ICAS 2022: BWB Enabling Technologies

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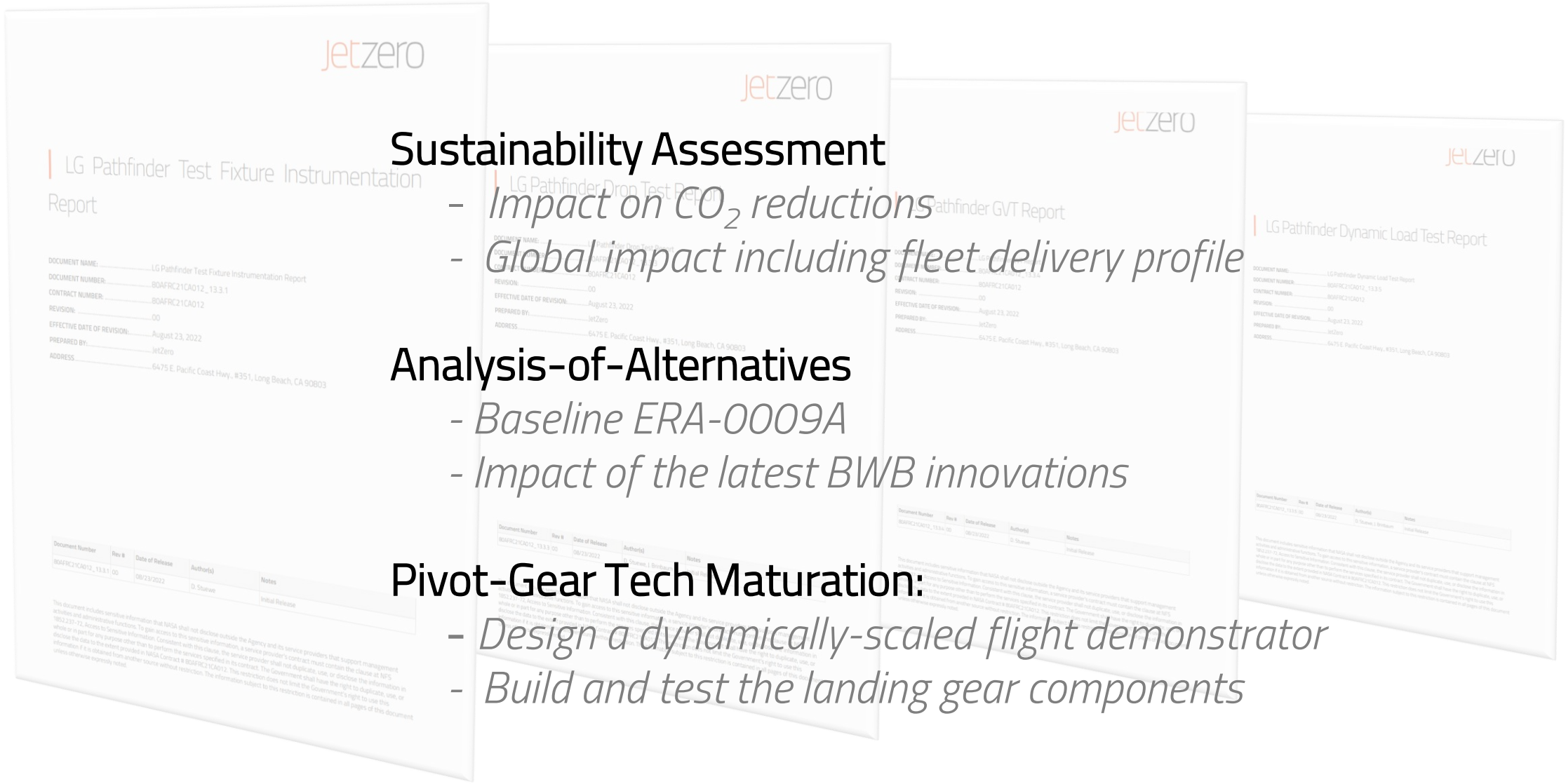
Authors: Mark Page, John Vassberg


jetzero
NASA
135
225
270

NASA Contract: 80AFRC21CA012



Sustainability Assessment

- *Impact on CO_2 reductions*
- *Global impact including fleet delivery profile*

Analysis-of-Alternatives

- *Baseline ERA-0009A*
- *Impact of the latest BWB innovations*

Pivot-Gear Tech Maturation:

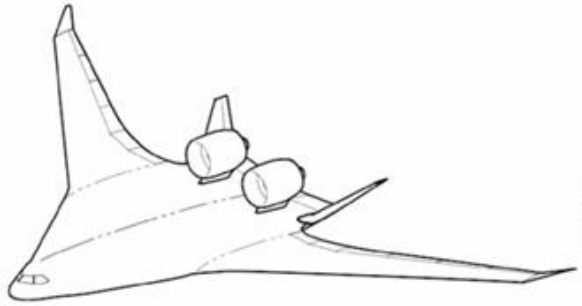
- *Design a dynamically-scaled flight demonstrator*
- *Build and test the landing gear components*

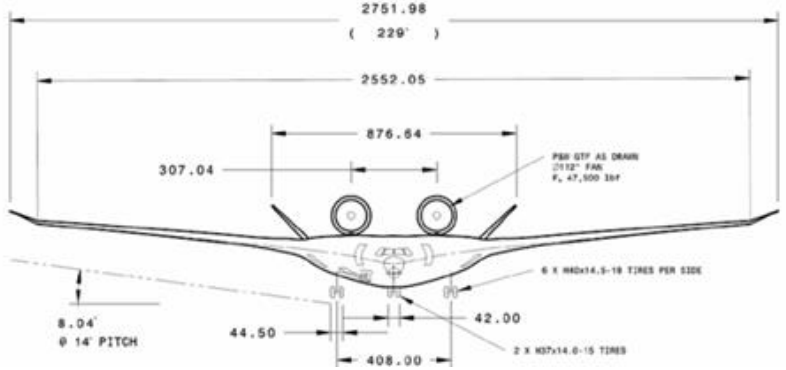
Analysis of Alternatives

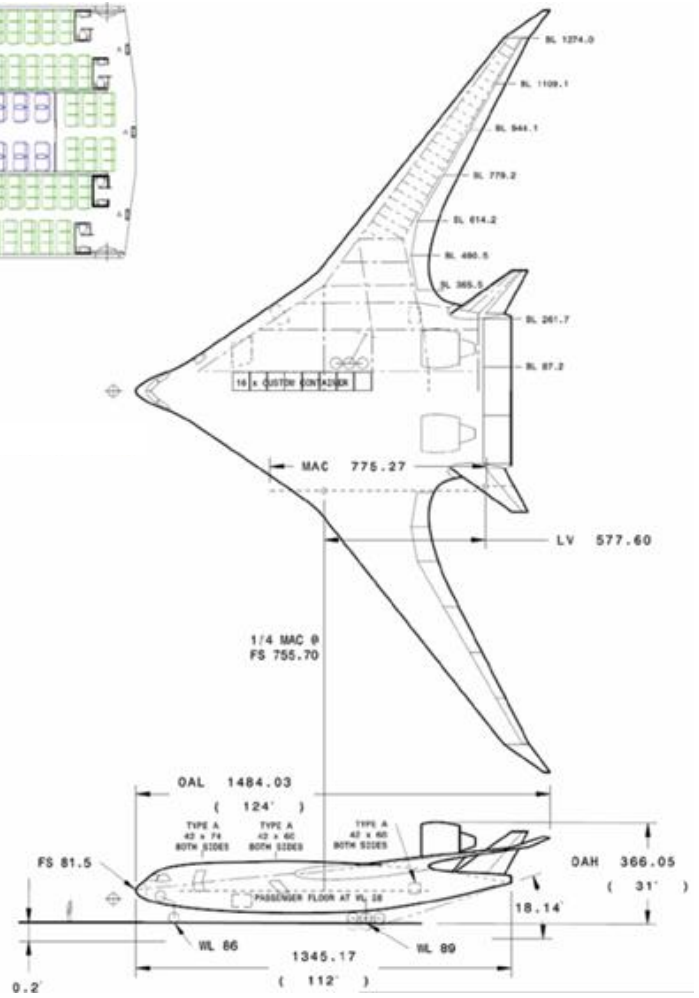
- Describe the new technologies in the JetZero BWB
- Isolate the effect of each technology on sized performance
- Provide sufficient data for an independent review by NASA
- Benchmark against the Capstone ERA BWB
- Step-1, JetZero sizing tools were synced to published ERA-0009A data
- Step-2, a new ERA-0009A was sized with JetZero's Vision System Pay/Range
- Each new technology was sized & optimized one at a time
- Finally, all new technologies were sized & optimized together

Benchmark - NASA/Boeing ERA Study 2011

- Double-Deck
- Upper deck pax
- Lower deck cargo
- Lower deck MG wells
- Conventional landing gear
- Podded nacelles
- Slats
- Body Fins
- Group-IV compatible LG
- Group-VI compatible span
- 219pax 3-class
- Design Range = 8,000nmi







JetZero Vision System

- Single-Deck
- No Slats
- Pivot-Gear
- Semi-Buried Nacelles

Analysis of Alternatives - Sizing Criteria

Still-Air-Range	4,000nmi
Pax	150-230 in a 3-class cabin
Max Rate-of-Climb	> 300fpm at Initial Cruise Altitude [ICA]
ICA	Set for a cruise-climb to top-of-descent at 45,000ft
Ceiling	45,000ft for best fuel-efficiency at FAR25 limit for standard safety factors
1.3g CL margin	buffet margin preserved for all conditions
Takeoff field length	< 6,000ft @ 150pax <7,500ft @ 230pax (modest improvement over incumbents)
Vref	< 130kts @ 150 pax <150kt @ 230 pax, at Max Landing Weight [MLW].
Reserves	100nmi extended cruise plus a 45-minute hold at cruise altitude.

Analysis of Alternatives – New Features

Results relative to a Double-Deck BWB with conventional gear, slats, and podded engines		Add Semi-buried Nacelles	Remove Lower Deck Cargo Add Outboard Cargo	Remove Slats	Add Pivot-Gear
MTOGW	Max Takeoff Gross Weight	-3.7%	-3.6%	-0.3%	-0.7%
OEW	Operating Empty Weight	-4.1%	-6.0%	-0.3%	-0.5%
TOFL	Takeoff Field Length	2.9%	-1.5%	15.2%	-25.3%
LFL	Landing Field Length	0.2%	0.6%	12.0%	-22.7%
SLST	Engine Thrust	-7.7%	-2.6%	-0.9%	-2.3%

New Feature Benefit is 10%+ in fuel-burn with COTS engines. Total benefit 30%+
10% TOFL/LFL benefit. 14% SLST benefit

All enabled by Single-Deck, which is enabled by Pivot-Gear, which allows Slat Deletion…which…

Simplification for Fuel Efficiency

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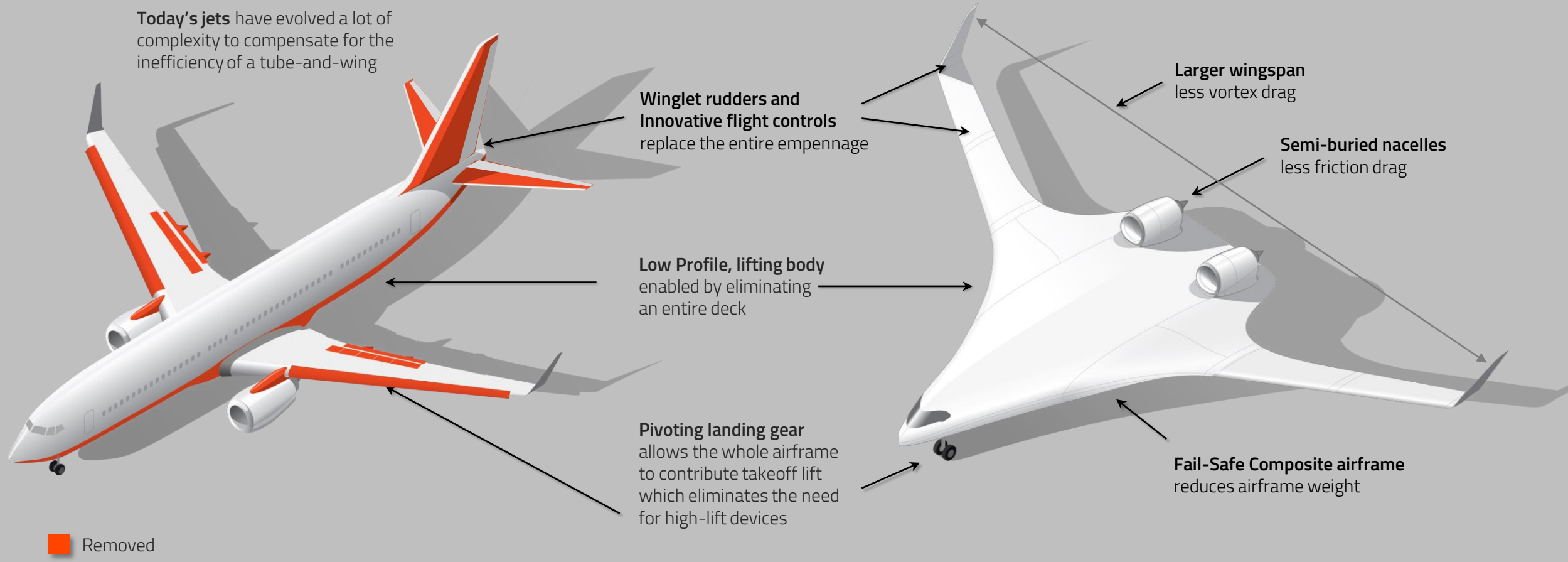

Pivot-Gear – Enabling Technology for Single Deck and Family

Effect of Gear Position on a Single-Deck BWB

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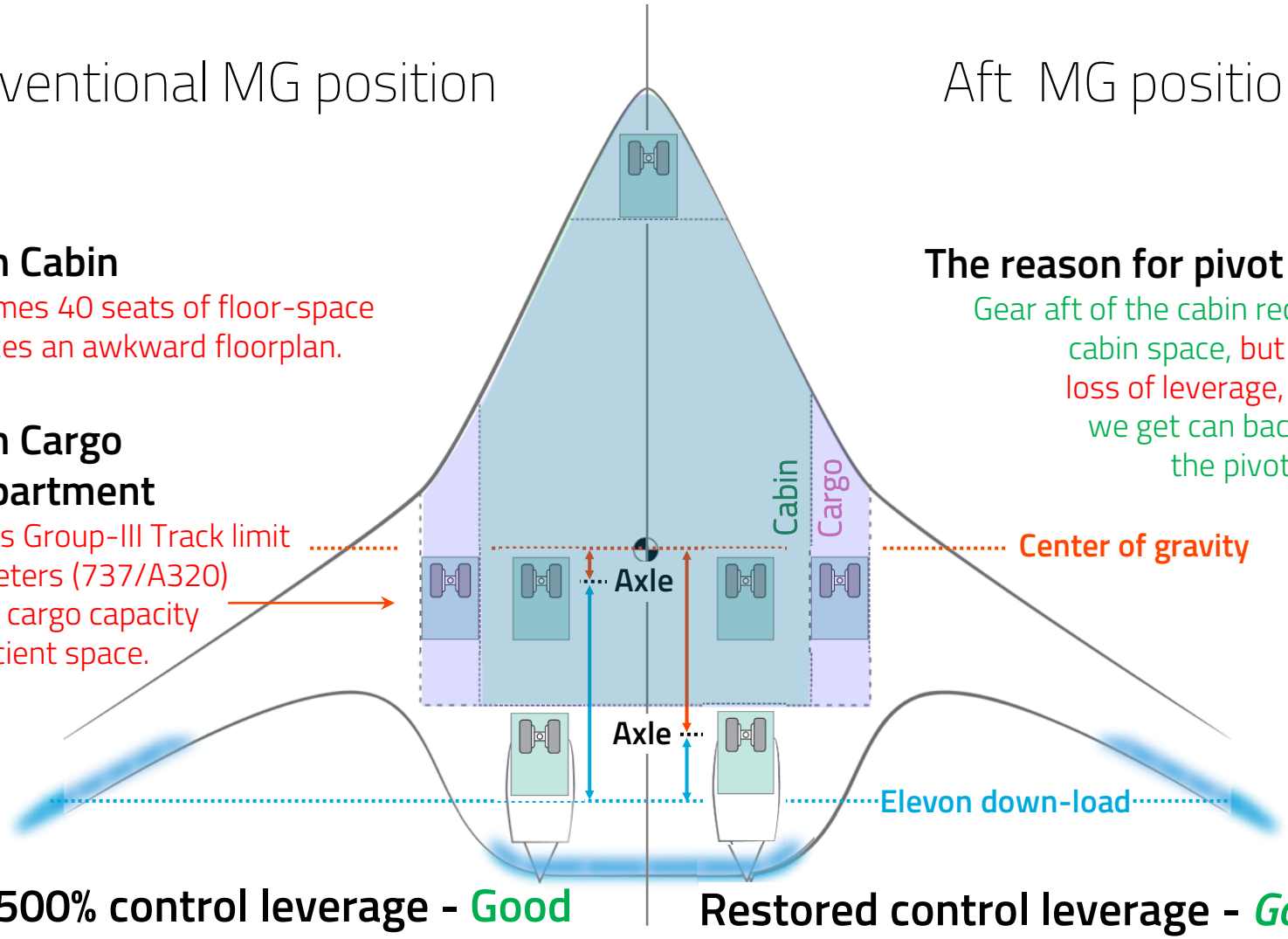
Conventional MG position

MG in Cabin
Consumes 40 seats of floor-space
Produces an awkward floorplan.

MG in Cargo Compartment
Violates Group-III Track limit of 9 meters (737/A320)
Halves cargo capacity
Insufficient space.

Aft MG position

The reason for pivot gear
Gear aft of the cabin recovers cabin space, but at the loss of leverage, which we get can back with the pivot-gear.

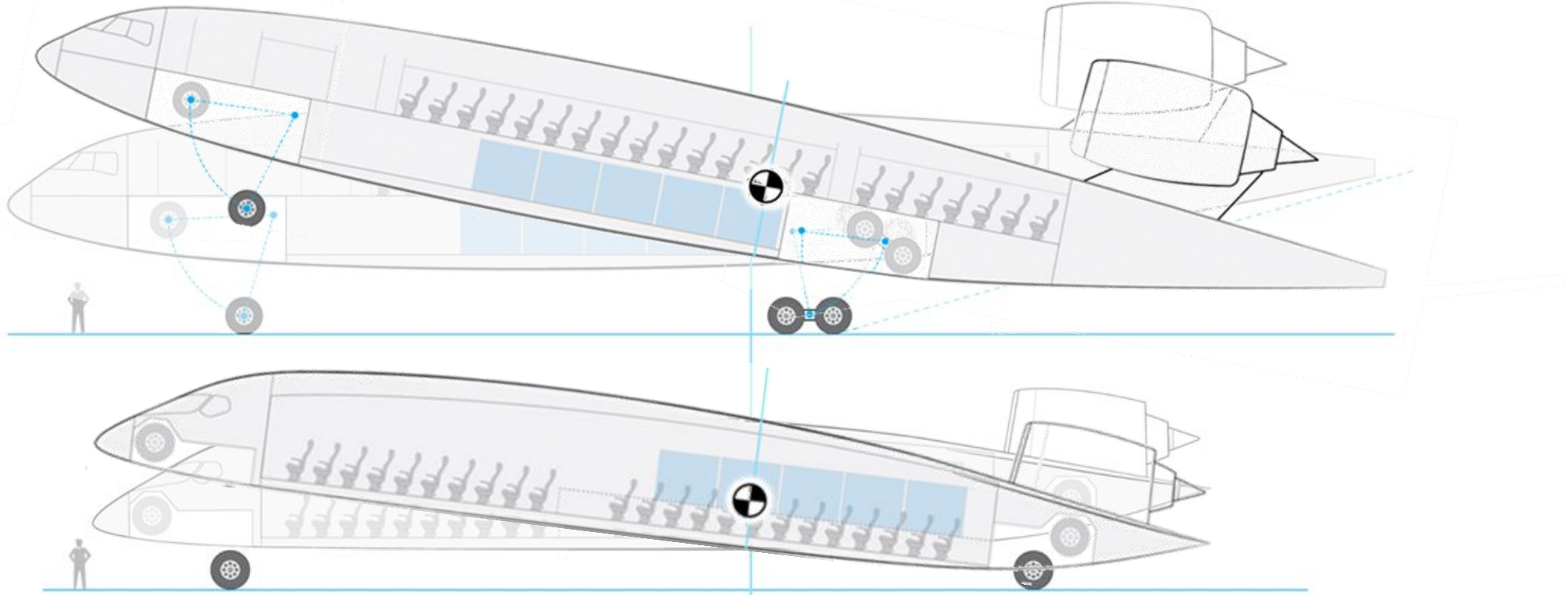


500% control leverage - Good

Restored control leverage - *Good*

But, how does a Pivot-Gear work?

Historical Double-Deck vs. JetZero Single-Deck



Thickness and chord are reduced with a Single Deck

Conventional Takeoff Rotation - pivot about the main-gear bogie
Pivot-Gear Takeoff Rotation - pivot about the CG

The MG and NG are mechanically-linked front-to-back

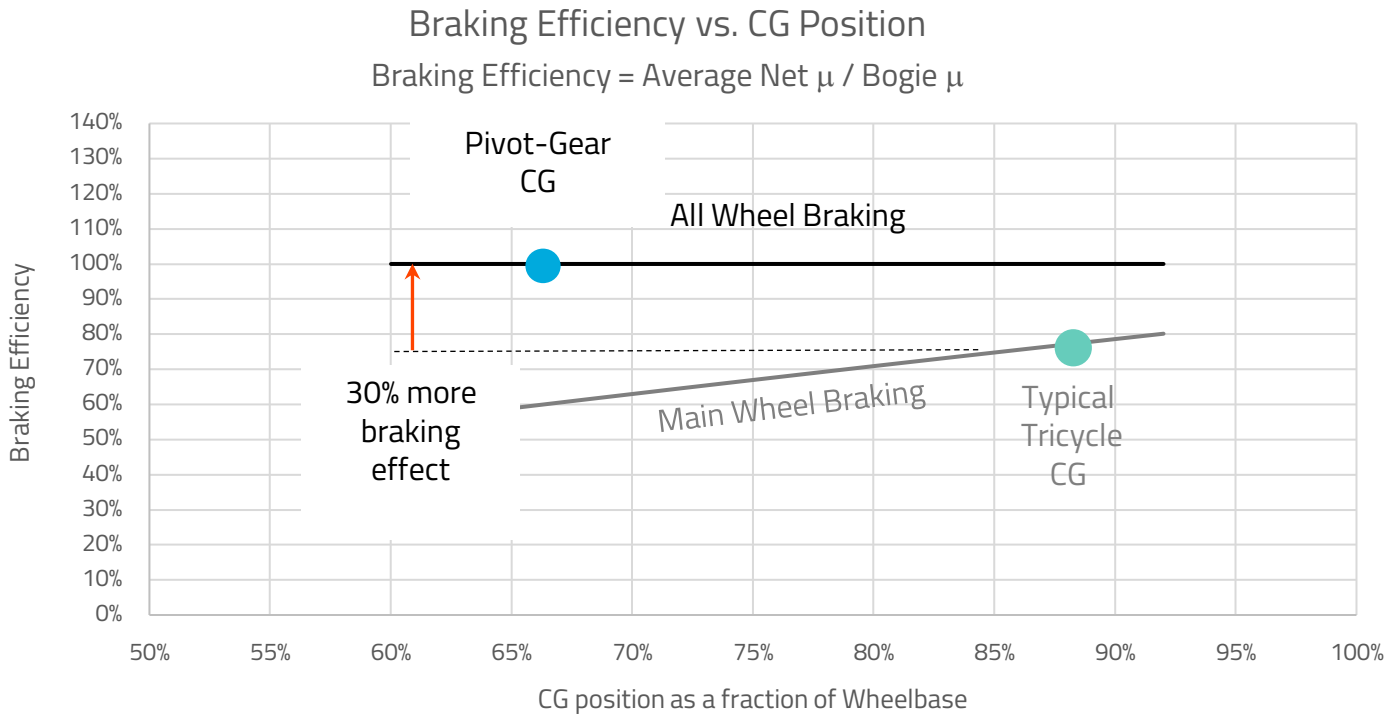
The motion is totally passive - no actuation

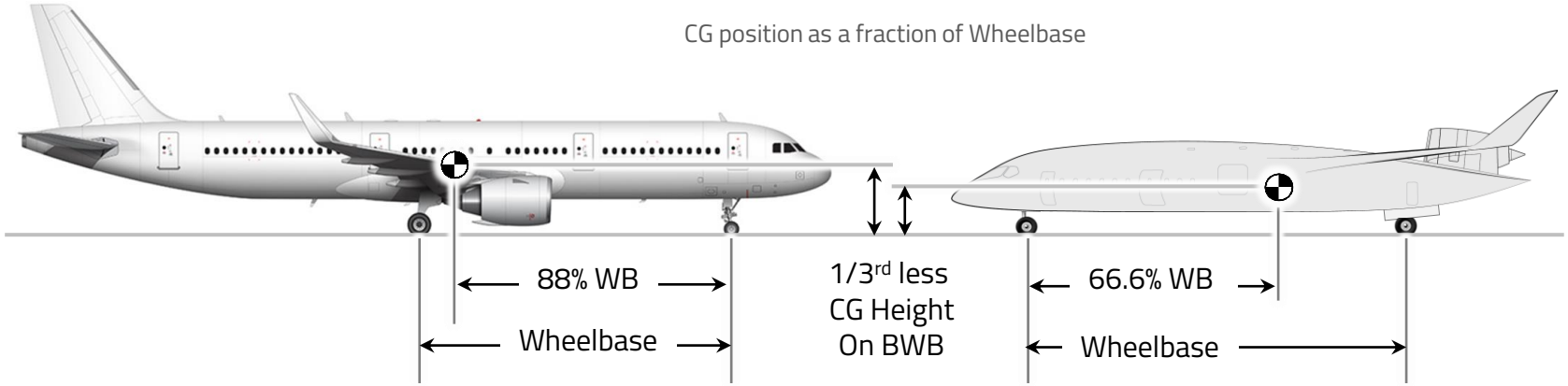
Pivot-Gear in Action

Surprise Benefit – More Braking Effect

The Pivot-Gear needs brakes on all 3 gear since they share equal load, and we can't afford to give up 1/3rd of our braking power.

Pleasant surprise. "weight transfer" is un-used on present NG. Harvesting the weight transfer with all-wheel braking increases deceleration by 30%.



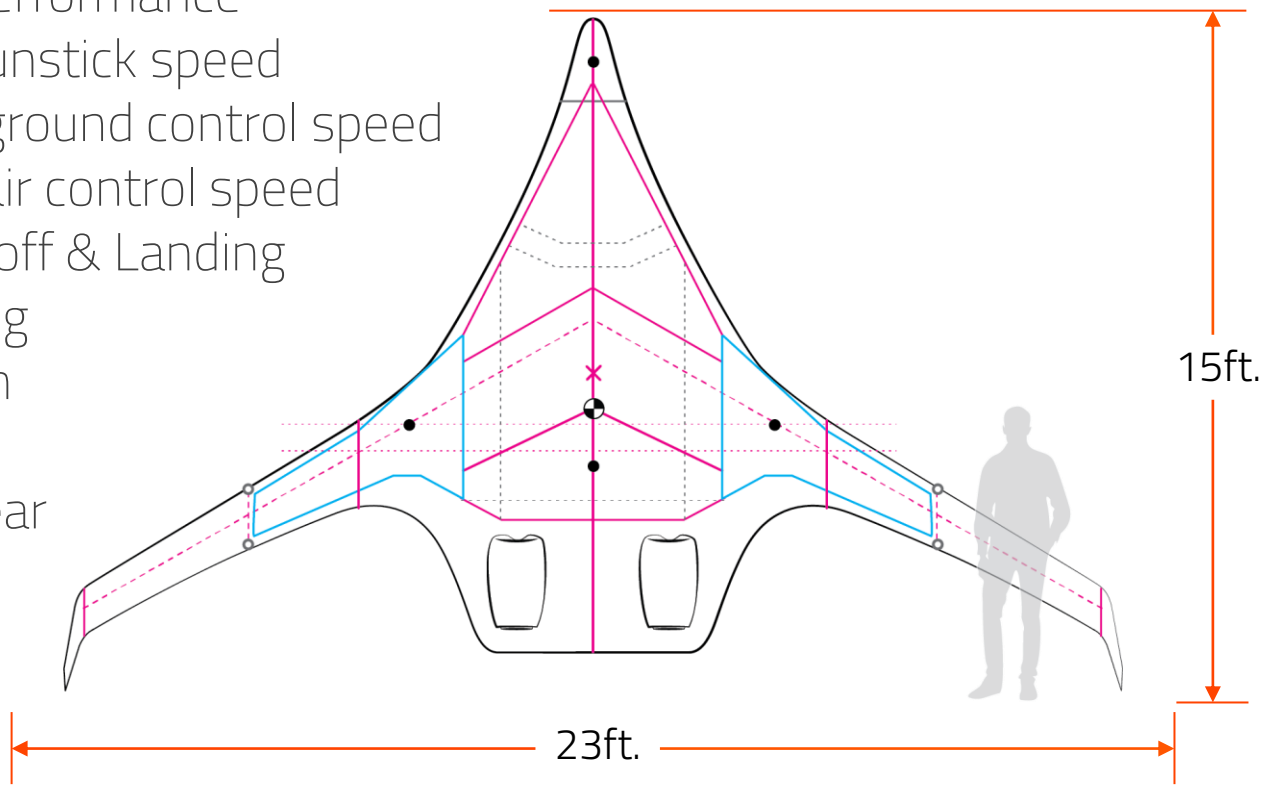


12.5% Scale Pivot-Gear Pathfinder

How do we achieve TRL6? - Pathfinder Scale Model

The Pathfinder will Demonstrate:

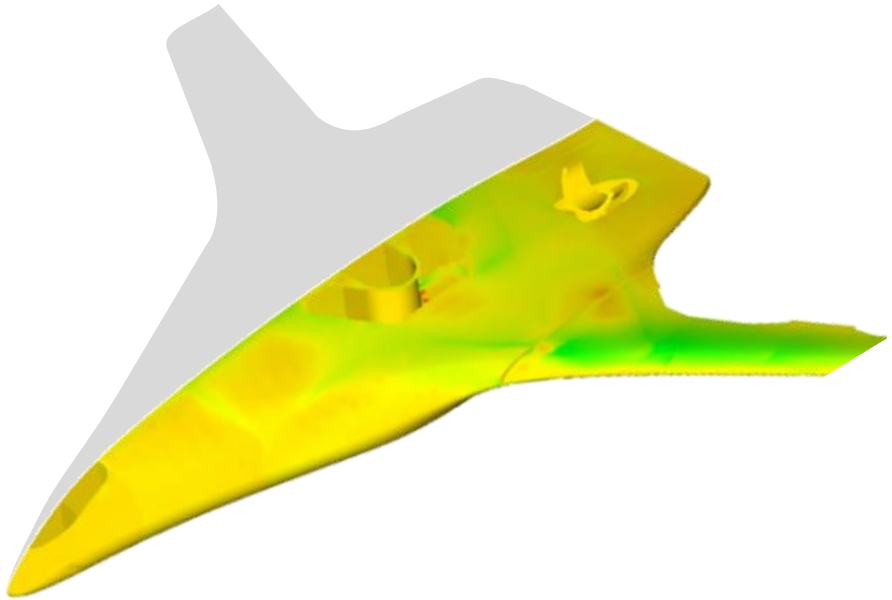
- TOFL and LFL performance
- V_{MU} Minimum unstick speed
- V_{MCG} Minimum ground control speed
- V_{MCA} Minimum air control speed
- Crosswind Takeoff & Landing
- All-wheel braking
- Abused Rotation
- Failure modes
- Conventional Gear

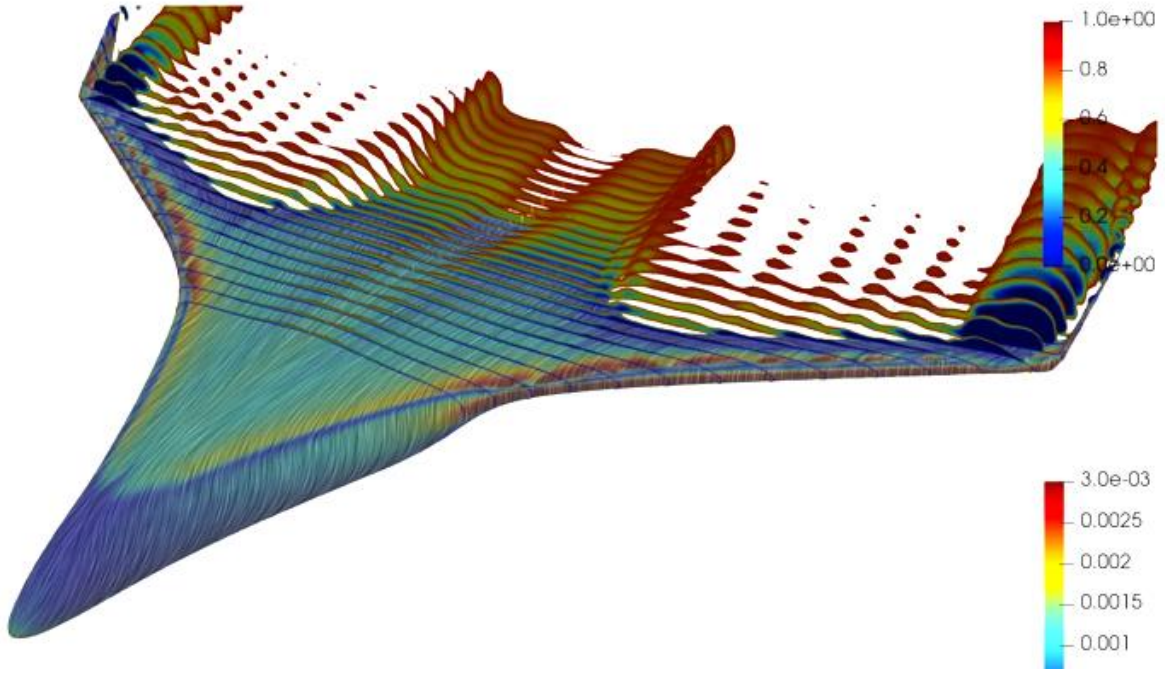


Gross weight	500	lb.
Static Thrust	77	lb.
W/S	9.6	psf.
T/W	31	%
Fan Power	2x 10	kw.
SL Std. TOFL	778	ft.

V1	42	Keas
VR	47	Keas
VMU	48	Keas
VLO	52	Keas
V2	52	Keas

Pathfinder Design Analysis





FEA Strength and deflections
Flutter analysis

CFD validation of Rn-corrected airfoil stack
- Pathfinder is at only 4.4% of full-scale RN
- New airfoils to match aero including C_{Lmax}

Pathfinder Scale Model Details

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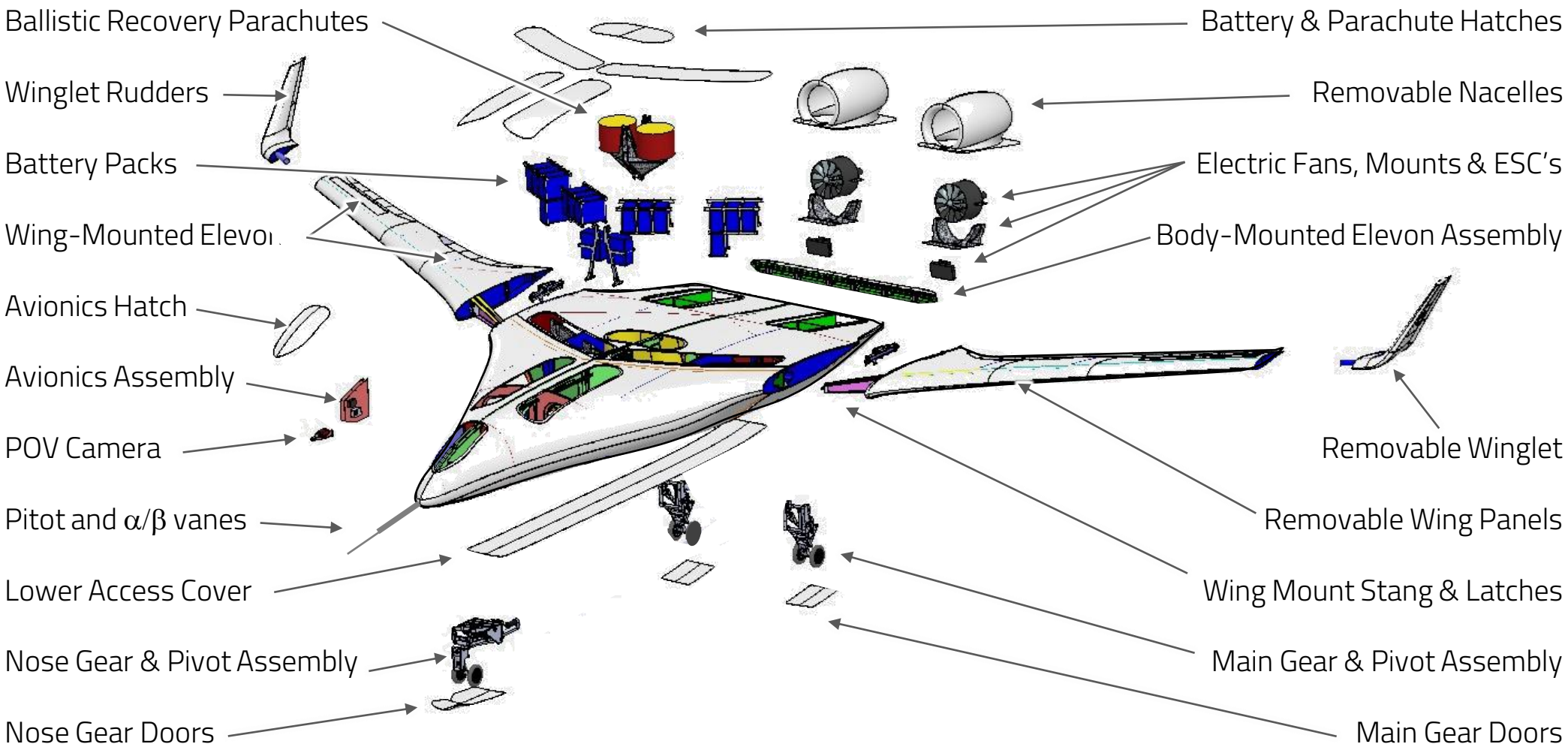
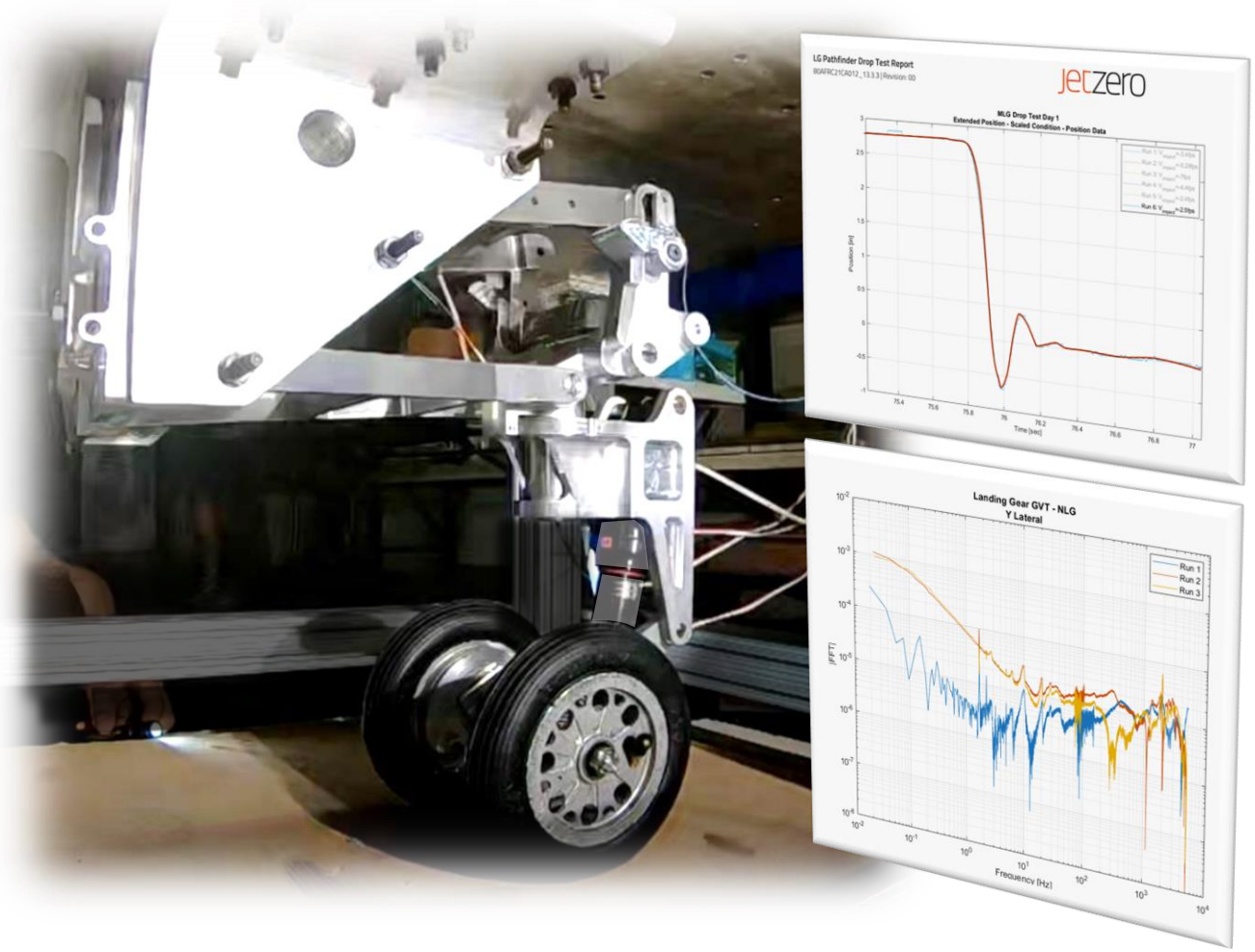


Pathfinder will be 10% larger than X-48

Pathfinder Scaled Landing Gear

- Dynamically-scaled gear
- Scaled dampers
- Identical Mechanization
- Oversized scale structure
- Castering wash-in/wash-out
- Fail-safe detent
- Drop Tested Individually
- Drop Tested collectively
- Damping Assessment
- GVT



Next – *Assemble the Airframe and Flight Test in 2023!*

Jetzero | Thank You!