

SUBPRO

A new Norwegian research innovation center on subsea production and processing

Sigurd Skogestad, NTNU



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Center for
Research based
Innovation



OBJECTIVES AND GOALS

The primary objective of the SUBPRO center at NTNU is to become

- ***a leading international subsea research center***

that provides

- ***top quality candidates,***
- ***knowledge,***
- ***basis for industrial innovations and technology***

in partnership with the most important industrial players in the field.

OUR PARTNERS



From NTNU side: Joining forces across disciplines

Professor Hallvard Svendsen
(Separation and Reactor
Technology)

Professor Johan Sjøblom
(Ugelstad lab)

Professor Sigurd Skogestad
(Process Systems Engineering)
Centre Director

Professor Sigbjørn Sangesland
(Petroleum Technology)



Project Coordinator: Jon Lippe

Co-Director: Professor Mary Ann Lundteigen, Reliability,
Availability, Maintenance and Safety (RAMS)

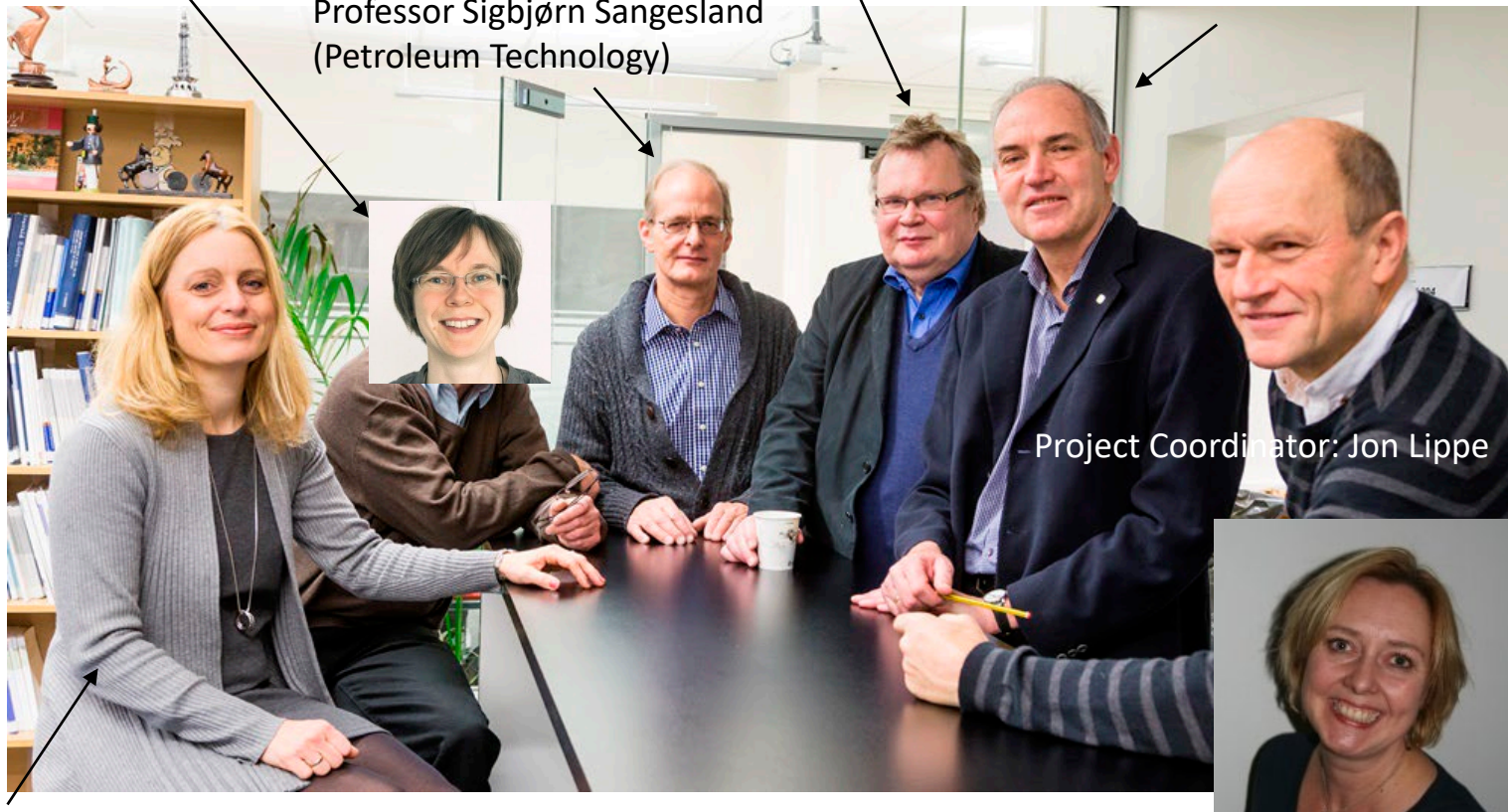
From NTNU side: Joining forces across disciplines

Ass. Professor Hanna Knuutila
(Separation and Reactor
Technology)

Professor Johan Sjøblom
(Ugelstad lab)

Professor Sigurd Skogestad
(Process Systems Engineering)
Centre Director

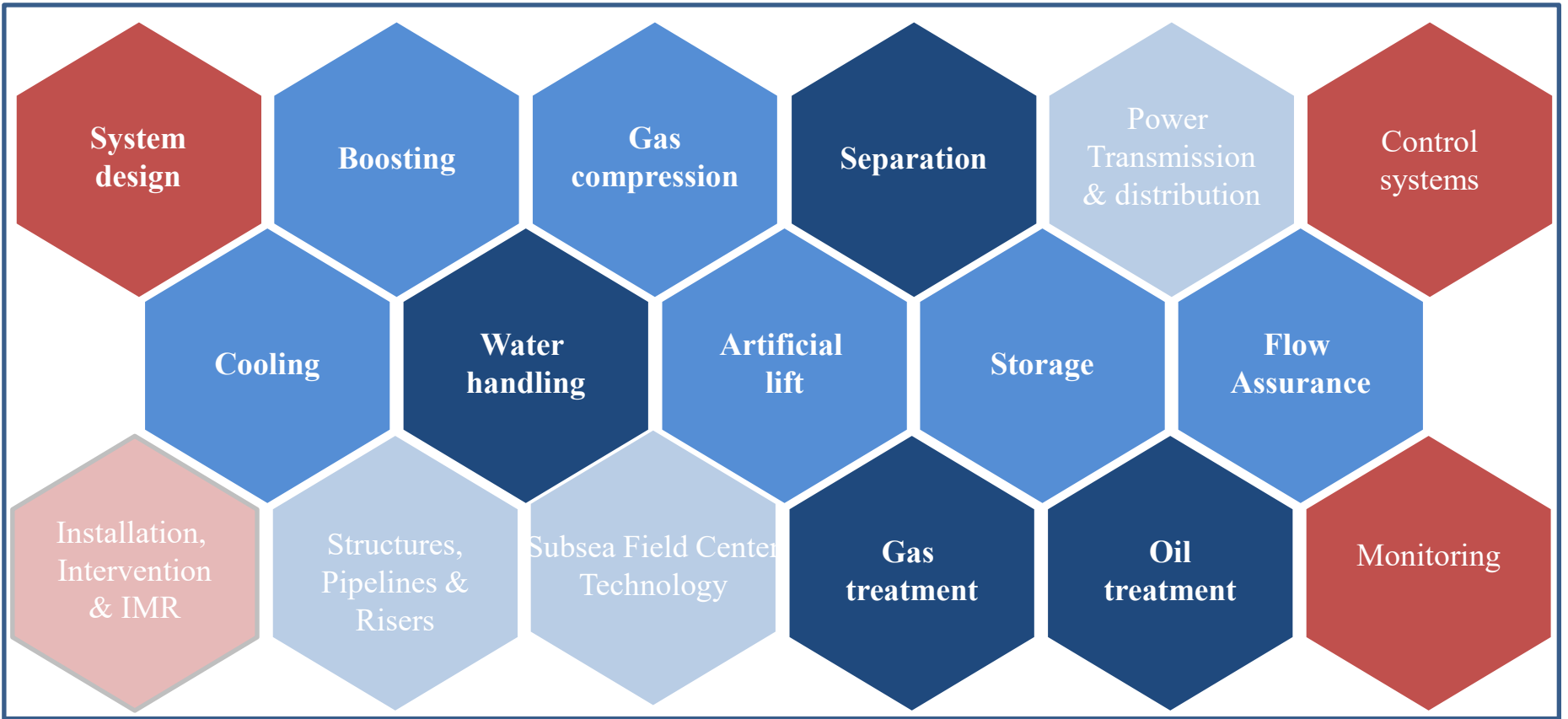
Professor Sigbjørn Sangesland
(Petroleum Technology)



Project Coordinator: Jon Lippe

Co-Director: Professor Mary Ann Lundteigen, Reliability,
Availability, Maintenance and Safety (RAMS)

Faglig koordinatør: Gro Mogseth



Main process directly covered by SUBPRO

Main process partly covered by SUBPRO

Main process not covered by SUBPRO

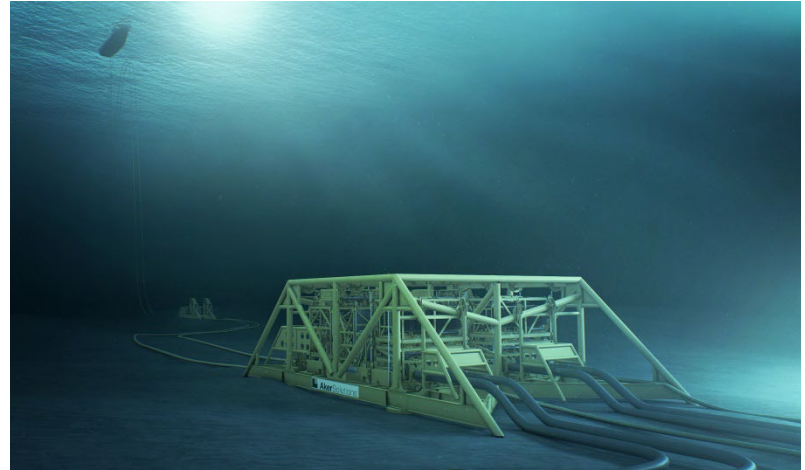
Supporting systems directly covered by SUBPRO

Supporting systems indirectly covered by SUBPRO

MAIN RESEARCH AREAS

Subsea systems engineering and operation

- **Modelling and simulation** of subsea components and systems
- **System design**: Design for more available and robust subsea systems
- **Safety**: Barrier philosophy for subsea facilities
- **Operation**: Condition based maintenance and performance optimization
- **Control**: Development of robust and self-optimizing control strategies

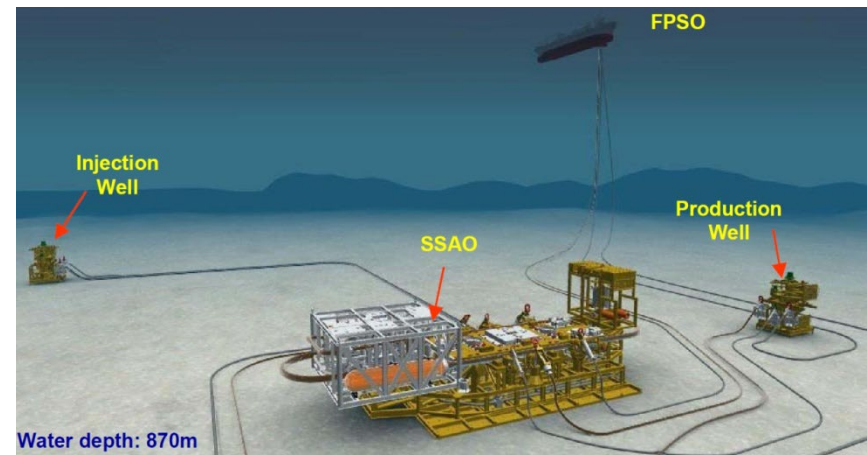
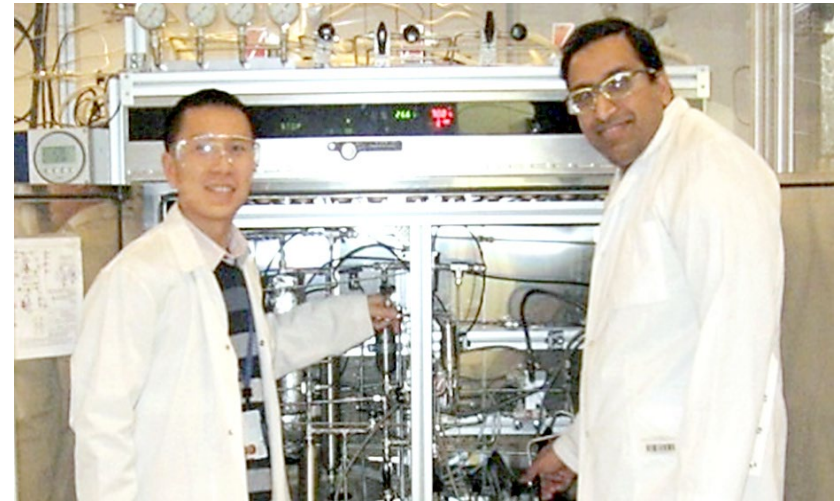


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MAIN RESEARCH AREAS

Subsea separation

- Fundamentals of heterogeneous systems
- Solid/liquid separation
- Liquid/liquid separation and water management
- Gas-liquid separation
- Gas treatment



RESOURCES

- 30 million NOK per year over 8 years (30 million USD in total)
- About 20 PhD's and postdocs at any time
- Master students

- 18 professors at three NTNU departments – cross discipline collaboration
 - Chemical Engineering
 - Petroleum Technology and Applied Geophysics
 - Production and Quality Engineering

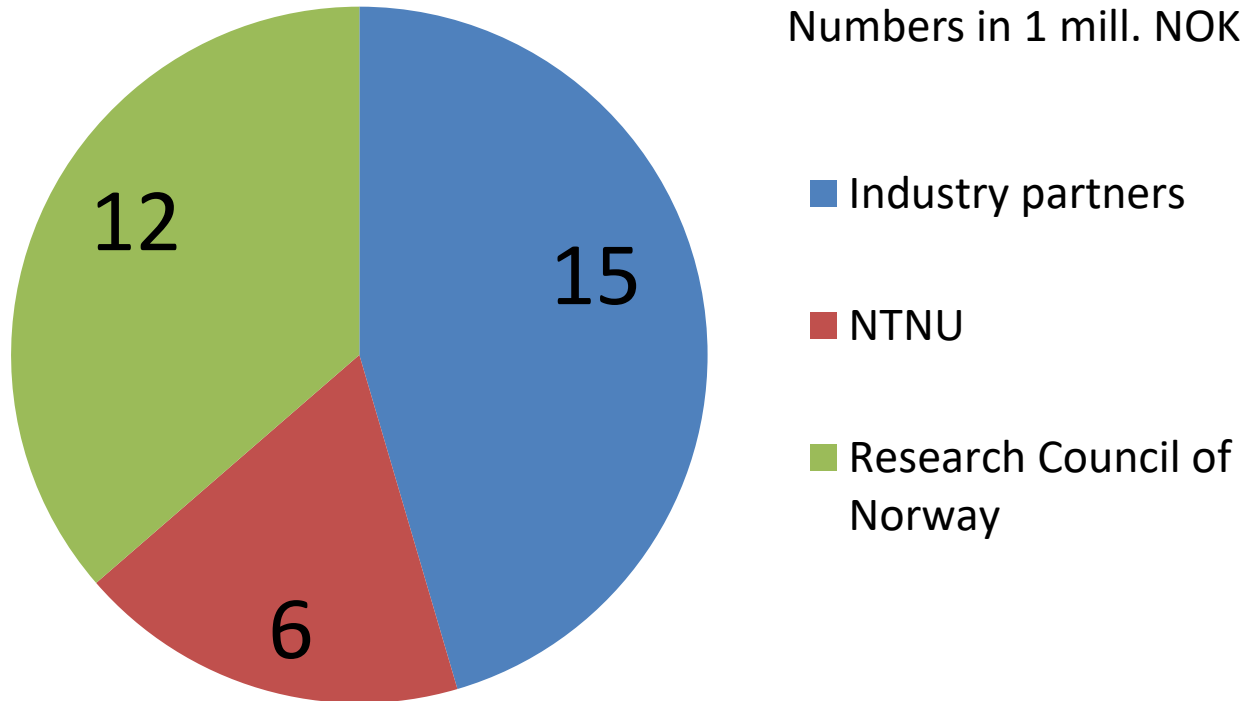
- In kind contributions from industry partners (personnel, knowledge, data)

Duration of project: June 2015 – 2023

BUDGET (TENTATIVE)

Total budget ca. 33 mill. NOK per year

Numbers in 1 mill. NOK



PROJECT STRUCTURE

FIELD ARCHITECTURE

CASE 1 (Gas field)

CASE 2 («Arctic»)

CASE 3 (Mature oil)

SEPARATION

WATER MANAGEMENT

OIL TREATMENT

GAS TREATMENT

REMOTE OPERATION

RAMS
(RELIABILITY, AVAILABILITY, MAINTENANCE,
SAFETY)

SYSTEM CONTROL

RESEARCH AREA 1. FIELD ARCHITECTURE

Industrial challenges

- Standardization of subsea modules
More effective separation and boosting systems.
- Reduce weight and size of systems /
Modularization
- Cost effective strategies for development and
operation of remote offshore oil reservoirs with
low pressure and low temperature.
- Increase separation efficiency by avoiding choking
- Long transportation to shore or existing production facilities / flow assurance issues: high
water cut, low productivity wells, harsh environment.



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Sub projects

Sub project leader

1.1 Subsea gate box

Sigbjørn Sangesland

1.2 Identification and assessment of field development concept for remote offshore
oil reservoirs

Milan Stanko

1.3 Development of flexible numerical models for multiphase boosters

Jesus De Andrade

Research area reference group (Companies):

Input from industry partners is welcome!

Research area team:

- Sigbjørn Sangesland, Milan Stanko, Jesus De Andrade, Michael Golan; NTNU Department of
Petroleum Engineering and Applied Geophysics
- Industry partners which are interested to contribute with in kind:
Input from industry partners is welcome!

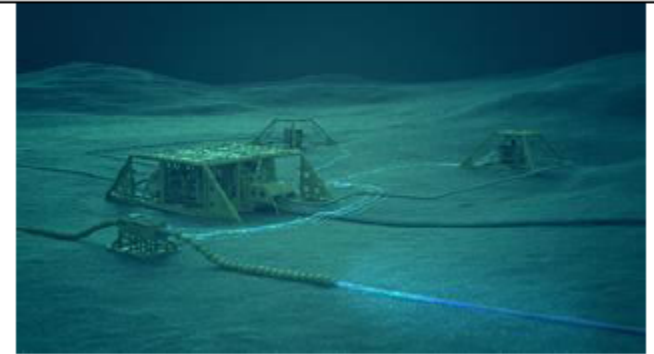
RESEARCH AREA 2.

SEPARATION - WATER / OIL / GAS TREATMENT

Industrial challenges

- Modularization of sea bed systems /more compact unit design/standardization
- Improved separation efficiency / New separation concepts
- Water management (injection and disposal)
- H₂S and CO₂ handling
- Hydrate and wax control

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Sub projects (PhD projects, Postdoc projects, industrial projects, lab projects etc.)

Sub project leader

2.1 Produced water quality and injectivity

Gisle Øye

2.2 Particle formation, plugging, adhesion and transport of wax/asphaltenes

Kristofer Paso

2.3 Semi-processed well fluids / emulsions

Johan Sjöblom

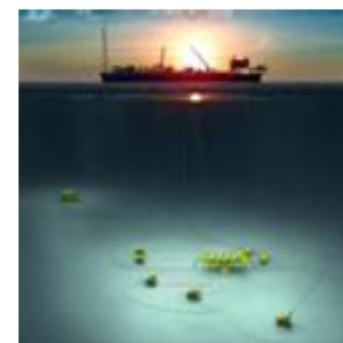
Sub projects (PhD projects, Postdoc projects, industrial projects, lab projects etc.)	Sub project leader
2.4 Membrane and membrane contactors for subsea separation	Liyuan Deng
2.5 Combined H ₂ S and hydrate control	Hanna Knuutila
2.6 Particle breakup and contactor studies	Hanna Knuutila
2.7 Modelling and experimental investigations of fluid particle breakage	Hugo Jakobsen
2.8 Multi-scale modelling of interfacial mass transfer and adsorption during coalescence	Brian A. Grimes
2.9 Compact subsea separation concepts	Milan Stanko/Sigbjørn Sangesland
<p>Research area reference group (Companies): Input from industry partners is welcome!</p>	
<p>Research area team:</p> <ul style="list-style-type: none"> - Johan Sjöblom, Gisle Øye, Kristofer Paso, Sebastian Simon, Brian Grimes, Hugo Jakobsen, Hanna Knuutila, Magne Hillestad, Liyuan Deng and Hallvard Svendsen, Department of Chemical Process Engineering - Sigbjørn Sangesland and Milan Sanko, Department of Petroleum Engineering - Participants from Department of Production and Quality Engineering <p>Industry partners which are interested to contribute with in kind: Input from industry partners is welcome!</p>	

RESEARCH AREA 3. REMOTE OPERATION

Industrial challenges

- Improving and complementing process models needed to support more robust and flexible dynamic control
- Design and operation with autonomous control strategy
- Achieving high reliability and availability
- Higher precision in condition based maintenance
- Safety operation with no negative impact on environment

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Sub projects (PhD projects, Postdoc projects, industrial projects, lab projects etc.)

Sub project leader

3.1 New integrated safety and control philosophy subsea
(short title: Subsea control and safety philosophy)

Mary Ann Lundteigen

3.2 Incorporating reliability and availability in the design of subsea systems
(short title: Reliability and availability in design)

Mary Ann Lundteigen

3.3 Condition and prognostics based maintenance
(short title: Prognostics-based maintenance)

Anne Barros

Sub projects (PhD projects, Postdoc projects, industrial projects, lab projects etc.)	Sub project leader
3.4 Model library for accurate and efficient steady-state and dynamic simulation of subsea processes (short title: Modelling and model library)	Sigurd Skogestad
3.5 Formalisms for control-oriented modelling of subsea systems (short title: Control-oriented modelling)	Olav Egeland
3.6 Improved control of demanding subsea processes (short title: Control of demanding processes)	Christian Holden
3.7 Estimation of un-measurable variables (short title: Process state estimation)	Johannes Jäschke
3.8 Control degrees of freedom for extending remaining useful life (RUL) (short title: Control strategies for life extension)	Johannes Jäschke
Research area reference group (Company and persons): <i>To be specified</i>	
Research area lead: Mary Ann Lundteigen Research area project team: Sigurd Skogestad, Johannes Jäschke, Anne Barros, Christian Holden, Olav Egeland Industry partners that are interested to contribute with in kind: Input from industry partners is welcome!	

4.1 Overview of sub projects

1. FIELD ARCHITECTURE

1.1 Subsea gate box

1.2 Identification and assessment of field development concept for remote offshore oil reservoirs

1.3 Development of flexible numerical models for multiphase boosters

2. SEPARATION

2.1 Produced water quality and injectivity

2.2 Particle formation, plugging, adhesion and transport of wax/asphaltenes

2.3 Semi-processed well fluids / emulsions

2.4 Membrane and membrane contactors for subsea separation

2.5 Combined H₂S and hydrate control

2.6 Particle breakup and contactor studies

2.7 Particle breakup and contactor studies

2.8 Multi-scale modelling of interfacial mass transfer and adsorption during coalescence

2.9 Compact subsea separation concepts

3. REMOTE OPERATION

3.1 New integrated safety and control philosophy subsea

3.2 Incorporating reliability and availability in the design of subsea systems

3.3 Condition and prognostics based maintenance

3.4 Model library for accurate and efficient steady-state and dynamic simulation of subsea processes

3.5 Formalisms for control-oriented modelling of subsea systems

3.6 Improved control of demanding subsea processes

3.7 Estimation of un-measurable variables

3.8 Control degrees of freedom for extending remaining useful life (RUL)

Visit us at www.ntnu.edu/subpro

The screenshot shows a web browser window displaying the SUBPRO website. The browser's address bar shows the URL <http://www.ntnu.edu/web/subpro/subpro>. The website header features the 'SUBPRO' logo on the left, a large image of an offshore subsea structure in the center, and the 'sfi' logo (Centre for Research-based Innovation) and 'NTNU - Trondheim Norwegian University of Science and Technology' logo on the right. A navigation menu below the header includes 'SUBPRO', 'Partners', 'Research', 'Facilities', 'Education and recruitment', and 'Contact'. A secondary navigation bar shows 'Subsea production and processing' with a Norwegian flag icon. The main content area features a large image of a subsea field with the caption 'Subsea field overall perspective ©2015 Aker Solutions'. To the right of this image is a 'Contact' section with a portrait of Sigurd Skogestad, Centre Director, and his email address skoge@ntnu.no. Below the main content is a 'SUBPRO goals' section with a paragraph of text and a list of four goals. At the bottom, there are three columns of text: 'Research', 'Facilities', and 'Education and recruitment'. The browser's taskbar at the bottom shows various application icons and the system clock indicating 13:09 on 27.05.2015.

SUBPRO

Centre for Research-based Innovation
NTNU - Trondheim
Norwegian University of Science and Technology

SUBPRO Partners Research Facilities Education and recruitment Contact

Subsea production and processing



Subsea field overall perspective ©2015 Aker Solutions

SUBPRO goals

The primary objective of the SUBPRO center for research based innovation is to become a leading international subsea research center that provides top quality candidates, knowledge and technology innovations. This will be done in partnership with the most important industrial players in the field.

Our goals

- Develop new knowledge and technology to meet future challenges in subsea production and processing
- Provide technological platform for oil companies and suppliers
- Establish international excellence in academia and industry in subsea production and processing
- Educate master students and PhD candidates within subsea production and processing

[About SUBPRO and the background for the centre](#)

Contact



Sigurd Skogestad, Centre Director
Email: skoge@ntnu.no
[Contact the people at SUBPRO](#)

Centre for Research-based Innovation

Research Facilities Education and recruitment

13:09 27.05.2015

CONTACT PERSONS

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Co-director Prof. Mary Ann Lundteigen

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Web site

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