3rd FABEC Vertical Flight Efficiency (VFE) Workshop – 7 DEC 2022 – Nice Airport

Aircraft Energy Management in the TMA

Insights into the SESAR projects DYNCAT and ALBATROSS

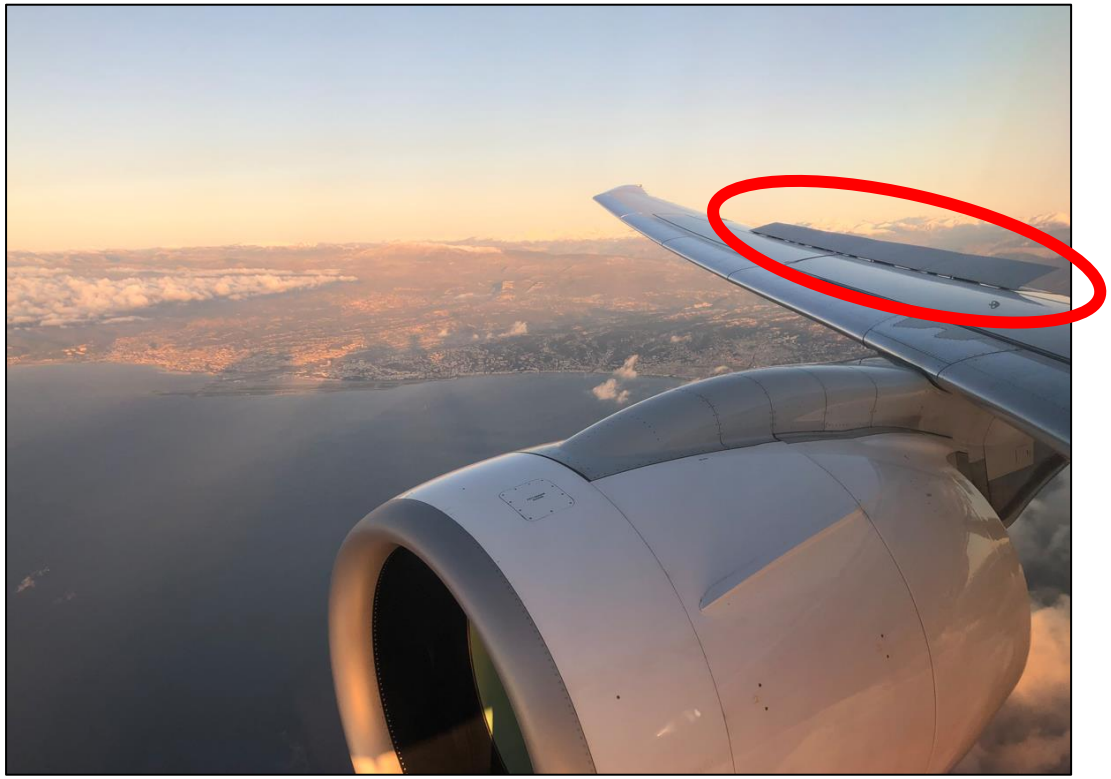
Martin Gerber, Technical Pilot Airbus A320, Flight Operations Engineering

LUFTHANSA GROUP

SWISS

This morning on the way to Nice for the FABEC workshop…

…something went wrong from a VFE perspective



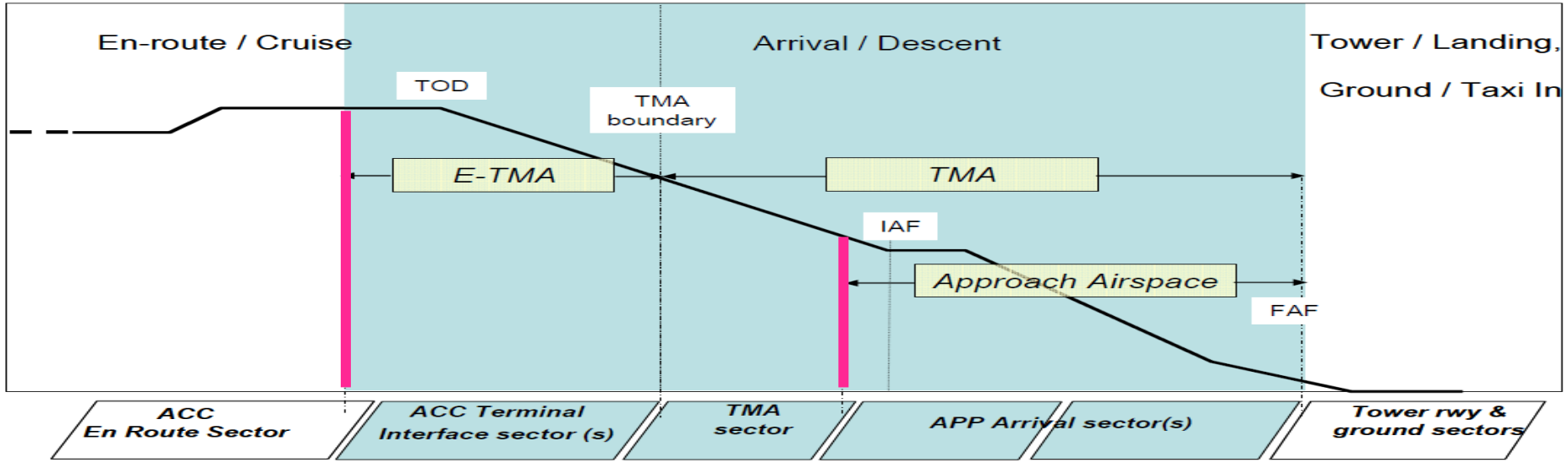
Maximum speed brake descent over Nice…

… followed by 2 min high-thrust level flight

We have some work to do!

Energy Challenges from Top of Descent to Touchdown

Trying to find the root causes



Source of graphics: Eurocontrol

Sector	ACC	Approach
VFE reducing influencing variables	Too early descents from ToD Fixed descent rates	Early descents and late descents leading to either level flights or excessive energy dissipation means
Aircraft lateral guidance	NAV Mode towards IAF along STAR waypoints Direct to RNAV transition waypoints	Largely tactical radar vectoring in HDG mode
Main VFE Restrictions	Airspace Structure, Traffic Flow, Sequencing	Airspace Structure, Final Sequencing, Separation
Existing tools	Idle Factor Tuning Descent Profile Optimizer (DPO) FANS C	**Distance-to-Go information from ATC** **«Pilot's best guess»** **PBN-to-xLS, T-bars**
Projects (selection)	ODP Trials 2019-202 LSZH SESAR ALBATROSS EXE-04 (TMA entry ALT) SESAR ALBATROSS EXE06B SESAR ADSCENSIO	SESAR DYNCAT SESAR ALBATROSS EXE-03 (LNAS) SESAR ALBATROSS EXE-05 (PBN-to-ILS)

Focus of today's presentation: VFE within the TMA

Why is it so difficult to perform idle descent within TMA?

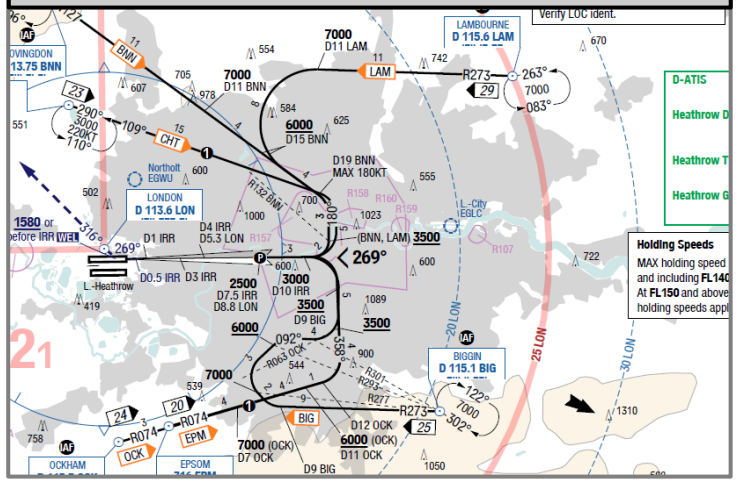
Without accurate information about the distance-to-go (DTG) no idle thrust approaches

Today's situation: variability on lateral path length in TMA

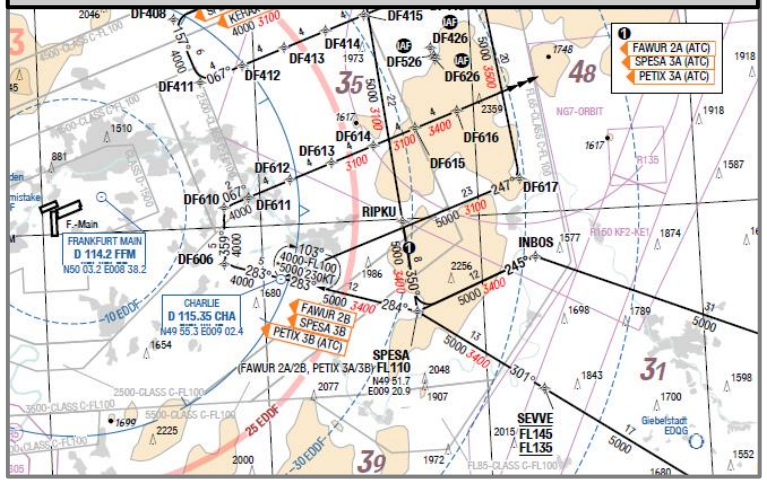
Solving the lateral path uncertainty problem to enable idle thrust approaches

Published Procedure:

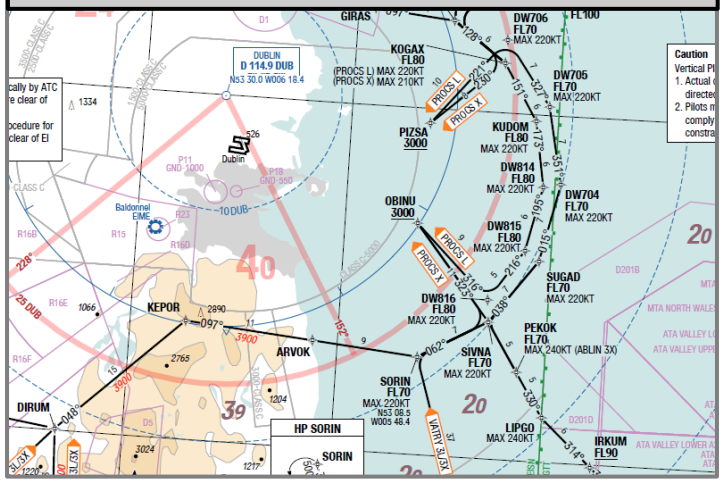
Heathrow: radar vectoring after IAF



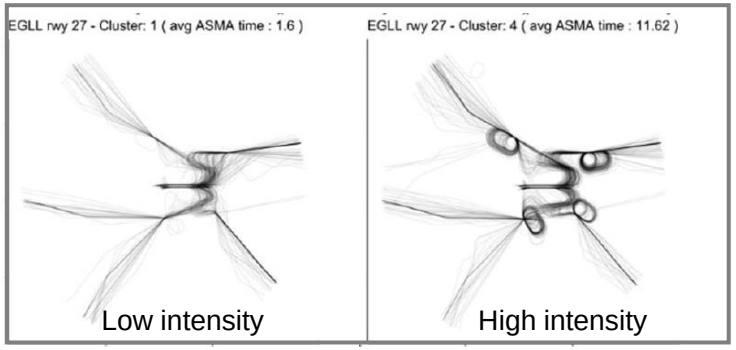
Frankfurt: open-path STAR

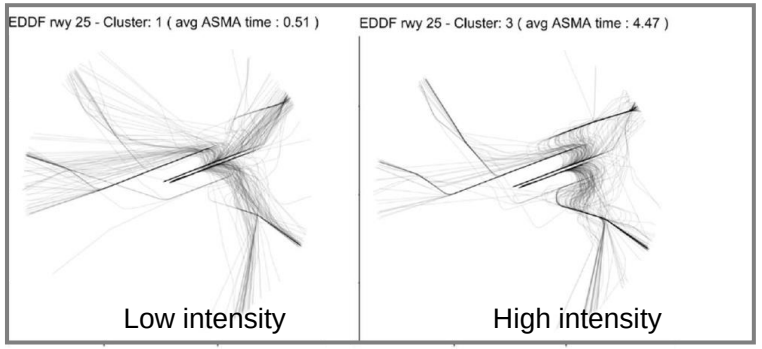


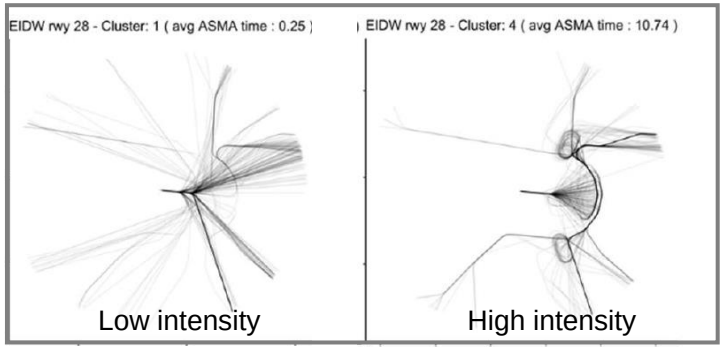
Dublin: Point Merge



Real Flights:







Source: B. Favennec, S. Guillemot, E. Hoffman and K. Zeghal, "Introducing Dynamicity in the Terminal Areas", Eurocontrol, AIAA Aviation Forum, 15–19 June 2020.

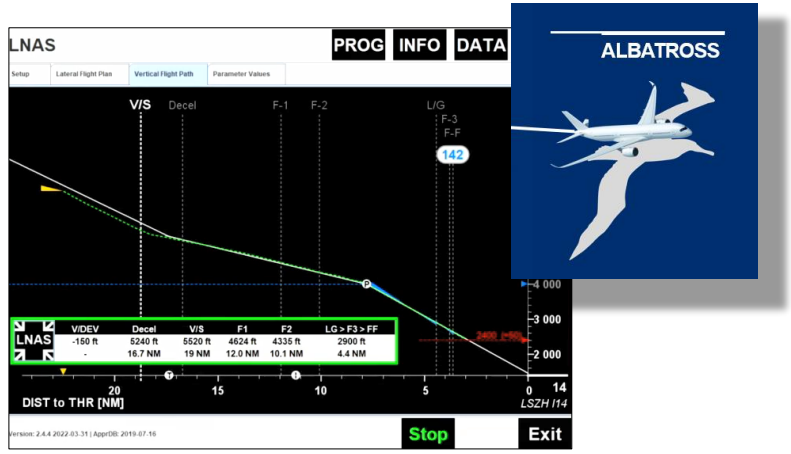
From EFB-Demonstrator to Avionics-Integration

SUPPORTED BY sesar JOINT UNDERTAKING

SESAR Projects for «Perfect Green Approach»: Development of Pilot Support Functions

VLD 2 ALBATROSS EXE-03, 2020 - 2023

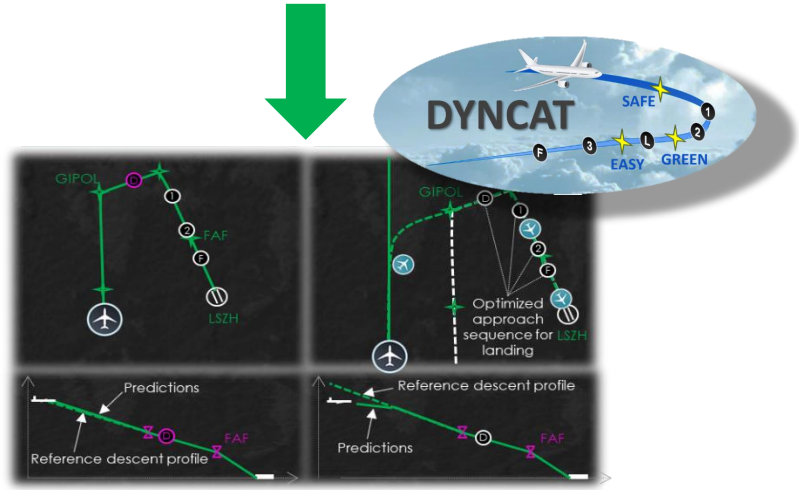
- Idle thrust approaches with **Electronic Flight Bag (EFB)** pilot assistance concept s/w **LNAS** (Low Noise Augmentation System) on A320neo in regular revenue operation
- Closed-path WPT sequence for ILS RWY 14 in LSZH
- Dynamic flaps and L/G extension to stabilize at 1'000 ft AGL



EFB concept software LNAS

Exploratory Research DYNCAT, 2020 - 2022

- Development of **Flight Management System (FMS)** prototype function **DYNCAT** (Dynamic Configuration Adjustments in the TMA) based on LNAS concept
- Distance-to-Go (DTG) / Requested Time of Arrival (RTA) / Permanent Resume Trajectory (PRT) function
- Energy cues for pilot

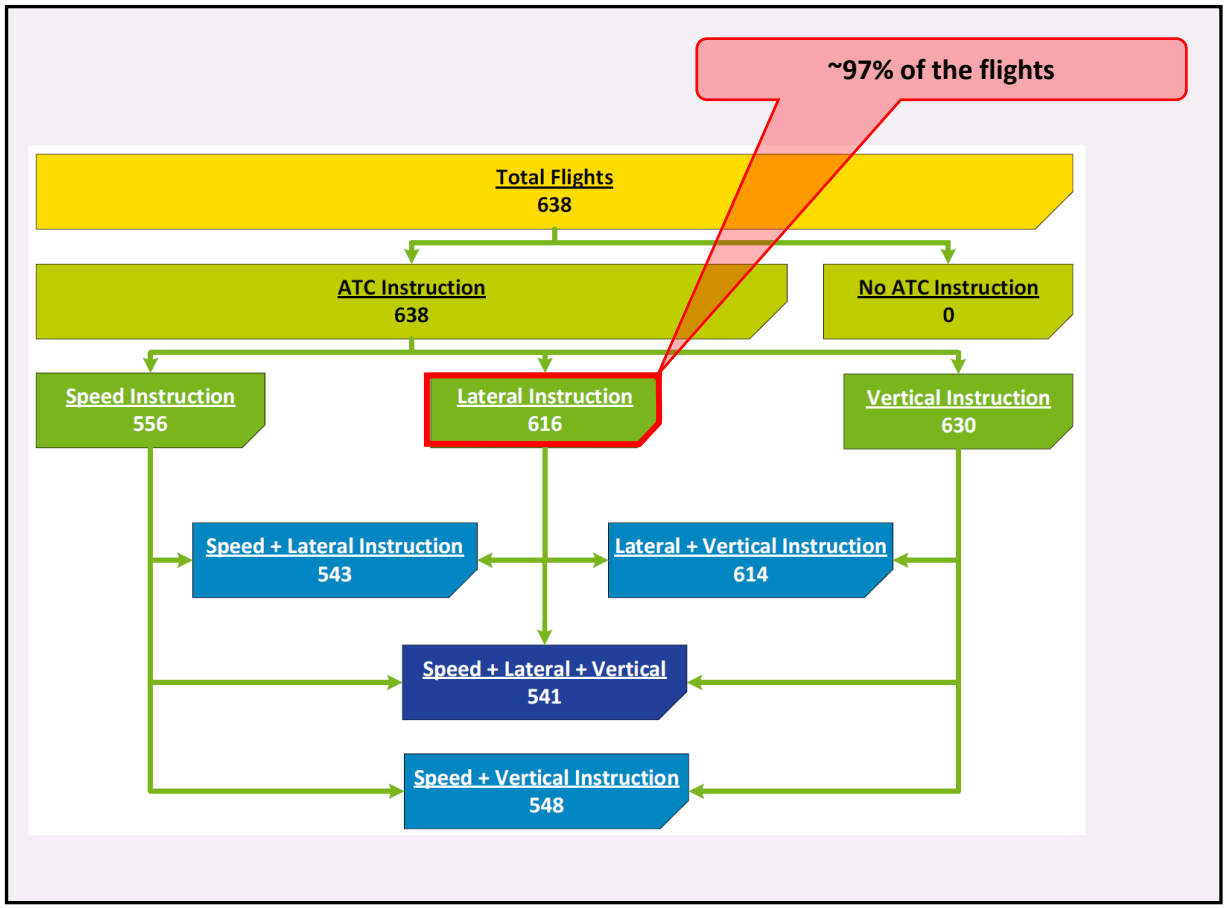


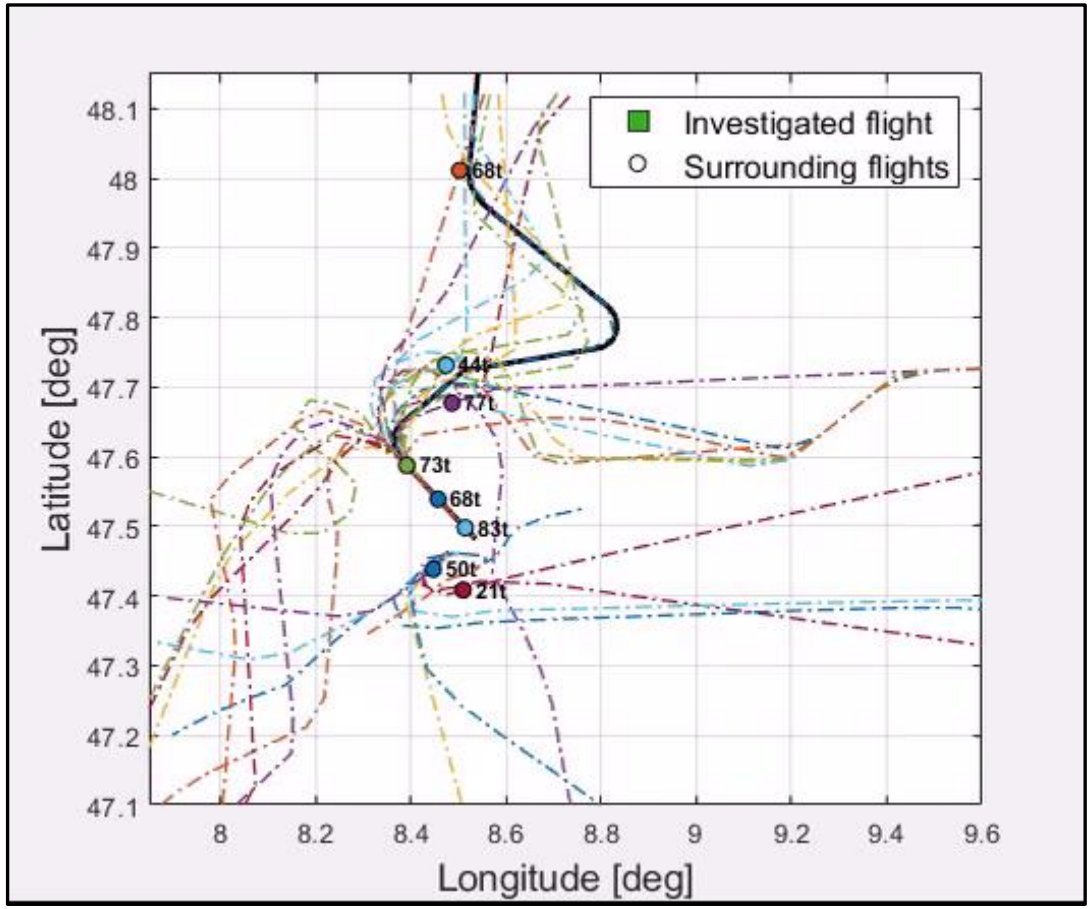
FMS prototype function DYNCAT

LUFTHANSA GROUP THALES Building a future we can all trust DLR Empa Materials Science and Technology SKY LAB SWISS

Analysis of Current Operation at LSZH

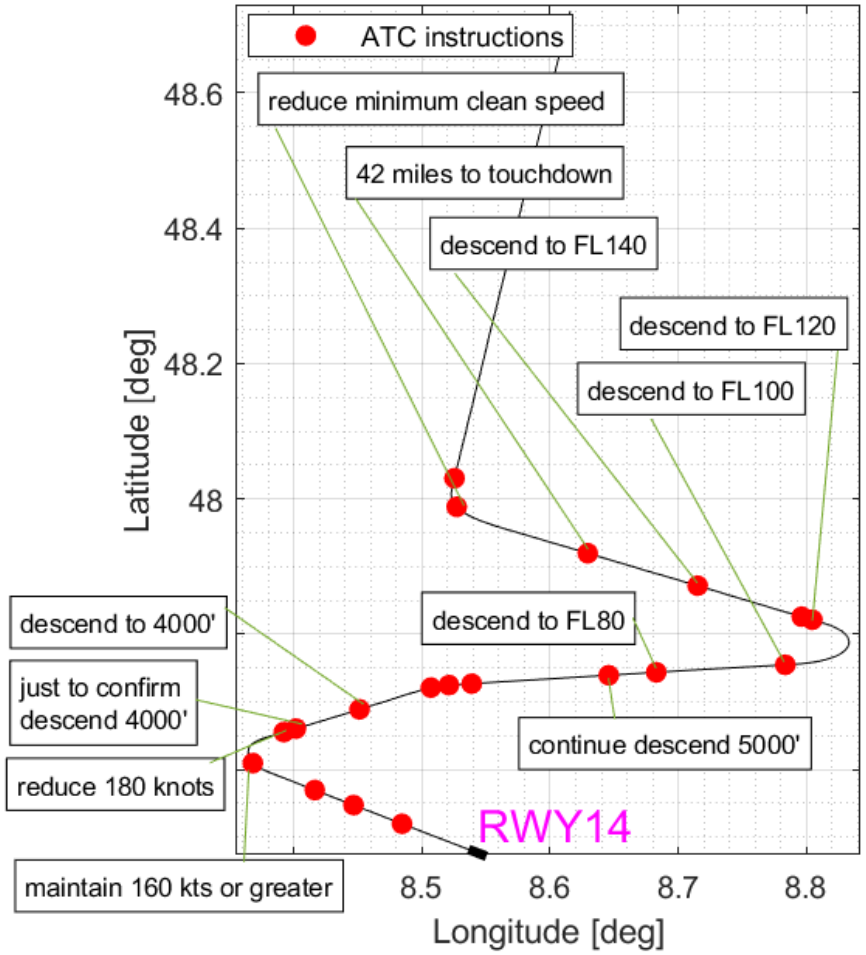
Combining ATC voice data, full flight data, wind data, traffic data and noise measurements

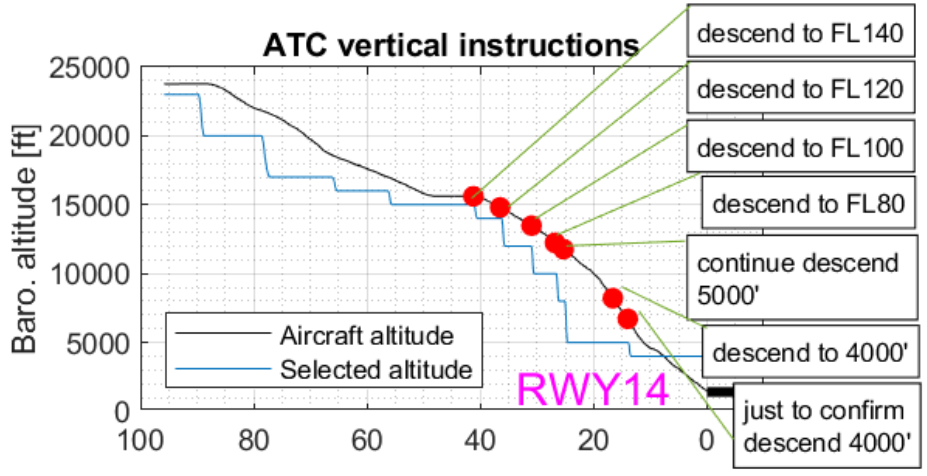


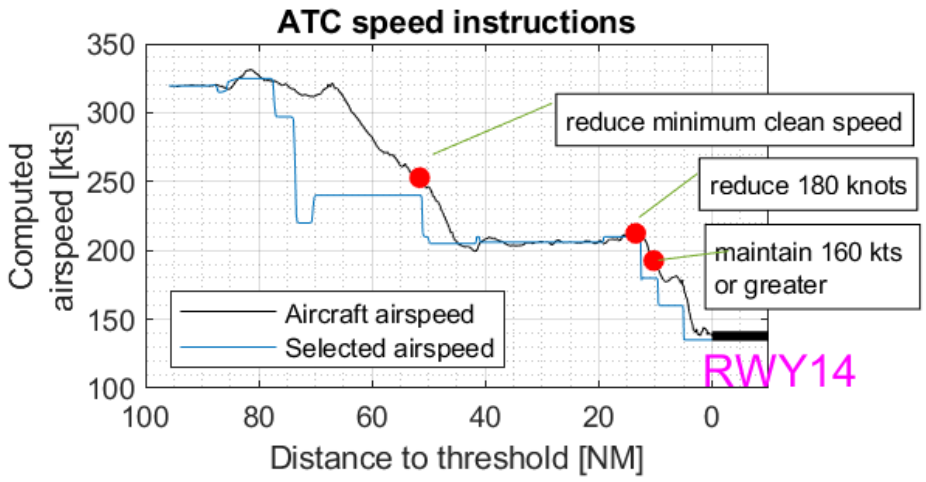


Analysis of Current Operation at LSZH

Impact of ATC instructions on VFE

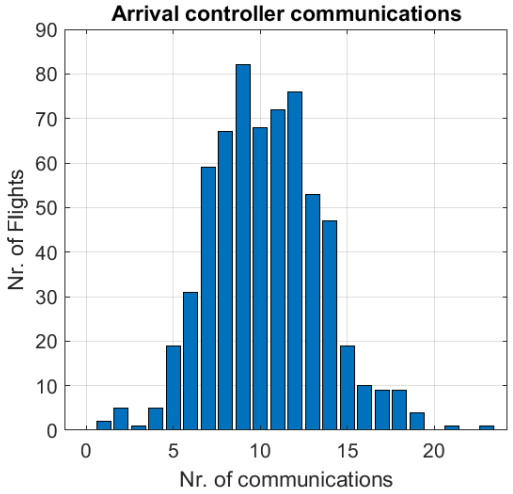


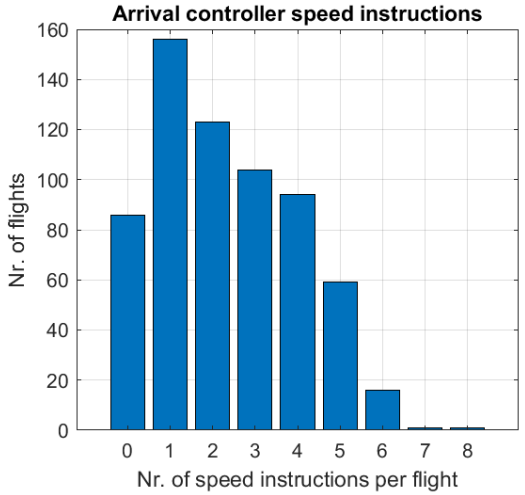


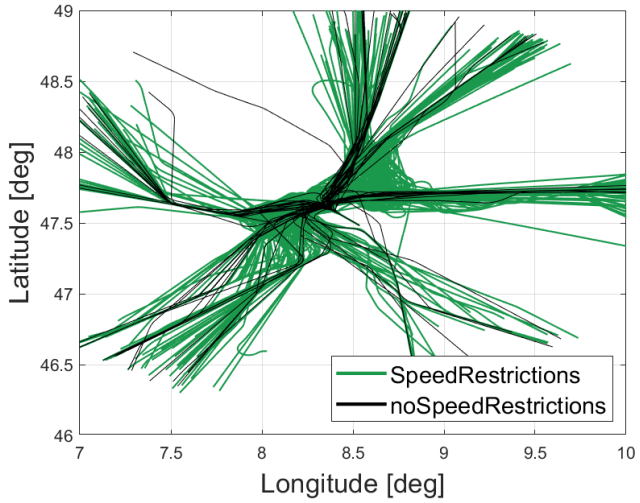


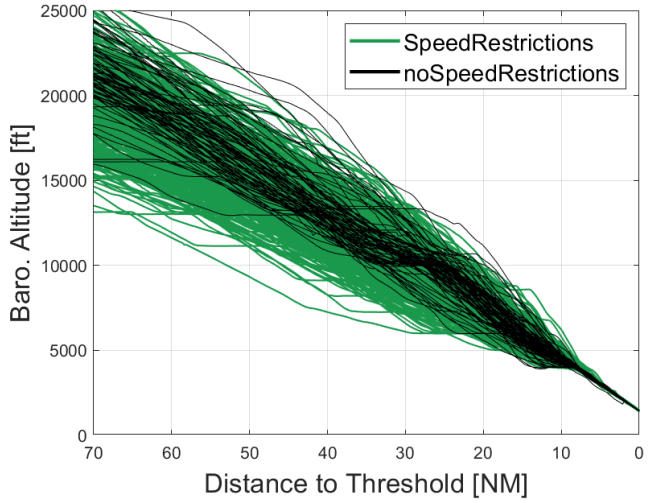
Analysis of Current Operation at LSZH

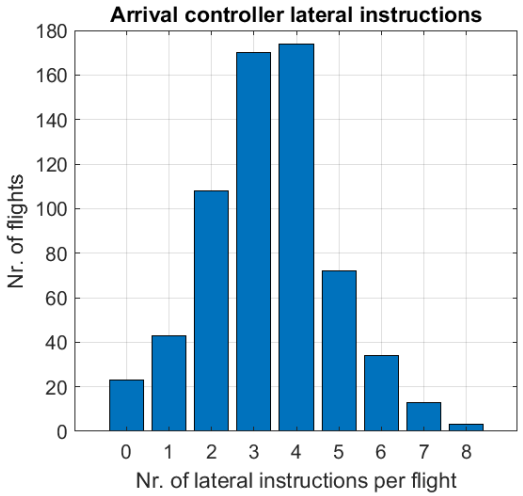
Impact of ATC instructions on VFE

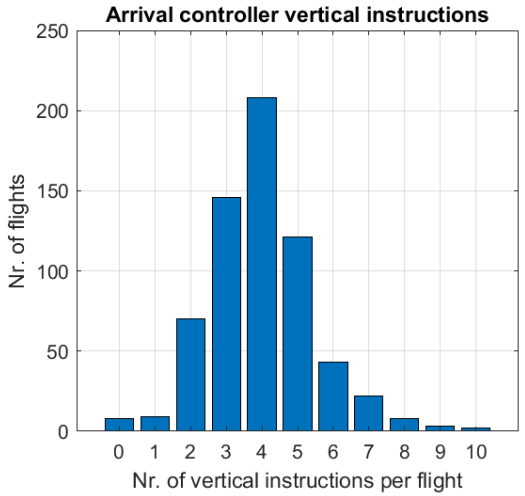


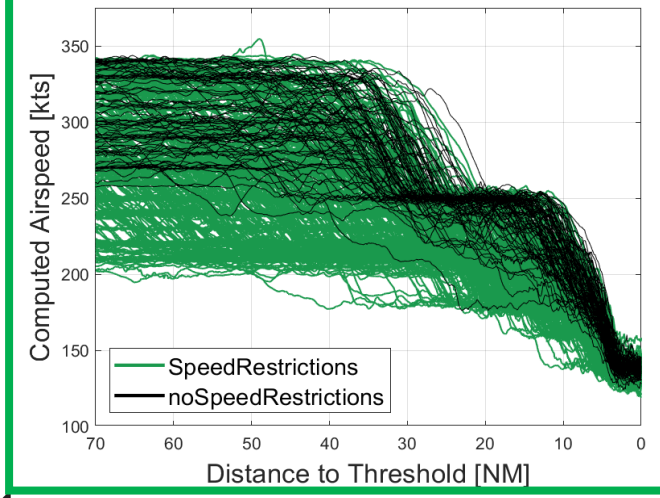


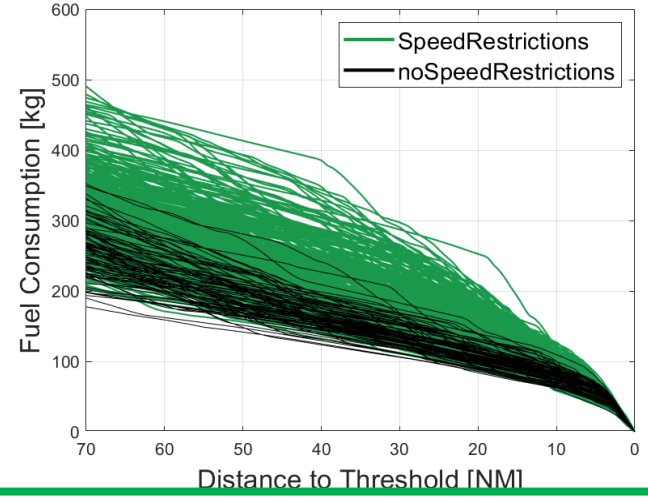












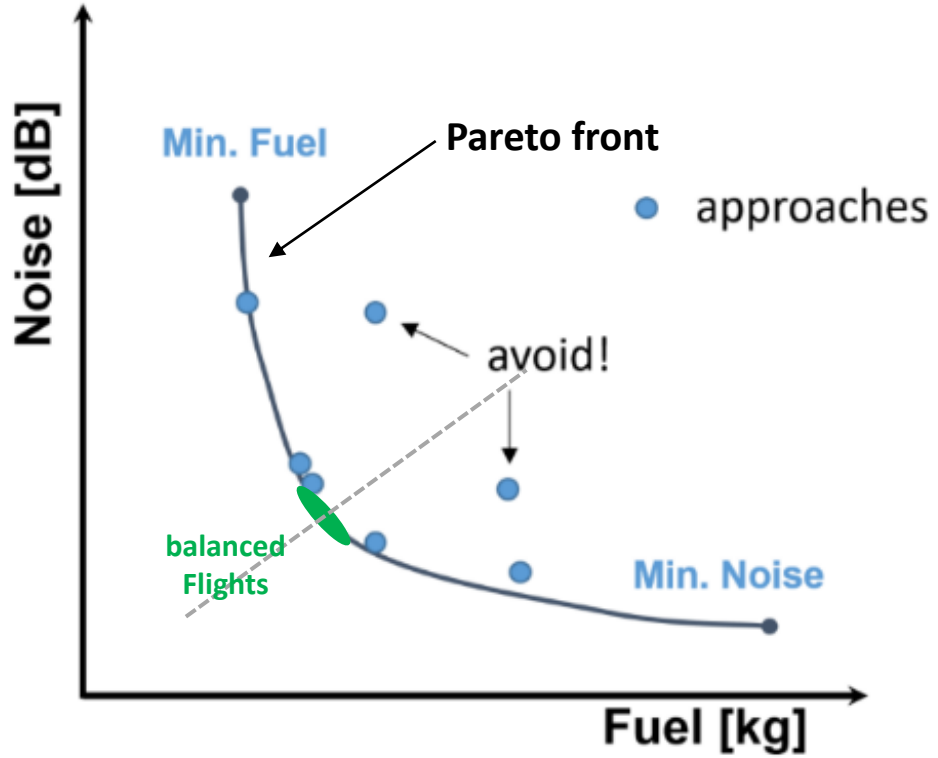
Descent and Approach Strategy

Trade-off between fuel consumption and noise reduction

General strategy
a) Engines in idle
b) Minimise drag

Low noise strategy
→ Minimise Speed
→ Reduce Speed before height

Minimal fuel consumption
→ Minimise flight time
→ Reduce height before speed



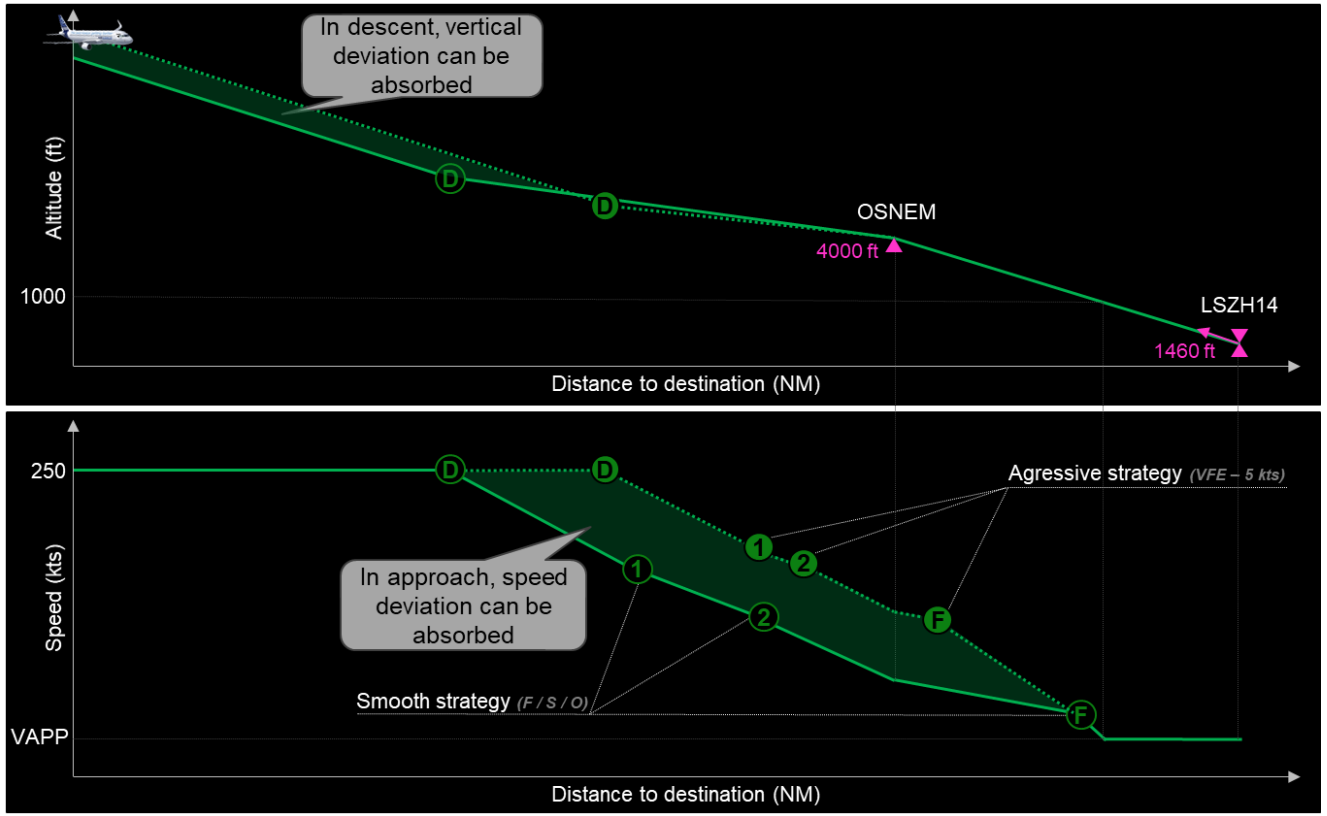
→Optimise noise close to the airport and reduce fuel consumption further away!

→Energy-balanced approaches → lower noise exposure & less fuel consumption.

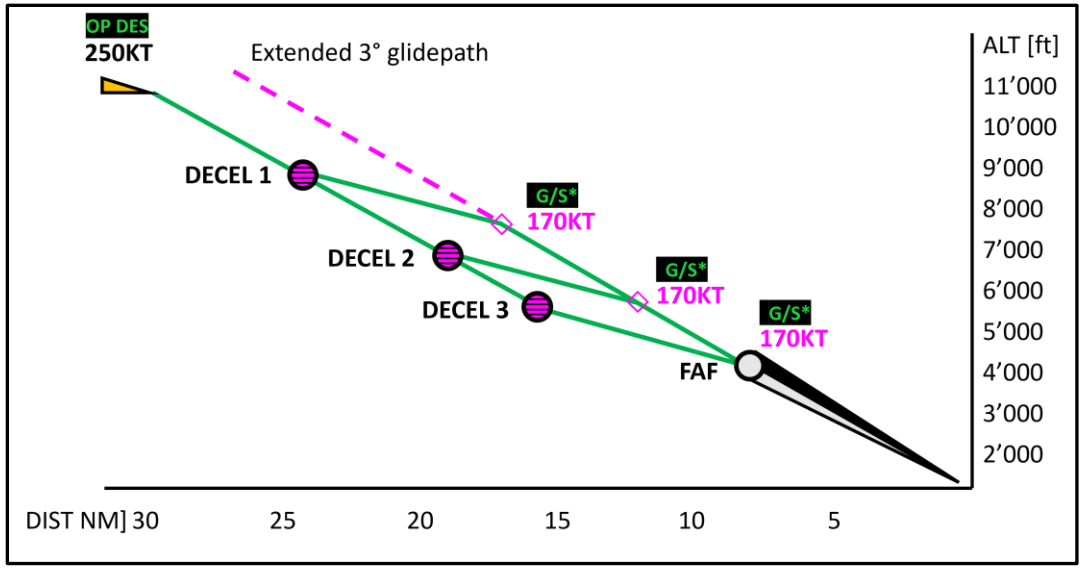
Descent and Approach Strategy

Full idle thrust approaches: different vertical profiles with different speed profiles

a) Glideslope intercept @ FAF: variable vertical deviation before DECEL and variable G/S speed: Current DYNCAT prototype implementation



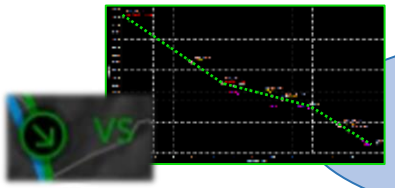
b) Glideslope intercept ≥ FAF: speed-dependent vertical offset and minimum drag constant speed with flaps 2 @ glideslope



→ Deceleration may be tactically initiated by ATCO for separation purposes while still enabling an idle descent profile between IAF and touchdown.

FMS Prototype Development

Building Blocks for Idle Thrust Approaches



Optimised Continuous Descent Approach (CDA)
to reduce noise footprint

Permanent Vertical deviation symbol
to support altitude management

Adjustable Permanent Resume Trajectory (PRT)
based on ATC DTG or RTA information under vectoring

Dynamic flaps sequence and pseudo-waypoints
to support the energy management in approach

DYNCAT factor
to reduce the PDB conservatism

Extend/Retract speed brakes message
to avoid excessive and noisy application

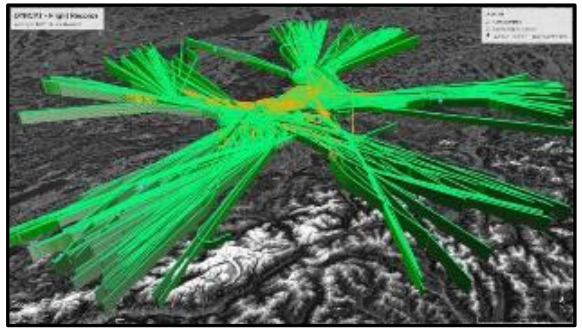
Optimised Distance To Go and Margin
to support an efficient flight

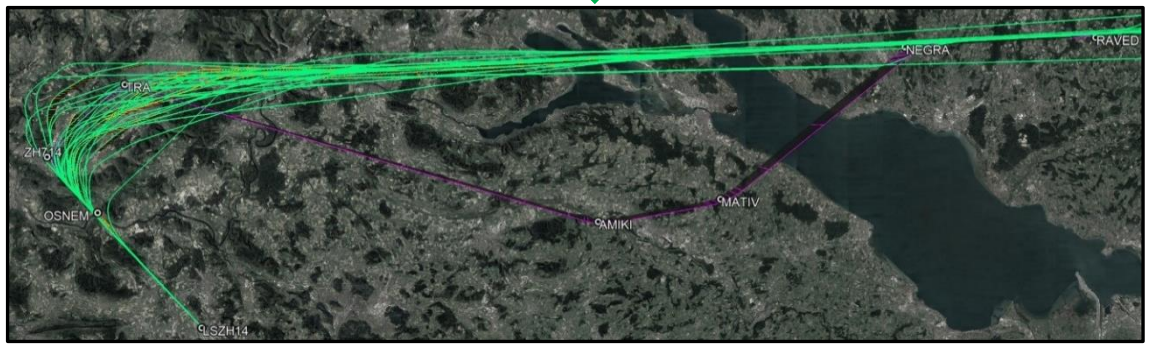
LUFTHANSA GROUP THALES Building a future we can all trust DLR Empa Materials Science and Technology SKY LAB SWISS

Prototype Testing: Scenario

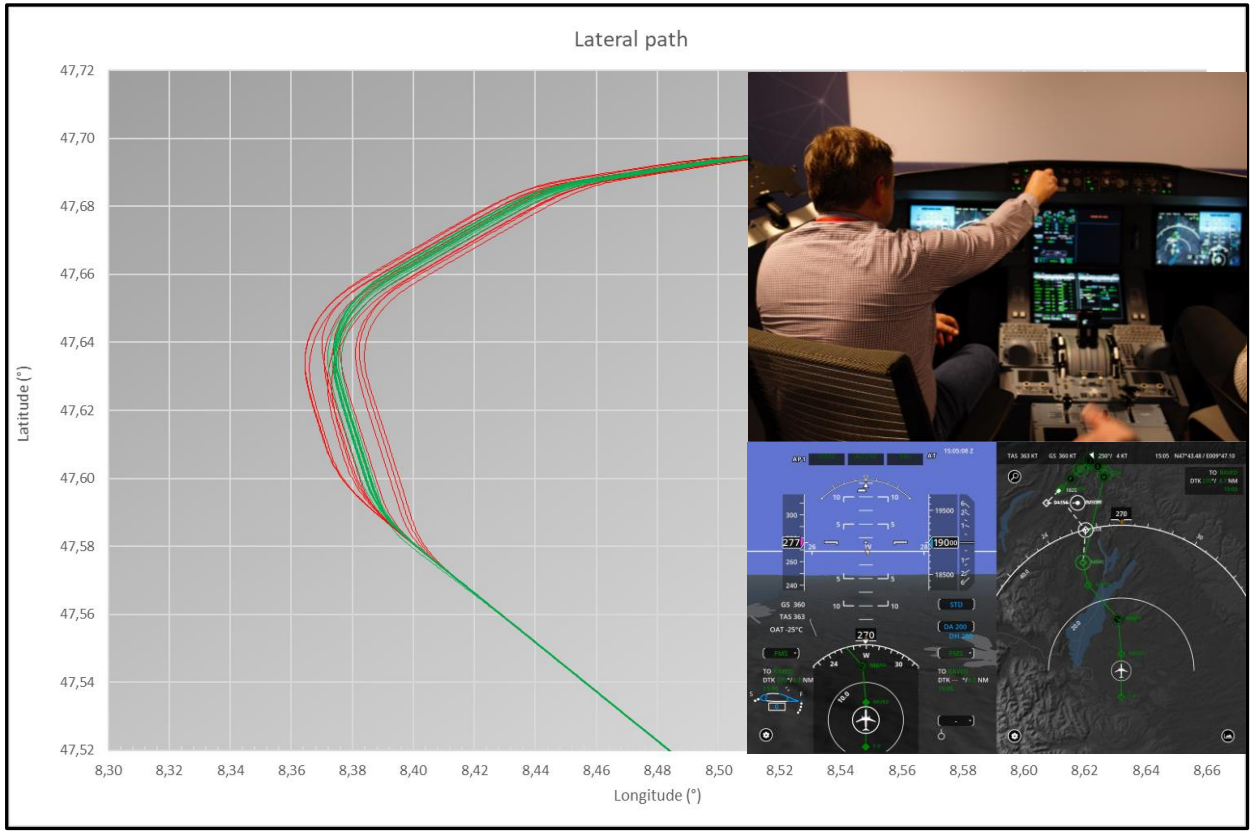
Real-time piloted simulations in Toulouse on Thales FMS Test Bench, 21-25 March 2022

Real World





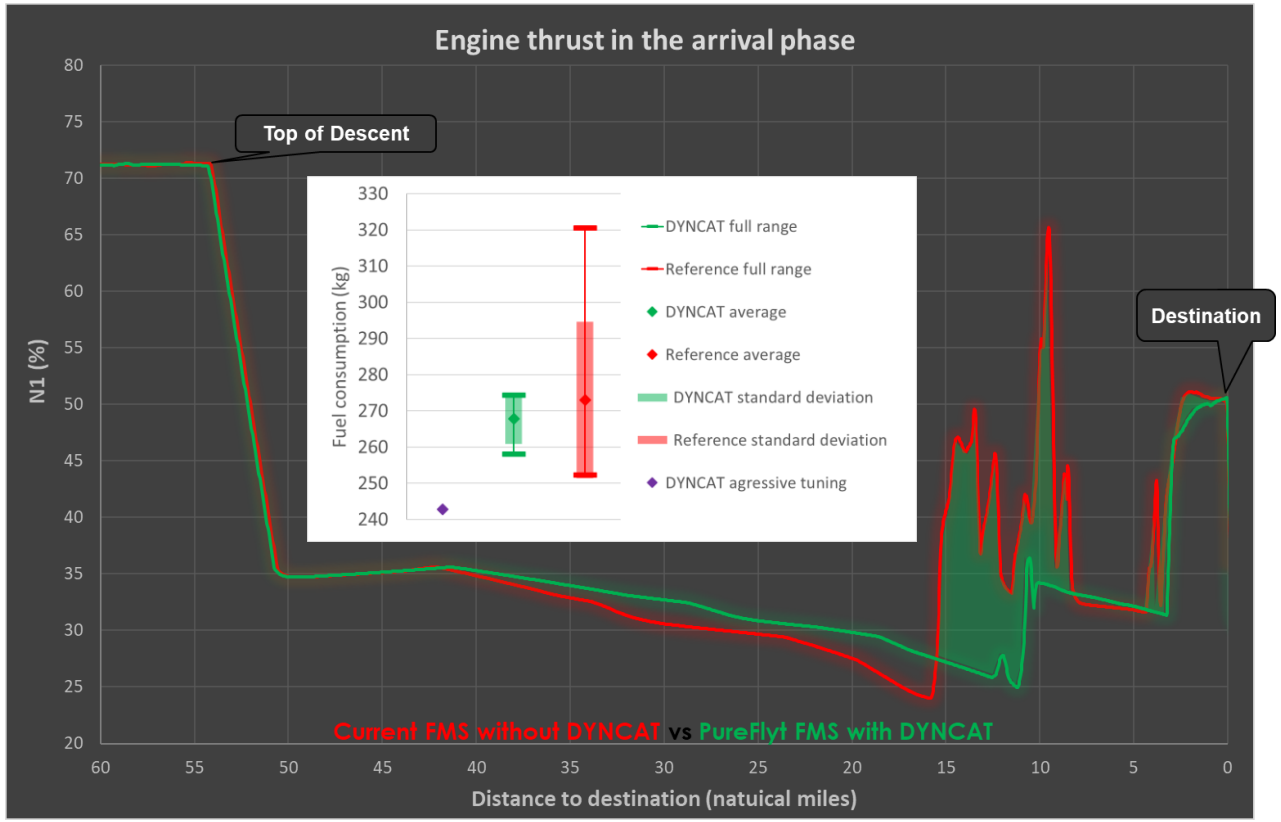
FMS Test Bench

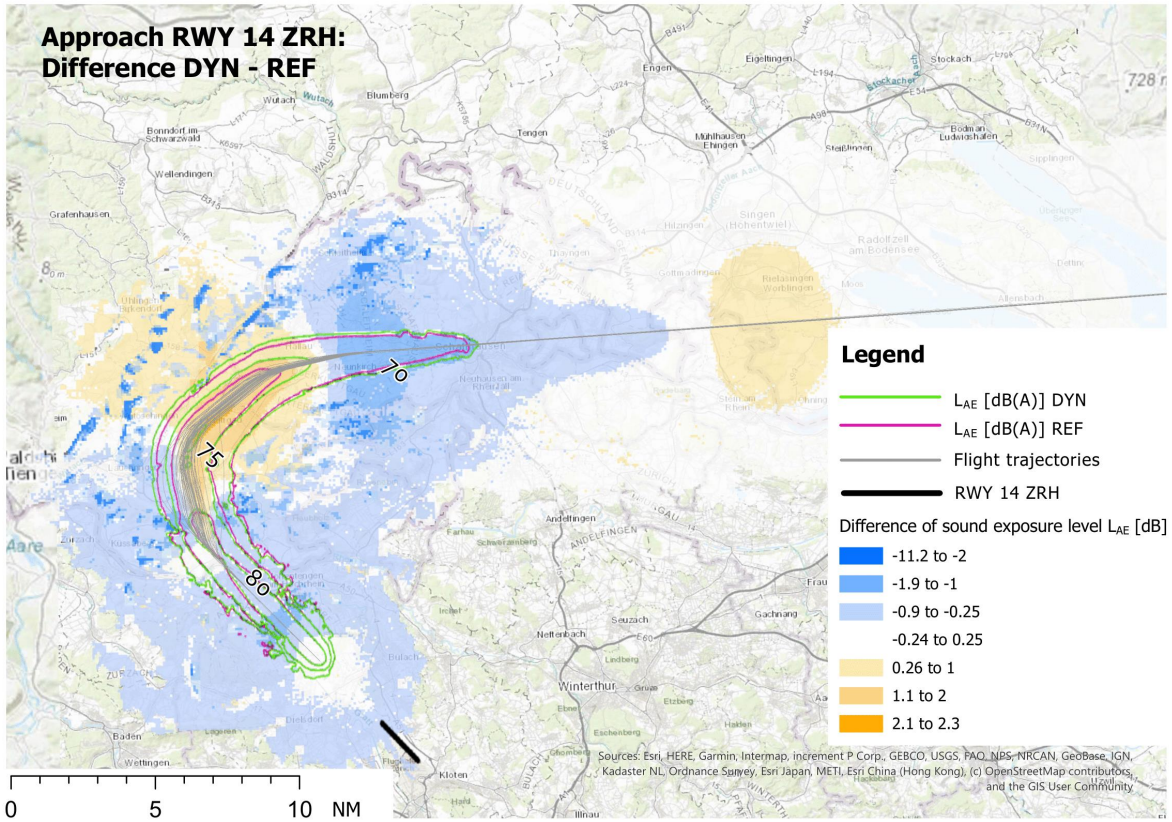


Realistic scenarios based on real flight data with over-energy situations caused by a shortcut.

Prototype Testing: Results

Fuel & Noise Reduction



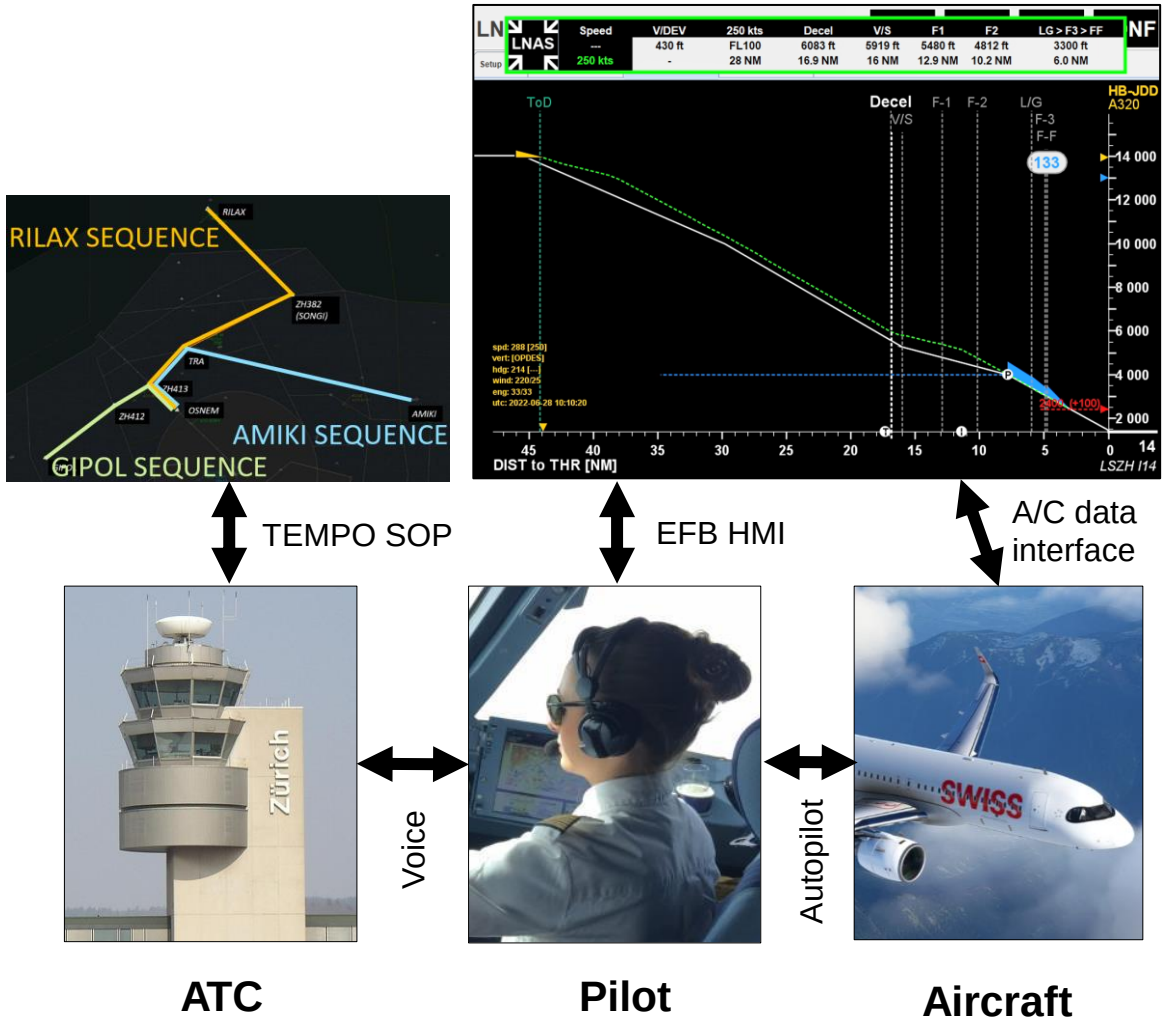


DYNCAT facilitates the anticipation of the global energy dissipation strategy while enabling idle thrust profiles. It reduces noise emissions and fuel burn. Balanced approach with noise trading in the far distance.

SESAR VLD 2 ALBATROSS

Exercise 03 – Demonstration of Idle Thrust Approaches in Revenue Ops on A320neo

- Simulation model adaptation to A320neo flight physics
- HMI improvement validation
- 44 Evaluation pilots
- Temporary ATC Procedure for ILS RWY 14: Skyguide approved a temporary **closed-path waypoint sequence** with different default speed schedules (so-called “Albatross Sequence”).
- **Phase I (Jul-Aug 2022)**: Reference flights – closed-lateral path with target speed 170 kt at FAF without LNAS pilot assistance system
- **Phase II (Sep-Nov 2022)**: Flights along closed lateral path with LNAS pilot assistance system
- **Results expected for January 2023**



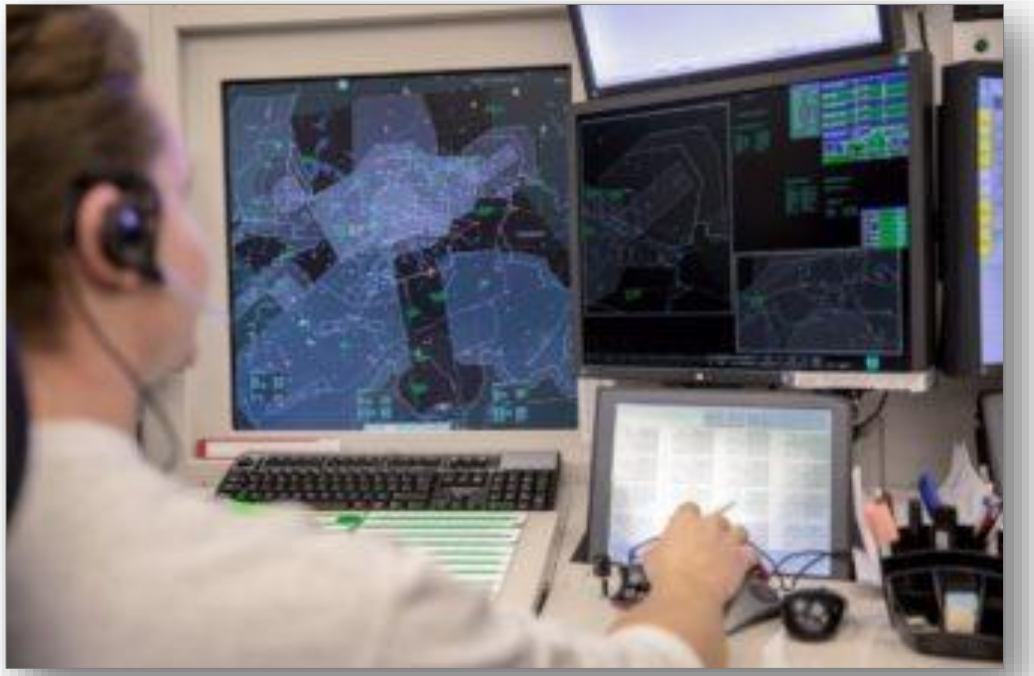
LUFTHANSA GROUP skyguide DLR SWISS

Recommendations to ATC for Idle Approaches

Support with accurate information about the distance-to-go (DTG)

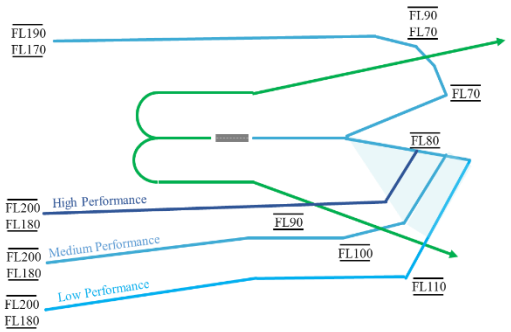
Provide more information and make use of flexibilities:

- **More reliable Distance-to Go** (DTG) information:
  - *«Cleared for the approach via WPTxx, WPTxy, FAF»*
  - *«Expect 40NM track miles»*
- **Flexibility in ATC** assignments for speed and altitude wherever feasible. Rather use targets than fixed instructions for rate and speed:
  - *«Descend when ready»*
  - *«Start reducing speed to reach 180kt at FAF»*
  - *«Reduce speed 200kt or less»*
  - *«Maintain 160kt or more»*
  - *«Follow the speed constraints on STAR»*
  - *«Expect FL 100 at WPT x»*
  - *«You are in sequence behind heavy at 10 NM final»*
  - *«No traffic behind, do you prefer own line-up?»*



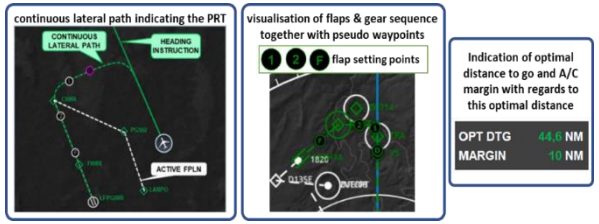
Follow-Up Project: Combining ATM Side & Airborne Side

Solving the lateral path problem to enable idle thrust approaches

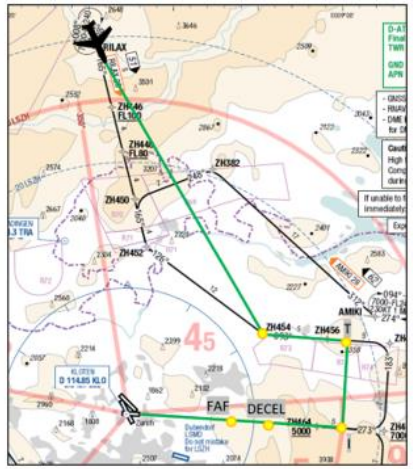


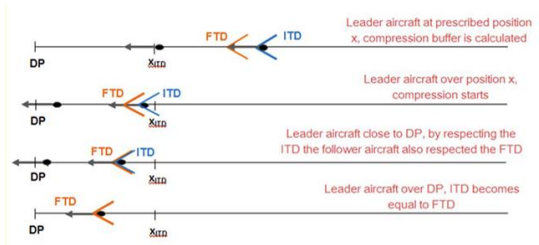
Dynamic Route Structures for closed-path PBN clearances

CPDLC with capacity to upload ATC constraints

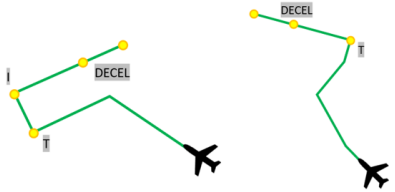


On-board energy management function & permanent trajectory based on ATC constraints





Landing Optimized Runway Delivery (LORD) with Final Target Distance (FTD) Indicator to maintain high capacity



ADS-C EPP downlink of additional pseudo-waypoints (e.g. point of deceleration) to display aircraft capability / RTA capability

ATM Side

New Structures & Procedures

Novel Communication

Airborne Side

Enhanced Avionics

Follow-Up Project: Combining Airborne Side & ATM Side

Solving the lateral path problem to enable idle thrust approaches

1) The current DYNCAT FMS prototype is embedded in the scope of a fully operational concept which has to be further developed in the next step of a follow-up project (DYN-MARS: Dynamic Management of Aircraft Configuration and Route Structures).
2) The lateral path determination on board should be extended to consider different Permanent Resume Trajectory (PRT) options and to enable PBN procedures within the TMA.
3) ALBATROSS EXE 03 to demonstrate feasibility of closed-path PBN procedures with reliable and predictable aircraft speed schedules. Paradigm shift from purely tactical vectoring towards “less-invasive” air traffic management in TMA while maintaining high capacity.
4) If combined with on-board energy management functions and extended datalink communication (ADS-C EPP), closed PBN procedures will a) lower the noise footprint compared to lateral path spreading with purely tactical radar vectoring and b) at the same significantly reduce fuel burn.

Thank you for your attention

Questions?