Addendum 2 to the DLR Camera User's Manual

Use of the Andor Camera with the liquid cooler

Version 0.06

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Starting from Aug 9, 2023 the DLR Andor camera can be used with an external liquid cooler - in addition to the internal thermoelectric cooler (TEC) - which enables achieving deeper CCD temperatures. In addition to the obvious advantages in terms of performance, there are some risks for the instrumentation associated with the use of the circulator. For this reason, it is important that the user of the system strictly adheres to the guidelines highlighted below. The responsibility for the correct use of the equipment lies completely with the observer. The mentioned risks concern the possible build up of moisture and the overheating of the TEC. Both events can have catastrophic effects on the camera system. The two points the observer should be aware of are:

1) The temperature of the refrigeration liquid should not go below the dew point. Otherwise moisture will build up in the camera and damage the electronics.
2) Using liquid cooling allows deeper CCD temperatures to be achieved. Whenever setting a deep CCD temperature (< -30 C) make sure that the refrigerator pump is switched on. Selecting a deep temperature on the camera GUI while the refrigerator pump is off can overheat and destroy the TEC.

In order to simplify the operations of the camera, a new automatic control of the coolant liquid temperature has been implemented in the cooler application. When this mode is selected (highly recommended) in the **`Configuration/Temperature settings`** dialog of the Coolit! program, the cooler follows automatically the dew point temperature, thereby avoiding condensation. This operation mode assures that the coolant is always at the lowest possible temperature.

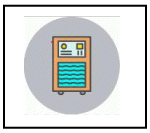
Calibration tests have shown that the actual dew point lies a couple of degrees below the reading reported by the program's hygrometer, so small excursions (a few tenths of degree) below the dew point represent no problem. Due to the time constant of the system, if a very rapid increase in the relative humidity takes place, it could happen that the coolant temporarily lies considerably below the dew point, in which case a sound alarm is generated by the application. In this case the cooler "catches up" within a minute or two, and there is no need for action, although the user should be alert.

When using the auto mode, the user only needs to care about the CCD temperature. In order to simplify the choice of the CCD temperature, starting from version 1.07 the camera GUI shows an additional field in the **`CCD temperature Control`** group box showing the TEC delta T. This value represents the temperature difference between the cold and hot side of the TEC. The user should select the CCD temperature as cold as possible, but such that the TEC delta T is never colder than -67°C. At a TEC delta T below -62°C the corresponding led symbol becomes yellow, indicating that the situation requires attention. At a TEC delta T of -67°C the corresponding led symbol becomes red and an alarm beep is issued.

The TEC deltaT depends on the coolant temperature, which in turn depends on the current dew point temperature, and will change during the night. The observer shall be prepared to adjust the CCD temperature during the night whenever it approaches the critical temperature.

Start of observations

1) Start filterwheel and telescope GUI on Wastro12
2) Restart TECS and RTS2 via corresponding icon on Wastro12 desktop
3) Open the liquid cooler GUI on Andor-Controller by clicking on the Icon (Coolit! app).



4) Make sure that the operation is in automatic mode in the **`Configuration/Temperature Settings`** menu entry.
5) Start the pump.
6) Start the camera acquisition program (**`Astphot/acquire`**)
7) Set the desired CCD temperature in the **`Configuration`** pane of the camera acquisition program. The temperature should be chosen so that the TEC delta T is never colder than -67°C.

End of observations

1) Warm-up the CCD to a temperature of -20°C.
2) When the set temperature is achieved, quit the camera GUI.
3) Switch the pump off on the liquid cooling device and wait for the pump LED to become gray.
4) Close the liquid cooler GUI.

Known issues and mitigation measures

TEC glow

The Andor camera suffers from a glow from the thermoelectric cooler, which produces streaks of light propagating from the right-hand side (larger column numbers) of the chip. The glow is a function of the TEC dissipated power, which is in turn a function of the temperature difference between the temperature of the coolant liquid and the CCD temperature. So, the best performance for the camera will be a trade-off between dark current generation (which requires a deeper CCD temperature) and a low glow generation (which requires a higher CCD temperature and a lower liquid coolant temperature). The glow can be calibrated out, provided bias and dark frames are available at the same CCD and liquid coolant temperature as the science frames. The user should therefore plan to acquire adequate

calibration frames. Some stock bias and dark frames for a number of CCD and liquid coolant temperatures are available on the CAHA ftp server under the `/Andor/darks/` directory.

CCD residual image and stability of the CCD sensitivity

It has been observed that at higher temperatures (>~ -40° C) the camera exhibits a residual image for high intensity sources. Also, at those high temperatures the sensitivity of the chip seems to exhibit a hysteresis. Both the issues are greatly reduced at lower CCD temperatures. However, a few practices are advised for best performance.

1) Before acquiring the first science image, after the camera has been switched on and has reached the operating temperature, acquire a couple of flat fields in the illuminated dome at a near-full well level. This procedure appears to stabilize the sensitivity of the camera.

2) Even at low temperatures, a very low level of residual image appears to be present in the chip. While the level is so low that it is not visible in science frames, it might be visible in long dark exposures. It is therefore recommended to acquire dark frames after the camera has been switched on and has reached the operating temperature. If, on the other hand, for operational reasons, darks need to be acquired after science images or after flat fields, it is recommended to warm-up the camera to 0° C first and then cool it again to the operational temperature. This procedure erases any residual image that might be present.

Flat-field pattern

The Andor CCD exhibit quite a flat-field strong pattern (at the 4 – 5 % level) that is wavelength-dependent and is particularly conspicuous in the blue end of the spectrum. The pattern is well removed by flat-fielding when using narrow-band filters and medium-band filters as Johnson R and V. Using very broad band filters, as the clear filter and the luminance filter, however, might result in a partial removal of the pattern.

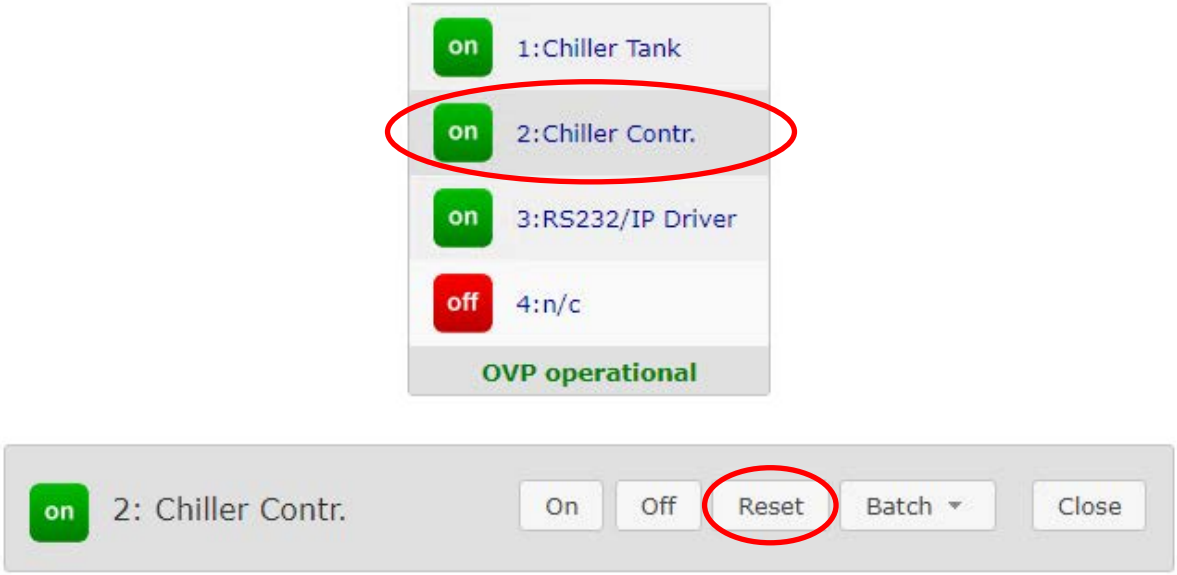
Liquid cooler warnings

The liquid cooler is controlled by the acquisition computer via an application. During the first weeks of operations, a few issues have been encountered, of which the camera user should be aware. Most of these issues are temporary, and the system recovers by itself. Some other issues require intervention by the user or by the CAHA staff.

1) The status of the cooler is polled by the acquisition computer every 5 seconds. It has happened that rarely a communication error occurs, and the cooler unit is reported offline. If this condition occurs when the cooler is operating, a warning beep is generated by the application. In general, the condition is benign, and the connection is recovered during the next poll. In such case the user has no action to take. However, if the condition persists, so that the error is issued continuously every 5 seconds, this means that the device is really unreachable. This could be due

to a general network error, or by the device being powered down. The user should get in touch with the CAHA staff, so that they will verify the functioning of the device.

2) Occasionally the cooler has reported the warning #-21 or #-22, which signifies a problem with one of the compressors. In such cases, until now the cooler has autonomously performed a reset, which has resolved the issue within a few seconds. In this case there is no action to take. However, should the condition persist, then the user should try to power-cycle the device. This can be achieved by logging into the cooler power strip web control page by typing the URL `ikonreschiller.caha.es` in a browser with the username `user` and the same password as the computer ultra2. At this point press on the reset button corresponding to the item "2: Chiller Contr.", as shown in the following picture.



3) Occasionally the cooler has reported the error "#-16 TRIAC/RELAY CONNECTION OPEN". In general, this condition is persistent and requires a power cycle to be fixed. Should this condition occur, the user can use the reset procedure described in point 2.

In any case, should any error condition occur that causes an alarm by the cooler and that is not resolved spontaneously within a few seconds or that is not resolved by power-cycling the device, then the CAHA staff should be alerted.