Subsea Mechanical Dispersion – A New Response Technology..?

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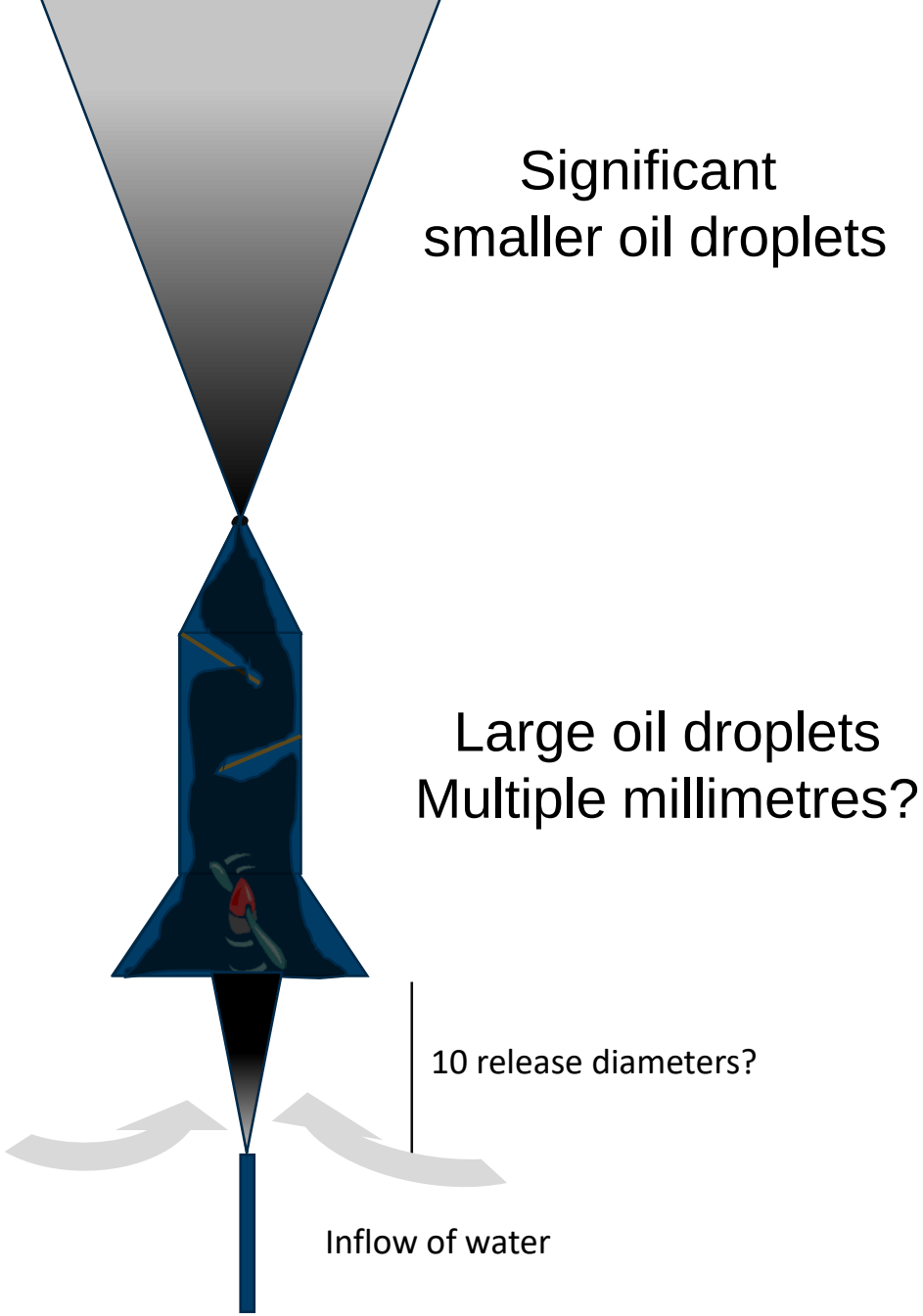
Basic concept Subsea MECHANICAL dispersion - SSMD

Droplets from a subsea release are significantly reduced in size by mechanical forces.

Several feasible concepts are tested at SINTEF Ocean



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SSMD R&D Program History

2012: R&D Project initiated by BP

2017: Feasibility-I (Oil + Water jetting)*

2018: Feasibility-II (Oil & Gas + HP)*

2019: Large-scale testing at Ohmsett

Next? Possible full-scale testing of equipment

Funders

bp

equinor

TOTAL

AkerBP

Lundin Norway

* in close cooperation with: Exponent OCEANEERING

SINTEF

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(BP initiated Phase-I and introduced concept to SINTEF)

Why developing/promoting SSMD…?

Two example scenarios:

1. Subsea dispersant injection (SSDI) problematic due to regional legislation
2. Too low turbulence for dispersant-oil mixing & droplet formation

Dispersant use not permitted in Russia

Low turbulence in release from seabed

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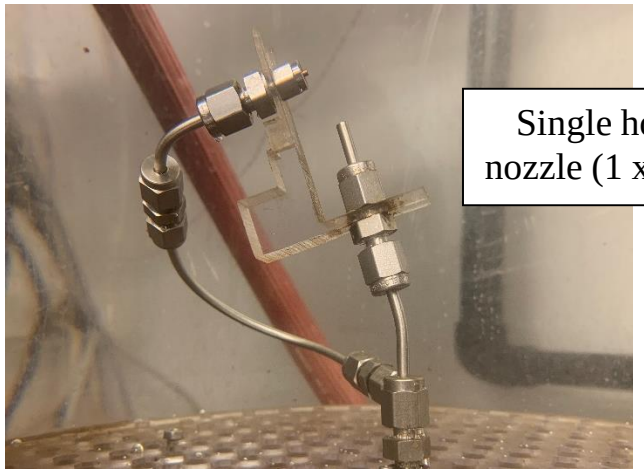
Phase-I: Testing of Ultrasound unit

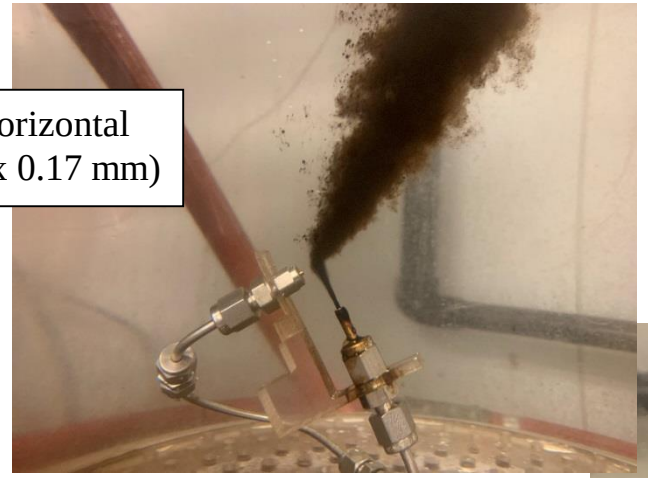
The ultrasound probe marinized and inserted into the SINTEF MiniTower

Phase-I: Mechanical shearing device

The mechanical shearing device used in the MiniTower (80 liters of natural sea water)

Phase-II: Water Jetting - Nozzle configuration

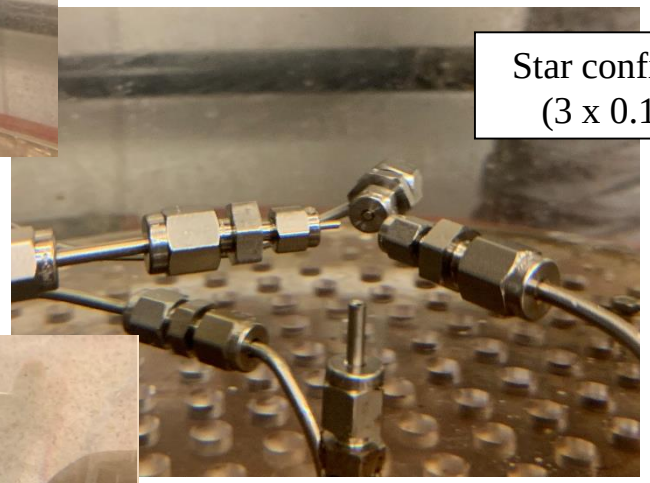


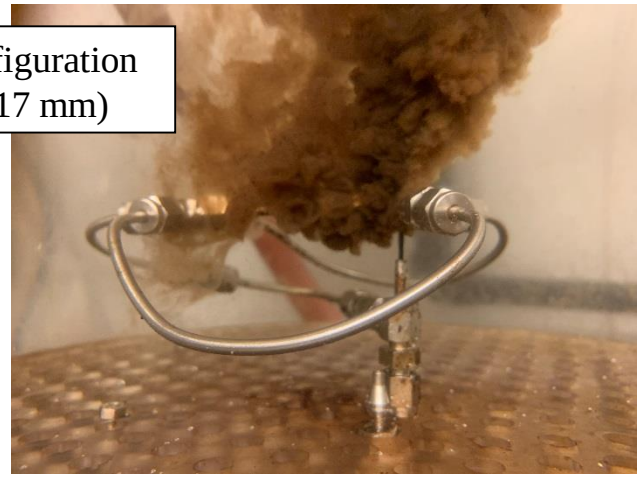


Single horizontal nozzle (1 x 0.17 mm)

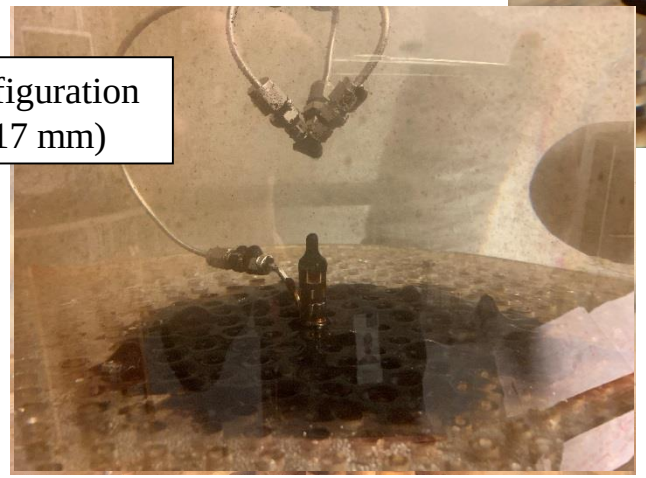
Three designs tested:

- Single (horizontal) nozzle
- Star configuration
- Grid Configuration





Star configuration (3 x 0.17 mm)



Grid configuration (3 x 0.17 mm)

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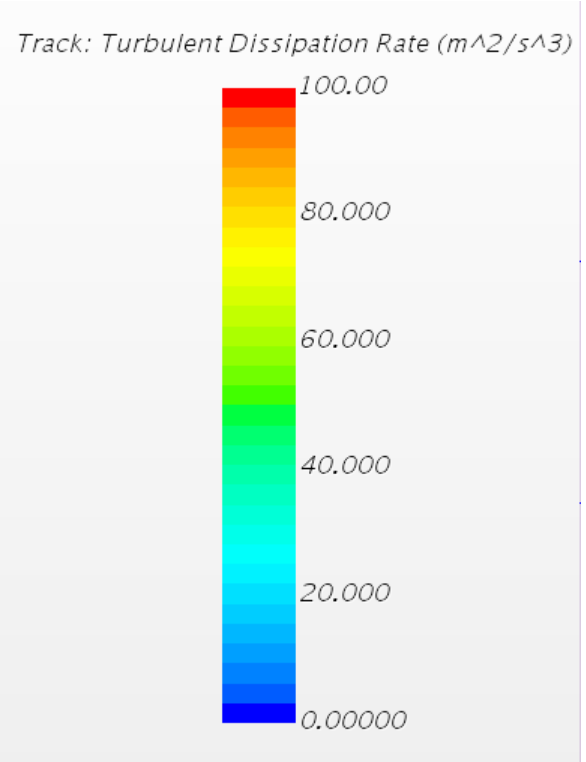
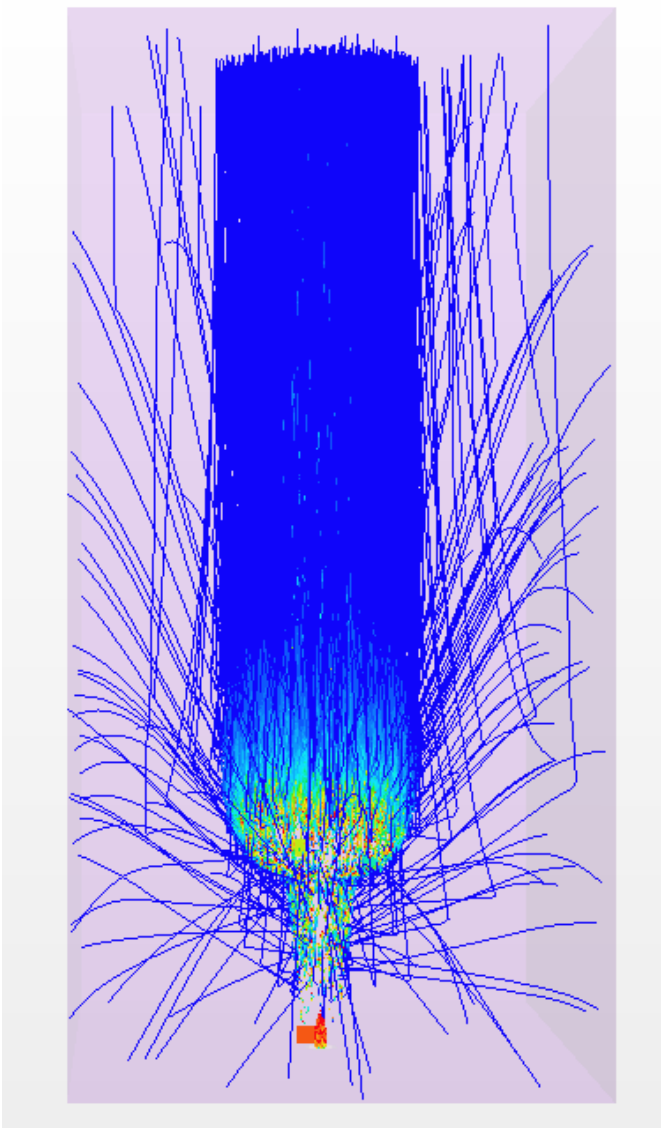
Phase-III: Optimize nozzle design (CFD)



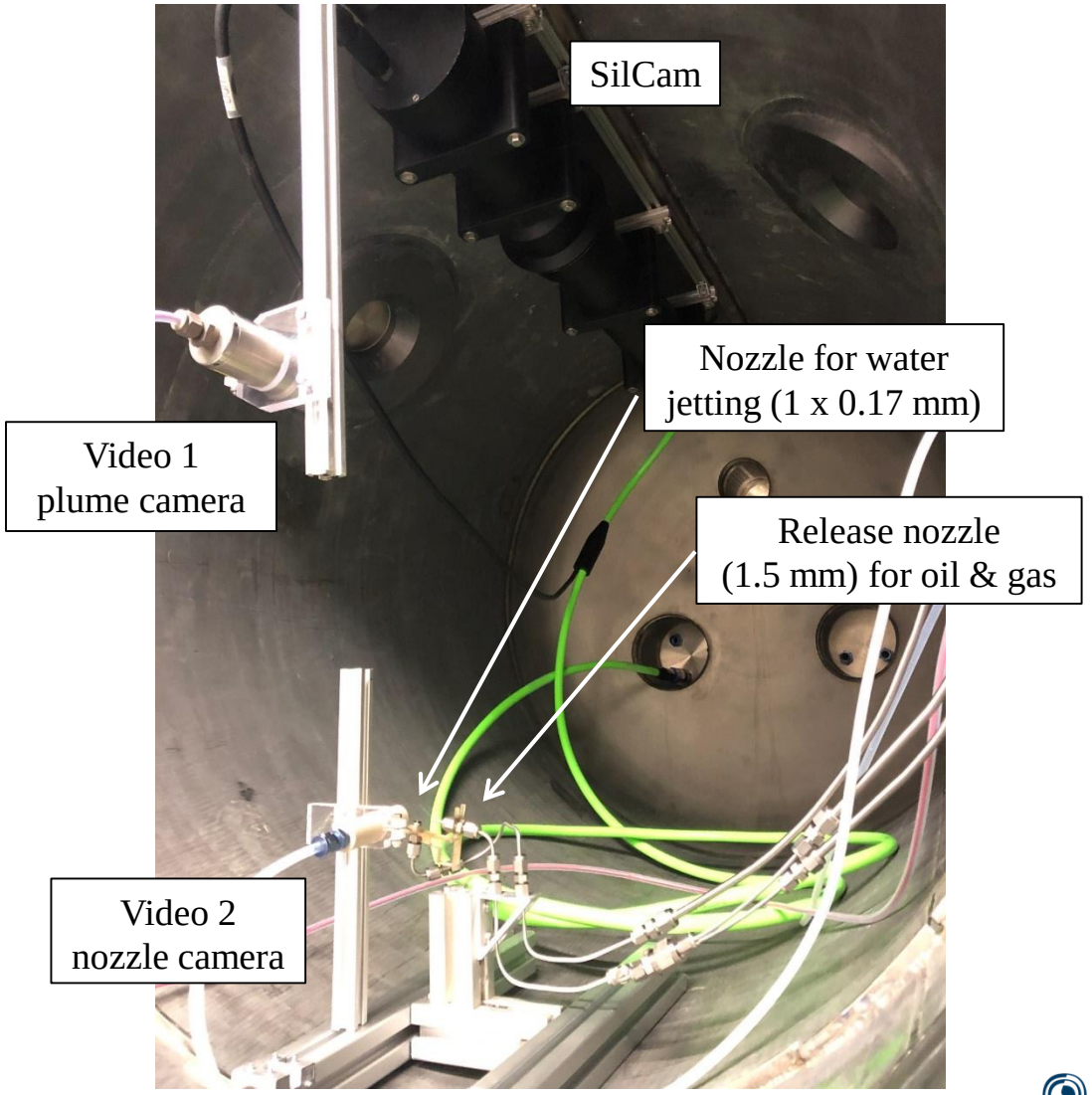
Star Configuration
HP experiments
(30 bar)



Using Turbulent Dissipation Rate metrics to quantify efficiency of different nozzle design

Phase-III: HP testing in SINTEF TiTank

1.4 m^3 Titan pressure tank at SINTEF-NTNU



Testing under pressure (30 bar) needed to eliminate cavitation ("artificial" lab. effect)

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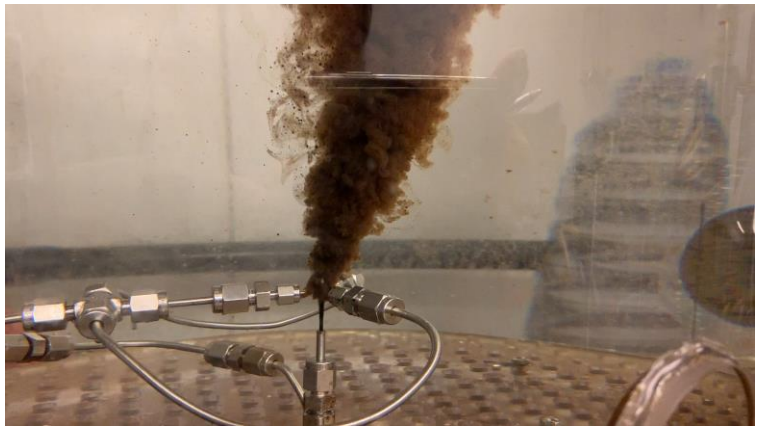
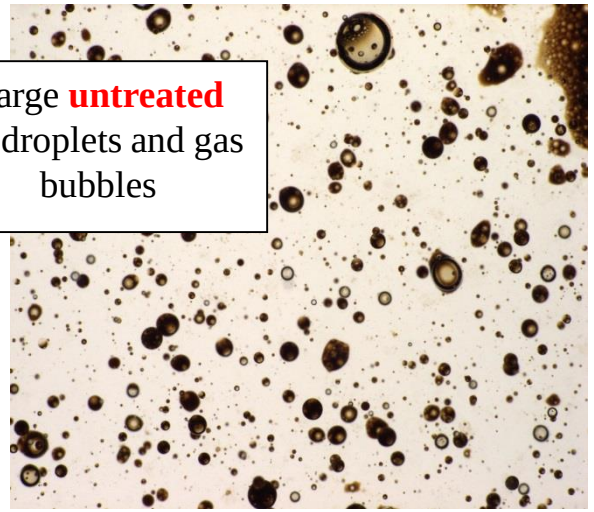
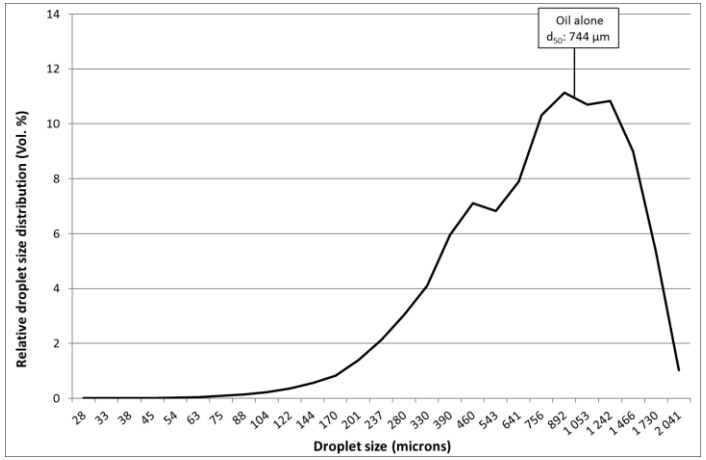
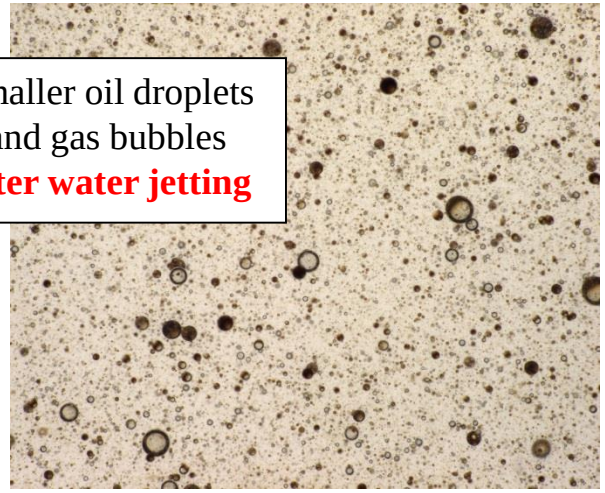
Phase-III: Combined releases (oil & gas)



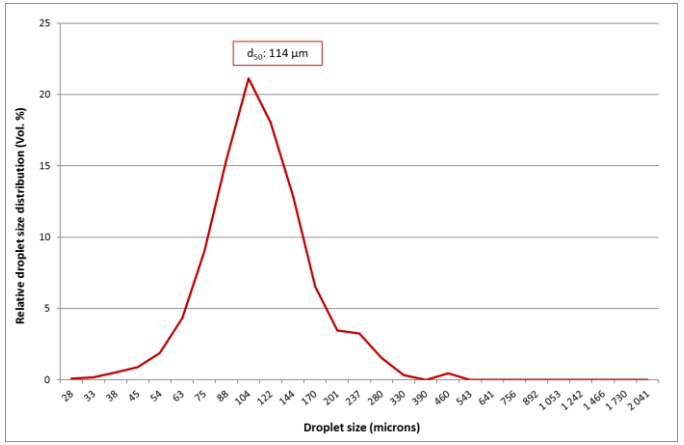


Large **untreated** oil droplets and gas bubbles





Smaller oil droplets and gas bubbles **after water jetting**



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Phase-III: Design & cost study (full-scale)

Figure 12: Quick slip on flange solution, female.

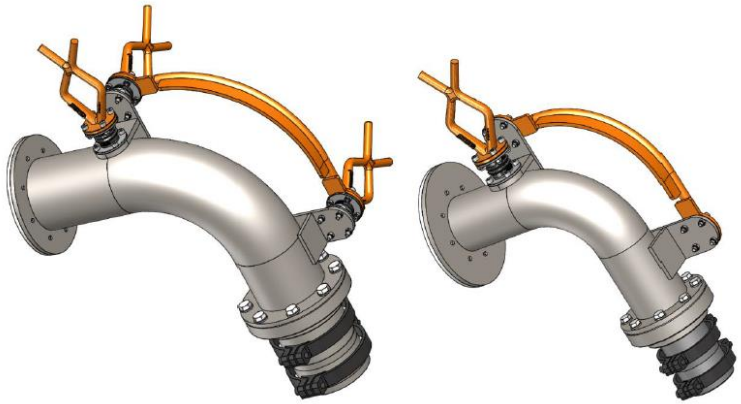
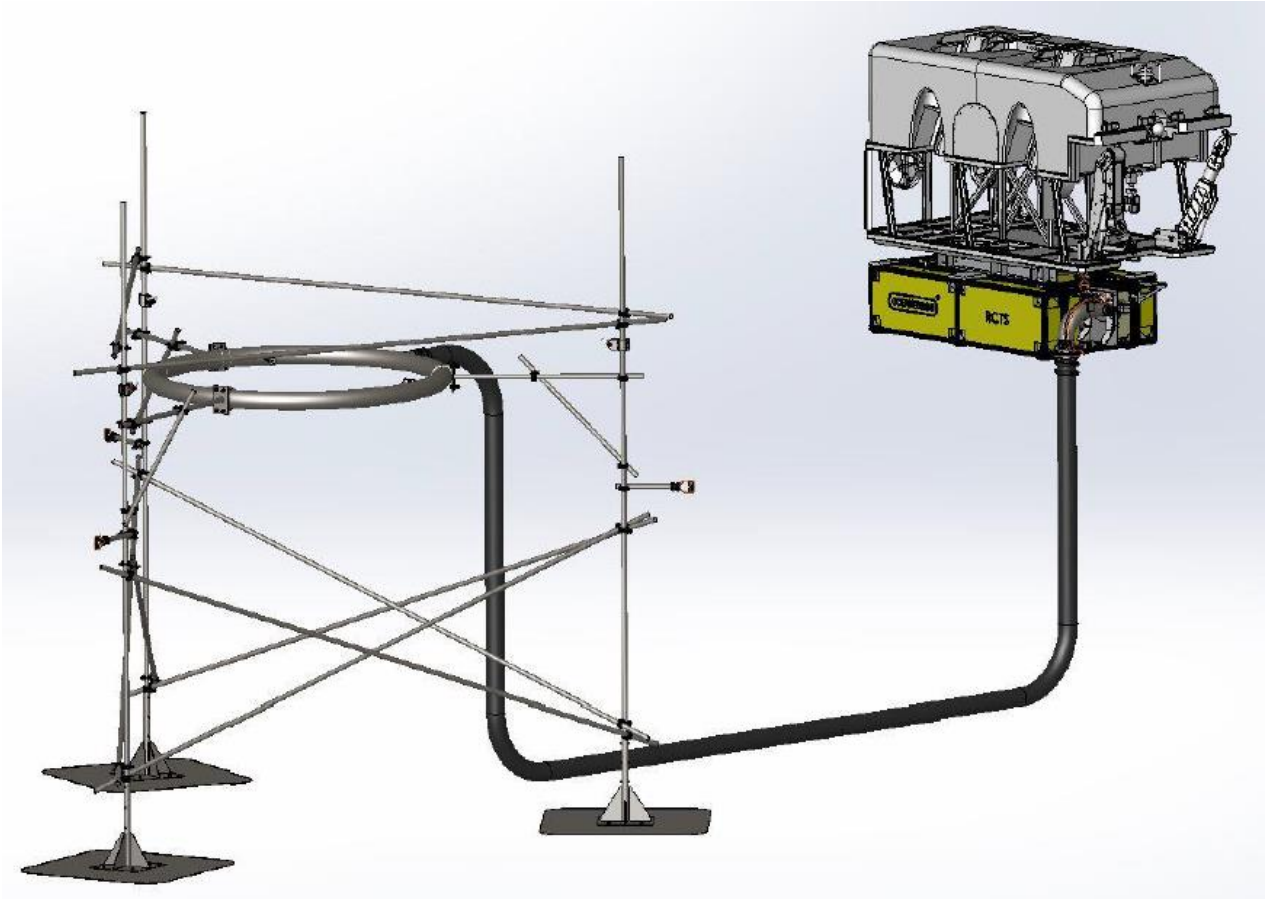
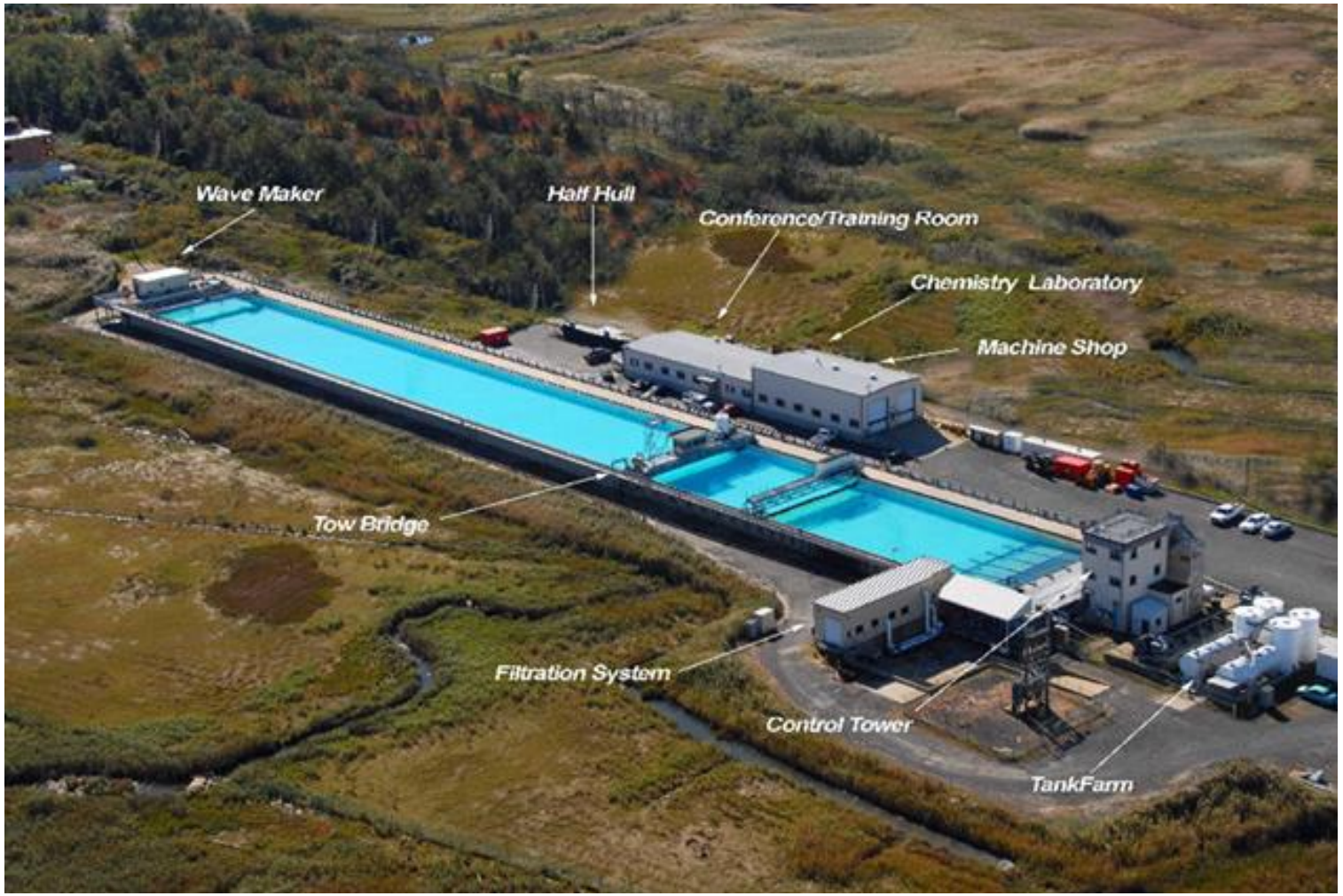


Figure 13: Quick slip on flange solution, male. Left - 6in, Right – 4in



Phase-IV: Large-scale testing, Ohmsett, US



Ohmsett test tank: Length 200 m, width 20 m, depth 2.4 m and 9 500 m^3 of salt water.

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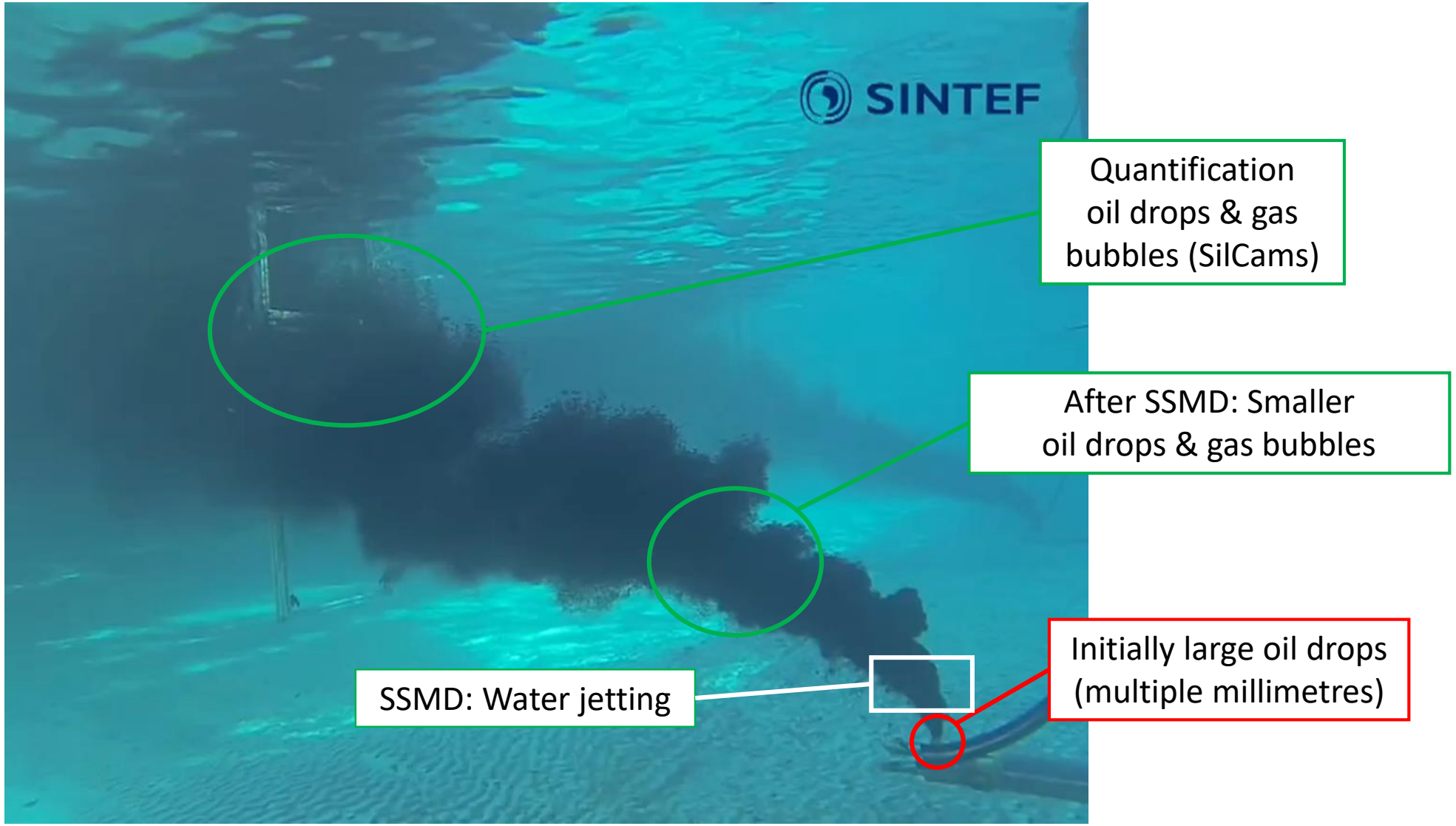
Large-scale testing at Ohmsett



SINTEF experiments in 2015 (API) & 2018 (BSEE) with large-scale releases of oil & gas and SSDI

Towards Operational Technology (TRLs)

TR4: Technology prototype demonstrated in laboratory environment

TRL: 9

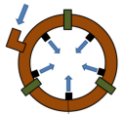
TR3: Technology proof of concept demonstrated

TRL: 5

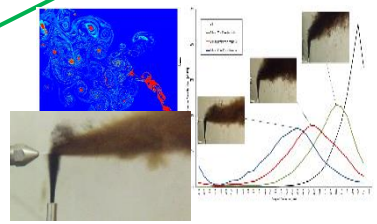
TRL: 4

TR2: Technology concept and speculative application formulated

TRL: 3



TRL: 2



TR9: Full-scale unit testing in real environment

TR5: Technology prototype tested in relevant environments

Phase-I Phase-II Phase-III Phase-IV Phase-V

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Conclusions - SSMD

- Lab experiments verify that water jetting significantly reduce oil droplet size with 30% water flow (non-cavitating + oil & gas).
- Nozzle configuration optimized by CFD modelling.
- Full-size SSMD concept designed based on submersible pumps and ROVs.

Further work:

- Large-scale verification at Ohmsett (December 2019)
- Full-scale testing with ROVs, subsea pumps, and nozzle frame (2020?)

SSMD a new tool in the Oil Spill Contingency Toolbox…?

Subsea Mechanical Dispersion - SSMD

Dispersant application on surface oil slicks

Mechanical recovery

Bioremediation

Mechanical Surface Dispersion

Subsea Dispersant Injection - SSDI

In-situ Burning

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