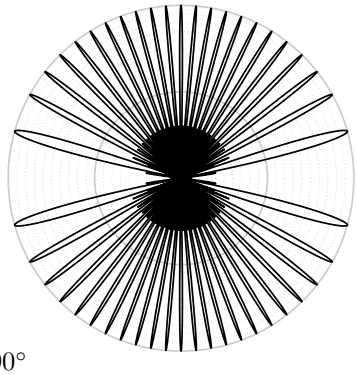
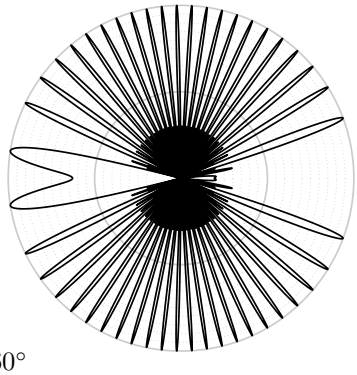
Uniform rectangular array: Isotropic elements

All plots in dB scale.

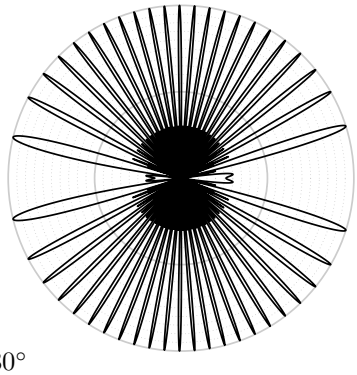
Azimuthal slice



90°

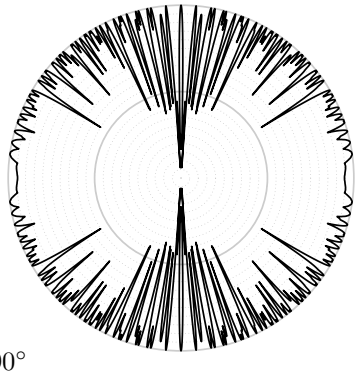


60°

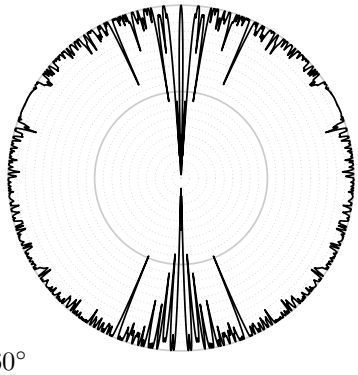


30°

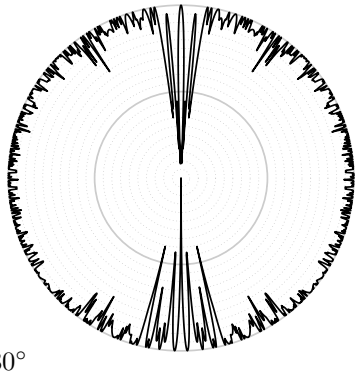
Maximum around beam axis



90°



60°



30°

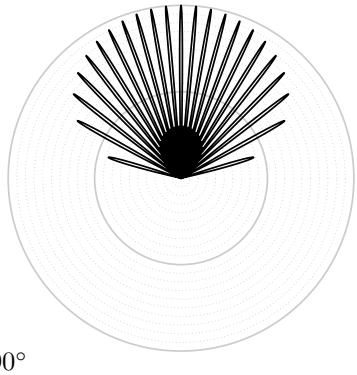
Commentary

Very poor directional discrimination. Since the array is regular, sidelobes are just as high as main lobe; and since array is sparse (elements more than a wavelength apart) there are many sidelobes over the sky. Beam steering simply rotates the sidelobe pattern.

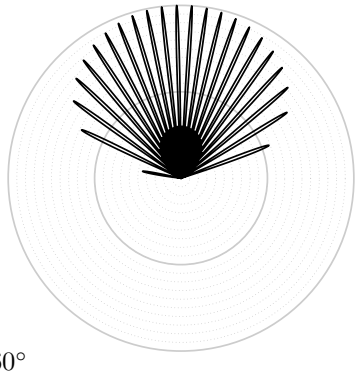
Uniform rectangular array: Upward-pointing dipoles

All plots in dB scale.

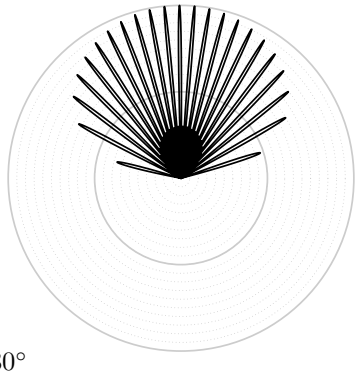
Azimuthal slice



90°

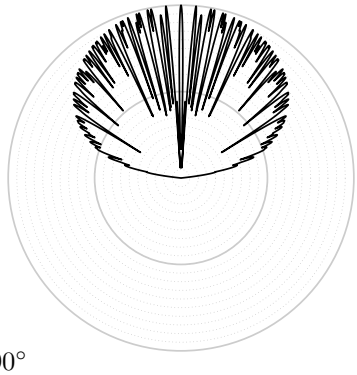


60°

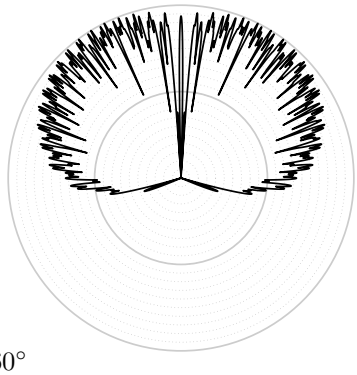


30°

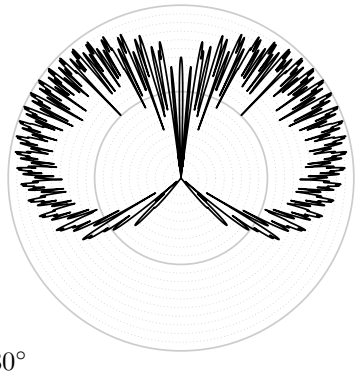
Maximum around beam axis



90°



60°



30°

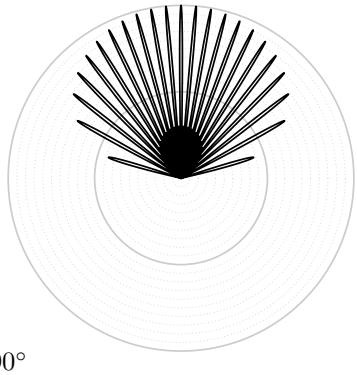
Commentary

As before. Dipole gives better response along vertical axis, but beam steering still has little effect.

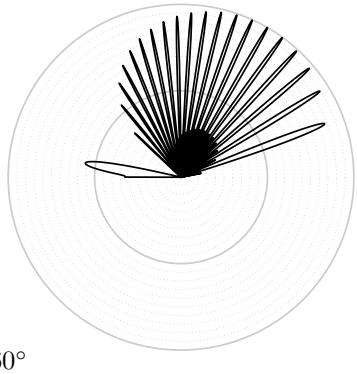
Uniform rectangular array: Outward-pointing dipoles

All plots in dB scale.

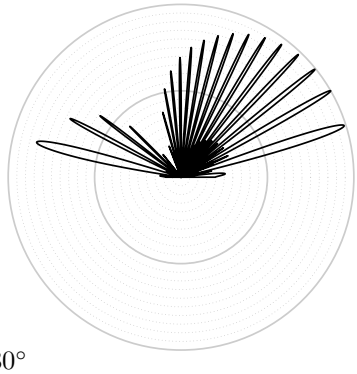
Azimuthal slice



90°

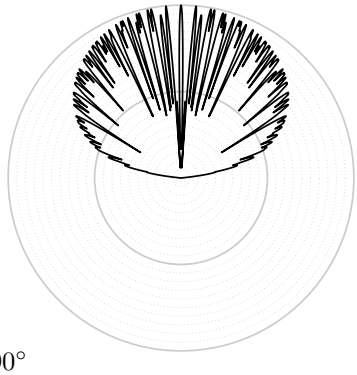


60°

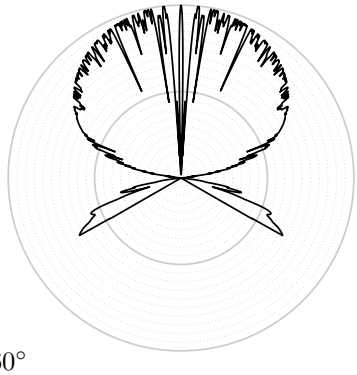


30°

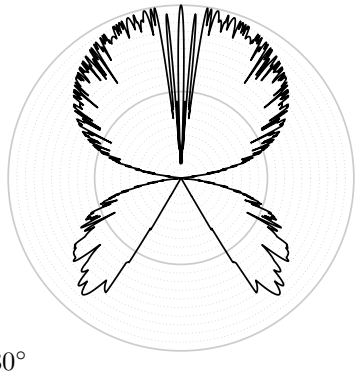
Maximum around beam axis



90°



60°



30°

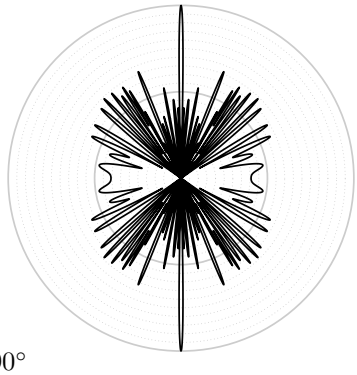
Commentary

If the elements are physically steered in conjunction with signal phasing, then we get some preferred directionality from the element response, and some refinement from the phased array. However, there are still many sidelobes within the dipole response pattern.

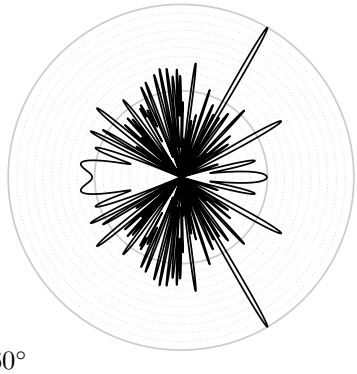
Pseudorandom array: Isotropic elements

All plots in dB scale.

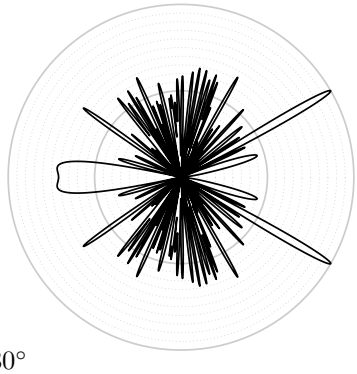
Azimuthal slice



90°

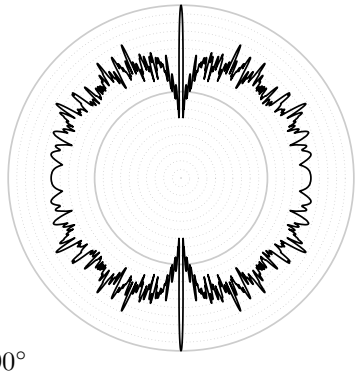


60°

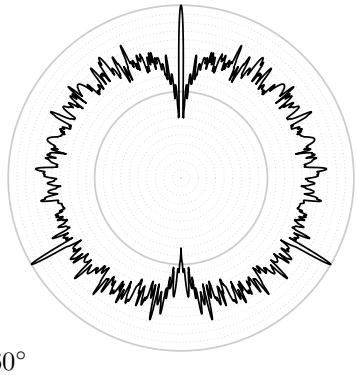


30°

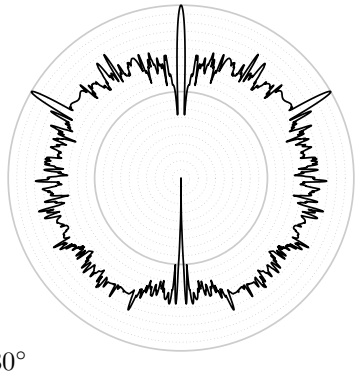
Maximum around beam axis



90°



60°



30°

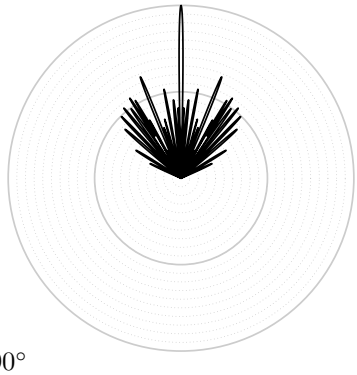
Commentary

Pseudorandom arrays give much better directional discrimination, as sidelobes are reduced by a factor $1/\sqrt{N}$. Symmetry across the array plane means there are still "reflections" of the main beam that give the same response.

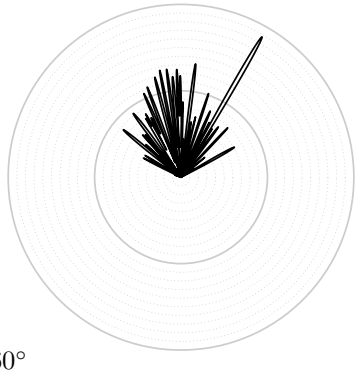
Pseudorandom array: Upward-pointing dipoles

All plots in dB scale.

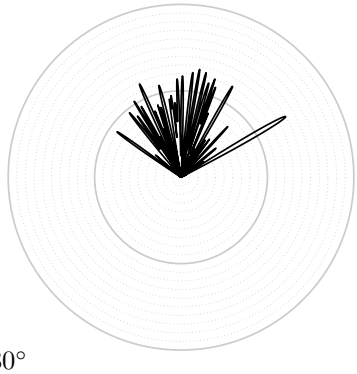
Azimuthal slice



90°

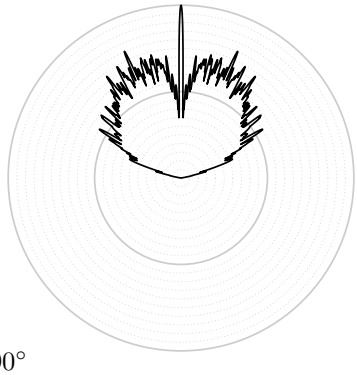


60°

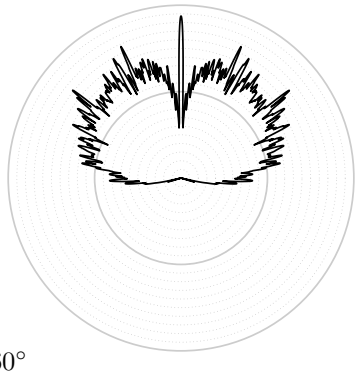


30°

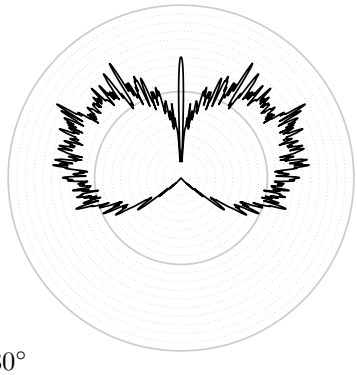
Maximum around beam axis



90°



60°



30°

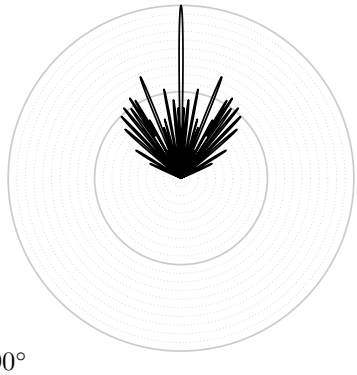
Commentary

Upward-pointing dipoles reduce the response of beams pointed off the vertical axis, to the point that eventually vertically-oriented sidelobes start to have better response than the main beam. Note that imposing zero response to below-horizon sources removes the "reflections" of the main beam.

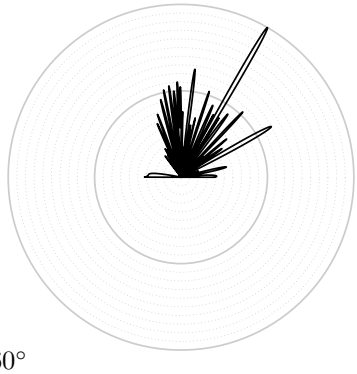
Pseudorandom array: Outward-pointing dipoles

All plots in dB scale.

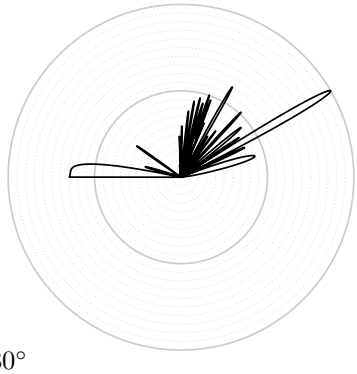
Azimuthal slice



90°

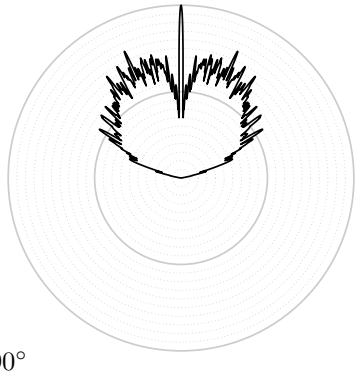


60°

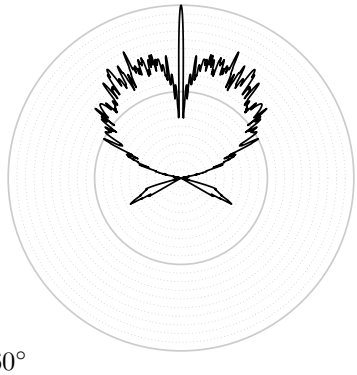


30°

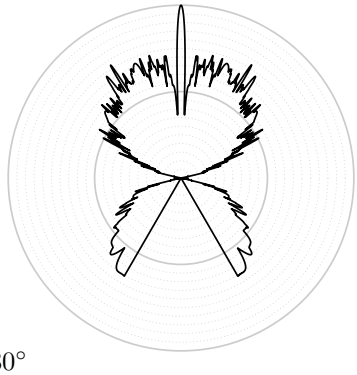
Maximum around beam axis



90°



60°



30°

Commentary

Combining physically-pointed dipoles with pseudorandom phased array beam steering gives the best directional response. However, we lose some of the benefits of purely electronic steering (requires moving parts, is slower, and can only physically point towards one source at a time: we could form multiple concurrent beams but only one would gain the full element response).