

Wise Observatory C28 - Jay Baum Rich - Telescope Manual

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ABSTRACT

The Wise Observatory of Tel-Aviv University has been operating since 1971. After three decades of operating its single 40 inch telescope, a Centurion 18 inch telescope (C18) was built in 2003, and a Centurion 28 inch telescope (C28) named the Jay Baum Rich telescope was purchased and built in 2012, and several other telescopes has been added to the observatory since. This document describes the operation of the C28 which was commissioned during 2013.

The operating systems include programs to set the telescope to objects, automated guider, automated and robotic observations, operation of the CCD and instruments, remote observing, and various other tasks.

The purpose of this manual is to describe the use of the C28. The aim is to help the observer to operate the instruments properly and to avoid mistakes so that the observing time will be fully and properly used.

The C28 is described in a paper by Brosch et al. 2015, *Ap&SS*, **359**, 49, available through the Wise Observatory manual web page mentioned below.

Since the Wise Observatory is in constant development this manual will hopefully be updated according to the developments. This document is available via the WWW at <http://wise-obs.tau.ac.il/observations/Man/>

General information about the Wise Observatory is available at <http://wise-obs.tau.ac.il/>

Information about the Department of Astronomy and Astrophysics of Tel-Aviv University is available at <http://www.astro.tau.ac.il/>

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Chapter 1

Introduction

The Wise Observatory, named in honor of Florence and George Wise, the first president of Tel-Aviv University and his lady, was dedicated in October 1971. The observatory is owned and operated by Tel-Aviv University (TAU), Israel, and is dedicated to research in observational optical astronomy. It is located on a high plateau in the central part of the Negev desert (longitude $34^{\circ}45'48''$ E, latitude $30^{\circ}35'45''$ N, altitude 875 m, time zone -2 hours relative to Universal Time. New Israel coordinates are 177040, 500876). The observatory code given by the International Astronomical Union is 097. The site is about 5 km west of the town of Mitzpe Ramon, 200 km south of Tel-Aviv and 86 km south of Beersheva. The town of Mitzpe Ramon has a population of about 6000 and offers facilities in housing, schools and basic medical services. The town management had cooperated with the observatory in controlling and shielding street lights and outside illumination to minimize the additional light background, but in the last few decades together with a large development of the town, the light pollution from the town has increased considerably.

The characteristics of the site, prior to the establishing of an astronomical observatory on it, were described by Vidal & Feldman 1974, *Q.J.R.astr.Soc.* **15**, 462. The number of clear nights (zero cloudiness) is about 170 a year. The number of useful nights is about 240. The best season, when practically no clouds are observed, is June to August, while the highest chance for clouds are in the period January to April. Winds are usually moderate mainly from NW and N. Storm wind velocities (greater than 40 km/h) occur, but rarely. The wind speed tends to decrease during the night. Temperature gradients are small and fairly moderate. After 23:00 LT, the gradient is usually 0.2°C/h the year round. The average relative humidity is quite high, with a tendency to decline during the night from April to August. The average seeing is about 2–3 seconds of arc. A few good nights have seeing of $1''$ or less while some show seeing larger than $5''$. Typical extinction coefficients, in mag/airmass, are: $k_V = 0.24$, $k_{U-B} = 0.22$, $k_{B-V} = 0.14$, $k_{V-R} = 0.05$, and $k_{R-I} = 0.07$. These are median values for the 1990s decade. A review of the observing conditions at the Wise Observatory

is given in Brosch 1992 Q.J.R.astr.Soc., **33**, 27–32.

The 0.71-m Centurion 28 (C28 – Jay Baum Rich Telescope) was installed in 2013. The telescope operates from a 5.5 meter ScopeDome and is equipped with a large format CCD camera – currently a PL16801 of FLI. Observations are performed remotely, either from the Observatory main building, from Tel-Aviv University, from home, or from abroad.

Main research activities include: imaging and photometry of asteroids, binary stars, extra solar planets candidates, quasars and active galactic nuclei.

The Wise Observatory E-mail address is: admin@wise.tau.ac.il. The FAX number is: +972-3-6408179 and the phone numbers of the Tel-Aviv headquarters, on the campus of TAU, are +972-3-6408729 or +972-3-6409279. The phone number of the Mitzpe Ramon site is +972-7-6588133 and FAX at +972-7-6588303. There is an Internet connection to the observatory site which allows access to almost all computers at the observatory.

The purpose of this manual is to describe the C28 and its operation. The aim is to help the observer operate the instrument properly and avoid mistakes, so that the observing time will be fully and properly used.

1.1 Observing Time Policy and Procedure

Policy

The equipment and facilities of the Wise Observatory are constructed and maintained for the use of the general scientific community. Available observing time on the Wise Observatory telescope will be shared between staff members, students and visitors, and will be allotted on the basis of scientific merit and suitability of instruments. The final responsibility for all time allocation shall be the director's.

Procedure

1. Requests for observing time are submitted to the observatory office using the standard Observing Time Request Form. Tex and postscript files of the Time Request Form are available over the Internet at <http://wise-obs.tau.ac.il/observations/forms/>.
2. Requests for observing time should be made for the six month periods October 1 - March 31 or April 1 - September 30, and should be submitted prior to the preceding August 1 and February 1 respectively. Late requests will be granted only in exceptional cases at the discretion of the director.
3. Graduate students must submit an endorsement from their faculty advisor along with the form. The endorsement must contain statements concerning the student's aca-

demic standing, the acceptability of the proposed research to the department, and the capability of the student to perform the proposed work.

4. Requests will be reviewed by a scheduling committee appointed by the director.
5. Any applicant who feels that the decision on the telescope allocation has been unfair may appeal directly to the observatory director for reconsideration.
6. Once telescope allocations have been made, revisions in schedules must be negotiated through the director.

1.2 Guidelines for Visiting Astronomers

All observations at the Wise Observatory are done now automatically and in a robotic way from remote. However, in an exceptional cases (which have to be approved by the director) the observer can be at the observatory.

The Observatory staff have put together a few guidelines with a view to making your stay a more efficient and pleasant one. If there are any questions or we can help in any way, please do not hesitate to contact the observatory staff.

Our headquarters are situated on the university campus in Ramat-Aviv, a suburb of Tel-Aviv north of the city center. The Observatory site itself is about 200 km south of Tel-Aviv.

Prior to departing for the site, the astronomer is encouraged to visit the TAU office for briefing and discussions with the Observatory staff. It is therefore advisable to plan to be in Tel-Aviv at least one day earlier than the commencement date of the observing run.

Likewise, if the observer should need some assistance in transferring data or reduction, a day or two in Tel-Aviv will be required at the end of the run.

N.B. The visitor must take into consideration that Tel-Aviv University, as most public institutions in Israel, is closed on Friday, Saturday and religious or national holidays. Sunday is a working day in Israel.

1.2.1 Transportation

a. To and from Ben-Gurion International Airport:

Ben-Gurion International Airport is about 20 km from Tel-Aviv. There are taxicab, buses, and a train line between the airport and Tel-Aviv.

b. To and from Mitzpe Ramon:

The Wise Observatory is situated 5 km west of the township of Mitzpe Ramon. Buses run regularly every 15-20 minutes from the Central Bus Station of Tel-Aviv, or every 30

minutes from Tel-Aviv North (Arlozorov) Railway Station, to Beersheva (roughly 3/5 of the way to Mitzpe Ramon), and then somewhat less frequently (about every hour, depending on the time of day) from Beersheva to Mitzpe Ramon. There is also train line with a frequency of every half hour between Tel-Aviv and Beersheva. The trip takes all in all three and a half to four hours.

N.B. Buses and trains do not run on the Sabbath, from Friday afternoon to Saturday evening and the same applies from the afternoon before until the evening after official holidays.

Cars can be hired at the airport or in Tel-Aviv. At peak season it might be advisable to reserve in advance.

The observer should coordinate his arrival in Mitzpe Ramon with the Observatory staff in regard to time and meeting place.

c. At the site:

At Mitzpe Ramon there is a utility car, driven by the technical assistant, for traveling to and from the site. The utility car may not be used outside Mitzpe Ramon and the site, except in cases of emergency.

In order to drive the car there is a need for a special permit from the University authorities. Please consult with the Observatory technical manager regarding issuing this permit (it is a lengthy procedure which is not easy to complete).

1.2.2 Accommodation

a. In Tel-Aviv:

It is advisable to reserve accommodation in Tel-Aviv a few weeks in advance through a reliable travel agency. We shall be glad to assist in making reservations for accommodation in Tel-Aviv (at the visiting astronomer's expense) if the following details are provided a few weeks in advance: arrival date and time, airline and flight number, room requirements (single or double accommodation) and duration of stay.

Likewise accommodation can be arranged for the end of the run, if we are advised of the visitor's requirements.

b. In Mitzpe Ramon:

In the town of Mizpe Ramon there are several places to stay (hotel, youth hostel, etc.). Please consult the local site manager regarding the options. Observers may stay at one of the two furnished rooms in the observatory for the duration of the observing run; these rooms offer very basic accommodation. In such a case the observer's sleep will probably be interfered by the noise during the daily maintenance work.

Meals are obtainable at one of the few restaurants in the town of Mizpe Ramon, but

can also be self-prepared in the observatory where basic cooking facilities and utensils are available. It must be noted that no restaurants or shops are open in Mitzpe Ramon from Friday afternoon to Sunday morning. The same applies to official holidays.

Observers who wish to be accompanied by members of their families, students or other guests, should first obtain the consent of the director.

There are sets of keys for the observatory. Please consult the site manager in order to obtain the keys. **THE KEYS MUST BE RETURNED AT THE END OF YOUR RUN.**

1.2.3 The Observatory: Operating Procedures & Briefings

As in every scientific laboratory, the basic rules are “if you are not sure, then don’t” and “if something unexpected occurs, stop everything and call for help”. For safety reasons no one is allowed to work at night alone.

1. Whenever a night assistant is assigned to an observer, the responsibility of the Observatory and the operation of the telescope rests with the night assistant.
2. Astronomers who receive permission from the director to work at the site without a night assistant must be thoroughly instructed by the site manager before the beginning of the observing run. It is the responsibility of the observer to see to it that he is properly instructed. Astronomers must strictly follow the local staff instructions and adhere to any written instructions that are supplied.
3. First-time visitors, or astronomers who have not been at the Observatory for more than 6 months, should plan to be at the site at least 6 hours before the actual run starts, in order to familiarize themselves with the Observatory, the safety procedures and the instruments.
4. Instruments will be changed only during the daytime shift, excluding Saturdays and official holidays.
5. Astronomers who plan to take away their data, should bring their own media. We currently use writable CD-ROMs and DVDs recorded on a PC platform.
6. The telephone +972-7-6588133 is a wireless one with an extension in the 1m dome. It is to be used for work only. No international calls are permitted, unless authorized by the director.

1.2.4 Publications and Acknowledgment

It is expected that visiting astronomers will utilize the observations they obtain at the Wise Observatory for the preparation of publications describing their research activity.

Publications by non-staff astronomers of such research should carry the following credit lines: an asterisk by the author(s) name to refer to a footnote stating, “Visiting astronomer, the Florence & George Wise Observatory, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel-Aviv University, Israel”. The paper should carry the following acknowledgment: “This paper is [partly] based on observations collected at the Wise Observatory with the C28 Jay Baum Rich telescope.”

Also, a reference to the C28 paper (Brosch et al. 2015, Ap&SS, **359**, 49) should be placed in the paper.

The C28 telescope and most of its equipment were acquired with a donation by Dr. Michael Rich, a donation by Dr. Michael Shara and a grant from the Israel Academy of Sciences and Humanities.

Notification of any papers published for which the Wise Observatory is given a credit line would help keep the Observatory publication records accurate and current.

1.3 Image backup and the permanent archive

All observations of the C28 are being backed up on two disks. One is on the computer wise-gate at TAU in the directory /home/mizpe-bck/C28backup/ which is also available for access from the wise-ftp computer. The second backup is at the observatory on the mizpe-cdr computer under the directory h:\C28backup\.

The procedure to backup the files can be done by clicking the icon “C28 Backup Data” that is on the desktop of the computer. This will automatically backup the files to the proper directories described below. Note that in order to copy the files of a specific night you need to click on the icon **after** midnight of the night of the observations, usually in the morning after all observations and calibration images were taken (note that if you click on the icon before midnight it will copy the files from the night before and not of your night).

Backup can also be done manually when observations end from the c28-pc computer with the Total Commander window using the pre-defined tabs for the working directories. On the left side of the Total Commander window there is a tab called “images” which is connected to the c:\Program Files\ACP Obs Control\Images\ directory on the c28-pc computer. In that directory there are the images taken every night with in subdirectories called yyyyymmddc28.

On the right side of the Total Commander window there is a tab called “mizpe-bck-backup”

which connects to the directory /home/mizpe-bck/C28backup/ on the wise-bck computer at TAU.

At the end of the night you need to copy the yyyyymmddc28 directory to the C28backup directory with the same name, yyyyymmddc28.

You can put this copy procedure in the background so that you can continue to use the Total Commander window while copying.

Also, you need to copy that yyyyymmddc28 directory to the tab called “mizpe-cdr-backup” which connects to the directory E:\C28backup\ on the mizper-cdr computer at the observatory.

Once the transfer is completed you need to check that the files were transferred correctly. The simple check is to check that their sizes are identical to their original sizes in the original directory. One needs to enter the two directories and check the number of files and the total bits number in each panel of the Total Commander window and see if there is a discrepancy. If some of the sizes are different then something was wrong during the transfer and the procedure of transferring should be repeated. If all files were transferred well the numbers will be the same.

The above procedure ensures that two copies of the data are kept (one on mizpe-bck at TAU and one on mizpe-cdr disk at the observatory. The backup at TAU is also copied automatically to a third backup). It is the night’s Principal Investigator responsibility to make sure that the files were transferred correctly and fully - otherwise s/he will lose valuable data.

1.4 Safety Instructions

1. When moving the telescope, you must ensure that it does not run below the horizon.
2. Check the humidity at least once every 2 hours, and more frequently when humidity is higher than 80%. You must close the dome if water condensation begins to form, usually above 90%.
3. Do not attempt to make any repair whatsoever to the telescope measuring instruments, or dome on your own, nor to the operating softwares. Call a member of the staff in any event or breakdown.
4. Always lock the doors of the building.
5. Always use a torch when moving in darkness.
6. Make sure you know the telephone numbers of the emergency services in Mitzpe-Ramon and those of the local staff members.
7. When leaving the C28 dome make sure to close and lock tightly and correctly the door.

Telephone Numbers:

Dan Maoz, Observatory Director	W: 03-6408538
Shai Kaspi, Technical Director	M: 054-7236295 H: 09-7405648
Ezra Mashal, Former Technical Director	M: 052-3529230 H: 03-5400633
Sami Ben-Gigi, Site Manager	M: 052-2703382 H: 08-6588829
Avi Lachmi, Assistant Site Manager	M: 052-9215778
Tel-Aviv Office	03-6409279 (FAX: 03-6408179)
Site numbers	08-6588133 (FAX: 08-6588303)

Emergency Services:

Police	100
Red Magen David (ambulance & medical service)	08-6588569
Civil Guard	08-6588333

1.4.1 Security at the Observatory Site

1. The above list of emergency telephone numbers is posted in the office of the site manager, in the control room, and in the dome room. The observer should familiarize her/himself with the location of this list.
2. A document of “Security and Safety Rules” for the Wise Observatory is available at the observatory and through the Internet at:

http://wise-obs.tau.ac.il/observatory/pakam_avtacha.pdf

The document is in Hebrew and cover different aspects of security and safety at the observatory. Any person working or observing at the observatory has to read and be familiar with these rules and has to sign at the observatory that he has read them and understood them.

3. The site manager, or, in his absence, the day/night assistant is in charge of all security measures, and observers are expressly requested to comply with his instructions.
4. The gate of the compound and the doors of the building must be kept locked.
5. During observation, every person must be equipped with a flash-light. It is forbidden to walk around without a flash-light.
6. There are security cameras around the observatory. The cameras’ images are displayed on a computer in the control room called mizpe-cdr and they show the grounds around the observatory. The observer should use this screen to monitor the activity around the observatory.
7. There are 5 projectors on the observatory walls which light the surroundings of the observatory. In case there is something suspicious the projectors can be turned on. To turn the projectors on one can use a software on mizpe-cdr computer desktop which is call “Projectors” and has an icon of a lightening. When you run the program a window is opened with a button. when you hit the button its background will turn yellow and the projectors around the observatory will start to work. It takes them a few minutes to get to their maximum illumination. The projectors can be turned on also using a switch in the main electricity board in the electricity/generator room. The switch is located on the left side of the main new electricity board, and is labeled as “outside light switch” and it is near switch number 54 (which is labeled “outside light”). Pay attention not to turn these projectors on when you are exposing an image as the light will ruin your observation.

Chapter 2

C28 Camera

2.1 CCD

The C28 telescope is now working with a FLI ProLine PL16801 camera with KAF-16801 CCD from Finger Lakes Instrumentatio at the prime focus. This CCD has 4096×4096 pixels of size 9 micron square and the pixel scale on the C28 is 0.834 arcsec/pix which gives a field of view of 56.9×56.9 arcmin (0.95×0.95 degrees, which gives an area of 0.9 square degree). In the unbinned mode the readout noise is 9 electrons, the gain is 1.7 e-/ADU, the bias level is around 997 (with STD of 10) and the saturation level is 65536.

The deadtime of the CCD include reading time of 12 sec (one can decrease that if using a subframe or binning). If one uses the guider then there is additional deadtime of 5 sec for guider settling time. A substantial dead time of 27 sec is added when using the RBI flood mode in order to enable to initial flushing of the CCD (note the important comment about that in the second paragraph of the next subsection 2.1.1). When using the “AcquireImages” script or the scheduler there is additional deadtime for astrometric solution of the image and some book keeping for the observations. This dead time is varying and can take of order of 30 sec. If one is using dithering this may add about 30 sec for the deadtime.

2.1.1 RBI flood

The KAF-16801 CCD is known to have ghosts that are left on it from bright stars that were observed in the previous exposure (some residual charge that is left in the pixels after the CCD was read out). To solve this there is a need to pre-flash the CCD before the exposure. This is done by using the “RBI-flood” as the Readout Mode of the CCD. The RBI flood is created by a ring of LEDs near the CCD that illuminate the CCD not in a uniform light. The relatively bright light exposure fills-in the traps in the semiconductor. The cleaning readouts leave these traps filled so that when the next exposure is taken immediately after the readout no charge is trapped there and, obviously, no residuals of a previous image are

transferred to the new image. The RBI flood option should ALWAYS be on for the FLI since this CCD is known to have this issue.

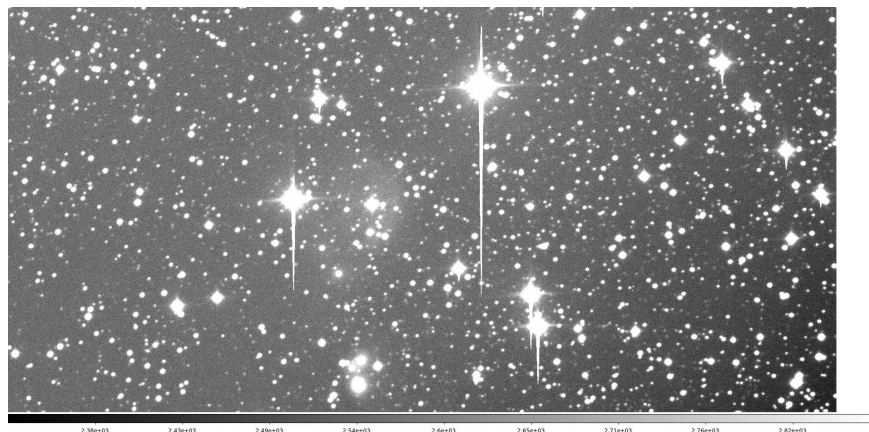
When working in the RBI flood mode then 27 seconds are being added to the dead time of the exposure in order to enable the initial flushing of the CCD. Note that the time stamp in the FITS header is of when the CCD is ordered to start the exposure. So, after that order and that time stamp the RBI flood is starting and the exposure itself starts 27 sec AFTER the time stamp in the FITS header (DATE-OBS keyword). Thus, one needs to add 27 sec to that time stamp in order to get the accurate time of when the exposure started.

In other words, the RBI-flood delay is not 'added' to the time of the header during the image creation. The DATE-OBS keyword is the time that the MaximDL is instructed to do the observations. Then MaximDL waits for the Flushing of the RBI to end (about 27 sec), and then the image is exposed and finally read out. Thus, to get the time of when the exposure start, which is after the wait of the 27 sec for flushing, one needs to add to the DATE-OBS the 27 sec. Then to get the mid-time of the exposure one needs to add half of the exposure time.

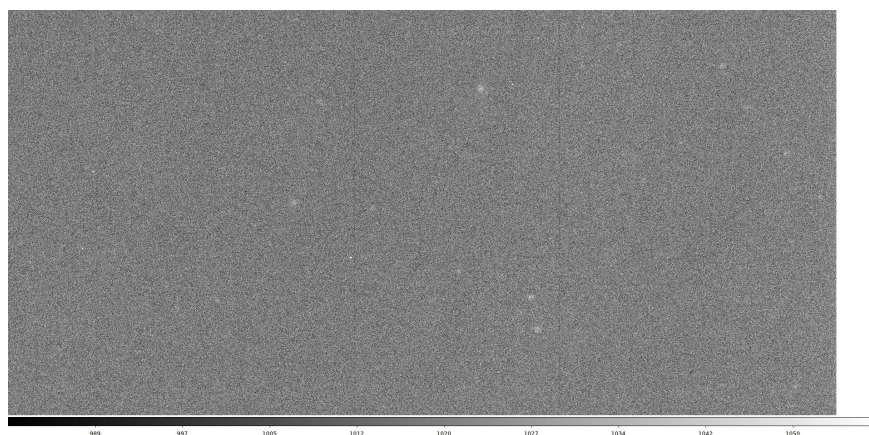
Below is a comparison between the readout modes: with/without RBI flood:

First, a 150s exposure of a field with bright stars was taken, followed by a 150s dark exposure, both without RBI flood. Then another 150s exposure of the same field was taken, followed by a 150s dark exposure, both with RBI flood.

Here's a zoom on an area in the image with saturated stars. The first light image:



The non-RBI flood dark:

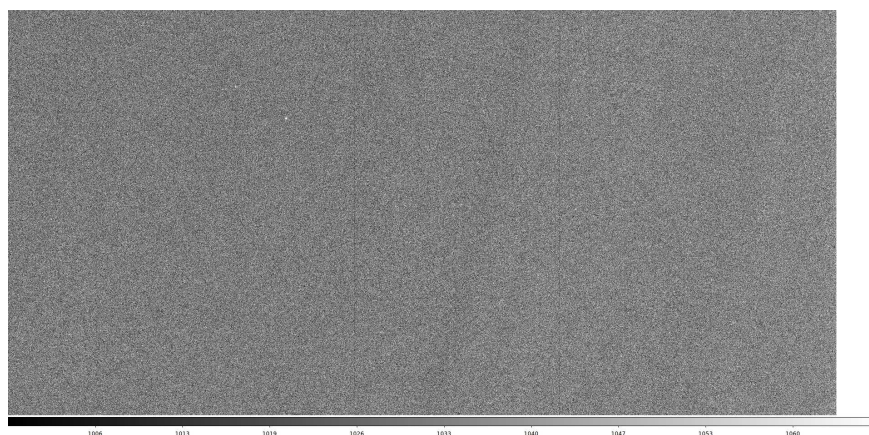


If one looks closely one can see "ghosts" of the bright stars. The background level is ~ 1020 and the ghosts are ~ 20 – 30 counts above the background.

Second light image:



Dark with RBI flood:



Background level is ~ 1040 , and no ghosts are seen.

2.2 Filters

A FLI CFW-9-5 filter wheel with 5 positions is attached to the CCD camera and is facing the focus lens. Filter size is 65×65 mm square, and the filter thickness range is 1.0–5.0 mm. There are also adapters to insert a 2" filters (round or square), for filter thickness range of 1.0–5.0 mm (the adapter thickness is about 1 mm). One position is kept with a “luminance” filter, and the other 4 positions are broad filters and narrow band line filters (various H α , [SII], etc.)

When changing filters in the filter wheel one needs to define them in the MaximDL in the setup tab. Also, In the “ACP Planner” in tools/preferences one need to check the box on the “Multiple filters”, and then press the “Get from Maxim” (after the MaximDL software operating and connected to the CCD). This sets and defines all filters in the “ACP Planner”. Another place to define the filters is also in the FilterInfo.txt file which is in:

C:\Users\Public\Documents\ACP Config\FilterInfo.txt

The filters are accessible from the “Expose” tab of the MaximDL’s “Camera Control” window. One needs to choose a filter before starting the exposure. It takes few seconds for the filter to change. Another option is to use the “Setup Sequence” in the “Sequence” tab and to set in it the “Light” exposures to be with the required filter. Remember to take sky-ff with the filters you need.

Different filters have different focus position. In the ACP system the shifts between the filters

The focus for the different filters is set up automatically according to the filter position. If you focus in luminance filter then when moving to another filter the focus will move. However, one must remember to connect the MaximDL to the focuser before you make any filter change.

The position of the focus is shown in the FocusMax window. However, when one moves the focus from the RoboFocus window the numbers in the FocusMax window do not get updated. To get the correct number of the focus position one needs to click on the “config” button of the RoboFocus window and in the window that will be opened one will see the current position of the focus in the upper right side of the window. This position will also get updated when one moves the focus from the RoboFocus. This is the number one needs to record as the focus position.

One can have a rough transformation from luminance (L) to R. L is a very wide band that covers 400-700 nm cutting off the Hg city lights and the red atmospheric emissions. The transformation does not include a color term and so it is probably good to about 0.1 mag. The transformation is

$$R=22.1 - 2.5 \log (L)$$

where L is the net counts-per-second through the L filter. This means that a source that produces 10 counts/sec, i.e. $R=19.6$, could be observed with a reasonable S/N with a couple of minutes exposure. All depending on the orientation (light from MR) and Moon phase.

We use the Luminance filter instead of clear position since the focus dynamical range of the C28 is very small and we needed to put a glass in the filter wheel so that the focus of the filters and “clear” will be close enough otherwise we would not be able to focus. We do not have a “clear” glass that fits the C28 filter wheel and if we will not put any glass the telescope will not be in focus and we will need to change the adapter of the camera to the telescope – which is a lot of work (many hours to get it right). There is not much difference between the clear and the Luminance, mainly given the quantum efficiency of the CCD.

Basically we can put all the 2” filters we have for the the 1m telescope in the C28, but all of them are narrower than the Luminance filter.

The “planet filter” – ExoP – starts at 5000 Å and has no limit in the red while the Luminance starts at 4000 Å and stops at 7000 Å.

Info about the filters is at http://wise-obs.tau.ac.il/observations/filters/C28_filters/ .

2.2.1 Reading Overhead

When taking a sequence of a full frame (4096x4096 pixels) through the ”ACP” the overhead time of reading and displaying the image can reach to a few minutes since it includes astrometric solving of the image, guiding overheads, RBI flood, etc.

To shorten the overhead time one can observe directly from the MaximDL and save a lot of the overhead time.

Also, overhead shortening can come from taking a sub-frame of the FLI CCD. The following table gives the overhead time of reading and displaying the image when not using an auto-guider and when operating the CCD directly from MaximDL’s “Camera Control” window in the ”Expose” tab in its “AutoSave” mode. (sub-frames were taken about around the center of the CCD; the given average time is over about 100 images):

Sub-Frame	Overhead time (sec)
4046×4096	5.01
2000×2000	2.88
1000×1000	2.22
250×250	1.75
250×100	1.73
100×100	1.63

Note: Below a field of 250×250 pixels the shortening of the dead time is not significant at all.

2.3 Guider

From the seminal paper describing the 28-inch telescope:

The guider telescope is an Orion AstroView 120ST telescope, with an aperture of 120-mm and a focal length of 600-mm (f/5). The guider camera at the focus of the Orion telescope is a miniature SBIG STi CCD camera equipped with a Kodak KAI-340 chip with 648484 anti-blooming pixels each 7.4 μ m square, yielding a field of view of 27.2×20.4 arcmin with ~ 2.5 arcsec pixels.

To do dithering with the guider in ACP: the guider pixel is about 2.5 arcsec, thus to dither by 20 arcsec the dither parameter should be 8 pixels.

2.4 Telescope Motion Limits

The C28 motion has built in limits which disable it from going below the horizon. The limit is at Hour Angle of 04:50 to the East and to the West, i.e., the telescope cannot go to objects which are above 72 degrees from the Zenith to the east or to the west. **Always make sure that the Right Ascension of your object is less than 4:50 hours away from the Sidereal Time when you observe your object, otherwise the telescope will not be able to get to your object.**

When the telescope hits the limit switches the motor moves the telescope about 20 degrees back to the direction it came from. If the telescope is tracking, i.e., power is connected to the telescope, then it will move back about 20 degrees and then continue to track for about an hour and then will hit the switch again and bounce back and so on until a human intervention that will move it higher or kill the power.

We note that there are times that after a few hits to the limit switches they fail and do not bounce the telescope but kill all power to the telescope and it stays like this until someone will come physically to the telescope, move it out of the limit switch and reset the power. This is why observer should avoid getting to the situation that the telescope will reach the limit switch – although it is not fatal it is not good to the telescope to hit the limit switches.

The parking position of the C28 is at Sidereal Time and at Declination of -45 degrees which is elevation of 14.4 degrees and this is why we set in the ACP a limit which is set to altitude of 13 degrees, Thus ACP will not allow to point the telescope to altitude lower than 13 degrees.

2.5 ACP Scripts

The ACP (Astronomers Control Program) operates the main operations done with the C28 telescope. It has several scripts which are used to help the observer to do his observations. The scripts are placed in the c:\Program Files\ACP Obs Control\Scripts\ directory

The scripts can be reached through the “Select the Script...” Button in the ACP interface. You can open the scripts in a text-editor (notepad or wordpad) to see the scripts. Many scripts have some description of how to use them at their beginning. To run a script you need to choose it from the “Select the Script...” button and then to click the “Run” button.

Here are a few scripts which are most useful:

1. **AutoFlat** - takes a sequence of flatfields with the filter that is currently in front of the camera in the filter wheel.
2. **AcquireImages** - runs through a sequence of objects in different positions in the sky, different exposures, and different filters, in a predefined program and operates the C28 practically in an automatic mode like a robotic telescope. The plans are at “c:\program files\ACP obs control\plans\” and an example of a set of commands is:

```
#STARTSETNUM 1 ; Added by ACP/AcquireImages.vbs
```

```
#INTERVAL 0 ; Bias
```

```
#repeat 15
```

```
#DARK
```

```
#INTERVAL 10 ; Dark, set exp time here
```

```
#repeat 5
```

```
#DARK
```

```
#INTERVAL 20 ; Dark, set exp time here
```

```
#repeat 5
```

```
#DARK
```

```
##INTERVAL 25 ; Dark, set exp time here
```

```
##repeat 10
```

```
##DARK
```

```
#INTERVAL 300 ; 300 second exposures
```

```
#Filter C #REPEAT 999
```

```
Seneca 23 50 23.3 +02 15 07
```

```
#STARTSETNUM 2 ; Added by ACP/AcquireImages.vbs
```

```
#INTERVAL 150 ; 150 second exposures
```

```
#Filter C
```

```
#REPEAT 999
```

```
Balam 21 11 42 -12 46 01
```

```
#STARTSETNUM 2 ; Added by ACP/AcquireImages.vbs
#INTERVAL 50 ; 50 second exposures
#REPEAT 3
2002EZ11.060522 10 13 13 +11 34 06
#INTERVAL 20 ; 20 second exposures
#DITHER 5
ngc7331 22:37:04.2 +34:24:58.5
m31 00:42:44.3 +41:16:09.4
```

No empty lines are allowed in the plan.txt file., between the name of the object and its right ascension one needs to use tab and also between the RA and Dec.

9. **CloseTelescope** - sends the telescope to park position and turns its power off, moves the dome to home position and closes it, warms the CCD and turns it off.

2.6 Robotic Operation

Before start, you will need to create some requests in the scheduler's database. The Schedule Browser is the graphical tool supplied with Scheduler that lets you browse and enter an observing requests. The observing request can be generated by a RTML (Remote Telescope Markup Language) File, or a simple txt plan file input, which needs to be inserted into the Schedule Browser database. Plans can be created easily by using the "ACP Planner", or in any other manner. If you choose to create the plan without using the ACP Planner, make sure to check it, via "ACP Plan Checker" before you insert it into the Schedule Browser.

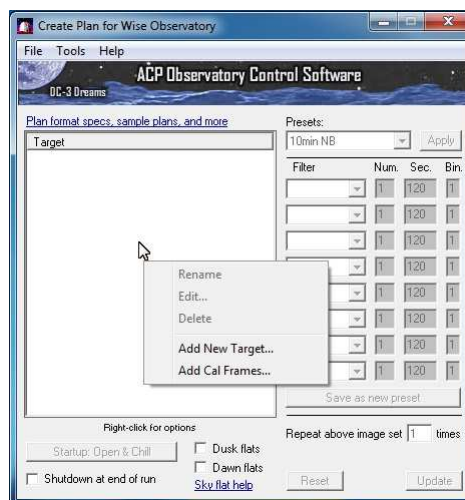
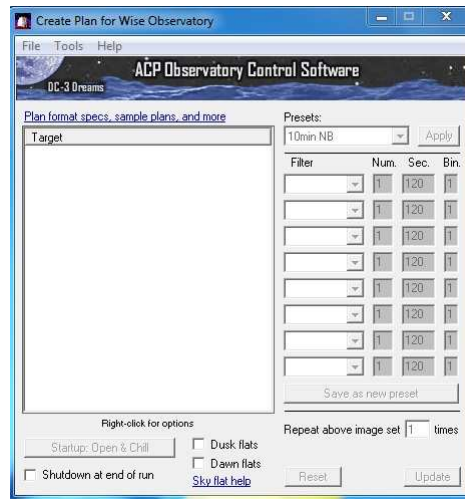
2.6.1 Create your plan with "ACP Planner"

The ACP Planner provides a nice and simple interface to create your own plans. When using the ACP Planner, you can be sure that the plan is 100% ok to use by the ACP, you don't need to check it via "ACP Plan Checker" before running.

Open "ACP Planner" by pressing its icon on the desktop.

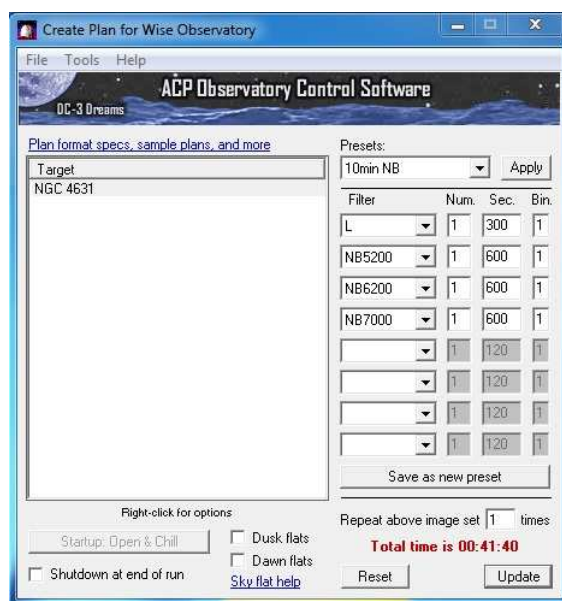
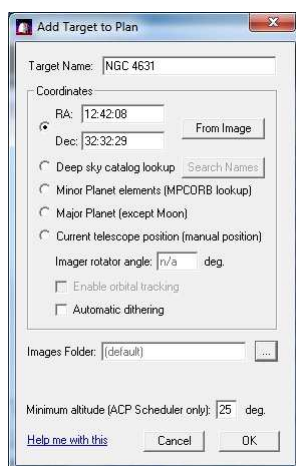
The following window will be opened:

Move the mouse cursor over the big white area (under "Target"). Right-click on the white area to open the options menu, and choose "Add New Target...".



A new window will be opened, in it give the name of your target, e.g., NGC 4631, and insert its coordinates. If your target is listed in a known deep sky catalog, you can skip the above and try to search for it via the “Deep sky catalog lookup”, this will automatically insert its name and coordinates.

If you want to add dithering for your images, check the box next to “Automatic dithering”. Set the “Minimum altitude” to 25 deg, and confirm with 'OK'. The target will now be added to your target’s list, and you will need to define the filter set for it:



For each filter, set “Sec.” — the exposure time in seconds, “Bin.” — for binning, and “Num” — the number of times to repeat this exposure consecutively, thus without a filter change.

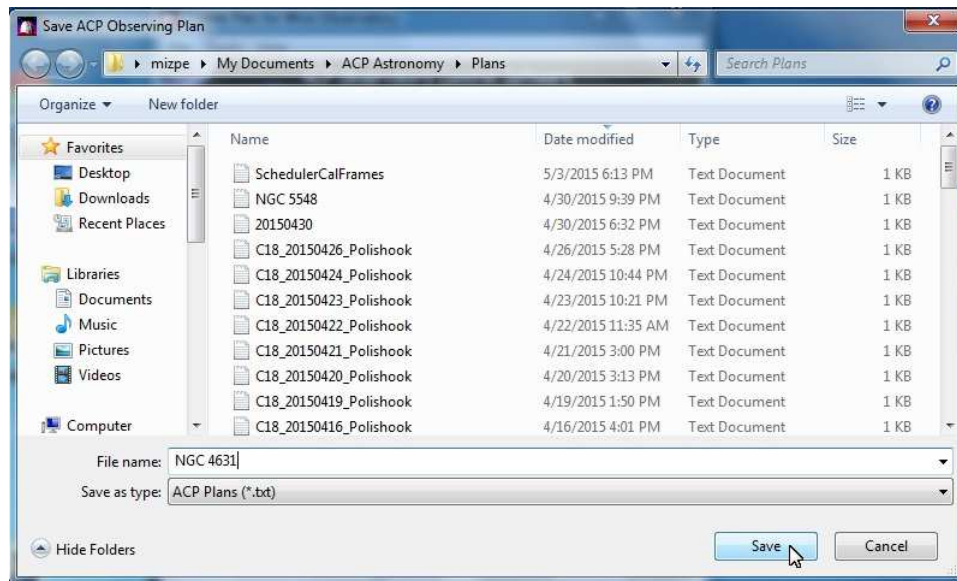
Leave “Repeat above image set” to 1 “times” (we’ll deal with it later).

Press “Update” button at the bottom of the window.

For another target, Move the mouse cursor over the big white area (under “Target”). Right-click on the white area to open the options menu, and choose “Add New Target...”, and repeat the above stages (do not forget to press update at the end of each target insertion).

Save the ACP Observing Plan at the default path by giving it a name you choose:

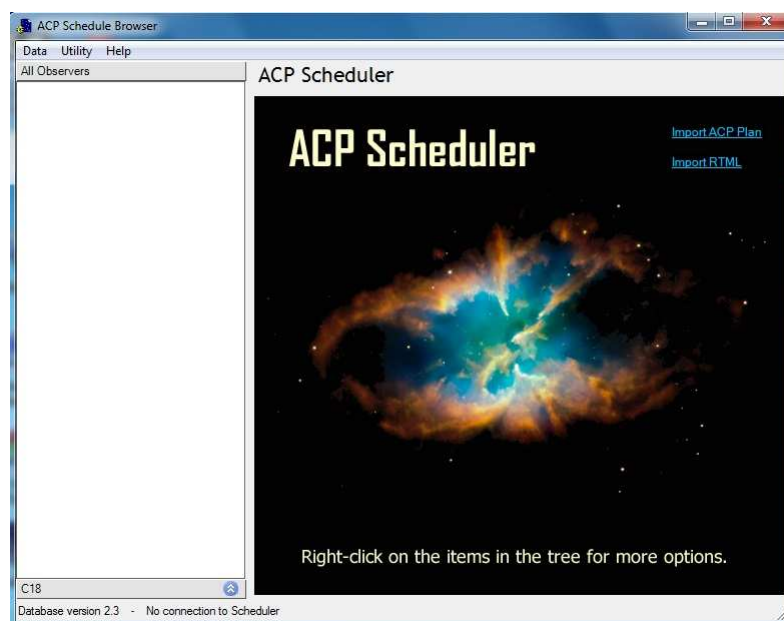
The plan is saved under C:\Users\mizpe\Documents\ACP Astronomy\Plans\ , and you’re done. The plan can be used to create a project in the Schedule Browser, or if you are not working robotically, you can run it as a regular plan under “AcquireImages” script.



2.6.2 Schedule your project

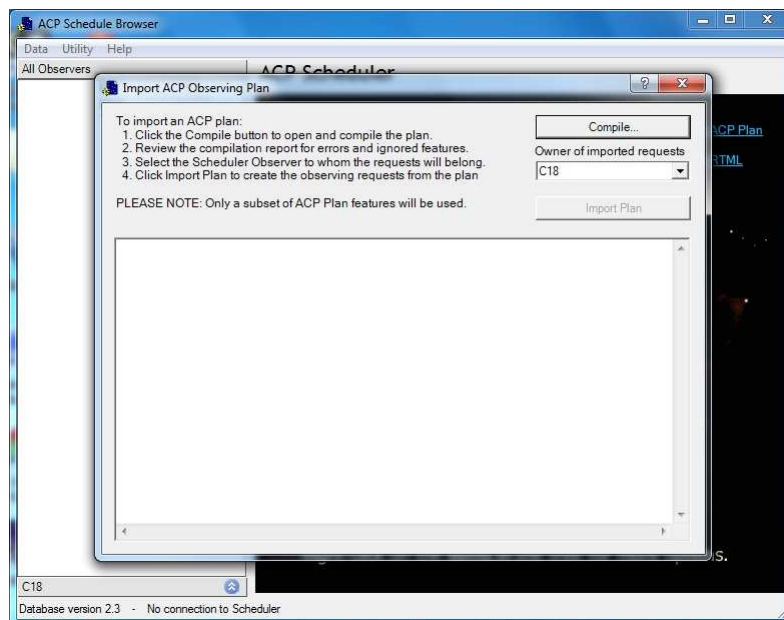
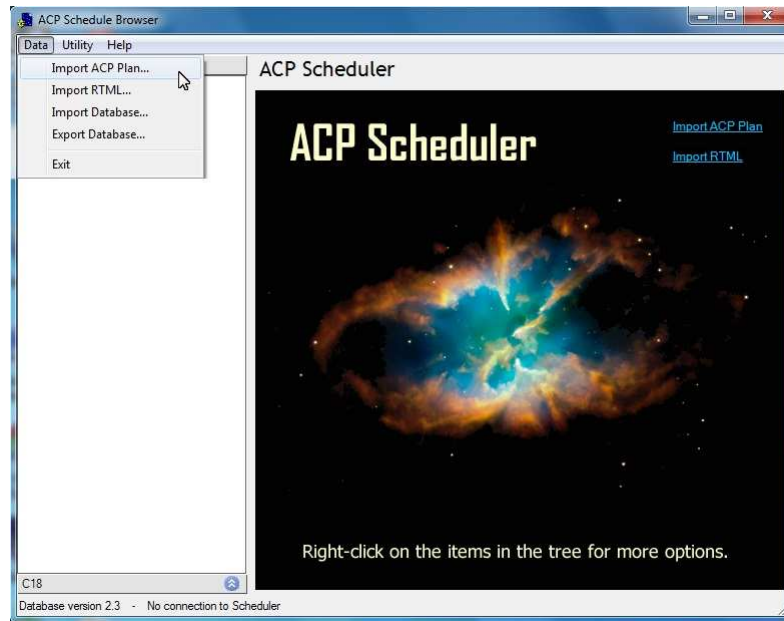
Open “ACP Scheduler” by pressing its icon on the desktop.

The following window will open:

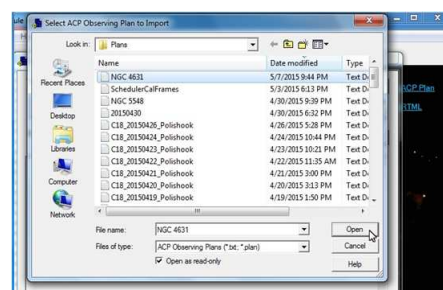


On the upper menu, press 'Data' and select “Import ACP Plan...”

A new window (the compiler) will open:

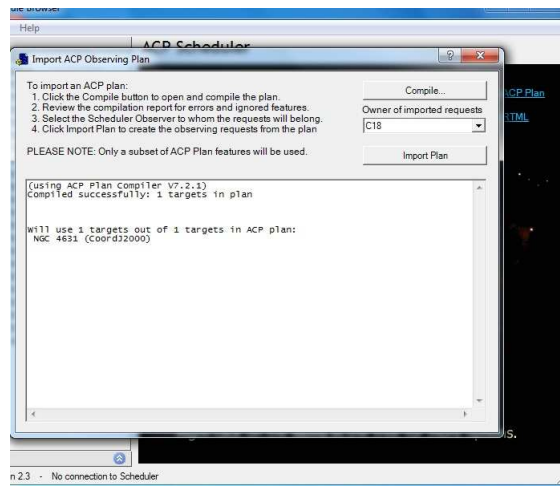


Press “Compile”, and the default plan folder will open:

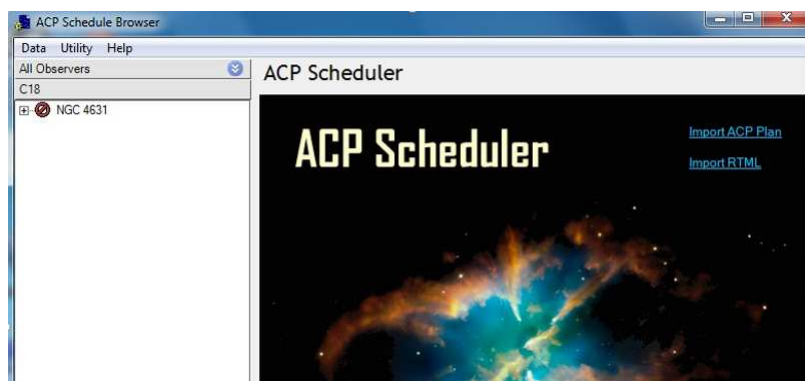


Locate the plan you have created in section 2.6.1 above, and press 'Open'. This will compile

the plan file for the robotic use:

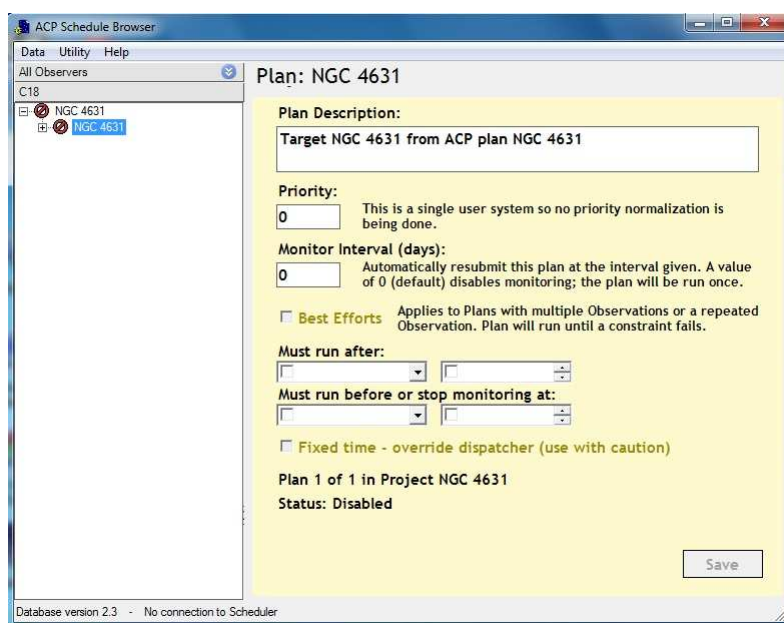


Press “Import Plan” and your plan will added to the project’s list:



If a plan imported successfully (also if not), you should get an appropriate message on the big white box. If the plan imported successfully, close that window and you should see the project on the Browser’s list.

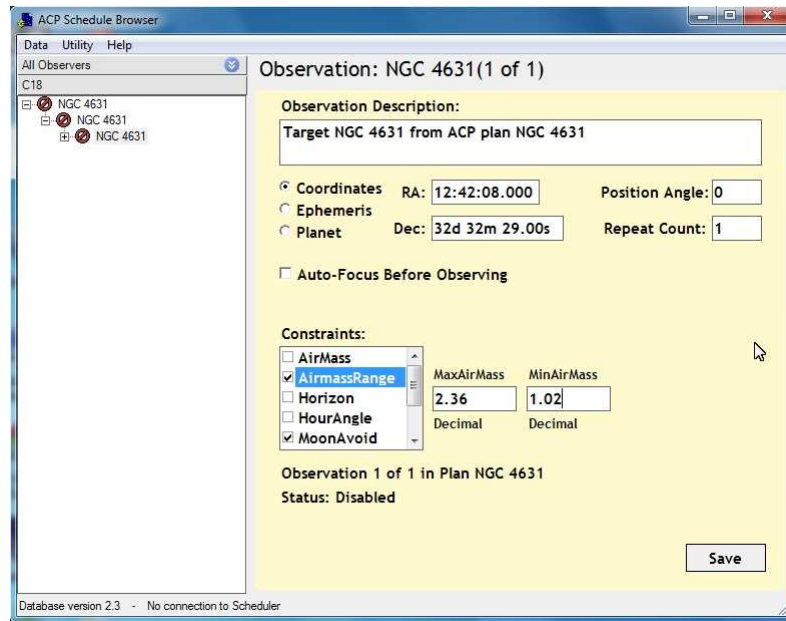
Press the “+” sign and all plans (targets actually) under this project will appear. For each plan, you can fill a short description of the target, or leave it as is.



You can specify a starting time, to ensure plan will not start earlier. You can also provide a time limit which means plan will not start after, but be advised that if the plan has already started, it would not stop even if time limit has come, since it’s only time interval for plan start. Press “Save” when done.

Note: Avoid specifying both start and end time points, otherwise why using a Scheduler?

Press the “+” next to the plan’s name and open the observation info page:



On this screen, you can define constraints for the target. If at some point at night, the object reaches above altitude 80 deg, you should add an “AirmassRange” constraint such as the one shown above, or set “MinAirMass” to 1.02. This is needed since the dome’s shutter obscures about 10 degrees from the zenith. Note that Airmass is about $1/\cos \varphi$, where φ is the zenith angle or ($\varphi = 90^\circ - \text{altitude angle}$).

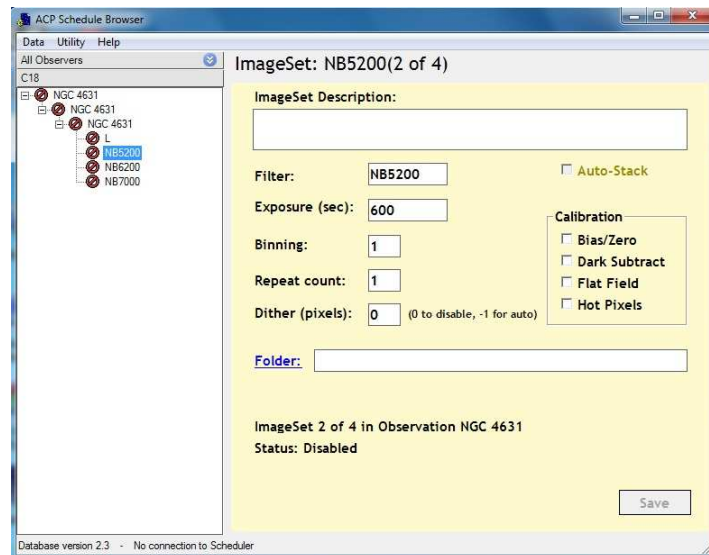
There are several various constraints that are available from that screen and one can add them to the observations. Some of the constraints are hour angle, moon distance, etc.

If you know how many times to repeat the whole filter set, you can enter it now (“Repeat Count”). If you want to take as many sets as possible, you can enter an arbitrary “big enough” number of repeats, then “Save” and go back to previous window to check the “Best Efforts” option, then “Save” it again.

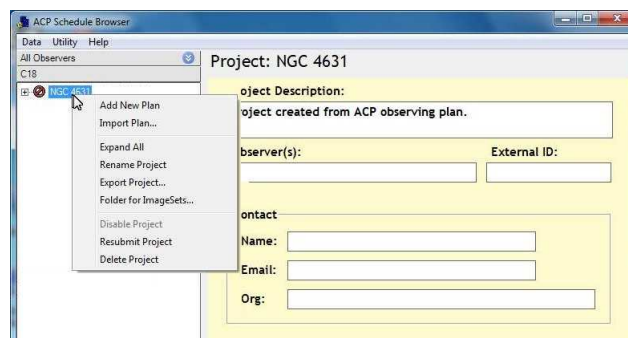
Note: A “Best Efforts” plan will run until a constraint fails, it means that if you specify a big number of repeats (to take as many sets as possible), and neither constraint fails – it might take all the observing time of the night, preventing other plans from start.

You can also access the image sets, for each filter, by pressing the “+” sign at the tree on the left hand side of the window. You will see exactly what you have set through the “ACP Planner”, but if you do make any changes, just remember to “Save” again.

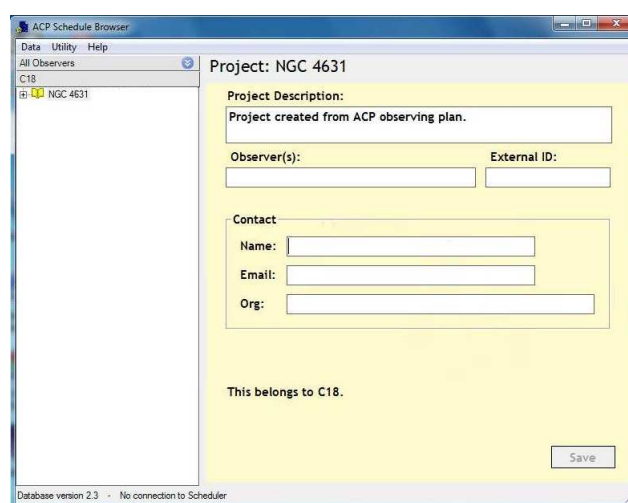
Note the “no parking” red sign next to the project, plan etc. This means that the lines below are disabled. When adding a new project, it will always be in “disabled” mode, to prevent unwanted start.



In order to activate the project, you should right-click the project's name and select "Resubmit Project".



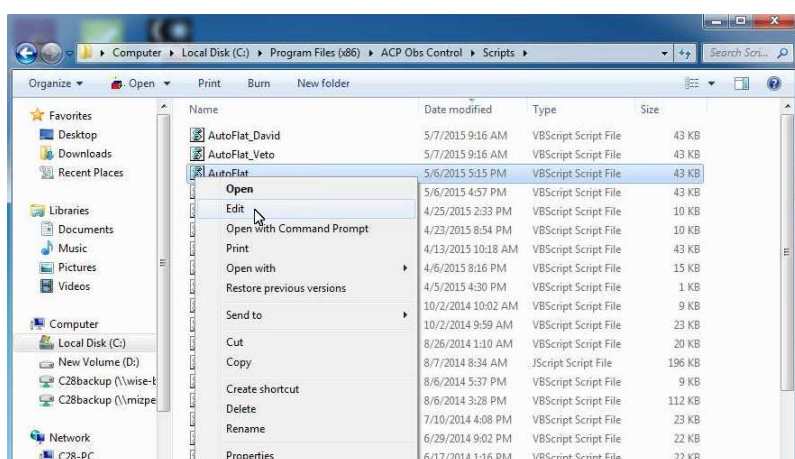
Note how the "no parking" sign changes into a yellow smiley face, indicating project is scheduled.



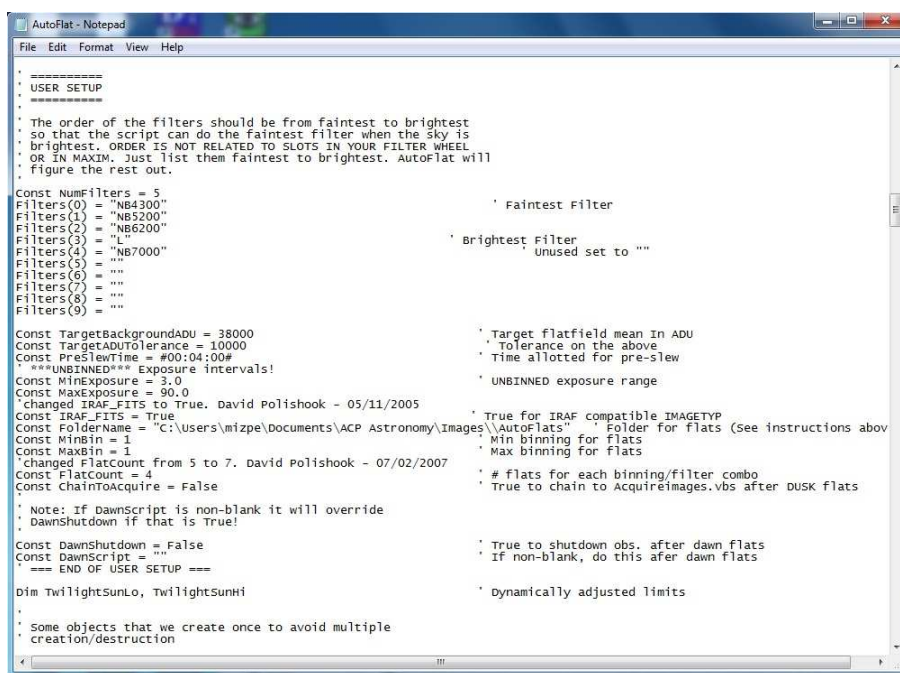
The science images are stored in: C:\Users\mizpe\Documents\ACP Astronomy\images\ Every night the Scheduler will create a folder with the current date in a format of yyyy-mm-ddc28 . This folder contains the science images and also the biases, darks, and flat-fields.

2.6.3 Creating 'AutoFlat' script

In order to take the correct flat fields, that suits your observations, at both dusk and dawn, you will need to create an “AutoFlat” script. Enter the default script folder: C:\Program Files (x86)\ACP Obs Control\Scripts, right-click the existing “AutoFlat” script and select “Edit”.



Scroll down until you reach the “User Setup” section:



Set the “Const NumFilters = x”, where x is the number of filters that are going to be used during the night.

Specify the filters that you are going to use (from faintest to brightest), by typing the filter’s names. The names should match the filter’s names as they appear in the MaxIm DL’s “Setup Filter” list. If there are empty lines, you must set them to ””, as the above example.

Save the file CTRL+S.

On Scheduler’s main window, you can find two check boxes: “Dusk flats” and “Dawn flats”. Checking any one of them, will run a script named: “AutoFlat”. The “Dusk flats” calls the script at sunset, while the “Dawn flats” calls the script just before sunrise.

Note: In order to take Dusk flats robotically, the script must be in the default folder, and you must start the Dispatcher at least 35 minutes before sunset. If you start the Dispatcher less than 35 minutes before sunset, the Scheduler won’t run the “AutoFlat” script, and will go to “Sleep” mode, in that case (and only in that case) you can manually load and run the “AutoFlat” script from the ACP, without stopping the Dispatcher. This won’t damage the robotic work, since “AutoFlat” ends before it is dark enough to start observing.

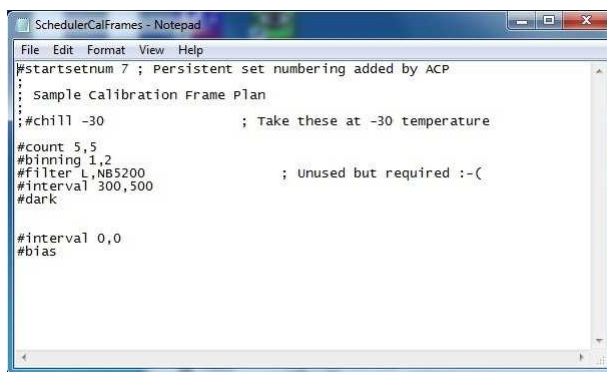
The flat field images are at C:\Users\mizpe\Documents\ACP Astronomy\Images\AutoFlats

2.6.4 Creating Dark & Bias file

Scheduler has an option to have ACP acquire dark and bias frames (cal frames) after observing completes. To do this, Scheduler simply runs an ACP observing plan called SchedulerCalFrames.txt. If this plan exists in the ACP default plans folder: C:\Users\mizpe\Documents\ACP Astronomy\Plans, the specified dark and/or bias frames will be acquired.

At the above default plan folder look for a file named “SchedulerCalFrames” and right-click to “Edit” it.

Here is a typical calibration frame plan for ACP. Note that it is a requirement for filters to be listed even though they are not used for cal frames. This is a quirk of ACP’s plan language:



```
File Edit Format View Help
#startsetnum 7 ; Persistent set numbering added by ACP
:
: Sample calibration Frame Plan
:
: #chill -30 ; Take these at -30 temperature
:
: #count 5,5
: #binning 1,2
: #filter L,NB5200 ; Unused but required :-C
: #interval 300,500
: #dark
:
: #interval 0,0
: #bias
```

This plan will chill the CCD to -28, then take 5 dark frames of 300 sec, binning 1, and 5 dark frames of 500 sec, binning 2 each. Then take 5 bias frames at binning 1, and 5 bias frames at binning 2.

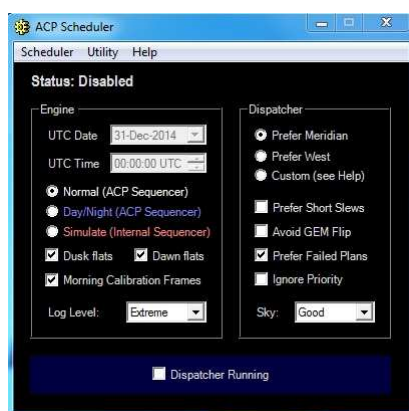
2.6.5 Starting the robot

Close any program running on the background, except for the “Clarity” window (which should be always running).

you probably want to use the “WatCam” as well to see the dome from the outside.

Open “ACP Scheduler” from its icon on the desktop.

Wait for 30 seconds, until this window appears:



If the Scheduler remains minimized, locate it on the toolbar (yellow gear icon at the bottom of the desktop), then right-click on it and choose: “Restore”.

Make sure the mode selector is set for Normal (ACP Night Only).

Check the box next to “Dispatcher Running”. Now the robot is running.

From this point, Scheduler will do anything necessary to accomplish the projects.

Note: No need to worry if nothing immediately happens. Your observations will be taken when constraints are met and when time is available for them; this means that there is no way to know exactly which and when a project executes. In other words: We cannot get an observing timetable from the Scheduler, but keep in mind that Scheduler itself wants to finish the work as soon as possible, so if conditions are good and constraints are met, then Scheduler will do the work as quickly as possible.

At any time, you can select View Log in the Scheduler menu to see a journal of the Scheduler’s activity or watch the progress via the Schedule Browser.

Alert: It is strongly recommended not to touch anything (e.g., open or close programs on

the background) while the Dispatcher is running, as it can cause the Scheduler to crash and most times forces to re-boot the computer. If you have to do something manually, you should first uncheck the Dispatcher Running check box. This will stop Scheduler from running, and prevent any software conflict.

Though the scheduler will sleep all day, you may want to stop it in the morning so you can shut down ACP, transfer images and files, or so it will not automatically start observing on the next night.

2.6.6 What's going on when Dispatcher is running?

What will happen immediately, after activating the Scheduler, depends on many parameters, such as time, targets, weather, sky condition etc. If Scheduler starts very early before sunset or it does not have work to do immediately when sunset, you'll probably see the status changes to "Sleeping". It means Scheduler is running and waiting for the right time to wake up. If you start the Scheduler 35 minutes before sunset and it needs to start working as soon as possible (e.g., catching a target before it setting), you will probably shortly see the status: "Open" and the Scheduler will start doing some "startup tasks". If you start the Scheduler 35 minutes before sunset, it will probably take "Dusk Flats" (if enabled and AutoFlats script was found), shortly after observatory has opened.

"Startup tasks" are done when Scheduler needs to open the observatory, e.g., at the beginning of the evening or when weather is safe again after an unsafe period of time. The "Startup tasks" is basically the indicator for ACP to run a script named: "StartupObs". This script has custom made for the C28 and can be used only for C28 operation. It was written by Saar Niv, and does all starting procedures in order to set the telescope, and also the softwares, so they are ready to work. The normal output when that script it operated is the following:

```
*** Welcome to the Wise Obervatory C-28 telescope!

==> Connecting with the dome. Please wait...
==>      (may take up to a minute!)
==> Applying power to the CCD camera...
==> Activating MaxIm DL...
==> Loading FocusMax + Robofocus...
==> Connecting with the cameras...
==> Turning camera's cooler on...
==> Applying power to the telescope...
```


==> Connecting with the telescope...

Telescope currently pointing at:

RA = 6h 29m 26.572s

Dec = -44d 34m 22.771s

==> Observatory is now open and ready to use!

When observatory is ready, and the weather is good the observatory will be opened on sunset and will activate the "AutoFlat" script. The normal output of that script is as following:

Initializing AcquireSupport V8.0.3

Weather safe, server is Boltwood Cloud Sensor II

Telescope is ACP->LXP, driver V1

Dome is ScopeDomeUSB Dome

MaxIm DL is version 6.11

Imager is FLI

Using focus offsets and star mags from FilterInfo.txt

Selecting filter ExoP from previous ACP run at 20160408@000146 UTC

Imager readout modes:

0 is 8 MHz

1 is 8 MHz (RBI Flood)

2 is 1 MHz

3 is 1 MHz (RBI Flood)

Using Normal and Fast readout modes from RoModeInfo.txt

Normal mode is 8 MHz (RBI Flood)

Fast mode is 8 MHz (RBI Flood)

Autoflat mode is 8 MHz (RBI Flood)

Guider is SBIG Universal (no rotator)

Guider plate scale unknown, guided dither with guider pixels

Max unguided exposure 30 sec.

(assuring that FocusMax is running now...)

Calculated unbinned plate scales (arcsec/pix): H = 0.83 V = 0.83

Calculated field of view (arcmin): H = 56.6 V = 56.6

Plate solving With GSC 1.1 (ok for wider fields)

All-sky plate solving will be attempted when needed

(ignore the filter message above)

Waiting to start dusk flats at 7:01:25 PM
Start slew to auto-flat area...
(wait for slew to complete)
(slew complete)
Starting dusk flats. Low Sun at 7:44:20 PM
Starting flat field acquisition.
Start slew to flat area in sky...
(wait for slew to complete)
(slew complete)
FLAT: Exp=3 Bin=1 Filt=Luminance
Background mean = 65536, sigma = 0.0 (ADU)
Still too light...waiting 1 min. to try again
OK, Sun is now at -0.4 deg. elevation
FLAT: Exp=3 Bin=1 Filt=Luminance
Background mean = 65536, sigma = 0.0 (ADU)
Still too light...waiting 1 min. to try again
OK, Sun is now at -0.8 deg. elevation
FLAT: Exp=3 Bin=1 Filt=Luminance
Background mean = 65536, sigma = 0.0 (ADU)
Still too light...waiting 1 min. to try again
OK, Sun is now at -5.2 deg. elevation
FLAT: Exp=3 Bin=1 Filt=Luminance
Background mean = 64799, sigma = 118.6 (ADU)
Still too light...waiting 1 min. to try again
OK, Sun is now at -5.5 deg. elevation
FLAT: Exp=3 Bin=1 Filt=Luminance
Background mean = 42378, sigma = 208.5 (ADU)
Start slew to flat area in sky...
(wait for slew to complete)
(slew complete)
FLAT: Exp=3 Bin=1 Filt=Luminance
Background mean = 33688, sigma = 179.4 (ADU)
Start slew to flat area in sky...
(wait for slew to complete)
(slew complete)
FLAT: Exp=8.97 Bin=1 Filt=ExoP

Background mean = 39272, sigma = 192.1 (ADU)

Start slew to flat area in sky...

(wait for slew to complete)

(slew complete)

FLAT: Exp=8.68 Bin=1 Filt=ExoP

Background mean = 29800, sigma = 160.9 (ADU)

Sun is now at -7.8 deg. elevation

Flat acquisition complete.

After the flatfield the scheduler is waiting for the sun to be at elevation of -12 degrees below the horizon and then it starts the "AutoFocus" script in which it uses FocusMax to focus the telescope. The normal output of that script is as follows:

Initializing AcquireSupport V8.0.3

Weather safe, server is Boltwood Cloud Sensor II

Telescope is ACP->LXP, driver V1

Dome is ScopeDomeUSB Dome

MaxIm DL is version 6.11

Imager is FLI

Using focus offsets and star mags from FilterInfo.txt

Selecting filter ExoP from previous ACP run at 20160408@000146 UTC

Imager readout modes:

0 is 8 MHz

1 is 8 MHz (RBI Flood)

2 is 1 MHz

3 is 1 MHz (RBI Flood)

Using Normal and Fast readout modes from RoModeInfo.txt

Normal mode is 8 MHz (RBI Flood)

Fast mode is 8 MHz (RBI Flood)

Autoflat mode is 8 MHz (RBI Flood)

Guider is SBIG Universal (no rotator)

Guider plate scale unknown, guided dither with guider pixels

Max unguided exposure 30 sec.

(assuring that FocusMax is running now...)

Calculated unbinned plate scales (arcsec/pix): H = 0.83 V = 0.83

Calculated field of view (arcmin): H = 56.6 V = 56.6

Plate solving With GSC 1.1 (ok for wider fields)

All-sky plate solving will be attempted when needed

Start slew to FocusArea...
(wait for slew to complete)
(slew complete)
Search 15 deg-square area for suitable target stars
Looking for stars between mags 10.6 and 15
Found mag 10.6 star, GSC 1925-1301; nothing within 169 arcsec.
Star J2000 coordinates RA=07:56:23 Dec=23 43' 52"
Using star at mag 10.6. Slew to star.
Start slew to AutoFocus...
(wait for slew to complete)
(slew complete)
Updating pointing...
Switching from ExoP to Luminance filter for pointing exposure
No focus change required
(taking 5 sec. exposure, Luminance filter, binning = 4)
(using 8 MHz (RBI Flood) readout mode)
(starting exposure)
(exposure complete)
(exposure complete and image downloaded)
Image finished
Plate-solve pointing image.
513 image stars found
507 catalog stars found
Solved! 114 stars matched.
Average residual is 0.36 arcsec.
Pointing error is 24.051 arcmin @ angle 176.69
True focal length is 2222.2 mm.
True binned plate scales (arcsec/pix): H = 3.34 V = 3.34
True image center (J2000): 07h 56m 28.9s 23 19' 51.29"
Imager sky position angle is 3.5 deg.
[sync] telescope synced
Re-slew to target.
Start slew to AutoFocus...
(wait for slew to complete)
(slew complete)
Target is now centered.

(AF will use 8 MHz (RBI Flood) readout mode)

Starting Autofocus...

**** Beginning Focus Run ****

FocusMax Version: 3.8.0.20

System: C28

Camera: FLI

LS: -0.011271 RS: 0.011813 PID: 522.97

Min/Max flux setting = 50/750K

Min/Max exp. setting = 0.05/5.00

Flux target = 193649

Using arithmetic mean

Move direction: In

Filter = Luminance (slot 4)

Current position = 819

NearFocus HFD: 7

Focus Start: 1967

Find star binning = 1x1

Initial exposure = 0.43

Target star found X: 2309 Y: 2367 Flux: 1290353 HFD: 259.03

Focus binning = 1x1

Total Flux = 1009383, next exposure = 0.08 sec

Target star found at X = 2279, Y = 2478 Flux = 234337

Max pixel = 2564 Count = 1

Focus exposure will be 0.08 sec

Position , HFD , Mean Best Focus , X , Y , Flux

1967	23.87	0	2279	2478	234337
------	-------	---	------	------	--------

1253	08.26	0	2282	2478	254575
------	-------	---	------	------	--------

On correct side of focus

Move to Near Focus HFD (7)

Taking 3 additional readings

1253	06.17	0	2282	2479	220537
------	-------	---	------	------	--------

1253	07.55	0	2282	2479	248130
------	-------	---	------	------	--------

1253	07.85	0	2284	2479	250812
------	-------	---	------	------	--------

Average HFD = 7.46

Making move to Near Focus

```

1214 07.05 0 2283 2478 255182
1214 07.32 0 2284 2479 259571
** Starting Near Focus **
Position , HFD , Mean Best Focus , X , Y , Flux
1214 07.32 855 2284 2479 259571
1214 06.84 876 2285 2479 257184
1214 06.97 879 2285 2479 253389
1214 07.32 873 2286 2479 257860
1214 07.29 870 2286 2478 257174
Best Focus is: 870
Moving to 870
870 03.47 870 2286 2479 237153
Decreasing subframe width to 30
870 03.28 870 2287 2479 230113
870 03.47 870 2286 2479 226367
Position = 870 Mean HFD = 3.41
Temperature = 623.00
Focus time = 367 sec
Auto-focus Completed
FocusMax auto-focus successful!
HFD = 3.41
Focus position = 870
Slewing back to original position...
Start slew to AF return...
(wait for slew to complete)
(slew complete)
Autofocus finished.

```

At this stage the scheduler will start doing observations that were given for it for that night. The dome will stay open the whole night, even if Scheduler finish its work and has nothing left to do.

If there is a problem with the scheduler and it crashes some of the following may appear in the ACP window and the scheduler will say "User Intervention"

```

Initializing AcquireSupport V8.0.3
**Script Error**
Source: ACP.AcquireSupport
Message: **The weather is unsafe. Cannot continue.

```

Traceback:

Failed in Main() at line 31 column 1

Script Context:

```
28: Set Telescope = Util.ScriptTelescope ' Need this for parking/tracking
29: Set ACP = CreateObject("ACP.AcquireSupport") ' Enables slewing
30:
=> 31: Call ACP.Initialize
    ~
32:
33:
34: ' =====
-- end --
```

If ‘User Intervention’ appears in the scheduler window the observer need to kill the scheduler window and take care of the problem.

At sunrise, Scheduler will tell ACP to run the “ShutdownObs” script which will first close the dome and then shuts down the rest, in an organized way.

IMPORTANT: If at some point, weather becomes bad or unsafe usually the ACP decide on closing of the dome using the weather script. If for some reason you want to close the observatory manually you should disconnect the Scheduler by unchecking the box near “Dispatcher Running” and manually run the “ShutdownObs” script from ACP. The script which can be found at the default path: C:\Program Files (x86)\ACP Obs Control\Scripts\ . This will first close the dome and then shuts down the rest, in an organized way, and will take bias and darks as were define for the scheduler.

2.6.7 End or Disconnect the robot

The observatory will automatically shut down at the morning after it will finish taking dark & bias calibration frames. Note that the dome should already be closed, since Scheduler closes the dome at sunrise to protect the CCD, and to take the calibration frames. Therefore, a closed dome does not mean observatory is shut down. When finished to shutting down the observatory, the ACP console will display:

```
*** The observatory has been closed.
```

On the “ACP Scheduler” panel, uncheck the box next to “Dispatcher Running”.

Logs of the whole ACP work are stored for each night in: C:\Users\mizpe\Documents\ACP Astronomy\Logs\

2.7 Manual Operation

A manual procedure to operate the C28 is suggested here.

Initialize

- Start about an hour before sunset so to allow the CCD time to cool.
- Open VNC to c28-pc.tau.ac.il.
- Make sure the time of the clock of the computer is local time and that the Dimension4 program is running on the c28-pc and is updating the UT. Note to close the Dimension4 program by pressing the minimize icon and NOT the close (X) icon.
- Open Skype to “c28-pc” to see and hear what is going in the C28 dome. If in parallel a Skype window is opened on the c28-pc computer close it to minimize computer resources.

- Open the Internet browser “Explorer” and go to <http://132.66.65.13> which is the relays box of the C28 (in the favorites bar there is a link to the “C28 Relay Switch”). Enter the user name and password for the observatory and you will be on the screen that enables to turn the power on and off to the different components.
- In the “C28 Relay Switch” window turn on the power to the CCD and to the telescope by clicking on “Switch On”. Then minimize the “Explorer” window.
- Open the ACP program from c28-pc desktop.
- Connect the ACP to the camera using the menu “camera”→“connect”. MaximDL windows will open and will be connected to the camera and the “coolers” will be turned on. Cool the camera to about -30 degrees in the winter and about -20 in the summer, making sure that at the stable temperature the “cool power” is about 90%. If the CCD does not goes to the temperature you desire, choose the temperature it reached to as the working temperature and make sure you take the flat-fields, bias, dark and images all with the same CCD temperature. To change the temperature use in the “setup” tab the “cooler” button (in the “Camera 1” area).
- In the MaximDL’s “Camera Control” window on the “Guide” tab click on the “Settings” button and make sure that the setup is: Xspeed= -2.094 , Yspeed= -2.024 , and Angle= 175.87 .
- Open “Total Commander”, make sure images from previous night are in the “c:\program files\ACP obs control\images\yyyymmddc28” directory and that they were backed up to “wise-gate/mizpe/C28backup”.
- You can open the “Target commander” to view the times, sun & moon positions, and to check target lists. You can load your target list into “c:\program files\ACP obs control\plans\” so that it will be available to the tool.

Open

- About 15 minutes before sunset:
- In the “ACP” window press “Telescope” → “Connect”. The ACP will be connected to the telescope and to the dome. the “ScopeDome” program will be opened as well.
- In the ACP click “Select the Script...” and choose the script “FS2_sync”. Then press “Run” to run the script which will check the telescope absolute encoders and will calibrate the telescope coordinates.
- In ACP press the “Dome Control” button to Open the “ACP Dome Control” window. In that window press the “open” button to open the dome. If the “open” button is not active try to press the “home”, “park”, or “close” buttons until the “open” button will be active (otherwise you can try to use the ScopeDome program to open the dome). The dome will open and then will follow the telescope.
- In MaximDL open the “Observatory” window (small observatory icon near the small CCD icon in the MaximDL program) and in the “setup” tab in the “Telescope” section press “connect” to connect MaximDL to the telescope. Also in the “Focuser 1” section press on “connect” to the Focuser. A “Focus-Max” and a “RoboFocus” windows will appear. Minimize the “Focus-Max” window and close the “Observatory” window.
- Click on the “config” button of the RoboFocus window and in the window that will be opened you will see the current position of the focus.
- Using the MaximDL’s “Camera Control” window in the “Expose” tab choose “Single”. Then move between the “Clear” filter and the “luminance” filter a few times and make sure the focus moves accordingly (press the “Get Current Position” in the “config” window of “Robo Focus”. The luminance position focus is around 500.

Flat-fields

- When the sun is at about -4 degrees below the horizon take flat fields. Make sure that the dome light is off. You can use the script “AutoFlat”. See section 2.6.3 to setup the script with the filters that you need. To operate the script choose it from the “Select the Script...” button and then press “Run”.
- You can also get the flatfield images in a manual operation in which you will take a sequence of exposures using the “autosave” option in certain filters with a delay between the exposures. During the delay between the exposures the telescope should be moved a bit using the option “move telescope here” that one gets when clicking the right mouse button on the image (when using the AutoFlat scripts the telescope moves automatically between exposures).

Calibration

- Check the telescope calibration by going to a bright star using the ACP window. Press “slew or sync” to send the C28 to a star (best to use the “_BrightStarCatalog.lst” list in the “Targets Commander” tool) and press “go to” . It’s best to choose a bright star near the zenith and a bit to the South-East to avoid the wind.
- The telescope and dome will move to the position you asked. Make sure the coordinates the telescope has arrived to are the ones you wanted.
- In the MaximDL’s “Camera Control” window from the “Expose” tab choose “Single” and take a 1 sec exposure. Check if the star is in the middle of the field. If not, point the mouse to the star and right-click the image and choose “Point Telescope Here”. Take another exposure and repeat this until the star is in the middle of the frame. You can also use the “Nudge” button and window to move the telescope a bit. When finished, make sure you have the initial coordinates in the ACP in the “Slew Or Sync Telescope” window, press “Sync” to calibrate the telescope coordinates, and click “yes” to confirm.

Focus

To focus the telescope:

- Take an exposure of a field for two seconds using the “Expose” tab in the “Camera Control” window and using the filter you will mostly use during the night.
- Make sure there is a suitable star near the center of the CCD (i.e., not saturated and not too faint - a few hundred counts are enough).
- Focus the telescope using the “Focus” tab of the “Observatory” window in MaximDL:
 - Go to the “Focus” tab of the “Observatory” window in MaximDLI. In the “Autofocus” section press “Start”. The tool will move on the different focus positions and will show in the curve the best focus.
 - Point to the focus to the optimal focus by entering the focus position in the “Absolute” window, and press move to.
 - The current focus for the “luminance” filter is around a position of 500.
 - Note that the position should always be between 2 and 2800. Do not allow the lens to move in any case beyond those numbers as the lens might get stuck.
 - Remember to write the focus position in the log you’ll fill in the morning.
- You can do a focus test for the telescope several times a night, since the focus might change with the temperature during the night.
- The telescope is now ready for work.

Observing

- In the ACP program go to your object using “slew or sync” where you enter the coordinates and press “go” .
- Operate the MaximDL guider using the “guide” tab in the MaximDL’s “Camera Control” window. Take one exposure by checking the “expose” check mark, enter an exposure time (note the declination is coming up automatically from the telescope), and press “start”.
- Note that the lamp in the dome is turned off while observing.
- Once you get an image choose a star for guiding and click on it. This will put its coordinates in the “X” and “Y” boxes. Check the mark next to “Track”, and press “start”. The telescope will start to track.
- To see a graph of the guider errors click on the “Graph” button.
- To take exposures go to the “Expose” tab in the “Camera Control” window. Press “Autosave” button and a window of “Autosave Setup” will appear.
- Setup the sequence you want to carry out (check the box next to the line you want, give an image name, the exposure integration time, and the number of exposures). Also change the “AutoSave FileName” into the current date, and when done setting press “ok”. To start the observation press “start”.
- NOTE: there is a caveat concerning using the “AutoSave” with a sequence of different filters and the guider. Please see the last paragraph of section 2.2 for details.
- When done, go to another object (while turning the dome light on) and so on the entire night.
- An alternative and better option is to use the “AcquireImages” script in which you need to prepare an observing “plan.txt” file for it and then the script will carry out your plan, including moving the telescope, moving filters, moving between objects, etc. Note that the images are written in a subdirectory with the date of the observation. To operate the script press the “Select the Script...” button and choose the “AcquireImages” script. Then press “Run” to run the script. You will be prompt to choose the plan from the list of plans, so choose your “plan.txt” file. Then the script will carry out the observing plan (no need for a second “Run” after choosing the plan).
- During the night you need to take bias and dark frames. In the “Expose” tab in the “Camera Control” window. Press “Autosave” button and a window of “Autosave Setup” will appear. Set up a sequence of about 5 darks with the exposure you have and about 5

bias. Also change the “AutoSave FileName” into the current date, and when done setting press “ok”. Then in the “expose” tab press “Start” to take and register the sequence of biases and darks. During this, the dome should be closed and the light be turned off.

Close

- Observations usually continue until the sun is -12 degrees below the horizon at sunrise. When finishing the work for the night you can take a flat field sequence if needed.
- Choose the script “ShutdownObs” and “Run” it. It will carry out the following actions (or you can carry them all separately by hand):
- In MaximDL’s “Camera Control” window in the “setup” tab press “Warm Up” and wait until the “Cooler Power” will go to zero. Then press “cooler off” and then press “disconnect” to disconnect from the camera.
- In MaximDL open the “Observatory” window (small observatory icon near the small CCD icon in the MaximDL program) and in the “setup” tab press on Focus 1 section “disconnect” to disconnect from the the Focuser.
- In ACP choose from the “Camera” menu the “disconnect” option.
- Move the telescope close to its parking position, i.e, to RA=ST and Dec=-45:00:00, using the “slew or sync” button.
- Move the dome to its home position using the ACP “Dome Control” window and choosing from the “dome” menu the “Home”.
- Close the dome using the ACP program “Dome Control” (click “Dome” → “close”).
- In ACP choose from “Telescope” menu the “Disconnect”.
- Exit the ACP program.
- Open the Internet browser “Explorer” and go to <http://132.66.65.13> which is the relays box of the C28 (in the favorites bar there is a link to the “C28 Relay Switch”). Enter the user name and password for the observatory and you will be on the screen that enables to turn the power on and off to the different components.
- In the “C28 Relay Switch” window turn off the power to the CCD and to the telescope by clicking on “Switch Off”. Then minimize the “Explorer” window.
- Open “Total Commander”. If images were written into a subdirectory named after the date of observations in the “c:\program files\ACP obs control\ images\” directory then rename it to `yyyymmddc28` and copy into it the other images like bias, dark, and flats that were not written to it. Then copy this subdirectory to `wise-gate/mizpe/C28backup` . Verify that the files were copied correctly, i.e. check the sum of image sizes in kb is the same in the original and copied directories.
- It is the responsibility of the principal investigator (PI) of the night to make sure that all

files were backed up correctly.

- Fill out the log in: <http://wise-obs.tau.ac.il/observatory/log.html?C28>
- Close your Skype connection to c28-pc.
- Go to sleep.

2.8 Tips and Trouble shooting

Closing manually

If you want to close the observatory before the end of the night you need to stop the scheduler and by unchecking the Dispatcer and run the "ShutdownObs" script from ACP so that it will close the observatory and take bias and darks, or run the "ShutdownObs_old" if you do not want to take bias and darks.

When ScopeDome sticks and does not close the dome or accept commands

Close the ScopeDome window. In the Internet browser "Explorer" and go to <http://132.66.65.13> which is the relays box of the C28 (in the favorites bar there is a link to the "C28 Relay Switch"). Enter the user name and password for the observatory and you will be on the screen that enables to turn the power on and off to the different components. Turn off the power to ScopeDome and then turn power on again. Now open the ScopeDome window and things should work.

When there is unsafe weather

When the weather script closes the observatory due to unsafe weather the power to the telescope and the CCD does not stop. Since the telescope keeps tracking as long as it has power it keeps going to the west and after some hours will hit the limit switch on the west. One needs to be alert for this and every few hours to move the telescope to the East so that it will not hit the limit switch.

When the weather script is activated due to bad weather and close the dome, the ACP waits for 10 minutes of good weather before it declares safe weather and resume observations.

The weather is connected to the ACP and not to the Scheduler, so the weather script will work even when the Scheduler is disabled.

Check the weather

Please check the weather frequently using also the clarity of the C28, and the weather station of the 1m (weather-pc), and the cloudwatcher computer. If you do not have a communication to one of these 3 computers please contact the observatory staff for details. Another option is to call the observers on the 1m and to ask them to call you when they close the 1m (with the hope that they will remember to do so).

Humidity limit

The weather station has limits in humidity of 100% since if we give it the true value (85%) it gives problems. The weather script of the ACP is checking the station and if humidity is above 85% it closes the dome, although the clarity will say that it is still good weather (since it is still below 100%). The ACP closes the observatory automatically at 85% and so you should do. If humidity in the clarity is 85% (which means in the weather-pc of the 1m it is 90% (there is ~5% difference between them) you should close the observatory.

To run a script when the weather script is active and weather is bad

If the weather is bad and the dome is closed and you want to call the night off and close everything then: in order to run a shutdown script when the weather script is active, first stop the dispatcher by unchecking the box next to it. Then disconnect the weather sensor from the ACP by going into the “Weather” tab of the ACP and hit “disconnect”. Then go to the ACP “preferences” into the “weather” tab and uncheck the box next to the “Enable weather services”. Only then it is possible to run any other script. Once you are done with the other script remember to go back to the ACP “preferences” into the “weather” tab and check the box next to the “Enable weather services”. The weather will connect automatically when the Scheduler will be reopened, or you can go to the “Weather” tab of the ACP and hit “connect”.

Must do at the end of work

At the end of the work it is advised to check that the power to the CCD and the telescope are off. To do this open the Internet browser “Explorer” and go to <http://132.66.65.13> which is the relays box of the C28 (in the favorites bar there is a link to the “C28 Relay Switch”). Use the user name and password for the observatory if needed and you will be on the screen that enables to turn the power on and off to the different components. If the “Explorer” is already there make sure to “reload” the page to get the current situation. If the CCD and telescope are not off then in the “C28 Relay Switch” window turn off the power to the CCD and to the telescope by clicking on “Switch Off”. The “ScopeDome” and “WeatherStation” relays should be always on. Then minimize the “Explorer” window.

Robofocus window does not open on the screen

When Robofocus window does not open on the screen, but opened minimized in the bottom bar, one needs to close it then go to the “Properties” of the icon and on the tab of “Shortcut” in the line of “Run” choose “Maximized”. Then click OK and run the Robofocus from its icon. It will be opened with the windows maximized on the whole screen and you will be able to adjust the size of the window. Once done close the program and go again to its “Properties” and choose for the “Run” the option “Normal Window”. The next time you will run Robofocus it will be opened to the size you choose.

Manually close the dome

When you have a gap in the observations and you want to close the dome for some time, you can run the ACP-waether script from the ACP window. Another option is to stop the dispatcher and then manually close the dome. Or run the “ShutdownObs” script from the ACP, if you want to call the night off. Always remember that when the dome is closed and there is still power to the telescope then it keeps tracking the sky and after some hours it will hit the limit switch so one has to move it to the East every few hour so that it will not reach tot he limit switches or get too low in elevation.

AutoFlat script start

The Scheduler starts the AutoFlat script only when the sun is in the the elevation that was defined for it to start (sun at 0 degrees on the horizon).

Scheduler Morning calibration frames

In the scheduler the “Morning calibration frames” option has to be unchecked. This option is legit as long as the “Close” button in the ACP can park the dome and close the shutter (like, for example, in the C18). For some reason the ScopeDome won’t behave that well and a special procedure is needed to allow the closure. When checking the “Morning calibration frames” option, the Scheduler orders the ACP to press the “Close” button just before taking the darks & bias, but since this command is not working with our ScopeDome, the result is that it ends with failure (“Dome/roof failed to close within 5 minutes”) and ACP throws this error after it waits too long. Instead, Sa’ar designed the Shutdown procedure so it can bypass this problem. If the “Morning calibration frames” option is unchecked, the Scheduler thinks it has nothing else to do after taking dawn flats, so it runs the “ShutdownObs” script. This script contains the special procedure for closing the dome, but it is not really shutting down the observatory. When the dome is closed and the telescope is parked, it chains another script that takes the morning calibration frames (darks & bias), when done, this script chains another script named: “FinishShutdown”, which ends all other tasks and completes the Shutdown.

Scheduler workig mode

The scheduler is designed to work with the RBI flood mode and with astrometric solution. If one wants to work without any of these feature one need to work in manual mode.

Scheduler starts before time

Sometimes when starting the scheduler and enabling the “Dispatcher Running” it stars open up the telescope and dome straight away without waiting for the sunset. This happens when changing the mode of operation in the main panel of the Scheduler and then returns it back to the right one which is “Normal”. The solution is to set the mode to the right one (“Normal”), and then to restart the computer.

Find Lost Scope script

If the telescope is not able to calibrate its coordinates, i.e. using the FS2_sync script does not do accurate work, and the telescope has the wrong pointing coordinates one can run the script called FindLostScope which is doing a search over all sky and find the position of the telescope.

If FindLostScope+FS2_sync do not solve the problem of the telescope calibration one can fix it manually by switching the astrometric solution catalog from USNO to GSC with a smaller number of stars, this helps decreasing the time needed for the astrometric solution.

Observing different fields in a repeating sequence

The scheduler is not suitable for observing different fields in a repeating sequence. For that task one needs to use the “AcquireImages” script which can loop over the fields. In this case, it is better to work in a “Semi Robotic” mode, which means, the Scheduler can do all startup tasks and focus, then it should be disconnected and one should run the “AcquireImages” script. When work is done, it is possible to re-engage the Scheduler so it will take flats, bias/dark and close the observatory. Another option is to run the “AcquireImages” script when the scheduler is in its sleep mode, but one has to make sure that the script ends before the scheduler exits its sleep mode (e/g/. to observe an object or to do the closing in the morning.

Names in image header

One can put in the observer name and the object name in the header by using in MaximDL: File → settings → FITS header, and choosing the object or observer keyword and editing it. However, note when you finish the observations you have to change it back to blank value, otherwise the next day it will have the same values as you changed it to.

Test menu of the Scheduler

The Scheduler has a Test menu that one can use in order to operate only part of the scheduler sequence. To operate scripts from the Test menu the dispatcher must be unchecked and then one can run the scripts in order to startup, shutdown, take flats etc.