Meteor Scatter: How Much Antenna is Too Much?

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Can an antenna be too big or have too much gain? Perhaps surprisingly, in some circumstances the answer is a definite "Yes."

High gain means narrow beamwidth. Even supposing that a sharp beam can be directed just as desired, you may sometimes want your transmitter to illuminate a larger range of directions, or to receive signals with reasonable gain over a larger range. Such situations can exist even for point-to-point communication — for example, when station A tries to work station B, at a known location some 800 – 1200 km away, on a VHF band using meteor scatter.

The most probable path geometries for random meteor scatter are offset by angles of about 8° – 16° either side of the great circle path. Smaller offsets apply to the longest paths, of order 2200 – 2400 km; paths under 1000 km have optimum offsets near the high end of the range. The largest number of meteor-scatter reflections will occur when stations A and B use antenna beamwidths that overlap throughout most of the potentially useful scattering volume. This implies beamwidths at least twice the offset angle: around 32° for 800 km paths, or 16° for the longest feasible paths. Of course, antennas with higher gain and narrower beams may yield stronger signals, when they produce any at all; but for efficient completion of their desired contact, A and B may be interested in getting *more* meteor reflections, rather than *stronger* ones.

A Yagi antenna with 30° beamwidth has boom length of about 3 wavelengths and gain 13 dBd. Three wavelengths at 50 MHz is nearly 60 ft, so few if any amateur antennas for this band are likely to be "too large" for effective meteor-scatter use. At 144 MHz, however, Yagis of 5 wavelengths and more are quite practical. Their beamwidths will be significantly less than 30°, so they will be sub-optimal for meteor-scatter contacts at moderate distances.

Real-world amateur meteor scatter experience confirms the picture outlined above. For meteor scatter out to 1600 km on the 2-meter band, an optimized 10–12 element Yagi (length 1.8 – 2.5 λ) is probably close to the optimum antenna. Takeoff angles for meteor scatter are no more than about 15°, so a vertical stack of two such Yagis (which would have the same beamwidth in azimuth) would be even better. Horizontal stacking of a pair, or a 2 × 2 box of four such Yagis, would work well beyond about 1600 km, but would be sub-optimal at shorter distances. On the longest feasible meteor-scatter paths, beyond about 1800 km, the rule-of-thumb once again becomes "bigger is better." Note that for these long paths the optimum takeoff angle has fallen to less than 3°, so antenna height in excess of 5 λ (about 35 ft at 144 MHz) is also important.