Reduction of aircraft noise sources

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Outline

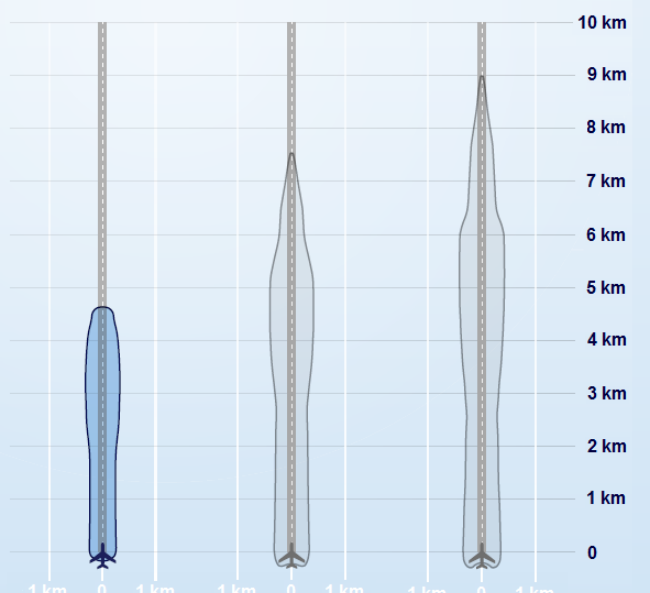
NEW TECHNOLOGIES THAT MAKE NEW AIRCRAFT QUIETER

NEW TECHNOLOGIES THAT MAKE EXISTING AIRCRAFT QUIETER

CONCLUSIONS

NEW TECHNOLOGIES THAT MAKE *NEW* AIRCRAFT QUIETER

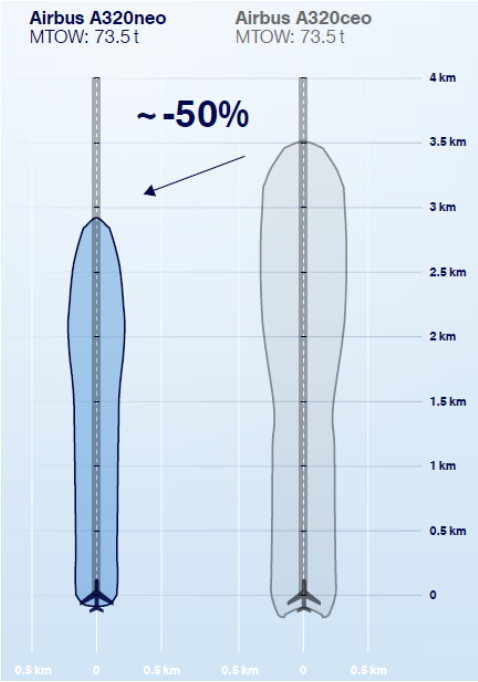
New aircraft generation with latest technologies shows significantly smaller noise contours – Airbus A350-900



The 85 dB(A) maximum noise level contours are shown for a takeoff with Lufthansa standard takeoff procedures and maximum takeoff weight (MTOW).
(Contours provided by Airbus)

- The Airbus A350-900 has an approximately **40 - 50% smaller noise contour** compared with the Airbus A340.
- Besides noise the A350-900 consumes **25% less fuel** compared to its predecessors.
- Lufthansa Group has placed a firm order for 25 A350-900.

New aircraft generation with latest technologies shows significantly smaller noise contours – Airbus A320neo



The 85 dB(A) maximum noise level contours are shown for a takeoff with Lufthansa standard takeoff procedures and maximum takeoff weight (MTOW).

Contours provided by Airbus

- The Airbus A320neo (new engine option) has an approximately **50% smaller noise contour** compared to previous Airbus A320's.
- Besides noise the A320neo consumes **15% less fuel** compared to its predecessors.
- Lufthansa Group has placed a firm order for 116 aircraft of the A320neo – series.

Airbus A320neo : new technologies – geared turbo fan

- In JAN 2016 Lufthansa took delivery of the first Airbus A320neo.
- More than a decade of research and development have now lead to the first engine for Airbus A320 with geared turbo fan technology that allows turbine and fan running at different optimized speeds.

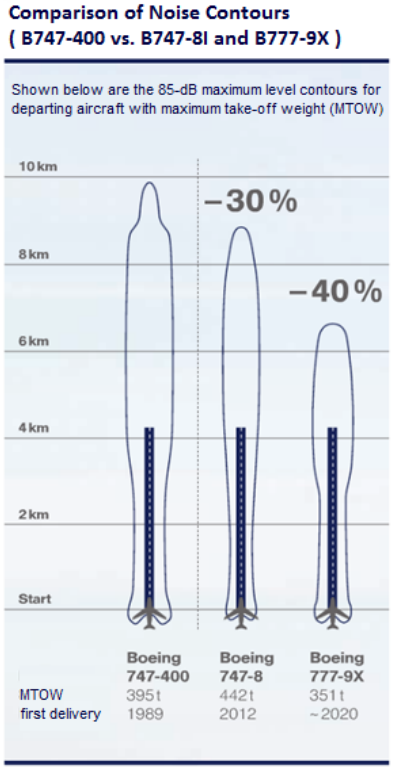
- **larger fan diameter:**

  → larger, but slower mass flow
  → less jet noise, less fuel
  → larger by-pass ratio
  → better shielding of hot stream

- **slower fan speed:**

  → slower speeds at fan blade tips eliminating buzz saw noise
  → less engine inlet noise

Long haul aircraft: significant reduction of noise contours



Contours provided by Boeing

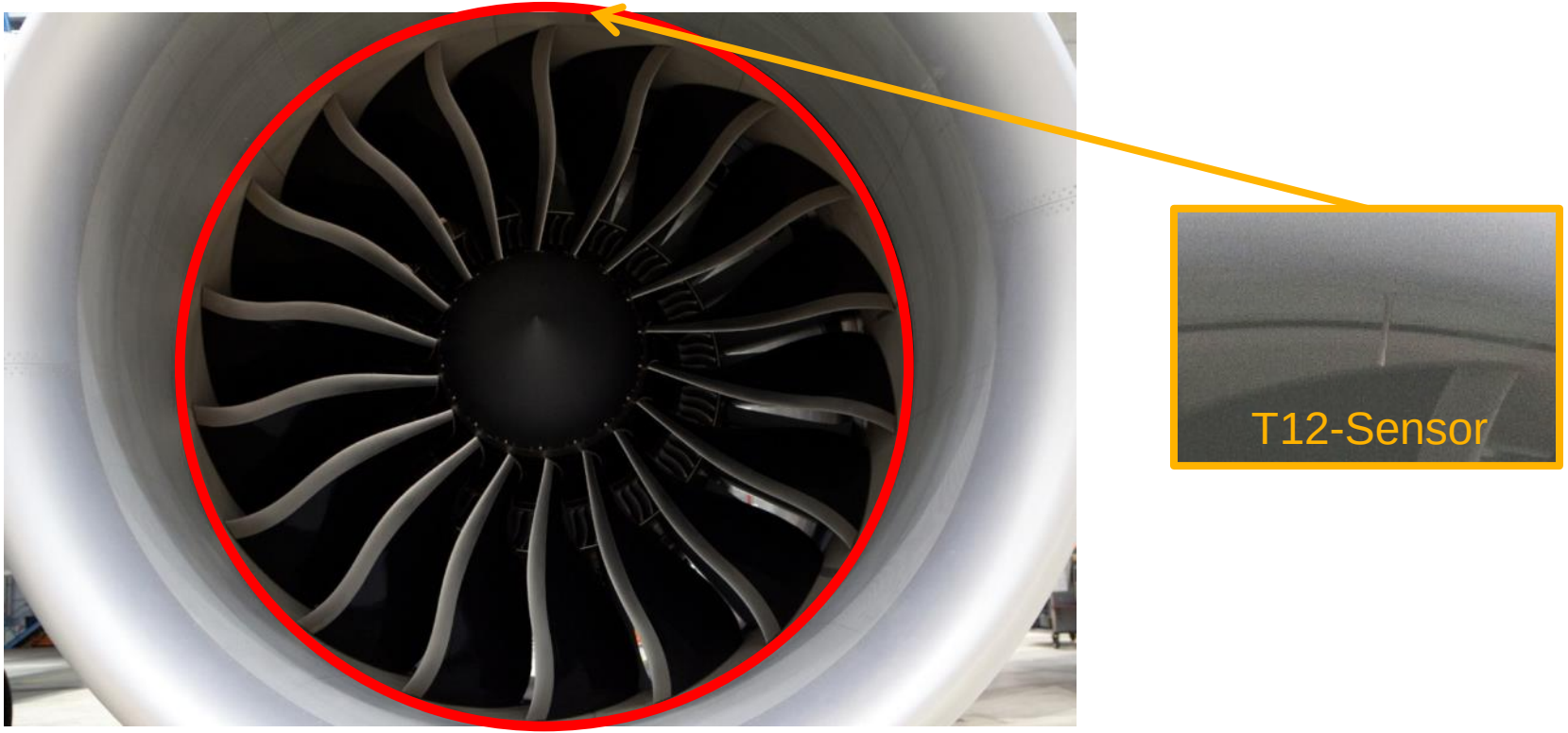
- Significant reduction of noise contours by 30-40% compared to B747-400.
- B747-8I replaced part of the B747-400 fleet since 2012.
- From 2020 on the remaining B747-400 will be replaced by B777-9X.

B747-8I - engine exhaust nozzle: modified edges (Chevrons) reduce jet noise

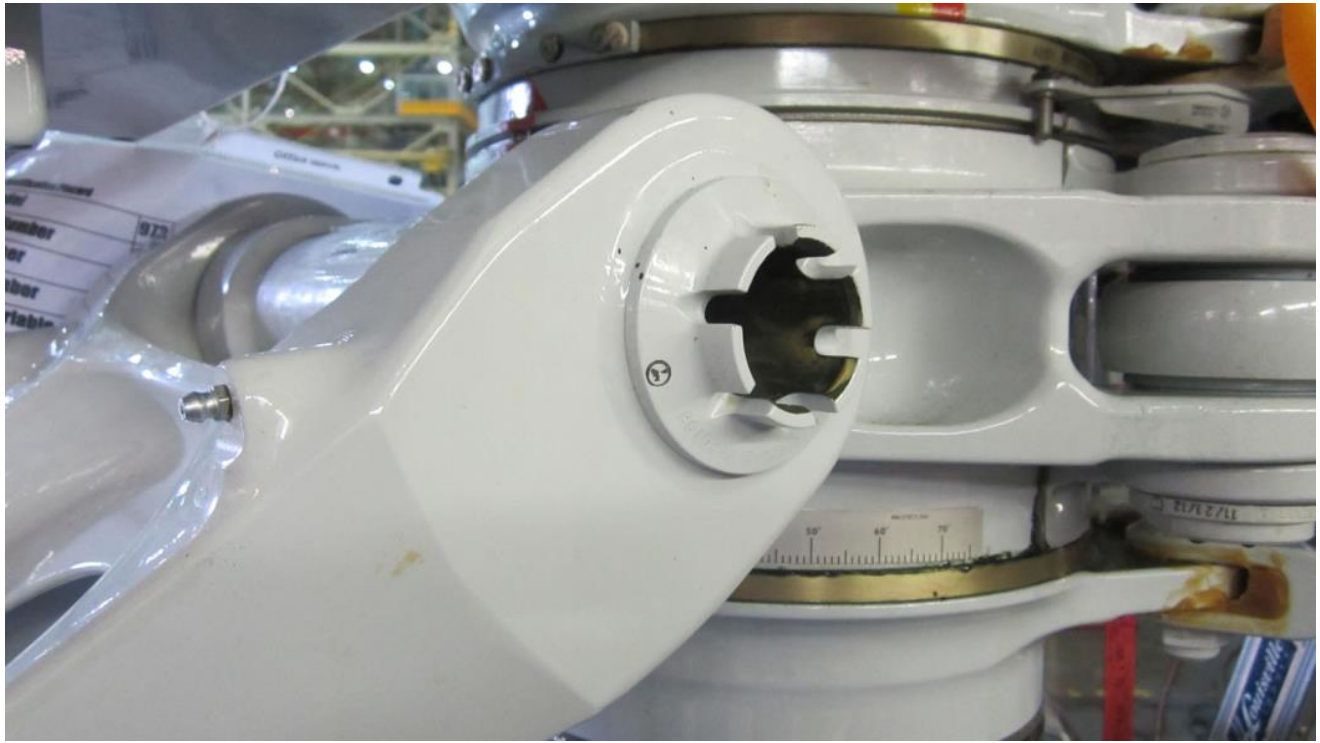
- DLH/DLR 2001 – chevron nozzle tested on CFM56-5A-engine:
  Departure: Reduction of jet noise by ~1dB

- Boeing 747-8I: new GEnx-2B67 engines are equipped with two chevron nozzles: hot stream and cold stream which contribute to significant noise reduction at departure.

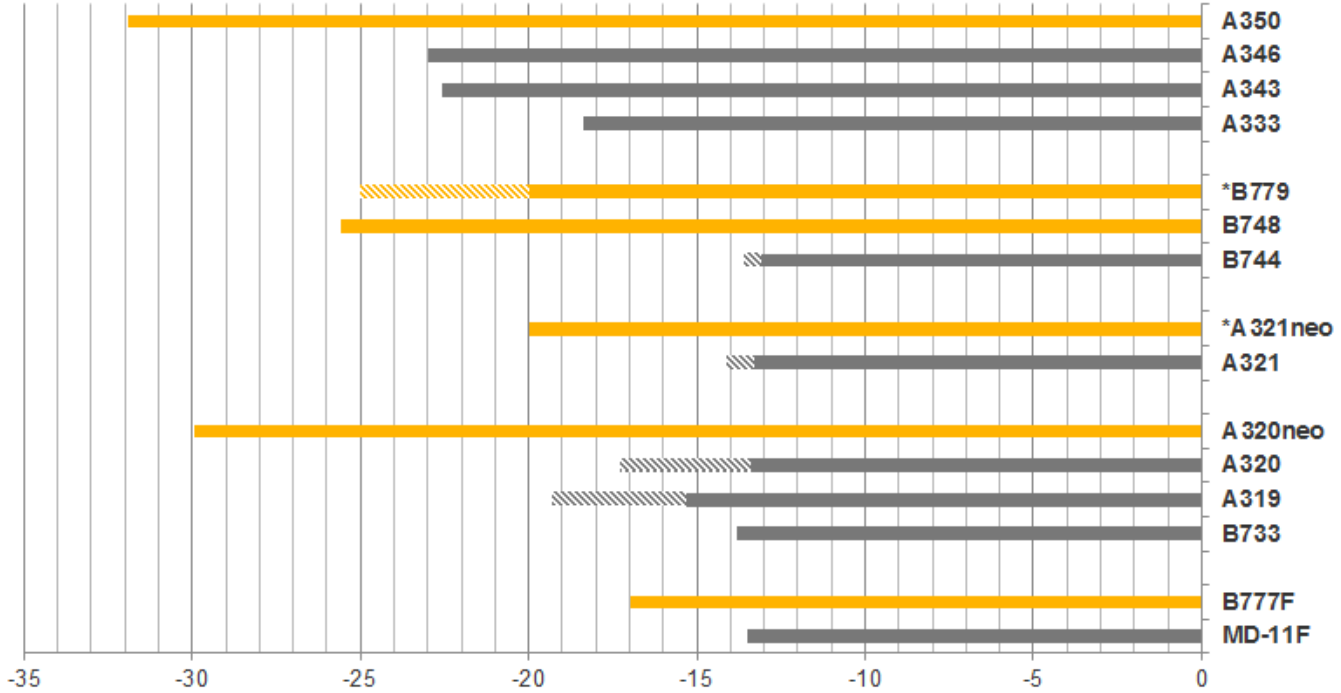
B747-8I - engine: new 'acoustic liners' without splices and T12-Sensor mounted at larger distance to the fan reduce noise of GEnx-2B engine inlet



B747-8I - nose landing gear:
'castellated edges' of hollow bolt are cutting tones



Noise certification values of Lufthansa Group aircraft fall significantly below the limits of the ICAO chapter 3 standard



* manufacturer‘s target values / estimated range; noise certificates pending

NEW TECHNOLOGIES THAT MAKE *EXISTING* AIRCRAFT QUIETER

Investigating modifications of CF6-80-engine (MD-11F) /1

- Fan running at high speeds is producing strong tones at departure.
- Two modifications of acoustic panels to reduce fan tones have been developed and successfully tested at Lufthansa Technik's engine test cell in HAM.
- Therefore fly over noise measurements were conducted to test modified panels under real flight conditions.

modified engine inlet

top → down: two modifications (100% and 50% hardwall) and OEM panels

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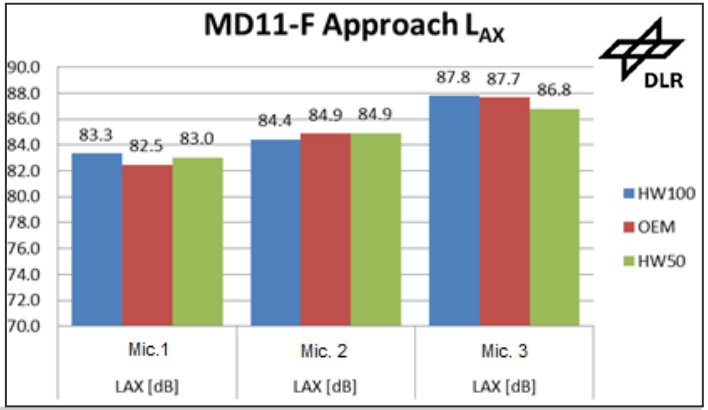
Investigating modifications of CF6-80-engine (MD-11F) /2

- Flyover measurements were performed at Cochstedt Airport in June 2015.
- Three Lufthansa Cargo MD11F were equipped with different acoustic panels.

- 24 flights per aircraft have been recorded by DLR.
- Results show no difference between different acoustic panels with respect to the uncertainty of measurements.
- No clear indication that modified panels are quieter.



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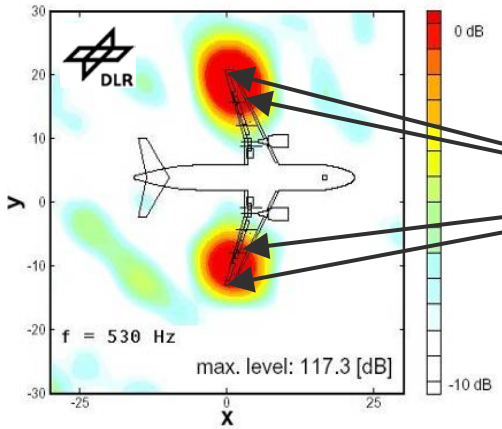
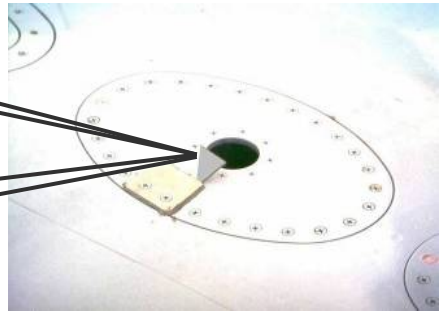
Lufthansa Airbus A320 family: vortex generators /1

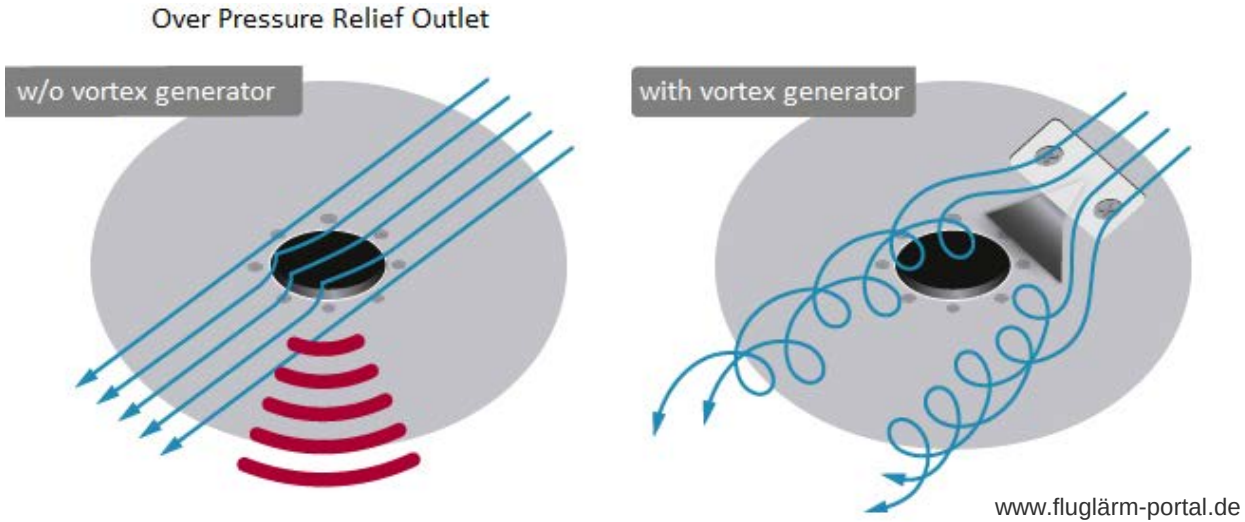
- Over pressure relief outlets at the lower wings surface generate two distinct tones at ~530 und 580 Hz.
- Prototype-vortex generators successfully tested by LH and DLR.





Lufthansa Airbus A320 family: vortex generators /2

- Air that is passing over the over-pressure relief outlet produces a whistling noise in the same way as air that is blown across an open bottle.
- The new device mounted upstream in front of the outlet is generating two vortices that are lifting up the air disturbing the flow that reaches the edge of the cavity.



www.fluglärm-portal.de

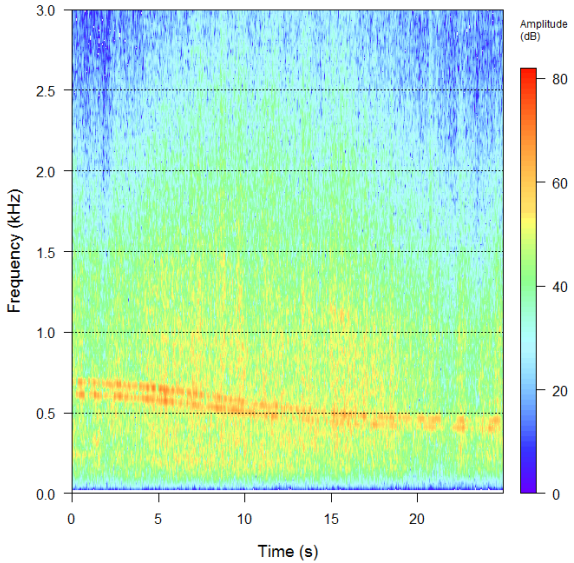
Lufthansa Airbus A320 family: vortex generators /3

- Spring 2014: Airbus delivered first new A320 equipped with vortex generator to Lufthansa.
- Autumn 2014: Start of retrofit of existing fleet.
- In the future roughly 200 LH-aircraft will be quieter by up to 4 dB between 10-17 km before touch down.
- At larger distances the effect is even greater (up to 9 dB) according to Airbus data.

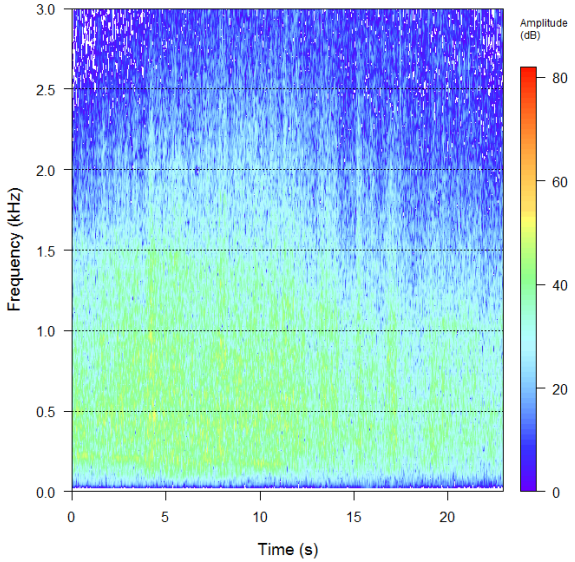
Lufthansa Airbus A320 family: vortex generators /4

- Measurements of airport noise monitoring station proved, that vortex generators cut carateristic tones between 500 und 600 Hz.

Without:



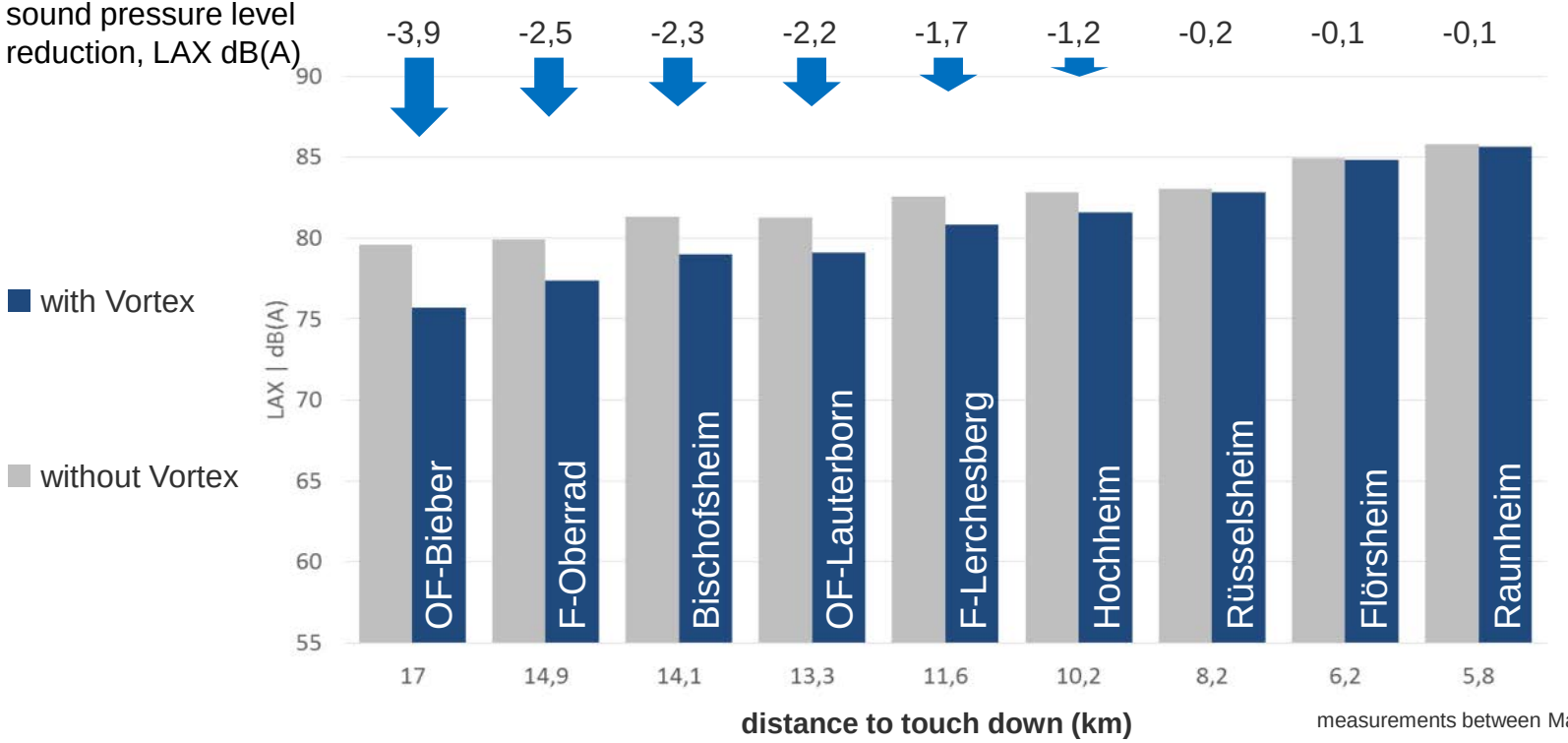
With:



Graphics. Fraport AG

Lufthansa Airbus A320 family: vortex generators /5

sound pressure level reduction, LAX dB(A)

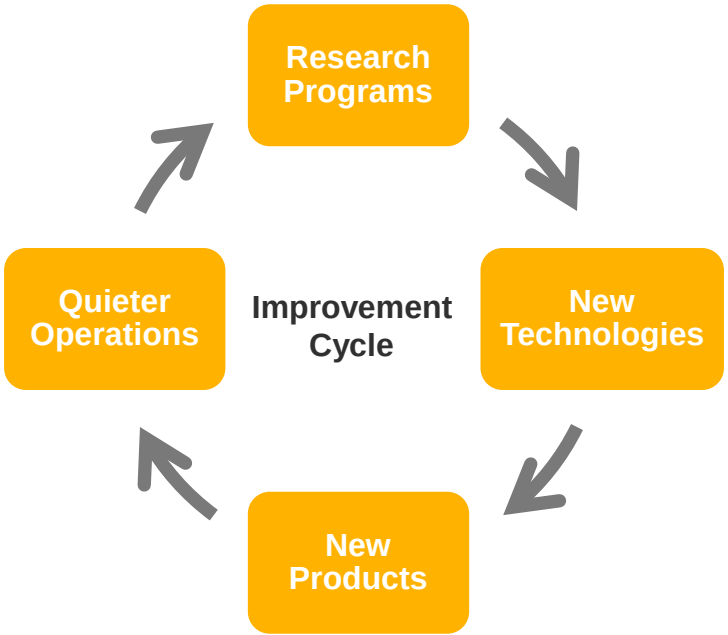


measurements between Mar 2014 – Feb 2015

Source: Fraport AG

Conclusions

- Intensive research and development leads to quieter technologies for both airframe and engine.
- Specific noise per aircraft has been reduced significantly over decades.
- Larger steps have been made in engine technology.
- Reducing airframe noise remains a key challenge for quieter approaches.
- Continuous research activities needed in order to keep the improvement cycle running.
- Surprises are still possible: negative, but positive too.




THANK YOU!