Sparse Arrays

(Formerly known as Bright Objects)

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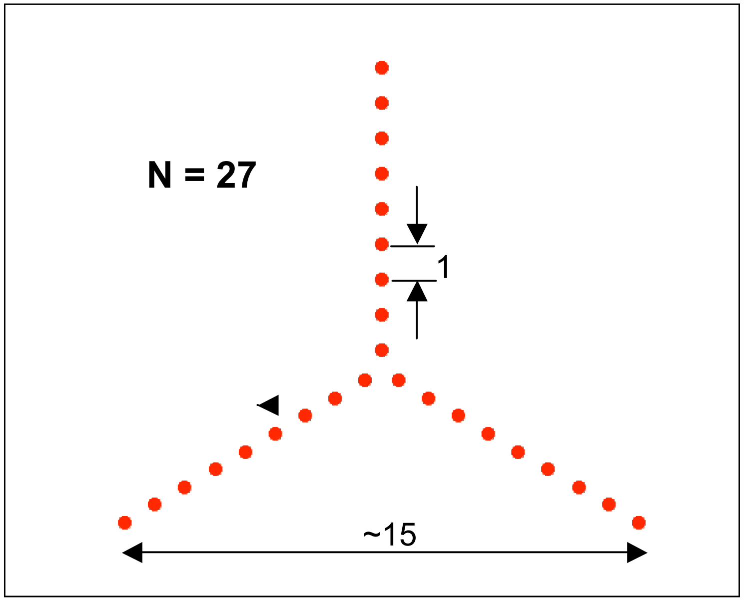
General considerations

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

How many telescopes?

N = 20 to 30 telescopes

- Aim for roughly 20 × 20 pixels: Images of interacting binaries, BEL regions . . .
- The ratio $B_{\mathrm{min}}/B_{\mathrm{max}}$ (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



What size telescopes?

D **= 8 m — or 2 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_{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_{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 = 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.

Possible technical issues

- Coherent amplification could be an option. The benefits of correlating *lots* of baselines might outweigh the noise penalty.
- 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)