Argos Photometric Systems

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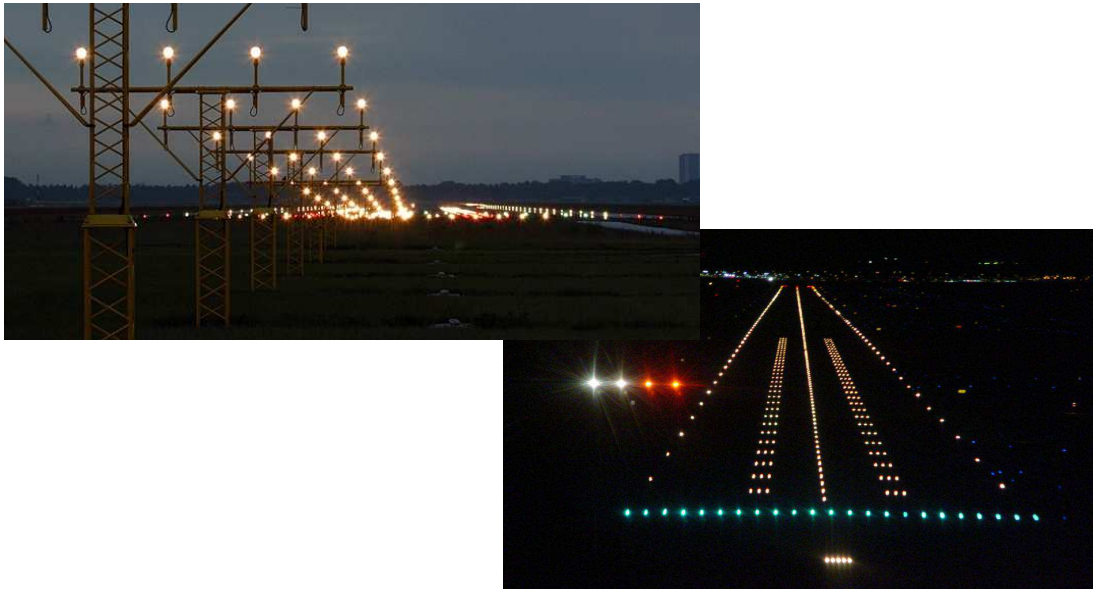
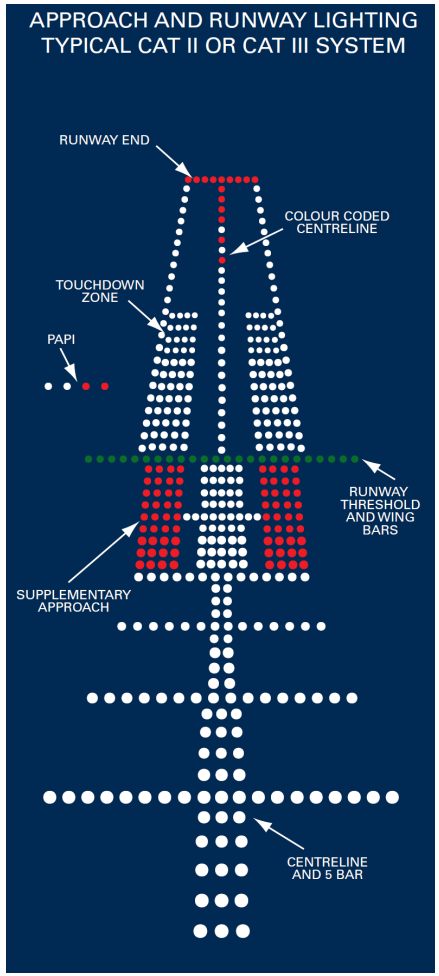
October 2013

Argos Photometric Systems

Classification of AGLS measurements (I)

The Airfield Ground Lighting Systems (AGLS) are complex systems which may assume various configurations and a crucial importance for air navigation



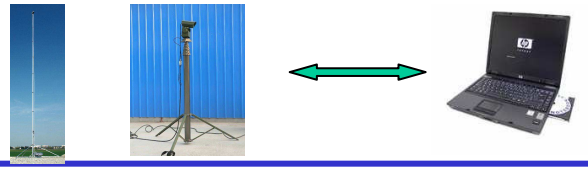


A significant share of airport security relative to the operations in both night time and daytime under low visibility depends on the operational efficiency of AGL

Classification of AGLS measurements (II)

	Airfield Ground Lighting System
	Precision Approach Path Indicators
	Fixtures post-repair and/or pre-installation verification
	Illuminated Vertical Signs
	Approach Ligthing System
	Obstacle detection for Approach and Takeoff Surfaces

SMF Products

Product	Fixture	System + Calibration tool
SMF/PAPI		
SMF/M		
SMF/L		
SMF/SIGN		
SMF/ODS		
SMF/ALS		

Patents & Certifications

Patents

- SMF/M (RM2007A000099 dated February 21st 2007)
- SMF/PAPI Italy (RM2007A000679 dated December 28th 2007)
- SMF/PAPI U.S. (12/536648 dated July 2009)

Certifications

- Italy - SMF/PAPI issued by ENAC (0000376 dated January 2008)
- Italy - SMF/M issued by ENAC (0036044 dated June 2009)
- Spain - SMF/PAPI issued by AENA through Bureau Veritas (10.IT.714340.729 dated February 2010)
- U.S. - SMF/PAPI issued Intertek (100147381CRT-001 dated September 2010)
- Mexico - SMF/PAPI issued DGAC (January 2011)
- Greek - SMF/PAPI issued HCAA (July 2011)
- U.S. - SMF/PAPI for LED PAPI issued by FAA (September 2012)
- Canada – SMF/PAPI AC issued by TCCA 300-006 Rev. 01 (October 2012)

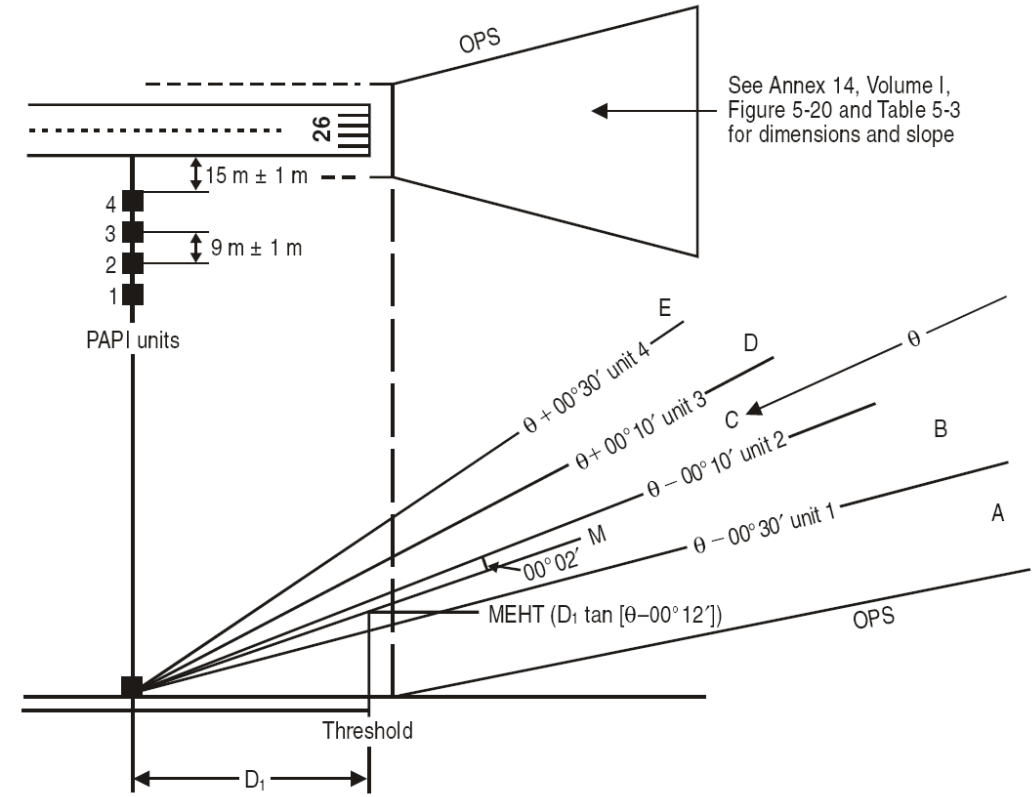
SMF/PAPI

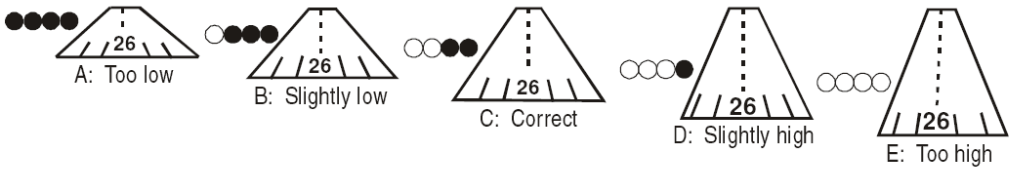
Photometric Measurement System dedicated to PAPI Alignment

ICAO Aerodrome Design Manual Requirements

- The 4 PAPI units are installed at 9 m distance, 15 m left of the runway border
- Unit A or 1 is the farest
- 4 other units may be installed on the right side (with unit A as the farest).

- The APAPI includes only 2 units aiming at θ +/- 15'.





● Red

○ White

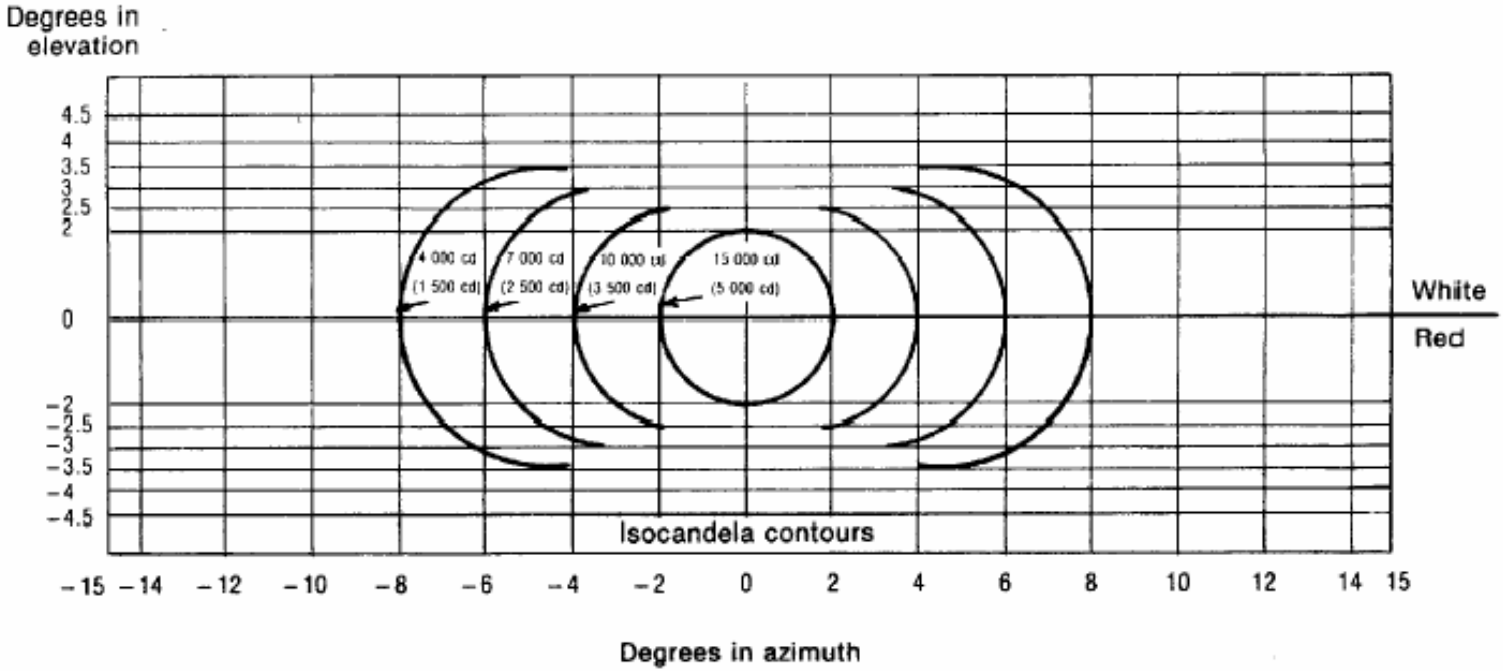
M = unit 2 setting less 00° 02′

D_1 = distance of PAPI units from the threshold

Legend:

- OPS: obstacle protection surface
- MEHT: minimum eye height over threshold.

ICAO required light intensity distribution



Note 1.— These curves are for minimum intensities in red light.

Note 2.— The intensity value in the white sector of the beam is no less than 2 and may be as high as 6.5 times the corresponding intensity in the red sector.

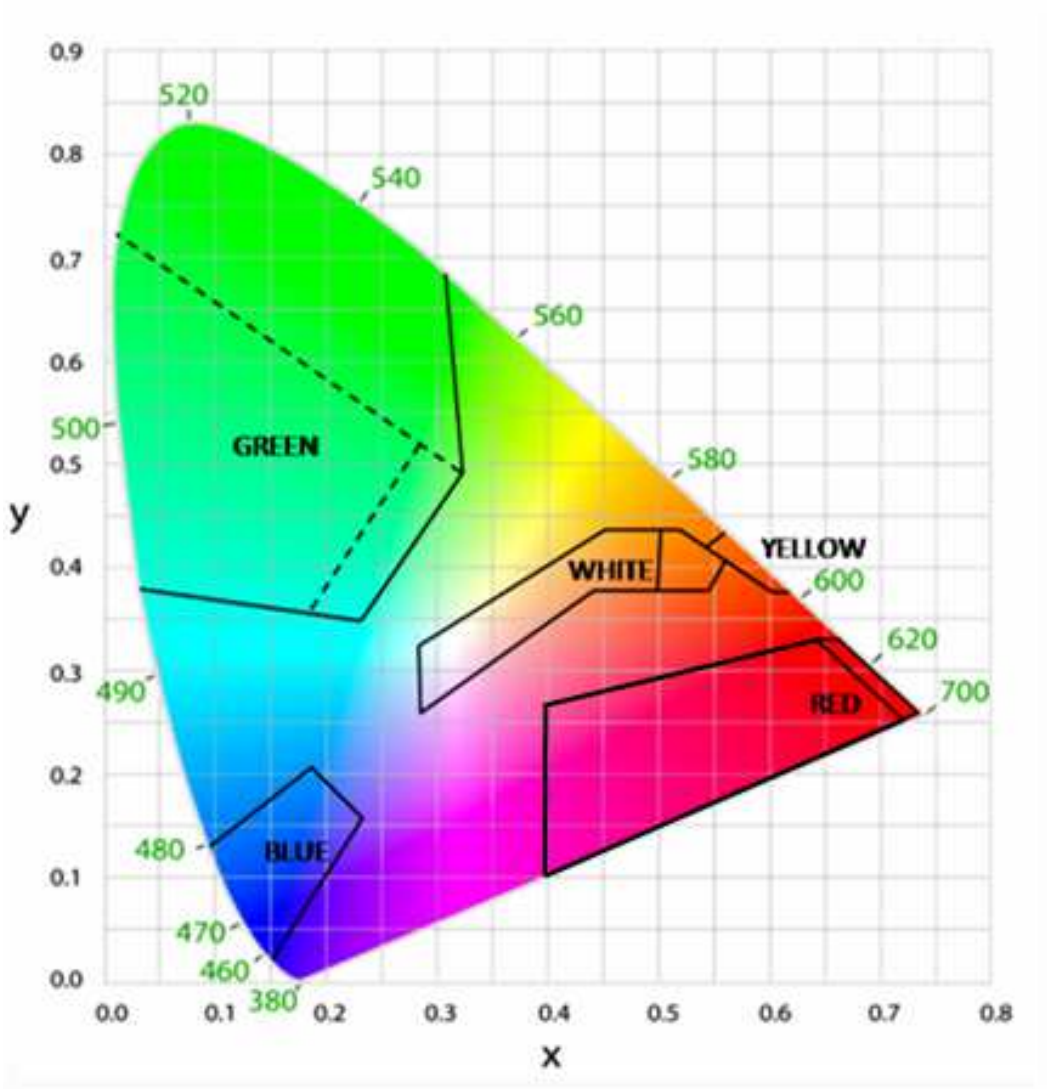
Note 3.— The intensity values shown in brackets are for APAPI.

See Annex 14, Appendix 2, Fig. 2.23

ICAO required colors for PAPI

Color standards are defined in spec SAE AS25050 (Colors, Aeronautical Lights and Lighting Equipment, General Requirements For), for variable white and red.

White and red colors shall be verified at elevation angle of +/- 2° respect to color transition angle (Annex 14, Appendix 1, 2.2.4 and 2.2.5).



PAPI – New ICAO recommendations

"Method of checking
8.3.18.1 Individual unit setting angles are checked by use of a clinometer, or equivalent means of angular measurement, in accordance with the manufacturer's instructions. Errors in excess of one minute of arc should be corrected. A visual comparison between all the units in the system set at the same angle may be used to identify a unit in which there is a misalignment between the optical system and the datum plate. The cause of any misalignment of this nature should be ascertained and corrected before any adjustment is made to the setting angles."

"8.3.18.2 Electronic equipments - based on computer image analysis and able to perform angular measurement by external observation of PAPI light beam – are required for a more precise check of PAPI units tuning, on the assumption that such equipments may have an overall precision and accuracy response better than clinometers or flight inspections. Appropriate authorities will assess in force of specific certifications that these equipments are allowed to operate, assuming that their absolute precision and accuracy are better than one minute of arc.

Argos Assumption (I)

Assumption I

Mechanical methods based on the usage of spirit clinometers don't measure neither the real angle of color transition nor the quality of transition itself: they rather measure the inclination of the portion of PAPI box where the inclinometer has been applied

Assumption II

Nothing therefore allows to presume that the beam is exactly assuming the same angle of the whole box. Even the usage of an external optical gouge doesn't provide the required accuracy due to need of a very accurate measurement of distance and height of the gouge itself. This situation can be easily expressed by the following formula

$$Ir = Ic + C$$

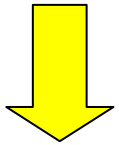
where:

Ir is the real angle of the output beam, Ic is the angle read on the inclinometer scale and C is an unpredictable value (+/-) representing the contribute given by all the factors out of control of inclinometer and affecting the real angle of the beam (including of course the accuracy of the inclinometer itself).

Argos Assumption (II)

Assumption III

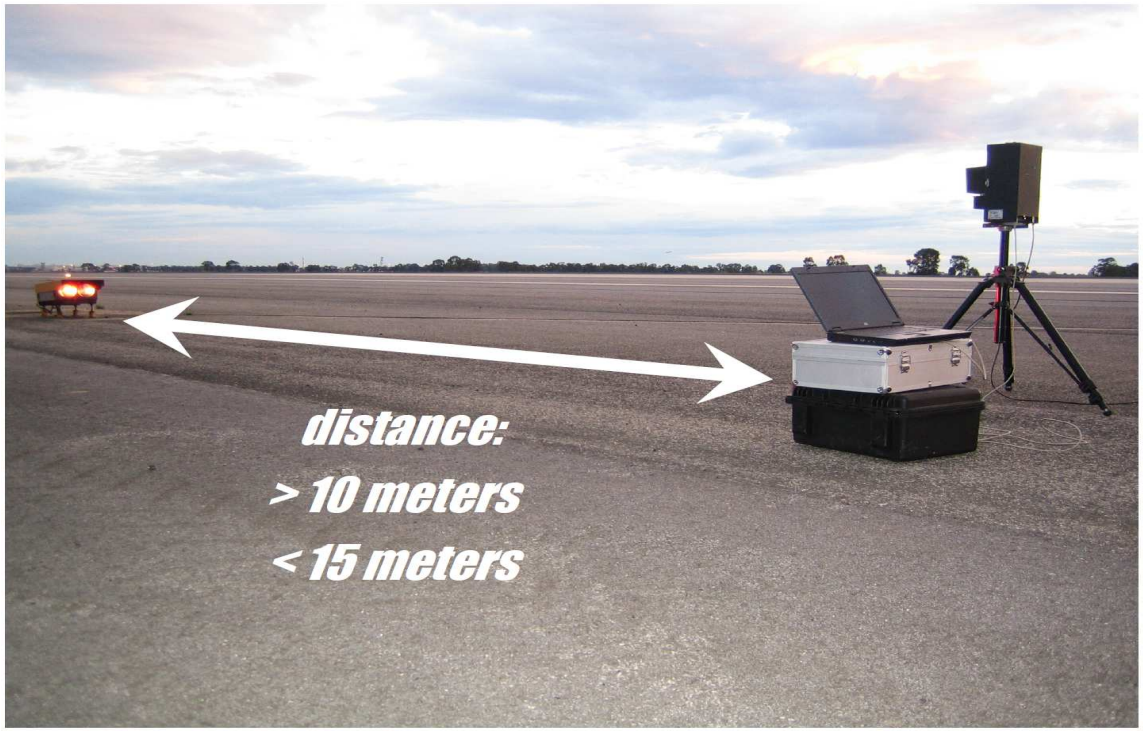
The accurate assessment of PAPI performances needs the external observation of the PAPI beams using on ground or in flight positional reference systems

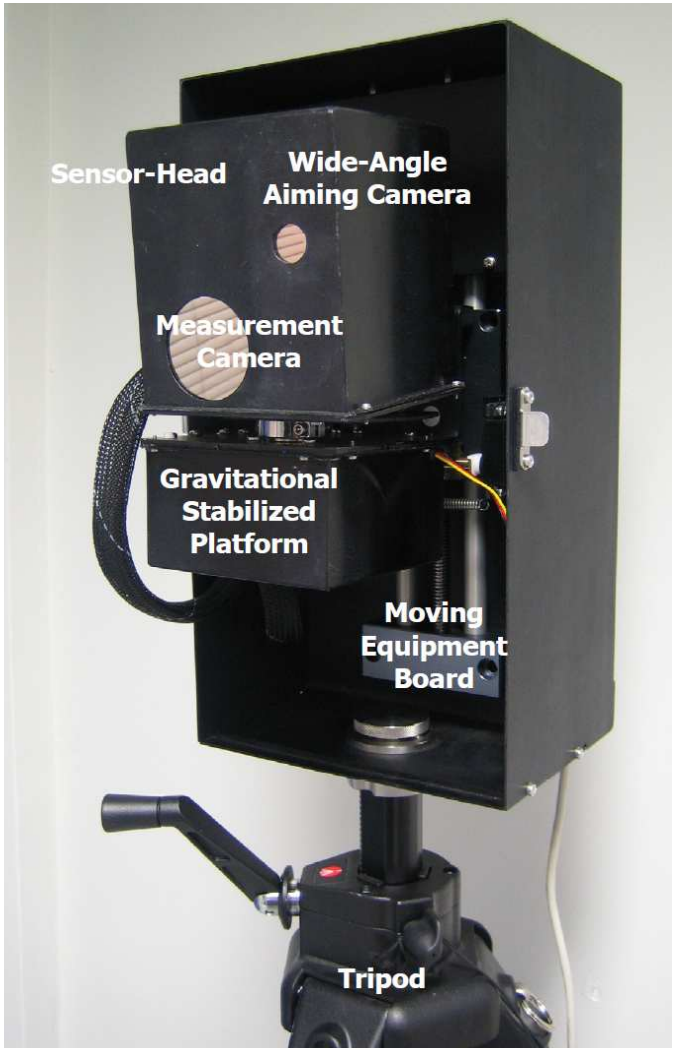


The Optoelectronic equipment is a powerful solution that applies in near field condition the concepts of flight inspection giving a more accurate measurement of transition angle and additional information about the whole status of PAPI beam

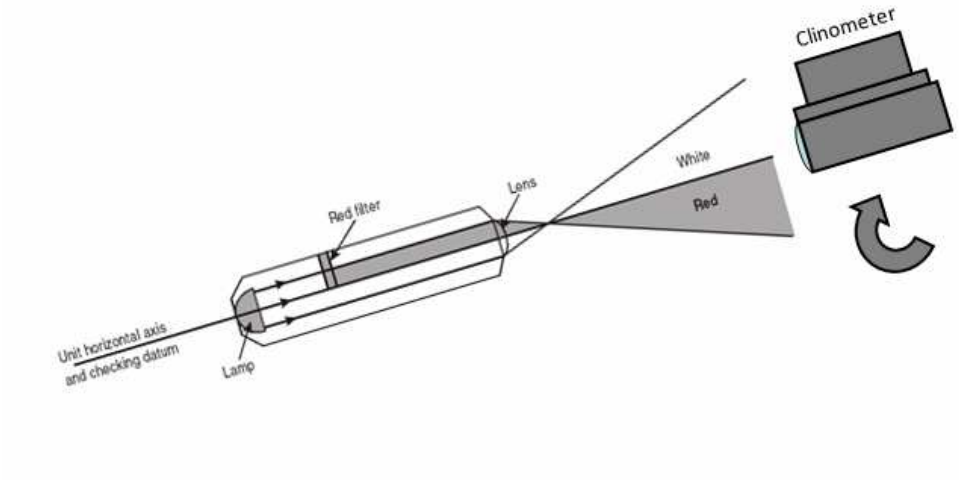
SMF/PAPI: The Argos solution

An Optronic Sensor head mounted on a auto leveling 3D moving mechanism driven by a PC running an image analysis software.

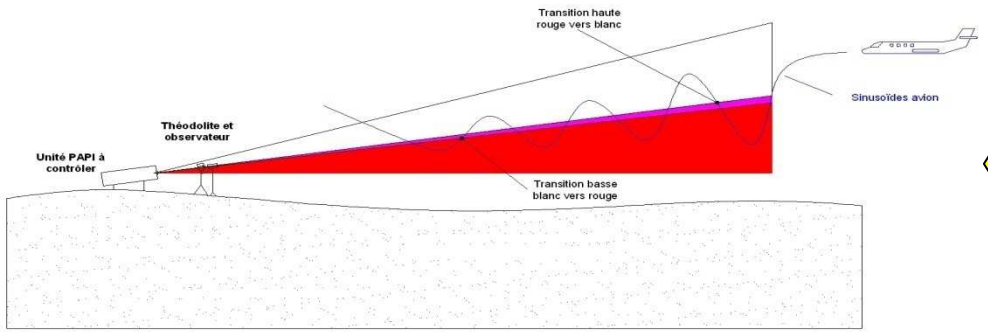




SMF/PAPI: Comparison with Flight check (I)



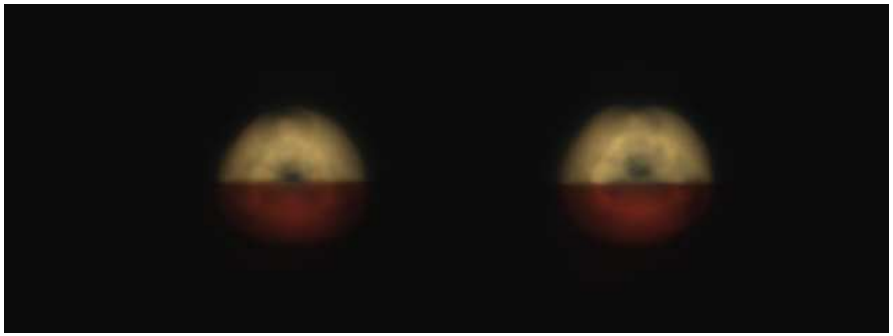
SMF/PAPI INSTRUMENT



FLIGHT INSPECTION

SMF/PAPI: Comparison with Flight check (II)

SMF/PAPI INSTRUMENT



What the instrument sees

FLIGHT INSPECTION

What the pilot sees

SMF/PAPI: Comparison with Flight check (III)

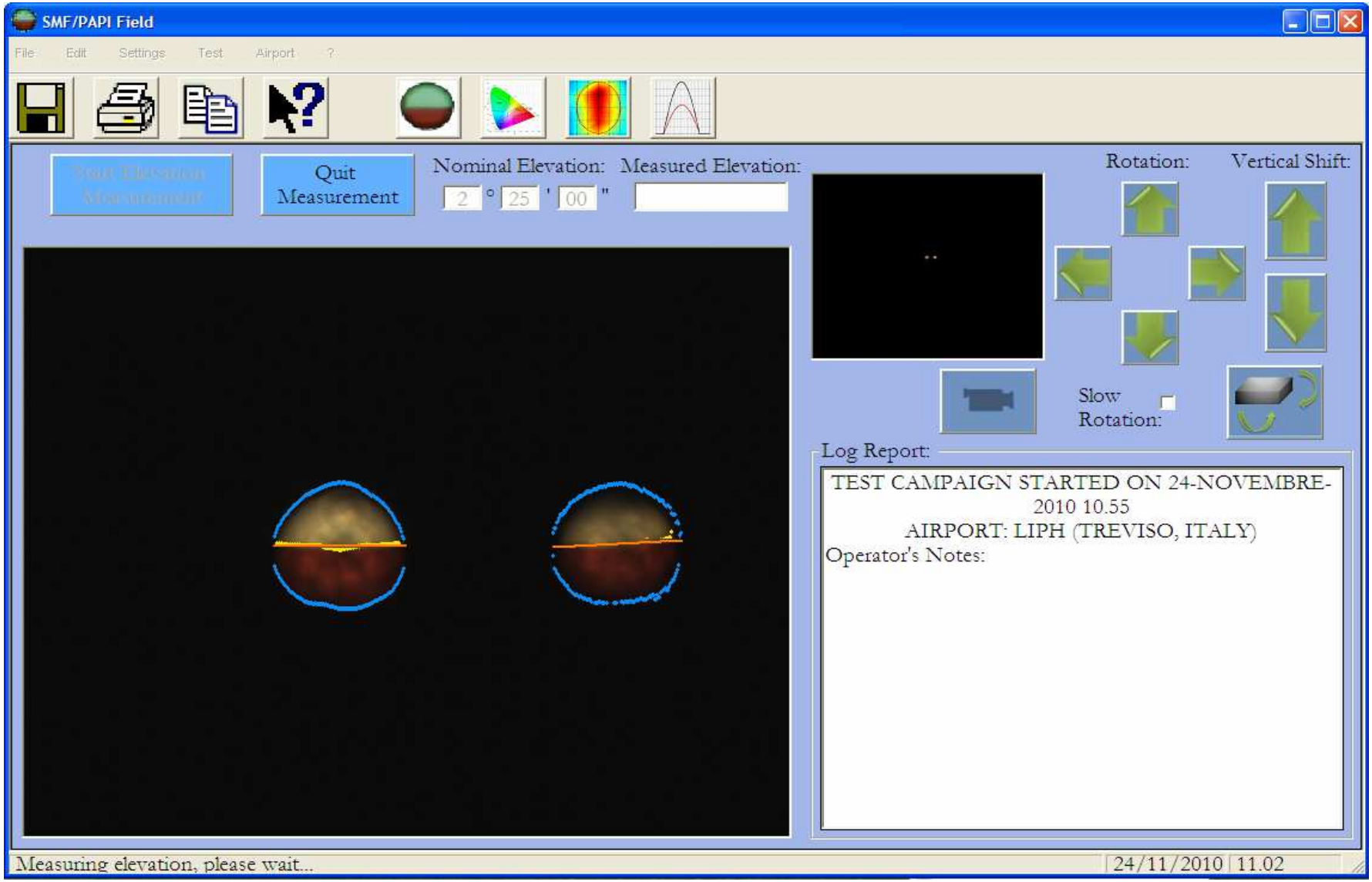
- Easy to use and to deploy in the field
- Angle measurement is available immediately including the instructions on how to correct the PAPI unit position if necessary.
- Measures the beam real angle with an accuracy better than 1'
- Measures all photometric parameters requested by ICAO
- Reveals any problem in the PAPI projector including defocusing issues

SMF/PAPI INSTRUMENT

- Not easy scheduling and little or no time to re-align the PAPIs if required.
- Not able to measure intensity and colour parameters

FLIGHT INSPECTION

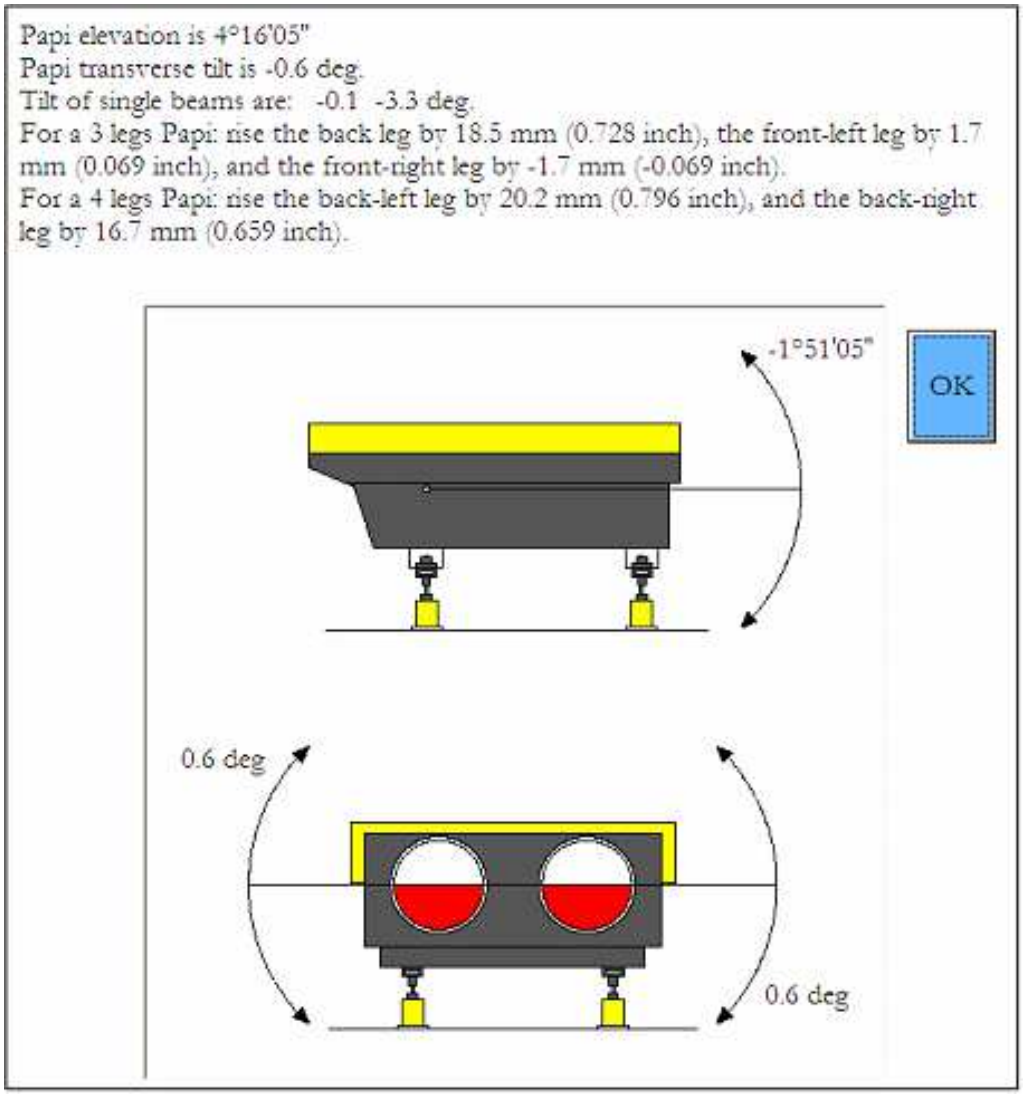
SMF/PAPI: Automated Elevation Measurement (I)



SMF/PAPI: Automated Elevation Measurement (II)

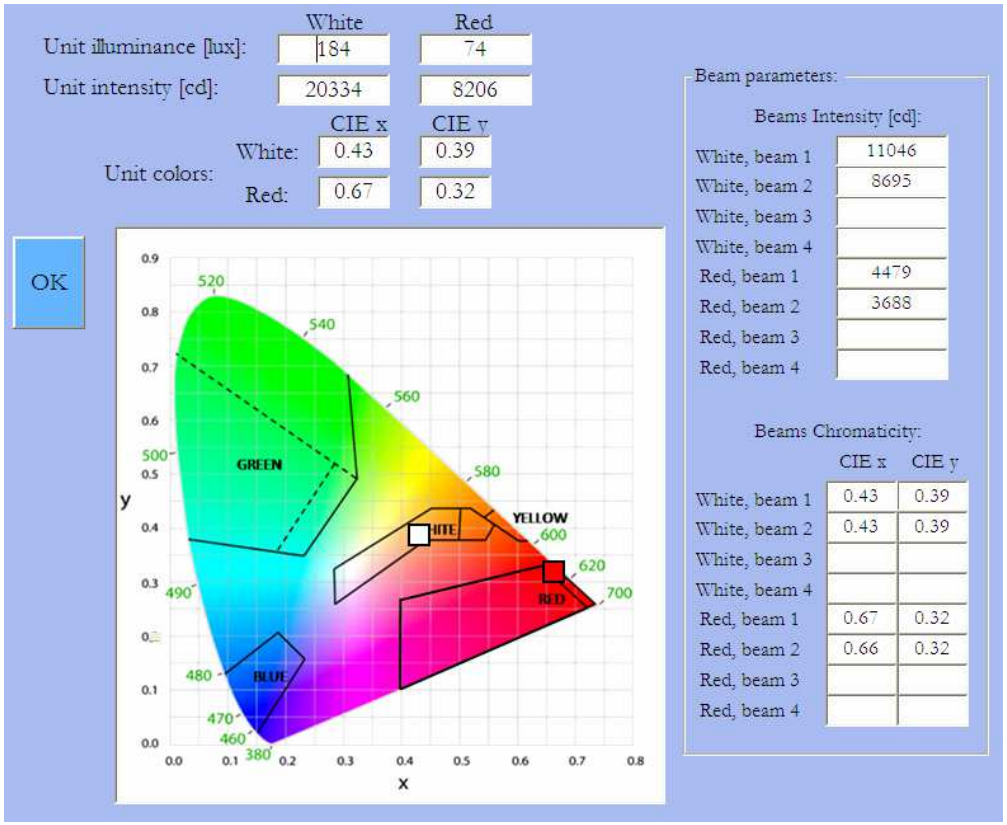
After the test is terminated, the following information will be displayed:

- PAPI unit elevation angle
- PAPI transverse tilt angle (optical horizontality of the unit)
- Transverse tilt of the single beams (horizontality of the red filters inside the unit)
- Indications to the operator for a proper alignment of the PAPI unit
- System software will also warn the operator if the PAPI unit is showing unfocused or misaligned optics.

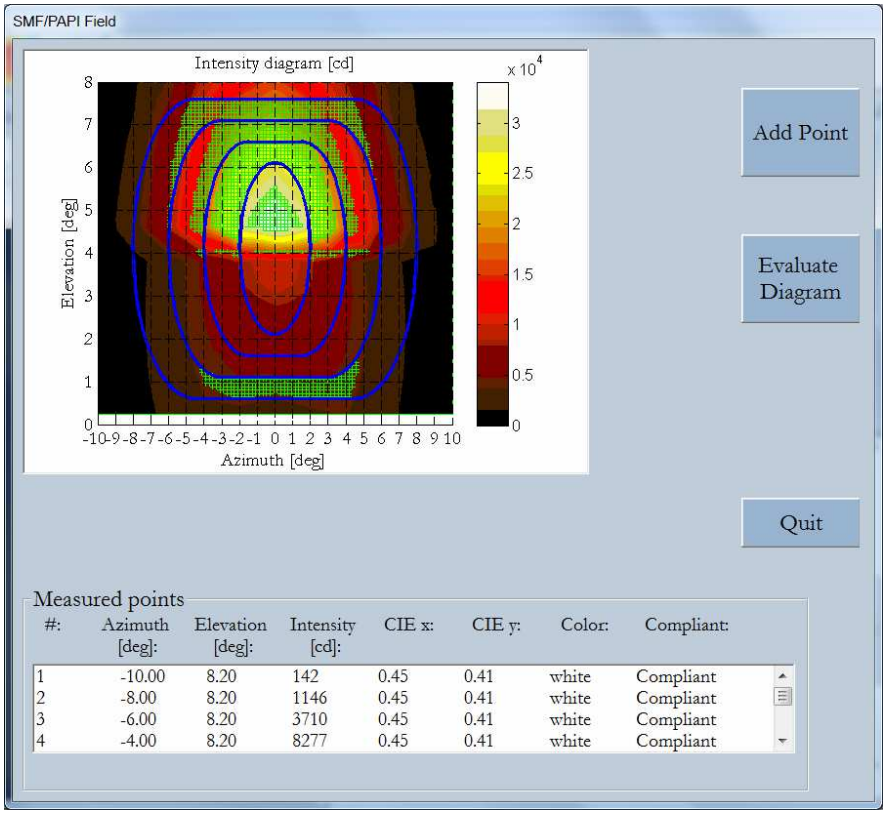


SMF/PAPI: Performing the Intensity/Chromaticity Test

Chromaticity



Intensity



SMF/PAPI: Papi Position Intensity Diagram

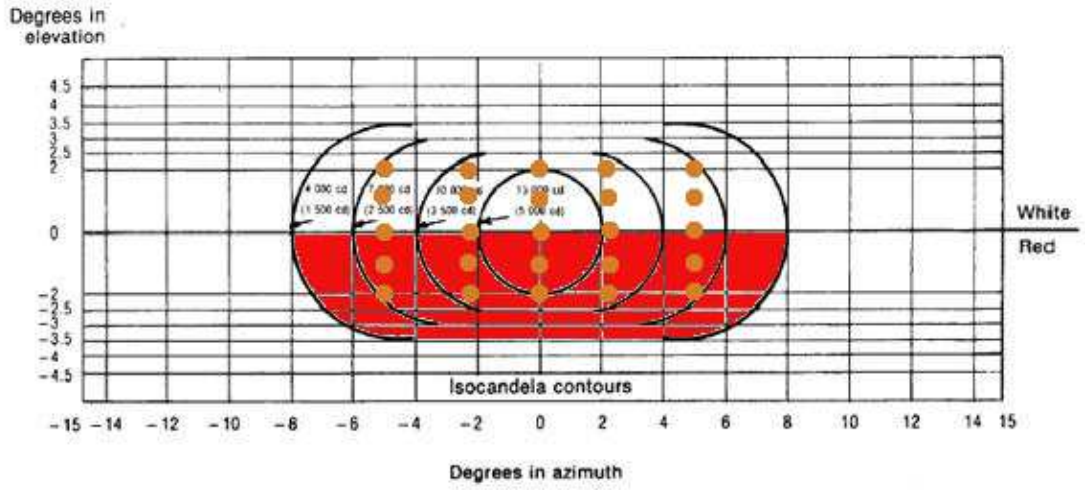
	-0,88	-0,44	0	0,44	0,88	
Measuring head Vertical shift over center area	0,34 (2°)	0,34 (2°)	0,34 (2°)	0,34 (2°)	0,34 (2°)	WHITE AREA
	0,17 (1°)	0,17 (1°)	0,17 (1°)	0,17 (1°)	0,17 (1°)	
	-0,88	-0,44	0	0,44	0,88	

	needed value	needed value	needed value	needed value	needed value	
Papi Position	-0,88 (5°)	-0,44 (2,5°)	0	0,44 (2,5°)	0,88 (5°)	CENTER AREA

	-0,88	-0,44	0	0,44	0,88	
Measuring head Vertical shift below center area	-0,17 (1°)	-0,17 (1°)	-0,17 (1°)	-0,17 (1°)	-0,17 (1°)	RED AREA
	-0,34 (2°)	-0,34 (2°)	-0,34 (2°)	-0,34 (2°)	-0,34 (2°)	
	-0,88	-0,44	0	0,44	0,88	

Table of displacement values at 10 m distance.

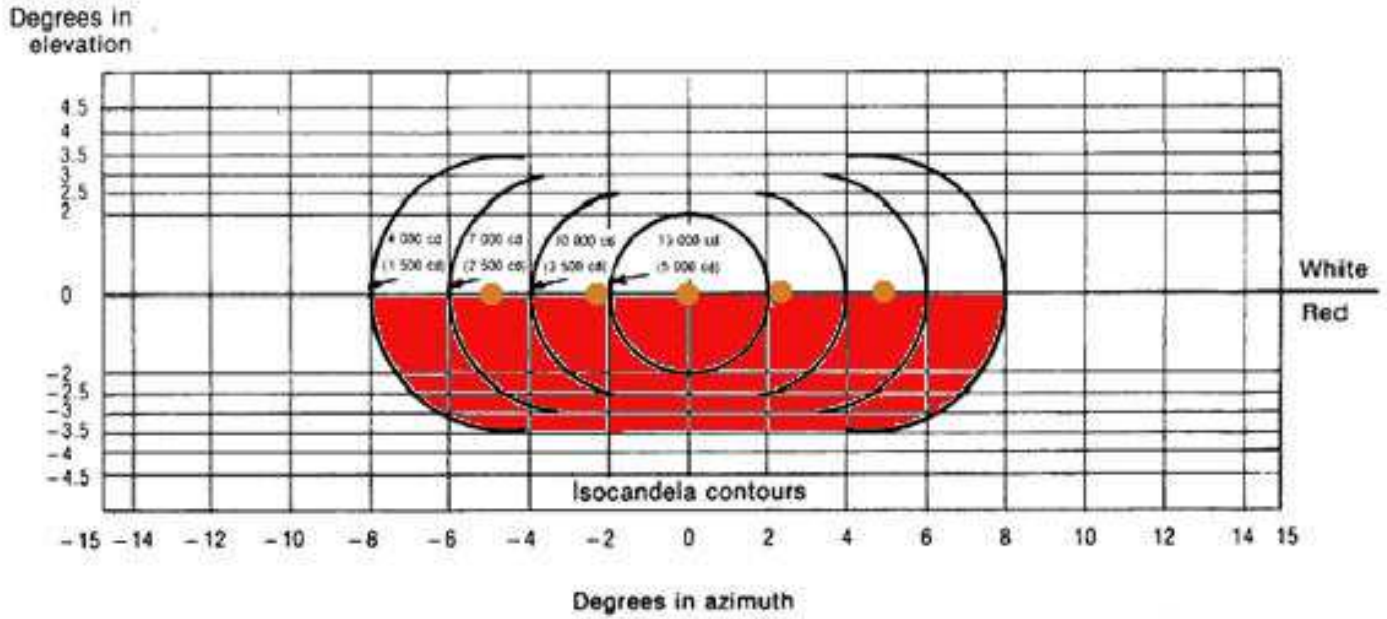
Distance is set from tripod center to PAPI output lens.



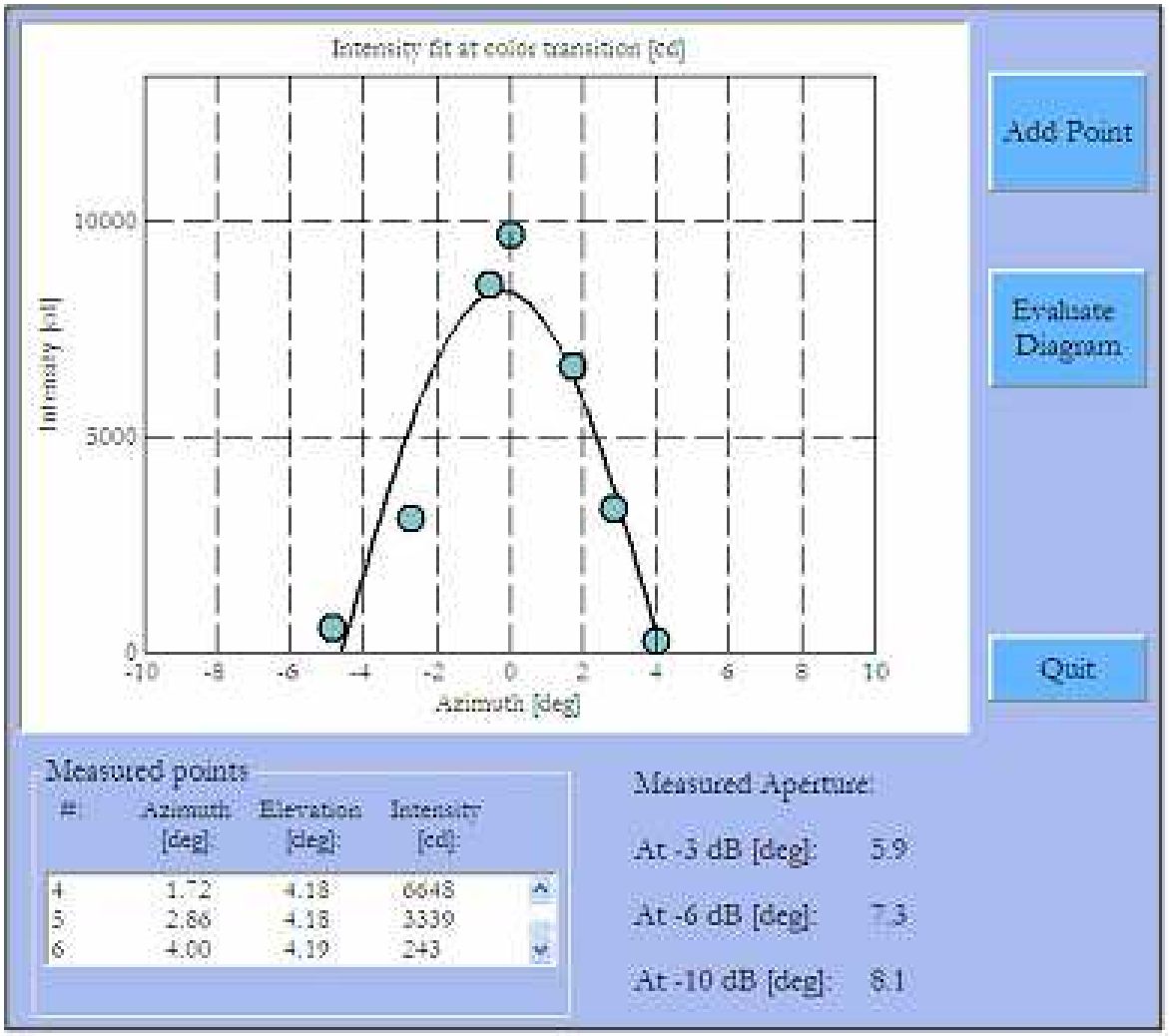
SMF/PAPI: Papi Position Aperture Diagram

	needed value		needed value		needed value		needed value		needed value	
Papi Position	-0.88 m (-5°)		-0.44 m (-2.5°)		0		0.44 m (2.5°)		0.88 m (5°)	On the colour transition

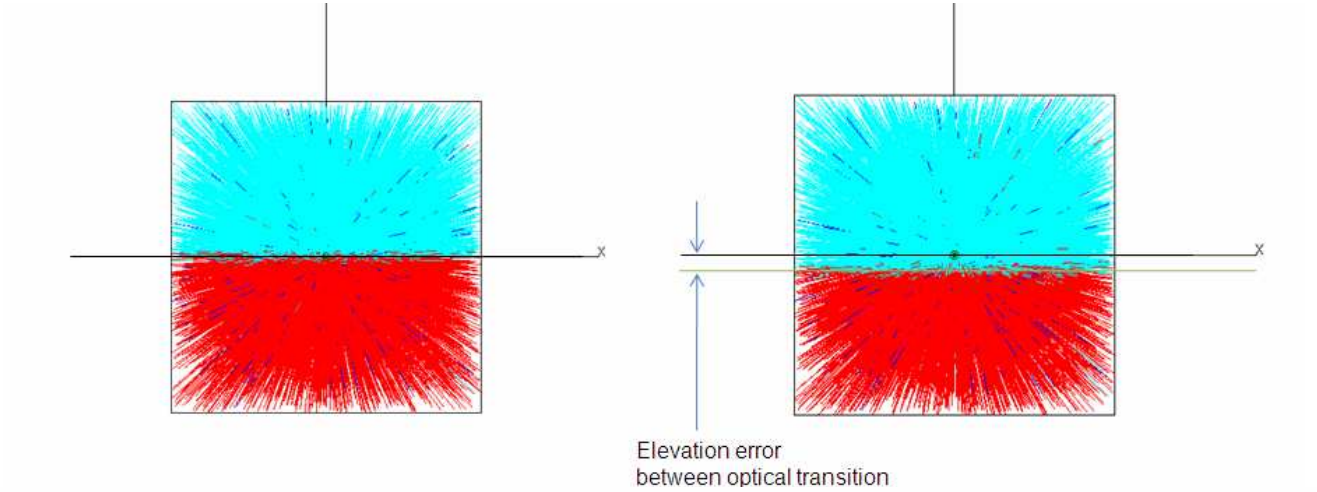
Table of displacement values at 10 m distance.



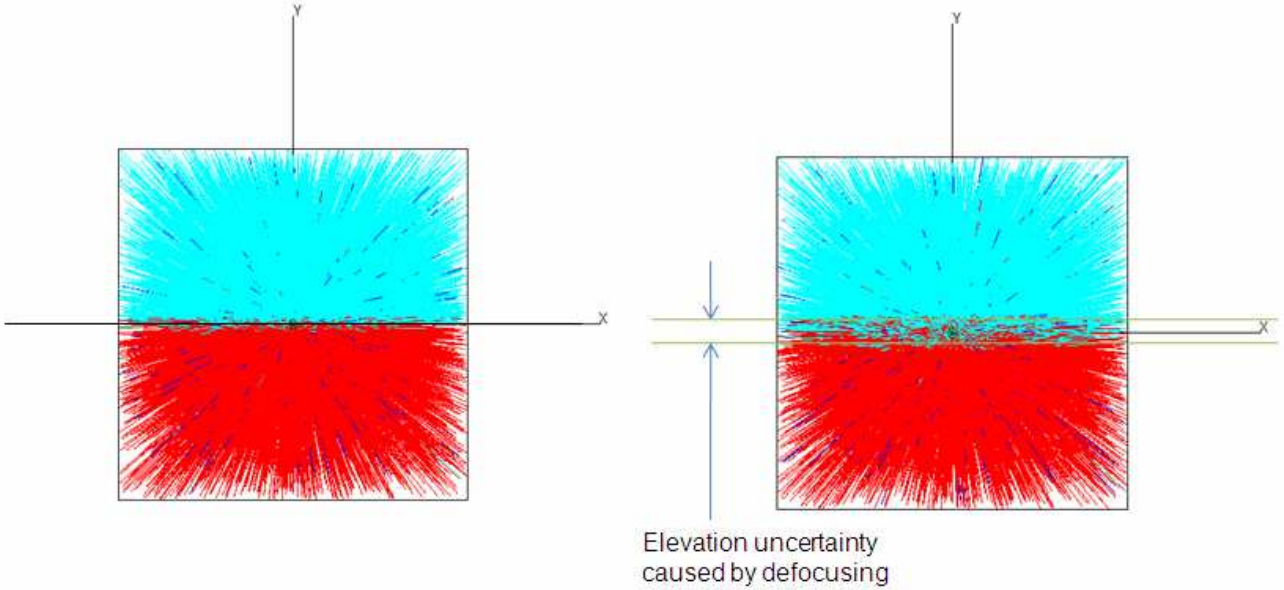
SMF/PAPI: Performing the Aperture Test (n points)



SMF/PAPI: Effects of red filter vertical and longitudinal shift (I)



Vertical shift: Elevation Error



Longitudinal shift: Defocusing

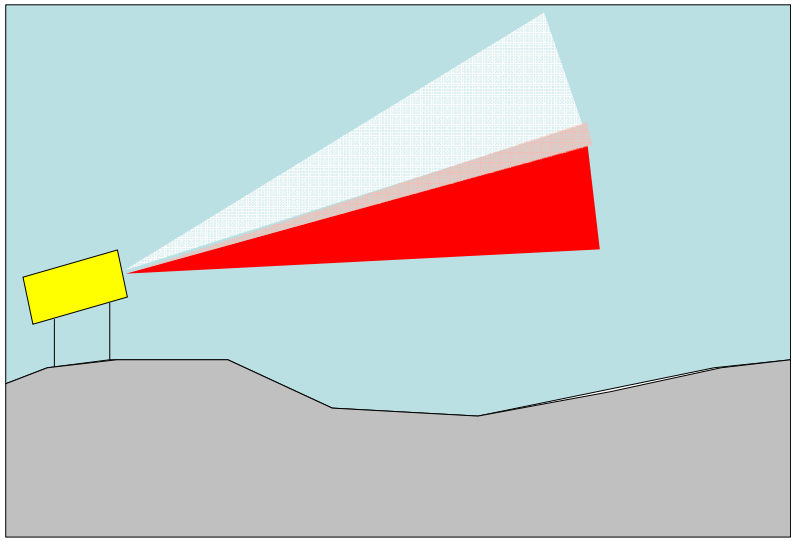
SMF/PAPI: Effects of red filter vertical and longitudinal shift (II)

Elevation Error

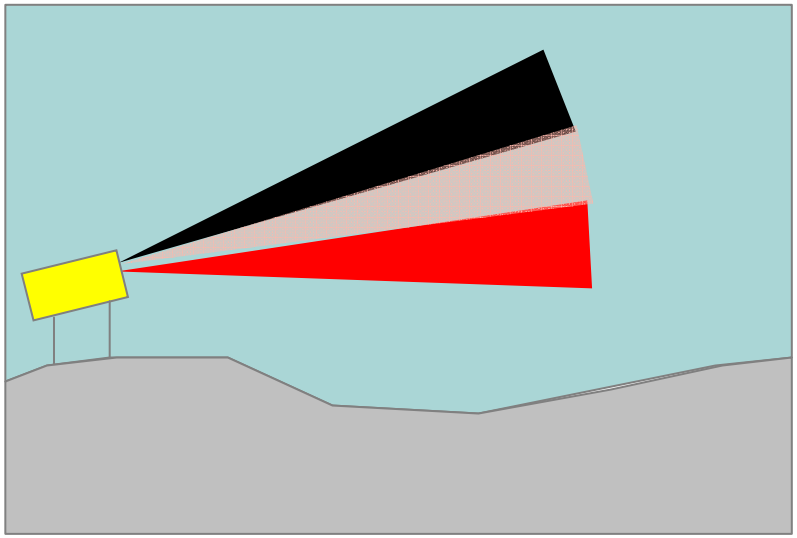
In a typical PAPI unit model, the elevation error between the mechanical axis and the color transition may reach values of 14' for 1 mm of filter vertical misalignment.

A significant difference may arise between the value given by the inclinometer and the flight check values.

Defocusing



Normal transition



Abnormal transition due to defocusing

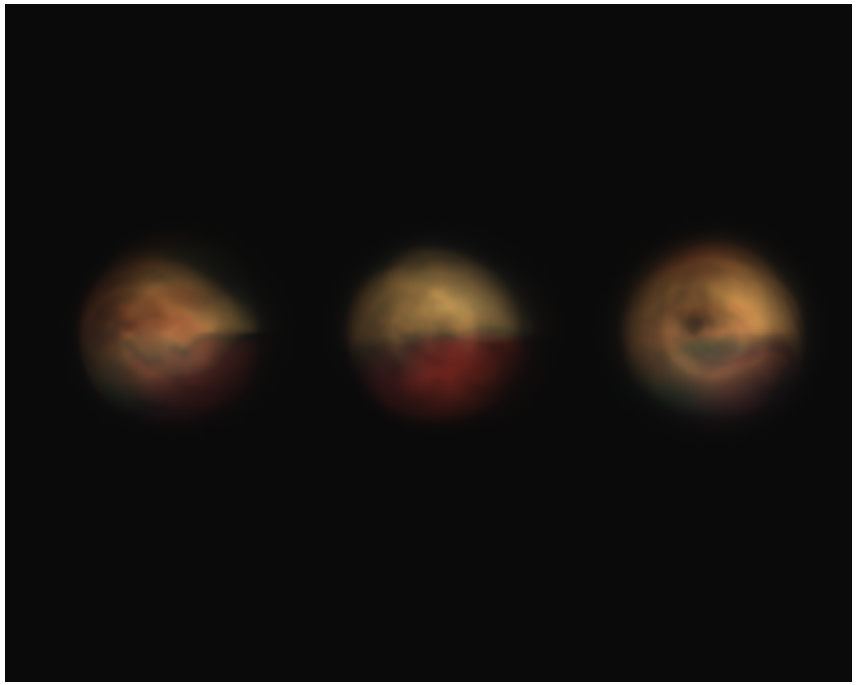
SMF/PAPI: Effects of red filter vertical and longitudinal shift (III)

PAPI unit with misaligned red filters (but not unfocused): needs filter alignment before tests.

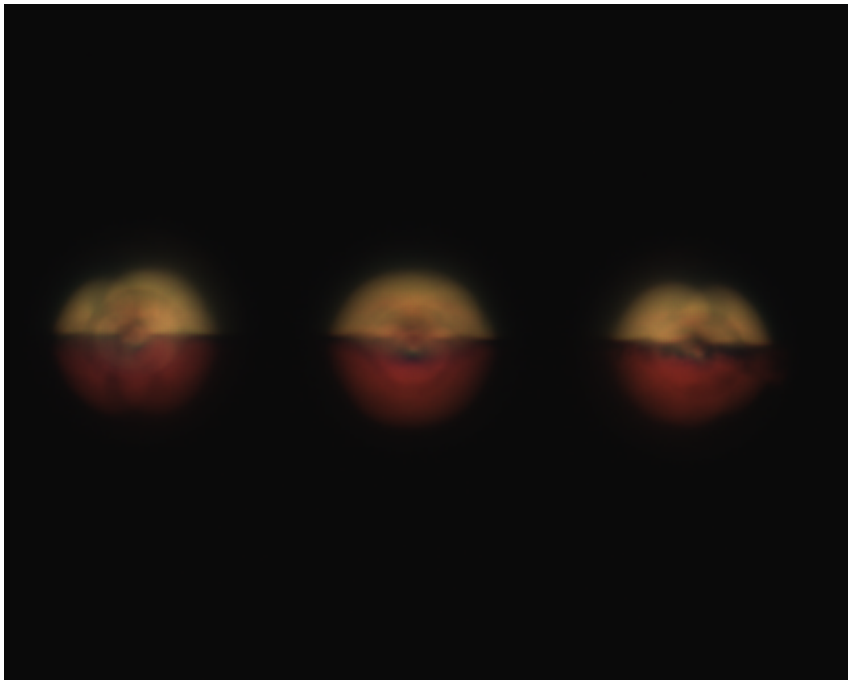
Red filters are properly focused and aligned through SMF/PAPI

SMF/PAPI: Effects of red filter vertical and longitudinal shift (IV)

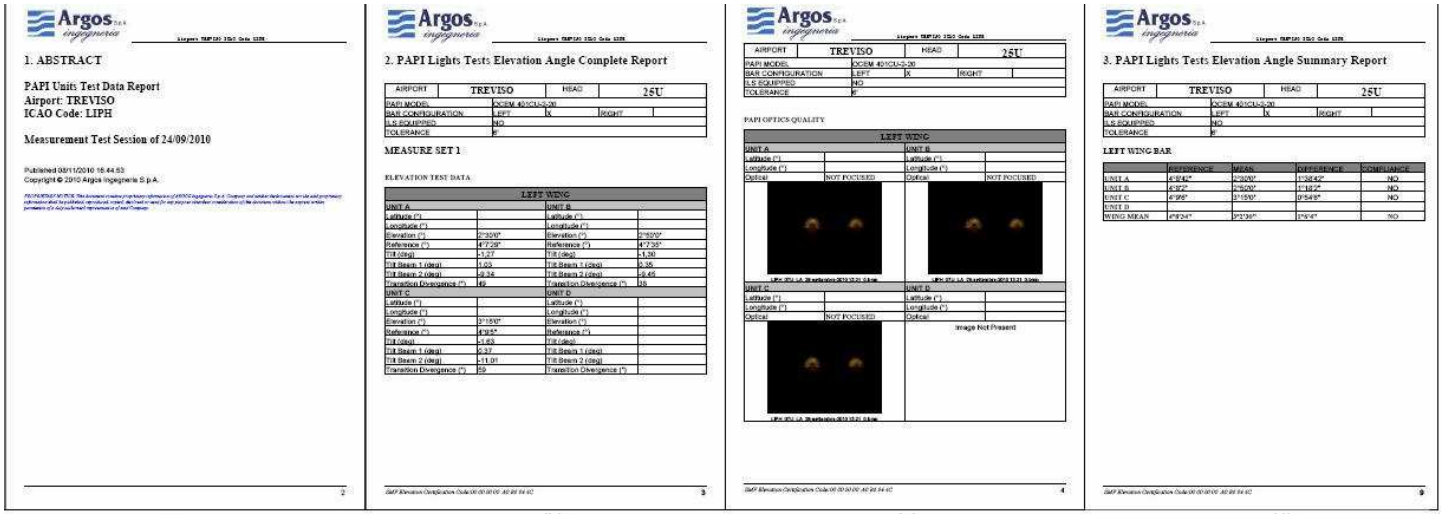
PAPI unit with unfocused and misaligned red filters: needs filters focusing and alignment before tests



The same PAPI unit after re-focusing and re-alignment performed using the SMF/PAPI instrument:



SMF/PAPI: Automatic Report



1. ABSTRACT

PAPI Units Test Data Report
Airport: TREVISO
ICAO Code: LIPH

Measurement Test Session of 24/09/2010

Published 08/11/2010 16:44:53
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(a)

2. PAPI Lights Tests Elevation Angle Complete Report

AIRPORT	TREVISO	HEAD	25U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	NO		
TOLERANCE	6'		

MEASURE SET 1

ELEVATION TEST DATA

LEFT WING			
UNIT A		UNIT B	
Latitude (°)		Latitude (°)	
Longitude (°)		Longitude (°)	
Elevation (°)	2°30'0"	Elevation (°)	2°55'0"
Reference (°)	4°7'29"	Reference (°)	4°7'35"
Tilt (deg)	-1.27	Tilt (deg)	-1.30
Tilt Beam 1 (deg)	1.03	Tilt Beam 1 (deg)	0.95
Tilt Beam 2 (deg)	-9.24	Tilt Beam 2 (deg)	-9.45
Transition Divergence (°)	49	Transition Divergence (°)	58
UNIT C		UNIT D	
Latitude (°)		Latitude (°)	
Longitude (°)		Longitude (°)	
Elevation (°)	2°15'0"	Elevation (°)	
Reference (°)	4°35'5"	Reference (°)	
Tilt (deg)	-1.63	Tilt (deg)	
Tilt Beam 1 (deg)	0.37	Tilt Beam 1 (deg)	
Tilt Beam 2 (deg)	-11.01	Tilt Beam 2 (deg)	
Transition Divergence (°)	59	Transition Divergence (°)	

(b)

AIRPORT	TREVISO	HEAD	25U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	NO		
TOLERANCE	6'		

PAPI OPTICS QUALITY

LEFT WING			
UNIT A		UNIT B	
Latitude (°)		Latitude (°)	
Longitude (°)		Longitude (°)	
Optical	NOT FOCUSED	Optical	NOT FOCUSED
UNIT C		UNIT D	
Latitude (°)		Latitude (°)	
Longitude (°)		Longitude (°)	
Optical	NOT FOCUSED	Optical	Image Not Present

(c)

3. PAPI Lights Tests Elevation Angle Summary Report

AIRPORT	TREVISO	HEAD	25U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	NO		
TOLERANCE	6'		

LEFT WING BAR

	REFERENCE	MEAN	DIFFERENCE	COMPLIANCE
UNIT A	4°9'42"	2°30'0"	1°39'42"	NO
UNIT B	4°9'2"	2°55'0"	1°14'2"	NO
UNIT C	4°9'6"	2°15'0"	0°54'6"	NO
UNIT D				
WING MEAN	4°9'24"	2°23'0"	1°1'4"	NO

(d)

2. PAPI Lights Tests Intensity and Chromaticity Complete Report

AIRPORT	TREVISO	HEAD	07U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	YES		

MEASURE SET 1

INTENSITY

LEFT WING			
UNIT A		UNIT B	
WHITE	RED	WHITE	RED
Latitude (°)	Latitude (°)	Latitude (°)	Latitude (°)
Longitude (°)	Longitude (°)	Longitude (°)	Longitude (°)
Luminance (lux)	Luminance (lux)	Luminance (lux)	Luminance (lux)
Intensity (CD)	Intensity (CD)	Intensity (CD)	Intensity (CD)
Intensity Beam1 (CD)	Intensity Beam1 (CD)	Intensity Beam1 (CD)	Intensity Beam1 (CD)
Intensity Beam2 (CD)	Intensity Beam2 (CD)	Intensity Beam2 (CD)	Intensity Beam2 (CD)
Azimuth (deg)	Azimuth (deg)	Azimuth (deg)	Azimuth (deg)
Elevation (deg)	Elevation (deg)	Elevation (deg)	Elevation (deg)
UNIT C		UNIT D	
WHITE	RED	WHITE	RED
Latitude (°)	Latitude (°)	Latitude (°)	Latitude (°)
Longitude (°)	Longitude (°)	Longitude (°)	Longitude (°)
Luminance (lux)	Luminance (lux)	Luminance (lux)	Luminance (lux)
Intensity (CD)	Intensity (CD)	Intensity (CD)	Intensity (CD)
Intensity Beam1 (CD)	Intensity Beam1 (CD)	Intensity Beam1 (CD)	Intensity Beam1 (CD)
Intensity Beam2 (CD)	Intensity Beam2 (CD)	Intensity Beam2 (CD)	Intensity Beam2 (CD)
Azimuth (deg)	Azimuth (deg)	Azimuth (deg)	Azimuth (deg)
Elevation (deg)	Elevation (deg)	Elevation (deg)	Elevation (deg)

(e)

AIRPORT	TREVISO	HEAD	07U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	YES		

CHROMATICITY

LEFT WING			
UNIT A		UNIT B	
WHITE	RED	WHITE	RED
Latitude (°)	Latitude (°)	Latitude (°)	Latitude (°)
Longitude (°)	Longitude (°)	Longitude (°)	Longitude (°)
x=0.0	x=0.0	x=0.0	x=0.0
y=0.0	y=0.0	y=0.0	y=0.0
Image Not Present		Image Not Present	
UNIT C		UNIT D	
WHITE	RED	WHITE	RED
Latitude (°)	Latitude (°)	Latitude (°)	Latitude (°)
Longitude (°)	Longitude (°)	Longitude (°)	Longitude (°)
x=0.0	x=0.0	x=0.0	x=0.0
y=0.0	y=0.0	y=0.0	y=0.0
	Image Not Present	Image Not Present	Image Not Present

(f)

AIRPORT	TREVISO	HEAD	07U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	YES		

2. PAPI Lights Tests Intensity Diagram Report

MEASURE SET 1

LEFT WING			
UNIT A		UNIT B	
Reference (deg)	Image Not Present	Reference (deg)	
UNIT C		UNIT D	
Reference (deg)		Reference (deg)	Image Not Present

(g)

AIRPORT	TREVISO	HEAD	07U
PAPI MODEL	OCEM 401CU-S-20		
BAR CONFIGURATION	LEFT	X	RIGHT
ILS EQUIPPED	YES		

MEASURE SET 1

LEFT WING			
UNIT A		UNIT B	
Aperture at -3dB (deg)		Aperture at -3dB (deg)	5.455
Aperture at -6dB (deg)		Aperture at -6dB (deg)	8.869
Aperture at -10dB (deg)		Aperture at -10dB (deg)	7.877
Image Not Present			
UNIT C		UNIT D	
Aperture at -3dB (deg)	2.091	Aperture at -3dB (deg)	
Aperture at -6dB (deg)	11.515	Aperture at -6dB (deg)	
Aperture at -10dB (deg)	12.727	Aperture at -10dB (deg)	
		Image Not Present	

(h)

SMF/CLC

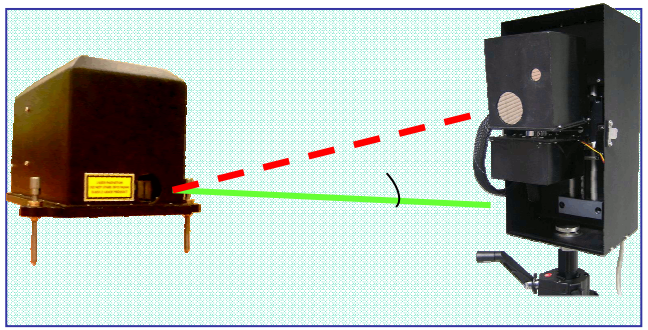
SMF/PAPI Calibration Tool

SMF/CLC – Overview

SMF/CLC is an equipment designed to check the calibration of SMF/PAPI and then guarantee the specified accuracy in Elevation measurement.

The tool is strongly recommended for:

- **manufacture, for final factory acceptance test before the delivery**
- **End User, to check SMF/PAPI performance before the measurements**



SMF/Mobile

Photometric Measurement System
Dedicated to fast AGL lightings testing

ICAO Recommendations (I)

ICAO specified performance level of AGL

"9.4.20 A light shall be deemed to be unserviceable when the main beam average intensity is less than 50 per cent of the value specified in the appropriate figure in Appendix 2. For light units where the designed main beam average intensity is above the value shown in Appendix 2, the 50 per cent value shall be related to that design value.

9.4.21 A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking system reliability."

ICAO Recommendations (II)

Further ICAO specifications

- The need of the in-field measurement of the intensity, beam spread and orientation of lights included in the approach and runway lighting systems
- Measuring all lights, as far as practicable, to ensure conformance with the applicable specification
- Using a mobile measuring unit of sufficient accuracy to analyze the characteristics of the individual lights
- The frequency of measurement of lights should not be less than twice a year for in-pavement lights and not less than once a year for other lights
- The percentages of serviceable lights in order to provide continuity of guidance; additionally, an unserviceable light shall not be permitted adjacent to another unserviceable light
- The chromaticity limits of colors to be used for aeronautical ground lights, in accord with the 1983 specifications of the International Commission on Illumination (CIE 1931).

ICAO Recommendations (III)

CIE 1931 Chromaticity Diagram

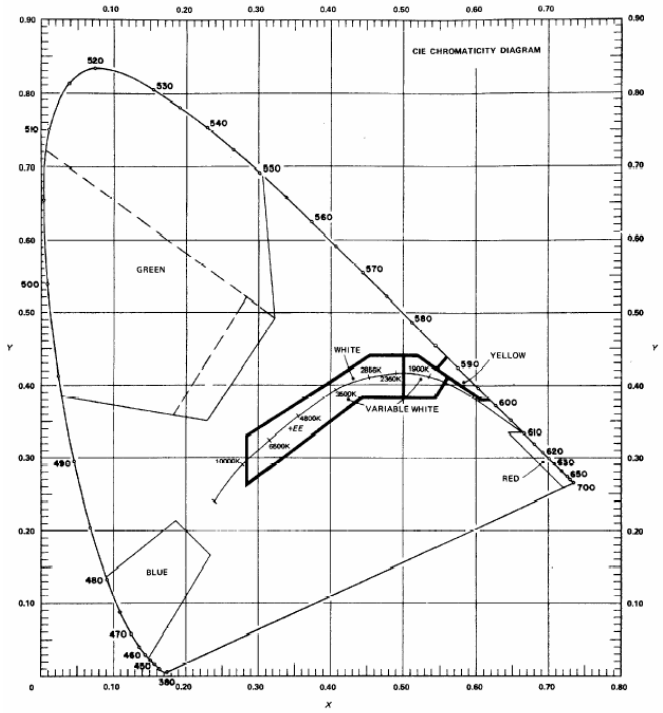


Figure 1.1 Colours for aeronautical ground lights

Grid for measurement of approach and runway lights

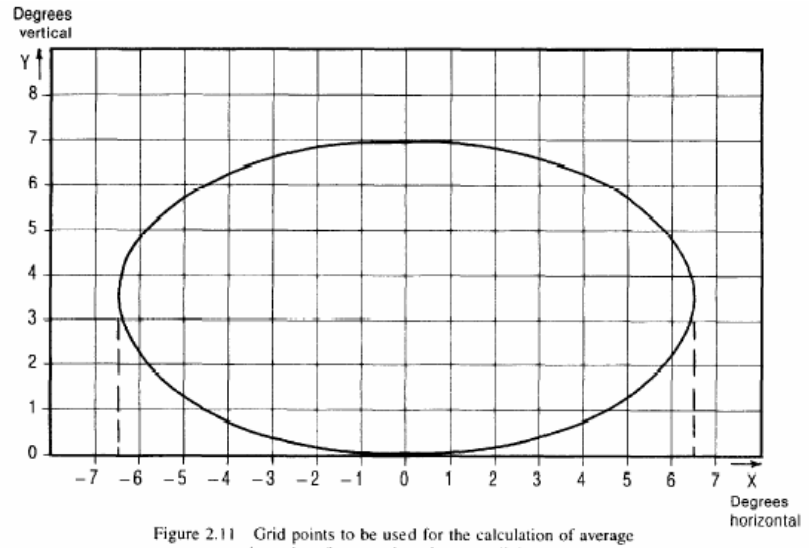


Figure 2.11 Grid points to be used for the calculation of average intensity of approach and runway lights

Grid for measurement of taxiway centre line and stop bar lights

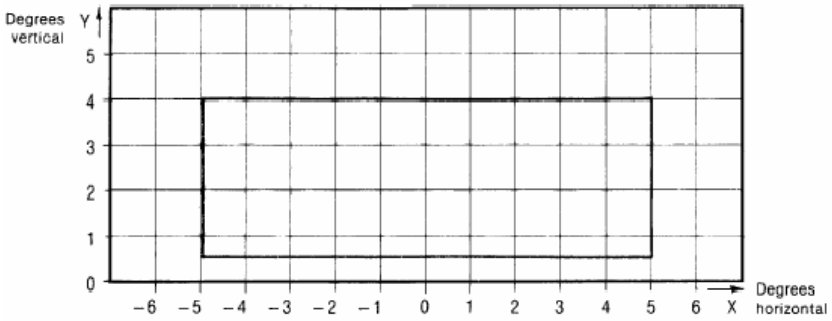


Figure 2.21 Grid points to be used for calculation of average intensity of taxiway centre line and stop bar lights

SMF/M: The Argos solution (I)

SMF/M is a mobile photometric measurement system of AGL equipment, designed, developed and manufactured by ARGOS INGEGNERIA in order to perform the measurement of the airfield lights on the move along runways and taxiways in non-stop mode.

SMF/M can be easily installed on the front of any commercial vehicle suitable to operate on the airfield. The Customer can decide for a fixed installation on a dedicated vehicle or for a temporary installation

SMF/M is easy to use: the operator is assisted step-by-step by the system software running on the on-board PC.

SMF/M has been patented by Argos (RM2007A000099 dated 21st February 2007

SMF/M: The Argos solution (II)

The regular and systematic use of SMF/M can:

- identify quickly and certainly the lights that do not comply with ICAO recommendations, that need to be cleaned, repaired or replaced;
- maintain compliance of AGLS to current regulations and to the airport category;
- optimize the operating costs of AGLS, providing useful information to improve the maintenance service.

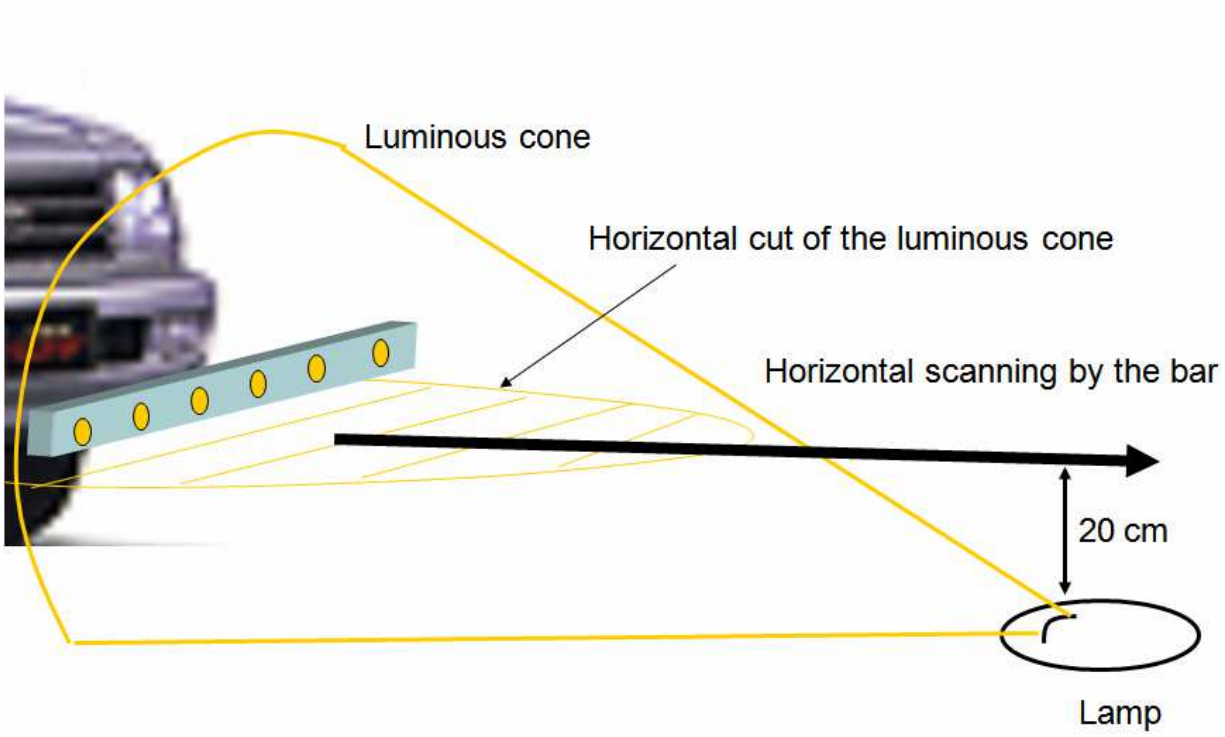
SMF/M system features:

- Reliability
- Accuracy
- Precision
- Ease of use
- Efficiency

SMF/M: Working Principle

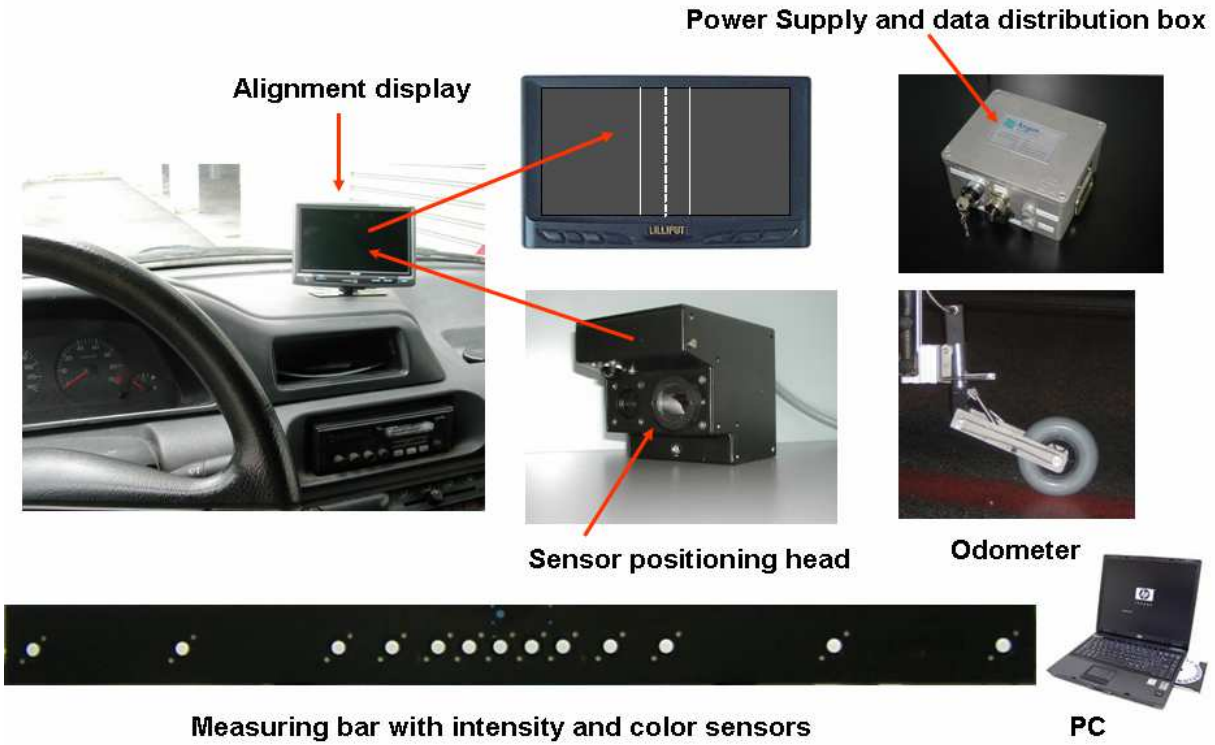
The measuring bar of SMF/M is installed orthogonally to the direction of the move and thus cuts the light beam emitted by the lamp.

The vertical scan in the grid points, as requested by ICAO, is done by the system software through the reconstruction from the light beam samples acquired on the move.



SMF/M: System Architecture

- **Data acquisition system** (photometric sensors, sensor manager board)
- **Position determination system** (S2 sensor, odometer, GPS, etc.)
- **Alignment system** (video camera, alignment display)

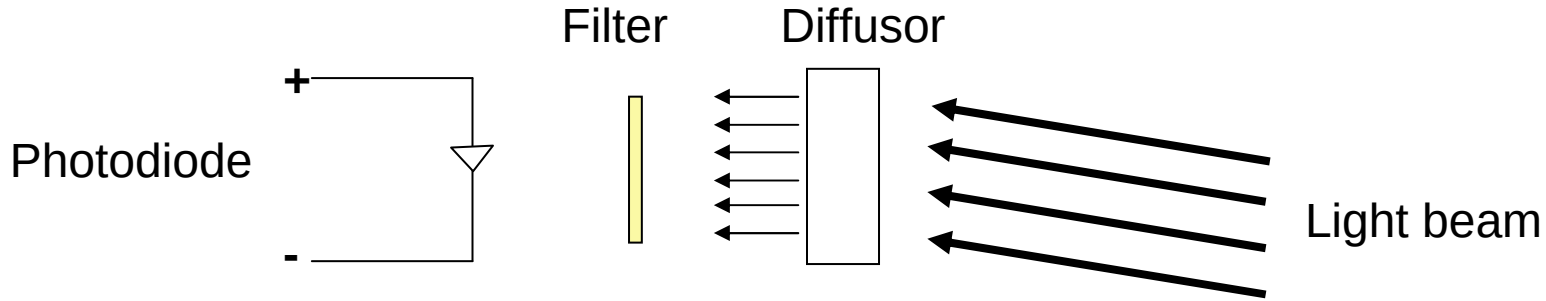


- **Service system** (cabling, power supply and data distribution)
- **Mechanical system** (main and fitting frames)
- **Data processing system and HMI** (PC, touch screen)

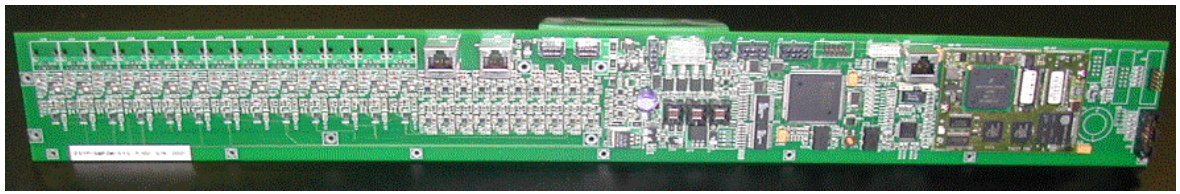
SMF/M: Data Acquisition system (I)

The measuring bar bears an array of 13 luxmeters and a color sensor compliant to the CIE 1931 specification, distributed along the bar in order to get the best resolution/distance ratio:

The sensors are made of photodiodes with integrated filters and diffusors, that perform the initial correction of the angular incidence of light:



Inside of the measuring bar there is electronics for data acquisition and preprocessing:



SMF/M: Position Determination

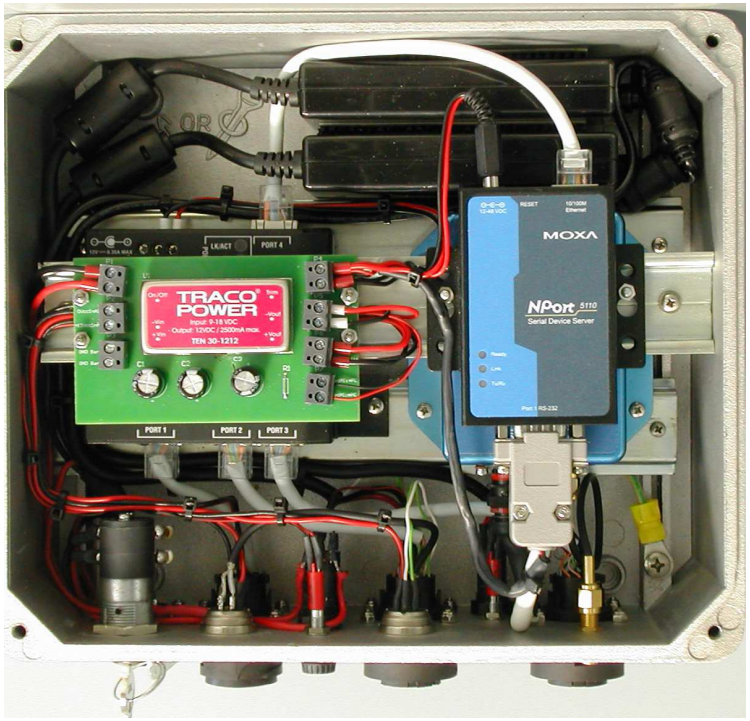
The bar hosts also a special sensor positioning head, containing a S2 sensor for Visual angle determination.

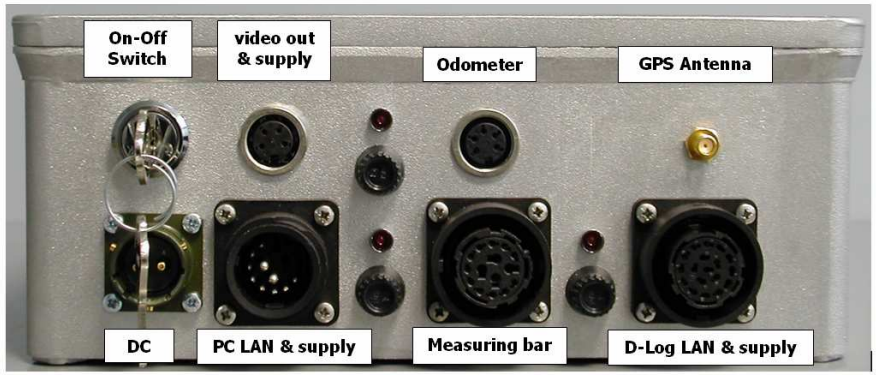
The sampling frequency used by the measuring bar is defined by the distance run, rather than by time; therefore operator can stop the vehicle and restart it without affecting the measurement. The SMF/M acquires a light sample every 10 cm of distance run, measured by a high resolution odometer.

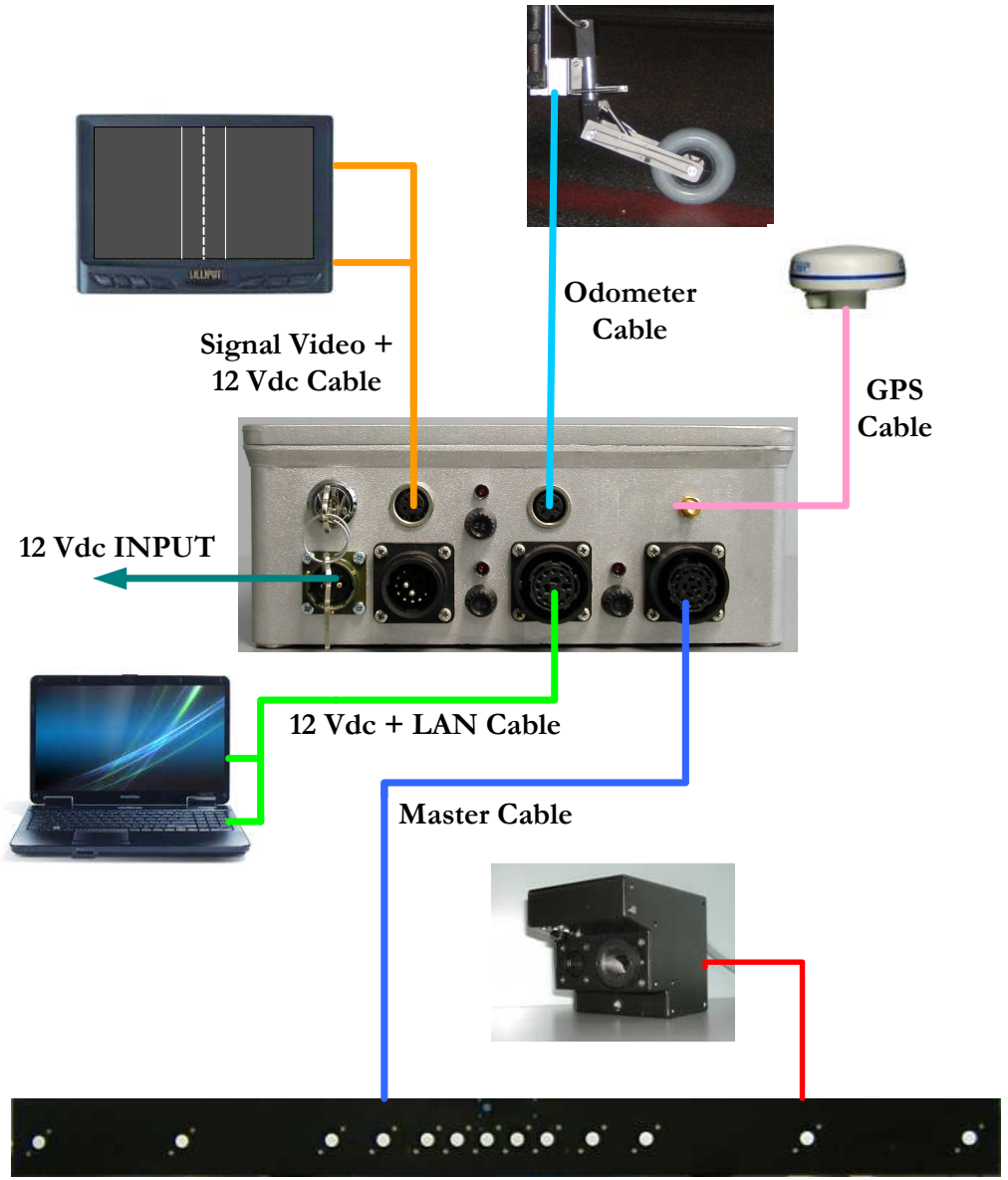
SMF/M: Alignment Control

The sensor positioning head supplies SMF/M with necessary information about the position and orientation of lights under test and guides the car driver through the on-board alignment display.

SMF/M: Service System



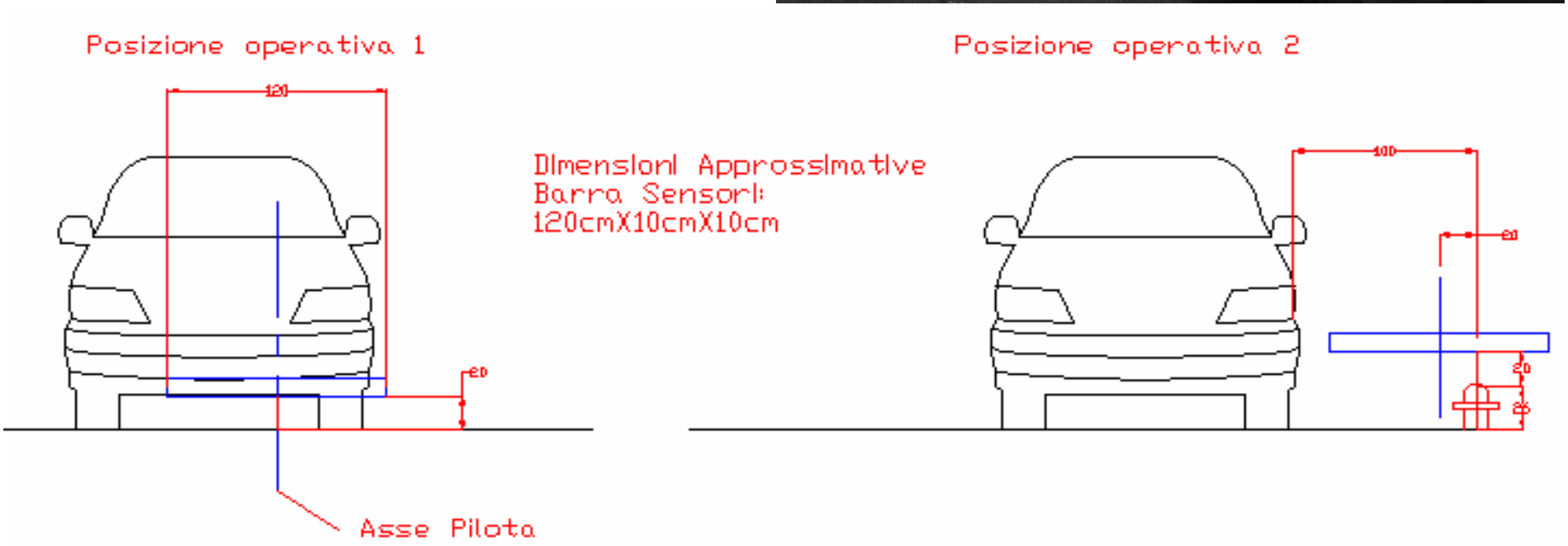




SMF/M: Mechanical System (I)

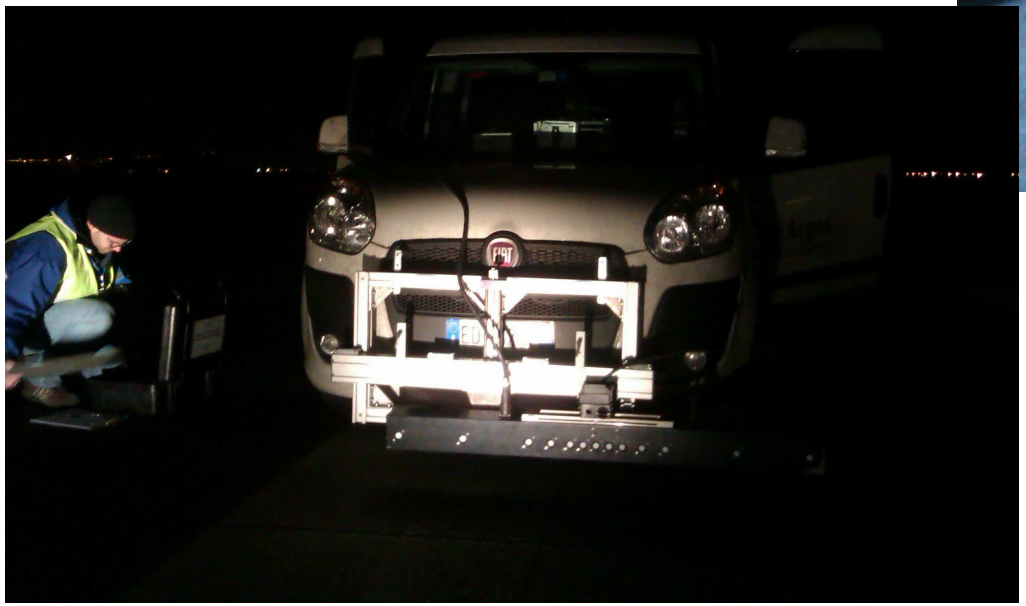
The main system frame is equipped with a sliding arm to keep the measuring bar, in one of two operating posititons (1 or 2).

The main system frame can be adjusted to different heights of elevated lamps



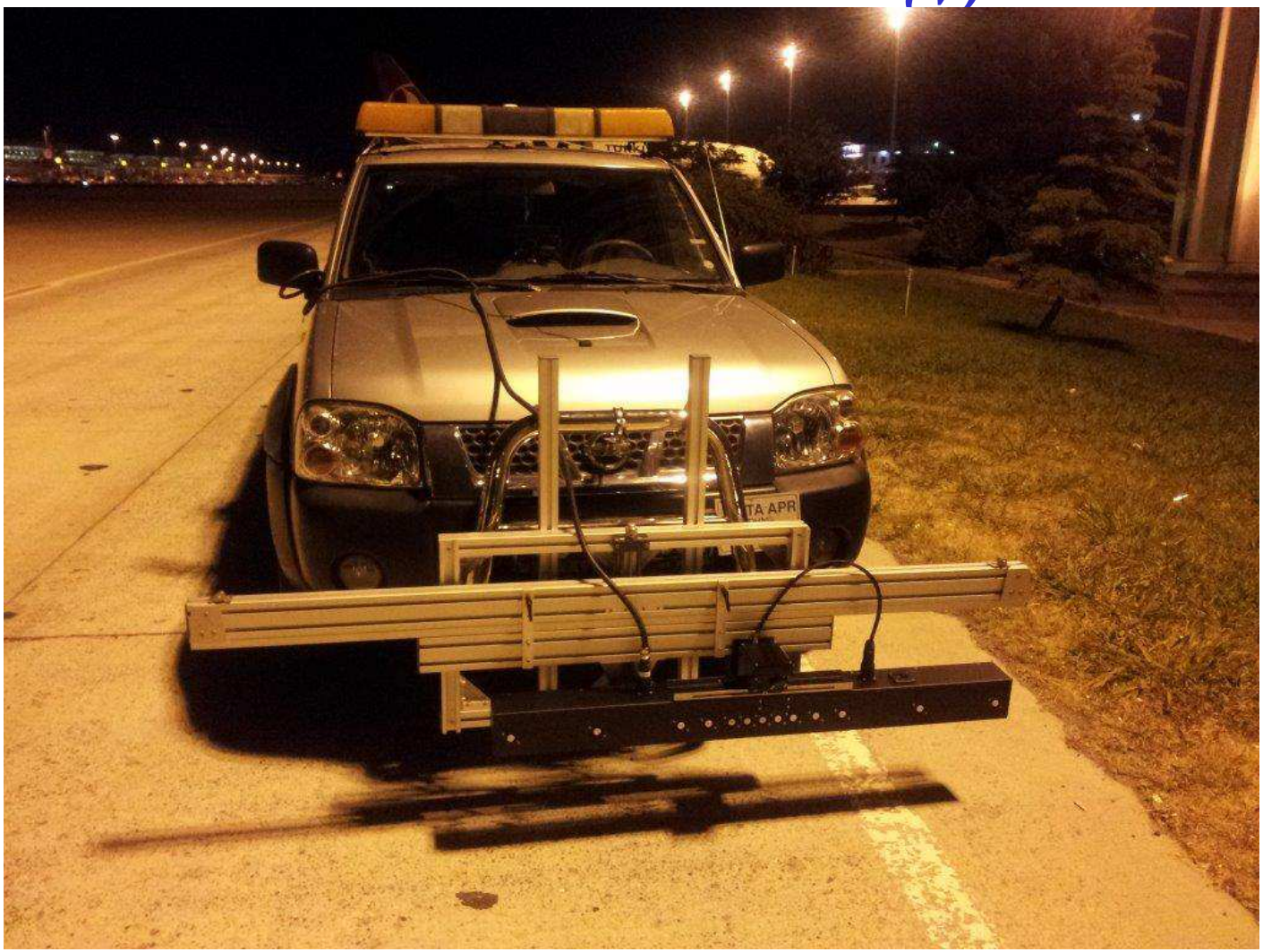
SMF/M: Mechanical System (II)

SMF/M: Mechanical System (III)

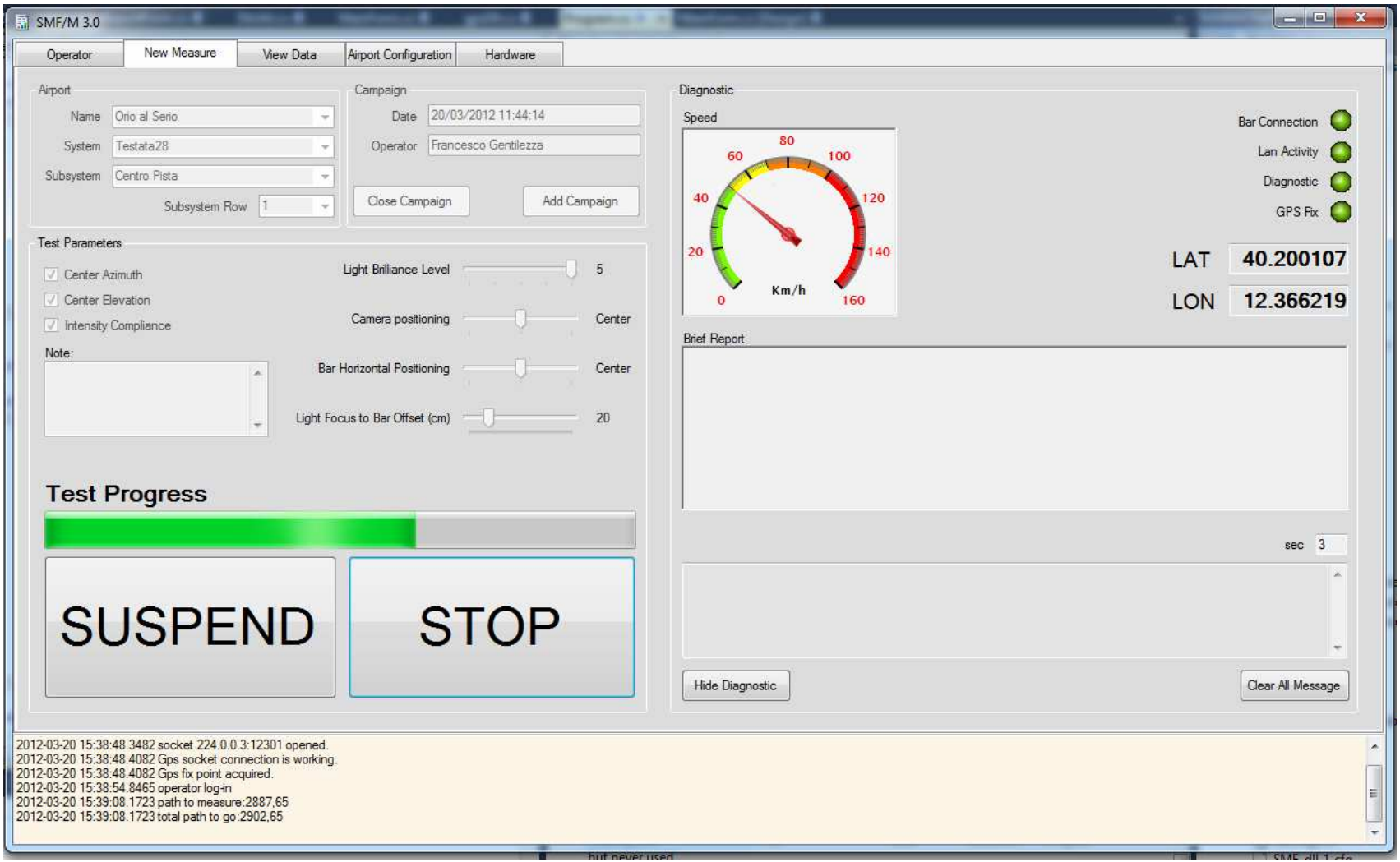


SMF/M: Mechanical System (IV)

SMF/M: Mechanical System (V)



SMF/M: Data Processing & HMI (I)

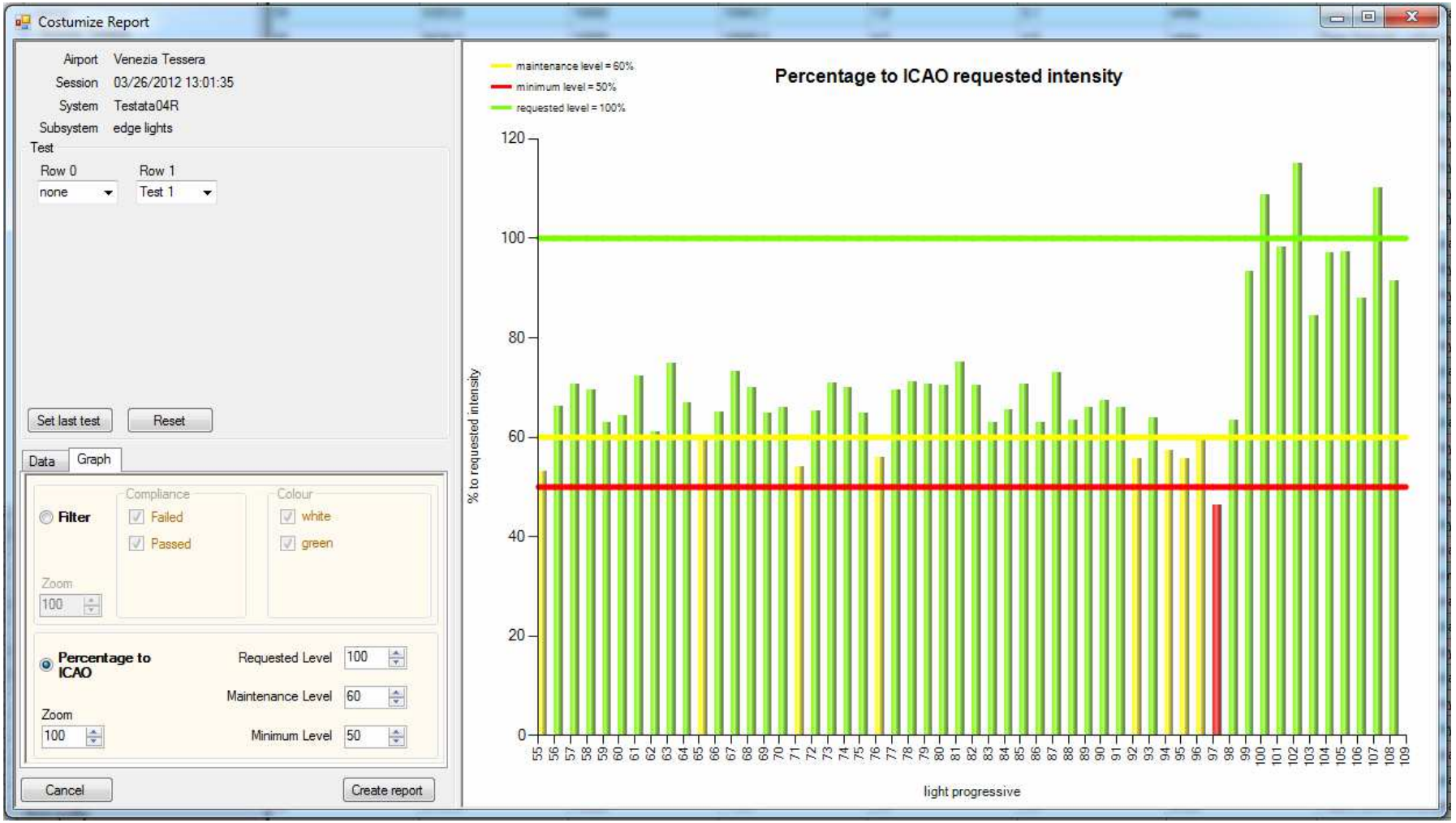


SMF/M: Data Processing & HMI (II)

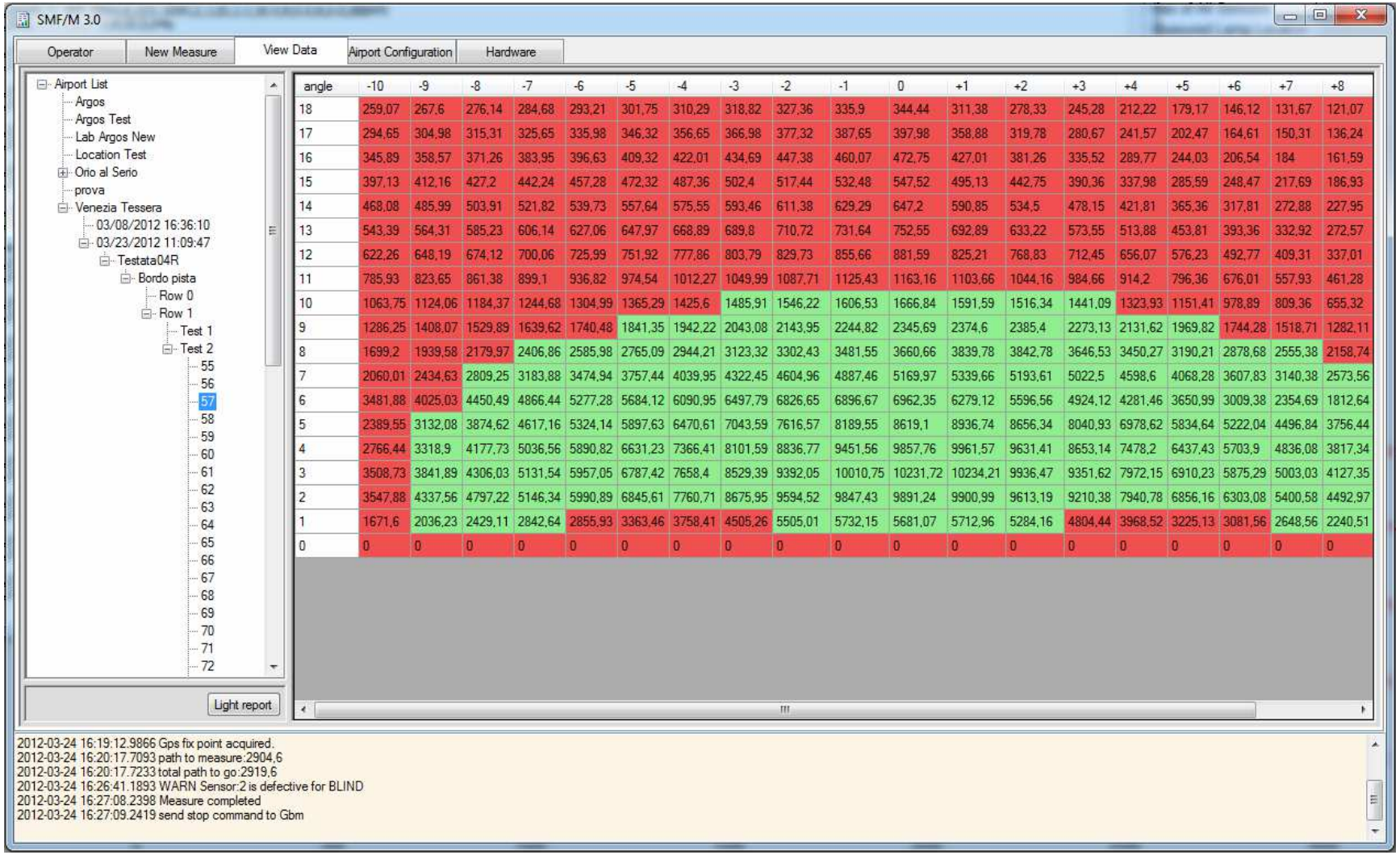
System Name	Runway 22L
Subsystem Name	bordo pista
Total number of lights	20
Total number of fail lights	5
Percentage of fail lights	25
Percentage requested by ICAO	85
Result	**NOT COMPLIANT**

progressive	avg level	req intensity	% to Req Intensity	max level	toe in	elevation	colour	drive quality	latitude	longitude	error code
1	7370	10000	73.7	13399,1	-1,8	3,4	white	94	45,51566338	12,36569612	Pass
2	10117,7	10000	101.2	21305,5	-1,4	3,3	white	99	45,51525927	12,36514545	Pass
3	6617,5	10000	66.2	8658,5	-1,8	4,1	white	96	45,51488097	12,36462729	Pass
4	4953,9	10000	49.5	10487,4	-1,8	3,2	white	97	45,51447882	12,36410532	Intensity and Toe-in not compliant
5	7861,8	10000	78.6	14006,2	-2,9	4	white	97	45,51408239	12,36358141	Pass
6	8156,1	10000	81.6	13884,7	-3,2	3,6	white	97	45,51368348	12,36305436	Pass
7	7754,3	10000	77.5	14033,5	-1,6	3,7	white	93	45,51327586	12,36252963	Pass
8	7850	10000	78.5	13443,6	-3,1	4,4	white	100	45,51287585	12,36201742	Pass
9	1901,4	10000	19.0	6133,6	-11,9	3,8	white	68	45,50687554	12,35430777	Driving error
10	9526,5	10000	95.3	14087,3	-3,1	4,7	white	100	45,50646465	12,35378266	Pass
11	1318,2	10000	13.2	1567,4	0,3	13	white	89	45,50605553	12,3532626	Intensity, Toe-in and Elevation not compliant
12	6991,4	10000	69.9	10073,4	-0,5	4,5	white	91	45,5056529	12,35275451	Pass
13	7463,4	10000	74.6	13841,9	-5	3,4	white	96	45,50526306	12,35223524	Pass
14	9508,5	10000	95.1	17523,5	-2,2	3,4	white	99	45,50487599	12,35172042	Pass
15	7973,3	10000	79.7	13635,9	-3,3	3,7	white	98	45,5044764	12,35120601	Pass
16	9432,1	10000	94.3	12672	-2,2	4,8	white	97	45,50406894	12,35069437	Pass
17	1666	4000	41.7	4309,4	-5,4	1,9	yellow	99	45,49564298	12,33987228	Intensity not compliant
18	5728	4000	143.2	8081,7	-1,4	5,7	yellow	91	45,49523951	12,33935267	Pass
19	4121,9	4000	103.0	6972,3	-3,6	4,5	red	99	45,49484422	12,33883484	colour not compliant
20	6043,1	4000	151.1	10643	-2,3	3,6	yellow	97	45,49445384	12,33833915	Pass

SMF/M: Data Processing & HMI (III)

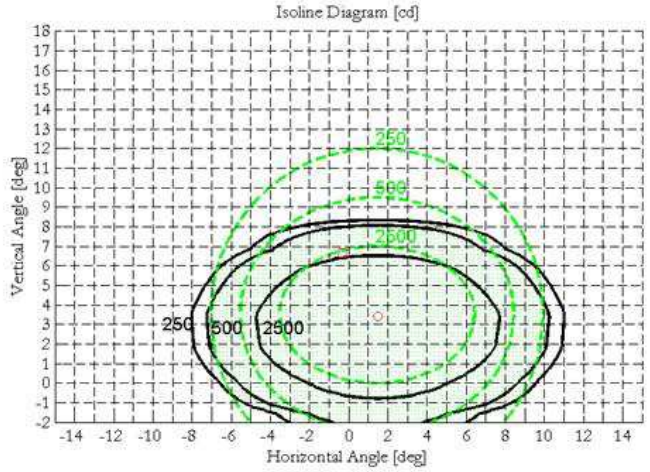


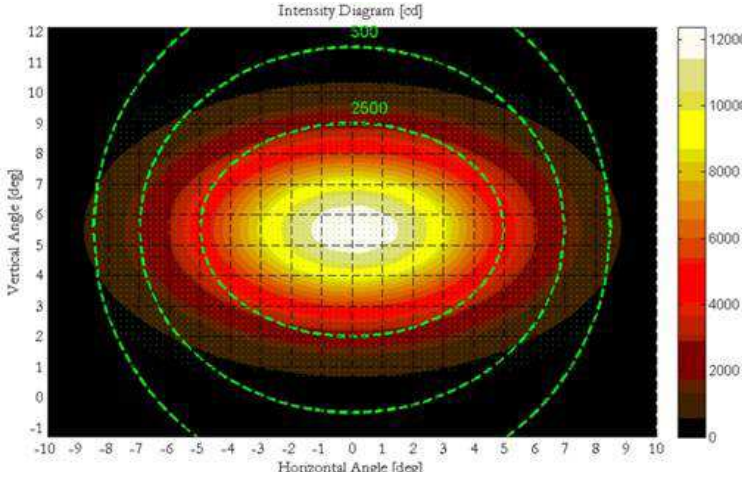
SMF/M: Data Processing & HMI (IV)

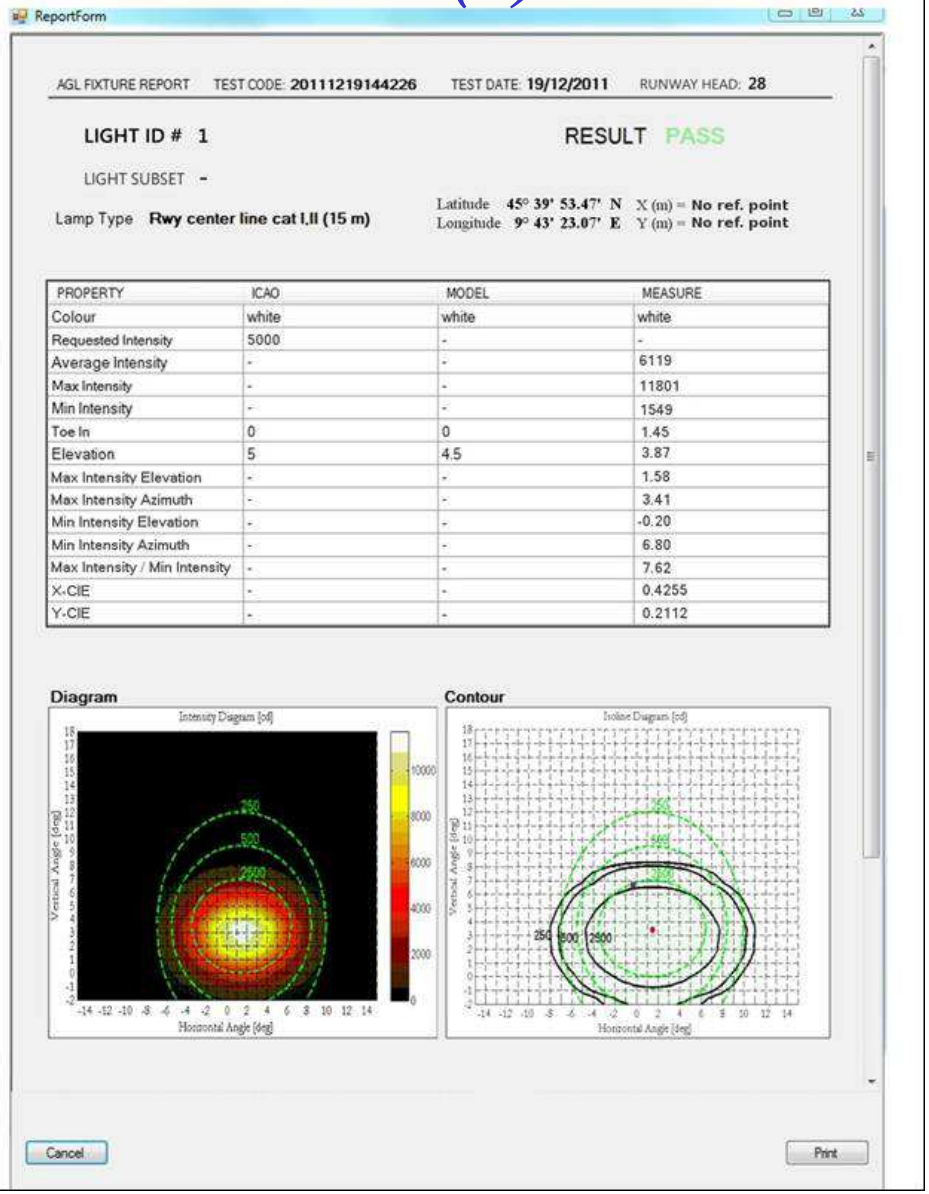


angle	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8
18	259,07	267,6	276,14	284,68	293,21	301,75	310,29	318,82	327,36	335,9	344,44	311,38	278,33	245,28	212,22	179,17	146,12	131,67	121,07
17	294,65	304,98	315,31	325,65	335,98	346,32	356,65	366,98	377,32	387,65	397,98	358,88	319,78	280,67	241,57	202,47	164,61	150,31	136,24
16	345,89	358,57	371,26	383,95	396,63	409,32	422,01	434,69	447,38	460,07	472,75	427,01	381,26	335,52	289,77	244,03	206,54	184	161,59
15	397,13	412,16	427,2	442,24	457,28	472,32	487,36	502,4	517,44	532,48	547,52	495,13	442,75	390,36	337,98	285,59	248,47	217,69	186,93
14	468,08	485,99	503,91	521,82	539,73	557,64	575,55	593,46	611,38	629,29	647,2	590,85	534,5	478,15	421,81	365,36	317,81	272,88	227,95
13	543,39	564,31	585,23	606,14	627,06	647,97	668,89	689,8	710,72	731,64	752,55	692,89	633,22	573,55	513,88	453,81	393,36	332,92	272,57
12	622,26	648,19	674,12	700,06	725,99	751,92	777,86	803,79	829,73	855,66	881,59	825,21	768,83	712,45	656,07	576,23	492,77	409,31	337,01
11	785,93	823,65	861,38	899,1	936,82	974,54	1012,27	1049,99	1087,71	1125,43	1163,16	1103,66	1044,16	984,66	914,2	796,36	676,01	557,93	461,28
10	1063,75	1124,06	1184,37	1244,68	1304,99	1365,29	1425,6	1485,91	1546,22	1606,53	1666,84	1591,59	1516,34	1441,09	1323,93	1151,41	978,89	809,36	655,32
9	1286,25	1408,07	1529,89	1639,62	1740,48	1841,35	1942,22	2043,08	2143,95	2244,82	2345,69	2374,6	2385,4	2273,13	2131,62	1969,82	1744,28	1518,71	1282,11
8	1699,2	1939,58	2179,97	2406,86	2585,98	2765,09	2944,21	3123,32	3302,43	3481,55	3660,66	3839,78	3842,78	3646,53	3450,27	3190,21	2878,68	2555,38	2158,74
7	2060,01	2434,63	2809,25	3183,88	3474,94	3757,44	4039,95	4322,45	4604,96	4887,46	5169,97	5339,66	5193,61	5022,5	4598,6	4068,28	3607,83	3140,38	2573,56
6	3481,88	4025,03	4450,49	4866,44	5277,28	5684,12	6090,95	6497,79	6826,65	6896,67	6962,35	6279,12	5596,56	4924,12	4281,46	3650,99	3009,38	2354,69	1812,64
5	2389,55	3132,08	3874,62	4617,16	5324,14	5897,63	6470,61	7043,59	7616,57	8189,55	8619,1	8936,74	8656,34	8040,93	6978,62	5834,64	5222,04	4496,84	3756,44
4	2766,44	3318,9	4177,73	5036,56	5890,82	6631,23	7366,41	8101,59	8836,77	9451,56	9857,76	9961,57	9631,41	8653,14	7478,2	6437,43	5703,9	4836,08	3817,34
3	3508,73	3841,89	4306,03	5131,54	5957,05	6787,42	7658,4	8529,39	9392,05	10010,75	10231,72	10234,21	9936,47	9351,62	7972,15	6910,23	5875,29	5003,03	4127,35
2	3547,88	4337,56	4797,22	5146,34	5990,89	6845,61	7760,71	8675,95	9594,52	9847,43	9891,24	9900,99	9613,19	9210,38	7940,78	6856,16	6303,08	5400,58	4492,97
1	1671,6	2036,23	2429,11	2842,64	2855,93	3363,46	3758,41	4505,26	5505,01	5732,15	5681,07	5712,96	5284,16	4804,44	3968,52	3225,13	3081,56	2648,56	2240,51
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SMF/M: Data Processing & HMI (V)







SMF/LAB-CHS

Photometric Measurement System
Dedicated to Indoor AGL lightings testing

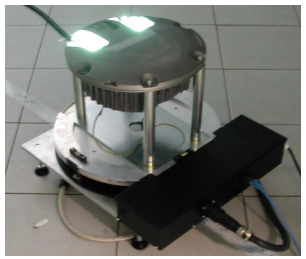
SMF/Lab – Overview

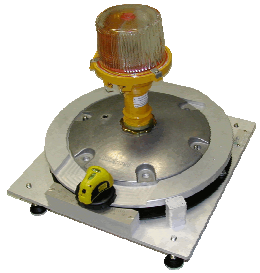
Workshop instrument for *indoor* photometric measurement of airfield lights.

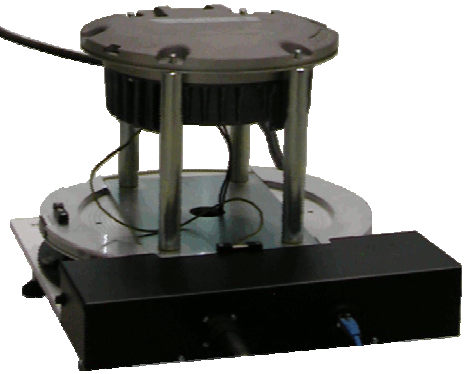
The measurement bar is the same of SMF/M system, and stays in a steady vertical position while the signal under test rotates by means a dedicated turn-table put at 3 mt distance.

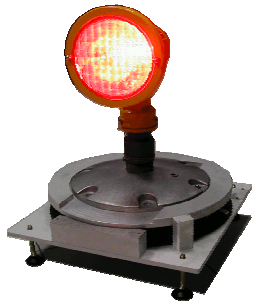
SMF/Lab is particularly efficient for:

- **verification of the lights before the installation;**
- **test of a new supply;**
- **test after repair;**
- **check after dismounted lights.**







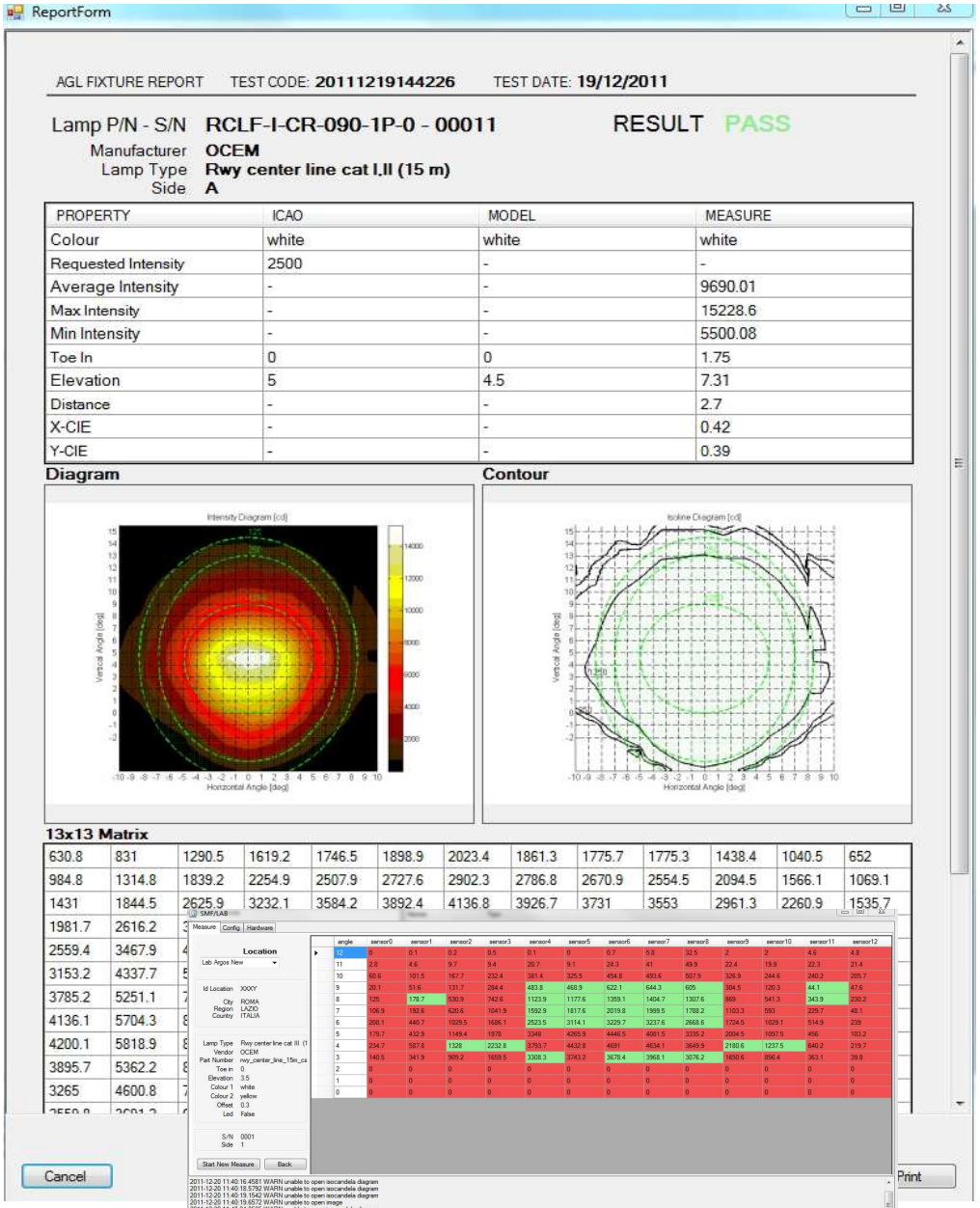


SMF/Lab – Output data

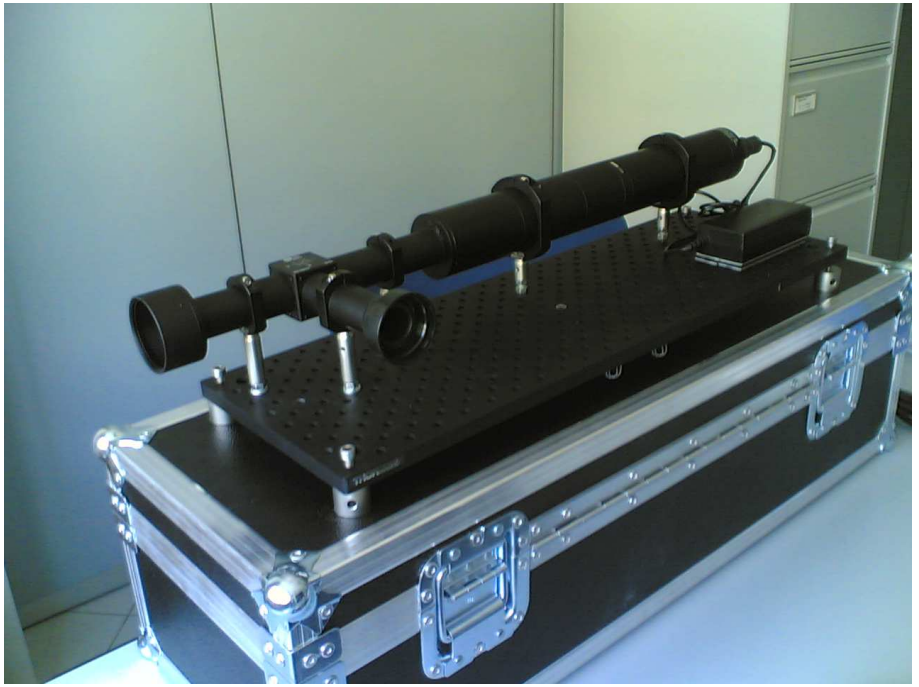
Once the scanning is completed, the general form is recalled and the results of measurement are shown in the window containing all the records related to lamp under measurement.

For each light complete printable reports are automatically produced with:

- Average, Maximum and Minimum Intensity
- Isocandela Diagram and Contour
- Elevation and Toe-in angles
- Maximum and Minimum positions
- Colour
- Compliancy to ICAO standards



SMF/MCT

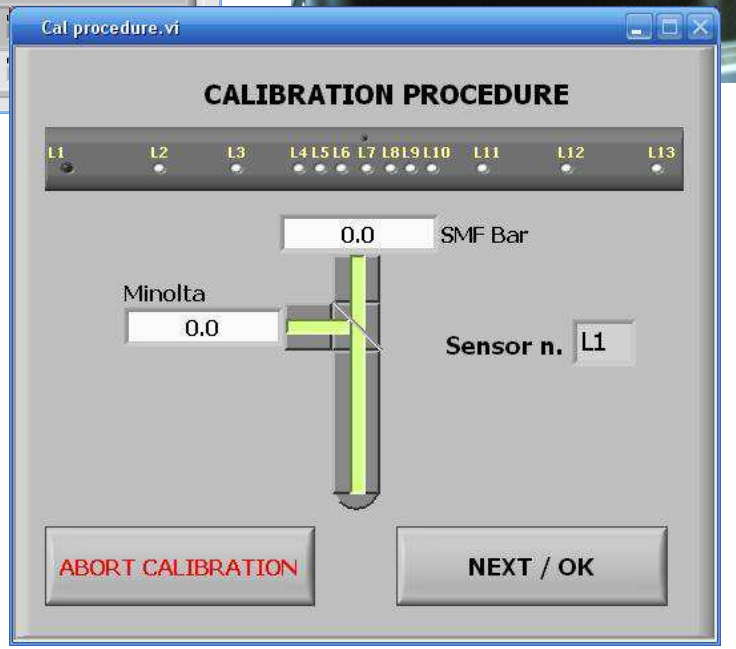


SMF/Mobile Calibration Tool

SMF/MCT – Overview

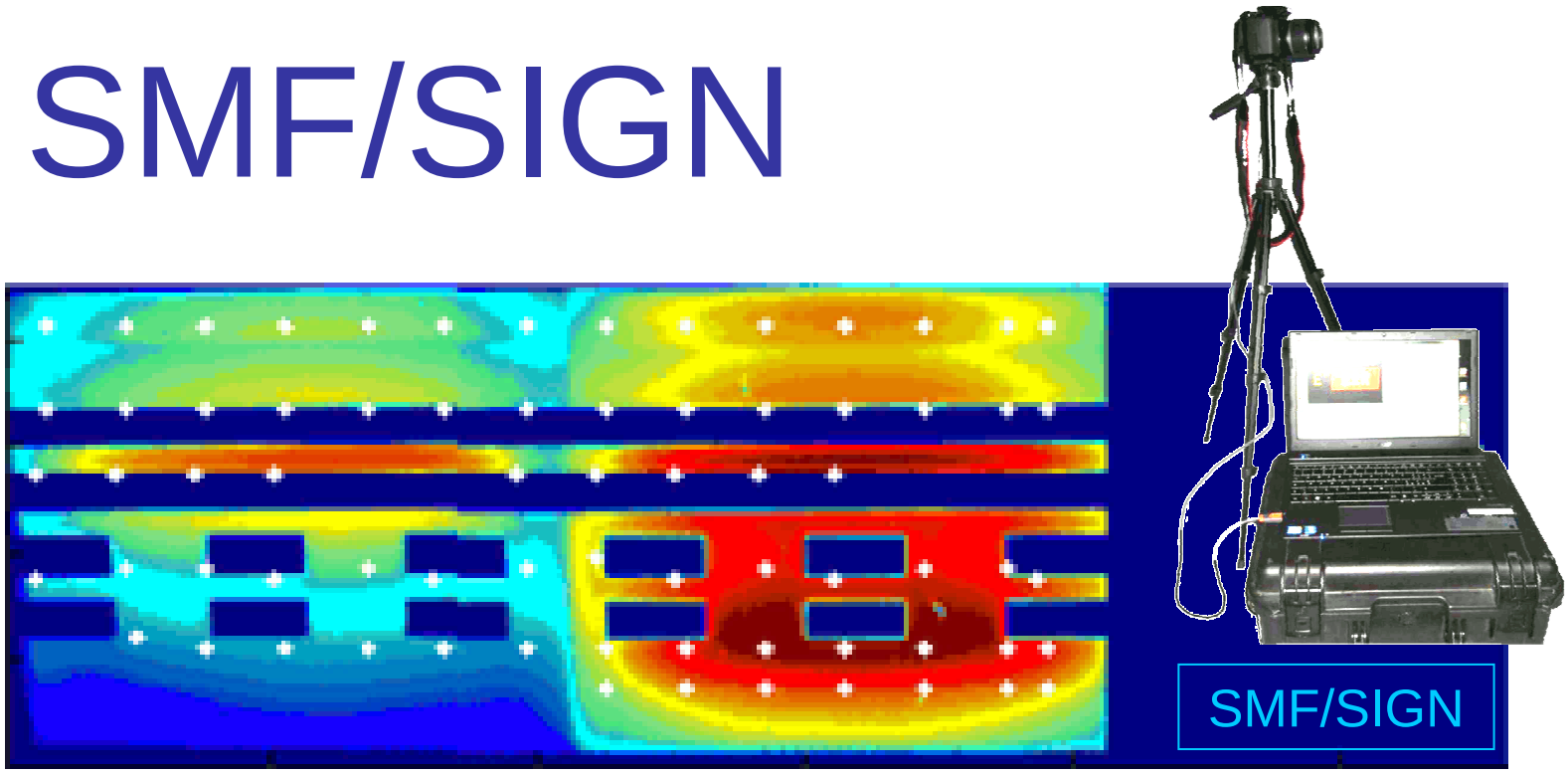
SMF/MCT is an equipment designed to check the calibration of optical sensors installed on SMF/M and then to guarantee the specified accuracy in measuremen

SMF/MCT is a calibration tool based on stable reference light, a reference instrument (Minolta T-10M) and a dedicated software.



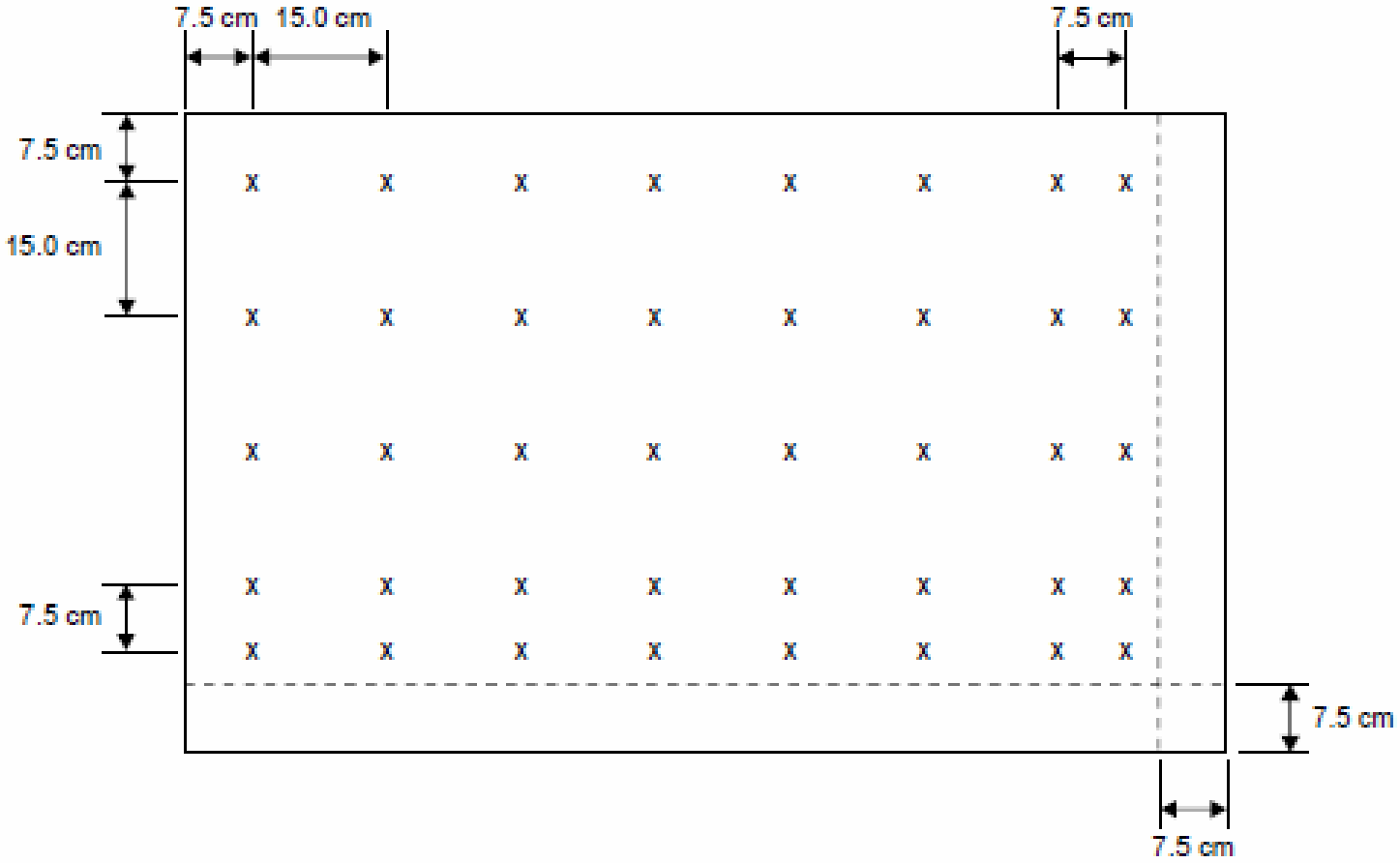
SMF/MCT allows a systematic and repeatable calibration of the SMF/Mobile instrument.

SMF/SIGN



Photometric Measurement System
Dedicated to Airfield Vertical Guidance Sign

ICAO Recommendations



Standard procedure for the Average Luminance measurement (cd/m2) of a Sign

See Aerodromes, Annex 14, Volume I, Aerodrome Design and Operations, App. 4-3

SMF/Sign – Overview

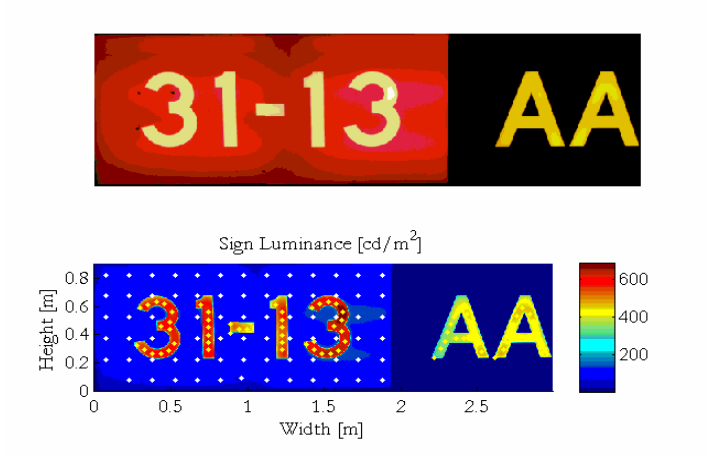
New generation automatic instrument, consisting of digital camera, luminance sensor and PC, able to perform extremely fast measurements of photometric characteristics of airfield illuminated vertical signs of any dimension and type in conformity with the recommendations of ICAO Annex 14 and ENAC APT 13-A.

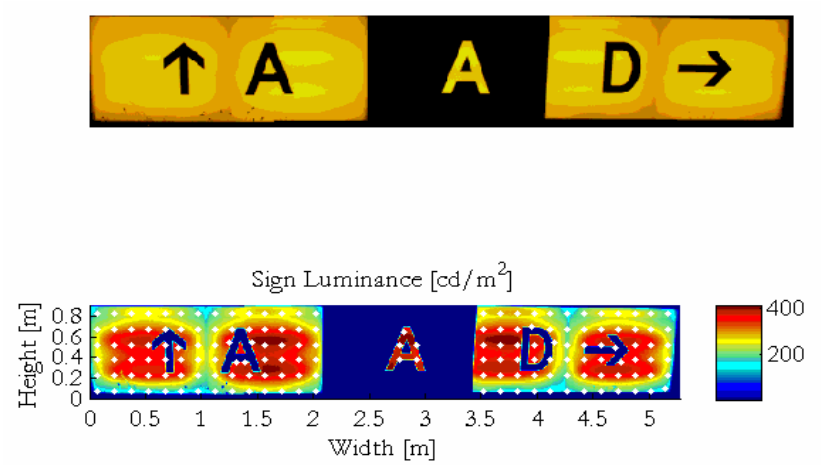
SMF/SIGN provides:

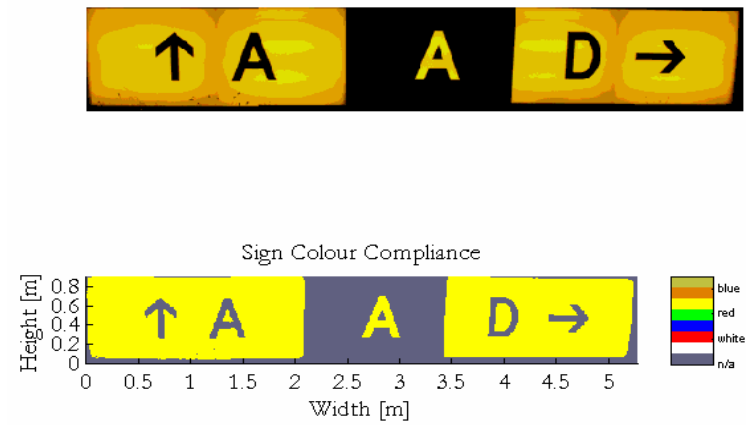
- False colour image of the Sign luminance, with a resolution of 1 mm
- Colour map image of ICAO admitted colours (white, red, yellow, black, green, orange), with 1 mm resolution

- Average Luminance for each colour
- Chromaticity for each colour
- Luminance Ratio between adjacent points on the grid for each colour
- Luminance Ratio between maximum and minimum values points on the grid for each colour
- Luminance Ratio of red colour to the white
- Luminance factor (given the luminance of the standard D65 illuminating source)
- Dimensional Ratio of characters fonts to the Sign

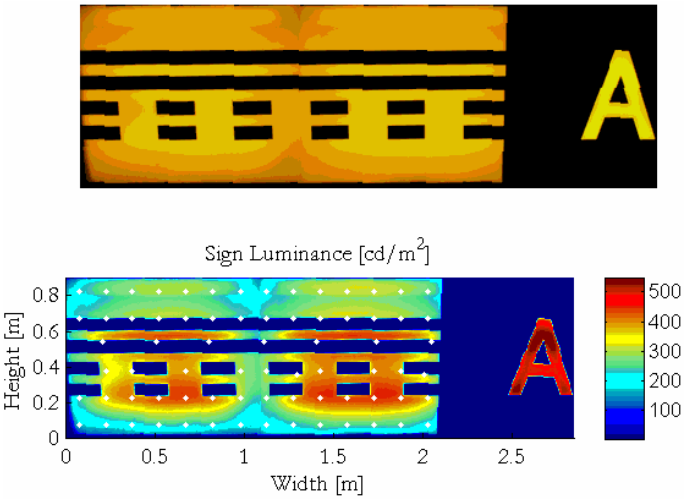
SMF/Sign – Output data (I)

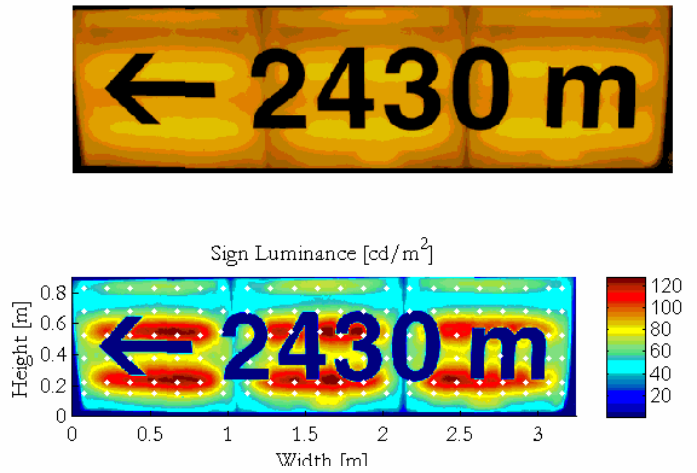


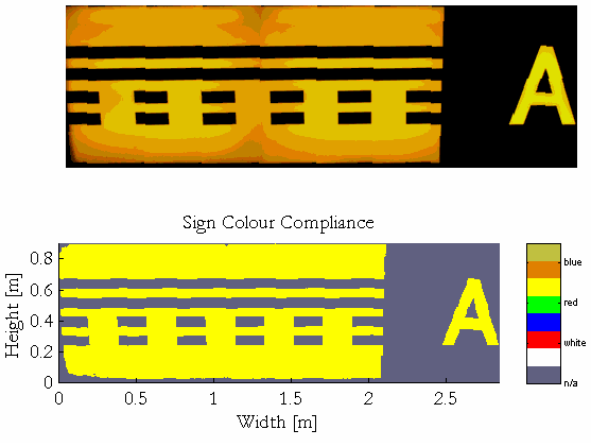


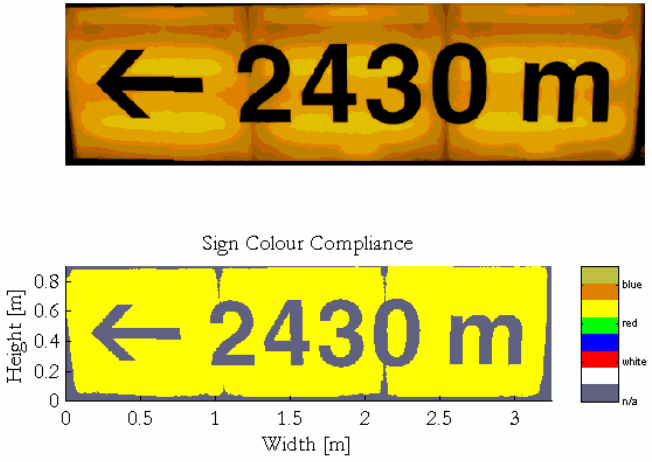


SMF/Sign – Output data (II)





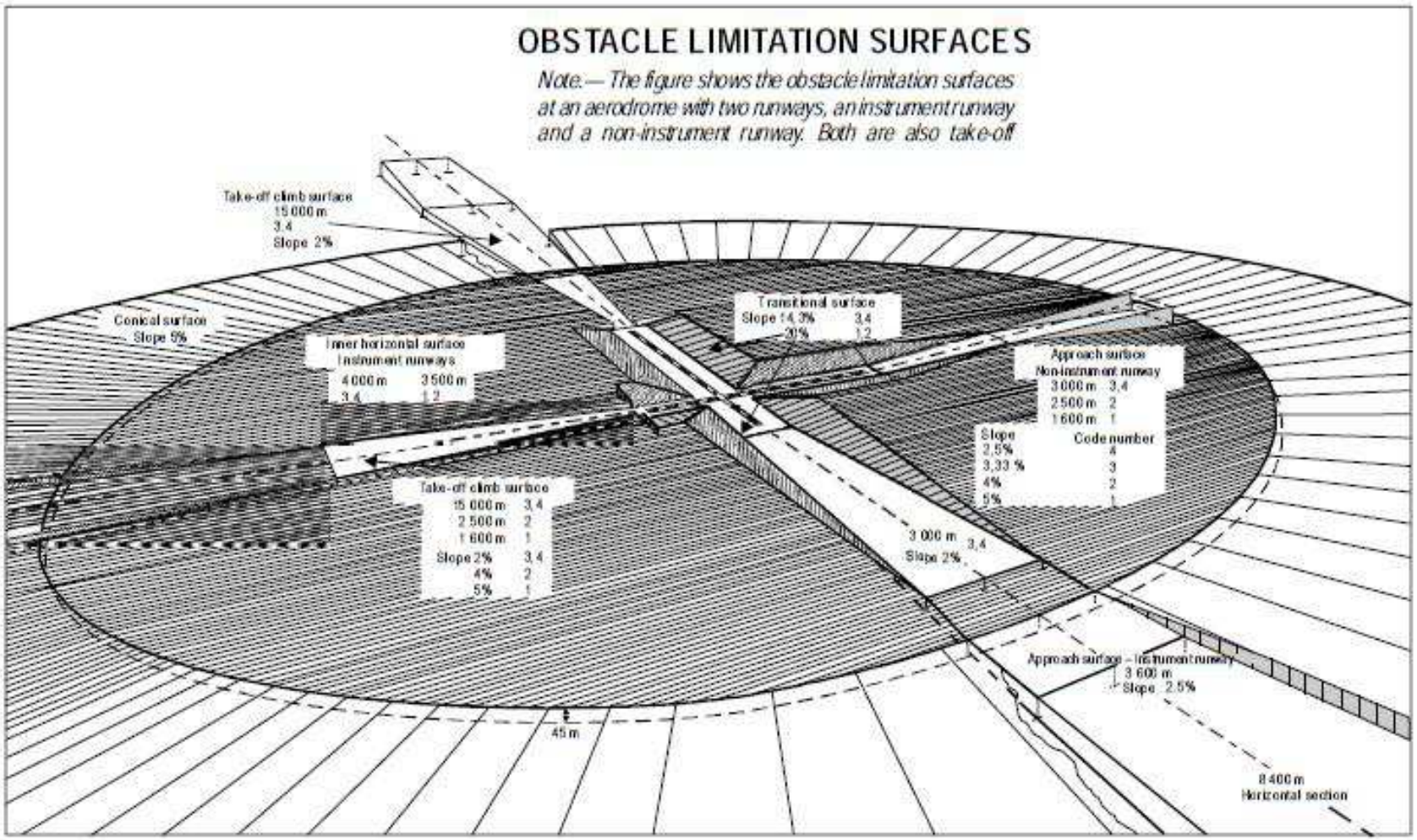




SMF/ODS

Obstacle Detection System

ICAO Recommendations



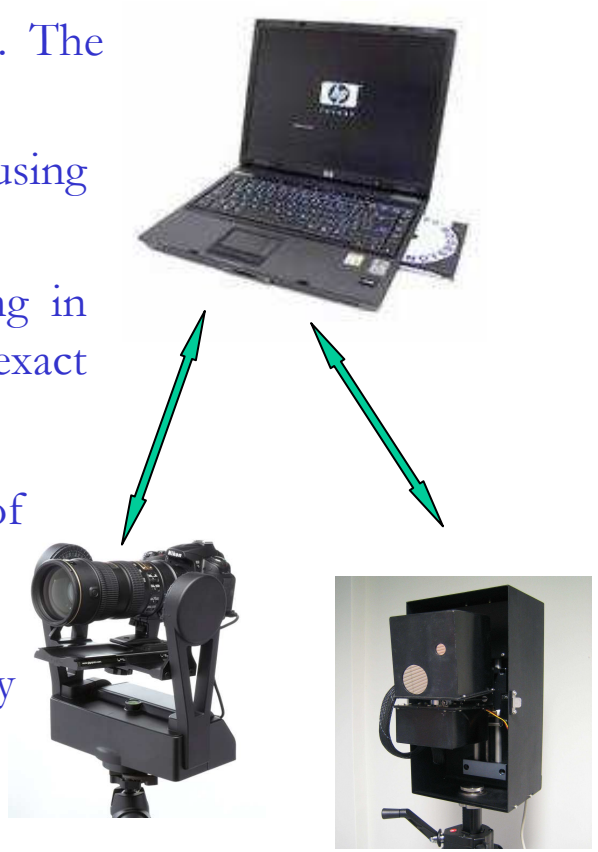
Annex 14, Chap. 14 and ICAO Annex 15, Sect. 10.4.

SMF/ODS – Overview

State-of-the-art instrument able to automatically detect the presence of objects penetrating the Approach Surface (AS) of the runway.

The operation is based on the scan of the surface under test. The following actions are performed:

- The part of the AS nearest to the runway head is measured using SMF/PAPI system
- The remaining part is measured with the camera working in conjunction with SMF/PAPI system in order to define the exact elevation angle

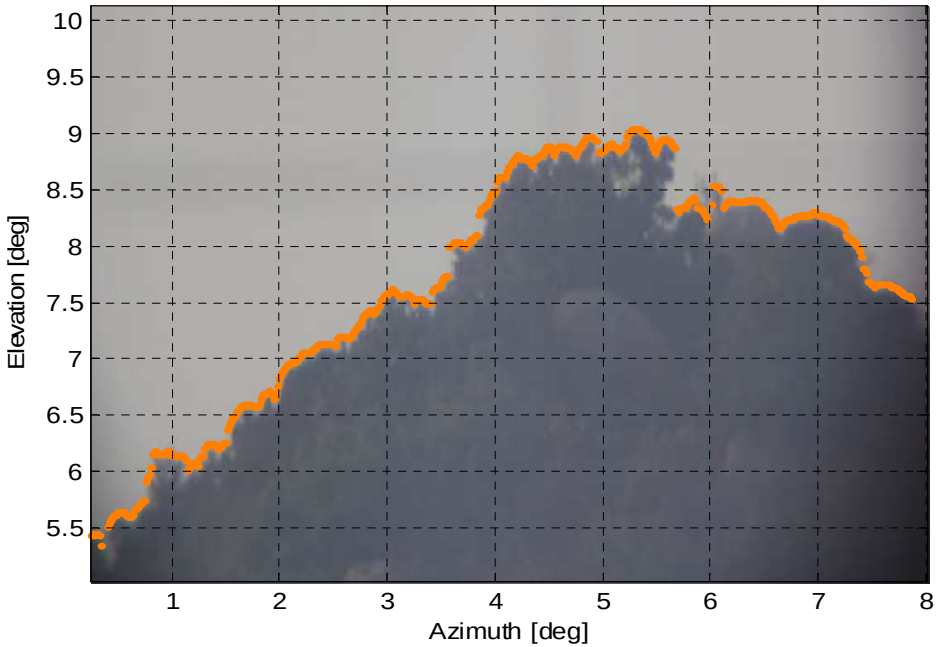


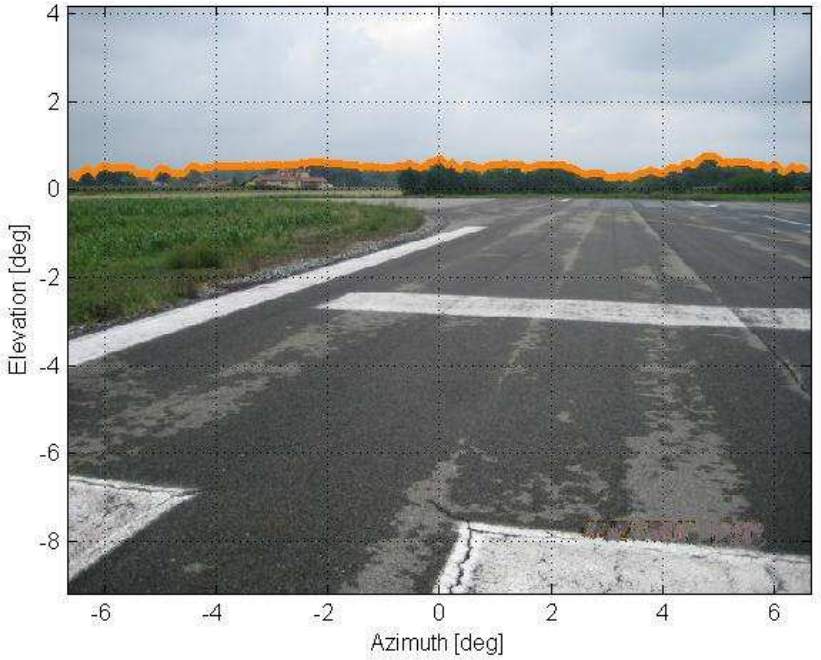
The result of image processing is a curve following the contour of the obstacles, integrated with additional information, such as elevation angle of obstacles with respect to gravitational horizon and azimuthal angle with respect to the central axis of the runway or with respect to the point where the measurement was performed.

The entire measurement process takes just a few minutes and the resolution of obstacle detection is of 13 cm at the distance of 15 km.

SMF/ODS – Output data (I)

SMF/ODS – Output data (II)





SMF/ALS

Photometric Measurement System
Dedicated to Approach Landing System lighting

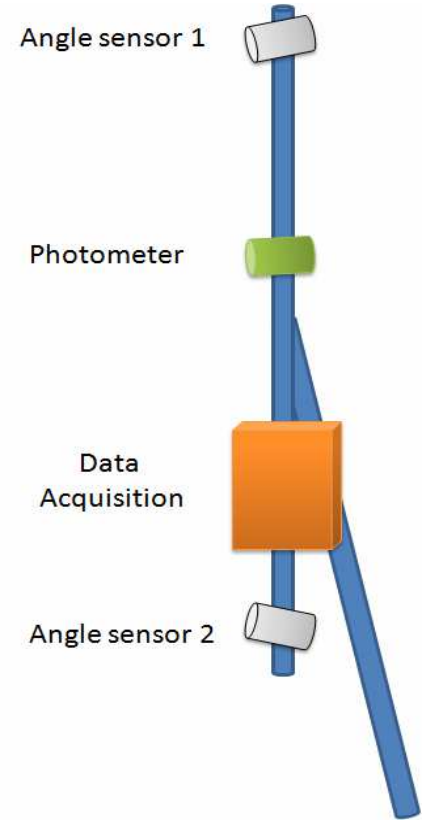
SMF/ALS - Overview

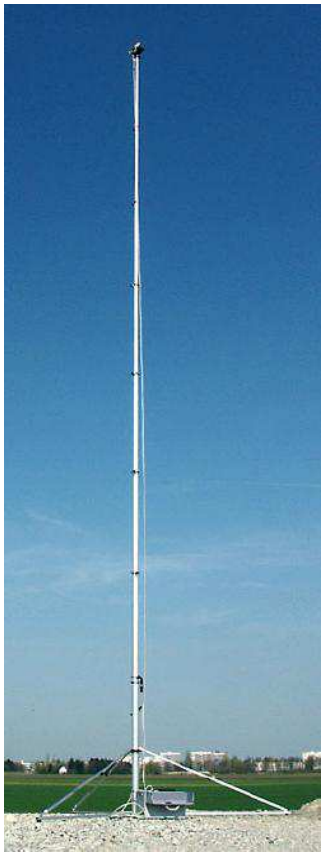
New advanced instrument to measure photometric performances of approach signals mounted on masts.

SMF/ALS is based on a special sensor able to detect the angle under which the light source appears.

It is mounted on a lightweight telescopic mast extensible up to 6 mt height.

SMF/ALS can be installed on a mobile trolley or a vehicle.





SMF/NET

Photometric Measurements Central Control System
Dedicated to AGL Maintenance

SMF Net – Overview