Introduction to the Summer School

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I believe, that the idea of a Summer School in Spectrum Management for Radio Astronomers first came up in a conversation I had with Jim Cohen, during one of the long walks back to our hotel from one of a number of excellent restaurants we visited in May 2000, during the World Radiocommunications Conference held in Istanbul. After the WRC, Jim went on sabbatical, I believe, and got busy with other things. Soon after that Darrel became Chairman of IUCAF, and the idea was discussed further over a beer or two at a Geneva restaurant during a WP 7D meeting, (a pretty standard way of doing business by the WP 7D crowd), and here we are today!

There appeared to be at least two good reasons to hold such a school. The first was that the most experienced radio astronomers active in spectrum management had either just retired, or were then about to do so. Thus Dick Thompson, who we are lucky to have here as one of our lecturers, had officially retired the previous year. And I had attended the first in a long series of Boris Doubinsky retirement parties (which I believe are still going on) in Istanbul, while John Whiteoak, who chaired WP 7D for many years, retired shortly after the WRC. Others are likely to follow within a decade or so, so an infusion of younger people into spectrum management from the radio astronomy side is highly desirable. Secondly, the few newcomers to this activity had little previous exposure to spectrum issues, and even less to the language, structure, and culture of the International Telecommunication

Fig. 1: The GBT, which is located in the National Radio Quiet Zone.

Union (ITU). Defending radio astronomy interests in spectrum fora is never easy, and to be thrown into the middle of a WRC is not a very pleasant way to learn about how to do it, as some present here can surely tell!

Well, there are few ways to entice people into spectrum management! Few teenagers are smart enough to decide early on that they want to go into spectrum management when they grow up. Even among technical people not too many are aware of what the activity is about, and most scientists are turned off when you begin an explanation. Important, maybe! But boooooring In fact, most of those in spectrum management, be they astronomers, engineers, or lawyers, drift into it accidentally, and then decide to stay. So, we thought that there had to be a better way, and hopefully this Summer School is going to turn out to be one of those better ways!

And while we are at it, I thought I'd give you a definition of Spectrum Management. When I happened to drift into this activity, I was given the office occupied by the previous incumbents. As usual, there was lots of junk left on the walls, a definition of spectrum management among them. It is the best that I ever found, and I kept it! Here it is:

> **"Radio Frequency Management Is Done by Experts Who Meld Years of Experience With a Curious Blend of Regulation, Electronics, Politics and Not a Little Bit of Larceny. They Justify Requirements, Horse-trade, Coerce, Bluff and Gamble With an Intuition That Cannot Be Taught Other Than by Long Experience."**
>
> **Vice Admiral Jon L. Boyes**
> **U.S. Navy**

Well, he certainly did have it right!

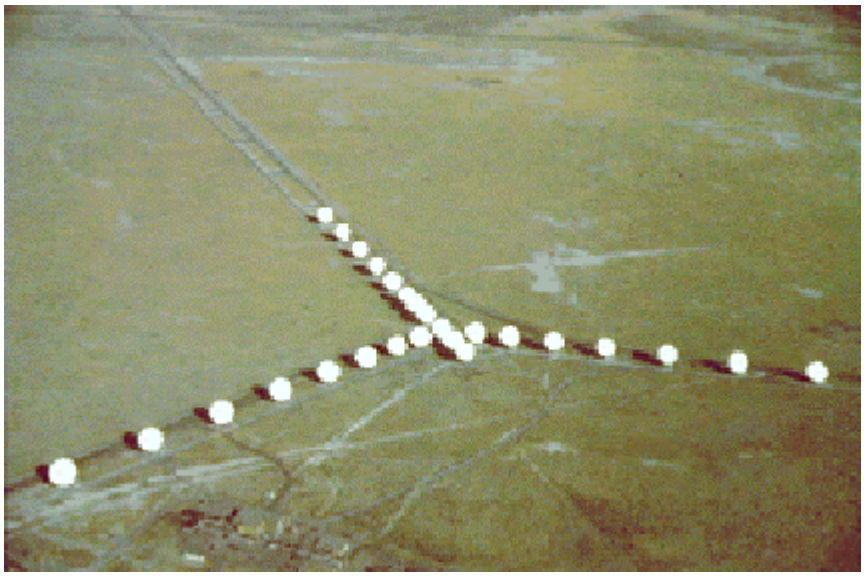

Fig. 2: The VLA consists of 27 antennas arranged in a huge Y pattern, up to 36 km (22 miles) across. Each antenna is 25 meters (81 feet) in diameter; their output is combined electronically to give the resolution of an antenna 36 km (22 miles) across, with the sensitivity of a dish 130 meters (422 feet) in diameter. At the highest observing frequency (43 GHz) this gives a resolution of 0.04 arc seconds, which is sufficient to see a golf ball held by a friend 150 km (100 miles) away. The dishes can be moved along a track, which allows the telescope to perform the radio equivalent of a zoom lens.

I was told that some of you may have never seen a radio telescope or array, and so here are some pictures to introduce you to them, before you get a chance to visit the GBT in person. Pictures of many more can be seen near the entrance to this building.

Fig. 3: The Arecibo telescope is a 305 m (1000 feet) diameter spherical reflector, 167 feet deep, and covers an area of about twenty acres. The surface is made of almost 40,000 perforated aluminum panels, each measuring about 3 feet by 6 feet, supported by a network of steel cables strung across the underlying karst sinkhole.

Fig. 4: Some radio telescopes. From top left-to-right: (a) The Parkes telescope, Australia; (b) The IRAM mm-wave telescope, Granada, Spain; (c) The Westerbork array, the Netherlands; (d) The Nobeyama interferometer, Japan.

Finally, I made an attempt to summarize the worldwide investment in radio telescopes made during the 1990s together with that expected to be made in this decade. I am sure that I omitted some, but as an approximation it will do. The worldwide investment in radio telescopes during these two decades is expected to run to roughly one billion dollars, although the real figure is likely to end up being higher.

USA

GREEN BANK TELESCOPE (GBT)	**NRAO**	**$ 85 M**
ARECIBO (UPGRADE)	**NAIC**	**$ 22 M**
SUBMILLIMETER WAVELENGTH ARRAY (SWA)	**SAO**	**$ 62 M**
EVLA (Phase I)	**NRAO**	**$ 50 M**
ALMA (US Contrb.)	**NRAO**	**$330 M**
LARGE MILLIMETER TELESCOPE (LMT)	**U Mass**	**$ 43 M**
CARMA	**U. Calif- CALTECH**	**$ 15 M**
ALLEN TELESCOPE ARRAY (ATA)	**Berkeley-Private**	**$ 25 M**
SKA (Development)	**Consortium**	**$ 1.5 M**
Total		**$633.5 M**

Non-USA

ALMA	**EUROPE**	**$330 M**
LMT	**MEXICO**	**$ 43 M**
GMRT	**INDIA**	**~ $ 50 M?**
SARDINIA	**ITALY**	**~ $ 60 M?**

Our ultimate objective is to protect this investment for science and make sure that radio astronomers continue to have access to the spectrum, so that we can continue to learn about the Universe!

Thank you, and have a very enjoyable week!