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# RFRB0413 RF Ranging Base (Preliminary)

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## Features

- High-accuracy RF ranging capabilities
- Line-of-sight accuracy as low as  $\pm 5$  cm
- Non-line-of-sight accuracy as low as  $\pm 10$  cm
- 45+ meters outdoors range
- 30+ meters indoor range
- High-resolution, milli-meter tracking capabilities
- High tracking update frequency at up to 100 Hz
- Based on Atmel AT86RF233, low power, 2.4GHz transceiver for ZigBee, RF4CE, IEEE 802.15.4, 6LoWPAN, and ISM applications
- Powerful Atmel AT91SAM3S Cortex-M3 micro-controller with 256 kBytes of flash, 48 kBytes of SRAM, and running at up to 64 MHz.
- Large 64x128 dot-matrix LCD
- High-Speed USB serial CDC interface
- Simple 4-Button user interface for standalone applications

## Applications

- Asset tracking
- Robotics (aerial & terrestrial)
- Security

## Description

The GreinaTec RF Ranging Base (RFRB) is a high-accuracy ranging and tracking device that uses regular radio frequencies in the 2.4 GHz ISM band to measure the distance between two RFRBs at centimeter accuracies, and allows to track at milli-meter precision.

The RFRB comes packaged with a 1200 mAh Lithium-Polymer battery, allowing the RFRB a runtime of approximately 17 hours at a full charge. A standard 2.1 mm 5 V barrel plug allows for an easy recharging of the battery once they are depleted.

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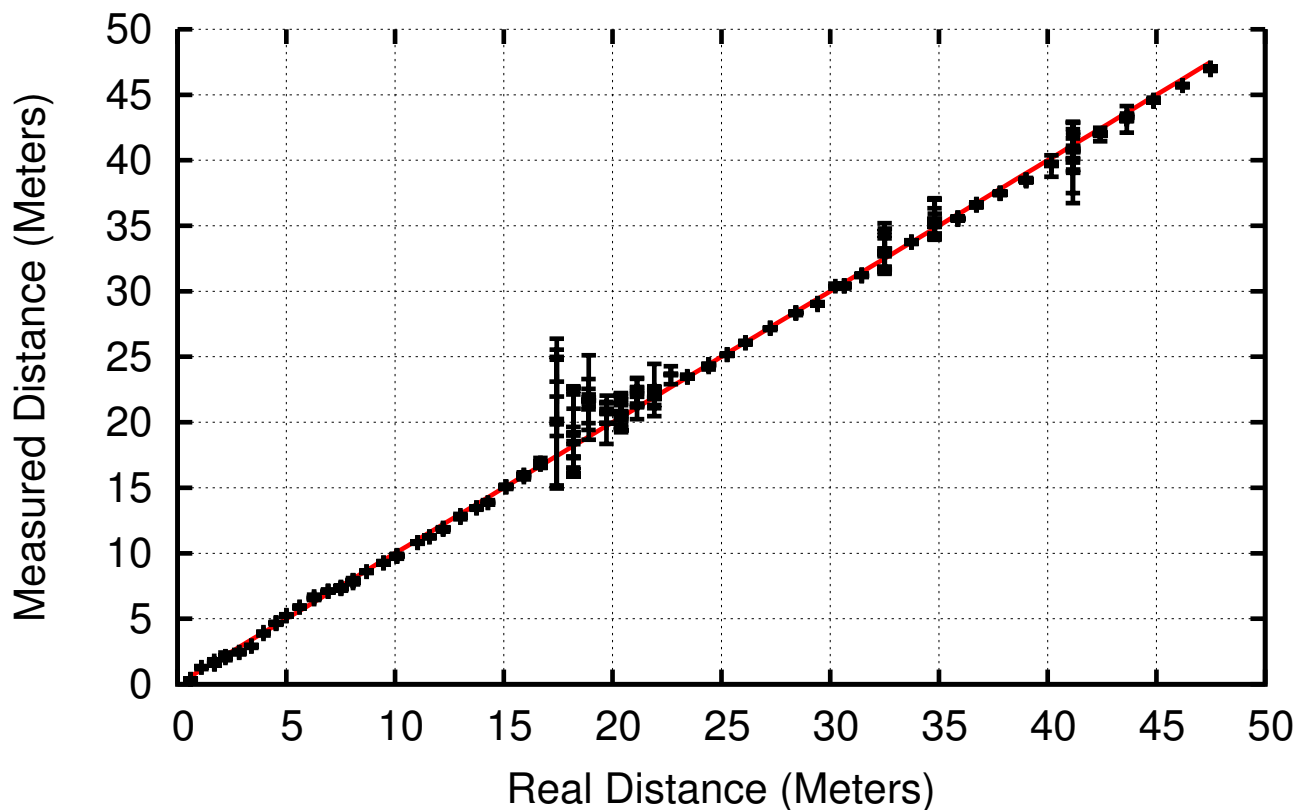
# 1. Typical Performance Characteristics

## 1.1 Absolute Ranging Accuracy - Line-of-Sight

The following figure depicts the absolute ranging accuracy, including 95% confidence intervals. The absolute ranging accuracy is on the order of tens of centi-meters over the range of 0-48 meters.

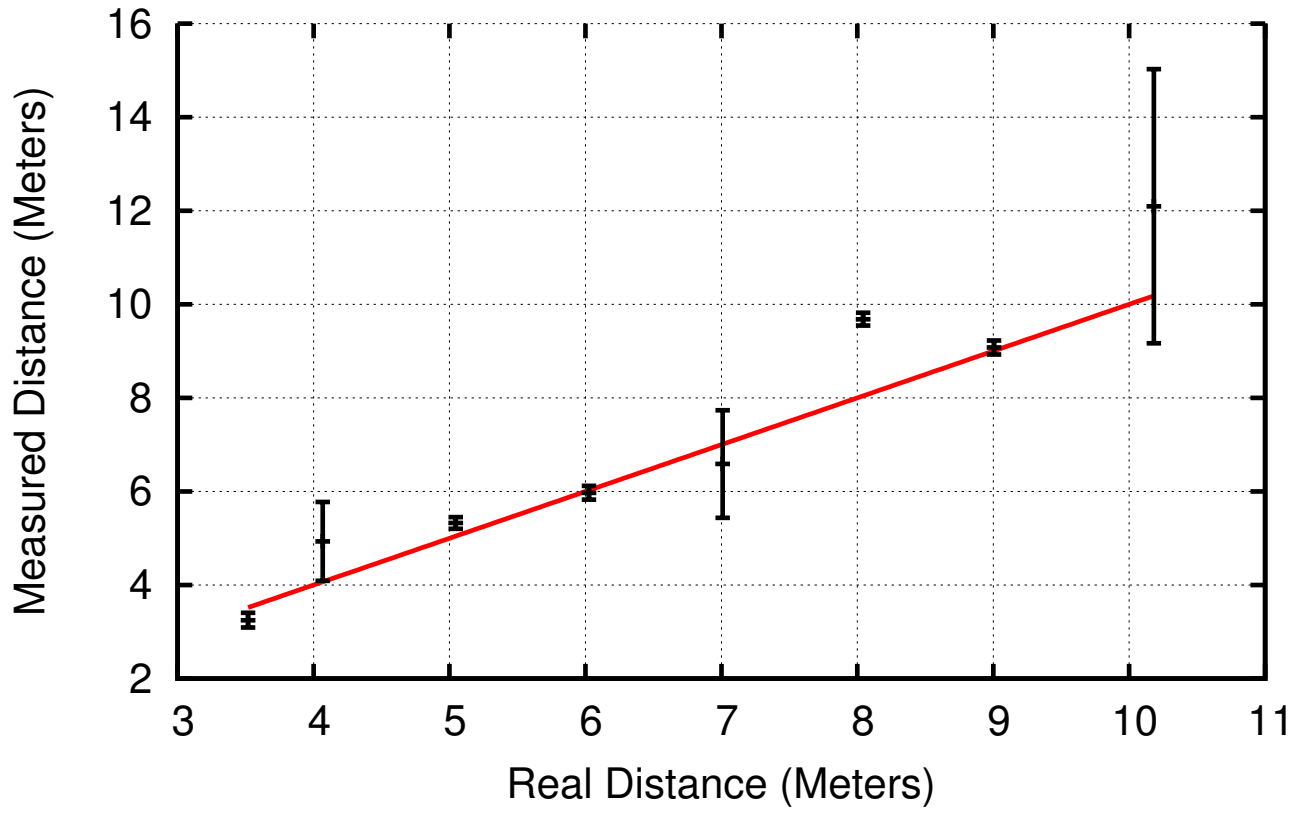
There are two areas, one around 18 meters, the other around 33 meters, where the accuracy is significantly worse. These are probably ground-bounce as well as multi-path effects of the line-of-sight setup. Future software updates will detect these scenarios, and mitigate the problem by identifying the proper ranging path.

The environment was a direct-Line-Of-Sight path (LOS), over concrete, with the nodes elevated by about 100 cm from the ground.



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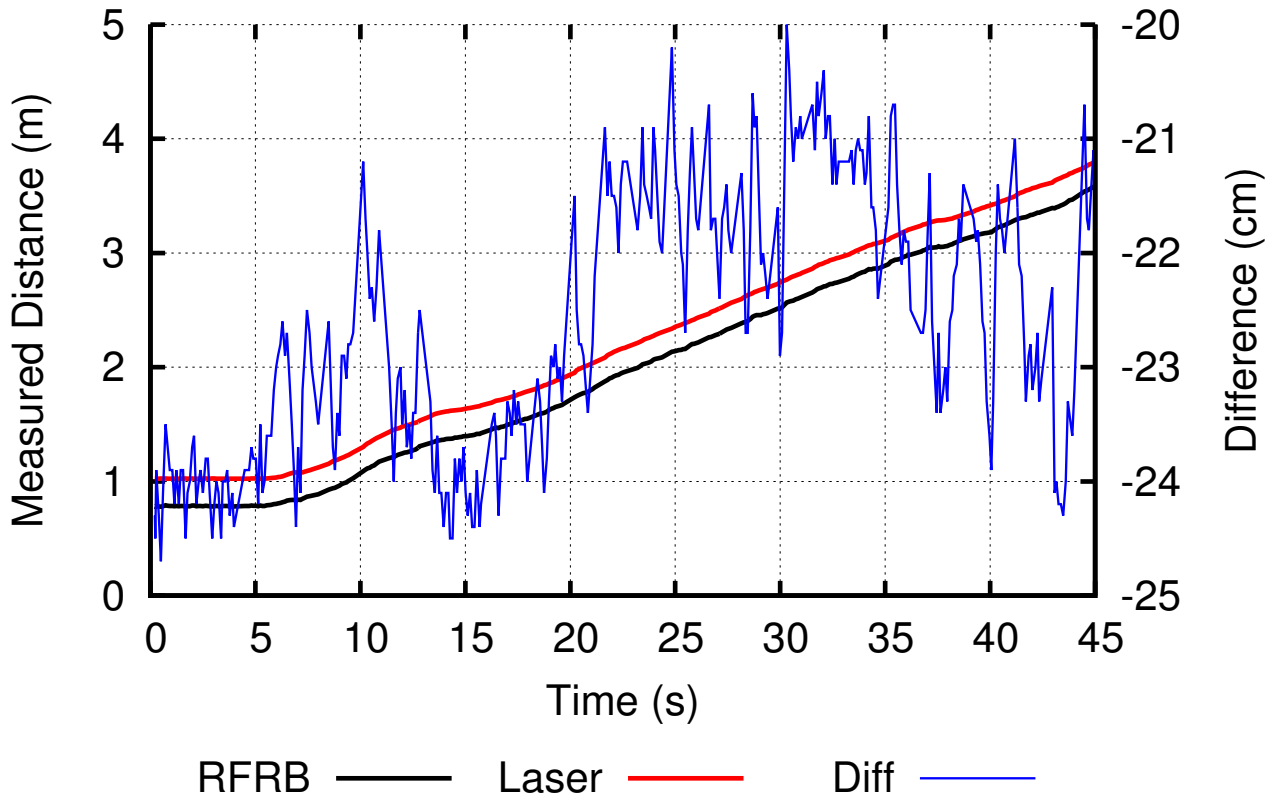
## 1.2 Absolute Ranging Accuracy - Non-Line-of-Sight



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## 1.2 Tracking Accuracy

The following Figure shows the tracking accuracy while moving one of the nodes from a distance of 1 meter, to ~ 4 meters. We measured ground-truth using a laser range finder collecting range measurements at the same time as we tracked the moving RFRB with our technology. We attribute most of the error to a synchronization issue between the laser range finder, sampling the distance at a few samples per second, compared to the RFRB sampling at 70 samples per second. We observe this in scenarios where the error is lower while moving slower (seconds 12-17 in the figure below).



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