

UiO : **Institutt for informatikk**

Det matematisk-naturvitenskapelige fakultet

ELITE – Signal Processing and Imaging

CS – Imaging and Biomedical Computing

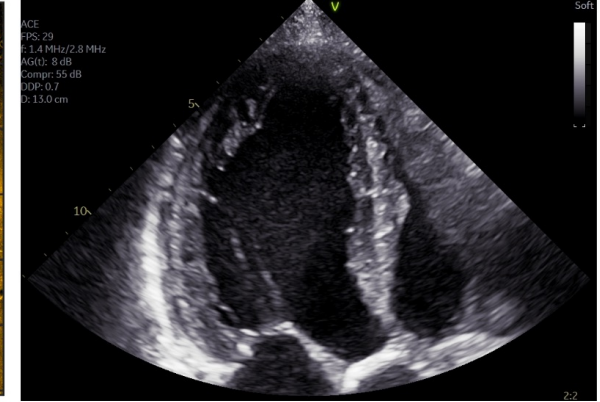
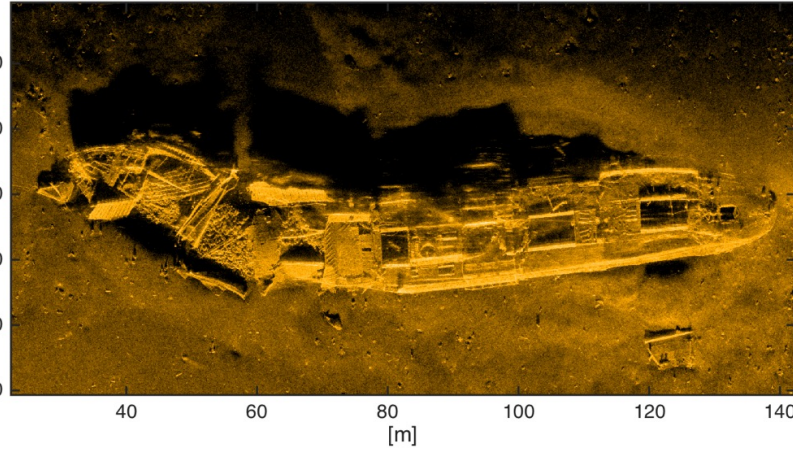
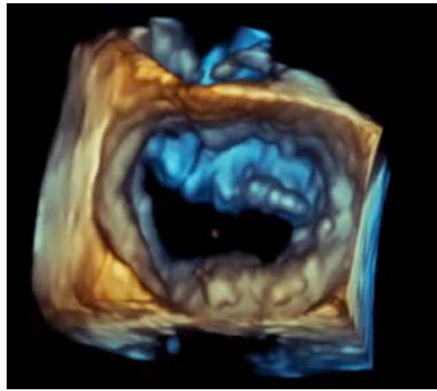
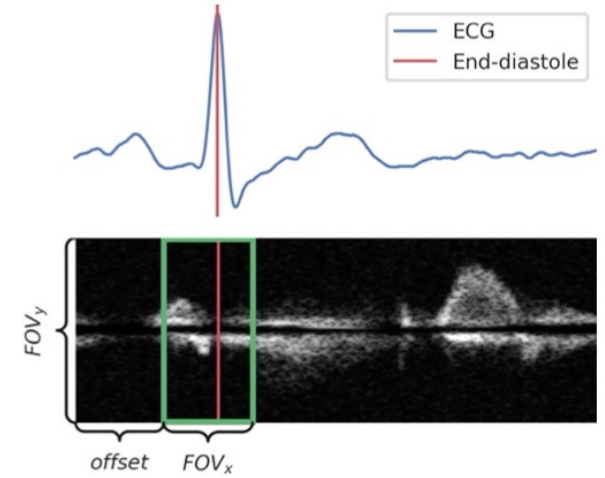
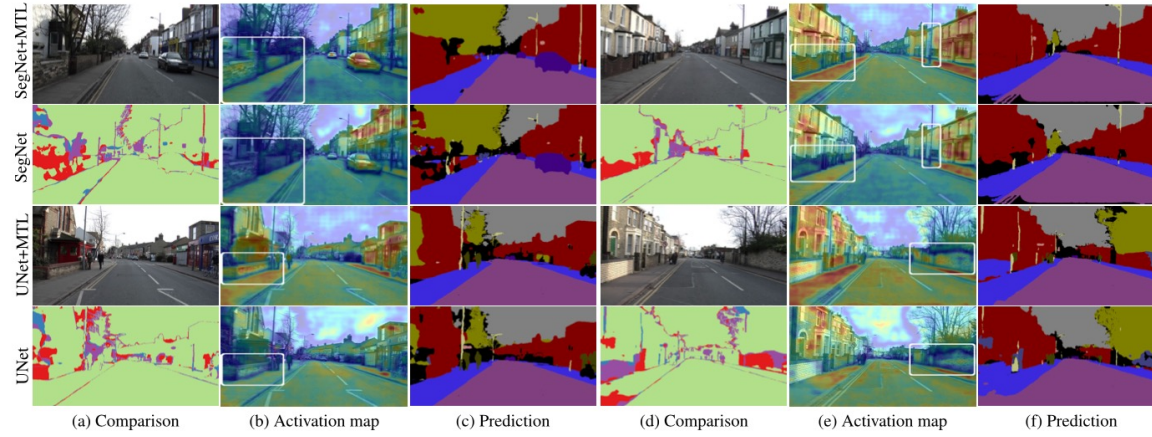
DS – Digital Image Processing

Course aspects, Research, ... and beyond

16 August 2022



The Digital Signal Processing and Image Analysis research group (DSB)



(d) Case example 5: ALAX - Aberration correction

DSB group key research areas

- Signal processing & beamforming *e.g., algorithms to generate images from collected data*
- Deep learning & Image processing *e.g., algorithms to make sense of images*

Key applications

- Image analysis in, e.g., remote sensing & medical
- Medical ultrasound
- Sonar
- Infrasound & atmospheric probing

ELITE

Signal Processing and Imaging

Eksempel 1

4. semester	Masteroppgave	Masteroppgave	Masteroppgave
3. semester	Masteroppgave	Masteroppgave	Masteroppgave
2. semester	Masteremne	Masteremne	Masteremne
1. semester	Masteremne	Masteremne	Masteremne
	10 studiepoeng	10 studiepoeng	10 studiepoeng

Eksempel 2

4. semester	Masteroppgave	Masteroppgave	Masteroppgave
3. semester	Masteremne	Masteroppgave	Masteroppgave
2. semester	Masteremne	Masteremne	Masteroppgave
1. semester	Masteremne	Masteremne	Masteremne
	10 studiepoeng	10 studiepoeng	10 studiepoeng

- Mandatory:**
- IN4015 – Ultrasound Imaging
 - IN5340 – Statistical Signal Processing

CS

Imaging and Biomedical Computing

Example

4. semester	Master's thesis	Master's thesis	Master's thesis
3. semester	Master's thesis	Master's thesis	Master's thesis
2. semester	IN4200 – High-Performance Computing and Numerical Projects / Mandatory course	Elective course	Elective course
1. semester	FYS-STK4155 – Applied Data Analysis and Machine Learning / Mandatory course + HSE courses	MAT4110 – Introduction to Numerical Analysis / Elective course	Elective course
	10 ECTS credits	10 ECTS credits	10 ECTS credits

- Mandatory, 2 out of:**
- IN4200 – High-Performance Computing and Numerical Projects
 - FYS-STK4155 – Applied Data Analysis and Machine Learning
 - MAT4110 – Introduction to Numerical Analysis

DS

Digital Image Processing

Recommended plan with a master's thesis of 60 ECTS credits

4. semester	Master's thesis		
3. semester	Master's course / Master's thesis	Master's course / Master's thesis	Master's course / Master's thesis
2. semester	Master's course / Master's thesis	Master's course	Master's course
1. semester	Master's course	Master's course	Master's course
	10 ECTS credits	10 ECTS credits	10 ECTS credits

- Mandatory:**
- STK-IN4300 – Statistical Learning Methods in Data Science
 - IN-STK5000 – Adaptive methods for data-based decision making
- Recommended:**
- IN5520 – Digital Image Analysis
 - IN5400 – Machine Learning for Image Analysis

Study build-up

- **Deadline registration teaching & exams: 18 August 2022**
- **Study direction compositions:**
 - **ELITE** – Signal Processing and Imaging:
<https://www.uio.no/english/studies/programmes/electrical-engineering-master/programme-options/signal-processing/index.html>
 - **CS** – Imaging and Biomedical Computing:
<https://www.uio.no/english/studies/programmes/computational-science-master/structure/index.html>
 - **DS** – Digital Image Processing:
<https://www.uio.no/english/studies/programmes/datascience-master/structure/>
- **Courses recommended by the Digital Signal Processing & Image Analysis team:** <https://www.mn.uio.no/ifi/english/research/groups/dsb/studies/courses/index.html>

Master's thesis (60 credits)

- Independent, scientific research
- Corresponds to 1 study year completed by: written thesis, oral presentation & oral examination
- Opportunity to specialize in a chosen research topic
- Recommended course may vary depending on programme option, project, & supervisor

Deadline 1. December!

Study agreement, project description and research plan. For some this can be even ~early October!

- **ELITE students: writing course in early autumn, starting off an MSc project plan**
- **CS students: Essay as first part of MSc**

⇒ **Start looking for a supervisor and Master's thesis topic early!**

Database of project suggestions: <https://www.mn.uio.no/ifi/studier/masteroppgaver/dsb/>



Algorithms & methods to make better images and characterization



Digital signal processing and image analysis group (DSB)

Permanent



Anne



Alex



Peter



Andreas



Adín



Yücel



Fritz
emeritus

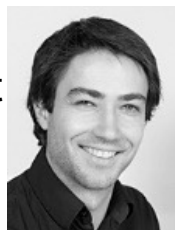


Sverre
@physics

Group
leader

Section
leader

Adjunct



Are
(NR)



Andreas
(ICGI/OUS)



Håvard
(ICGI/OUS)



Eigil
(GEVU)



Roy
(FFI)



Alan
(U. Bath)

PhDs & Postdocs

Postdocs:

- Ole Marius Hoel Rindal, CIUS
- Sarina Thomas, Postdoc, EchoAI with GEVU

PhD and Postdoc fellows recently joined:

- Gabor Gereb, KM collaboration PhD
- Håvard Kjellmo Arnestad, Dept PhD grant
- James Claxton, Visual Intelligence SFI PhD
- Fabian Bull, Visual Intelligence SFI PhD
- Marius Aasan, Visual Intelligence SFI PhD
- Dhananjay Tomar, UiO dScience PhD
- Martine Tan, Dept PhD grant

Internal PhDs:

- Børge Solli Andreassen, INIUS (MN)
- Kristine Baluka Hein, KD (MN)
- Tollef Struksnes Jahren, INCUS (NFR/GE)
- Dharani Dhar Maddali, INIUS (MN)
- Mohammad Reza Sajadi, INIUS (MN)
- Ghadi S. Al Jajj, (MN)

External PhDs:

- Sander Bøe Thygesen, (Equanostic / NFR)
- Ole Jacob Lorentzen, (FFI)
- Mujde Akdeniz, MARCIUS (EU/GE)
- Cristiana Tiago, MARCIUS (EU/GE)

Courses @DSB

Signal processing

- IN3190/4190 Digital signal processing
- IN3015/4015 Ultrasound Imaging
- IN5340 Statistical Signal Processing
- IN5450 Array Signal Processing

Image analysis

- IN2070 Digital image processing
- IN5400 Machine Learning for Image Analysis
- IN5520 Digital Image Analysis

Additional course suggestions

<https://www.mn.uio.no/ifi/english/research/groups/dsb/studies/index.html>

Larger collaboration projects

CIUS (Centre for Innovative Ultrasound Solutions)

- SFI hosted by NTNU
- NTNU / GE Vingmed / Kongsberg Maritime / FFI

Visual Intelligence SFI

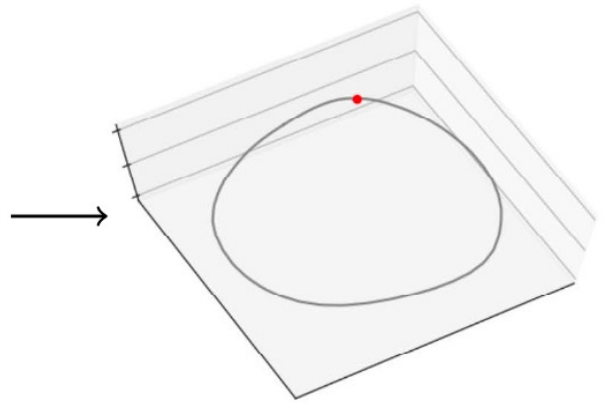
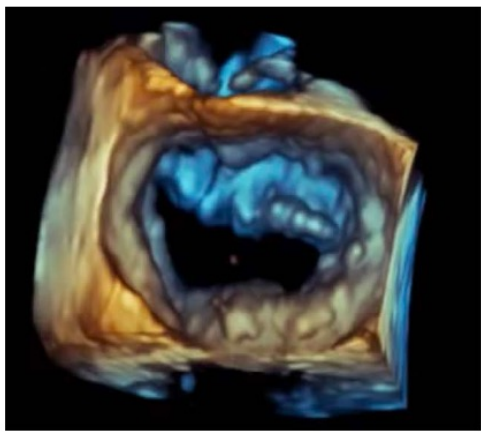
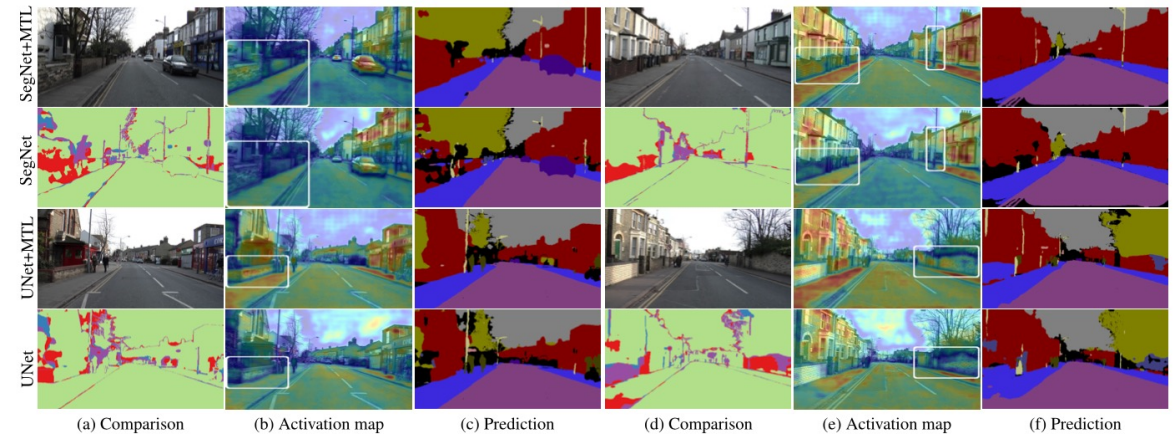
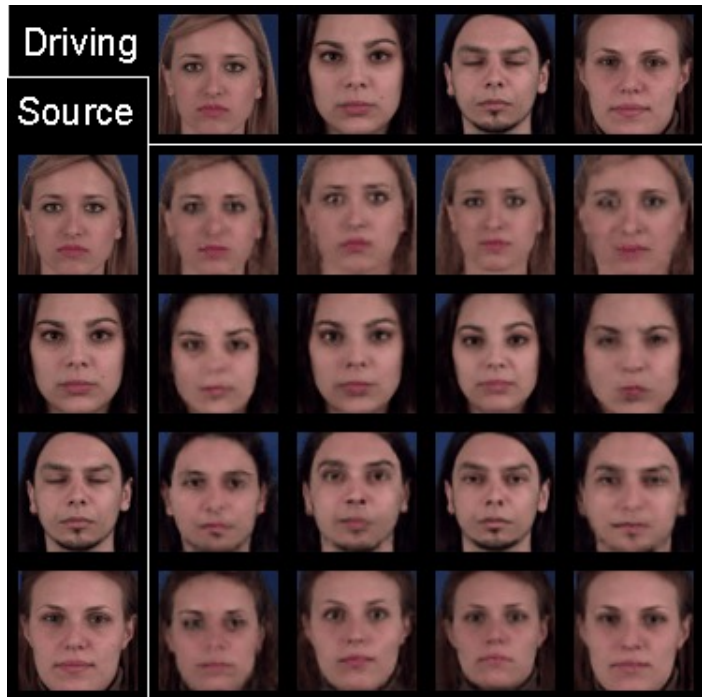
- Hosted by UiT
- Started January 2021
- NR / UiT & GE Vingmed /...

DoMore! (domore.no)

- IKT Lighthouse project (NFR)
- High-impact project just finished, but collaborations continue

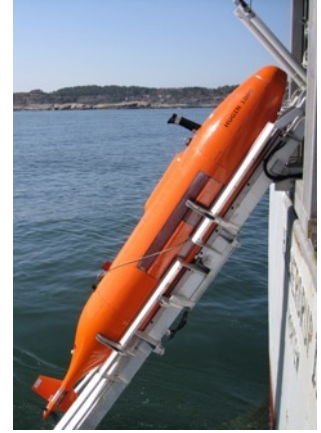
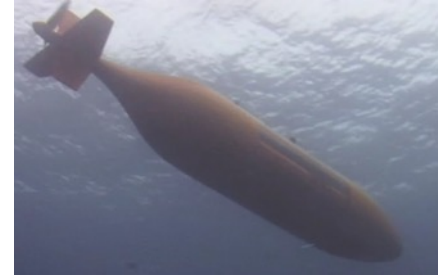
Slides if we have time →

Deep learning, machine learning, image analysis



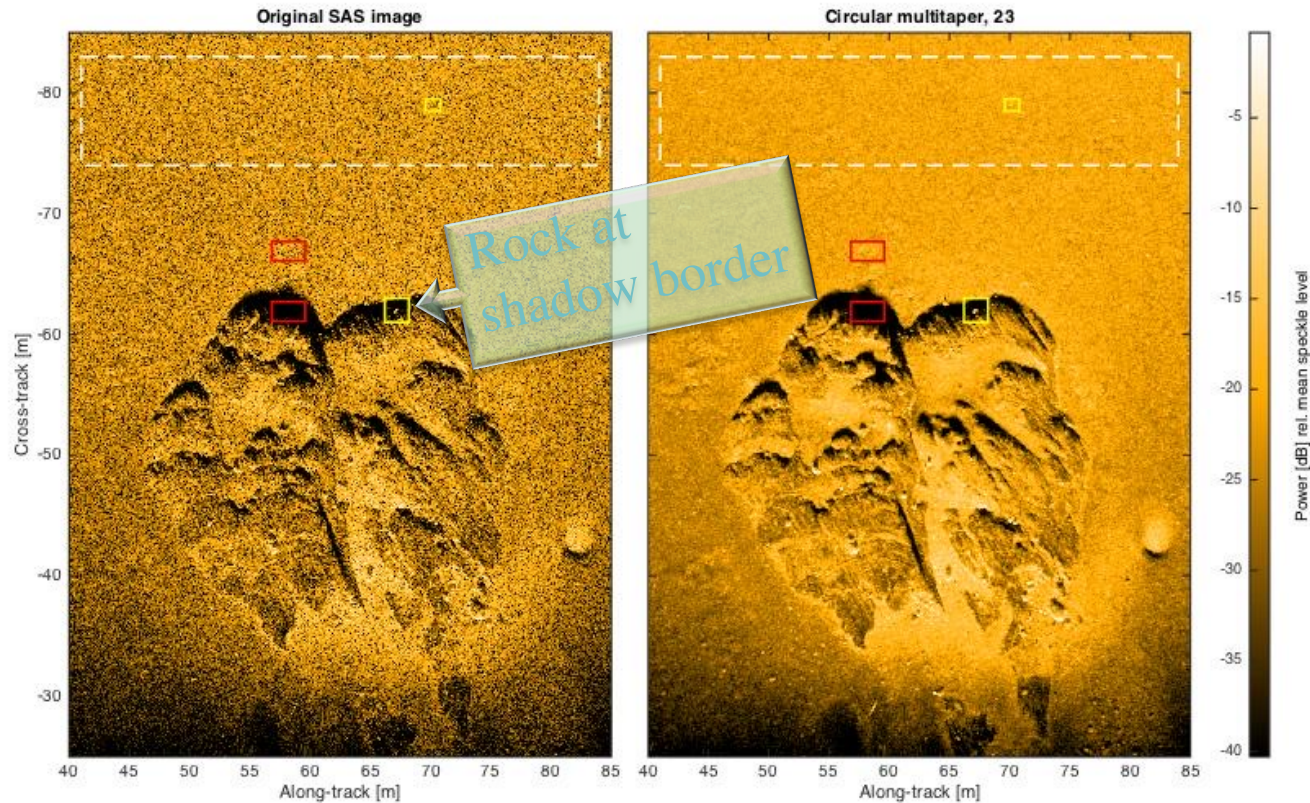
Improved imaging in sonar and ultrasound

- Sonar
 - SAS imaging; Speckle reduction w/improved resolution
 - Gas seep detection
- Ultrasound
 - High resolution imaging with
 - adaptive beamforming
 - USTB: An open source initiative



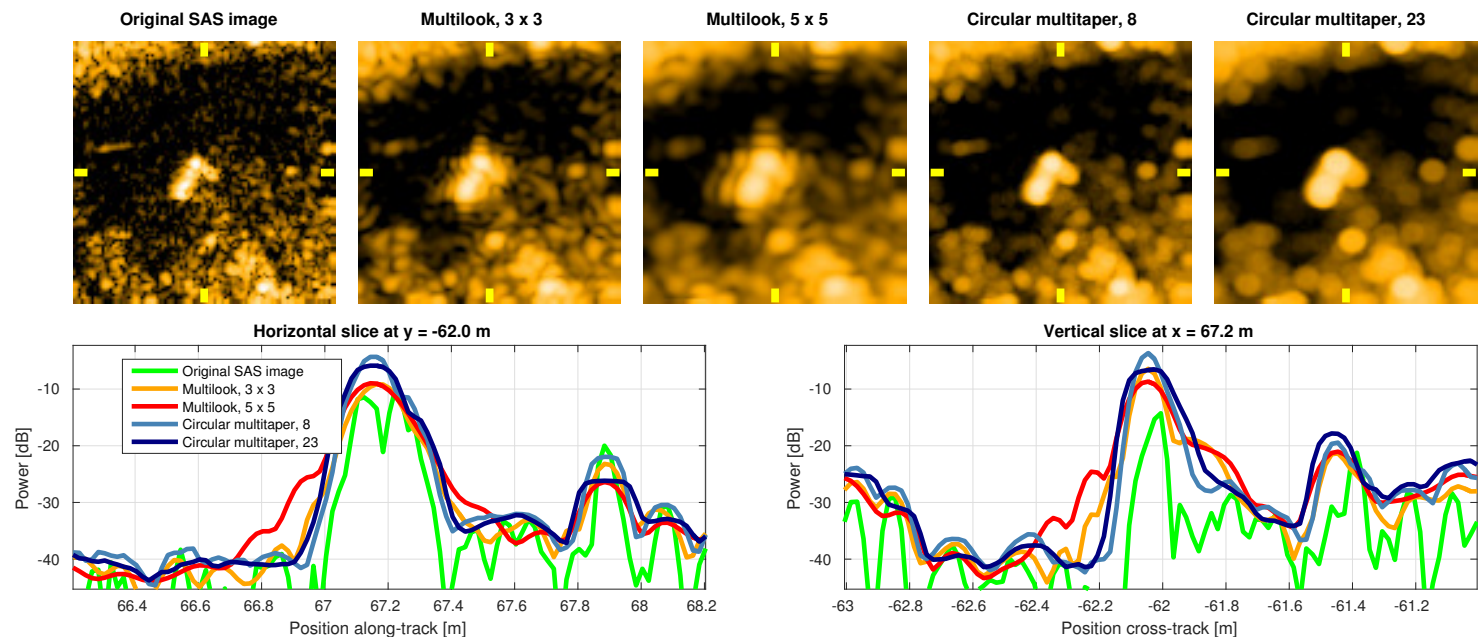
SAS image of a rock formation

Original image and a speckle reduced image



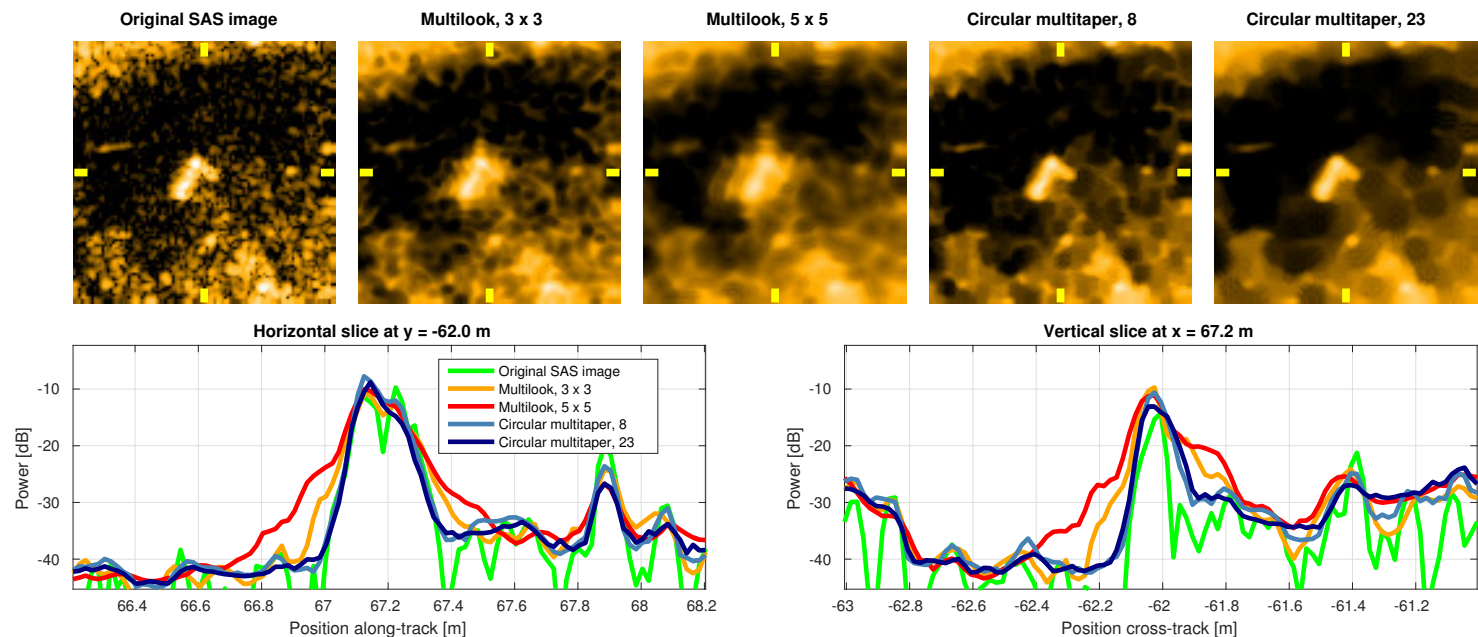
Rock at shadow border, UNSTEERED

Various approaches for speckle reduction

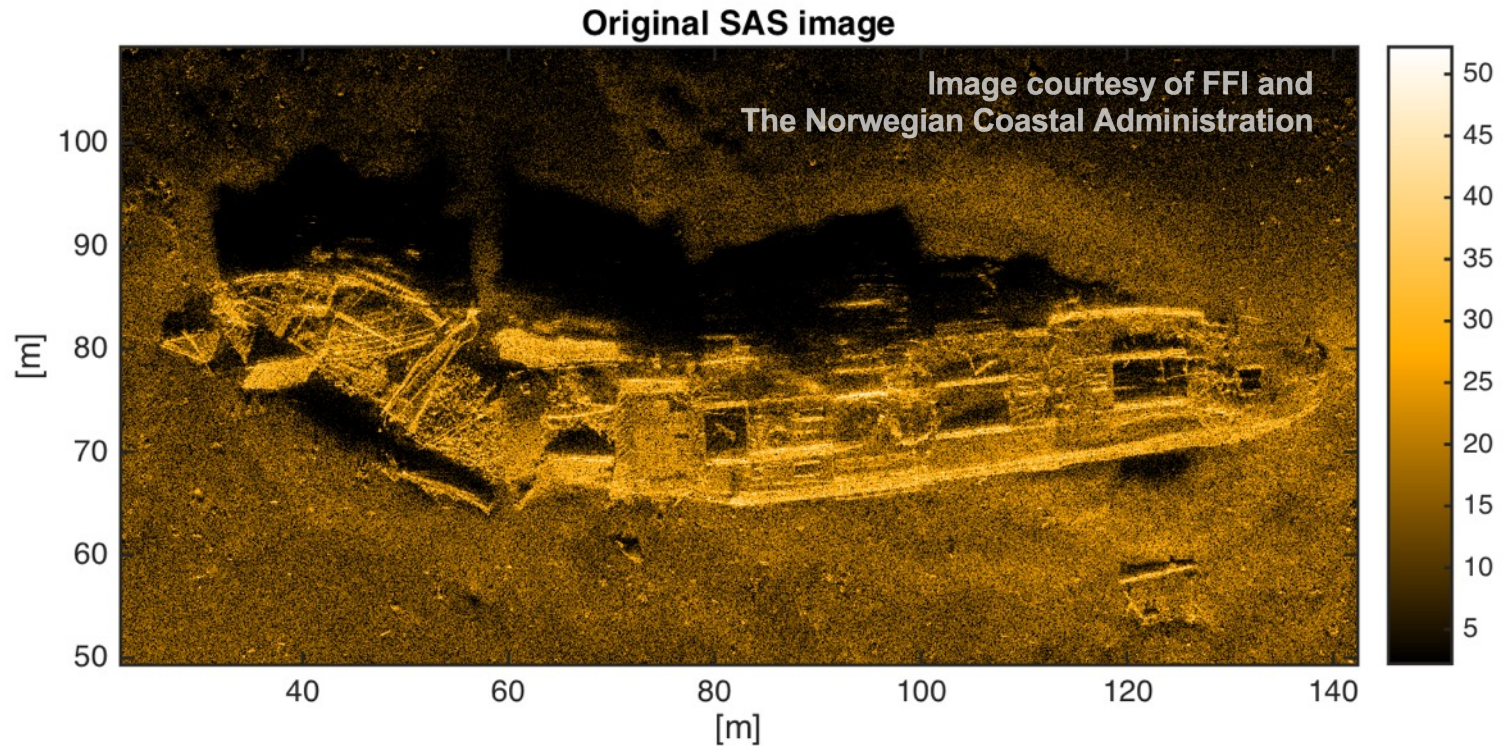


Rock at shadow border, MICRO-STEERED

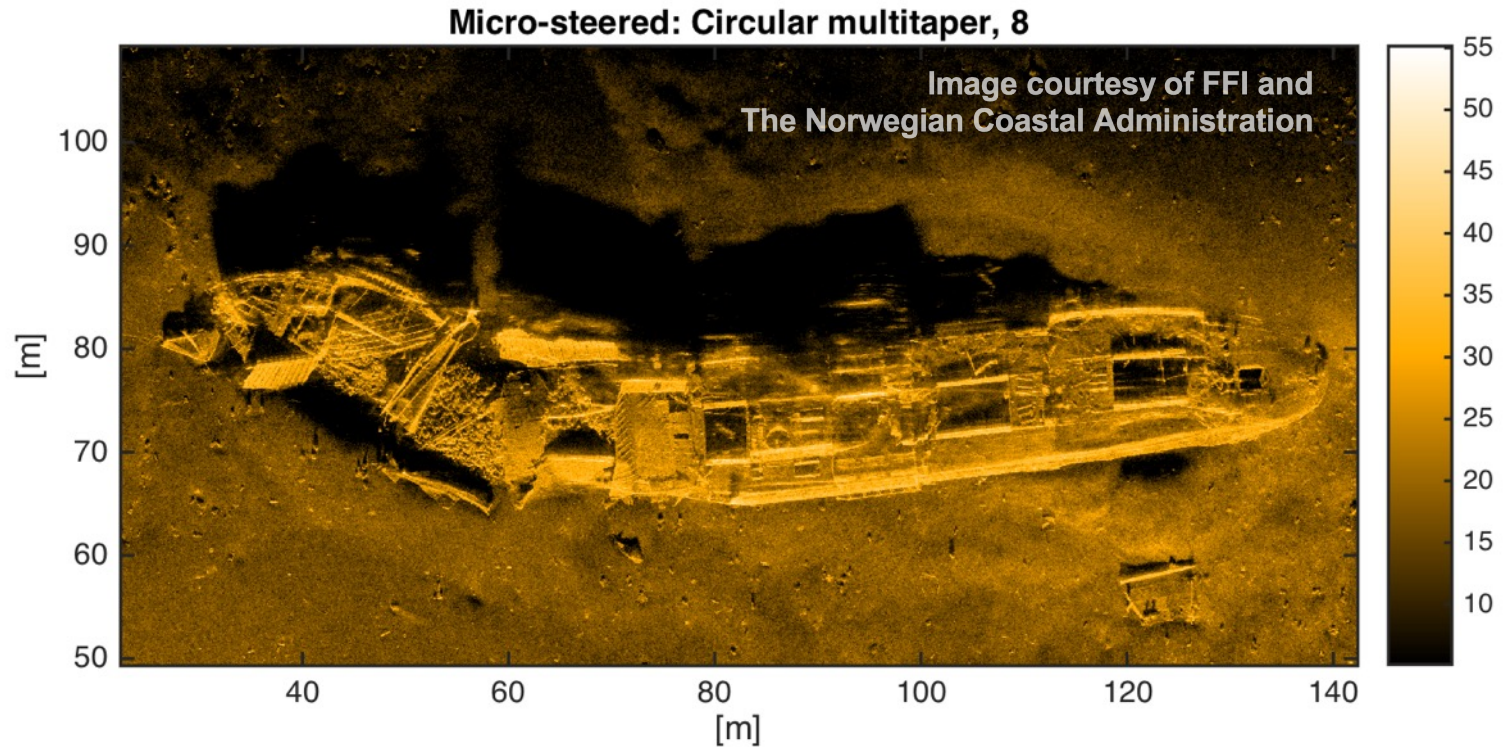
Various approaches for speckle reduction



A complex target; Wreck



A complex target; Wreck ...

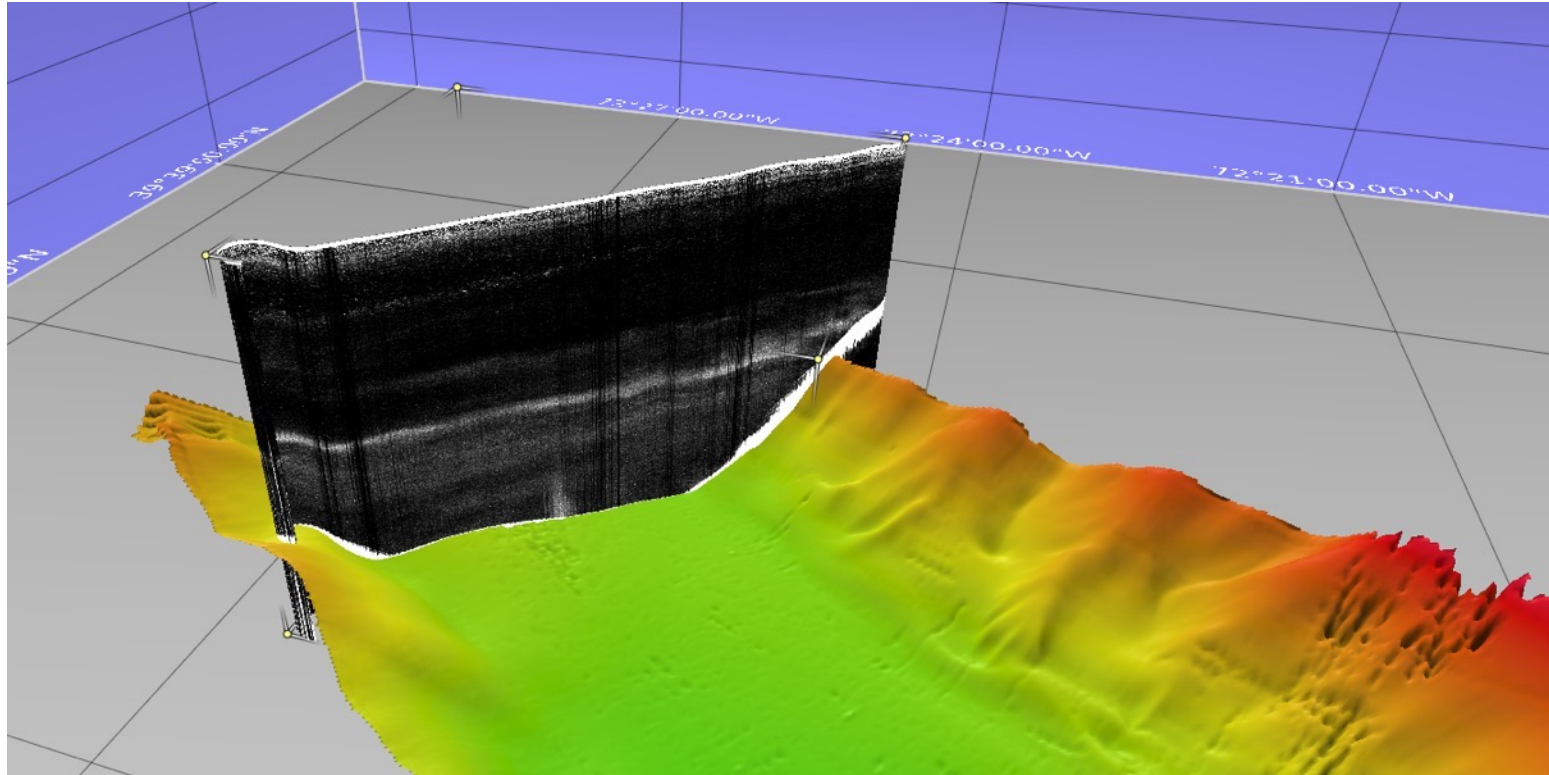




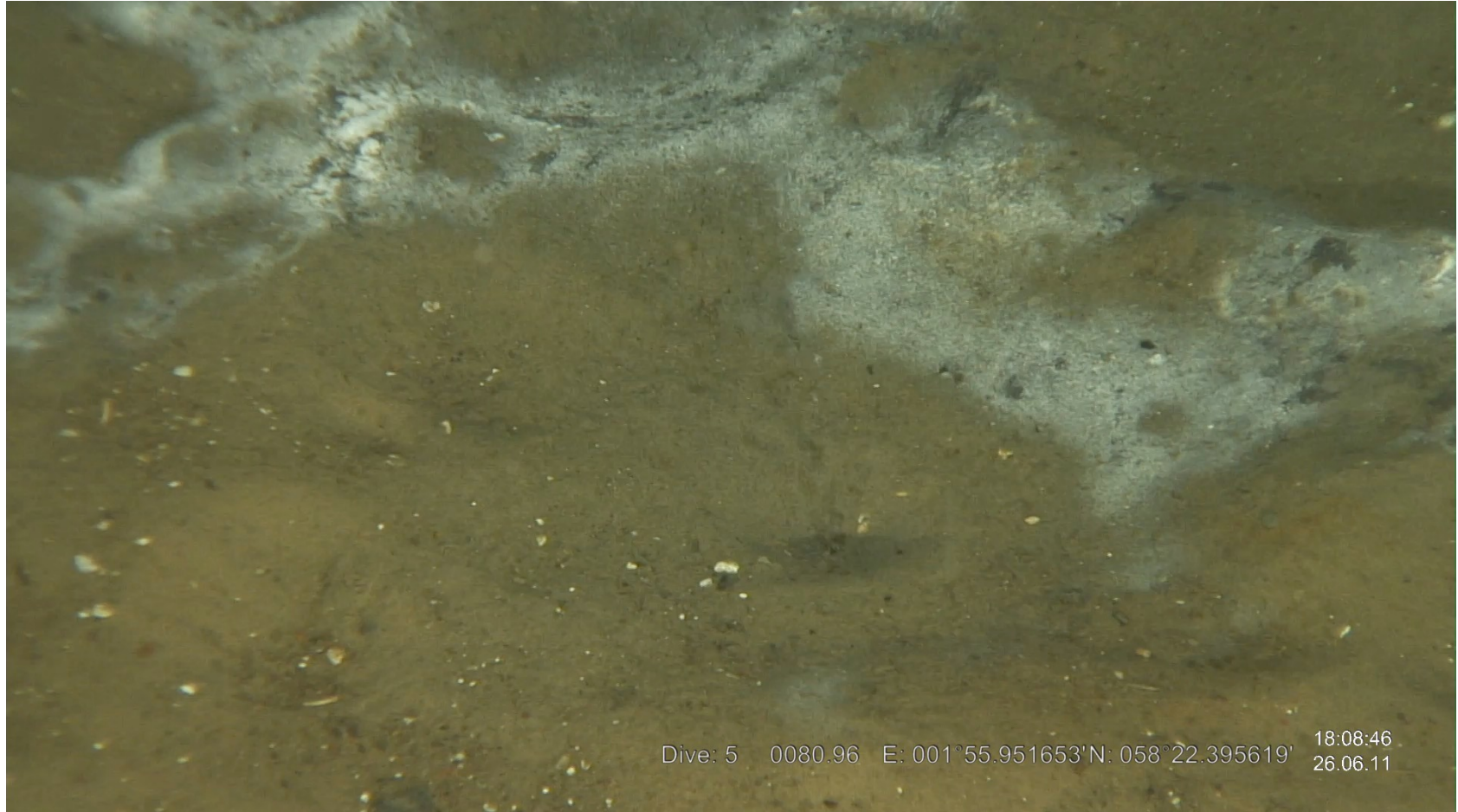
Ann A.E.
Blomberg

Gas detection in sonar images

Combined bottom detections and water column data w/gas seep

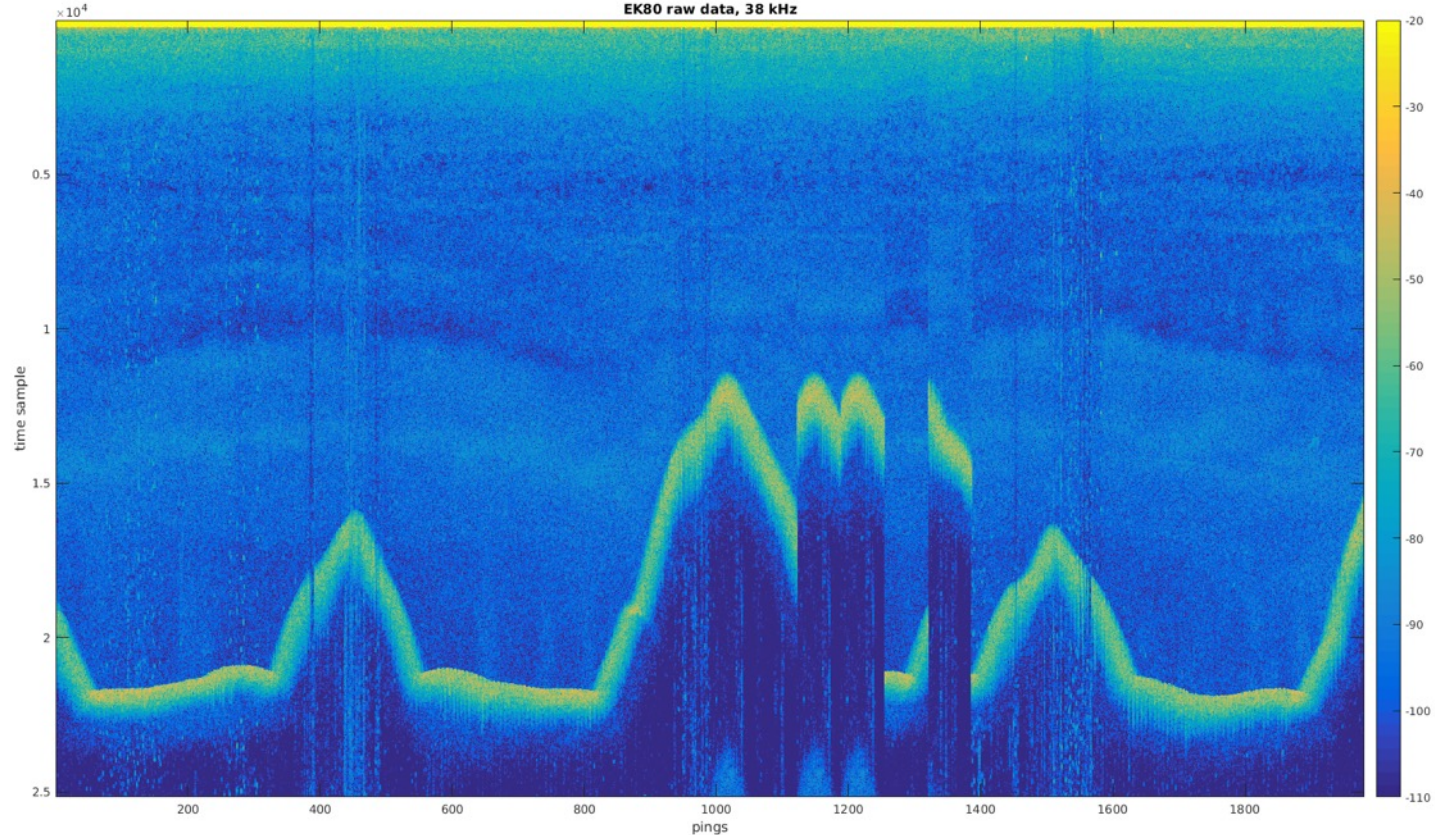


Example: Video from abandoned well, leaking small amounts of shallow gas



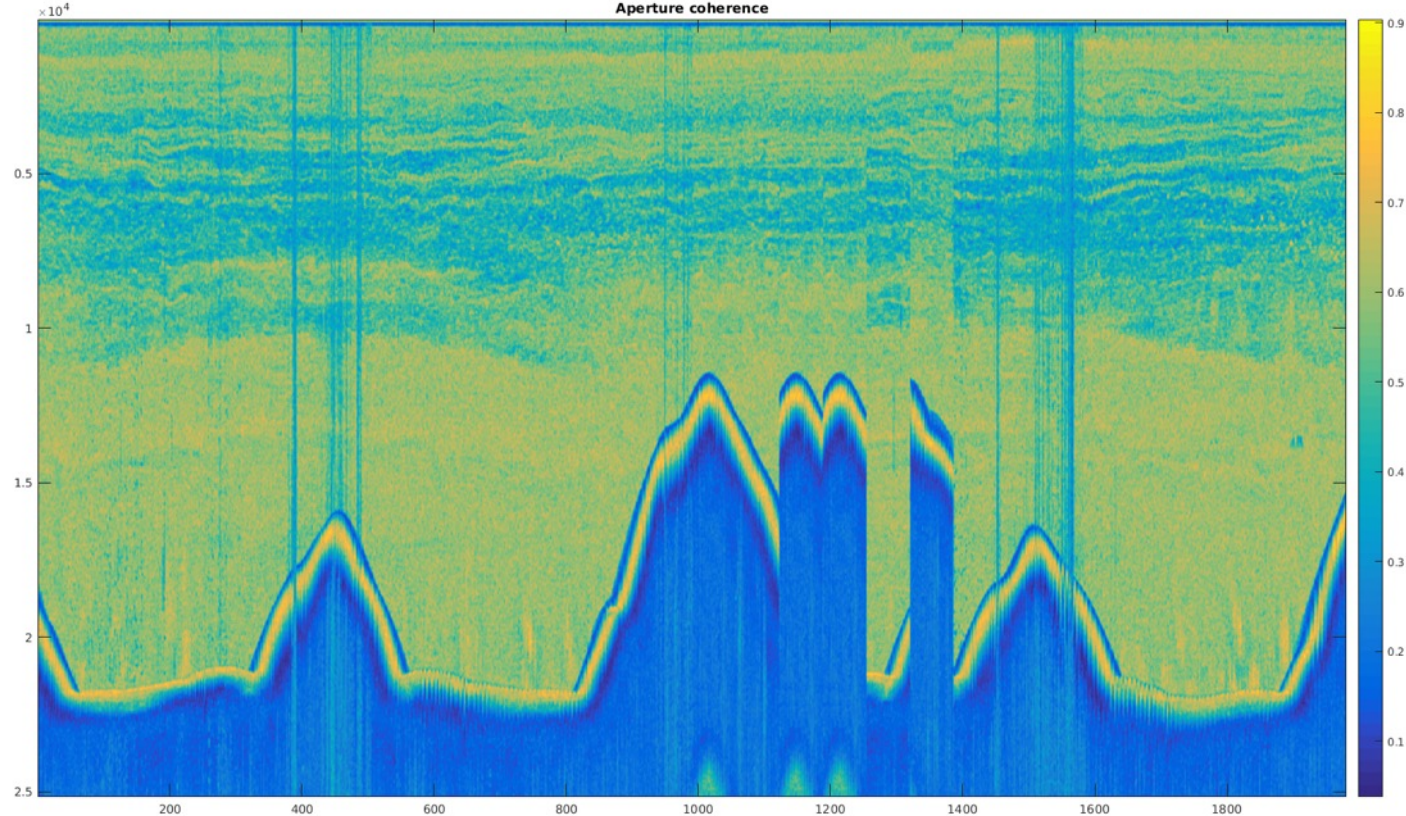
Single beam, Water column data, Standard DAS

Gas seeps barely visible. Several crossing of underwater canyon.



Single beam, Water column data, Coherence factor

Gas seeps barely visible. Several crossing of underwater canyon.





Ole Marius
Hoel Rindal

High resolution ultrasound imaging



CrossMark

Ultrasound in Med. & Biol., Vol. 43, No. 10, pp. 2494–2499, 2017
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0301-5629/\$ - see front matter

<http://dx.doi.org/10.1016/j.ultrasmedbio.2017.05.023>

● Technical Note

HYPOTHESIS OF IMPROVED VISUALIZATION OF MICROSTRUCTURES IN THE INTERVENTRICULAR SEPTUM WITH ULTRASOUND AND ADAPTIVE BEAMFORMING

OLE MARIUS HOEL RINDAL,^{*} SVEND AAKHUS,[†] SVERRE HOLM,^{*} and ANDREAS AUSTENG^{*}

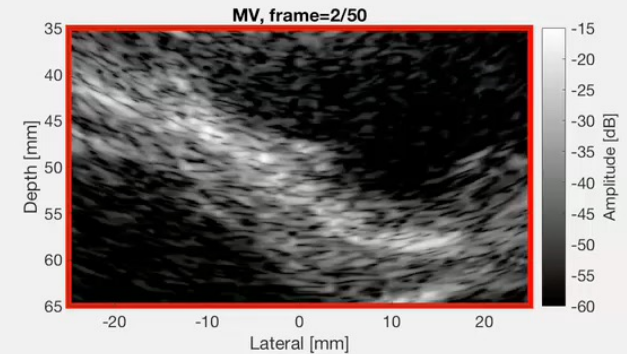
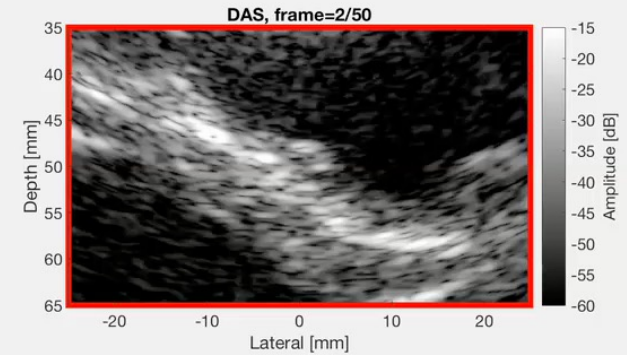
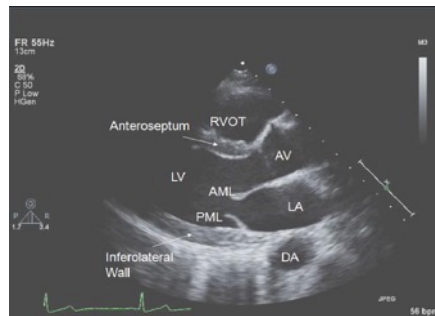
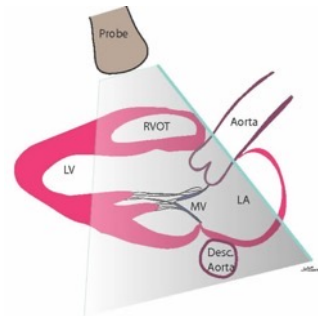
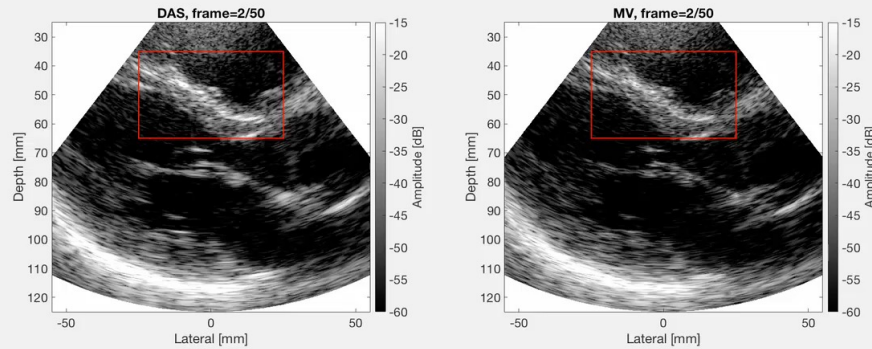
^{*}University of Oslo, Oslo, Norway; and [†]Norwegian University of Science and Technology, Trondheim, Norway

(Received 3 March 2017; revised 24 May 2017; in final form 27 May 2017)

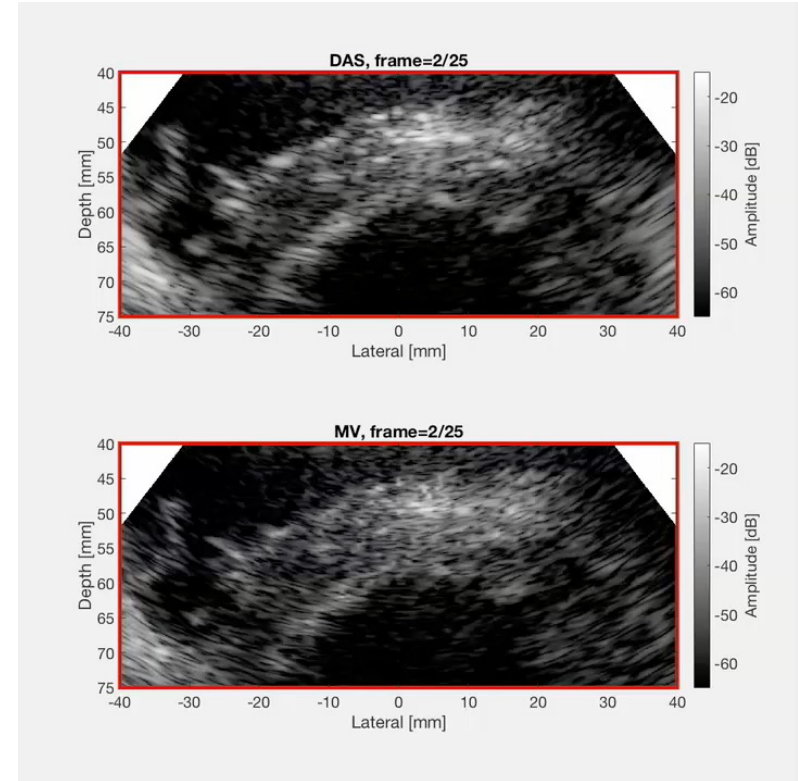
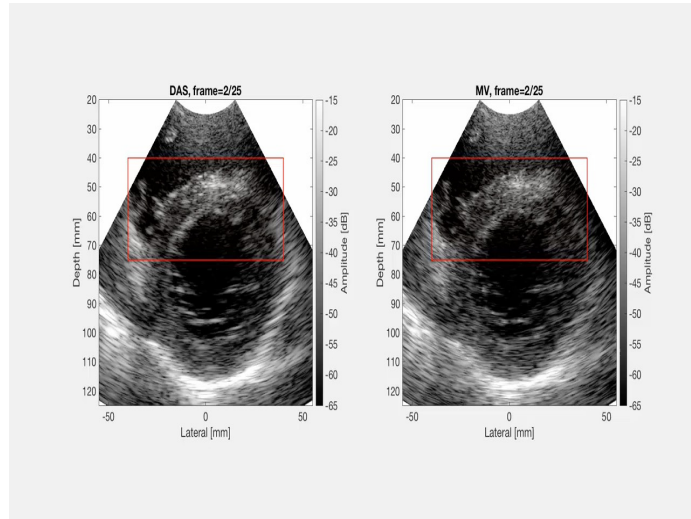
Abstract—In this work, *in vivo* ultrasound cardiac images created with Capon's minimum variance adaptive beamformer are compared with images acquired with the conventional delay-and-sum beamformer. Specifically, we provide three views of a human heart imaged through the parasternal short-axis, the parasternal long-axis and the apical four-chamber views. The minimum variance beamformer produced images with improved lateral resolution, resulting in better resolved speckle structure and improved edges, especially on close investigation of the interventricular septum. These improvements in image quality might possibly improve the visualization of microstructures in the human heart. (E-mail: omrindal@ifi.uio.no) © 2017 World Federation for Ultrasound in Medicine & Biology.

Key Words: Minimum variance beamforming, Capon beamforming, Ultrasound imaging, Cardiac imaging.

Parasternal Long-Axis view



Parasternal Short-Axis view





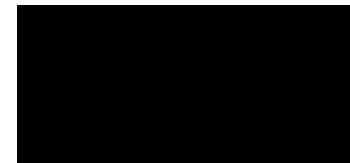
Ole Marius
Hoel Rindal



The UltraSound Toolbox

MATLAB toolbox for processing ultrasonic signals

Alfonso Rodriguez-Molares, Ole Marius Hoel Rindal, Olivier Bernard, Arun Nair,
Muyinatu A. Lediju Bell, Hervé Liebgott, Andreas Austeng, and Lasse Løvstakken

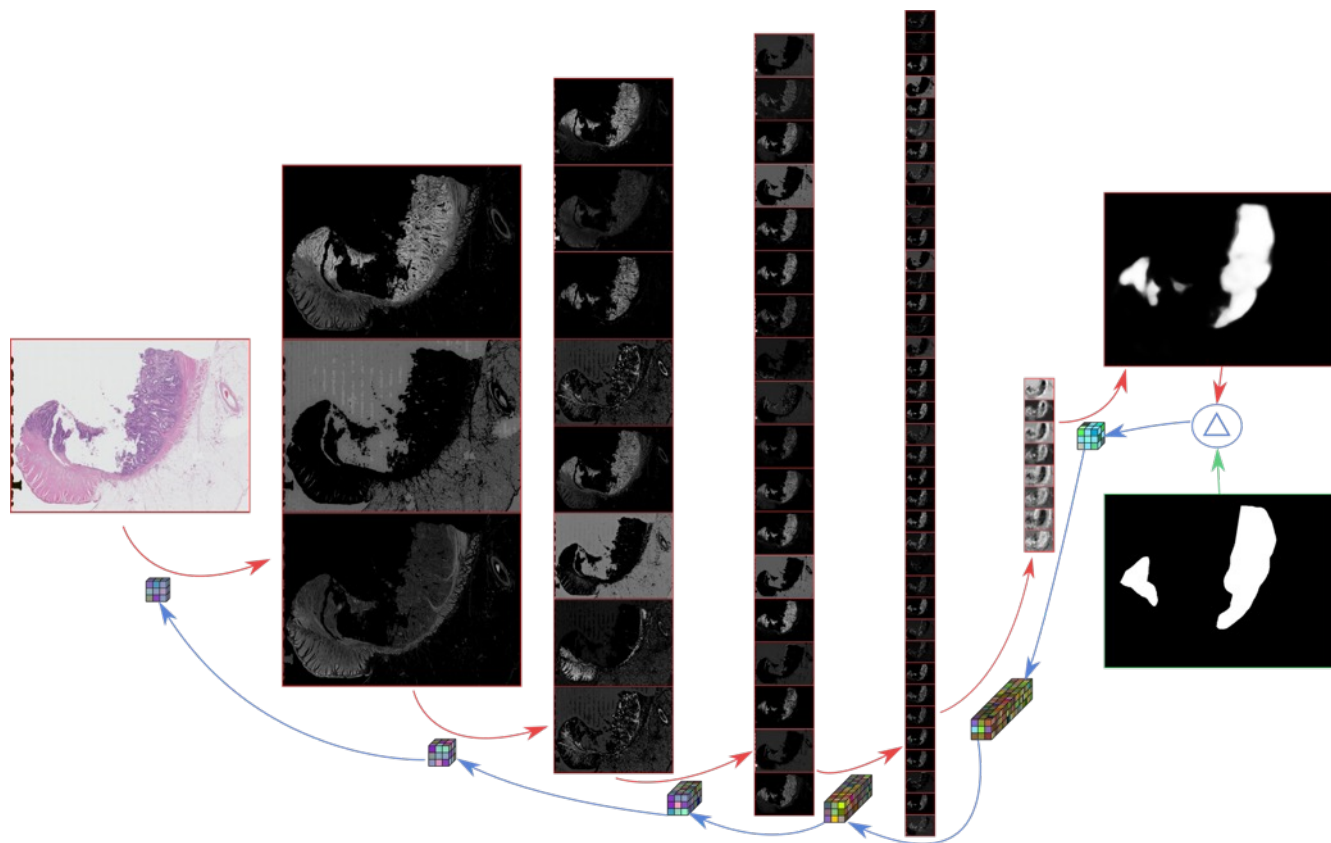


ultrasoundtoolbox.com / ustb.no

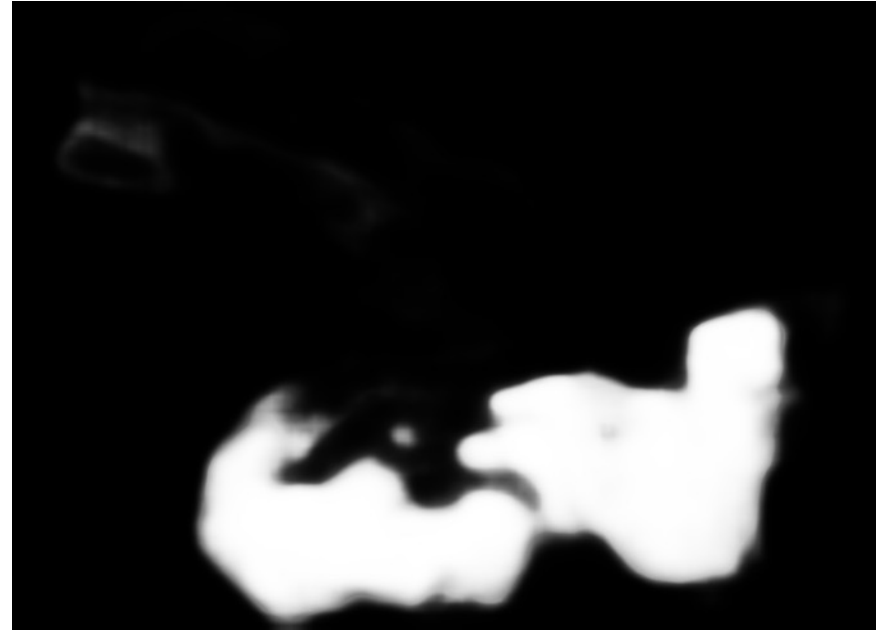
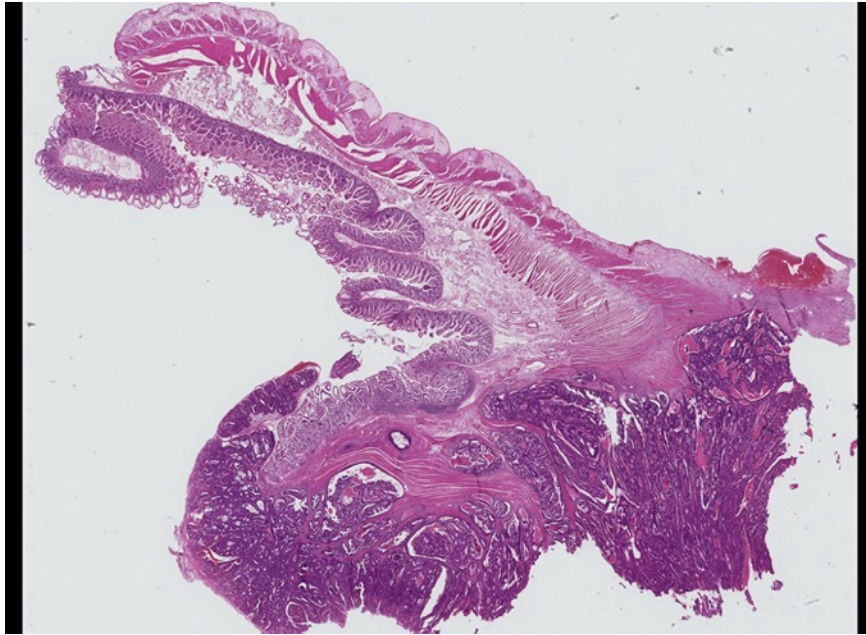


Ole Johan Skrede

Deep learning in digital pathology

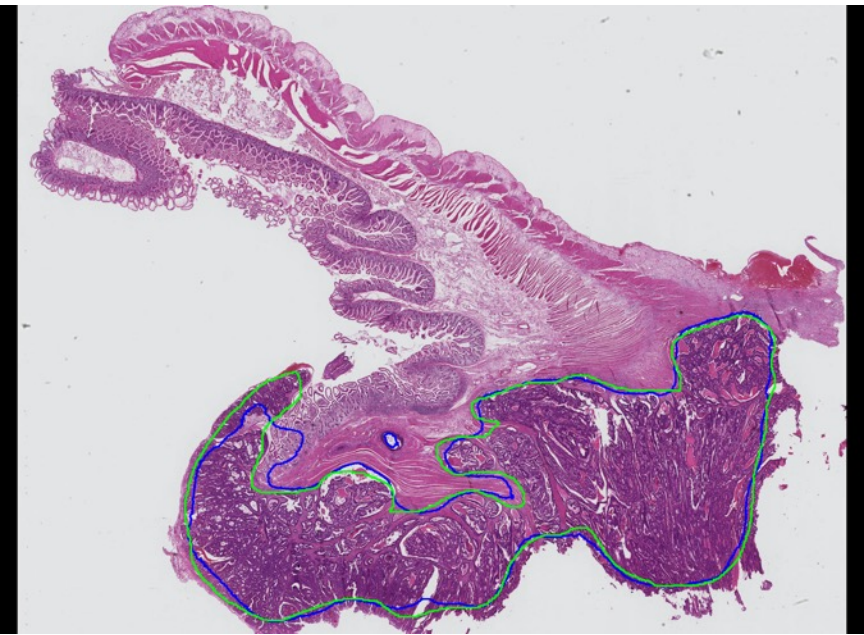
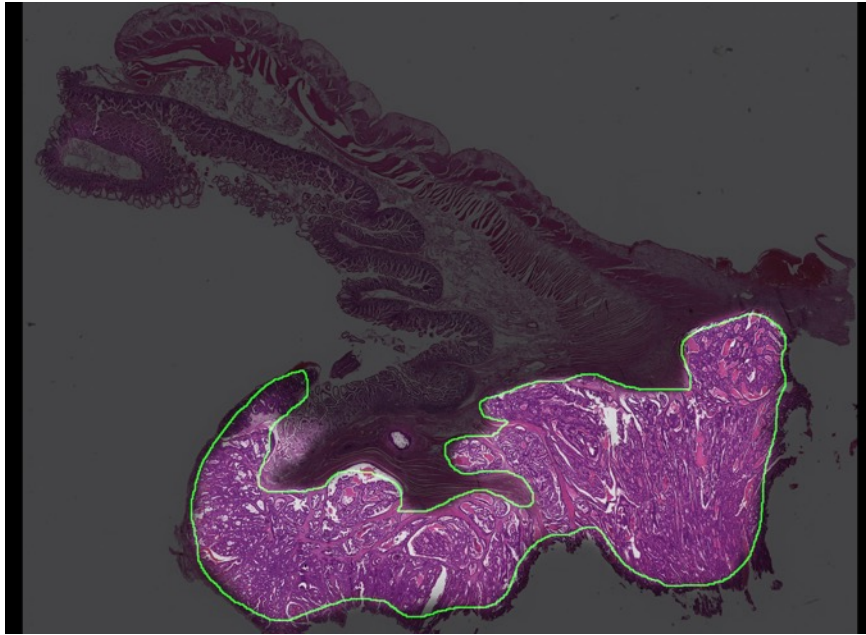


Example: Original + probability from NN



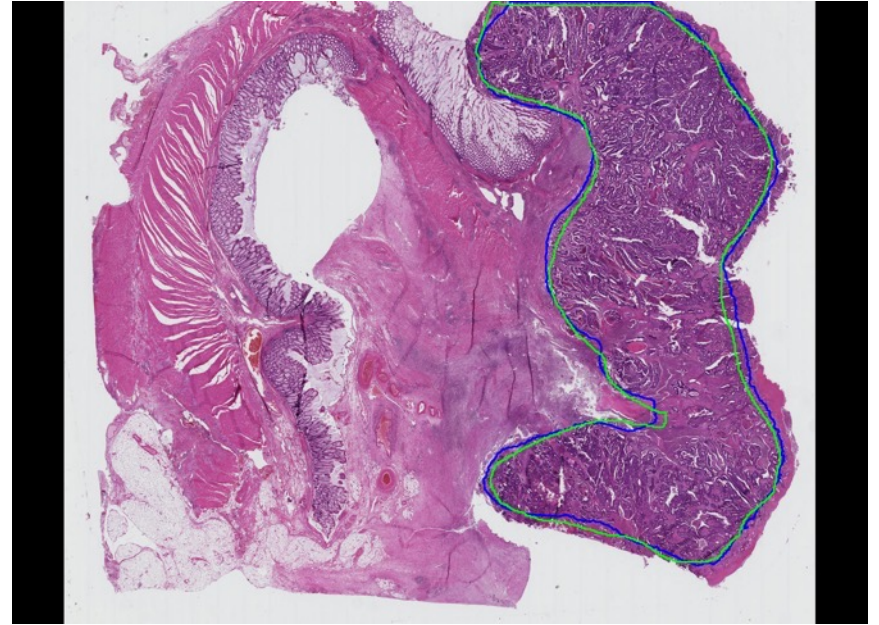
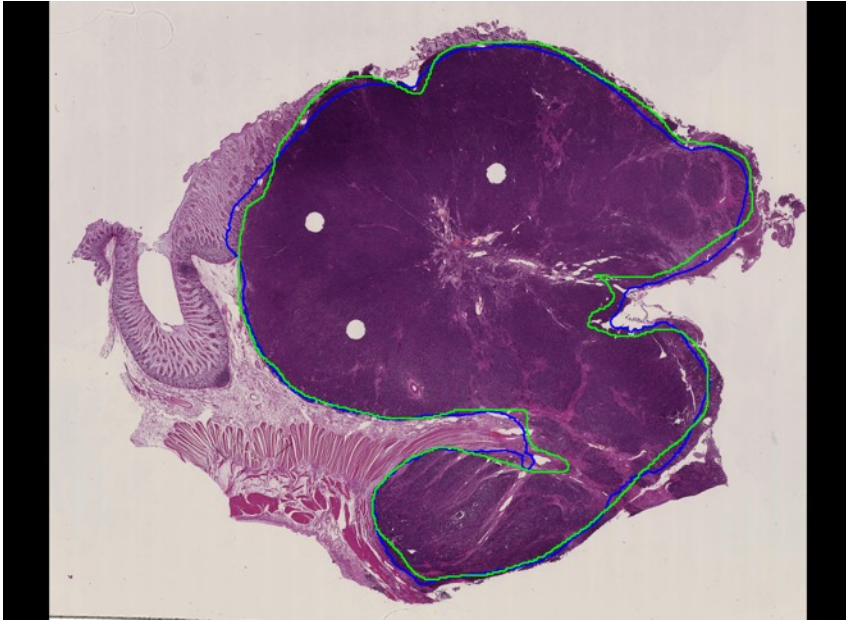
Example: Original x probability + deliniated

Green: from NN, Blue: from pathologist

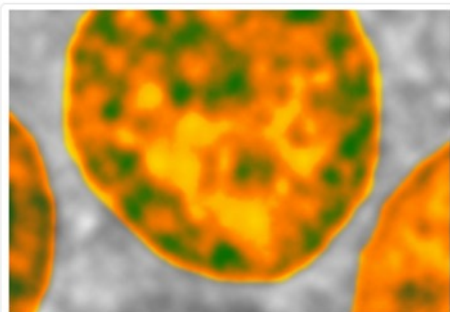


More examples ...

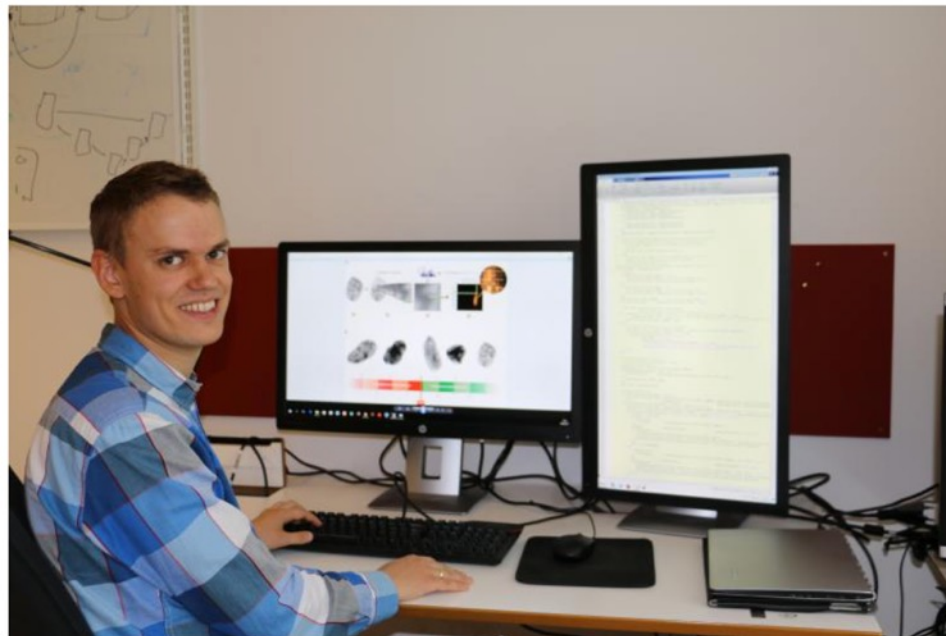
Green: from NN, Blue: from pathologist



Andreas defended his PhD
in September 2017.
He is now an adjoint
professor @DSB



De grønne områdene i cellekjernen viser det såkalte kromatinet. Det kan si mye om pasientens prognose.
Illustrasjon: Oslo universitetssykehus



Andreas Kleppe viser hvordan databasert bildeanalyse kan brukes i diagnostisering og behandling av mange kreftformer. Her viser han hvordan det tas bilder av et stort antall kreftceller fra hver enkelt pasient Foto: Gunhild M. Haugnes/UiO [Bruk bildet](#).

Bildeanalyse gir mer treffsikker kreftdiagnose

Andreas Kleppe har utviklet en ny metode som presist slår fast hvor alvorlig en kreftsykdom er. Metoden kan brukes på mange kreftformer.

av [Gunhild M. Haugnes](#) - 16. oktober, 2017

Extra slides →

Resources

Water tanks

- 3 water tanks of different sizes
- Positioning systems for sonar and ultrasound field measurements
 - ONDA AIMS III Hydrophone Scanning System
 - Custom-made positioning system for large water tank (2x1.5x1.5 m³)

Ultrasound scanners

- Verasonics Vantage 256 research ultrasound scanner
- GE Vingmed Vivid E95 research and clinical ultrasound scanner

High-performance computing

- Group / Department / Faculty resources
- Granting access to National HPC resources possible

Processing & prototyping

- USTB, Ultrasound Toolbox developed and maintained in collaboration with NTNU & others

Selected projects, array signal processing & acoustic imaging

Ole Marius H. Rindal, PhD 2019, now Postdoc:

- *Software Beamforming in Medical Ultrasound Imaging - a blessing and a curse*

Antoine Blachet, PhD submitting 2021:

- *Improved mapping rate in seabed mapping with sonar*

PhD Stine Myhre Hverven, PhD ongoing:

- *Ultrasound imaging for improved segmentation*

Ole Jacob Lorentzen, PhD ongoing:

- *Synthetic Aperture Sonar Interferometry in Rough Seafloor Bathymetry*

Tor Inge Birkenes Lønmo, PhD 2020:

- *Adaptive Beamforming and Autocalibration for Swath Sonars*

Ann Elisabet A. Blomberg, PhD 2012 & Postdoc

- *Adaptive Beamforming for Active Sonar Imaging*

Johan-Fredrik Synnevåg, PhD 2009

- *Adaptive beamforming for medical ultrasound Imaging*

Kaja F. Kvåle, PhD 2020:

- *Detection of mechanical waves in the left ventricle using high frame rate imaging*

Fabrice Prieur, PhD 2012 & Postdoc 2019

- *Nonlinear propagation of ultrasonic signals. Theoretical studies and potential applications*

Stig A. Synnes, PhD ongoing:

- *Ultra Wideband Synthetic Aperture Sonar*

Yücel Karabıyık

- *Advanced waveform modulation and associated signal processing techniques*

Jon Petter Åsen, PhD 2014

- *Accelerating adaptive ultrasound imaging algorithms by means of general-purpose computing on graphics processing units*

Announcing PhD grants spring 2021

- Ultrasound array signal processing
- Array signal processing collaboration, with Kongsberg Maritime

Digital signal processing and image analysis group (DSB)

Signal processing

- Peter Näsholm
 - Ultrasound/Infrasound
- Andreas Austeng
 - Ultrasound/Sonar

Image analysis & deep learning

- Anne Solberg
 - Ultrasound, Remote sensing, Deep learning
- Alexander Binder (jan 2021 →)
 - Deep learning
- Fritz Albregtsen (emeritus)
 - Microscopy

Adjunct Professors:

- Are Jensen, NR
- Håvard Danielsen, ICGI/OUS
- Andreas Kleppe, ICGI/OUS
- Eigil Samset, GE Vingmed
- Roy E Hansen, FFI
- Alan Hunter, CIUS/Univ. Bath, UK

Projects

Visual Intelligence SFI

- Hosted by UiT
- Starting January 2021
- NR / UiT & GE Vingmed /...

DoMore! (domore.no)

- IKT Lighthouse project (NFR)
- Run by ICGi@OUS

CIUS (Centre for Innovative Ultrasound Solutions)

- SFI hosted by NTNU
- NTNU / GE Vingmed / Kongsberg Maritime / FFI

Projects

Medima (Multimodal medical imaging and image analysis)

- Strategic Faculty research initiative

INCUS (The Intelligent Cardiovascular Ultrasound Scanner)

- BIA / NFR & GE Vingmed

INIUS (Intelligent Interventional Ultrasound Scanner)

- Innovation cluster, MN
- GE Vingmed & The Intervention Centre, OUS

Projects

AutoActive

- IKTPluss, Sintef / OUS / NTNU / MS-Senteret i Hakadal

Infrastructure-less indoor positioning in 3D

- BIA / NFR & Sonitor / FFI / UiO

IPN-projects, NFR

- **Kongsberg Maritime:** Elementkalibrering av sonarer og ekkolodd. 1 PhD.
- **GE Vingmed:** 1 Postdoc

Middle atmosphere dynamics probing using infrasound

- FRIPRO project lead by Peter, under NORSAR position umbrella