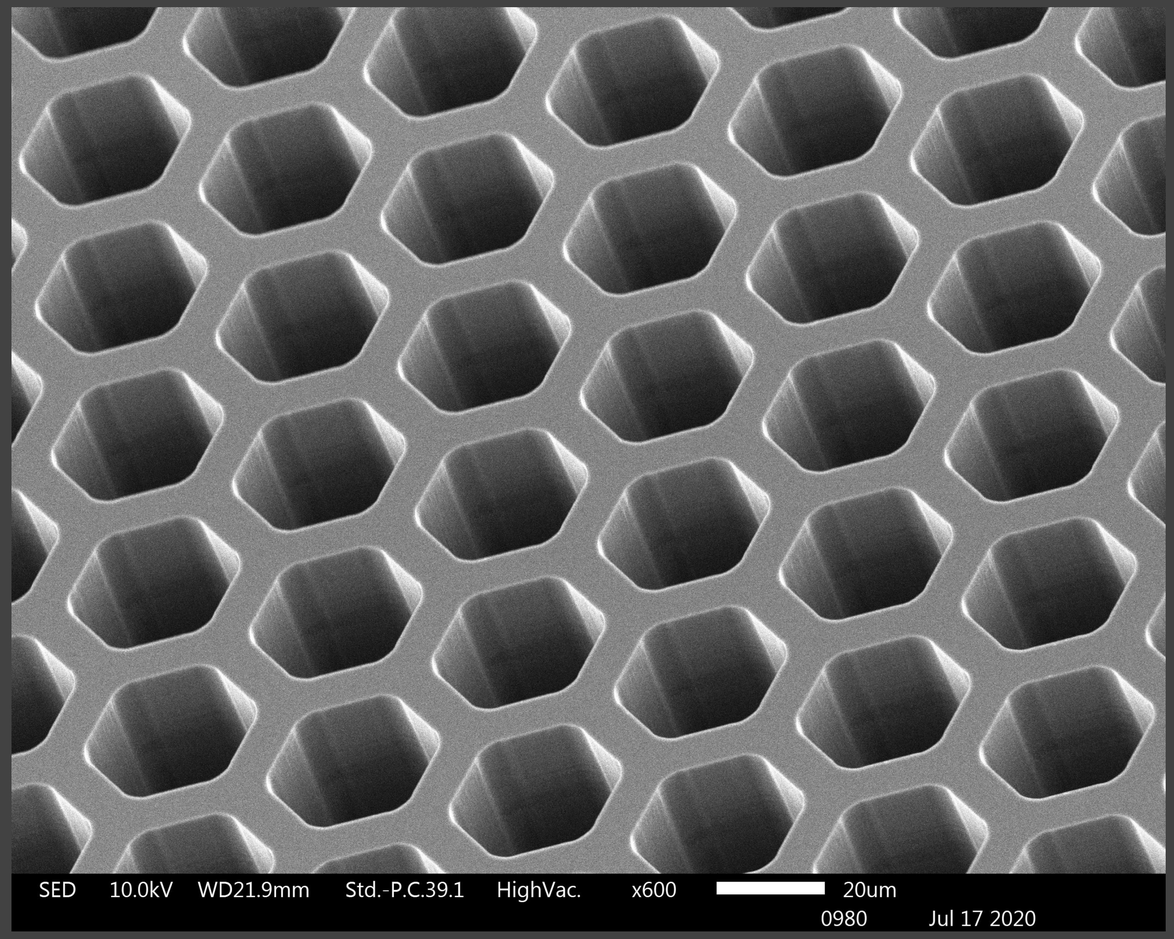
- SRON/TUD is the state-of-the-art (SpaceKIDs project)
- Designed for space-based observatories



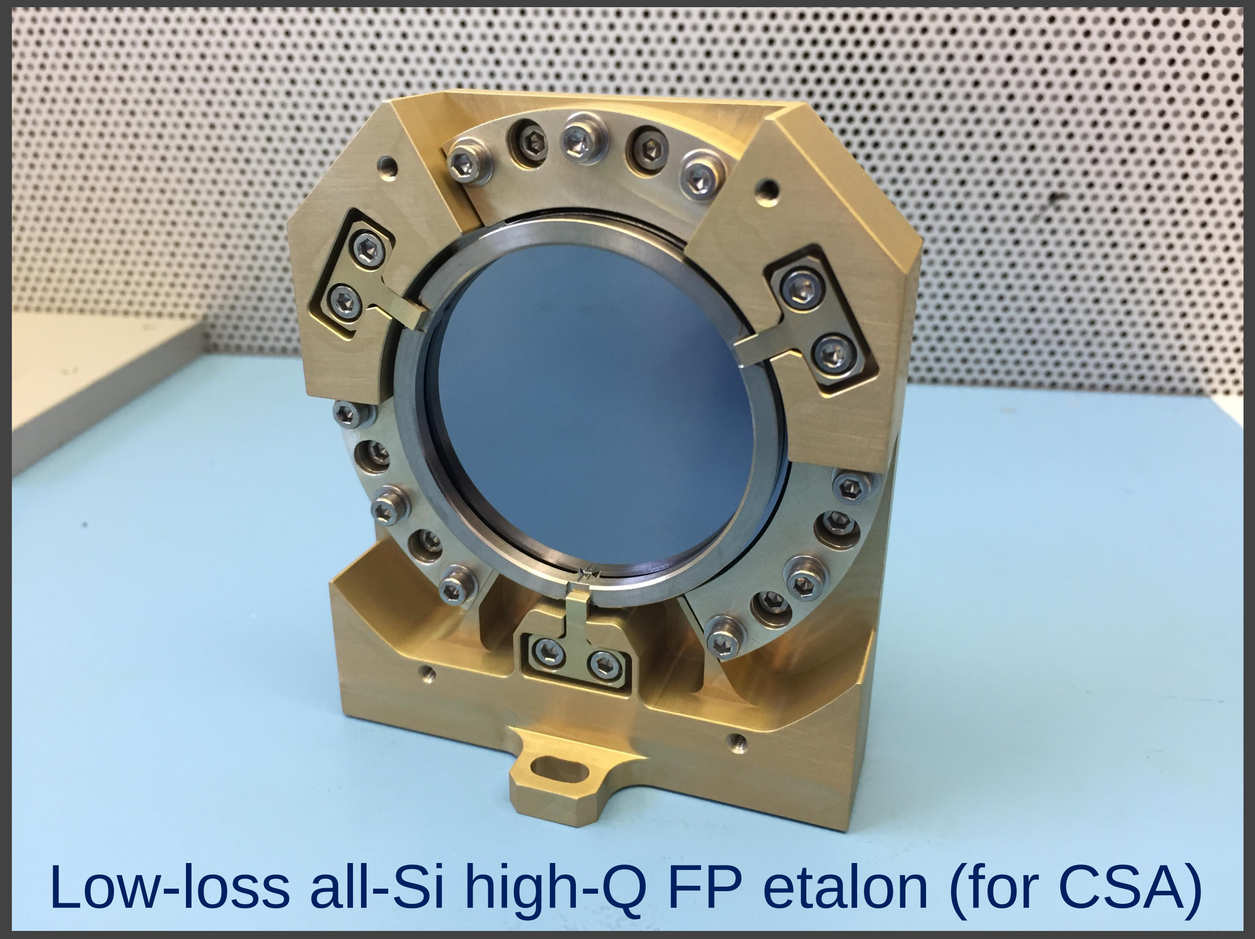


Silicon Micro-machined Dispersive and Planar Integrated Optics

Synthetic dielectric (DRIE in HRFZ-Si)

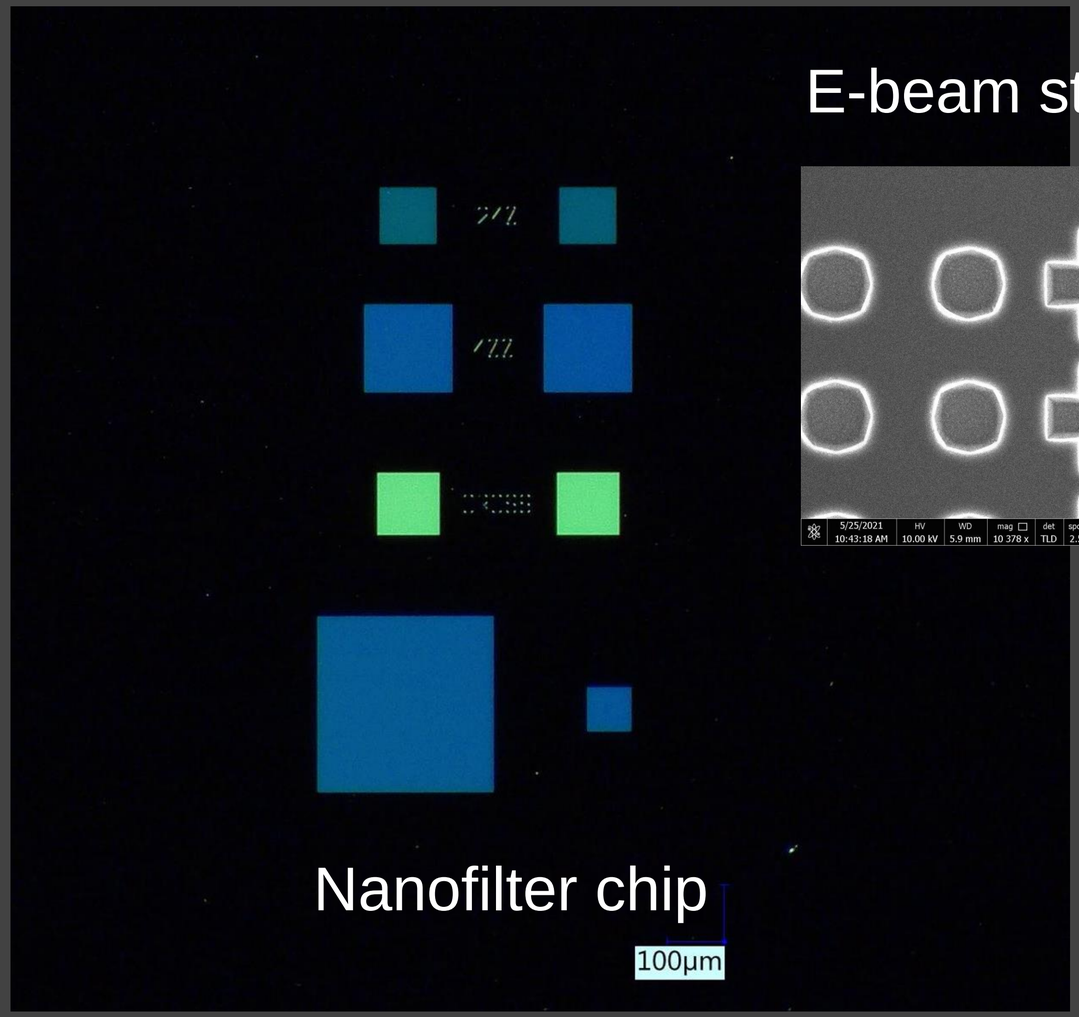


Goal: R~10^5 in the far-IR (PPD science)



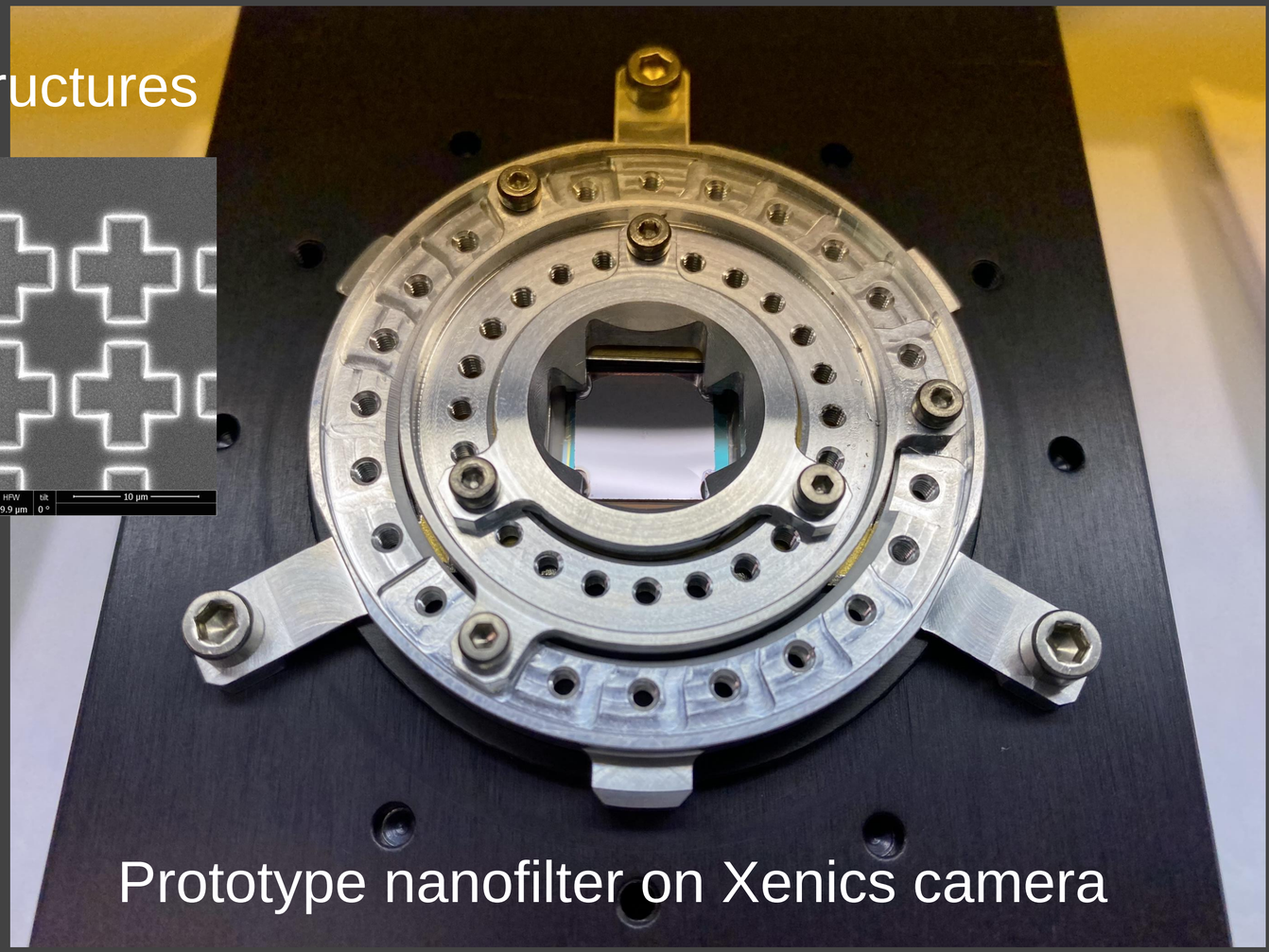
Low-loss all-Si high-Q FP etalon (for CSA)

Compact Earth Observations Instruments: Compressive Sensing with Nanofilters



Nanofilter chip

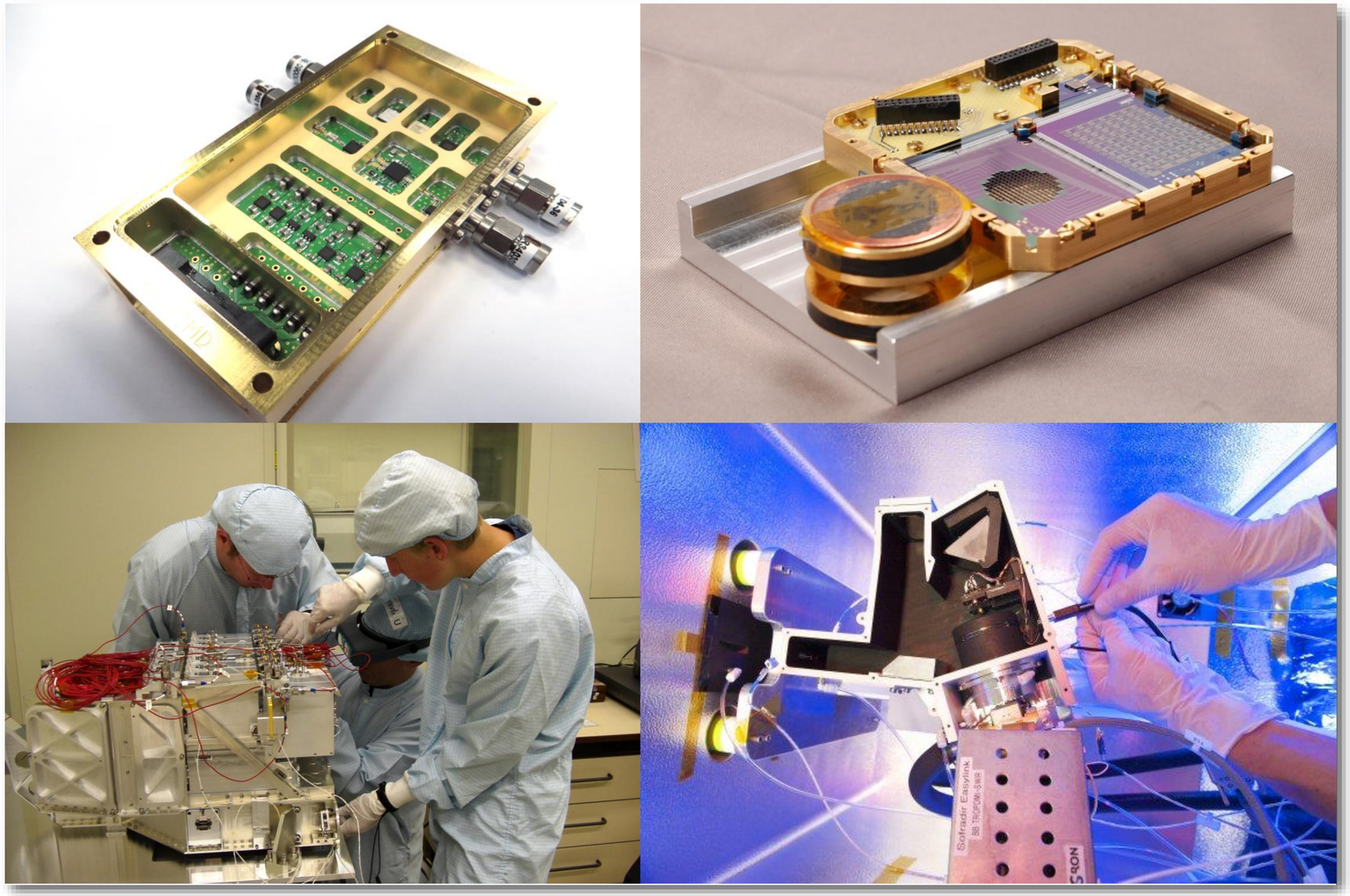
E-beam structures



Prototype nanofilter on Xenics camera

Goal: ultra-compact imaging spectrometers measuring trace gases

SRON Engineering Group



- Based in both Leiden (50 persons) and Groningen (10 persons)
- Extensive space experience (Electronics, Mechanical, Software)
- State of the art mechanical and electronic space production facilities
- Signal Chain Electronic knowledge
- Quality group PA/QA

Development, Training, and Knowledge Transfer

AIRBUS
PHOTONIS
ASML
SystematIC
veldlaser
AimValley
cosine measurement systems
SUMIPRO bv Submicron lathing
PMP Precision Mechanical Production
STT PRODUCTS B.V.
s[&]t dependable solutions
ceratec TECHNICAL CERAMICS BV
PHILIPS Innovation Services
NEWAYS
NTS MECON
Shell Nederland
TNO innovation for life
NORTHERN NETHERLANDS REGION OF SMARTFACTORIES
VDL VDL Enabling Technologies Group
ISIS
Holland.
Holland High Tech
Global Challenges, Smart Solutions

Come work with us!

SRON ILO: Paul Hieltjes

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