SETI

- Project Ozma

  First *SETI* project done by Frank Drake in 1960 using the 85 foot radio telescope in Green Bank West VA

  Searched for 21 cm signals from 2 nearby solar-type stars

- Other Early searches were mostly:

  schedule fillers

  or parasitic, i.e., a SETI "backend" analyzes same signal being studied for astrophysical reasons

  or confined to not so wonderful radio telescopes with not so wonderful receivers

  or prototype tests

Dedicated *SETI* Projects

Project Sentinel/META/BETA

Project Sentinel started in 1983–84 by Paul Horowitz of Harvard with funding from the Planetary Society

It was a very cheap project using an old 84 foot radio telescope at Harvard, MA and electrnics based on Apple Computers.

Beacon search with minimum bandwidth of 0.01 Hz. It turns out that is the minimum possible BW because the interstellar medium spreads signals a bit. 84 ft telescope at Harvard, MA

With clever use of the Apples Horowitz was able to observe more than 100,000 channels.

The initial search was very sensitive but also made some rather restrictive assumptions about how the *ETI* would be broadcasting. Expansion to 350 k Hz total BW and 8.4 million channels (100 ks)

In 1985 (with funding Stephen Spielberg) the system was expanded to more than 8 million channels which made it possible to relax some of the assumptions. It was renamed Project META.

META had several advantages over earlier searches:

all sky

very high sensitivity

terrestrial signals easily rejected. Because of very narrow bandwidth signals drift from channel to channel in a few seconds

Disadvantages: ETI has to be broadcasting to us at a magic frequency at very narrow bandwidth

Results of First 5 Years of Project META

Published in Astrophys Jour, 1993, 415, 218–235 (Horowitz & Sagan)

Northern sky covered 3 times, twice at 21 cm, once at 21 cm/2

Detected 37 spectral peaks that are good candidates for ETI origin. **None of these repeated** either during the initial observation (within about 3 min), or the next day or in reobservation (6 months to year later)

Project BETA started operation in Oct. 95. Follow-up of META (funding Planetary Society)

Now 240 million 0.5 Hz channels All sky, with immediate follow-up (on same telescope), and will completely cover the water-hole 1.4-1.7 Ghz

NASA SETI/HRMS

NASA started a *SETI* program in 1982 funded at $\sim$ 2 M/yr(M = megabuck)

Realized that the major problem was the frequency search

Developed prototype multi channel spectrum analyzer (MCSA) and signal processing software

Because of tremendous data flow rate processing must be highly automated with very small false alarm rate.

In 1990 obtained funding for 10 yr project at about 10 M$/yr. The project was named HRMS (High Resolution Microwave Survey). (Funding canceled in 1993)

MCSA and logic software hardwired into individual chips

Could adjust bandwidth and number of channels ranging up to 14 million channels

Planned a two part search with existing antennae startin on Columbus Day 1992

targeted $\sim$ 800 nearby solar type stars. Very high sensitivity and very narrow bandwidth

Lower high sensitivity whole sky survey with wider frequency coverage. Still 300 times more sensitive than previous sky surveys

Project Phoenix

The NASA SETI project was defunded shortly after it started operation. It was named *Project Phoenix* (`http://www.seti-inst.edu/`) being the NASA SETI project reborn from the ashes. It operates with private funding at a level of 5–10 M$ per year and is trying to build an endowment to ensure continuous operation.

Phoenix has the NASA equipment & much of the personnel

Despite some confusing publicity, Phoenix is really a "beacon search."

Their first stage involved an upgrade of the spectral processor to 74 million channels and adding confirmation hardward using 2nd antenna at a remote site.

Phoenix in OZ 1995

Aim:

to observe 200 stars using the 210 foot radio telescope in Parkes (Australia)

1.2-3.0 GHZ with 1 Hz BW

2.5-5 min/star

stars mostly single solar-type stars $\sim$5 Gyrold

Did:

20,000 observations

lots of intereference in some freq. ranges

Phoenix now uses a Follow Up Detection Device (FUDD) to automatically check for interference. When a signal is detected at the primary telescope a message is sent to a remote telescope telling it to observe in the same direction at the same frequency.

FUDD tests ruled out all but 12 signals. These were also later identified as interference

Phoenix in Green Bank 1996–1998

NRAO plans to stop operating the old 140 foot radio telescope as soon as the new GBT is operational (originally hoped to be 1997)

Phoenix had planned to raise enough funds to continue operating the 140 foot as a dedicated *SETI* instrument.

The GBT is still not operational so the 140 foot is available only part-time for Phoenix.

Starting in October of 1996 Phoenix has had roughly six observing sessions per year.

As in Australia the search is from 1–3 GHz targeting (mostly) solar-type 5 Gyr old stars.

The second follow-up antenna in Georgia became operational in mid 1997.

The Phoenix agreement with NRAO fell through. The last observing session was in April 1998.

Needless to say they didn't find any *ETI*.

Phoenix has returned to Arecibo where the first HRMS observations were done in 1992.

Five Observing sessions so far. At least one very exciting false alarm.

There are nice Arecobo diaries at
`http://www.seti-inst.edu/seti/our_projects/project_phoenix/past_searches/Welcome.html`