

Hot tub economics
Seti at home update
Thermal energy basics
Radio astronomy books
Digital scanner "photos"

By now, you have probably gotten the word that the SETI at home research has really taken off. Full details are at <http://setiathome.ssl.berkeley.edu> In just their very first day of operation, centuries of computing power were turned loose on an advanced search for extraterrestrial intelligence.

This seems to be an exceptionally well designed experiment in parallel computing. Each volunteer gets some screen saver software and just under half a megabyte of data. When your computer is not busy doing anything else, their data gets digitally filtered and returned.

The processing normally takes 24 to 36 hours of computing time. The Fourier-related coherent algorithms seem ten times better than anything ever tried before. Only your unused computer time is diverted.

All the ongoing "winners" appear on top twenty video game style "high score" listings.

The big Arecibo radio telescope in Puerto Rico is busy doing a full sky survey for another long term project. The SETI data is just slurped off of a parallel feed.

At essentially zero added cost.

The main survey gets parked at the usual "water hole" in the microwave region. There is both an atmospheric window and fairly low noise between the hydrogen molecular resonance at 1420.406 and three of the hydroxyl resonances at 1621.231, 1667.359, and 1720.530 MHz. More information on molecular resonance did show up in [MUSE118.PDF](#).

For these and other reasons, this is thought to be good ET territory. Their particular search centers on the 1420 MHz hydrogen resonance. As figure one shows us, a band from 1418.75 to 1421.25 MHz is recorded. This data is sliced up into 250 frequency bands.

You'll get several hundred seconds worth of the 10 kilohertz bandwidth work unit to filter.

Fancy coherent filtering looks for the energy in every work unit. Likely targets should have stronger energy

at one frequency than another.

Useful energy should also rise and then reduce over twelve seconds in a Gaussian manner as the sky is swept.

Finally, valid signals should also chirp or sweep slightly in frequency. The latter Doppler shift is caused by the target planet's motion.

At this writing, SETI at home has distributed over a million work units and has gotten a third of them back. Racking up well over a millenium of computing time! Which obviously seems to be well beyond human brain capability. By bunches.

No, ET has not reversed any phone charges yet. But your real truth and beauty of this fine program lies in its proven ability to bypass funding and bureaucratic hassles while delivering amazing computing power.

A listing of a several useful radio astronomy books has been added for you as this month's resource sidebar.

I do expect to see lots more web based intensively parallel computing projects showing up. Stuff that can get results ridiculously faster for a negligible fraction of government lab research funding rates.

And free of hidden agendas.

I've been wondering if this same stunt might not be appropriate for my magic sinewaves. New candidates are taking 40 to 50 hours per amplitude these days. Seems there are a lot of possible 768 bit words. And the real goodies appear to lie in those scary uncharted nether regions beyond. A definitive catalog sure would serve as a useful resource. More details up at www.tinaja.com/magsn01.html.

Let me know if you want to work with me on this.

Hot Tub Economics Review

I recently finished repairing and upgrading an older hot tub. I got to thinking about just what can be done to reduce operating costs and shorten warmup times.

Figure two shows a "typical" older hot tub installation. Water loops from the tub through its pump, a filter, a heater, and back into the tub again in a closed loop. Temperatures of 102 degrees for socializing or 104 or even 105 degrees for mild therapy are the norm. Possibly 108 degrees for brief and intense therapy. The temperature regulation thus should be strictly held under one degree if possible.

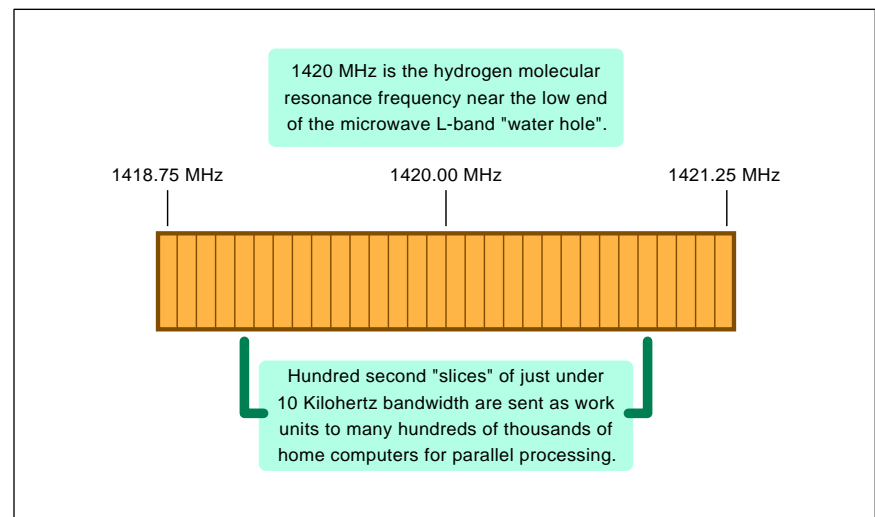


Fig. 1 – THE SETI AT HOME project monitors frequencies near the hydrogen molecular resonance at the low end of the "water hole". When you participate, you get a screen saver that background filters a few hundred seconds of a 10 kiloHertz work unit. Processing usually takes 24 to 36 hours. Many ~millenia~ of computer time have already been completed.

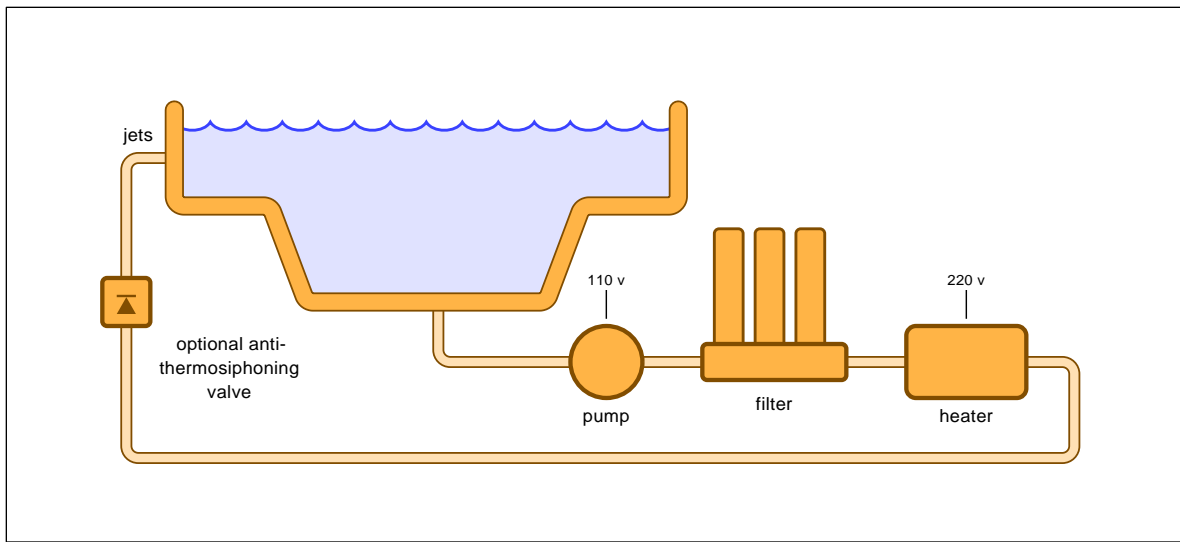


Fig. 2 – A TYPICAL HOT TUB setup.

Siting:

0. Remember that full hot tubs are insanely heavy. Placing one on the third floor of a remodeled century-old farmhouse is a no-no. Older or lighter deck installations should also be structurally reviewed.
1. Install the tub in a separate building or atrium or whatever that is neither outside nor fully inside your living space. This is required for humidity control, ventilation, privacy, and energy efficiency. While avoiding possible flood, mildew, rust, scorpion, termite, or other bug problems.
2. If the heater and pump are separate from the tub, install them in the warmest possible location. Preferably well insulated and certainly free from wind or night sky radiation. Consider a solar panel boost.
3. Add a thick spray-on layer of urethane foam to the under bottom of the tub and to all exposed pipes. Provide a two- or three-speed pump that only slowly circulates water during initial heating. Use an oversize filter for reduced pressure drop. Provide a high side anti-thermosiphoning valve if one seems to be needed.
4. A thick and flat folding insulated lid is a must. One that provides a skirted and solid seal all the way around. A second floating inside cover can also be worthwhile.
5. Avoid "bypass" style heaters with high differential ΔT mechanical thermostats. Make sure the thermostat time constant is sufficiently low. Also that excessive cycling does not take place coming up to working temperature. If possible, sense the temperature electronically inside the tub itself.
6. Carefully plot and record your heating rate of rise and your cooling rate of drop. Do so for all seasons. If you loose more than eight degrees per day, find out why.

Use:

1. Turn the tub on just soon enough to come up to use temperature. Provide a timer or other intelligent control to prevent running unused. Use your rate-of-rise plots to determine warmup time. Then adjust as needed.
2. Remove the cover only during use. Flip back only half of the cover rather than when you are using the tub by yourself. Do not ever let a cover get waterlogged.
3. Keep and use a tub thermometer. Use the minimum temperature appropriate for the intended tub use. A heater override switch is often a good choice.
4. Use air bubble injection only when the effect is specifically being enjoyed. Blower air is especially energy wasteful. Blowers also tend to be excessively noisy.
5. Using a hot tub a second day in a row is nearly "free".

Heaters can be wood, solar, natural gas, propane, resistive electrical, or heat pumps. Wood and solar both do tend to end up maddeningly difficult to tightly regulate to the temperatures needed. Gas or propane is usually the cheapest when available. Heat pumps specifically for hot tub usage are still outrageously expensive. They'll also drop in efficiency when cold.

Thus, 220 volt resistance heaters usually end up as the norm.

My particular older warmer-upper consisted of this pair of 6 kilowatt immersion heaters. Because a cheap mechanical thermostat can not work with less than a five or a ten degree ΔT , a "bypass" scheme is used. Only a fraction of the water actually goes through the heater. Thus a ten degree ΔT thermostat holds to one degree. On the average. *If* it is only heating one tenth of your total water.

This heater design had some other bad habits. All the thermostats only loosely leaned up against their steel case. Leading to slow cycling. And a poor warmup time. Caused in part by the thermostat having to slowly cycle during much of the warmup time.

Some Numbers

Back to the science books: A *BTU* or *British Thermal Unit* is the amount of energy it should take to raise the temperature of one pound of water by one degree Fahrenheit. Or roughly the chemical energy in one large kitchen match. There are 3413 BTU's in one kilowatt hour of electricity.

Fig.3 – SOME RECOMMENDATIONS for hot tub energy efficiency.

Or 0.2930 watt hours per BTU.

The pounds of water, of course, do depend on the size of the hot tub. But for a 6 foot 8 inch hexagon hot tub, something under 500 gallons should be a usefully conservative estimate.

For exact numbers, note that there will be 7.5 gallons or 63.4 pounds of water in a cubic foot. Then calculate your actual volume.

Or else carefully fill your tub five gallons at a time.

Figure roughly eight pounds per gallon for a total of 4000 pounds and 4000 BTU's per degree of warming. Or, at a cost of ten cents per kilowatt hour, 1171 watts per degree.

Say *twelve cents per degree*.

How much heating you will need depends on how much the tub cooled since your last use. A cold warmup from 60 degree water to 102 degrees requires at least 40,000 BTU's to the tune of \$5. A second-day rewarming in a tub that has cooled off by eight degrees costs around \$1.20 per day. Or \$36 per month. Or \$432 per year.

Curiously, *running your tub every second day costs you about the same as using it daily*. You might lose ten degrees during the first day and only seven or so during the second. Thus, repeated tub use is nearly "free".

In absence of heat losses, twelve kilowatt hours of energy should raise your hot tub temperature at a rate of ten degrees per hour.

Hot tub heat losses can come from conduction, convection, or radiation. The secret is to *keep as much heat in the tub as you can between uses*.

Conduction will be proportional to temperature differentials, while your radiation starts off much weaker but shoots up with your *fourth power* of temperature difference. Thus, it will always be better to *heat immediately before use*. Every time.

Your most important defense here is a good two inch thick insulating cover. One which tightly fits and is kept on when not in use. Preferably a split folding one that need not always be totally removed. A second inner floating cover might also help.

A thick coating of urethane foam on the *underside* of the tub is also a good idea. This extra process during installation can make a big difference and easily pays for itself.

If the pump, heater, pipes and filter

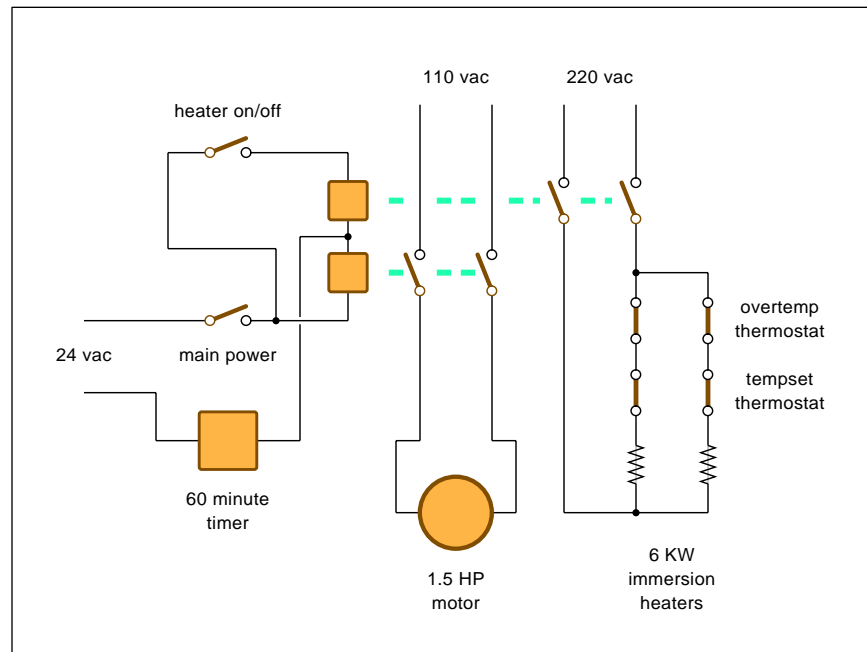


Fig. 4 – A POSSIBLE WIRING DIAGRAM for hot tub experiments. Thermostats are purposely set slightly high and overridden with a manual heater switch. Operating costs dropped dramatically.

are remote from the tub itself, these should be kept at the highest possible temperature. And well insulated from wind and night sky radiation.

Certain larger hot tubs might also *thermosiphon* during non-use times. In which the warmer water rises, runs slowly *backwards* through the filter and pump, cools down, and wells up from below. Which was definitely a problem for me on very cold nights. I fixed it by adding a \$9 one-way valve "diode" from the hardware store. The valve is best placed in a non-obvious *high side position after your heater*.

Otherwise, it might interfere with pump priming.

Does your pump add to the heat? In absence of losses and running full tilt, a two horsepower pump should warm the water about the same as a 1.6 kilowatt heater does.

Or around *one-sixth* of your total input energy. But the pump rarely runs full power, and the circulation losses sap some of this heat.

The pump itself would seem to add only a modest amount of heating at best. On the other hand, when your old heater is taking its good old time about temperature cycling, much of your pump energy is largely wasted. Perhaps to the tune of fifteen cents per warmup hour.

Possibly by as much as \$200 or more per year.

Thus, we have got a second reason besides convenience for very rapid warmups. A two-speed pump is best. One that only moves the minimum amount of circulating water needed during the heatup process.

What about air injection? "Cane air" or any "venturi" cools your water moderately by bubbling much colder room temperature air through it. But blower powered bubble machines do dramatically cool off your water. An obvious rule here is to *only use costly air injection whenever somebody is actually enjoying its effects*.

Measuring Gain and Loss

Two things that are very important to measure here: The *hourly warmup rate of rise*. And your *daily rate of cooling*. Any old thermometer can be used for this. Plot temperature versus time on a graph. Although some extra precision will be needed if you want to measure exact BTU losses.

By measuring your warmup rate, you will be able to turn on your tub exactly for the required heating time. And by knowing your cooling losses, chances are you can reduce them by finding their cause.

The figures change somewhat with

RECOMMENDED RADIO ASTRONOMY BOOKS

- Boffin: A Personal Story of the Early Days of Rad...* (Brown)
- Extragalactic Radio Sources: From Beams...* (J. Roland)
- High-Sensitivity Radio Astronomy* (N. Jackson)
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- Variability of Active Galactic Nuclei* (H. Richard Miller)
- Very Long Baseline Interferometry: Tech...* (G. L. Verschuur)

For more details, see www.tinaja.com/amlink01.html

the seasons and the exact water level. But these are easily adjusted for.

Some hot tub energy conservation suggestions appear in figure three. You can decide which of these are or are not convenient or cost effective for your own use. Many newer tubs have improved thermostats, undertub insulation, slow warmup circulation, and similar energy improvements.

An Intelligent Controller

All of which cries for a better way. As an experiment, I modified the switching per figure four so I could turn the heater off and on manually. *But only when the pump is running!* I then cranked the thermostat settings way up, being careful to keep those overtemp safety sensors in place.

Warmup time dropped dramatically. Operating costs went down, caused mostly by the pump running less.

And eliminating a few heat cycles that did not do anything useful.

Sadly, I did have to carefully pay attention to precisely how long this forty minute warmup took. A simple \$19 mechanical timer might prevent waste here. I selected an *Intermatic* FD60MC, available in most hardware stores. Check out their useful website at www.intermatic.com

Figure four shows details. Hot tub electrical safety is rather important, so lower voltage switching, GFI, or pneumatic remotes are a must.

A better route, of course, would be a custom intelligent controller.

First, you'd put a decent electronic thermal sensor inside the tub itself. Perhaps a *Dallas* DS16242 or similar

device having a resolution of a tiny fraction of a degree and a circulating water time constant of a second or two. Feed this to a Basic Stamp or a custom PIC that knows the inside and outside ambient temperature, the time of day, whether the lid was off, the heating and cooling rates, and your favorite use time.

The controller would then use the tub temperature and its heating rate to anticipate when you want to use the tub. It would then turn the tub on somewhat earlier, applying full heat to bring the tub up to just under your favorite temperature.

When it hits a desired temperature, it would switch to an ultra low power "maintenance" heating mode. Which would be held so long as the lid still remains on. Better yet, will shut down after an hour or two just in case you forgot or changed your mind.

During its "use" mode, your heat power would be adjusted to hold the desired temperature. Giving precisely more or less as needed.

Lots of possibilities here.

NEED HELP?

Phone or email all your US Tech Musings questions to:

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Imaginative Images

Getting full color images up onto websites are the big deal these days. For everything from an auction up at www.ebay.com to your own website sales pages. Because so many of the images on the web look so bad, you can definitely gain an advantage by making all of yours first rate.

For smaller banner ads and other places where lettering is important, the GIF format is probably best. But for just about everything else, JPEG is probably the way to go.

I've found an amazingly simple method to provide higher quality web "photography". One which seems to give superb results. You simply start using a scanner as a camera.

The advantages here are that you get outstanding resolution combined with exposures, distortion, focus, and lighting that are right on. You now can also work directly with bitmaps. This gives you scads more sharpness and eliminates lots of generational editing artifacts. Because bitmaps do gobble up memory at a prodigious rate, a CD-R drive is a must.

The available depth of field on my *Hewlett Packard Scanjet* 6100C is utterly amazing. Disadvantages are that you have a "flat" view; there are obvious size limits; and that parts of the object further from the glass may end up much darker.

I will start by setting a piece of test gear on the scanner bed. Erasers are placed under critical edges to get all of the knobs stable and flat. These supports can easily get edited out later. Be sure to have the object main surface precisely flat and parallel with the glass.

It is extremely important to use a machinist's combination square to exactly line up your subject with the scanner. Try for a one pixel accuracy if at all possible.

Colored paper then is positioned behind and around the subject, trying to get as close as possible without any cropping. Zooming and enlarging somewhat will usually give you a pix which ends up "full size" at higher monitor resolutions.

After scanning, I send the pix to plain old *Paint*. The brightest portion of the background is then selected for a masking standard. You then can

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mask background to subject. Suitably blending (anti-aliasing) on diagonals.

Other tricks such as removal of supports, scratches, or blemishes are easily done. Shadow improvement is another possibility here.

Finally, the bitmap gets cropped, brightened, sized, gamma corrected, and converted to JPEG with Arcata's *ImageViewer* or some similar utility. Adobe's *PhotoShop*, of course, is one other obvious possibility.

Most images can be improved with modest increases in both brightness and contrast.

Plus a gamma adjustment.

I'll normally zoom somewhat with the scanner. This gives you a normal sized display on a higher res monitor. I tend to keep the JPG file sizes in the 100K range for sharp lettering.

These larger images should click expand *on user command only*.

It does take lots of practice, but your results can end up incredible.

A tutorial with more detail is up at www.tinaja.com/blat01.html. These actual images can be newly found at www.tinaja.com/barg01.html Custom services are also available.

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New Tech Lit

From *Microchip Technology*, a fresh 1999 *Technical Library* CD ROM. Including details on their new PIC18CXX2 high performance chips. More on the PIC micros in general at www.tinaja.com/picup01.html.

From *Texas Instruments*, data booklets on the TLC32AD50 and the TLC320AD75 sigma-delta chips. The former for low speed instruments, the latter for stereo A/D. From *Tritech*, lots of interesting new data sheets. Such as a TR83100CF voice storage controller, TR88L811CS touch pad mouse controller, and their new TR88L803 pen input processor.

A new *Abbeon Cal* pub has lots of thermal machines and related tools, books, and techniques of interest for

Plastic Working. Industrial latches and fasteners are detailed in a new Zoom CD ROM from *Southco*.

Facts Finder is a quarterly GPS navigation pub from *Trimble*. Also newly updated is a *NEMA Electrical Standards and Product Guide*. Mini catalogs of specialized wireless and communications catalogs are newly available from *Artech House*.

Featured trade journals for this month are *Industrial Laser Solutions* by *Pennwell*. And a *Micro Publishing News* from *Cygnusos*.

Crash Course in PC Technology is the latest book in that Lou Frenzel series. From *Newnes*. More details on this and similar texts can be found at www.tinaja.com/amlink01.html.

For those insider secret details of active filters, do check out my *Active*

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As usual, most of the mentioned resources do appear in our *Names & Numbers* or *Radio Astronomy Books* sidebars. Always check here before emailing don@tinaja.com or calling our no-charge voice helpline. ♦

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