HEAT
High Elevation Antarctic Telescope

Revealing the Life Cycle of the interstellar medium

formation of cold HI clouds

warm neutral and ionized gas

disruption of molecular clouds

stellar evolution

star formation

SRON

UNSW

THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY • AUSTRALIA
Pre-HEAT: a complete 0.2-meter submm telescope

- measure sky opacity at 450 microns
- perform a 10' resolution map of the Galactic Plane in $^{13}$CO J=6-5 (661 GHz)
- prototype the components that we will use in HEAT
Design Challenges:

- Must be easy to install
- Robust, automated operation (1 year between visits!)
- 200W power budget (100W heaters, 100W instrument)
- 6 month delivery
- ...and on a tiny budget from NSF
PLATO arrives at Dome A  (19 January 2008)
Sun (and Moon) scans set the telescope coordinate axes (pointing)
The submm transparency is measured by examining the brightness temperature of the sky at different elevation angles.

The sky temperature would be 2.7K (the cosmic microwave background) if it were completely clear, and the ambient atmospheric temperature if completely opaque.
An early example of a skydip measurement from Pre-HEAT

PreHEAT 450µm $\tau = 0.76$
26–Feb–2008 17h UTC
Exceptional 450 micron opacity from Dome A

median at South Pole
Derived Precipitable water vapor from Dome A

- best 25% weather at Mauna Kea is here
- median at ALMA site is here
At PWV $<<$ 100 um, entirely new atmospheric windows open to ground based observatories. How often does this occur at Dome A?
Passive soundings of the ground near the 183 GHz water line allows the total column of water vapor to be estimated.
Testing the technique: comparison with radiosonde measurements from the South Pole in 2008
Combined MHS and Pre-HEAT data

Precipitable water vapor (mm)

661 GHz transmission

2008 day

PLATO/PreHEAT
NOAA–18/MHS
Does Dome A lie at the precipitable water vapor minimum?

Almost.
The PWV minimum appears to pass near the geometrical center of the entire Dome A 'ridge'. The opposite end of the ridge, a site labeled 'Ridge A' by Saunders et al. (2009), appears to lie at the PWV minimum.

Fig. 20.— Surface contours in the vicinity of Dome A. Data from Liu et al. (2001), axes are in degrees. The lesser detail on the left hand side is an artifact of the available data resolution.

Lower PWV at Ridge A could be attributed to less cloud cover. Dome A itself lies near a ridge of high cloud activity toward the coast. Clearer weather tends to lie further inland.

Fig. 10.— Closeup of Figure 7(d), showing the wintertime fractional cloud cover from the Aqua CERES-MODIS results. The ridgeline of minimum cloud cover passes to the south of Dome A.
Current Status, 2009

- The receiver system still works!
- The telescope drive does not. :( 
- A mechanism for taking data at a fixed elevation angle is in place.

Scientific Papers

- SPIE papers for PLATO and Pre-HEAT in 2008
- The first scientific paper summarizing PLATO in PASP (Yang et al. 2009)
- The first science letter from Pre-HEAT has just been submitted to Nature
- Two additional science papers from Pre-HEAT are foreseen in 2009.
Astronomical Spectra of $^{13}$CO J=6-5 at 661 GHz

Pre-HEAT repeatedly measured the same azimuthal slices of Centaurus-Crux once per day for several weeks.

[Position–velocity diagram image]
Next steps: PreHEAT to HEAT

Primary 0.65 m
Surface 5 um rms
Pointing 15 arcsec
Power 200-400 W
Not all surveys are comparable...

Let's take a sample 1 sq degree around $l = -33.3$, $b = -0.3$ to illustrate.
Goal: A Breakthrough Study in 'Galactic Ecology'

A Super-survey consisting of HI from ATCA/Parkes, [CII] and [NII] from STO and HEAT, CO/\(^{13}\)CO from MOPRA, with high-J lines from HEAT, would:

- Reveal formerly invisible components of interstellar matter: clouds of \(\text{H}_2\) without CO.
- Witness directly the formation and destruction of GMCs.
- Disentangle warm diffuse gas from cold atomic & molecular clouds in the Galaxy.
- Depict how/where interstellar clouds are made in the Galaxy and how long they live.
- Clarify the intricate 'feedback' between star forming clouds, the stars that form in them, and their Galactic environment.
- Allow construction of a Milky Way template that can be used to interpret the unresolved emission from distant galaxies: e.g. ALMA, SMA, Herschel, and SOFIA.
### SUMMARY of REQUIREMENTS for OBSERVATORIES AT DOME A

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<tr>
<th>Observatory</th>
<th>Aperture</th>
<th>Power</th>
<th>Cryogenics</th>
<th>Mass</th>
<th>Manned?</th>
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<tr>
<td>Pre-HEAT</td>
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