

i2MAP Dorado Midwater Imaging AUV Preliminary Design Review



Rev 1.0

Scientific Requirements

The goal of the i2MAP project is to develop an autonomous imaging system that will allow us to automate the midwater time-series data collection process; to shift from ROVs to AUVs.

Basic scientific requirement: To build a system capable of collecting video transecting imagery and environmental data of the quality of that currently collected with the ROVs, or better.

ROV transecting data is currently collected under the following conditions:

- Video quality = 1080i, 30 fps
- Wide field of view (~85° horizontal)
- Adequate and even lighting throughout the field of view
- 120 minutes of video storage (11 depths x 10 minute transect each + leader/trailer)
- Speed: 1.0 knots (~55 cm/sec)
- Environmental sensors:
 - CTD (salinity, temperature and depth)
 - Oxygen sensors x2 (dissolved O₂ concentration)
 - Transmissometer, 25 cm (water clarity/relative concentration of particulates in water)

Functional Requirements

(see full text in 901209 project folder)

- The AUV transecting imaging system must replicate the existing ROV based quantitative mid-water transects such that the results of the transects can be compared in a scientifically valid way.
- Maintain the current image data processing and video annotation chain OR create a new processing chain that can be executed with a similar degree of complexity and effort.
- Provide for simultaneous operation with an environmental sensing package (CTD, oxygen X 2, and transmissometer sensors) comparable with that of the ROVs.
- Meet the weight, balance, interface and configuration requirements of a Dorado AUV payload such that extraordinary measures are not required for routine AUV operation.
- Be installed and removed from the AUV Dorado with a minimum of effort, consistent with similar nose cone payloads.

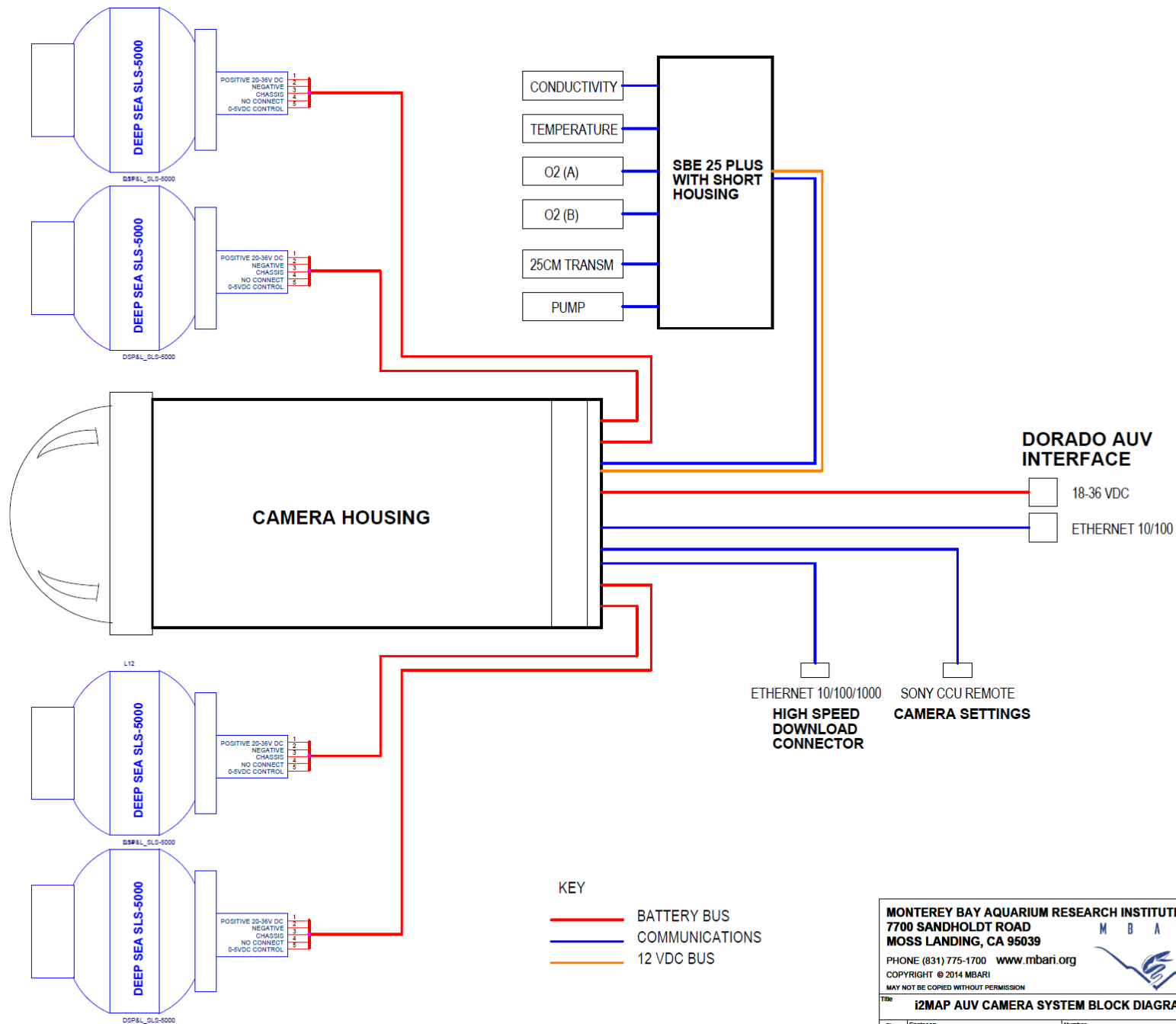
Design Requirements

(see full text in 901209 project folder)

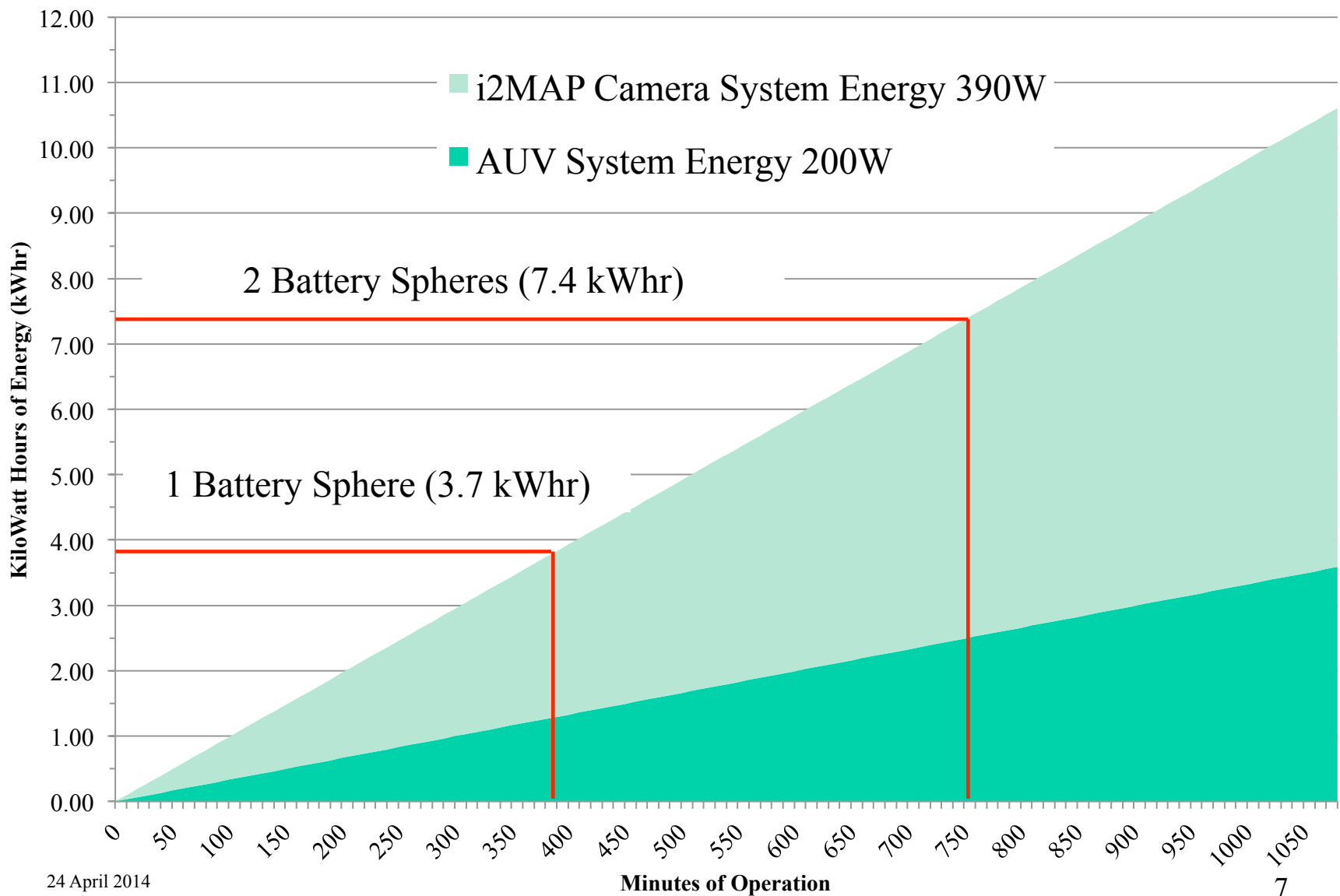
- Capture format. The imaging system must capture in a progressive scan format with a minimum resolution of 1920x1080 4:2:2 format at 10 bits at 60 frames per second or greater (1080 60P) for 120 minutes.
- The video records must include SMPTE timecode data that is synchronous with the environmental instrumentation data.
- Depth of field. The imaging system shall allow the identification of small plankton at a range from 0.1 to 2.5 meters from the camera dome with the camera lens in a fixed focus position. Note: it is desirable but not required that the camera system be able to image objects further from the camera than 2 meters, ideally out to 10 meters distance.
- Width of field. The lens system shall have at least an 80 degree horizontal viewing angle.
- The light bars shall hold 4 DSPL Sealights in a position that minimizes backscatter and glaring.
- The Dorado camera payload shall provide for simultaneous operation with the standard CTD, oxygen (x2) and 25 cm transmissometer instruments of the CTD AUV OR duplicate these instruments on the camera payload. The data must be available as part of the standard AUV data load path and be accessible to VARS.
- Operate at specific depths from 50 meters to **1500 meters** performing 11 individual transects of 330 meters length.
 - Dorado shall maintain a constant depth during a commanded transect to within +/- 1 meter.
 - Dorado shall maintain a constant pitch angle during a commanded transect of +/- 10 degrees.
 - Dorado shall maintain a constant roll angle during a commanded transect of +/- 20 degrees.
- The electrical interface to the Dorado AUV must be compatible with:
 - 18 to 36 Volts DC, 15 Amperes maximum continuous current. *Note that SeaCon reports 16A*
 - The data interface is 10/100BaseT Ethernet.

Overall System Design

- System Layout
- Energy budget
- AUV interface
- CTD and other environmental sensors



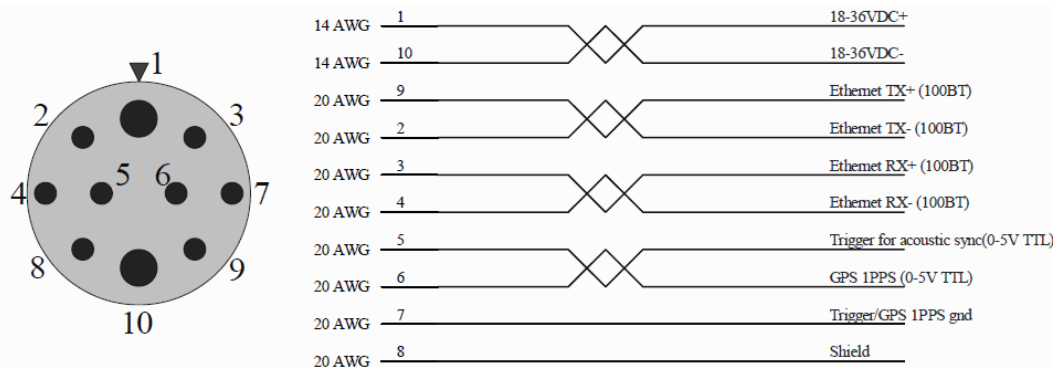
Total Energy Use by Dorado (1 m/sec.)



Dorado AUV interface & Power Budget

- **Hardware Interface.**

- The electrical interface to the Dorado AUV must be compatible with:
 - 18 to 36 Volts DC. (new battery will be 20-36V)
 - 15 Amperes maximum continuous current . (SeaCon reports 16A)
- **NOTE: this is 270 Watts at low battery and 540 Watts at high battery. We need about 390 Watts to run 4 lights full power (20A @ 18VDC).**
- The data interface is 10/100BaseT Ethernet.

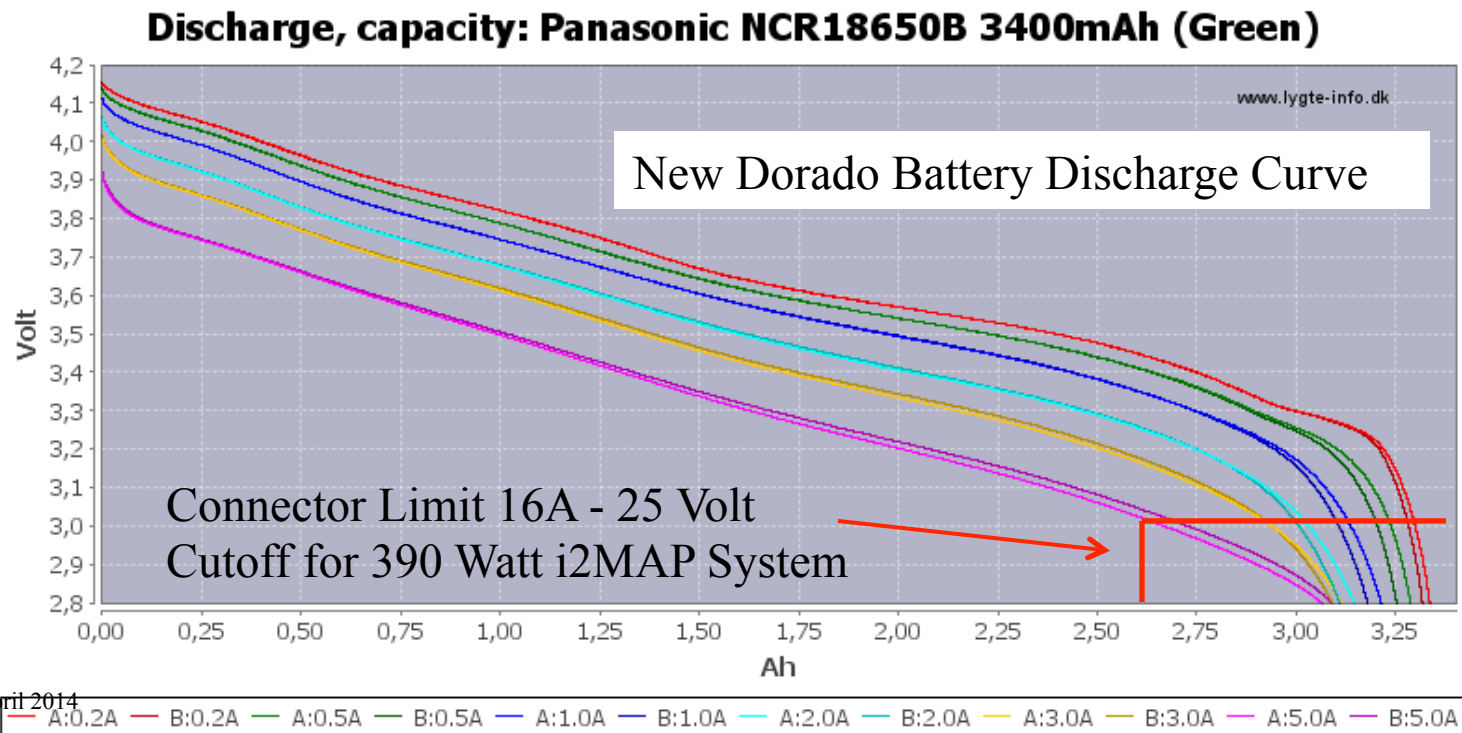


MINK-10-CCPL
Cable
Female Face

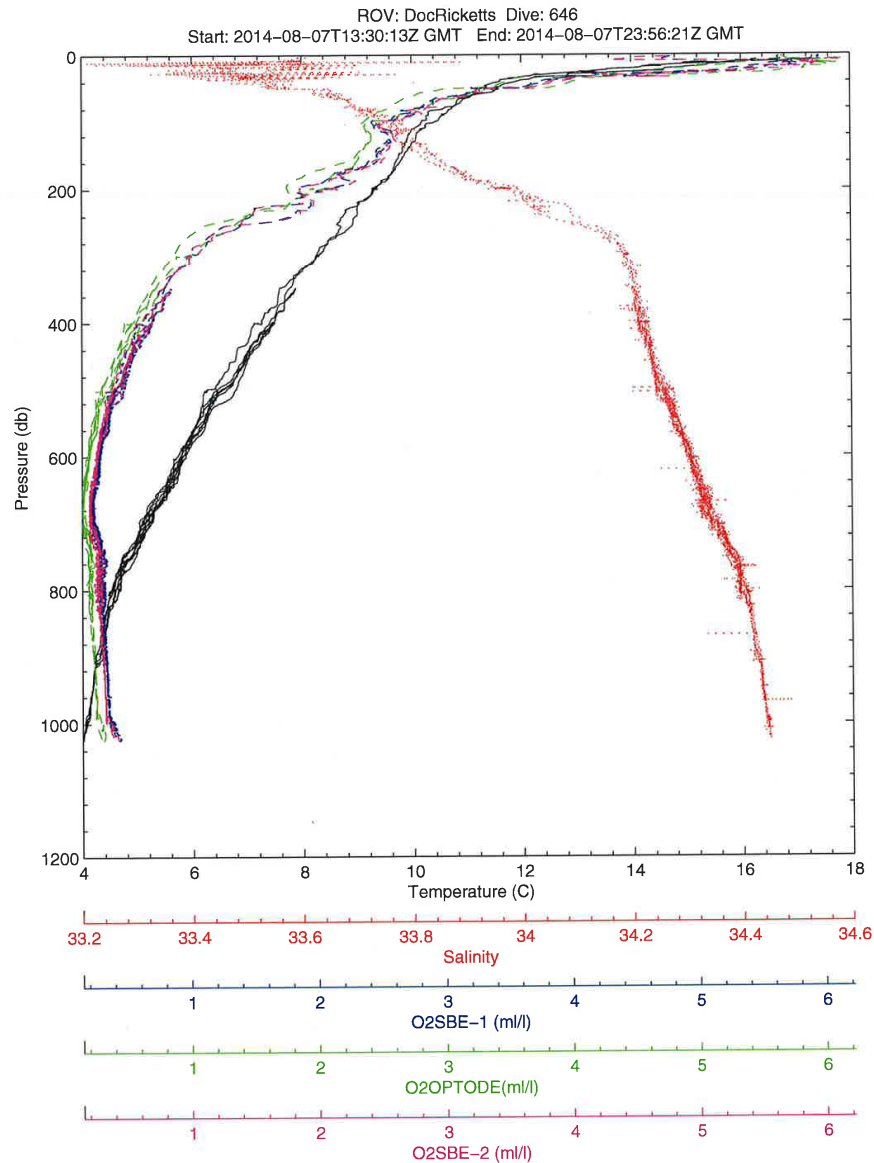
(Received via email from Hans Thomas February 25, 2014)

i2MAP Limited by the AUV Connector Maximum Current

- With 4 x 80 Watt lights we are limited by the Dorado interface connector 16 Ampere maximum at low battery voltages (<25 Volts).
- Required solution:
 - Cut off i2MAP lights or reduce output when AUV battery voltage drops below 25 Volts.



Environmental Sensing



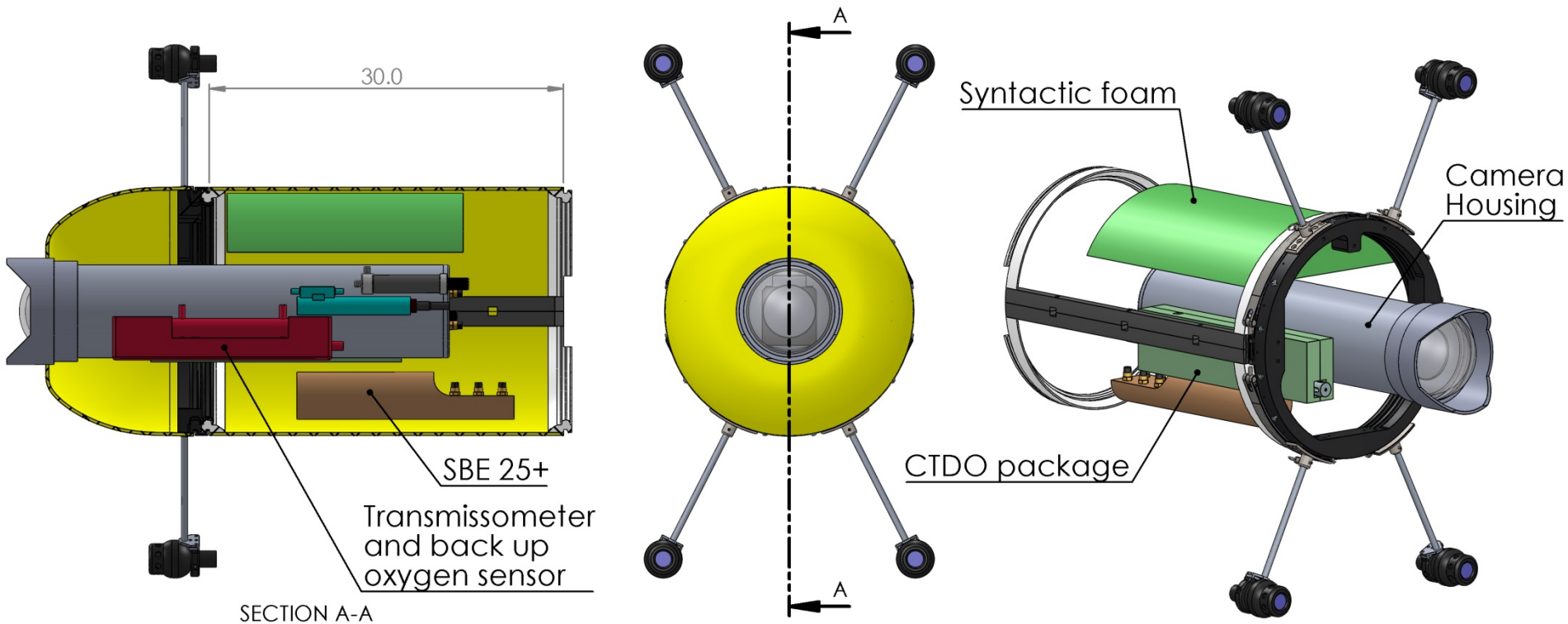
Environmental Sensor Suite

- Sea-Bird 25plus in shortened 6800 m housing
 - Eight 0-5 volt A/D input channels
 - Two RS-232 input channels
 - 2000 m depth sensor (accuracy = 2 m, resolution = 0.3 m)
 - SBE 3F temperature sensor (initial accuracy ± 0.001 °C)
 - SBE 4C conductivity sensor (range = 0.0 – 7.0 Siemens/m, initial accuracy ± 0.003 S/m)
 - SBE 5 submersible pump
- SBE 43 dissolved oxygen sensor (x2) w/ flow duct (initial accuracy $\pm 2\%$ of saturation)
- Wet Labs C-Star 25 cm path length Transmissometer

Second pump, O₂ sensor and transmissometer will be integrated into system in 2015



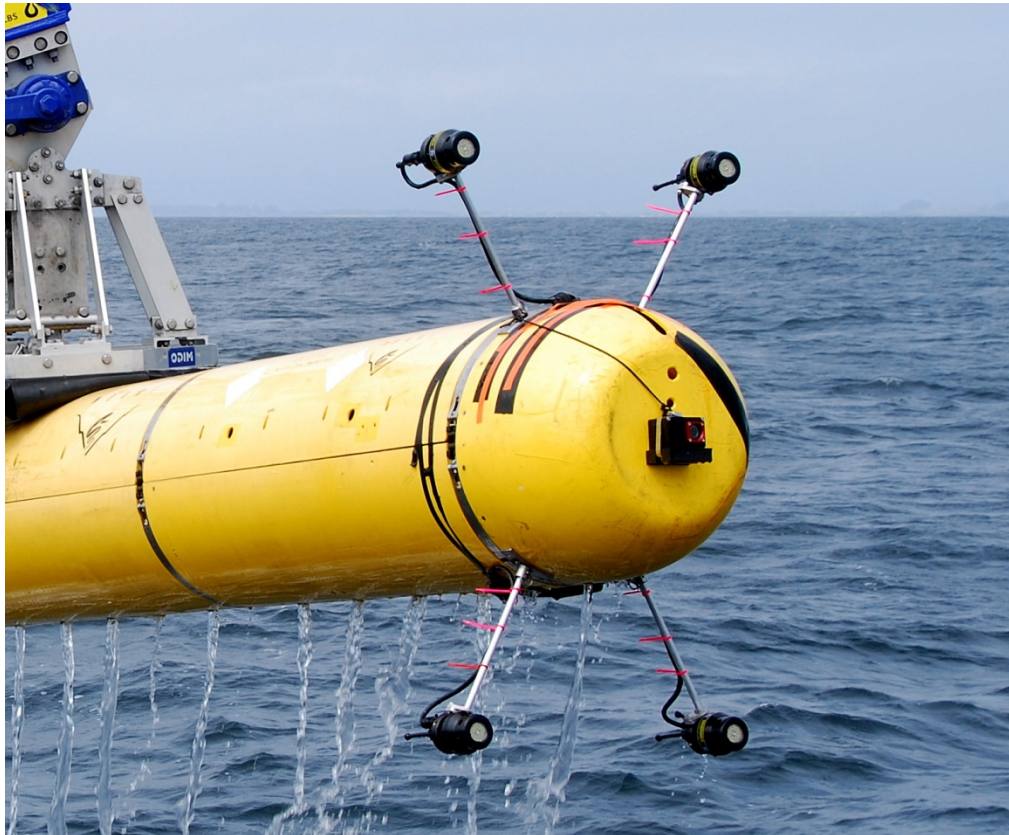
Mechanical layout of I2Map section

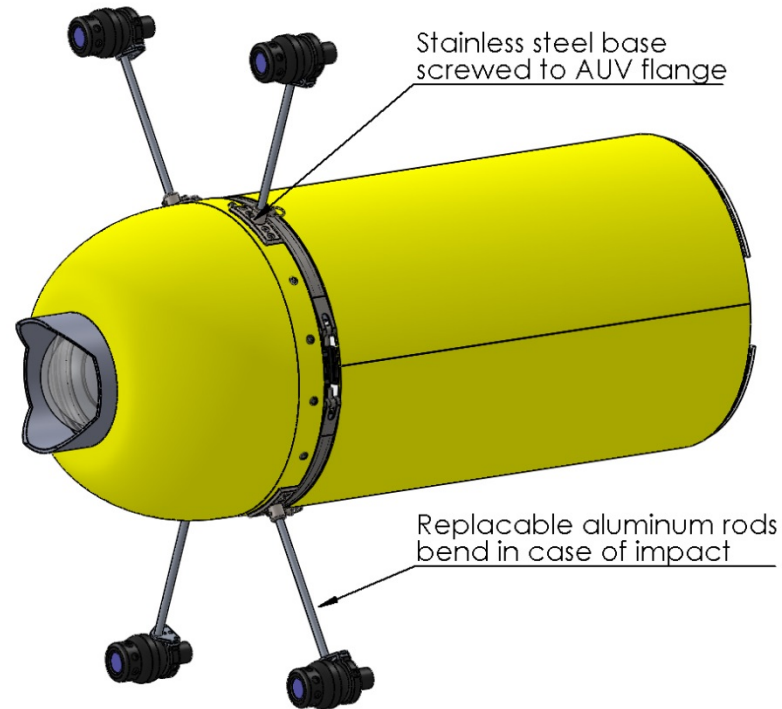
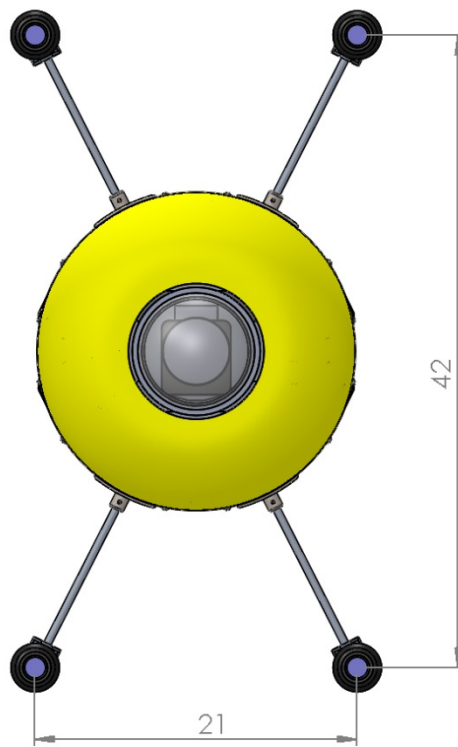


Total mass (without bracketry) = 160 lbs
Displacement = 2.9cf or 185 lb of seawater
Foam density: 24 lb/cf , less than 1cf needed

Lighting

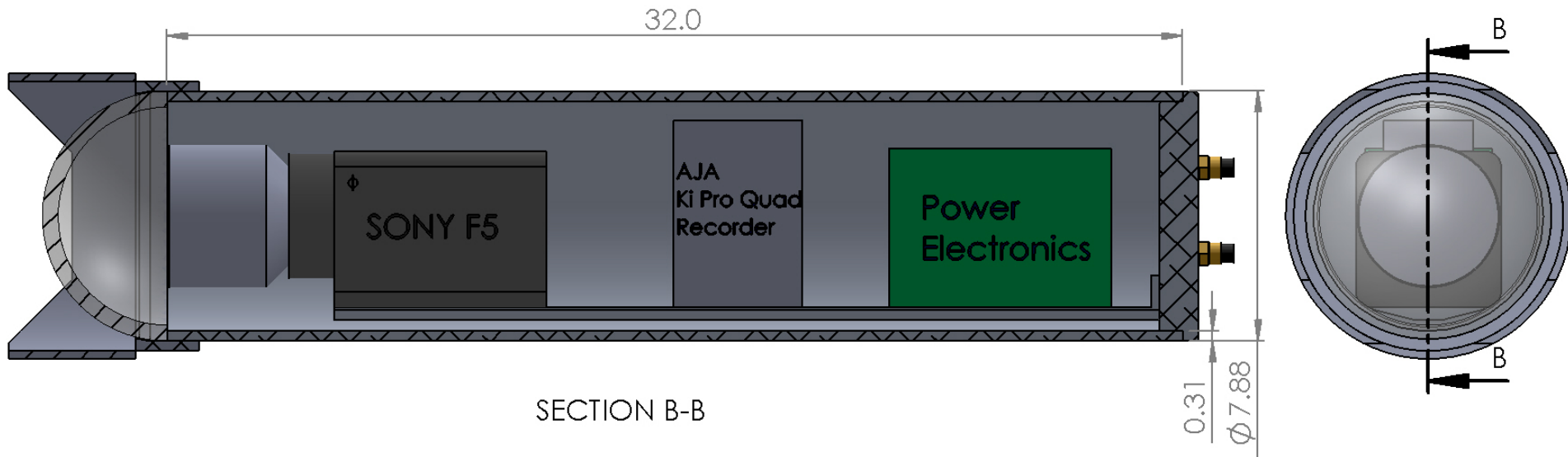
- 4 DSPL Sealight spheres.
- Mounted on rods to reduce backscatter





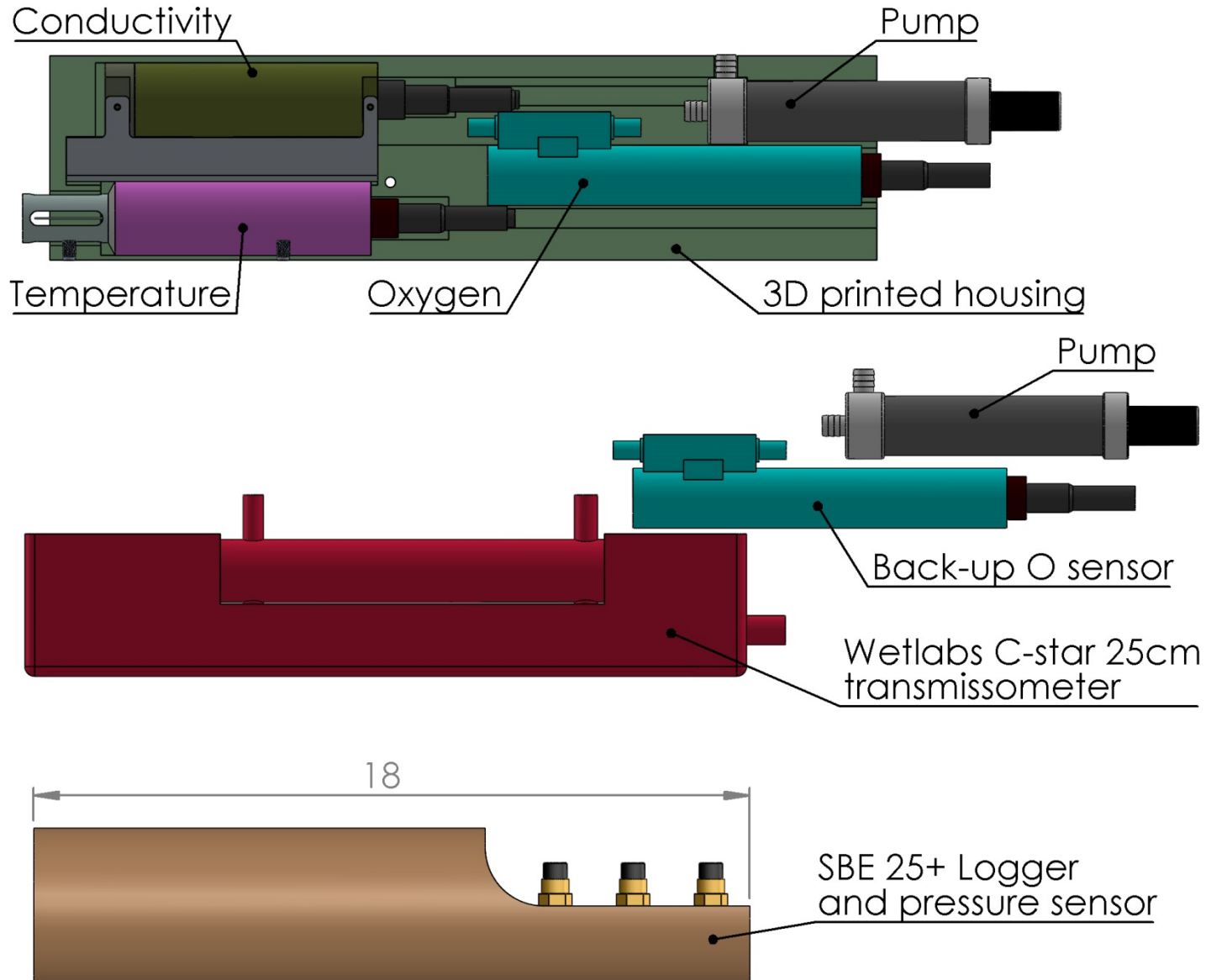
Problem	Solution
Lights are vulnerable during deployment and recovery	Rods will bend in case of collision to avoid damage to lights and fairing. Damaged rods can be replaced easily. Light can be protected in a plastic shell.
Lines or other objects could get caught in the light bars	Risk is minimal according to AUV team. A guard line can be used when operating in high risk areas.
Drag is increased	See Rob's analysis

Camera housing



- Material: 8" OD, $\frac{1}{2}$ " wall extruded aluminum tubing
- Crush depth: 2200m
- Mass: 50 lbs
- Working on dome and optical elements with optical engineer
- Mounting of camera and optical elements still TBD

Environmental sensors



Vehicle Control And Stability

Design Speed Raised to 1.0 m/s (2kts)

- May be able to eliminate body wings.
 - Probably will retain winglets on the duct.
 - May add vertical winglets!
 - The next sea trial will determine the answers.
-
- Quick review of stability and control situation:

Three Problems:

1. How to prevent buoyancy from dragging vehicle up at low speed?
 - Add body wings.
 - Ballast low; about 4 lbf.
2. How to control the vehicle (steering and diving) at low speed?
 - Add winglets to the duct.
 - Increase the control gains.
3. How to damp oscillations caused by drag at the nose?
 - Add winglets to the duct.

First Two Problems: How to Maintain Depth (Resist Buoyancy) and Change Depths at Low Speed?

Wings 14" Behind Eye Center, With Bars

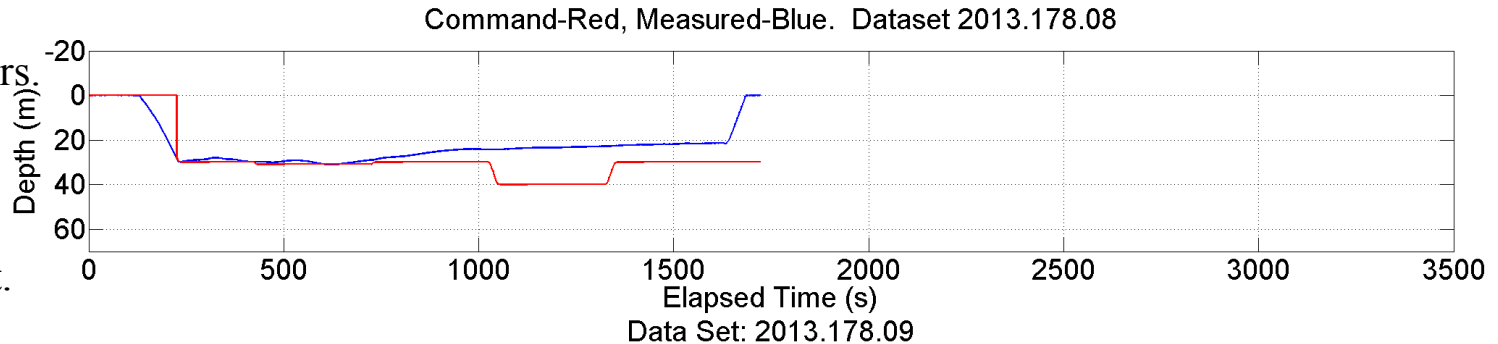


MAUV with Wings, Winglets, Round Bars

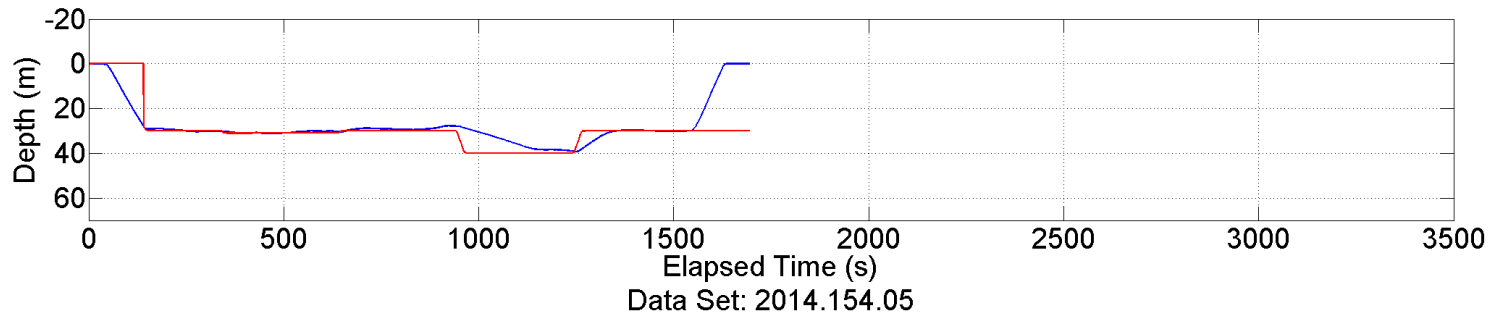


Improvement in Depth Control at 0.5 m/s

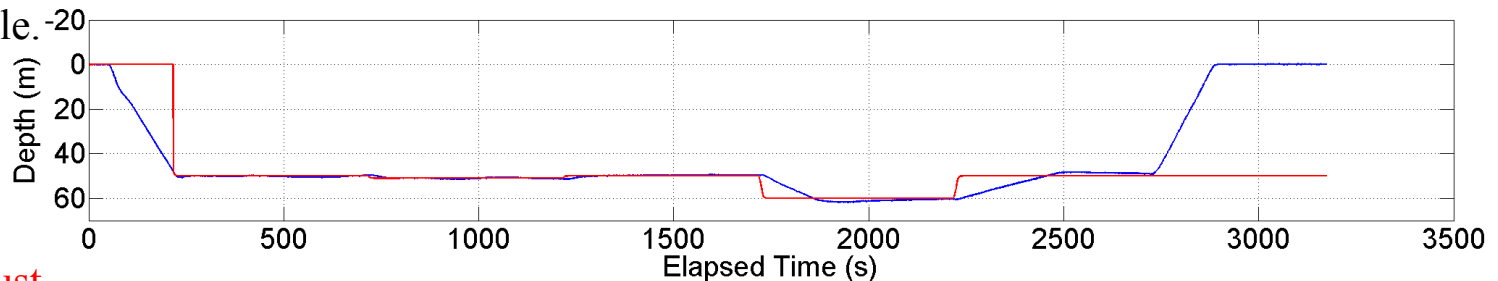
Ctd vehicle.
Streamlined bars.
With lights.
No Wings.
No Winglets.
5.8 lbf buoyant.



With Wings.



Mapping vehicle.
Round bars.
With lights.
With Wings.
With Winglets.
With Gain Adjust.
5(?) lbf buoyant.



- Controllability will improve at 1.0 m/s.
- May be able to eliminate body wings.
- If wings are needed, will design/fabricate a swept version.

Third Problem: Oscillations Caused by Lights

- Adding drag or lift or both to the bow is destabilizing.

Ctd vehicle.

Streamlined bars.

With lights.

No Wings.

No Winglets.

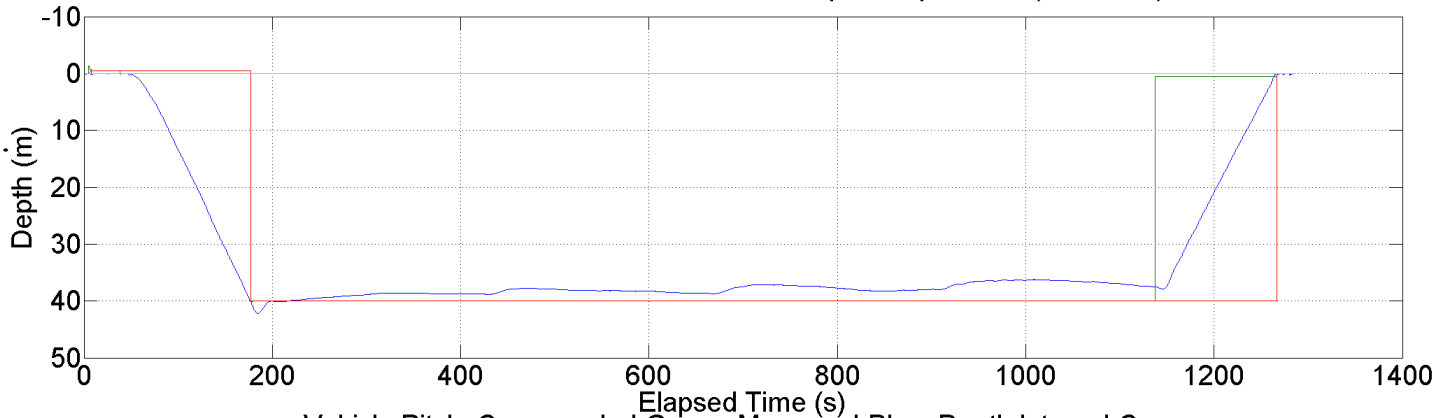
4.5 lbf buoyant.

Speed = 0.5 m/s.

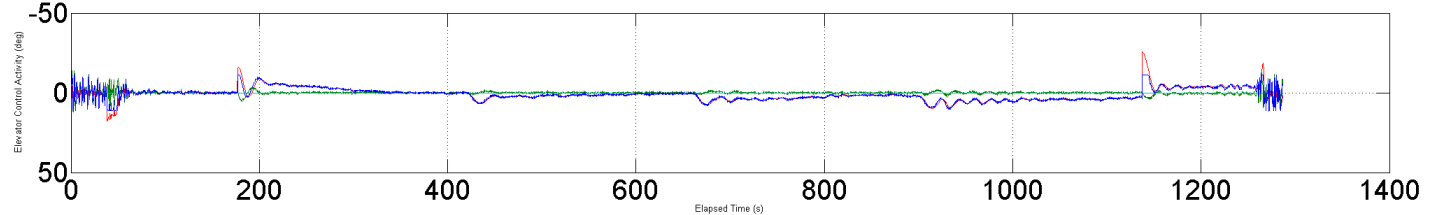
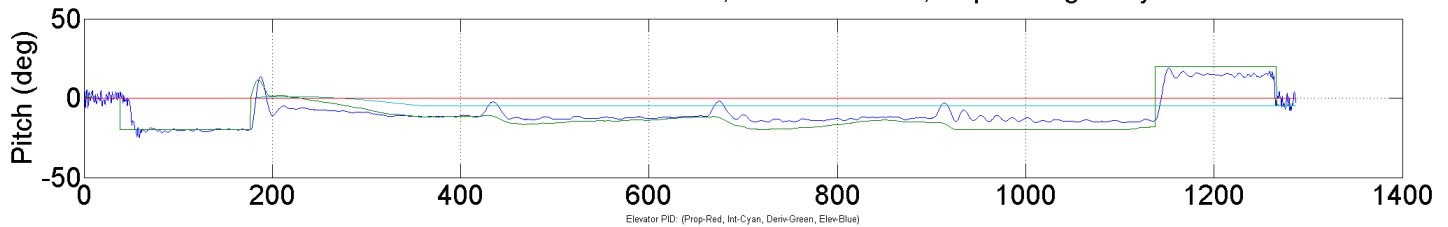


Third Problem: Second Case

Depth: Commanded-Green; Smoothed Command-Red; Measured-Blue ; Data Set: 2013.178.05
If Native Alt Ctrl Green=Alt Cmd, Red=Equiv. Depth Cmd (Not Used)



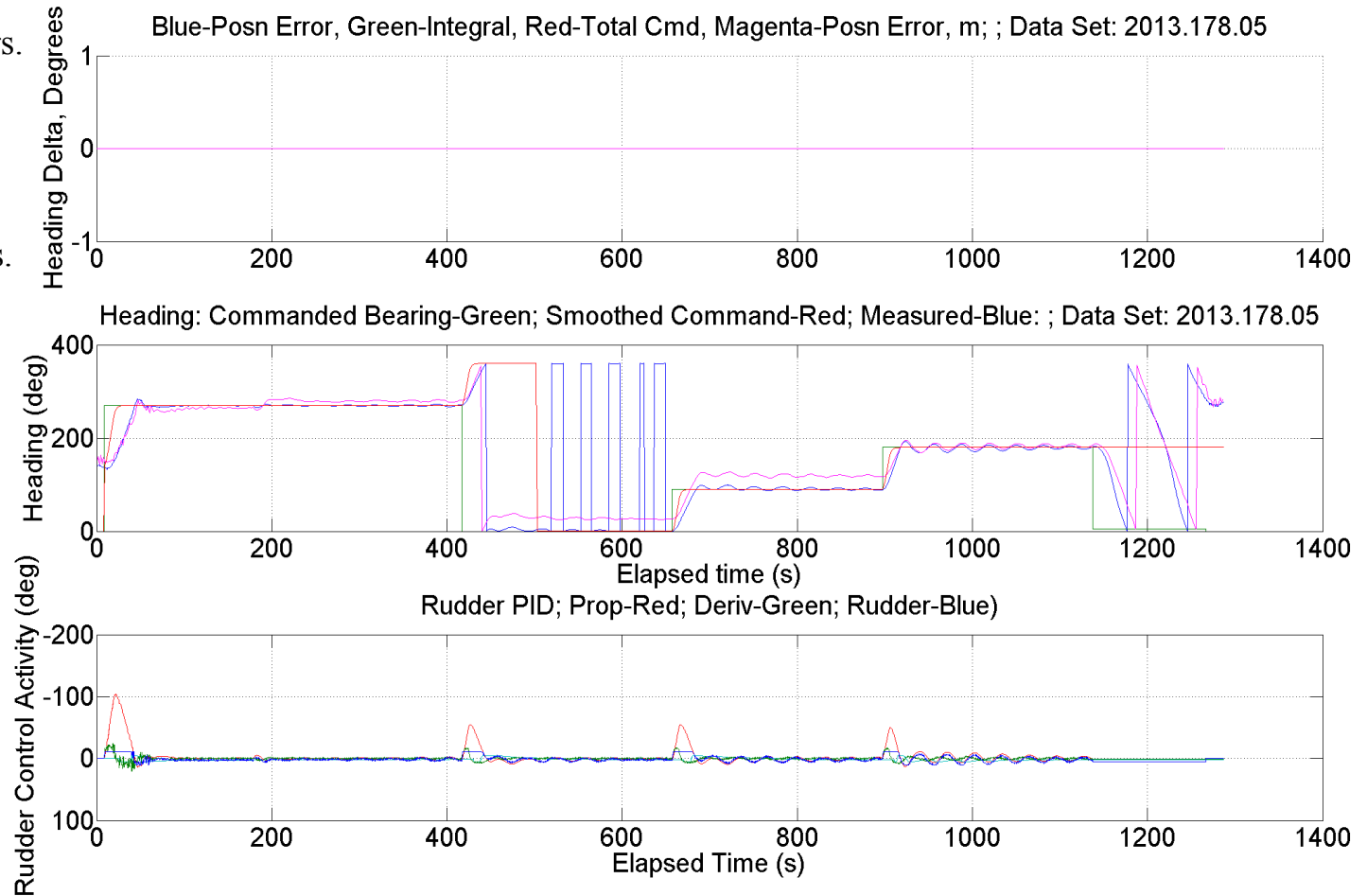
Vehicle Pitch: Commanded-Green; Measured-Blue; Depth Integral-Cyan



Ctd vehicle.
Streamlined bars.
With lights.
No Wings.
No Winglets.
5.8 lbf buoyant.
Speed = 0.5 m/s.

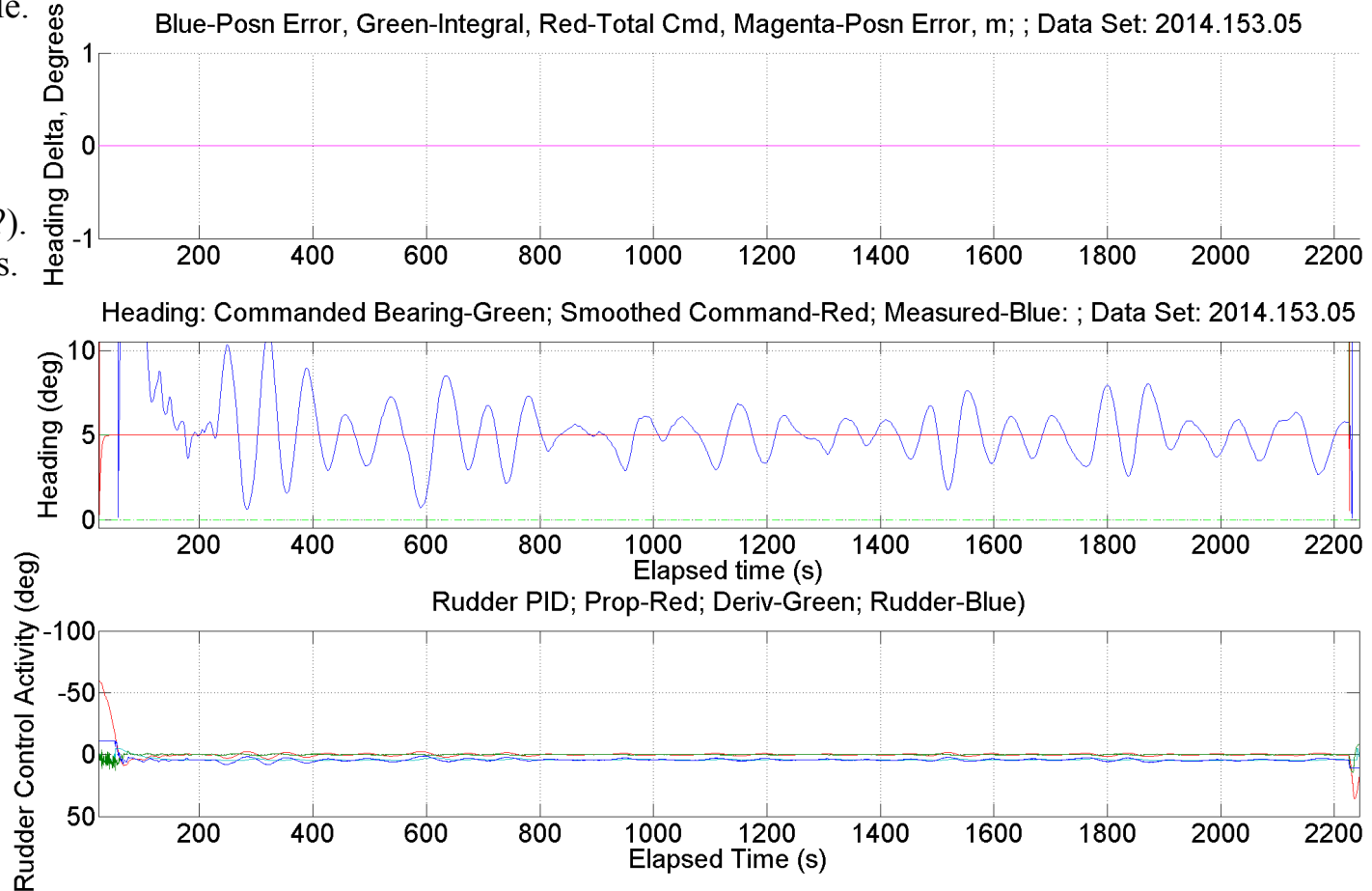
Second Case: Heading

- Ctd vehicle.
- Streamlined bars.
- With lights.
- No Wings.
- No Winglets.
- 5.8 lbf buoyant.
- Speed = 0.5 m/s.



Third Case: Heading

- Mapping vehicle.
- Round bars.
- With lights.
- With Wings.
- With Winglets.
- 5 lbf buoyant (?).
- Speed = 0.5 m/s.



Angular Rates

- 0.5 m/s.
- Approximate maximum angular rate of particle:
 - Horizontal plane: 0.37 rad/sec (21 deg/sec)
 - Vertical plane: .31 rad/sec (18 deg/sec)
- 2013 CTD Vehicle with horizontal streamlined bars:
 - Heading: 30 second period, max yaw rate .04 rad/sec. (178.05)
 - Vertical no winglets: 17 sec period, max pitch rate .03 rad/sec. (178.05)
- 2014 Mapping Vehicle with round bars, wings, winglets:
 - Heading: 70 second period, max yaw rate .01 rad/sec.
 - 5-10 degrees peak-to-peak (153.05).

Next Steps

- Predict steady-state performance at 1.0 m/s with simulation.
 - Wings necessary?
 - Winglets necessary?
 - Angles of attack below stall?
 - Duct not railed?
- Predict oscillation frequency and amplitude at 1.0 m/s with (another) simulation
 - Large enough to smear video frames?
- Conduct sea trials at 1.0 m/s
 - Try without wings.
- Adjust analytic models to match sea-trial results.
 - Reliable simulation can quickly answer questions and avoid expensive, risky, and time-consuming sea trials.

Conclusions

- Buoyancy and controllability problems now low risk.
- May be able to eliminate body wings.
- Winglets damp light-bar-induced oscillations? Working on this now.

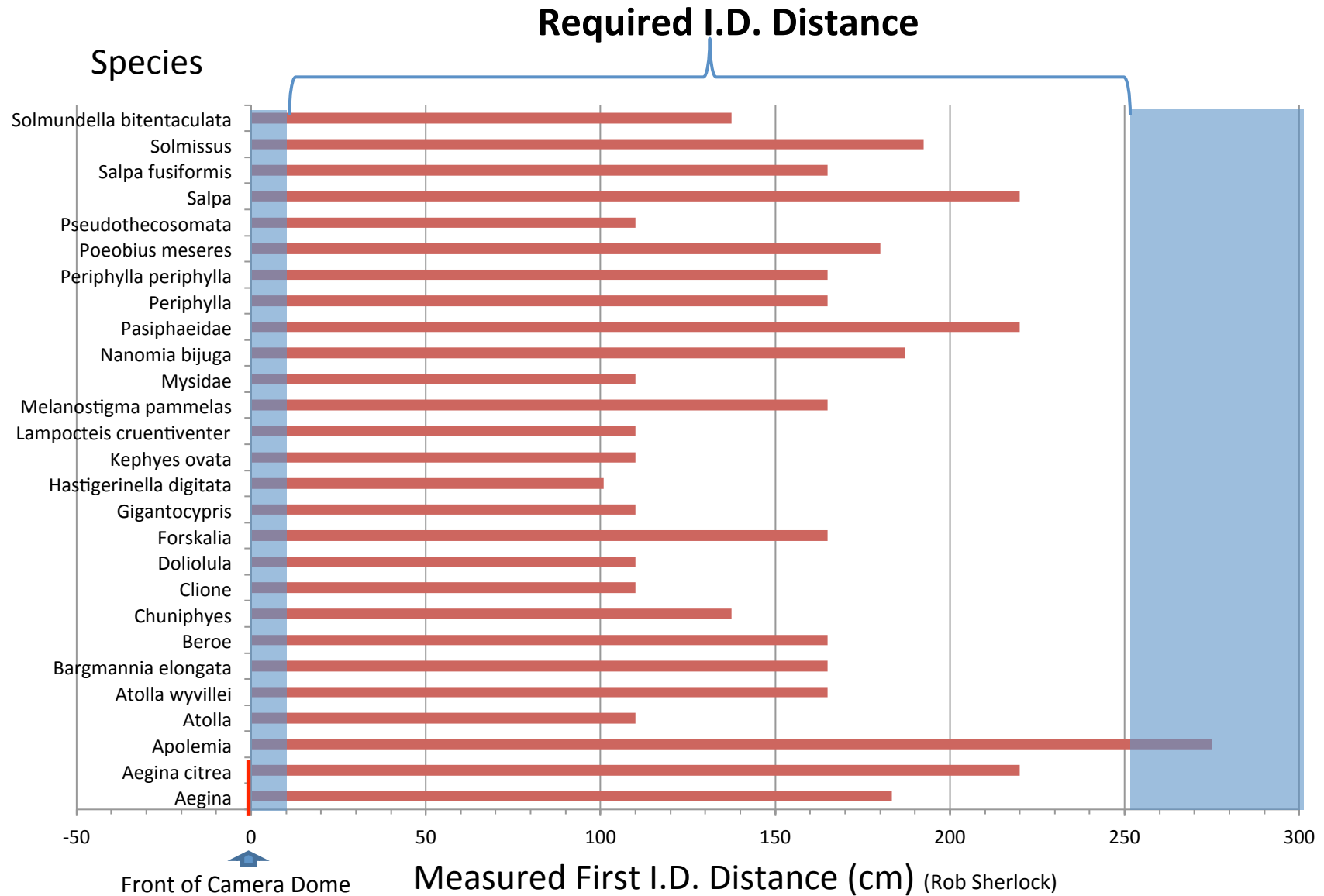
Next

- Use simulators to predict controllability and oscillation parameters at 1.0 m/s.
- 1.0 m/s sea trial to verify.
- Incorporate recent sea-trial data into simulators to improve accuracy.
- End-to-end test of final system

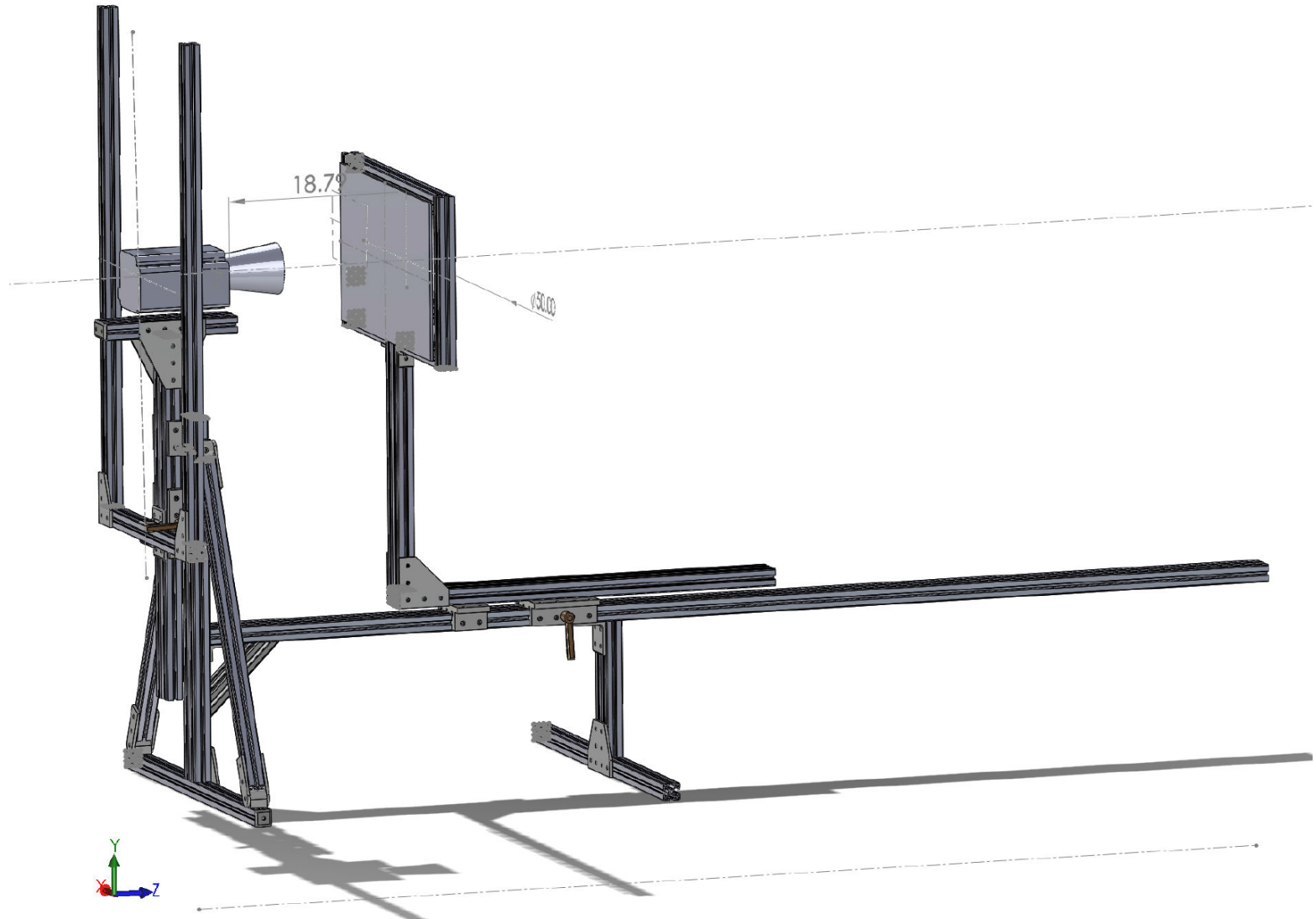
Camera System

- Camera and Lens Testing
- Optical Dome and adapter design
- Video Format Selection
 - Temporal Resolution
 - CODEC Performance
- Recorder
 - Recording Capacity
 - Post mission workflow
- Conclusions

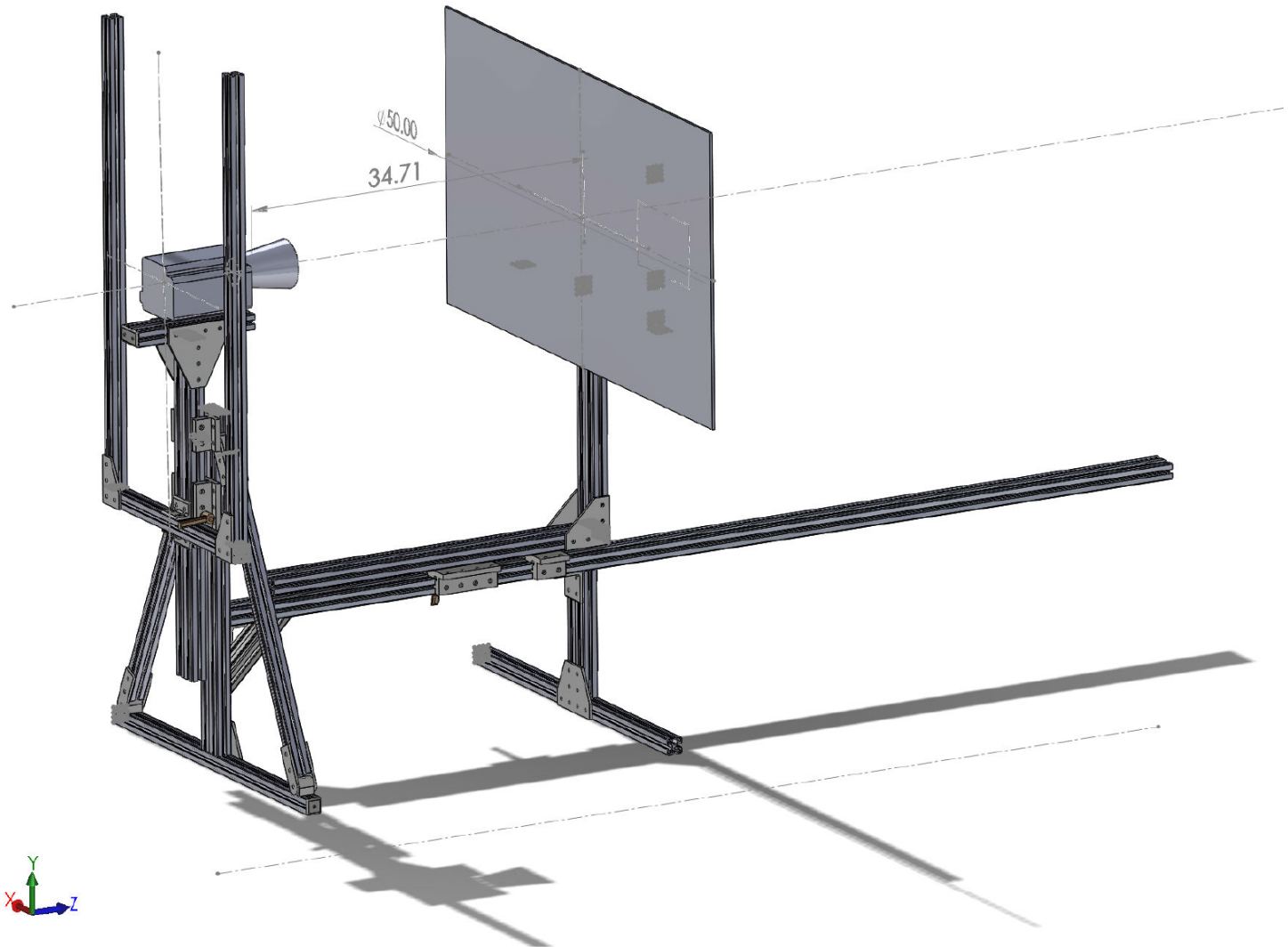
Distance Requirements for the Identification of Representative Organisms in the Camera Field-of View



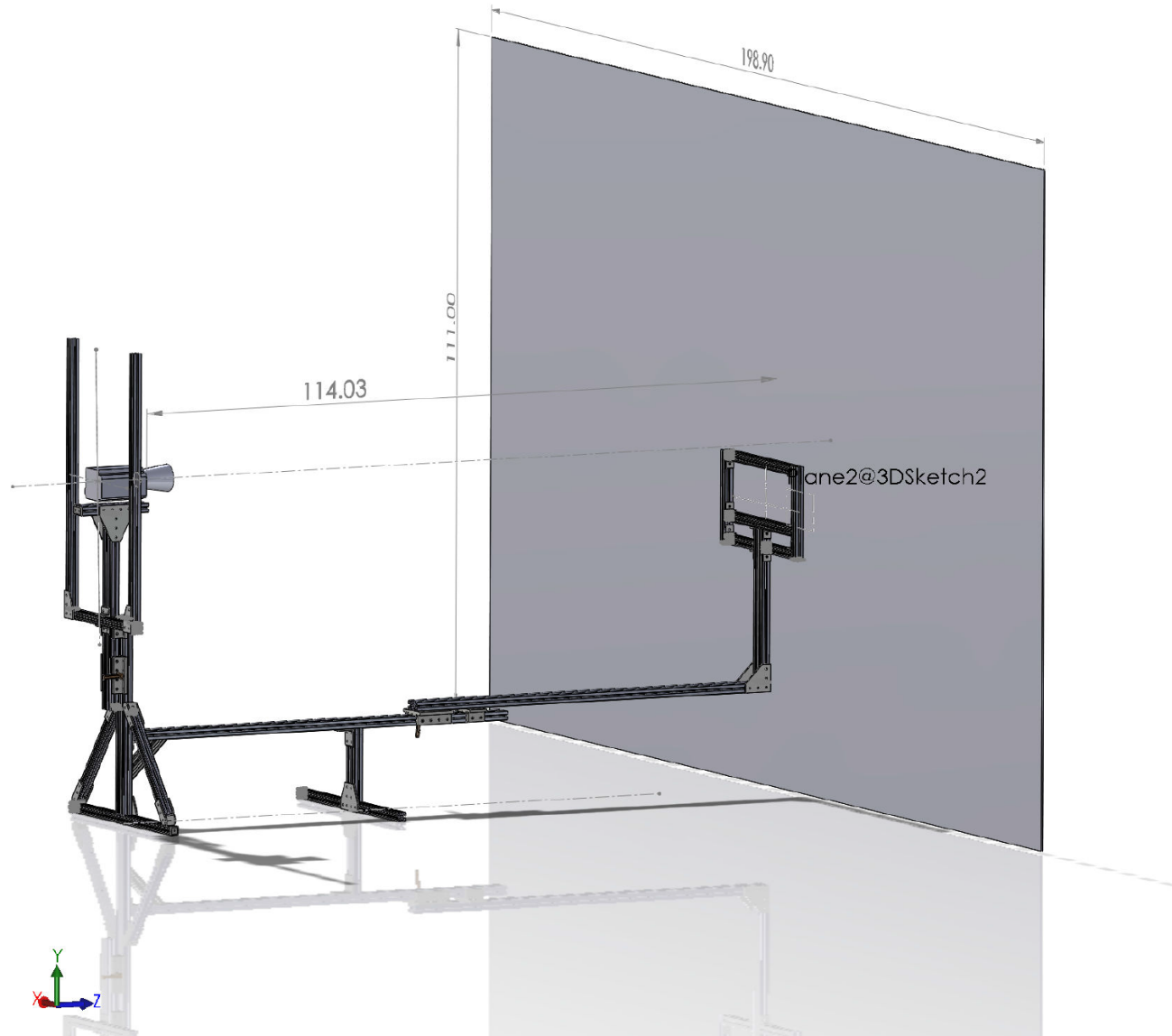
Close Focus Test (~10cm from dome)



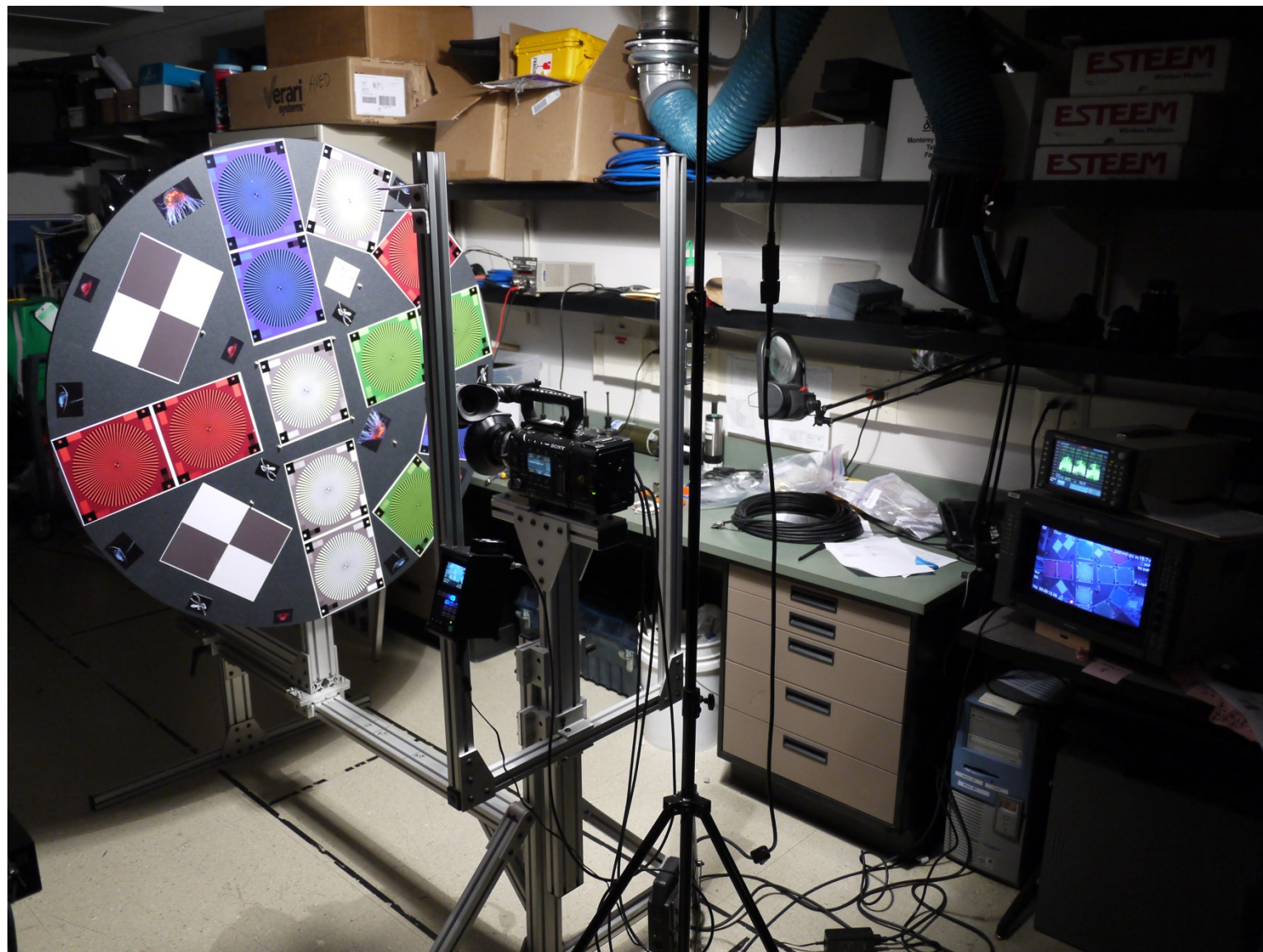
Resolution Testing (~ 0.5 m from dome)



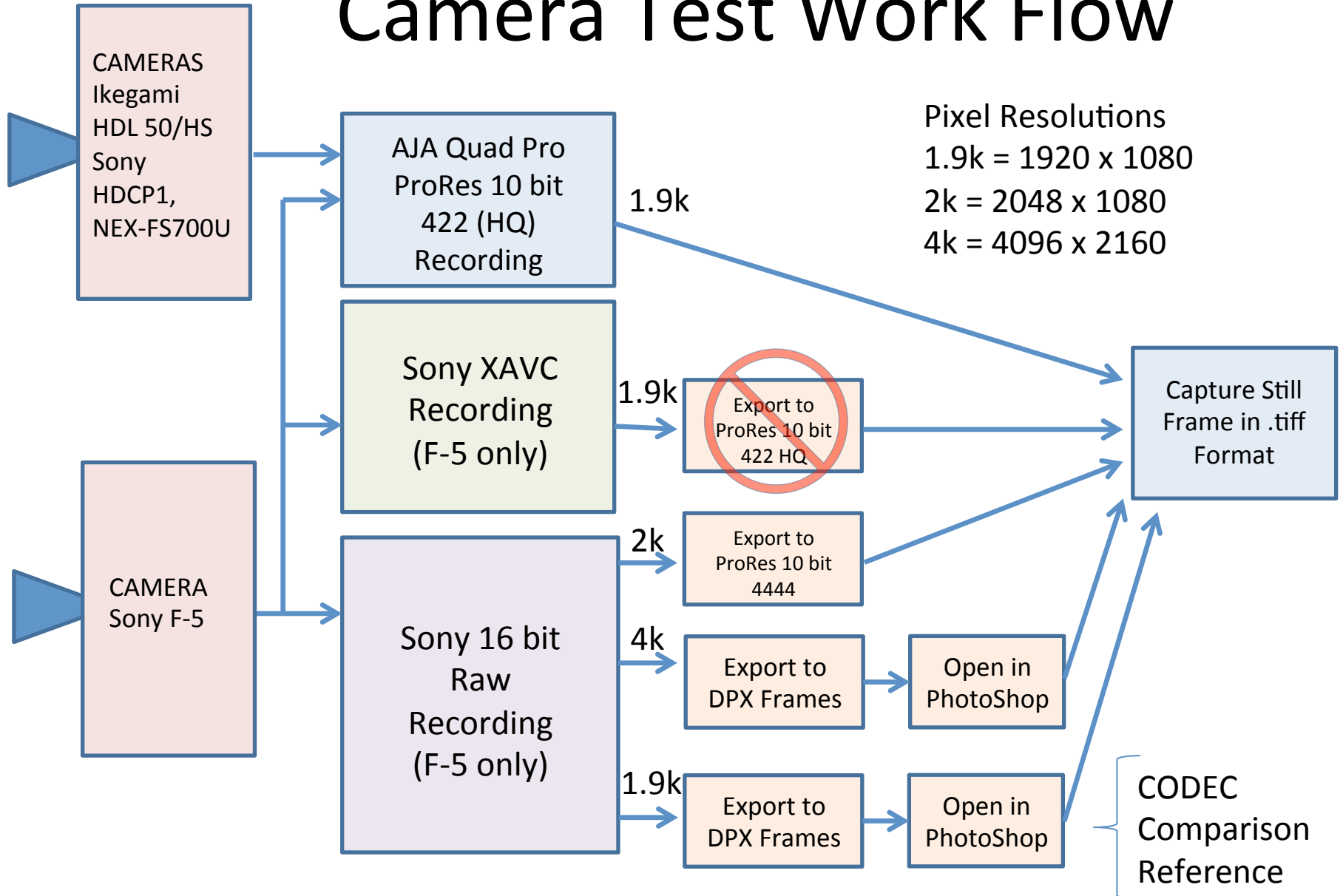
Far Focus (~2.5m from dome)



Camera Test Setup

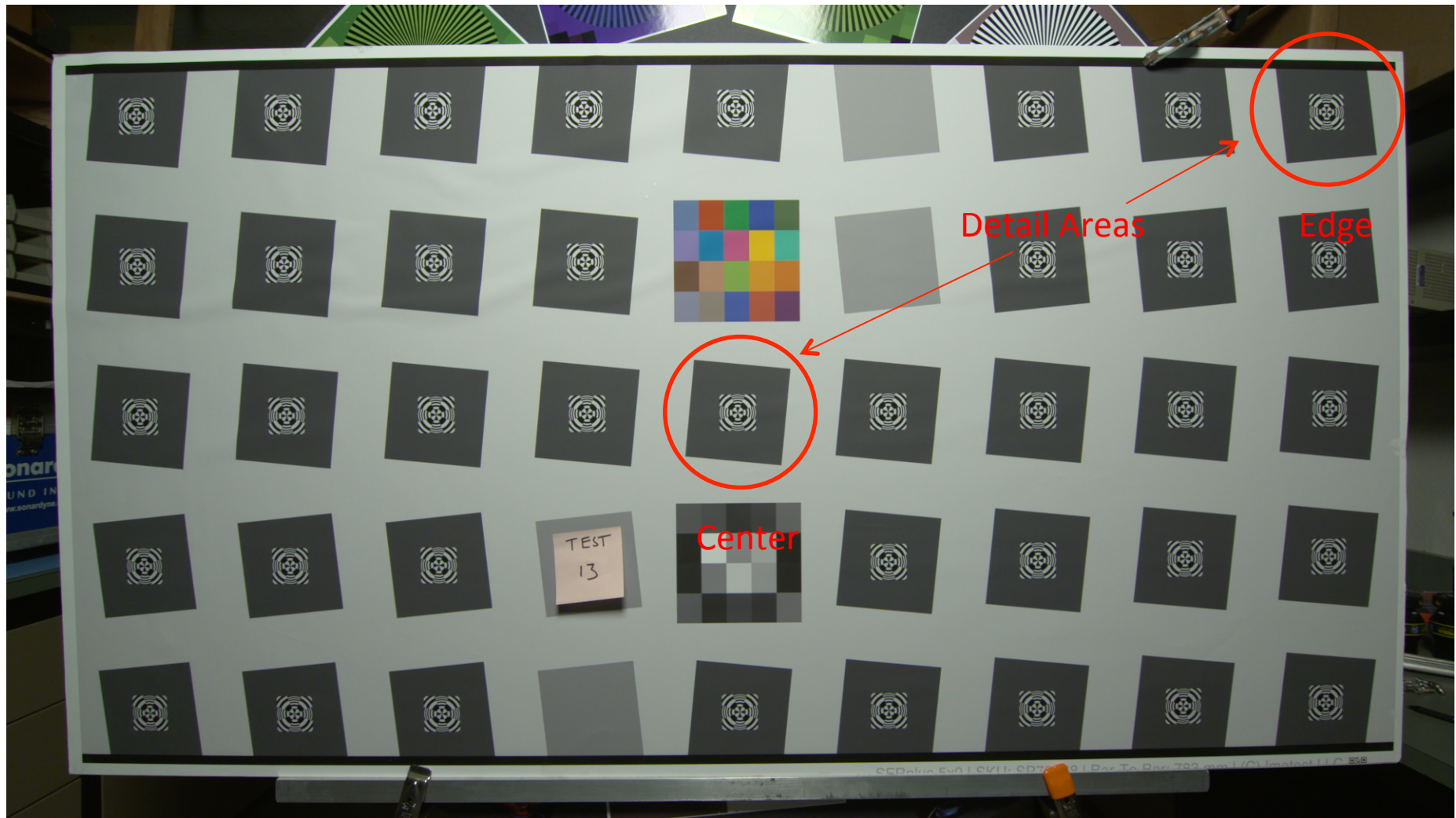


Camera Test Work Flow



Camera Detail Resolution Comparison Locations

Target Distance at "Sweet Spot" ~ 0.5 Meters From Dome



Sony F-5, SCL-P11X15 Lens, 400 lux, 70 IRE, Target 36 inches

Camera Comparison

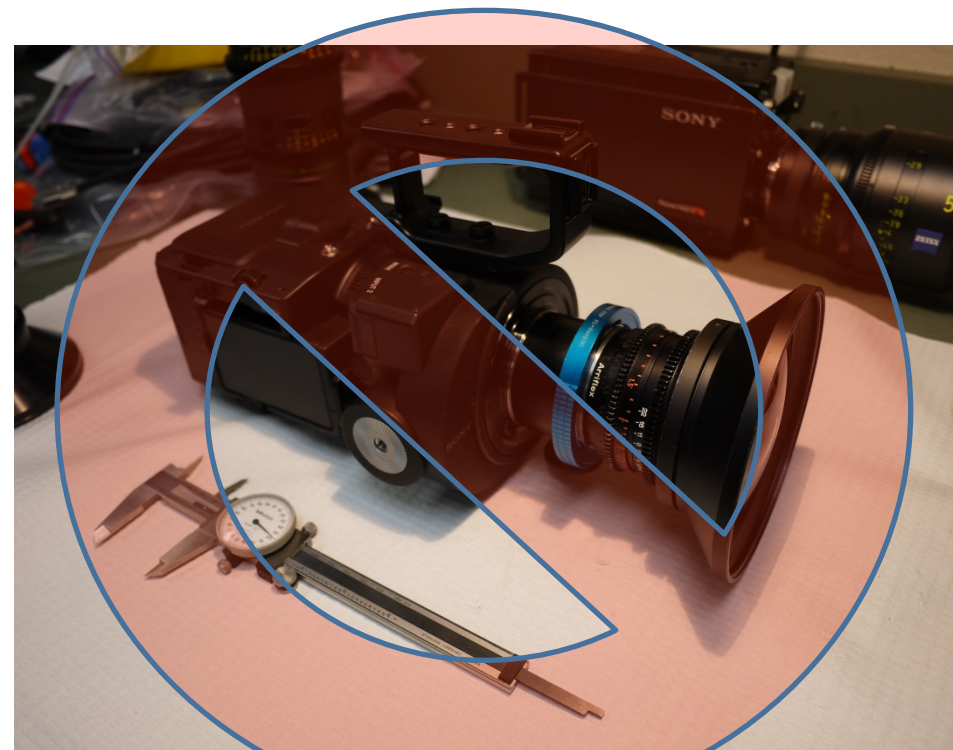
Sony HDCP1 vs. Ikegami HDL50/HS



The B4 Mount Lens Winner Was Used for The Camera Test
Zeiss Digi Prime T1,9/5mm

Camera Comparison

Sony NEX-FS700U vs. Ikegami HDL50/HS

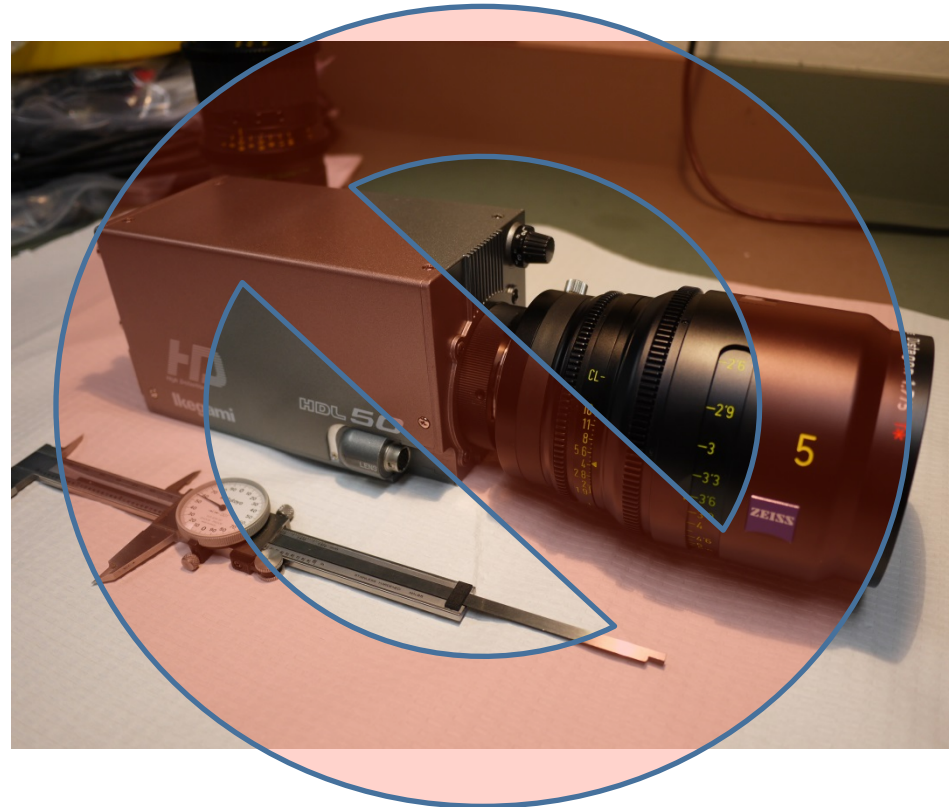


The PL and B4 mount Lens Winners Were Used for The Camera Test

Sony SCL-P11X15 Lens and Zeiss Digi Prime T1,9/5mm

Camera Comparison

Sony F-5 vs. Ikegami HDL50/HS



The PL and B4 mount Lens Winners Were Used for The Camera Test

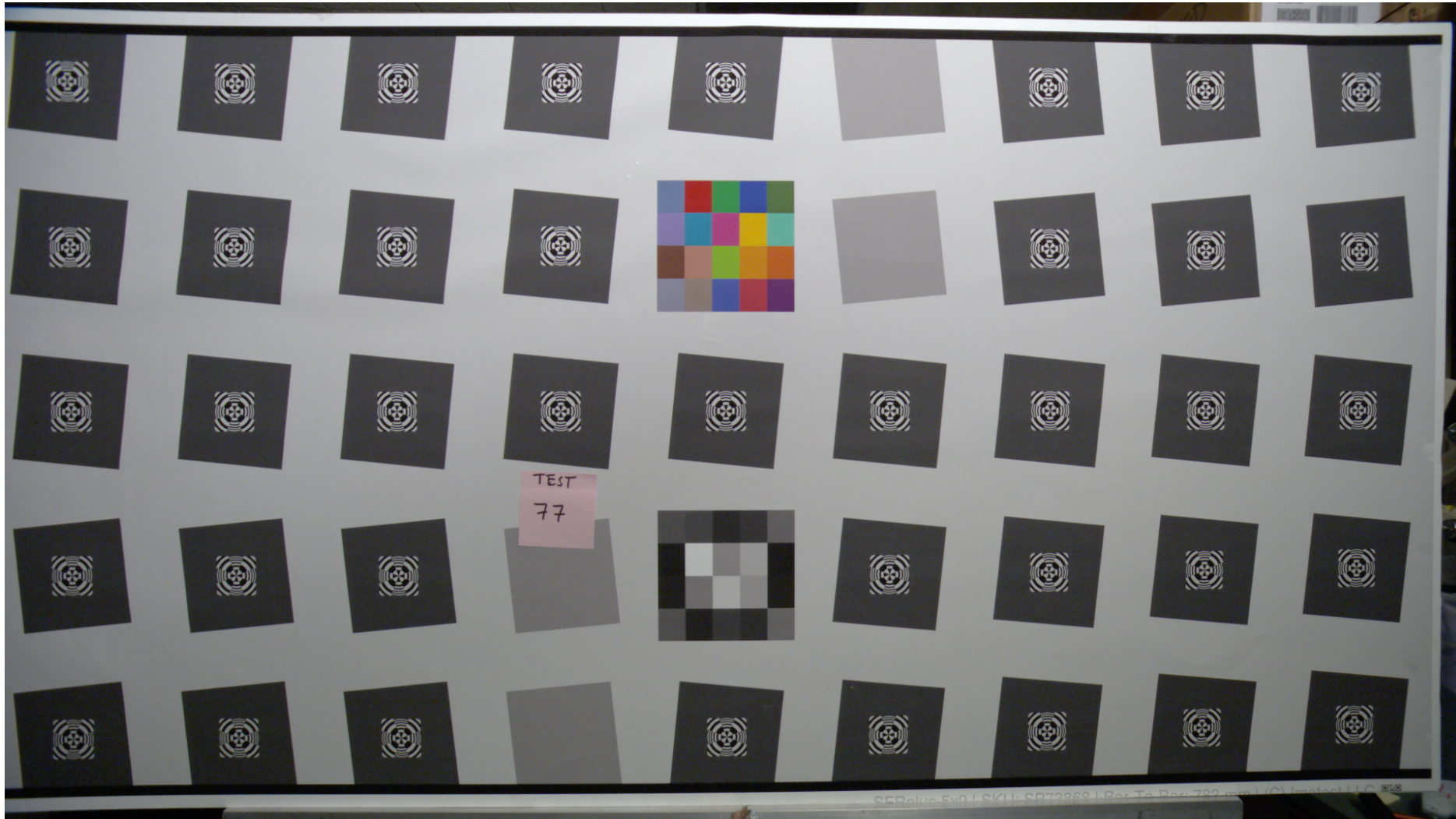
Sony SCL-P11X15 Lens and Zeiss Digi Prime T1,9/5mm

Finalist #1 Sony F-5 and Sony SCL-P11X15 Lens



Sony F-5, SCL-P11X15 Lens, 400 lux, 70 IRE, Target 36 inches File: Test_13X.tiff

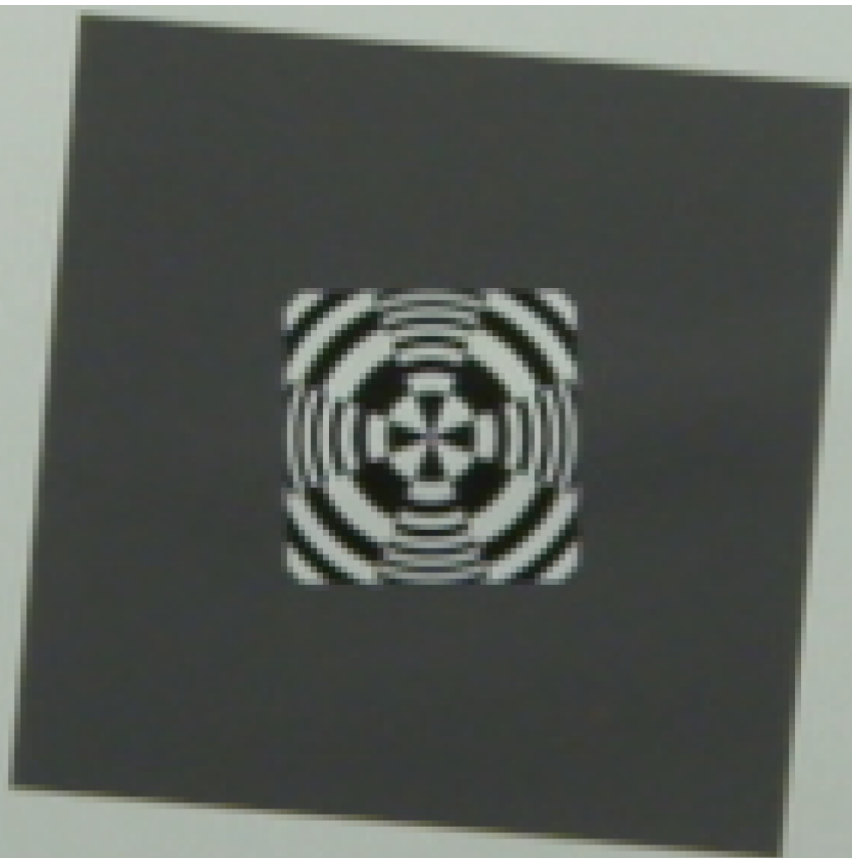
Finalist #2, Ikegami HDL-50/H and Zeiss Digi Prime T1,9/5mm Lens



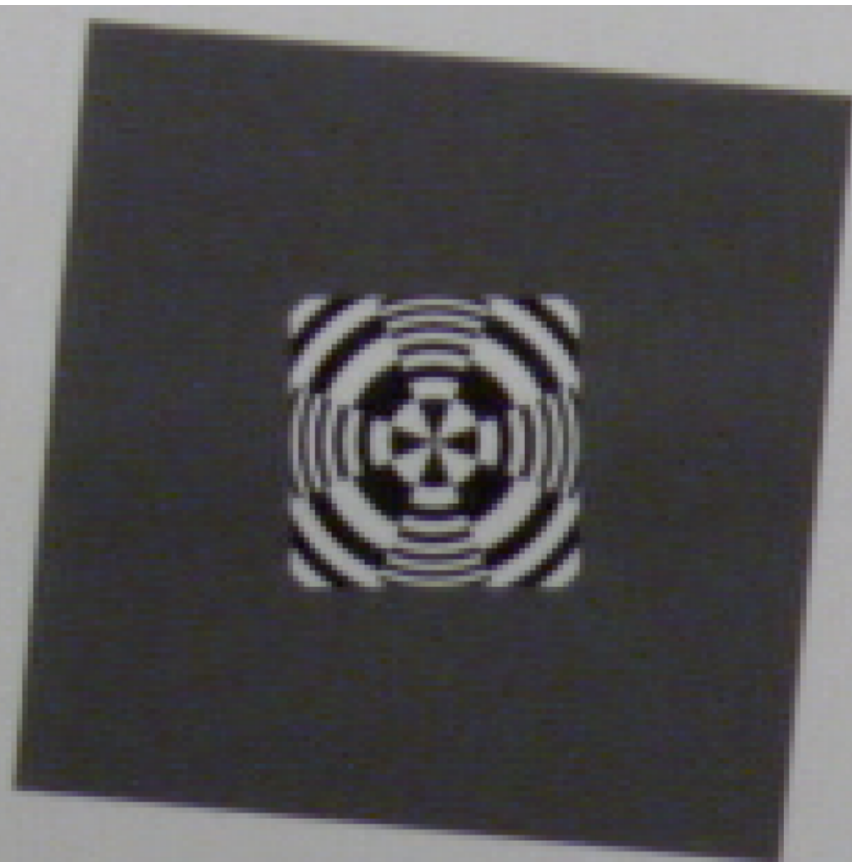
Ikegami HDL50/HS, 5mm Lens, 140 lux, 80 IRE, Target 39 inches File: Test_77.tiff

Sony F-5 vs. Ikegami HDL50/HS

Center Resolution



Sony F-5, Sony 11mm Lens, 400 lux,
ISO 800, Target 36 inches, 1920x 1080 P60
File: Test_13X.tiff



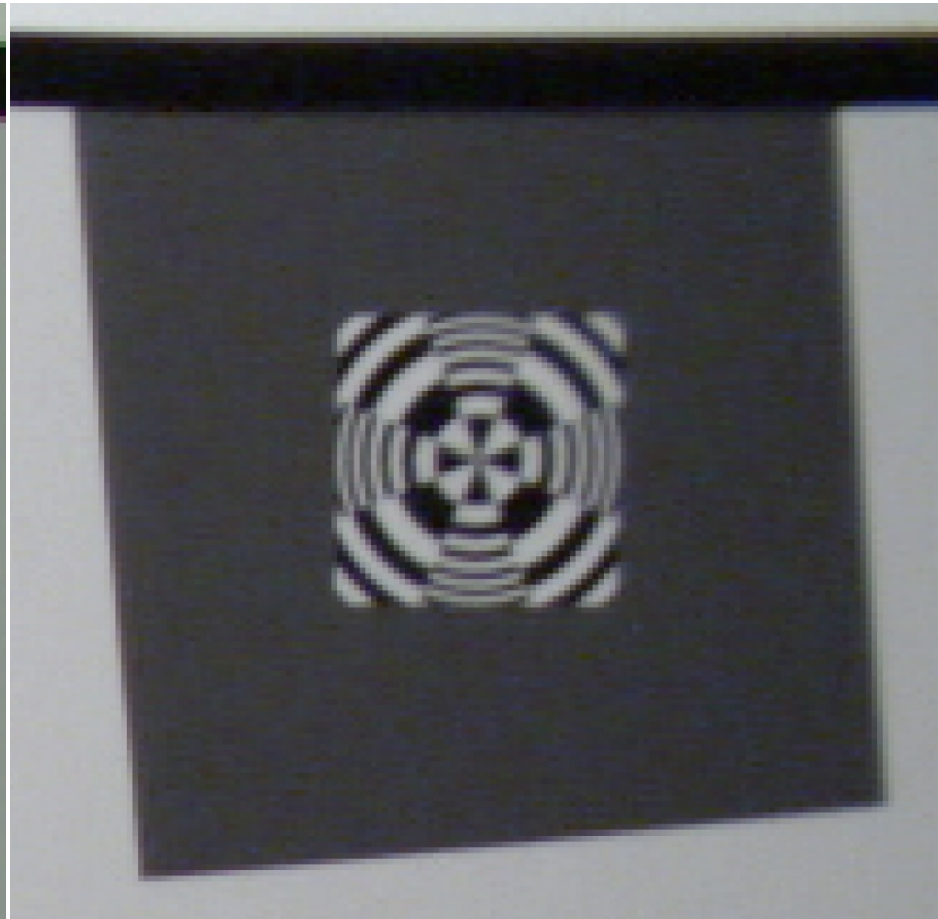
Ikegami HDL-50/HS, Zeiss 5mm Lens,
140 lux, 80 IRE, Target 38 inches
File: Test_77.tiff

Sony F-5 vs. Ikegami HDL50/HS

Edge Resolution



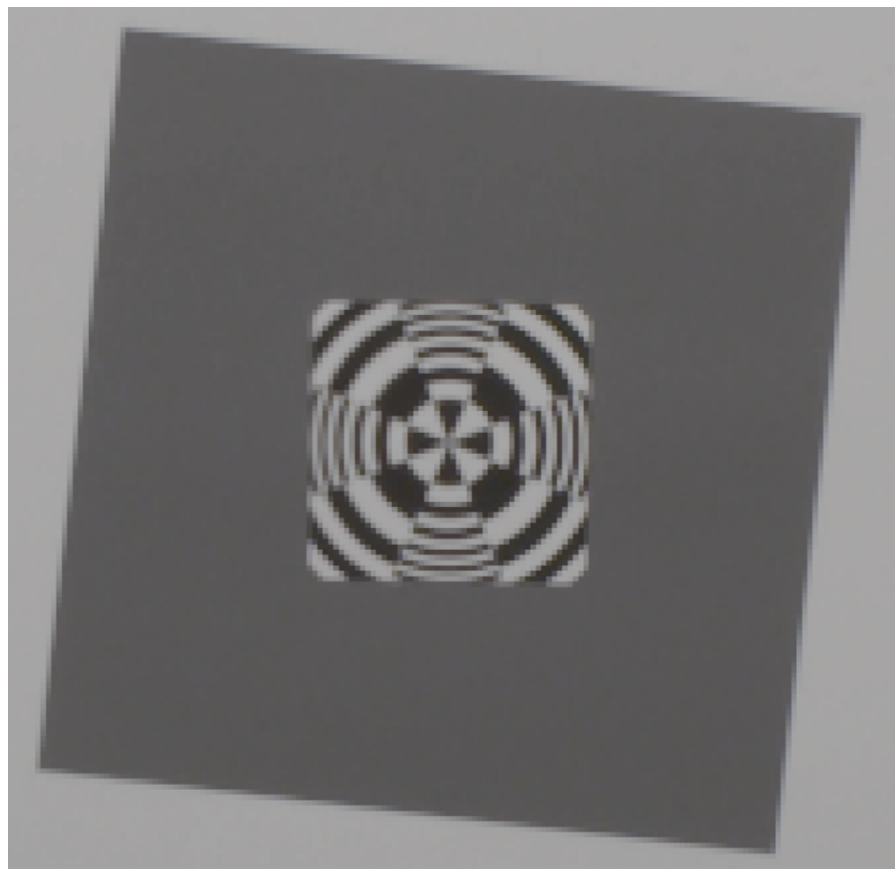
Sony F-5, Sony 11mm Lens, 400 lux,
ISO 800, Target 36 inches, 1920x 1080 P60
File: Test_13X.tiff



Ikegami HDL-50/HS, Zeiss 5mm Lens,
140 lux, 80 IRE, Target 38 inches
File: Test_77.tiff

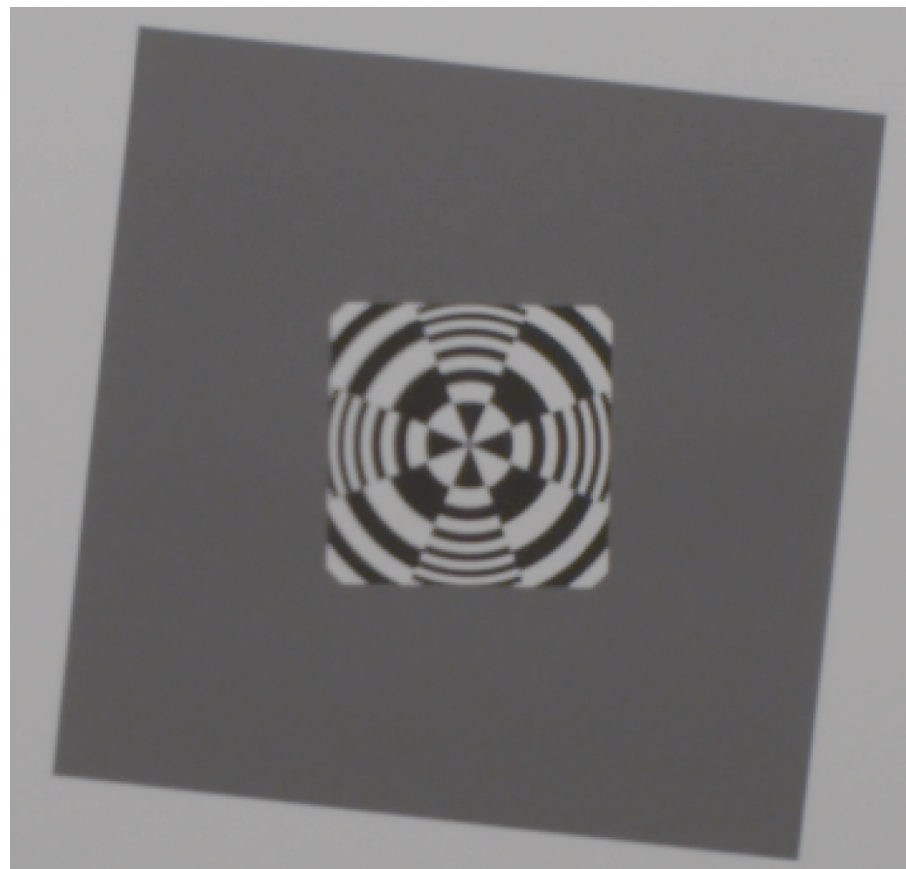
Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K)

Center Resolution



Sony F-5, Zeiss 12mm Lens, 400 lux,
IE 800, Target 36 inches, 1920x 1080 P60
(no color correction)

File: Test_54_1920_4444.tiff

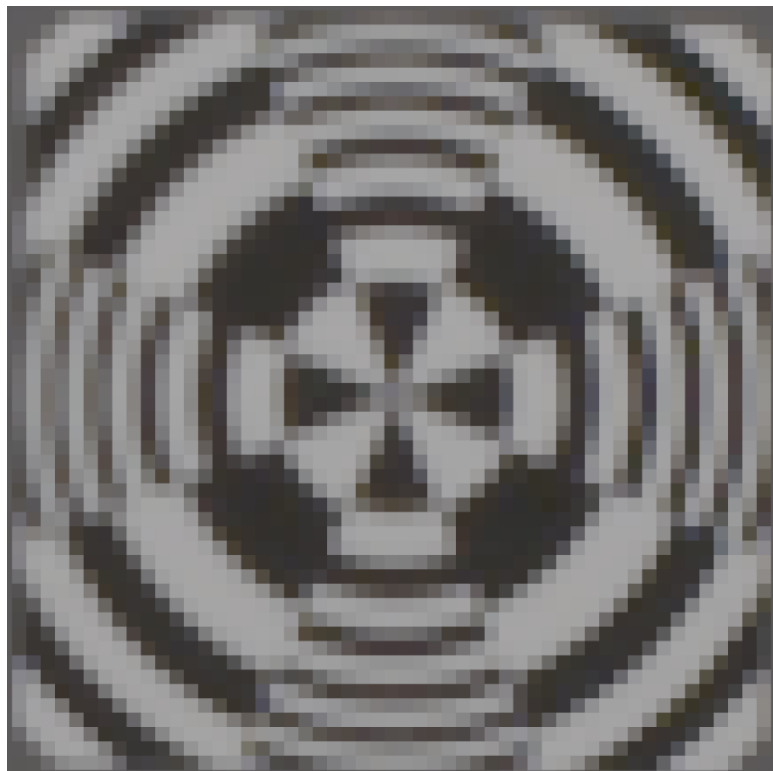


Sony F-5, Zeiss 12mm Lens, 800 lux,
IE 2000, Target 34 inches, 4K P60
(no color correction)

File: Test_54_4K4444.tiff

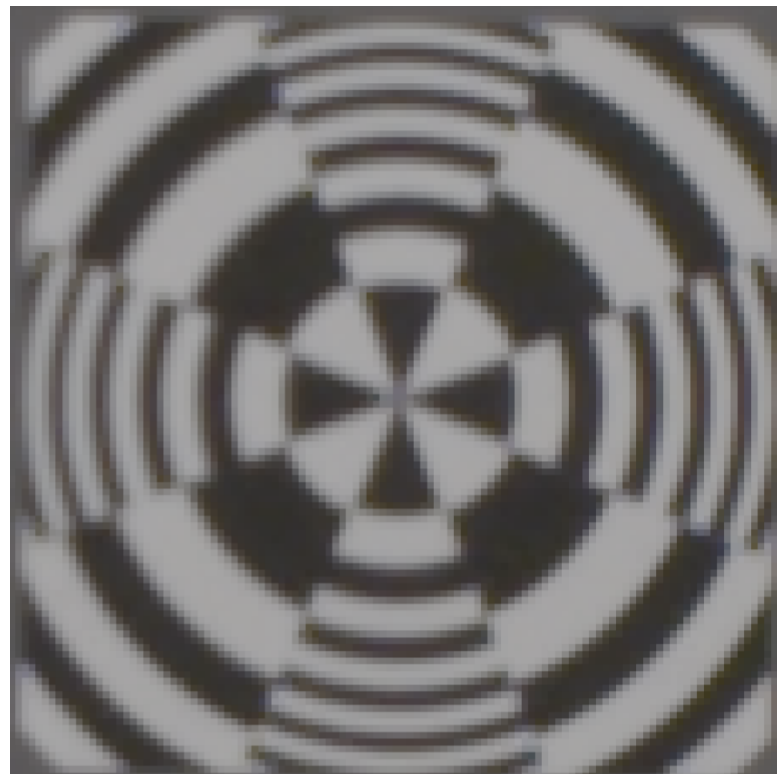
Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K)

Center Resolution - Detail



Sony F-5, Zeiss 12mm Lens, 400 lux, ISO 800, Target 34 inches, 1920x 1080 P60
(no color correction)

File: Test_54_1920_4444.tiff



Sony F-5, Zeiss 12mm Lens, 800 lux, IE 2000, Target 34 inches, 4K P60
(no color correction)

File: Test_54_4K4444.tiff

Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K)

Edge Resolution



Sony F-5, Zeiss 12mm Lens, 400 lux, ISO 800, Target 34 inches, 1920x 1080 P60
(no color correction)

File: Test_54_1920_4444.tiff



Sony F-5, Zeiss 12mm Lens, 800 lux, IE 2000, Target 34 inches, 4K P60
(no color correction)

File: Test_54_4K4444.tiff

Sony F-5 vs. Ikegami HDL50/HS

Color Reproduction (4:2:2 Format)

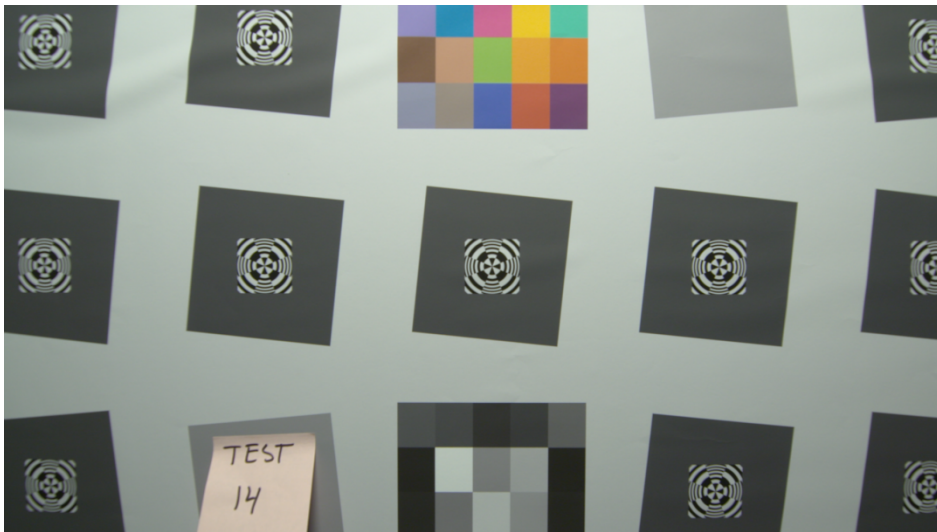


Sony F-5, Sony 11mm Lens, 400 lux, ISO 800, Target 36 inches, 1920x 1080 P60
(no color correction)



Ikegami HDL-50/HS, Zeiss 5mm Lens, 140 lux, 80 IRE, Target 38 inches
(no color correction)

Test Showing the Sony F-5 and the Sony SCL-P11X15 Lens Meets the i2MAP Depth of Field Requirements (at F 5.6)



Sony F-5, Sony SCL-P11X15 lens set to 11mm, 560 lux, 75 IRE, Target 18 inches (10cm from dome equiv.), F 5.6, focus distance 31.5 inches

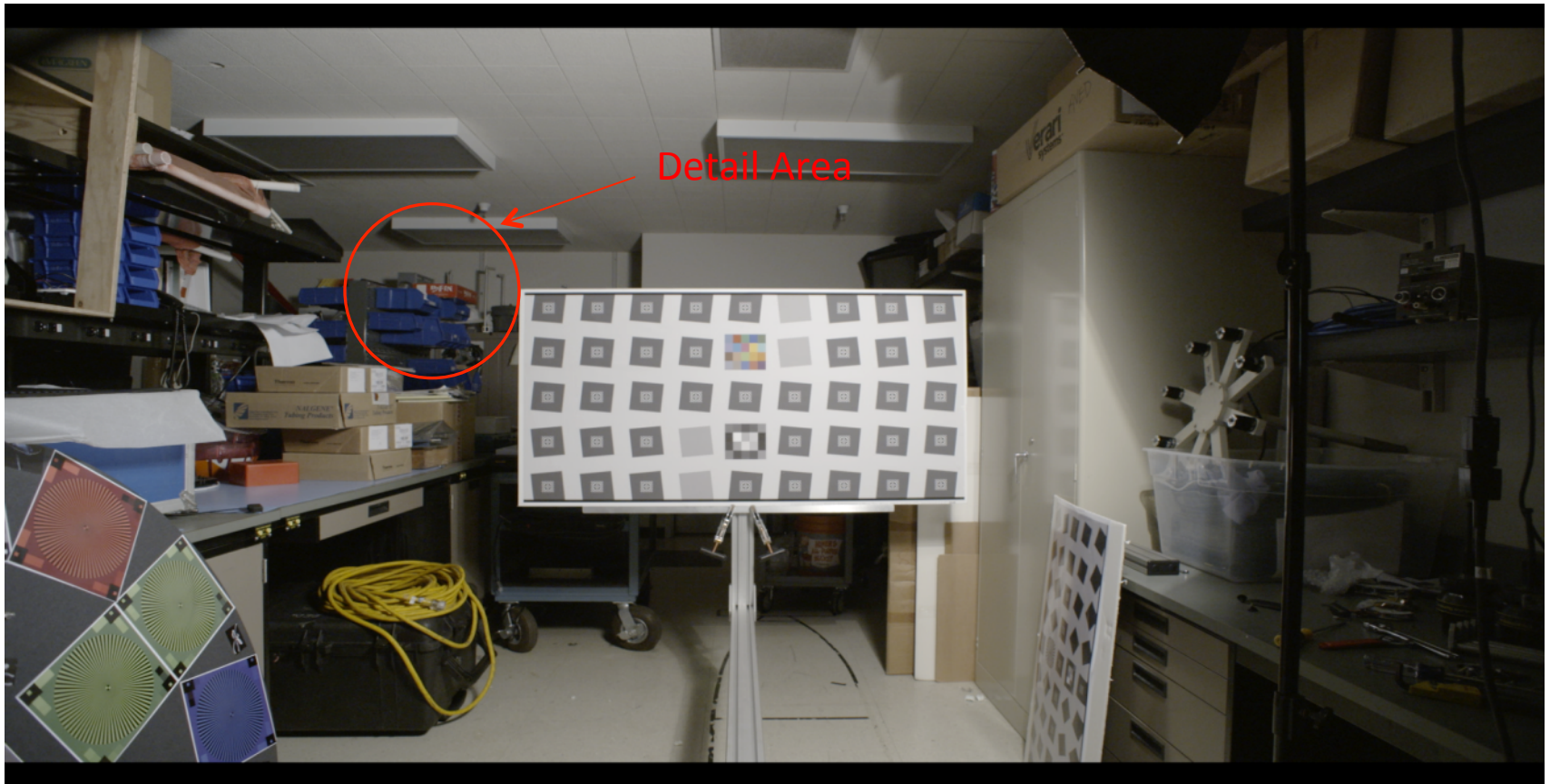
File: Test_14.tiff



Sony F-5, Sony SCL-P11X15 lens set to 11mm, 560 lux, 75 IRE, Target 113 inches (2.5m from dome equiv.), F 5.6, focus distance 31.5 inches

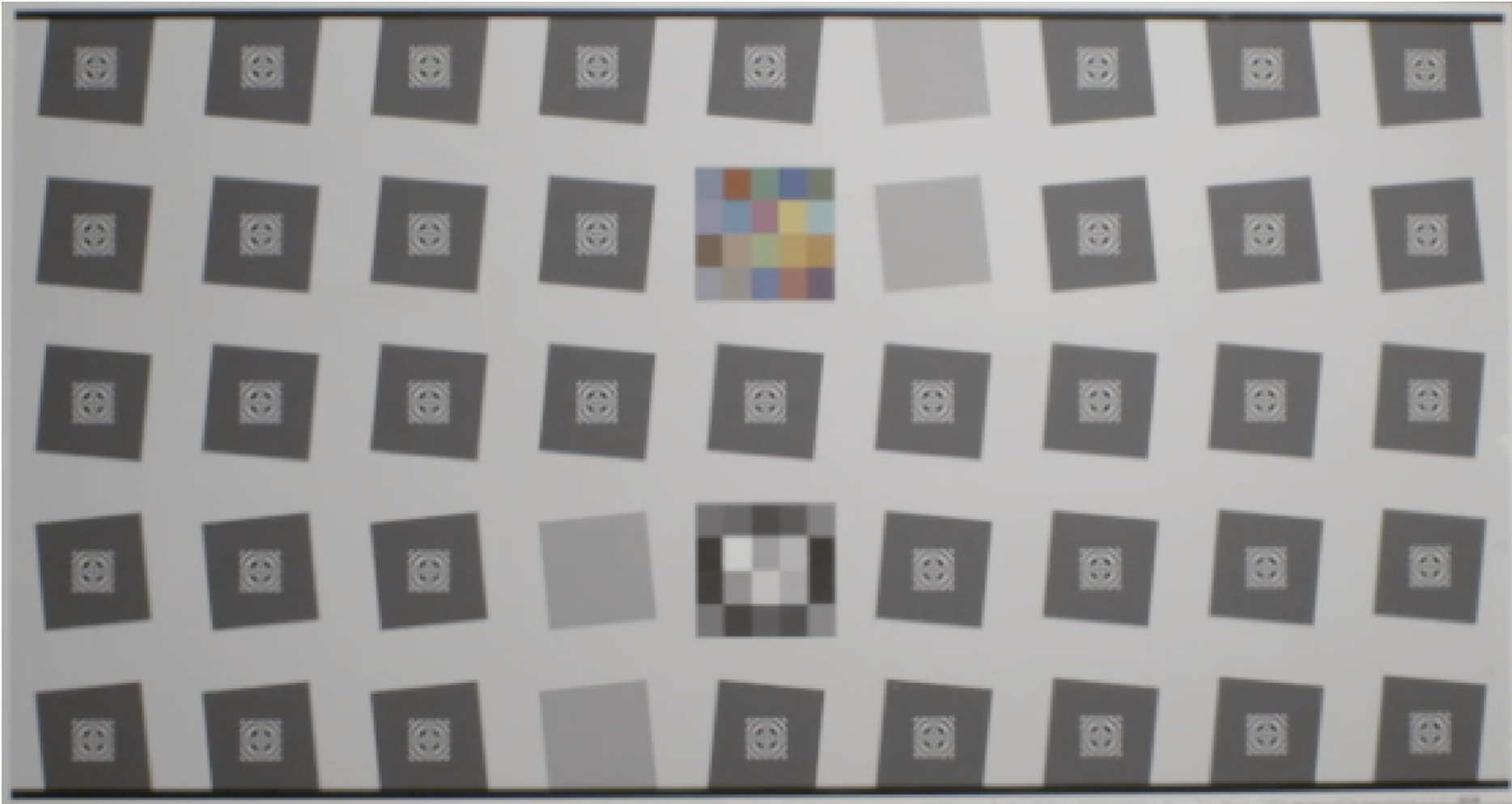
File: Test_45.tiff

Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K) Resolution Example



Sony F-5, Zeiss 12mm Lens, 500 lux, IE
2000, Target 113 inches, 2K P60
(no color correction)
File: Test_53_2K.tiff

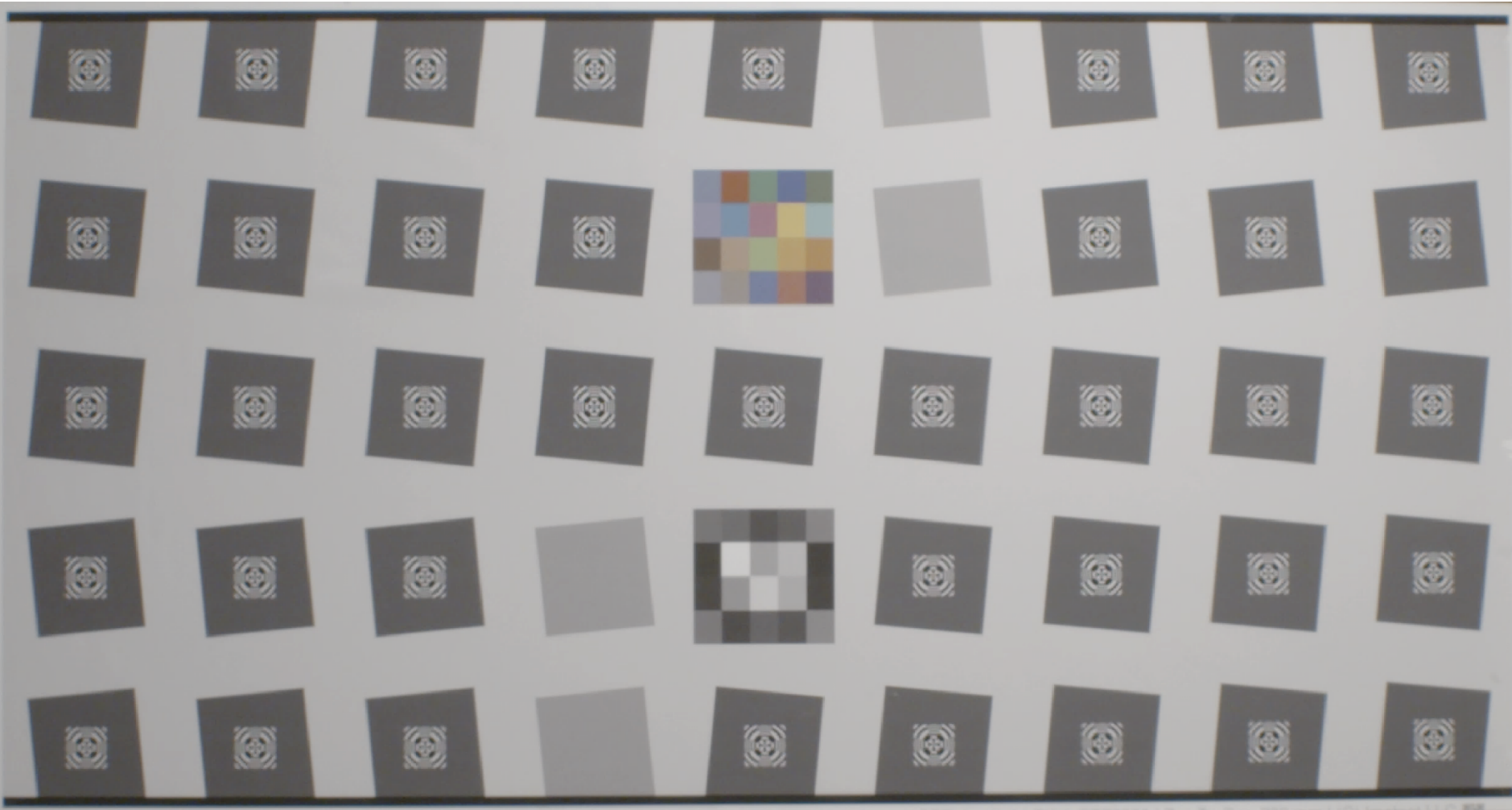
Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K) Resolution Example 2A



Sony F-5, Zeiss 12mm Lens, 500 lux, IE 2000, Target 113 inches, 2K
P60 (Lightened 10%) File: Test_53_2K.tiff

Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K)

Resolution Example 2B



Sony F-5, Zeiss 12mm Lens, 500 lux, IE 2000, Target 113 inches,
4K P60 (Lightened 20%) File: Test_53_4K444.tiff

Sony F-5 1920 X 1080 vs. Sony F-5 4096 X 2160 (4K) Resolution Example 1



Sony F-5, Zeiss 12mm Lens, 400 lux,
IE 800, 1920x 1080 P60
(+20% brightness correction)
File: Test_53_2K4444.tiff



Sony F-5, Zeiss 12mm Lens, 800 lux,
IE 2000, 4K P60
(+20% brightness correction)
File: Test_53_4K4444.tiff

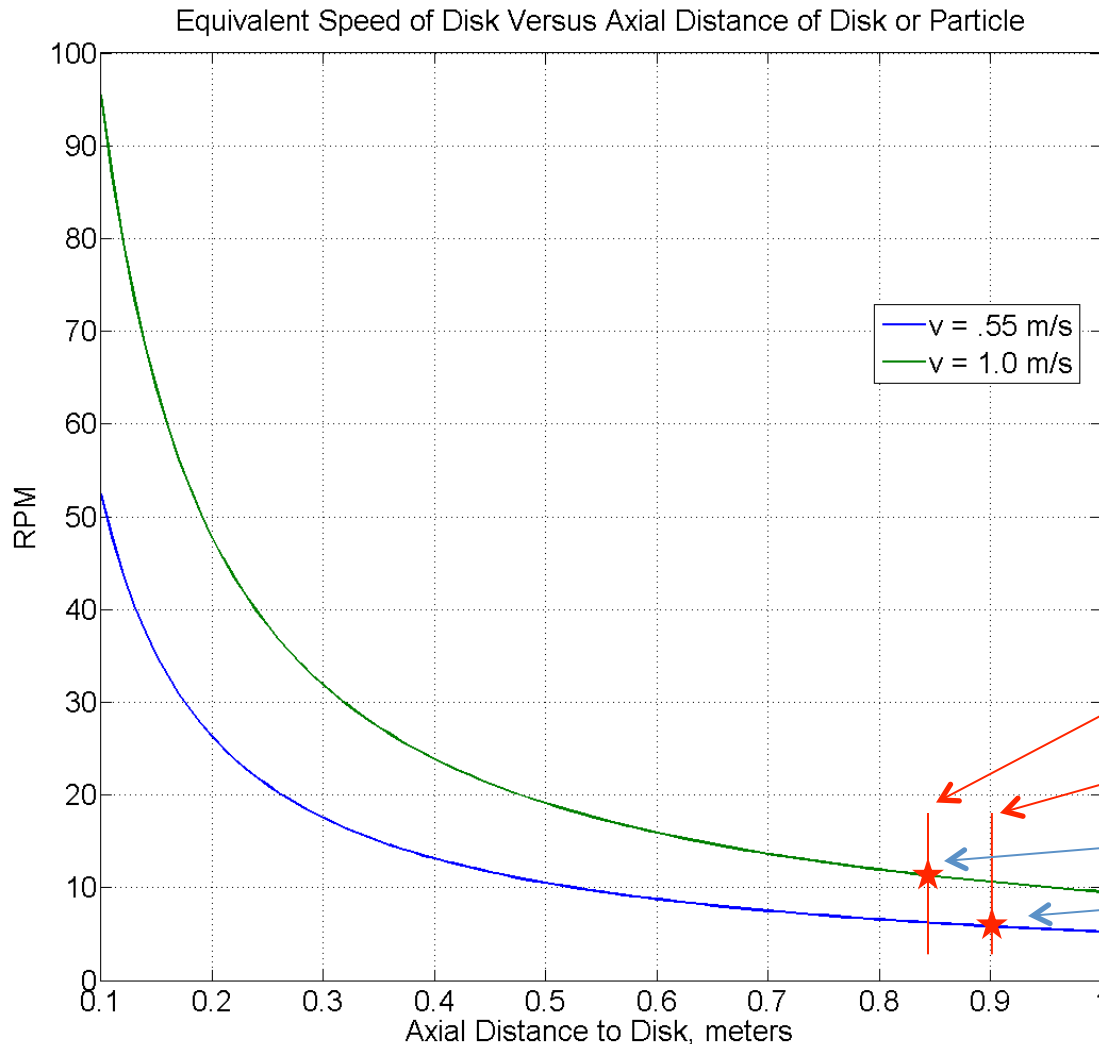
Optical Dome Design

- In the final process of selecting the optical design consultant.
- Aspherical front dome design is recommended to support 4k resolution (minimize field curvature).
- Mechanical design would be done in house.

Temporal Resolution Testing

Rotating Test Target Reproduced Object Angular
Velocities Simulating AUV Speeds of 0.55 and
1.0 meters per second

Translation of Vehicle Motion to Focal-Plane



$$v^P = v^T \quad (1)$$

$$-f \frac{rv}{x_{3p}^2} = -f \frac{r}{x_{3t}} \omega \quad (2)$$

$$\omega = \frac{vx_{3t}}{x_{3p}^2} \quad (3)$$

$$\omega = \frac{v}{x_3} \quad (4)$$

x_{3p} – focal plane to particle

x_{3t} – focal plane to disk

Eqn. 3 => 4 if they're equal.

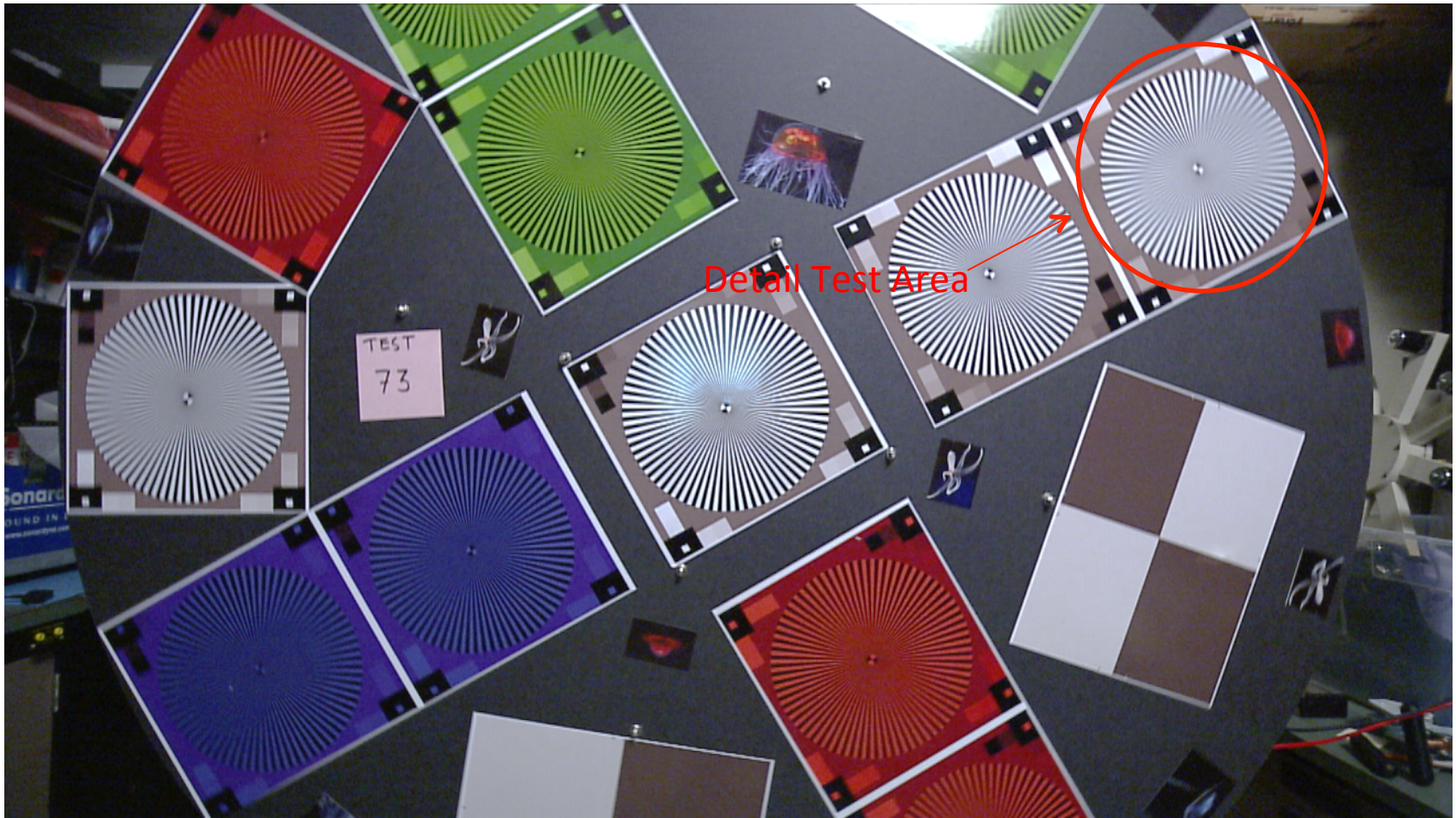
Super-35 Camera Distance
(adjusted for 0.5 meters from dome)

2/3 Camera Distance

1.0 m/sec. = 11 RPM

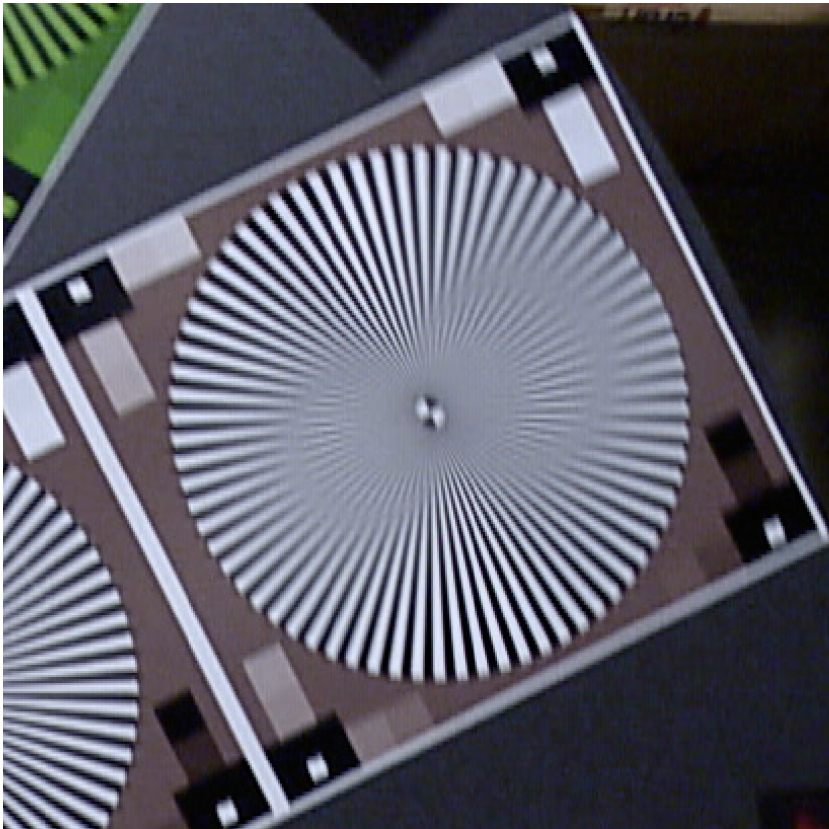
0.55 m/sec. = 6 RPM

Temporal Resolution, Can We Get Good Image Quality at 1 Meter Per Second? Enter The Wheel of Death

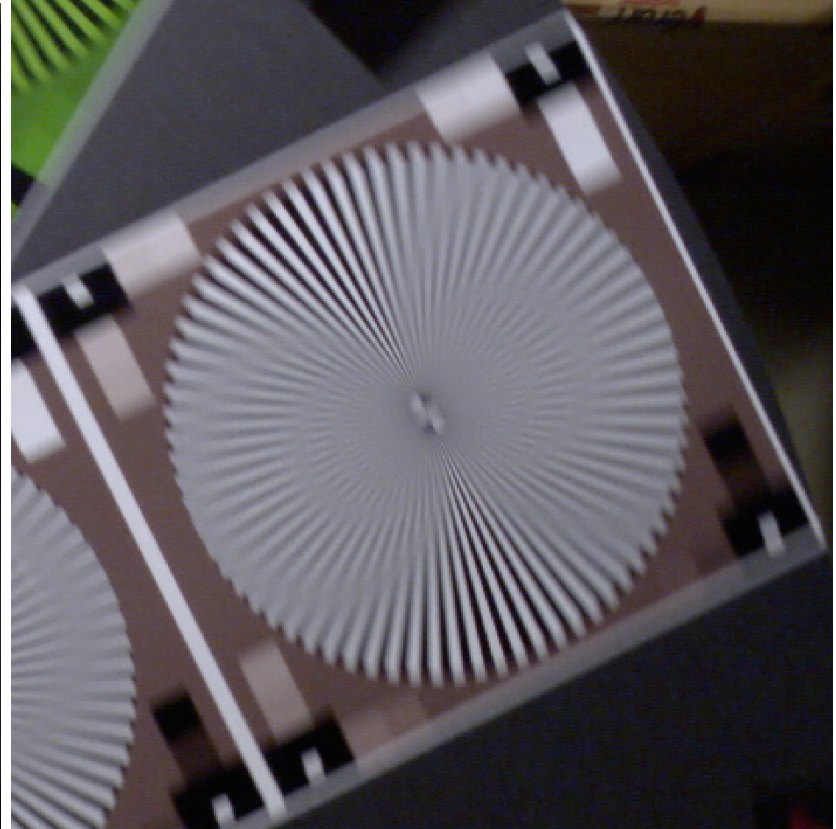


Ikegami HDL50/HS, Zeiss 5mm Lens, 100 lux, 1920x 1080i 30
Disk 6 RPM (~ 0.5 m/sec), File: Test_73_White.tiff (DeInterlaced)

Comparison of Current (0.5 m/sec.) and Planned (1.0 m/sec.)
Temporal Resolution at the 0.5 Meter from Dome “Sweet Spot”.

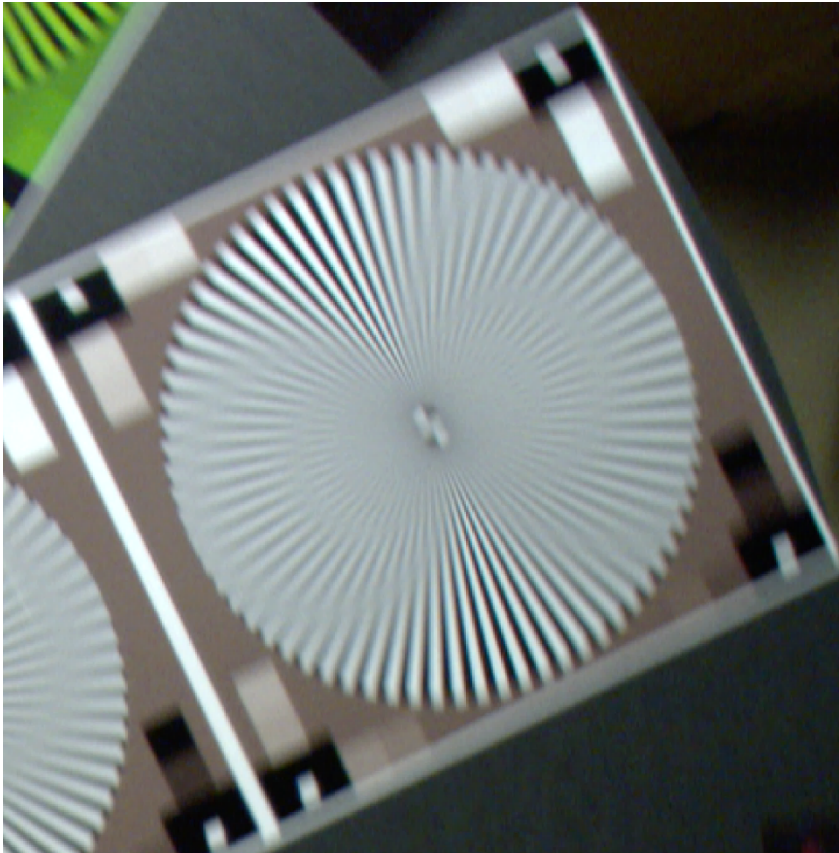


Ikegami HDL50/HS, Zeiss 5mm Lens,
110 lux, 1920x 1080i 30
Disk 6 RPM (~ 0.5 m/sec)
File: Test_73_White.tiff (DeInterlaced)

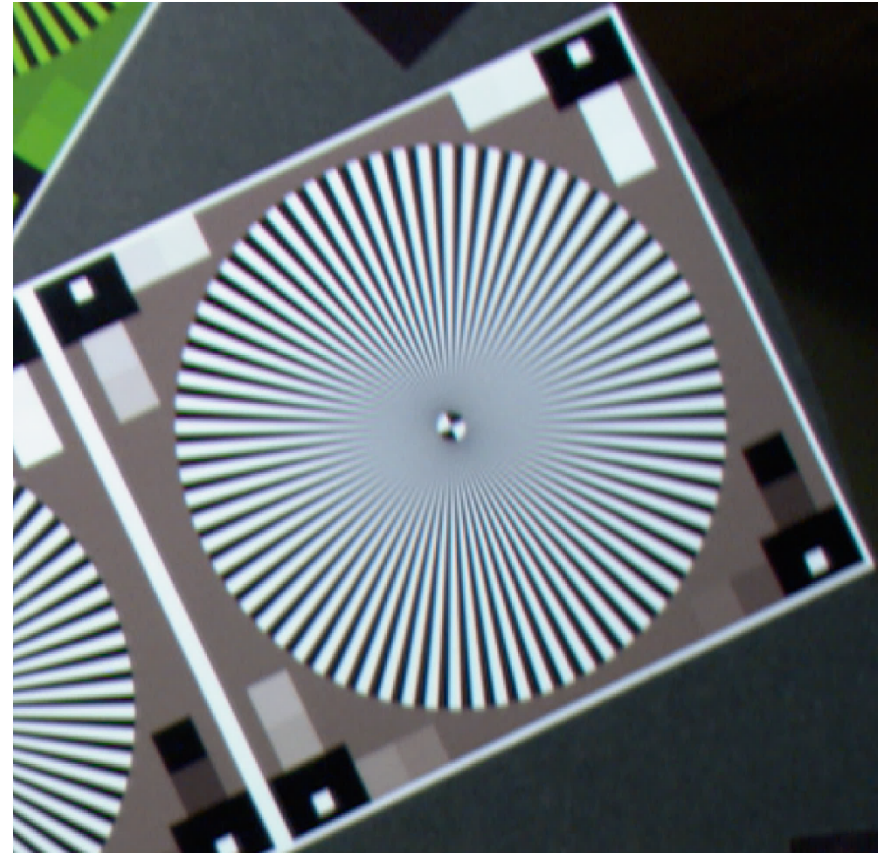


Ikegami HDL50/HS, Zeiss 5mm Lens,
170 lux, 1920x 1080 P60
Disk 11 RPM (~ 1 m/sec)
File: : Test_76_White.tiff

The Effect of Camera Shutter at The Planned (1.0 m/sec.) AUV Velocity tested at the 0.5 Meter from Dome “Sweet Spot”.



Sony HDCP1, Zeiss 5mm Lens,
120 lux, 1920x 1080 P60
Disk 11 RPM (~ 1 m/sec), No Shutter
File: Test_66_White.tiff

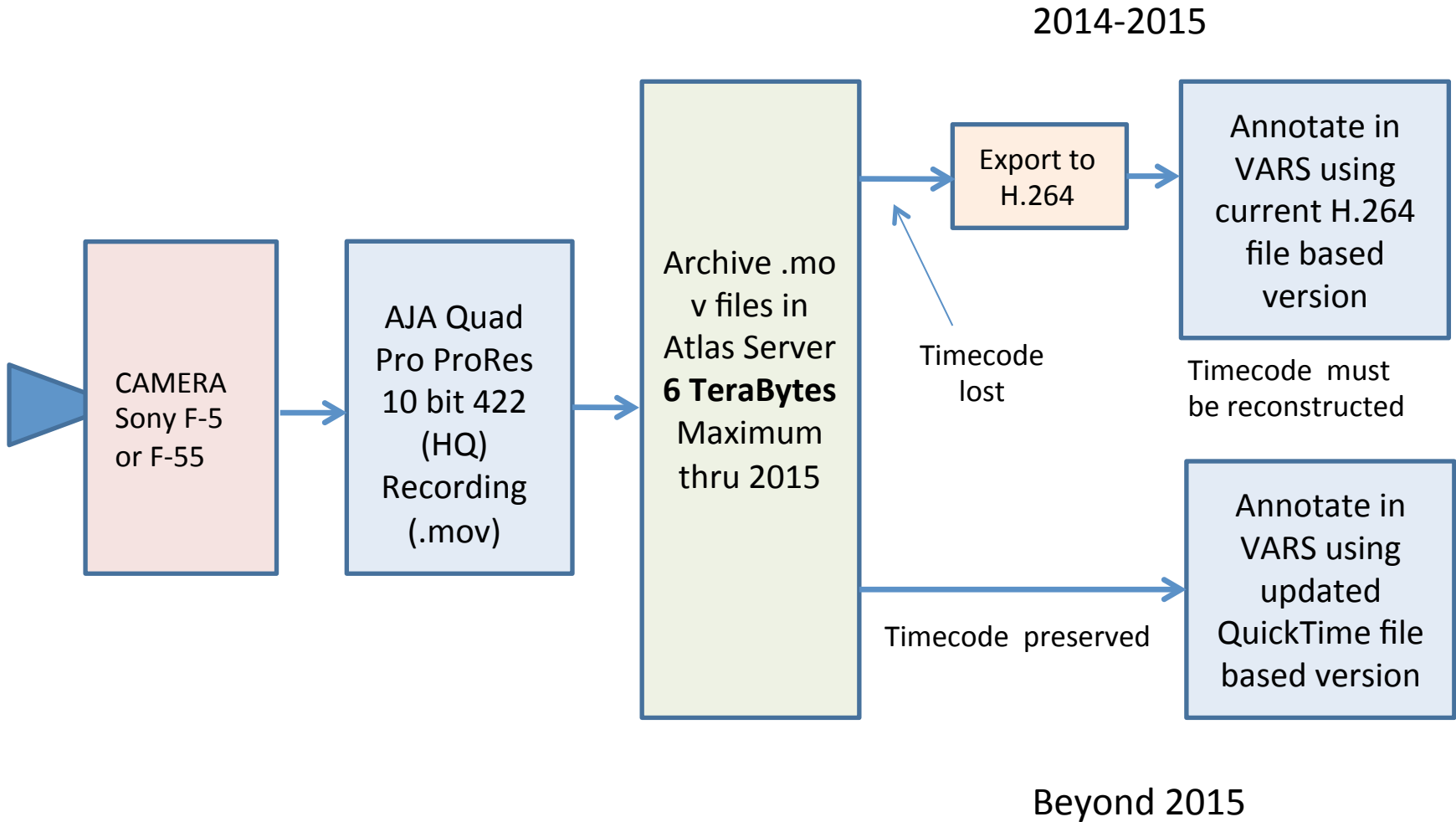


Sony HDCP1, Zeiss 5mm Lens,
800 lux, 1920x 1080 P60
Disk 11 RPM (~ 1 m/sec), Shutter 1/250
File: Test_68_White.tiff

i2MAP Video Recorder Options

Maximum Framerate		1080 60P	
Recorder Name		AJA Ki Pro Quad recorder	
Power Requirements		12-18VDC, 31.2-35.5W typical-41.5W Max	
Storage Media		2 X AJA's Pak512 512GB SSD	
Useable Size GB		960	
Cost Each		\$2,590.00	
Cost/GB		\$2.70	
Native Formats and Frame Rates Supported by Recorder	Dual Link SDI (SMPTE 372M)		Y
	3G SDI (SMPTE 424M)		?
	720P 60		Y
	1080P 60		Y
Video Format (may not all be supported)	Data Rate in mega bits per second (Mbps)	Ratio N:1	
1080p 30 native (4:2:2)	1485		
1080p 60 native (4:2:2)	2970		
D-5 4:1 compression 25P	269		
Apple ProRes 422 10 bit 30P	147	10	871
Apple ProRes 422 (HQ) 10 bit 30P	220	7	582
XAVC HD codec 10 bit 4:2:2 60P	223	13	
	293	10	437
Apple ProRes 4444 30P	330		388
Apple ProRes 422 (HQ) 10 bit 60P	440	7	291
HDCAM SR 10 bit 4:2:2 30P	440	3	
DPX image sequences, SMPTE 268M-2003 60P	440		
Apple ProRes 4444 60P	660		194
Download from sealed housing?		Yes, 10/100/1000 Ethernet	
Sustained transfer rate, Mb/s/second		400	
Hours to download 1 hour 1080 60P 4:2:2 from sealed housing		1.10	
Recorder Cost		\$3,995	

Post-Mission Work Flow



Estimated System Cost Comparison

Cost Comparison	Ikegami HDL50/HS	Sony F-5	Sony F-5 4K upgrade
Output Format	1920x1080P 60	1920x1080P 60	4096x2160P 60
Camera	\$28,630	\$17,000	\$12,000
Lens	\$9,100	\$6,000	
Recorder	\$3,995	\$3,995	
Memory	\$2,590	\$2,590	
Total	\$44,315	\$29,585	\$41,585

Budget was ~ \$57,592

Camera and Recorder Testing

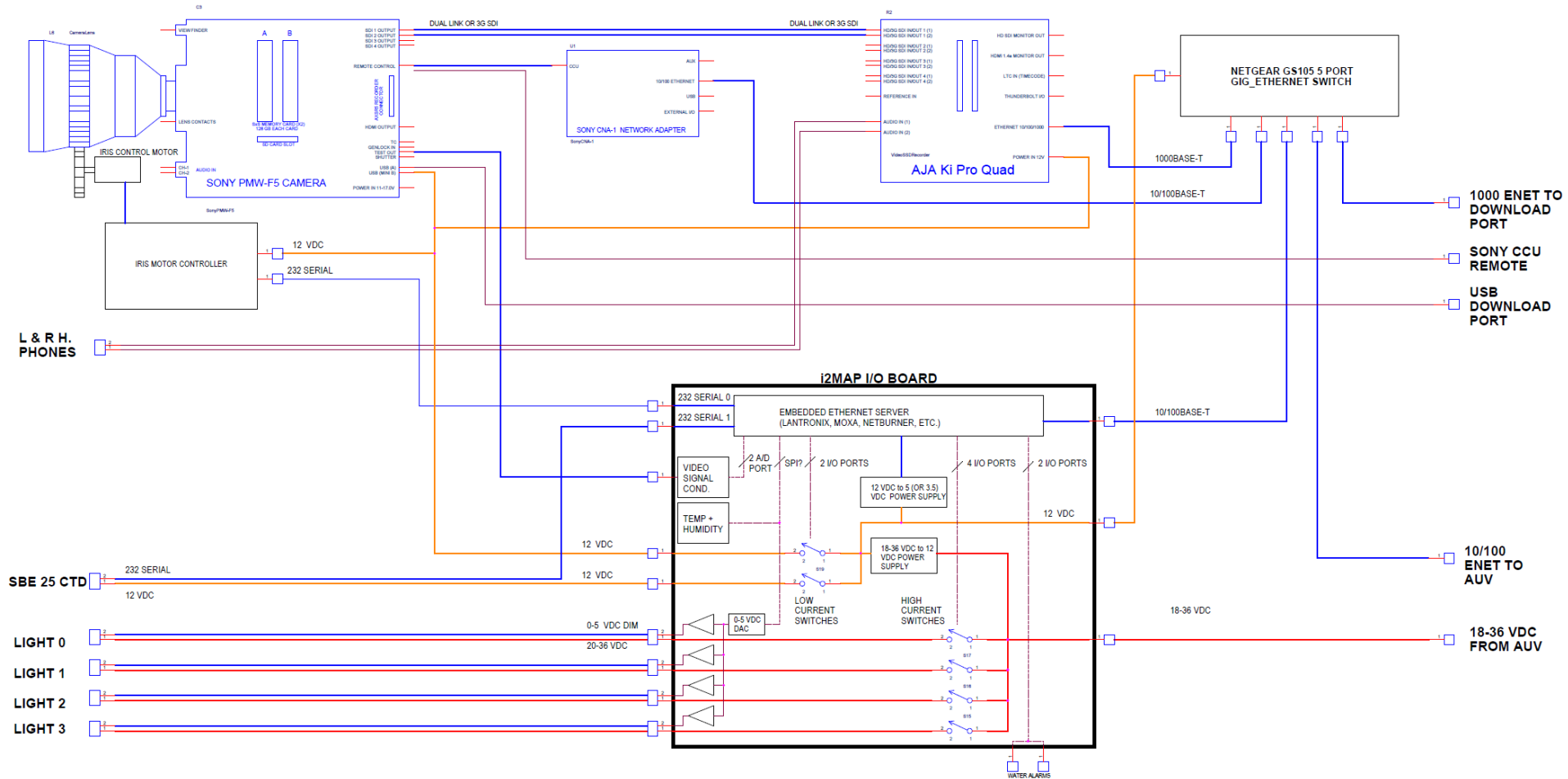
Conclusions

- Camera
 - The F-5 camera is about 2 stops slower when depth of field control is taken into account.
 - Shutter speed of 1/250 is needed to completely freeze the motion of 1 meter per second transect.
 - Ikegami has black adjustment issues on power-up boot. Suggest putting 100% filter in one position in filter wheel – would require camera control.
- Video Recorder
 - The Apple ProRes 422(HQ) CODEC is visually lossless.
- We should have adequate illumination.
 - Need ~ 3200 lux maximum with F-5 at 0dB gain and 1/250th shutter.
 - 4 lights measure at ~ 3500 – 5000 lux at 0.5 meters from dome.

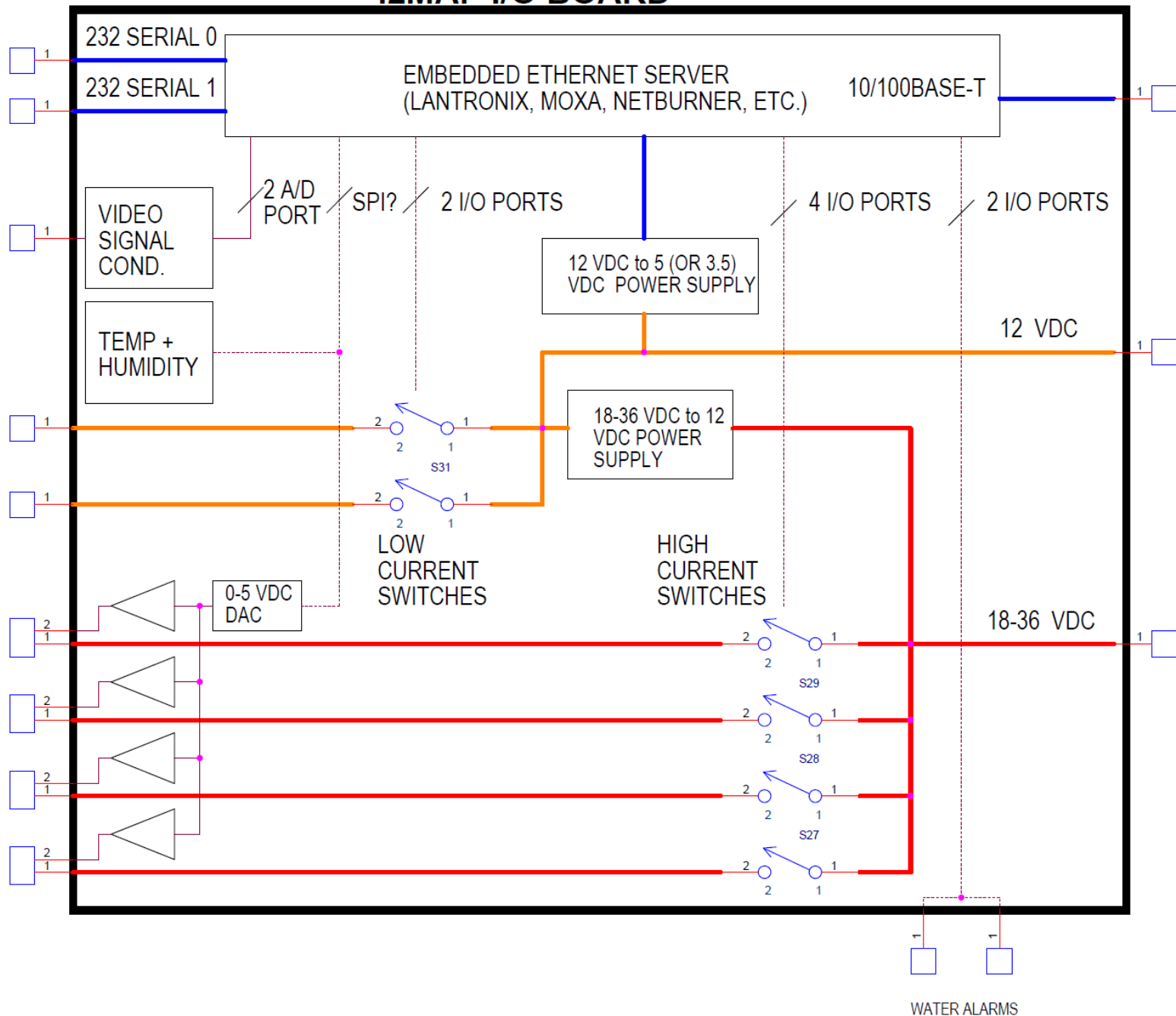
Which is the best camera for us?

- Ikegami HDL-50/HS 2/3" box camera
 - Box camera has a great picture but is limited to 1920 X 1080 60 frames per second.
 - Box camera is the smallest and would be slightly easier to integrate – except for auto black balance on boot-up.
- Sony F-5 super 35 format camera.
 - F-5 Cine camera has 4K sensor and offers a migration path to higher resolution formats, 2K and 4K.
 - Current recording limitation is 2048 X 1080 60 frames per second.
 - AJA has recording hardware in development that supports 4K at 60 frames per second that may be available in the future.
 - Sony F-5 can be upgraded to 4K output for \$12,000.
- Cost is very similar – Go with the F-5

CAMERA HOUSING BLOCK DIAGRAM



i2MAP I/O BOARD



Supervisory Control Software

- Component Power Switching
- Digital Recorder Control
- Camera Control
- Data logging
- Recorder/AUV Time Synchronization

Power Switching

- Cycle power to:
 - Lights
 - Camera
 - Recorder
- Approach: COTS Device Server
 - Digital I/O switches (lights)
 - Ethernet/HTTP interfaces
 - Serial to Ethernet (CTD, temp & humid, servo)
- Example: Moxa NPORT SDS



Digital Recorder Control

- Testing the Ki Pro Quad unit from AJA
- Ethernet communication
- HTTP command interface
 - Change settings (file names, format, etc.)
 - Start/Stop recording
- Easily test command functionality using browser

Camera Control

- To be implemented in 2015
- Ethernet Communication
- Command interface TBD
- Configuration Settings TBD
 - White balance
 - Load predetermined configurations

Data Logging

- CTD Data
- Environmental
 - Temperature, humidity
- Peak and average light intensity
 - From video signal
 - May use to adjust aperture (2015)

Time Synchronization

- Adjusting the recorder time to match Main Vehicle Computer (MVC)
- Physically set the AJA date and time using buttons on the device
- Programmatically change the output file name to include the MVC time
 - 19-37-54_200m.mov (12:37:54 PDT)
- Adjust video timecodes in postprocessing

Design Approach

- All functionality will reside in MVC software modules
- Use familiar Server Interface to expose settings, switches, and data to other MVC modules (standard practice)
- Functional interfaces to devices implemented in one or more MVC driver modules
- Needed control parameters will be available in a mission script behavior

Mission Script

behavior waypoint

```
{  
    depth = 200;  
}
```

:

behavior videocam

```
{  
    videoname = "200m";  
    record = start;  
}
```

:

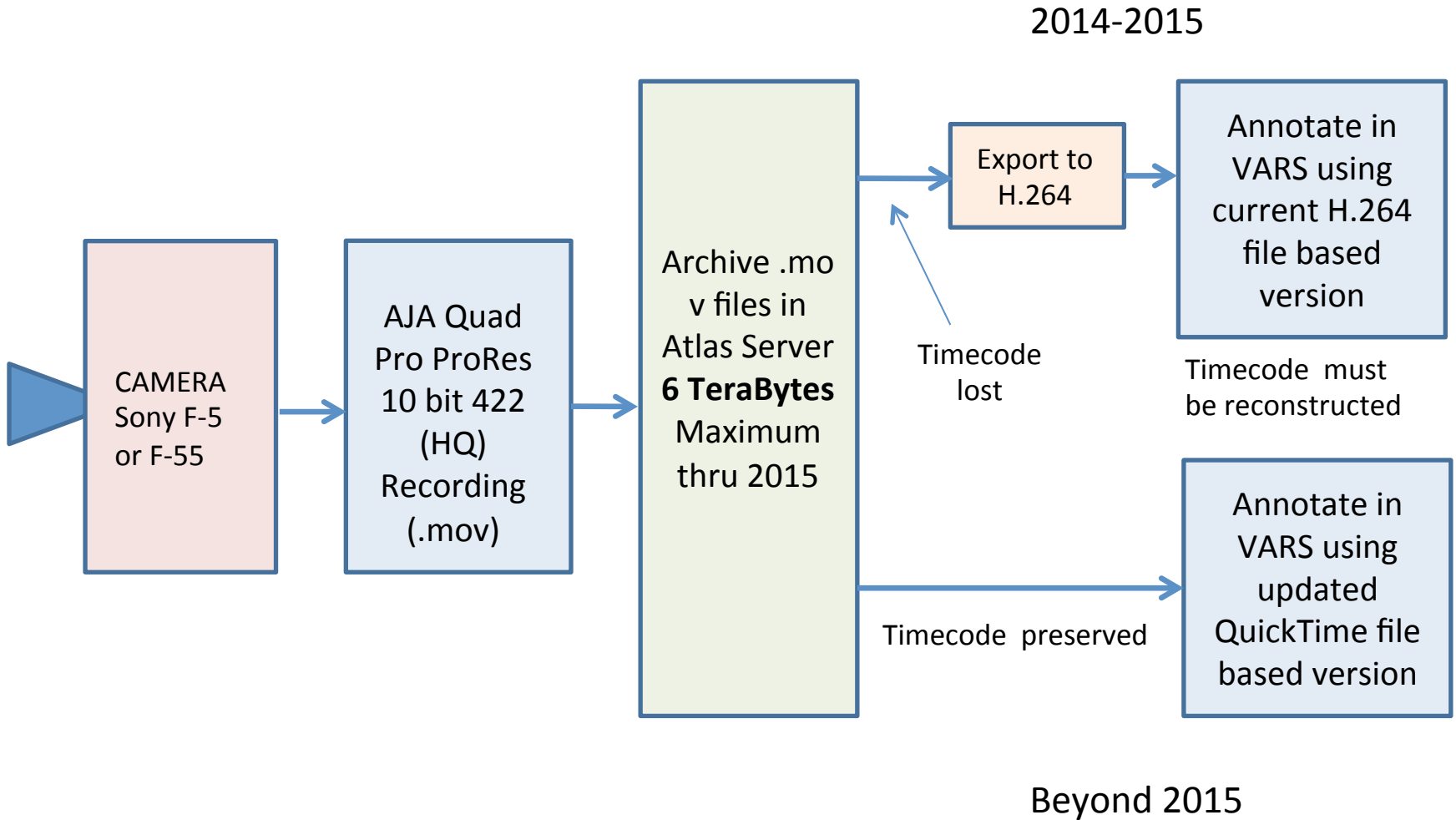
behavior videocam

```
{  
    record = stop;  
}
```

Pros and Cons vs. Microcontroller

- Pros
 - No middleware development
 - Functionality implemented in one place
 - Reduced testing time
 - Maintenance is simplified
 - Familiarity to Engineering and AUV ops
- Cons
 - Interface to the AUV section is more complicated
 - Porting to another system requires re-implementation

Post-Mission Work Flow



Budget

Descriptions in black were budgeted for 2014

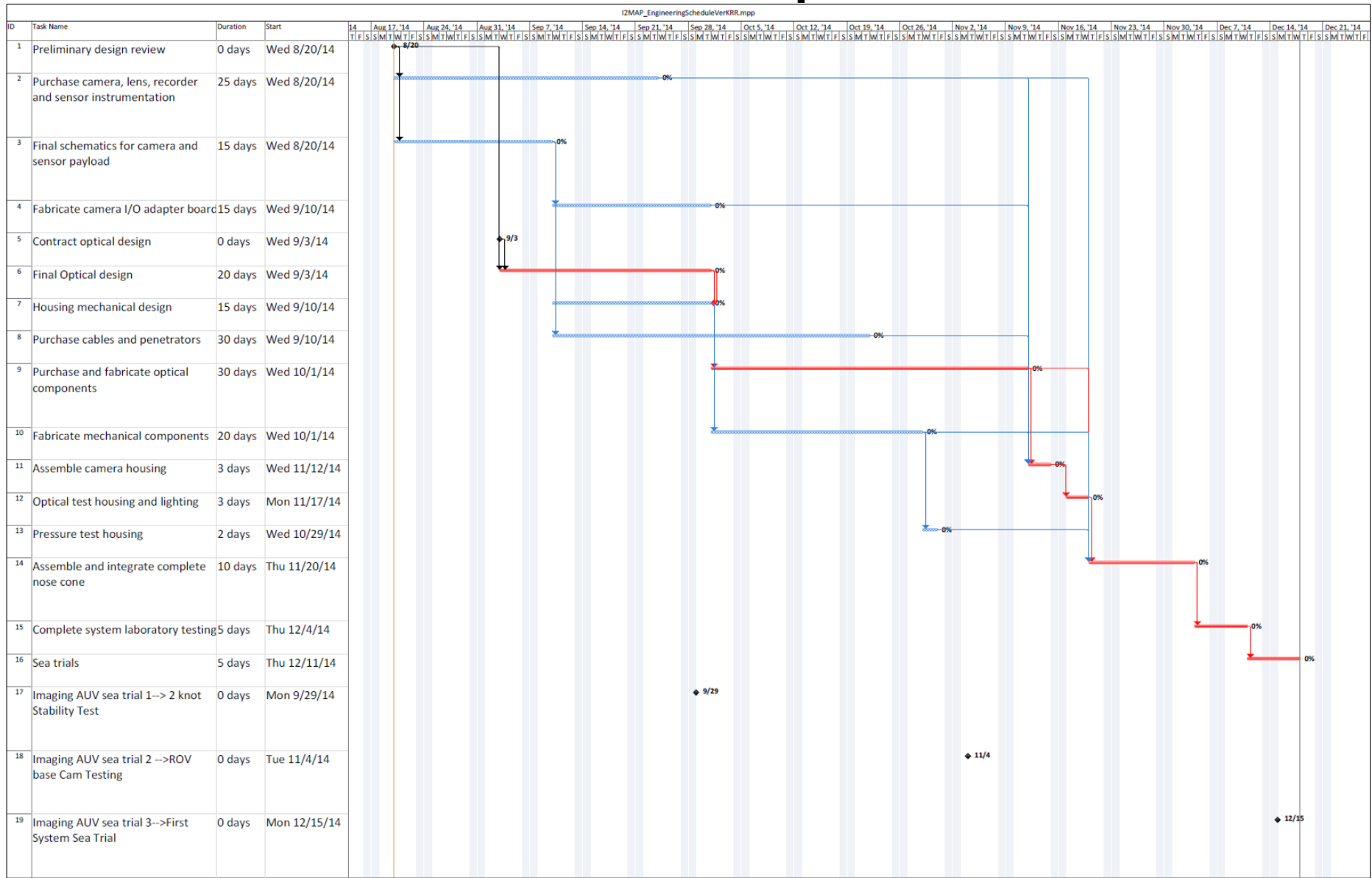
Descriptions in green and red were budgeted in 2013 but not used due to schedule delays and were not granted roll over into the 2014 budget.

Roll over request for items described in red were not funded.

Roll over request for items described in green were given a “Will consider” later, as needed.

Sub-Account	Description	2014 Budget	Known & Estimated Costs to Date	Balance Avail
Capitol Equipment	HDTV Camera	\$25,000	\$17,000	\$8,000
Capitol Equipment	HDTV Prime Lens	\$27,000	\$6,000	\$21,000
Capitol Equipment	Sea-Bird 25plus CTD	\$8,500	\$36,500	(\$28,000)
Capitol Equipment	Syntactic Foam, 2000m	\$9,000	\$2,000	\$7,000
Capitol Equipment	Dome port	\$0	\$10,000	(\$10,000)
Total Capitol Equip.		\$69,500	\$71,500	(\$2,000)
Conference Fees/Reg	NAB (\$150)	\$0	\$150	(\$150)
Total CF/Reg.		\$0	\$150	(\$150)
OS Equipment Rental	Lenses	\$0	\$765	(\$765)
Total OS-Eq. Rent		\$0	\$765	(\$765)
OS General	Adapter Optics Fabrication	\$3,500	\$1,000	\$2,500
OS General	Optical Consultant (\$5K)	\$0	\$5,500	(\$5,500)
Total OS-Gen.		\$3,500	\$6,500	(\$3,000)
Postage/Shipping	Postage	\$350	\$0	\$350
Postage/Shipping	Lens/Camera Shipping (\$1.6K)	\$0	\$802	(\$802)
Total Post/Ship		\$350	\$802	(\$452)
Computer (Hardware)	Control Computer Hardware	\$800	\$1,000	(\$200)
Total Comp. Hard.		\$800	\$1,000	(\$200)
Computer (Software)	Video Analysis Software (\$0)	\$0	\$321	(\$321)
		\$0	\$321	(\$321)
General Supplies	Power and Comms Interface board	\$900	\$2,000	(\$1,100)
General Supplies	Digital Video Recorder	\$2,400	\$4,223	(\$1,823)
General Supplies	Digital Recording Media	\$3,192	\$1,815	\$1,377
General Supplies	Housing Interconnect Cabling	\$2,400	\$2,400	\$0
General Supplies	Pressure Housing	\$9,000	\$6,000	\$3,000
General Supplies	AUV Nose Cone Fairing	\$3,900	\$3,900	\$0
General Supplies	Camera Testing Supplies (\$2.2K)	\$0	\$1,970	(\$1,970)
General Supplies	Light frame Materials	\$0	\$658	(\$658)
Total Gen. Suppl.		\$21,792	\$22,966	(\$1,174)
Tools		\$0	\$247	(\$247)
Total Tools		\$0	\$247	(\$247)
Sales Tax (8.25%)		\$7,598	\$508	\$7,090
Total Sales Tax		\$7,598	\$508	\$7,090
Domestic Travel	NAB Los Vegas, NV (\$1K)	\$0	\$839	(\$839)
Total Dom. Travel		\$0	\$839	(\$839)
2014 Total		\$103,540	\$105,598	
Balance Available				(\$2,058)

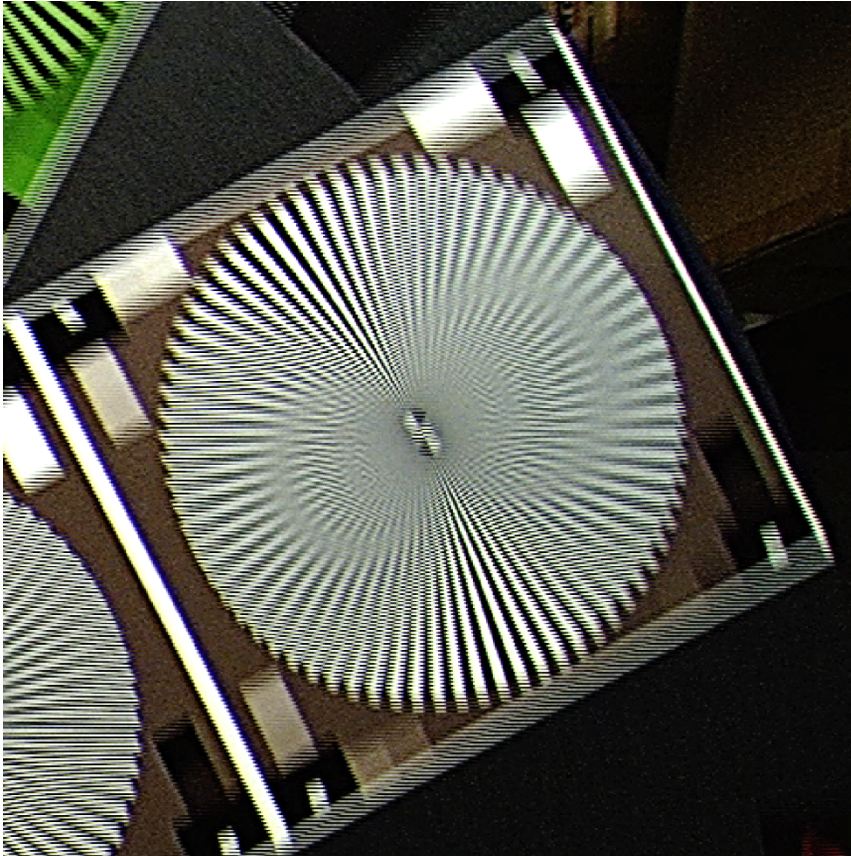
Schedule Update



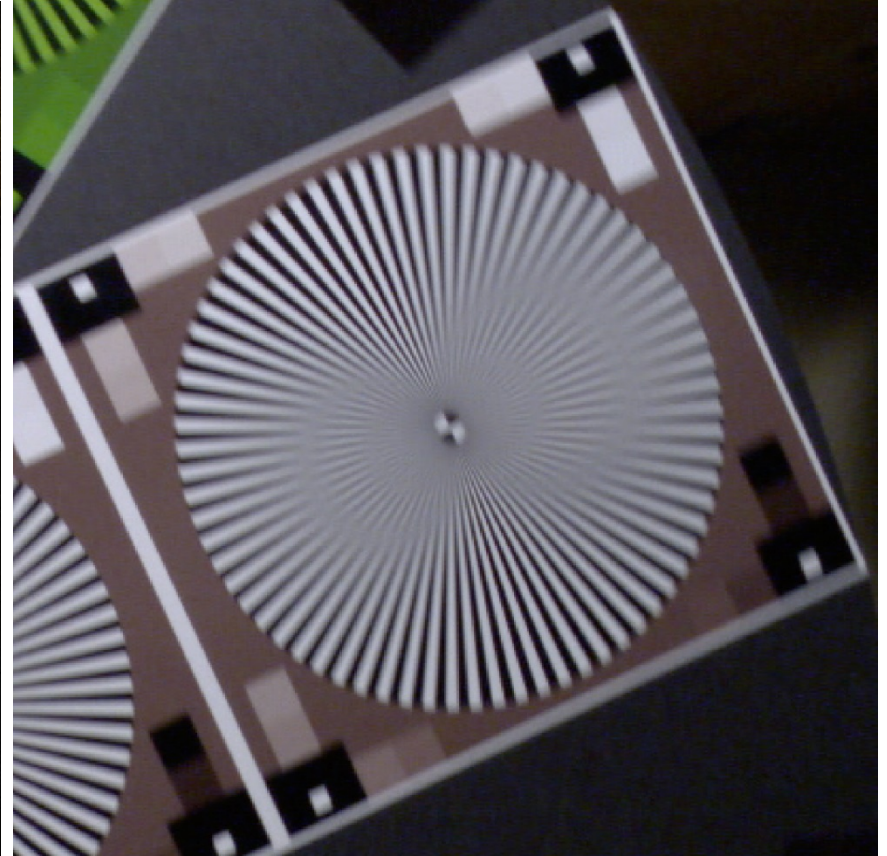
END

Extra Slides

Comparison of the current ROV standard of 1920x 1080i 29.97 at
simulated AUV Speed of 0.5 m/sec. and 1920x 1080 P59.4
(Progressively Scanned)

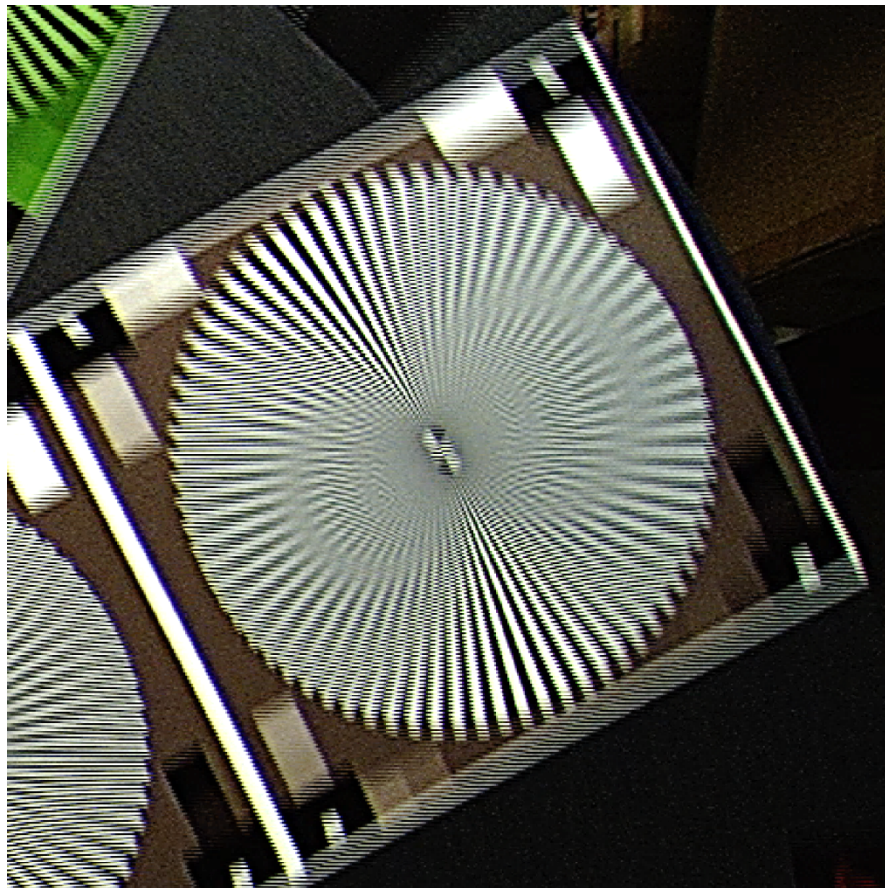


Ikegami HDL45, Fujinon 5.5x10 Lens,
110 lux, 1920x 1080i 29.97
Disk 6 RPM (~0.5 m/sec)
File: Test_103_White.tiff (not DeInterlaced)

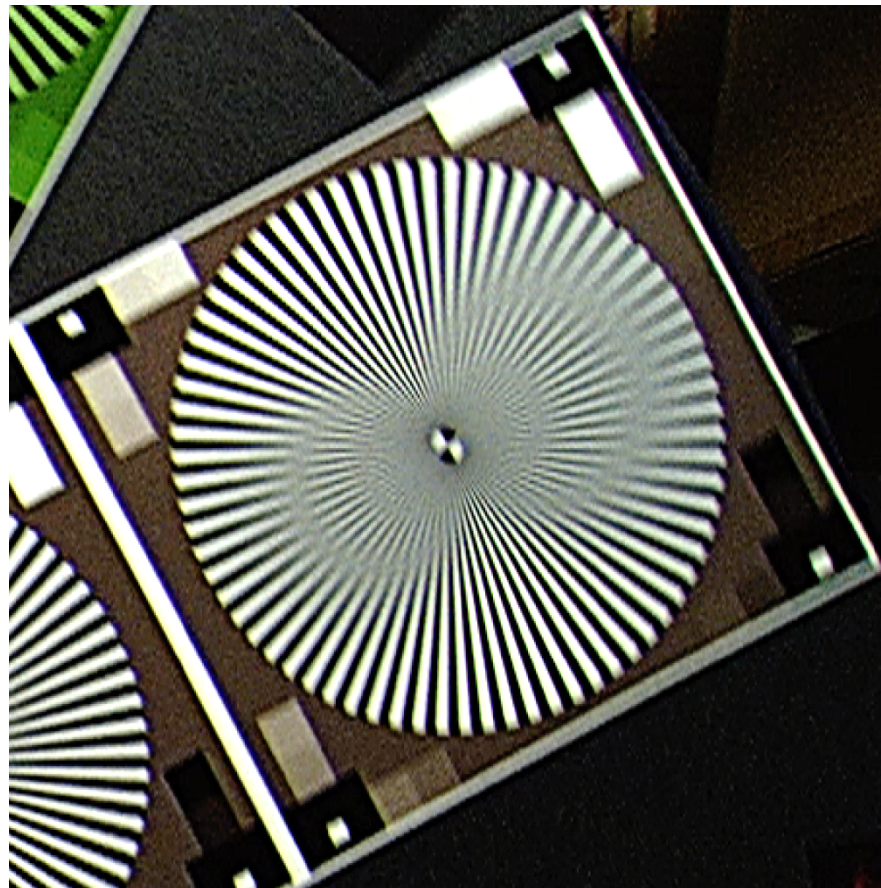


Ikegami HDL50/HS, Zeiss 5mm Lens,
170 lux, 1920x 1080 P60
Disk 6 RPM (~0.5 m/sec)
File: : Test_74_White.tiff

Comparison of the current ROV standard of 1920x 1080i 29.97 at simulated 0.5 m/sec. and the same image de-interlaced using Photoshop

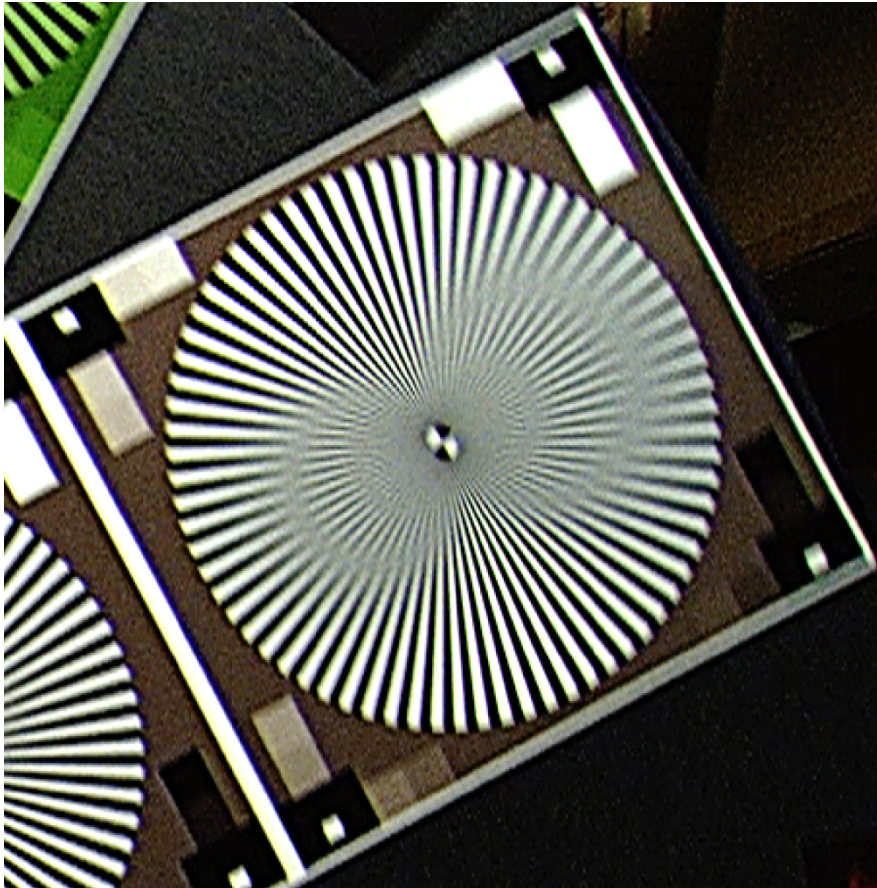


Ikegami HDL45, Fujinon 5.5x10 Lens,
110 lux, 1920x 1080i 29.97
Disk 6 RPM (~0.5 m/sec)
File: Test_103_White.tiff (not DeInterlaced)

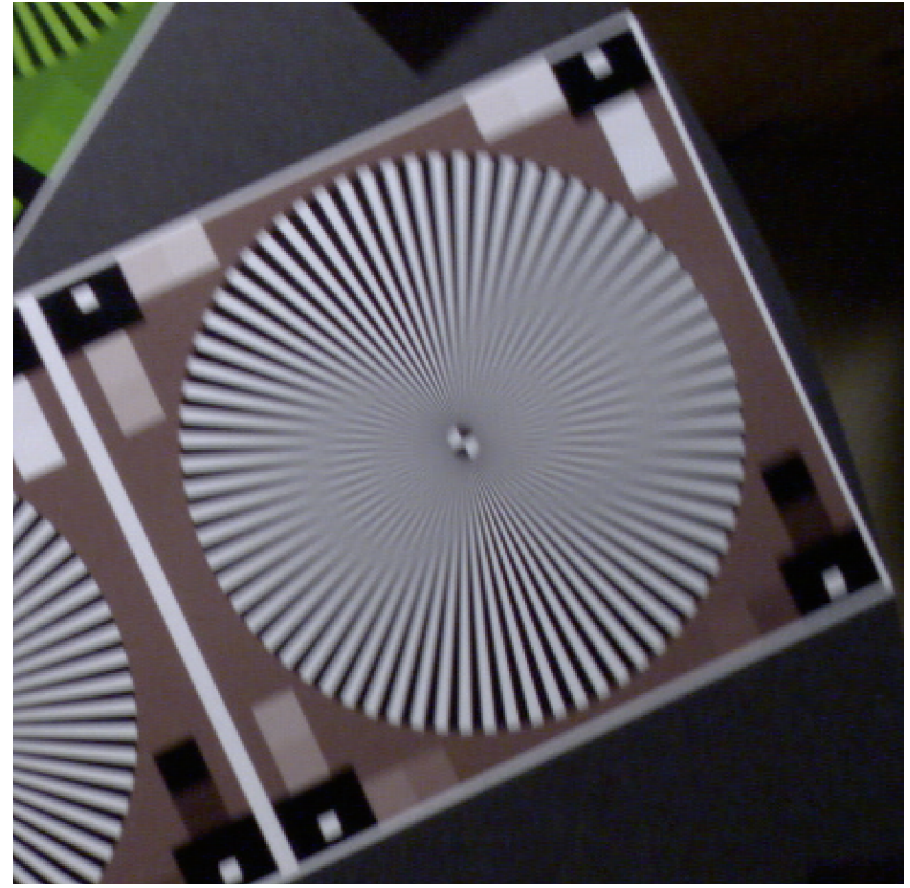


Ikegami HDL45, Fujinon 5.5x10 Lens,
110 lux, 1920x 1080i 29.97
Disk 6 RPM (~0.5 m/sec)
File: Test_103_White.tiff (DeInterlaced)

Comparison of the current ROV standard of 1920x 1080i 29.97 at simulated 0.5 m/sec. De-Interlaced and 1920x 1080 P59.4 (Progressively Scanned)



Ikegami HDL45, Fujinon 5.5x10 Lens,
110 lux, 1920x 1080i 29.97
Disk 6 RPM (~0.5 m/sec)
File: Test_103_White.tiff (DeInterlaced)



Ikegami HDL50/HS, Zeiss 5mm Lens,
170 lux, 1920x 1080 P60
Disk 6 RPM (~0.5 m/sec)
File: : Test_74_White.tiff