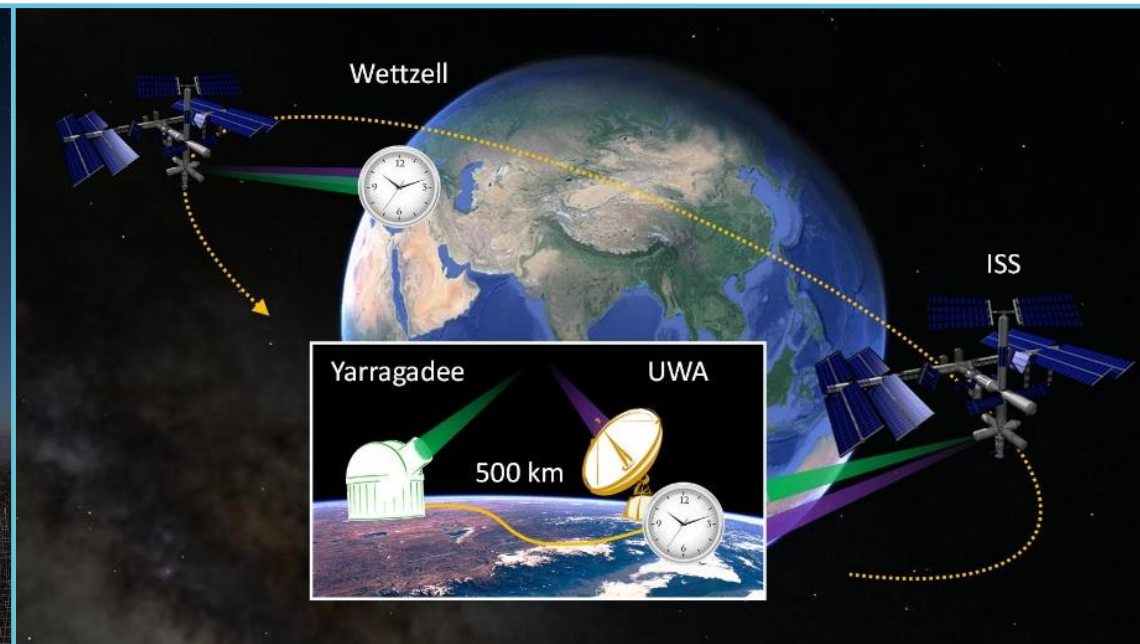
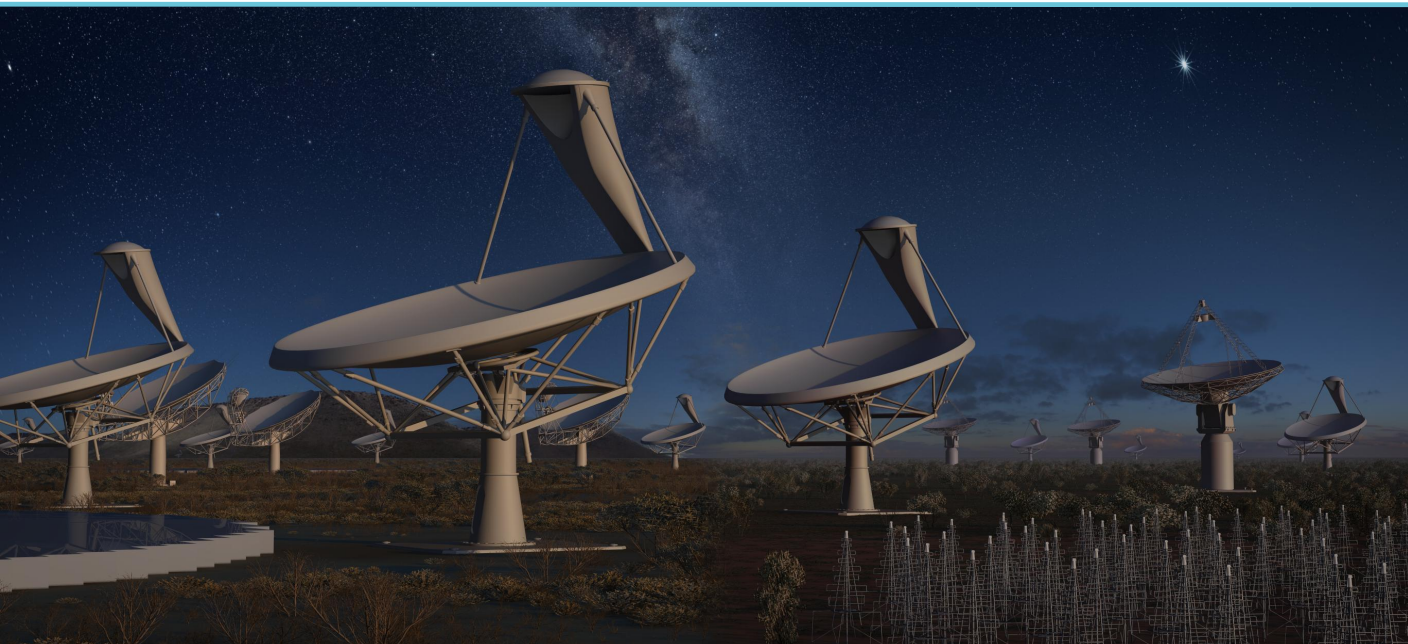


Stabilized Frequency Transfer for Radio Astronomy and Space Science Applications

David Gozzard

Frequency Transfer

- Phase synchronization for the SKA
- Timescale comparison for ACES



Phase synchronization for the SKA

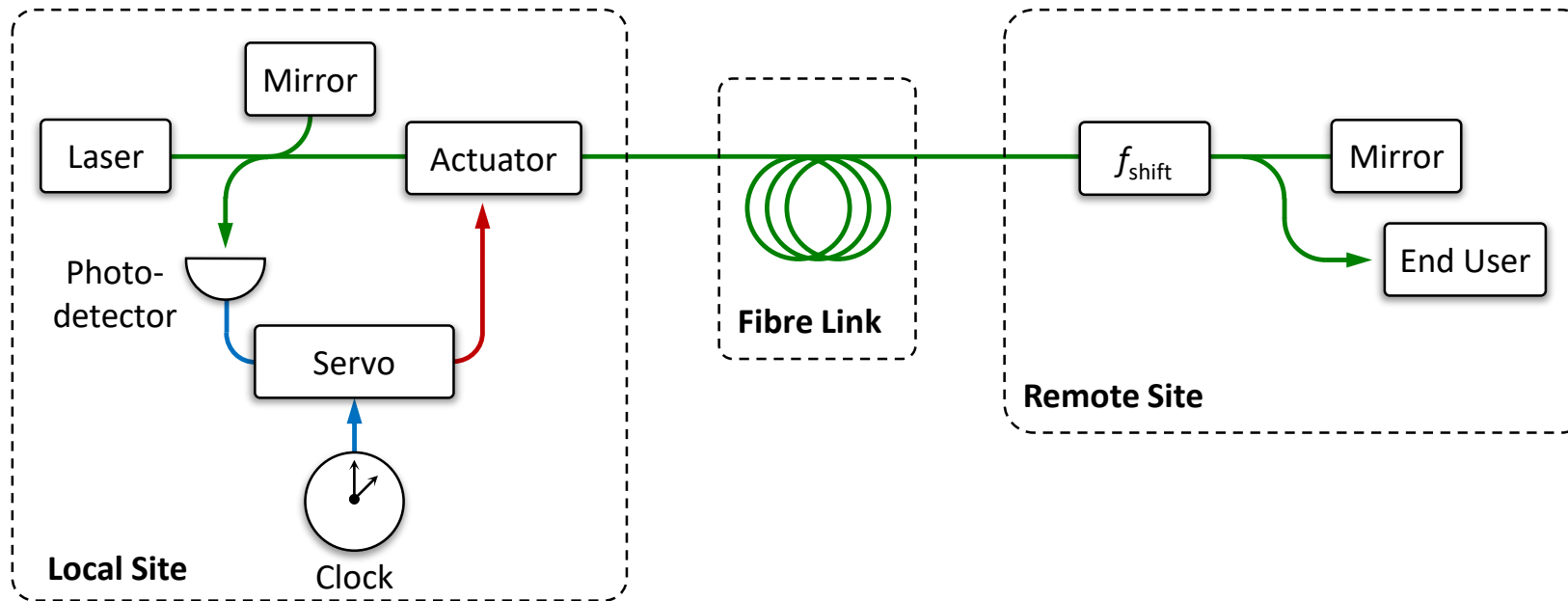
Requirements

- Coherence loss:
 - Less than 2% over 1 s
 - Less than 2% over 60 s
- Less than 1 rad phase drift over 10 min
- Link lengths up to 175 km
- Other – cost, scalability, glass-box, RFI, etc

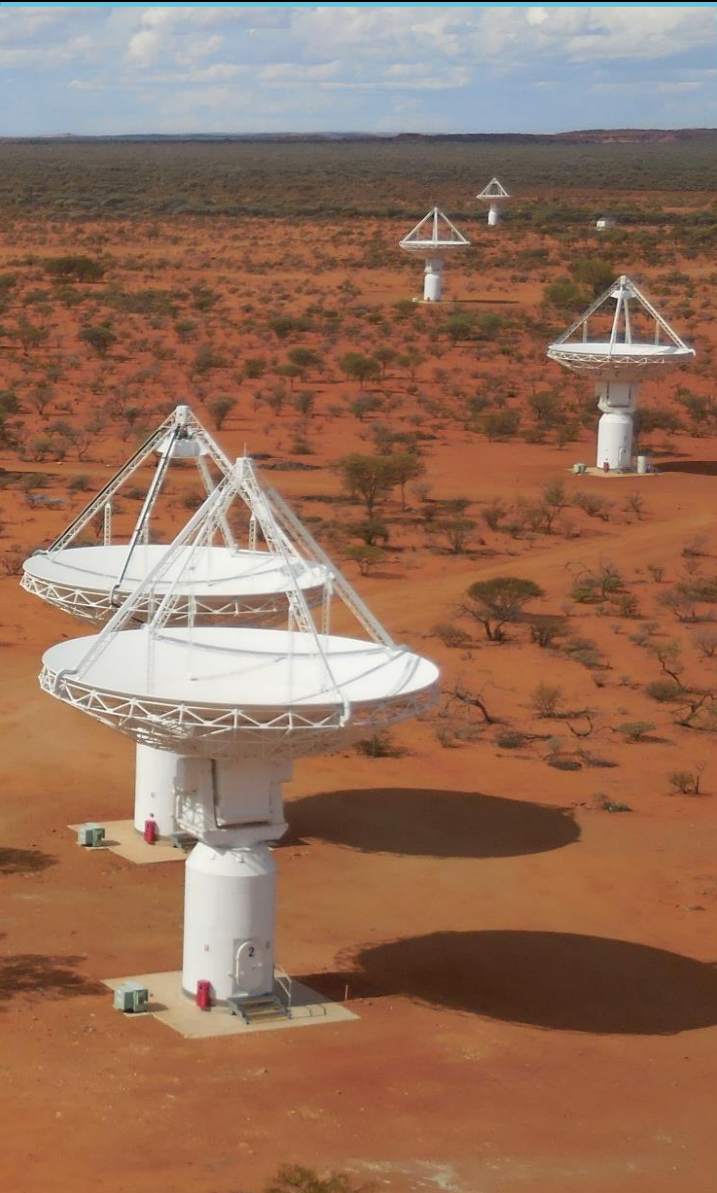


Phase synchronization for the SKA

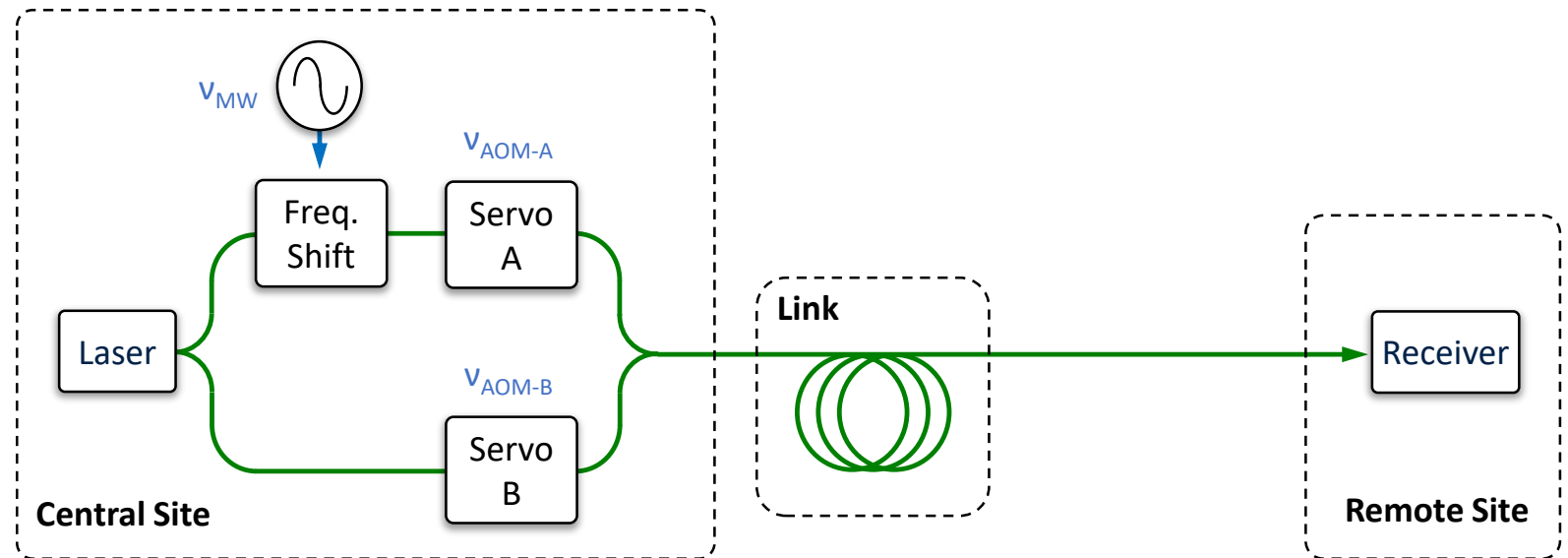
- Transmitted signal reflected back from remote site
- Self-heterodyned
- Actuator pre-compensates outgoing signal



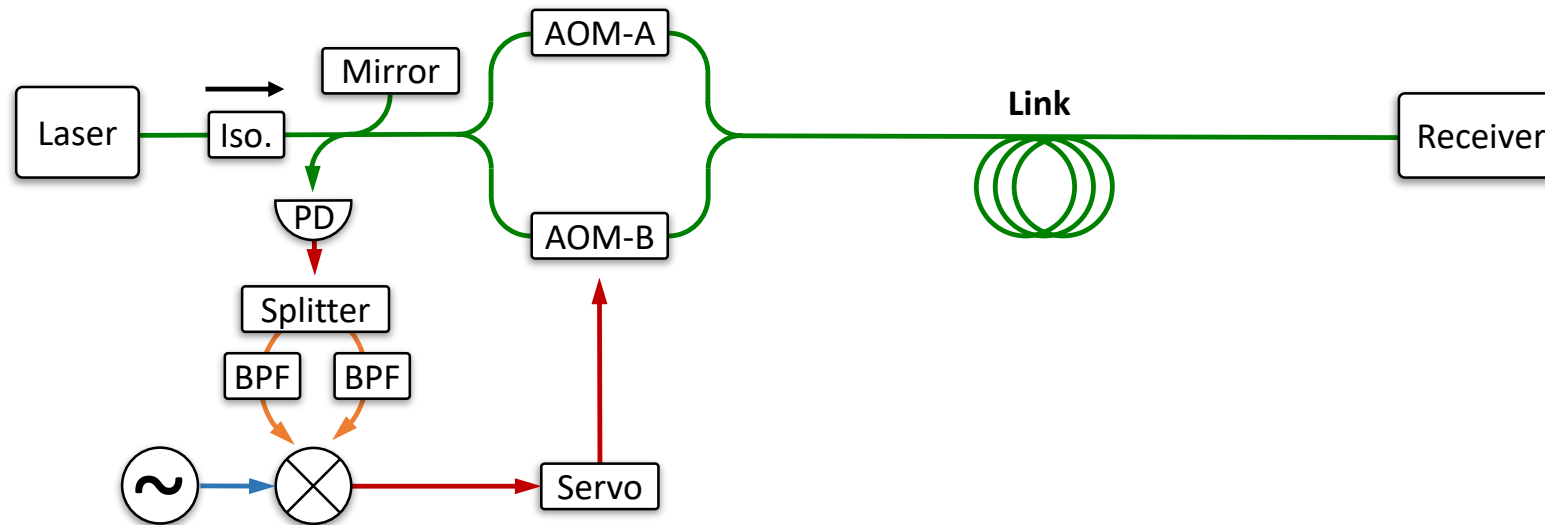
Phase synchronization for the SKA



- First concept – dual frequency transfer
- Tested at MRO
- *Gozzard et al. 2018 IEEE PTL 30 87*

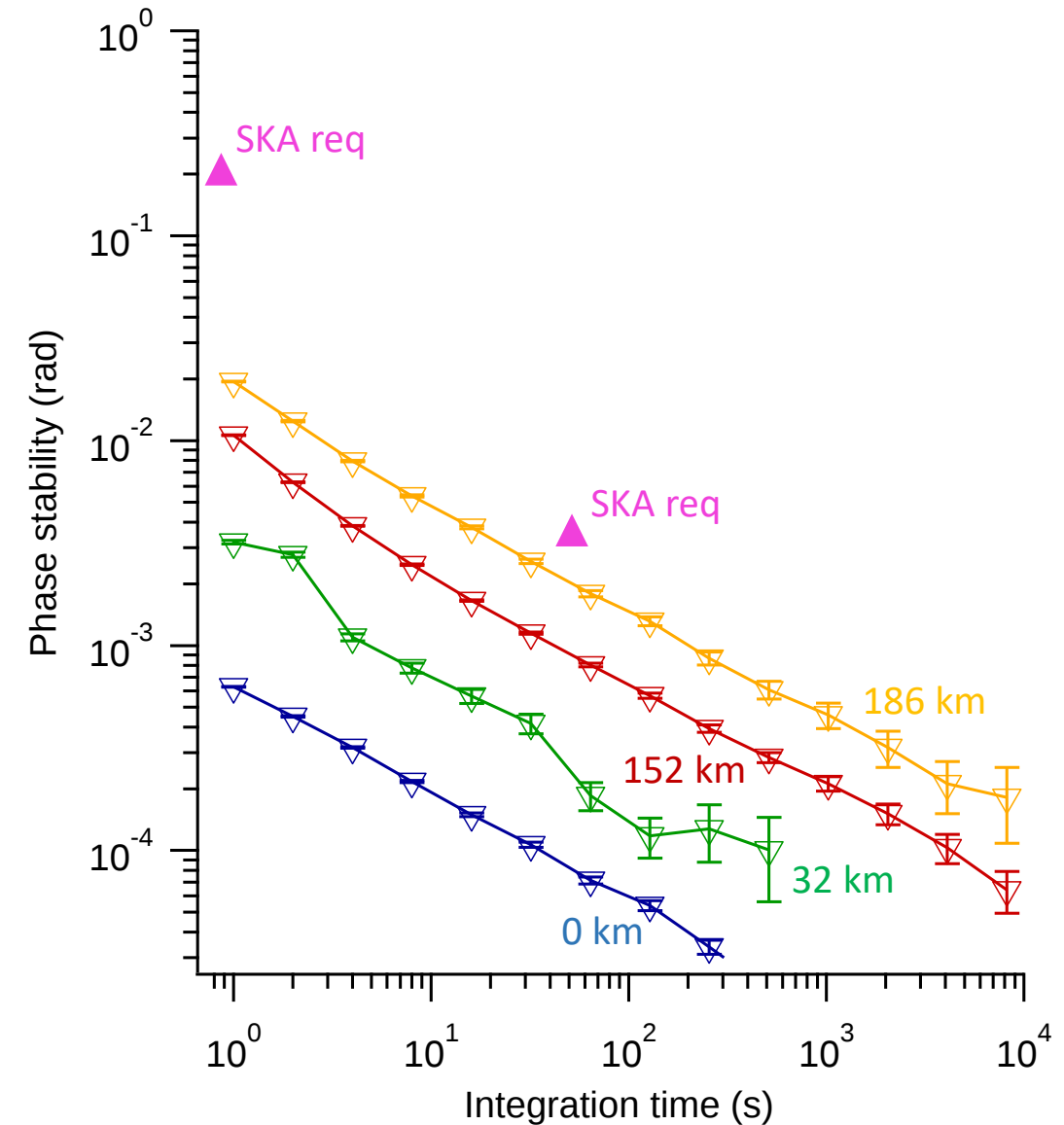


- Stabilize the Mach-Zehnder
- Different concepts for SKA-LOW and MID
- SKA-LOW



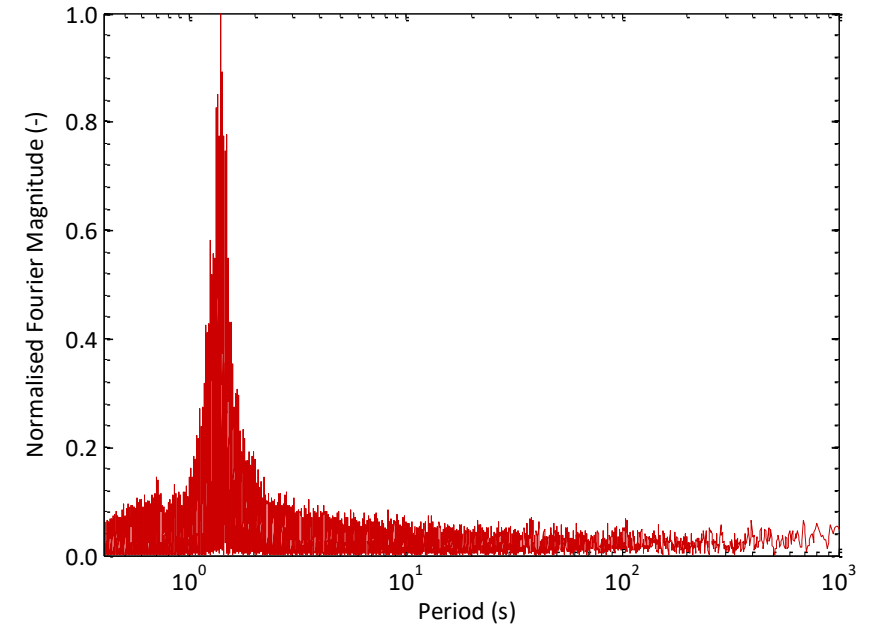
SKA-LOW tests

- 186 km of overhead fibre at South African SKA site
- 1000 times more noise than buried fibres
- Successfully stabilized
- *Gozzard et al. 2018 IEEE PTL* **30** 258
- *Gozzard et al. 2017 Opt. Lett.* **42** 2197

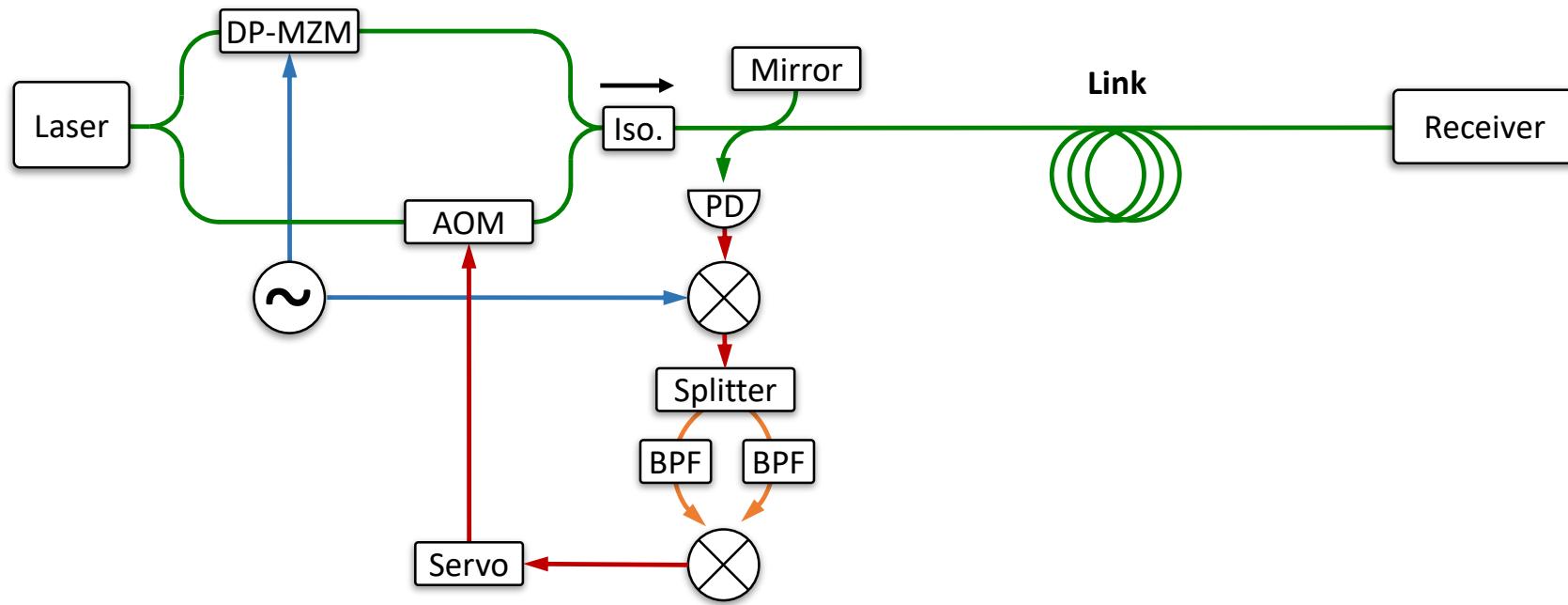


SKA-LOW tests

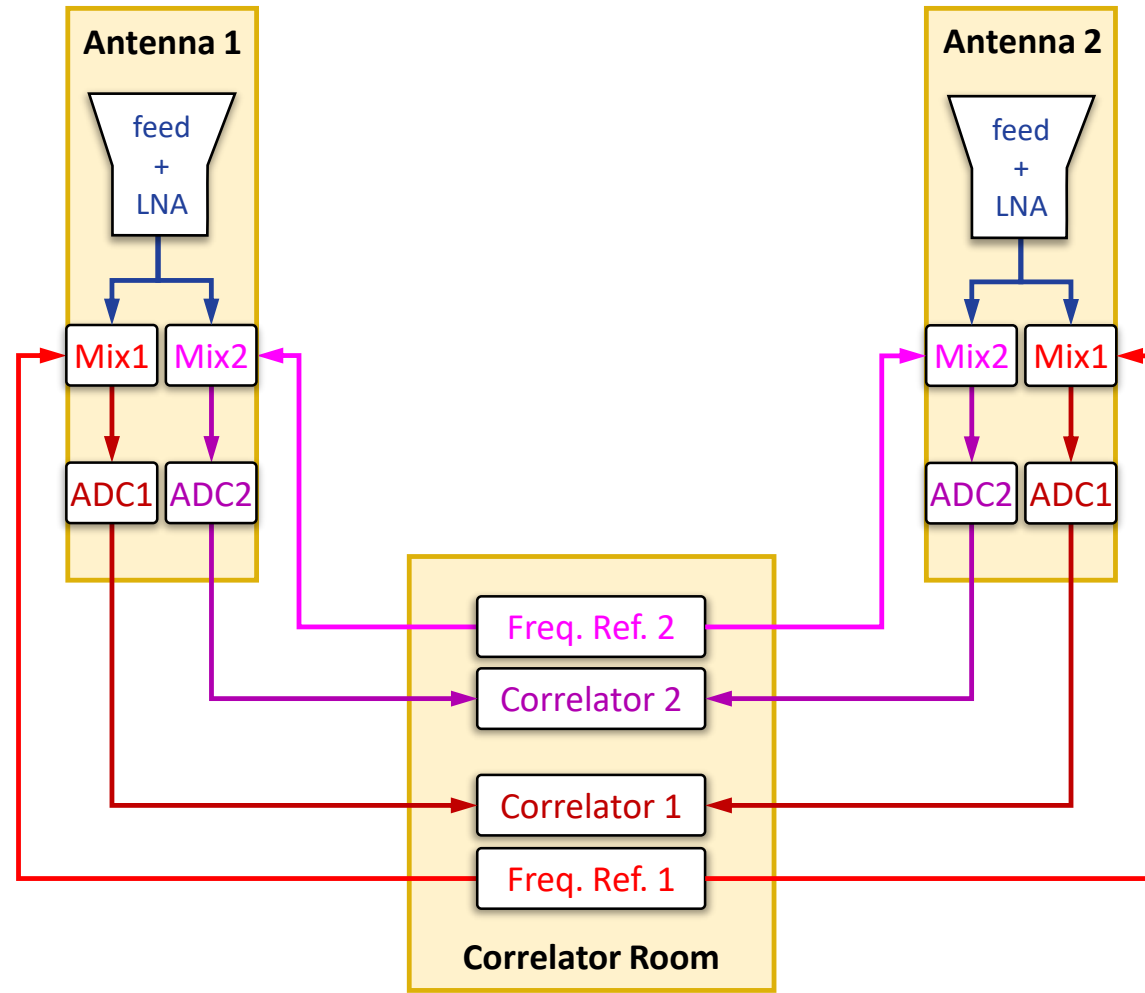
- 186 km of overhead fibre at South African SKA site
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- *Gozzard et al. 2018 IEEE PTL* **30** 258
- *Gozzard et al. 2017 Opt. Lett.* **42** 2197



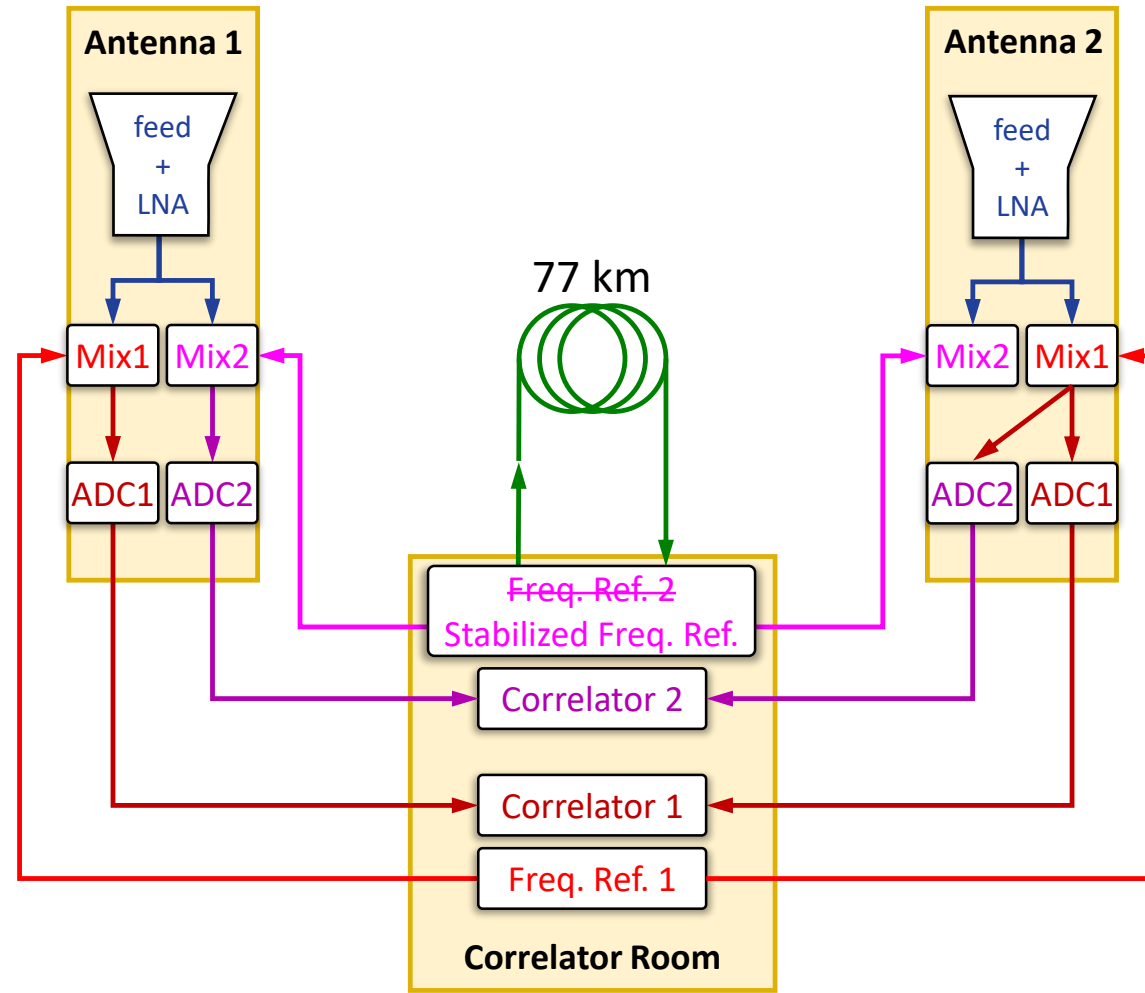
- Stabilize the Mach-Zehnder
- Change the detection scheme
- *Schediwy et al. 2017 Opt. Lett. 42 1648*



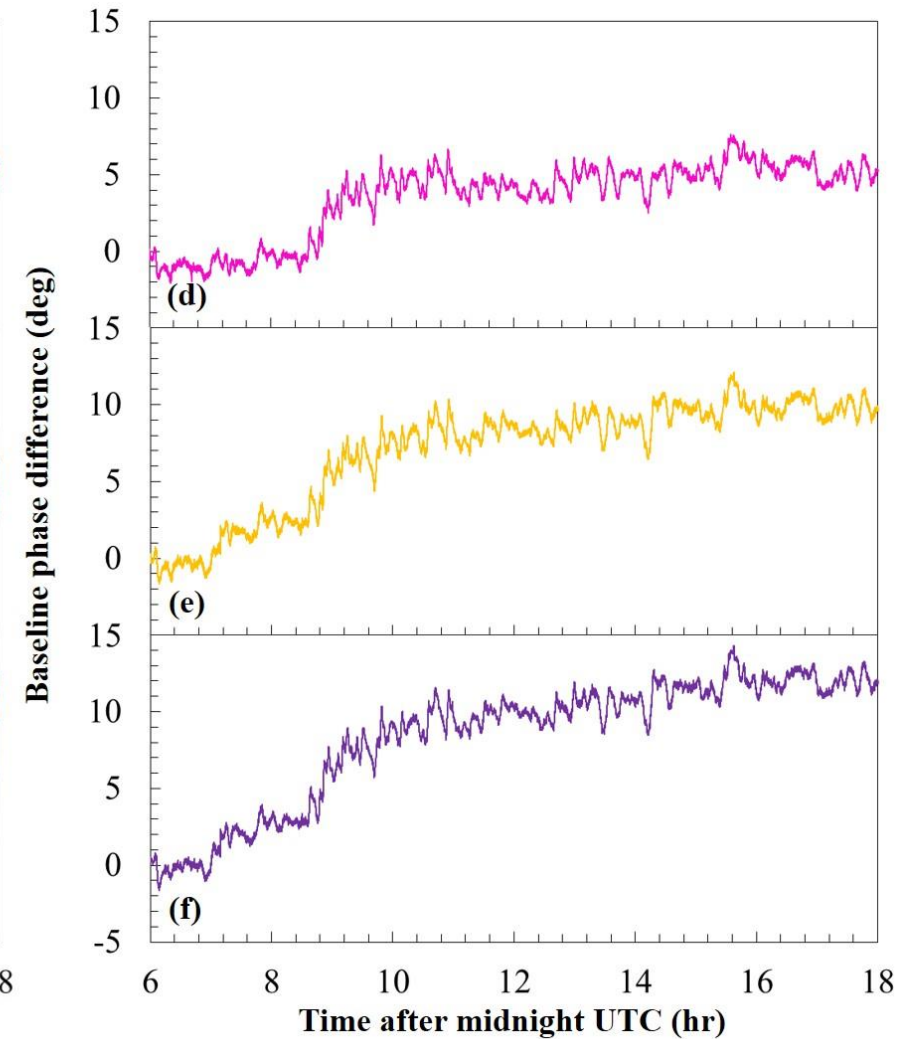
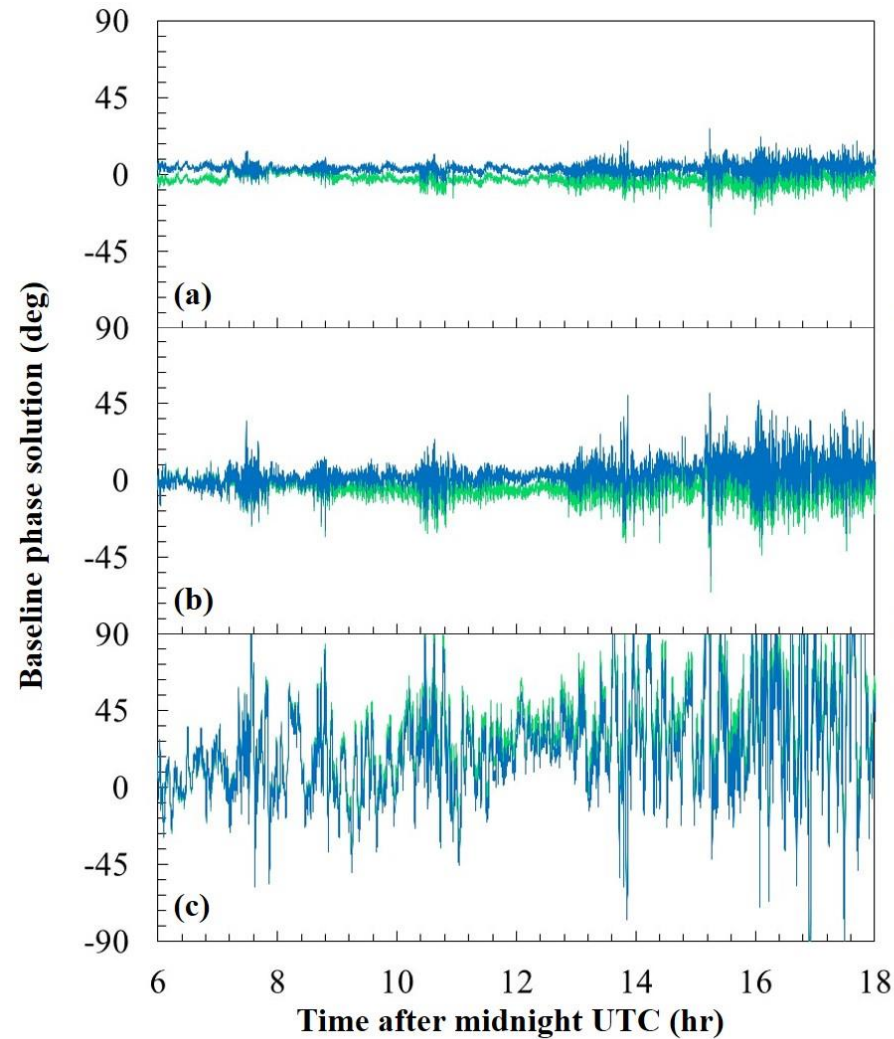
Astronomical Verification



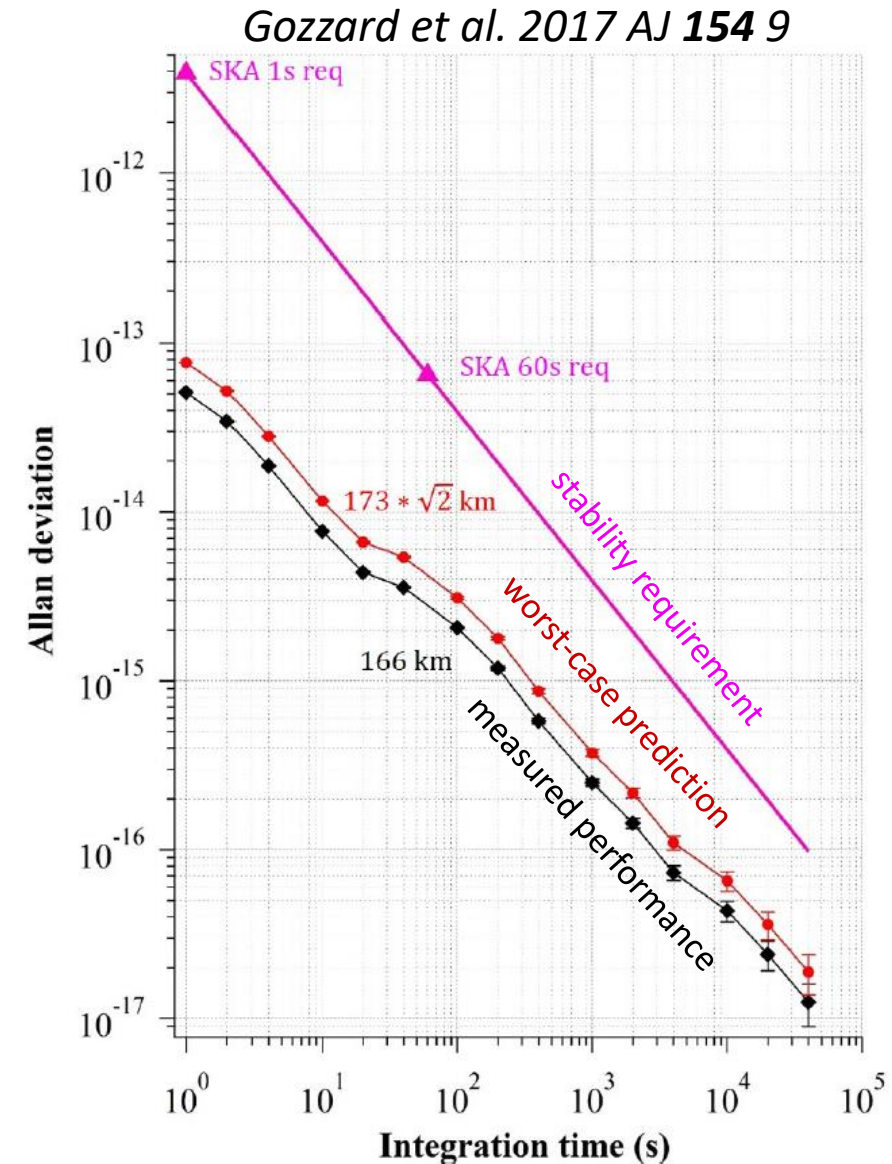
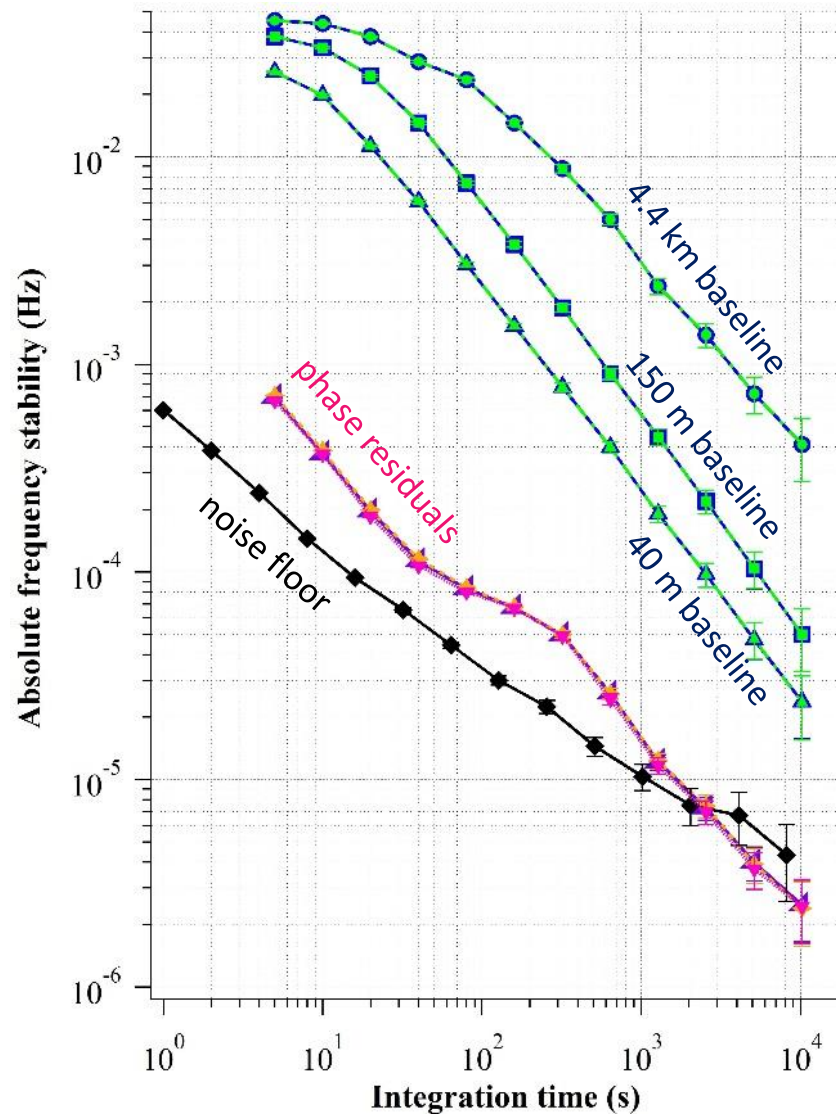
Astronomical Verification

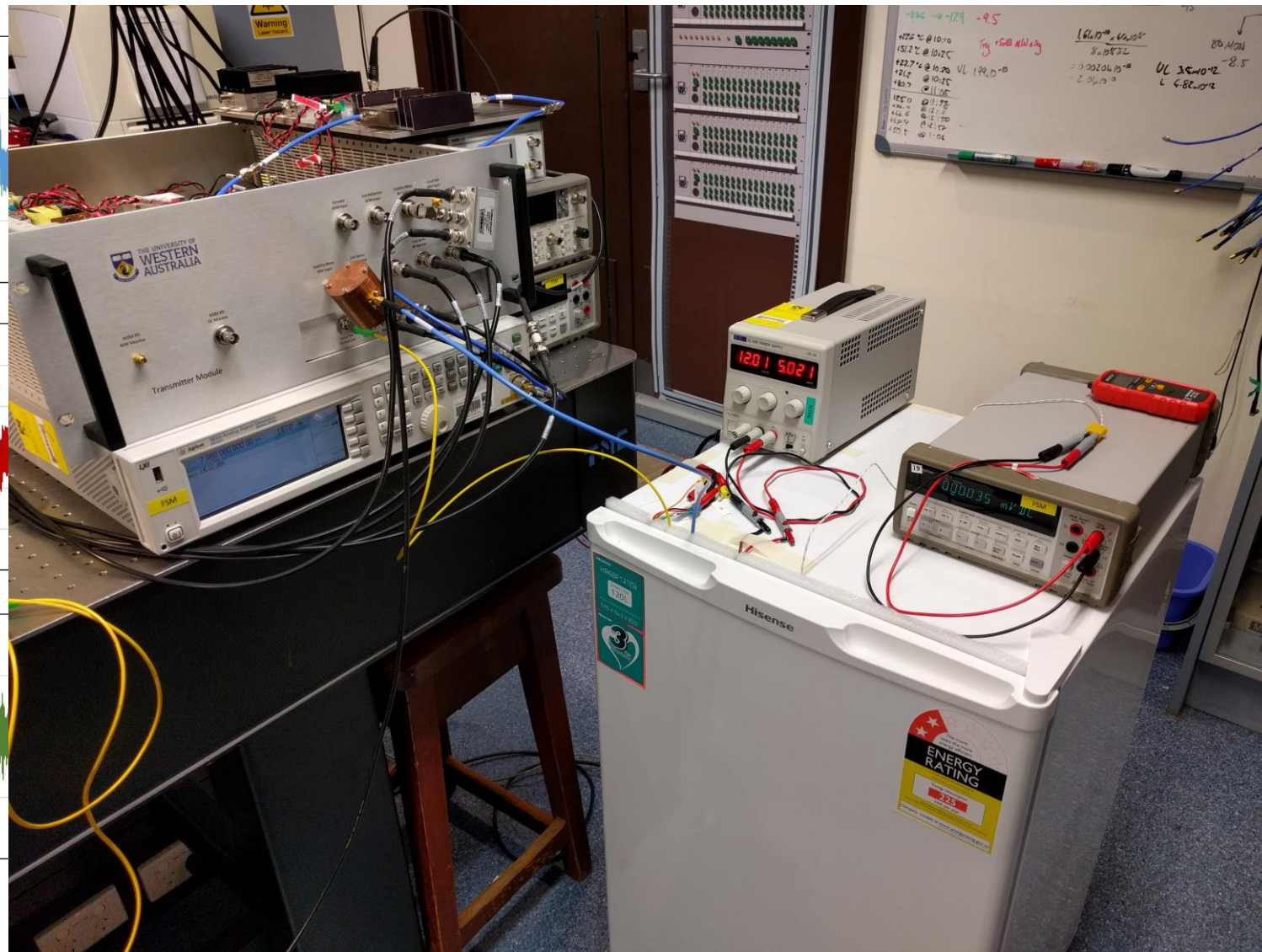


Astronomical Verification



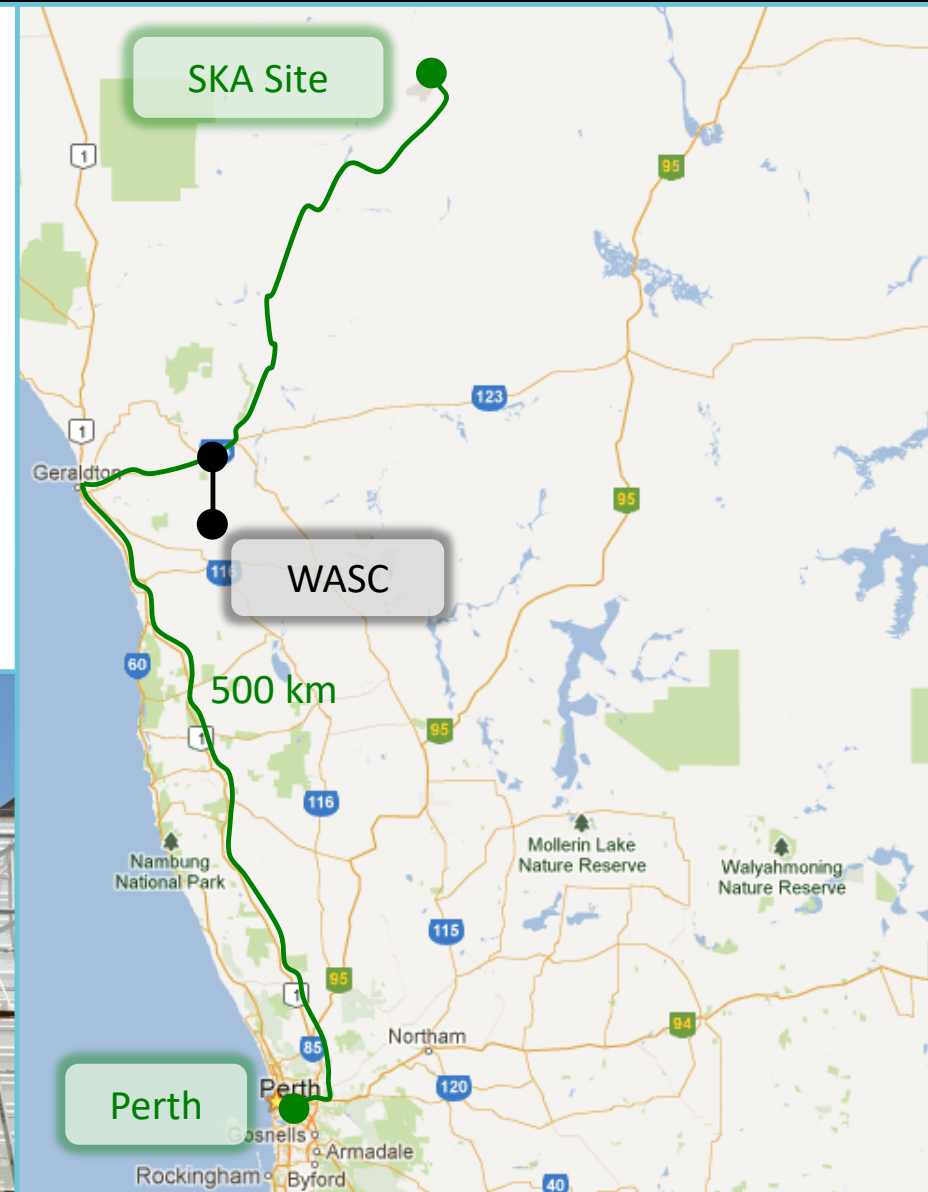
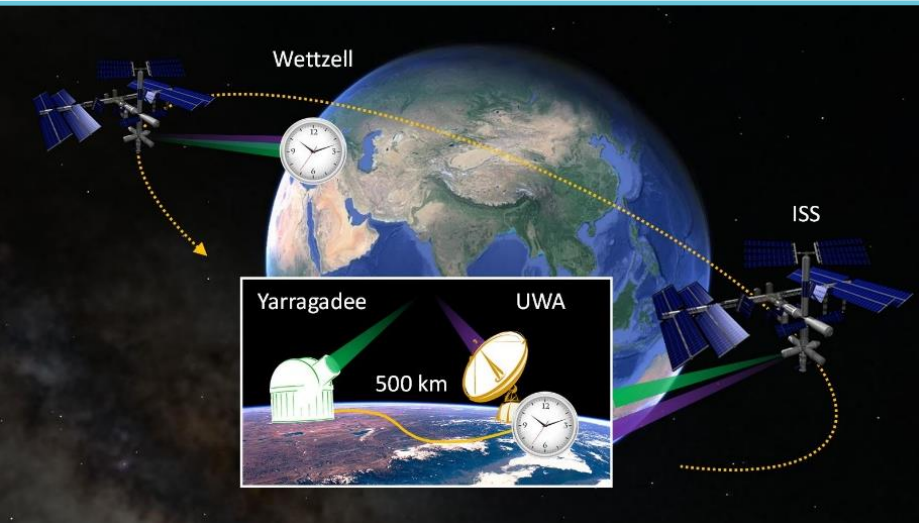
Astronomical Verification





ACES/Free-space links

- UWA node for ACES
- Need to link to laser ranging station in Yarragadee
- ~50 km fibre gap



ACES/Free-space links

- Collaborating with ANU for AO
- Short distance tests at UWA
- *Gozzard et al. Stabilized free-space optical transfer (in prep)*



Future Work

- MeerKAT
- SKA-MID manufacture
- ngVLA
- More free-space – longer, AO, MW
- Breakthrough Starshot
- Optical Interferometry

