



NASA EXPLORATION ATMOSPHERE TEST 6: BACK TO BACK EVAS

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18th May 2026 - Denver
96th Annual AsMA Scientific Meeting

1

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Disclosure Information

96th Annual Scientific Meeting
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I have no financial relationships to disclose.

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

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Fundamentals

- ↓pressure:
 - Tissues release nitrogen bubbles
 - Too much bubbling: Decompression Sickness (DCS)
 - Type I DCS: Mild/Joint pain
 - Type II DCS: Severe/life threatening
 - Pre-EVA denitrogenation via oxygen prebreathe *reduces* DCS risk during EVA
- High workload/ambulation = higher risk

DCS Risk

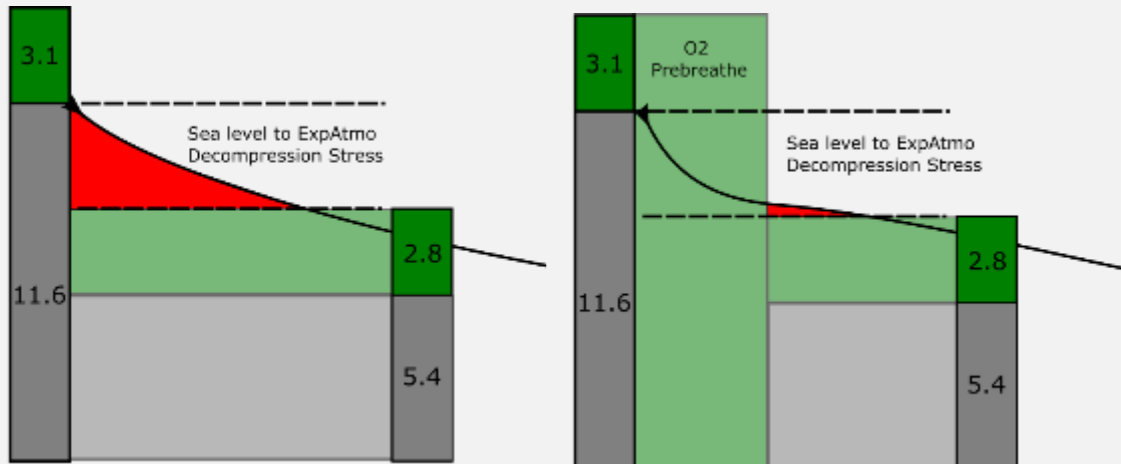


Atmospheric
Composition

EVA
Workload

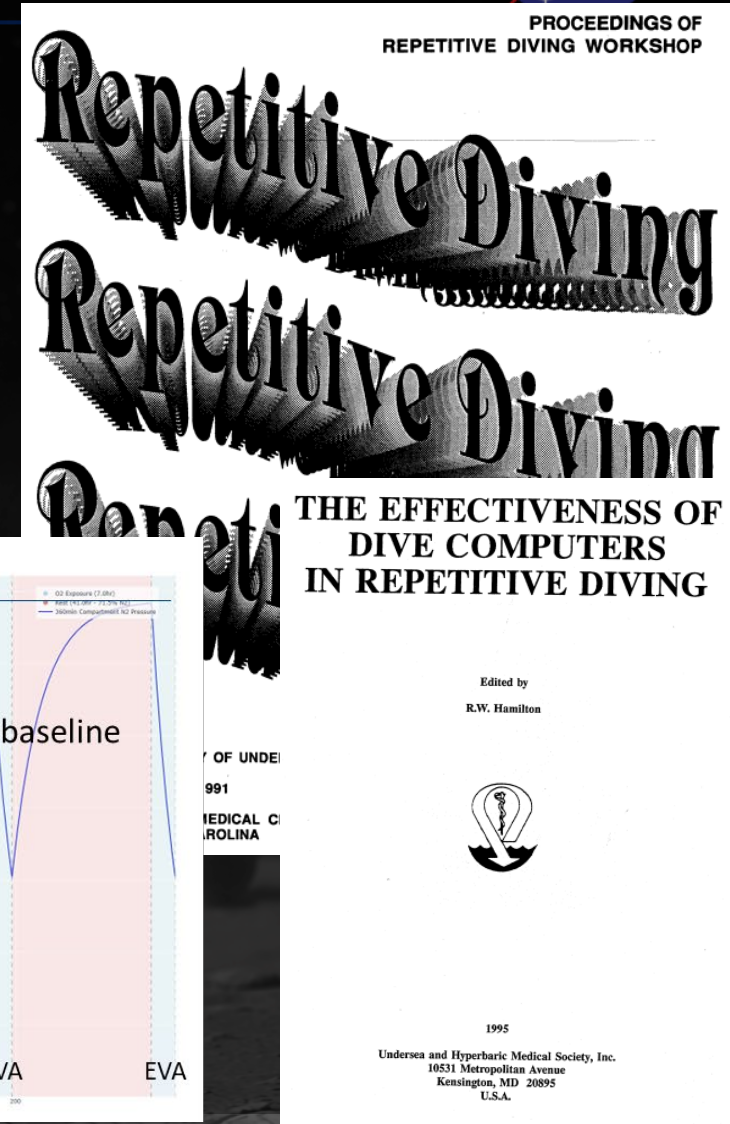
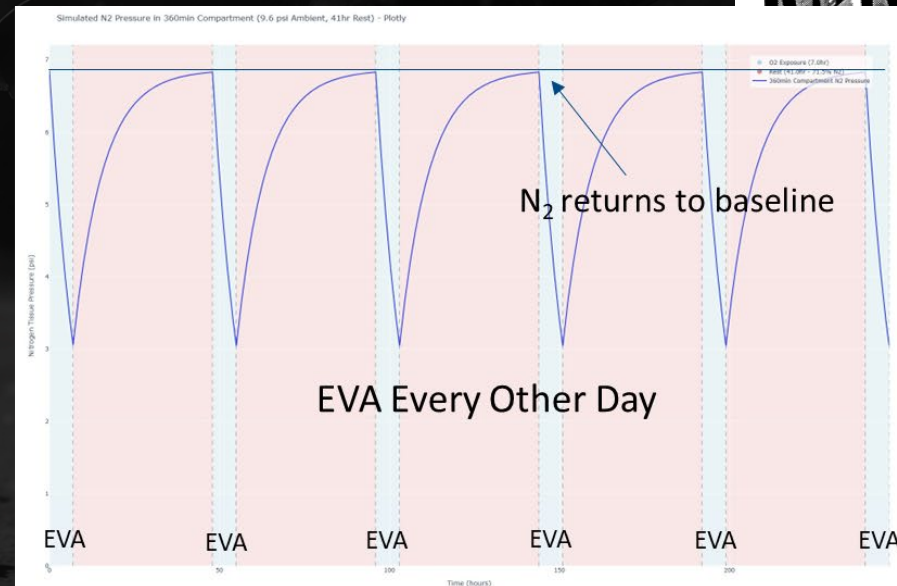
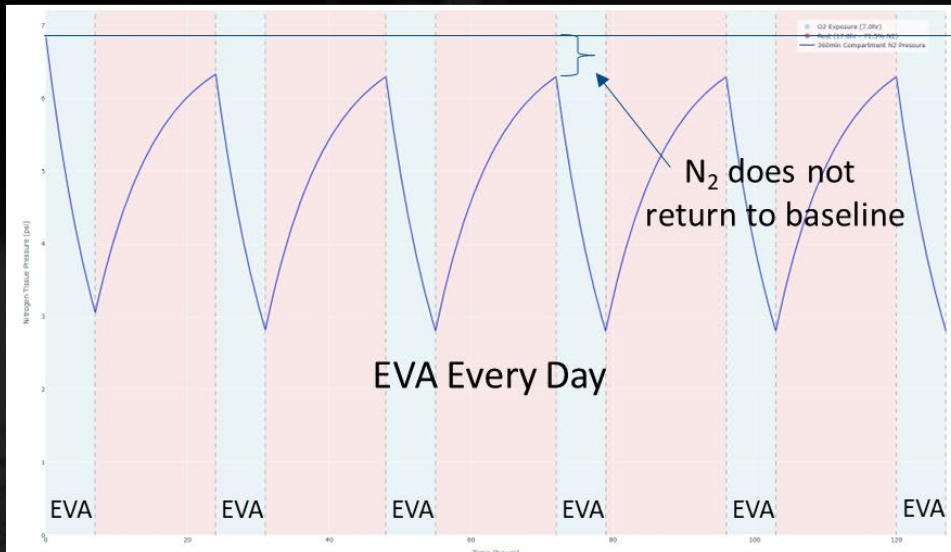
Prebreathe
Duration

Suit
Pressure



“Repetitive” EVAs

- “Back to Back” (<24hrs) between EVAs results in the denitrogenation from previous EVA benefits the subsequent EVA
- Models suggest DCS Risk drops from 7% -> 3%
- Inflammation studies show >24hrs elevation





How do we actually test?





Overall Plan

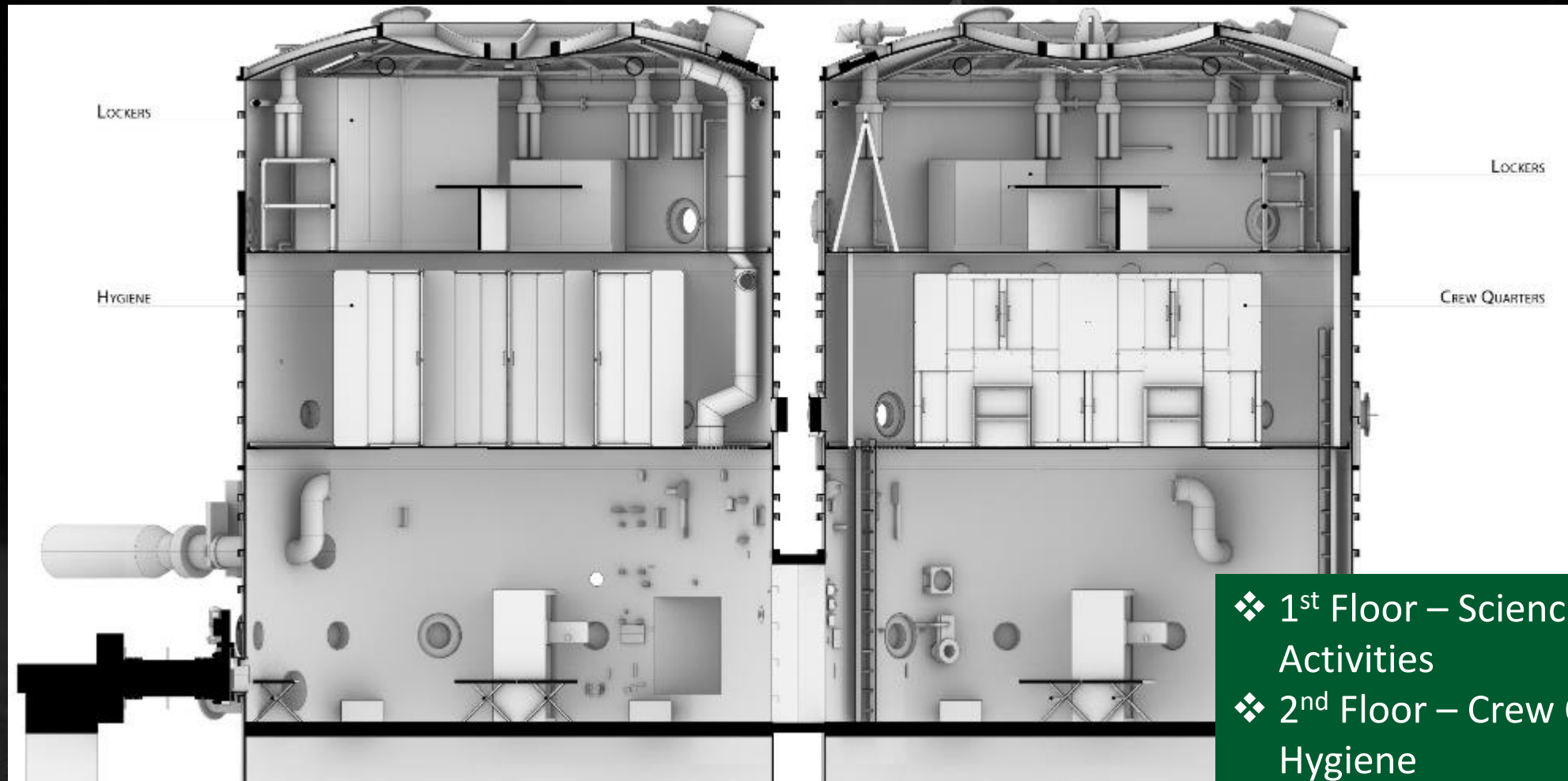
EA-6:

- Chamber: 9.6 psi / 28.5% O₂
- EVA: 4.3 psi
- 16 subjects
 - 2 groups of 8 subjects
- Two cycles of 7 days in chamber:
 - 48hr 'equilibration'
 - 6hr EVA sim every day (n=5)
 - Theoretical maximum: 80 exposures
- Prebreathe protocols
 1. 120-minute
 - If 3 DCS I cases or 1 DCS II case, then switch to
 2. 150-minute
 3. 180-minute
- Self-scanning (as implemented in EA-4 & EA-5):
 - All subjects trained, rather than 2 techs
 - Allowed increase from 6 to 8 subjects
 - Extensive practice pre and during test non-EVA periods

		Exposures (cumulative)
Day 1	Saturation	
Day 2	Saturation	
Day 3	EVA 4.3	8
Day 4	EVA 4.3	16
Day 5	EVA 4.3	24
Day 6	EVA 4.3	32
Day 7	EVA 4.3	40
Day 8	Chamber Turn	
Day 9	Chamber Turn	
Day 10	Chamber Turn	
Day 11	Prep	SUBJECT SWAP
Day 12	Saturation	
Day 13	Saturation	
Day 14	EVA 4.3	48
Day 15	EVA 4.3	56
Day 16	EVA 4.3	64
Day 17	EVA 4.3	72
Day 18	EVA 4.3	80



20FT Chamber Overview

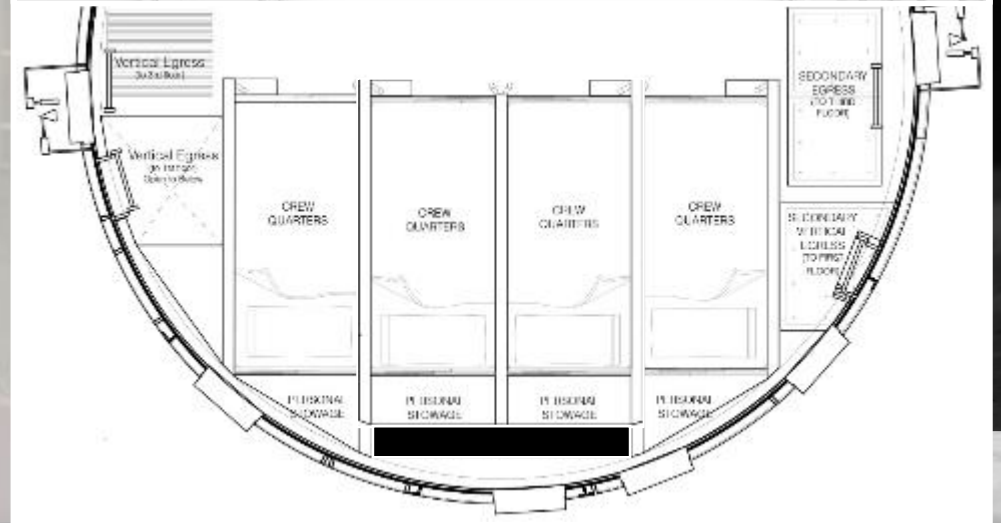


- ❖ 1st Floor – Science & EVA Activities
- ❖ 2nd Floor – Crew Quarters & Hygiene
- ❖ 3rd Floor – Stowage & Media Center

3rd Floor Configuration



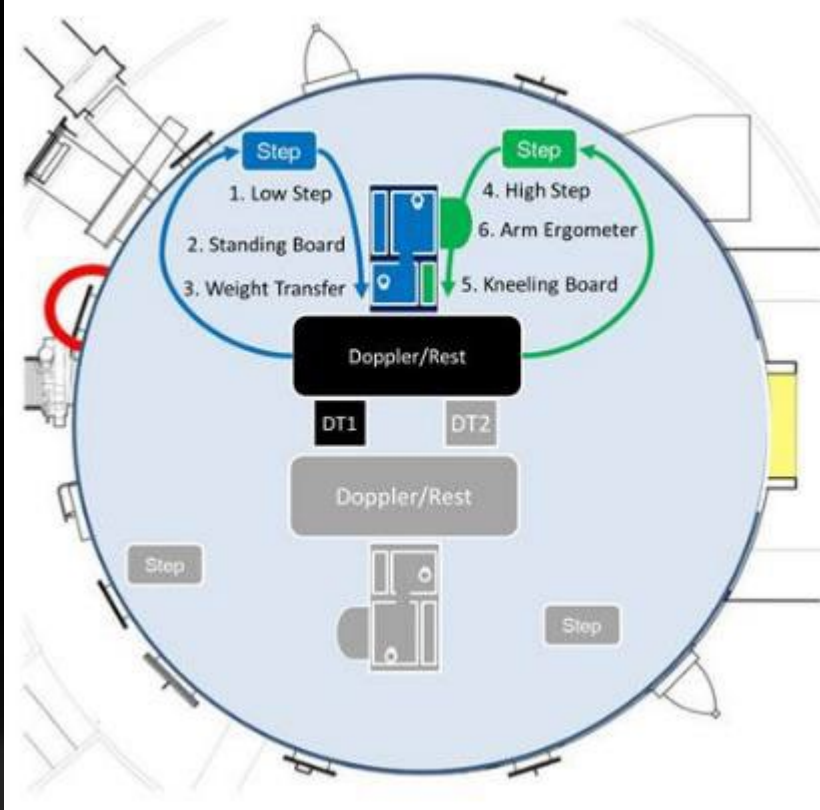
2nd Floor – Crew Quarter Layout



EVA Sim Stations



EVA Simulation

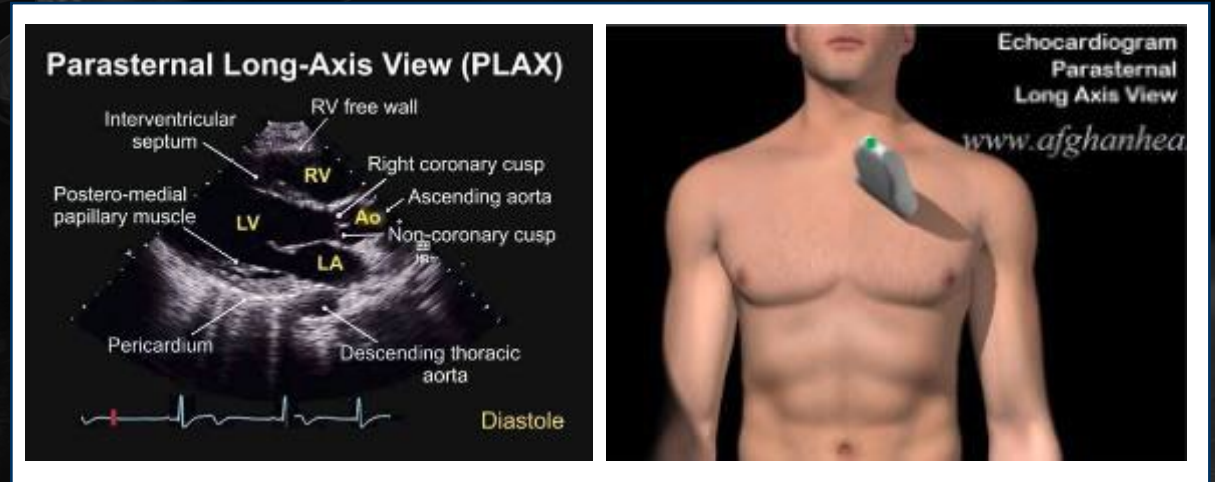
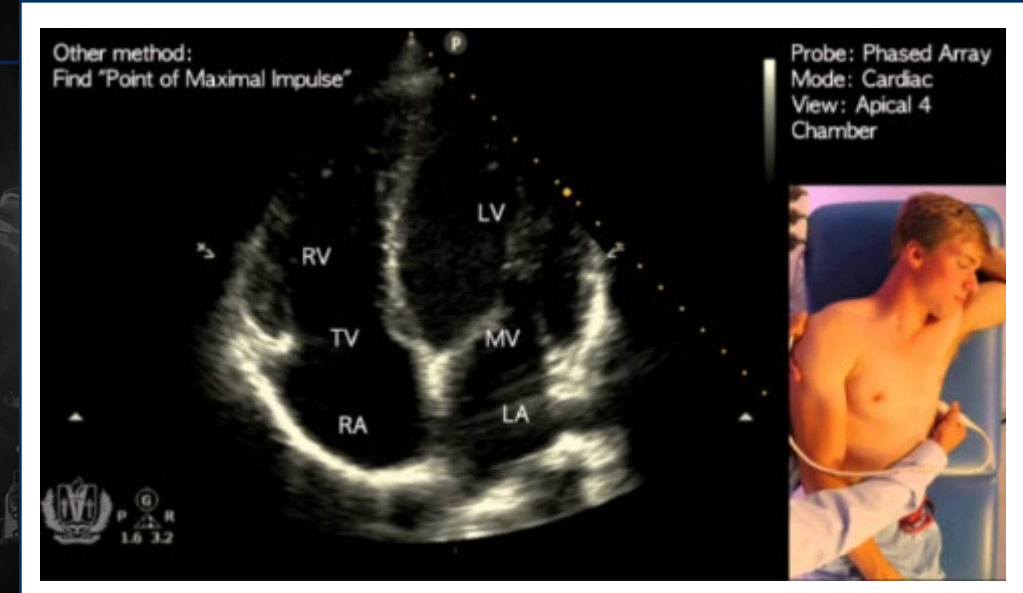


EVA Sim Presented at AsMA 2022
see *Estep et al.*



VGE Methods

- Every 15 min:
 - Subject lays on the cot in a left recumbent position
 - The operator gels the Vivid iQ ultrasound probe and acquires an apical cross-section view of the heart and heart chambers (top)
 - If the apical view is not easily visible, a parasternal long-axis view is imaged instead (bottom)
 - Alternates with Doppler auscultation of L parasternal border



Results





Test Outcomes

Conducted 19-day altitude mission:

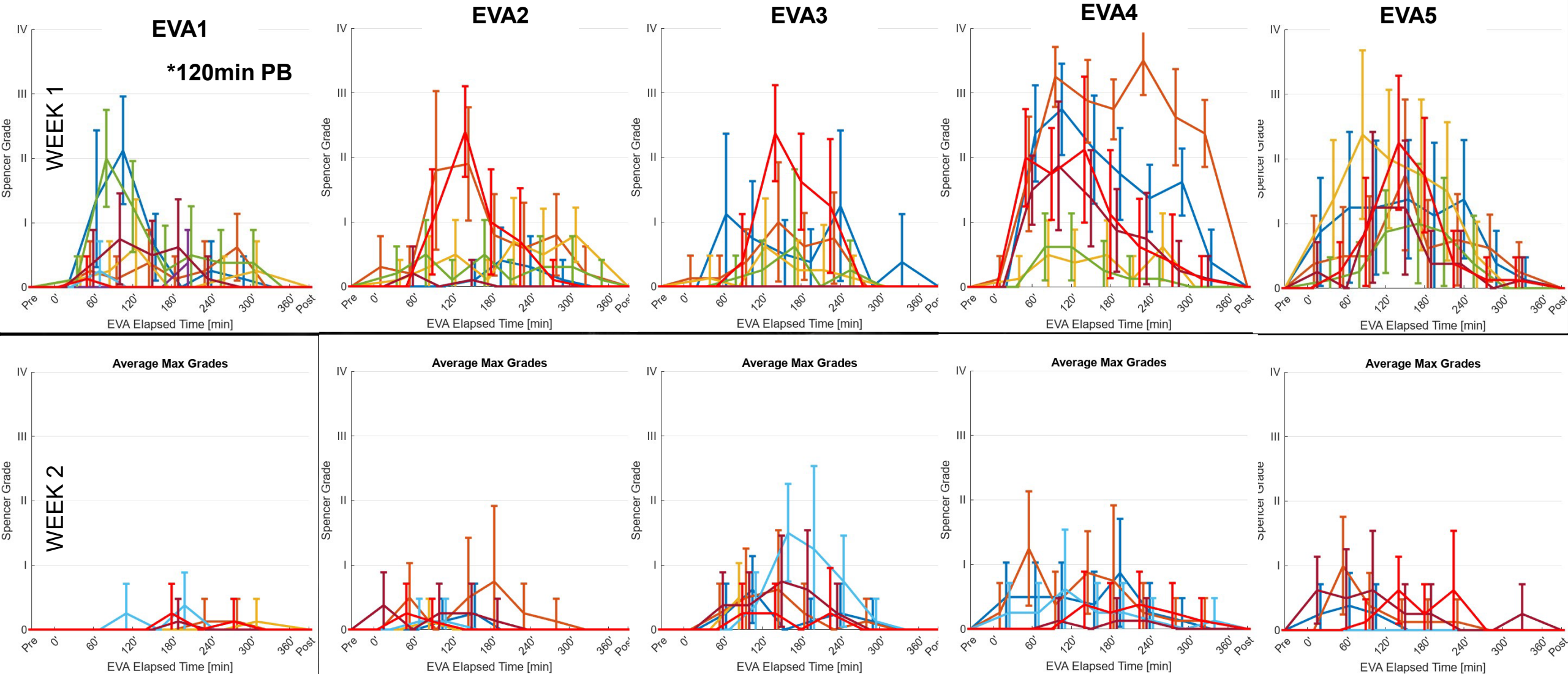
- 10 simulated EVAs completed
- Tested 2 prebreathe protocols
- Tested 16 subjects total
- Collected 62 out of a theoretical 80 maximum exposures
 - Due to the inability to introduce backups 'mid-test', we instead ran two 1-week tests
- 100% data capture for participating subjects

Secondary studies:

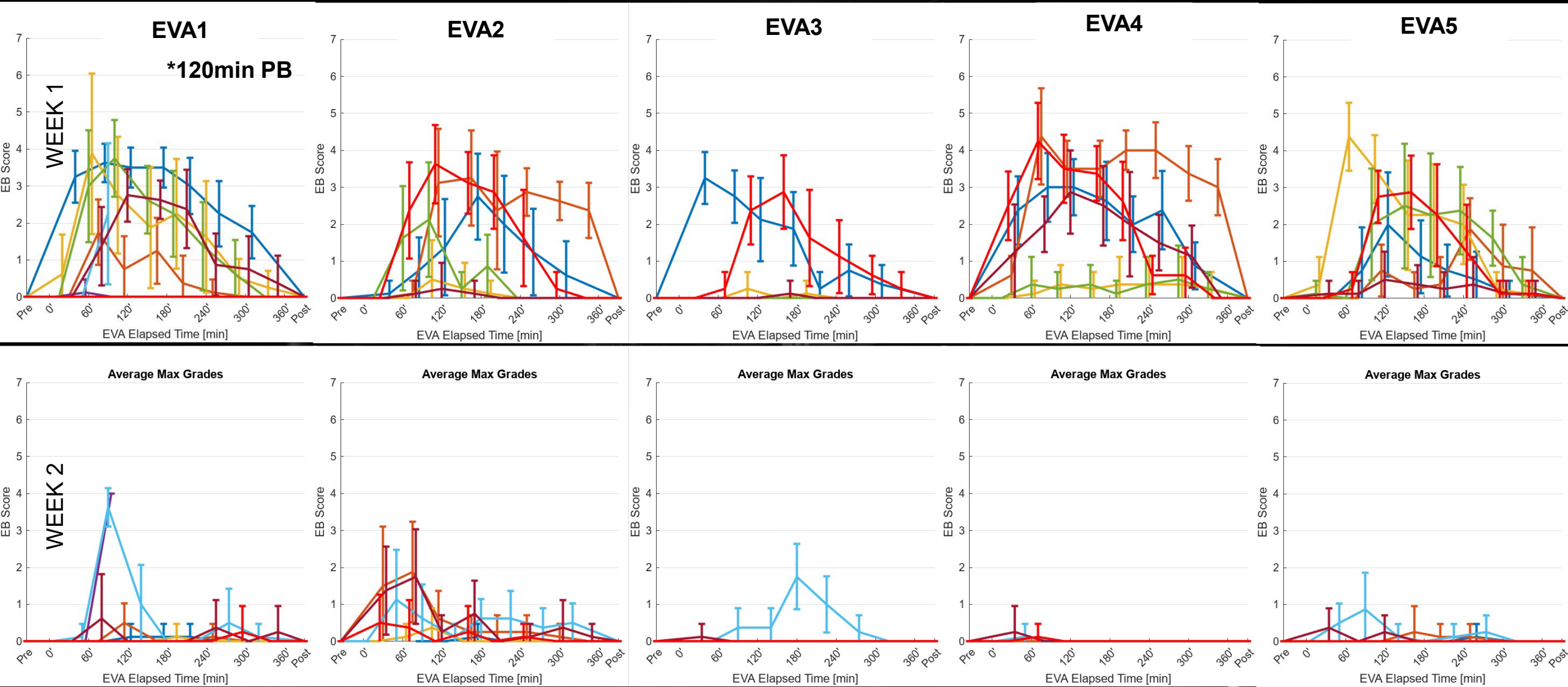
- "HLS Food" nutrition (and addition of warm water)
- "HLS clothing" – all 16 subjects participated
- Blood markers of decompression stress – 15 subjects participated

		Planned Day (Total)	Actual Day (Total)	Subjects
Day 1	Saturation			
Day 2	Saturation			
Day 3	EVA 4.3	8 (8)	8 (8)	-2 (DCS II)
Day 4	EVA 4.3	8 (16)	6 (14)	
Day 5	EVA 4.3	8 (24)	6 (20)	
Day 6	EVA 4.3	8 (32)	6 (26)	
Day 7	EVA 4.3	8 (40)	6 (32)	
Day 8	Chamber Turn			
Day 9	Chamber Turn			
Day 10	Chamber Turn			
Day 11	Prep	SWAP		
Day 12	Saturation			
Day 13	Saturation			-1 (not DCS)
Day 14	EVA 4.3	8 (48)	7 (39)	-1 (not DCS)
Day 15	EVA 4.3	8 (56)	6 (46)	
Day 16	EVA 4.3	8 (64)	6 (52)	-1 (not DCS)
Day 17	EVA 4.3	8 (72)	5 (57)	(DCS I)
Day 18	EVA 4.3	8 (80)	5 (62)	

Doppler Results



Ultrasound Results



DCS Cases

- EVA #1: 120-min prebreathe x2 DCS II (neurological) cases
 - During TD03 (July 17, 2025), two subjects were removed for medical evaluation and treatment
 - Test team determined no constraint to continue test the next day
 - Chamber parameters were nominal within limits of test criteria
- EVA #4: 150-min prebreathe x1 DCS I case
 - Challenging symptomatology and history resulted in this case being judged as Type I DCS post test

i. The RAC matrix is defined as follows:

Table 1 – Risk Assessment Code Matrix

CONSEQUENCE CLASS	LIKELIHOOD ESTIMATE				
	A	B	C	D	E
I	1	1	2	3	4
II	1	2	3	4	5
III	2	3	4	5	6
IV	3	4	5	6	7

Ambient Pressure Excursions	DCS Type 1	III/A/2	III/A/2	Closed/Accepted
	DCS Type 2 'subtle'	II/A/1	II/B/2	Closed/Accepted
	DCS Type 2 'severe'	I/B/1	I/D/3	Closed/Accepted
	ER	II/B/2	II/D/4	Closed/Controlled

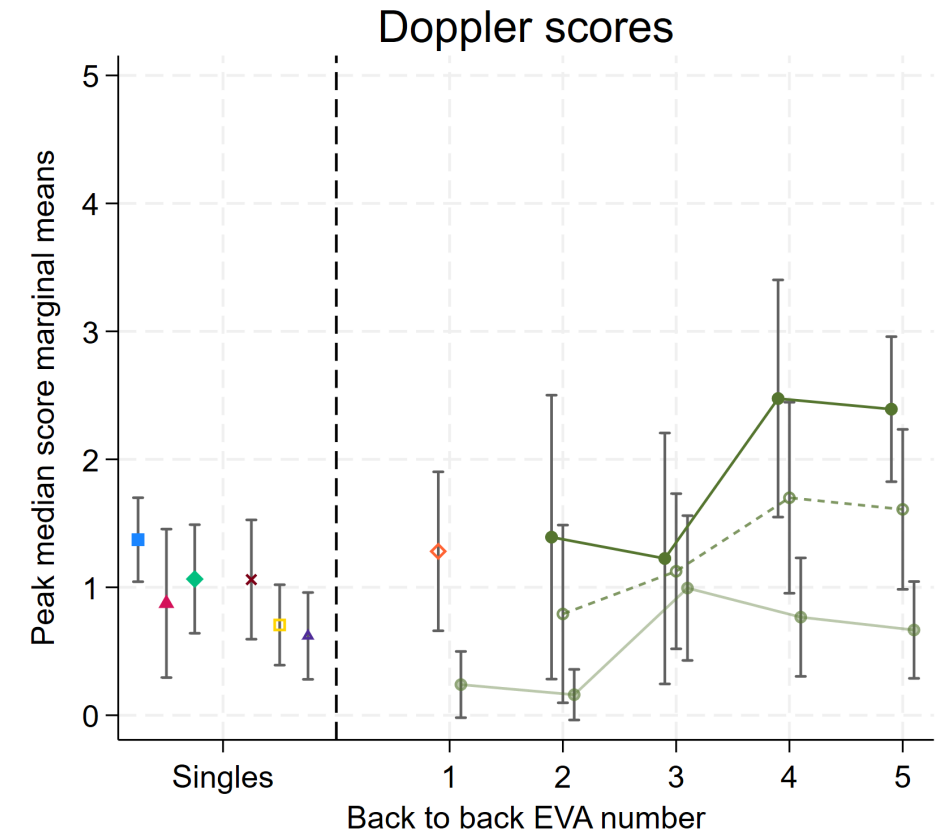
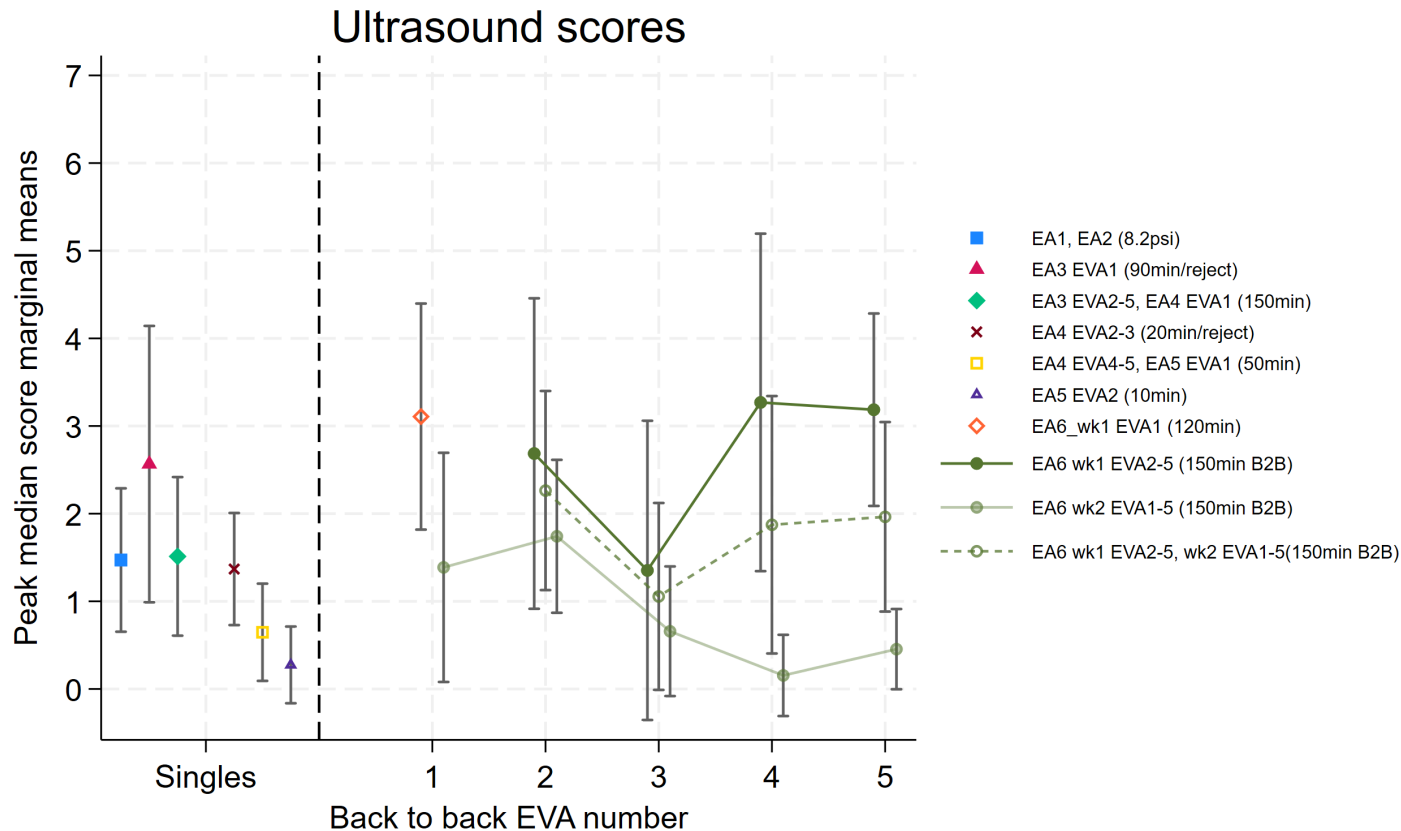
Likelihood	11ft	SSATA	20ft (5EVA)	20ft (2EVA)
A – likely			18% (III/A/2)	
B- probably	16%		11% (II/B/2)	
C- may		8%		8% (III/C/4), 5% (II/C/3)
D – unlikely			1% (I/D/3)	0.4% (I/D/3)
E- improbable	0.05%	0.08%		

Statistical Analysis



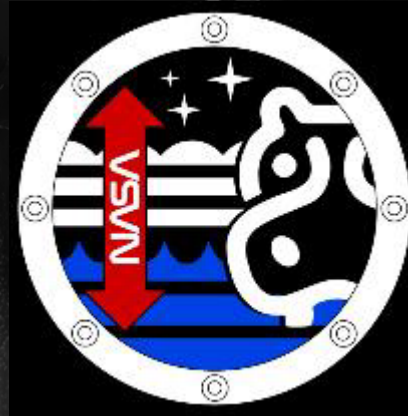
- Large inter and intra-subject variability results in a lot of “noise”
 - No clear “signal” suggests impact of back-to-back is not a significant negative driver
 - **Weakens the ‘predictive value’ of VGE**
- No clear “back to back” benefit/penalty – but higher DCS than expected, ‘30min margin’ of planned ops:

Need new DCS Standard for Artemis Missions



Summary

- Artemis Concept of Operations:
 - Daily (“back to back”) EVAs
 - <16hrs between EVAs
- Tested using the current Exploration Atmosphere
 - 9.6psi/28.5%O₂
- Aggressive prebreathe (PB) protocol
 - Would prevent floor/ceiling effects
 - Observed Type 2 DCS
 - Increased PB by 30min
 - High variability in VGE
 - observable difference with “15hr surface interval”
- This type of testing led to
New NASA DCS Standard for Artemis Exploration



Backup/Reference



What is NASA-STD-3001

- NASA-STD-3001 requires human testing to
 - $\leq 15\%$ incidence of Type I DCS (@95% CL)
 - $\leq 20\%$ incidence of Grade IV VGE (@95% CL)
 - No Type II DCS
- Prebreathe study yields:

$$\frac{\# \text{ DCS cases}}{\# \text{ of exposures}}$$
- Statistical conversion to:
 - % DCS risk and Confidence Limits at 5%-95%
 - Confidence limits are driven by N more so than actual risk
 - Thus, reaching 3001 req'ts is contingent on sample size

NASA-STD-3001 does NOT address Cumulative Risk:

- Loss of EVA is a *mission* risk – determined by mission
- ***Artemis does not currently have mission-wide DCS risk***

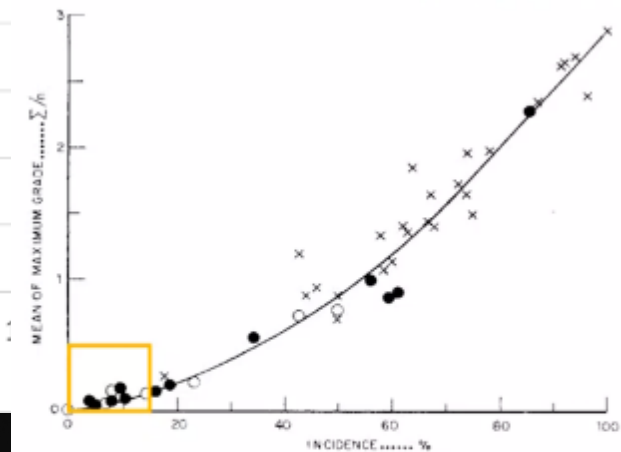
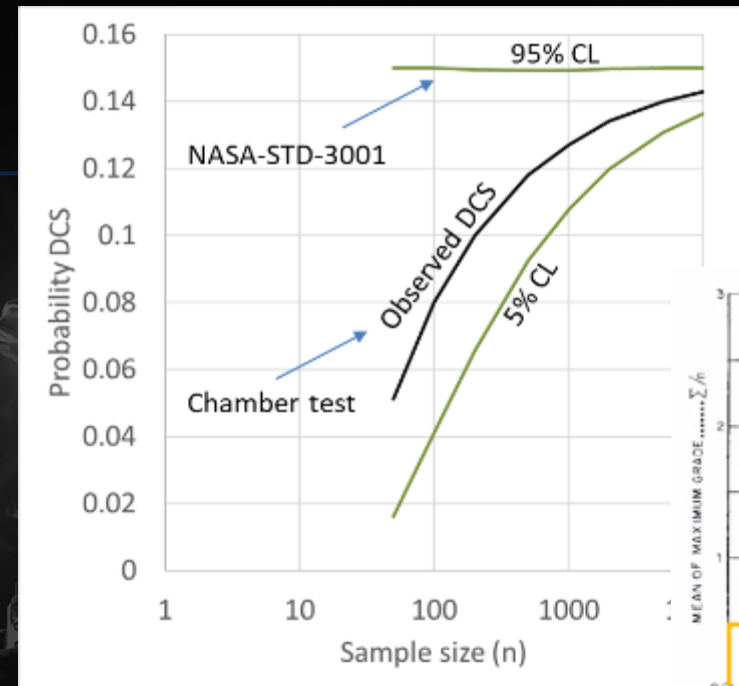
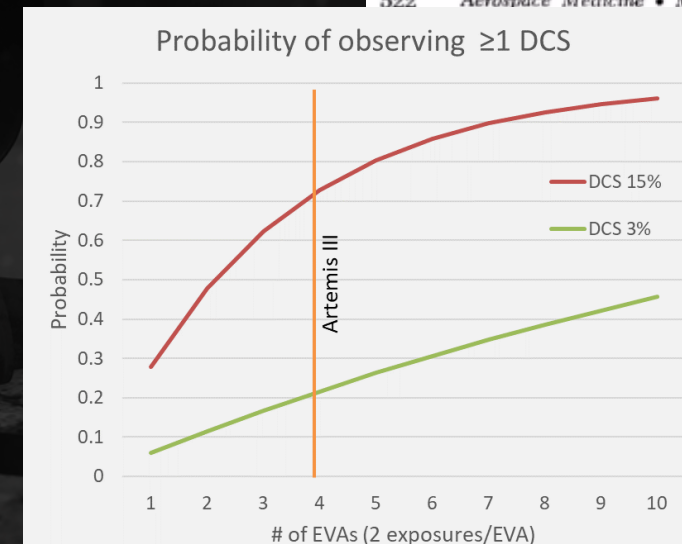


Fig. 4. Incidence and mean grade of altitude decompression sickness from 1942 to present: Crosses, 26 types of exposure with no information on body fat (Table II); Circles, 13 types of exposures (Table I), if filled F > 12 kg, if not filled F < 12 kg.

522 Aerospace Medicine • May, 1971





New NASA DCS Standard – April 8th 2026

6.2.2.4 Decompression Sickness (DCS) Risk Identification

[V2 6008] Each program shall define mission unique DCS mitigation strategies to achieve less than 4% probability of DCS occurrence with 95% confidence by using the following ground chamber test criteria:

- a. No serious DCS in ground exposures
- b. VGE shall be assessed to determine decompression stress

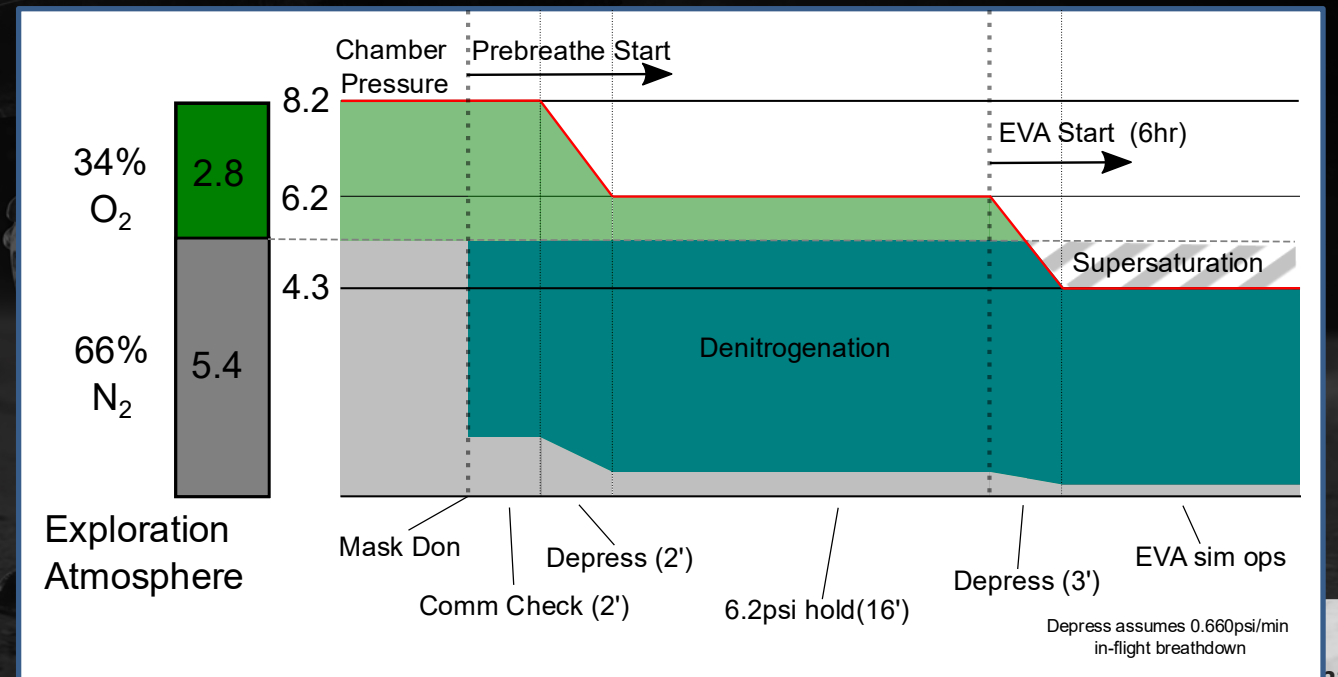
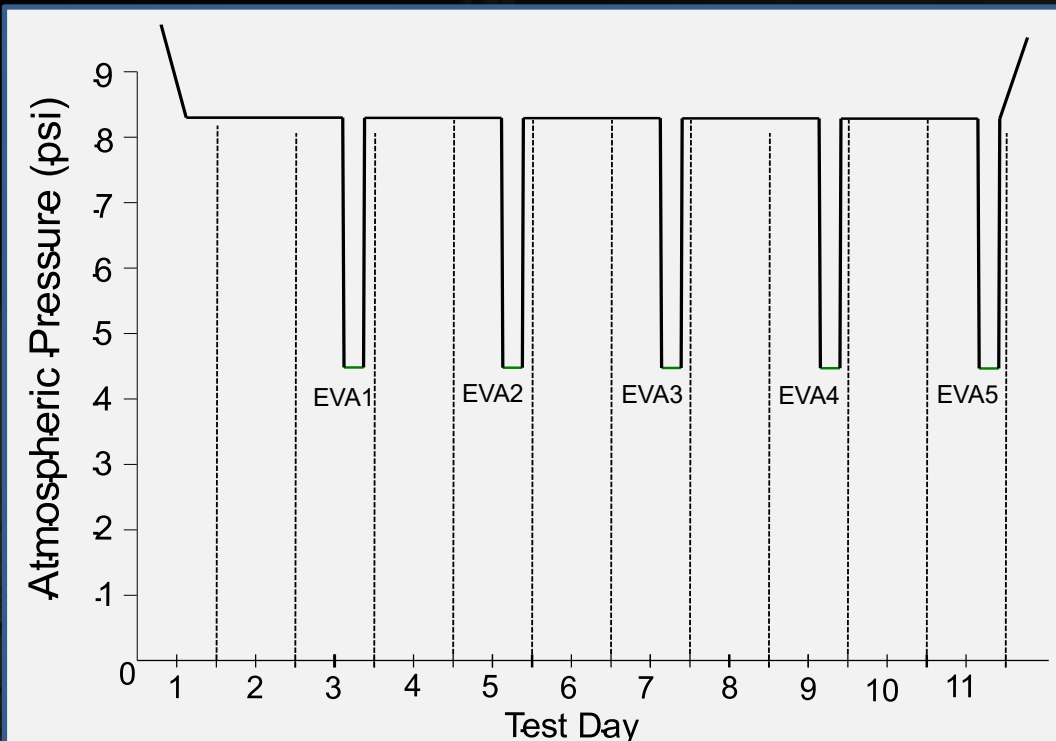
[Rationale:

- *The distribution for the probability of DCS must have 95% of the distribution below 4%, indicating over 95% confidence (probability) that the probability of DCS is less than 4 using appropriate statistical methods.*
- *For example, in order to meet the Bayesian distribution Probability of any DCS <4% with 95% confidence, ground testing will require 47 exposures with no DCS. Using frequentist approach, the number of trials is 74.*
- *Examples of Serious DCS include but are not limited to chest pain/substernal disturbance (chokes), visual symptoms, paralysis, cognitive impairment, inability to carry out task.*
- *Venous gas emboli (VGE) as measured via ultrasound can serve as an indicator of decompression stress. This can help eliminate prebreathe protocols that carry significant decompression stress without requiring extensive chamber test campaigns. The negative predictive value (absence of VGE) is correlated to no DCS.*
- *The DCS standard is for validating protocols during ground testing; not for use in flight.*
- *The DCS standard aims to prevent impacts on long-term health as well as loss of mission as a result of decompression sickness (DCS) in Exploration missions, where timely return to Earth is not feasible.]*



Prebreathe Validation Approach

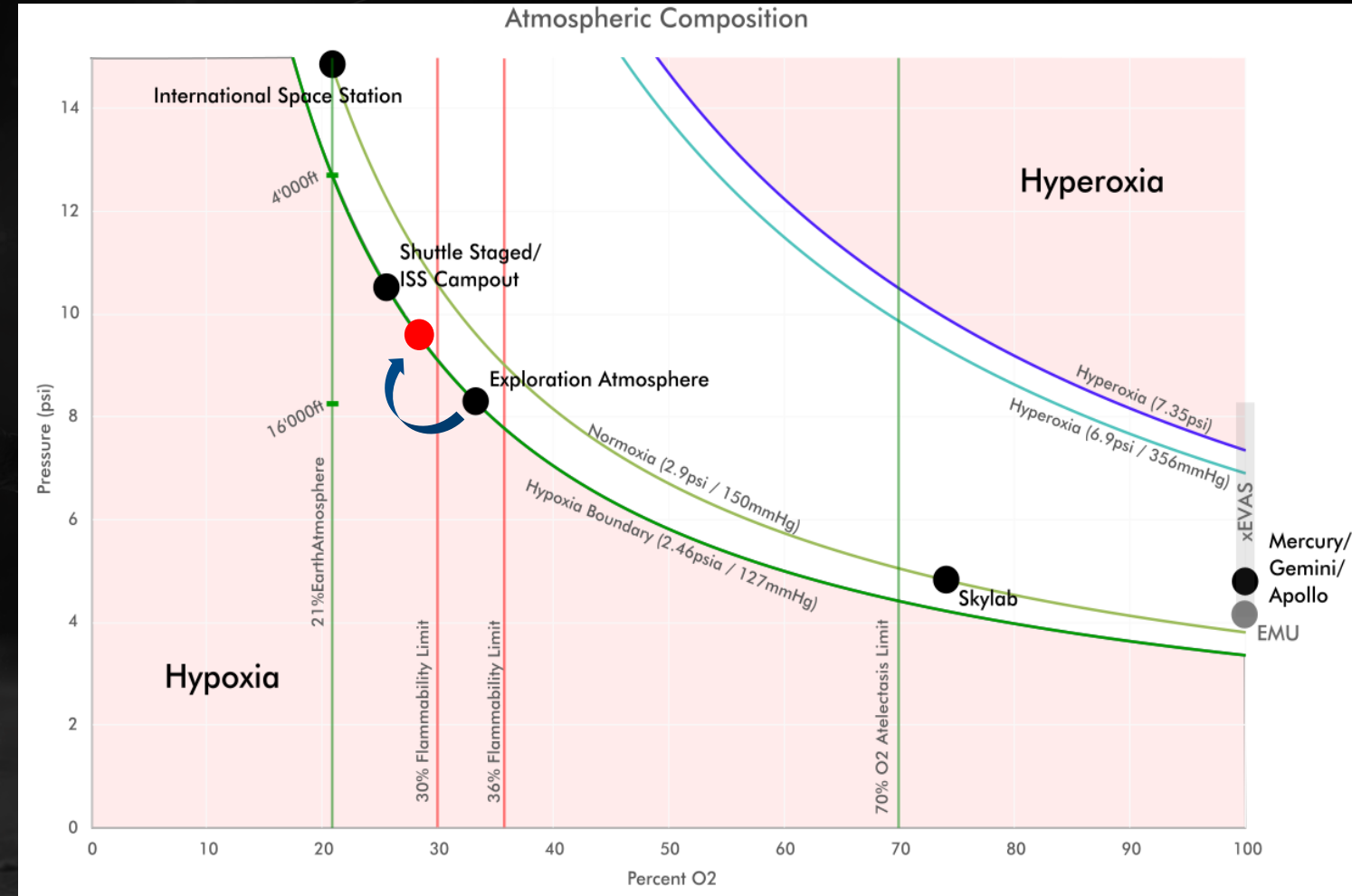
- What prebreathe is sufficient to meet NASA-STD-3001 standards in a Lunar/Mars environment?
 - Equilibrate to Exploration Atmosphere: 8.2psi/34% O₂ for 48 hrs (after 3hr O₂ PB)
 - Minimum prebreathe duration: 20 min ≥ 6.2psi
 - Simulated EVA: 4.3psi/85% O₂
 - Simulate EVA workload: 6 tasks for 6hrs across workload ranges





Exploration Atmosphere (EA) 8.2psi/9.6psi set point

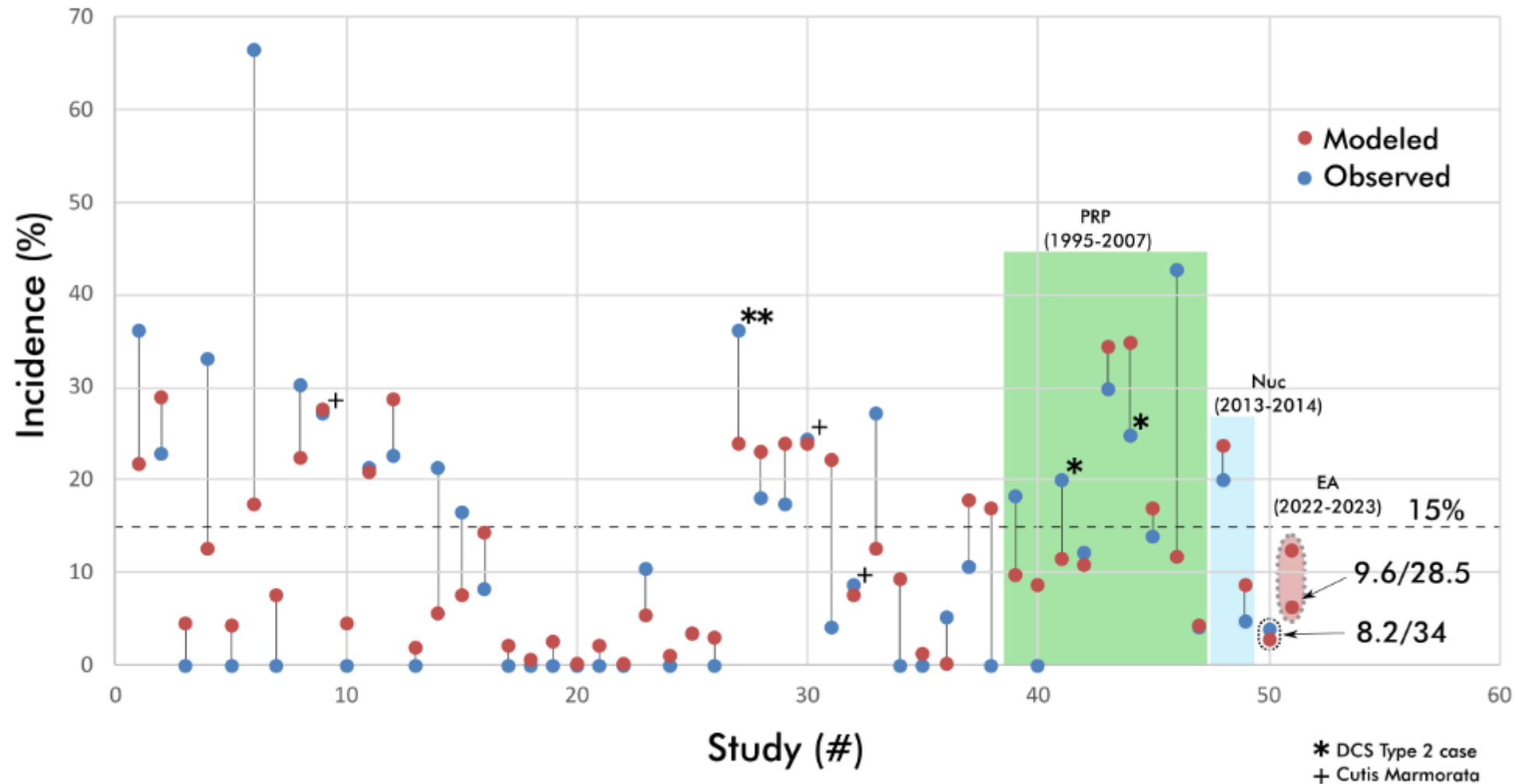
- Original “EA” was 8.2psi/34% O₂, with a 20-min prebreathe
- HLS concern for materials/flammability risk triggered extensive review effort
- M2MCB decision July 2024:
 - Set 9.6psi/28.5% O₂ cabin for Artemis 3
 - Explore use of an elevated suit pressure to compensate for higher habitat pressure and retain shortened prebreathe



Historical NASA Testing



NASA Historical Decompression Studies (1982-2023)

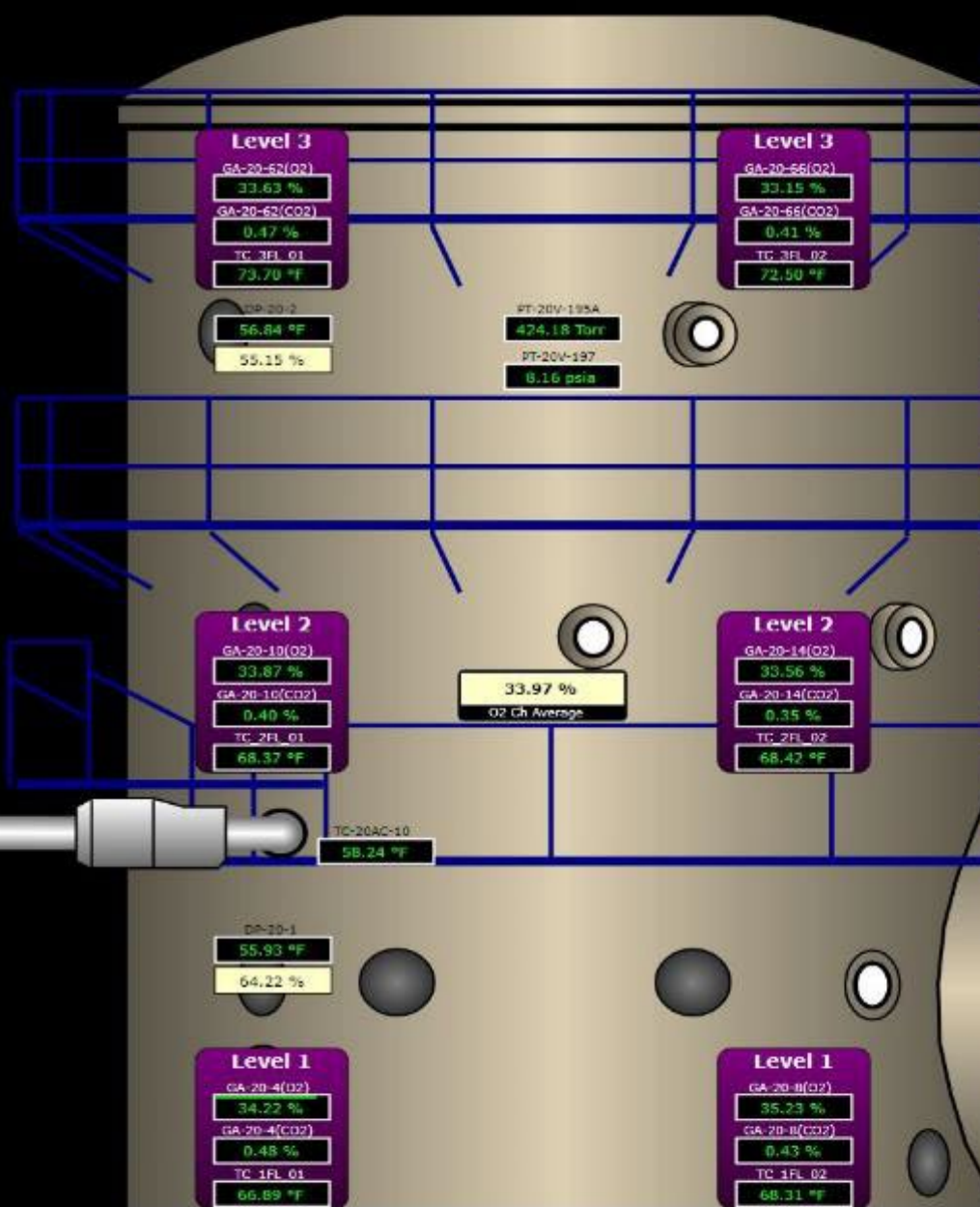






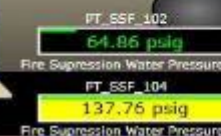
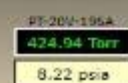
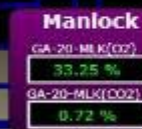
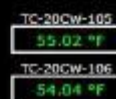
Chamber: HMI Enabled

Manlock: HMI Enabled



PT-20V-195A	424.182 Torr	Main Chamber High
PT-20V-195B	10.330 Torr	Main Chamber Low
PT-20V-196A	424.936 Torr	Man Lock High
PT-20V-196B	10.350 Torr	Man Lock Low

Oxygen		
PT-O2-8	872.819 psig	Primary Supply Regulator Outlet
PT-O2-16	864.513 psig	Oxygen Supply Console Inlet
PT-O2-28	901.804 psig	Secondary Supply Regulator Outlet
PT-O2-106	80.478 psig	Man-Lock Regulator Outlet
PT-O2-112	80.456 psig	Man-Lock Supply
PT-O2-206	80.333 psig	Main Chamber Regulator Outlet
PT-O2-212	80.247 psig	Main Chamber Supply
PT-O2-306	29.314 psig	Chamber Atm. Regulator Outlet
PT-O2-312	29.317 psig	Chamber Atm. Supply
PT-T02-806	80.272 psig	85% O2 Regulator Outlet
PT-T02-812	873.453 psig	85% O2 Supply Console Inlet
PT-T02-814	80.321 psig	85% O2 Main Chamber Supply





20' Chamber

TTD# 7636

11 Day Manned Run

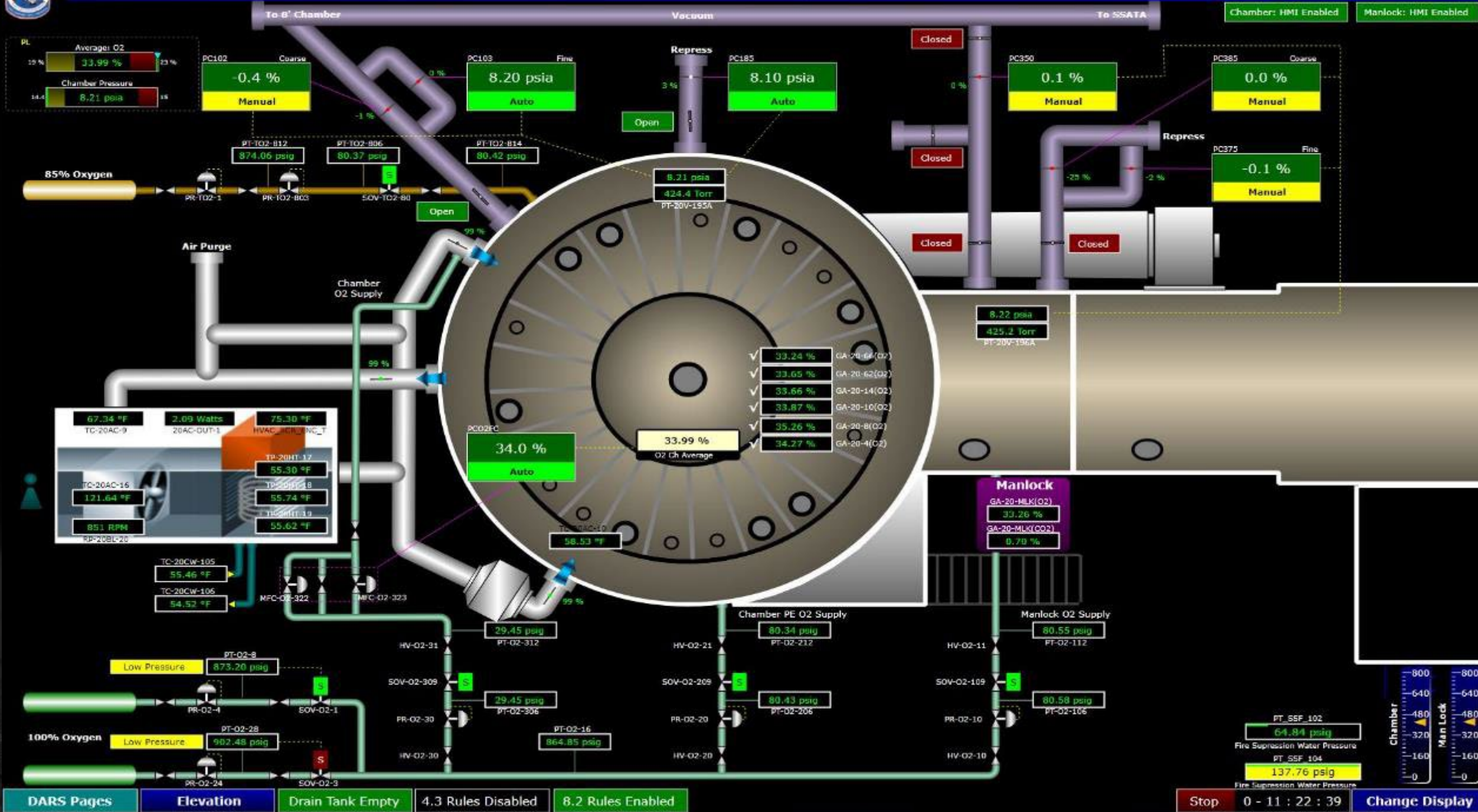
Logged in:



06/16/2022 23:54:50

Chamber: HMI Enabled

Manlock: HMI Enabled



DARS Pages

Elevation

Drain Tank Empty

4.3 Rules Disabled

8.2 Rules Enabled

Stop

0 - 11 : 22 : 39

Change Display

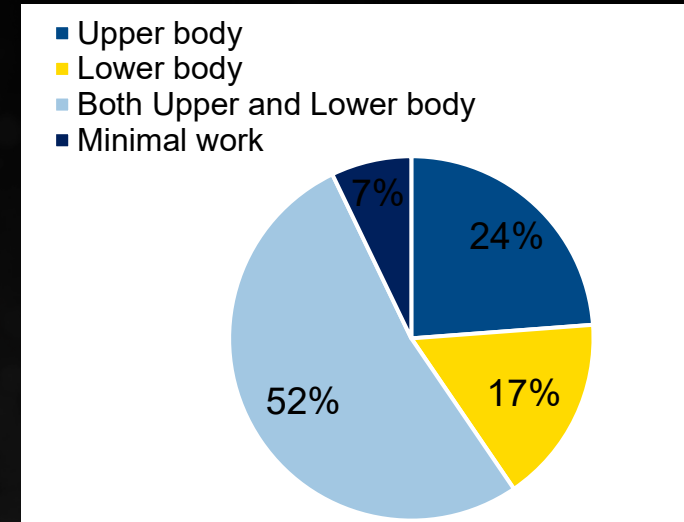


EVA Simulation – Rationale for Tasks

- 61 exploration EVA tasks^[2] were decomposed into 126 subtasks then characterized by functional requirements of each subtask

- Categories:**

- Body Positioning:** Seated, Kneeling, Standing, Mobile, etc.
- Muscle Groups:** Whole/Both, Upper, Lower
- Ambulation:** None, Walking, Walking (terrain), Walking (slopes), Crawling, Climbing
- Loading Bearing:** None, Carrying, Pushing/Pulling, Attached to Suit
- Loads:** None, Minimal (<5 lbs), Variable, Heavy (>30 lbs)
- Upper Body Reach (Workspace):** None, Standard, Extended
- Hand Usage:** None, Fine Motor Skills, Grip Strength, Vibration, Shock, Other/Combination
- Task Occurrence:** Rare (<10% of EVAs), Some (~30%), Many (~50%), Most (~75%), Nearly All (>90%)
- Task Duration (expected)**
- Task Frequency:** 1-2 times per EVA, Every 2 hours during EVA, Every hour during EVA, 1-30 minutes during EVA



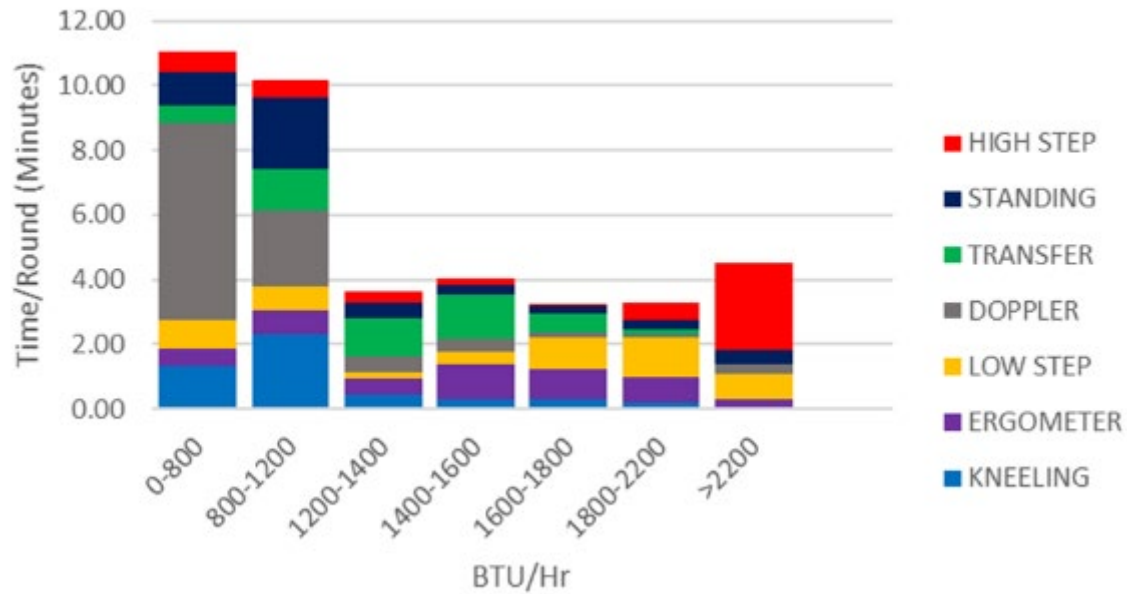
Parent Task Title	Children of the Parent Task	Load Bearing Type	Upper Body Loads	Upper Body Reach	Fine Motor / Grip	Task Occurrence	Task Duration	Task Frequency
Offload Equipment from Landers	mobile, upper and lower body work	Carrying Load	Variable Load (minimal to heavy)	Extended Workspace	Grip Strength	Rarely Occurs in any EVA (<10%)	5-15 minutes	Every 1-30 minutes during EVA
Offload Equipment from Landers	mobile, upper and lower body work	Pushing / Pulling Load	Heavy Load (> 30 lbs.)	Extended Workspace	Grip Strength	Rarely Occurs in any EVA (<10%)	5-15 minutes	Every 1-30 minutes during EVA
Load Equipment onto Rovers	mobile, upper and lower body work	Carrying Load	Variable Load (minimal to heavy)	Extended Workspace	Grip Strength	Occurs in many EVAs (~50%)	5-15 minutes	Every ~1 hr during EVA
Clean Equipment	stationary, upper body work while kneeling	No Load	No Significant Loading	Extended Workspace	Fine Motor	Occurs in some EVAs (~30%)	15-60 minutes	Total of 1-2 times during EVA
Clean Equipment	stationary, upper body work while standing	No Load	No Significant Loading	Extended Workspace	Fine Motor	Occurs in most EVAs (~75%)	15-60 minutes	Total of 1-2 times during EVA
Conduct Visual Inspection / Examine Surroundings	mobile, ambulation	No Load	No Significant Loading	None	Fine Motor	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every 1-30 minutes during EVA
Conduct Visual Inspection / Examine Surroundings	seated	No Load	No Significant Loading	None	None	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every ~1 hr during EVA
Conduct Photo Documentation	stationary, upper body work while kneeling	Other / Unknown	Minimal Load (less than 5 lbs.)	Standard Workspace	Fine Motor	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every 1-30 minutes during EVA
Conduct Photo Documentation	stationary, upper body work while standing	Other / Unknown	Minimal Load (less than 5 lbs.)	Standard Workspace	Fine Motor	Occurs in nearly all EVAs (90-100%)	1-5 minutes	Every 1-30 minutes during EVA



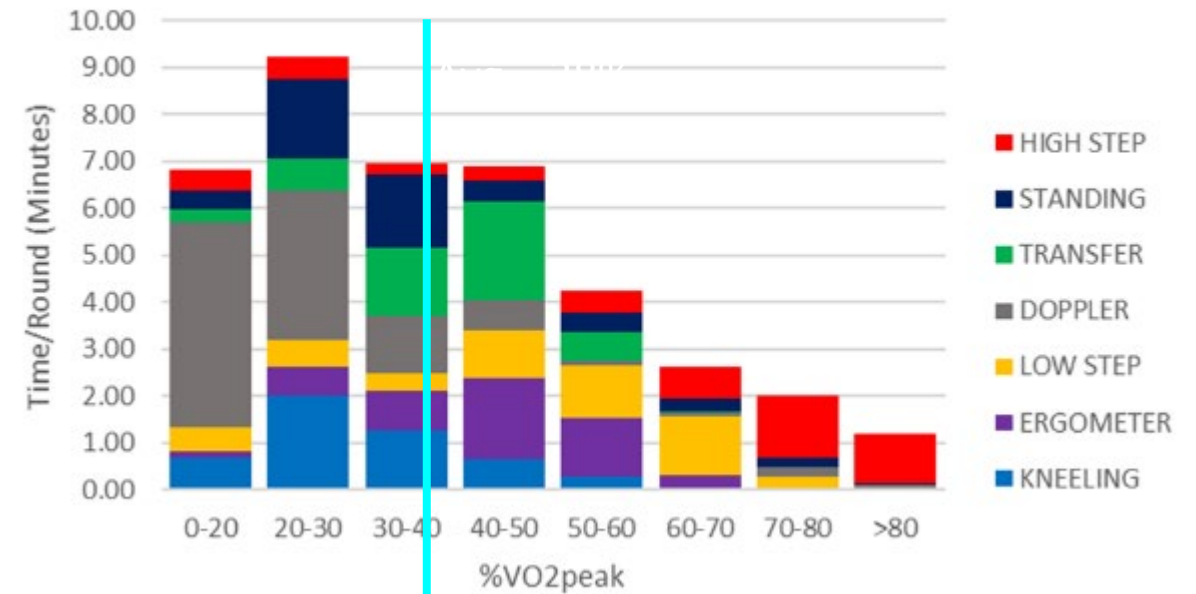
Pilot Data - Results

- The average %VO₂peak across all tasks was ~38% (1274 BTU/hr).

Met Rate Zones per Activity - BTU/hr



Met Rate Zones per Activity - VO₂peak



Modified Eftedal Brubakk Score



- Exploration Atmosphere VGE Scoring uses the Modified Eftedal Brubakk Score. Scoring is done only considering right atrium & ventricle.*

Score	Definition
0	No Visible Bubble
1	Occasional bubbles
2	At least 1 bubble every 4-heart-cycle
3	At least 1 bubble every heart cycle
4	Not more than one thirds of every image
5	Not more than two thirds of every image
6	Near whiteout; individual bubbles still discerned
7	Whiteout; individual bubbles can't be discerned

* No LVGE detected.

Eftedal O, Brubakk AO. Agreement between trained and untrained observers in grading intravascular bubble signals in ultrasonic images. Undersea Hyperb Med. 1997 Winter;24(4):293-9. PMID: 9444060.

Analysis and Scoring Methods



Ultrasound and Doppler Scoring

- Ultrasound videos were scored based on number of VGE / bubbles present during imaging over 10 cardiac cycles (Modified Eftedal Brubakk Score, right).
- Doppler audios were scored based on 'bubble signals', or audible peaks in doppler waveforms

Doppler Bubble Grading Spencer Scale

Grade	Description
0	A complete lack of bubble signals
I	An occasional bubble signal with the great majority of cardiac periods free of bubbles
II	Many, but less than half, of the cardiac periods contain bubble signals, singly or in groups
III	All the cardiac periods contain showers of single-bubble signals, but not dominating or overriding the cardiac motion signals
IV	The maximum detectable bubble signal sounding continuously throughout systole and diastole of every cardiac period, and overriding the amplitude of the normal cardiac signals

Score	Definition
0	No visible bubbles
1	Occasional bubbles
2	At least 1 bubble every 4 heart cycles
3	At least 1 bubble every heart cycle
4	Not more than one third of every image
5	Not more than two thirds of every image
6	Near whiteout; individual bubbles still discerned
7	Whiteout; individual bubbles can't be discerned

Data Analysis / Graphs

- Scores for rests and leg flexes – left and right – were acquired via Vivid iQ Ultrasound w/ doppler wave acquisition application.
- Scores between cross-graders (n=3 to 4 per crew member at each time point) were averaged for the resting and flexing periods.
- Max scores and average scores of resting and flexing periods were graphed.
- Data is represented by mean $\pm$ standard deviation.



Long Prebreathe is not compatible with High Tempo EVA

SAT	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	
8.2psl /34% O2	SLEEP (8.0 HRS TOTAL)					Postsleep- 1.5 hrs		PMC & DPC	EVA Prep (excl. PB)	Prebreathe	EVA (8 HRS)								Post-EVA Overhead	Meal	MARGIN (60 mlns)	PMC & DPC	Presleep - 1.5 hrs	SLEEP		
10.2psl /26.5% O2	SLEEP (6.0 HRS TOTAL)			Postsleep- 1.5 hrs		PMC & DPC	EVA Prep (excl. PB)	Prebreathe (3.5 HRS)			EVA (8 HRS)								Post-EVA Overhead	Meal	PMC & DPC	Presleep - 1.5 hrs	SLEEP			
14.7psl /21% O2	Postsleep- 1.5 hrs	PMC & DPC	EVA Prep (excl. PB)	Prebreathe (7 HRS)							EVA (8 HRS)								Post-EVA Overhead	Meal	PMC & DPC	Presleep - 1.5 hrs	SLEEP (2.5 HRS TOTAL)			

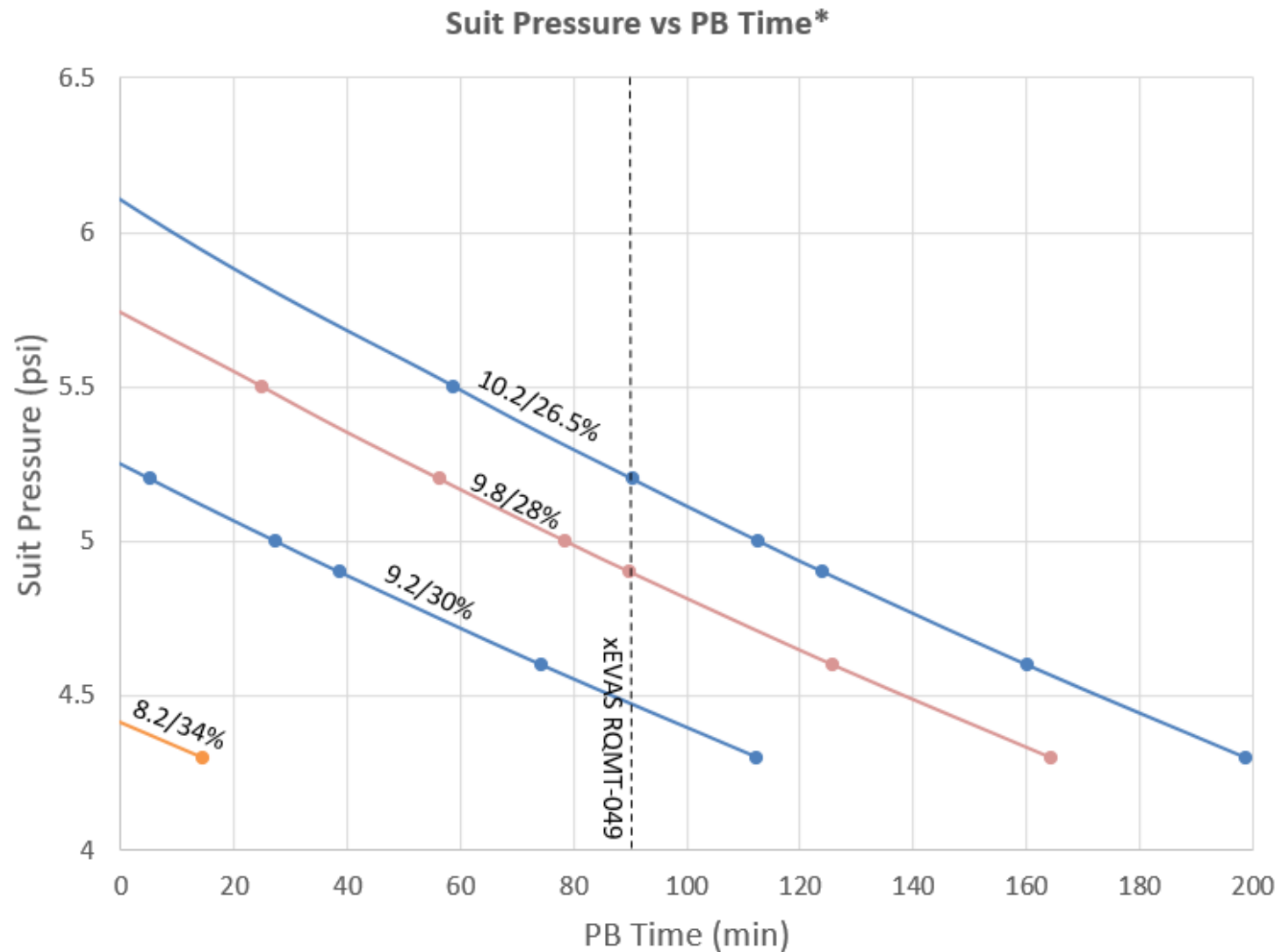
Assumptions

- 1 DPCs are for system status checks and any general Q&A for crew
- 2 PMCs are for pre/post EVA medical status checks
- 3 Sleep period = 8 hrs, immediately following Presleep activity (no sleep shifting for crew during surface ops)
- 4 Post/presleep include routine system/HAB cks, hygiene and meal
- 5 EVA Prep includes pre-EVA conference with MCC

Operational Goal: < 60min prebreathe



Suit Pressure can shorten prebreathe



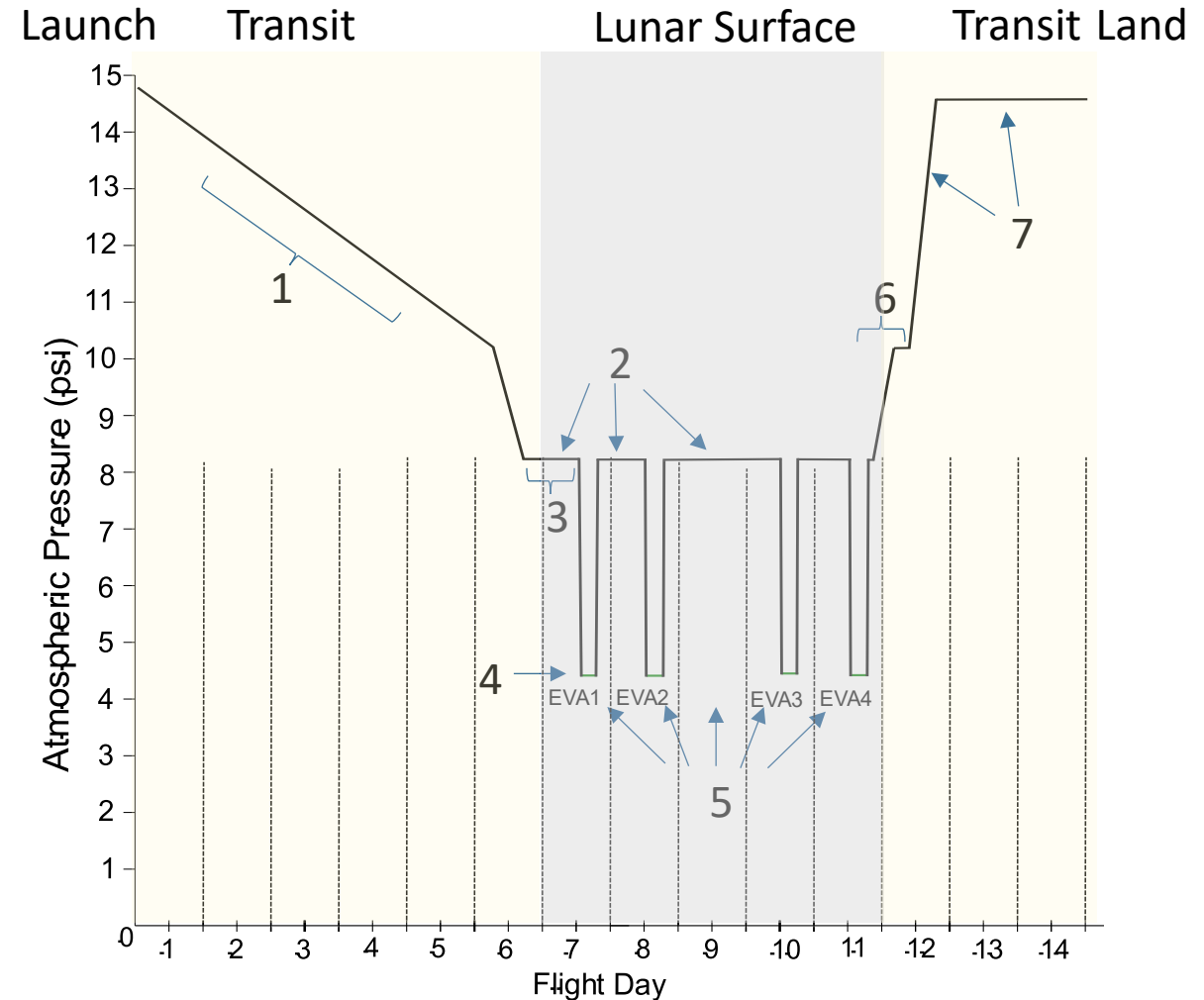
*3% DCS Risk, Conkin TR20 Model



EA-6 In a nutshell



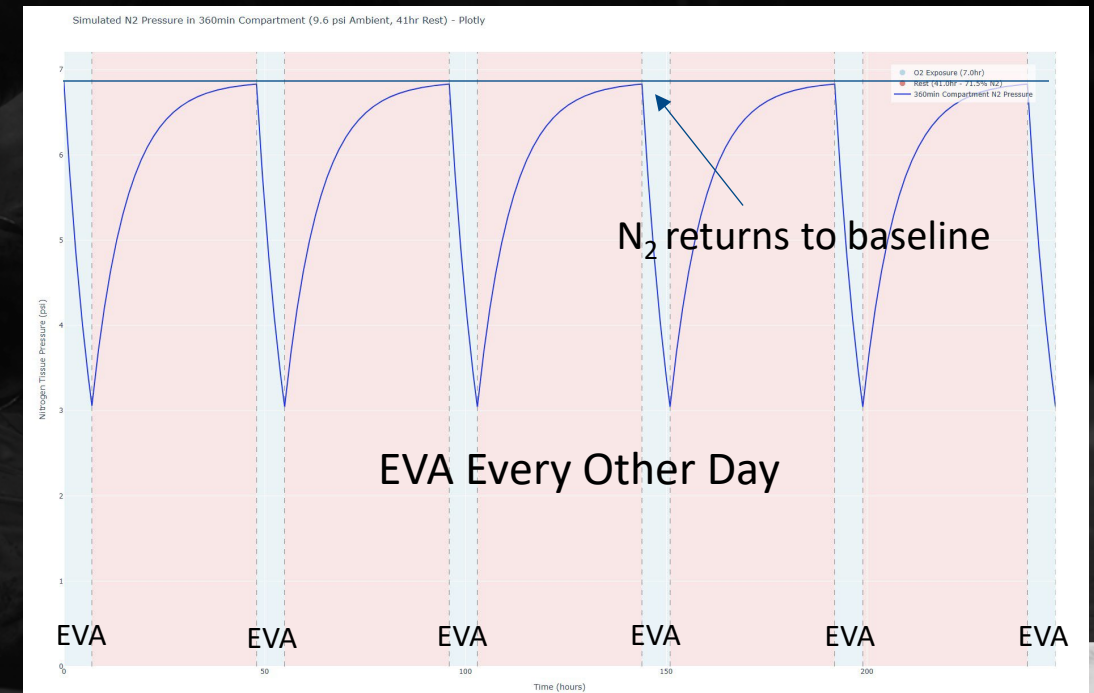
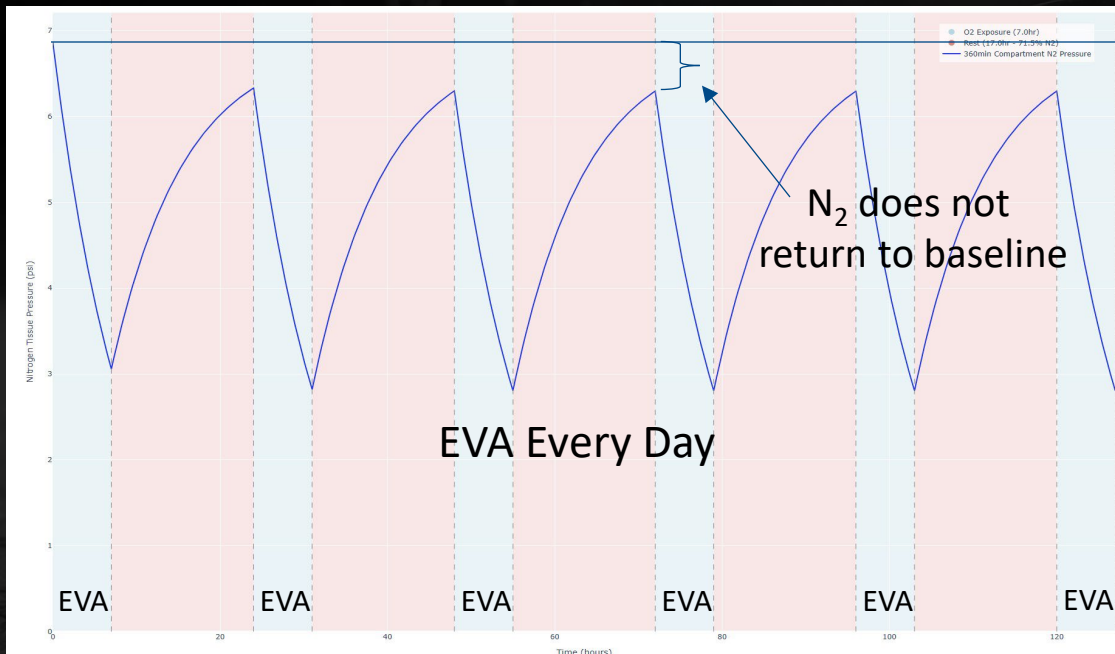
- Artemis 3 Mission:
 - Return to the Lunar surface
 - Timeline: Daily EVAs x2, Off-day, Daily EVAs x2
- Significant gap in literature on “back to back” EVA
 - Diving studies, eg REPEX (Hamilton), RNT, etc exist
 - No such equivalence for altitude
 - Apollo – No decompression stress (100% O₂ cabin)
 - ISS/Shuttle – usually 1+ days ‘OFF’
 - USAF – 30min ‘flights’/2hr exposures



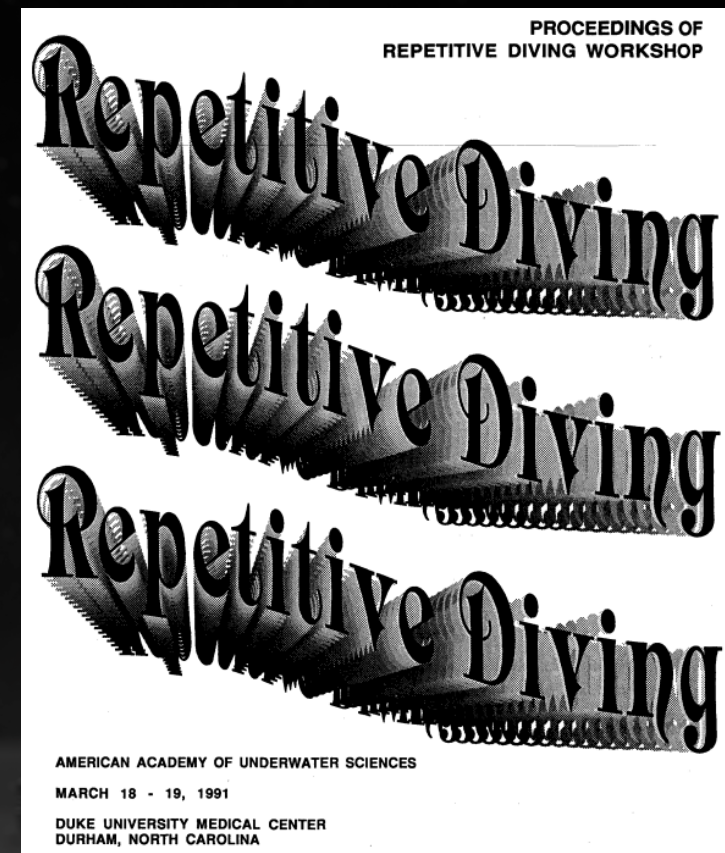
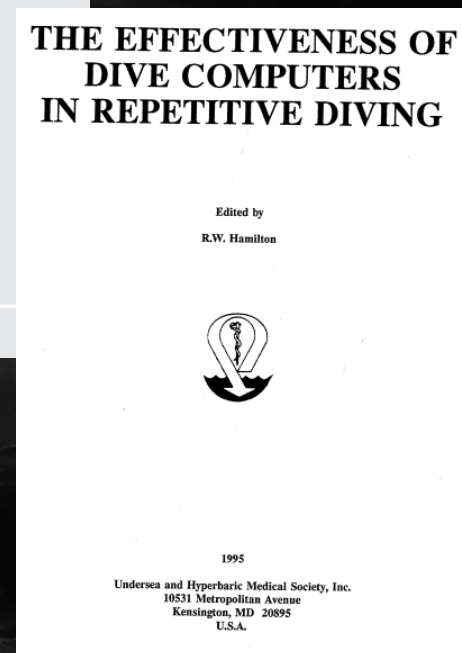
What about the *next* EVA?

■ “Repetitive Exposures”

- Nitrogen in the body decreases during PB and EVA, reaccumulates post EVA
- Next EVA – if $\sim < 36$ hours apart – has less nitrogen (theoretically less risk)
 - Eg Daily EVA: Starting N_2 for EVA1: 6.9psi, subsequent EVAs start at 6.3psi (ie, body is at ~ 9.3 psi/33% O_2)
- Inflammatory response may take longer to recover from (theoretically more risk)
- **Additional Unknown unknowns – higher or lower risk?**
- No definitive study with human subjects exists



...repeated exposures helps? Or hurts?



- Bubbles taper down
- 2024: Inflammatory markers remain elevated >24hrs

What does Back to Back Mean for current ConOps?

- “Back to Back” (<24hrs) between EVAs results in the denitrogenation from previous EVA benefits the subsequent EVA

- **BGI15 model**

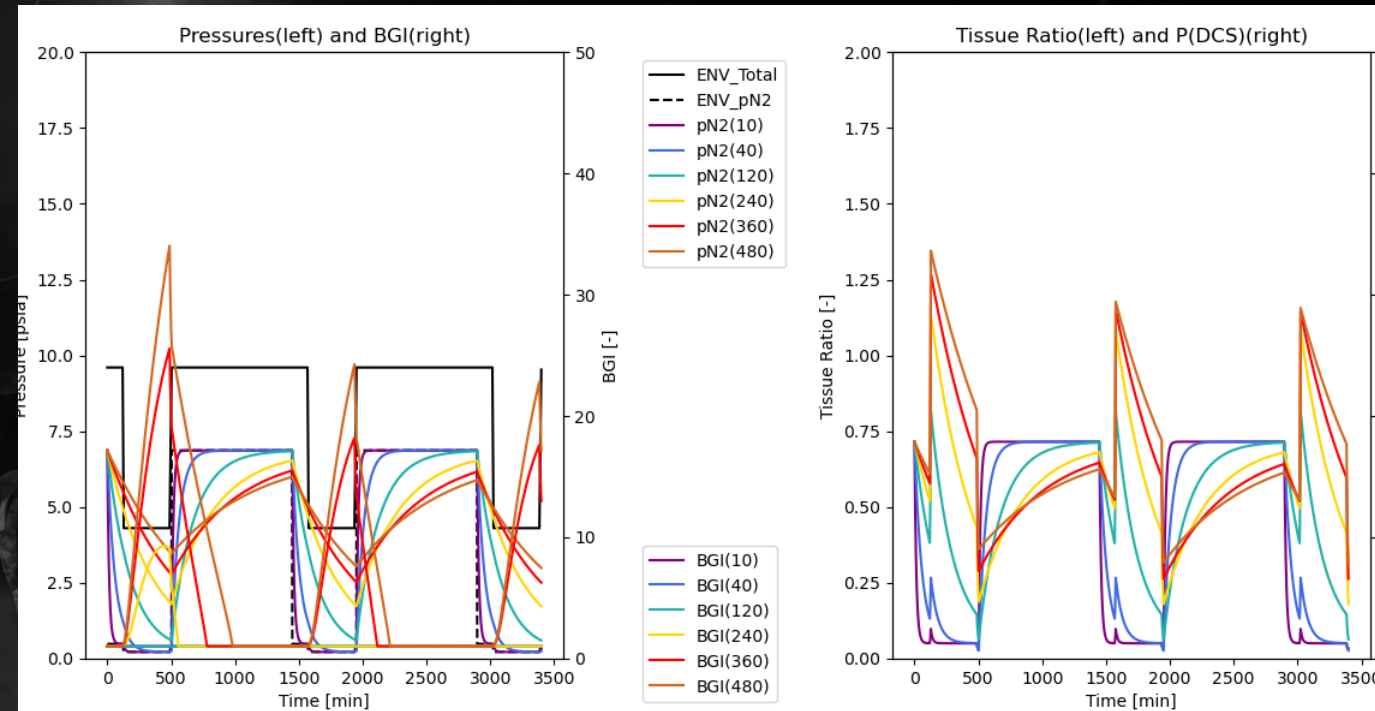
- [Pre EVA: 3.14%]
- EVA1: 9.96%
- EVA2: 7.09%
- EVA3-5: 6.90%

- **TR20 model**

- EVA1: 3.86%
- EVA2: 1.94%
- EVA3-5: 1.86%

- **Inflammatory Markers**

- Literature: Blood markers stay elevated >24hrs POST exposure



DETAILED Doppler/Ultrasound results



EVA#

WEEK
1

Doppler WEEK 1

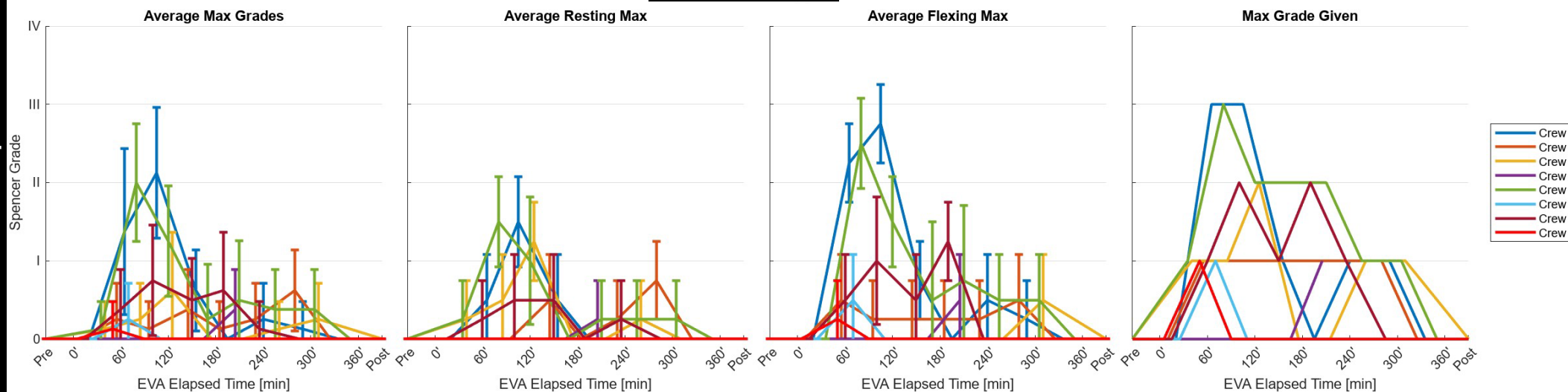
WEEK
2

Doppler WEEK 2

WEEK 1

1

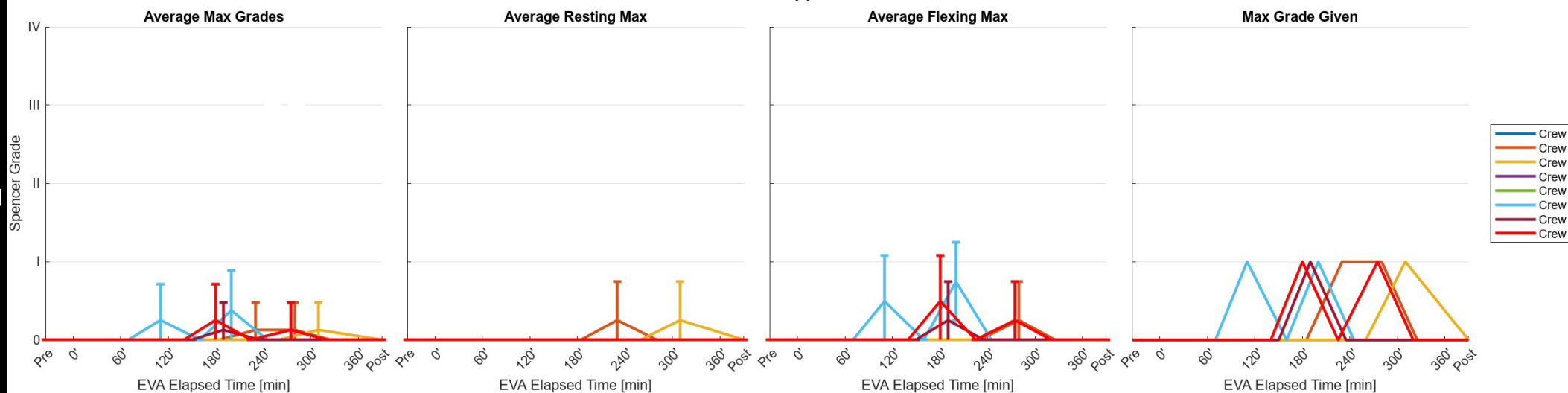
EVA1

120min
PR

WEEK 2

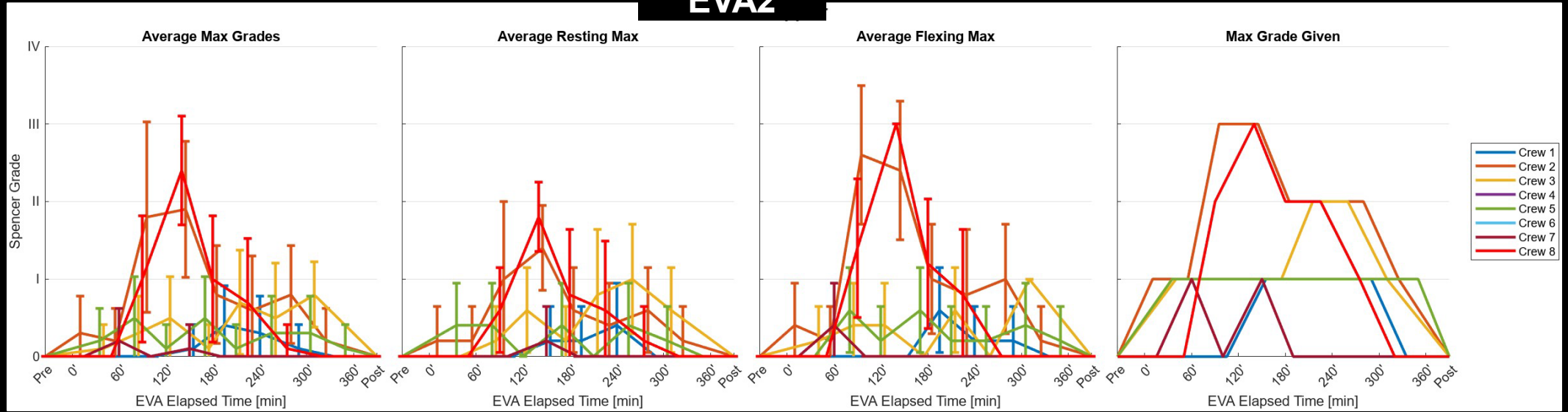
2

EA-6 TD03 Doppler

150min
PR

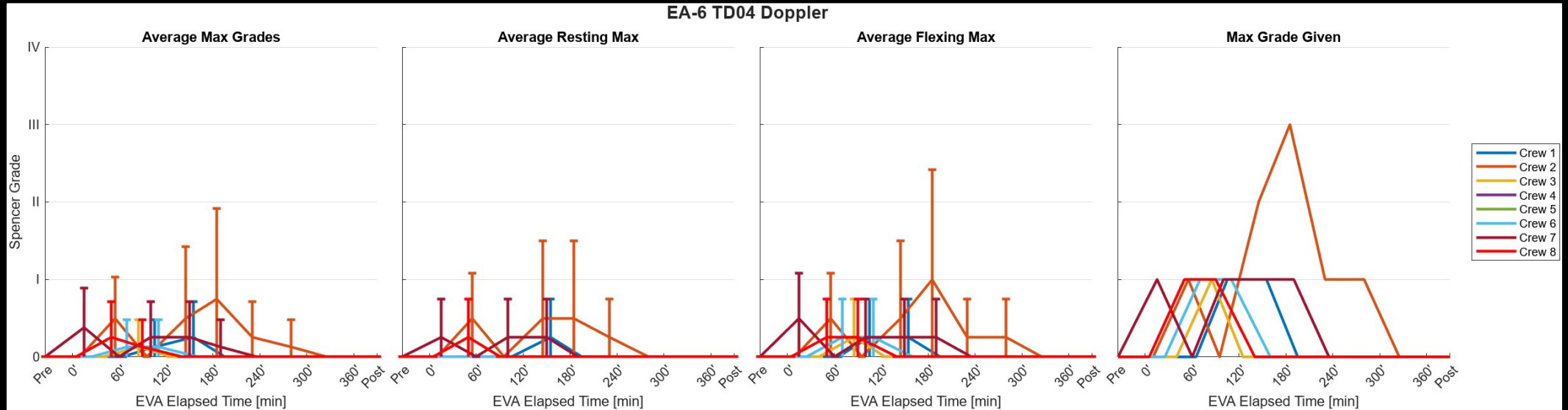
EVA2

WEEK 1



150min
PR

WEEK 2

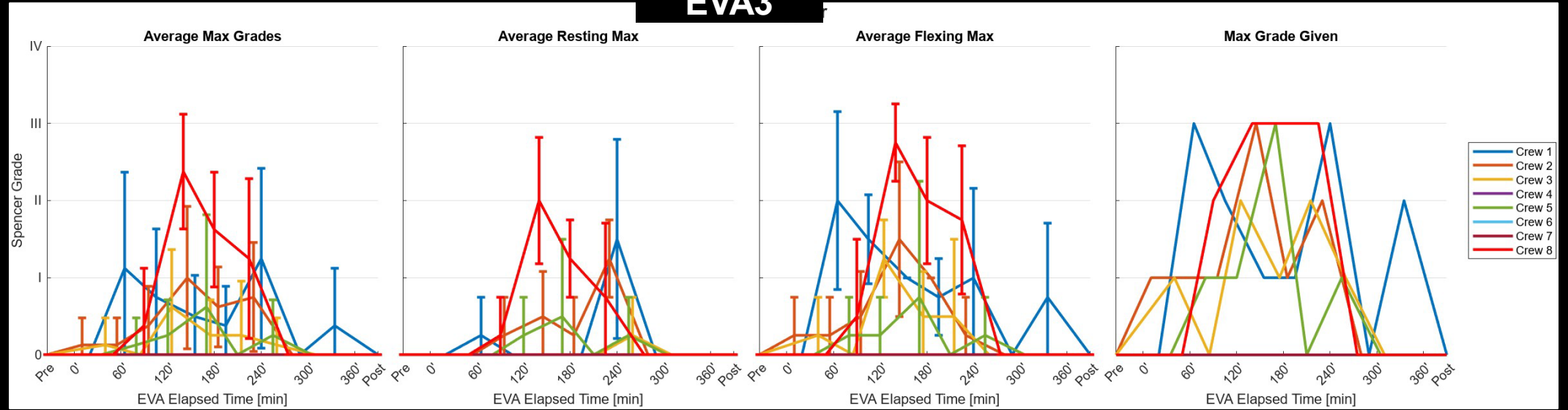


150min
PR

EA-6 TD04 Doppler

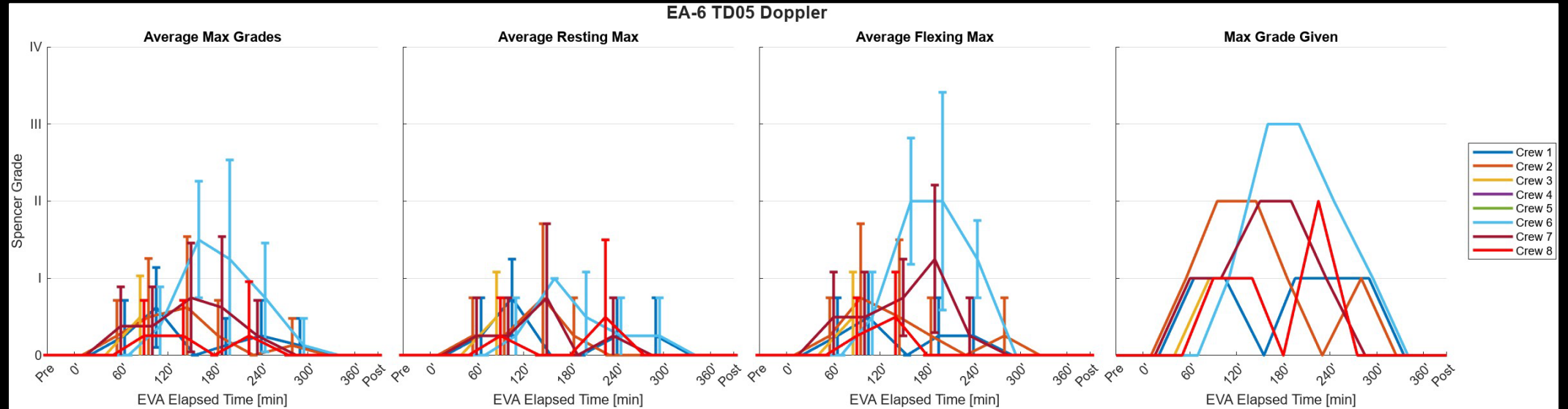
EVA3

WEEK 1



150min
PR

WEEK 2



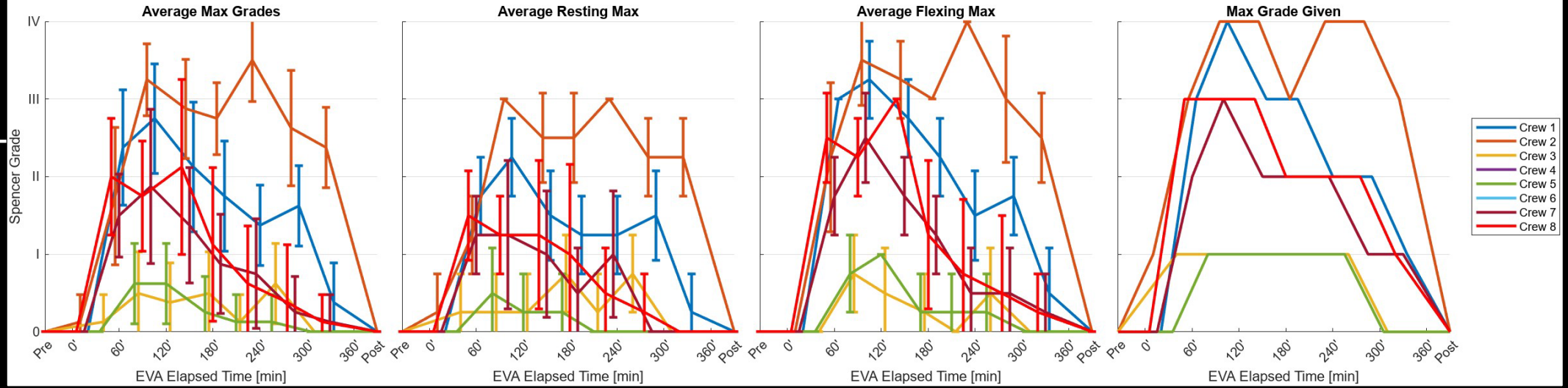
150min
PR

EA-6 TD05 Doppler

EVA4

WEEK 1

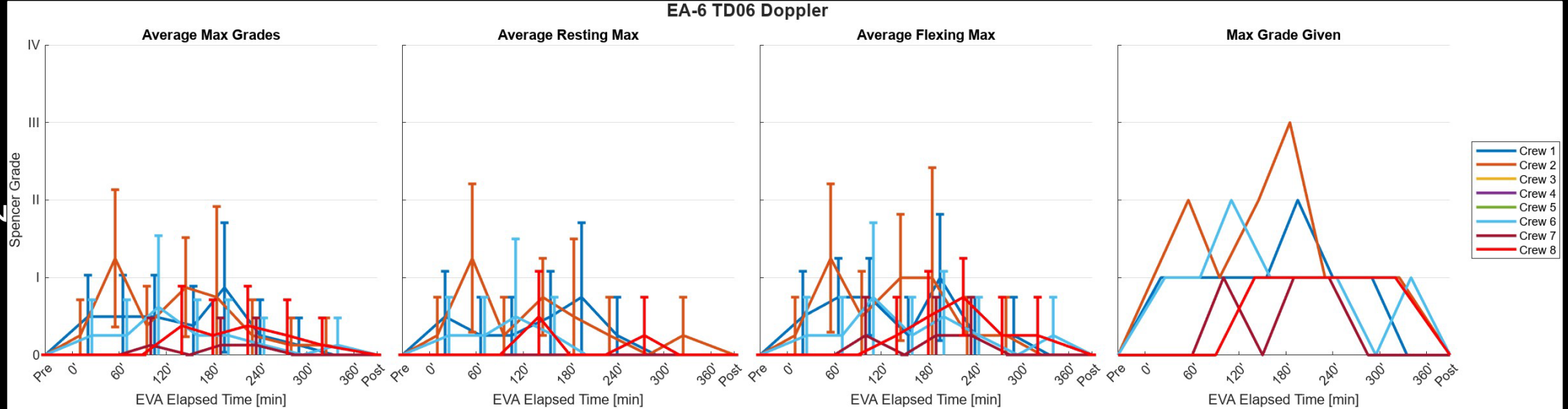
1



150min
PR

WEEK 2

2



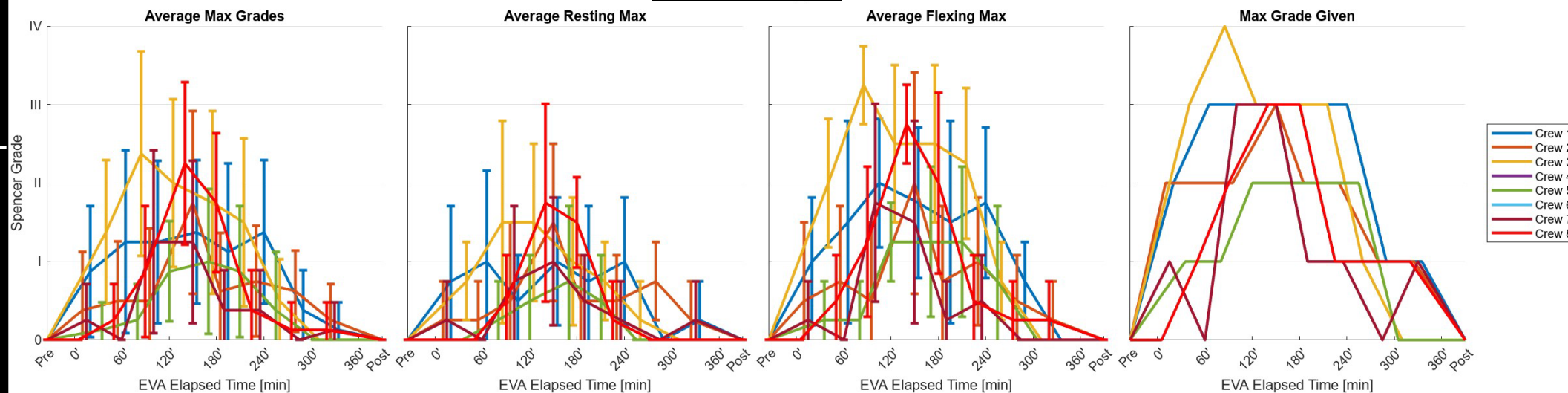
150min
PR

EA-6 TD06 Doppler

WEEK 1

1

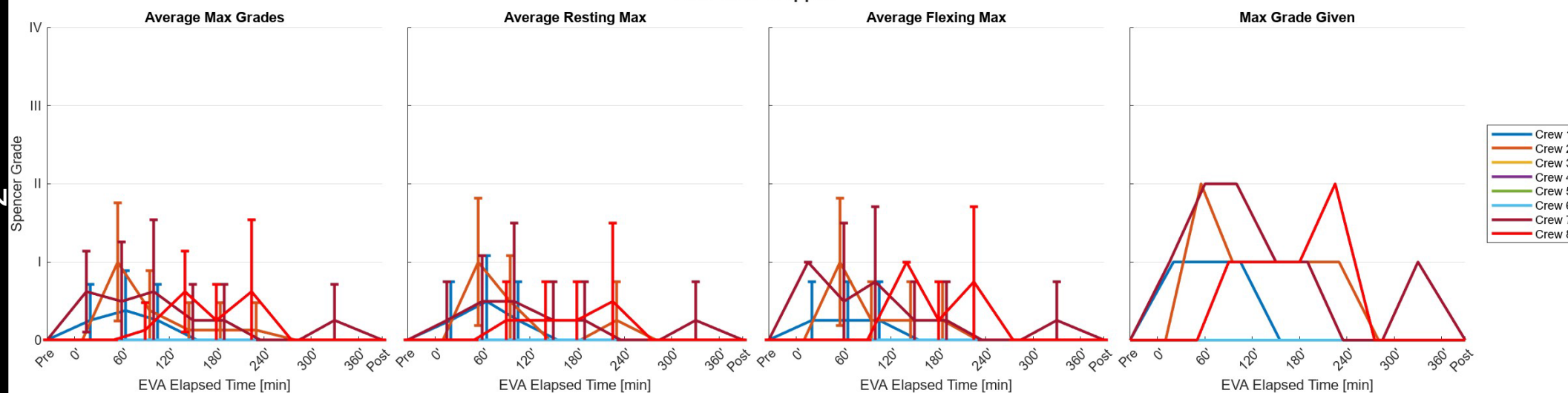
EVA5

150min
PR

WEEK 2

2

EA-6 TD07 Doppler

150min
PR

EVA#

WEEK
1

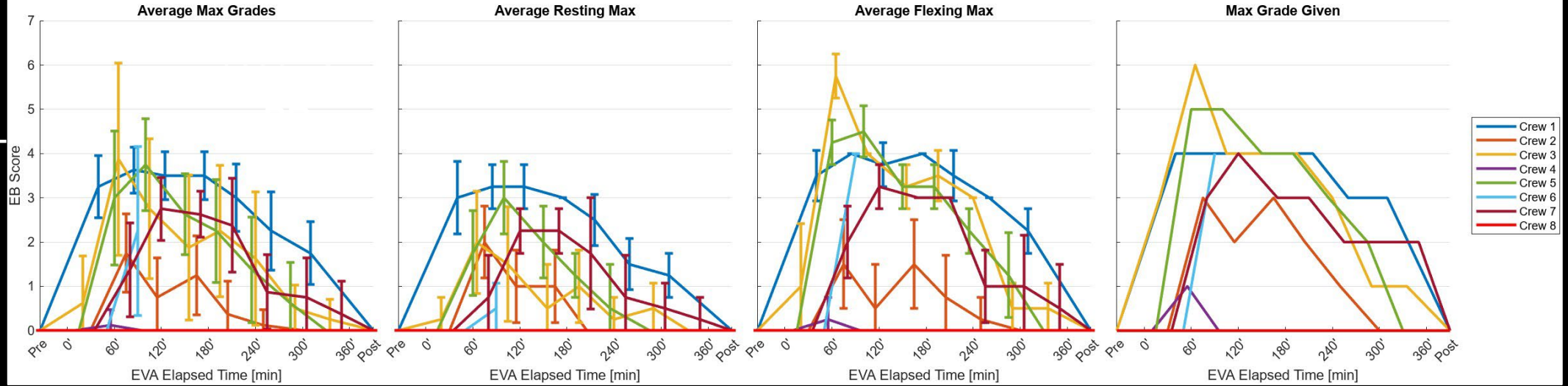
Ultrasound WEEK 1

WEEK
2

Ultrasound WEEK 2

EVA1

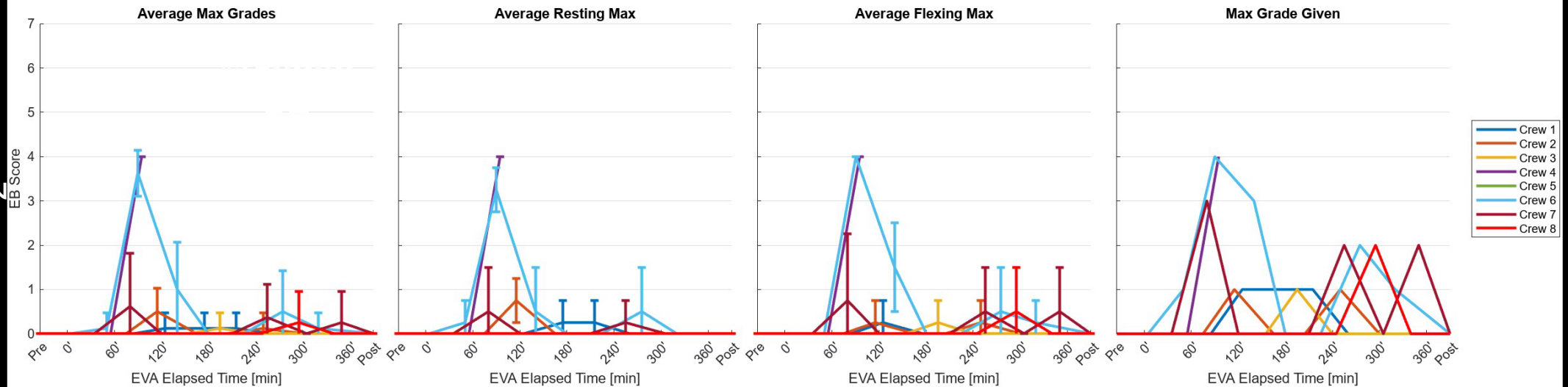
WEEK 1



120min
PR

WEEK 2

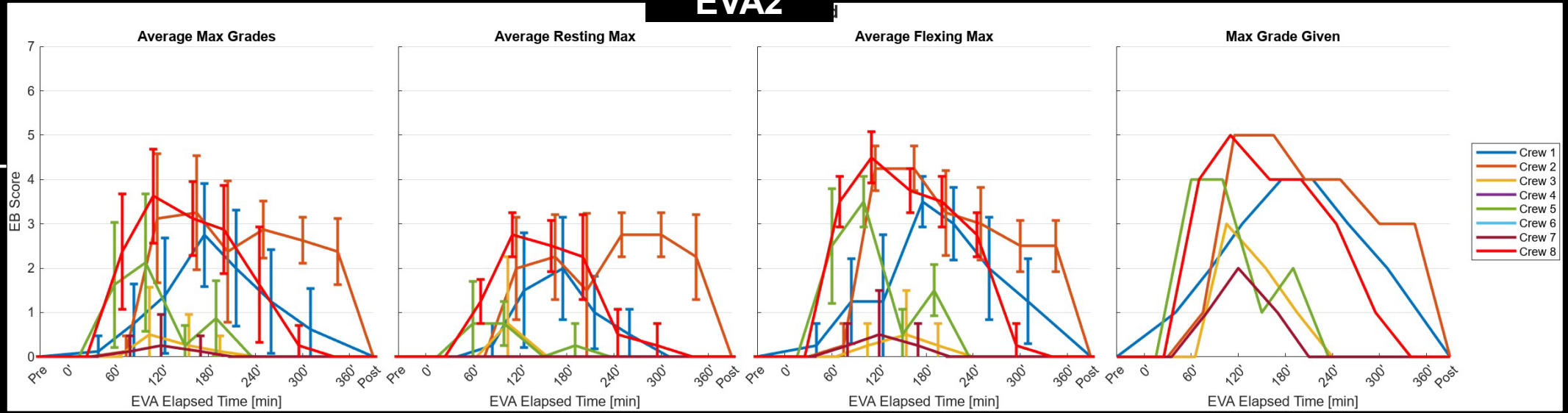
EA-6 TD03 Ultrasound



150min
PR

EVA2

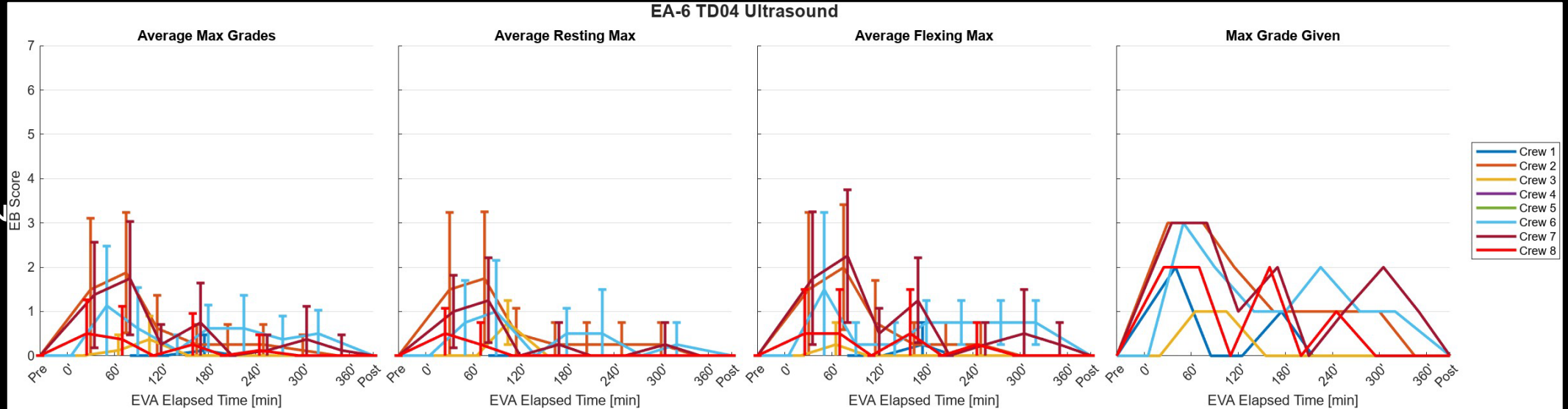
WEEK 1



150min
PR

WEEK 2

EA-6 TD04 Ultrasound

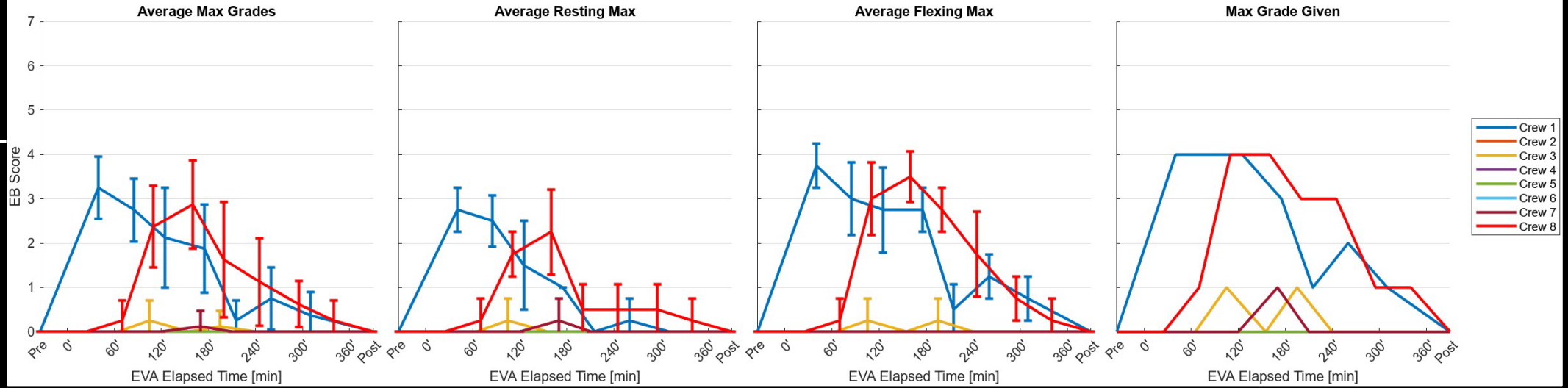


150min
PR

EVA3

WEEK 1

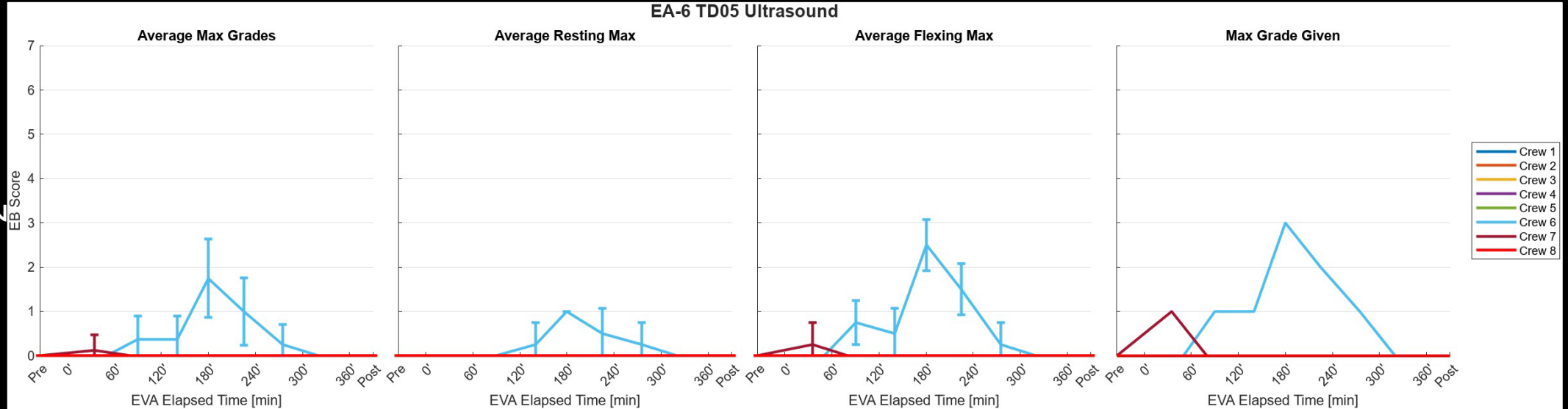
1



150min
PR

WEEK 2

2



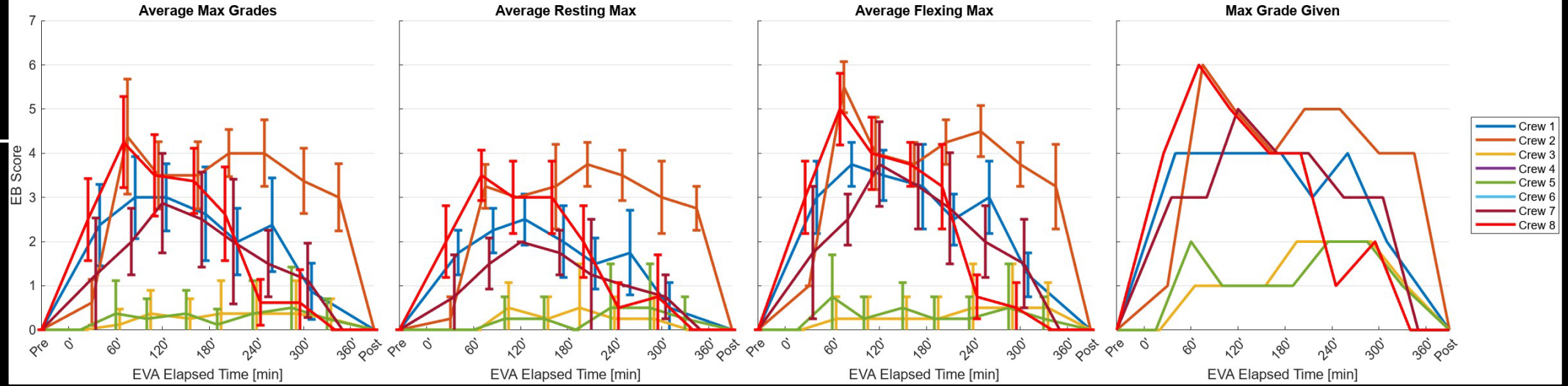
150min
PR

EA-6 TD05 Ultrasound

EVA4

WEEK 1

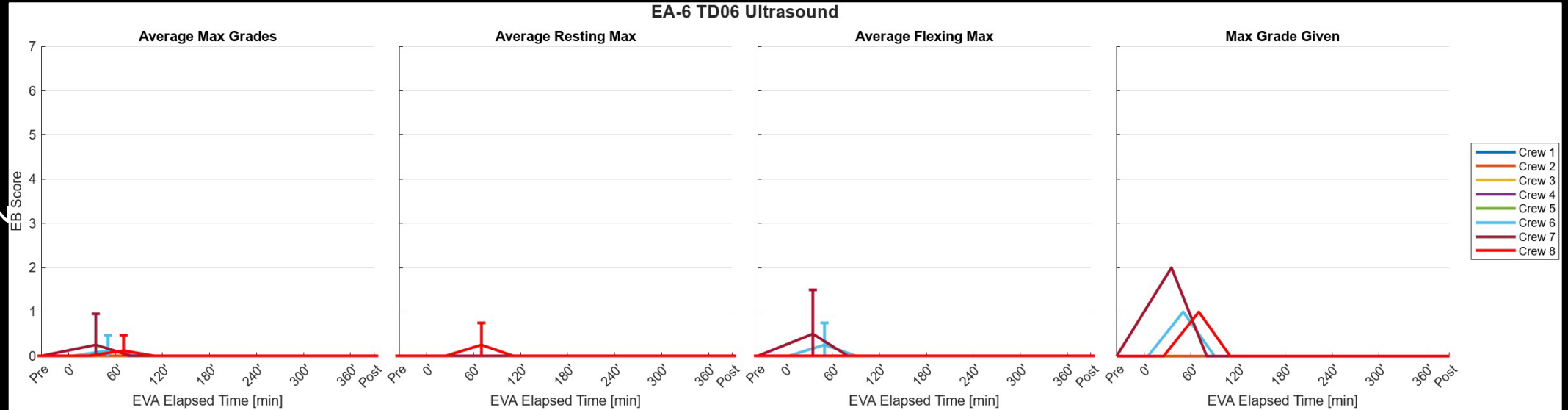
1



150min
PR

WEEK 2

2

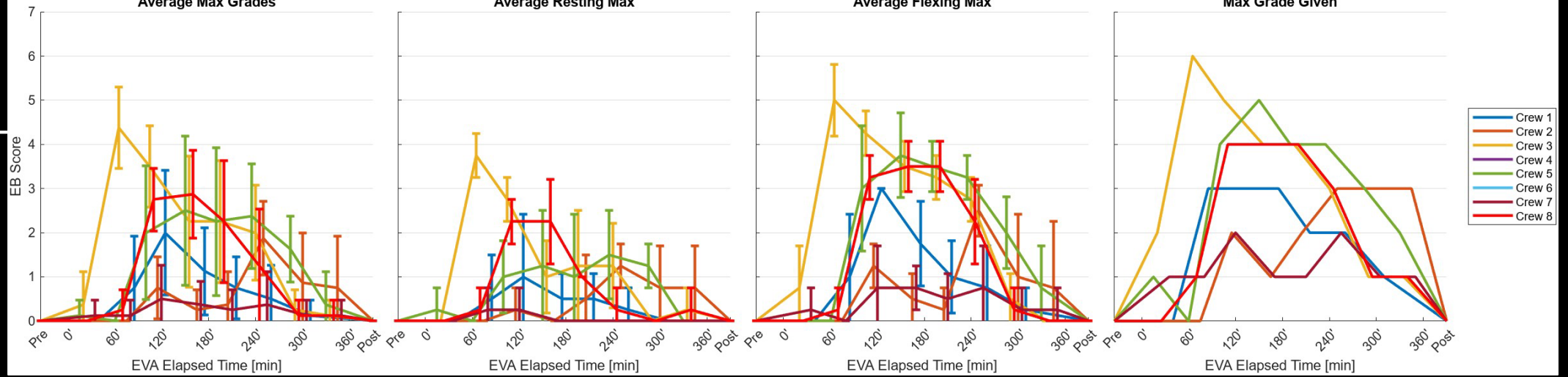


150min
PR

EA-6 TD06 Ultrasound

EVA5

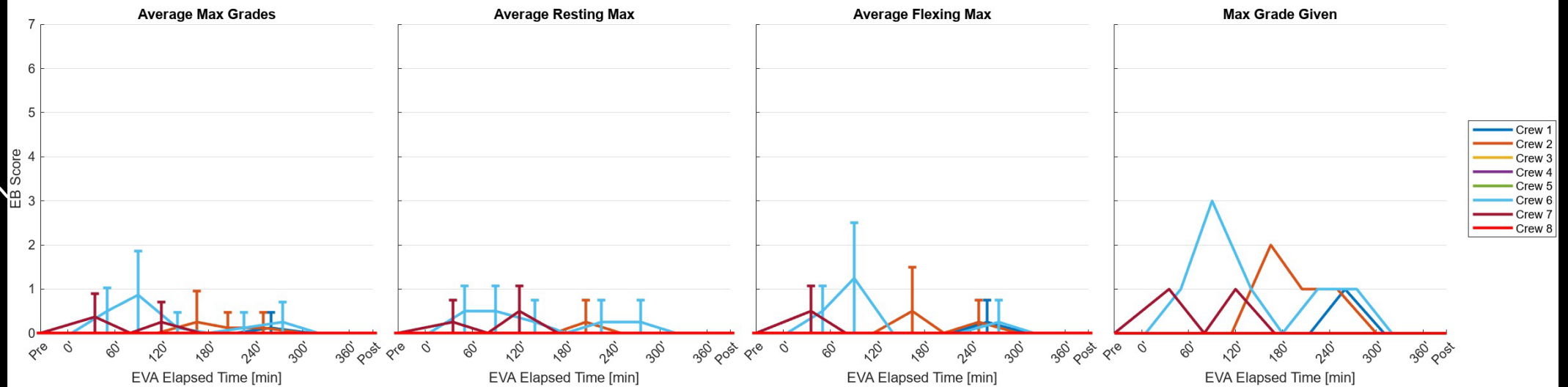
WEEK 1



150min
PR

EA-6 TD07 Ultrasound

WEEK 2



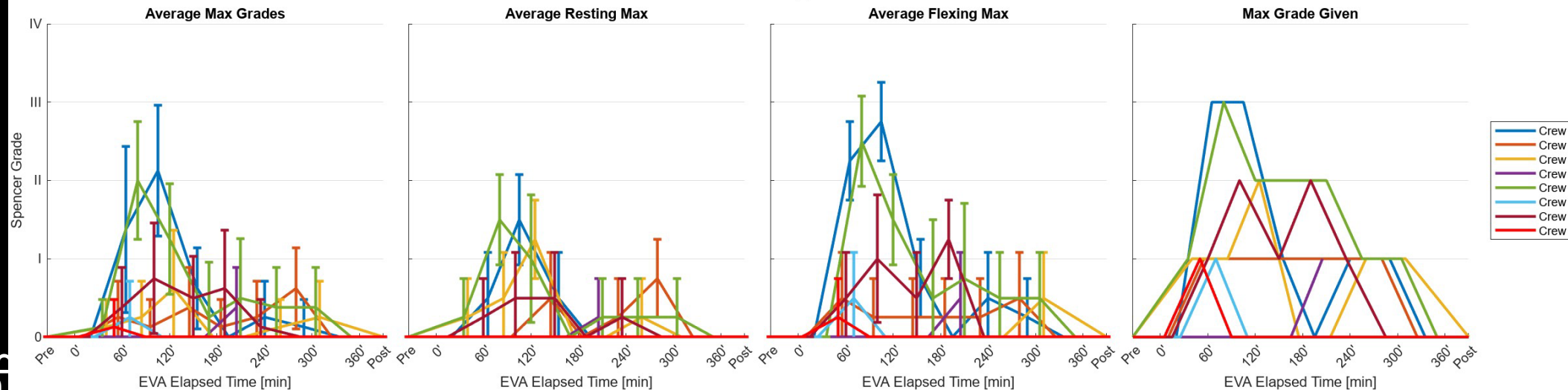
150min
PR

Doppler WEEK 1

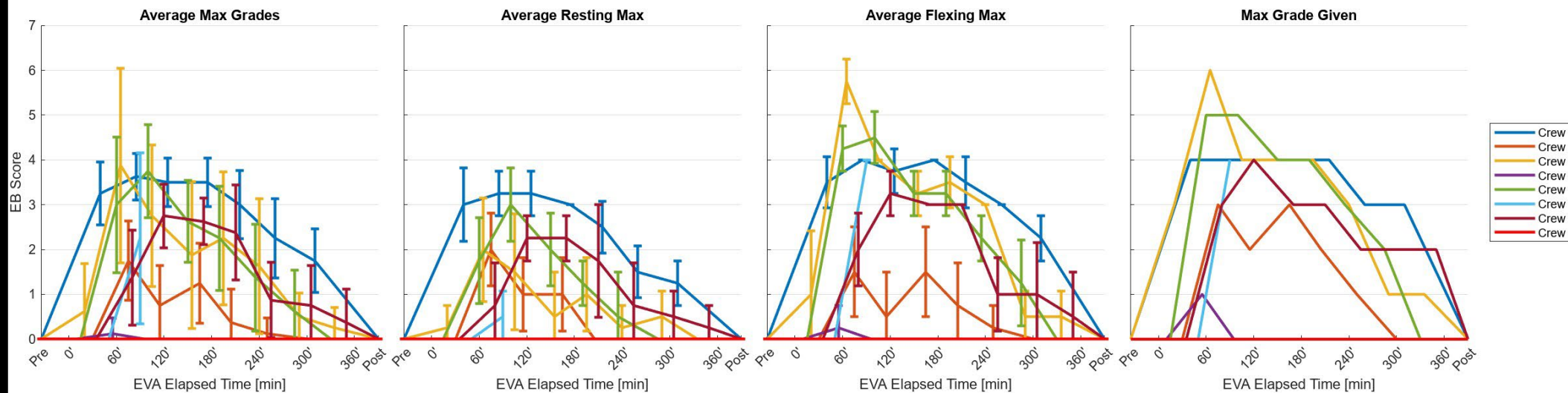
Ultrasound WEEK 1

120min
PB

EA-6 TD03 Doppler

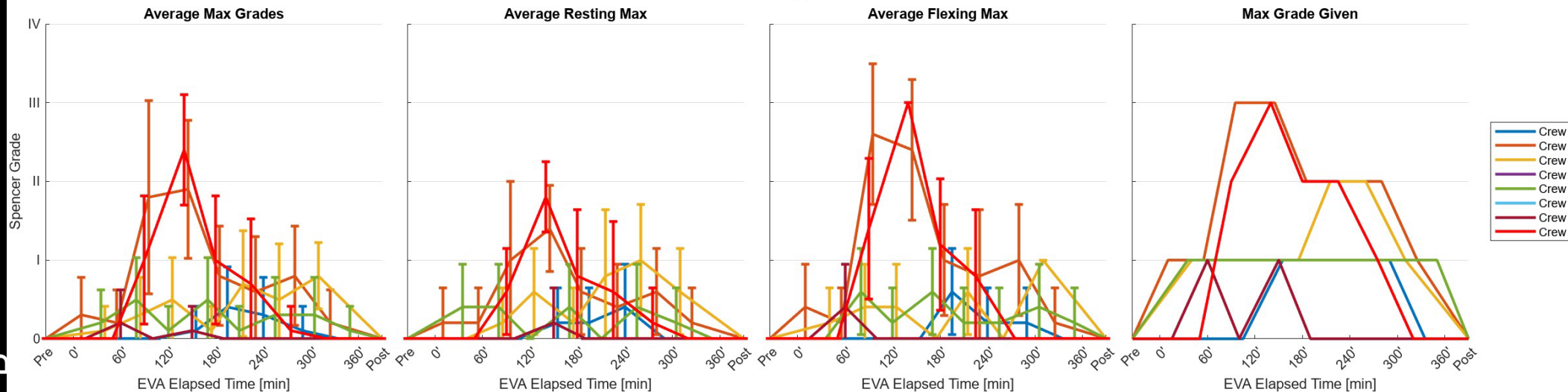


EA-6 TD03 Ultrasound

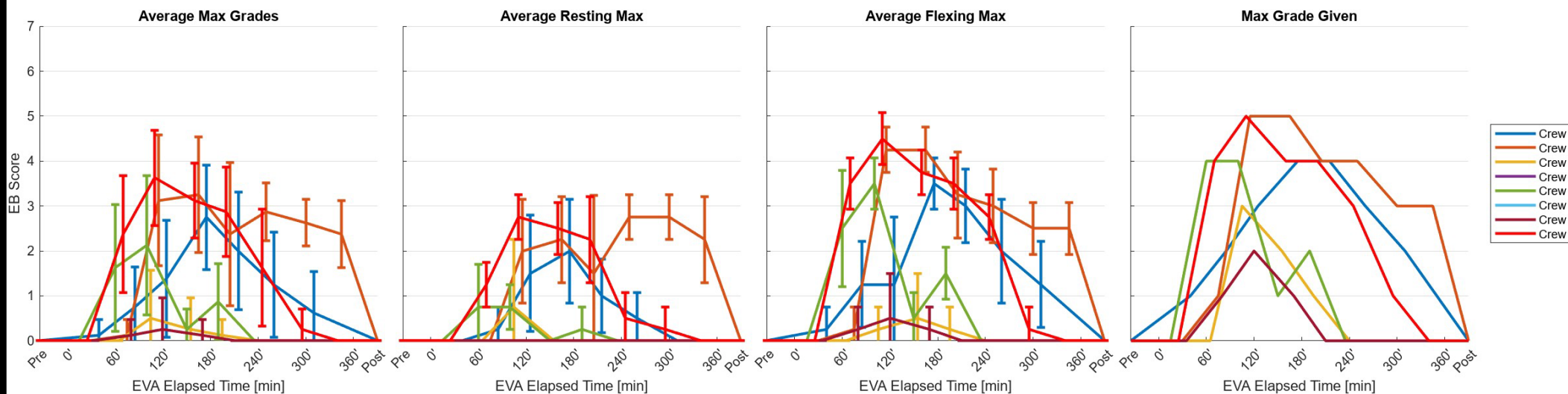


150min
PB

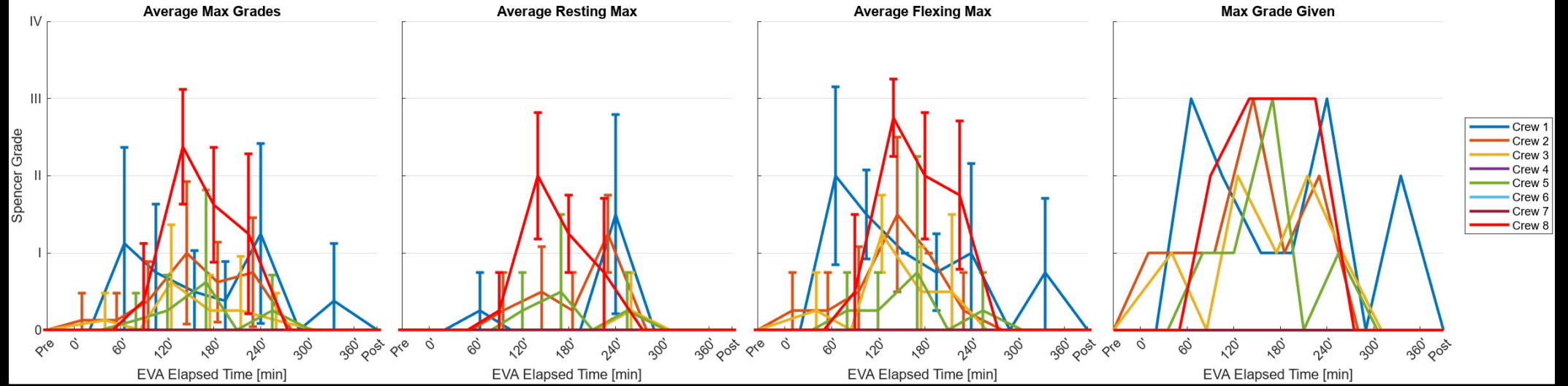
EA-6 TD04 Doppler



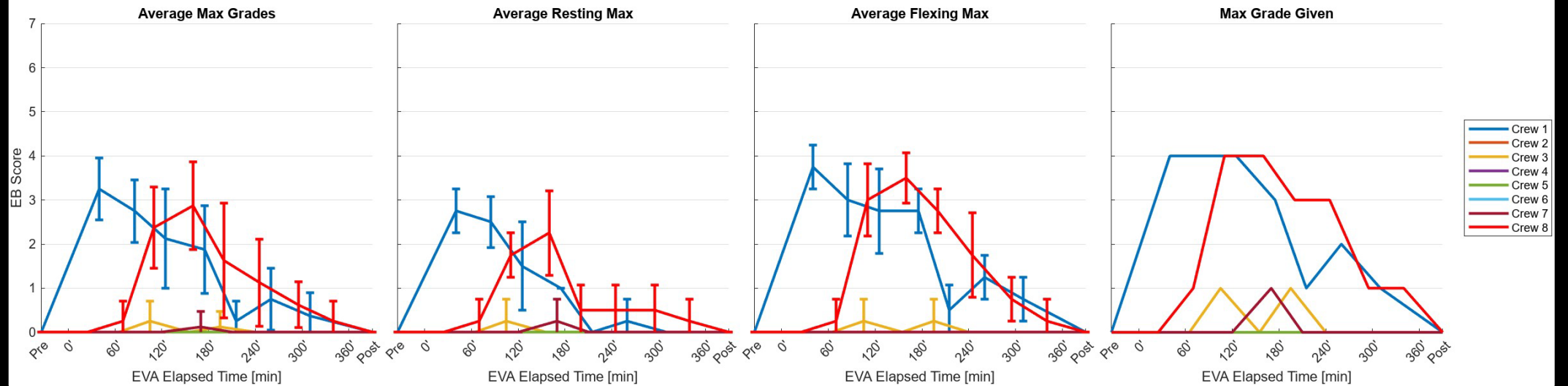
EA-6 TD04 Ultrasound



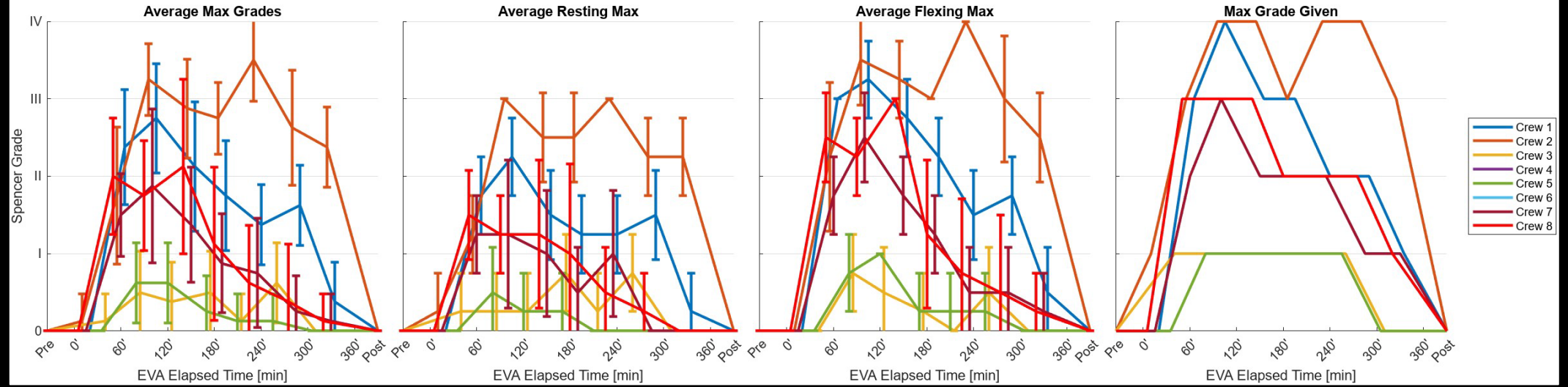
EA-6 TD05 Doppler



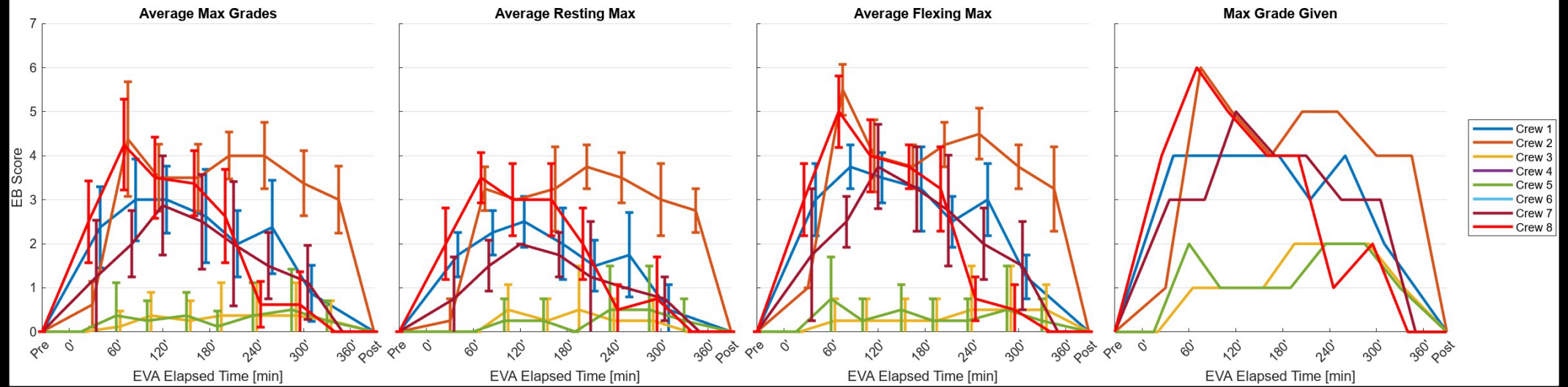
EA-6 TD05 Ultrasound



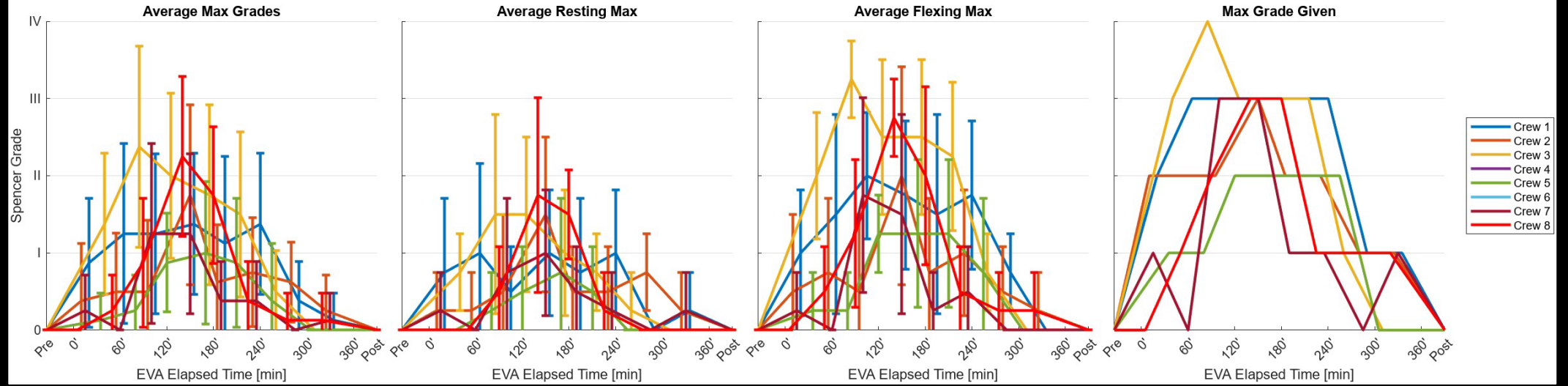
EA-6 TD06 Doppler



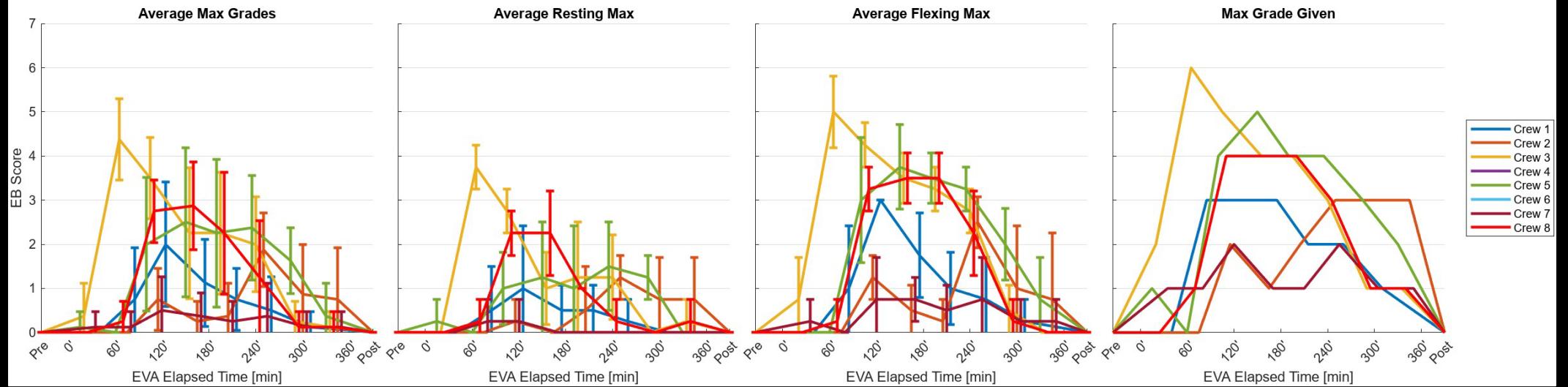
EA-6 TD06 Ultrasound



EA-6 TD07 Doppler



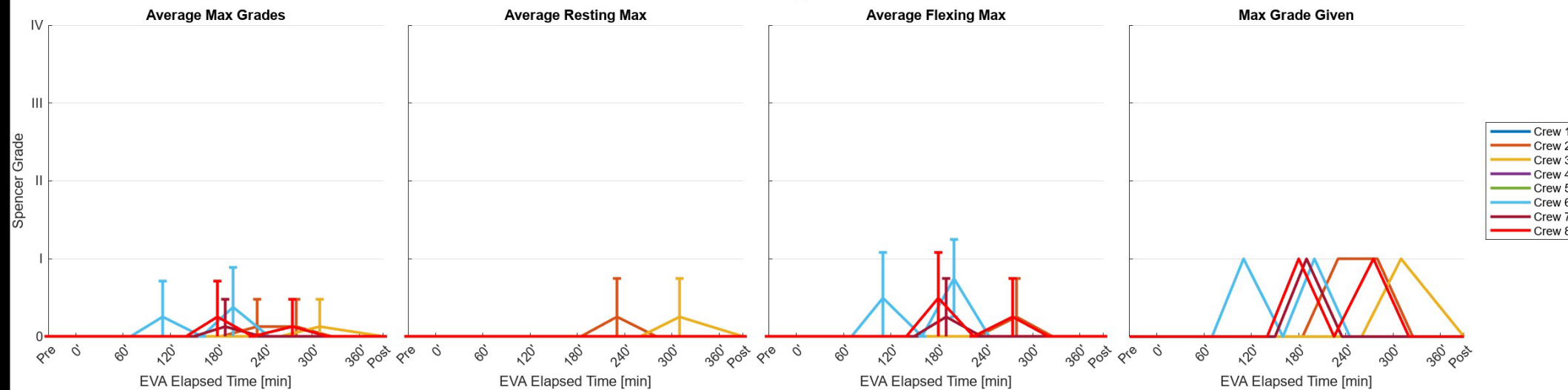
EA-6 TD07 Ultrasound



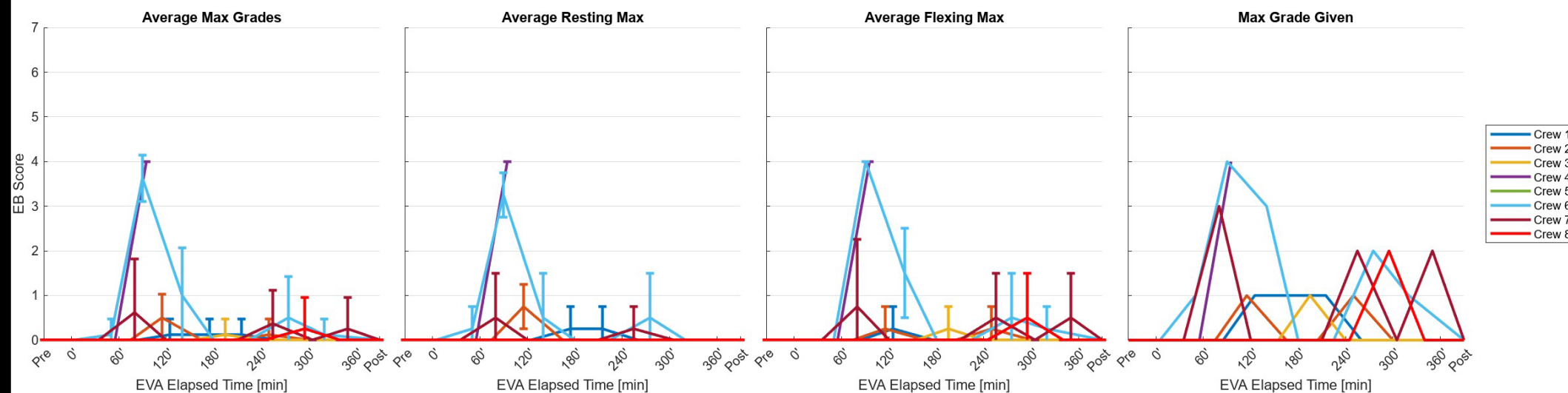
Doppler WEEK 2

Ultrasound WEEK 2

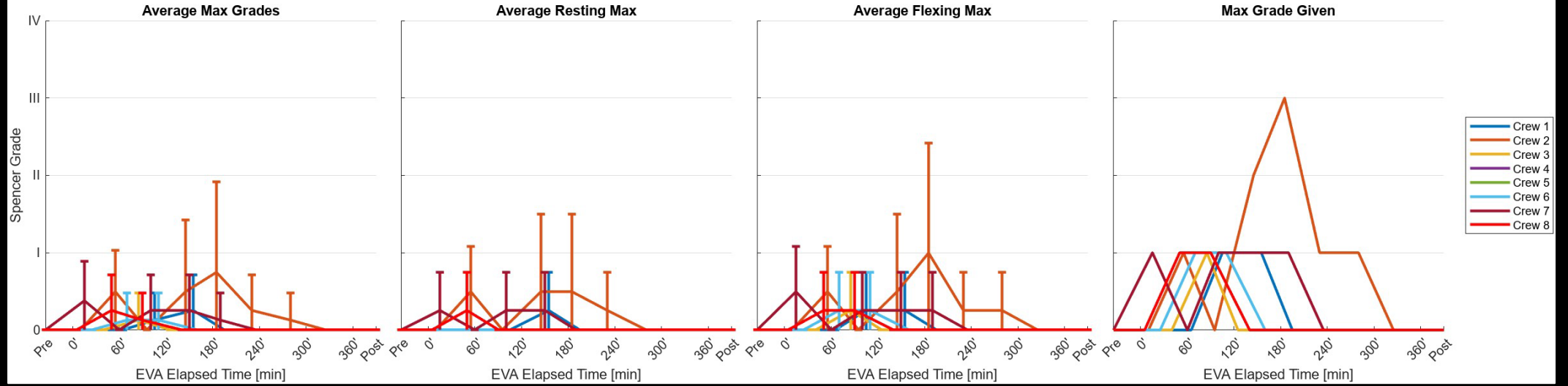
EA-6 TD03 Doppler



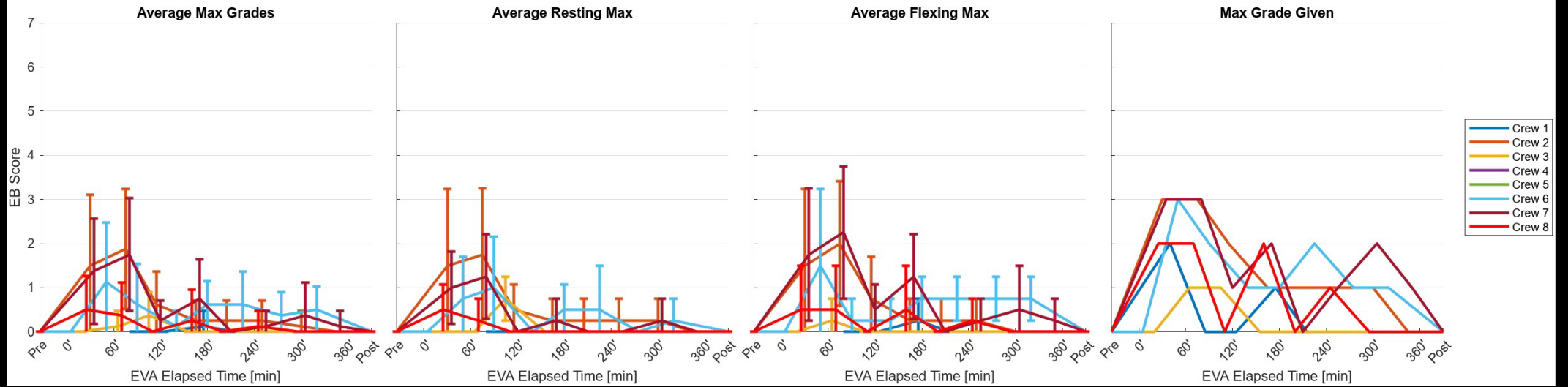
EA-6 TD03 Ultrasound



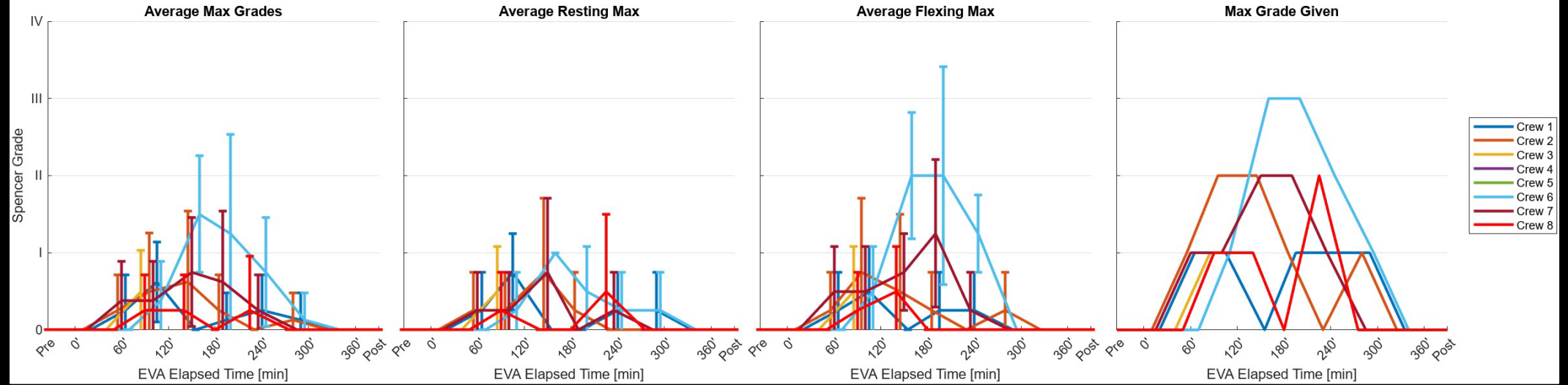
EA-6 TD04 Doppler



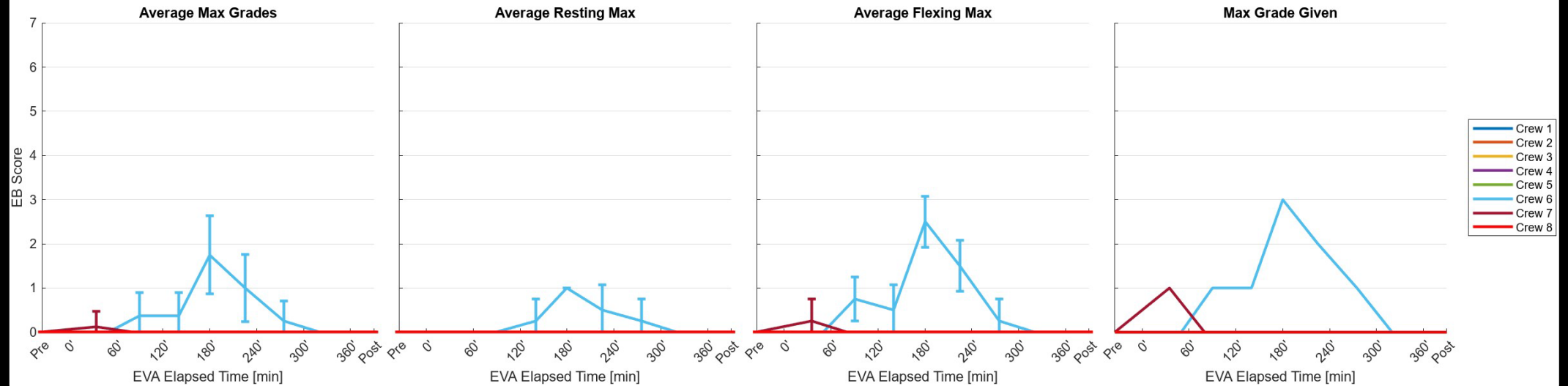
EA-6 TD04 Ultrasound



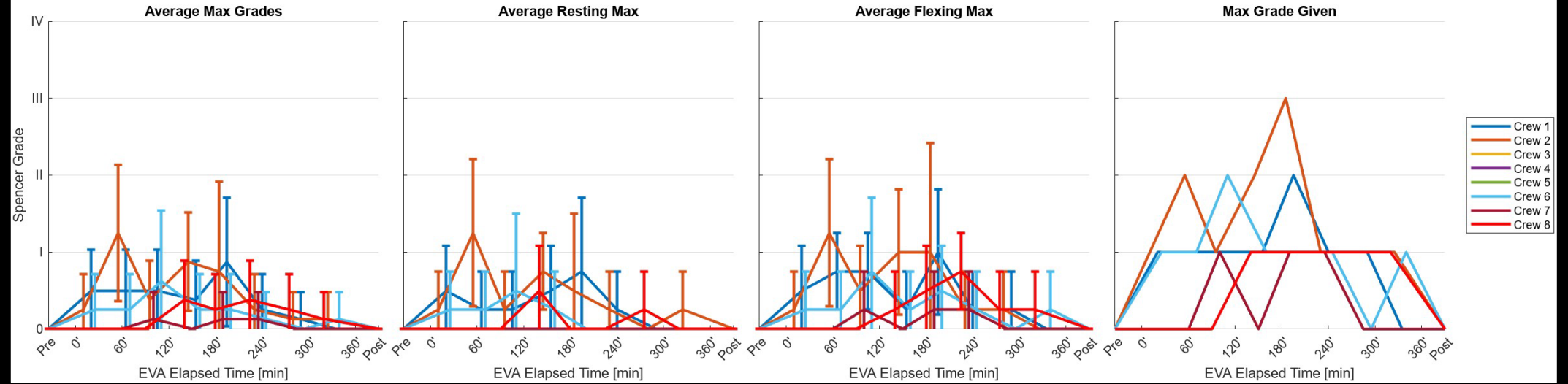
EA-6 TD05 Doppler



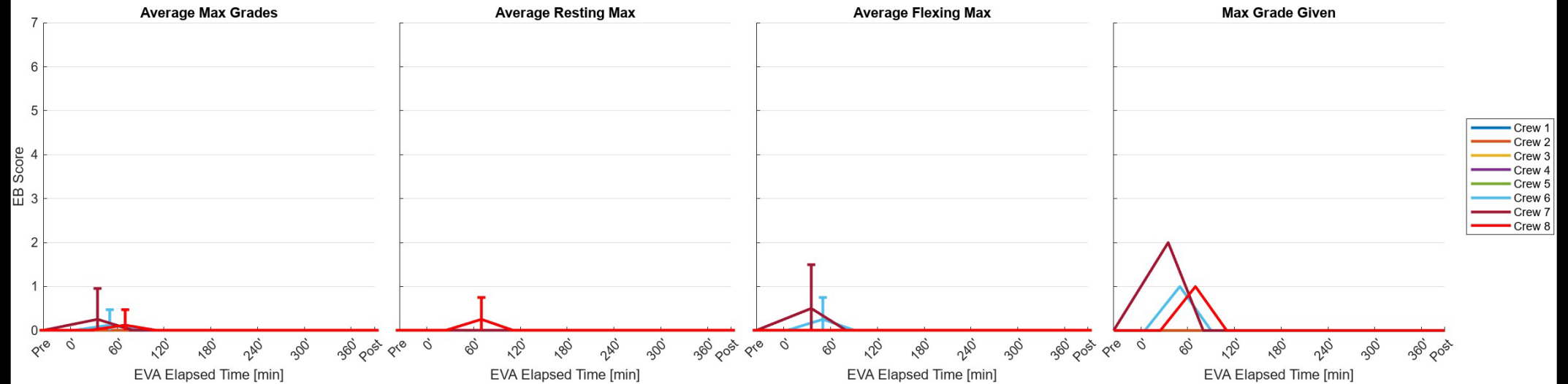
EA-6 TD05 Ultrasound



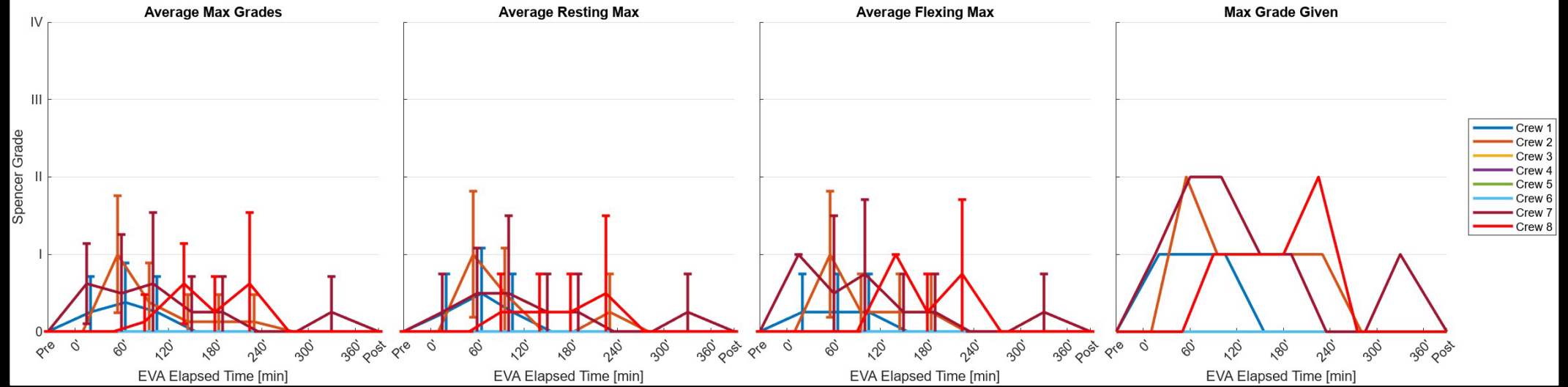
EA-6 TD06 Doppler



EA-6 TD06 Ultrasound



EA-6 TD07 Doppler



EA-6 TD07 Ultrasound

