Innovation durch Integration im Flugzeugbau

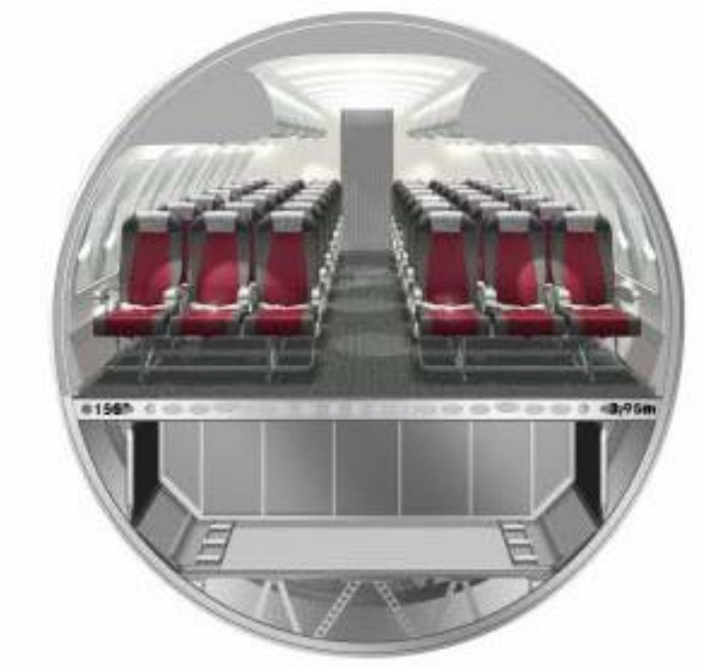
Wolfgang Machunze; Airbus Group Innovations

3. Fachkongress Composite Simulation

Motivation
Zonal Clustering of System-Installations

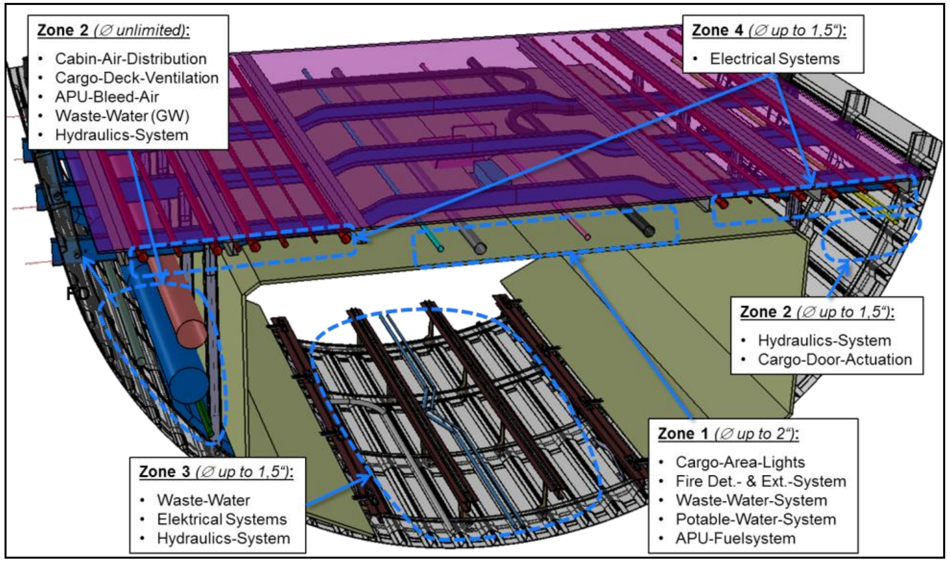
Current situation on A320:

- Systems above crossbeam
- Separation/segregation of systems to satisfy requirements only
- Part-by-part assembly and integration of PAX-floor and most systems

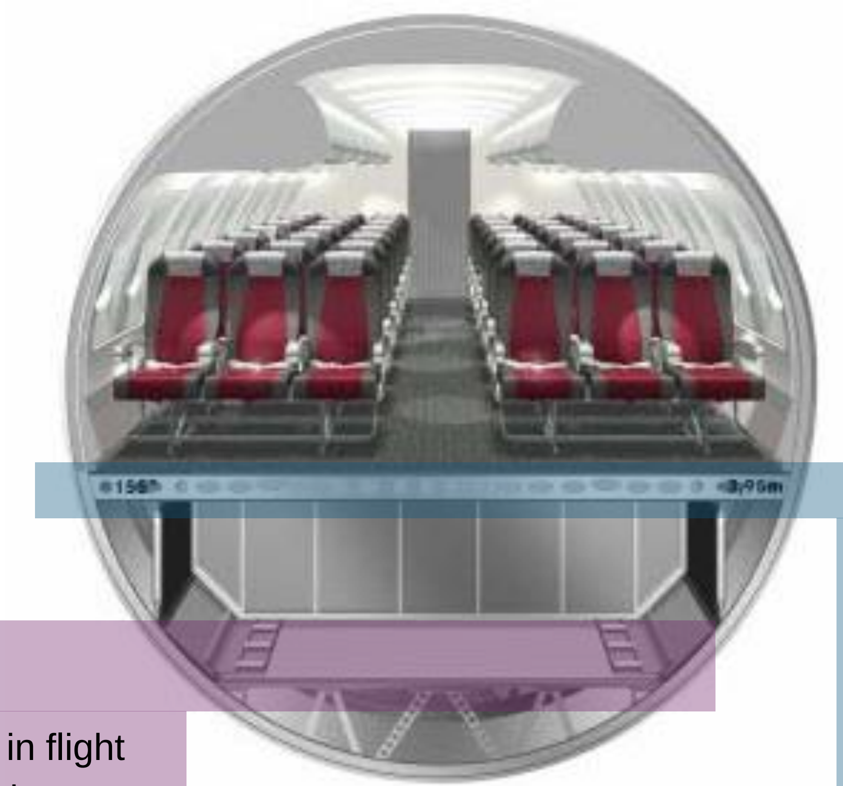


Demand for next generation S/A:

- Improved access for maintenance & assembly
- Decreased complexity for system routings
- Modular integration philosophy
- Improved system technologies
- Separation of Systems in Zones / Segregation of Systems



Motivation
Deduced influencing parameters and structural solution



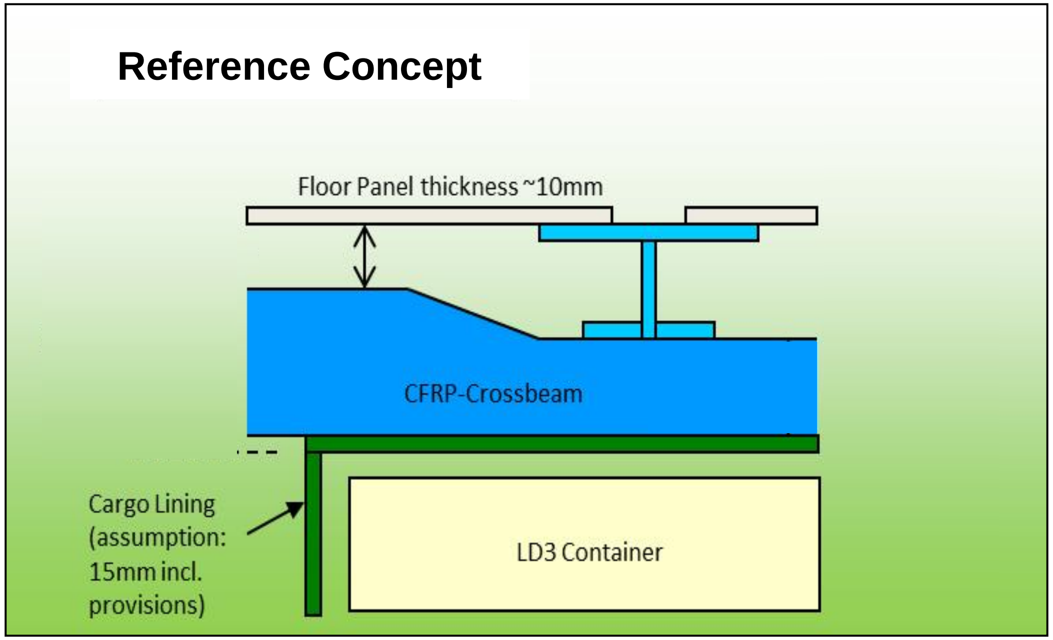
Pax Floor area

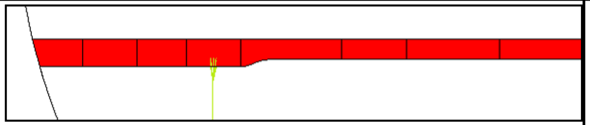
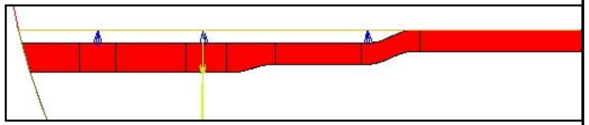
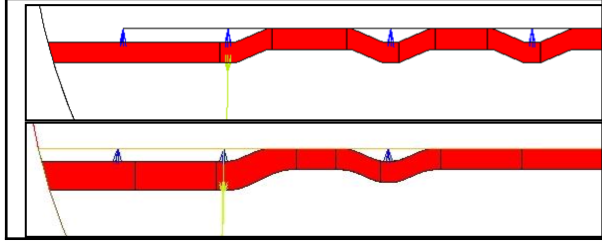
1. Enable optimal system integration design for cross beam → floor height reduction with **CCB**
2. Enable drill free **modular assembly of pre-equipped PAX floor** with tolerance management

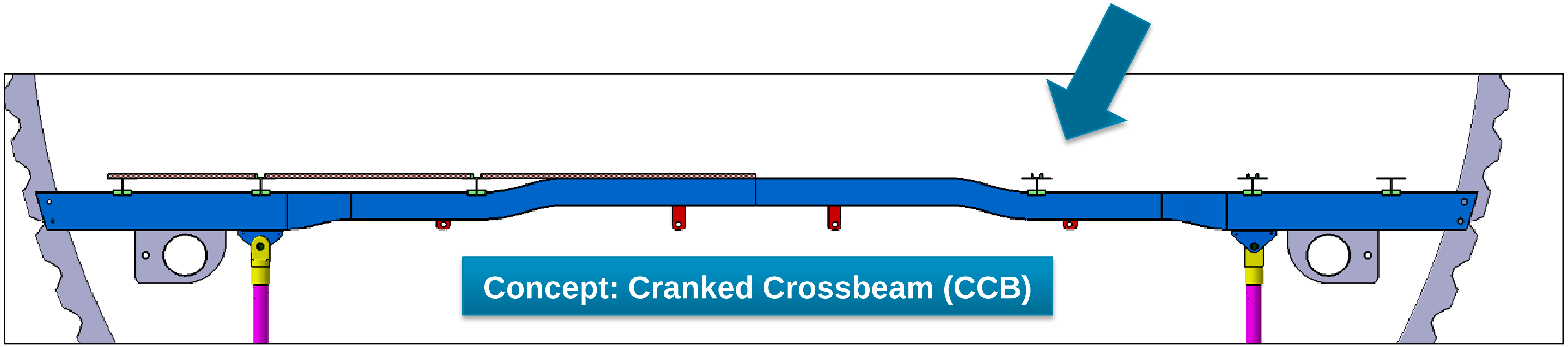
Cargo Floor area

3. Simplify installation of systems in flight direction → no cross beam within new **Cargo floor concepts →** system access via cargo deck
4. Crash performance without cross beam → **Tension absorber within cargo floor area**

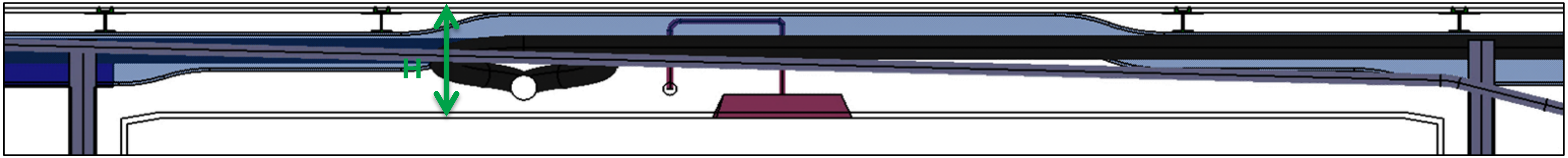
1. Crank cross beam
Multi-disziplinary architecture for zonal clustering within PAX-Floor



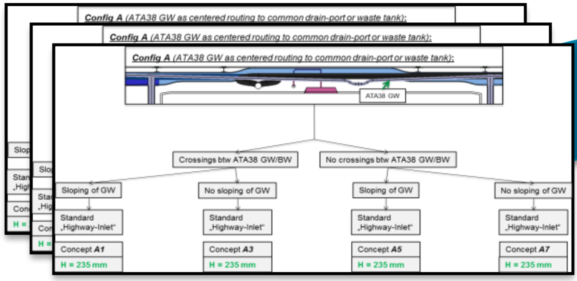
AG-Innovations Concepts	Weight
	100%
	103,8%
	111,3%



1. Crank cross beam
Pax floor height study - Summary

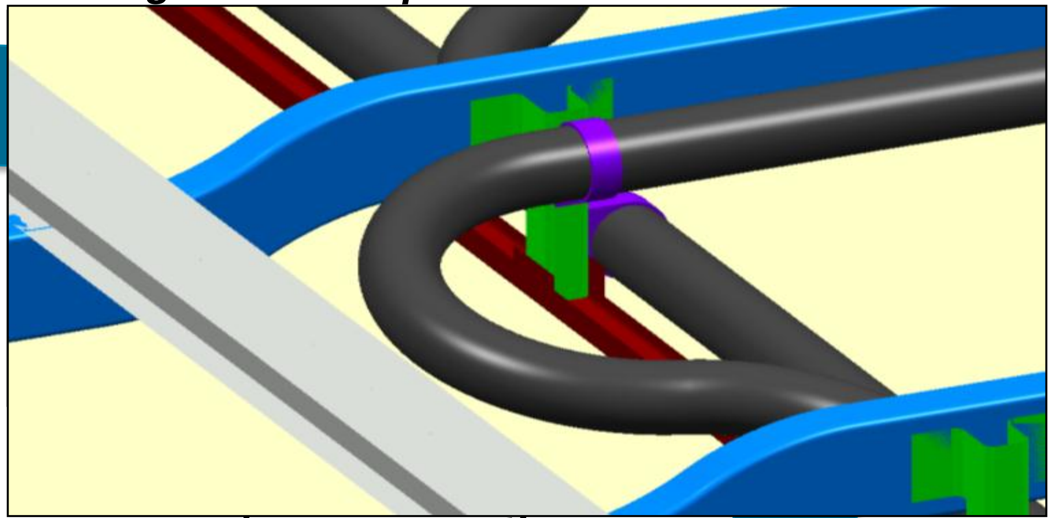


3 Initial Configuration:

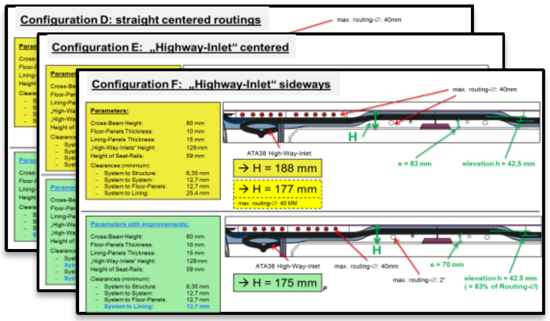


H = 235 mm

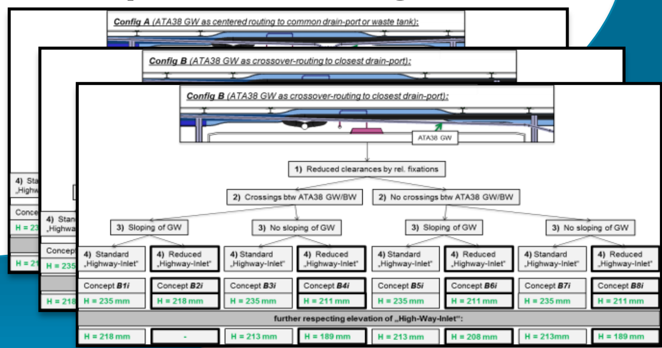
Recognition of Improvement-Potential:



New Configuration:



H = 164 mm – 189 mm



H = 189 mm – 218 mm

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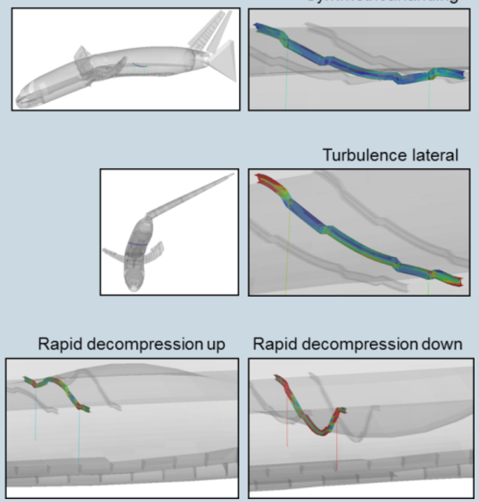
1. Crank cross beam
Verification by manufacturing and testing

Numerical sizing

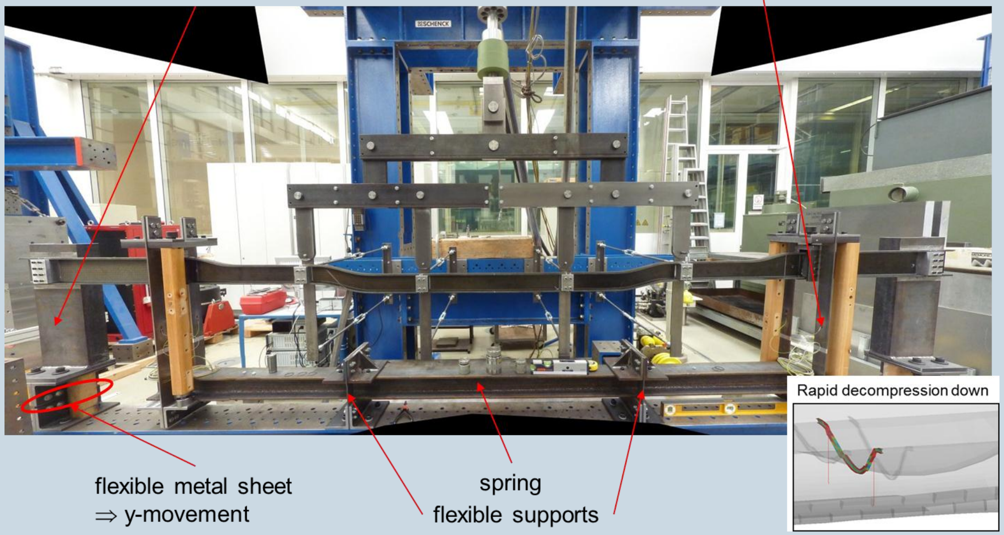
- 8 load cases considered within sizing process for cross beam structure

Design mainly driven by bending loads

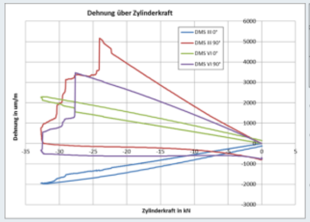
- Ground Loads
  - ➢ Symmetrical landing case
- Gust Loads
  - ➢ Continuous turbulences lateral
- Failure Loads
  - ➢ Rapid decompression up
  - ➢ Rapid decompression down
- Double inner pressure – tension loads



Static testing for full scale cross beam



- CFRP C-cross beam manufactured by braiding, winding and UD plies
- Test of most critical scenario: Rapid decompression
- Good correlation between numerical results and testing
- Sizing with linear solver Optistruct
- Consideration of thickness and angle deviations due to UD-braiding within numerical simulation



	Span position [mm]	Already applied DMS	Additional DMS on left CCB-side
DMS 3	530	• Web • Inside Z1	• -
DMS 6	580	• -	• Web • Inside Z1

- Critical area within cranked area of CCB
- DMS applied in mayor loading direction within cranked area
- Slight deviations between test and simulation

DMS #	Span position [mm]	Position	Strain [um/m] **Test**: 32.5 kN	Strain [um/m] *1 **FEM**: 32.5 kN	Deviation [%]
III 0°	530 Elem 20658153	Z1 - inside	-1943	-2134	9.8
III 90°	530 Elem 20658153	Z1 - inside	4333 (21.82 kN) Failure 21.82 kN	3578 (21.82 kN)	-17.4
VI 0°	580 Elem 20659707	Z1 - inside	2290	2470	7.8
VI 90°	580 Elem 20659707	Z1 - inside	3440 (27.3 kN) Failure 27.3 kN	3101 (27.3 kN)	-9.0

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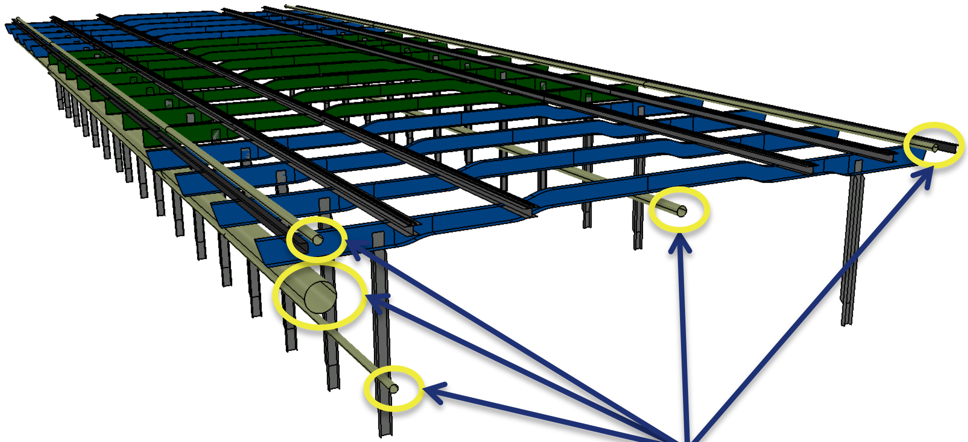
2. Modular assembly of system pre-equipped PAX floor Architectures

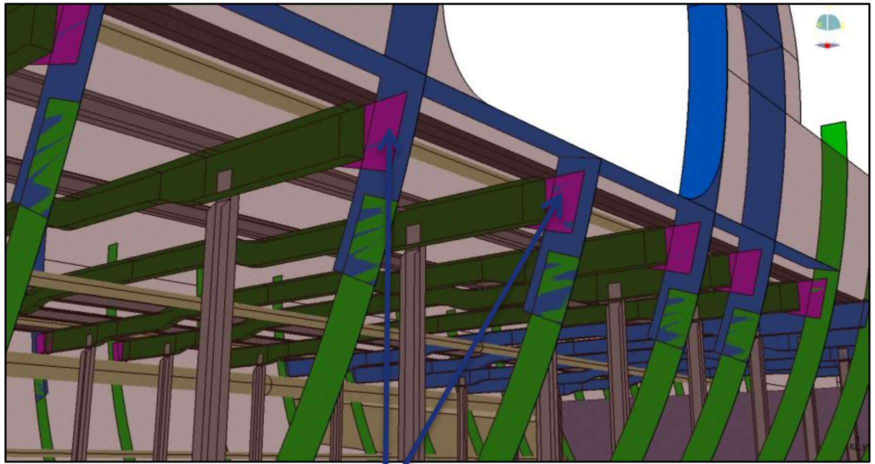
Objective:	Assumptions:	Expected Results:
• Dust-free, tolerance-compensating assembly of pre-equipped PAX-floor grid as a modular component	• Fuselage assembly as a „baguette“ • Integration of floor grid in aft-fuselage	• Appropriate Built-Concepts • Proof of feasibility • Results about interface-sensitivity • Quantities about interface tolerances

Floor Grid Module:



Bagging of system-interfaces required

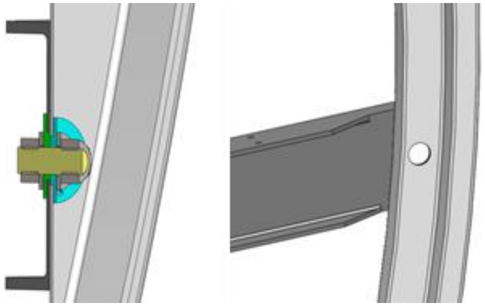
Interconnections at DSS:

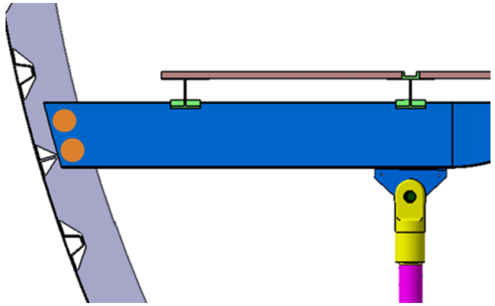


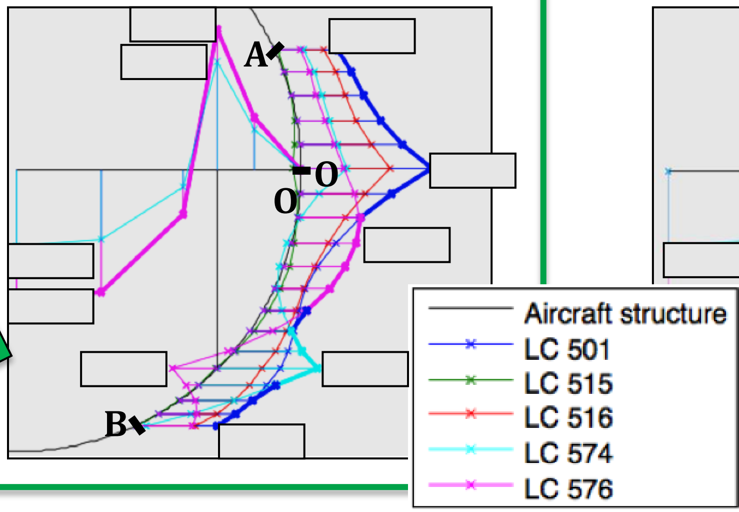
Couplings required (pre-drilled DSS & coupling)

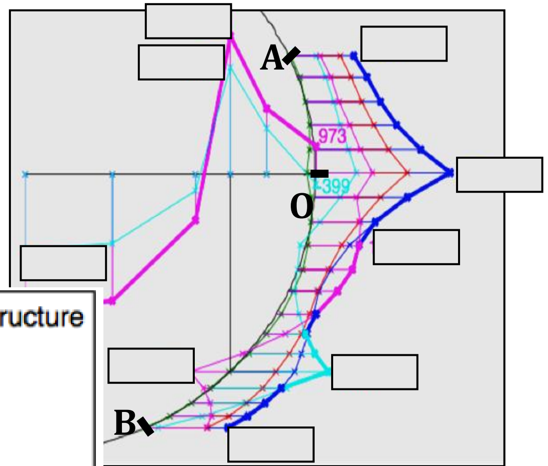
2. Modular assembly of system pre-equipped PAX floor Concepts

Today	Concepts	
Riveted Connection Moment Fixed	Single bolted Moment Free	Double bolted Moment Fixed



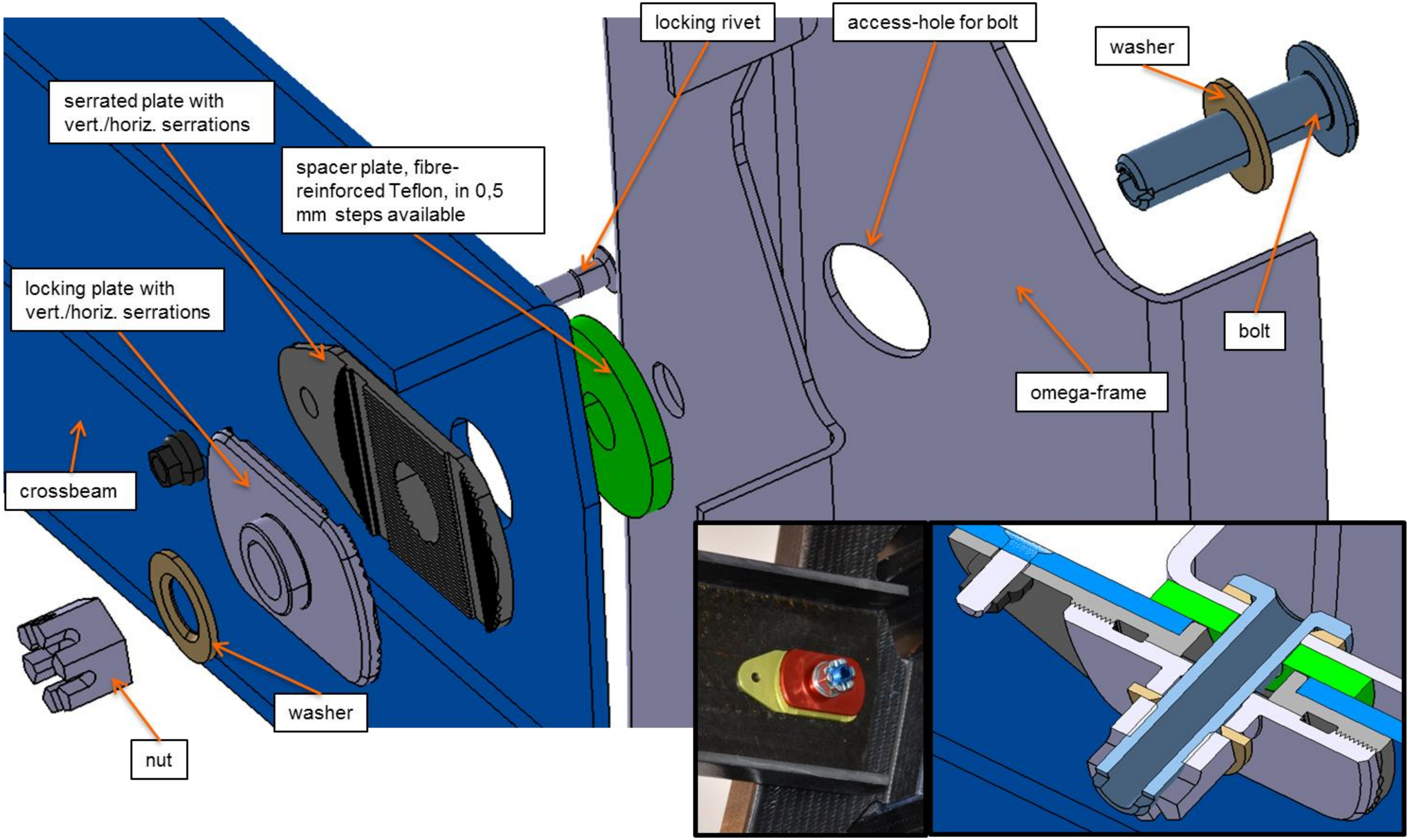






Weight saving potential

2. Modular assembly of system pre-equipped PAX floor
Detailed design for “Serrated plates concept”



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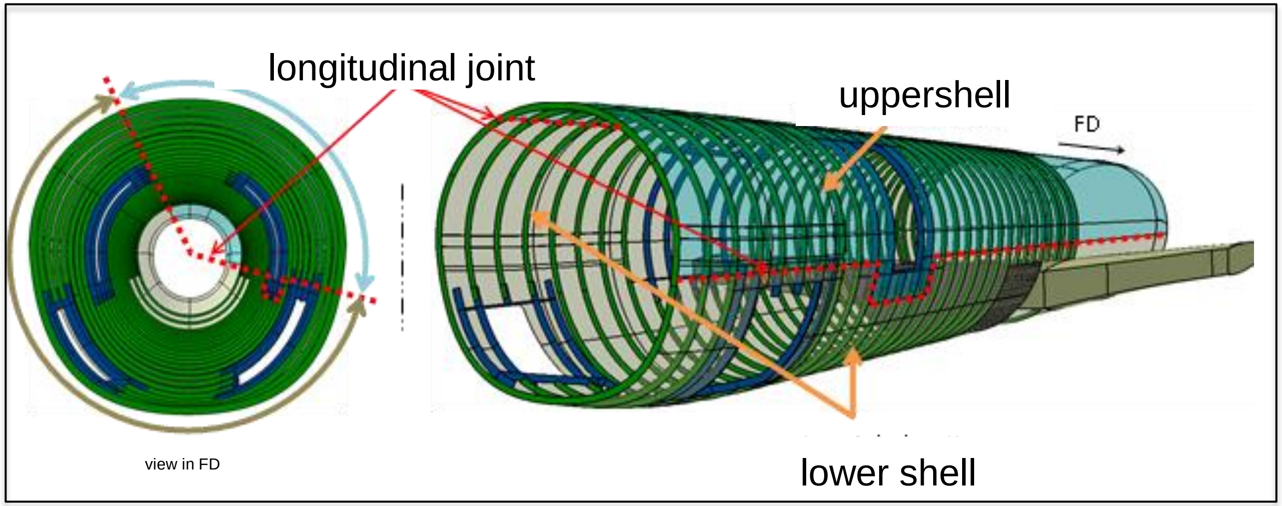
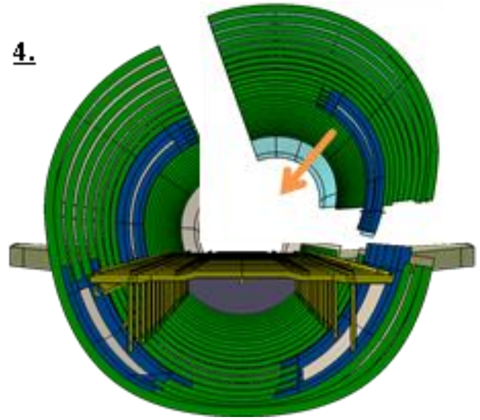
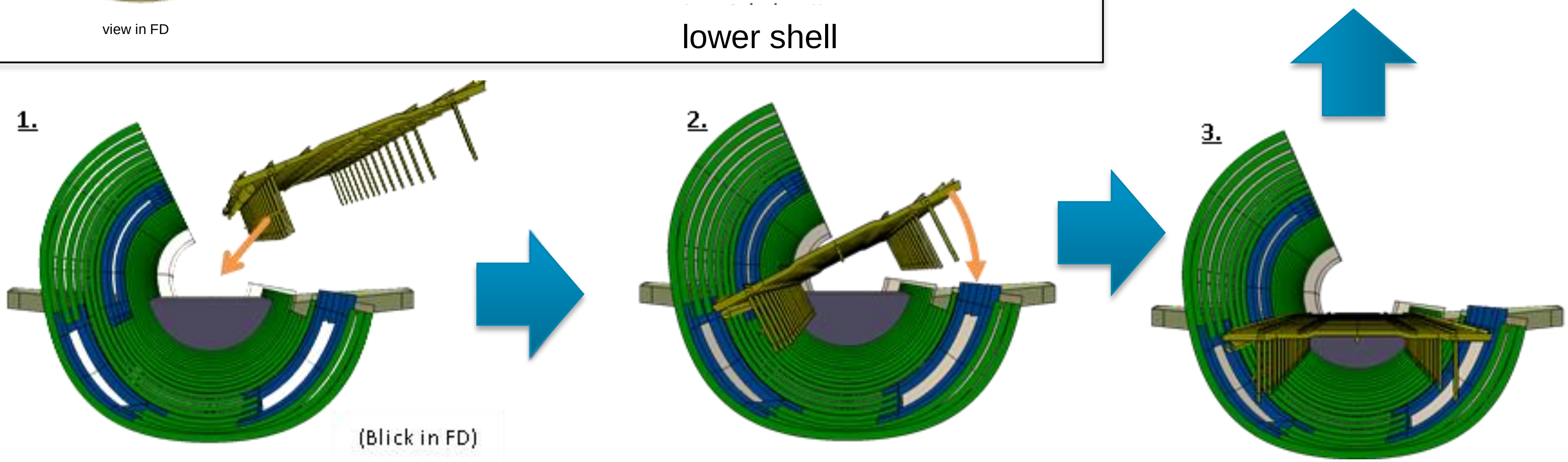
2. Modular assembly of system pre-equipped PAX floor
Built concepts

„Diagonal Ditched Baguette“

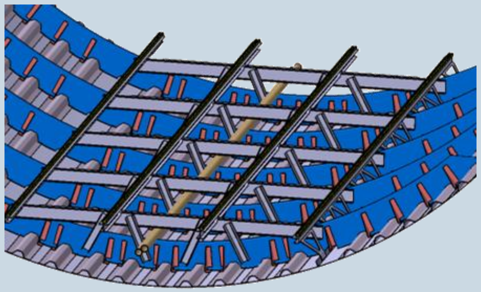
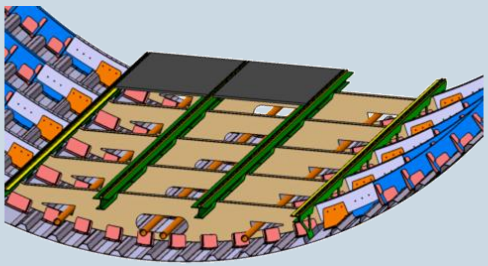
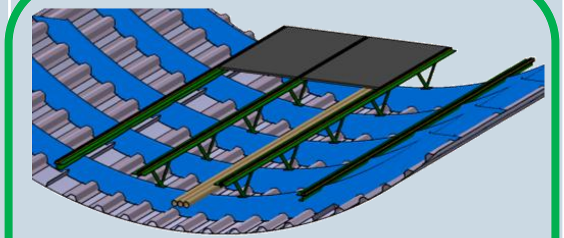
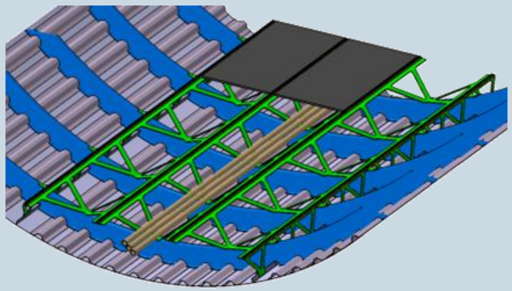






3. Cargo floor structure for system integration
Concept study

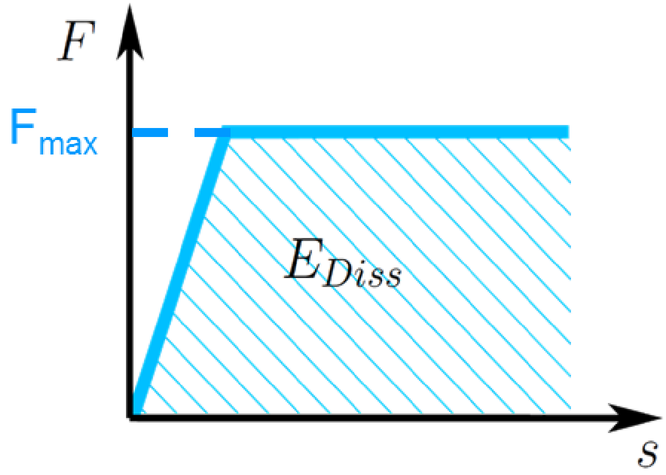
- Several cargo floor concepts are developed with the help of diverse optimisation techniques
- Four final concepts (and one reference concept) are investigated in detail, including
  - Sizing
  - Design
  - First assembly & system integration concepts

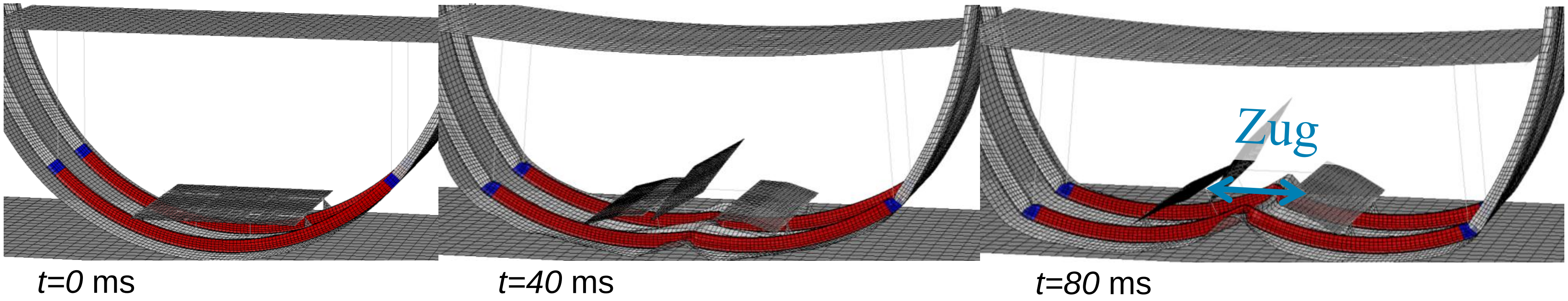
Reference	**C1 cross-rib**	**C2 longitudinal beam** **baseline / advanced**	**C5 corrugated sheet**
			
100 %	129 %	85 % / 90 %	97 %

Crash behavior of cargo floor without cross beam

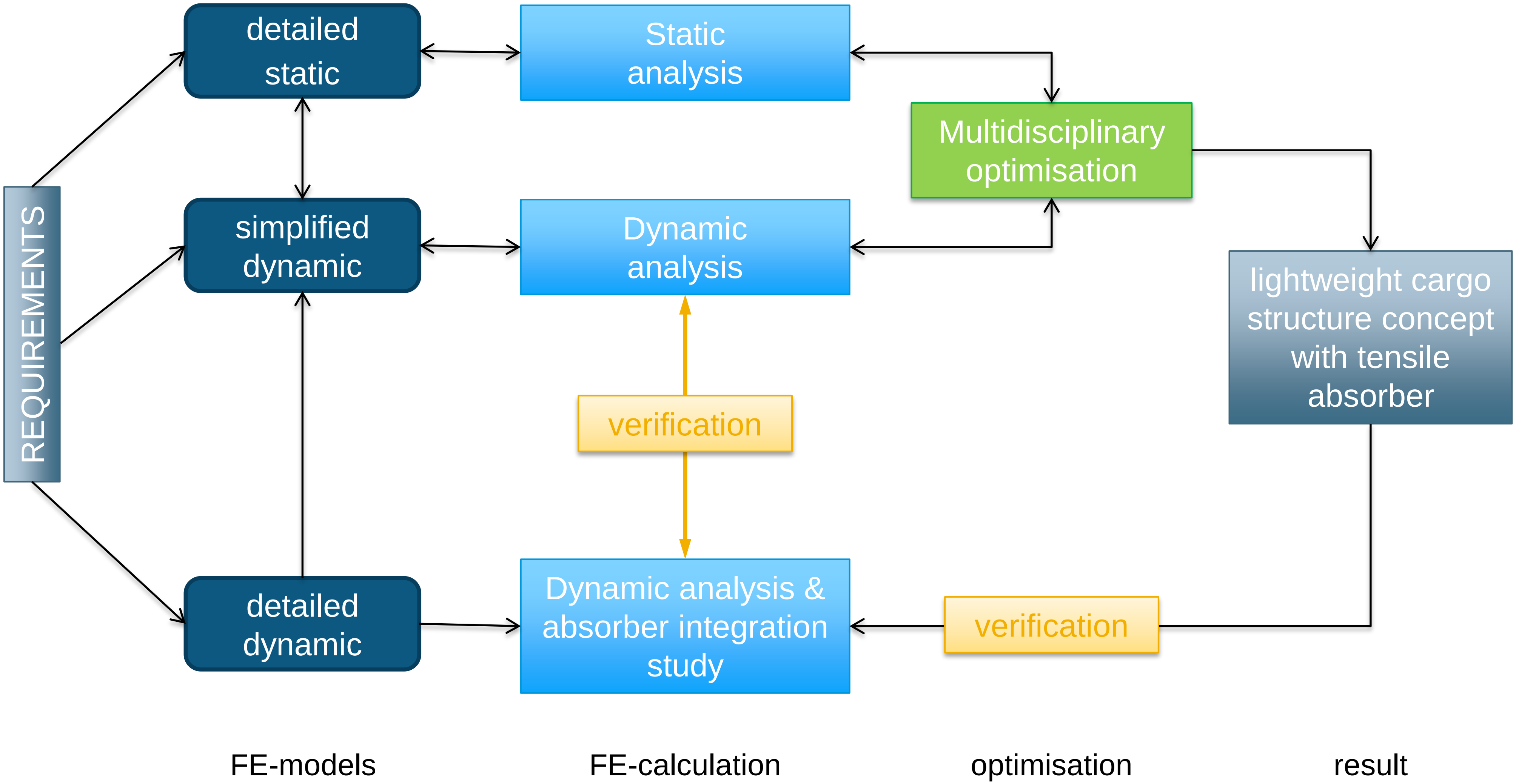
4. Tension energy absorber within cargo floor
Crash behavior

- Omitting of cross beam in cargo floor
- Tension on in cargo floor level
- Integration of tensile absorber below cargo floor
- Target: reduction of kinetic energy 10 – 30 %

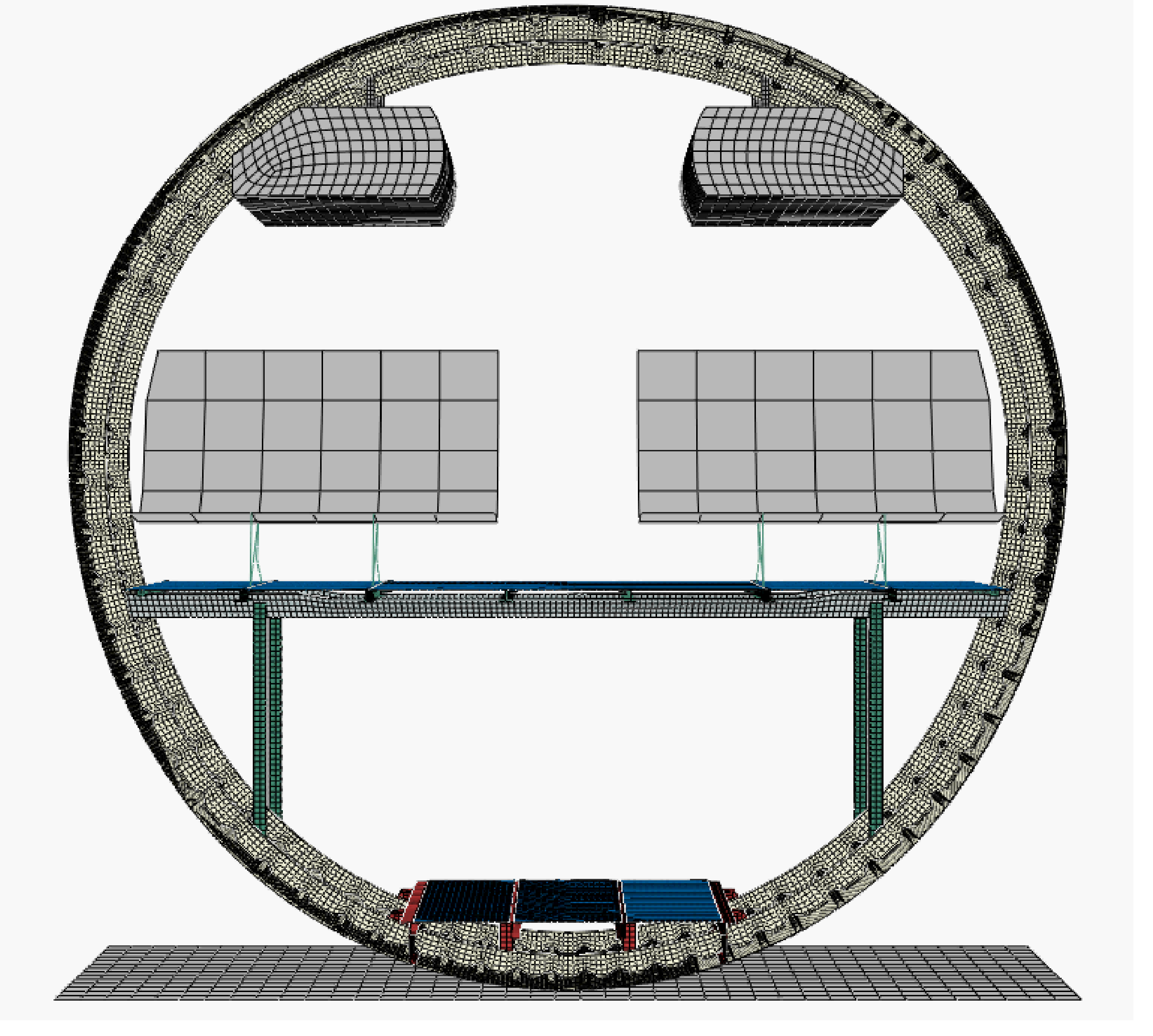




4. Tension energy absorber within cargo floor
Multi Disciplinary Optimisation Approach



4. Tension energy absorber within cargo floor
Abaqus crash model



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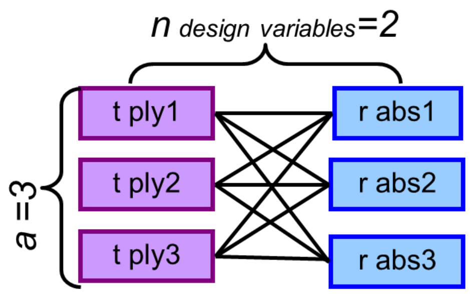
4. Tension energy absorber within cargo floor
Dynamic model: DoE → Approximation function

DoE (design of experiments)

- Design variables:
  F_{max} + frame thickness
- Investigation of general behaviour
- Limits for energy dissipation and weight increase not yet defined

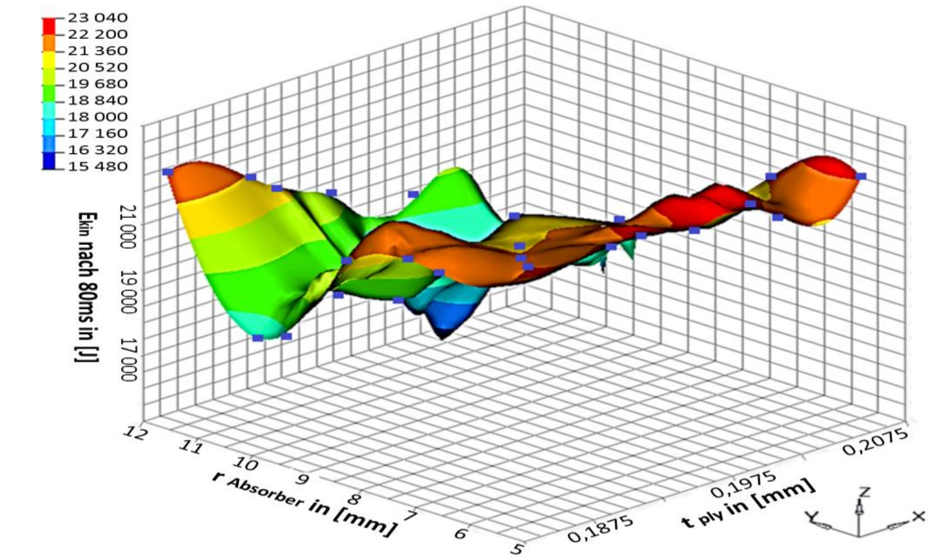


$$n_{Stüztstellen} = a^{n_{Entwurfsvariable}}$$

- 5 values per design variable
  → 25 support points

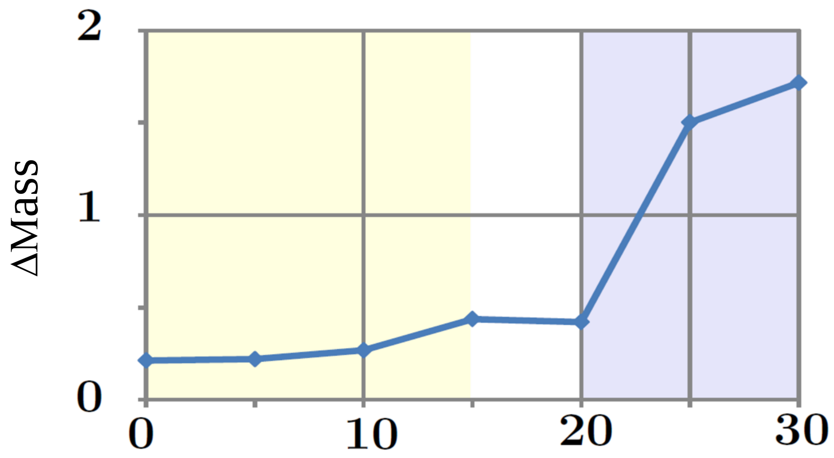
Approximation function

- Method: Kriging (by hyperstudy)



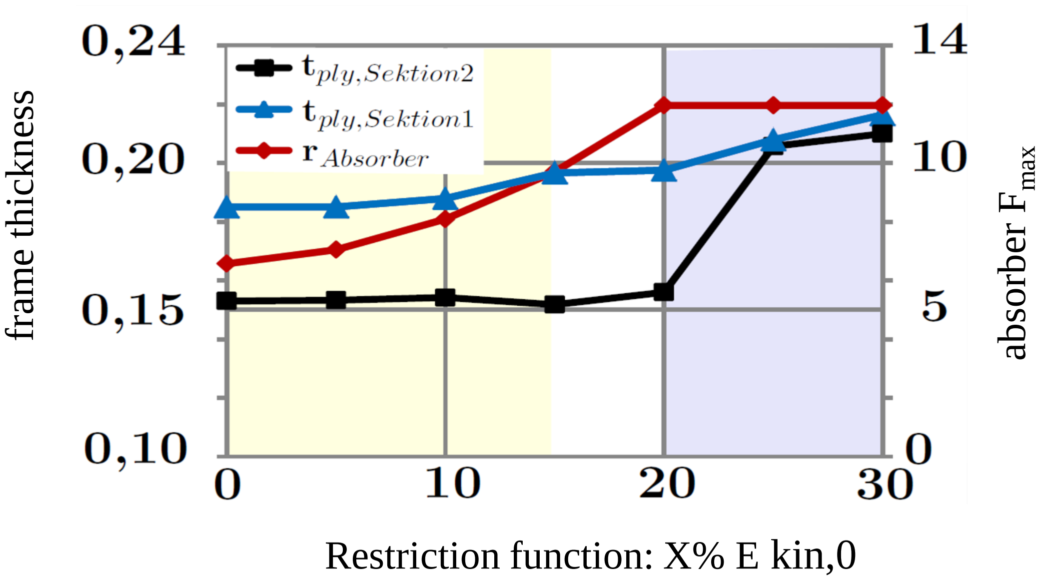
Generation of dynamic model independent from optimisation process

4. Tension energy absorber within cargo floor
MDO: Final result



Static dominated area (yellow):

- Low mass increase
- Minimal frame thickness
- Energy absorption by absorber



Dynamic dominated area (blue):

- Limit for absorber F_{max}
- Frame thickness increases
- High mass increase

Final full scale demonstrator with 3 frame bays

Integration of tension absorber into cargo floor currently under investigation

Thank you for your attention

<u>Presenter</u>

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