

# STRUKTURMECHANISCHE AUSLEGUNG

Wie kommt Computational Structural Mechanics (CSM) in den Vorentwurf?



- Kurzvorstellung DLR-BT
- Strukturmechanisches GTlab-Modul (SMM)
  - Ausgangssituation, Ziele
  - Funktionsweise, Demos
  - Modul-Designentscheidungen
- Ausblick
  
- Fragen gerne jederzeit

# Institut für Bauweisen und Strukturtechnologie (BT) Abteilung Bauteilgestaltung und Fertigungstechnologie (BGF)

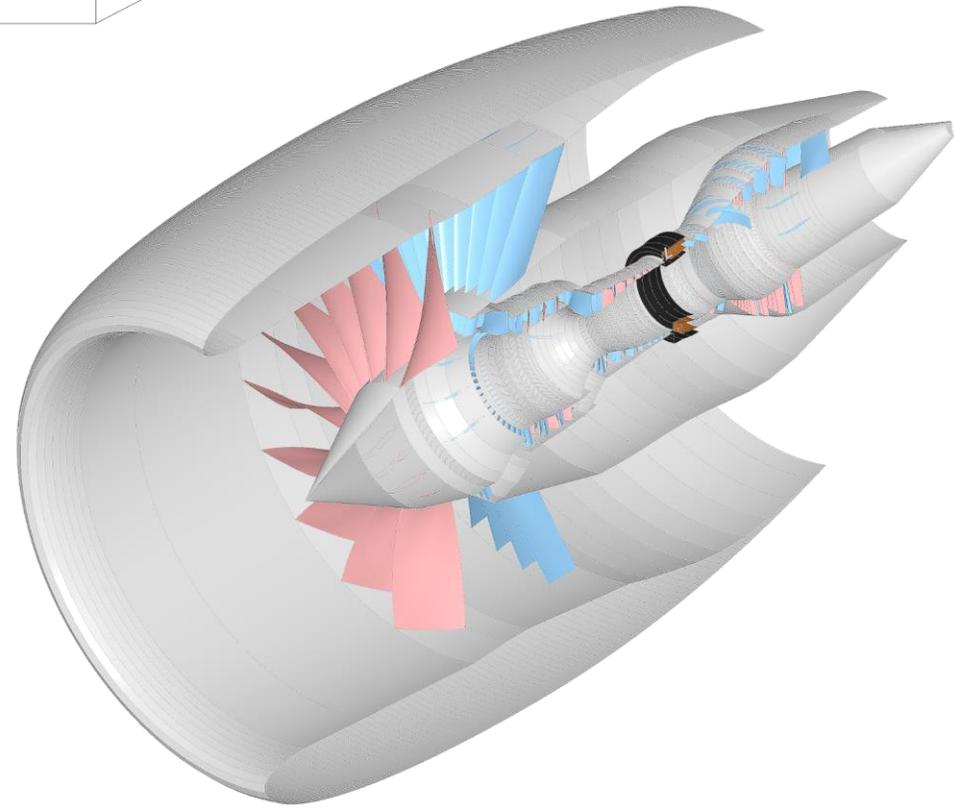
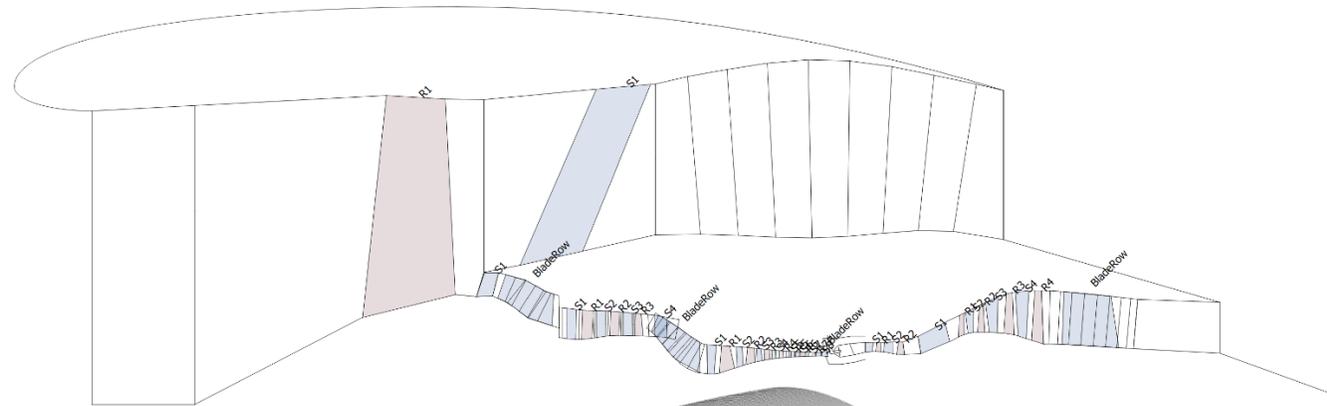


- Fachgruppe „Strukturen für Luftfahrtantriebe“
- Entwicklung von CSM-Methoden zur Auslegung und Bewertung
- Multidisziplinäre Auslegung und Optimierung von Komponenten
- Entwicklung von Bauweisen und Herstellverfahren für hochbelastete Strukturen in allen Bereichen der Luftfahrtantriebe, inklusive der Fertigung dieser Strukturen selbst



# Ausgangssituation

- GTlab-Performance
  - Drehzahlen
  - Temperaturen
- GTlab-PreDesign
  - Erste Schaufelgeometrie (BladeGen, 3D, ADP)
  - Bauraum
- Scheibe?
  - Annahme: Blisk
- Statische Integrität?



# Strukturmechanisches Modul (SMM)



- Ziele
  - Automatisierung wo sinnvoll und machbar
  - Dezentrale Strukturmechanik, direkt bei den Bedarfsträgern
- Dadurch mehr Kapazität für Innovation

# SMM – Prozesse



- Radialspalt, Fillet

File Edit Tools Window Help Dev

Explorer

- ADAPT-TF\_demo
  - Performance
  - PreDesign
    - Schedules
    - Parameterization
    - ADAPT-TF
      - FAN
      - ITD
      - ICD2
      - ICD1
      - BURNER
      - CORENOZZLE
      - TEC
      - NACELLE
      - BYPASSDUCT
      - BOOSTER**
      - HPC
      - HPT
      - LPT
    - Meshes
  - Materials
- ADAPT-Git-TF
- ADAPT-Git-TP

3D Pre Design Plot - BOOSTER

FPS: 52.9 (7.6)  
Rendered: (imm.)  
Triangles: 156.5k(1.3k)

Processes/Calculators

demo

Run Add...

Geometry Details

- Tip Clearance
- Add Fillet

Properties

**BOOSTER - GtdCompressor**

Property	Unit	Val
Main		
Volume	[m <sup>3</sup> ]	0
Mass	[kg]	0
inertiaX	[kg*m <sup>2</sup> ]	0
Center of Gravity		
cogX	[m]	0

Export DAE STP Load Step M M STP Export Step Fit To View Axo

# SMM – Prozesse



- Radialspalt, Fillet
- Blattnetz
- Drucklasten
- Scheibendesign

The screenshot displays a CAD application window titled "3D Pre Design Plot - BOOSTER". The interface includes a menu bar (File, Edit, Tools, Window, Help, Dev), a toolbar with icons for home, assembly, folder, save, and undo, and a search bar. The Explorer panel on the left shows a hierarchical tree structure:

- > FAN
- > ITD
- > ICD2
- > ICD1
- > BURNER
- > CORENOZZLE
- > TEC
- > NACELLE
- > BYPASSDUCT
- ▼ BOOSTER
  - Stage Definition
  - ▼ Blades
    - > S1
    - > R1
    - > S2
    - > R2
    - > S3
    - > R3
    - > S4
  - > Downstream Sta
  - > Compressor Dat
- > HPC
- > HPT

The main 3D view shows a detailed model of a compressor stage with blue blades and a grey casing. A coordinate system (X, Y, Z) is visible at the bottom left. The Processes/Calculators panel on the right shows a list of tasks:

- demo
- ▶ Run 'Standard Task' + Add...
- ▼ Geometry Details ✓
  - Tip Clearance ✓
  - Add Fillet ✓
- ▼ Standard Task
  - Blade mesher
  - Mapper
  - Disk geome...

The Properties panel for the selected "Standard Task - GtTask" shows the following table:

Property	Unit	Value
▼ Execution		
Skip		<input type="checkbox"/> false
Process Runner		<< selec...

The bottom status bar includes options for "Export DAE", "STP Load Step", "M", "M", "STP Export Step", "Fit To View", "Axo", and "Properties".

# SMM – Prozesse



- Radialspalt, Fillet
- Blattnetz
- Drucklasten
- Scheibendesign
- Scheibennetz

The screenshot shows a CAD application window with the following components:

- Menu Bar:** File, Edit, Tools, Window, Help, Dev
- Toolbar:** Home, Add, Folder, Save Project (highlighted), Undo
- Explorer Panel:**
  - ADAPT-TF\_demo
    - Performance
    - PreDesign
    - IntelliGraphs
    - Meshes
      - D:/GTlab\_projects/AD
        - Found Meshes
          - BLADE
            - Nhub
            - Ntip** (selected)
            - Nhubedge
            - Nle
            - Nps
            - Nss
            - Nsurface
            - Nte
            - NtipLE
            - NtipTE
            - Ntipchord
            - Ntipedge
            - SFtip
            - SFhub
            - SFps

- 3D View:** Displays a blue mesh of a curved blade tip. The window title is "3D Pre Design Plot - BOOSTER".
- Processes/Calculators Panel:**
- demo
  - Run
  - Add...
  - Standard Task
    - Blade mes... (checked)
    - Mapper (checked)
    - Disk geo... (checked)
    - Disk mesh... (disabled)
    - Hot-to-Co... (disabled)
    - CalculiX F... (disabled)
- Search: (Ctrl+F)
- Properties
- Ntip - gtmesh::VmapMeshGeometrySet**
- Property | Unit | Value
- Filepath
  - File Path of Hdf file | D:/G...
- Path in Hdf file
  - Path in Hdf file | VMA...
- Search: (Ctrl+F)
- Properties | HDF5 Object Properties

# SMM – Prozesse



- Radialspalt, Fillet
- Blattnetz
- Drucklasten
- Scheibendesign
- Scheibennetz
- Hot-to-Cold Blatt

File Edit Tools Window Help Dev

Explorer

- ADAPT-TF\_demo
  - Performance
  - PreDesign
  - IntelliGraphs
  - Meshes
    - D:/GTlab\_projects/ADAP
      - Found Meshes
        - BLADE
        - DISK
      - Meshes Data Variable
  - H5 HDF5 Module
  - Materials

3D Pre Design Plot - BOOSTER Meshes

Mesh Viewer

Processes/Calculators

demo

Run Add...

- Standard Task
  - Blade mes...
  - Mapper
  - Disk geom...
  - Disk mesh...
  - Hot-to-Co...
  - CalculiX F...

Q (Ctrl+F)

Properties

DISK - gtmesh::VmapMeshObject

Property	Unit	Value
Filepath		
File Path of Hdf file		D:/G...
Path in Hdf file		
Path in Hdf file		VMA...

Q (Ctrl+F)

Properties HDF5 Object Properties

# SMM – Prozesse



- Radialspalt, Fillet
- Blattnetz
- Drucklasten
- Scheibendesign
- Scheibennetz
- Hot-to-Cold Blatt
- Offdesign Statik

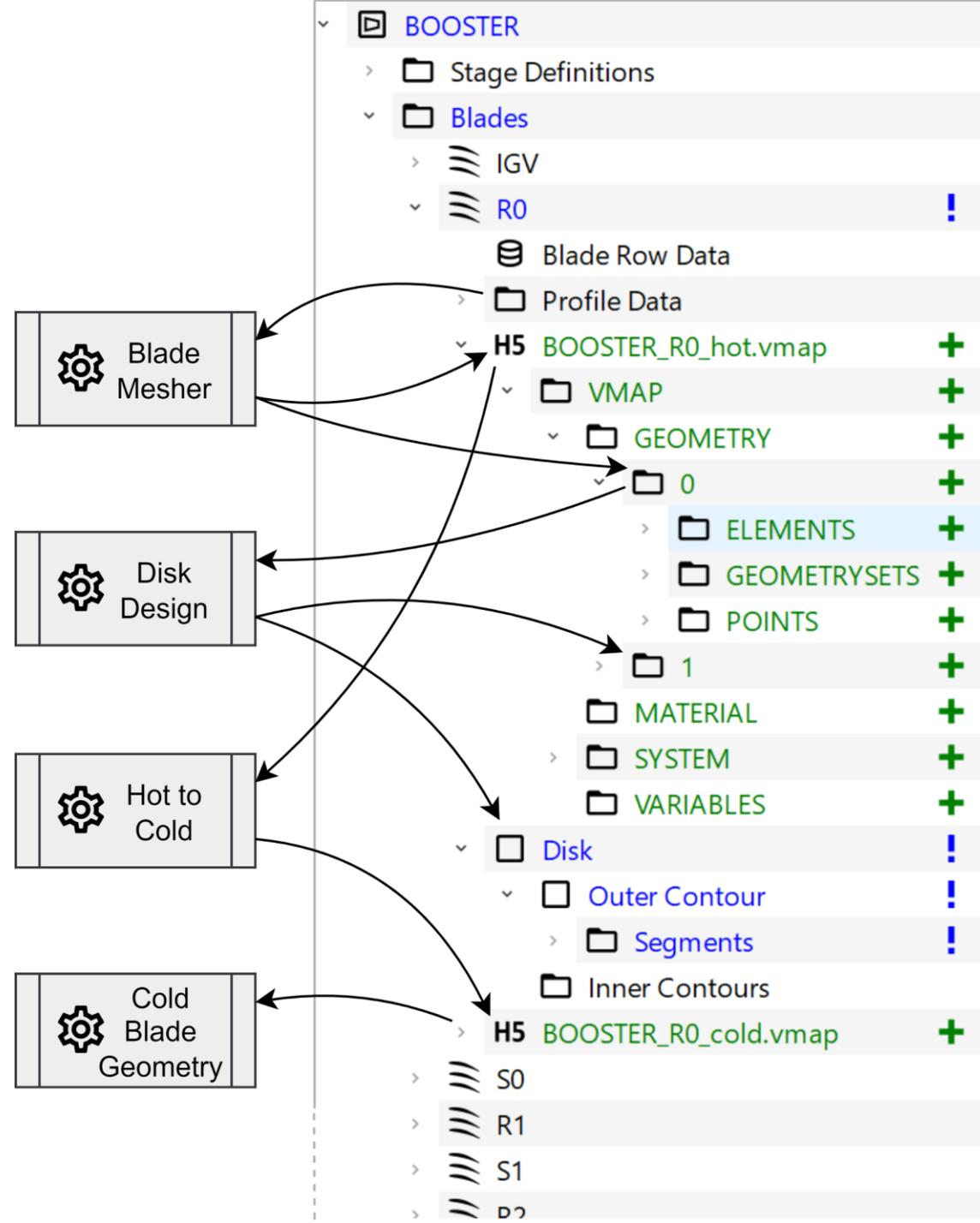
The screenshot displays a CAD software interface with a 3D mesh of a blade in the center. The interface includes a menu bar (File, Edit, Tools, Window, Help, Dev), a toolbar with icons for home, cube, folder, save, and undo, and a search bar. The Explorer panel on the left shows a project structure for 'ADAPT-TF\_demo' with folders for Performance, PreDesign, IntelliGraphs, Meshes, and Materials. The Meshes folder is expanded, showing 'D:/GTlab\_projects/ADAP' with sub-folders 'Found Meshes' (containing 'BLADE' and 'DISK') and 'Meshes Data Variable'. The 3D Pre Design Plot - BOOSTER window shows the mesh. The Processes/Calculators panel on the right lists several tasks: Standard Task, Blade mes..., Mapper, Disk geom..., Disk mesh..., Hot-to-C..., and CalculiX F... The Properties panel for 'BLADE - gtmesh::VmapMeshObject' shows a table of properties:

Property	Unit	Value
Filepath		
File Path of Hdf file		D:/G...
Path in Hdf file		
Path in Hdf file		VMA...

- Radialspalt, Fillet
- Blattnetz
- Drucklasten
- Scheibendesign
- Scheibennetz
- Hot-to-Cold Blatt
- Offdesign Statik
- Aeroelastik-Export, FOD-Export, ...
- Campbell-Diagramme, MAC, ...

# SMM – Daten

- SMM liest und modifiziert parametrische und numerische Daten
- Parametrisch: Pre-Design
  - Fillets
  - Scheiben
- Numerisch: HDF5
  - [www.vmap-standard.org](http://www.vmap-standard.org)



- *„Automatisierung wo sinnvoll und machbar“*
- Kein eigenes Datenmodell
- Vorlagenbasierte Workflows
  - Anwendungsfälle
  - Robustheit, UX
- Modularität vs. Integration
- Tools: Wiederverwendung vs. Neuimplementierung
  - Standard Open Source
- End-to-End Testing
- Deployment über G2Lab Maintenance Tool
- *„Dezentrale Strukturmechanik, direkt bei den Bedarfsträgern“*

- Details zum SMM-Design: NAFEMS World Congress 2025
- Weitere Funktionalitäten: Post-Processing, Turbine, FSI, ...
- LLM-Interface: Letzter Vortrag morgen „ChatGTlab“
- Fragen? Live-Demo?

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