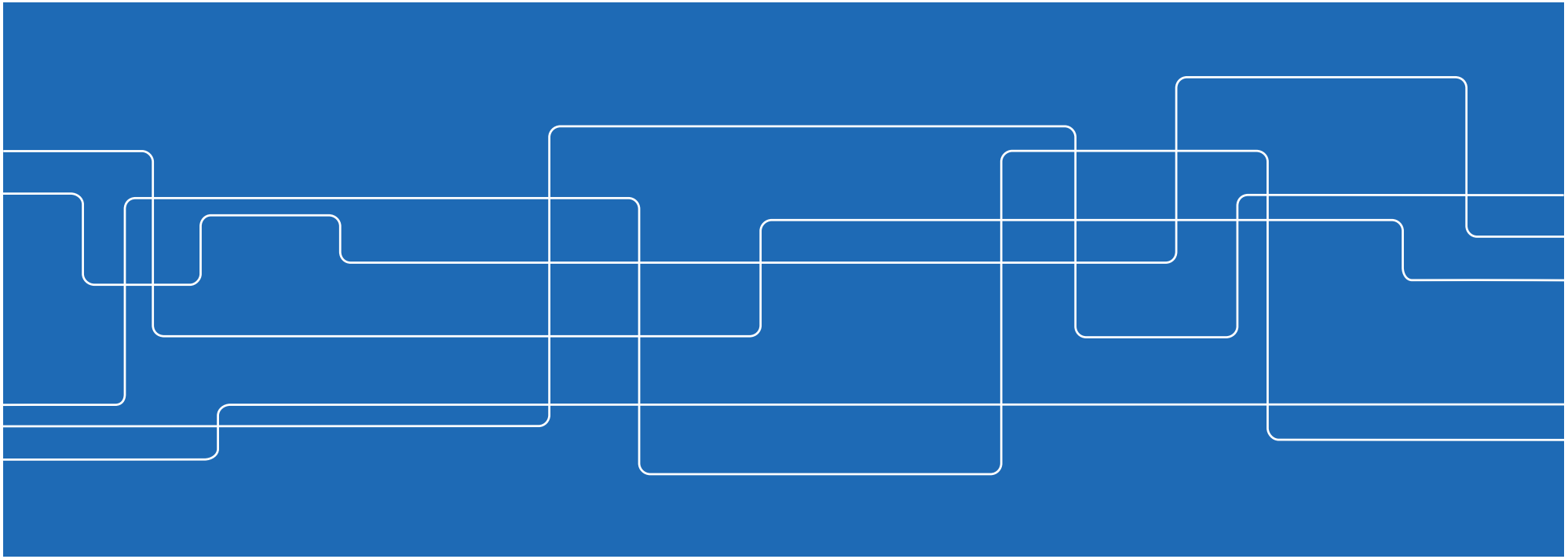
Light weight vessels operation in brashed ice

Magnus Burman
mburman@kth.se



Light weight ships and winter conditions

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S-LÄSS

OFFSHORE VÄST

About the project

Background

Are **light weight ships** e.g. WFSV or passenger ships built in aluminium or FRP **suitable** for operation in winter climate?

… and how do to **manage** such operations?

Project goal

Gather and collect technical and operational experiences from existing organisations with light weight ships operating in winter conditions.

The knowledge base will be used for

- Indicating limiting factors
- Provide a background for in-depth studies, analyses and development

Challenges

- Many and diverse opinions
- Various backgrounds
- Different geographic locations
- Lack of documentation

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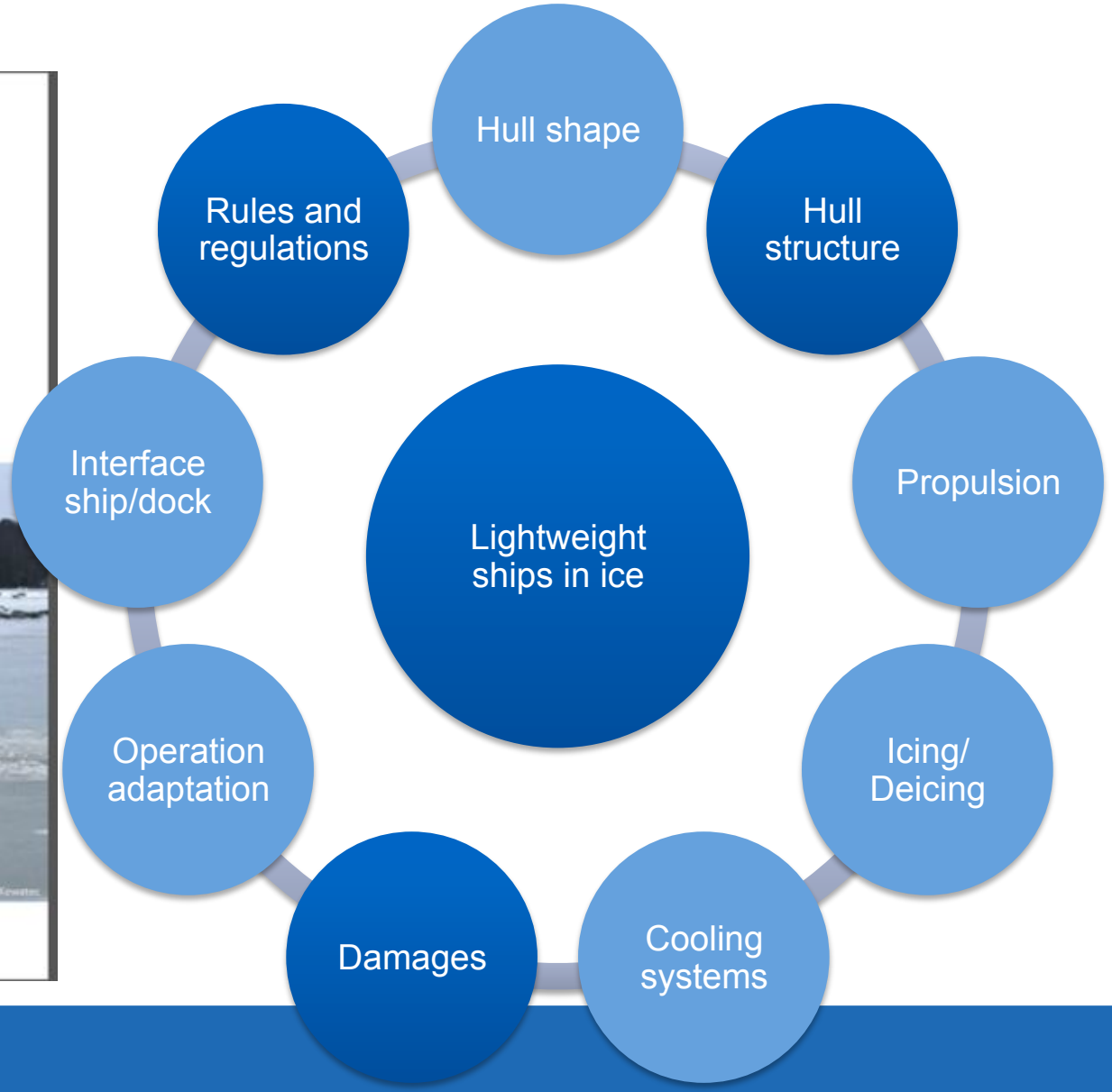
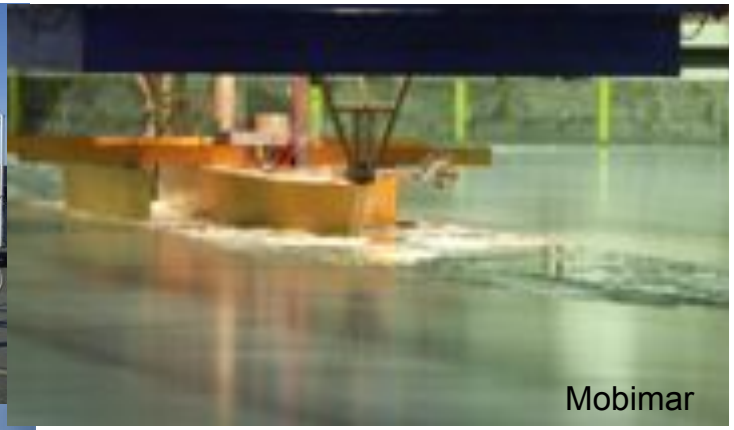
Light weight ships and winter conditions



Based on 33 interviews

Hull shape

Foto: Lena Fosselius-Peterson



Mobimar

Foto: Swede Ship Marine

Mono hulls

Catamaran

Trimaran

Propullsion systems

Fixed propeller / rudder

Water jet

Azimut / Pod / IPS

Bow propeller

Trim / Interceptors


Foto: Steelprop Finland OY

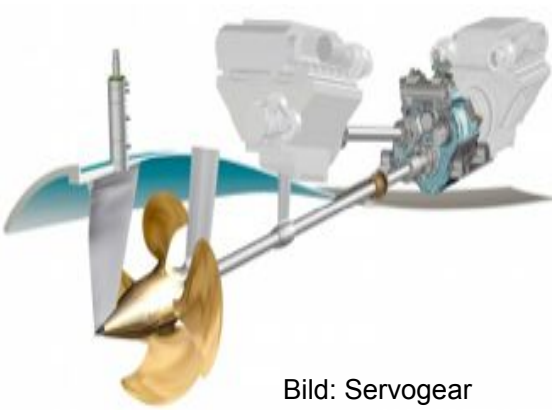


Bild: Servogear


Foto: Johan Edvardsson

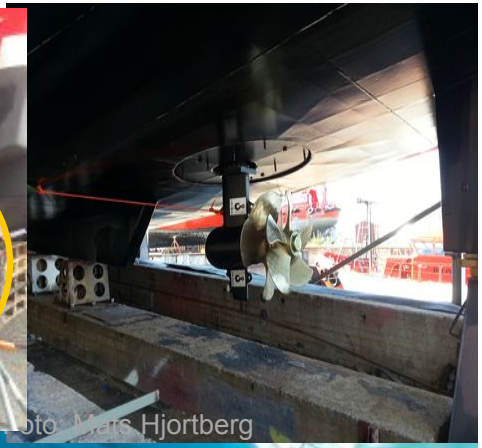


Foto: Mats Hjortberg

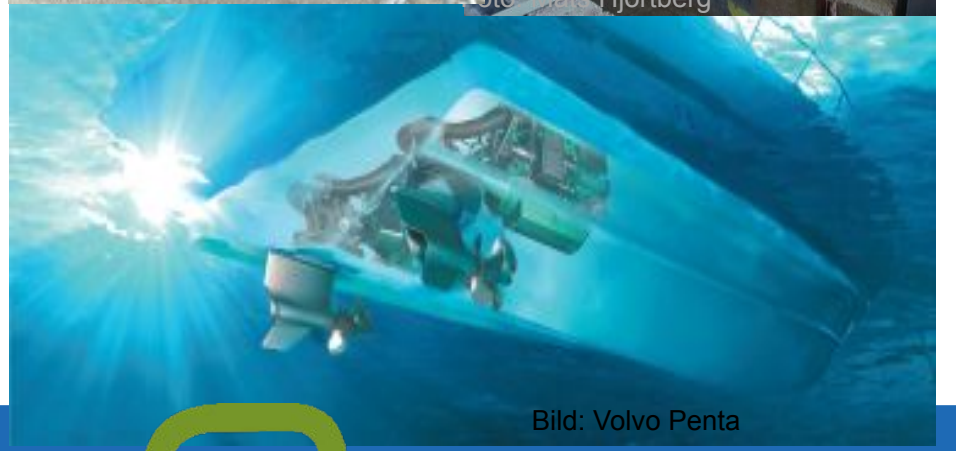


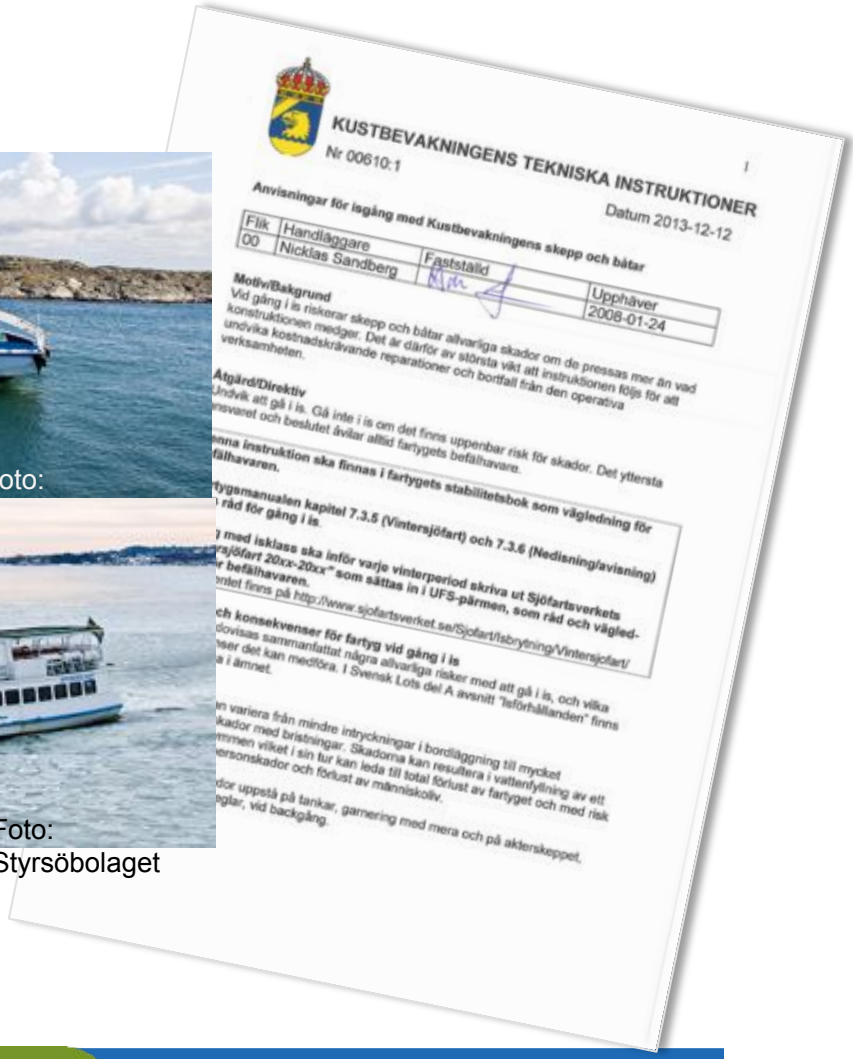
Bild: Volvo Penta

Operation adaptation for winter traffic

- Winter traffic time table
- Shift of vessel
- Reallocation of stops
- Docking at night
- Ice channels
- Reverse manoeuvres
- Restrictions

Foto:

Foto:
Styrsöbolaget



KUSTBEVAKNINGENS TEKNISKA INSTRUKTIONER

Nr 00610:1

Datum 2013-12-12

Anvisningar för isgång med Kustbevakningens skepp och båtar

Flik	Handläggare	Fastställd	Upphäver
00	Nicklas Sandberg		2008-01-24

Motiv/Bakgrund

Åtgärd/Direktiv

Existing damages

Excessive wear bottom color

Slashed bow fenders

Holes in kind on aluminum vessels

Damage to the bilge keels

Hose rupture of water jets

Over heating of the main and auxiliary engines

Poor statistics on ice damage due deficiencies in the reporting system.
The class lacks experience when they do not rate these ships for navigation in ice .

coat in FRP single shell

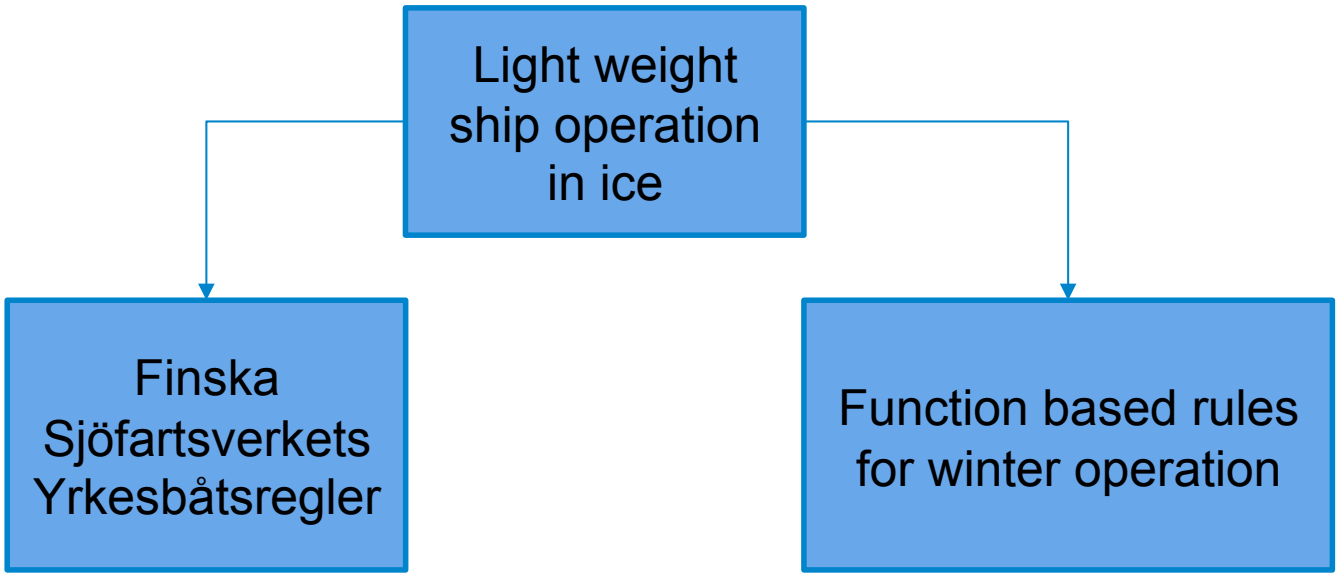
Rules and regulations

The most common regulations for small ships used by interviewed organisations are

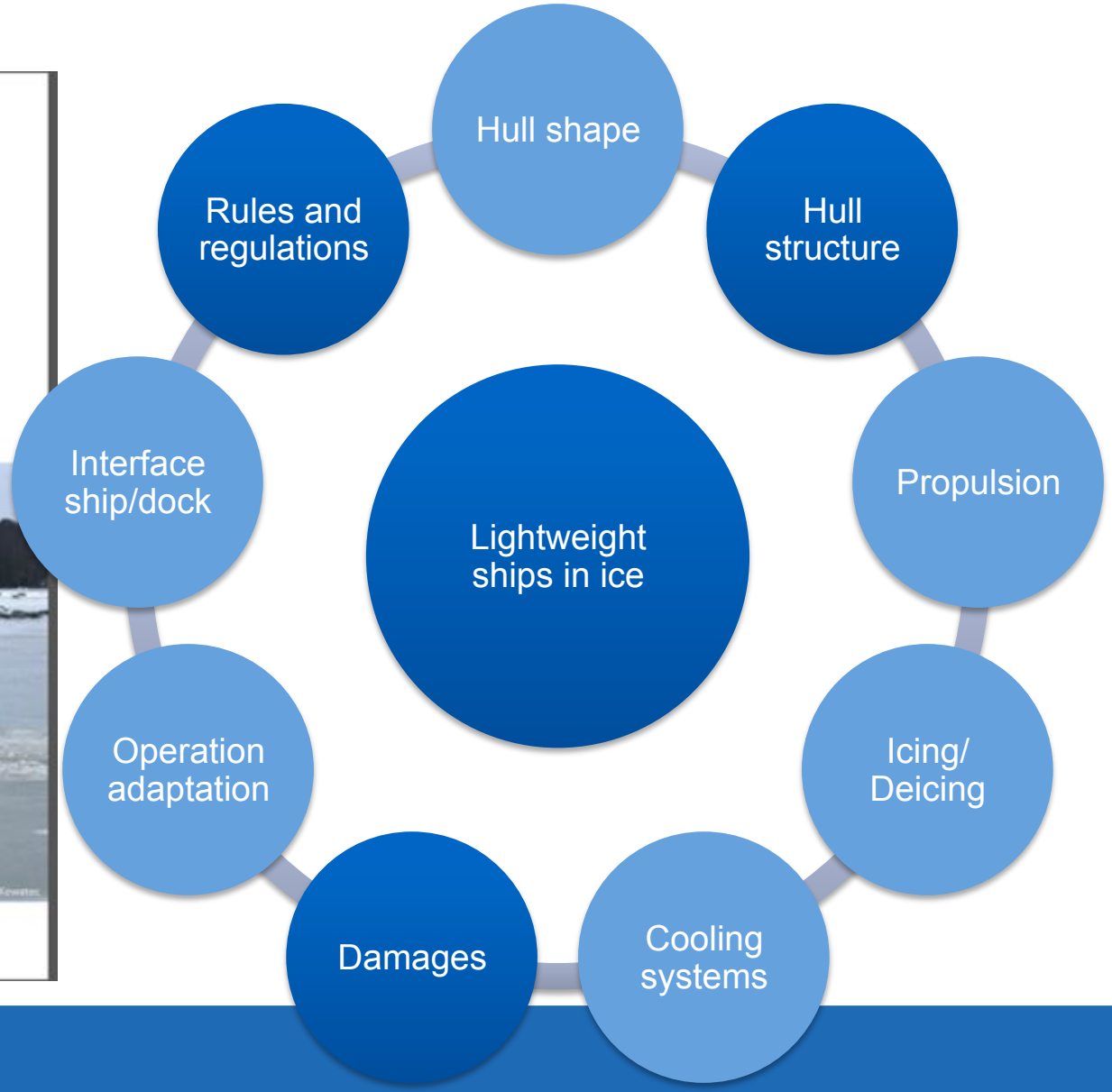
- NBS-Y, Nordisk båtstandard för yrkesbåtar under 15 m 1990 (Sverige, Norge, Finland Danmark)
- Sjöfartsverkets Yrkesbåtsregler (Finnish Maritime Administration - Commercial Craft Rules) Version 2009:1 (Finland)
- Bekendtgørelse om Meddelelser fra Søfartsstyrelsen F, teknisk förskrifts om mindre erhvervsfartøjers bygning og udstyr m.v. (Danmark)

Regulation development

- National rules before class
- Function based rules - concern about increased cost
- One way forward might be two tracks



Light weight ships and winter conditions



Based on 33 interviews

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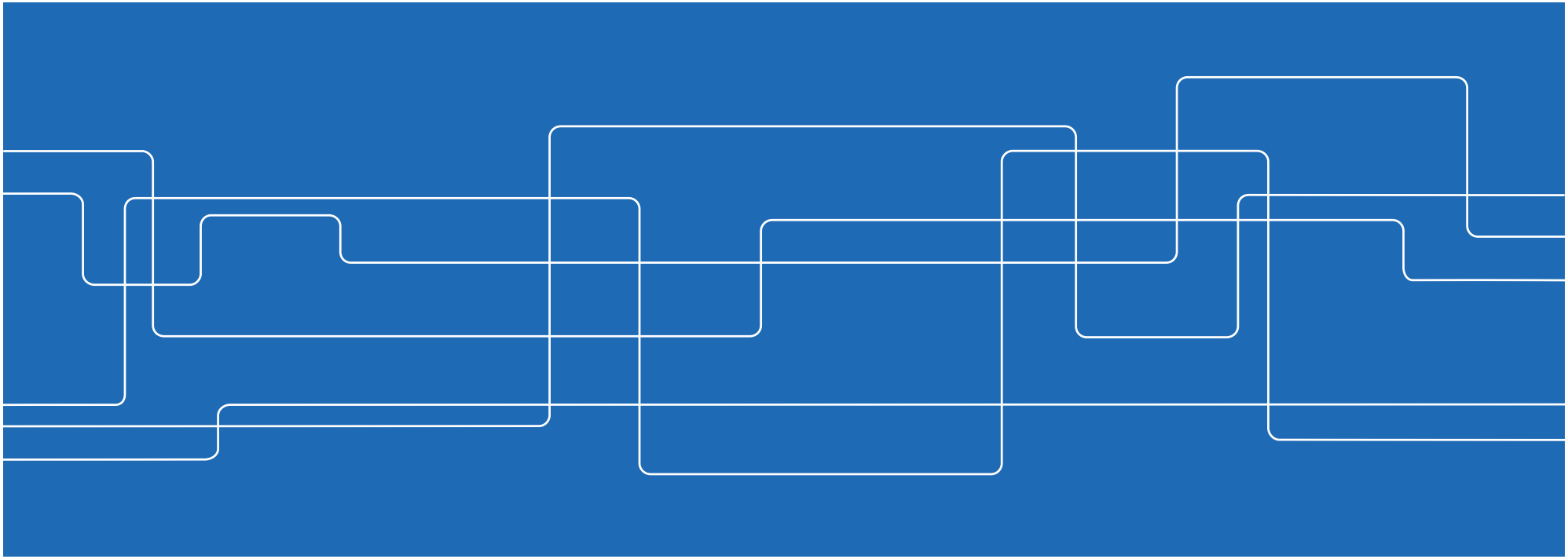
Magnus Burman & Niclas Niclasen



Lightweight operation in ice - motivation

Waterway will provide an capacity increase in public transport

Light weight and high speed vessels is part of a sustainable transport system

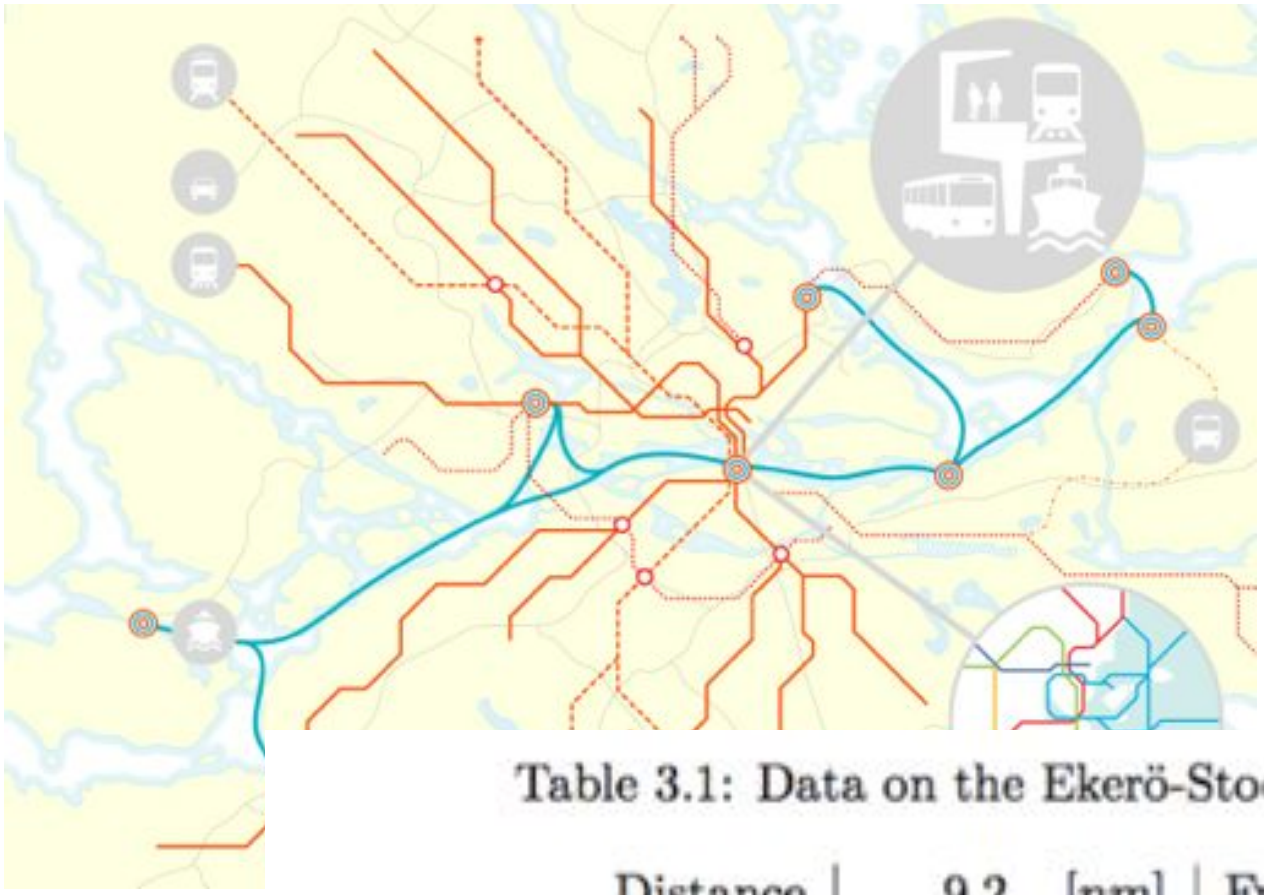
Few (if any) publication on interaction ice and lightweight (high speed) ships

Operator experience – no problem

Unverified opinions dominate the debate on light weight FRP vessels operating in ice

More information – www.waterway365.com

Operational profile – Stockholm

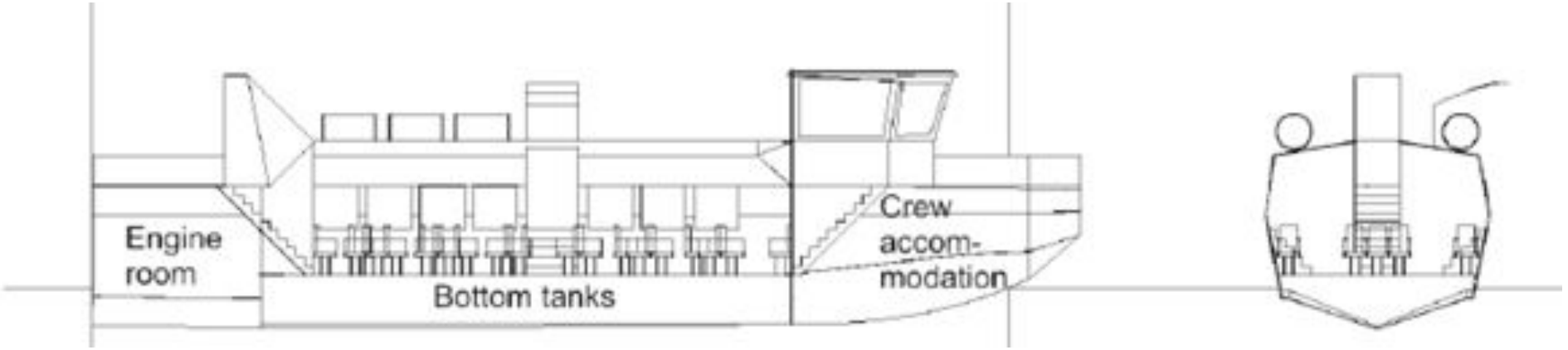


Waterway
Subway
Commuter train

Table 3.1: Data on the Ekerö-Stockholm route

Distance	9.2	$[nm]$	From appendix A.1
Draft restriction	3.2	$[m]$	Shallow water at Ekerö
Breath restriction	≈ 20.0	$[m]$	Narrow passage at Ekerö
Air draft restriction	24.0	$[m]$	Under Västerbron
Maximum ice thickness	≈ 0.2	$[m]$	Section 5.1

The vessel



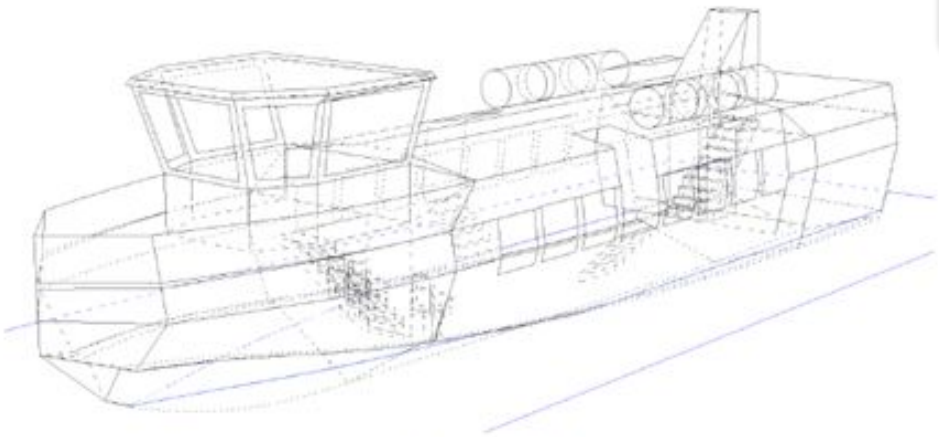
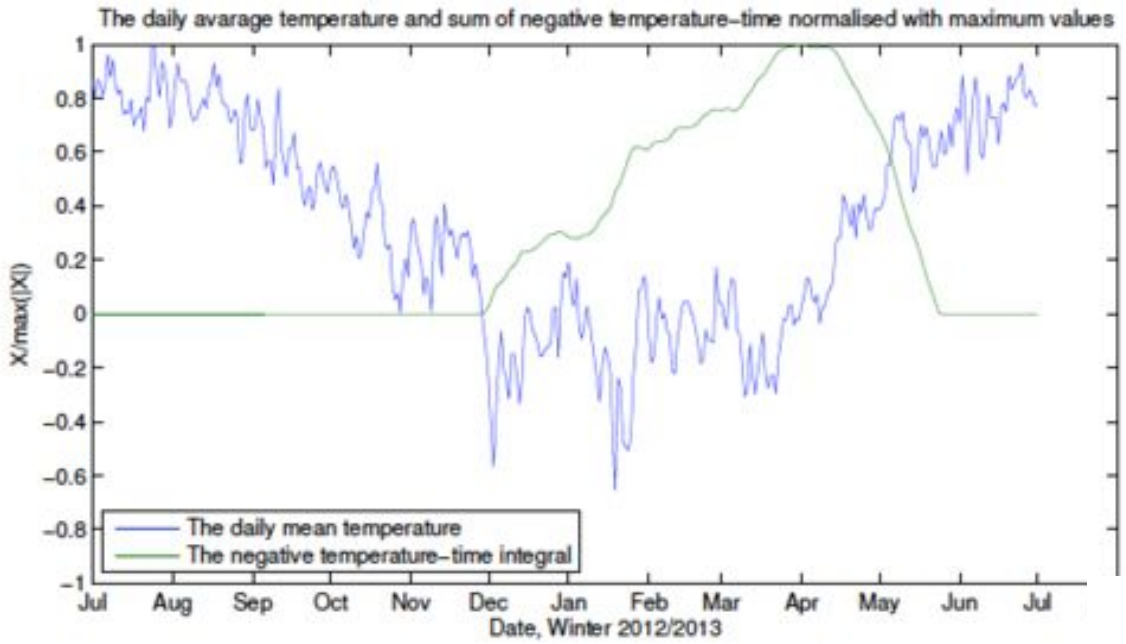
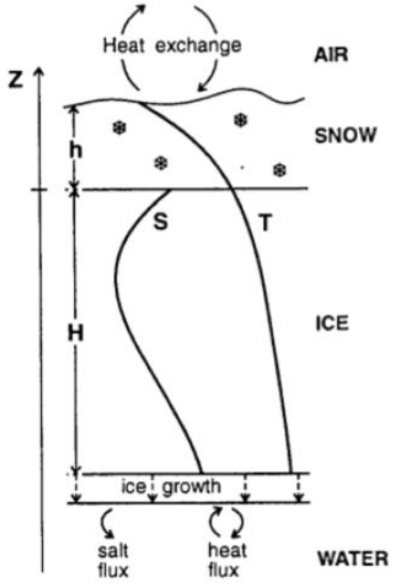


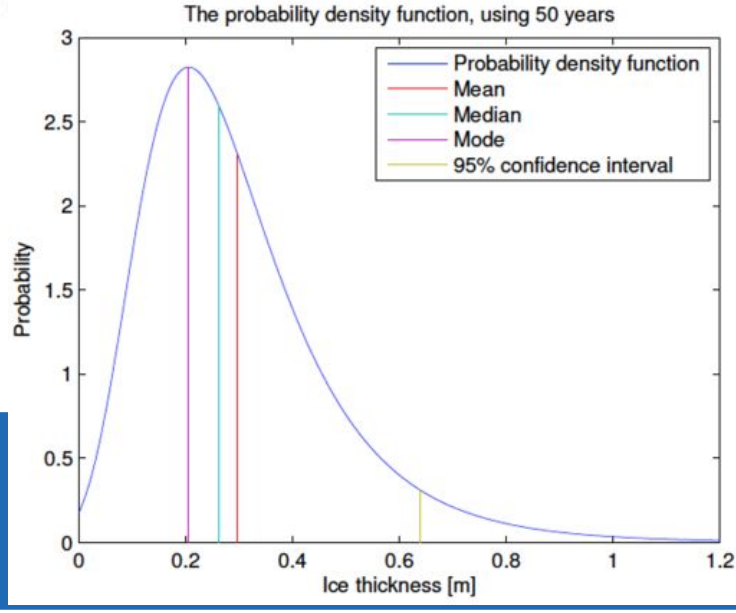
Table 3.4: The Outline Specification (O.S.) in the form of a table

Waterline length of the vessel	20.68	$[m]$
Length overall	22.41	$[m]$
Moulded breath of the vessel	6.92	$[m]$
Moulded depth of the vessel	3.20	$[m]$
Design draught of the vessel	1	$[m]$
Design speed of the vessel	40	$[kn]$
Displacement of the vessel	≈ 48	t
Lightweight of the vessel	≈ 38	t
Deadweight of the vessel	≈ 10	t
Water capacity	1,000	$[L]$
Fuel capacity	$\approx 1,750$	$[kg]$
Installed power (MCR)	1,400	$[kW]$
Passenger capacity	90	Passengers
Maximum number of seated passengers	64	Passengers
Number of life rafts	6	
Life raft capacity	180	Persons

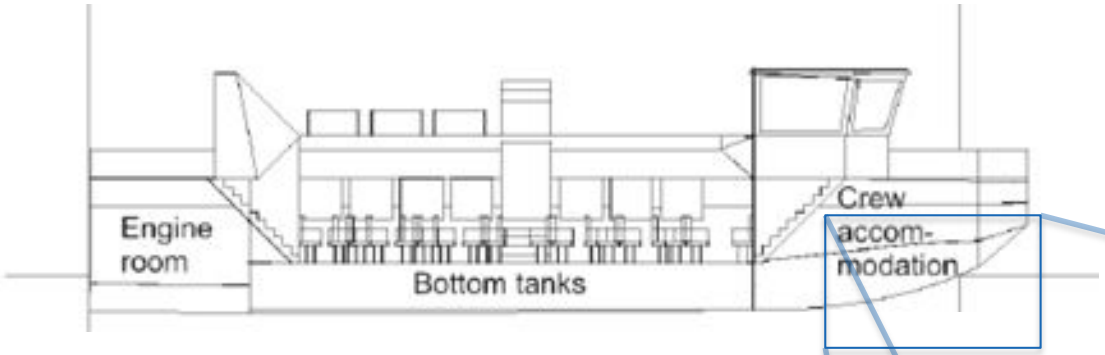
Ice loading – ice thickness

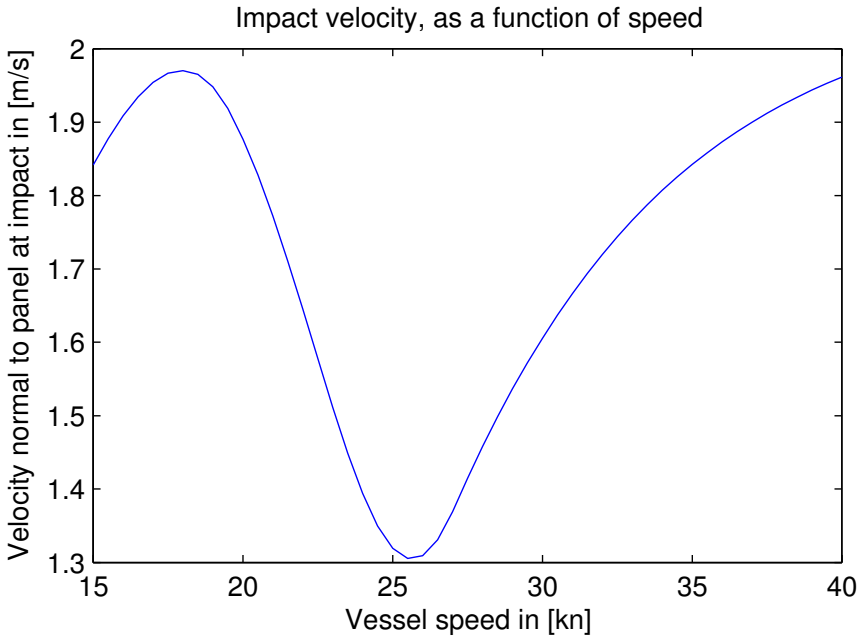


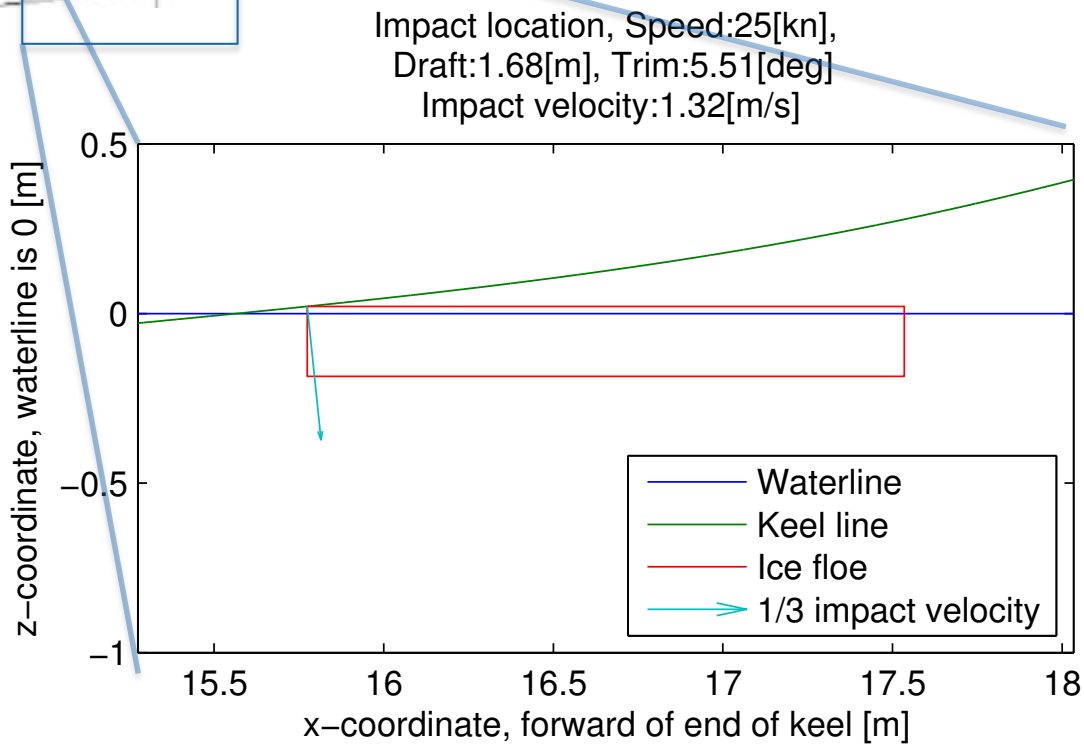




Ice impact model







Panels

Bröderna Aa

Docksta Shipyard

Test series

Rigid steel plate – impact speed variation (mass constant)
– impact mass variation (speed constant)

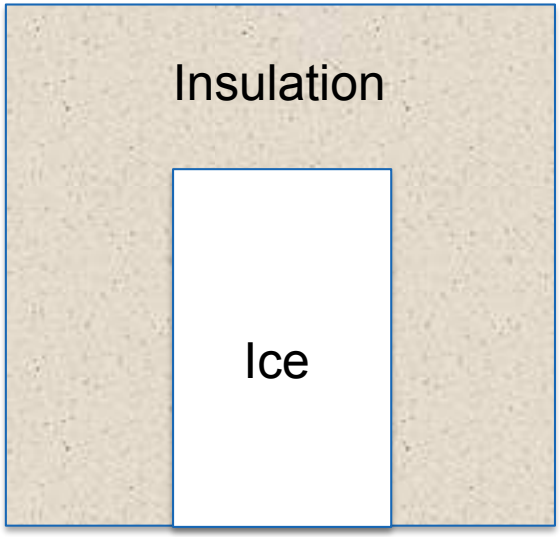
Aluminium panel 1 – impact speed variation (mass constant)
Aluminium panel 2 – impact mass variation (speed constant)

Carbon panel – impact mass variation (speed constant)

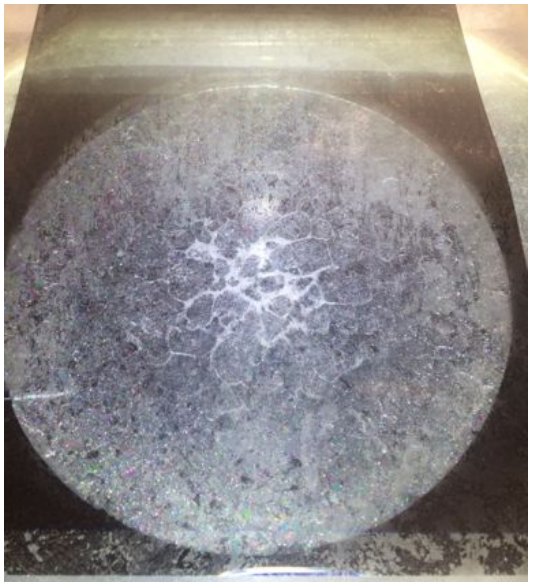
Mass – 215, 300, 400, 500, 600 kg
Speed – 1.50, 1.77, 2.05, 2.29, 2.51 m/s

(Corresponding kenitic energy in impact)

Making of ice



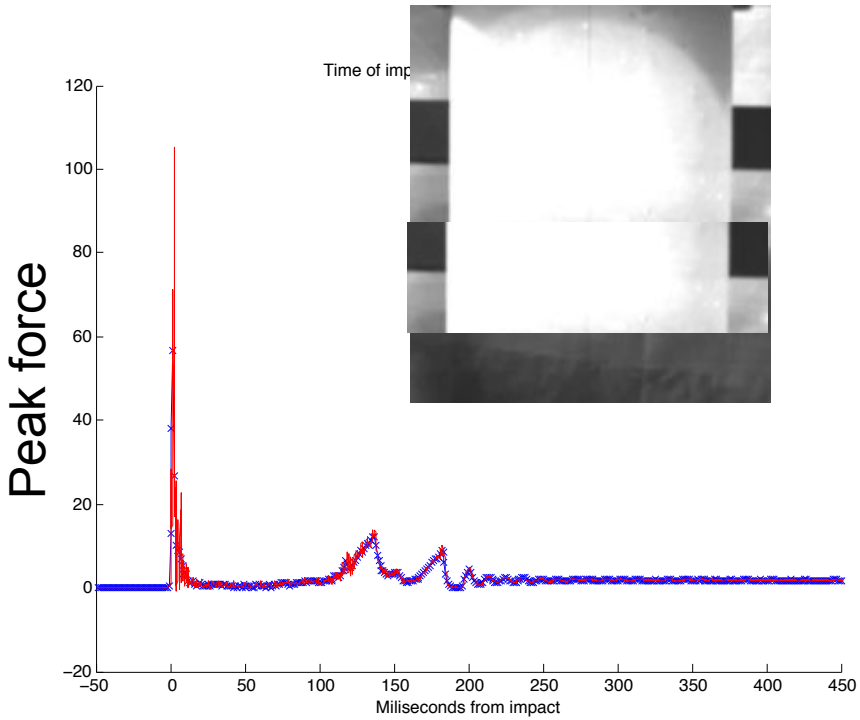
-26°C
Crushed ice + water + cold
Ice test block
Freeze from bottom and up
to avoid cracking

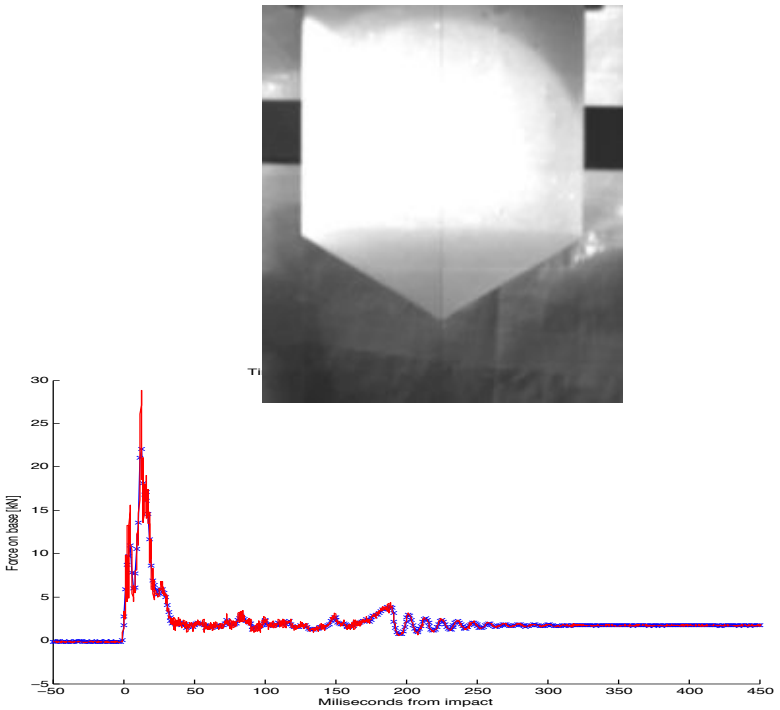


Ice structure analysis

Ice cone geometry

Impactor geometry





Initial test series to evaluate ice cylinder

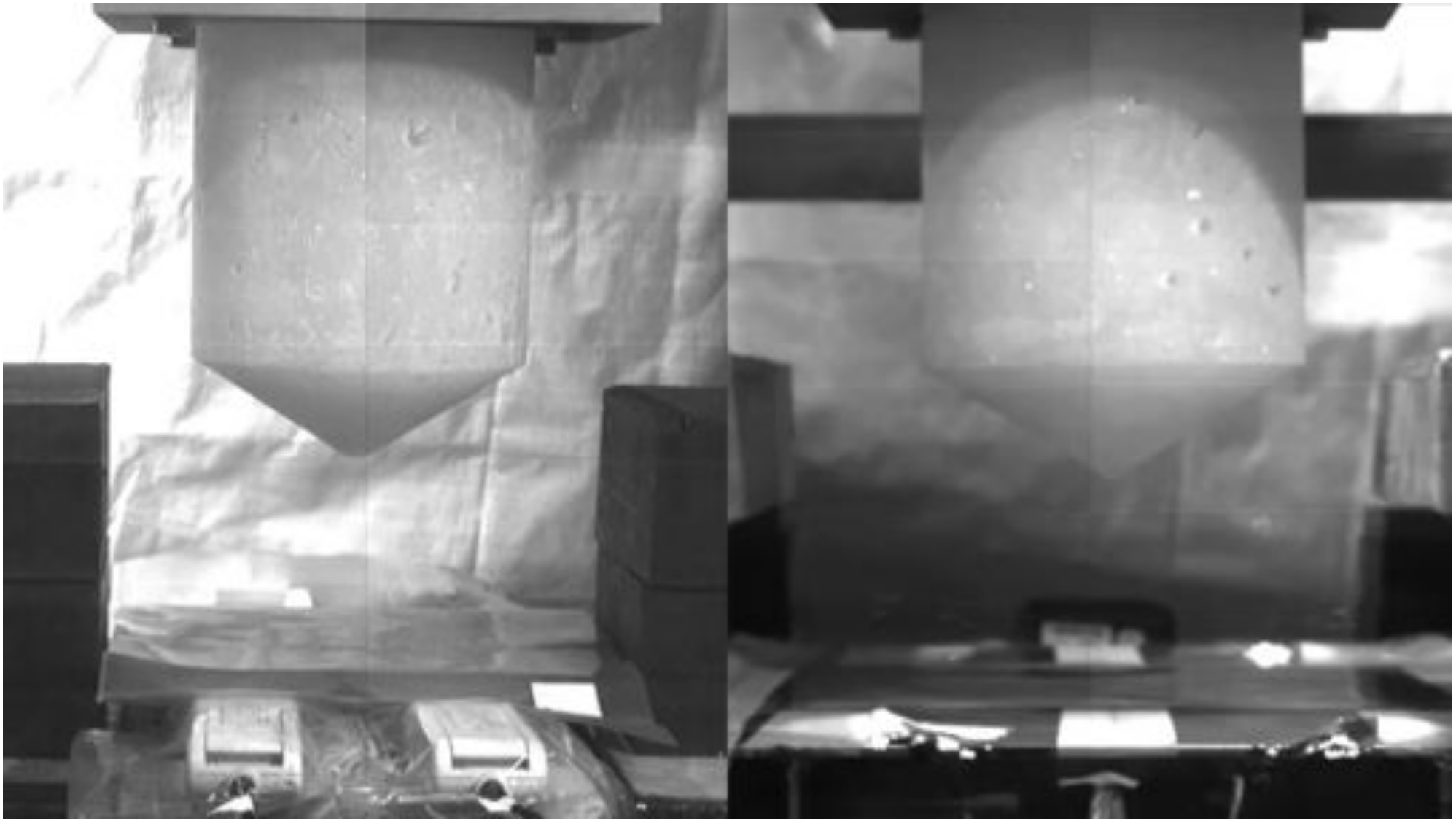
Impact setup

Ice impactor

Pressure mapping film

Markings for indentation measurements


Impact weight
Ice impactor
High speed camera



Rigid steel panel

Aluminium panel

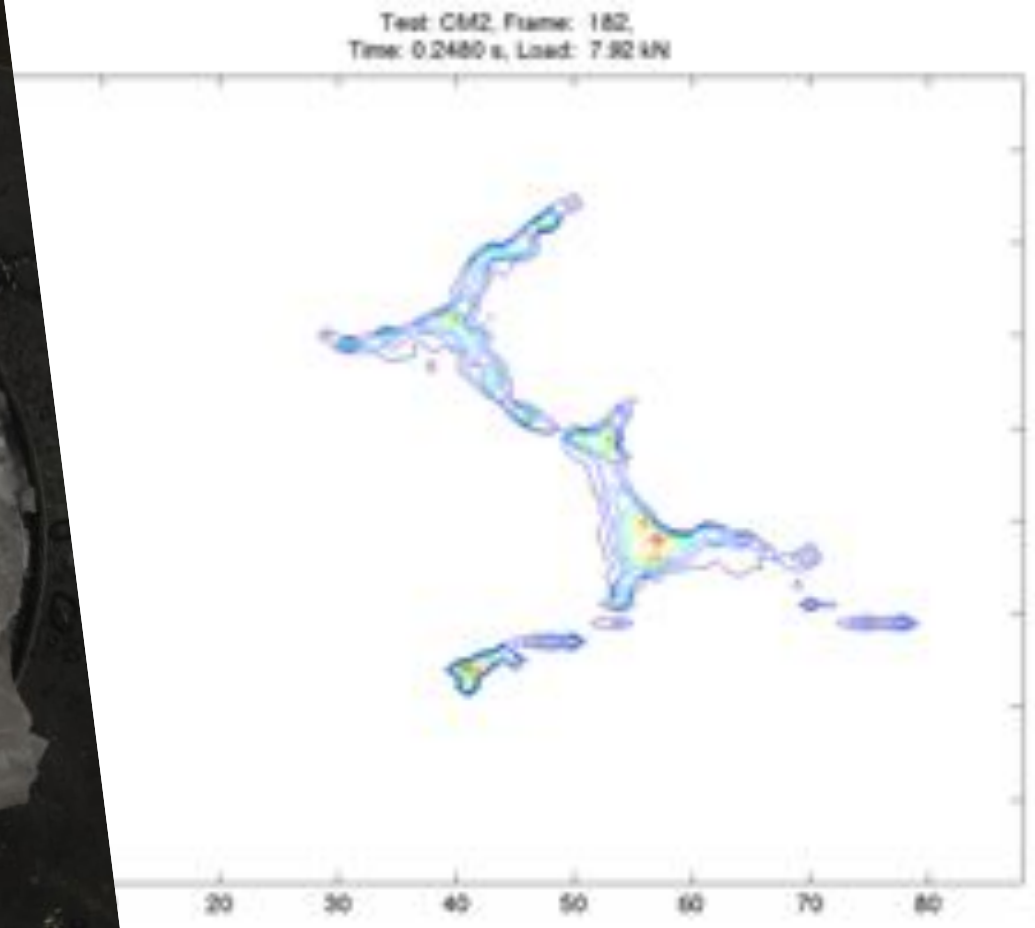
1.5 m/s, 215 kg

Carbon fibre sandwich panel

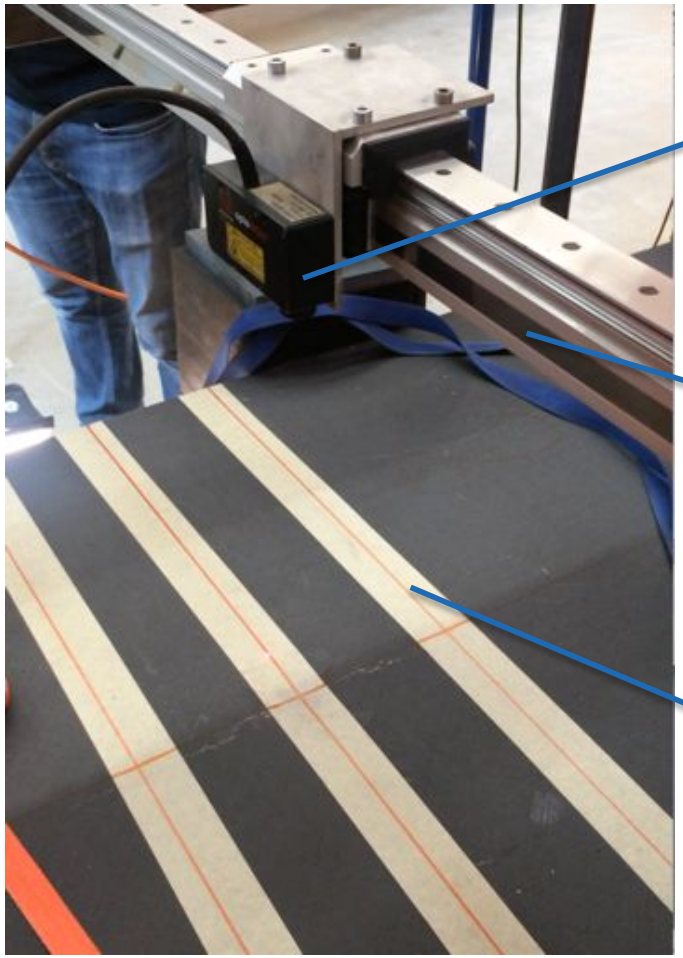
Aluminium panel

1.5 m/s, 215 kg

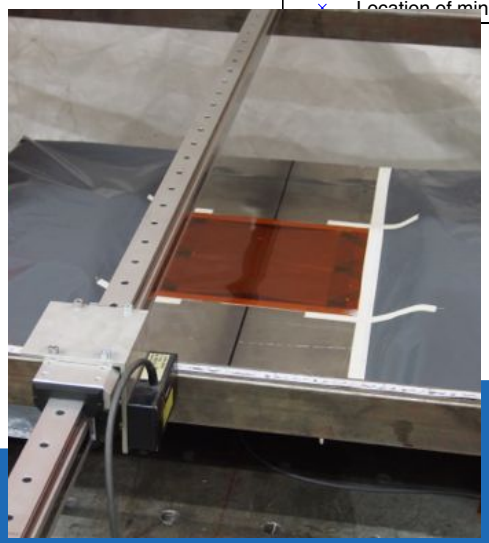
Fracture surface vs pressure mapping

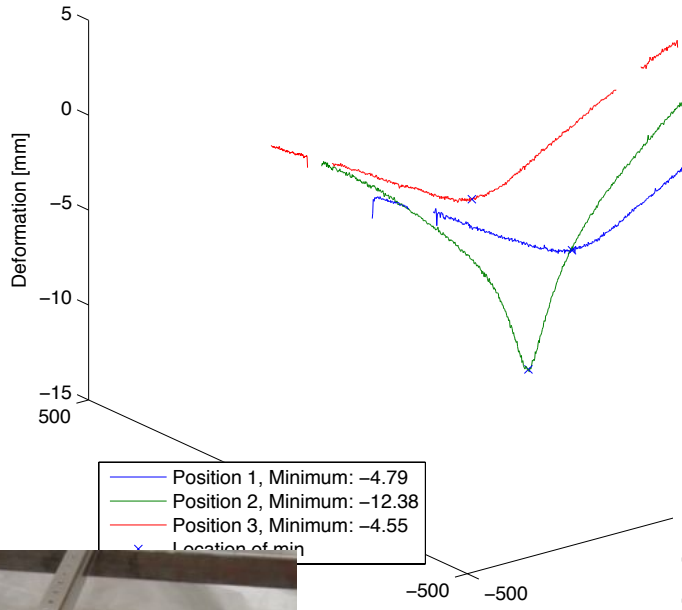


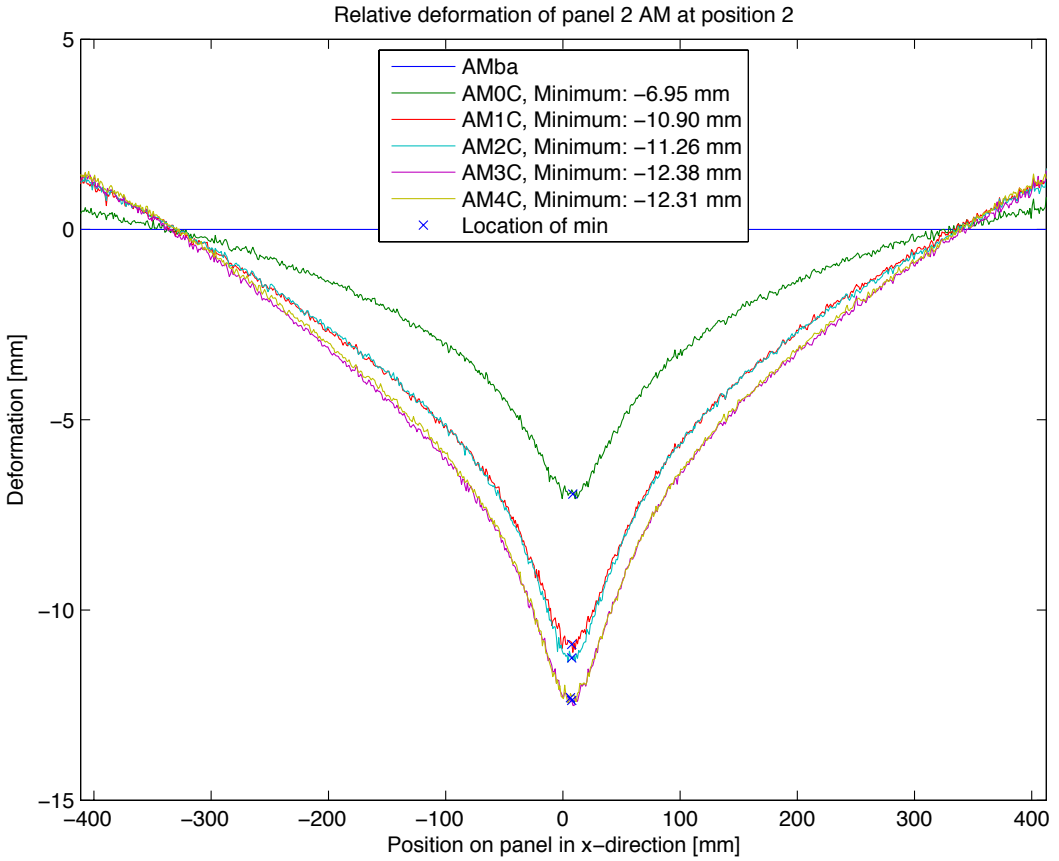
Indentation measurements



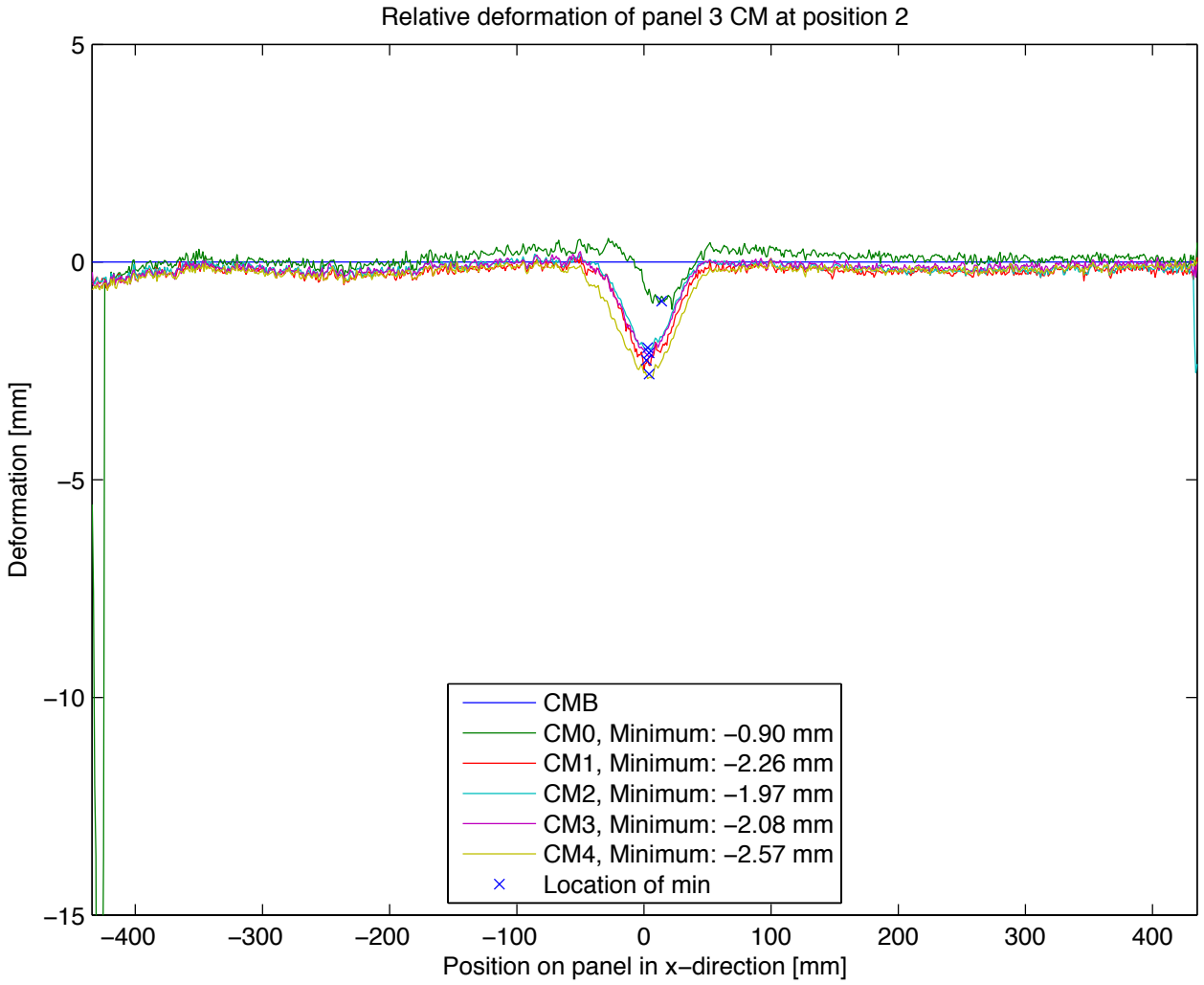
Deformation Aluminium



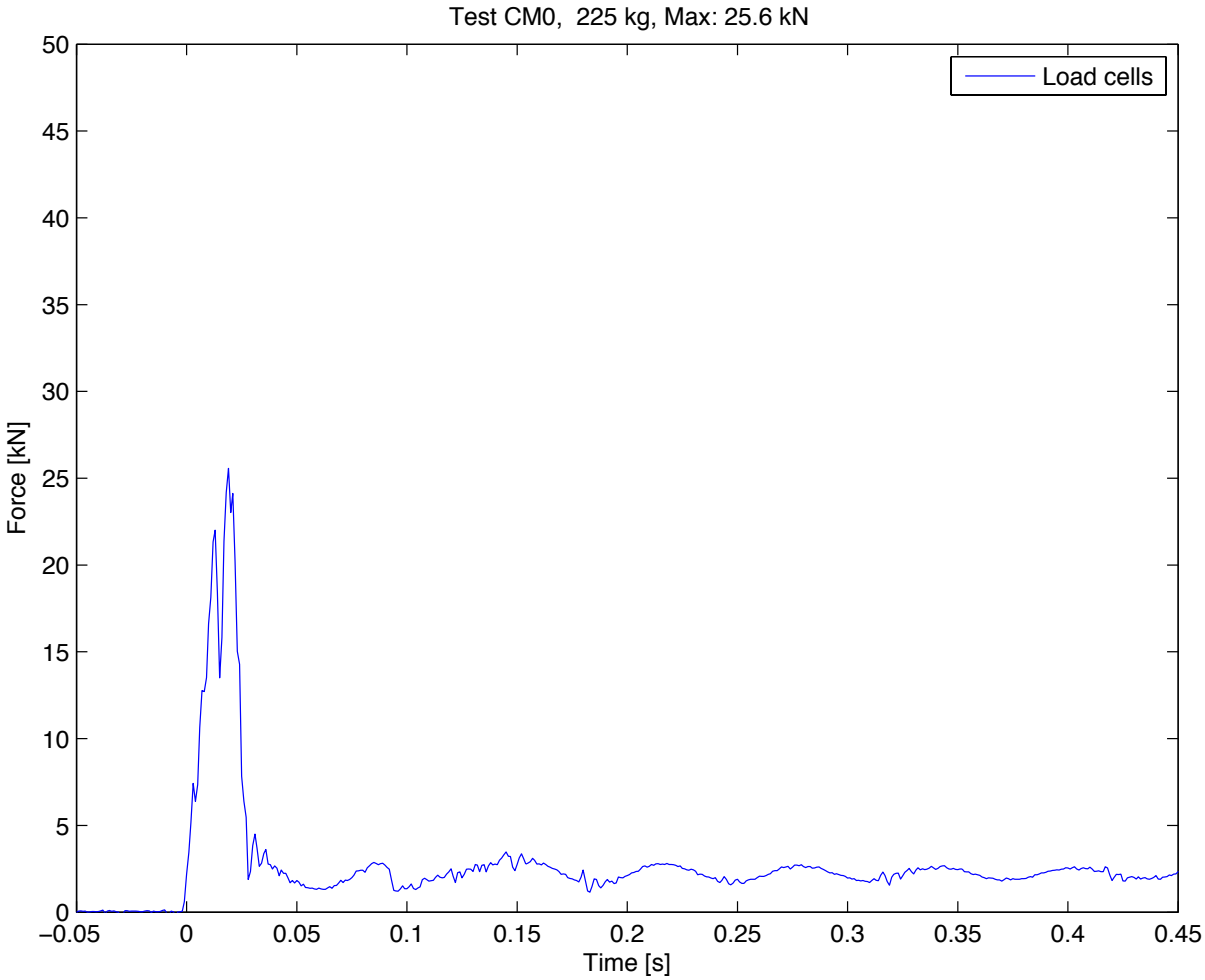




Deformation CFRP sandwich



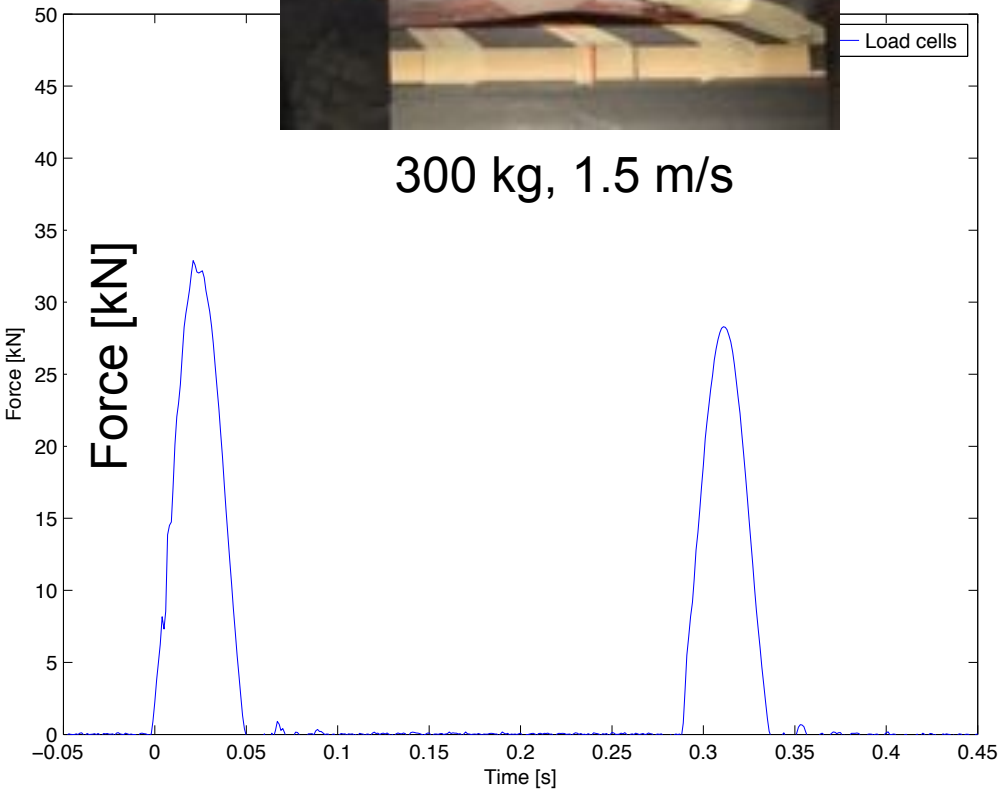
Max force / load readings



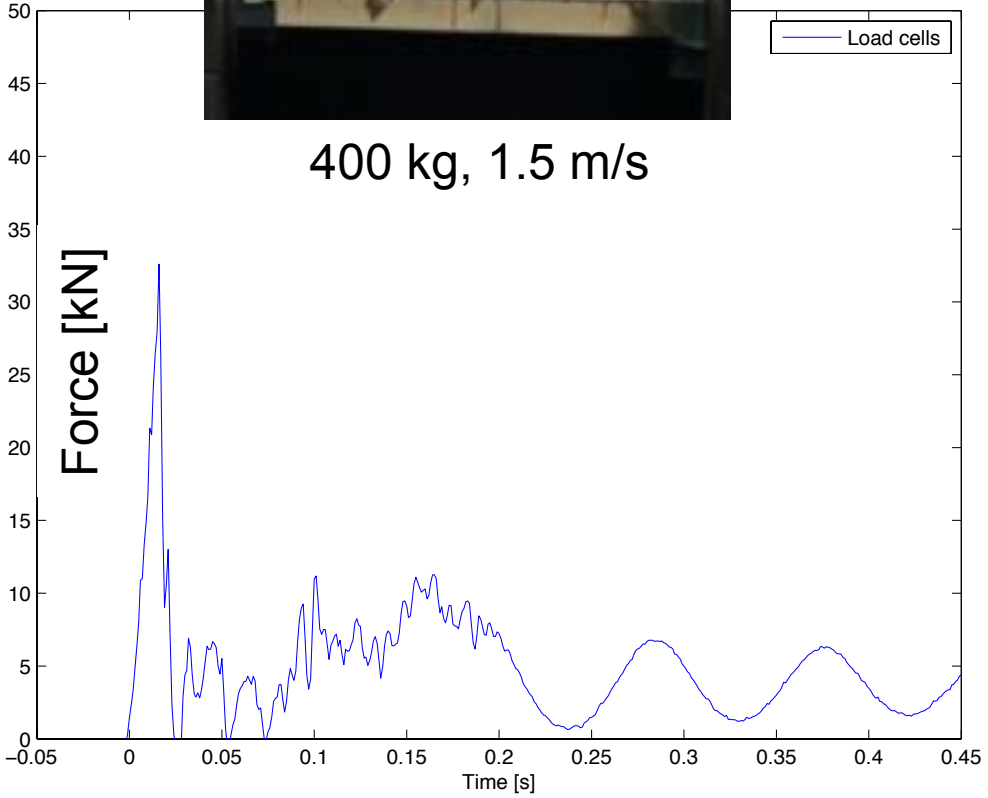
Load is sum of measurement from the four load cells under the panel

Ice fracture vs no ice fracture

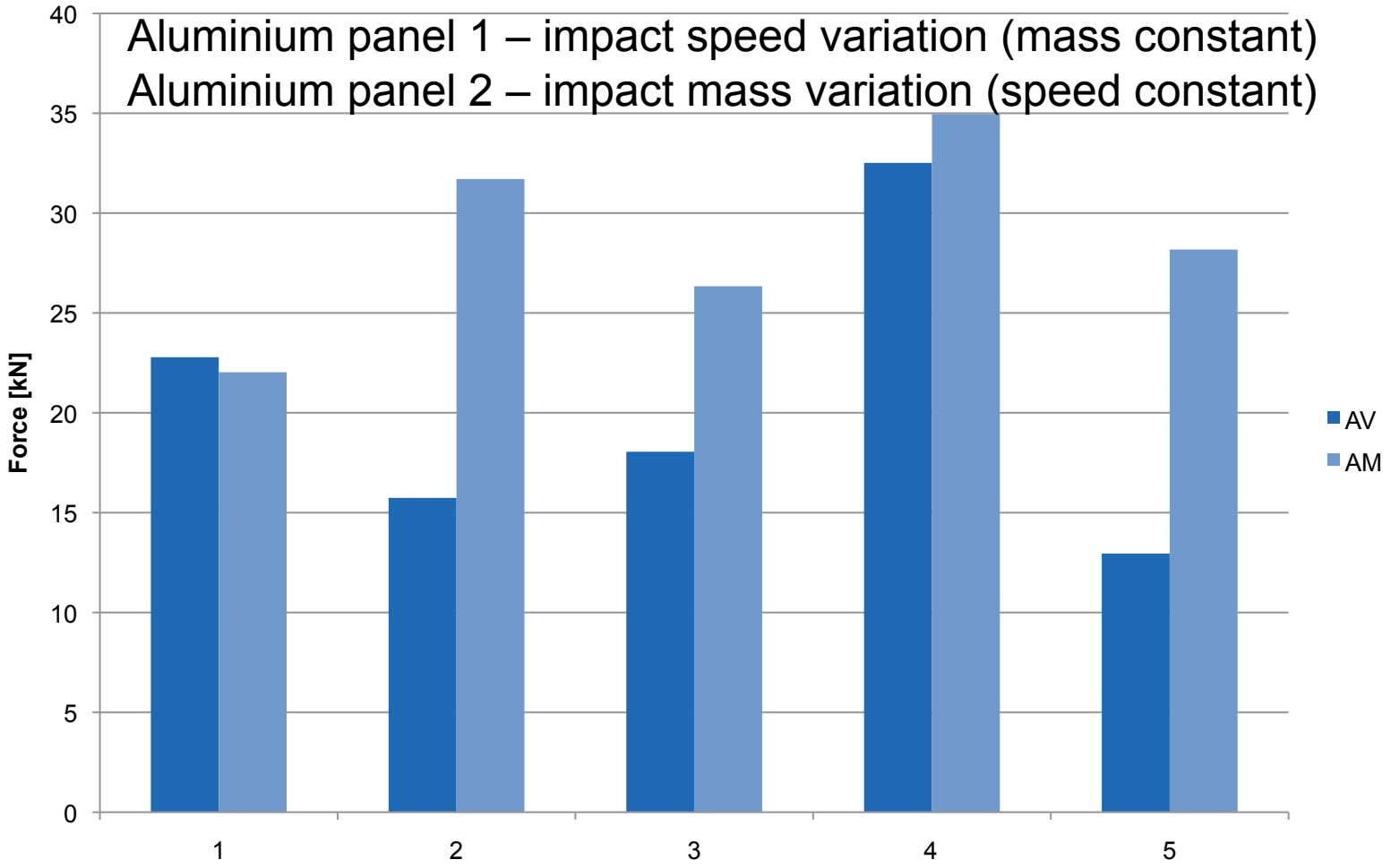
300 kg, 1.5 m/s



400 kg, 1.5 m/s



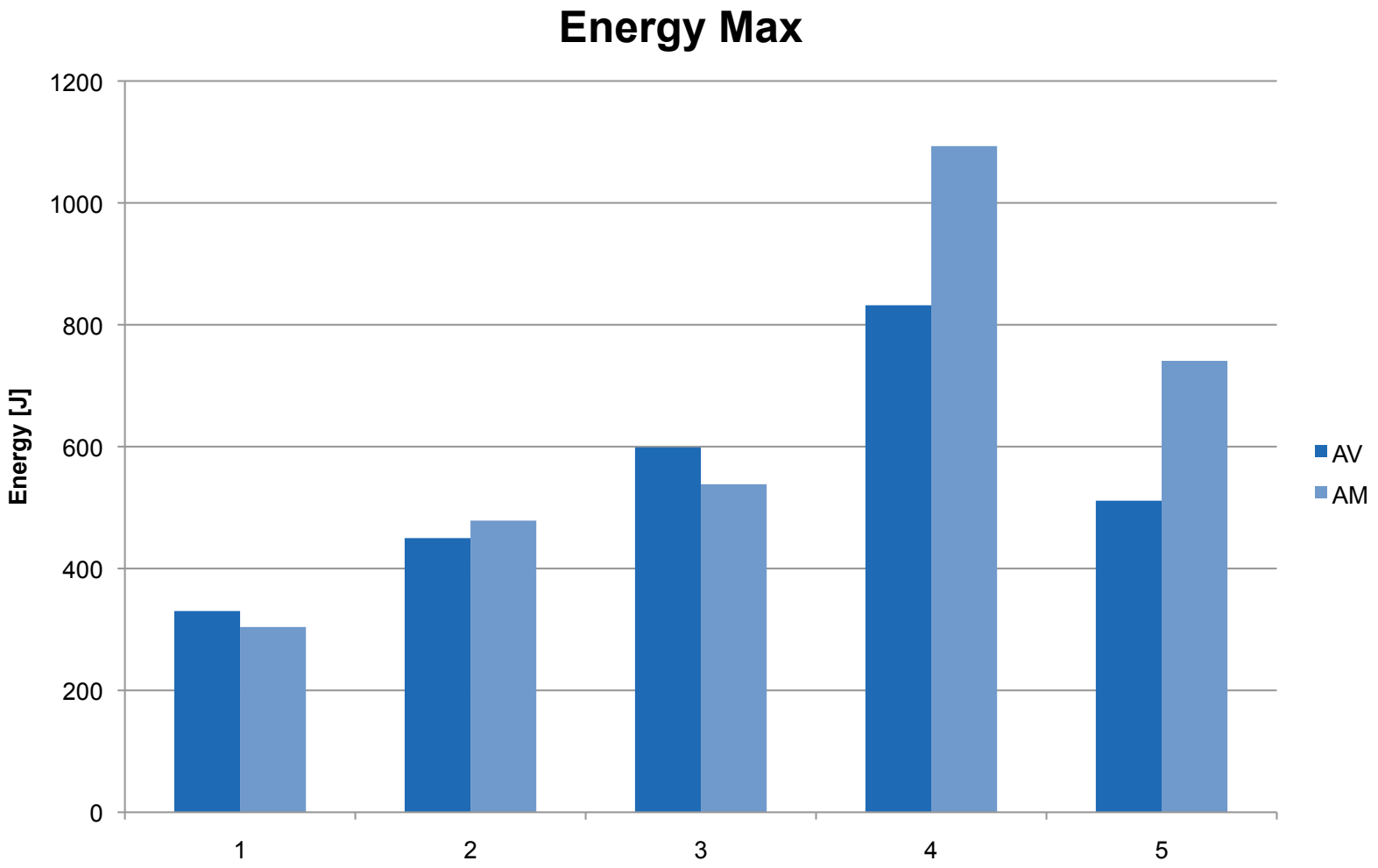
Peak force – different settings
Aluminium panel



Aluminium panel

Aluminium panel 1 – impact speed variation (mass constant)

Aluminium panel 2 – impact mass variation (speed constant)



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