

PSR Base Unit Training Exercise Manual

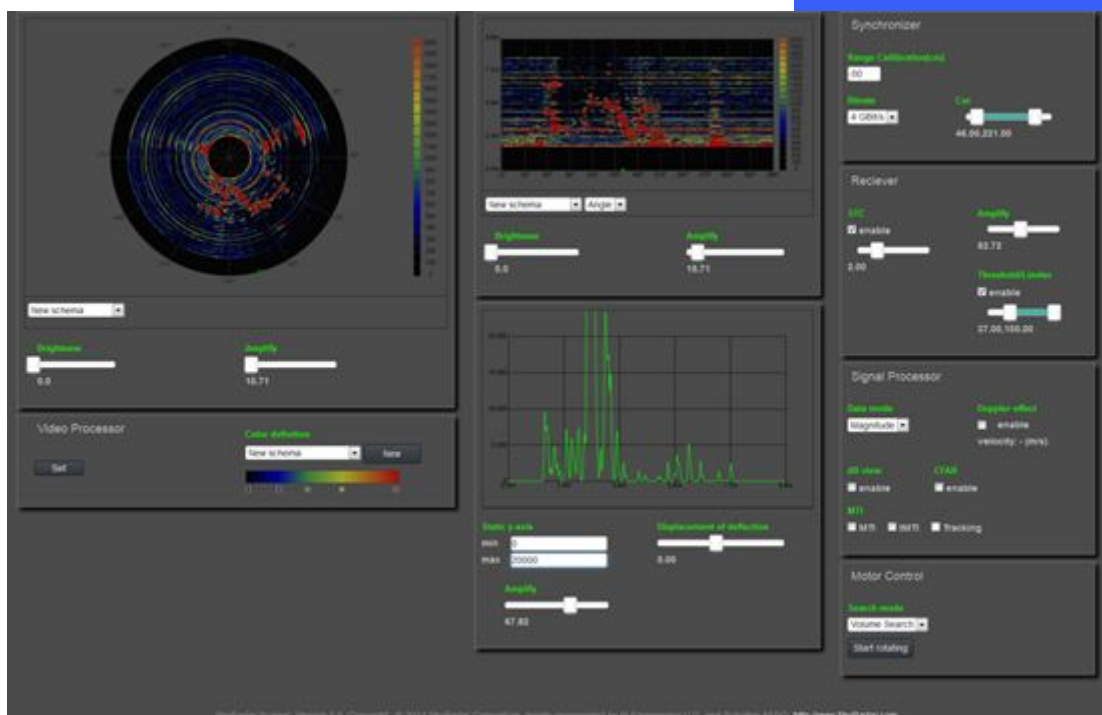


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PSR Base Unit – Exercise Training Manual

1 Range Resolution

1.1 Abstract

Demonstrating the relationship between bandwidth (here: the bitrate) and range resolution (here the end of the range scale in PPI screen). Caused by the fixed number of range cells increasing the dimension of the resolution cell increases as well the unambiguous range. But the transmitted power is limited – the real maximum range depends on the conditions of the fundamental radar equation. Thus there are two independent limitations in radar: the pulse period and the energetic conditions.

1.2 Performance Indicators

- Learners will be able to understand and interpret the relation between bandwidth and range resolution.
- Learners will be able to identify the most suitable range calibration to receive the best image.
- Learners will be able to understand and interpret the results indicated in the different scopes

1.3 System Set up

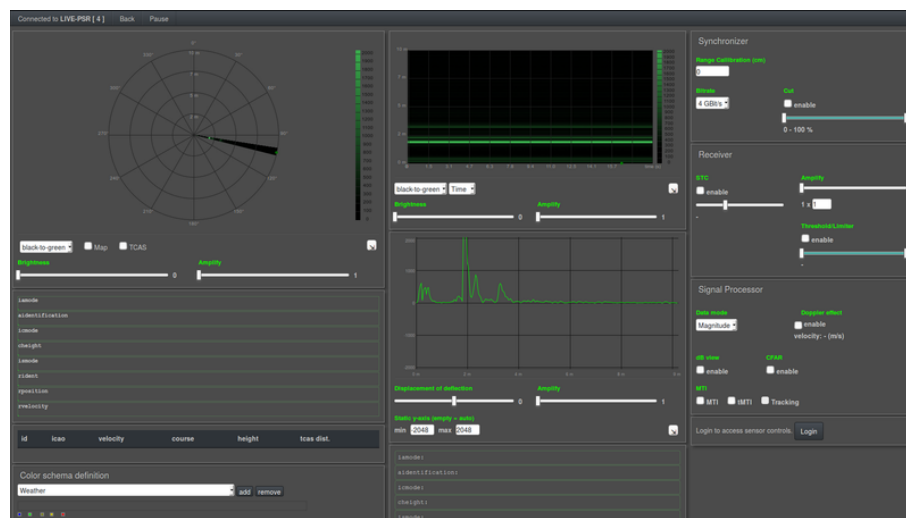
The radar will be placed on the rotary tripod, however the tripod will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

1.4 Experimental Procedure

Try to find a cross section of a target. Recognize the distance of the target in the A-Scope. After changing the bitrate to a lower value as 4 Gbit/s, the position of the target is changing. The distance scale maps to the real distances. Changing the bitrate affects the maximum distance and the resolution. The higher the bitrate is, the higher the resolution is and the lower the maximum distance is. To demonstrate the range resolution, two objects should be placed near by each other. You should see two different cross sections generated by the targets in the scope. When changing the resolution to a lower bitrate, the two cross sections are nearer by each other, until they looks like one cross section. This is the range resolution.



2 Sensitivity Time Control / STC Filter

2.1 Abstract

Demonstrating the Function of Sensitivity Time Control (STC). The echo signal of an e.g. corner reflector should have approximately the same amplitude both in range of 8 meters and in range of 2 meters.

Students can define the exponent of the STC and then observe the effect on their own screens. Normally we expect that as explained by the radar fundamental equation this is an exponent corresponding to the fourth root. But other exponents have a better effect by the better pulse integration in near range.

In long range radars there is additionally the effect of the curvature of the earth to decrease the fixed clutter in longer range. Therefore the exponent 2 or 3 is used mostly.

2.2 Performance Indicators

- Learners will be able to understand and interpret the relation between STC exponent and the impact on the radar images in the scopes.
- Learners will be able to calibrate the STC settings to receive a good radar image.

2.3 System Set up

The radar will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

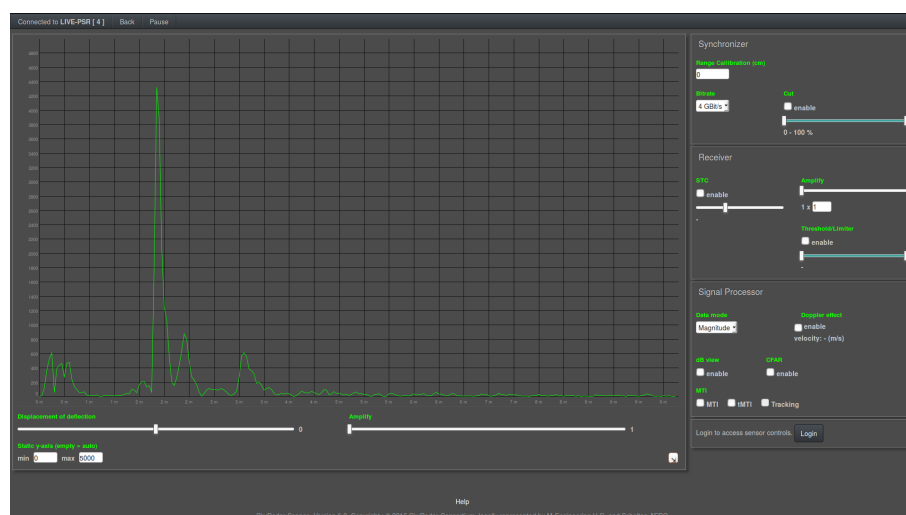
- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

Settings in Receiver:

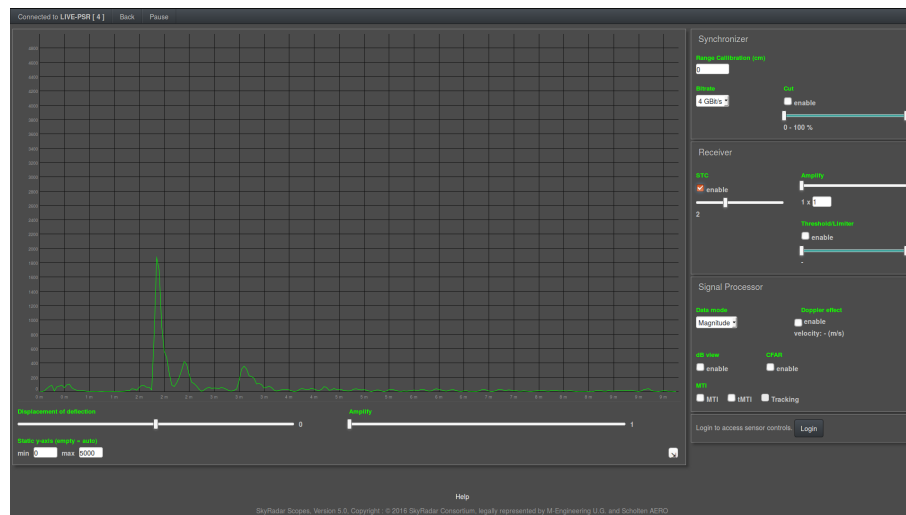
- STC: Enable

2.4 Experimental Procedure

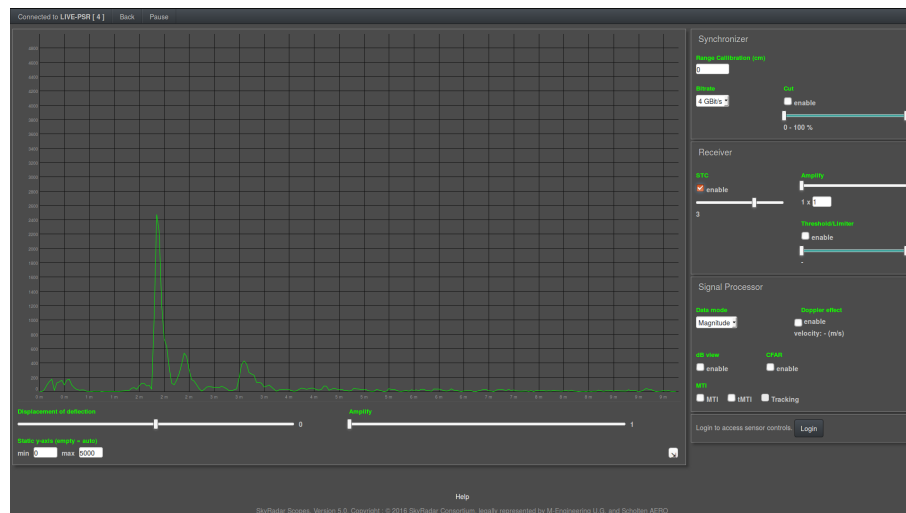
The initial setting without STC.



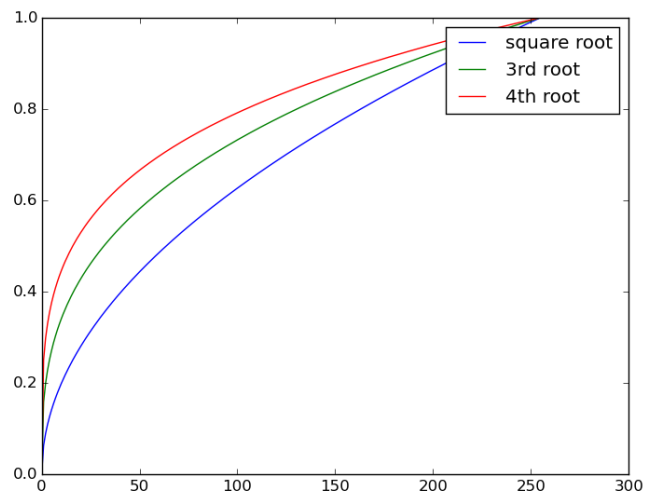
Enabling STC with the power of 2 reduces the signal strength at the beginning more as at the end.



The third root looks different.



The STC function works with following functions:



3 Effect of Noise

3.1 Abstract

Demonstrating the hiding effect of noise. Very small reflecting objects can be lost, if the receiver's gain is too high. But these targets are also lost, if the gain is too weak. You have to find a compromise between the gain of the receiver (and the gain of the display unit) and a clear noiseless image.

3.2 Performance Indicators

- Learners will be able to understand and interpret the relation between receiver's gain and the impact on noise and consequently on the clarity of the radar images in the scopes.
- Learners will be able to calibrate the gain to receive a good radar image.

3.3 System Set up

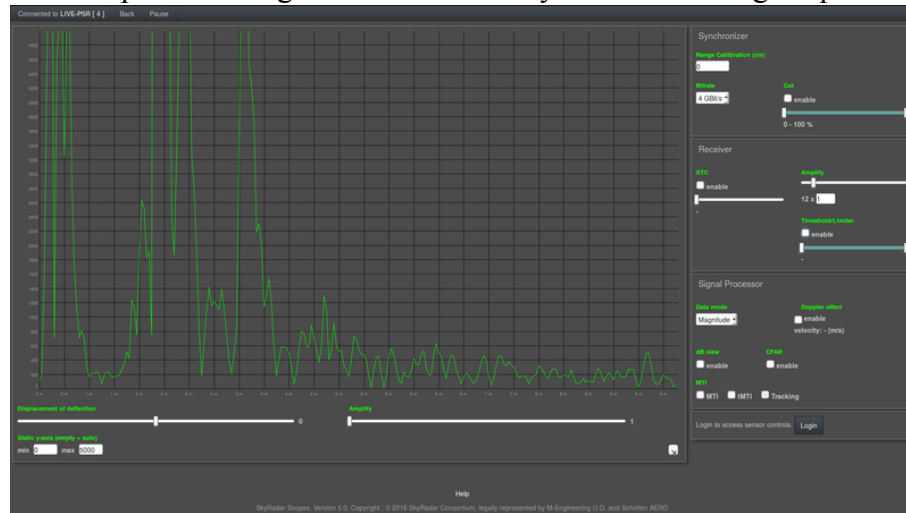
The radar will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

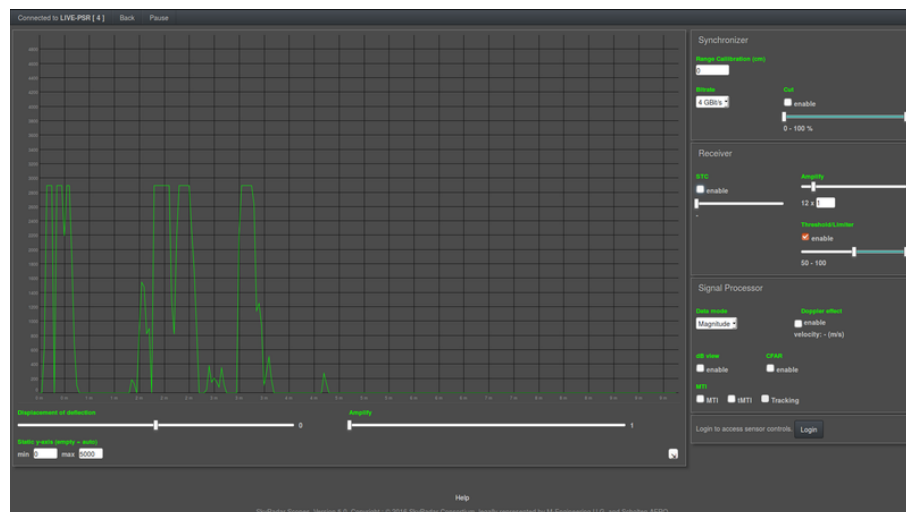
- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

3.4 Experimental Procedure

First you amplify the signal with the control Amplify. In this example we've take the factor 12. It amplifies the signal 12 times. Then you see following scope:



Then you take care of a cross section to observe. Enable the control Threshold/Limiter and use the left slider to raise the noise reduction. The whole graph shifts to negative. Values which are lower after the correction as 0, are set to 0. The task is to throw information away without affecting the observed cross section



Additionally you can combine this experiment with the STC Function. This will reduce the noise at the beginning and you get better results.

4 Threshold Function

4.1 Abstract

Nearly the same task may be demonstrated using the threshold to reduce the noise level.

4.2 Performance Indicators

- Learners will be able to understand and interpret the relation between threshold and the impact on noise and consequently on the clarity of the radar images in the scopes.
- Learners will be able to calibrate the gain to receive a good radar image.

4.3 System Set up

The radar will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

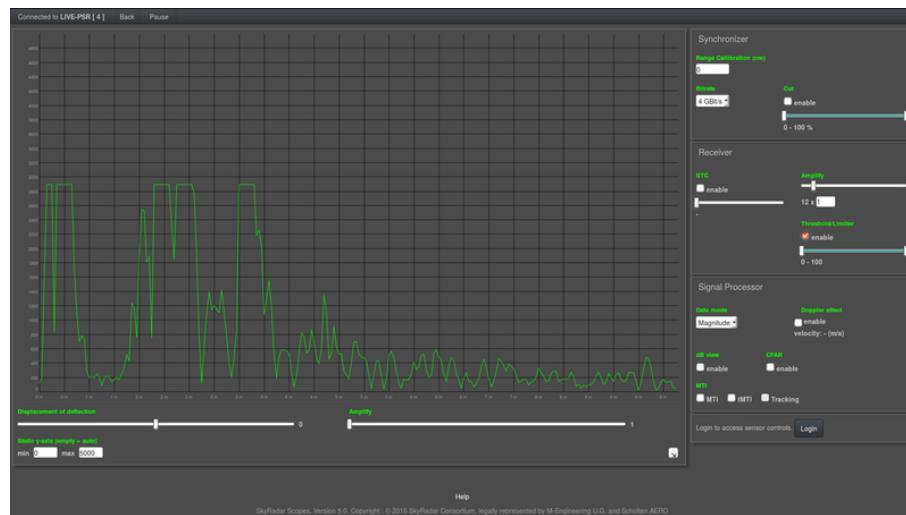
- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

Settings in Receiver:

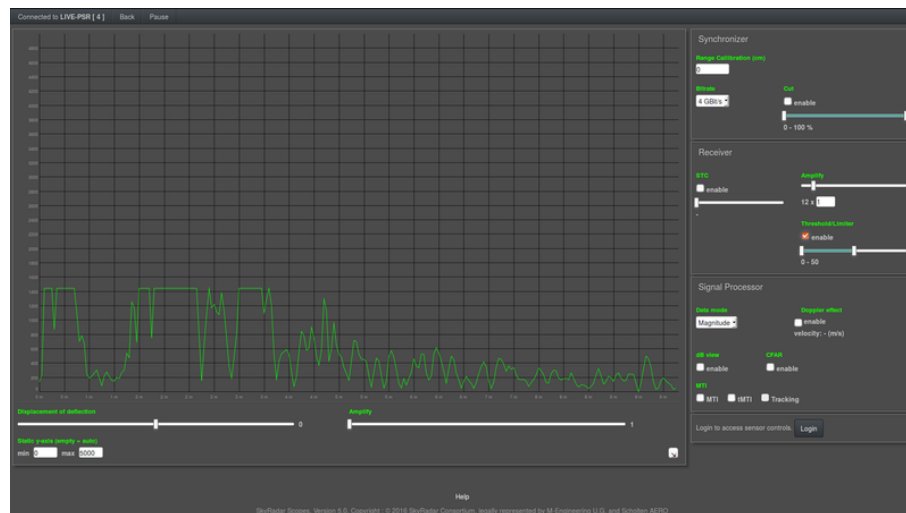
- Amplify: 12
- Threshold/Limiter: Enabled
- Noise: 0

4.4 Experimental Procedure

Activating the Threshold/Limiter limits the upper spikes of the graph. To reduce the upper limit, change the position of the right slider at the Threshold/Limiter.



After changing the setting of Limiter to 50, we get following result:



The upper limit is reduced. All values which are bigger than the relative setting, are cut at the upper limit. Values which are lower, are not affected.

5 B-Scope and Limiter

5.1 Abstract

If the receiver is saturated, then the contrast of the B-Scope is decreased. This effect you can show with the regulating device “limiter”. In practical trainings the students can use the controls for gain, thresholding and limiting to get an informative radar picture that shows all objects of interest without disturbances.

5.2 Performance Indicators

- Learners will be able to understand and interpret the relation between receiver's saturation, gain and threshold and the impact on noise and consequently on the clarity of the radar images in the scopes.
- Learners will be able to calibrate threshold and gain to receive a good radar image.

5.3 System Set up

The radar will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

Settings in Receiver:

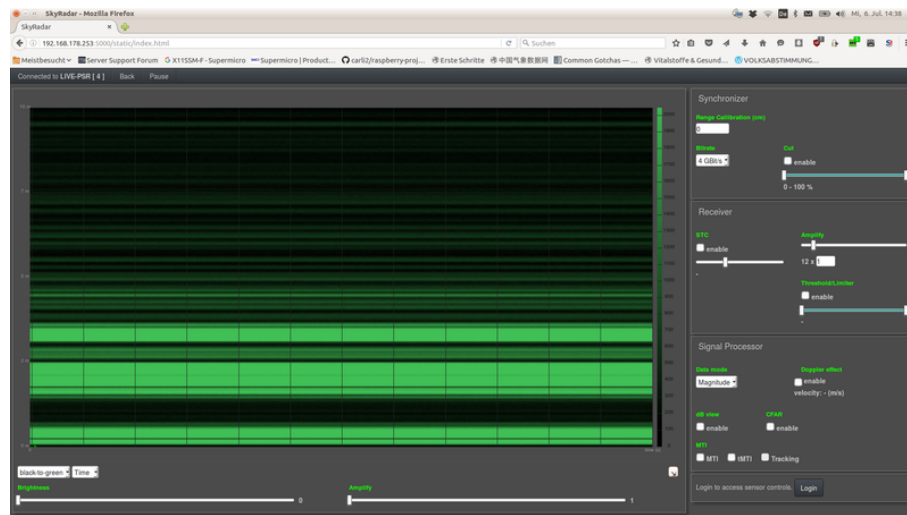
- Amplify: 12
- Threshold/Limiter: Enabled
- Noise: 0

Settings in B-Scope:

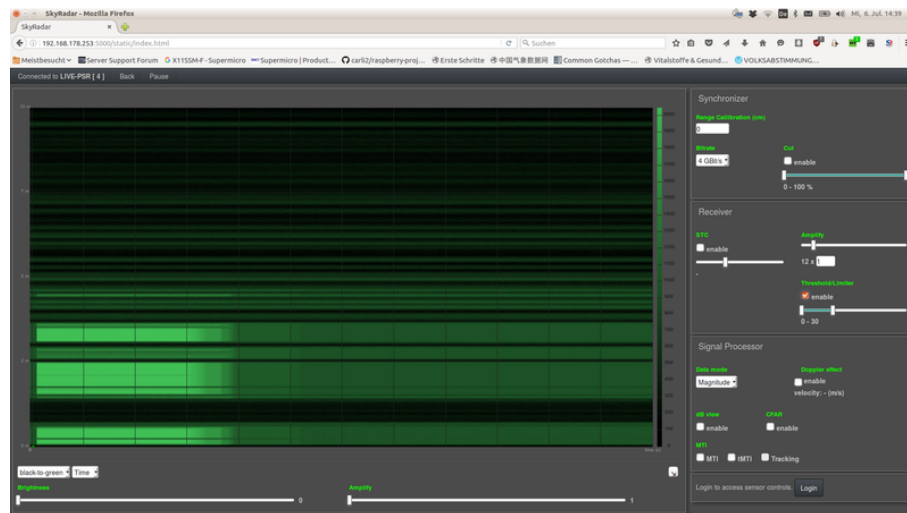
- Time

5.4 Experimental Procedure

Use the B-Scope in time based mode. You'll see this picture.



Change the right slider of Threshold/Limiter to a lower value, affects the contrast in the B-Scope.



When using the PSR in rotating Mode, you'll see the same effect on the PPI-Scope.

6 A-Scope and I-Data (Doppler Effect)

6.1 Abstract

Using the A-scope and the input mode “I-Data” for demonstrating the influence of Doppler Effect. On the A-Scope you can see the alternating phase shift of the echo signal caused by the Doppler Frequency.

6.2 Performance Indicators

- Learners will be able to understand and interpret the relation between Doppler effect, I-Data and the representations on the A-Scope.
- Learners will be able to set the I-data to receive a good radar image in the A-Scope.

6.3 System Set up

The radar will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

Settings in Receiver:

- Amplify: 22
- Threshold/Limiter: Enabled
- Noise: 0

Settings in B-Scope:

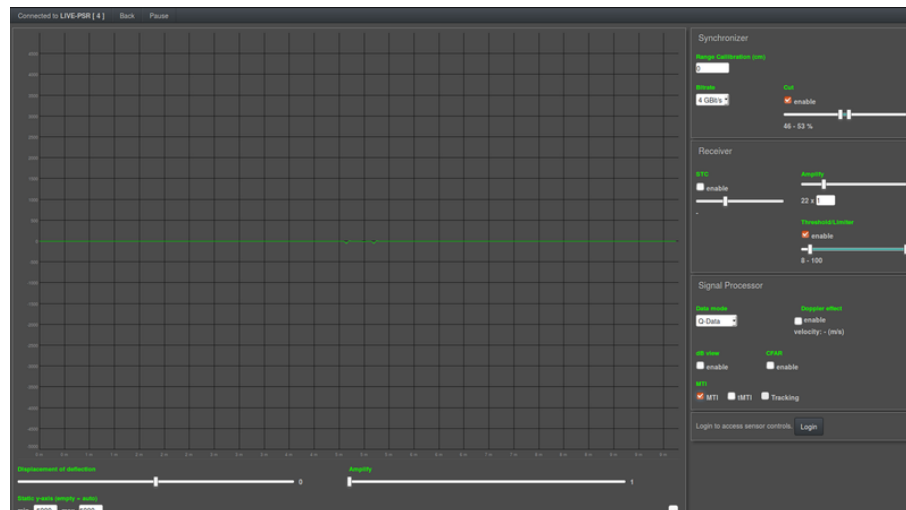
- Time

Signal Processor:

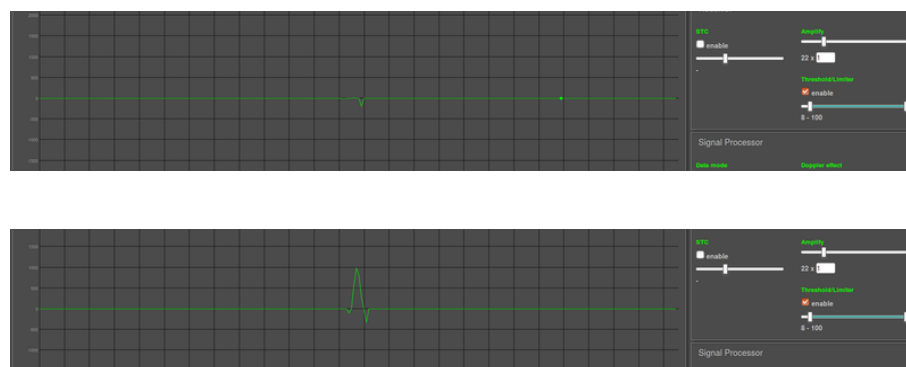
- Data Mode: I-Data or Q-Data
- MTI: Disabled

6.4 Experimental Procedure

Try to find the cross section of a rotating fan. To remove all data, you're not interested in, use the Function Cut in Synchronizer. You can change the sliders to view only from the beginning range to the end range. All Data outside will be not displayed. Then activate the function MTI. Now you'll see only moving targets. When there is no movement, you'll see only noise.



When the fan is rotating with high speed, you won't see much changes. After switching the fan off, you'll see the phase change on the scope. It does not matter, which data mode has been selected.



When you compare the both pictures above, you'll see the phase change during the fan is rotating slowly.

7 MTI with Remote Controlled Quadcopter

7.1 Abstract

The phase shift, analyzed in the previous exercise can be used for measuring of speed, or for simple Moving Target Indication (MTI).

The Remote Controlled Quadcopter is a simple moving target. It does not need to fly in every case. It is also sufficient when the target is located somewhere in the class room and slowly turns its rotors only.

7.2 Performance Indicators

- Learners will be able to understand and interpret the relation between Doppler effect, I-Data and Moving Target Indication
- Learners will be able to apply Moving Target Indication to identify and track moving objects.
- Learners will be able to set the I-data to receive a good radar image in the A-Scope.

7.3 System Set up

The radar will be non-rotating, best looking at targets in 3-10 m distance.

Settings in Synchronizer:

- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

Settings in Receiver:

- Amplify: 22
- Threshold/Limiter: Disabled

Settings in B-Scope:

- Time
- Amplify: 10

Signal Processor:

🎬 Data Mode: M-Data

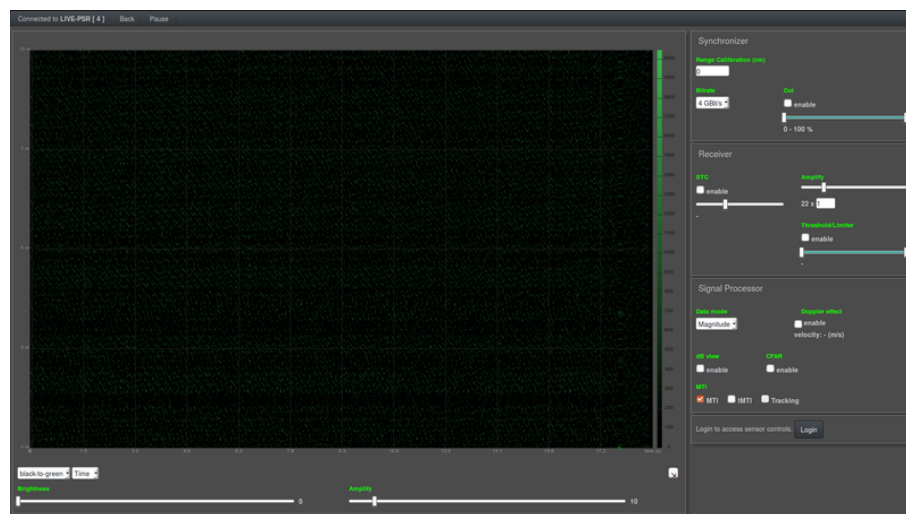


TI: Eanbled

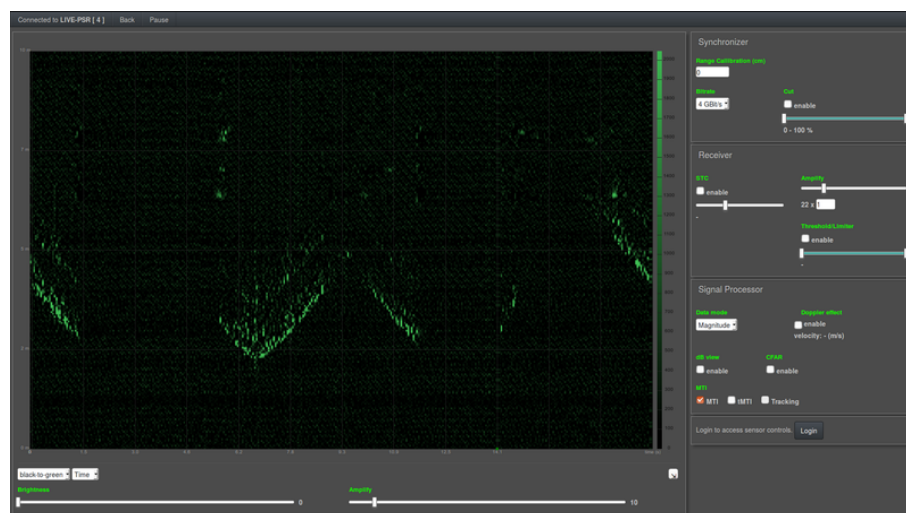
M

7.4 Experimental Procedure

For this experiment you need a moving target. A human is reflecting the rays at 24GHz very good. Without movement you'll see a screen like this one:



A moving human as target looks like this:



The X-Axis is time based. When the crossection is moving down in the scope, the object is moving to the radar. When the target is moving up, it means the object is moving away from the radar.

8 Parabolic Reflector and the Effect

8.1 Abstract

The parabolic reflector forms a fan beam pattern. The quadcopter can be used to show the dimension of the cone of silence of the PSR. In this demonstration the radar may better work with stopped antenna.

8.2 Performance Indicators

- Learners will be able to understand and interpret the effect of the parabolic reflector .
- Learners will be able to detect the cones of silence in a radar.

8.3 System Set up

The radar will be non-rotating, best looking at targets in 3-10 m distance.

In this experiment, the B-scope uses the time mode in the x-axis

Settings in Synchronizer:

- Range Calibration: -50 cm
- Bitrate: 4 Gbit/s

Settings in Receiver:

- Amplify: 22
- Threshold/Limiter: Disabled

Settings in B-Scope:

- Time
- Amplify: 10

Signal Processor:

- Data Mode: M-Data

8.4 Experimental Procedure

For this experiment you need two persons. One person is flying the drone and is trying to hit the beam. The other person observes the Scopes and correct the settings during recognizing the cross section. As the lessons before, you should use all functions to get a better scope. When you have find the ideal settings for the drone, you focus on the positions of the drone and the scope. After this lesson you'll understand the difficulty to operate a radar with a small beam in non-rotating mode.