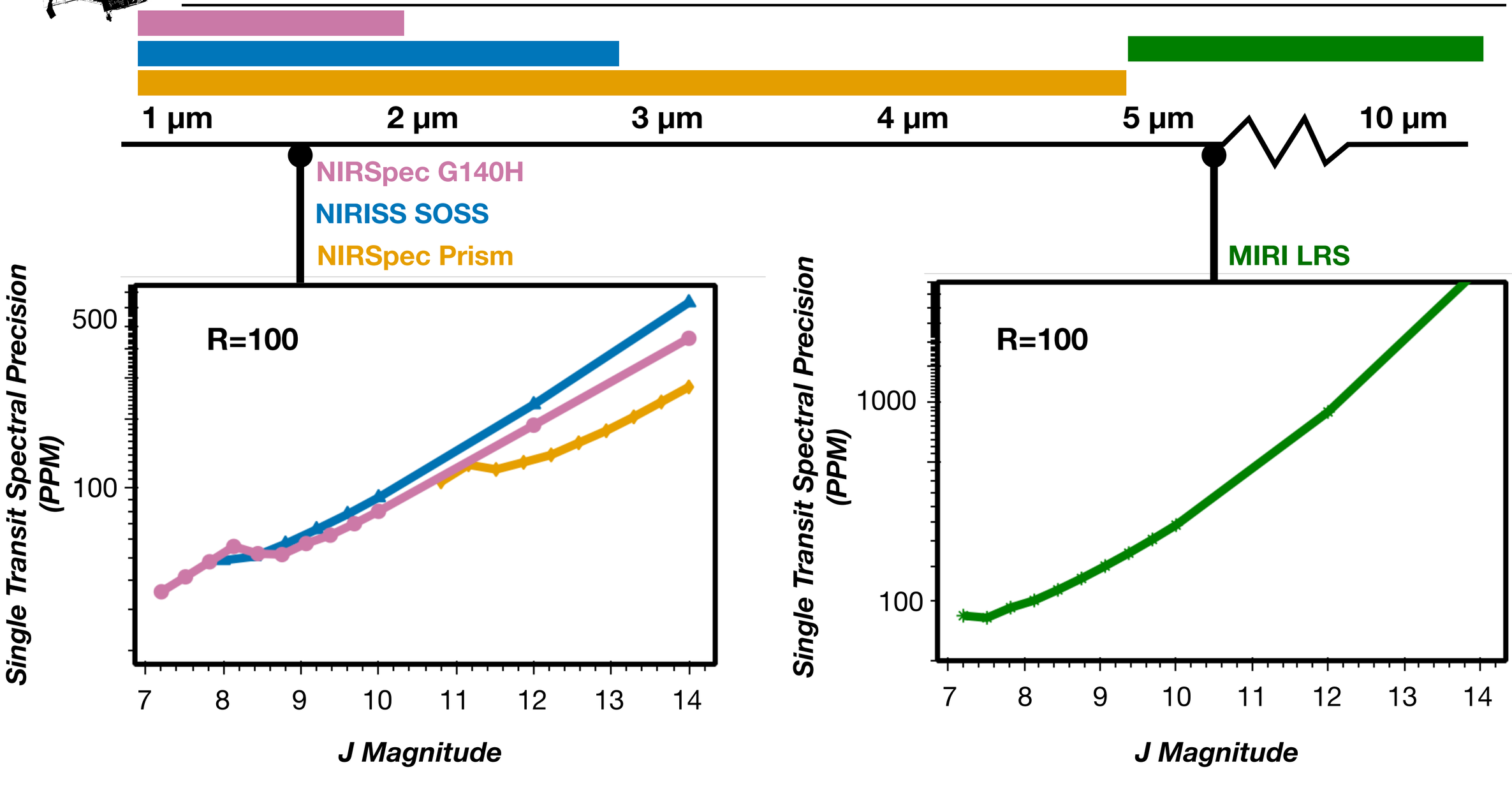
Observing Small Planets with JWST: Capabilities and Challenges

Natasha Batalha - ExoPAG

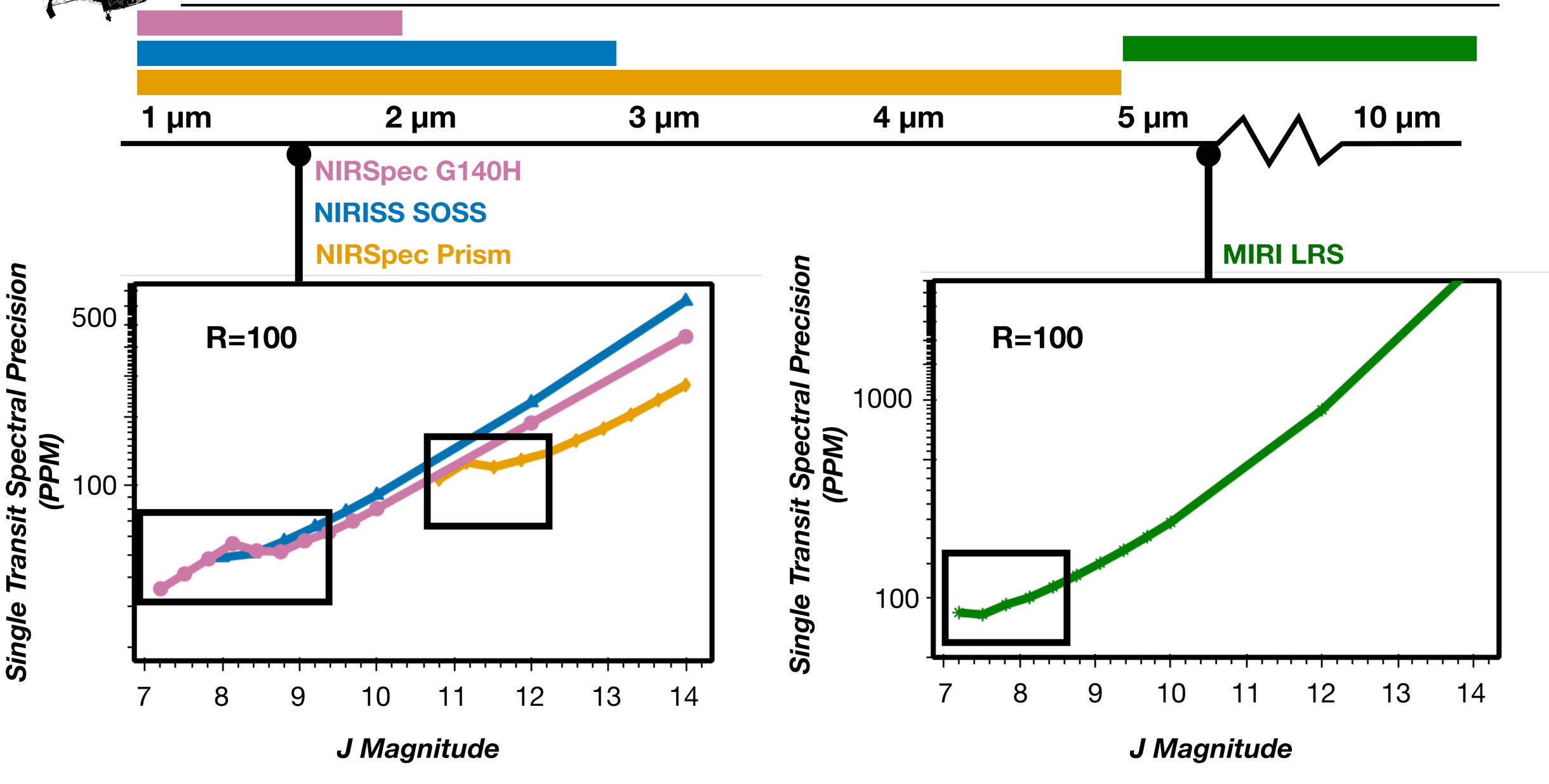
Capabilities and Challenges:

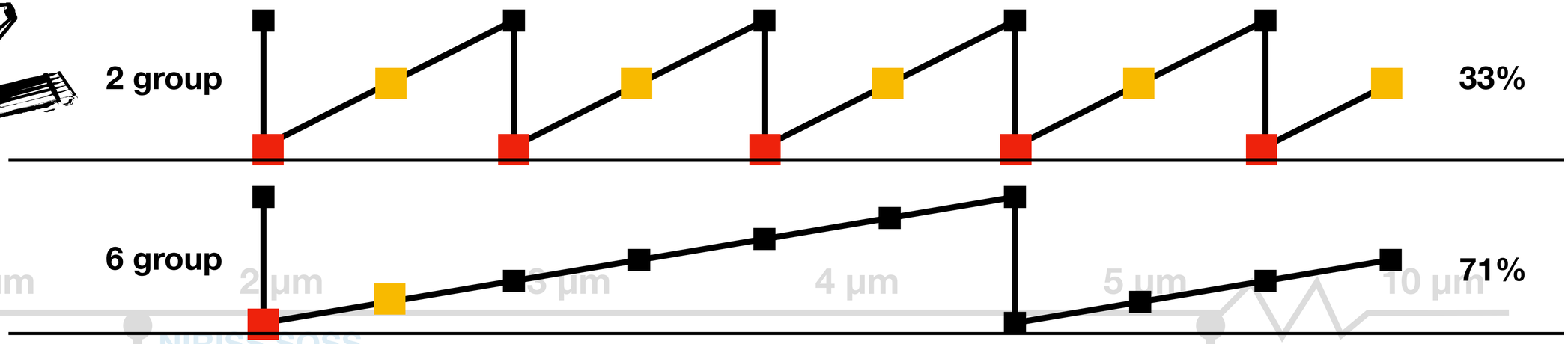
1. Attaining high precision
2. Detecting molecules
3. Constraining composition

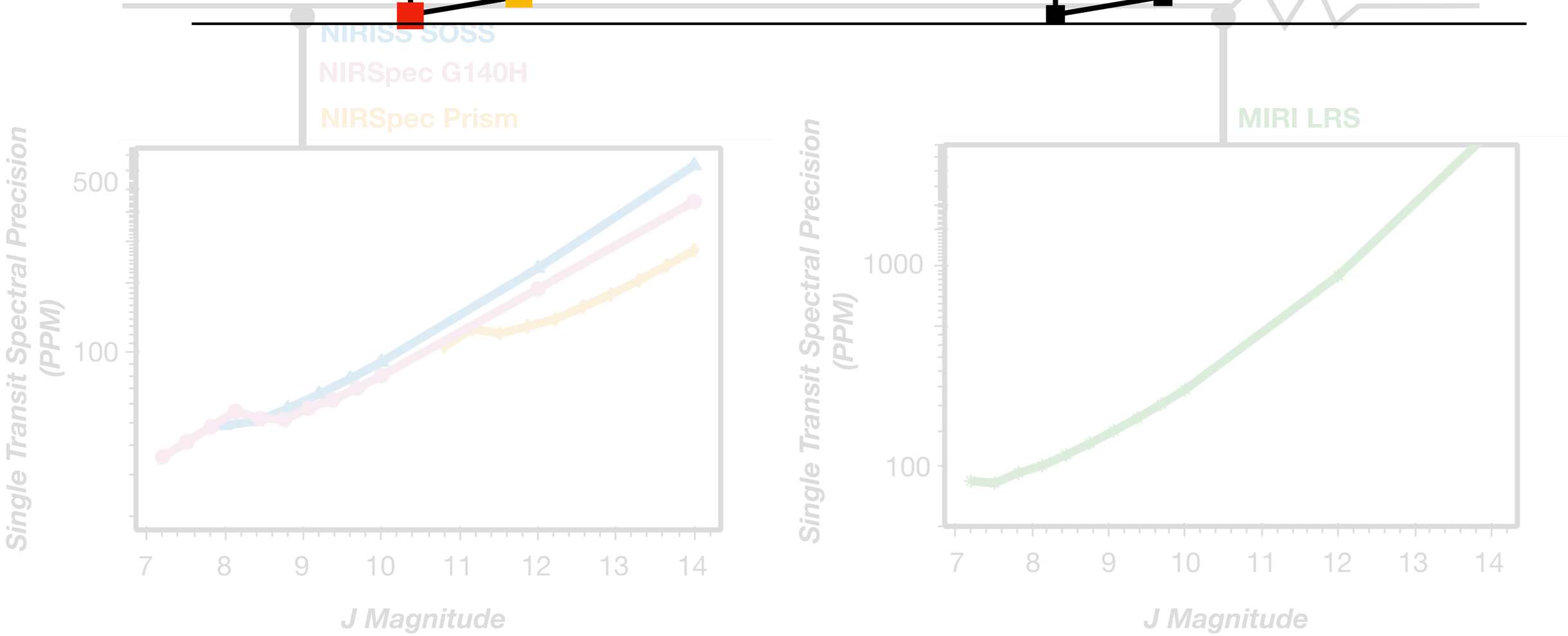
Attaining high precision over maximum wavelength



Attaining high precision over maximum wavelength




2 group
33%
6 group
71%


1 µm
2 µm
3 µm
4 µm
5 µm
10 µm
NIRISS SOSS
NIRSpec G140H
NIRSpec Prism
MIRI LRS
Single Transit Spectral Precision (PPM)
500
100
7
8
9
10
11
12
13
14
J Magnitude
Single Transit Spectral Precision (PPM)
1000
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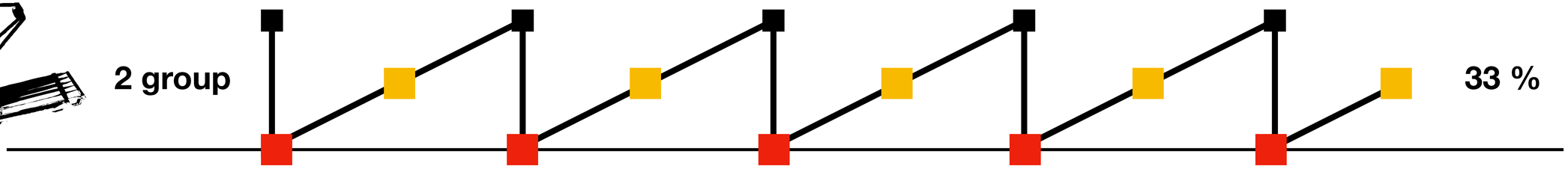
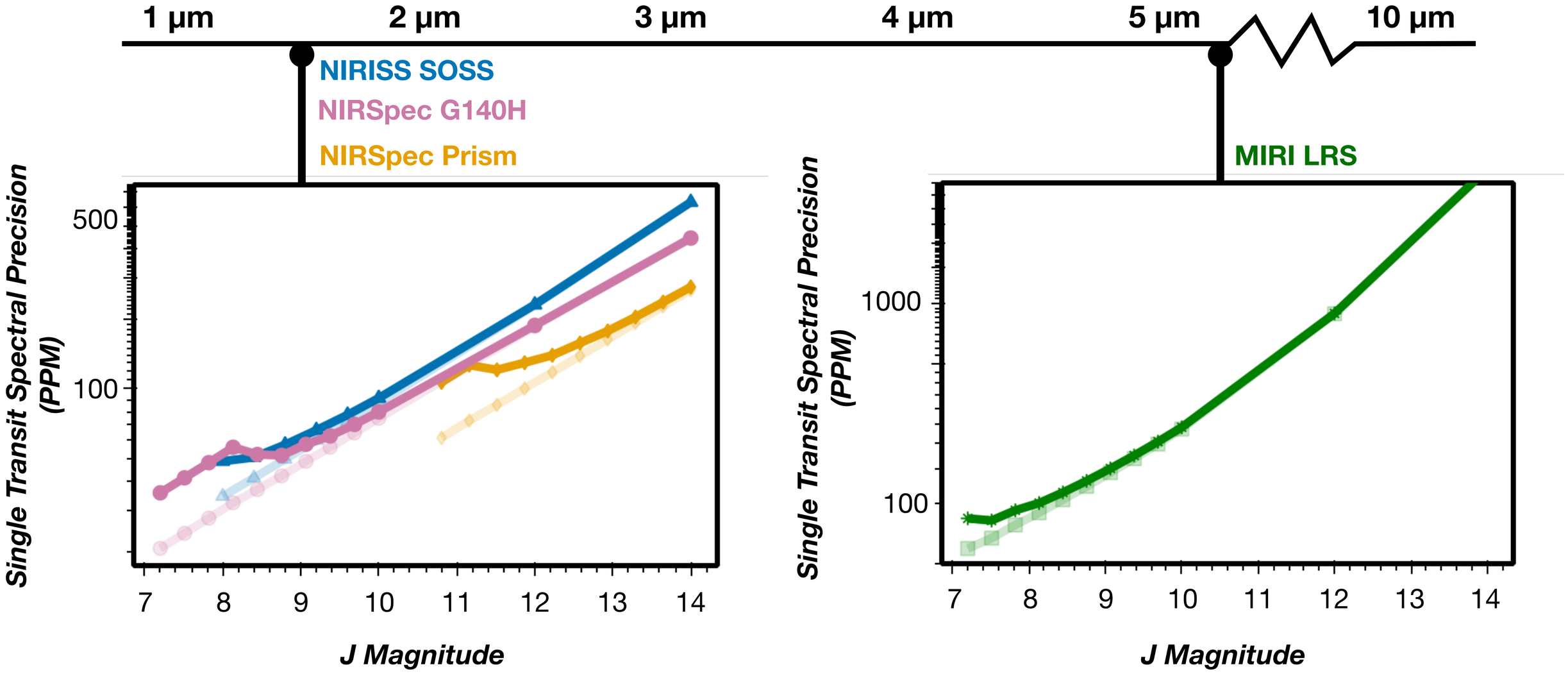
14
J Magnitude


2 group
33 %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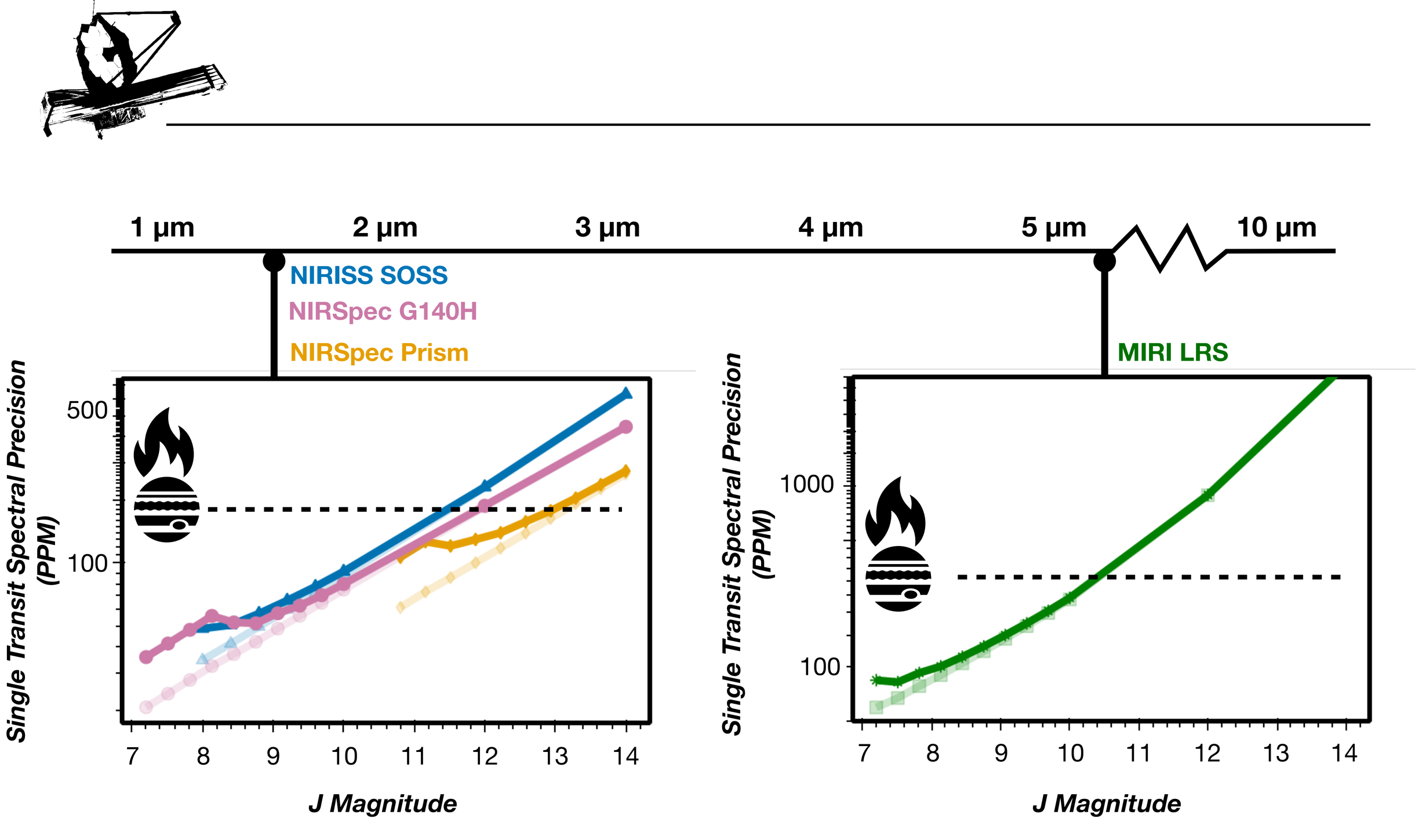
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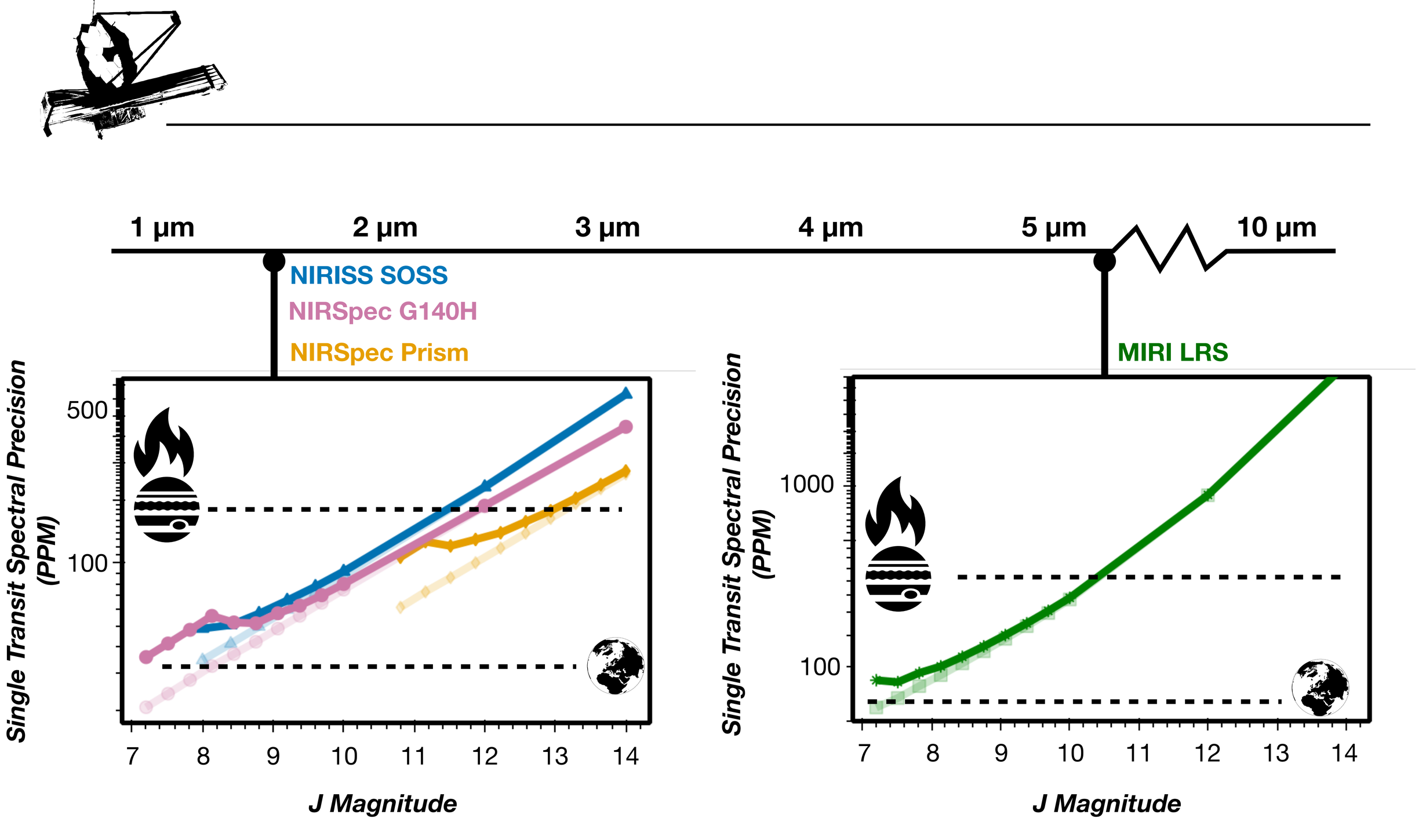
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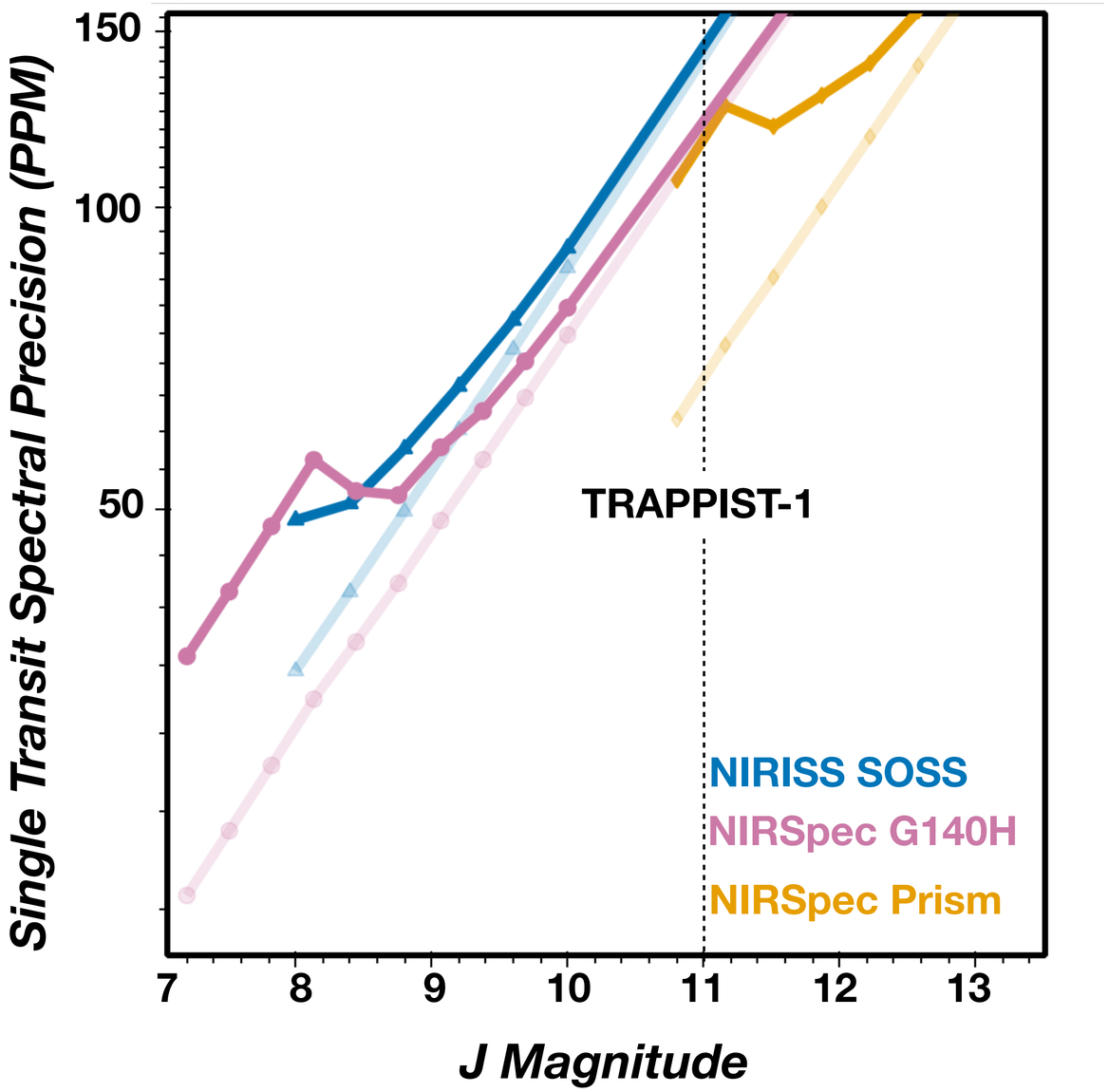
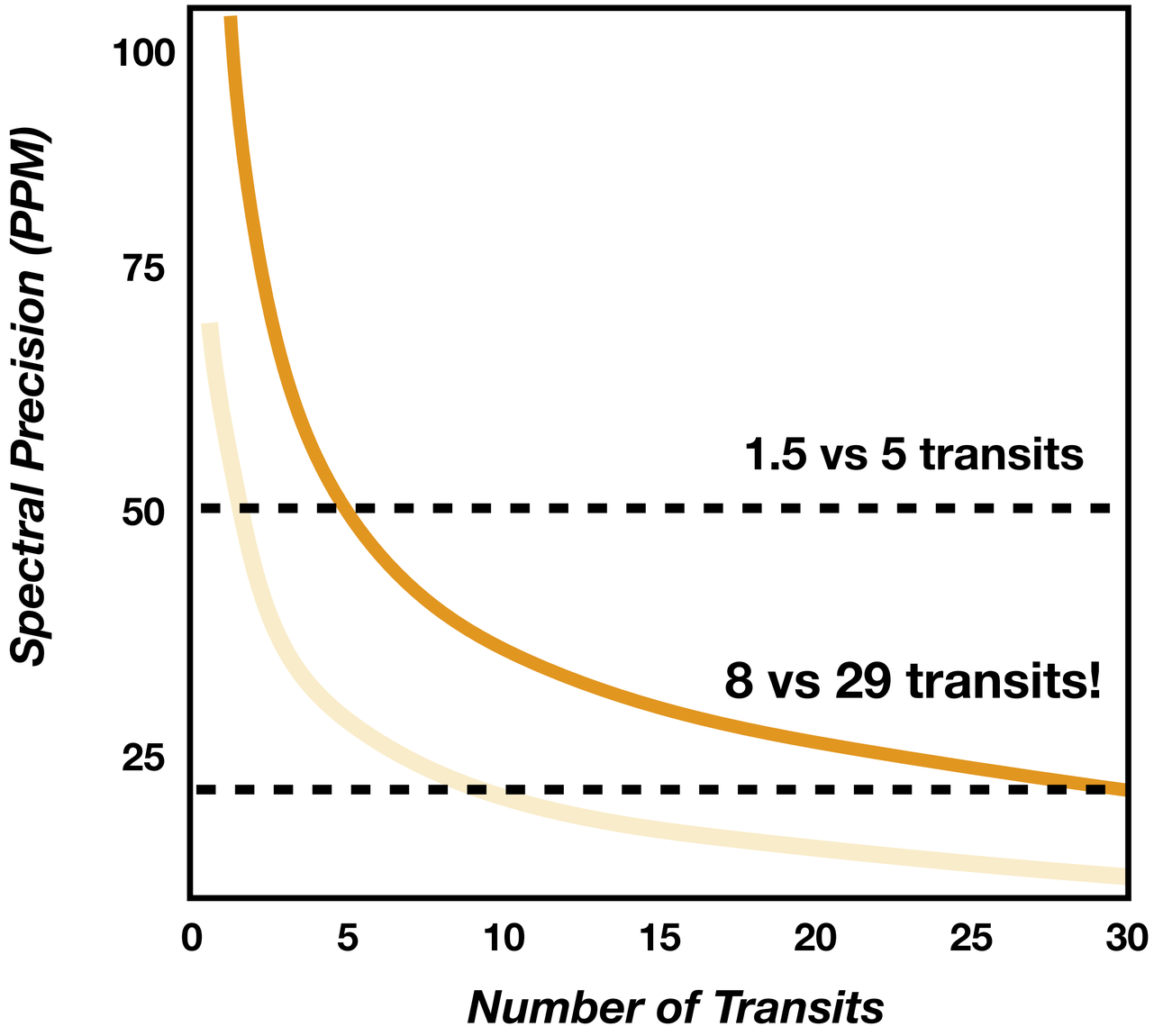
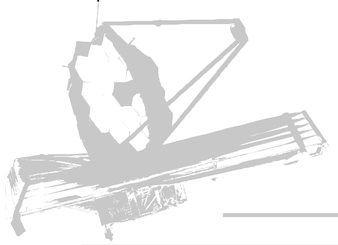
Low efficiency impedes optimal precision for bright targets







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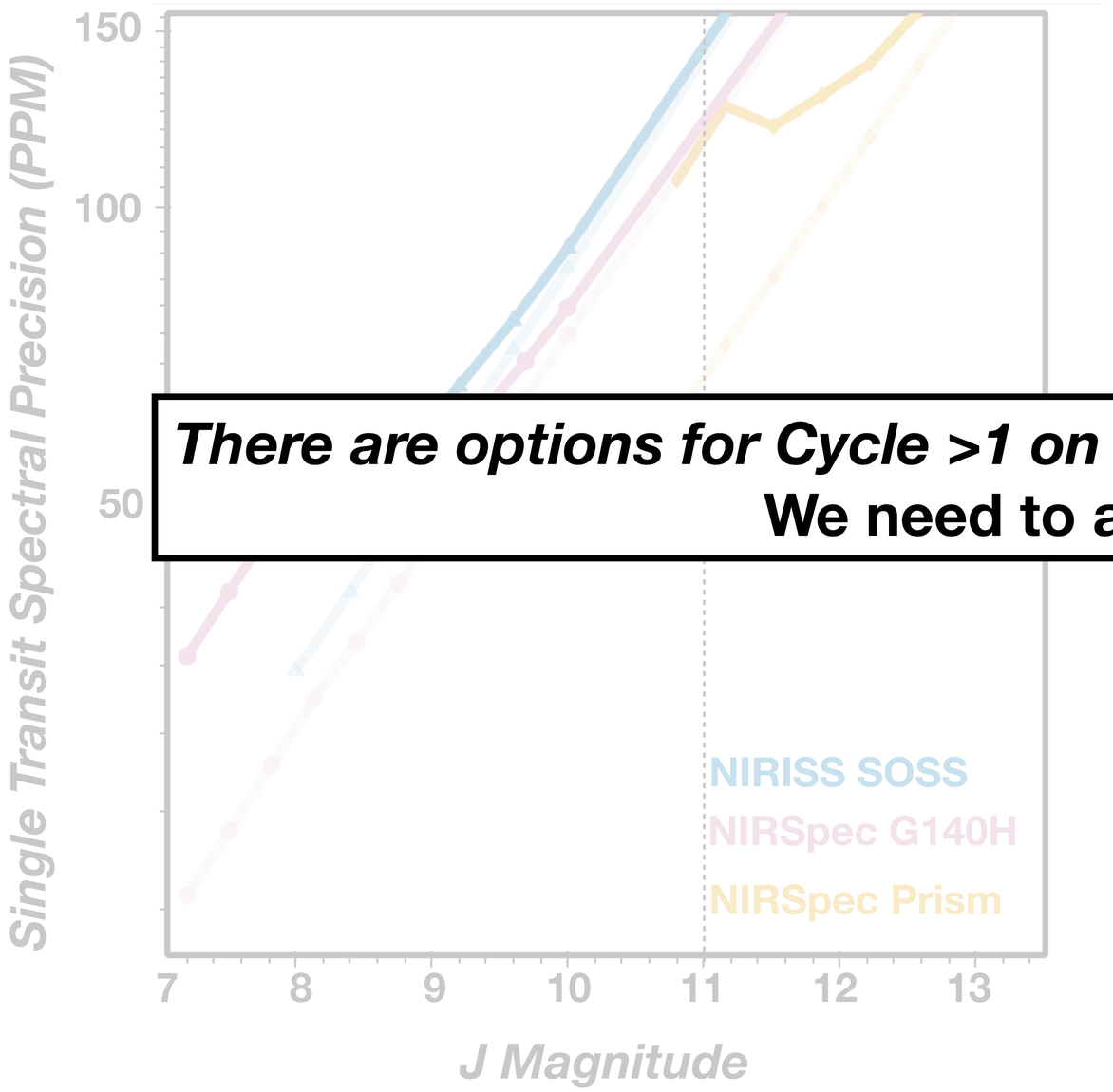
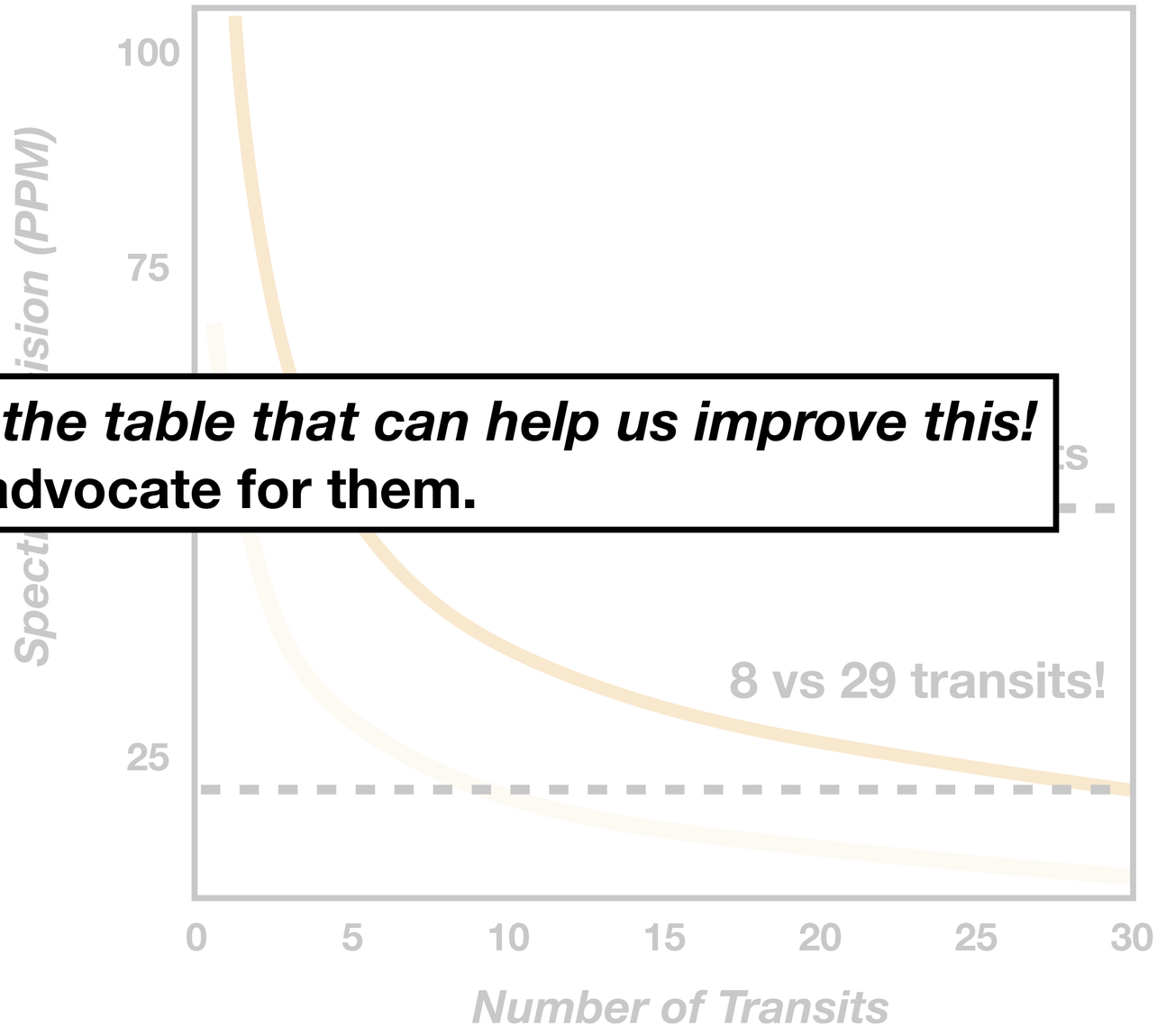
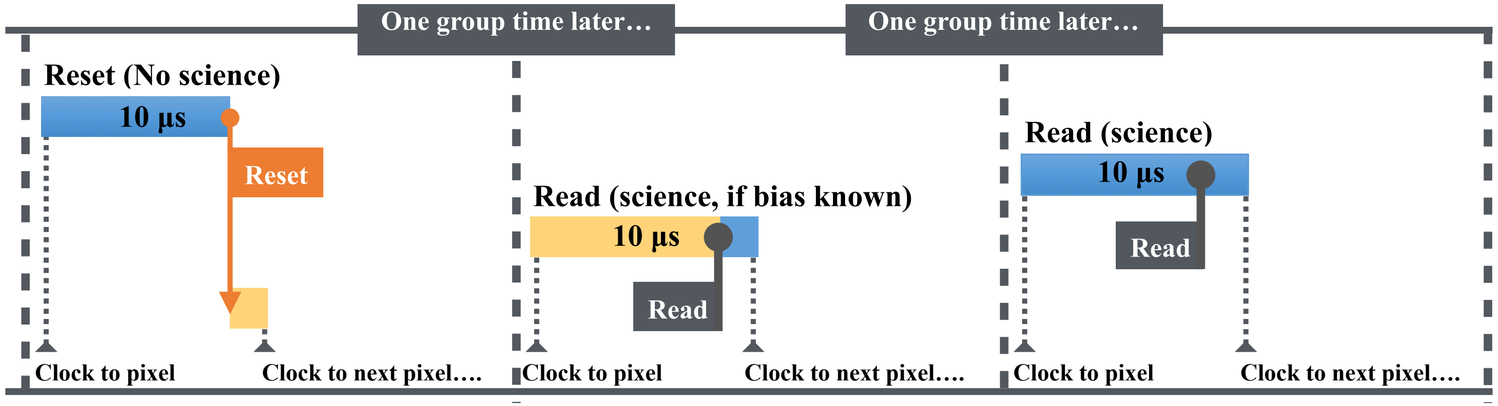




There are options for Cycle >1 on the table that can help us improve this!
We need to advocate for them.

It is still possible to improve read out speeds in Cycle >1!

Currently Approved:
33%

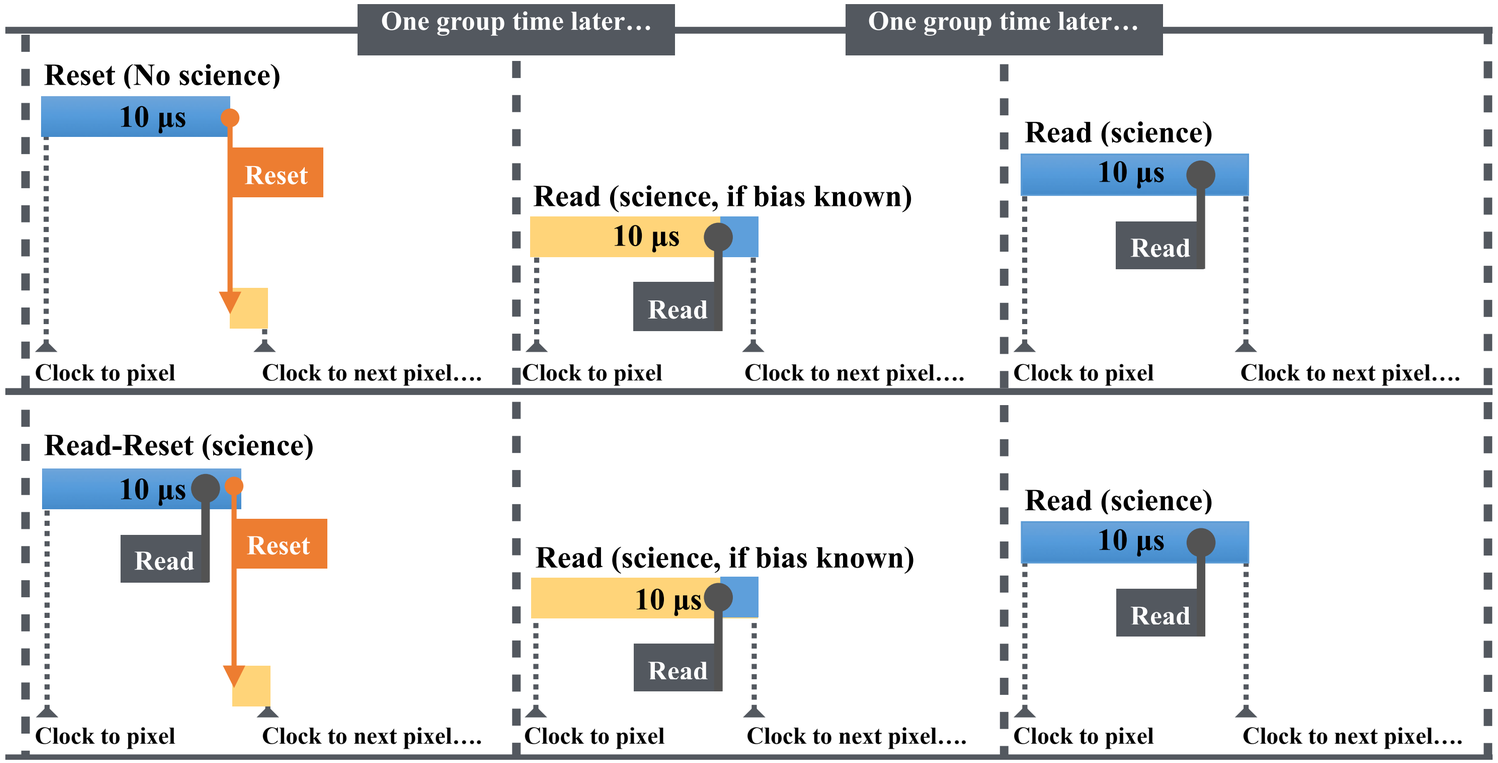


Batalha+ApJL 2018

It is still possible to improve read out speeds in Cycle >1!

Currently Approved:
33%

67%



Batalha+ApJL 2018

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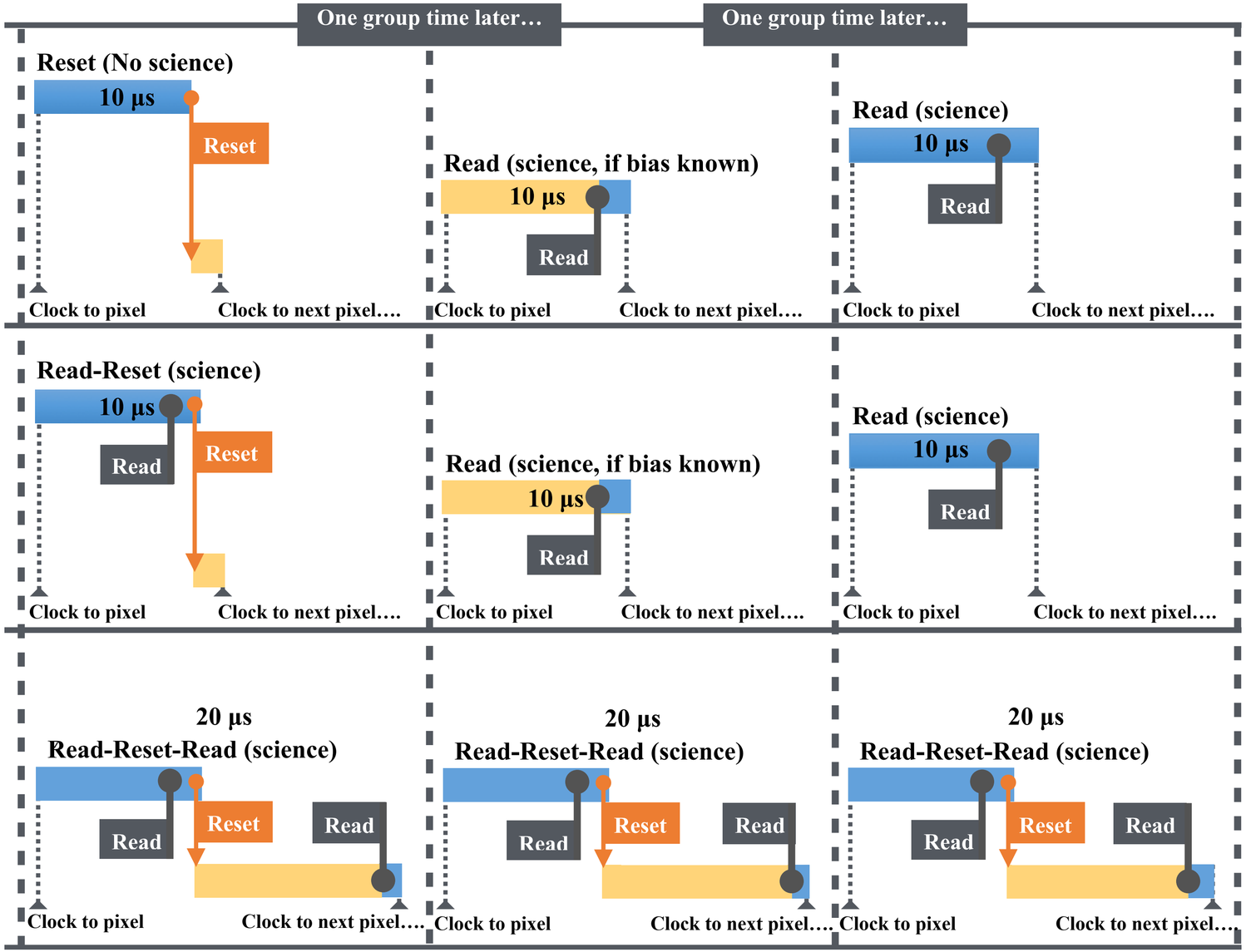
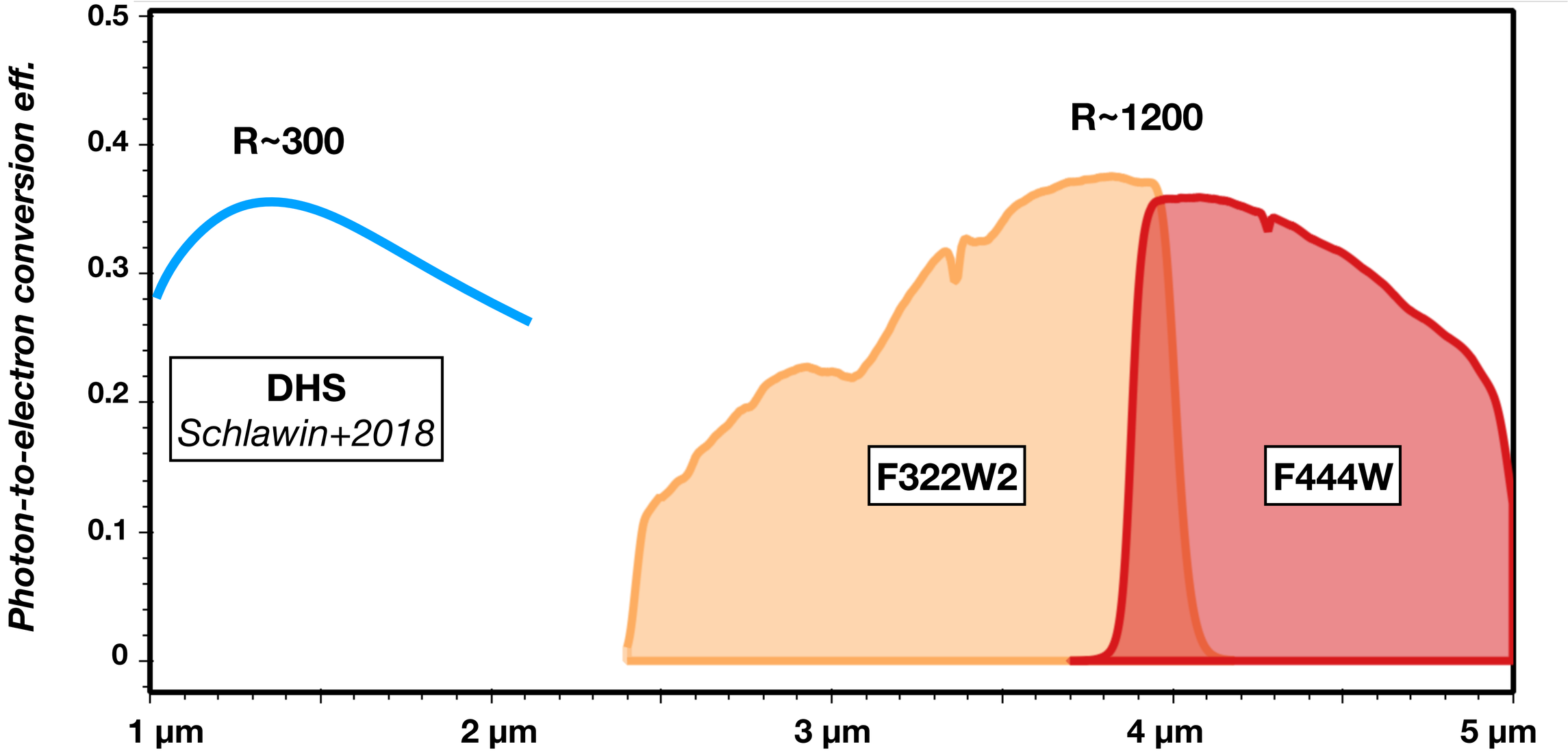
67%

~100%



Batalha+ApJL 2018

NIRCam DHS could improve 1-2.22 μm efficiency on bright targets



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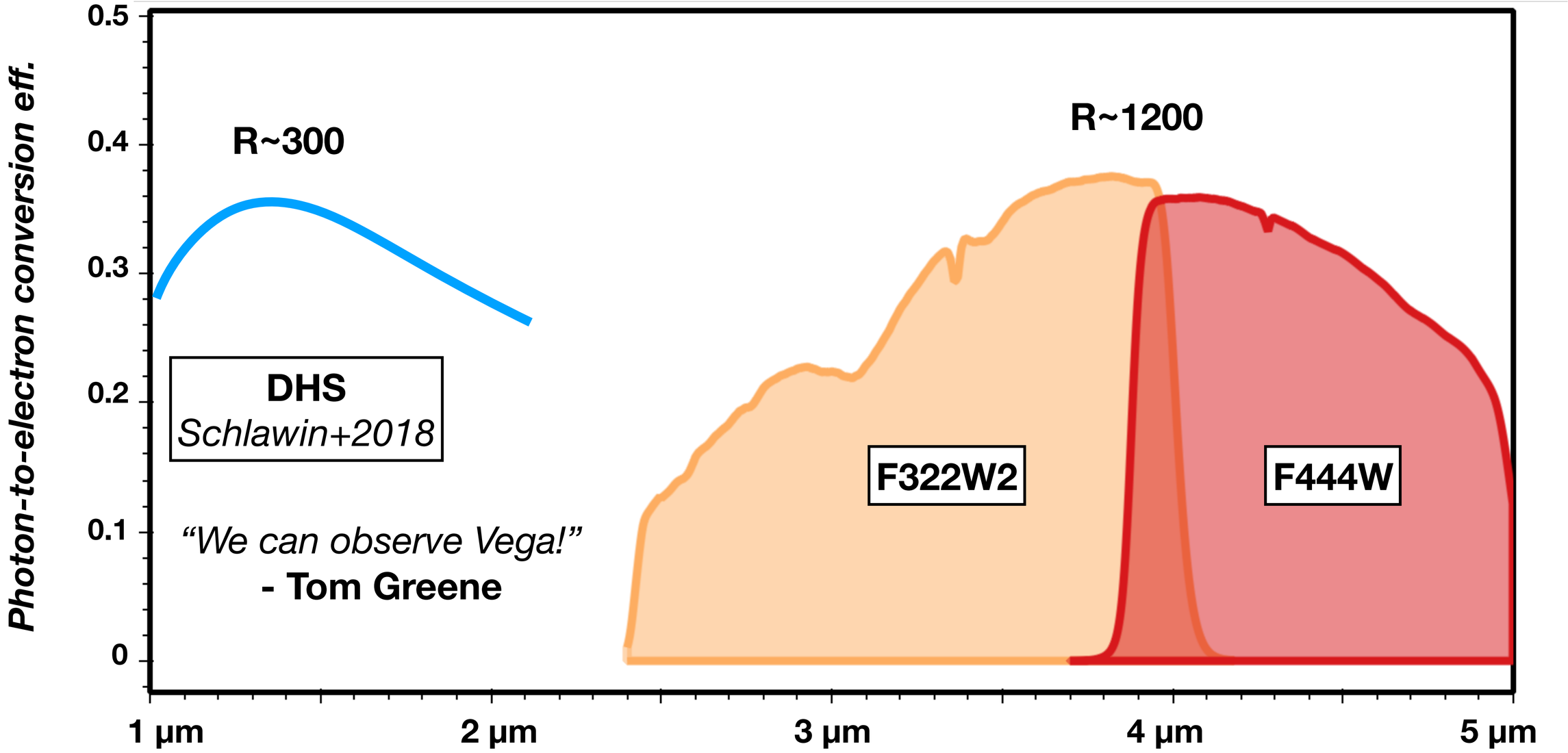

Capabilities

High precision spectroscopy

Challenges

Attaining highest precision possible. Need to ensure DHS and faster readout mode in Cycle 2

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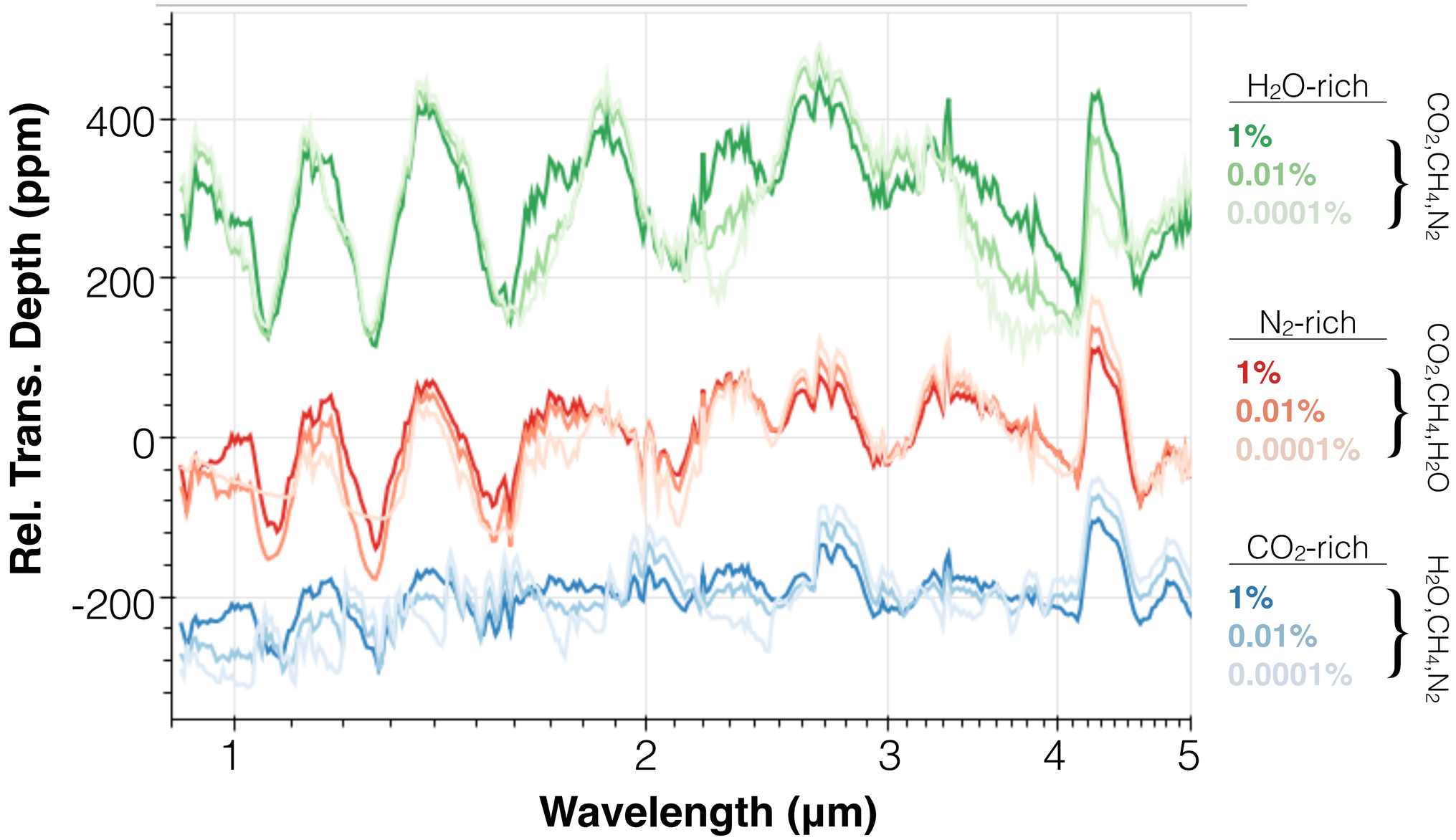
What could we do with this precision??

Brief look at NIRSpec Prism TRAPPIST-1 in transmission.. More to come next with real models!



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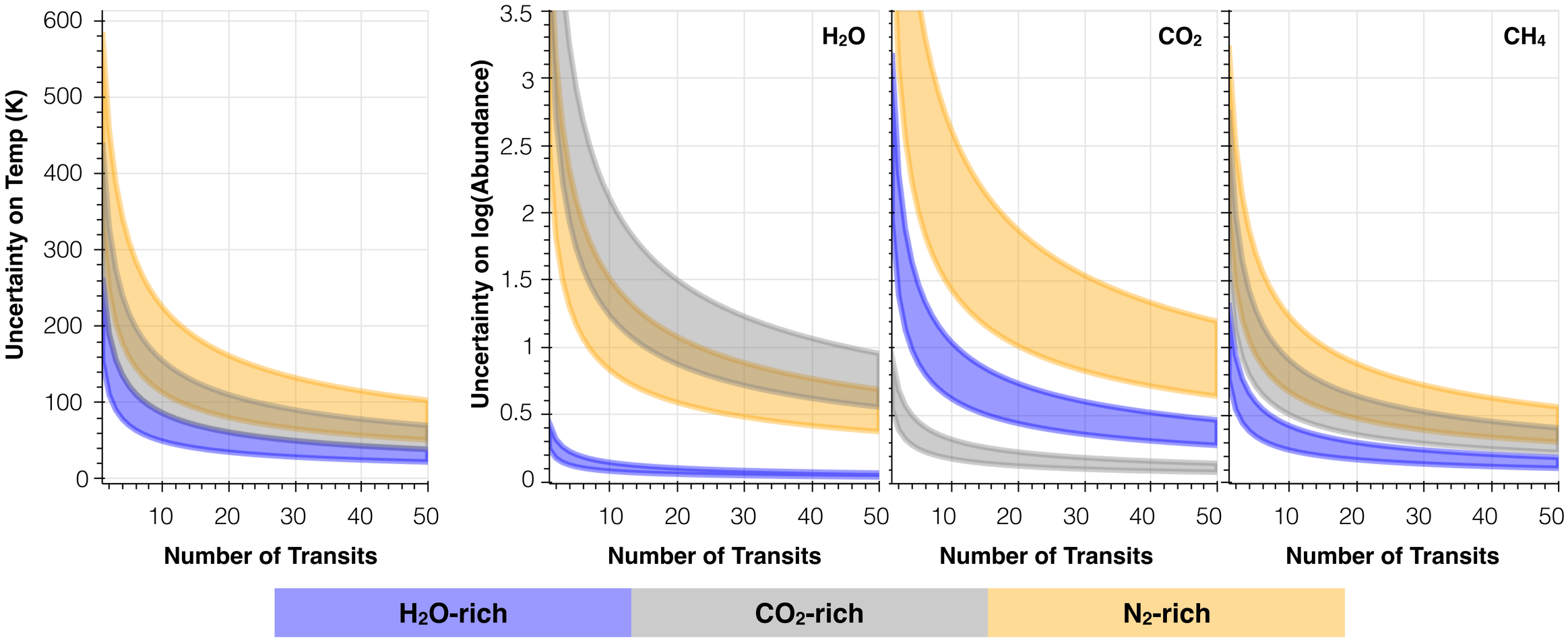

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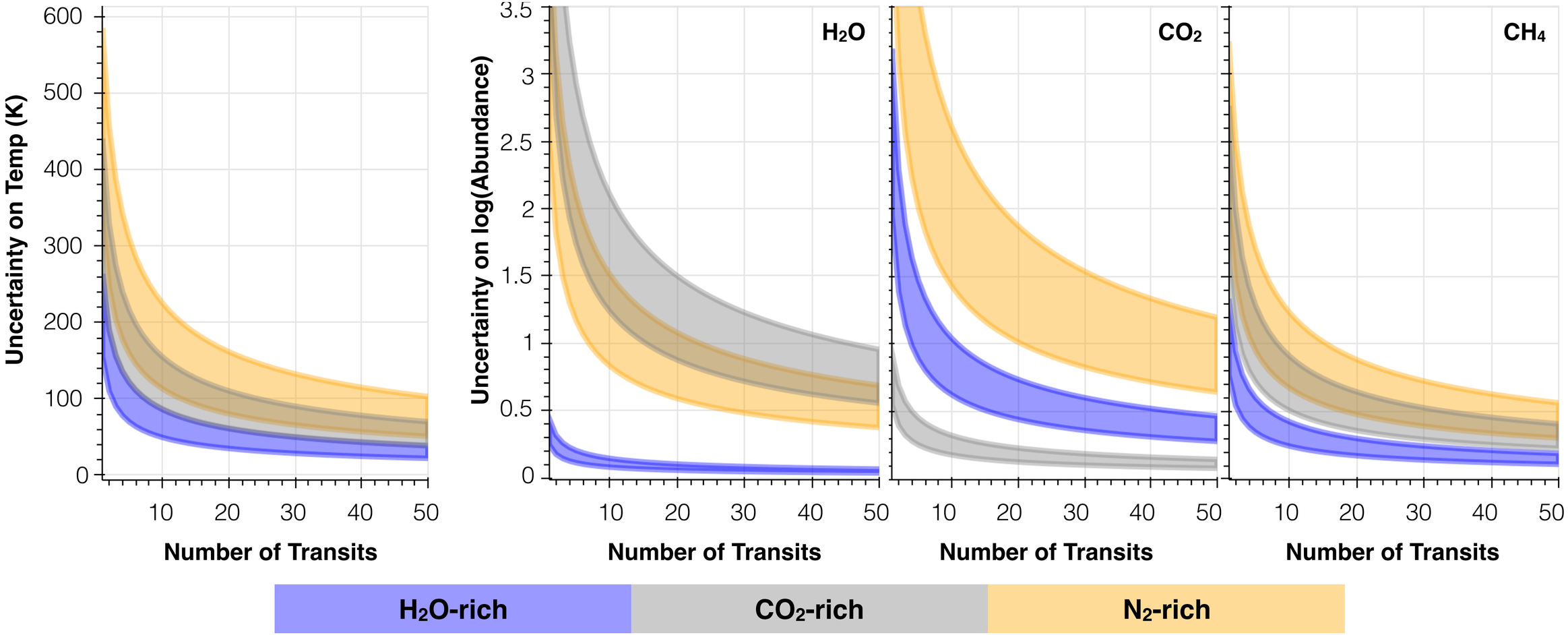

H_2O-rich | **CO_2-rich** | **N_2-rich**

Temperature errors: **±75 K**

Mixing ratio errors:

- ± **0.5 dex** (best case)
- ± 1 **dex** (most likely)
- ± **2 dex** (cloud coverage)

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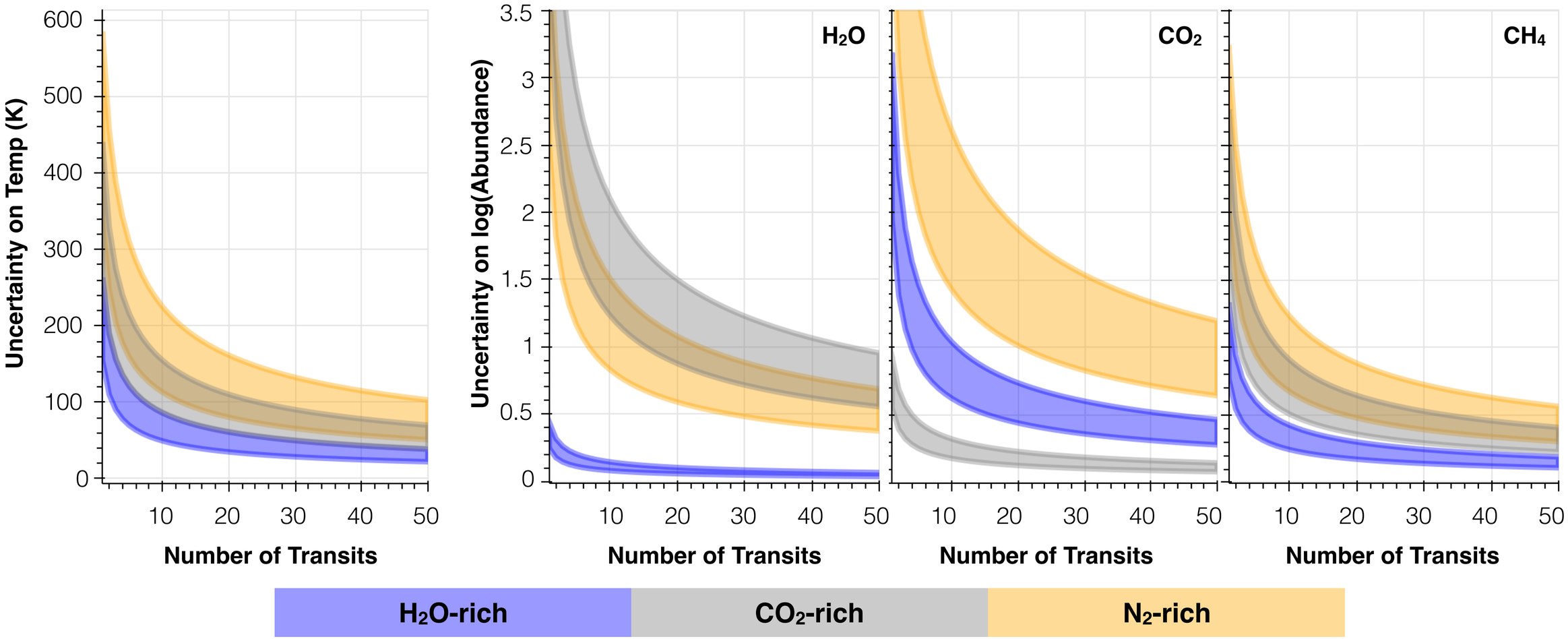
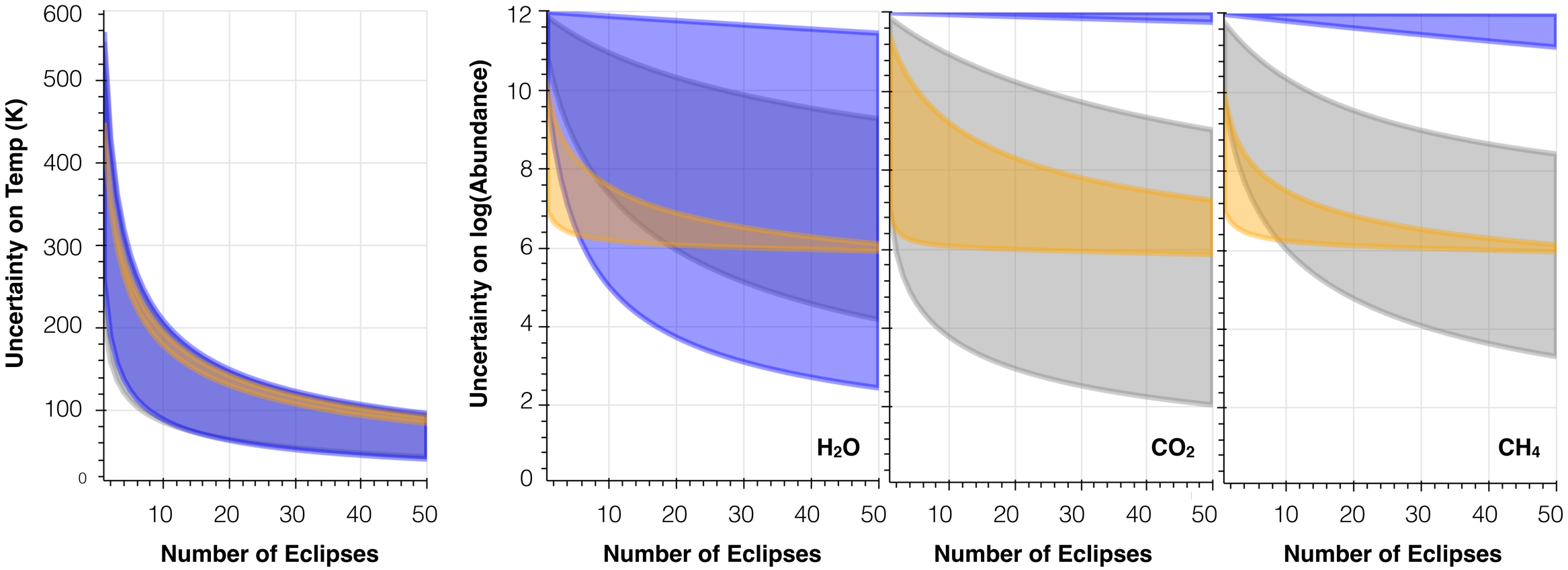


Always detect the dominant absorber!

Brief look at MIRI LRS TRAPPIST-1 in emission.. More to come next with real models!



Molecular detections are very difficult

Capabilities

- *High precision spectroscopy*
- *Ability to detect dominant absorber*

Challenges

- *Attaining highest precision possible. Need to ensure DHS and faster readout mode in Cycle 2*
- *Emission and trace gasses*

Capabilities

- *High precision spectroscopy*
- *Ability to detect dominant absorber*

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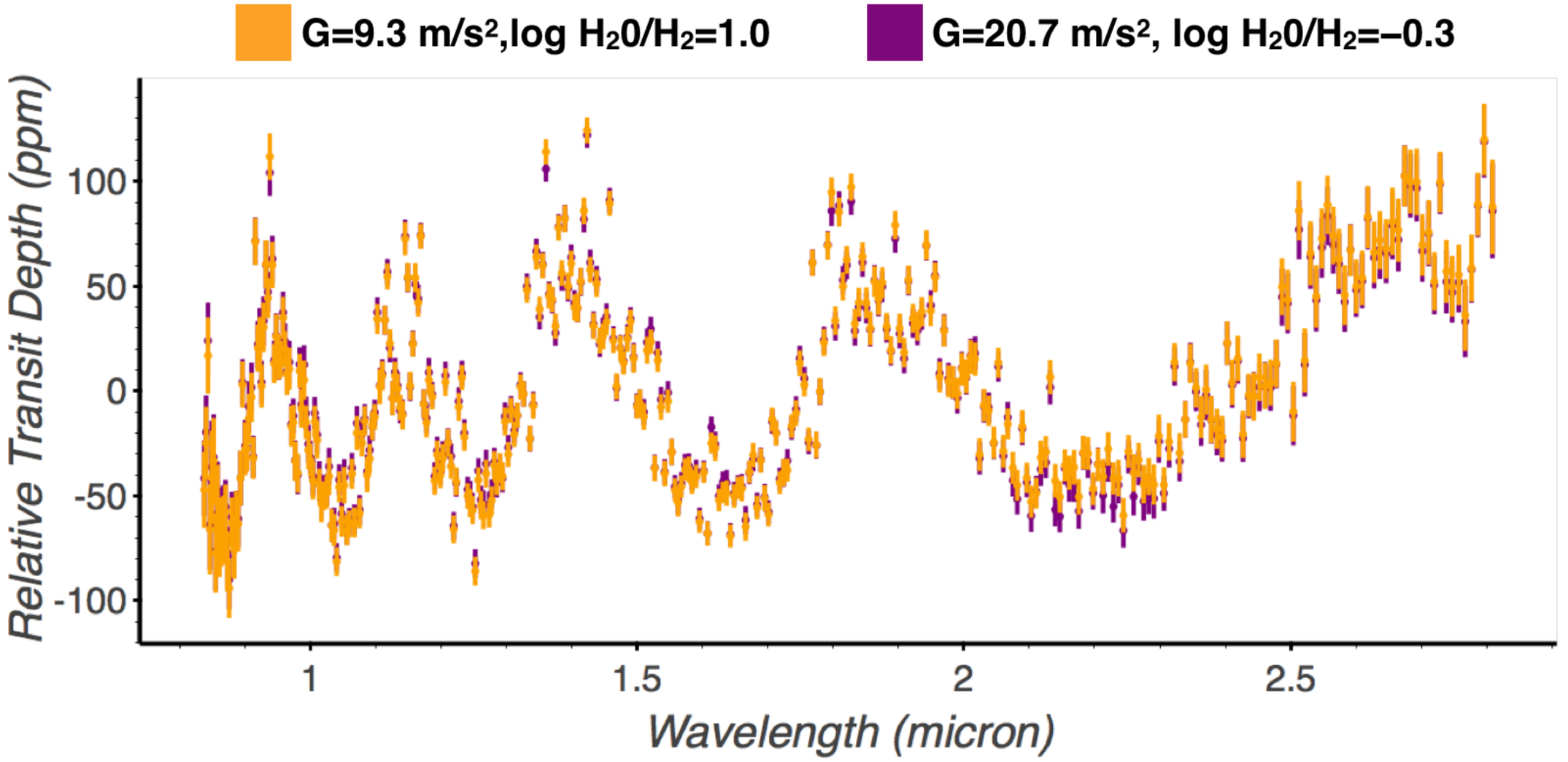
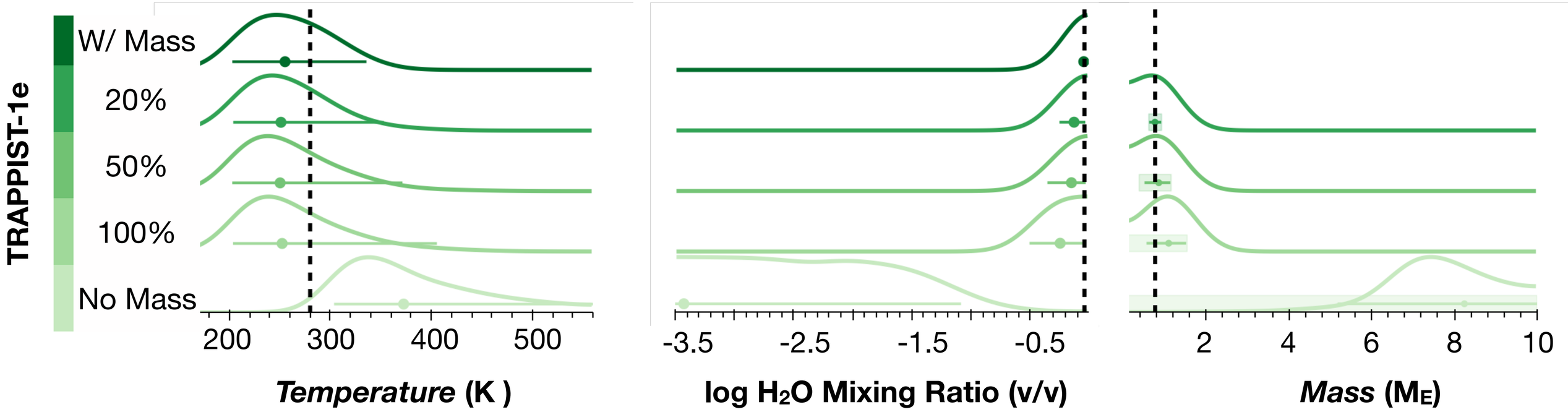
What could impede robust constraints on dominant absorber?

Mass composition degeneracies exist



N. Batalha, E. Kempton, et al 2017 ApJL

No mass constraints impede our ability to robustly determine composition



N. Batalha, T. Lewis, J. Fortney, N. Batalha, E. Kempton, et al submission T-1 week

Capabilities

- ***High precision spectroscopy***
- ***Ability to detect (****sometimes constrain****) dominant absorber***
- ***Simultaneous extreme precision RV***

Challenges

-  ***Attaining highest precision possible. Need to ensure DHS and faster readout mode in Cycle 2***
-  ***Emission and trace gasses***
-  ***Need mass to get robust atmospheric composition***