Possibility to do polarization monitoring with the 1.4m Milankovich telescope at Vidojevica

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Collaborators on this topic/talk:

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Dr. Luka Popovic (AOB, Serbia)

Outline

- Shortly about Vidojevica

  - history, geography, infrastructure, science ...
- 1.4m telescope “Milankovic”
- First experiences in pol. measurements.

History

2019: Gradnja paviljona za 40cm teleskop

2018: Premeštanje 1.4m teleskopa

2017-2018: Izgradnja novog paviljona sa kupolom

2016: Isporuka i instalacija 1.4m teleskopa u priv. pav.

2010-2015: Početak i kraj BELISSIMA EU projekta

2011: Nabavka pomoćnih instrumenata (AllSky ...)

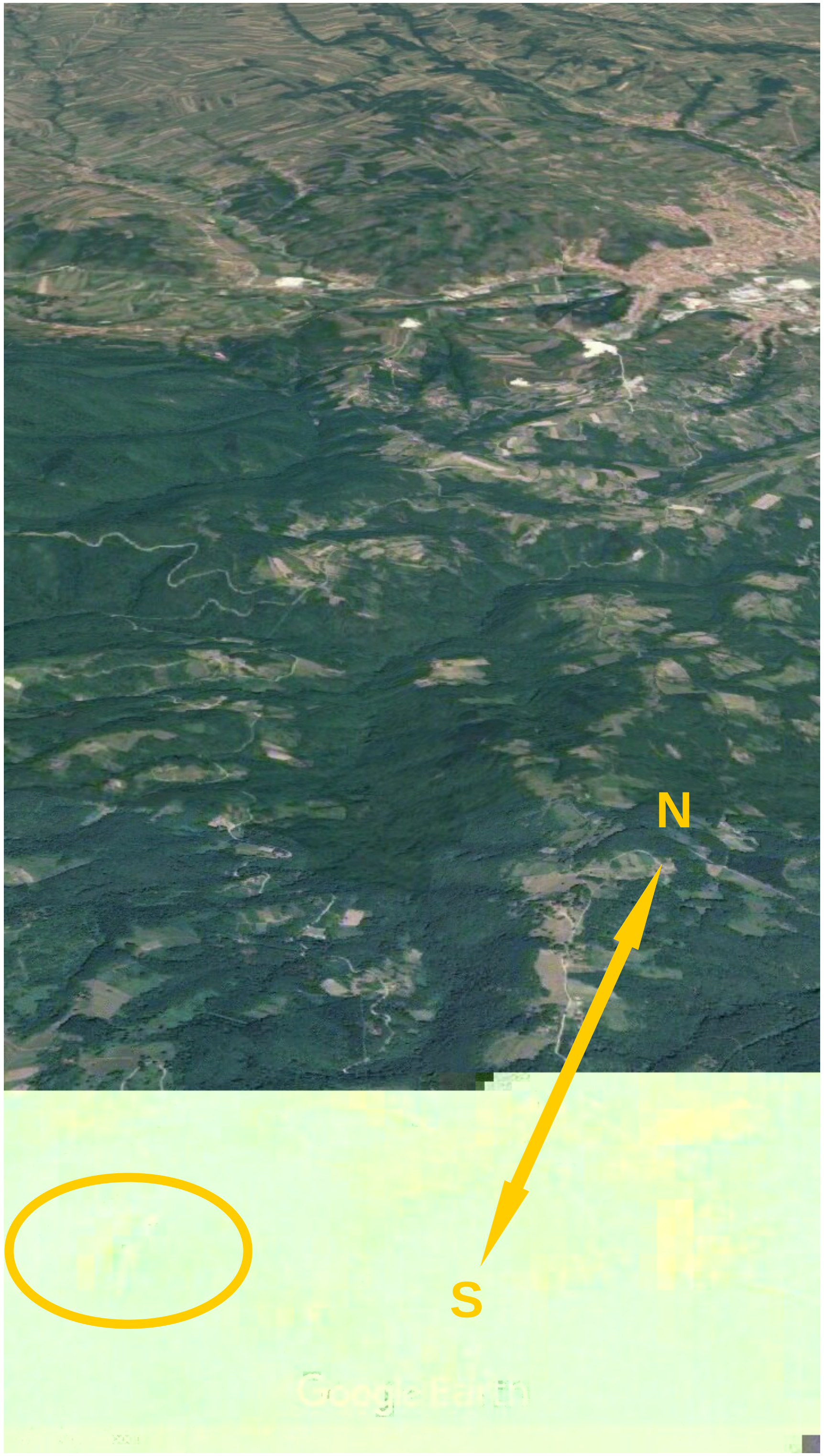
2010: Instalacija / kalibracija 60cm teleskopa

2005-2010: Izgradnja ifrastrukture

2005: Nabavka 60cm teleskopa

2003: Početak postojanja stanice

Geography


N
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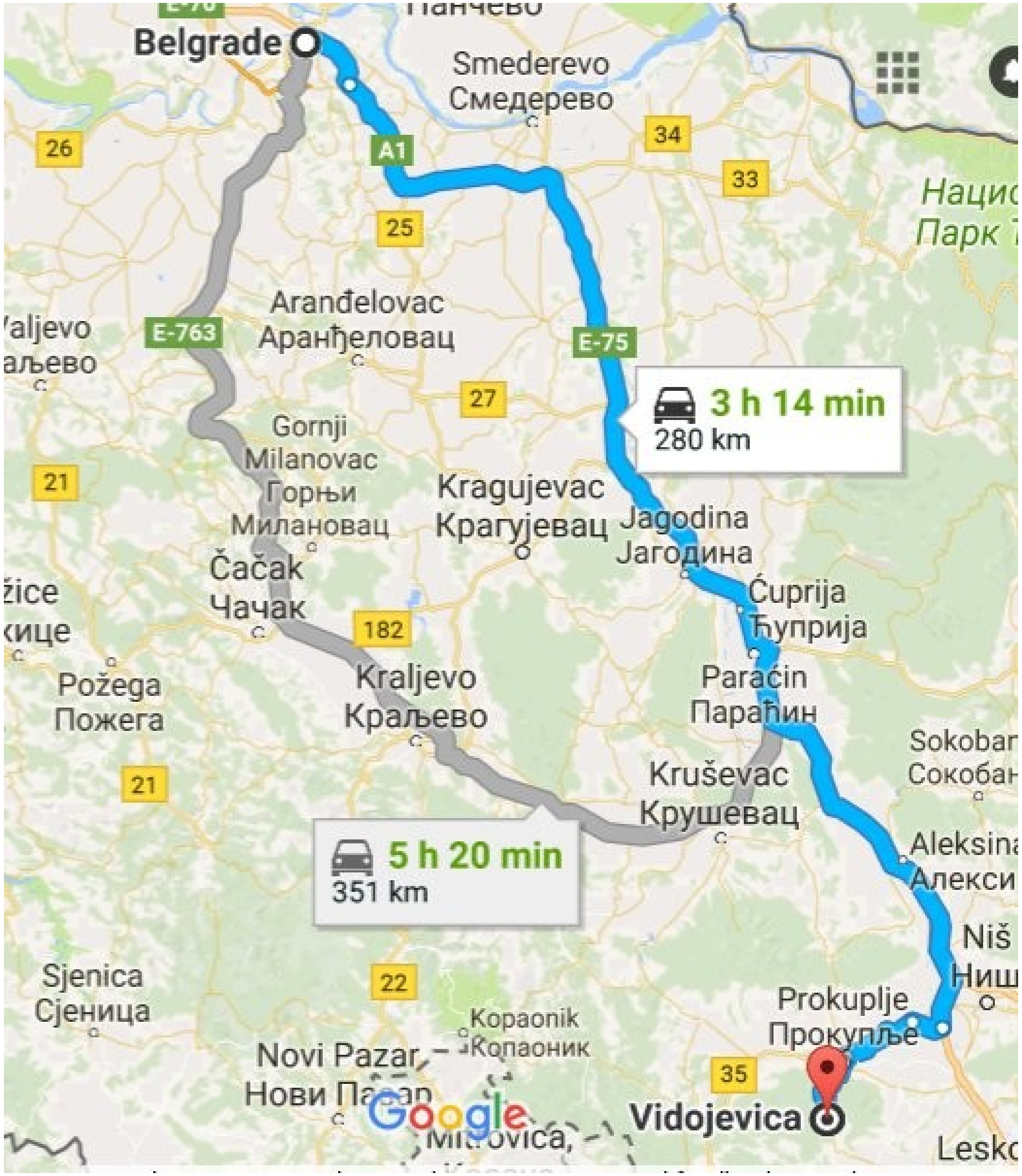
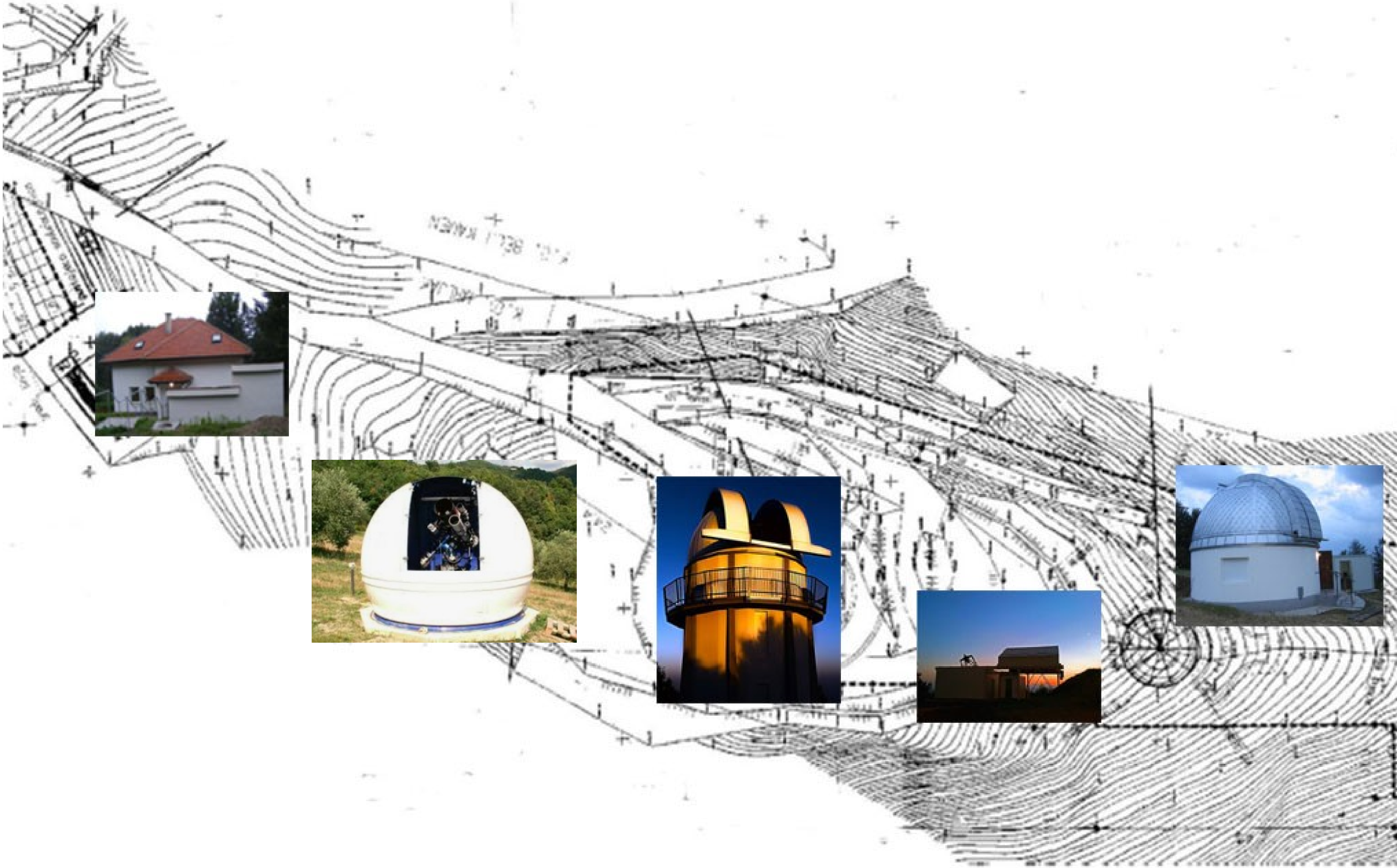
Google Earth

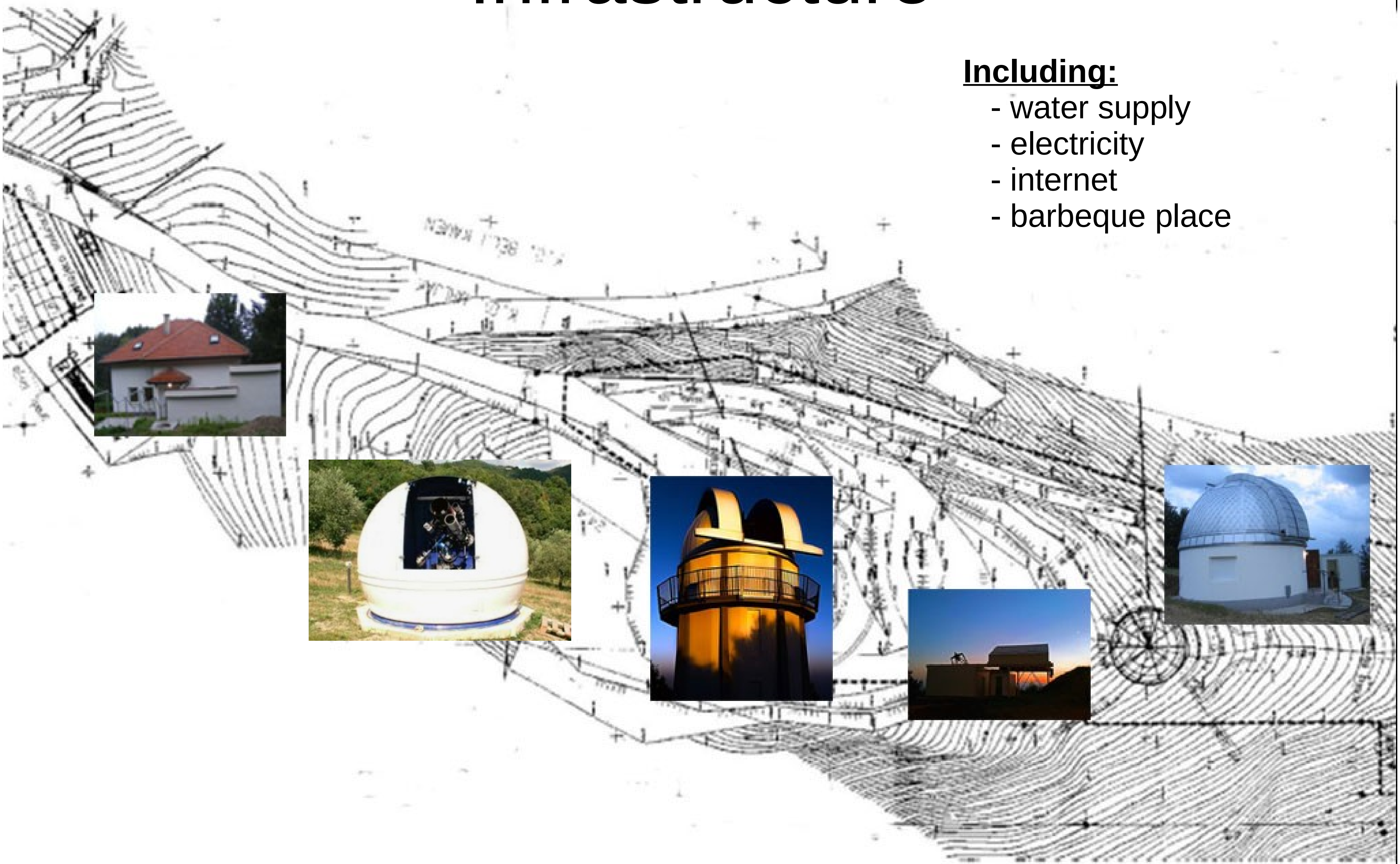

Belgrade
Smederevo
Смедерево
Aranđelovac
Аранђеловац
Gornji
Milanovac
Горњи
Милановац
Kragujevac
Крагујевац
Jagodina
Јагодина
Čačak
Чачак
Ćuprija
Ћуприја
Paraćin
Параћин
Kraljevo
Краљево
Kruševac
Крушевац
Požega
Пожега
Aleksinac
Niš
Ниш
Prokuplje
Прокупље
Sjenica
Сјеница
Novi Pazar
Kopaonik
Копаоник
Vidojevica
3 h 14 min
280 km
5 h 20 min
351 km
A1
E-75
E-763
Google

Infrastructure



Infrastructure

Including:
- water supply
- electricity
- internet
- barbeque place



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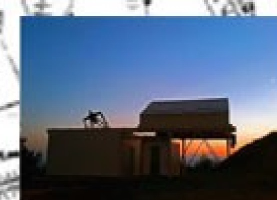


Obs. conditions:
- ~120 clear nights
- ~ 1/4 is photometric
- ~ 1/10 wind gasp
- ~ 80/90 nights used because of work regime
- median seeing ~1”

/home/ovince/Users/oliver_2019/aktivnosti/banjaZdrelo_12-15nov/predavanje/PANORAMA.MOV

Observing programs

(99% photometry/astrometry/imaging and 1% spectroscopy and 0% polarimetry)

<u>Classical obs programs:</u>

- physics of ecllipsing binary stars
- dynamics of visual binary stars
- astrometry
- SN remnants
- so on

<u>Follow-up obs. programs:</u>

- Gaia (photometry of ToO)
- WEBT (blazars)
- DWF (fast radio bursts)
- LSST (Dr. Luka P.)

<u>Alerts:</u>

- occultations
- comets
- asteroids
- so on

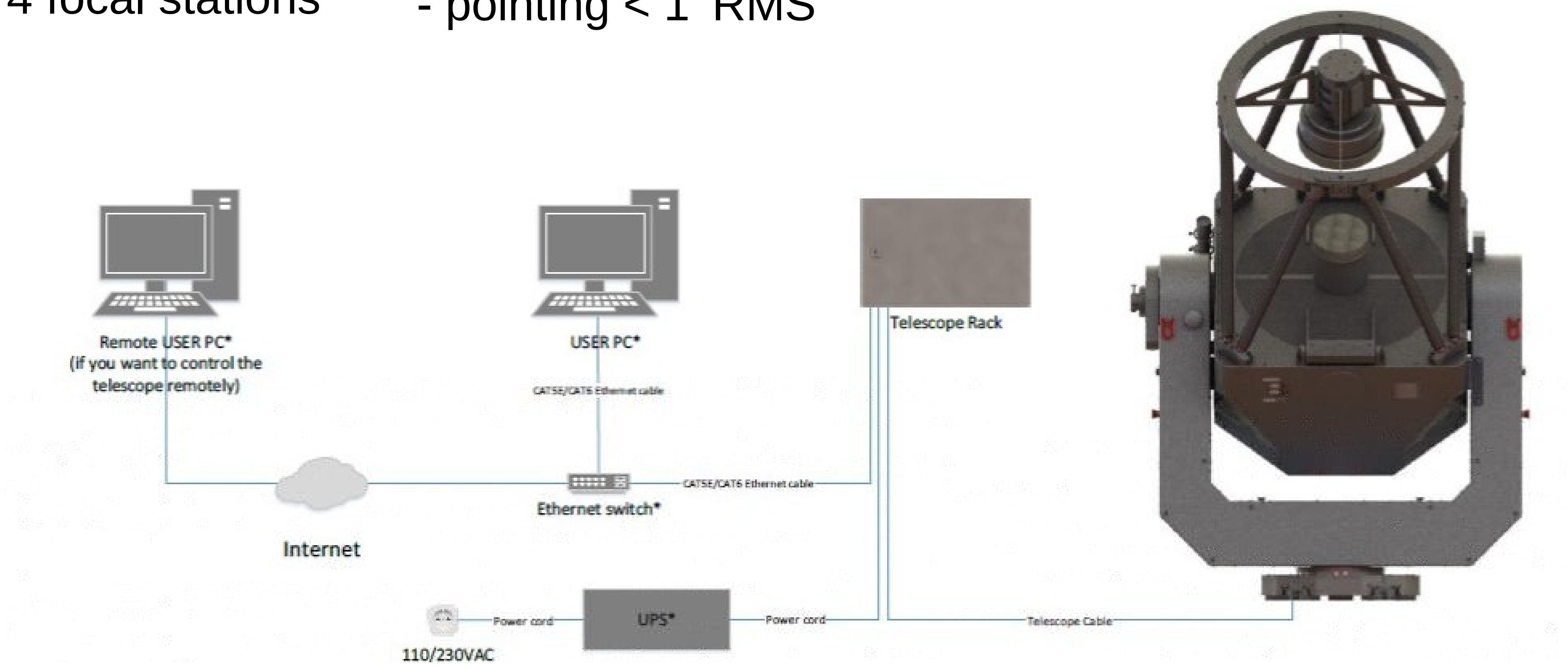
Telescope Milankovic

Specification:

- ASA company
- AltAz mount
- RC optical system
- Mirrors are LOMO
- 4 focal stations

Specification:

- TCS is in the fork > compact
- DDM mount => high spped
- tracking acc. <0.5” in 5min operation (o-loop)
- tracking acc. <0.25” in 30min operation (c-loop)
- pointing < 1' RMS



Polarimetry - basics

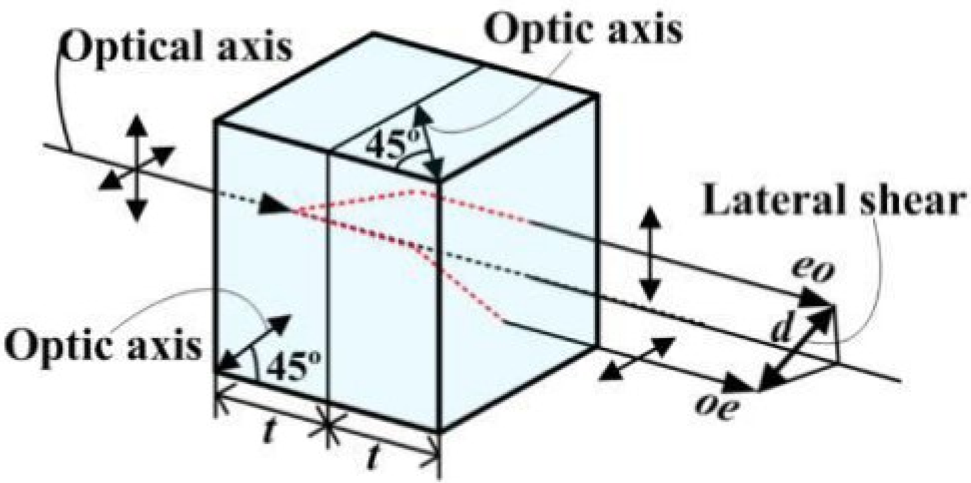
- Stokes showed that pol. light can be described with 4 parameters: I, Q, U, V
- Polarization state can be determined by 3 parameters: Q/I, U/I, V/I
- In the case of linear polarization V=0 => q=Q/I, u=U/I
- Common practice, linear polarization is described with:

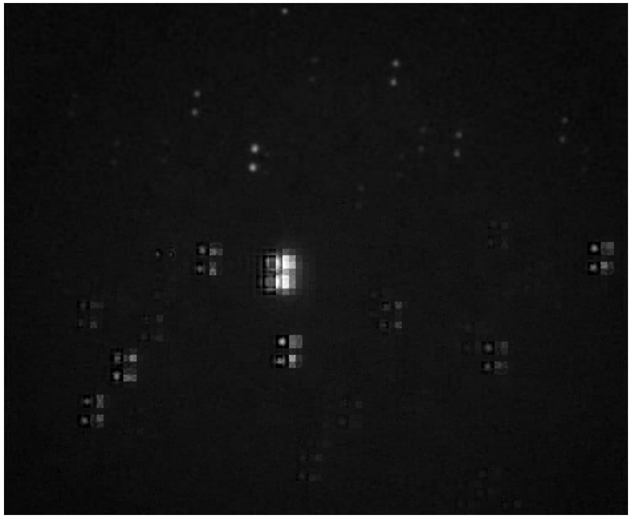
$$P = \sqrt{q^2 + u^2}$$ — degree of linear polarization

$$\Theta = \frac{1}{2} * \arctan\left(\frac{u}{q}\right)$$ — PA of the plane of vibration of E vector

Polarimetry - polarimetry system

Savart plate (double calcit plate) divide the beam in two orthogonal components called ordinary and extraordinary components





$$for\ \alpha = 0^o : q = \frac{F1 - F2}{F1 + F2}$$

$$for\ \alpha = 45^o : u = \frac{F1 - F2}{F1 + F2}$$

$$P = \sqrt{q^2 + u^2}$$

$$\Theta = \frac{1}{2} * \arctan\left(\frac{u}{q}\right)$$

Photon statistics

(theoretical view of possibility for pol. monitoring with telescope)

$$P^2 = q^2 + u^2$$

$$q = u = \frac{F1 - F2}{F1 + F2}$$

$$=> N \approx \frac{2}{\sigma(P)^2}$$

$$for\ \sigma(P) = 0.001\% => N \approx 2E10\ ph$$

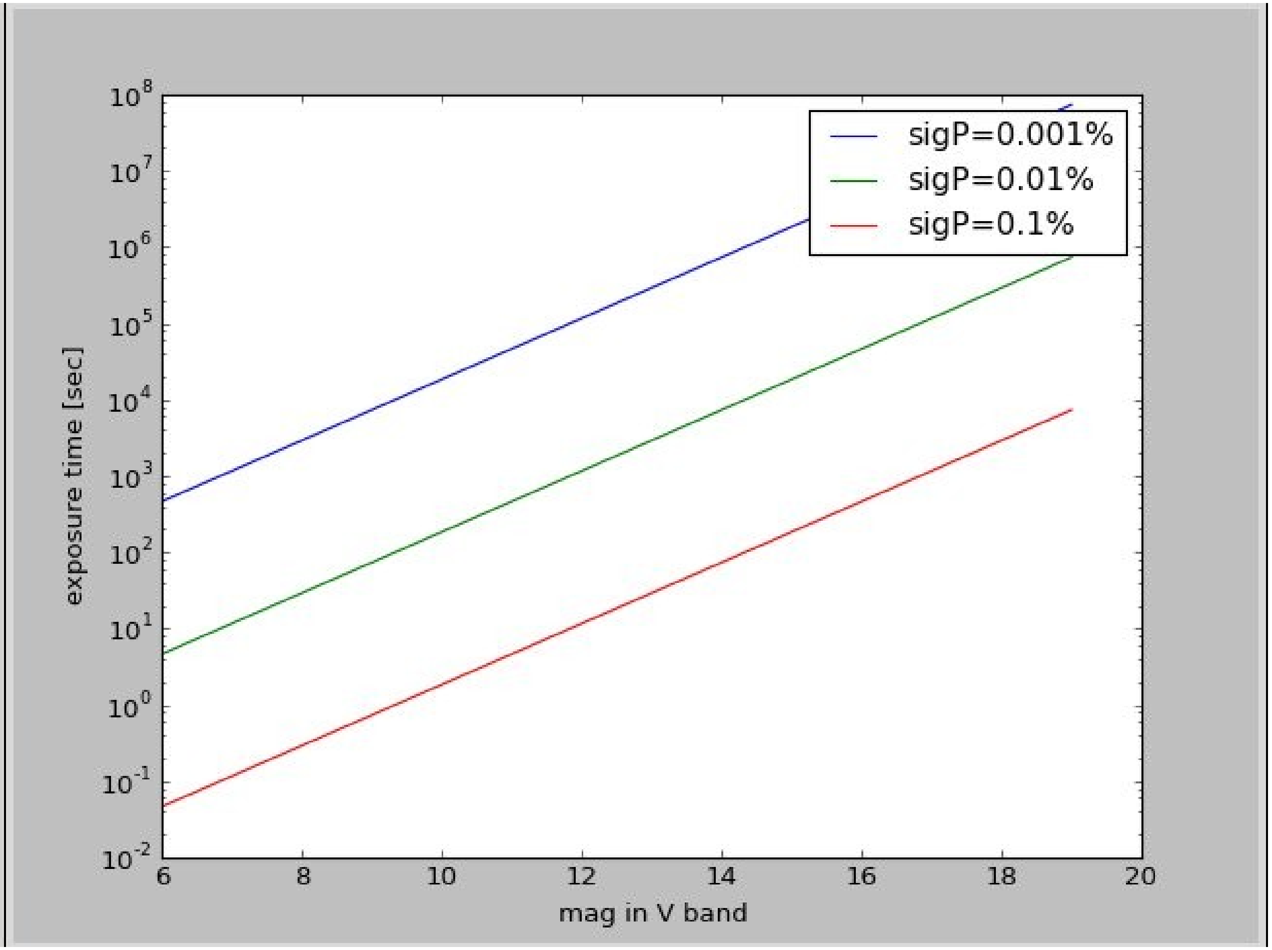
$$for\ \sigma(P) = 0.01\% => N \approx 2E8\ ph$$

$$for\ \sigma(P) = 0.1\% => N \approx 2E6\ ph$$

Photon statistics

$$N = F_0 * 10^{-0.4m} * A * t_{exp} * \Delta\lambda * T$$

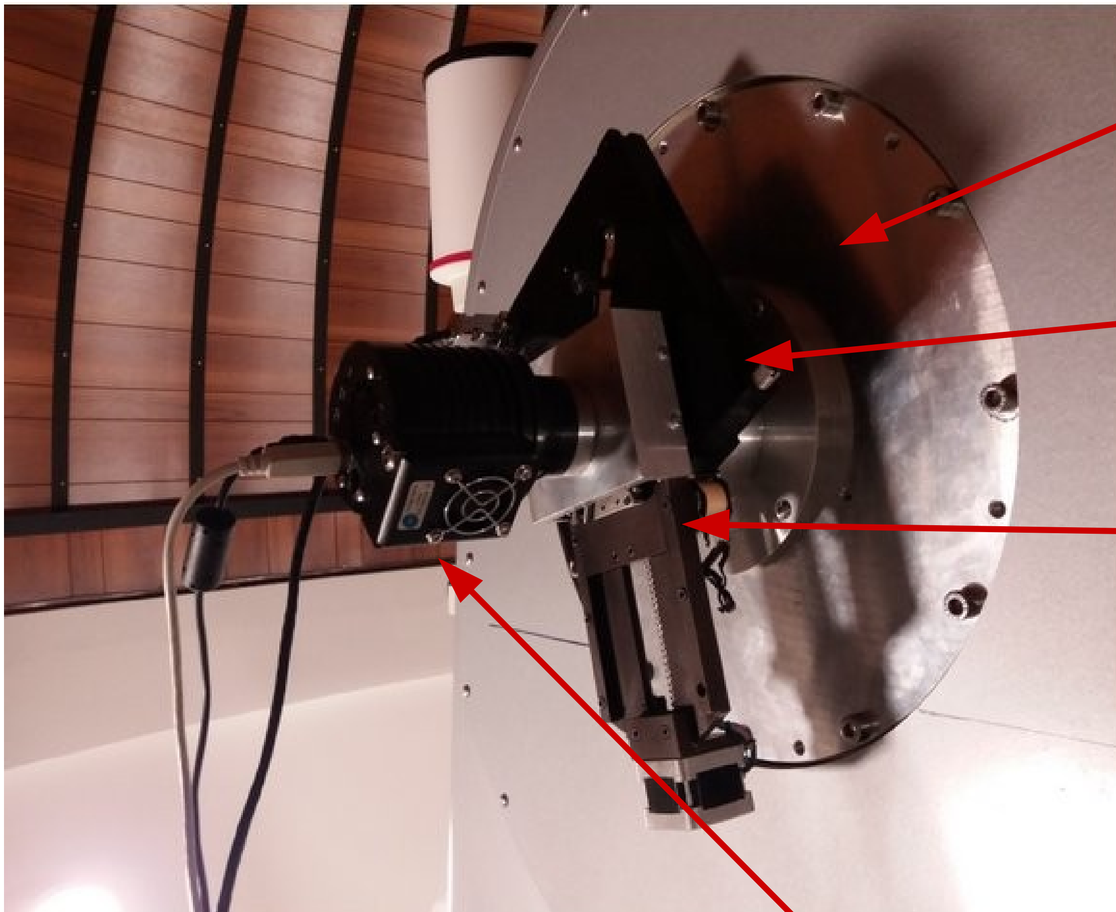
N - photon count
Fo - std. zero flux
m - star magnitude
A - area of the aperture
texp - exposure tim
dLam - filter band width
T - total transparency



e.g. m=14

t ~ 200h for 0.001%
t ~ 2h for 0.01%
t ~ 1.3 min for 0.1%

Instrumental setup



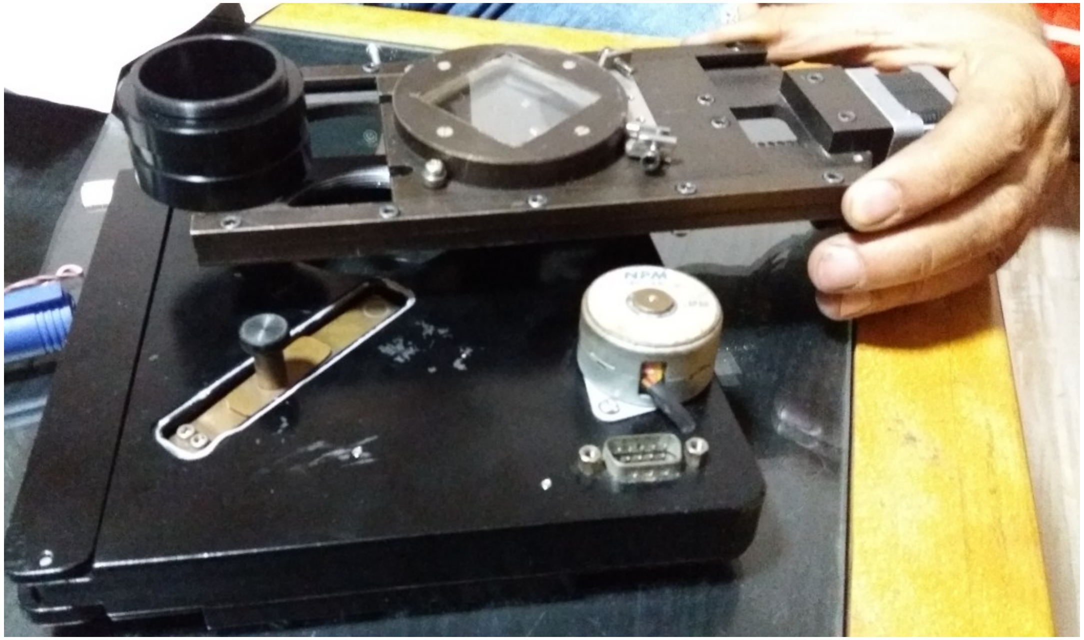
Telescopes right port

Optec filter-wheel (BVRIL)

housing for polarimetric analyzer

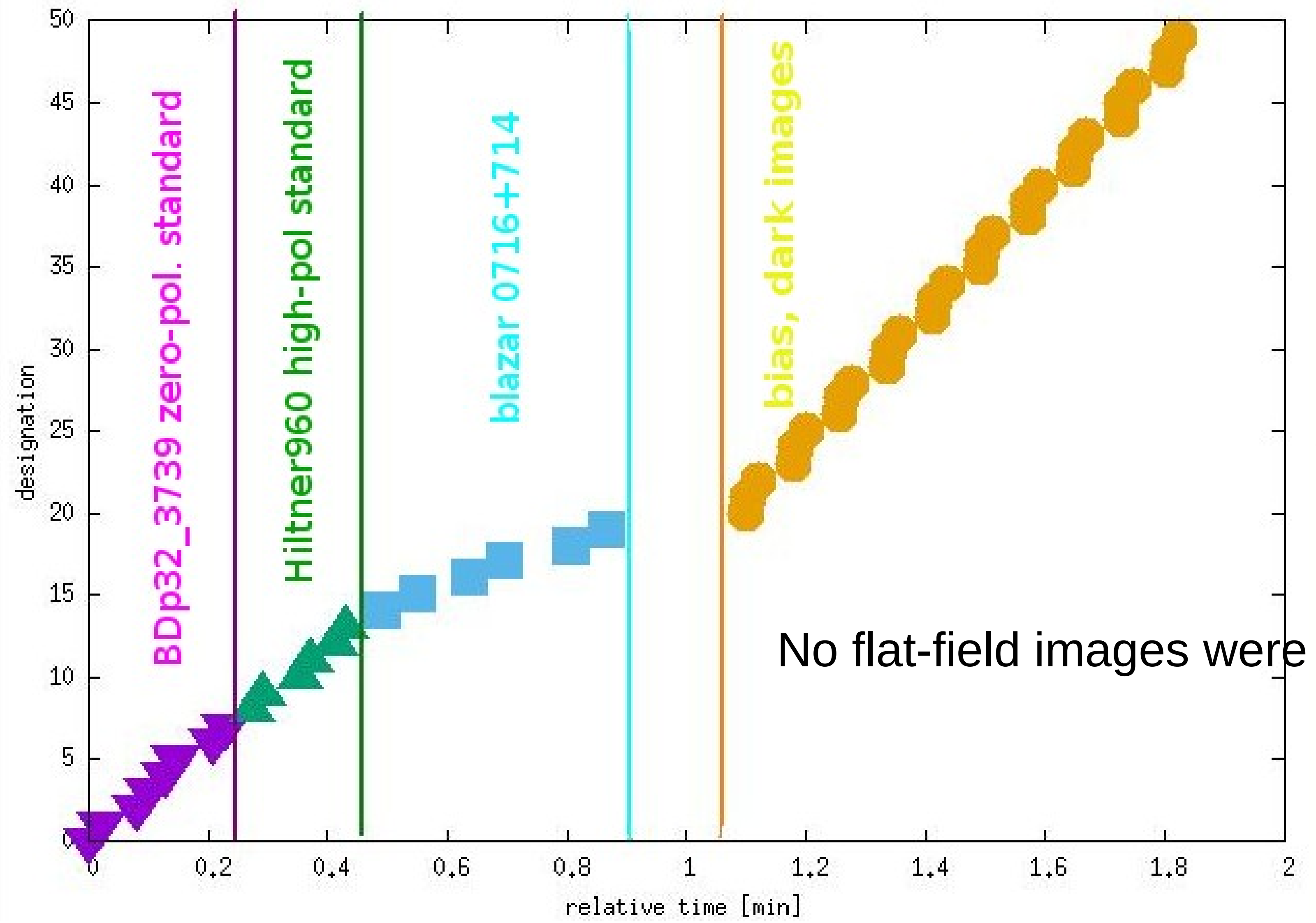
CCD detector

Polarimetric system



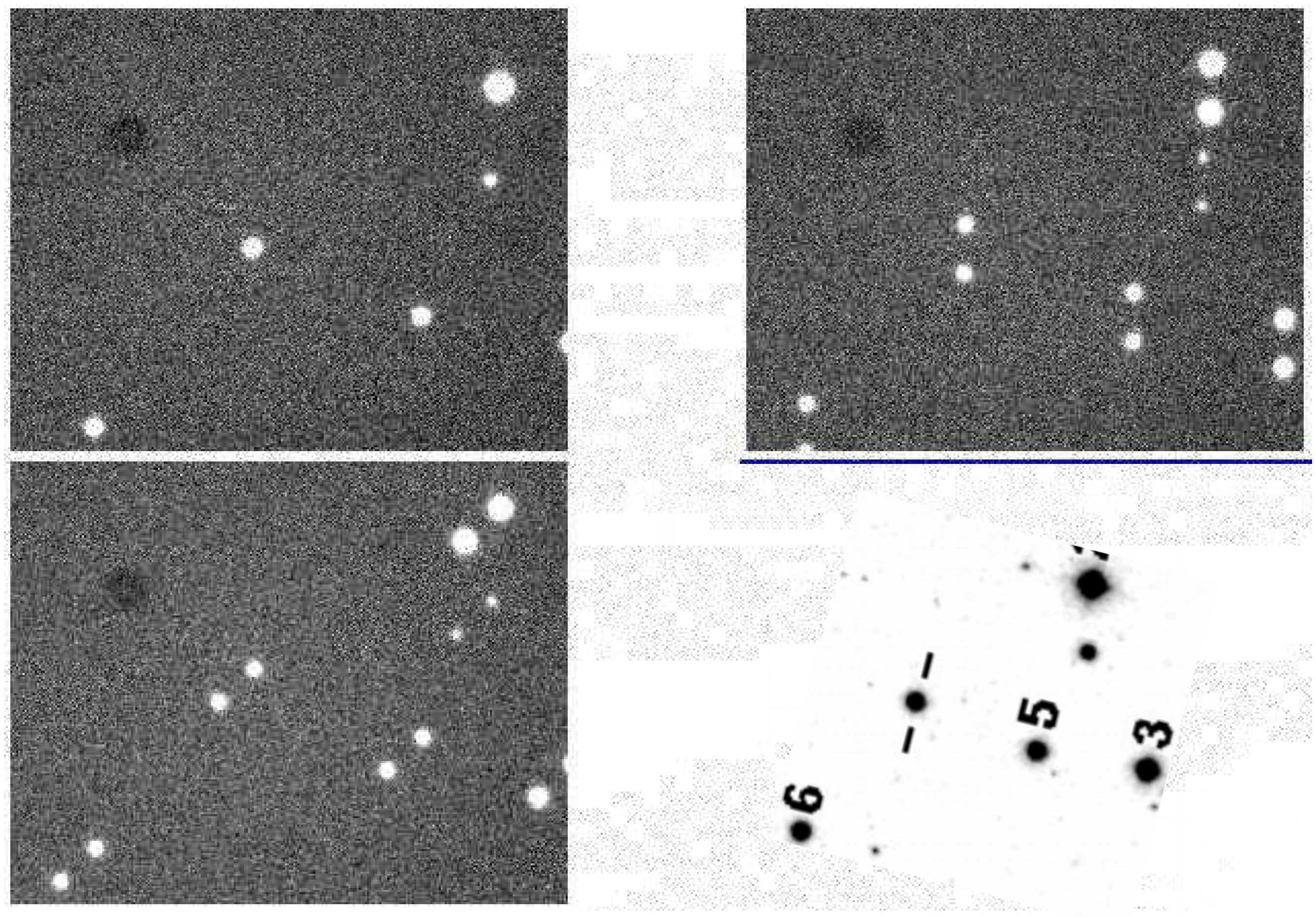
* savart plate is the polarizer
* one can shift the SP into/from the FOV (motorized/automated)
* one can rotate SP for 45 degree manually

Observation log

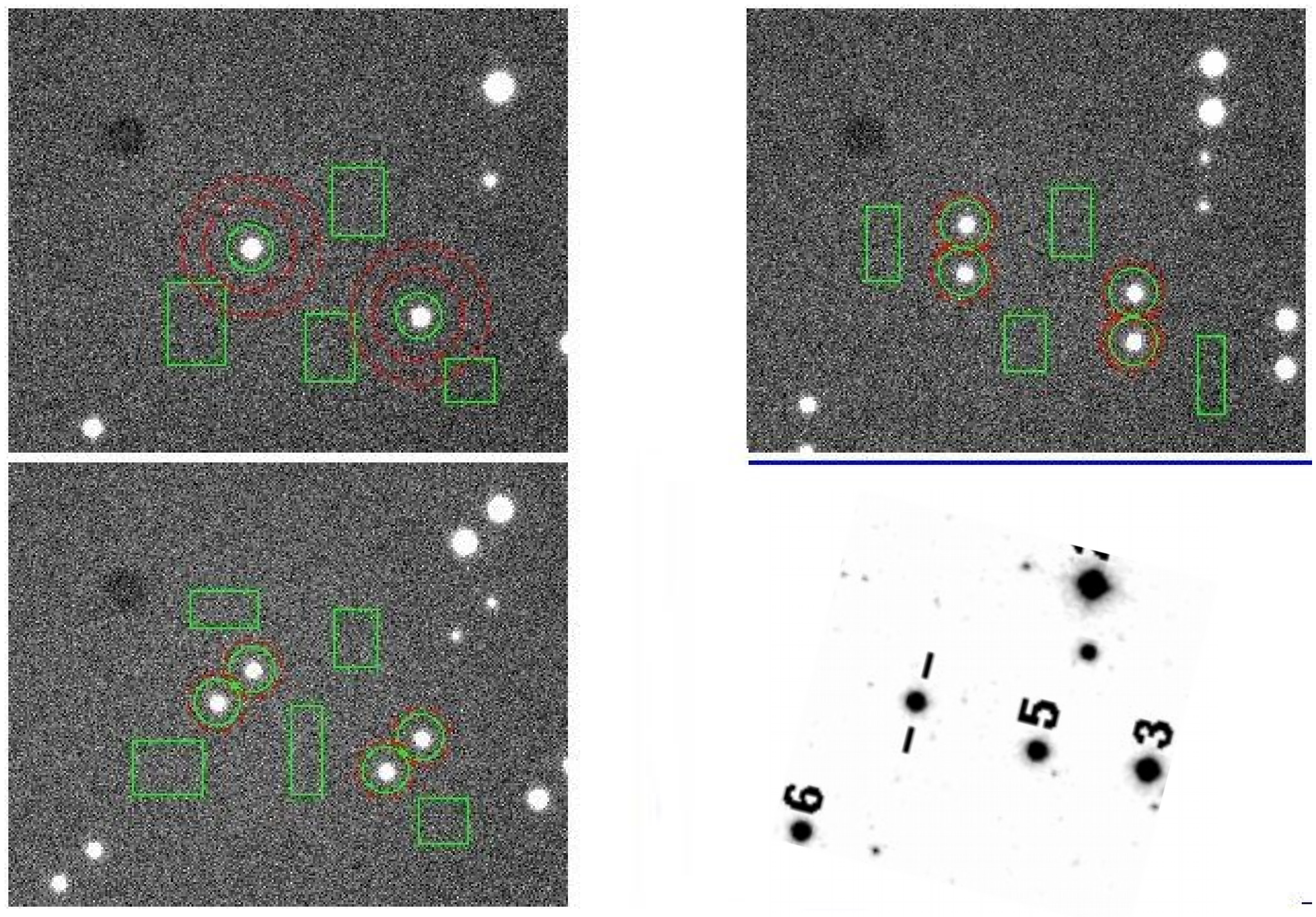


No flat-field images were taken

CASE: Blazar 0716+714



CASE: Blazar 0716+714



First results

Blazar	P=0.068(??), Theta=153.71(??) [o]
hiltner 960	P=0.093(??), Theta=3.71(??) [o]
BDp32	P=0.029(??), Theta=9.12(??) [o]

Still to be done/learned:

- Error calculation !!!

- Correction of the obtained result for instrument polarization (using ZP star)

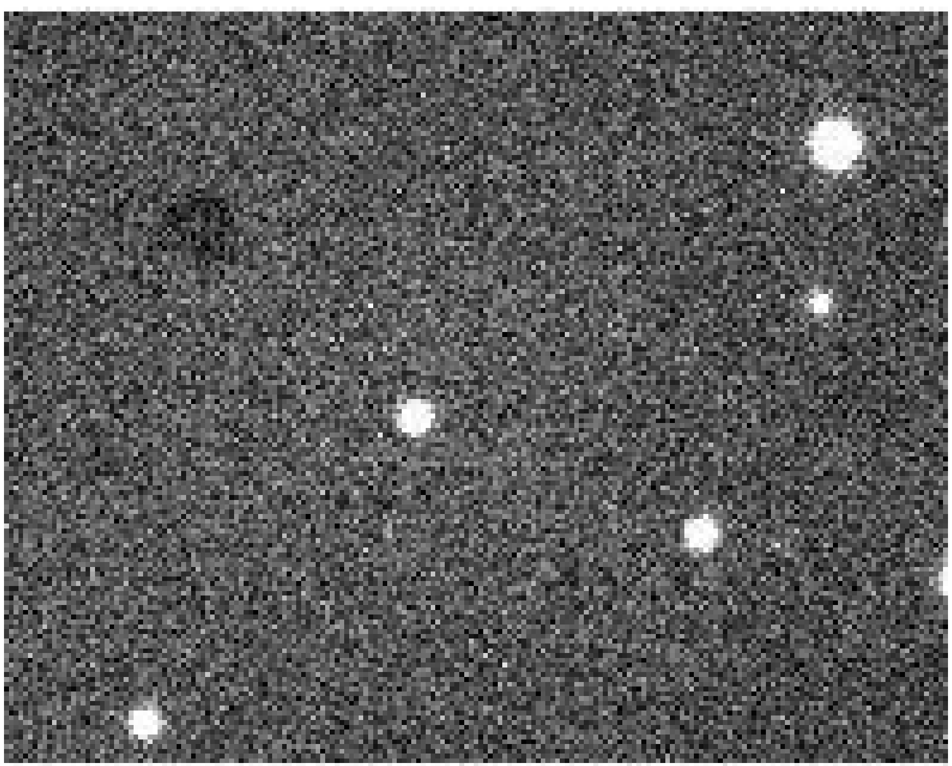
- Determine the Theta zero point (using HP star)

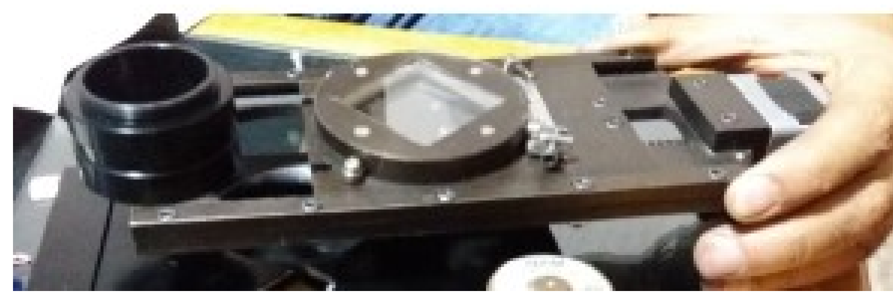
Problems encountered

No FF images were taken

At the time of obs. the polarizer was not automatized so taking FF was an imposible mission with hands

1. The FOV is small => no noticable vignetting
2. Still lot of cosmetic error are present

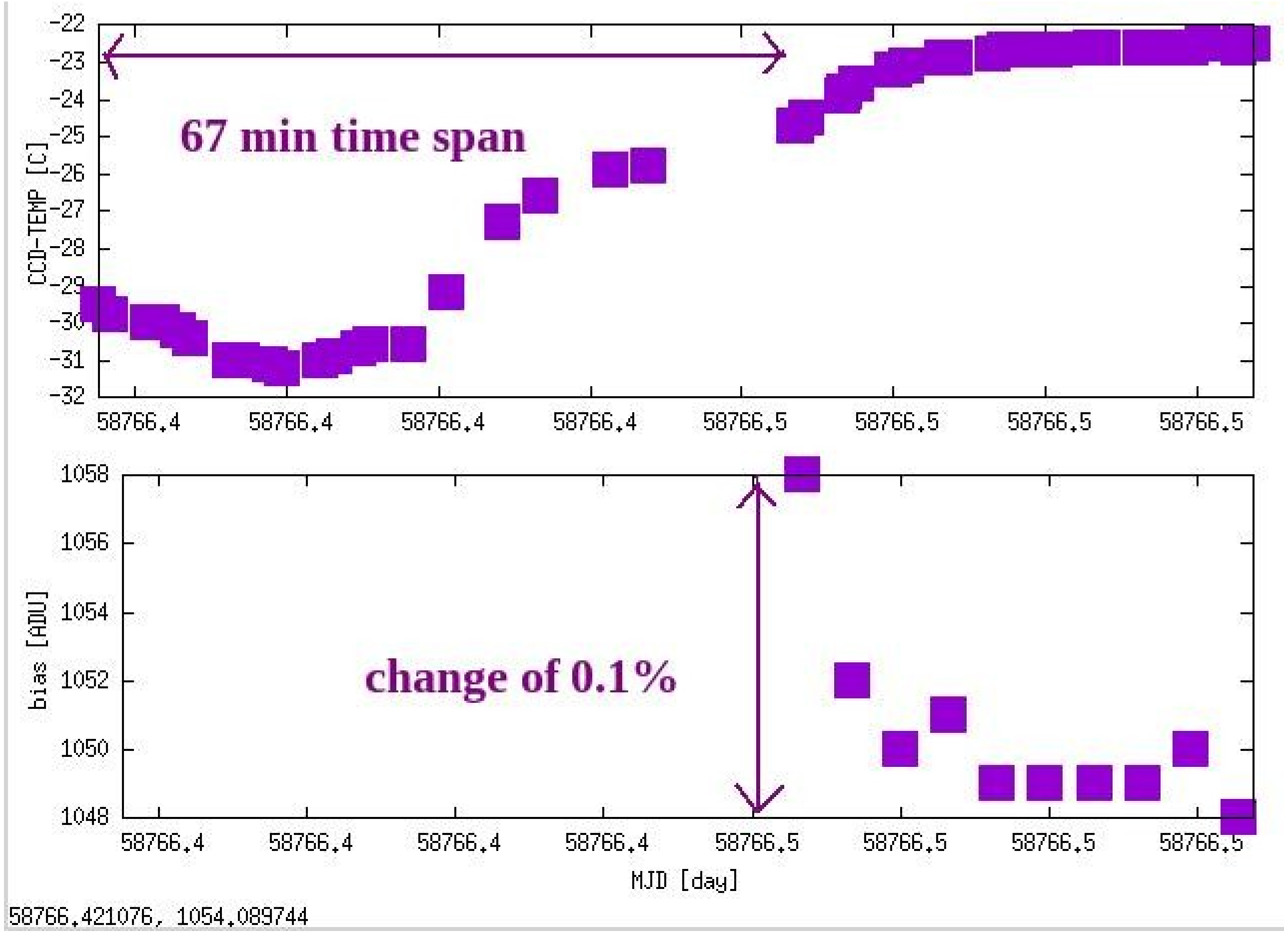




Strange CCD performance

* Large temperature change in time
  - temperature stabilization?
  - correlation with ambient temperature?
  - both?

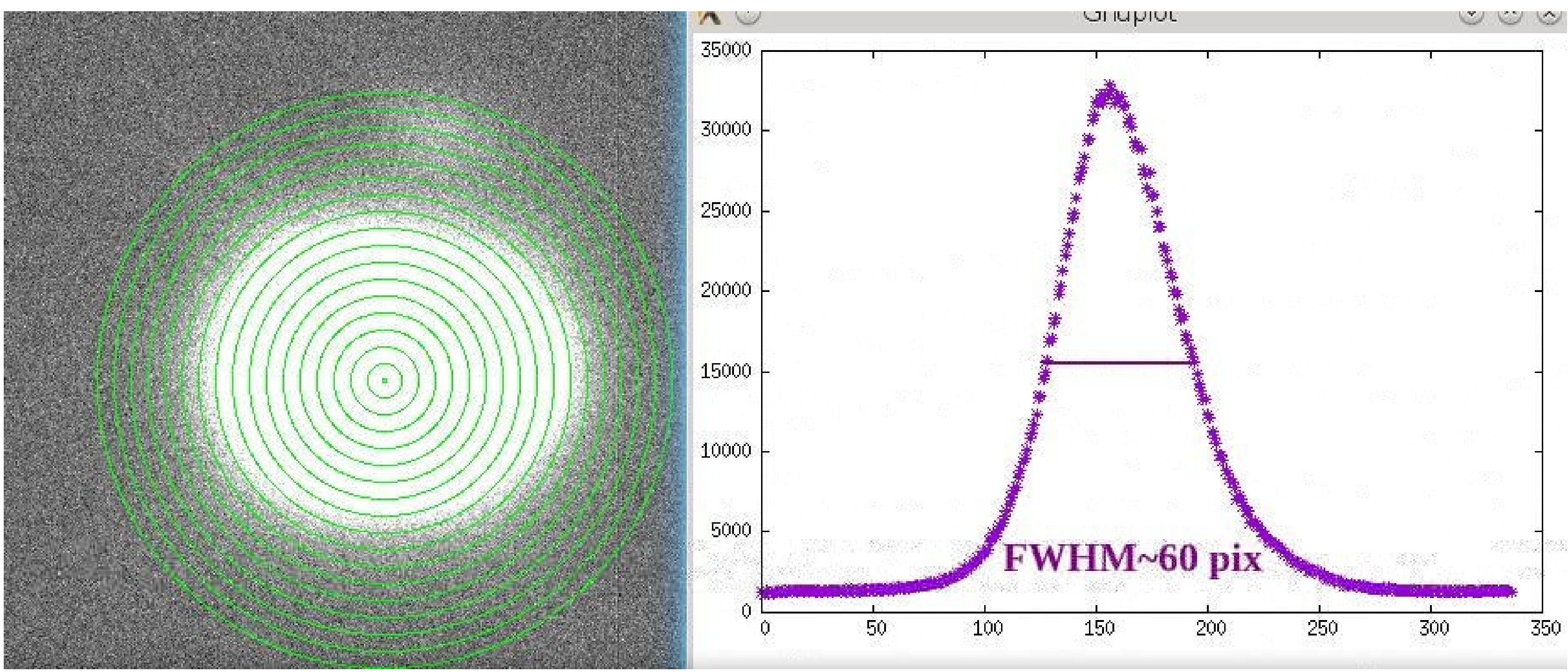
* opposite bias level behavior with temperature variations



oversampling

- CCD is a planetary camera Triux-SX694
- pix size 4.54um => pix scale 0.08” (seeing=1” => FWHM~13pix)
- measured FWHM~60pix => something is happening in the air

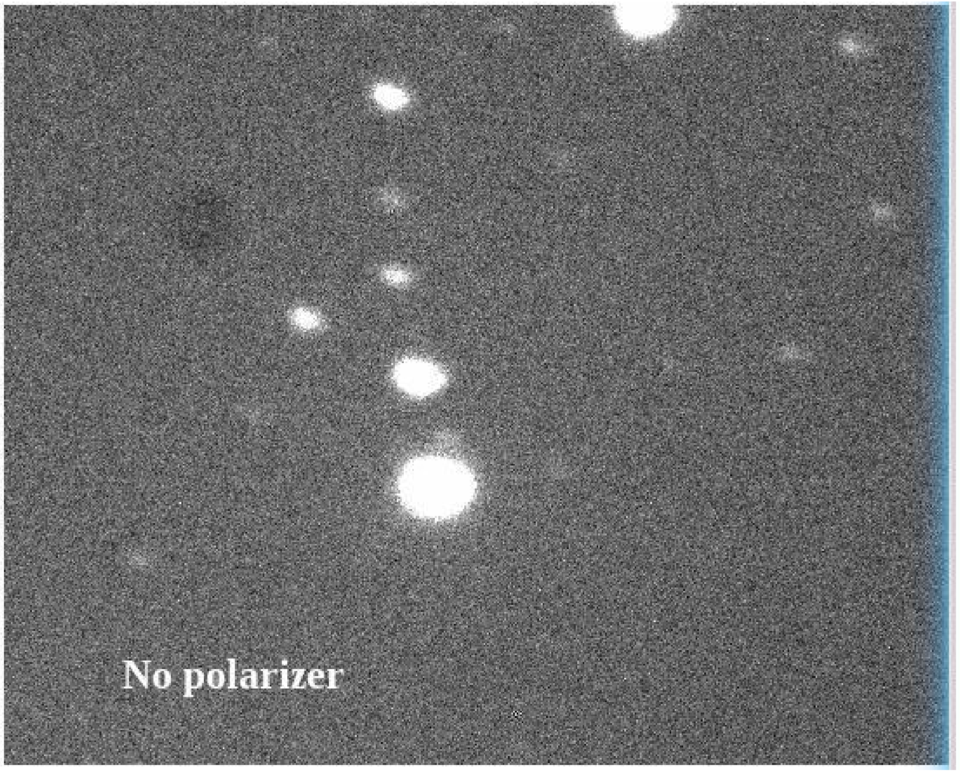
Q: Can humidity influence pol. measurements?

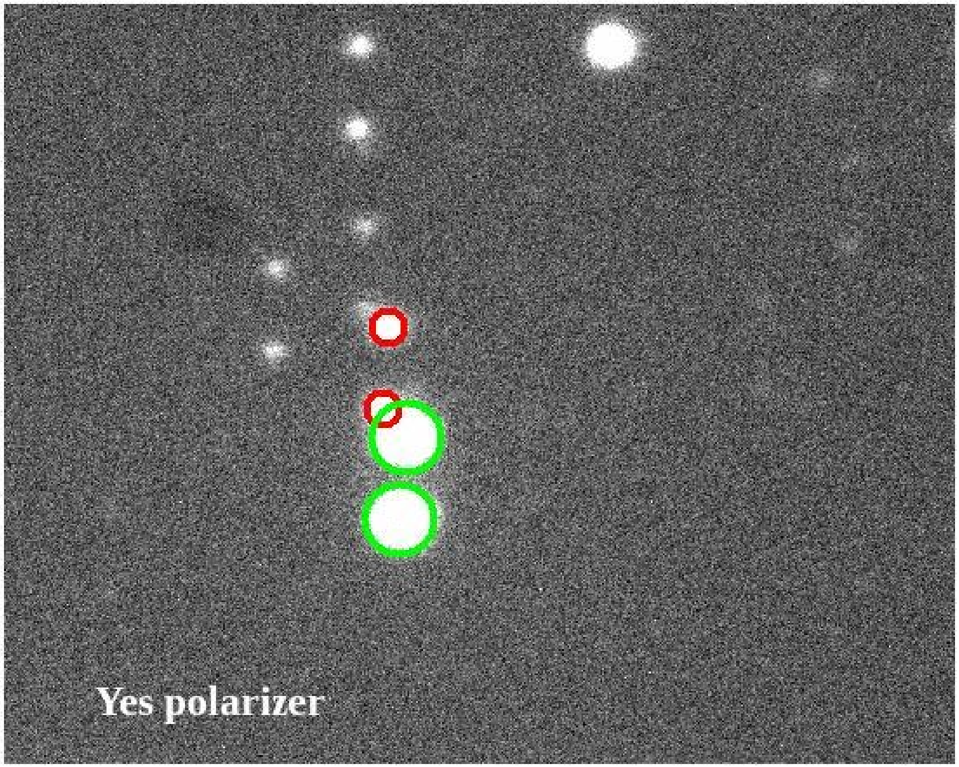


star blending

Q: Is there any method to avoid blending?

Q1: If yes so, how to correct it?

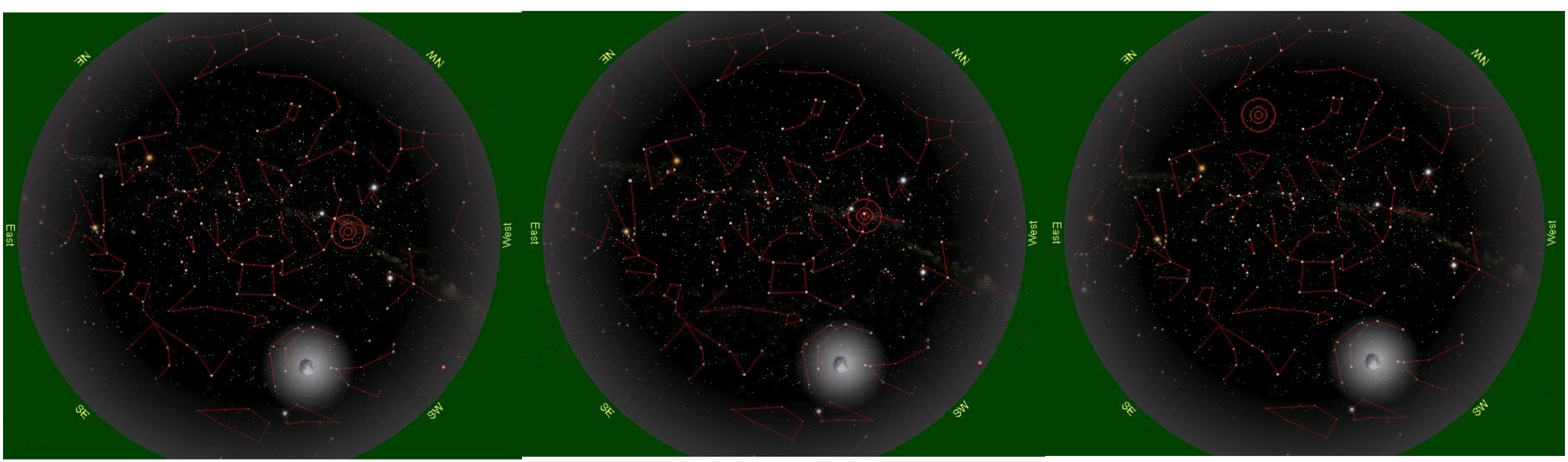




polarization by moon

Q1: Still not sure how to correct for the polarization from the Moonlight?

Q2: Does it matter if teh target, ZP str and HP star are at different part of the sky relative to Moon, sky glow, city light ...?



Conclusions

* Yes, polarimetric observations are possible (with great care and obs. time to better than 0.001% precision)

* instrumental changes:
  - Providing a new CCD should be considered (adequate ps, light weight ...)

* Maybe installing a FF table in the dome.

* Maybe to provide a double Wollaston polarizer

* Avoid Moon

* Maybe to apply some method where blending is eliminated (mask in fp) or to marginalize its effect (observing in many angles and fitting sin/cos function).