4.7 Lärmreduktion durch Triebwerkskonzepte

4.7.1 Vortragender

Bernhard. Köppel, MTU Aero Engines AG

Bernhard Köppel studierte Luft- und Raumfahrttechnik an der Technischen Universität Stuttgart. Der Diplomingenieur ist bei der MTU Aero Engines AG Leiter Flugphysik und Betriebskostenanalyse, Neue Programme. Vor seiner beruflichen Tätigkeit bei MTU arbeitete er für den Triebwerkshersteller Rolls-Royce in Berlin und für den Flugzeugbauer Fairchild Dornier in Oberpfaffenhofen bei München.

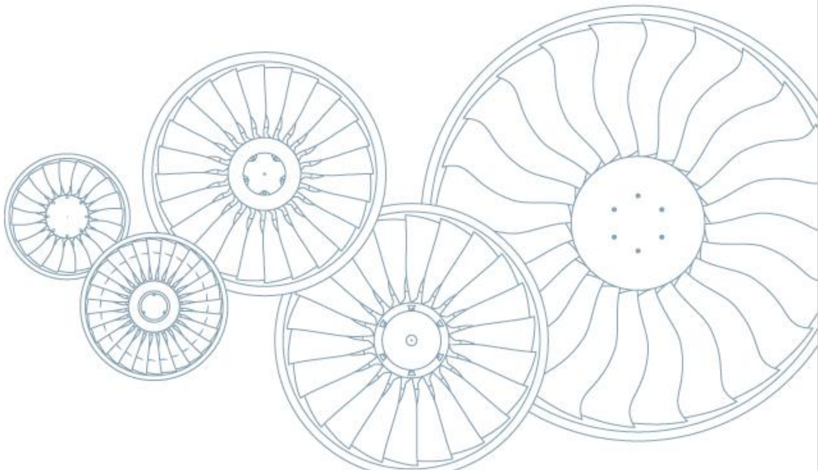
Nähere Informationen zur Organisation:
Die MTU Aero Engines ist Deutschlands führender Triebwerkshersteller. Sie entwickelt, fertigt, vertreibt und betreut zivile und militärische Luftfahrtantriebe sowie Industriegasturbinen. Technologisch führend ist sie bei Niederdruckturbinen, Hochdruckverdichtern, Herstell- und Reparaturverfahren.
Im Bereich der zivilen Instandhaltung ist die MTU Maintenance der weltweit größte unabhängige Triebwerksinstandhalter. Auf dem militärischen Gebiet ist die MTU Aero Engines der Systempartner für fast alle Luftfahrtantriebe der Bundeswehr. Die MTU unterhält Standorte weltweit; Unternehmenssitz ist München. Im Geschäftsjahr 2012 haben rund 8.500 Mitarbeiter einen Umsatz in Höhe von rund 3,4 Milliarden Euro erwirtschaftet. Anfang März dieses Jahres hat das Unternehmen den 32. Innovationspreis der deutschen Wirtschaft erhalten und im April den Deutschen Innovationspreis. Ausgezeichnet wurde die MTU beide Male für die schnelllaufende Niederdruckturbine des Getriebefan-Triebwerks.

4.7.2 Präsentation

Link zum Mitschnitt der Präsentation:
Deutsch: http://www.youtube.com/watch?v=1UtiK9Op8A8&feature=youtu.be
English: http://www.youtube.com/watch?v=YDLhzDnCrlU&feature=youtu.be

Noise Reduction by New Engine Concepts

ICANA 2013, Frankfurt, October 30-31, 2013



Bernhard Koeppel
Senior Manager Flight Physics, New Programs
MTU Aero Engines

Agenda

The Geared Turbofan (GTF) Concept

GTF Applications

GTF Development Status

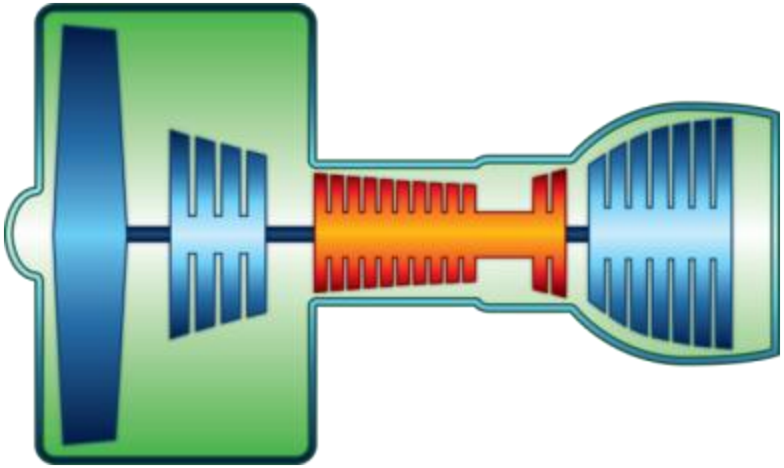
GTF Outlook

Geared Turbofan: A Step Change in Propulsion

Conventional Turbofan

Fan speed constrained by low pressure spool

Low Compressor & Low Turbine speed constrained by fan



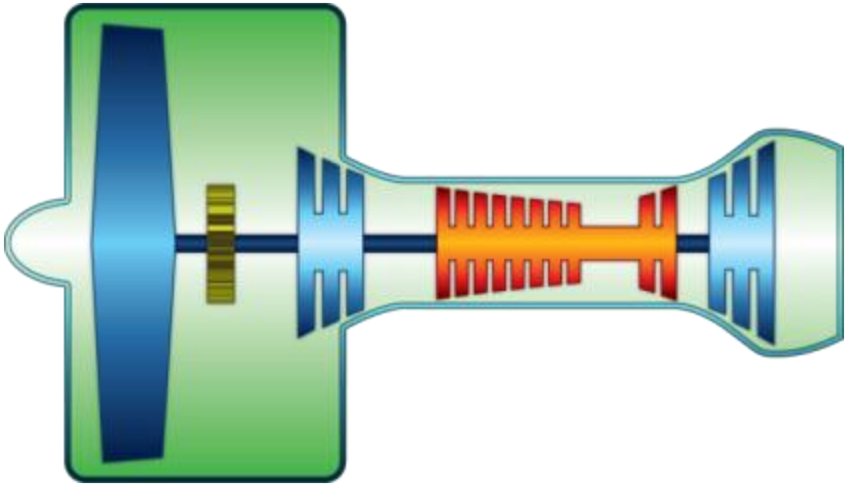
Incremental Improvement

(source: PW/MTU)

PurePower™ GTF Engine

Optimized low-speed Fan

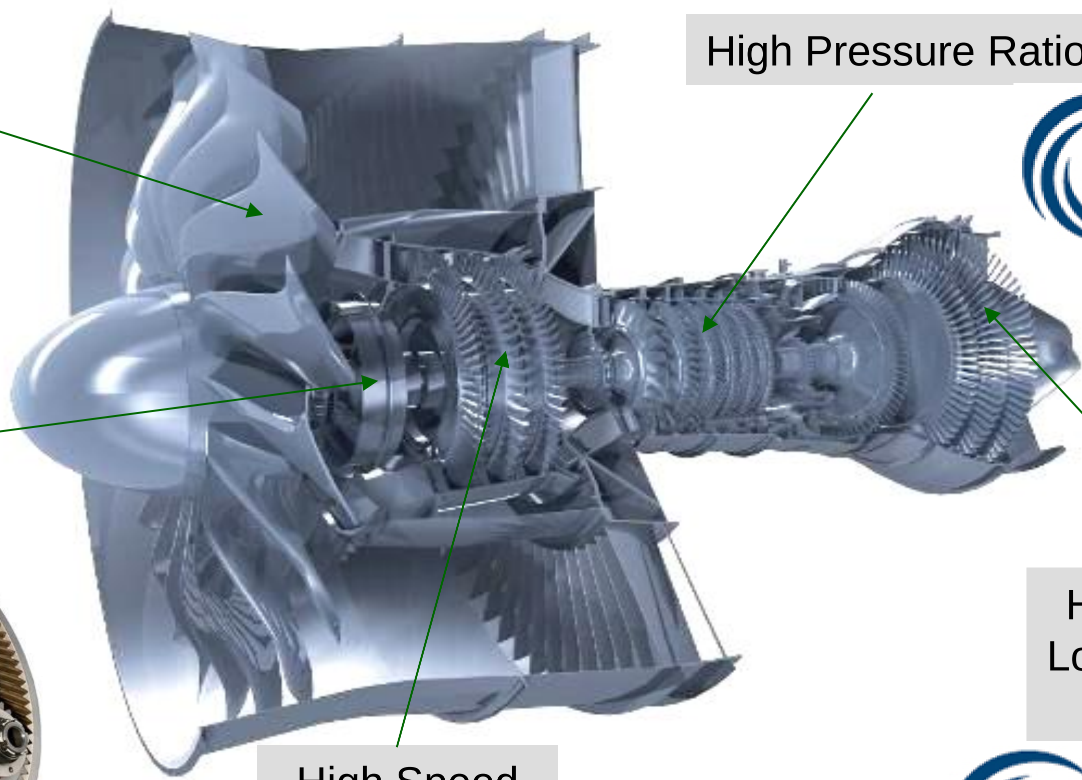
Optimized Low Compressor & Low Turbine



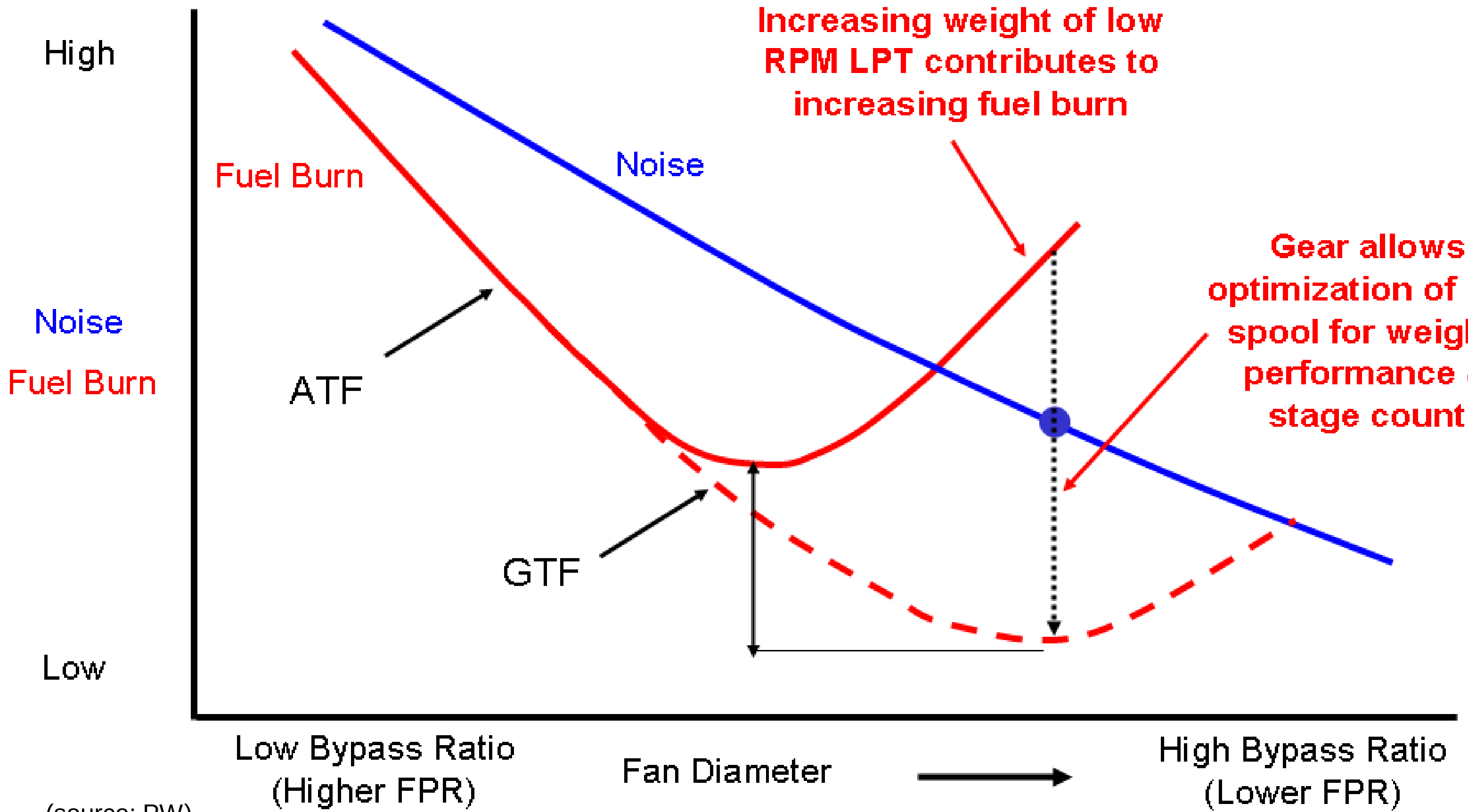
Step Change Improvement

Fuel, CO_2 **Noise** **Maintenance**

Geared Turbofan: Development of new Components

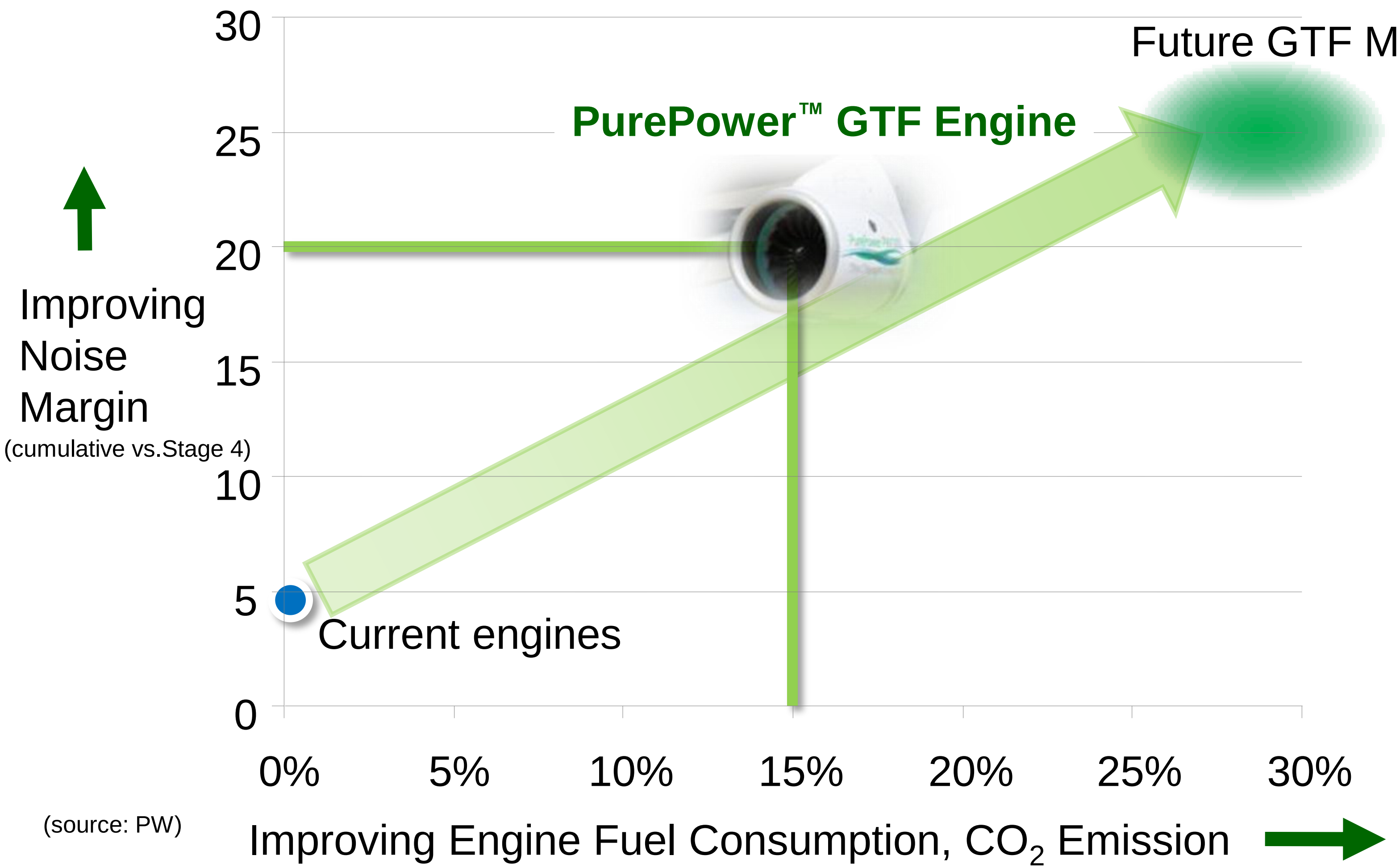


Geared Turbofan: Benefits of increased Bypass Ratio



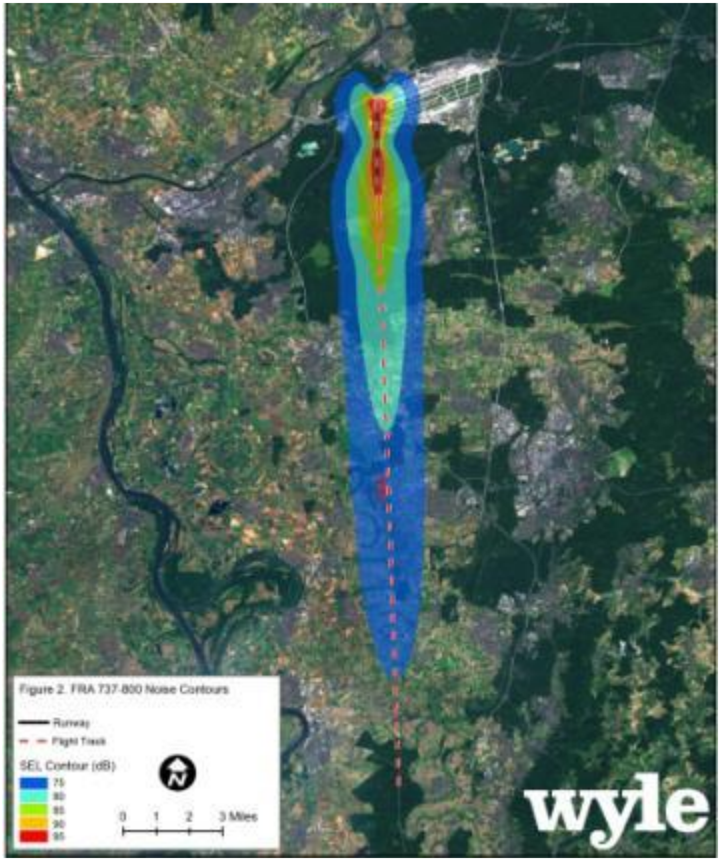
(source: PW)

Geared Turbofan: Step Change Improvements Fuel, CO_2 & Noise



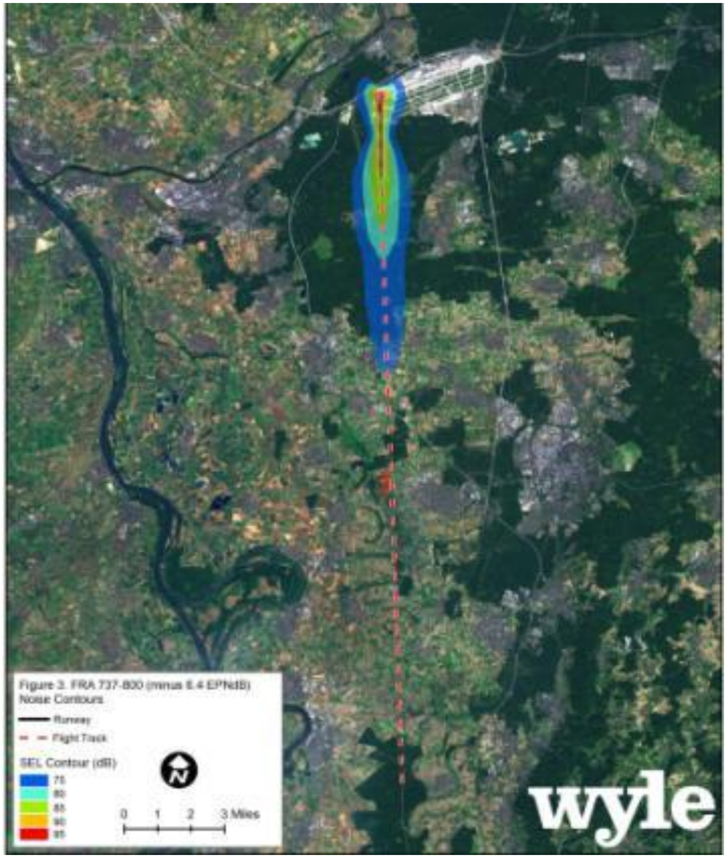
(source: PW)

75% reduction in noise footprint – Frankfurt Airport (FRA)



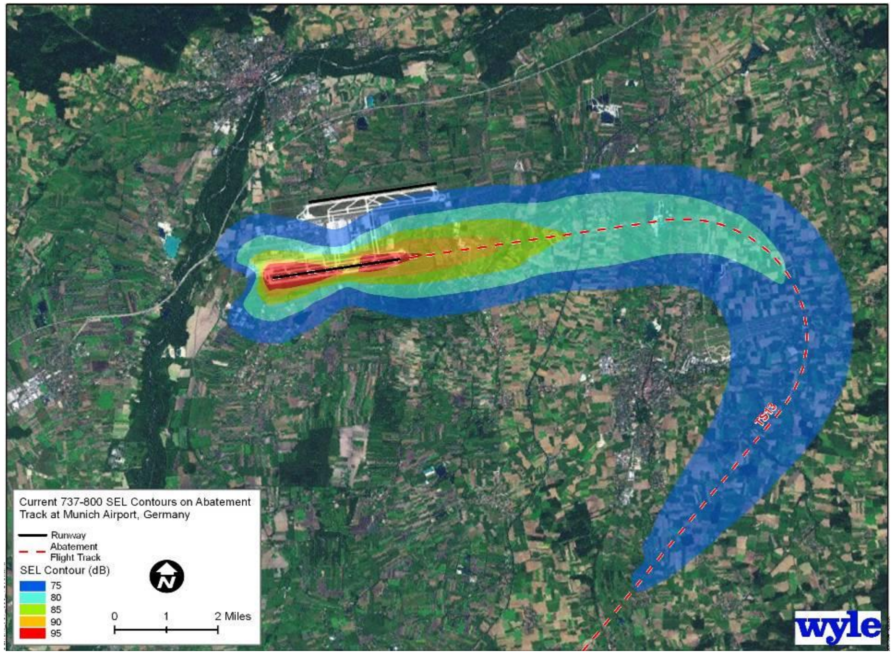
Today's Aircraft

Geared Turbofan Powered Next Generation Aircraft

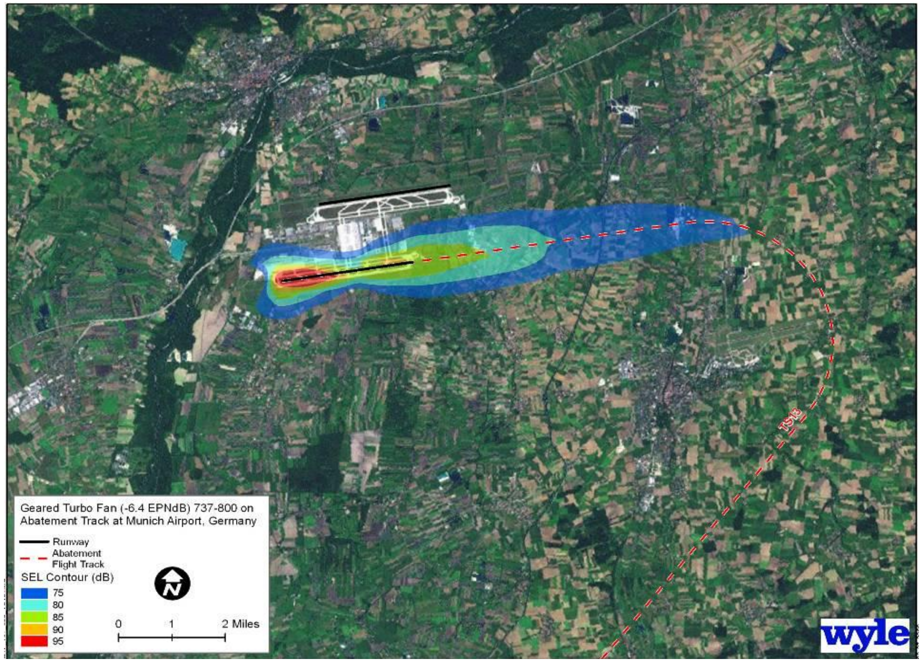


Noise Simulation: Pratt & Whitney, SEL Contour Source: Wyle Laboratories

75% reduction in noise footprint – Munich Airport (MUC)



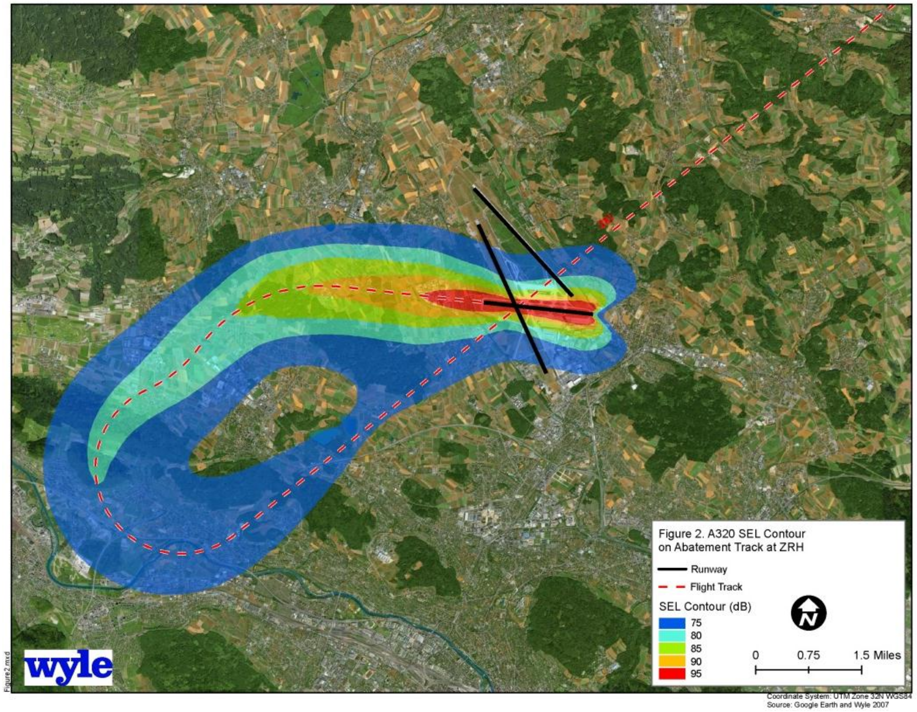
Today's Aircraft



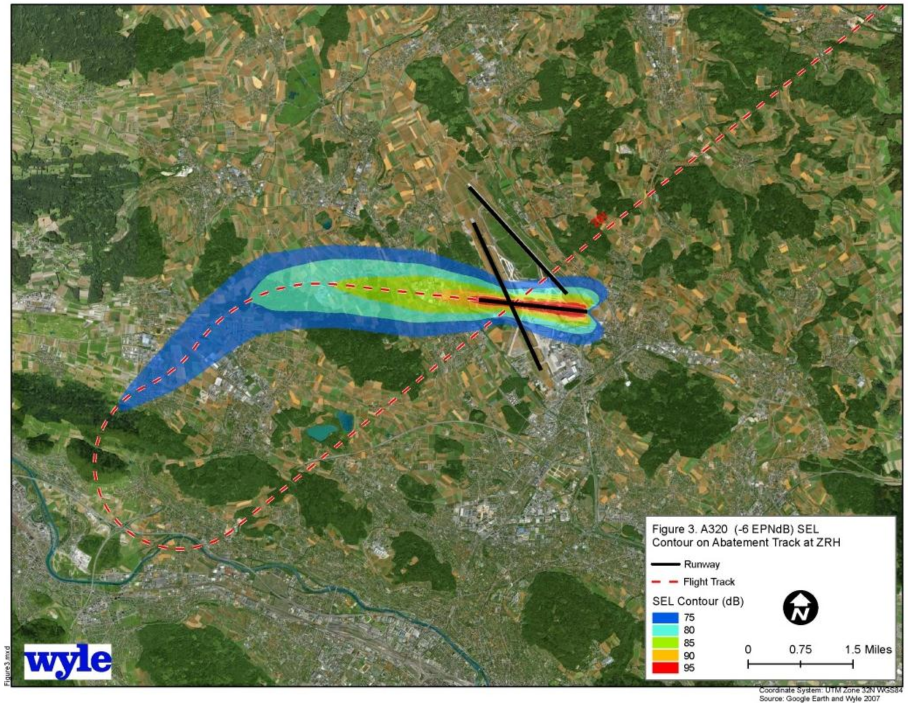
Geared Turbofan Powered Next Generation Aircraft

Noise Simulation: Pratt & Whitney, SEL Contour Source: Wyle Laboratories

75% reduction in noise footprint – Zürich Airport (ZRH)



Today‘s Aircraft

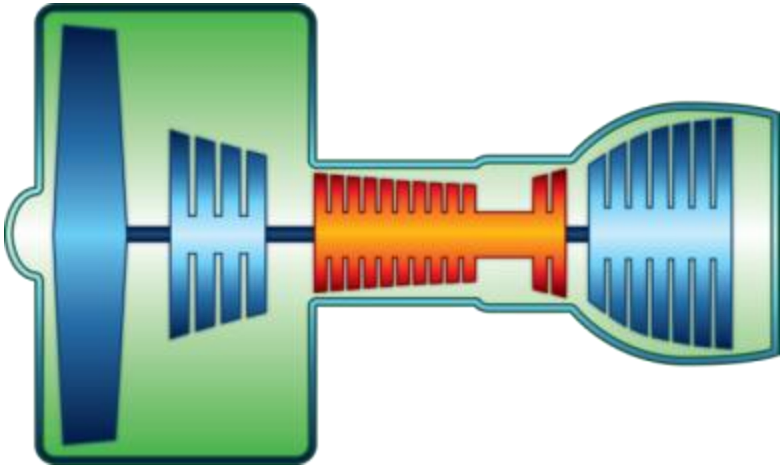


Geared Turbofan Powered Next Generation Aircraft

Noise Simulation: Pratt & Whitney, SEL Contour Source: Wyle Laboratories

Geared Turbofan: Step Change Improvement Maintenance

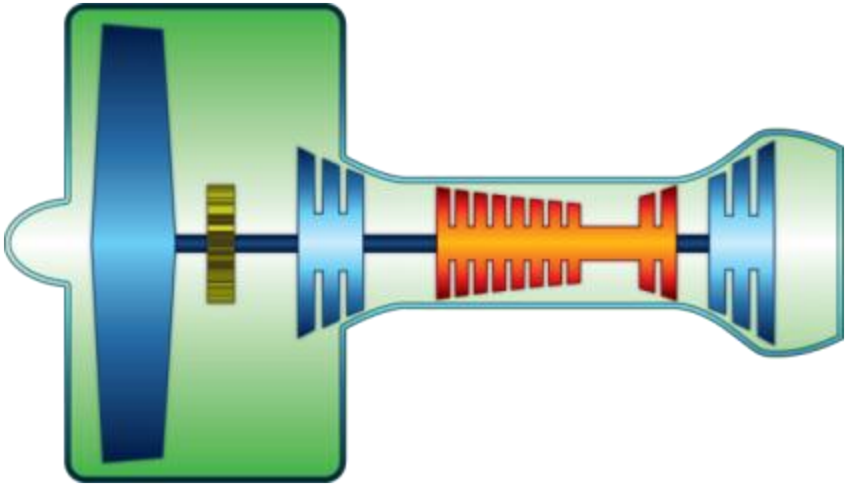
Conventional Turbofan



Reference Engine

(source: PW)

PurePower™ GTF Engine



Fewer stages / LLPs

Fewer parts

Lower temperatures

Lower costs

PurePower PW1000G Engine Benefits

Fuel Burn	✓	-15%
CO_2/NOx	✓	-3,600 tonnes/ CAEP6-50%
Noise	✓	-15 to -20 dB to Stage 4
Maintenance cost	✓	stages/ airfoils/ LLPs
Schedule	✓	Earliest EIS

(source: PW/MTU)

Agenda

The Geared Turbofan (GTF) Concept

GTF Applications

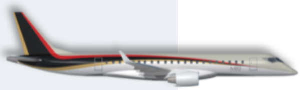
GTF Development Status

GTF Outlook

PW1000G applications

2012	2013	2014	2015	2016	2017	2018

Bombardier CSeries
(PW1500G)



Mitsubishi MRJ
(PW1200G)

Airbus A320neo
(PW1100G)

Irkut MS-21
(PW1400G)

Embraer E-Jet Gen2
(PW1700G/ PW1900G)

2012	2013	2014	2015	2016	2017	2018

Bombardier CSeries

Key facts

- 2 models: CS100/ CS300
- 110/ 135 seats (1-class, 32”); further stretch possible
- 5-abreast cabin
- Up to 3,150 nm range
- Two PW1500G (21-23k)
- Exclusive powerplant
- Launch July 2008
- EIS 2014

177 firm aircraft orders (211 options, 388 total)

Airbus A320neo

Key facts

- 3 models:

  A319neo/ A320neo/ A321neo
- 138/ 168/ 199 seats (1-class, 32”)
- 6-abreast cabin
- up to 4,200 nm range
- Two PW1100G/ LEAP-X (24-33k)
- Launch December 2010
- EIS Oct 2015

2380 firm aircraft orders (1090 options, 3470 total)

Mitsubishi Regional Jet MRJ

Key facts

- 2 models: MRJ-70/ MRJ-90
- 78/ 92 seats (1-class, 32”)
- 100-seat version under evaluation
- 4-abreast cabin
- 1,800 nm range
- Two PW1200G (15-17k)
- Exclusive powerplant
- Launch March 2008
- EIS 2017

165 firm aircraft orders (160 options, 325 total)

Irkut MS-21

Key facts

- 3 models: MS-21-200/ -300/ -400
- 150/ 181/ 212 seats (1-class, 32”)
- 6-abreast cabin
- up to 3,000 nm range
- Two PW1400G/ PD-14 (24-33k)
- Launch 2007
- EIS 2017

225 firm aircraft orders (20 options, 245 total)

Embraer E-Jet Gen2

Key facts

- 3 models: E175G2/ 190G2/ 195G2
- 78/ 96/ 124 seats (1-class, 32”)
- 4-abreast cabin
- up to 2,800 nm range
- Two PW1700G (up to 17k) or two PW1900G (up to 23k)
- Exclusive powerplant
- Launch 2013
- EIS 2018

165 aircraft on order (200 options, 365 total)

Over 4500 engines on order (including MoUs)

PW1100G A320neo	PW1200G MRJ	PW1400G MS-21	PW1500G CSeries	PW1700/1900G E-Jet Gen 2
				
Lufthansa, ILFC, IndiGo, TransAsia, jetBlue, Fly Smart go, Alafco, Cebu Pacific Air.com, CIT, Qatar Airways, norwegian.no, Philippine Airlines, spirit airlines, Lion Air, LAN TAM LATAM Airlines Group, volaris, Aviation Capital Group, Air Lease Corporation, Hawaiian Airlines	ANA, TSH Trans States Holdings, SkyWest Airlines	CRECOM, nordwind airlines, VEB Leasing, Ilyushin Finance Co, Rostekhnologii	Lufthansa, Lease Corporation International, Republic Airlines, Malmö Aviation, Korean Air, atlasjet, PrivatAir, Ilyushin Finance Co, airBaltic, طيران الخليج Gulf Air, porter, Odyssey, *Undisclosed (1)*	SkyWest Airlines, ILFC, *Undisclosed (5)*

Agenda

The Geared Turbofan (GTF) Concept

GTF Applications

GTF Development Status

GTF Outlook

PW1500G Type Certificate

<u>February 20, 2013:</u>

Transport Canada issues the

Type Certificate for the PW1500G

(CSeries) engine models …

PW1519G

PW1521G &

PW1524G


Transport Canada Transports Canada

Type Certificate

E-38

Pursuant to Canadian Aviation Regulations PART V, SUBPART 21, this Type Certificate is issued to:

Pratt & Whitney Canada Corp.
1000 Marie Victorin
Longueuil, Quebec
J4G 1A1

For the Following Aeronautical Product(s):

PW1519G PW1521G PW1524G

Details of the type design, basis of certification, operating limitations and other associated airworthiness requirements are specified in:

Department of Transport Type Certificate Data Sheet E-38 Issue 1

or latest revision

Director, National Aircraft Certification
For Minister of Transport

February 20, 2013
Date of Issue

Canada

CSeries Flight Test

September 16, 2013:

First Flight of CS100

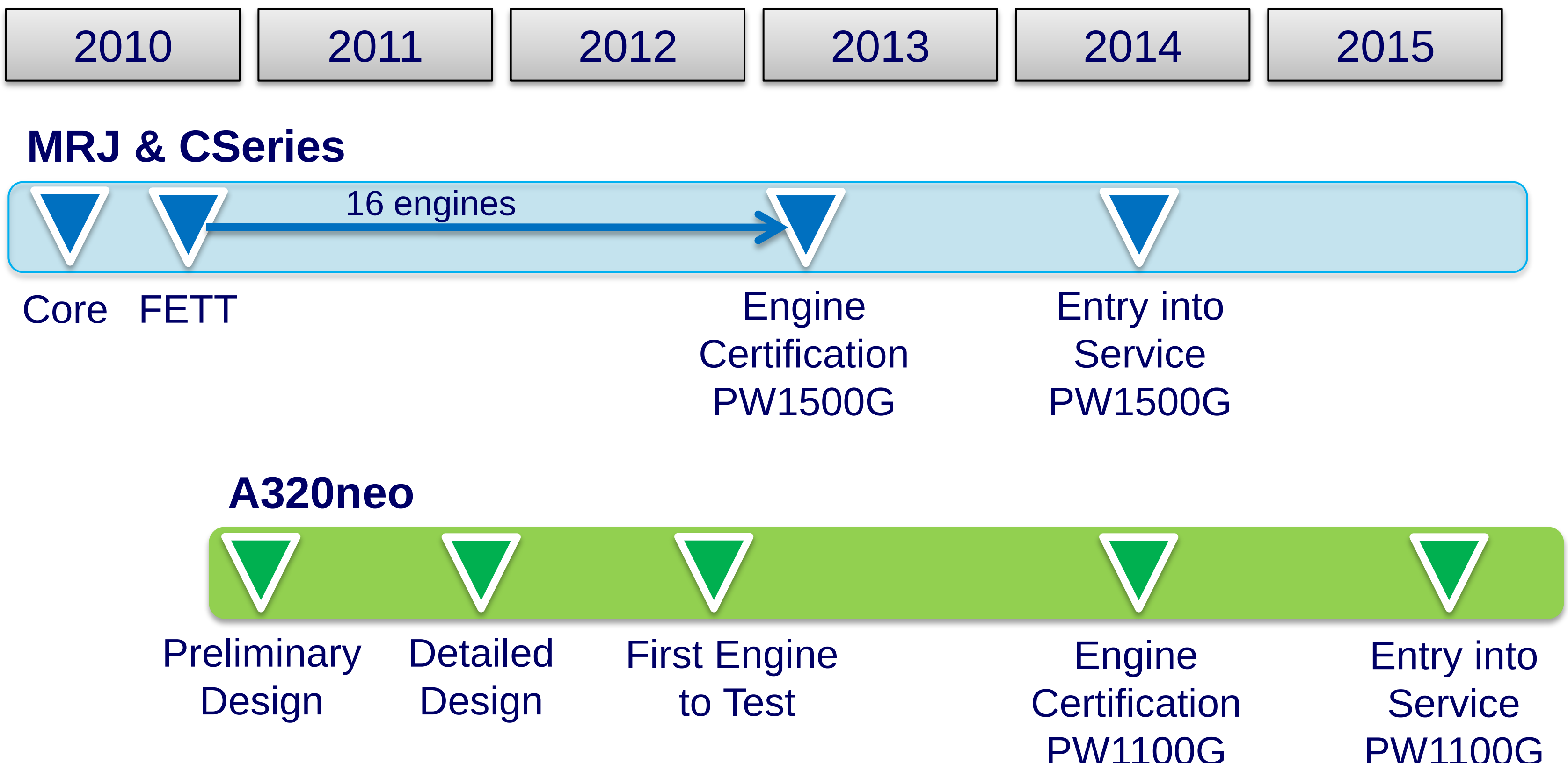
marks the start of the

Bombardier CSeries

flight test program

(source: Bombardier)

PW1100G benefits from extensive PW1200G and PW1500G Development Experience and Learning



(source: PW/ MTU)

PW1100G (A320neo) Engine Testing

Nov 28, 2012

May 15, 2013

(source: PW)

Agenda

The Geared Turbofan (GTF) Concept

GTF Applications

GTF Development Status

GTF Outlook

The GTF engine concept is not limited to a specific thrust range. There is a bright future for the GTF engine in the airliner market.

(source: PW/ MTU)

Thank you for your attention!

4.8 Bedeutung des Aktiven Schallschutzes als Auswahlkriterium der Kaufentscheidung für die Lufthansa-Gruppe

4.8.1 Vortragender

Nico Buchholz, Leiter Konzernflottenmanagement, Deutsche Lufthansa AG (DLH)

In March 2001 Nico Buchholz joined Deutsche Lufthansa AG in Frankfurt. His responsibilities include strategic fleet planning, commercial and technical aircraft evaluation including engines, procurement of aircraft and engines, aircraft specification, commercial ownership / asset management and the marketing and sales and leases of used aircraft for all airlines and partners within the Lufthansa Group, thus managing a portfolio of close to 800 aircraft. He was responsible for initiating the institution of a dedicated Lufthansa A380 Entry-Into-Service group. His team played an influential part in the development of the Boeing 747-8, the Boeing 787 and the Airbus A350. Moreover, Nico Buchholz is and was entrusted with the task of restructuring several fleets within the group. He also is a director in several Lufthansa affiliates besides being linked to the STAR Alliance fleet team.

Nico Buchholz, born in Hamburg, was initially employed in the import and export business. In 1982, he enrolled at the Berlin Technical University to study aeronautical engineering with the emphasis on aircraft design, flight operations and air traffic. He concluded his academic education with a Masters degree in airport transport management at the Cranfield Institute of Technology in 1989. Today he is also a visiting lecturer at several business schools.

From 1989 to 1998, Nico Buchholz was employed at Airbus Industries in Toulouse. He worked in global product marketing, the department for technical and commercial aircraft evaluation and comparisons and subsequently moved to aircraft sales. There he was directly responsible in European Sales, among others, for aircraft sales to Germany, Finland and Sweden as well as for coordination with the Star Alliance.

In 1998, he moved to a post in Berlin with the Rolls-Royce Aero-Engines. He was responsible for worldwide activities in marketing, sales, contracts, customer service and communications of German products in the military, airline and private sectors. Thereafter Nico Buchholz joined Deutsche Lufthansa AG.

4.8.2 Präsentation

Link zum Mitschnitt der Präsentation:

Deutsch: http://www.youtube.com/watch?v=hp0y0tM6HsU&feature=youtu.be

English: http://www.youtube.com/watch?v=a-QTHFrewB0&feature=youtu.be

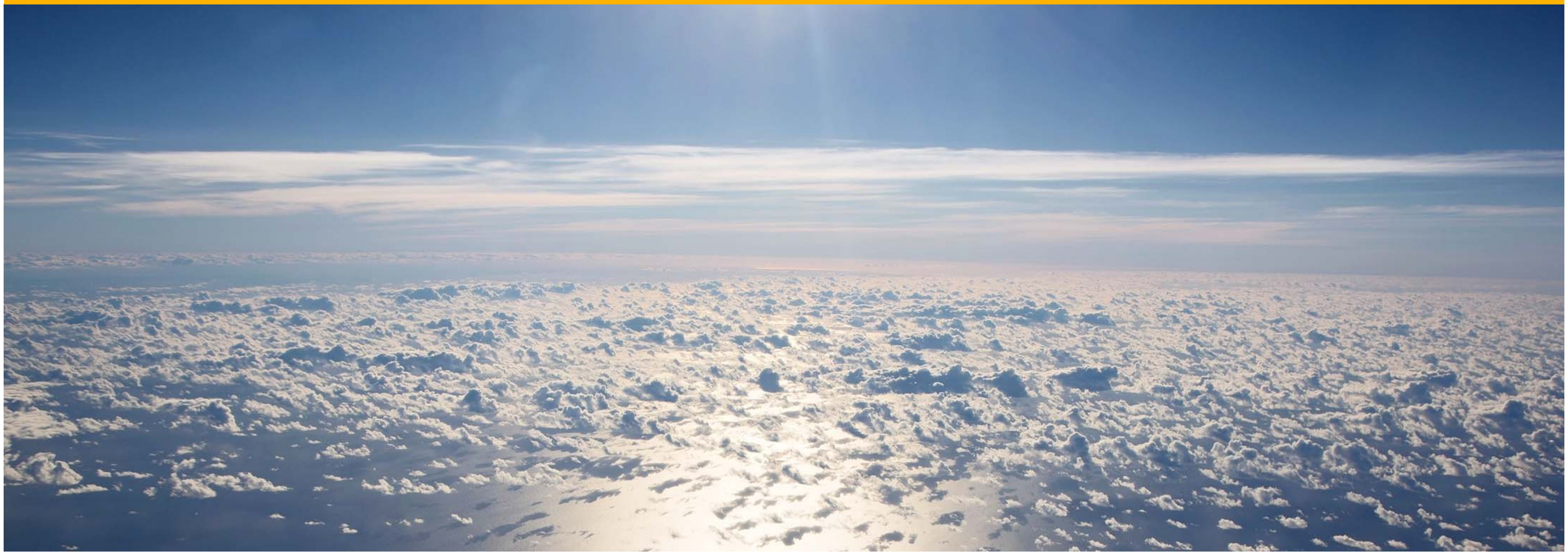
Lufthansa Group

Frankfurt/Main, October 30th 2013

Noise reduction as a key component in the aircraft selection process

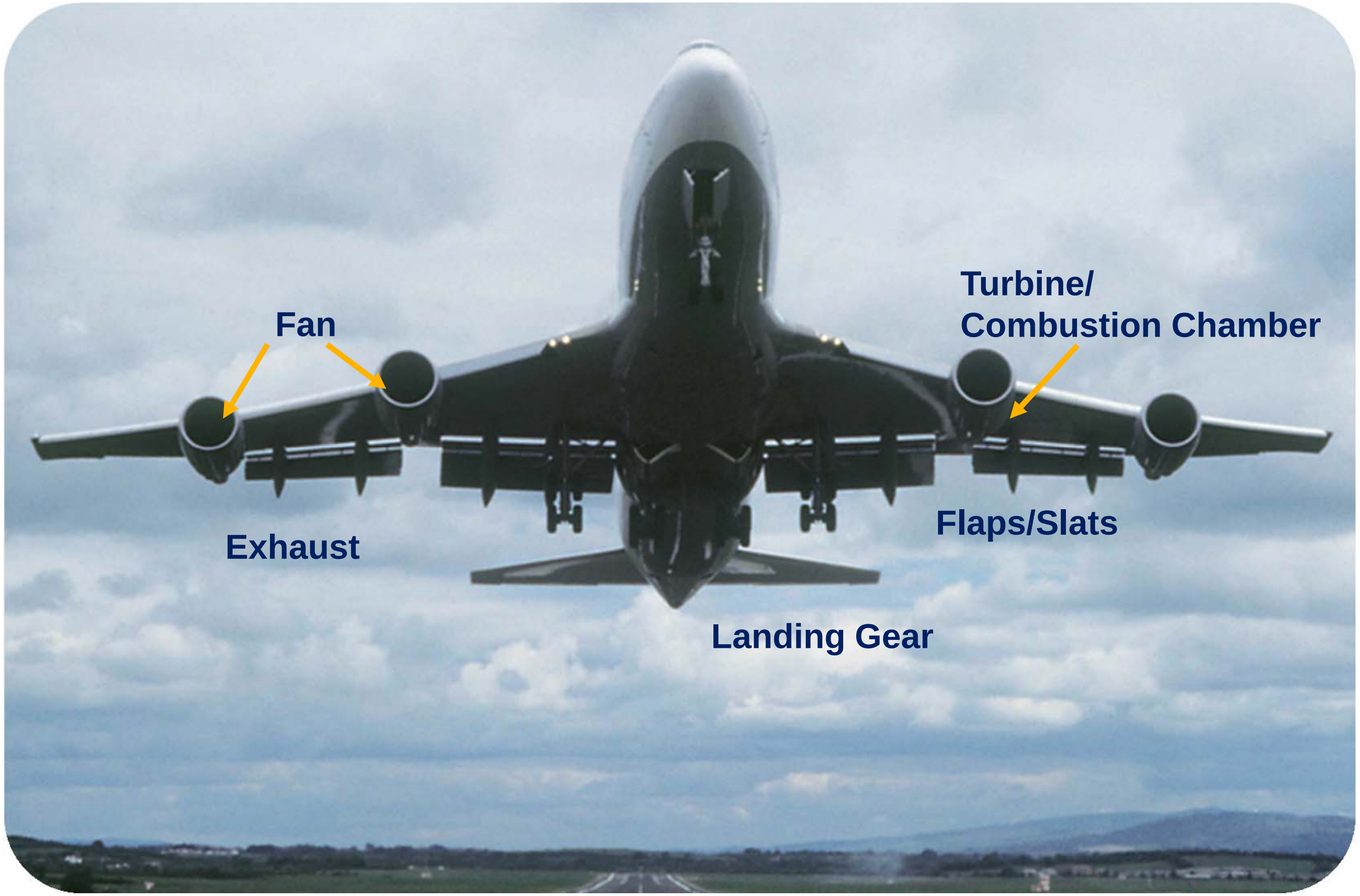
Nico Buchholz

EVP Lufthansa Group Fleet Management



lufthansagroup.com

Stating the obvious: Sources of noise



Reasons to focus on noise - environmental acceptance and reduction of drag hence fuel burn and CO_2

Lufthansa Group

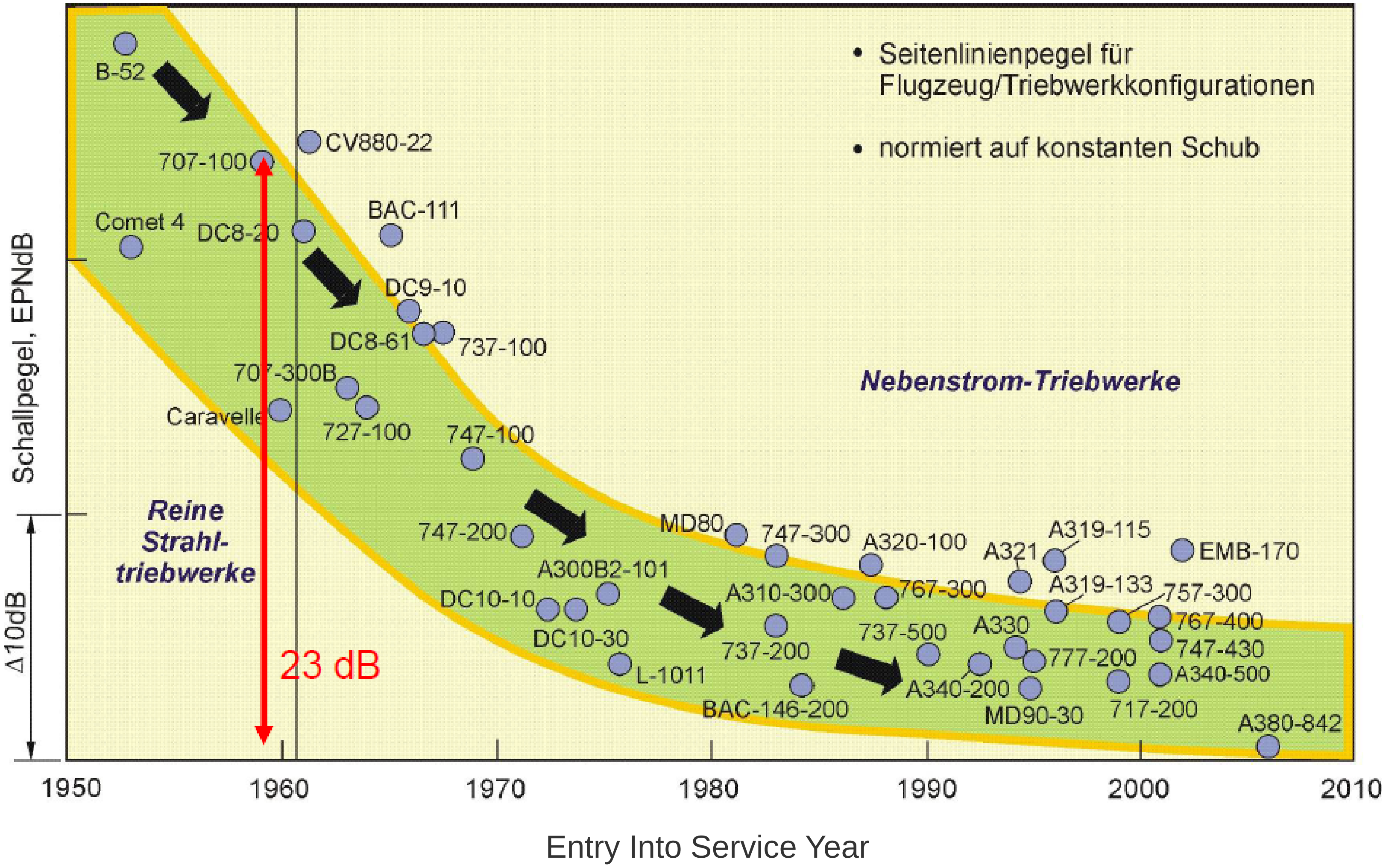
Lufthansa‘s Group Fleet Management

Single Interface
- Single Interface towards manufacturers
- central, standardized A/C evaluation and **design inputs** to OEMs
- central purchasing and commercial specification, integrating respective operators

Central Group Coordination
- Fleet strategy
- group-wide coordination of primary invest (in A/C) also maximising synergies
- syncronisation of A/C specification within group for flexibility
- Central remarketing and leasing integrating respective operators

Uniformity
- group-wide depreciation rules according to corporate governance
- owned assets preferred over leased assets, however some leasing will continue

Over time significant noise reductions were achieved in civil aviation



Source: DLR

Leveraging technology example: 1963-1988 „produced“ a fuel reduction of nearly 40% whilst cutting noise by multiples

EIS: 1963/68

25 years

EIS: 1988

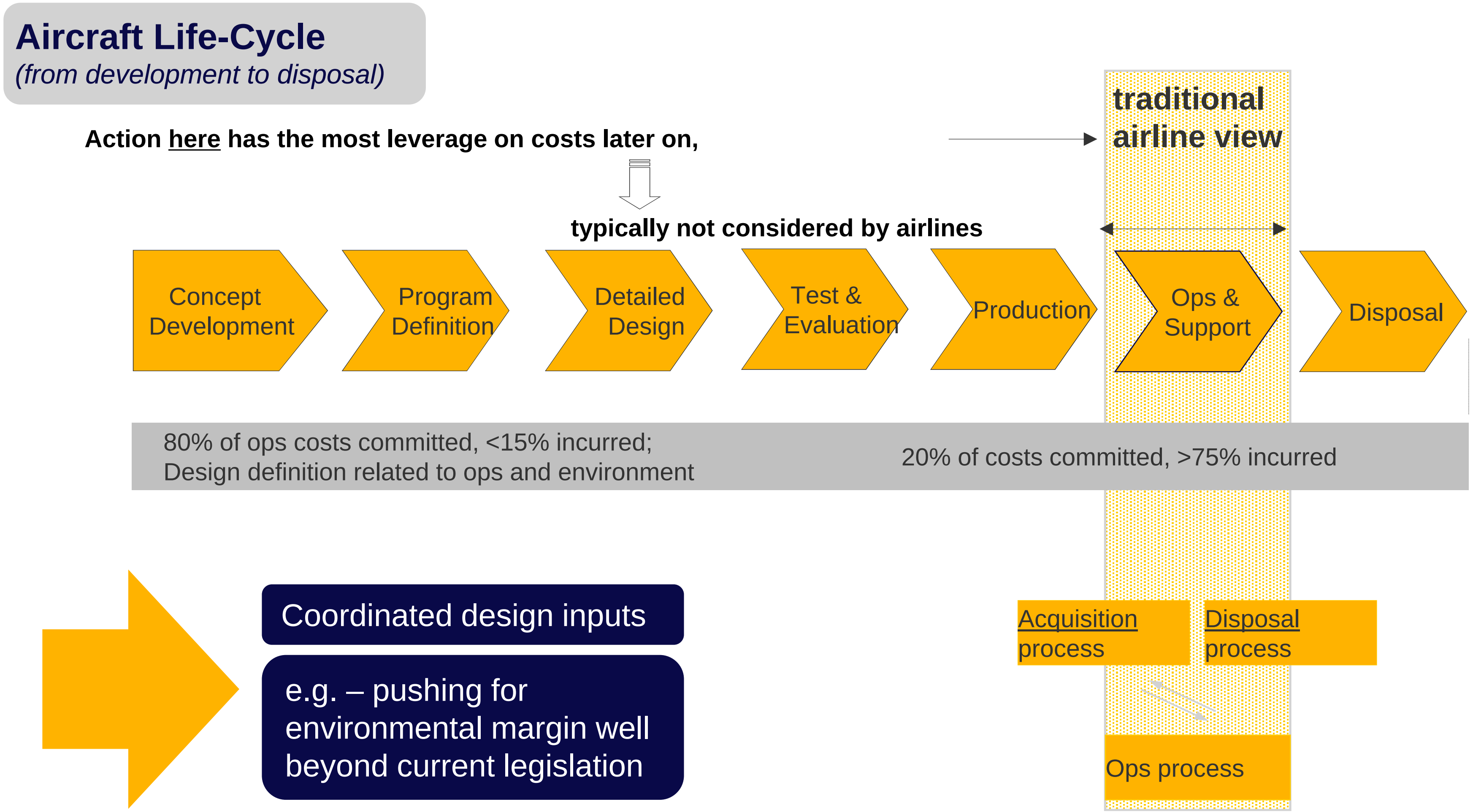
Σ Operating Cost-Change:
- 25% (Trip and Unit Cost)

Major improvements:

- 2- vs. 3-Man Cockpit - 23%
- Fuel-Consumption-Reduction - 39%
- Maintenance - 20%
- Fees (weight & noise) - 21%

Remarks:
- 500nm Mission
- 150 Seats (both aircraft)

Fleet Management looks at the operational life cycle through dedicated involvement in the whole aircraft life cycle, meaning around 40 years



Lufthansa Group

As part of the aircraft evaluation there is a focus on a multitude of requirements and potential incompatible trade offs

Evaluation Criteria

- **Flight performance**
  Range, Speed, Take-off & Landing performance
- **Operating costs/limitations**
  Fuel consumption, Fees, Maintenance costs, **Emission/Noise costs**
- **Technology**
  Engine technology, new avionics und materials
- **Environmental sustainability**
  Noise-, CO_2-emissions & pollution
- **Product**
  Cabin comfort, Seating,….
- **Fleet strategy**
  Long-term development of LH Group fleet
- **Industry political influences**
  Competition of OEMs, Two-OEM-strategy
- **Risk assessment**
  OEM risk, Technology risk, Funding risk, Market risk
- **Feasibility study**
  Comparison of competing A/C models

Airline Fleet Management – Squaring the "virtuous" circle: the constant challenge for sustainability

Planning of invest and capacities requires a long term fleet strategy and a broad horizon. Fleet decisions on types have to satisfy multiple criteria

Conflicting Interests

Homogeneous fleet	*versus*	Operational flexibility
Economies of Scale	*versus*	Product differentiation
Fleet commonality	*versus*	Risk mitigation/-spread
Innovative aircraft	*versus*	Low capital expenditure

Plus:

Determine a low complexity fleet, market driven multiple aircraft sizes offering high flexibility in operation and performance while being state of the (technical) art and sustainable highly economical **with the least possible environmental impact.**

Our environment….

Our orders
Aircraft deliveries 2013-2025

EUR 36bn

until 2025

Lufthansa Group	
Airbus A380	4
Boeing 747-8	15
Boeing 777	45
Airbus A350	25
Airbus A330	3
Airbus A320 Family, Embraer 195, Bombardier CSeries	203
Total deliveries	**295**

295

new aircraft 2013–2025

current fleet 30.9.2013: 632 aircraft

Entry into the ‘2-litre class’
2.9 litres per passenger and 100 kilometres

Boeing 777-9X
- Enhancement of the Boeing 777
- Aerodynamically optimized wings
- New, efficient and quiet engines

Airbus A350-900
- Completely new construction
- New, efficient and quiet engines

As a result, this means
- 25 % less kerosene and emissions
- 20 % decrease in unit costs (per ASK)
- Reduction in noise footprint of 30 %

-20%

Unit costs

30%

quieter

-25%

kerosene consumption

Lufthansa Group

A large choice of products to evaluate

Short Range

Long Range




Lufthansa Group

Lufthansa's recent aicraft acquisitions will help to sustainably reduce noise emissions (firm orders, partially already in service)

Bombardier CSeries for SWISS
(PW GTF engines)

Boeing 747-8 for Lufthansa
(GE GEnx engines)

Airbus A320neo for Lufthansa
(PW GTF engines*)

Airbus A350-900 for Lufthansa
(RR Trent XWB engines)

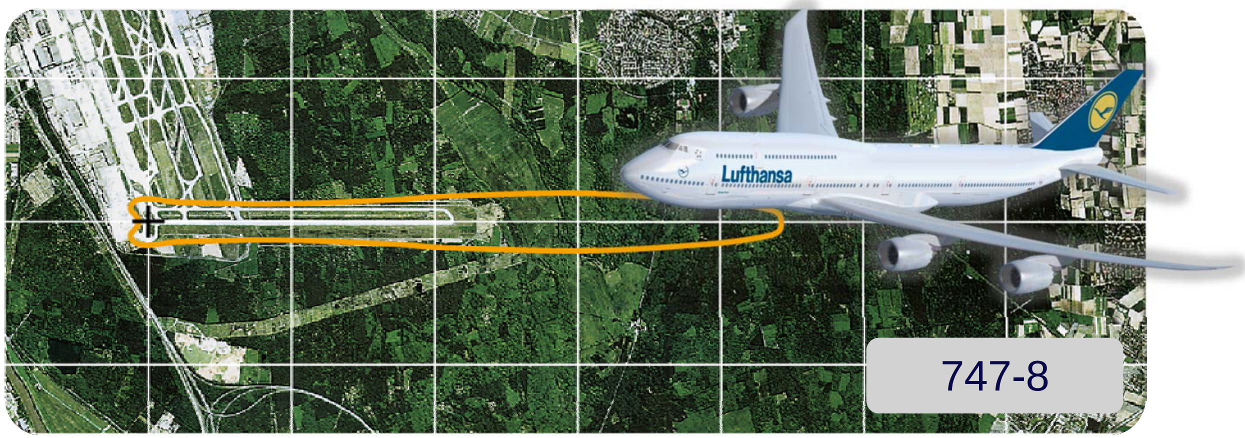
Boeing 777-300ER for SWISS
(GE GE90 engines)

Airbus A380 for Lufthansa
(RR Trent 900 engines)

Boeing 777-9X for Lufthansa
(GE GE9x engines)

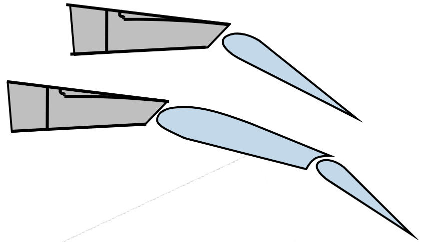
*decision pending for part of the order

Despite being a much more capable aircraft, the external noise of the Boeing 747-8 was significantly reduced vs. its predecessor, the 747-400 based on Lufthansa inputs; current analysis what can be retrofitted to the 747-400

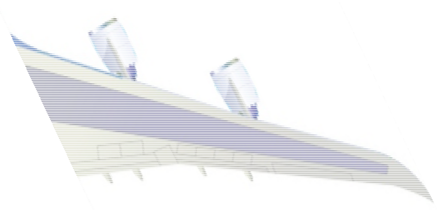


Frankfurt/Main Airport, RWY 18, MTOW mission, 85 dBA contour (standard Lufthansa departure procedure)

New double-slotted inboard and single slotted outboard flaps

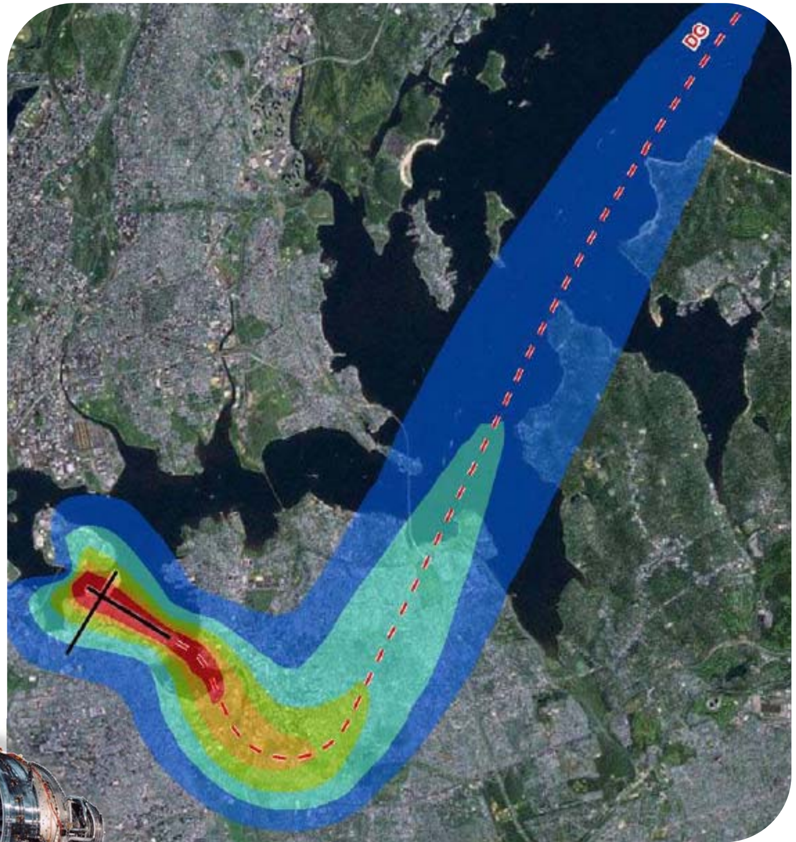


New efficient wing

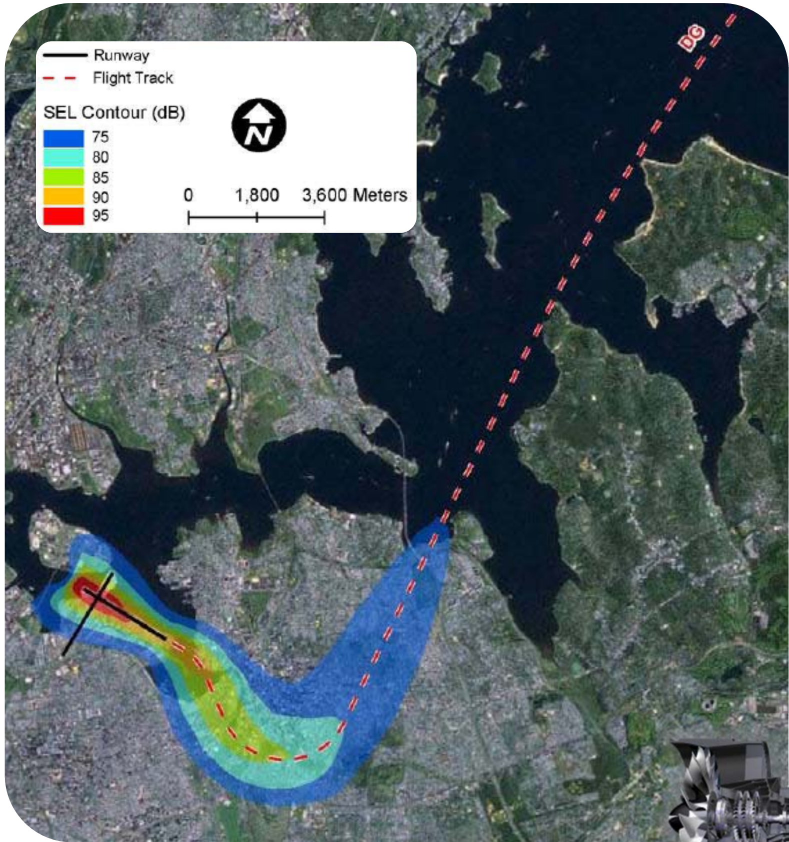


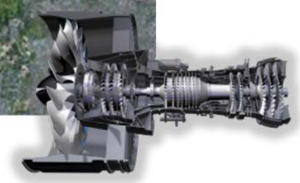
New engines with chevron nozzles, tested by LH already years ago

Pratt & Whitney's Geared Turbofan Engines, selected for the CSeries (Swiss) and the A320neo (LH), reduce noise emissions considerably



conventional engine





PW GTF

New York LaGuardia, generic narrowbody aircraft
source: Pratt & Whitney, SEL contours

Lufthansa Group

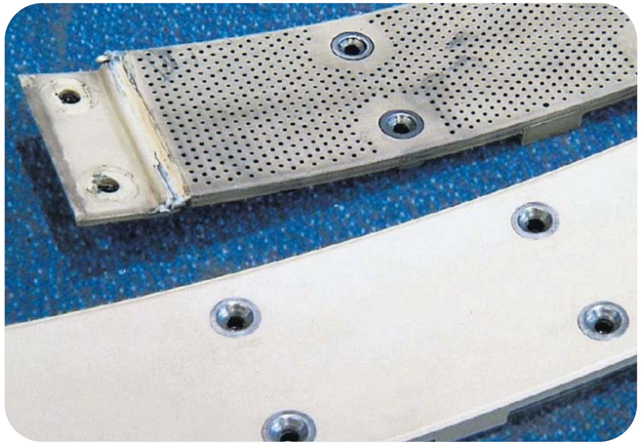
Besides the acquisition of new, quiet aircraft Lufthansa constantly invests in improving the existing fleet (1)

Lufthansa Boeing 737

noise levels at certification points dropped by up to 2 EPNdB

Retrofit at engine intake: installation of hard wall forward acoustic-panels (HWFAP):

Foto: I. Friedl, Lufthansa



Acoustic Panels: old (top) and new

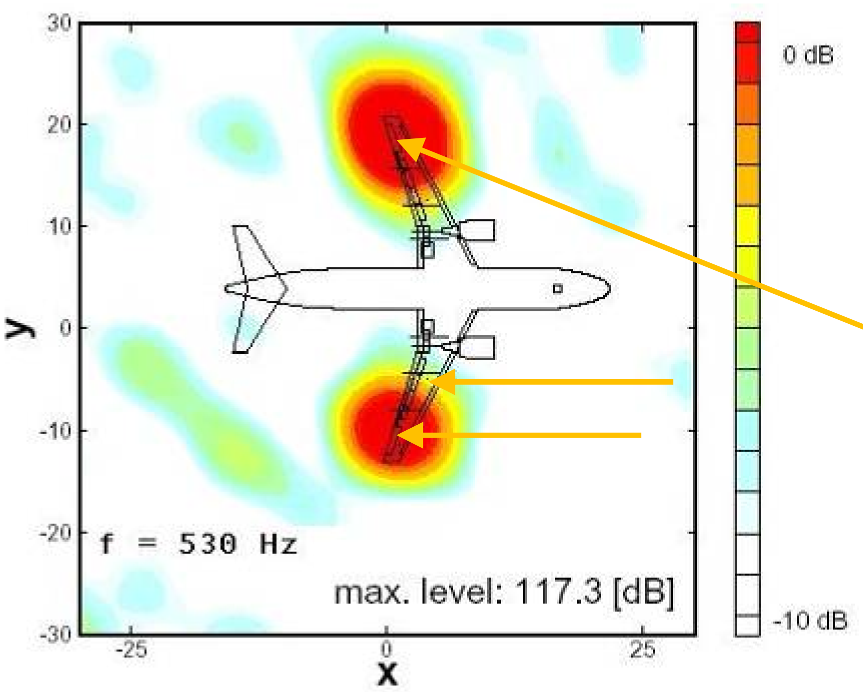
Exchange of 12 acoustic panels completed on FRA-based aircraft by the end of 2011

CFM56-3

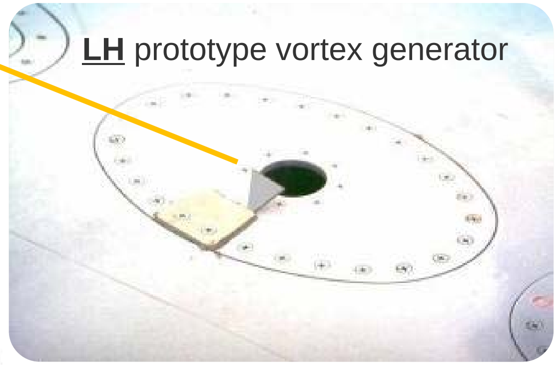
Besides the acquisition of new, quiet aircraft Lufthansa constantly invests in improving the existing fleet (2)

Lufthansa Airbus A320

Overpressure relief outlets at lower wing surface produce two strong tones at 530 and 580 Hz:



Lufthansa announced in Februar 2012 to cut these tones by installing vortex generators in front of the outlets.



Prototype vortex generators have been tested successfully
First installation on LH aircraft planned for Q1 2014

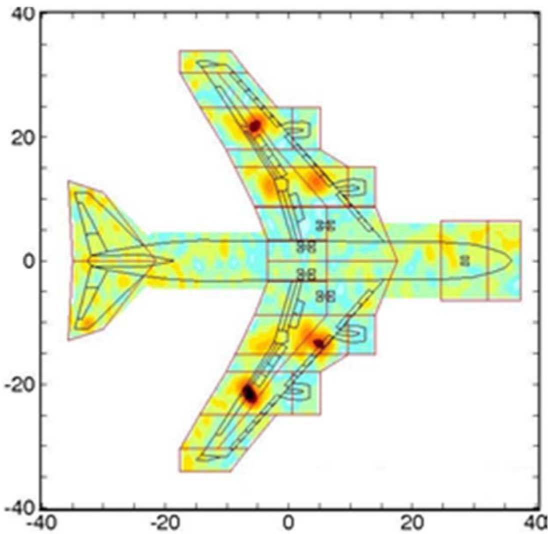
Besides the acquisition of new, quiet aircraft Lufthansa constantly invests in improving the existing fleet (3)

Lufthansa Boeing 747-400

National R&D projects FREQUENZ and MODAL: flyover noise measurements and data reduction funded by Federal Ministry of Economics

- MODAL 2012 – 2015:
  - → identification of excess noise sources
  - → understanding noise generating mechanisms and interdependencies
  - → definition of noise reducing measures

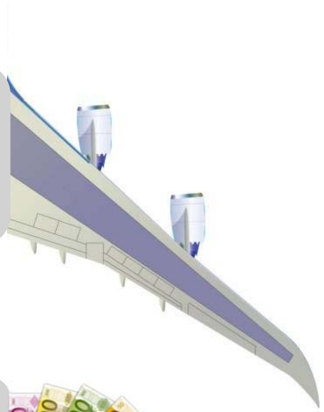
Foto: C. Lahiri, DLR-AT, Berlin



Operating a low-emission fleet is in the utmost interest of an airline like Lufthansa – several drivers can be identified

Technology

- New engines with better noise characteristics (and less fuel burn!)
- New aerodynamics with lower noise
- Inherently quiet aircraft are the "easiest" way to lower noise emissions

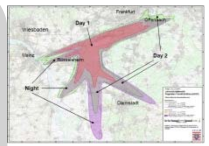


Economics

- Noise-related charges increasing
- Night flying bans pose economic incentive to reduce noise

Corporate Responsibility

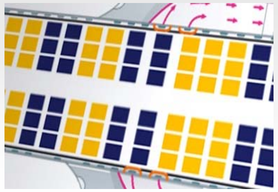
- Local partnership with residents as future growth enabler
- Environmental impact of aviation as long-term issue to enable future prosperity of the sector
- Many employees of Lufthansa live in the vicinity of airports and are part of the neighborhood communities



Summary:

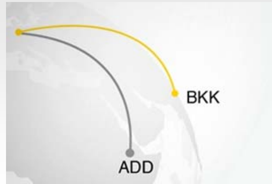
Criteria for selecting aircraft

Number of seats

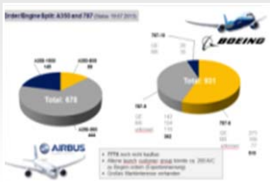


Unit costs per seat-kilometre

Range



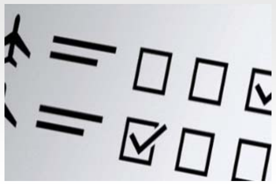
Aircraft market



Lufthansa Technik

In-flight products

Delivery slots



Engines

Noise and environmental efficiency

Lufthansa Group

Noise and Environment

Lufthansa Group

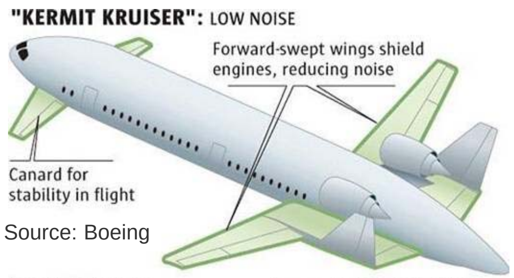
Some thoughts in summary….

- While new generation of aircraft provides a step forward, existing aircraft can be retrofitted with noise reducing measures
- Lufthansa has been and is one of the very few airlines able and willing to drive this topic within the OEM world – examples raised Vortex Generators, Accoustic panels, flaps,..
- we need a long term sustainable reliable planning baseline for the industry taking all environmental elements into account

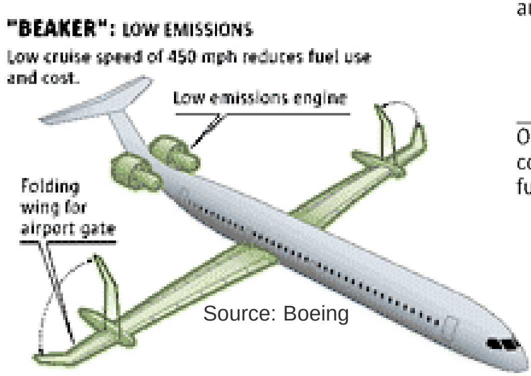
Plenty of ideas … but what is the target? As an industry we need a long term reliable political and environmental framework


Source: Airbus

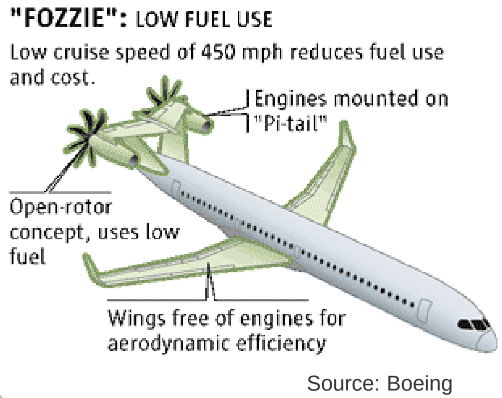
Low Noise



Source: Boeing



Source: Boeing



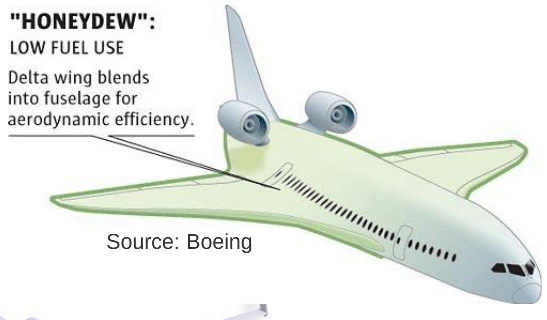
Source: Boeing

Low Emissions

Radical Aerodynamics


Source: Bauhaus Luftfahrt

Radical Efficiency



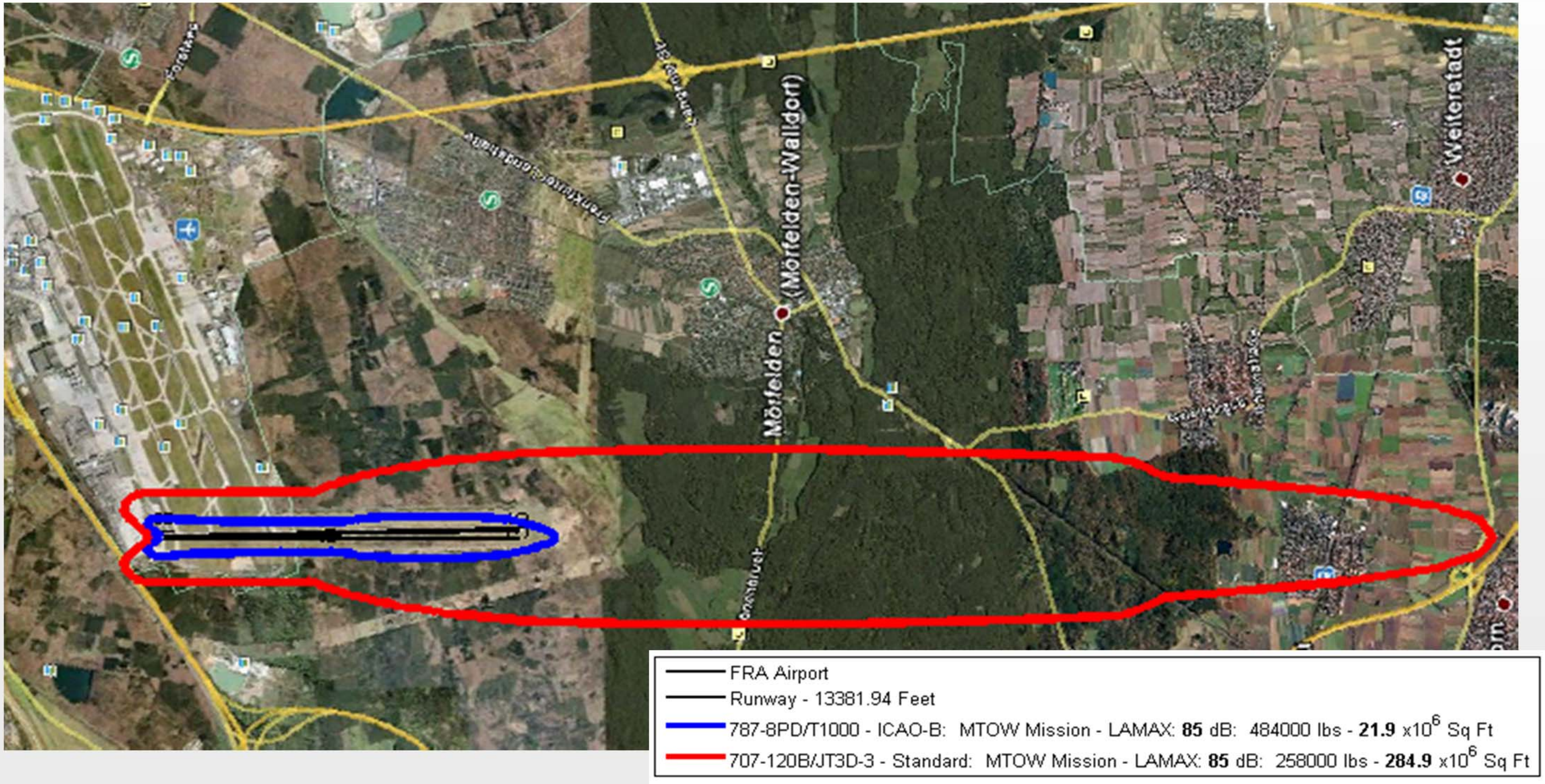
Source: Boeing


Source: MIT

Structural Efficiency

Allow me one question: what would have been the target noise level 50 years ago on the red line? the blue line or more?

Modern technology as a friendly neighbour – twice the size at more range but producing only a 7.7% noise-footprint compared to the 707



Lufthansa Group


A modern Fleet cares
Thank you

Questions & Answers

Lufthansa Group

Disclaimer in respect of forward-looking statements

Information published in this presentation with regard to the future development of the Lufthansa Group and its subsidiaries consists purely of forecasts and assessments and not of definitive historical facts. These forward-looking statements are based on all discernible information, facts and expectations available at the time. They can, therefore, only claim validity up to the date of their publication. Since forward-looking statements are by their very nature subject to uncertainties and imponderable risk factors – such as changes in underlying economic conditions – and rest on assumptions that may not or divergently occur, it is possible that the Group's actual results and development may differ materially from those implied by the forecasts. Lufthansa makes a point of checking and updating the information it publishes. It cannot, however, assume any obligation to adapt forward-looking statements to accommodate events or developments that may occur at some later date. It neither expressly nor conclusively accepts liability, nor gives any guarantee, for the actuality, accuracy and completeness of this data and information.

Sources for pictures and graphics:
Boeing, Airbus, Bombardier, Embraer, Rolls Royce, GE, PW, MHI, Comac, Irkut, Sukhoi, Porsche, DLR, Lufthansa, Zefa, own

4.9 Wie wählt BA Flugzeuge in einem sensitiven HUB wie London-Heathrow aus

4.9.1 Vortragender

Captain Dean Plumb, Strategy and Environment Manager, British Airways (BA)

Since 2009 Captain Dean Plumb has been the Environment Strategy Manager for British Airways, with a particular focus on the policy and operational aspects of aviation noise. He is a member of the UK Department for Transport's Aircraft Noise Management Advisory Committee and recently chaired a UK cross-industry group developing and publishing environmental best practices for the ground and departure phase of operations.

Prior to his current post he held a number of senior roles within the airline's Flight Operations Department, including leading key elements of the fleet replacement evaluation that ultimately selected the Airbus A380 and Boeing B787 aircraft. Other roles within the airline included managing the Flight Technical Support and Despatch teams responsible for the performance and flight planning of the airline's 270,000 annual flights. Between 2000 and 2006 he held a variety of pilot management, technical and training roles for the Boeing 757/767 and B737 fleet.

Captain Plumb's background is as operational flight crew. He has flown throughout the world and currently operates European flights from Gatwick. Prior to joining British Airways flew the Airbus A320 for a UK based carrier operating in the Middle East and also served in the Royal Air Force as a transport pilot, flying tactical and long-range duties and as a training captain. In his final tour of duty before leaving the Royal Air Force he was responsible for training standards on one of the RAF's 4 operational C130 squadrons.

4.9.2 Präsentation

Link zum Mitschnitt der Präsentation:

Deutsch: http://www.youtube.com/watch?v=X6xH_GvIK0o&feature=youtu.be

English: http://www.youtube.com/watch?v=wwoteSh07g0&feature=youtu.be

BRITISH AIRWAYS

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Airline Considerations at a Noise Sensitive Hub 30th October 2013

NB: This presentation contains third party information and is reproduced in good faith. British Airways cannot guarantee the accuracy of all data used.

Captain Dean Plumb

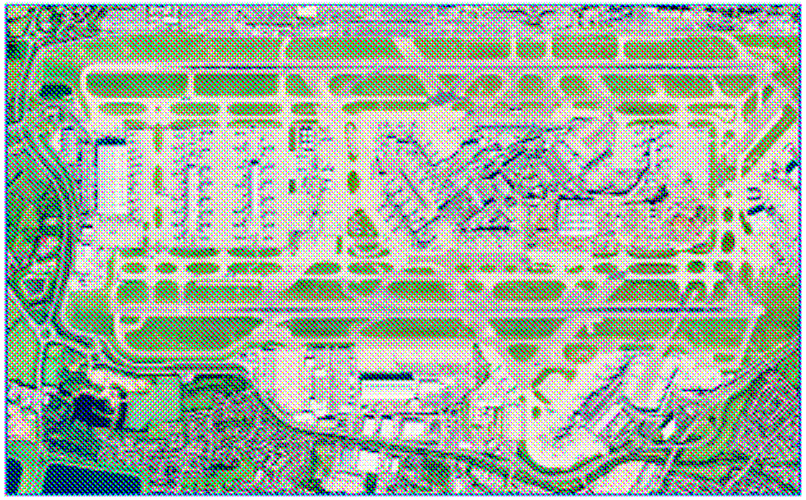
Environment Strategy Manager

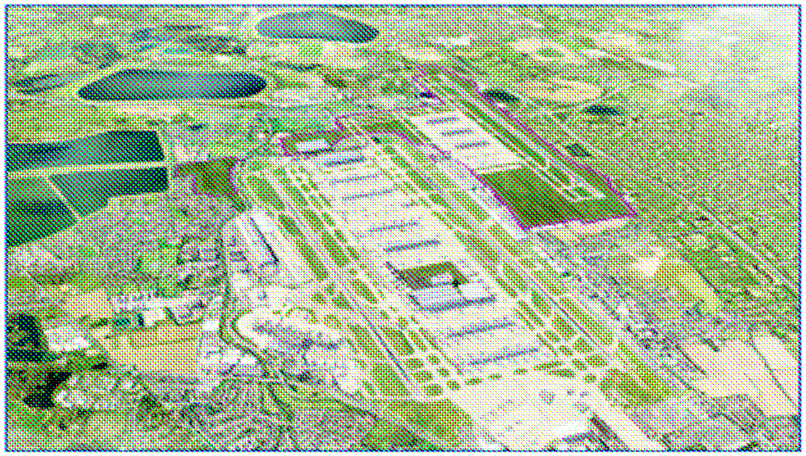
About British Airways

- Based at London Heathrow and is the airport's major operator flying approximately 50 per cent of flights at the airport.
- Significant presence at London Gatwick and its wholly owned subsidiary BA CityFlyer is the biggest operator at London City Airport.
- The airline has a fleet of c240 aircraft including c115 longhaul aircraft. The airline's route network currently serves in excess of 160 different cities.
- The airline operates in excess of 300,000 flights per annum.

Heathrow airport

- Limited to 480,000 annual movements .
- Operates at circa 99.2% of capacity.
- Any form of disruption can lead to significant delays, including into the night period.
- Despite these pressures, 3rd runway was cancelled primarily due to noise concerns.
- Airports Commission considering future UK hub capacity options.



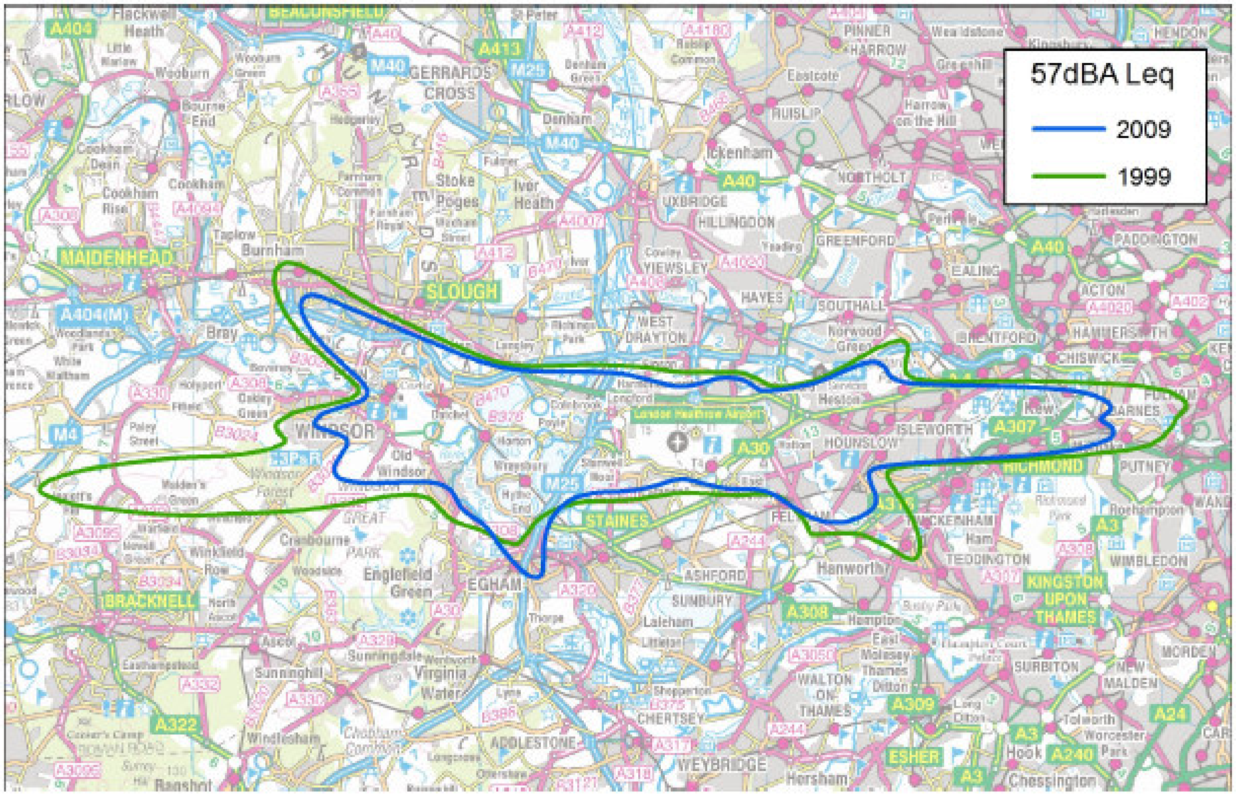


*Images reproduced with kind permission of Heathrow Airport Ltd.

Noise affected population

Rank	Country Code	Airport Name	Movements / year	Pop' in 55 Lden
1	**UK**	**LONDON - HEATHROW**	**475,762**	**725,500**
2	Germany	Frankfurt Main	200,583	238,700
3	France	Paris Charles De Gaulle	516,398	171,300
4	Portugal	Lisbon Airport	135,007	136,500
5	France	Paris Orly	218,760	109,300
6	**UK**	**Manchester**	**224,535**	**94,000**
7	Italy	Naples	63,400	86,500
8	Norway	Trondheim	53,328	79,600
9	Italy	Milan Linate	100,113	73,800
10	**UK**	**Glasgow**	**107,095**	**63,600**
-	-----------	--	----------	---------
19	Spain	Madrid	414,370	39,800

Population Encroachment



57db Laeq contour has reduced by **52%,** from **234.9 km2** to **112.5 km2** between 1991 and 2009.

But - more than **13,000** extra homes in new 57 dB contour since **1991** – a 15% increase.

Heathrow night quota count (QC)

- Noise quotas cap the amount of noise energy emitted at night.
- Takes account of the noise emitted by aircraft type - the noisier the aircraft, the fewer that can be operated within the cap
- Natural incentive for airlines to use less noisy aircraft.
- Provided long term regulatory stability allowing noise to be prioritised.
- A380 design included a trade-off of fuel efficiency to meet London QC requirements.

Night flights

What is the issue?

Noise created by aircraft at night may cause more disturbance to some people because there is less background noise from other sources and the majority of people will be trying to sleep. Similarly, night noise may appear worse in the summer because people tend to sleep with windows open more frequently.

Is there a ban on night flights?

Heathrow has always been a 24 hour operation airport. There is not, and never has been, a night ban. However, for the reasons above and in order to try to balance the interests of the local communities and those of the airports users, there are restrictions and rules regarding night flights.

Who makes the restrictions?

The Department for Transport (DfT) is responsible for making the restrictions on the types of aircraft that can be scheduled to fly at night. In setting the restrictions the aim has been to maintain a balance between the need to protect local communities from too much aircraft noise at night and the operation of services where they provide economic benefits.

BAA does not set the rules but strictly monitors compliance with all Government restrictions in force. We report regularly to the DfT and the Heathrow Airport Consultative Committee (HACC). This is an independent consultative forum made up of representatives of local authorities, councillors, business and airlines and the DfT.

What are the restrictions?

Aeroplanes are certified by the International Civil Aviation Organisation (ICAO) according to the noise they produce. They are classified separately for both take off and landing.

The night flying restrictions are divided into summer and winter seasons. They consist of a movements limit and a quota count system. This means that points are allocated to different aircraft types according to how noisy they are. The noisier the aircraft type, the higher the points allocated. This provides an incentive for airlines to use quieter aircraft types.

Night Period and Night Quota Period

The 'Night Period' is 23:00 to 07:00 hours local during which period the noisiest types of aircraft (classified QC/8 and QC/16) may not be scheduled to land or take-off.

The 'Night Quota Period' is from 23:30 to 06:00 hours local, during which period aircraft movements are restricted by a limit on the number of movements with noise quotas as an additional measure. These number of movements and quota counts allowed are set for each season as opposed to each night.

The Quota count system

Aircraft are given quota count (QC) classifications as follows:

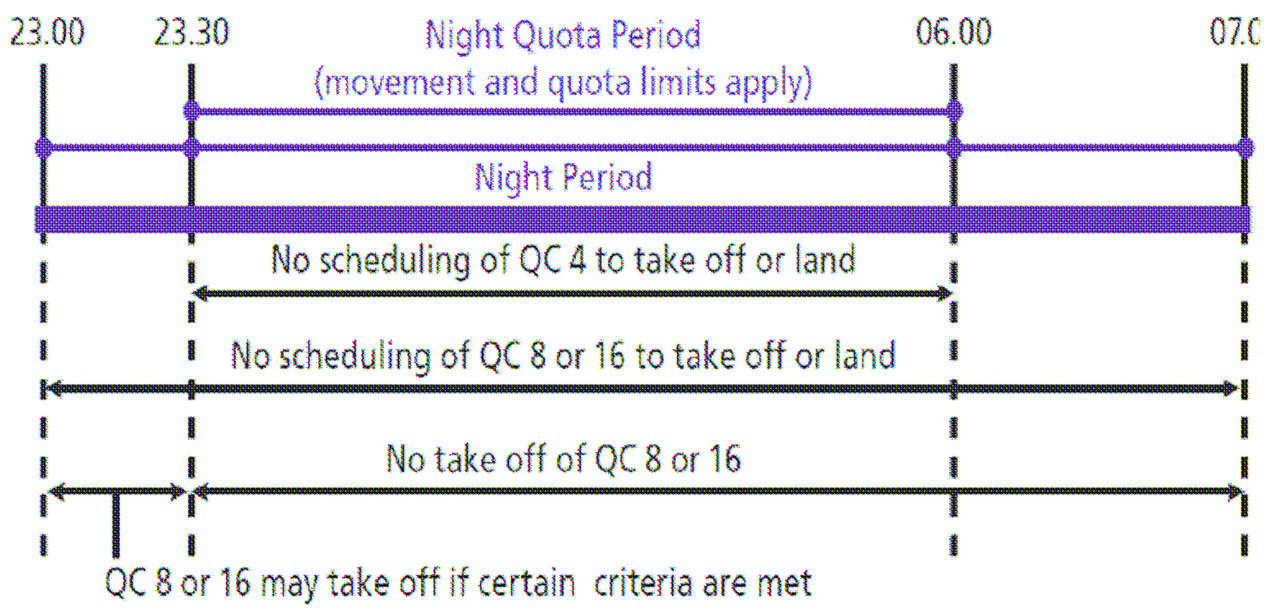
Certified noise level (EPNdB)	Quota count
More than 101.9	QC / 16
99 – 101.9	QC / 08
96 – 98.9	QC / 04
93 – 95.9	QC / 02
90 – 92.9	QC / 01
87 – 89.9	QC / 0.5
84 – 86.9	QC / 0.25

Heathrow
Making every journey better

*Heathrow Night Flights Fact Sheet - Reproduced with kind permission of Heathrow Airport Ltd.

Night Restrictions

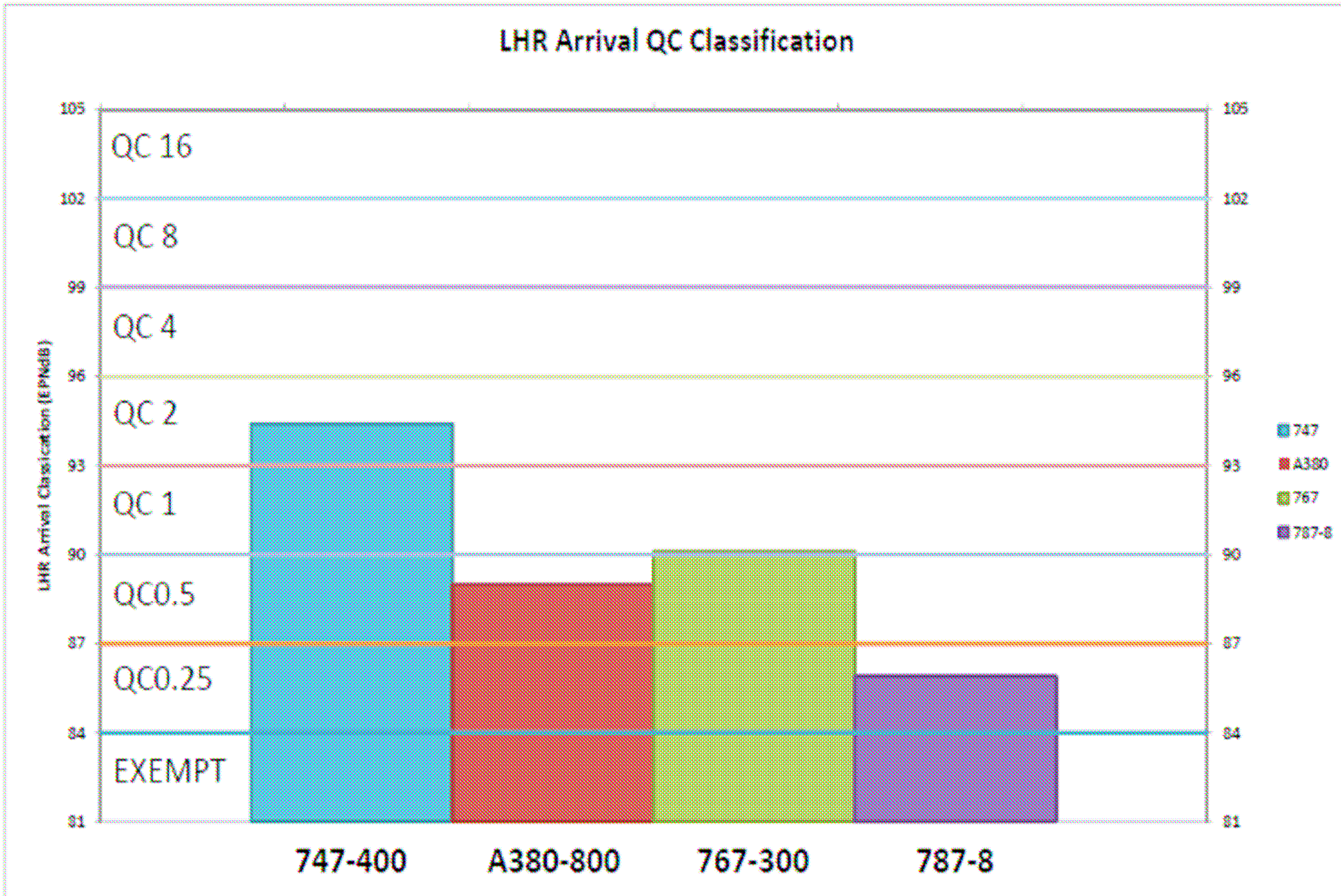
- Summer = 3250 ATMs / 5100 points
- Winter = 2550 ATMs / 4080 points
- No QC4 aircraft scheduled 23:30 – 0600
- Voluntary scheduling ban – no arrivals before 04:30 (L)



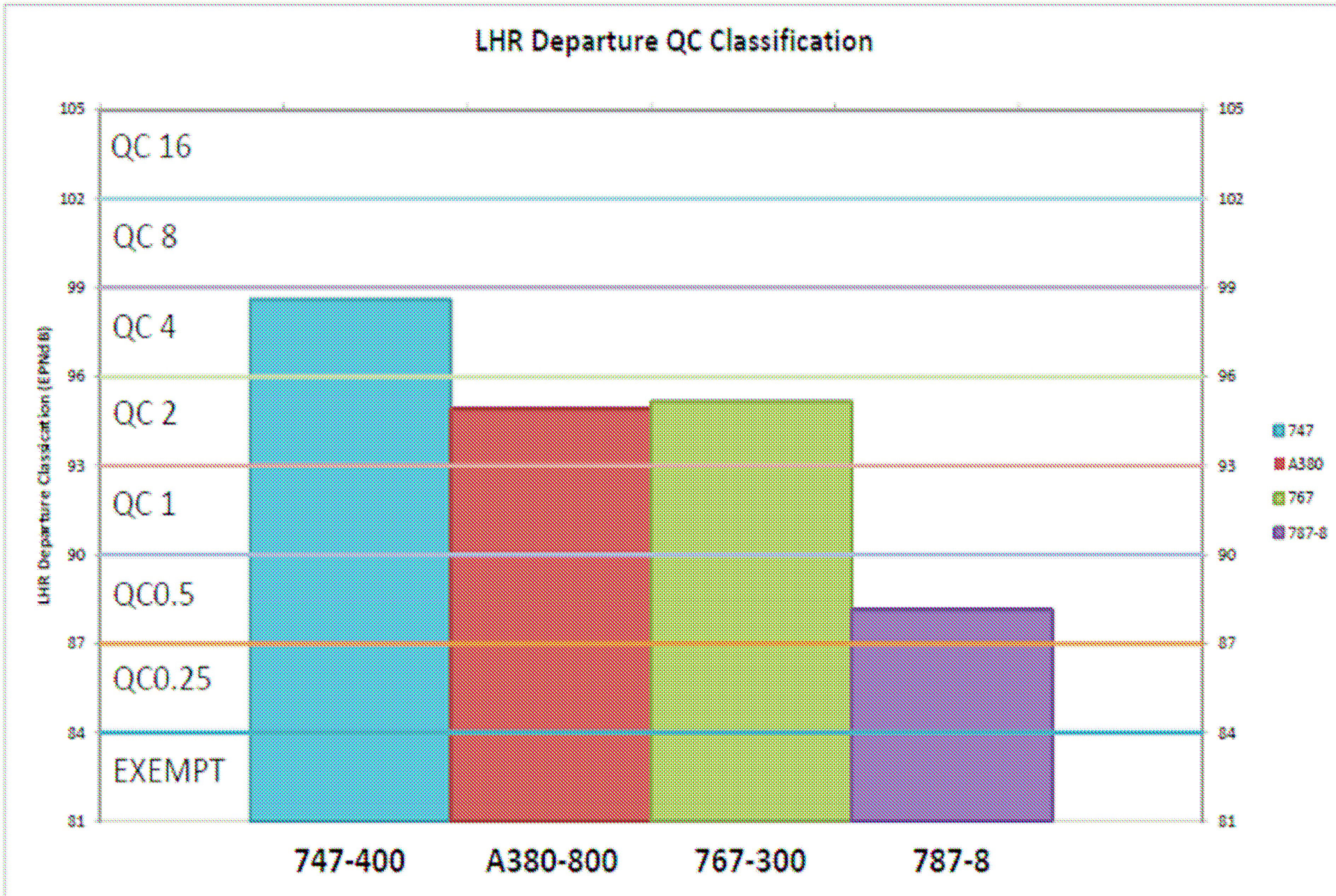
Quota count groupings

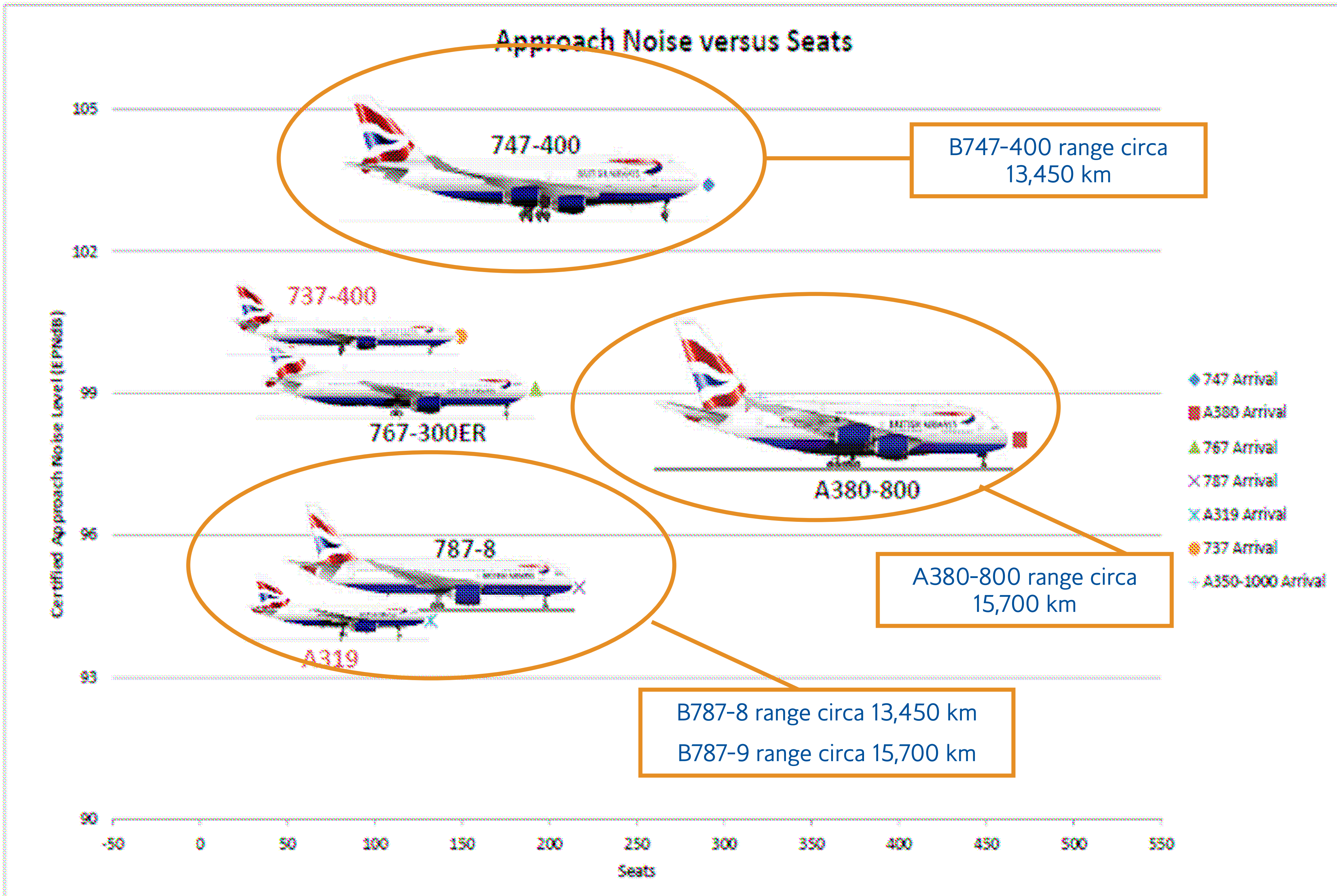
Certified noise level (EPNdB)	Quota count
More than 101.9	QC / 16
99 – 101.9	QC / 08
96 – 98.9	QC / 04
93 – 95.9	QC / 02
90 – 92.9	QC / 01
87 – 89.9	QC / 0.5
84 – 86.9	QC / 0.25

Each QC band represents a halving / doubling of noise energy (3dB) e.g. QC 2 is half the noise energy of QC 4.

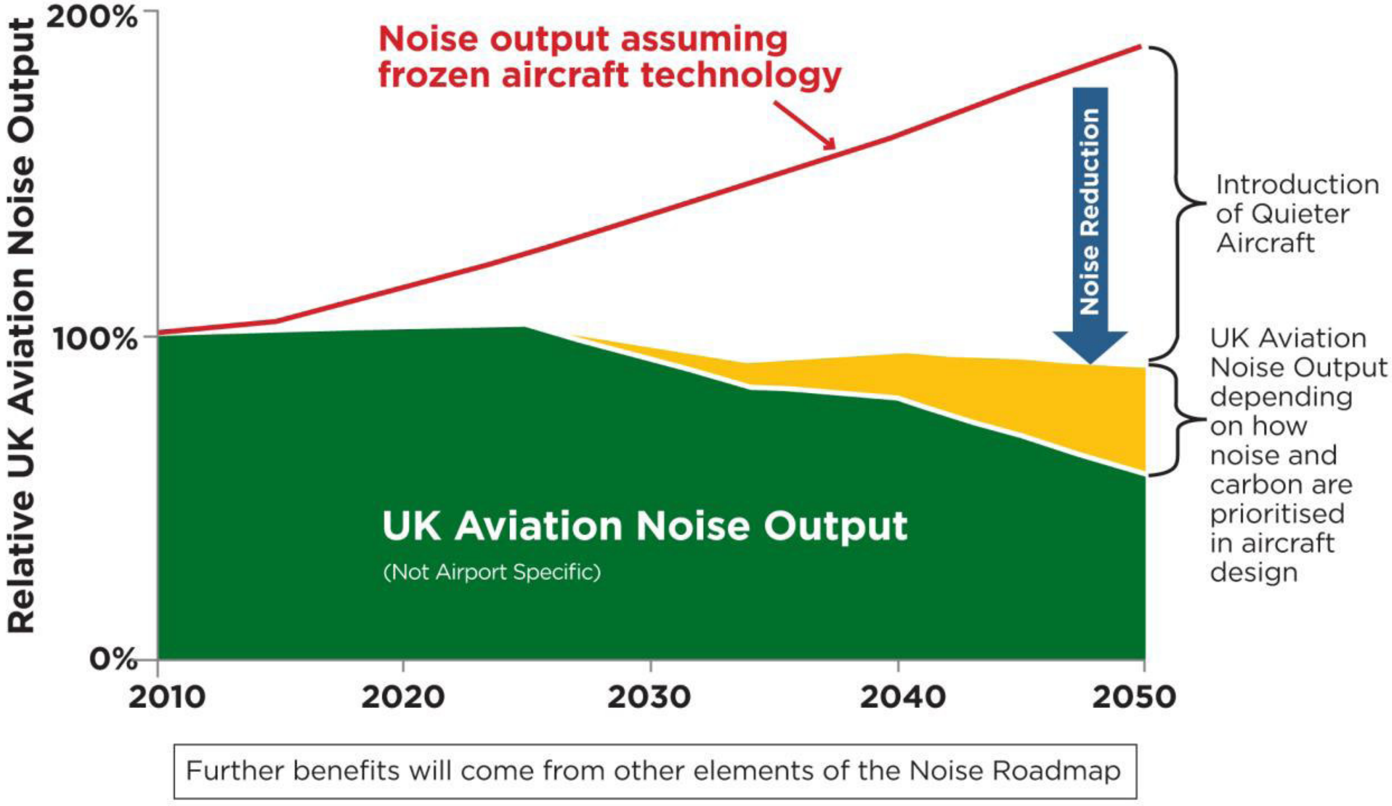


LHR Arrival QC Classification
LHR Arrival Classification (EPNdB)
105
102
99
96
93
90
87
84
81
QC 16
QC 8
QC 4
QC 2
QC 1
QC0.5
QC0.25
EXEMPT
747
A380
767
787-8
747-400
A380-800
767-300
787-8


LHR Departure QC Classification
QC 16
QC 8
QC 4
QC 2
QC 1
QC0.5
QC0.25
EXEMPT
105
102
99
96
93
90
87
84
81
LHR Departure Classification (EPNdB)
747
A380
767
787-8
747-400
A380-800
767-300
787-8


Approach Noise versus Seats
747-400
B747-400 range circa
13,450 km
737-400
767-300ER
A380-800
A380-800 range circa
15,700 km
787-8
A319
B787-8 range circa 13,450 km
B787-9 range circa 15,700 km
747 Arrival
A380 Arrival
767 Arrival
787 Arrival
A319 Arrival
737 Arrival
A350-1000 Arrival
Certified Approach Noise Level (EPNdB)
Seats
105
102
99
96
93
90
-50
0
50
100
150
200
250
300
350
400
450
500
550

Sustainable Aviation Noise Roadmap



When to retire aircraft…

Many factors affect the aircraft retirement decision:

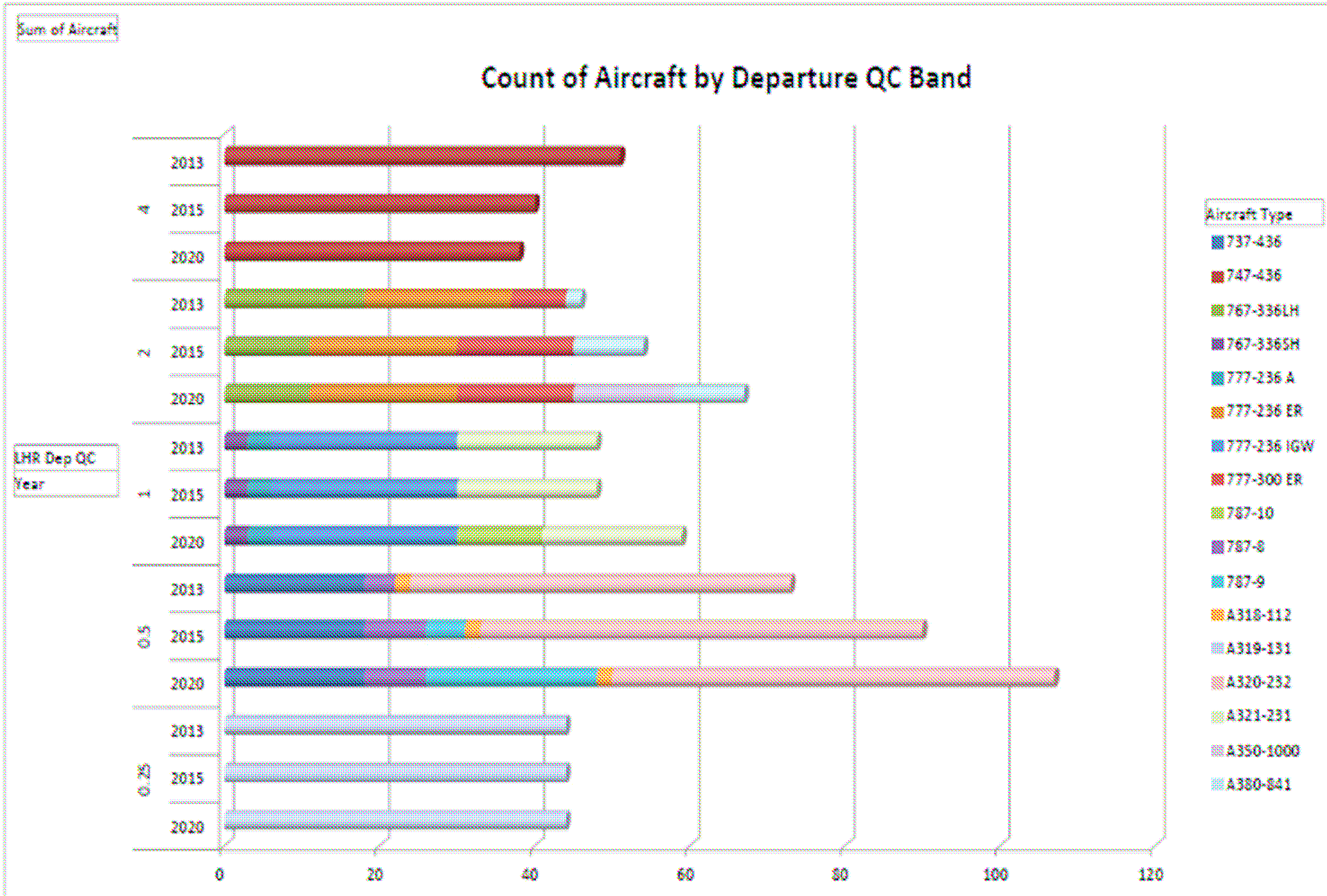
- The age of the aircraft;
- Operating, maintenance and depreciation costs compared with a new aircraft;
- Availability of suitable replacement aircraft;
- Whether the aircraft are leased or owned;
- Commercial strategy (eg plans to grow or to cut routes);
- The state of the economy and commercial demand.

Issues affecting fleet replacement

- Many factors considered when selecting aircraft:
  - Balance of environmental requirements:
    - Fuel / carbon efficiency,
    - Noise performance,
    - Local Air Quality standards;
  - Capacity requirements of routes and whole network,
  - Capacity / range of aircraft,
  - Cost of purchase and operating aircraft,
  - Ability to finance; list price for an A380 is circa $400m,
  - 25+ year life of aircraft – economically viable life of aircraft.

Major fleet renewal underway

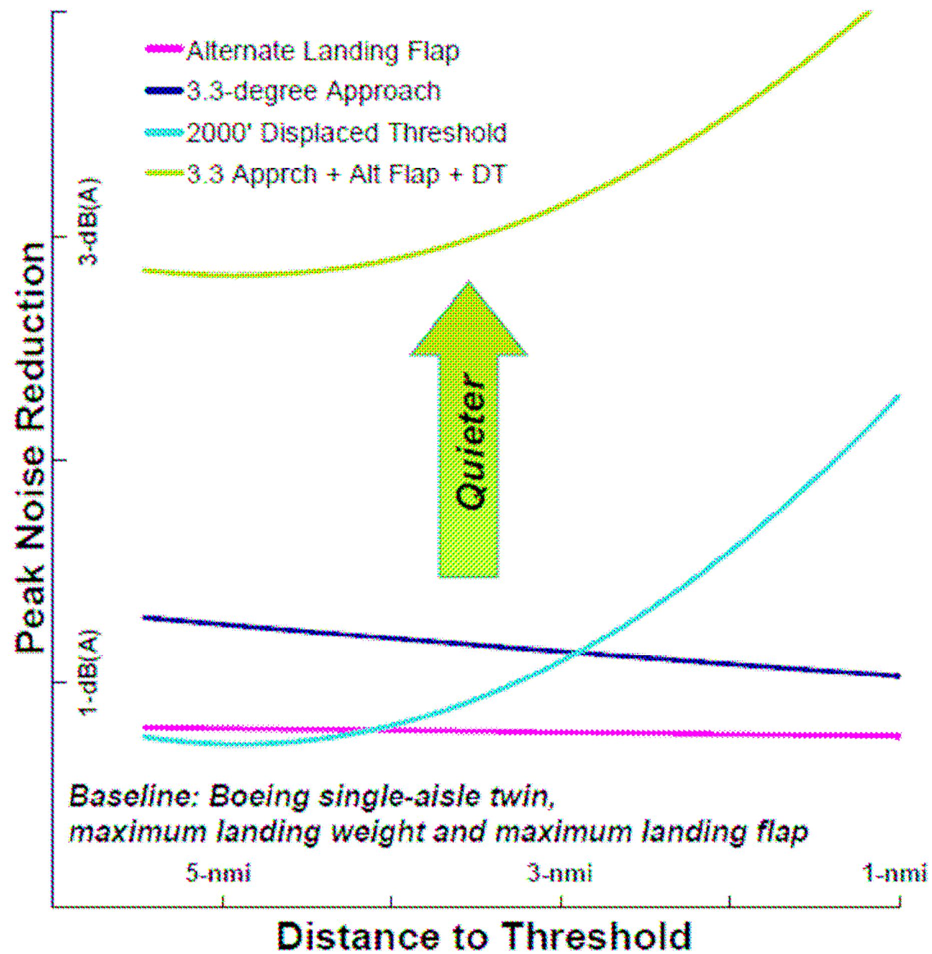
- Fleet renewal will allow retirement of B747-400.
- A380 and B787 now in service, A350s also on order.
- Firm orders:
  - 12 A380
    - QC 0.5 Arr
  - 42 B787
    - B787-8 = QC 0.25 Arr
    - B787-9/-10 = QC 0.5 Arr
  - 18 A350
    - QC to be confirmed (expected 0.5 Arr)



Sum of Aircraft
Count of Aircraft by Departure QC Band
LHR Dep QC
Year
4
2
1
0.5
0.25
2013
2015
2020
0
20
40
60
80
100
120
Aircraft Type
737-436
747-436
767-336LH
767-336SH
777-236 A
777-236 ER
777-236 IGW
777-300 ER
787-10
787-8
787-9
A318-112
A319-131
A320-232
A321-231
A350-1000
A380-841

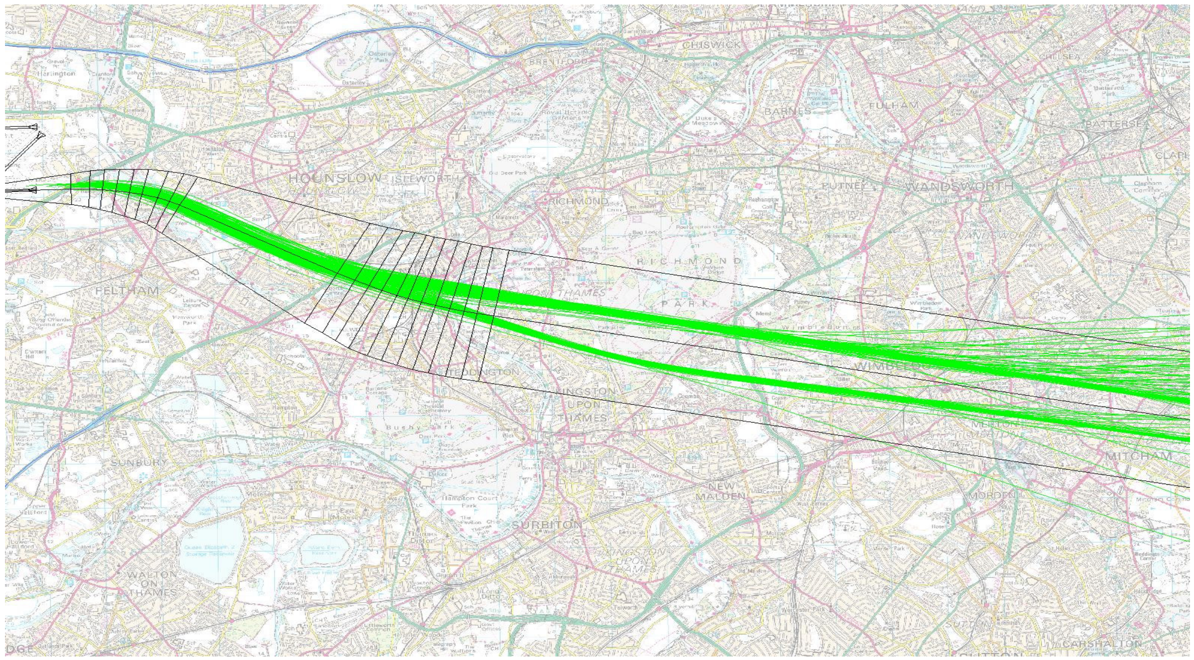
Operational techniques

- **Alternate Landing Flap**
  - Less thrust / fuel to fly path
  - Increased landing speed
- **Displaced Threshold**
  - More height
  - Reduced runway length
- **Increased approach angle**
  - Less thrust / fuel to fly path
  - More height
  - Increased vertical energy



* Reproduced with kind permission of Boeing Corporation Ltd.

New techniques – offset departure trials



- Modern navigational capabilities offer new possibilities,
- By alternating routes on a weekly basis can create “predictable airborne respite”
- Trials developed with HACAN and planned for Dec 2013 – Jun 2014.

Summary

- Airlines recognise the vital importance of limiting and mitigating the noise impacts of operations,
- Technology improvements have already delivered 65% reduction in noise and will deliver a further 65% by 2050,
- Fleet renewal plans are affected by a variety of practical and financial factors, have long lead times and aircraft must stay in service for many years to provide a return on investment,
- Improvements are undermined if governments fail in their responsibilities to avoid population encroachment towards airports.

BRITISH AIRWAYS

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4.10 Stand der Forschung zur Bekämpfung des Fluglärms an der Quelle

4.10.1 Vortragender

Prof. Dr.-Ing. Jan Delfs, Abteilungsleiter Technische Akustik, Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) / Institut für Aerodynamik und Störungstechnik

Studies: Mechanical Engineering, specialization in Technical Mechanics and Aerospace at "Technische Universität Braunschweig" (Diploma) 1990

Studies abroad: 1 yr University of Waterloo/Waterloo, Ontario, Canada 1986/87, DAAD scholarship 3 months practice term 1989, Aerospatiale (now Airbus), Toulouse, France Dissertation: Dr.-Ing. Technische Universität Braunschweig 1994, „Numerische Simulation der transitionellen schallnahen Plattengrenzschichtströmung"

Professional Career:

Current position (since 2002):

Head Technical Acoustics Institute of Aerodynamics and Flow Technology of DLR (German Aerospace Center, Braunschweig, Germany), status: 19 scientists

Professorship for Technical Acoustics C3 at "Technische Universität Braunschweig" (common call of TU Braunschweig and DLR)

Scientific employee at „Institute for Aerodynamics and Flow Technology" of DLR (formerly "Institute of Configuration Aerodynamics") 1995-2002.

University assistant C1 at Institute of Fluid Mechanics and Fluid Machines at Karlsruhe University (TH) 1994 - 1995.

Scientific employee at "Institute for Fluid Mechanics" of TU Braunschweig 1990 - 1994.Lectures "Basics of Aeroacoustics", ii) "Methods of Aeroacoustics", iii) "Numerical Methods in Computational Aeroacoustics" (latter commonly with Dr. Roland Ewert), "Technische Universität Braunschweig, regular lectures on graduate level "Fundamentals of Flow Acoustics", University of Karlsruhe (TH), winter term 1995/96, 1996/97, 1997/98 "Flow Instabilities", University of Karlsruhe (TH), summer term 1995

Guest scientist stays abroad "Dept. Aero- and Astronautics", Stanford University, CA, U.S.A., 3.5 months, summer 1998, 8 months 2012/13 (Prof. S. K. Lele) "Dept. Mathematics" of Florida State University, Tallahassee, FL, U.S.A., 6 months, winter 2006/07 (Prof. C.K.W. Tam)

Awards:

Otto Lilienthal award of DLR 2005

Committees:

Deutsche Gesellschaft für Luft- und Raumfahrt e.V. DGLR (German Aerospace Society): Member and head of committee T2.3 „Strömungsakustik und Fluglärm" (Flow Acoustics and Aviation Noise)

German representative in "Aeroacoustics Specialist Committee" of CEAS (Council of European Aerospace Societies)

American Institute of Aeronautics and Astronautics (AIAA): Member and associate member of "Aeroacoustics Technical Committee"

Fields of research:

Sources and reduction of aircraft noise, especially airframe noise

Numerical aeroacoustics, advanced turbulence models

Acoustic windtunnel testing & flyover noise testing

Noise of wind turbines

4.10.2 Präsentation

Link zum Mitschnitt der Präsentation:

Deutsch: http://www.youtube.com/watch?v=HJtfNPl2360&feature=youtu.be

English: http://www.youtube.com/watch?v=CbCRLorlTaE&feature=youtu.be

Latest research on the reduction of aircraft noise at the source

ICANA 2013, Frankfurt

Jan Delfs
Institute of Aerodynamics and Flow Technology
Technical Acoustics
Braunschweig, Germany
jan.delfs@dlr.de

Lars Enghardt
Institute of Propulsion Technology
Engine Acoustics
Berlin, Germany
lars.enghardt@dlr.de

DLR

Outline

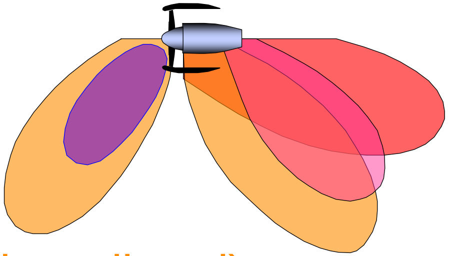
- sources of aircraft noise
- low noise technology for current aircraft
- conclusions

sources of aircraft noise

DLR

Sources of exterior noise at transport aircraft

➢ Take-off:



engine noise

- o jet
- o fan tonal (+ broadband)
- o (compressor)

➢ Approach:

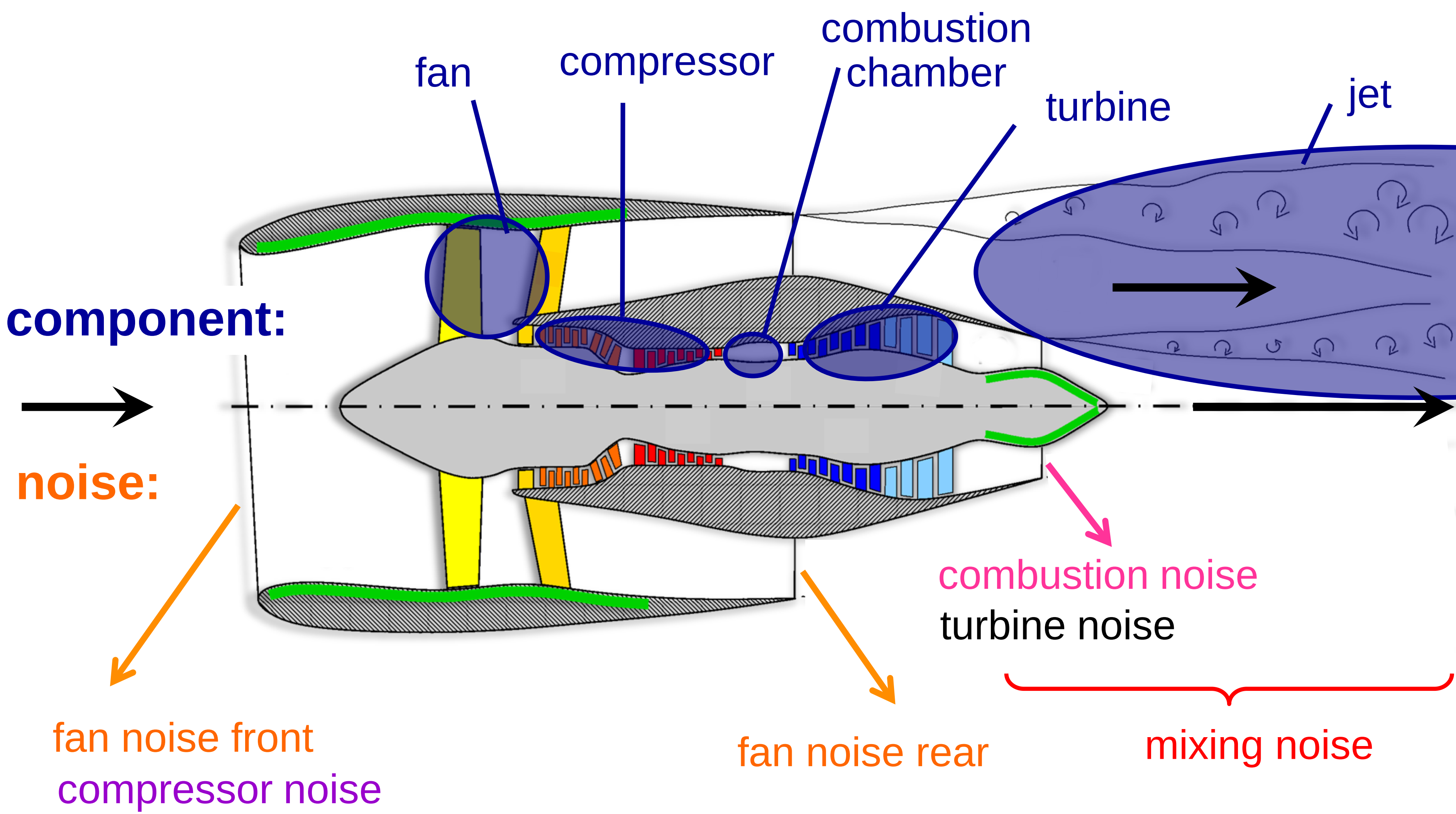
engine noise

- o jet
- o fan broadband (+ tonal)
- o combustion + turbine

airframe noise

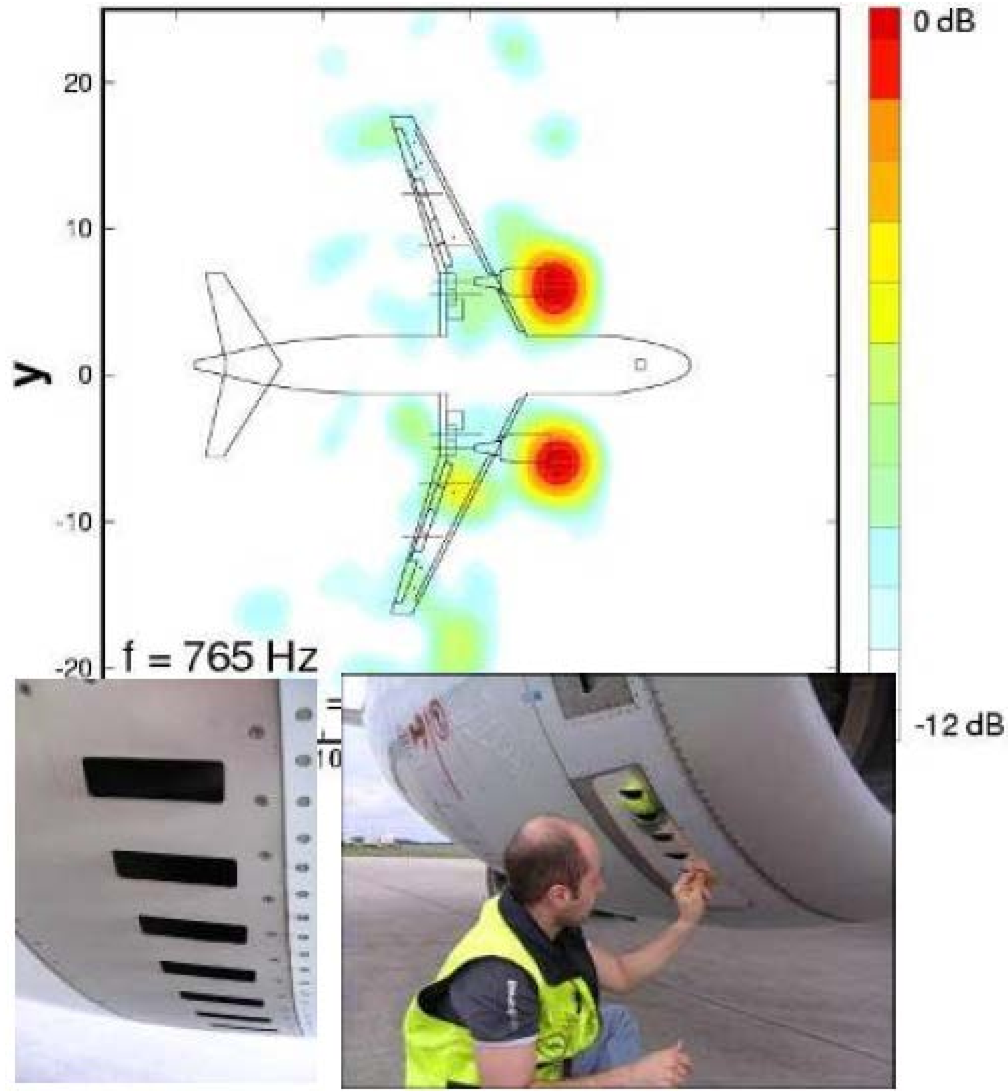
- o high lift devices
- o landing gears
- o installation related sources

Sources of turbofan engine noise



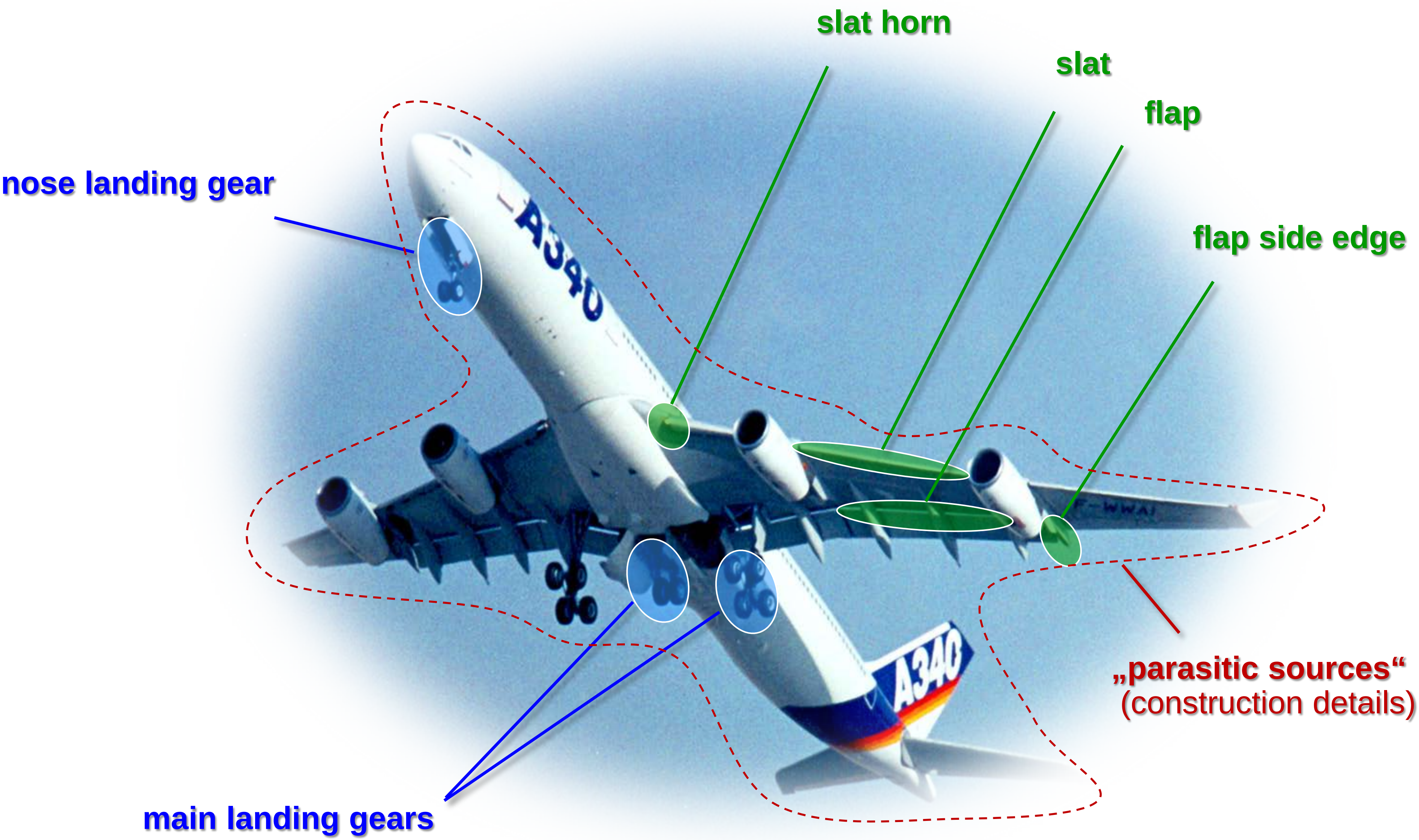
Parasitic tones at engines

Nacelle de-icing air outlets



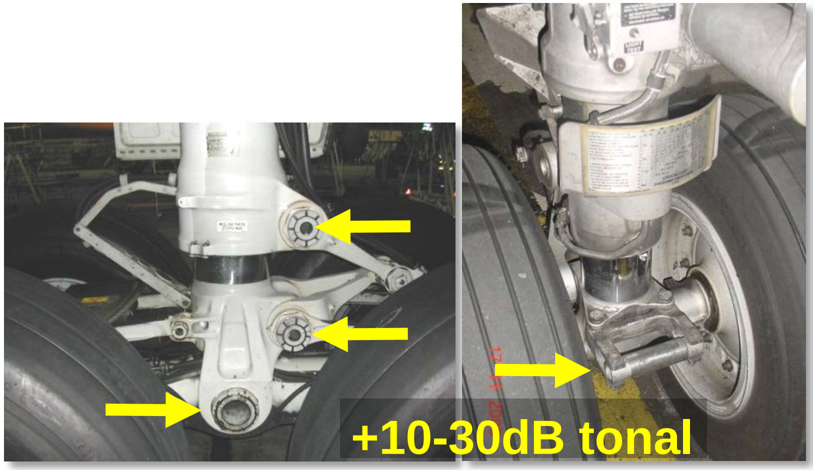
Siller, DLR

Sources of airframe noise at aircraft



Parasitic sources at real a/c airframes

- tone noise from pin-holes in landing gear pins/bolts (hollow for weight reasons)



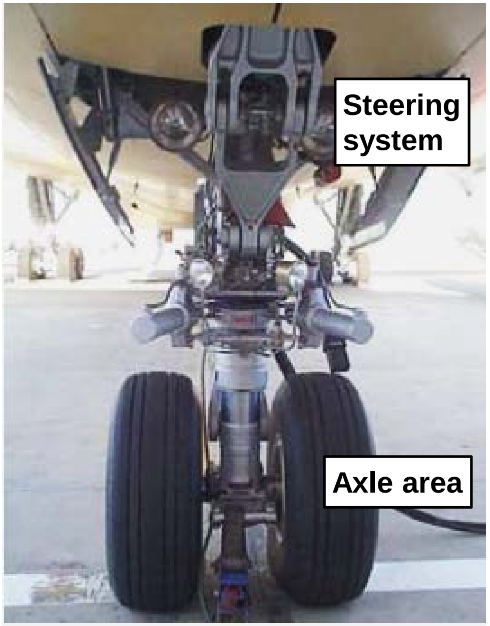
- tone noise from pressure release openings

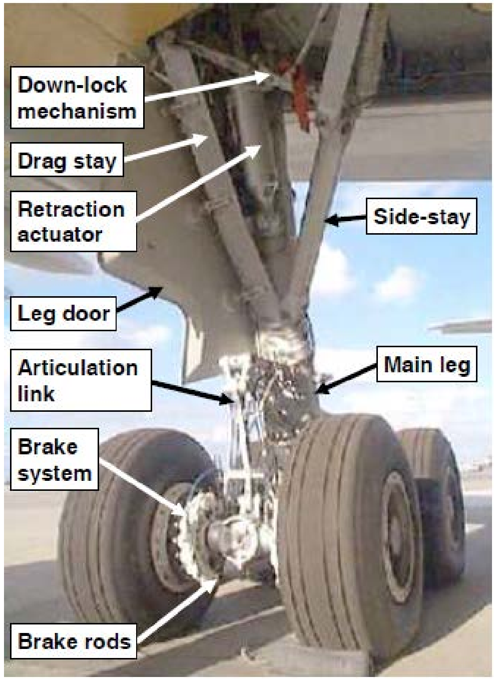
- broadband excess noise from slat/flap tracks

- broadband excess noise from recessed geometries

Landing gear noise

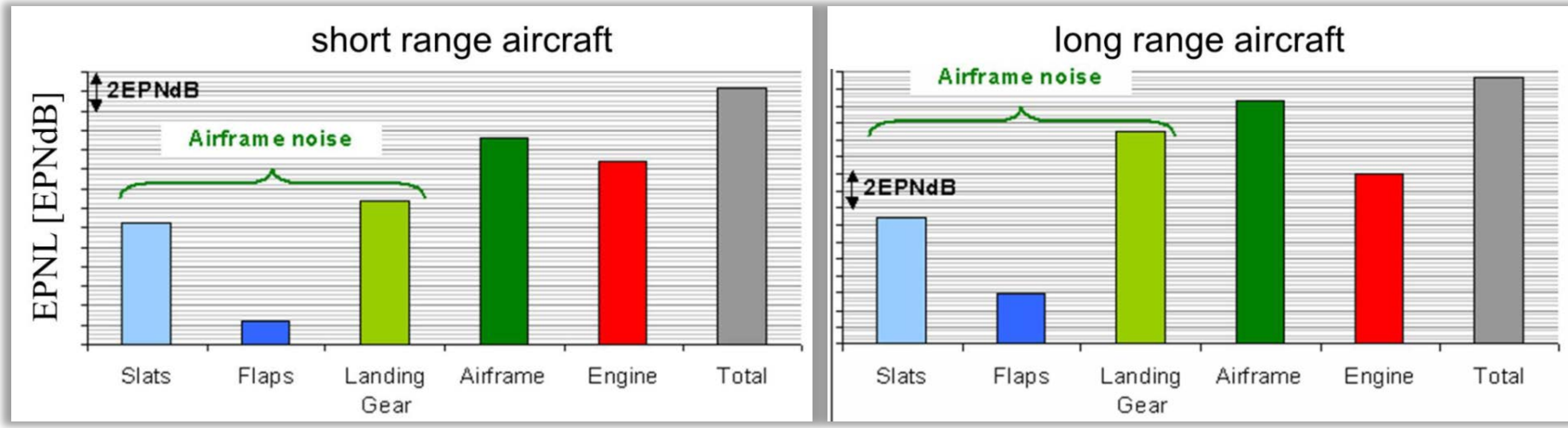
- considerable experimental research during past 15 years in EU and USA
- most important source of airframe noise (at certifcation point)
- very broadband in character (slow roll-off of spectrum)
- size^2 scaling of intensity for similar geometry
- speed^6 scaling of intensity (compact source components)
- no pronounced directivity due to complex cluster of compact sources



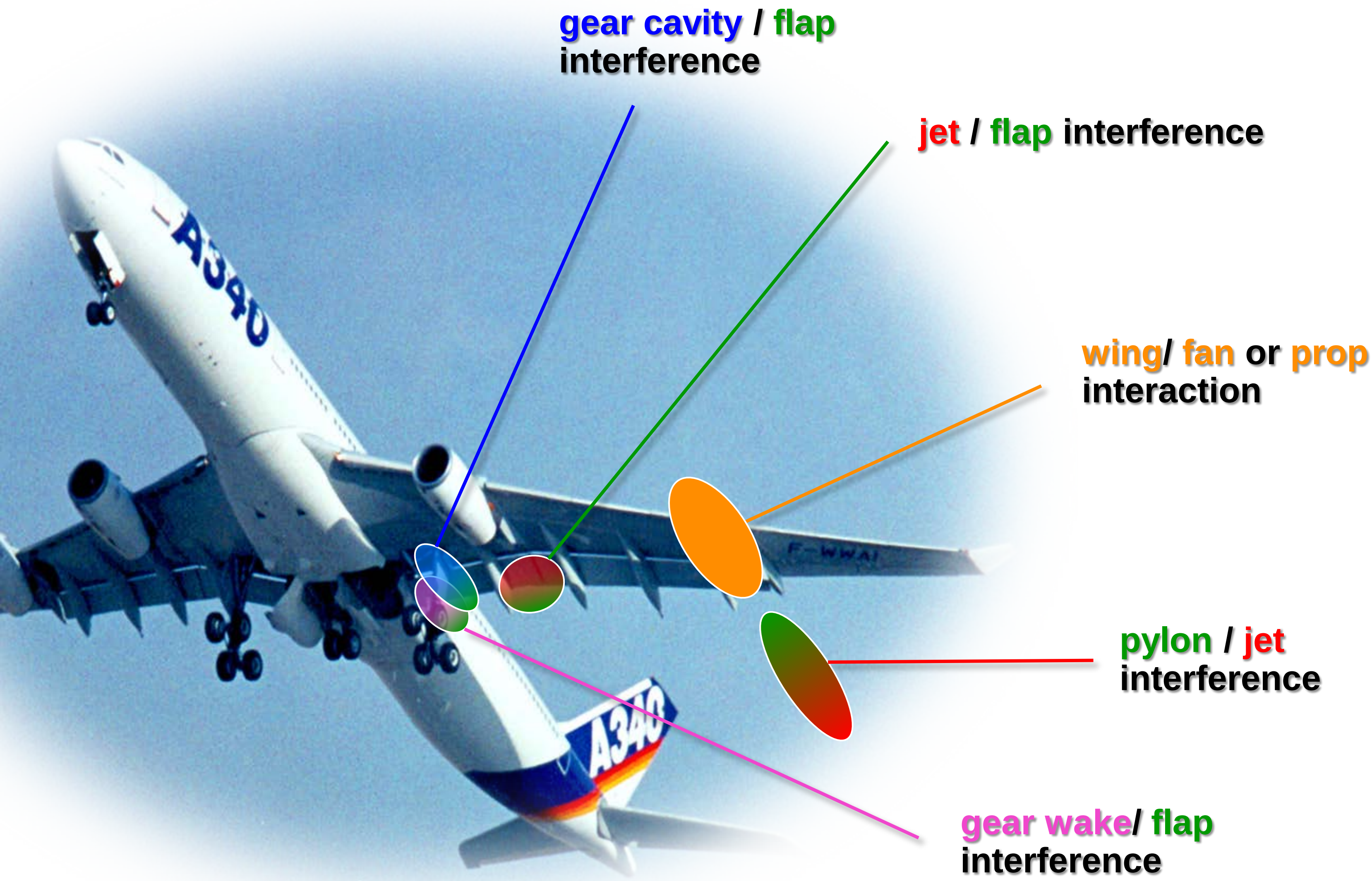


Typical rank ordering of sources at approach

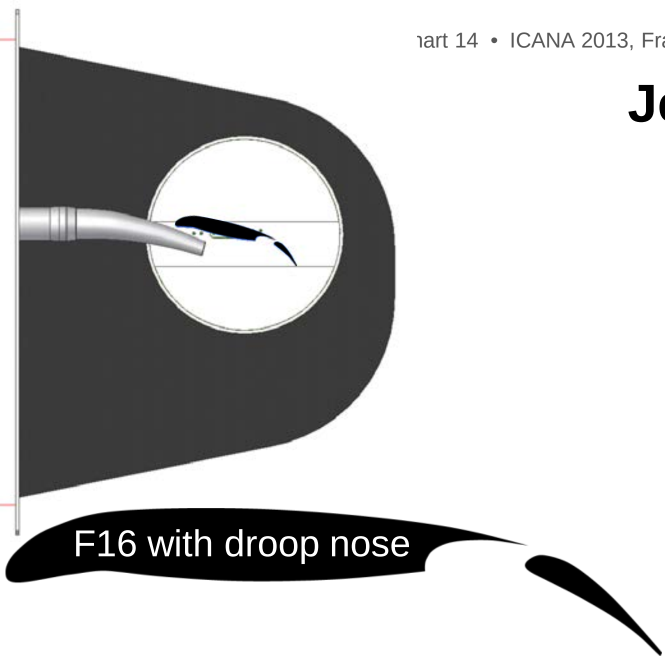
Source: Airbus

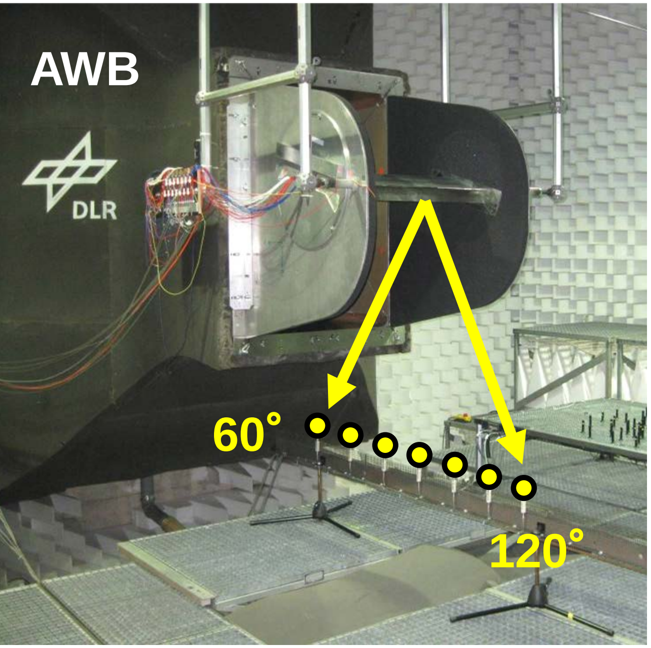


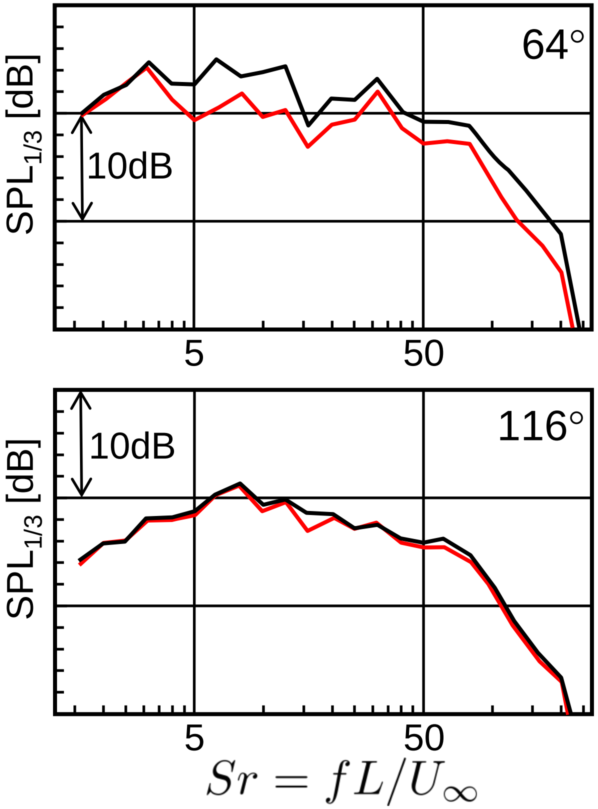
Installation sources of exterior noise at aircraft



Jet flap interference (JFI)







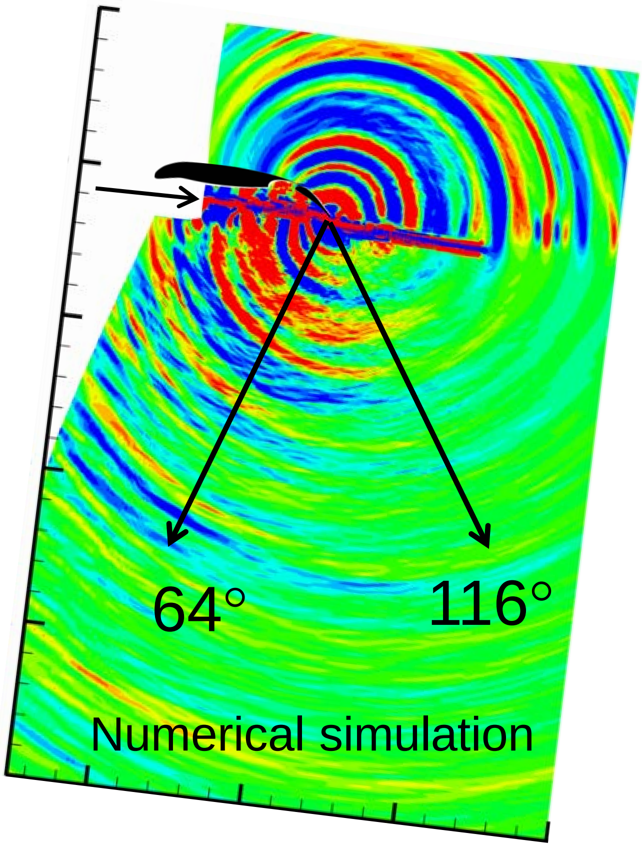
— total

— sum jet + flap (each isolated)

Flight speed $U_\infty = 60$ m/s

Jet speed $U_{jet} = 185$ m/s

(cold single stream jet)



Numerical simulation

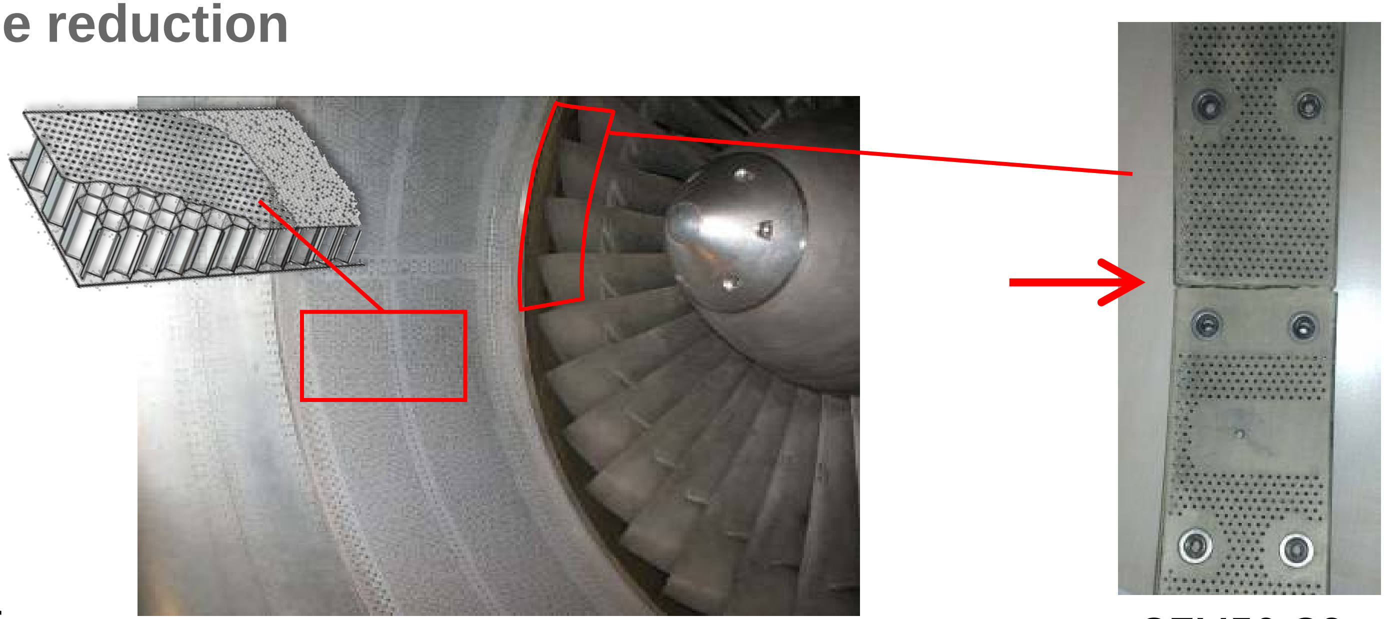
Pott-Pollenske, Dierke, Lufo HIT 2011

Low noise technologies for current aircraft

Engine noise reduction

fan noise

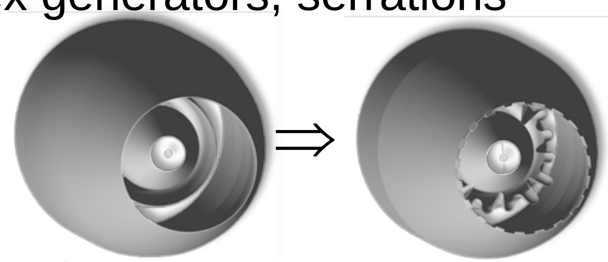
- lined ducts
- splice-less casing
- nacelle lip-liner
- swept rotor leading edge, swept stator
- cut-off design
- increased diameter



CFM56 C3
fan-forward
casing liner

jet noise

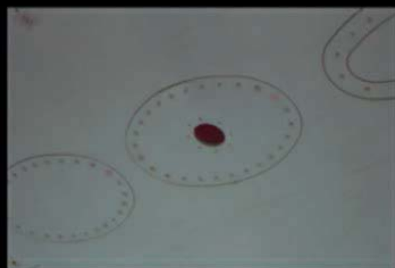
- increased diameter
- internal mixer and/or
- vortex generators, serrations

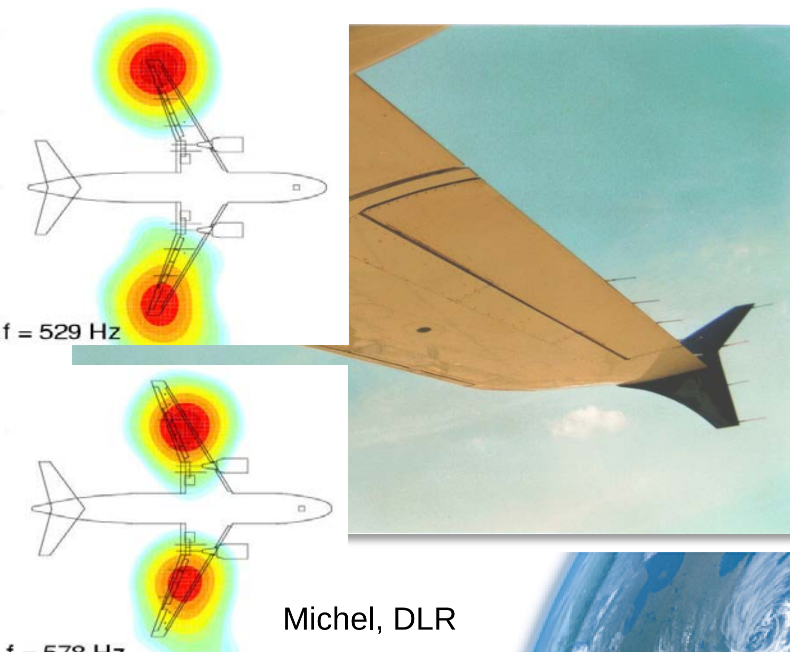


Source: Boeing

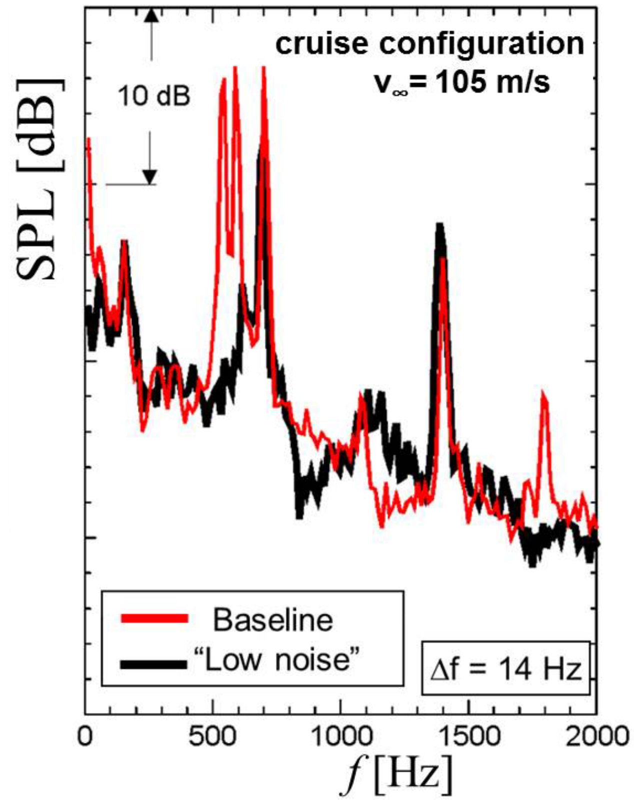
Elimination of parasitic tones at wings

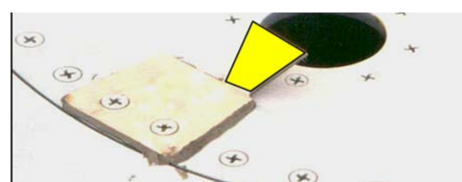
Approach noise of a current short/medium range a/c

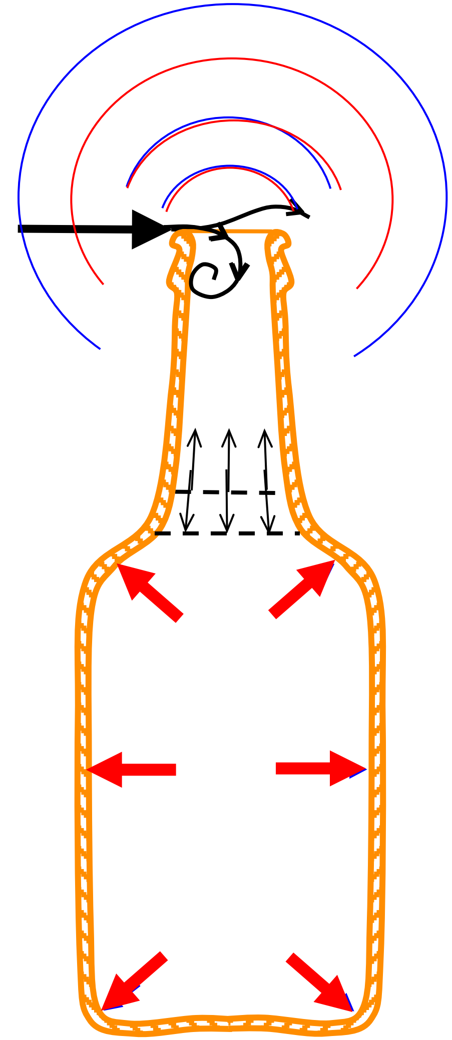




Michel, DLR



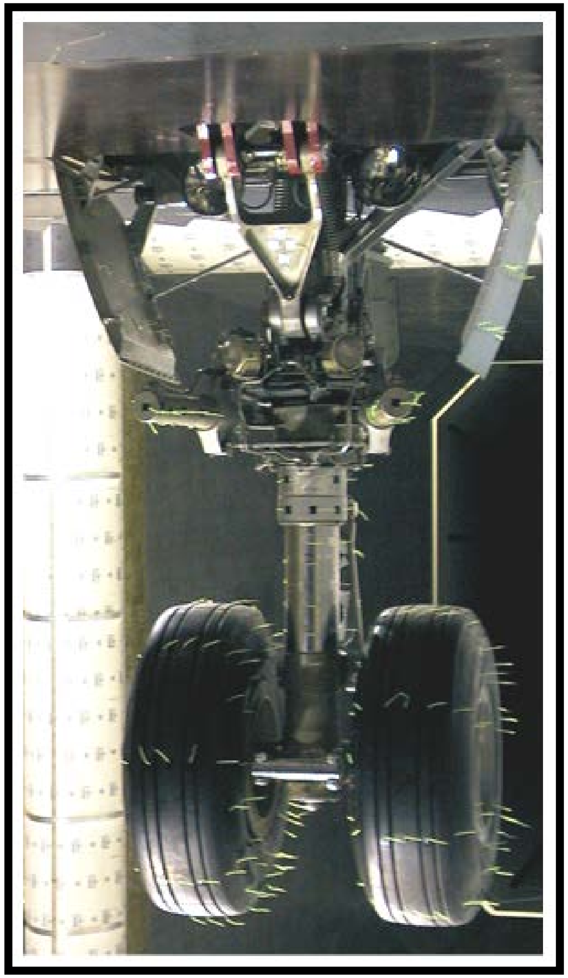




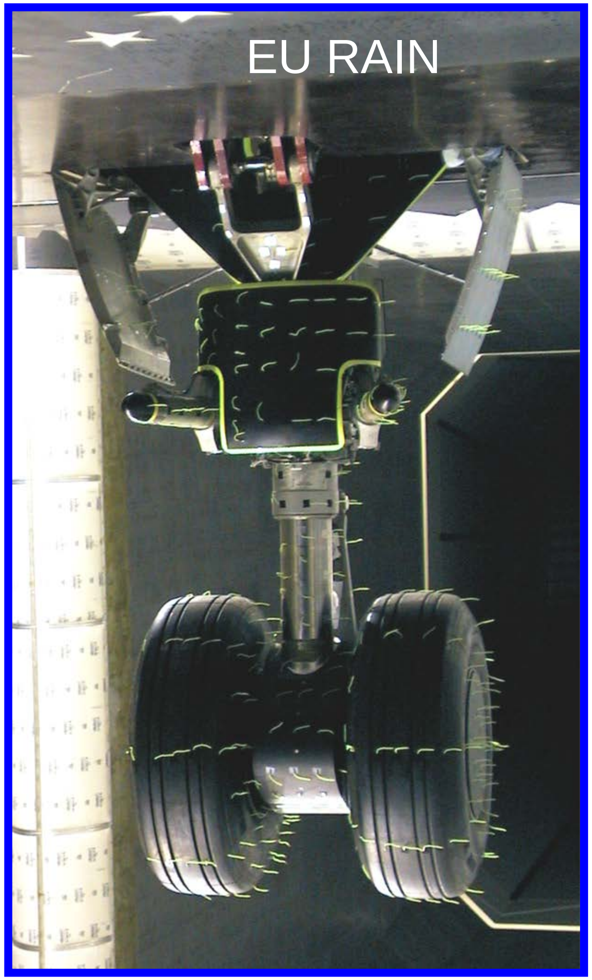
Helmholtz resonator

M. Pott-Pollenske et al. 2002

Low noise nose landing gear



A340 nose landing gear



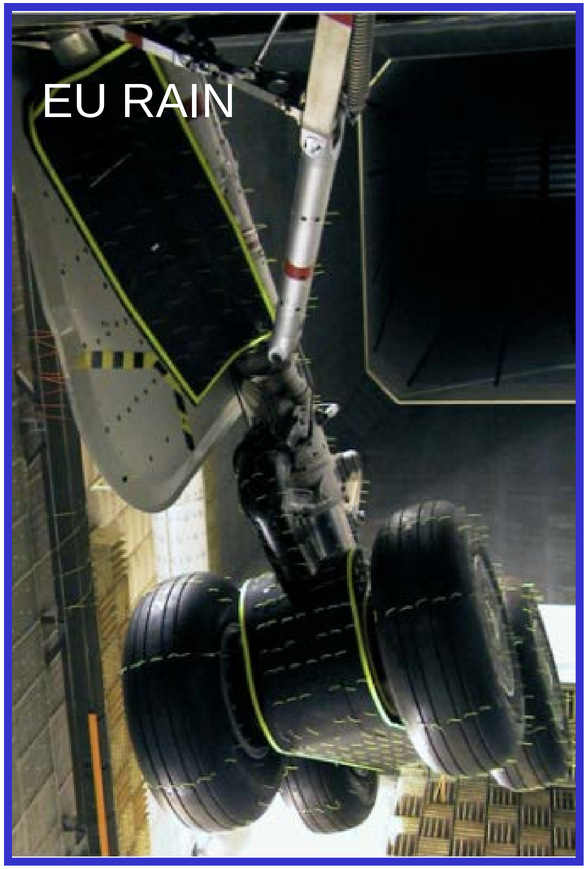
retro-fitted
~ 2.6 dB reduction

low noise NLG
~ 6.3 dB reduction

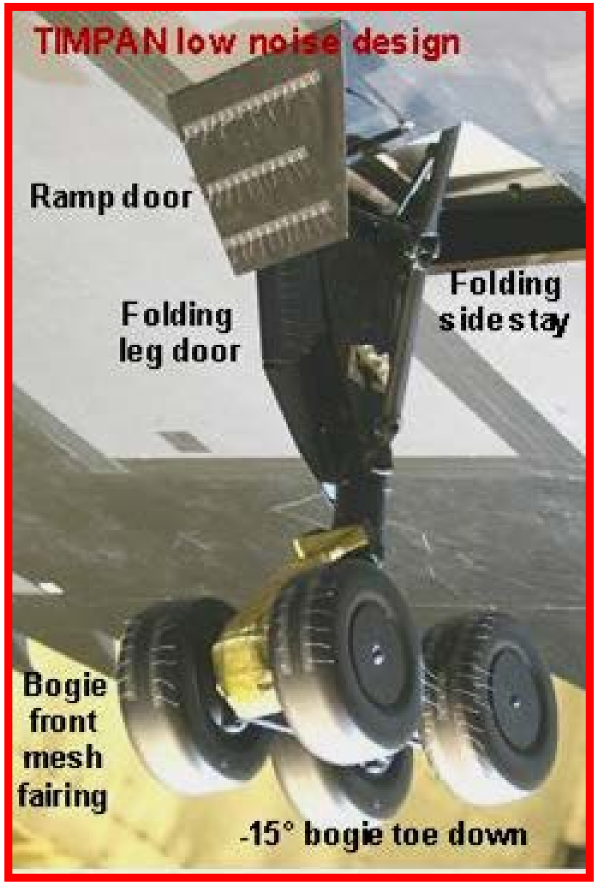
W. Dobrzynski et al. 2001…06

Low noise main landing gear

A340 main landing gear

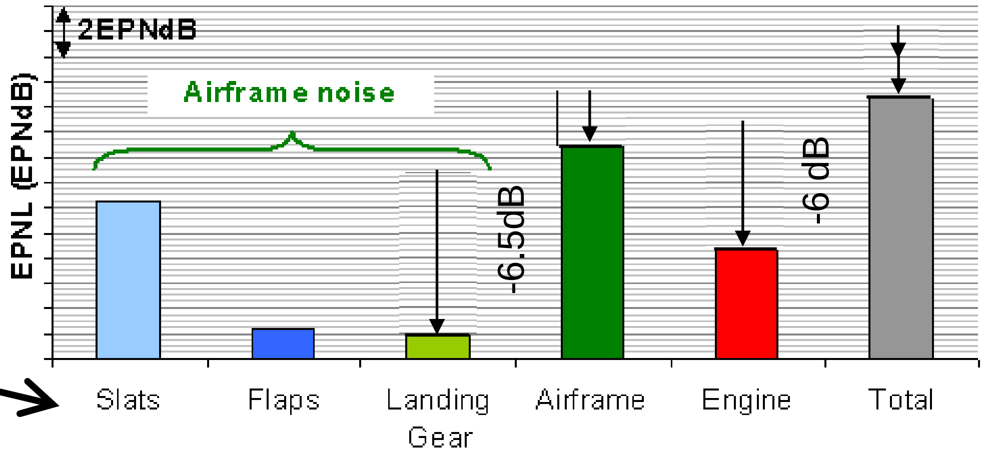


retro fitted
~ 2.5 dB reduction



low noise
8 dB(A) reduction

Significance of high lift devices for airframe noise

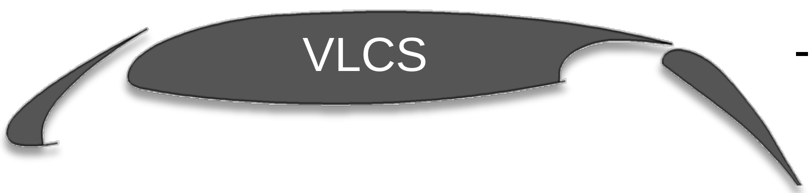


⇒ Noise reduction at landing gear of limited effect for a/c if High Lift Devices unaltered

- But: much more difficult to improve, since aerodynamically highly optimized component
- Significance discovered by DLR (Dobrzynski), 1998

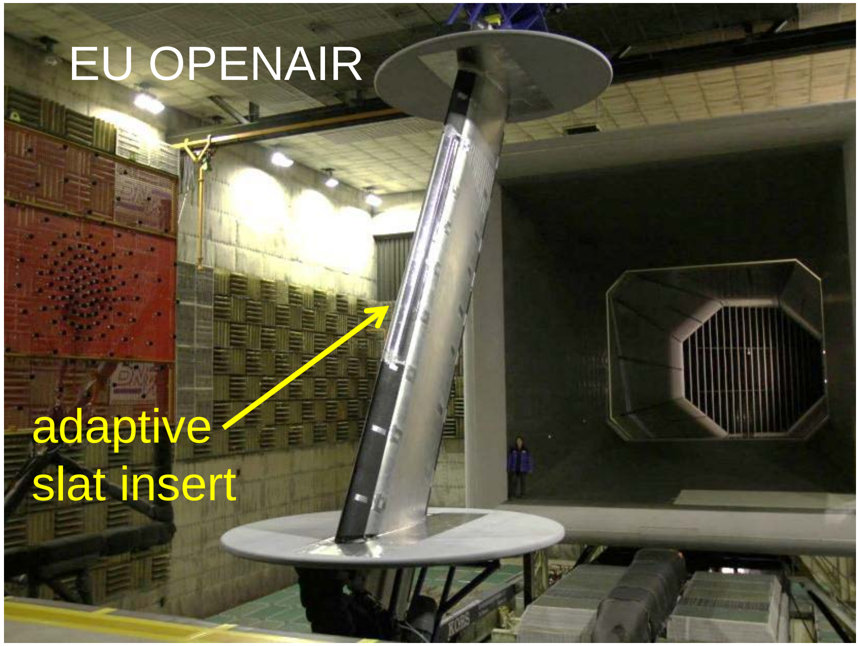
Low noise slat

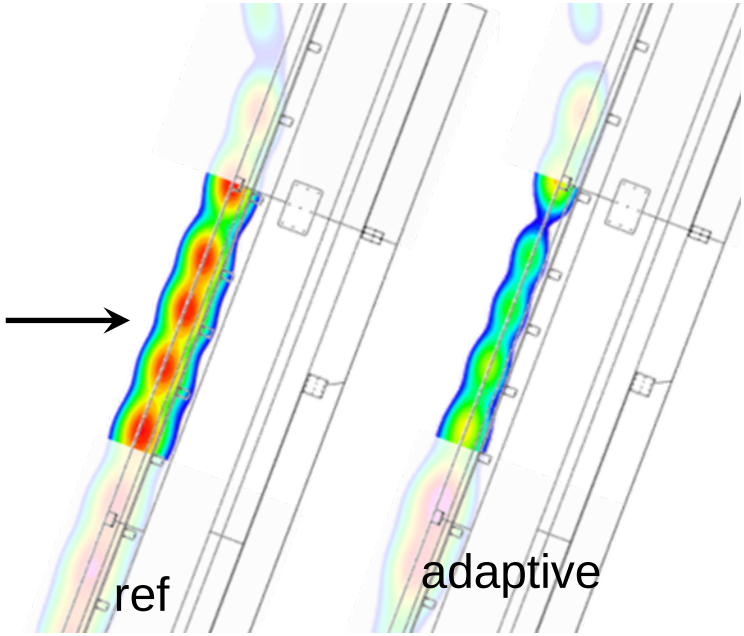
-4…5 dB



- 4…5 dB

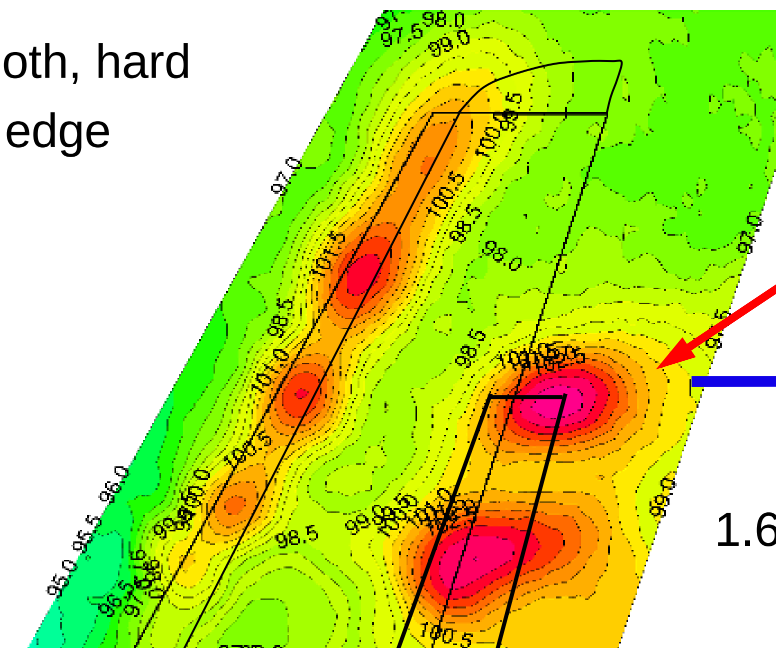
-3…5 dB





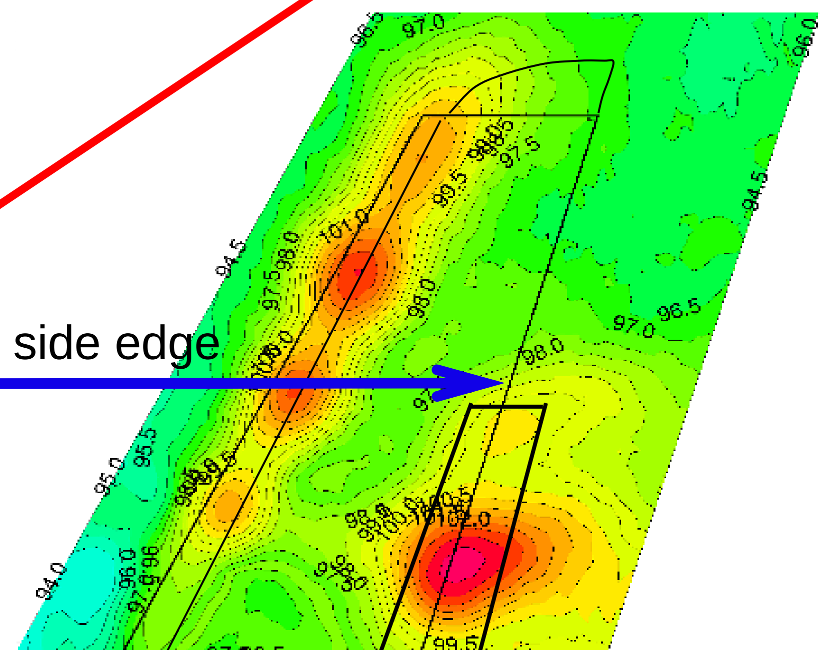
Noise reduction on flap side edges

Smooth, hard side edge



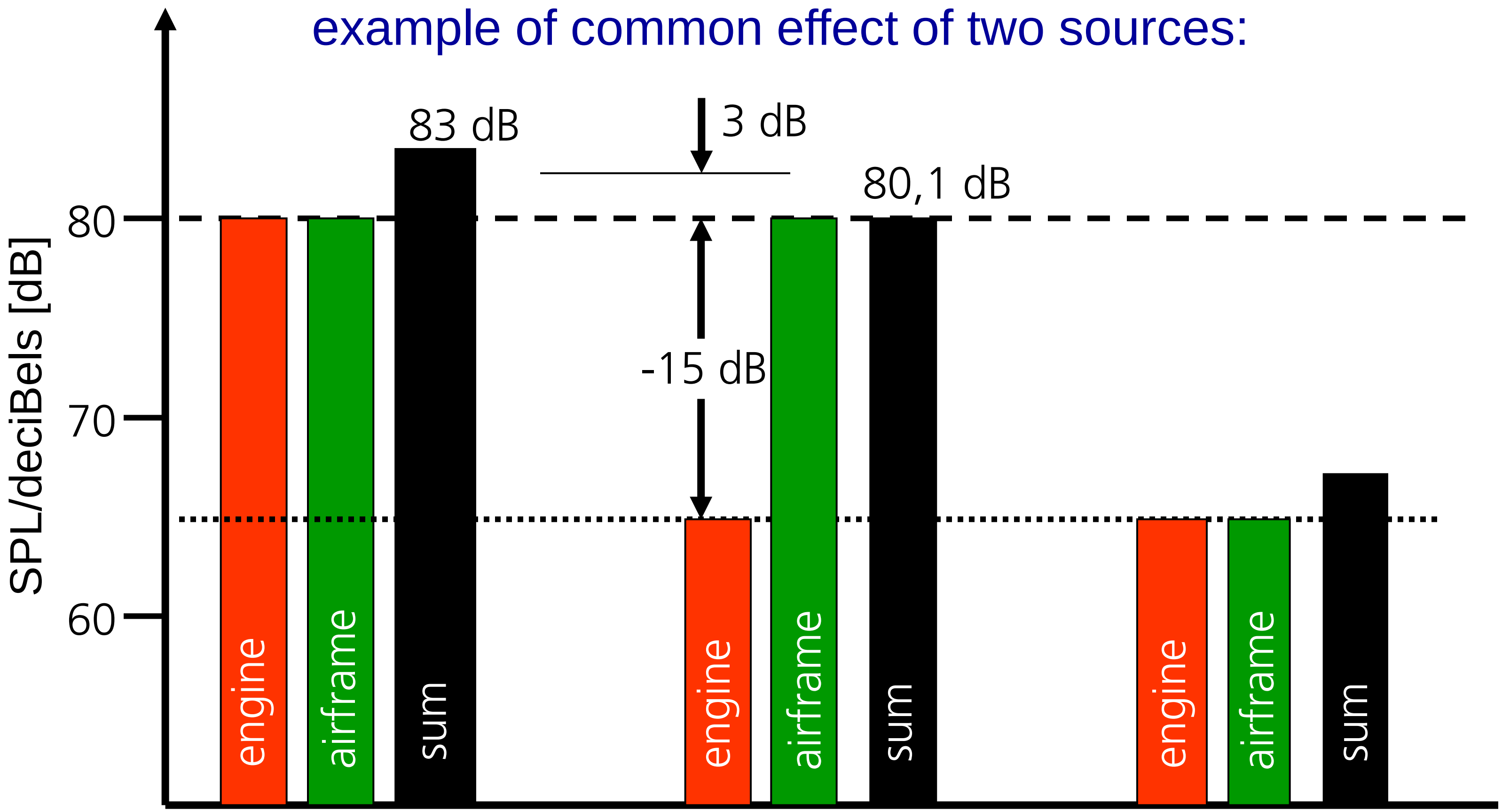
Brush side edge

1.6 kHz



W. Dobrzynski et al. 2001

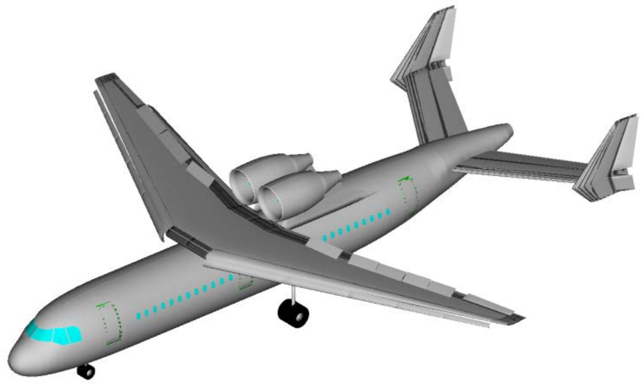
Source noise reduction at complete aircraft

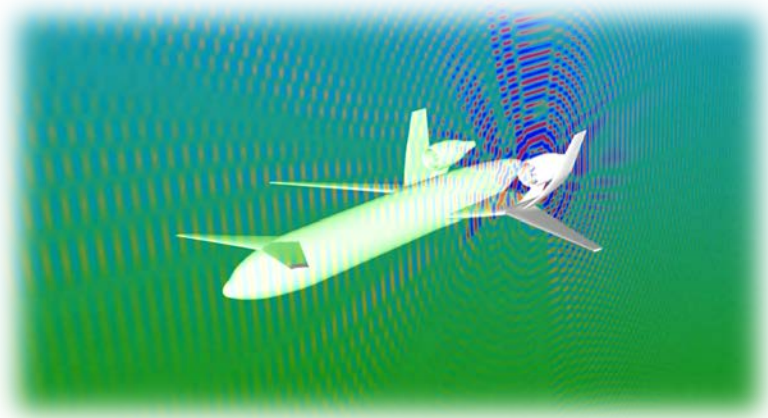


For more silent aircraft
sources of about equal strength have to be reduced alltogether!

Conclusions

- All, engine, airframe, and installation sources important
- considerable progress made in engine low noise technology the past (most important jet + fan)
- highly effective flyable low noise landing gear technology developed
- high lift system is THE challenge for approach noise
- parasitic sources easily removable
- only partial application of low noise technology will have very limited effect
- next generation transport a/c will be dominated by installation sources
- noise driven a/c architectures? High potential of noise shielding.





4.11 Erfahrungen mit dem erhöhten Anflugwinkel von 3,2 Grad

4.11.1 Vortragender

Dr. Reinhard König, Deutsches Zentrum für Luft- und Raumfahrt

Education: PhD in Aircraft Engineering 1988
Thesis about "Aircraft Behavior and Control in Wind-Shear Conditions"

Affiliation(s) and Function(s):
1977-1982 Technical University of Braunschweig, Germany
1983 Volkswagenwerk Wolfsburg, Germany
since 1984 German Aerospace Center (DLR); Institute of Flight Systems, Flight Dynamics and Simulation Department in Braunschweig, Germany

Experience:
- Aircraft behavior and control in wind-shear
- Gust load alleviation
- Flight simulation
- Noise abatement flight procedure design

Present Position:
Deputy of Flight Dynamics and Simulation Department
Team Leader of Flight Procedure Group

Further Information about the company:
DLR is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project execution organisation.
DLR has approximately 7400 employees at 16 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

4.11.2 Präsentation

Link zum Mitschnitt der Präsentation:

Deutsch: http://www.youtube.com/watch?v=Kwmjv_Euf_s&feature=youtu.be

English: http://www.youtube.com/watch?v=0n9YiL-vXkY&feature=youtu.be

Experience with the steeper approach angle of 3.2 degrees

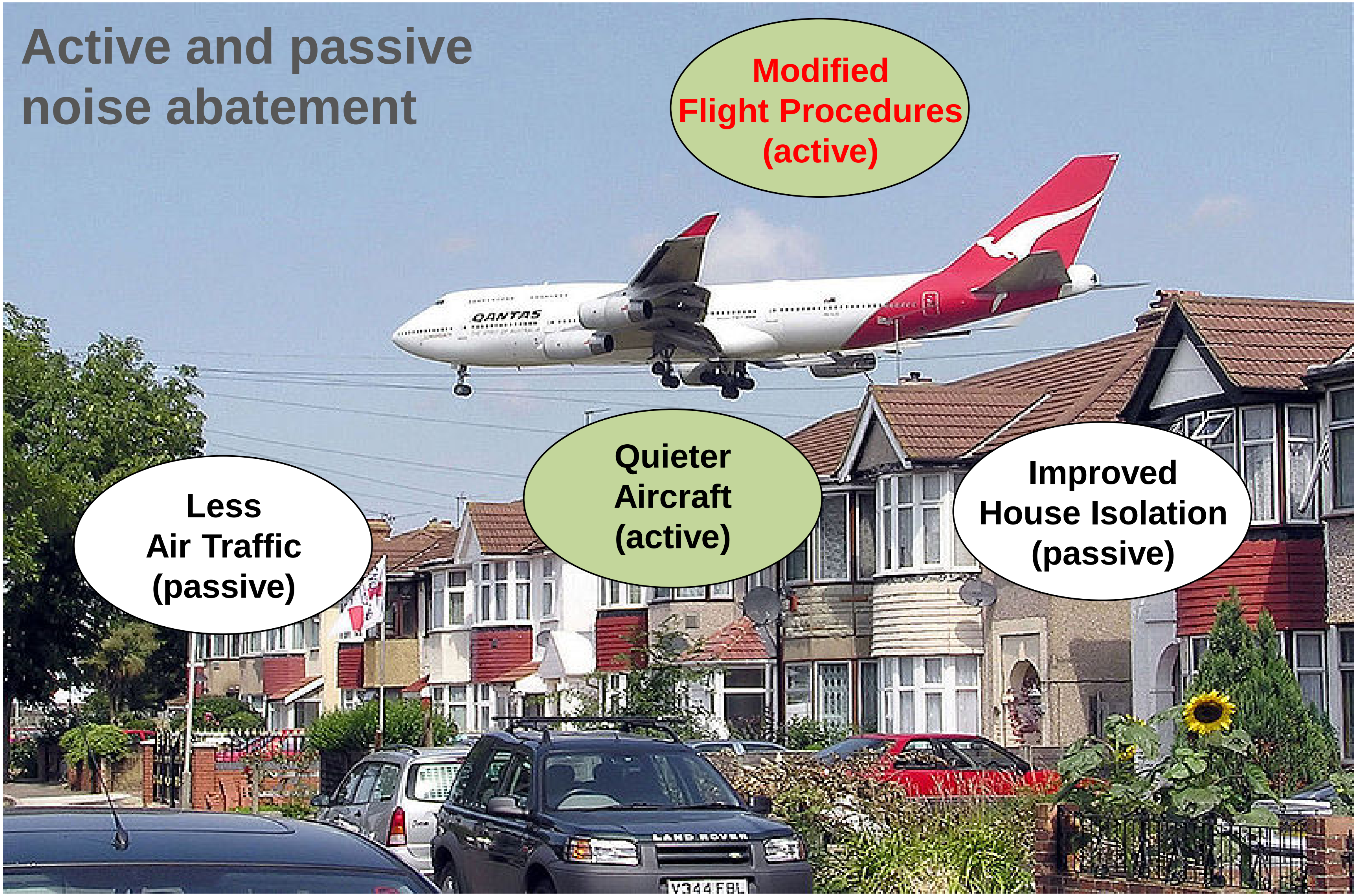
Erfahrungen mit dem erhöhten Anflugwinkel von 3,2 Grad

Dr. Reinhard König
German Aerospace Center (DLR) - Institute of Flight Systems
Deutsches Zentrum für Luft- und Raumfahrt (DLR) - Institut für Flugsystemtechnik
Braunschweig, Germany

2nd International Conference on Active Noise Abatement
October 30th - 31th, 2013, Frankfurt Airport

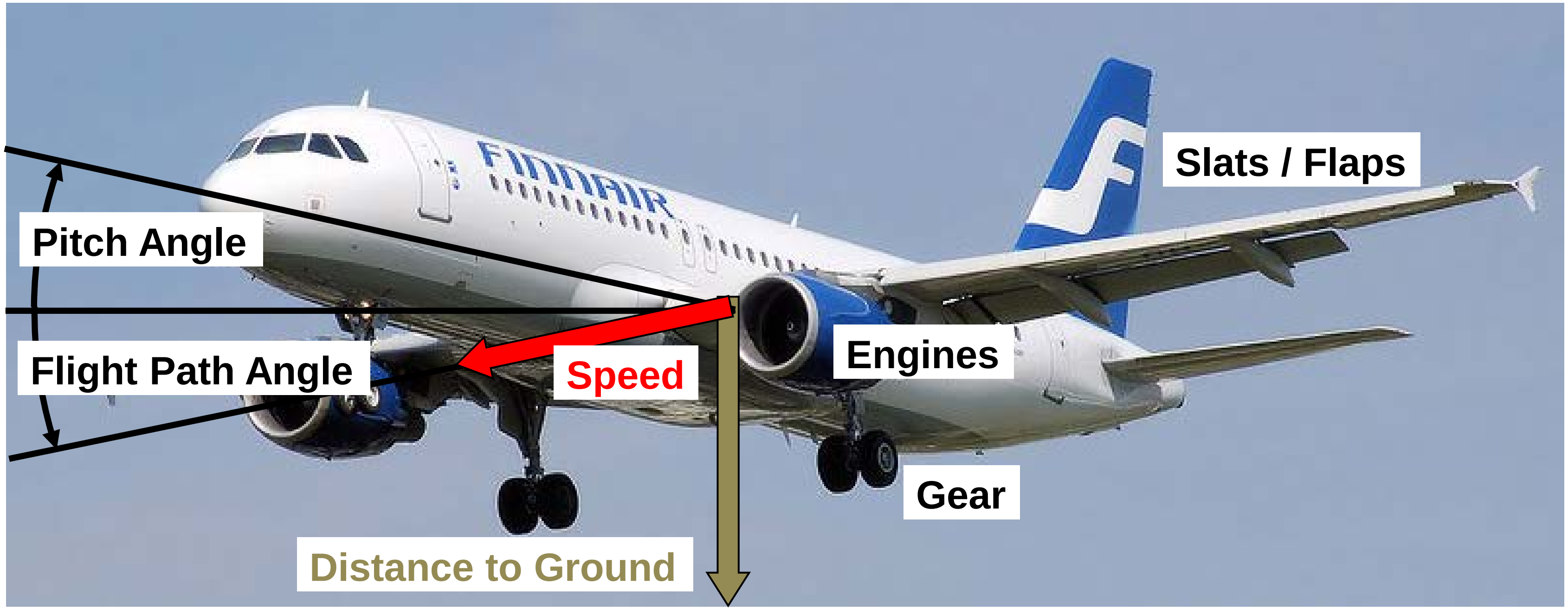
DLR

Active and passive noise abatement



DLR

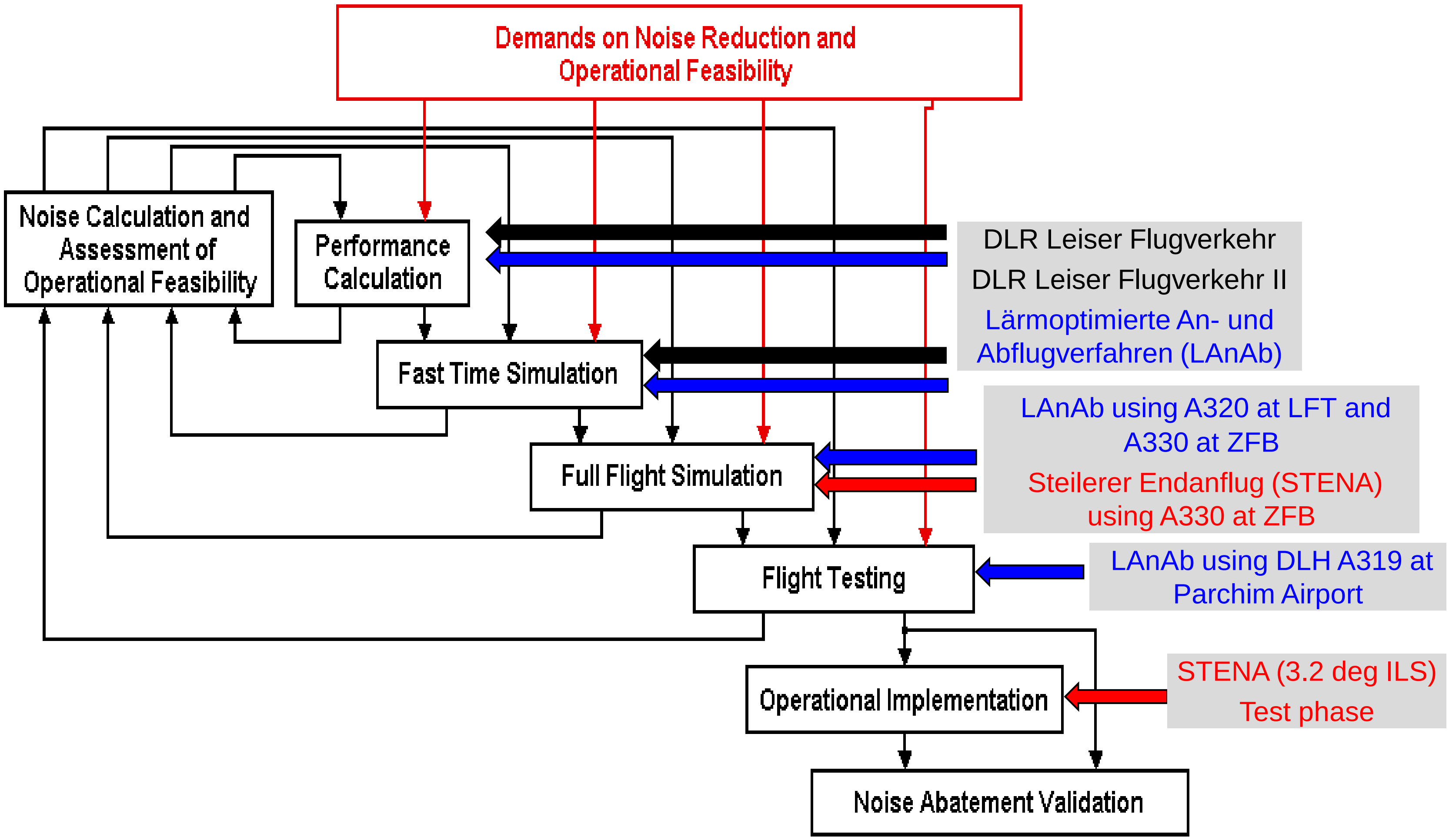
Noise emission from aircraft



- The primary noise sources of an aircraft are the engines, the slats/flaps and the gear.
- The slat/flap- and the gear noise depend strongly on speed.
- The engine noise depends on thrust, which depends on required flight path, required speed and aircraft configuration.
- The noise on ground depends on the distance to the aircraft and on the emitted noise.
- A noise abatement procedure design process has to consider all these relations.

DLR

Noise abatement procedure design process

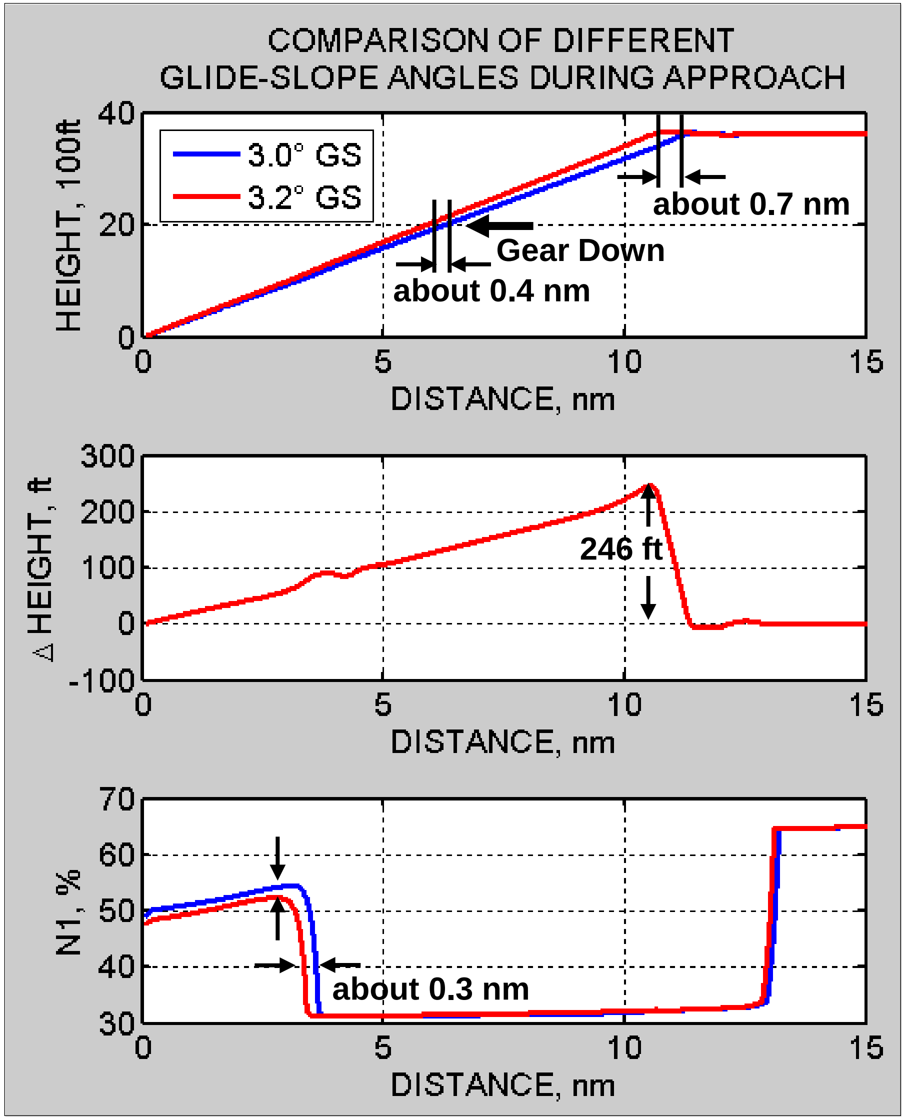


Steeper final approach of 3.2 deg

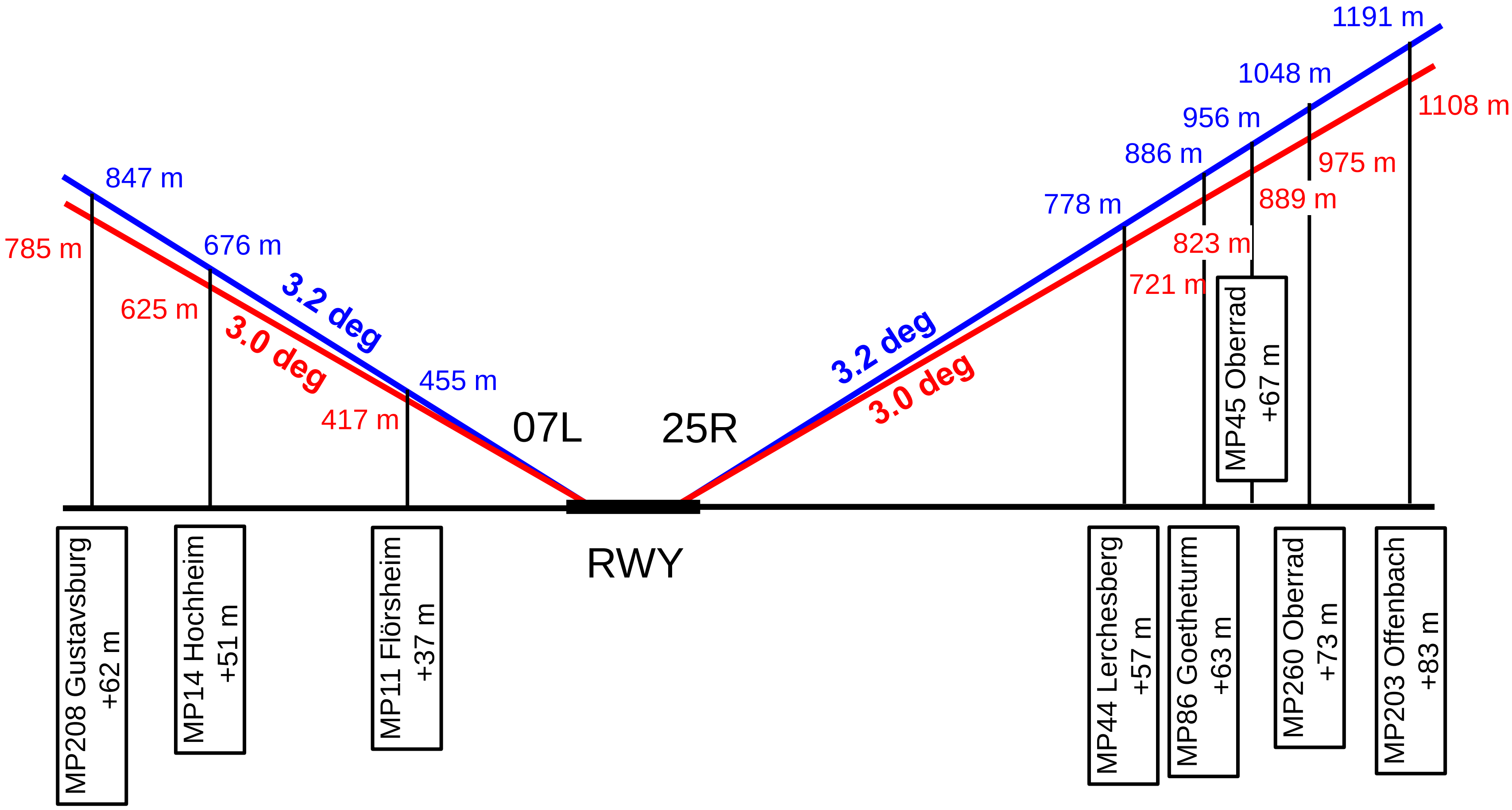
Glide slope angles up to 3.2° do not require any procedural changes for A320/A330.

Expected noise reduction contributions are:

- Up to 246 ft more height
- ILS intercept 0.7 nm closer to the airport
- Flaps deployment before intercept may also be 0.7 nm closer to the airport
- Gear deployment is 0.4 nm closer to the airport (same height of 2000 ft)
- Thrust increase for a/c stabilization 0.3 nm closer to the airport
- Required thrust is lower
- All effects lead in theory to ca. 1 dB less maximum sound level on ground



ILS geometry and overflight heights



Operational test implementation of a 3.2 deg ILS

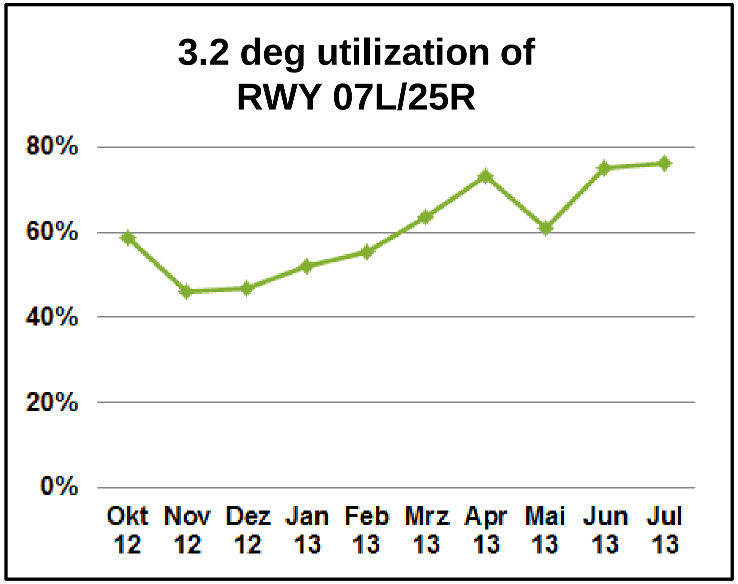
- The Runway Northwest of the Frankfurt Airport is certificated for precision approaches only.
- Therefore a redundant ILS system is installed, which allows 3.0 deg and 3.2 deg operations at the same time.
- Due to the results of the STENA-Study all involved parties agreed upon a 3.2 deg CAT-I test phase of one year duration.
- The German authority BMVBS allows this testphase starting on October, 18, 2012.
- The DLR Institute of Flight Systems evaluates the noise abatement at the measuring points of Fraport and UNH.

UNH Umwelt- und Nachbarschaftshaus Kelsterbach

3.2 deg test phase activities

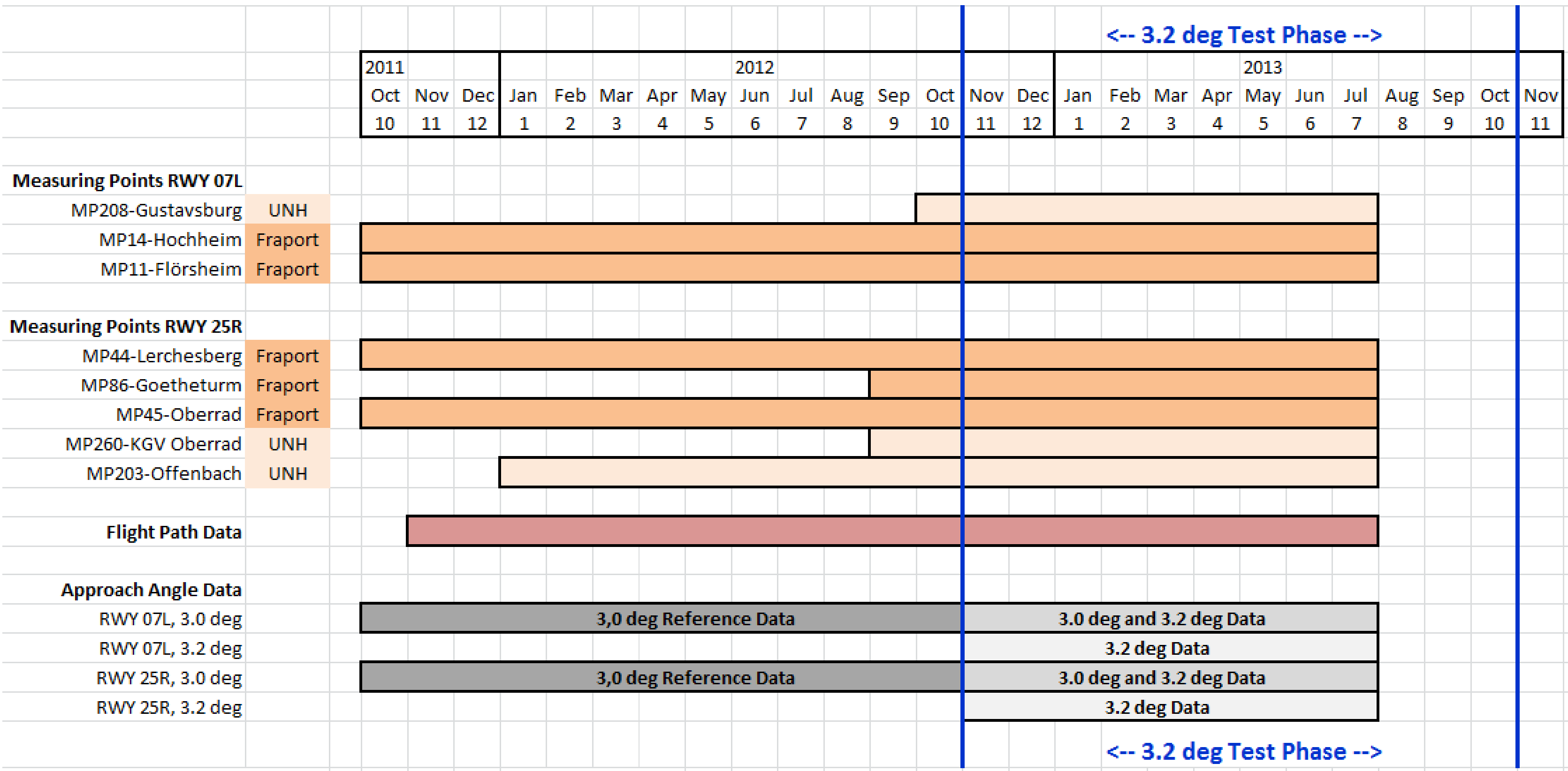
- From October 2012 to May 2013 DFS offers 3.2 deg under headwind conditions and pilots could accept or not.
- After May 2013 until October 2013 the aircraft has to land on another runway if the pilot does not accept 3.2 deg.
- DFS records the 3.2 deg cases.
- Fraport and UNH monitor the noise events at 3 stations for 07L direction and 5 stations for 25R direction.
- Fraport monitors the "Gear Down" behaviour at measuring point "Lerchesberg"
- DLR evaluates noise and flight path measurements continuously during the testphase.

DFS	Deutsche Flugsicherung (Air Traffic Control)
Fraport	Frankfurt Airport
UNH	Umwelt- und Nachbarschaftshaus Kelsterbach
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)



- The utilization of the 3.2 deg final landing approach increases over time and reaches in July 2013 ca. 76%.
- The acceptance is very high. During July 2013 only 0.2% crews had declined the 3.2 deg approach.
- No safety-related incidents occured

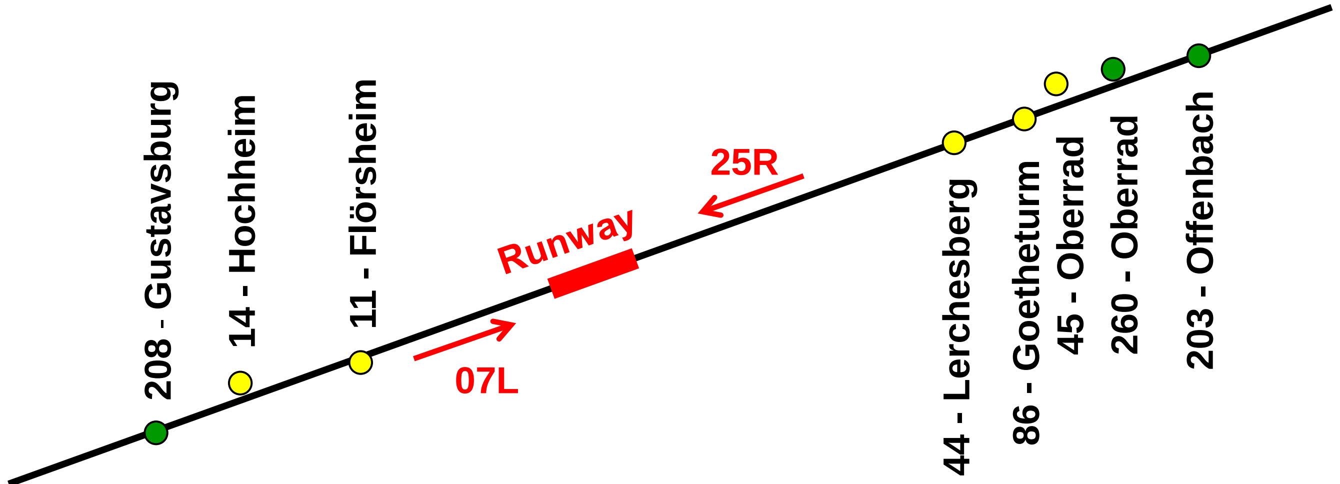
Noise- and flight path data availability to evaluate noise abatement



Cockpit data are not available for any evaluation!

DLR

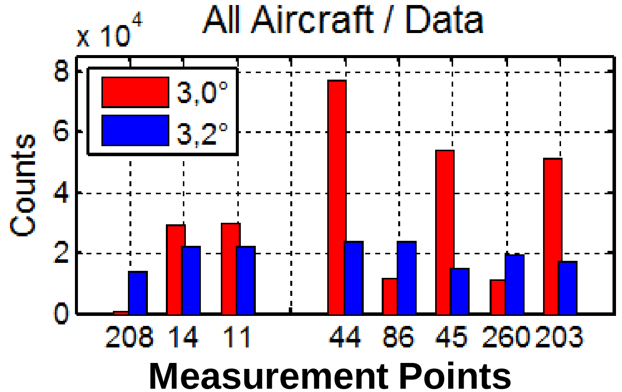
Measuring points and way to present the statistic results



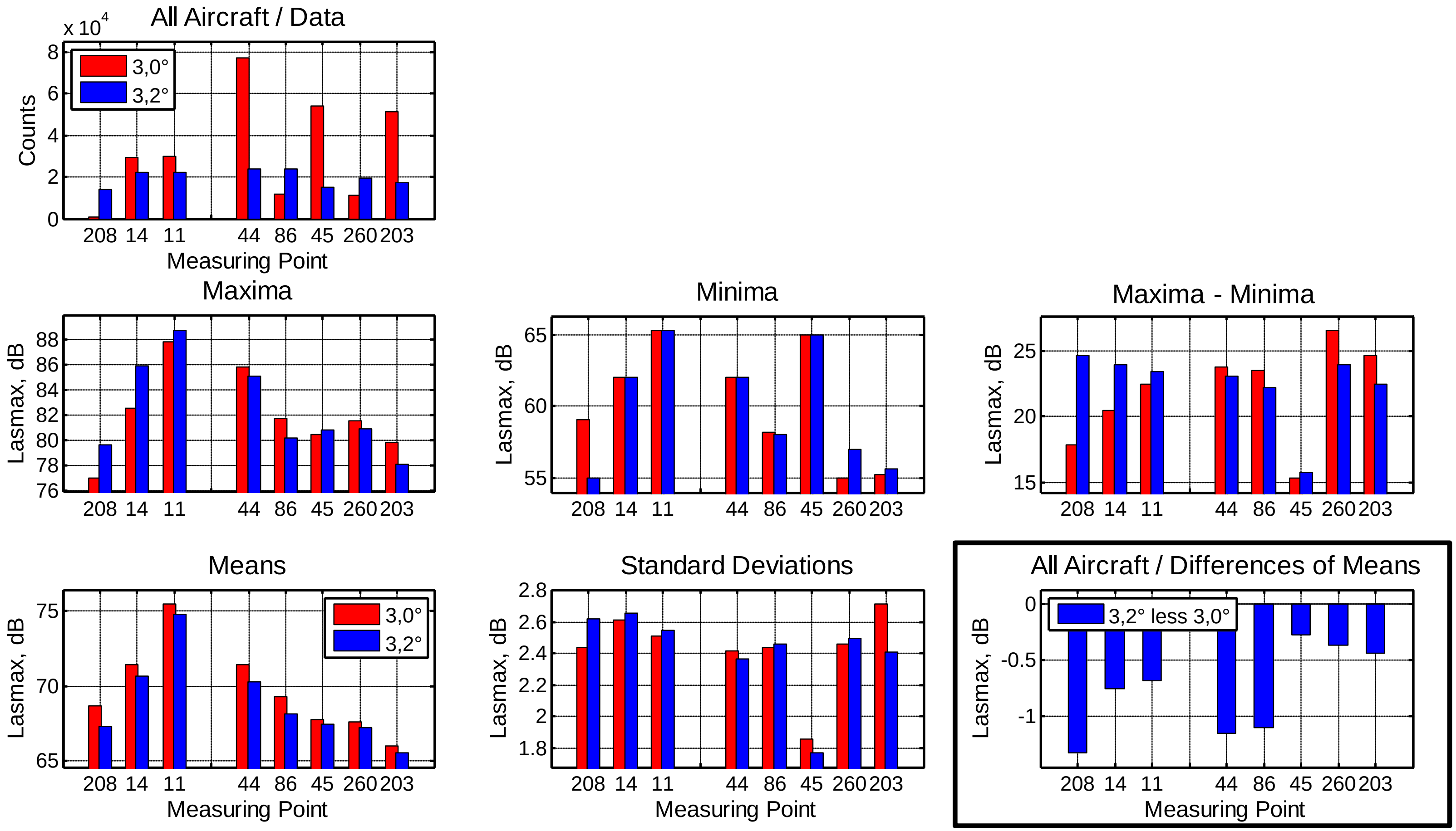
Fraport Measuring Point

UNH Measuring Point

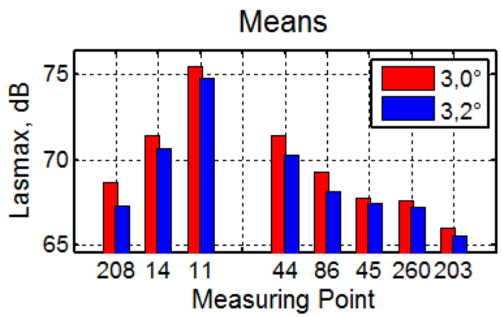
Example

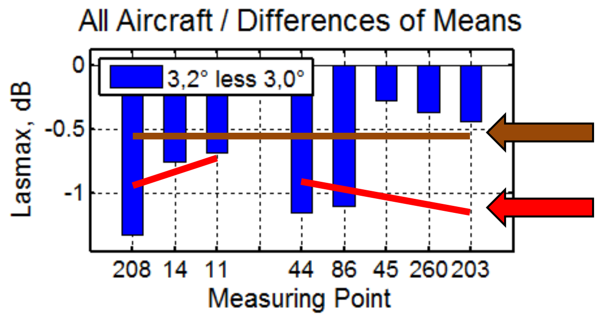


Statistics of maximum sound level - all aircraft - (1)



Statistics of maximum sound level - all aircraft - (2)





Geometrical damping from theory if measuring point position is directly below the glide path.

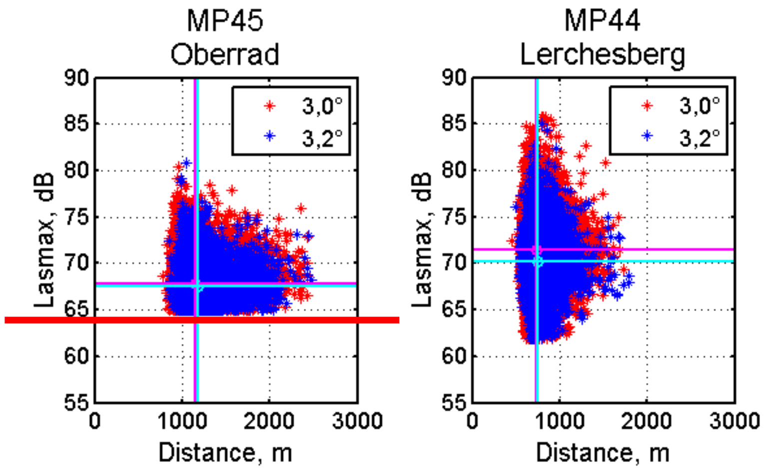
Both, geometrical and theoretical atmospheric damping for the conditions 15°C, 70% humidity and 2000 Hz.

Insufficient 3.0 reference data at MP208 because of late installation

	ILS 30ref	ILS 32	Both
MP 208	1096	13940	15036
MP 14	29456	22141	51597
MP 11	29690	22147	51837
MP 44	77410	23866	101276
MP 86	11820	23929	35749
MP 45	54240	14929	69169
MP 260	11417	19484	30901
MP 203	51532	17052	68584
All	266661	157488	424149

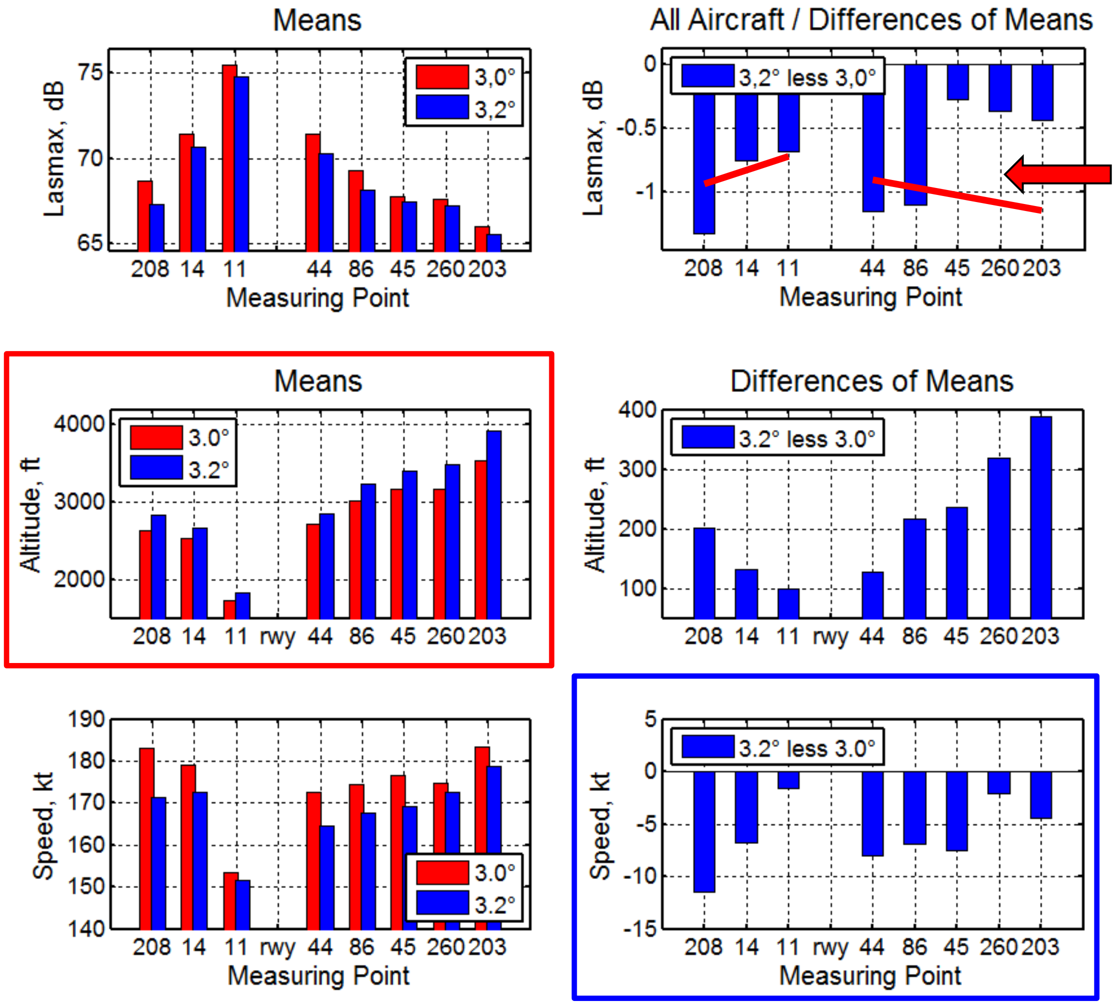
Evaluated noise measurements

65dB measurement threshold at MP45



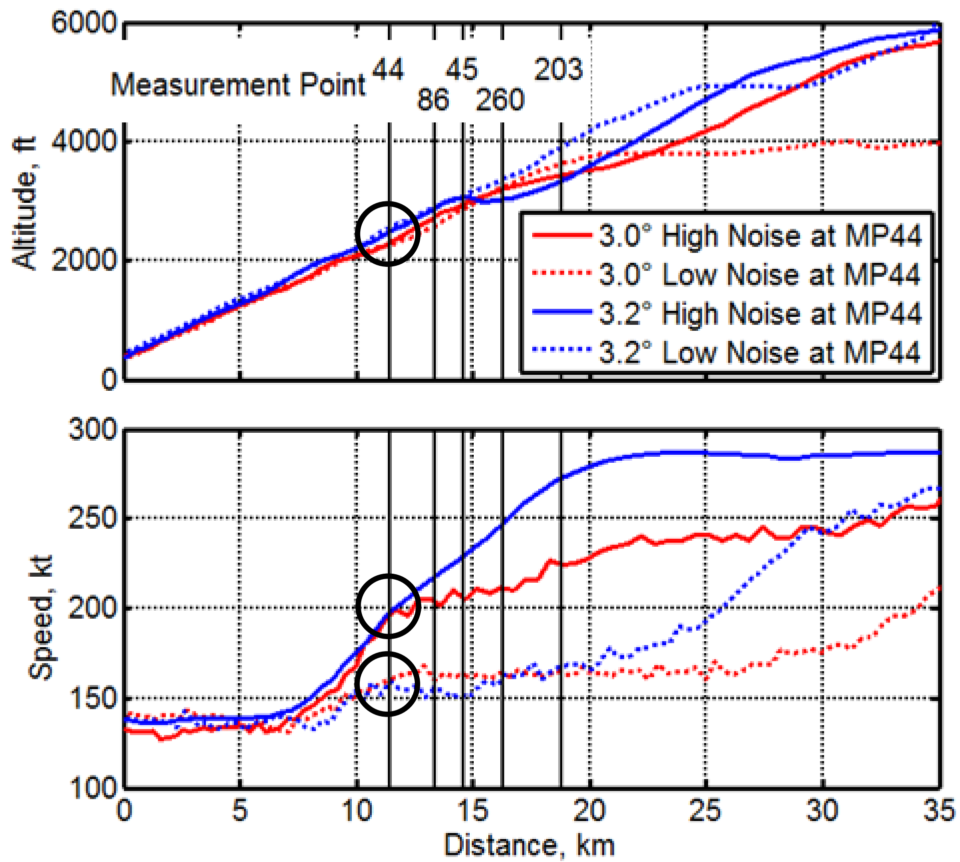
Lasmax over the distance to the aircraft at time of measurement

Statistics of maximum sound level "Lasmax" - all aircraft - (3)



- MP44, MP86 (and MP208) show more noise abatement than expected from theory, MP203, MP260 (and MP45) show less.
- The altitude at time of maximum noise level measurement is slightly higher than from geometry expected. Due to directional sound characteristics the maximum noise emission takes place before flying directly over the measuring point.
- The speed on 3.2 deg is at MP44 8 kt lower than on 3.0 deg. This could be one reason for more noise abatement than expected.
- Another reason could be that on 3.2 deg ca. 10% aircraft have "gear down", against ca. 20% on 3.0 deg (diploma thesis V. Stein).

Influence of speed on noise results, extreme cases (1)



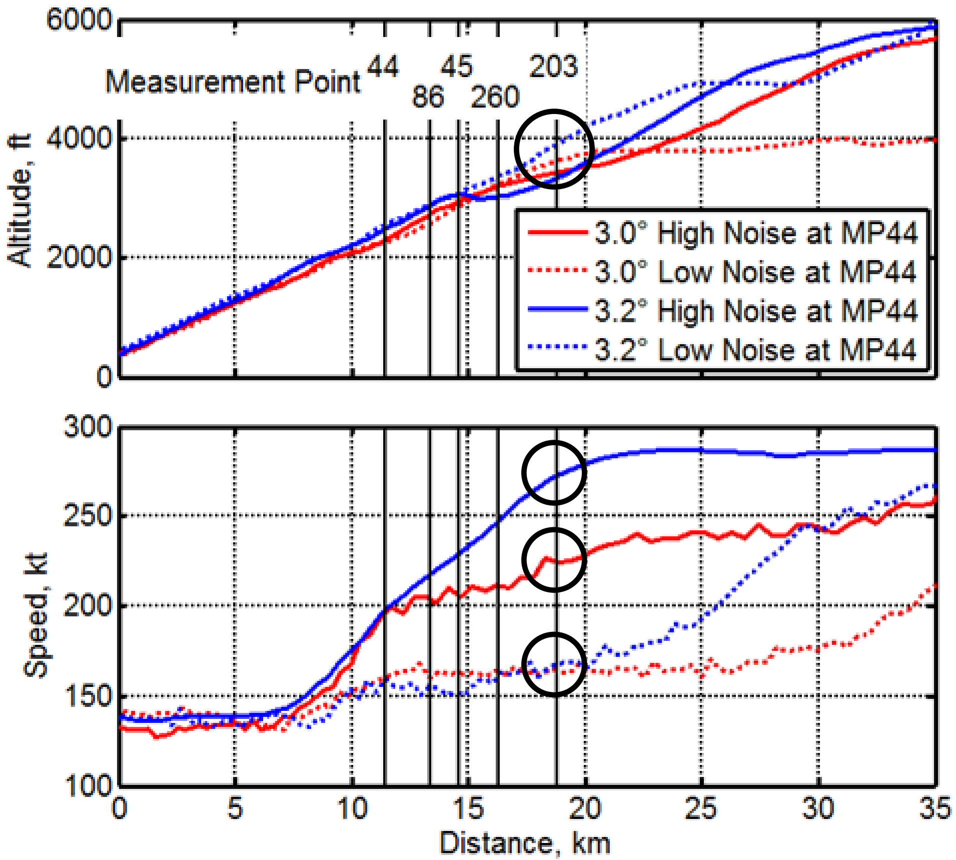
- Selection of two 3.0 deg and two 3.2 deg cases respectively with high and with low noise at MP44.
- The maximum noise level differs at the same approach angle by more than 12 dB.

Comparison of maximum noise level at the same approach angle

	3.0 High	3.0 Low	3.2 High	3.2 Low
MP	Lasmax	Lasmax	Lasmax	Lasmax
44	77,9	65,4	77,5	64,7
Difference	**-12.5**		**-12.8**	

- The extreme different noise levels are correlated with the aircraft speed.
- Furthermore, the aircraft speed is correlated with the type of approach (Continuous Descent Approach or approach with intermediate altitude).
- The speed difference is up to 40 kt.

Influence of speed on noise results, extreme cases (2)

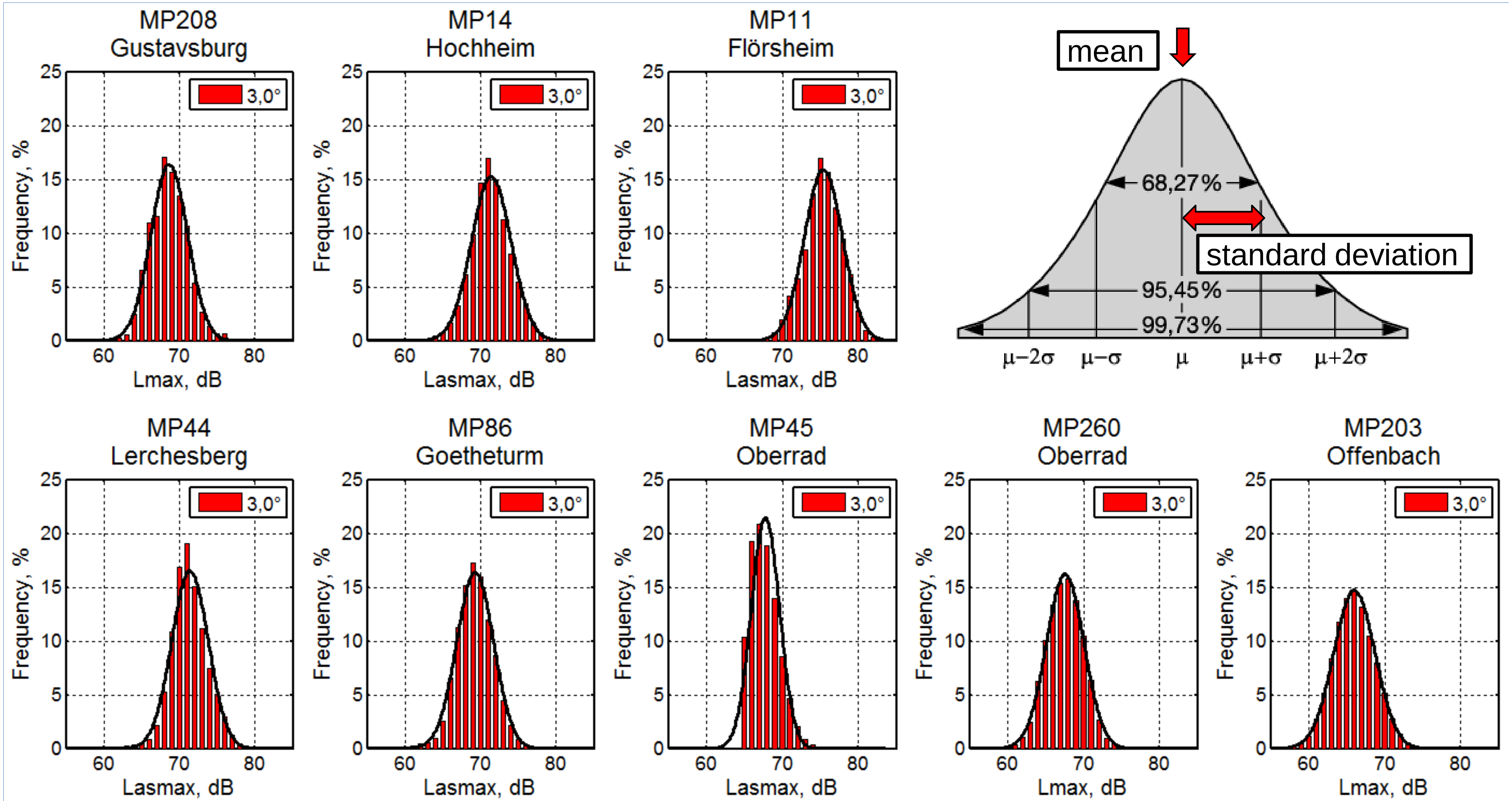


- At MP203 the altitude differs up to 1000 ft and the speed differs up to 100 kt, but the noise is nearly the same. There must be different noise emissions from the aircraft due to thrust, flap setting and/or use of speed brakes.

	3.0 High	3.0 Low	3.2 High	3.2 Low
MP	Lasmax	Lasmax	Lasmax	Lasmax
44	77,9	65,4	77,5	64,7
86	73,2	64,9	75,1	71,9
45	71,7	64,8	73,7	71
260	69,3	62,3		70,3
203	71,9		69,4	71,2

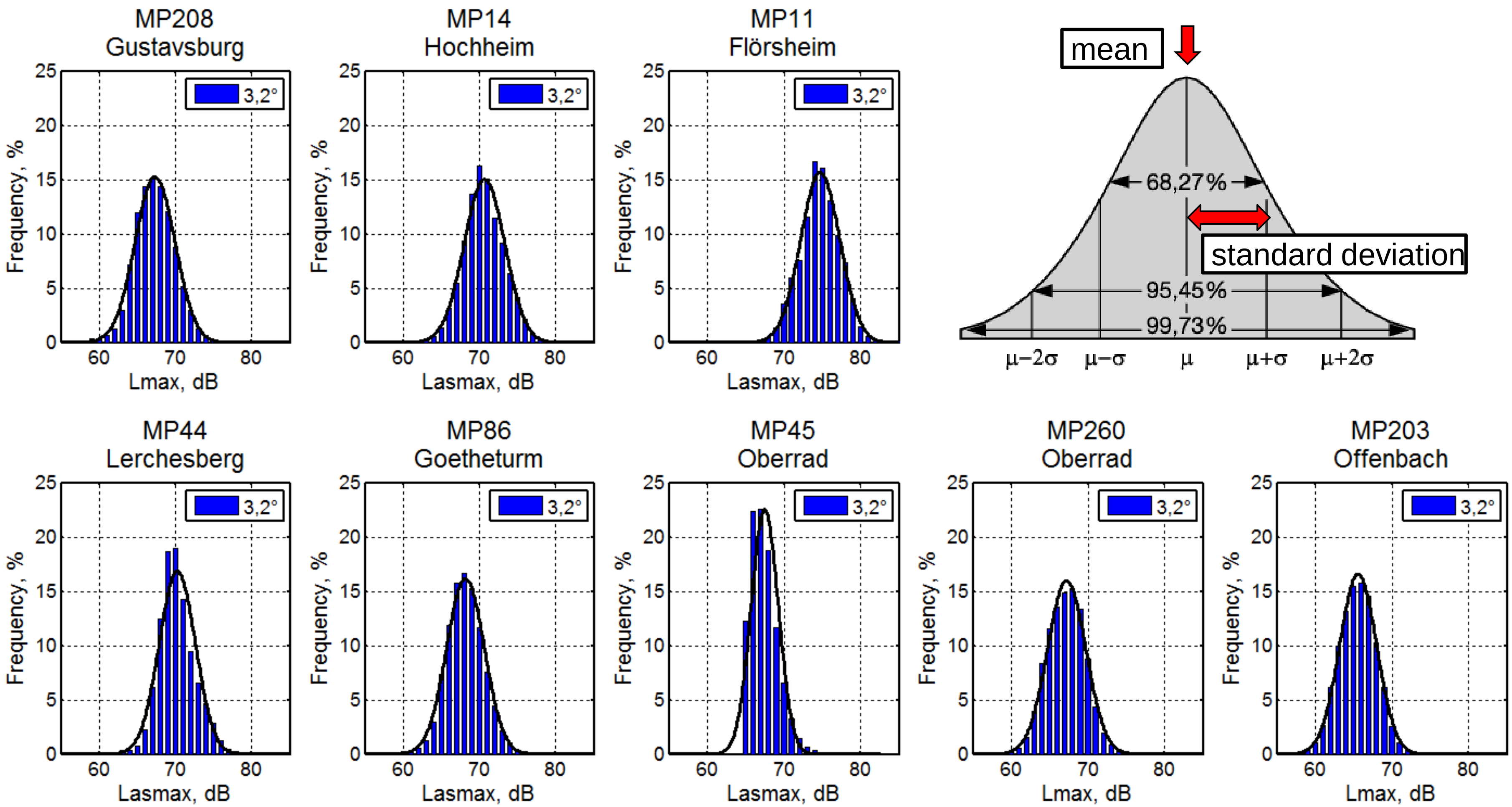
- The "High Noise" approaches are both Continuous Descent Approaches with late deceleration to final approach speed. A deceleration on glide path requires often speed brake usage and / or early gear down. Both increases the noise emission significantly!

Frequency distribution and corresponding Gaussian distribution of 3.0 deg approaches - all aircraft -



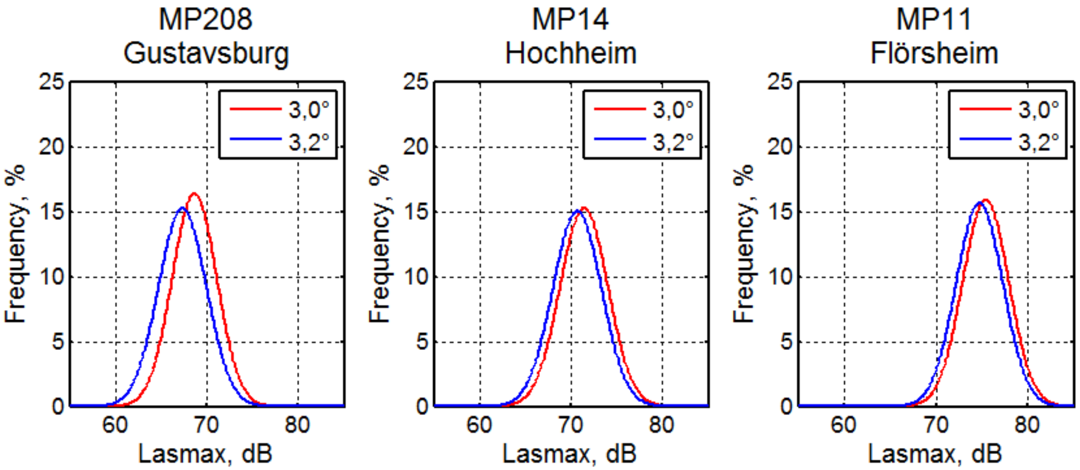
Gaussian distribution with mean and standard deviation from measurement

Frequency distribution and corresponding Gaussian distribution of 3.2 deg approaches - all aircraft -

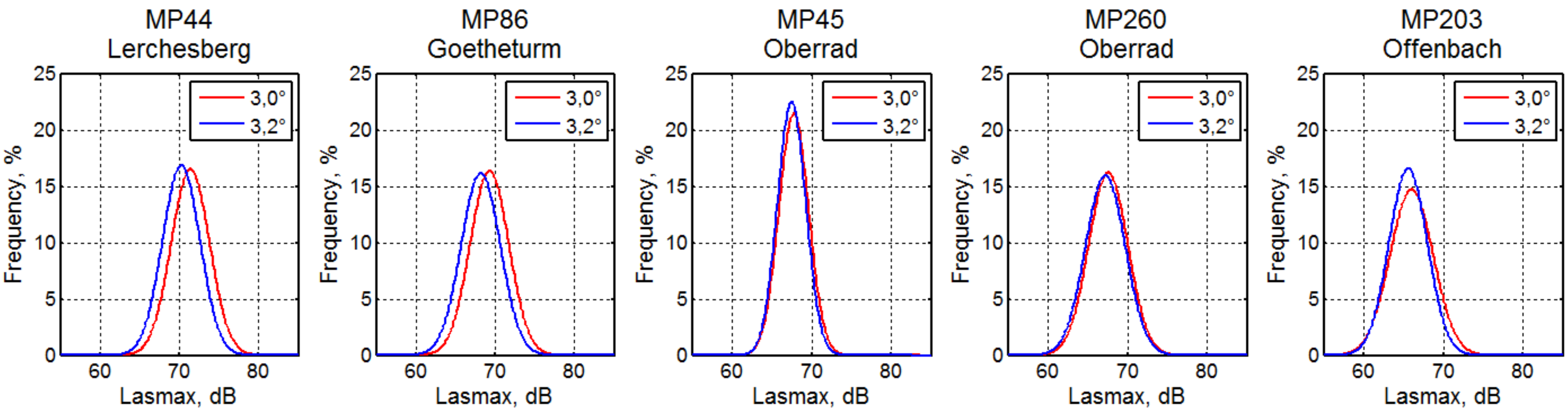


Gaussian distribution with mean and standard deviation from measurement

Comparison of Gaussian distributions of 3.0 and 3.2 deg approaches - all aircraft -



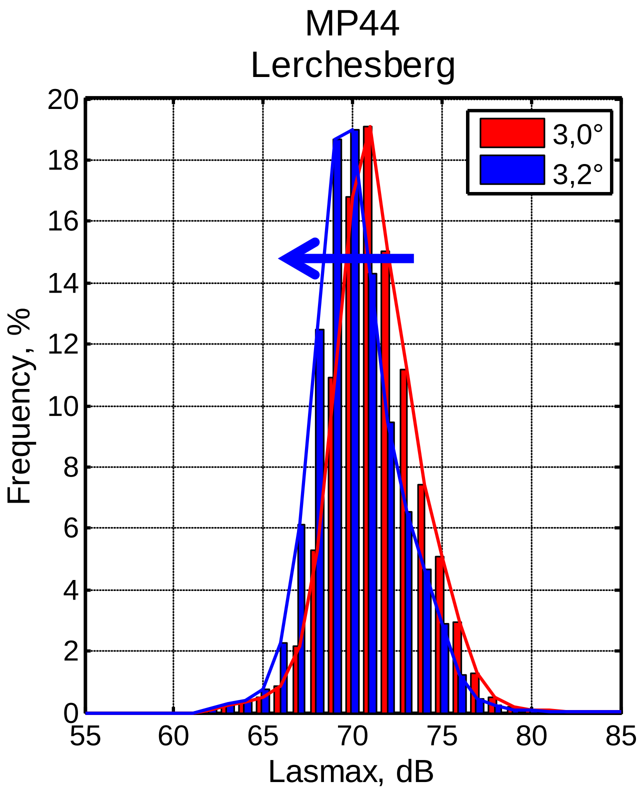
Movement of the gaussian distribution to the left shows the achieved noise abatement.



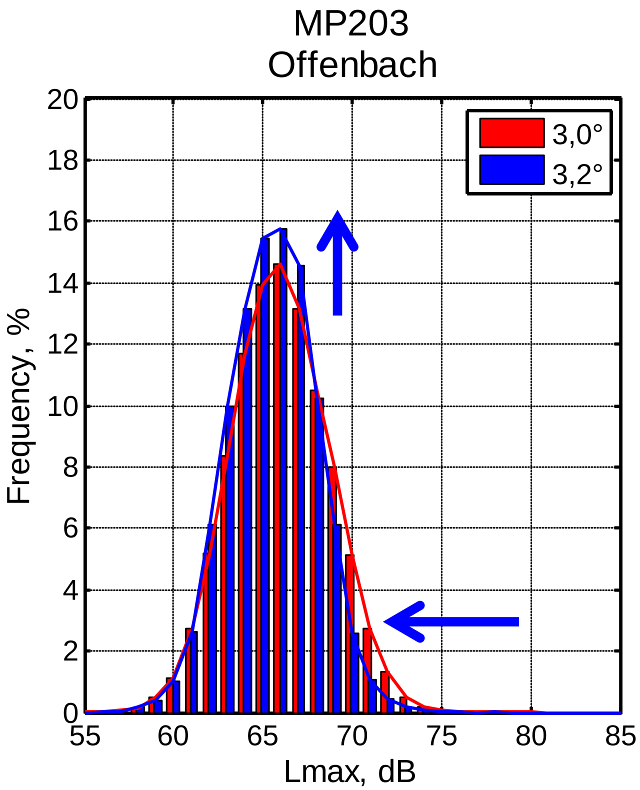
DLR

Noise abatement can be shown through movement of frequency distribution or change of its shape

Movement of frequency distribution
Significant decrease of the mean
Less occurence of high noise,
more occurence of low noise

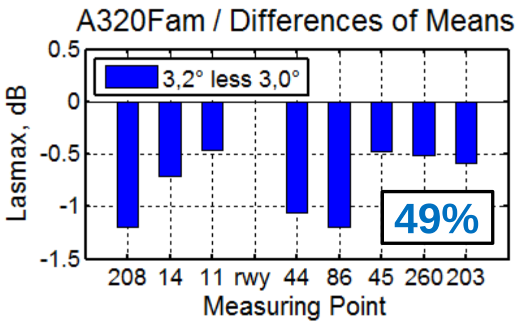


Change of frequency distribution shape
Small decrease of the mean
Less occurence of high noise,
more occurence near mean

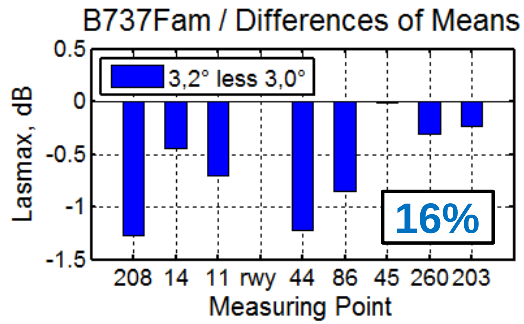


Statistics of maximum sound level "Lasmax" - aircraft groups -

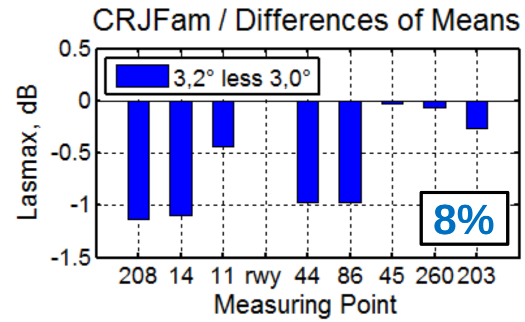
A318 / A319 / A320 / A321



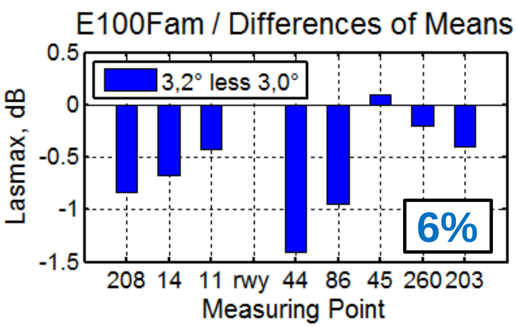
B733 / B734 / B735 / B736
B737 / B738 / B739



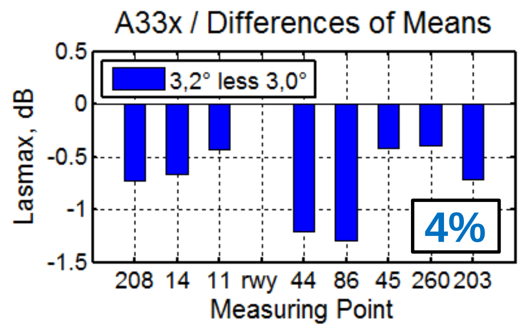
CRJ2 / CRJ7 / CRJ9 / CRJX



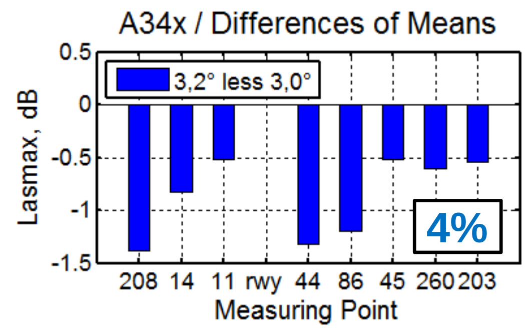
E135 / E145 / E170 / E190



A332 / A333



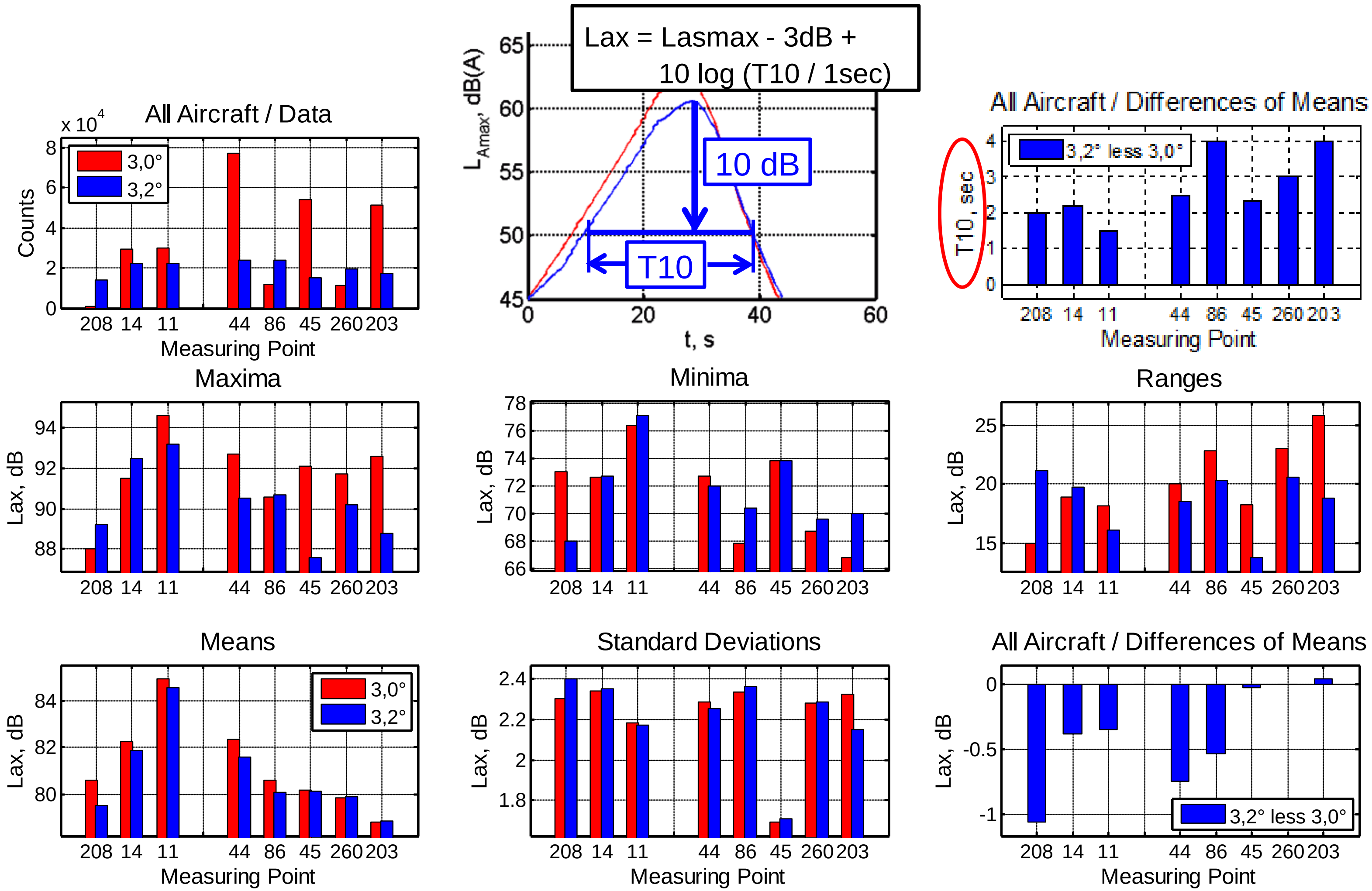
A343 / A345 / A346



X% Percentage of all sound level measurements

DLR

Statistics of single event sound level "Lax" - all aircraft -



Conclusions

- The current 3.2 deg test phase can be regarded as successfull. It shows
  - a very high rate of acceptance by the pilots,
  - no changes in operation,
  - no impact on safety at all and
  - a noise abatement between 0.5 and 1.2 dB.
- The results from theory and from the safety studie STENA are confirmed.
- At the measuring point Lerchesberg (MP44) the expected noise abatement is exceeded. This may be a result from
  - a lower speed as shown from the flight path data and/or
  - a later gear extension as indicated by visual observation.
- The expected noise abatements at the measuring points Oberrad (MP260) and Offenbach (MP203) were not reached. The reasons for that could not yet be identified.

Future work

- Noise and flight path evaluation with data from August 2013 to October 2013.
- Find out the reasons for lower noise abatement as expected at MP260 and MP203.

Thank you very much for your attention

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Institute of Flight Systems

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DLR

4.12 GBAS Entwicklung – weltweites Update

4.12.1 Vortragender

Pat Reines, Business Development, Honeywell International Inc.

Pat has been with Honeywell since 1985, and in his tenure served in a variety of roles in its Defense and Space and Air Transport and Regional commercial airline business. Currently, Pat is the senior manager for Honeywell's SmartPath Ground Based Augmentation Systems (GBAS) and has served in this role for more than a decade. As senior manager, he is a global advocate and subject matter expert for GBAS technology and the benefits it can provide to airports, airlines, air navigation service providers, communities, and the flying public.Previously, Pat served as both the strategic campaign director for SmartPath and the product's business development manager.
Pat holds multiple engineering degrees from Purdue University and George Washington University and is a former U.S. Air Force helicopter pilot

Further Information about the company:
Based in Phoenix, Arizona, Honeywell's aerospace business is a leading global provider of integrated avionics, engines, systems and service solutions for aircraft manufacturers, airlines, business and general aviation, military, space and airport operations.
Honeywell is a Fortune 100 diversified technology and manufacturing leader, serving customers worldwide with aerospace products and services; control technologies for buildings, homes and industry; turbochargers; and performance materials. Based in Morris Township, N.J., Honeywell's shares are traded on the New York, London, and Chicago Stock Exchanges.

4.12.2 Präsentation

Link zum Mitschnitt der Präsentation:
Deutsch: http://www.youtube.com/watch?v=t3hzpEn4_gA&feature=youtu.be
English: http://www.youtube.com/watch?v=RbfGs9UvmX8&feature=youtu.be

Pat Reines
(pat.reines@honeywell.com)

SmartPath® Update
Ground Based Augmentation System (GBAS)
& Performance Based Navigation (PBN)
A New Era in Precision Navigation

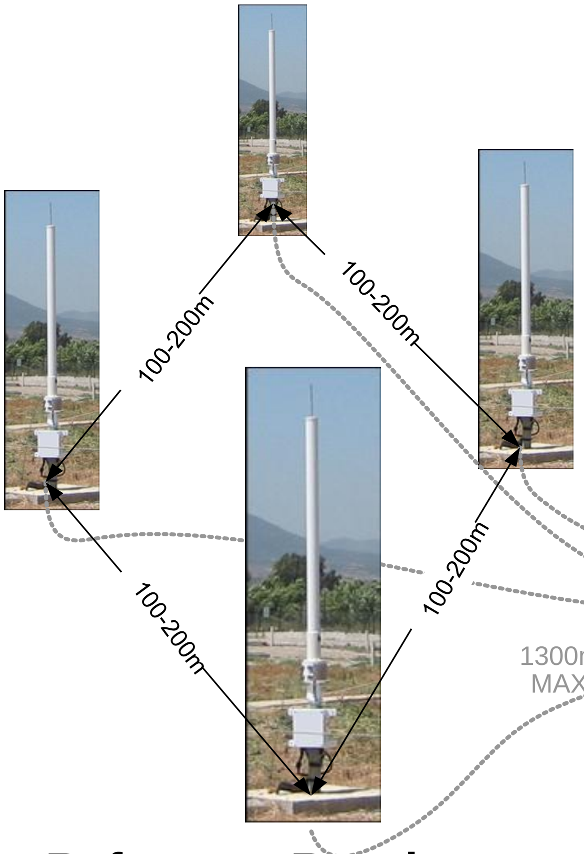
Honeywell

Overview

- Ground Based Augmentation System (GBAS) Refresher
- Certified GBAS Installations
- GLS Installations and Forecast
- SmartPath Value Summary
- A Call to Action

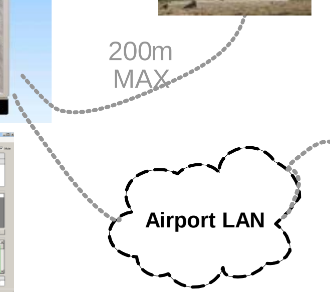
26 ILS Approaches = 26 Localizers and Glide Slopes

Honeywell SmartPath GBAS



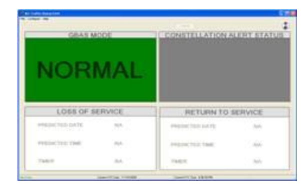
Dual Processor Channels

- Differential Corrections
- Overall System Integrity
- Approach Database
- Redundant Channel



VHF Broadcast

- Corrections, Integrity, Approaches
- Horizontally Polarized, Omni-Directional
- 108-118 MHz
- 2 TDMA Time Slots
- 2 Hz Corrections
- Redundant Radio



Reference Receivers

- Multipath Limiting Antenna (MLA)
- Narrow Correlator GPS Receiver
- 2 Hz Measurements
- 4 GPS Receivers

Maintenance Data Terminal

- System Status, Mode, Control
- System Alerts, Alarms
- Approach Control

TDMA – Time Division Multiple Access
Hz – Hertz
LAN – Local Area Network (typ. Ethernet)

Air Traffic Status Unit

- System Mode
- System Availability

Bremen First Flight

World's 1st/Only FAA/ICAO Compliant

FAA CAT-I Certified 4 Sep 2009

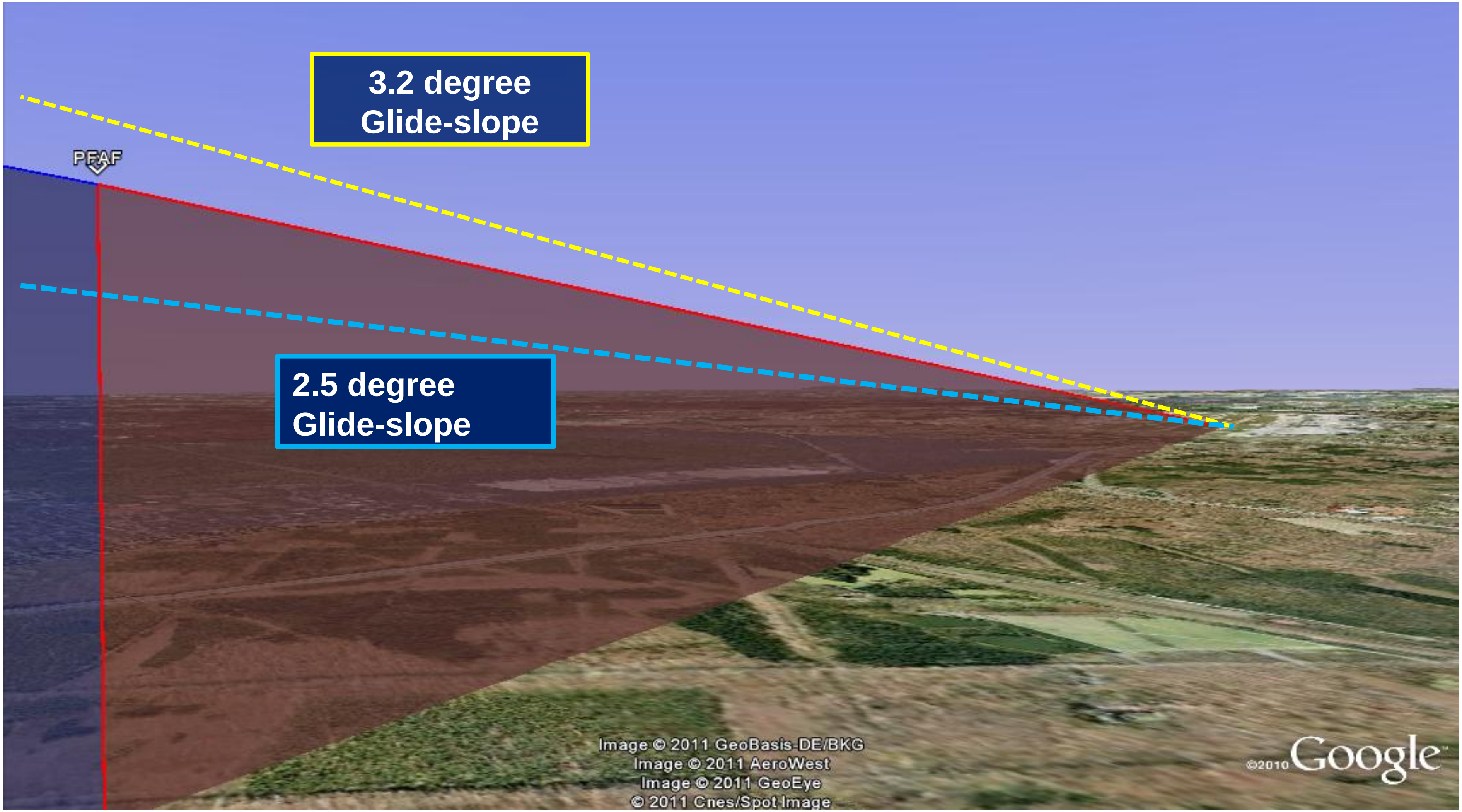
German BAF Certified 28 Nov 2011

- The first unrestricted GLS landing occurred at Bremen, Germany 9 Feb 2012.
- Air Berlin flight 6573 landed at 21:52 using Honeywell's SmartPath system.

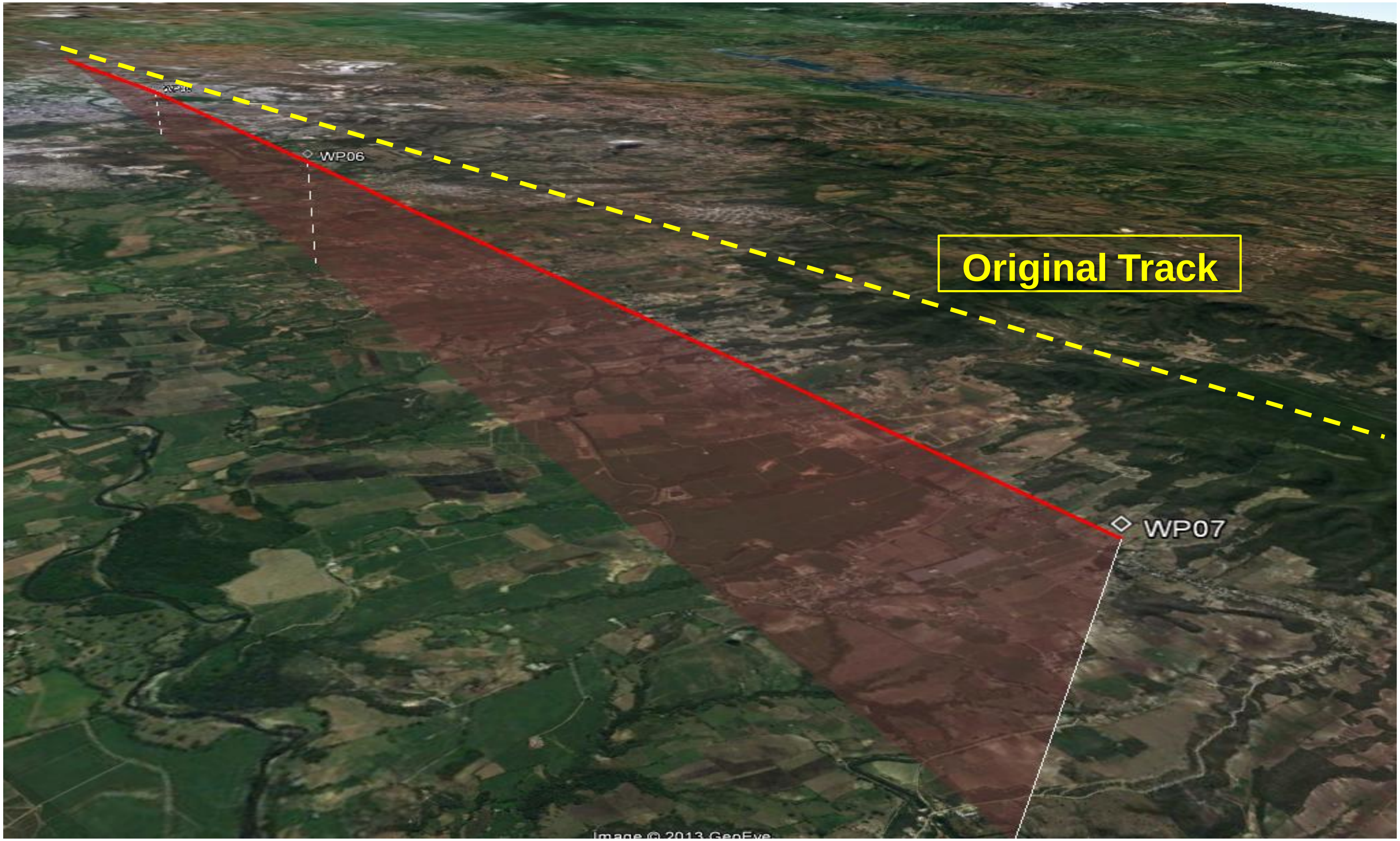
GBAS: Programmable Touchdown Points and Path

- ILS: single defined vertical path, same touchdown point on runway
- SmartPath GBAS: multiple touchdown points and glide slope combinations

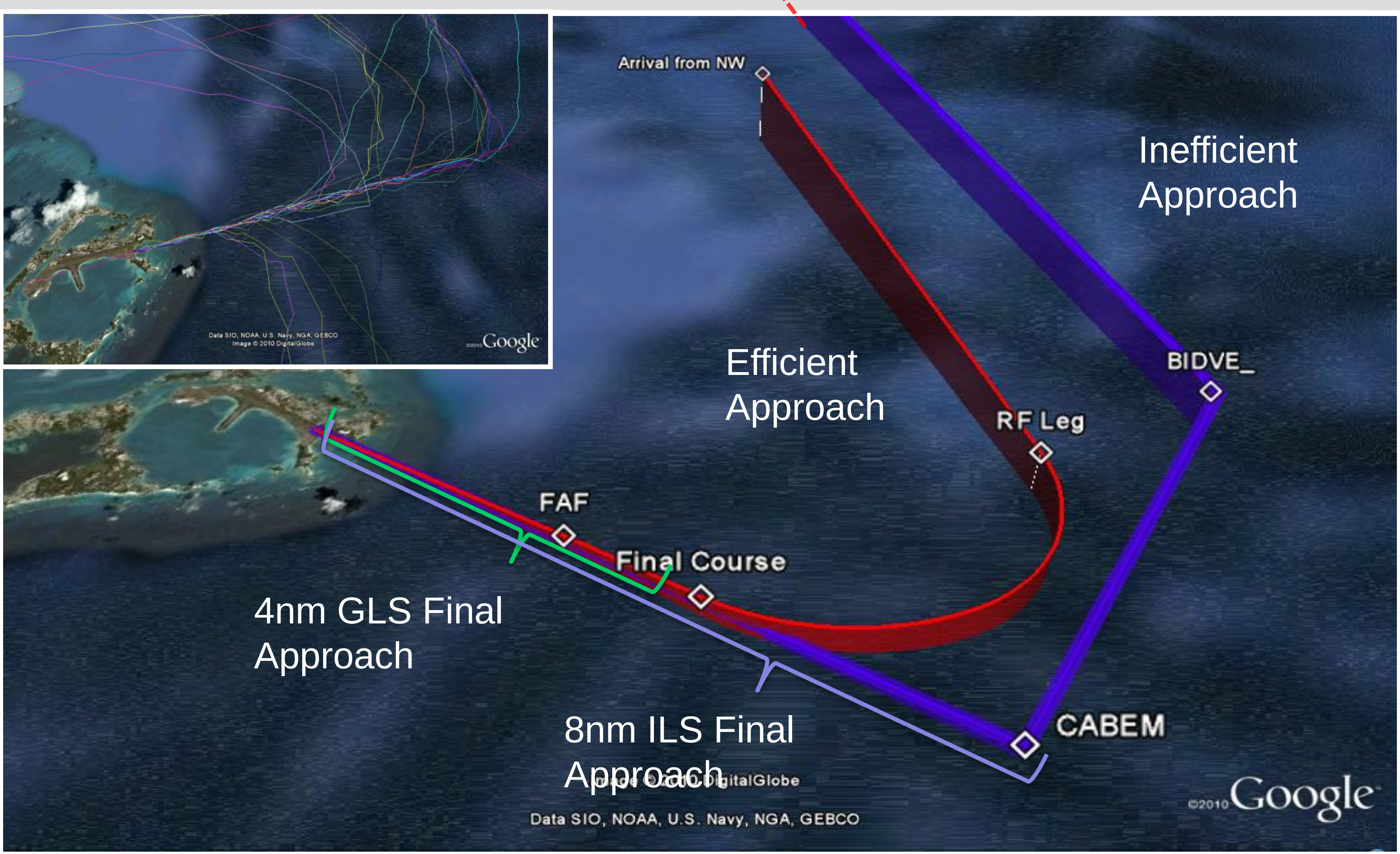
GBAS: Programmable Touchdown Points and Path



GBAS Offset Approaches



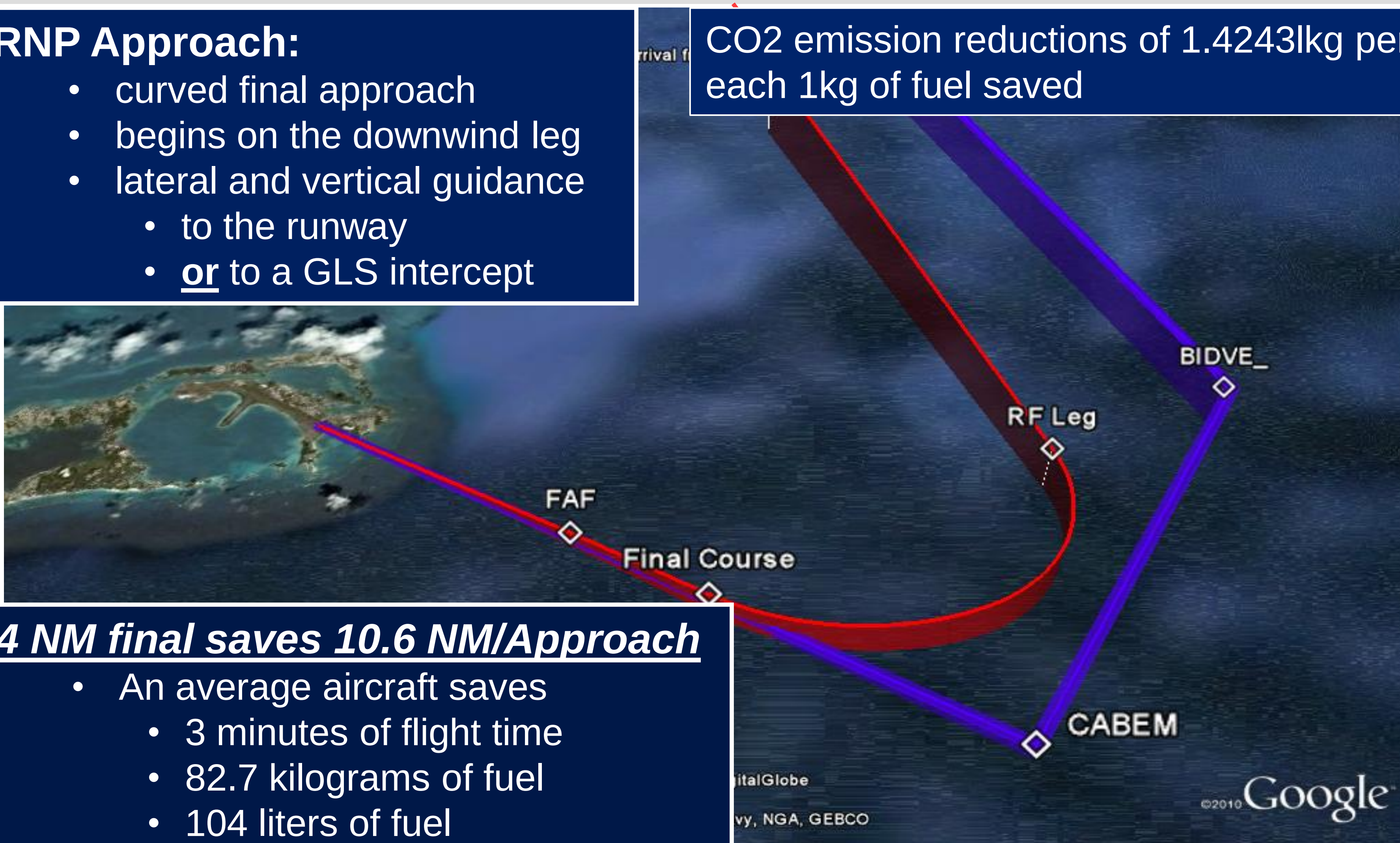
RNP + GBAS GLS: Enabling Maximum Efficiency



RNP + GBAS GLS: Efficiency Quantified

RNP Approach:
- curved final approach
- begins on the downwind leg
- lateral and vertical guidance
  - to the runway
  - **or** to a GLS intercept

CO_2 emission reductions of 1.4243lkg per each 1kg of fuel saved

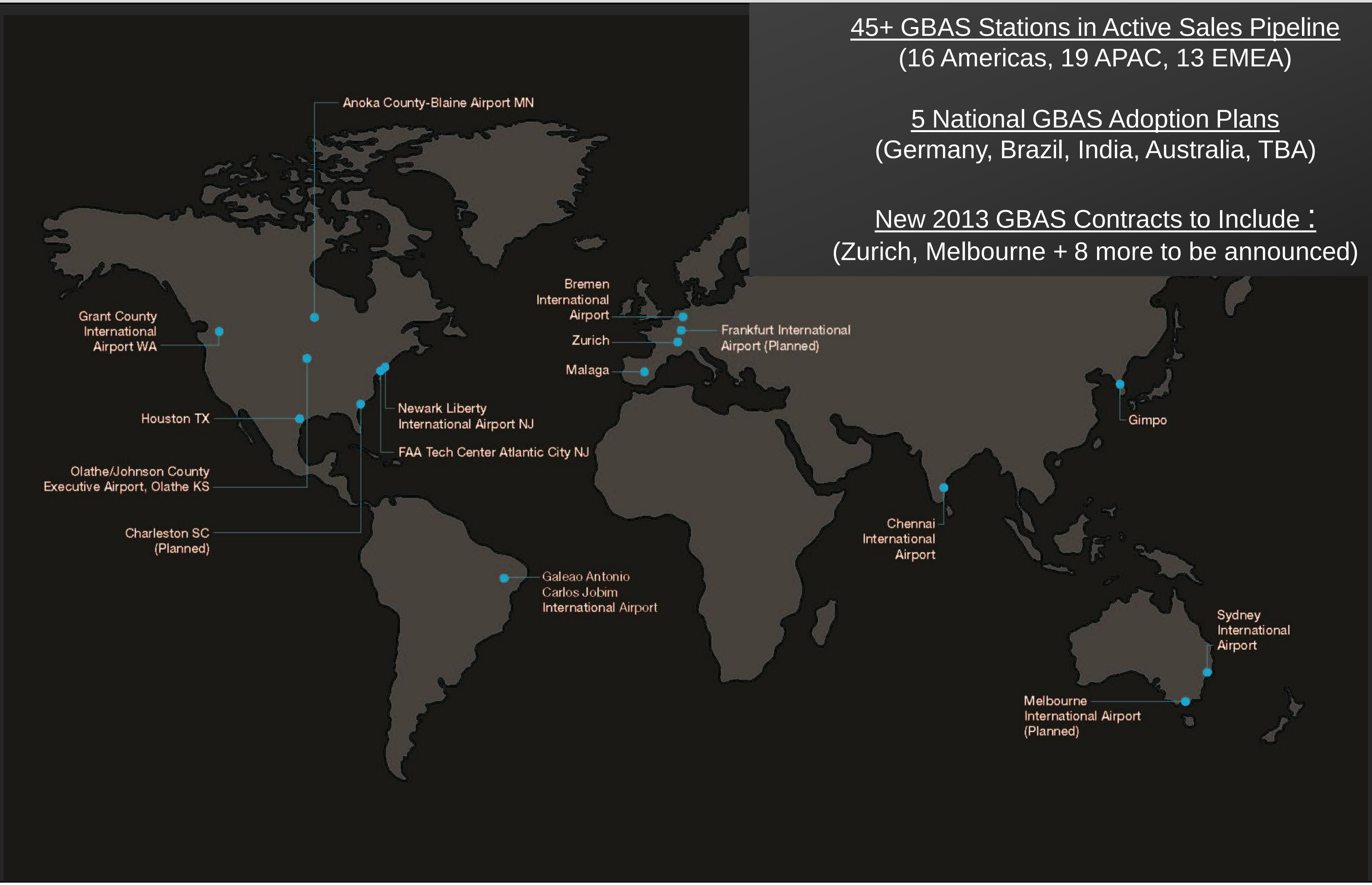


4 NM final saves 10.6 NM/Approach
- An average aircraft saves
  - 3 minutes of flight time
  - 82.7 kilograms of fuel
  - 104 liters of fuel

Honeywell

→ Honeywell.com

Rapidly Increasing GBAS Adoption



<u>45+ GBAS Stations in Active Sales Pipeline</u>
(16 Americas, 19 APAC, 13 EMEA)

<u>5 National GBAS Adoption Plans</u>
(Germany, Brazil, India, Australia, TBA)

<u>New 2013 GBAS Contracts to Include :</u>
(Zurich, Melbourne + 8 more to be announced)

Airlines should now equip new deliveries to be GLS ready!

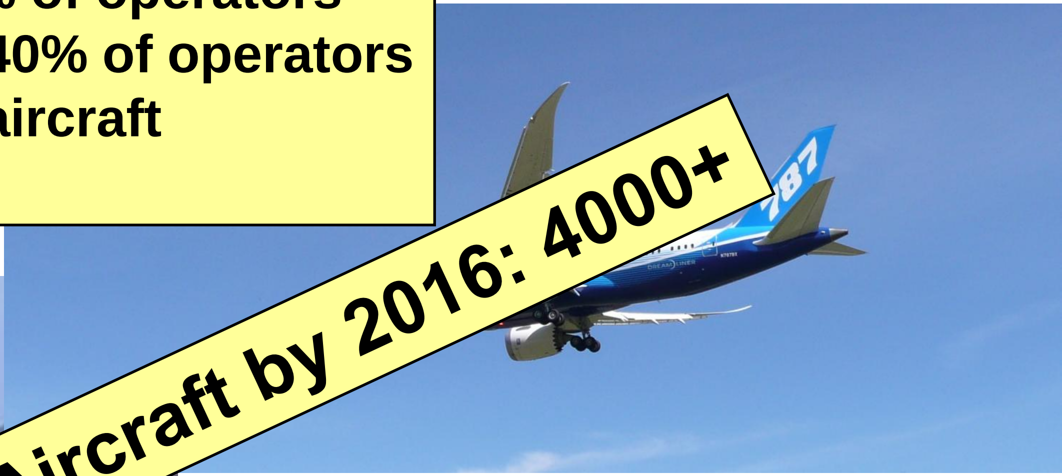
GLS: GBAS Airborne Implementation

737NG: GLS certified,
650 GLS activated = 20% of operators
900 GLS provisioned = 40% of operators
787: GLS certified, basic = 886 aircraft
747-8: GLS certified, basic

A-380: GLS certified, 8 airlines
A-320 family: GLS certified, 8 airlines
A-330/340: GLS certified 2013
A-350: GLS certified at entry into service, 4 airlines

GLS: GBAS Airborne Implementation

737NG: GLS certified,
650 GLS activated = 20% of operators
900 GLS provisioned = 40% of operators
787: GLS certified, basic = 886 aircraft
747-8: GLS certified, basic



GLS Equipped Aircraft by 2016: 4000+

A-380: GLS certified, 8 airlines
A-320 family: GLS certified, 8 airlines
A-330/340: GLS certified 2013
A-350: GLS certified at entry into service, 4 airlines

SmartPath Certification Baseline, Growth

- **SmartPath Cat I System Design Approval**
  - FAA: September 2009
  - BAF (Germany): December 2011
  - CASA (Australia), Spain: Q1 2014
  - Brazil, Korea: Q4 2014
- **Cat II performance from Cat I system**
  - Aircraft and flight operations requirements
  - **Available 2014**
- **Cat III development and validation underway**
  - Minimal or no ground station hardware changes
  - FAA Cat III ground station/avionics contracts to Honeywell 2010
  - Prototype ground station/avionics: 2011
  - Flight testing and additional development: 2012-2015
    - FRA flight tests October 2013
  - **Operationally available ~2017-2018**

SmartPath Summary

- ***Increased airport efficiency:***
  - Eliminates ILS critical zones
  - Enables flexible approaches; synergistic with RNAV/RNP
  - Offers precision approach where ILS cannot due to geography
- ***Lower life-cycle cost:***
  - 26 different precision approaches from a single ground station
  - One SmartPath GBAS serves all runways, initial acquisition cost is lower
  - Lower maintenance cost
  - Lower flight inspection cost
  - Growth to Cat II/III
- ***Increases level of safety:***
  - Signal stability (immune to signal bends inherent in ILS)
  - Precision lateral and vertical guidance
- ***Reduced noise/ shorter routes:***
  - GBAS final approach segment optimizes curved path approaches
  - Lower approach minimums
  - Autoland capability

Regulator

Airlines

Lowers operational cost, and increases schedule reliability

ANSP

Enhances safety, environmental impacts, ATM modernization

Airports

Improves capacity, lowers cost, future proof to CAT III

Value is shared across all stakeholders

Stakeholder Involvement Throughout the Whole Project = Successful Implementation

Regulator

Airlines

Low…
cost,…
sched…

…y,
…nmental
impacts, ATM
modernization

Airports

Improves capacity,
lowers cost, future
proof to CAT III

Action Required

Value is shared across all stakeholders

Stakeholder Involvement Throughout the Whole Project = Successful Implementation

Regulator

Airlines

Low...

...y,
...nmental
impacts, ATM
modernization

Airports

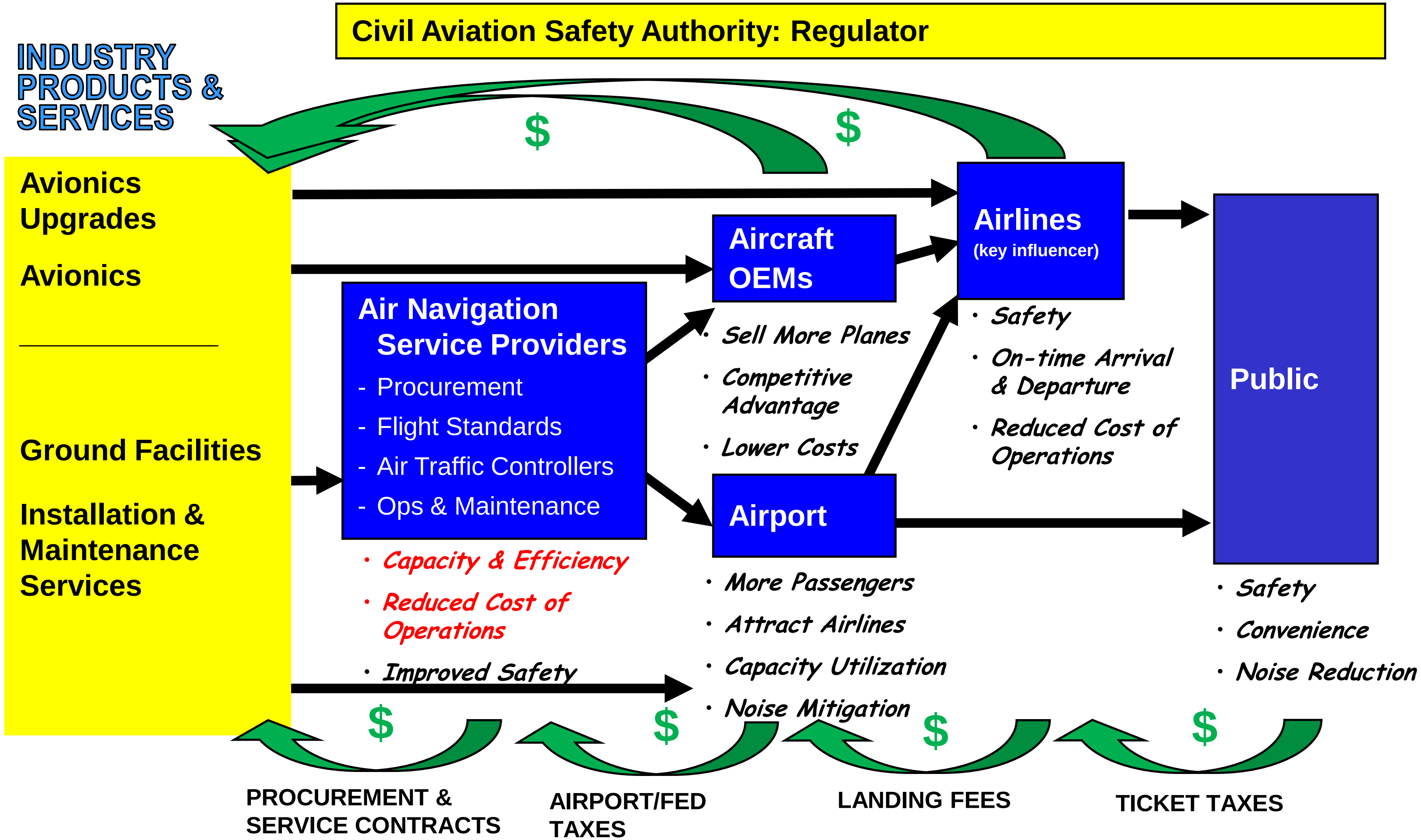
Improves capacity, lowers cost, future proof to CAT III

Leadership Required

Value is shared across all stakeholders

Stakeholder Involvement Throughout the Whole Project = Successful Implementation

Business Case Value Chain

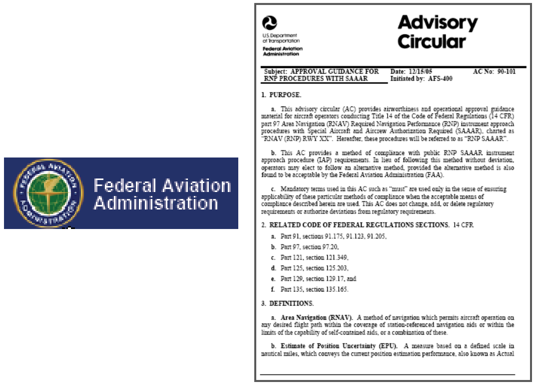


The Honeywell - Hughes Team: PBN Planning & Deployment Experts

Aircraft & Airside Equipage

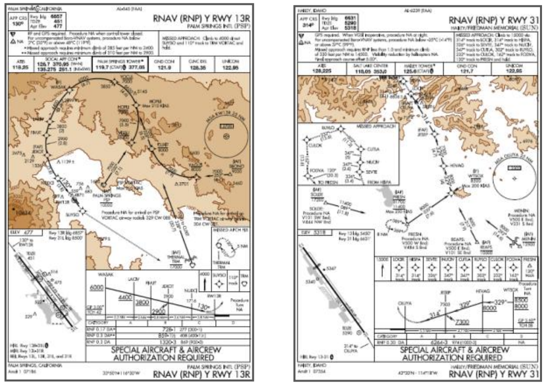
- Honeywell Equipment
  - GBAS Systems
  - FMS software upgrades to bring low RNP capability to most Honeywell equipped aircraft
  - Inertial Reference Units
  - WAAS GPS Receivers
  - Display Systems
  - EGPWS
  - MMR/INR Units

Operational Approval



- Consultancy Services
  - Operational approval preparation and submittal package for AC90-101 or AMC 20-26
  - Crew/ATC Training Services
  - PBN Roadmap Development
  - Obstacle Surveys
  - Environmental Impact Surveys
  - Efficiency / Fuel Saving Programs

RNP Operations



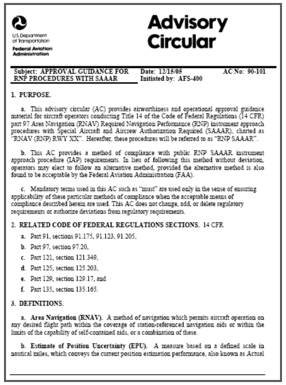
- Procedure Development and Database Validation
  - RNAV, RNP, RNP AR, WAAS LPV, GBAS GLS Procedure Design
  - Validation of all public RNP AR procedures & validation every 28 day cycle. 540 day procedure revalidations.
  - Flight, Obstacle and Simulator Validation for Air Carrier, Business and Helicopter Flight Operations.

The Honeywell - Hughes Team:
PBN Planning & Deployment Experts

Aircraft & Airside Equipage

Operational Approval

Federal Aviation Administration

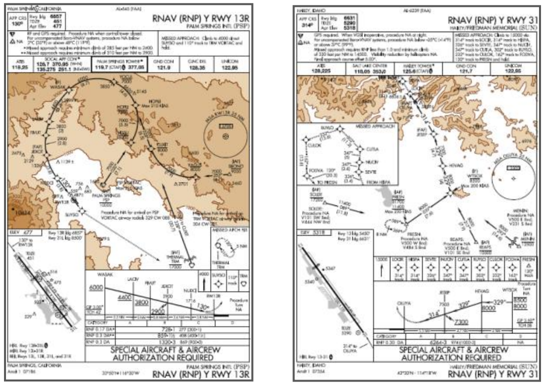

Advisory Circular

1. PURPOSE.

2. RELATED CODE OF FEDERAL REGULATIONS SECTIONS.

3. DEFINITIONS.

RNP Operations



Flexible, Low-risk SmartPath Implementation Programs Available Now

- **GBAS Systems**
- FMS software upgrades to bring low RNP capability to most Honeywell equipped aircraft
- Inertial Reference Units
- WAAS GPS Receivers
- Display Systems
- EGPWS
- MMR/INR Units

- Operational approval preparation and submittal package for AC90-101 or AMC 20-26
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- **PBN Roadmap Development**
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Database Validation

- **RNAV, RNP, RNP AR, WAAS LPV, GBAS GLS Procedure Design**
- Validation of all public RNP AR procedures & validation every 28 day cycle. 540 day procedure revalidations.
- Flight, Obstacle and Simulator Validation for Air Carrier, Business and Helicopter Flight Operations.

Questions?

Honeywell