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Parametric Hull Form Optimization for a Wind Farm Installation Vessel

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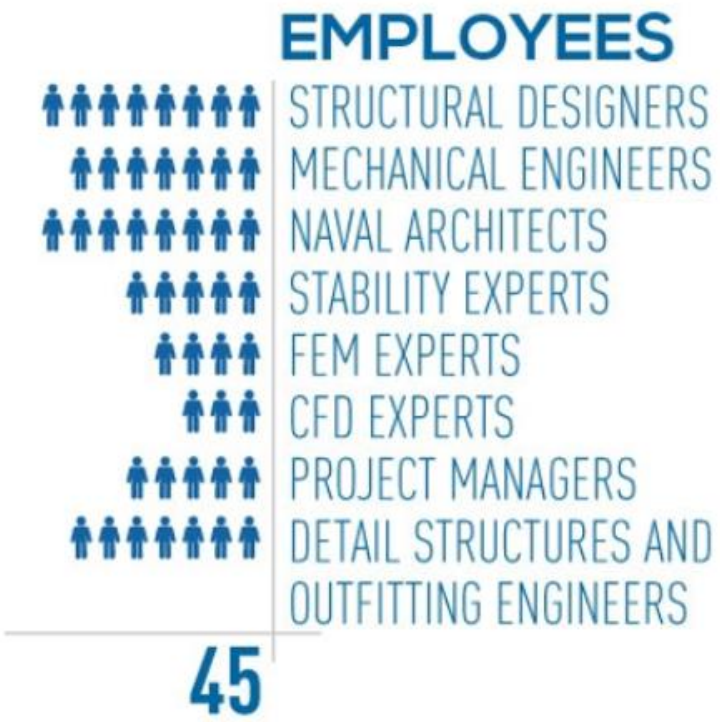
WHO IS DEKC

HISTORY

WHAT IS DEKC

MARITIME DESIGN & ENGINEERING COMPANY

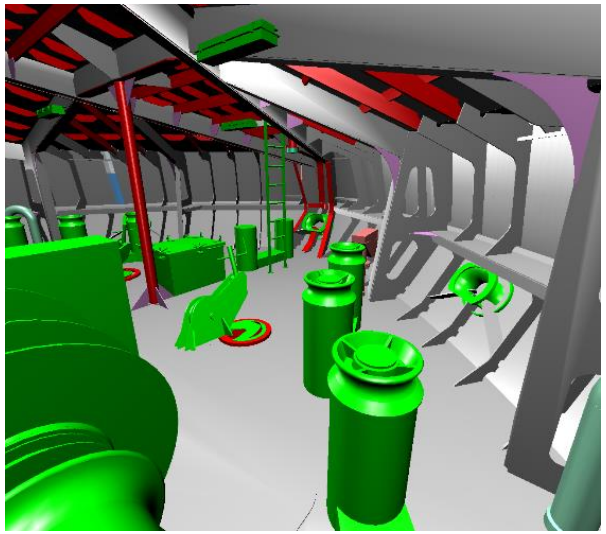


WHY DEKC

COMPLETE RANGE OF MARINE ENGINEERING

DESIGN

DETAIL ENGINEERING



OPERATIONAL SUPPORT

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Van Oord's AEOLUS

- L = 140 m
- B = 38 m
- T = 6.0 m
- Speed = 12 kn

Upgrade?

Larger main crane

Deeper max draft

Sponsons along side

Enlarged spudcans

AEOLUS 2.0

- L = 140 m
- B = 44 m
- T = 6.6 + 2.0 m

- No changes to propulsion or powerplant

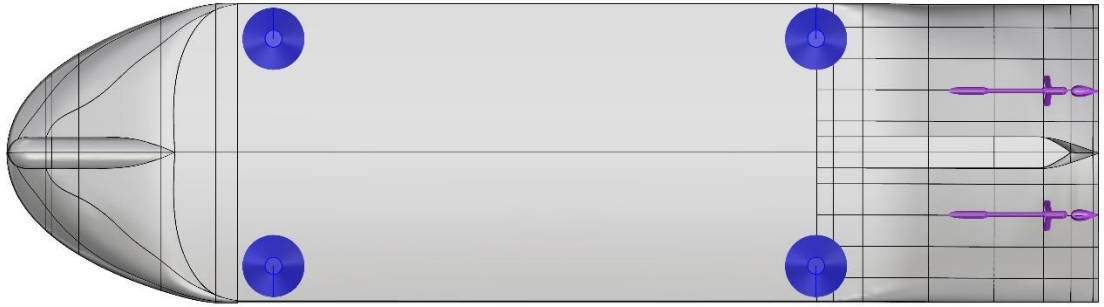
- Speed = ??? kn

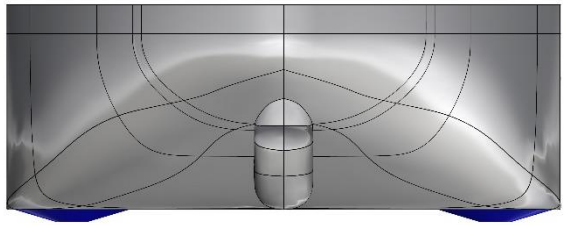
Topics for today

- Project outline
- Geometry modeling
- Optimization
- Results

Project Outline

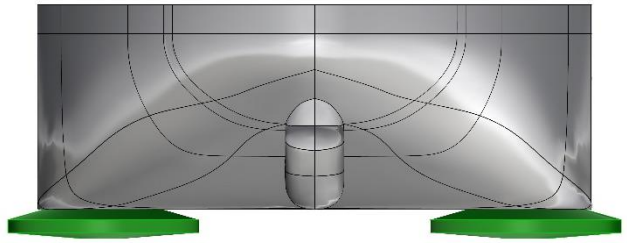
Goals





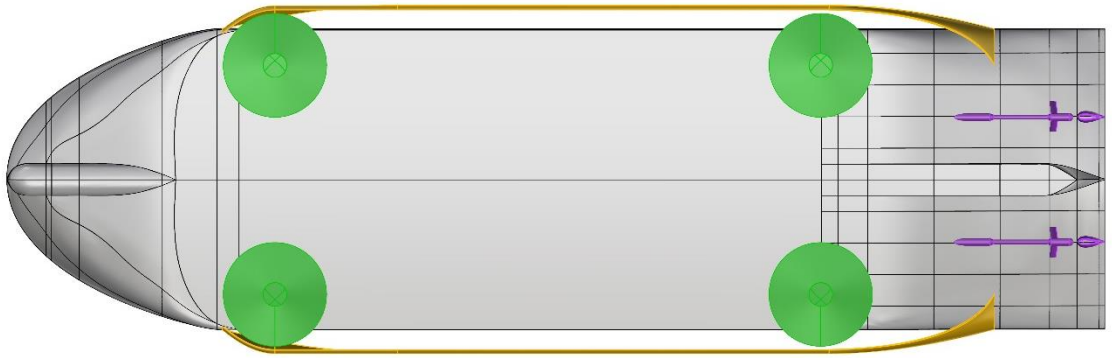
Goals

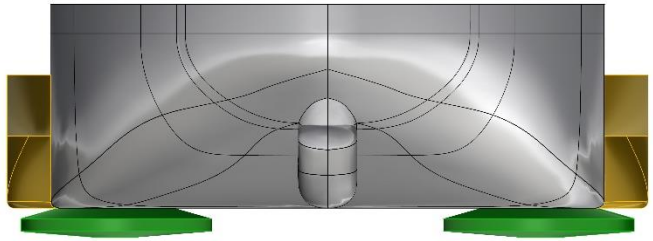
- Increase spudcan size
  - Current construction not to be changed
  - Spudcans protrude below hull



Goals

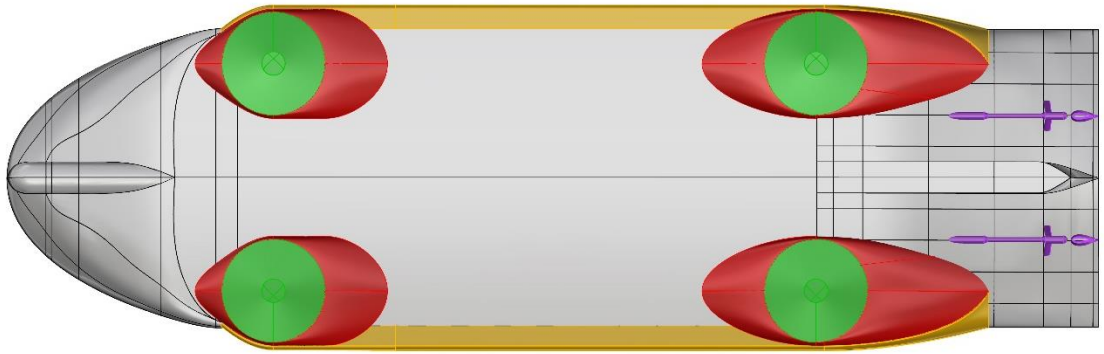
- Increase spudcan size
  - Current construction not to be changed
  - Spudcans protrude below hull
- Increase vessel transport capacity
  - Increase design draft
  - Add sponsons

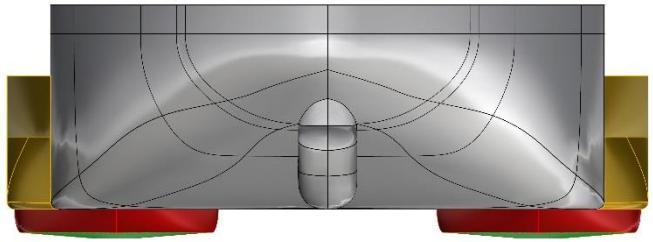




Goals

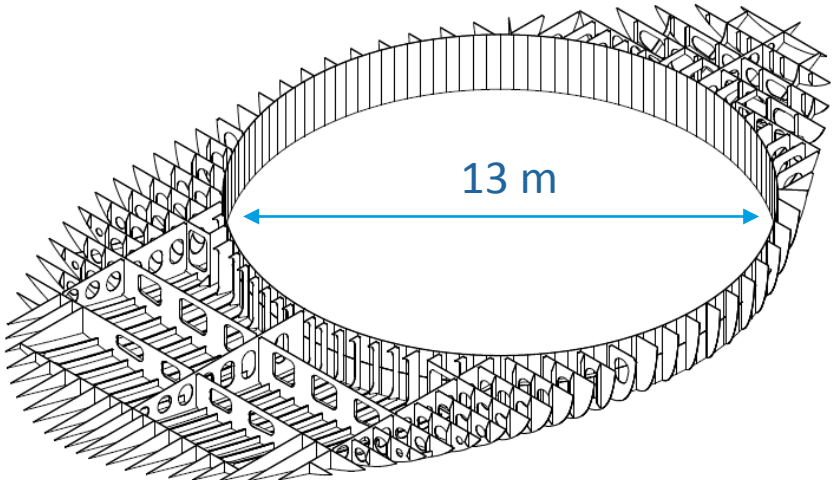
- Increase spudcan size
  - Current construction not to be changed
  - Spudcans protrude below hull
- Increase vessel transport capacity
  - Increase design draft
  - Add sponsons
- Minimize speed loss (no extra power)
  - Flow bodies designed around spudcans
  - Sponson and flow body optimization

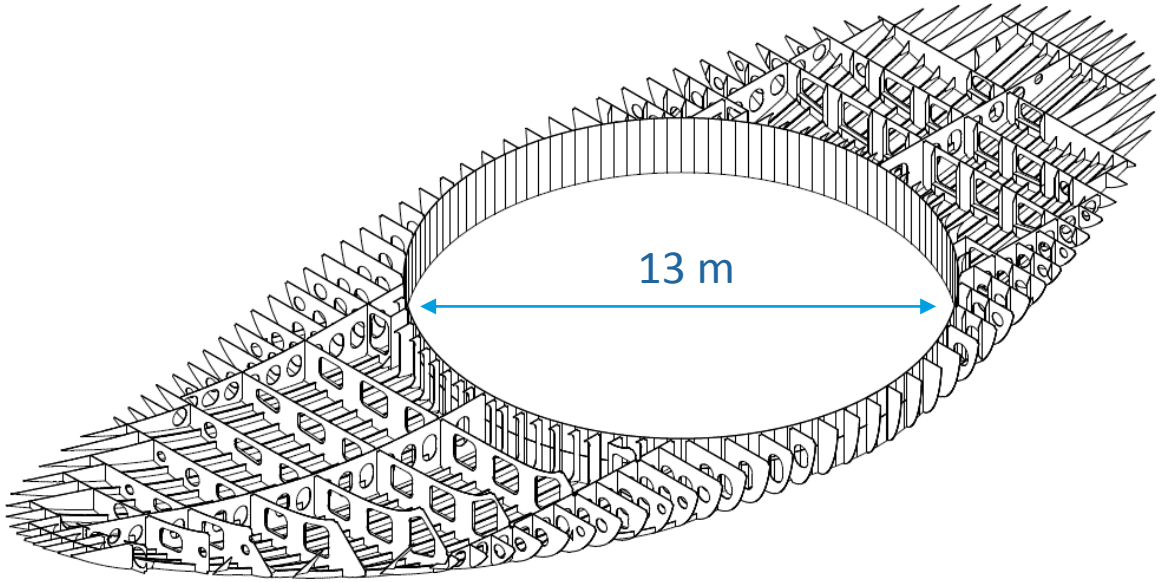




Additional Requirements

- Good buildability
  - Consider building section dimensions
  - Minimum intersection angles
- Easy integration on existing vessel
  - Align with existing construction
  - Maintain tank boundaries
  - Keep to flat intersection surfaces as much as possible





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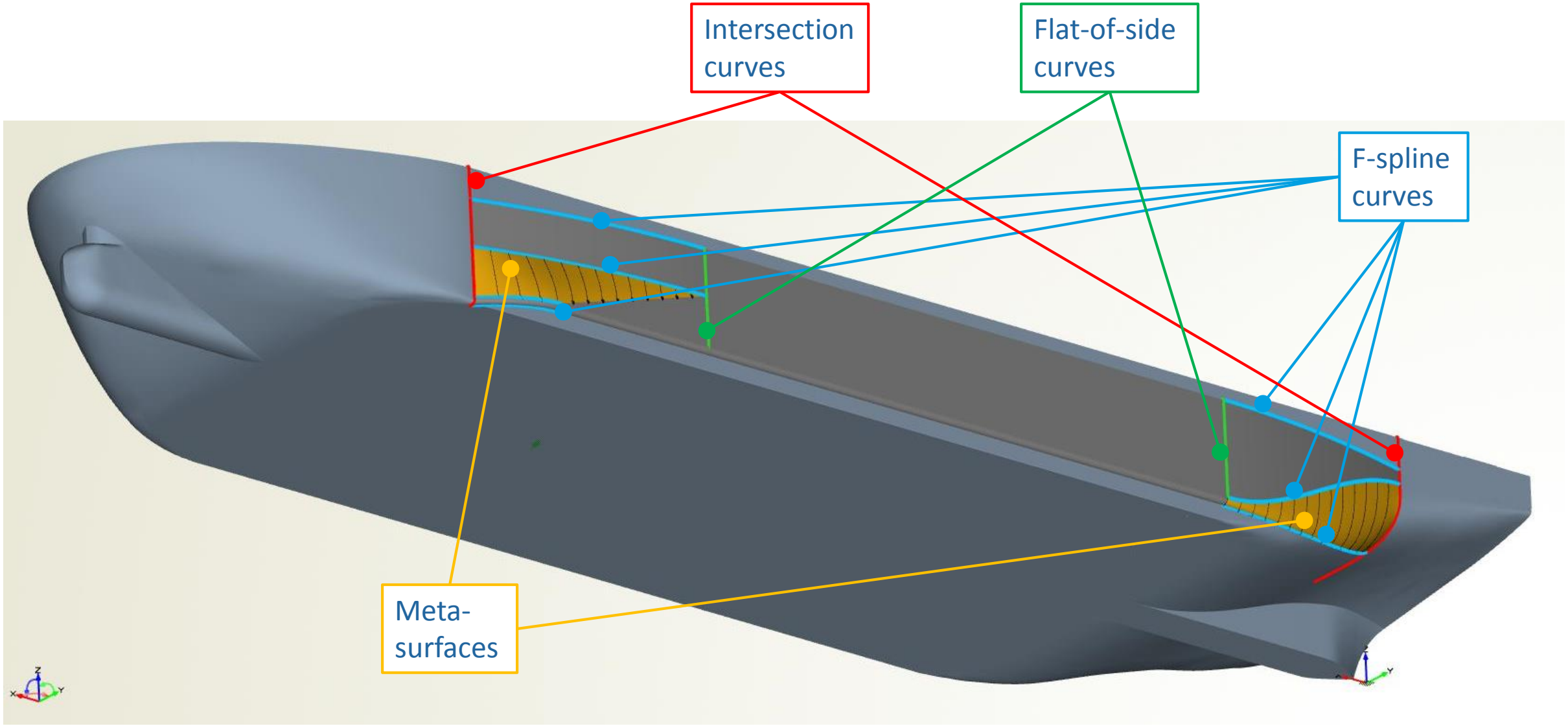
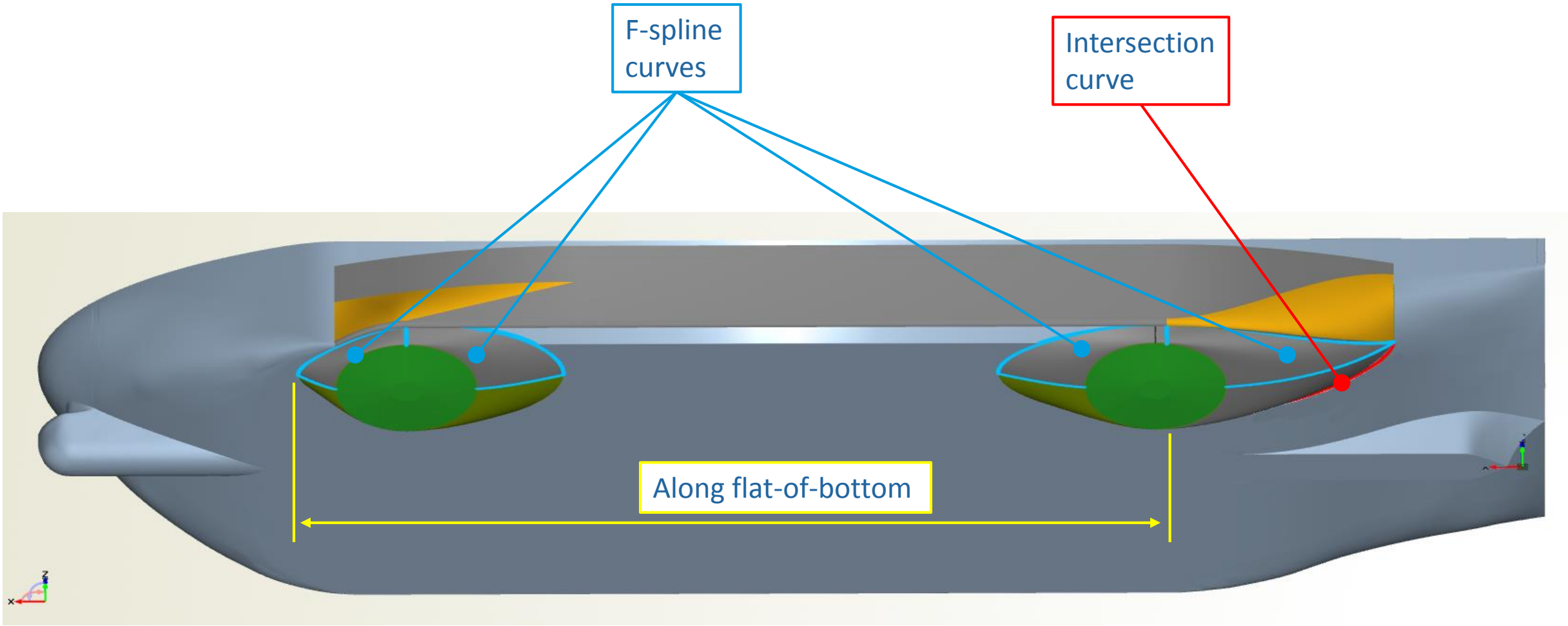
Geometry Modeling

Sponson Geometry

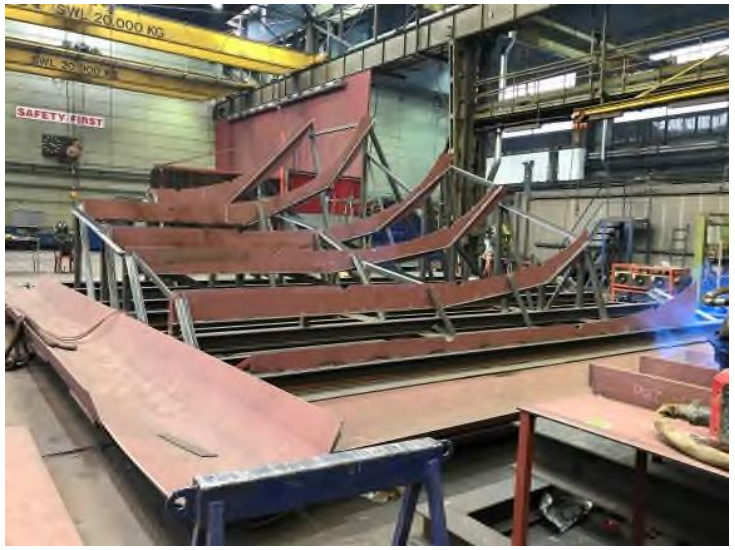


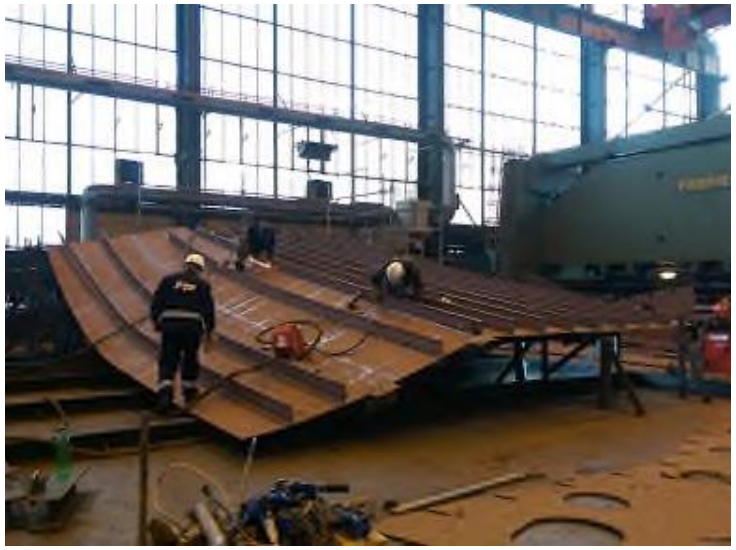
Flow Body Geometry



Production of Sponsons and Flow Bodies

- CAESES geometry imported directly into Cadmatic Hull
- No production fairing necessary (good quality shape!)





Optimization

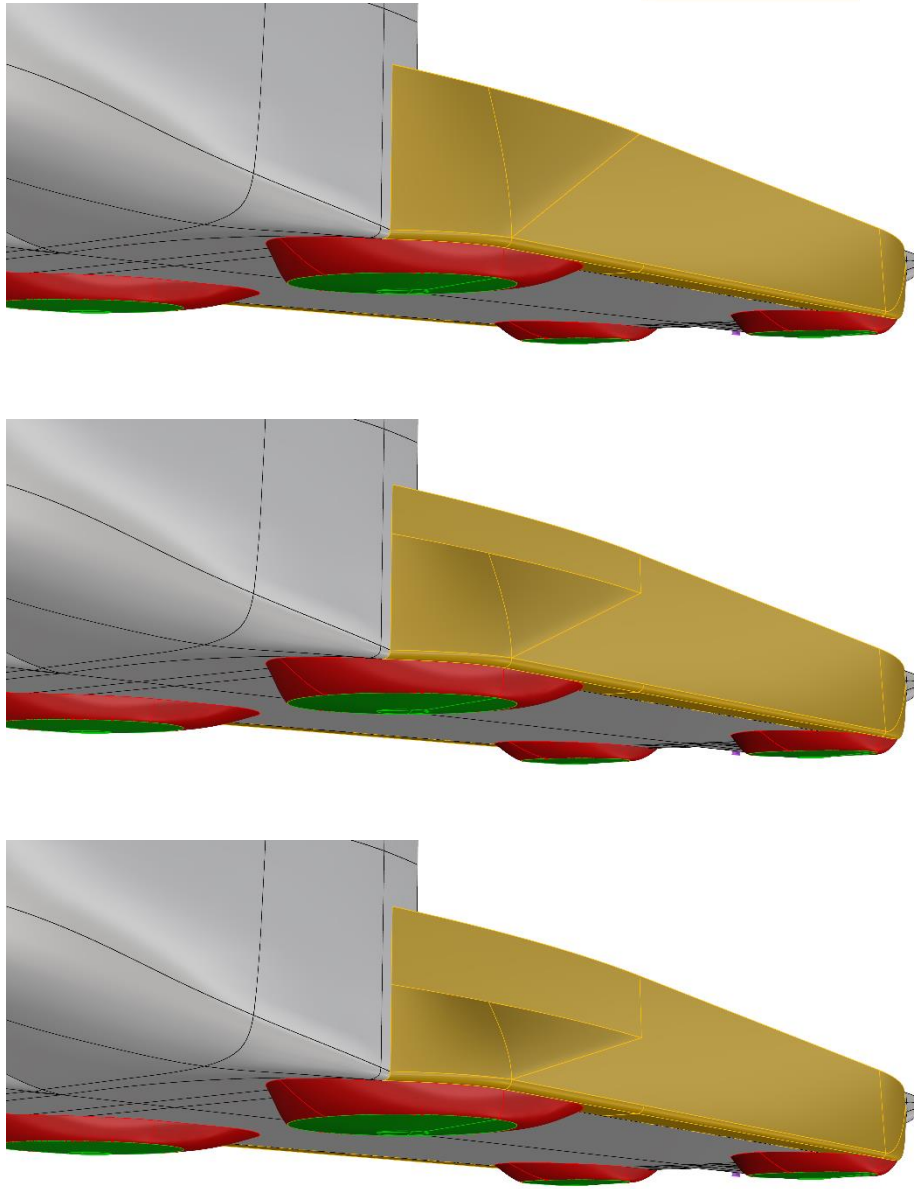
Global Strategy

- Objectives
  - Minimize resistance
  - Minimize velocity gradients in propeller plane
  - Maximize hull efficiency

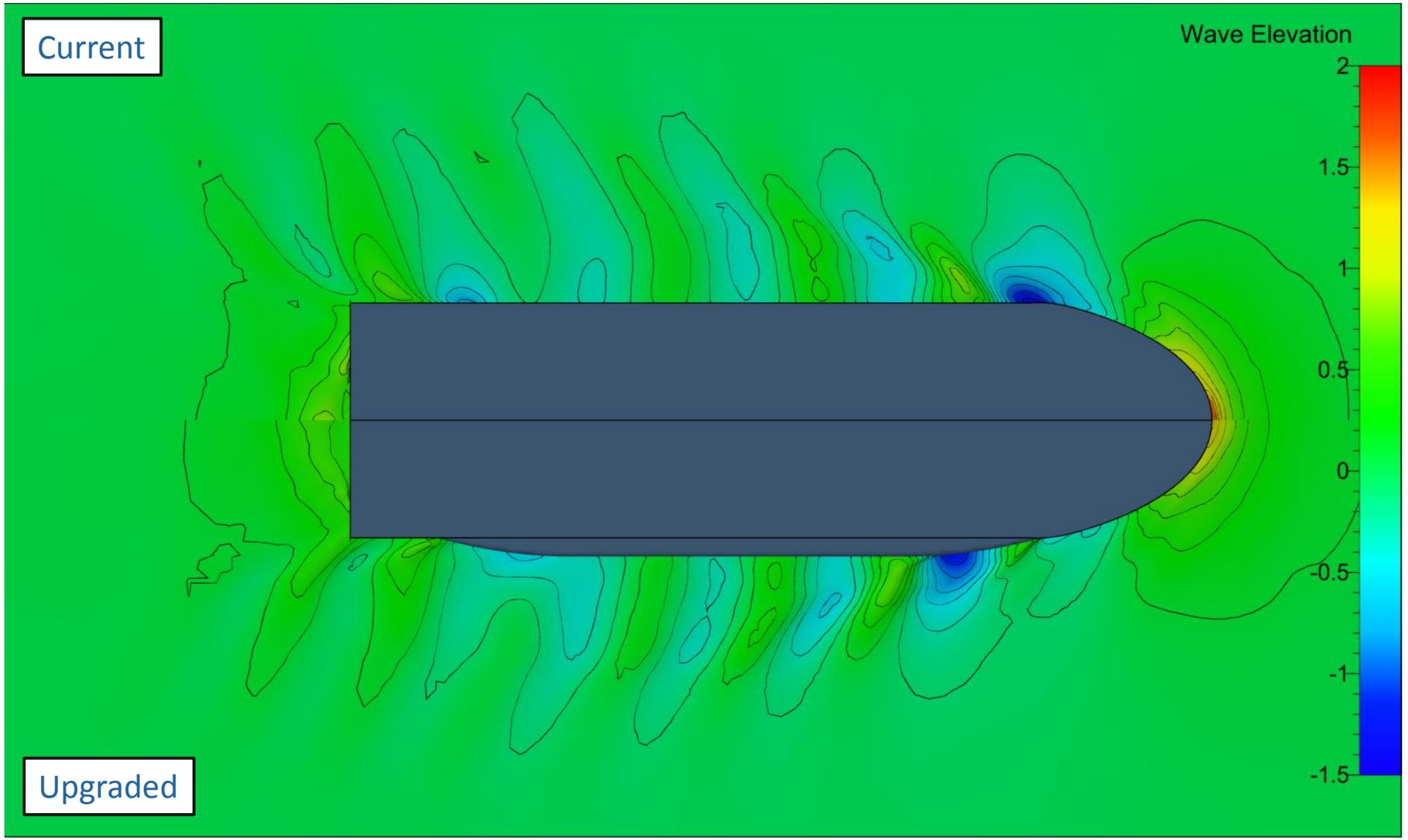
- Two optimization steps
  - Minimizing wave resistance
  - Minimizing viscous resistance and propulsive losses

Minimizing Wave Resistance (1)

- Sponson interacts with fwd shoulder wave
  - Generate favorable interference
  - Smooth fwd shoulder
- Focus on sponson geometry
  - Minimize entry angle at waterline
  - Maximize smoothness at waterline
  - Constructional constraints respected

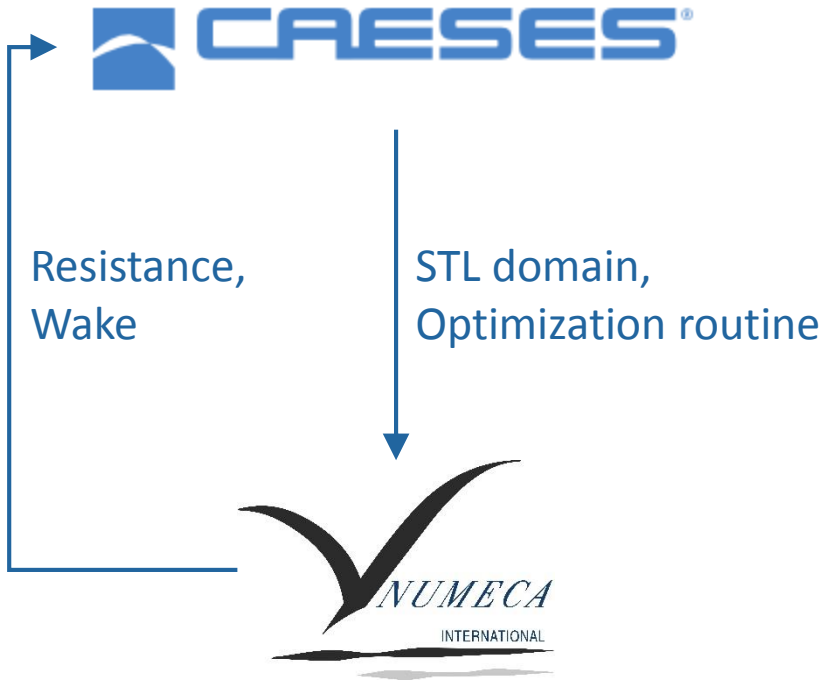


Minimizing Wave Resistance (2)

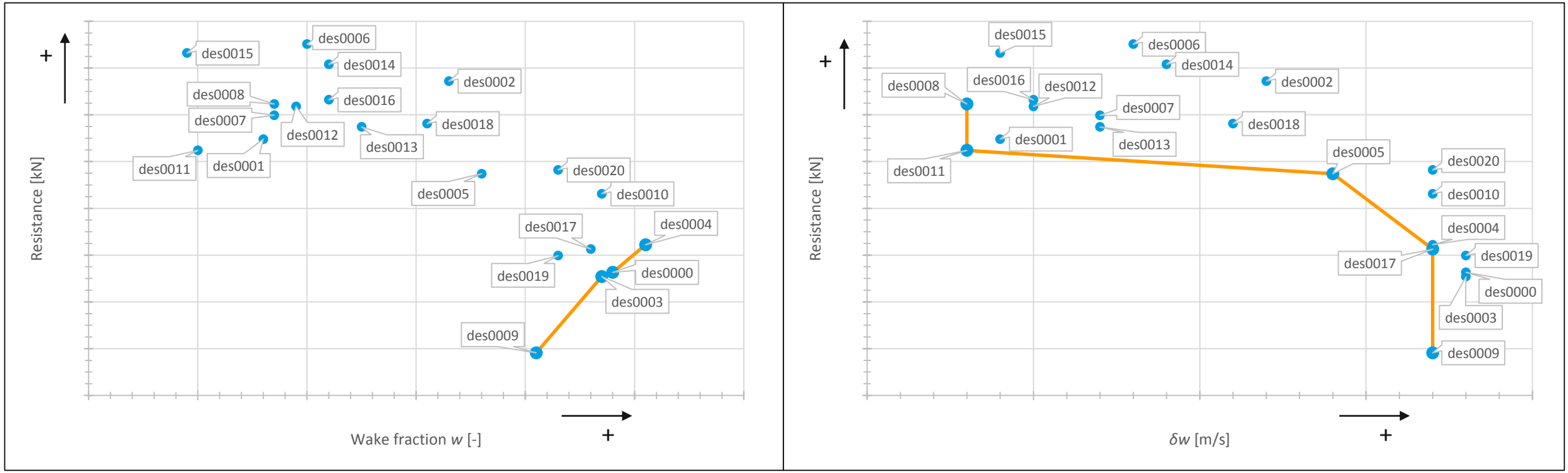


Minimizing Viscous Losses (1)

- Parametrized sponson and flow body models
- Two-stage multi-objective optimization
  - Global optimization using Sobol
  - Local optimization using Tsearch
- Software connection from CAESES to Numeca FINE/Marine



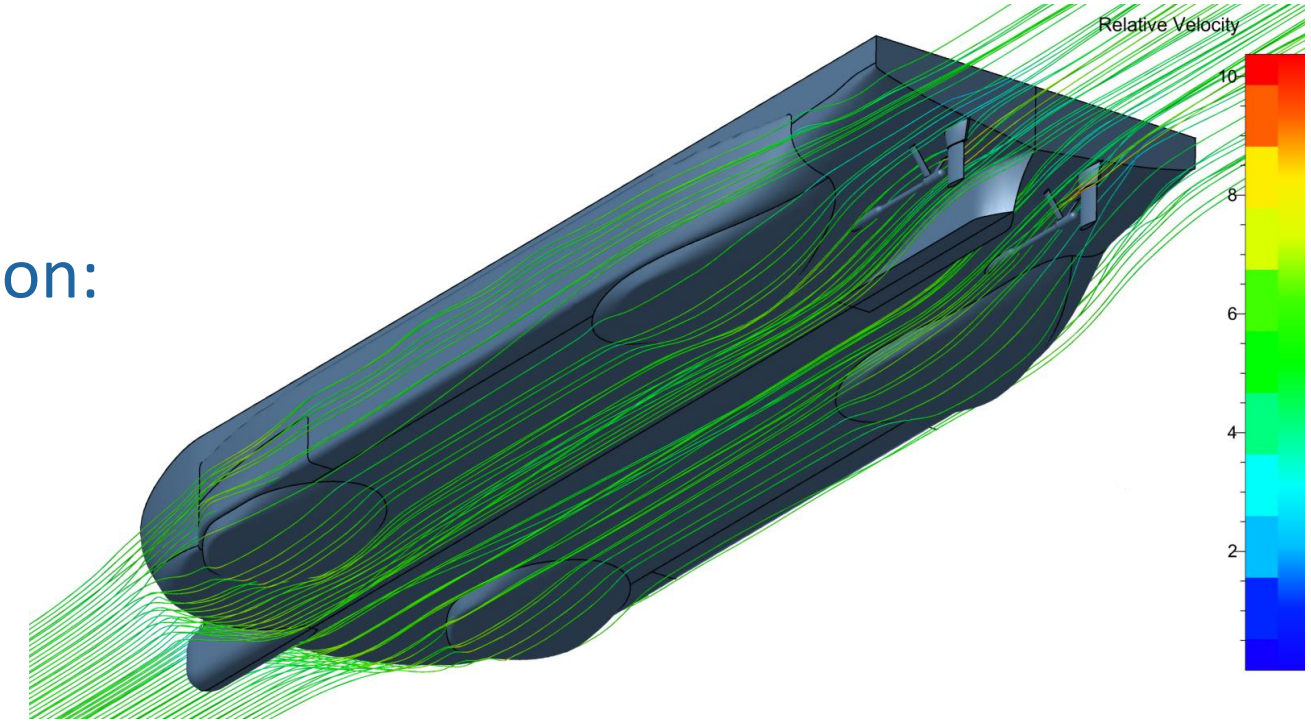
Minimizing Viscous Losses (2)



Results (1)

- Simulations performed with appendages and actuator disks
  - Effective power determined directly
  - Hull efficiency calculated

- Delivered power prediction based on:
  - Determined hull efficiency
  - Towing tank tests
  - Sea trial data



Results (2)

Draft	+10.0 %
Beam	+15.8 %
Calm-Water Resistance (without optimization)	+257.0 %
Calm-Water Resistance (after optimization)	+28.6 %
Propulsive Efficiency	-6.9 %
Design Speed	-8.3 %

AEOLUS 2.0

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- Speed = 11 kn

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