



Lecture organised by RAeS
Hamburg Branch
Hamburg Aerospace Lecture
Series
(DGLR, RAeS, VDI, ZAL,
HAW Hamburg)
09.01.2020
HAW Hamburg (Hamburg
University of Applied
Sciences)



Winglets@Airbus

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

AIRBUS

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.

DGLR / HAW Prof. Dr.-Ing. Dieter Scholz
DGLR Dr.-Ing. Martin Spieck
RAeS Richard Sanderson

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<http://www.raes-hamburg.de>
<http://www.vdi.de/>
<http://www.zal.aero/veranstaltungen>



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

A high-angle aerial view of a coastal city, likely Hong Kong, with a large body of water, a suspension bridge, and dense urban development. The wing of an Airbus A350 aircraft is visible in the upper right corner, with the text 'A350' and a logo on the leading edge.

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

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.

We set the highest environmental standards in our sector

Sustainable Development

In 50 years we have reduced

noise by **75%**

CO₂ by **80%**

NO_x by **90%**



An Airbus takes off or lands every 1.2 seconds



37,000+
Daily flights

20.058
Aircraft sold

12.488
Delivered

60
Produced monthly



Flight Plan

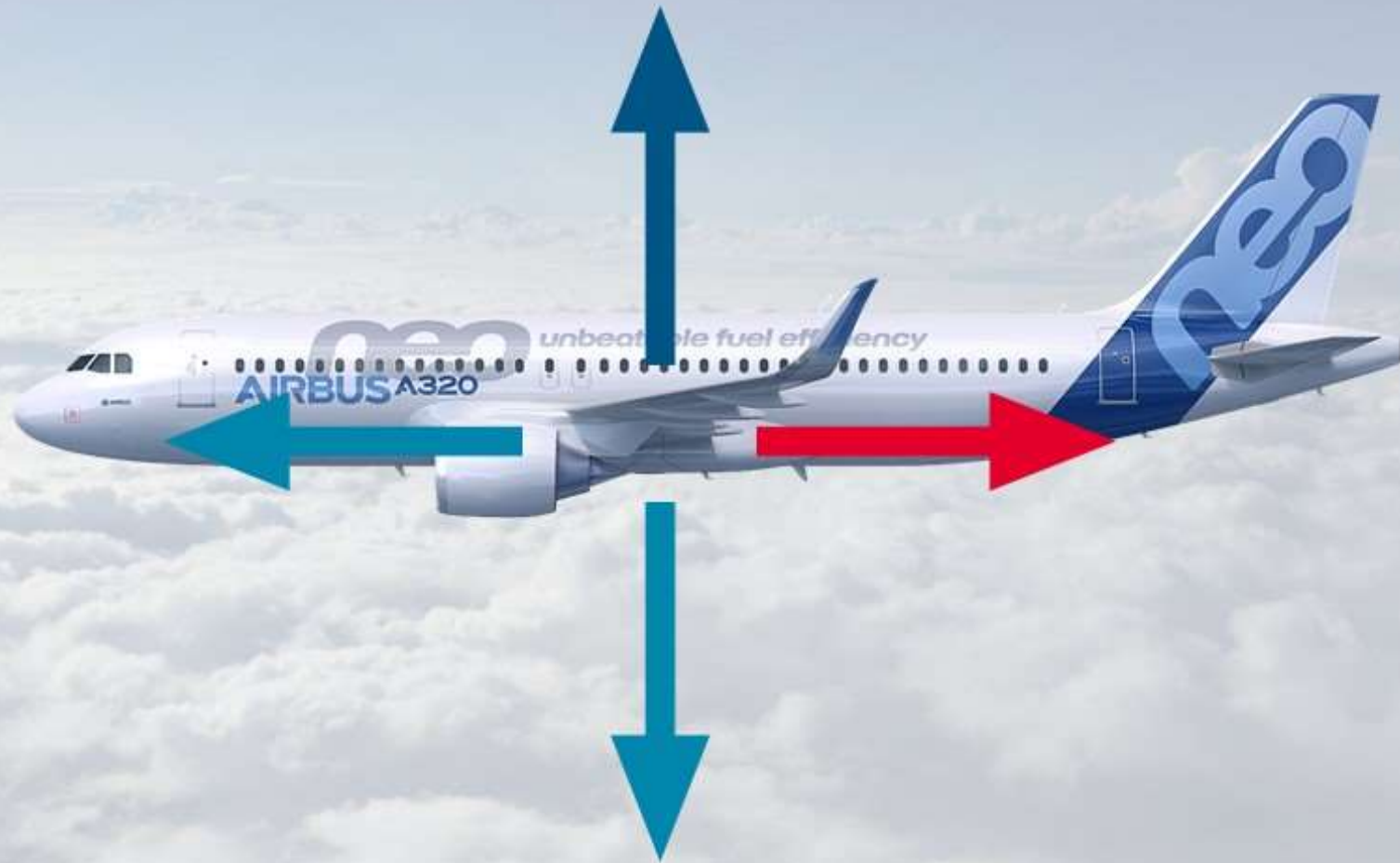
Drag is needless

Winglets basics

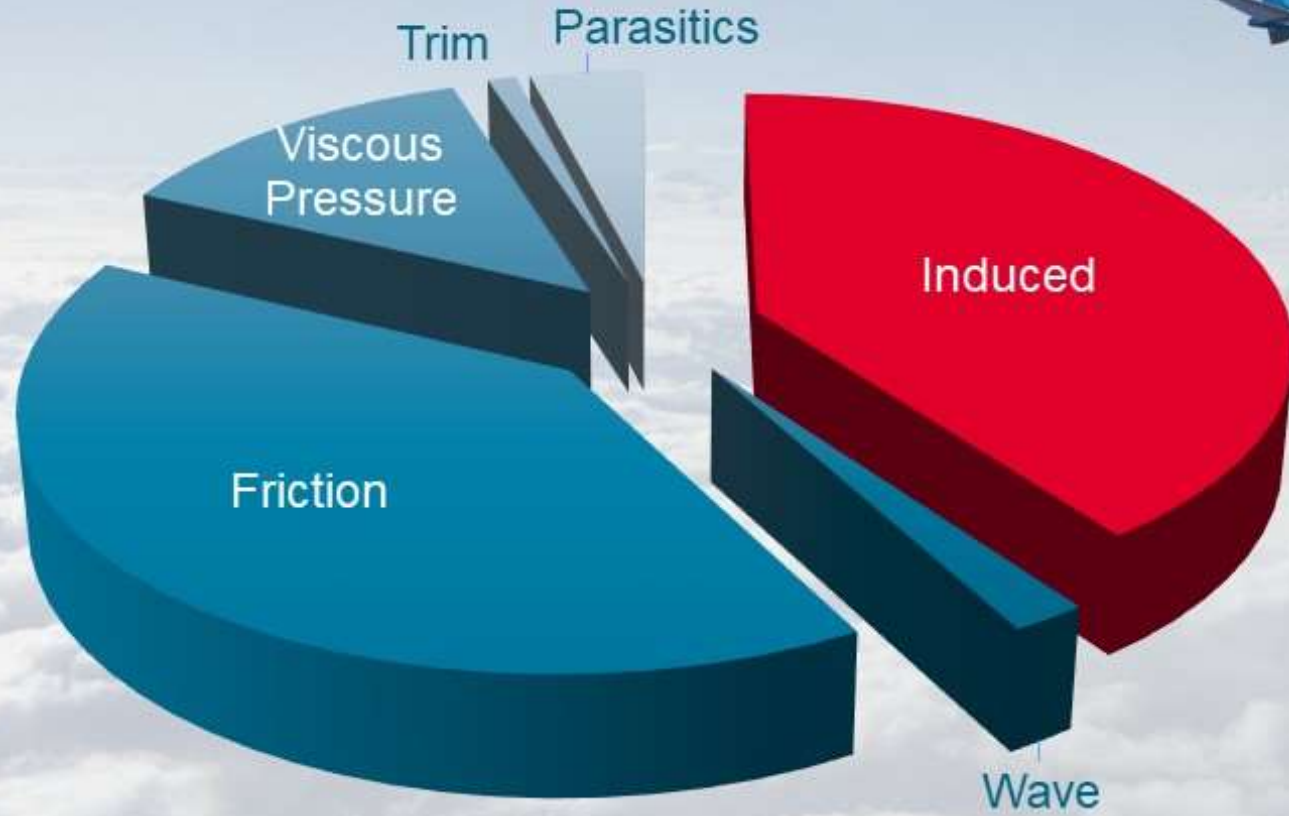
Winglets integration

Airbus solutions

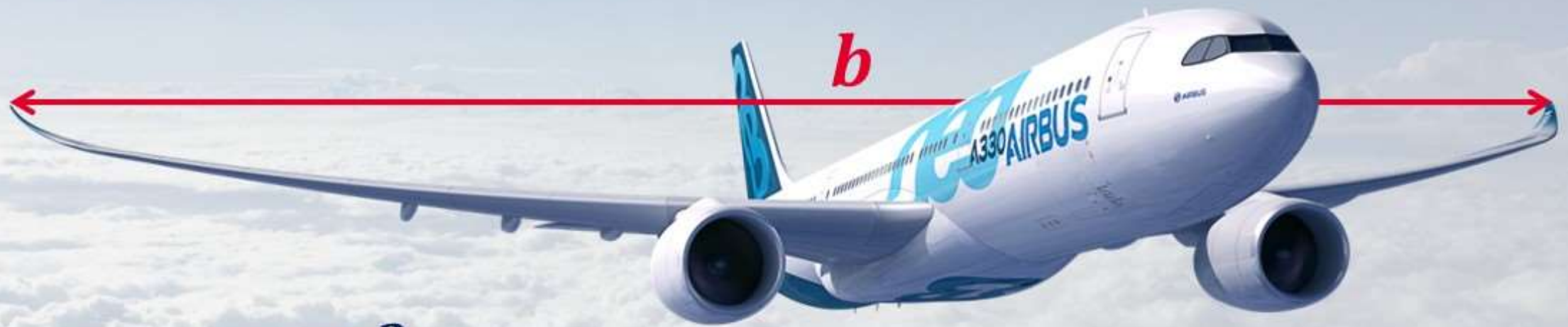
Aircraft in steady flight



Drag breakdown in cruise flight



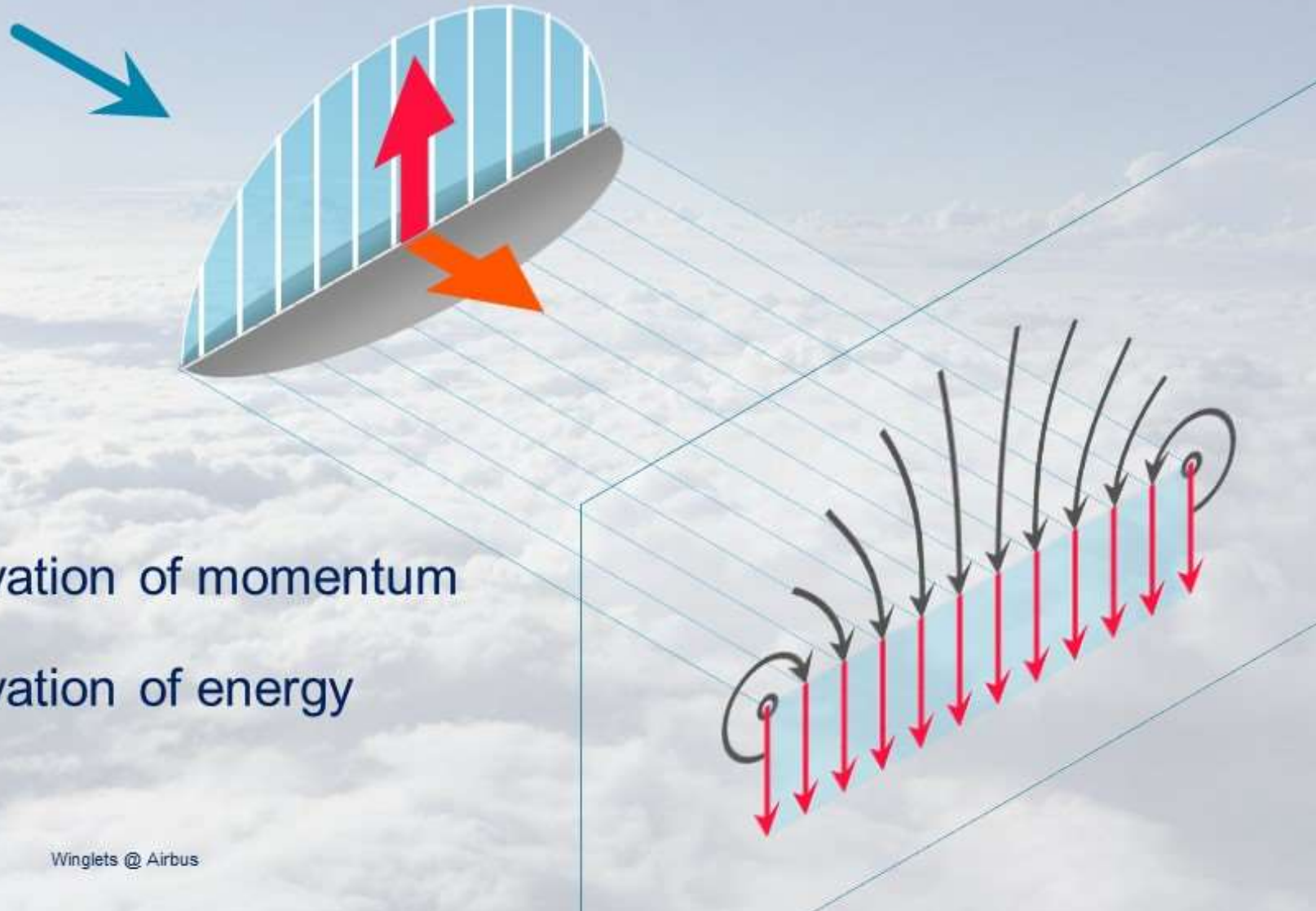
Induced Drag - Span



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

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

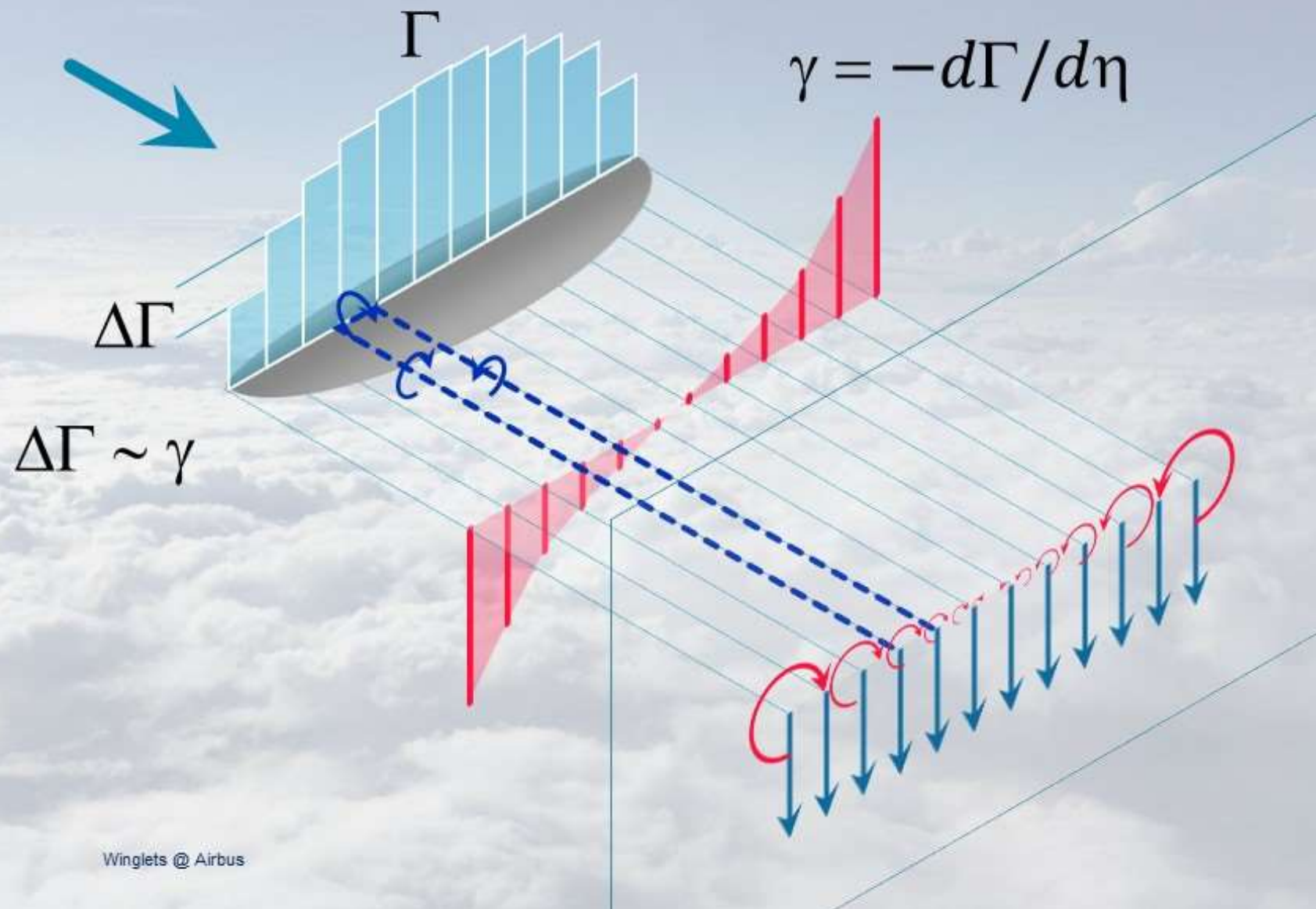
Basics – lift dependent drag



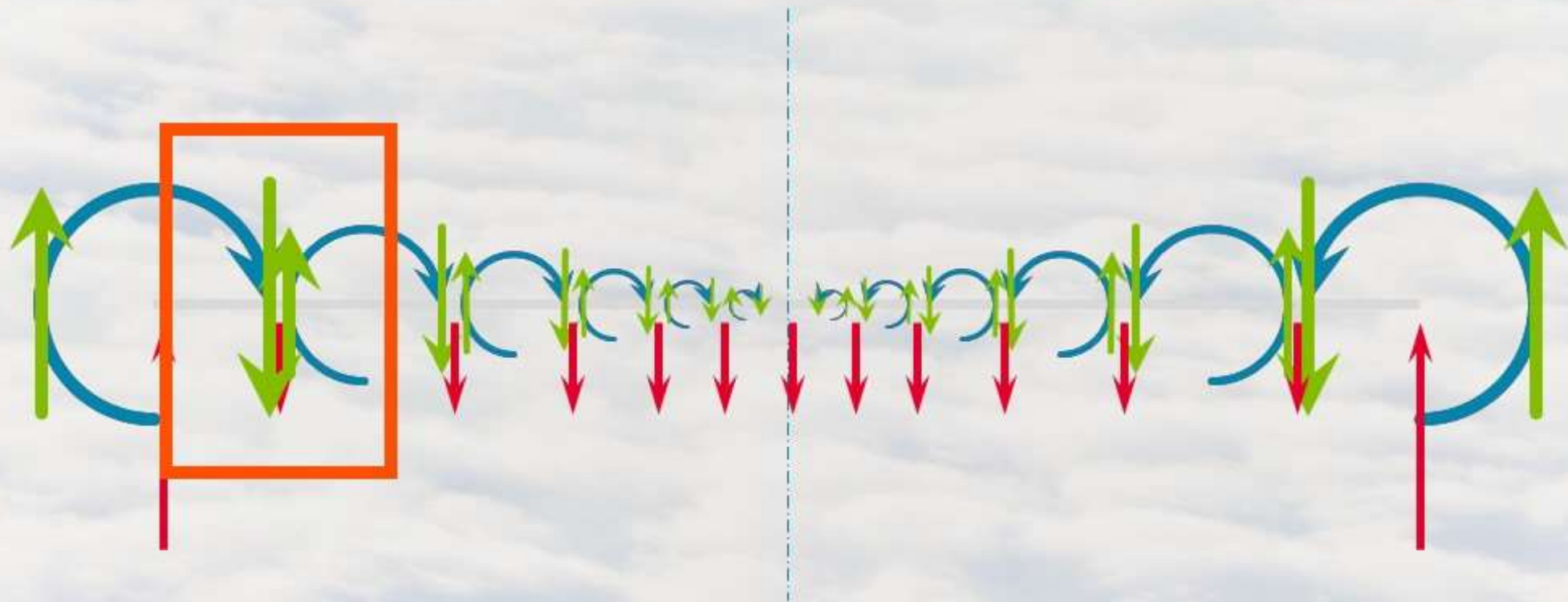
Conservation of momentum

Conservation of energy

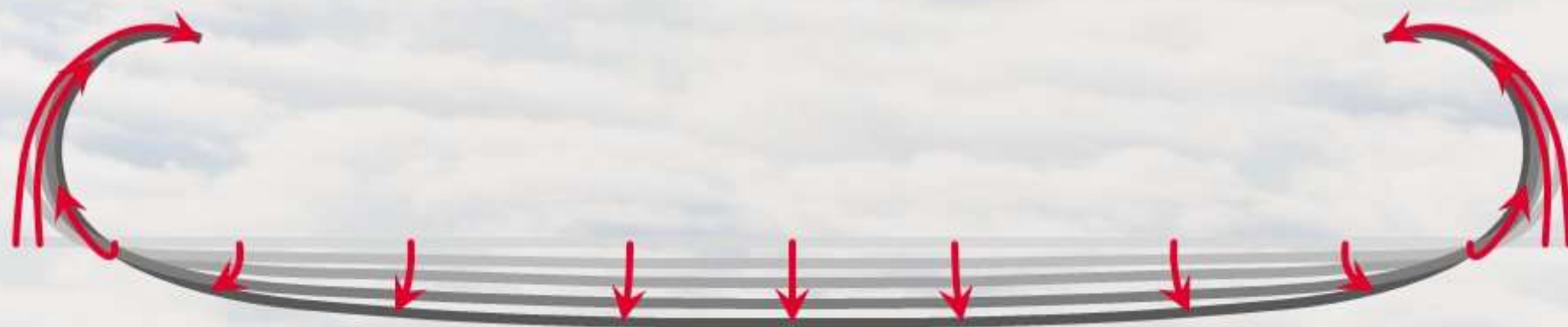
Vortex System Model



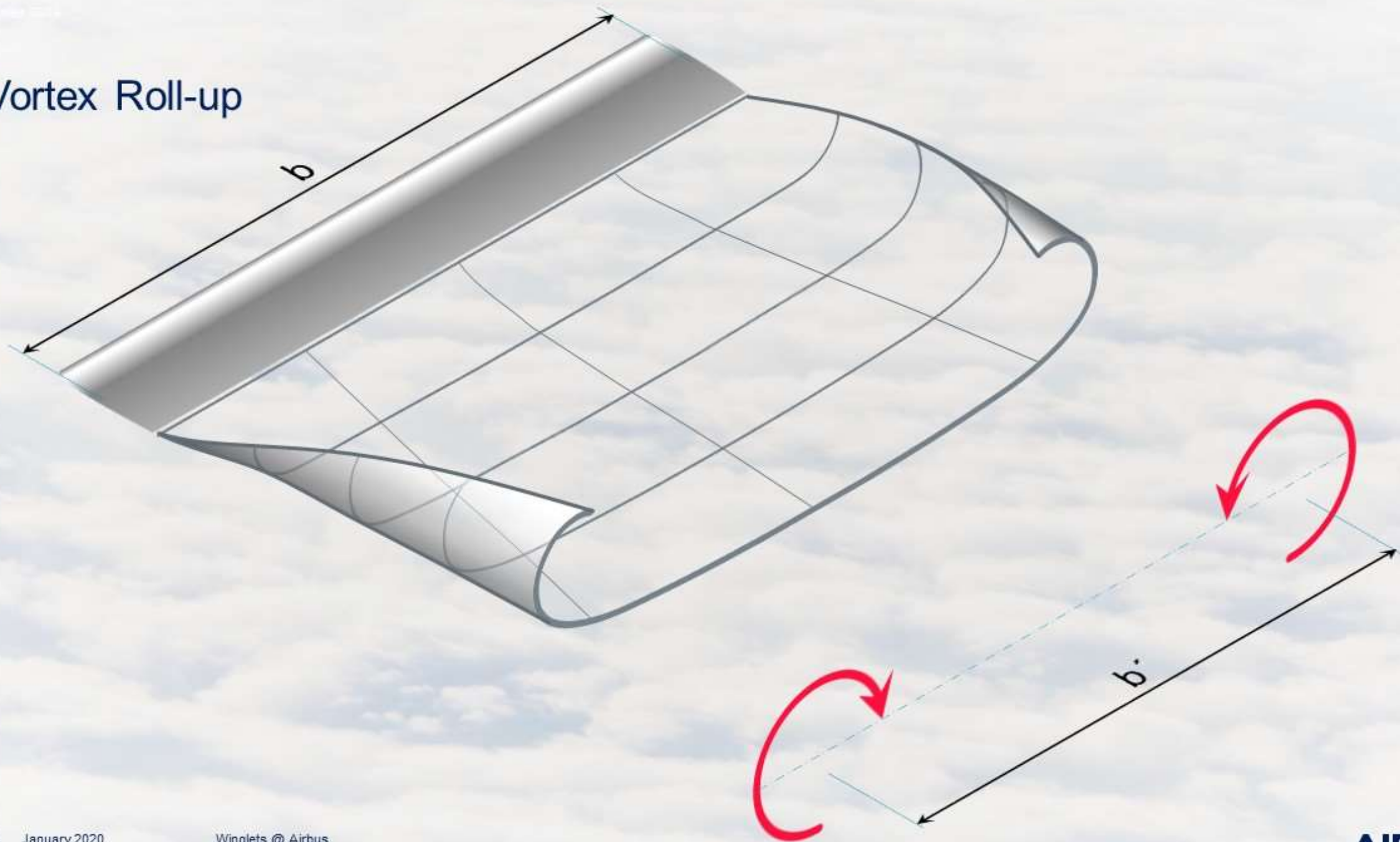
Vortex System



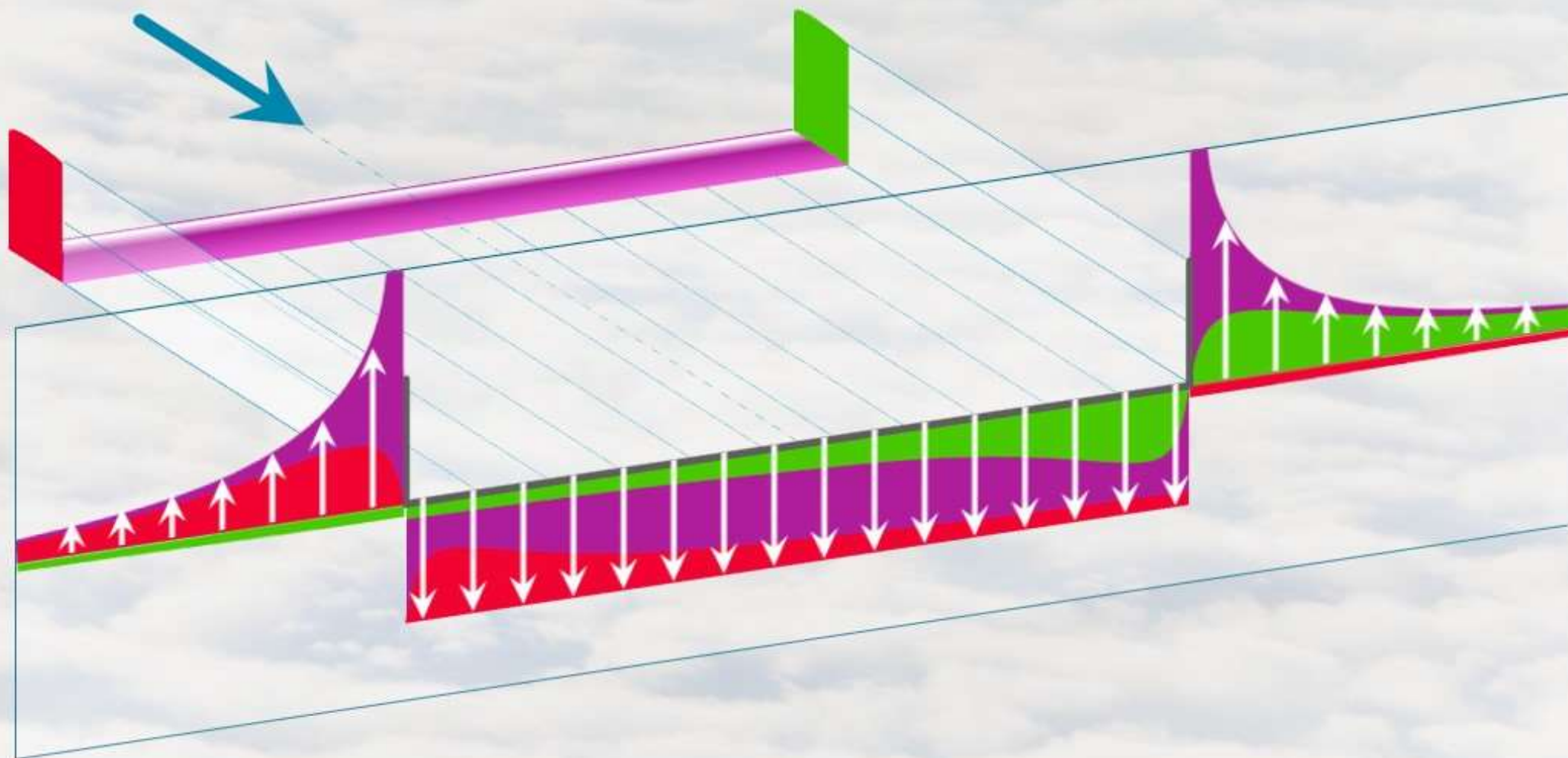
Vortex Roll-up



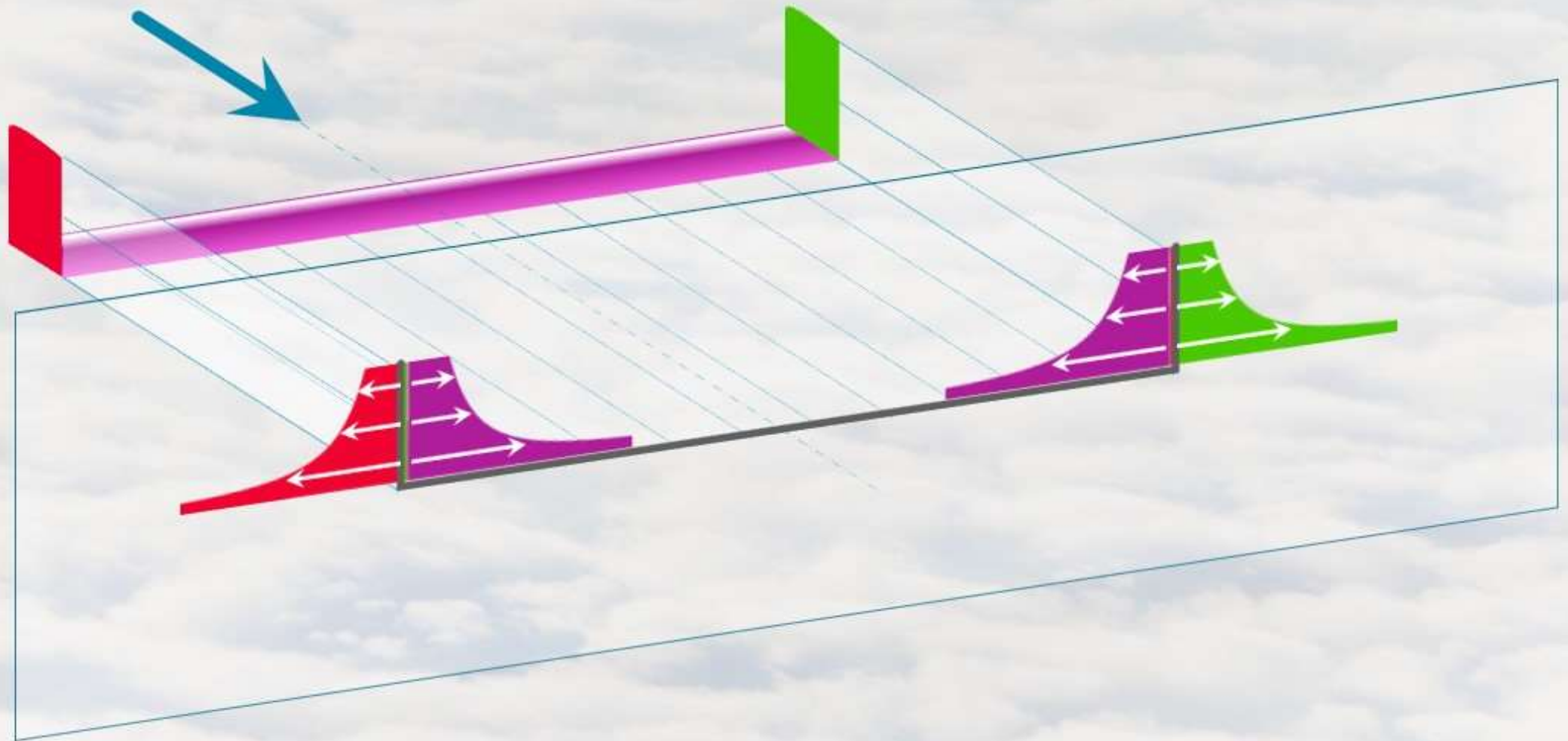
Vortex Roll-up



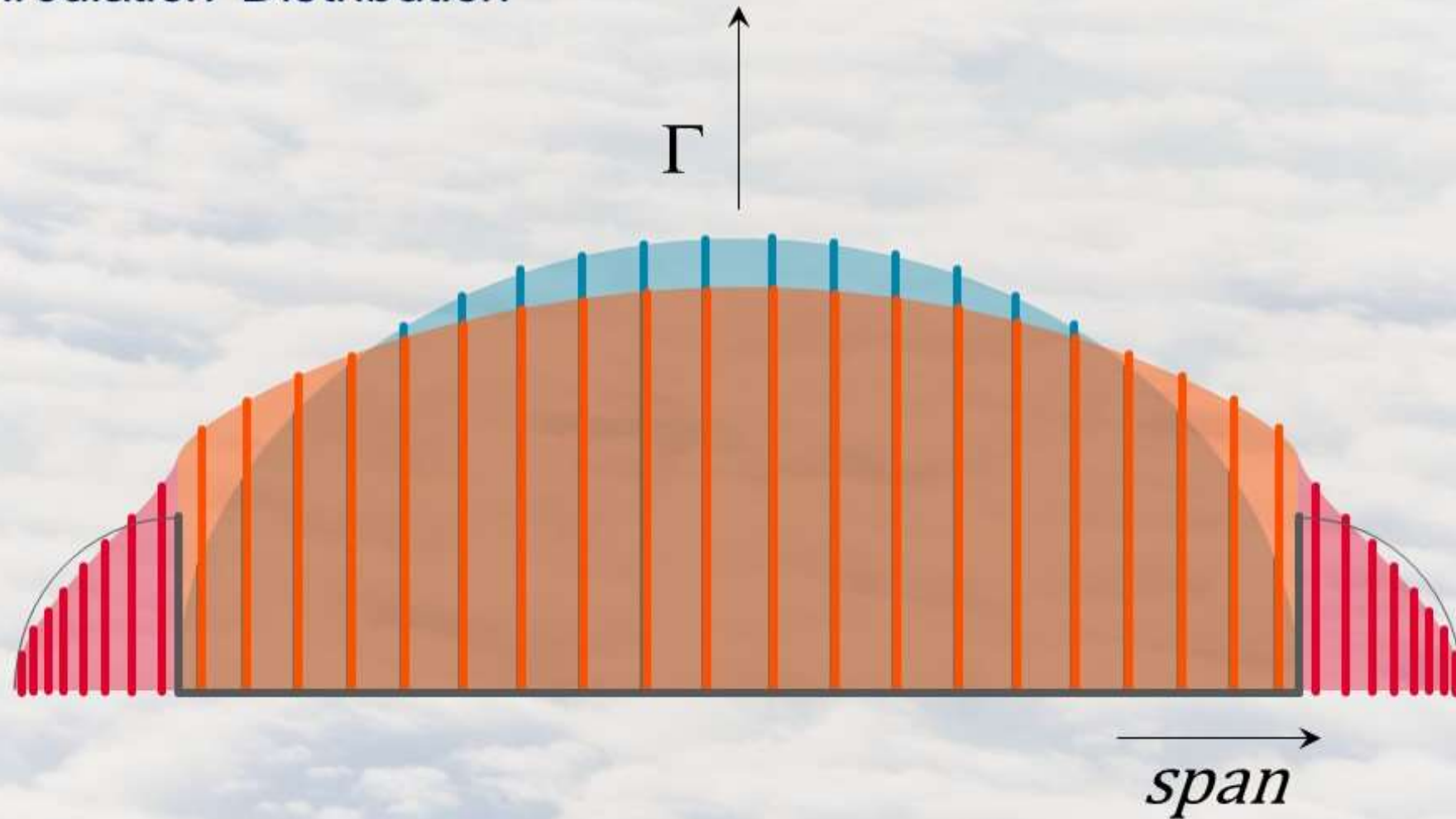
Downwash



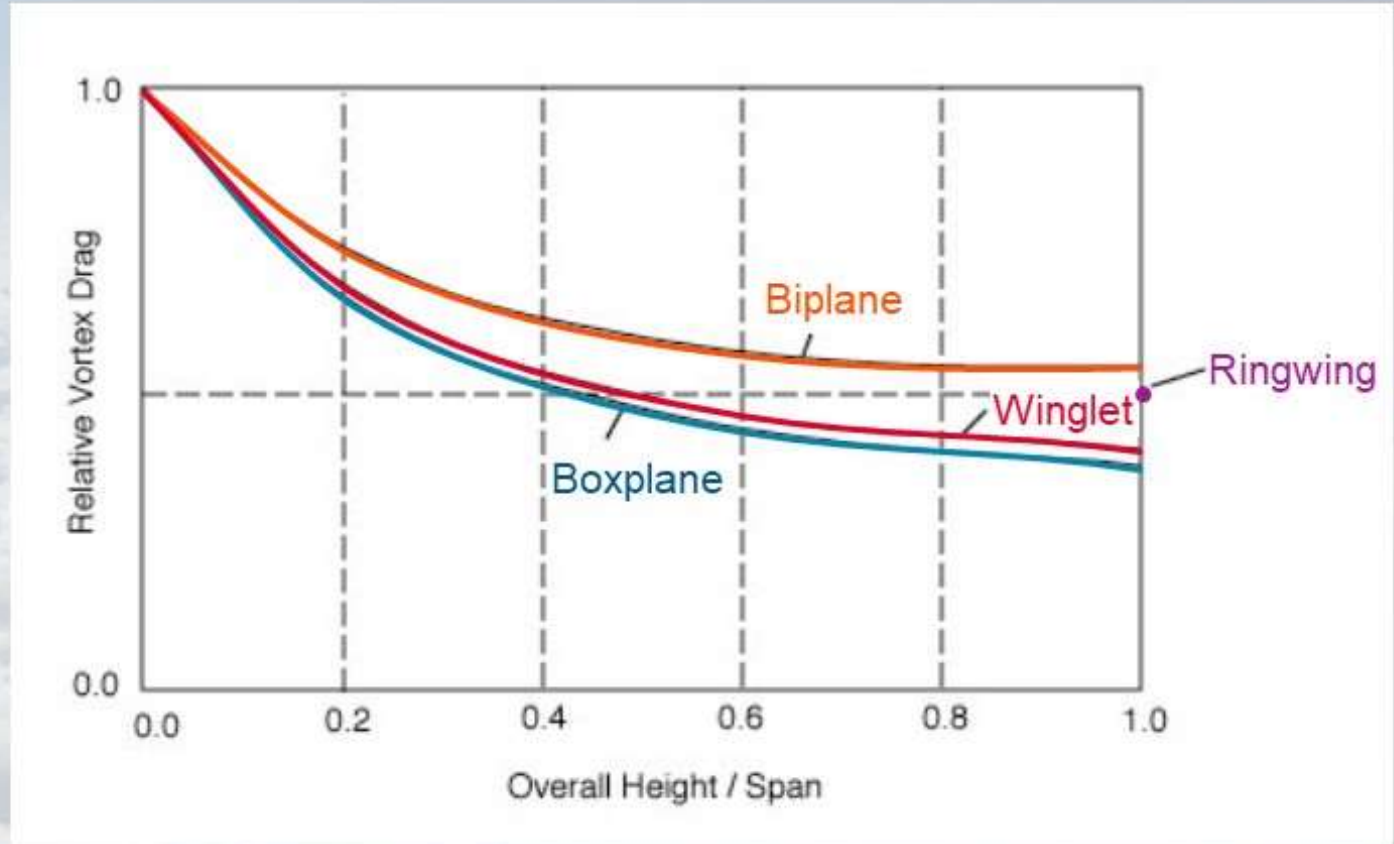
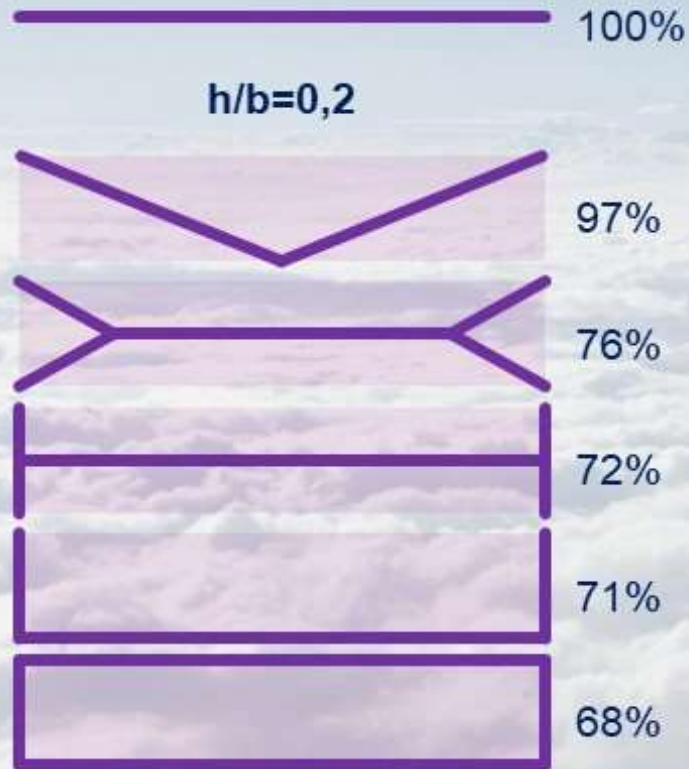
Sidewash



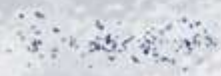
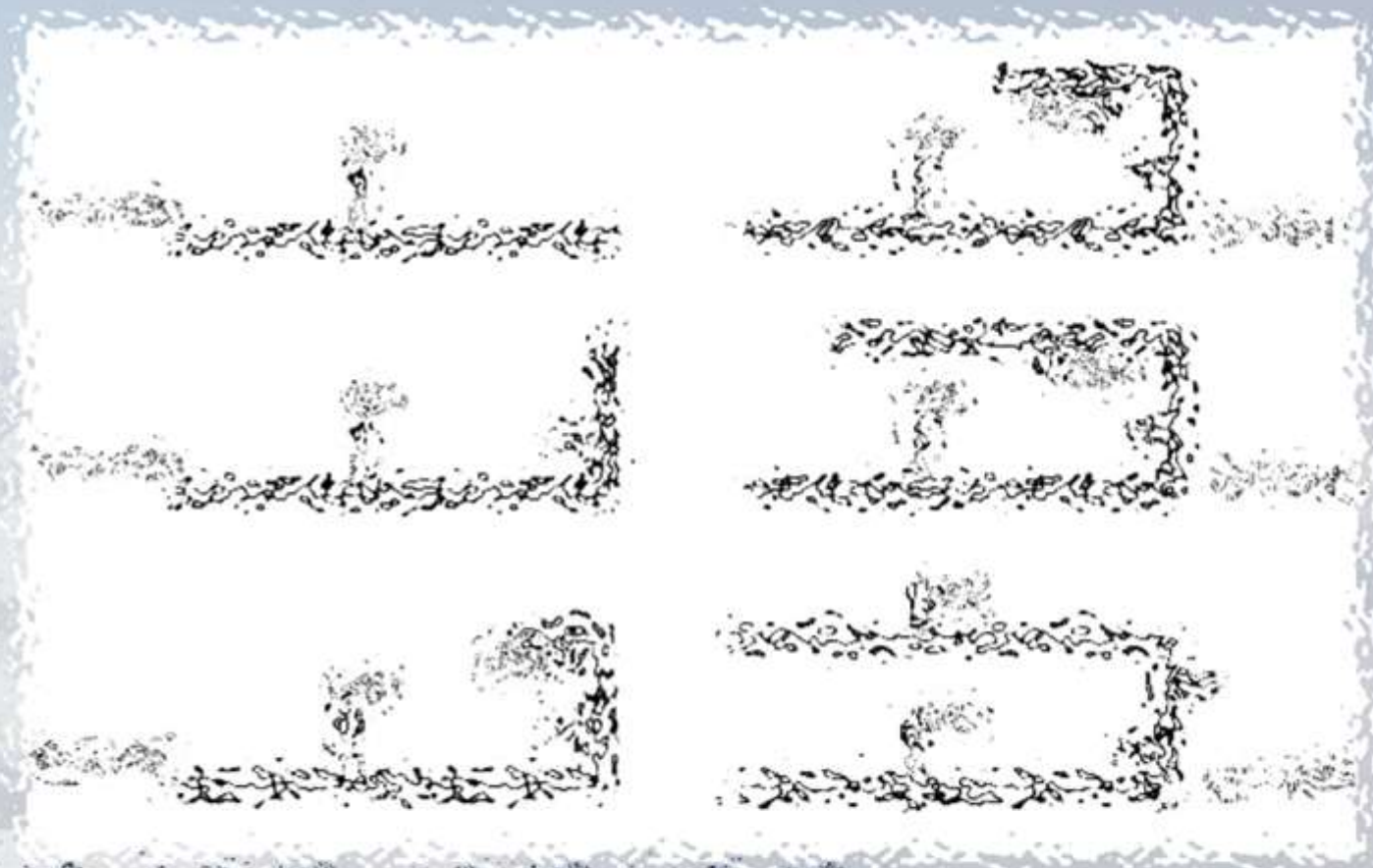
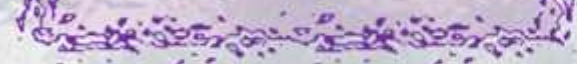
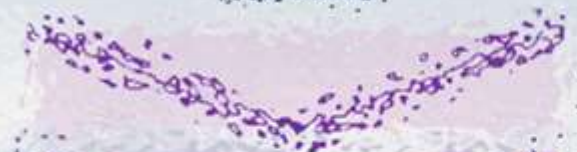
Optimal Circulation Distribution



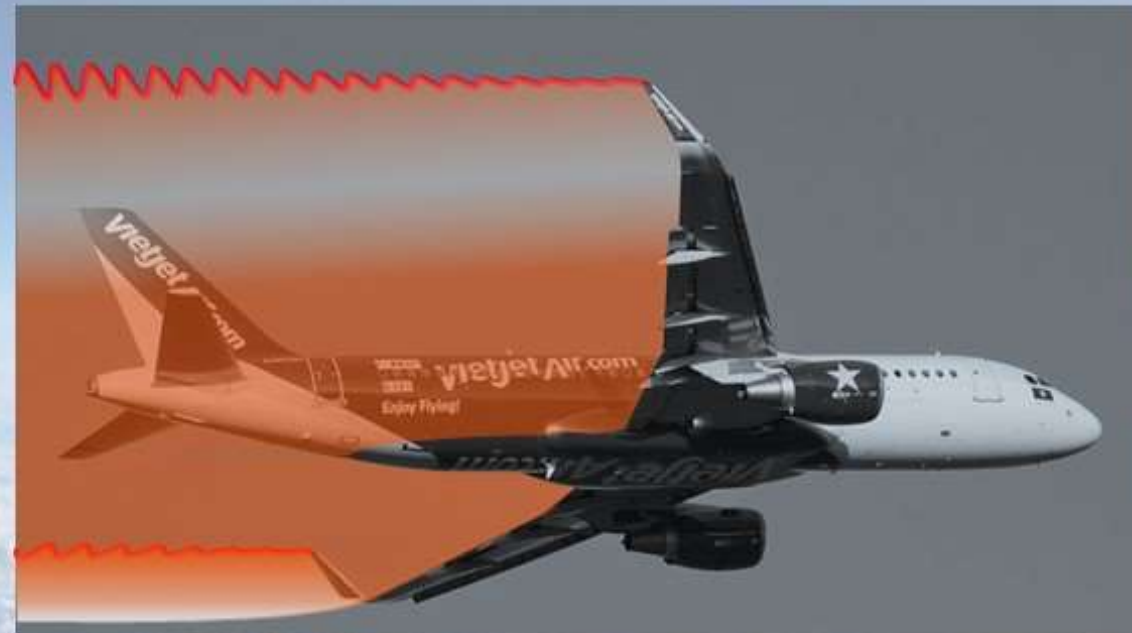
Induced Drag – Non-planar Wing Systems



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



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!!!



Winglets Integration



profile drag ↑

wetted area ↑

flow complexity ↑

high-lift ↑↓

cost ↑

effort for retrofit ↑

mass ↑

flexibility effects ↑

Induced
drag LS ↓

induced drag HS ↓

wave drag ↓

noise ↓

look ↑

TOFL ↓

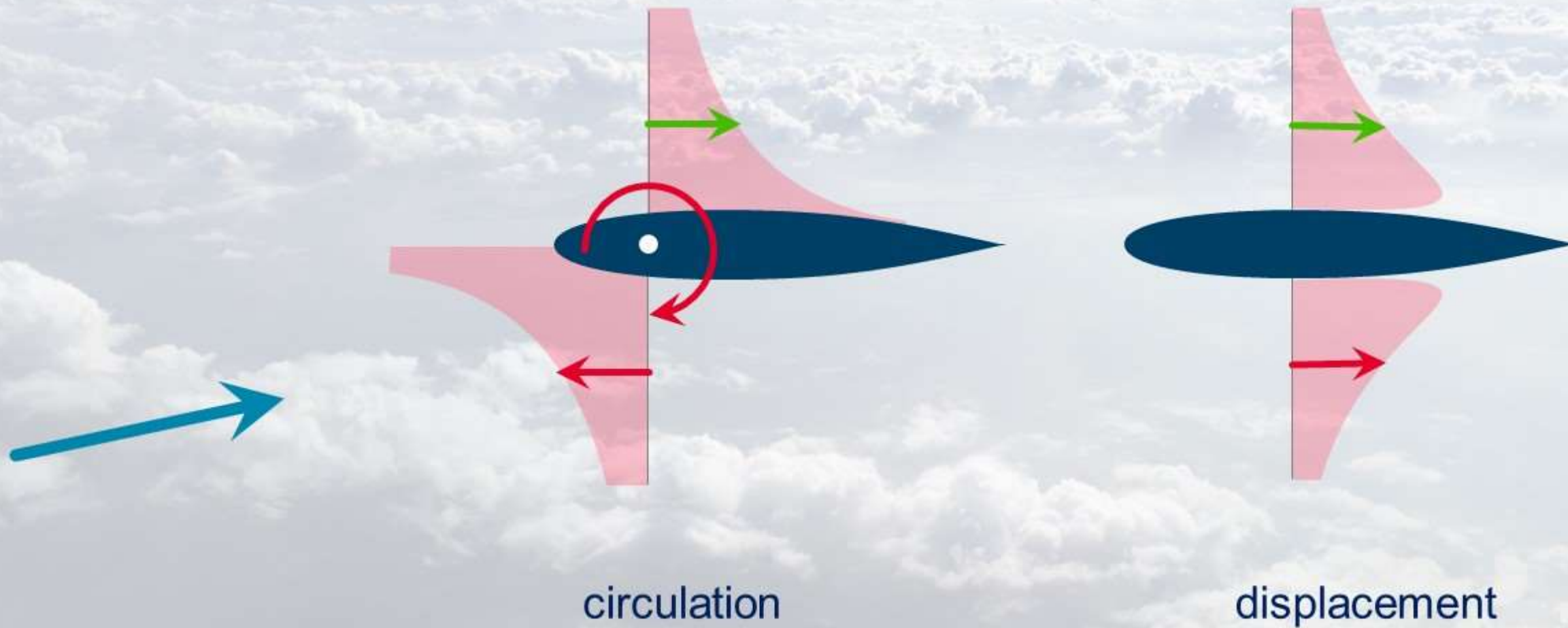
range ↑↓

ceiling ↑

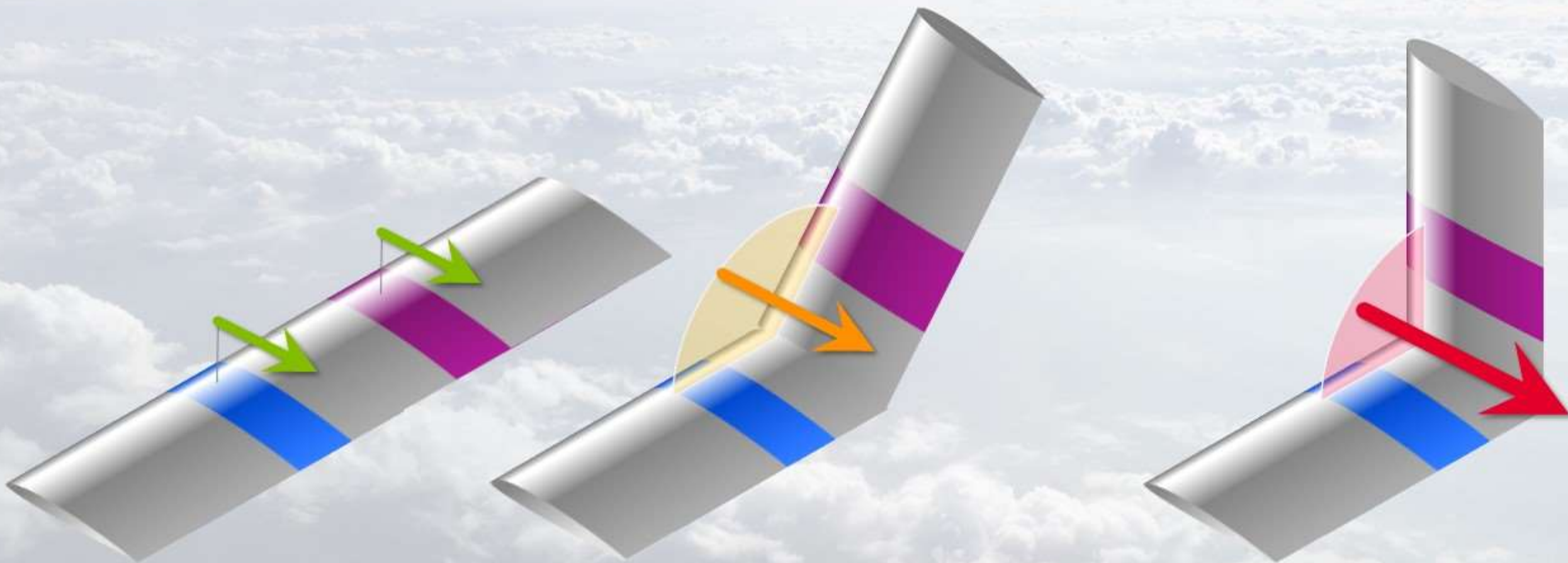
ground operations ↑↓

fuel consumption ↓

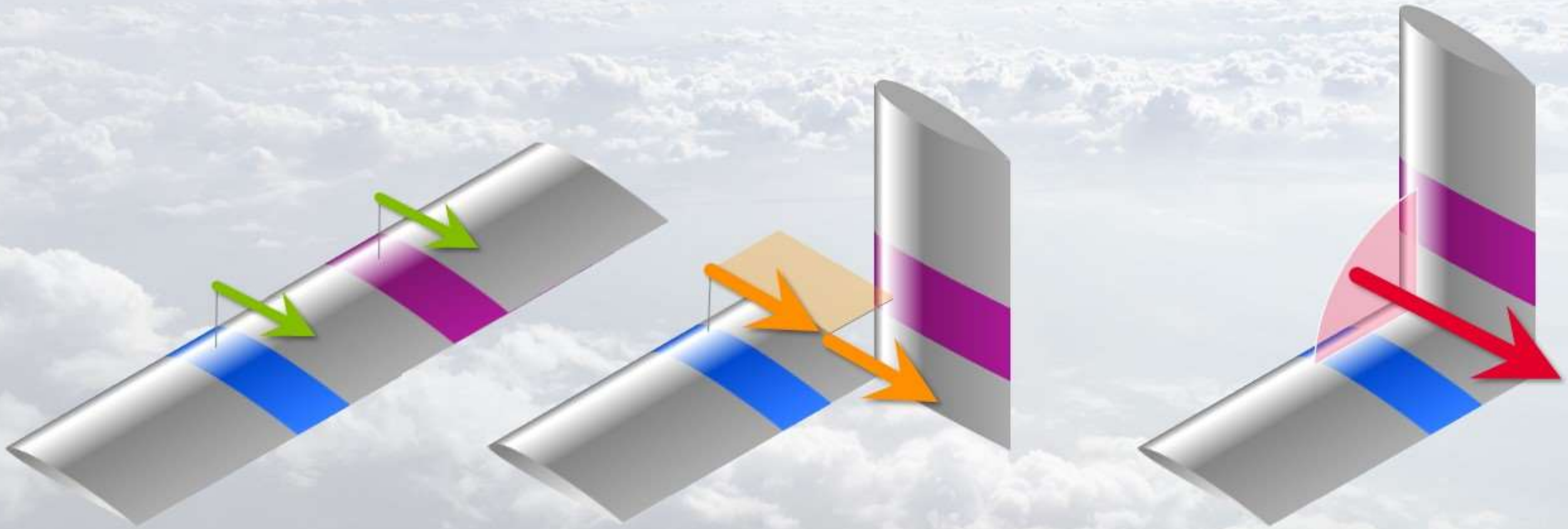
Challenge – Corner Flow



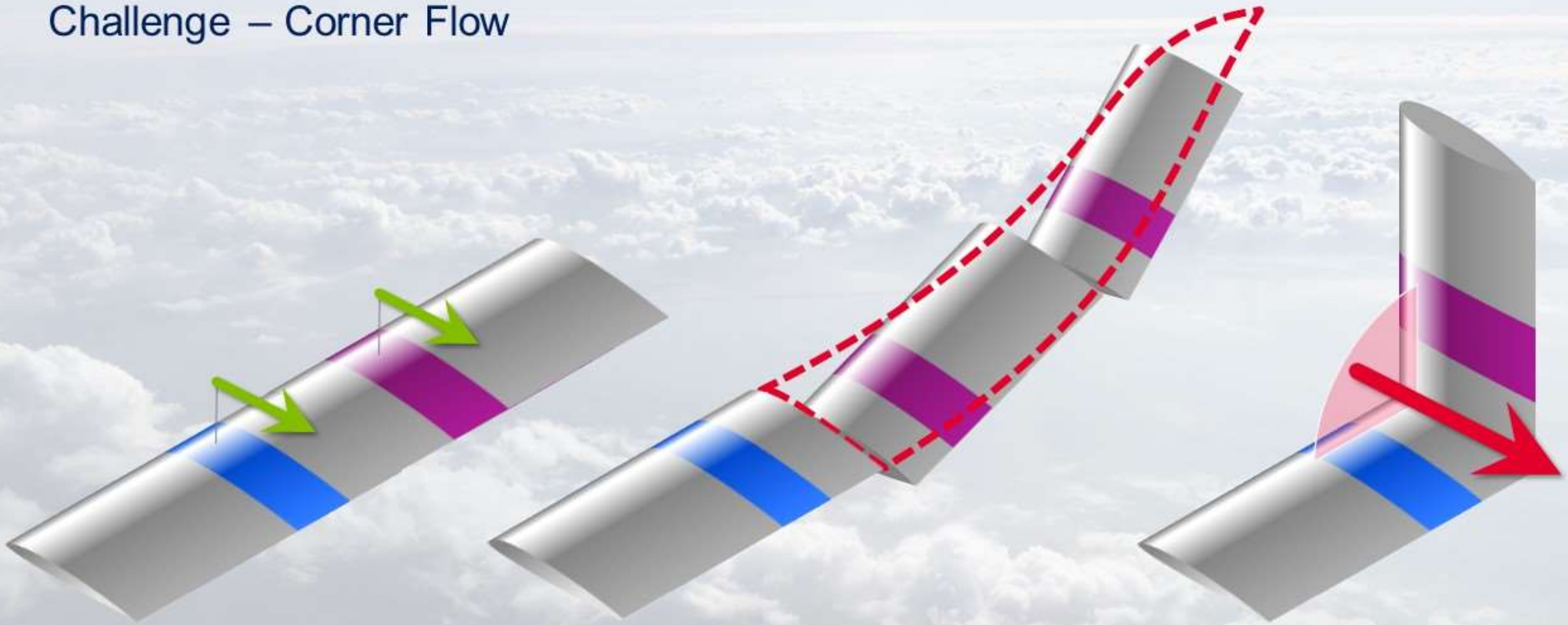
Challenge – Corner Flow



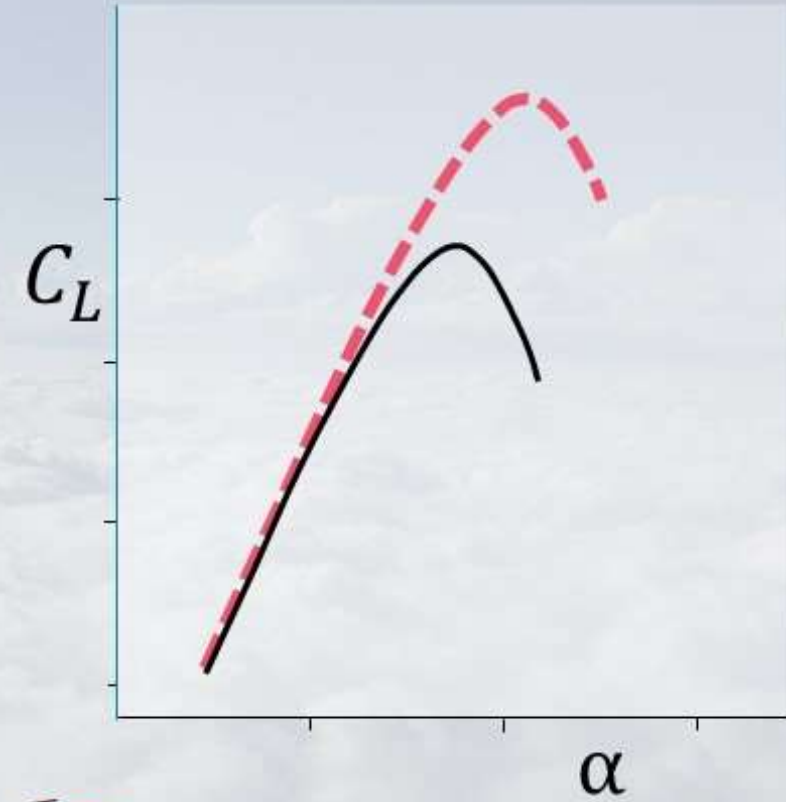
Challenge – Corner Flow



Challenge – Corner Flow



Challenge – High Lift



Challenge – Retrofit

wing and winglet are an integrated system

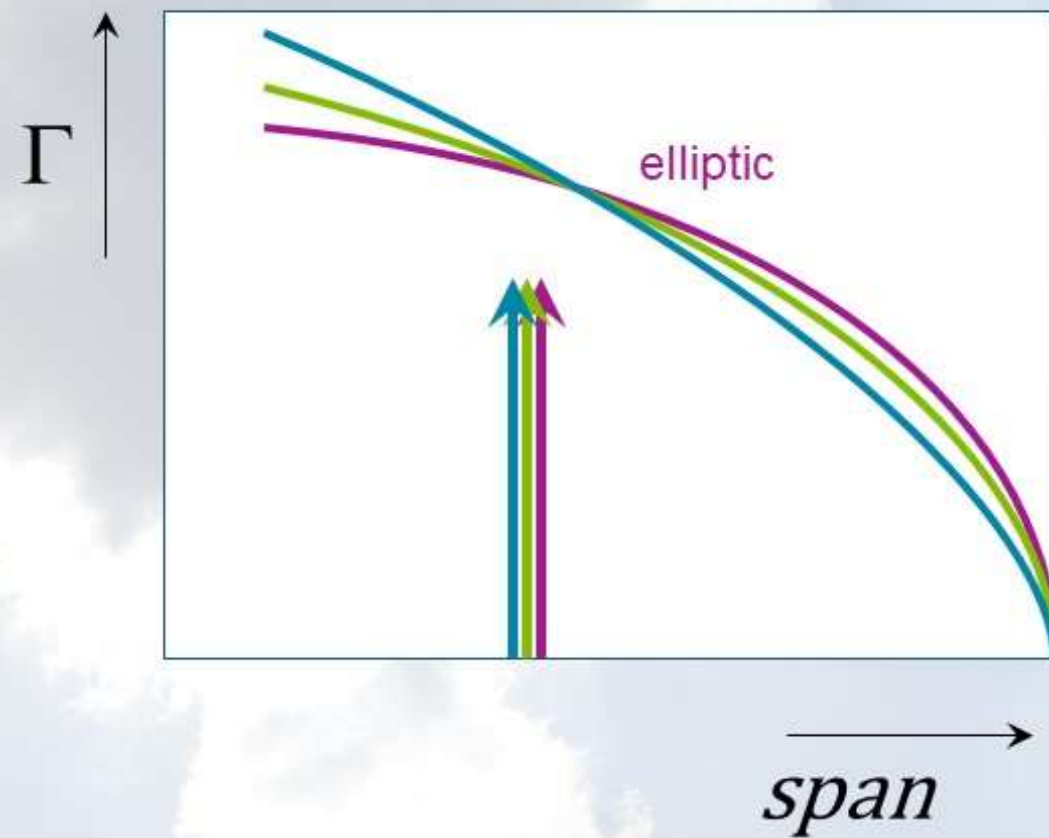
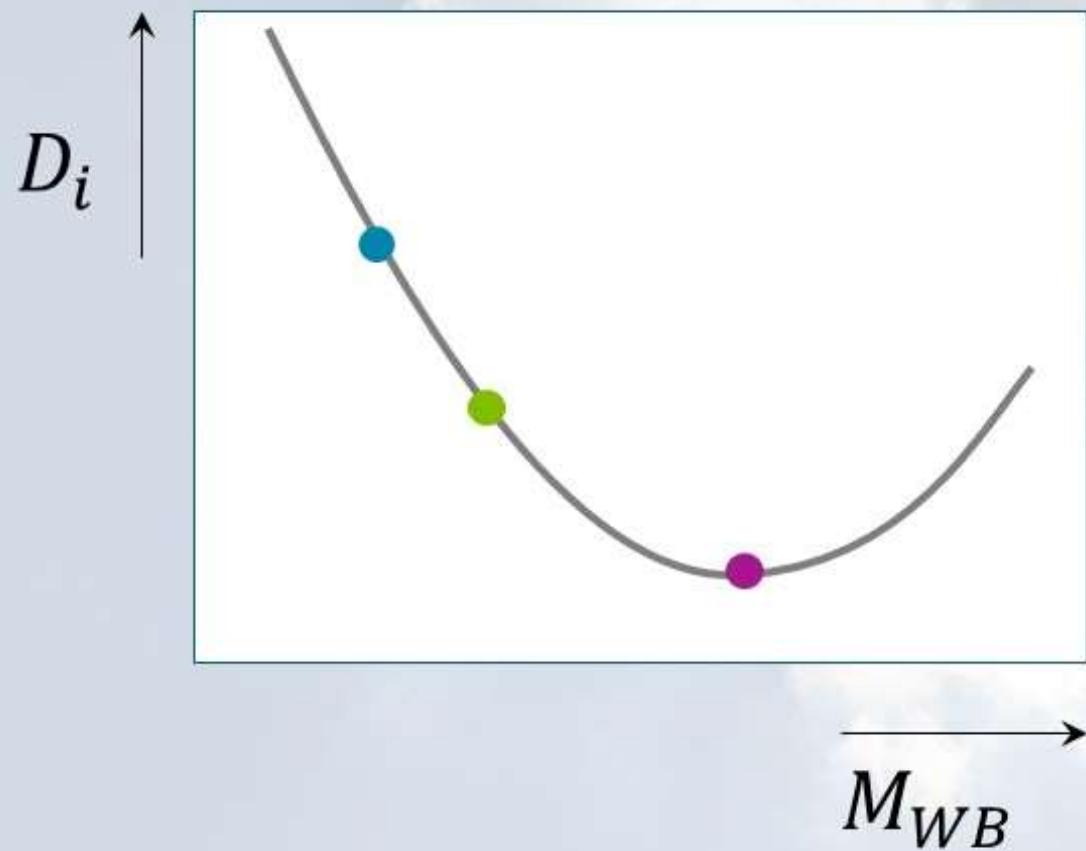
integrated design and development with new developments only

the existing wing is a constraint

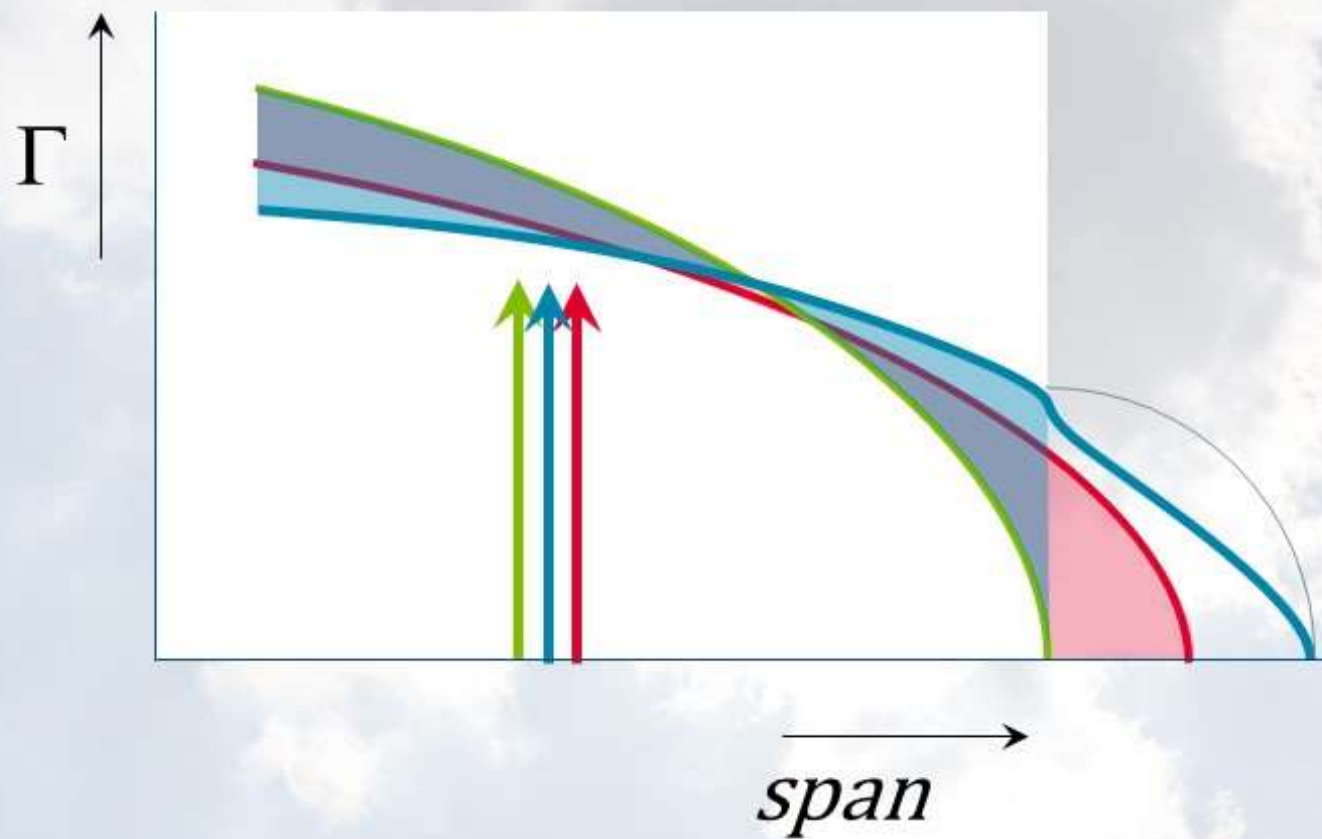
tuning of the circulation is marginal



Challenge – Retrofit



Challenge – Retrofit



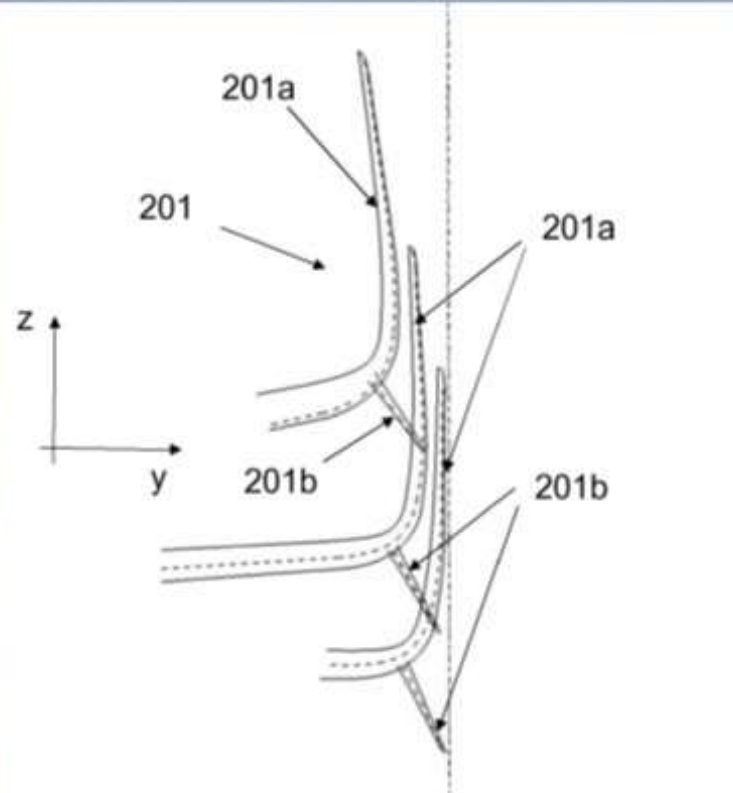
Challenge – Gate Limits



Challenge – Flexibility Effects

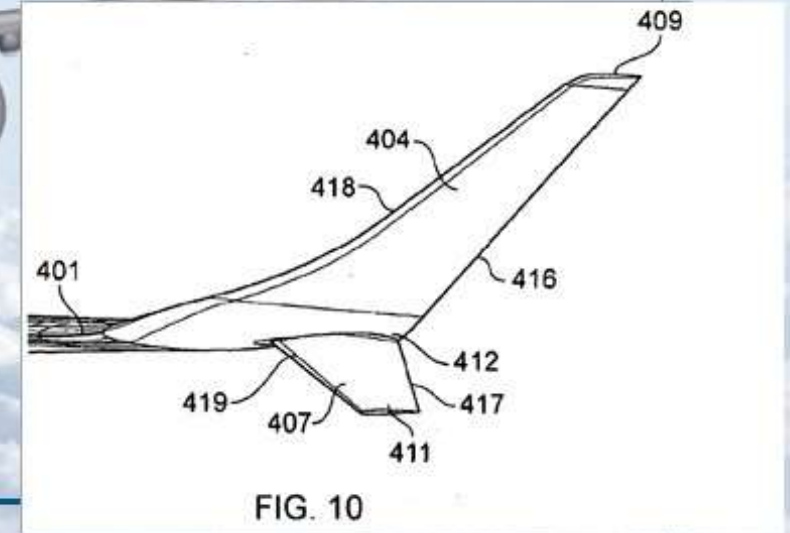


Challenge – Flexibility Effects



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; LEOVIRYAKIT,
Kasidit; HELLER, Gerd; A WINGLET AND METHOD OF
DESIGNING A WINGLET, filed 08.02.2018





A300

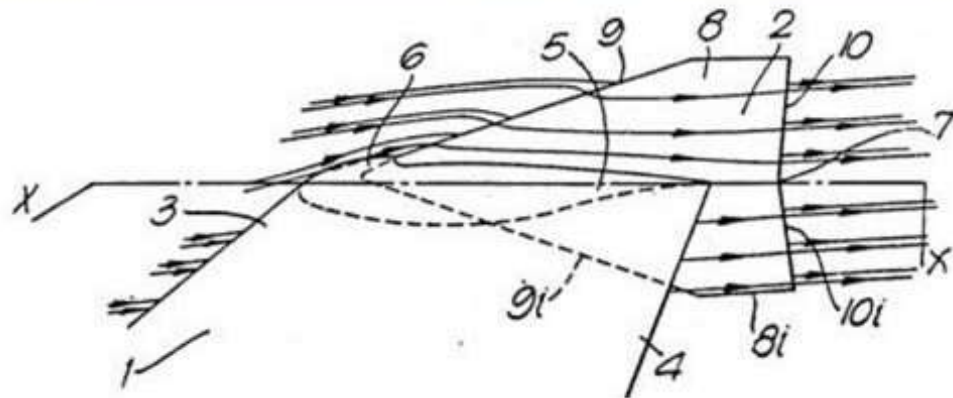
FF 28.10.1972 (B1)
no device

FF 27.12.1974 (B4)

WTF 68°

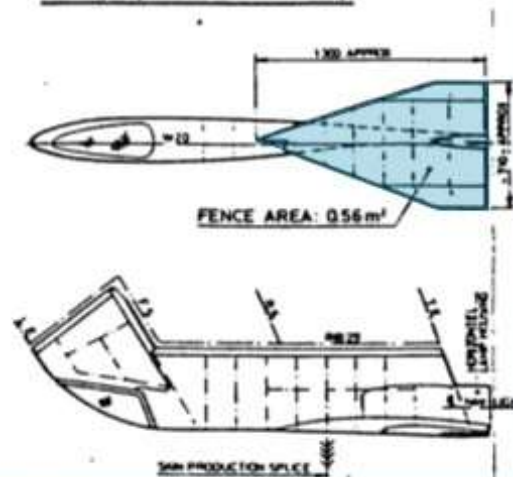
H 0,7m

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

Wing tip fence assembly



A310

FF 03.04.1982

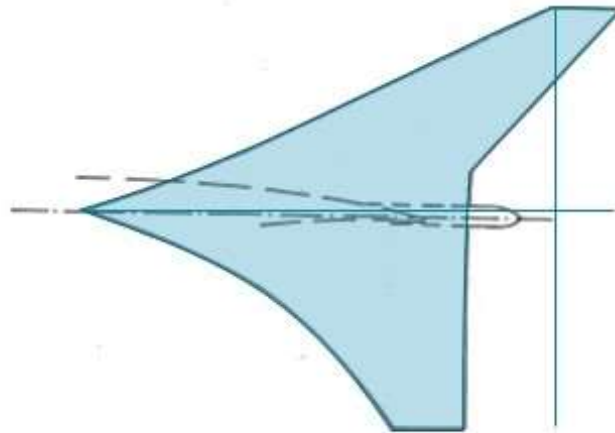
WTF 65°

H 1,4m

L 1,7m



A310-300 Wing Tip Fence



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”



A330

FF 340 25.10.1991

FF 330 02.11.1992

60° canted winglet

H 1.2m

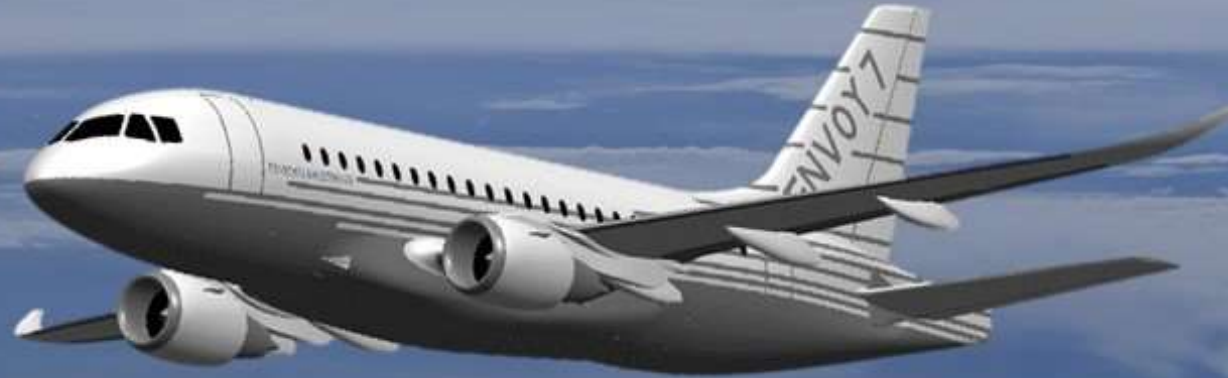
S 0.7m



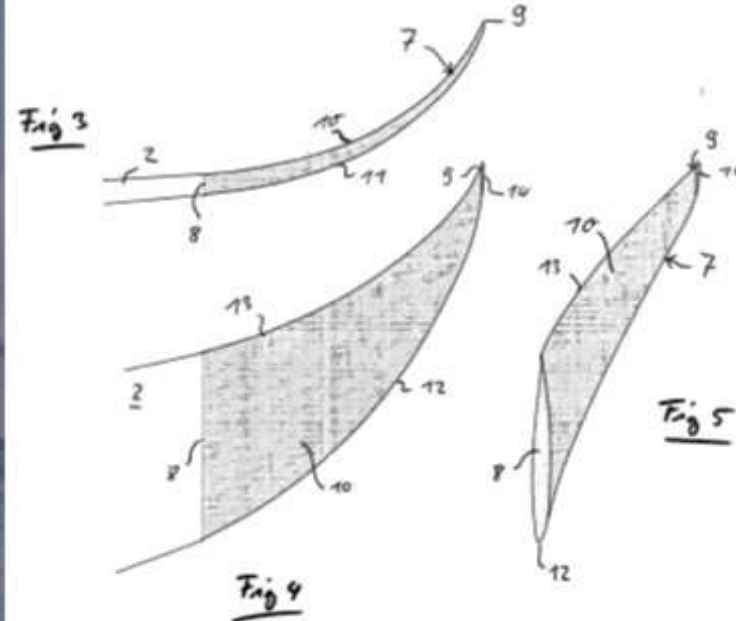
shark

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





A380

FF 27.04.2005

WTF 65°

H 2.3m

L 2.8m





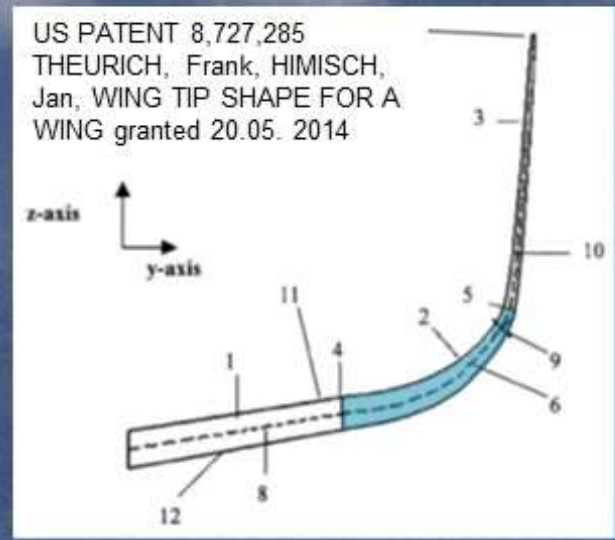
A320 sharklet

FF 29.11.2011

Sharklet

H 2.5m

S 1.7m



A350

FF 14.06.2013

shark type

H 2.3m

S 2.9m



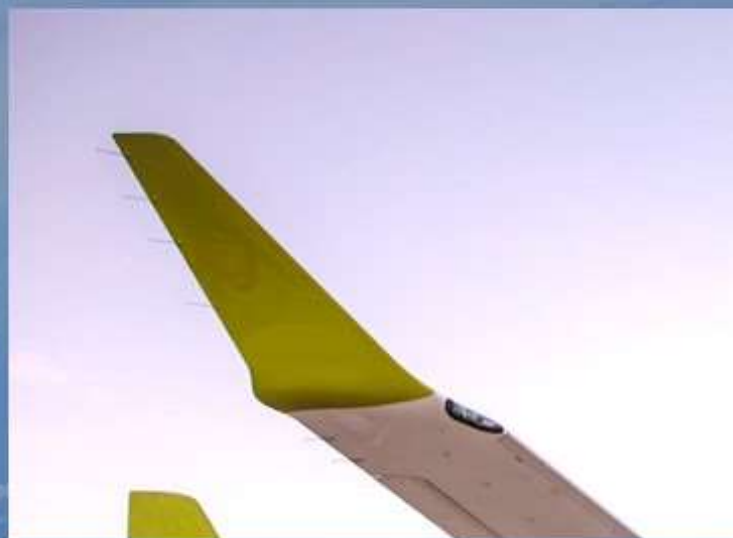
A220

FF 16. Sep 2013

50° canted winglet

H 1.4m

S 1.1m





A320neo

FF 25.09.2014

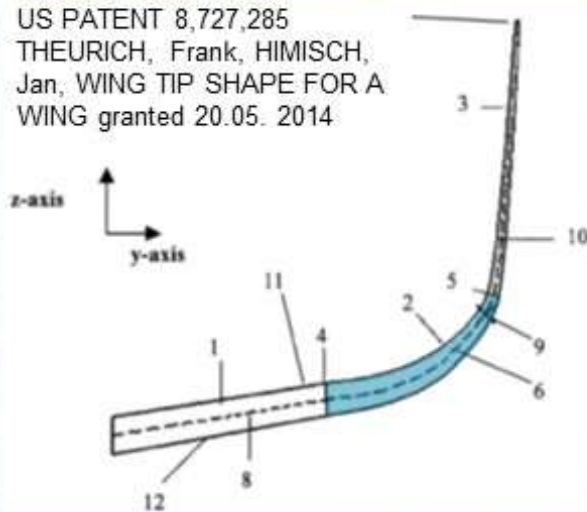
Sharklet

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





A330neo

FF 19.10.2017

shark type

H 1,3m

S 2,4m



Thank you!

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