

Norwegian Network on Radiation Detection and Imaging Technology

Presentation for ERDIT Workshop,
11-12. April 2016 in Athens

Dirk.Meier@ideas.no in behalf of the

Norway Network on Radiation Detection and Imaging Technology



Source: IDEAS

Overview

Norway Network for Radiation Detection and Imaging Technology (tentatively NORDIT, www.nordit.no)

1	UiO	University of Oslo, www.mn.uio.no/fysikk	University
2	UiB	University of Bergen, www.uib.no/ift	University
4	SINTEF	SINTEF Minalab, Oslo, www.sintef.no/en/all-laboratories/minalab/	Research Organization
5	IFE	Institute for Energy Technology, www.ife.no	Research Foundation
6	EnSol	Ensol AS, Bergen, www.ensol.no	SME
7	IDEAS	Integrated Detector Electronics AS, Oslo, www.ideas.no	SME

R&D strategy and funding

1	NRC	Research Council of Norway, Oslo, www.forskningsradet.no	Governmental
2	NSC	Norwegian Space Center, Oslo, www.romsenter.no	Governmental

Purpose of the Network

NORDIT is inspired by ERDIT www.erdit.eu , and inherits its **mission** from ERDIT www.erdit.eu/content/erdit-mission-0

The **background** for the activity is in www.erdit.eu/content/background

NORDIT goals and purpose are (extracted from www.erdit.eu/content/background)

1. To create an academy-industry platform to address the key scientific challenges for development of high-performance radiation detectors.
2. To coordinate the research on radiation detectors and build an industrial competitive edge at European level.
3. To facilitate access to national and international R&D funding.
4. To promote a detector roadmap for future research and innovation.

UiO – University of Oslo



Department of Physics, www.mn.uio.no/fysikk

Nuclear Physics, Particle Physics, Electronics

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Projects

Upgrade of the LHC experiments at CERN

Radiation effects in electronics components

Instrumentation for OCL (Oslo Cyclotron Laboratory)

Instrumentation for other CERN experiments: ISOLDE, AEGIS

UiB – University of Bergen



Department of Physics and Technology, www.uib.no/ift

Nuclear Physics, Particle Physics, Space Physics, Microelectronics

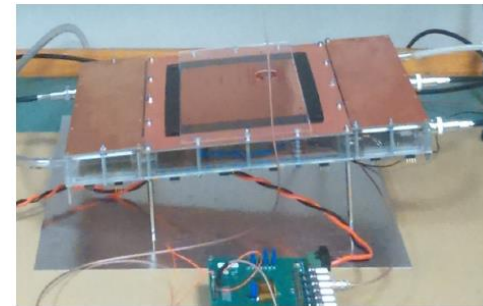
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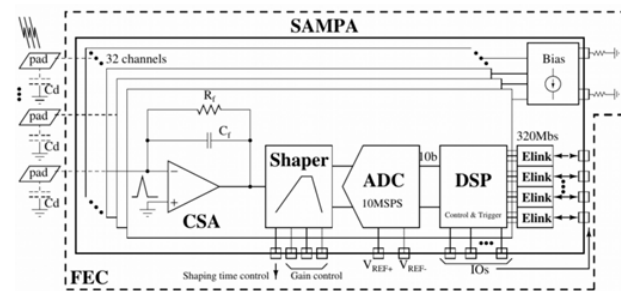


Projects

Upgrade of the LHC experiments at CERN,
prototyping of tracking detector systems (Si-pixels, GEMs)

Readout-ASIC design, system integration

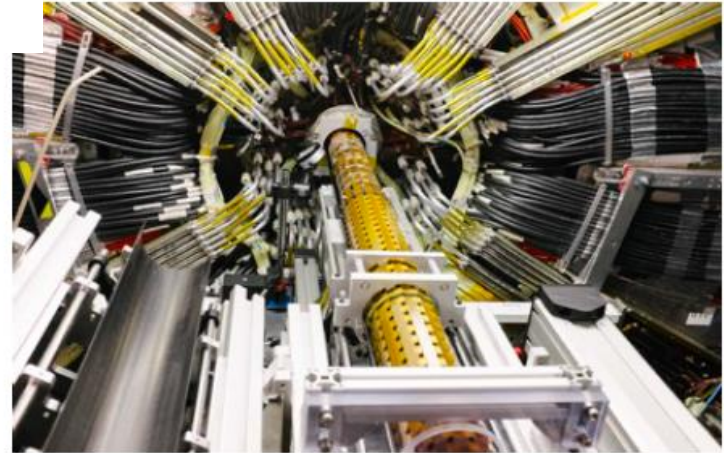
Prototyping of sampling calorimeters
(Si-pixel or scintillator/Si-PM readout)



UiO + UiB R&D in Particle Physics Radiation Detectors

Physics Departments at the Universities of Oslo, www.mn.uio.no/fysikk, and Bergen, www.uib.no/ift

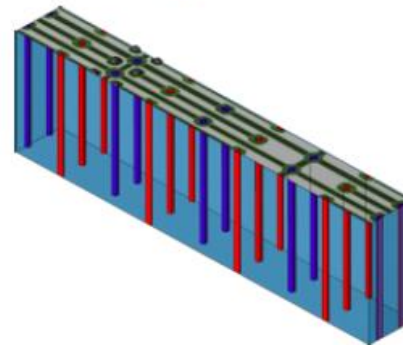
- ALICE Inner Tracking System (MAPS technology)
- ATLAS Semiconductor Tracker (strip) and IBL (pixel)
- ATLAS Inner Tracker (Si 3D sensor), 2015 testbeam operation, new sensors expected autumn 2016 (SINTEF)
- AEGIS (direct H-bar annihilation detector), silicon strip to be finished spring 2016 (with SINTEF and IDEAS)
- New results for 3D MiMiC (10 μm thick) for dosimetry (lead by SINTEF) *JINST 10 (2015) P11007*
- Interesting applications in various areas such as medical and space physics



ATLAS Silicon pixel Inner B-Layer (IBL) installation

Challenges & Interests :

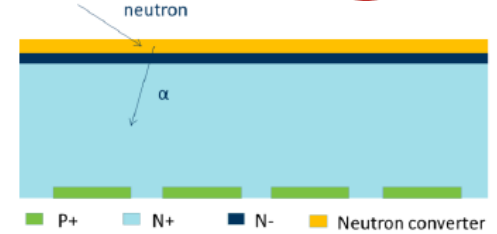
- Very radiation hard detectors
- Fast charge collection, fast & sparse readout
- Large active areas, sensors with active edge
- Cryogenic operation (77 K, 4 K), UHV
- New geometries & new materials
- Thin (< 40 μm) & thick sensors (future)
- Complex large scale and small scale structures



ATLAS 3D pixel R&D



UiB + UiO Radiation Detector R&D



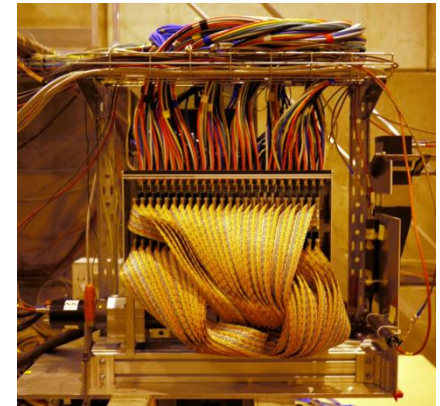
Instrumentation for ESS

high-resolution silicon-based neutron detectors (in collaboration with SINTEF)

Instrumentation for Particle Therapy centers, e.g.

3D microdosimeters
(in collaboration with SINTEF)

Proton-CT prototype (based on MAPS)



Space instrumentation

X-ray and gamma detectors
(satellite/balloon experiments)



SINTEF MiNaLab is a Micro- and Nanotechnology Laboratory in Oslo, Norway

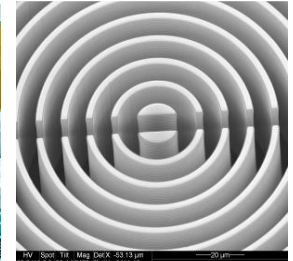
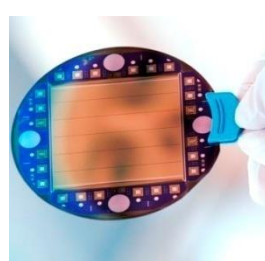
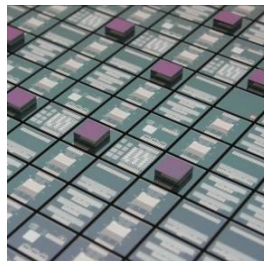
www.sintef.no/en/all-laboratories/minalab/

Contacts: Fabrice.Lapique@sintef.no, angela.kok@sintef.no,

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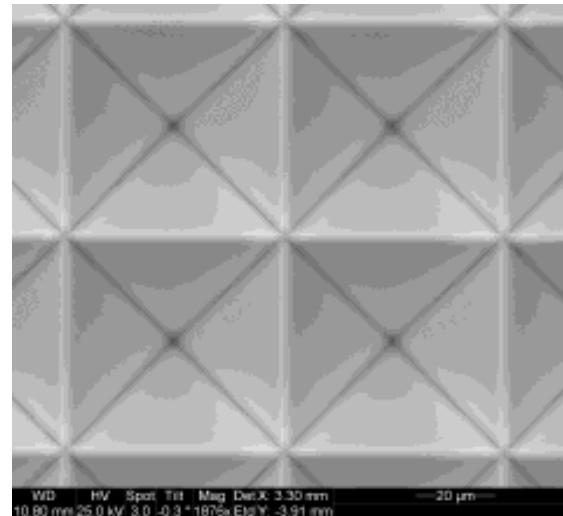
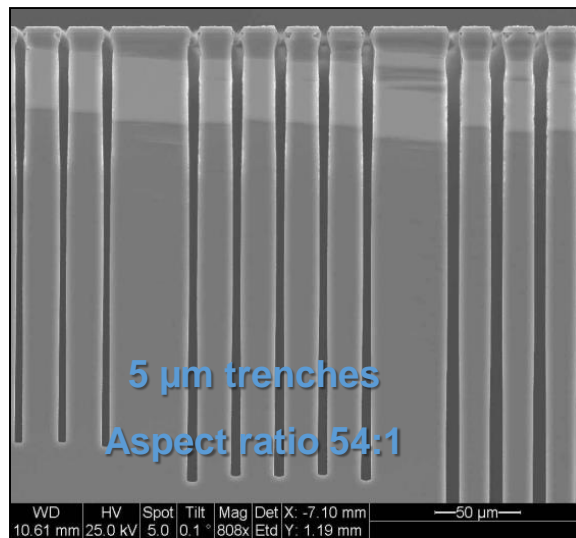
- Clean room facilities of 800 m²
- Silicon production line with capacity of 10.000
 - 150 mm wafers
 - Micro-environments with class 10
- The most advanced laboratory in Norway for micro- and nanotechnology, situated on the campus of UiO
- Over 30 years experiences in advanced silicon radiation detectors
- Unique expertise in micromachining and micro-electro-mechanical systems (MEMS)



SINTEF MiNaLab MEMS Technologies for 3D Silicon Detector Processing



- DRIE- Deep Reactive Ion Etching (Bosch process)
- TMAH wet etching of Si
- Wafer bonding (fusion, anodic, Al-Al, BCB, plasma,...)
 - Double & triple stack
- Through-silicon vias based on doped polysilicon



www.sintef.no/en/all-laboratories/minalab/

SINTEF MiNaLab – Ongoing Sensor R&D Projects

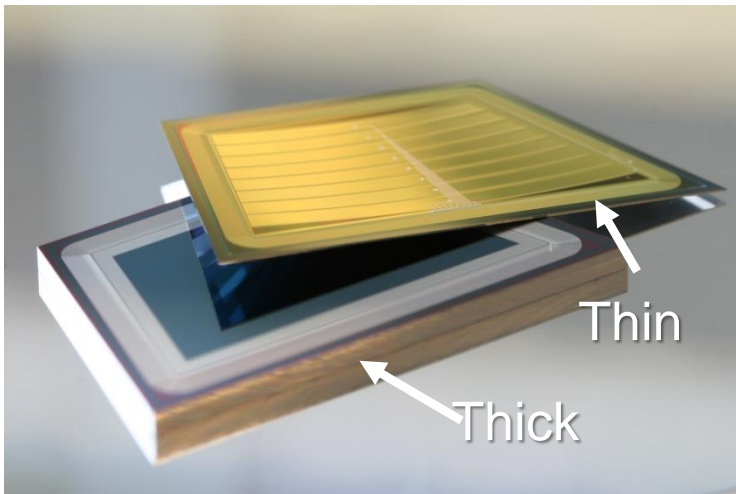
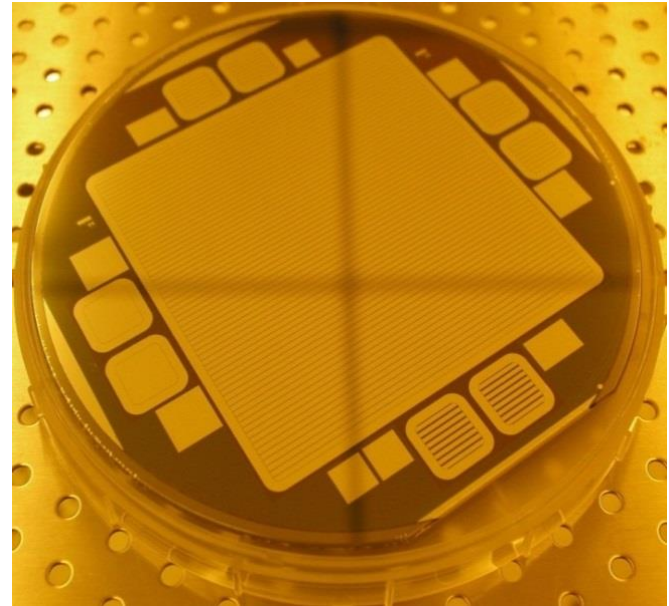


Project name/description	Partners	Funding
3D SOI thin sensors for radiation monitoring in space and other space science applications	SINTEF	ESA
Edgeless and slim edge planar silicon sensors	SINTEF	Internal
3D silicon sensors for the ATLAS upgrade	SINTEF, UiO	NRC
Advanced detectors for better awareness of neutrons and gamma rays in environment	CTU, SINTEF, IDEAS	NRC, EEA
Silicon-based 3D mini and microdosimetry	SINTEF, UiO, UiB, ESRF, CMRP, Manchester	NRC
GraSeRad - Graphene integrated with semiconductor devices for high performance radiation detection	SINTEF, UiO, NTNU, IDEAS, (Purdue University, University of Michigan)	NRC

www.sintef.no/en/all-laboratories/minalab/

SINTEF MiNaLab – Other Radiation Sensor Products & Technologies

- Silicon Drift Diodes (SDDs)
- PIN diodes
- Single- and double sided strip detectors
 - DC – readout
 - AC – readout (FOXFET, Polysilicon resistors)
- Pixel detectors (including Medipix)
- Photo diodes 190 to 1100 nm spectral range
 - PIN-diodes, quadrants and arrays
 - Avalanche photodiodes (reach through structure)



- Emerging research areas @ SINTEF:
 - Non-Si sensor substrates: SiC, diamond, CdZnTe
 - Photodetectors based on graphene and other nanomaterials

www.sintef.no/en/all-laboratories/minalab/

Sensor thicknesses from 10 μm to 2 mm

IFE - R2D2

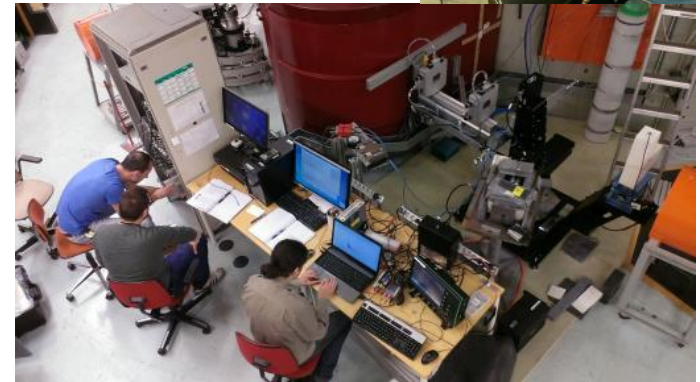


IFE is the Institute for Energy Technology in Norway, www.ife.no
R2D2 is Test Beamline at JEEP II Reactor at Kjeller, Norway,
<https://www.ife.no/en/ife/departments/physics/projects/r2d2>

Contact: Isabel Llamas-Jansa, isabel.llamas@ife.no

The main goal is to provide a dedicated beam channel for testing of detectors and the development of new neutron techniques relevant to ESS.

- R2D2 is a collaboration between IFE and ESS
- The focus of R2D2 is testing new detection technologies such as ^{10}B -based detectors, scintillators and GEMS
- R2D2 tests materials for neutron guides and radiation shielding



IFE- NcNeutron



IFE is the Institute for Energy Technology in Norway, www.ife.no
NcNeutron is the Norwegian Center for Neutron Research

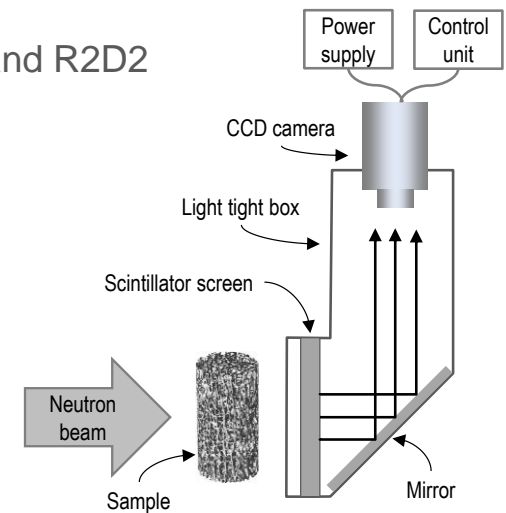
Contact: bjorn.hauback@ife.no

Funded by the Research Council of Norway within the INFRASTRUKTUR program

- A new state-of-the-art neutron reflectometer based on the RAINBOWS concept
- A new cold moderator in JEEP II for neutron reflectometry and small angle neutron scattering (SANS)
- A versatile neutron imaging and tomography setup
- A modern residual stress neutron diffractometer
- The already existing neutron instrumentation: SANS, ODIN, DIFF and R2D2

Neutron imaging and tomography setup

- adapted to a variety of sample sizes (maximum 20x20x15cm)
- with a rotating sample stage
- beam area of 20 cm x 20 cm



EnSol – R&D for Neutron Detector



EnSol AS researches and develops new techniques and applications in nanotechnology and nano-material engineering, <http://www.ensol.no>
Contacts: Claudia.Aguirre@EnSol.no, Phil.Denby@EnSol.no



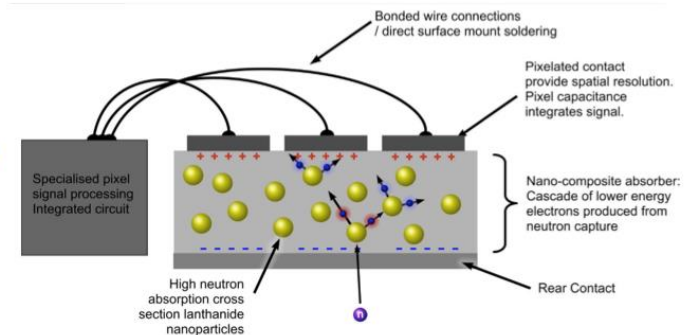
Institute for Energy Technology

LaNNDe

Lanthanide Based Nano-Composite Solid State Neutron Detector

Objective: To develop a commercially viable neutron imaging detector (including signal processing electronics) for medical & research applications

With the neutron-absorbing nuclei (lanthanide nanoparticles) inside the detector volume (rather than on the surface) it is expected that LaNNDe achieve the same efficiency as the ^3He gas tubes.



R&D challenges:

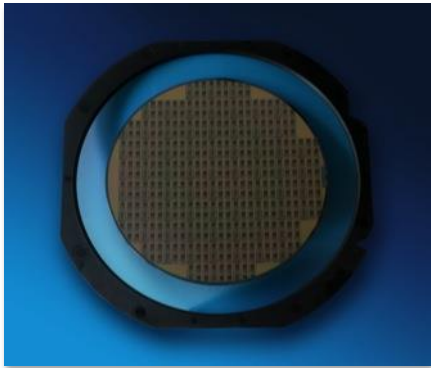
- **Nanoparticle** (composition, concentration, neutron absorption, size, shape, etc.)
- **Encapsulating matrix** (band gap, dielectric permittivity, volume fraction, compatibility with the nanoparticles)
- **Electrical contacts** (conductivity, diffusion, Schottky barriers, work function)
- **Signal processing electronics** (pixelation)

IDEAS – Radiation Detection and Imaging Technology

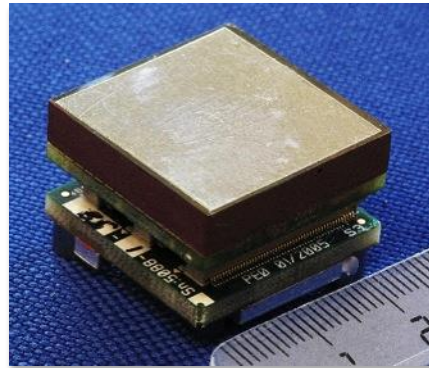


IDEAS develops radiation detection and imaging subsystems with proprietary readout technology for harsh environments, www.ideas.no

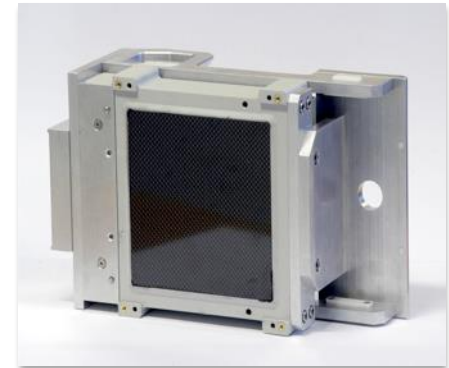
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Readout ICs
and ASICs



Radiation
Detector Modules



Gamma
Cameras

www.ideas.no -> Products

IDEAS – Space R&D Projects



Project	Partners	Funding
JUICE RADEM ASIC, IDE3466, Proc. SPIE Astro 2016, and EGU 2015, adsabs.harvard.edu/abs/2015EGUGA..1711661H	EFACEC, LIP, PSI, ESA, IDEAS	ESA, NSC
NIRCA – Near Infrared Readout Controller ASIC, Proc. SPIE 9451, IR Techn., dx.doi.org/10.1117/12.2180439	IDEAS	ESA, NSC
SIPHRA – Silicon Photomultiplier Readout ASIC, IDE3380 Proc. AMICSA 2016	IDEAS	ESA, NSC
AMADEUS – MCP Readout ASIC, IDE1180, www.ideas.no/products/ide1180-amadeus	IDEAS	
Others	IDEAS + partners	Eurostars, H2020

IDEAS **designs** integrated circuits for the readout and control of radiation detectors and imaging arrays. The circuits have been developed originally for specific technologies and applications; the specifications might also meet other than the original requirements. The circuits are available as bare dice or packaged chips and can be sold from stock or can be manufactured within a short time.

www.ideas.no/downloads/

Thank You

NORDIT - Norway Network for Radiation Detection and Imaging Technology



Source: IDEAS