

A background image showing two astronauts in white space suits floating in space against a dark blue sky. The image is semi-transparent and serves as a backdrop for the text.

# **IMPACT OF SLEEP SHIFTING STRATEGIES ON THE INTERNATIONAL SPACE STATION**

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# Sleep on the ISS



# Sleep on the ISS

- Crew average ~6h of sleep in space per night
- ISS schedules have become more stable: consistent bed and wake times (2130 to 0600)
- Schedules sometimes disrupted by uncontrollable operational events



## Sleep Strategies Study

**Background** Methods Results Conclusions



# WE AIMED TO:

**Characterize sleep  
shifting strategies**

**Determine when  
strategies took place**

**Compare sleep outcomes  
on nights surrounding  
operational events to all  
other nights**

**Sleep Strategies Study**

Background **Methods** Results Conclusions



# Sleep Shifting Strategy:

## splitting sleep

- **Variable effects of splitting sleep on alertness and performance:**
  - higher latency & more arousals, but lower WASO (Roach 2015)
  - same PVT lapses, differences in peak performance times (Short et al. 2015)
  - more sleep inertia (Hilditch 2016)

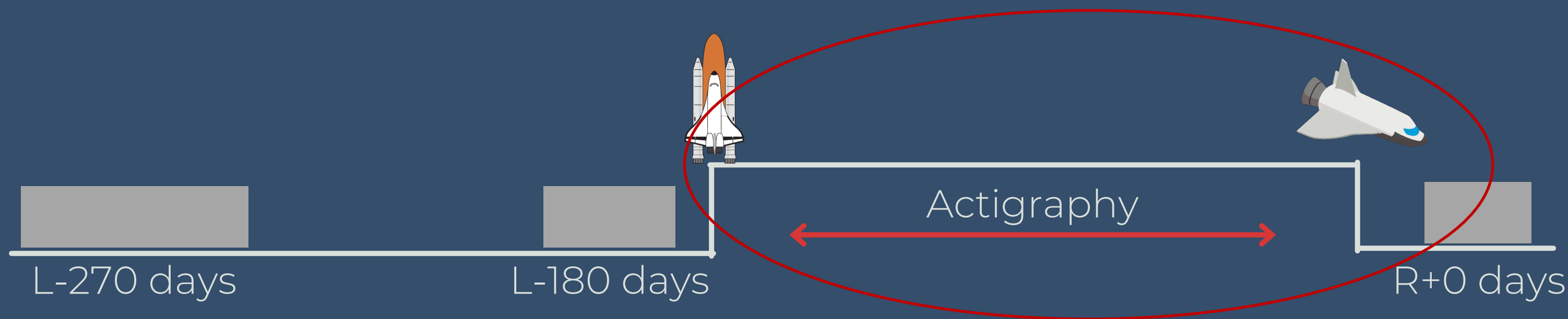
# n = 28 crewmembers on the ISS (Spaceflight Standard Measures)

[Preliminary data]

## Measures

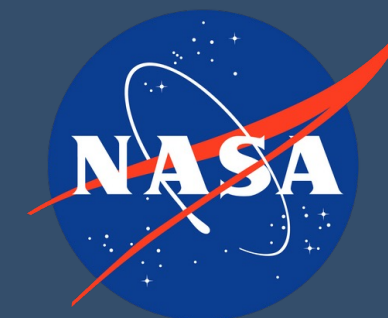
- Actigraphy
- Sleep logs (every day on the ground, monthly inflight)

- Continuous: first 9 crew collected actigraphy every day in space
- Intermittent: most recent crew wears for 2-week period every 2 months



## Sleep Strategies Study

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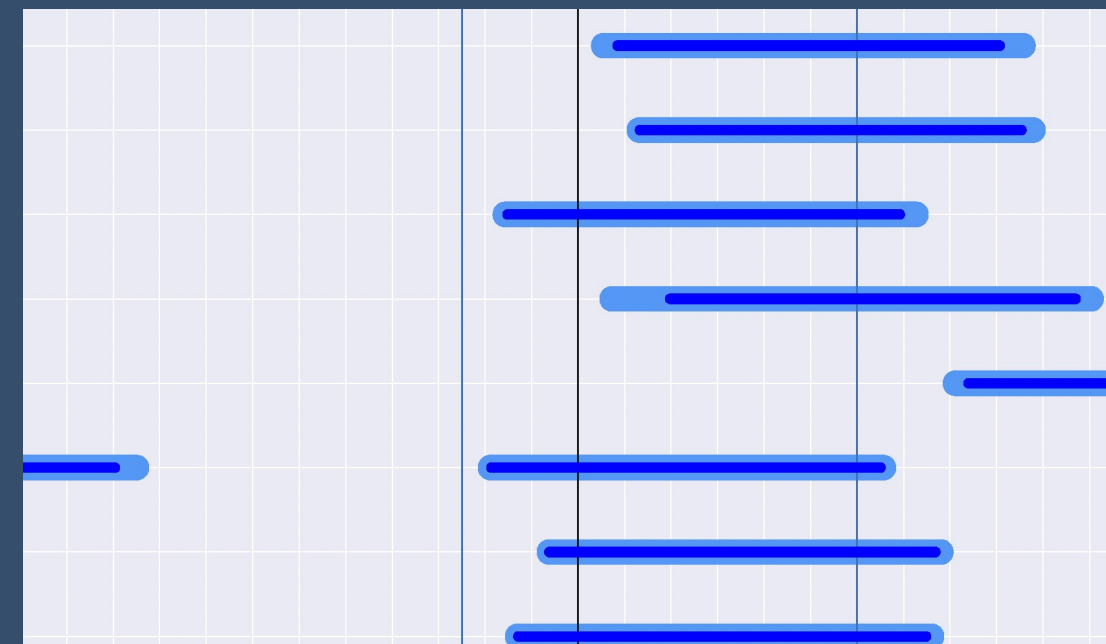
# Split sleep.

- = Splitting the daily sleep opportunity in two surrounding nominal sleep episode

# vs. Phase delay

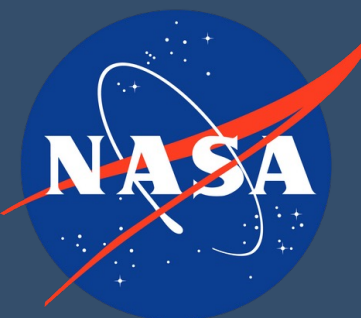


Nominal sleep opportunity

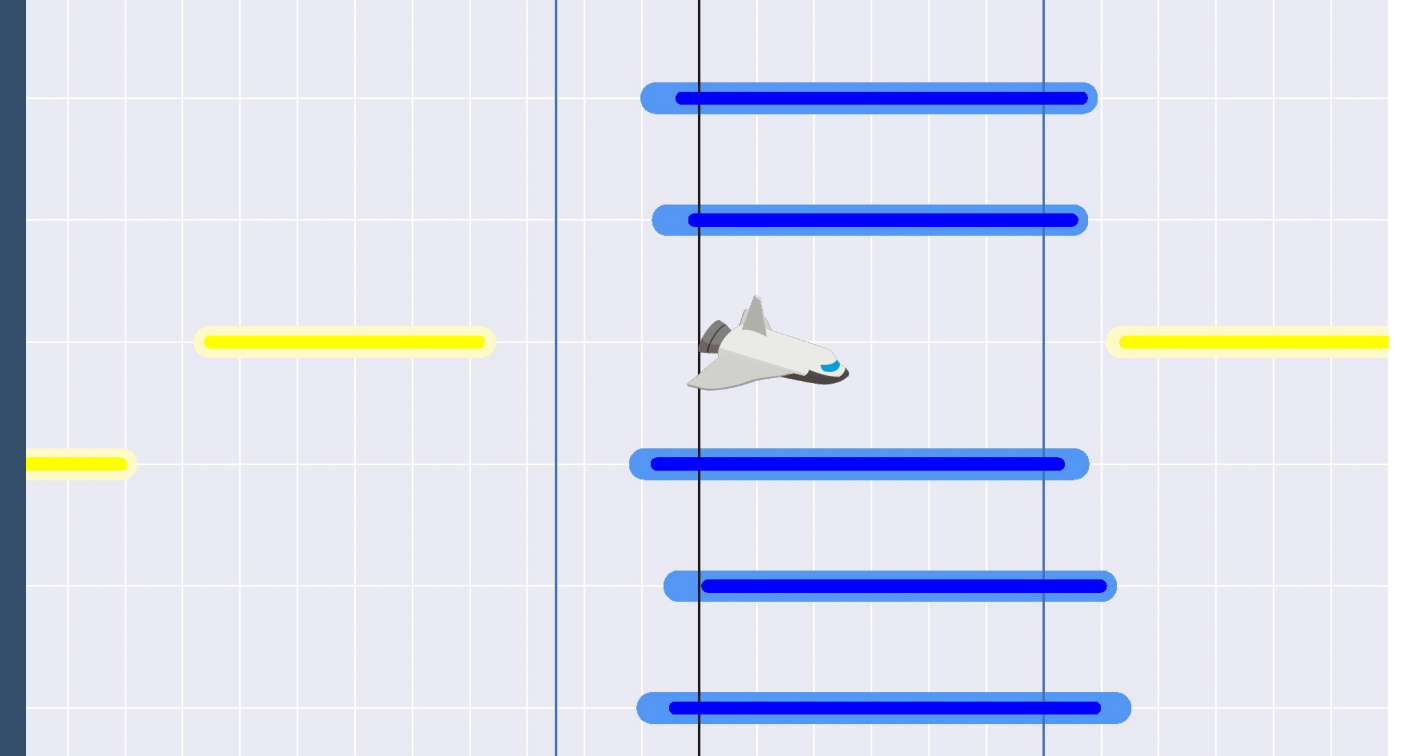
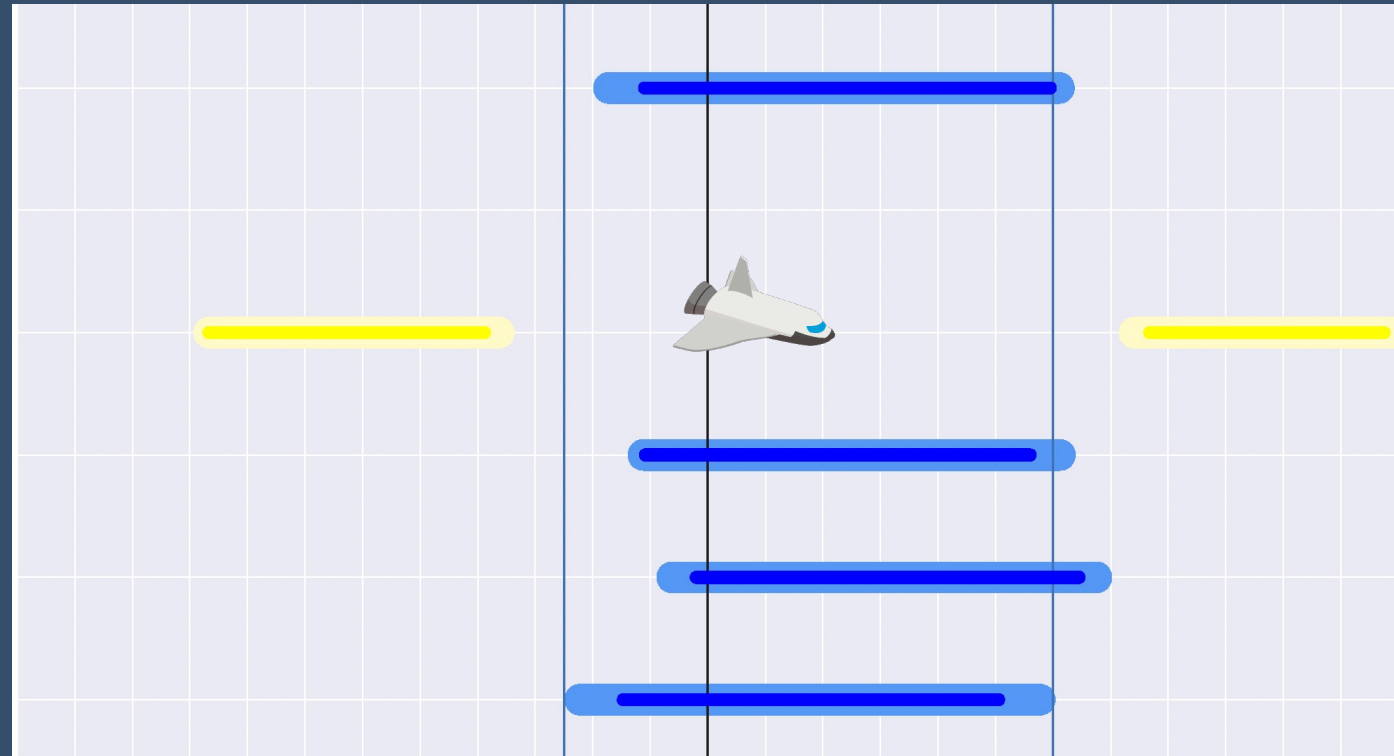


## Sleep Strategies Study

Background **Methods** Results Conclusions

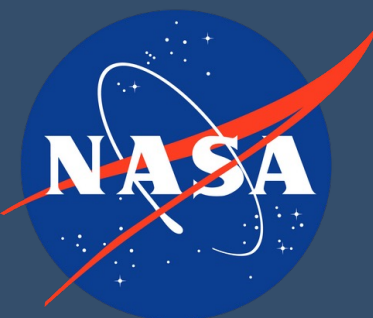


# Crew shift together



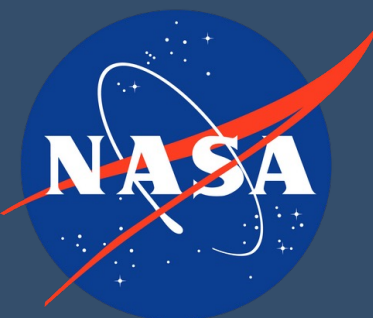
## Sleep Strategies Study

**Background** Methods Results Conclusions



# Split sleep

- 12 crew
- 17 total episodes of split sleep
- All surrounding 8 Visiting Vehicle events (Docking, Undocking, Relocation)
  - VV events occurred between 2330 and 1000 GMT

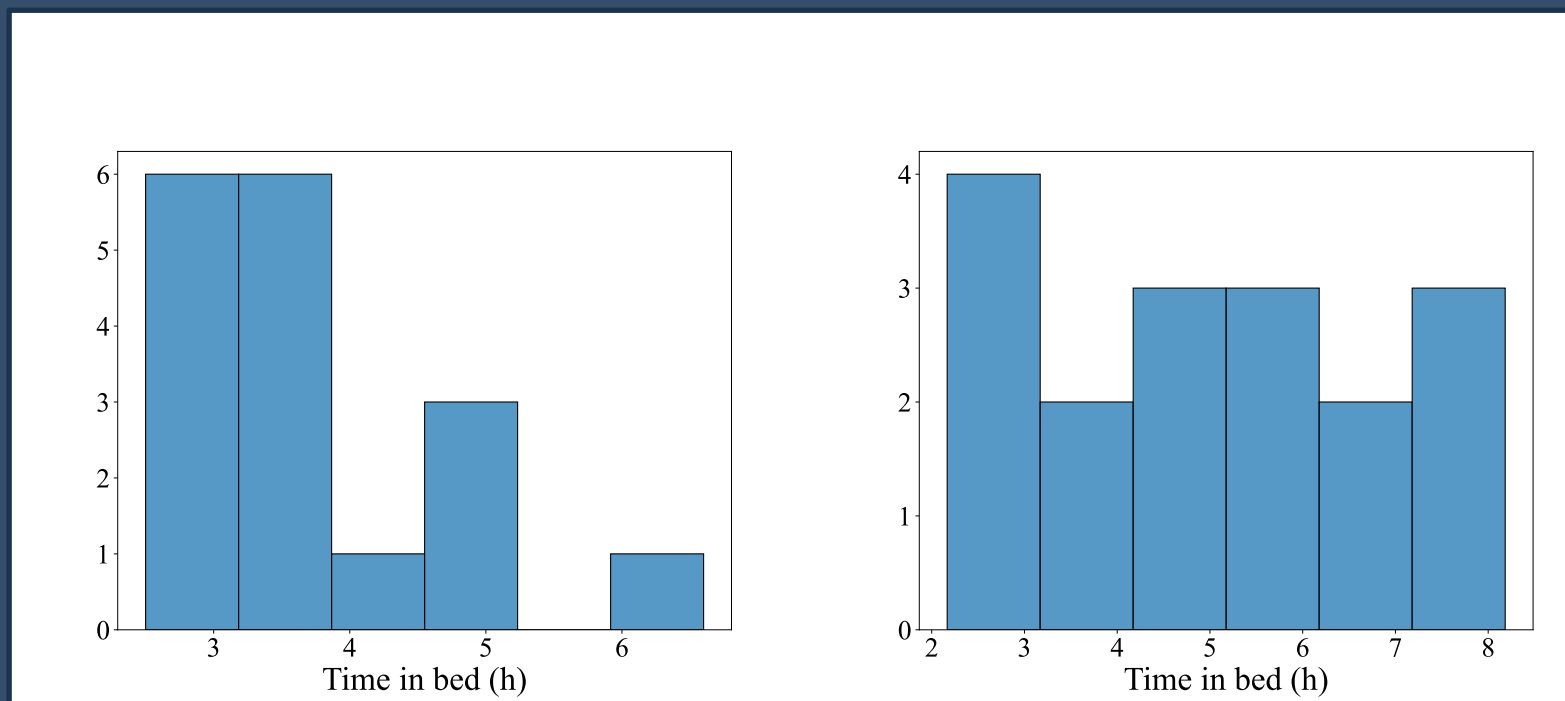


# Sleep Outcomes: split sleep

## Difference between rest phases 1 and 2

Phase 1

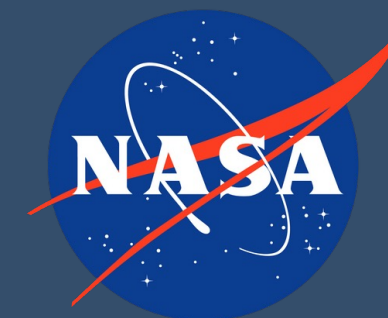
Phase 2



	Phase 1	Phase 2	Total
Time in Bed (h)	3.69 (1.05)	5.06 (1.91)	8.75 (1.98)
Efficiency %	74.53 (13.06)	81.85 (8.81)	78.19 (8.94)
WASO	19.82 (12.90)	25.41 (18.87)	45.24 (27.96)
Latency	22.18 (29.21)	11.35 (14.03)	30.26 (14.16)

## Sleep Strategies Study

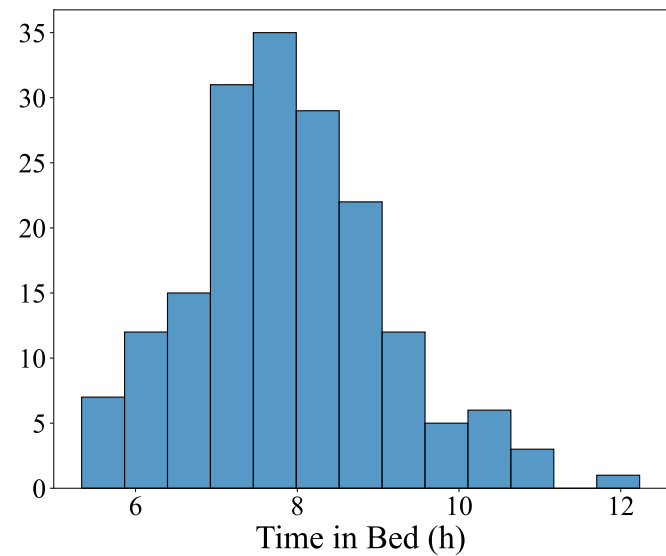
Background Methods **Results** Conclusions



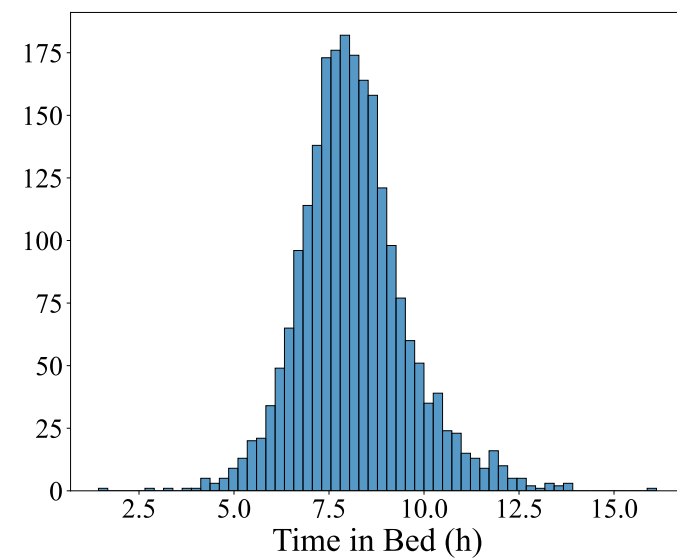
# Sleep Outcomes: all nights

## Nights after visiting vehicles

VV nights



No VV nights



	Split sleep	Other nights following VV	All other nights
N (#nights)	17	178	2216
Time in Bed (h)	<u>8.75 (1.98)</u>	7.81 (0.81)	7.96 (0.58)
Efficiency (%)	<u>78.19 (8.94)</u>	82.93 (6.23)	82.38 (4.28)
WASO (min)	45.24 (27.96)	37.46 (18.20)	36.03 (10.69)
Latency	33.53 (35.54)	24.19 (20.45)	30.26 (14.16)

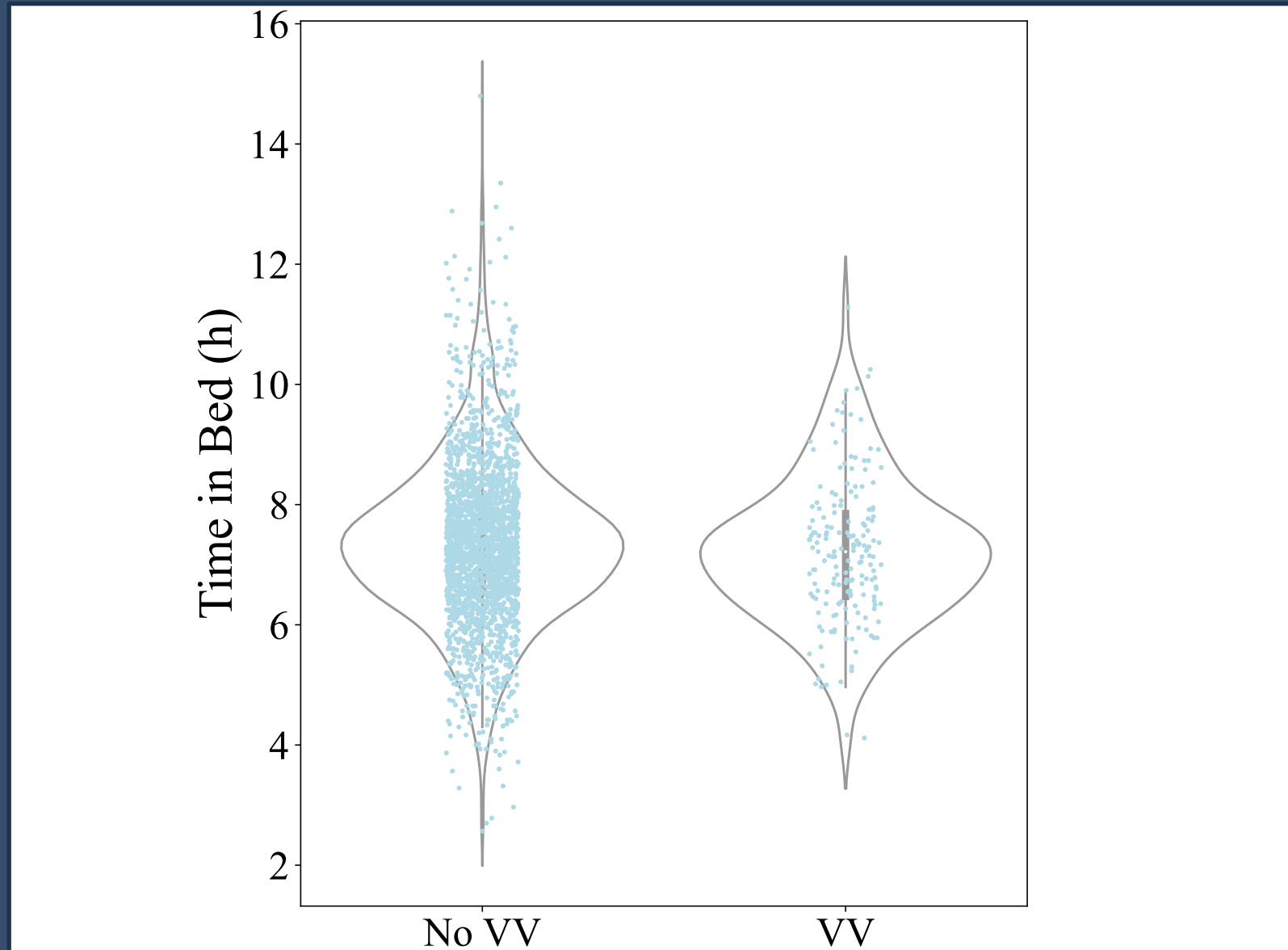
## Sleep Strategies Study

Background Methods **Results** Conclusions



# Sleep Outcomes: all nights

## Nights after visiting vehicles



	Other nights following VVs	All other nights
N (#nights)	178	2216
Time in Bed (h)	7.81 (0.81)	7.96 (0.58)
Start Time	23.59 (2.08)	23.12 (0.86)
End Time	7.47 (1.51)	7.11 (0.83)

## Sleep Strategies Study

Background Methods **Results** Conclusions



# Conclusions

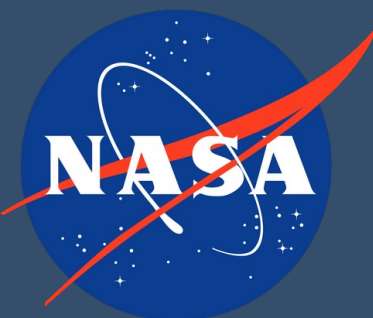
[Preliminary data]

## SLEEP DURATION IS MAINTAINED

- Taking a nap before and after a visiting vehicle arrival during the nominal sleep opportunity did not result in reduced sleep
- Nights following VV events had later sleep and wake times

## LIMITATIONS

- Only 17 split sleep episodes
- Relying on limited data – because of current intermittent actigraphy, less sleep data from nights of events



# Future directions

## ASSESS EVENTS

- Timing of VV dock and undock
- Whole period VV is docked
- Location of sleep (e.g., when excess crew are on station)

## COUNTERMEASURES

- Use of hypnotics
- Quantify impact of sleep stations

## EVA<sub>s</sub>

- Limited caffeine
- IVA role also important

# NASA AMES

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# THANK YOU!

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