Winglets@Airbus

Gerd HELLER, Airbus Commercial Aircraft
Hochschule für Angewandte Wissenschaften, Hamburg
January 9th 2020

AIRBUS

Deutsche Gesellschaft für Luft- und Raumfahrt Lilienthal-Oberth e.V. Bezirksgruppe Hamburg

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ZAL

Verein Deutscher Ingenieure Hamburger Bezirksverein e.V. Arbeitskreis Luft- und Raumfahrt

Hamburg Aerospace Lecture Series
Hamburger Luft- und Raumfahrtvorträge

HAW HAMBURG

RAeS Hamburg in cooperation with the DGLR, VDI, ZAL & HAW invites you to a lecture

Winglets@Airbus

Dr.-Ing. **Gerd Heller**, Senior Aerodynamics Expert, Airbus Operations

Date: Thursday 09 January 2020, 18:00
Location: HAW Hamburg Berliner Tor 5, (Neubau), Hörsaal 01.11

Lecture followed by discussion
No registration required !
Entry free !

Lecture in English if requested

Winglets, the small "wings" at the tip of aircraft wings, have long been of particular interest. Do they only offer a convenient area for the airline logo, or are there any other good reasons for equipping an aircraft with winglets?
In fact, winglets have a global influence on the flow field and can thus make a significant contribution to reducing air resistance.
But how does a winglet work in detail? How can aerodynamic mechanisms be used to generate a noticeable effect on the aircraft system in a severely restricted parameter space? It also requires profound knowledge of various interactions with other disciplines.
Is the integration of winglets the real challenge? There are clear differences between retrofitting existing aircraft or a new design.
Finally, all solutions, along with their respective motivations, will be presented on the basis of the complete Airbus fleet.

After graduating from the Technical University of Munich with a PhD, Gerd Heller joined Dornier as an aerodynamicist in 1997 and in 1999 became Head of Aerodynamics. In 2003 he moved to Airbus in Bremen where he became Local Domain Manager, Airbus Deutschland. He then held various positions within the Aerodynamics Department before becoming Senior Expert Aerodynamics in 2014.

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DGLR Bezirksgruppe Hamburg http://hamburg.dglr.de
RAeS Hamburg Branch http://www.raes-hamburg.de
VDI, Arbeitskreis L&R Hamburg http://www.vdi.de/
ZAL TechCenter http://www.zal.aero/veranstaltungen

Hamburg Aerospace Lecture Series DGLR HAW Hamburg RAeS VDI ZAL

Hamburg Aerospace Lecture Series von DGLR, RAeS, ZAL, VDI und HAW Hamburg (PSL)
http://hav-connect.aero/Group/Lectures

Aviation drives our global economy

Air traffic doubles every 15 years

4.1 billion
Passengers

62.0 million
Tonnes of freight

65.5 million
Jobs supported

$2.4 trillion
Global GDP annually

Source ATAG 2019

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We are in a growth industry

Strong and resilient passenger traffic growth

by 2037:

new aircraft required

39,210

market value

$4.9 trillion

Passenger traffic growth

4.4 % p.a.

Airbus GMF 2018

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We set the highest environmental standards in our sector

Sustainable Development

In 50 years we have reduced

noise by **75%**

CO_2 by **80%**

NO_x by **90%**

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An Airbus takes off or lands every 1.2 seconds

37,000+
Daily flights

20.058
Aircraft sold

12.488
Delivered

60
Produced monthly

End October 2019

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Flight Plan

Drag is needless

Winglets basics

Winglets integration

Airbus solutions

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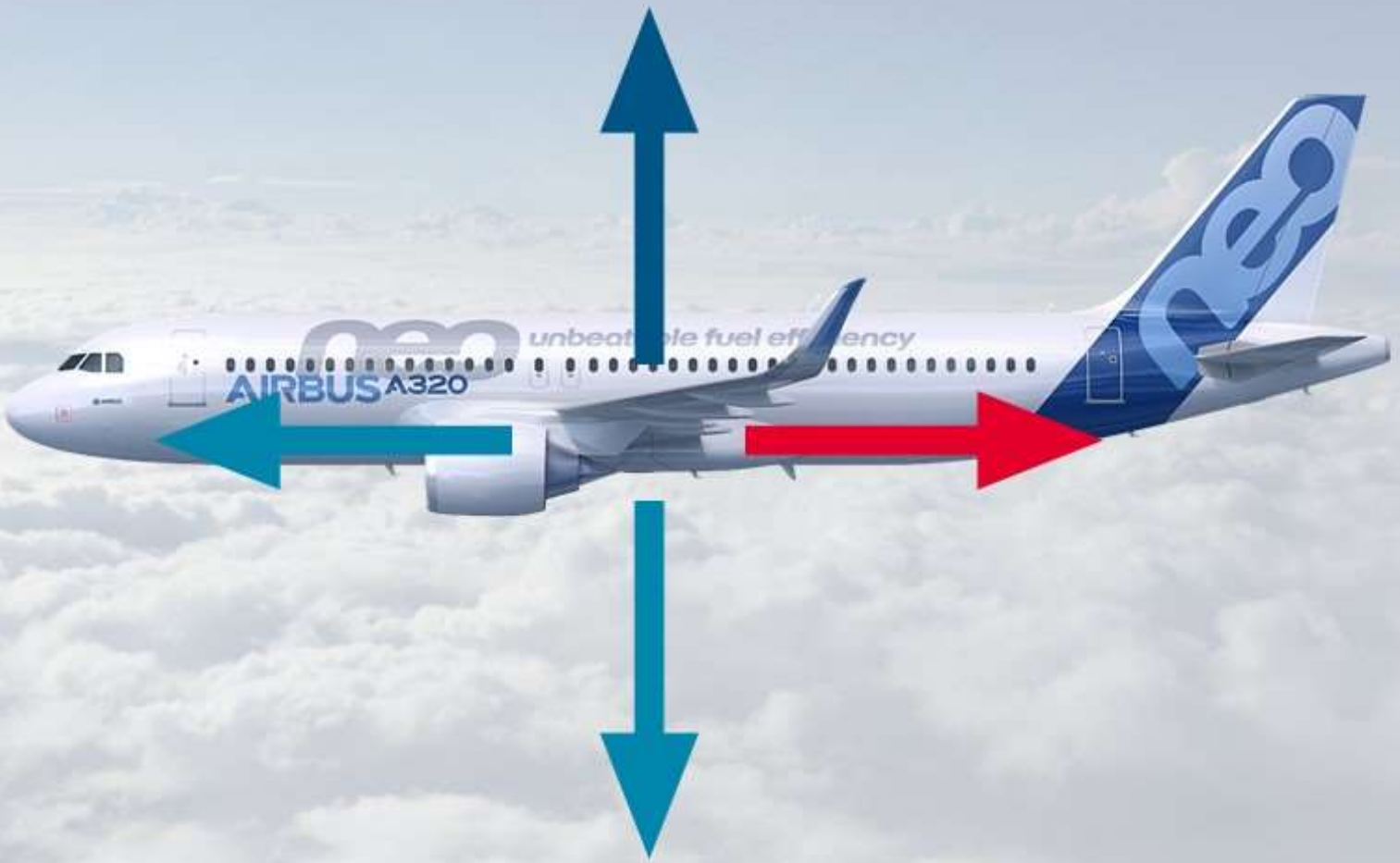
Aircraft in steady flight



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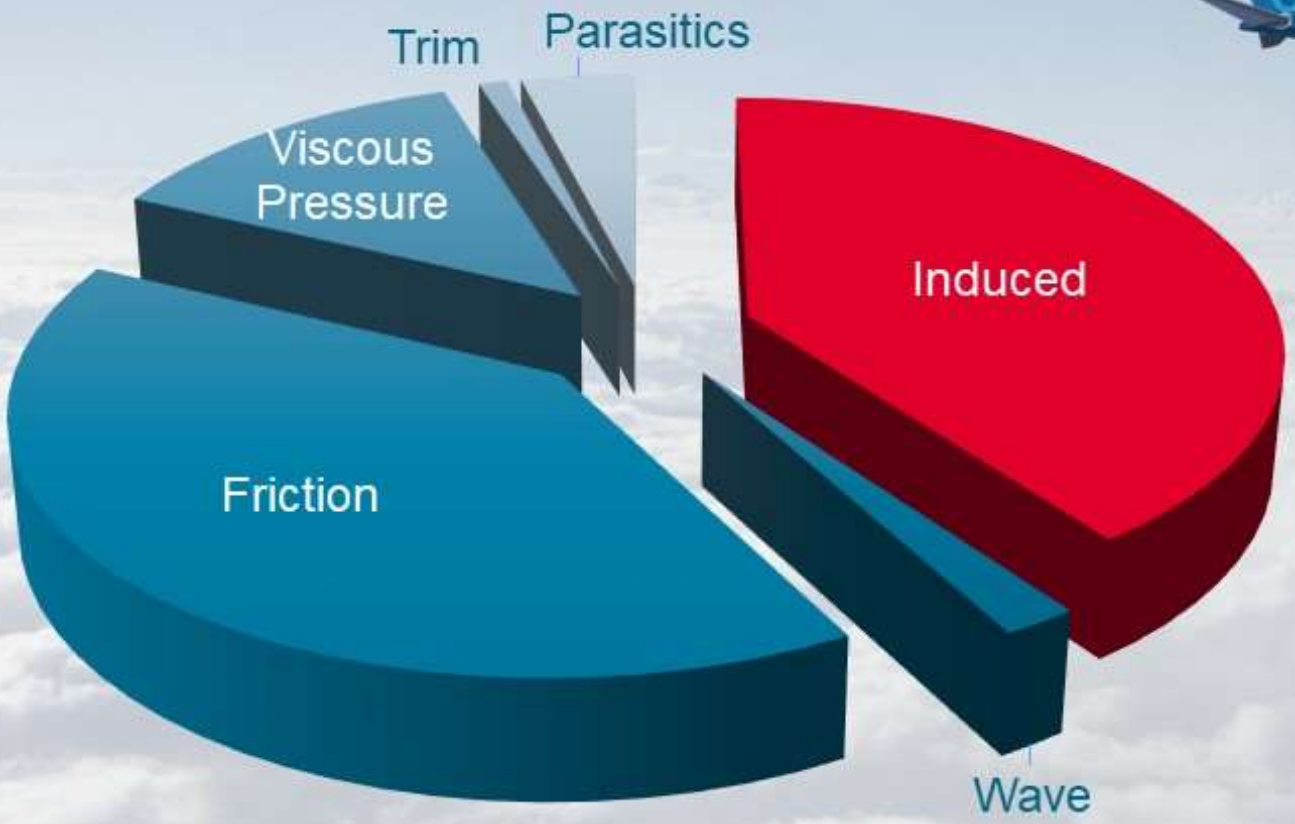
Drag breakdown in cruise flight



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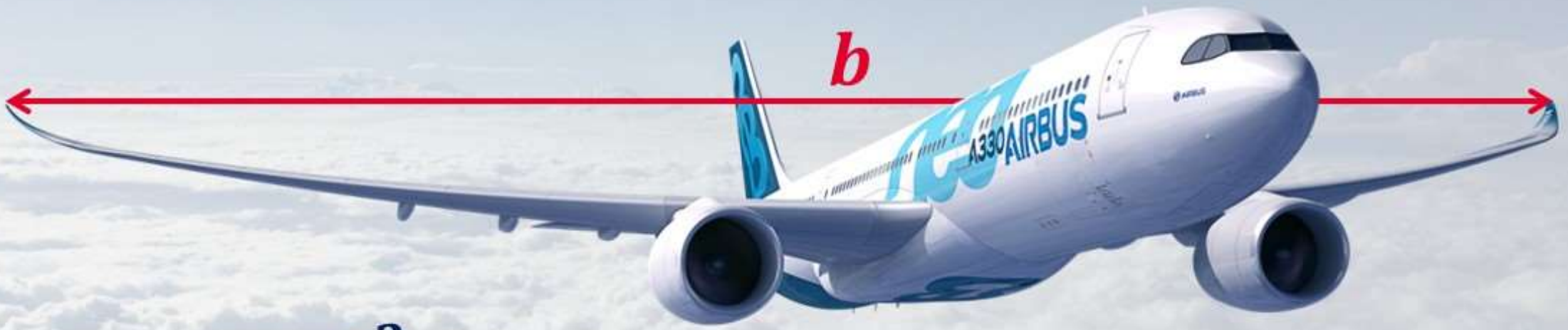
Induced Drag - Span



$$D_i = \frac{L^2}{q_\infty \cdot b^2 \cdot \pi \cdot e}$$

	+10%	span
→	-17%	induced drag
→	-7%	total drag

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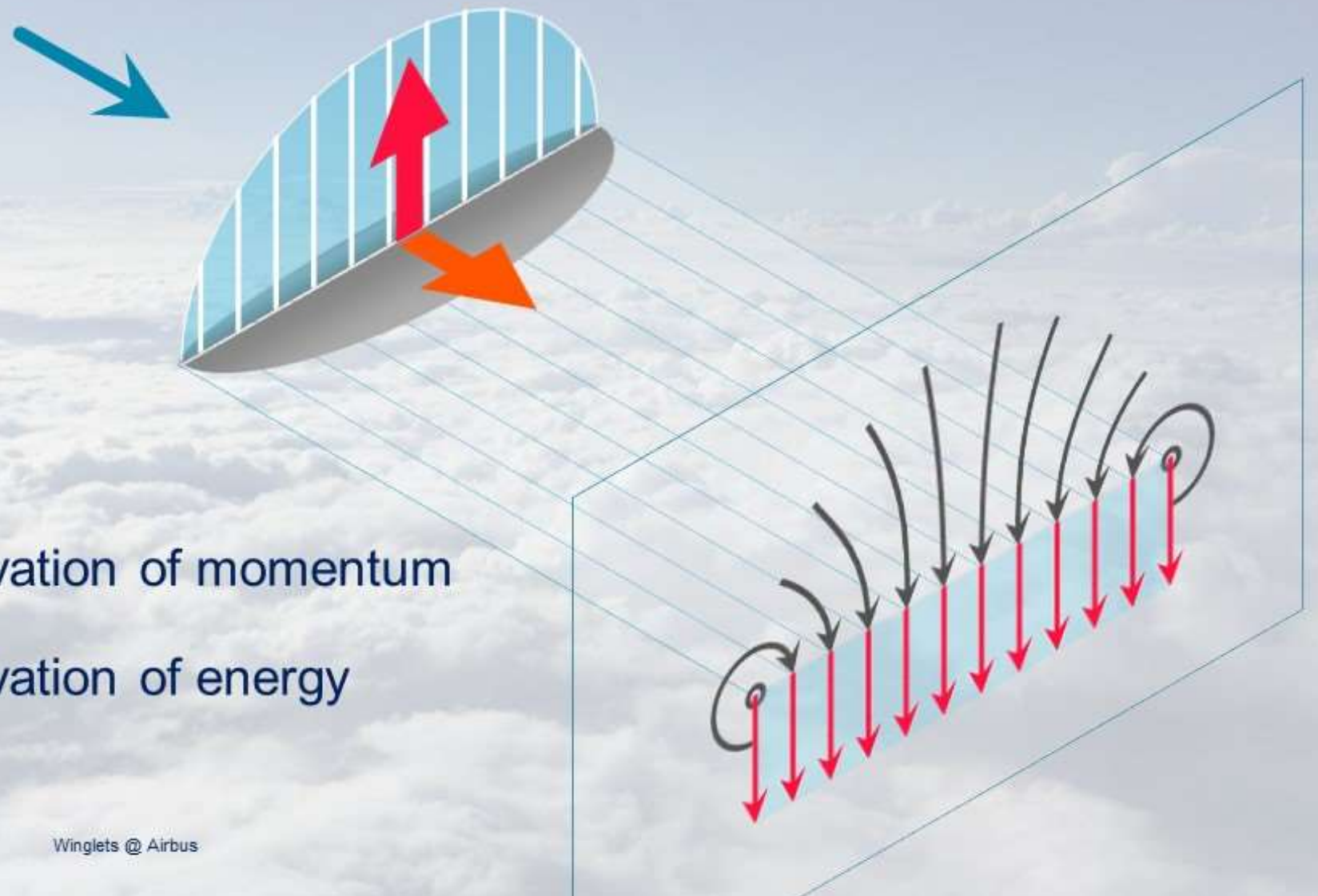
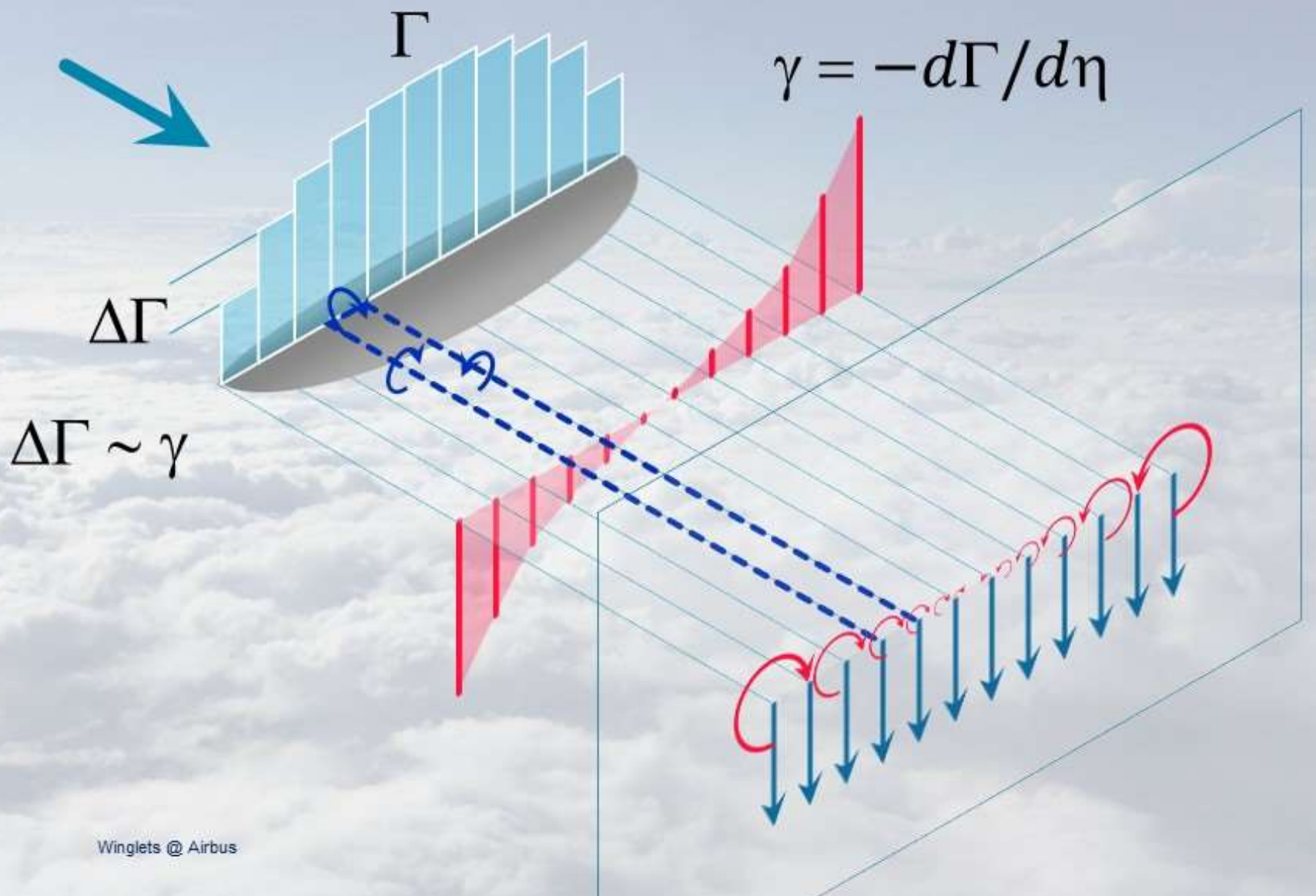
Basics – lift dependent drag



Conservation of momentum

Conservation of energy

Vortex System Model



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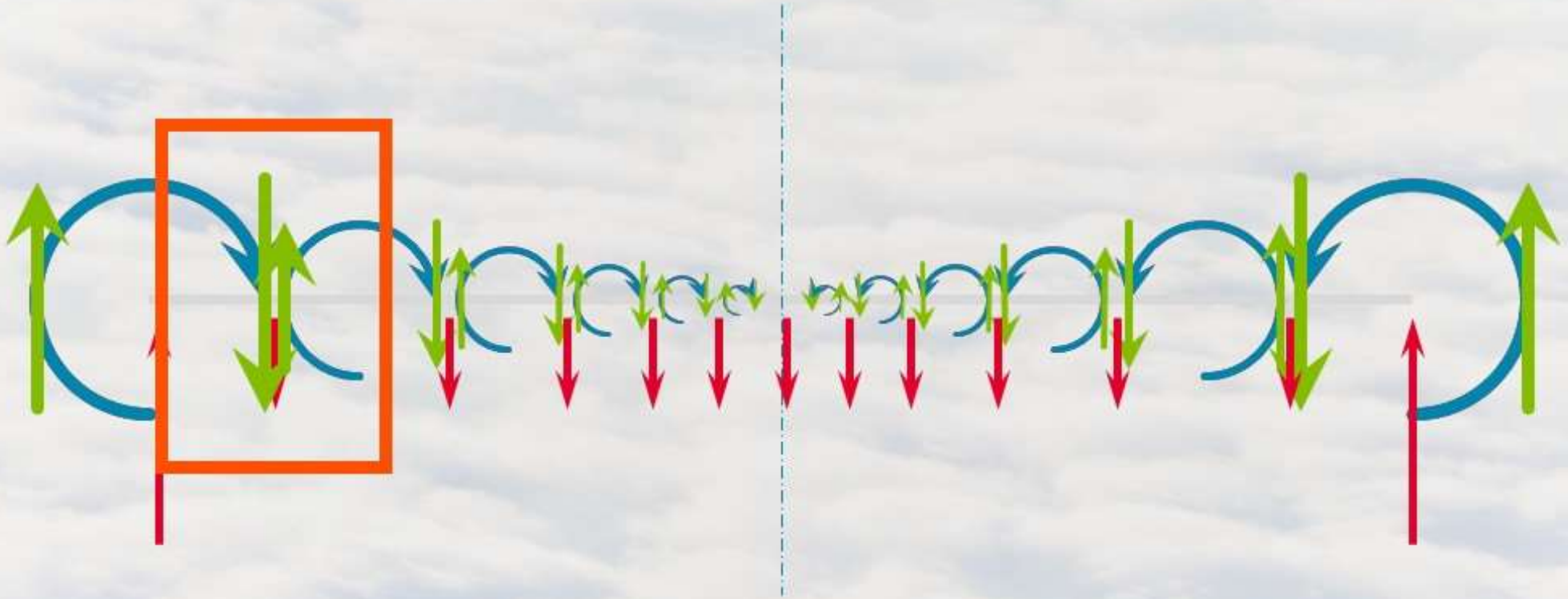
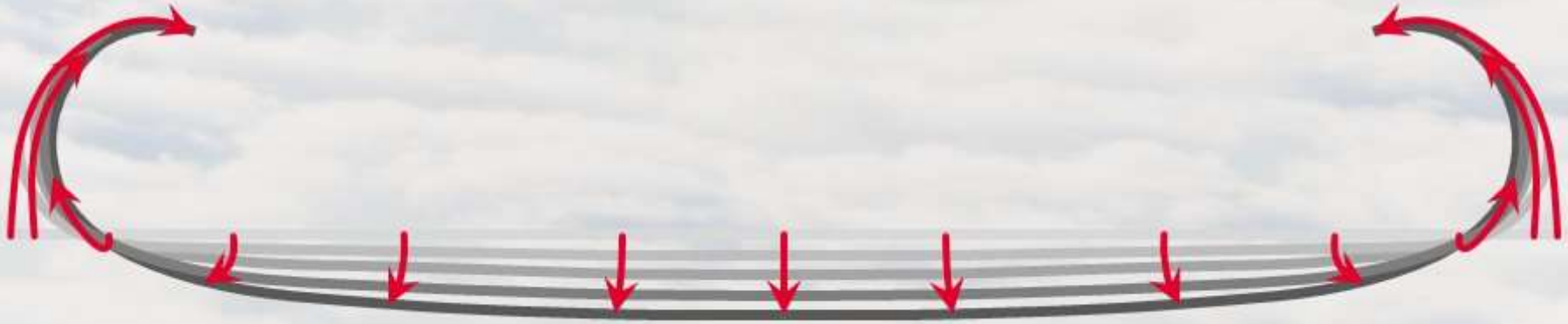
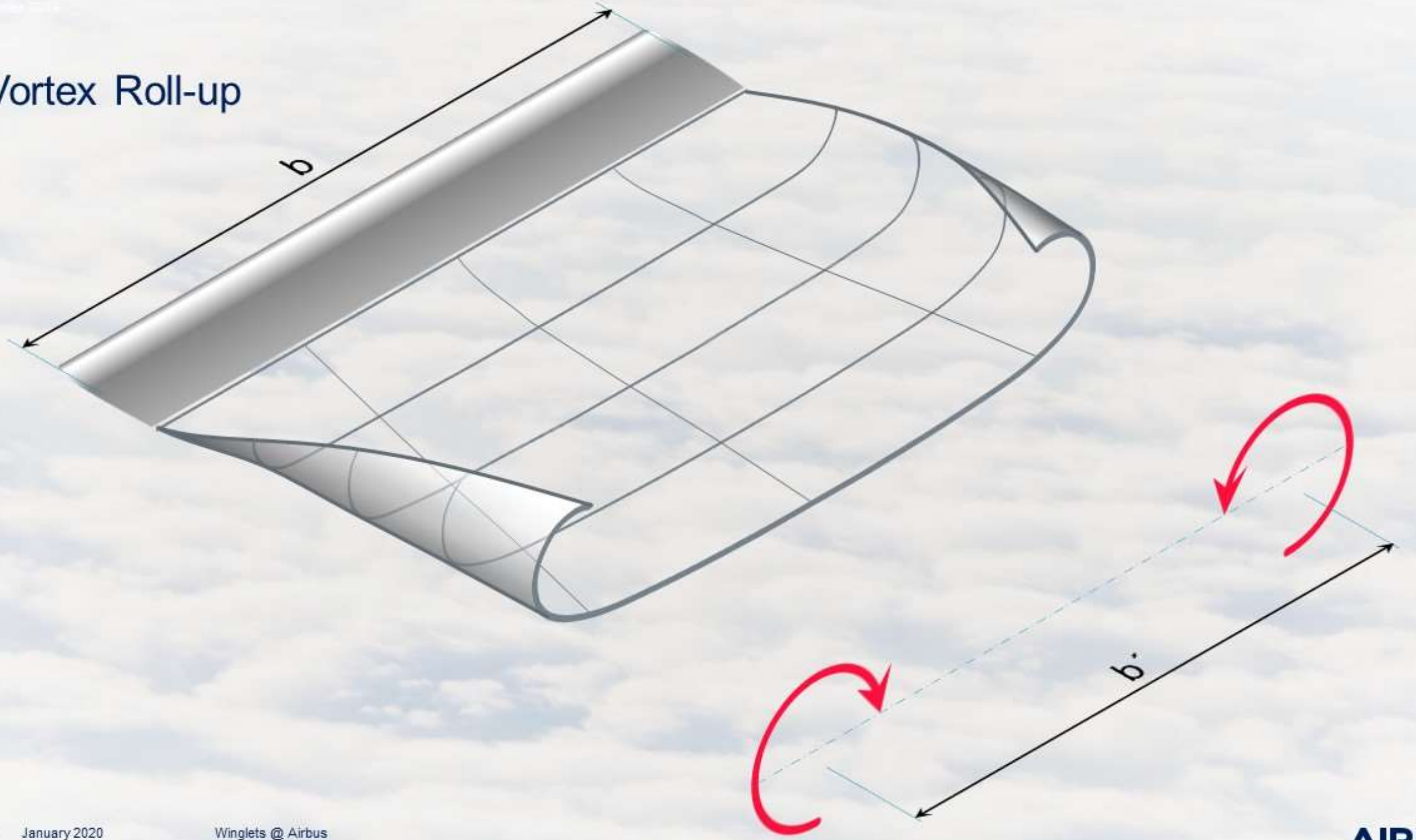
Vortex System



Vortex Roll-up



Vortex Roll-up



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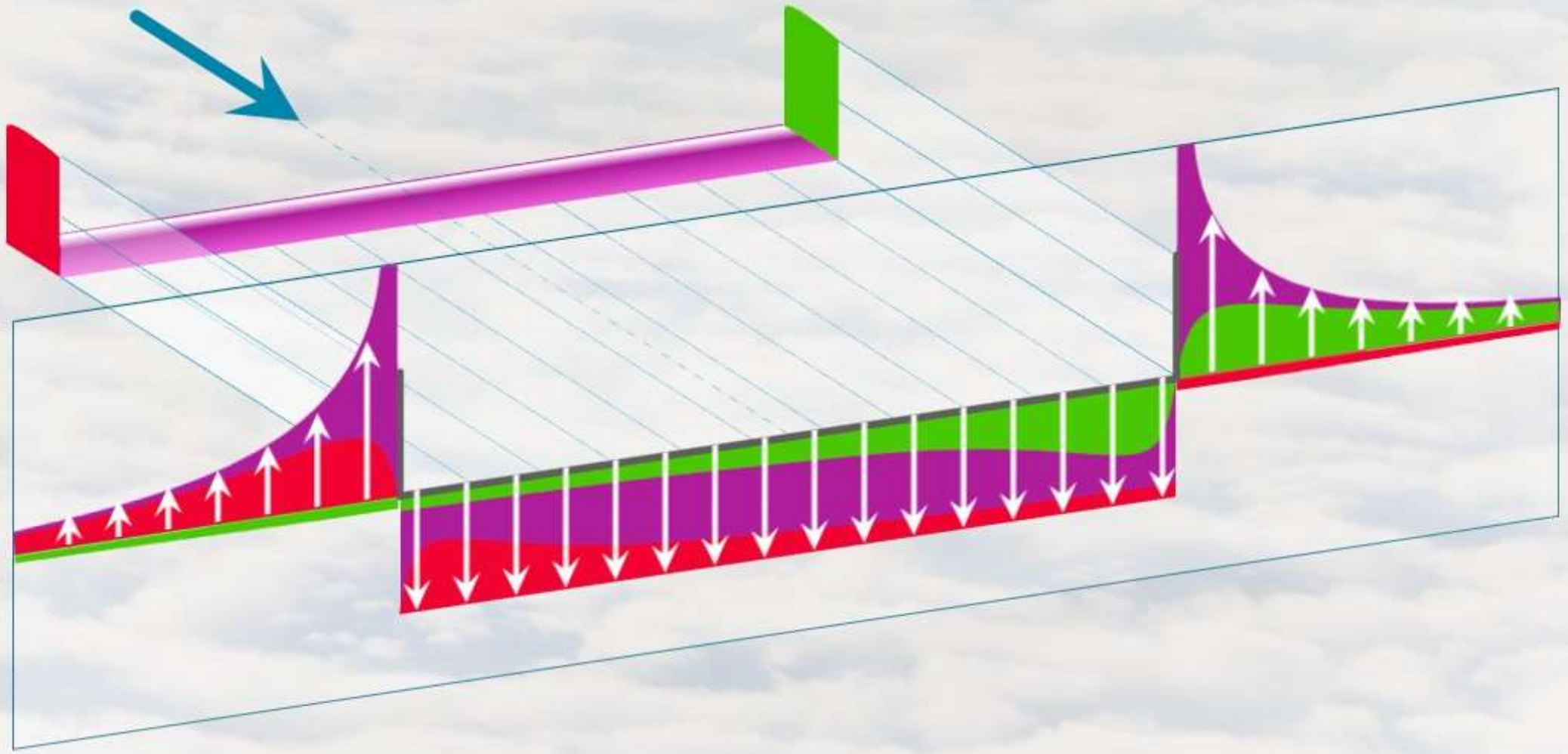
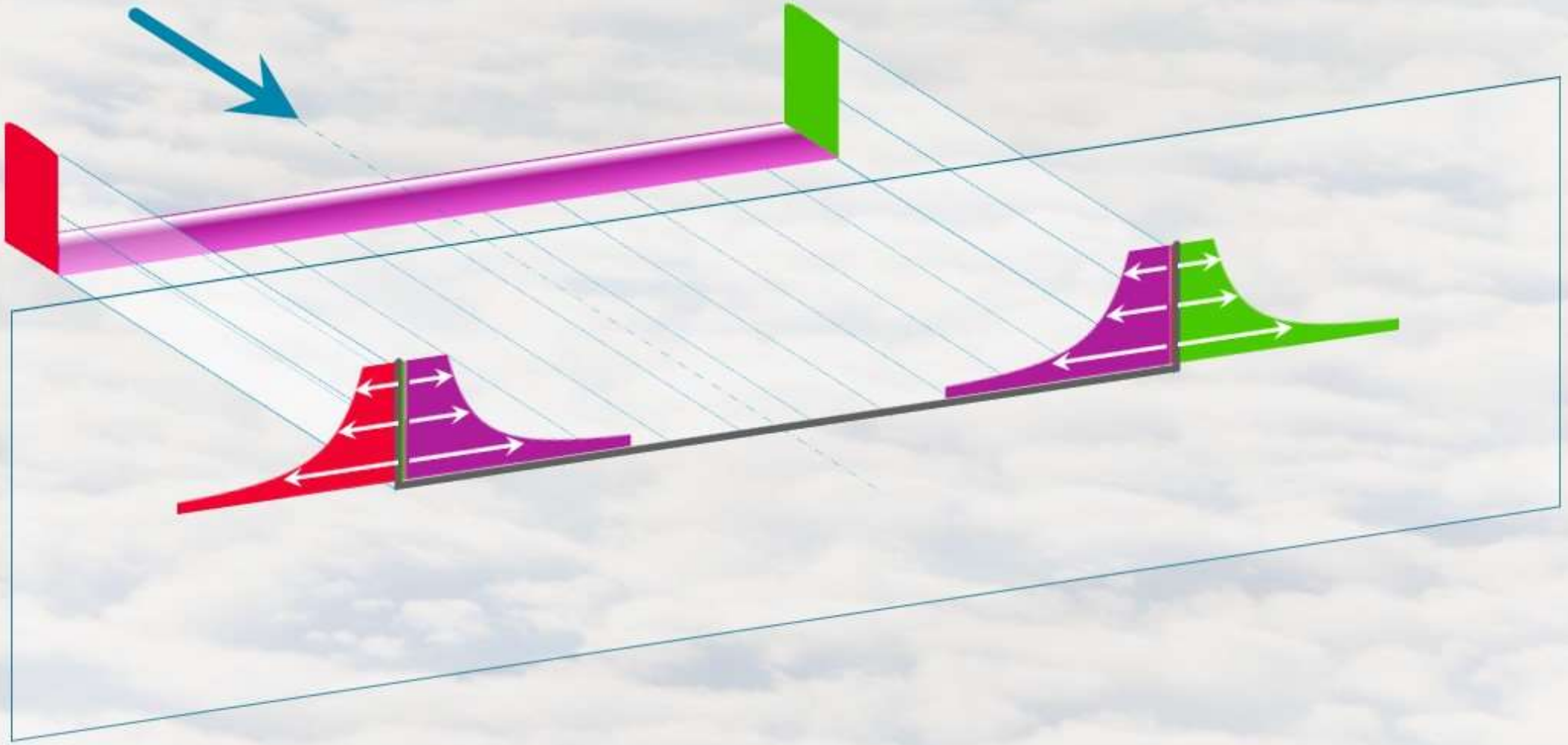
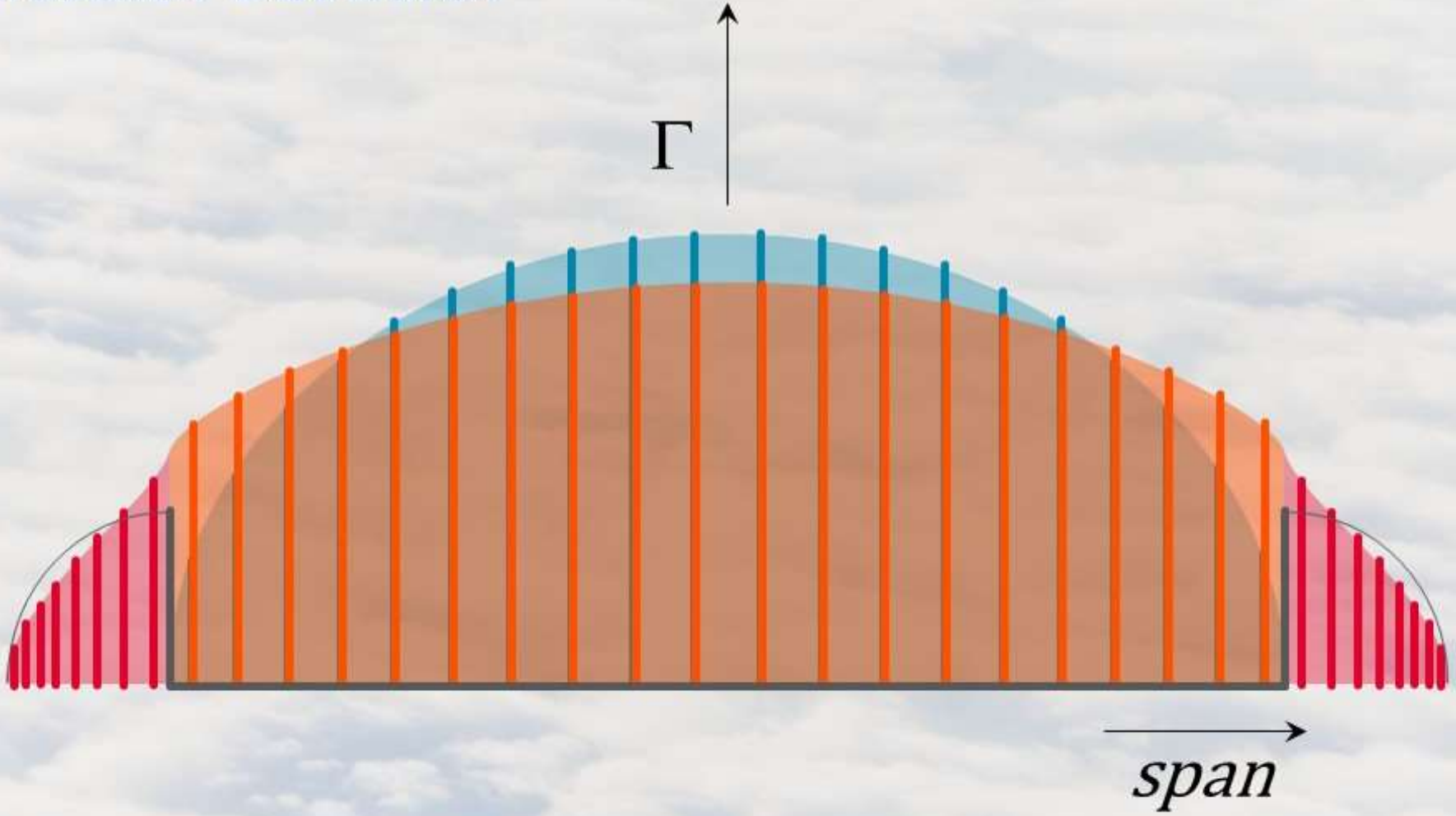
Downwash



Sidewash



Optimal Circulation Distribution



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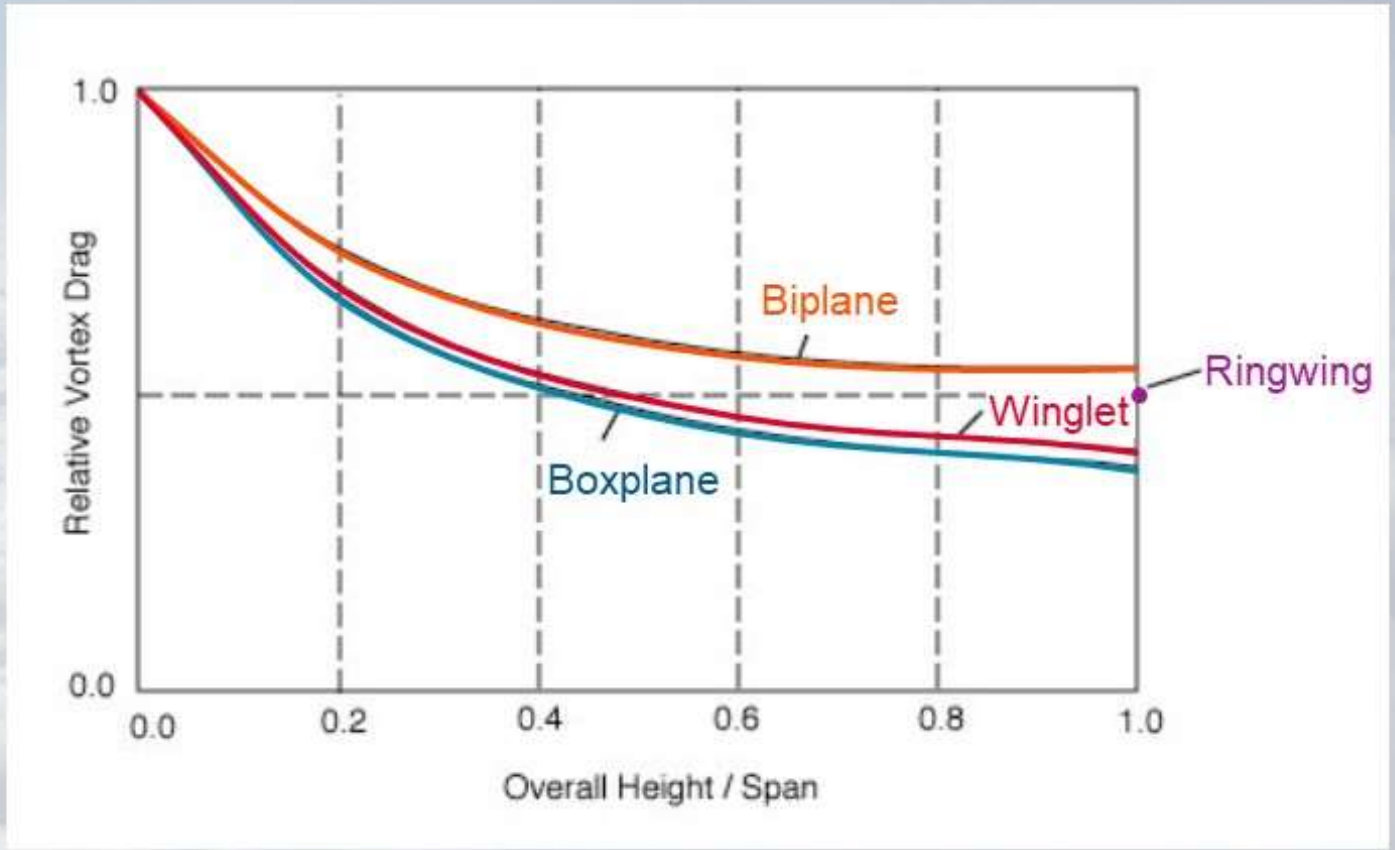
Induced Drag – Non-planar Wing Systems



from I. Kroo, VKI lecture series on Innovative Configurations and Advanced Concepts for Future Civil Aircraft, June 6-10, 2005

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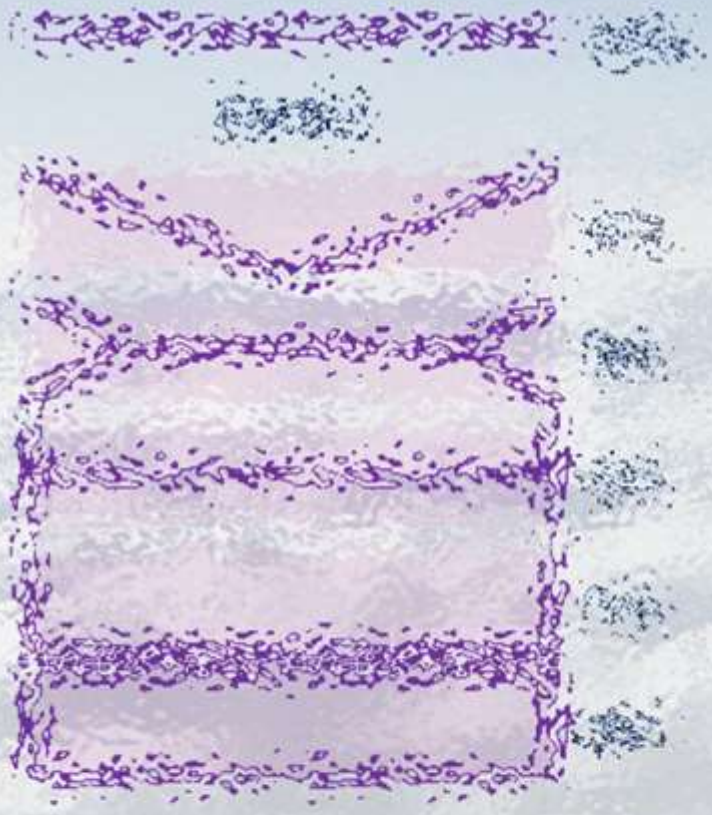

Myth – Influencing the Tip Vortex

A Wing/Winglet creates more than the tip vortex

The vortex system is a global phenomenon

The vortex system is an effect, not a cause

Global effect through local manipulation is impossible!!!

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Winglets Integration

profiledrag↑

wetted area↑

high-lift↑↓

flow complexity↑

Induced drag LS ↓

induced drag HS ↓

wave drag↓

noise↓

look↑

TOFL ↓

range↑↓

effort for retrofit ↑

cost↑

ceiling↑

ground operations↑↓

mass↑

fuel consumption↓

flexibility effects↑

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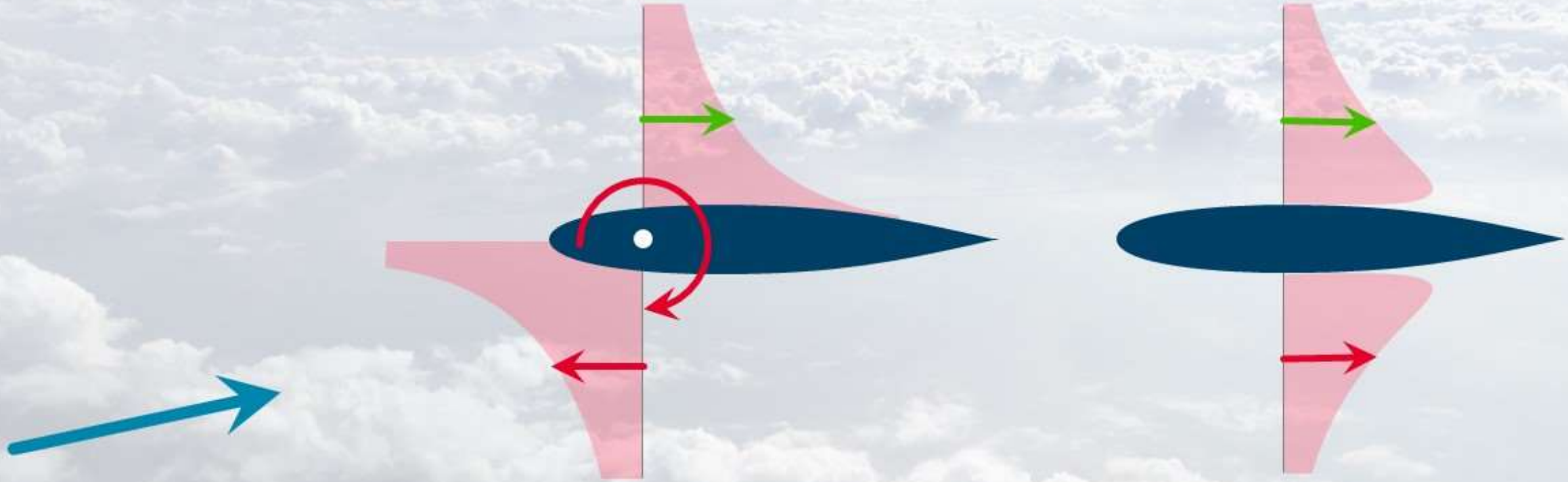
Challenge – Corner Flow



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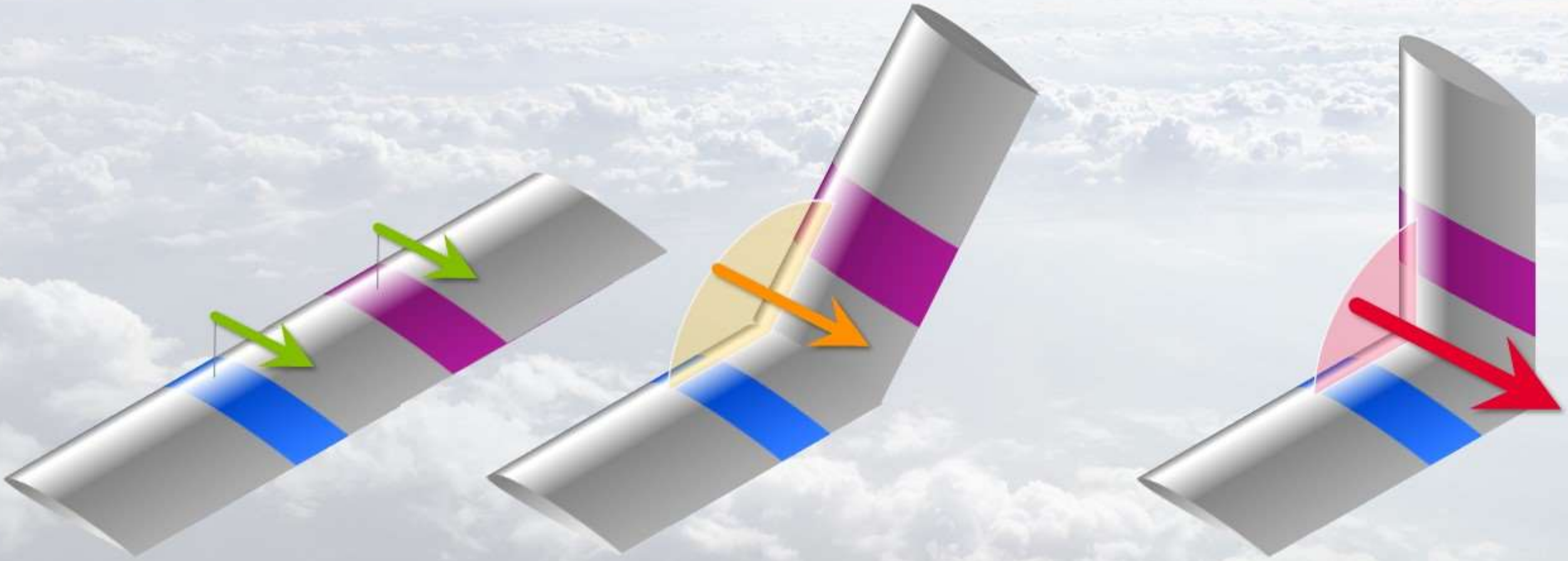
Challenge – Corner Flow



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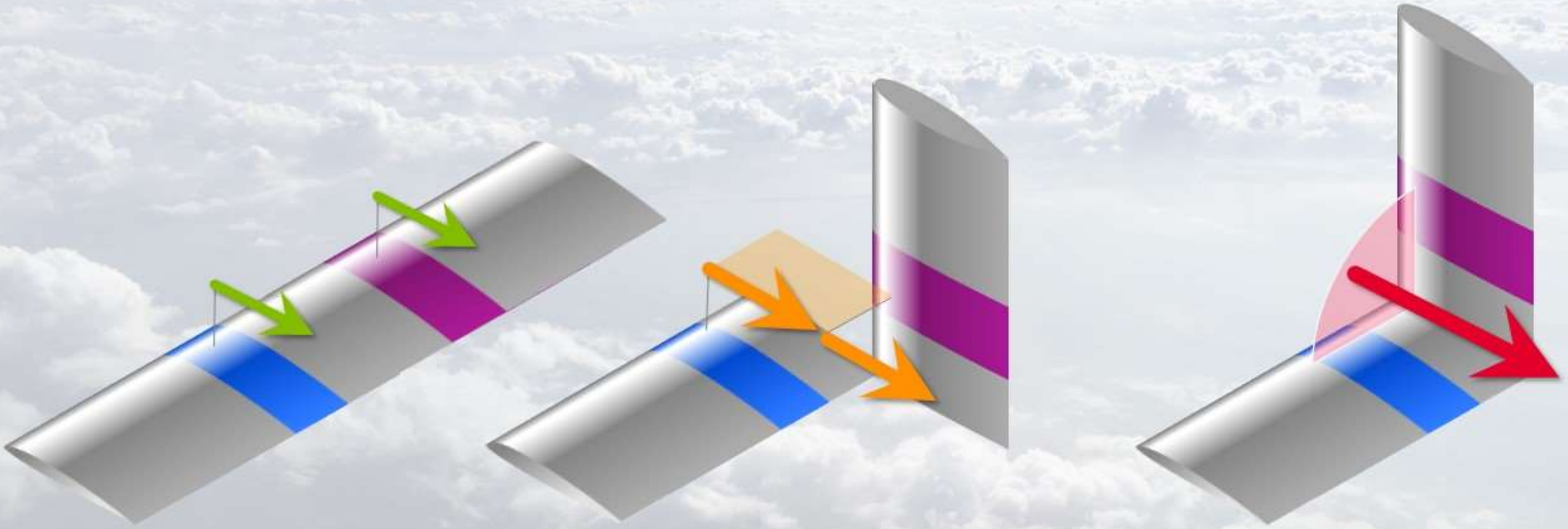
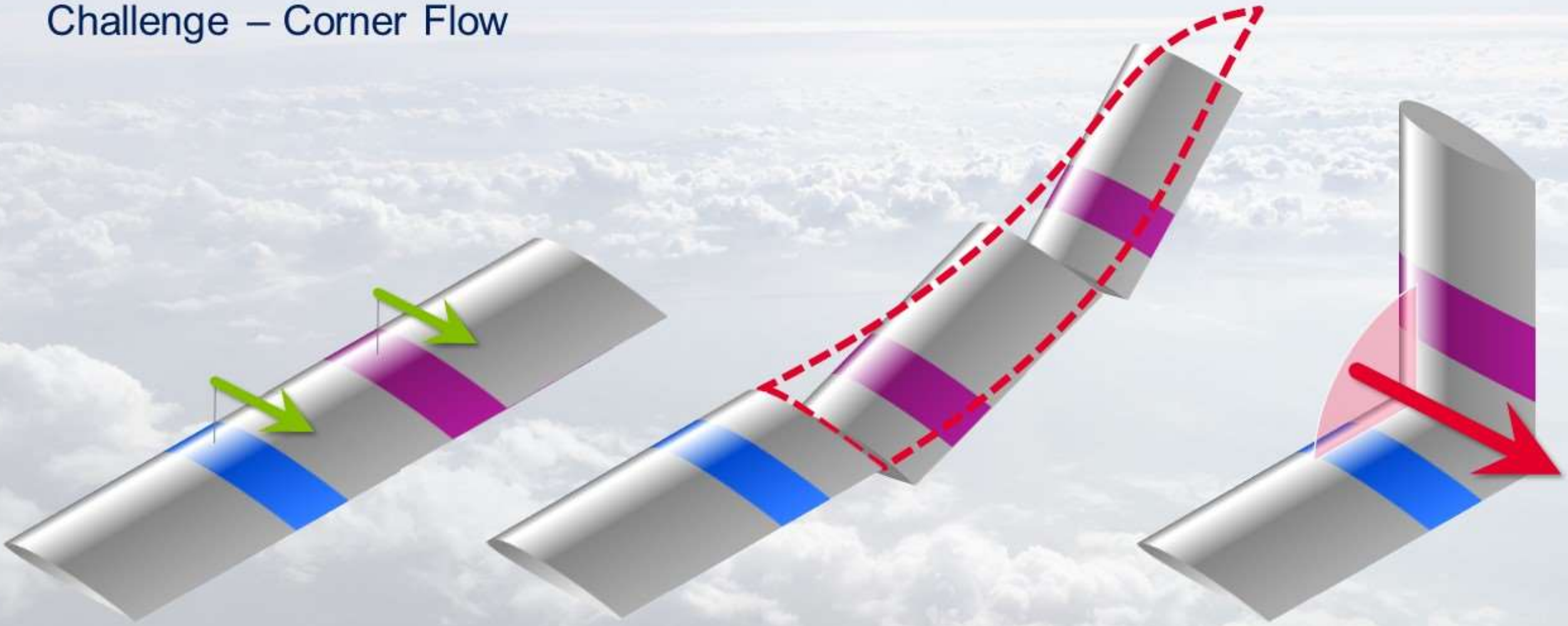
Challenge – Corner Flow



Challenge – Corner Flow



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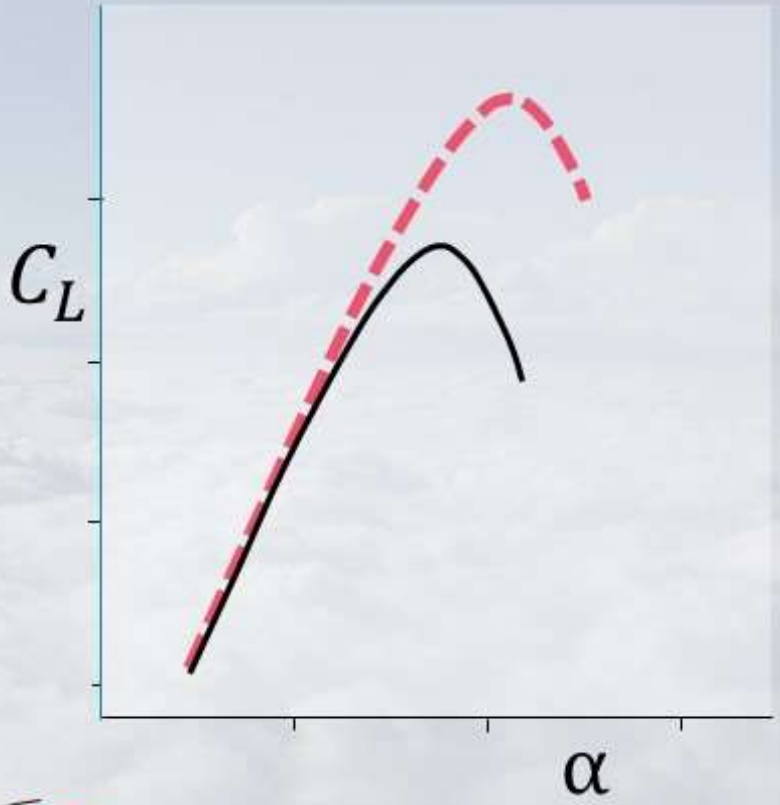
Challenge – High Lift



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Challenge – Retrofit

wing and winglet are an integrated system

integrated design and development with new developments only

the existing wing is a constraint

tuning of the circulation is marginal

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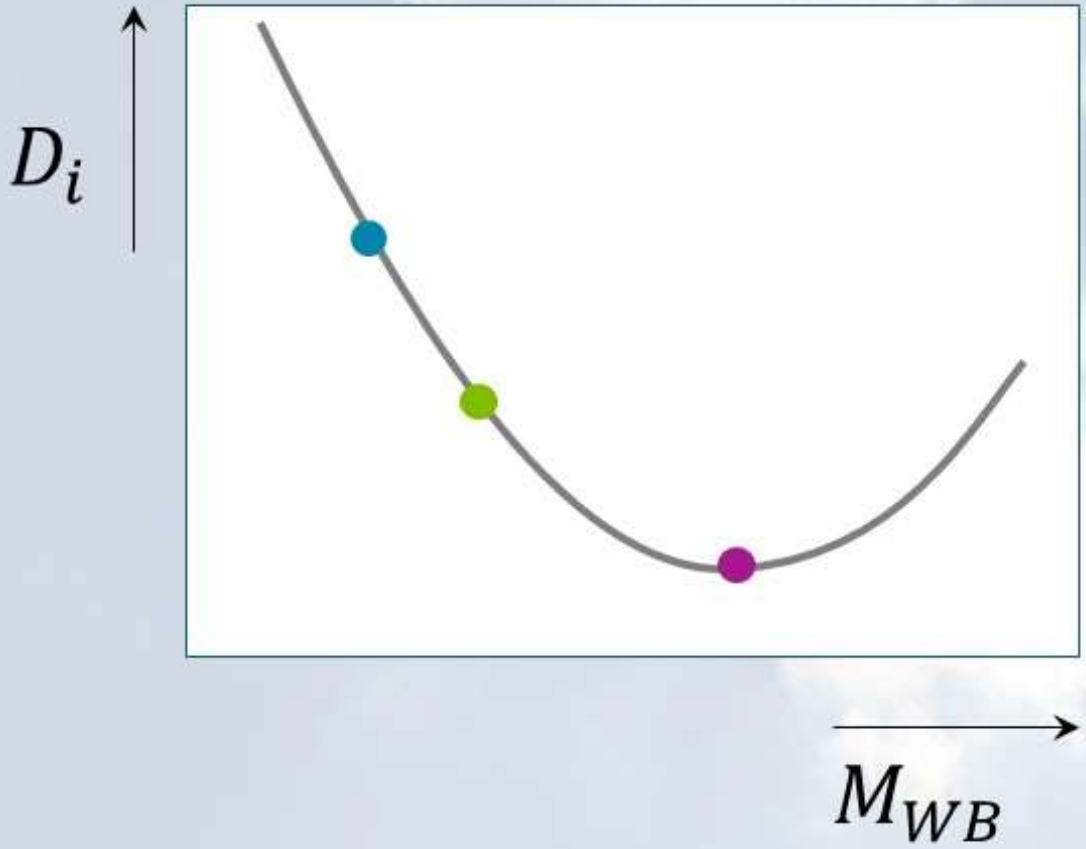
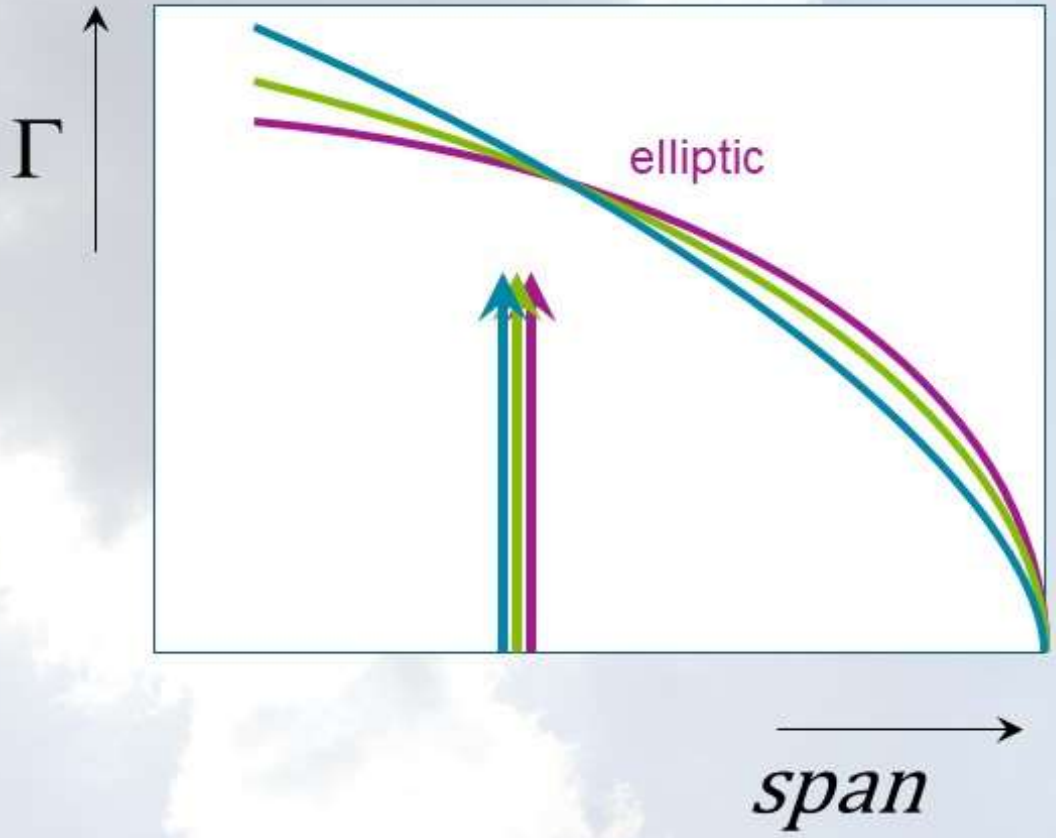
Challenge – Retrofit





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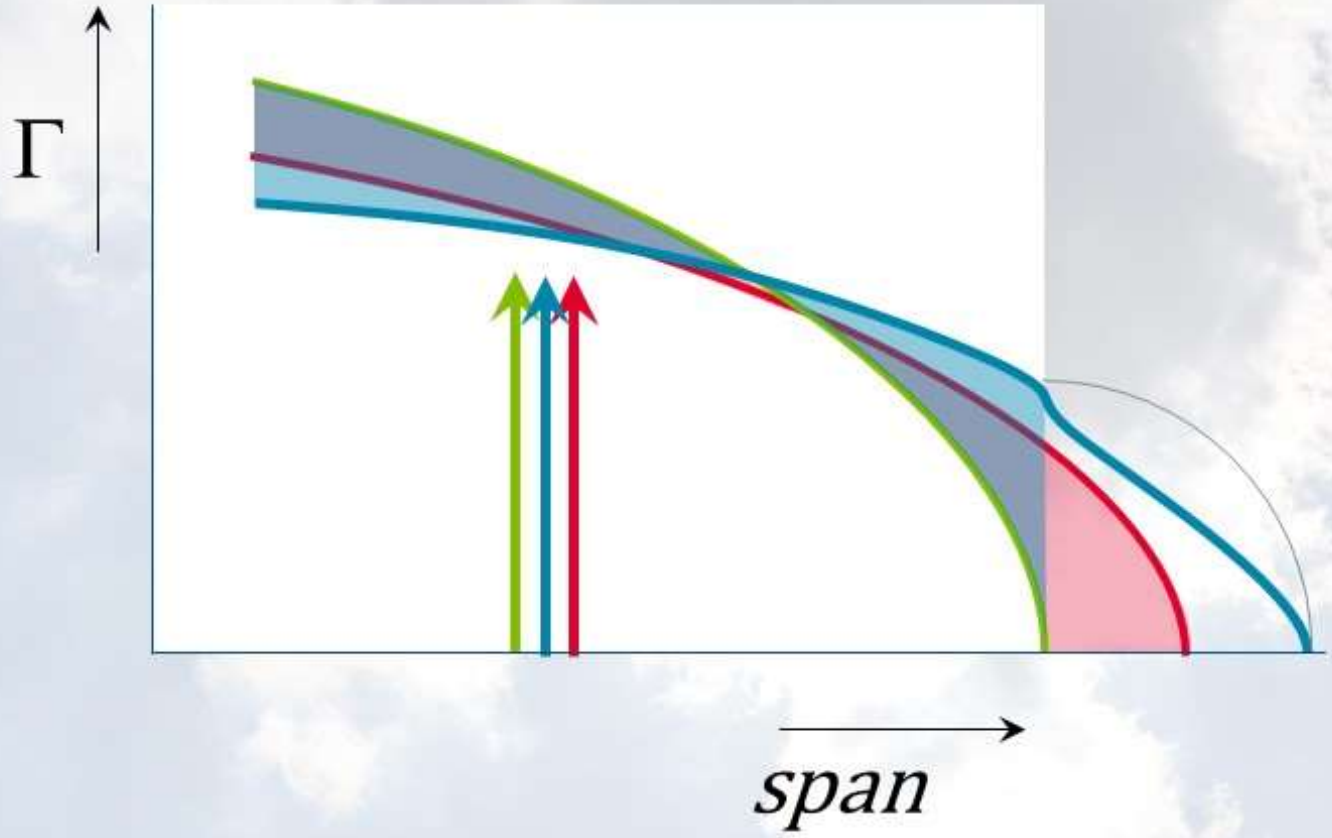
Challenge – Retrofit



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Challenge – Gate Limits

36m

Challenge – Flexibility Effects

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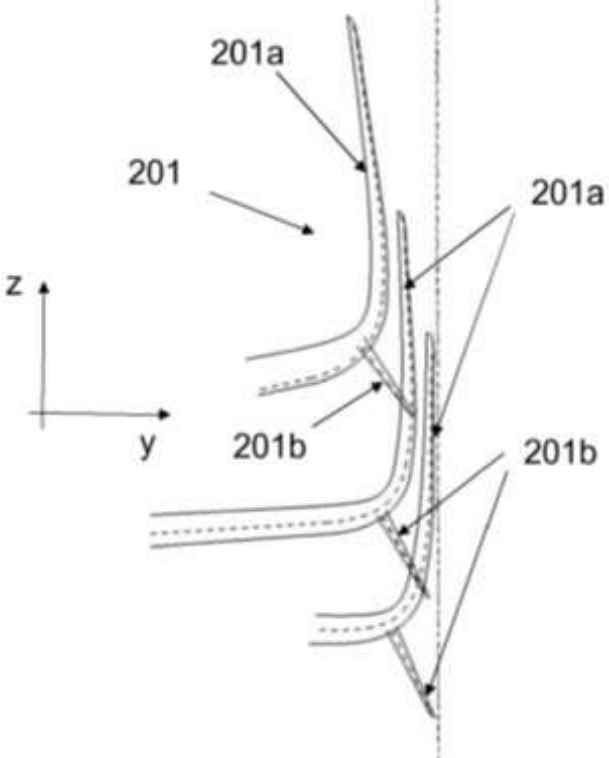
Challenge – Flexibility Effects



EUROPEAN PATENT SPECIFICATION EP 2 593 362 B1, WRIGHT, Christopher; CHU, James, K.; HIMISCH, Jan; WING TIP DEVICE AND METHODS, filed 07.07.2011

EUROPEAN PATENT APPLICATION EP 3 366 576 A1, COMMIS, Ben; WRIGHT, Christopher; LEOVIRIYAKIT, Kasidit; HELLER, Gerd; A WINGLET AND METHOD OF DESIGNING A WINGLET, filed 08.02.2018

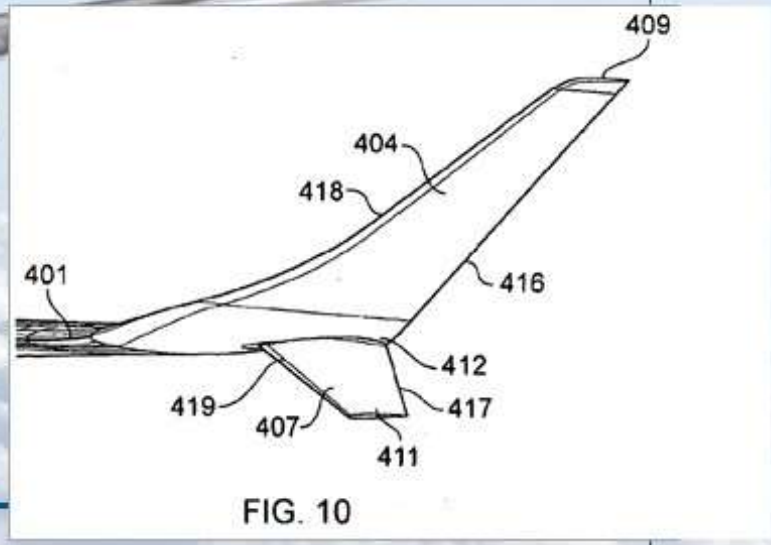


FIG. 10

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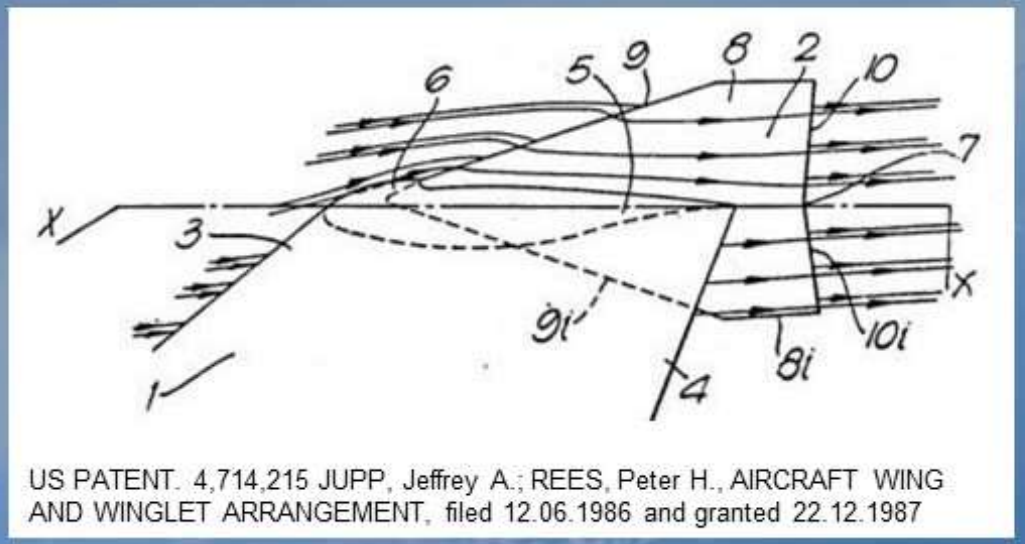
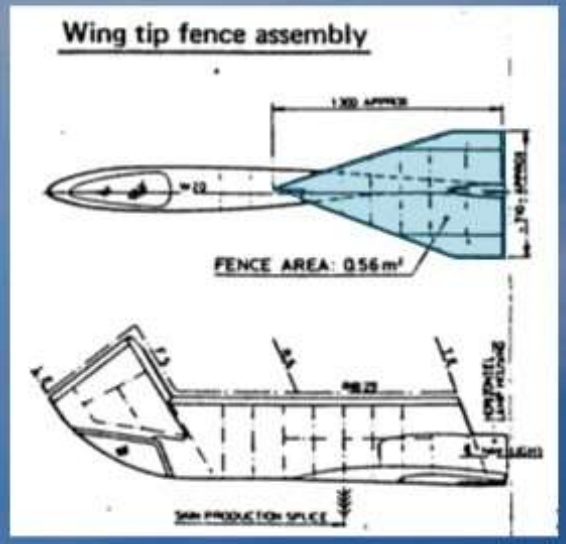
A300

FF 28.10.1972 (B1)
no device

FF 27.12.1974 (B4)
WTF 68°
H 0,7m
L 1,3m



US PATENT. 4,714,215 JUPP, Jeffrey A.; REES, Peter H., AIRCRAFT WING AND WINGLET ARRANGEMENT, filed 12.06.1986 and granted 22.12.1987



AIRBUS

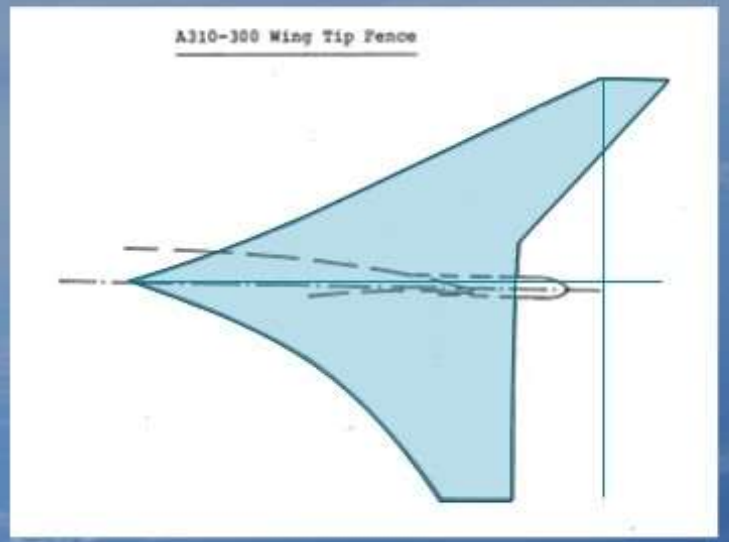
A310

FF 03.04.1982

WTF 65°

H 1,4m

L 1,7m



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A320

FF 22.02.1987 (-100)
no device

FF 28.07.1988 (-200)
WTF 65°
H 1.0m
L 1.2m

"the aircraft and the wing are optimal and improvements, if at all, will be only marginal"

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A330

FF 340 25.10.1991

FF 330 02.11.1992

60° canted winglet

H 1.2m

S 0.7m

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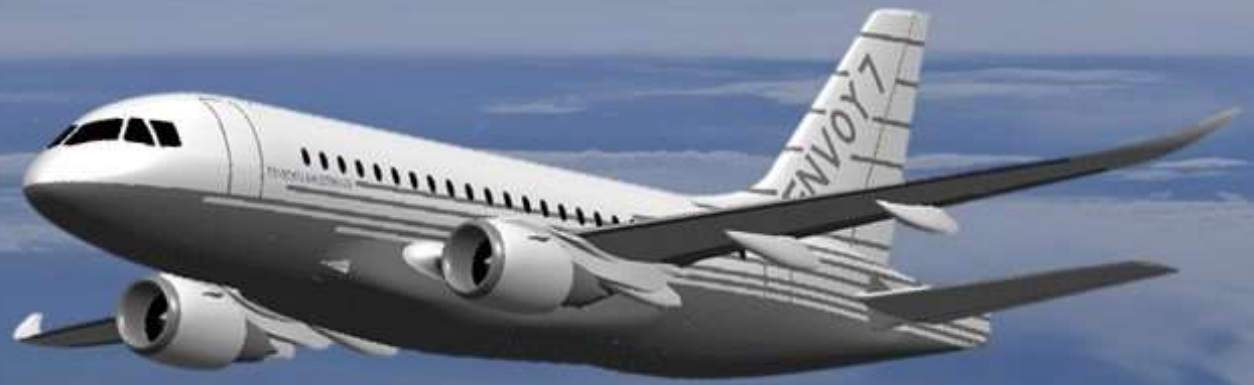
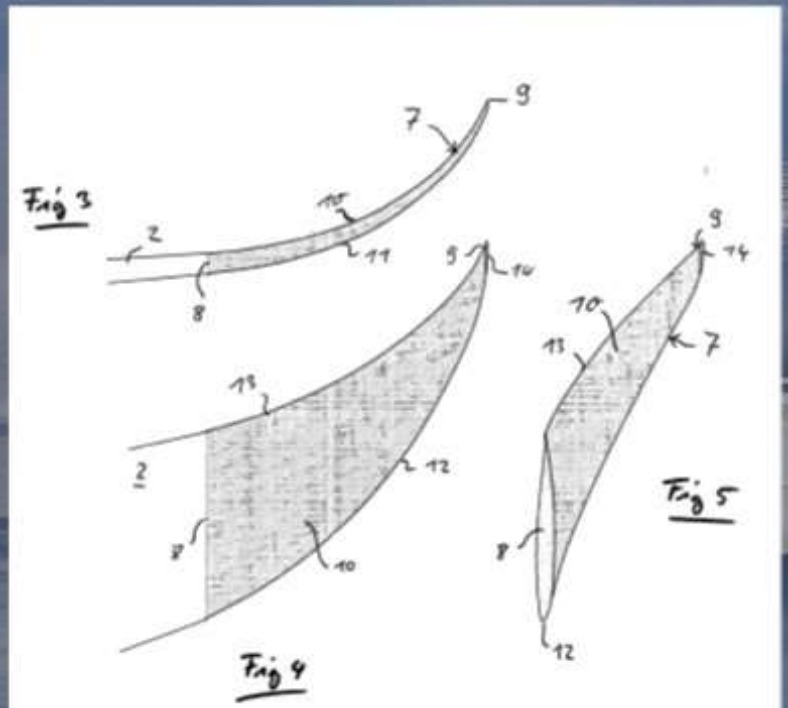
shark

invention 2001

shark type



shark flat
shark
super shark
728JET wingtip
standard winglet



PATENT DE 101 17 721 B4, G. Heller, P. Kreuzer, M. Maisel:
Flügelspitzenverlängerung für einen Flügel, erteilt 27.09.2007

Abb. aus G. Heller, DGLR JT 2001-103, Aerodynamische Leistungssteigerung durch Flügelspitzenmodifikationen am Beispiel der Envoy7

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A380

FF 27.04.2005

WTF 65°

H 2.3m

L 2.8m

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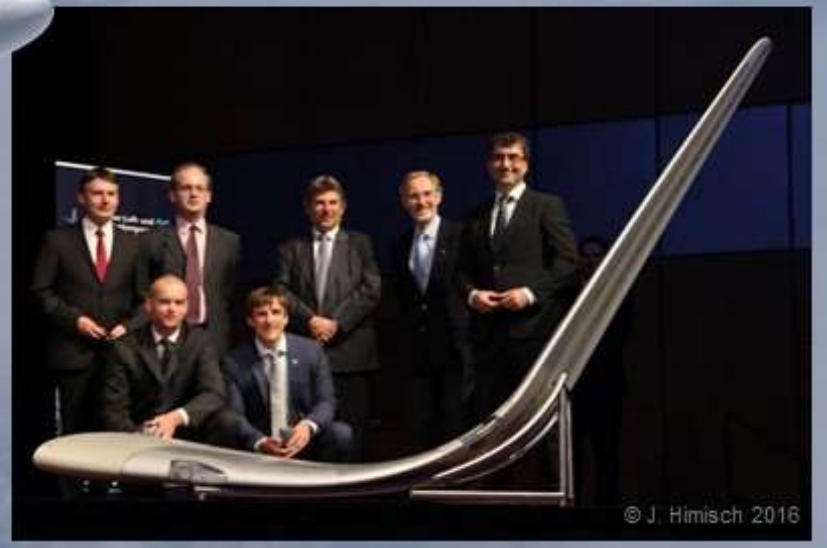
A320 sharklet



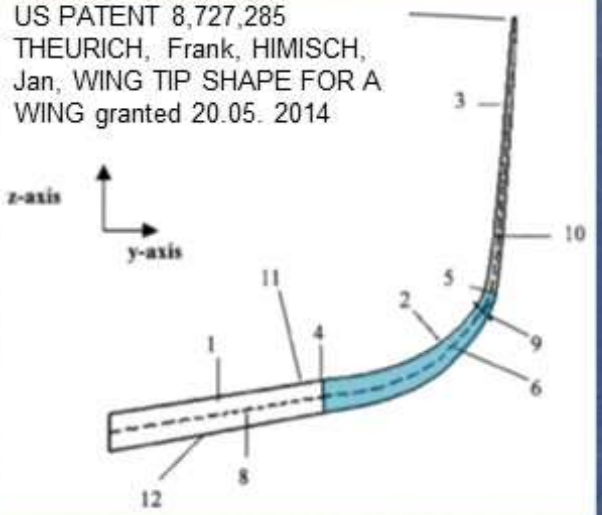
FF 29.11.2011

Sharklet

H 2.5m

S 1.7m

US PATENT 8,727,285
THEURICH, Frank, HIMISCH, Jan, WING TIP SHAPE FOR A WING granted 20.05. 2014



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A350

FF 14.06.2013

shark type

H 2.3m

S 2.9m

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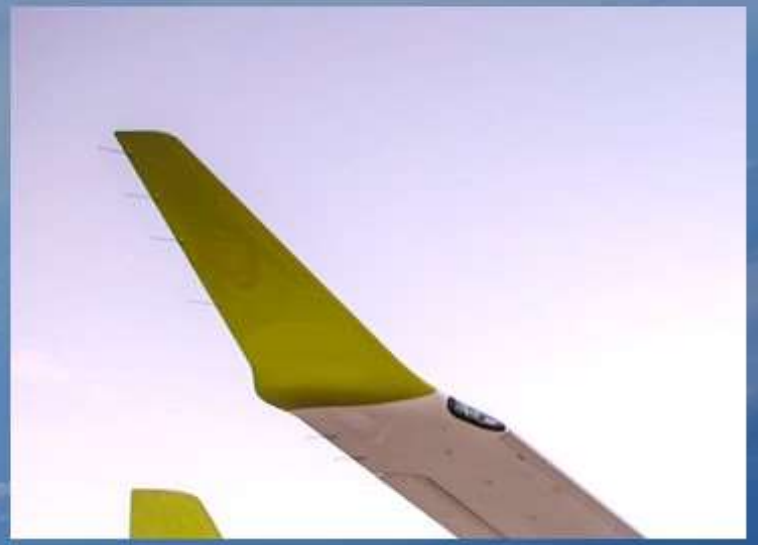
A220

FF 16. Sep 2013

50° canted winglet

H 1.4m

S 1.1m



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A320neo

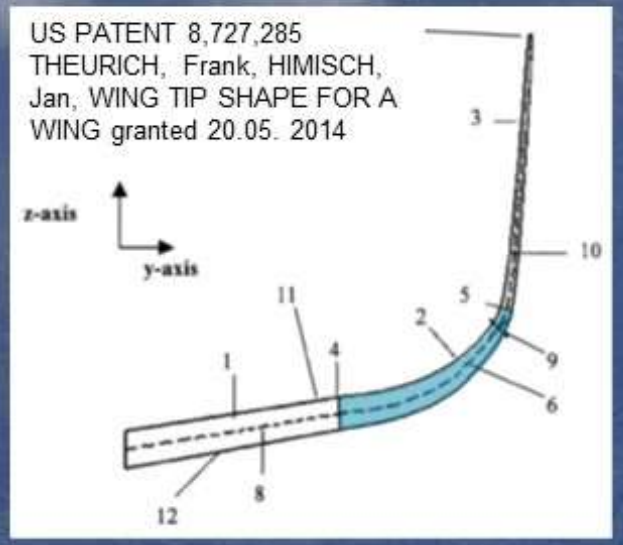
FF 25.09.2014

Sharklet

H 2.5m

S 1.7m

US PATENT 8,727,285
THEURICH, Frank, HIMISCH, Jan, WING TIP SHAPE FOR A WING granted 20.05. 2014



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A330neo

FF 19.10.2017

shark type

H 1,3m

S 2,4m

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Thank you!

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Deutschland

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