

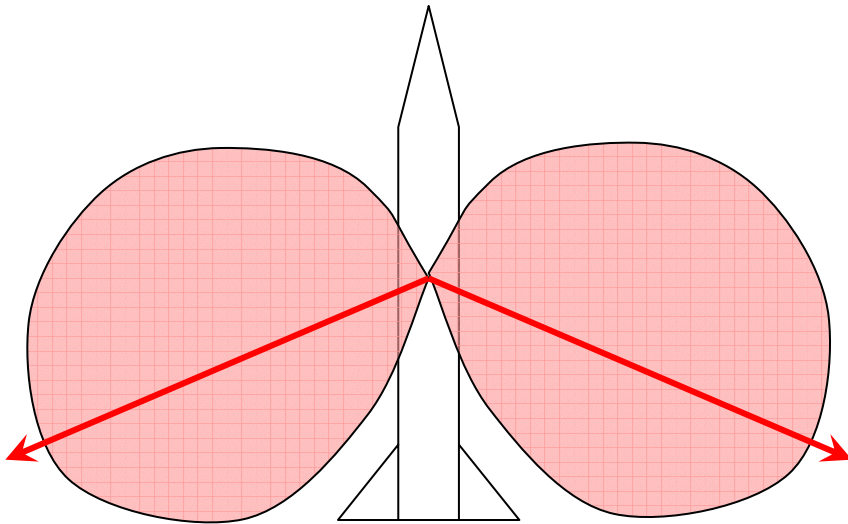
Antenna Simulations for SugarShot

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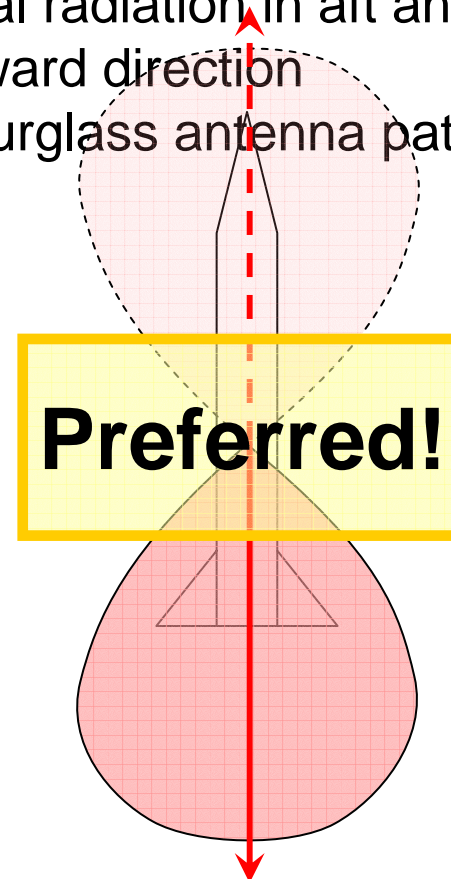
Basic Design Options

- Two possible design approaches, depending on the position of the ground station relative to the rocket's trajectory:

a. Radial radiation, perpendicular to rocket axis or directed slightly downward; blind spots in the forward and aft directions (toroidal antenna pattern)



b. Axial radiation in aft and/or forward direction (hourglass antenna pattern)

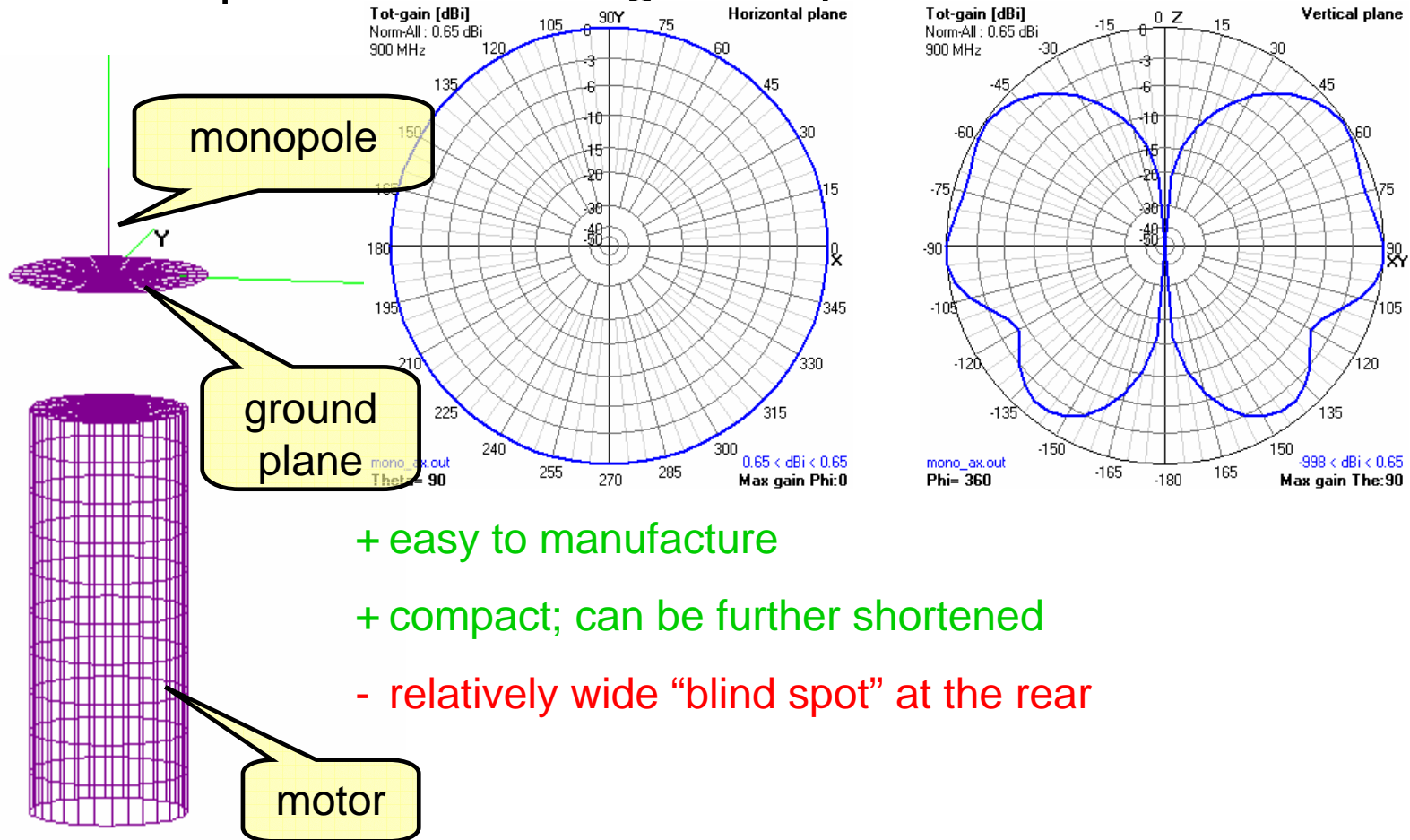


Simulation model

- Metal parts of engine and payload will significantly affect antenna pattern
- For simulation, the engine will be modeled as a metal cylinder slightly thinner than the rocket body
- Good enough (and relatively fast) for basic comparison of antenna types
- More detailed geometry information should be used for fine tuning

1. Antennas inside the body

Axial monopole on circular ground plane



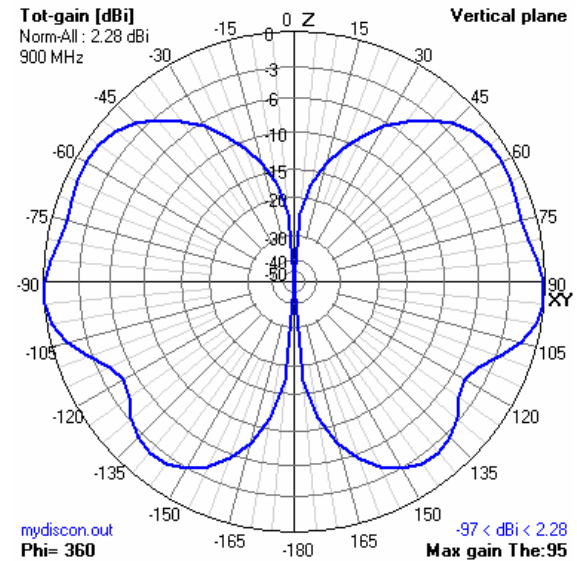
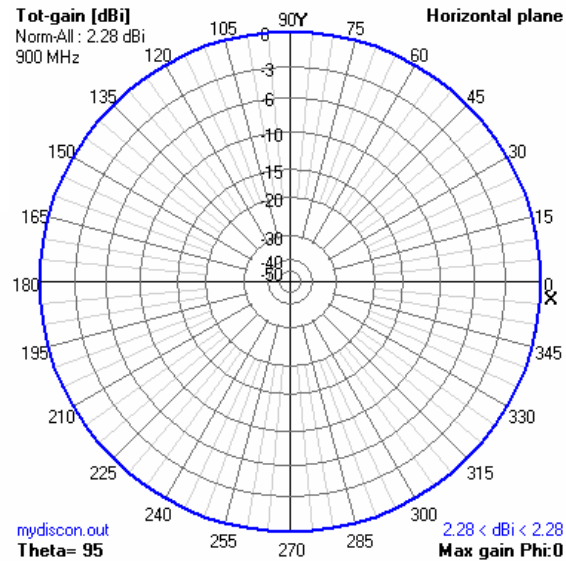
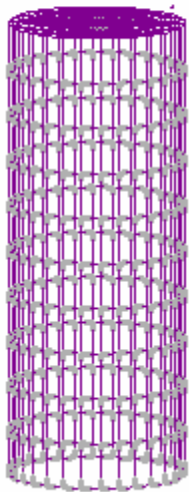
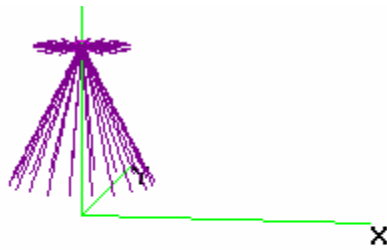
+ easy to manufacture

+ compact; can be further shortened

- relatively wide "blind spot" at the rear

1. Antennas inside the body

Discone



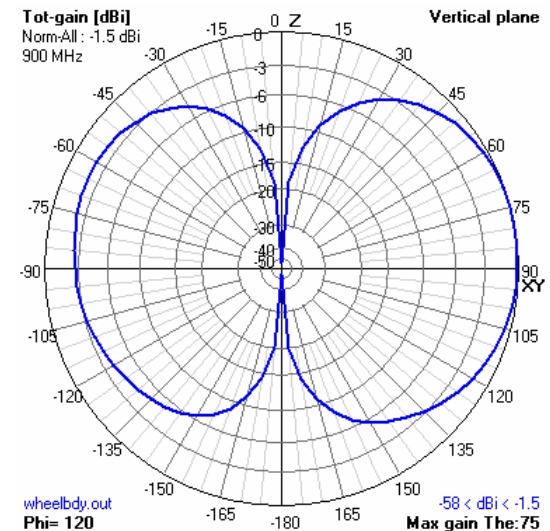
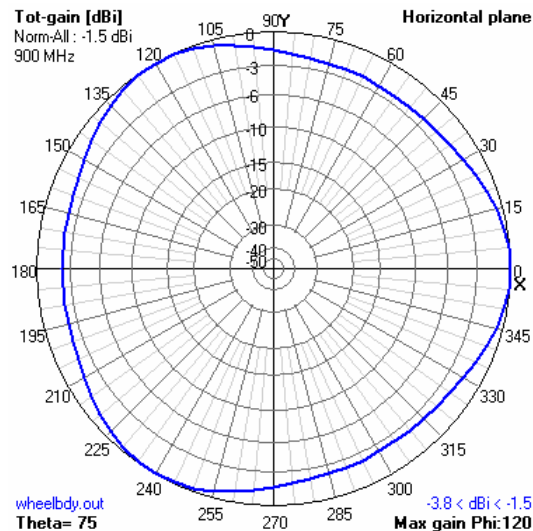
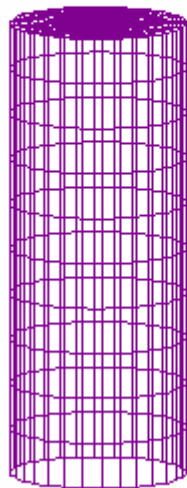
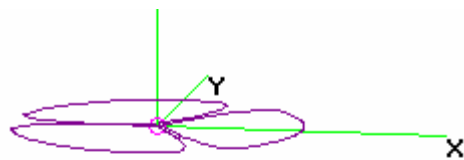
+ wide-band, relatively easy to manufacture

- for frequencies below approx. 900MHz the discone diameter will be too large

- relatively wide "blind spot" at the rear

2. Antennas outside the body

Wheel antenna

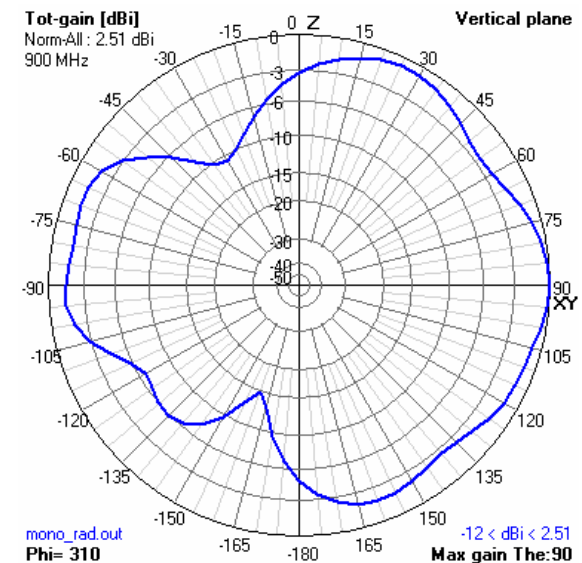
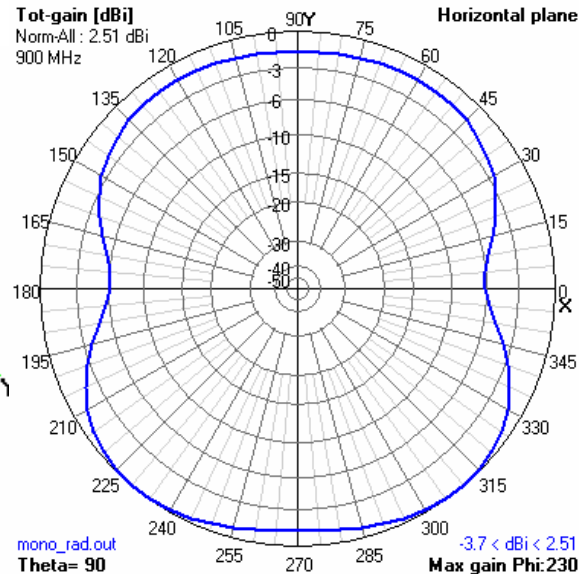
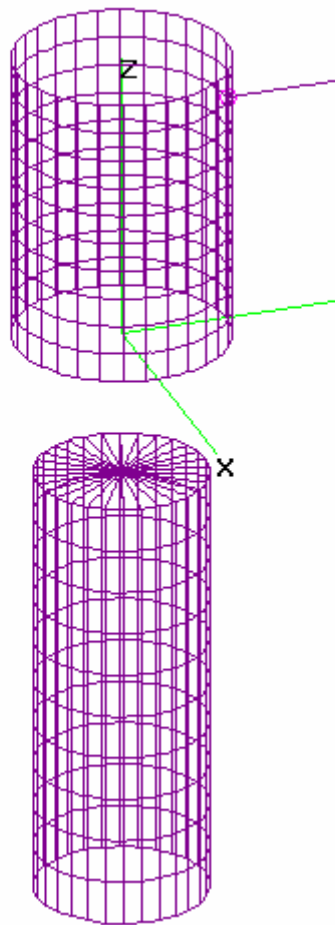


+ easy to manufacture

- structure extends well beyond the rocket body; diameter approximately equals 0.6 wavelengths (20cm at 900MHz)
- needs matching network to connect to 50 Ohm

2. Antennas outside the body

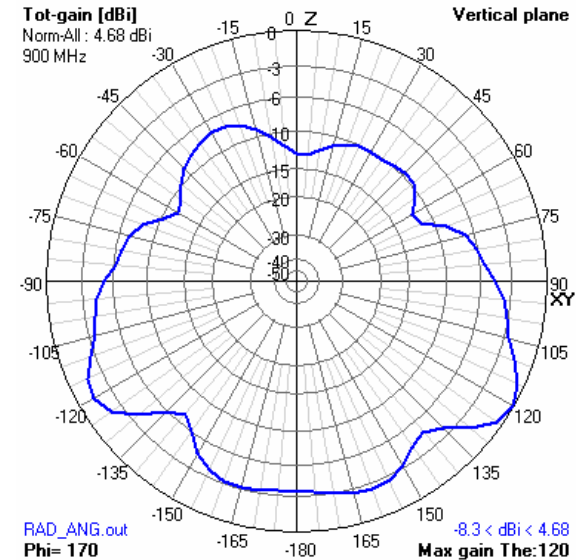
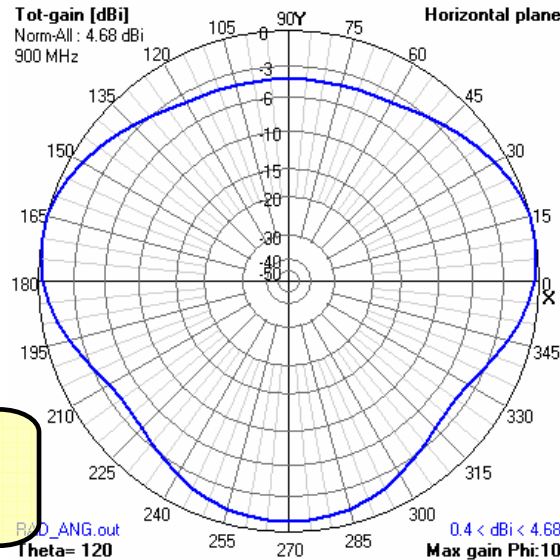
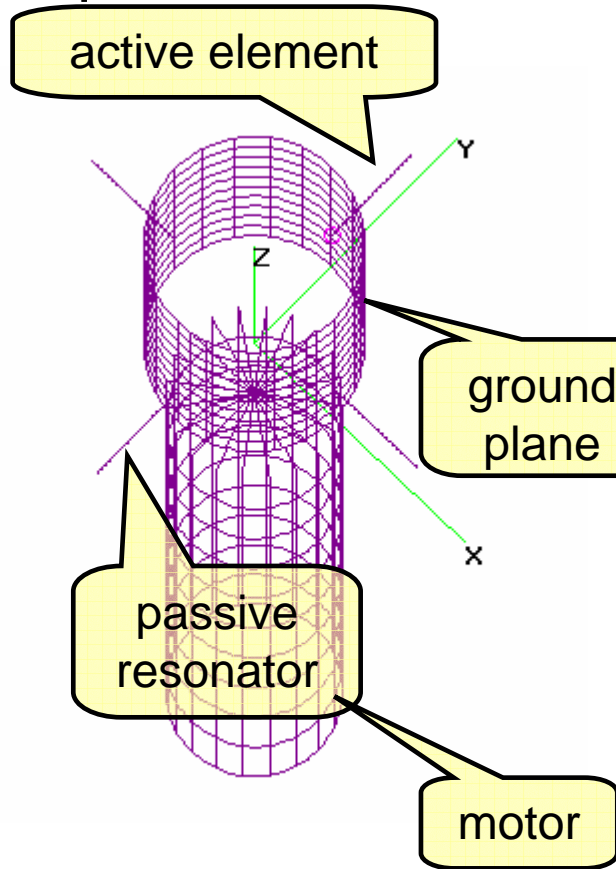
Radial monopole with cylindrical ground plane



- + relatively easy to manufacture
- + can be further shortened
- + pattern can be optimized by adjusting size and shape of ground plane
- complicated and asymmetric pattern
- additional drag

2. Antennas outside the body

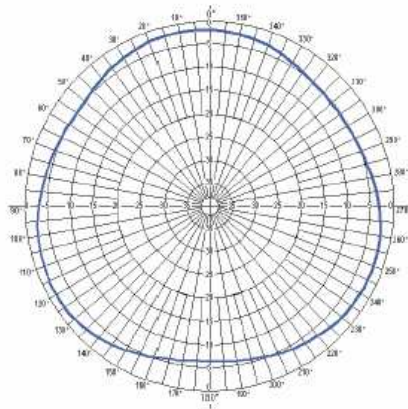
Radial monopole with cylindrical ground plane and passive resonators



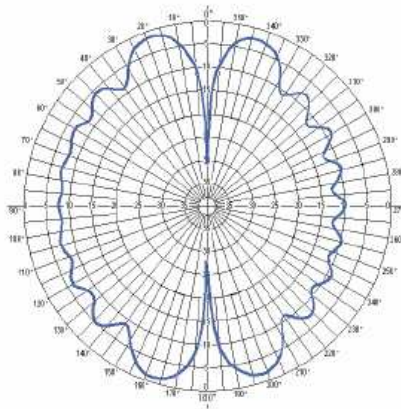
- + relatively easy to manufacture
- + good radiation towards the rear
- + can be further shortened
- + pattern can be optimized by adjusting size and shape of ground plane or length/number/position of resonators
- complicated pattern
- additional drag

2. Antennas outside the body

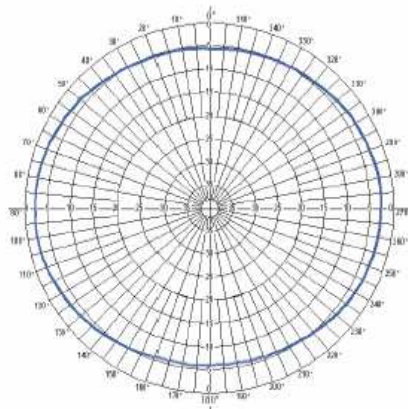
Cylindrical patch antenna (patterns of commercial product)



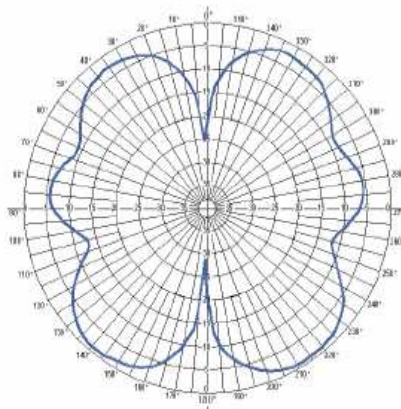
ROLL - 2230 MHz
ISOTROPIC - 2 dB



PITCH - 2230 MHz
ISOTROPIC - 7 dB



ROLL - 421 MHz
ISOTROPIC - 2 dB



PITCH - 421 MHz
ISOTROPIC - 2 dB

- + relatively narrow “blind angle”
- + structure does not extend much beyond the rocket’s body
- relatively low bandwidth, therefore requires very precise design and manufacturing