ICAO EUR/MID Radio Navigation Symposium

UAV Solutions for NavAids Flight Inspection

ALI BAGHERIAN

IRAN

Antalya, Turkiye
(6-8 February 2024)

How UAV supports Air Navigation System Flight Inspection

SARPs overview

Annex 10

Document 8071

Ground versus Flight Tests

The requirements and conditions

Glide Path

Ground and Flight Test- UAV Test

Correlation with Flight Inspection

Localizer

Ground and Flight Test- UAV test

Correlation with Flight Inspection

VOR

Ground Check and Flight Test with UAV

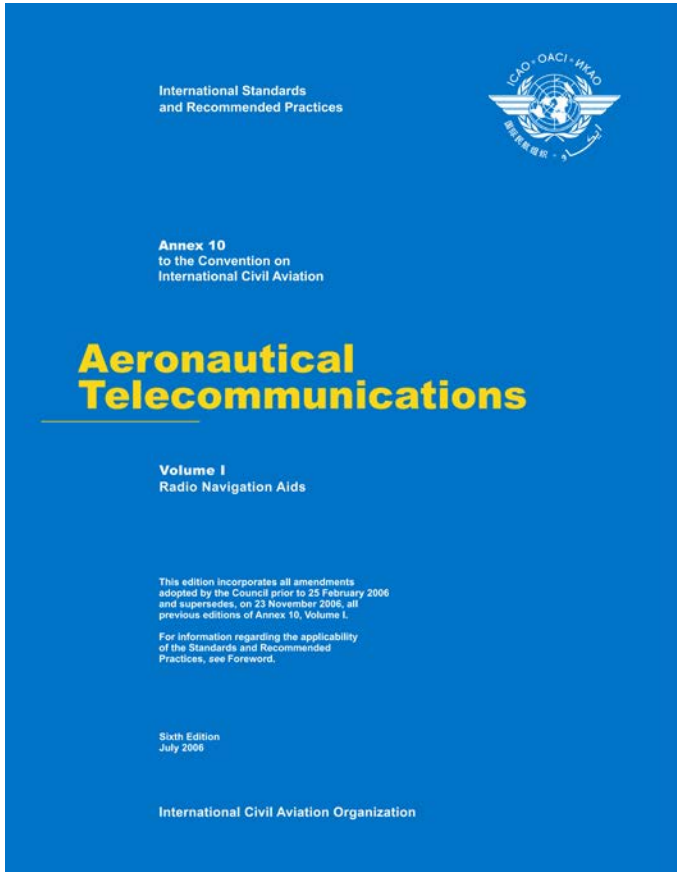
PAPI

SARPs for PAPI Light-

Inclinometer/UAV

Flight Test and Correlation

Radio Navigation aids Testing – Annex10



2.2 Ground and flight testing

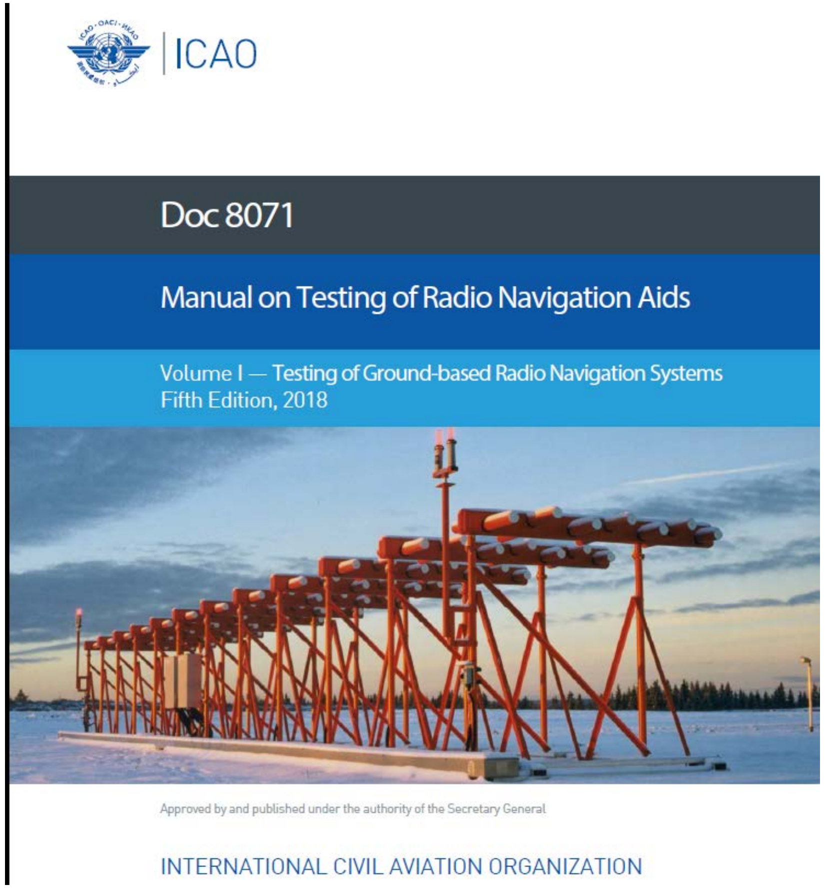
2.2.1 Radio navigation aids of the types covered by the specifications in Chapter 3 and available for use by aircraft engaged in international air navigation shall be the subject of periodic ground and flight tests.

Note.— Guidance on the ground and flight testing of ICAO standard facilities, including the periodicity of the testing, is contained in Attachment C and in the Manual on Testing of Radio Navigation Aids *(Doc 8071).*

Test versus Inspection

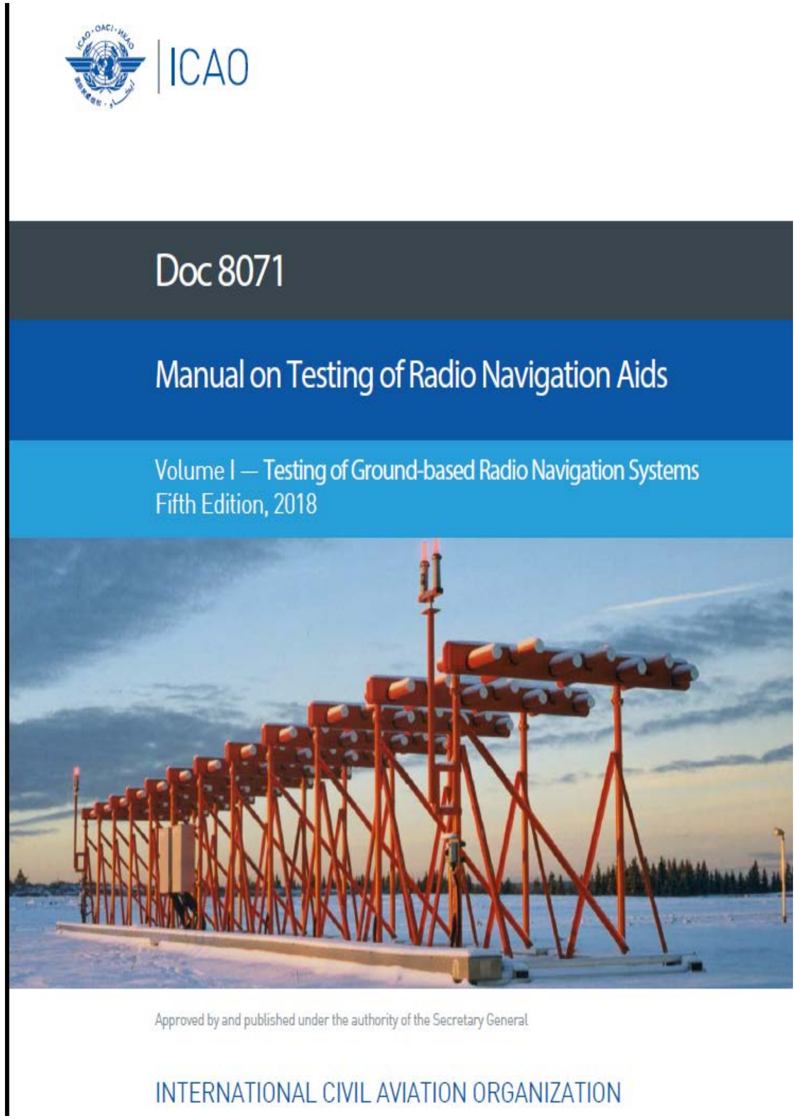
— *Testing:* A specific measurement or check of facility performance that may form a part of an inspection when integrated with other tests.

— *Inspection:* A series of tests carried out by a State authority or an organization as authorized by the State to establish the operational classification of the facility.



USE OF REMOTELY PILOTED AIRCRAFT SYSTEMS

1.18.2 Remotely piloted aircraft systems (RPAS) or unmanned aerial vehicles (UAV) should be assessed to determine that they provide the payload capability, speed and range necessary to conduct a flight inspection for navigation aids as recommended herein in a cost-effective manner.

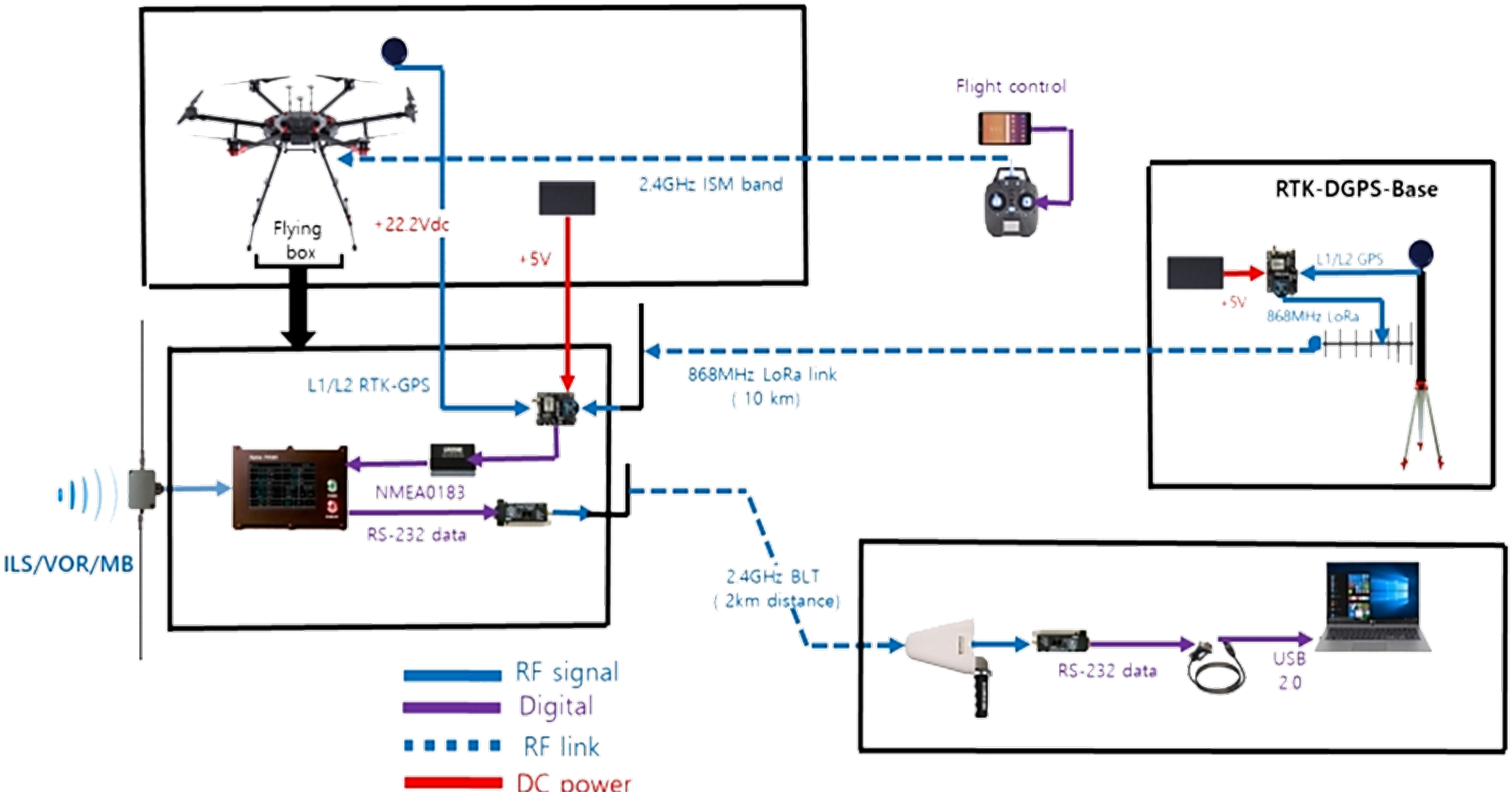


Ground versus flight Testing/Inspection

	Ground	Flight
Carried out	at the facility or at a point on the ground remote from the site .	in the air
Specialist	trained maintenance	trained flight crew
Test Equipment	appropriate test equipment	suitably equipped aircraft
Technical Factors	- accurate and quick in evaluation of the facility performance - carried out more frequently - can be used as indicators to determine flight inspection duration.	- important in the proof of facility performance - represents a sampling of the radiated signals in the operating environment.
Economic Factors	Less Expensive	Expensive
Challenges	Establish correlation between ground and flight tests	

Flight Testing versus Flight Inspection

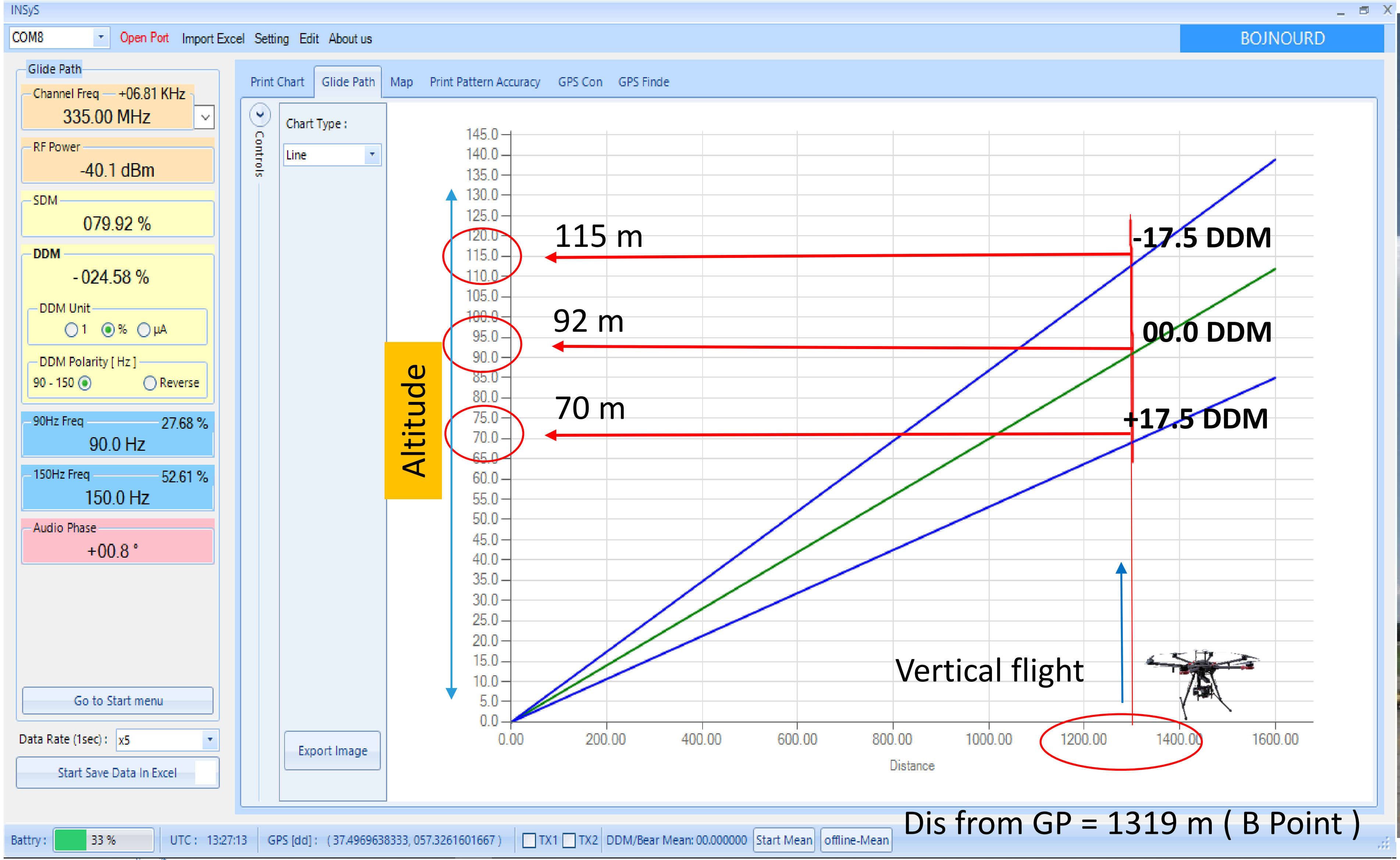
Hardware Configuration

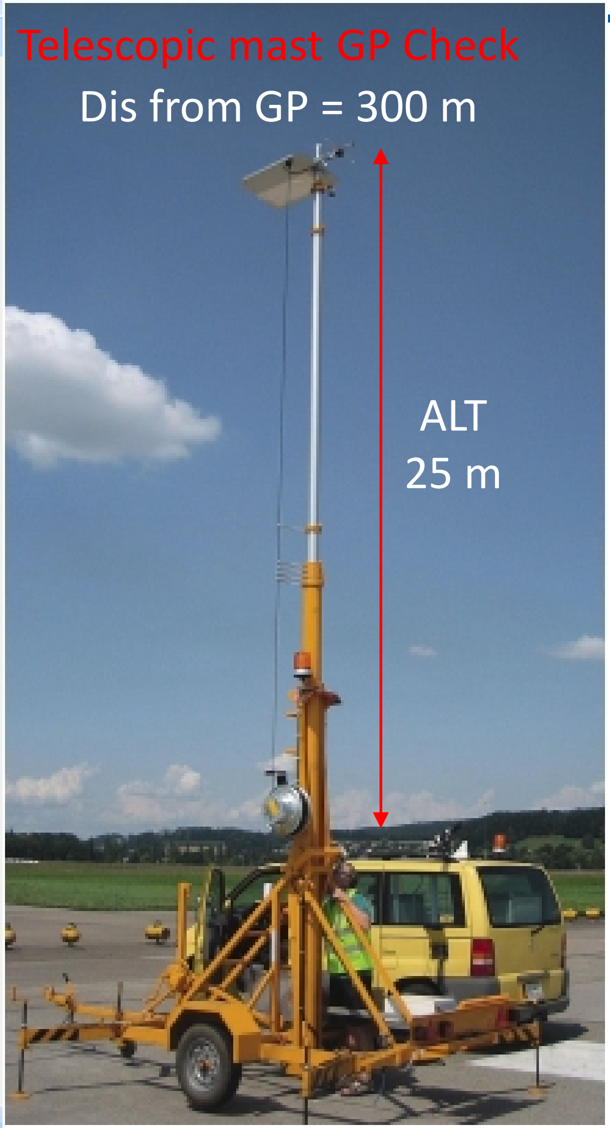


Measured Parameters – Glide Path

- GP Displacement sensitivity
- GP Width , Alarms
- Identification
- GP Angle

Glide path Ground & Flight Testing





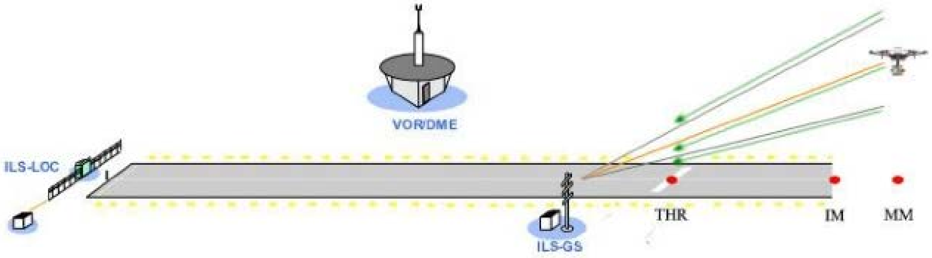
Telescopic mast for glide path measurements.

Photo: Rohde&Schwarz Service Center in Cologne.

Test Method

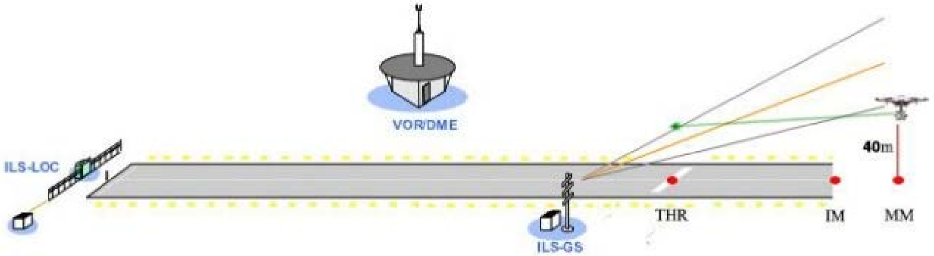
After the monitoring and previous stage:

The drone flies linearly from MM point to THR point, then the angle and lower/upper width values would be checked and their mean would be calculated.

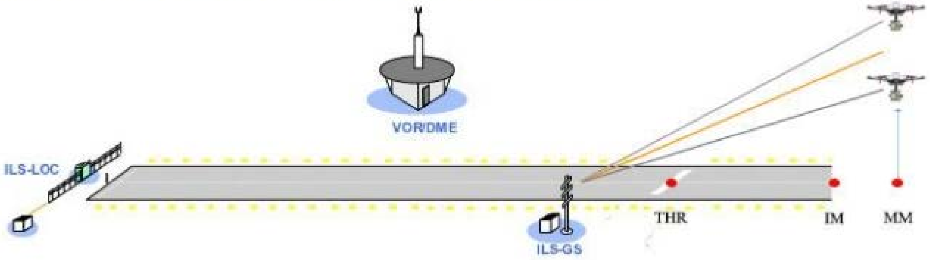


GP periodic/commission check

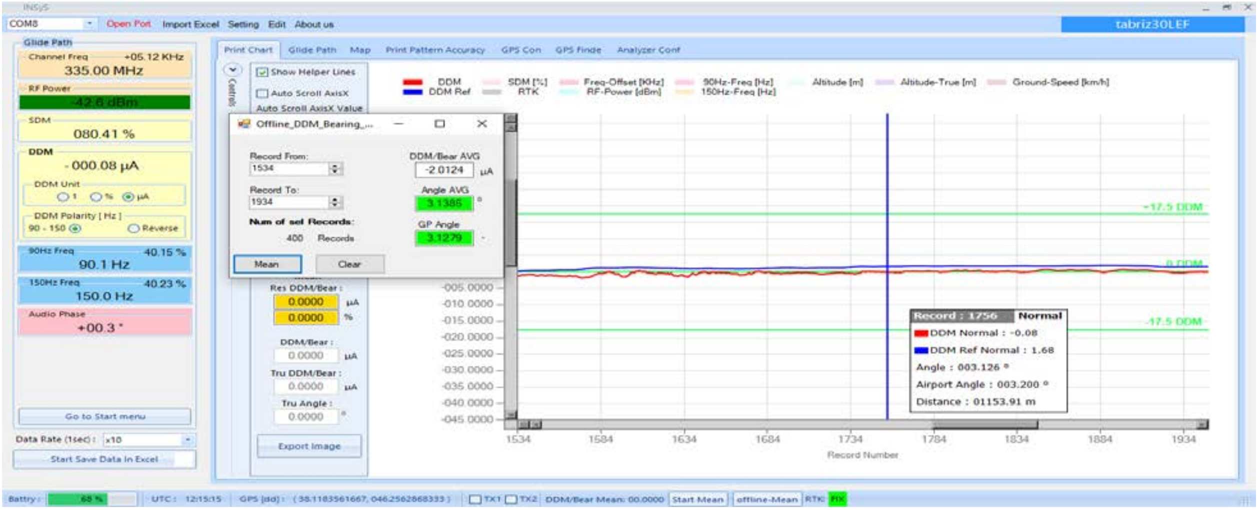
Flight is performed as Level Run from MM point to THR point at 40m altitude (AGL) and Angle and width are checked.



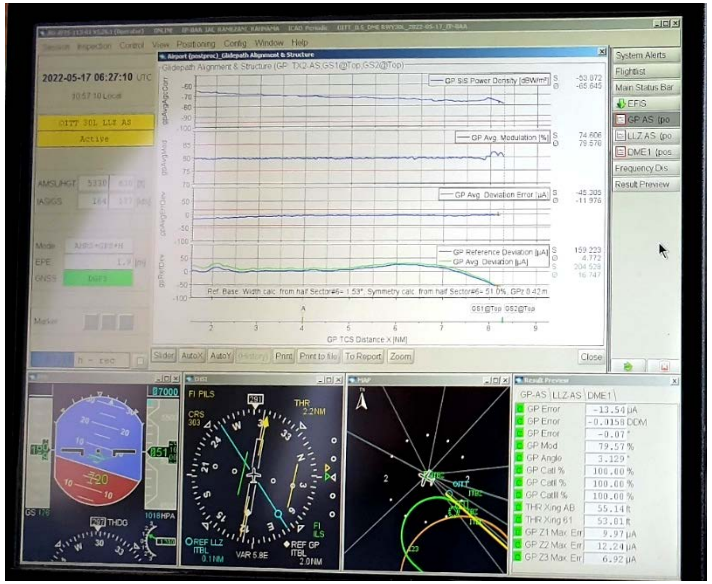
Vertical flight is performed at MM point, width and angle are checked.

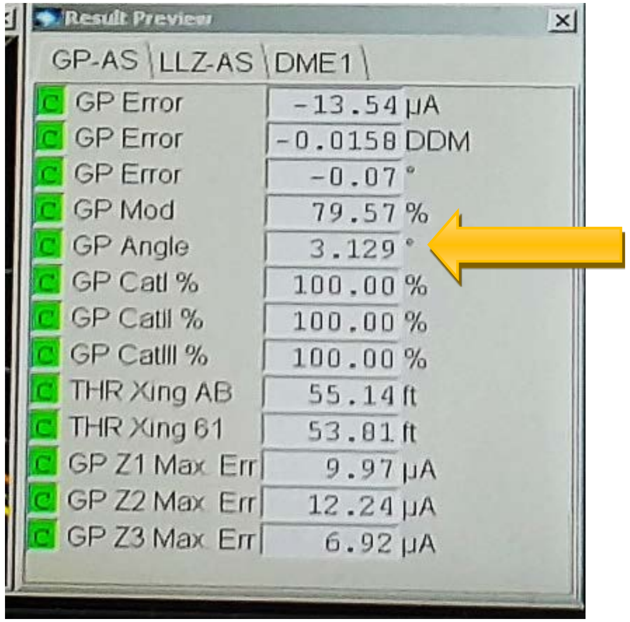


Flight Testing Correlation



Tabriz Int'l Airport
ILS RWY 30L
GP Angle AVG by UAV
Angle = 3.127°





Tabriz Int'l Airport
ILS RWY 30L
GP Angle AVG by Aircraft
Angle = 3.129°

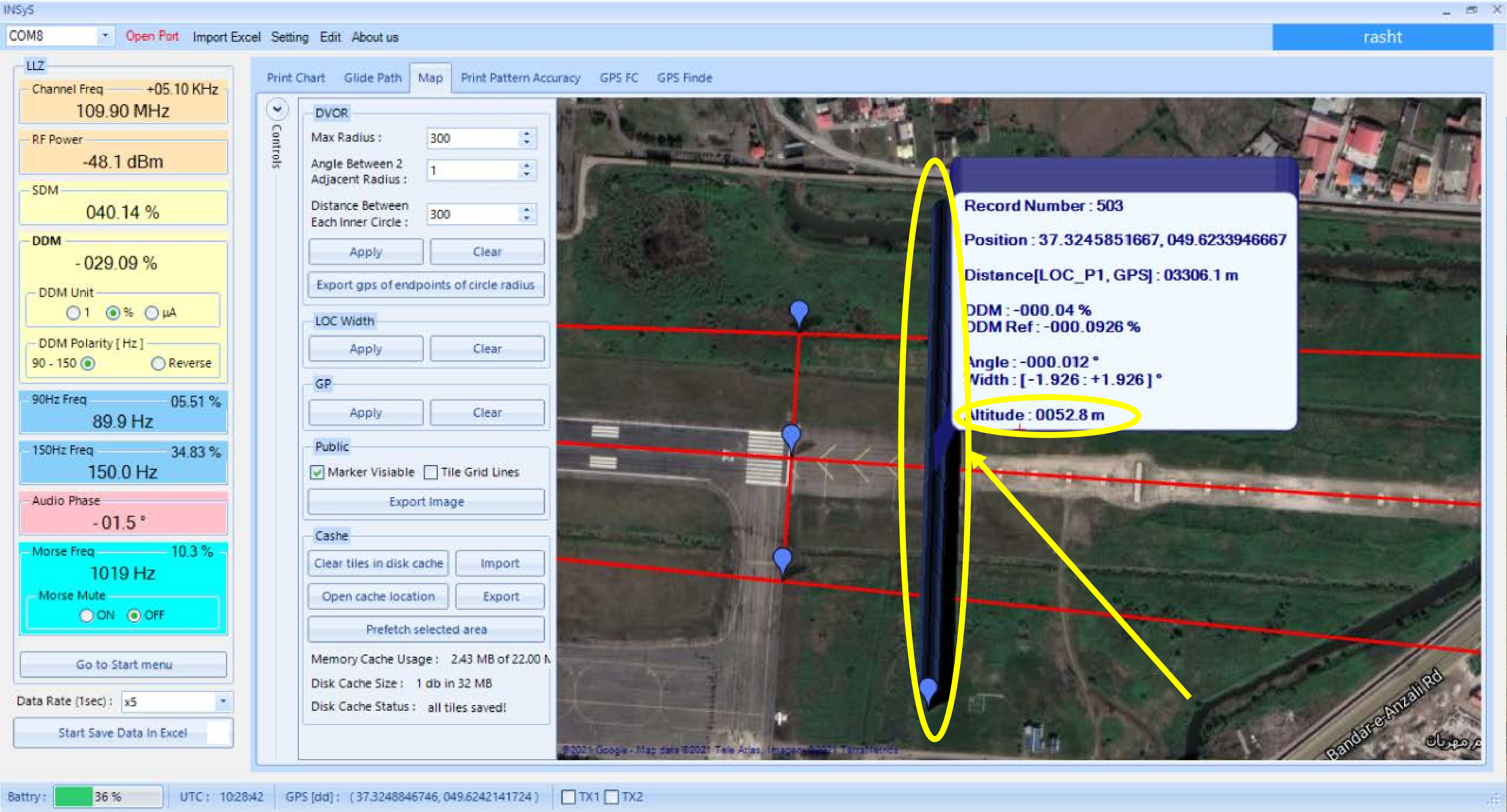
ICAO

Measured Parameters - Localizer

- LOC Width , Alarms
- LOC Course alignment
- LOC Displacement sensitivity

LLZ Ground & Flight Testing

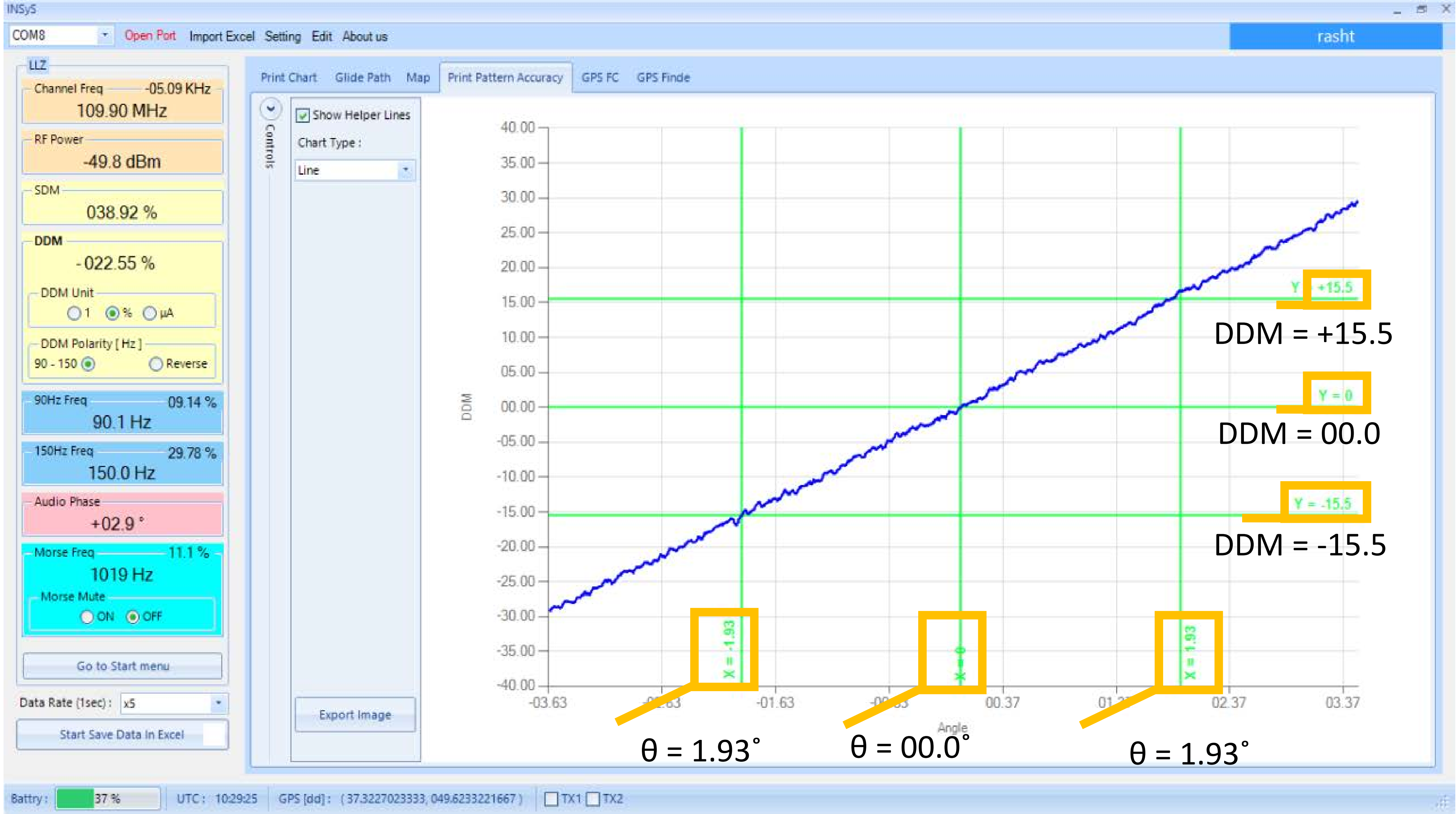
Drone Check LOC



Ground Check LOC

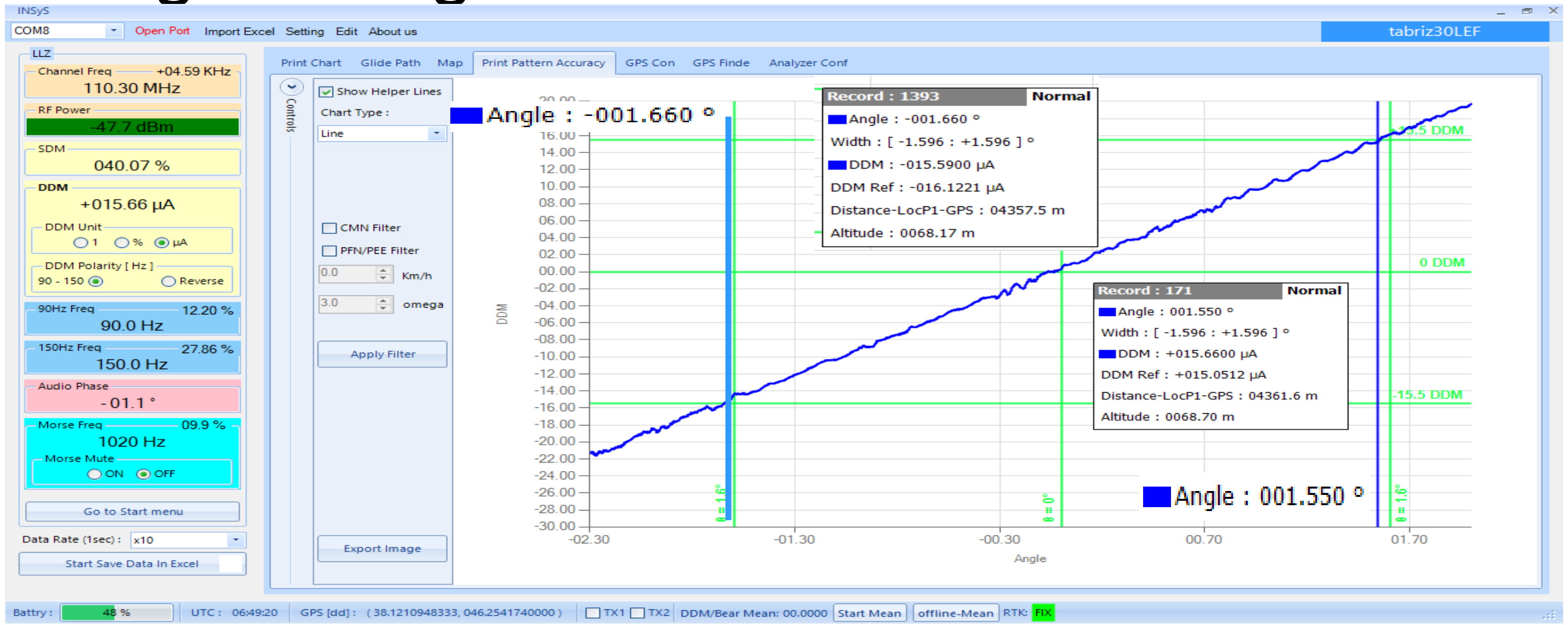
ICAO

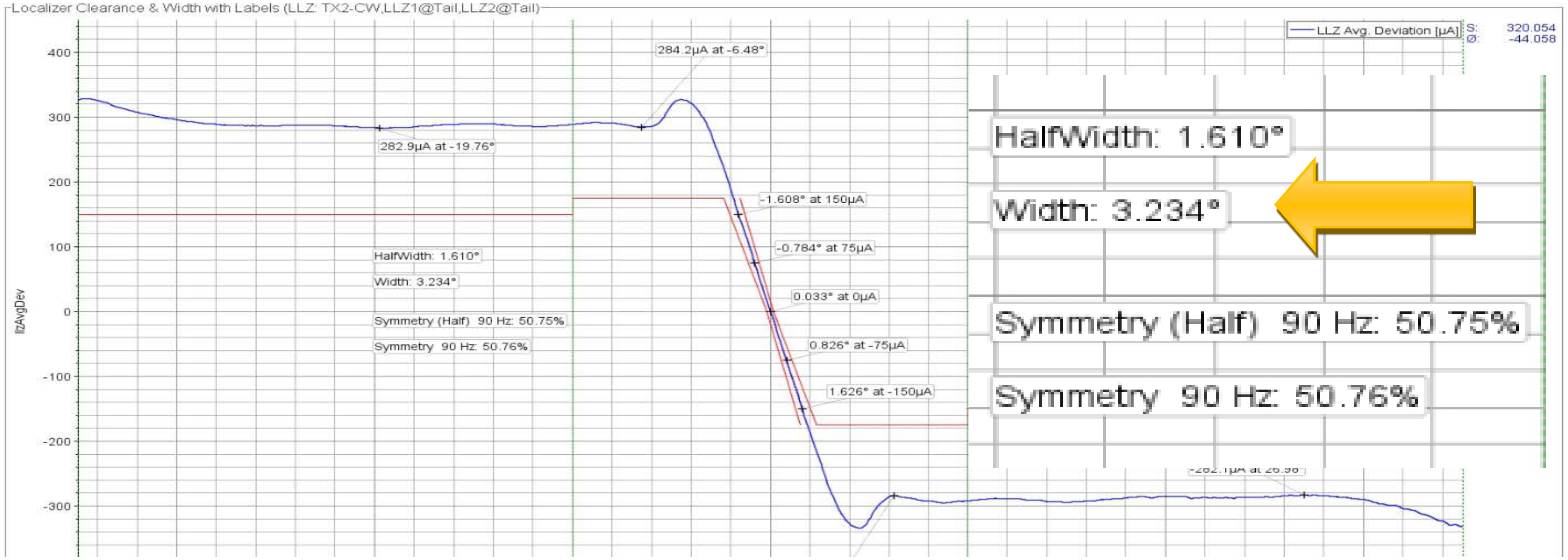
Flight Testing LLZ WIDTH



ICAO

Flight Testing Correlation





Tabriz Airport ILS RWY 30L

LOC Width by UAV

Width = 3.21°

Tabriz Airport ILS RWY 30L

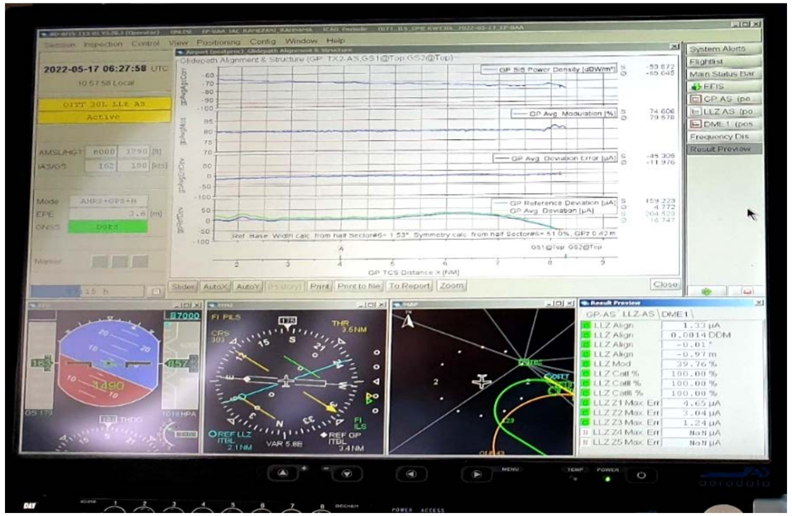
LOC Width by Aircraft

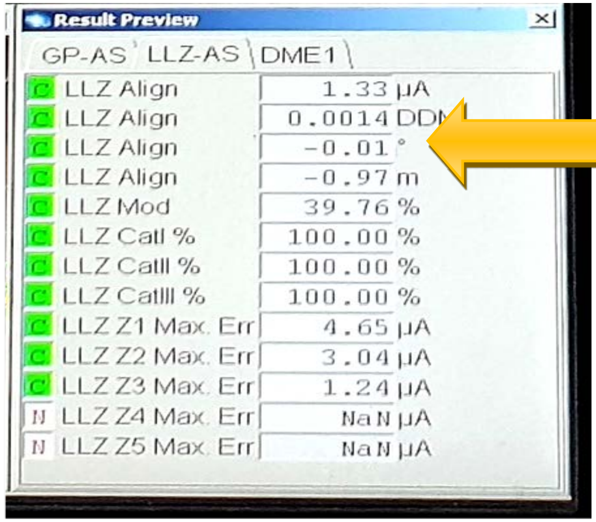
Width = 3.23°

ICAO

Flight Testing Correlation

Tabriz Airport ILS RWY 30L LOC Center AVG by UAV Angle = -0.0149





Tabriz Airport ILS RWY 30L LOC Center AVG by Aircraft Angle = -0.01°

(D)VOR

Checks and measurements performed:

- 9960Hz Modulation depth & frequency
- 30Hz Modulation depth & frequency
- Bearing
- Bearing Error
- Deviation

ICAO

Flight Testing VOR

UAV VOR Check(360 Ground Check not possible)

Ground Check VOR

VOR / Bearing Error

PAPI Lights TEST Using a Drone

Doc 9157, Part 4
Fifth Edition
Amendment No. 1
12/7/21

AERODROME DESIGN MANUAL

PART 4 — Visual Aids

Fifth Edition — 2021

AMENDMENT NO. 1

To incorporate this amendment:

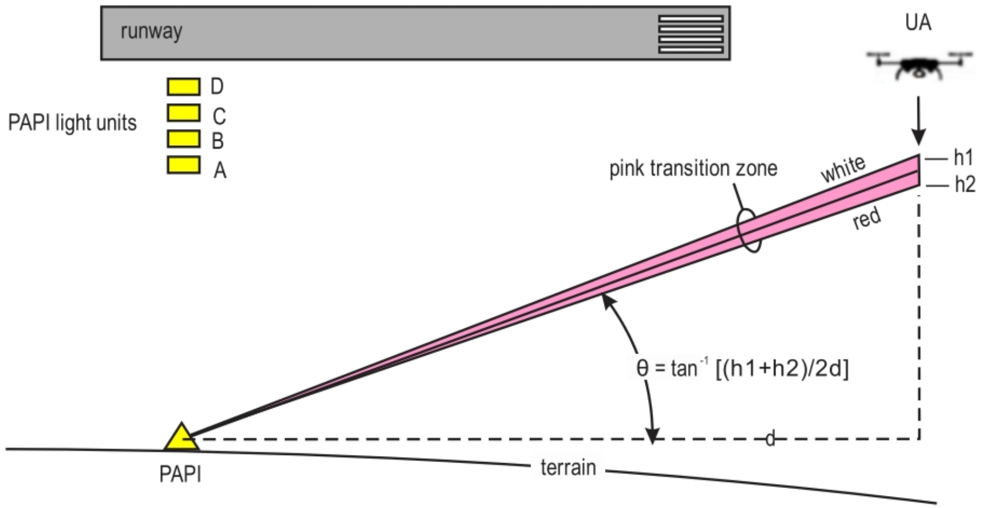
a) insert the following new and replacement pages: (vii), (xi), 8-31 to 8-43 and 15-13 to 15-15;

b) record the entry of this Amendment on page (iii).

Use of an unmanned aircraft system (UAS)

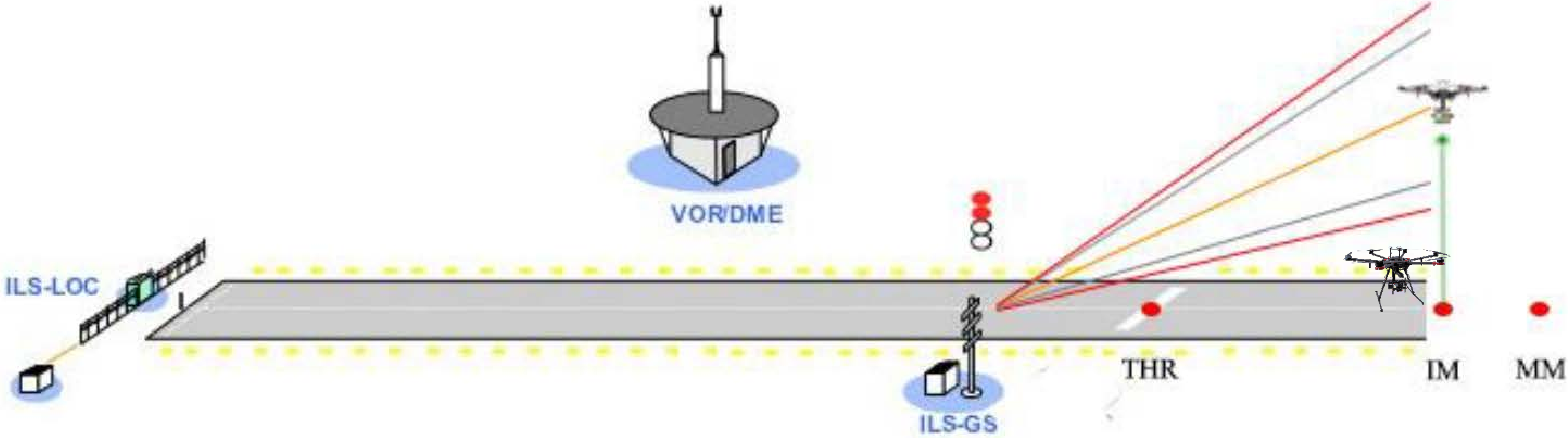
8.3.43 An unmanned aircraft system (UAS) may be used as an alternative method for measurement of PAPI settings. A typical UAS includes an unmanned aircraft (UA), a control station or remote pilot station (RPS), a data link (C2 Link) between the UA and its control station/ RPS for managing the flight, and possibly, other components such as launch and recovery equipment and a ground processing unit, to which measurement data is downloaded. In order to obtain high dimensional precision, a real time kinematic (RTK) base station is necessary. The collected data can be viewed in real-time at the site and recorded for later analysis.

8.3.44 For a typical operation, the UA is positioned at least 300 m downwind of the PAPI system. Vertical scanning or measurement by the UA enables the operator to determine heights h1 and h2, which are the upper and lower limits of the transition zone from red to white, as shown in Figure 8-24. The light unit setting angle θ is then computed using the formula:



PAPI Lights TEST

Navigate the drone to fly vertically at IM point and check PAPI lights



PAPI Lights Correlation

Calibration by Clinometer

Calibration by Drone

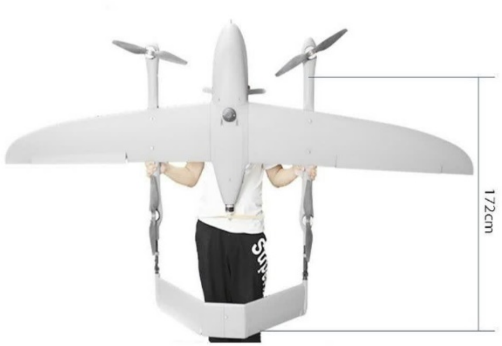
Pilot eyes versus UAV eyes

In checking the PAPI lights, we noticed another problem that the pilot can't see from the inspection aircraft due to the long-distance during the inspection also the predominance of white or red light, and that is the inconsistency of the internal lenses of each PAPI lights unit. UAVs solves this problem by zooming the image in the installed camera on the UAV. So it can detect the difference between the lenses of each unit picture.By using UAV it is possible to find the problem and adjust the angular settings for each PAPI light befor flight inspection.

Evolution of UAV measurements

The tests performed in this presentation were at the short distances with the normal size UAV with limited range.

By using UAVs with the ability to fly higher and farther, the test field can broaden with more sampling.



Advantages of UAV solutions for NavAids Flight Inspection

- Reduce **flight time** for expensive flight inspection aircraft.
- Reduce the potential **hazards** and **risks** for flight inspection aircraft and crew.
- Reduce chain **costs**(Maintenance,Operation,Fuel,...)
- Reduce impact on normal **air traffic** density during flight calibration.
- Reduce the workload of the **flight crew** and **ATSEP** & **AGL** engineers.
- Reduce **environmental** impact (air and noise pollution).
- Reduction of human and system errors in ground checks of navigation aids.
- Enhanse aviation safety.
- Possible evolution in SARPs about UAV to support flight inspection by ICAO

Prepared by

ALI BAGHERIAN

EBRAHIM RAHNAMA

MOSTAFA ASAADI

KAVEH PARTO


MONTREAL
HQ
PARIS
Office
BEIJING
Sub-office
CAIRO
Office
MEXICO CITY
Office
DAKAR
Office
BANGKOK
Office
NAIROBI
Office
LIMA
Office

Thank You!