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A 2.4Ghz Low-Power 5dBi Vertical Collinear Antenna for 802.11 Applications

By Brian Oblivion and Capt.Kaboom

NOTE: www.aerialix.com has created a kit based on our design in 5dBi, 8dBi, and 12dBi configurations. You can also purchase an assembled antenna at reasonable cost. The finished radome is fiberglass, and the materials are cut and wound to specification. The open source assembly instructions can be used to assemble the design presented here.

Introduction

This is a follow up design that culminated everything we learned from building the first collinear antenna, that was based off of UHF repeater Antennas. This one is more suited for 802.11 operation. It is small, very inexpensive, and the materials are much easier to work with.

Construction time can take a few days up to a week, depending on your drive and resourcefulness. Proper acquisition of materials and the tools at your disposal will accelerate construction time.

There are 2 main sections to this antenna. Starting from bottom to top of the antenna, they are the RF connector/decoupler section with feedline and the elemental array section comprised of a meander-line coil, and the element tubing.

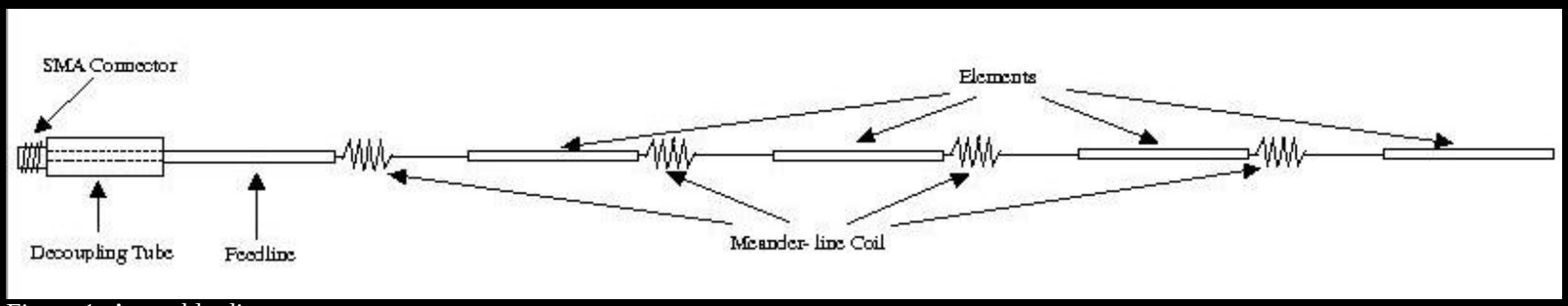

Figure 1. Assembly diagram.

Equipment and Materials Needed

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Components:

        3 12" length of 3/64 K&S brass rod
        3 12" length of 3/32 K&S brass tubing
        1 12" length of 11/32 K&S brass tubing
        1 SMA Female PCB mount connector (Round Base) digikey part# J608-ND

        solder (non-acid core plumbing solder)
        flux paste

        PVC Pipe to fit antenna assembly into.

Tools:

        Required:
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        Precision metal saw.
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High-wattage soldering gun ( >260 Watt )
Regular soldering iron
metal ruler (Metric/english)
metal sandpaper
metal file(s)
[ SCREW FOR WINDING COILS ] need specs.
vise(small)

Would make life MUCH easier:
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hand-held pipe cutter
micrometer (optional)
Dremel tool with metal grinding/cutting heads or metal grinder
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Measurements

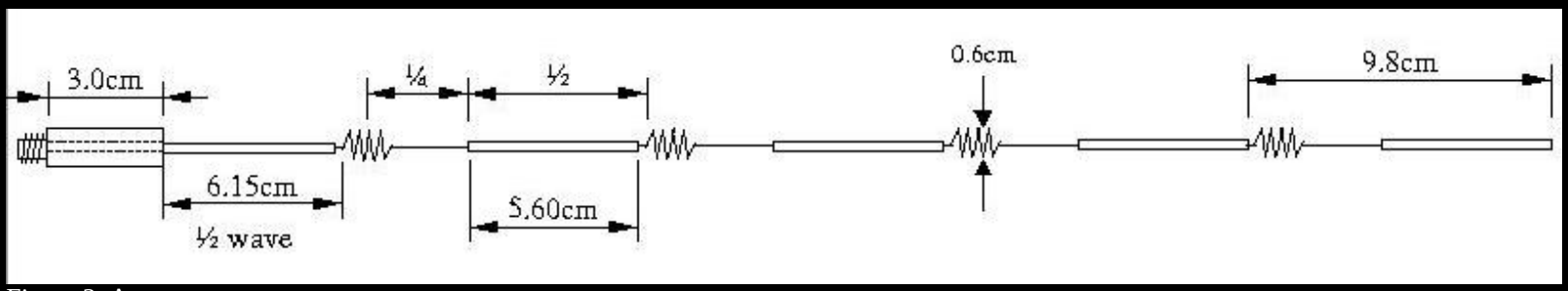


Figure 2. Antenna segment measurements.

The schematic of the electrical components of the antenna is displayed in Figure 2. Note: this schematic is for a four element collinear array. The 1/2 wavelength and 1/4 wavelength measurements calculated above are to be applied to the various elements in this schematic.

The length of the feedline is approximatly 9cm. The length of is not extremely critical.

Note that the first measurement from the end of the decoupling tube is a 1/2 wavelength to the *beginning of the first coil*.

The next critical measurement is from the middle of the coil to the beginning of the first brass tube element, which is 1/4 wavelength. The cycle then repeats again for the remaining elements, where a 1/2 wavelength exists between the beginning of the next brass tube element to the beginning of the next coil.

Construction

We found that it was easier to cut brass in batches, as you don't have to constantly adjust the micrometer. A picture of the various components can be viewed here.

Brass Tubing Preperation:

The 11/32 tubing is used for the decoupler. A tube/pipe cutter makes this task very easy, and should be used. Otherwise you will need to use a fine metal saw, dremel tool or a hacksaw if you are really slummin. You only need to prepare one 3cm length. Always cut it a little long and file/grind down to the appropriate length.

The 3/32 tubing is used for the antenna elements. It is not very difficult to prepare with the brass tube cutter. A supplier that carries the K&S Brass stock will also either carry or be able to special order a tube cutter for you. Always cut a little more than needed and file/grind down to the appropriate length. You will need to prepare one feedline tube, and 4 antenna elements.

The 3/64 solid brass rod is also very easy to work with. The thickness of the brass rod makes it very pliable for bending, yet strong enough to retain the new shape with sufficient rigidity. Figure 3 depicts an easy way to coil the rod. We used a threaded concrete screw with 6 threads per cm.

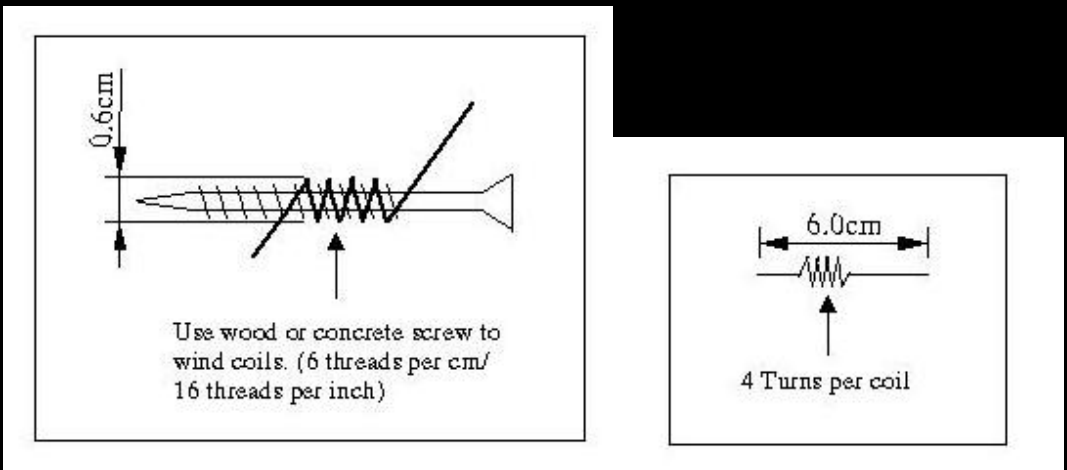


Figure 3. Coil bending jig and coil measurements.

A vice or a pair of vice grips can be used to hold the screw and brass rod together for subsequent turns. You will need to prepare 4 coils. Make sure you leave about a 1cm at the beginning of the coil and about 2cm at the other end. Adequate uncoiled brass rod will allow for positioning later during assembly. The outer diameter of the coil should be ~0.6cm.

Decoupler Assembly:

The decoupler assembly is a simple process. First, slide the feedline brass tubing over the center conductor of the SMA connector, allowing about 1mm of conductor at the bottom to solder the tubing to. Solder it. When completed, it should look like this. Figure 4 depicts a completed decoupler assembly.

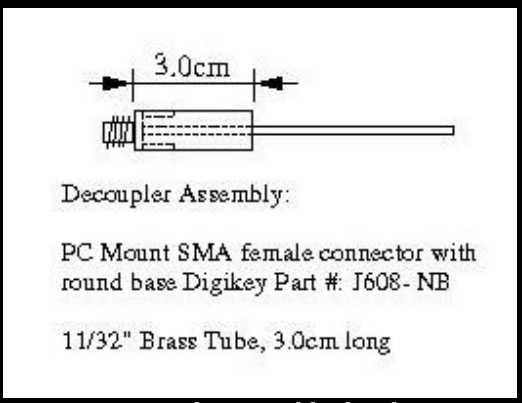


Figure 4. Decoupler assembly detail.

Next, take the 11/32 decoupler tubing and insert the SMA connector with the feedline now soldered to it, feedline first. It will be very snug, so make sure you deburred and opened up the end you are inserting the SMA connector into with a file. Leave an amount of the round SMA connector base for soldering to the brass tube.

You have now completed the decoupler assembly.

Element assembly:

Each element is matched with a coil segment. The relationships are indicated in figure 2 above. The important relationship is from the middle of the coil to the beginning of the brass tube element is 1/4 wavelength. Then from the Beginning of each tube to the start of the first turn of the next coil is a 1/2 wavelength all the way up the antenna until the final element is placed.

Element soldering:

Element soldering is pretty straight forward. You can do this with almost any soldering iron you can find. A trusty old Weller works fine.

Solder all the elements at this point before proceeding to the next section. Your antenna should like this and this.

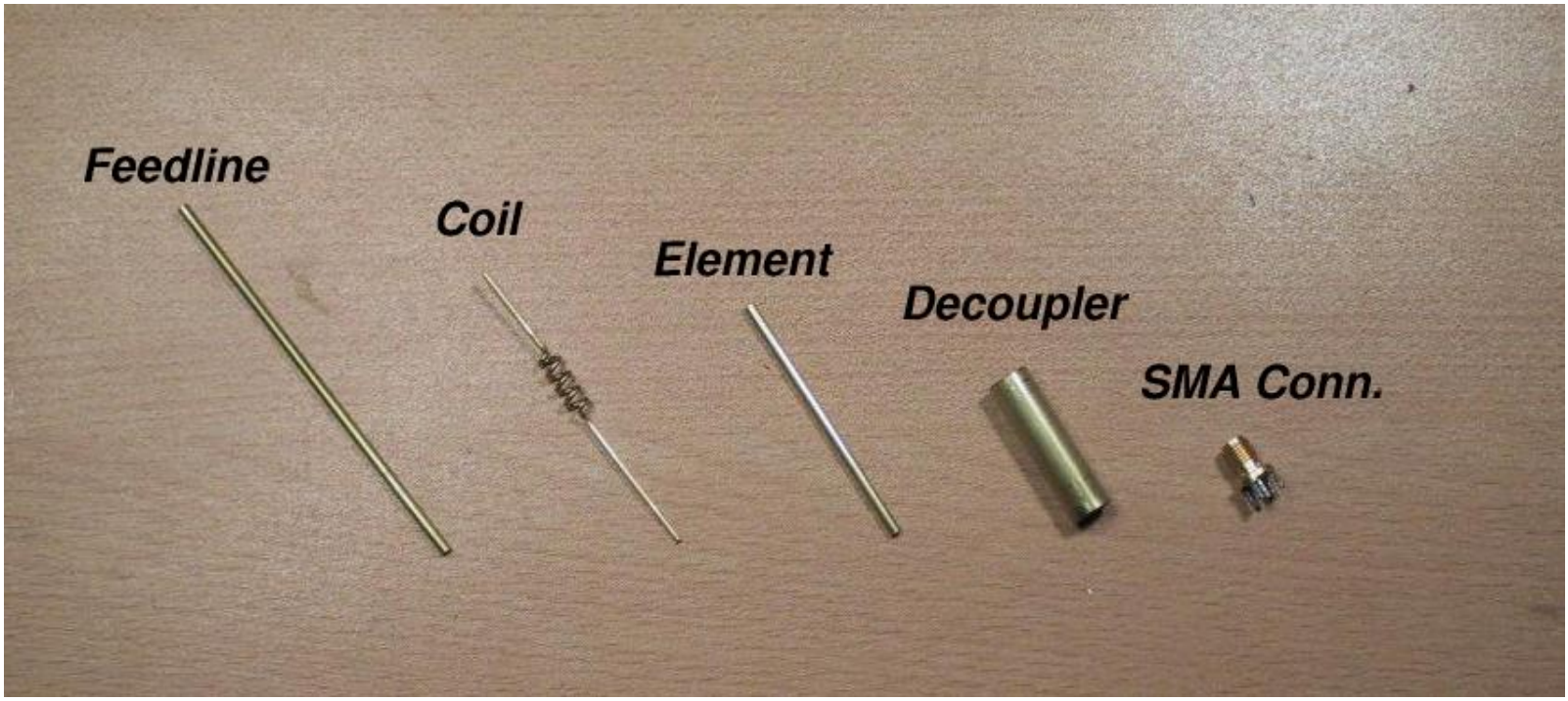
Tuning and final assembly

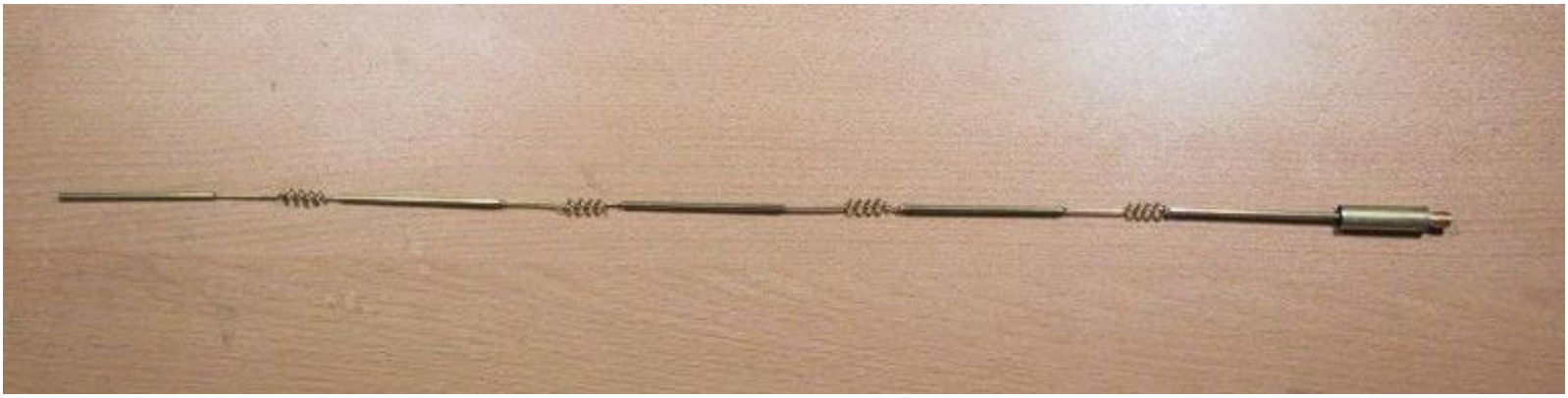
Tuning:

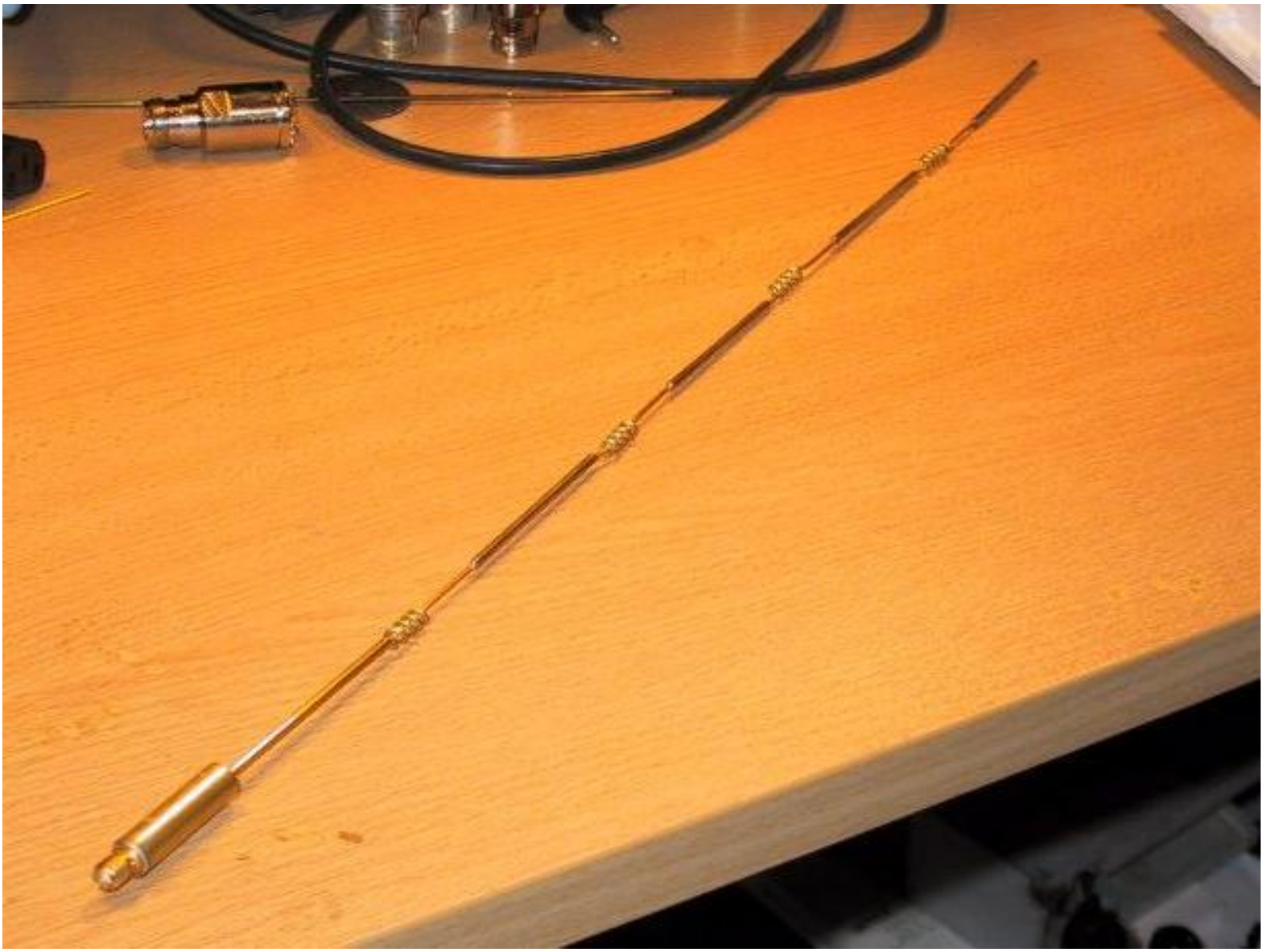
If you follow these instructions carefully, you will not need to tune it. The measurements were all designed around the middle of the 11 channels used in the US.

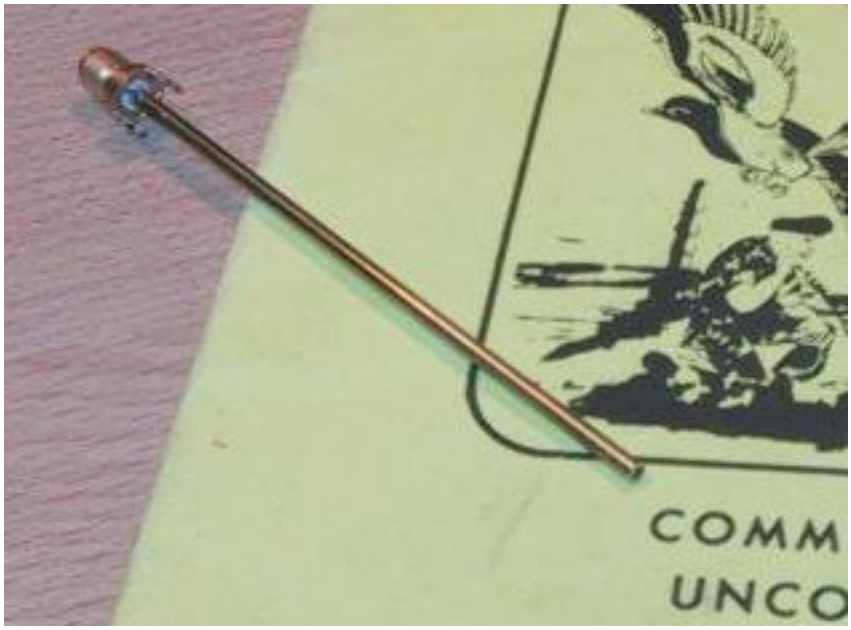
Radome construction:

Outdoor electrical UV resistant conduit was used for the radome. It was cut to the appropriate length to accomodate the entire array, leaving the female SMA connector hang out the bottom by 50mm. The array is held in place with plumbers epoxy. We used a PVC cap to cover the top, but it could have been sealed with plumbers epoxy as well. Using double sided sticky tape, the array is held in place at 2 locations within the tube.


Feedline
Coil
Element
Decoupler
SMA Conn.



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