Instrumentation Technologies

# Libera Single Pass H
# General measurements and testing at CIEMAT

# 1 Measurements in laboratory at Instrumentation Technologies

Initial measurements and verification of the unit performance were conducted in the laboratory at Instrumentation technologies. The measurements were performed under various conditions, at different RF frequencies and signal levels. The geometrical coefficients were set to the default value of 10 mm.

## 1.1 Evaluation at 324,224 MHz

The unit was first evaluated by means of a power sweep in a 60 dB range at 324,224 MHz. A bipolar pulse signal generator based on PIN diode has been developed to simulate the pickup signal with amplitudes of ±4V. The system was set-up for the measurements of the second harmonic frequency component (650 MHz) of the pickup signal in order to avoid the coupling between the RF system and the diagnostic system through the vacuum pipe.

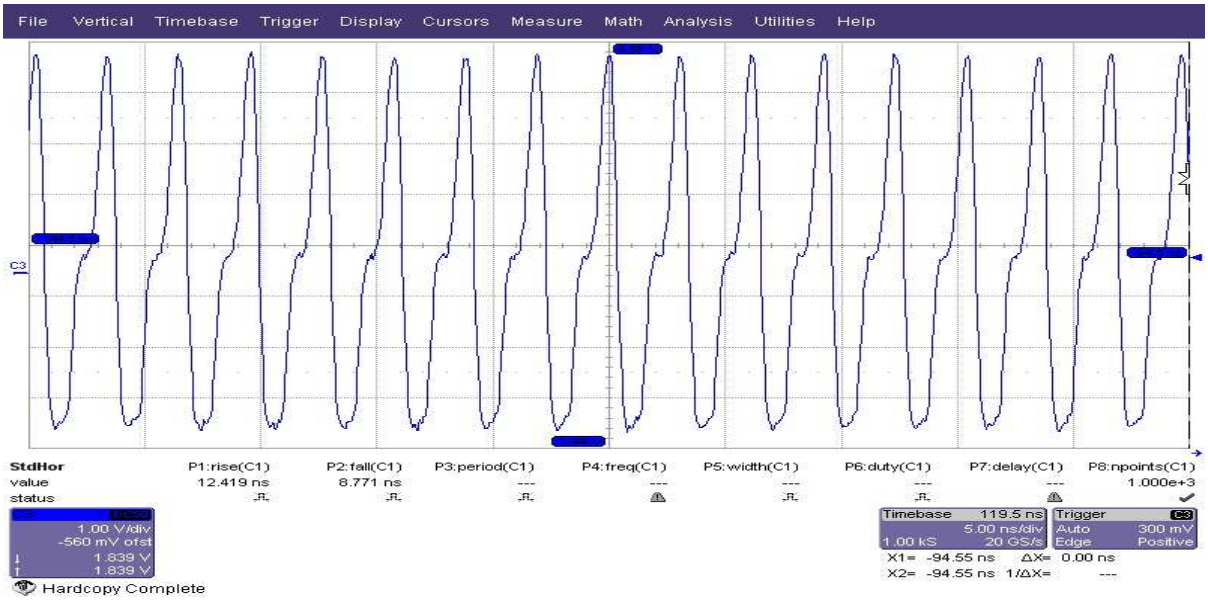



**Figure 1: Pulse generator signal**

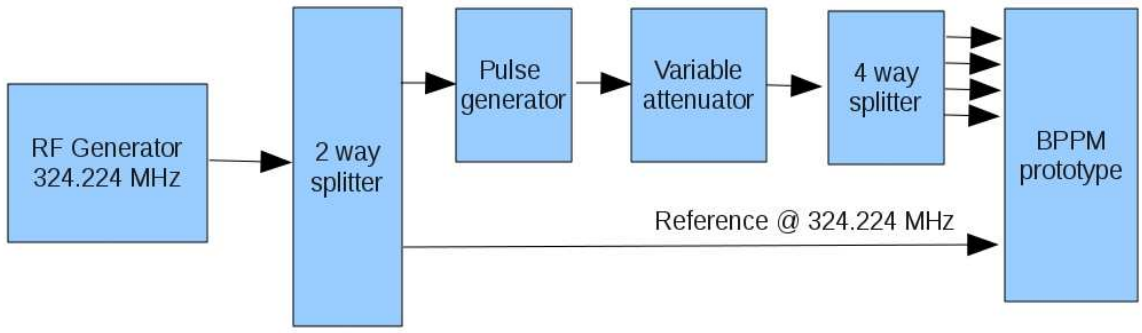



**Figure 2: Setup of the measuring chain**

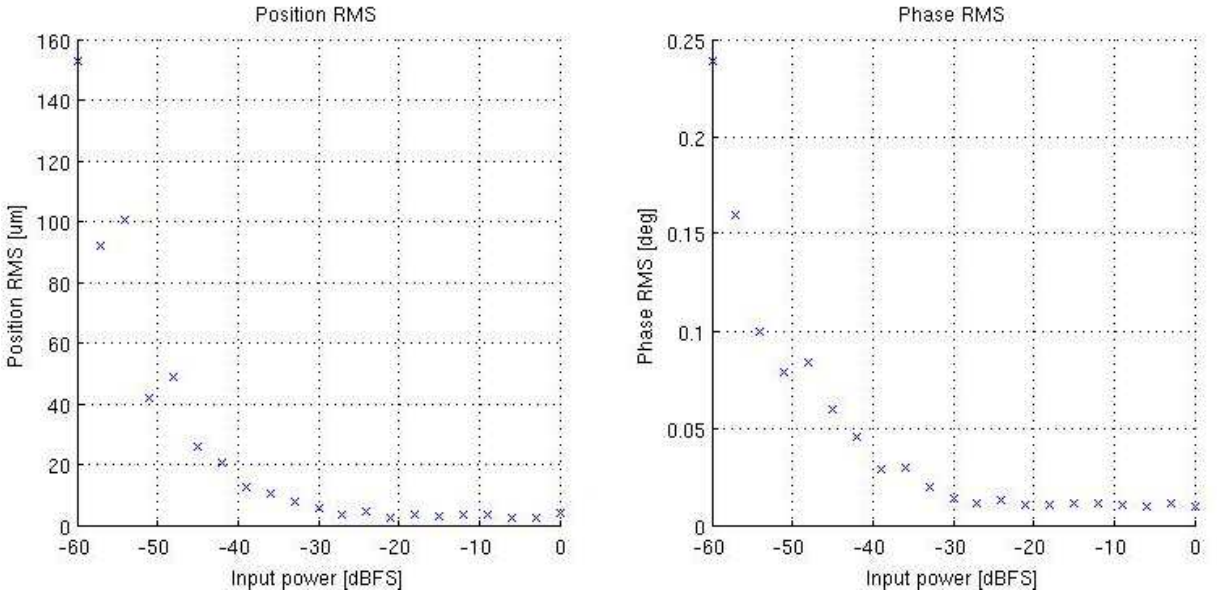



**Figure 3: Measured position and phase uncertainty in the range of 60 dB at 650 MHz (0 dBFS corresponds to ±4V input.)**

## 1.2 Evaluation at 175 MHz

As second, the tests were performed at 175 MHz input signal. The system was set-up for the measurements of the second harmonic frequency component (350 MHz). The data was acquired at 1 MS/s output rate.

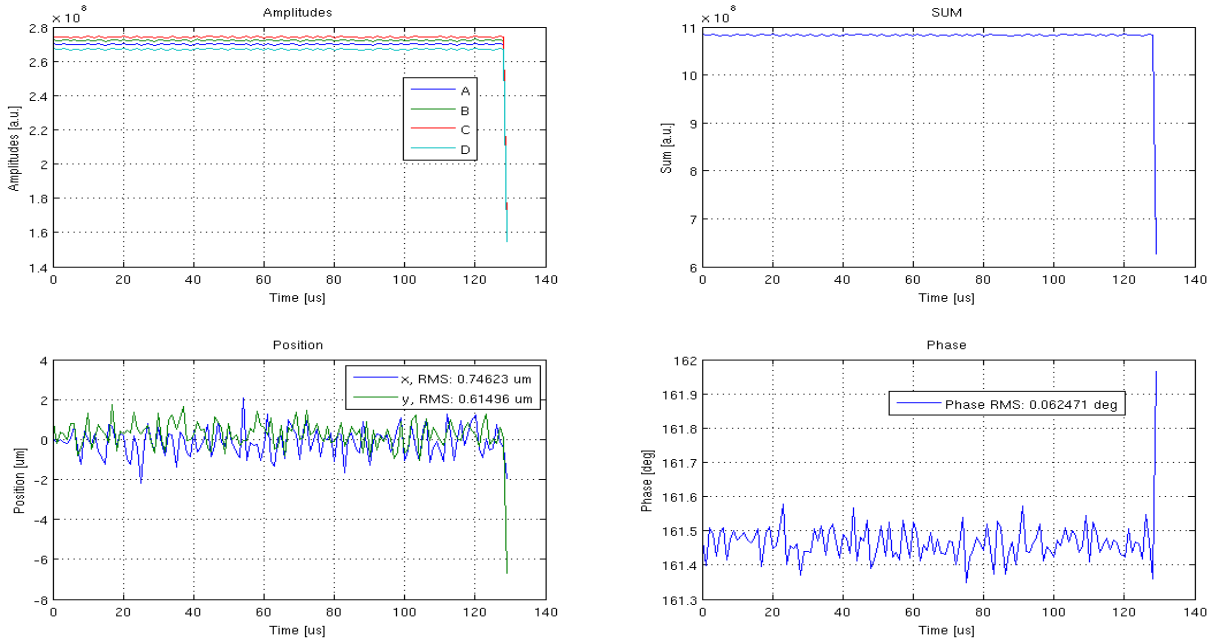



**Figure 4: Acquisition and processing of 120 us long signal at 1MS/s output rate.**

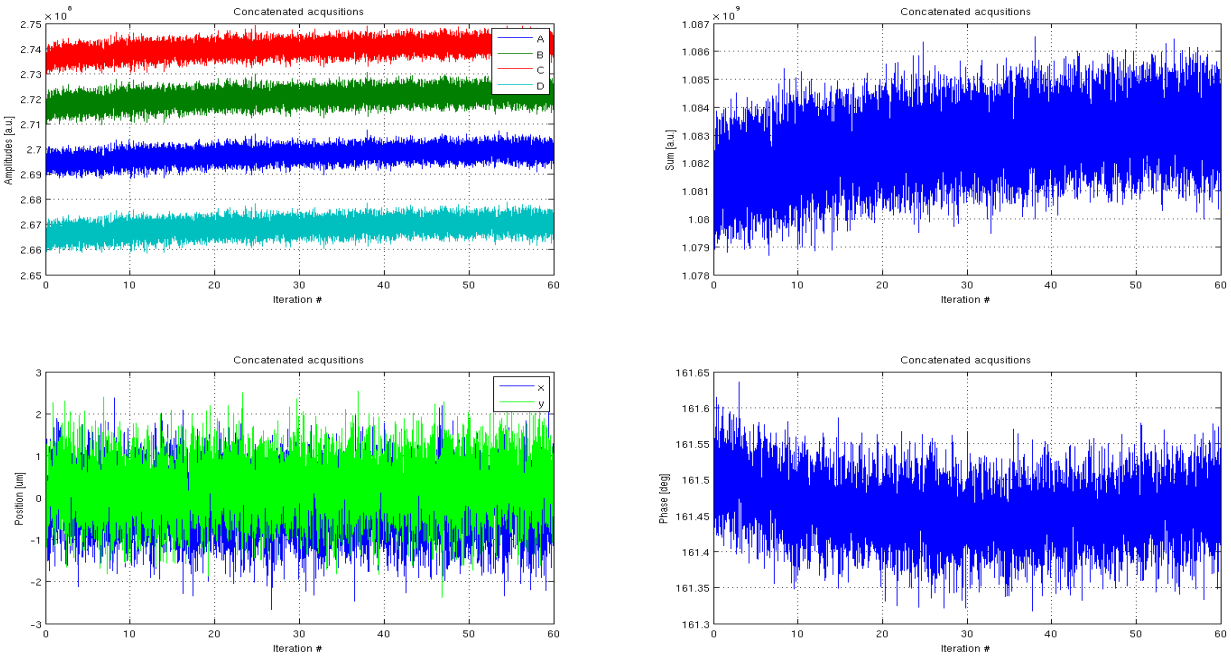



**Figure 5: Long term acquisition over 1 minute; 120us window was acquired every second at 1MS/s rate.**

# 2 Measurements at CIEMAT

Characterization measurements of the same electronics unit were carried out at a CIEMAT lab together with the CIEMAT accelerator unit. The measurements were performed on a CIEMAT wire test bench with the 175 MHz / 10 dBm signal input connected to the wire. The Libera single Pass H system was set-up for the measurements of the second harmonic frequency component (350 MHz). The geometrical coefficients of the test bench sensor were k=12.8 mm.

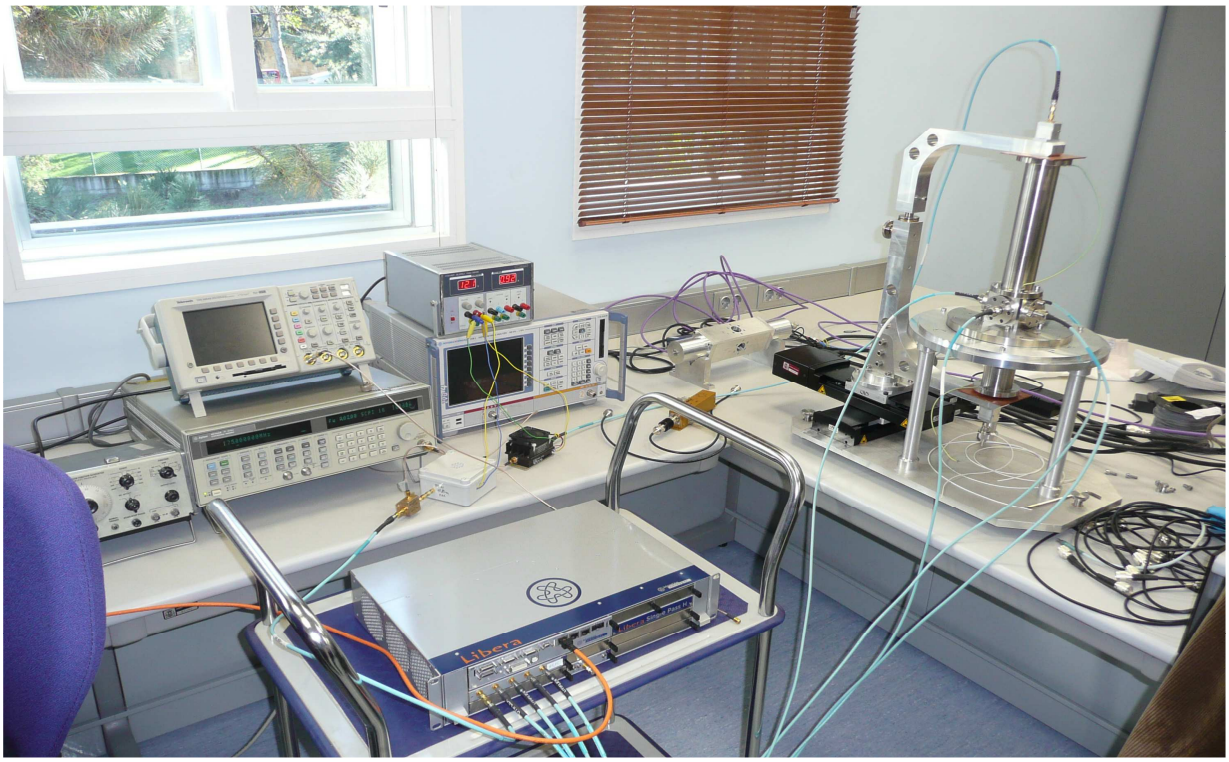



**Figure 6: Testing setup at CIEMAT: Generated signal is connected to the wire at the top of wire test bench), four button-type electrodes are connected to Libera Single Pass H (in front), just besides the reference signal input. The wire position may be controlled in X and Y by means of two stepper motors (black)**

## 2.1 Wire movements

Different measurements were performed on the test bench, first by moving the wire over larger displacements and checking the position. From each 120us long macro acquisition one position and phase result was extracted. Below figures shows concatenated macro acquisition information. In such a way the repeatability of the Libera single Pass H was measured. Below figure shows the wire movement measurement concatenated results for the displacements over a larger scale (x = +1 mm, -1 mm, +2 mm; y = 0 mm). The results prove that the impact on the phase measurement of an off-centered beam within the measured range may be neglected.

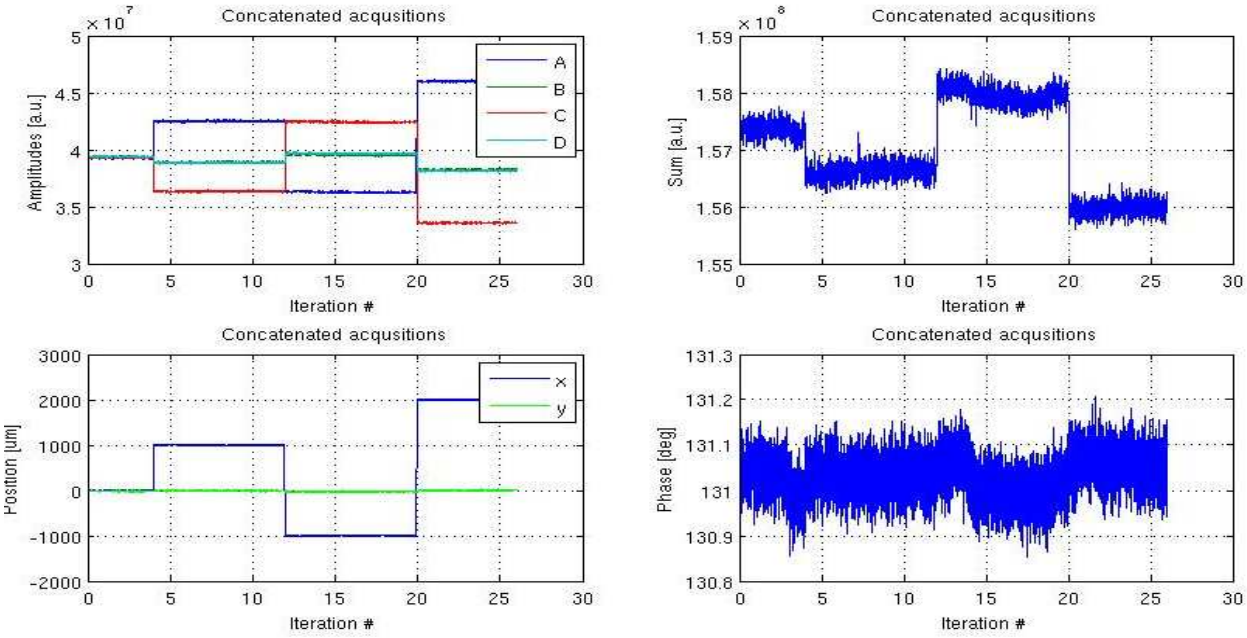
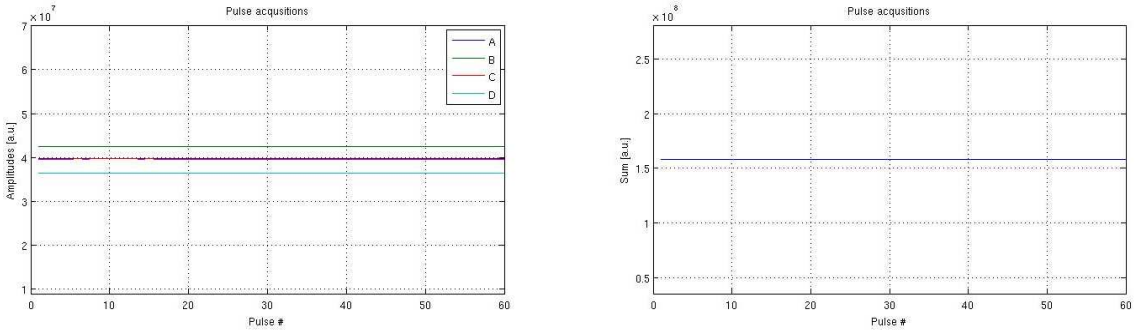
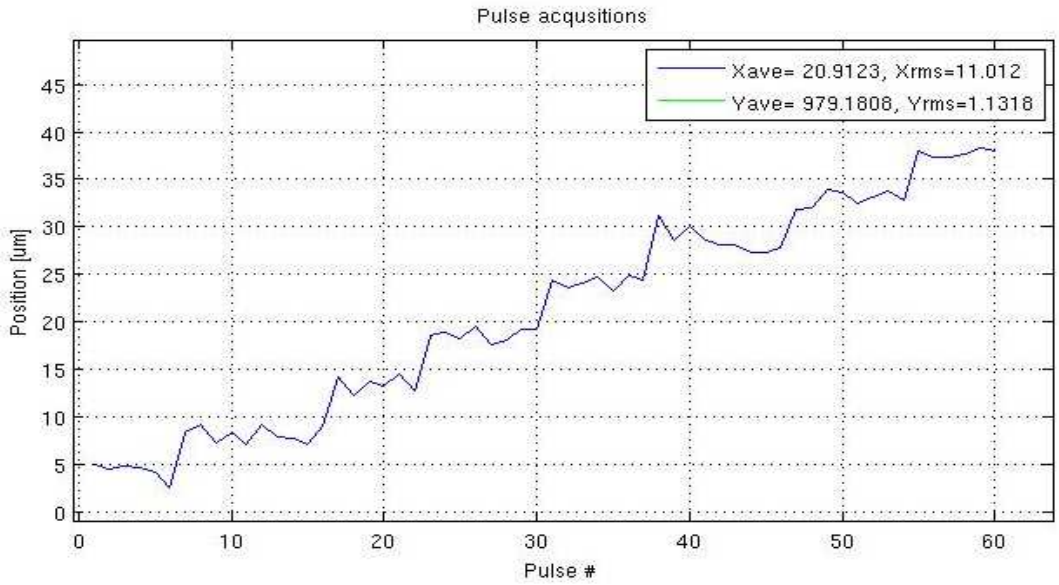



**Figure 7: Measurements of wire positions at a large scale (x = 0 mm, +1 mm, -1 mm, +2 mm; y = 0 mm).**

Furthermore the wire was moved in continuous steps of 5 micrometers in x direction, to prove the performance of the Libera Single Pass H system. Below figures show the x-position measurement performed during the displacements within 60 seconds – one data point per second. The phase resolution of this measurement was noted to be 0,0259 deg.



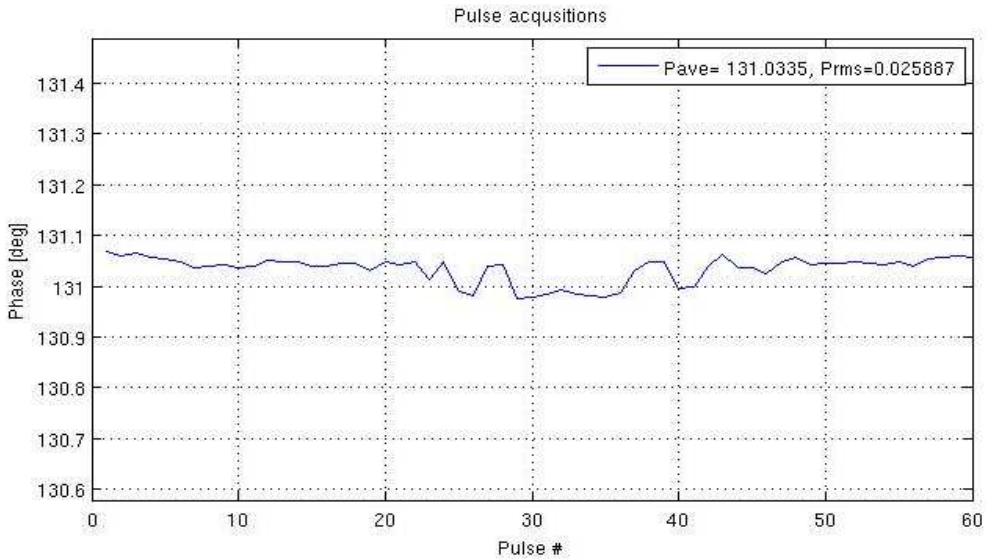




**Figure 8: Wire movement – by 5 um steps in x-direction. 7 steps are seen in position measurement .**

## 2.2 Acquisition of the macro pulse structure

In this measurement input signal was in the form of macro pulses using an external trigger. The signal acquisition by Libera Single Pass H was triggered by an external synchronized trigger. 10 consecutive pulses were acquired, each over 120 microseconds. The Libera Single Pass H system conducted measurements with submicron resolution for X and Y position and phase resolution of 0,0074 deg.

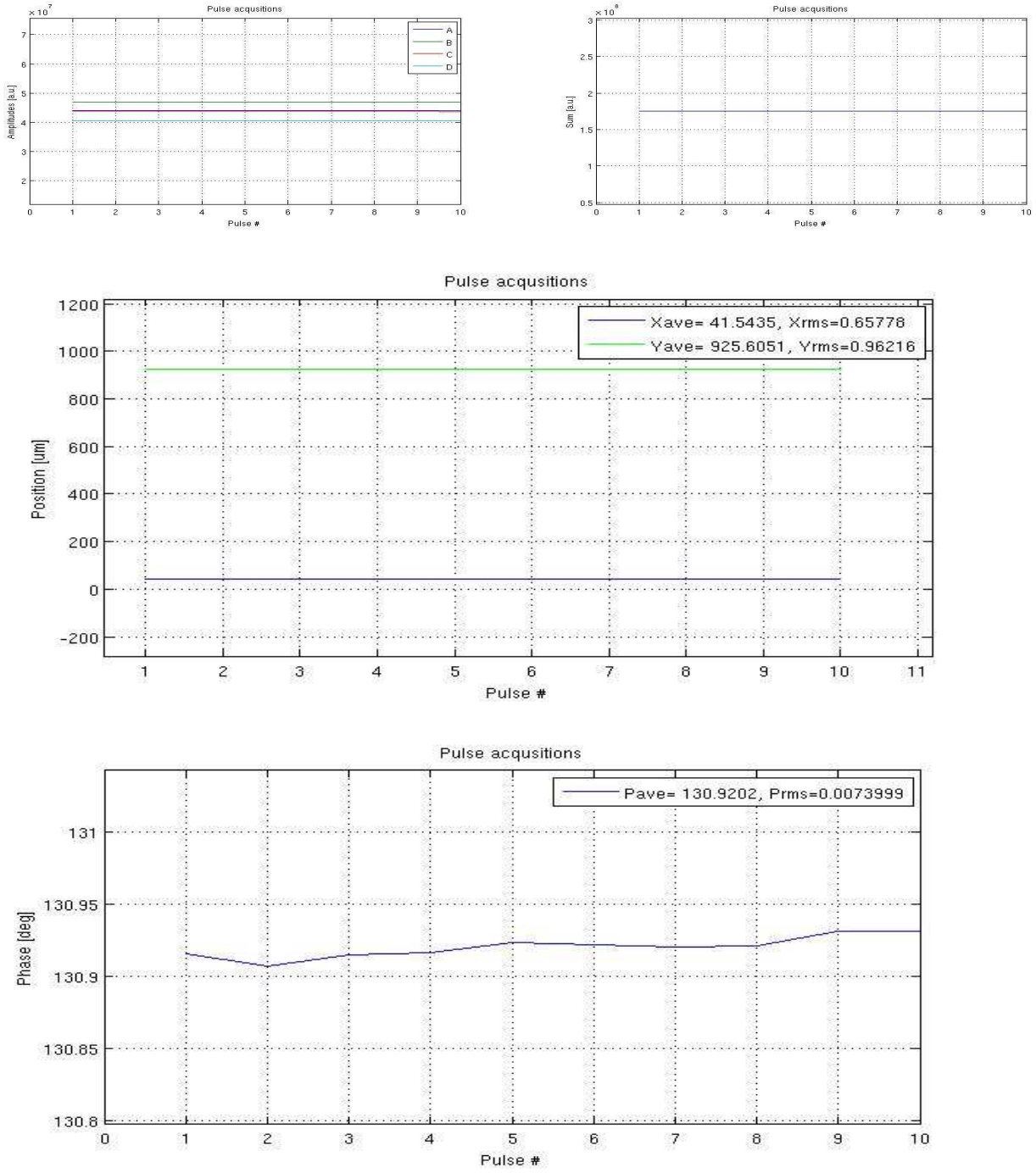



**Figure 9: Macropulse acquisition, each over 120 us.**

## 2.3 Phase Shifting

The phase shift measurement was done with inserting the phase delay bullets into the RF chain and running two acquisitions. This is not the most elegant solution, because in this way we **interfere in the measuring setup** and the phase shift is not acurate. The phase shift measurement will be repeated with the dedicated phase shiftig device.

| No. of phase delay bullets | Measurement 1 [deg] | Measurement 2 [deg] |
|---|---|---|
| 0 | 131.089 | 131.097 |
| 1 | 122.19 | 122.201 |
| 2 | 114.35 | 114.38 |
| 1 | 122.54 | 122.62 |
| 0 | 130.41 | 130.71 |