

Square Kilometer Array:

The worlds most powerful radio telescope!

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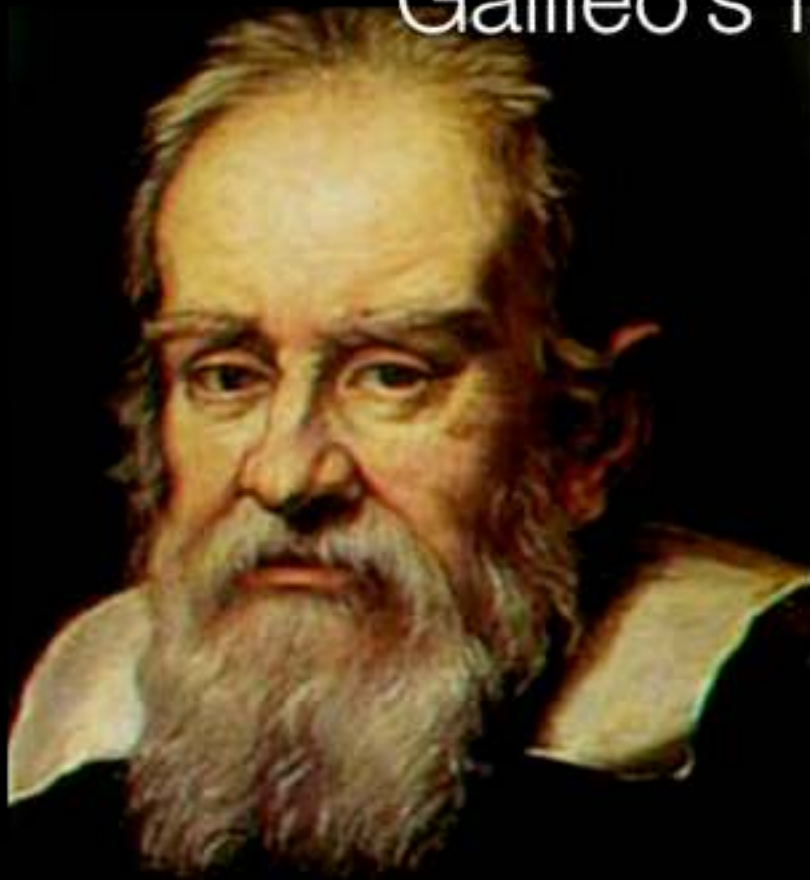
With support from ICRAR (International Centre for Radio Astronomy)

Outline

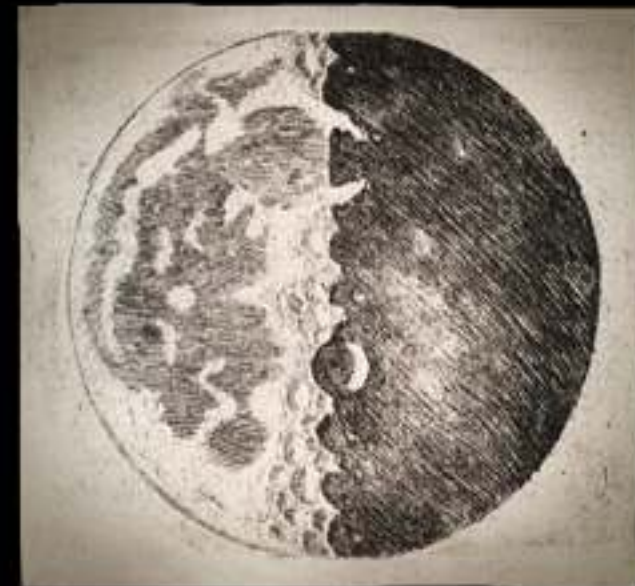
- History
 - SKA (Square Kilometer Array)
 - ASKAP (Australia SKA Pathfinder)
 - West Australia and the Boolardy station
 - First dish on site.
 - Technological challenges.
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- Fulldome show 1: Realm of Light, a brief history of time.
 - Fulldome show 2: Kaloukahina, the enchanted reef.

History: Galileo Galilei (1564-1642)

Galileo's first steps on the journey



New stars



The mountains of the Moon

Why build larger telescopes?

- The light gathering power and ability to resolve detail is proportional to the area of telescope lens.
- So if the lens of the human eye has a radius of about $1/3\text{cm}$, and the Galileo telescope had a radius of 1 inch so it had a collecting area 20 times that of the human eye.
- Herchel's telescope was 50 inches diameter so had the collecting areas of 45,000 human eyes.
- Diameter of the Hubble space telescope is 2.5m so it has the collecting area of 170,000 human eyes.



Human eye
Radius $1/3\text{cm}$



Galileo telescope
Radius 1 inch

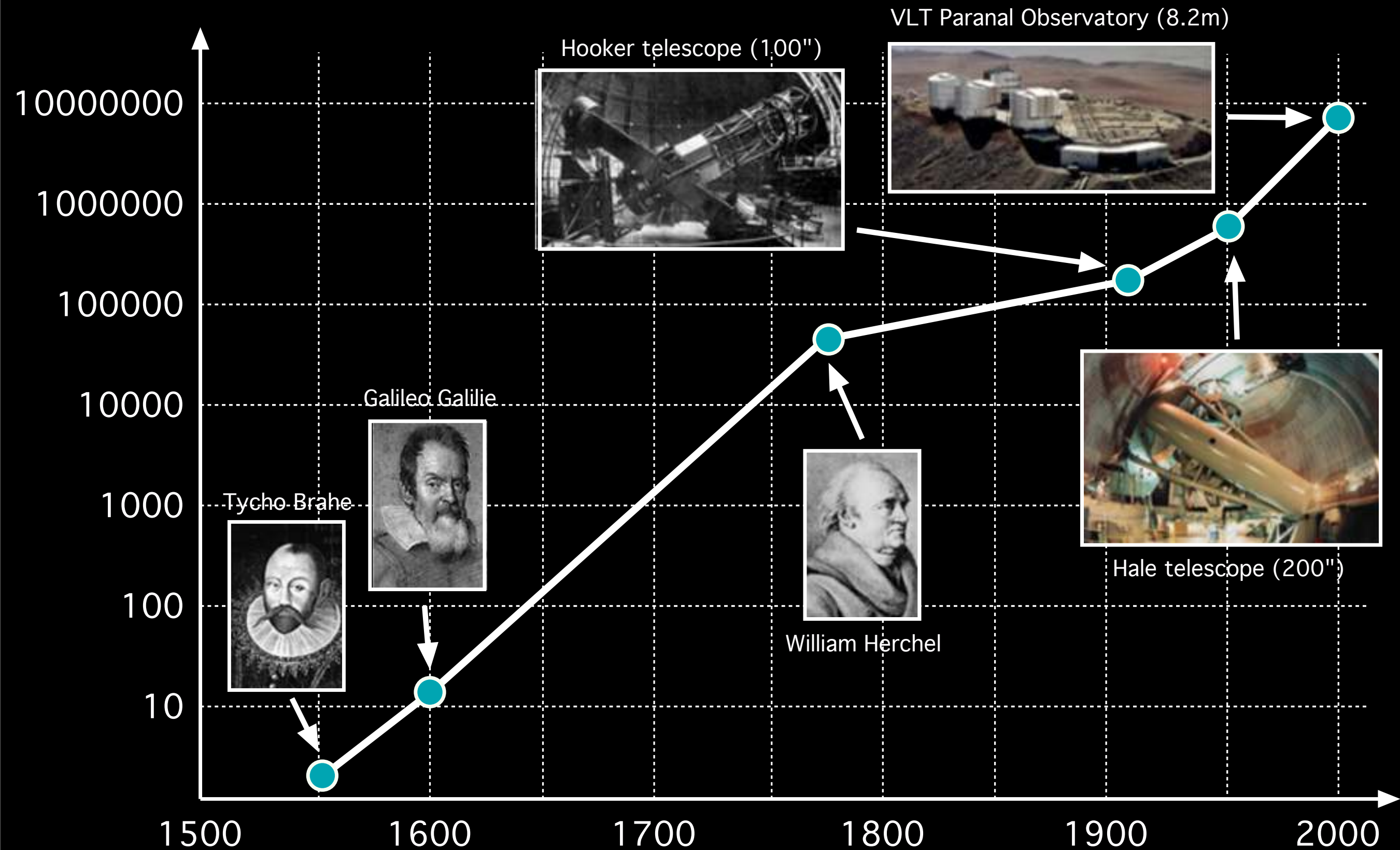


Herschel's telescope
Radius 25 inch

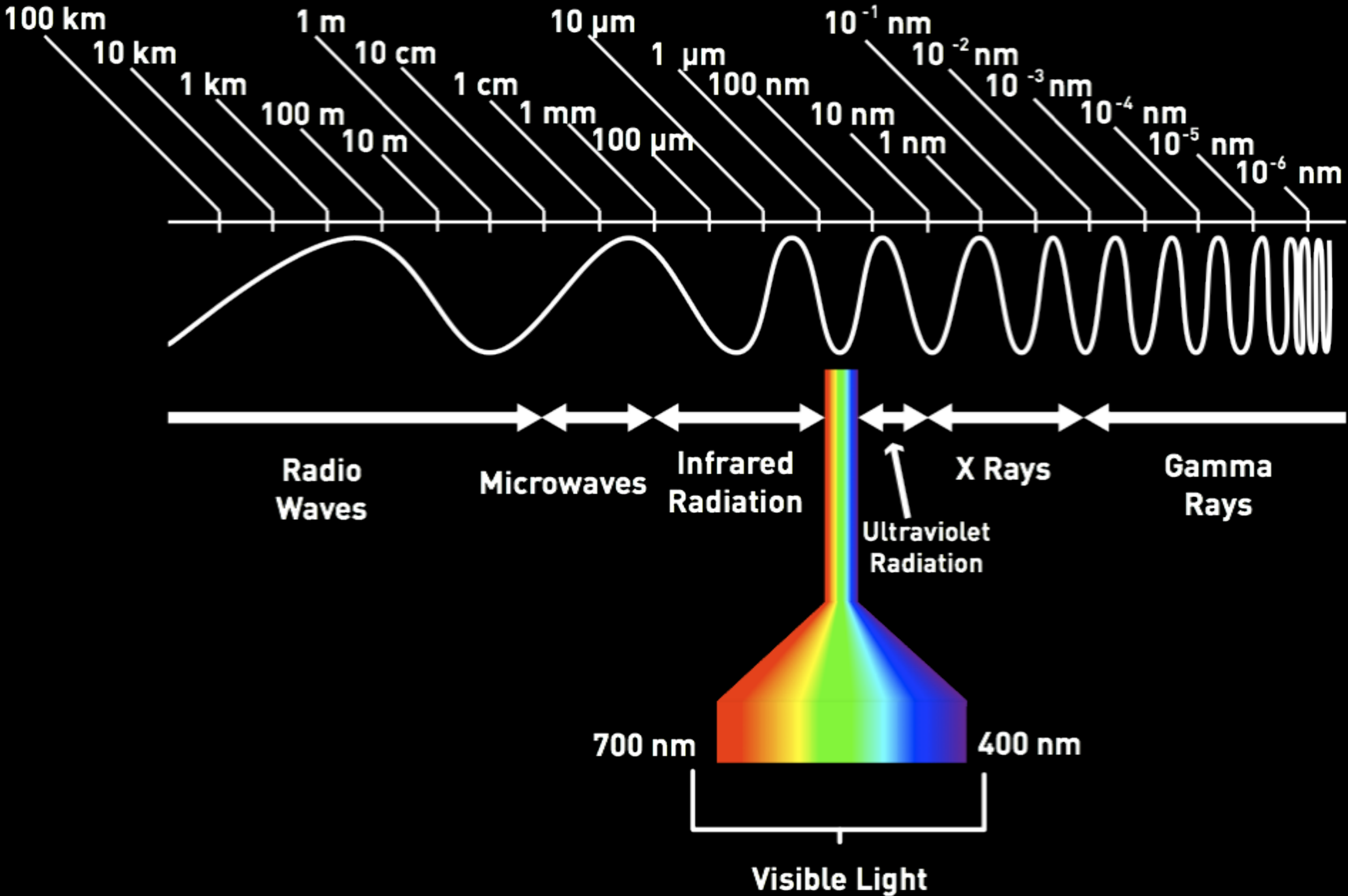


Hubble telescope
Radius 1.25m

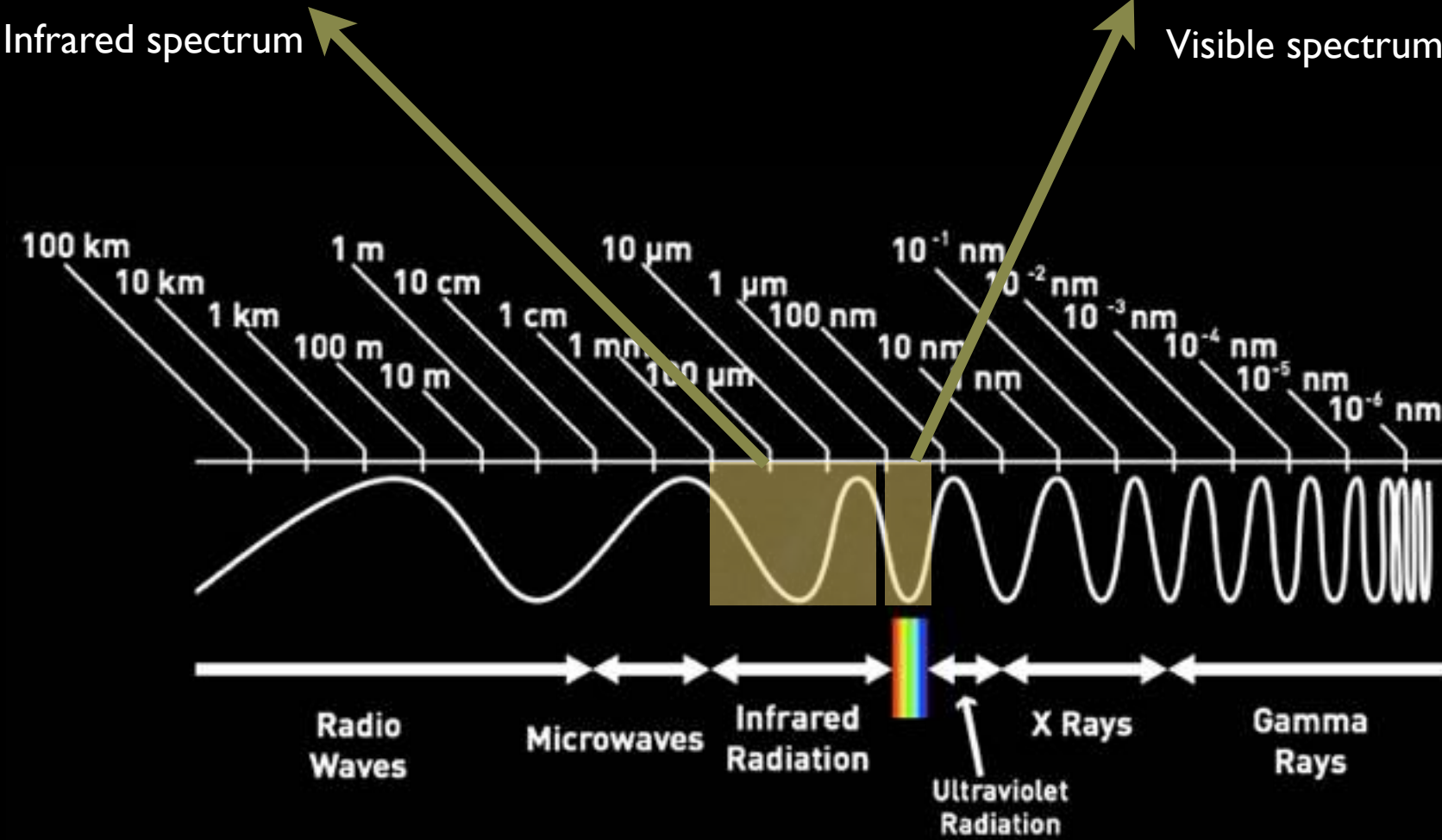
Eyes on the sky through history



Electromagnetic spectrum



Seeing the world at different wavelengths.

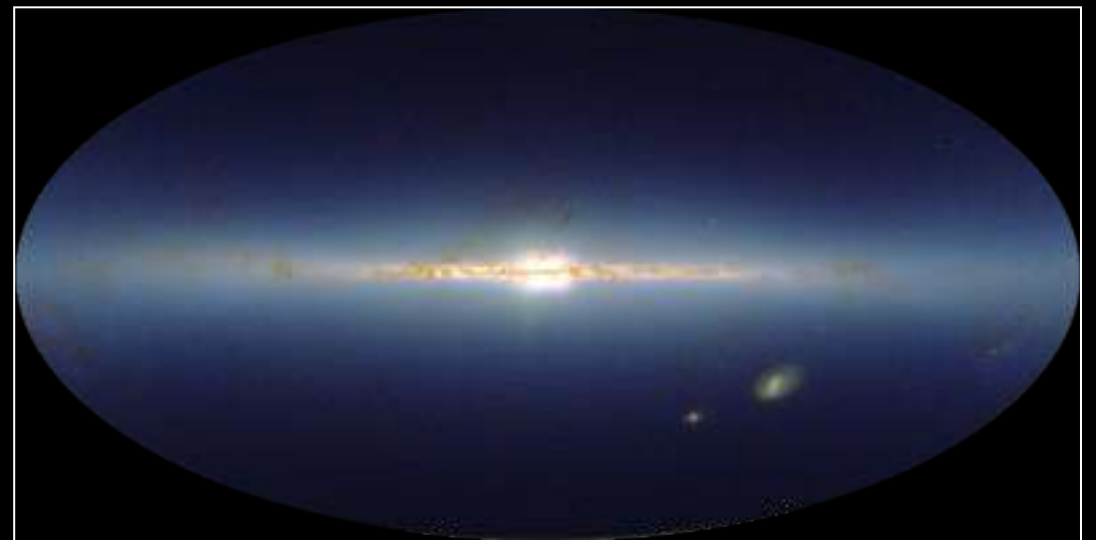


Radio waves

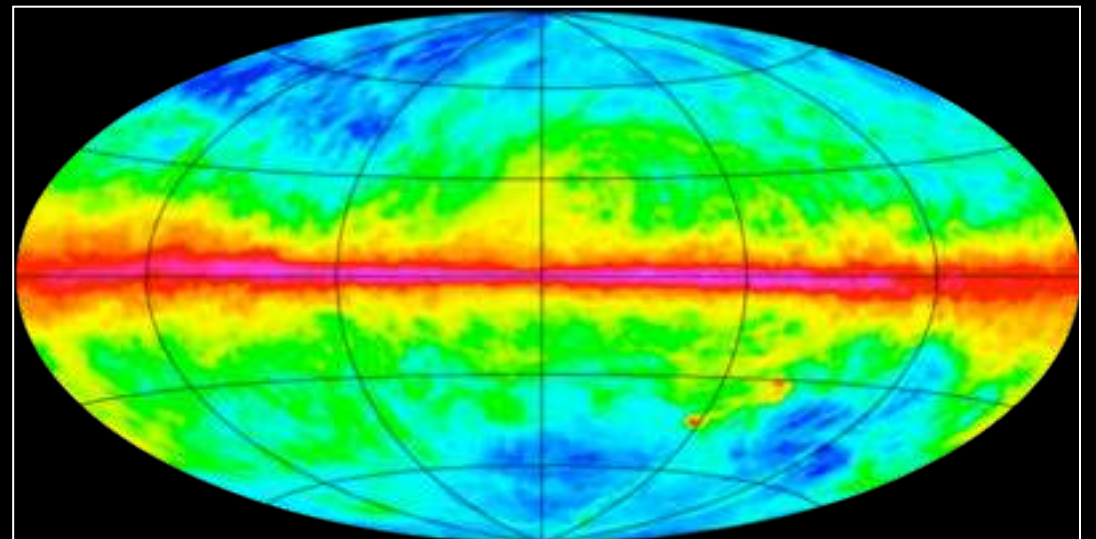
- An optical telescope sees the same part of the electromagnetic spectrum as our eyes.
- Visible light is blocked by dust whereas other parts of the EM spectrum are less affected.
- Things that cannot be seen with an optical telescope can be seen with a radio telescope.
- Radio wavelengths are longer than the wavelength of visible light so dishes need to be larger than optical telescopes.
- In the same way as a lens focuses the collected light on a small sensor, so a dish focus the radio waves on a sensor.



Milky way in visible part of the spectrum

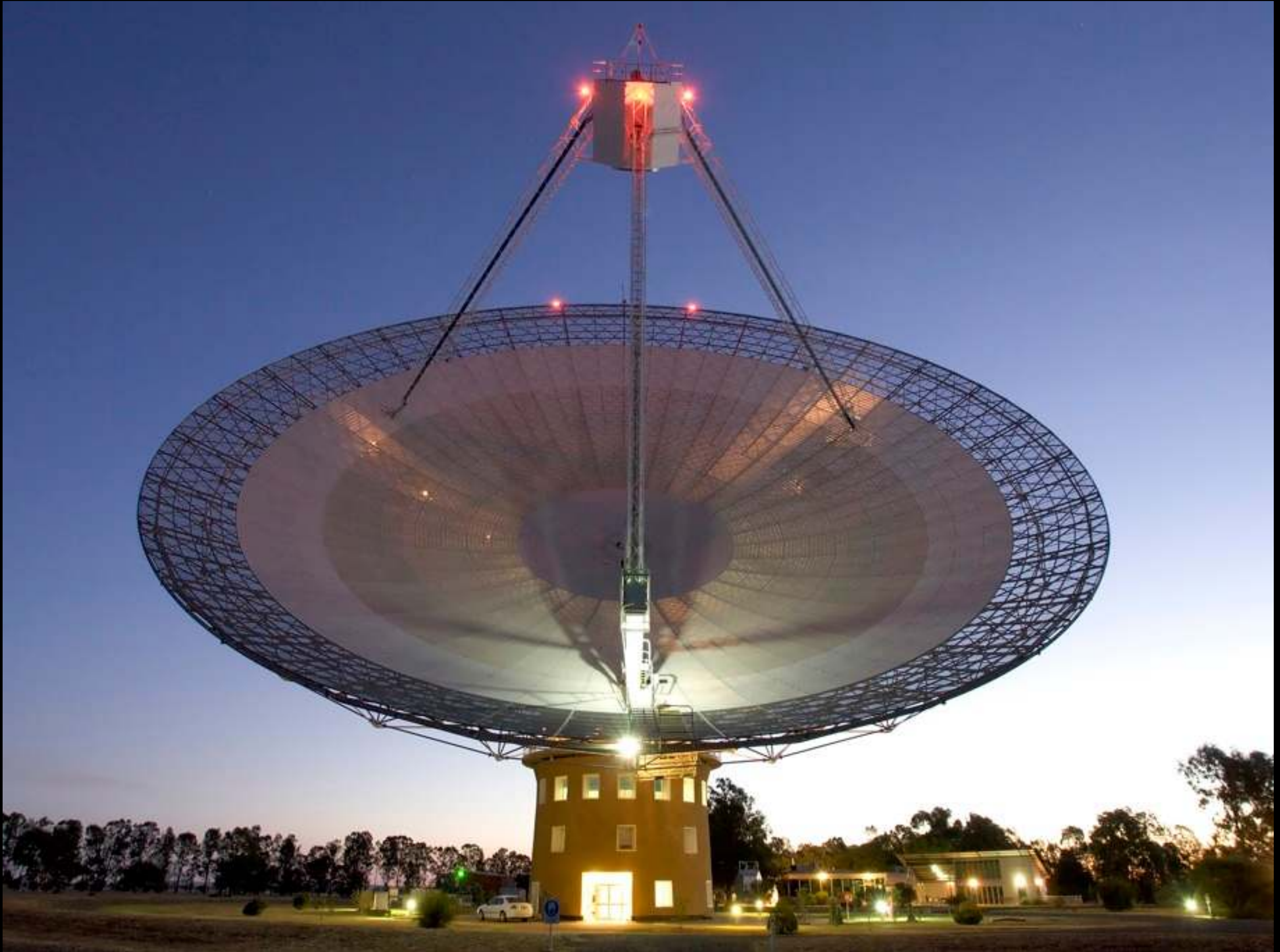


Milky way in infrared part of the spectrum



Milky way in radio wave part of the spectrum

Parkes Radio Telescope (Australia): 1,000 square m



Arecibo Observatory, Puerto Rico: Worlds largest radio telescope



Square Kilometer Array

- The bigger the dish the fainter the objects that can be observed.
- Can't keep building larger and larger dishes. They become too heavy to steer or support themselves.
- If lots of smaller dishes are spread out and the signals combined it can have the same effective size as a large dish. This is called an interferometer.
- Project to build the worlds largest radio telescope by a factor of over 50.
- Will have the collecting area of 1 square kilometer, or 1,000,000 square meters.



Summary

- The SKA will have the effective collecting area of 1km x 1km.
- The SKA will be 50 times more sensitive than the best radio telescope today and be 10,000 times the survey speed.
- The SKA will help answer the following questions:
 - How did the Universe begin?
 - How were the first stars and galaxies formed?
 - Are we alone in the Universe?
 - Was Einstein right in his description of how space, time, and gravity behave?

International project

- The SKA Program is a collaboration between over 70 organisations and institutions in 20 countries - namely Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, The Netherlands, New Zealand, Poland, Portugal, Russia, South Africa, South Korea, Spain, Sweden, the United Kingdom and the United States.



- Approximately AUS\$3 billion to build and \$200 million per year to operate.
- Expect to be fully operational by 2025.

Where will it be built?

- A radio telescope needs a very radio quiet location, this generally means low population.
- General requirements
 - Away from towns or cities.
 - Flat space for hundreds of km.
 - Dry and geologically stable.
 - Access to technology and industry.
 - Accessible to the science community.
 - Stable economy and government.
- Current short listed countries are West Australia and South Africa.



China



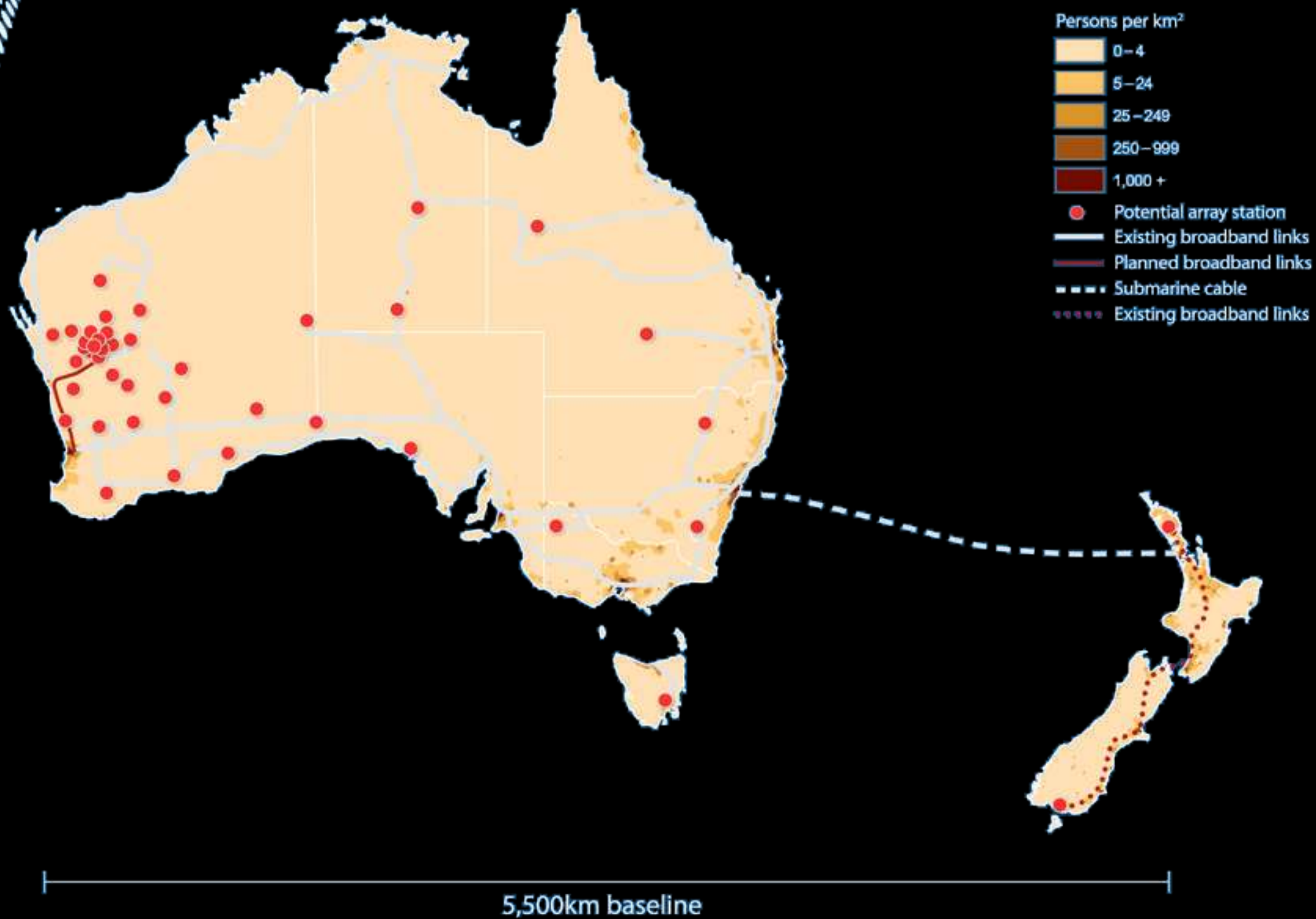
Argentina



Southern Africa



Western Australia



How quiet do we need to be?



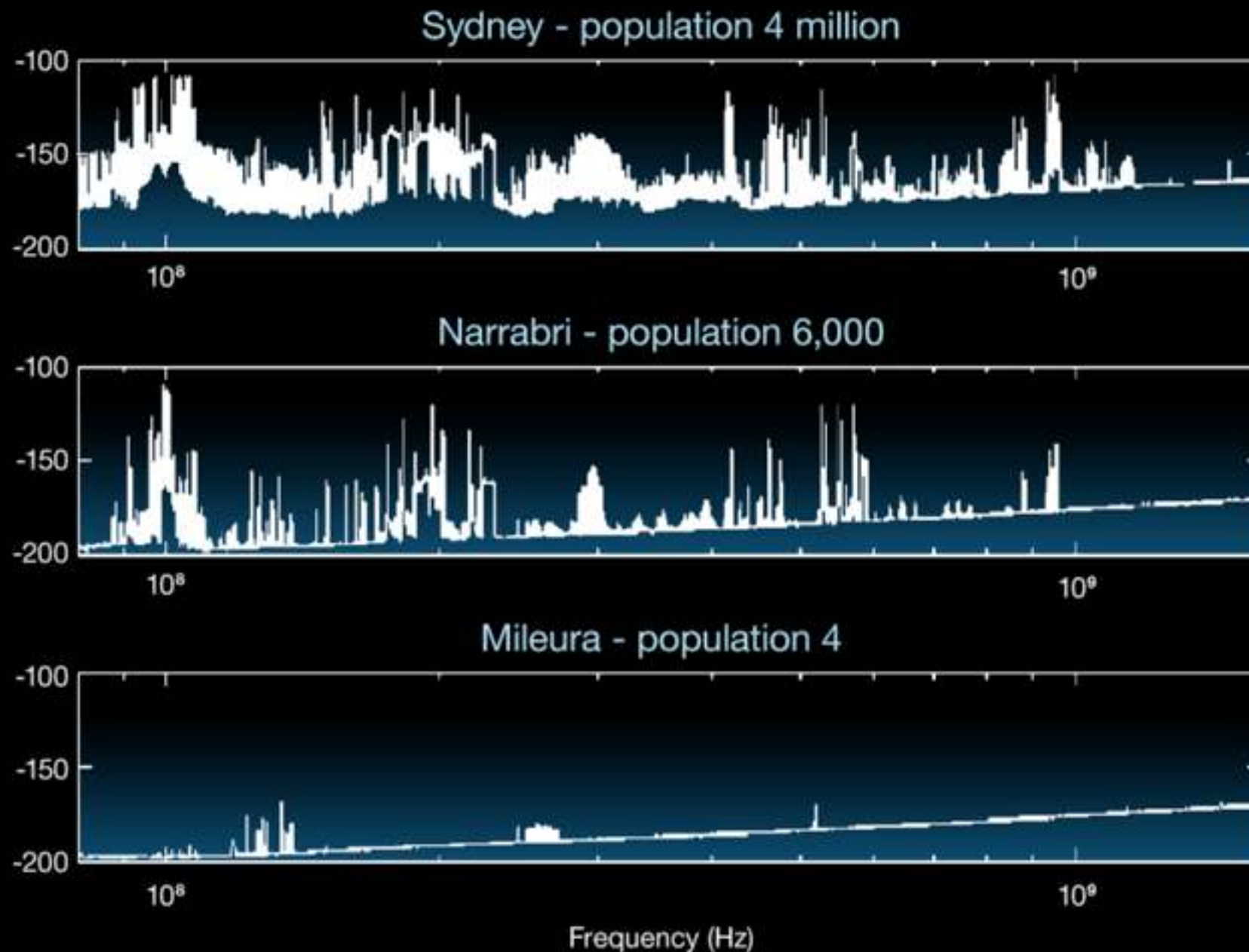
Energy of a falling
snowflake < 30 micro joules



Energy collected by ALL radio telescopes, ever is
less than that of a falling snowflake

ASKAP:Australia SKA Pathfinder

- The SKA will not be built until 2020.
- In the meantime South Africa and Western Australia are building smaller instruments in order to solve technological problems.
- In Western Australia this is called the ASKAP:Australia SKA Pathfinder.
- Being built in the Murchison region of Western Australia, one of the best radio quiet locations.



ASKAP summary

- Will consist of around 36, 12m diameter dishes.
- Even though ASKAP will only be a few percent of the SKA it will still be a very powerful radio telescope and will do valuable science for the next 10 years.
- Should be fully operational by 2013, 6 dishes are on site now.



Chequer board sensor array on each dish

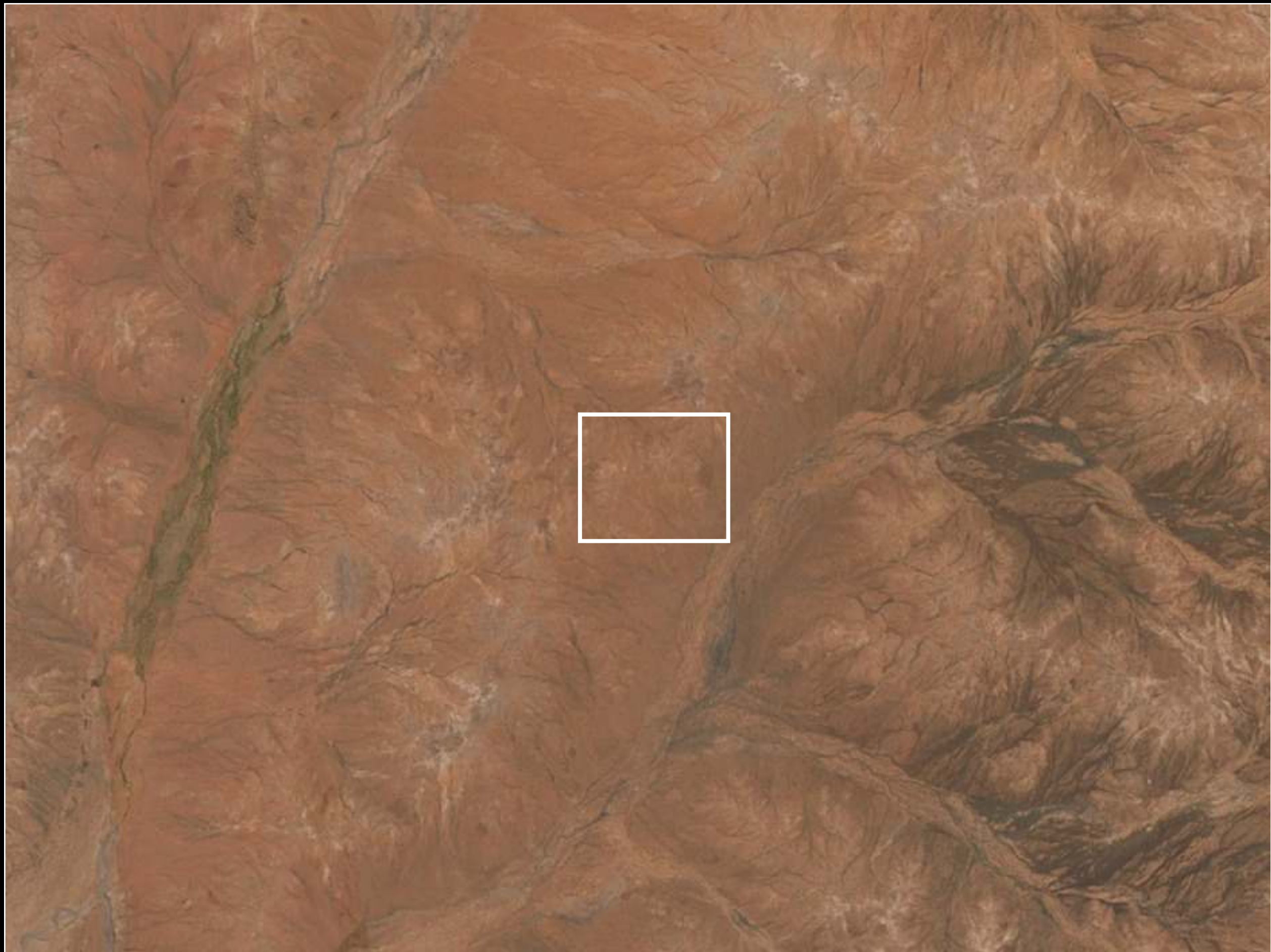
Artist impression



Astrophysics, Swinburne University

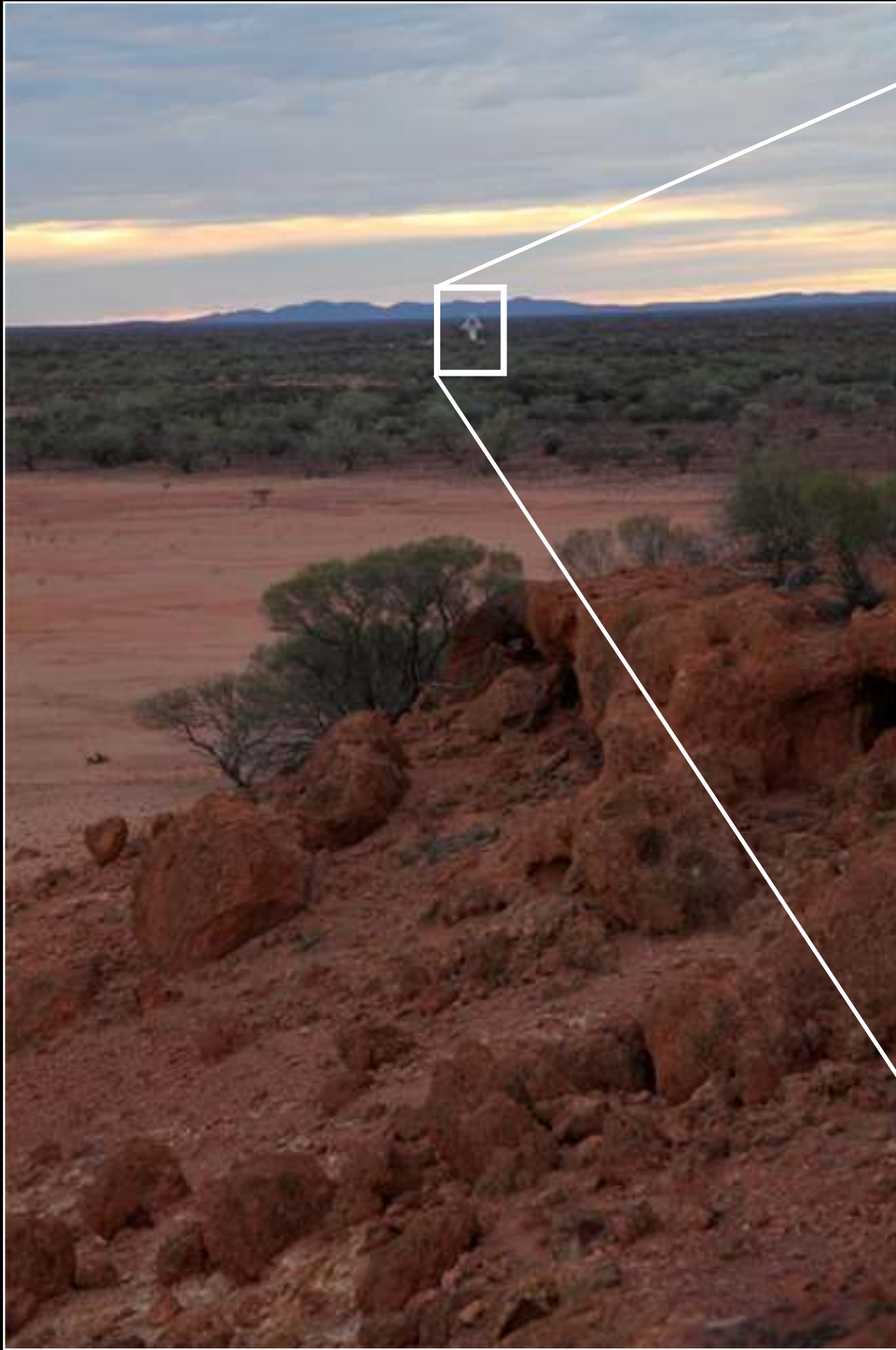
ASKAP site











How remote is it?



First dish - June 2010



Technological Challenges for the SKA

- Data generation and storage.
Each hour it will collect more data than the entire world wide web.
- Network speed.
It will require the worlds fastest network technology.
- Computer processing.
It will require extremely powerful computers to process the data.
1000 times the most powerful computer of today.
- Electricity.
It will require highly renewable energy across a widely distributed array.

Meeting the technological challenges of the SKA will have a significant impact on many industries.

Questions?

- Fulldome show 1: Realm of Light, a brief history of time.
- Fulldome show 2: Kaloukahina, the enchanted reef.