Okanagan Observatory

RAdius

August 2011 (*Inaugural Issue)*

Radio Astronomy's NEW Okanagan Face!

by Hugh Pett

I wonder if Richard Christie realized what he was inspiring on June 21 this year, with his offhand comment that a useful radio telescope kit costs less than $10,000.00. Several minds fired up that night, including mine. My interest in radio predates that in astronomy by a few years (age 6, versus age 9), and my amateur radio work has provided thousands of happy hours of building, experimenting and explaining to others.

After quick searches on the Internet, it was clear that building a radio telescope could cost even *less* than Richard's figure. That was enough for me - I wanted to build a radio telescope at the Okanagan Observatory, and use it to explain to schools and others about how another segment of the electromagnetic spectrum can tell us more about our universe.

Once the question of funding was set aside (my responsibility), lots of Okanagan Centre members waxed enthusiastic about the idea. It took only a couple of days to line up some heavy hitters in the radio astronomy fraternity to help me stay on course. Ken Tapping and Chris Purton have been more than generous in commenting on my ideas, pointing me in the direction of useful resources, and laying a firm theoretical foundation for this project.

Ken's oft-repeated (I'm a slow learner!) caution to go slow and build on experience finally sank in. What at first looked like a one-year project to an all-singing, all-dancing sophisticated interferometer radio telescope stretched out into at least a five-year effort, and probably even longer.

I quickly learned that getting together a system to just tune in on the Sun, the strongest radio source in the heavens by far, would take a couple of thousand dollars, a lot of work, a sprinkling of good luck, and many consultations with people who have tackled this before me. This definitely took my aspirations down to a much slower pace than originally hoped for. On the other hand, I can look forward to years of pleasure learning, building and working with people that are keen and capable.

Welcome to the RAdius newsletter, which I will publish about half a dozen times a year, not on any particular schedule.

What's in a Name? *the story behind the name for this newsletter*

I like to put names to people and things; I wanted something that both described the radio telescope project, and was catchy so readers would remember it.

Almost everything about astronomy, including in the radio portion of the spectrum, deals with radii. Every time we turn our telescope to the sky, its axis marks a radius from us to the source. Our telescopes use circles in more ways than I care to count; the mathematics describing our efforts is full of radial measurement.

And for me, the word "radius" most fortuitously begins with the acronym for radio astronomy - RA. Hence the odd capitalization in the title.

Now that the hard part in starting this newsletter is settled (getting a catchy name,) the fun part of preparing this inaugural issue is underway.

Okanagan Observatory Radio Telescope - the people

Gathering names of people to call upon for assistance took two emails, primarily to the one who sparked it all: Richard Christie. Although he is very busy this year, his contacts resulted instantly in offers of assistance from Ken Tapping and Chris Purton. Ken has done backyard radio astronomy for many years, and knows many of the first-time pitfalls (and therefore can warn me about them.) Chris got all fired up on some of my questions about how to do things like align an interferometer, producing as a result a 12-page treatise:

> "It's far more detailed than you need at present (parts are, in fact, horribly academic - I just got too interested in the whole phenomenon), but may be useful in the future when you're grappling with the details of interferometry.
> It helps you to calculate all kinds of fun stuff."

The first couple of weeks I had questions most days for Ken and Chris, and although Ken had warned me he would not promise prompt responses, he was very quick to answer.

I had a very useful chat with Erik Rosolowsy at UBCO ,where he showed me some of the work students in fourth year had done. His PhD thesis used radio astronomy, so this is right up his alley. His students may well be some of those using the radio telescope in the future.

One requirement for this radio telescope is one or more parabolic dishes, known as C-band satellite dishes. These are 10 feet (3 meters) in diameter, and the best for the job are made of metal mesh. A friend of a friend, Mervin, has in the past collected such for the scrap value, and enthusiastically began searching out dishes in good enough shape (literally!) to be used in the telescope. A son-in-law of the same friend teaches mechanical engineering at UBCO, and an hour with Rudi showed me how difficult it will be to achieve the pointing accuracy Ken laid down: within +/- .2 degree in each of altitude and azimuth. Remember that this is for a contraption ten feet across, subject to wind and snow loading, sitting out in the middle of nowhere. I will have to learn a whole new nomenclature just to *understand* how to make the Az-El mounts. Let alone actually *build* them.

Finally, the whole technology of radio astronomy has changed drastically in the last while, from super-sensitive electronic circuits and racks of equipment, into simple hardware feeding massively-powerful microcomputers. The super-sensitivity is still needed, but only at the focus of the dish; everything (more or less) from that point on is digital. Ken had put me on to Marcus, who is a fount of knowledge about things radio-astronomical. Especially Linux operating systems - but that is another story.

The Windows kid gets a Linux makeover

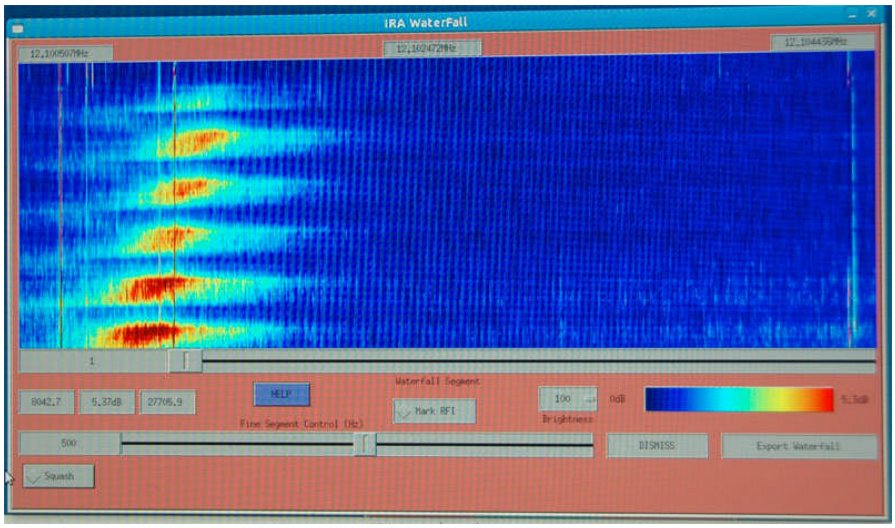
Marcus lives near Ottawa, and among other fun activities is restoring a 60-foot dish to operate as a radio telescope. And he writes radio astronomy software. And he builds the special low-noise amplifiers that sit at the foci of the dishes. And he helps develop the whole field of "Software-Defined Radio" (SDR).

With all this going on, he has been so very patient with me (the "Windows kid") as I struggle to wrap my fading brain around the Linux operating environment. Why do I attempt this? Because almost all professional software work in radio astronomy (as in so many other fields of scientific endeavour) uses Linux as the basis.

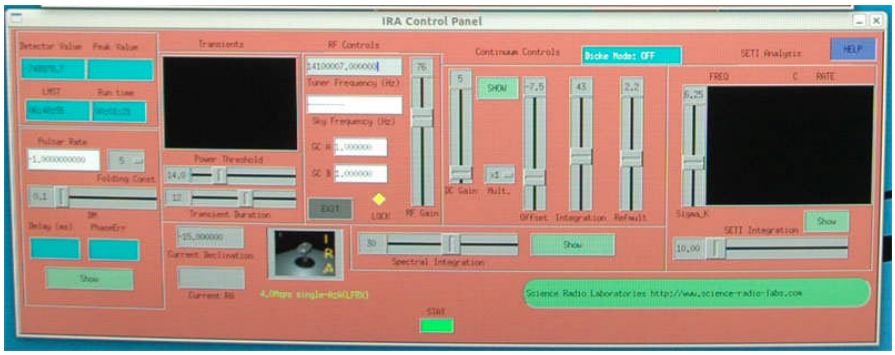
I am very slowly coming to understand the basics of Linux, with the help of the book "Linux all-in-one for Dummies", and numerous questions to Marcus. He must have the patience of Job, as he rapidly fires back useful advice and comments on everything from how to find the sound card in the Linux operating system, to where to find parameters in his radio-astronomy software (called "IRA"); which he had already explained to me a week earlier (I said I'm a slow learner!) He manages to reply several times a day, and well into his nighttime; I wonder when he has a chance to sleep!

The New Face of Radio Astronomy

The new face can be summed up in two computer images, shown here:



this is the "waterfall", displaying radio emissions as a function of both frequency (horizontal axis) and time (vertical axis). It slowly cascades down the window.
(I actually made this image yesterday)



a number of parameters and displays round out the software, which has enough sophistication to handle two receivers in interferometer mode.

The steps ahead - the five-year roadmap

Now that I am a whole month into this project, I can vaguely discern some of the steps ahead. This list is by no means complete, nor particularly settled. So much can happen to change it that I may never want to call it a schedule; however, I have made a SWAG as to when some of these things might occur.

Some things have already happened:

June/July:	acceptance by the Observatory Working Group of the concept of a radio telescope at the Okanagan Observatory
ultimate goal established:	a dual-dish radio interferometer, operating at H1 frequency (1420MHz), fully tracking in azimuth and elevation
funding arrangements settled:	working with Zoli to keep track of expenditures
initial hardware acquired:	a super-microcomputer, 6-core AMD 3.33GHz processor, 8GB RAM;
	USRP1 radio receiver from Ettus Research (www.ettus.com)
software acquired:	radio astronomy computation and display;
	authoring tools for software-defined radios

Things still to come:

hardware:	two Low-Noise Amplifiers (LNAs) (Fall 2011) parts to make up additional amplifiers (Fall 2011)
Construction projects:	two helical antennas, which with the LNAs should be able to record interference patterns from the Sun (Fall 2011 - very optimistic)
	simple mount for helical antennas, allowing fixed pointing in elevation (Winter 2011)
	single dish, fixed azimuth, local control of elevation (Summer 2012)
	dual dish, fixed azimuth, local control of elevation (Summer 2013)
	single dish, Az-El mount with .2deg pointing accuracy (Summer 2014)
	dual dish, Az-El mount with .2deg pointing accuracy (Summer 2015)
	Internet access to telescope operation (Summer 2012 through Summer 2016)
Presentations:	noise from the Sun (Summer 2012)
	interferometer patterns from the Sun (Fall 2012)
	interferometer patterns from a few strong non-Solar sources (Winter 2012)
	Internet presentations (remote operation) (Winter 2012)