BUILDING COST-OPTIMIZED INTERSTELLAR BEACONS FOR MESSAGING

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How would we on Earth build galactic-scale Beacons to attract the attention of extraterrestrials, as some have suggested we should do? From the point of view of expense to a builder on Earth, experience shows an optimum tradeoff. This emerges by minimizing the cost of producing a desired power density at long range, which determines the maximum range of detectability of a transmitted signal. We derive general relations for cost-optimal aperture and power. For linear dependence of capital cost on transmitter power and antenna area, minimum capital cost occurs when the cost is equally divided between antenna gain and radiated power. For non-linear power law dependence a similar simple division occurs. This is validated in cost data for many systems; industry uses this cost optimum as a rule-of-thumb. Costs of pulsed cost-efficient Beacon transmitters are estimated from these relations using current cost parameters ($/W, $/m^2) as a basis. We show the scaling and give examples of such Beacons. Galactic-scale 1-10 kly range Beacons will be expensive. They can be built for a few billion dollars with our present technology. Such beacons have narrow 'searchlight' beams and short 'dwell times' when the Beacon would be seen by an alien observer in their sky. More powerful Beacons are more efficient, have economies of scale: Cost scales only linearly with range R, not as R^2, so number of stars radiated to increases as the square of cost. Similarly, on a cost basis they will likely transmit at higher microwave frequencies, ~10 GHz. The natural corridor to broadcast is along the galactic radius or along the local spiral galactic arm we are in. A companion paper asks 'If someone like us were to produce a Beacon, how should we look for it?'