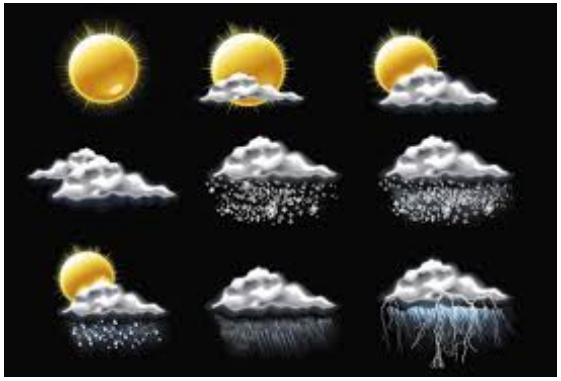
A prototype weather monitoring system at CTA-N



Lluís Font, Markus Gaug

UAB & CERES-IEEC

Central Calibration Facilities meeting
Barcelona 2-5 October 2017

Background

A weather monitoring system has been designed for both CTA sites

UC-CAL-ATMO-4000 → CTA weather monitoring

UC-CAL-ATMO-6000 → Broadcasted weather monitoring for CTA

UC-CAL-ATMO-7000 → Human readable weather report

UC-CAL-ATMO-8000 → ATMO sentinel

- Full weather monitoring system will be delivered for both CTA-N (in-kind contribution of CTA-Spain) and CTA-S (by another party)
- CTA-Spain will also provide the common software and collaborate in the design of related weather monitoring parts of GUI.
- GUIs could be hosted in OES (Observation Execution System) and OSS (Operations Support System).
- DESY's (intented) in-kind contribution includes major parts of OES + its full GUI. DESY has designed an array control system and started to design a GUI for the operator OES.
- LST1 is already in construction in CTA-N

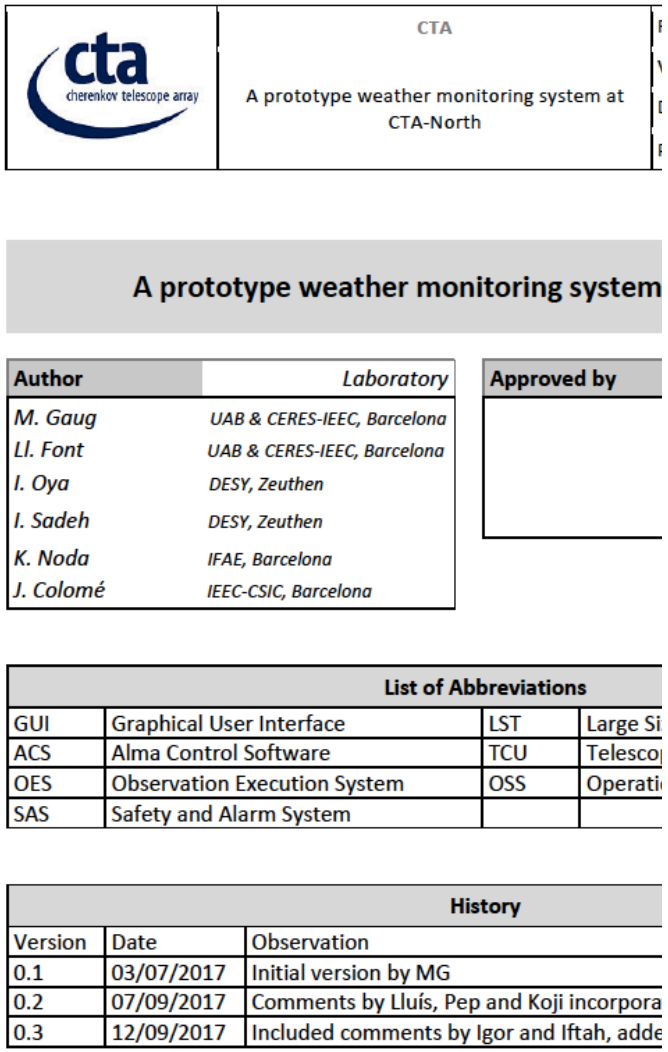
Goal

Development and construction of a CTA-N weather monitoring system (WMS) prototype (simple):

1.- Provide LST1 with a WMS independent of MAGIC.

2.- Start testing the system and the future elements of the final CTA WMS:

- Reliability
- Communication with the OES prototypes
- WMS GUI



CTA

A prototype weather monitoring system at CTA-North

A prototype weather monitoring system

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M. Gaug	*UAB & CERES-IEEC, Barcelona*
Ll. Font	*UAB & CERES-IEEC, Barcelona*
I. Oya	*DESY, Zeuthen*
I. Sadeh	*DESY, Zeuthen*
K. Noda	*IFAE, Barcelona*
J. Colomé	*IEEC-CSIC, Barcelona*

Approved by

List of Abbreviations

GUI	Graphical User Interface	LST	Large Si
ACS	Alma Control Software	TCU	Telesco
OES	Observation Execution System	OSS	Operati
SAS	Safety and Alarm System		

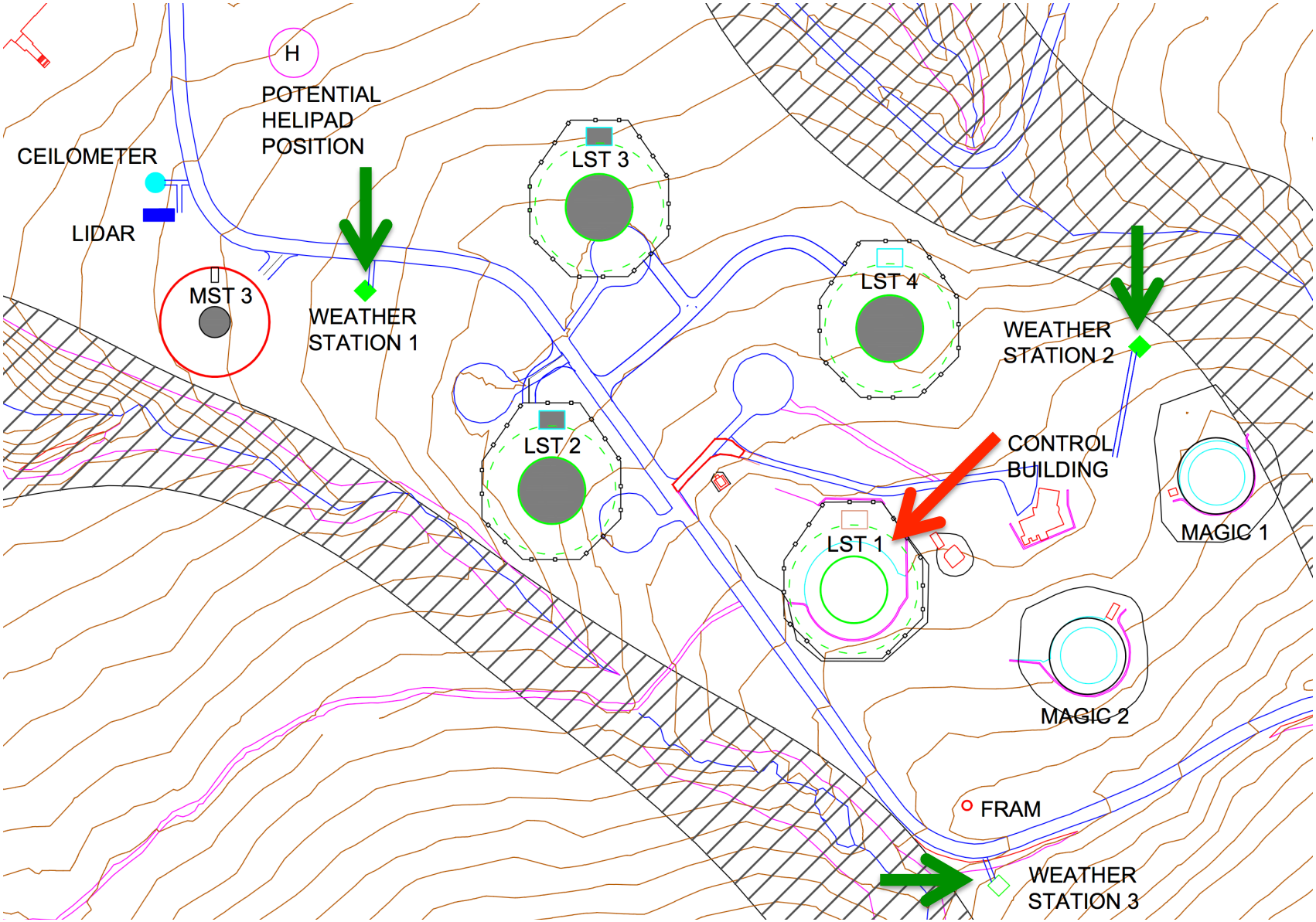
History

Version	Date	Observation
0.1	03/07/2017	Initial version by MG
0.2	07/09/2017	Comments by Lluís, Pep and Koji incorpora
0.3	12/09/2017	Included comments by Igor and Iftah, adde

Scope

- 1 WS (T, P, RH)
- 1 3D-Doppler anemometer

- A pole fixed to one of the containers (“commissioning container”)
- Small computer inside the commissioning container (weather monitoring software and GUI)
- Development of WMS software prototype:
  - Interface to the TCU ACS control foreseen for the LST1
  - A prototype stand-alone data acquisition system
  - A test bench for prototypes of the CTA monitoring database
  - A test bench for prototypes of the CTA GUIs


H
POTENTIAL
HELIPAD
POSITION
CEILOMETER
LIDAR
MST 3
WEATHER
STATION 1
LST 3
LST 4
LST 2
LST 1
WEATHER
STATION 2
CONTROL
BUILDING
MAGIC 1
MAGIC 2
FRAM
WEATHER
STATION 3

Implicated partners

Responsible person	Institute	Task
I. Oya, I. Sadeh, T. Schmidt	DESY Zeuthen	DESY will deliver the back-end framework of the GUI. In addition a baseline frontend implementation for monitoring panels, which is ready to be integrated with the monitoring database framework. This will include time-series monitoring plots and histograms.
M. Gaug, Ll. Font	UAB & CERES-IEEC, Spain	Hardware selection and installation, Stand-alone data acquisition system Prototype GUI
J. Colomé	IEEC-CSIC, Barcelona	Interface to the TCU ACS control foreseen for the LST1
K. Noda	IFAE, Barcelona	Contact to LST1 and general overview

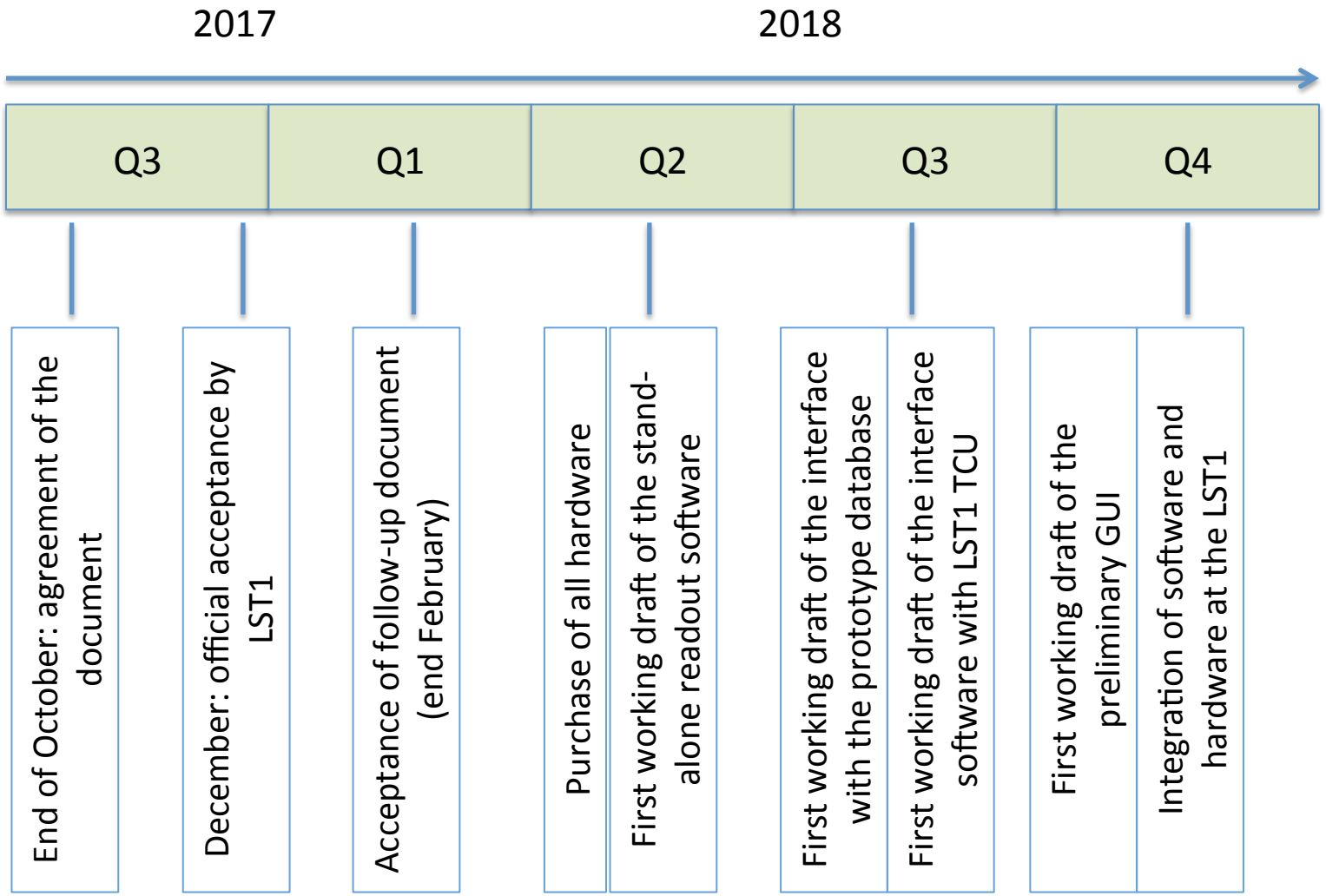
Cost and manpower estimates

Hardware (sensors, cables, computer)	6000 €
Travels (La Palma, meetings)	4000 €
	10000 €
Manpower (FTE hours)	1000 h

Deliverables

1. A working WS + 3D anemometer connected to LST1 TCU
2. A preliminary GUI, compatible with the GUI framework foreseen for CTA, which can be gradually extended and upgraded.
3. An interface to the prototype database, compatible with the final format foreseen for CTA by the DESY colleagues, which can be gradually extended and upgraded.

Schedule


2017
2018
Q3
Q1
Q2
Q3
Q4
End of October: agreement of the document
December: official acceptance by LST1
Acceptance of follow-up document (end February)
Purchase of all hardware
First working draft of the stand-alone readout software
First working draft of the interface with the prototype database
First working draft of the interface software with LST1 TCU
First working draft of the preliminary GUI
Integration of software and hardware at the LST1


Thank you

Backup

The Northern Site: ORM

Pre-production

3.10.3.4.6	Weather monitoring
3.10.3.4.6.7	Complementary Instruments
3.10.3.4.6.7.1	Electric field mills
3.10.3.4.6.7.1.1	Establish usefulness
3.10.3.4.6.7.2	Dust counters
3.10.3.4.6.7.2.1	Establish usefulness
3.10.3.4.6.7.3	Accelerometers
3.10.3.4.6.7.3.1	Establish usefulness
3.10.3.4.6.7.4	National Rain radars
3.10.3.4.6.7.4.1	Check availability
3.10.3.4.6.7.4.2	Check possibility of integration in ACTL
3.10.3.4.6.7.5	Weather forecasts
3.10.3.4.6.7.5.1	Check availability
3.10.3.4.6.7.5.2	Check possibility of integration in ACTL

- ✓ Useful from MAGIC experience but feedback from ACTL and PO needed
- ✓ Useful for aerosol modelling and feedback to operators
- ✘ Not necessary for La Palma
- ✓ Available from Spanish National Meteorological service. CTA GUI (Iftach Sadeh, from DESY)
- ✓ IAC has an agreement with SAT24. CTA GUI (Iftach Sadeh, from DESY)

Coverage: 100% :no equipment cost; only labour (FTEs)

Next actions (to do)

Start interaction with ACTL (GUI, electric field mills) and PO, and IAC

The Northern Site: ORM

Production

			Whole CTA	Whole CTA	ORM
10 COM	4.100.030.04.06	Weather monitoring	€ 374.868,00	€ 316.339,00	€ 154.993,00
10 COM	4.100.030.04.06.01	Classic weather station	€ 55.135,00	€ 52.484,00	€ 26.242,00
10 COM	4.100.030.04.06.02	Anemometers	€ 98.928,00	€ 83.226,00	€ 41.613,00
10 COM	4.100.030.04.06.03	Rain sensors	€ 68.051,00	€ 27.876,00	€ 27.876,00
10 COM	4.100.030.04.06.04	Complementary Instruments	€ 152.754,00	€ 152.754,00	€ 59.262,00

3 classic WS + 2 spares (1 from LSTs weather monitoring) → Same model?

6 anemometers + 2 spares (3 recycled from LSTs weather monitoring)

9 rain sensors + 2 spares

Complementary instruments:

1 Electric field mill:	35.362,00
1 dust counter:	17.900,00
Rain radars:	3.000,00
Weather forecasts:	3.000,00
Accelerometer:	Not required

Coverage

100% (CTA-Spain, FEDER funds) in two steps:

139.302,00 – 34.350,00 (Weather monitoring for LSTs) = **104.952,00** **by the end of 2016**, covering:

All the weather monitoring equipment but complementary instruments (or any other option)

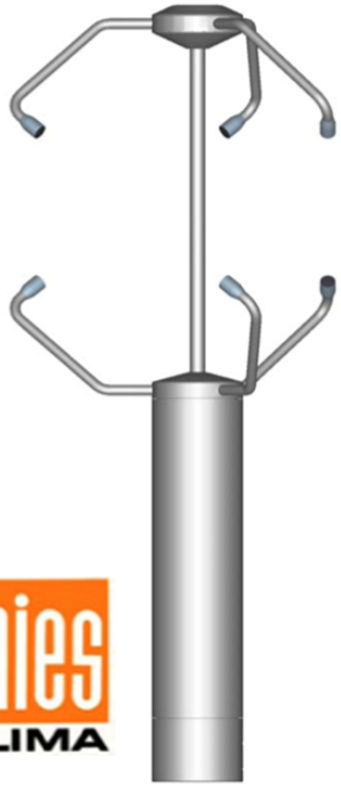
The rest of Spanish contribution will come later (2017-18).

✓ Sensors (almost) decided

Standard Weather Stations

✓ Sensors (almost) decided

Ultrasonic anemometers 3D



Thies CLIMA

4 Maintenance

As the device does not have moving parts, i.e. is not subject to wear during operation, no servicing is required.

5 Calibration

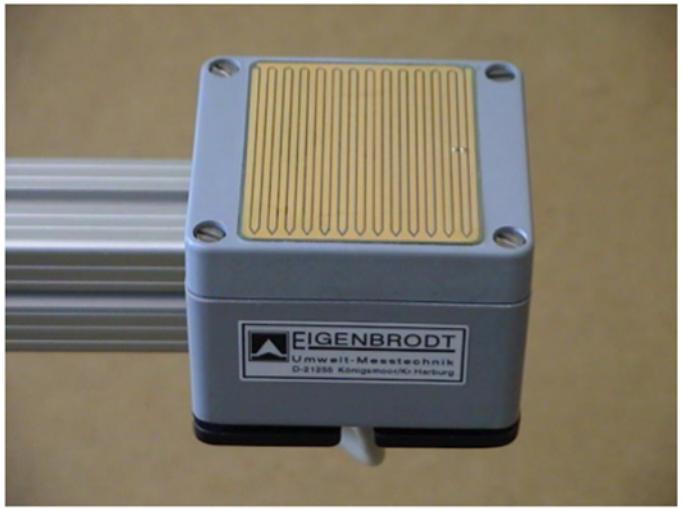
The ultrasonic anemometer does not contain any adjustable components such as electrical or mechanical trimming elements. All components and materials used show invariant behaviour in terms of time. This means that no regular calibration is required due to ageing. Errors in measured values are only caused by mechanical deformation of the transformer arms and associated changes in measurement path lengths.

The acoustic virtual temperature can be used to check the measurement path length. A change of 0.17 % in the measurement path length and thus a measuring error of 0.17 % for the wind velocity corresponds to a deviation in the virtual temperature of 1 K at 20°C.

With a 6 K temperature deviation there is thus a measuring error of approx. 1 % for the wind velocity

✓ Sensors (almost) decided

Rain sensor: PRECIPITATION SENSOR – IRSS 88 from Eigenbrodt



EIGENBRODT

Overview

The goals

- Provide the site with weather monitoring information to guarantee safety operation of the telescopes. Prevent equipment damage.
- Contribute to the site climatology and full atmospheric characterization of the site.

The strategy

- Acquire robust WS and weather monitoring instrumentation (24/365 with no failure for 30 years of remote operation)
- Redundancy
- Final selection and placement of the sensors is site-specific (Classic WS + anemometers + rain sensors + complementary instruments)
- Production: all equipment and implementation for methods that are part of the final observatory .

The Southern Site: Armazones

Pre-production

3.10.3.4.6	Weather monitoring
3.10.3.4.6.7	Complementary Instruments
3.10.3.4.6.7.1	Electric field mills
3.10.3.4.6.7.1.1	Establish usefulness
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3.10.3.4.6.7.5	Weather forecasts
3.10.3.4.6.7.5.1	Check availability
3.10.3.4.6.7.5.2	Check possibility of integration in ACTL

✓ Probably not needed. Still to be studied.

✓ Useful for aerosol modelling and feedback to operators

✓ Useful, although analysis still ongoing

✘ Not available for Armazones

✓ Useful, although no studies performed yet

Coverage: 100% :no equipment cost; only labour (FTEs)

Next actions (to do)

Push for usefulness studies

The Southern Site: Armazones

Production

			Whole CTA	Whole CTA	Armazones
10 COM	4.100.030.04.06	Weather monitoring	€ 374.868,00	€ 316.339,00	€ 161.347,00
10 COM	4.100.030.04.06.01	Classic weather station	€ 55.135,00	€ 52.484,00	€ 26.242,00
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3 classic WS + 2 spares (1 from LSTs weather monitoring)

6 anemometers + 2 spares (3 recycled from LSTs weather monitoring)

9 rain sensors + 2 spares

Complementary instruments:

1 Electric field mill:	35.362,00
1 dust counter:	17.900,00
Rain radars:	Not available
Weather forecasts:	6.000,00
Accelerometer:	34.230,00

Coverage

~ 0% !!!

Next steps

Ask Johannes for EoI data related to Weather monitoring.
Identify Institutes interested in collaborating.
Take advantage of Use cases and ACTL integration from the Northern site.