Sparse Arrays
(Formerly known as Bright Objects)

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General considerations

• How many telescopes?
• Maximum baseline length
• Telescope diameter
• Wavelengths
• Will there be an intermediate stage?
How many telescopes?

\(N = 20 \text{ to } 30 \text{ telescopes}\)

- Aim for roughly 20 \(\times\) 20 pixels: Images of interacting binaries, BEL regions . . .
- The ratio \(B_{\text{min}}/B_{\text{max}}\) (in an evenly spaced array) is roughly \(N/2\).
- Number of pixels across the image is roughly \(N\).
- A larger number is difficult due to complexity.
- Snapshot mode important—affects number of telescopes
- Reconfigurable

\[ N = 27 \] ~15
What size telescopes?

\[ D = 8 \text{ m} \quad \text{— or} \quad 2 \text{ m in Antarctica} \]

- Telescope size is driven by the need for point sources to co-phase the array.
- Point sources should be available for \(~10\%\) of the sky at the North Galactic Pole.
  - NGP source density is relevant for extragalactic targets, but relaxing that to emphasize Galactic targets does not make a big difference.
- There is a tradeoff between telescope diameter and instrument efficiency. AQ’s optimistic assumptions underlie this estimate.
- An Antarctic site could reduce the size to \(~2\) m.
- Need to explore:
  - Is a dual feed mode needed to acquire co-phasing targets, or are the science targets bright enough themselves for fringe tracking?
  - If a dual feed is needed, do 8 m apertures gather enough light on the science target?
  - If dual feed is not needed, can the apertures be smaller?
What length baselines?

**Minimum** $B_{\text{max}} = 1$ to 2 km

- Below 1 km, we lose the desired resolution on targets such as interacting binaries.

- Free space beam transport and delay compensation are feasible at this range.

- For $B_{\text{max}} = 10$ km, fiber beam transport and delay are better.
Desired science capabilities

• Imaging resolution:
  – >10 pixels across stars
  – A few pixels on BLRs
  – Resolve photosphere of T Tauri

• Spectroscopic resolution:
  – General targets: $R = 10\,000$
  – Bright stars: $R = \text{up to } 100\,000$
  – These resolutions increase the coherence length, lower the impact of intrinsic dispersion in fibers.

• Snapshot imaging capability, visible to mid-IR

• IR wavefront sensing for AO

• Dual feed capability desirable for many programmes (TBD)
Possible technical issues

• Delay lines for 10 km baselines are hard to imagine. Can fiber optics be used for delay compensation?
  – Telecom industry probably will not help with ultra-low-dispersion fibers.
  – High spectral resolution may ease the problem.

• Free-space beam transport for 10 km baselines needs investigation. What are the requirements for transporting a single Airy disk?

• We expect that ELTs will improve the quality of AO, but we should keep an eye on this area.

• Coherent amplification could be an option. The benefits of correlating lots of baselines might outweigh the noise penalty.
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- The target acquisition FOV should be at least a few arcsec.

- Atmospheric dispersion compensation may be a problem.

- Subsystems should be demonstrated at small arrays (fibers, AO, beam combiners ...).
Summary

Elements: 20 to 30
  Reconfigurable; snapshot-capable
Telescope size: 8 m (or 2 m in Antarctica?)

Baselines: Minimum 1 to 2 km
  10 km may require fiber transport, delay
Wavelengths: Visible to mid-IR

Spectral resolution: \( R = 10^4 \)
  \( 10^5 \) for bright stars

Key technologies: Ultra-low-dispersion fibers
  AO (depending on how it develops in ELT context)