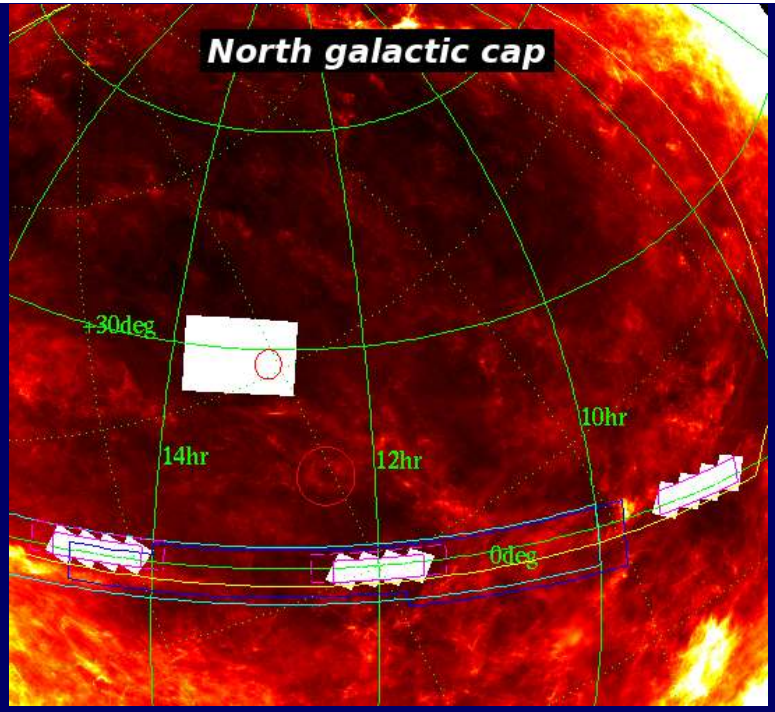
The Herschel ATLAS

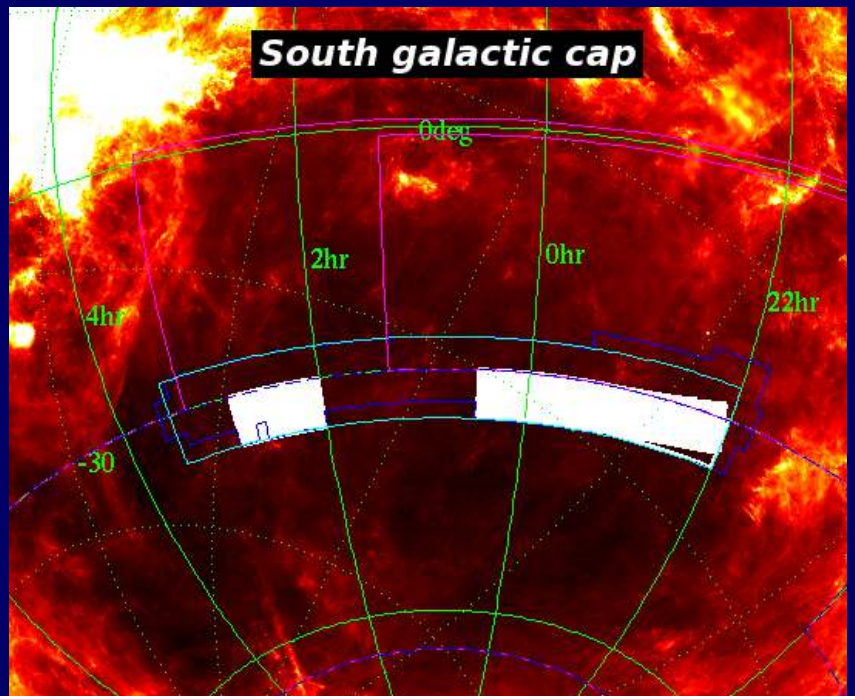
Steve Eales on behalf of the H-ATLAS team

- Largest Open Time Key Project (600 hours)
- A survey of 550 square degrees of the sky, four times larger than all other Herschel extragalactic surveys combined
- Five bands: 110,170,250,350 and 500 microns, with 5σ limit at 250 μm of 45 mJy

The fields

- Southern fields: 2dF, VISTA (VIKING), VST (KIDS), DES
- Equatorial fields: 2dF, SDSS, GAMA, VISTA (VIKING), UKIDSS, VST (KIDS), GALEX, GMRT
- Northern fields: SDSS, LOFAR, UKIDSS
- We predict 35,000 sources will already have redshifts, including 90% of those at z<0.1, and in the GAMA fields 90% at z<0.3



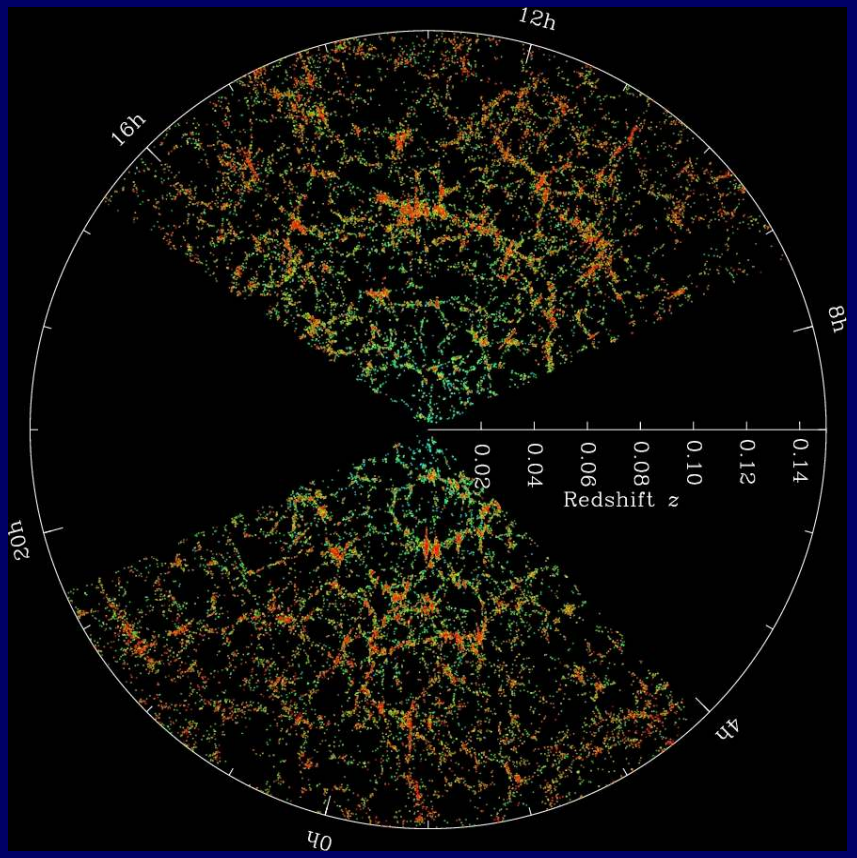


H-ATLAS Science Programme A

Far-IR/submm version of the Sloan photometric survey.

We aim to measure the dust content and dust obscured star formation in ≈30,000 galaxies in the nearby (z<0.3) universe.

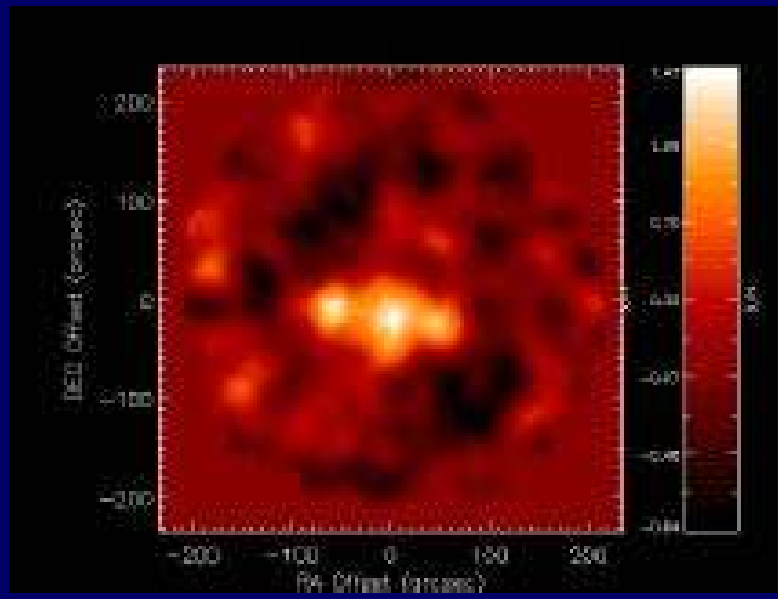
- ***How does star formation depend on environment?***
- ***How does dust mass depend on galaxy type and environment***
- ***How much evolution has there been in the last three billion years?***



Programme B – High-Resolution Observations of Planck Sources

We will survey one eightieth of the sky in two of the same bands as Planck

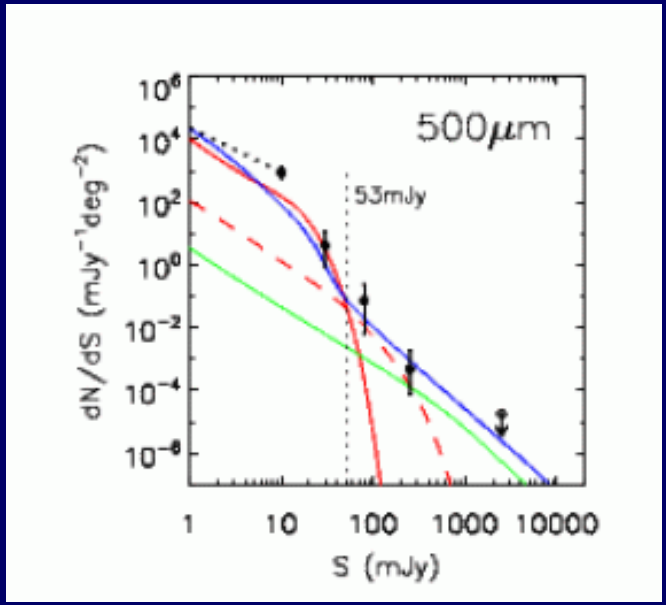
- **empirical test of Planck point-source extraction (positions, fluxes etc.)**
- **high-resolution observations of Planck point sources**
- **a clean 'SZ' sample of high-redshift clusters**
- **joint Herschel-Planck study of high-latitude dust**



BOLOCAM image at 1.1 mm of Abell 1835, showing the SZ effect and two dusty galaxies

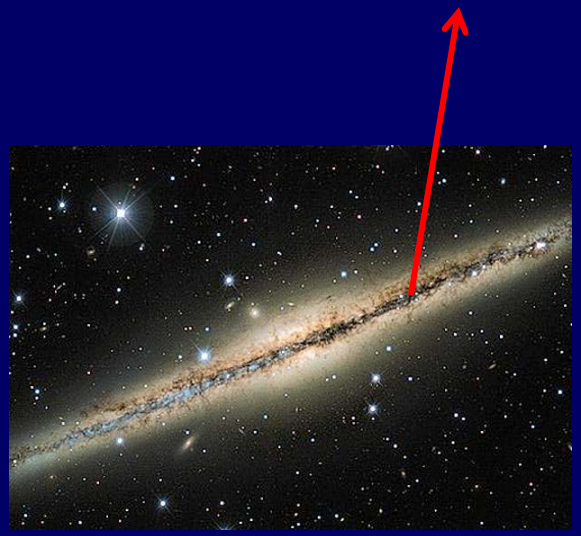
Programme C: Lensing

- **Existing lensing samples typically contain ≈10 sources**
- **Models suggest that 500 μm is the golden spot for finding lensed systems, and that the ATLAS should contain several hundred lenses.**
- **Possible projects: (i) investigations of the cosmic evolution of dark-matter halos, (ii) a study of submm sources well below the Herschel confusion limit, (iii) measurement of cosmological parameters.**

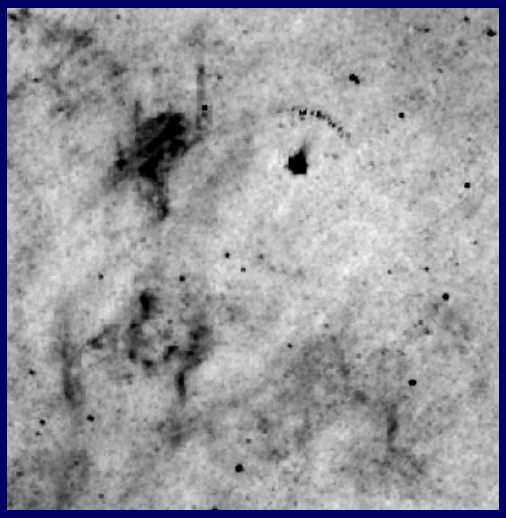


Blue – nearby galaxies; green – blazars; red – unlensed high-z galaxies; dashed red – lensed high-z galaxies

- **Programme D: studies of high-z AGN (e.g. stacking analysis on 10,000 SDSS quasars)**
- **Programme E: evolution and clustering of submillimetre galaxies**
- **Programme F: study of prestellar cores and protostars at high latitude**



When we look at high latitude, the dust is close!



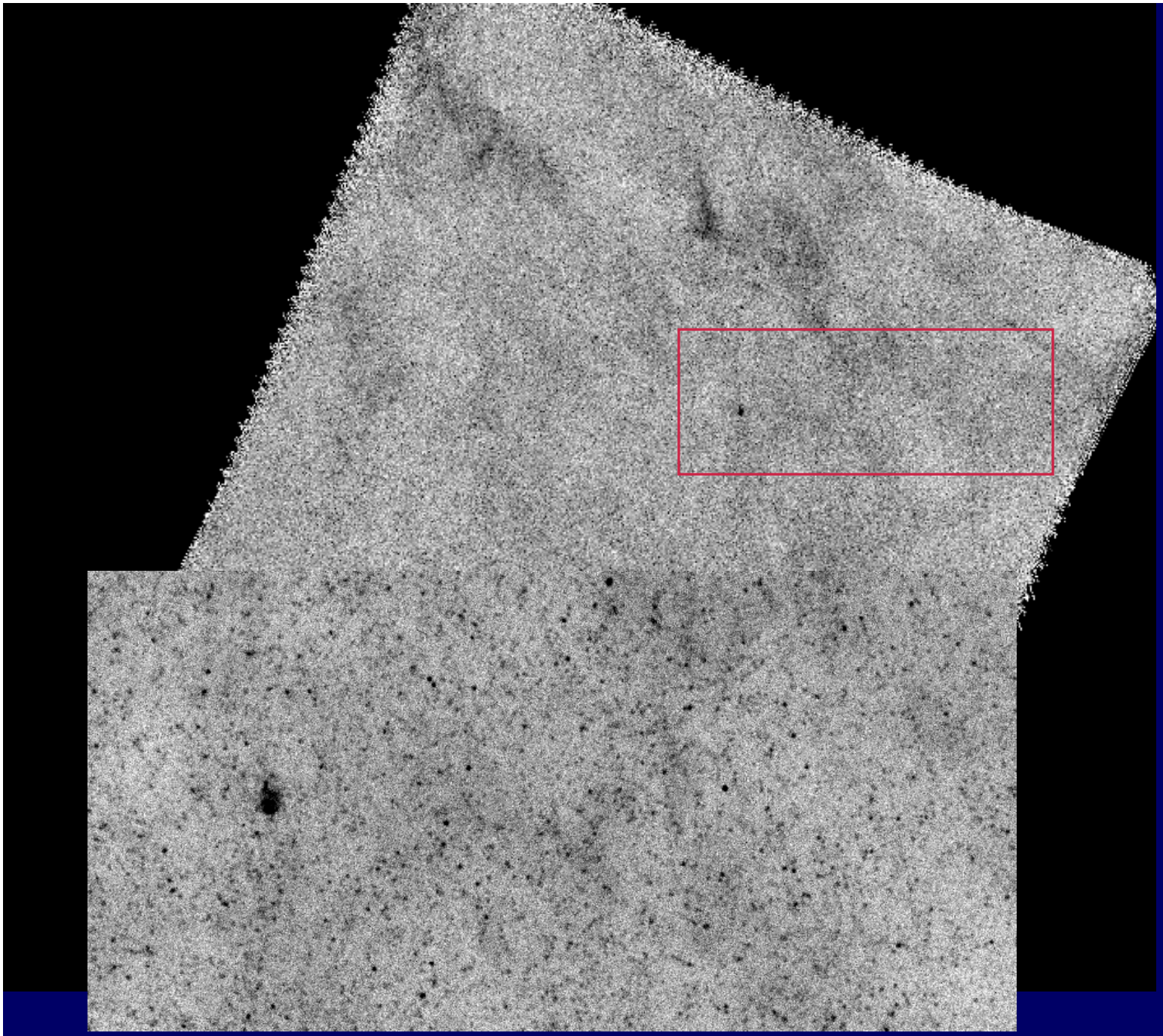
IRAS map at 100 μm of 10x10 deg^2 around the SGP

Science Demonstration Observations

- Herschel observed a 4x4 deg^2 region of one of our fields on the celestial equator on 22 November 2009 in parallel mode
- SPIRE data reduction fairly complete
- PACS data reduction less advanced

Hard-Core SPIRE Data Reduction

- New temperature correction module designed by Enzo Pascale (low-pass filter of temperature time streams, fifth-order polynomial fit to temperature time streams and then normalize and subtract from detector time streams).
- At 250 and 350 μm, no correlation between noise of different bolometers and 1/f knee is at a scale of ≈ 5.5 deg
- At 500 μm, some correlation between bolometers, and 1/f knee is at a scale of 1.7 deg
- High-pass the time streams at the 1/f knee for each array



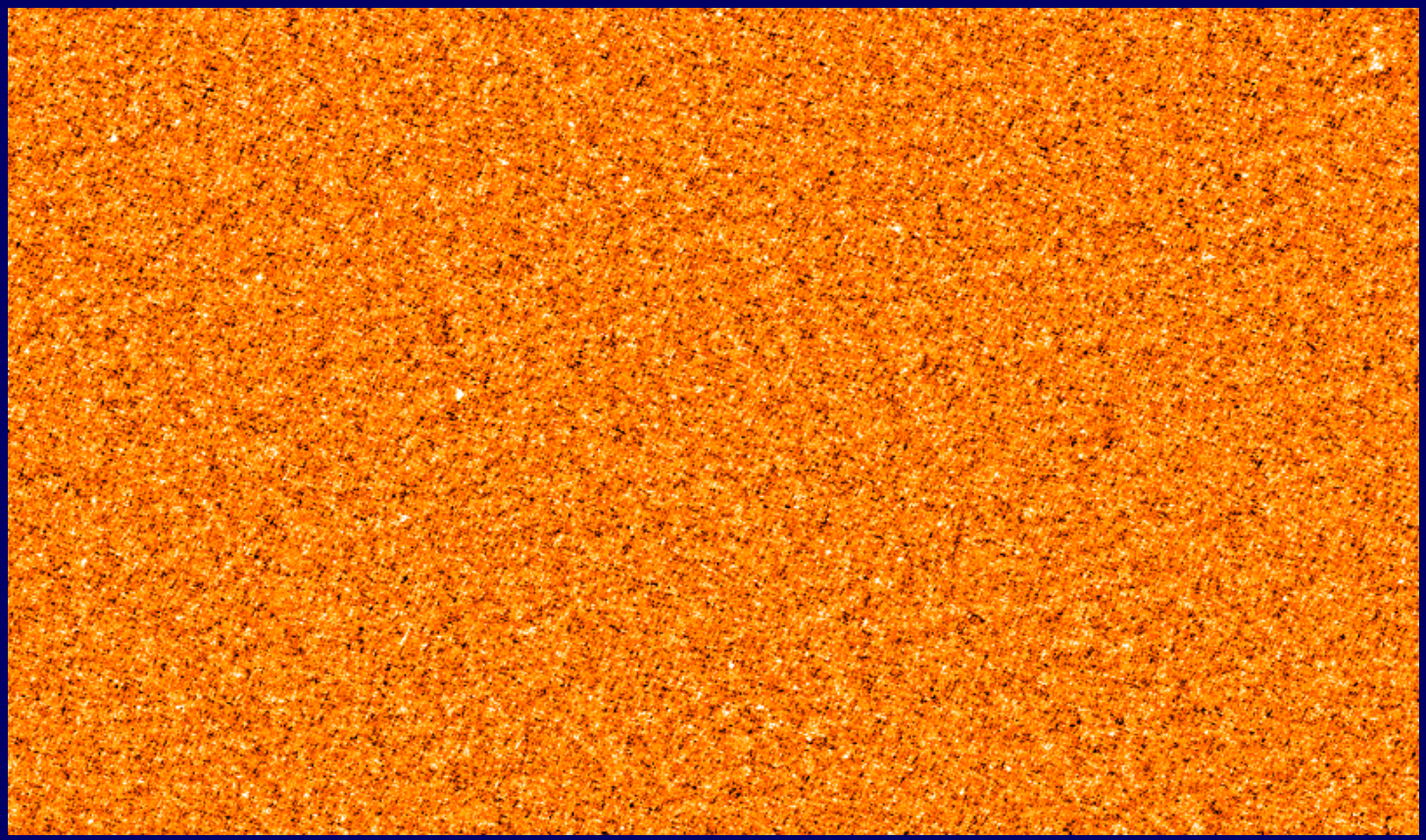
4 x 4 deg^2

250 μm

Hspot noise estimates in the three bands: 9.1, 12.4 and 10.5 mJy

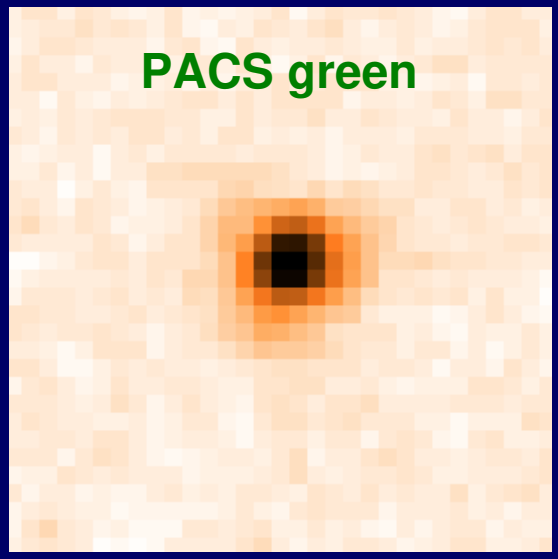
Measured noise: 9.4, 7.6 and 10.6 mJy

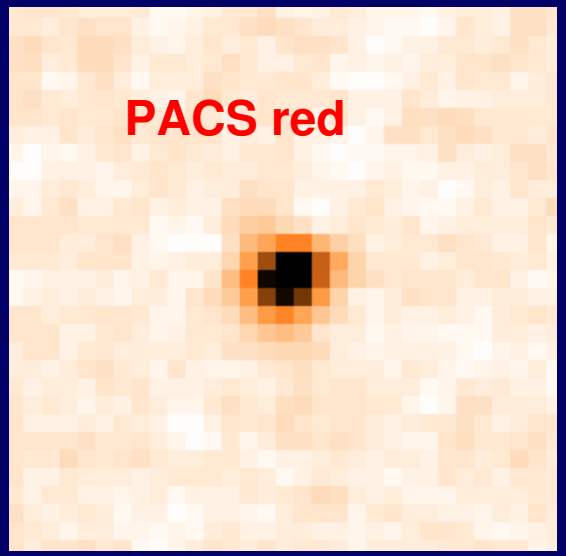
First PACS Images



PACS at 160 microns

- Current estimates of the noise are 30 mJy (1 sigma) at 110 μm and 46 mJy (1 sigma) at 170 μm.
- Hspot estimates: 13.4 mJy and 18.9 mJy
- Estimates of the point spread function from stacking suggest that the beam has not been smeared by fast-scanning
- Watch this space!



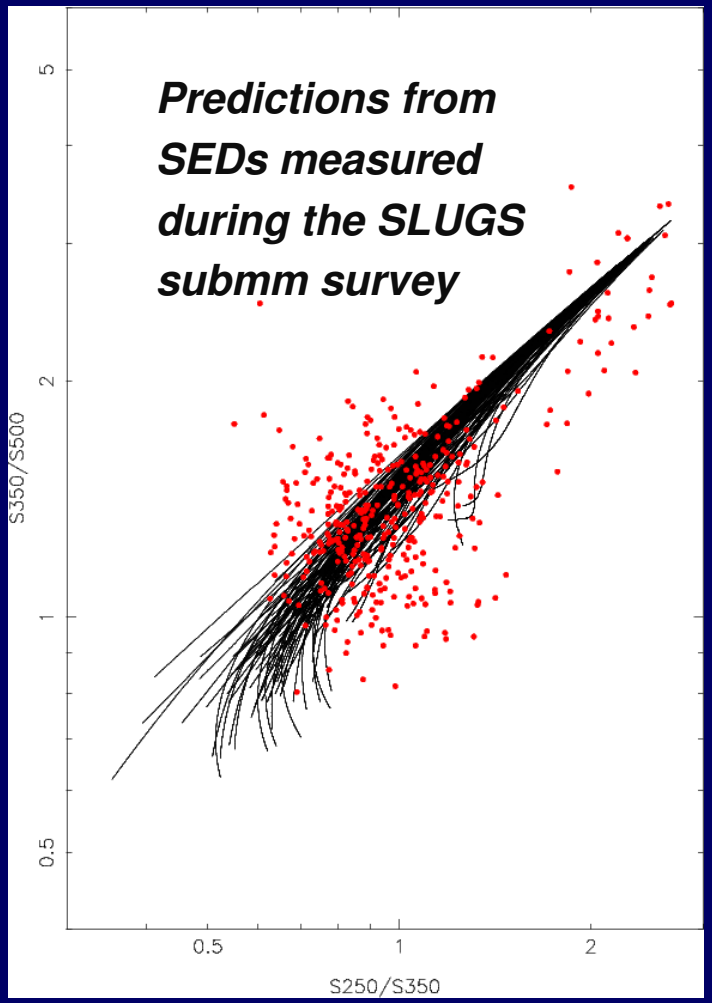


Source Extraction and Identifications

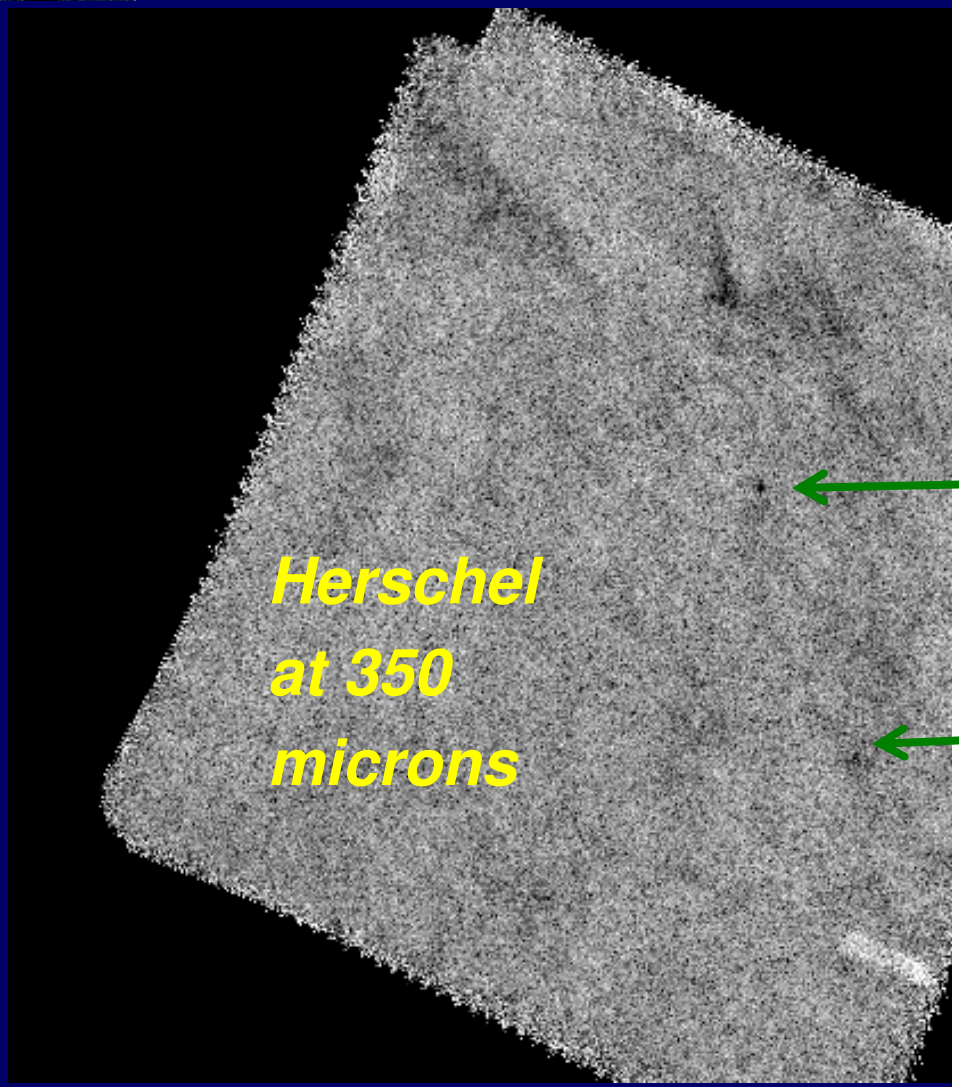
- We are currently trying five source-extraction packages, including two (MADX and the Matrix Filter Multi-Frequency Method) designed to operate at several frequencies simultaneously
- Counterparts are currently being found by a Bayesian method that uses both the positions and spectral energy distributions of the potential counterparts

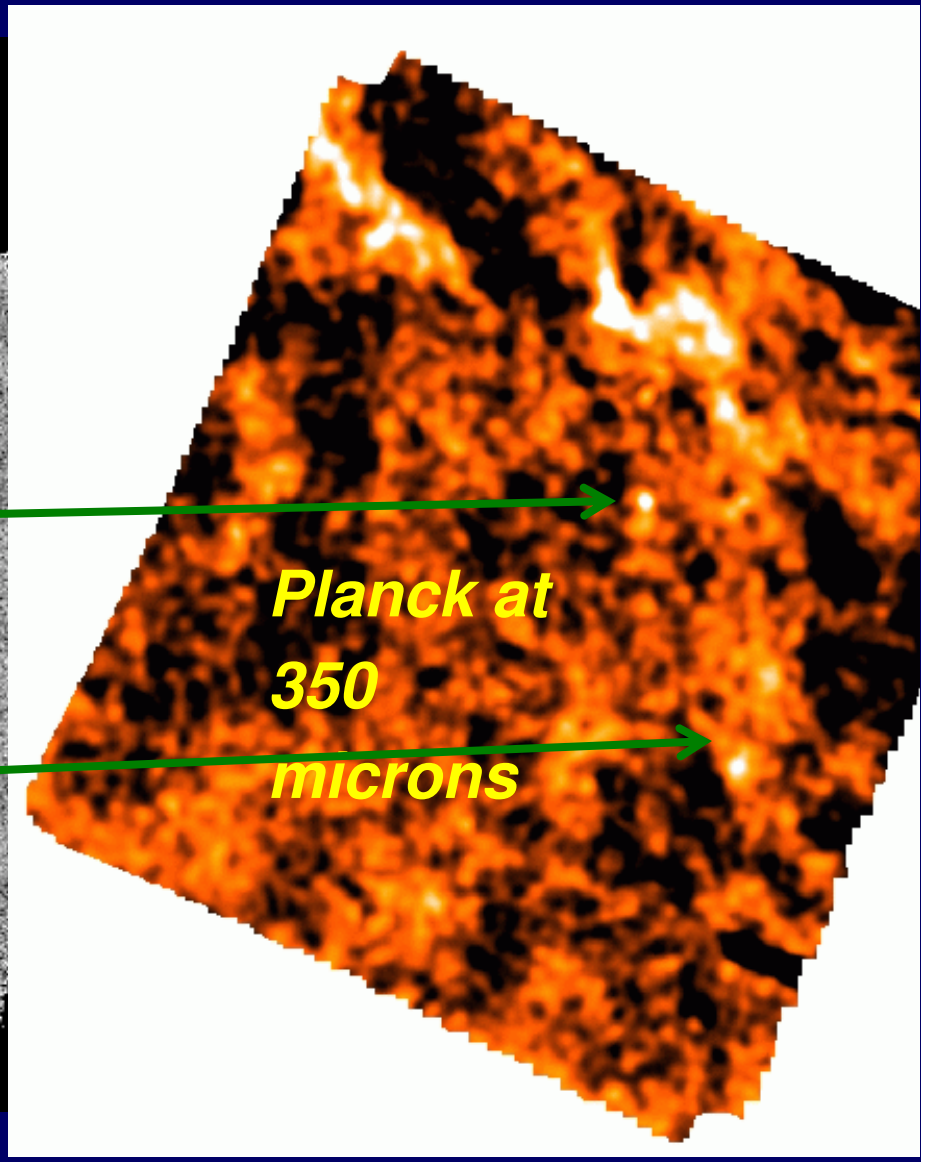
How Well Will We Do? Programme A

- MADX finds 14900 sources detected at >5σ, including 5053 detected at >5σ at 250 μm, 7178 at 350 μm and 479 at 500 μm
- Predicted total for survey is 521,000
- Predicted total at z < 0.3 (assuming redshift distribution is the same as models) is 80,000



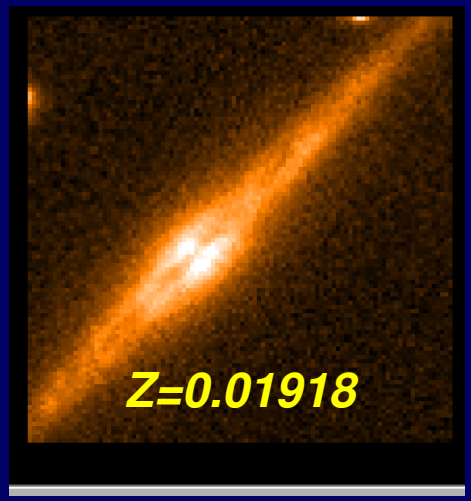
Programme B

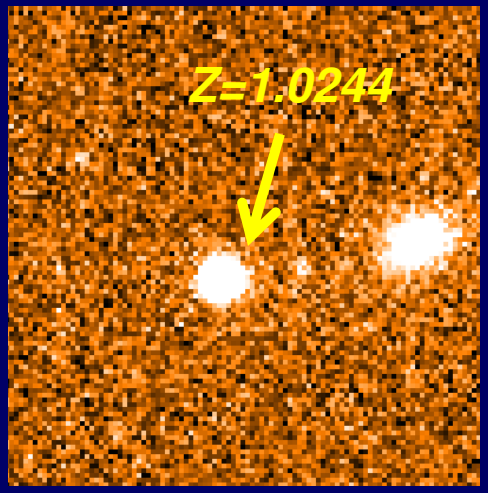


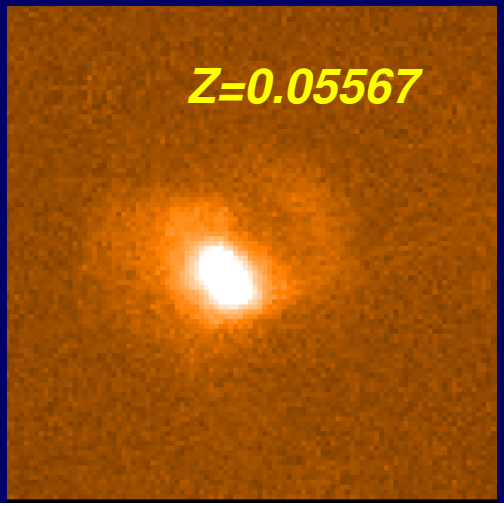


Programme C: Are the Bright 500-μm Sources Lensed

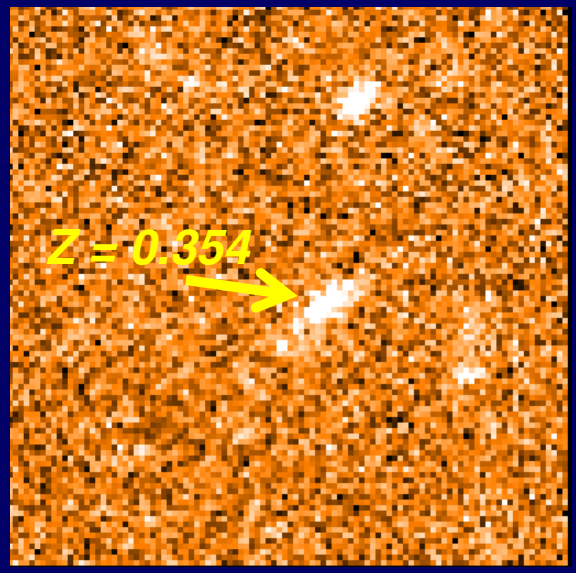
- There are eight SDP sources with flux at 500 μm above 100 mJy
- Two are galaxies at z<0.1
- One is a blazar

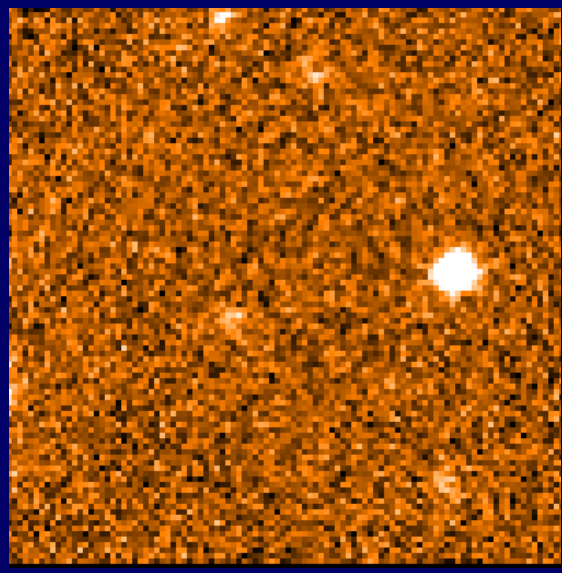


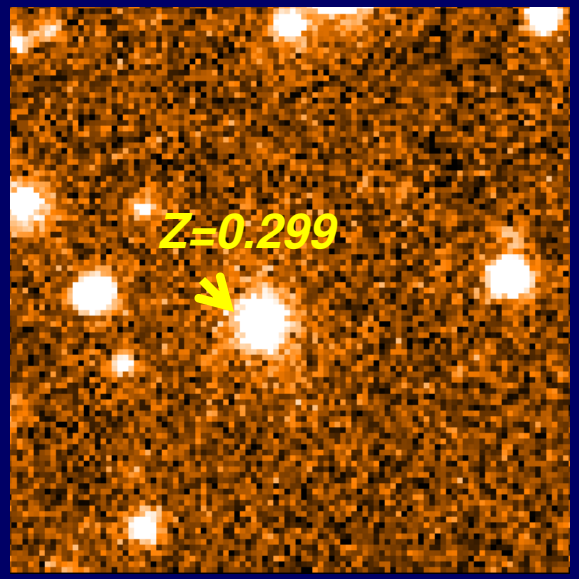


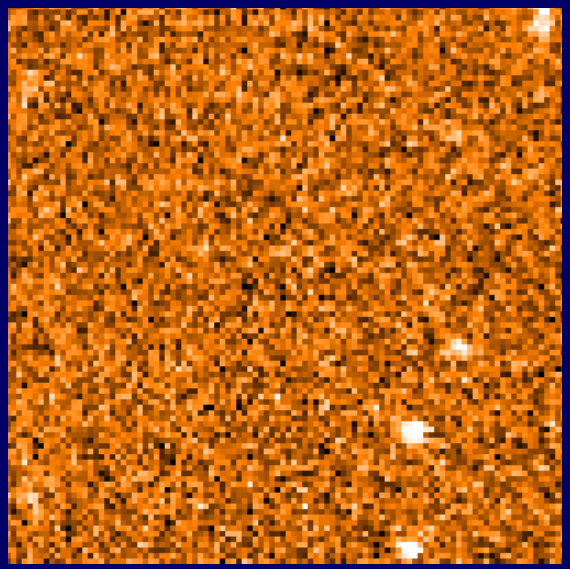


- But five are either unlensed high-z galaxies or lensed high-z galaxies



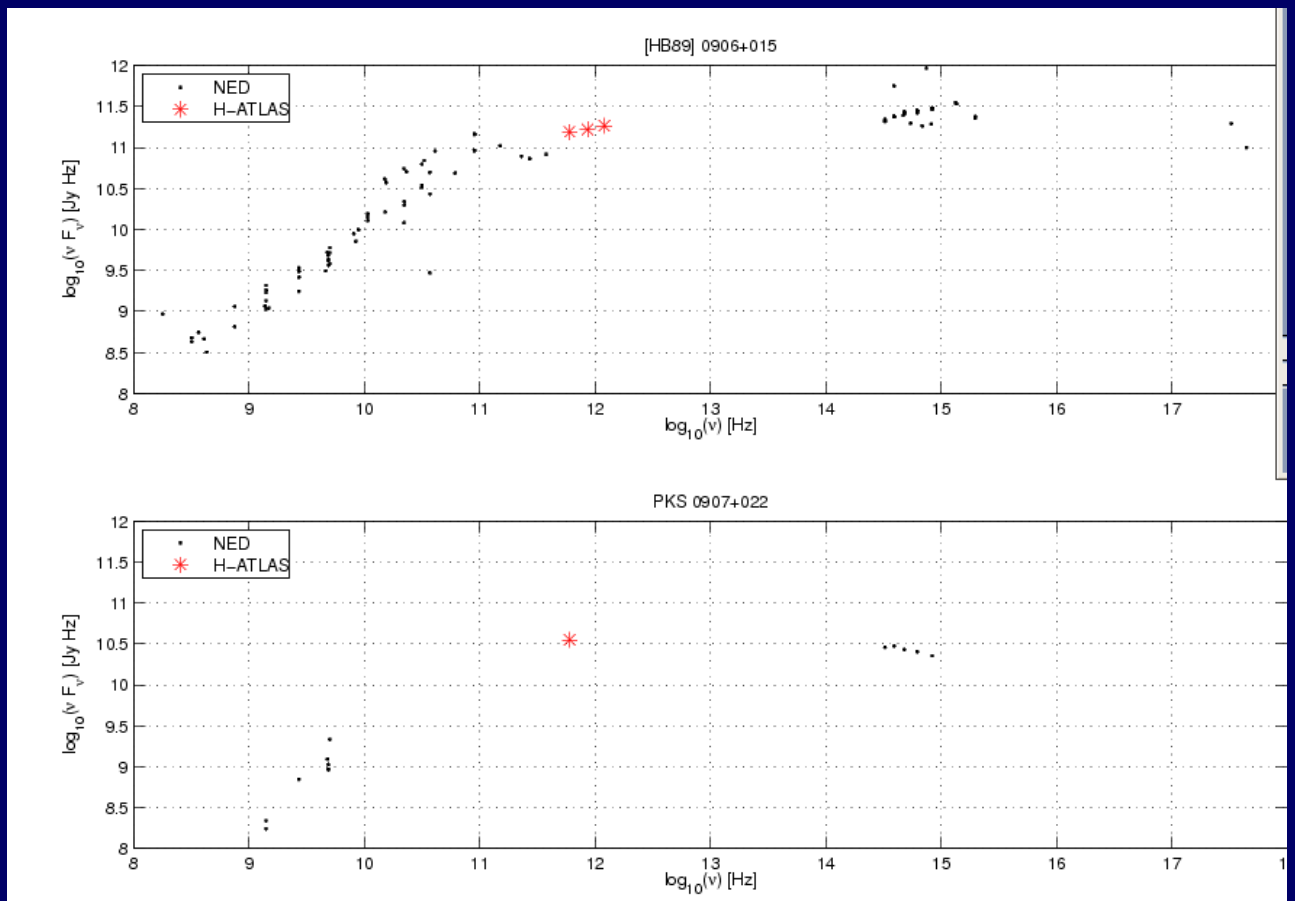




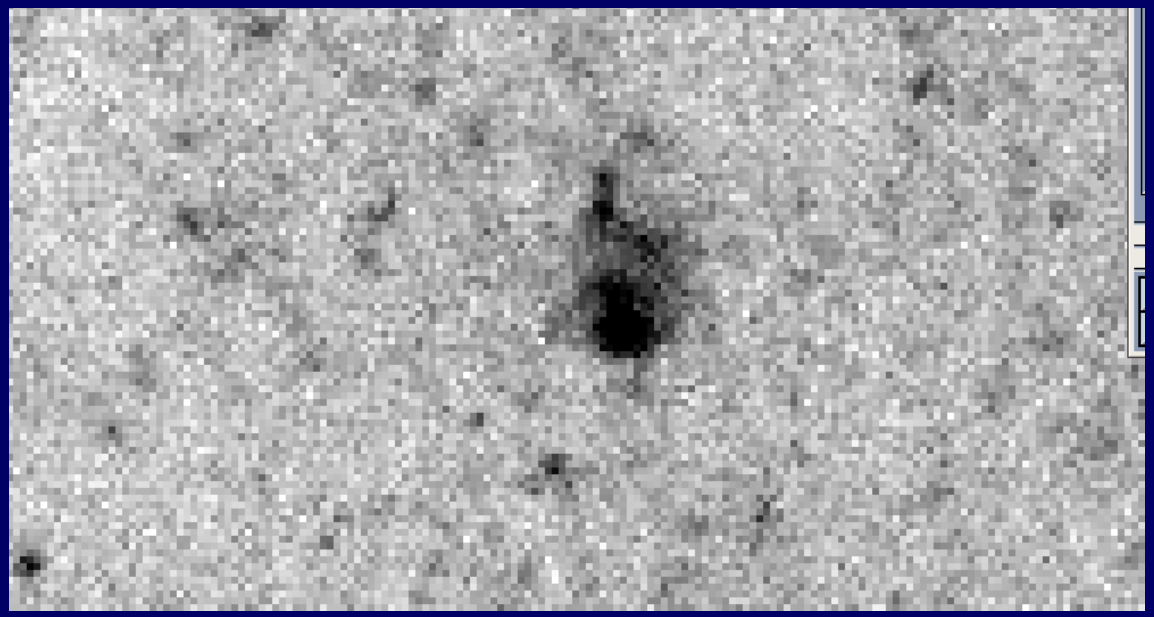


Programme 5: AGN

- Two blazars detected, including one which is one of the 200 brightest gamma-ray sources in the sky



Programme F: Galactic Science

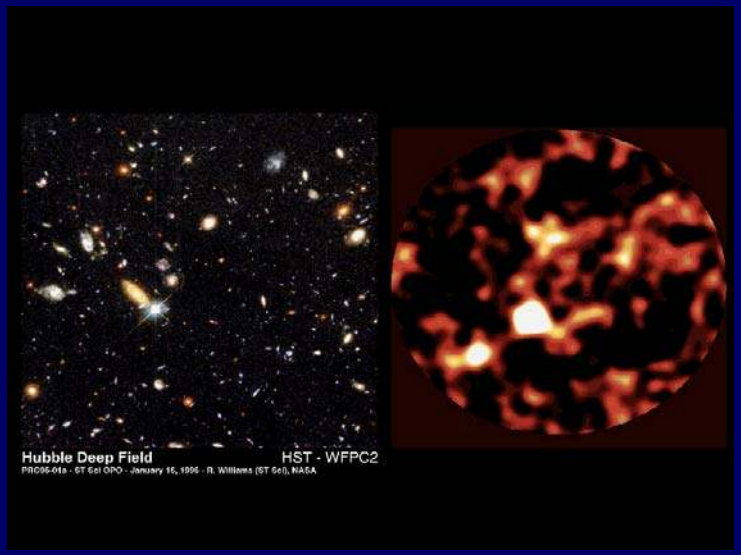


- If ‘blob’ is galactic, it is likely to be at a distance of less than 1 kpc.
- We estimate that its mass (gas plus dust) is less than 1 solar mass.
- Possible isolated prestellar core

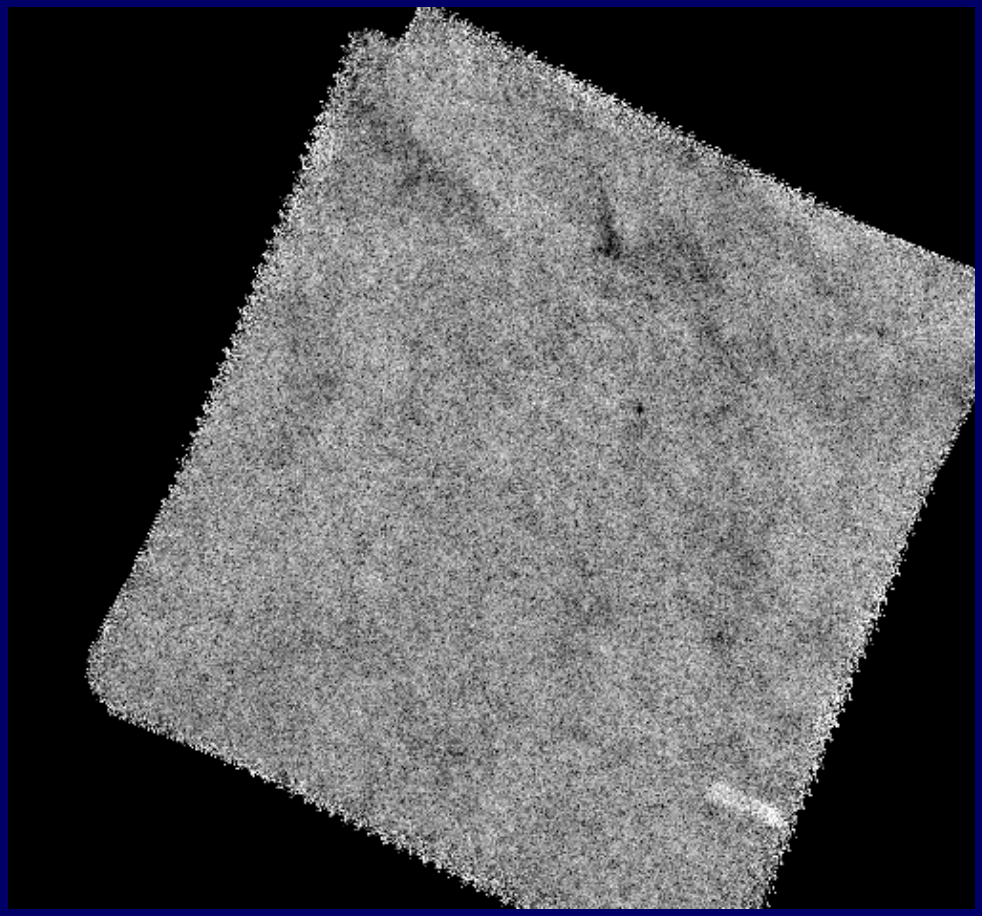
Conclusions

- *SPIRE survey is reaching our target noise limits*
- *PACS survey is a factor of 2-3 above the required sensitivity*
- *We are detecting 2-3 more sources than we expected*
- *The current 9-hour limit on AORS is a major problem for our maps of the SGP and NGP*
- *Other than that, are no major obstacles for any of the six H-ATLAS science programmes.*

Ten Years in Submm Astronomy



1998: SCUBA observations of the HDF – five sources after 20 nights



2009: Herschel – 15000 sources after 16 hours