PREDICTIONS ON FUTURE NOISE DEVELOPMENT: RELEVANCE OF ACTIVE NOISE ABATEMENT AT THE SOURCE

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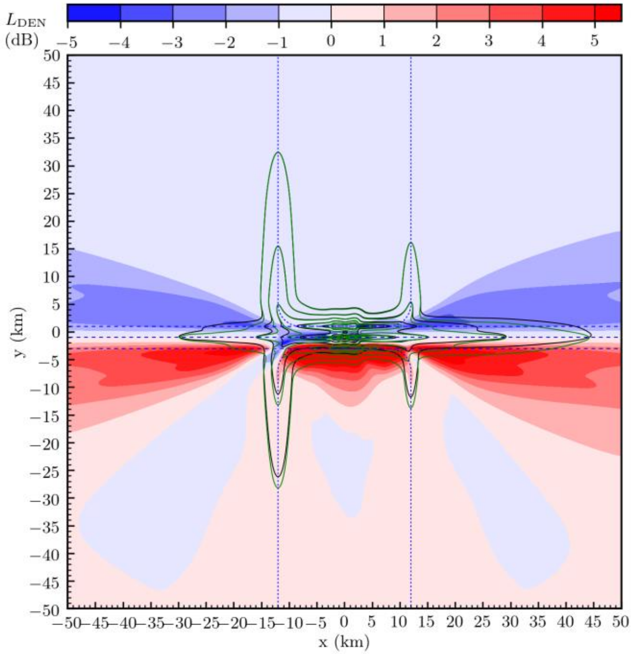
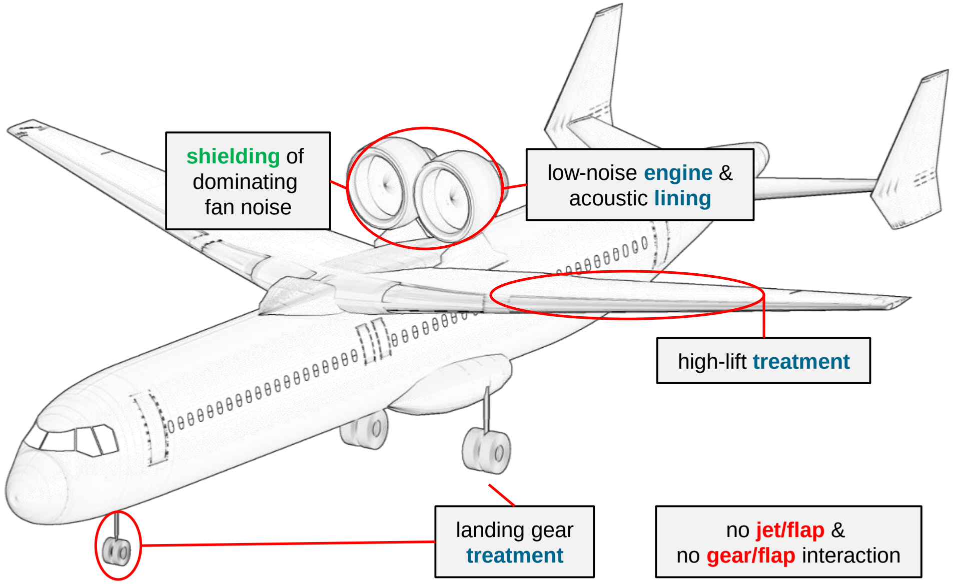
DLR

Overview

Part 1: Noise Development at typical German Airports: Results from the DLR-Project FLUID-21



Part 2: Relevance of Active Noise Abatement at the Source

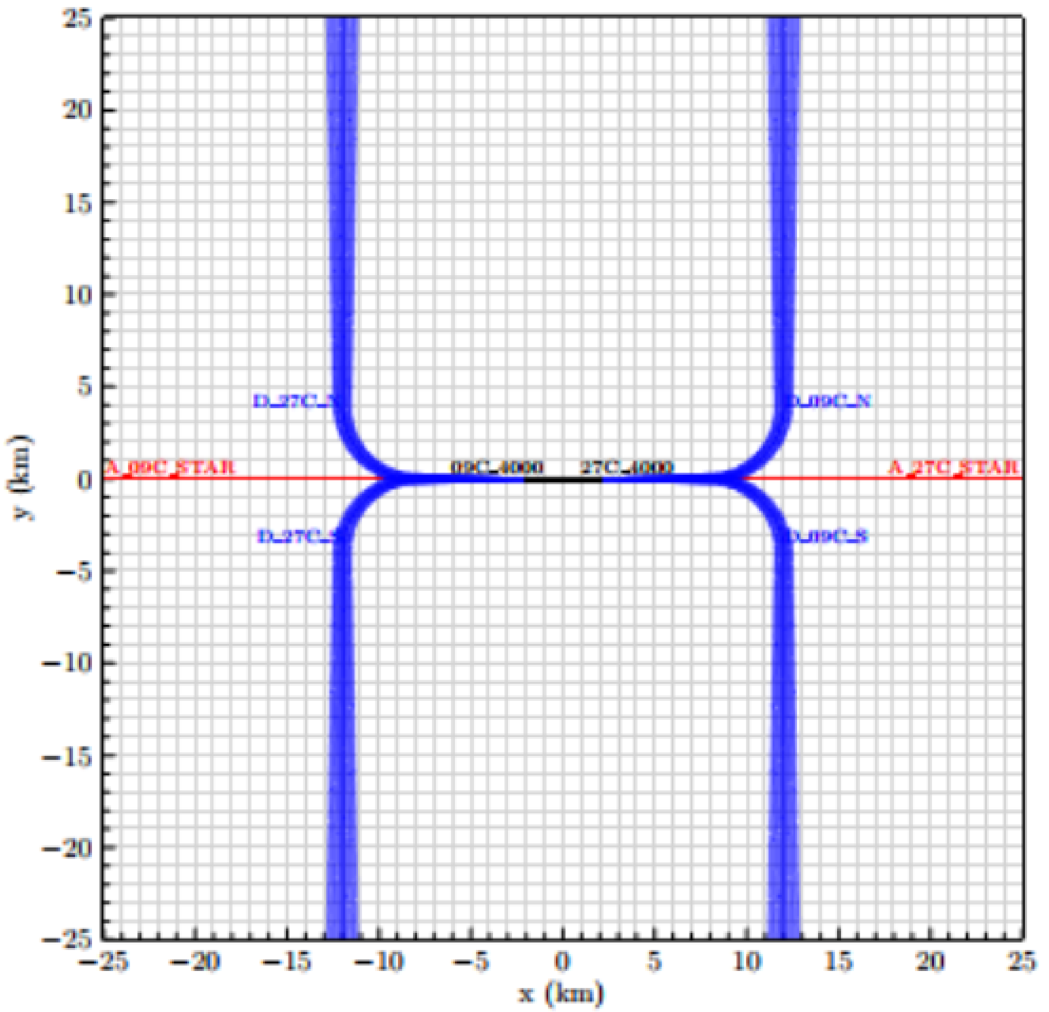


Noise Development at typical German Airports

DLR

design of FLUID-21 study

- 3 generic, for Germany representative airports:
  - **Single Runway Airport**
  - Parallel Runway Airport
  - Expansion to three Runway Airport
- forecast of air traffic up to year 2050
- noise calculation based on proposed AzB21 aircraft groups
- analysis of A-weighted continuous sound pressure levels



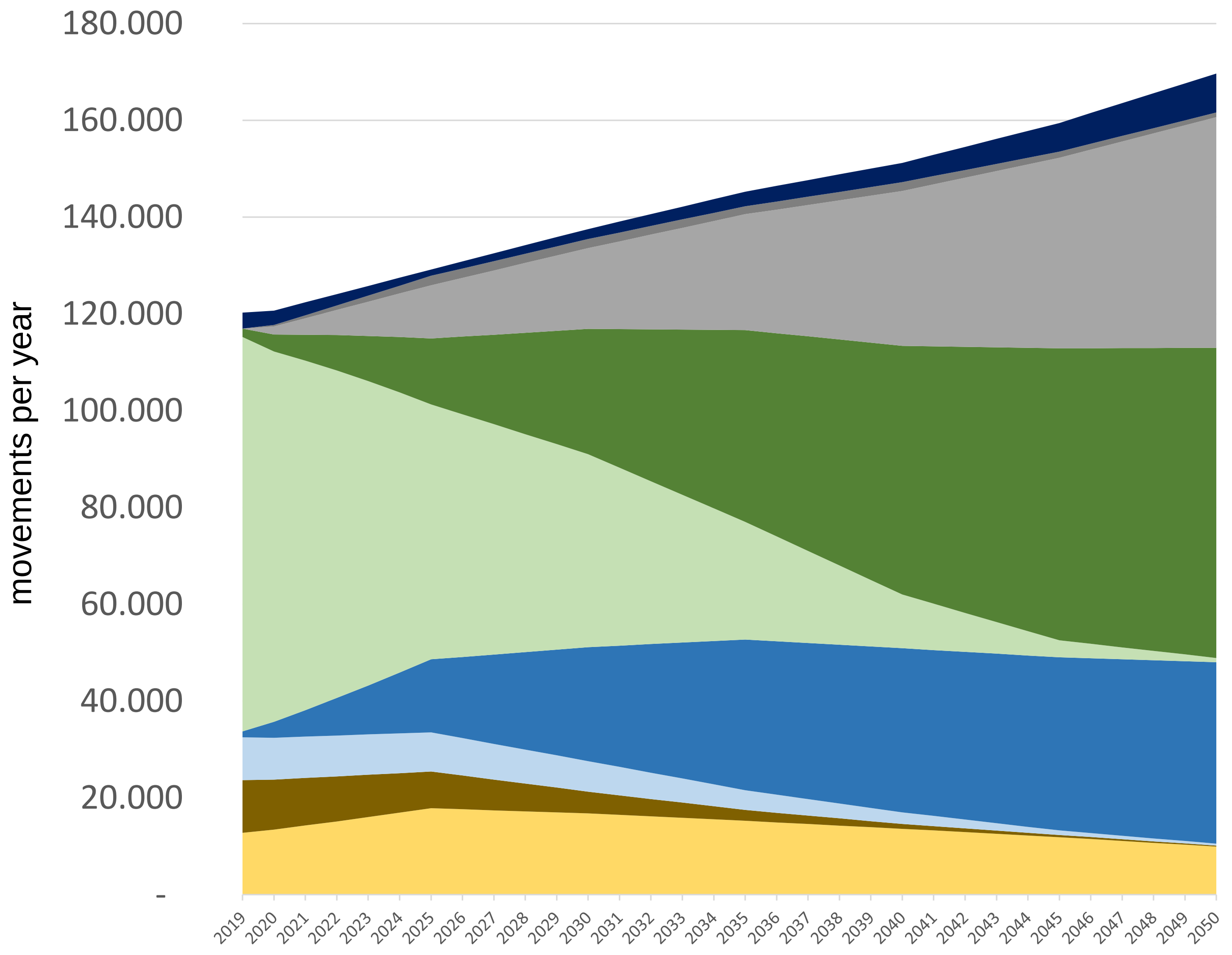
Route and runway system of the generic Single Runway Airport

Noise Development at typical German Airports

Development of Movements at the Single Runway Airport

aircraft groups

- aircraft over 320 MTOW
- modern two engine jets up to 320 MTOW
- modern two engine jets up to 130 MTOW
- older two engine jets up to 130 MTOW
- modern engine jets up to 70 MTOW
- older engine jets up to 70 MTOW
- older engine jets up to 50 MTOW
- propeller aircraft
- other



source: Wolfgang Grimme, DLR FW-LOE

Noise Development at typical German Airports

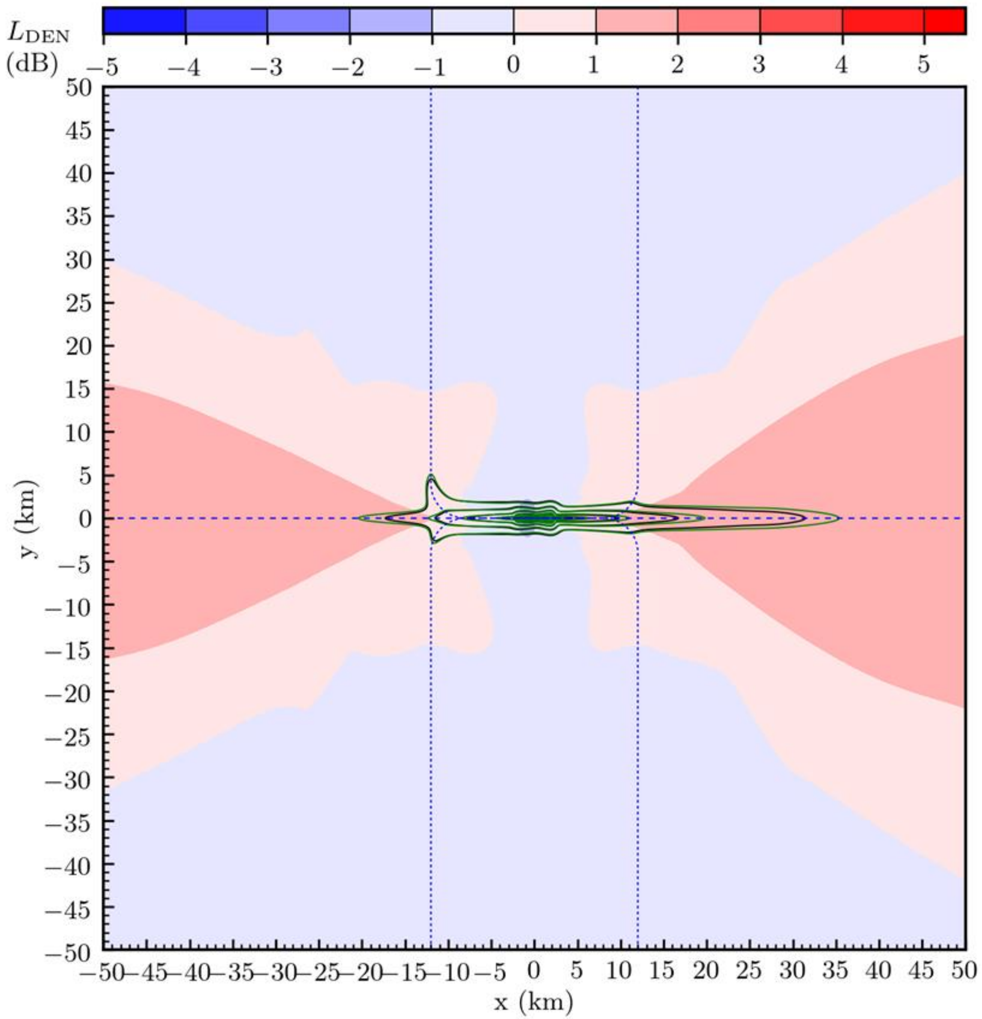
Development of Noise at the Single Runway Airport

areas with slight noise increase:

- overflights under landing conditions
  - bigger aircraft
    => higher aerodynamic noise sources

areas with slight noise decrease:

- overflights under takeoff conditions
  - quieter engines
    => engines are the dominant noise source at takeoff



Noise contours L_{DEN} and change of noise levels form 2019 to 2050 at the Single Runway Airport

Noise Development at typical German Airports

Development of Noise at the Single Runway Airport

no significant change in noise contour areas

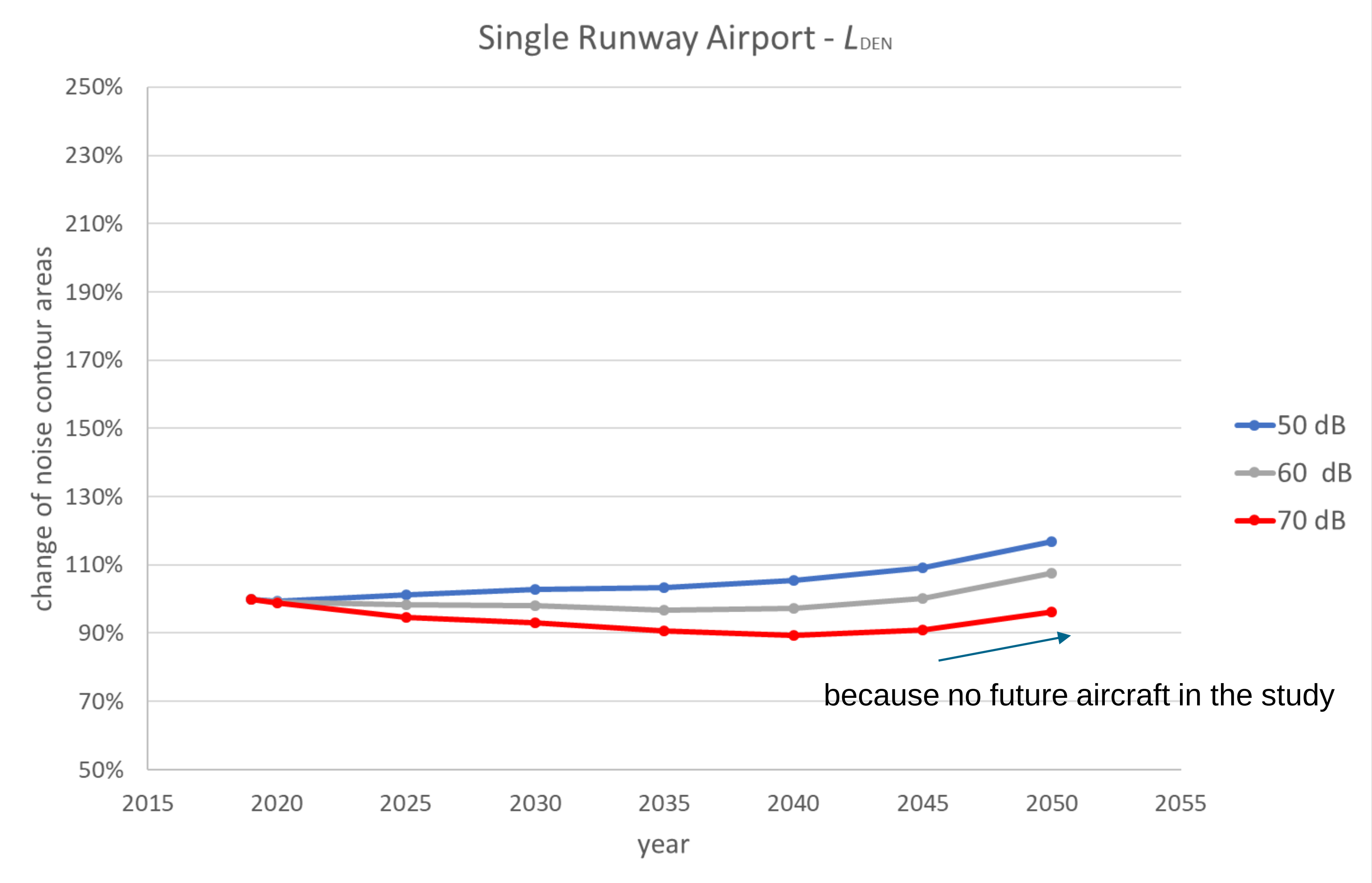
in this case:

- **at higher noise levels**

=> slight noise decrease

- **at lower noise levels**

=> slight noise increase



Noise Development at typical German Airports

Development of Movements at the Single Runway Airport - Frozen Technology

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- aircraft over 320 MTOW
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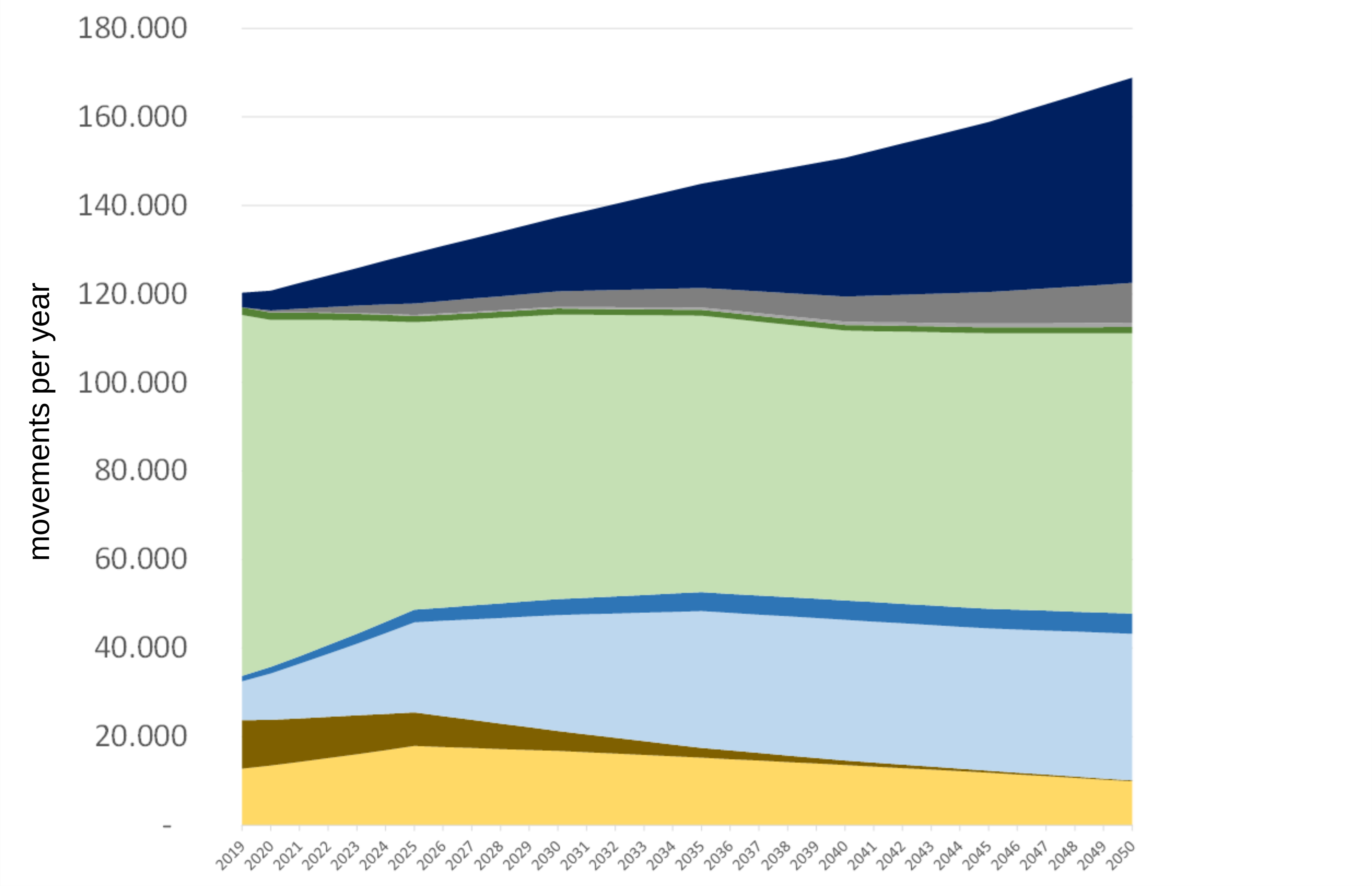
- other



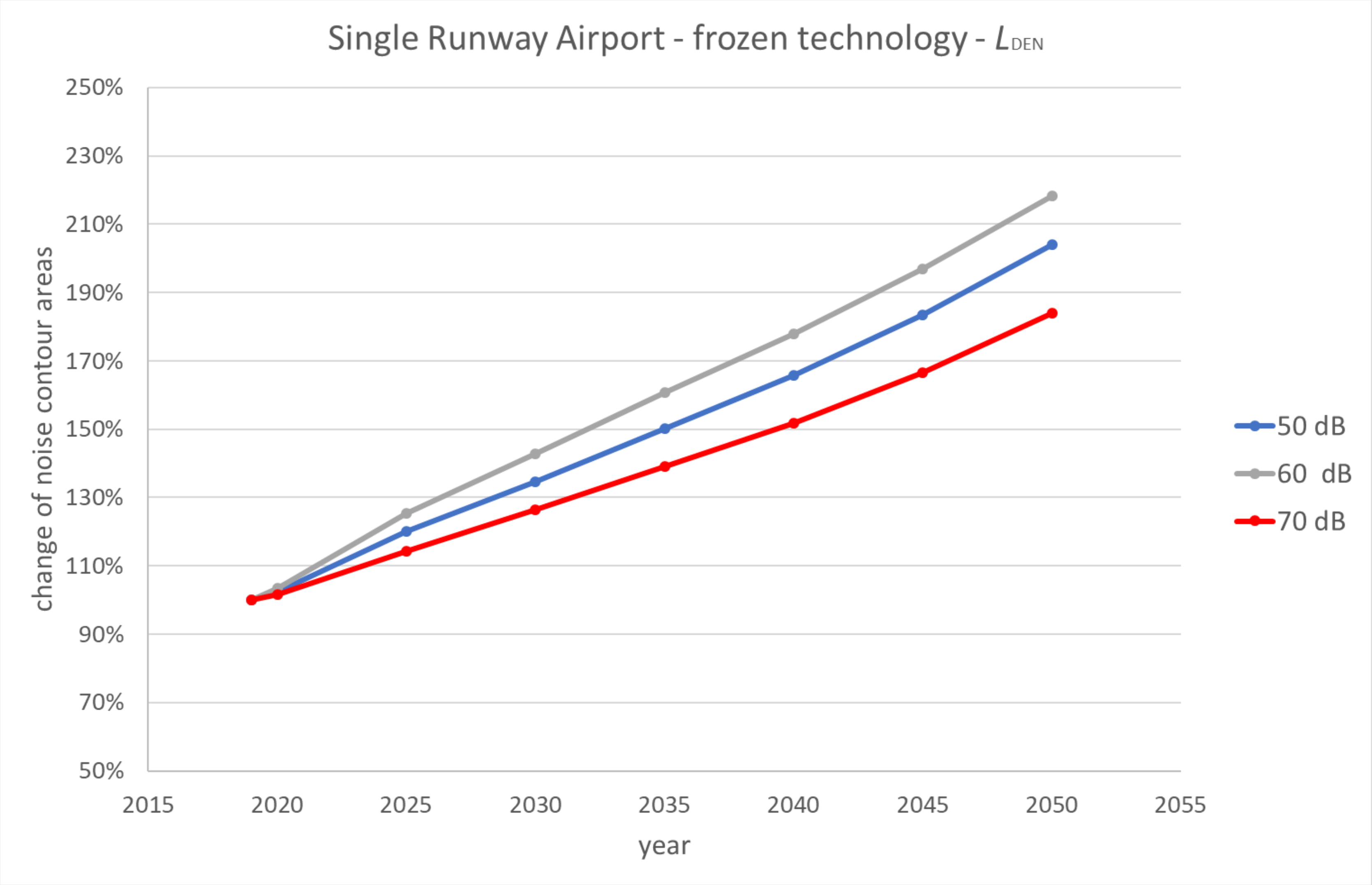
source: Wolfgang Grimme, DLR FW-LOE

Noise Development at typical German Airports

Development of Noise at the Single Runway Airport - Frozen Technology

important result:

progress in technology development is the main reason why noise contours at airports will not increase in the future



Noise Development at typical German Airports

Development of Movements at the Single Runway Airport - Frozen Movements

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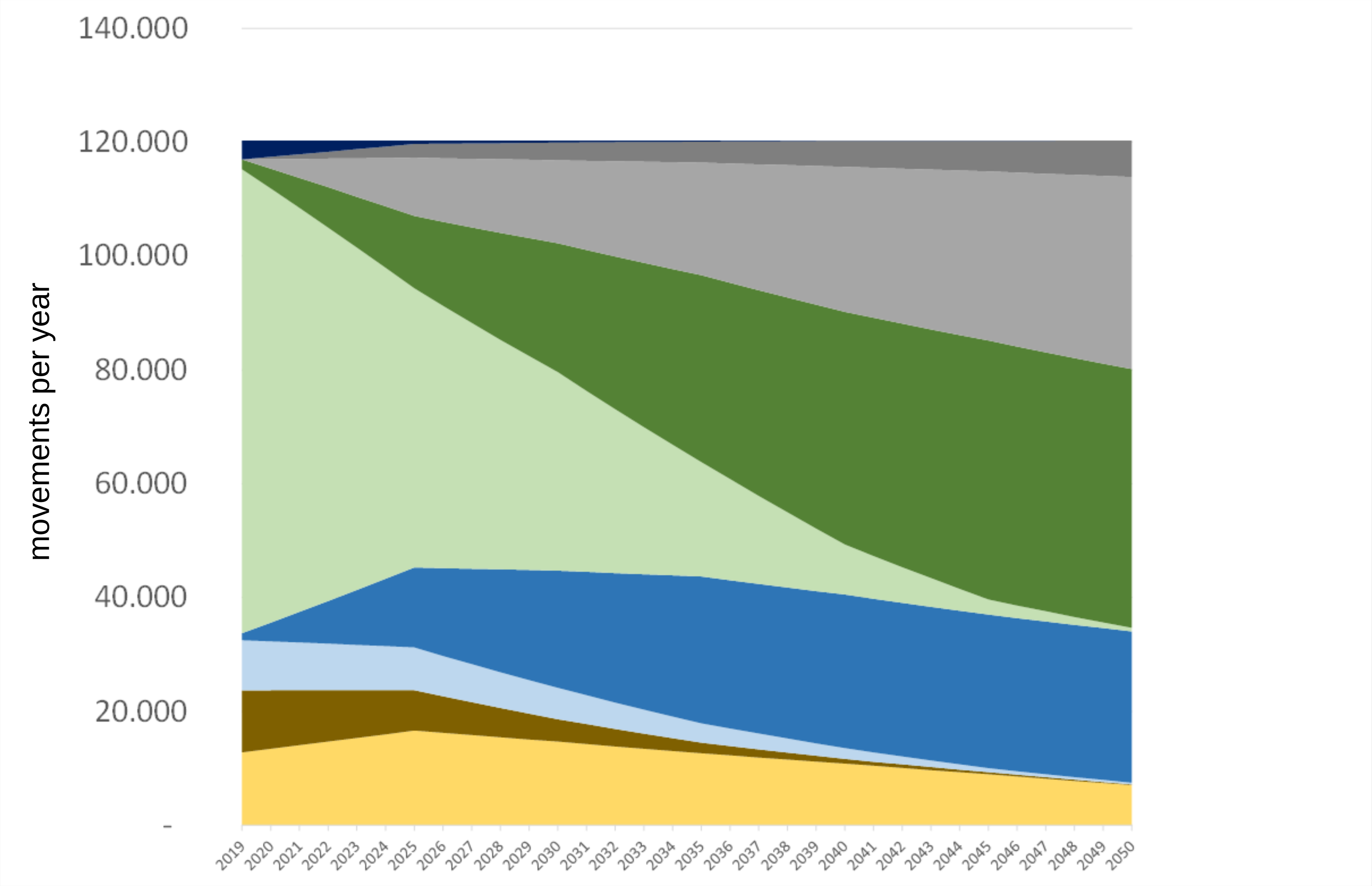
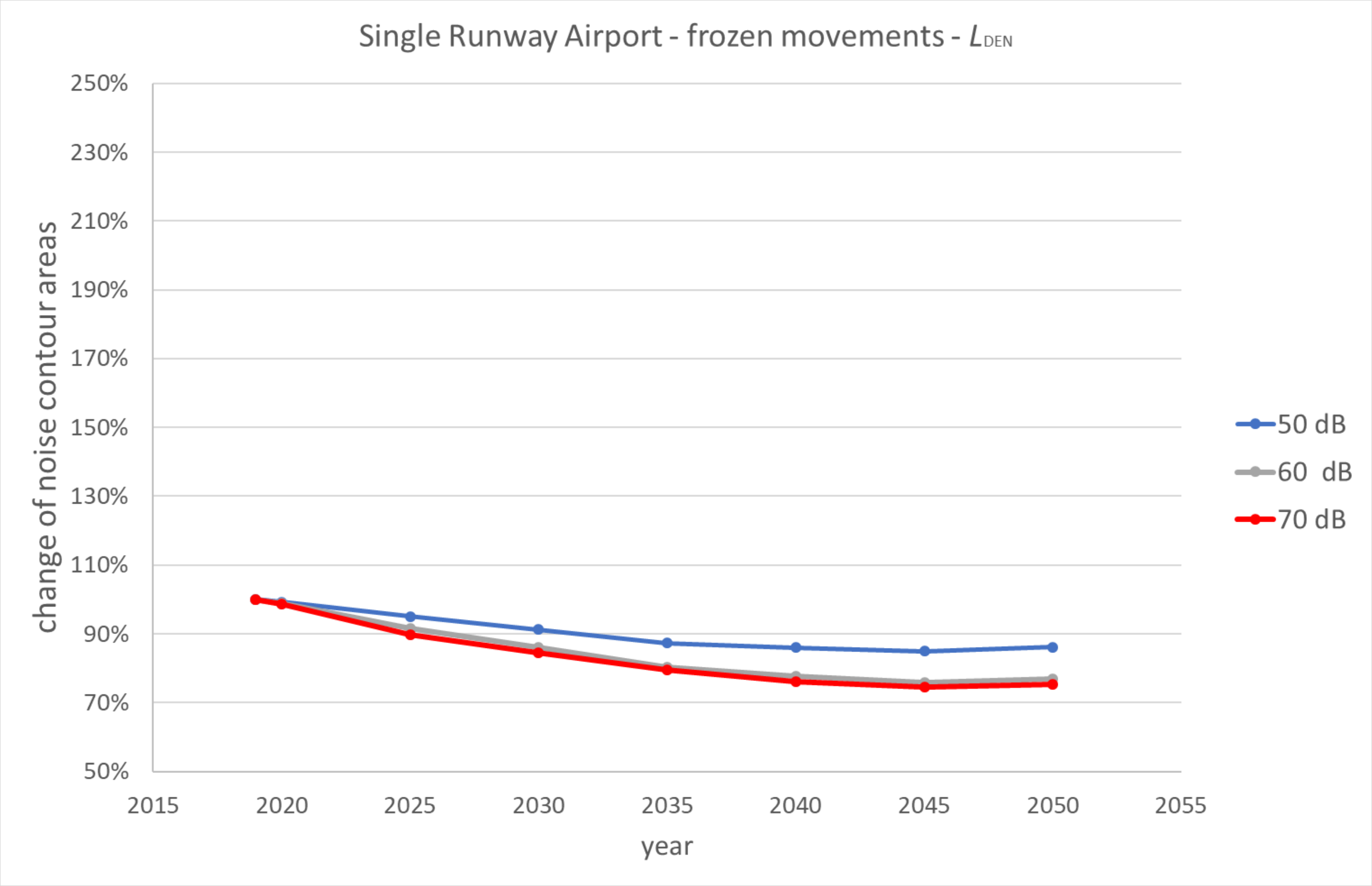


source: Wolfgang Grimme, DLR FW-LOE

Noise Development at typical German Airports

Development of Noise at the Single Runway Airport - Frozen Movements

only slightly smaller contour areas if there is no development of movements



Noise Development at typical German Airports

Development of Movements at the Single Runway Airport - Frozen max. Weight

aircraft groups

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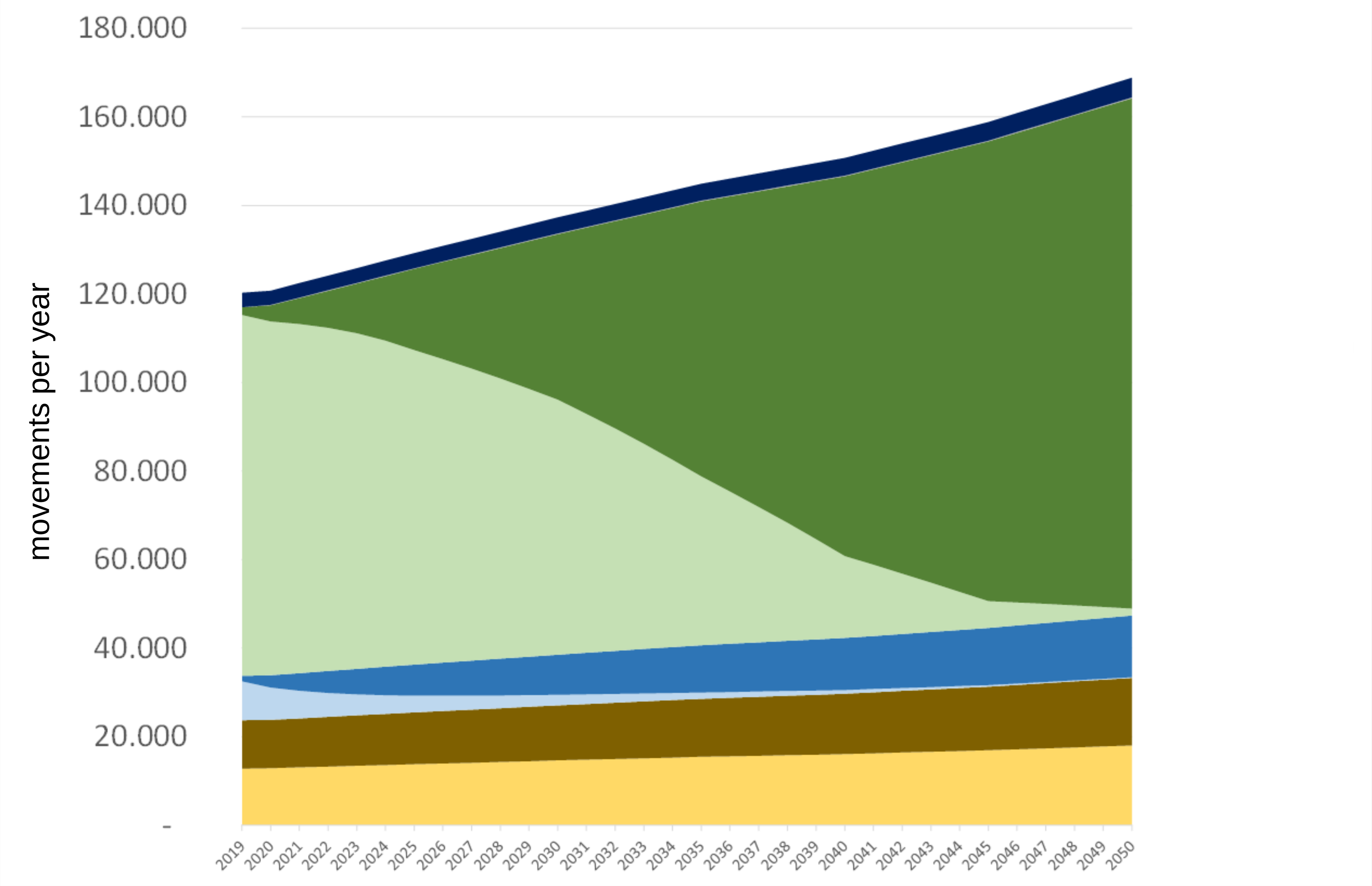


source: Wolfgang Grimme, DLR FW-LOE

Noise Development at typical German Airports

Development of Noise at the Single Runway Airport - Frozen max. Weight

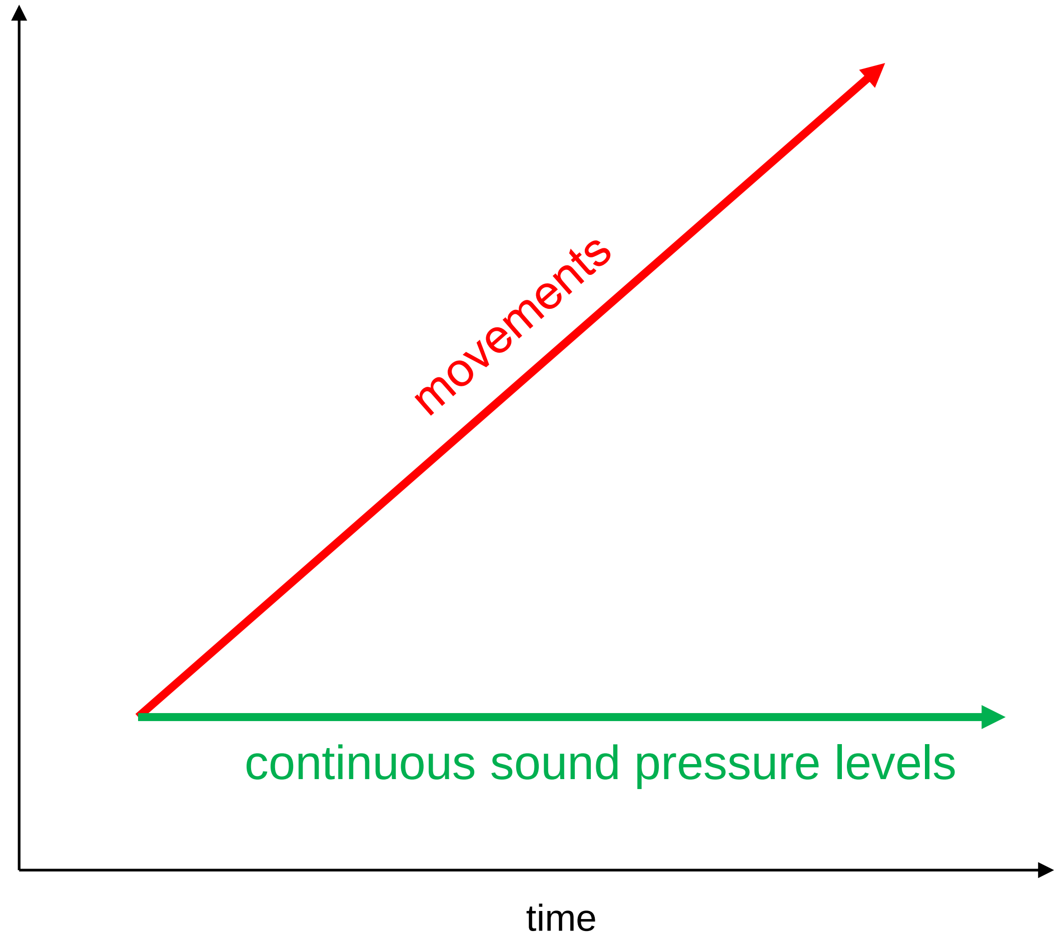
only slightly smaller contour areas if there is no development of max. weight

Noise Development at typical German Airports

Results from DLR-Project FLUID-21

outlook:

- continuous sound pressure levels will remain at a comparable level
- overflights under landing conditions will become a bigger problem
- limits of movements or max. weight show only negligible improvements with respect to continuous sound pressure levels
  – they could even be counterproductive if such a limit stops the introduction of new aircraft
- **best noise protection is the development of quieter aircraft and mandatory policies saying that these aircraft must be used**



Overview

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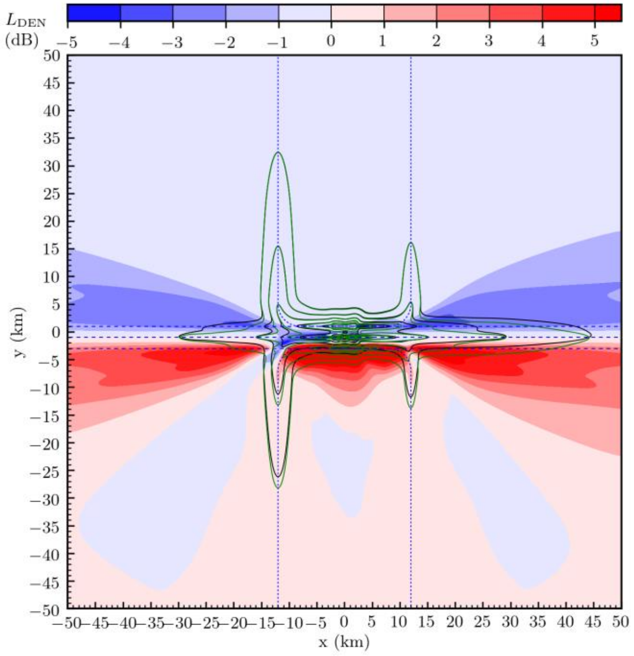
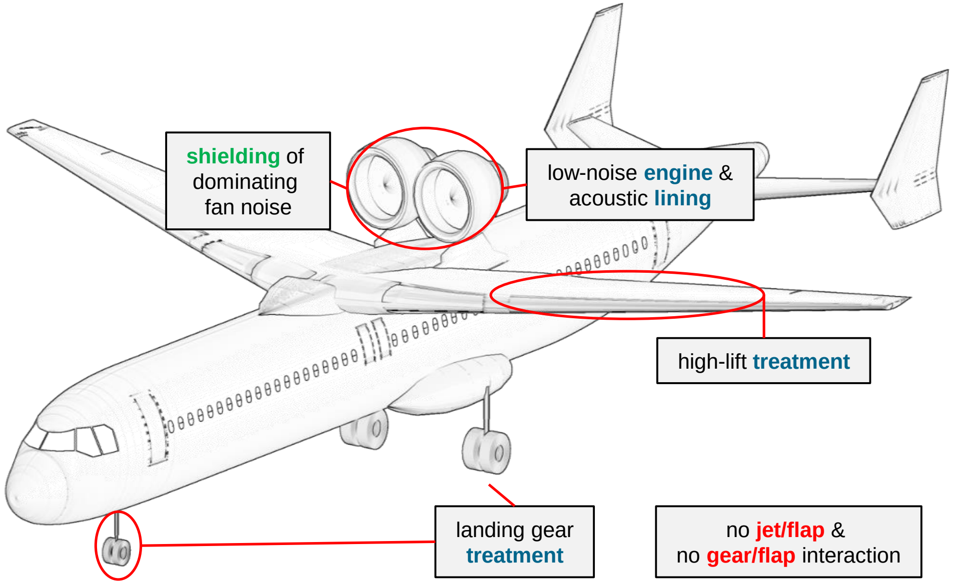


Part 2: Relevance of Active Noise Abatement at the Source

Operational Solutions



Relevance of Active Noise Abatement at the Source

Horizontal Flight Optimization

goal: minimizing the noise impact on the population

- individual local adjustments
    - taking into account fuel consumption

departure

- not always easy to translate orders into FMS
    - necessary to check flight results

for most routes none or no major improvements expected

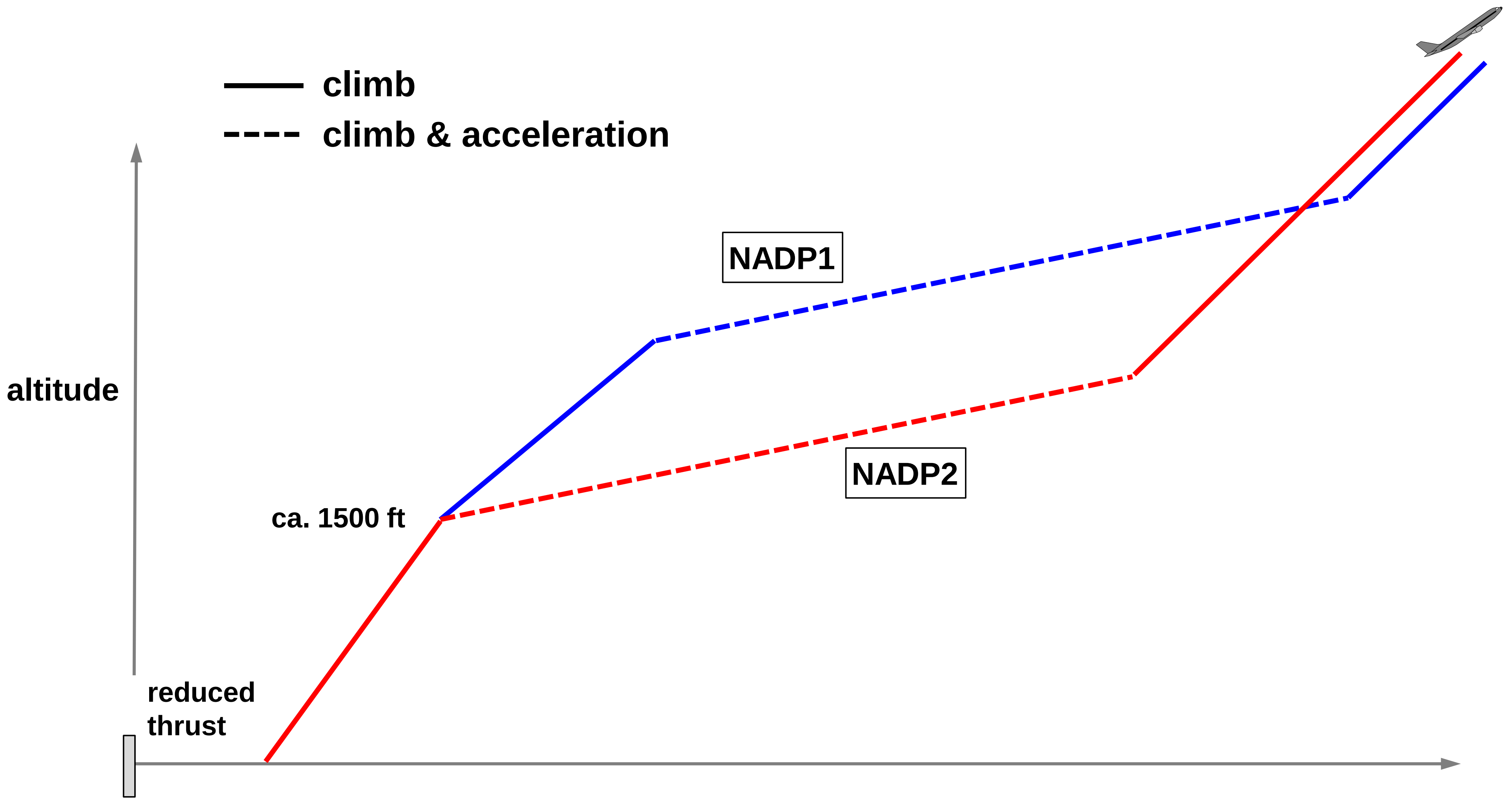
approach

- advanced 4D-routing systems necessary

curved approaches promise noise reduction for the population

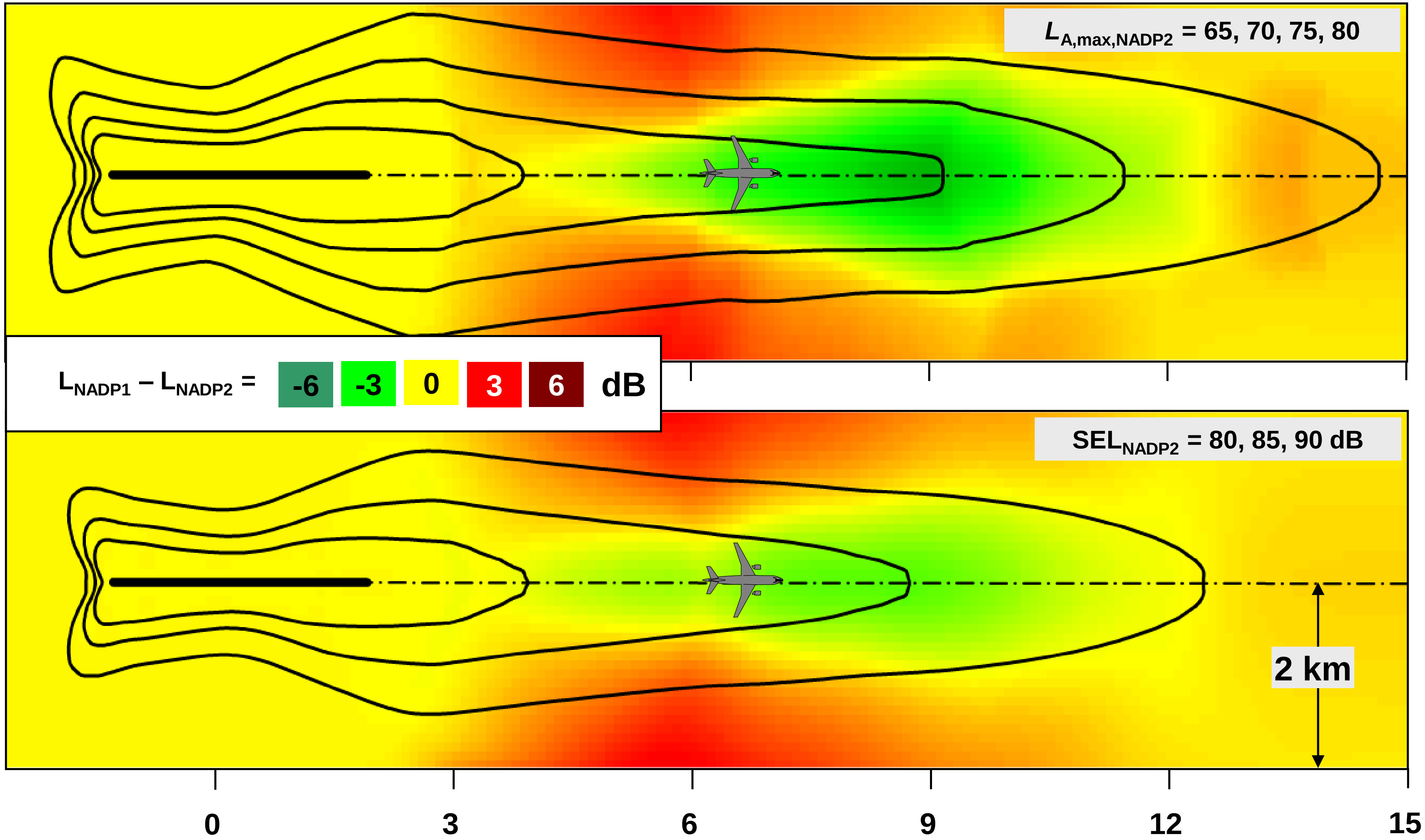
Relevance of Active Noise Abatement at the Source

Vertical Flight Optimization - Departure



Relevance of Active Noise Abatement at the Source

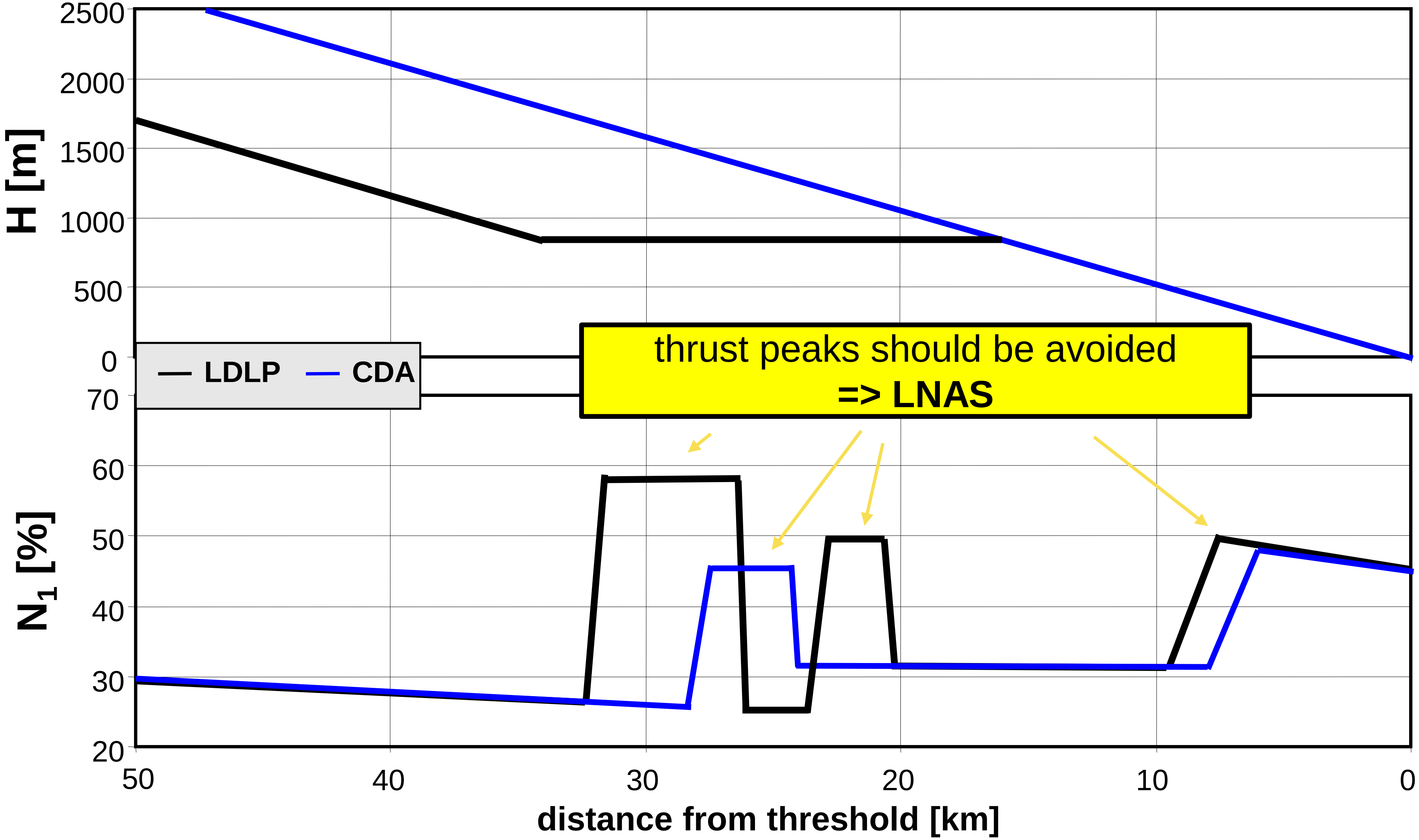
Vertical Flight Optimization - Departure



source: Ullrich Isermann DLR AS-HEL

Relevance of Active Noise Abatement at the Source

Vertical Flight Optimization - Approach

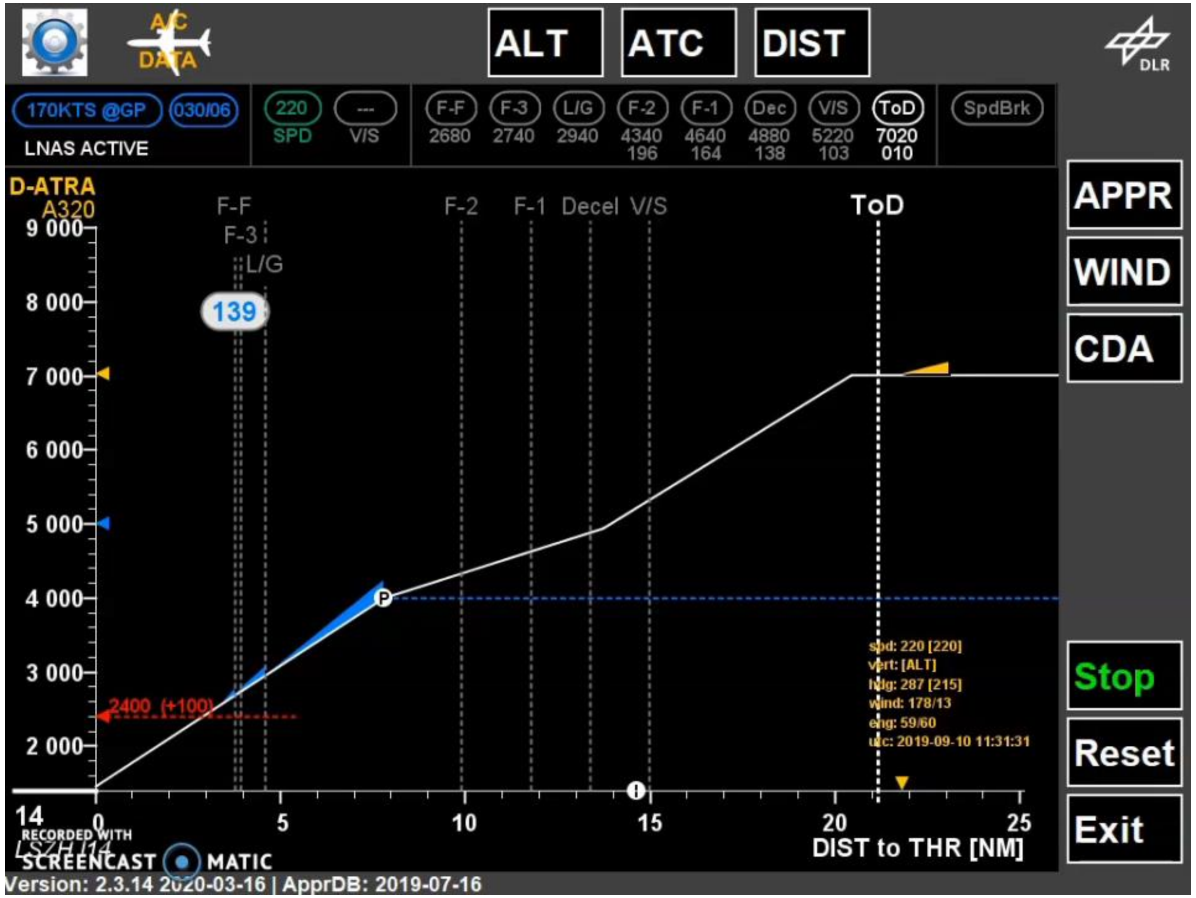


Relevance of Active Noise Abatement at the Source

LNAS (Low Noise Augmentation System) – from DLR-FT

real-time forward simulation using a full-flight aircraft model during descent

- **«mini flight simulator in real-time»** to predict the vertical profile and optimum configuration changes (flaps, landing gear)
- based on minimum energy vertical profile
- taking into account ATC constraints

source DLR, flight test demonstration with A320 ATRA at Zurich Airport, 2019.

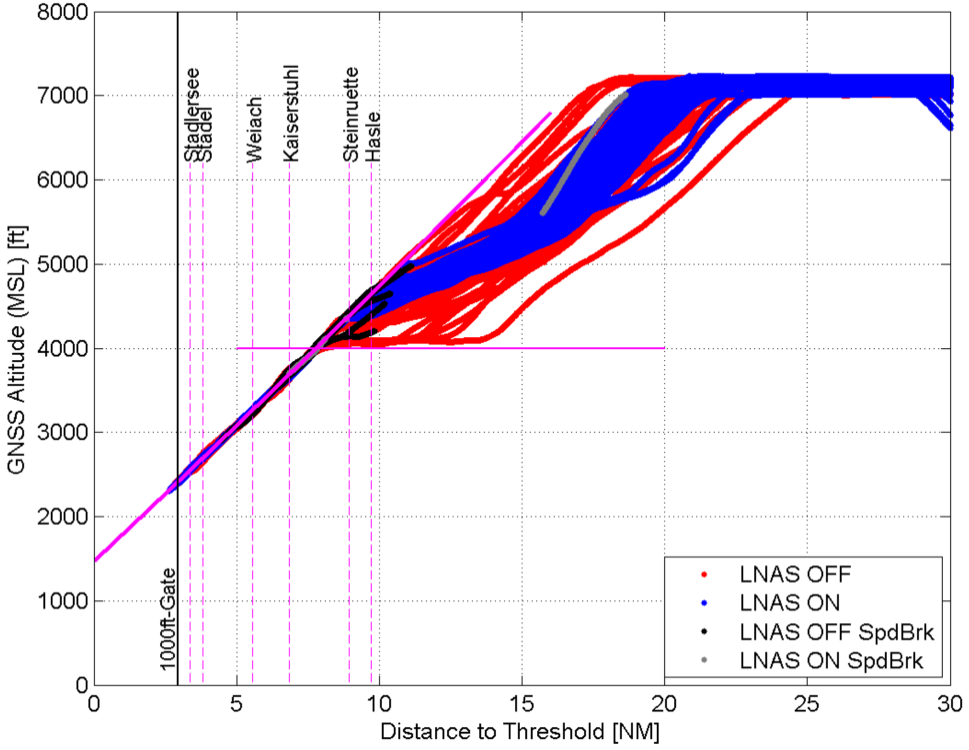
source: Fethi Abdelmoula DLR FT

Relevance of Active Noise Abatement at the Source

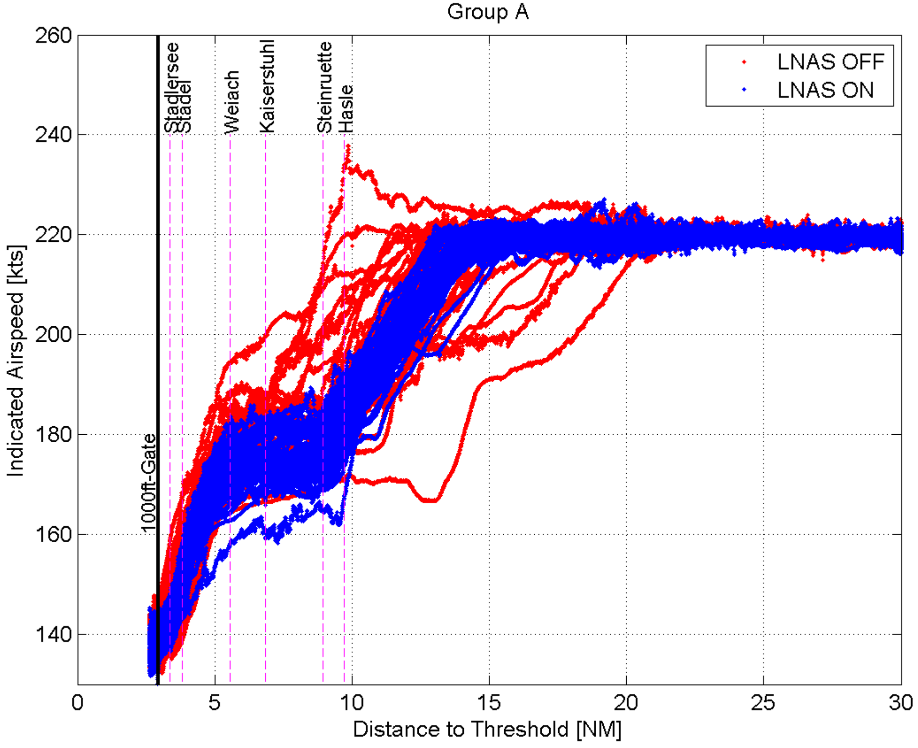
Results from LNAS Flight Test Campaign, Zurich 2019

flight of the most energy-optimized descent – performance results pilot vs. machine

vertical profile



speed profile



→ 6% fuel saving on last 26 NM [1)]

[1)] corresponds to 500 tons of fuel / year for SWISS A320 flights in 2019

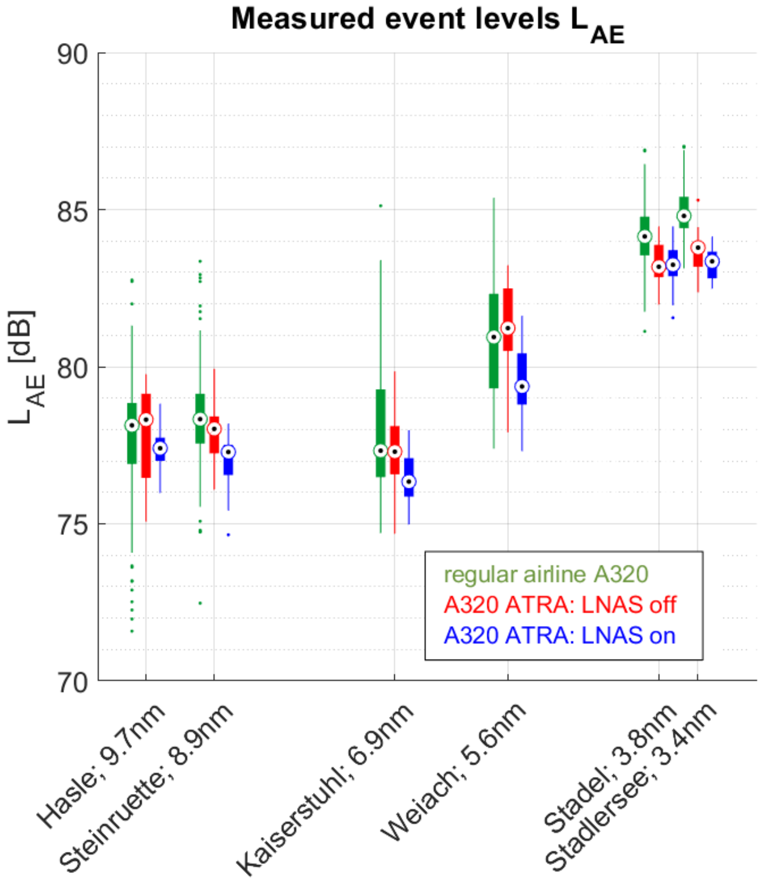
source: Fethi Abdelmoula DLR FT

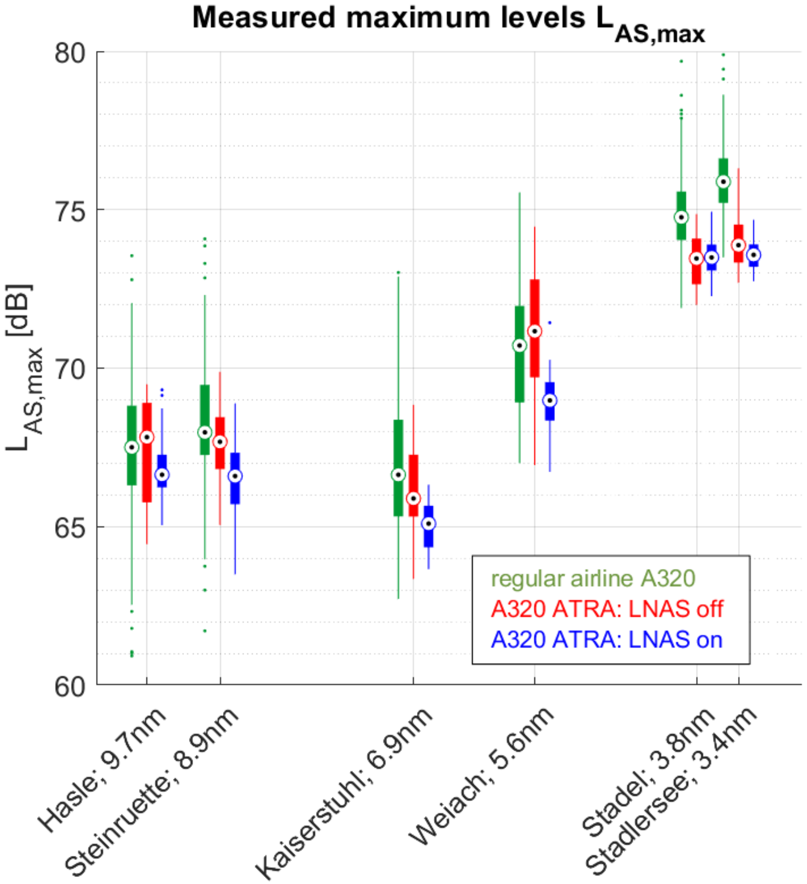
Relevance of Active Noise Abatement at the Source

Results from LNAS Flight Test Campaign, Zurich 2019

flight of the most energy-optimized descent – noise results pilot vs. machine

- 70 valid ATRA approaches: 43 with LNAS, 27 without LNAS
- 149 approaches by regular airline A320 for comparison





source: Fethi Abdelmoula DLR FT

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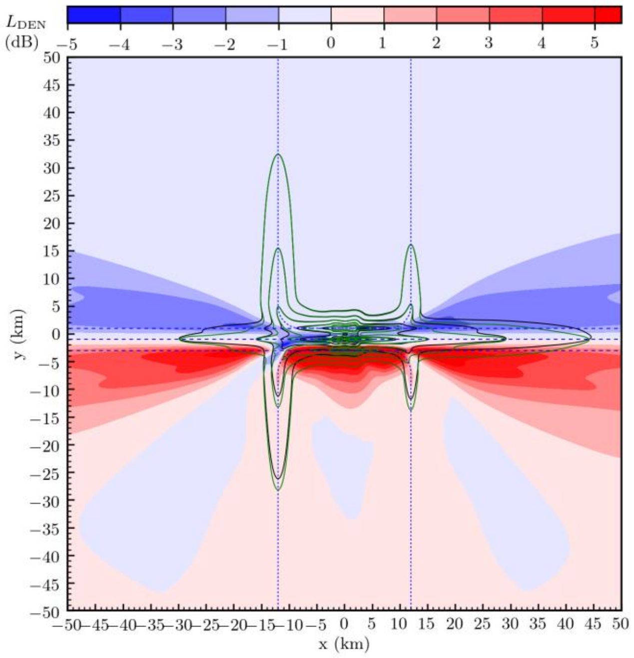
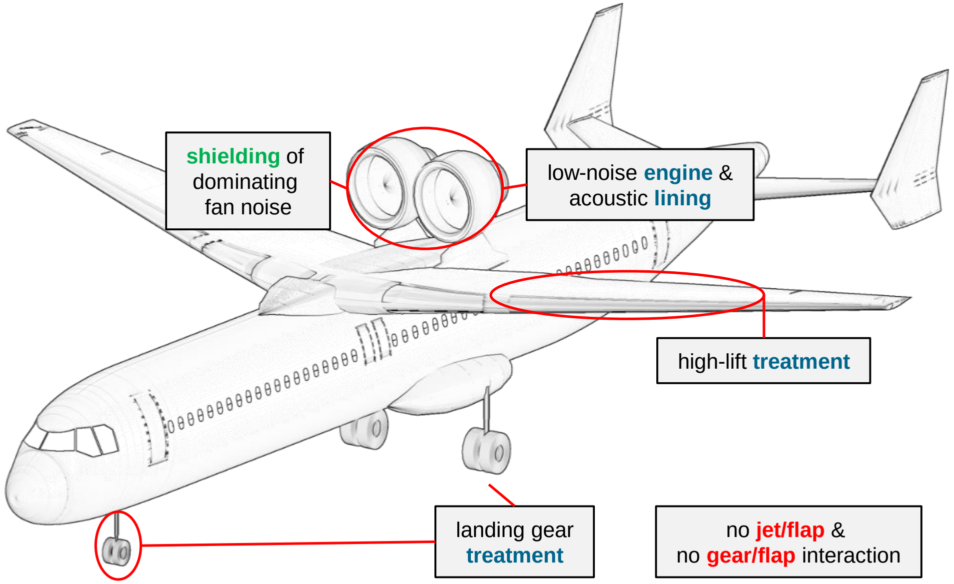


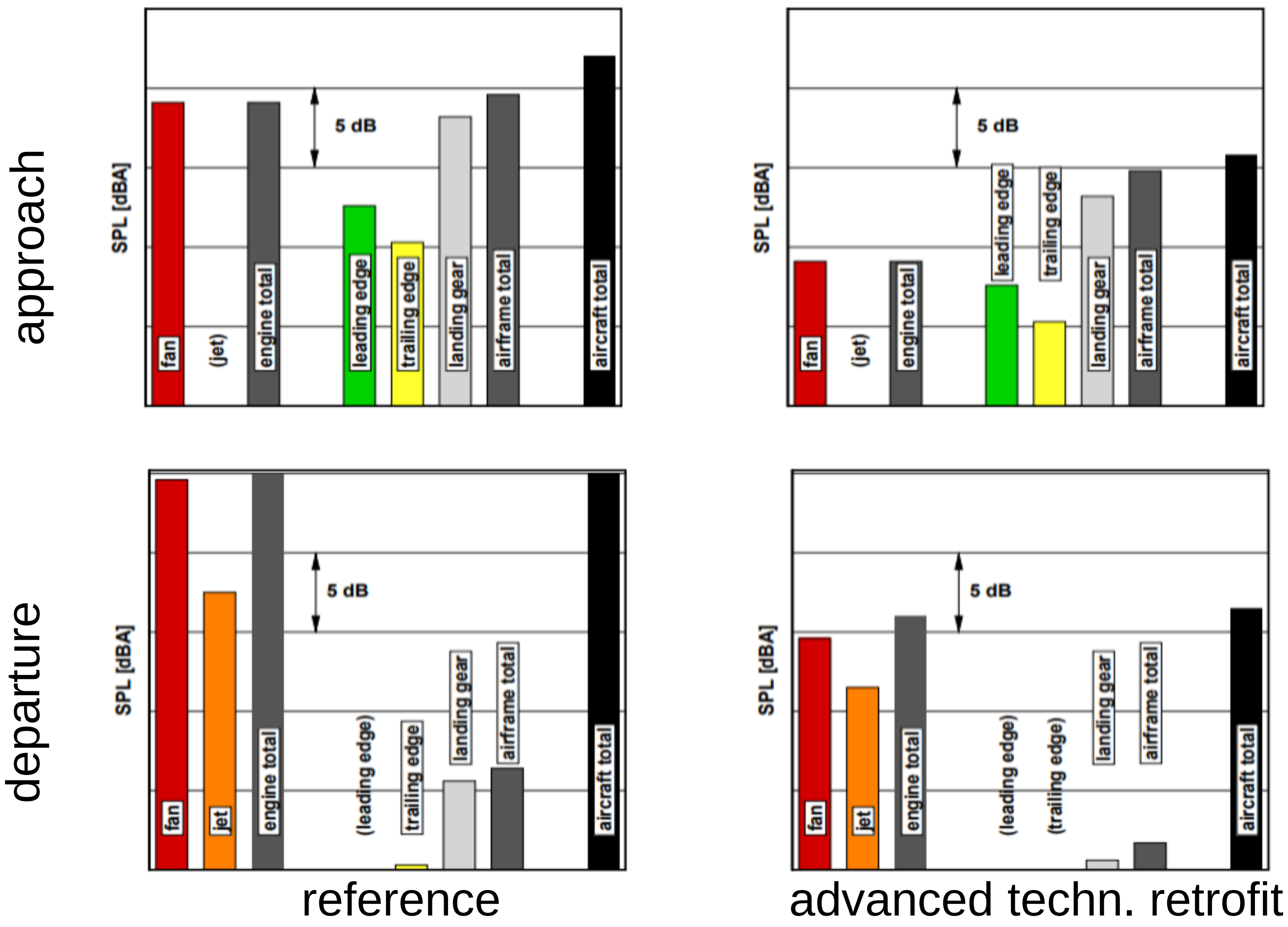
Part 2: Relevance of Active Noise Abatement at the Source

Technical Solutions



Relevance of Active Noise Abatement at the Source

Technical Solution - Retrofit



reduction

- noise goals, e.g., ACARE, not achievable by retrofitting → required measures: combination of **design**, **operation**, and **retrofit**
- main acoustic properties defined by design → noise as early **design objective**

https://doi.org/10.34912/ac-n0is3 source: Lothar Bertsch DLR AS-HEL

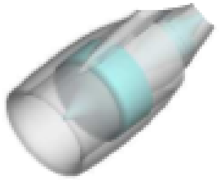
Relevance of Active Noise Abatement at the Source

Development of Parametric Tool PANAM

flight and noise simulation

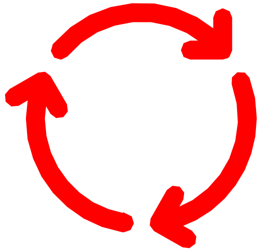
engines

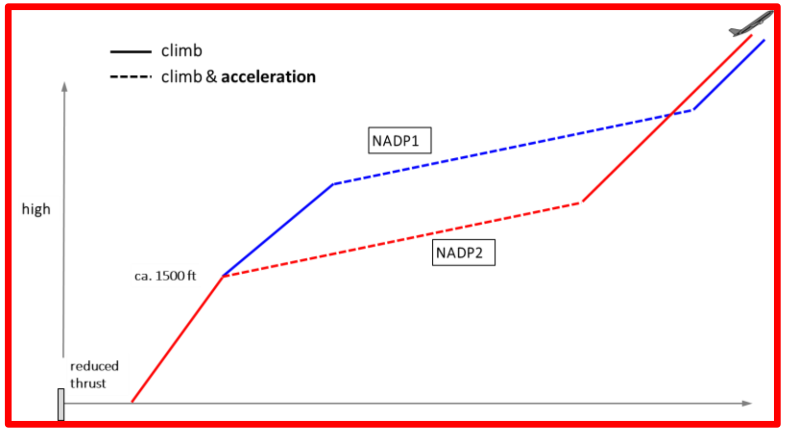
airframe



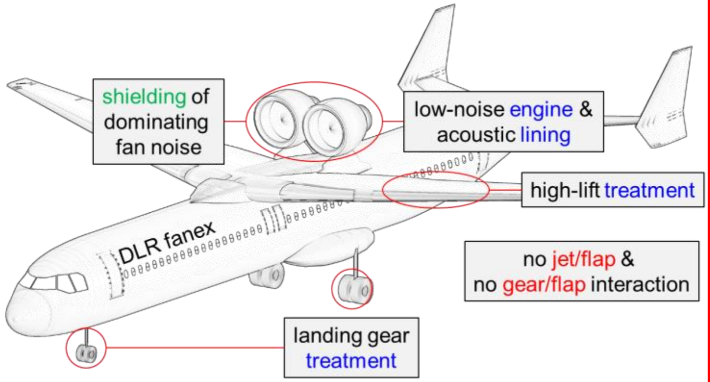
DLR-project LNATRA:
https://doi.org/10.2514/6.2021-2117

quieter technologies





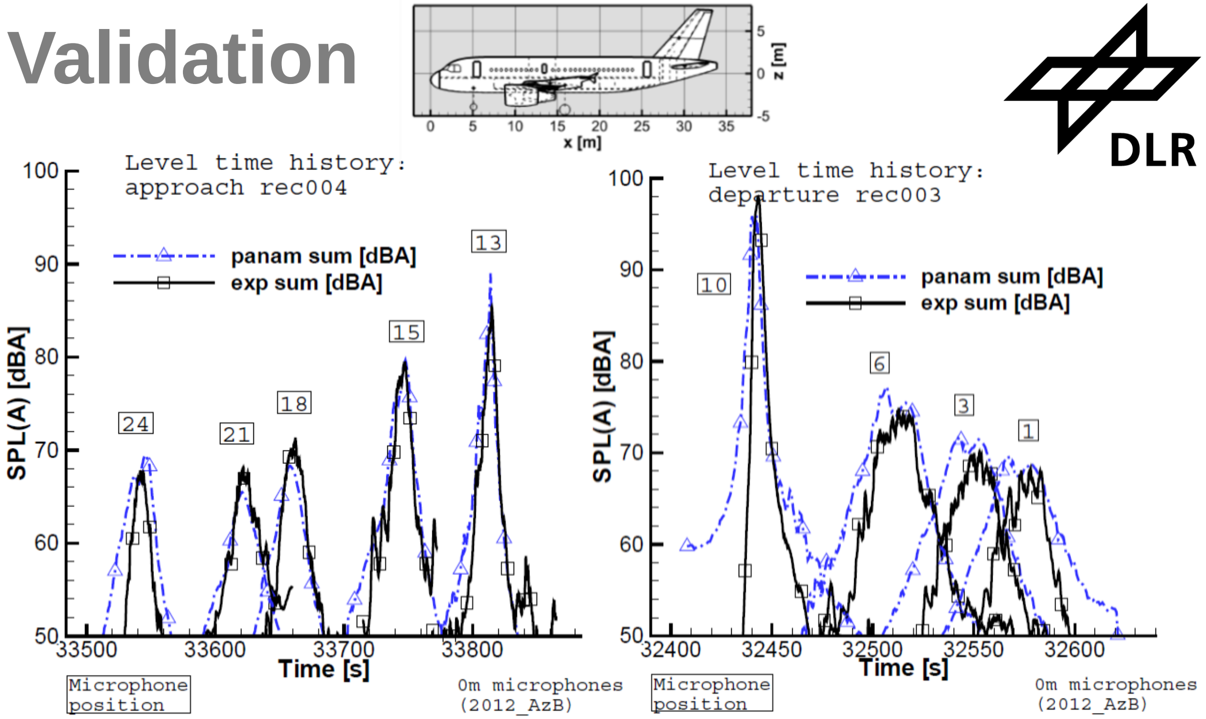
flight simulation



novel aircraft design

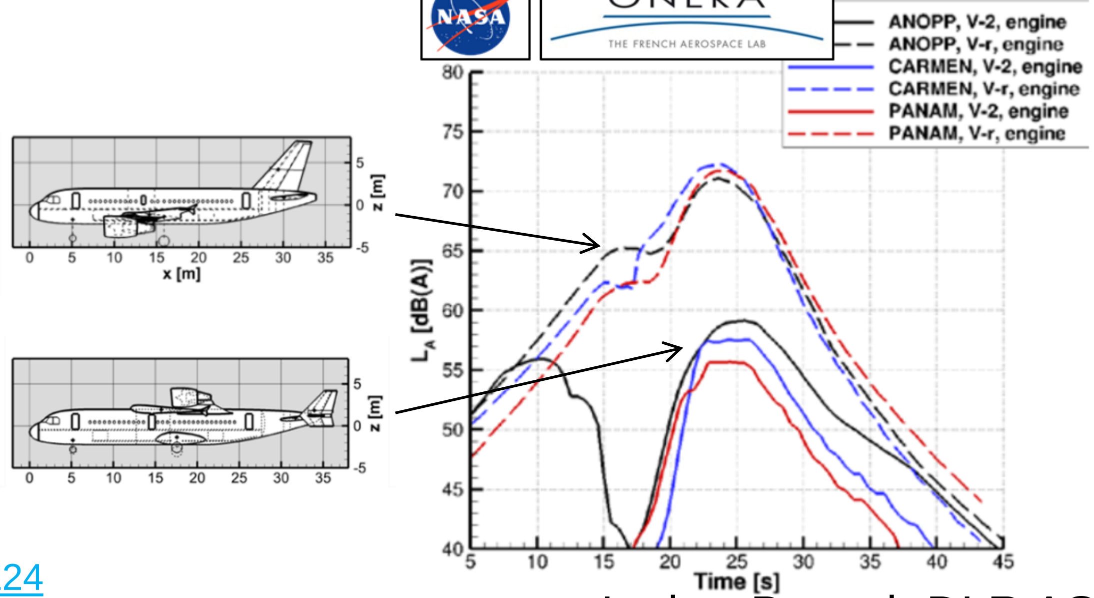
source: Lothar Bertsch DLR AS-HEL

Parametric Tool PANAM: Result Validation
(mixed-fidelity)



- based on experimental data
  - components: wind tunnel data / engine testbed
  - overall aircraft: measured fly-over data, e.g., A319*, A320, B747, Dornier 228, and VFW 614
  - available databases (cert. levels, NPD)

- comparison with numerical data
  - components: Hi-Fi aeroacoustic simulation
  - overall aircraft: tool-to-tool** comparison



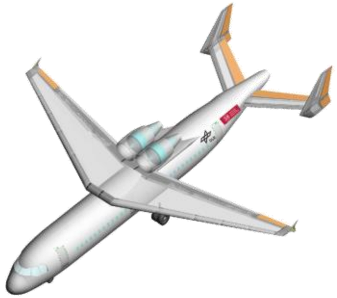
*) https://doi.org/10.34912/n0is3-d3sign **) https://doi.org/10.2514/1.C036124

source: Lothar Bertsch DLR AS-HEL

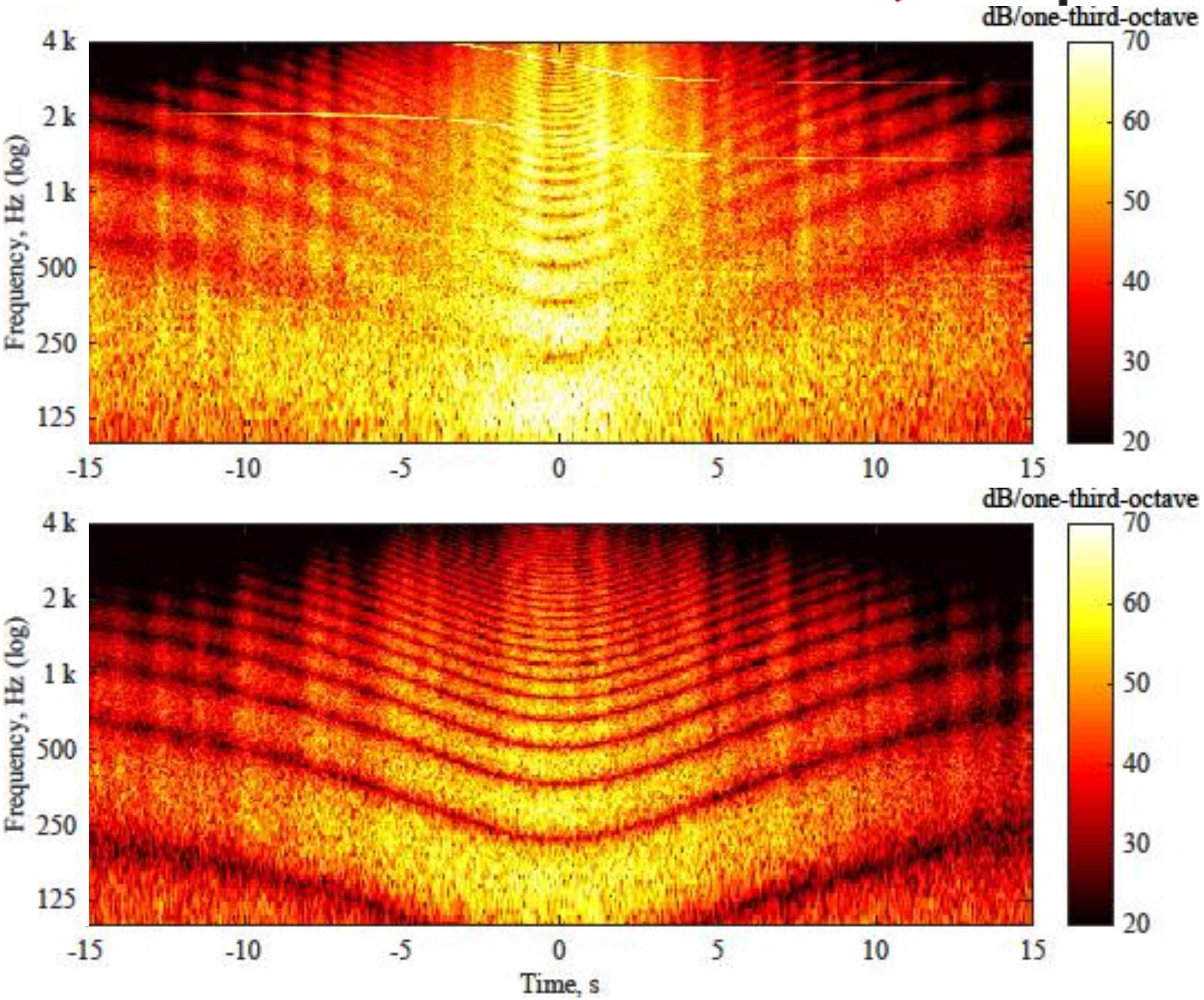
Perception Influenced Design ™

- approach situation
- receiver: 4 km prior touchdown

reference A319



game changer



https://doi.org/10.1016/j.scitotenv.2019.07.253

source: Reto Pieren EMPA, Lothar Bertsch DLR AS-HEL

Predictions on Future Noise Development: Relevance of Active Noise Abatement at the Source

SUMMARY

- **best noise protection is the development of quieter aircraft and mandatory policies saying that these aircraft must be used**

developing quieter aircraft

- takeoff:
  - quieter engines
- landing:
  - low noise aircraft design
    - quieter engines
    - quieter technologies for airframe
  - noise abatement procedures
    - pilot assistant
    - routing systems