Cricket Tracker Testing

Brixton Art Space

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Accuracy Tests

The room used for testing was 8 meters wide by 7 meters deep, and approximately 3 meters high. Four Crickets were mounted in a square on a pair of parallel aluminum rods, used for carrying lights, spaced 2.3m apart left to right, and 3.2m front to back. The Crickets were oriented face down, and connected by serial cables to a serial-to-usb converter, and by separate cables to a power supply. The serial-to-usb converter was connected to a computer by a usb cable.
Initial testing, using a handheld Cricket, confirmed the basic operation of the setup. Crickets lying on the floor in different places could be identified and located by the ceiling-mounted receivers.
A Cricket was mounted on one end of a ruler, attached to the top of a floor-standing oscillating fan, to generate a repeatable horizontal movement of the Cricket through the space [see fig. 1].

fig. 1

The 3-d coordinates of the moving Cricket, swept horizontally by the oscillating fan on a radius of about 80 cm were recorded using the log facility of the Cricket Tracker, and subsequently imported in Excel for analysis. The results [fig. 2] show a series of accumulated dots, representing the horizontal trajectory of the Cricket, measured in cm relative to the origin of the coordinate space (the left-front Cricket). The coordinates were accumulated over several complete sweeps of the fan. Z-coordinates were discarded. A fitted curve represents the closest approximation to the actual trajectory.

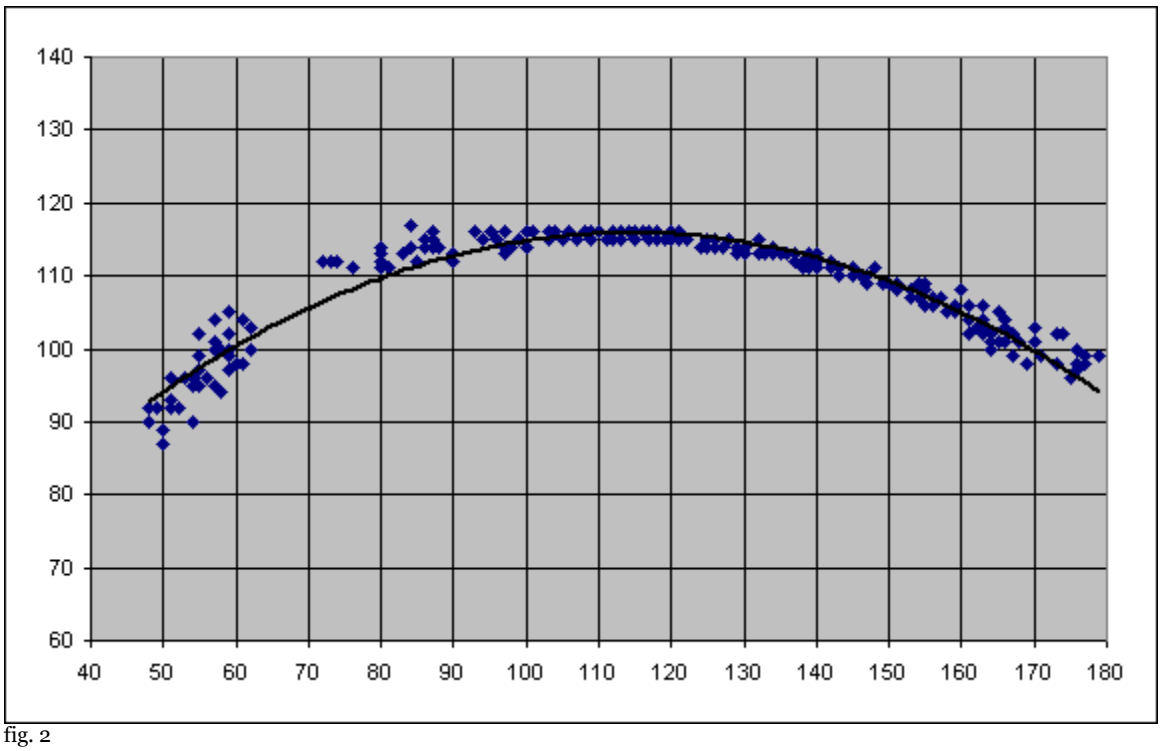

fig. 2

The most obvious features is the gap around (70, 105) were apparently no valid coordinates were obtained. It was suspected, that this gap was caused by obstruction of the ultrasound signal by a couple of lamps and a dimmer hanging from one of the beams on the ceiling. After removing the lamps, the gap was gone [fig. 3].

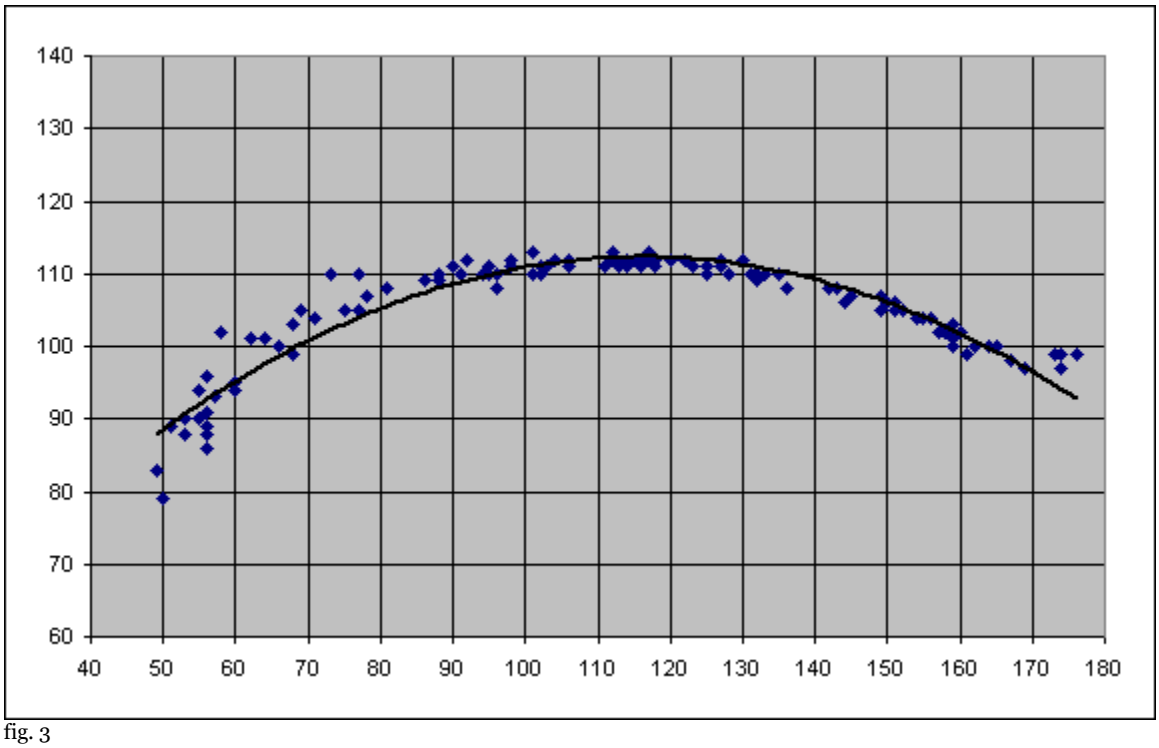

fig. 3

After moving the fan to a different position, the measurements again showed missing data, in the middle of the curve a gap was visible, and the right side of the sweep was missing entirely [fig. 4]:

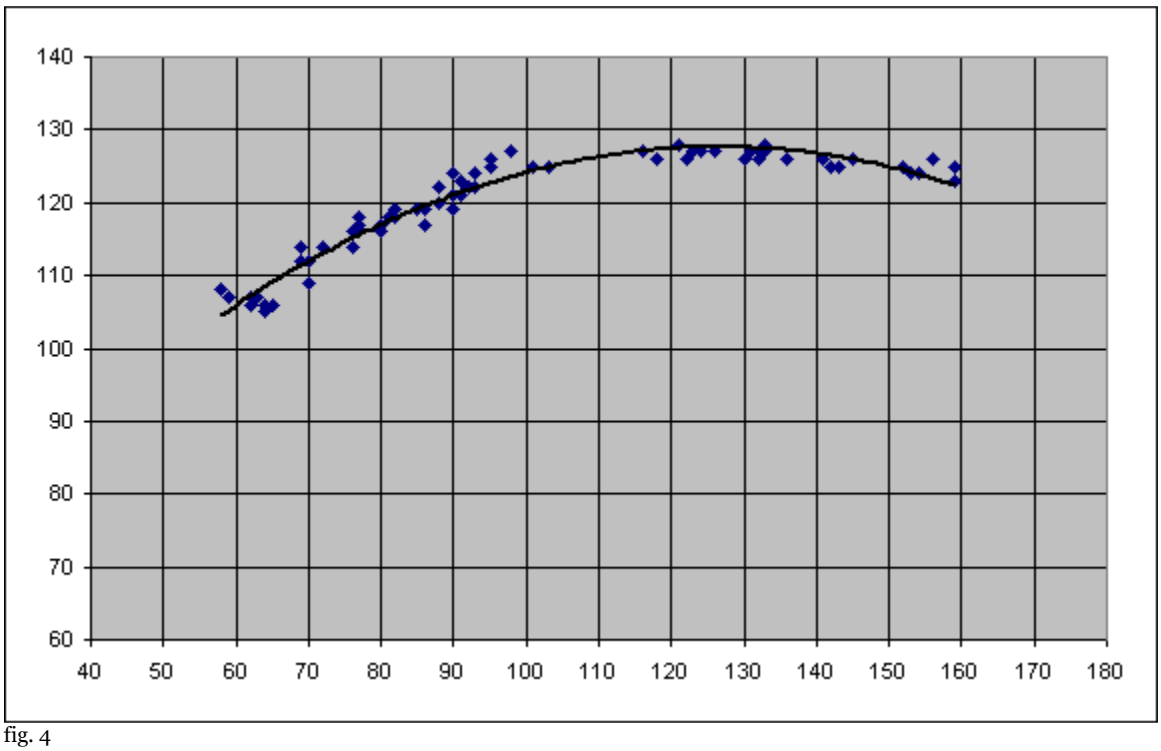

fig. 4

It appeared that the moving Cricket was not heard by at least three receivers (necessary for calculating 3-d position) and it appeared that the reception area was quite limited, the way the four receivers were set up. All four were facing straight down [fig. 5], and were spaced apart by 2.3 m along the X-axis and 3.2 m along the Y-axis.

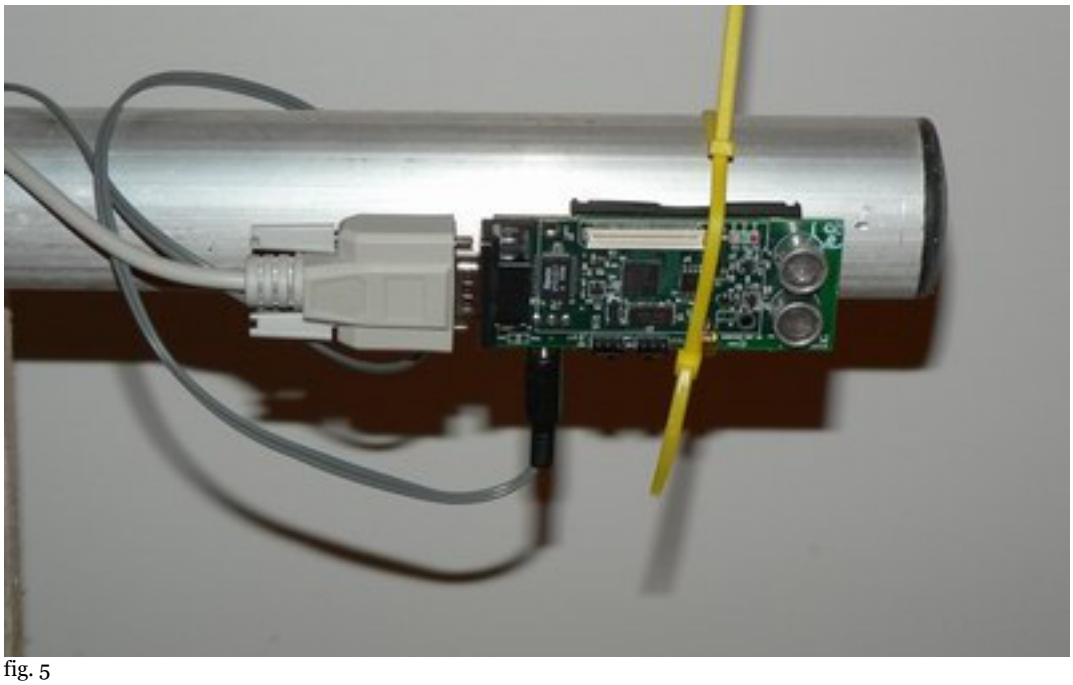

fig. 5

We decided to change the orientation of the receivers to aim directly at the centre area of the space, by moving one of the rear receivers to the middle, and removing the other rear-receiver altogether. So, now we had three receivers in a triangle, one left-front, a second right-front, and a third middle-rear. Furthermore, we adjusted the orientation of the receivers from face down to tilted by 45 degrees to aim directly at the centre of the space [fig. 6].

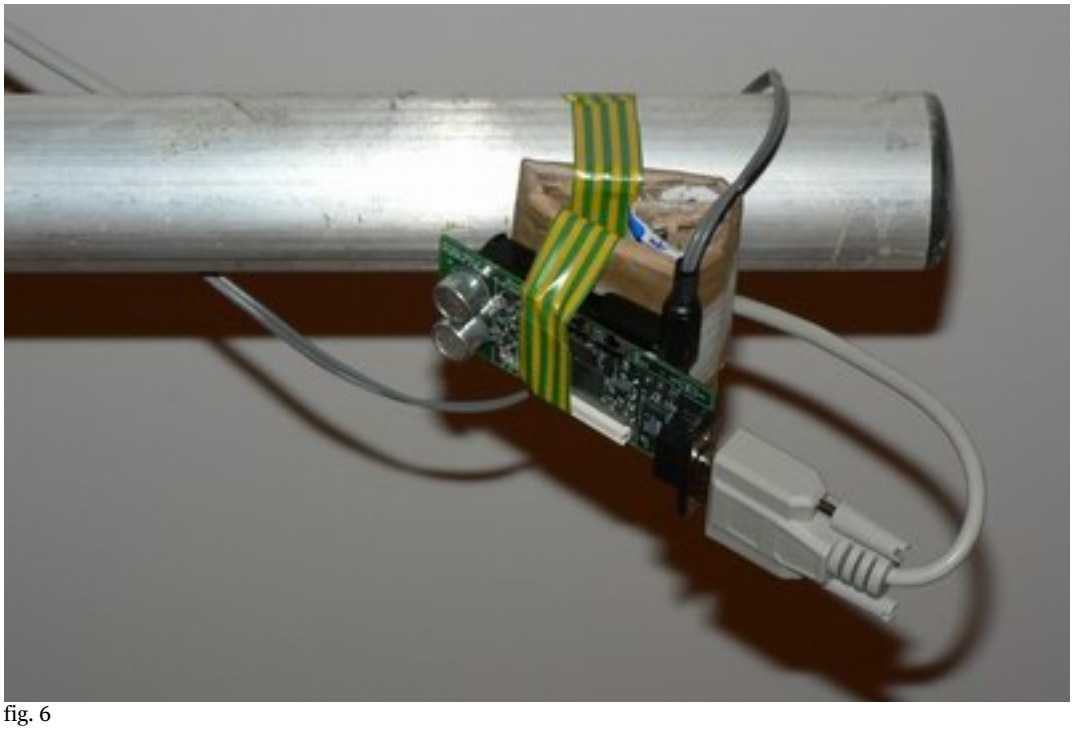

fig. 6

After this modification, we ran a second series of tests, which gave much better results [fig. 7, 8]:

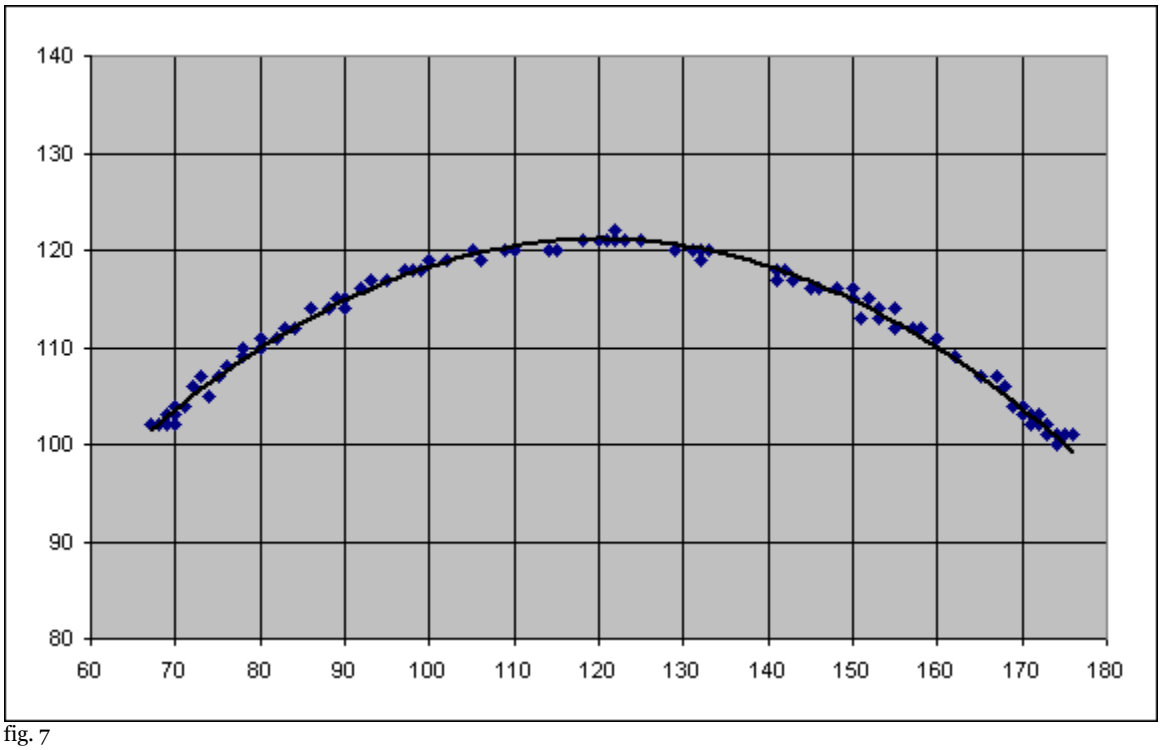

fig. 7

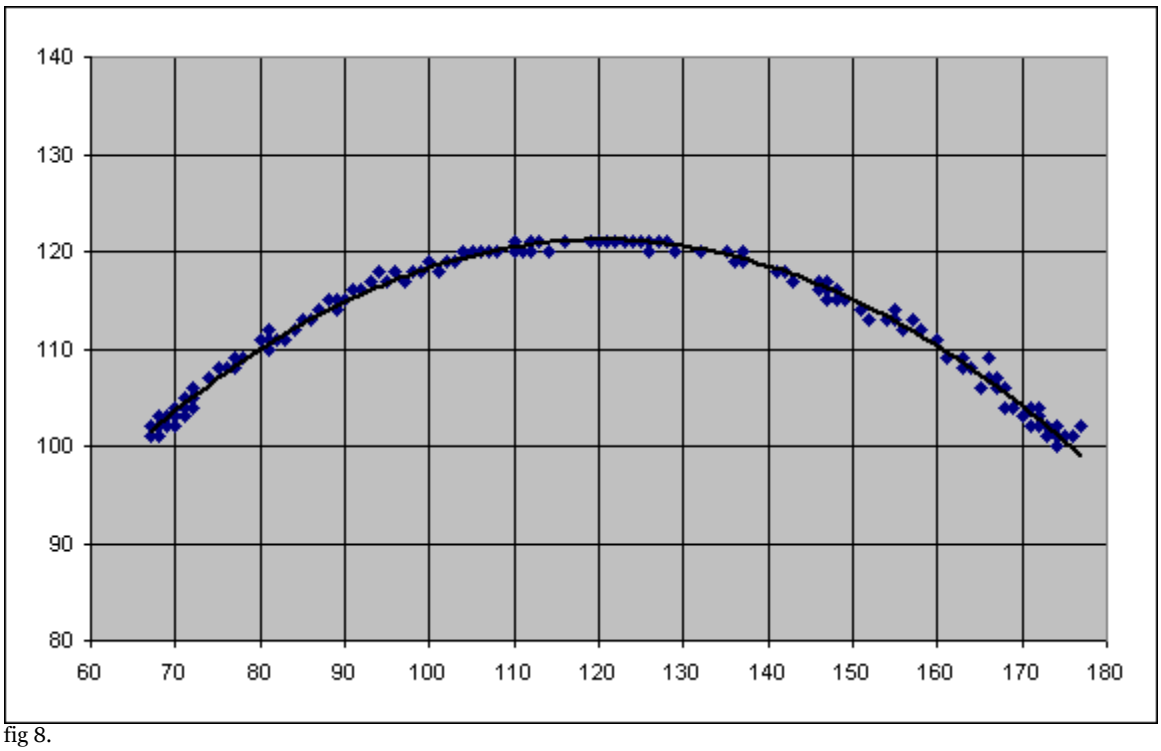

fig 8.

Having aimed the receivers properly, the accuracy of the Cricket Tracker was very high: to within 2 cm of the actual trajectory.

Directivity test

The need for aiming the Cricket receivers to the area of the moving target Cricket, reveals that the directivity of the Crickets is higher than expected. To get some quantitative data on the directivity, we tried to measure the boundaries of the reception area of a single Cricket receiver.
To do so, we used one of the ceiling mounted Crickets to act as a receiver, facing straight down, and placed a Cricket transmitter on a step ladder, facing straight up, directly under the receiver [fig. 9]. By pulling away the ladder in a straight line, and logging the continuously measured distance between the transmitter and the receiver to a file, we obtained a series of measurements up to the point were the cricket was out of range, and no distance measurement was obtained.

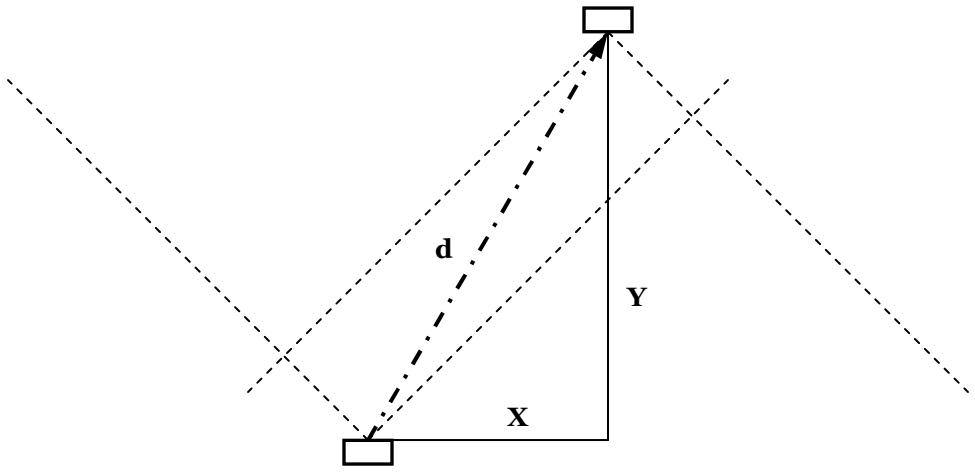

fig. 9

By placing the transmitting Cricket on different steps of the ladder and repeating the process, a series of measurements was obtained for varying values of Y (ranging from about 70 to 220 cm in 8 steps), resulting in distance measurements d [fig. 10].
In some cases, a reflected ultrasound pulse was received, resulting in a distance approximately three times too big, caused by reflection of the ultrasound signal via the ceiling and the floor to the receiver, instead of reaching it via a straight line.

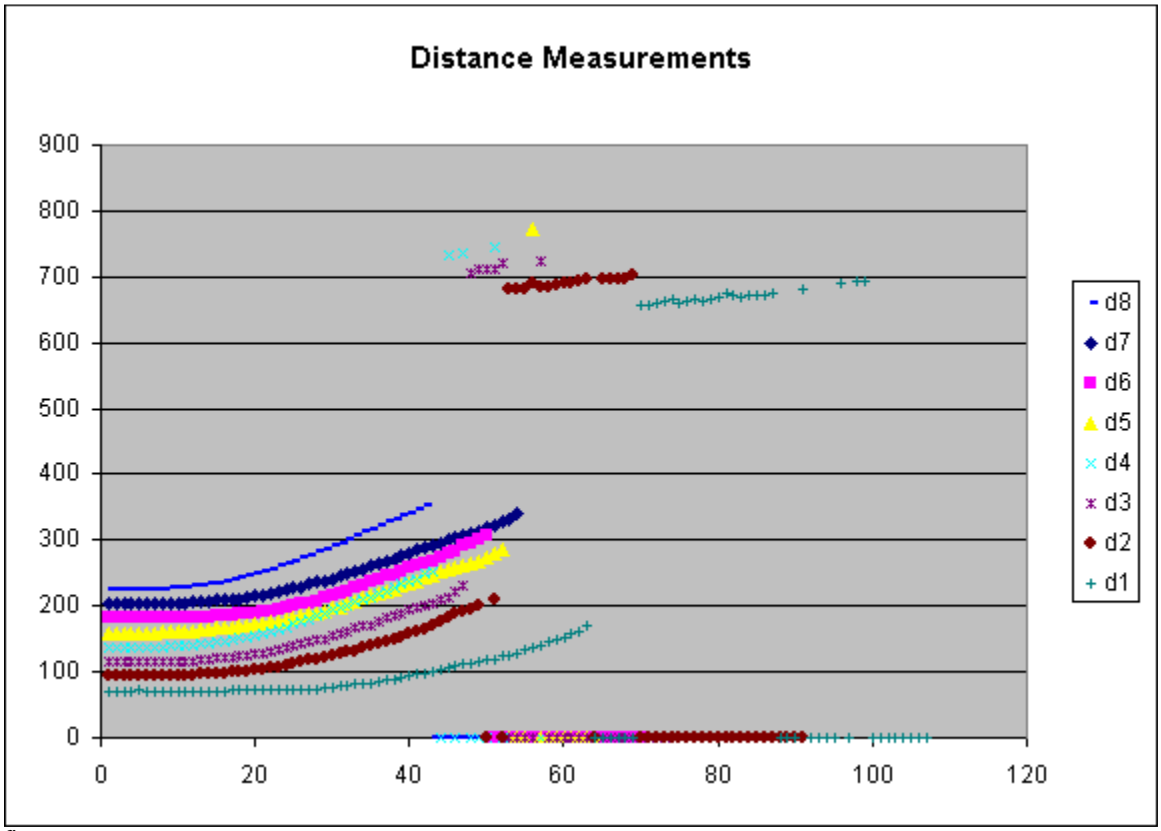

fig. 10

For higher values of Y, the setup was changed by mounting the receiver on a wall, facing horizontally to the opposite wall, and walking the handheld transmitter along parallel paths at a distance of 3 to 8 m from the receiver.

Using Pythagoras' theorem, the maximum lateral distance X could be calculated for each Y. Plotting the results gives us a graph of (half of) the reception area of the Cricket [fig. 11]. It is characterized by a wedge-shaped area (cone-shaped in 3-d), denoting the field of view, and limited by a circular shaped (spherical in 3-d) boundary, which is the maximum 'hearing' distance of the Cricket. The field of view appears to be about 90 degrees, and the maximum distance about 8 m.

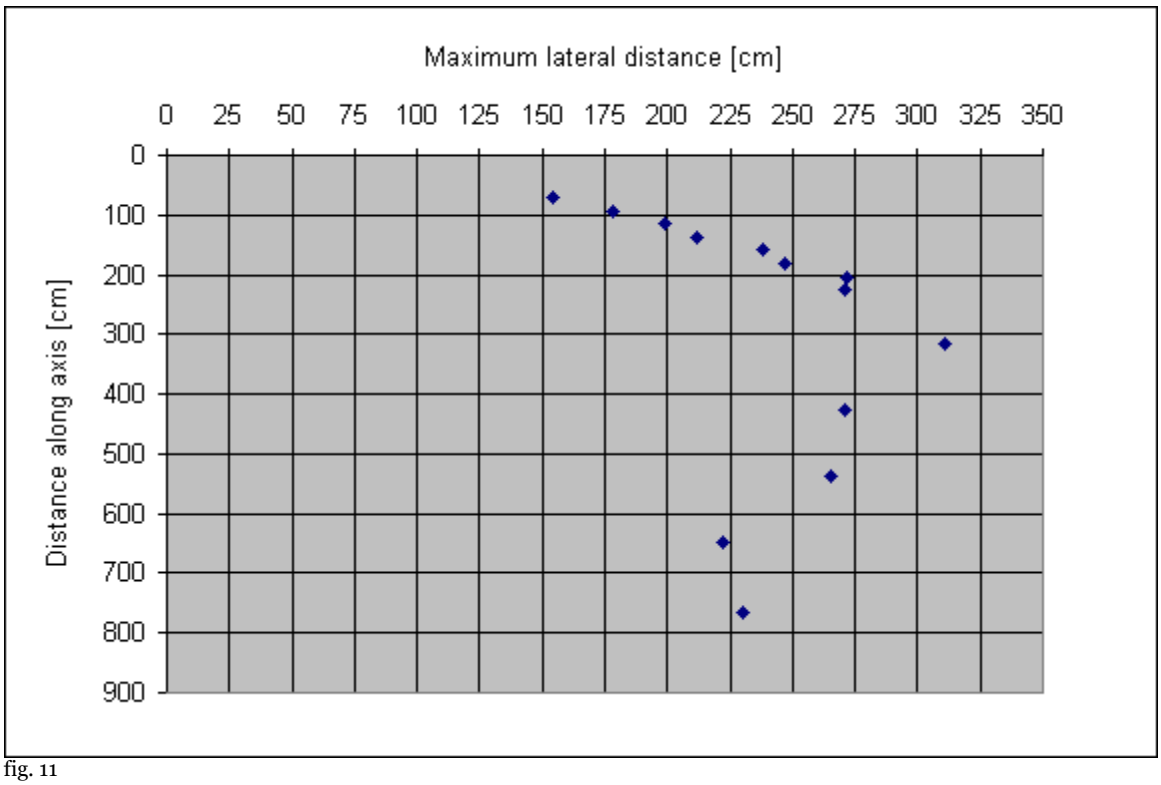

fig. 11

Cricket placement for tracking

To cover a certain area for tracking, we can calculate how far the Crickets are to be spaced apart, if mounted on a grid on the ceiling, facing straight down. If the Crickets are mounted at a height of at least 1.5 m above the tracked space, but not more than 8 m above the floor, each Cricket has a field of view roughly bounded by a cylinder of approximately 4.5 m diameter. Since at least three Cricket receivers have to be withing hearing distance from the tracked Crickets, they have to be spaced not more than 2 m apart, if placed on a rectangular grid, to ensure at at least 3 overlapping fields of view. For example: a stage area of 4 by 6 m requires 12 Crickets to cover it [see fig. 12].

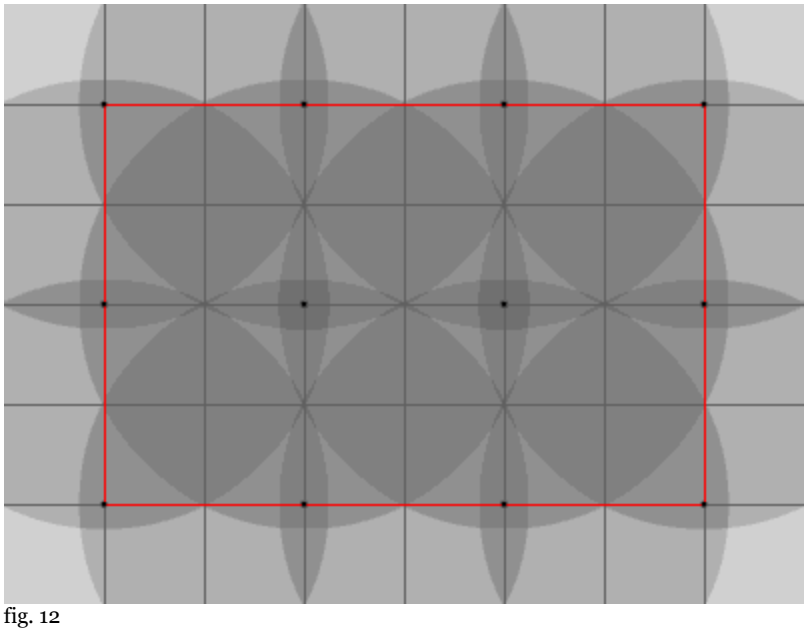
fig. 12