

# GAST-A Using SBAS Correction Data

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Knowledge for Tomorrow



# IGWG Denver

## A synchronized common approach is crucial to break the wall and create a positive momentum on GBAS technology deployment



### ANSPs:

- Reduced cost of operation after decommissioning of ILS Technology (at least partially)
- *Implement concepts of operations (and motivate ATCOs), that deliver benefits to Airlines to push equippage rate (e.g. Best Equipped Best Served concept)*

### Airports:

- Reduced impact of aircraft noise by higher glide slope intercept altitudes (avoid low level flight segments) or steeper glideslopes
- Higher airport capacity in low visibility operations (LVO)
- *Establish concepts to clear traffic off the runways in LVO*

### Airlines:

- Strive for high equipage rates of aircraft crucial to realize beneficial effects and to decrease ATC controllers workload (traffic differentiation)
- *Train and motivate pilots to execute GBAS approaches*

### Manufacturers:

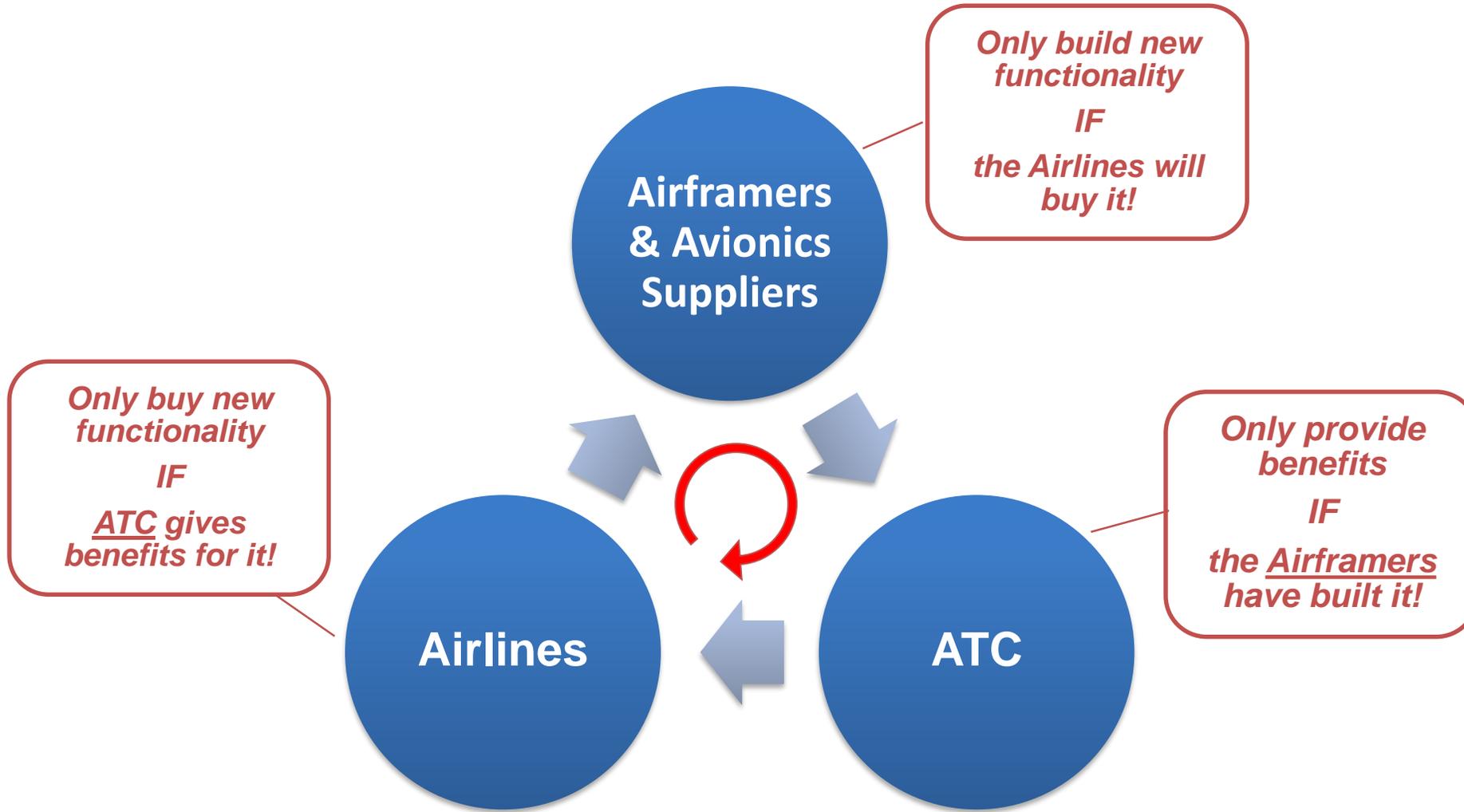
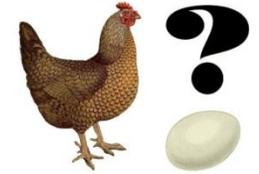
- *Support Airlines (Air) and ANSPs/Airports (Ground) to create business cases for investments and align Ground/Air efforts*

### ICAO/Regulators:

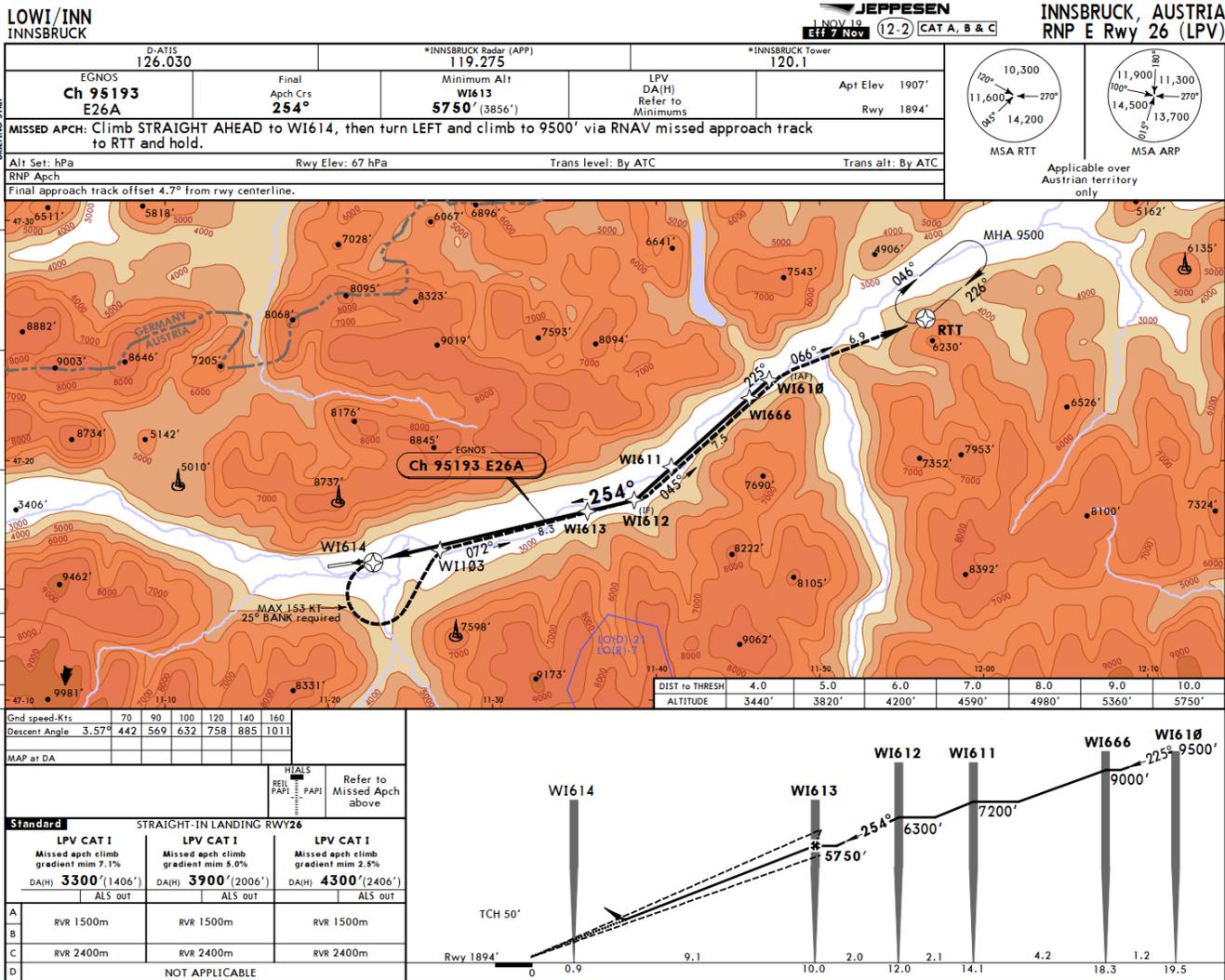
- *Deliver appropriate framework to allow quick progress*



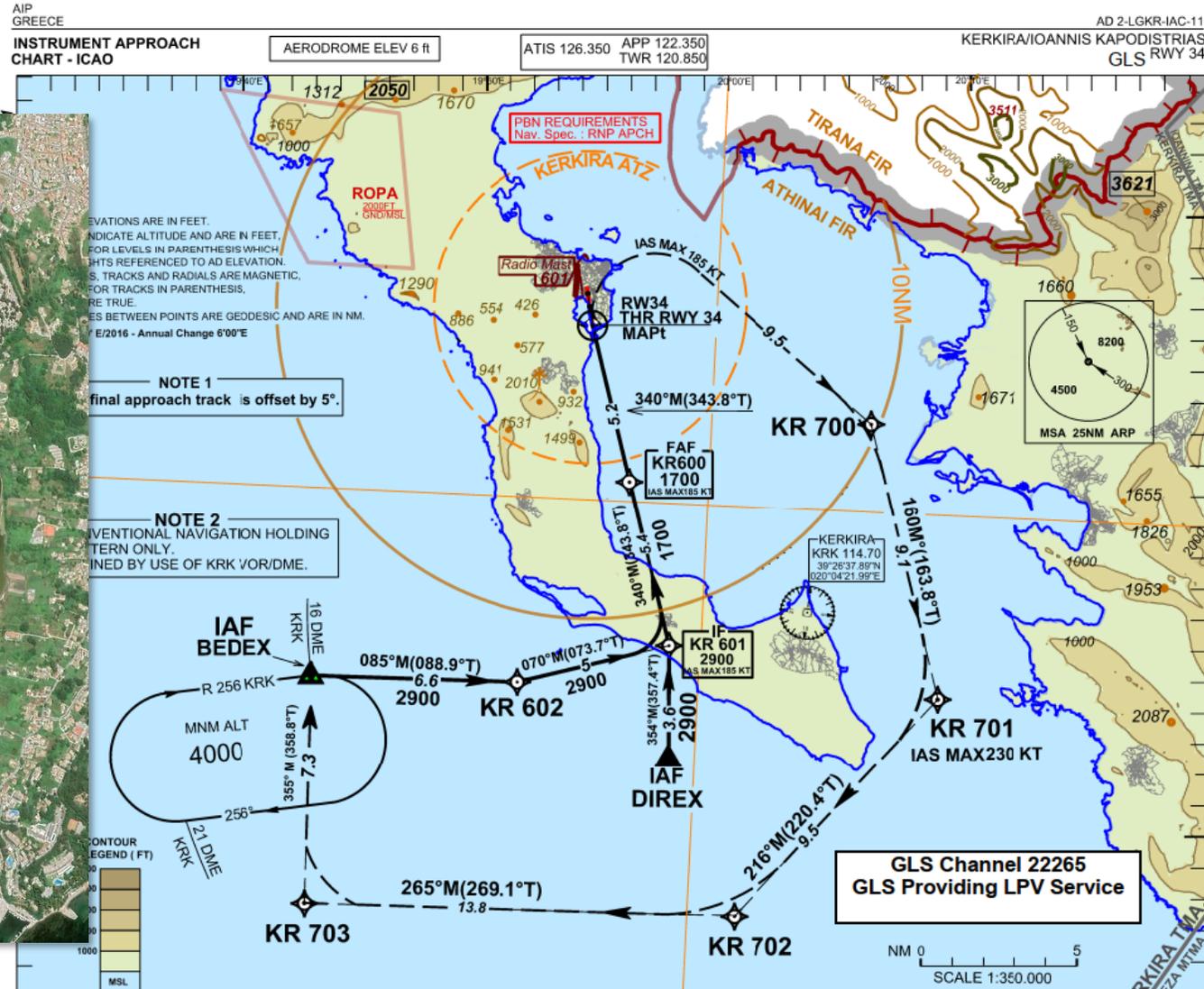
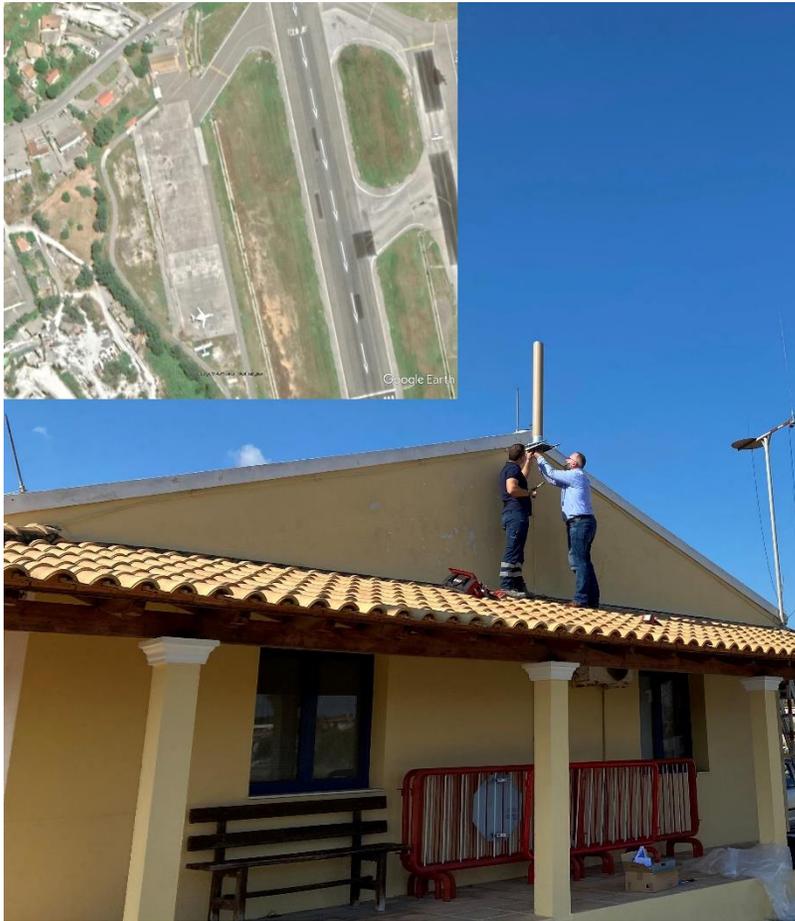
# GLS ... “Chicken-and-Egg Problem”



# Business Case: Approaches with LPV Only

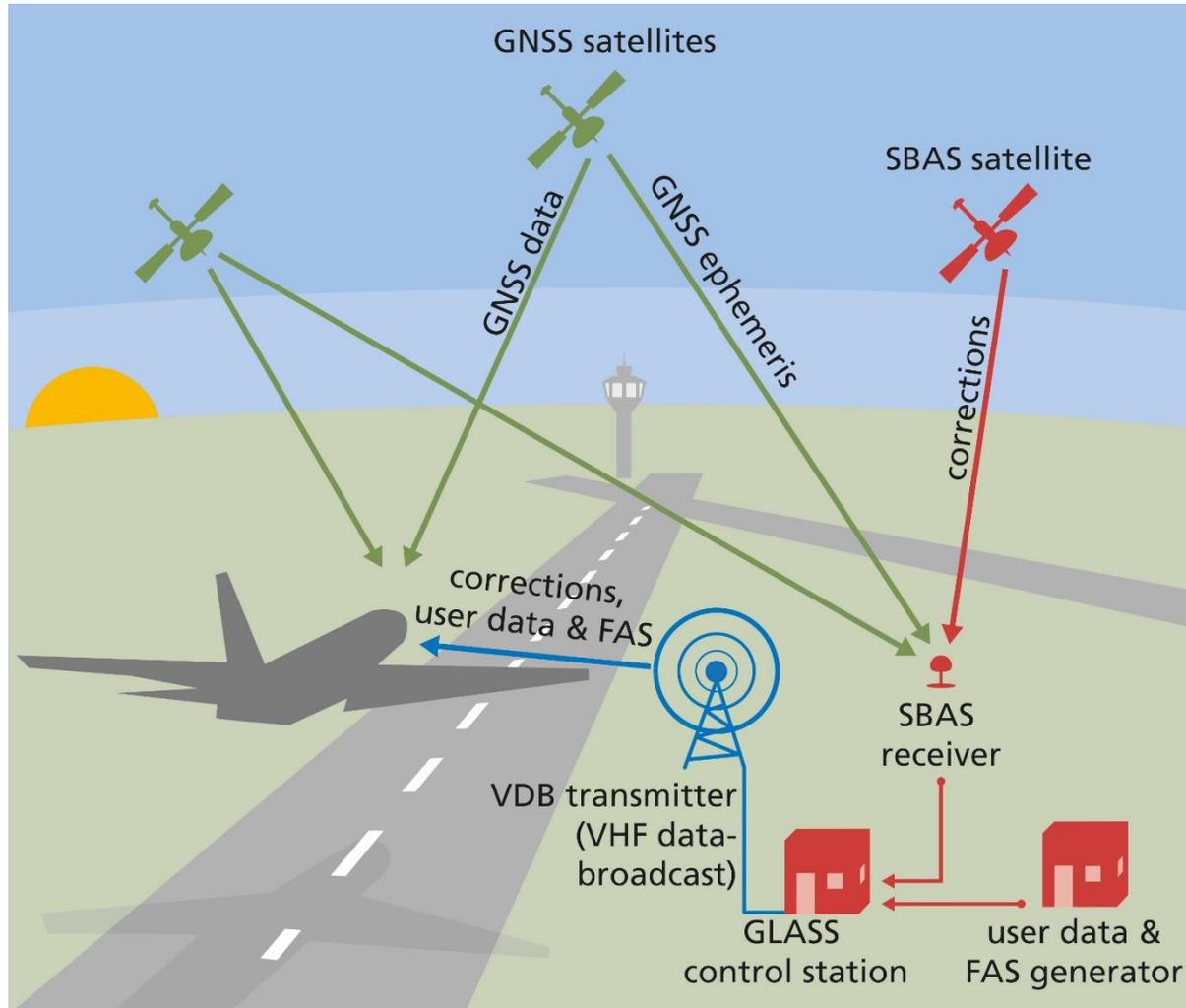


# Business Case: Constraints at Airports



LNAV Minimum 770ft

## From GBAS & SBAS to GLASS (GLS Approaches using SBAS)



Dautermann T., Ludwig T., Geister R. *et al.* Extending access to localizer performance with vertical guidance approaches by means of an SBAS to GBAS converter. *GPS Solutions* **24**, 37 (2020). <https://doi.org/10.1007/s10291-019-0947-7>



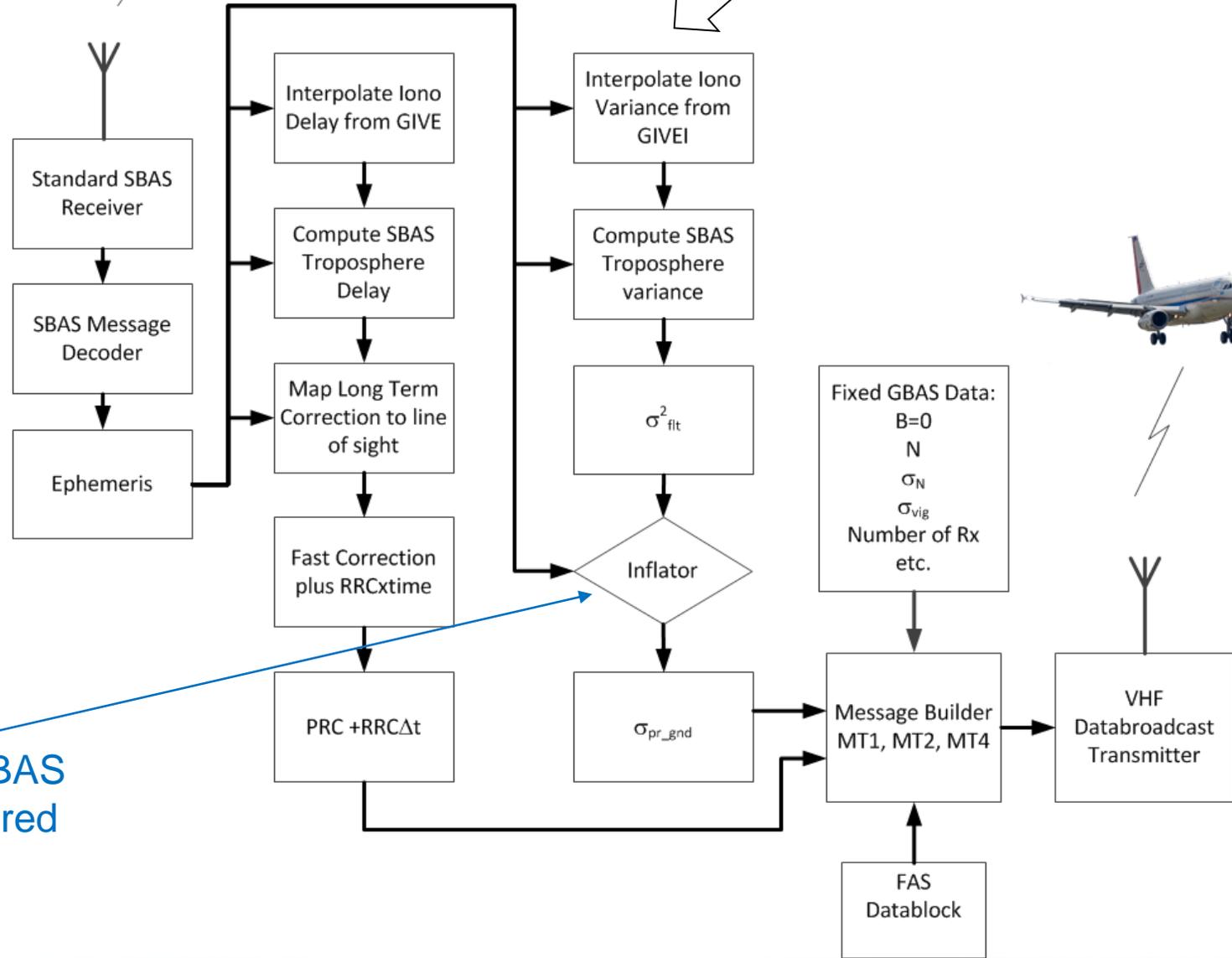
SBAS Satellite



# GLASS Technical Flow

$$\rho_{corrected,i} = \rho_{CSC,i} + PRC_i(t_{ofA}) + RRC_i(t_{ofA}) \times (t - t_{ofA}) TC_i + c\Delta t_{sv,corr} + IC_i$$

$$\sigma_i^2 = F \sigma_{pr\_gnd\_x}^2 [i] + \sigma_{tropo}^2 [i] + \sigma_{pr\_air}^2 [i] + \sigma_{iono}^2 [i]$$



Inserted, if mapping of SBAS HPL to GBAS LPL is desired

# FAS DB & Associated Issues

GLAS S26A**	GLAS S08A	GLAS S26B	GLAS S08B	GLAS S26I
Operation Type	0	SBAS Service Provider		0
Airport ID	ETNW	Runway		26
Approach Performance Designator	0 - GAST-A/B	Route Indicator		A
Reference Path Data Selector	1	Reference Path ID		S26A
LTP/FTP Latitude	52.4559889 °	LTP/FTP Longitude		9.44570000 °
LTP/FTP Altitude	94.80 m	Delta FPAP Latitude		-0.00265917 °
Delta FPAP Longitude	-0.02946972 °	TCH		50.00 ft
Glide Path Angle	3.00 °	Course Width		114.00 m
Delta Length Offset	0.00 m	Vertical Alert Limit		25.40 m
Lateral Alert Limit	40.00 m			

Approach Performance Designator APD=0

Normally should trigger a multiplier of 2 for the coded FASVAL → not evaluated by CMA-6024, GLU925, INR

Image Credit: AERODATA, taken with AERO FIS – CMA-6024 Receiver



# The “Time to Alert” Question

APV-1 → Requires 10s Time-to-Alert

Calculation for the GLASS System:

- The SiS TTA is the 5.2s from SBAS (unpublished proof in *“EGNOS Signal-in-Space System Safety Case Part A (Design, Development and Deployment) Issue 3 from 21 February 2008.”*)
- 3.5s for the missed message allocation
- $10s - 3.5s - 5.2s = 1.3s$

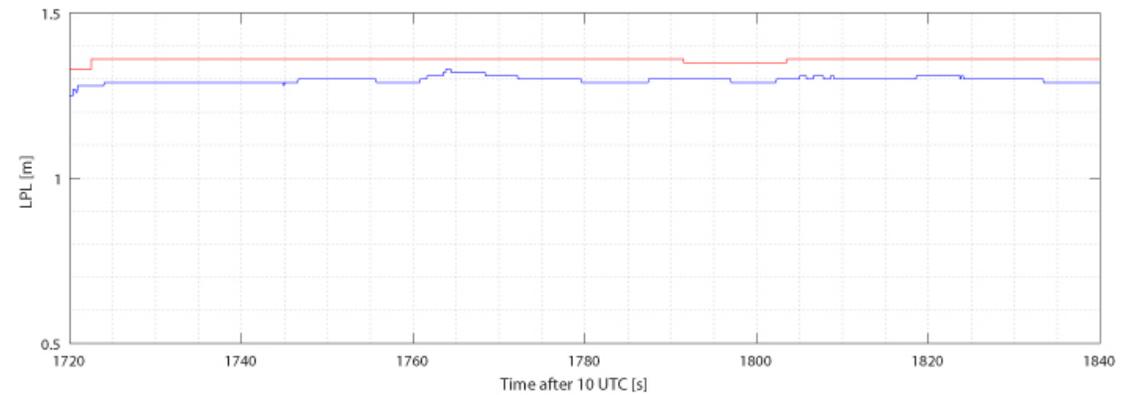
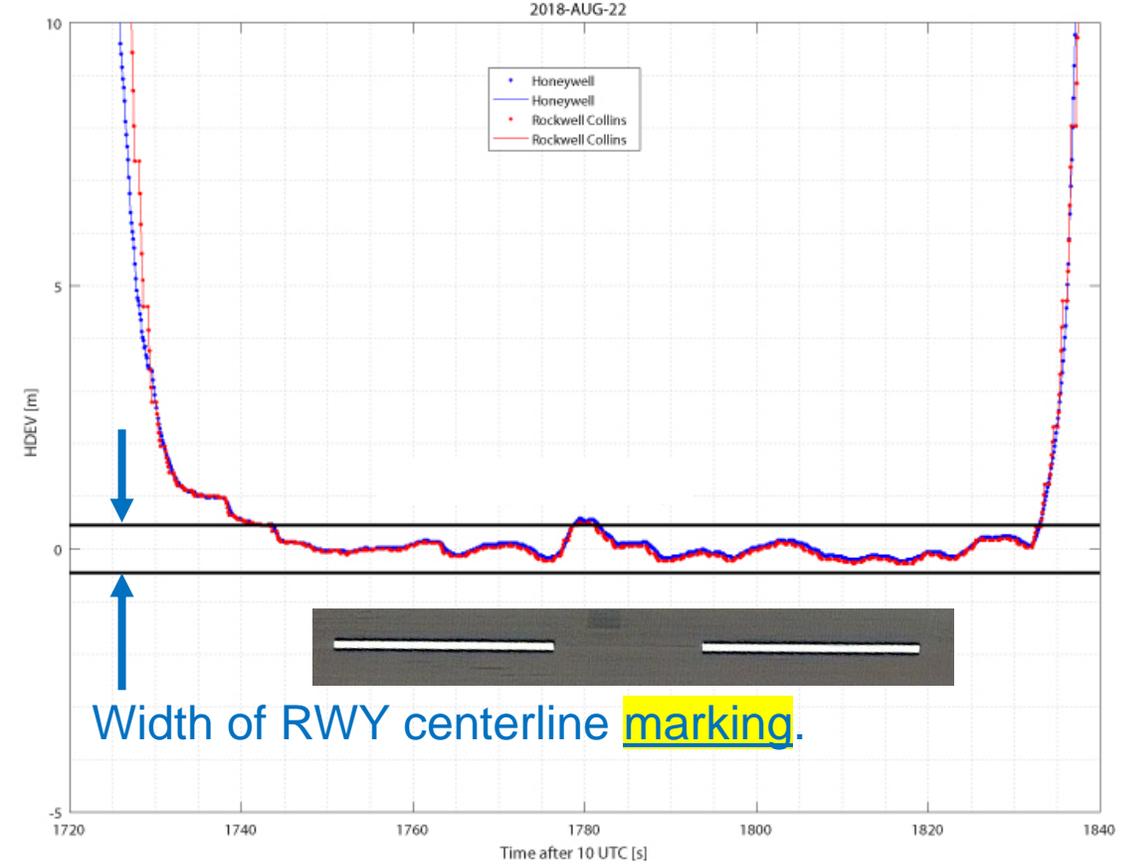
Processing on a Standard Linux PC takes about 20ms



# Ground Testing

## Using real avionics

- Rockwell Collins GLU 925 (Airbus version)
- Honeywell INR (B787 version)



# Flight Validation

Flight Calibration Services performed standard GBAS Flight Validation



AD-AFIS-220 V6.0.3 (Operator) OFFLINE/REPLAY D-CFME FCS BRC ICAD Special 2018-11-12\_D-CFME\_EDVE\_GBAS\_DLR\_5

Session Inspection Control View Positioning Config Window Help

OFFLINE/REPLAY  
 2018-11-16 16:09:58 UTC  
 17:09:58 Local

Replay 1x [stop] [play]

EDVE 2.6 VDB AS  
 Replaying

AMSLHGT 2840 2510 [ft]  
 IAS/GS 156 174 [kts]

Mode INS+GPS+H  
 EPE 0.20 [m]  
 GNSS EDGES  
 LT ? ?

Marker [ ] [ ] [ ]  
 99:36 h  
 00:00.00  
 Start Reset

Overview | Tacan | NAV | GNLU-930

Channel 22453 Mode GLS GPS GBAS

GBAS SBAS

Correction data Reference position FAS Data

Message header  
 Message type 4 Station ID GLAS Message length 92

\*\*GLAS G26A\*\* | GLAS G08A

Operation type	0	LTP/FTP latitude	50.32029472 [°]
SBAS service provider	0	LTP/FTP longitude	10.57569472 [°]
Airport ID	EDVE	LTP/FTP altitude	130.40 [m]
Runway	26	Delta FPAP latitude	-0.00213639 [°]
Approach performance designator	1 - GA87-0	Delta FPAP longitude	-0.03513261 [°]
Route indicator	2	TCH	16.46 [m]
Reference path data selector	3	Glide path angle	3.00 [°]
Reference path ID	G26A	Course width	114.00 [m]
		Delta length Offset	312.00 [m]
		Vertical alert limit	25.38 [m]
		Lateral alert limit	40.00 [m]

System Alerts  
 Flightlist  
 Main Status Bar  
 EFIS  
 Frequency Dis...  
 Receiver

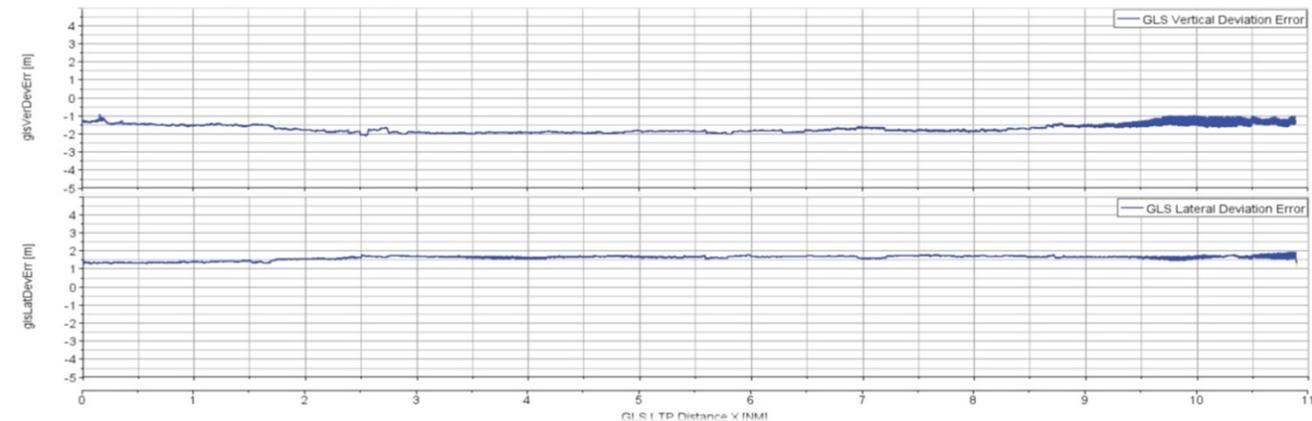
PFD  
 3290  
 156  
 2685  
 GS 174  
 1032 HPA

EHSI  
 FI PILS  
 CRS 263  
 THR 7.6 NM  
 REF GBAS  
 GARR 9.2 NM  
 VAR 1.7E

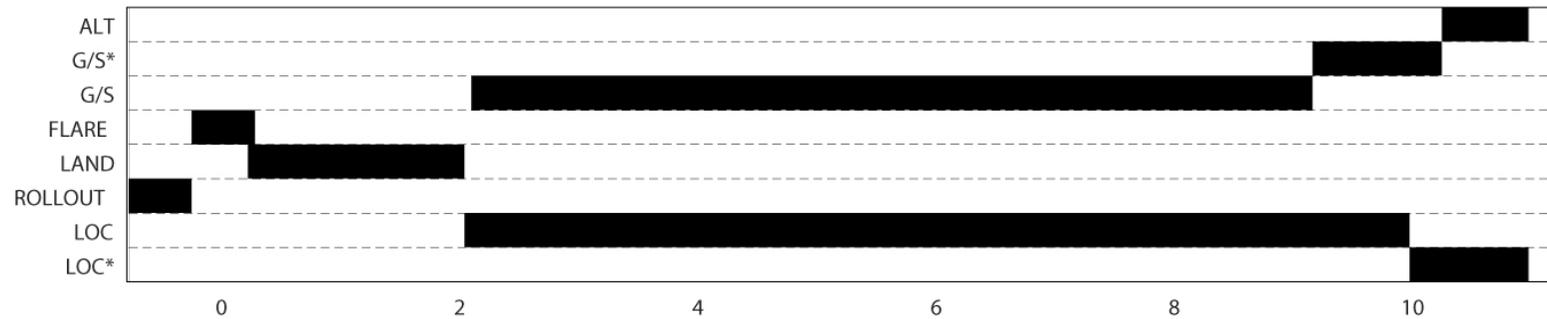
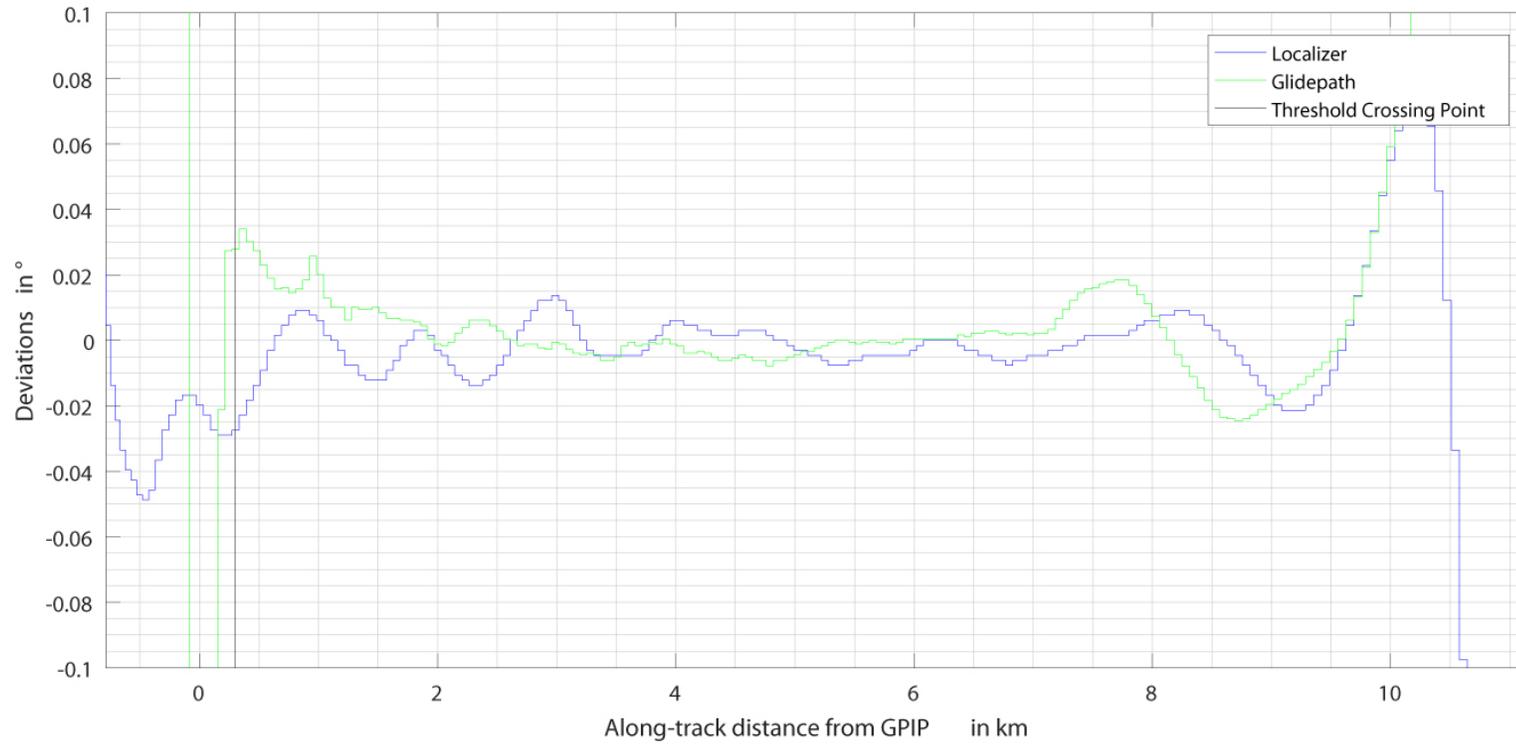
MAP  
 REPLAY

Frequency Display

NAV1	111.10	111.10
NAV2	111.10	111.10
TAC1	111.10	BWG 48%
TAC2	111.10	--- 48%
DME1	111.10	BWG 48%
DME2	111.10	BWG 48%
ADF1	427.00	427
EB1	1575420.00	
GLS1	117.950	G26A 22453

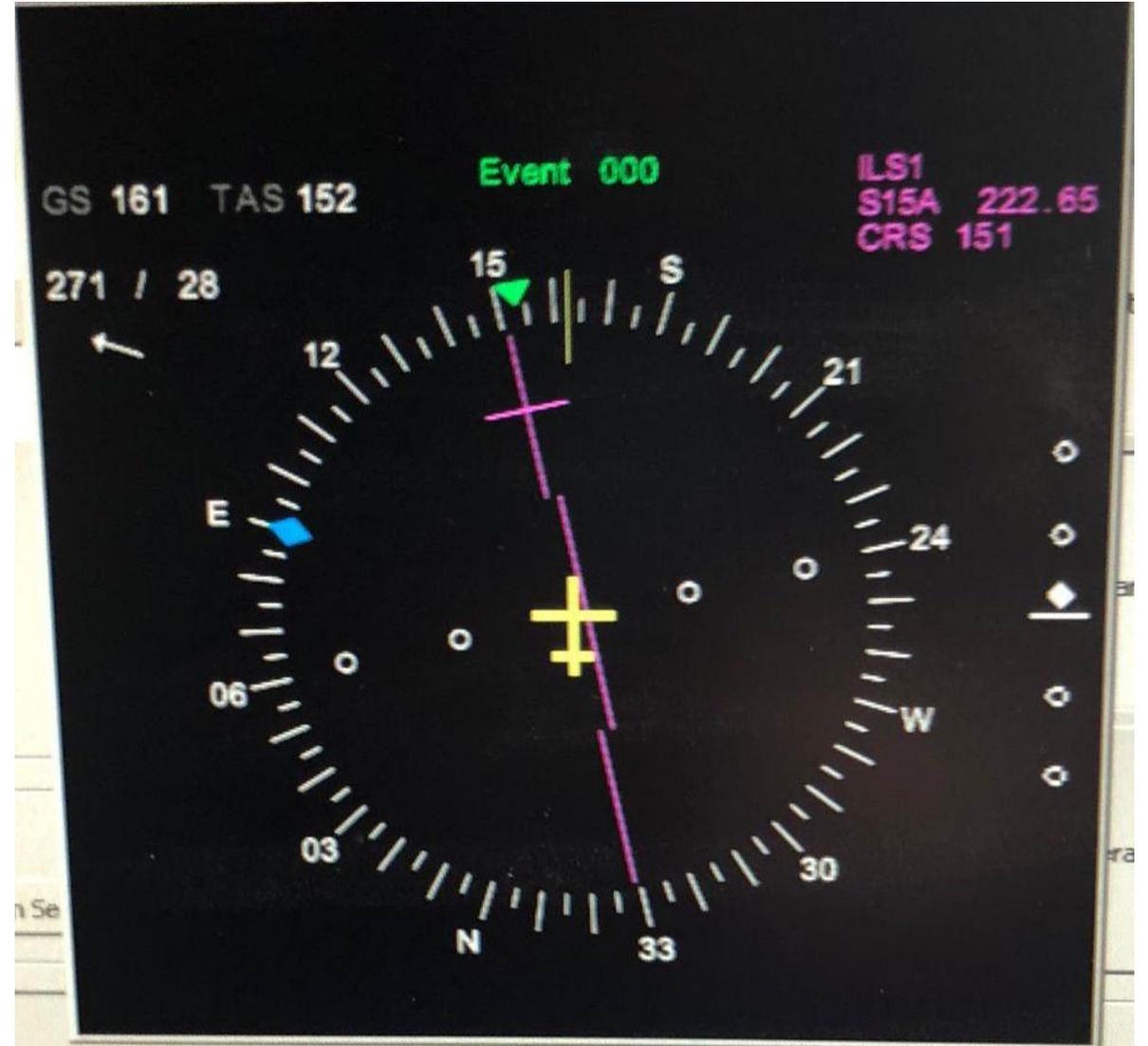


# Lufthansa Charter D-AIBI (A319)

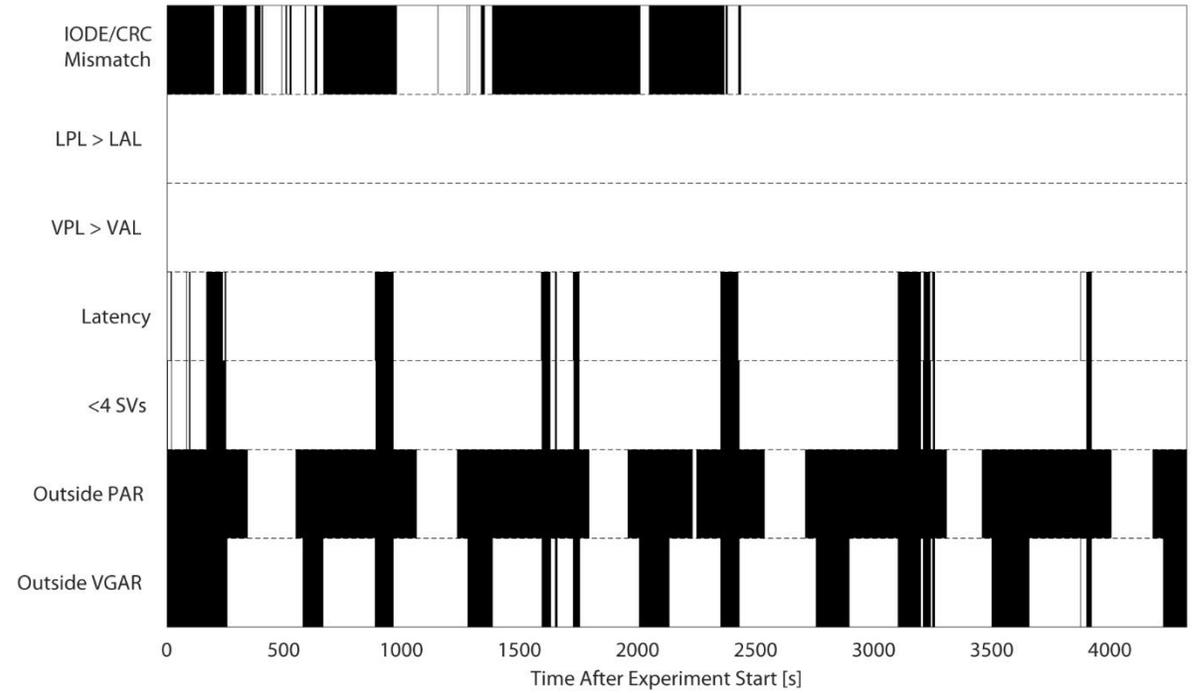
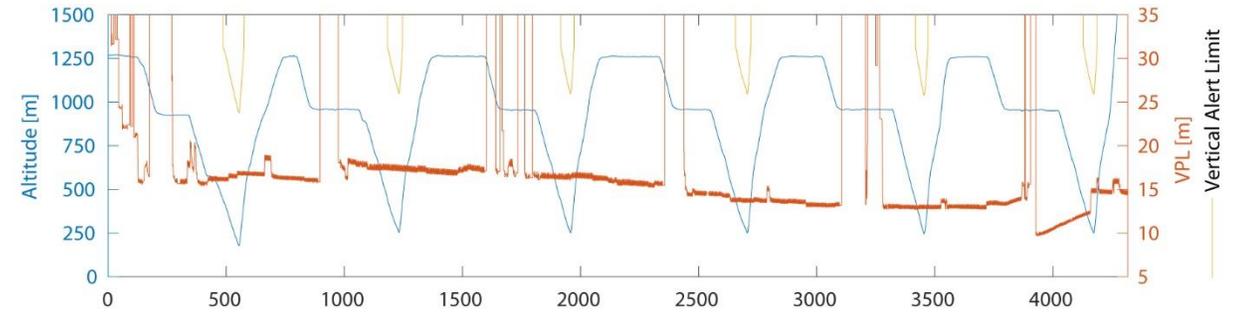


# DLR's Advanced Technology Research Aircraft





# Flight Tests in Kerkyra (CFU)



# Test with German Air Force

Installation at Wunstorf ETNW

- Airbus A400M test upcoming



## Questions for the Group

SARPS has little content about GAST-A, if so mostly related to GRAS

Receiver behavior: APD-0 is being ignored

Planned tests: Collins GLU2100, Thales MMR, Honeywell IMMR

