K-Band Focal Plane Array: Observing Modes

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NRAO-Green Bank

Science Drivers

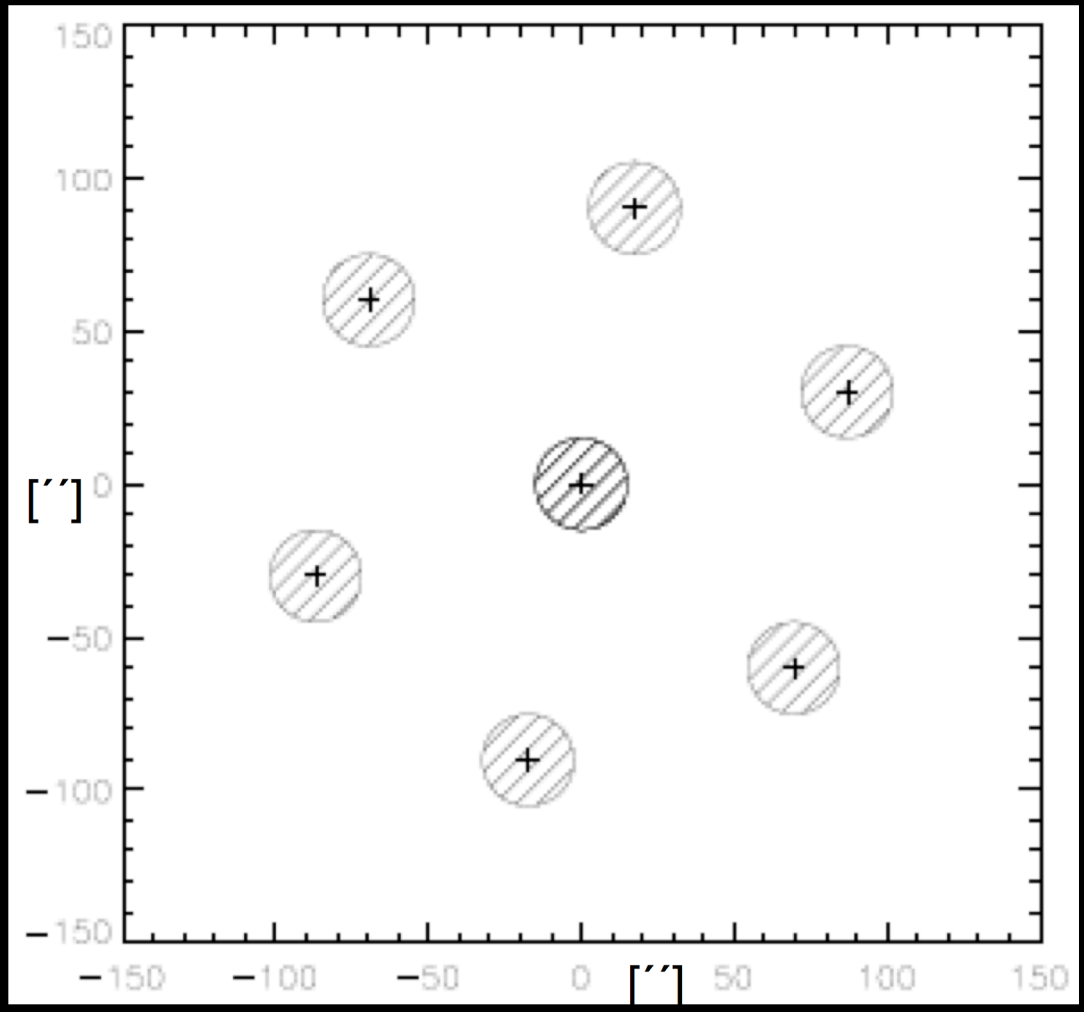
1. Mapping nearby star-forming regions
   - probing the density, temperature, turbulence, inflows and outflows of star-forming cores with NH_3 and CCS
   - cores have sizes > 33´´
   - distributed over regions of 3´ and up

   ⇒ Mapping
2. Interstellar chemistry
   - searching for new complex molecules towards Sgr B and OMC-1
   - distributed over large angular scales (> 3´)

   ⇒ deep observations at a single position

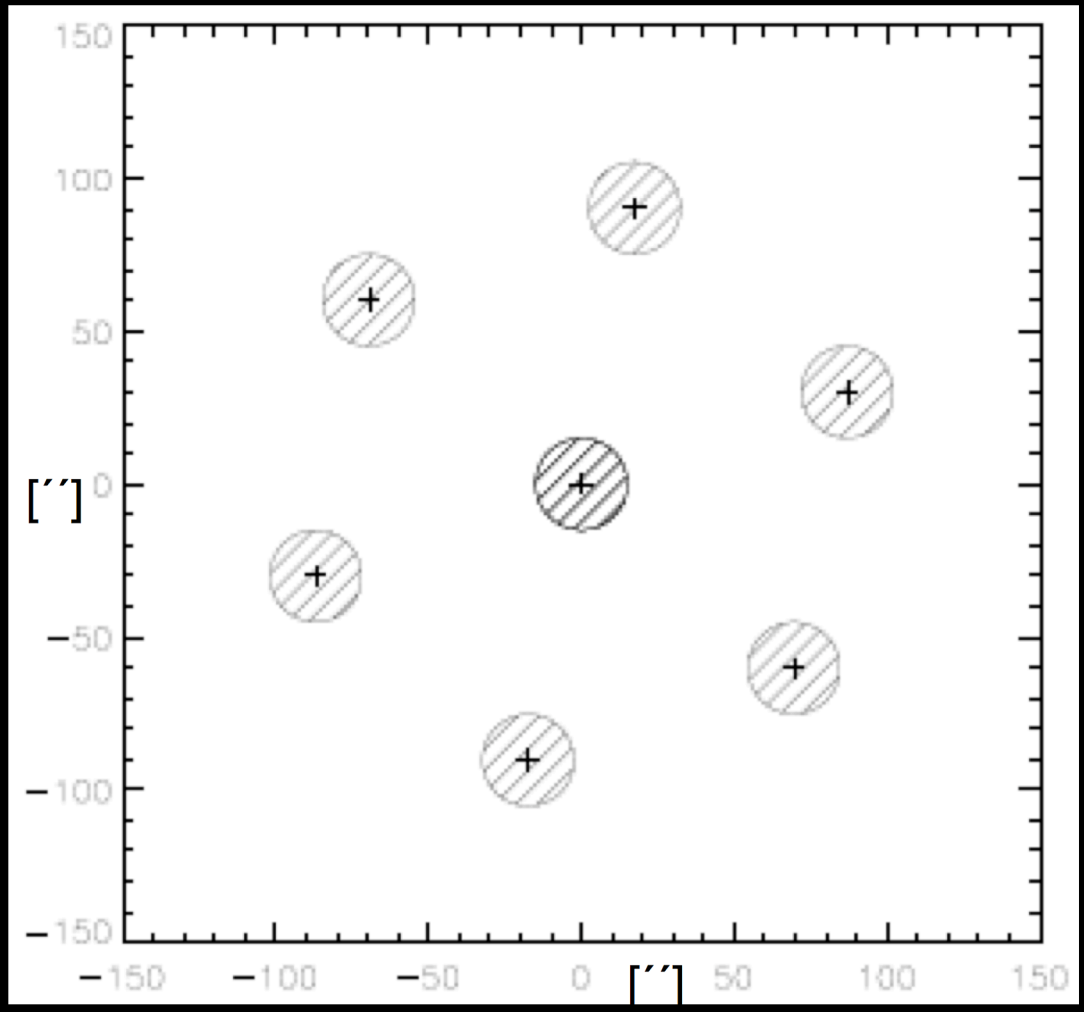
Feed Layout

- 7 beams, hexagonally packed yields the densest spacing on the sky and is symmetric
- 92´´ spacing,
  at 18 GHz, 2.3 HPBW
  at 24 GHz, 3.1 HPBW
  at 26.5 GHz, 3.4 HPBW
- ~ 30´´ HPBW at 24 GHz
- no feed rotator
- Can get uniform coverage with a single azimuth scan



Feed Layout

- Other configurations may provide more complete coverage for azimuth scans (e.g. increase the spacing in azimuth and decrease in elevation)
- These configurations will limit the total number of beams we could install, however.
- These configurations are not efficient for mapping in other coordinate systems.

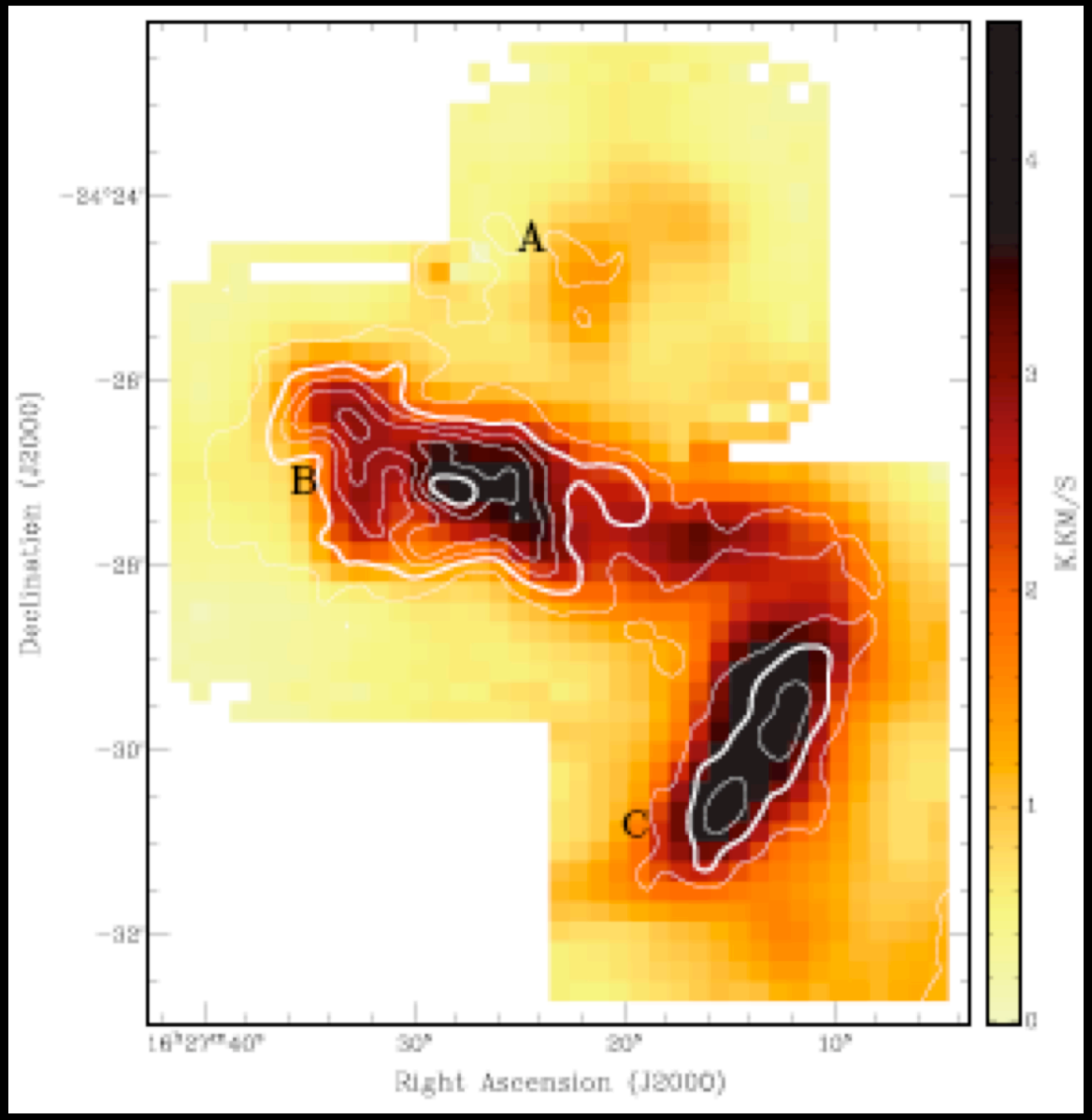


Mapping individual cores

Ophiuchus B star-forming complex in L1688 by Friesen et al. (2008, in prep).

The 7-beam KFPA is well matched in size to a single core.

This is most efficiently done with a small raster map scanning along constant declination.



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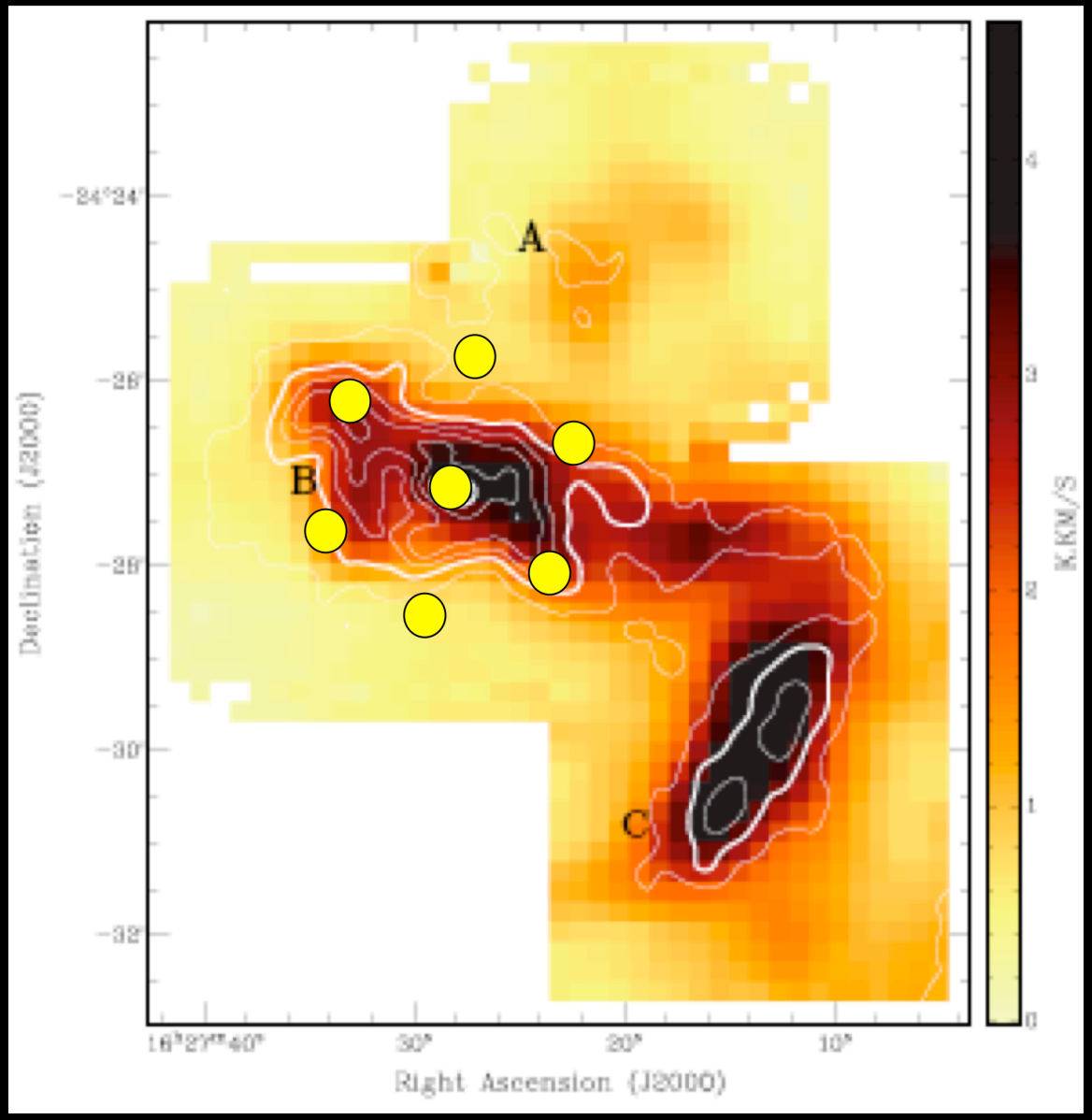
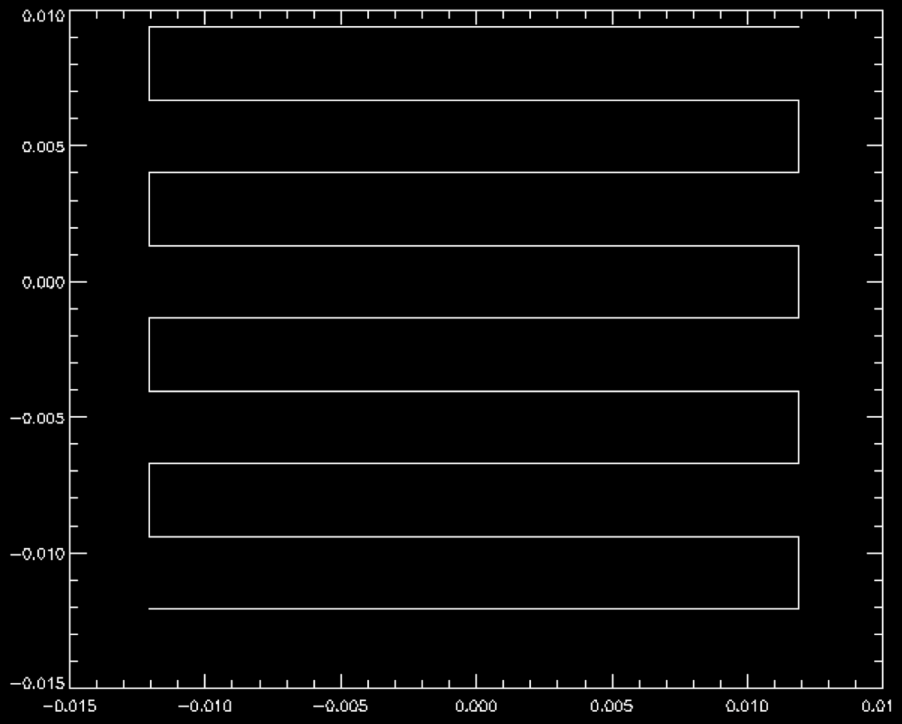
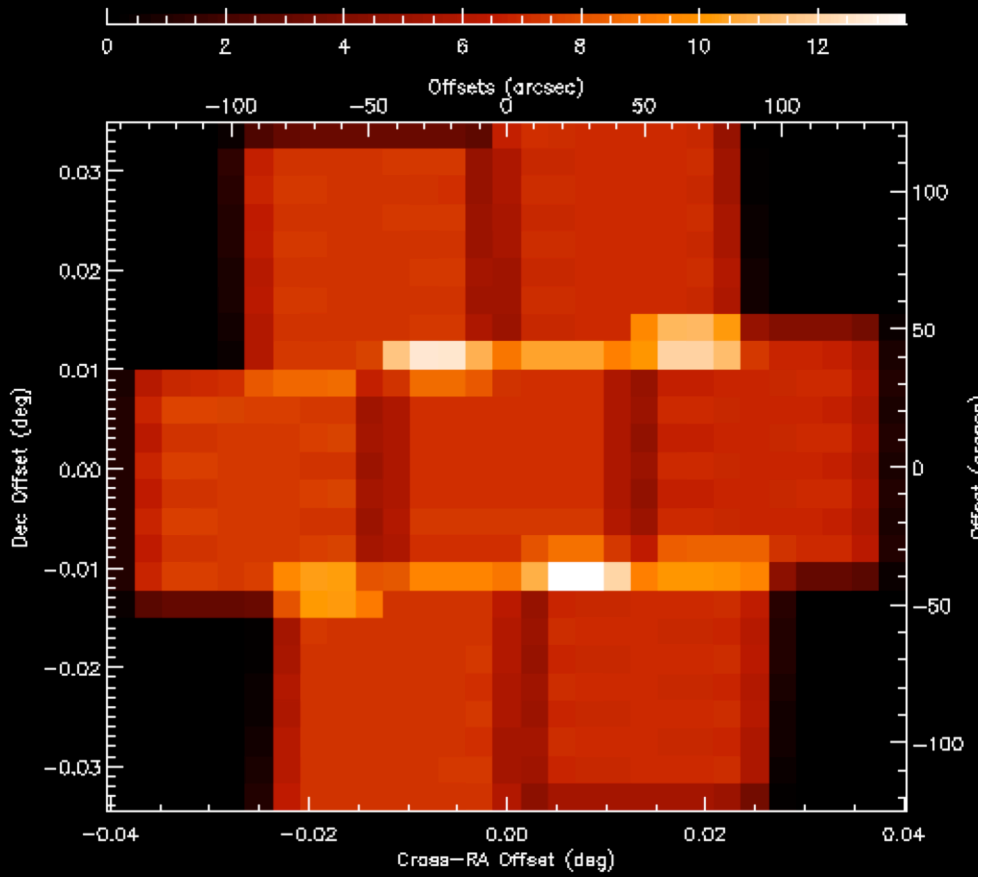


Mapping the KFPA footprint



A small raster map produces relatively uniform coverage of 3´x3´ field.



68% of observing time within field

50% of pixels within 7% of mean integration time

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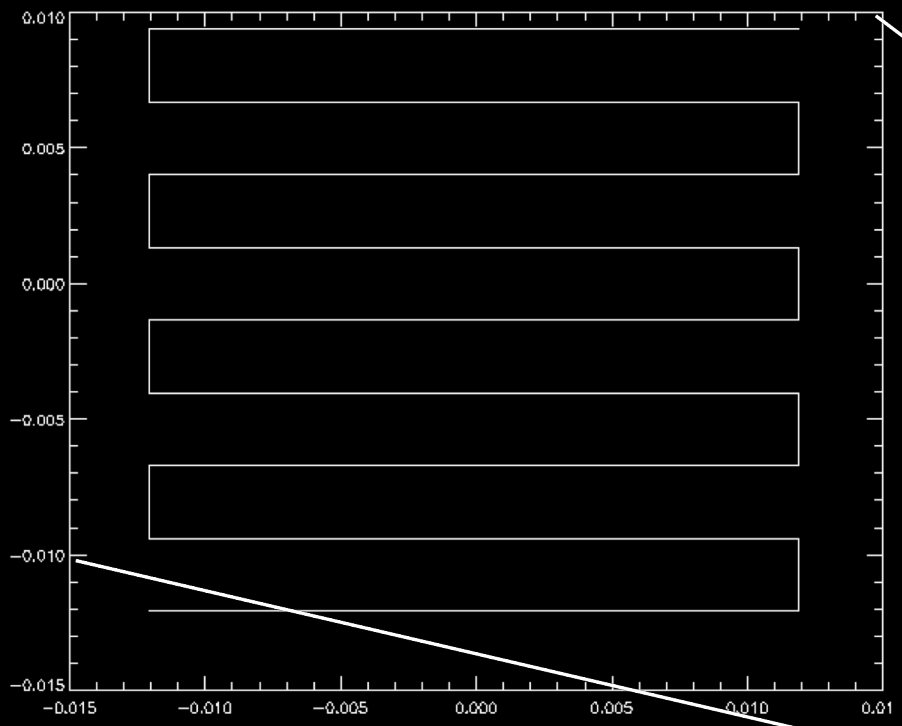

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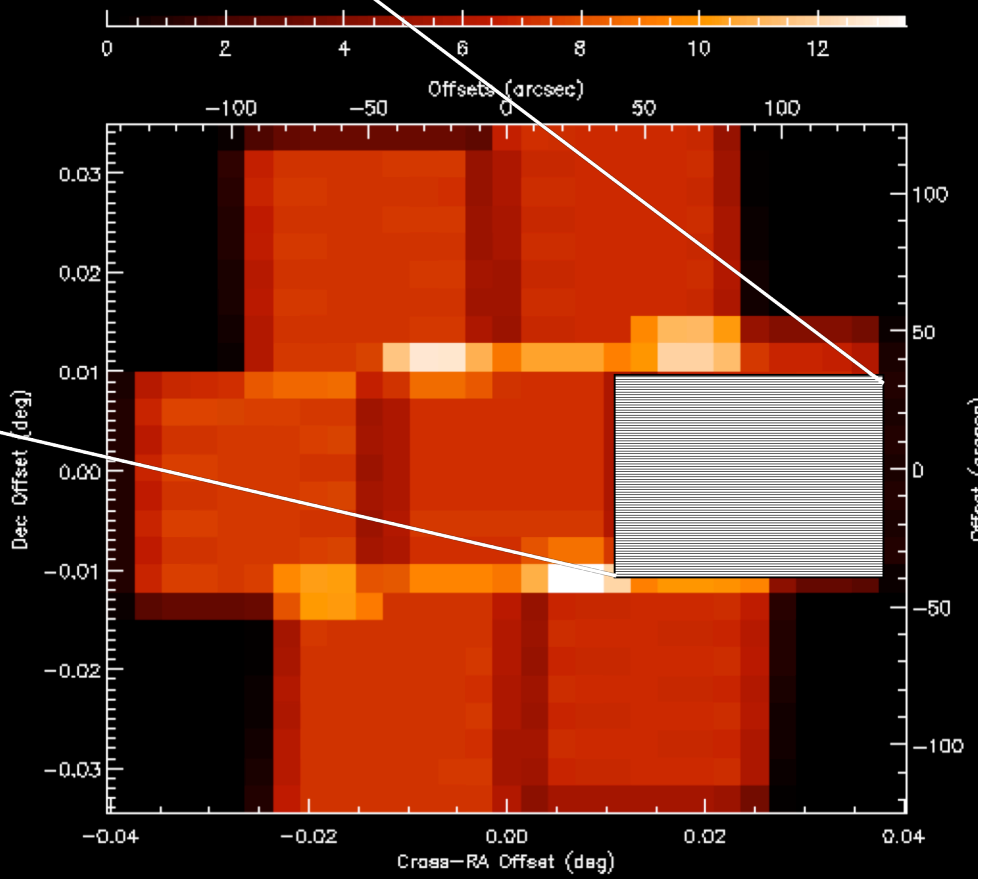

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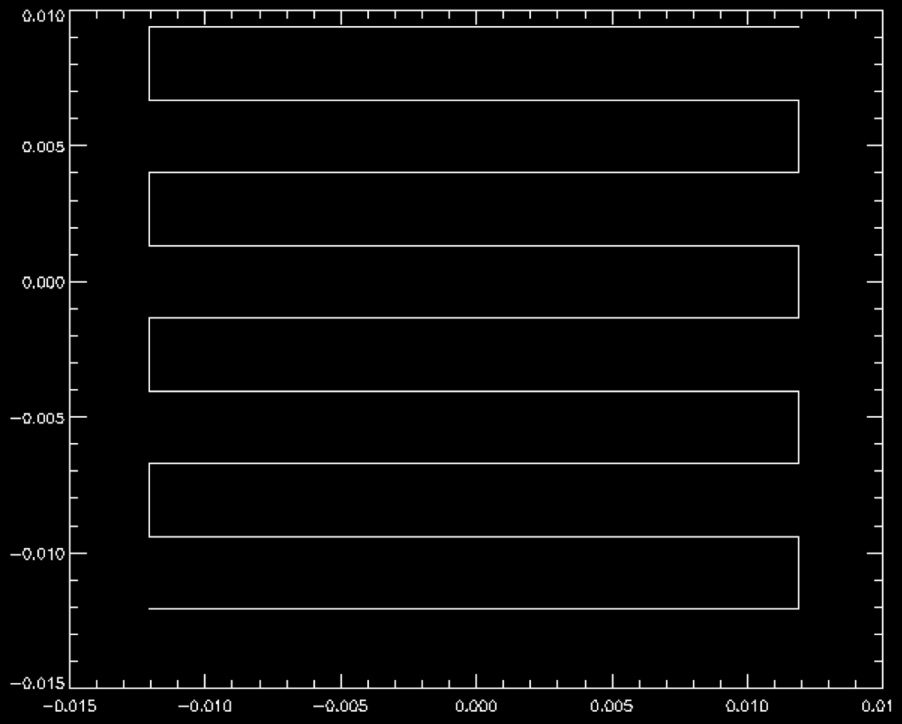

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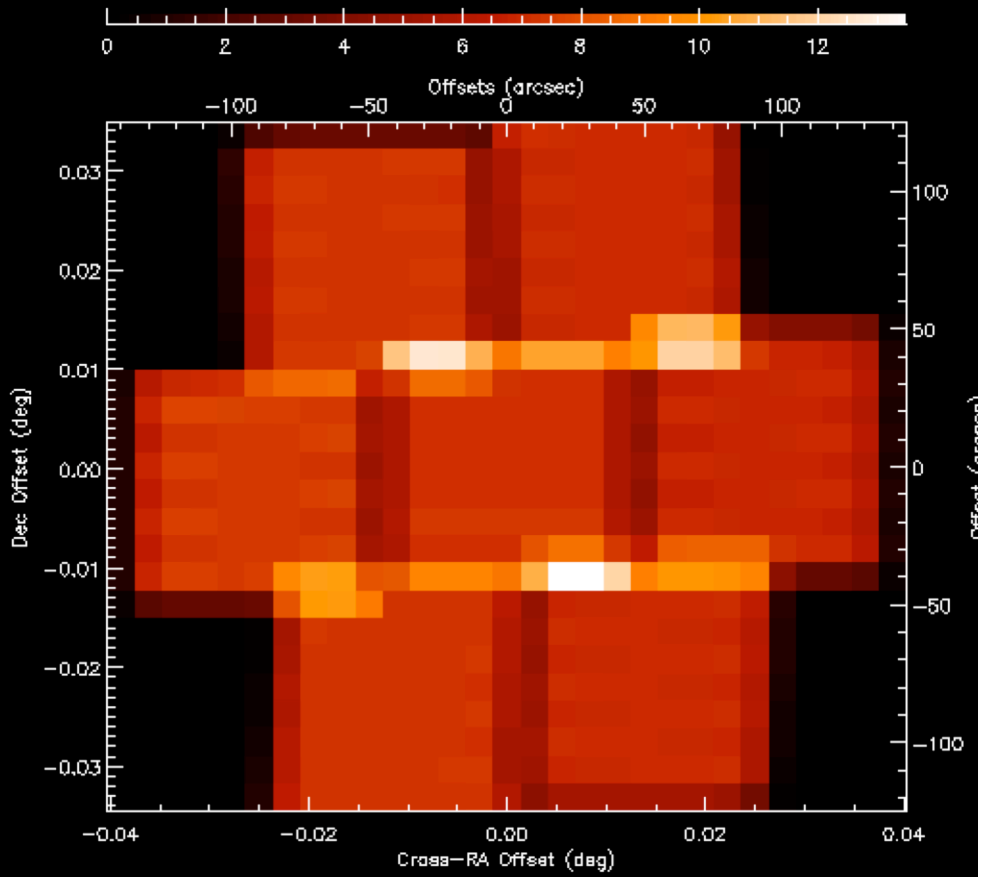

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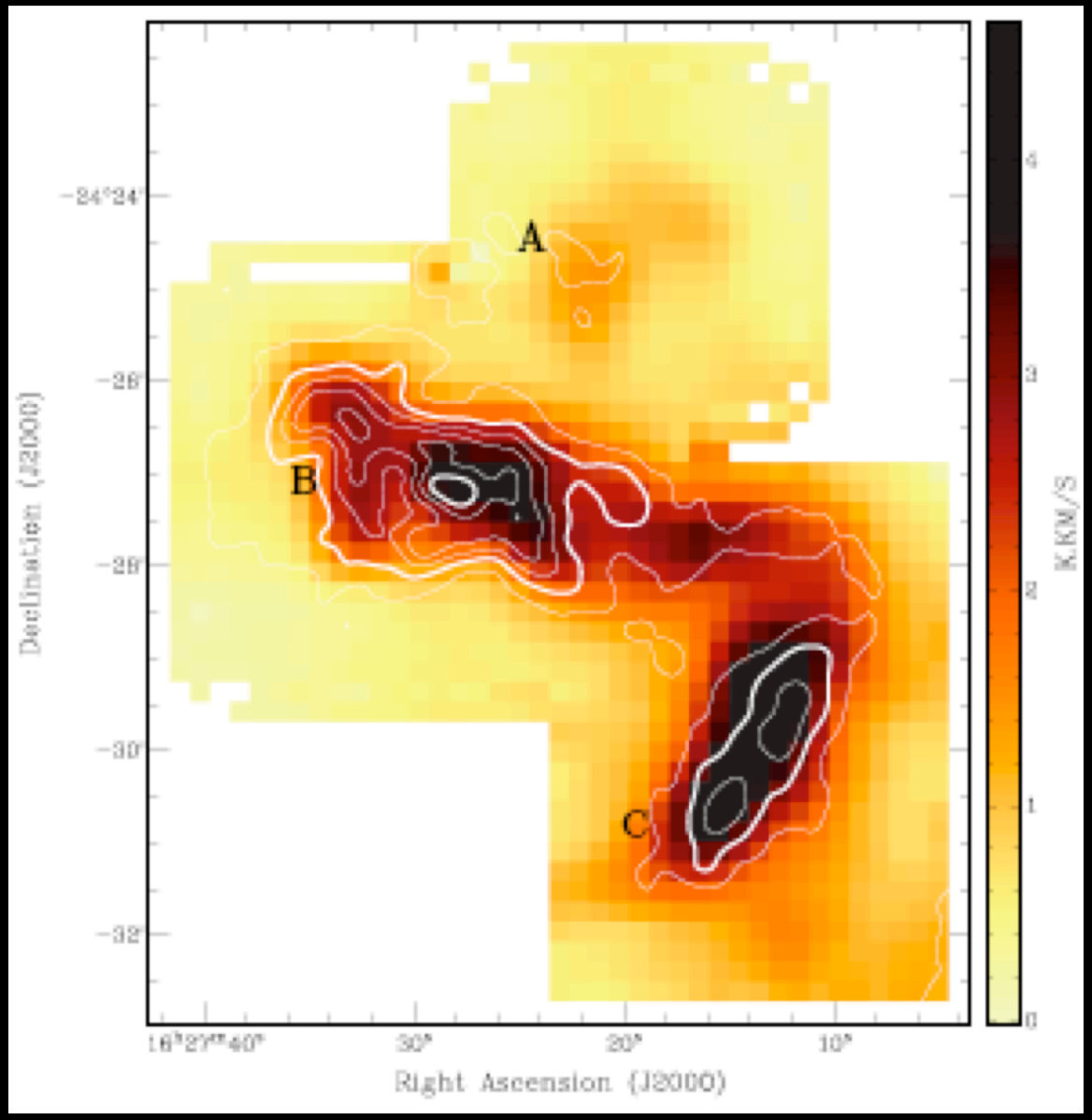
Mapping the KFPA footprint

This mapping procedure nicely matches the size of cores within nearby star-forming regions.

It provides nearly uniform coverage while minimizing time spent mapping outside the region of interest.

These map properties are nearly independent of the hour angle or declination of the source.



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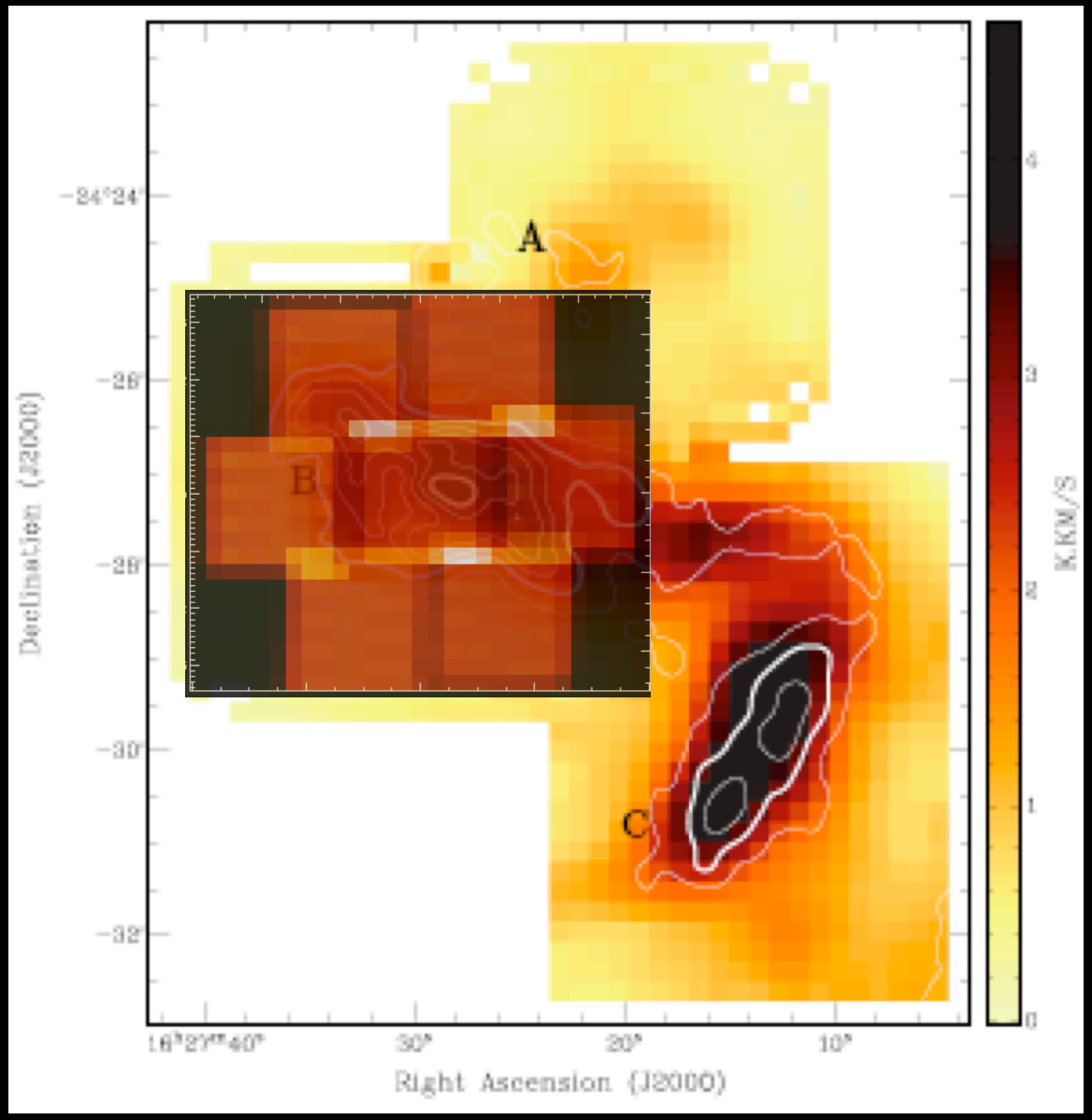
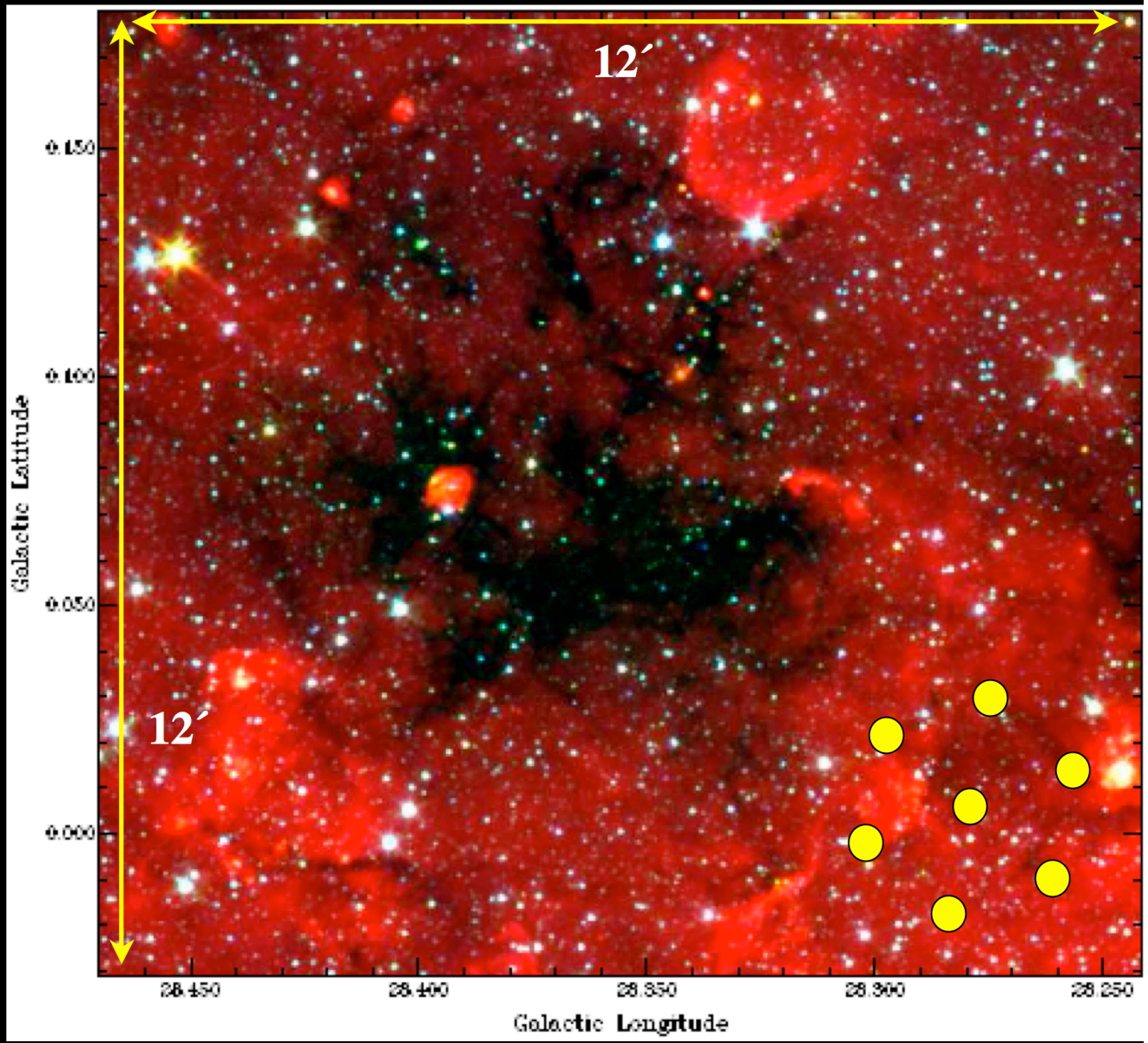


Mapping Large Regions

Spitzer GLIMPSE map of an Infrared Dark Cloud (IRDC).

144 sq. arcmin.

Large raster map can cover region with 87% efficiency and uniform coverage (20-30% variation in integration time).



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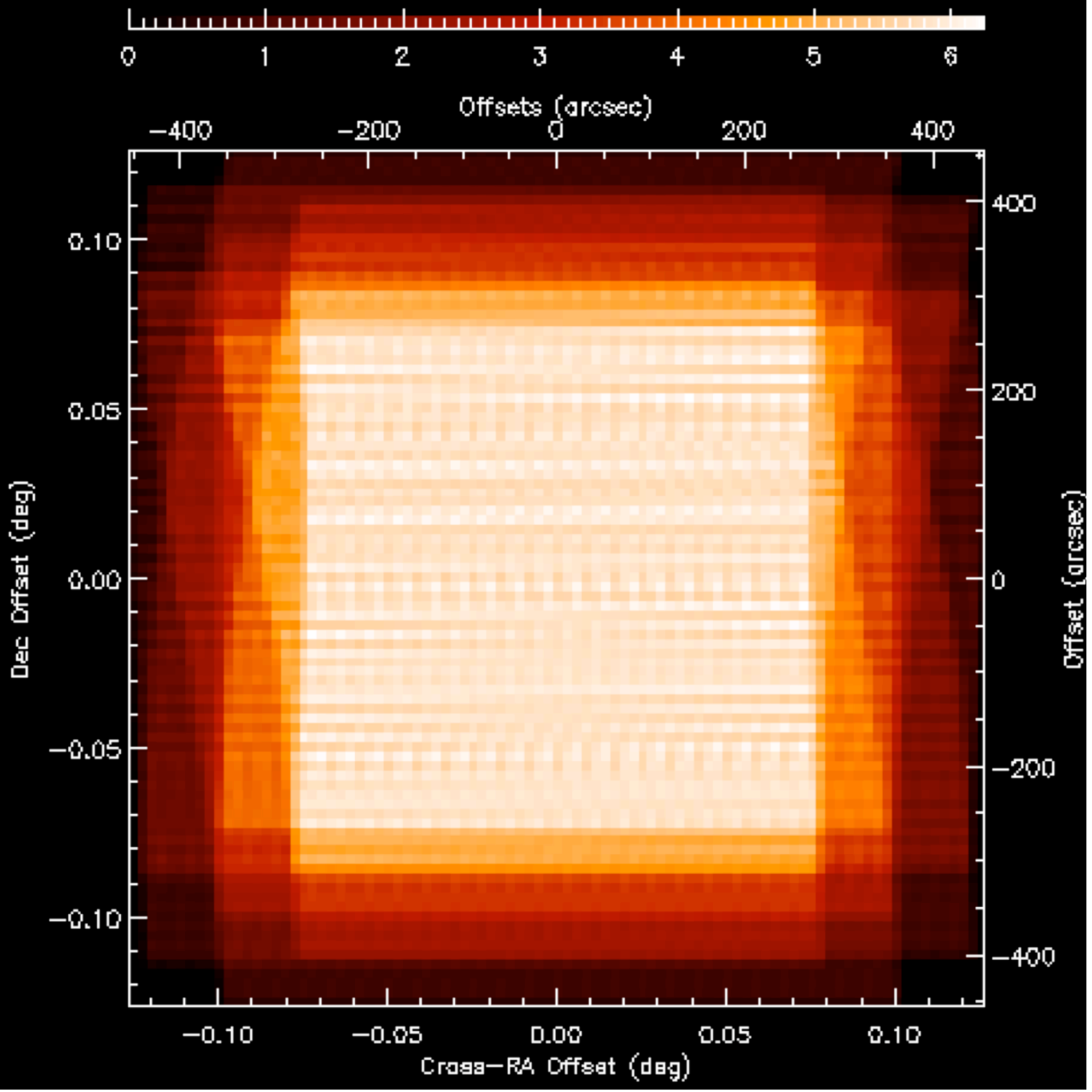

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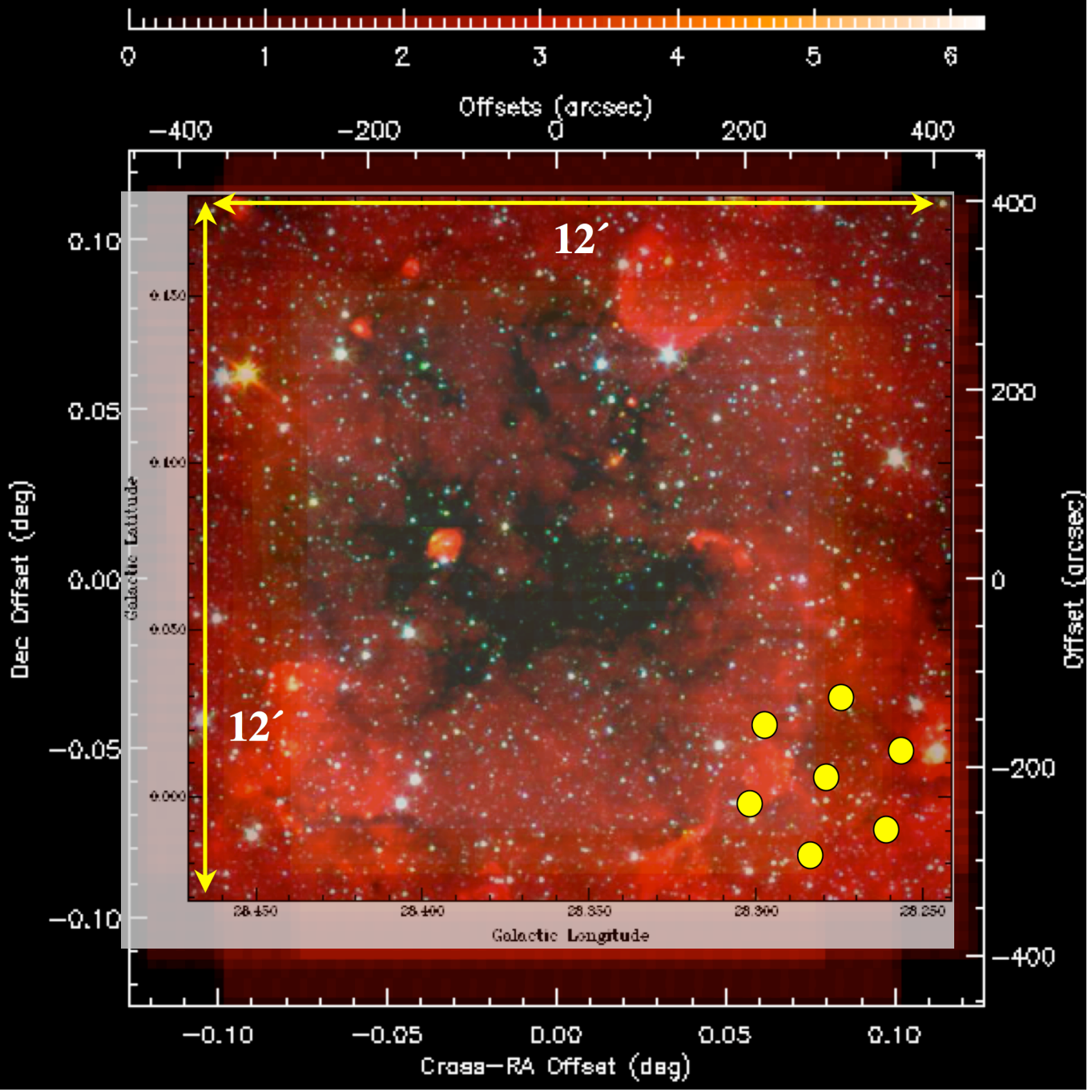

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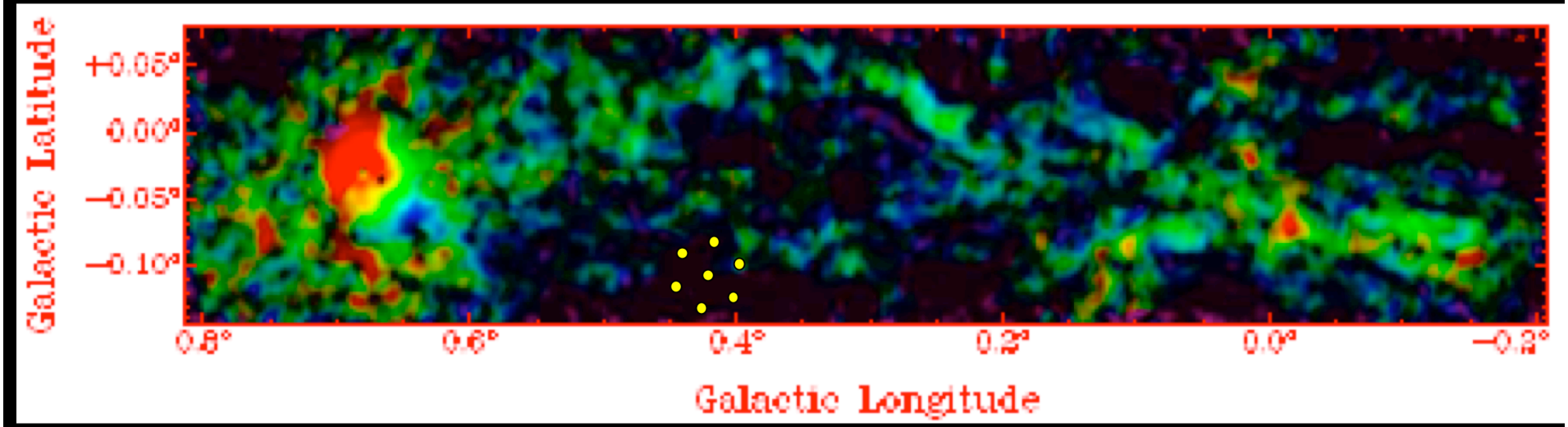


Temperature map of the Galactic Center from J. Ott.

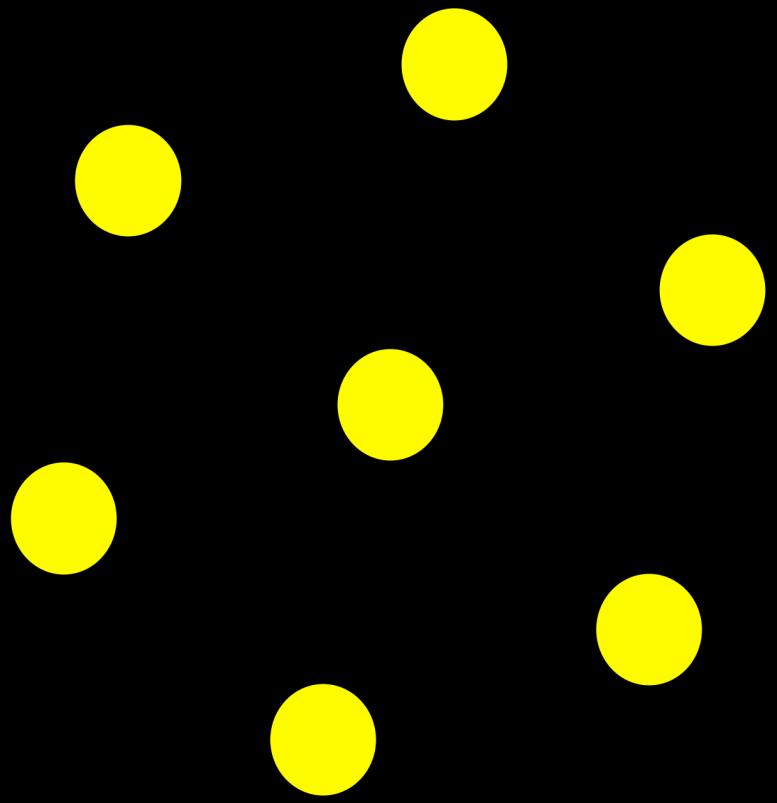
Size = 15′ x 60′ = 900 sq. arcmin

Could map with a 61-pixel array using same approach,

but with a higher efficiency and similarly uniform coverage.

Searching for Molecules

For sources extended beyond array footprint where the observer does not care about spatial information, we can do position- or frequency-switching.



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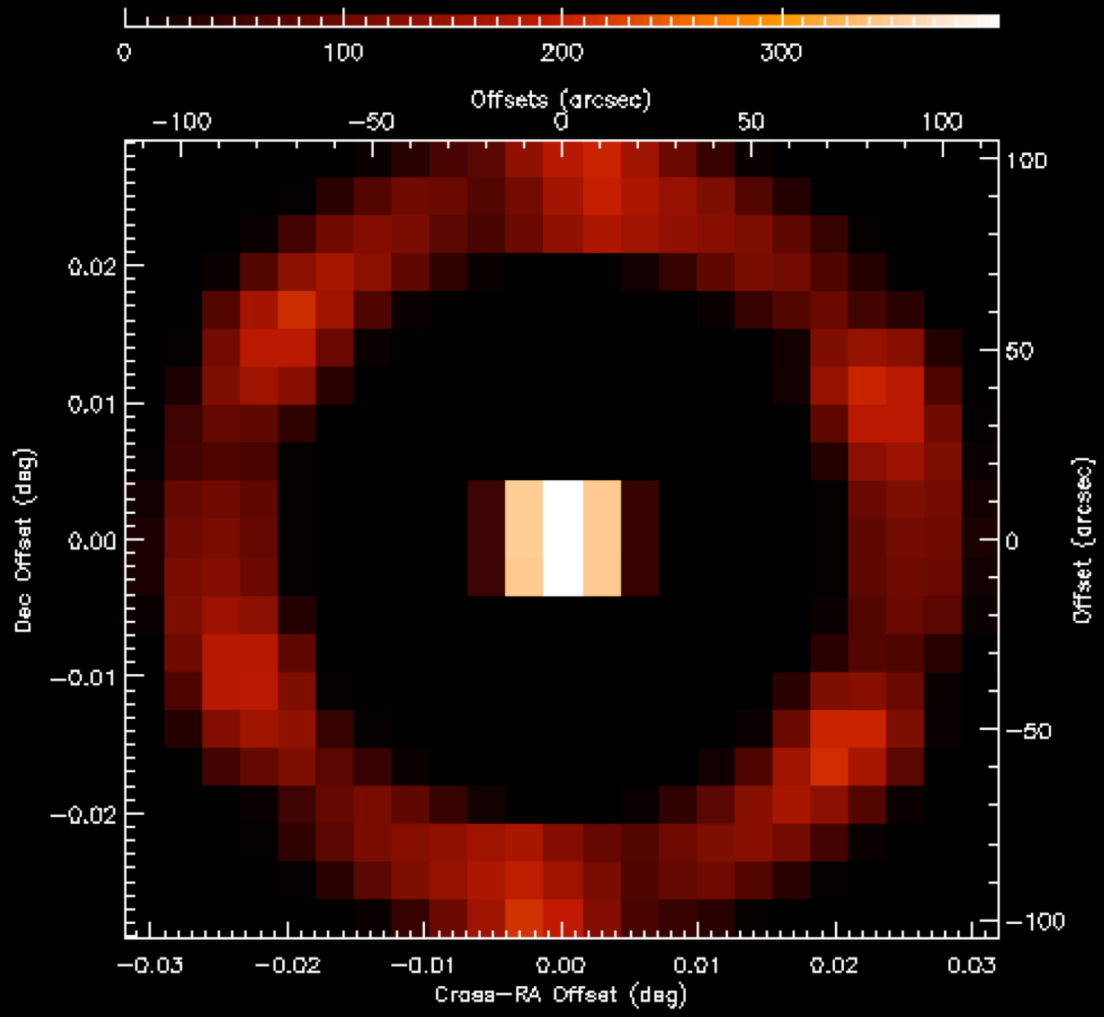

Observing Point Sources

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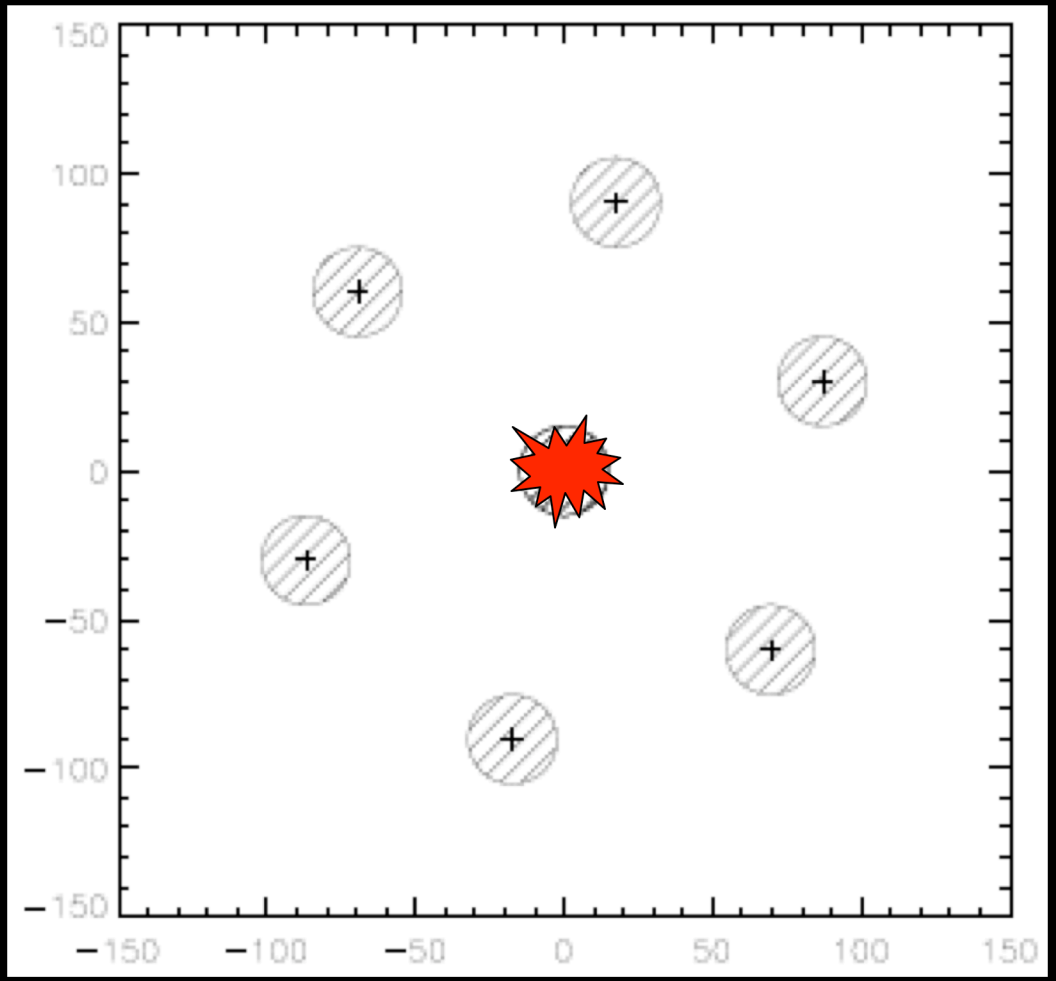

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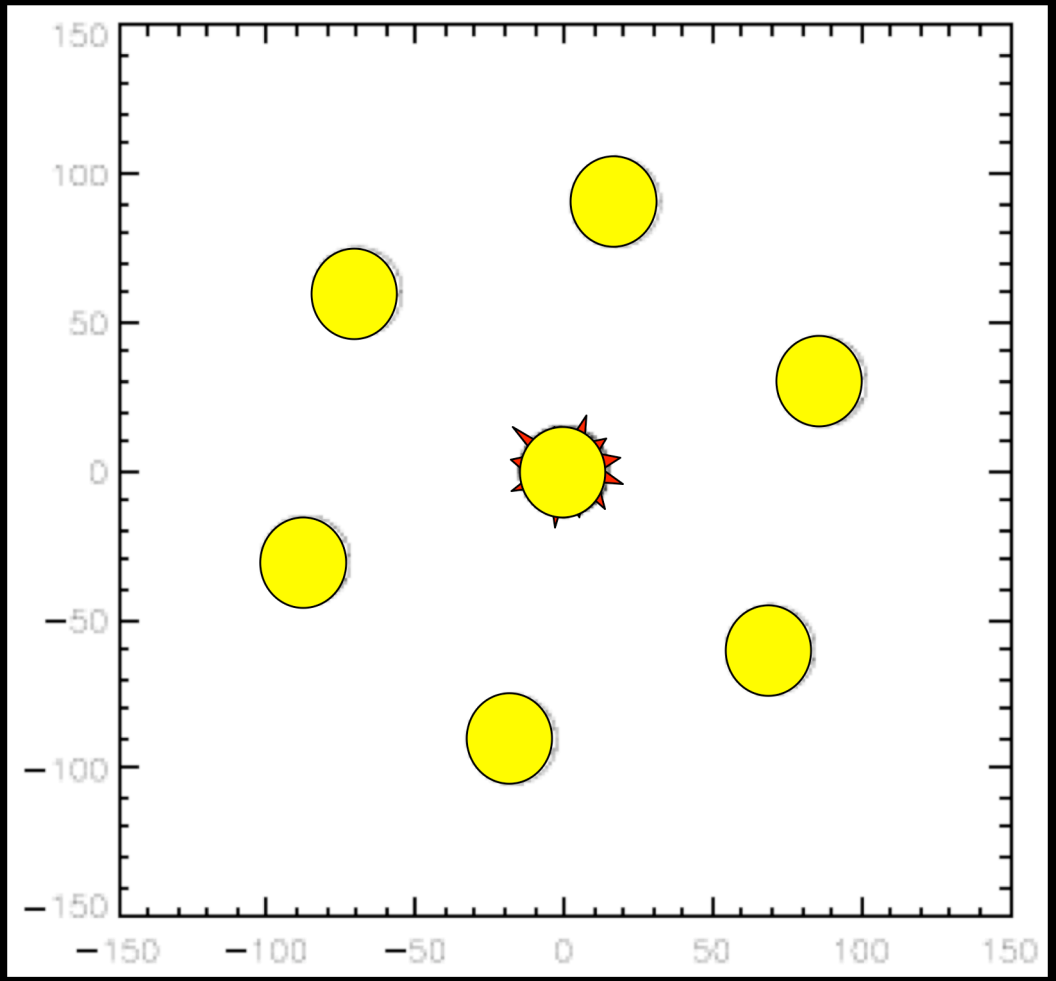
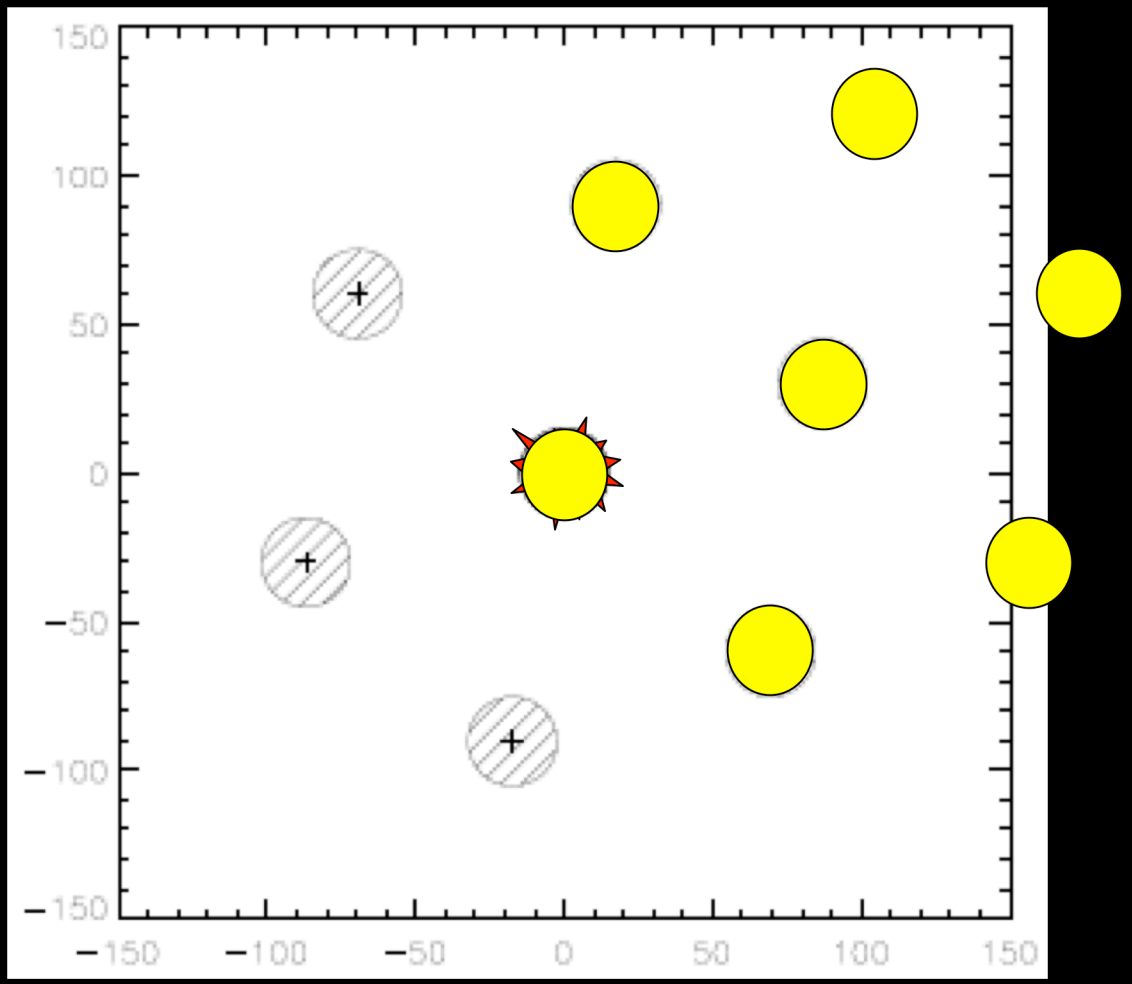


Single Pointing Modes



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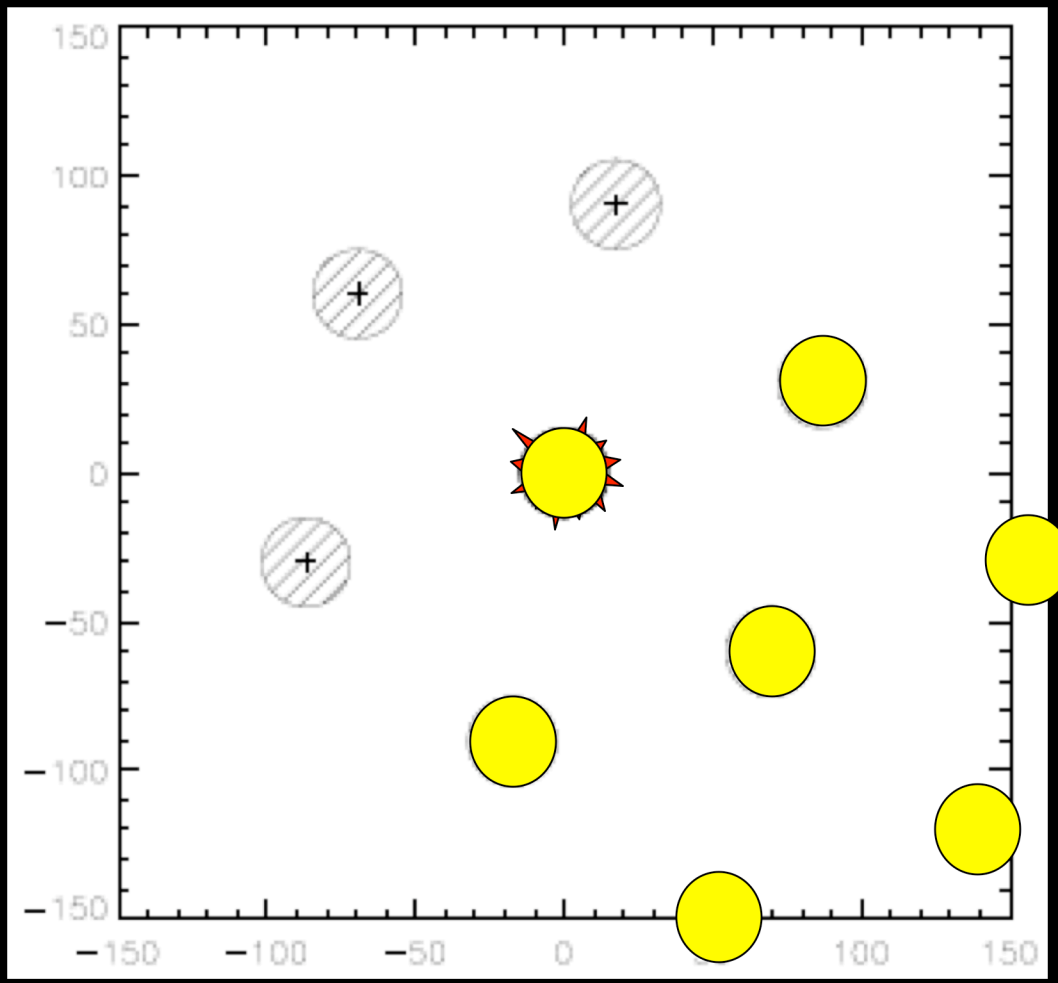

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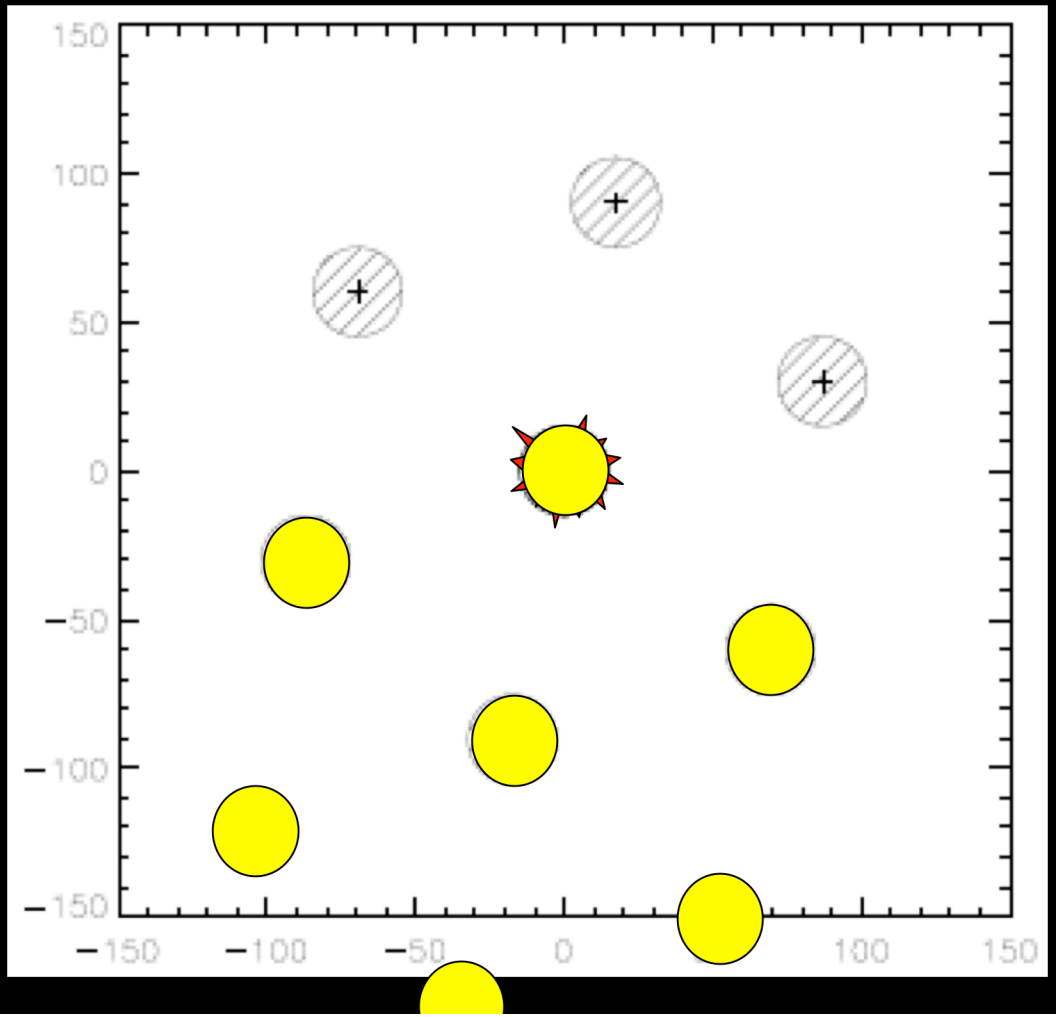

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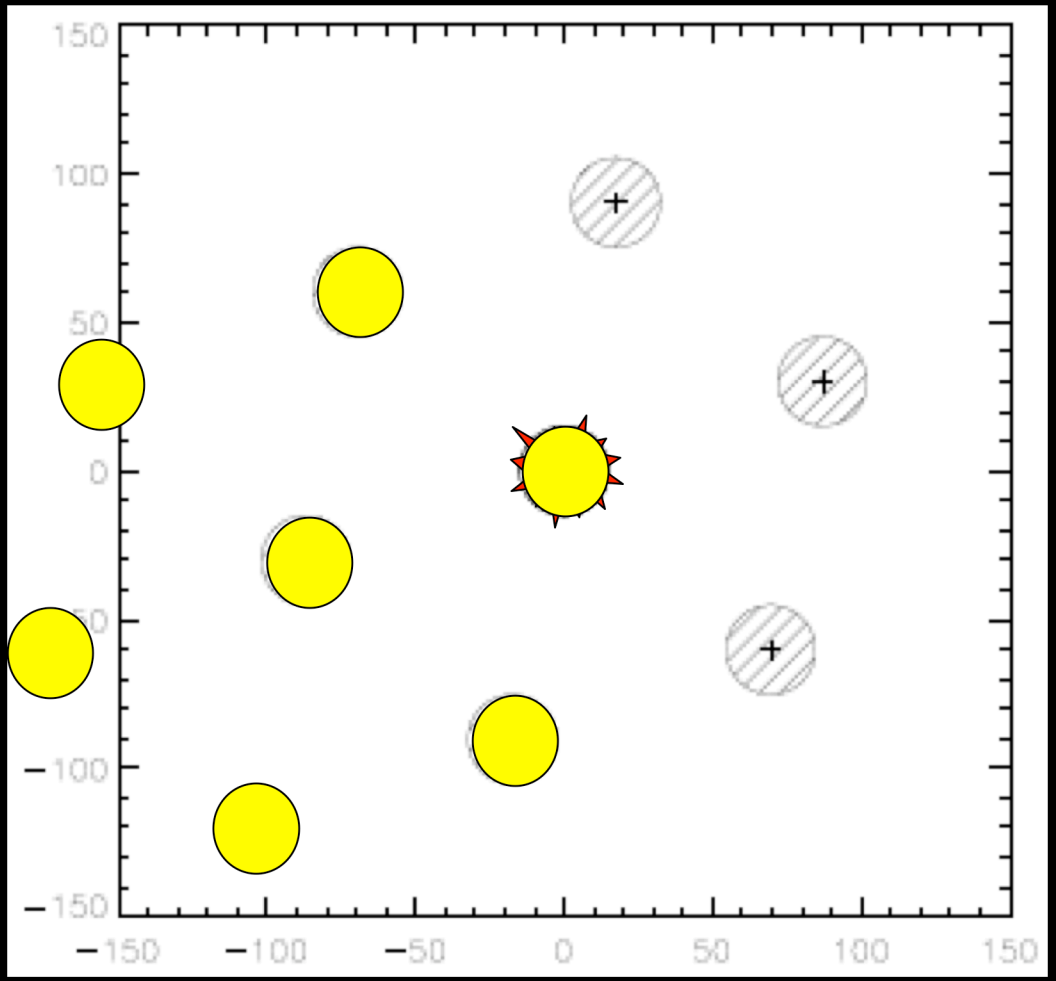

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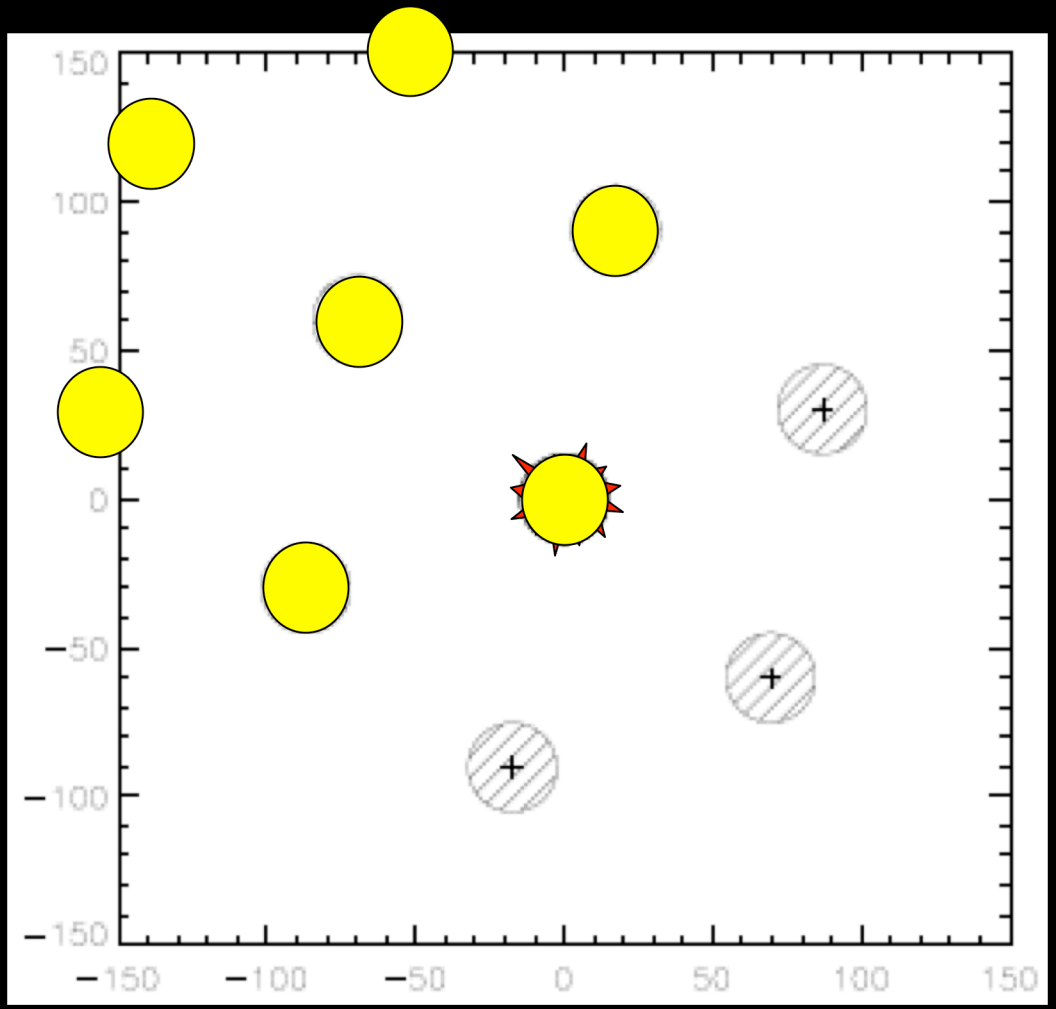

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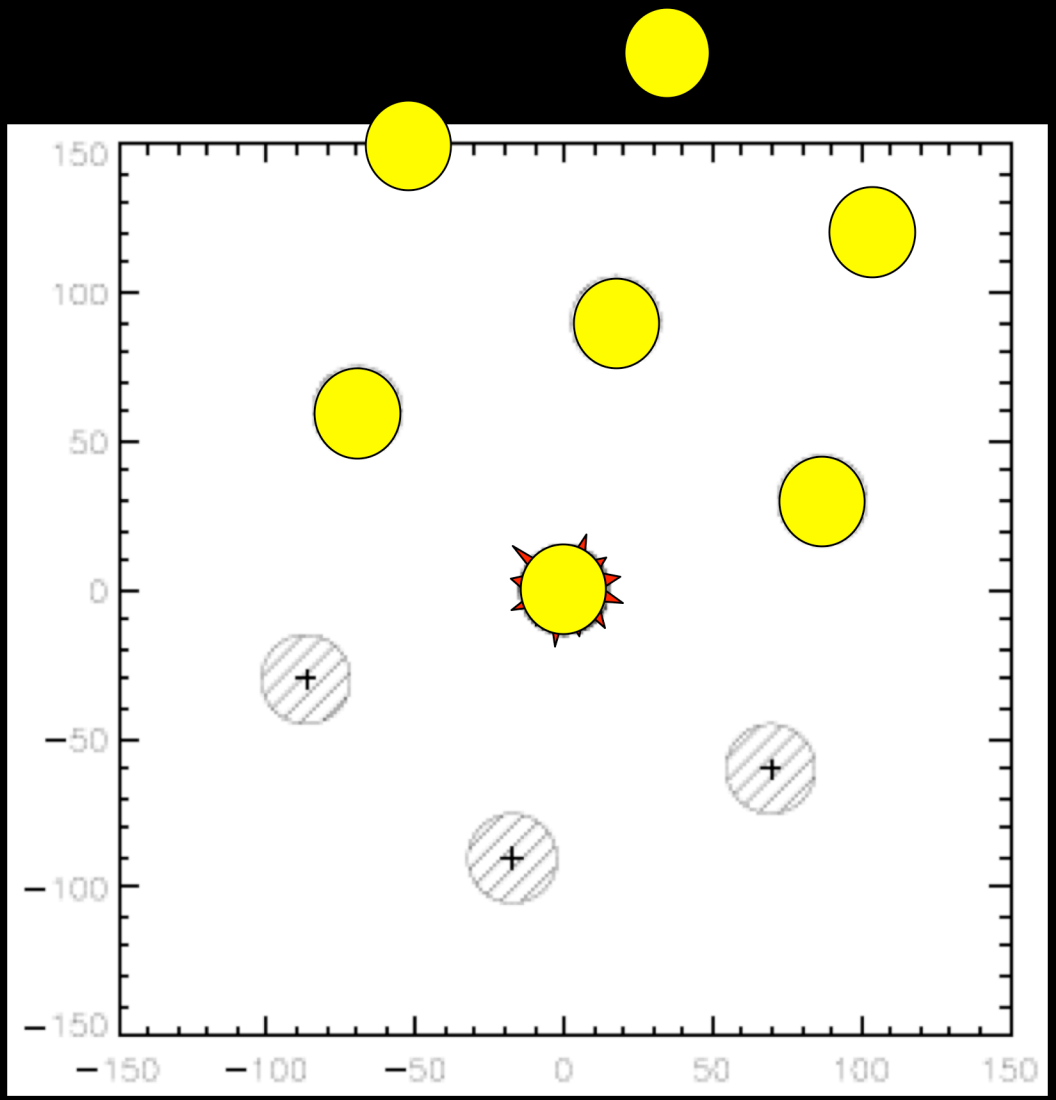

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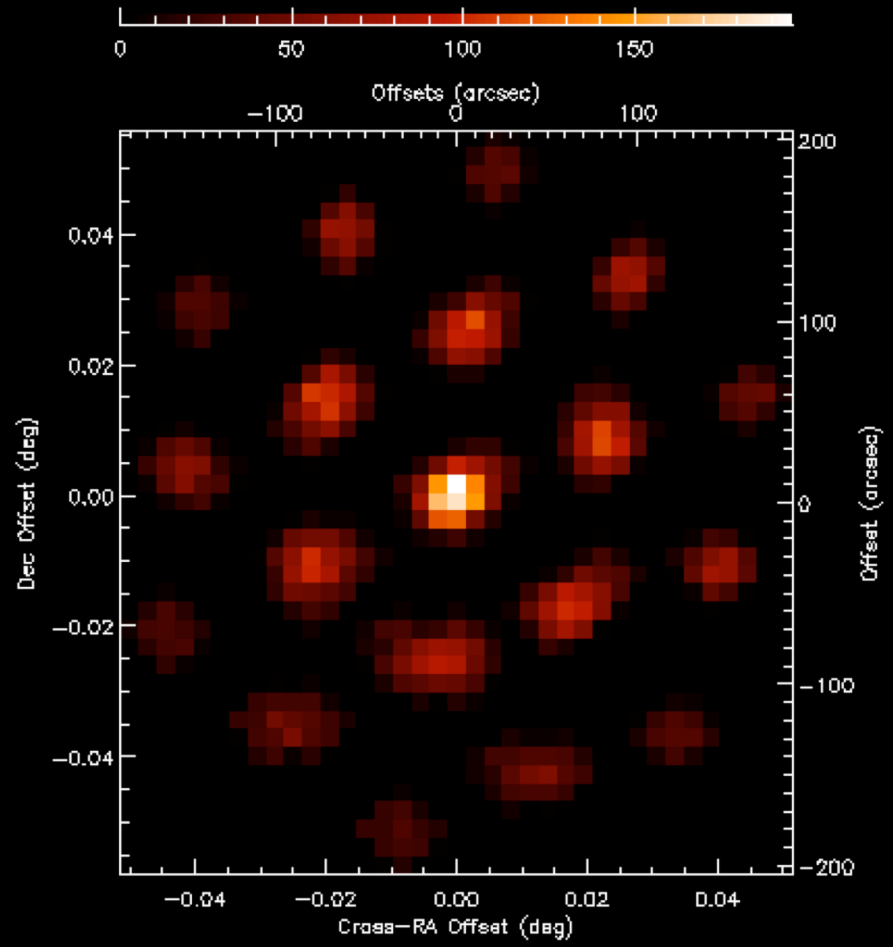

The result is 6 OFFs for each ON, although the OFFs are spatially distinct.

Conclusions

- A hexagonally packed array is the most compact and most symmetric configuration for the array. Any advantages of other packings of a 7-pixel array would become disadvantages for a 61-pixel array.
- Simple raster scans in celestial coordinate systems provide nearly uniform coverage with little loss in efficiency from mapping outside the region of interest
- We can cycle through individual beams for observations of point sources ("MX" mode).
- For larger sources, we can position-switch or frequency-switch if we do not wish to map.
- All of these modes will also work using only 4 or 2 beams.