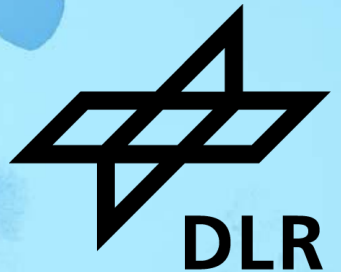


AIRCRAFT HANGAR T25

Lucas Kugler, DLR Institute for System Architectures in Aeronautics

16.11.2024



Acronym Definition



Acronym	Definition
A/C	Aircraft
AEO	All Engine Operating
AMC	Aircraft Mission Calculation
App	Approach
APU	Auxiliary Power Unit
Avg.	Average
BPR	Bypass Ratio
CAS	Calibrated Airspeed
CS 25	Certification Specifications for Large Aeroplanes
CFRP	Carbon-Fiber-Reinforced Polymers
CG	Centre of Gravity
CPACS	Common Parametric Aircraft Configuration Schema
DC	Drag counts
EIS	Entry Into Service
EOF	End of Field
FL	Flight Level
hAP	Airport Altitude
HiFi	High Fidelity

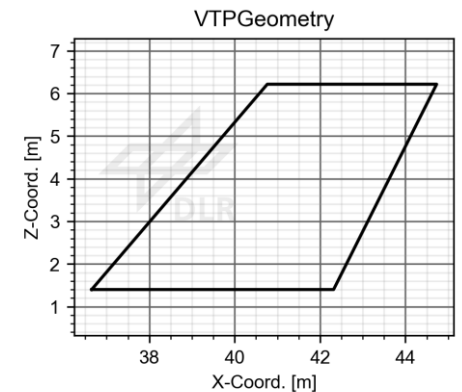
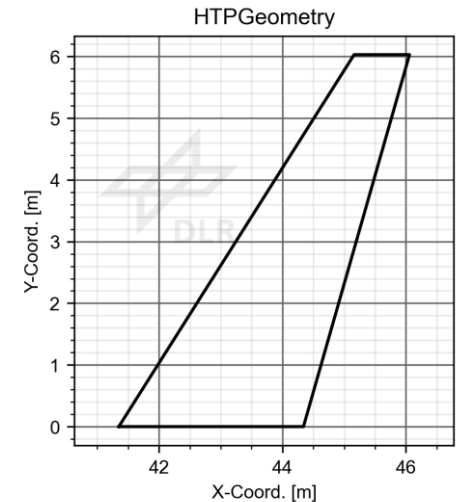
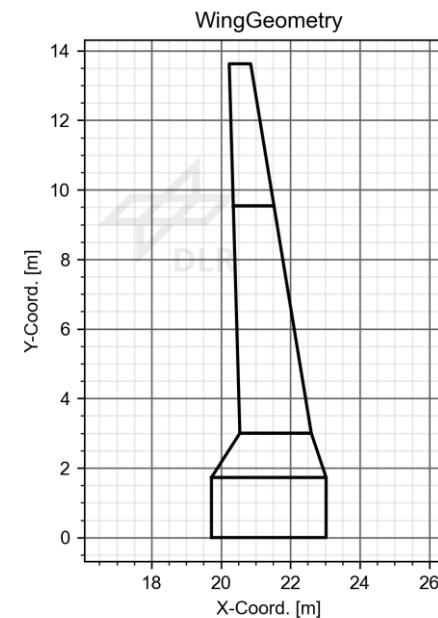
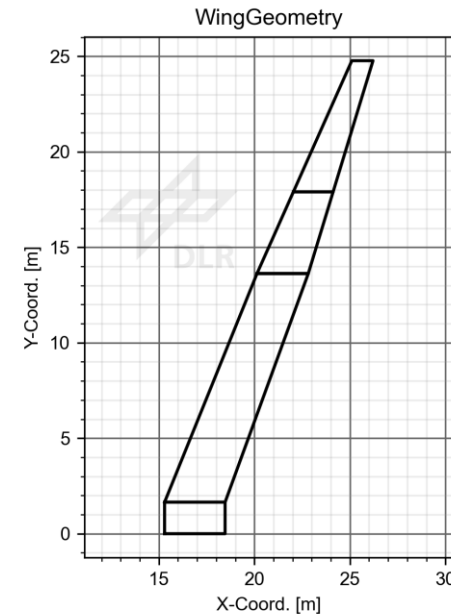
Acronym	Definition
HTP	Horizontal Tail Plane
ICA	Initial Cruise Altitude
ISA	International Standard Atmosphere
IPT	Intermediate Pressure Turbine
ITD	Intermediate Turbine Duct
JAR	Joint Aviation Requirements
klbf	Kilo Pound-Force
kn	Knots
LE	Leading Edge
LFL	Landing field length
LoFi	Low Fidelity
MCL	Maximum Climb Thrust
MCR	Maximum Cruise Thrust
MEM	Manufacturer Empty Mass
MLM	Maximum Landing Mass
MTO	Maximum Take-off Thrust
MTOM	Maximum Take-Off Mass
MZFM	Maximum Zero-Fuel Mass

Acronym	Definition
NM	Nautical Mile
OAD	Overall Aircraft Design
OEI	One engine inoperative
OEM	Operating Empty Mass
OPR	Overall Pressure Ratio
PAX	Passenger
RCE	Remote Component Environment
ROC	Rate of Climb
RTO	Reserve Take-off Thrust
RWY	Runway
SFC	Specific Fuel Consumption
SL	Sea Level
TE	Trailing Edge
TLARs	Top-Level Aircraft Requirements
TOC	Top of Climb
TSFC	Thrust Specific Fuel Consumption
VTP	Vertical Tail Plane

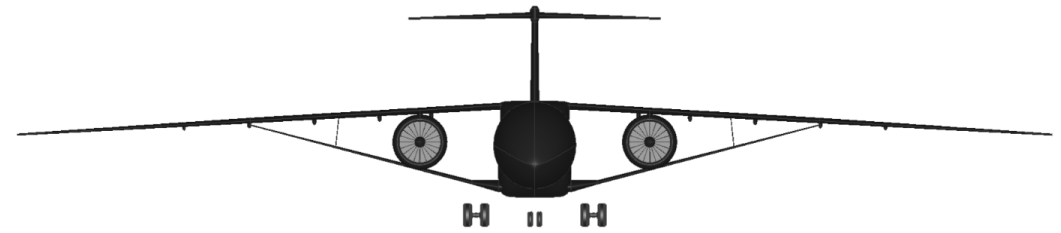
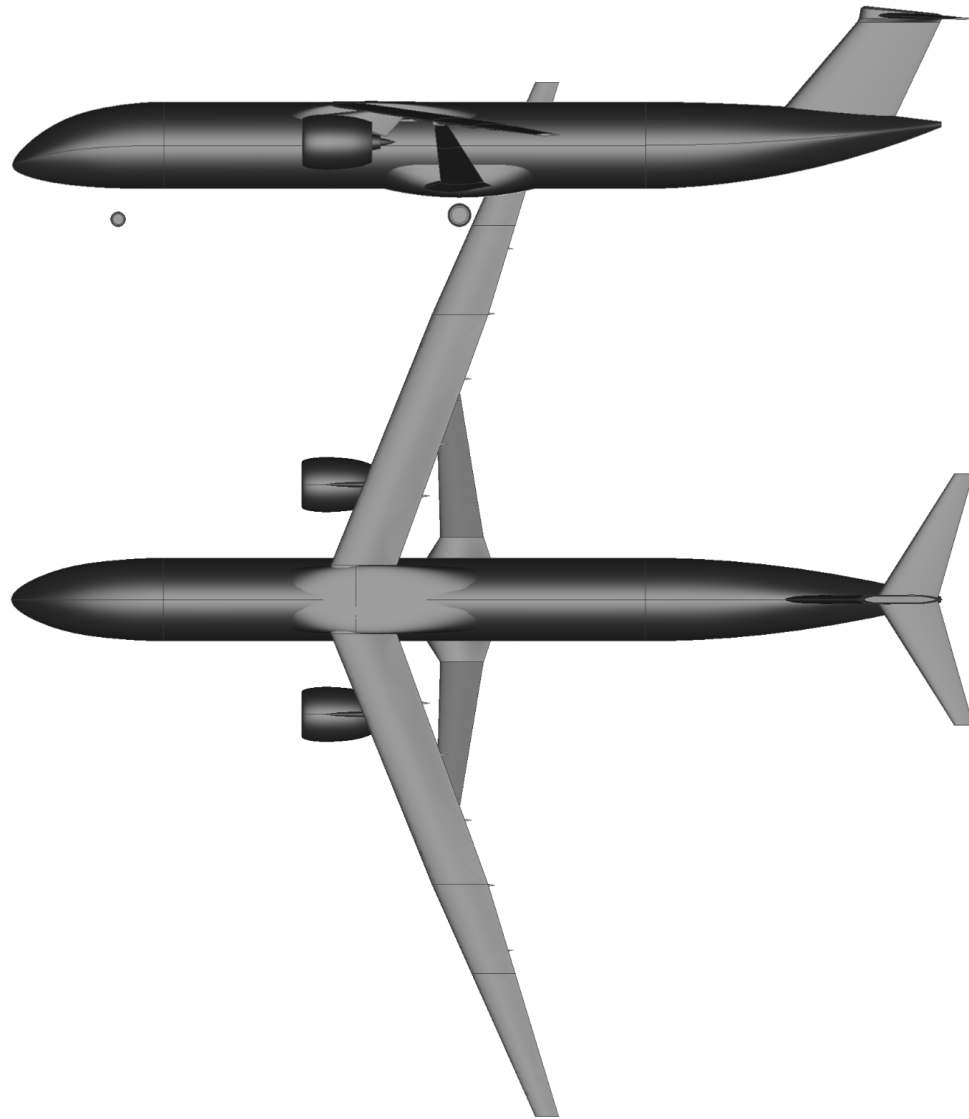
Lifting Surface Geometry Overview



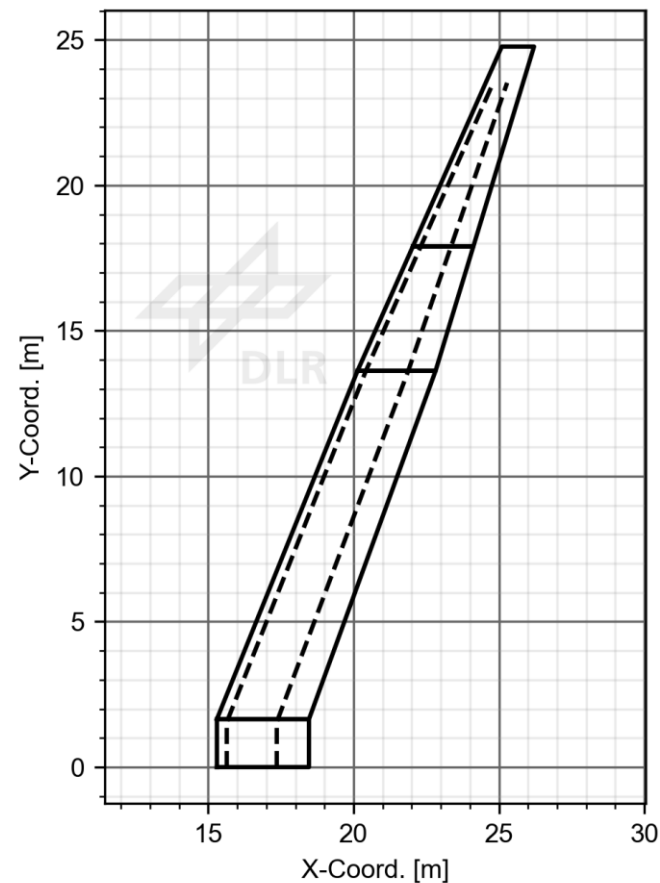
Parameter	Unit	Wing	Strut	HTP	VTP
Reference Area	m ²	122.69	46.63	23.43	23.20
Span	m	49.54	27.25	12.05	4.82
Aspect Ratio	-	20.00	16.81	6.20	1.00
Taper Ratio	-	0.35	0.30	0.30	0.70
Mean Aerodynamic Chord	m	2.09	0.68	2.13	4.87
Avg. 1/4 Chord Sweep	deg	21.89	-2.53	28.60	37.45
Avg. Dihedral	deg	-3.00	15.33	-1.50	-
Lever Arm	m	-	-	23.75	20.10
Volume Coefficient	-	-	-	1.8123	0.0713
Material	-	CFRP	CFRP	CFRP	CFRP



CPACS Output

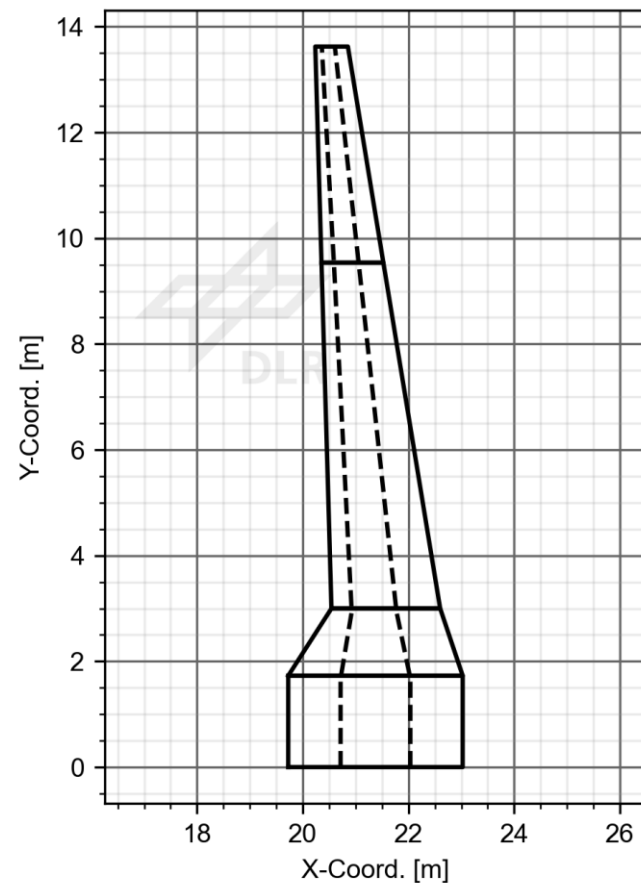


Wing Box Geometry Overview



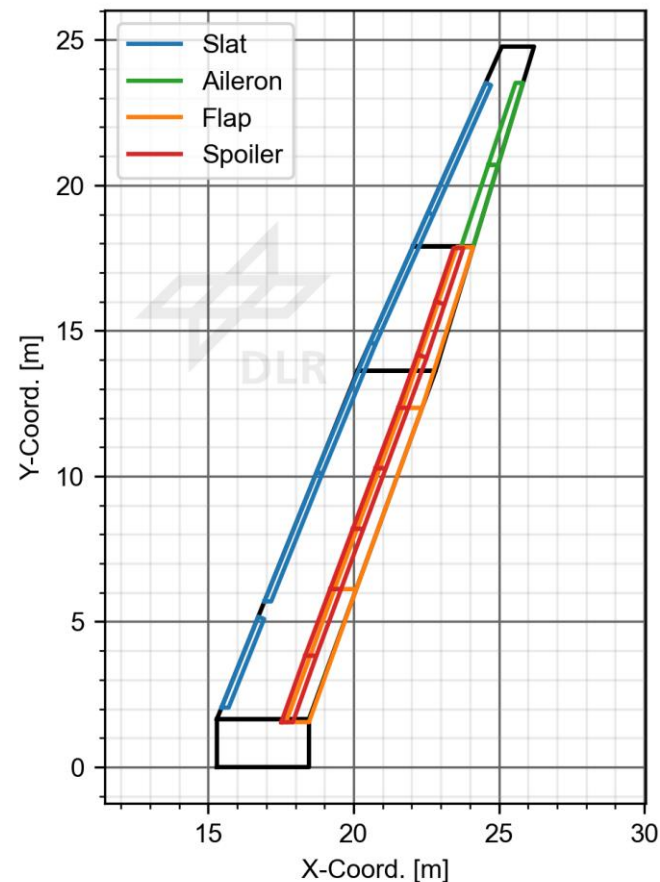
Wing Section	Unit	Center	Root	Kink	Mid	Tip
Position	m	0.00	1.65	13.62	17.90	24.77
Rel. Position	%	0.00	6.66	55.00	72.27	100.00
Chord	m	3.16	3.16	2.68	2.08	1.11
1/4 Chord Sweep	deg	0.00	0.00	21.50	22.28	22.29
LE Sweep	deg	0.00	0.00	22.00	24.00	24.00
TE Sweep	deg	0.00	0.00	20.00	16.90	16.90
Dihedral	deg	0.00	0.00	-3.00	-3.00	-3.00
Thickness Ratio	%	10.00	10.00	10.00	10.00	9.00
Front Spar	%	10.70	10.70	10.70	12.97	21.67
Rear Spar	%	65.00	65.00	65.00	63.21	56.10

Strut Geometry Overview



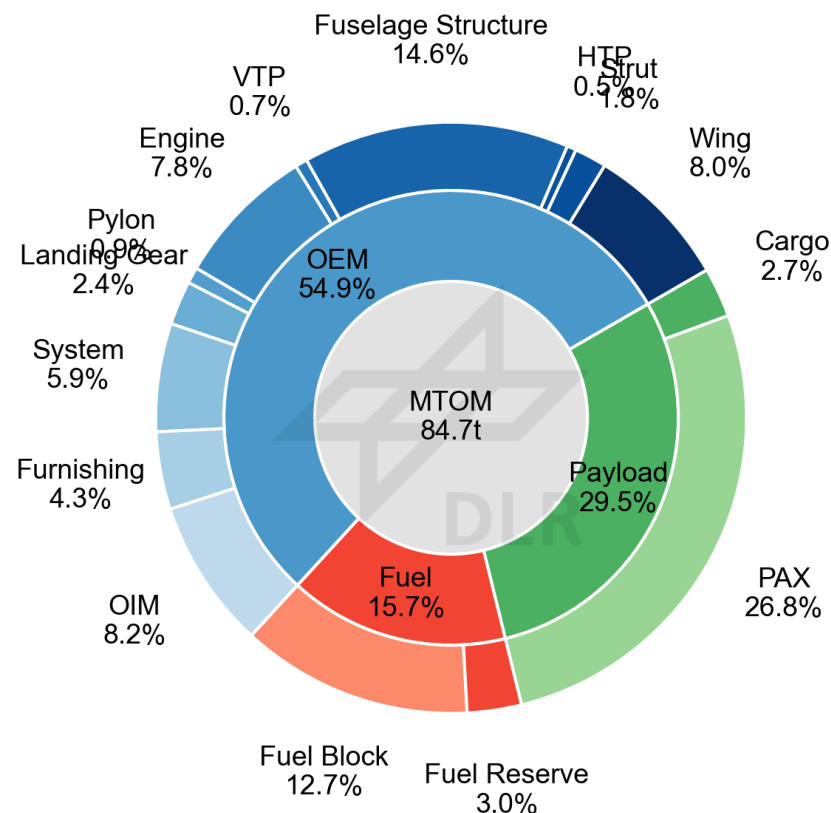
Wing Section	Unit	Center	Root	Kink	Mid	Tip
Position	m	0.00	1.73	3.00	9.54	13.62
Rel. Position	%	0.00	12.68	22.02	70.00	100.00
Chord	m	3.30	3.30	2.06	1.17	0.62
1/4 Chord Sweep	deg	0.00	0.00	21.72	-3.59	-3.58
LE Sweep	deg	0.00	0.00	40.00	-3.61	-3.61
TE Sweep	deg	0.00	0.00	-18.51	-9.33	-9.33
Dihedral	deg	0.00	0.00	8.00	9.36	9.36
Twist Angle	deg	-0.85	-0.85	-0.50	-0.71	-0.85
Thickness Ratio	%	15.00	15.00	10.00	10.00	10.00
Rel. Spar Position						
Front Spar	%	10.70	10.70	10.70	12.97	21.67
Rear Spar	%	65.00	65.00	65.00	63.21	56.10

Wing Movable Arrangement Overview



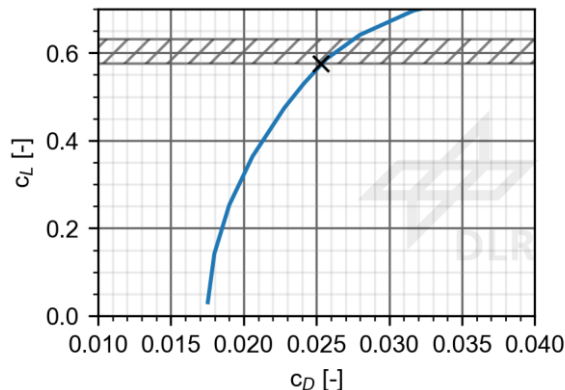
Control Surface	y Inboard	y Outboard	Chord Inboard	Chord Outboard
Slat1	2.046	5.172	0.24	0.23
Slat1	5.696	10.152	0.23	0.22
Slat2	10.152	14.609	0.22	0.21
Slat3	14.609	19.066	0.21	0.22
Slat4	19.066	23.523	0.22	0.22
Aileron1	17.877	20.7	0.42	0.34
Aileron2	20.7	23.523	0.34	0.26
Flap1	1.547	6.118	0.79	0.75
Flap2	6.118	12.349	0.75	0.68
Flap3	12.349	17.877	0.68	0.56
Spoiler1	1.544	3.831	0.4	0.38
Spoiler2	3.831	6.118	0.38	0.37
Spoiler3	6.118	8.195	0.37	0.36
Spoiler4	8.195	10.272	0.36	0.35
Spoiler5	10.272	12.349	0.35	0.34
Spoiler6	12.349	14.18	0.34	0.36
Spoiler7	14.18	16.011	0.36	0.35
Spoiler8	16.011	17.842	0.35	0.34

Mass Properties

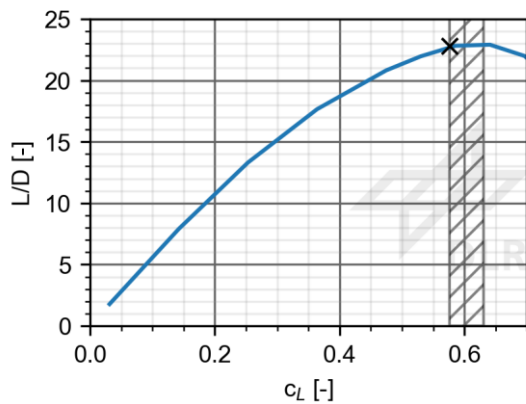


Component	Mass [kg]	x-Pos [m]
Wing	6747	20.14
Strut	1497	22.06
Fuselage Structure	12357	20.08
HTP	430	43.72
VTP	564	40.9
Pylons	748	17.16
Power Units	6568	16.05
Main Gear	1669	21.43
Nose Gear	371	5.07
Systems	5014	15.45
Furnishings	3600	20.75
Manufacturer Empty Mass (MEM)	39567	-
Operating Items	6934	-
Operating Empty Mass (OEM)	46502	19.51
Maximum Payload	25000	20.75
Maximum Fuel	15929	19.7
Maximum Zero-Fuel Mass (MZFM)	71502	-
Maximum Landing Mass (MLM)	74157	-
Maximum Take-Off Mass (MTOM)	84693	19.9

Aerodynamic Performance

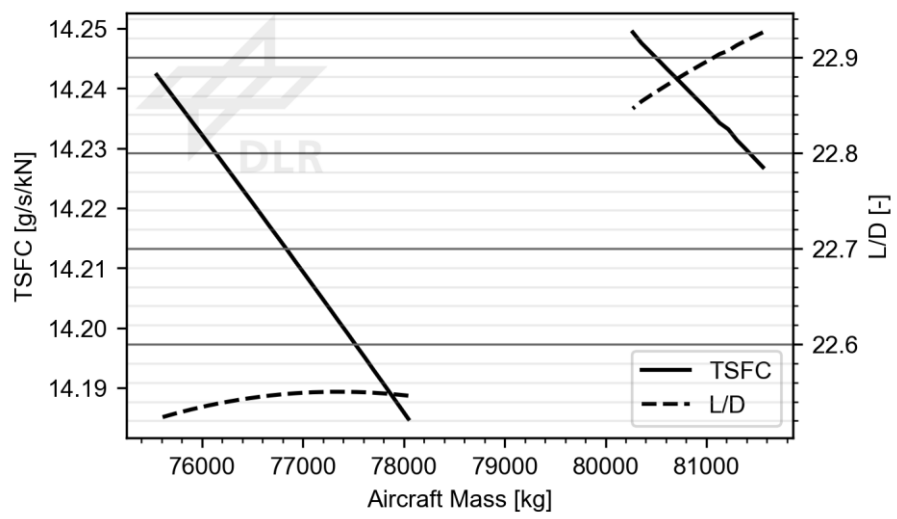


- Clean: $Ma=0.78$, Flight Level=376
- × Mid Cruise: $Ma=0.78$, Flight Level=370
- ▨ Cruise c_L



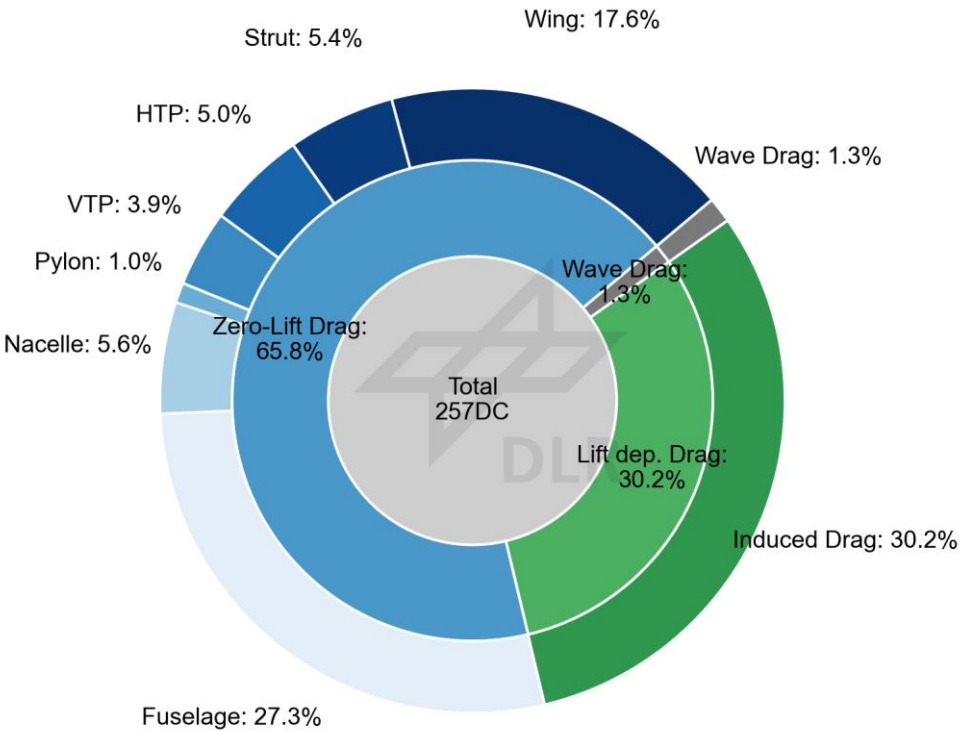
- Clean: $Ma=0.78$, Flight Level=376
- × Mid Cruise: $Ma=0.78$, Flight Level=370
- ▨ Cruise c_L

Engine Performance and Aerodynamics matching:



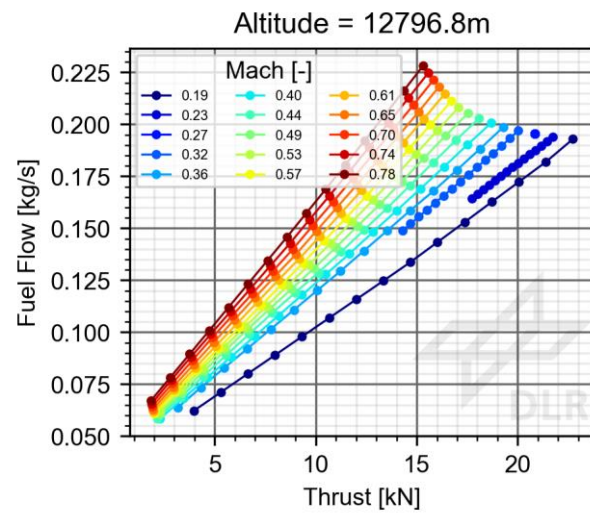
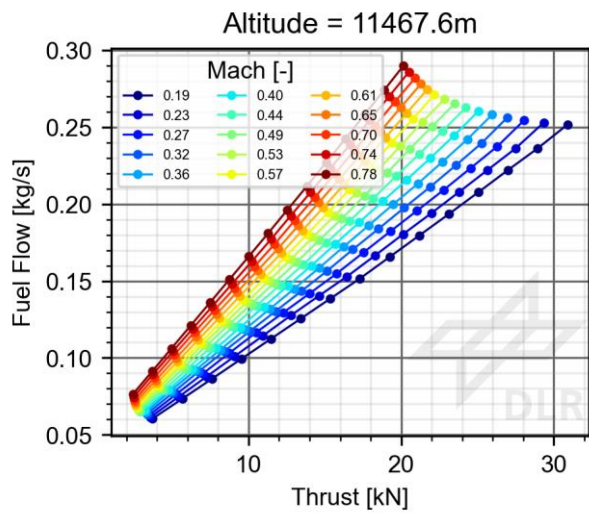
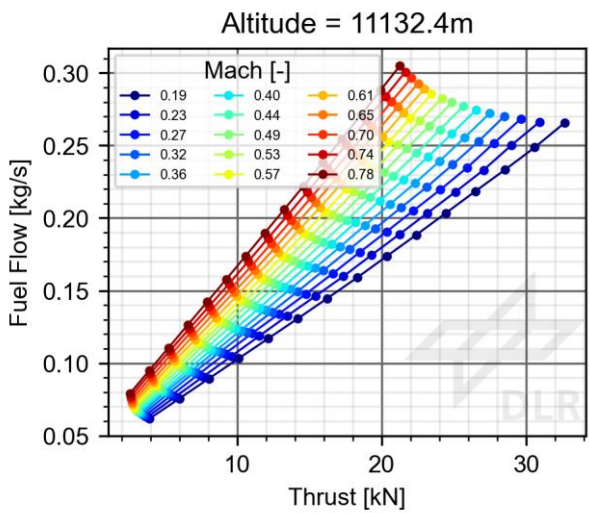
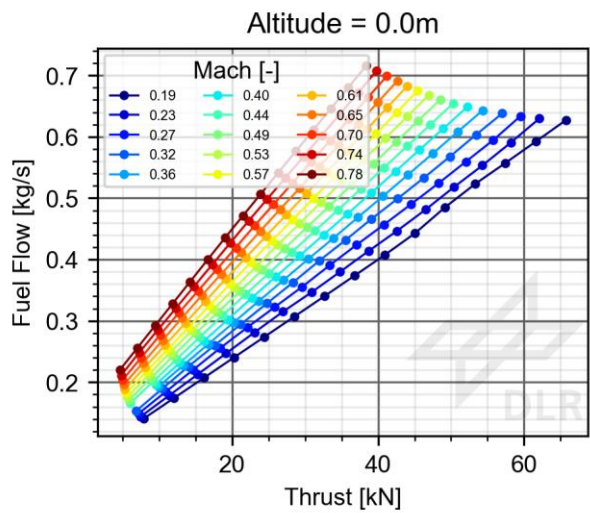
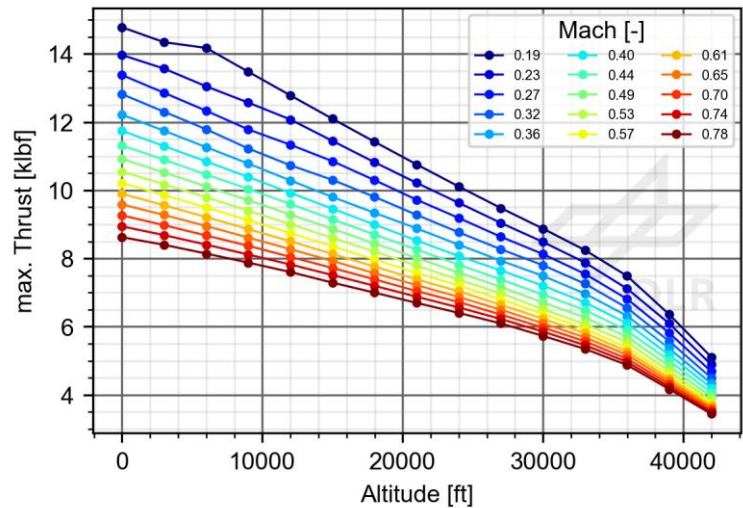
- TSFC
- - - L/D

Mid-Cruise Aerodynamic Drag Breakdown (Ma=0.78, Flight Level 376)



Parameter	Drag Breakdown [DC]	Relative [%]
Zero-Lift Drag	155.0	60.4
Wing	45.1	17.6
HTP	12.9	5.0
VTP	9.9	3.9
Fuselage	70.0	27.3
Pylon	2.6	1.0
Nacelle	14.4	5.6
Lift dep. Drag	77.6	30.2
Induced Drag	77.6	30.2
Wave Drag	3.3	1.3
Total Drag	256.6	100.0

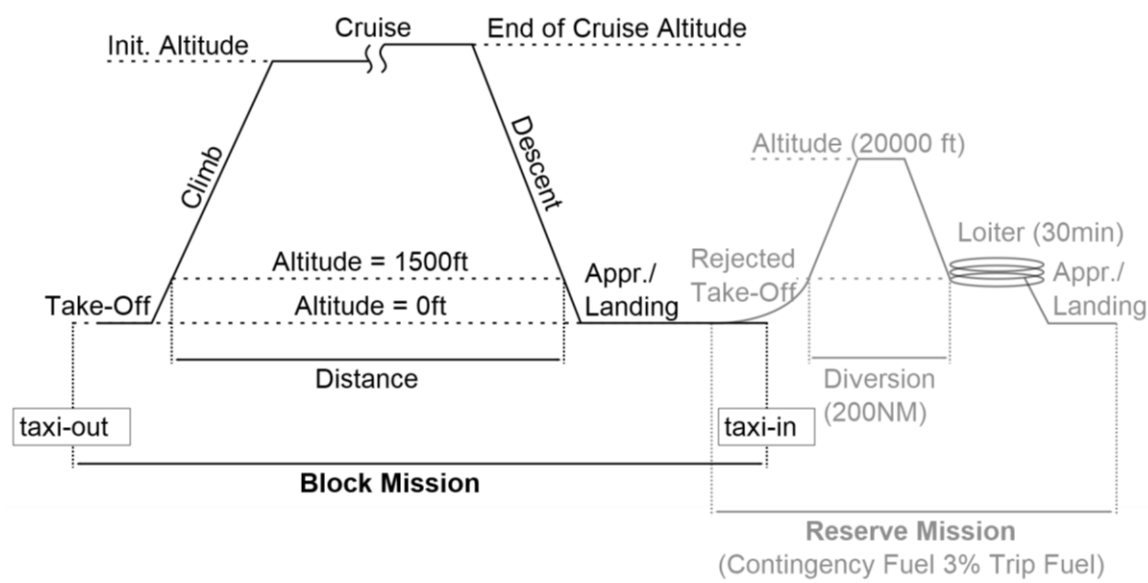
Engine Performance



Mission Definition and Key Aircraft Characteristics



A design mission with a range of 2500NM and a number of passengers of 239PAX at 95 kg/PAX was defined according to T25v4 specification. For this design mission, all performance data are calibrated i.e. engine and aerodynamic performances

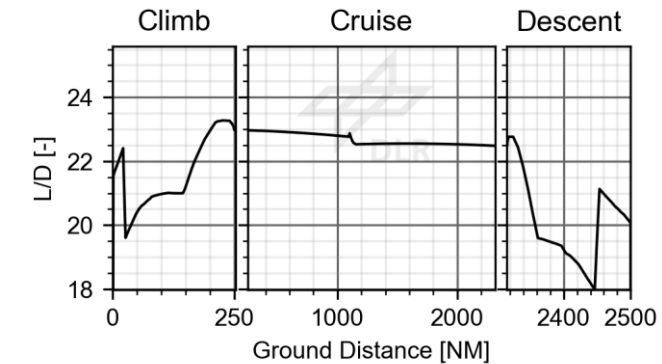
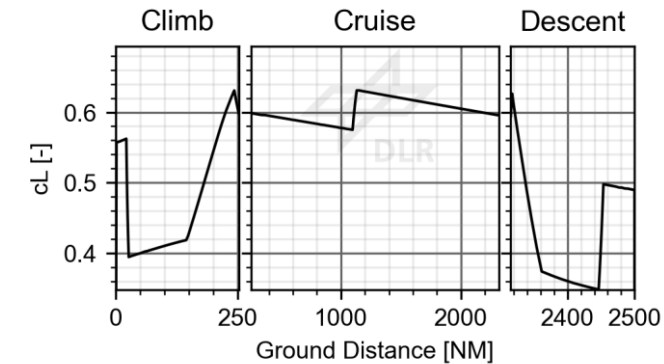
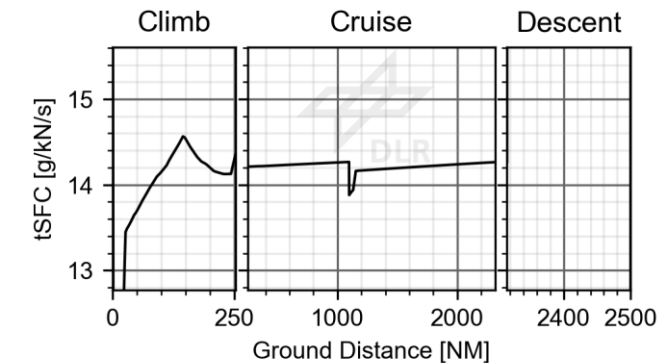
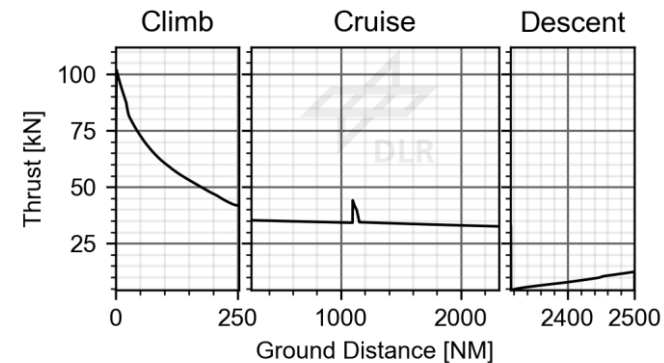
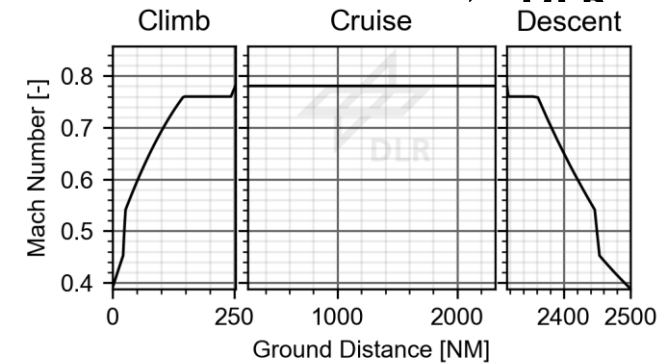
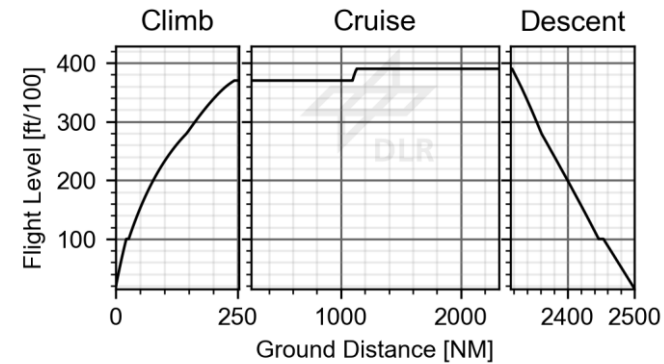


Parameter	Unit	Value
Design Range	NM	2500
Design Passenger Capacity	-	239
Design Cruise Mach Number	-	0.78
Max. Take-Off Mass	t	84.7
Max. Landing Mass	t	74.2
Max. Zero-Fuel Mass	t	71.5
Operating Empty Mass	t	46.5
Max. Fuel Mass	t	15.9
Max. Payload	t	25
Wing Area	m	122.7
Wing Span	m	49.5
Mean Aerodynamic Chord	m	2.1
Wing Loading (@MTOM)	kg/m ²	577.7
Thrust-to-Weight Ratio (@ISA)	-	0.209
Engine Type	-	Turbofan
Thrust (Sea Level Static, ISA)	kN	86.6

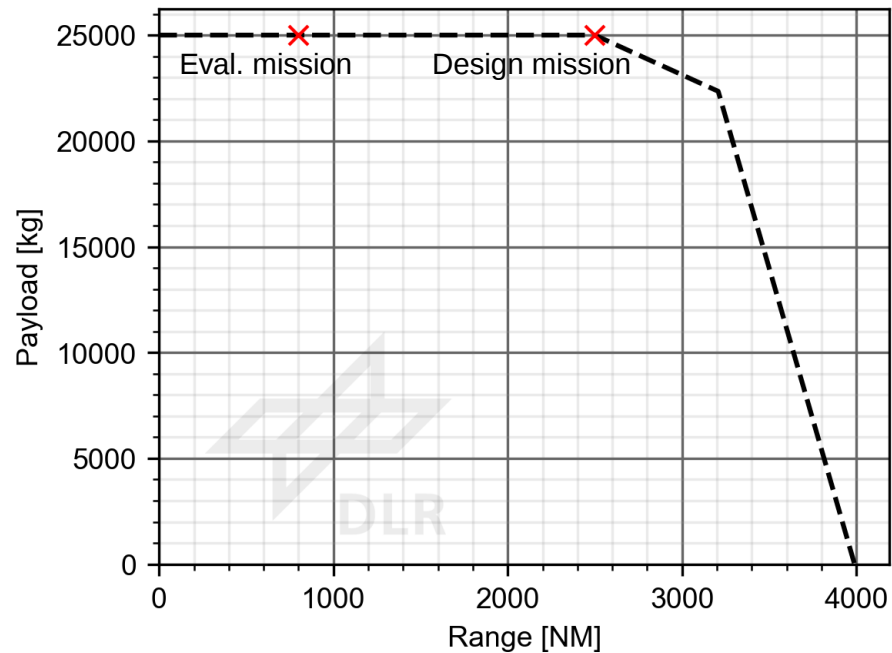
Design Mission Performance



Mission Phase	FLight Time [min]	Fuel Mass [kg]	Distance [NM]
Block Mission	363.6	10672.2	2507.0
Take-Off	2.0	136.6	0.0
Climb	37.9	1940.6	252.4
Cruise	276.7	8043.0	2062.9
Descent	31.1	447.4	184.8
Approach & Landing	4.0	60.4	0.0
(Taxi-In)	5.0	37.3	0.0
Reserve Mission	102.0	3349.5	459.0
Go-Around	1.6	55.3	0.0
Diversion Climb	26.1	1042.9	153.8
Diversion Cruise	0.7	21.2	4.6
Diversion Descent	33.0	947.3	184.2
Holding	30.0	897.5	109.4
Diversion Approach & Landing	3.6	59.5	0.0
Contingency	0.0	318.8	0.0



Payload-Range Characteristics



General Information:

- Max. Payload: 25000 kg
- Design No. PAX: 239 @ 95 per PAX
- Design Mission: 2500NM @ 25000 kg Payload

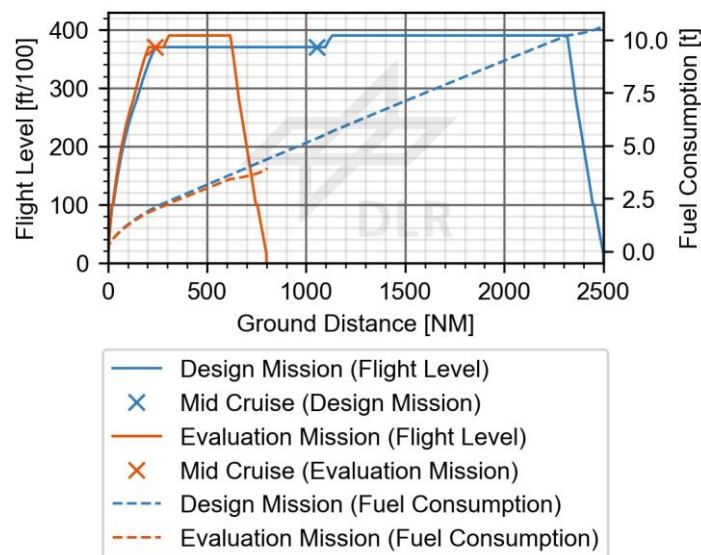
Mission Profile:

- Start/Arrival: Typical Short-Medium-Range Allowance
- Climb: 300kts
- Cruise: Mach 0.78
- Descent: 300kts

Reserve:

- No wind, ISA condition
- 200NM Alternate Airport
- 30min Holding @1500 ft
- Contingency Fuel: 3.0% Trip Fuel

Cruise Performance Comparison



Parameter	Design Mission	Evaluation Mission
Range [NM]	2500.0	800.0
Payload [t]	25.0	25.0
Mach Number (Cruise) [-]	0.78	0.78
Init. Cruise Altitude [FL]	370.0	370.0
Mid Cruise Altitude [FL]	370.0	370.0
End of Cruise Altitude [FL]	390.0	390.0
No. of Cruise Steps [-]	1.0	1.0

Parameter	Design Mission	Evaluation Mission
Mid Cruise Performance		
Lift Coefficient [-]	0.576	0.55
Drag Coefficient [-]	0.025	0.025
L/D Ratio [-]	22.78	22.42
CAS [m/s]	129.9	129.9
TAS [m/s]	230.2	230.2
Angle of Attack [deg]	0.4	0.2
Thrust [kN]	34.2	33.2
Thrust max. [kN]	44.3	44.3
tsfc [g/kN/s]	14.26	14.32
Avg. Cruise Performance		
Lift Coefficient [-]	0.602	0.589
Drag Coefficient [-]	0.0266	0.0262
L/D Ratio [-]	22.63	22.48
CAS [m/s]	126.4	125.2
TAS [m/s]	230.2	230.2
Thrust [kN]	34.1	33.4
tsfc [g/kN/s]	14.22	14.24