NLSRT Memo No. 28

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Subj: More on 300-ft replacement

I have been thinking about Jay Lockman's notion of a clear-aperture single dish with a constant-elevation focus, whose geometry would be essentially that of the scoop horn at Bell Labs, without the waveguide. I think this merits serious attention, as it could have many advantages that might more than compensate for the uncertainties associated with the novelty of the design.

1. Why would we even think about it ? (Skip to #2 if in a hurry).

It was clear from the Green Bank meeting that the science below 5 GHz is best served by a minimally-blocked aperture, >= 100-m in effective diameter, whose elevation coverage is limited only by the mountains. Minimal aperture blockage is important both to reduce far-out sidelobes (adding RFI protection for all low frequencies, reducing stray radiation for galactic HI work) and to flatten spectral baselines.

A compact array of small offset-feed dishes could do the job, and would be the *only* way to do it if the effective aperture must be > 200-m. But nobody has argued *hard* for an aperture that big on sensitivity grounds (even the sensitivity-conscious pulsar people would settle for a somewhat smaller aperture). Numerous practical concerns have also been voiced about arrays. Arrays are expensive to operate, maintain and refurbish (AHB). The big array "thinkers" are all preoccupied with VLBA, MMA and the AT (TJC). Low-elevation coverage is problematic in truly compact arrays (just about everyone). The implications of a large array computer at Green Bank have also been viewed negatively from two directions -- the single dish spectroscopists are rightly concerned about interactivity and data processing time, and the VLA staff are paralytic at the thought of a big computer East of the Rio Grande. So I suspect that the compact array may not get a serious hearing, even though I personally think that it would be a very flexible instrument that could also provide a growth path for the future if a >= 150-m aperture becomes desirable.

These trends convince me that we should think some more about truly clear-aperture designs in the 100 to 150-m class. We all recoiled in horror from the "conventional" offset-tower design at 100-m size, and two facts support that reaction. First, the largest known implementation of that design is an 11-m dish. Second, you need a tower height at least equal to the diameter of the dish to avoid very nasty illumination gradient problems. The second fact probably explains the first.

The clear-aperture concept dies if we abandon the compact array idea and stick to fully conventional offset-feed designs. I share Jay's reluctance to accept this death for a telescope that will go into the unique electromagnetic environment of the National Radio Quiet Zone. So read on.

standpoint of noise performance. Ground illumination by spillover from the primary reflector would be worse than that of a Cassegrain but better than that of a conventional prime focus. This might not be a big problem at short wavelengths where we would anyway under-illuminate the prime reflector. But it became an issue at Nancay, where they added a ground screen that seems to have done more damage to spectral baselines than it gained by improving noise performance. We would need to assess this problem quantitatively.

3. What to do?

It is tempting to avoid radically new designs in a project with the abbreviated time scale of this one. But, especially if the compact array concept fails to gain early support, at least one sub-group of engineers and scientists might evaluate Jay's proposal in some detail. The Nancay experience should be highly relevant. I judge that the scientific contributions of Nancay have been limited more by the style in which science is done in France, and by the limited H.A. coverage of that instrument, than by any fundamental flaw in its design. But I may be missing something.

In any case, I feel that it is not altogether safe to settle for a conventional on-axis single dish design. Several people have pointed out that the much of the astronomy community will instinctively react poorly to NRAO building "Bonn 20 years later" with funds from the pork barrel, even if we do drum up a plausible case for the science. A design with some truly innovative aspects could mute such criticism, though obviously at some risks. We should at least evaluate the risks.