

DEUTERIUM ARRAY MEMO #025

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April 24, 2003

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To: Deuterium Array Group

From: Alan E.E. Rogers

Subject: Proposed details of RFI reduction fence

In memo #20 I suggested the addition of a cylindrical fence around each 5×5 array to reduce the level of RFI from sources at the horizon. I have now examined the design of a fence more carefully. Looking through the literature I found 2 relevant papers:

- 1] Ruze et al, "Radar ground-clutter shields," *Proc. IEEE*, **54**, pp. 1171-1183, 1966.
- 2] Rao et al, "Study of ground clutter prevention fences for boundary layer radars," *Radio Science*, **38**(2), pp.13-1-13-15, 2003.

a) Single large vs many smaller fences

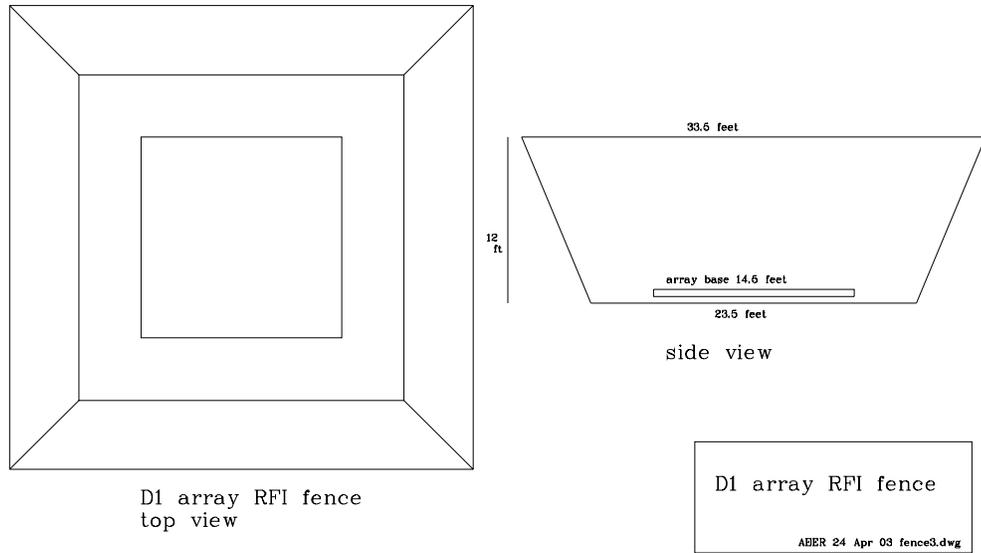
Using the simple knife edge diffraction theory the relationship between the height of a fence h and the distance d from the antenna operating at a wavelength λ for a nominal 20 dB reduction is

$$h \approx (2d\lambda)^{1/2} \quad \text{for } d \gg \lambda$$

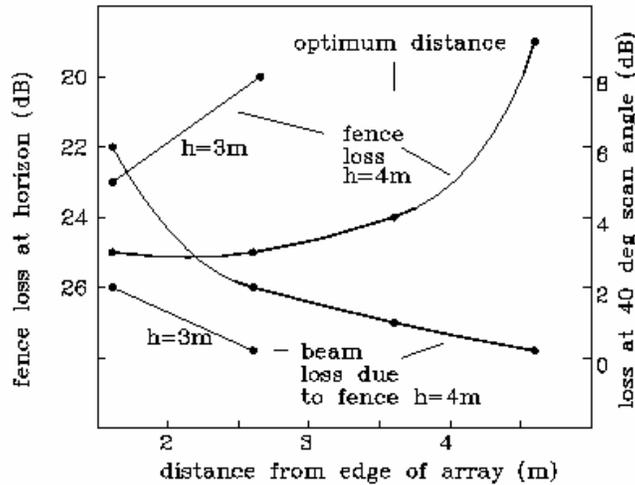
Further if we assume that the cost of a fence is proportional to the circumference times the height it might appear that a single large fence enclosing all the N 5×5 arrays would be less expensive than N separate smaller fences. However the cost of a fence is more likely to be proportional to the height squared due to structural considerations. In this case it is equally expensive to build separate fences for each 5×5 antenna or a single fence:

$$\begin{aligned} \text{Cost for } N \text{ separate} &= KNd^2 \quad (K = \text{constant}) \\ \text{Cost for single} &= KNd^2 \end{aligned}$$

However the equality only exists if we pack the 5×5 arrays right next to each other and right up to the fence. The height of a single large fence 100 m from an antenna has to be 14m (45 feet) high for 20 dB attenuation at the horizon. This is a rather large structure and perhaps even the height squared dependence is optimistic. I propose individual square fences 33.5 feet on a side as shown in figure 1. Ideally the sides should be sloping if this can be accomplished without significant added cost. I have written GTD software to analyze the fence attenuation using methods somewhat similar to that used in Rogers et al, *IEEE Trans. Ant. Prop.* **41**(1) pp. 77-84, 1993. Basically the method performs a numerical integration of the Hygen's wavefronts in the plane of the fence. For a fixed array beam scan angle the fence produces some oscillations in the shielding attenuation so that the overall performance



is better illustrated by averaged over a small range of beam scan angles. High computational accuracy is required because the horizon response of the array when the beam is pointing at zenith is already very weak. In the case of a cylindrical fence there is a reflection from the rear screen that results in an average degradation of about 2 dB in the horizon shielding. Figure 2 shows the results of numerical



wavefront integration for the diffraction loss due to the screen for signals coming from the horizon as a function of the horizontal distance of the screen's edge from the first row of elements of the array. Also shown is the loss due to diffracted blockage for signals arriving at a beam scan angle of 40 degrees (on an elevation of 50 degrees). If the fence is 4m high the best compromise between shielding and sky coverage is a distance of about 3.6m. The final choice of screen dimensions will depend on practical considerations of cost and materials.