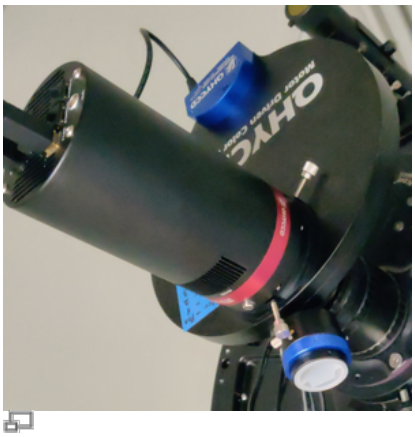
Specialised Astro Cameras

CMOS Cameras



Our QHY 600M including filter wheel

Our main cameras are CMOS cameras developed specifically for astrophotography. For deep-sky imaging we use two QHY 600Ms, which offer, among other things, a full-frame sensor, very high quantum efficiency, very low readout noise, and a very low dark current. For these cameras we also have an off-axis guider, one filter wheel with 9 positions, and one filter wheel with 7 positions.

A QHY 268M serves as the main camera for our two spectrographs. We also have a veTEC 533C from Omegon and a range of guiding and planetary cameras. These are used primarily for solar observations or as guiding cameras (see e.g. here) in combination with the QHY 600M and the spectrographs.

We have dedicated a separate article to the assembly of some of the cameras.

Main Cameras

	QHY 600M	QHY 268M	veTEC 533C
Model number	QHY 600M PRO-L	QHY 268M-PH	Omegon Pro veTEC 533C
Pixel size	3.76 μm x 3.76 μm	3.76 μm x 3.76 μm	3.76 μm x 3.76 μm
Number of pixels	9576 x 6388 (9600 x 6422 with overscan)	6252 x 4176 (6280 x 4210 with overscan)	3008 x 3008
Total chip size	36 mm x 24 mm	23.45 mm x 15.7 mm	11.3 mm x 11.3 mm
High Conversion Gain (HCG)	Photographic DSO Mode (#0): 26, High Gain Mode (#1): 56		101? (not published)
Max. ADC bit depth	16 bit	16 bit	14 bit
Field of view with CDK20	35.8' x 23.4'	23.3' x 15.6'	11.2' x 11.2'
Sampling	4.5 pixels per arcsec	4.5 pixels per arcsec	4.5 pixels per arcsec

Our QHY 268

Our QHY 485

Planetary/Guiding Cameras

Model	Model number	Number of pixels	Pixel size [µm]	Chip size [mm]	HCG	Bit depth (native)	Readout noise [e^-]	FPS	Peak QE [%]
QHY 485C	QHY-5-III-485C	3864 x 2180	2.9	11.2 x 6.3	-	8 & 16 (12) bit	0.77 - 2.4	44 @ 8 bit	> 90
QHY 462C	QHY-5-III-462C	1920 x 1080	2.9	5.6 x 3.2	100	8 & 16 (12) bit	0.5 - 2.6	135 @ 8 bit	> 90
ZWO ASI174	ZWO ASI174MM Mini Mono	1936 x 1216	5.86	11.3 x 7.1	-	10 & 12 (12) bit	3.5 - 6.0	128 - 164 @ 12 or 10 bit	77
ZWO ASI220	ZWO ASI220MM Mini Mono	1920 x 1080	4	7.68 x 4.32	106	8 & 16 (12) bit	0.6 - 3.2	7 - 14 @ 16 or 8 bit	92
ZWO ASI678	ZWO ASI678MM	3840 x 2160	2	7.7 x 4.3	182	12 bit	0.6 - 3.5	47.5 @ 12 bit?	83

Note: The QHY 462C has a high quantum efficiency in the red to near-infrared range, making it particularly interesting for planetary observations. In addition to the usual UV/IR filters, we have for this camera an IR850 filter that transmits only near-infrared light, as well as a relatively narrow-band methane filter around 880 nm.

Filter Wheels

QHY 600M

For the QHY 600Ms we have two filter wheels. The first is a QHY CFW3-XL with the following Bessel filters:

Filter position	1	2	3	4	5	6	7	8	9
Filter	H_alpha	OIII	SII	U	B	V	R	I	Clear
Comment	Narrowband	Narrowband	Narrowband	Broadband	Broadband	Broadband	Broadband	Broadband	

The transmission curves of the UBVRI filters can be found on the *Baader Planetarium* website: Filter transmission. The filter curves of the narrowband filters are similar to those of the STF-8300.

The second is a QHY CFW3-L with the following SLOAN/SDSS filters:

Filter position	1	2	3	4	5	6	7
Filter	u'	g'	r'	i'	z-s'	y'	Clear
Comment	Broadband	Broadband	Broadband	Broadband	Broadband	Broadband	

The transmission curves of the ugriz' filters can be found on the *Baader Planetarium* website: Filter transmission.

We also have a UFC filter changer system for our RASA 11 V2, which can be fitted with 50 mm x 50 mm square filters. We currently have a complete set of SLOAN/SDSS filters (see above) and H-alpha, O-III, S-II Ultra Highspeed filters.

CCD Cameras

In addition, four older CCD cameras (ST-7, ST-8, STF-8300M, ST-i) from SBIG (*Santa Barbara Instrument Group*) and one CCD camera (Skyris 445C) from *Celestron* are available.

The ST-7, ST-8, and STF-8300M are deep-sky cameras, although they are now rarely used due to their relatively small field of view. The ST-i and the Skyris 445C are “planetary cameras” that allow very short exposure times.

Our SBIG ST-8

All cameras can be controlled via Maxim DL.

Technical Data

	ST-7	ST-8	STF-8300	Skyris 445	SBIG ST-i
Model number	ST-7XME-D	ST-8XME	STF-8300M	Skyris 445C	ST-i Monochrome
Pixel size	9 μm x 9 μm	9 μm x 9 μm	5.4 μm x 5.4 μm	3.75 x 3.75	7.4 x 7.4
Number of pixels	765 x 510	1530 x 1020	3326 x 2504	1280 x 960	648 x 486
Total chip size	6.9 mm x 4.6 mm	13.8 mm x 9.2 mm	17.96 mm x 13.52 mm	6.26 x 5.01	4.8 x 3.6
Field of view with CDK20	6.9' x 4.6'	13.7' x 9.2'	17.9' x 13.5'	6.2 x 5.0	4.8 x 3.6
Sampling	1.9 pixels per arcsec	1.9 pixels per arcsec	3.1 pixels per arcsec	3.4	2.3

Filter Wheels

ST-7 & ST-8

A filter wheel with the following filters can be attached to the ST-7 and ST-8:

Filter position	1	2	3	4	5	6	7	8	9	10
Filter	U	B	V	R	I	H_beta	H_alpha	UHC-S	OIII	EMPTY

Comment	Broadband	Broadband	Broadband	Broadband	Broadband	Narrowband	Narrowband	Narrowband	Narrowband	

The transmission curves of the UBVRI filters can be found on the *Baader Planetarium* website: Filter transmission. The filter curves of the narrowband filters are similar to those of the STF-8300.

STF-8300

A filter wheel with the following filters is available for the STF-8300:

Filter position	1	2	3	4	5	6	7	8
Filter	Block UV/IR (L)	Blue	Green	Red	H_alpha	OIII	V	B
Comment	Luminance	Broadband	Broadband	Broadband	Narrowband	Narrowband	Broadband	Broadband

The transmission curves of the filters can also be found on the *Baader Planetarium* website: Filter transmission

The transmission curves of the V and B filters are identical to those in the ST-7 and ST-8 respectively.

Special Features

- An adaptive optics unit, the AO-7, can be placed in front of the ST-7 and ST-8, which can be used for guiding and optimising image quality (see e.g. here).
- In addition to the main imaging chip, the ST-7 and ST-8 contain a secondary guiding chip that allows the telescope to automatically track an object (see e.g. here) while the main CCD captures the actual images.
- The off-axis guiders of the STF-8300 and the QHY 600M have the advantage of being mounted in front of the respective filter wheel, meaning that guiding is independent of the guide star's brightness in the selected filter. As a result, fainter objects can be used as guide stars with these two cameras than is possible with the ST-7 or ST-8.

Maintenance

The desiccant cartridges of the cameras must be regenerated (baked out) at least every 12 months, otherwise there is a risk of ice forming on the cooled CCD sensors during winter. The desiccant cartridges of the ST-7 and ST-8 are located on the underside of the cameras and can be easily removed from the camera body with a screwdriver. This process is even simpler with the STF-8300, as the desiccant cartridge (mounted on the side) can simply be unscrewed by hand. The connection between the camera body and the desiccant cartridge is sealed with an O-ring, which unfortunately tends to slip off the cartridge and disappear into the camera's electronics. Care should therefore be taken here! To prevent unnecessary moisture accumulating inside the camera, the removed desiccant cartridge should be replaced with the dummy stored in the lab room. After four hours at 170 °C in a conventional oven (without the O-ring), the desiccant material inside the cartridges should be regenerated and ready to keep the cameras operational for another year.

DSLR

A Canon EOS 700D digital SLR camera is also available for short-exposure imaging and lucky imaging. This camera has been optimised for astrophotography by Baader through a replacement of the built-in filters. The transmission properties of the original Canon filter compared to the Baader filter can be seen in this image click (Baader Planetarium).

Technical Data

Our DSLR (Canon EOS 700D)

	EOS 700D
Image sensor	CMOS sensor
Pixel size	4.3 μm x 4.3 μm
Number of pixels	5184 x 3456
Total chip size	APS-C 22.3 mm x 14.9 mm
Crop factor and aspect ratio	1.6 and 3:2
Field of view with Celestron C14	19.6' x 13.1'
Field of view with Celestron C11	27.4' x 18.3'
Field of view with Celestron C11 + F/6.3 focal reducer	43.5' x 29.0'
Field of view with Celestron C8	37.7' x 25.2'
Field of view with Celestron C8 + F/6.3 focal reducer	59.9' x 40.0'
Exposure times	30–1/4,000 s (half or third stops)
ISO sensitivity	100–12,800 (expandable to 25,600)

Full HD video recording is also possible at a maximum ISO sensitivity of 6,400 (expandable to 12,800). The camera can be controlled via the tiltable and swivelling 7.7 cm LCD touchscreen or via a laptop. The continuous shooting speed is up to approximately 5 frames/s, maintained for approximately 22 shots (JPEG) or 6 shots (RAW).

It is also possible to control the camera remotely via computer.