

MoBat Sound-Based Localization of Multiple Mobile Devices on Everyday Surfaces

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Mobile Media Group

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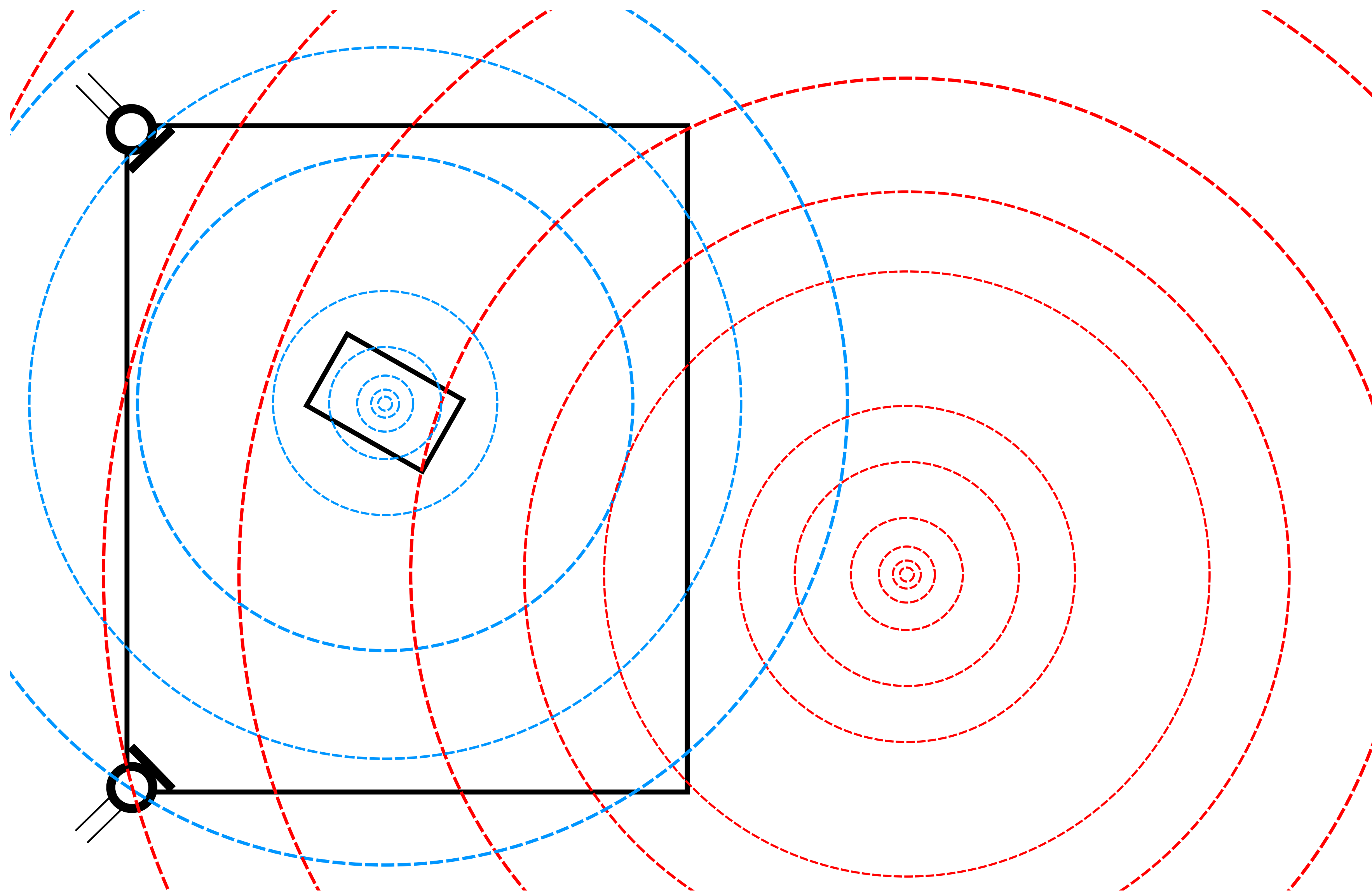
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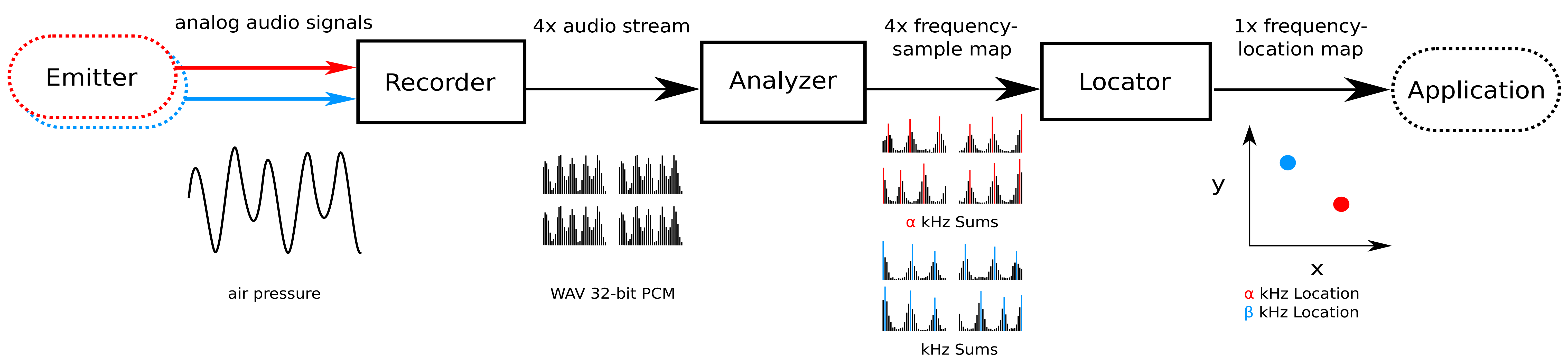
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ABSTRACT

We present MoBat, a combined hard- and software system designed to locate and track multiple unmodified mobile devices on any regular table using passive acoustic sensing.

Barely audible sound pulses are emitted from mobile devices, picked up by four microphones in the corners of a table and processed in a low-latency pipeline to extract position data. In contrast to other sound based tracking systems, MoBat is capable of continuously tracking multiple devices.



I RECORDER

In this stage the analogue signal of the ambient sound is recorded and converted to digital 32-bit PCM by the sound card.

The four microphones pick up the signal synchronously to allow calculation of the relative Time Differences of Arrival (TDOA).

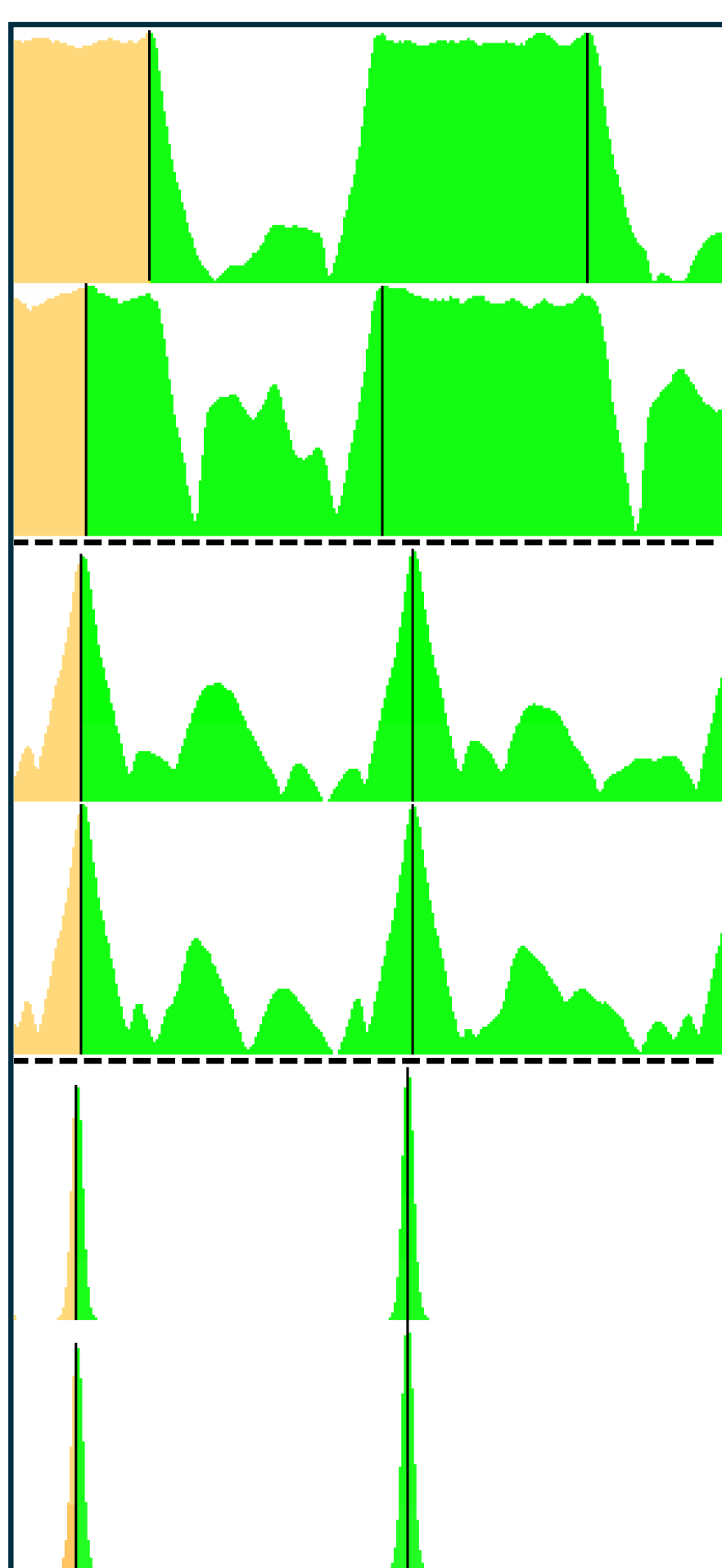
II ANALYZER

To retrieve information about the different frequencies, a series of short-time Fourier transformations is applied. Throughout several steps, such as normalization of the frequency sums, related peaks are matched. TDOAs for each of the recorded frequencies are determined using the peak positions.

III LOCATOR

The TDOAs imply the position of the sound source relative to each microphone. The table area is divided into a 2D grid. For each of the grid vertices, their and the sound source's distance to the microphone is compared. The emitter is considered to be located on the best matching vertex.

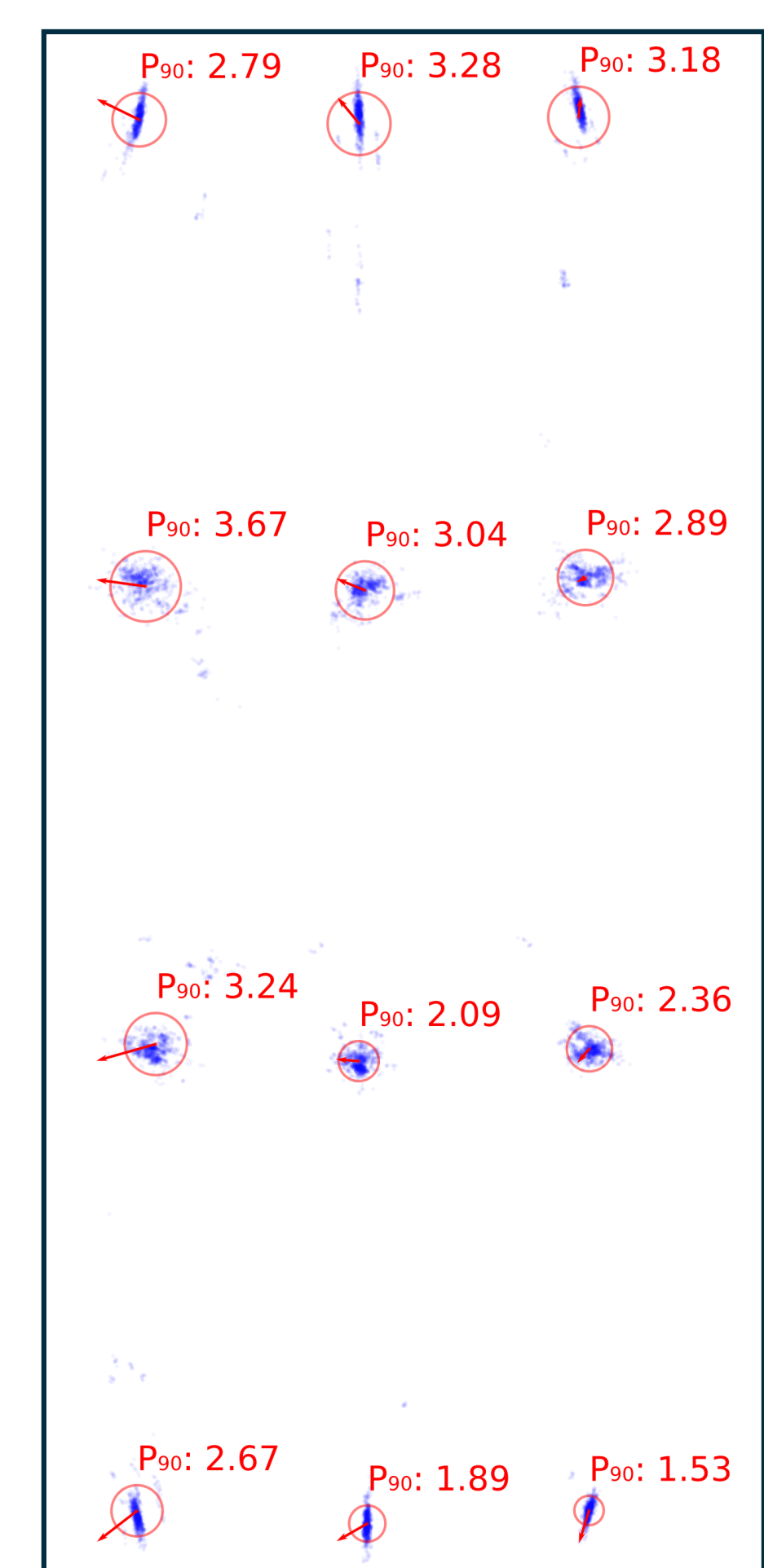
The accumulated amplitude of three different signal types. Green color indicates peaks matching between the channels. The upper two parts show signals with a different sine-pulse ratio. The last part shows a post-processed signal.



PERFORMANCE & DISCUSSION

Our system determines the position of the emitters 20 times per second. It has a maximum standard deviation of 2.2 cm and an average position error of 3.48 cm. It is therefore on par with similar tracking systems. Furthermore, MoBat is capable of tracking multiple devices simultaneously with comparable performance. The actual number of trackable devices is limited by the frequency response of the hardware. The position variance introduced by the continuous tracking approach is shown in the Figure on the right-hand side.

We consider MoBat as a low-budget system suitable for medium precision applications on flat surfaces.



Position distribution of one smartphone placed at different positions on a 1x2 m table. The located points are shown in blue. The red arrow indicates the shift of the mean position to the original position of the smartphone. The red circle indicates the 90th percentile.