

# Hanbury Brown & Twiss

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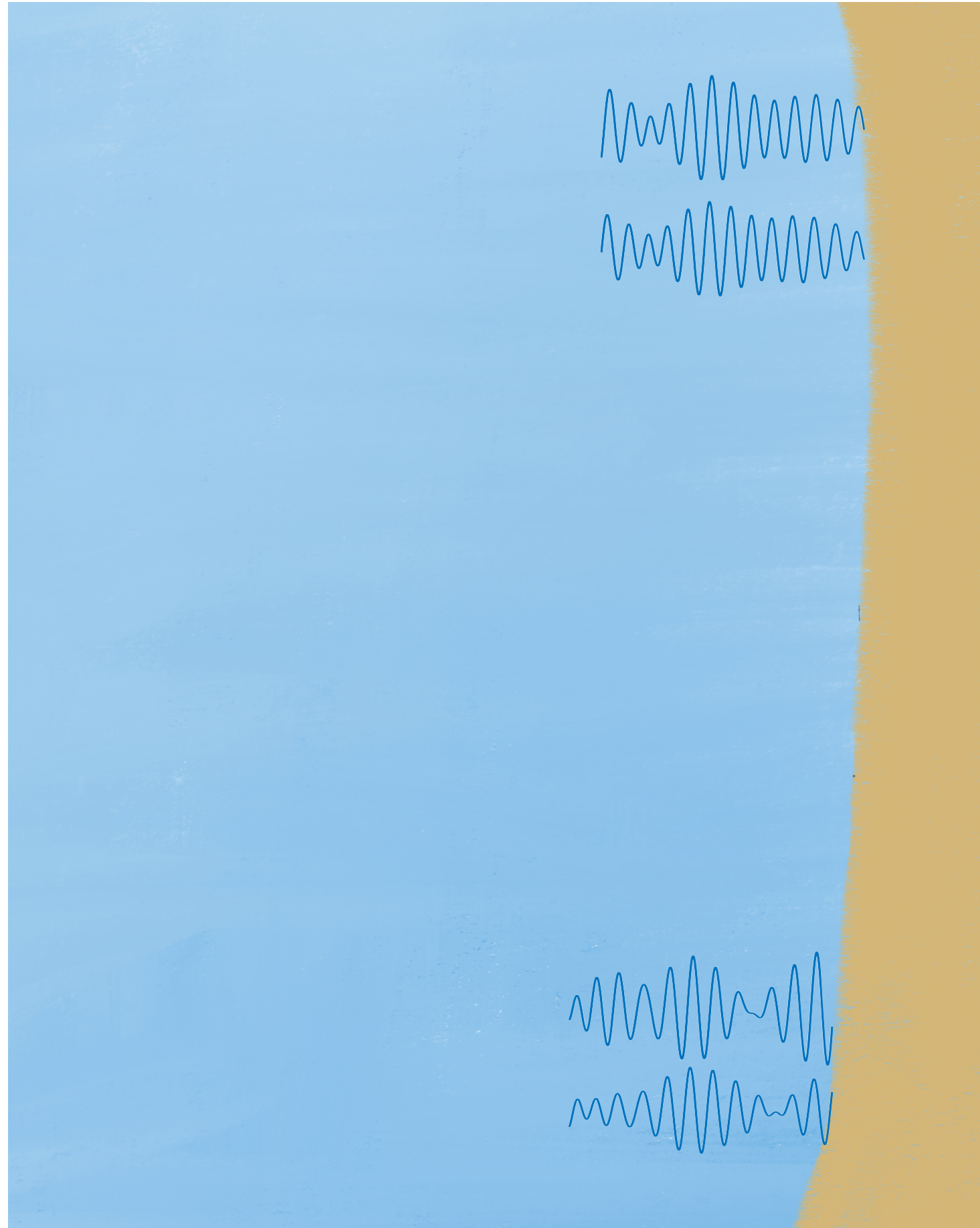
# Interferometers



# Combined ripple

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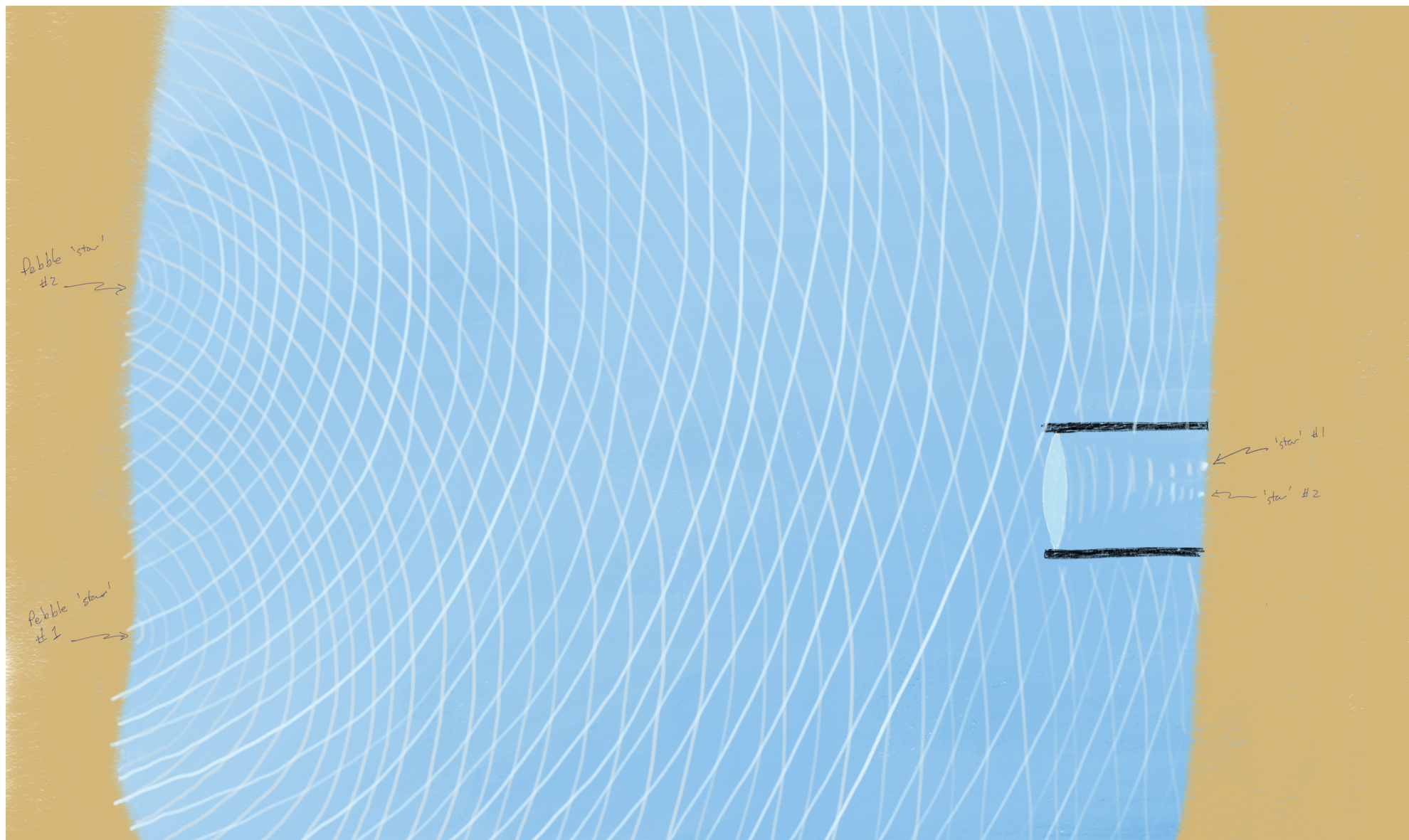
- If sources are close together, we need to walk a long way for the combined ripples to look different
- If sources are far apart, we don't need to walk very far for the ripples to look different



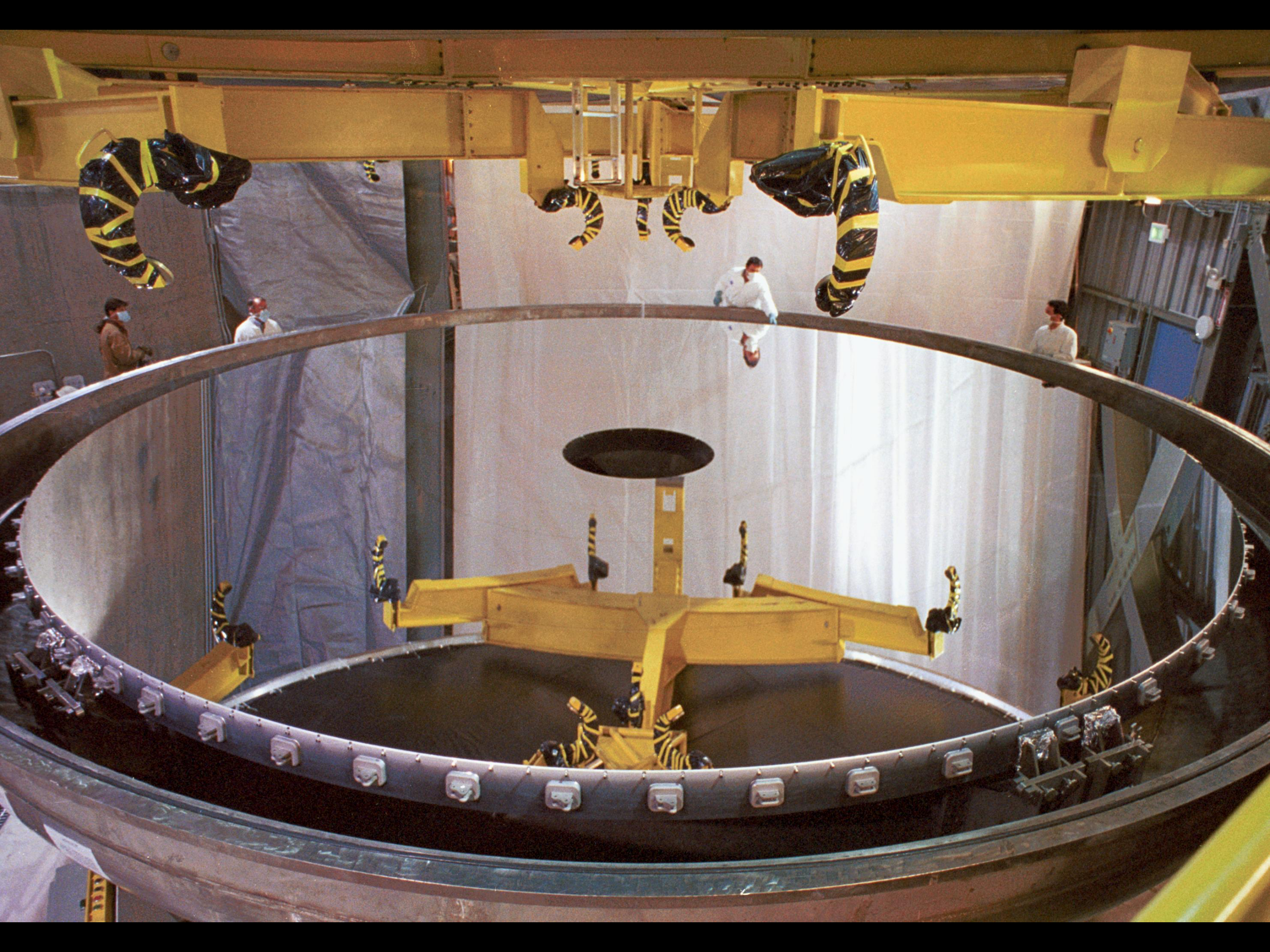
# Telescope resolution

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- If waves look different at different edges of the telescope, it can sort the light
- Bigger the telescope, the better the resolution (ability to sort)



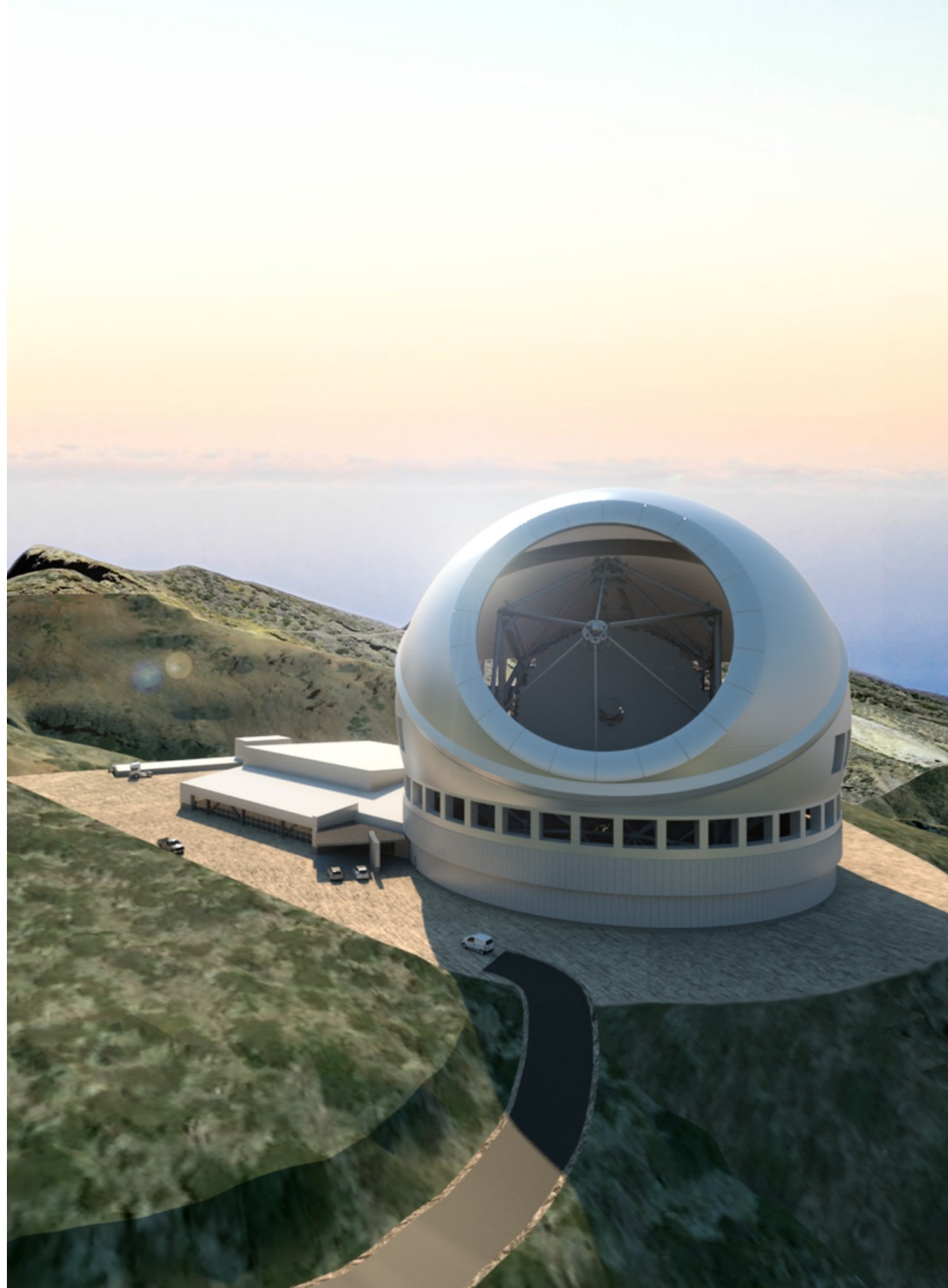






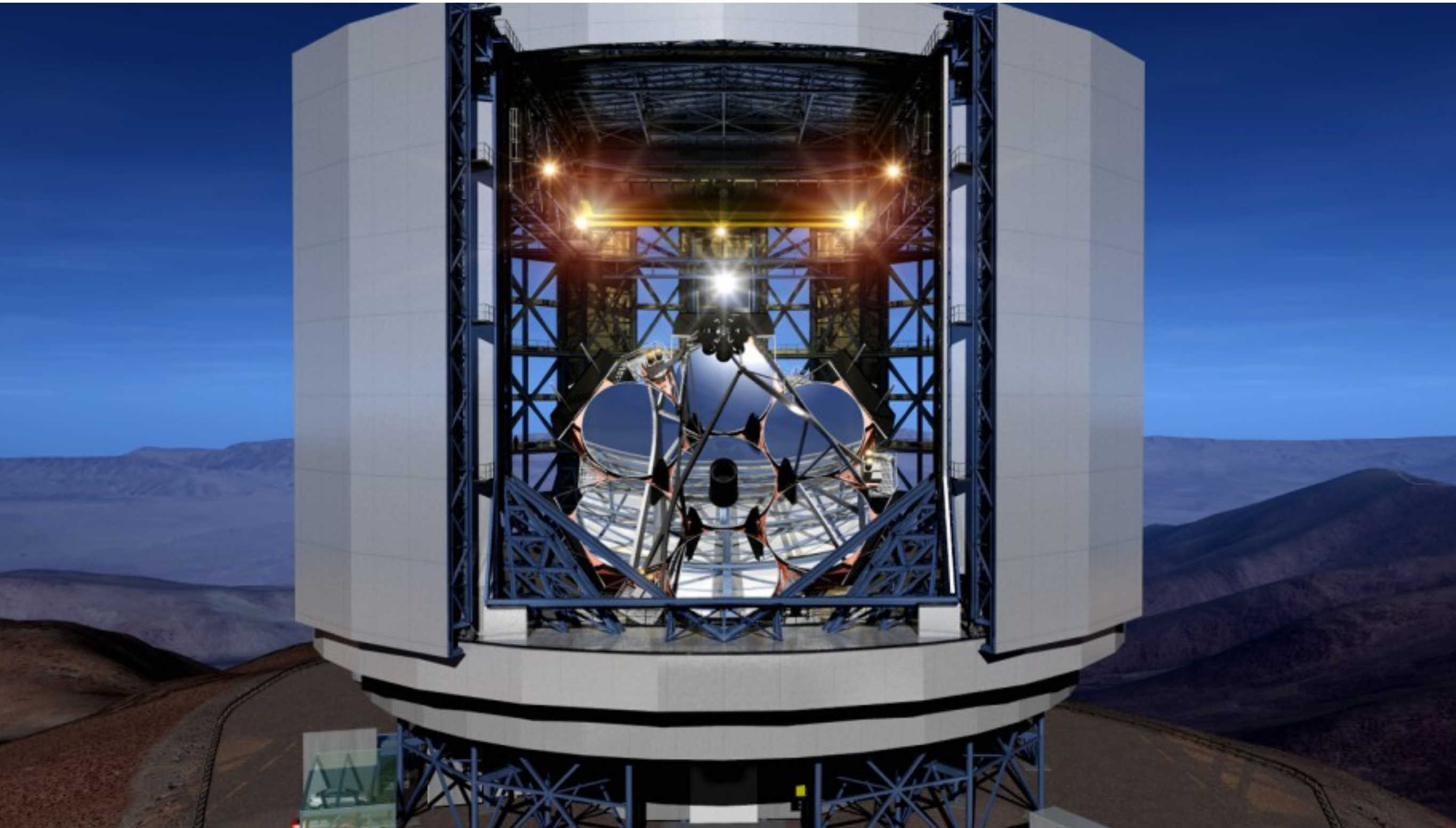
# Thirty meter telescope

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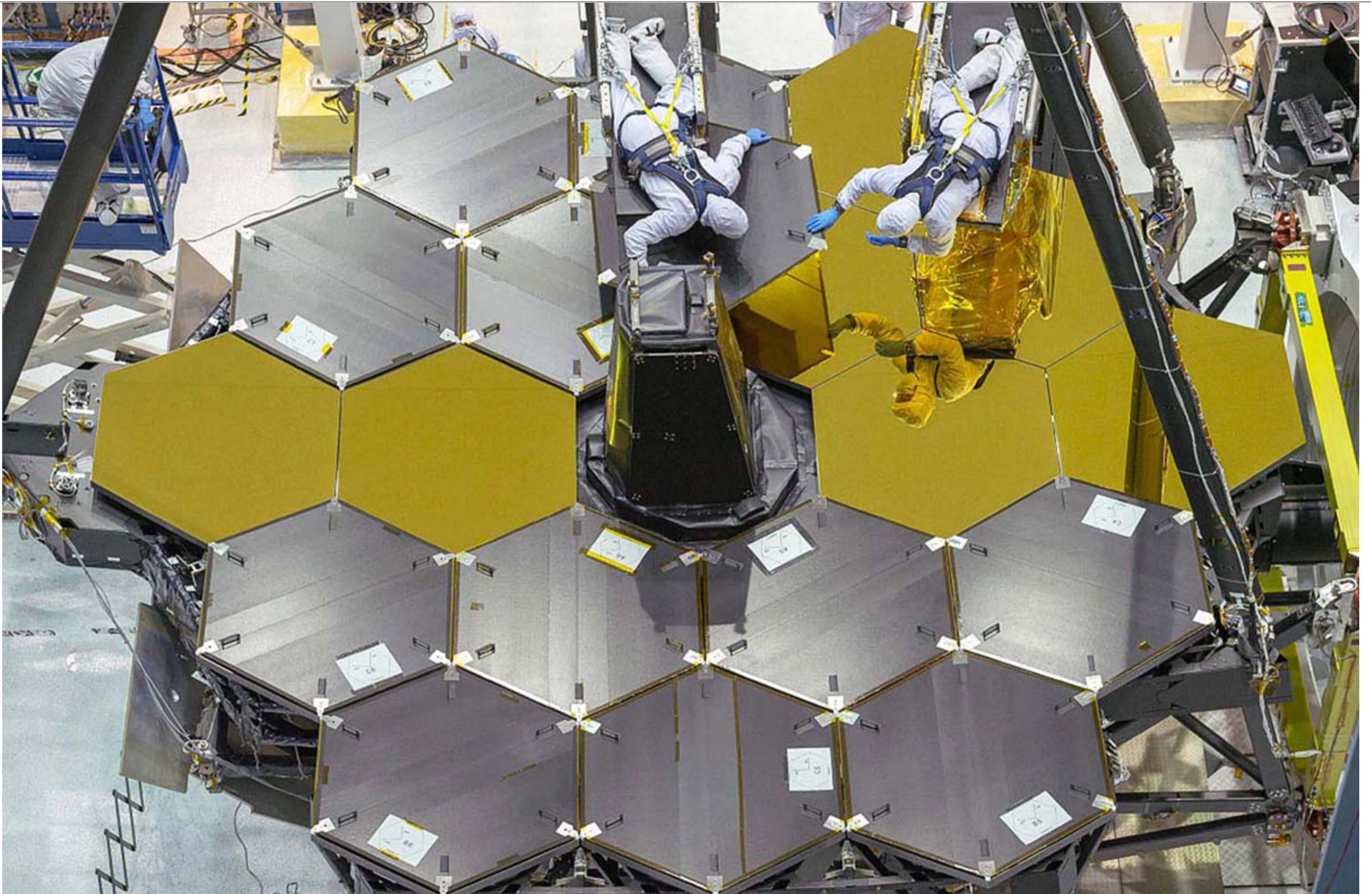
# Giant Magellan Telescope

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# James Web Space Telescope

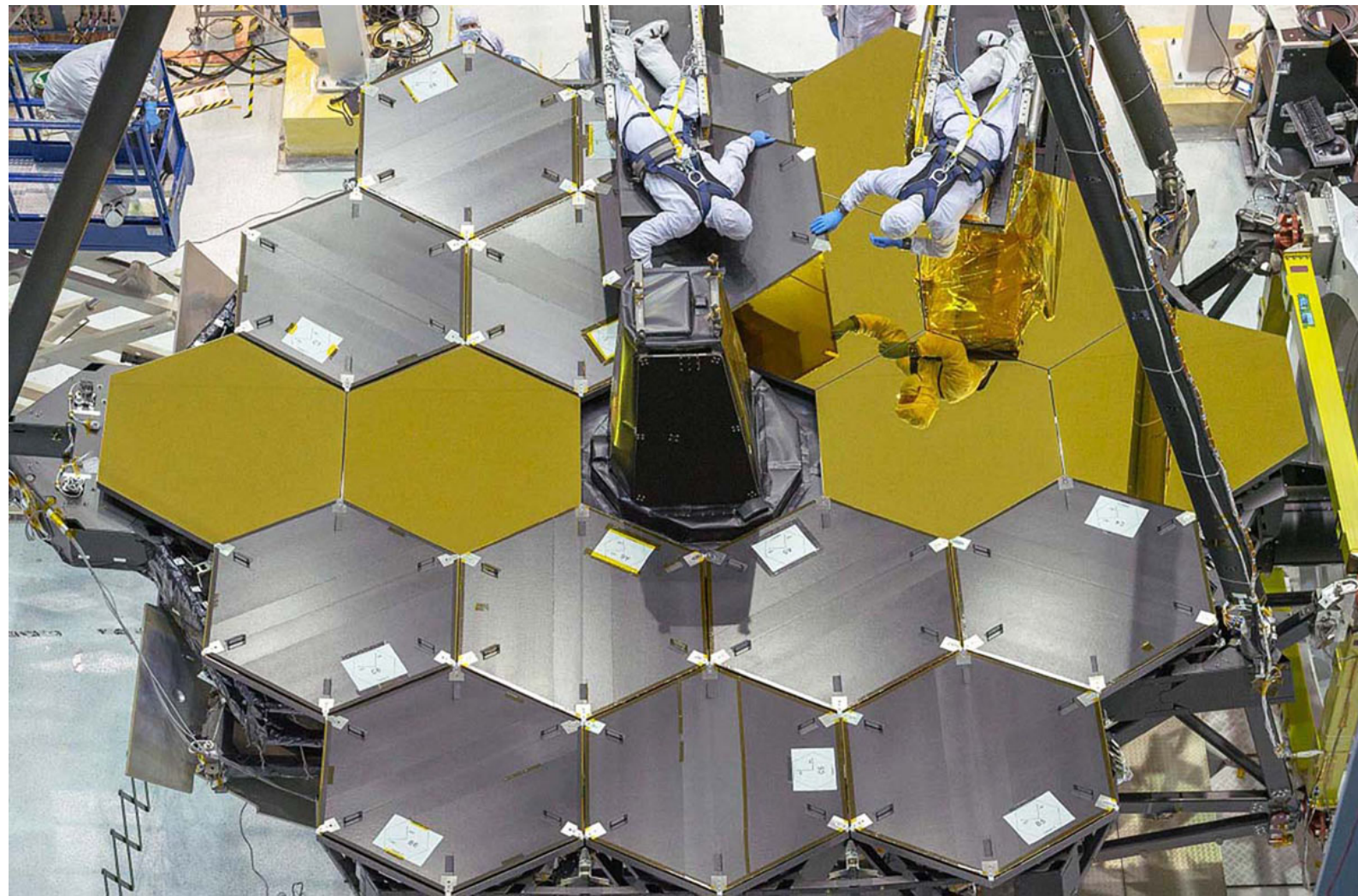




# How to think of an interferometer

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- Break a great big mirror into pieces
- Reassemble the pieces
- What happens if you don't put them all back together?

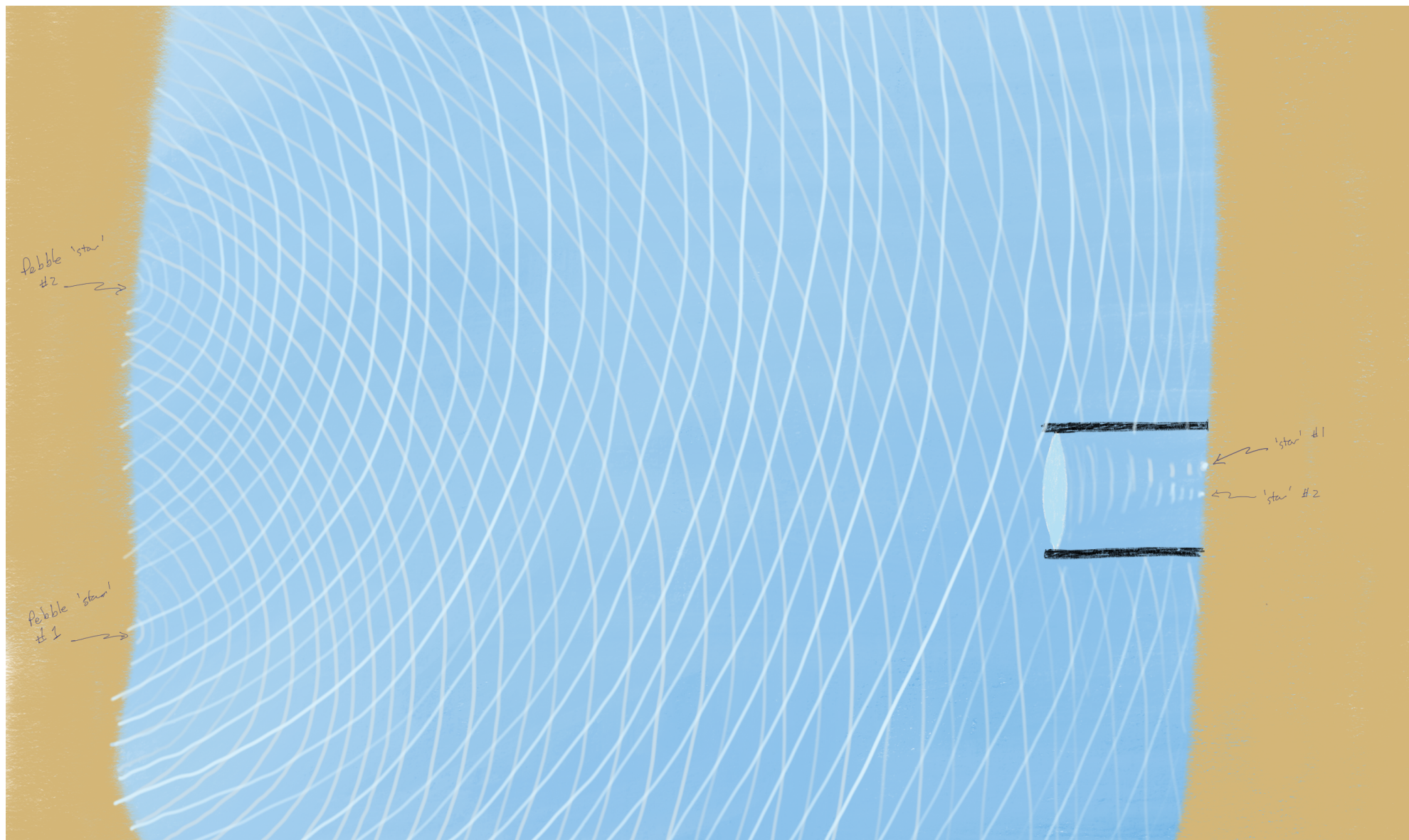




# Interferometer resolution

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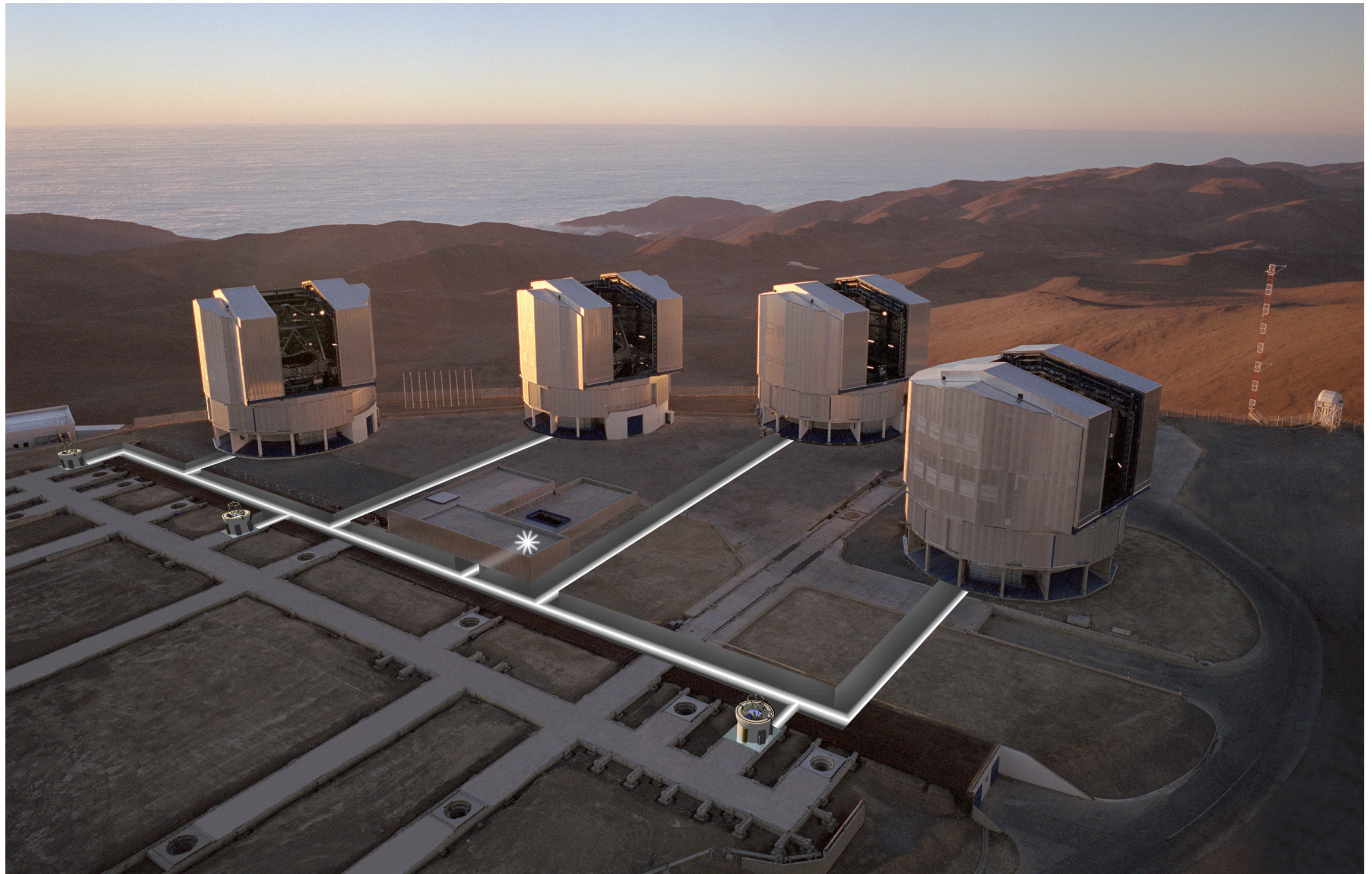
- **Great resolution (very large section of beach)**
- **Not as much light as full mirror of same size**





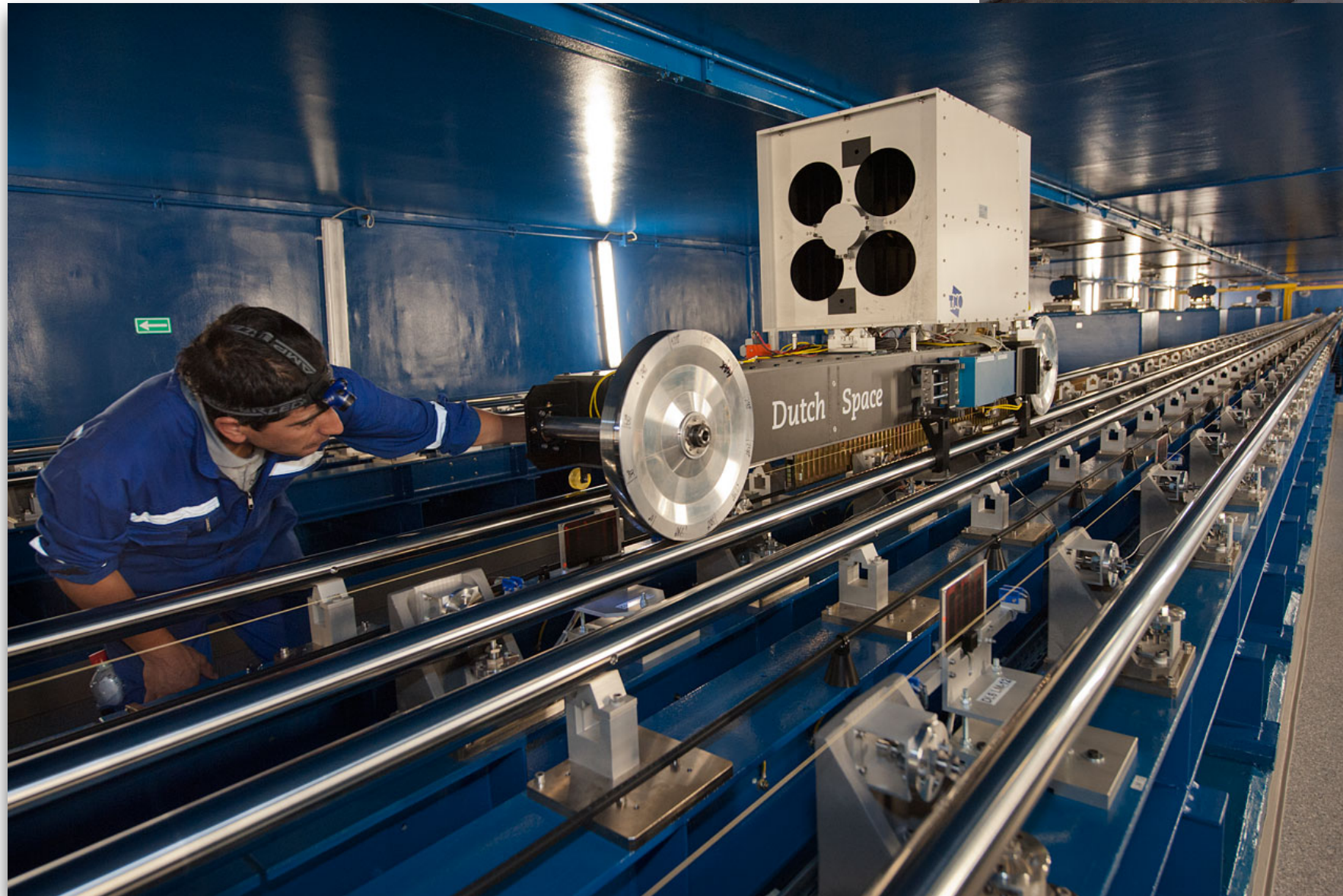
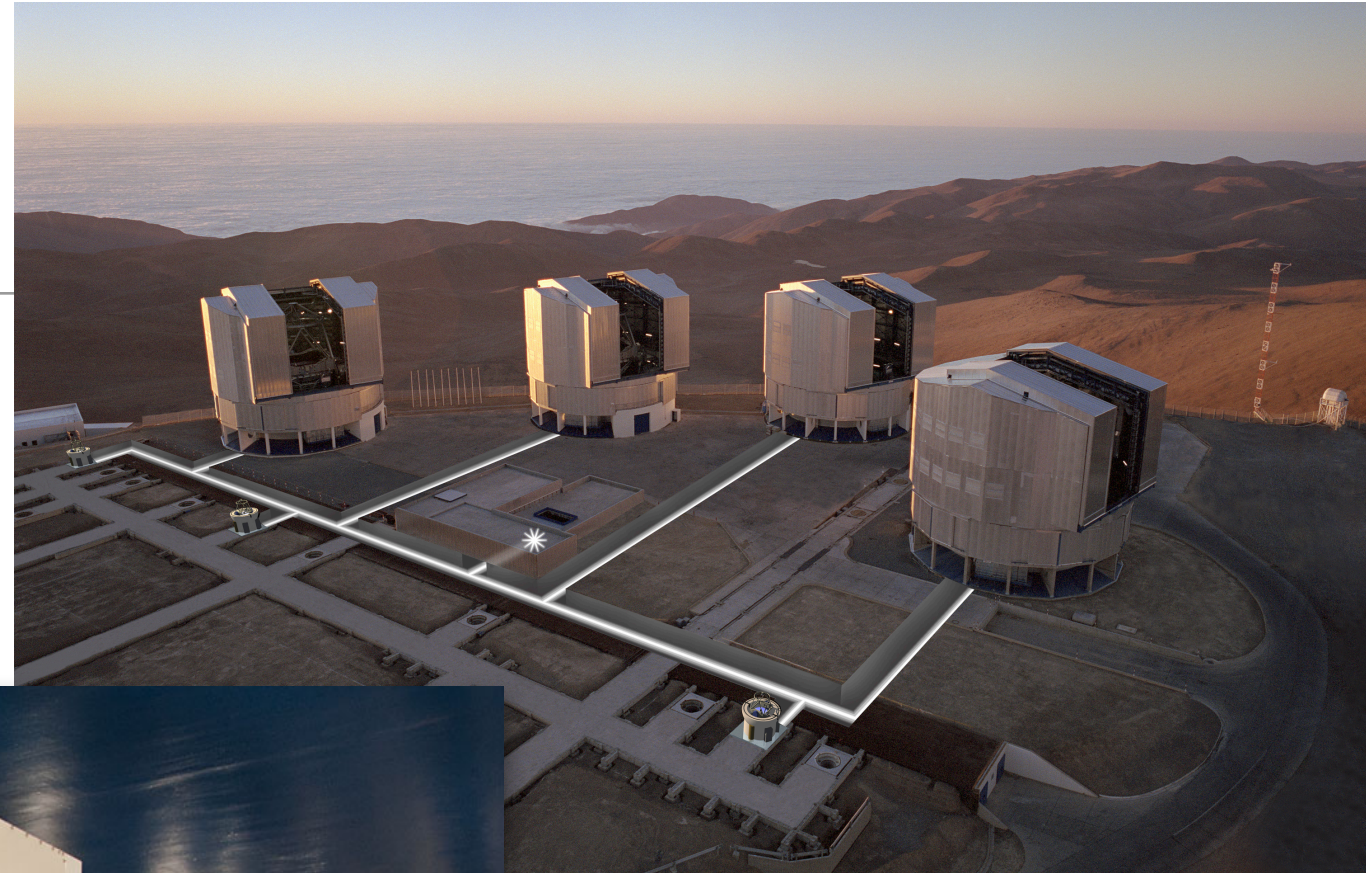
# VLT optical interferometer

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# Aligning an interferometer



Must be kept in alignment to less than a micron



# Movies

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<https://youtu.be/SarQyl4Z-YE?list=PLIjtd-EN90Lh3-AIj9cT4rYNCPU7p5jfM&t=76>

<https://vimeo.com/73104737>



# Australia Compact Array



Hanbury Brown & Twiss

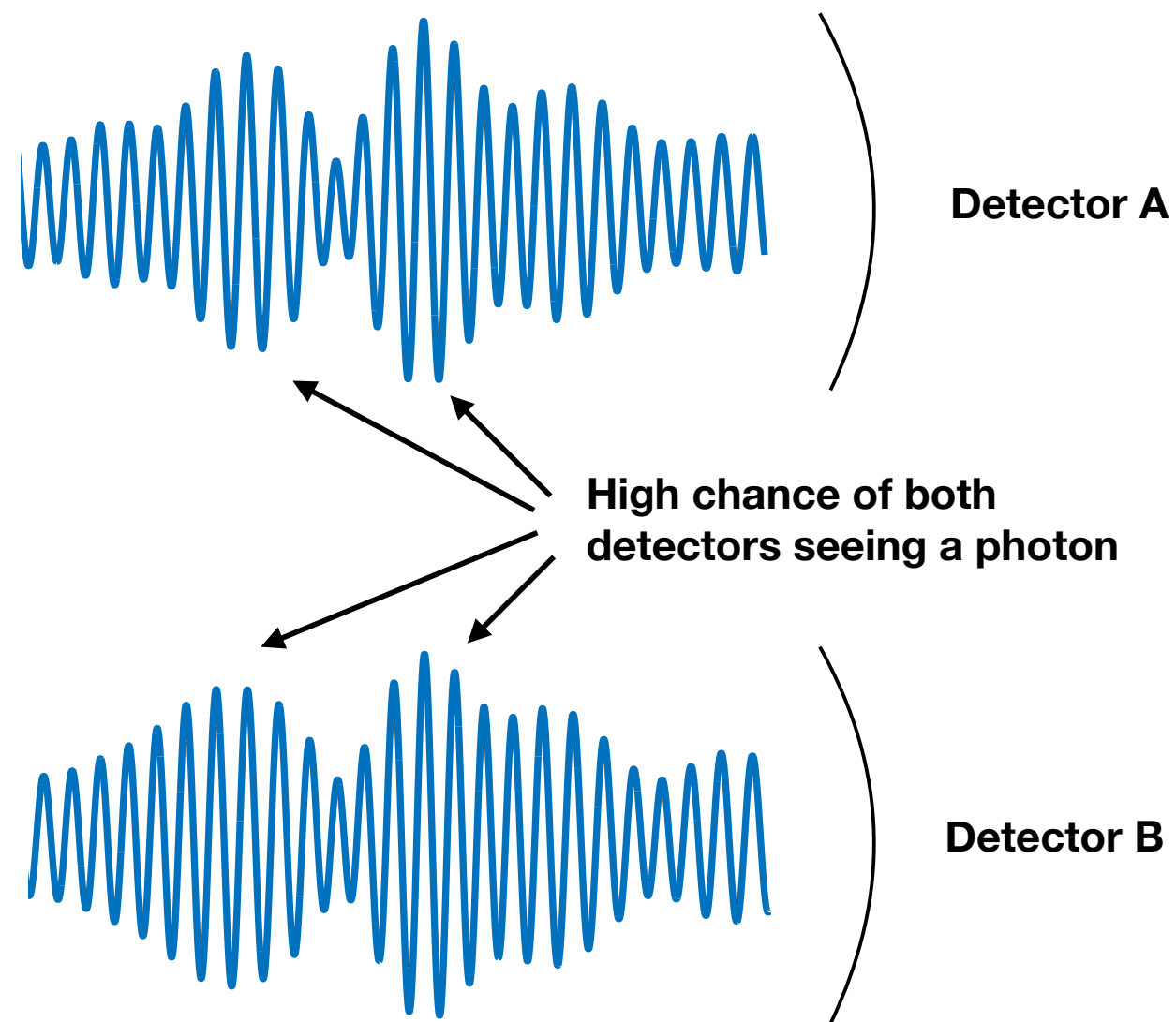
# What if you can't build an interferometer?

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- Either can't get alignment good enough
- Or can't build mirrors and lenses

# Correlated photon arrival in two telescopes

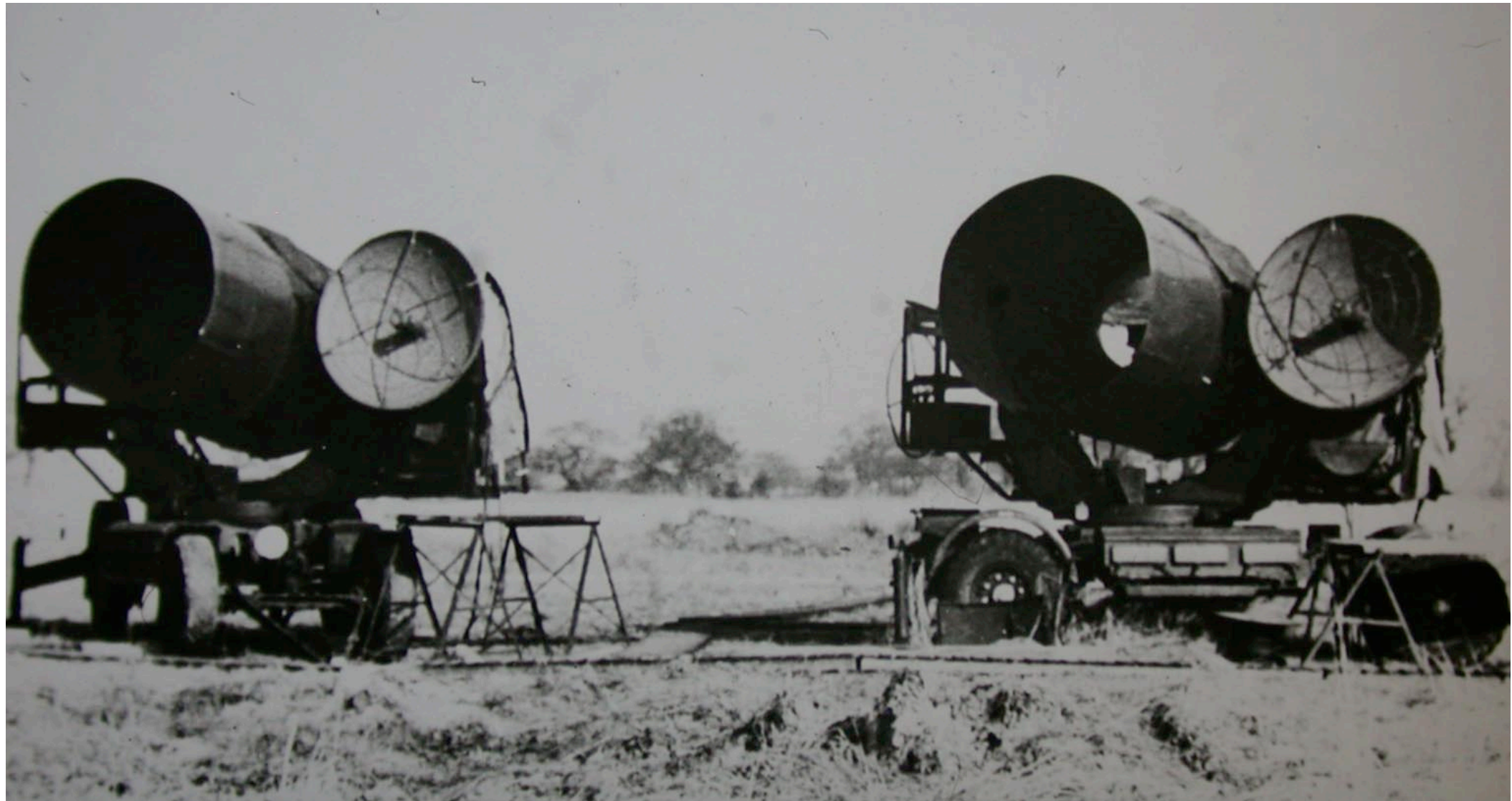
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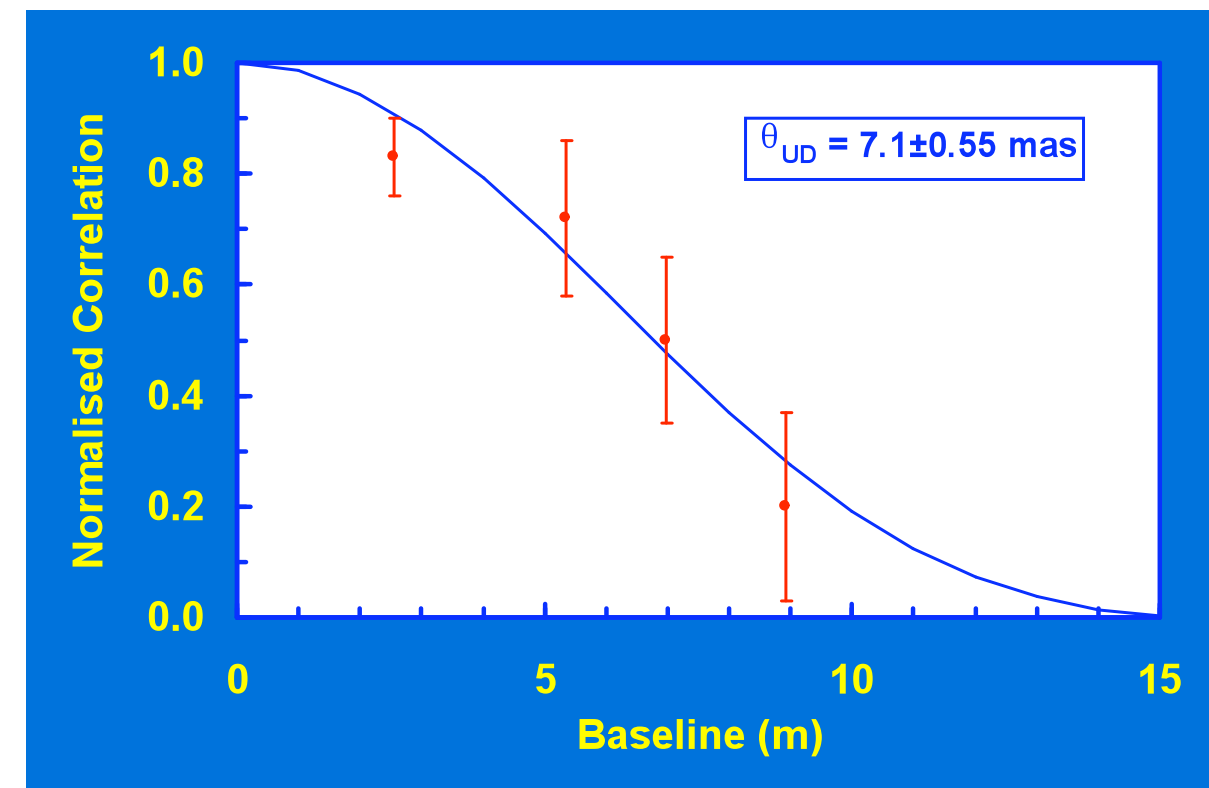
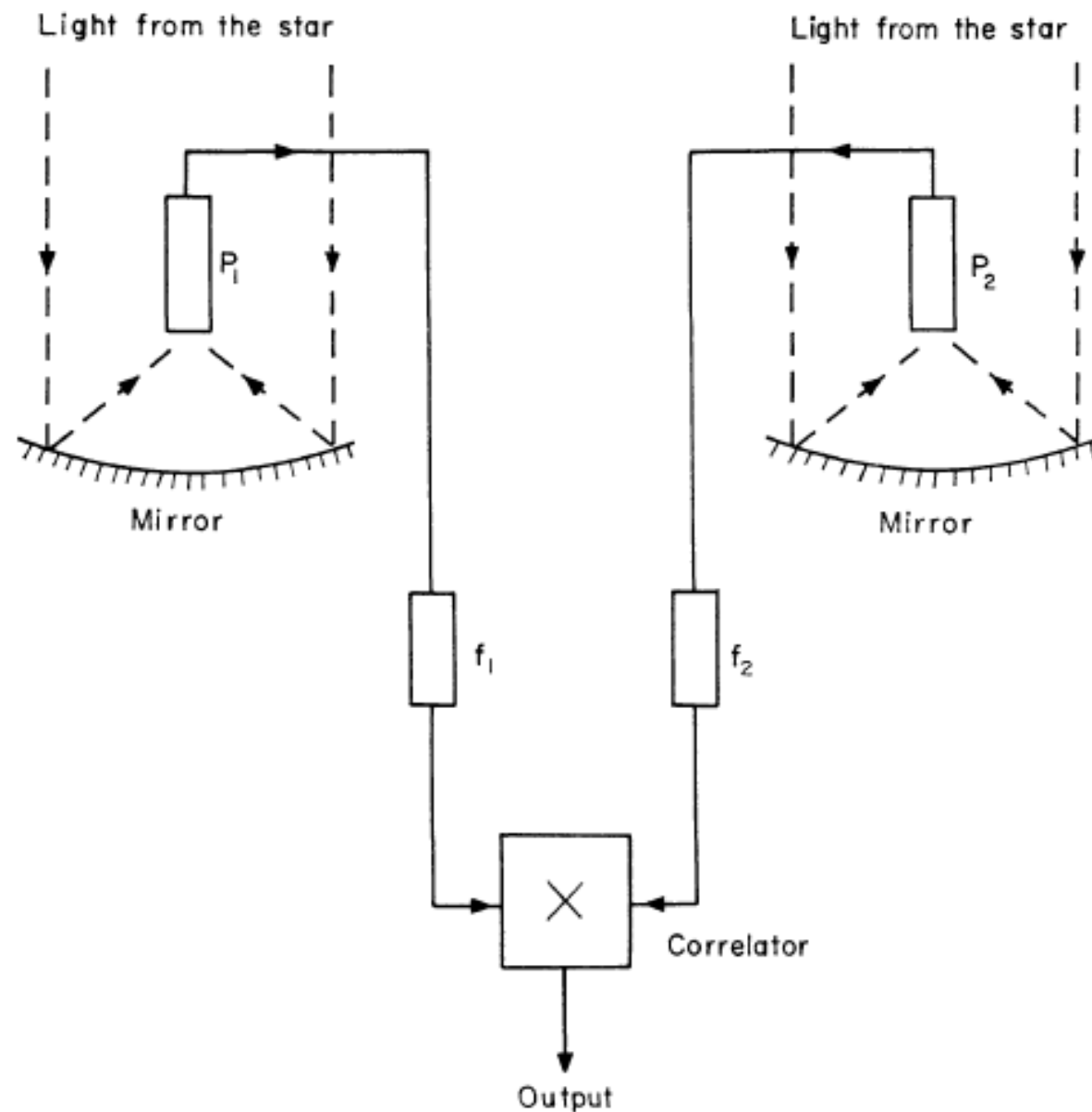


# Original instrument with searchlights

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# Size of the star Sirius

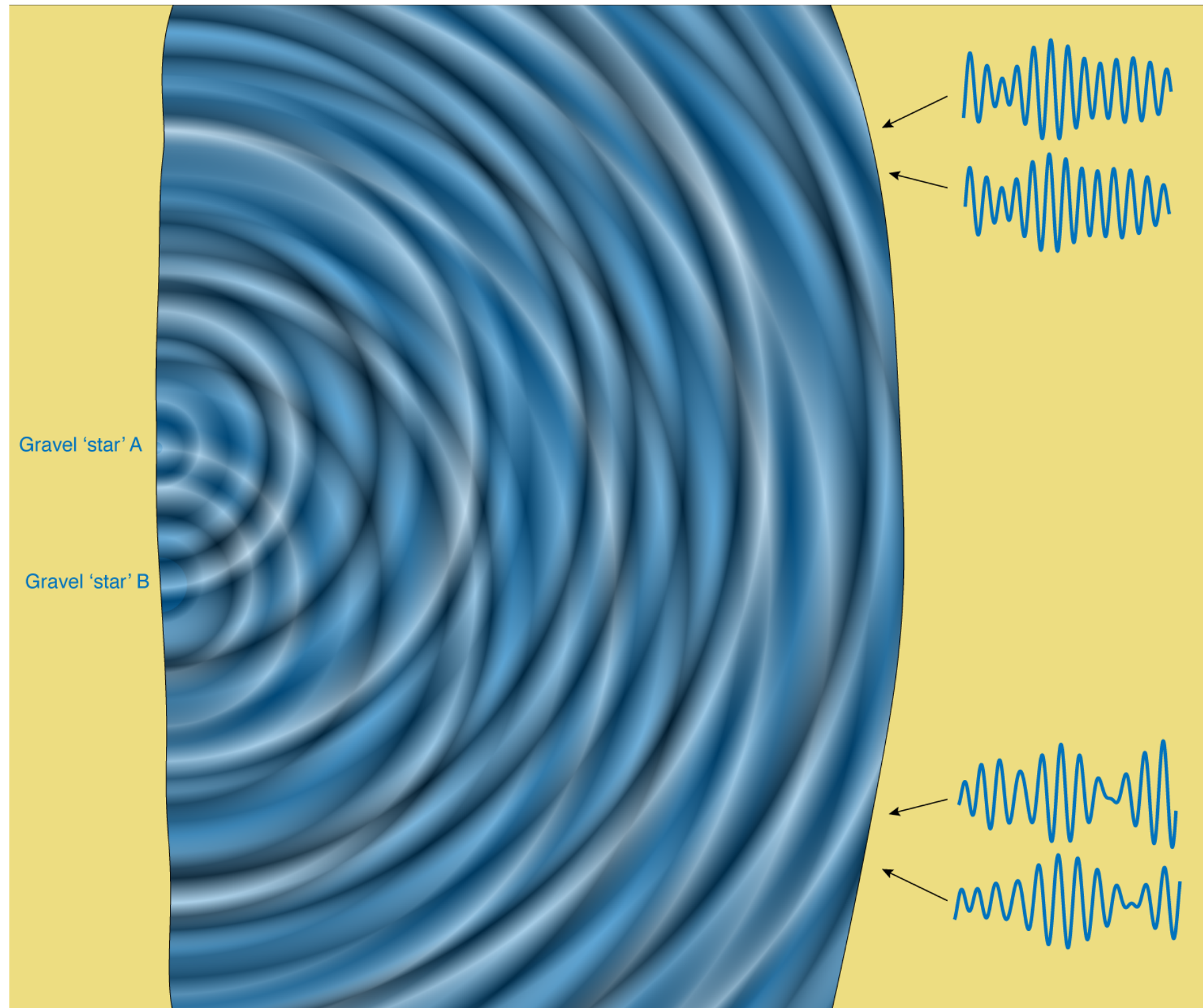


Baseline = distance  
between telescopes

# Combined ripple

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- Any two places near on the beach see very similar wave train
- Any two places far apart see very different wave train



# Huge controversy at the time

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- Birth of quantum optics
- Spatial version of temporal bunching we saw last week



# Narrabri Stellar Intensity Interferometer

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# “Building a steam roller to crack a nut” — HB

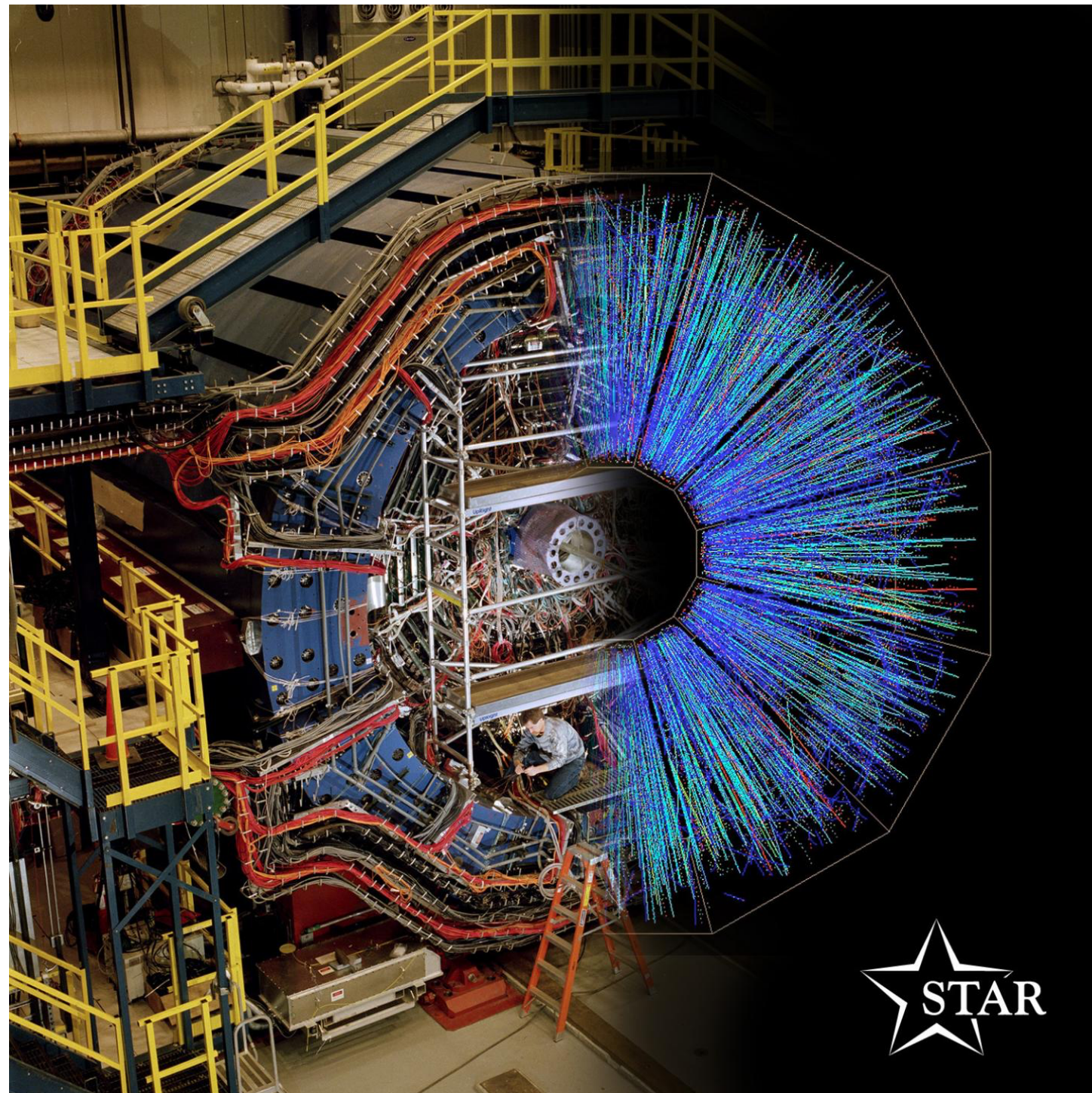
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With light arrival correlation is no longer used, interferometers (pieces of a large mirror) are much more sensitive and we can do the alignment.



# RHIC

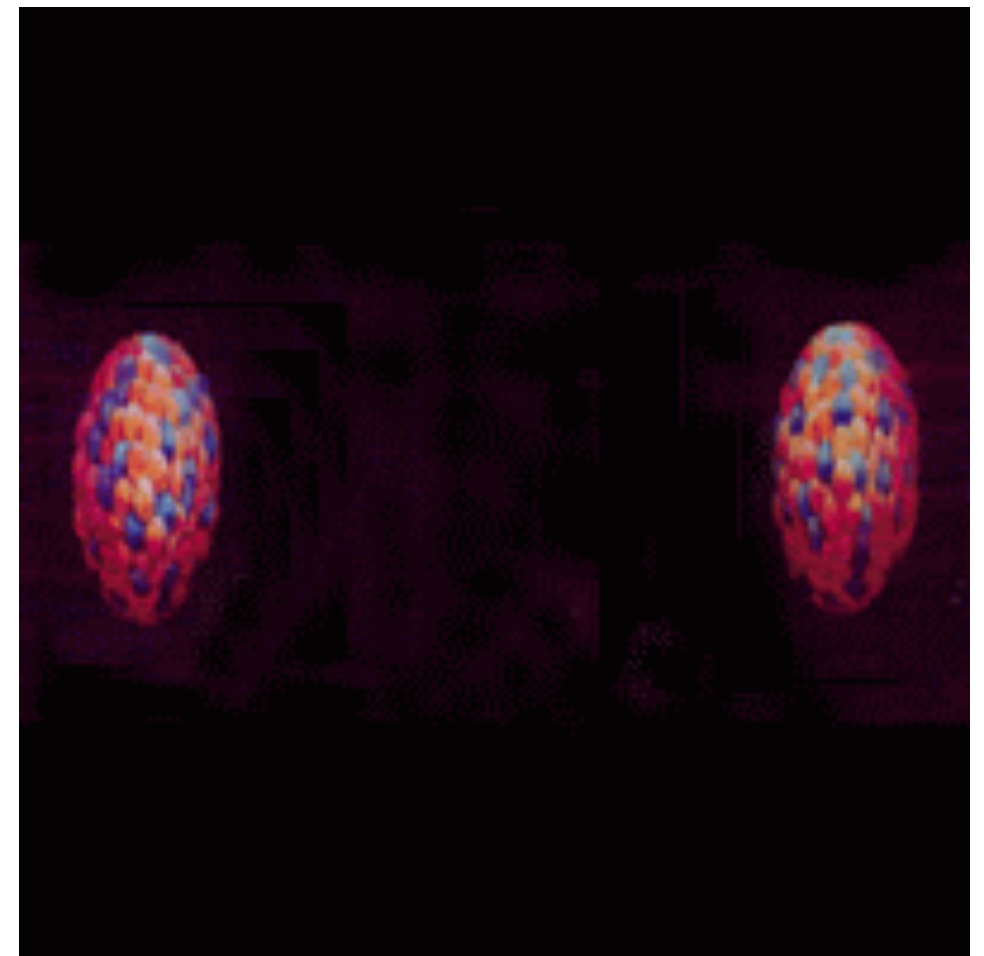
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# Collide two gold nuclei at nearly the speed of light

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- Melt into a quark-gluon plasma
- Mimics conditions of very early universe, before protons and neutrons could form
- Radiates huge numbers of ***pions***

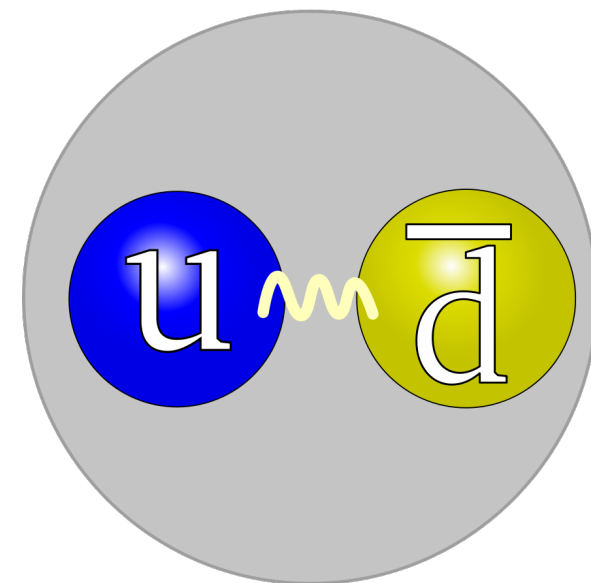




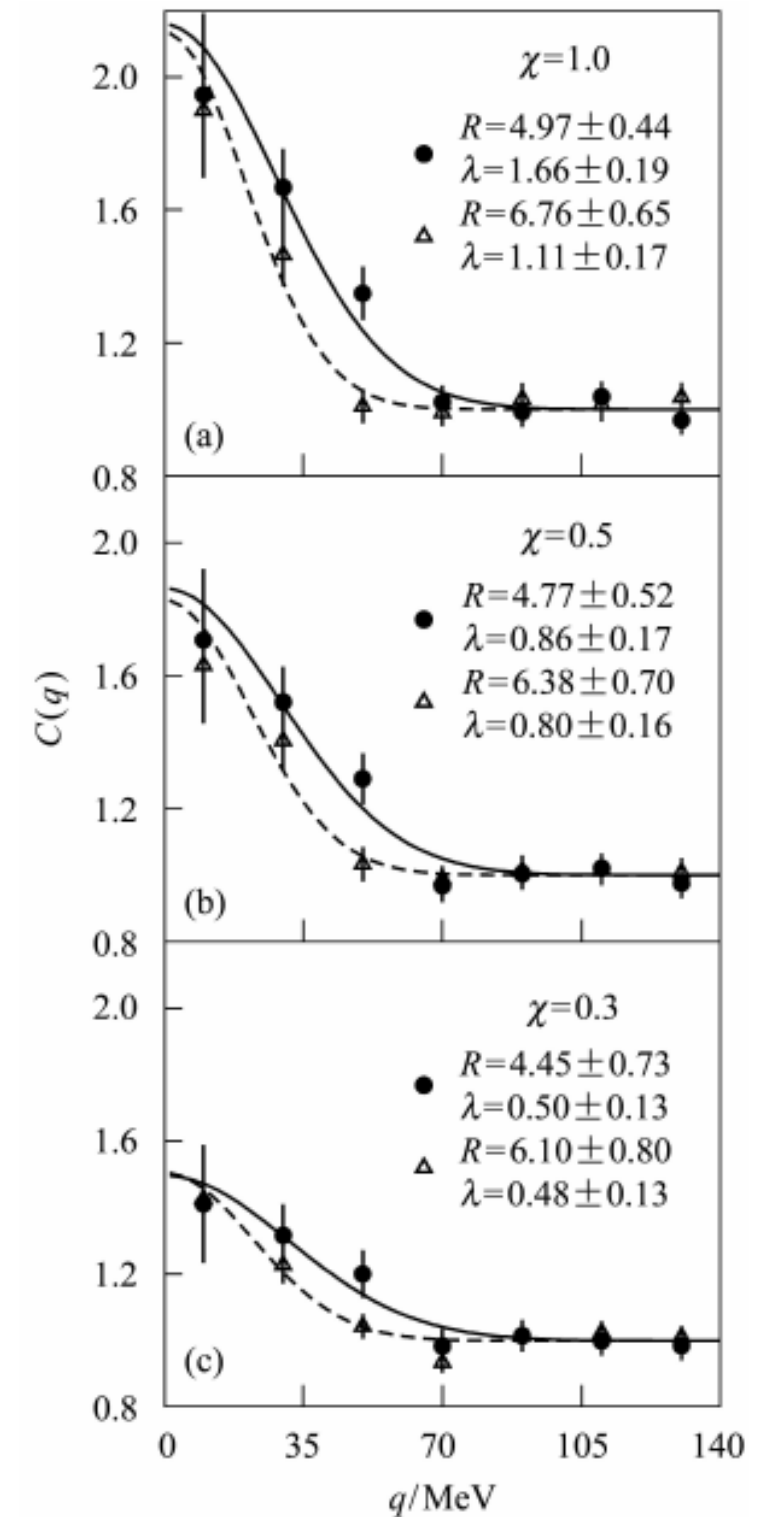
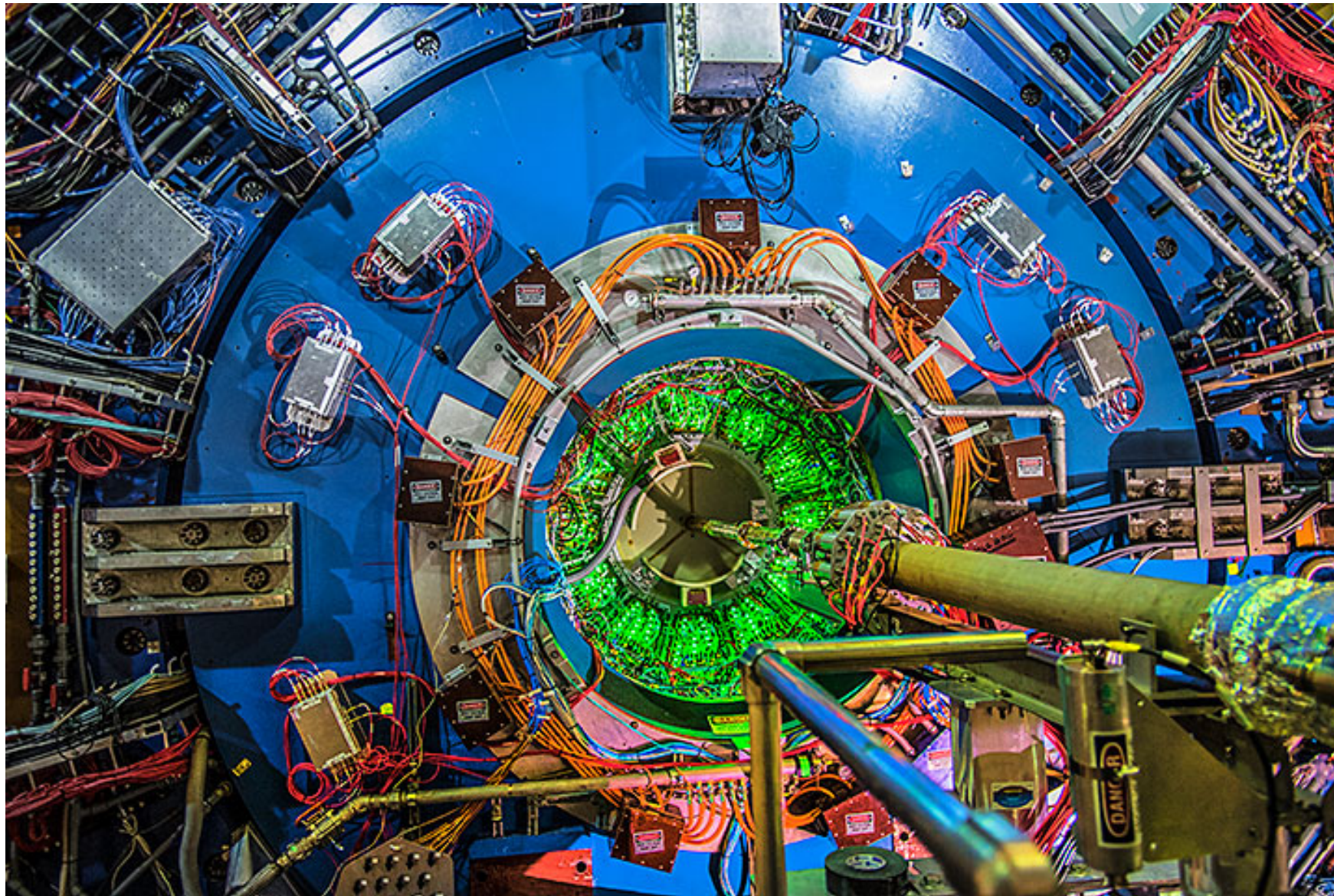
# Pions

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- Made up of two quarks
- Common but short lived
- Act like bosons (extroverts)



# Surround with detectors, look for correlation in arrival





# Using quantum bunching to study the earliest moments of the universe

