Next Generation Heterodyne Array for JCMT
Basic Questions

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Science Goals

- Galactic
  - Mapping of molecular clouds. Typically larger than Field of View. So mapping speed >> HARP.
  - High spectral resolution <1km/s.
  - CO(3-2) and ^{13}CO, CS, $C^{18}O$, HCO^+, HCN. This only requires ~329 to ~356GHz. What else is relevant?
- Extra-galactic
  - Mapping galaxies. Warm regions not usually >> 90” (10kpc at 23Mpc). So sensitivity & filling > HARP.
  - Moderate spectral resolution ~ 10km/s. BW >> 1GHz.
  - Probably same lines as above, but CO dominant.
- What other science goals should be included?

Line List (from HARP case)
Should add ~ 2GHz to bottom for ^{13}CO out to 3000km/s

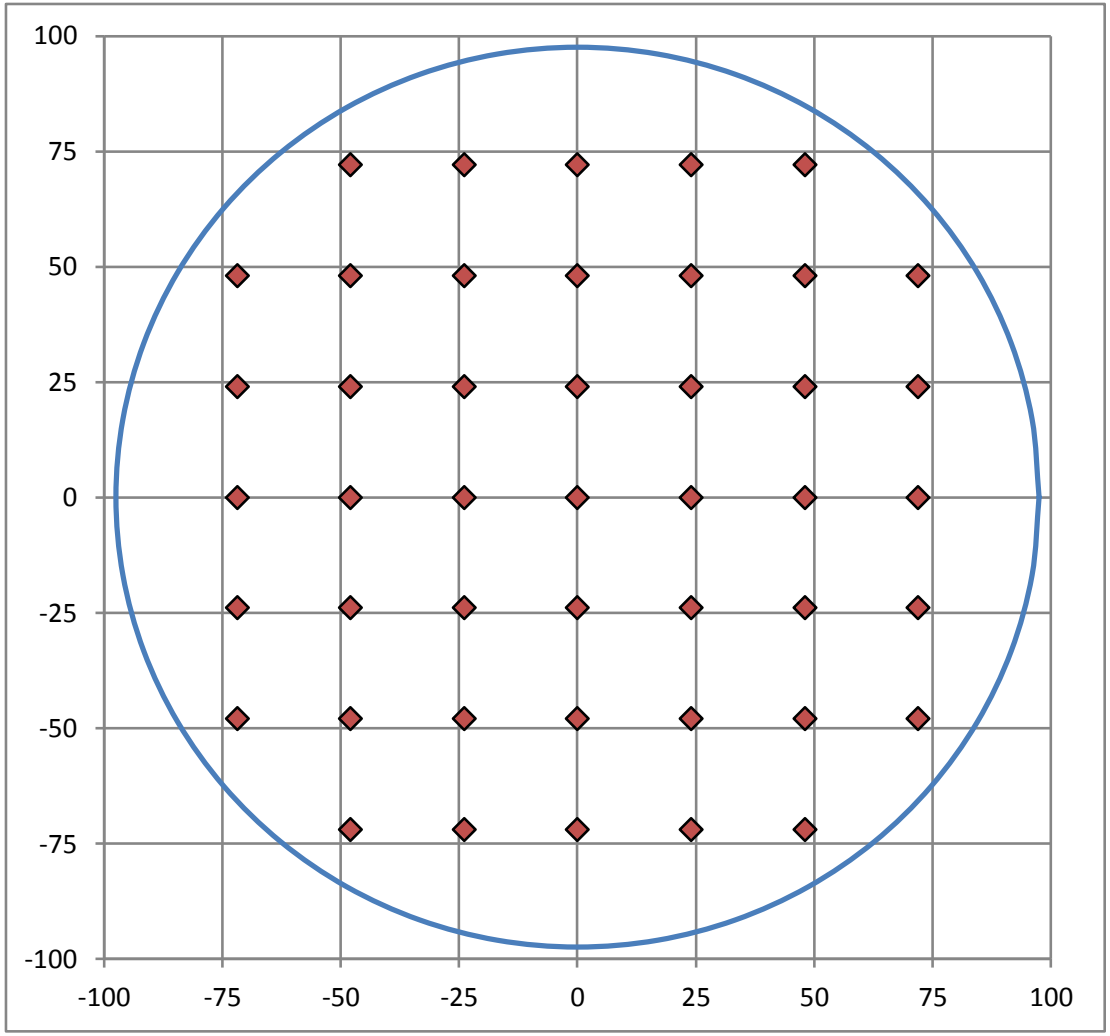
$C^{18}O$ 3-2	329.330
^{13}CO 3-2	330.587
$C^{17}O$ 3-2	337.061
$C^{34}S$ 7-6	337.396
CH_3OH $7_{14} - 6_{14}$	338.345
CS 7-6	342.883
$H^{13}CN$ 4-3	345.340
CO 3-2	345.795
$H^{13}CO^+$ 4-3	346.999
SiO 8-7	347.330
HCN 4-3	354.505
HCO^+ 4-3	356.734
DCN 5-4	362.046
HNC 4-3	362.630
H_2CO $5_{05} - 4_{04}$	362.736
^{13}CS 8-7	369.907
$H2D^+$	372.421
N_2H^+ 4-3	372.672

Ambitions

- Number of Pixels
  - Must be >> 16. But >> 100 is probably not practical without some radically new approach.
  - Recall that mapping speed goes as $N / (T_{sys}/\eta_b)^2$
- Noise Temperature
  - ALMA band 7 had T_{rx} (SSB) ~ 65K. This suggests goal of ~ 50K. Would give T_{sys} < 200K in good cond.?
- Polarization / Sidebands
  - Should aim at dual polarization. Can do that with a grid and two arrays rather than in mixer blocks?
  - Single side-band essential (to get sensitivity & cal).
  - Dual side-band “nice to have” e.g. multiple lines.

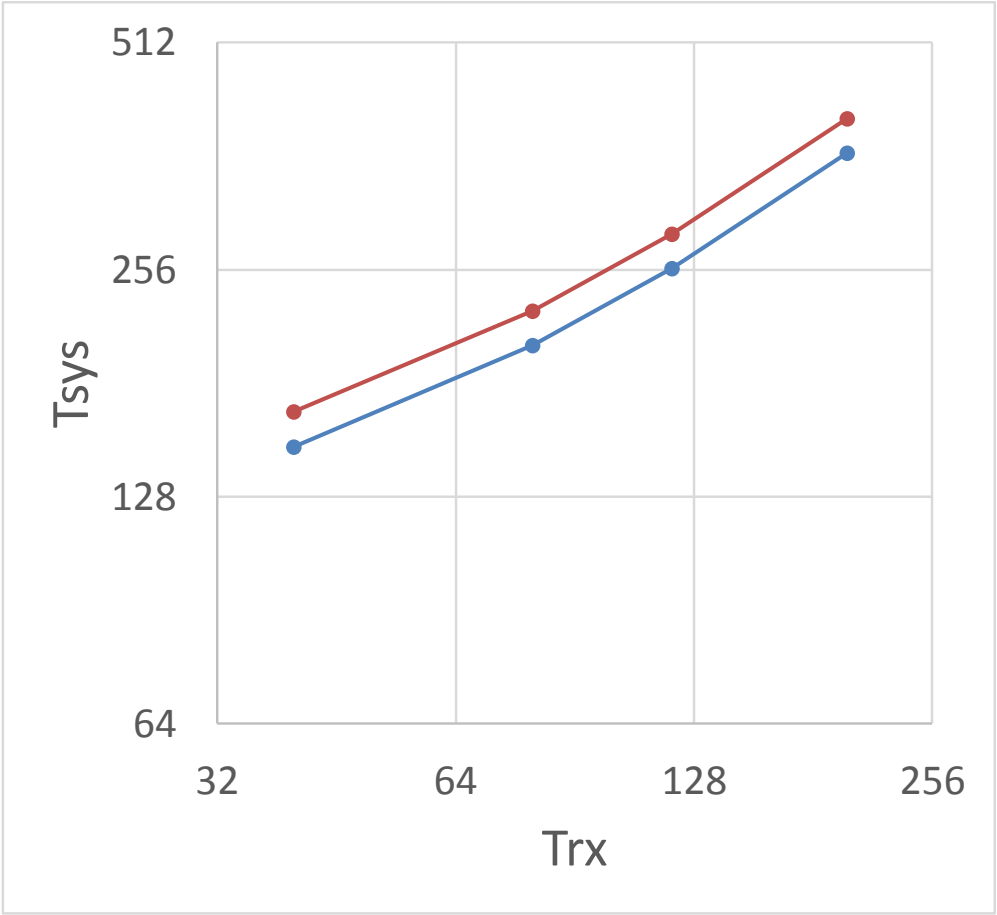
Largest Plausible with Present K-mirror

- 7x7 with 4 corners removed.
- Gives 45 pixels on 24 arcsec spacing
- Possibly x2 for second polarization or frequency



Diminishing Returns for Effort on Receiver Noise

- Plot of Tsys / Trx >
- Assumes 10% loss in optics, telescope and membrane
- 80% Atmospheric Transmission. (Good band 2 and elv > 60°.)
- Blue is Tsys
- Red corrected for beam efficiency of 90%



LO Distribution

- Quasi-optical

  A) Frequency dependent, e.g. Martin-Puplit or equivalent. Efficient but reduced bandwidth.

  B) Broad-band, e.g. mylar beamsplitter. N% coupled in means N% loss of sensitivity.

  Quasi optical coupling is NOT consistent with SSB in the mixers blocks. (LO and signal need to have opposite phase in the two mixers.)

- Waveguide

  In principle straight-forward. Use series of splitters from single source or perhaps several separate multipliers each driving part of the array.

  Note that if we can build balanced mixers then LO power requirement is reduced by at least a factor of 10.

- Photonic

  Possible new option to distribute two opitical signal and have photo-mixers in or very near to the mixer block. No multipliers needed.

Some Other Projects

- IRAM 30m – HERA 2x9 pixels 230GHz
  - Plan for 2x25 at 100GHz and 2x49 at 230GHz
- Köln working on new array for CCAT
  - CHAI (2x)64 at each of 475 & 650GHz
- Bonn for APEX – CHAMP 7 pixels at 690 & 810
  - LAsMA 7 pixels at 345GHz (end of this year?)
- Arizona HHSMT – SuperCam 64 pixels at 345GHz ?
- KASI/NAOJ for ASTE – 2x4 pix 300-500GHz 2019
- JPL, Bonn Lots of work on submm arrays for SOPHIA & various space projects, etc. KAPPa 16-pixel 650GHz, pathfinder for a “kilo-pixel array”