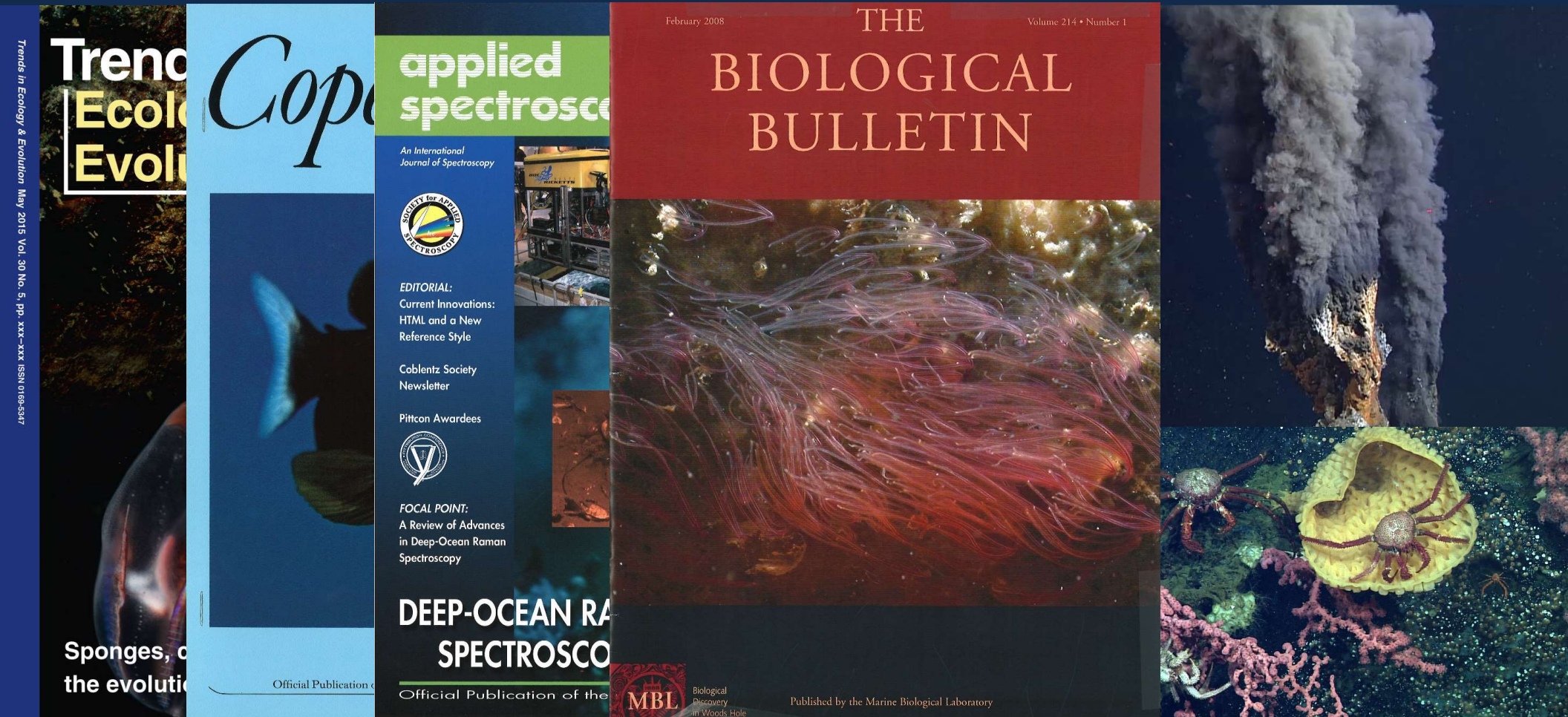
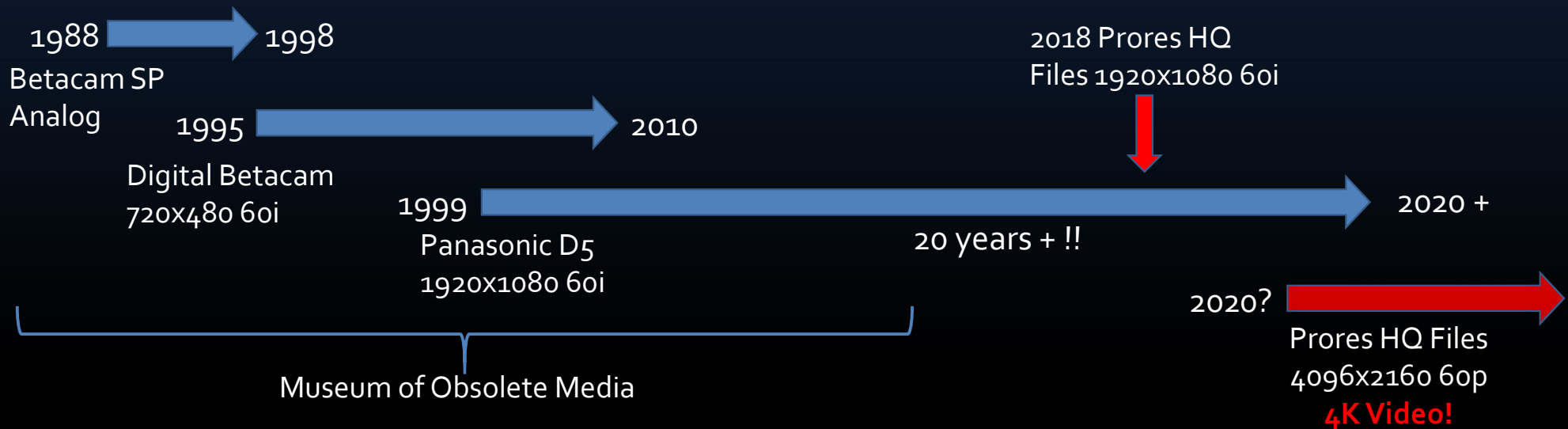
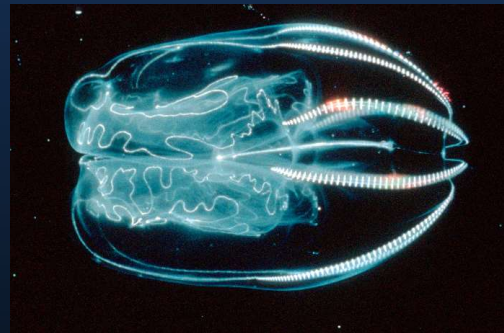


May 22, 2019 – Mark Chaffey
4K ROV Camera Development Abstract Presentation

The Importance of ROV Video to MBARI's Research Mission



How We Got Here – the History of Video Formats at MBARI



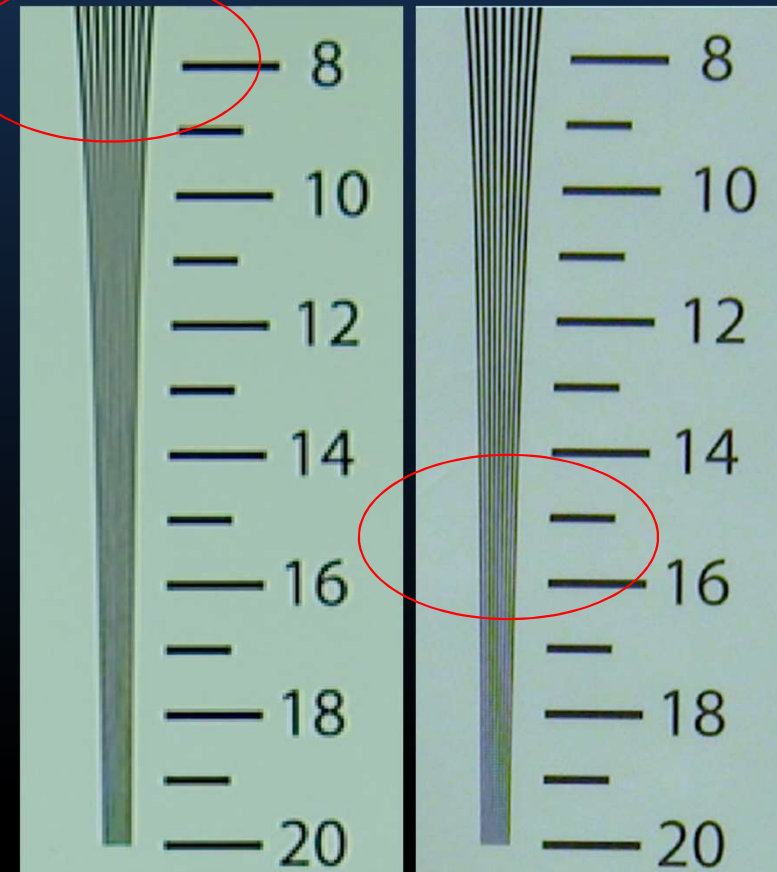
Advantages of 4K Video

- Four times the pixel resolution of current HD.
 - Better resolution increases scientific insight.
 - Provides high quality images for public outreach and education.
 - Allows cropping of images for publication without too much visual degradation.
- Images are scanned progressively.
 - Eliminates interlace artifacts.
- High quality camera modules are now available.
 - 2/3" 3-chip for excellent depth of field and sensitivity.
 - Compact modules suitable for deep housings.

i2MAP Test Tank Recordings Horizontal Resolution in
Hundreds of Line Pairs/Picture Width

Imaged in 2K

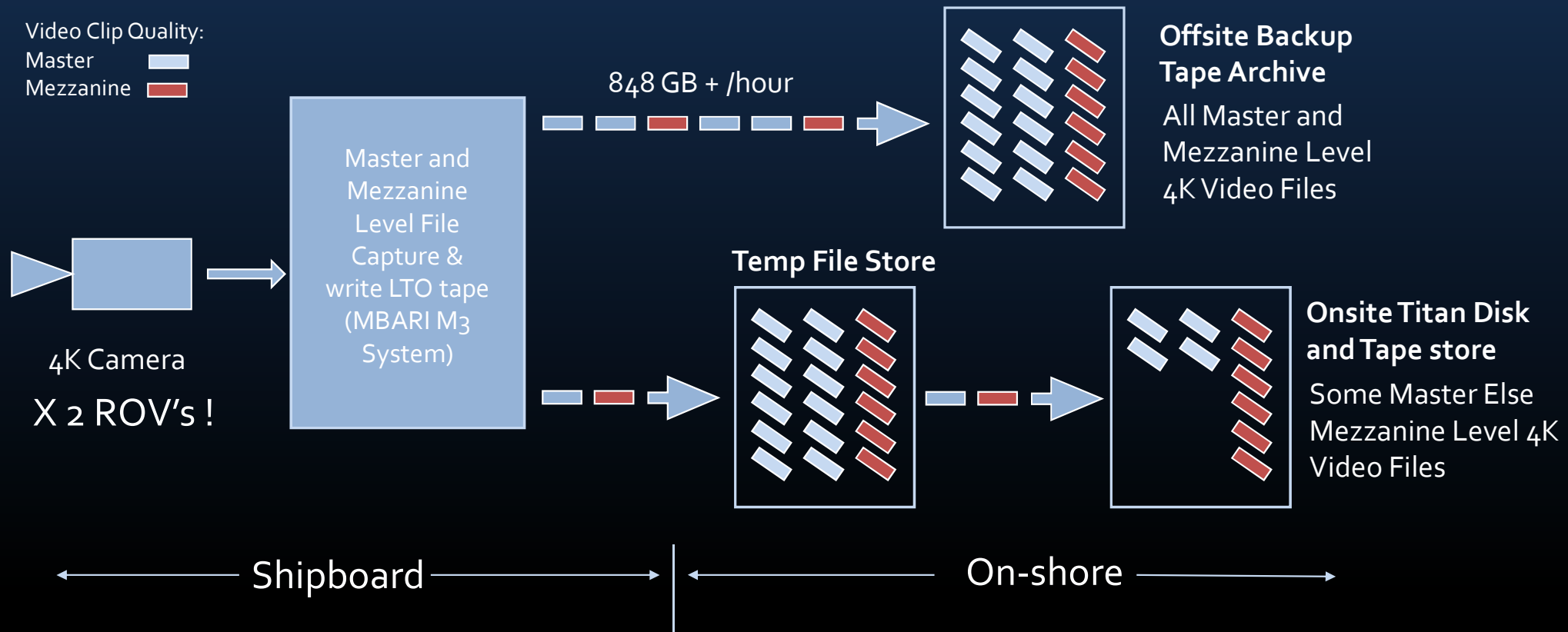
Imaged in 4K



4k Technical challenge of long term data storage

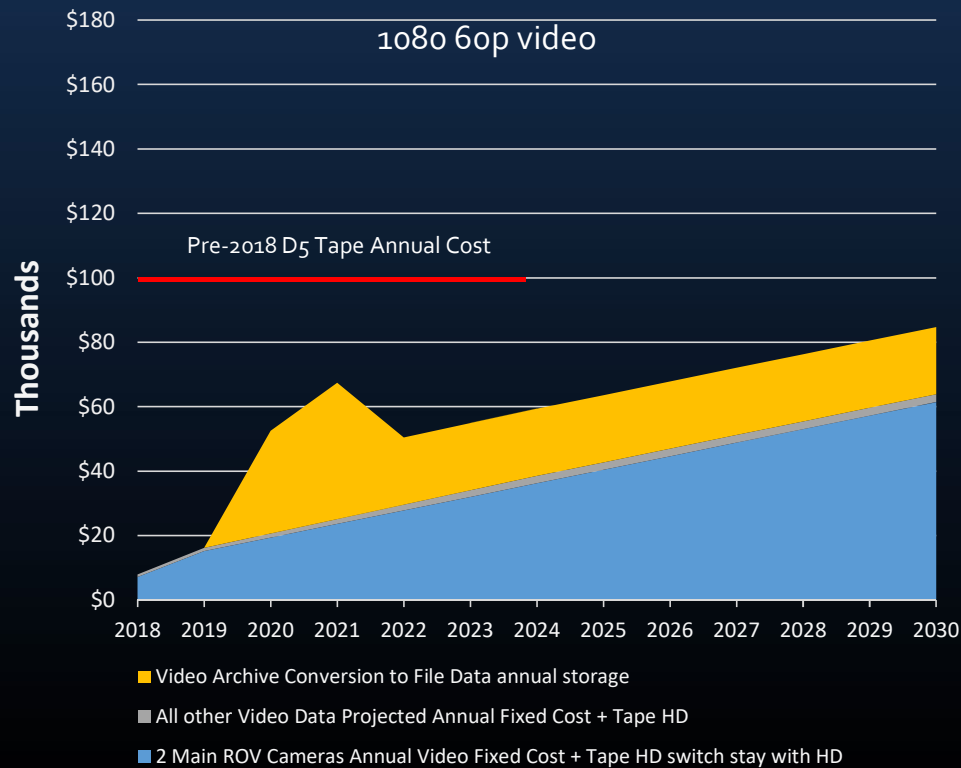
- 4K video at 60 frames per second (4096 x 2160 60p) is a very large jump in the amount of data.
 - Master level Apple ProRes Codec 422 HQ is about 848 Gigabytes per hour.
 - Mezzanine level H.264 or H.265 Codec is around 10:1 or 85 Gigabytes/hr.
- The MBARI Titan network share system has the capacity to support 4K video acquisition on MBARI's main vehicles for at least 10 years.
- Over a period of time the video data would grow to be by far the largest data share at MBARI.
- Are there responsible ways to reduce the 4K total video data volume while preserving the value of video data thereby lowering the resource and capital cost? Yes!

Handling the Data – Annotation Selects 4K Video at Master Level, All Else Mezzanine (H.265?) Only

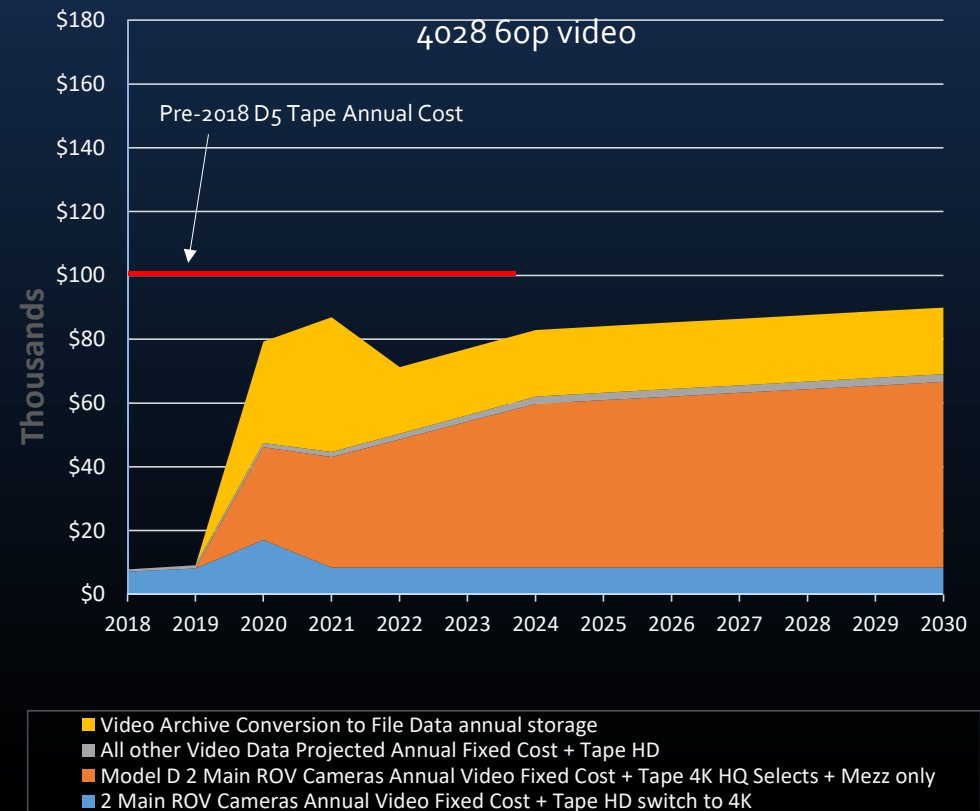


Looking Ahead - Video Storage Cost Comparison Stay with HD vs 20% 4K Selects

Annual Video Only Data Storage Costs with HD Cameras on ROV's

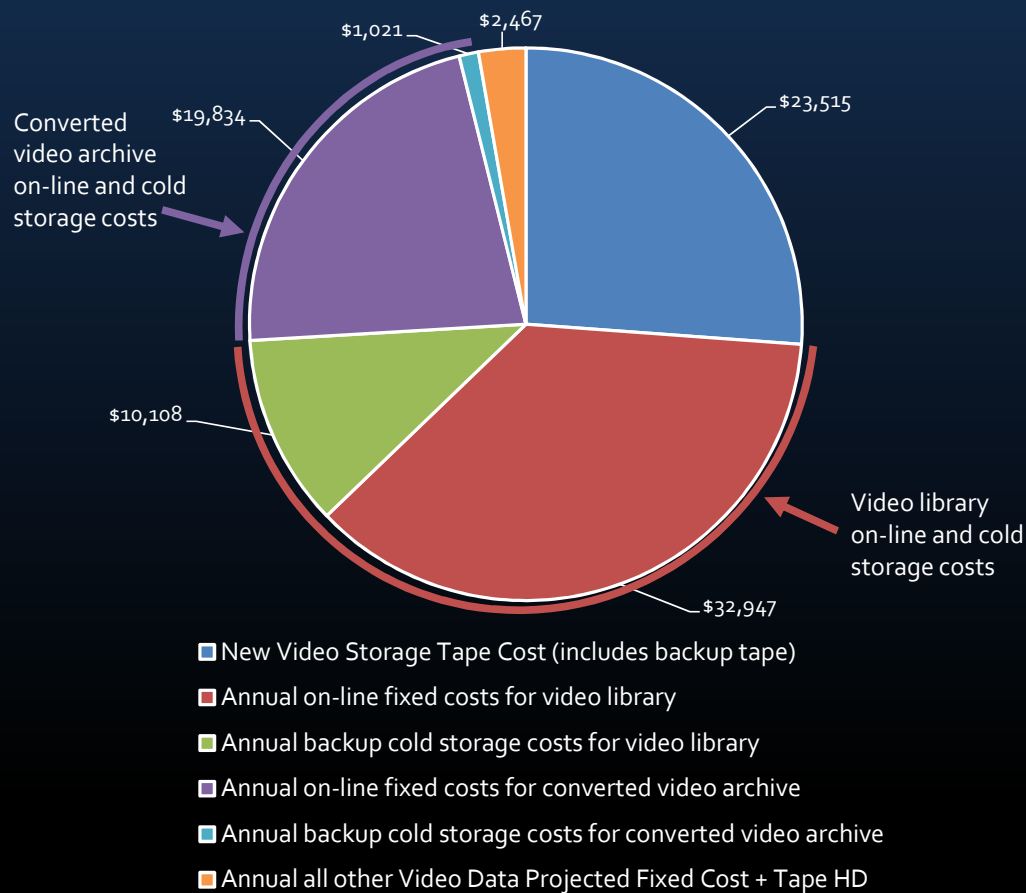


Annual Video Only Data Storage Costs with 4K Cameras on ROV's Model D Select 4K



Looking Ahead - 2030 Storage Costs with 20% 4K selects

2030 Annual Cost Breakdown: Model D - Select 4K Total Annual \$90,356



Major High Level Camera Requirements

- Image quality
 - Resolution
 - Contrast ratio
 - Color reproduction
- Camera controls
 - Zoom, focus and iris
 - Black and white balance, shutter speed , etc.
- Camera size and weight
- Camera cost
- Camera ease of maintenance

Full Requirements Doc:

\\Atlas\ProjectLibrary\901900_MBARI_Advanced_Imaging_Infrastructure\EngineeringDesignDocuments\4KCameraRequirements

MBARI requirements for our main ROV cameras

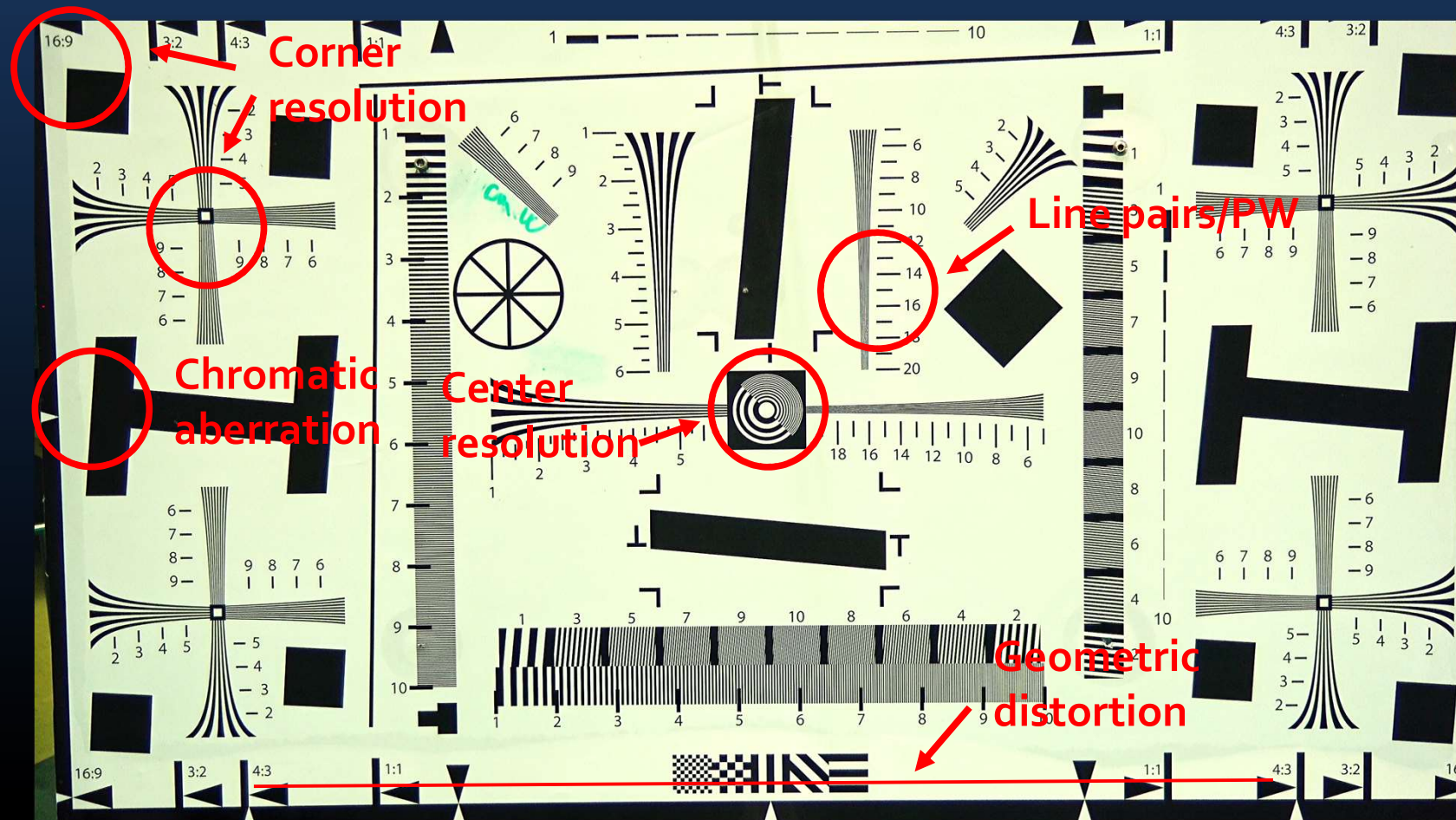
- MBARI requires professional quality zoom and focus controls!



Focus example

<https://www.youtube.com/watch?v=X8oWnbcLl4o>

(2,794,882 views)



Tests of Commercially Available 4K Cameras

DSP&L



SubC

Sulis



i2MAP 4K



Insite



Sony FCB-ER8550



Sony FDR-AX100



Building Blocks



All commercial cameras tested had very poor lens controls.....

Best Candidate Camera Module

- Sony HDC P50
 - 2/3" 3-Chip CMOS imager
 - 4096x2160 progressive scanning @ 60 frames/sec.
- 4K Resolution Lenses – very important!
 - Fujinon UA13x4.5 BERA 4K UHD Wide lens with 13x Zoom
 - Canon CJ12ex4.3B 4K UHD wide-angle lens with 12x Zoom



Camera Acquisition - Three potential paths forward

- Purchase commercial system

- Reward
 - Controlled cost
 - Easy maintenance and replacement support
 - Low MBARI technical risk
- Risks
 - Lower quality
 - High capital cost

- Co-develop with commercial vendor and license our contribution

- Reward
 - Maintain high quality
 - Shared technical risk
 - Easy maintenance and replacement support
- Risks
 - Some technical risk

- Develop and build in house

- Reward
 - Maintain high quality
 - Lower capital cost
- Risks
 - Technical risk
 - Higher engineering time commitment
 - Maintenance and replacement support can be more difficult
 - Unable to provide systems to outside partners

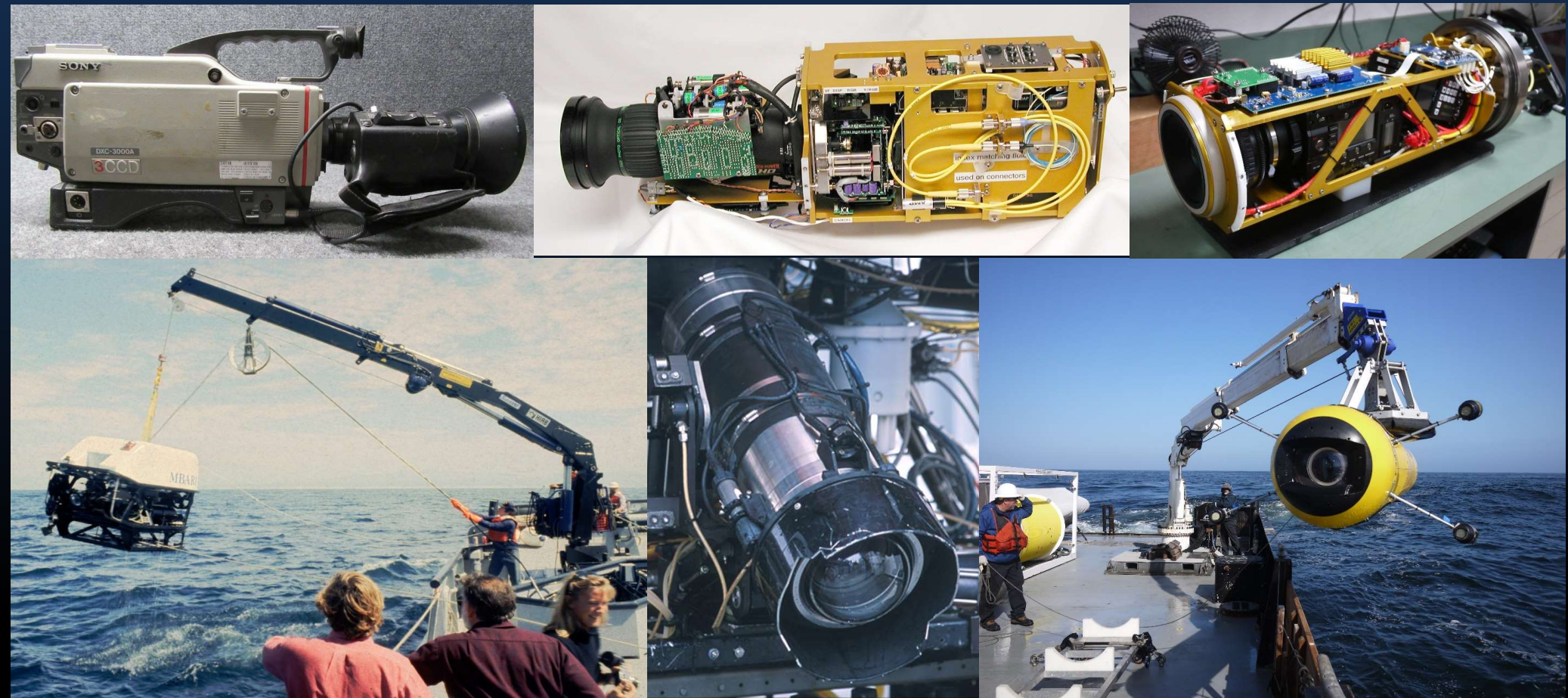
Camera Progress to Date

- Requirements developed and shared with vendors.
- Trying to qualify vendors who we are confident can do a good job.
 - Sulis camera and Subsea have expressed interest.
 - Need to contact additional potential vendors.
- The next step is to establish a final vendor list and issue an RFQ and evaluate the response.
- Simultaneously continue discussions on co-development.

Conclusions

- MBARI invests a tremendous amount of capital and resources on video acquisition, processing and maintaining the video library.
- Striving for the highest quality feasible for acquisition increases the value of all subsequent investments.
- MBARI is well positioned to once again take a big step forward and be a leader in deep sea video imaging.

Previous Work



Questions?