



Direct Signal-To-Noise Quality Comparison Between an Electronic and Conventional Stethoscope Aboard the International Space Station

Thomas Marshburn, Richard Cole,
Doug Ebert, Peter Bauer





Disclosure Information

85th Annual Scientific Meeting

Speaker's Name Here

I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use
in my presentation

Stethoscope Background

- The Exploration Medical Capability (ExMC) Element of the NASA Human Research Program recognizes the technology gap of "limited capability to auscultate, transmit, and record body sounds during exploration missions".
- Several auscultation studies have been conducted in simulated spacecraft noise environments, but no evaluations have included actual spaceflight data.

Stethoscope Aims

- 1) Compare the Littmann 3200 electronic stethoscope to the conventional stethoscope in various noise environments throughout the ISS w4 w5
- 2) Determine if the Littmann 3200 electronic stethoscope provides clinically useful recordings that can be easily heard above ISS background noise
- 3) Assess if the ExMC knowledge gap can be closed based on the ISS data
- 4) Provide additional data to focus future evaluations, if needed

Slide 4

w4 Reliably instead of easily
wyleuser, 1/17/2014

w5 background
wyleuser, 1/17/2014

Subjective Comparison

Phase One Methods

1) Testing Locations

- 1) Japanese Pressurized Module (JPM), mid-module by med laptop
- 2) Unity (Node 2) – Starboard Crew Quarters, door closed, fan high
- 3) Destiny (US Lab) - @ CRMS by CCAA fan
- 4) Tranquility (Node 3) – mid-module, inside WHC
- 5) Cupola – music playing in background

2) Signal-to-noise rankings (1 to 10 scale)

- 1) 1 = inaudible
- 2) 6 = expectation in emergency department
- 3) 8 = expectation in a clinic
- 4) 10 = clearest possible quality

3) Volume at 2 clicks above line

Slide 5

w1 Reliably instead of easily
wyleuser, 1/17/2014

w2 background
wyleuser, 1/17/2014

Store-and-Forward

Phase Two Methods

- Obtained additional ISS auscultation sound recordings through JAXA
- Selected ground simulation recordings to serve as controls
- Generated software rating program
- Recruited physician experts for ratings
- Conducted rating sessions

Hardware

3M™ Littmann® Electronic Stethoscope Model 3200



Benefits (per the manufacturer)

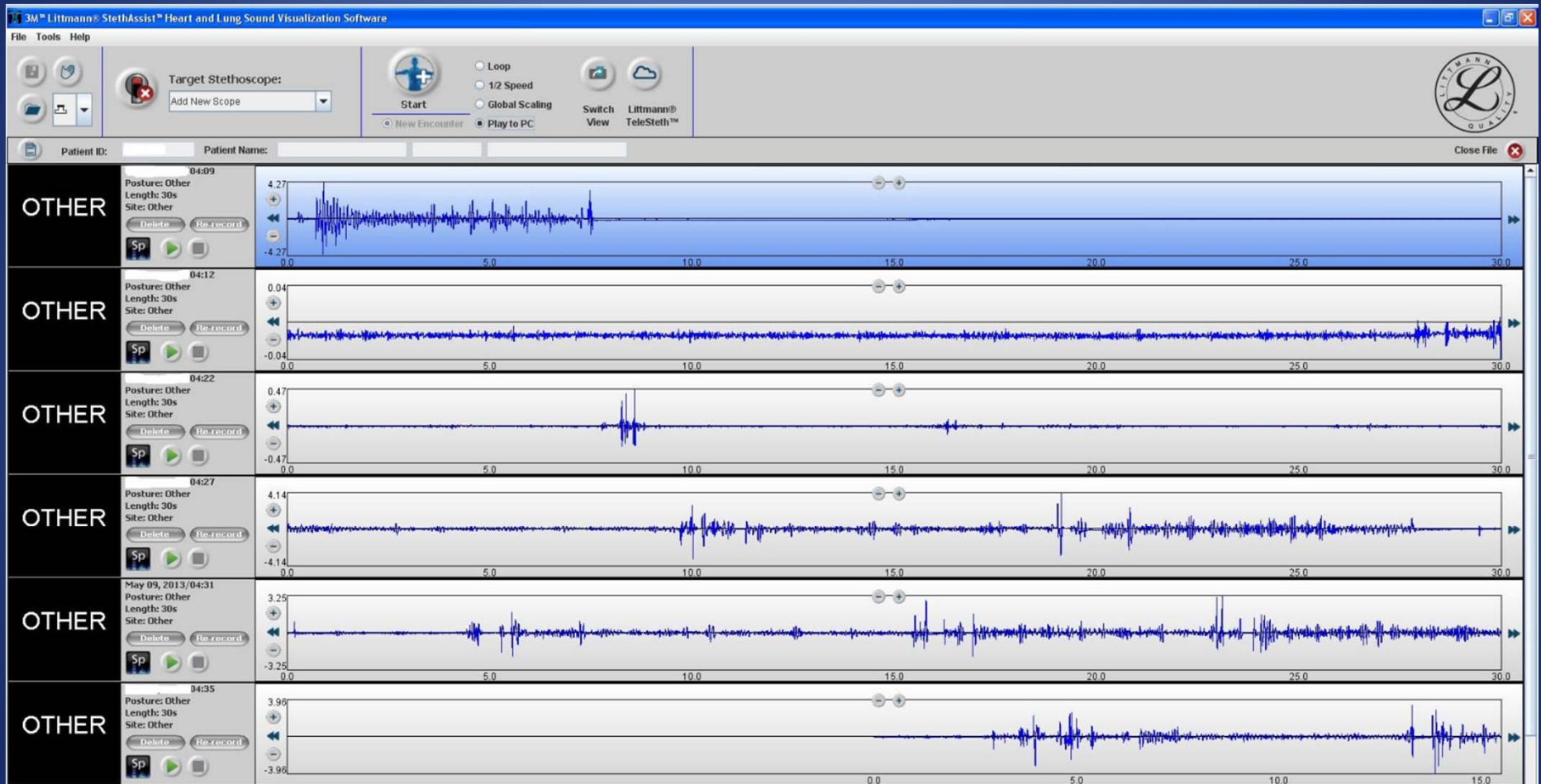
- Record and save up to twelve 30-second patient sound tracks*
- Transmit sounds via Bluetooth® technology (Bluetooth® adaptor included – not compatible with Apple devices)
- Listen remotely via 3M™ Littmann® TeleSteth™ System (sold separately)
- Eliminate 85% (on average) of ambient noise
- Amplify sounds up to 24x



* Limited to a single 30 second track on older models (JAXA hardware on orbit is only capable of one track)

From: http://www.littmann.com/wps/portal/3M/en_US/3M-Littmann/stethoscope/stethoscope-catalog/catalog/?N=5932256+4294958300&rt=d

Software – Littmann StethAssist



Audio Recording Sources

Body Sound	Preflight Control	ISS	Simulation Controls	Total
Cardiac	12	24	12	48
Lung		4	12	16
Bowel		3	2	5
			Grand Total:	69

Rating Software

Sound_Rating - 2013/11/18

Play the sound and rate the following statements for your level of agreement on a 10-Point scale with 1 = Strongly Disagree to 10 = Strongly Agree

Play Sound #1 of 69

	Strongly Disagree									Strongly Agree
	1	2	3	4	5	6	7	8	9	10
A. Body sounds can be heard over the background noise.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
B. The clarity of the audio recording is excellent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C. The audio recording quality is as good as if examining a live patient.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D. The audio recording is of sufficient quality to be clinically useful in patient assessment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

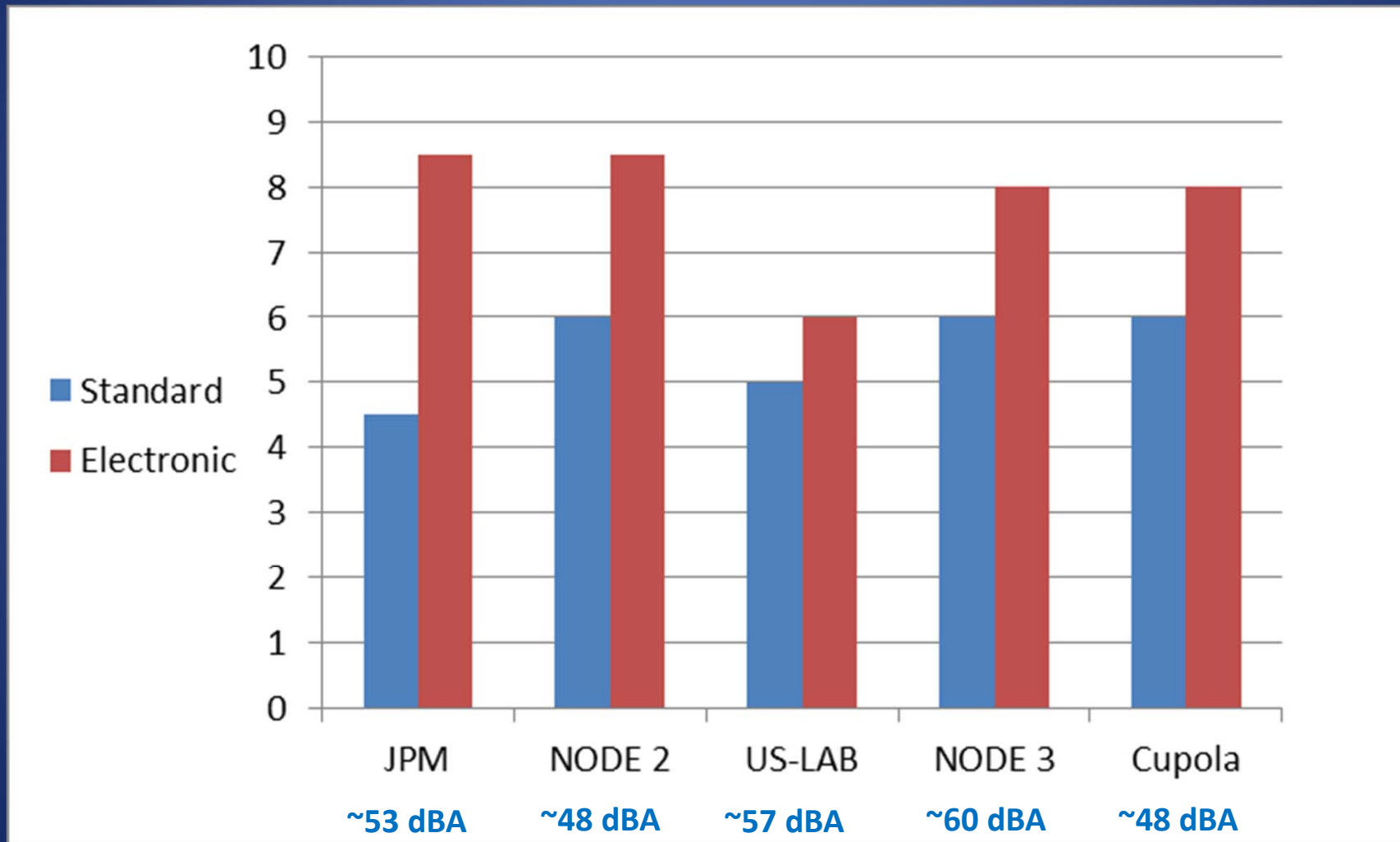
Comments (Optional):

Good heart sounds |

Next >>>

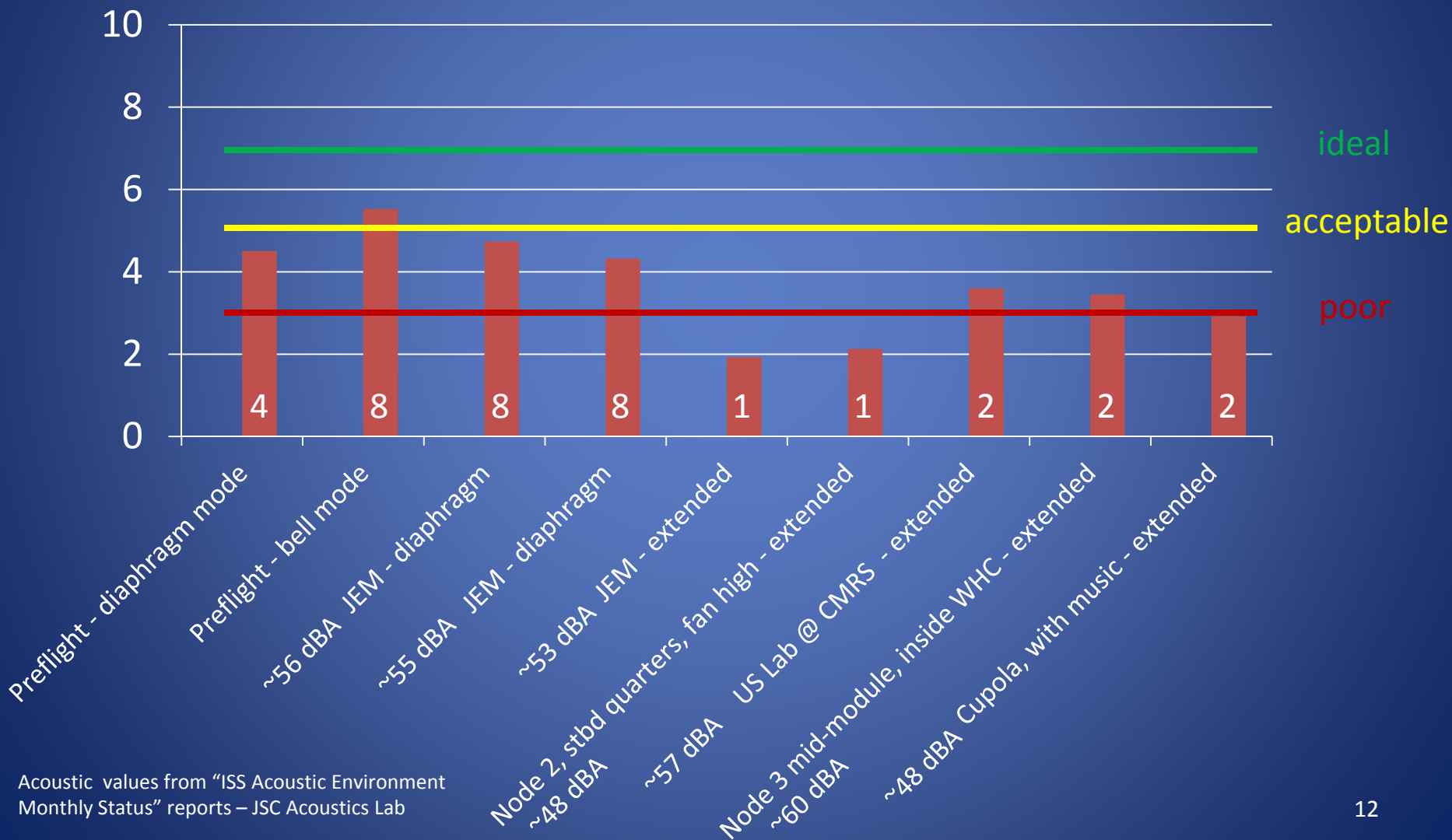
Cardiac Direct Auscultation

Subjective Comparison



Cardiac Store-and-Forward

composite rating (all question responses averaged)



Acoustic values from "ISS Acoustic Environment Monthly Status" reports – JSC Acoustics Lab

Cardiac Conclusions

- Electronic and conventional stethoscope rated lowest in lab by CRMS and CCAA (one of the loudest USOS fans)
- Electronic stethoscope rated higher than conventional stethoscope in each module tested
- Cardiac sound recordings were variable, but the “high n” evaluations approached or achieved the “acceptable” rating
- Due to extensive preflight screening, the likelihood of the need for cardiac auscultation during exploration missions is low
- Cardiac diagnostics are more definitive and comprehensive for ground evaluation by ECG and ultrasound, albeit more technically complex

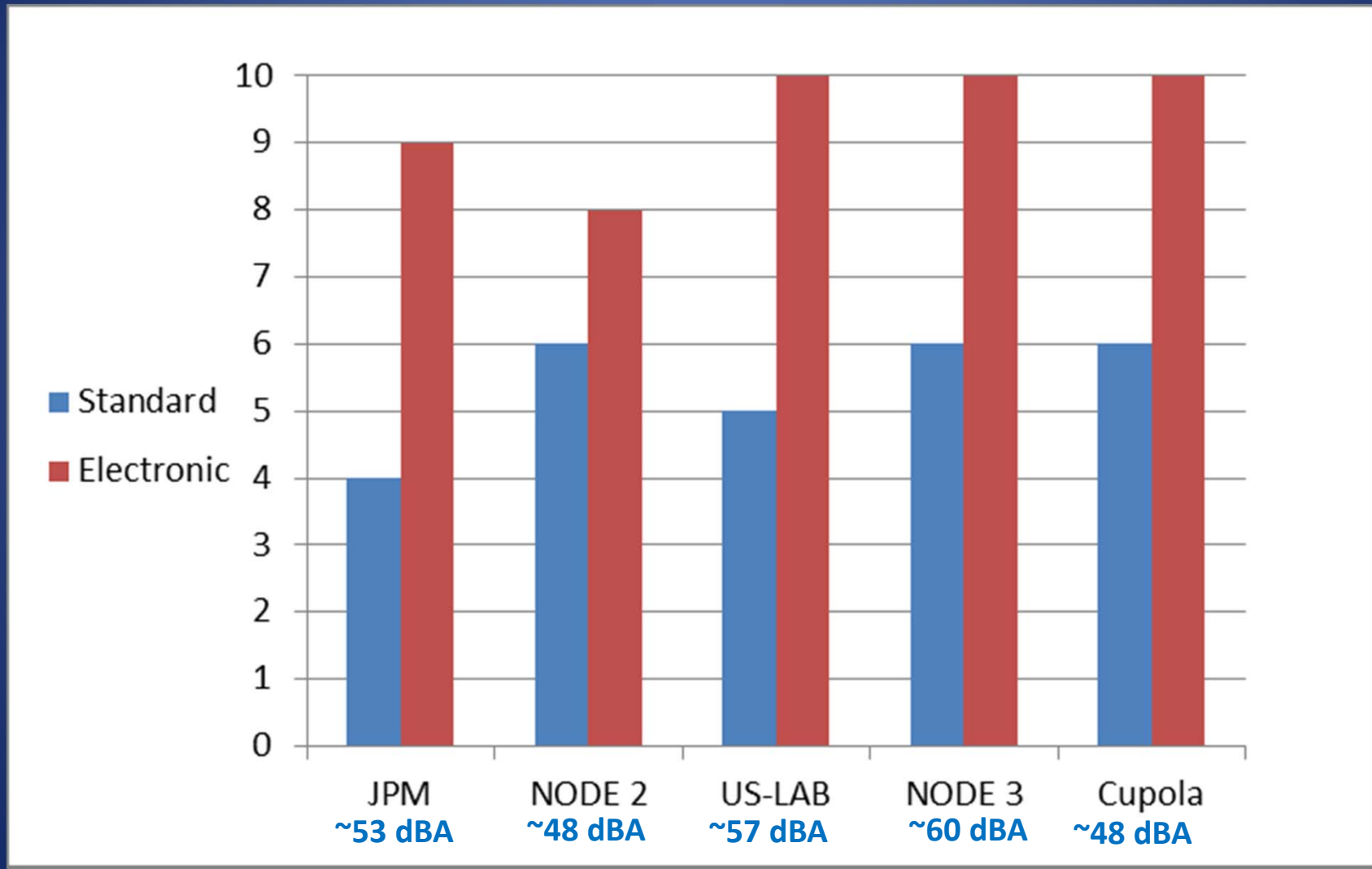
Slide 13

w3

wyleuser, 1/17/2014

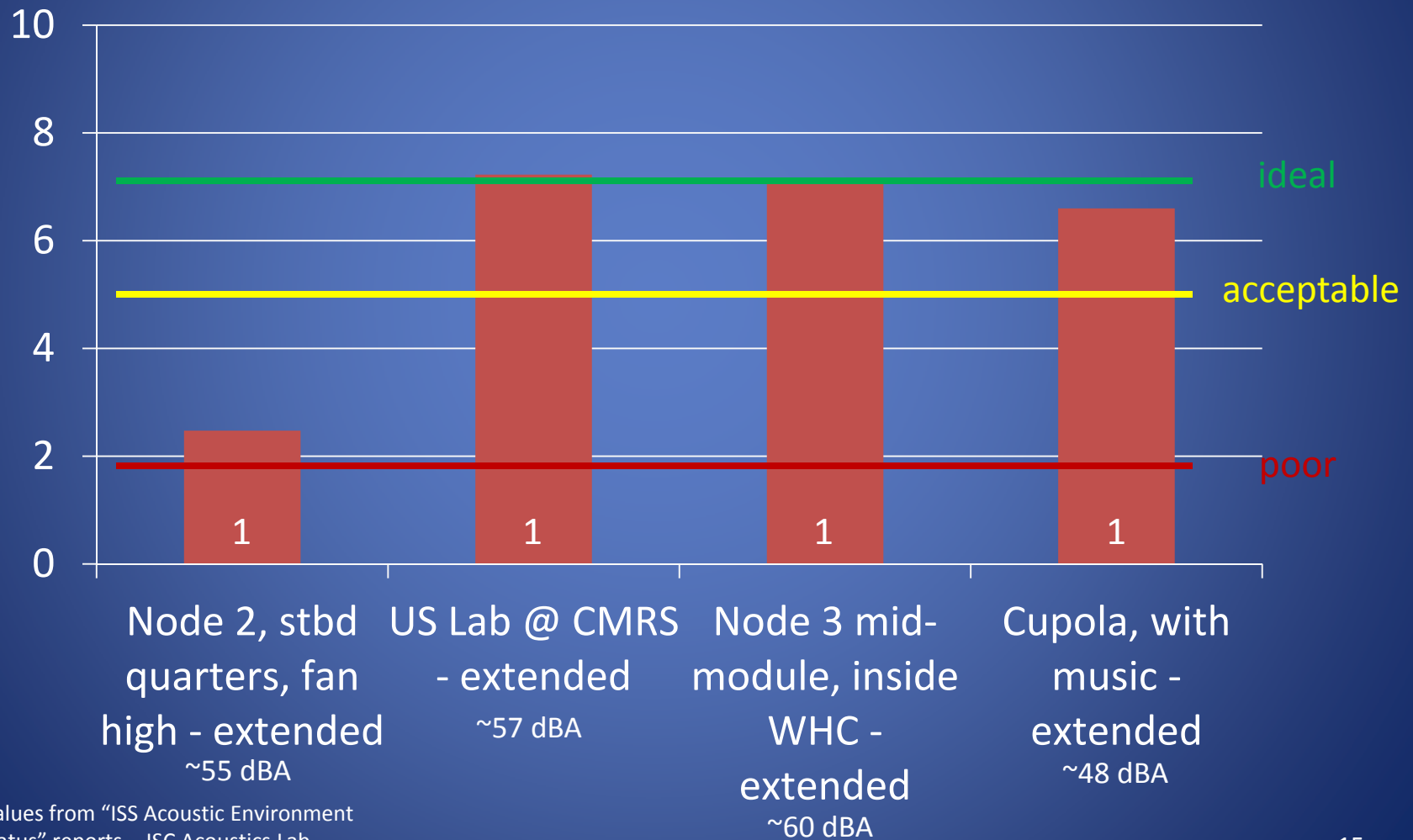
Lung Direct Auscultation

Subjective Comparison



Lung Store-and-Forward

composite rating (all question responses averaged)



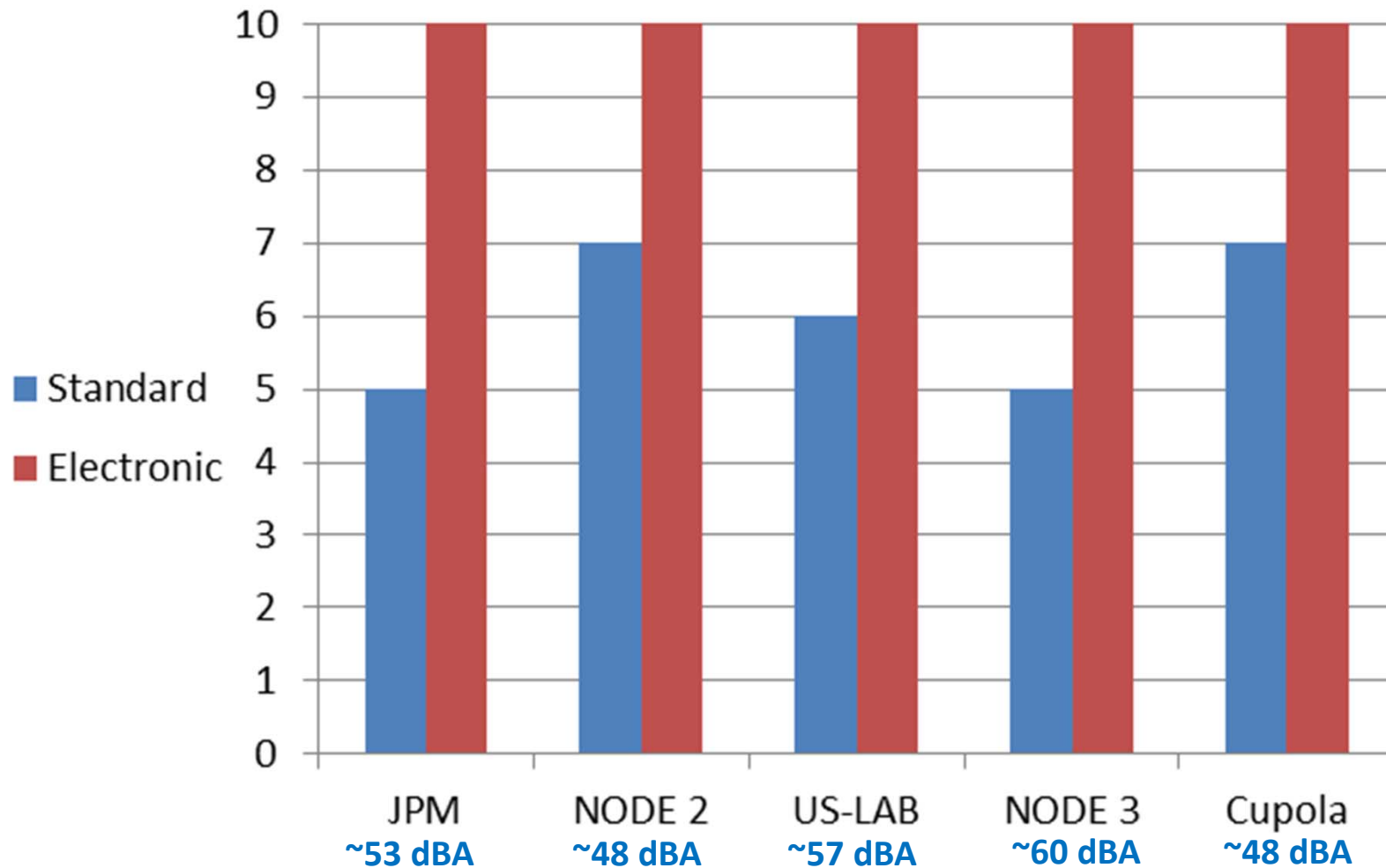
Acoustic values from "ISS Acoustic Environment Monthly Status" reports – JSC Acoustics Lab

Lung Conclusions

- Electronic stethoscope rated higher than conventional stethoscope in each module tested
- Lung sound recordings were variable, but 3 of 4 were in the “ideal” range
- Lung sounds may be the most important diagnostic target for exploration medicine
- Lung diagnostics are possible with other modalities, but are very limited (ultrasound)

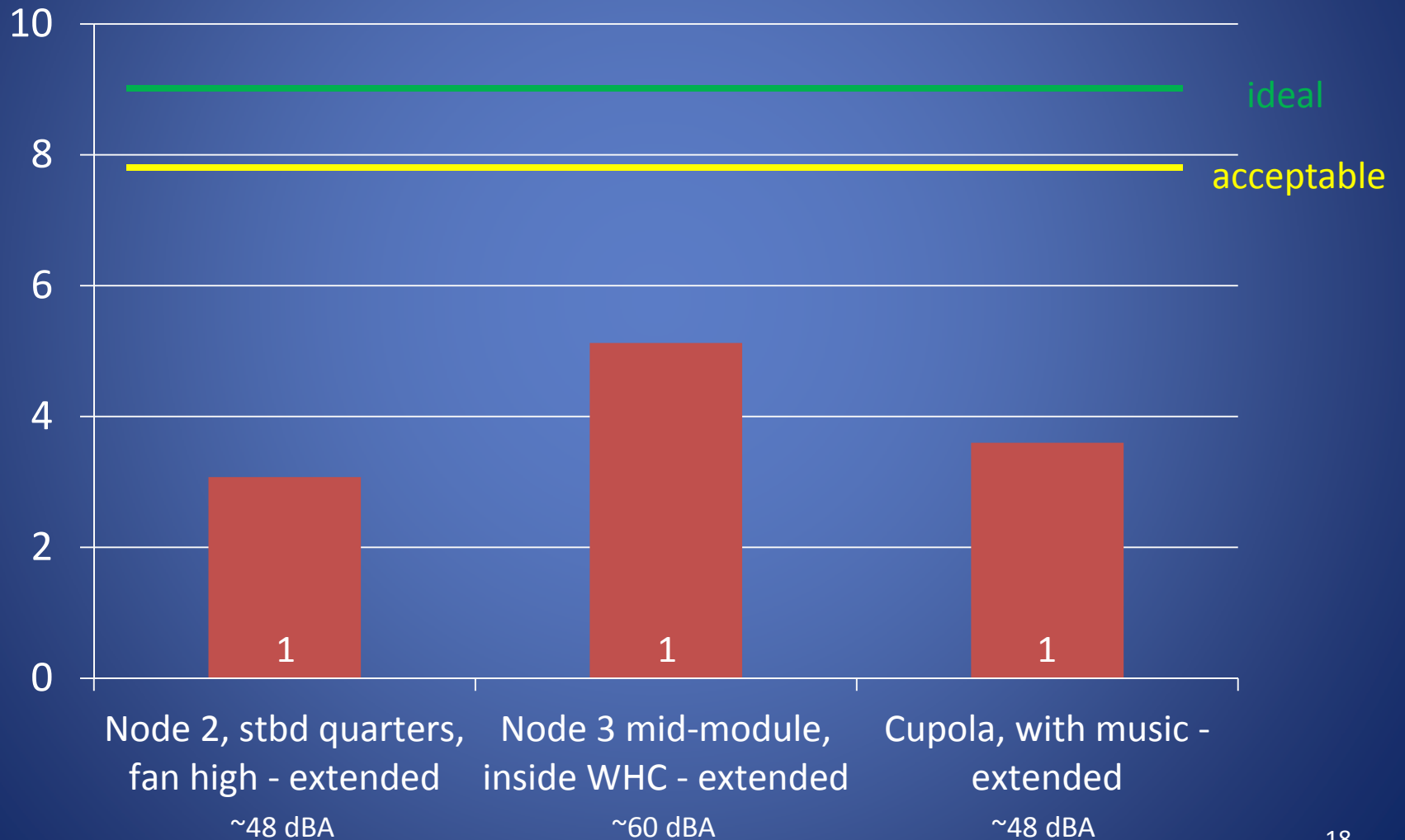
Bowel Direct Auscultation

Subjective Comparison



Bowel Store-and-Forward

composite rating (all question responses averaged)



Bowel Conclusions

- Electronic stethoscope rated higher (10/10) than conventional stethoscope in each module tested
- Bowel sound recordings did not achieve “acceptable” ratings
- Only three recordings of very short duration were evaluated, so results should not be considered conclusive
- Bowel motility could also be evaluated by ultrasound

Summary

- Direct comparison is limited to a single operator, future study is warranted to expand the number of operators and locations throughout the ISS
- Electronic stethoscope rated higher than conventional stethoscope for all body sounds and all ISS modules tested
- Cardiac recordings were in the “acceptable” to “poor” range, with those collected in more controlled manner scoring better
- Three of four lung recordings scored in the “ideal” range
- Bowel recordings scored substantially below the “acceptable” range, but track duration was short and n=3
- Consideration should be made to incorporate an electronic stethoscope into current and future space vehicle medical kits. Proper training, optimized selection of stethoscope modes and recording techniques would need development.

Acknowledgements

- JAXA
- John Pace - rating software
- Physician raters



Questions???

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