VOITH

The application of CAESES from a perspective of a propeller maker

David Bendl, 2017-09-28

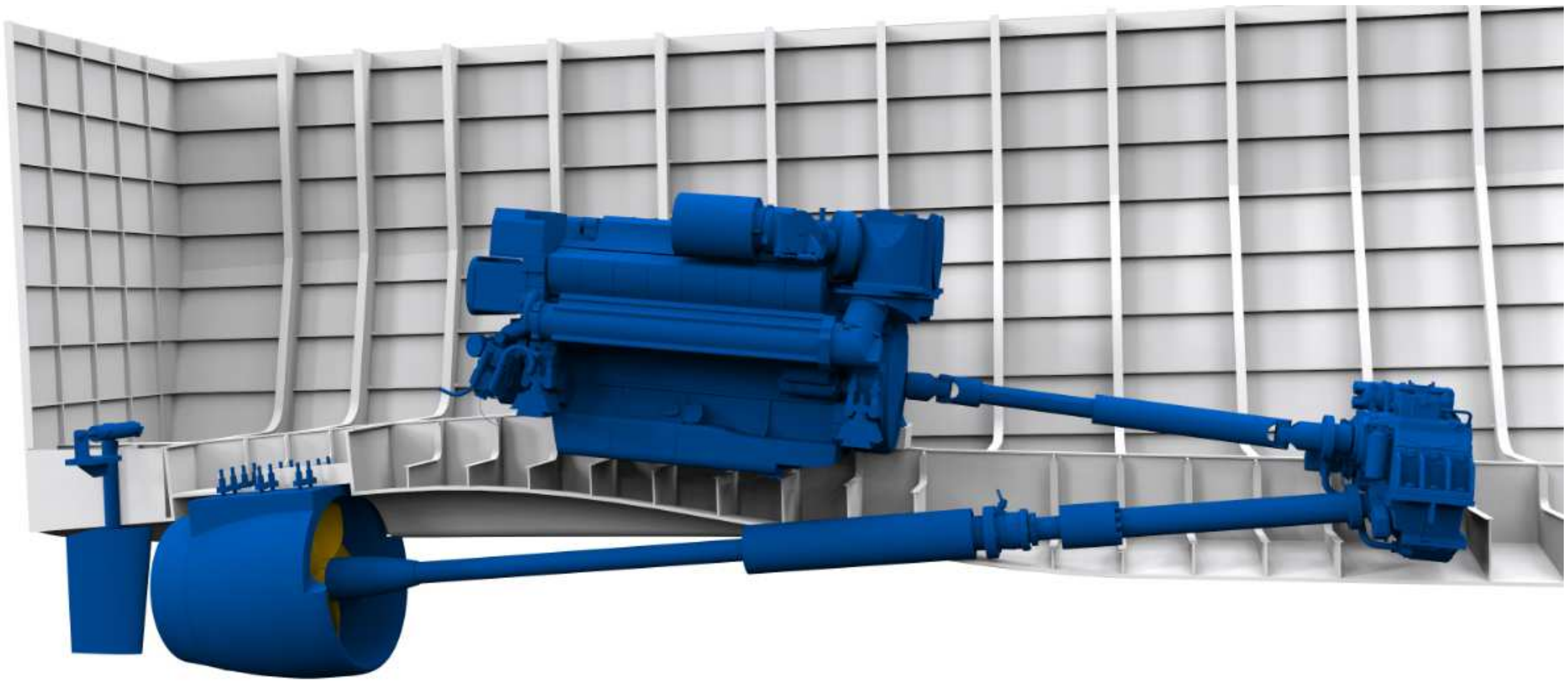
Welcome
to the Next
150 Years

VOITH

Voith Propulsion

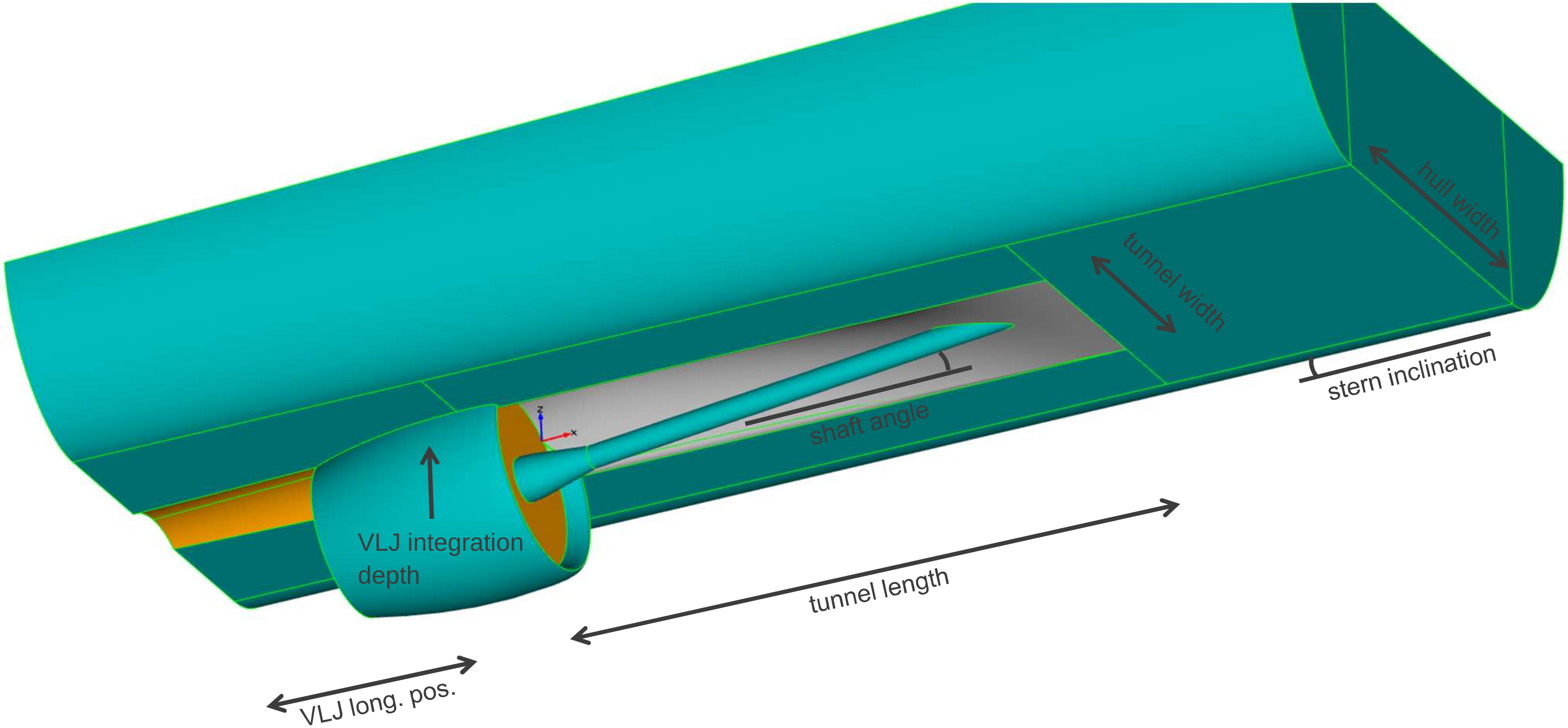
VLJ Integration Study

VLJ Propulsion Arrangement

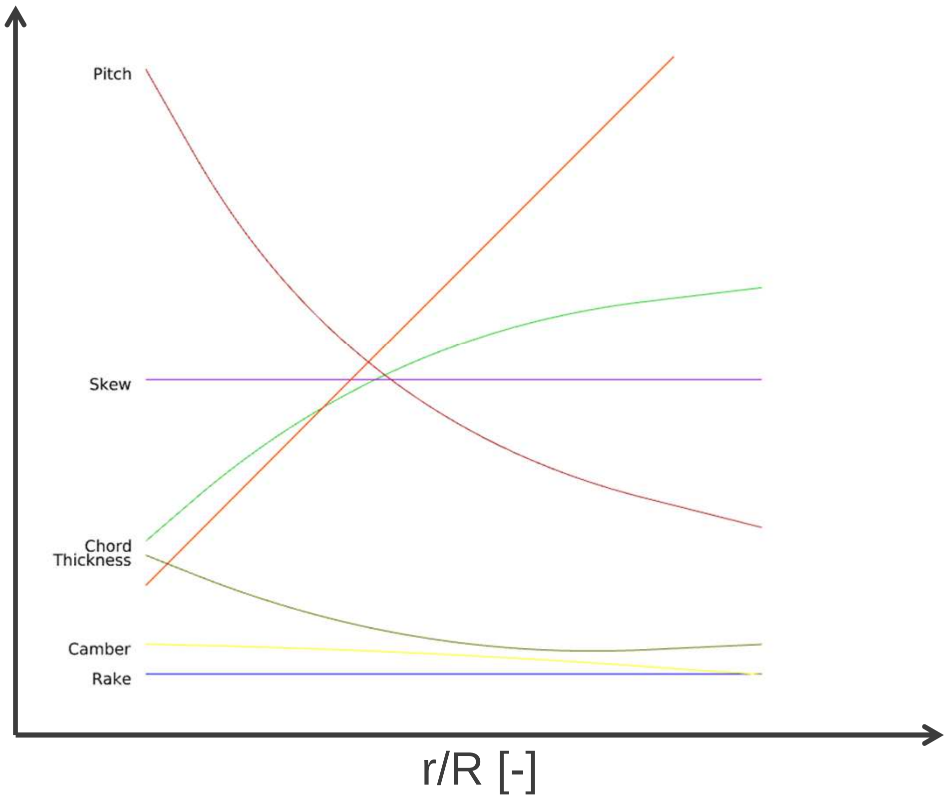


outlet tunnel VLJ inlet tunnel Shaft

Geometry Definition
Integration Parameters

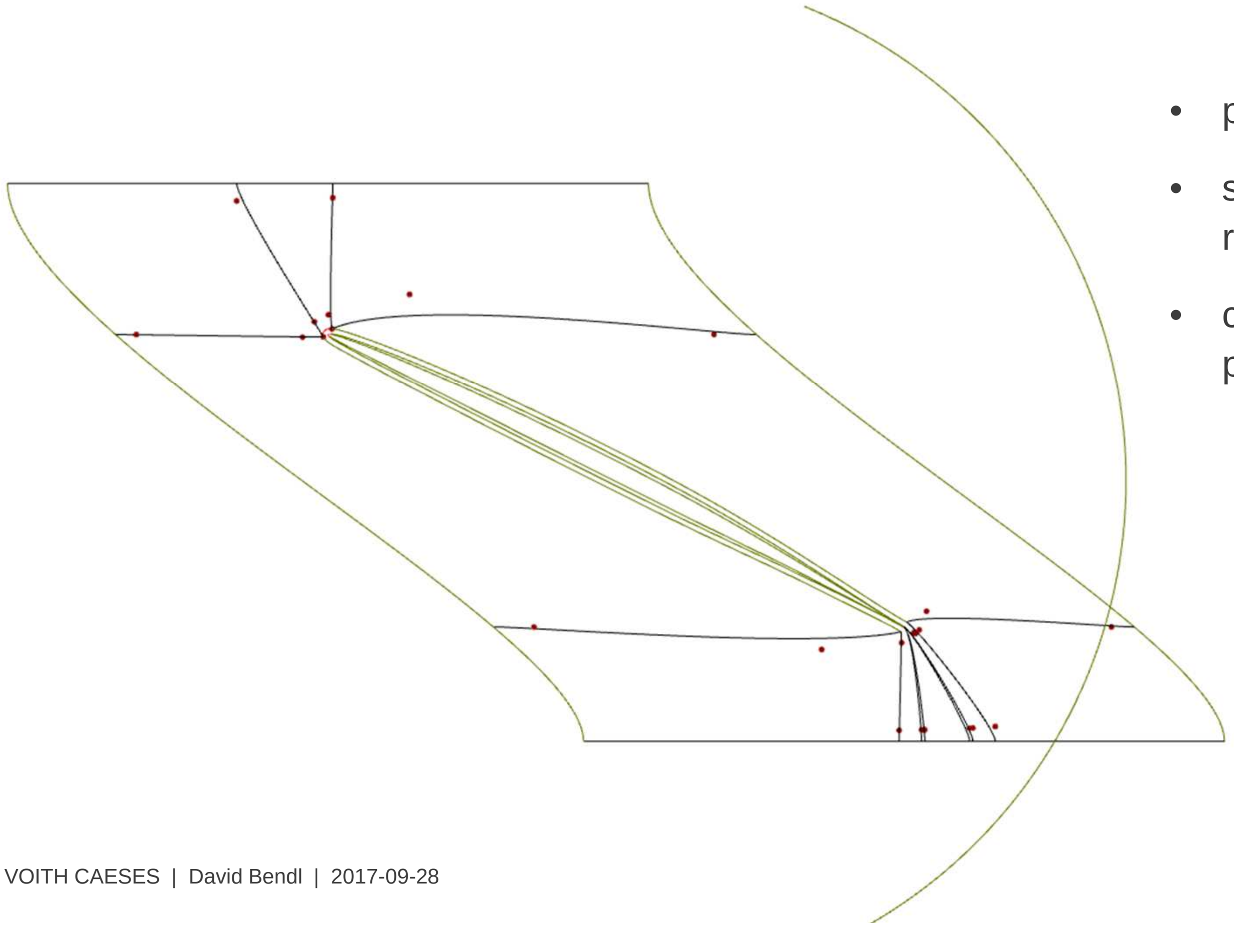


Geometry Definition
Rotor and Stator



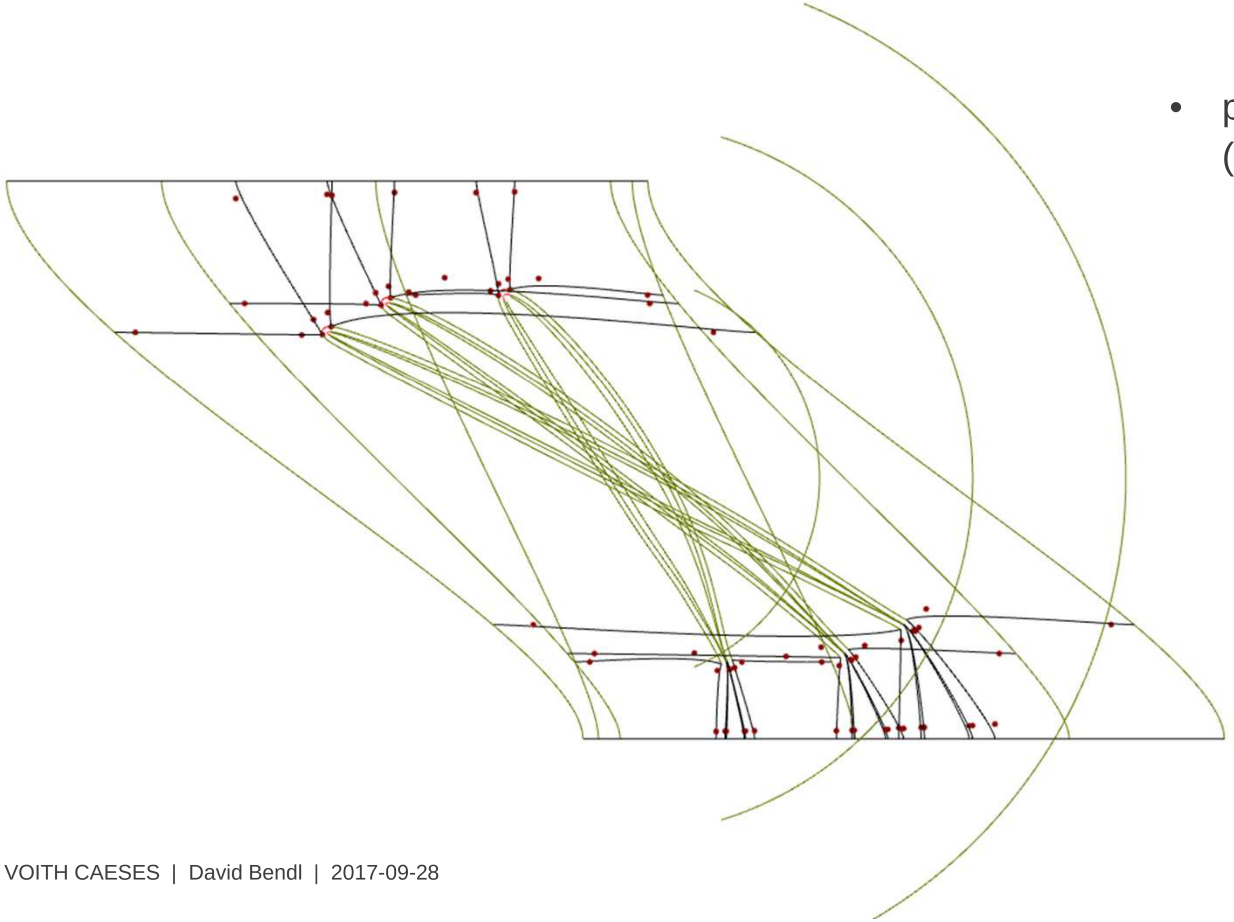
- blade parameters are defined on cylinder sections [r/R]
- chord relative to diameter
- thickness, camber, skew, rake relative to chord
- pitch [°] normalized by 90°

Geometry Definition
Rotor and Stator



- profile is generated on 2D plane (curve engine)
- subsequent block structured grid generation requires support geometry
- circle segment shows cylinder section for final profile position

Geometry Definition
Rotor and Stator



- profile for three positions is shown (r/R = 0.4, 0.7, 1.0)

Geometry Definition
Rotor and Stator

- view on the three cylinder sections

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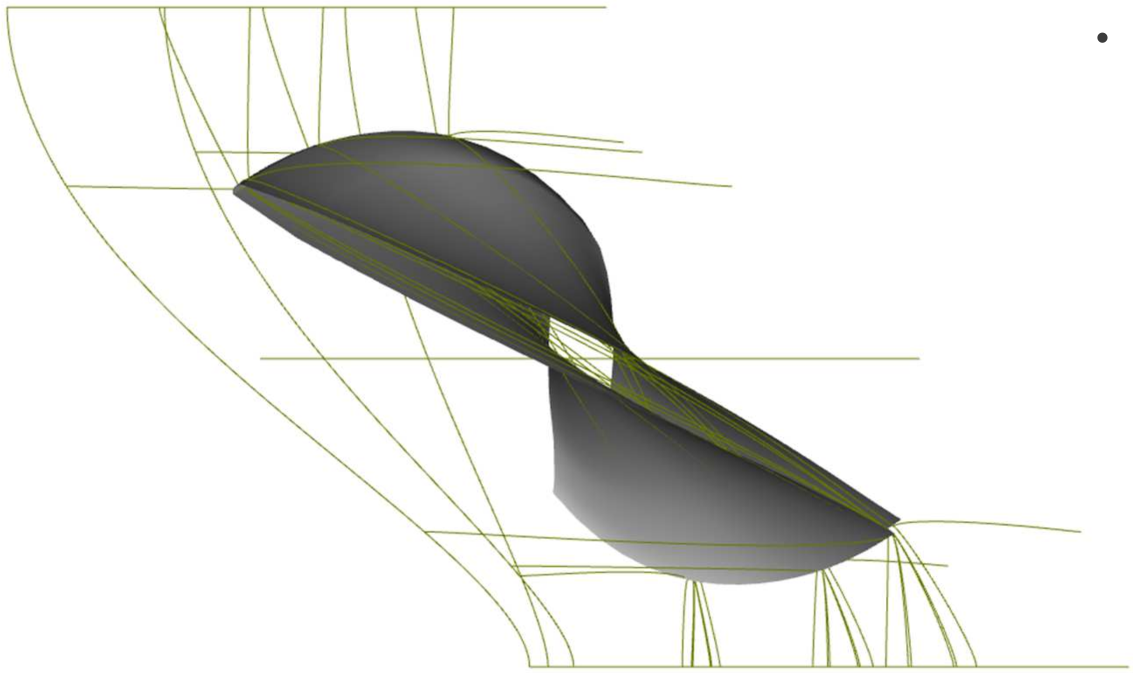
Geometry Definition
Rotor and Stator



- based on the profile curve engine the whole blade is created as meta surface

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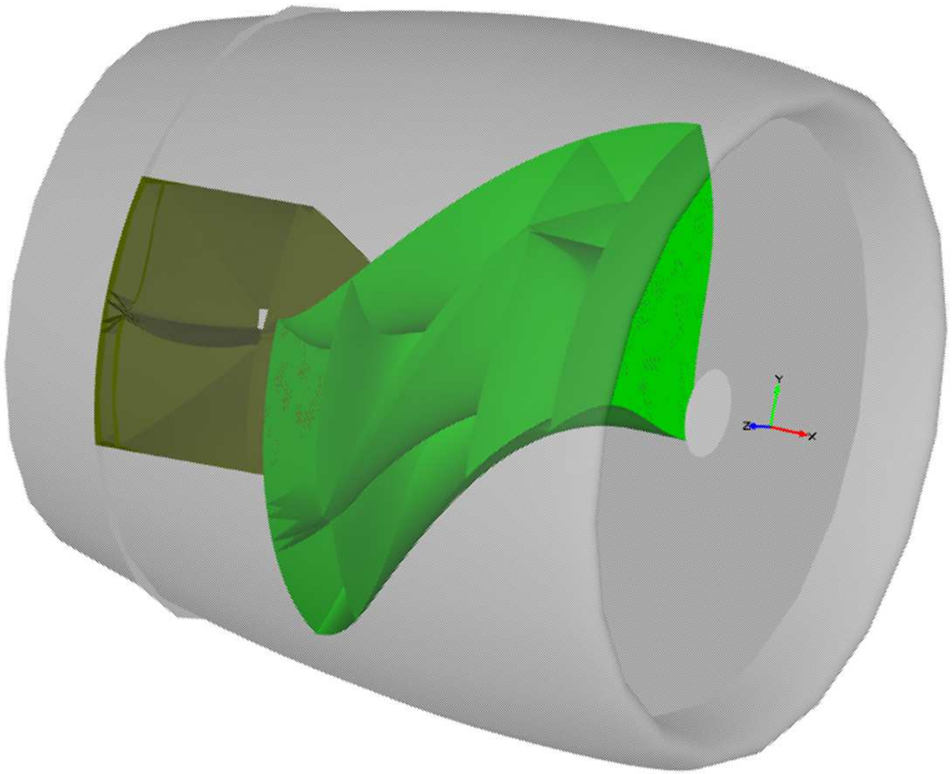
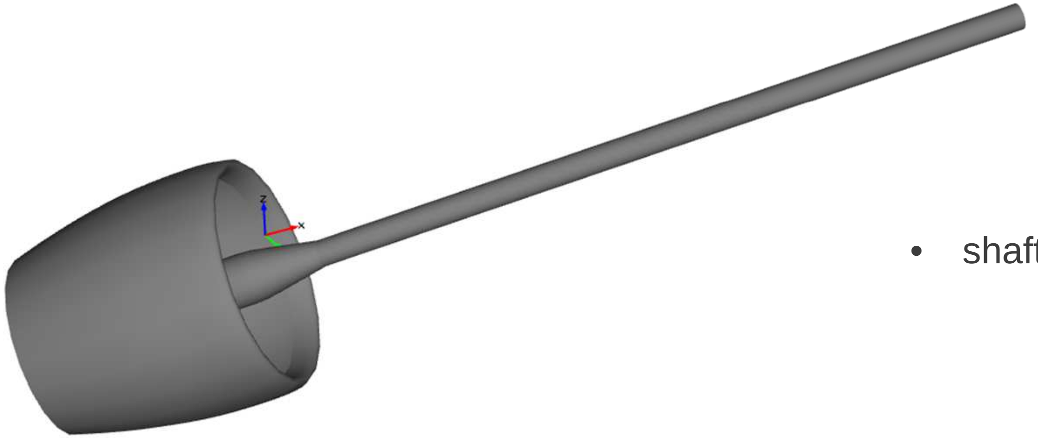
Geometry Definition
Nozzle



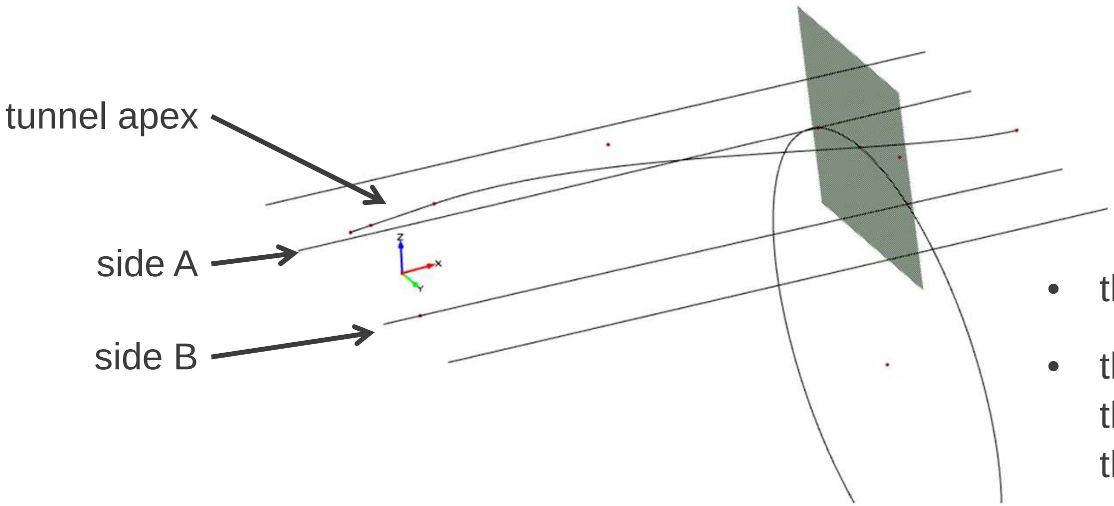
- nozzle is a simple rotational body
- rotor and stator are positioned inside of the nozzle

Geometry Definition
Nozzle and Shaft



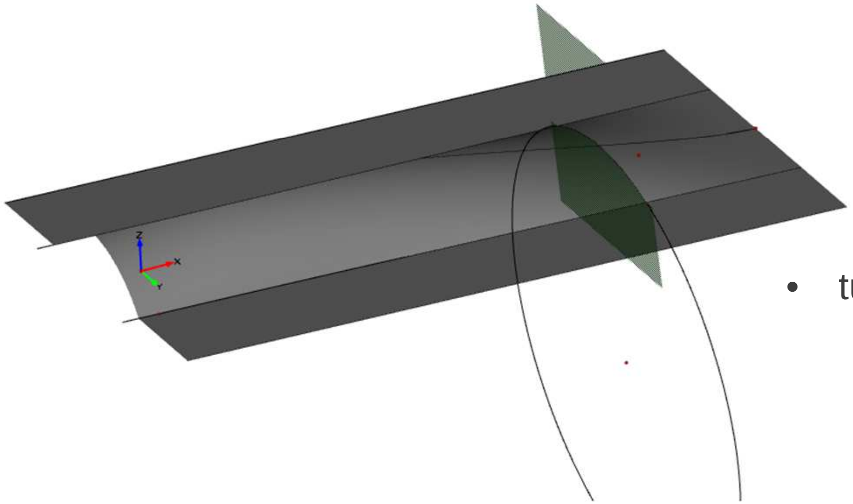
- shaft and hub complete propulsion line

Geometry Definition
Inlet Tunnel



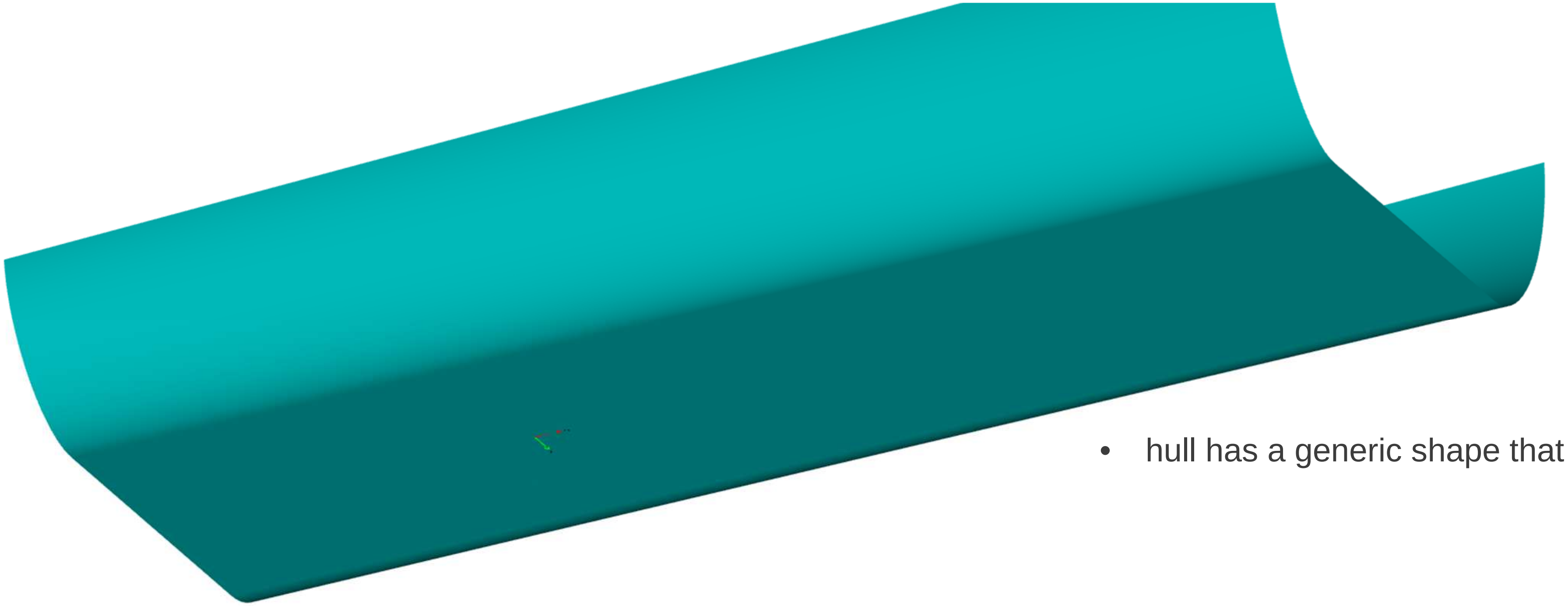
- integration requires a inlet tunnel
- curve engine is a three point circle
- the circle's axis is parallel to the rotor axis
- the circle' axis defines a plane that intersects the following definition curves and creates three circle points: tunnel apex, side A and side B

Geometry Definition
Inlet Tunnel



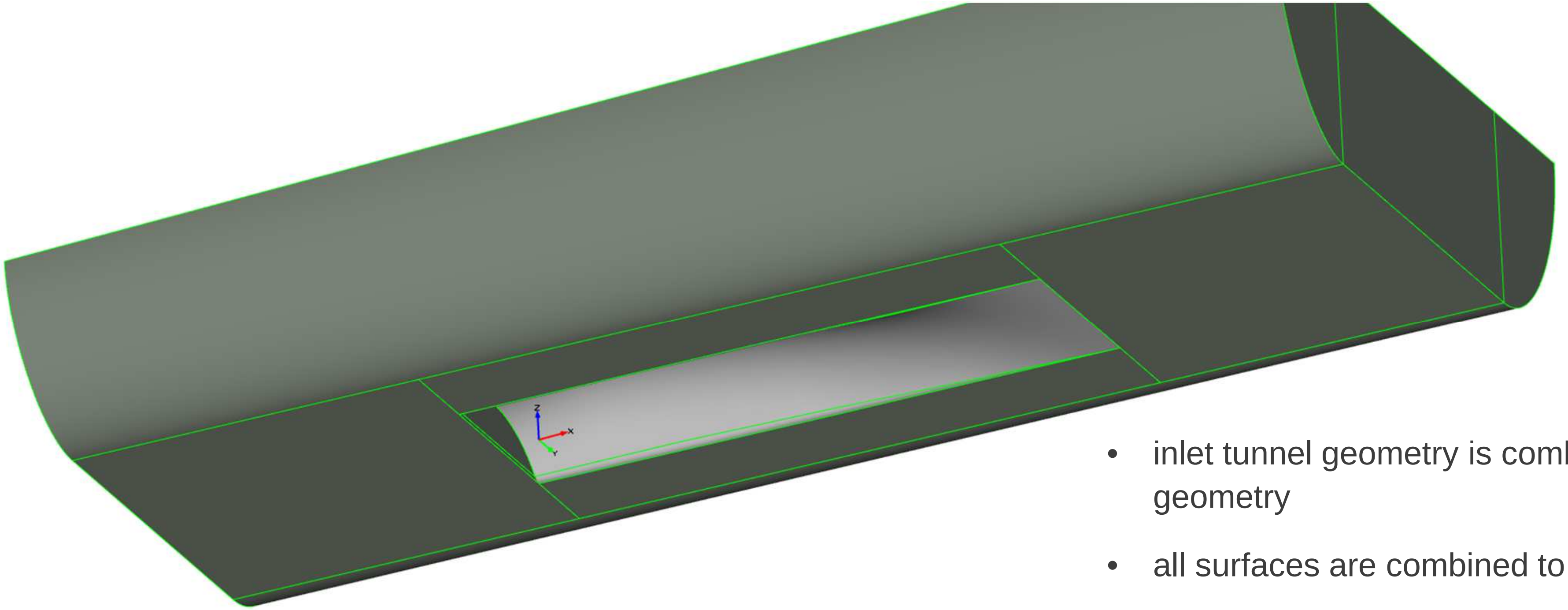
- tunnel is created as meta surface

Geometry Definition
Hull



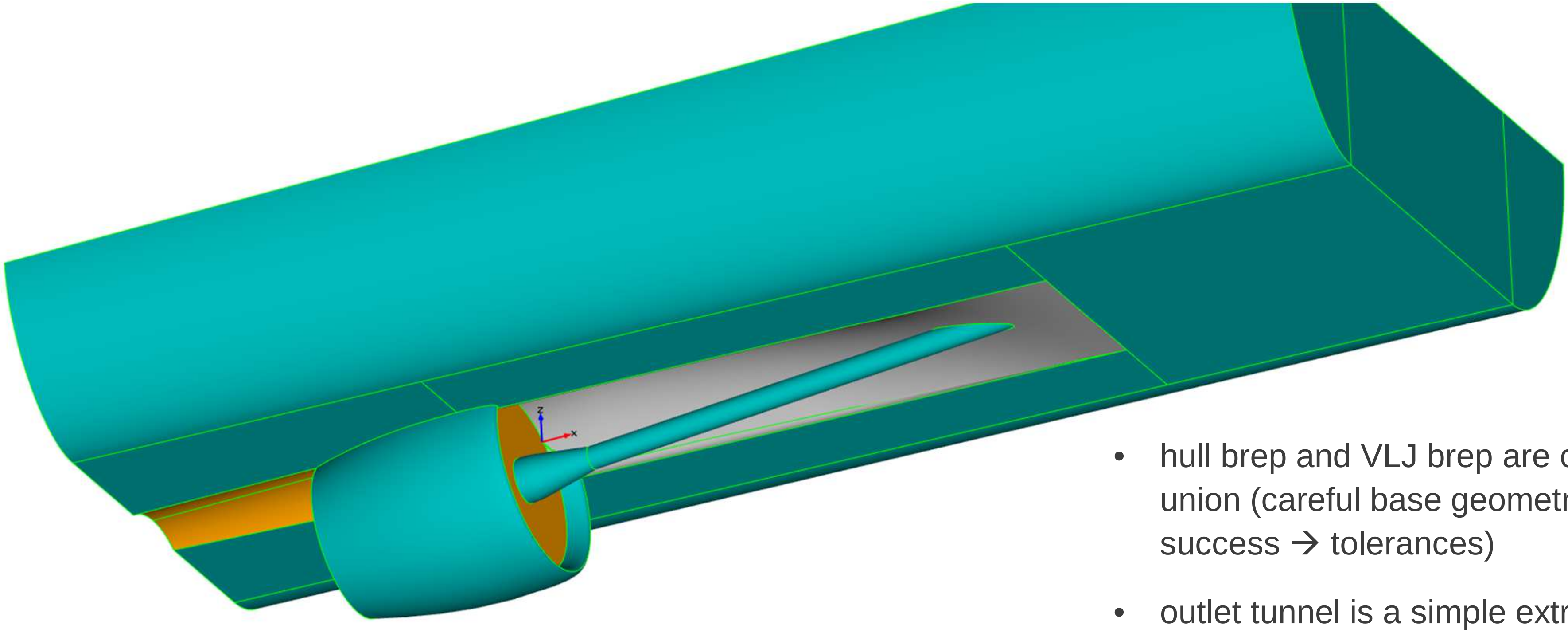
- hull has a generic shape that a simple integration

Geometry Definition
Hull and Inlet Tunnel



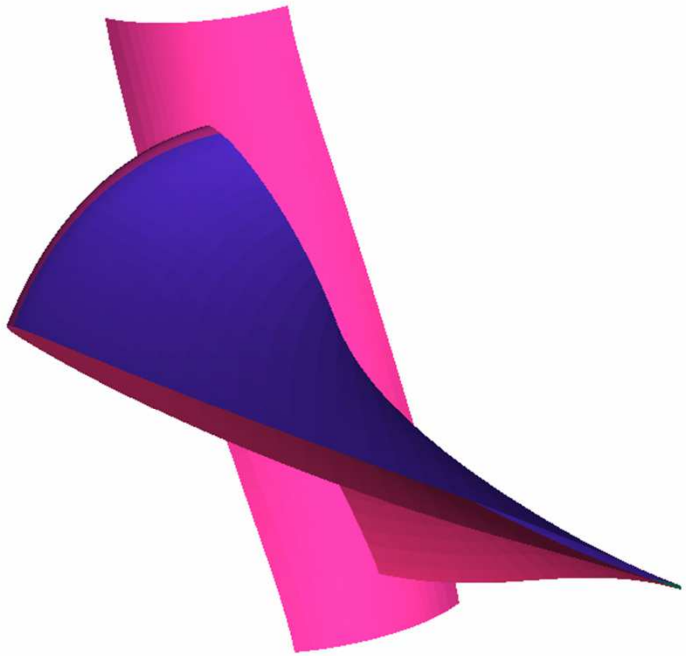
- inlet tunnel geometry is combined with hull geometry
- all surfaces are combined to one brep
- no boolean operations are used → more stable

Geometry Definition
Hull and VLJ Assembly

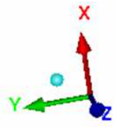


- hull brep and VLJ brep are combine by boolean union (careful base geometry definition assures success → tolerances)
- outlet tunnel is a simple extrusion of the nozzle's outlet as a boolean difference

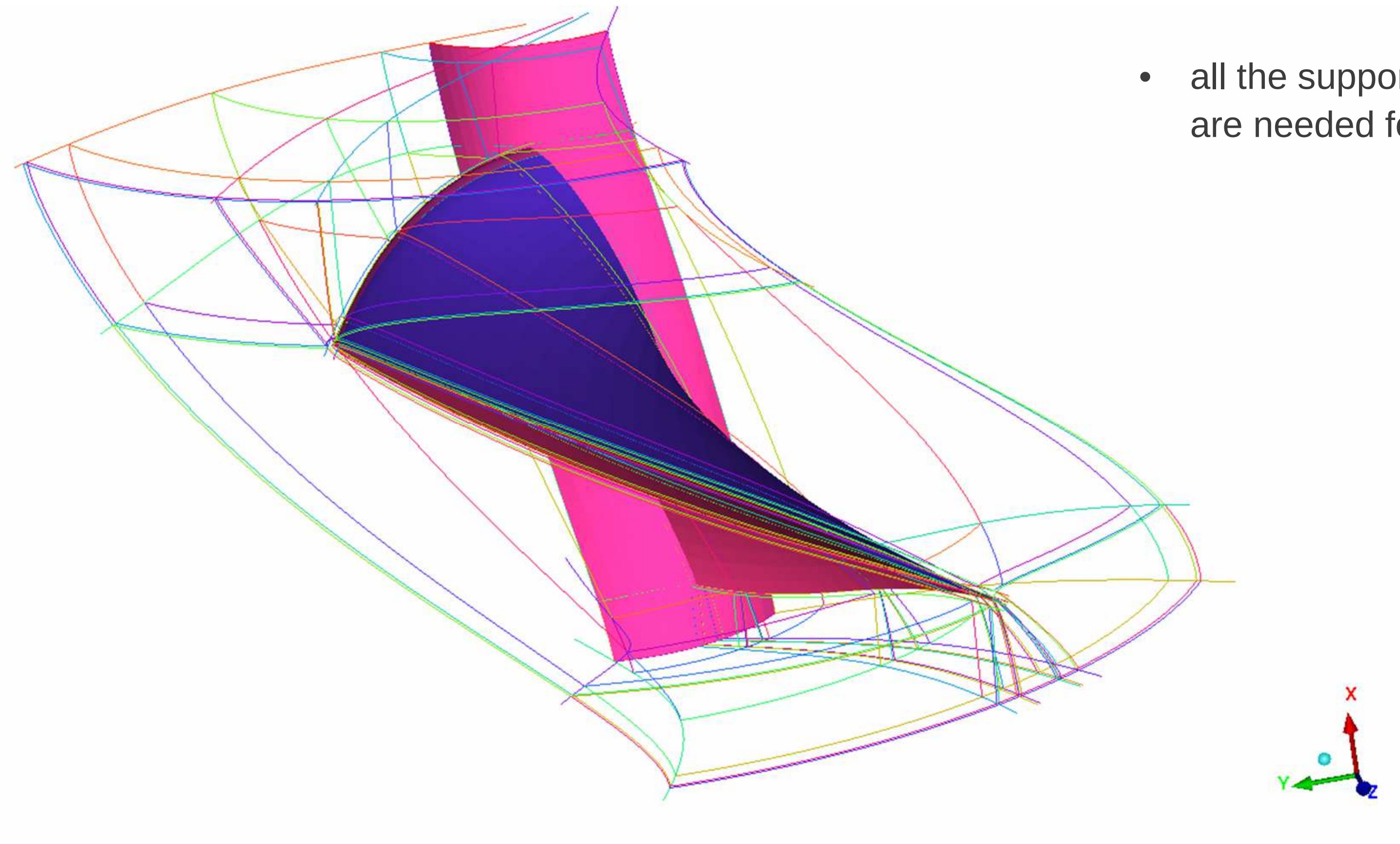
Grid Generation
Rotor and Stator (Structured Hexahedron Approach)



- rotor and stator mesh are created by Icem Hexa
- only one blade is meshed, whole rotor is defined rotated copies

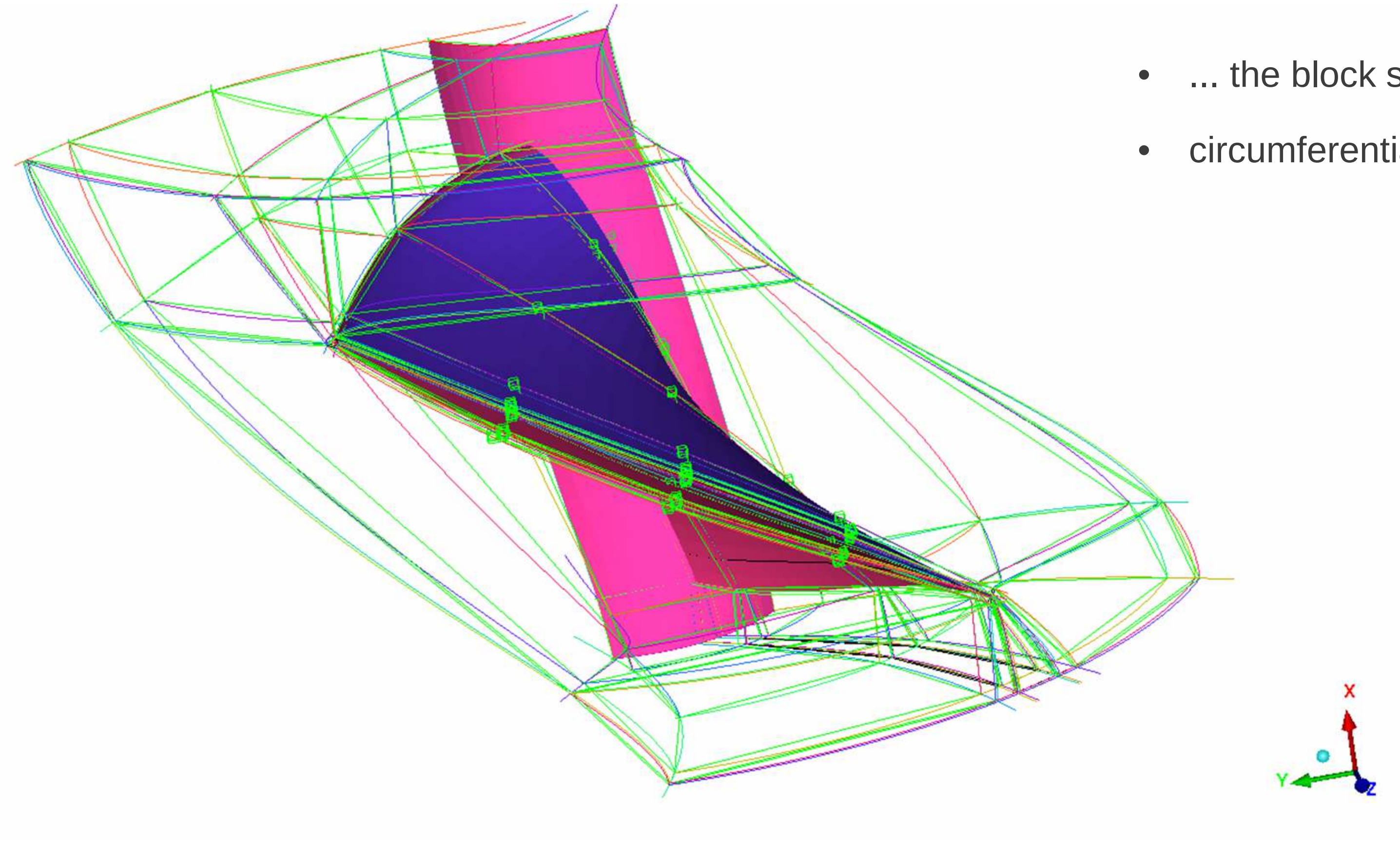


Grid Generation
Rotor and Stator (Structured Hexahedron Approach)



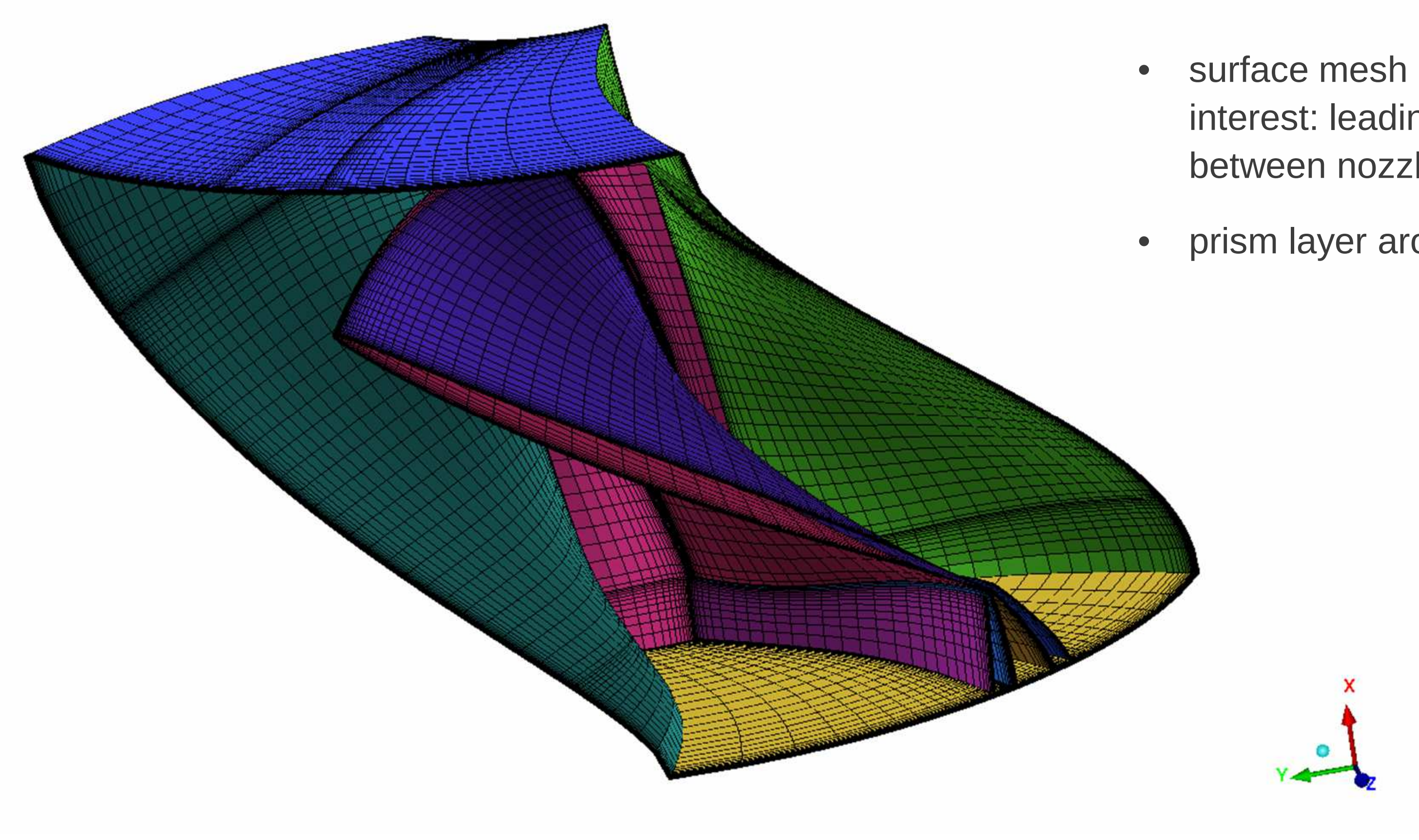
- all the support geometry (curves and surfaces) are needed for ...

Grid Generation
Rotor and Stator (Structured Hexahedron Approach)



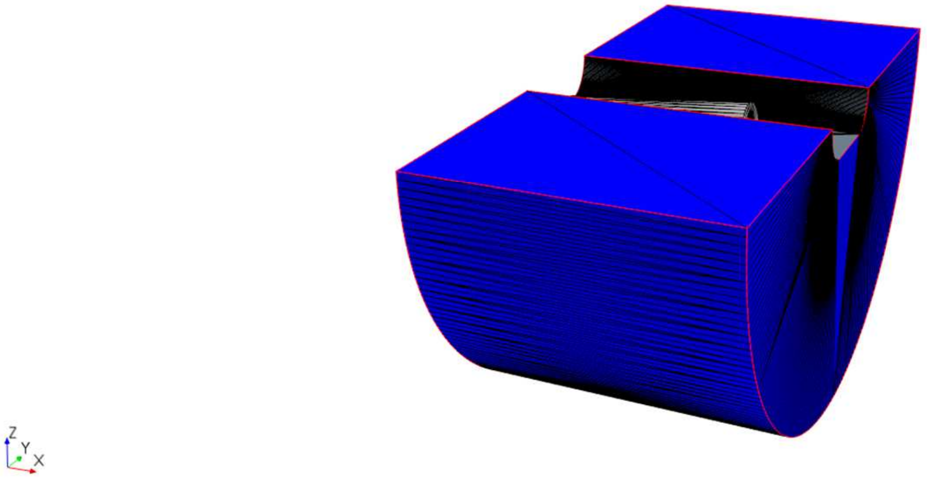
- ... the block structure of the hexahedron mesh
- circumferential symmetry is assured

Grid Generation
Rotor and Stator (Structured Hexahedron Approach)



- surface mesh has high density in regions of interest: leading edge, trailing edge, gap between nozzle and blade tip
- prism layer around all surfaces

Grid Generation
Hull Control Volume (Unstructured Polyhedron Approach)



- around the hull a half pipe control volume is created
- this region discretized by polyhedrons

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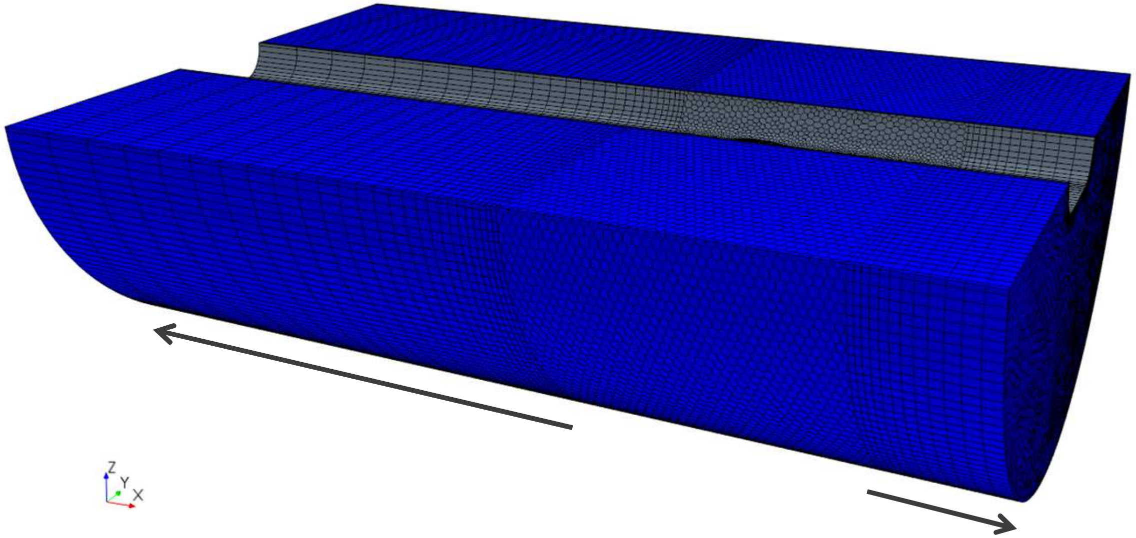
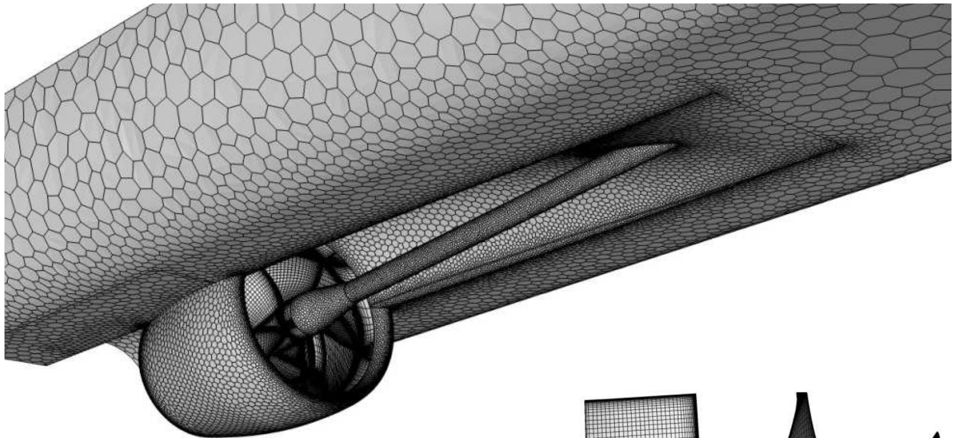
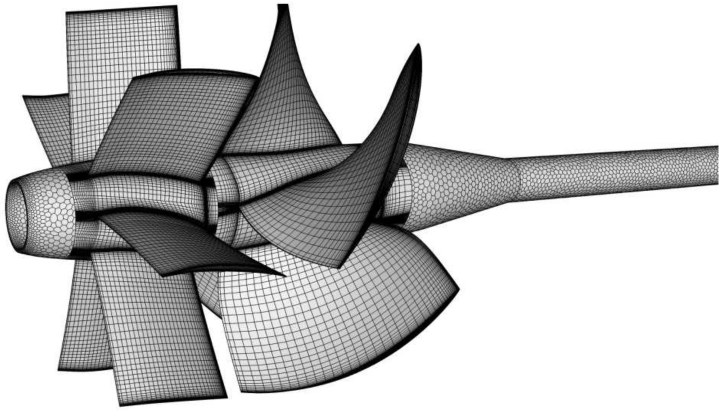
Grid Generation
Hull and Control Volume (Unstructured Polyhedron Approach)

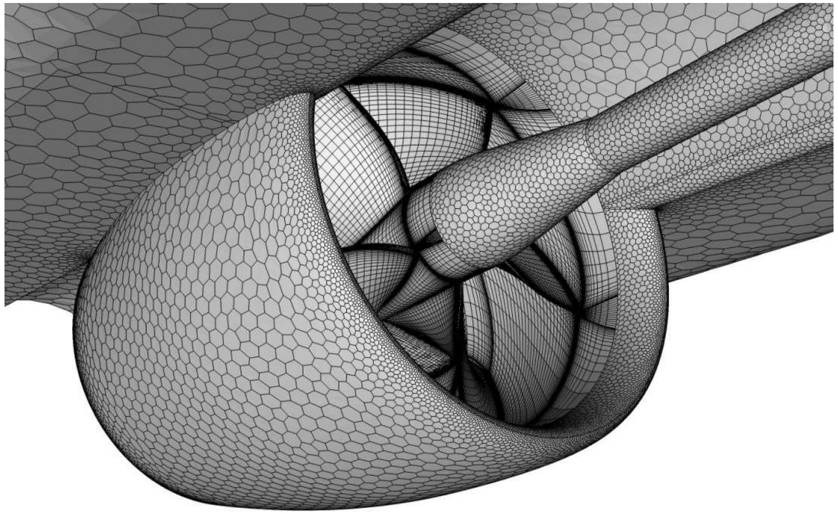


- complete control volume is created by extruding in- and outlet grid

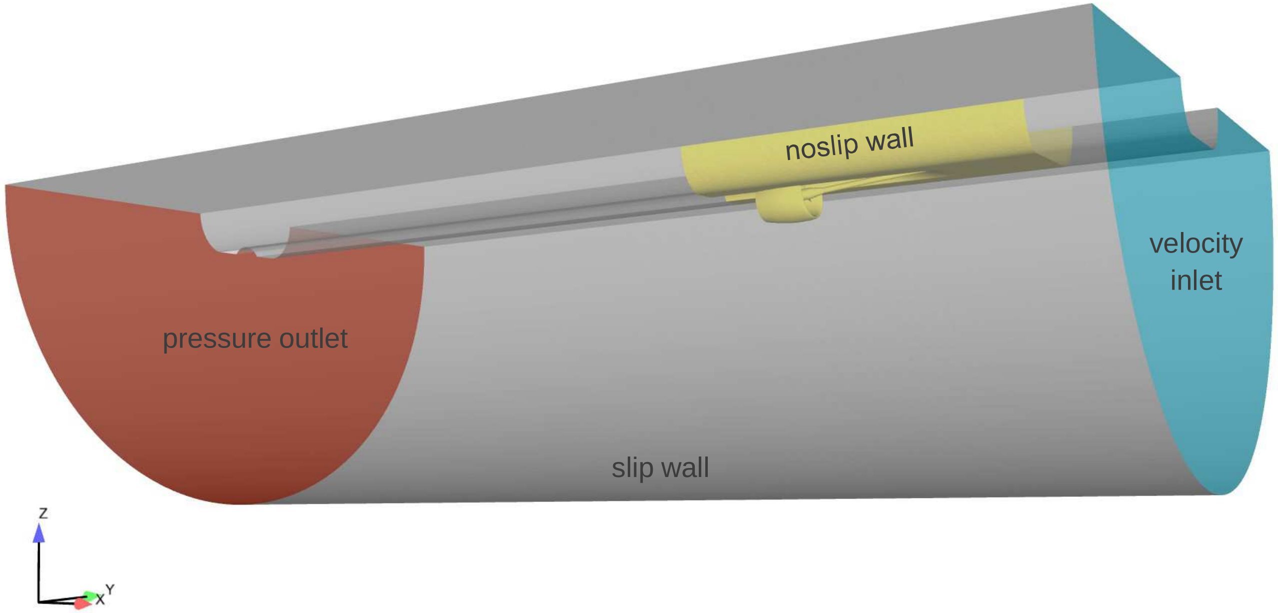
Grid Generation
Surface Mesh

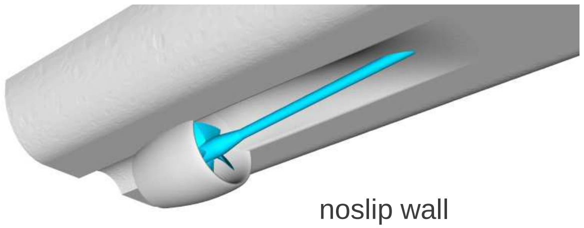




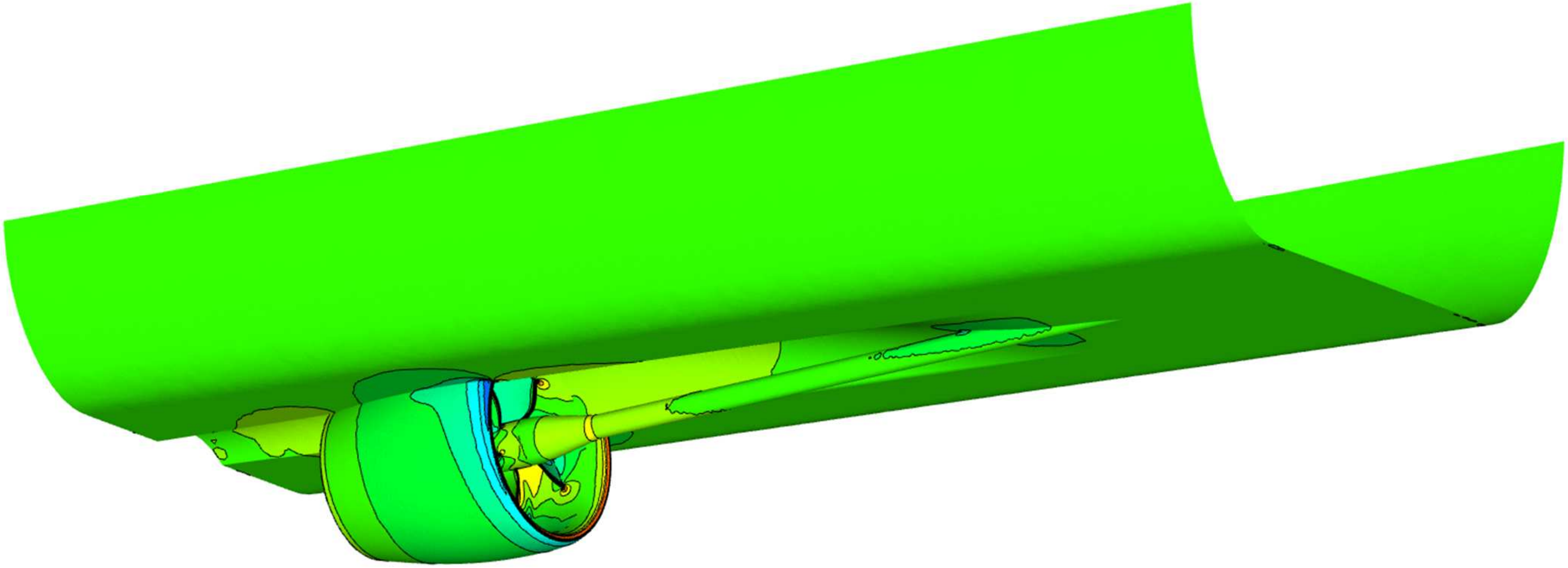


Control Volume
Boundary Definition





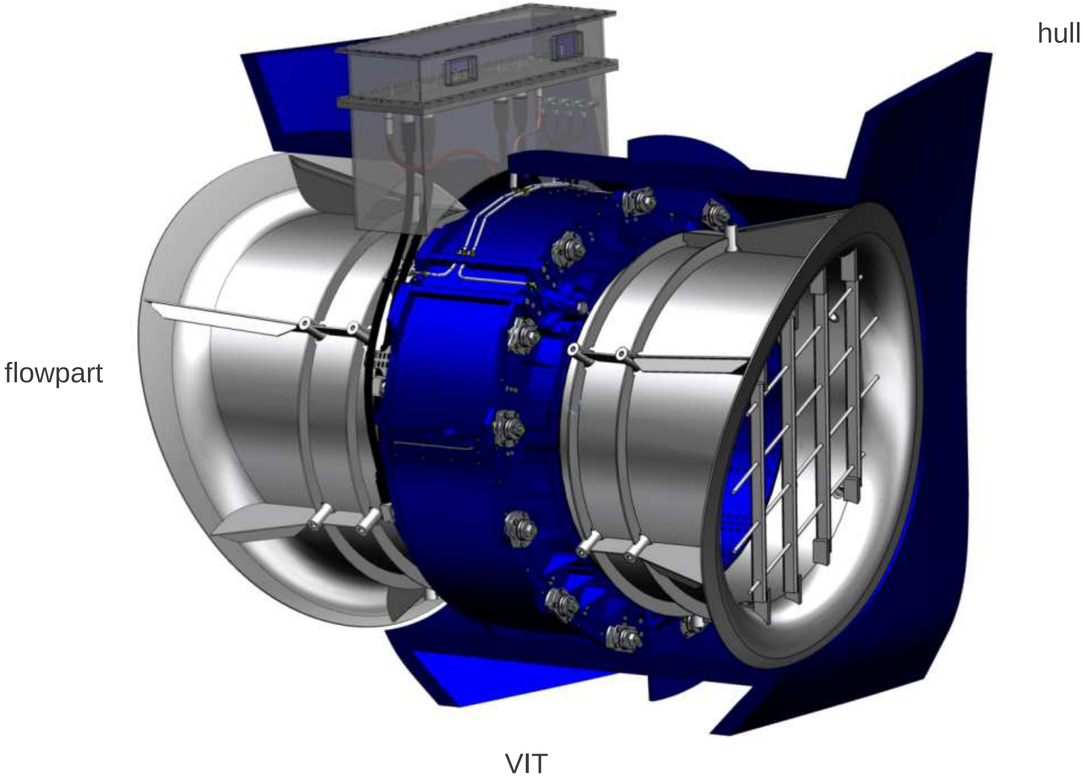
Integration Study
Integration Depth and Shaft Inclination



VIT Hull Interaction Study

VIT Interaction Study
Bow Setup

VIT Interaction Study
Flowparts (Tunnel Hull Transition)



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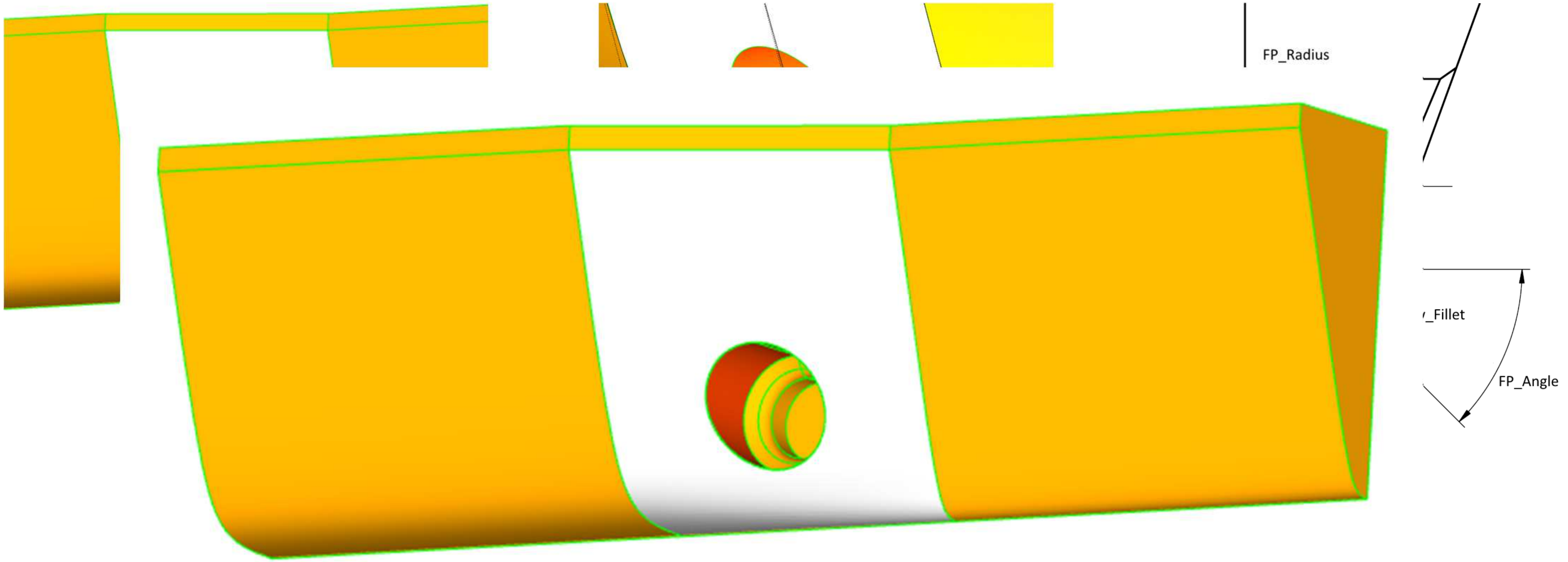
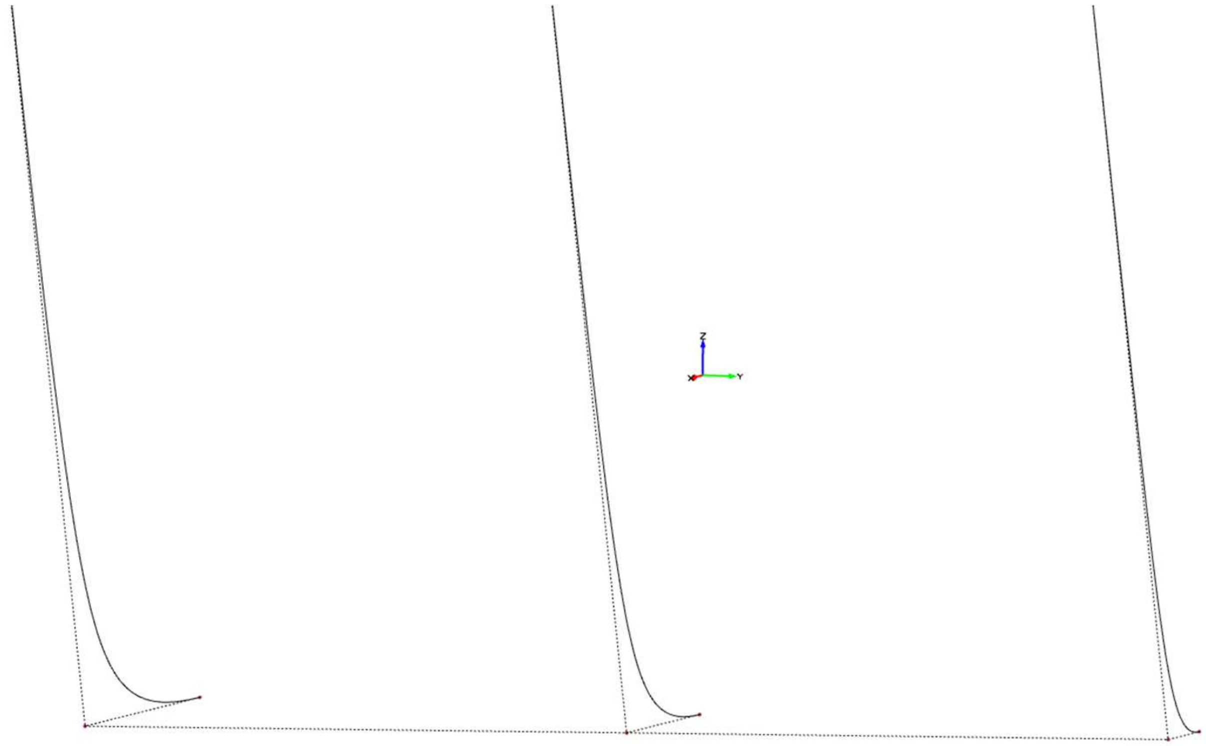
Geometry Definition
Hull and Flowpart Parameters

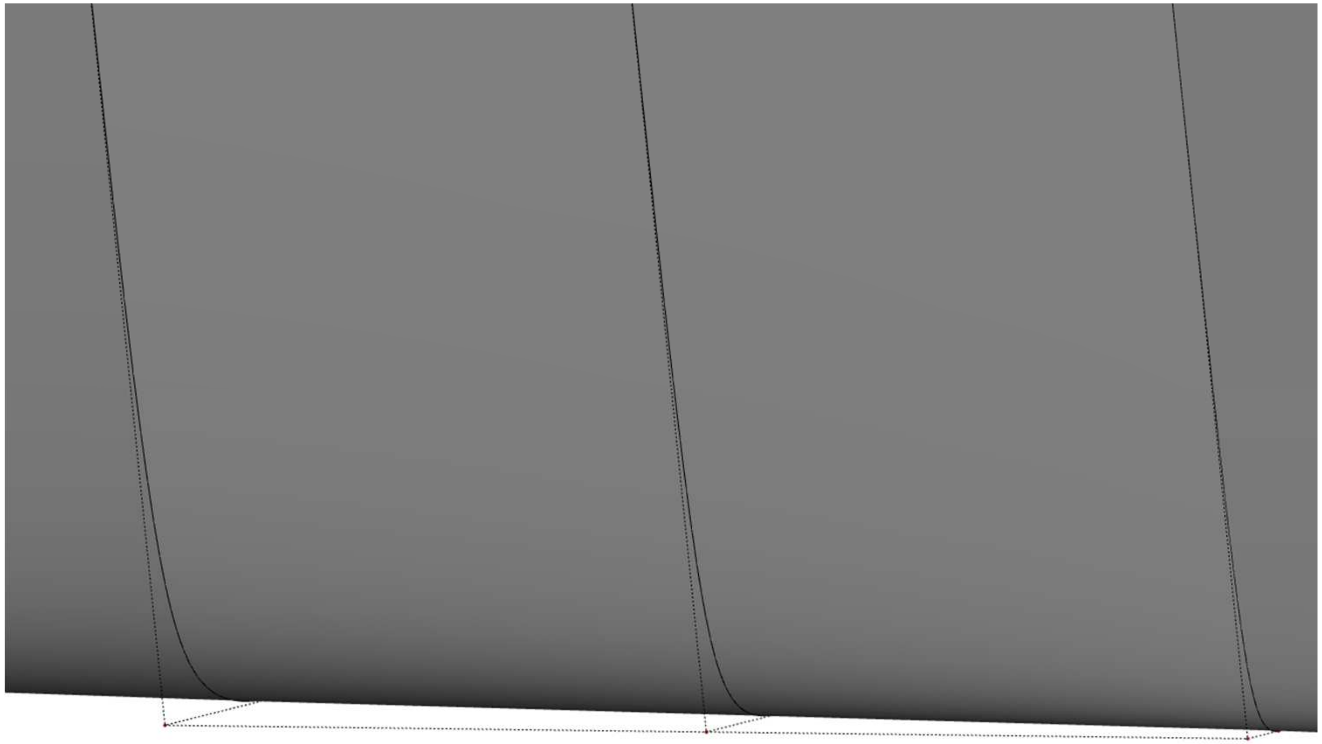


Geometry Definition
Bow



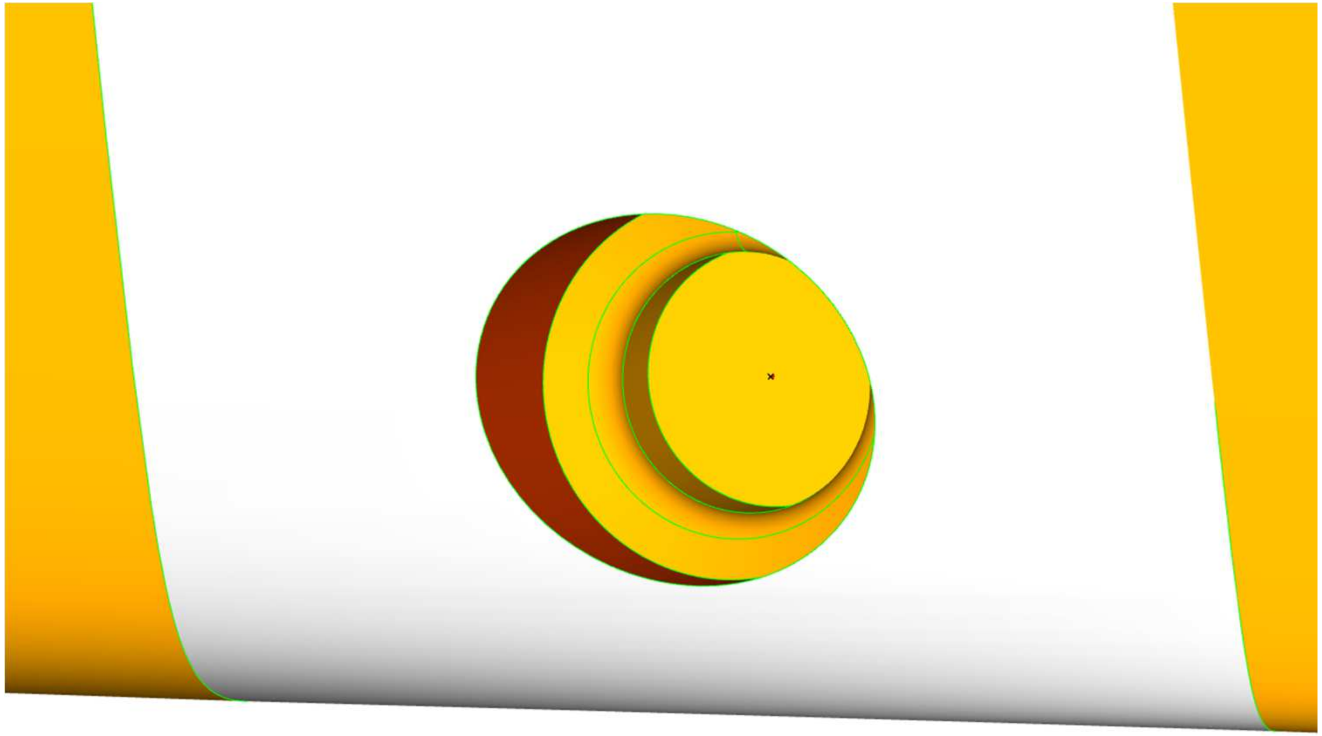
- bow geometry is based on simple three point b-spline curves
- facilitating Bow_SectionAngle, Bow_WaterlineAngle and Bow_FrontWidth

Geometry Definition
Bow



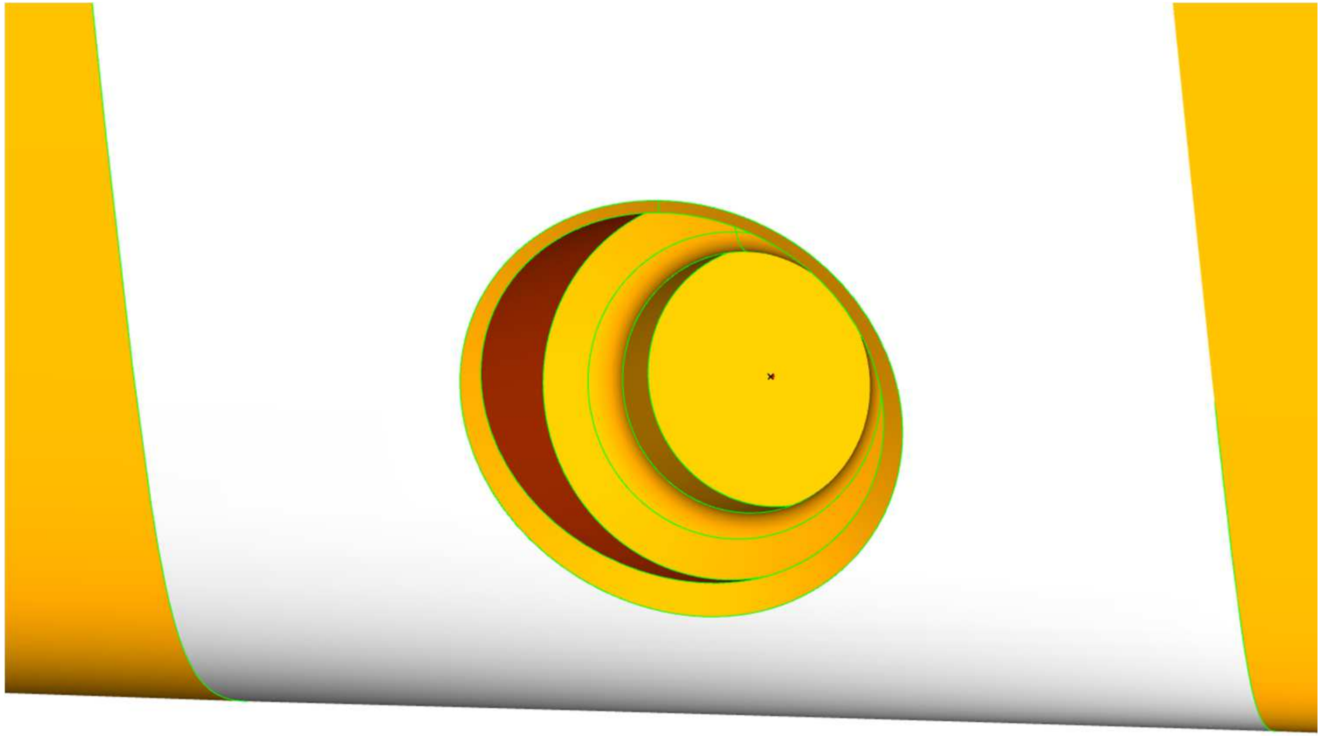
- a lofted surface connects the base curves
- side surfaces are simply extruded

Geometry Definition
Flowpart



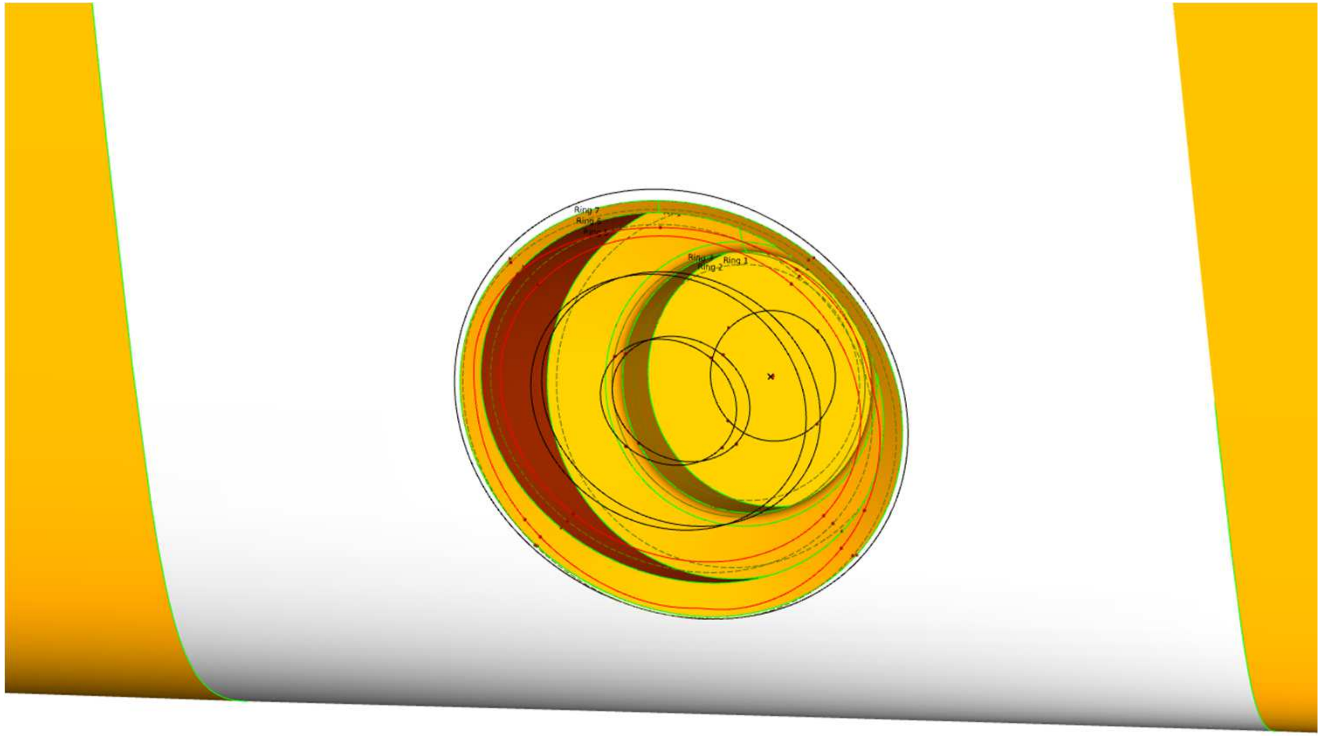
- flowpart and tunnel is created as one rotational brep
- the rotational brep is substracted from the hull brep

Geometry Definition
Tunnel Hull Transition



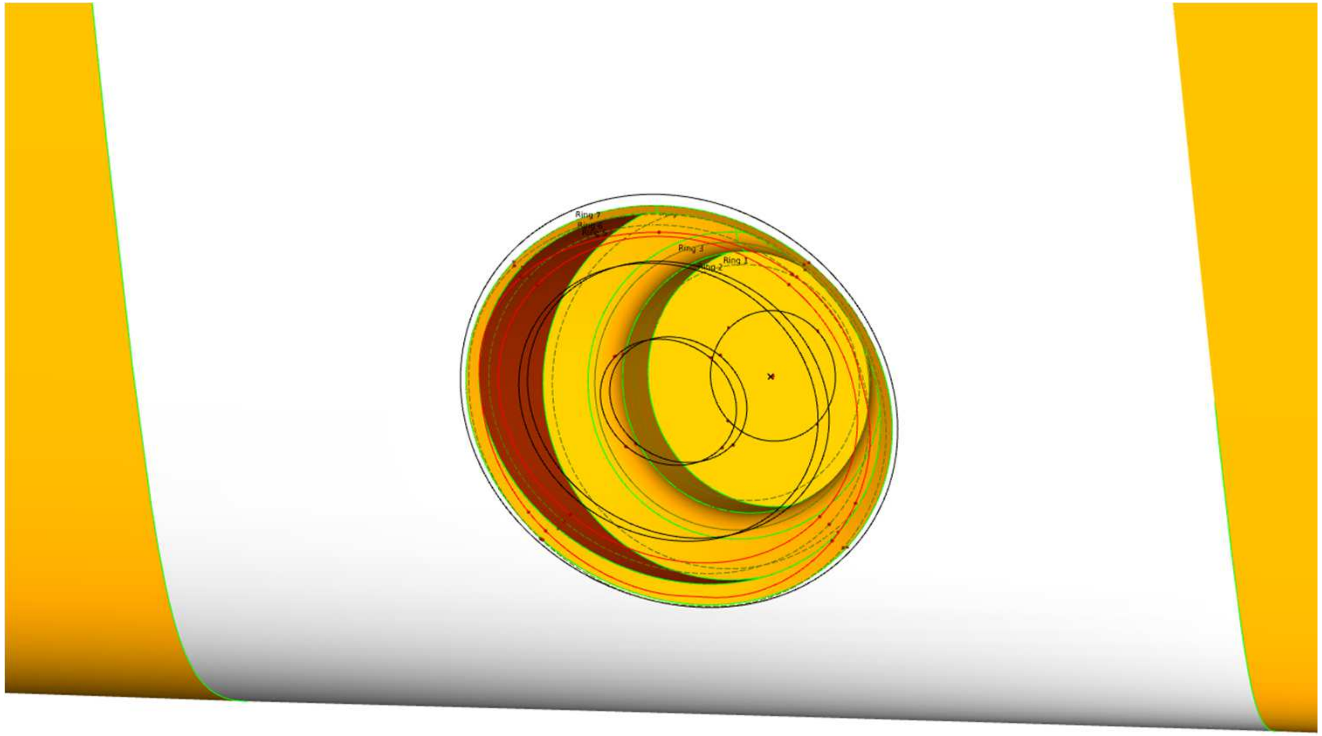
- Tunnel hull transition is created a linear edge fillet (huge benefit of breps!)

Geometry Definition
Support Geometry



- support curves are created based on brep edges
- they adapt to geometry changes

Geometry Definition
Support Geometry



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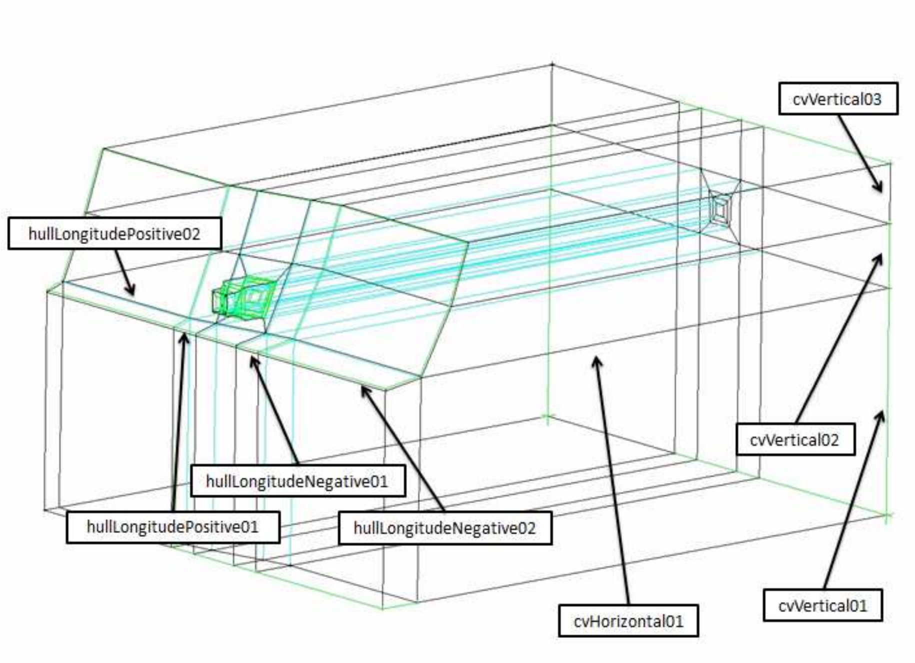
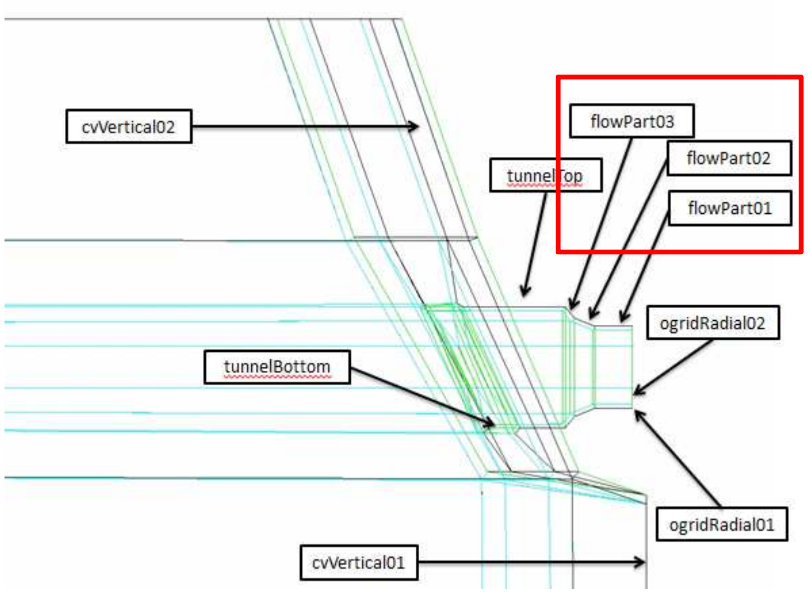
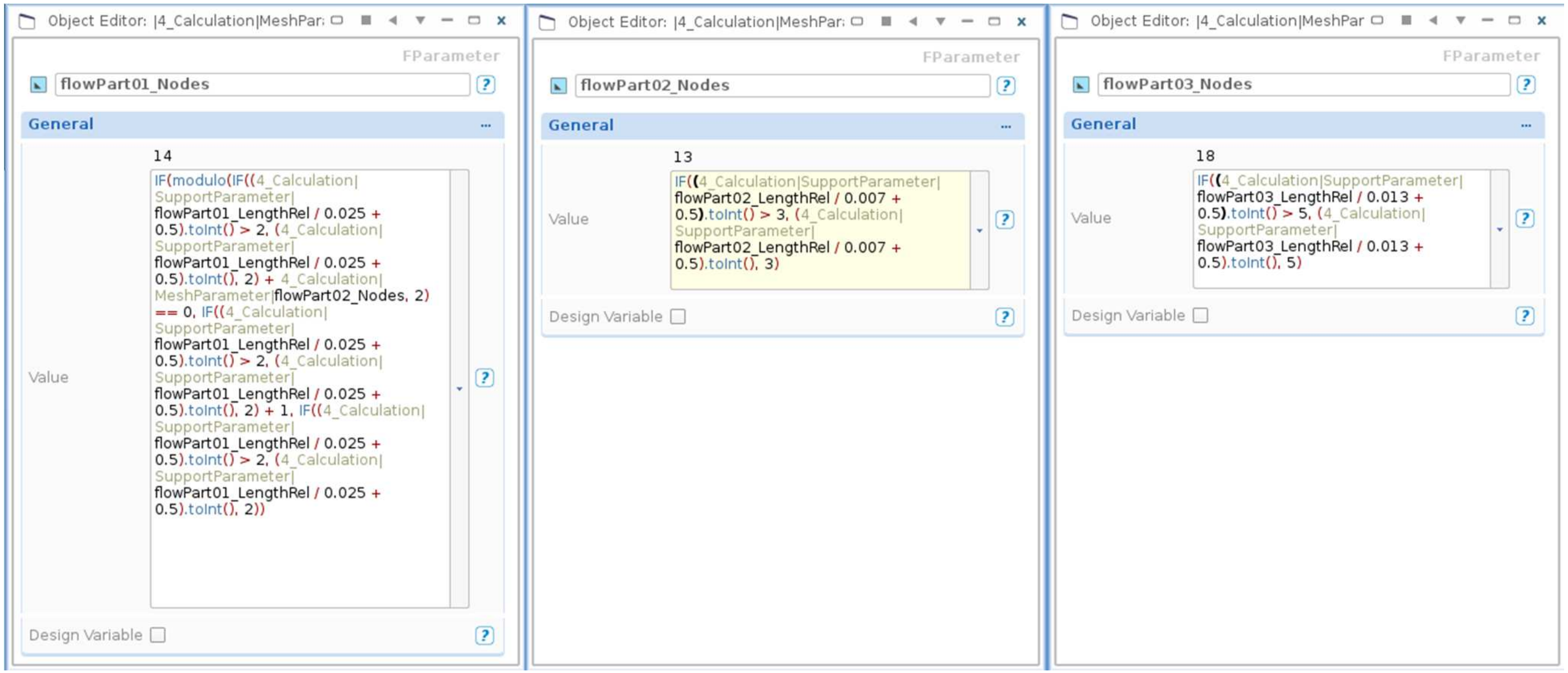
- they adapt to geometry changes

Grid Generation
Hull Control Volume (Structured Hexahedron Approach)

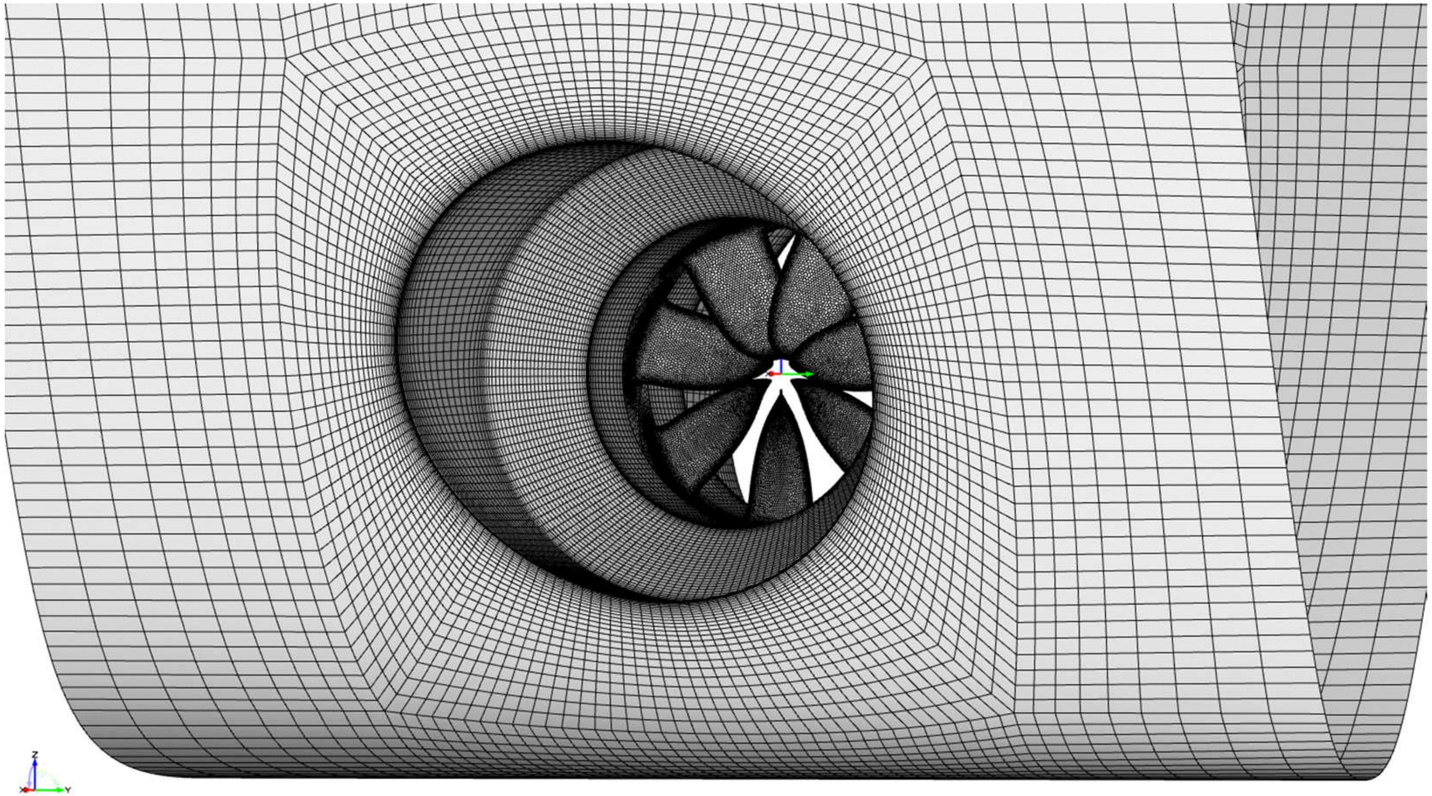




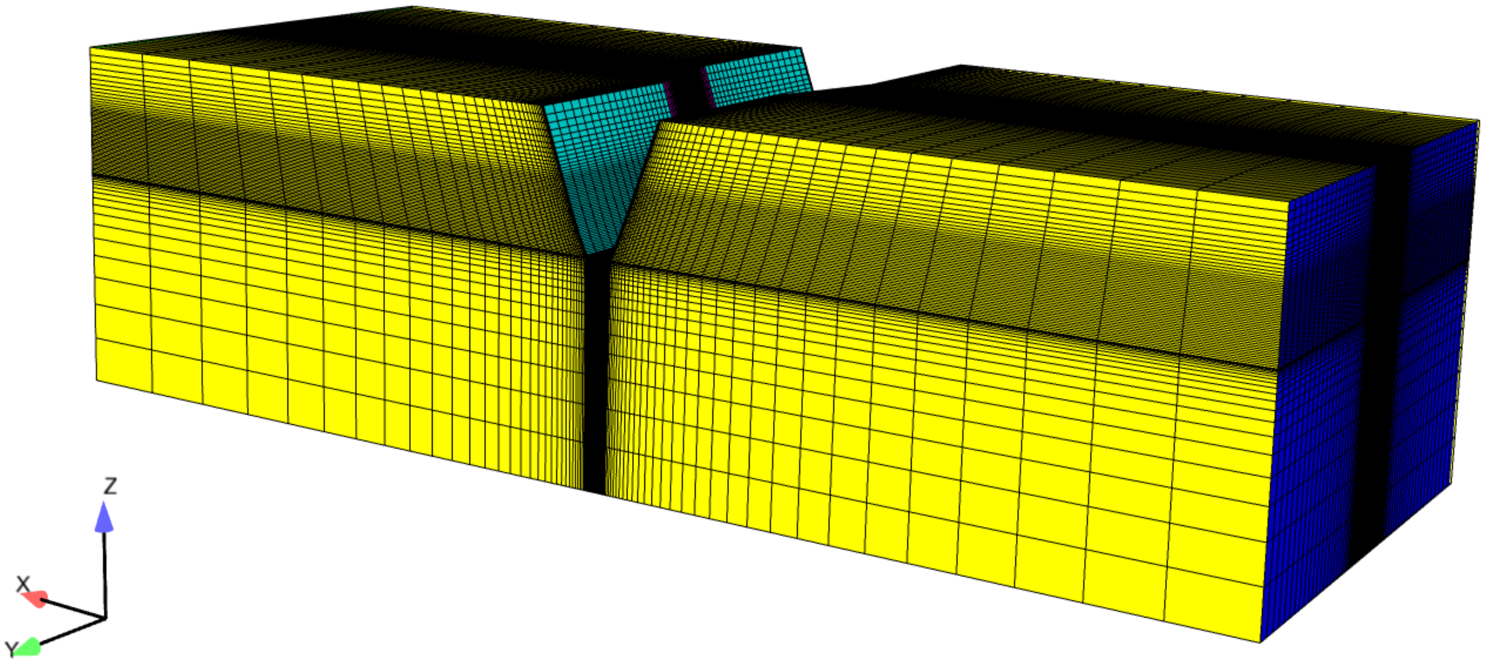
Geometry Definition
Mesh Parameters



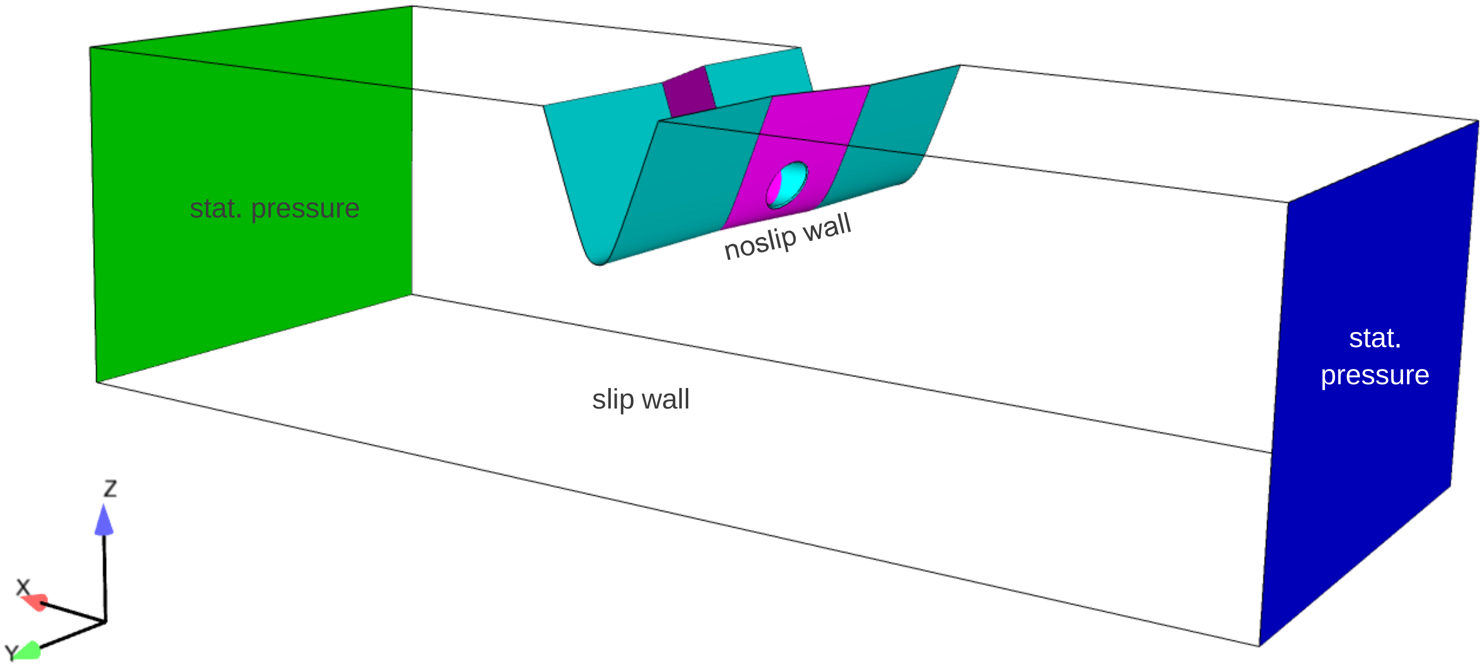
Grid Generation
Flowpart Study



Grid Generation
Control Volume

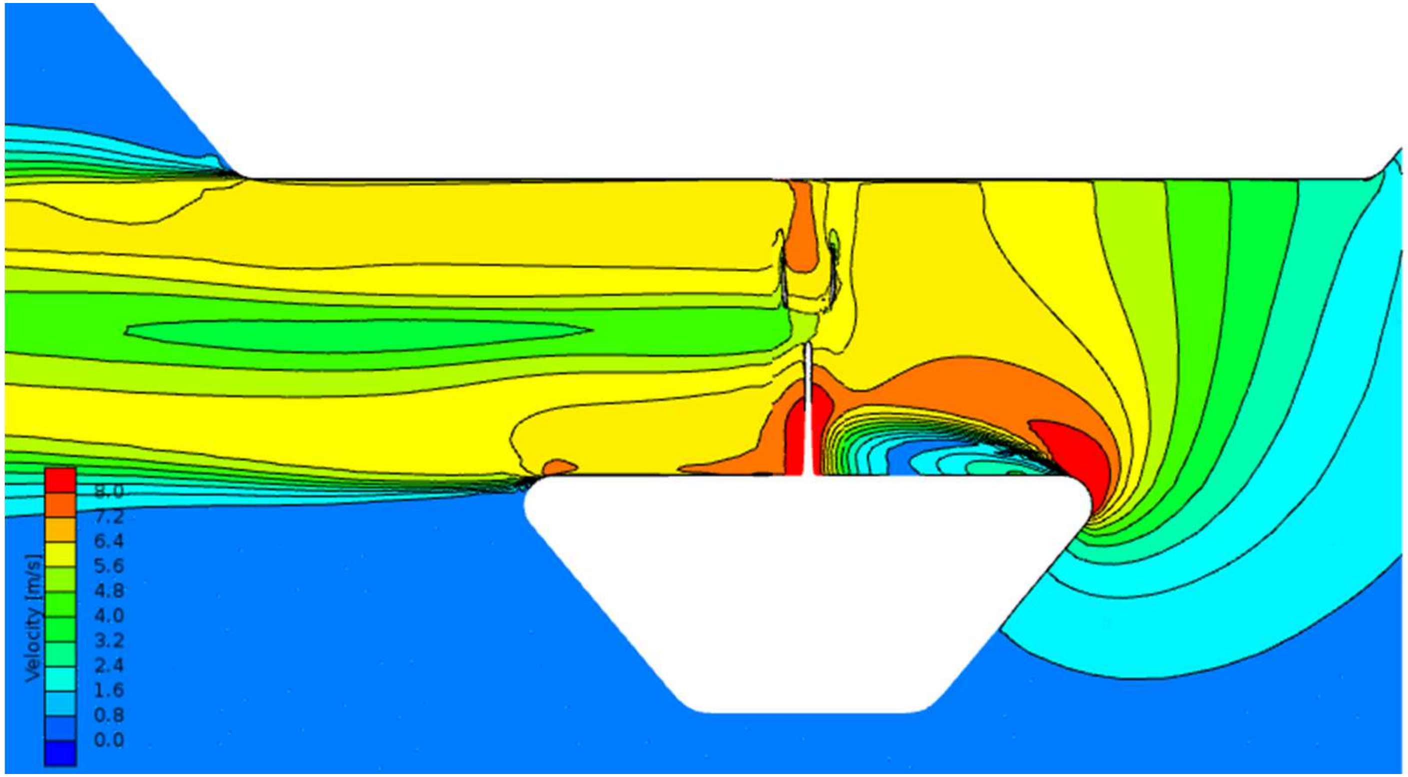


Control Volume
Boundary Definition



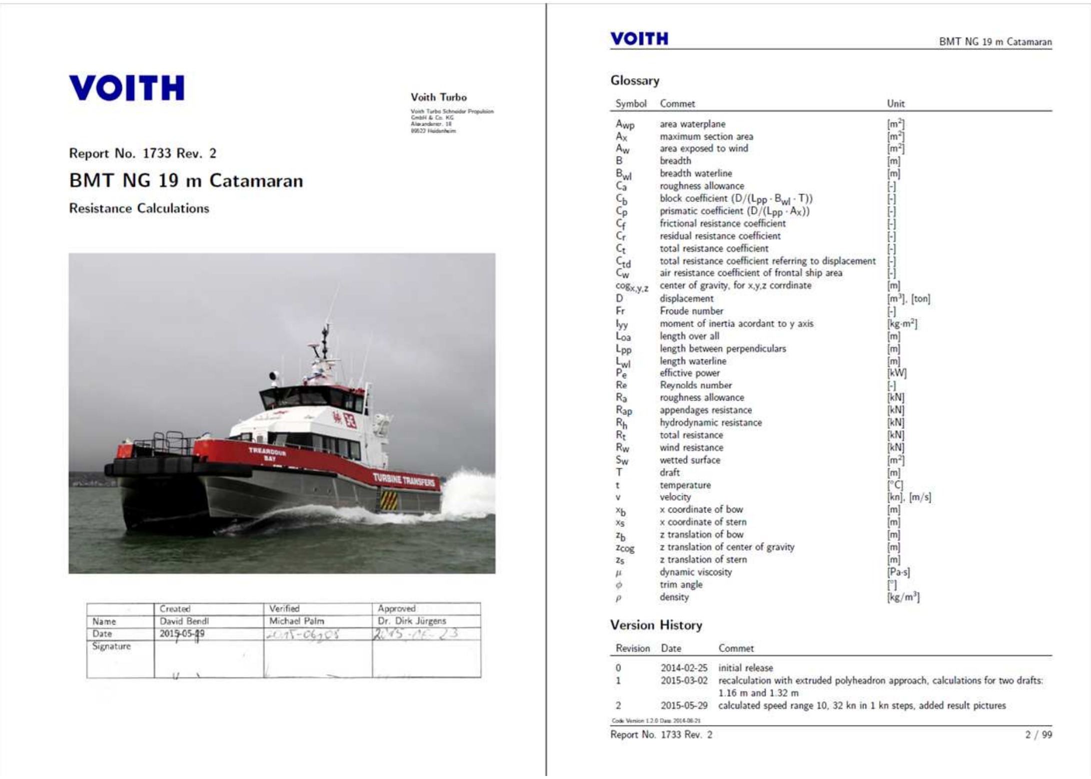
Rotor:
noslip wall
(rotational velocity)

Post Processing
Bow Study



Standard Report Resistance Calculation

Automatic Latex Report Creation Supported by CAESES



Voith Turbo

Report No. 1733 Rev. 2

BMT NG 19 m Catamaran

Resistance Calculations

	Created	Verified	Approved
Name	David Bendl	Michael Palm	Dr. Dirk Jürgens
Date	2015-05-29	[illegible]	[illegible]
Signature			

BMT NG 19 m Catamaran

Glossary

Symbol	Commet	Unit
A_{wp}	area waterplane	[m²]
A_x	maximum section area	[m²]
A_w	area exposed to wind	[m²]
B	breadth	[m]
B_{wl}	breadth waterline	[m]
C_a	roughness allowance	[-]
C_b	block coefficient $(D/(L_{pp} \cdot B_{wl} \cdot T))$	[-]
C_p	prismatic coefficient $(D/(L_{pp} \cdot A_x))$	[-]
C_f	frictional resistance coefficient	[-]
C_r	residual resistance coefficient	[-]
C_t	total resistance coefficient	[-]
C_{td}	total resistance coefficient referring to displacement	[-]
C_w	air resistance coefficient of frontal ship area	[-]
$cog_{x,y,z}$	center of gravity, for x,y,z corrdinate	[m]
D	displacement	[m³], [ton]
Fr	Froude number	[-]
I_{yy}	moment of inertia acordant to y axis	[kg·m²]
L_{oa}	length over all	[m]
L_{pp}	length between perpendiculars	[m]
L_{wl}	length waterline	[m]
P_e	effictive power	[kW]
Re	Reynolds number	[-]
R_a	roughness allowance	[kN]
R_{ap}	appendages resistance	[kN]
R_h	hydrodynamic resistance	[kN]
R_t	total resistance	[kN]
R_w	wind resistance	[kN]
S_w	wetted surface	[m²]
T	draft	[m]
t	temperature	[°C]
v	velocity	[kn], [m/s]
x_b	x coordinate of bow	[m]
x_s	x coordinate of stern	[m]
z_b	z translation of bow	[m]
z_{cog}	z translation of center of gravity	[m]
z_s	z translation of stern	[m]
μ	dynamic viscosity	[Pa·s]
ϕ	trim angle	[°]
ρ	density	[kg/m³]

Version History

Revision	Date	Commet
0	2014-02-25	initial release
1	2015-03-02	recalculation with extruded polyheadron approach, calculations for two drafts: 1.16 m and 1.32 m
2	2015-05-29	calculated speed range 10, 32 kn in 1 kn steps, added result pictures

Code Version 1.2.0 Date 2014-08-21

Report No. 1733 Rev. 2 2 / 99

- standard tool in project work
- often tank test results are not available for power predictions of our propellers
- or changes / enhancement on the hull have to be evaluated
- standardized hydrostatics, mesh generation, CFD setup, post processing and reporting

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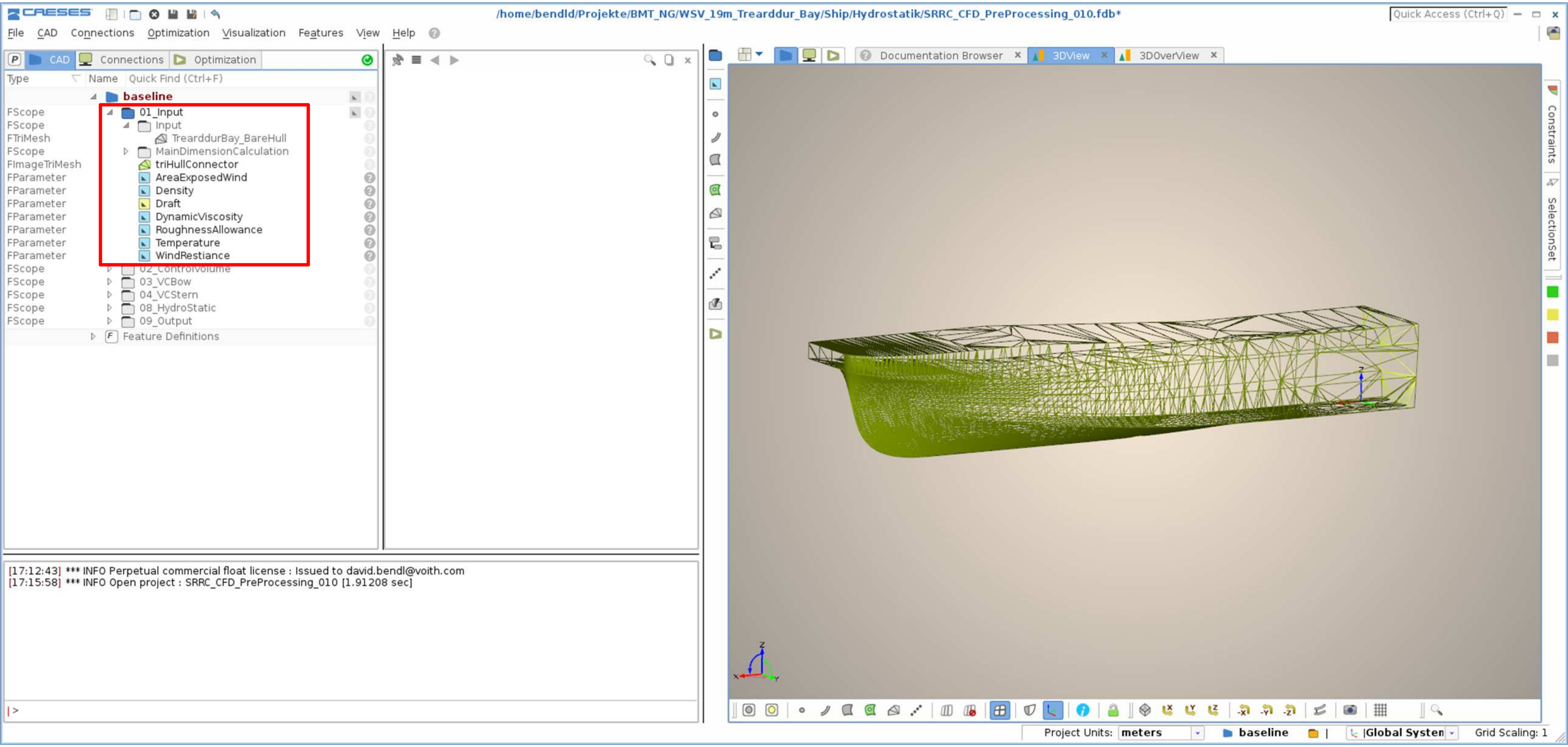

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File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
baseline
FScope 01_Input
FScope Input
FTriMesh TrearddurBay_BareHull
FScope MainDimensionCalculation
FImageTriMesh triHullConnector
FParameter AreaExposedWind
FParameter Density
FParameter Draft
FParameter DynamicViscosity
FParameter RoughnessAllowance
FParameter Temperature
FParameter WindRestiance
FScope 02_Controlvolume
FScope 03_VCBow
FScope 04_VCStern
FScope 08_HydroStatic
FScope 09_Output
Feature Definitions
Documentation Browser
3DView
3DOverView
Constraints
SelectionSet
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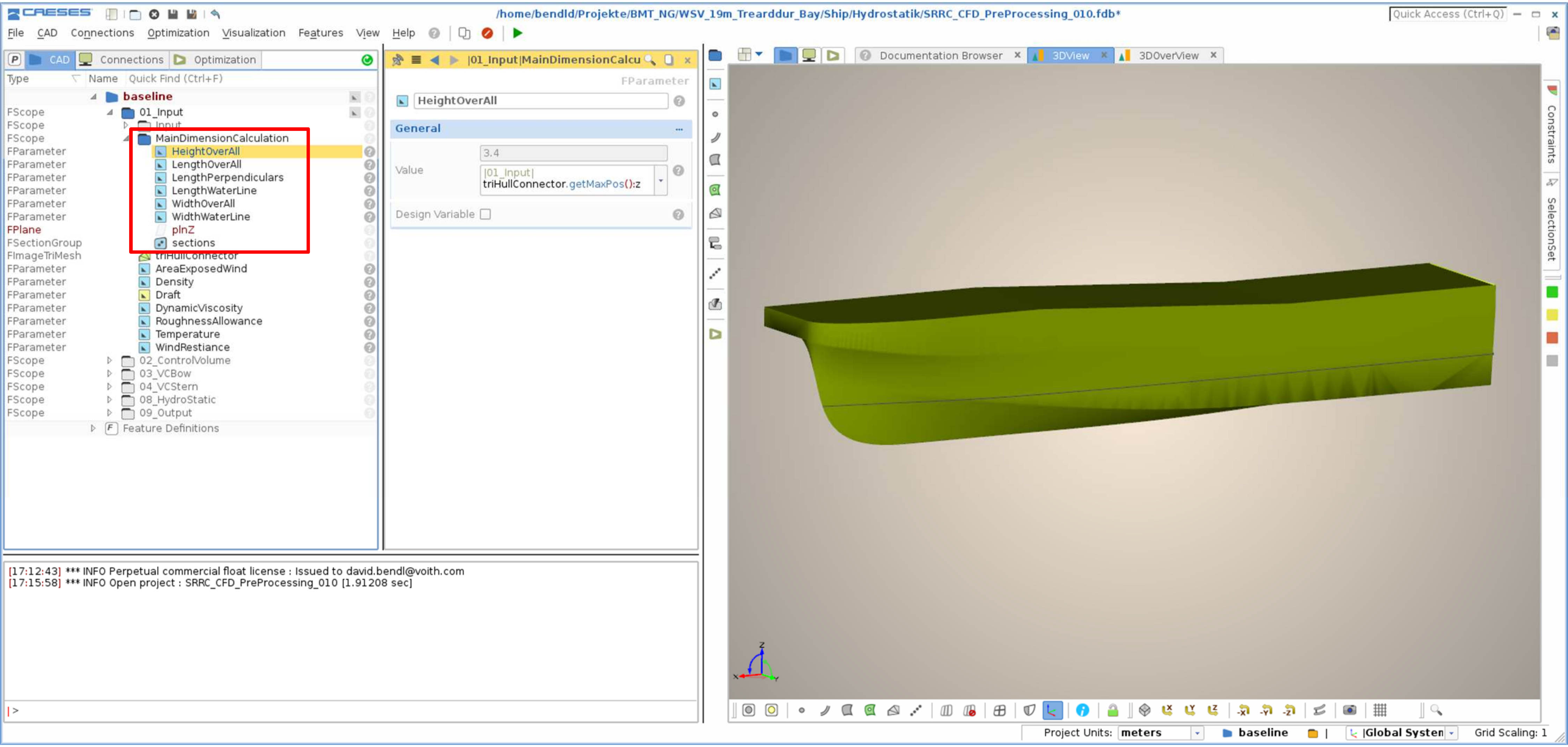
Global System
Grid Scaling: 1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File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
baseline
FScope 01_Input
FScope Input
FScope MainDimensionCalculation
FParameter HeightOverAll
FParameter LengthOverAll
FParameter LengthPerpendiculars
FParameter LengthWaterLine
FParameter WidthOverAll
FParameter WidthWaterLine
FPlane plnZ
FSectionGroup sections
FImageTriMesh triHullConnector
FParameter AreaExposedWind
FParameter Density
FParameter Draft
FParameter DynamicViscosity
FParameter RoughnessAllowance
FParameter Temperature
FParameter WindRestiance
FScope 02_ControlVolume
FScope 03_VCBow
FScope 04_VCStern
FScope 08_HydroStatic
FScope 09_Output
Feature Definitions
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FParameter
HeightOverAll
General
Value
3.4
|01_Input|
triHullConnector.getMaxPos():z
Design Variable
Documentation Browser
3DView
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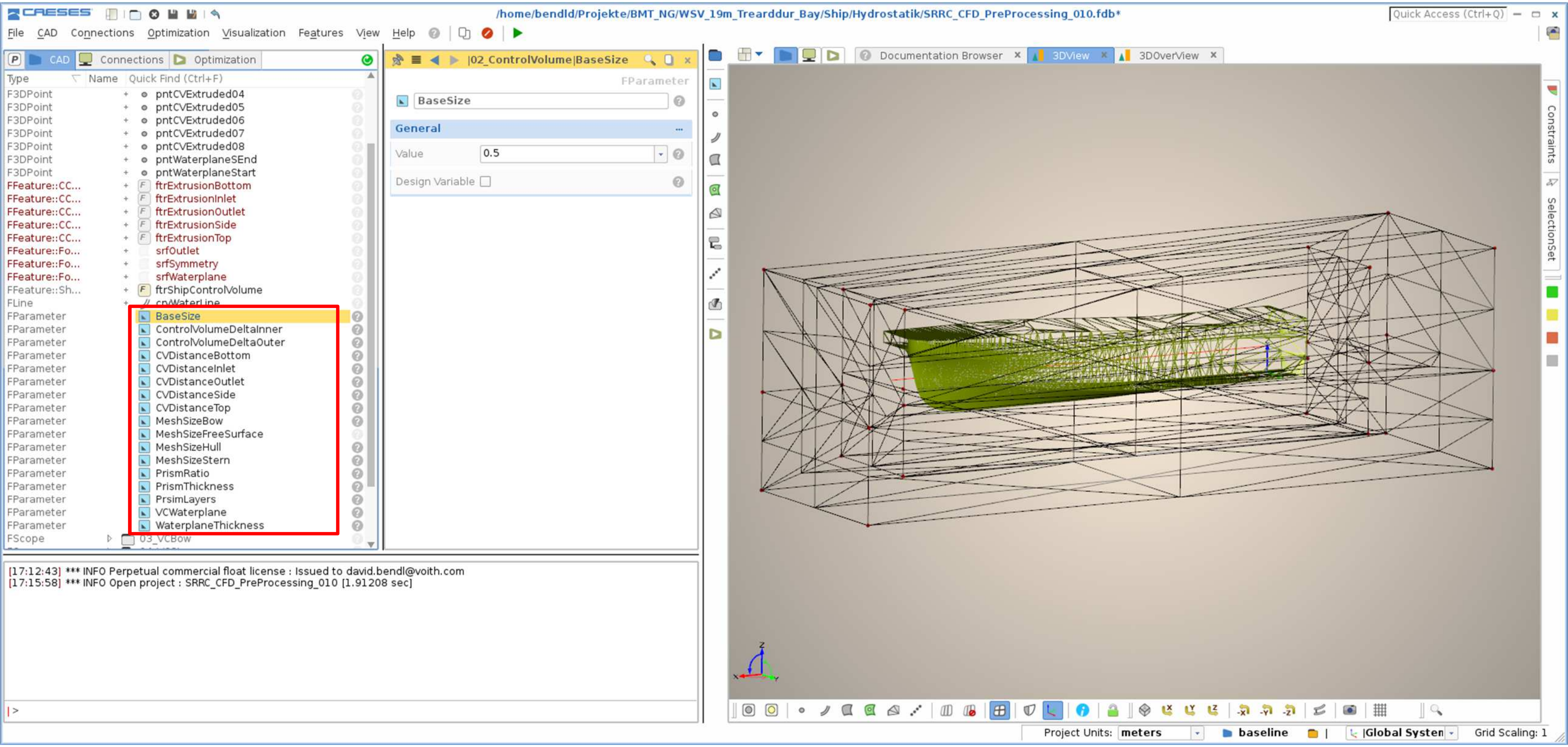
CAESES
/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
Quick Access (Ctrl+Q)
File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
F3DPoint pntCVExtruded04
F3DPoint pntCVExtruded05
F3DPoint pntCVExtruded06
F3DPoint pntCVExtruded07
F3DPoint pntCVExtruded08
F3DPoint pntWaterplaneSEnd
F3DPoint pntWaterplaneStart
FFeature::CC... ftrExtrusionBottom
FFeature::CC... ftrExtrusionInlet
FFeature::CC... ftrExtrusionOutlet
FFeature::CC... ftrExtrusionSide
FFeature::CC... ftrExtrusionTop
FFeature::Fo... srfOutlet
FFeature::Fo... srfSymmetry
FFeature::Fo... srfWaterplane
FFeature::Sh... ftrShipControlVolume
FLine crvWaterLine
FParameter BaseSize
FParameter ControlVolumeDeltaInner
FParameter ControlVolumeDeltaOuter
FParameter CVDistanceBottom
FParameter CVDistanceInlet
FParameter CVDistanceOutlet
FParameter CVDistanceSide
FParameter CVDistanceTop
FParameter MeshSizeBow
FParameter MeshSizeFreeSurface
FParameter MeshSizeHull
FParameter MeshSizeStern
FParameter PrismRatio
FParameter PrismThickness
FParameter PrsimLayers
FParameter VCWaterplane
FParameter WaterplaneThickness
FScope 03_VCBow
|02_ControlVolume|BaseSize
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Documentation Browser
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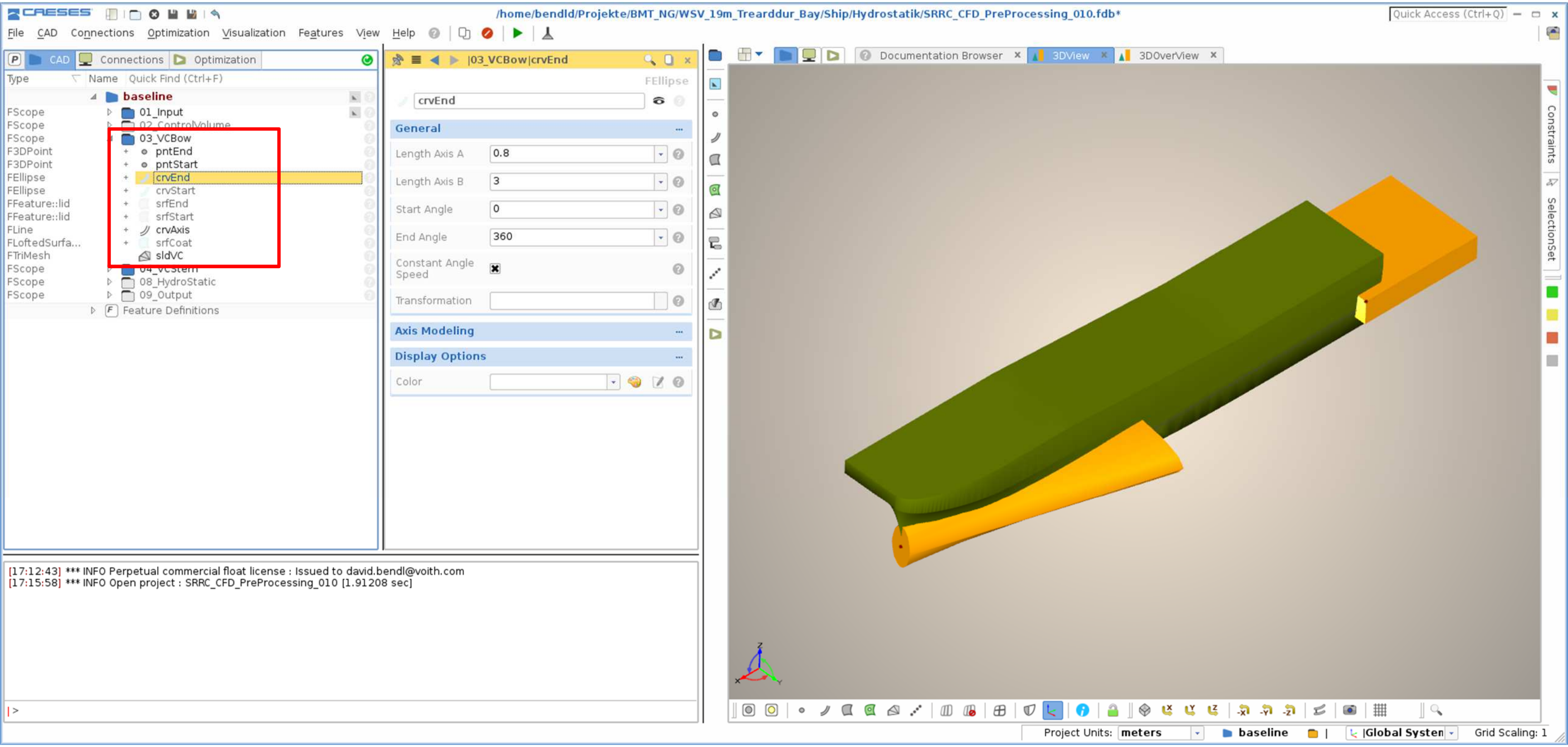
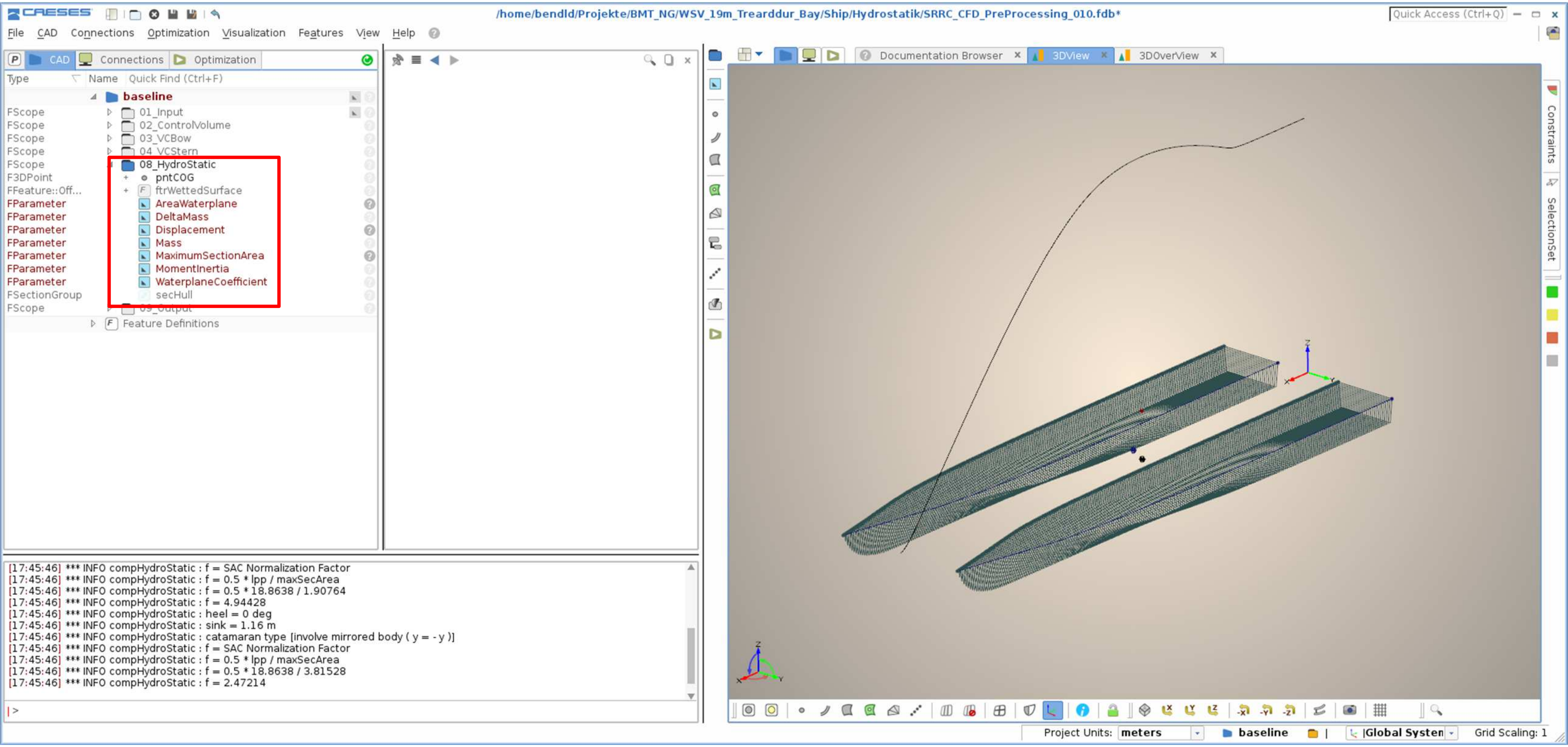
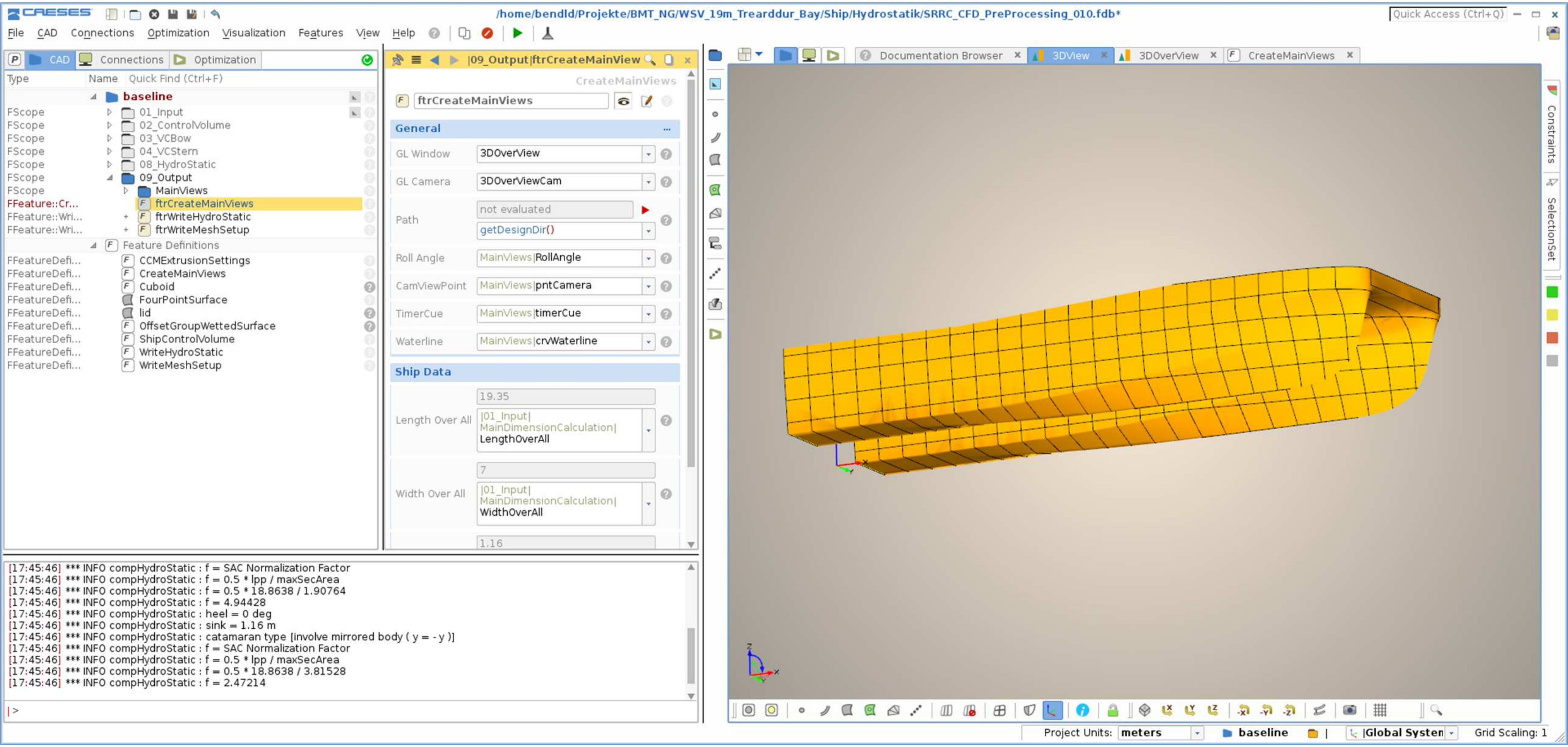
Global System
Grid Scaling: 1

VOITH


CAESES
/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
Quick Access (Ctrl+Q)
File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
baseline
FScope 01_Input
FScope 02_ControlVolume
FScope 03_VCBow
F3DPoint pntEnd
F3DPoint pntStart
FEllipse crvEnd
FEllipse crvStart
FFeature::lid srfEnd
FFeature::lid srfStart
FLine crvAxis
FLoftedSurfa... srfCoat
FTriMesh sldVC
FScope 04_VCStern
FScope 08_HydroStatic
FScope 09_Output
Feature Definitions
|03_VCBow|crvEnd
FEllipse
crvEnd
General
Length Axis A 0.8
Length Axis B 3
Start Angle 0
End Angle 360
Constant Angle Speed
Transformation
Axis Modeling
Display Options
Color
Documentation Browser 3DView 3DOverView
Constraints
SelectionSet
[17:12:43] *** INFO Perpetual commercial float license : Issued to david.bendl@voith.com
[17:15:58] *** INFO Open project : SRRC_CFD_PreProcessing_010 [1.91208 sec]
Project Units: meters baseline |Global System Grid Scaling: 1


/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
baseline
01_Input
02_ControlVolume
03_VCBow
04_VCStern
08_HydroStatic
pntCOG
ftrWettedSurface
AreaWaterplane
DeltaMass
Displacement
Mass
MaximumSectionArea
MomentInertia
WaterplaneCoefficient
secHull
Feature Definitions
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
[17:45:46] *** INFO compHydroStatic : f = 0.5 * 18.8638 / 1.90764
[17:45:46] *** INFO compHydroStatic : f = 4.94428
[17:45:46] *** INFO compHydroStatic : heel = 0 deg
[17:45:46] *** INFO compHydroStatic : sink = 1.16 m
[17:45:46] *** INFO compHydroStatic : catamaran type [involve mirrored body (y = - y)]
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
[17:45:46] *** INFO compHydroStatic : f = 0.5 * 18.8638 / 3.81528
[17:45:46] *** INFO compHydroStatic : f = 2.47214
Documentation Browser
3DView
3DOverView
Project Units: meters
baseline
Global System
Grid Scaling: 1

VOITH



/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
Quick Access (Ctrl+Q)
File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
baseline
FScope 01_Input
FScope 02_ControlVolume
FScope 03_VCBow
FScope 04_VCStern
FScope 08_HydroStatic
FScope 09_Output
FScope MainViews
FFeature::Cr... ftrCreateMainViews
FFeature::Wri... ftrWriteHydroStatic
FFeature::Wri... ftrWriteMeshSetup
Feature Definitions
FFeatureDefi... CCMExtrusionSettings
FFeatureDefi... CreateMainViews
FFeatureDefi... Cuboid
FFeatureDefi... FourPointSurface
FFeatureDefi... lid
FFeatureDefi... OffsetGroupWettedSurface
FFeatureDefi... ShipControlVolume
FFeatureDefi... WriteHydroStatic
FFeatureDefi... WriteMeshSetup
|09_Output|ftrCreateMainView
CreateMainViews
ftrCreateMainViews
General
GL Window 3DOverView
GL Camera 3DOverViewCam
Path not evaluated
getDesignDir()
Roll Angle MainViews|RollAngle
CamViewPoint MainViews|pntCamera
TimerCue MainViews|timerCue
Waterline MainViews|crvWaterline
Ship Data
Length Over All 19.35
|01_Input|MainDimensionCalculation|LengthOverAll
Width Over All 7
|01_Input|MainDimensionCalculation|WidthOverAll
1.16
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
[17:45:46] *** INFO compHydroStatic : f = 0.5 * 18.8638 / 1.90764
[17:45:46] *** INFO compHydroStatic : f = 4.94428
[17:45:46] *** INFO compHydroStatic : heel = 0 deg
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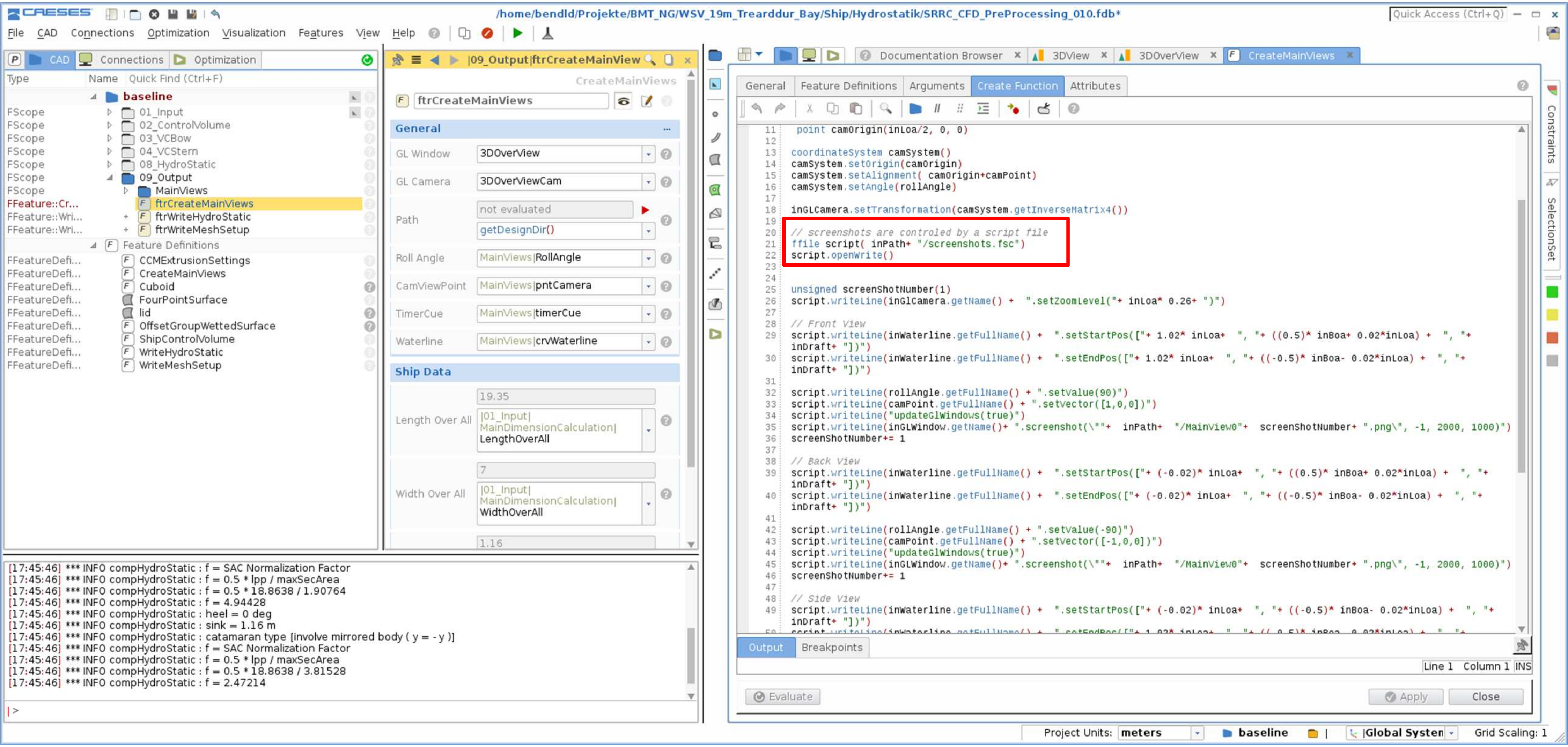
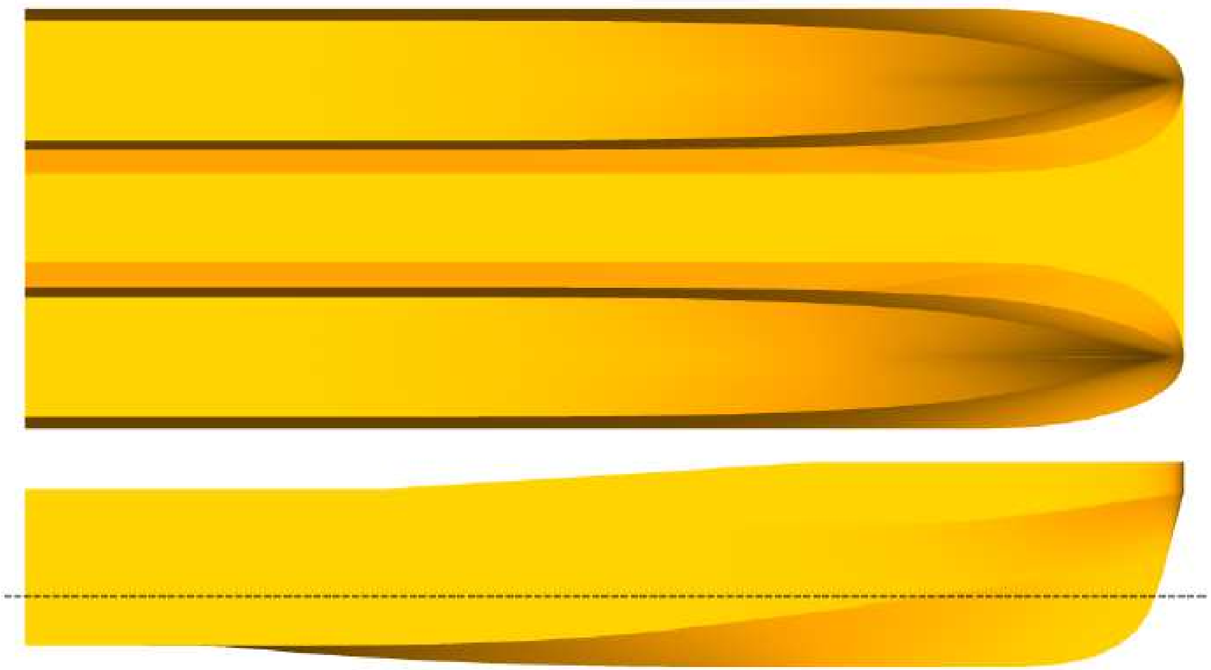
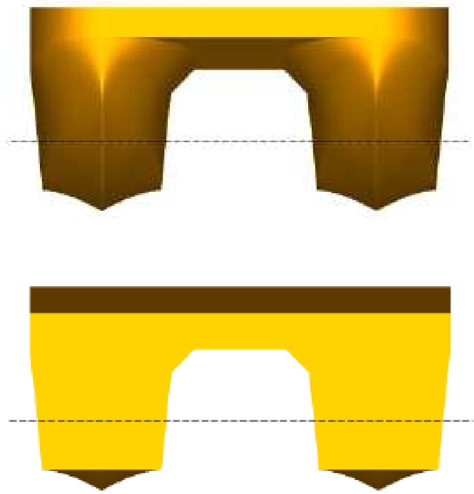
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
[17:45:46] *** INFO compHydroStatic : f = 0.5 * 18.8638 / 3.81528
[17:45:46] *** INFO compHydroStatic : f = 2.47214
Documentation Browser 3DView 3DOverView CreateMainViews
Constraints
SelectionSet
Project Units: meters
baseline
|Global System
Grid Scaling: 1

VOITH


/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
File CAD Connections Optimization Visualization Features View Help
|09_Output|ftrCreateMainView
ftrCreateMainViews
General
GL Window 3DOverView
GL Camera 3DOverViewCam
Path getDesignDir()
Roll Angle MainViews|RollAngle
CamViewPoint MainViews|pntCamera
TimerCue MainViews|timerCue
Waterline MainViews|crvWaterline
Ship Data
Length Over All 19.35
Width Over All 7
Documentation Browser 3DView 3DOverView CreateMainViews
General Feature Definitions Arguments Create Function Attributes
// screenshots are controled by a script file
ffile script(inPath+ "/screenshots.fsc")
script.openWrite()
unsigned screenShotNumber(1)
// Front View
// Back View
// Side View
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : heel = 0 deg
[17:45:46] *** INFO compHydroStatic : sink = 1.16 m
Evaluate Apply Close
Project Units: meters baseline Global System Grid Scaling: 1

Main Views





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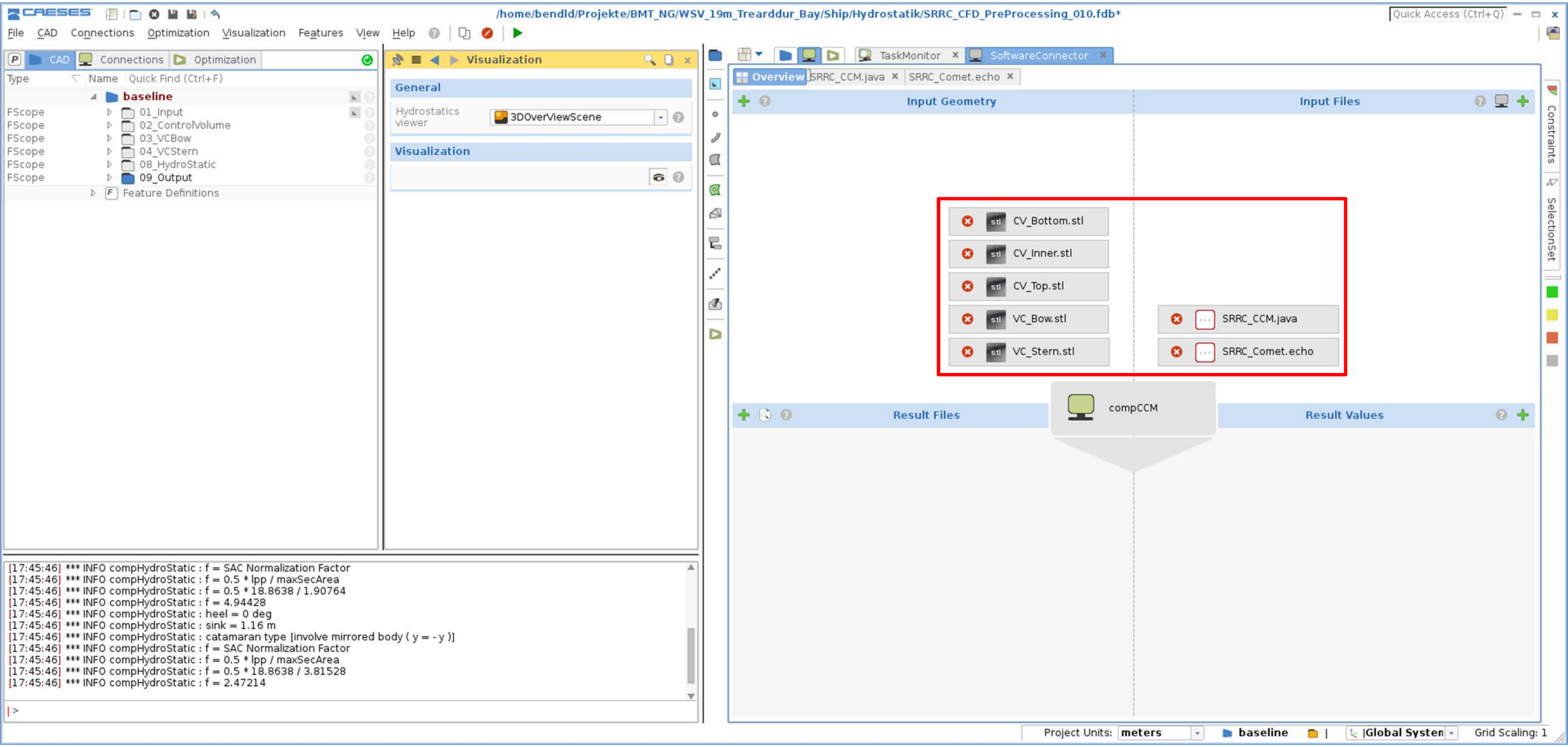
/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
Quick Access (Ctrl+Q)
File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
baseline
FScope 01_Input
FScope 02_ControlVolume
FScope 03_VCBow
FScope 04_VCStern
FScope 08_HydroStatic
FScope 09_Output
Feature Definitions
Visualization
General
Hydrostatics viewer 3DOverViewScene
Visualization
TaskMonitor
SoftwareConnector
Overview SRRC_CCM.java SRRC_Comet.echo
Input Geometry
Input Files
CV_Bottom.stl
CV_Inner.stl
CV_Top.stl
VC_Bow.stl
VC_Stern.stl
SRRC_CCM.java
SRRC_Comet.echo
compCCM
Result Files
Result Values
Constraints
SelectionSet
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
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[17:45:46] *** INFO compHydroStatic : heel = 0 deg
[17:45:46] *** INFO compHydroStatic : sink = 1.16 m
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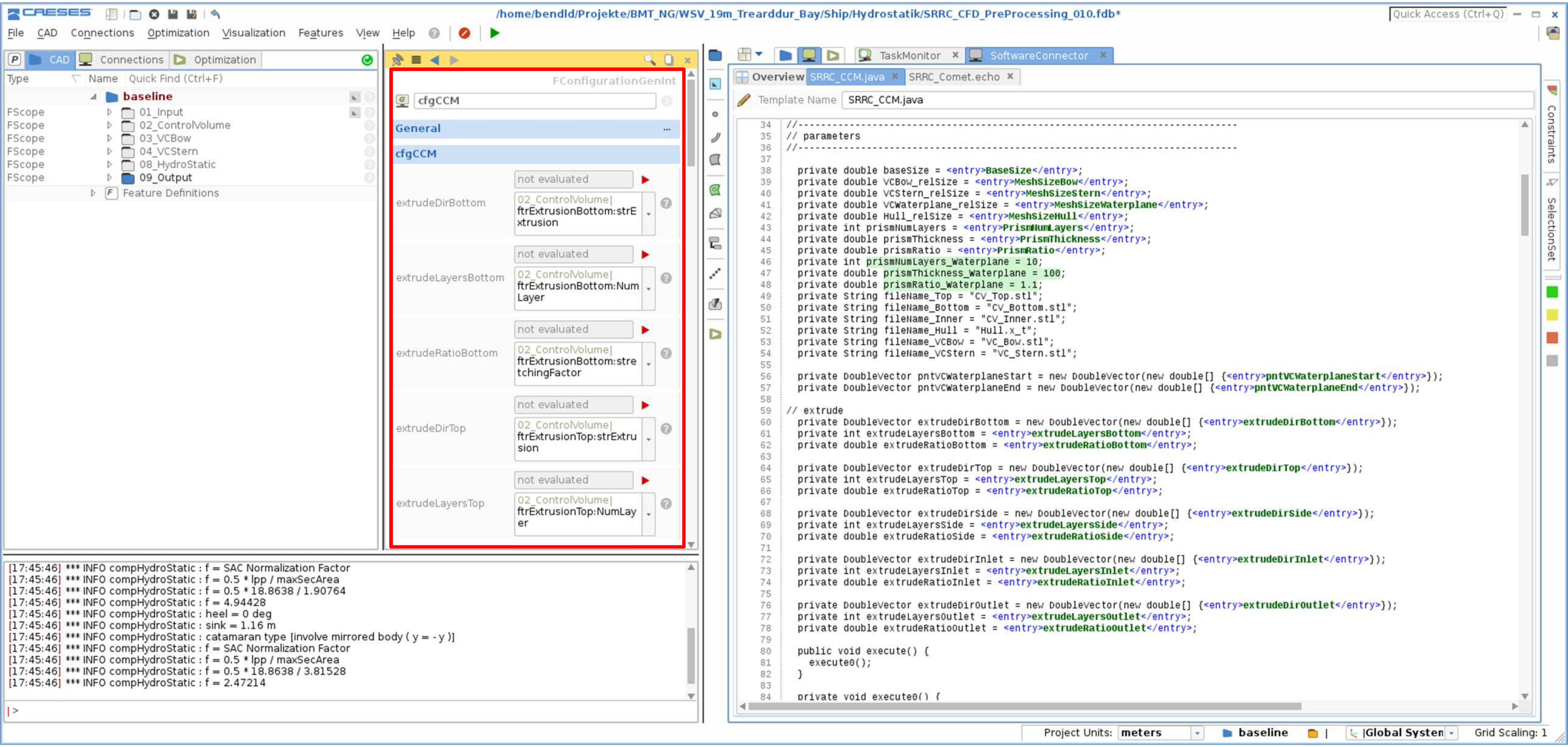
[17:45:46] *** INFO compHydroStatic : f = 2.47214
Project Units: meters
baseline
Global System
Grid Scaling: 1

VOITH



/home/bendld/Projekte/BMT_NG/WSV_19m_Trearddur_Bay/Ship/Hydrostatik/SRRC_CFD_PreProcessing_010.fdb*
Quick Access (Ctrl+Q)
File CAD Connections Optimization Visualization Features View Help
CAD Connections Optimization
Type Name Quick Find (Ctrl+F)
baseline
FScope 01_Input
FScope 02_ControlVolume
FScope 03_VCBow
FScope 04_VCStern
FScope 08_HydroStatic
FScope 09_Output
Feature Definitions
FConfigurationGenInt
cfgCCM
General
cfgCCM
extrudeDirBottom
not evaluated
02_ControlVolume|
ftrExtrusionBottom:strExtrusion
extrudeLayersBottom
not evaluated
02_ControlVolume|
ftrExtrusionBottom:NumLayer
extrudeRatioBottom
not evaluated
02_ControlVolume|
ftrExtrusionBottom:stretchingFactor
extrudeDirTop
not evaluated
02_ControlVolume|
ftrExtrusionTop:strExtrusion
extrudeLayersTop
not evaluated
02_ControlVolume|
ftrExtrusionTop:NumLayer
[17:45:46] *** INFO compHydroStatic : f = SAC Normalization Factor
[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
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[17:45:46] *** INFO compHydroStatic : f = 0.5 * lpp / maxSecArea
[17:45:46] *** INFO compHydroStatic : f = 0.5 * 18.8638 / 3.81528
[17:45:46] *** INFO compHydroStatic : f = 2.47214
TaskMonitor SoftwareConnector
Overview SRRC_CCM.java SRRC_Comet.echo
Template Name SRRC_CCM.java
//--
// parameters
//--
private double baseSize = <entry>BaseSize</entry>;
private double VCBow_relSize = <entry>MeshSizeBow</entry>;
private double VCStern_relSize = <entry>MeshSizeStern</entry>;
private double VCWaterplane_relSize = <entry>MeshSizeWaterplane</entry>;
private double Hull_relSize = <entry>MeshSizeHull</entry>;
private int prismNumLayers = <entry>PrismNumLayers</entry>;
private double prismThickness = <entry>PrismThickness</entry>;
private double prismRatio = <entry>PrismRatio</entry>;
private int prismNumLayers_Waterplane = 10;
private double prismThickness_Waterplane = 100;
private double prismRatio_Waterplane = 1.1;
private String fileName_Top = "CV_Top.stl";
private String fileName_Bottom = "CV_Bottom.stl";
private String fileName_Inner = "CV_Inner.stl";
private String fileName_Hull = "Hull.x_t";
private String fileName_VCBow = "VC_Bow.stl";
private String fileName_VCStern = "VC_Stern.stl";
private DoubleVector pntVCWaterplaneStart = new DoubleVector(new double[] {<entry>pntVCWaterplaneStart</entry>});
private DoubleVector pntVCWaterplaneEnd = new DoubleVector(new double[] {<entry>pntVCWaterplaneEnd</entry>});
// extrude
private DoubleVector extrudeDirBottom = new DoubleVector(new double[] {<entry>extrudeDirBottom</entry>});
private int extrudeLayersBottom = <entry>extrudeLayersBottom</entry>;
private double extrudeRatioBottom = <entry>extrudeRatioBottom</entry>;
private DoubleVector extrudeDirTop = new DoubleVector(new double[] {<entry>extrudeDirTop</entry>});
private int extrudeLayersTop = <entry>extrudeLayersTop</entry>;
private double extrudeRatioTop = <entry>extrudeRatioTop</entry>;
private DoubleVector extrudeDirSide = new DoubleVector(new double[] {<entry>extrudeDirSide</entry>});
private int extrudeLayersSide = <entry>extrudeLayersSide</entry>;
private double extrudeRatioSide = <entry>extrudeRatioSide</entry>;
private DoubleVector extrudeDirInlet = new DoubleVector(new double[] {<entry>extrudeDirInlet</entry>});
private int extrudeLayersInlet = <entry>extrudeLayersInlet</entry>;
private double extrudeRatioInlet = <entry>extrudeRatioInlet</entry>;
private DoubleVector extrudeDirOutlet = new DoubleVector(new double[] {<entry>extrudeDirOutlet</entry>});
private int extrudeLayersOutlet = <entry>extrudeLayersOutlet</entry>;
private double extrudeRatioOutlet = <entry>extrudeRatioOutlet</entry>;
public void execute() {
execute0();
}
private void execute0() {
Constraints
SelectionSet
Project Units: meters
baseline
Global System
Grid Scaling: 1

Finished Report Example

VOITH

Voith Turbo

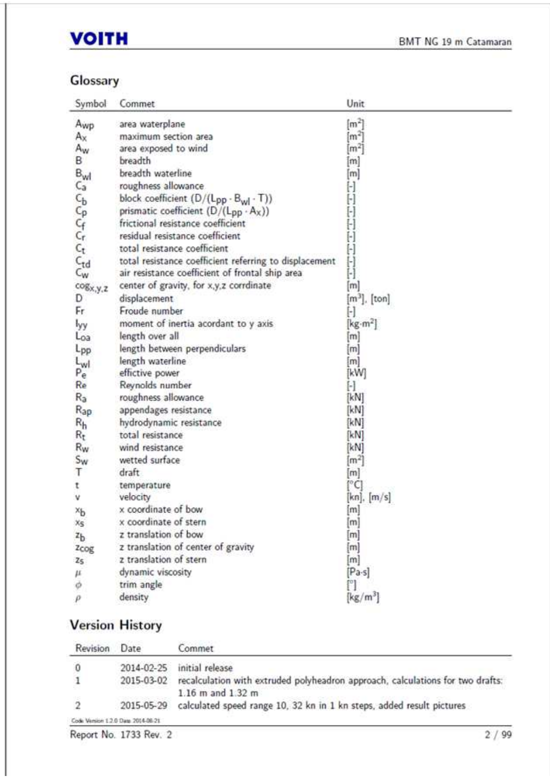
Voith Turbo Schneider Propulsion GmbH & Co. KG
Alexanderstr. 18
89522 Heidenheim

Report No. 1733 Rev. 2

BMT NG 19 m Catamaran

Resistance Calculations

	Created	Verified	Approved
Name	David Bendl	Michael Palm	Dr. Dirk Jürgens
Date	2015-05-29	[illegible]	2015-06-23
Signature			



VOITH — BMT NG 19 m Catamaran

Glossary

Symbol	Commet	Unit
A_{wp}	area waterplane	$[m^2]$
A_x	maximum section area	$[m^2]$
A_w	area exposed to wind	$[m^2]$
B	breadth	[m]
B_{wl}	breadth waterline	[m]
C_a	roughness allowance	[-]
C_b	block coefficient $(D/(L_{pp} \cdot B_{wl} \cdot T))$	[-]
C_p	prismatic coefficient $(D/(L_{pp} \cdot A_x))$	[-]
C_f	frictional resistance coefficient	[-]
C_r	residual resistance coefficient	[-]
C_t	total resistance coefficient	[-]
C_{td}	total resistance coefficient referring to displacement	[-]
C_w	air resistance coefficient of frontal ship area	[-]
$cog_{x,y,z}$	center of gravity, for x,y,z corrdinate	[m]
D	displacement	$[m^3]$, [ton]
Fr	Froude number	[-]
I_{yy}	moment of inertia acordant to y axis	$[kg \cdot m^2]$
L_{oa}	length over all	[m]
L_{pp}	length between perpendiculars	[m]
L_{wl}	length waterline	[m]
P_e	effictive power	[kW]
Re	Reynolds number	[-]
R_a	roughness allowance	[kN]
R_{ap}	appendages resistance	[kN]
R_h	hydrodynamic resistance	[kN]
R_t	total resistance	[kN]
R_w	wind resistance	[kN]
S_w	wetted surface	$[m^2]$
T	draft	[m]
t	temperature	[°C]
v	velocity	[kn], [m/s]
x_b	x coordinate of bow	[m]
x_s	x coordinate of stern	[m]
z_b	z translation of bow	[m]
z_{cog}	z translation of center of gravity	[m]
z_s	z translation of stern	[m]
μ	dynamic viscosity	$[Pa \cdot s]$
ϕ	trim angle	[°]
ρ	density	$[kg/m^3]$

Version History

Revision	Date	Commet
0	2014-02-25	initial release
1	2015-03-02	recalculation with extruded polyheadron approach, calculations for two drafts: 1.16 m and 1.32 m
2	2015-05-29	calculated speed range 10, 32 kn in 1 kn steps, added result pictures

Code Version 1.2.0 Date 2014-08-21

Report No. 1733 Rev. 2 — 2 / 99

Conclusion

1. great tool – many possibilities (design studies, optimization and even different tasks)
2. excellent support – fast response on questions and also implementation of new features
3. main work horse – all our standard calculation are run through CAESES

VOITH

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for Generations