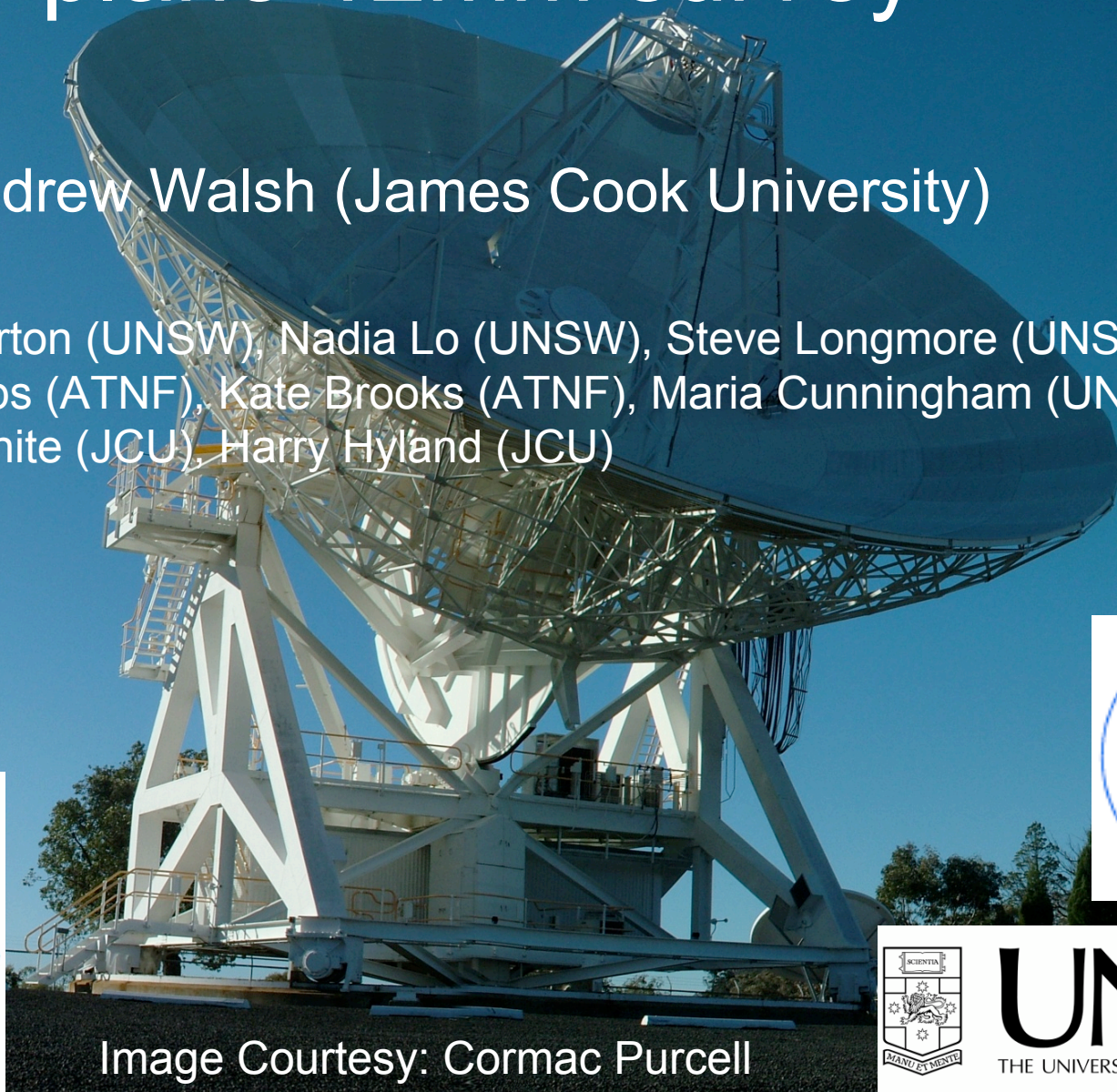


HOPS – the H₂O southern Galactic plane 12mm survey

Andrew Walsh (James Cook University)

Michael Burton (UNSW), Nadia Lo (UNSW), Steve Longmore (UNSW),
Chris Phillips (ATNF), Kate Brooks (ATNF), Maria Cunningham (UNSW),
Graeme White (JCU), Harry Hyland (JCU)

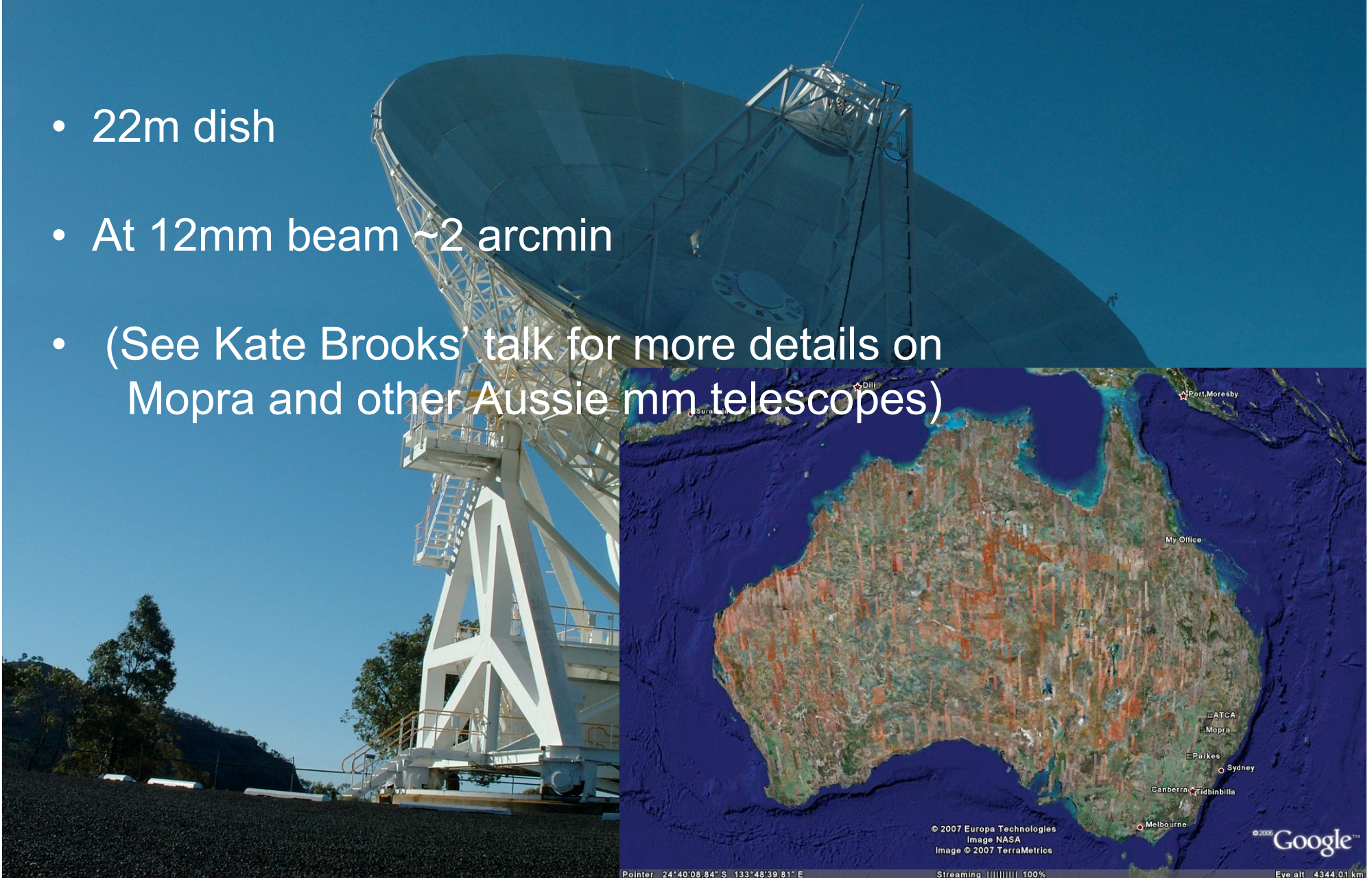


UNSW
THE UNIVERSITY OF NEW SOUTH WALES

Image Courtesy: Cormac Purcell

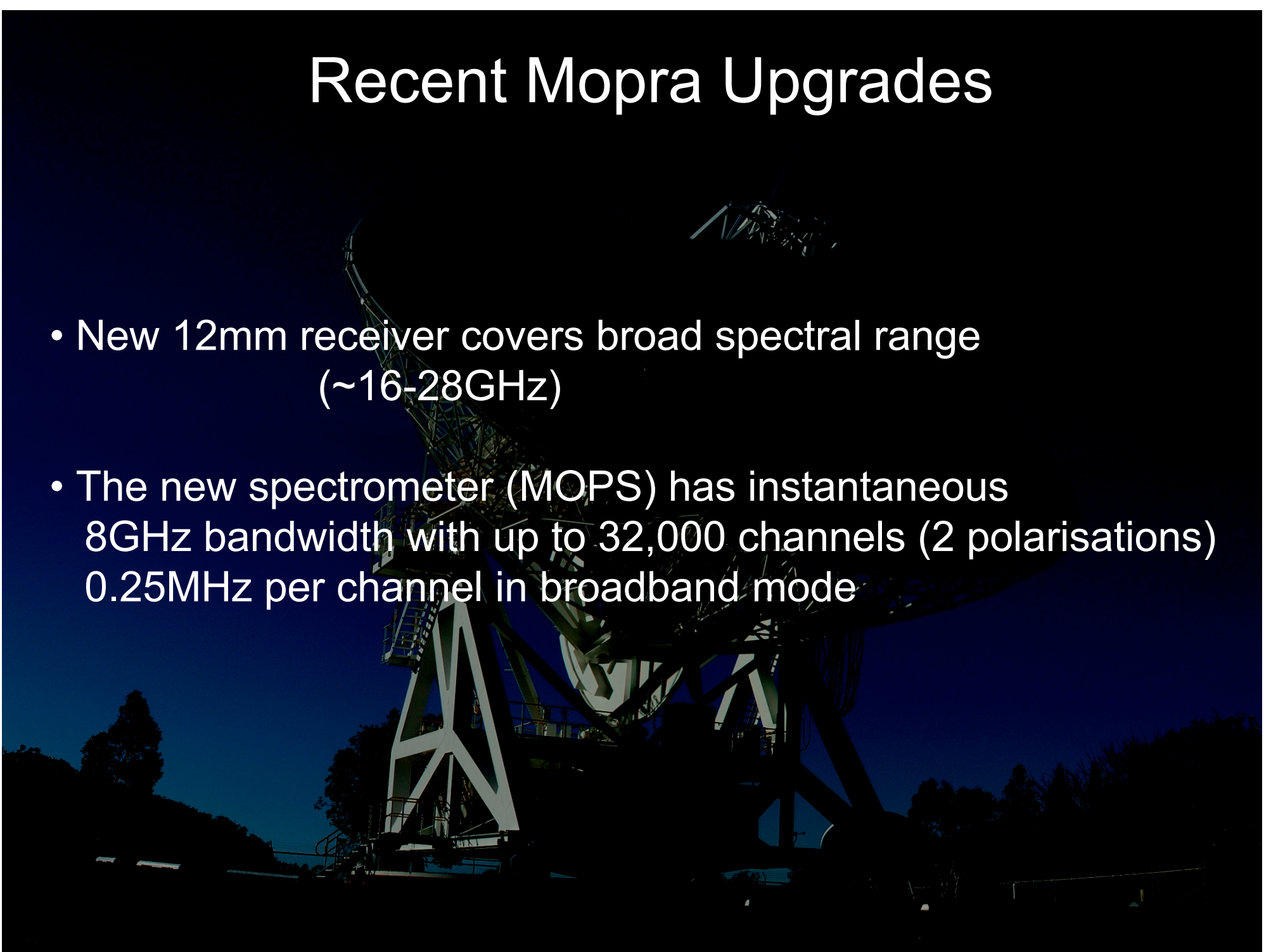
The Mopra Radiotelescope

- 22m dish
- At 12mm beam ~ 2 arcmin
- (See Kate Brooks' talk for more details on Mopra and other Aussie mm telescopes)



Recent Mopra Upgrades

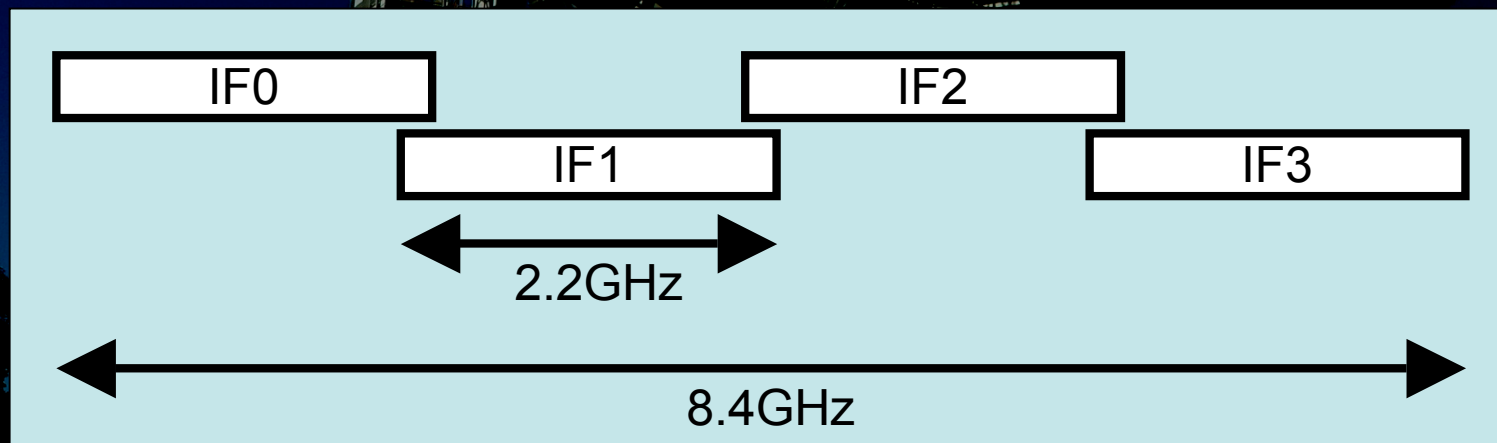
- New 12mm receiver covers broad spectral range (~16-28GHz)
- The new spectrometer (MOPS) has instantaneous 8GHz bandwidth with up to 32,000 channels (2 polarisations) 0.25MHz per channel in broadband mode



Mopra Radiotelescope

The new Mopra spectrometer (MOPS)

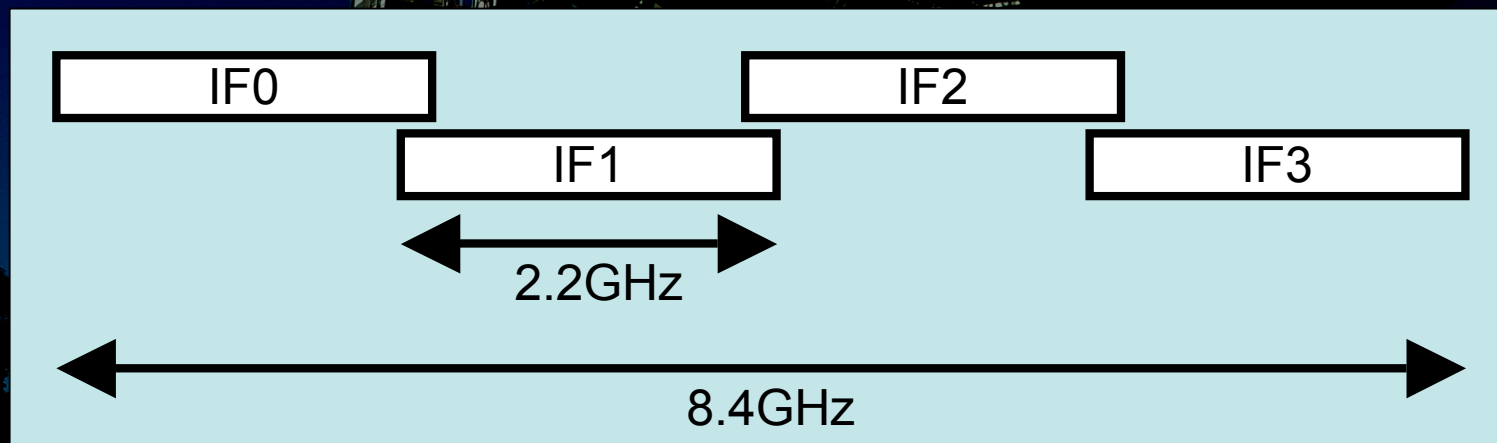
- Instantaneous 8GHz bandwidth split between 4 IFs of 2.2GHz width each



Mopra Radiotelescope

The new Mopra spectrometer (MOPS)

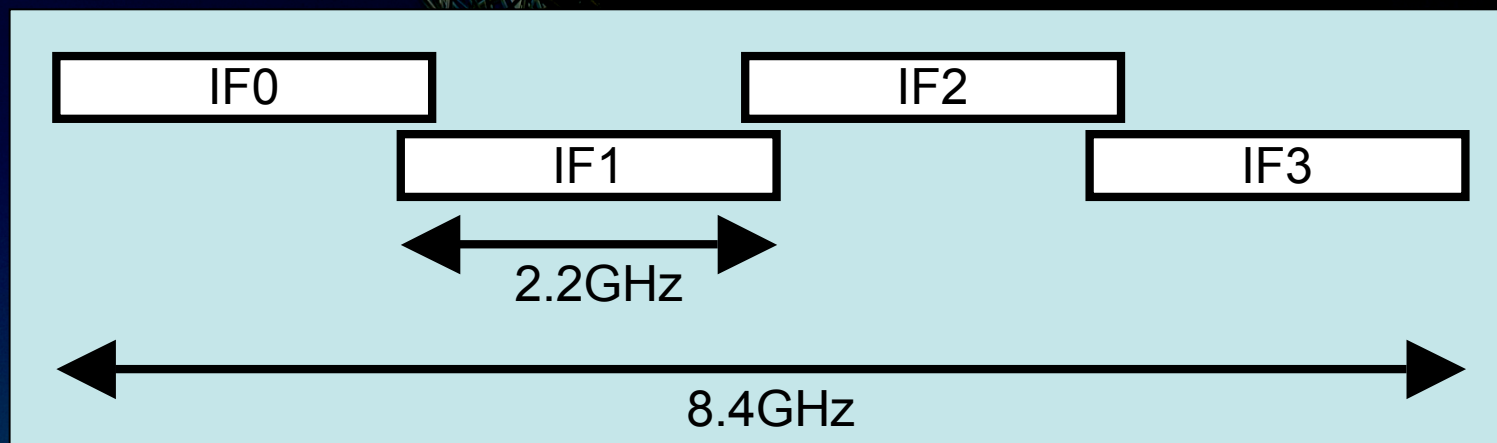
Broadband Mode or Narrowband mode



Mopra Radiotelescope

The new Mopra spectrometer (MOPS)

Broadband Mode



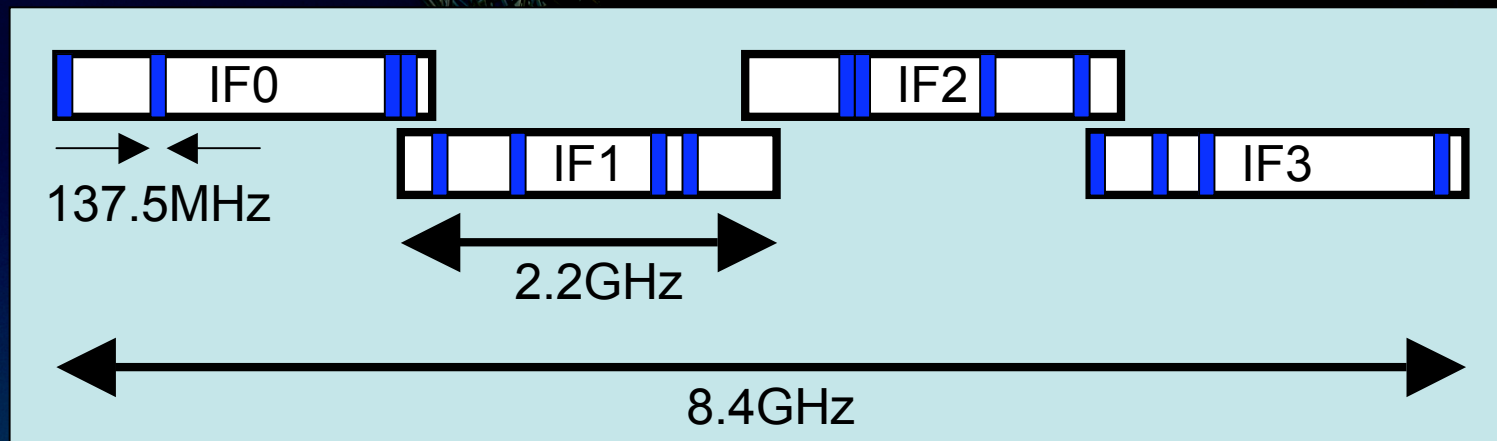
- 8192 channels per IF, 32768 channels in total
- Spectral resolution of 0.25MHz or ~ 3.2 km/s

Mopra Radiotelescope

The new Mopra spectrometer (MOPS)

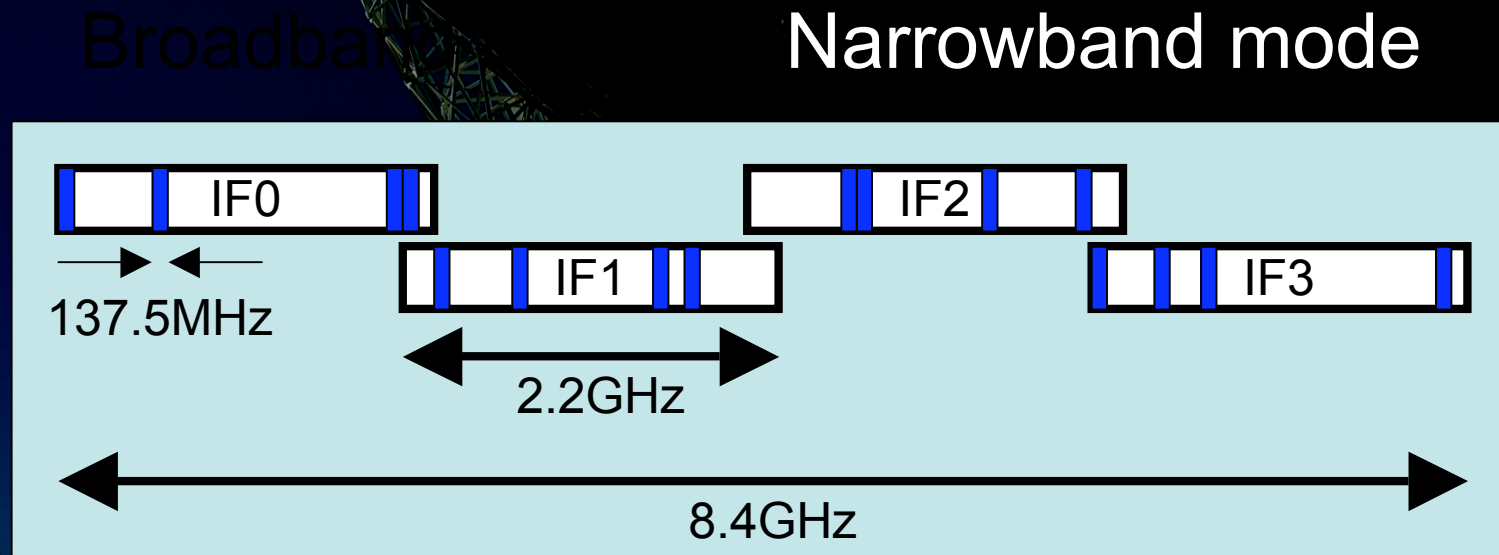
Broadband

Narrowband mode



Mopra Radiotelescope

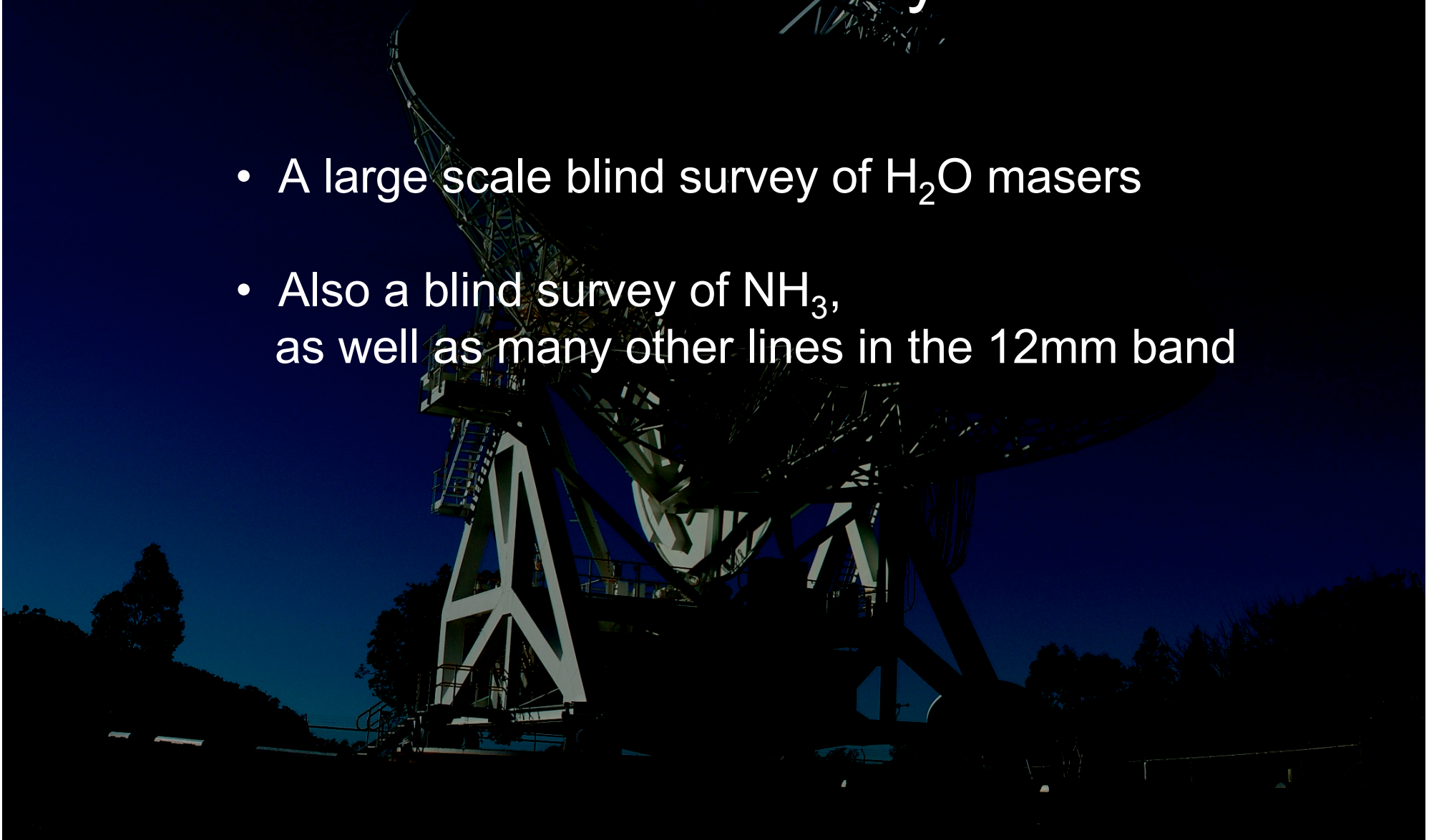
The new Mopra spectrometer (MOPS)



- 4096 channels per 137.5MHz zoom (16 zooms in total)
- Spectral resolution of 34kHz or ~ 0.4 km/s

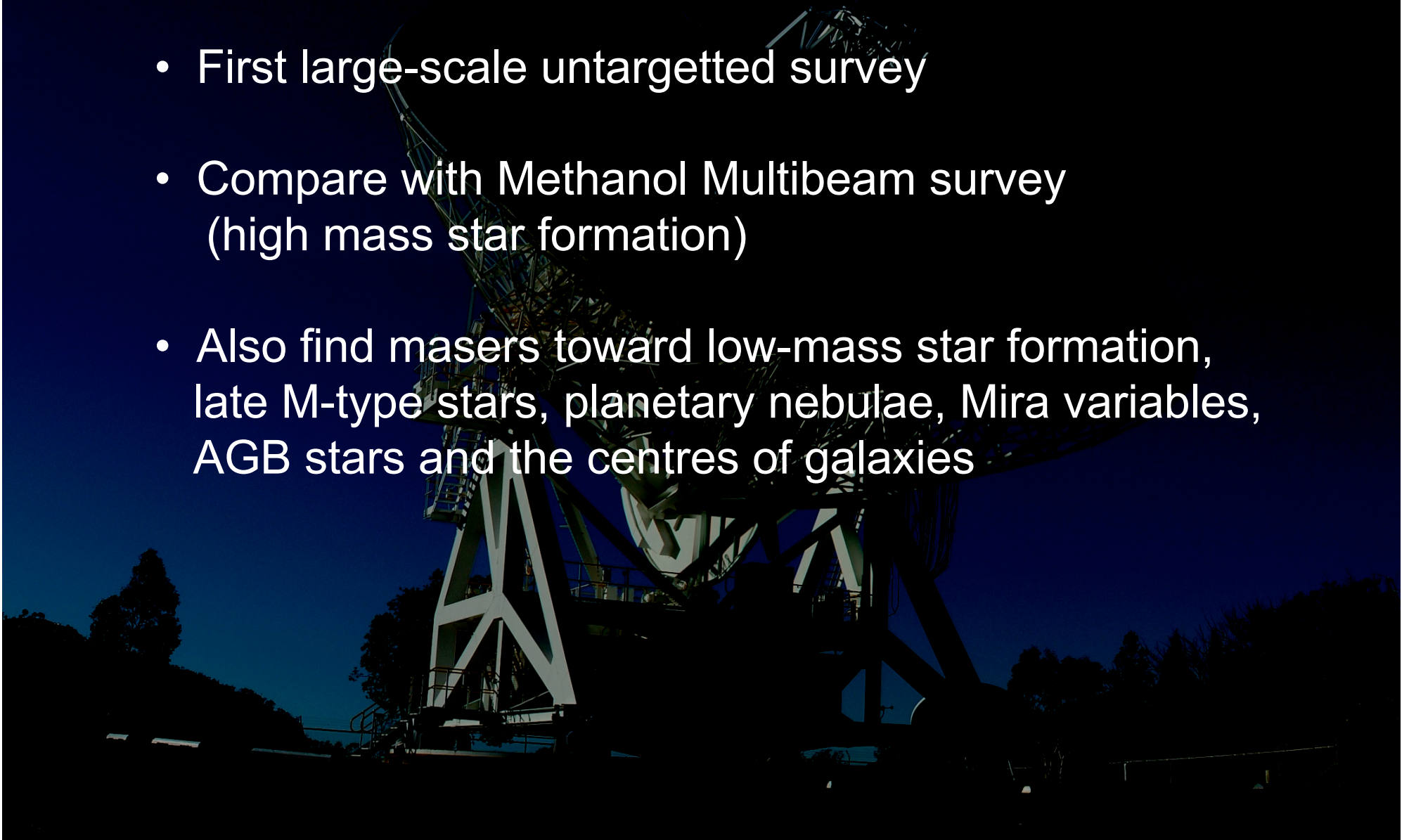
HOPS – H₂O southern Galactic Plane Survey

- A large scale blind survey of H₂O masers
- Also a blind survey of NH₃,
as well as many other lines in the 12mm band



H₂O Masers

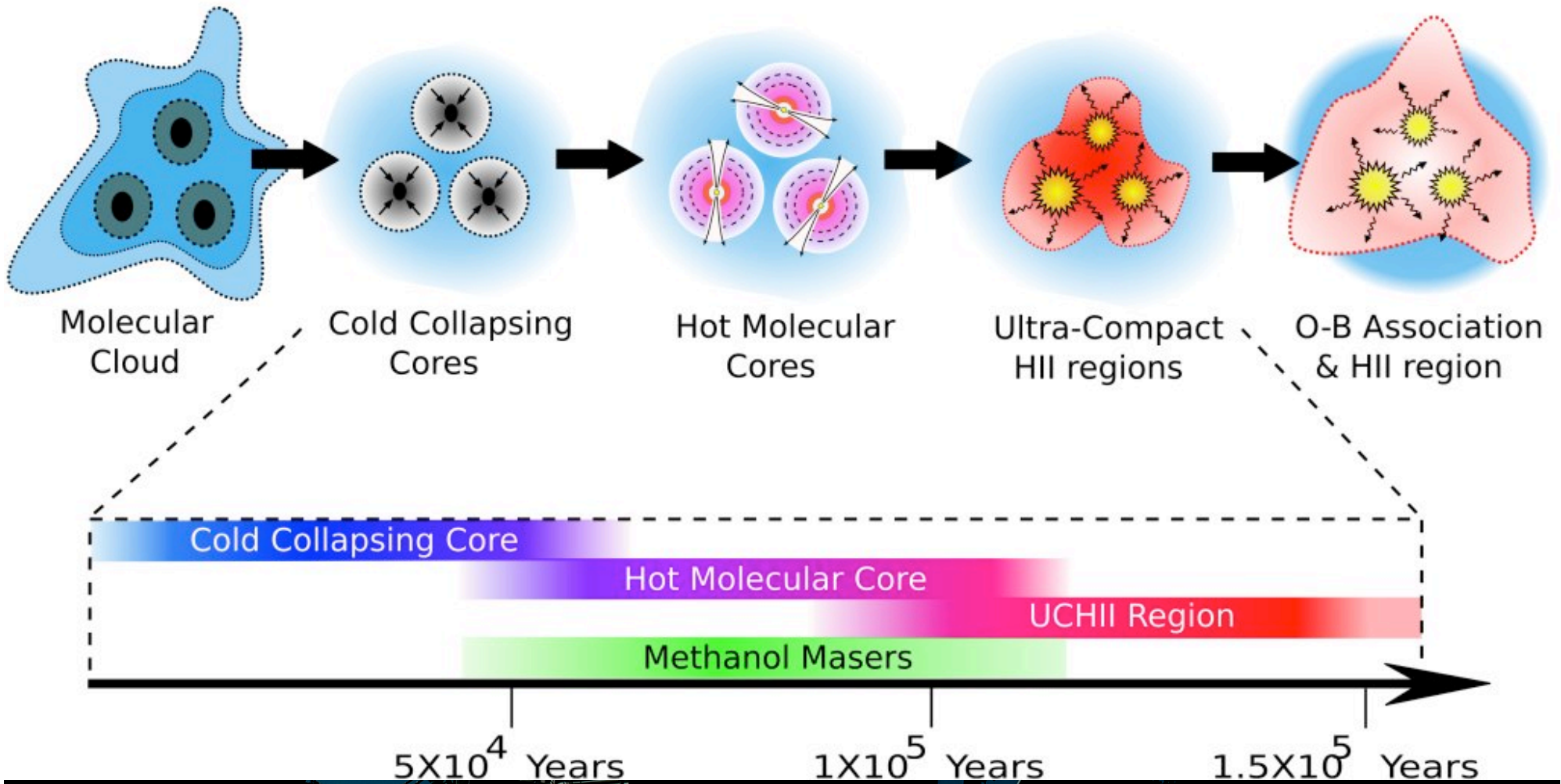
- First large-scale untargetted survey
- Compare with Methanol Multibeam survey (high mass star formation)
- Also find masers toward low-mass star formation, late M-type stars, planetary nebulae, Mira variables, AGB stars and the centres of galaxies



Galactic Ammonia

- NH_3 traces quiescent gas
- Kinematic information
- Comparison of (1,1), (2,2), (4,4) inversion transitions
→ estimate temperature
- Map high density component of the Galaxy
- Identify earliest stages of high mass star formation
- NH_3 masers

Galactic Ammonia



Galactic Ammonia

- NH_3 traces quiescent gas
- Kinematic information
- Comparison of (1,1), (2,2), (4,4) inversion transitions
→ estimate temperature
- Map high density component of the Galaxy
- Identify earliest stages of high mass star formation
- NH_3 masers

Other Lines

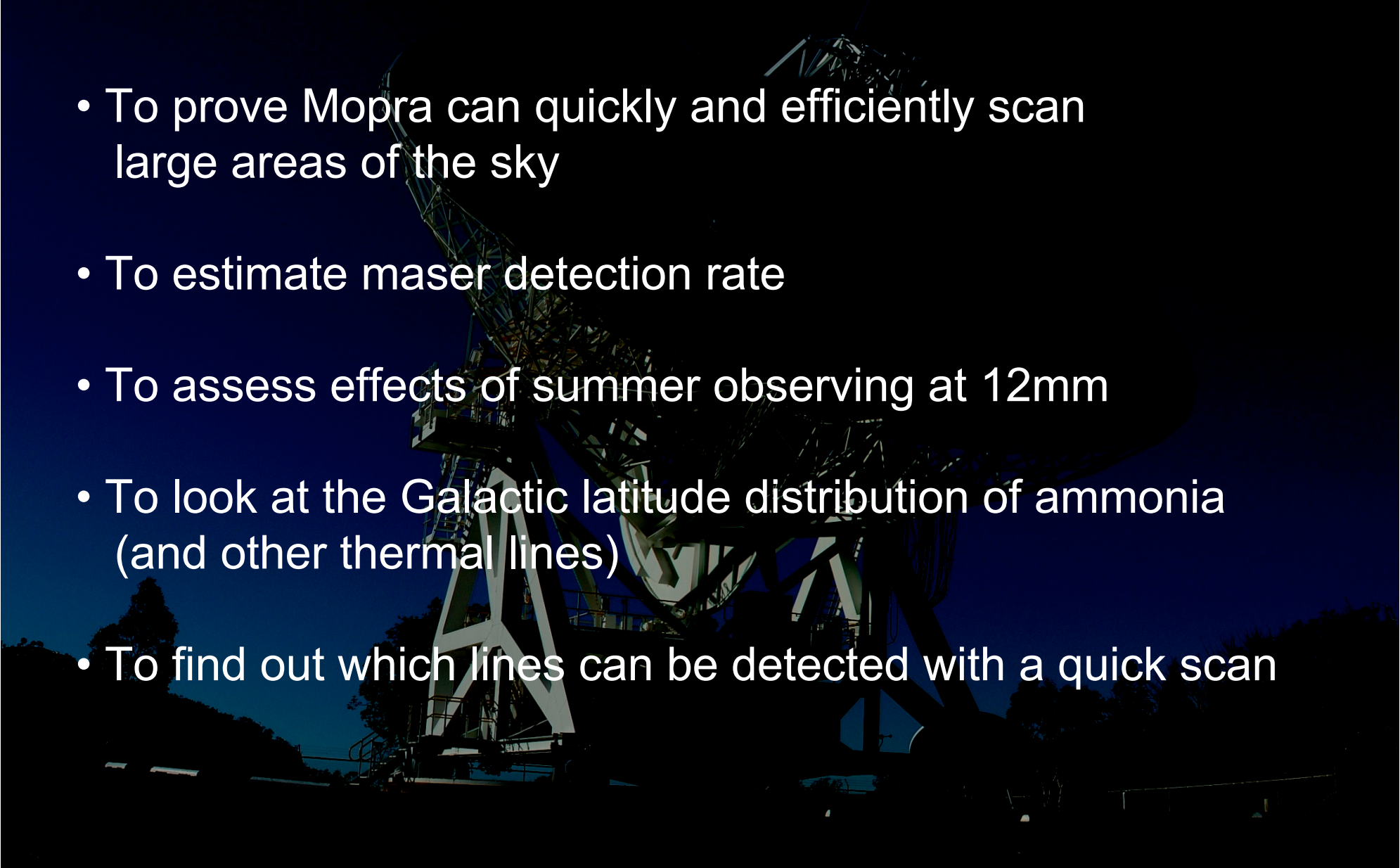


- HCCCN (3-2)
 - trace star formation sites
- Radio Recombination Lines (H62 α – H69 α)
 - trace ionised gas
- CH₃OH masers (both Class I and II)
 - compare two classes over a large sample

HOPS pilot survey

AIMS

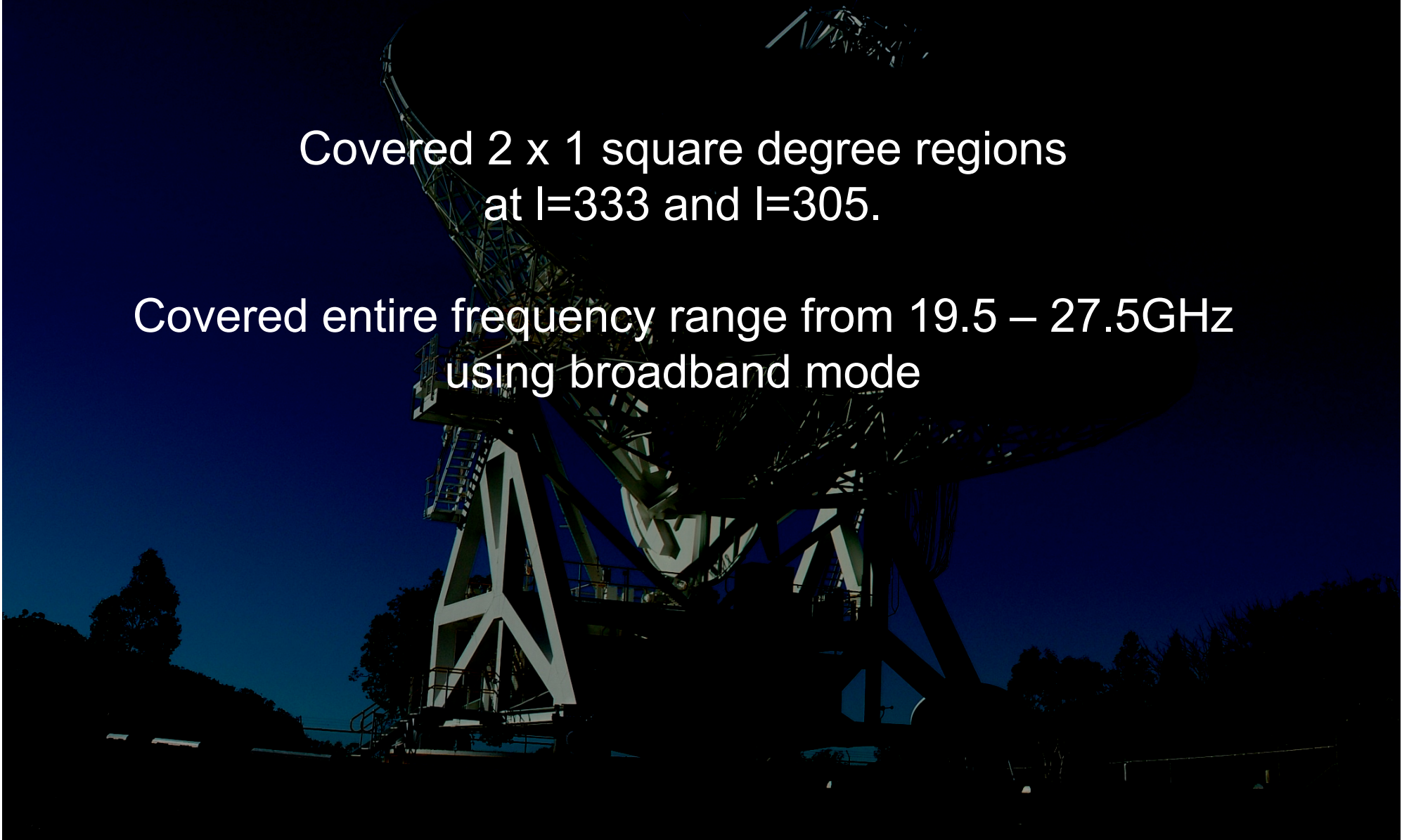
- To prove Mopra can quickly and efficiently scan large areas of the sky
- To estimate maser detection rate
- To assess effects of summer observing at 12mm
- To look at the Galactic latitude distribution of ammonia (and other thermal lines)
- To find out which lines can be detected with a quick scan



HOPS pilot survey

Covered 2 x 1 square degree regions
at $l=333$ and $l=305$.

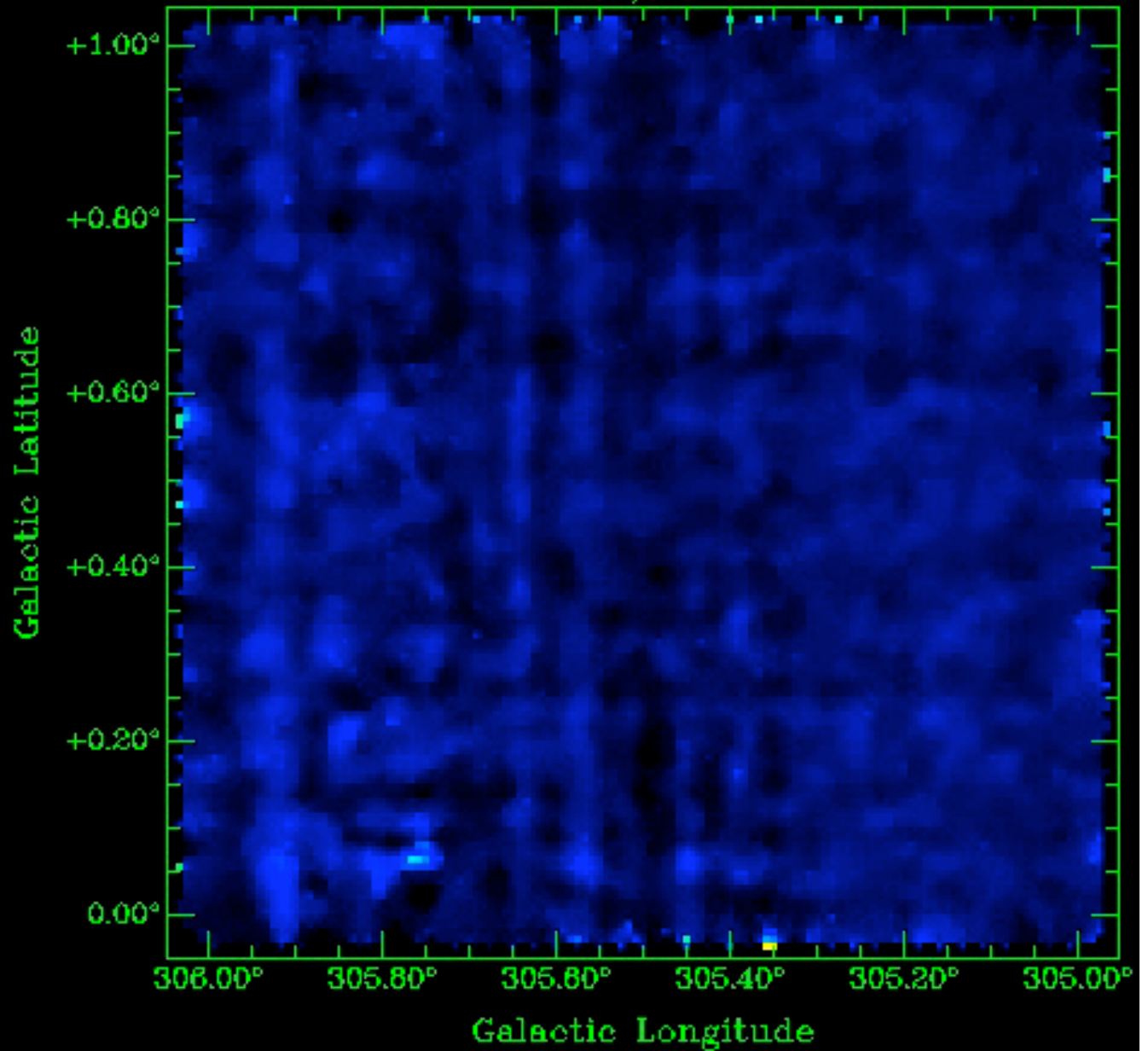
Covered entire frequency range from 19.5 – 27.5GHz
using broadband mode



Water Maser Data Cube

Velocity: -301.41 km/s

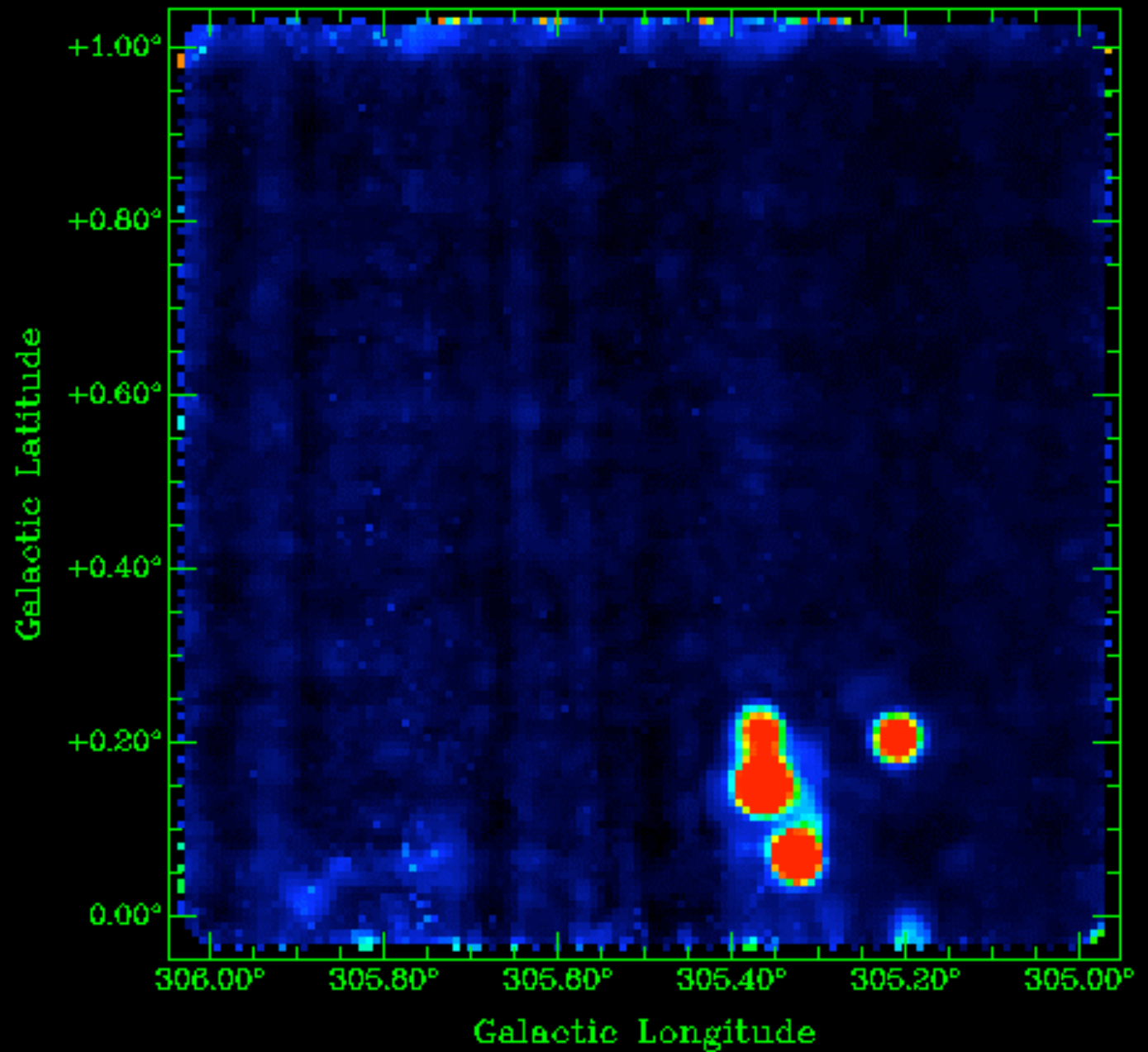
H₂O/H₂O



Outer
Galaxy

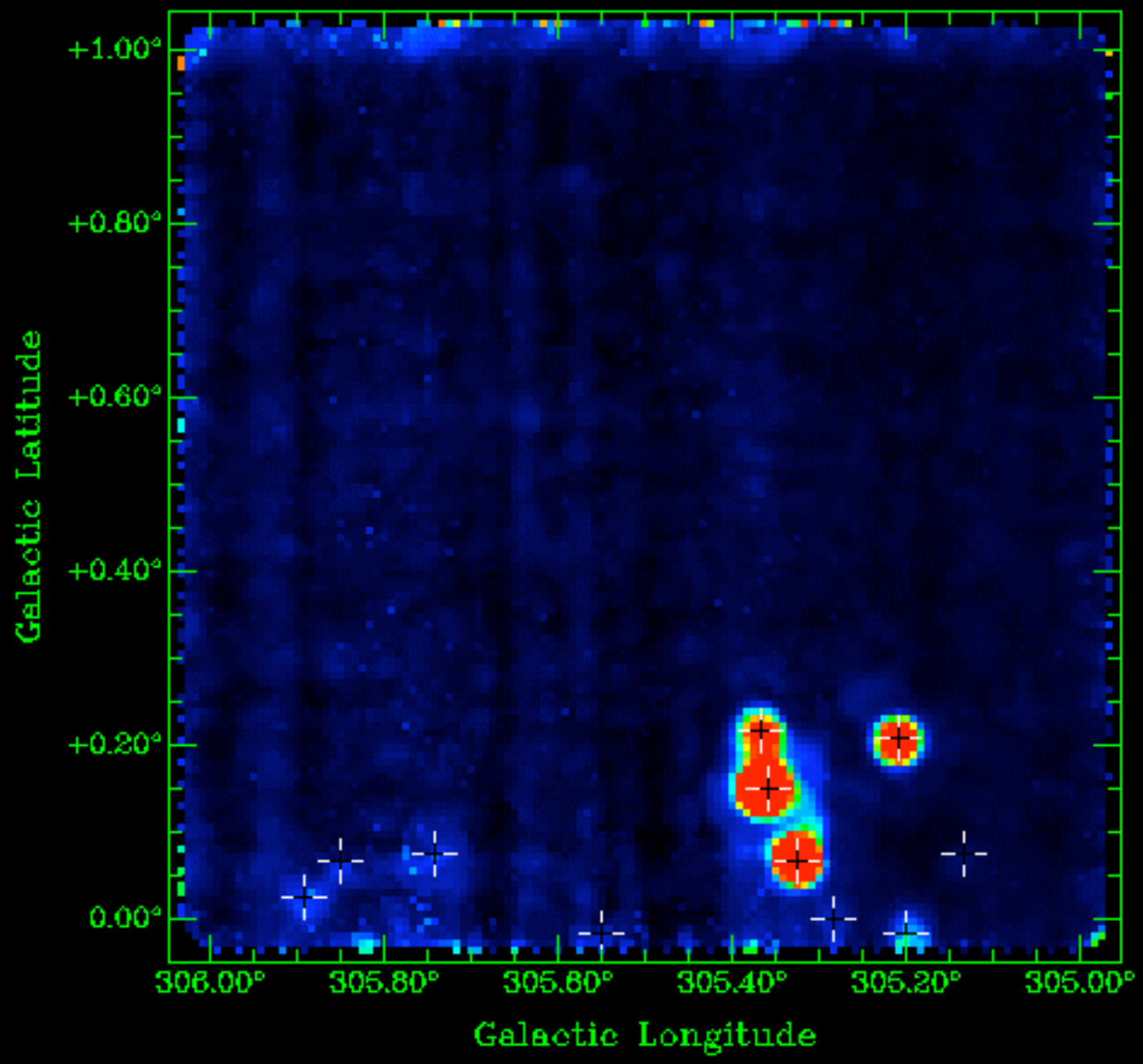
Water Maser Integrated Intensity

Outer
Galaxy



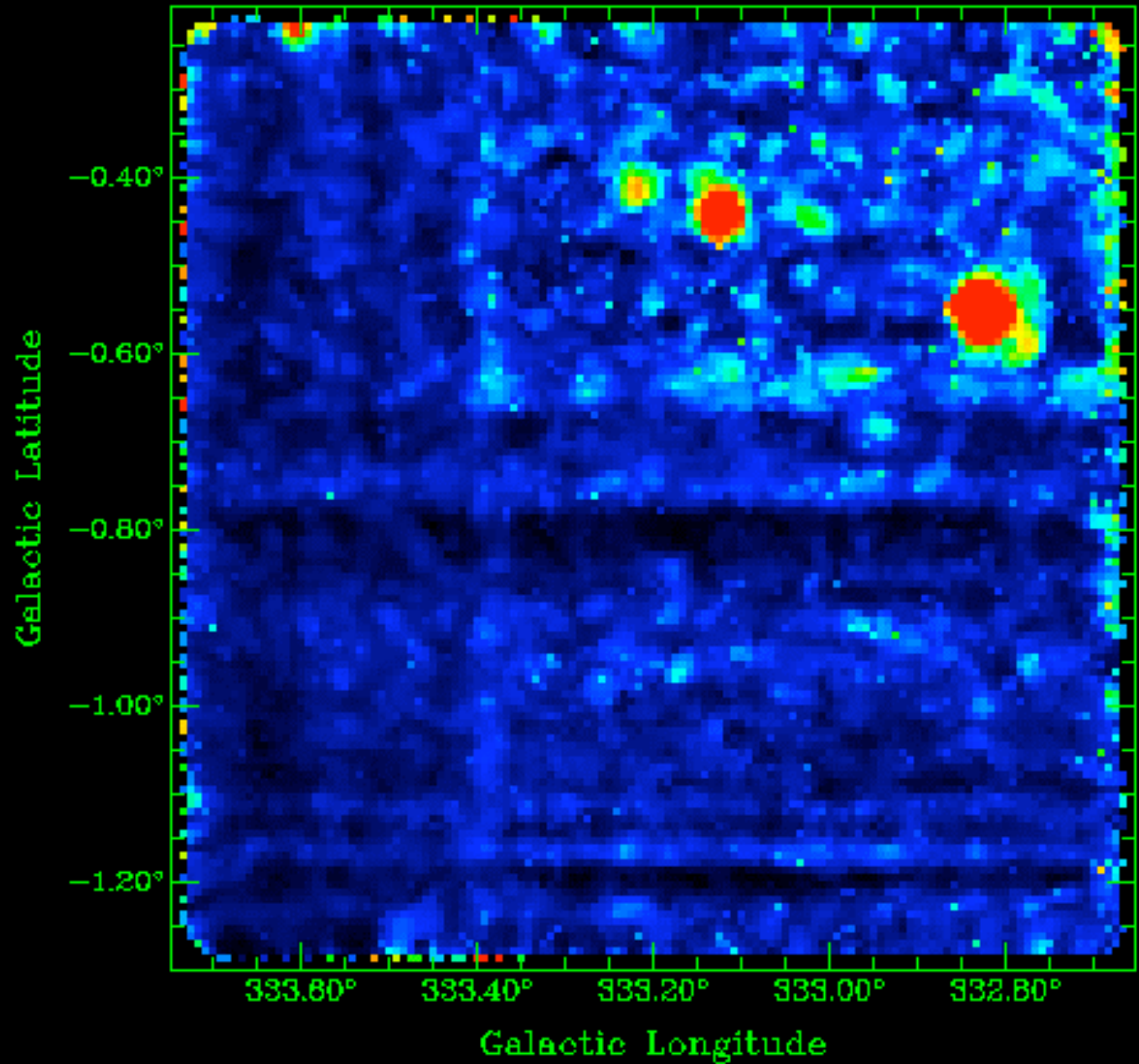
Water Maser Integrated Intensity

Outer
Galaxy



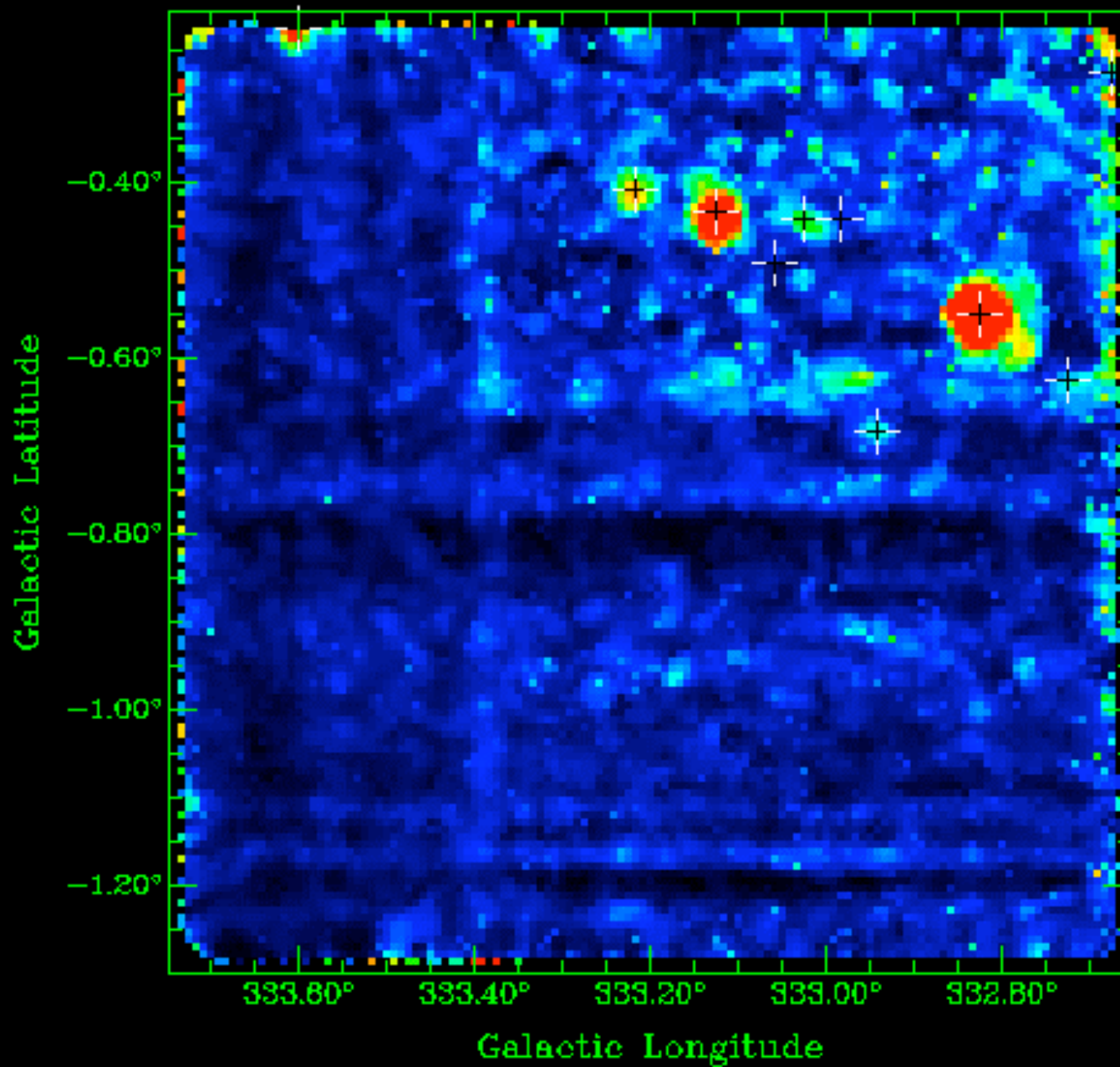
Water
Maser
Integrated
Intensity

Inner
Galaxy



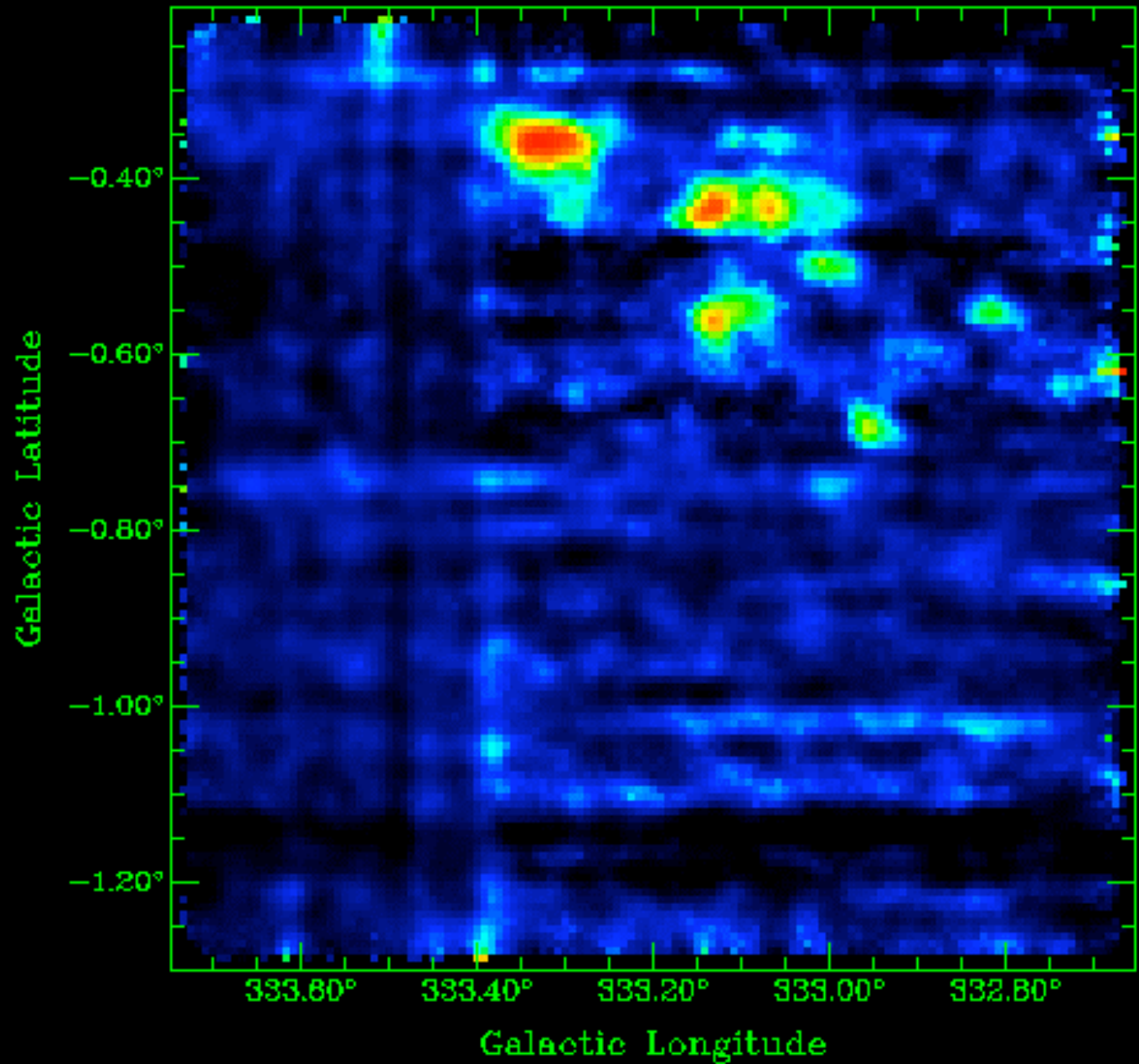
Water
Maser
Integrated
Intensity

Inner
Galaxy



NH₃ (1,1) Integrated Intensity

Inner
Galaxy

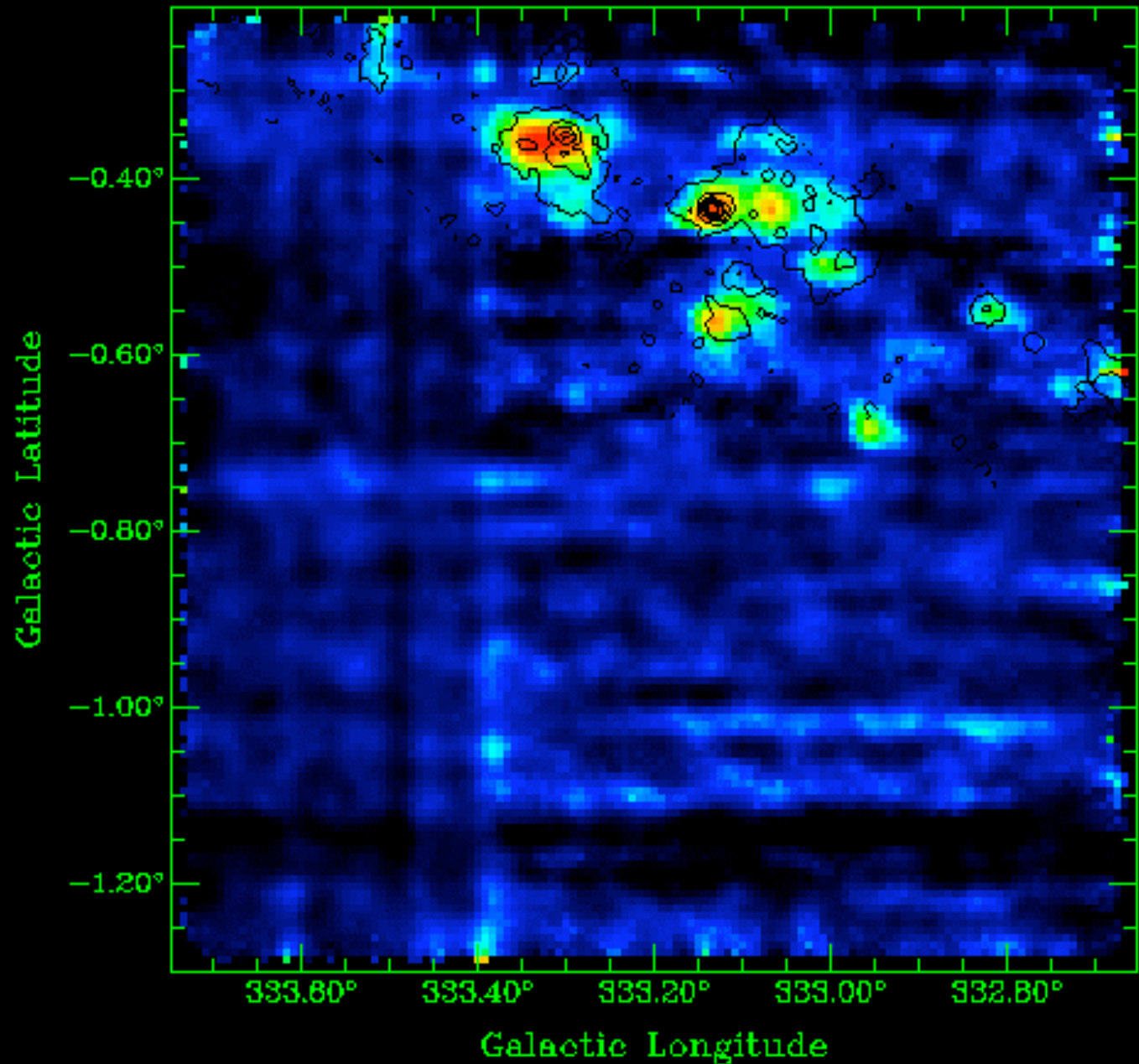


NH₃ (1,1)
Integrated
Intensity

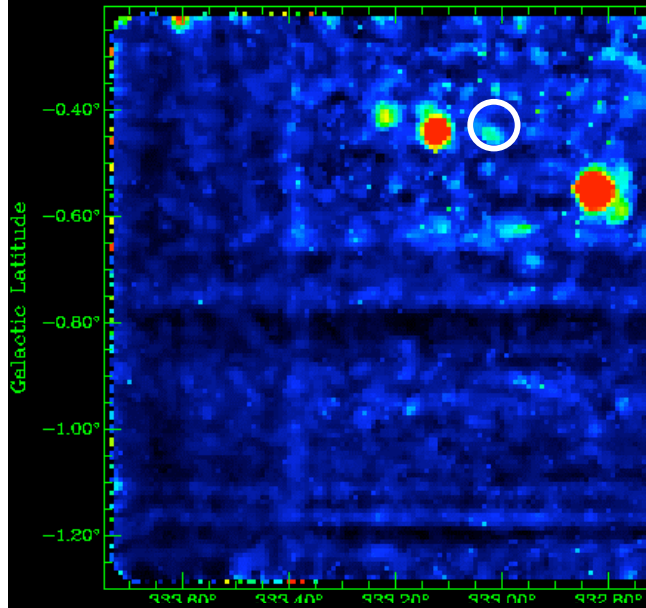
HCO⁺
Contours

(courtesy Nadia Lo)

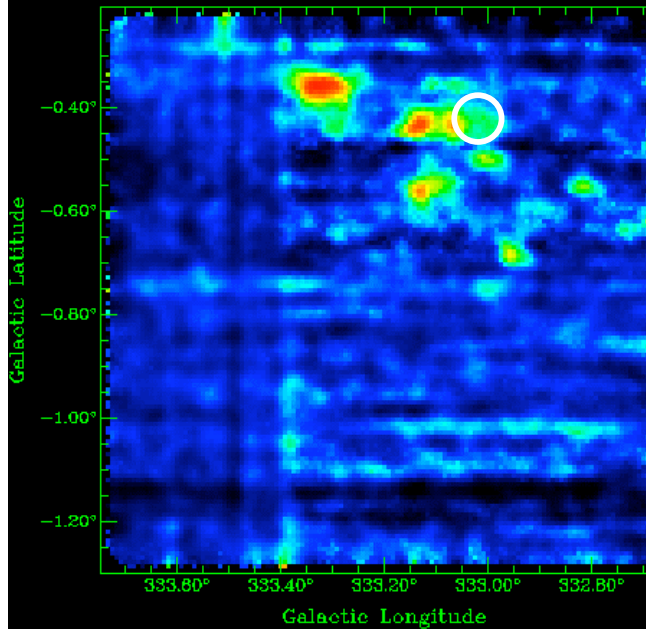
Inner
Galaxy



H₂O maser

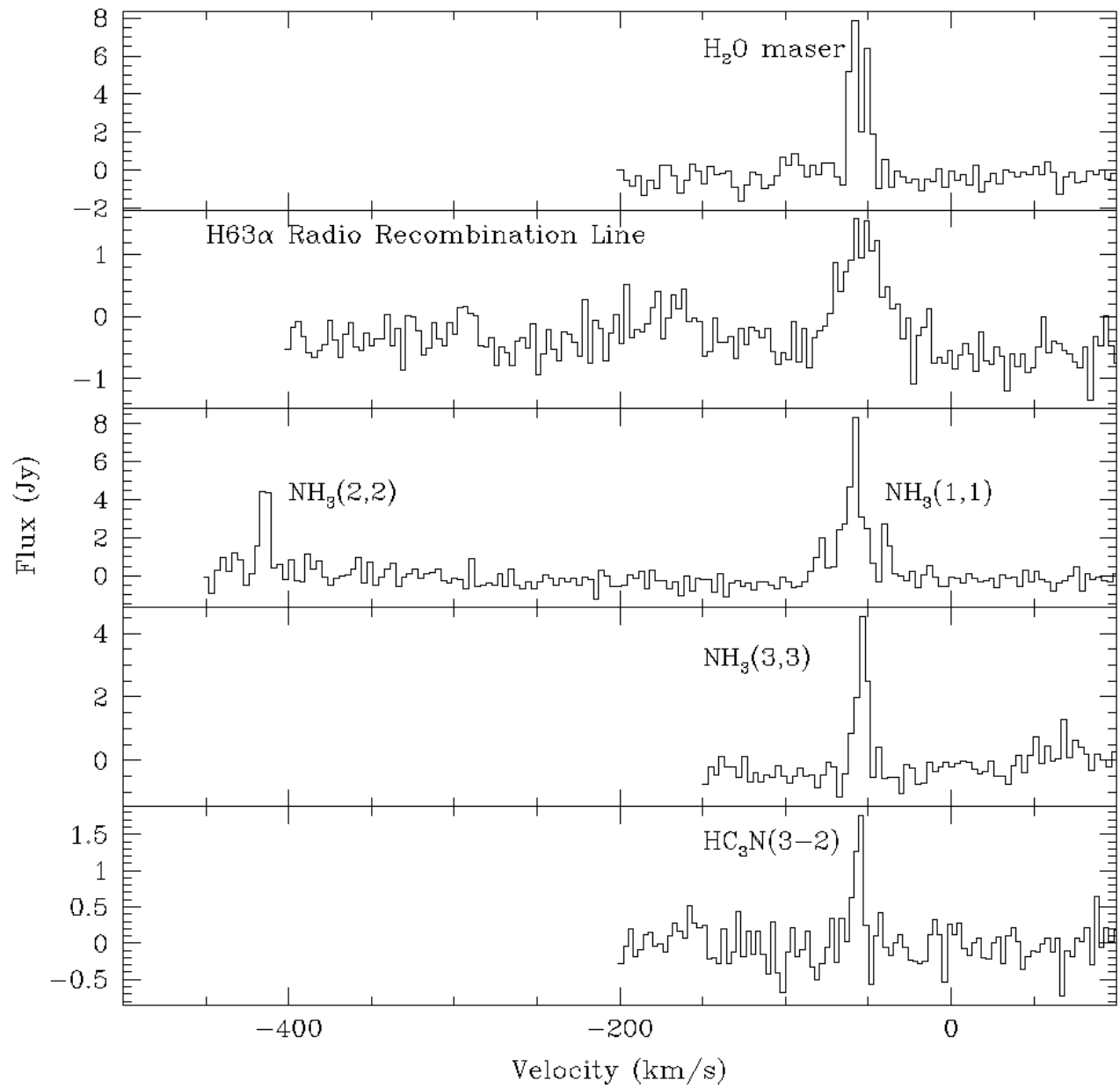


NH₃ (1,1)



H63 α RRL

HCCCN (3-2)



Summary of the pilot survey

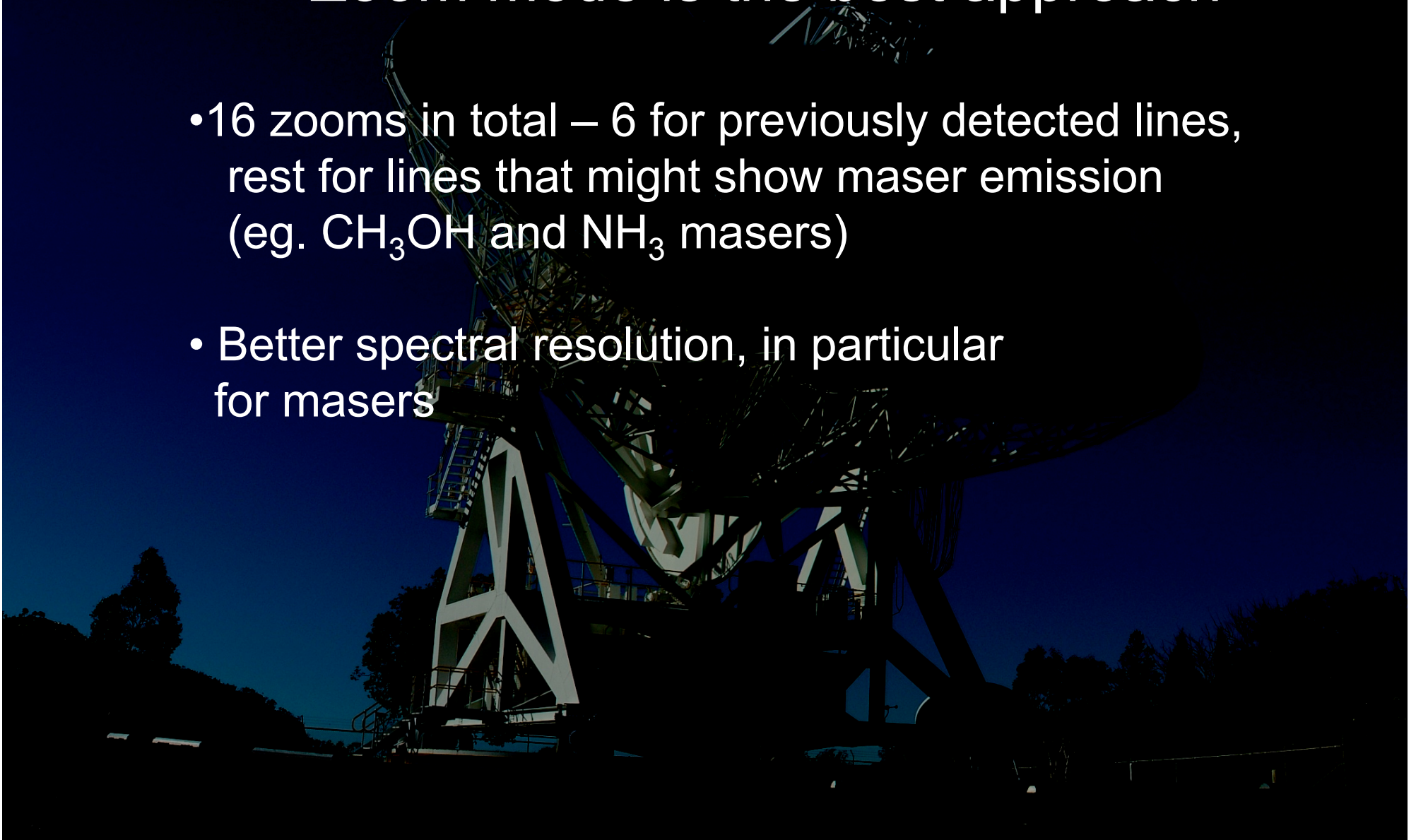


- Proved that the system works
- Easily detected 6+ lines:
 - H₂O;
 - NH₃ (1,1), (2,2) and (3,3);
 - HCCCN (3-2);
 - RRLs (H62 α – H69 α)
- Identified favourable weather conditions
- Defined survey width ($\pm 0.5^\circ$)
- Identified the zoom mode as best approach

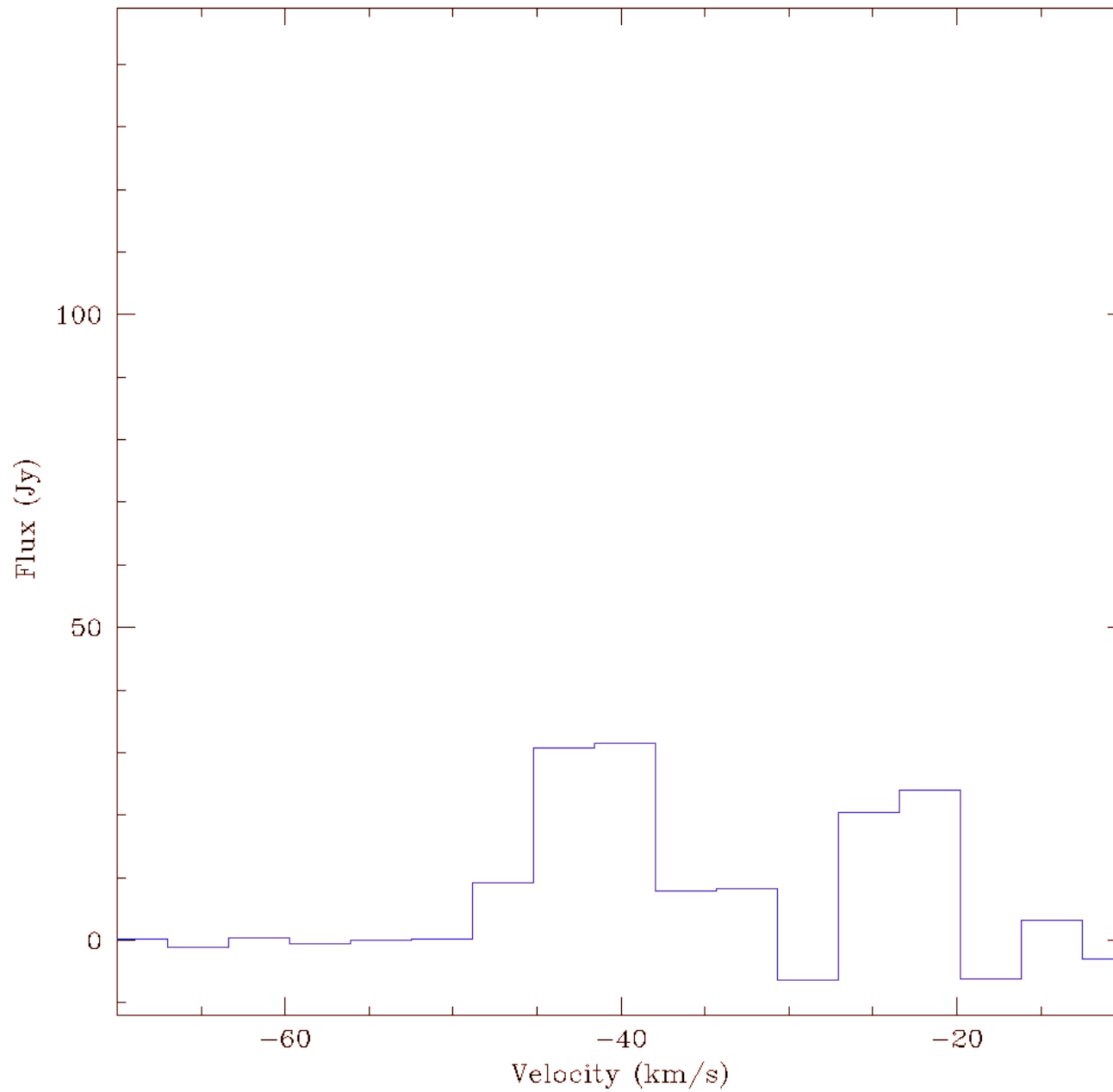
Summary of the pilot survey

Zoom mode is the best approach

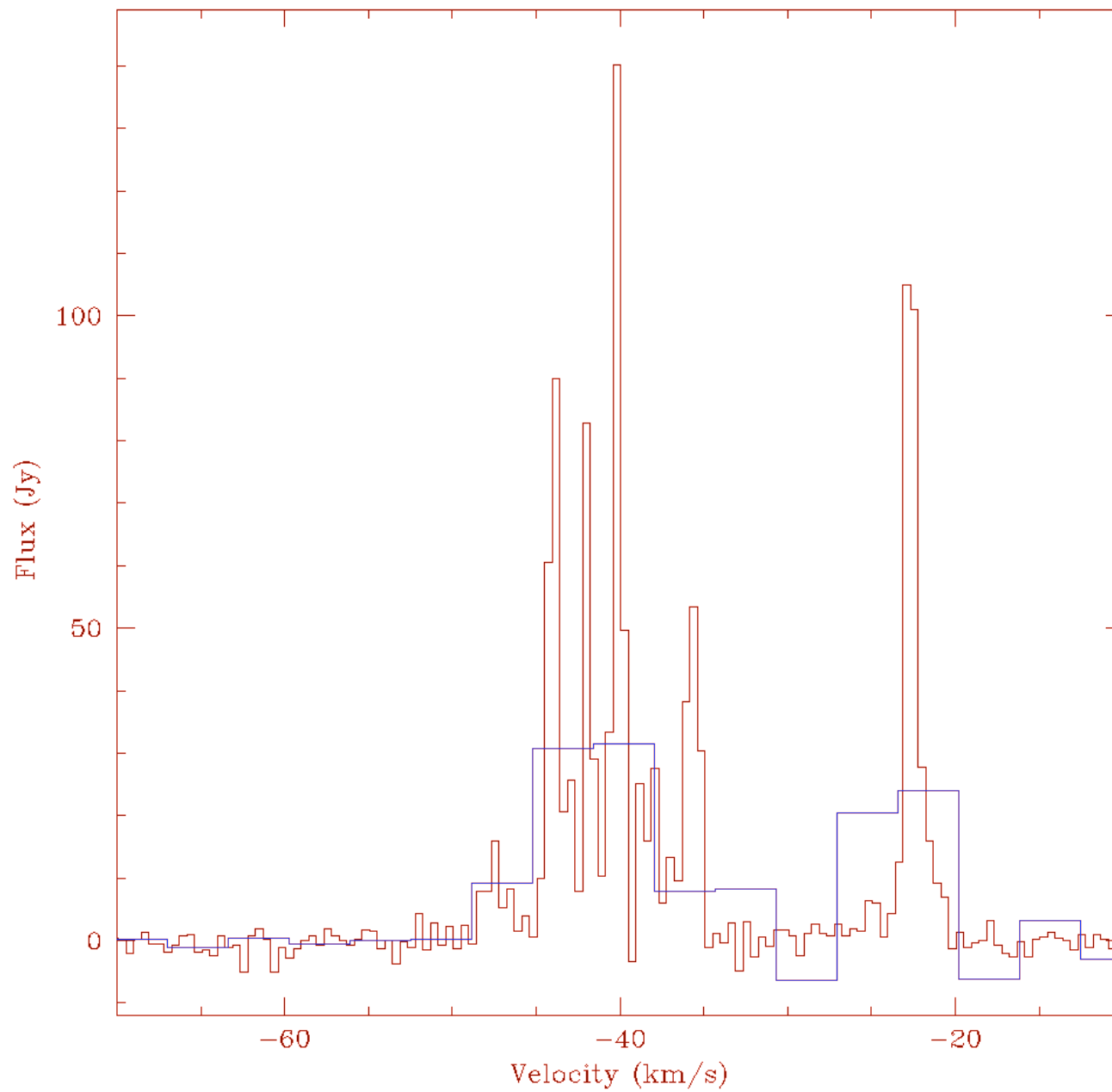
- 16 zooms in total – 6 for previously detected lines, rest for lines that might show maser emission (eg. CH_3OH and NH_3 masers)
- Better spectral resolution, in particular for masers



H₂O maser spectrum for G305.21+0.21 using broadband mode



H₂O maser spectrum for G305.21+0.21 using narrowband mode



Conclusion

HOPS – H₂O southern Galactic Plane Survey

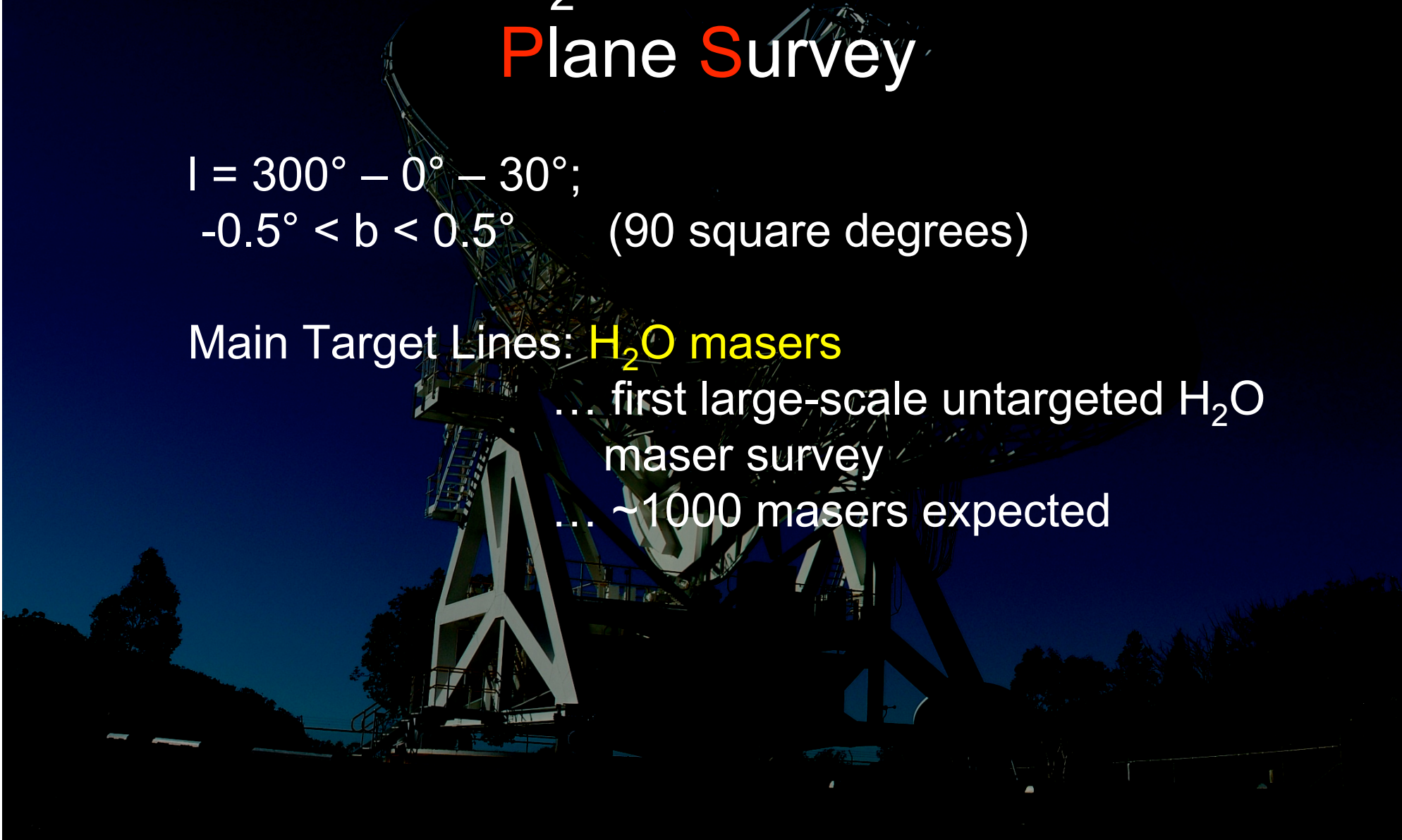
$l = 300^\circ - 0^\circ - 30^\circ;$

$-0.5^\circ < b < 0.5^\circ$ (90 square degrees)

Main Target Lines: H₂O masers

... first large-scale untargeted H₂O maser survey

... ~1000 masers expected



Conclusion

HOPS – H₂O southern Galactic Plane Survey

$l = 300^\circ - 0^\circ - 30^\circ;$

$-0.5^\circ < b < 0.5^\circ$ (90 square degrees)

Main Target Lines: H₂O masers

NH₃ (1,1), (2,2) and (3,3)

... distribution and temperature of
the high density component of
the inner Galaxy

... ~700 NH₃ cores expected

Conclusion

HOPS – H₂O southern Galactic Plane Survey

$l = 300^\circ - 0^\circ - 30^\circ;$

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Main Target Lines: H₂O masers

NH₃ (1,1), (2,2) and (3,3)

HCCCN (3-2)

... trace star formation sites

Conclusion

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$l = 300^\circ - 0^\circ - 30^\circ;$

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Main Target Lines: H₂O masers

NH₃ (1,1), (2,2) and (3,3)

HCCCN (3-2)

Radio recombination lines

... trace the ionised content

Conclusion

HOPS – H₂O southern Galactic Plane Survey

$l = 300^\circ - 0^\circ - 30^\circ;$

$-0.5^\circ < b < 0.5^\circ$ (90 square degrees)

Main Target Lines: H₂O masers

NH₃ (1,1), (2,2) and (3,3)

HCCCN (3-2)

Radio recombination lines

Thankyou!