Pre-Flight Calibration Service

Using Drone

ILS / VOR / PAPI

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As in DOC. 8071. VOL1. 1.18.2 ICAO mentions the use of other equipment such as UAVs for advanced checks on airport navigation assistance systems to increase inspection period by inspection aircraft.

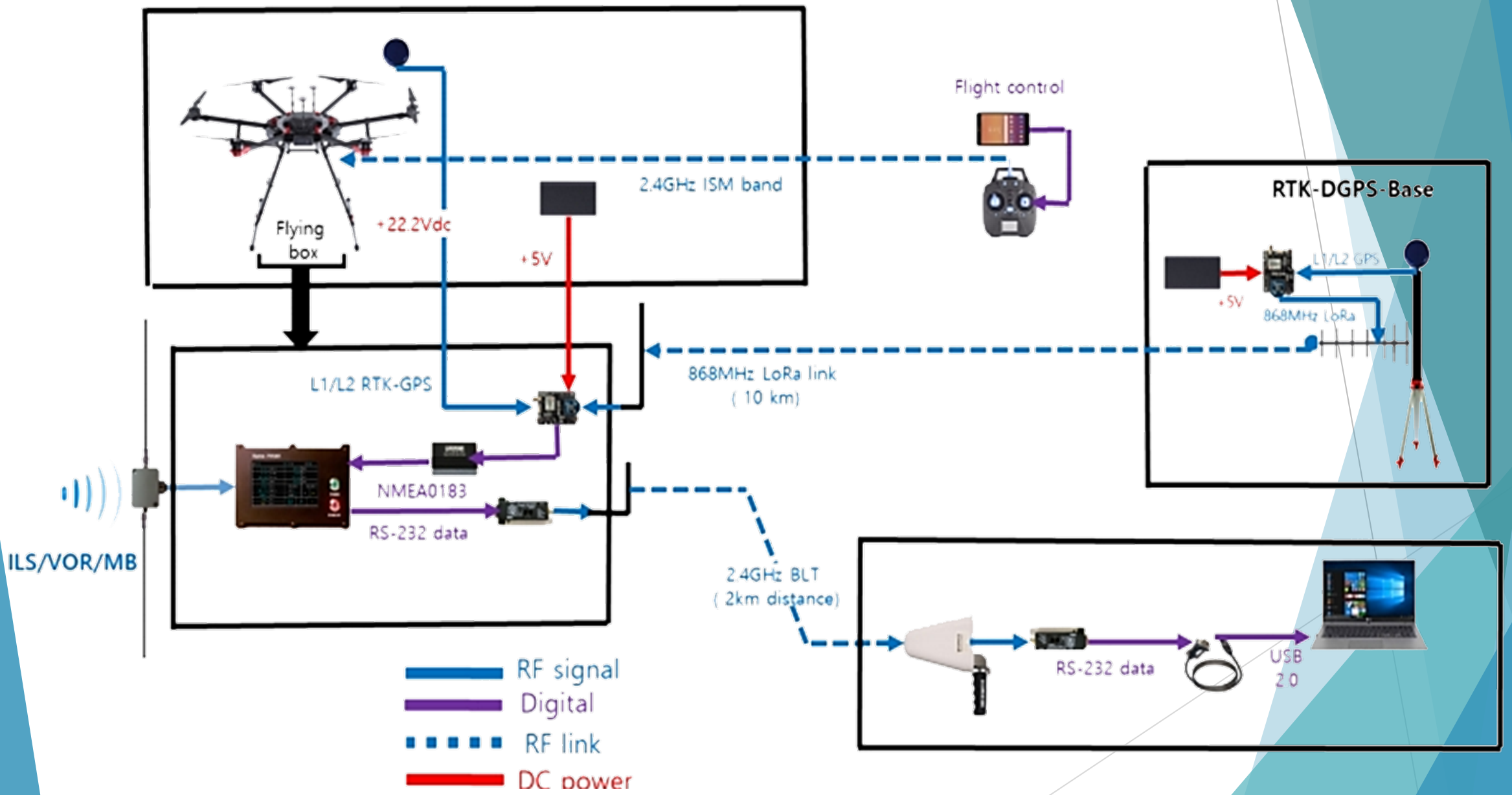
Appendix Q of Resolution A36-13 adopted by 36th session of ICAO Assembly (September 2007) states that ‘pending the possible availability of greatly improved ground testing facilities, radio navigation aids shall be checked through regular flight testing.

Using the drone method can be an improvement ground testing facilities.

Equipment List

- Drone
- Analyzer（PIR361）
- Application
- Surface
- iPad
- Data Link（40km）
- Camera（30x Zoom）
- RTK

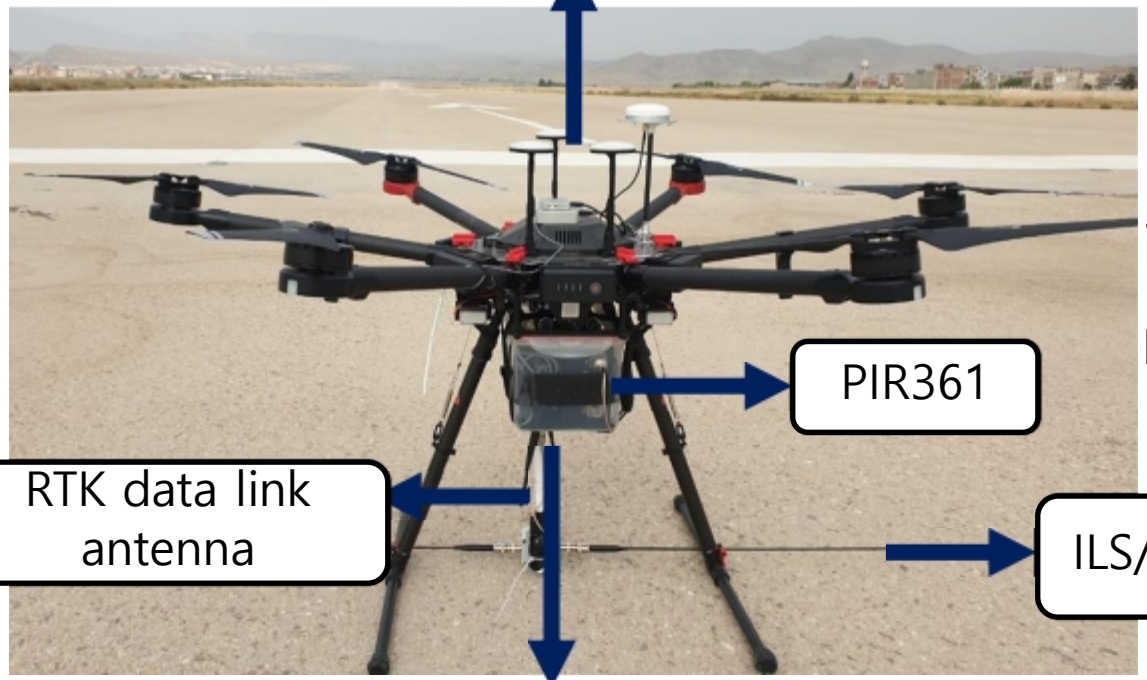
Hardware configuration and signal flow.



Comparison table

Parameters	PIR361	PNA-200	EVSF1000
Manufacturer	Kavics (Korea)	Canard drone (Spain)	Rohde & Schwarz (Germany)
외형			
Size (mm) (Ratio)	196 x 120 x 67 (1)	106 x 163 x 98 (1.07)	95 × 177 × 360 (3.8)
Weight (Ratio)	1.6kg (1)	0.83kg (0.5)	3.9kg (2.4)
Measurement	LOC,GP,VOR,MB	LOC,GP,VOR	LOC,GP,VOR
Wireless data	Bluetooth(1km)	WI-FI(1km)	X
Operating hours	10시간 (Battery 내장)	1.5시간 (Battery 내장)	외부전원 (Battery X)
GPS	External RTK, Internal SBAS	External drone RTK	External RTK
Ground check	O	X	O
Drone installation	O (Commercial drone)	O (Commercial drone)	O (Custom made drone)

PIR361 & Equipment Drone installation



DJI M600 PRO

In this type of Drone
Flight time with all equipment: 18 minutes

ILS / DVOR / PAPI Check by Drone system

Korea
Kavics

Localizer

Localizer Can Be Inspected/Commissioned.

Checks and measurements performed:

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

Federal Aviation Administration :

To facilitate the establishment of the facility parameters and to provide reference points from which the parameters can be periodically verified, ground checkpoints must be established at each localizer facility.

Because of the different types of localizer arrays and the unique terrain and siting conditions at each facility, it is not possible to specify the exact location and number of checkpoints.

Ground LOC Check

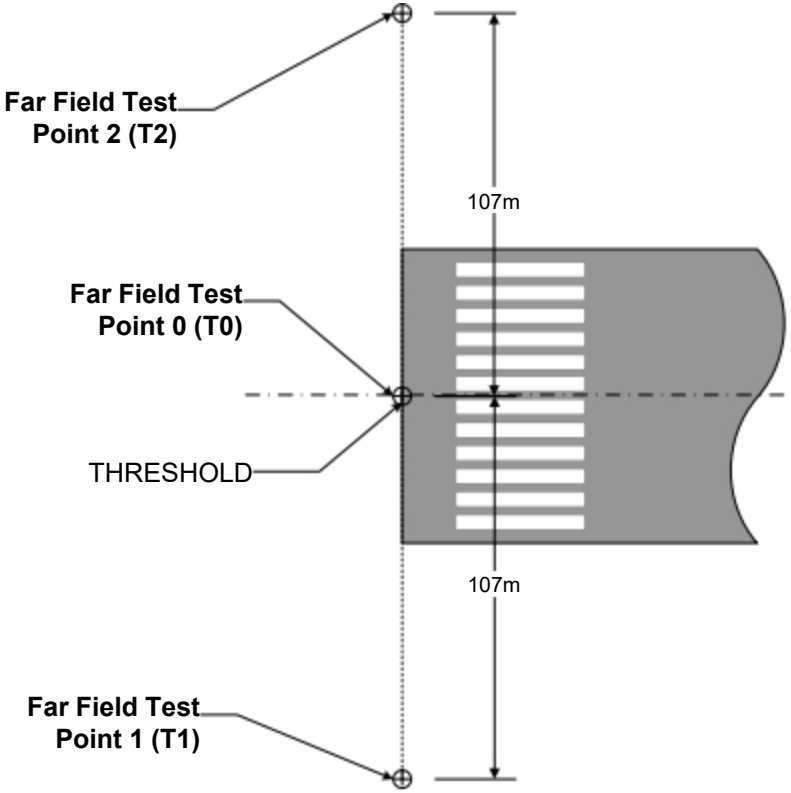


Figure 2 - Far Field Test Points

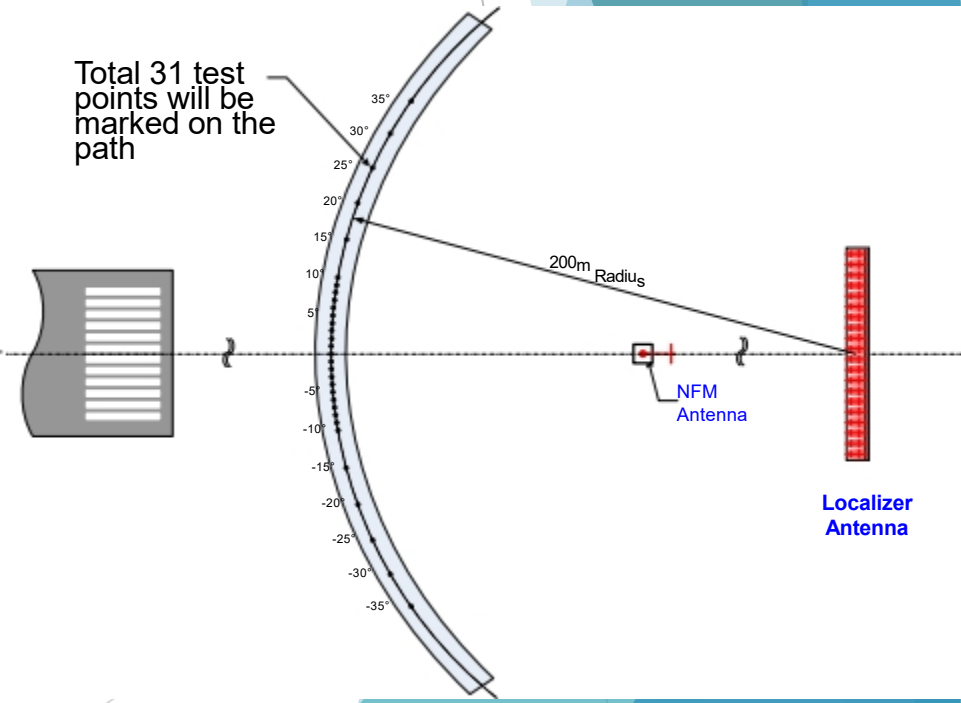


Figure 1 - Near Field Test Points

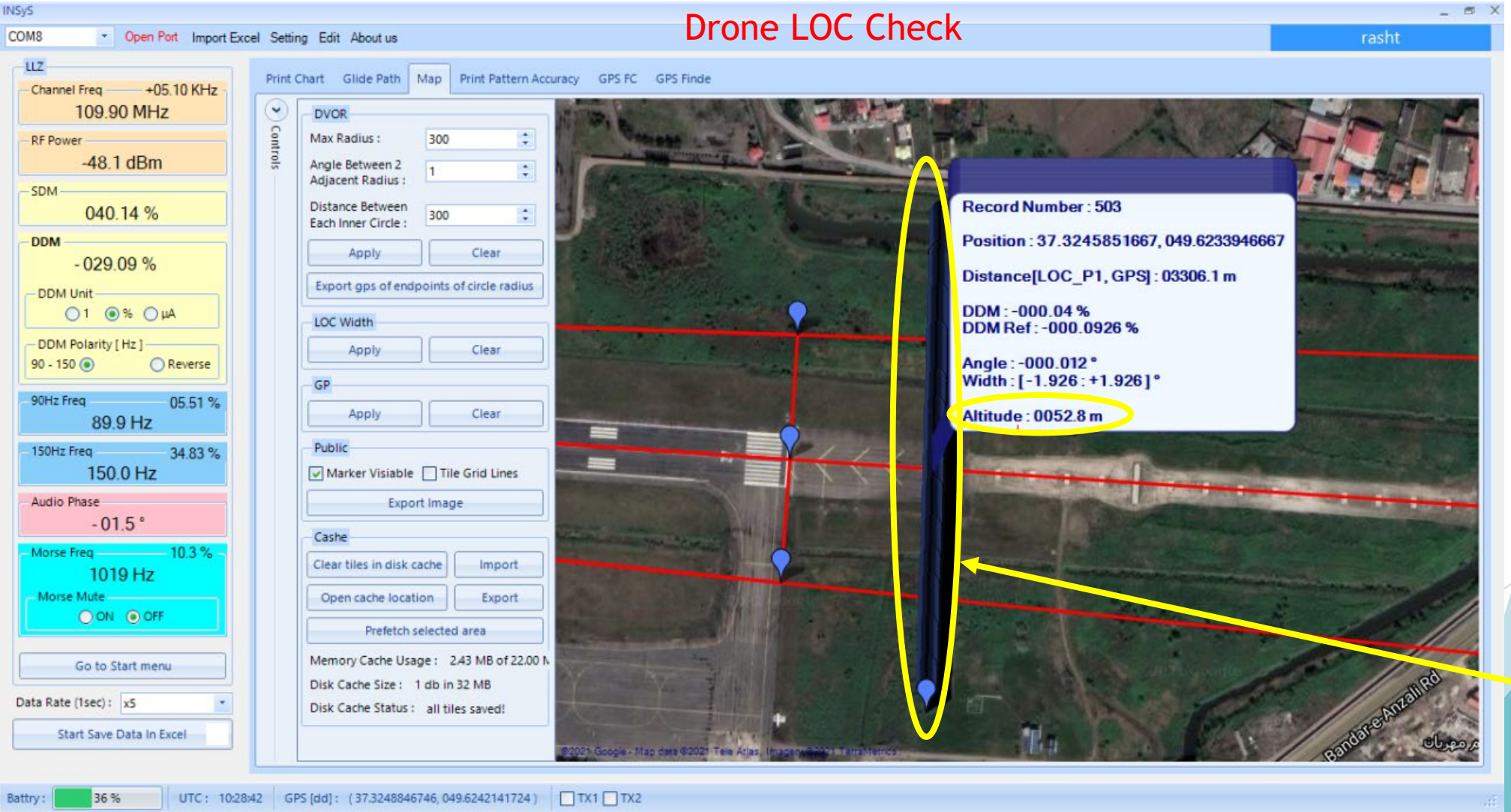
*One solution is to use Drones to check airport navigation aids.

Because in this method, all areas of signal propagation, which includes all the necessary points in each airport, are measured by the UAV & GPS (RTK) and displayed to the operator in the form of graphs and data.

Without the need for the operator to know those points or to go to those points.

Drone LOC Check

Ground LOC Check



Fly Drone cross width

LLZ WIDTH


INSyS
COM8
Open Port
Import Excel
Setting
Edit
About us
rasht
LLZ
Channel Freq
-05.09 KHz
109.90 MHz
RF Power
-49.8 dBm
SDM
038.92 %
DDM
-022.55 %
DDM Unit
1
%
µA
DDM Polarity [Hz]
90 - 150
Reverse
90Hz Freq
09.14 %
90.1 Hz
150Hz Freq
29.78 %
150.0 Hz
Audio Phase
+02.9 °
Morse Freq
11.1 %
1019 Hz
Morse Mute
ON
OFF
Go to Start menu
Data Rate (1sec) :
x5
Start Save Data In Excel
Print Chart
Glide Path
Map
Print Pattern Accuracy
GPS FC
GPS Finde
Controls
Show Helper Lines
Chart Type :
Line
Export Image
DDM
Angle
40.00
35.00
30.00
25.00
20.00
15.00
10.00
05.00
00.00
-05.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-03.63
-01.63
00.37
02.37
03.37
Y = +15.5
DDM = +15.5
Y = 0
DDM = 00.0
Y = -15.5
DDM = -15.5
X = -1.93
X = 0
X = 1.93
θ = 1.93˚
θ = 00.0˚
θ = 1.93˚
Battry :
37 %
UTC : 10:29:25
GPS [dd] : (37.3227023333, 049.6233221667)
TX1
TX2

Glide Path

Glide Path Can Be Inspected/Commissioned.

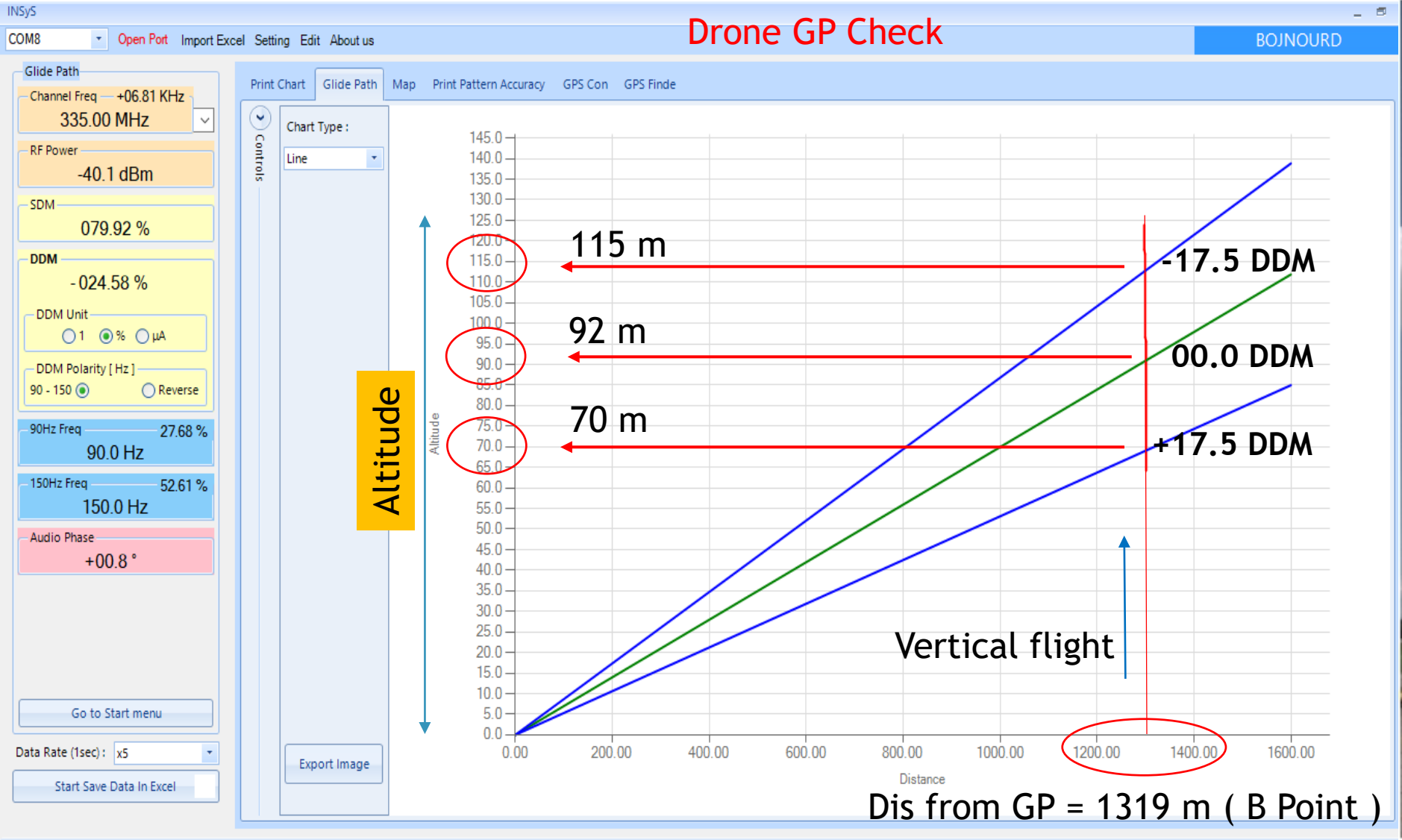
Checks and measurements performed:

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

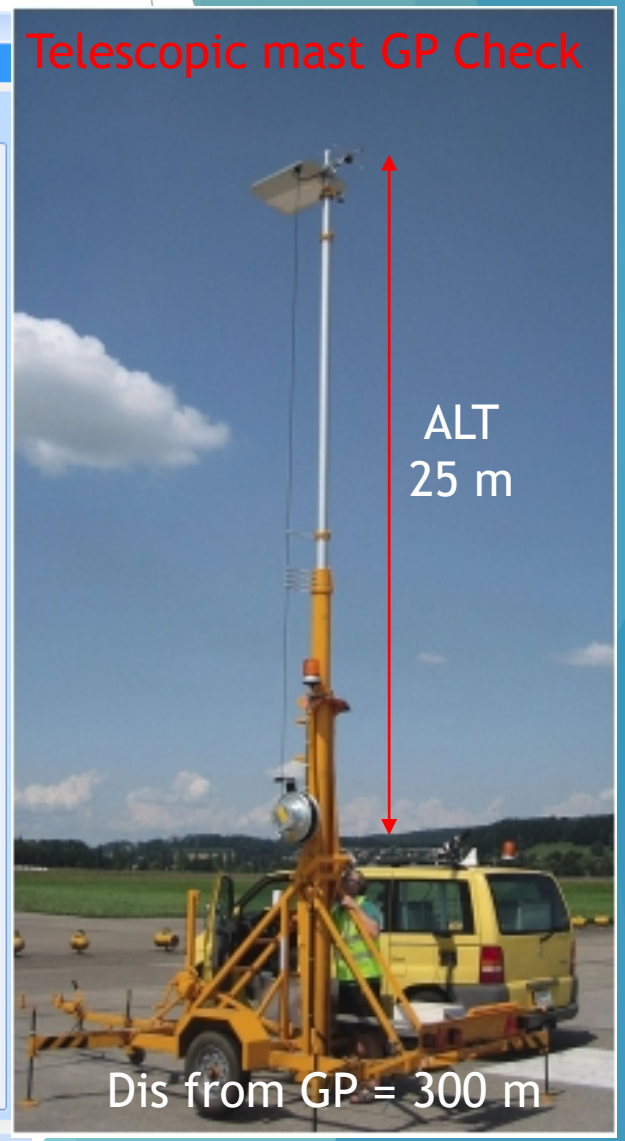
The ground ILS (Instrument Landing System) calibration operations are indeed restrained to the runway threshold, since they are performed using masts that generally don't go higher than around 25 meters, from the ground.

*But the use of UAVs can reduce these limitations and provide more reliable results for managers to make decisions.

Drone GP Check



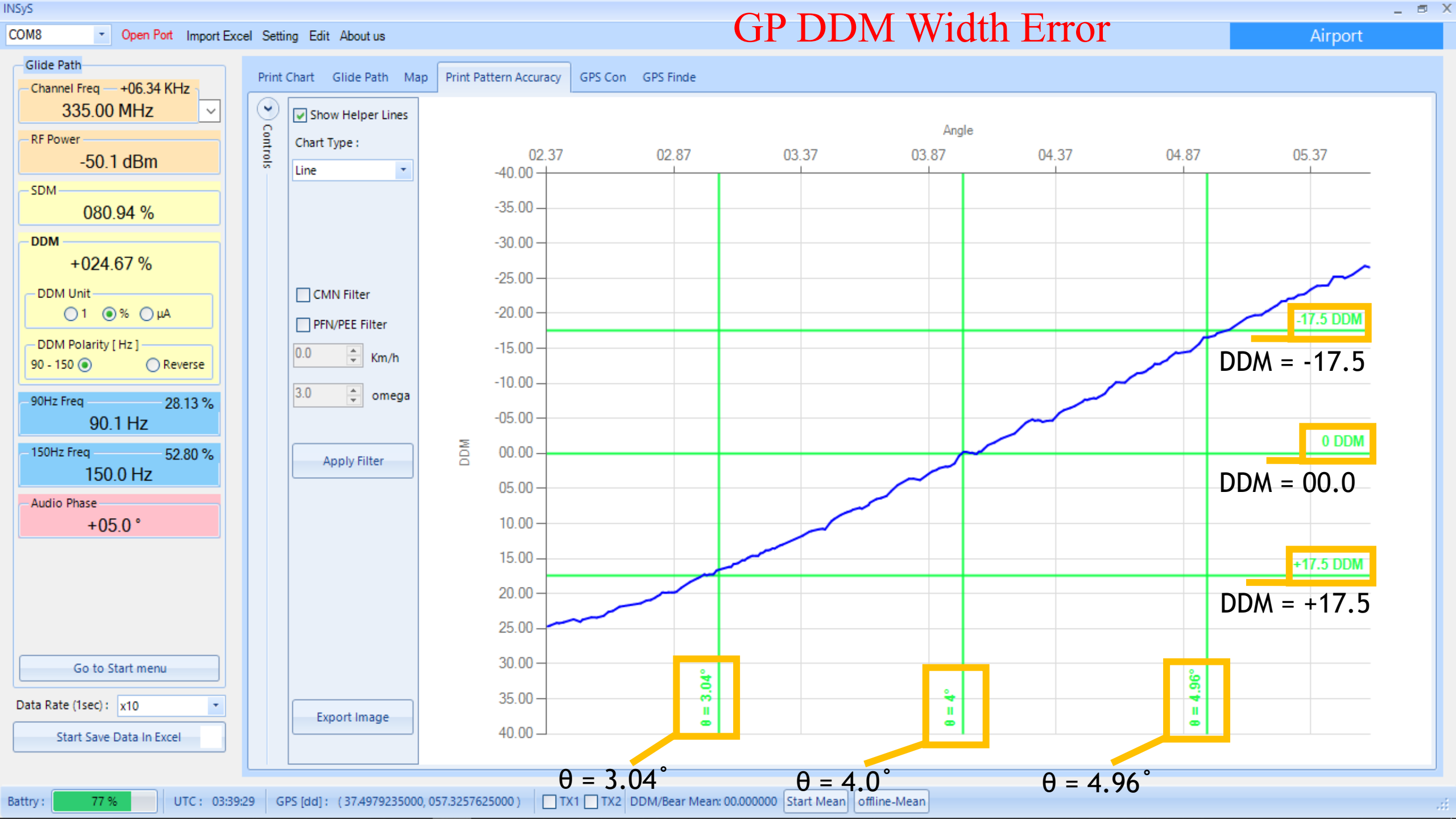
Telescopic mast GP Check



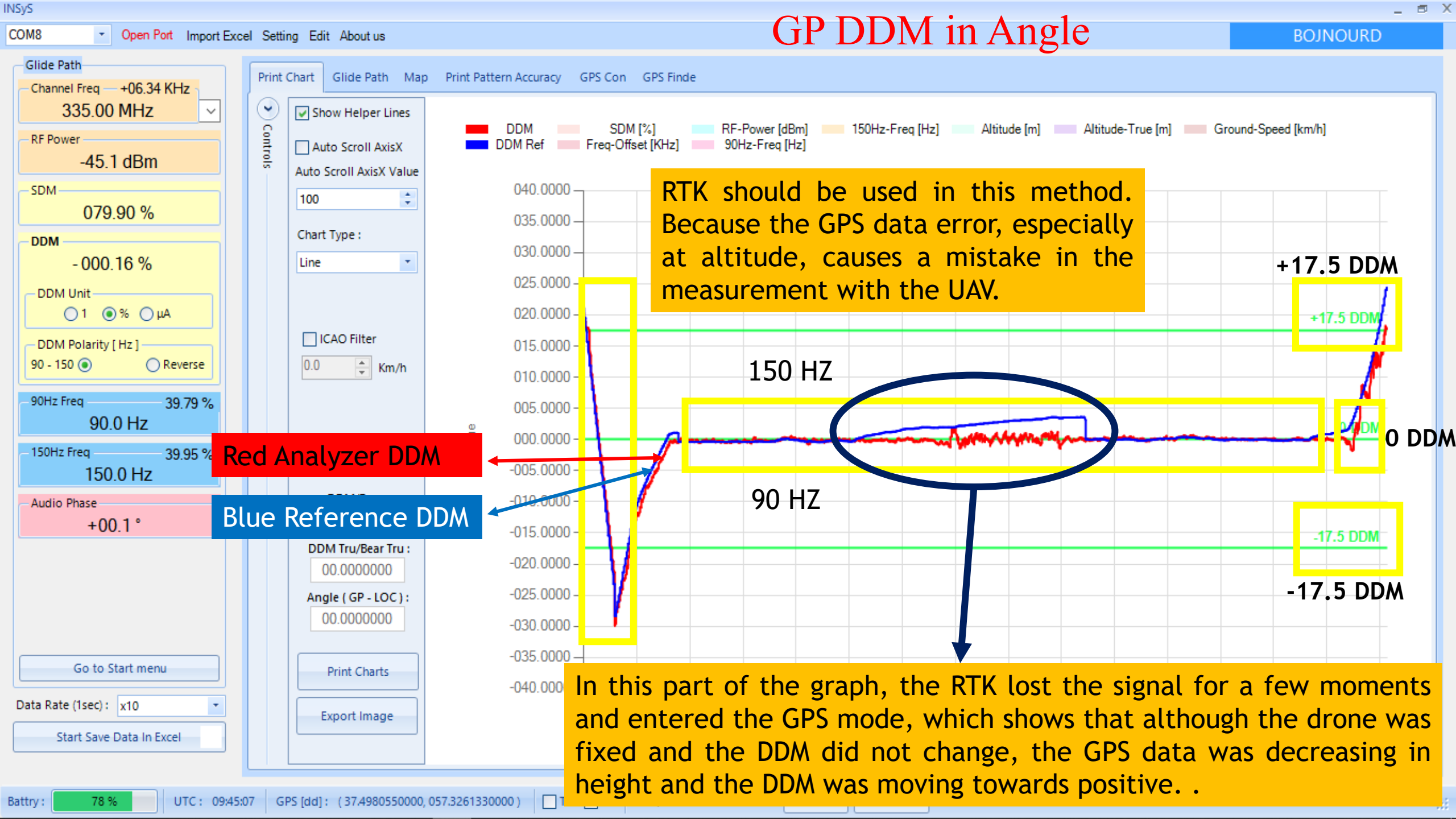
Telescopic mast for glide path measurements.

Photo: Rohde&Schwarz Service Center in Cologne.

GP DDM Width Error



GP DDM in Angle



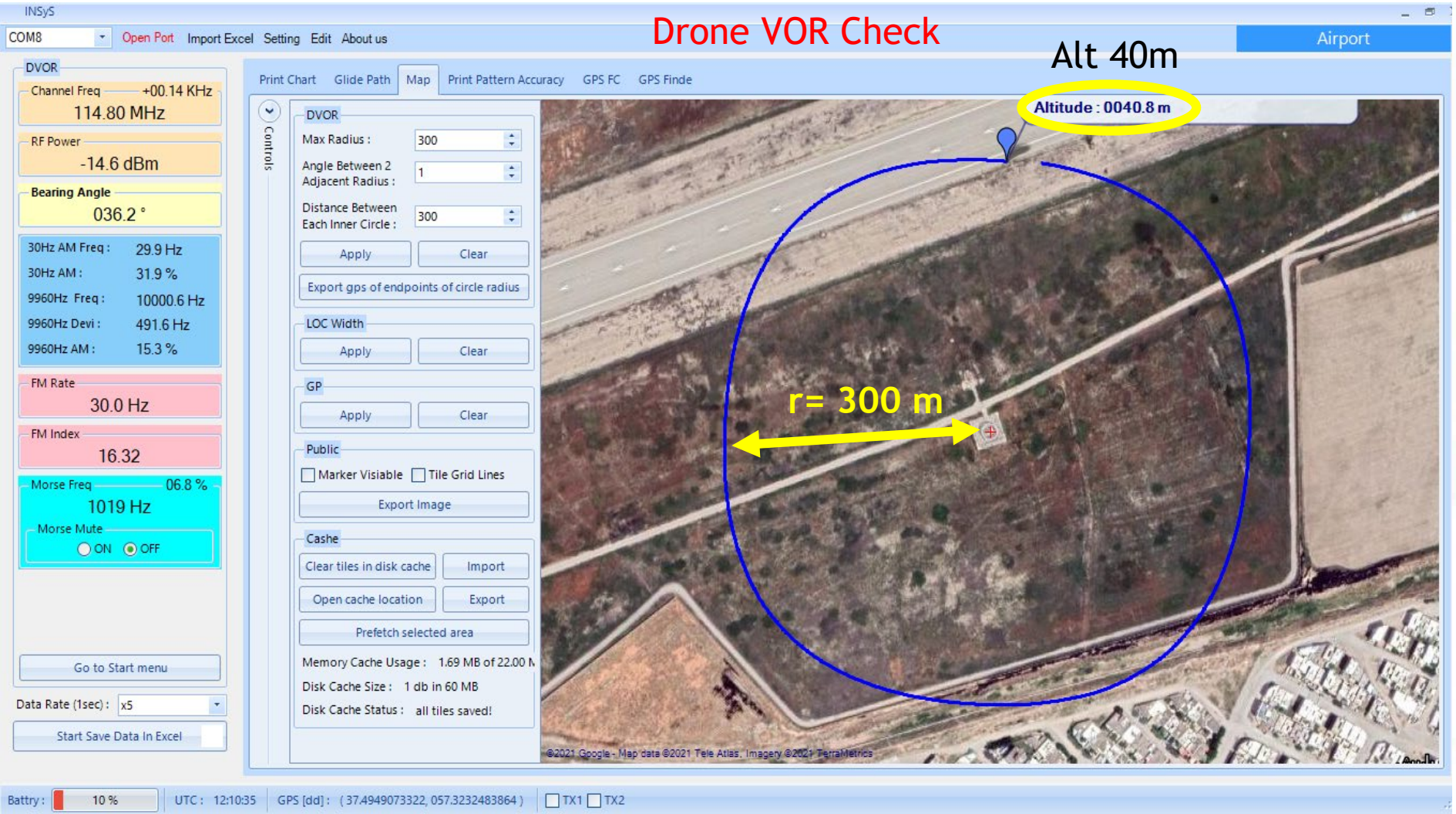
DVOR

DVOR Can Be Inspected/Commissioned.

Checks and measurements performed:

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

The inability to check the 360-degree signal emitted in the DVOR / VOR system space is another limitation of ground-based checks that can be overcome using UAVs.



VOR / Bearing Print Error

INSyS

COM8 | Open Port | Import Excel | Setting | Edit | About us | Airport

DVOR

Channel Freq +00.13 KHz
114.80 MHz

RF Power
-13.9 dBm

Bearing Angle
020.9 °

30Hz AM Freq :	29.9 Hz
30Hz AM :	30.1 %
9960Hz Freq :	10001.6 Hz
9960Hz Devi :	491.7 Hz
9960Hz AM :	15.5 %

FM Rate
30.0 Hz

FM Index
16.32

Morse Freq 06.8 %
1019 Hz
Morse Mute
ON OFF

Go to Start menu

Data Rate (1sec) : x5

Start Save Data In Excel

Print Chart | Glide Path | Map | Print Pattern Accuracy | GPS FC | GPS Finde

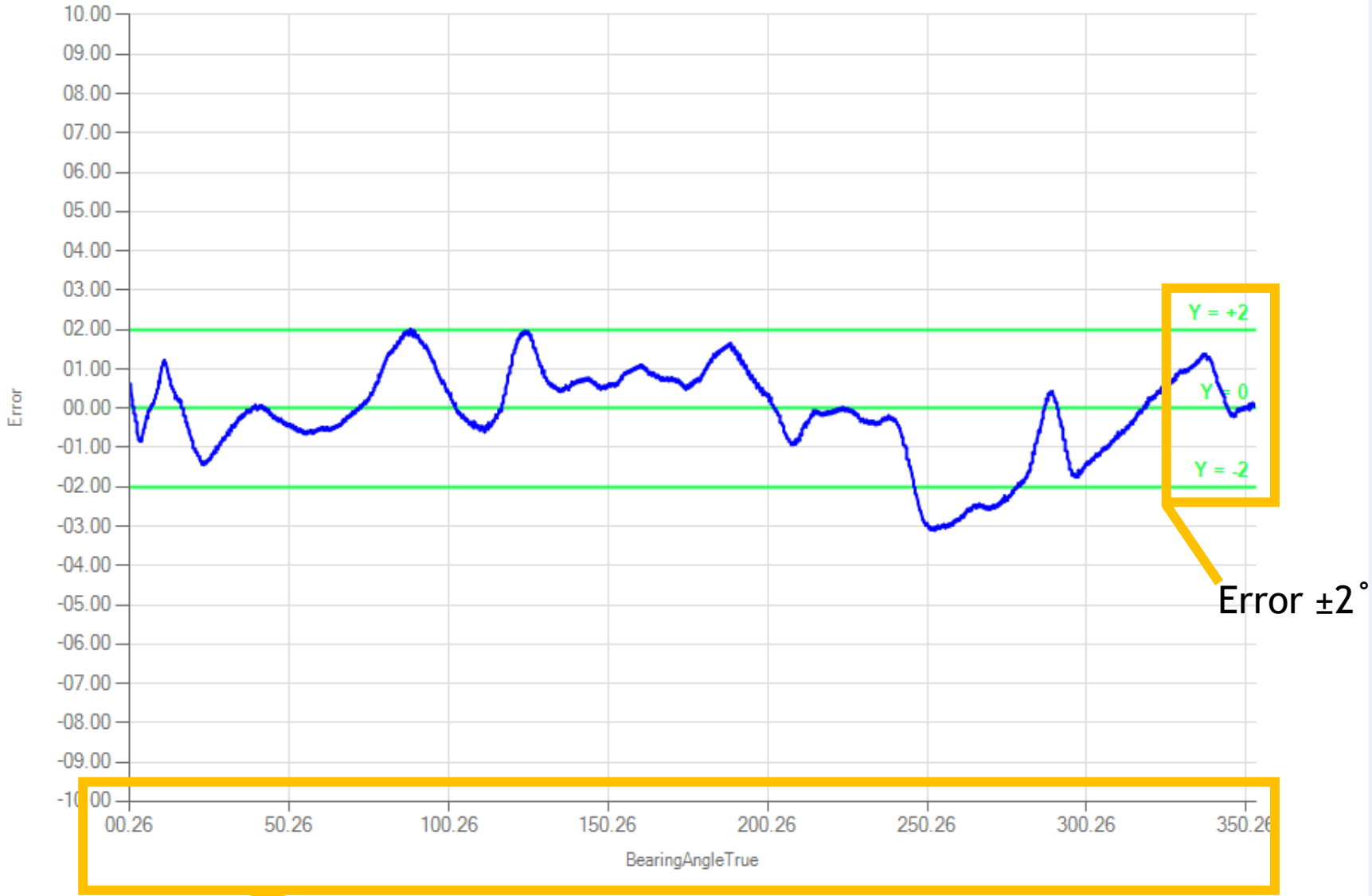
Controls

Show Helper Lines

Chart Type :

Line

Export Image



Error ±2˚

Bearing Angle 0˚ - 360˚

Battry : 9 % | UTC : 12:10:23 | GPS [dd] : (37.4967408333, 057.3247250000) | TX1 TX2

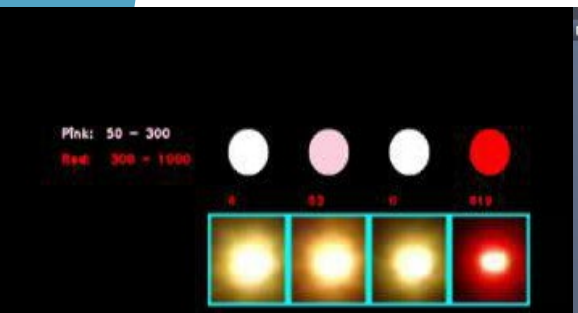
Measurements performed:

- Transition Angles For Each PAPI Unit
- PAPI System Angle
- Relative Brightness
- Angular Coverage
- Symmetry

Pre-flight calibration PAPI Using Drone Light to allow a fast, precise and economical calibration, with very few restrictions on operational aeronautical activity!

In the field tests that were performed, it was found that the adjustment of the PAPI lights using a clinometer has an error for various physical reasons.

PAPI Check GUI



Source :
Camera 0

Control | Parameters | Set

Orginal Resolution: 640 x 480
Estimated FPS: 75
Frame number: 2187

Show Full screen camera
Manual Detection

GPS device port
COM8 GPS Status
Start GPS Stop GPS

Control
Start Cam Update Proc
Stop Cam Export Result

Lights Location
Lat 37.477409000000
Long 57.336943000000 Auto
Alt 1078.3000000000 Save

UAV Location
Lat 0.000000000000 Angle (degree) -
Long 0.000000000000 Distance (meter) -
Alt 0.000000000000 Hight (meter) -

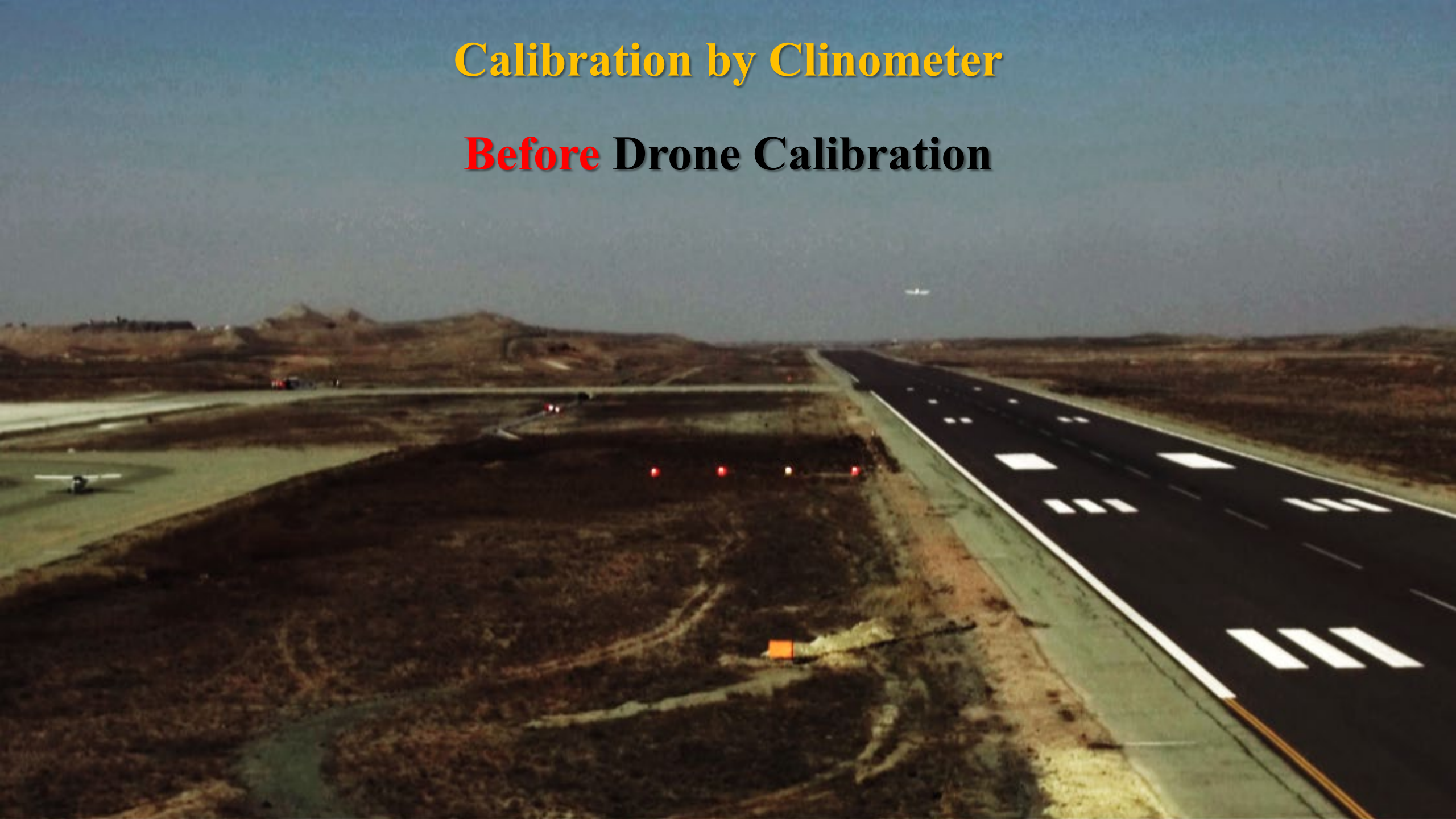
Monitoring

Color Changed | Color Changed | Color Changed | Color Changed

Light	Lat	Long	Alt	Change type	Angle	Time	Detetion type	Operation
A	0	0	0	1	-	22.53.00.239	Auto	حذف
A	0	0	0	1	-	22.53.00.313	Auto	حذف
A	0	0	0	1	-	22.53.00.341	Auto	حذف
D	0	0	0	1	-	22.53.00.664	Auto	حذف
D	0	0	0	1	-	22.53.00.696	Auto	حذف
D	0	0	0	1	-	22.53.00.728	Auto	حذف

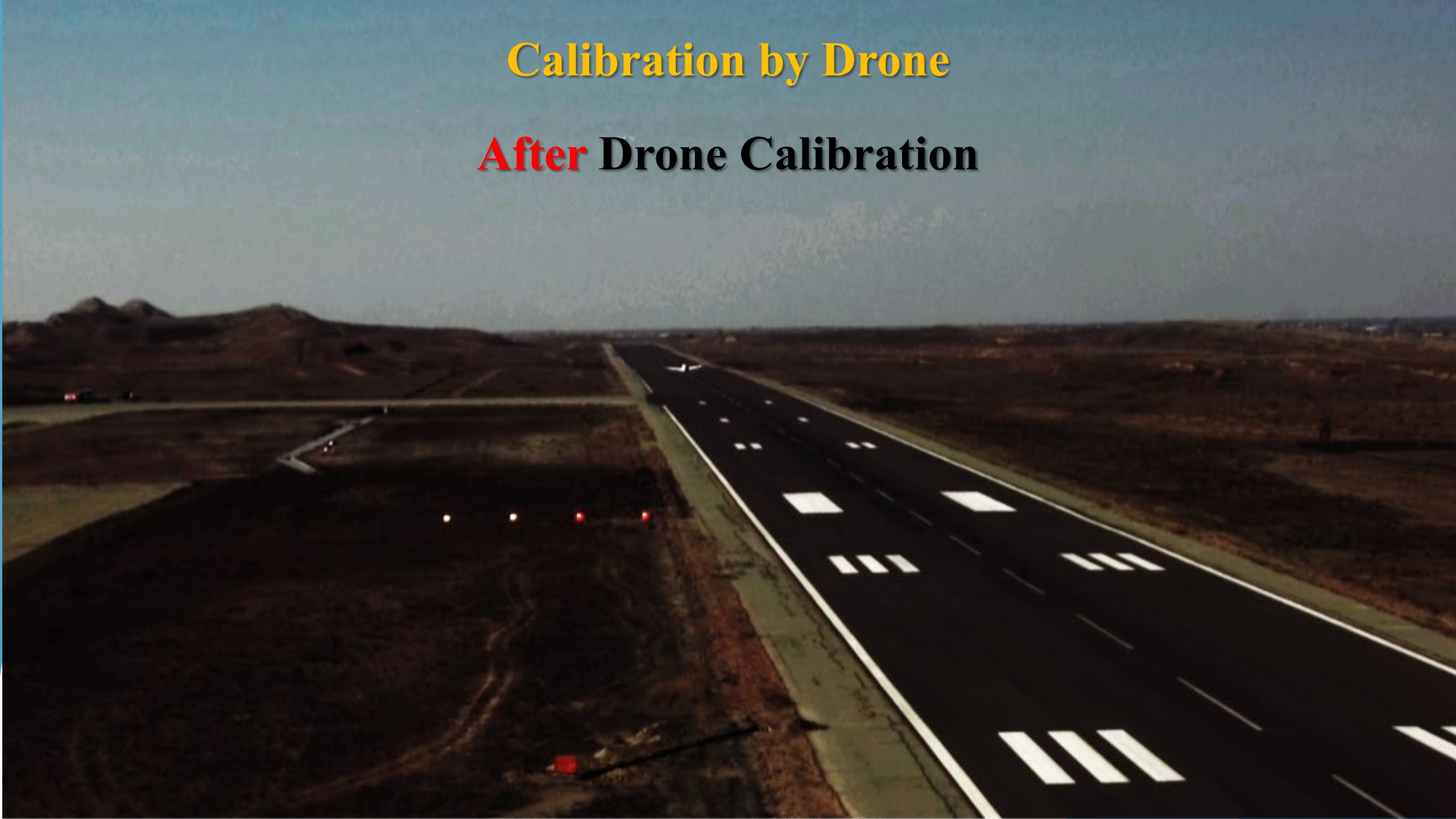
Calibration by Clinometer

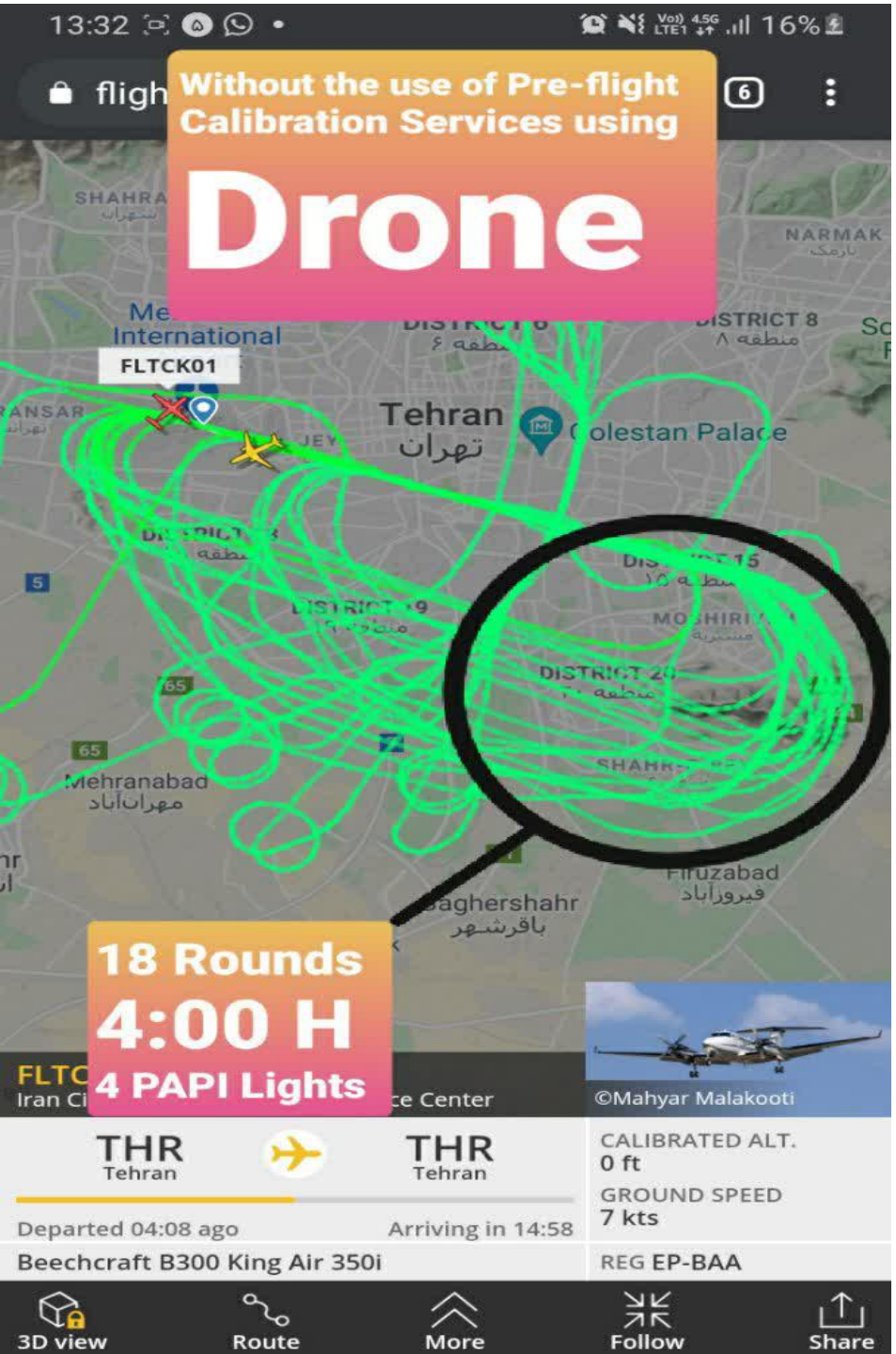
Before Drone Calibration



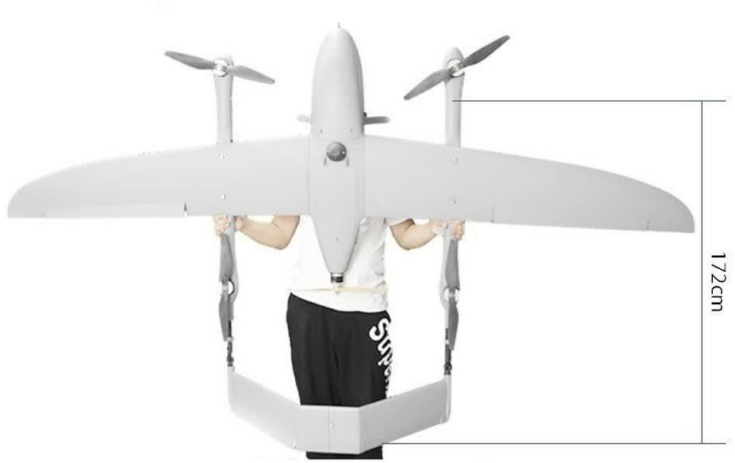
Calibration by Drone

After Drone Calibration




Without the use of Pre-flight Calibration Services using
Drone
FLTCK01
Tehran
تهران
18 Rounds
4:00 H
4 PAPI Lights
©Mahyar Malakooti
THR
Tehran
THR
Tehran
CALIBRATED ALT.
0 ft
GROUND SPEED
7 kts
Departed 04:08 ago
Arriving in 14:58
Beechcraft B300 King Air 350i
REG EP-BAA
3D view
Route
More
Follow
Share


by Pre-flight Calibration Services using Drone
flightradar24
FLTCK01
Karaj
کرج
12 Rounds
1:30 H
8 PAPI Lights
Iran Civil Aviation Training & Service Center
©Mohammad Rozve
THR
Tehran
N/A
CALIBRATED ALT.
0 ft
GROUND SPEED
67 kts
Beechcraft B300 King Air 350i
REG EP-BAA
3D view
Route
More
Follow
Share



The tests performed in this presentation were performed at the shortest distances.

If needed, if the drone has the ability to fly longer, it can go farther distances and higher altitudes.

In this case, we suggest the use of VTOL Drones that can fly up to a radius of about 100 km and They have an altitude of about 3 km.

Advantages of using a Drone:

- Reduce the flight time of the inspection aircraft.
- Reduce the potential dangers for inspection aircraft crew.
- Reduce chain costs.
- Reduce air traffic while flying inspection aircraft.
- Reduce the workload of the flight group and ATSEP & AGL engineers.
- Reduce air and noise pollution.
- Reduction of human and system errors in ground check of navigation assistance systems.
- Increase aviation safety.
- Increasing the number of inspection aircraft courses of navigation assistance systems with intermediate inspections by Drone.

All of Kavics solutions and procedures are developed and tested to comply with ICAO guidelines and specifications, such as Doc. 8071, Doc. 9157, Annex 10 or Annex 14.

Requests

- ✓ Instructions or local permits to use UAVs as an advanced method of checking airport navigation assistance systems.
- ✓ Increase the time between check periods of navigation assist systems by flight inspection aircraft.
- ✓ The need to perform pre-flight calibration when installing navigation assist systems.

Our company wholeheartedly declares its readiness for any field testing and cooperation with ICAO to achieve greater safety and reduce potential hazards to inspection aircraft and reduce chain costs.

Thank you for your attention