Independent curved approach procedures – safe and feasible?*

ICANA 2016
Dr. Bernd Korn, Tobias Finck, Vilmar Mollwitz, Dr. Christian Hanses,
Tim Stelkens-Kobsch

DLR – Institute of Flight Guidance

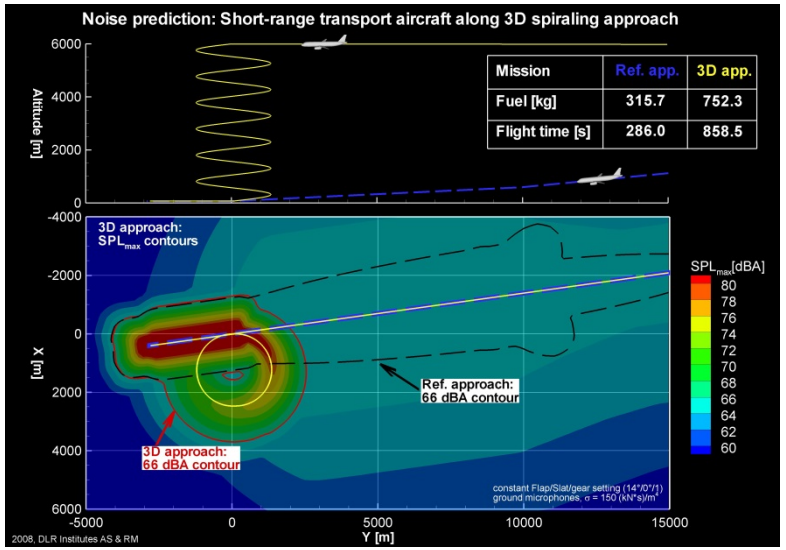
*Supported by UNH, FRAPORT, DFS

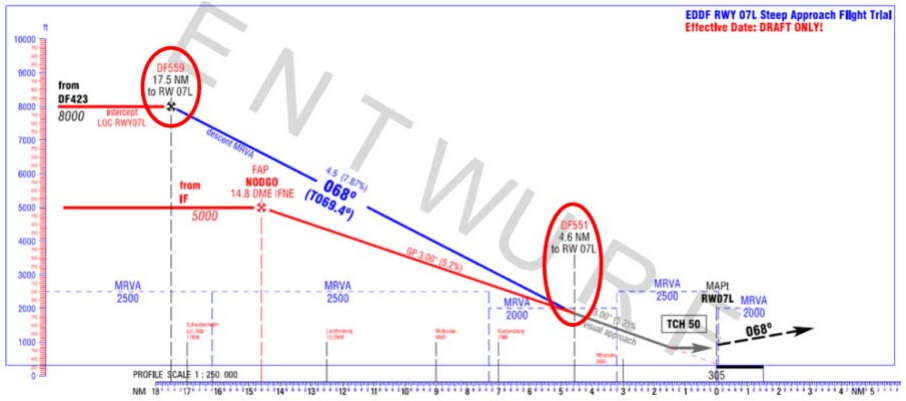
How to design Noise Abatement Approach Procedures?

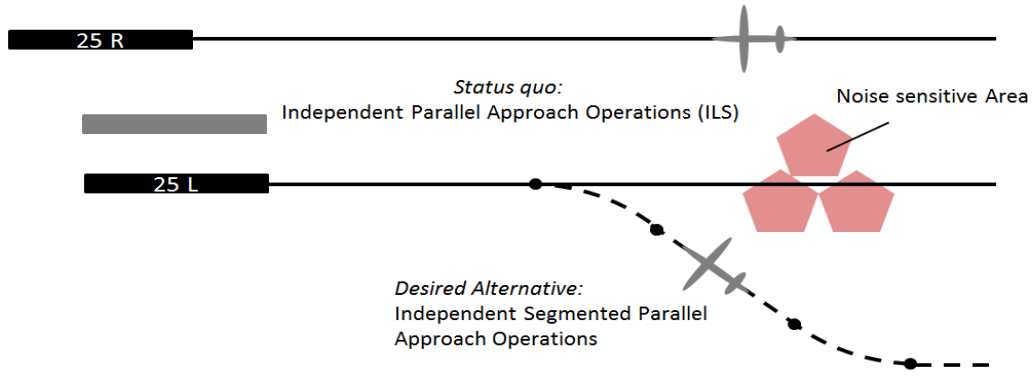
Optimize approach profiles:

1. Clean and idle as long as possible

2. Increase distance between a/c and population
   1. Higher approach profiles
   2. Lateral avoidance of populated areas



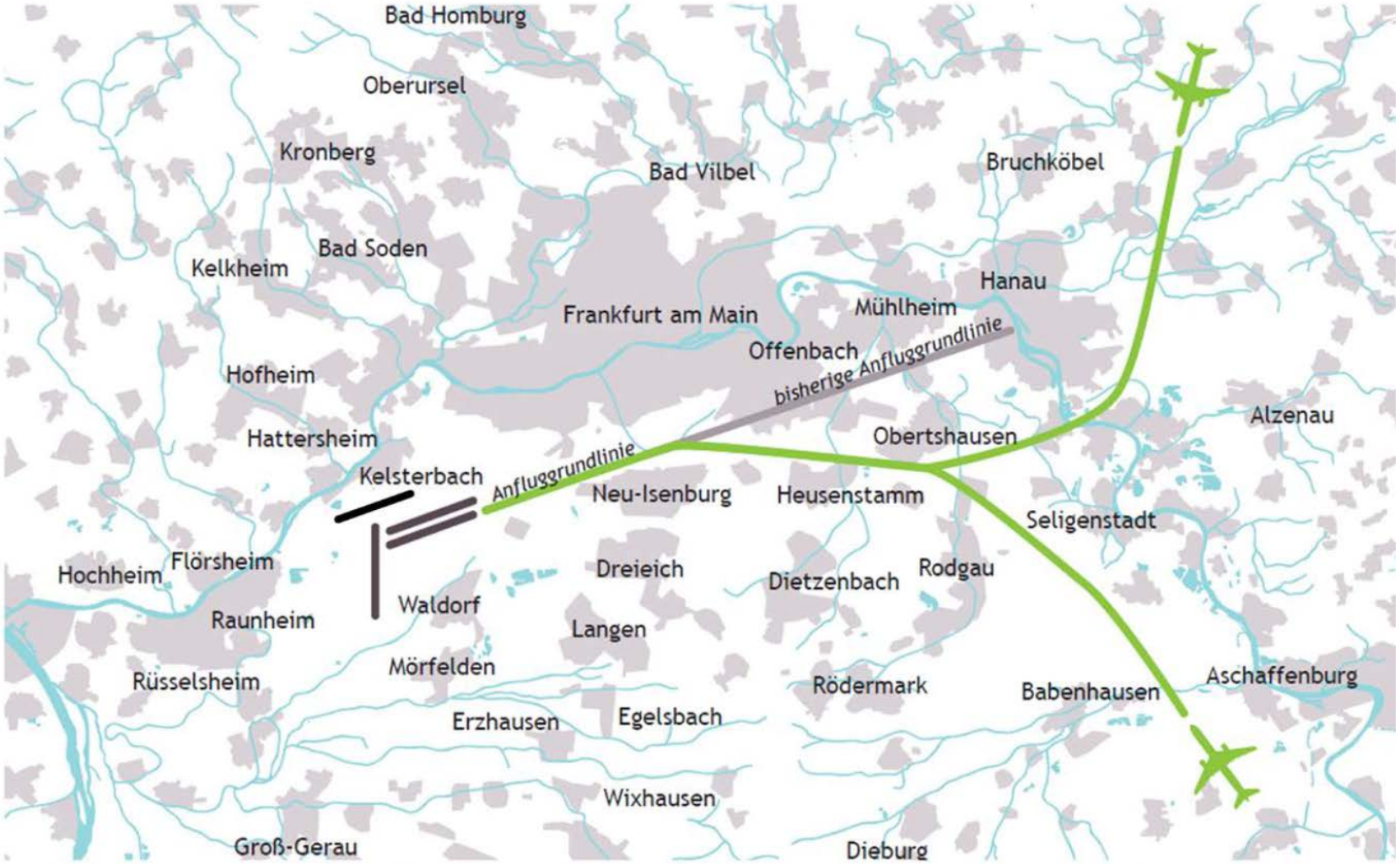




Segmented RNAV GPS Approach

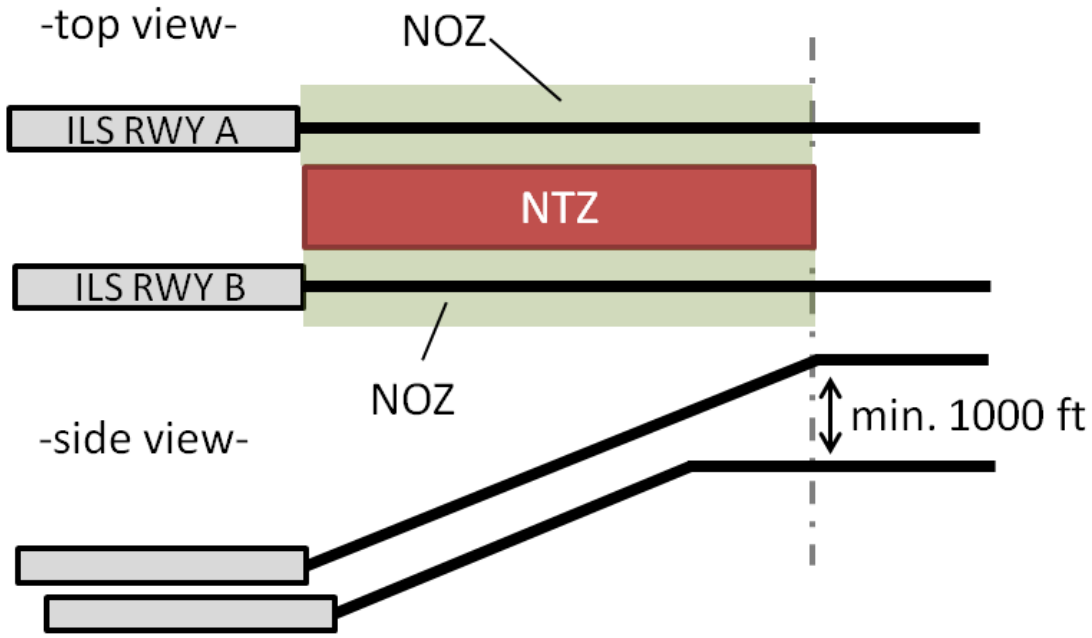
But:

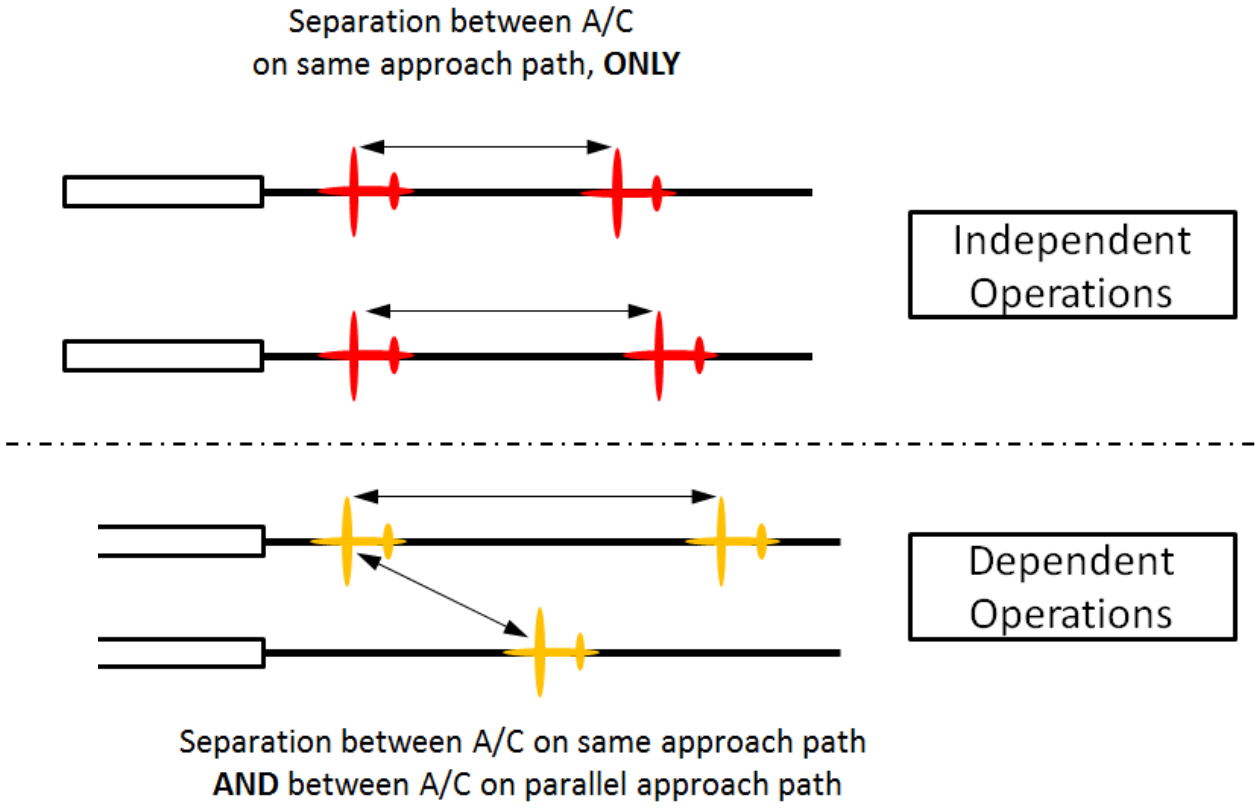
- No independent parallel approaches to RWY system
- Only applicable today between 23:00 and 05:00



Independent Approaches to Parallel Runways

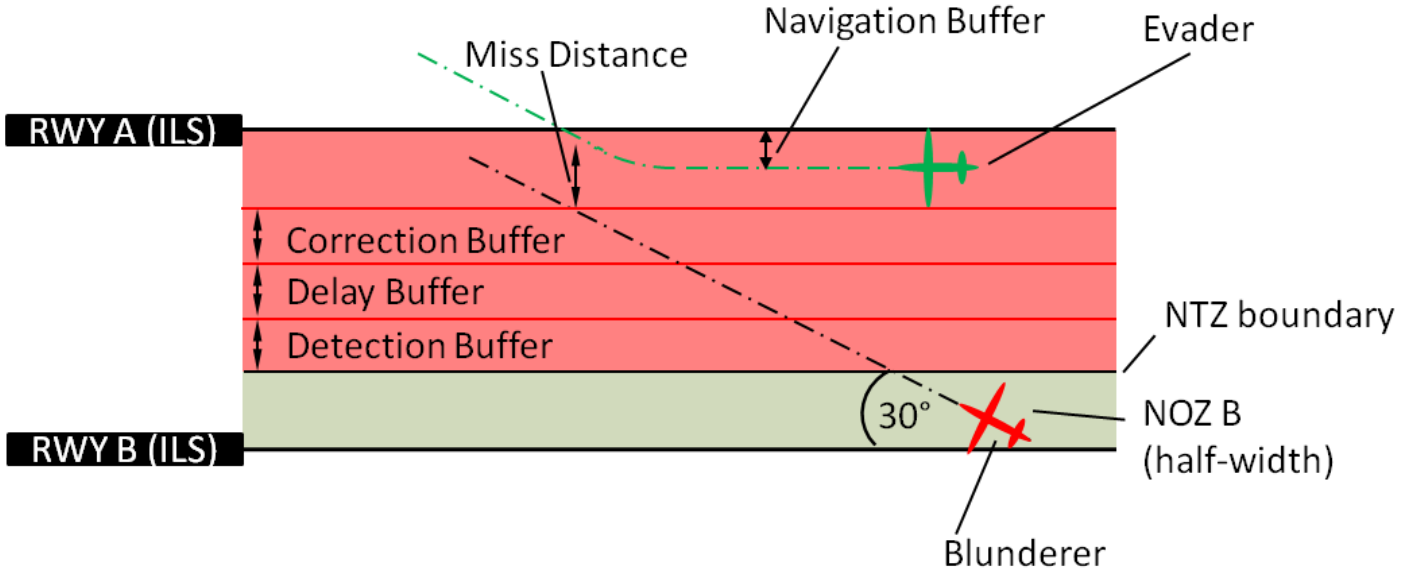
- Straight approaches
- Runway spacing at least 3400 ft (1036 m)
- Precision approaches (ILS or MLS)
- Implementation of a ground-based runway monitoring system, classically: Radar Surveillance





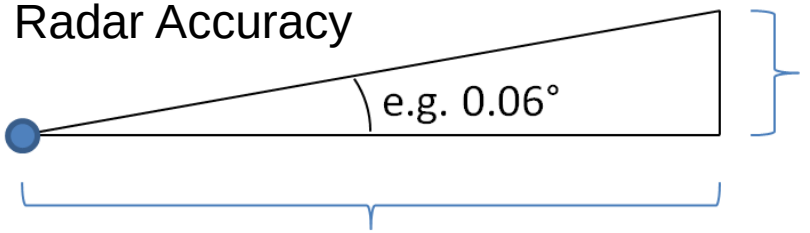
Where do the Minimum RWY Spacing Requirements Come From? ICAO's Safety Case

Safety concept based on a worst-case "blunder" scenario



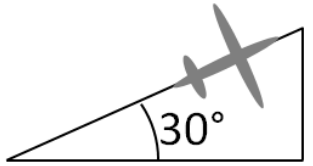
Size of Detection Buffer: → 120 m

Radar Accuracy



ICAO Standard: 10 NM

+ Radar Update Rate (2,5s)



$$d = t * v * \sin(30°)$$

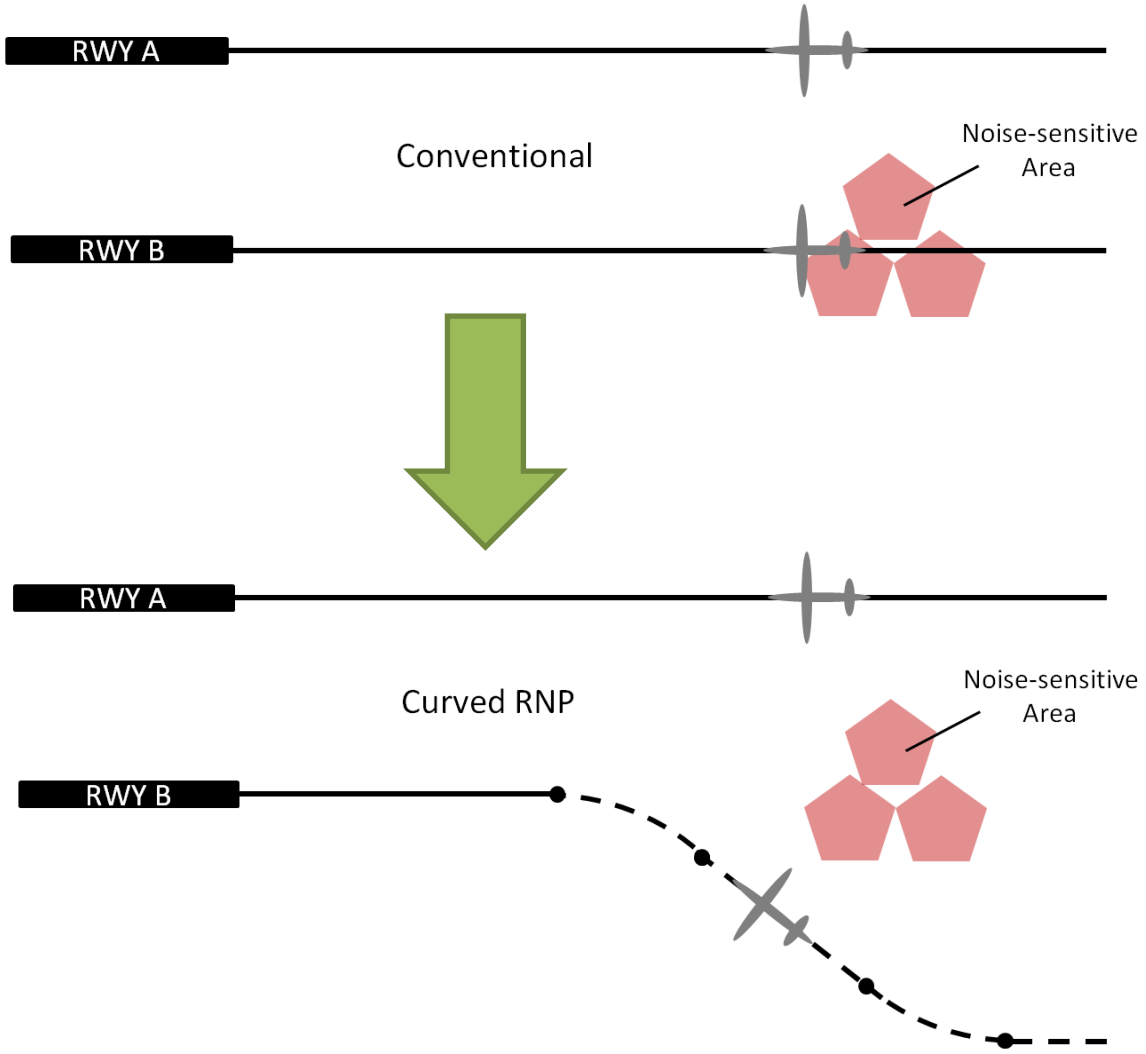
t: $Update\ Rate$

v: $150\ kt$

→100 m

→ 3400 ft (1036 m) Minimum RWY Spacing

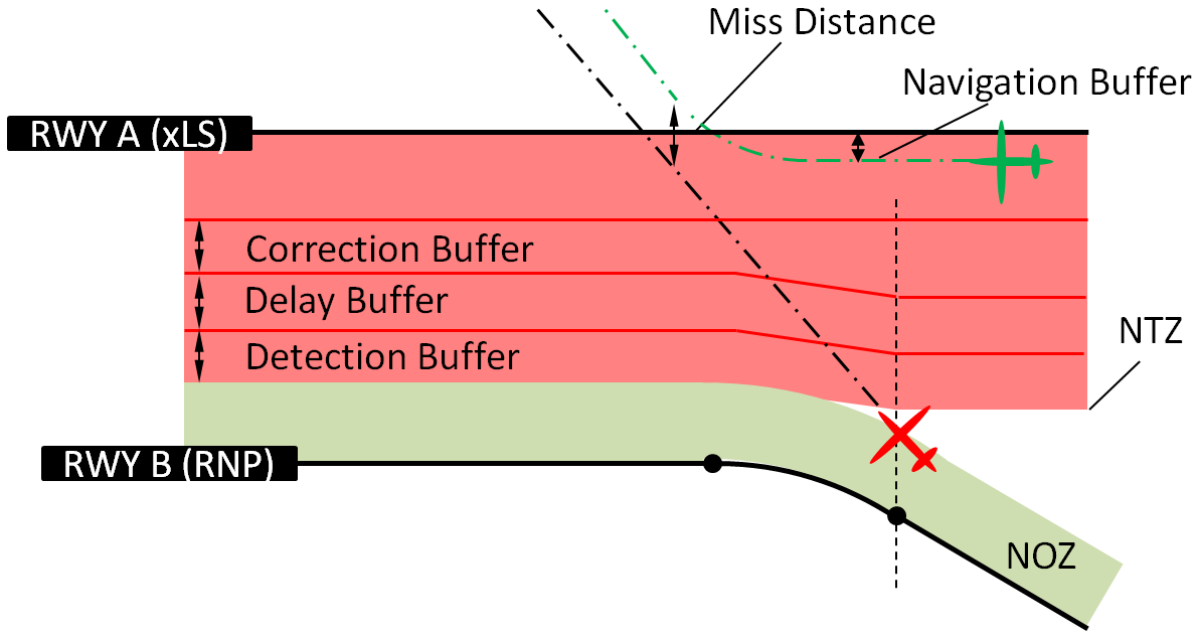
Independent curved approach procedures – safe?



Approach:

- RNAV Segmented → Advanced RNP
- Redimensioning of Normal Operating Zones (NOZ) and No Transgression Zone (NTZ) based on modified worst-case blunder scenarios
- Assumption: Worst-case blunder angle still 30° w.r.t. current approach track

Independent curved approach procedures – safe?

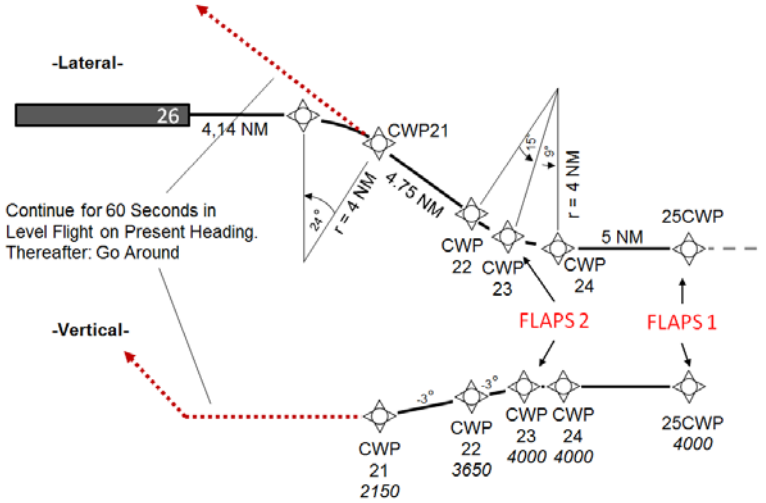


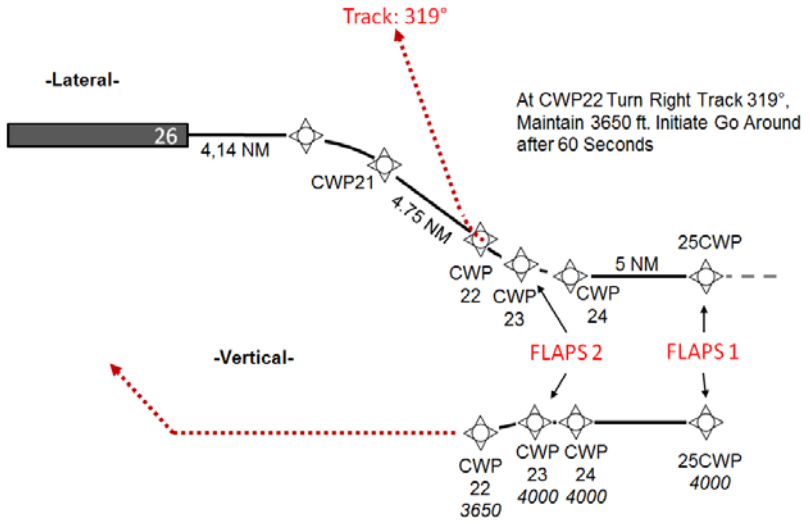
Assumption:

- Curved approach: RNP AR 0.3 ≈ Advanced RNP
- Blunder from curved approach
- Assumption: Worst-case blunder angle still 30° w.r.t. current approach track

Minimum RWY spacing required: 1750 m

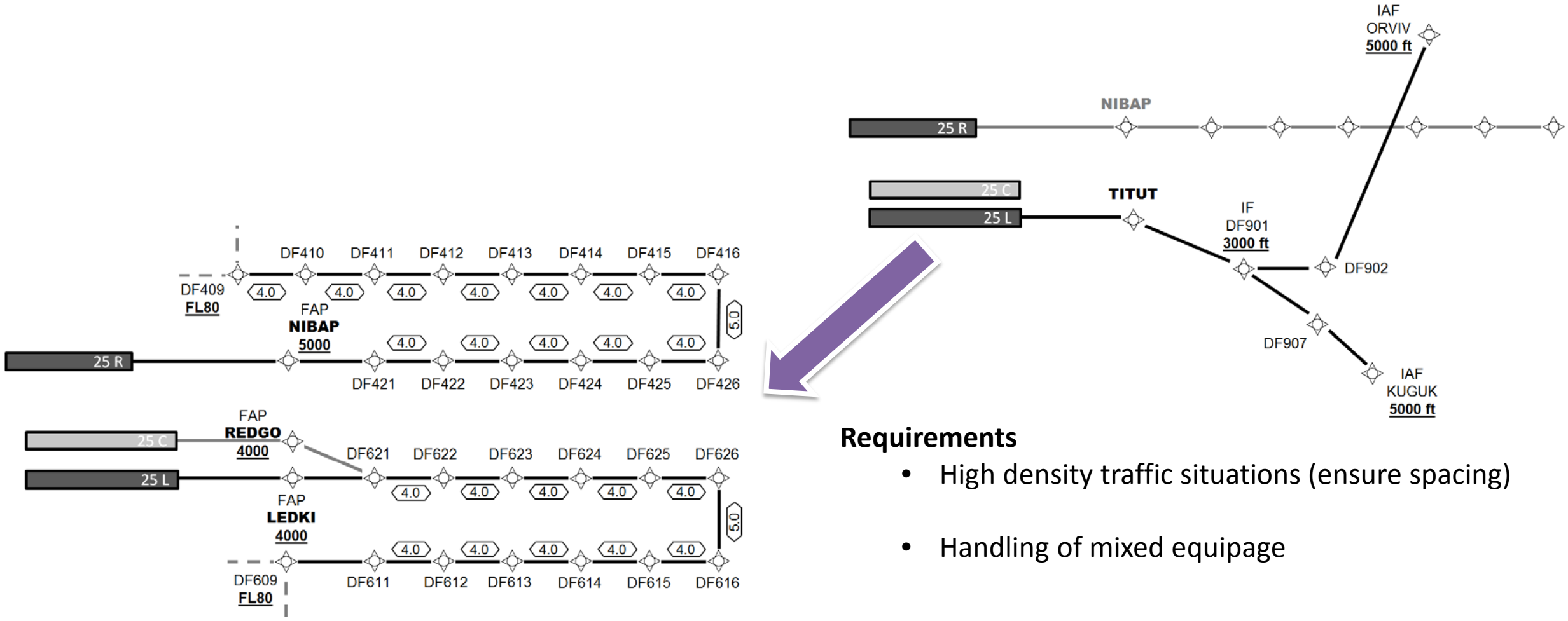
A320 ATRA Flight trials to validate assumptions at Braunschweig Airport





A320 ATRA Flight trials: Results

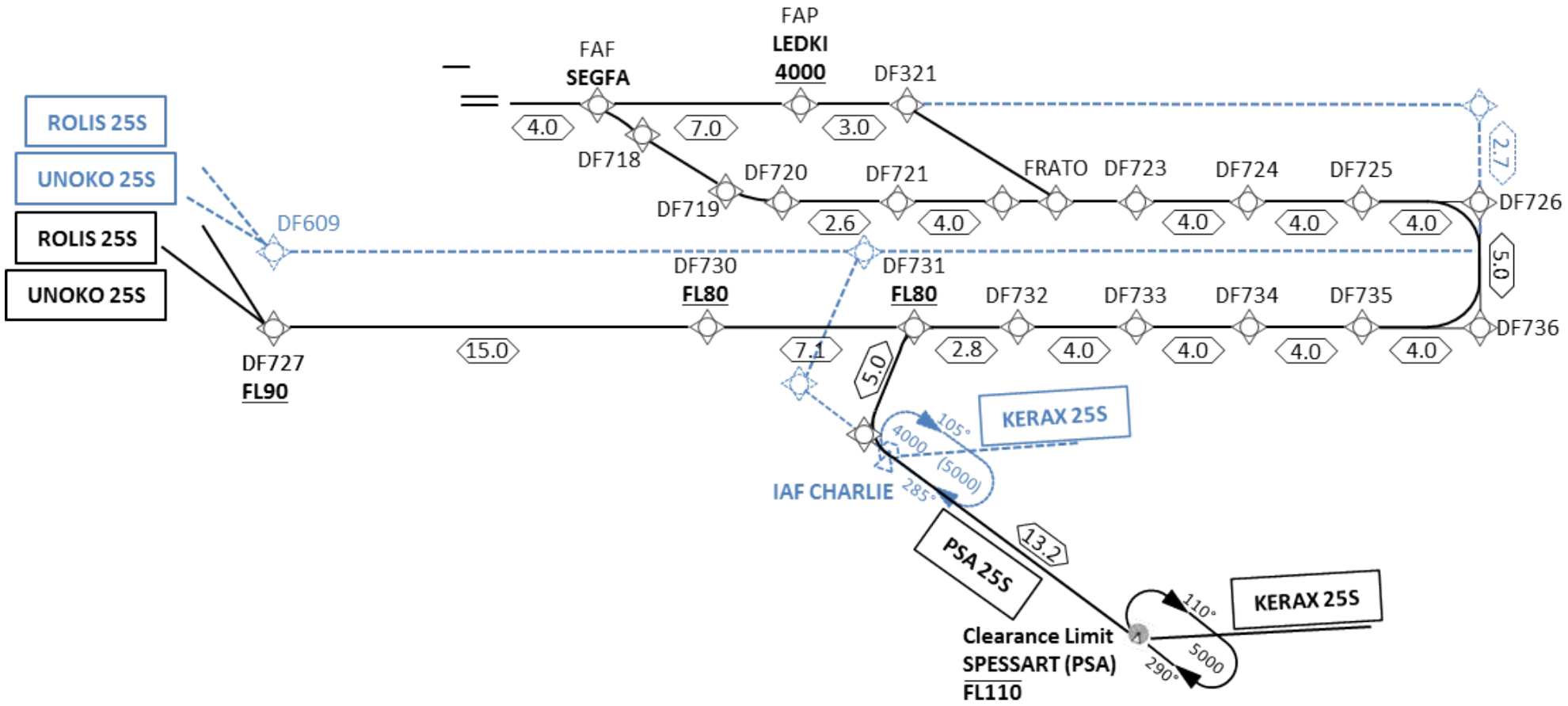
Independent curved approach procedures – operationally feasible?



Requirements

- High density traffic situations (ensure spacing)
- Handling of mixed equipage

New Route Structure



Real Time Simulation to assess Operational Feasibility

- Two weeks of simulation with 6 Controllers from DFS

- Focus on approach to RWY 25L (curved approach or ILS-approach)
  - No analysis of blunder scenarios, missed approach procedures
- Per simulation run:
  - 2 controller workstations (Feeder und Pickup)
- Curved approach: all aircraft with RNP-capability
- ILS-approach: all aircraft without RNP-capability
- Controller knows which aircraft are certified for RNP-approach

- Variation of Traffic and RNP-capability (segmented approach vs. ILS-approach) → six scenarios
- Every controller did every scenario on every position

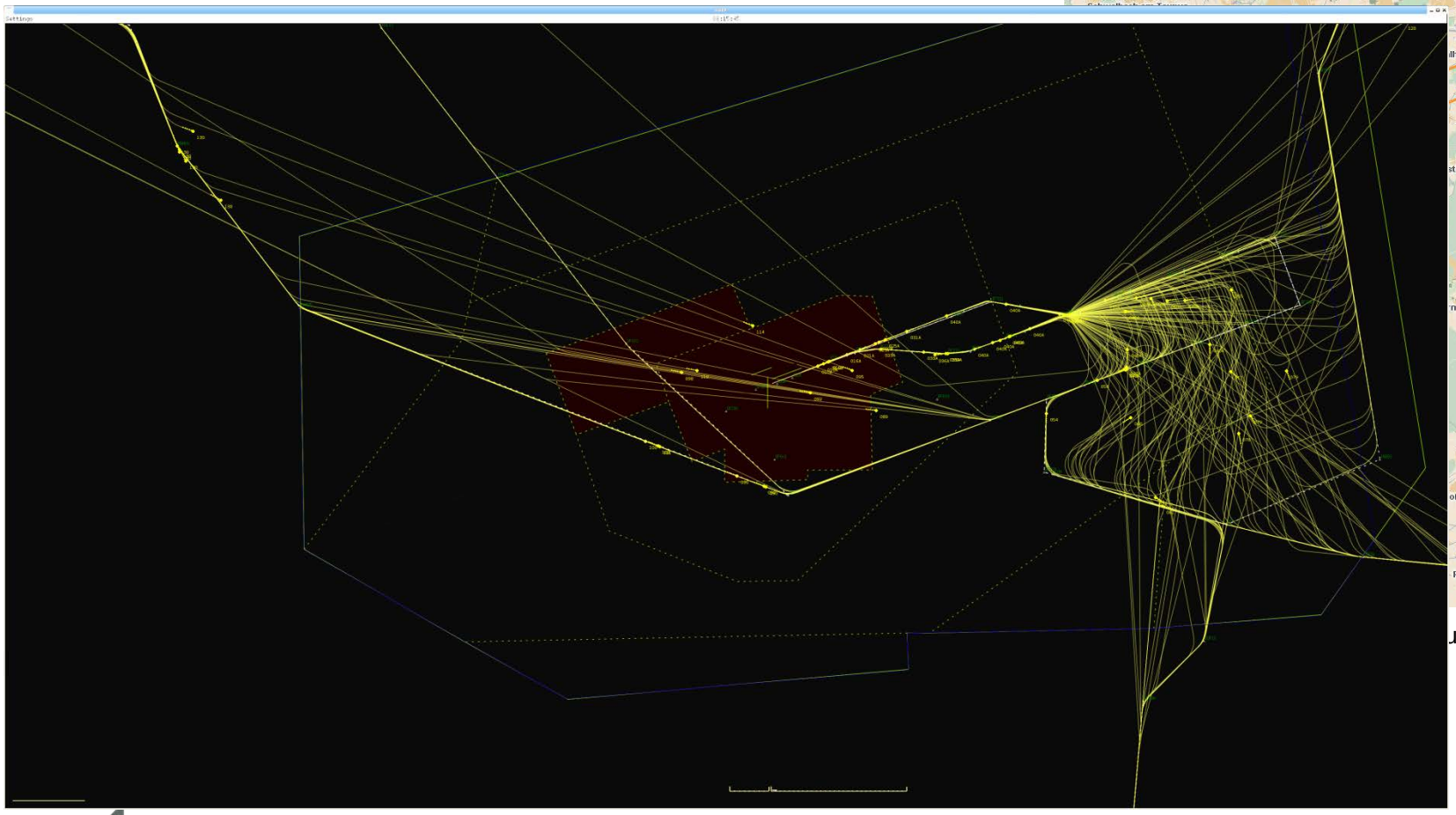
Real Time Simulation – Setup

- Flight plan 2014: busy summer day
  (core time 07:30 – 08:30 / RWY 25L: 28 approaches per hour)
    - Variation of RNP-capability
        - 50 % segmented approach/ 50 % ILS approach
        - 80 % segmented approach / 20 % ILS approach
        - 100 % segmented approach / 0 % ILS approach

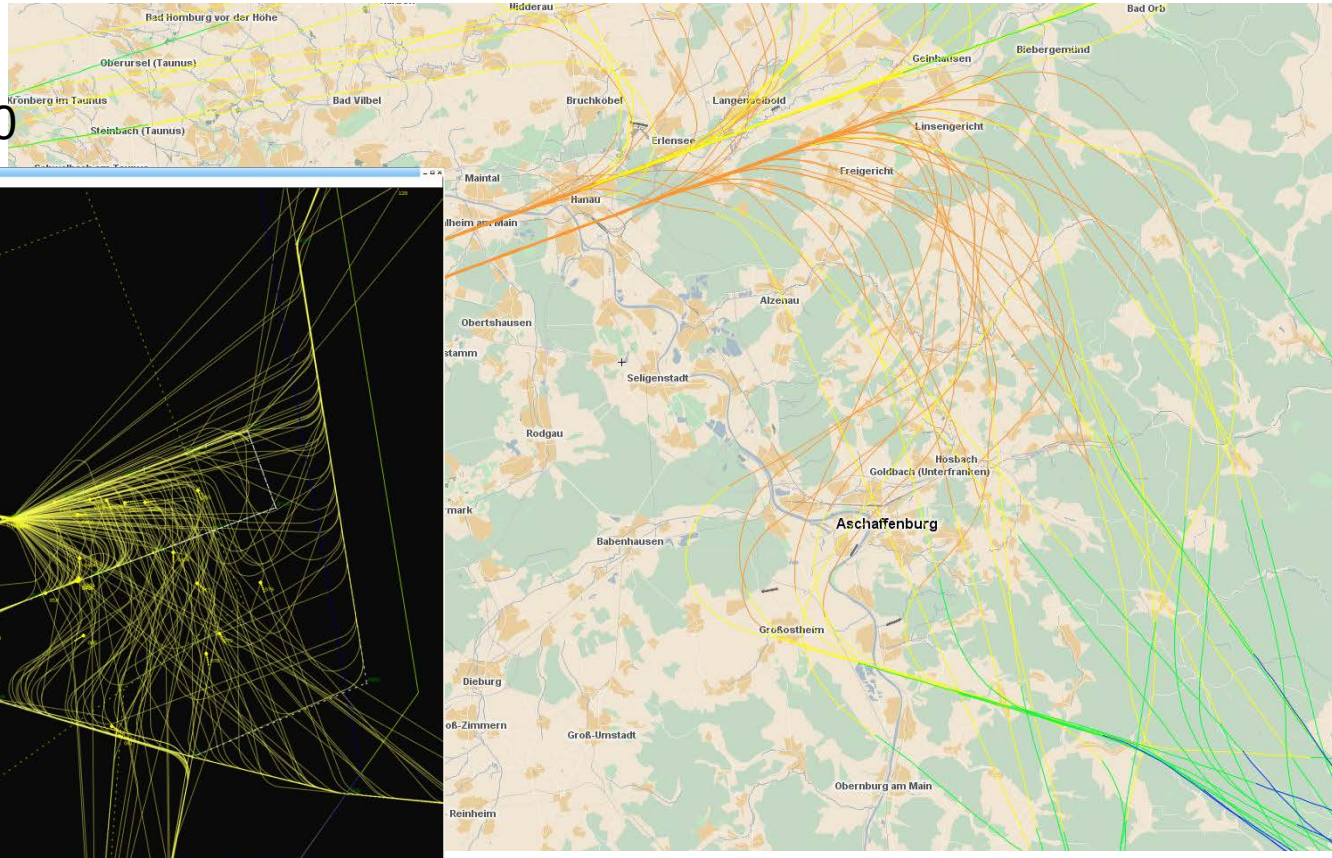
- Flight plan 2022: forecast Fraport
  (core time 10:30 – 11:30 / RWY 25L: 32 approaches per hour)
    - Variation of RNP-capability
        - 50 % segmented approach / 50 % ILS approach
        - 80 % segmented approach / 20 % ILS approach
        - 100 % segmented approach / 0 % ILS approach

Real Time Simulation Results – Flightpath

Scenario 1 – 2014 (50% RNP – 50% ILS) – 07:30 - 08:30



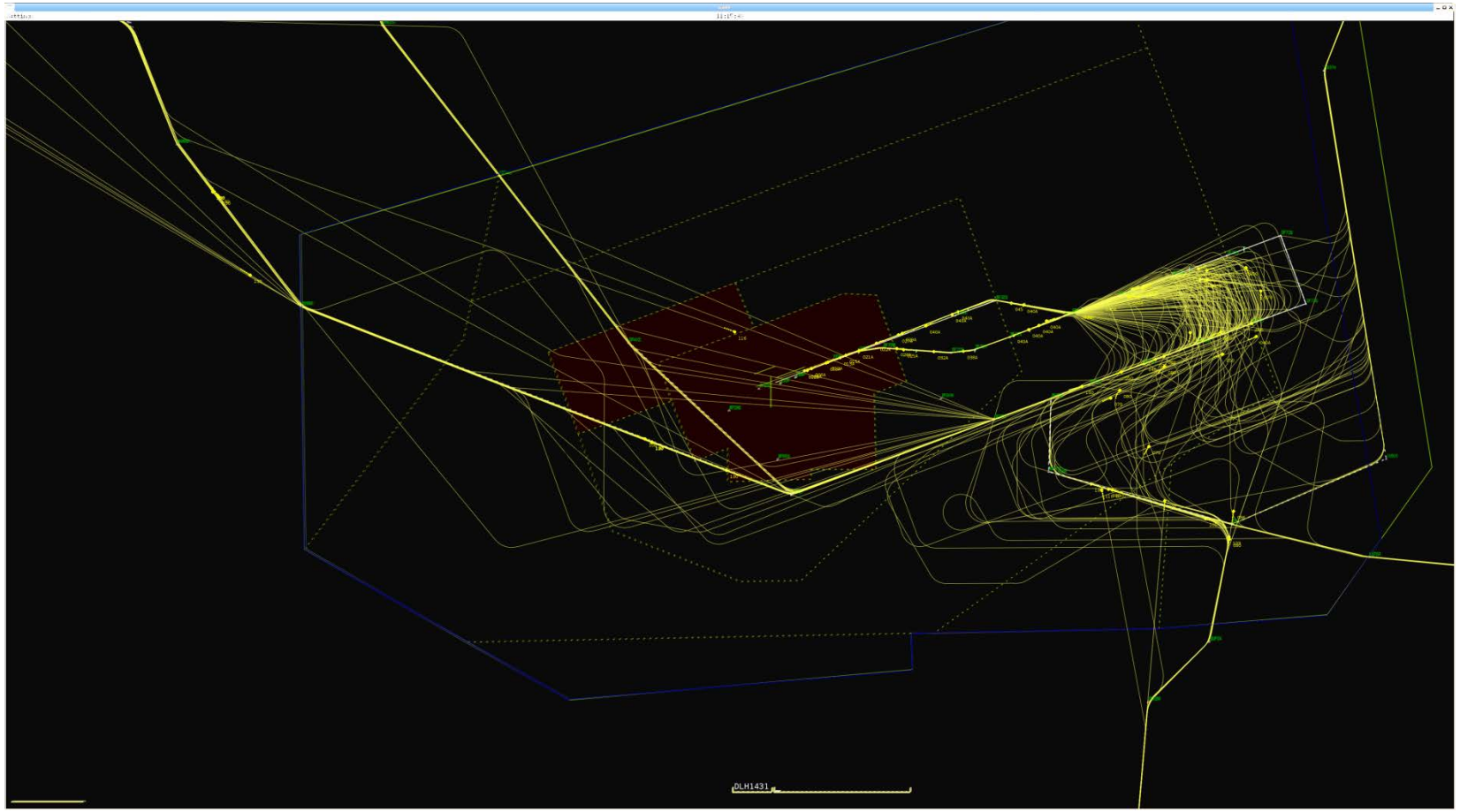
Radar tracks 07:30 – 08:30 (29.09.2016, real world)



uelle: DFS Deutsche Flugsicherung GmbH; STANLY_Track Frankfurt; URL: https://www.dfs.de/dfs_homepage/de/Flugsicherung/Umwelt/Flugverl%C3%A4ufe%20online/Frankfurt/; [14.10.2016]

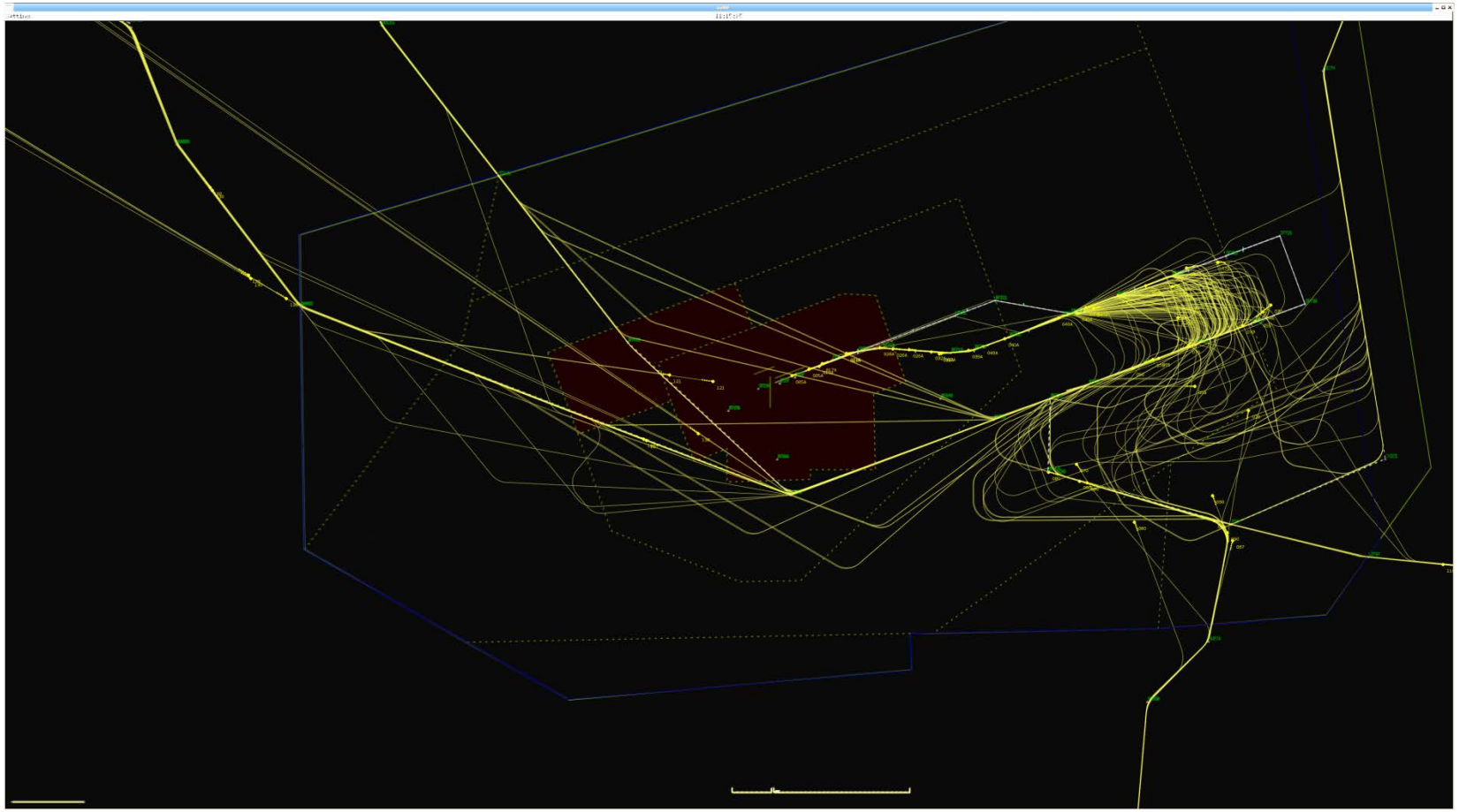
Real Time Simulation Results – Flightpath

Scenario 4 – 2022 (50% RNP – 50% ILS) – 10:30 - 11:30

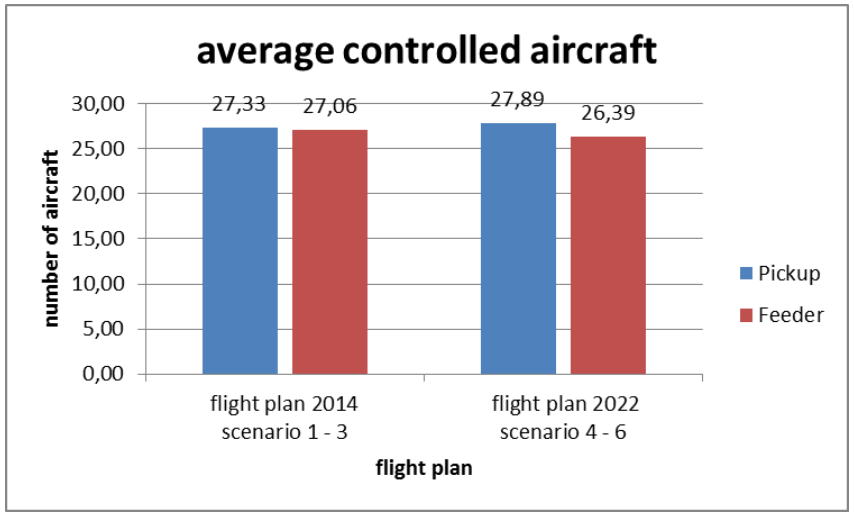


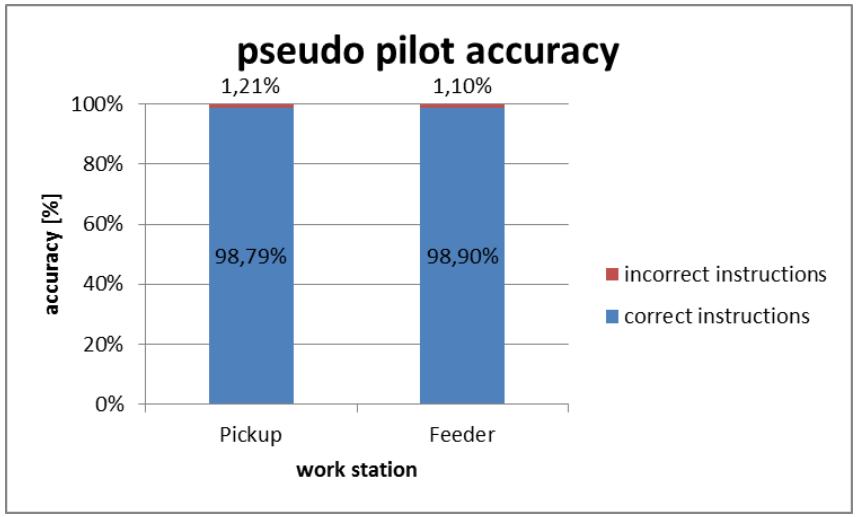
Real Time Simulation Results – Flightpath

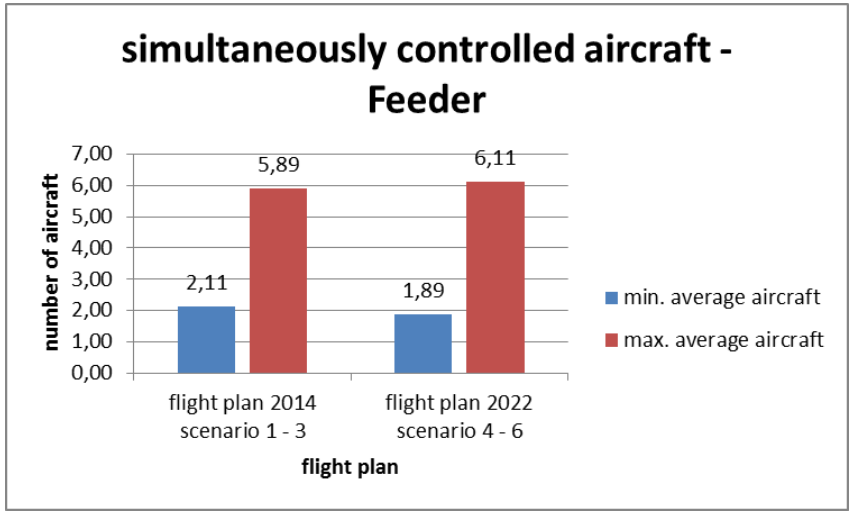
Scenario 6 – 2022 (100% RNP – 0% ILS) – 10:30 - 11:30

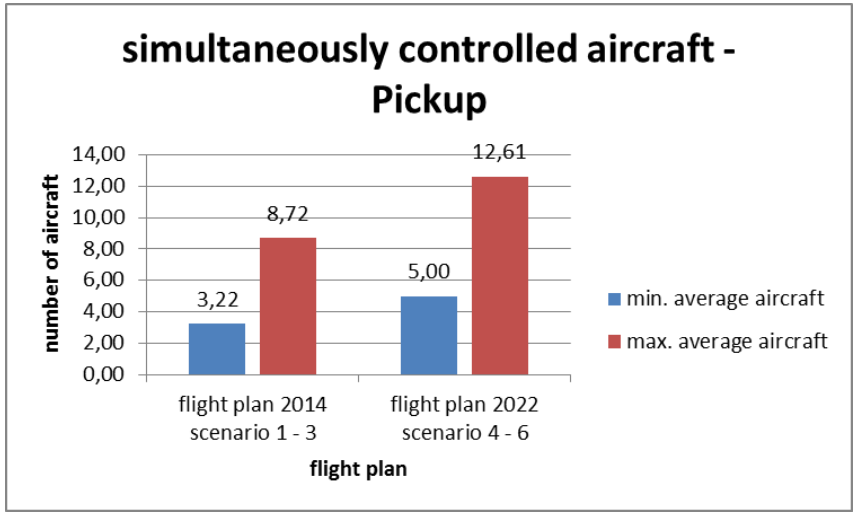


Real Time Simulation Results – Performance

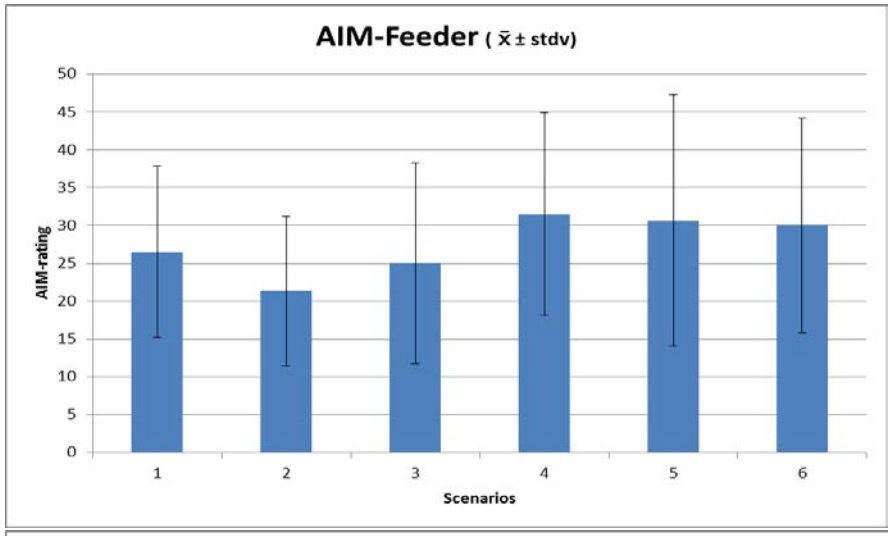


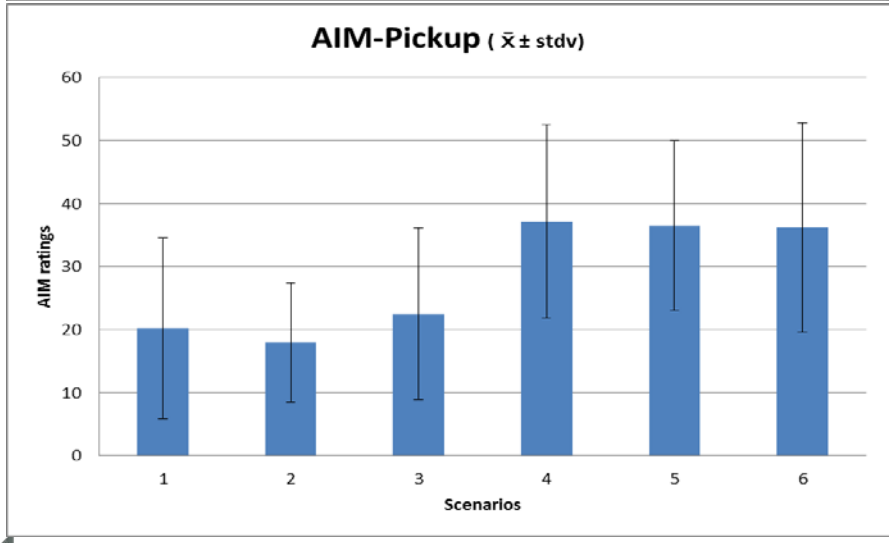






Real Time Simulation Results – Mental Workload (AIM)

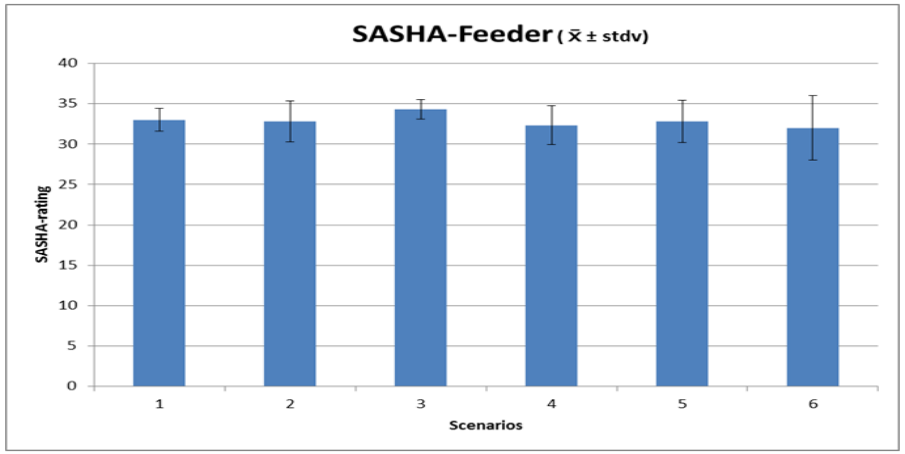


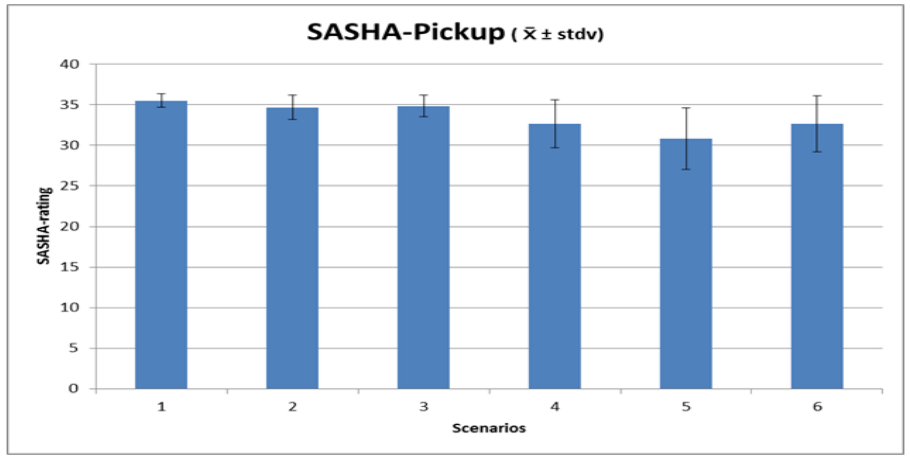


Scenario	Aver	Stdv	Σ/20
1	26,50	11,33	1,33
2	21,33	9,91	1,07
3	25,00	13,30	1,25
4	31,50	13,41	1,58
5	30,67	16,63	1,53
6	30,00	14,21	1,50

Scenario	Aver	Stdv	Σ/20
1	20,17	14,34	1,01
2	18,00	9,44	0,90
3	22,50	13,58	1,13
4	37,17	15,37	1,86
5	36,50	13,43	1,83
6	36,17	16,59	1,81

Real Time Simulation Results – Situation Awareness (SASHA)

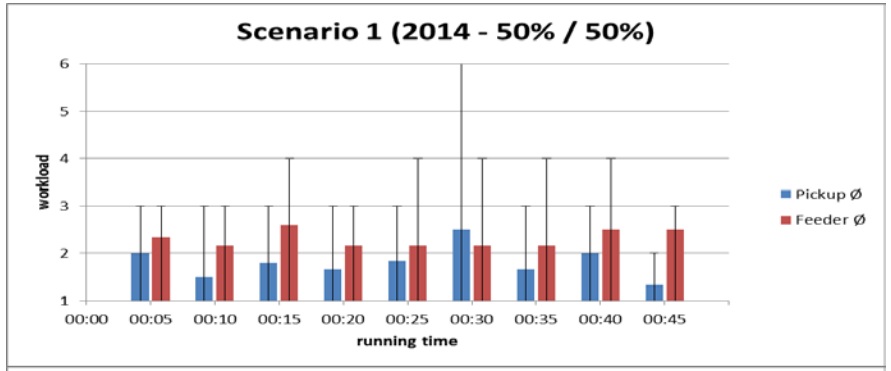


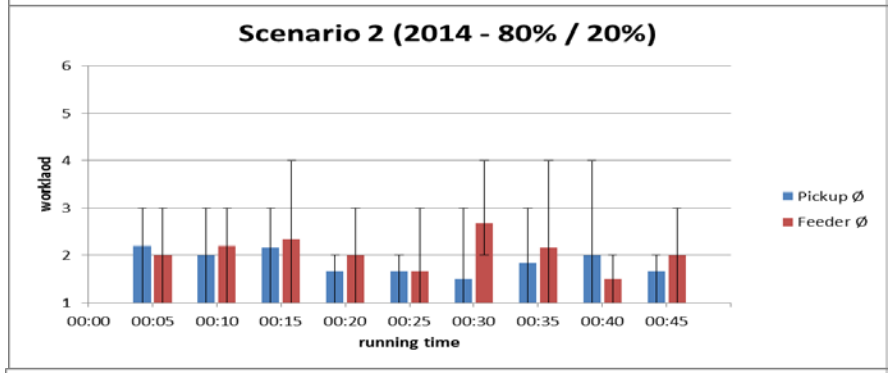


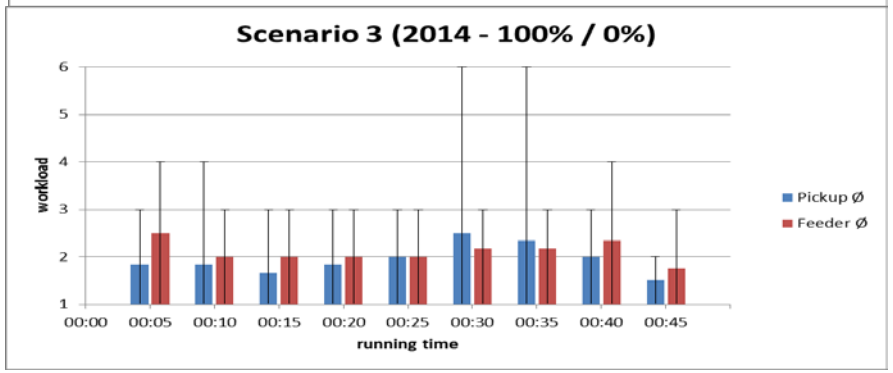
Scenario	Aver	Stdv	Σ/6
1	33,00	1,41	5,50
2	32,83	2,56	5,47
3	34,33	1,21	5,72
4	32,33	2,42	5,39
5	32,83	2,64	5,47
6	32,00	4,00	5,33

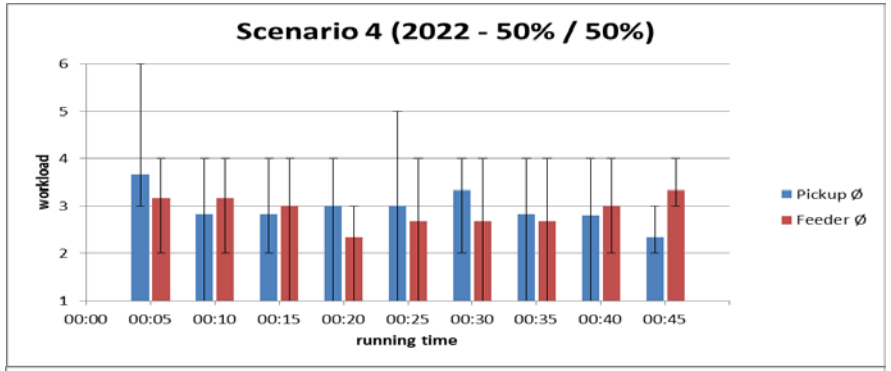
Scenario	Aver	Stdv	Σ/6
1	35,50	0,84	5,92
2	34,67	1,51	5,78
3	34,83	1,33	5,81
4	32,67	2,94	5,44
5	30,83	3,76	5,14
6	32,67	3,44	5,44

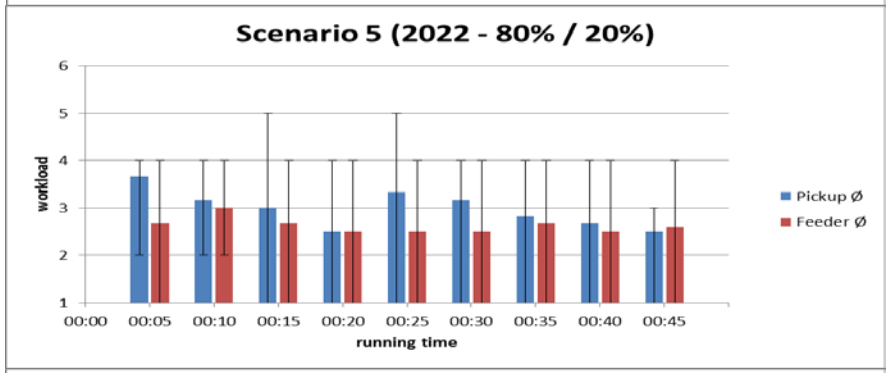
Real Time Simulation Results - ISA

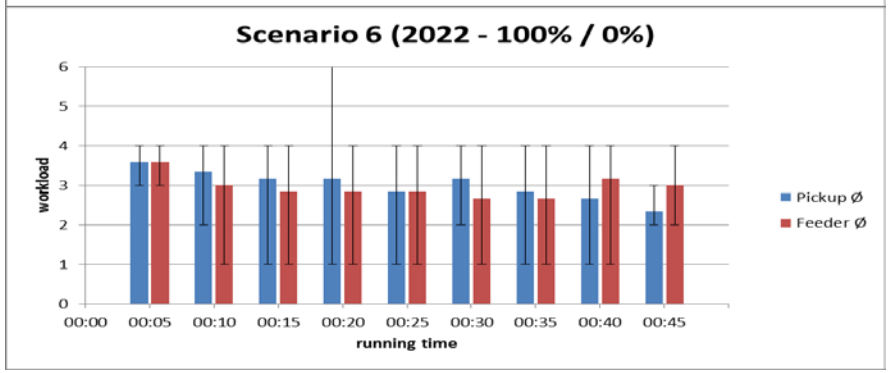












Conclusion from Real Time Simulations

- Procedure is suitable for EDDF
  - Route distance between the waypoints is enough
  - Feeder could handle max. 5 – 6 a/c simultaneously
  - p.r.n. Changes in airspace C
  - p.r.n. reintroduction of holdings

- Subjective measurements could not detect an effect of the percentage of aircraft with RNP capabilities
- Low level of workload and high level of situation awareness in all scenarios
- All controllers can imagine working with the system themselves

→ More studies necessary
  → Real Time Simulation with independent parallel approaches and departures
  → Wind effects
  → Blunder scenarios / Go Around Procedures
  → Speed reduction on the divergent route → aircraft separation

Overall Conclusions

- Independent ILS – Advanced RNP / RNP AR approaches seemed to be possible at Frankfurt
  - → has to be established at ICAO level
  - → option: effect of RNP-to-xLS to be investigated

- First results from Real Time Simulations
  - New route structure enables handling of mixed equipage
  - Envisaged traffic demand should be manageable