

SER-SAG-S2 in-kind: Follow-up with 1.4m Milankovic telescope

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SER-SAG-S2: Telescope in-kind contribution

- to characterize and supplement the LSST discoveries **massive follow-up observations are required**
- LSST follow-up observations would be coordinated through the Astronomical Event Observatory Network (AEON)
 - the network of telescopes ranging from 0.4m to 8m in aperture, distributed across the world



Astronomical Observatory Belgrade, founded 1887

AIM: integrate Milankovic 1.4m telescope at **Astronomical Station Vidojevica (ASV)** in AEON and to do follow-up photometric observations of LSST bright transients.

Optical follow-up with Milankovic 1.4 Telescope

SER-SAG-S2 in-kind LSST contribution = 1 PI

Contribution Lead: Maša Lakićević (Astronomical Observatory Belgrade)

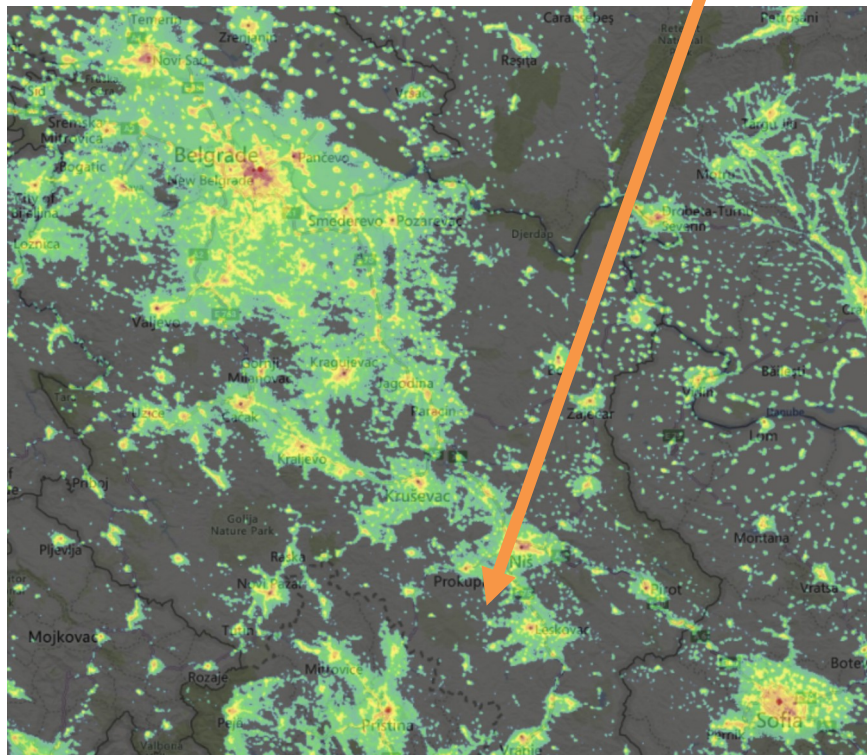
Members of team: Ana Lalović, Milan Stojanović, Oliver Vince, Jelena Kovačević-Dojčinović, Sladjana Marčeta- Mandić, Luka Č. Popović, Dragana Ilić, Anđelka Kovačević, Saša Simić, Branislav Vukotić, Đorđe Savić

TASKS OF SER-SAG-S2 IN-KIND CONTRIBUTION:

- Securing observing nights at Milankovic 1.4 telescope (Astronomical Station Vidojevica) with the Time Allocation Committee.
- Observations fully supported by SER-SEG-S2 team (currently in person operations).
- Data are processed by the data reduction pipeline and results (or raw data) available for download in 72h and kept on the SER-SAG cloud.

Astronomical Station Vidojevica (ASV)

- Observation site established by Astronomical Observatory of Belgrade.
- ASV located on Mt. Vidojevica - small light pollution, and good seeing conditions.

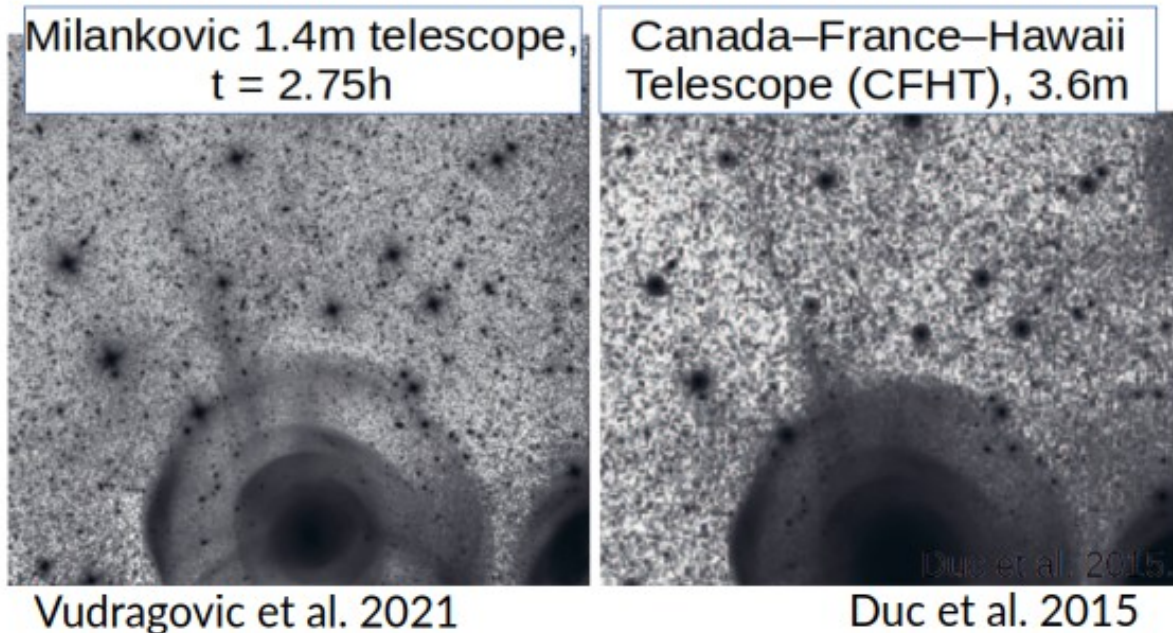


- About 40% of observational nights at ASV are with very good weather for observations.
- Average seeing is 1'' - 2'' (best seeing ~ 0.7'').
- Largest facility is 1.4m Milankovic telescope
- Possibility of fast response (telescope moving speed is 4-6 degree/sec)
- 6-year long experience in the Gaia-FUN-TO
- Instruments: photometry, low-res spectroscopy

Milankovic 1.4m telescope

- With Milankovic 1.4 m telescope we can well observe objects with magnitude smaller than 19.
- But, with special technique of observation (large dithering and large integral exposure time of a few hours), some structures in nearby galaxies can be seen with surface brightness limit of 28.5 mag/arcsec² in L-band (**Vudragovic et al. 2021; Muller, Vudragovic, Bilek, 2019, A&A, 632, L13**).

NGC 474



- In **NGC 474** the prominent shell structure and the stellar stream stretching to the north-east are clearly visible in both images (done with Milankovic and CFHT).
- The faintest stars detected in images with Milankovic telescope are of about **26 mag** in the g band, which is several magnitudes deeper than the detection limit of the SDSS (**Muller et al. 2019**).

1.4m Telescope Milanković

Port 1 @ telescope Milanković – AEON mode

Equipped with focal reducer 0.65, focal length 7132 mm (11200 mm).

- Andor iKon-L 936:

- Active pixels 2048 x 2048

- Sensor size 27.6 x 27.6 mm

- Pixel size (W x H) 13.5 μm x 13.5 μm

- Maximum readout rate 5 MHz

- Read noise 2.9 e-

- Maximum cooling -100°C

- Scale 0.39 arcsec/pixel, FoV 13.3 x 13.3 arcmin

- Available filters: B, V, R, I, L, Ha, Ha_cont, SII



Calls for proposals twice per year,

<https://vidojevica.aob.rs/>

Pipeline structure

Data reduction

`-f -b`

calibrated/

- Bias, flat and dark correction
- Cosmic rays and bad pixels removal
- Super-sky flat if sufficient dithering is applied

Astrometric solution

`-a --astool astrometry | twirl--astool`

astrometry/

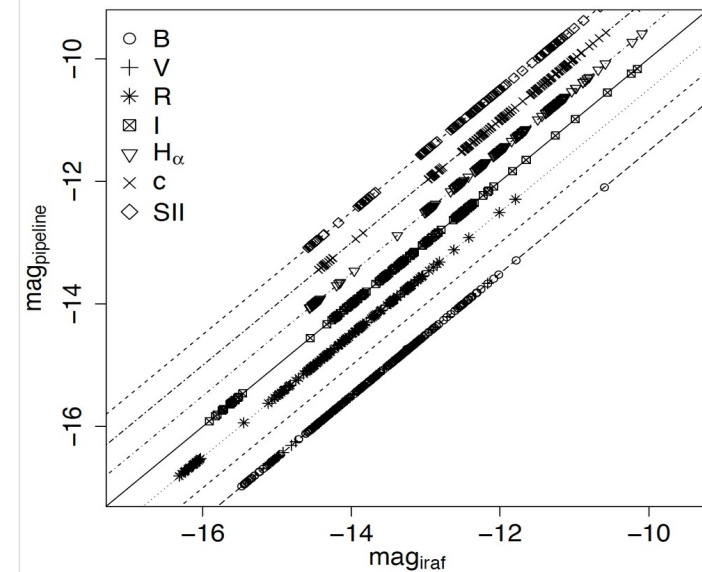
- Astrometry.net software
- Twirl python package

Aperture photometry of point sources

`-p -a`

photometry/

- Instrumental magnitudes
- Differential photometry (requires a catalog of comparison stars)



Pipeline vs. IRAF

Integration with the AEON



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observations to the overall science program, and by NOIRLab to review technical and scheduling feasibility. Please consult the appropriate space telescope call for proposals for instructions on where to enter this information.

Note for Gemini Time: Proposals that request observations with the Gemini telescopes **must submit a separate Gemini proposal** to NOIRLab using the Gemini PIT, to enable the observations to be entered into the Gemini queue system.

3.13 Rubin in-kind contributions starts in 25A

Starting in 25A NSF's NOIRLab will offer Rubin in-kind contribution telescope access. For 25A the telescopes include:

Nordic Optical Telescope

70 hours of observing time on the [Nordic Optical Telescope](#) (NOT) are available for supernova classification using the ALFOSC instrument. NOT is a 2.56m telescope located on La Palma, Spain. The Alhambra Faint Object Spectrograph and Camera, ALFOSC, offers low/medium spectroscopy. Successful PIs will be able to submit ToO triggers of potential SNe for classification. Fully reduced spectra will be uploaded to [WiSeREP/TNS](#) within 48 hours of observation.

Contact: Jesper Sollerman, jesper@astro.su.se

Milankovic 1.4m Telescope

2 nights per month are available on the [1.4 Milankovic Telescope](#) located at [Astronomical Station Vidojevica](#) near Prokuplje, Serbia. Optical Imaging is available with the [Andor iKon-L 936 CCD](#) and the following filters: Johnson B, V, R, I, L, filters and H α , H α continuum and SII. This facility offers AEON compatibility and is available for target of opportunity observations. Observations are taken in service mode. Raw data will be available within 24 hours and fully reduced and calibrated data within 72 hours. Observations will be performed from January through June 2025.

Contact: Maša Lakićević, mlakicevic@aob.rs

Results so far

- Nights secured
- Monitoring of AGNs and alert-based targets.
- Cloud storage grant awarded & Computing equipment purchased.
- First Noirlab ToO proposals received.
- First observations carried out in the last quarter of 2025.

- ☐ Calls for proposals twice per year, <https://vidojevica.aob.rs>
- ☐ SER-SAG team Website: astro-cloud.pmf.kg.ac.rs/asv.html
- ☐ Available filters: B, V, R, I, L, Ha, Ha_cont, SII
- ☐ Future: spectrograph, OCS
- ☐ Apply for Noirlab telescopes!
- ☐ Contact us: mlakicevic@aob.rs

SER-SAG astronomers get:

- ▶ Access to LSST data; DP2 in the moment
- ▶ Propose their projects using AEON network
- ▶ Possibility to open new collaboration using AEON network



Thank you!

