

Science camera description (revised Jan 10, 2018)

1. Sony UMC-S3CA:
 - a. 12 MP stills, HD and 4K video
 - b. 35 mm full-frame sensor
 - c. Extremely sensitive, up to ISO 409,000, 0.004 lx.
 - d. Self-recording to internal SD card with flexible compression options. Spec sheet says it can use 64 GB SD cards for up to 2 hrs of 4K video in XAVC S format at 100 Mbps. Likely it will support larger cards, we will have to test. Recording options include 100, 50, and 16 Mbps. 16 Mbps would provide 11 hrs on a 64 GB card. Between these options and the possibility of using larger cards (512 GB are available), this should be satisfactory. We will be testing the max SD size this month.
 - e. Records jpg and raw stills
 - f. includes a mechanical shutter
 - g. Remote control through serial interface, linux driver available (according to our sales rep. We need to confirm this).
2. Lens: Field of view?, minimum aperture? Our MIT colleague, Allan Adams is very familiar with the Sony/Zeiss lenses and has assembled a list of candidate lenses in the 28-55mm range. I suspect MBARI may have some direct experience as these are the same lenses used on the Sony A7S2. Alan also can recommend a zoom, but I think that should be a future upgrade. Currently, we are thinking a normal (50mm) lens would be best. We discussed this on our telcon today and Steve Rock seems inclined to go this way. If MBARI is in agreement, then ~50mm will be the choice. Recall this choice is for the science camera, the tracking cameras may have a wider FOV.
3. Domed housing. A 50 mm lens puts us in a position where we could use a dome or a flat plate. But given our emphasis on image quality, we strongly prefer a dome. Our preference would be to use an available housing and dome. Camera body WxHxD is 4 1/8" x 3 3/8" x 1 15/16", so the diagonal is 5.33". Preliminary estimate 6" or 8" internal diameter 14" long cylinder with optical dome on one end, domed end cap on the other. Flat end cap might make integration easier.
4. Normal operation would be fixed focus and fixed aperture, although both could be changed on-the-fly through the remote control interface
5. Camera video could be turned on/off, compression modes changed, and stills requested through the remote control interface.
6. Remote control interface would be addressed by the mission executive in the TX2
7. The remote control interface will support changes to focus and aperture, although we do not expect to take advantage of those features initially.
8. Power consumption: the UMC-S3CA spec sheet says "19 W (including lens)". Preliminary bench tests show that the camera draws ~6 watts while recording and ~4 watts without recording with no viewfinder. The power consumption increases with higher ISO settings but not dramatically. Charlie is quantifying these relationships now (power consumption as a function of ISO setting, recording mode, etc).
9. Recording media: our preferred method would be to record on an external SD card so we would not open the housing between dives. If that turns out to be unrealistic, then we have the option of opening the housing.

Summary: we need to consider the most appropriate lens. Here are some basic FOV and resolution specs for some common lenses:

Focal length	Horizontal angular FOV	Vertical angular FOV	Horizontal FOV at 1 m	Vertical FOV at 1 m	HD resolution	12 MP resolution
50mm	39.6°	27.0°	1.08m	0.72m	0.5mm	0.25mm
35mm	54.4°	37.8°	1.54m	1.03m	0.8mm	0.36mm
28mm	65.5°	46.4°	1.93m	1.29m	1.0mm	0.45mm

Notes from Allan's email 2017/10/18 concerning lens choices. If we decide to go with ~50mm, I think we would choose the Sony Sonnar 55 f/1.8 ZA

Lens	FOV (deg)	Min f (cm)	Mag	OD(mm)	Length (mm)
PRIMES					
A. Sony FE 85 f/1.4 GM	29	80	0.13	90	108
B. Zeiss Batis 85 f/1.8	29	80	0.13	81	92
C. Sony Sonnar 55 f/1.8 ZA	43	50	0.14	65	71
D. Sony Planar 50 f/1.4	47	45	0.15	84	108
E. Sony Distagon 35 f/1.4 ZA	63	30	0.18	79	112
F. Sony Sonnar 35 f/2.8 ZA	63	35	0.12	62	37
G. Sony FE 28 f/2	75	29	0.13	64	60
H. Zeiss Batis 25 f/2	82	20	0.19	81	78
ZOOMS					
I. Sony FE 24-70 f/2.8 GM	84-34	38	0.24	88	136
J. Sony FE 16-35 f/2.8 GM	107-63	28	0.19	89	122

Notes:

A&B: Two excellent 85mm primes. The Batis is markedly lighter and meaningfully smaller; the Sony GM has slightly (very slightly) better optical quality. Both are amazing lenses. No accident that they are very similar, they share many of the same core design choices. Important consideration with such long lenses, though: with an 80cm minimum focus distance, you will want to use a flat port rather than a dome, or will need to add suitable optics/diopter after the lens. That will trim your FOV a little further, but not too much.

C&D: Both excellent ~50mm primes. I own (and love) the Sonnar 55/1.8, which is smaller, lighter, and beautiful. The Planar is a lot bigger around, and longer, and heavier. It is arguably a better lens, but the difference is not overwhelming. With min focus of ~50cm, you might be able to get away with a large dome with optics/diopter, but more likely just go with a flat port.

E&F: Two great 35mm lenses with diametrically opposed designs. The Sonnar is TINY! The Distagon is much larger, almost the size of a serious zoom. Both are great lenses. The Sonnar is a little soft in the corners and has a bit more distortion, so for technical purposes you need to accurately model the lens. The Distagon is clearly a better lens, but not wildly so — and is a much bigger beast to handle. The Sonnar is just amazingly small — perhaps too small, actually, since you need the entrance pupil of the lens to sit at the center of the dome, and that pulls the camera body close to the dome, which will be important in designing the full housing. Something to consider. As for domes, you are looking at a 7-8" dome here without other modification, but we can probably add optics to tuck it into a 6" dome. You

could also go with a flat port, but at this FOV you start getting hit with significant aberration (chromatic and plain distortion).

G&H: Very different lenses. The 28 is amazingly clean — distortion is absolutely minimal — but there's a fair amount of vignetting. The 25 distorts a hair (still very low), but vignetting is much less. And again the Batis is considerably larger, though not a beast. Very easy to pair with a suitable dome.

I&J: Two nice zooms for your consideration.