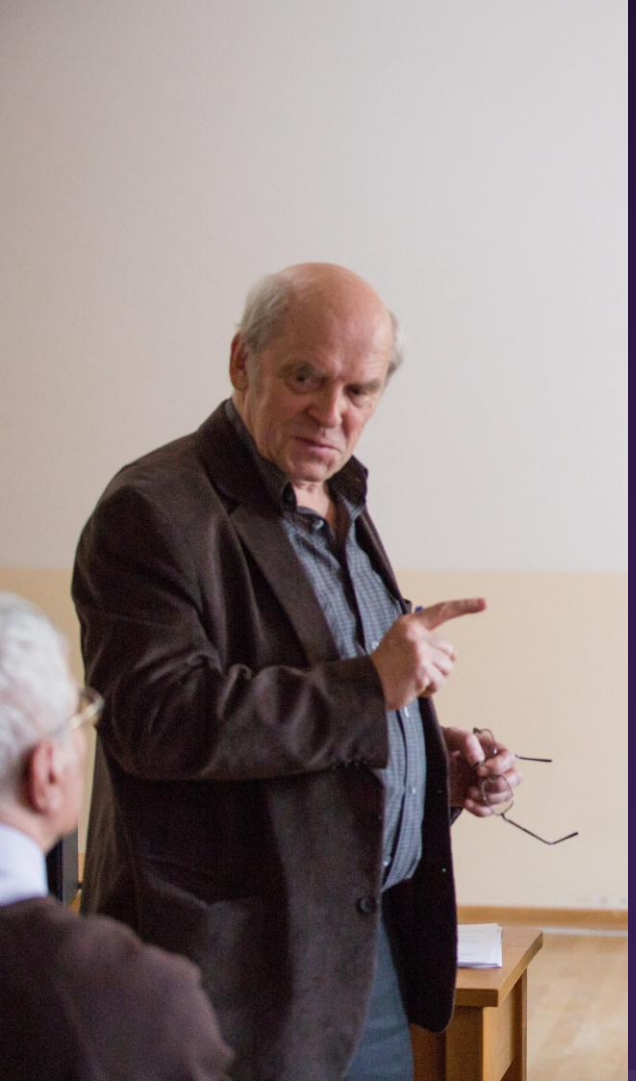
This talk is devoted to the memory of Dr. Victor Afanasiev

Universal Reducer for small telescopes

Roman Uklein,
Vladimir Amirkhanyan,
Alexandr Perepelitsyn,
Eugene Malygin,
Elena Shablovinskaya,
Irina Afanasieva
and
Victor Afanasiev

13th SCSLSA XIII SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS

23 - 27 August 2021
Belgrade, Serbia



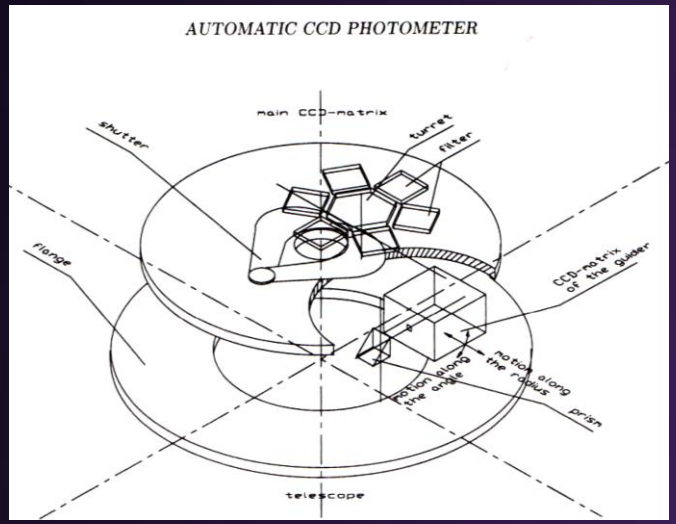
In memory of Dr. Victor Afanasiev

01.05.1947-21.12.2020

In recent years, Dr Afanasiev, in order to expand the capabilities of the 1-meter telescope of the Special Astrophysical Observatory of RAS, has applied the idea of a focal reducer for the 1-meter telescope of the SAO RAS. The Stokes-Polarimeter (StoP) and MAGIC instruments, as part of a project for monitoring active galaxies, designed and created under his leadership at the SAO, are the main topic of this talk.

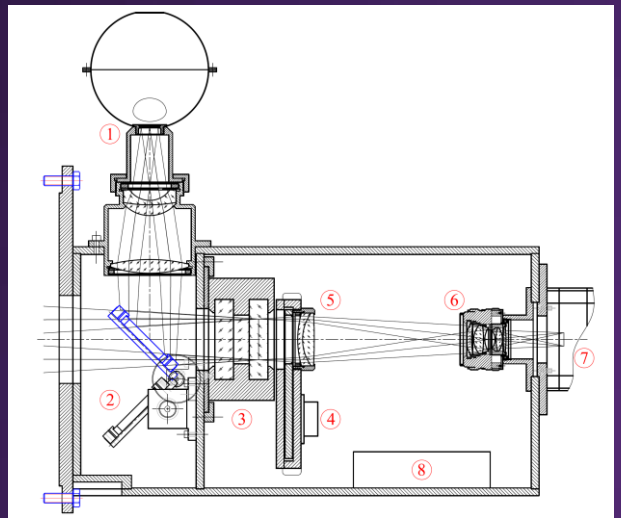
Timeline of design

- TAZIK-1 (1997)



Amirkhanian+ 2000
2000BSAO...50..142A

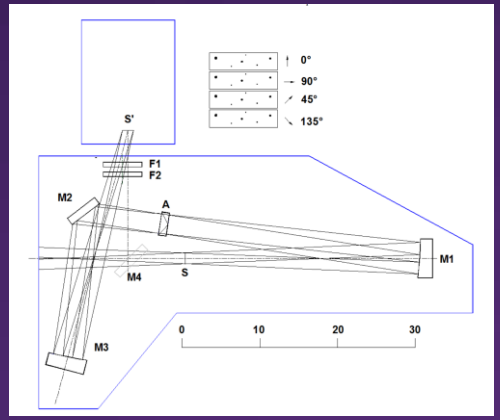
- MaNGaL (2017)



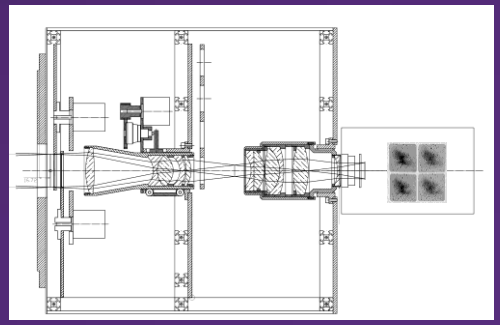
Moiseev+ 2020
2020ExA....50..199M

Afanasiev+ 2021
2021AstBu..76..102A

- StoP (2019)



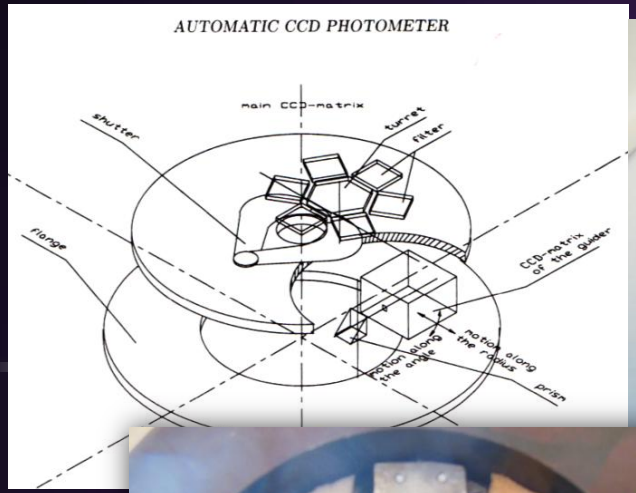
- MAGIC (2020)



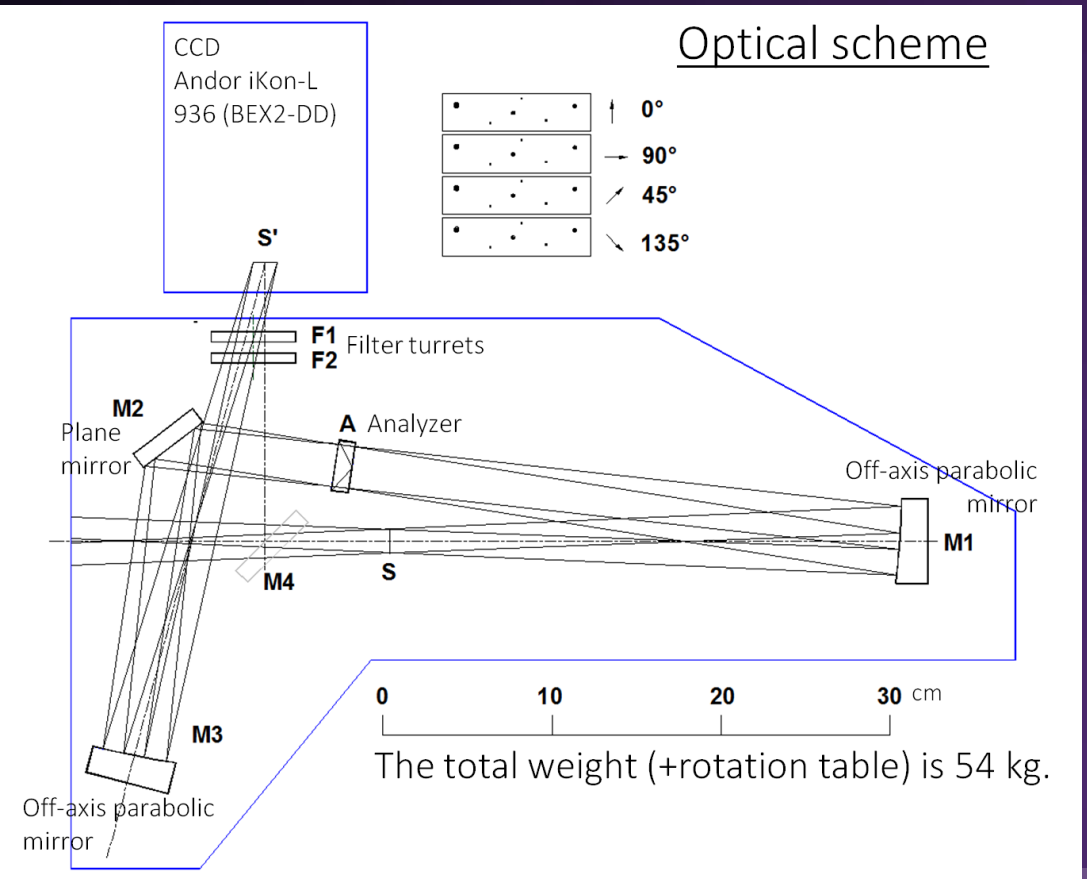
Afanasiev+ 2022
(in progress)

TAZIK-1: Automated CCD Photometer

- 1 observational mode:
- automated! photometry

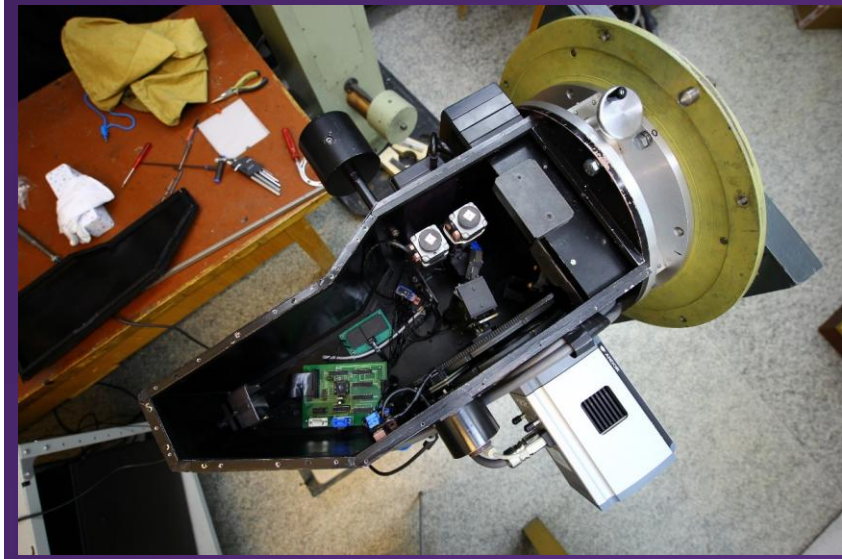


StoP : Stokes Polarimeter



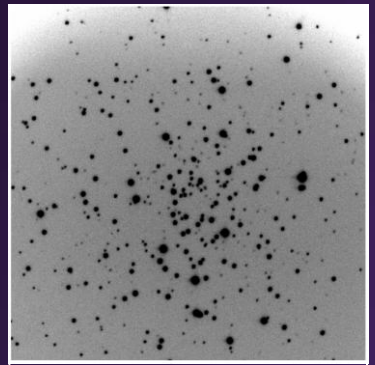
2 observational modes:

- photometry (plane mirror M4 in the beam, FoV=5'x7')
- polarimetry (rectangular mask in the S plane + polarization analyzer, FoV=1'x5')



StoP : Stokes Polarimeter

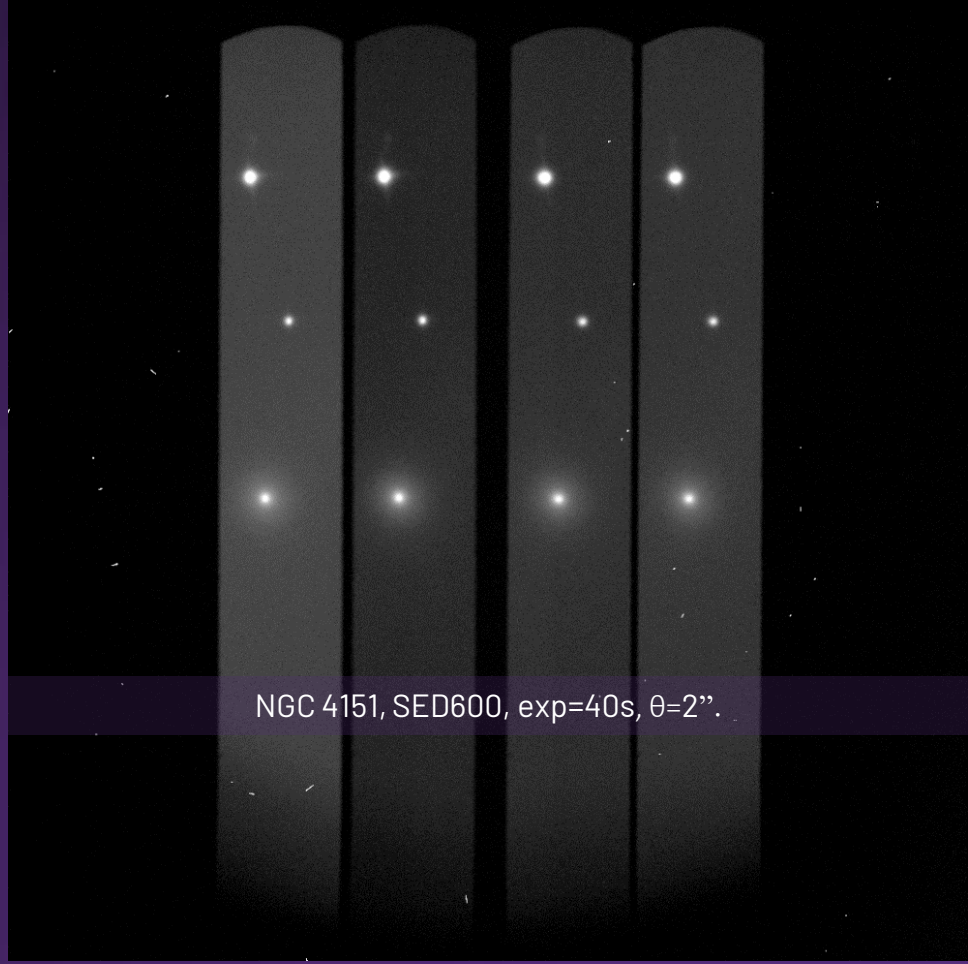
Quasar J0137+85 (z=0.5), SED725, exp=600s, θ=1.3”.



NGC 2420, R band.

NGC 4151, V, exp=15s, θ=2”.

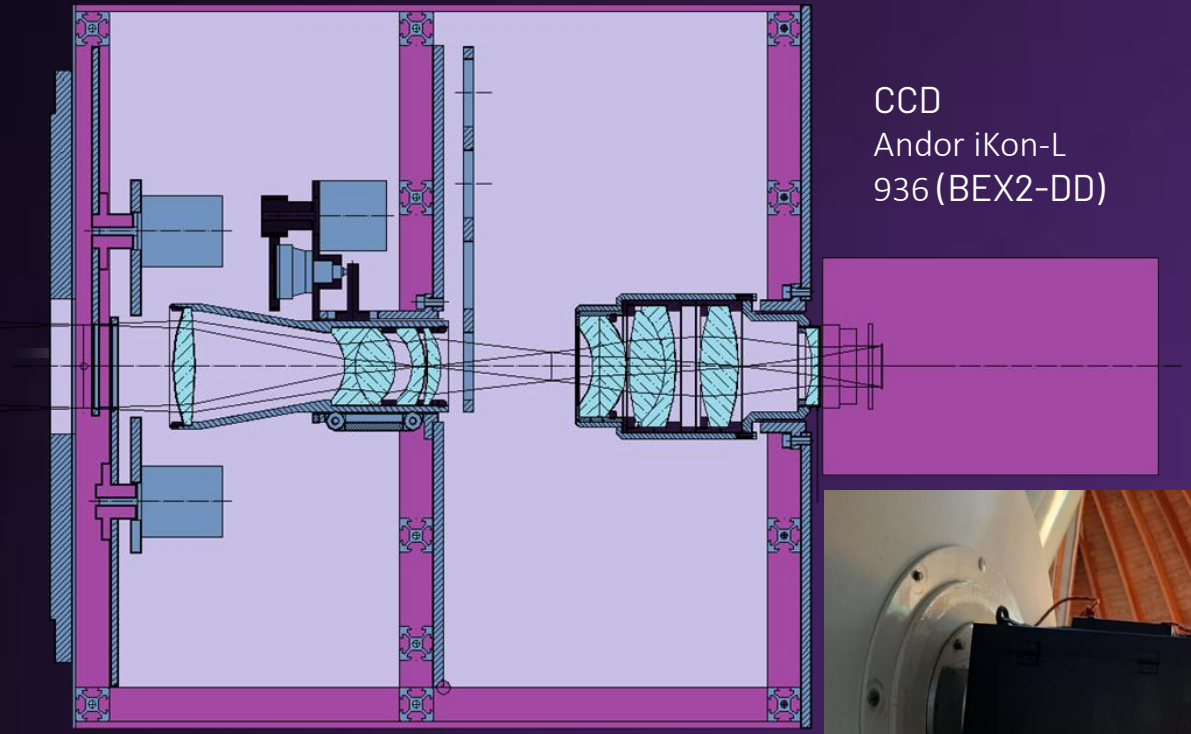
M42, composite image B+V+Ha, through solid clouds.



NGC 4151, SED600, exp=40s, θ=2”.

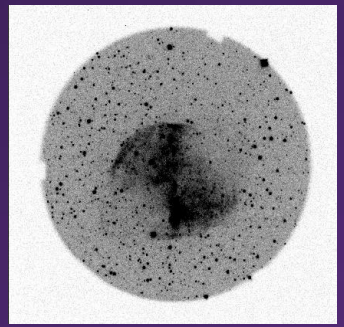
FoV = 1’x5’

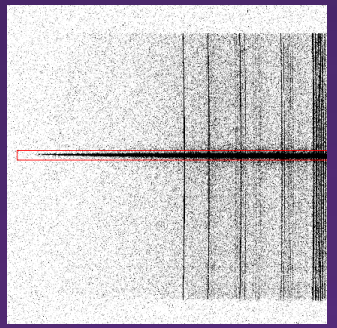
MAGIC : Monitoring of Active Galaxies by Investigation of their Cores

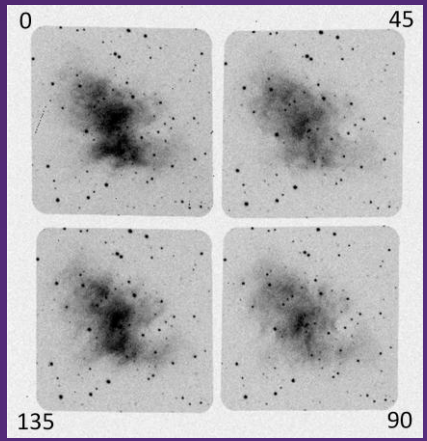


CCD
Andor iKon-L
936 (BEX2-DD)

3 observational modes:

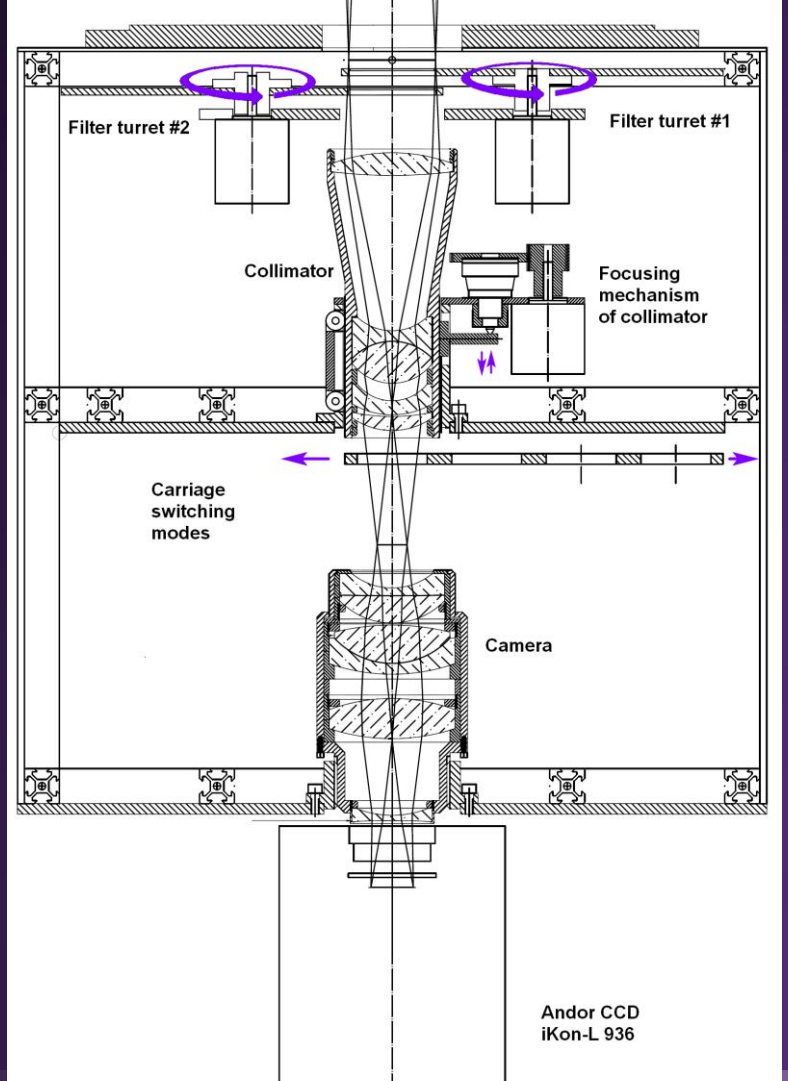


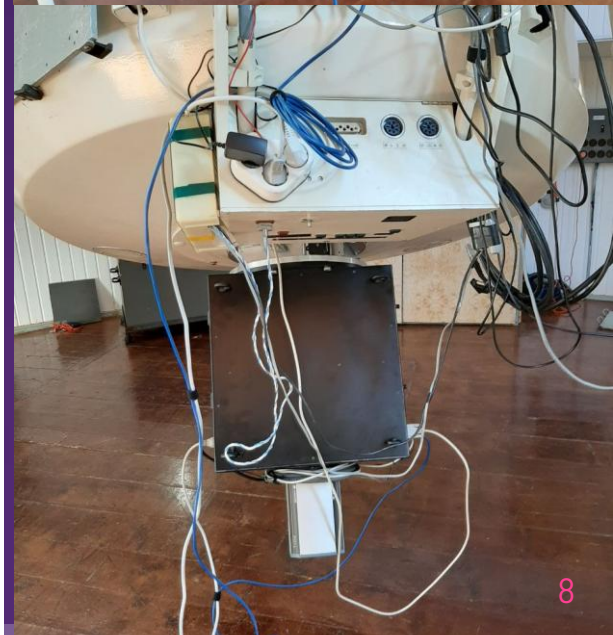




MAGIC :

Weight of the device (without CCD and turntable) - 23 kg, dimensions 410x420x270mm. The turntable is 14 kg, CCD is 7 kg.





Focal Reducer Principle

The primary focus of a telescope does not always provide the best observational parameters, especially in the case of large telescopes with a long focal length and oversampling of the image in it, despite the fact that modern detectors are of limited size… (Courtes, 1994)

From SAO Photo Archive

Spectral **C**amera with **O**ptical **R**educer for **P**hotometric and **I**nterferometric **O**bservations

SCORPIO

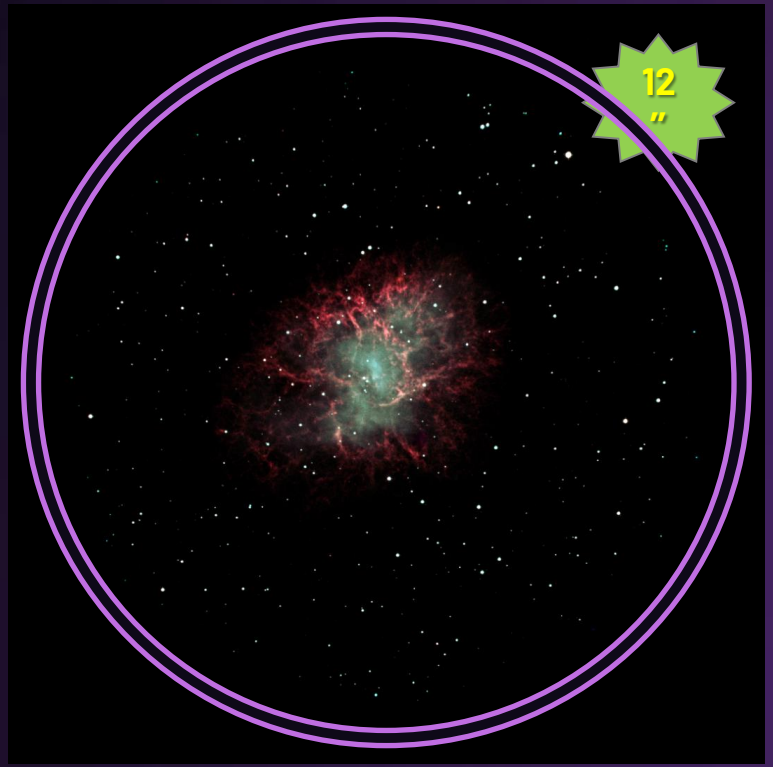
F/4 → F/2.6

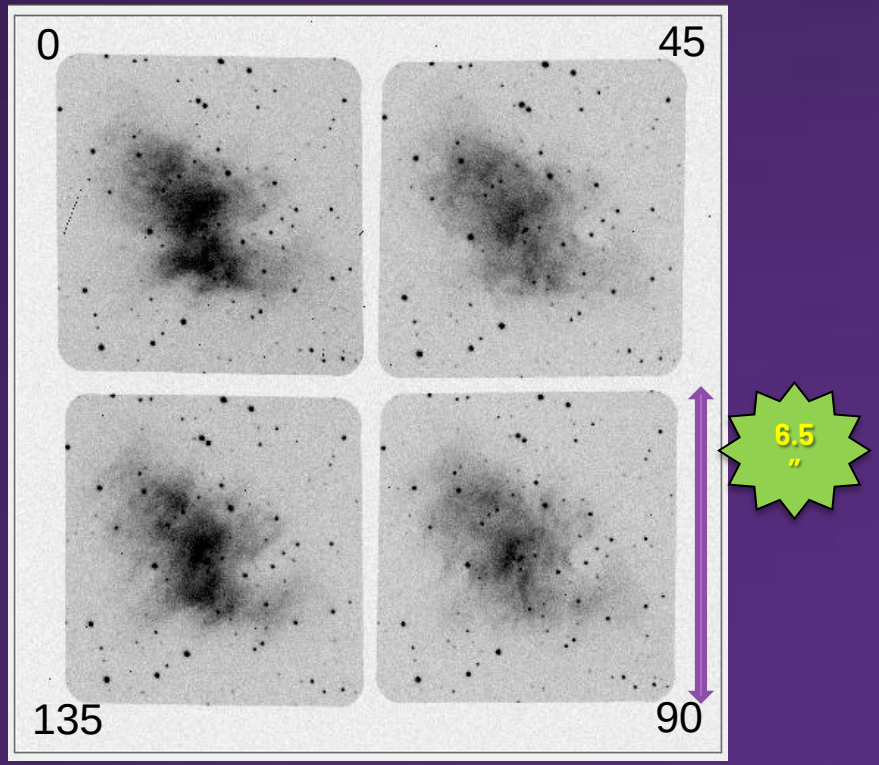
Bolshoi Telescope Alt-Azimutalny.
Photo by Roman Ya. Zhuchkov.

SCORPIO-2

MAGIC as Focal Reducer

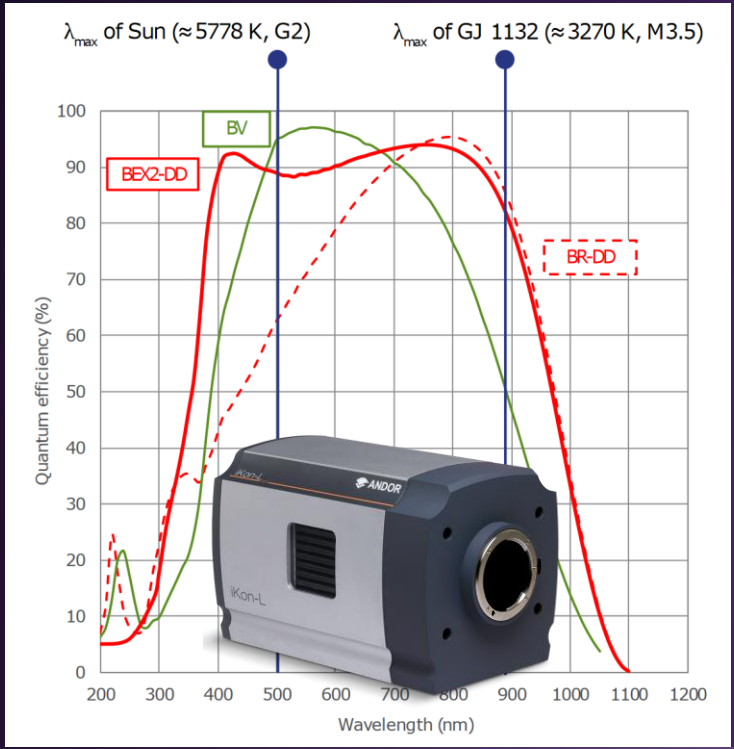
Zeiss-1000:
F/13.3 → F/6.1 (0.45”/px)

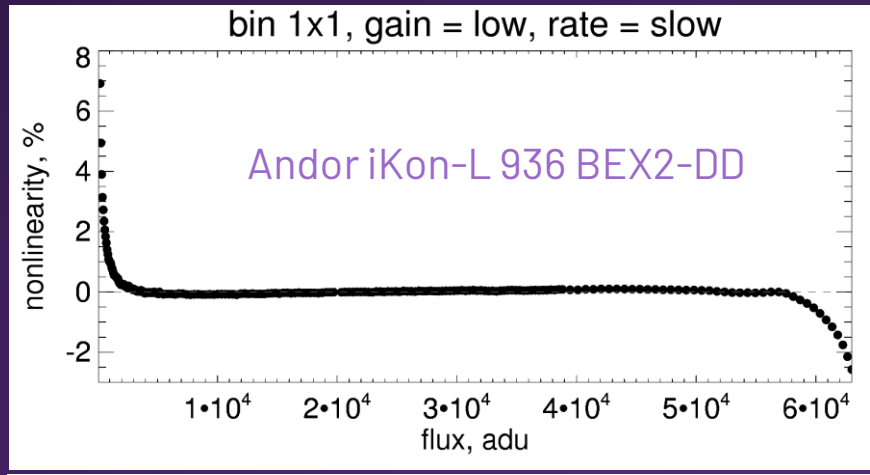


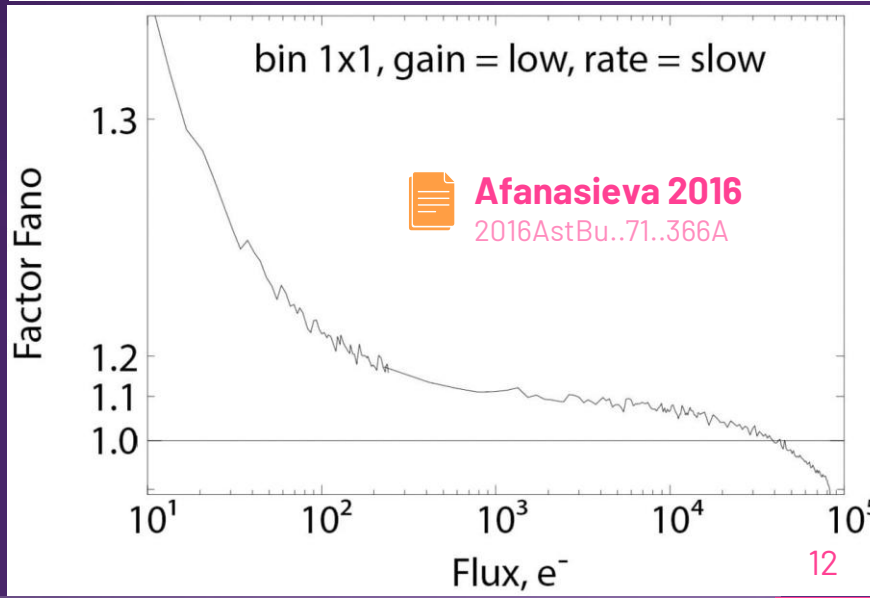


The CCD basic characteristics

- Deep Depletion 2048 x 2048 CCD
- 5-stage TE cooling up to -100°C using water







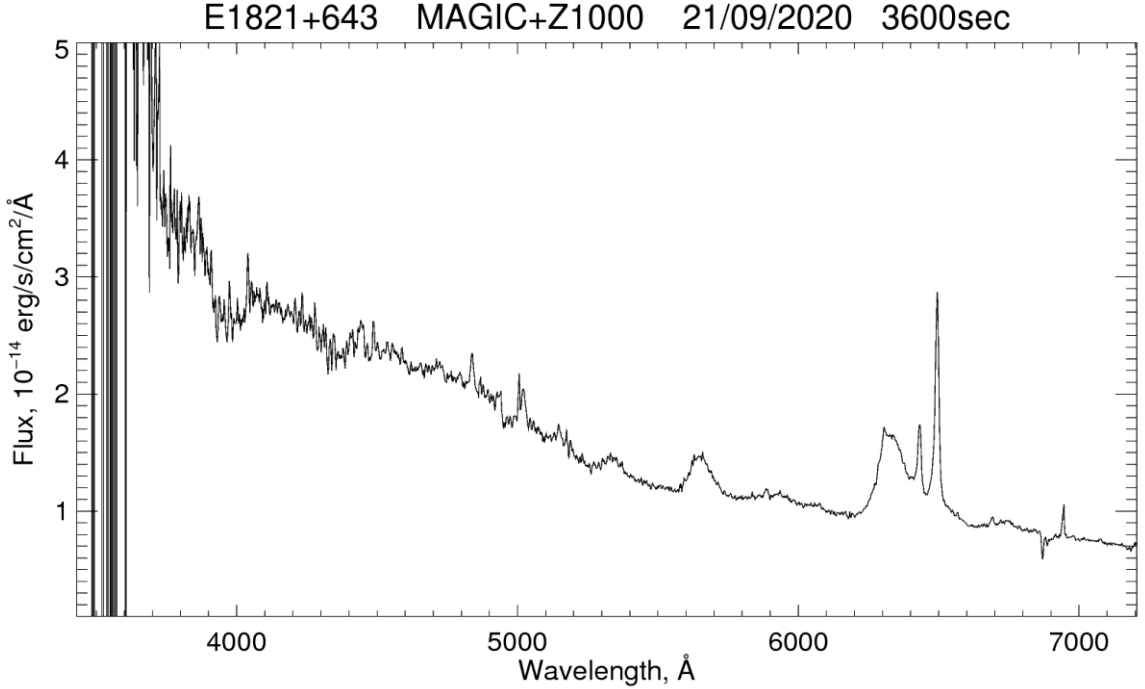
MAGIC programs at the 1-m telescope now

- PHOTOMETRY: (see next talk of Eugene Malygin)
- Photometric reverberation mapping of distant AGNs - Uklein R.
- SyG monitoring - Burenkov A.

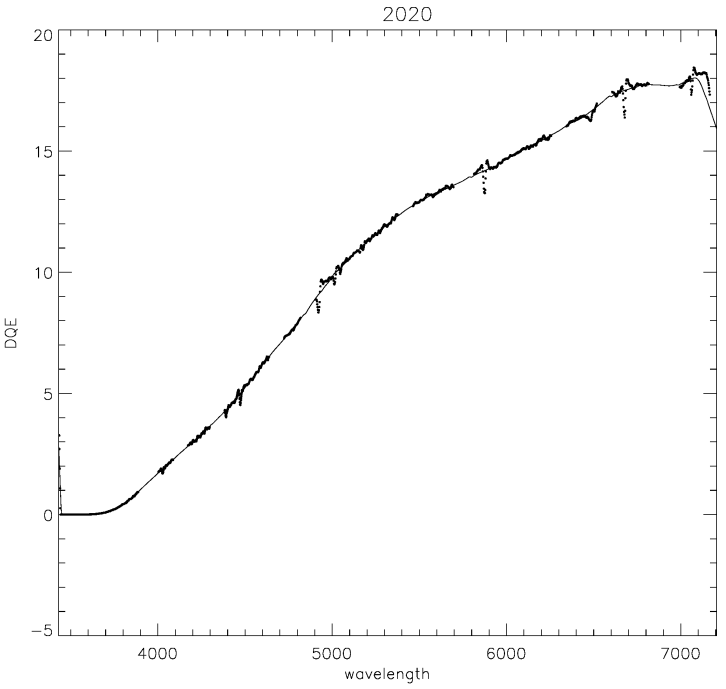
- POLARIMETRY: (see talk of Elena Shablovinskaya)
- Reverberation mapping of AGN Mrk 817 in polarized light - Ilic D.
- Reverberation mapping of AGNs in polarized light - Shablovinskaya E.
- NOPE-NOn-stop Polarization Experiment - Liodakis Y.
- Polarization of UU Cas - Vince I.

- LONG SLIT SPECTROSCOPY (limited):
- Spectroscopy of extended sources - Shablovinskaya E.
- Spectral monitoring of peculiar AGNs - Ilic D.

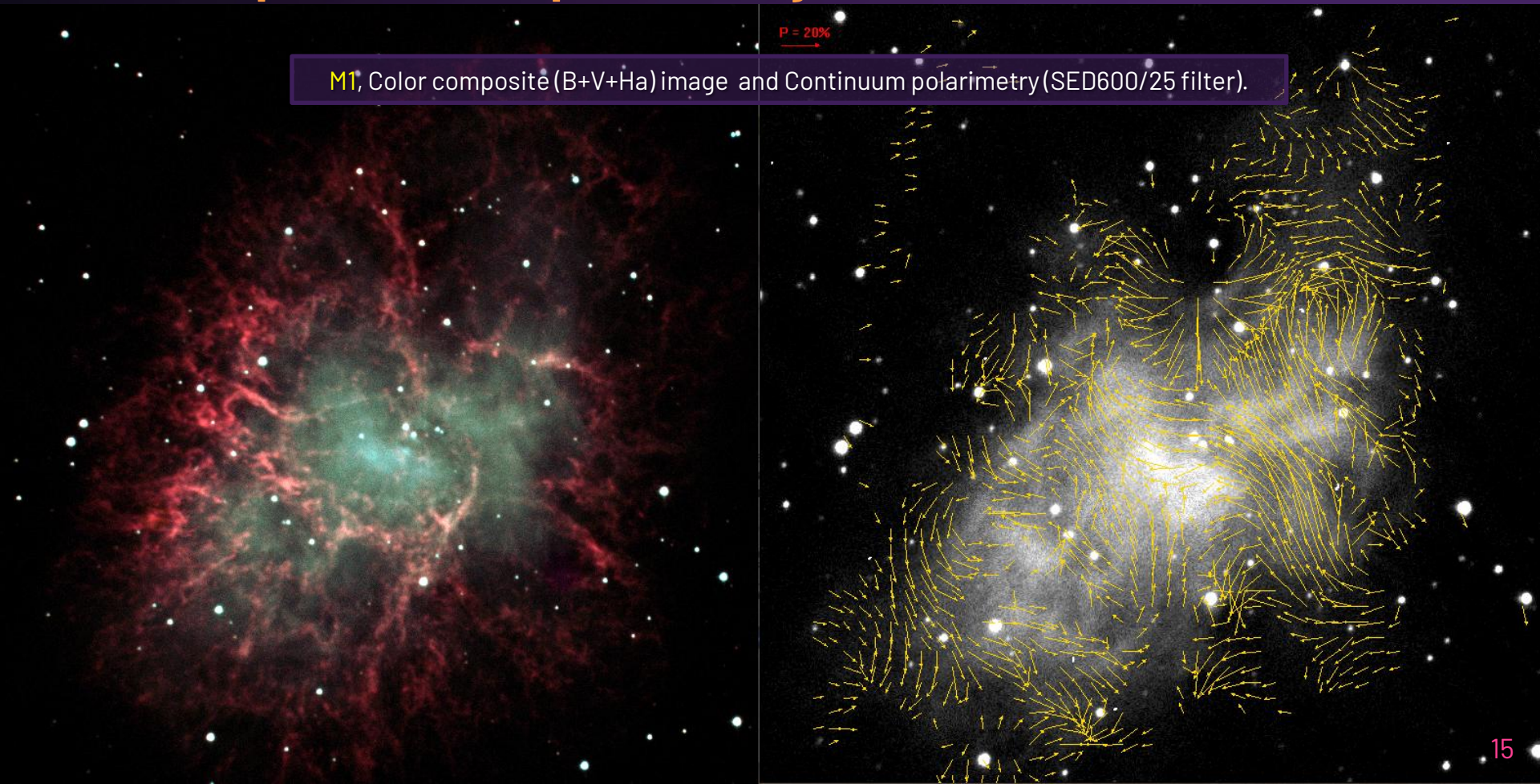
Example of MAGIC spectrum



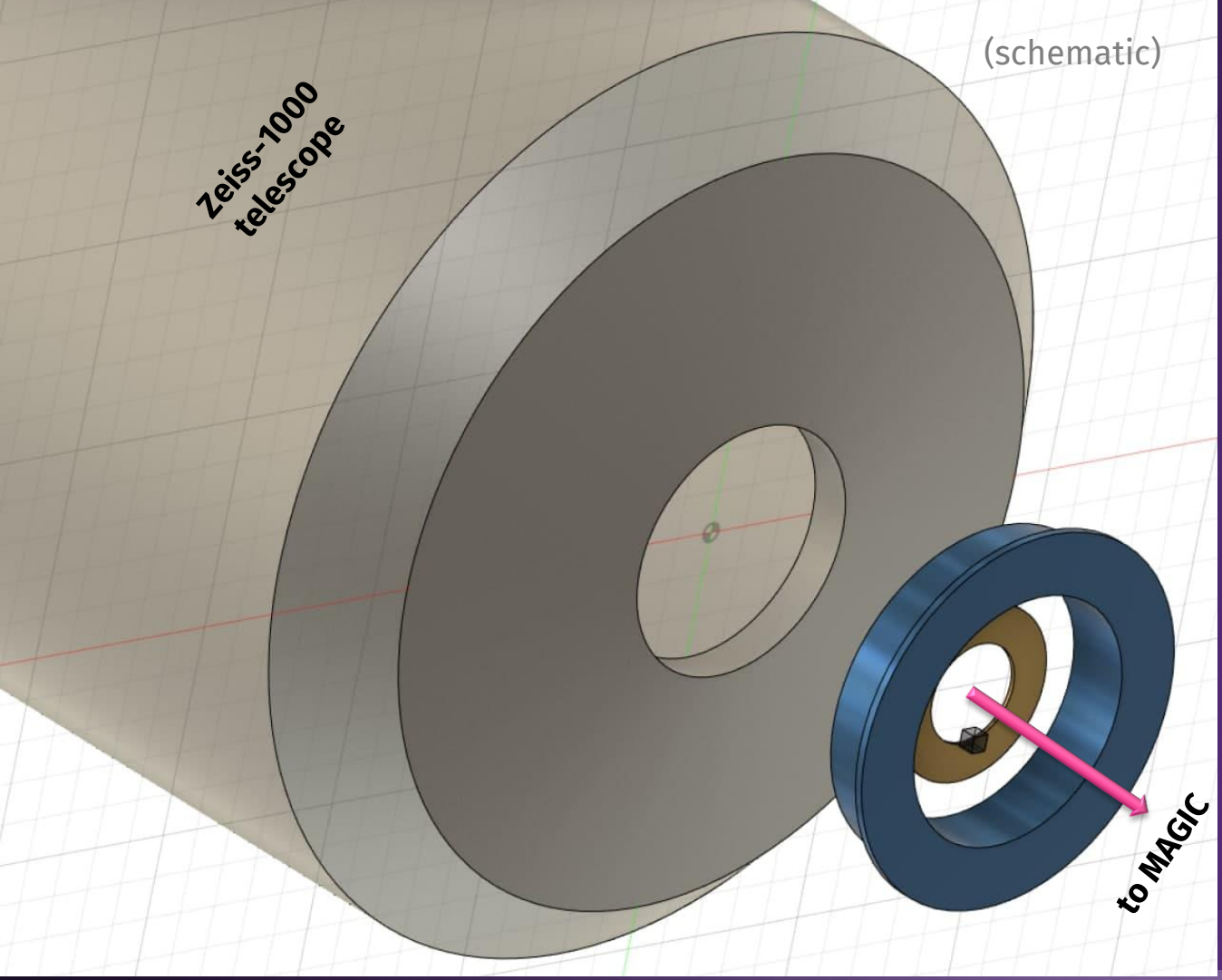
Measured DQE



Example of MAGIC polarimetry of extended source



M1, Color composite (B+V+Ha) image and Continuum polarimetry (SED600/25 filter).



Rotator + Guide

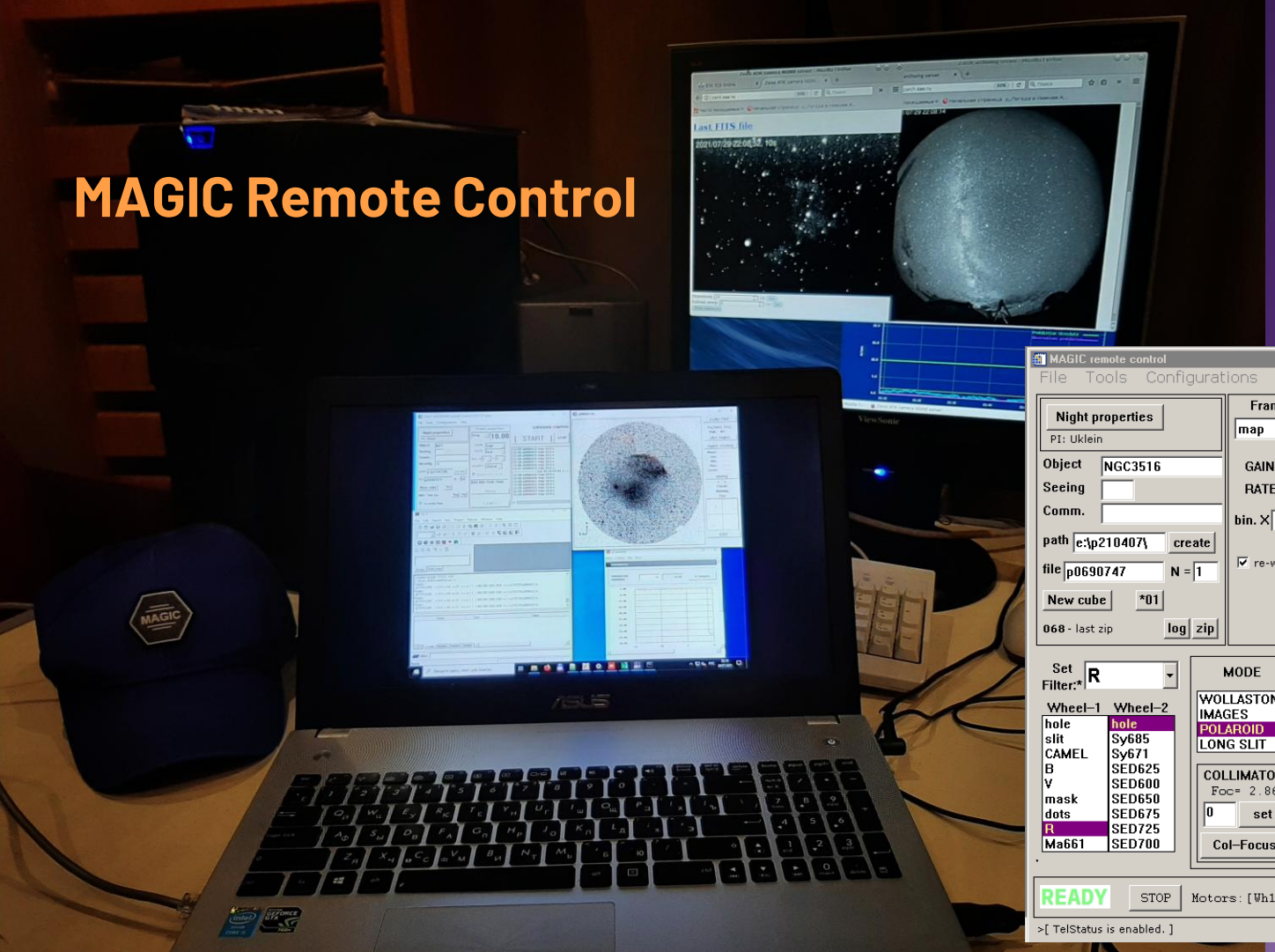
Amirkhanyan V.R.,
Perepelitsyn A.E.,
Uklein R.I.,
Pritychenko A.M.,
Komarov V.V.

The project is
in progress.

1. Automation of the rotator is required.
2. To ensure the normal quality of spectral and polarization observations on the Zeiss-1000 telescope, it is necessary to use an offset guiding.

MAGIC Remote Control

<u>Programming</u>:
IDL ~90%
Python ~10%



Summary

MAGIC is lightweight universal (multi-mode) focal 1:2.2 reducer that can be used on small telescopes to solve various observational tasks:

- Direct imaging in the Johnson-Cousins (UBVRI) photometric system and in the midband (SED) interference filters; the photometry in FoV ~12‘ with a scale of 0":45/pix (2 turrets, 9 positions each);

- Image polarimetry by quadrupole Wollaston prism with 6'.5 for each of the four directions of polarization;

- Long-slit 12’x2” spectroscopy with a resolution of *R*~1000 in the 400-740 nm range.

For a starlike target up to 14 mag in medium-band filters with a seeing of 1" for 20 minutes of total exposure, the photometry accuracy is better than 0.01 mag and the polarization accuracy is better than 0.6%.

In 2022 we plan to commission a rotator, a guide and a calibration illumination module on the 1-meter telescope for full-fledged operation MAGIC.

uklein@sao.ru
R.Uklein

amir@sao.ru
V.Amirkhanian

male@sao.ru
E.Malygin

Universals:
Grandson MAGIC and Grandfather SCORPIO

This work was supported by the Russian Science Foundation (grant no. 20-12-00030 "Investigation of geometry and kinematics of ionized gas in active galactic nuclei by polarimetry methods").

Thanks for your attention!