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Shielding skirt for prevention of salmon lice (*lepeophtheirus salmonis*) infestation on Atlantic salmon (*salmo salar*) in cages – a scaled model experimental study on different skirts and cage nets in currents and waves

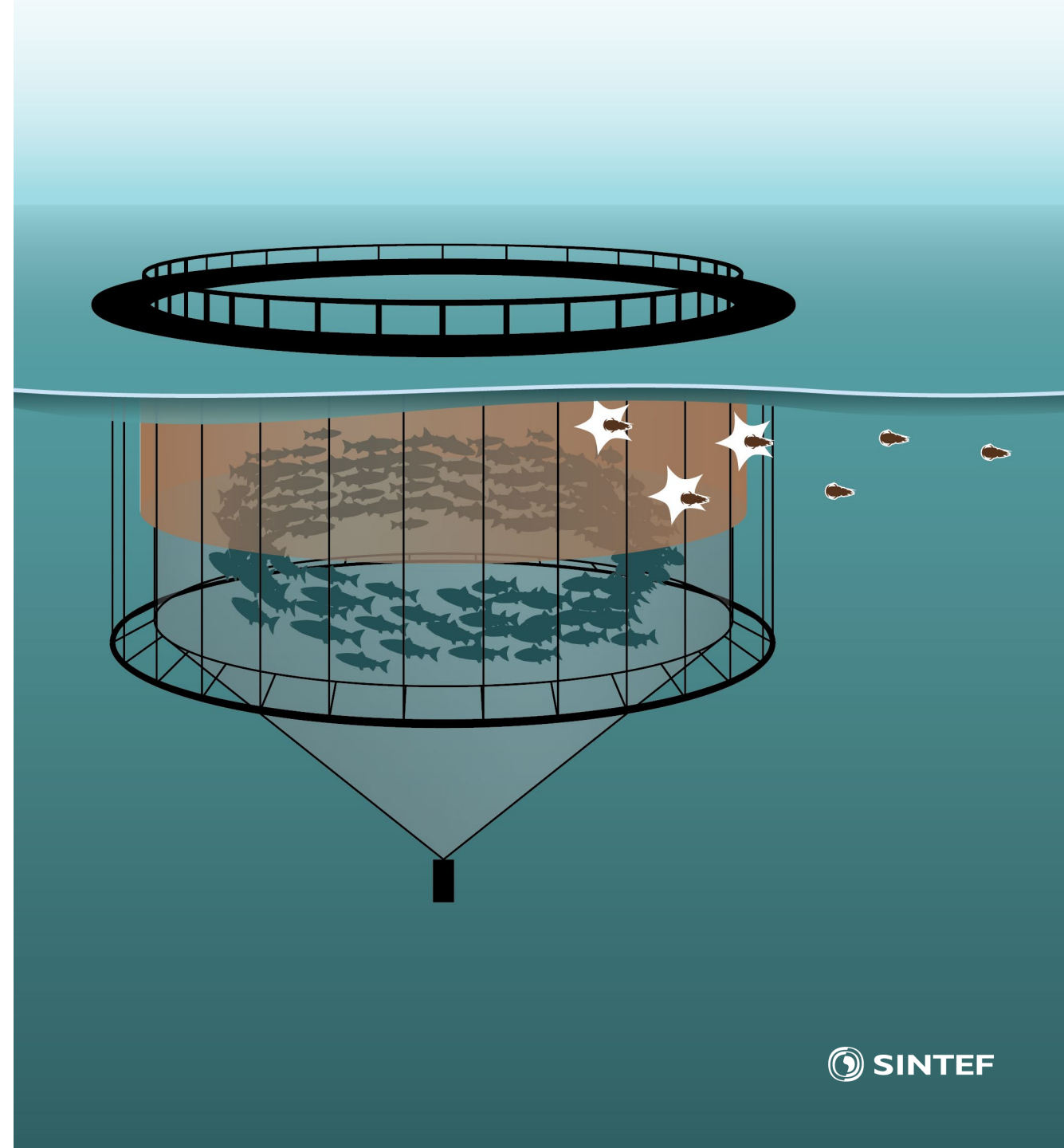
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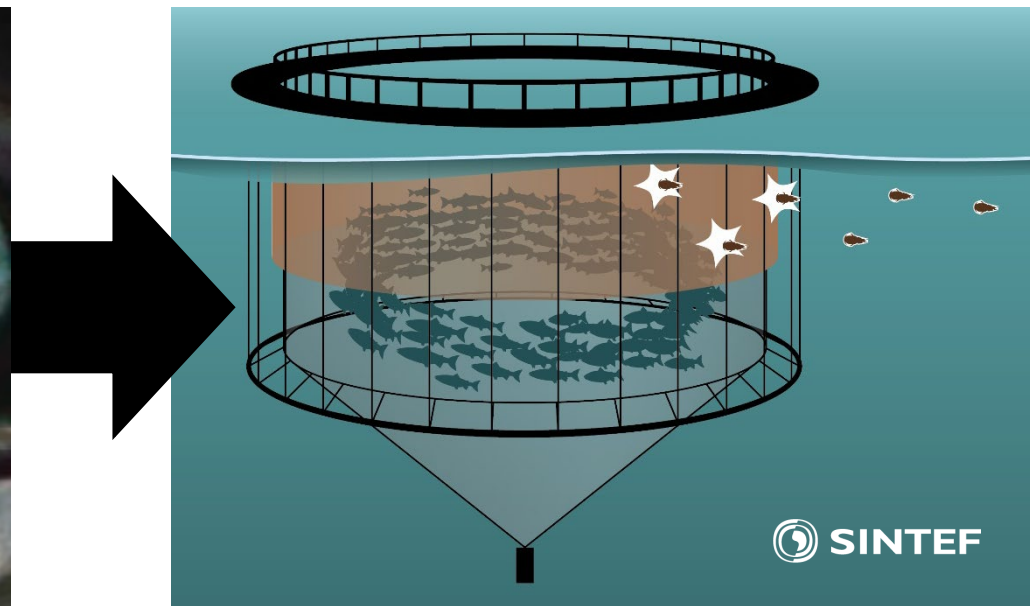
Outline

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 - Model
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- Results
 - Deformation
 - Drag forces
 - Waves
- Conclusions



Introduction

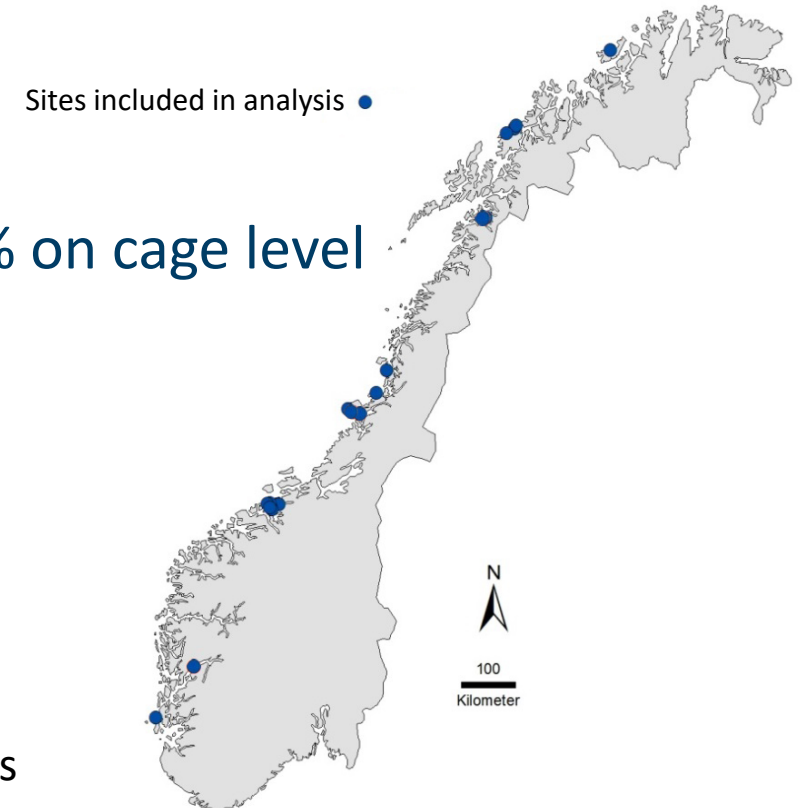
- Prevention is the main strategy in battling salmon lice in Norway
- Shielding skirts are the most important among the preventive measures
- Many salmon farmers have put them to use



Shielding skirts significantly reduce sea lice infestation

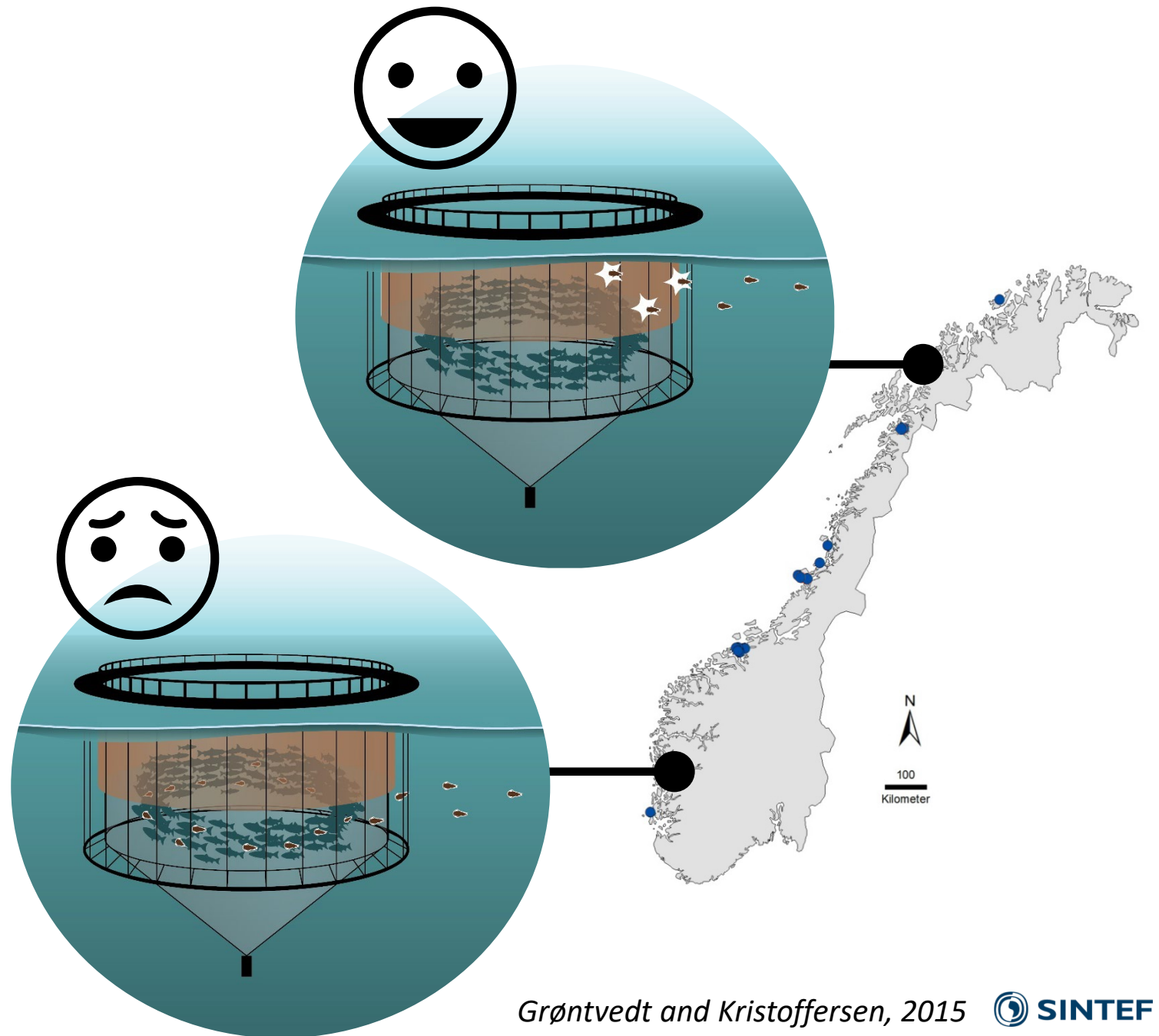
- Skirts reduced lice infestation with an average of 18 % on cage level
- On site level, reduction was on average 54 %

Data from:
17 sites
1582 observations

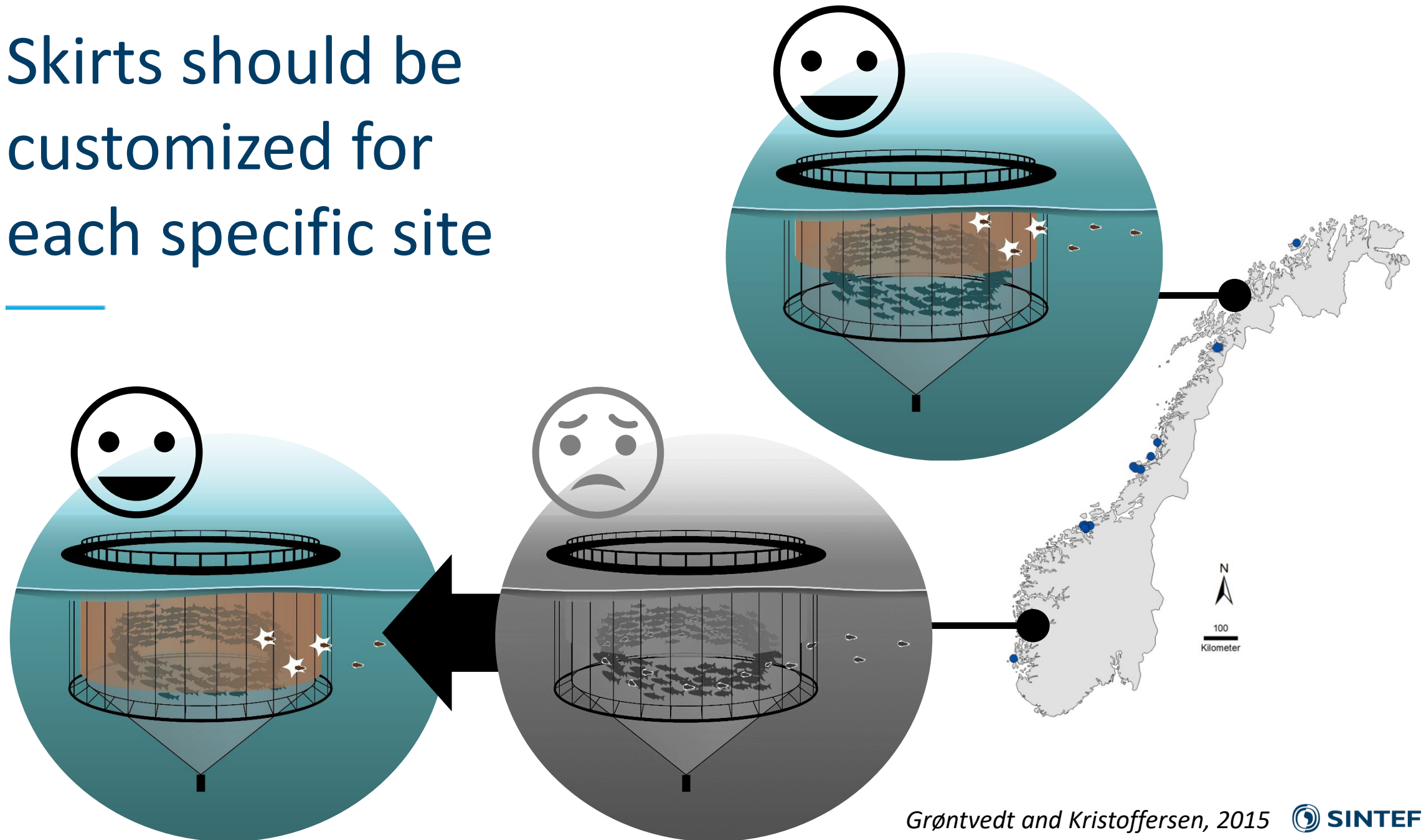


...but effect vary from site to site

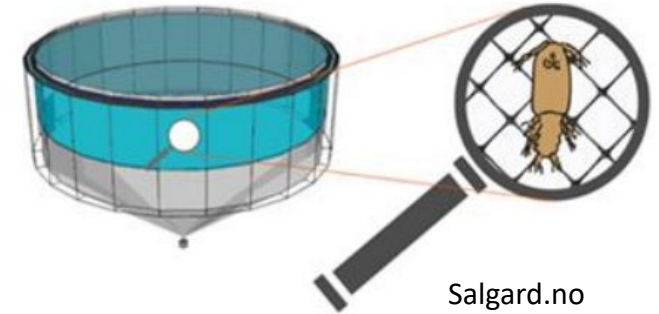
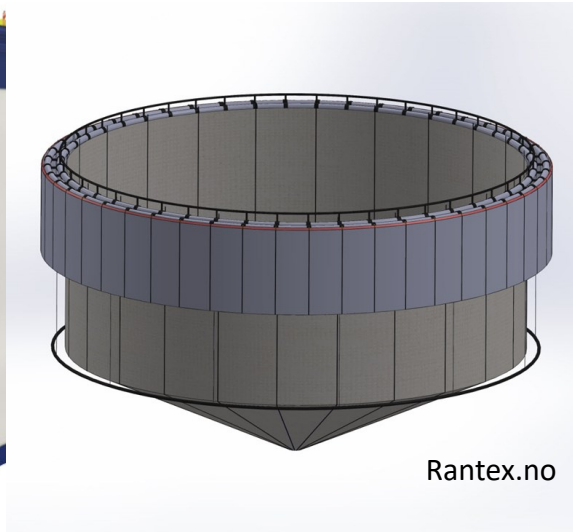
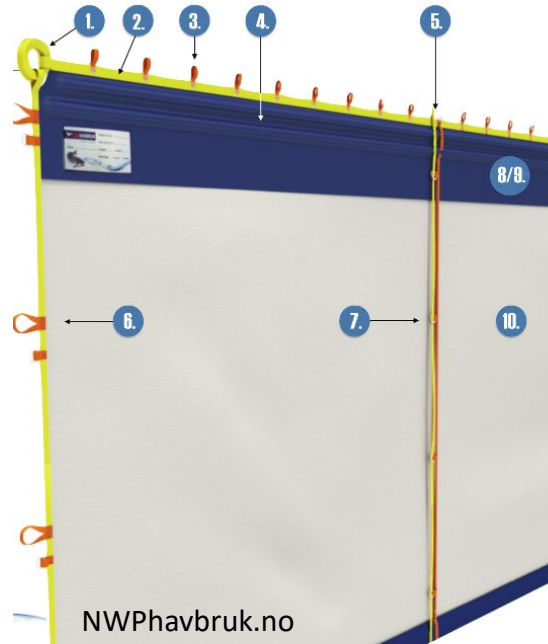
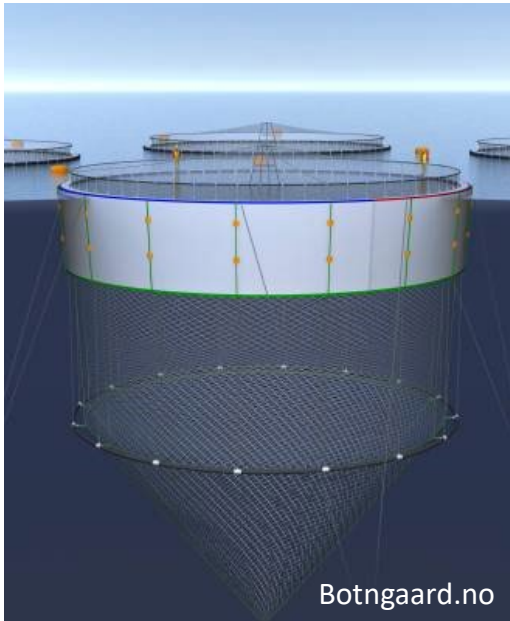
- Cage level: 6-28 %
- Site level: 0-80 %



Skirts should be customized for each specific site

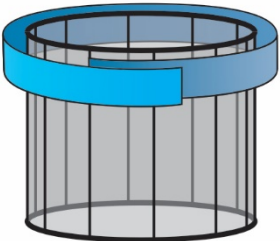
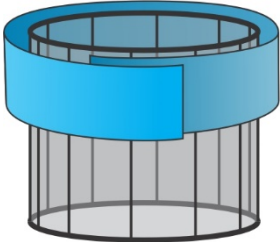
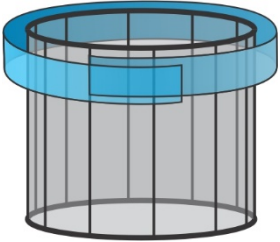
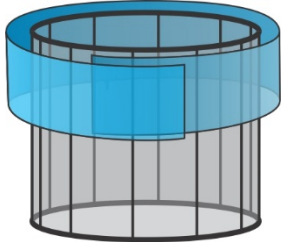
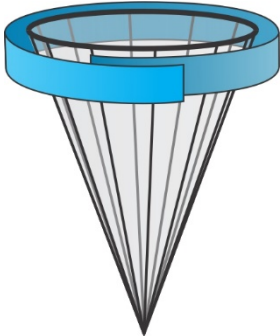
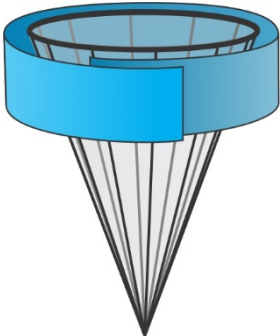
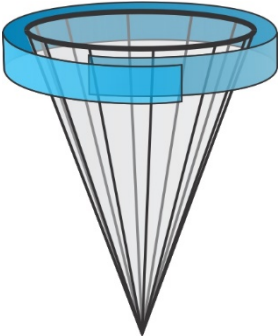
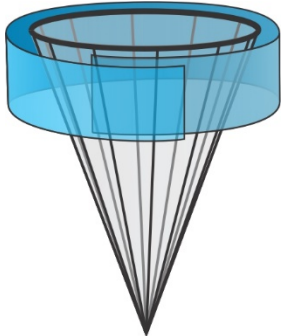


Many variations of skirts available



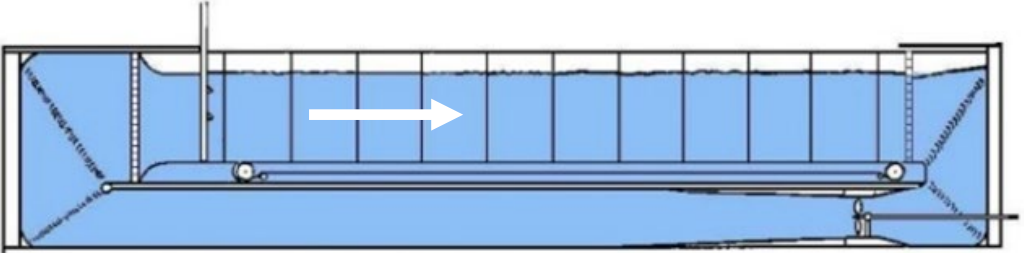
..but how do variations of skirts and nets behave in currents and waves?

Experiments

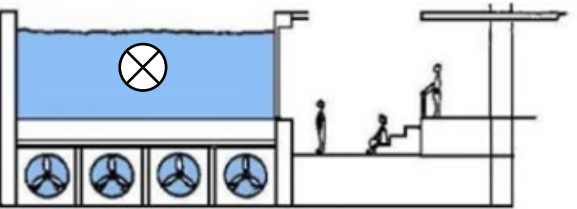
	Impervious skirt (solidity 100 %)		Plankton skirt (solidity 50 %)	
Skirt material				
Skirt depth	5 m	10 m	5 m	10 m
Cylindrical net				
Conical net				

Flume tank

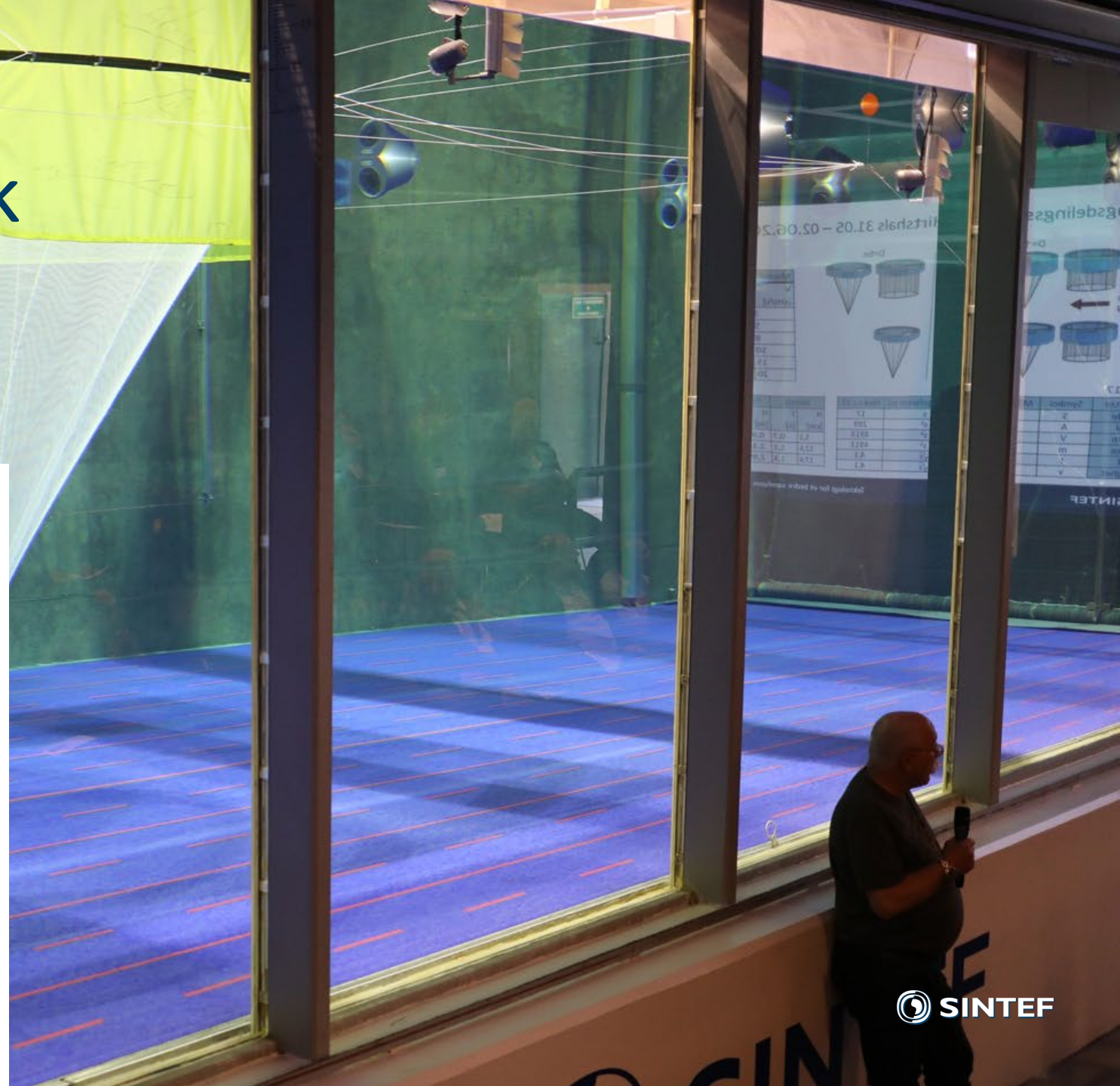
Measuring section: L: 21.3 m, H: 2.7 m, W: 8.0 m
Volume of water: 1200 m³
Windows: 20 pcs 2x3 m



Side view



Front view



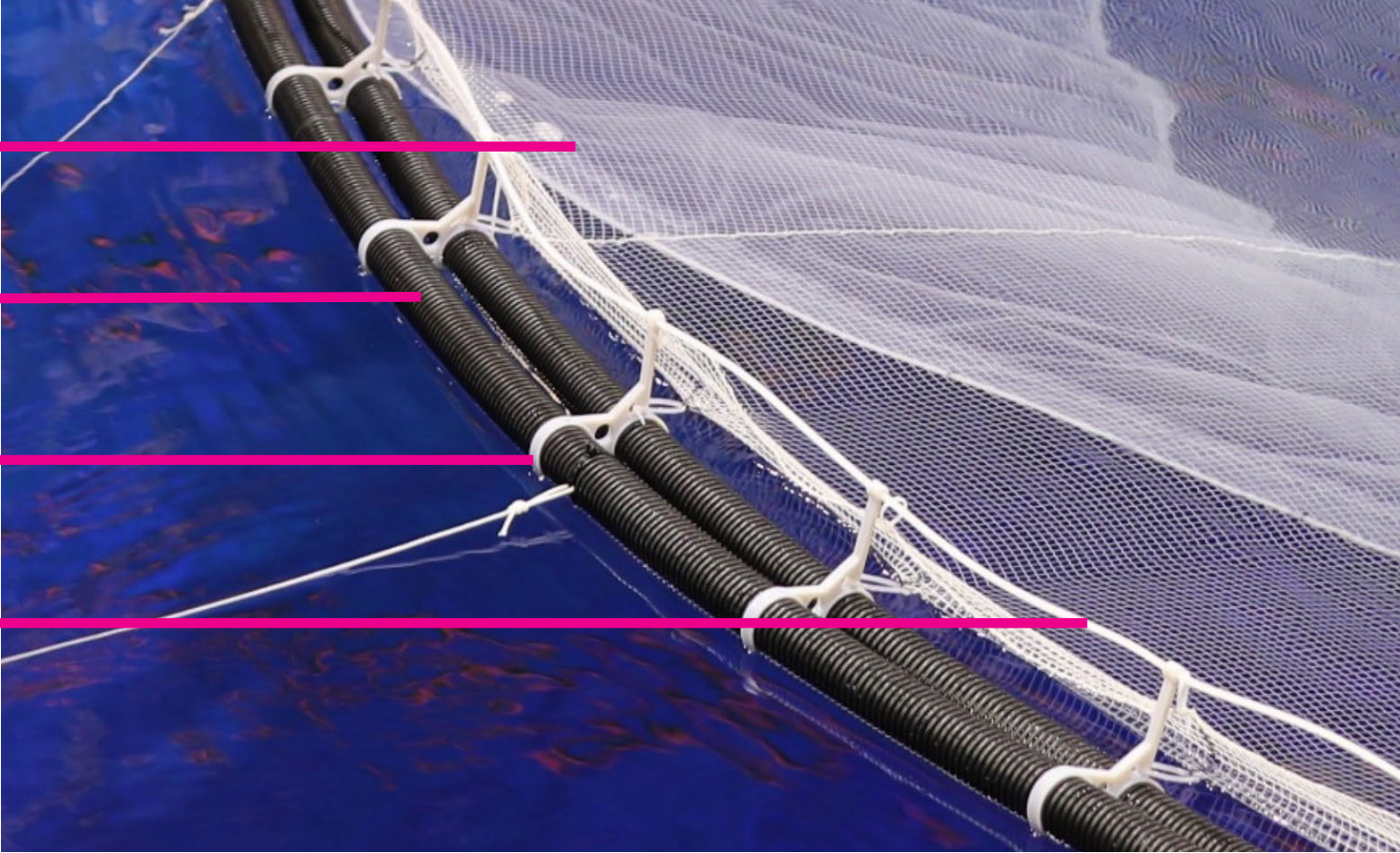
Model construction

Model net
solidity 20 %

32 mm flex tubes

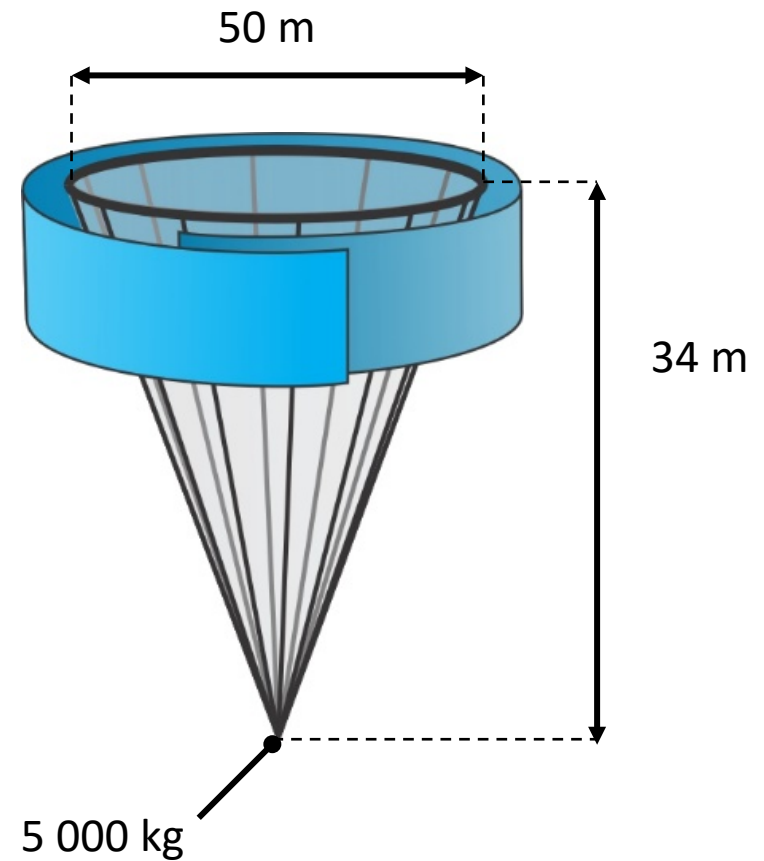
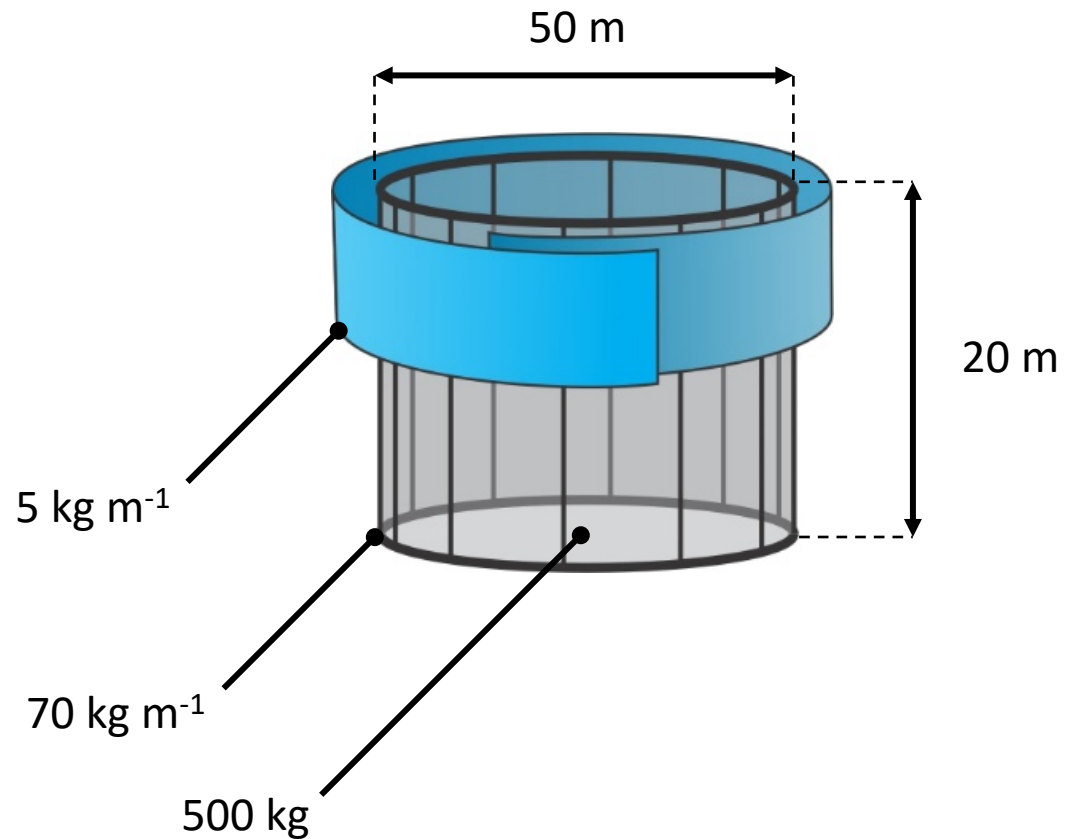
40 pcs 3d-printed
brackets

5 mm PE filler rod

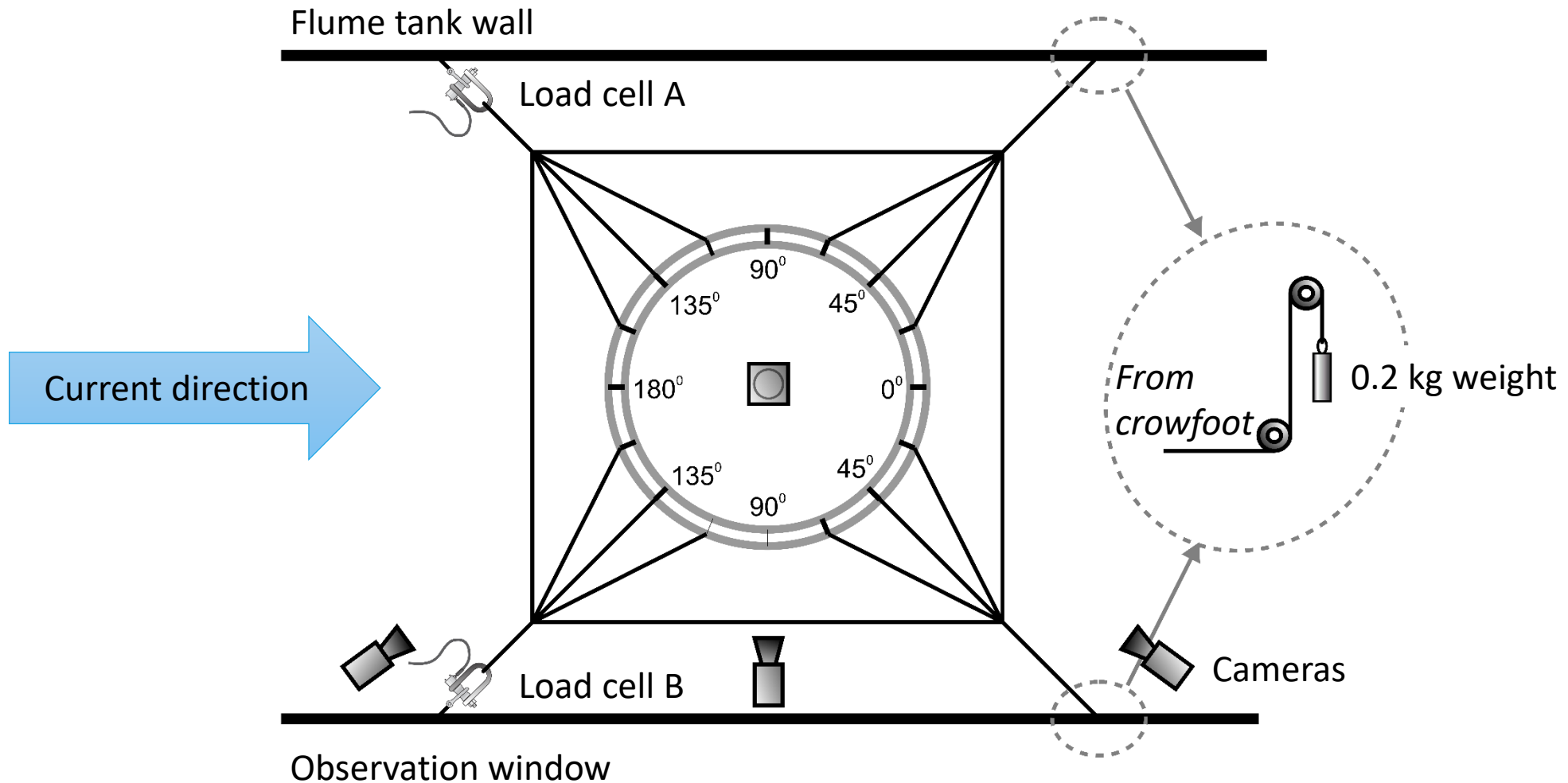


Model cage dimensions (full scale values)

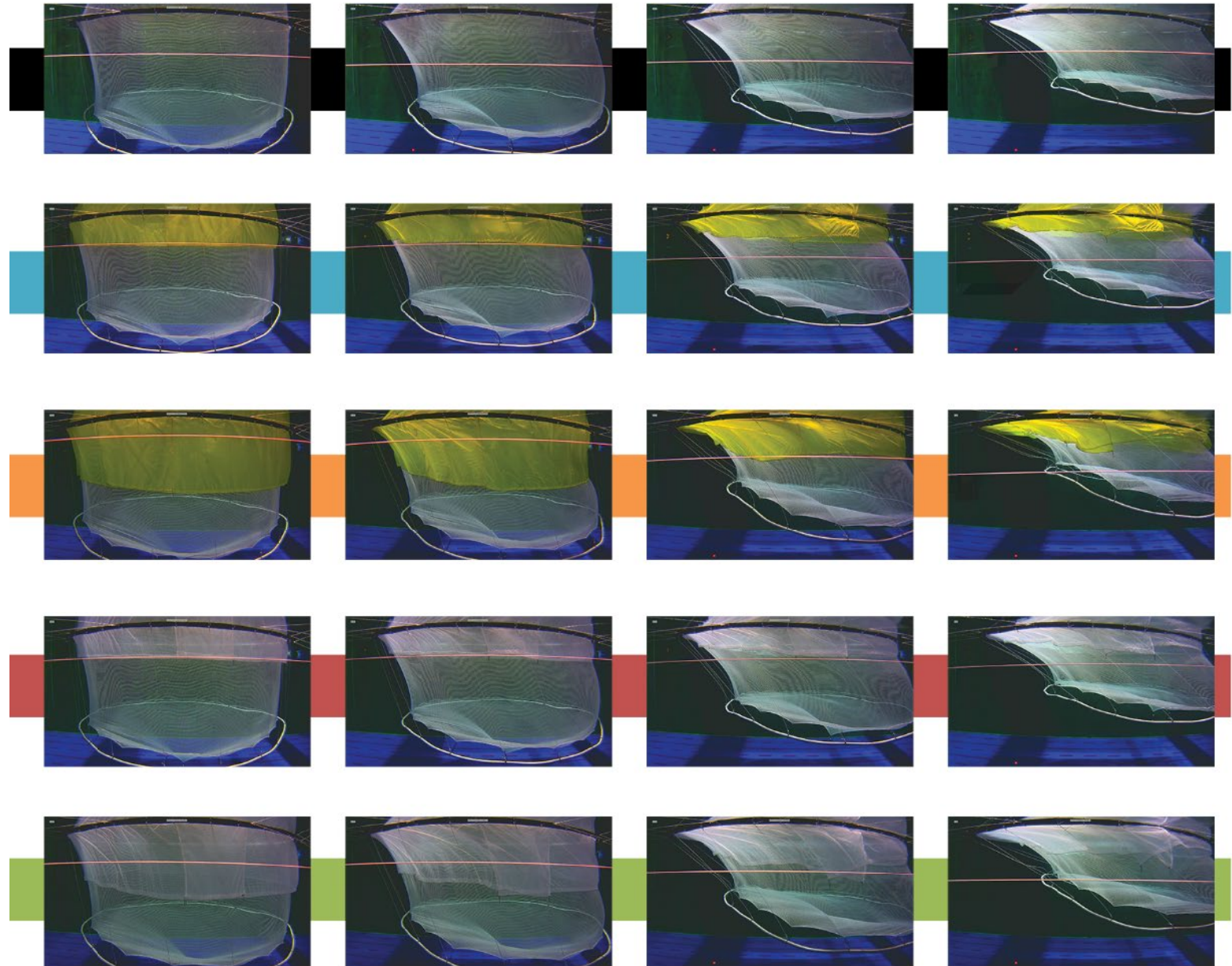
Scale 1:17



Experimental setup

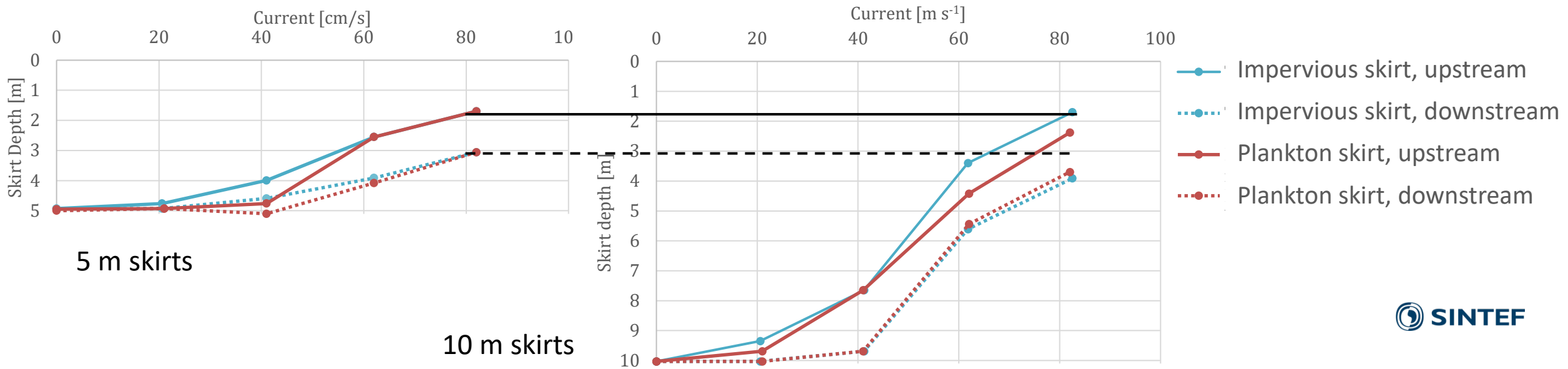
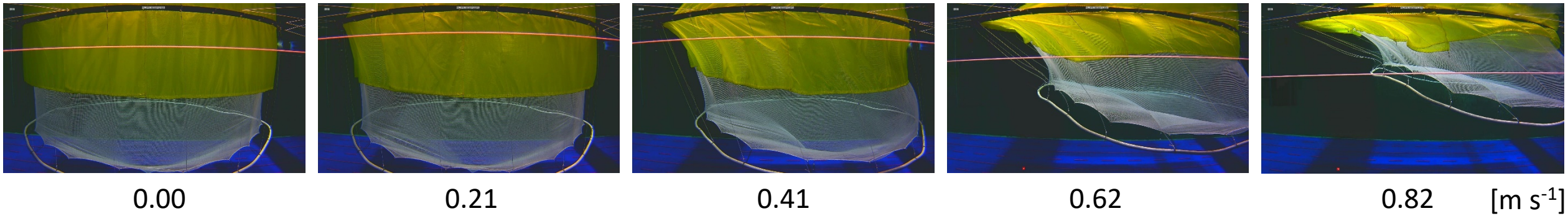


Deformation

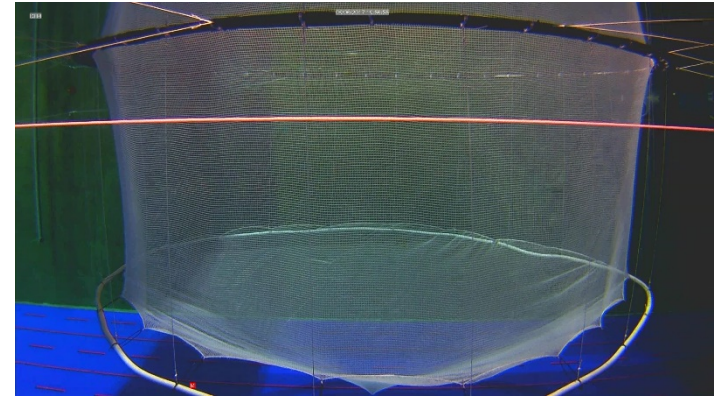


21 41 62 82

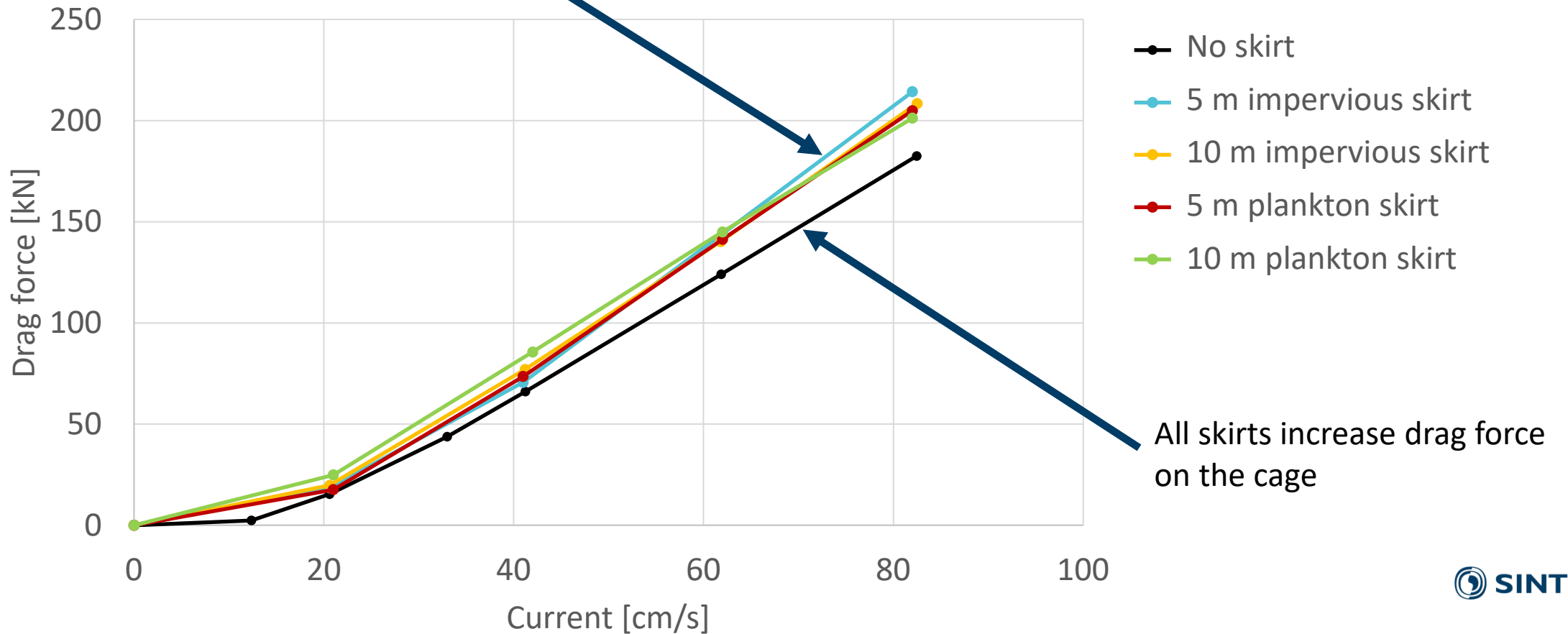
Deformation



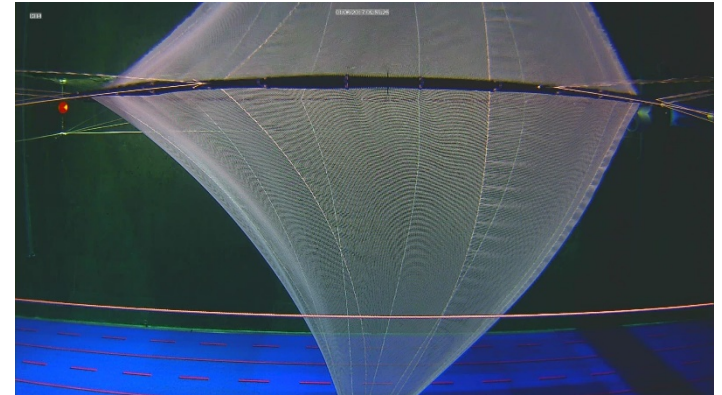
Drag force, cylindrical net



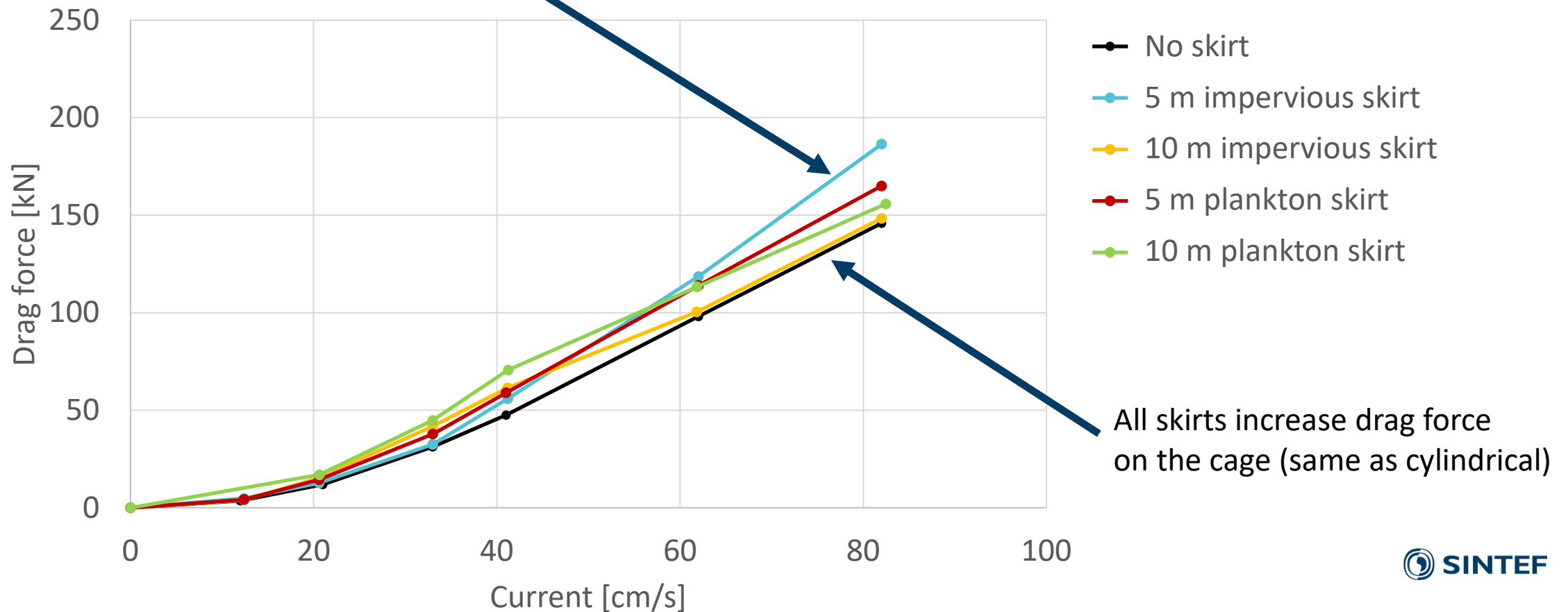
No clear difference between skirts



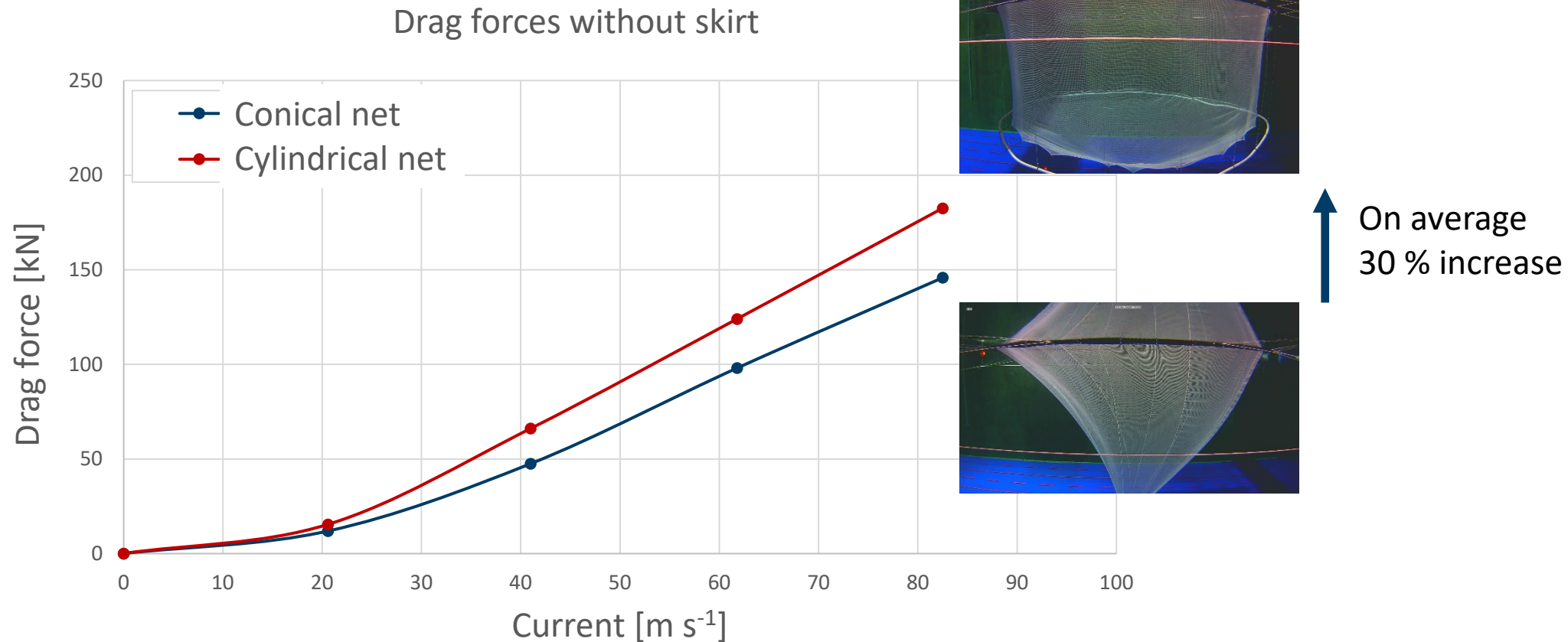
Drag force, conical net



Lower total drag force than cylindrical net

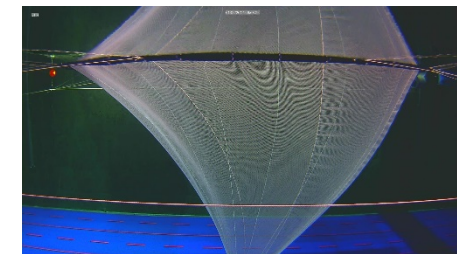
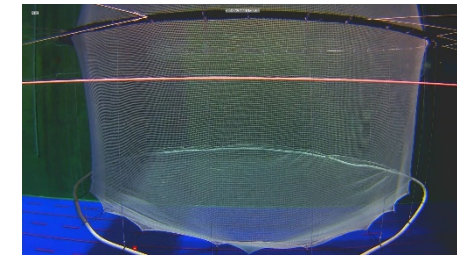


Drag forces on the two nets differ –affects comparison



Drag forces with skirts mounted differ similarly

Configuration	Drag force increase [%]	StDev
5 m impervious skirt	27,0	11,3
5 m plankton skirt	23,8	1,0
10 m impervious skirt	33,5	6,7
10 m plankton skirt	31,5	9,6

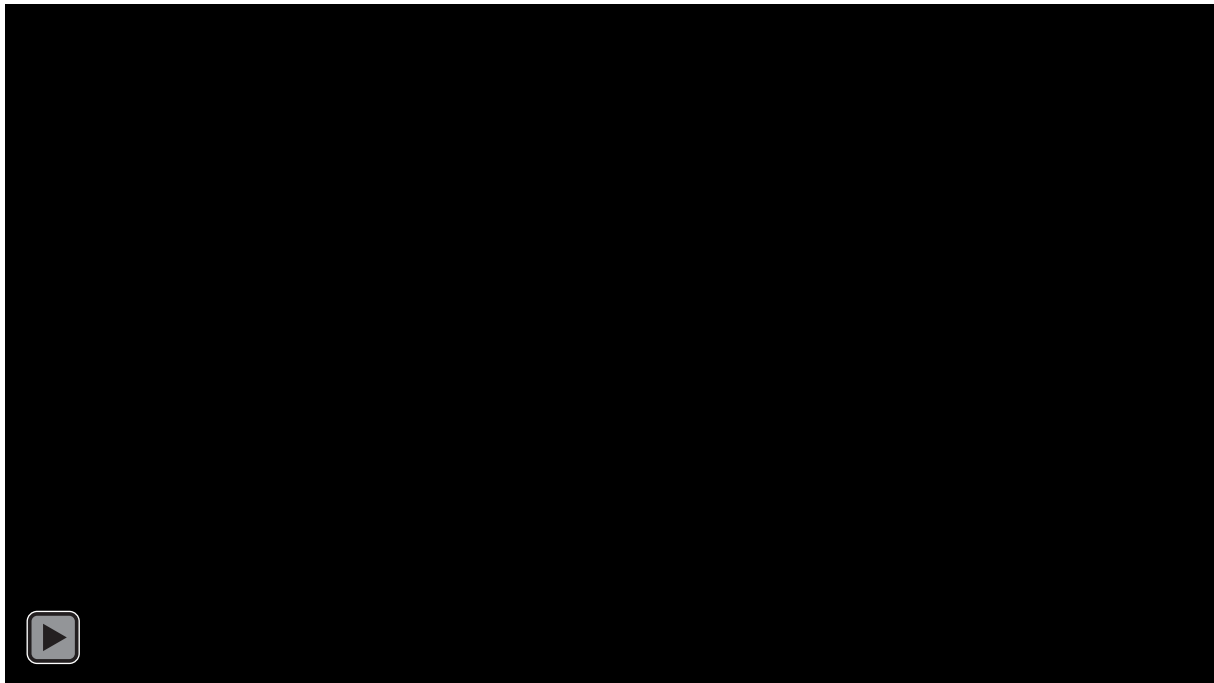
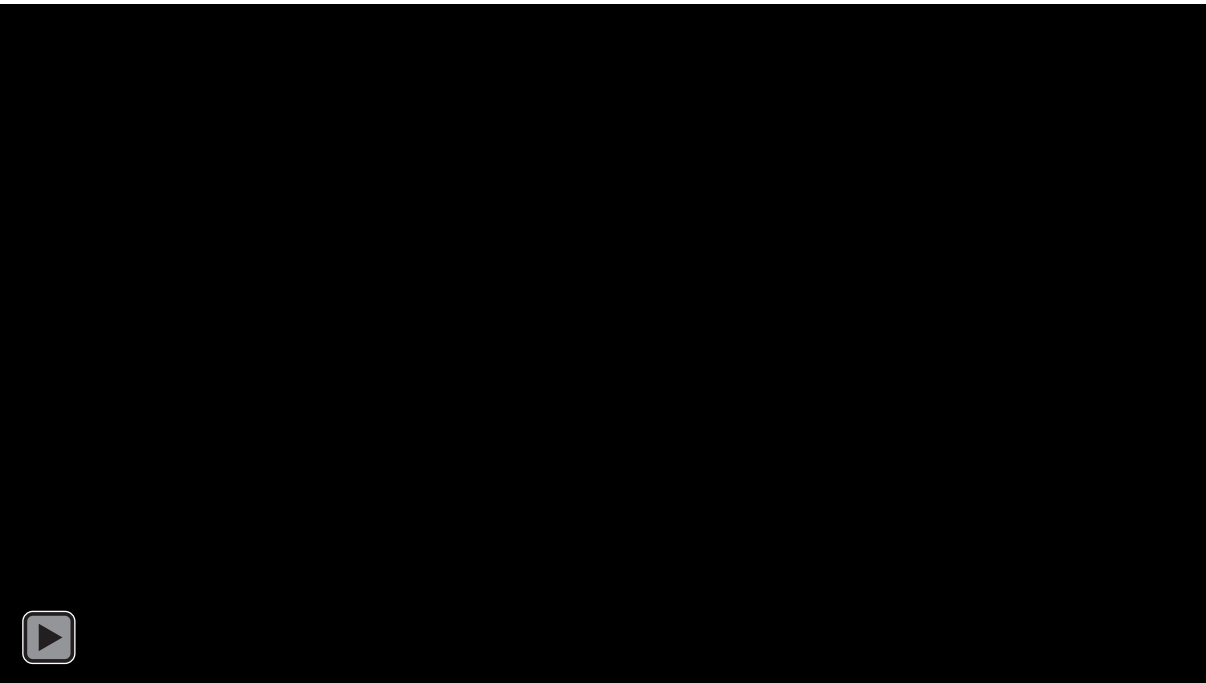
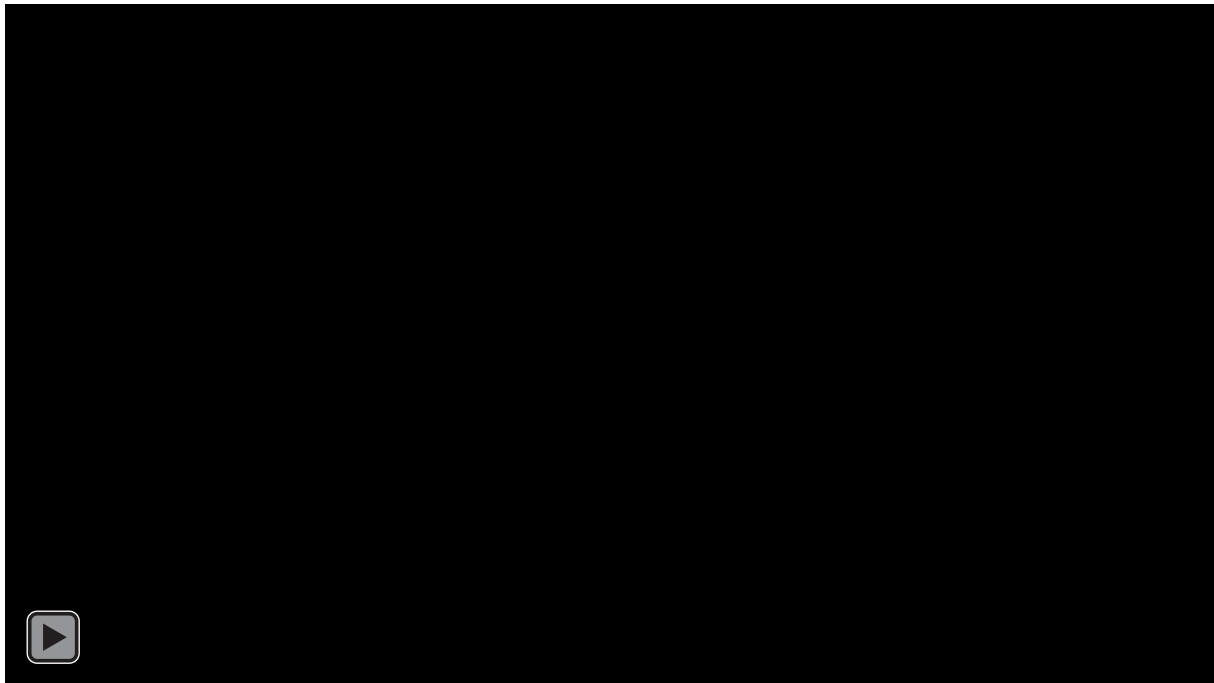
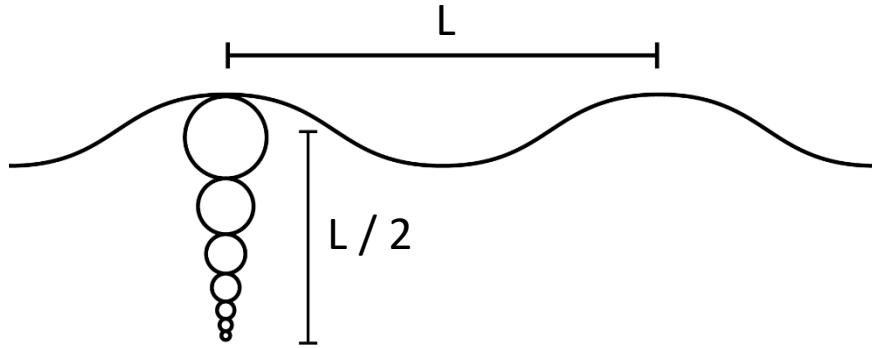


↑
On average
30 % increase

Skirts affect the two nets similarly when it comes to drag forces

Different waves

Water movement
greatest at the
surface
→ skirt might
crawl upward



Conclusions

- All configurations of skirts increase total drag force on the cage
- Only minor differences in drag force between variations of skirts
- Skirts increase the drag forces of cylindrical and conical nets similarly
- Skirt movement in waves is greatest at the water surface, which can result in the skirt crawling upward

Acknowledgements

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Kurt Hansen

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Teknologi for et bedre samfunn