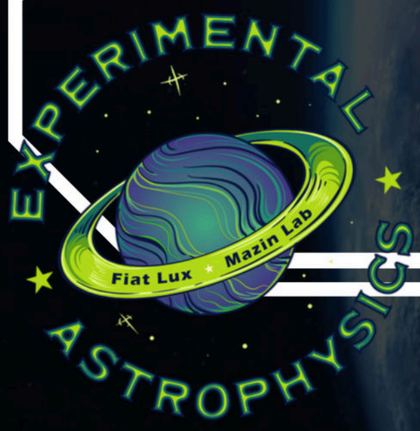
SPECTRAL ORDER SORTING WITH THE **MULTI-OBJECT MKID OPTICAL SPECTROMETER** [M.O.M.O.S.]

Crystal Kim*, Ronald López*, Hawkins Clay*, Joe Redford*, Aled Cuda*, Jeb Bailey^, Ben Mazin*
*University of California Santa Barbara, ^California Institute of Technology



Background: Microwave Kinetic Inductance Detector (MKID)

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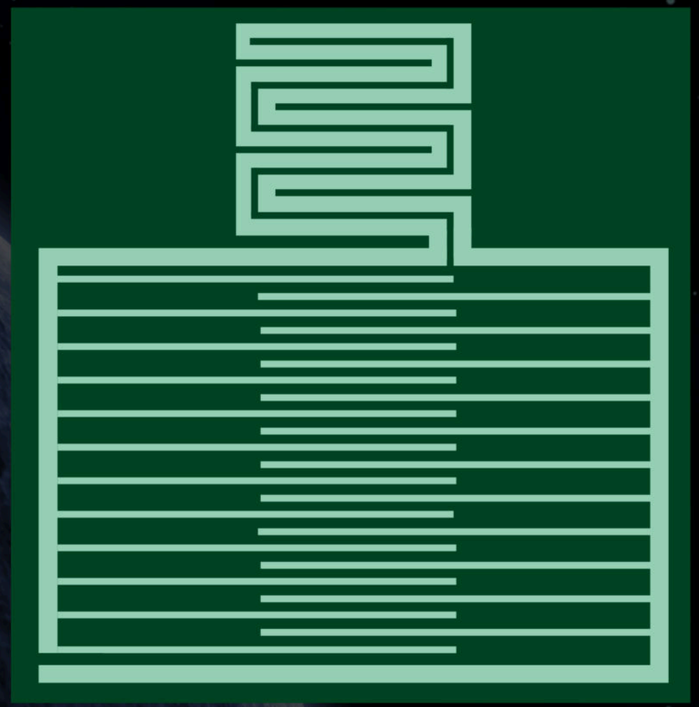
Energy Resolution

When a photon’s energy is absorbed by the inductor, the change in inductance can be measured.



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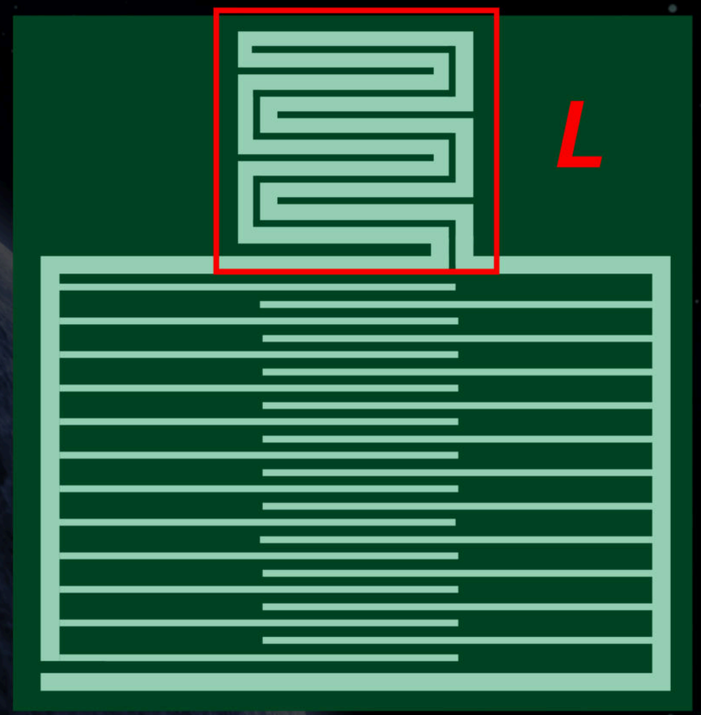

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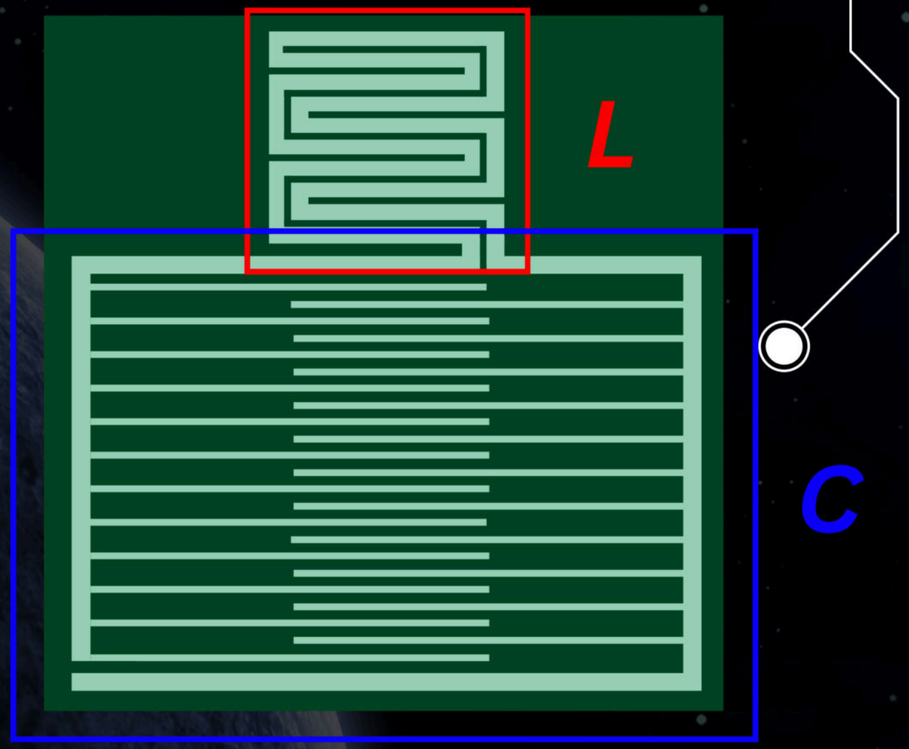

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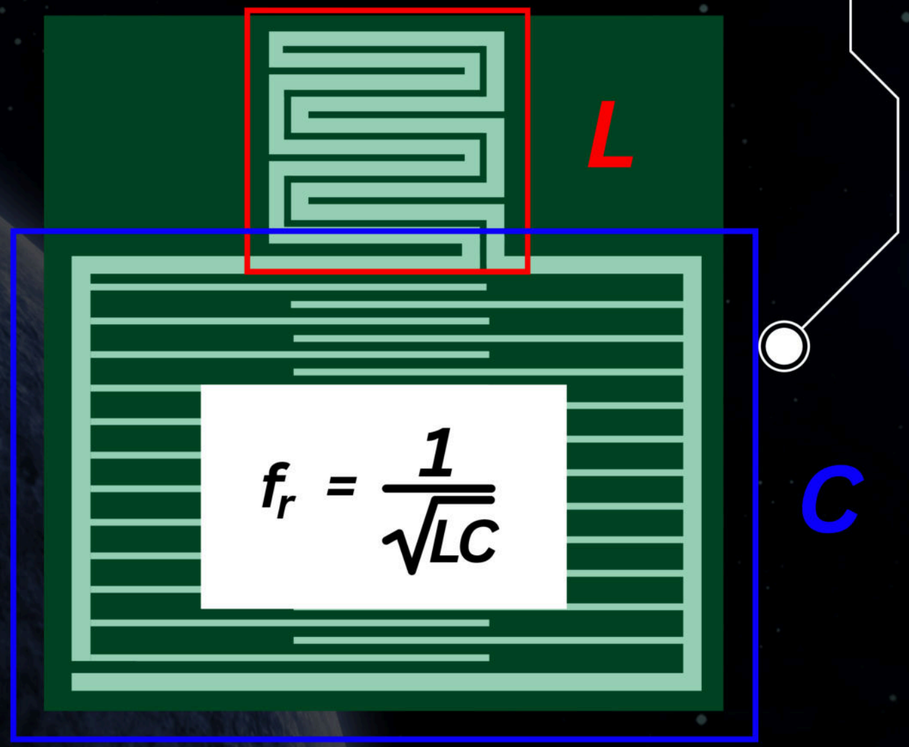

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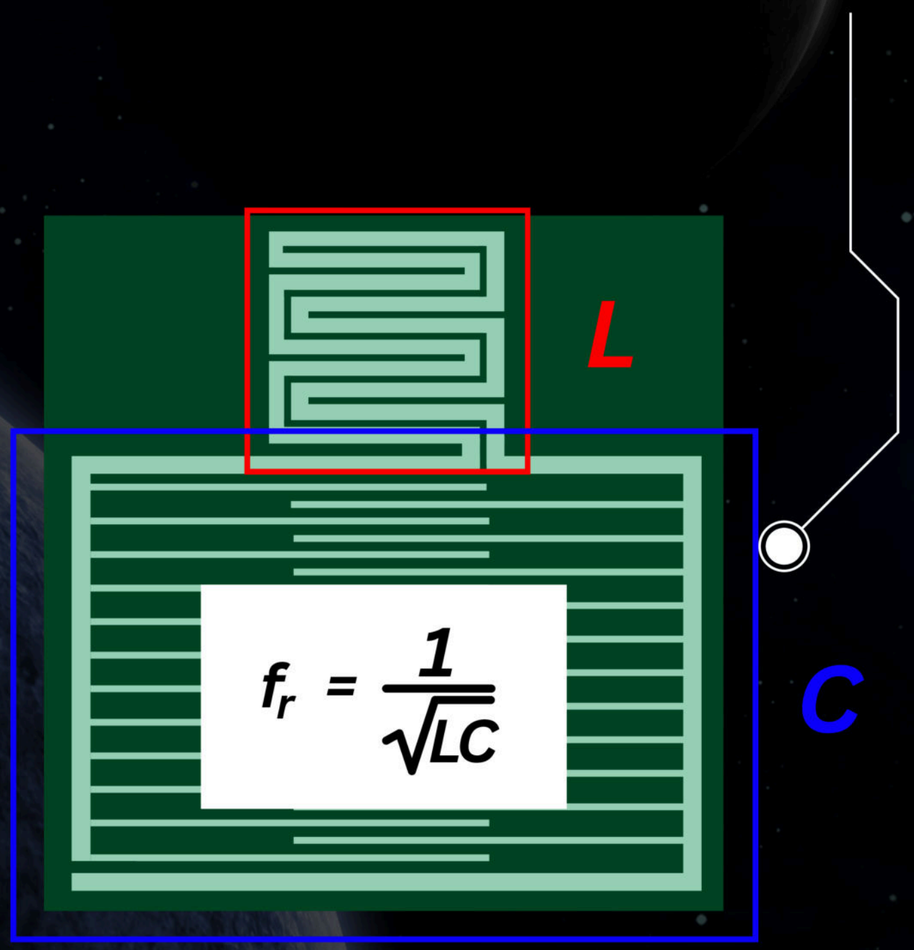
Thousands of MKID signals can be measured over a single cable, not common among superconducting detectors



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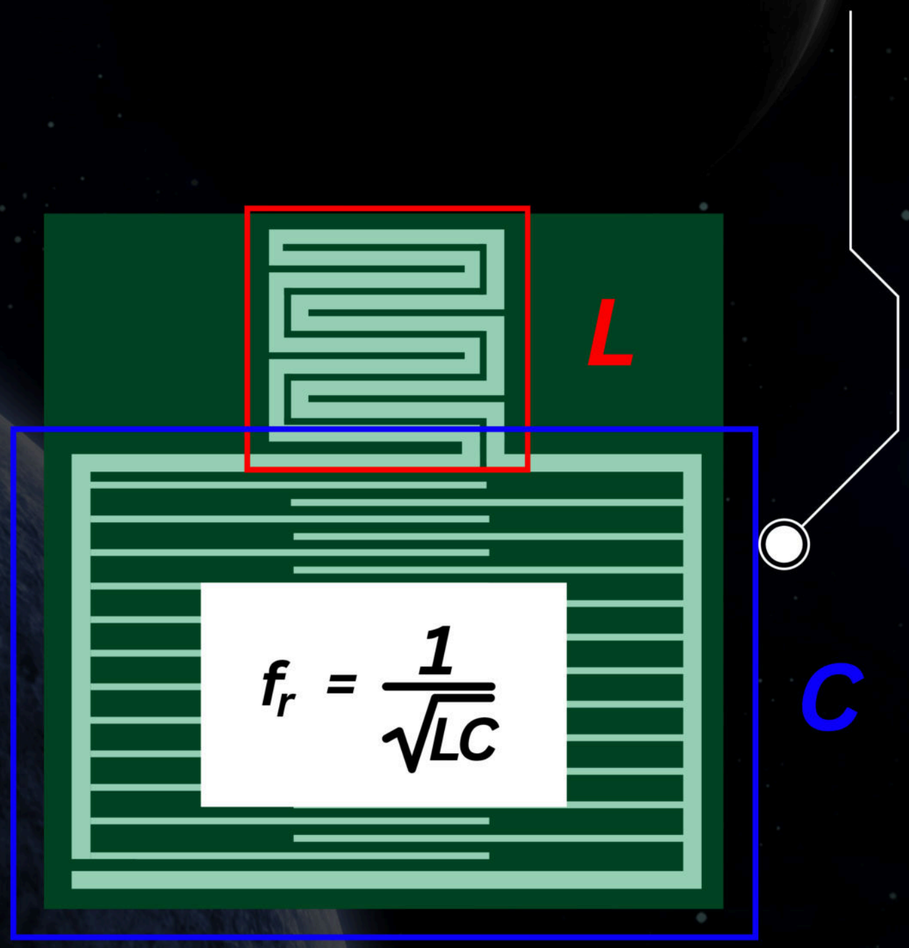

✗ **Read Noise**
✗ **Dark Current**

✓ **Timing Resolution**
~μs

Background: Microwave Kinetic Inductance Detector (MKID)

Handful of Deployed Optical-IR MKID Integral Field Units:

- 2013: ARCONS
- 2018: DARKNESS
- 2020: MEC
- 2023: XKID

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Poster 18: Nikki Zivkov (UCSB)
MEC Prime: Upgrading MKID Exoplanet Camera for High Contrast Exoplanet Imaging

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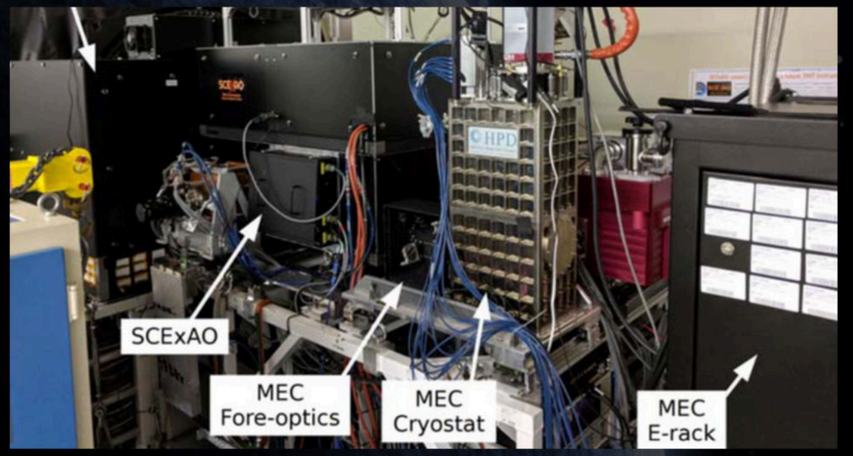
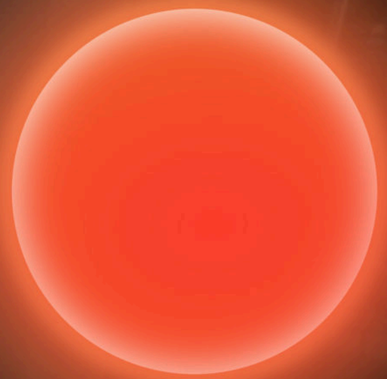
Why so few?

- Still in R&D phase
- MKID equipment is HUGE
- Uses a lot of energy
- Generally complicated



Background: Exoplanets

Total Exoplanets Discovered: **~6k**
Total Exoplanets Directly Imaged: **84**
NExScI 2025



M-dwarf
<0.5 M_sun
~80% of all stars

Earth-like exoplanet 
~1 per M-dwarf
Dressing 2013

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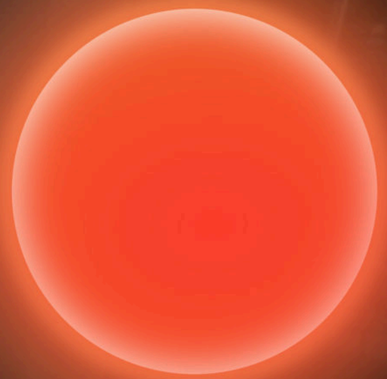

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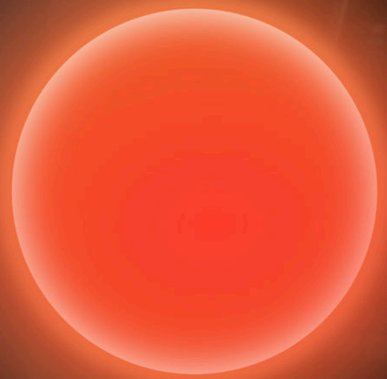

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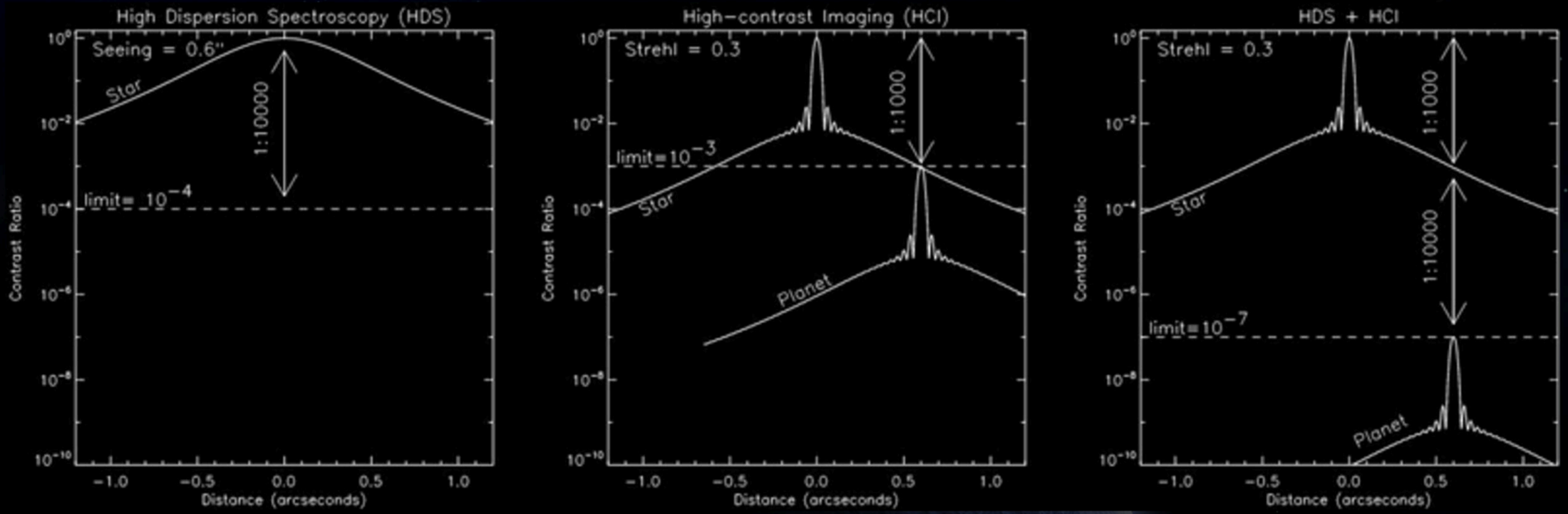
Extremely large telescopes:

- Next Gen MOMOS: Optical hi-res multi-object spectrometer

Background: High Dispersion Coronagraphy



Snellen et al. 2015

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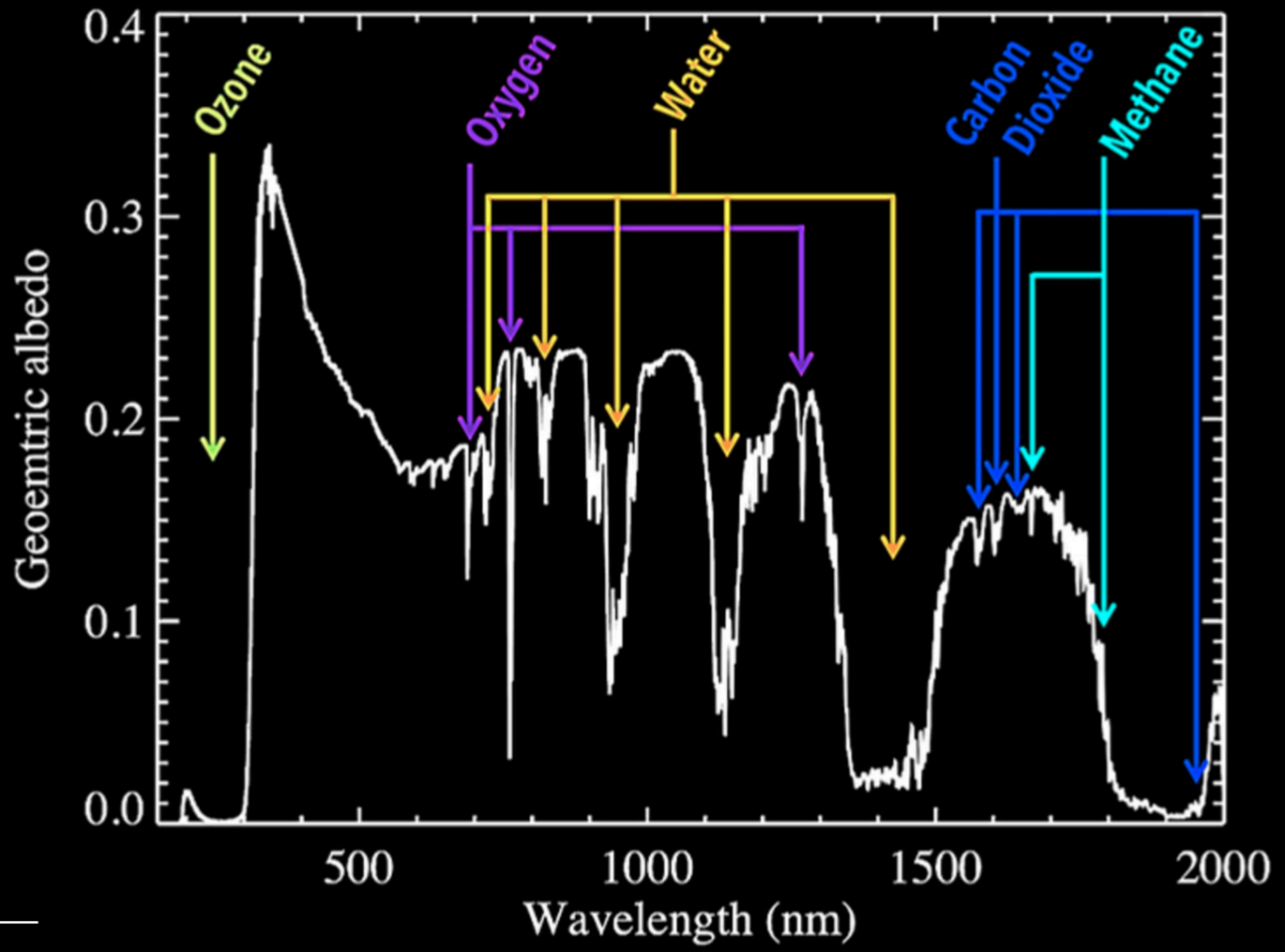
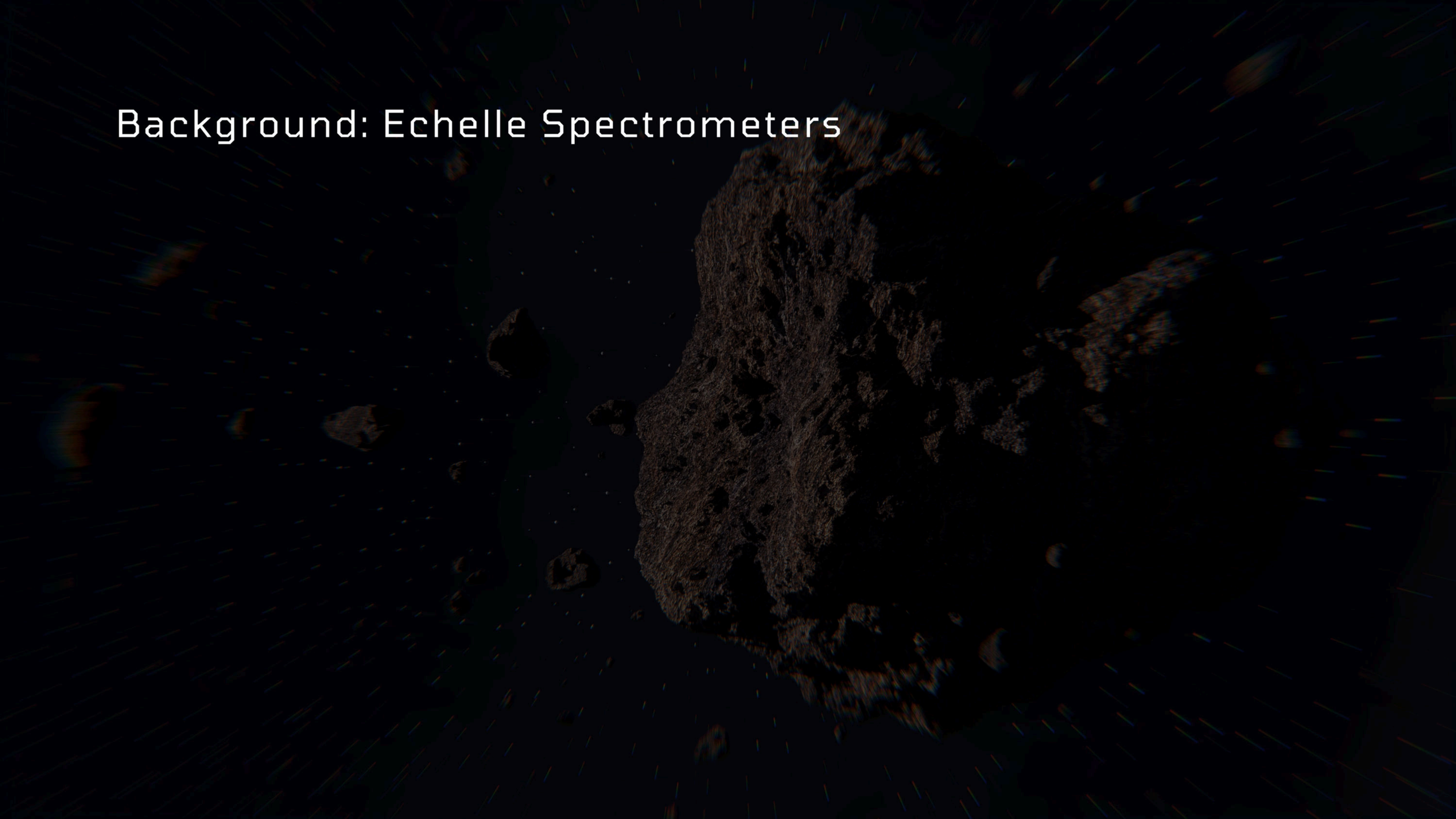


Background: Echelle Spectrometers



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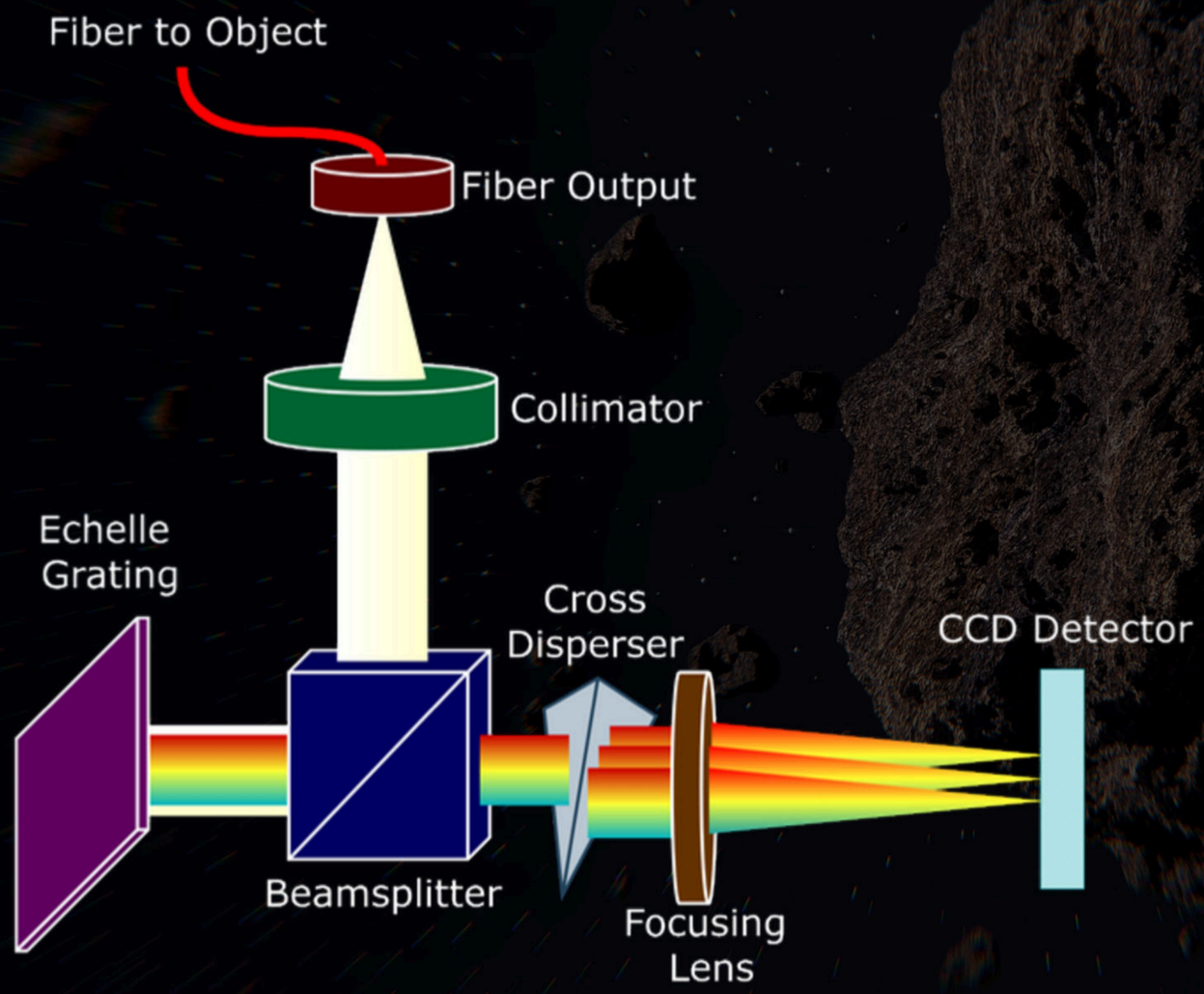

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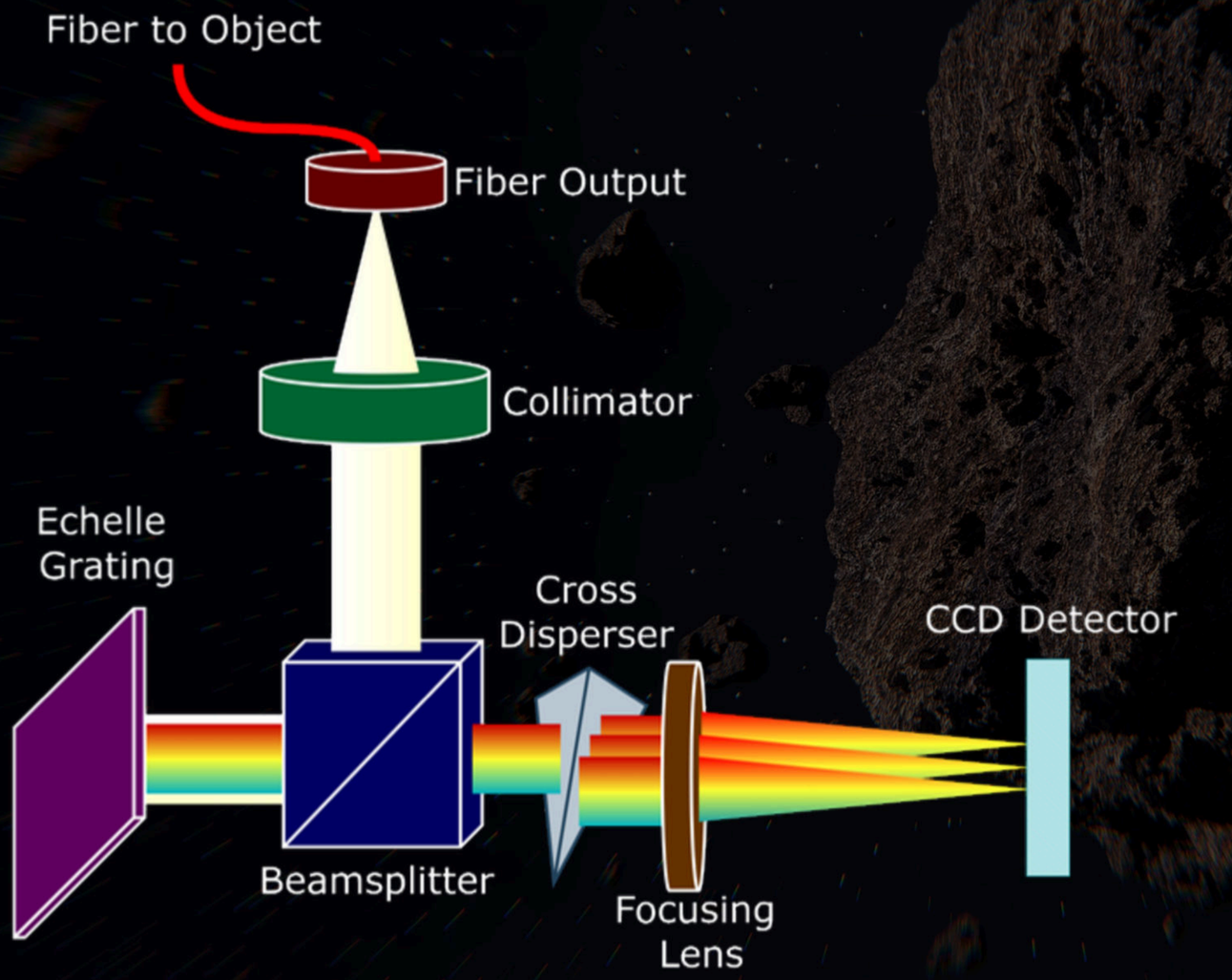

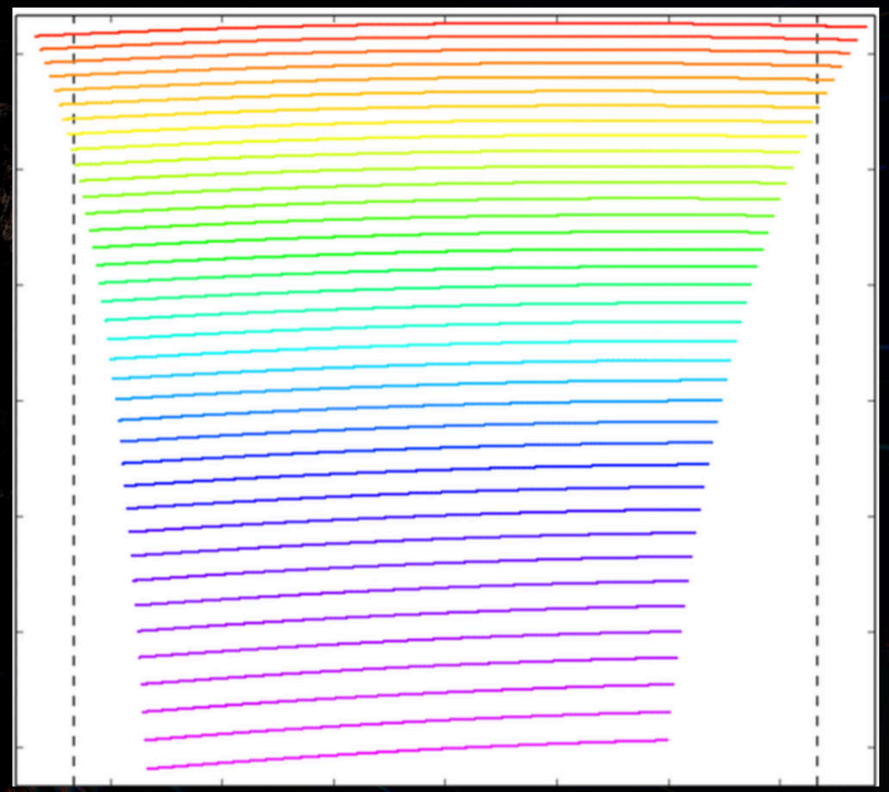

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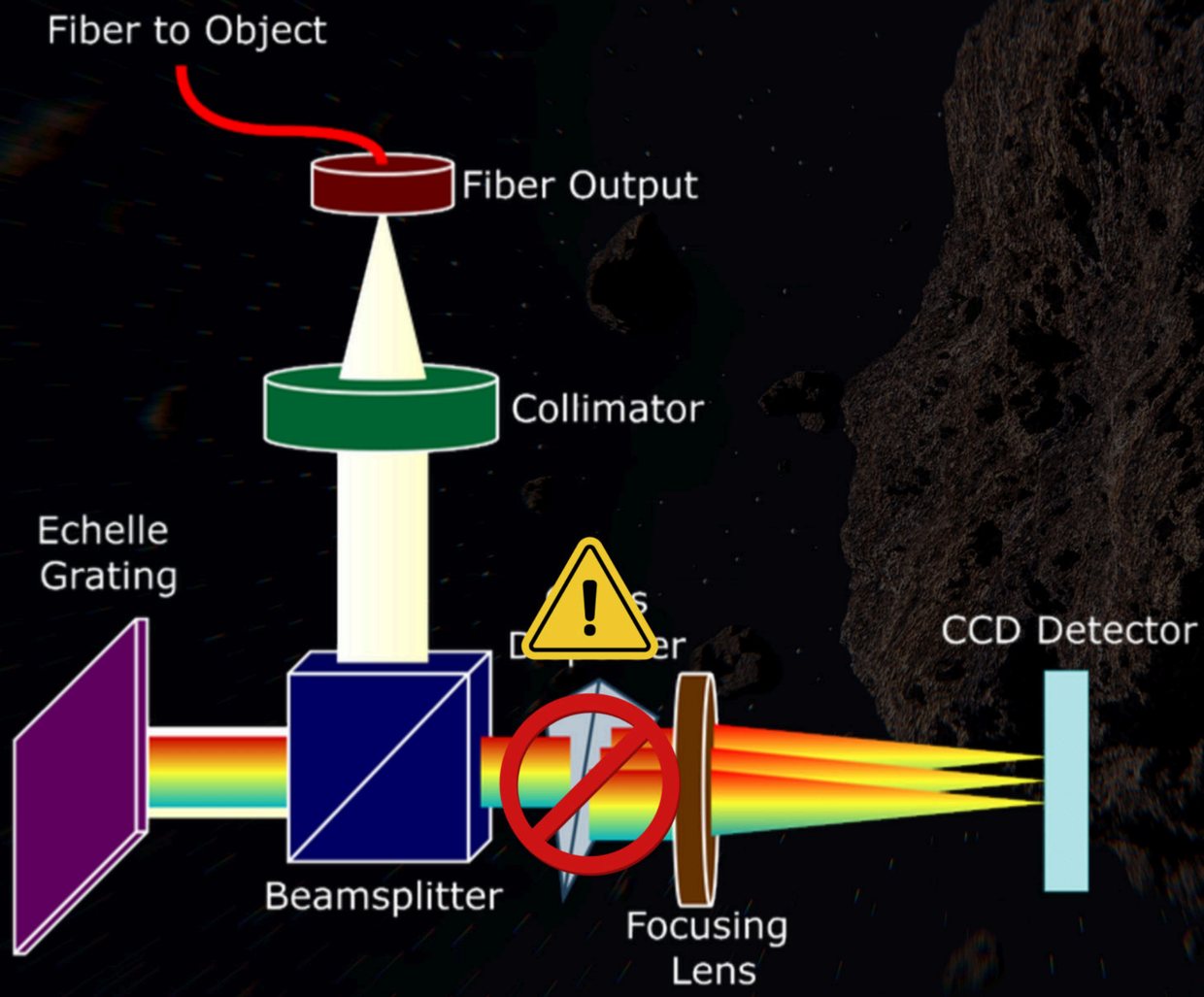
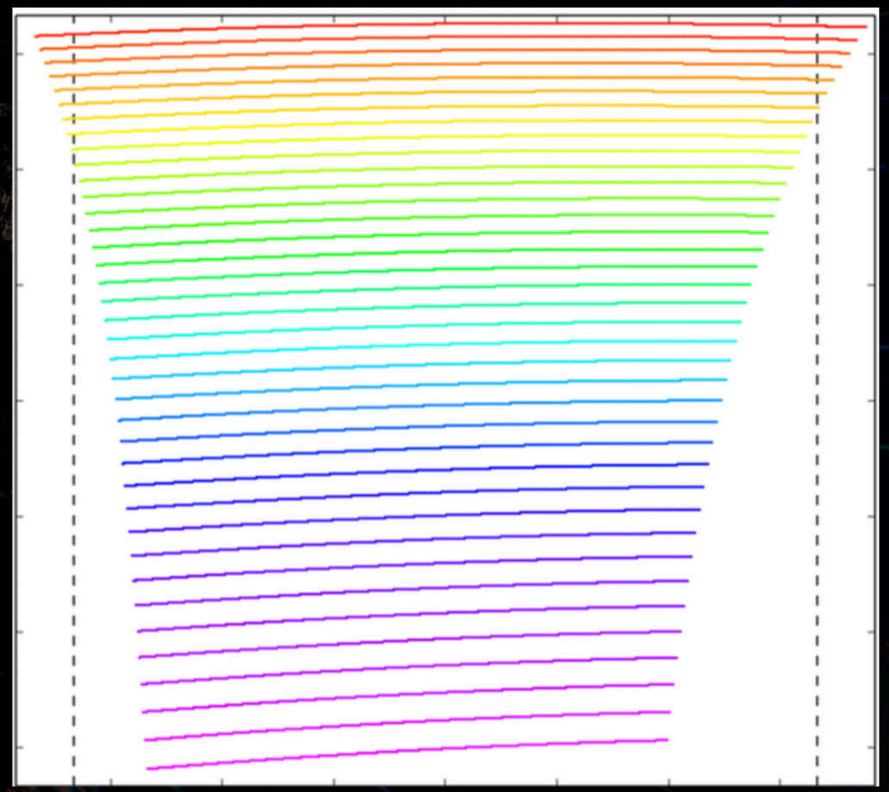
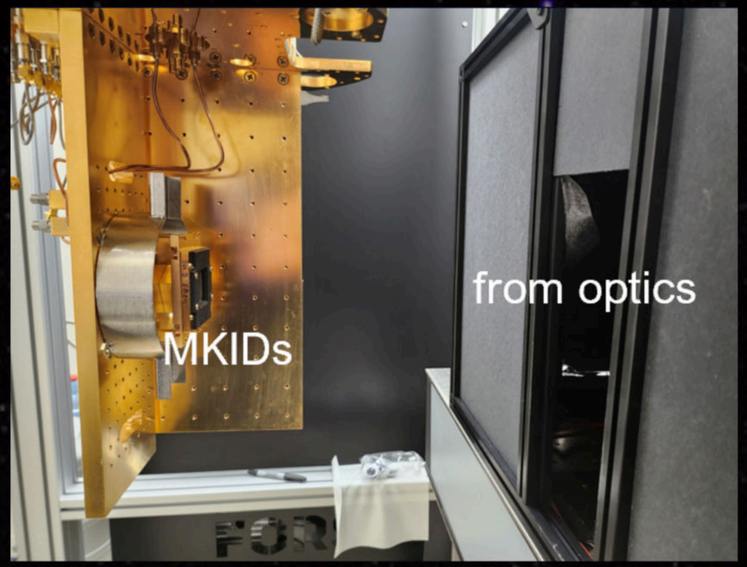
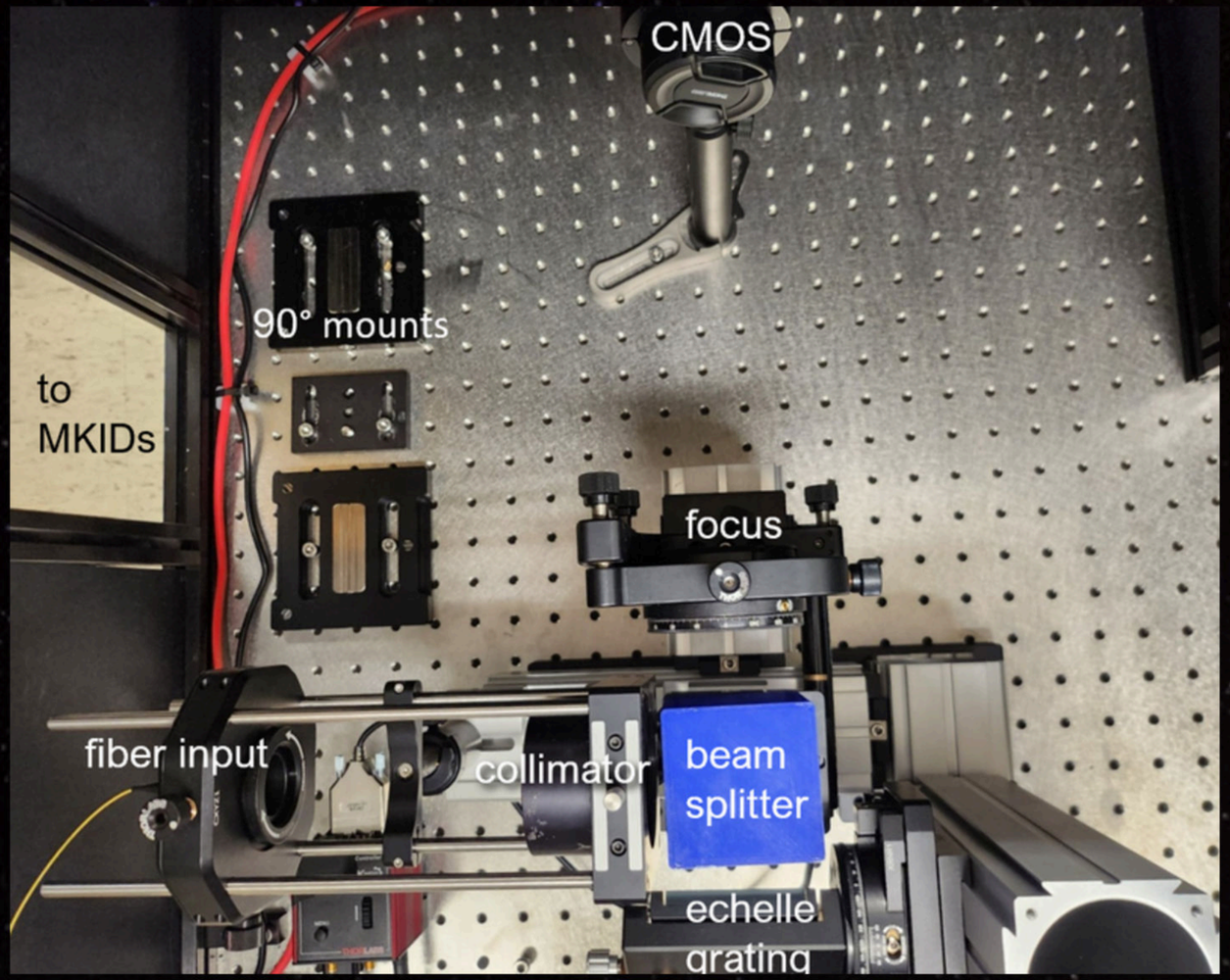




MOMOS Design





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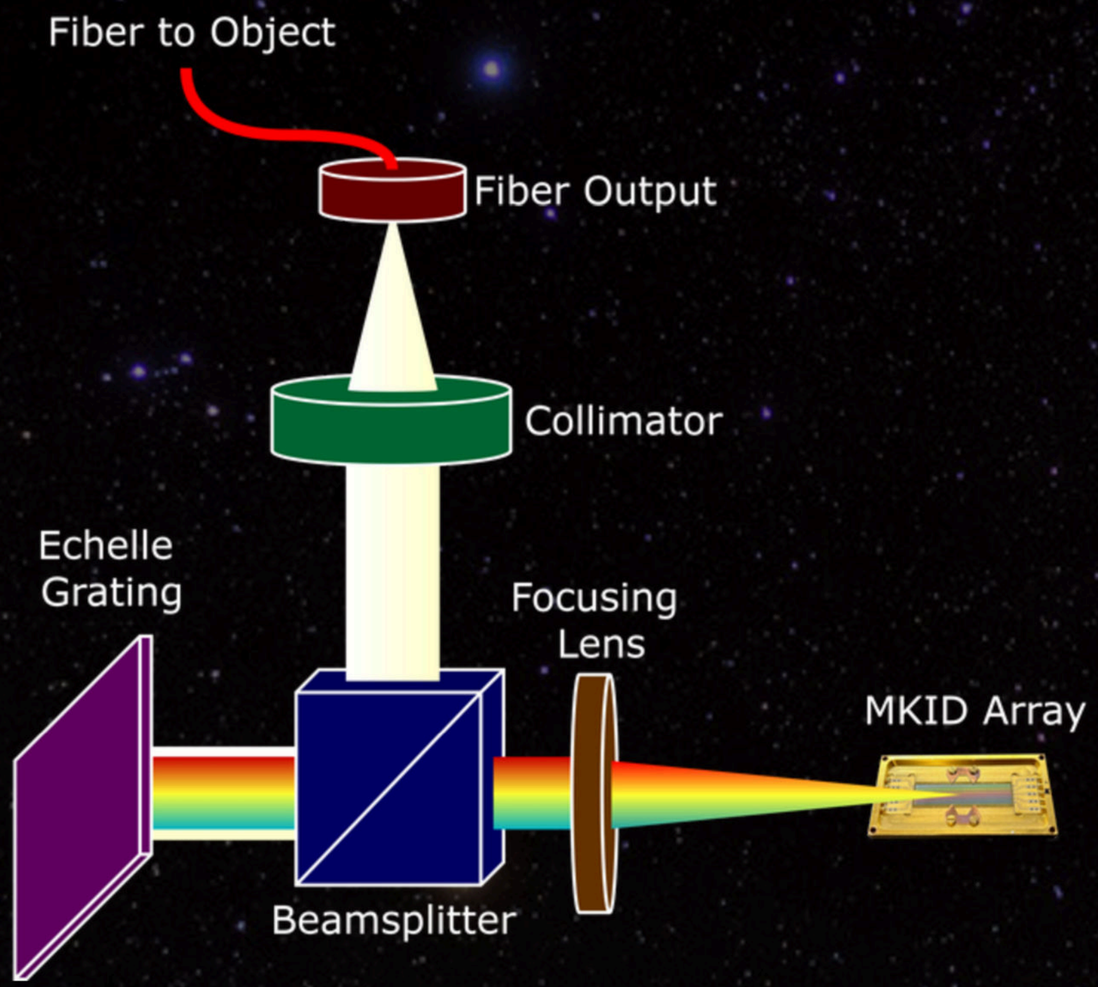

Current Design:

- 3 spectral orders from 400–800nm

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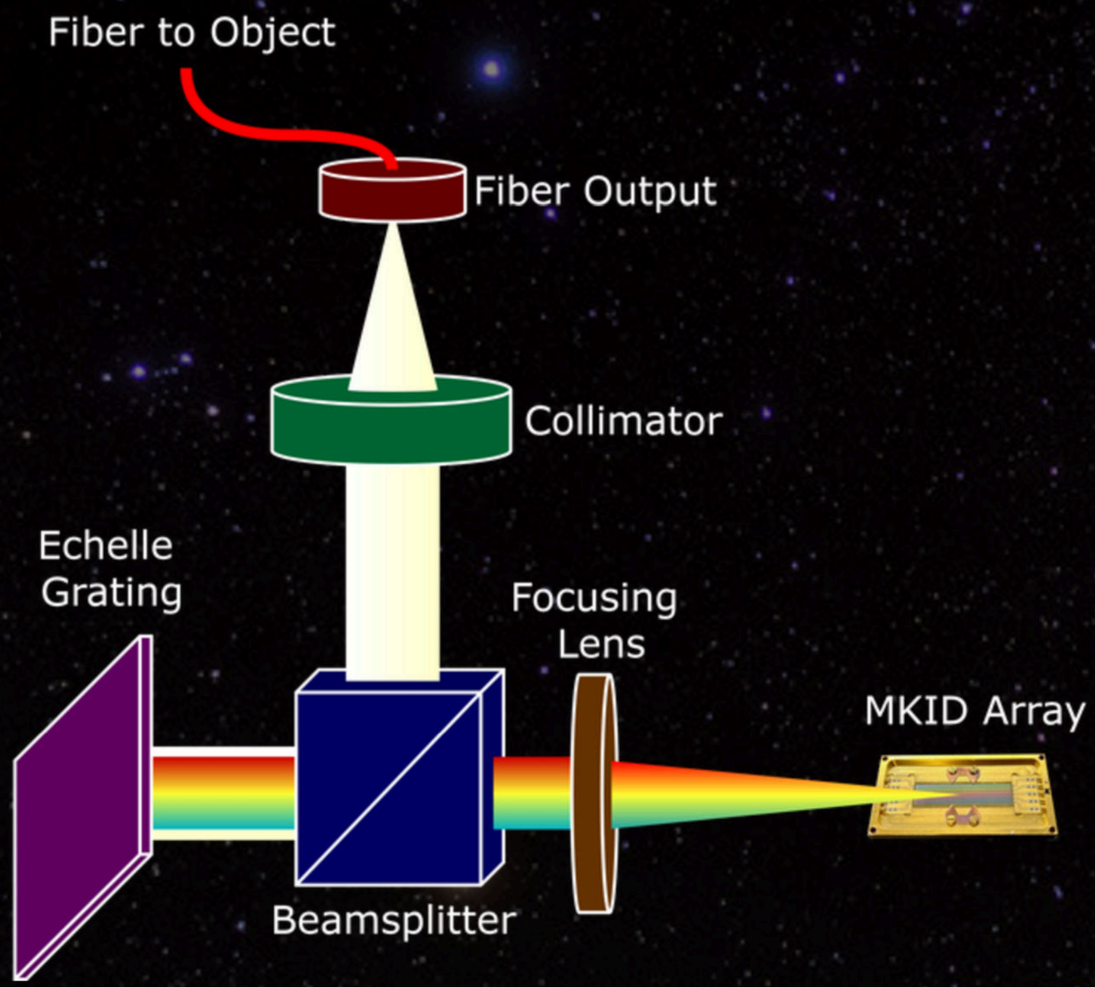

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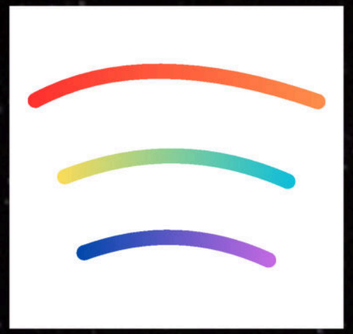

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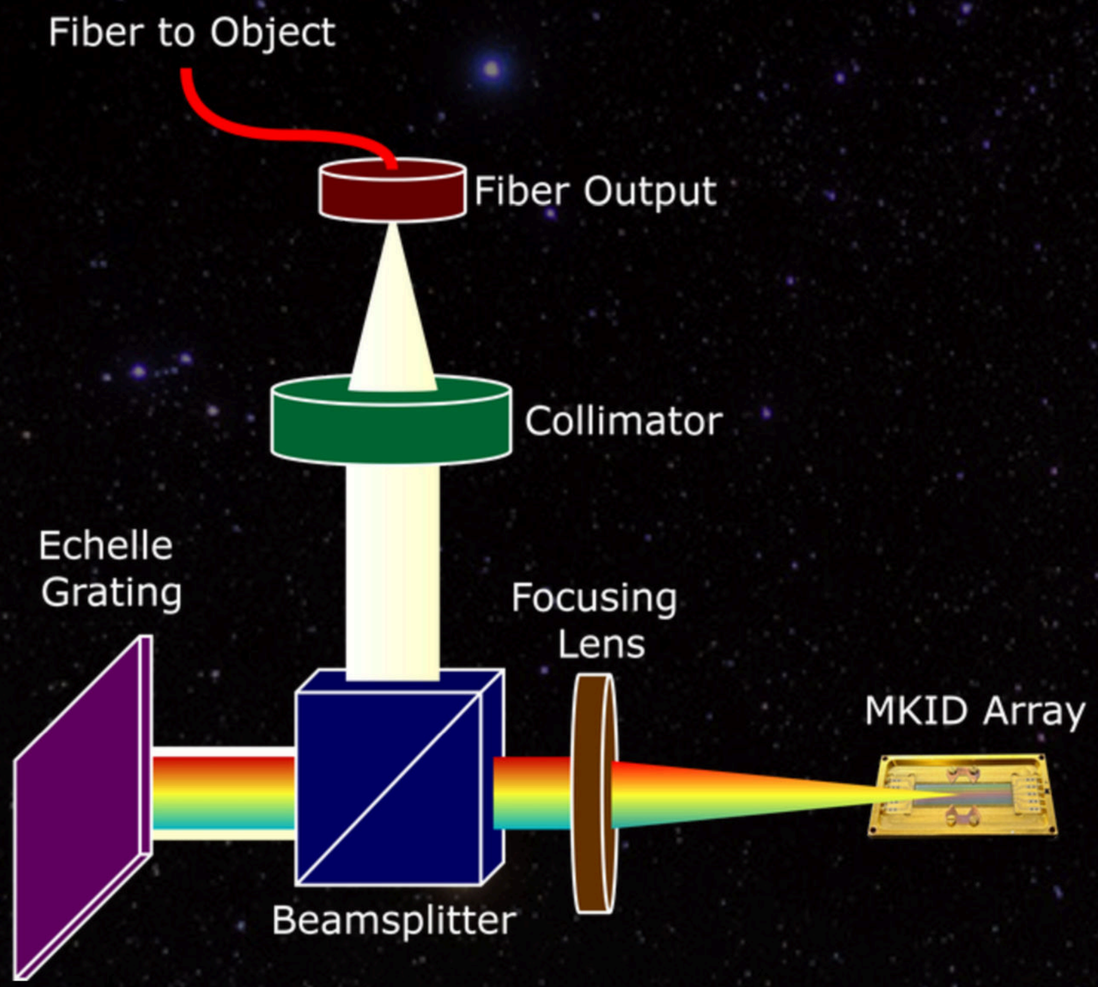

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- Total resolution R = $\lambda/d\lambda \sim 600$

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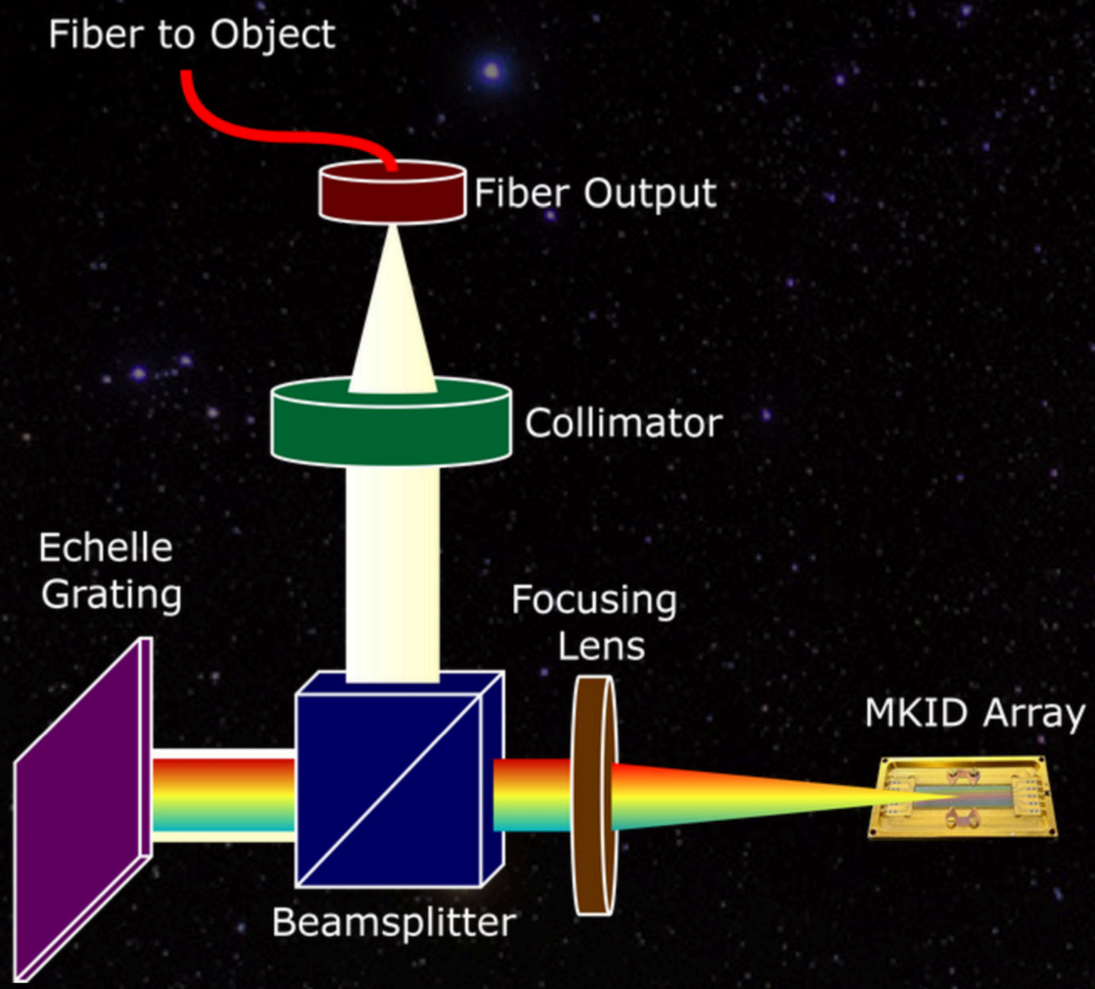

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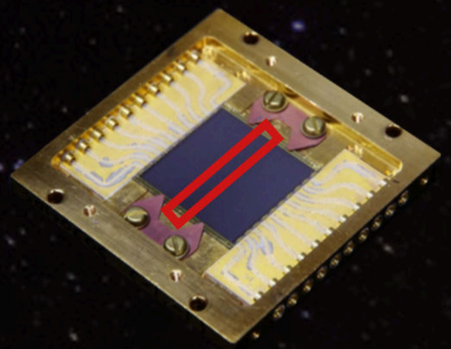
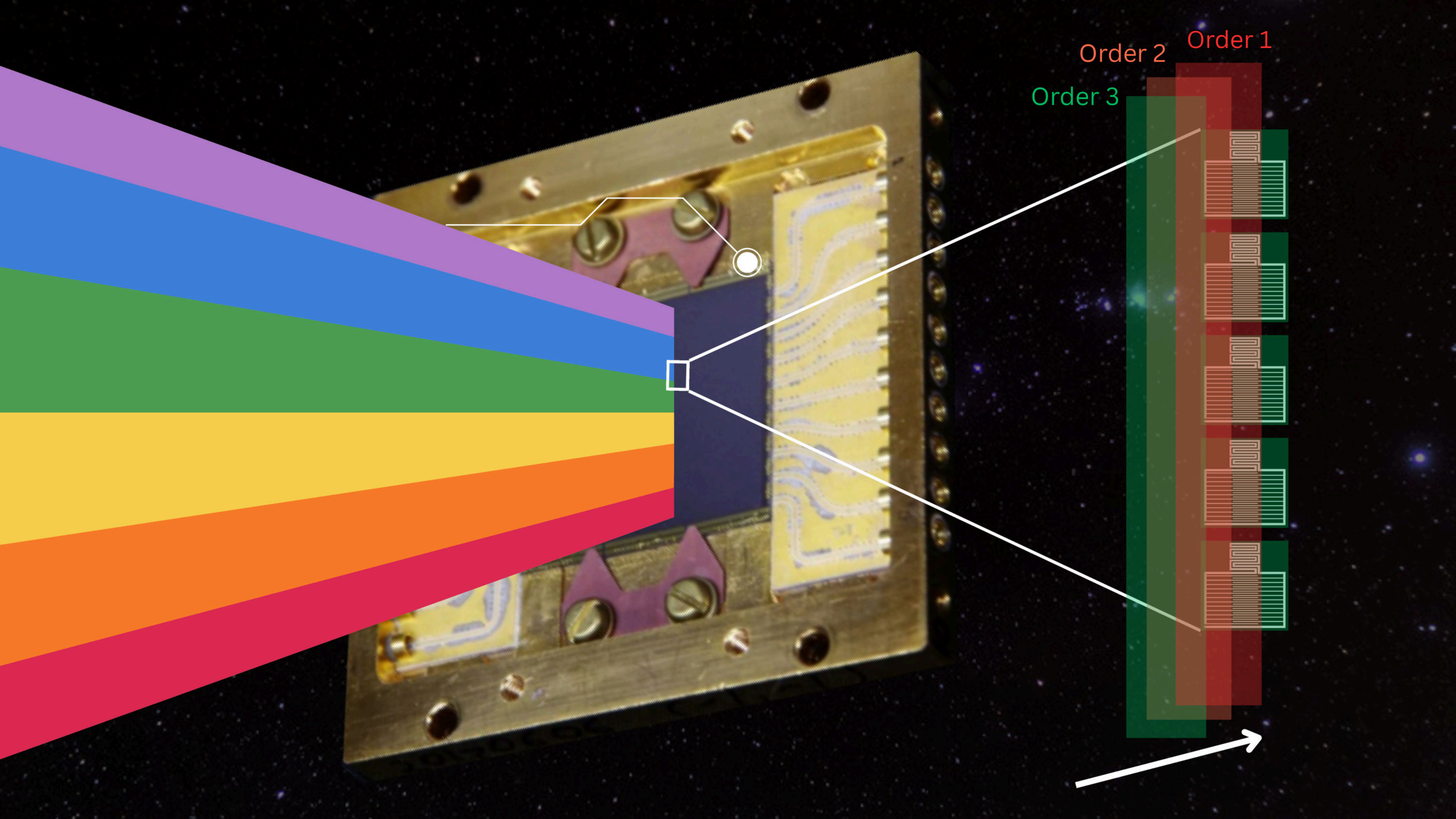
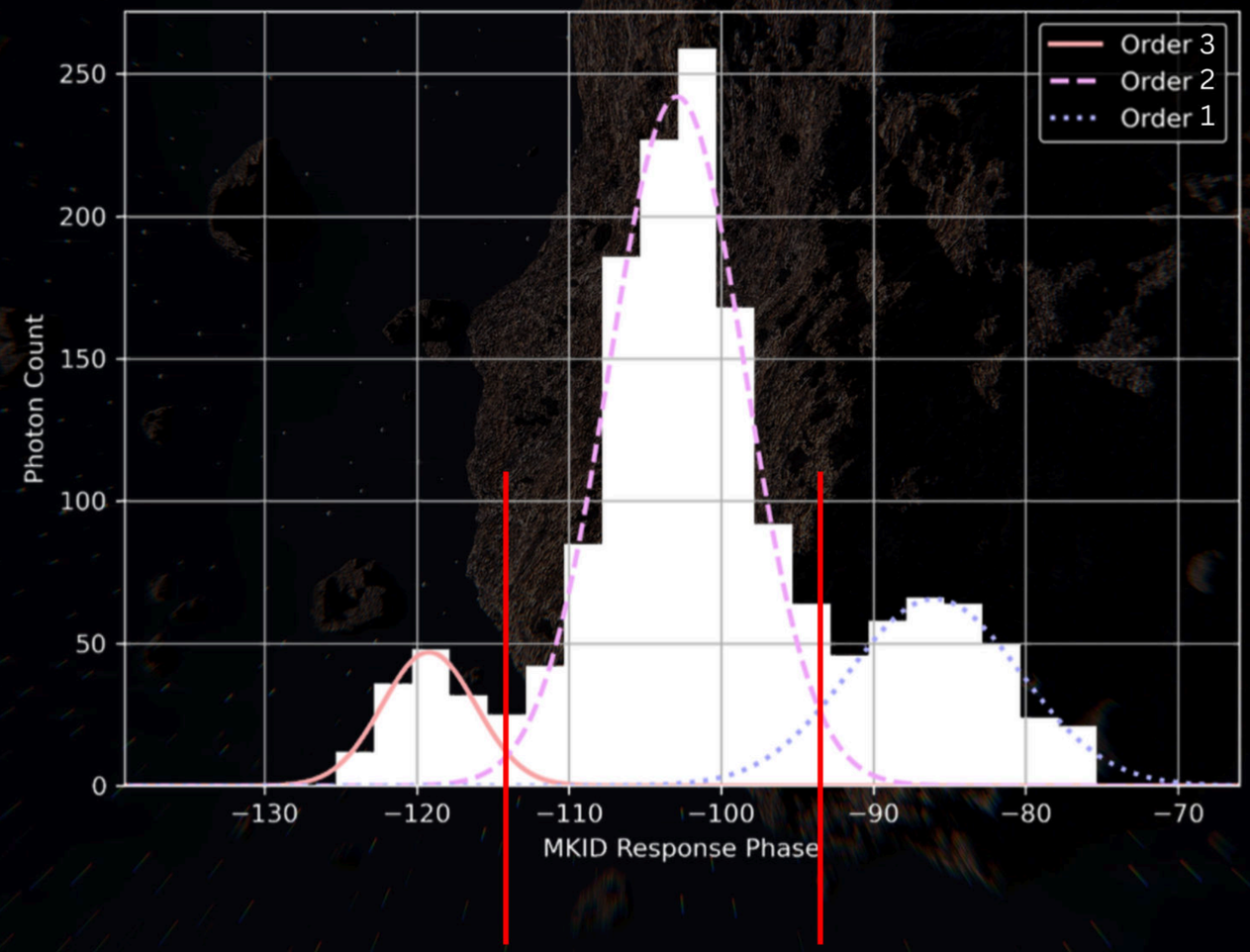
- 1 x 146 pixel MKID ‘ array’




Order 2
Order 1
Order 3

What is order-sorting?



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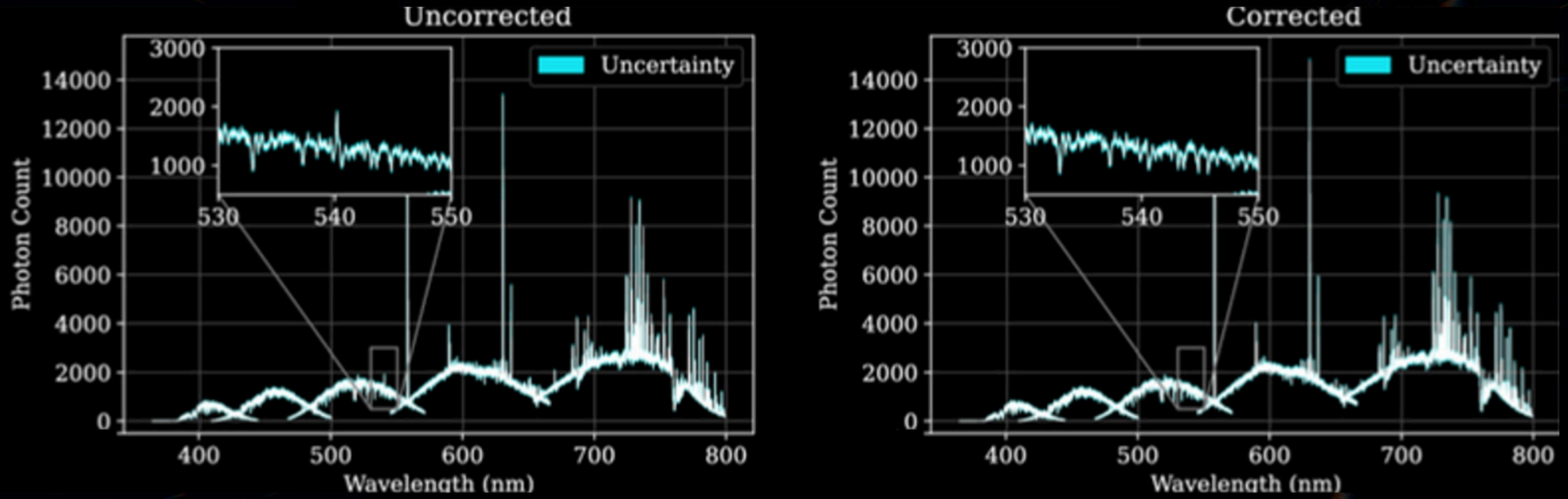

Kim et al. 2025

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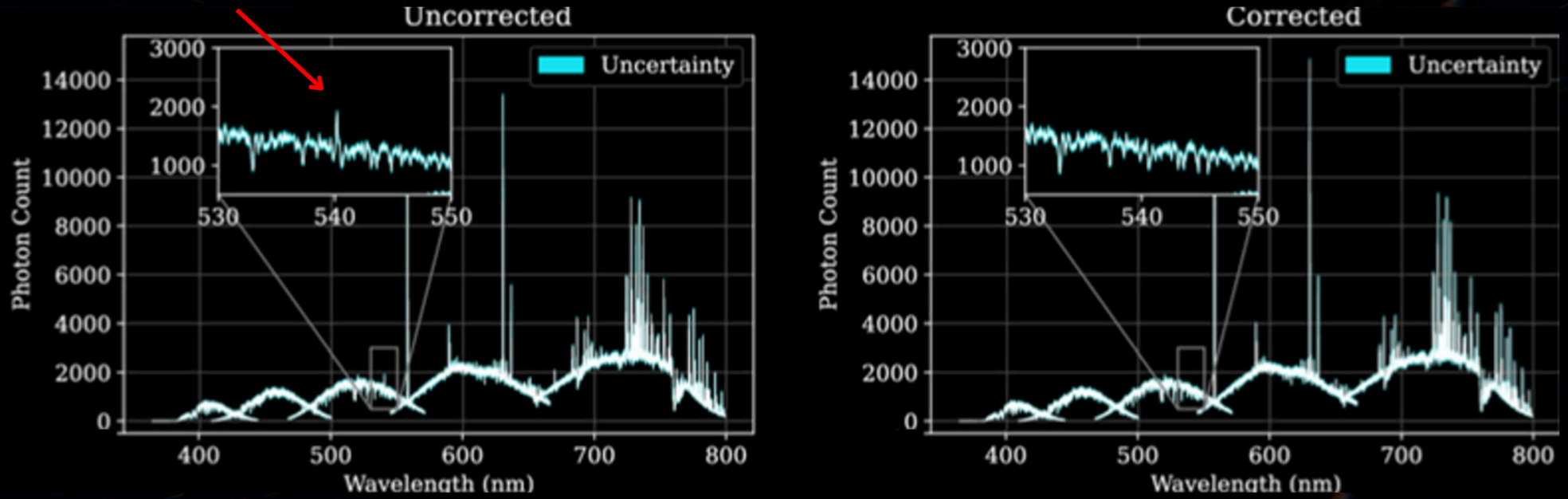

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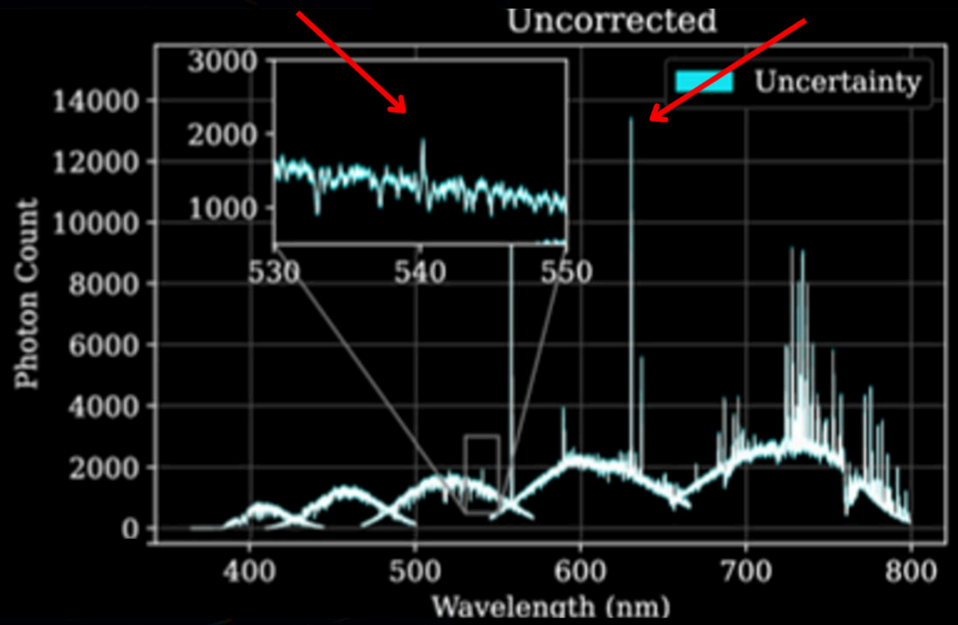

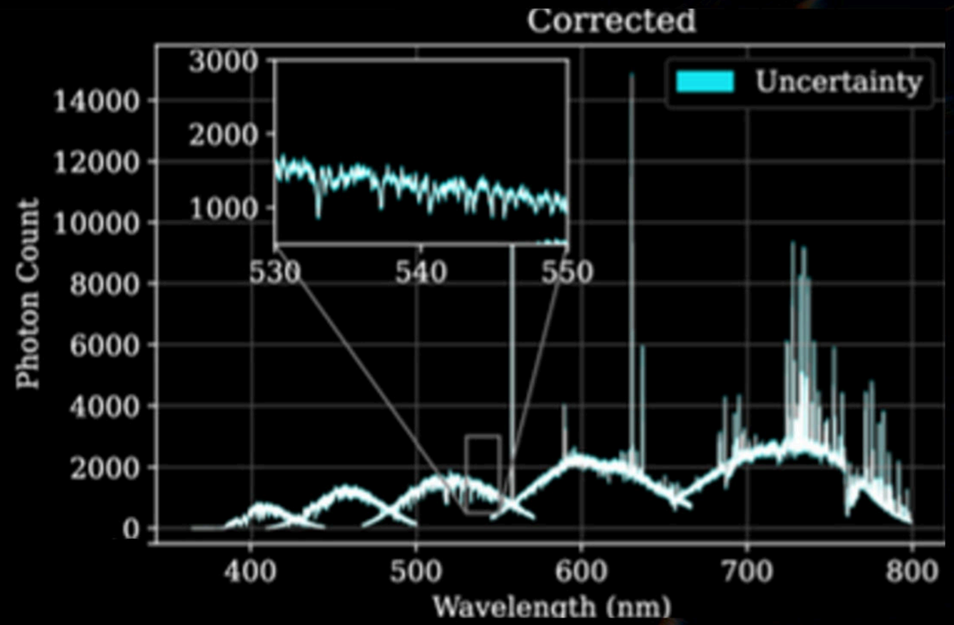

Kim et al. 2025

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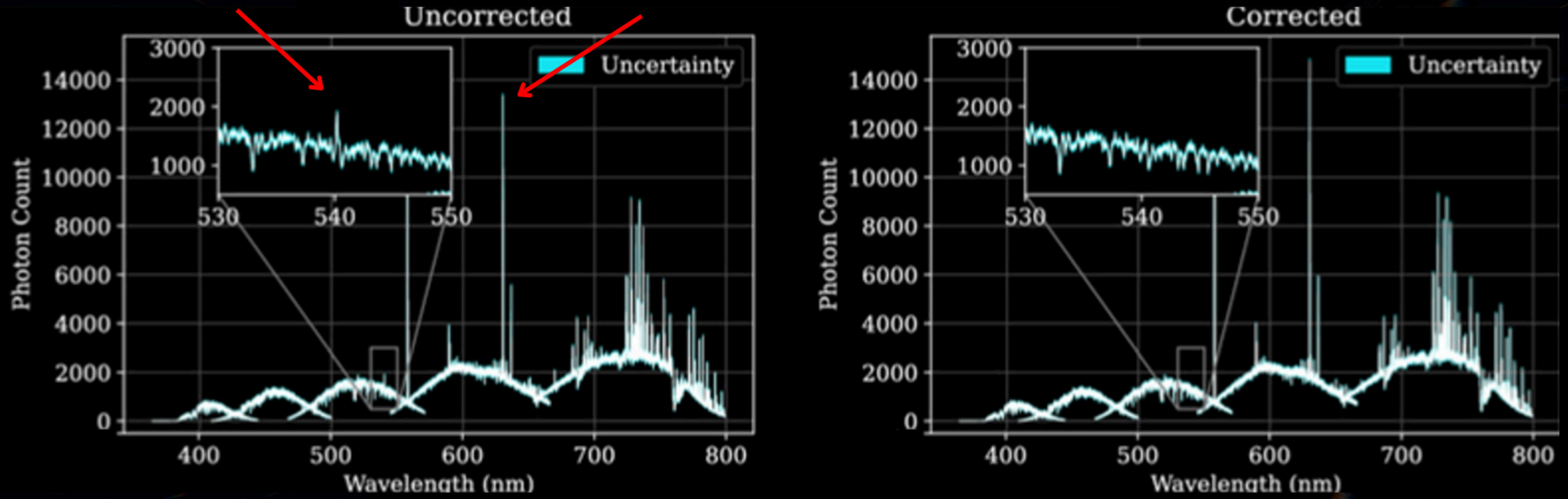
Same pixel!



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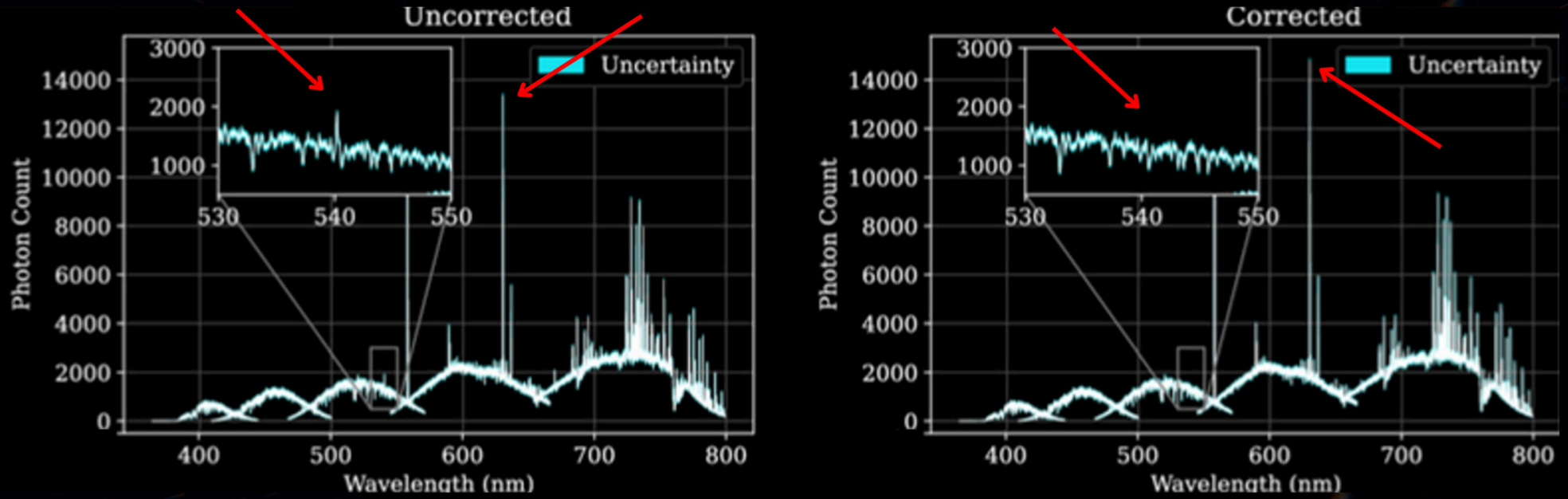

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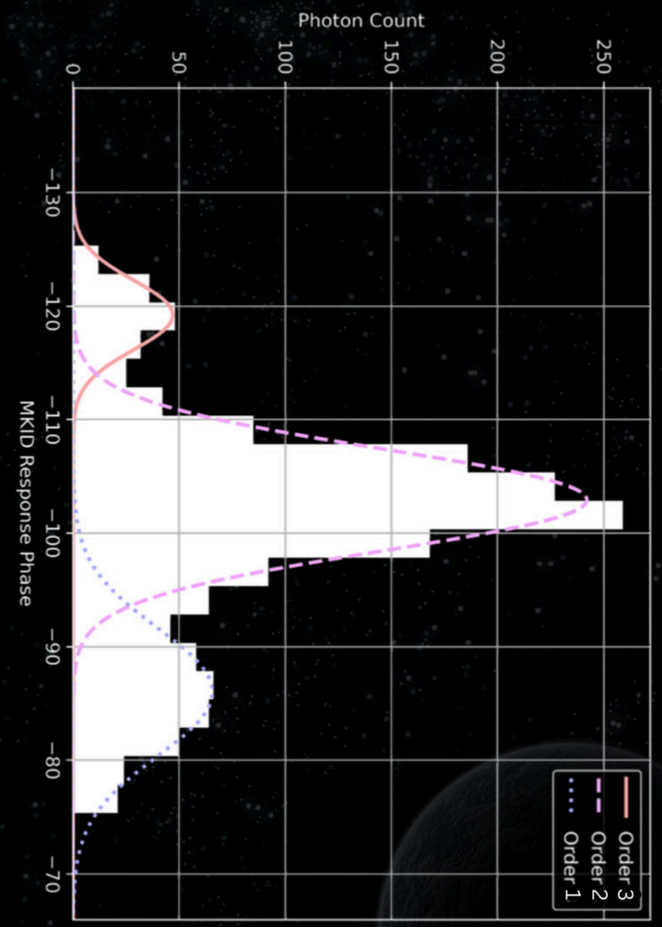
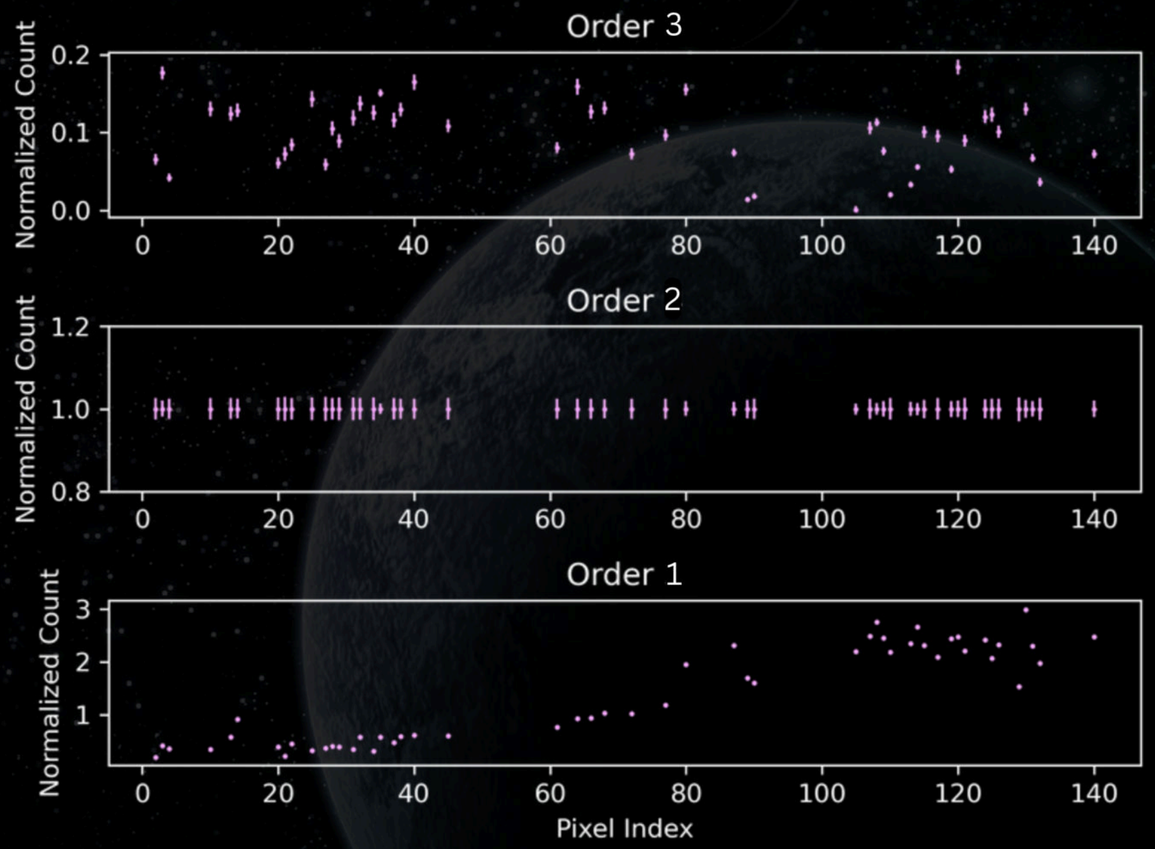
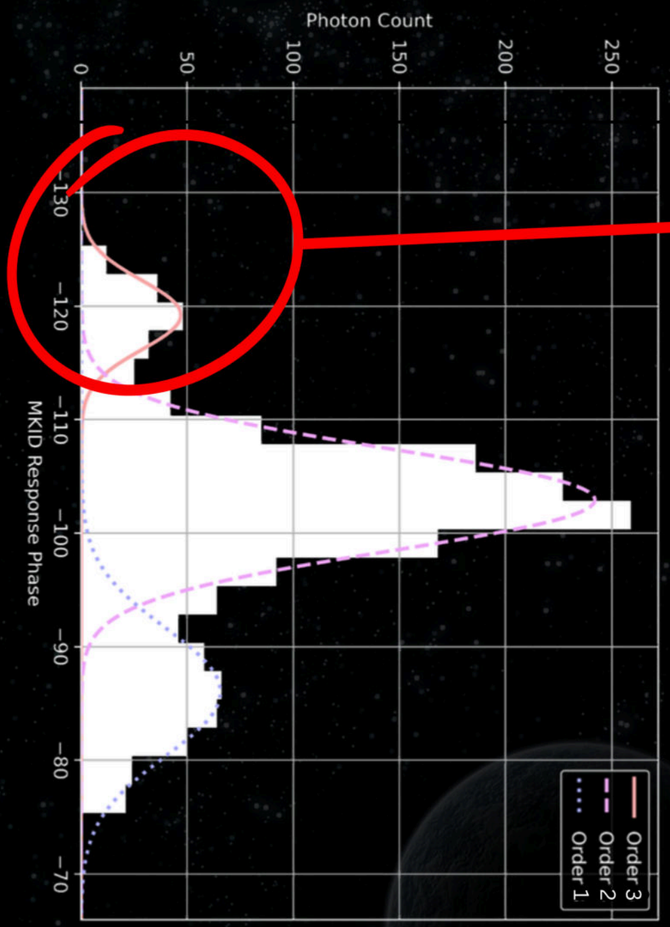
Results


Photon Count
0
50
100
150
200
250
MKID Response Phase
−130
−120
−110
−100
−90
−80
−70
Order 3
Order 2
Order 1


Order 3
Normalized Count
0.2
0.1
0.0
0
20
40
60
80
100
120
140
Order 2
Normalized Count
1.2
1.0
0.8
Order 1
Normalized Count
3
2
1
Pixel Index

Results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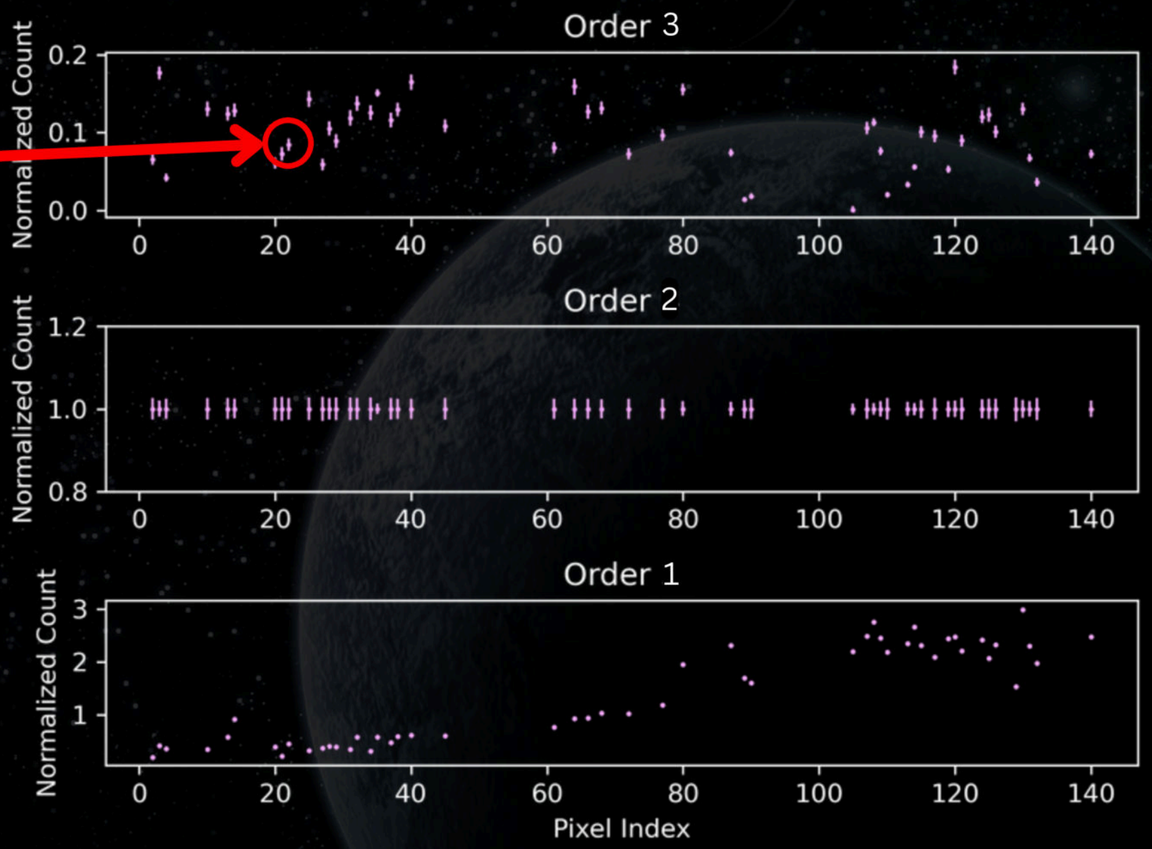
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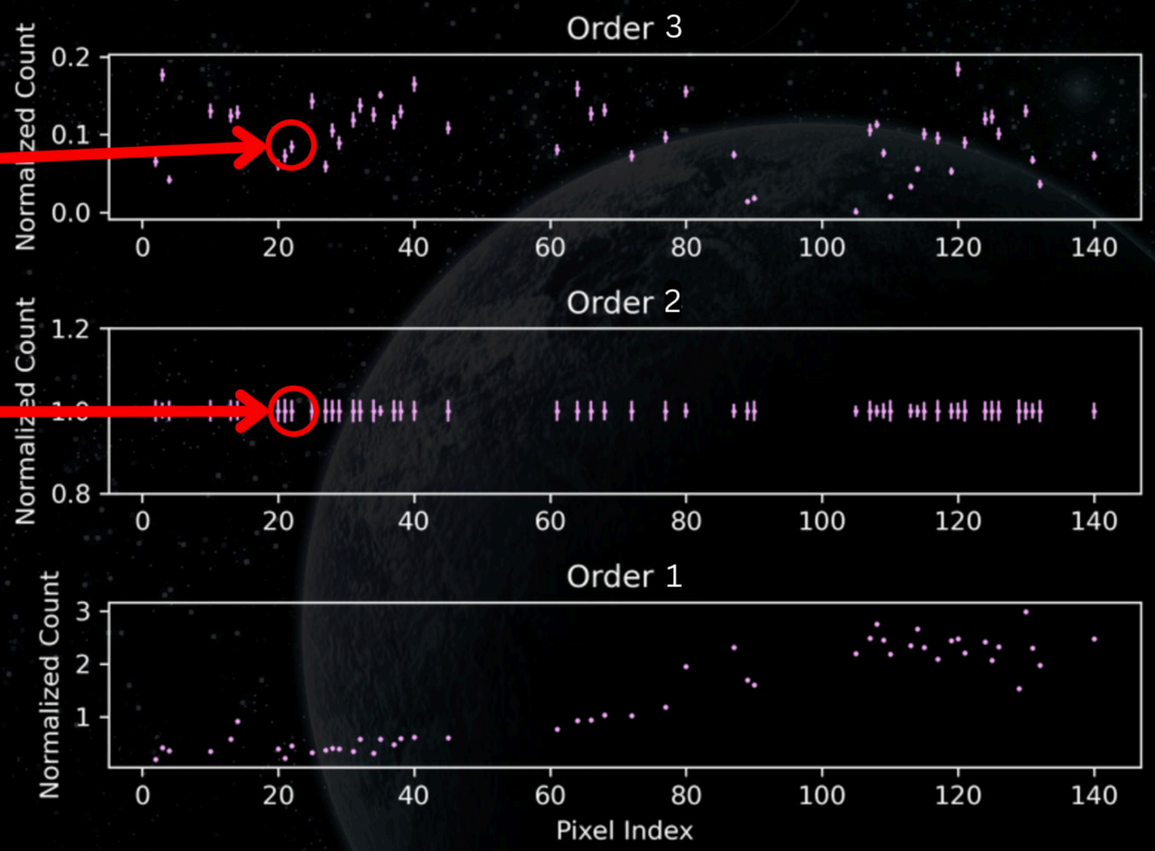
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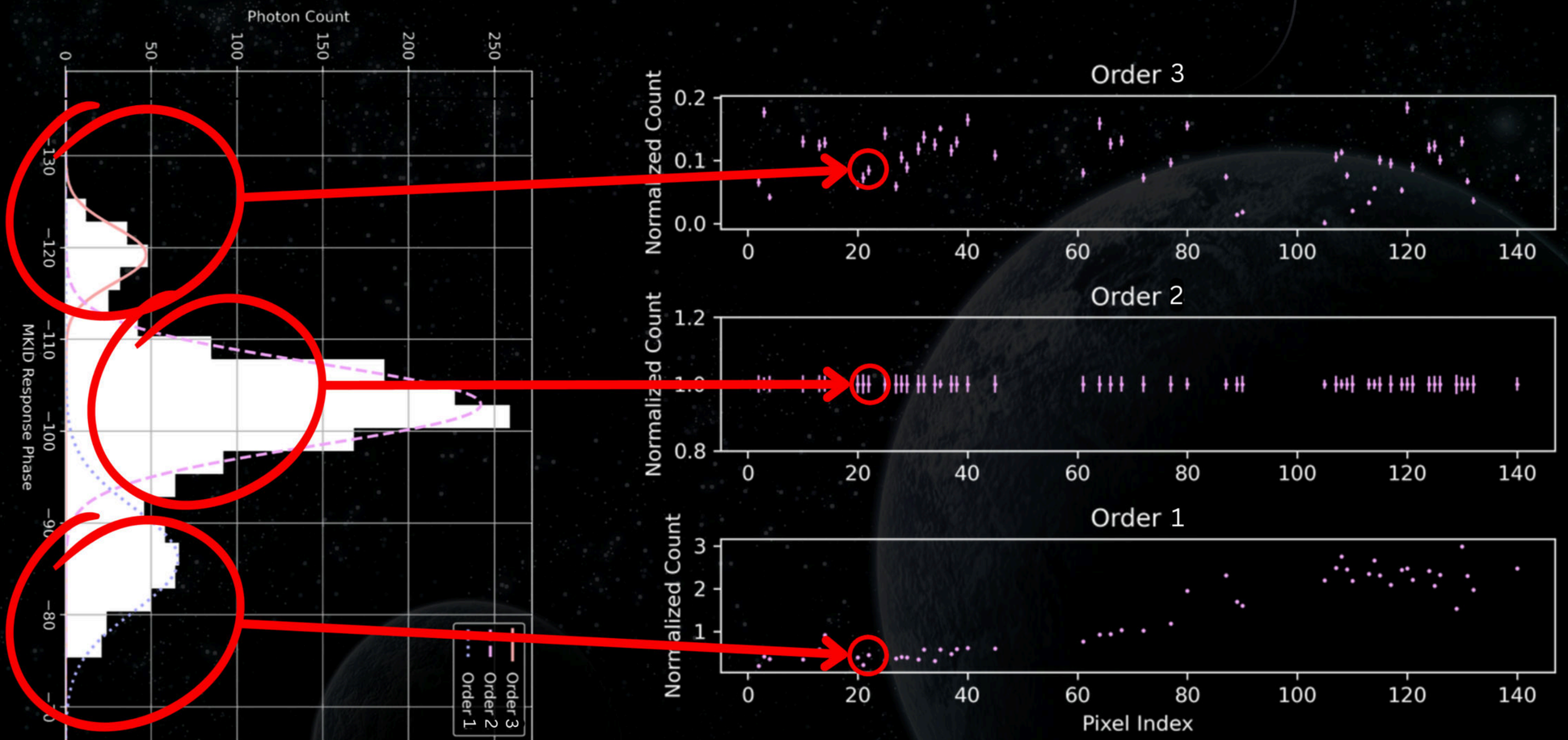
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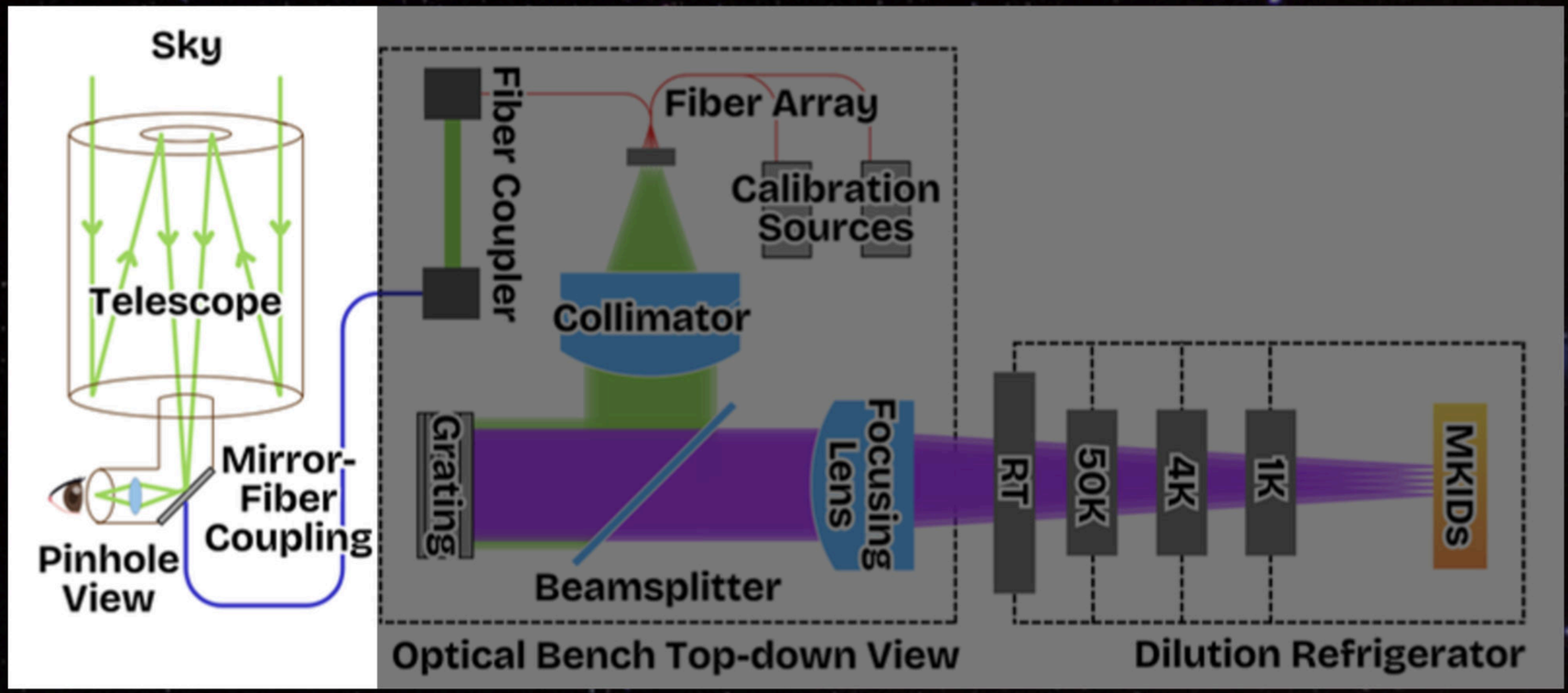
Big Picture

True (Intended) Design:

- Small telescope-to-fiber coupling



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True (Intended) Design:

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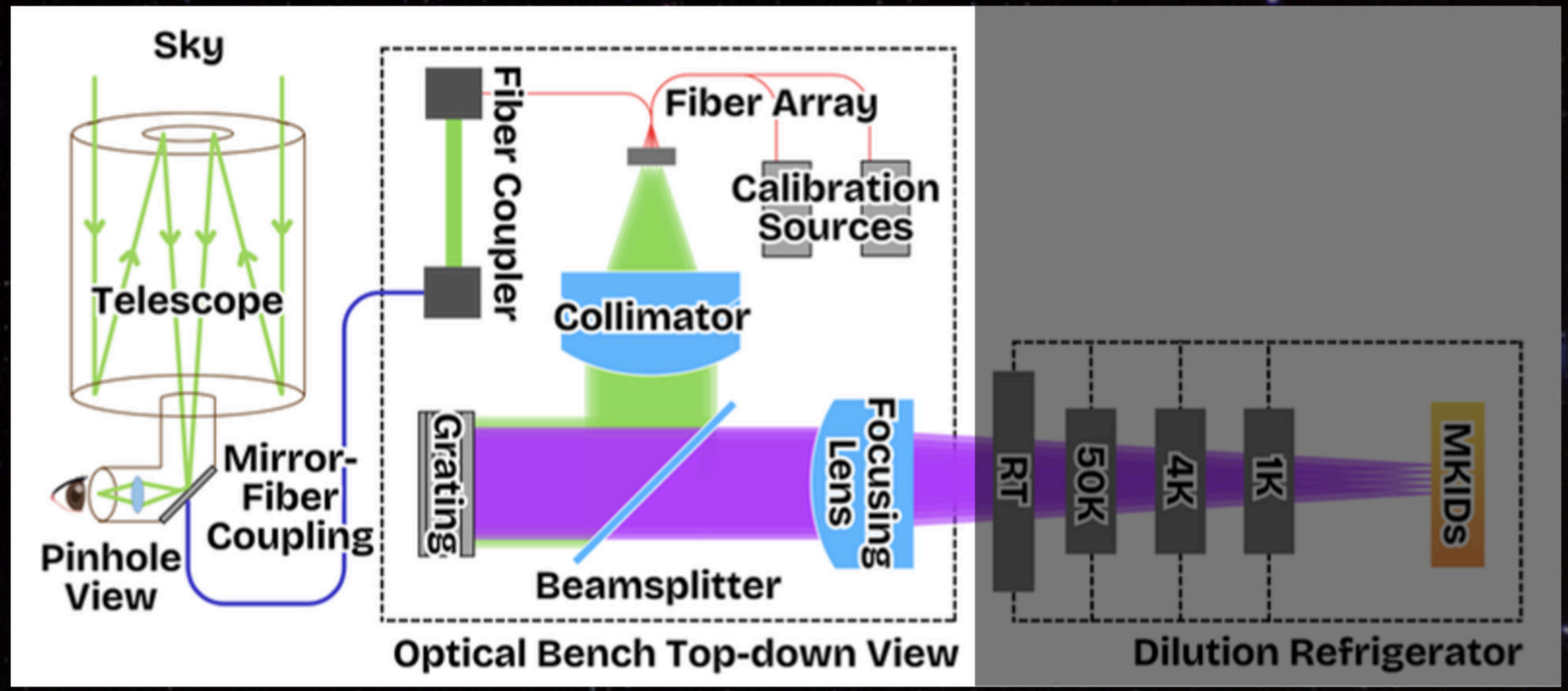
- 5 spectral orders from 400-800nm
- 5-fibers (objects)



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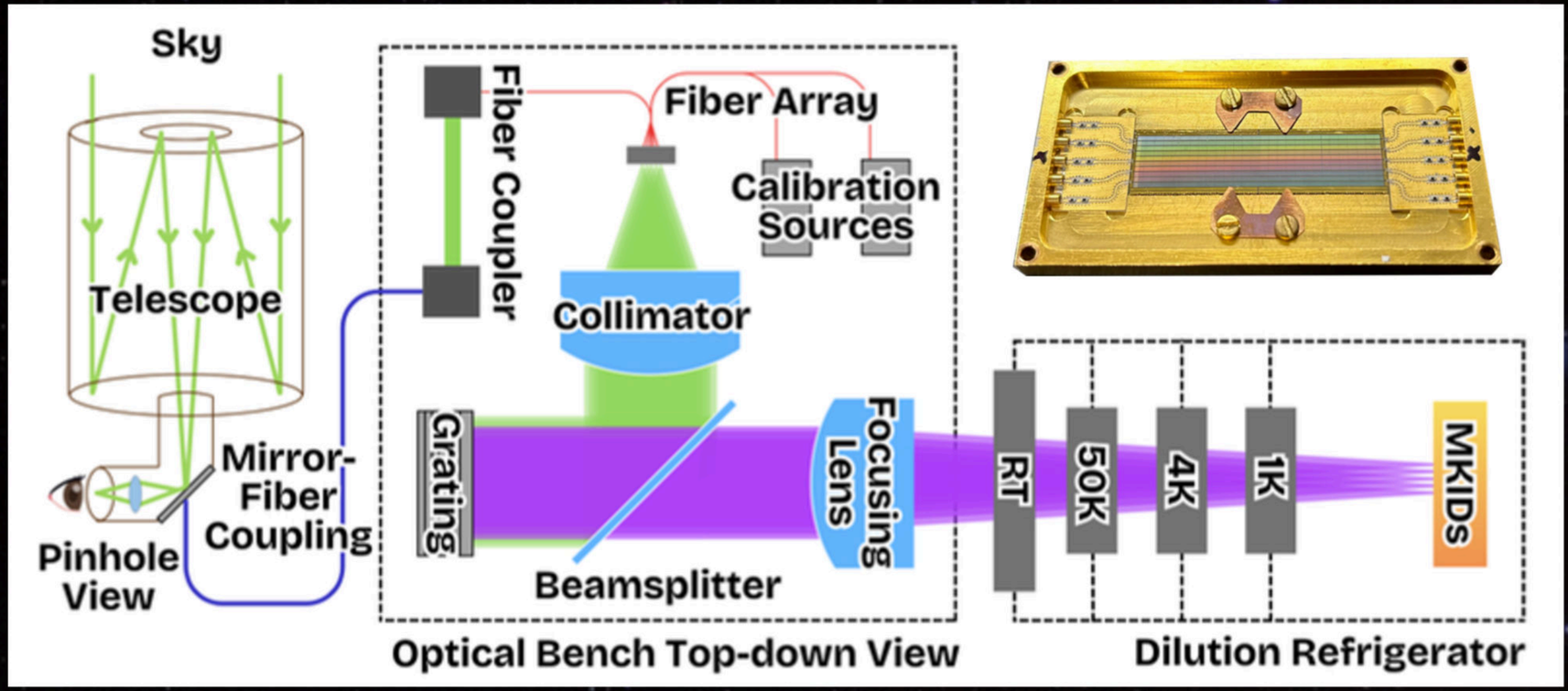
- Total resolution › 3000
- 5 x 2048 pixel MKID array



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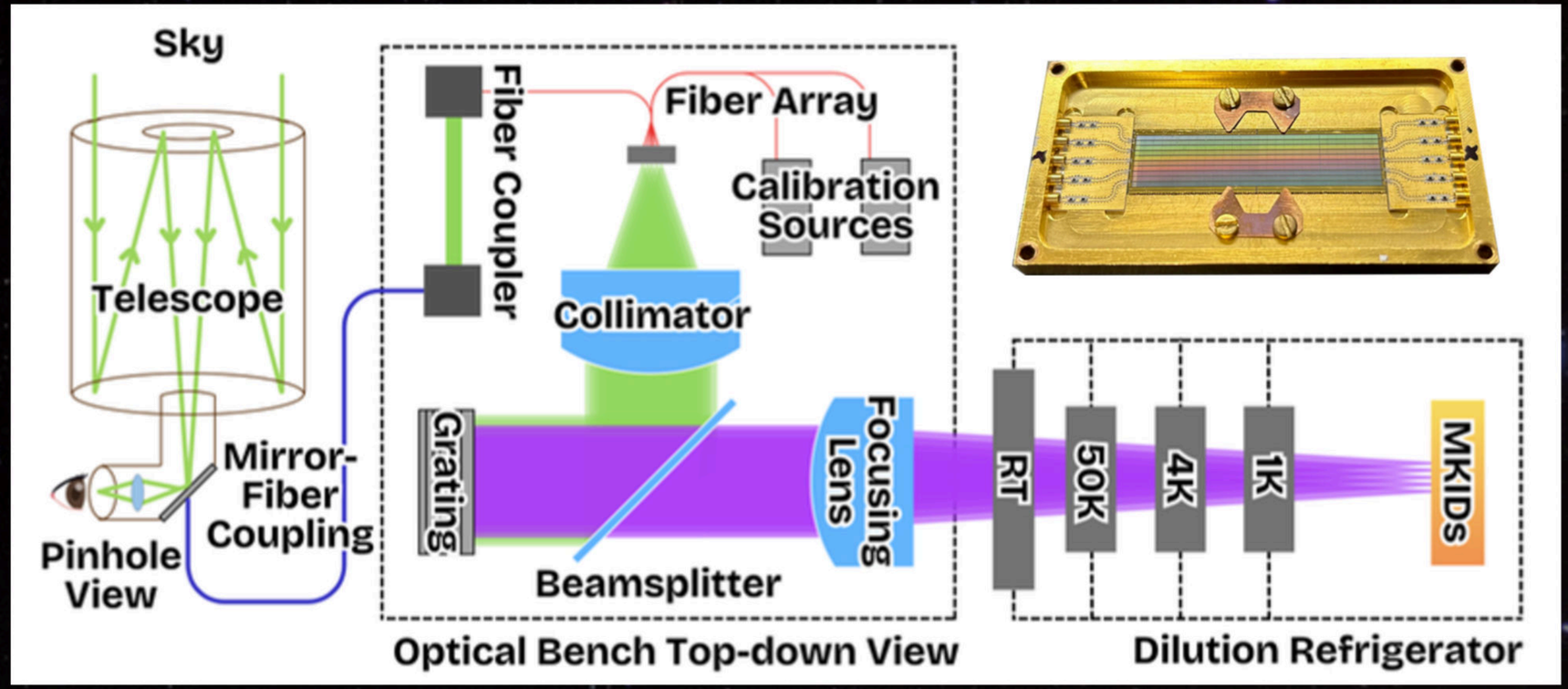
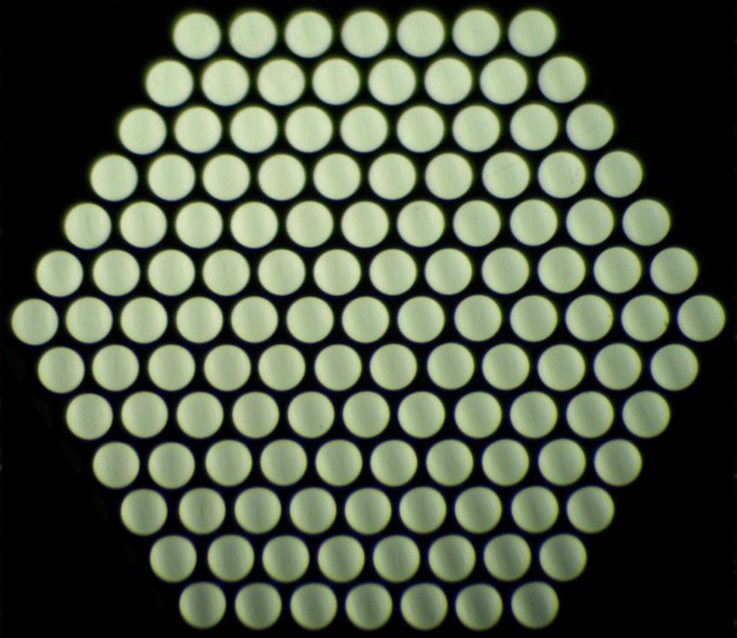
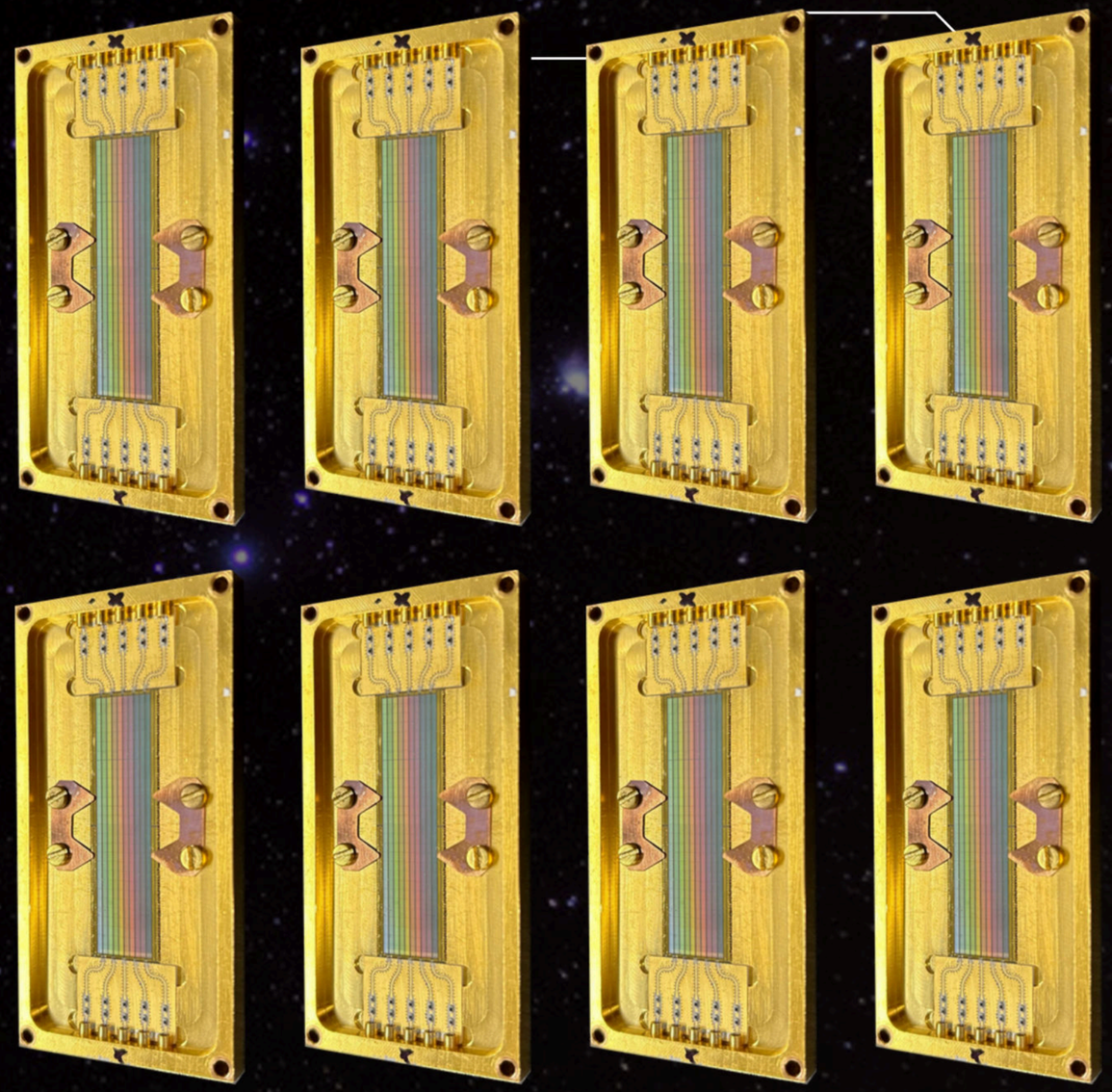
Coming 2026!



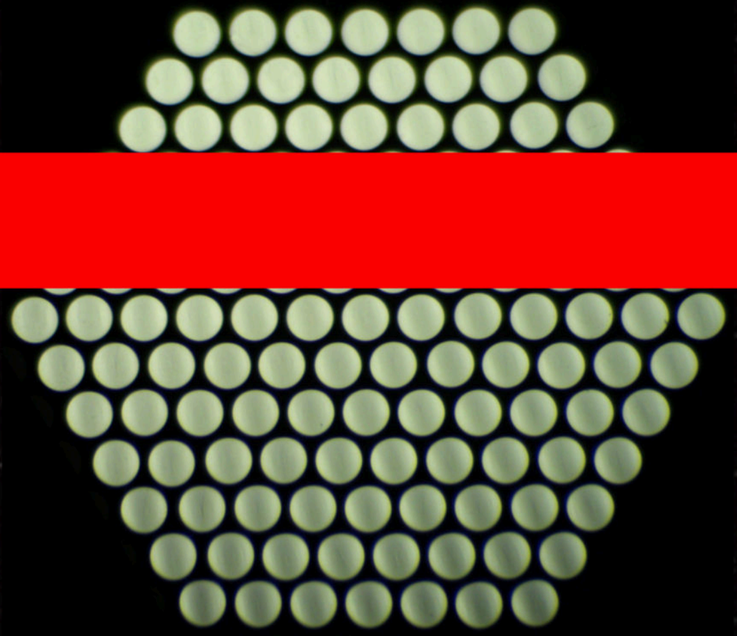
Big Picture



MOMOS IFS?



Big Picture



Questions?

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