Square Kilometer Array:

The worlds most powerful radio telescope!

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With support from ICRAR (International Centre for Radio Astronomy)

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Outline

- History
- SKA (Square Kilometer Array)
- ASKAP (Australia SKA Pathfinder)
- West Australia and the Boolardy station
- First dish on site.
- Technological challenges.

- 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

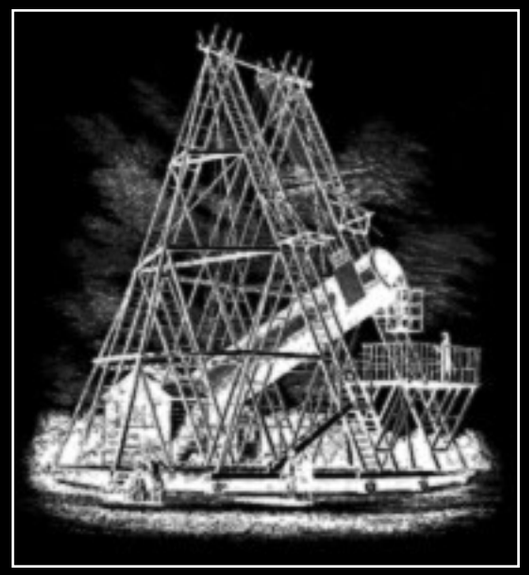
The mountains of the Moon

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 1/3cm, 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 1/3cm

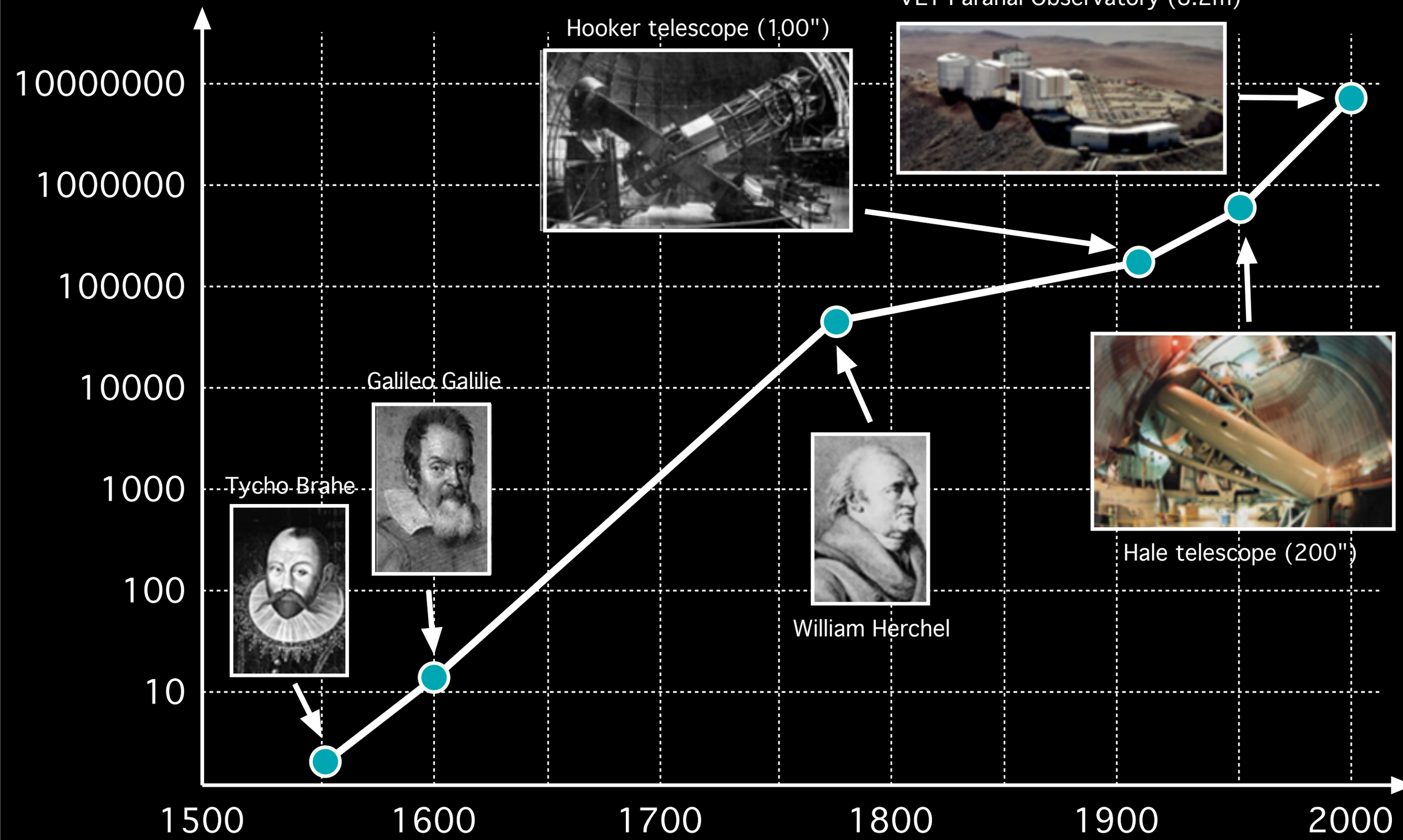
Galileo telescope
Radius 1 inch



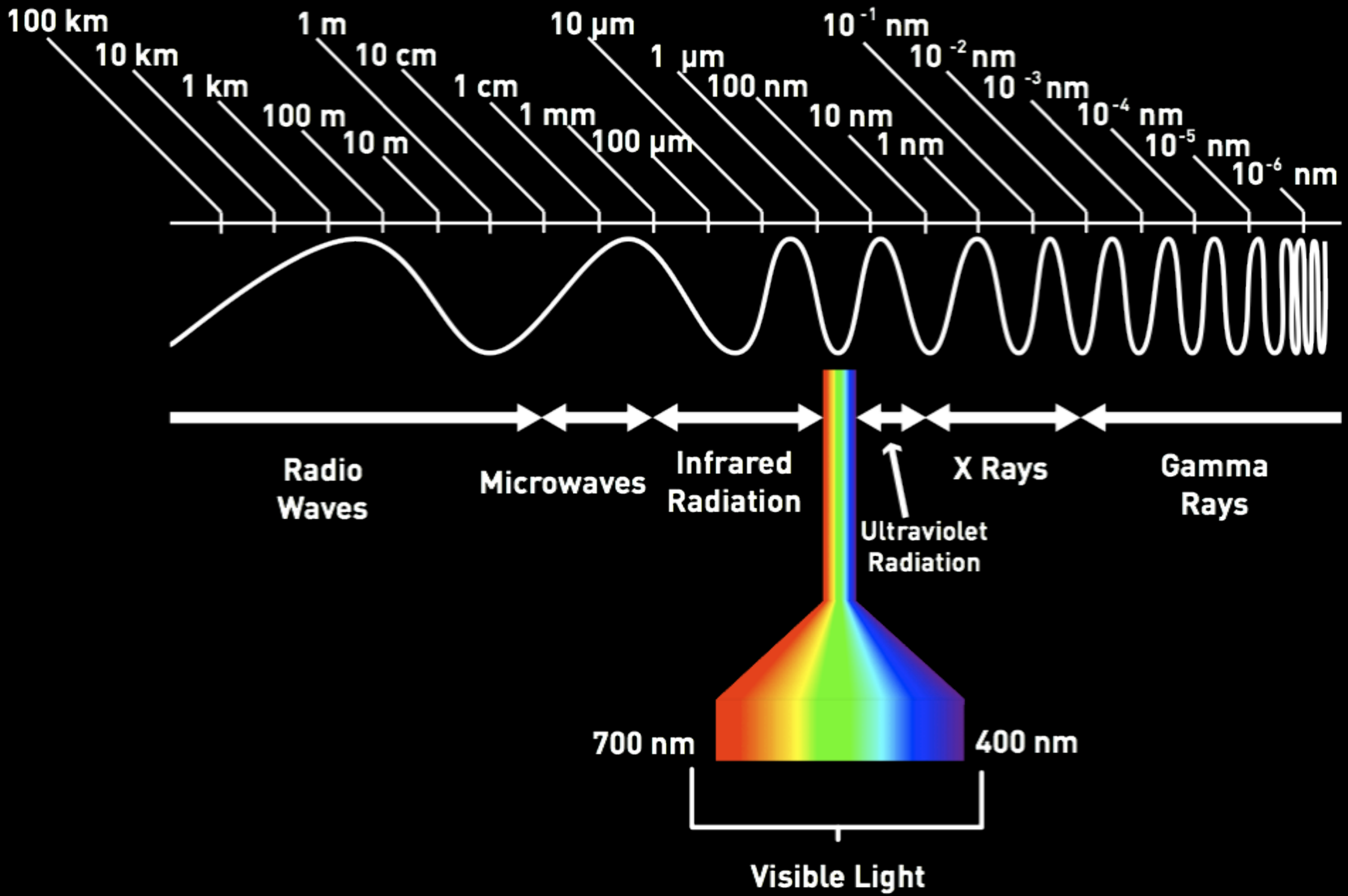
Herchel's telescope
Radius 25 inch

Hubble telescope
Radius 1.25m

Eyes on the sky through history



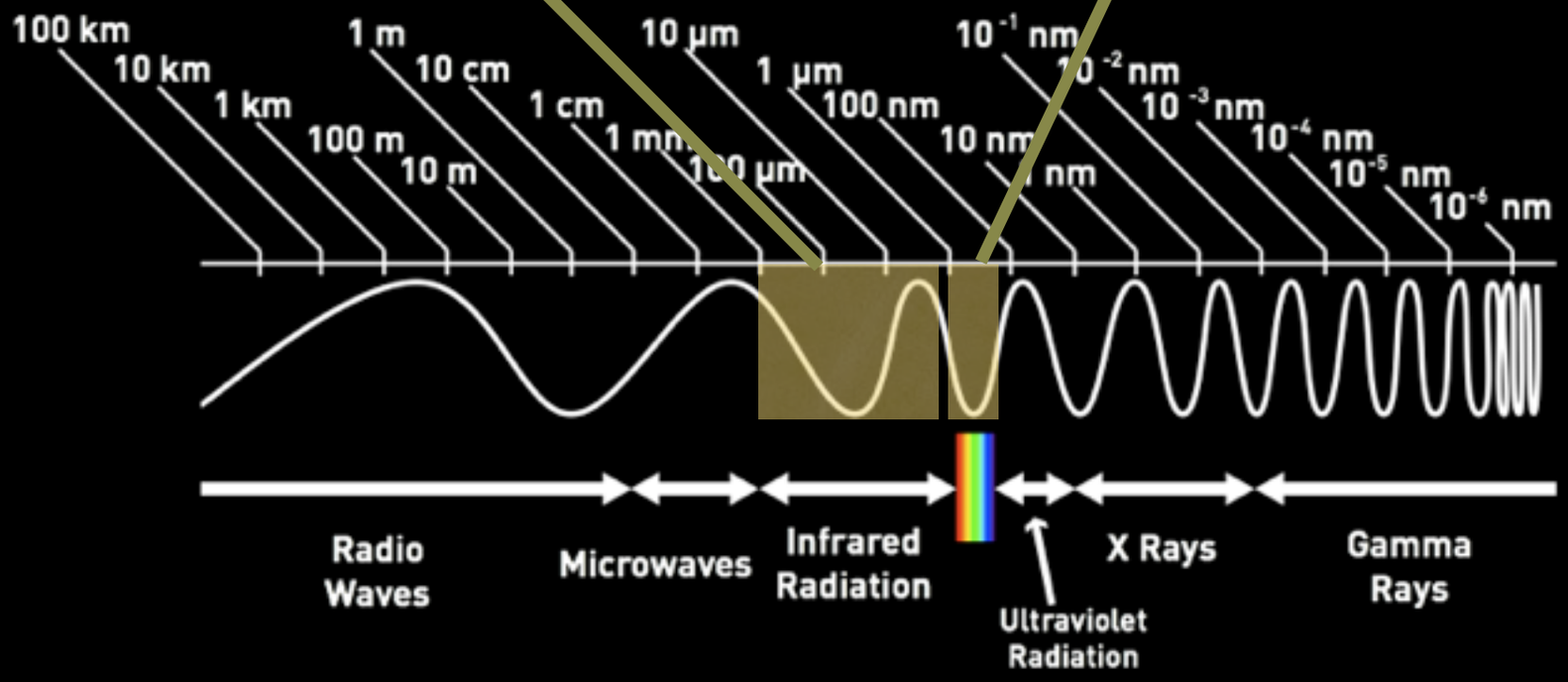
Electromagnetic spectrum



Seeing the world at different wavelengths.

Infrared spectrum

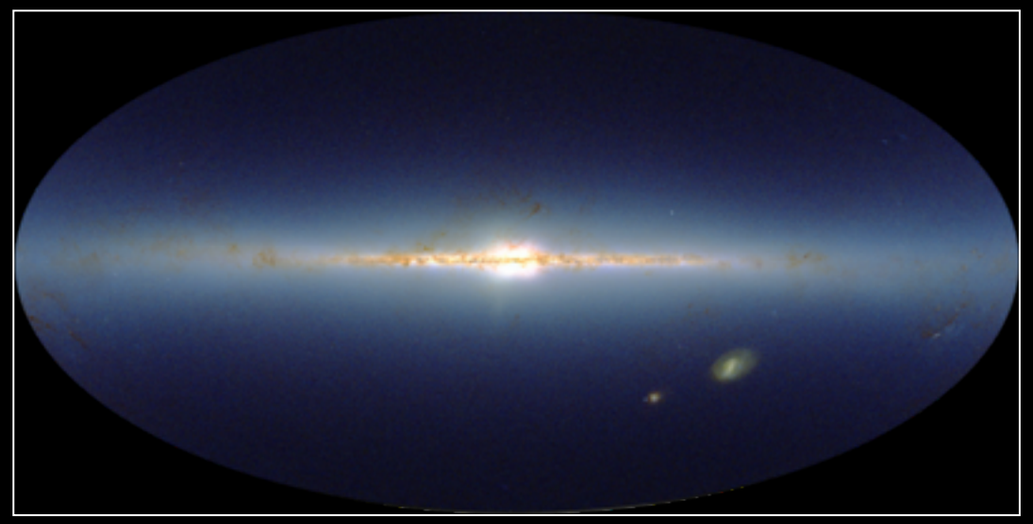
Visible spectrum



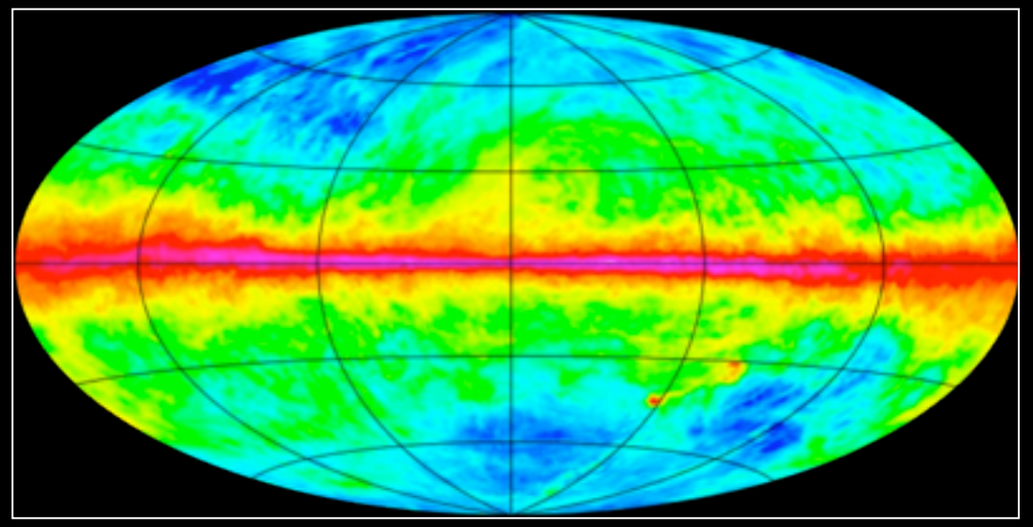
Radio waves

- 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 that 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.

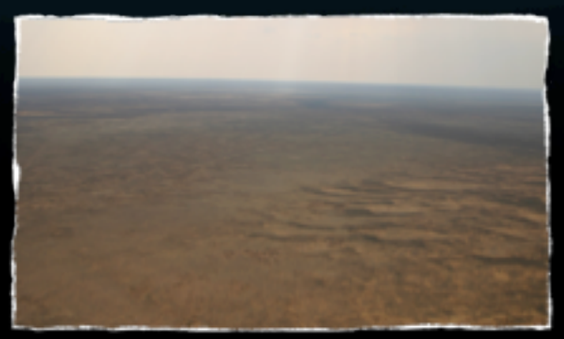
- Approximately AUS$3 billion to build and $200 million per year to operate.
- Expect to be fully operational by 2025.

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

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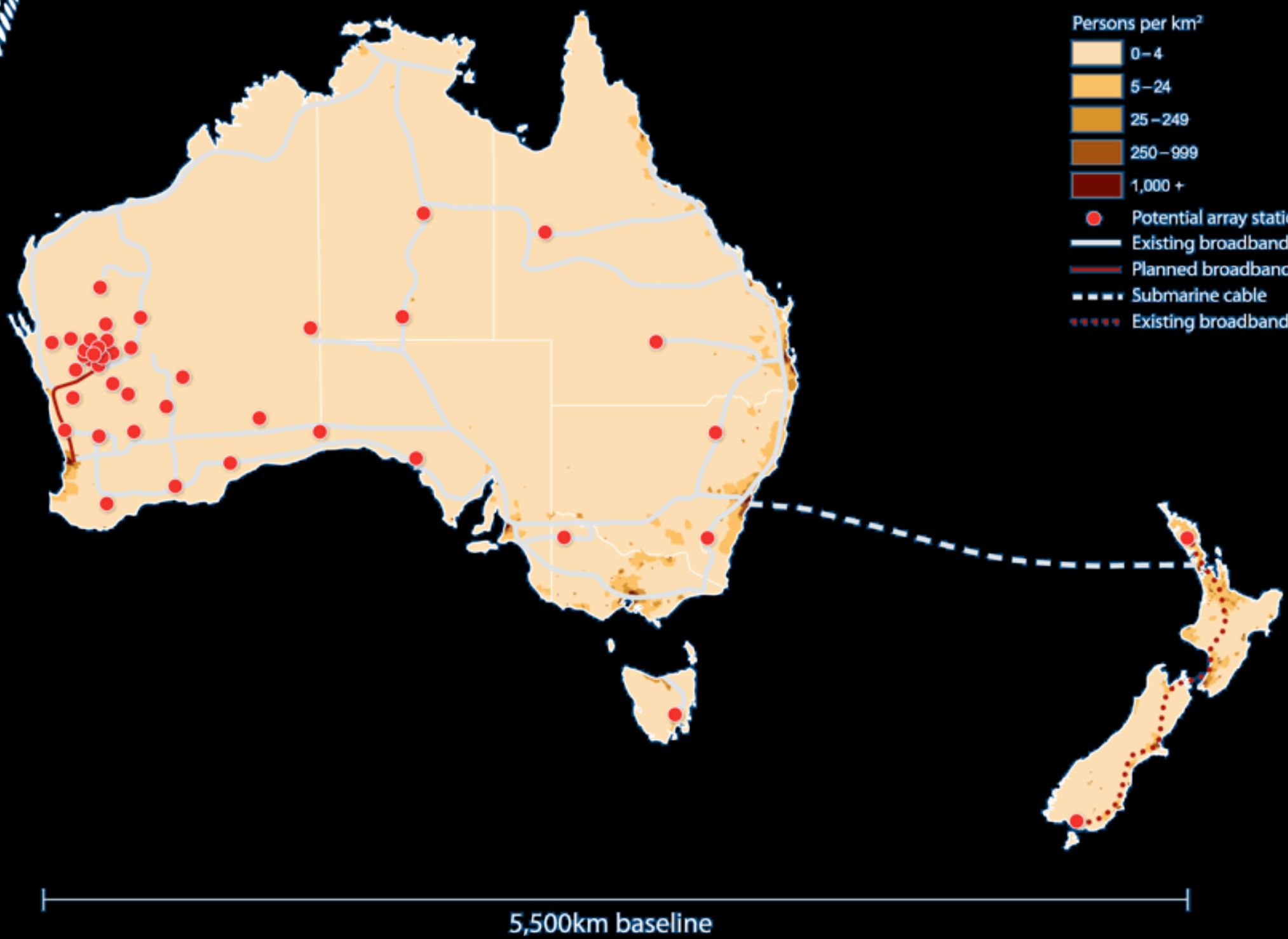
Square Kilometre Array ▸ Australia ▸ New Zealand



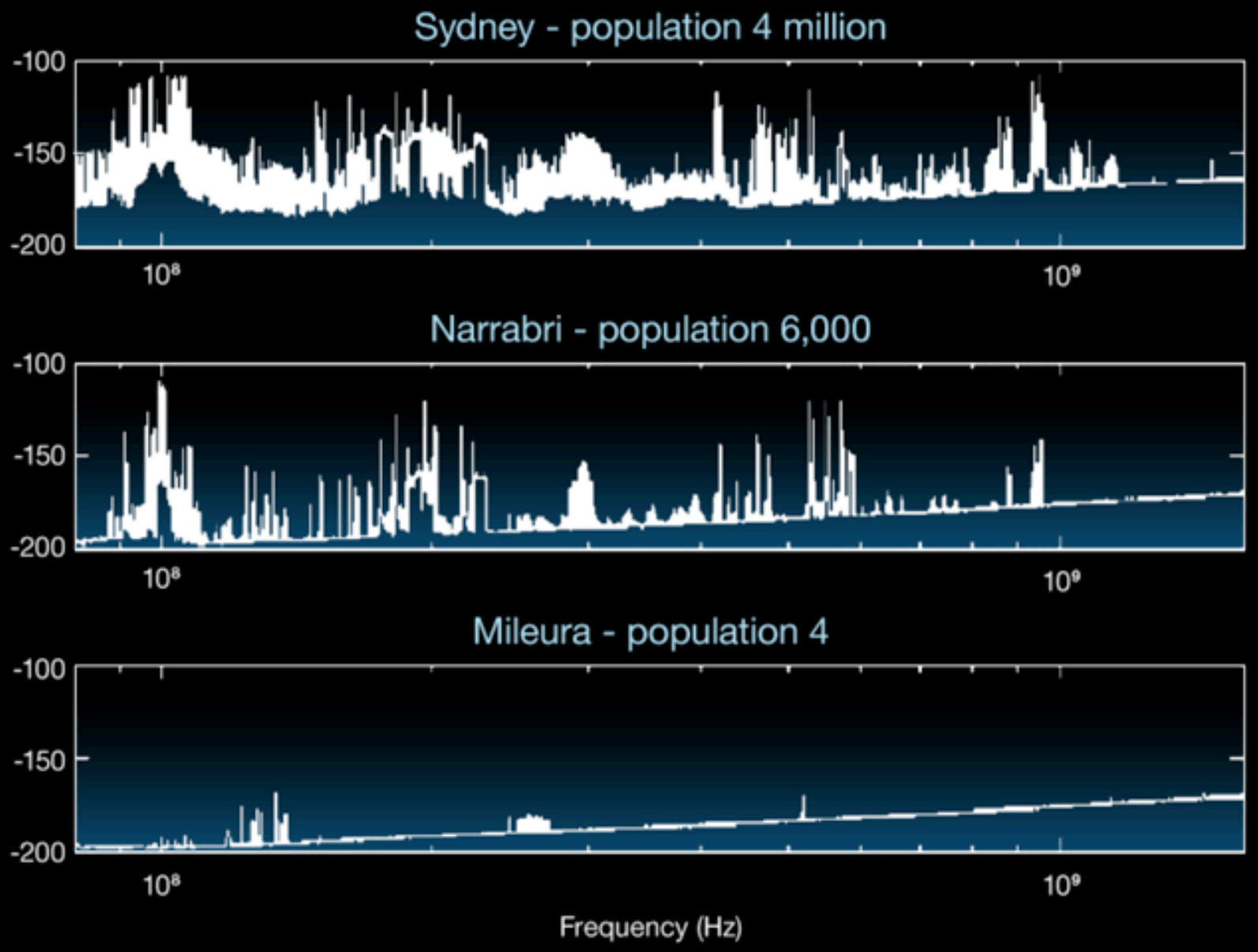
How quiet do we need to be?

Energy of a falling
snowflake < 30 micro joules

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

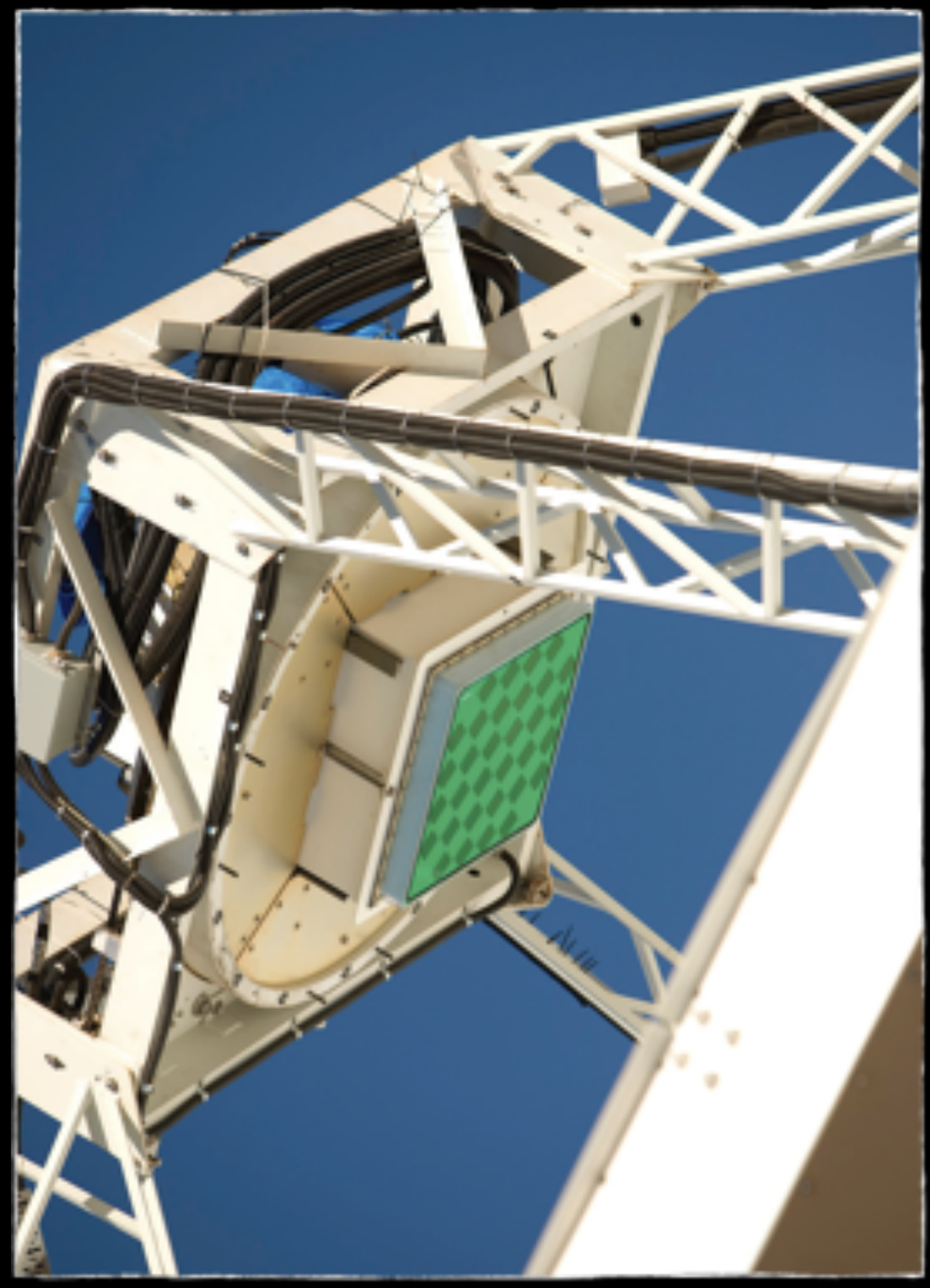
ASKAP: Australia SKA Pathfinder

- 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 ad will do valuable science for the next 10 years.
- Should be fully operational by 2013, 6 dishes are on site now.

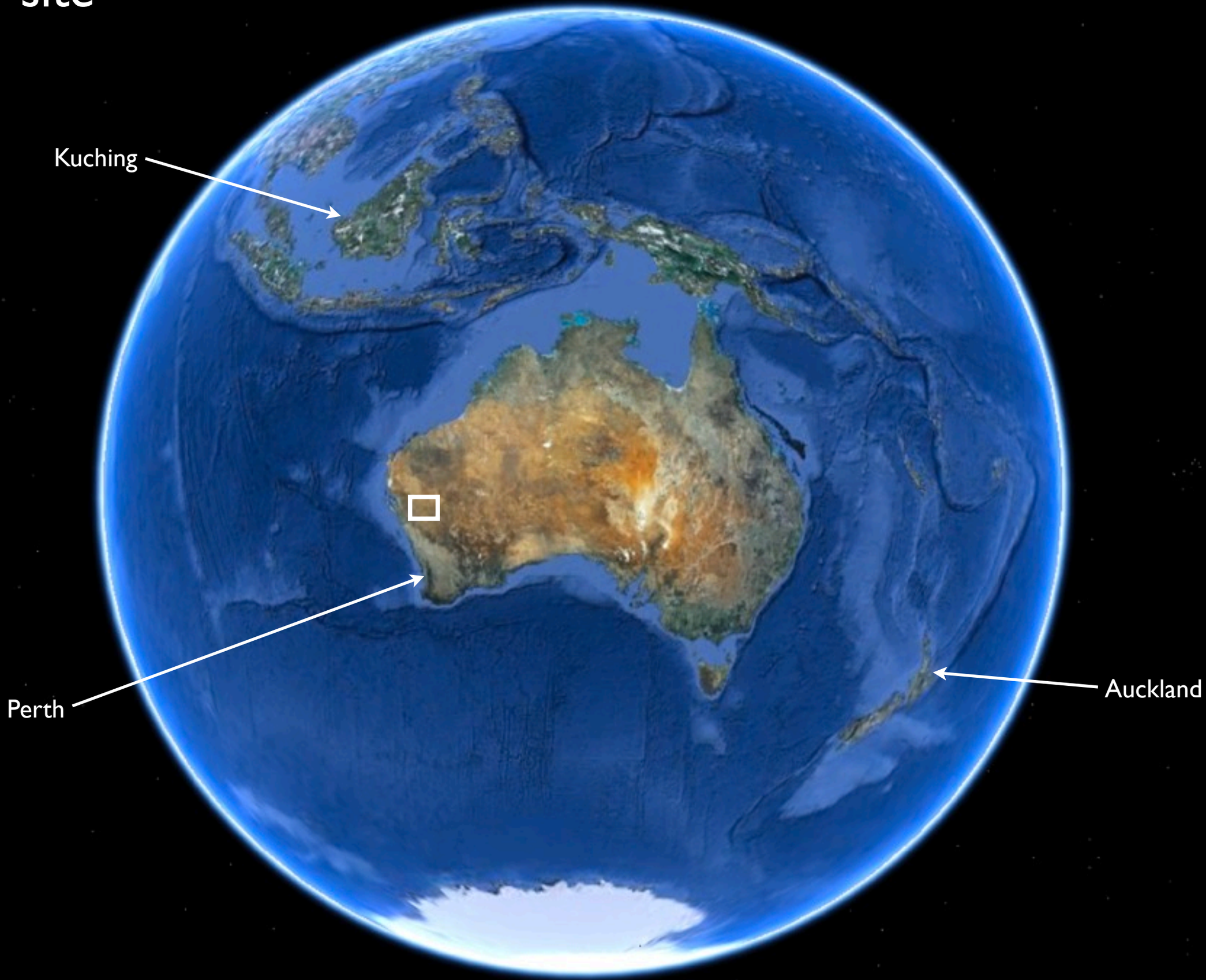


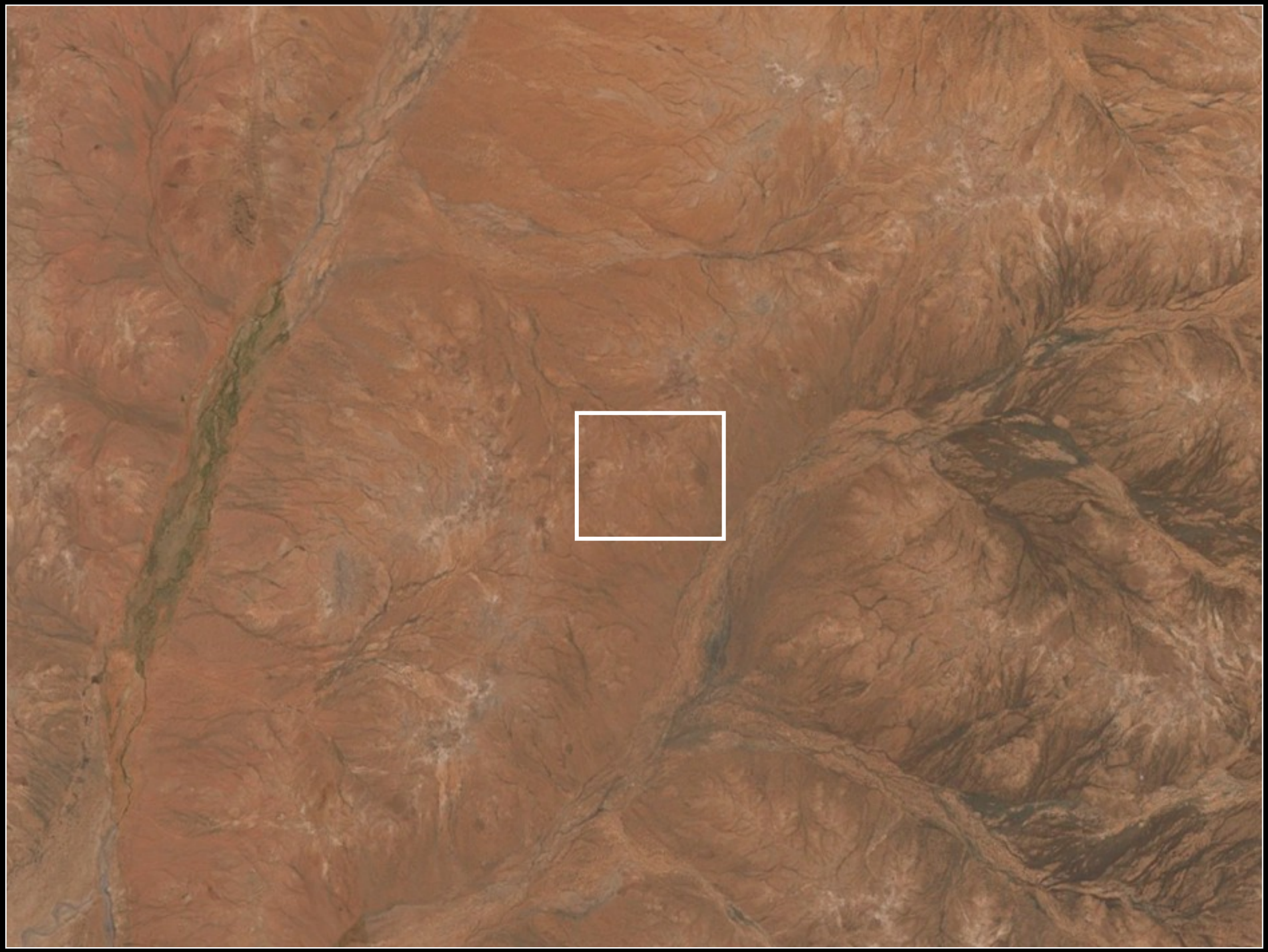
Chequer board sensor array on each dish

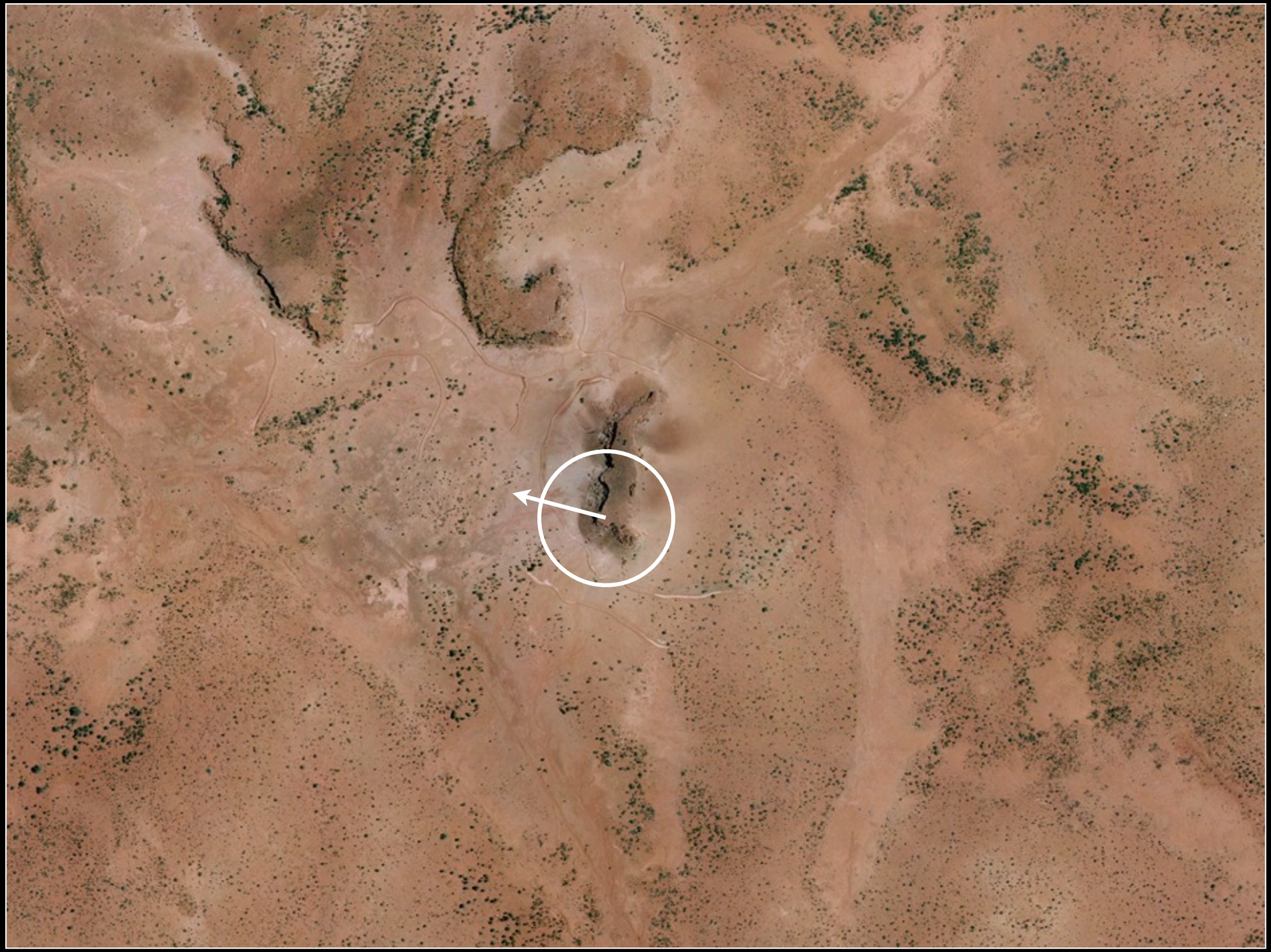
Artist impression

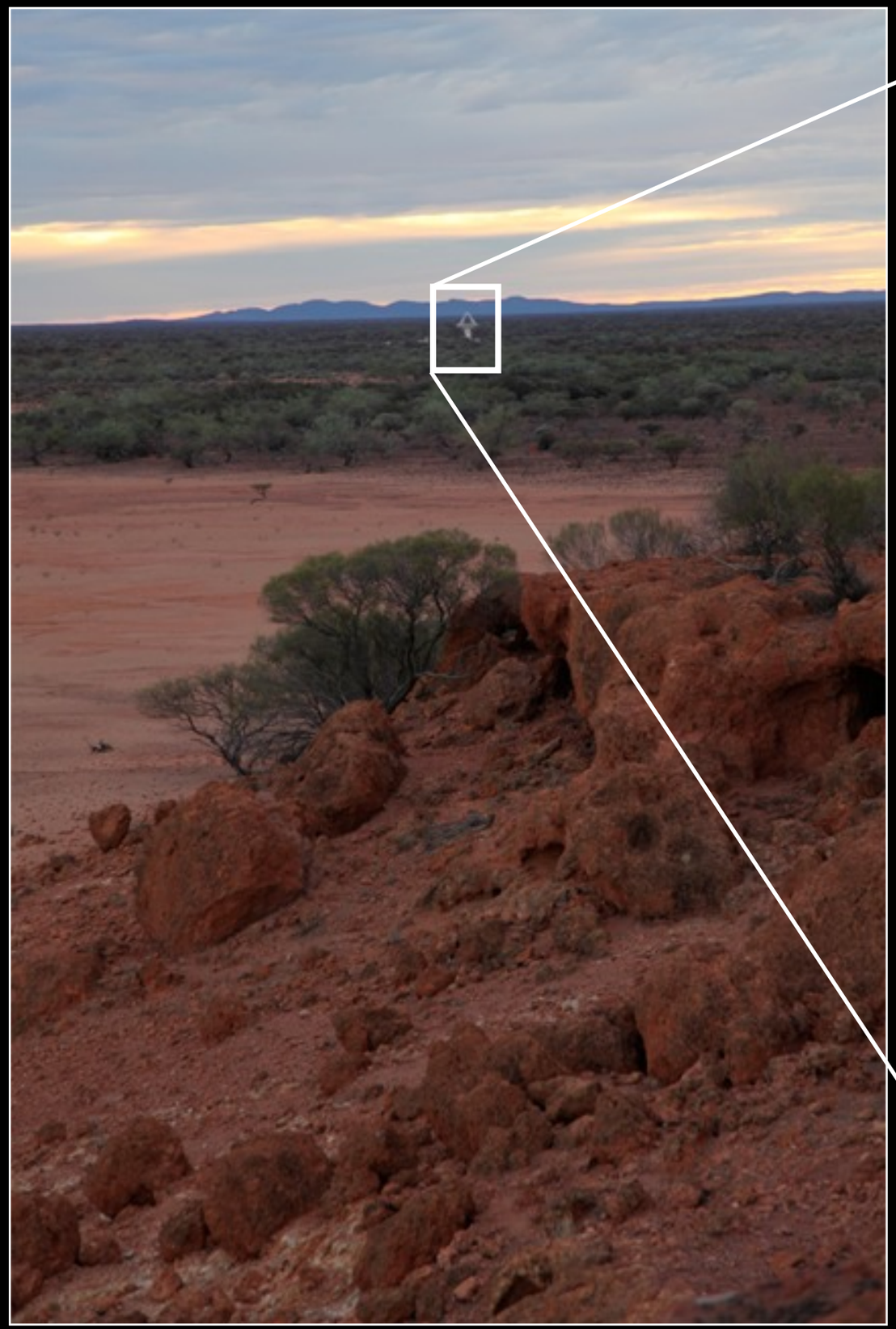
Astrophysics, Swinburne University

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.