

Status of the Focal Plane Instrumentation (FPI) Project of the 4 m DAG Telescope

Onur Keskin^{*(a, b)}, Sinan K. Yerli^(c), Cahit Yeşilyaprak^(d, e), Tolga Guver^(f, g), Sinan Aliş^(f, g), F. Korhan Yelkenci^(f, g), B. Bülent Güçsav^(d, e), Mehtap Ö. Arabacı^(d, e), Ayşe Erol^(h)

^(a) FMV Işık Univ., Engineering Faculty, Dept. of Mechanical Eng., Istanbul, Turkey; ^(b) FFMV Işık University, Center of Optomechatronics Application and Research (OPAM), Istanbul/Turkey;

^(c) Orta Doğu Teknik University (METU), Physics Department, Ankara, Turkey;

^(d) Atatürk Univ., Science Faculty, Dept. of Astronomy and Astrophysics, Erzurum, Turkey;

^(e) Atatürk Univ., Astrophysics Research and Application Centre (ATASAM), Erzurum, Turkey;

^(f) Istanbul Univ., Science Faculty, Dept. of Astronomy and Space Sciences, Istanbul, Turkey;

^(g) Istanbul Univ., Observatory Research and Application Center, Istanbul, Turkey;

^(h) Istanbul Univ., Science Faculty, Dept. of Physics, Istanbul, Turkey;

ABSTRACT

DAG (Eastern Anatolia Observatory in Turkish) will be the newest and largest (4m) observatory of Turkey in both optical (VIS) and near-infrared (NIR) with its robust observing site infrastructure. The telescope is designed to house 2 Nasmyth platforms which will be dedicated to NIR and VIS observations. A collaboration has recently been established among four Turkish universities including FMV Işık University (for adaptive optics systems), Middle East Technical University (for measurement, test and calibration purposes), Istanbul University (for new technology instruments, e.g. MKIDs) and as the coordinator Atatürk University (for obtaining NIR and VIS instruments). In this paper the status of the recently approved FPI project and its aims are presented and possible collaboration opportunities are emphasized.

Keywords: Focal plane instrumentation, Adaptive Optics, calibration, NIR - VIS instruments, MKID

1. INTRODUCTION

DAG Project (<http://dag-tr.org>) consists of a 4 m state-of-the-art telescope which will be able to perform observation in both visible (VIS) and near-infrared (NIR). DAG active optics telescope contract has been awarded to AMOS, the enclosure to EIE, and the building design to GUNARDA. In the current status: the final design review (FDR) of the telescope is completed, the preliminary design review (PDR) of the enclosure is completed with an expected FDR in mid-July, M1 blank acceptance is expected the second week of August, the FDR of the observatory building is completed and the construction is undergoing. Being the largest telescope in Turkey and enabling regional and international astronomical communities, DAG project is planned to hold cutting edge technological FPI instruments.

DAG Project Team and the Advisory Board consisting of both Turkish and international astronomers, engineers, and scientists evaluated the current astronomical and astrophysical developments and prepared a report (<http://dag-tr.org/Proje/SciTR>) as “DAG Scientific Goals”. In this report the expected 10-15 years roadmap has been decided and the contribution of DAG to both local and international communities have been underlined. Under this roadmap, the FPI project has been applied and recently funded by the Ministry of Development of Turkey. The FPI project will consist of:

- 1) A multi-purpose instrument with imaging and spectroscopy capabilities working in the optical wavelengths.

* O. Keskin: onur.keskin@isikun.edu.tr

- 2) An imager and spectrograph for the near-infrared.
- 3) Adaptive Optics (AO) System for real-time atmospheric compensation.
- 4) A new technology detector (preferentially imager)
- 5) State-of-the-art in house built de-rotators (DR)

Palandöken Mountains and regional atmospheric properties (low humidity, clear nights, no light pollution, height > 3000 m, low and stable wind profiles, infrastructure) allow DAG to perform NIR observations.

Important Updates of the DAG Project

- Road and service buildings will be finalized within 2016-2017
- Enclosure will be delivered by 2018
- Telescope will be delivered by 2019
- First light is planned by 2019 with FPI instruments
- Coating unit tender will be performed by 2018

2. FPI PROJECT OVERVIEW

The Project will be coordinated by the Ataturk University Astrophysics Research and Application Centre (ATASAM). Alongside the main project of the Ataturk University, Istanbul University and Orta Dogu Teknik Universitesi has been awarded as well to support the Ataturk University. Recently funded FPI project mainly focuses on to obtain multi-purpose instruments working for optical and near-infrared wavelengths. These instruments are expected to be the workhorses of the DAG telescope as the variety of scientific topics interested by the Turkish astronomical community is quite broad. Besides classical imagers and spectrographs, DAG team has intention to experiment new technology instruments such as microwave kinetic inductance detectors (see Guver et al., this meeting). In the framework of the FPI project different laboratories for test, calibration and maintenance will be established in each institution.

The project is expected to be finalized in 36 months which will overlap with the expected first light of the telescope, where the AO and DR systems will be built in Turkey with national collaborations.

Table 1. DAG FPIs

Focus	Instrument No	Wavelength	Type	Local Contribution (%)	Int. Contribution (%)
N1/N2		-	DR	50	50
N1		-	AO	90	10
N1	a	VIS	Im	95	5
N1	b	NIR	Im	95	5
N1	c	V/N	NTI	-	100
N2	a	VIS	Spec	80	20
N2	b	NIR	Spec	80	20
N2	c	NIR	MOS	-	100

N1: AO hosting focus; **N2:** Non-AO focus; **DR:** Derotator); **AO:** Adaptive Optics; **NIR:** Near-IR; **V/N:** VIS+NIR; **Im:** Imaging; **Spec:** Spectroscopy; **MOS:** Multi Object Spectrograph; **NTD:** New-technology detector

Nasmyth 1 FPIs

- N1-a: An optical imager such as CCD with high quantum efficiency will be used for general photometry purposes and monitoring transient objects.
- N1-b: An infrared imager will be used to study X-ray binaries and AGNs as well as galaxy evolution.
- N1-c: New technology detectors operating around 100 mK and allow observations from optical to near-infrared wavelengths.

Nasmyth 2 FPIs

- N2-a: DAG Project team has decided to obtain a spectrograph which will operate between 350-1000 nm with resolutions between 100-3000. This instrument is expected to be a workhorse for the Turkish astronomical community.
- N2-b: As DAG will be the first and largest telescope to operate in the near-IR in Turkey, spectroscopy will be very crucial. This instrument will enable Turkish astronomers to work in the wavelength range of 0.9 – 2.5 microns.
- N2-c: Although it is desired to have a multi-object spectrograph, this instrument slot can be reserved for future collaborations. Imagers (especially in VIS) are the main observing instrument. Sci-MOS equipment offer low noise and dark current while excluding the need of large and expensive cooling units.

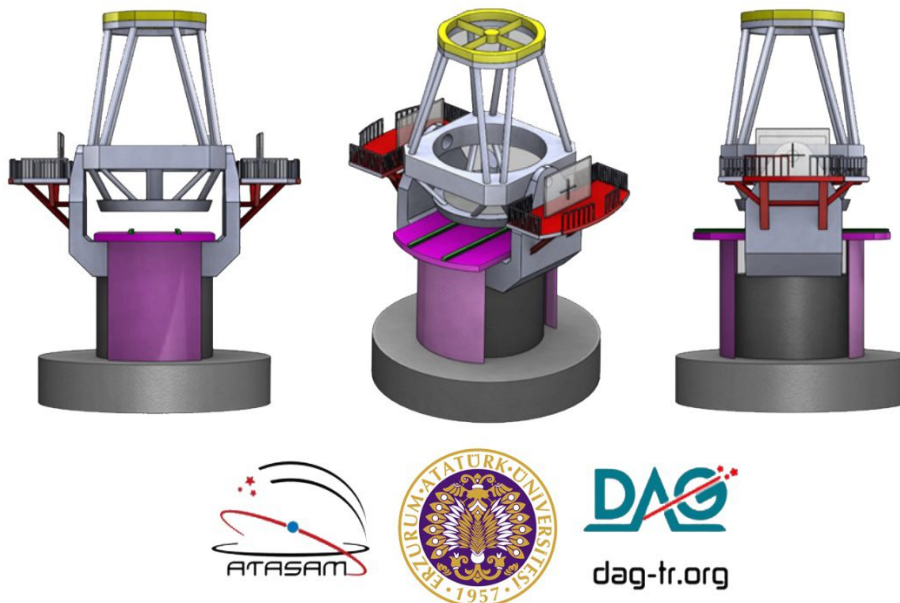


Figure 1. DAG Telescope Design

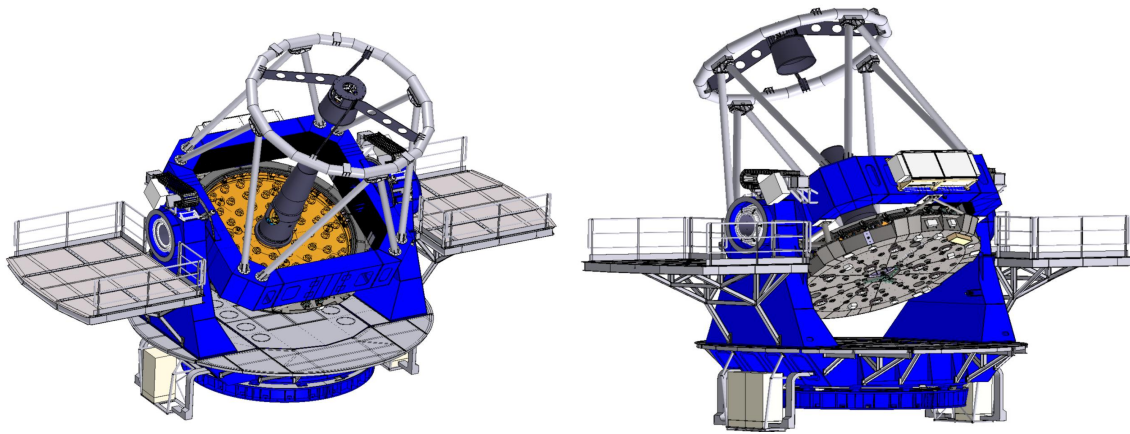


Figure 2. DAG telescope design front (left) and back (right).

3. SOCIO-ECONOMICAL AND SCIENTIFIC BENEFITS

Main benefits for the DAG telescope and its focal-plane instruments can be summarized as following:

- Turkish astronomers will be able to use modern instruments which required for novel research.
- DAG is designed to offer tracking observations with satellites in order to explore new celestial objects.
- With its AO system DAG will be able to provide higher resolution images than many of the larger ground-based telescopes.
- The technological development will widen the Turkish astronomical community's research topics into fields which they were not cover due to technical limitations before.

It must be noted that DAG will be the largest telescope in its longitudinal coordinates, the highest NIR telescope, and is designed to hold an AO system. Thus, with its cutting edge technologies, the outcome of the telescope will not only serve the national needs but also to the international communities with established collaborations.

The FPI project will be directed by Ataturk University Astrophysics Research and Application Centre (ATASAM) as it is the case for DAG telescope project. ATASAM is founded in 2012 and is responsible most of the astrophysical, and electro-optical research funded by the Ministry of Development related to DAG Project. ATASAM is located at Erzurum city center, where DAG is located at Karakaya Summit at 3170 m height at a site location (2500 decares) of Ataturk University. With its own institute DAG telescope will work efficiently and will not struggle with bureaucracy that much.

DAG Team is expecting to establish international collaborations for the instrumentation. This collaboration can be in the form of commissioning instruments to DAG telescope as well as sharing observing time with northern or southern telescopes/observatories. Although the recently approved FPI project allow DAG Team to obtain some brand new instruments, it is also possible to commission some old but very efficient and self-improved instruments at the DAG telescope. Current infrastructure at the site, opportunities of the ATASAM and future plans such as coating unit will ensure that DAG telescope will highly be demanded.



Figure 3. The site: Karakaya Summit (3170 m)

In the era of extremely large telescopes (ELTs), there will obviously be a necessity for medium-sized and large telescopes. As the telescope time will be highly costly for ELTs, many people would need to do follow-up studies or close monitoring of objects with relatively small telescopes. Especially, future telescopes/surveys such as LSST, GAIA, Euclid, Athena, eRosita will provide many interesting astronomical sources for further investigation. These future ground-based and space facilities will mainly focus on two research topics: galactic archaeology and extragalactic astronomy (including cosmology). Turkish astronomical community is familiar with both fields but relatively less with extragalactic studies due to having access small size telescopes. DAG telescope will enable Turkish astronomers work directly on these topics.

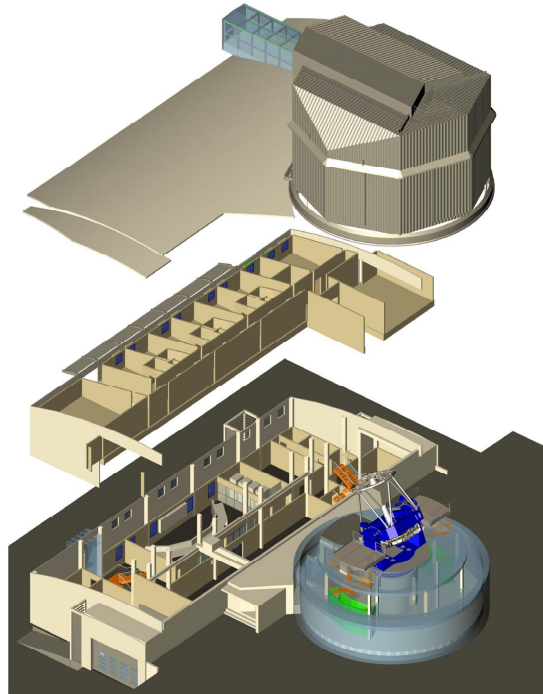


Figure 4. Expanded drawings of DAG

CONCLUSIONS

As the largest telescope project moves forward, the additional FPI project has just been funded by the Ministry of Development of Turkey. DAG team, within this short time scale and in collaboration of four national universities, has started the FPI project. This ambitious project will not only serve to national but also to the international astronomical communities. At this stage, collaboration for science and instrumentation is possible and expected.

ACKNOWLEDGMENTS

Authors would like to thank Republic of Turkey, Ministry of Development; FMV Işık University, Istanbul/Turkey; Orta Doğu Teknik Üniversitesi, Ankara/Turkey (Project No: 2016K121380); Atatürk University, Erzurum/Turkey (Project No: 2011K120230, 2016K121140); Istanbul University, Istanbul/Turkey (Project No: 2016K121370); Atatürk University, Erzurum/Turkey, Astrophysics Research and Application Center (ATASAM), Erzurum/Turkey; FMV Işık University, Center of Optomechatronics Application and Research (OPAM), Istanbul/Turkey; Istanbul University Observatory Research and Application Center (IUGUAM), Istanbul/Turkey; for their support throughout the DAG project.