

# DAG-MAM: Meteorological and Astronomical Monitoring

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## Introduction

DAG (Doğu Anadolu Gözlemevi - Eastern Anatolia Observatory) is an observatory project which will have a 4-meter class telescope that will be able to make observations in the optical (VIS) and near-infrared (NIR) wavelengths, in Erzurum, at 3170 meters. The first light of the telescope is planned to be taken in the last quarter of 2020.

In order to serve the observatory, meteorological and astronomical equipment were installed on the tower which we call MAM (Meteorological and Astronomical Monitoring). These devices (e.g. meteorological stations, all sky cameras, astronomical seeing monitors) produce different types of data. The data of these measuring devices are recorded and served via the DAG-MAM web services to telescope operators.

## Meteorological and Astronomical Monitoring System (MAM)

DAG-MAM is a "smart" ecosystem which consist of instruments, infrastructure, computational components and software, and aims to serve the important parameters for astronomical observations to telescope subsystems and operators by operating 24/7 without interruption. It also serves retrospective (daily, weekly, annual) data for other users (observers, technical personnel, researchers, and public). In this way, users can access statistical data of the observatory at any time by using DAG-MAM web-portal.

## Facilities

All equipment is located on a 5x5 meter platform on top of a 7-meter-high steel construction tower which was erected at DAG site in 2013, and moved to its current location in 2015. The MAM Tower and the devices on it are shown in Figure 1. Under the MAM Tower, there is a 2x2 meter prefabricated building with electrical panels, fiber converters and UKEP (remote control panels). Next to the MAM Tower, there is a larger prefabricated building within which UPSs, Servers and work spaces for MASS-DIMM observations and MAM system control are located.



Figure 1 - The tower height is 7 meters and the platform area is 5x5m. The meteorological and astronomical equipment of the DAG-MAM system is located on this tower.

## Meteorological Equipment

In the MAM system, meteorological equipment produced by different companies are used together. In particular, having different devices capable of making the same measurements is vital for continuous measurements. Equipment used in MAM system:

> Automatic Weather Observation Station (AWOS) manufactured by LSI-LASTEM. It is a weather station with temperature and humidity sensor, wind speed and wind direction sensor, solar radiation sensor and visibility sensor.

> Diffraction Lim. Cloud Sensor II. This sensor is capable of detecting cloudiness by observing the sky at two different wavelengths (8-14 microns) and comparing the sky temperature with the ground temperature.

> Vantage Pro 2 meteorological station manufactured by Davis Instruments.

> Stonex SC200 GNSS receiver and its GNSS antenna. It is aimed to perform PWV analysis from GNSS measurements.

> VAISALA WXT536 Multi-Parameter Weather Sensor. Two of these sensors are used. One is located on the tower and the other on the DAG construction site.

Device	Temp. (C)	Hum. (%)	Pres. (hPa)	Wind (m/s)
AWS	-40 / +60	0/100	600/1100	0/60
DVS	-40 / +65	1/100	540/1100	0/89
VAIS	-52 / +60	0/100	600/1100	0/60

Table 1 - Technical information of equipment used in the DAG-MAM

## Astronomical Equipment

DAG-MAM system currently has two all sky cameras (ASC). These cameras are OMEA and EUDA models from Alcor-System. All sky cameras monitor the observatory's sky during the day and night. With these cameras, night sky quality and all-night events (meteor, satellite, etc.) are recorded.

Device	Sensor	Resolution	FoV	Pixel Scale
OMEA	Color	4600x3520	180 x 180	2.9 arcmin/px
EUDA	Mono	3362x2537	180 x 180	4.1 arcmin/px

Table 2 - Specifications of the ASCs used in the DAG-MAM

In DAG-MAM system, there is a Cyclope seeing monitor of Alcor-System, which makes continuous observations for the observatory. Unlike other systems (DIMM etc.), this seeing monitor calculates seeing only by measuring the position changes of the Polaris ( $\alpha$  Umi) (Web-1).

DAG-MAM system includes a Rotating SQM (RSQM) designed and manufactured by ATASAM to measure night sky quality. The sky quality meter from Unihedron, which looks the sky at 4 different angles (30, 45, 60 and 90 degrees), is placed on a rotating platform and makes 15-minute turns in all directions of the night sky.

## The Art of Data Flow

The meteorological and astronomical equipment used in the DAG-MAM system produce different types of data due to their structure. Device-specific softwares have been developed for the integration of each data into the DAG-MAM system.

Virtualization system is used in DAG-MAM system to save space and cost. The servers have a virtual computers those are specific to each device and thus easy control is made. Software specific to the devices running on virtual PCs sends the data produced to the MAM-MASTER database server located on the MAM-01 server. MAM-SLAVE database server in ATASAM copies data from the MAM-MASTER server in near real-time.

DAG-MAM website shows data from the MAM-SLAVE server. In this way, data is presented in a secure way by indirect method.

Also, NTP time server is used to ensure the time unity of meteorological and astronomical devices and servers (virtual PCs). Time resolution of the DAG-MAM system was determined to be one (1) minute.



Figure 2 - DAG-MAM web site main page. Users can see five graphs about meteorological parameters and all sky camera.

## Conclusion

The Eastern Anatolia Observatory (DAG) is planned to receive the first light in 2020. The DAG-MAM project was implemented to monitor the atmospheric and astronomical data required for the observatory in a stable manner.

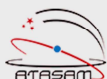
As mentioned in the content, DAG-MAM system is a superstructure project that has been spent overtime and money. Currently, the majority of the planned work packages (80%) have been successfully completed.

The work packages remaining before the opening of the observatory will be completed and the DAG-MAM system will be able to perform the entire surveillance on its own without the need for human intervention.

DAG-MAM system will also be available on mobile platforms (iOS & Android).

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