Antenna Conversions

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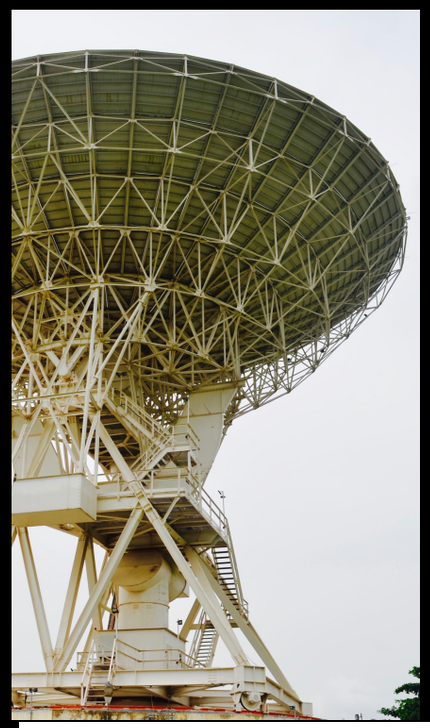
African VLBI Network: Putting Redundant Communication Antennas Across Africa to Use



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SQUARE KILOMETRE ARRAY

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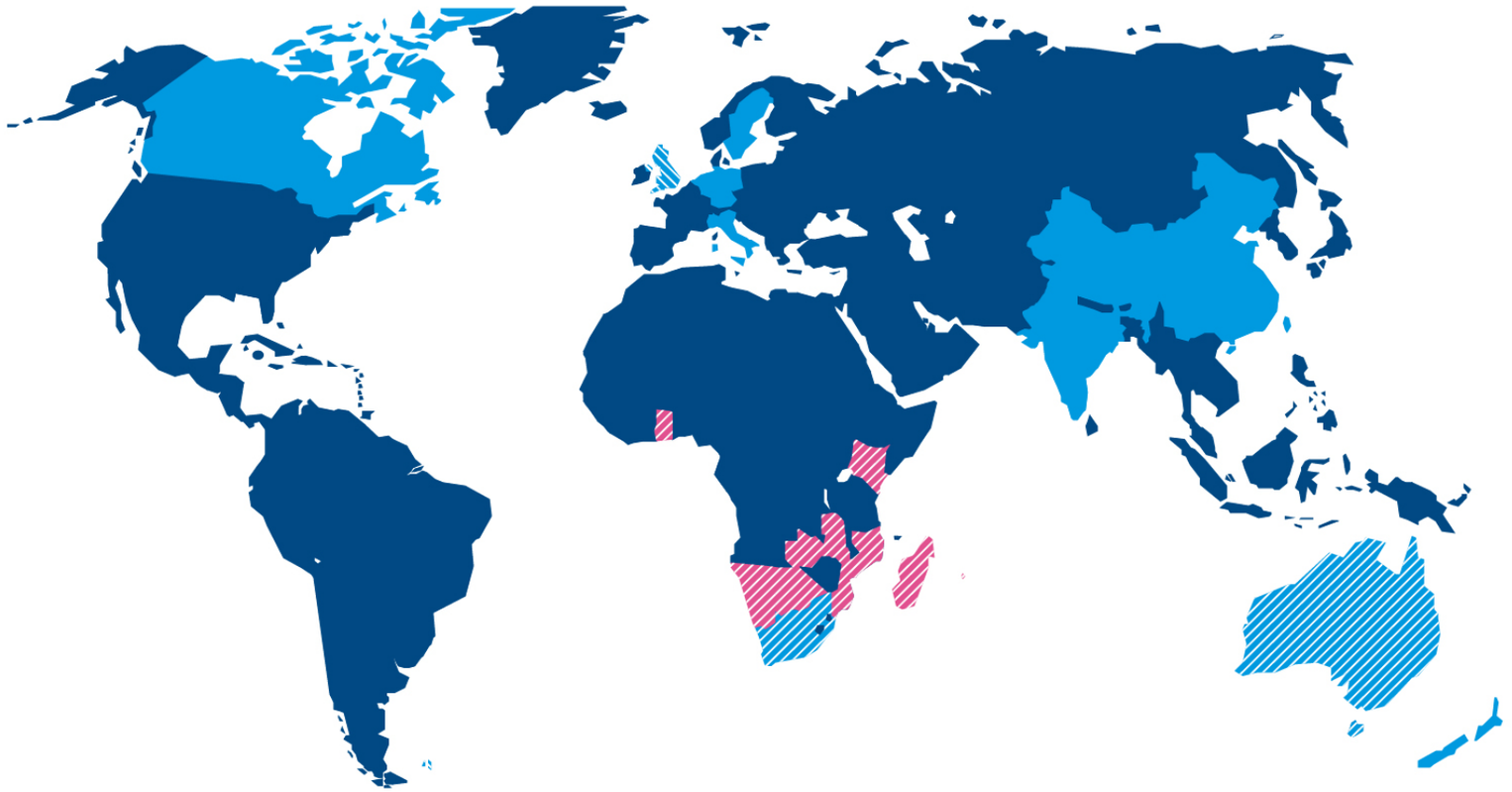
NRF National Research Foundation

SKA SQUARE KILOMETRE ARRAY

Outline

- A few basics about the antennas available for conversion;
- The big picture for a conversion project;
- Engineering approach for conversions;
- Risk management;
- Overview of some activities in pictures;
- Questions / Discussion.



SKA-South Africa

Little or no radio astronomy partner countries.

Key question: How will they handle such a big project?

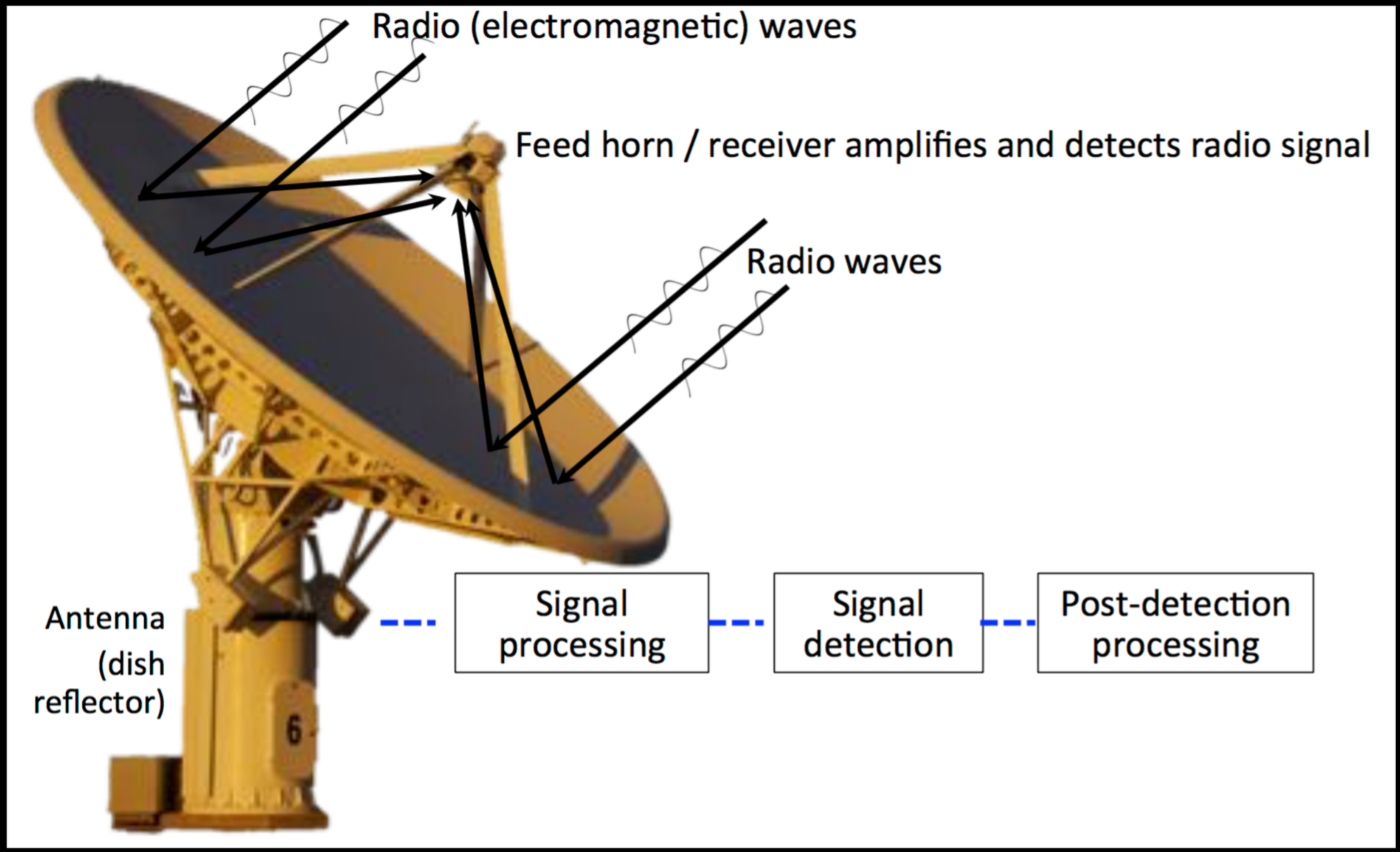
Options???? Build mini-SKA for training the partner countries.

Cost?

What & why the AVN?

- Develop a network of VLBI-capable radio telescopes on the African continent;
- Africa (led by South Africa) to co-host the Square Kilometre Array telescope with Australia, 9 African countries to host stations in SKA2 (including SA):
  - Develop the skills, regulations and institutional capacity needed in SKA partner countries to optimise African participation in SKA2 and enable participation in SKA pathfinder technology development and science;
  - Skills and knowledge transfer in African partner countries to build, maintain and operate radio telescopes independently;
  - Bring new science opportunities to Africa on a relatively short time scale and develop strong RA science communities.

Disciplines in demand for SKA/AVN



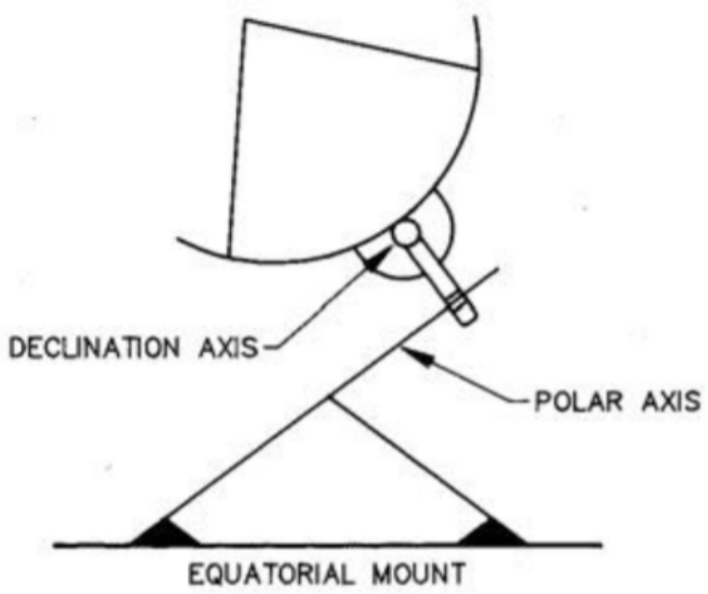
Structural & Mechanical Engineering, Communication, Analog & Digital Electronics, Electrical & Power, Civil, Software,
Science (focus on Astronomy, Astrophysics & Cosmology), Mathematics, Computer Sciences, etc.

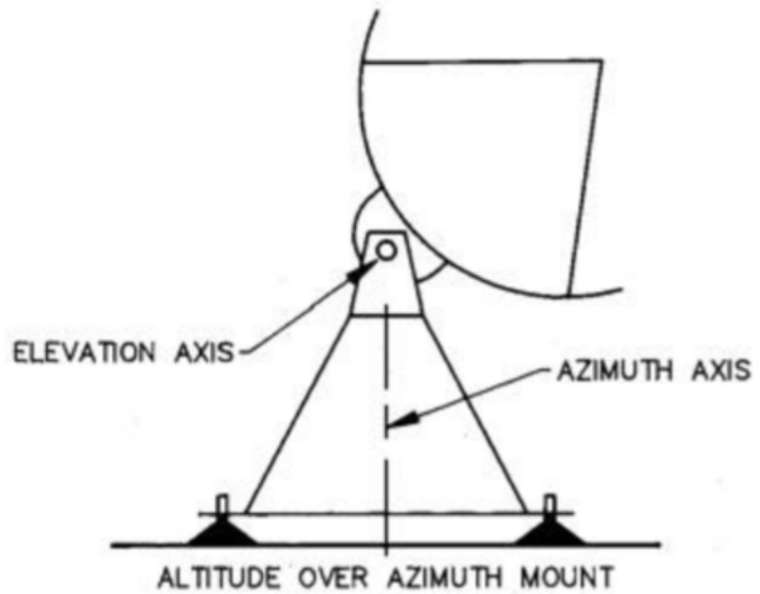
Identify from the figure where each discipline fit in. (class work)

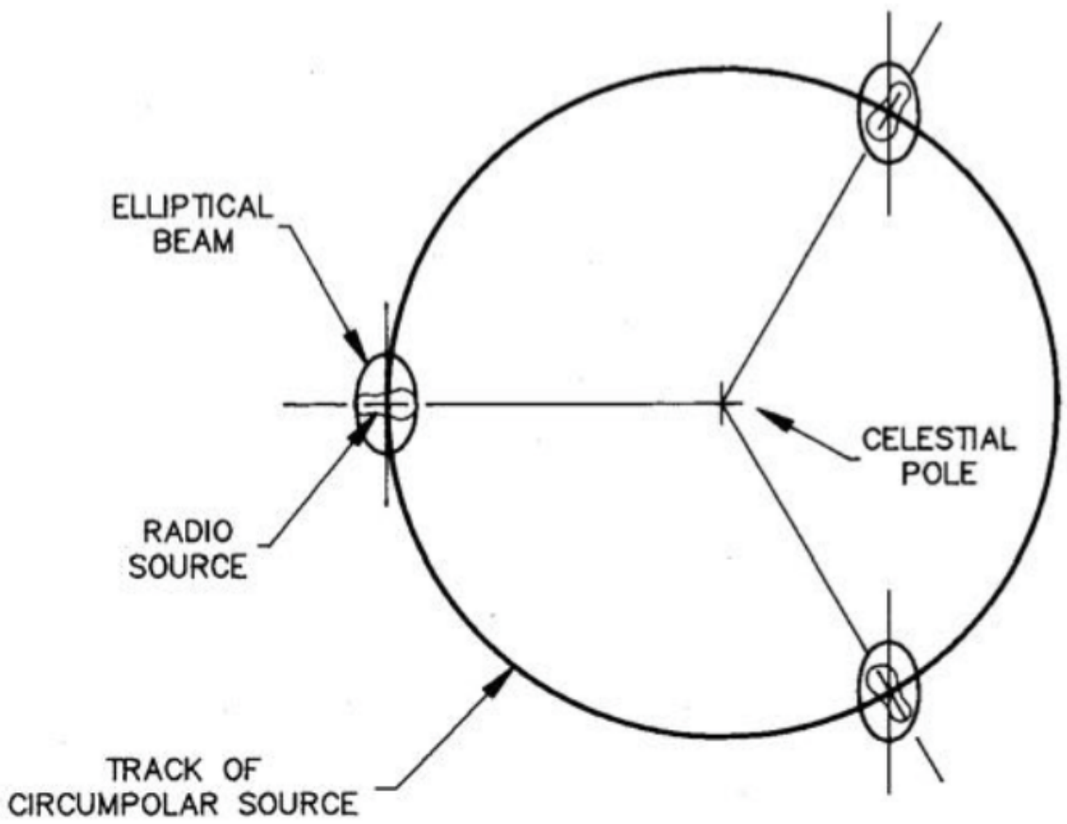
Mount Types

Different types of mount:

Modern antennas are mostly alt-az because they are cheaper to build.





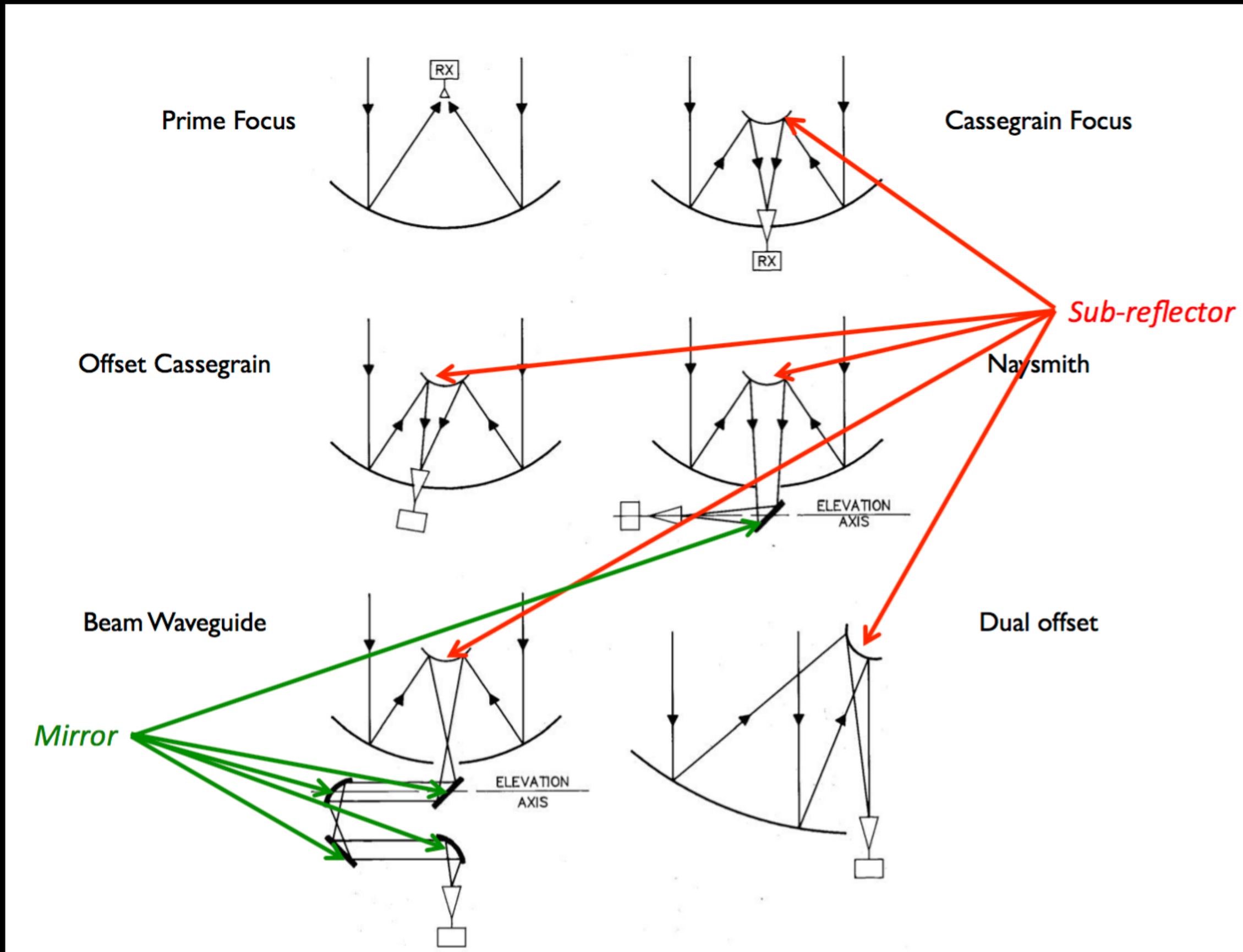


Disadvantage of alt-az telescopes is that the orientation of the telescope beam changes as the source moves across the sky.

For polarisation measurements, this must first be corrected for (usually in software).

Give me another example?

Sub-reflectors and Mirrors



Real Examples

Prime Focus
e.g. GMRT

Cassegrain Focus
e.g. Mopra (AT)

Offset Cassegrain
e.g. VLA and
ALMA

Naysmith
e.g. OVRO

Beam Waveguide
e.g. NRO

Dual gregorian
offset
e.g. ATA


DEMAG

Watch carefully!!! Mount type? Configuration?

For the same diameter main reflector, which is better and why?

Prime focus vs Offset Gregorian

- For prime focus configuration:
  - access to the receiver is restricted (high position, needs cherry picker or special equipment)
  - Blockage affecting efficiency and by metal structures in the way.
- For Offset Gregorian configuration:
  - Good access to receivers, with “feeds down” configuration, access to receiver is with small ladders etc.
  - No blockage of the aperture – bigger effective area.

Why did MeerKAT go from 80 prime focus to 64 offset Gregorians?

Why did MeerKAT go from 80 prime focus to 64 offset Gregorians?

- Antenna aperture efficiency:

η = Power collected by the feed / Power incident on antenna

  - Loss factors $\eta = \eta_{sf}\eta_{bl}\eta_{sp}\eta_{t}\eta_{misc}$:
    - Surface efficiency, η_{sf}
    - Aperture blockage efficiency, η_{bl}
    - Feed spillover efficiency, η_{sp}
    - Feed illumination efficiency, η_{t}
    - Other minor losses eg feed mismatch, η_{misc}

- 64 antennas means fewer parts, smaller correlator, less power, easy access to feeds / receivers, etc etc – lower overall system and life cycle costs and fewer items to be maintained.