SETI@HOME IN THE ERA OF BREAKTHROUH LISTEN. E. J. Korpela, J. Cobb, M. Lebofsky, D. Anderson, A.P.V. Siemion and D. Werthimer, [1]Berkeley SETI Research Center, University of California, Berkeley, CA 94720-7450

Introduction: Since it's public release in 1999, the capabilities of SETI@home have grown rapidly. The continuation of Moores law has led to personal computers more one thousand times faster than those available in 1999, with graphics processing units that can provide processing speeds only seen on supercomputers in the last century.

The capabilities of the SETI@home software have increased to better utilize the available processing power. Increases in radio astronomy instrumentation technologies have also led toimprovements in the potential data sources for SETI@home.

The Breakthrough Listen project promises to increase the data available to SETI@home by orders of magnitude. I will describe the evolution of SETI@home, and how it will change in the future to better match the available technologies, in the data sources, the data processing techniques, and the candidate identi_cation process.

SETI@home: Because an extraterrestrial civilization's signal has unknown bandwidth and time scale, the client software searches for signals at 15 octave-spaced bandwidths ranging from 0.075 Hz to 1220 Hz, and time scales from 0.8 ms to 13.4 seconds. The rest frame of the transmitter is unknown (it may be on a planet that is rotating and revolving), so extraterrestrial signals are likely to be drifting in frequency with respect to the observatory's topocentric reference frame. Because the reference frame is unknown, the SETI@home software examines about 1200 different Doppler acceleration frames (dubbed “chirp rates”), ranging from -100 Hz/sec to +100 Hz/sec.

At each chirp rate, peak searching is done by computing non-overlapping FFTs and their resulting power spectra. FFTlengths range from 8 to 131,072 in octave steps. Peaks greater than 24 times the mean power are recorded and sent back to the SETI@home server for further analysis.

Besides searching for peaks in the multi-spectral-resolution data, SETI@home also searches for signals that match the telescope's Gaussian beam pattern. Gaussian beam fitting is computed at every frequency and every chirp rate at spectral resolutions ranging from 0.6 to 1220 Hz (temporal resolutions from 0.8 ms to 1.7 seconds). The beam fitting algorithm attempts to fit a Gaussian curve at each time and frequency in the multi-resolution spectral data. Gaussian fits whose power exceeds the mean noise power by a factor of 3.2, and whose reduced c2 of the Gaussian fit is less than 1.42, are reported to the SETI@home servers. SETI@home also searches for pulsed signals using a modified Fast Folding Algorithm and an algorithm which searches for three regularly-spaced pulses.

Since 2011, we have added the ability to detect signals using autocorrelation analysis. It has been proposed that an extraterrestrial civilization could send a beacon that contains information (has appreciable bandwidth), yet is easily detectable by sending a signal and then, after a short delay, starting the broadcast of a copy of the signal. A signal of this type can be detected through autocorrelation, which will show a peak power at the given delay. Once the delay is known, the information within the signal can, in principle, be recovered. Version 8 of SETI@home contains an autocorrelation detector which acts on delays up to 6.8 seconds.

Breakthrough Listen:

Breakthrough Listen contributes additional data source to SETI@home in addition to our traditional use of Arecibo. Breakthrough Listen currently records at the Parkes Telescope and the Green Bank Telescope. Because of the size of this data only a small fraction (a few percent) can be analyzed with SETI@home. I'll present the results of the GBT observations which have been completed thus far, and some details of the observation pipeline.