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TEST REPORT

Test of Industrial Distance Sensor in real railways conditions.

This test has been arranged on Italian Railways. The major objective of this experiment was demonstration / investigation of a possibility to use technology, provided by Elva, for development a distance sensor, as a part of system "Railway objects Identification System" (hereinafter "GAMAV"), for application on railways vehicles, able to identify possible railway objects on the rails with the most accuracy.

Due to this task, the sensor should be tested on different objects are placed on railways lines up to 150m distance and how they can be selected for staying and moving stage of engine.

As a prototype, the distance sensor, part No. FMCW-10/94, is used with the following general specifications:

- Type: FMCW source;
- Operating frequency: 94 GHz;
- Sweep range: 500 MHz;
- Output power: 10 mW;
- Type of antenna: Gauss Lens Horn
- Gain: 38 dB
- Beam width at 3 dB level: 1.5 deg.

Two sensors with different output polarizations (linear and circular) were installed on temporary light support system on the front of engine. Using of two sensors allow to detect / cut off wrong reflected signals from the land and metal parts of railways lines. After setting at supports, systems were pointed in direct way onto a target at 150m distance. Data processing, saving and visualization from two sensors were arranged on laptop is placed into cabinet of the engine. Parallel all tests were stored on digital camera. Below you can see pictures with installed sensors.

To avoid two-times reflected signals in one sensor we used clockwise circular polarised wave for transmitting and anti-clockwise polarised wave for receiving. One time reflected wave will be received, because it changes direction of moving after reflection, instead of two times reflected wave that will be rejected on receiver input. Two different sensors were used to check effect of multi-passing at real conditions on railways.

At the first stage, the system was tested on unmoveable objects as a wall and a train. Also we get signal from a man is walking on railways.

The next test was done into actual moving of engine on railway. Signals from straight way, tunnel and some bends.

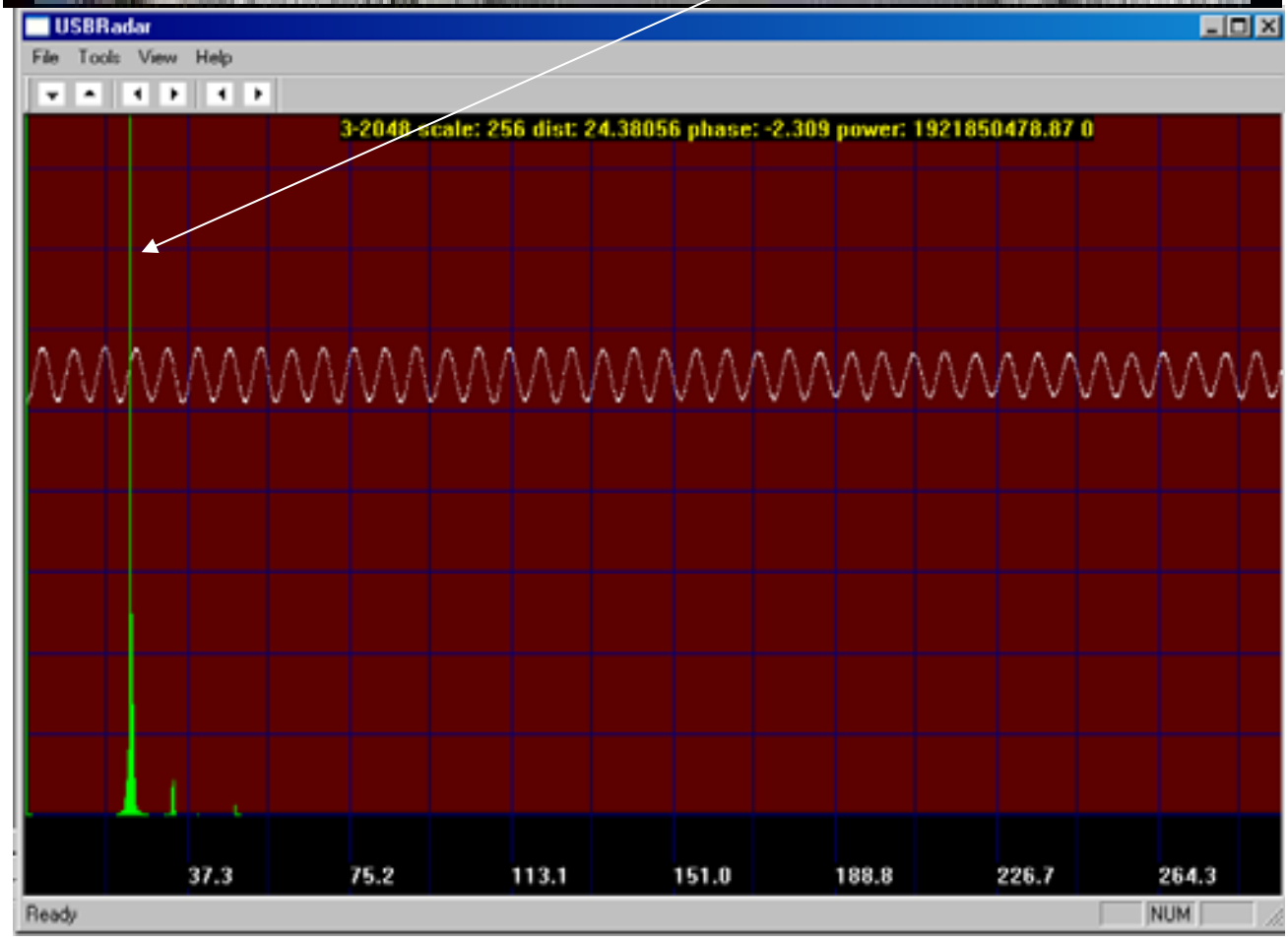
Results of these tests are presented pictures below. There are two pictures for each test: one is photo from digital camera and the next one is result of sensor measurements - plot of IF signal (white colour) and corresponding FFT function (green colour). As you can see on signal plot, there are signals from objects really presented on the picture. Based on this information we can measure distance to objects.

Due to achieved results we can do the following primary conclusions:

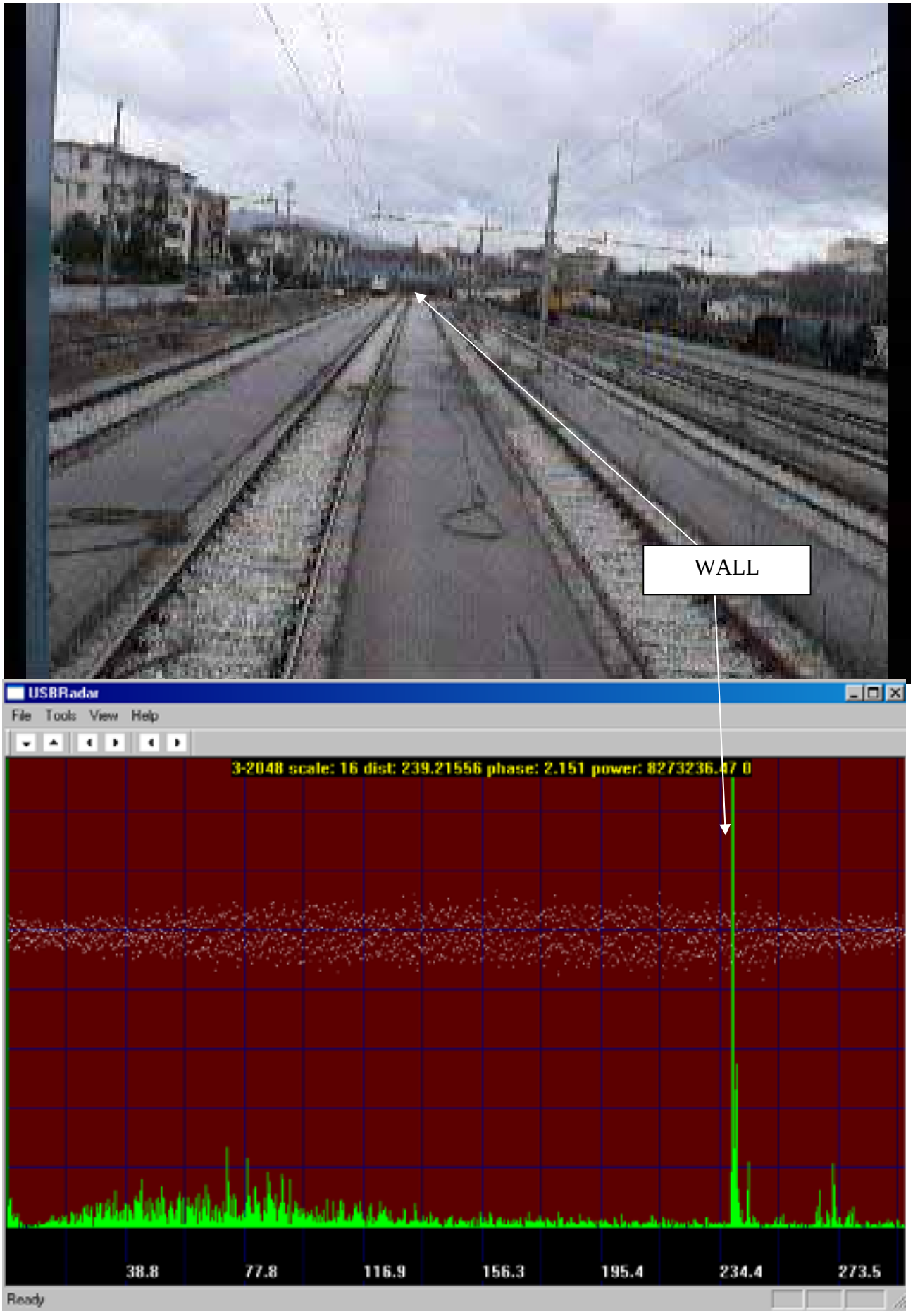
- Big targets, as a wall, train and so on, can be detected at least at 230m distance;
- Because of beam width of the sensor is rather narrow (1.5 deg), we didn't see any additional reflected signals from the land, railways lines and close placed objects, such as gate of tunnel and poles. Suchwise there is no necessity to use circular polarization. Also influence of side lobs of antenna is very small and we can ignore it;
- There is possibility to select different objects on the way at different distances. For example, we can see well signal from the man in front of train;

During field tests good operation of sensors were demonstrated. Sensor sensitivity and antenna pattern diagram are enough for the using in GAMAV project. On the other hand there are numbers of tasks which should be solved for final system. There is potentially possibility to measure both: speed of objects and distance at the same time. It is necessary to design new fast data processing algorithm for sensor to realise this feature. Two sensors or probably either more will be needed to achieve angle resolution specified in GAMAV. That will require significant R&D and engineering. To select signals at turns from objects around railway GPS intellectual system has to be used in parallel with sensor.

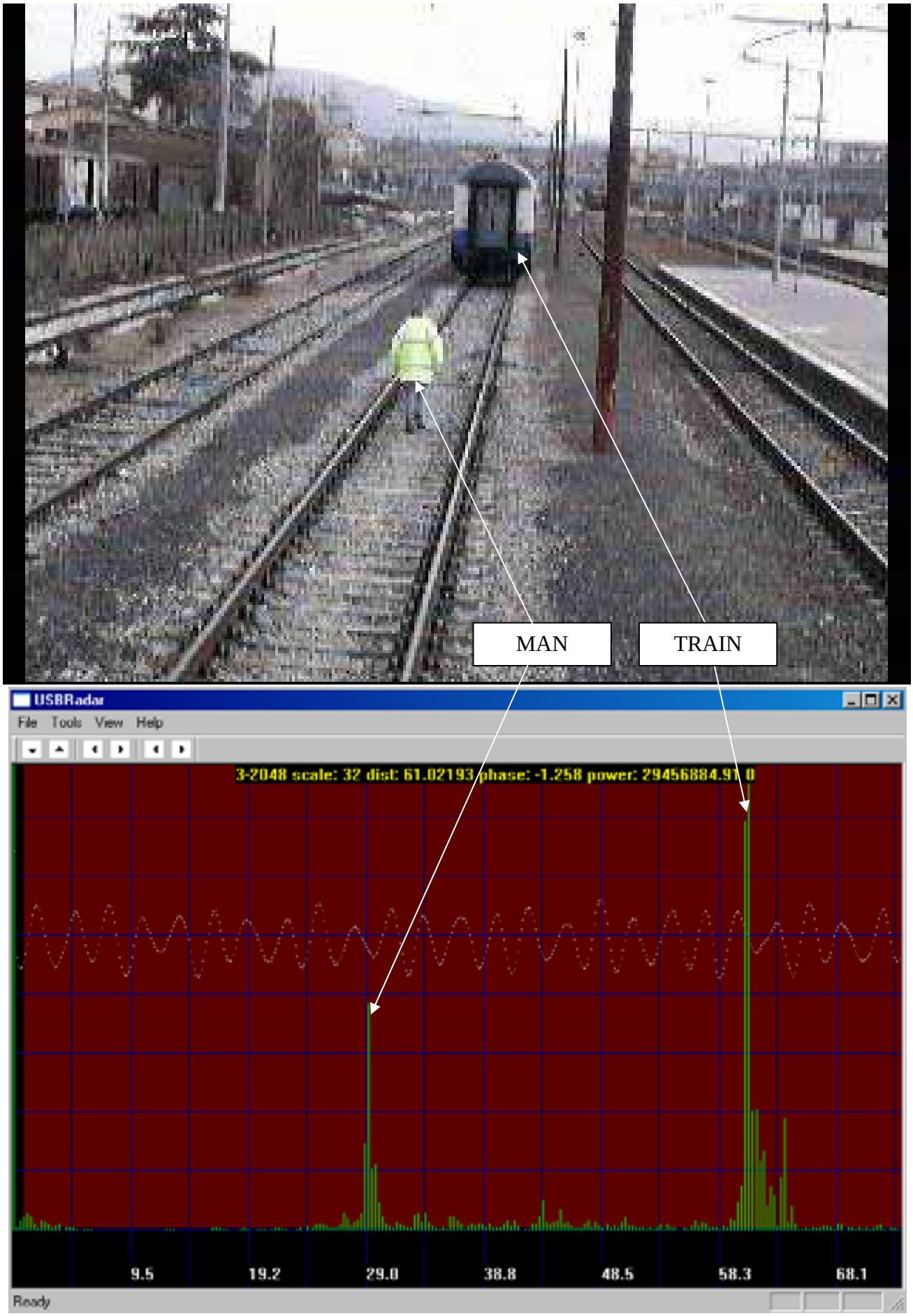
The wall at 24m.



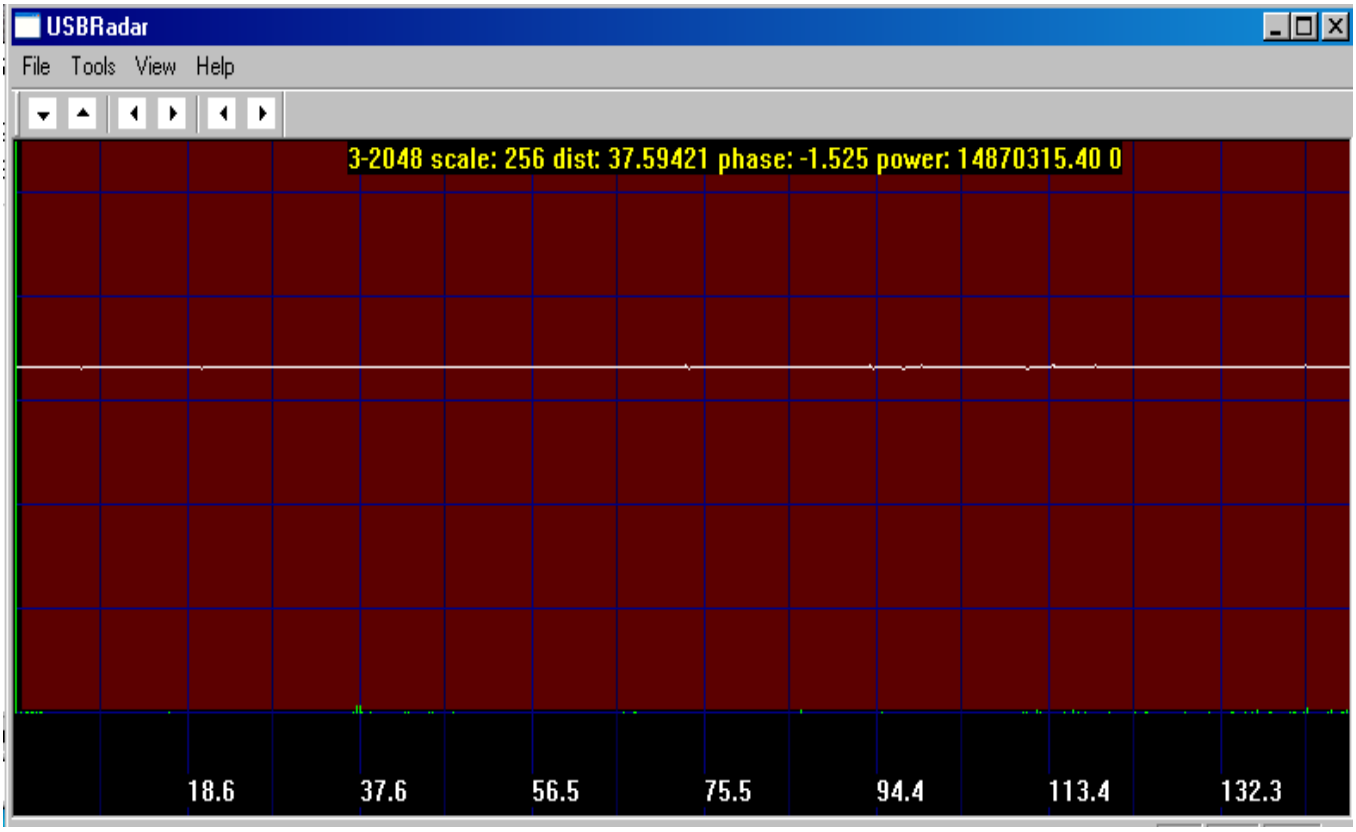
The wall at 234m.



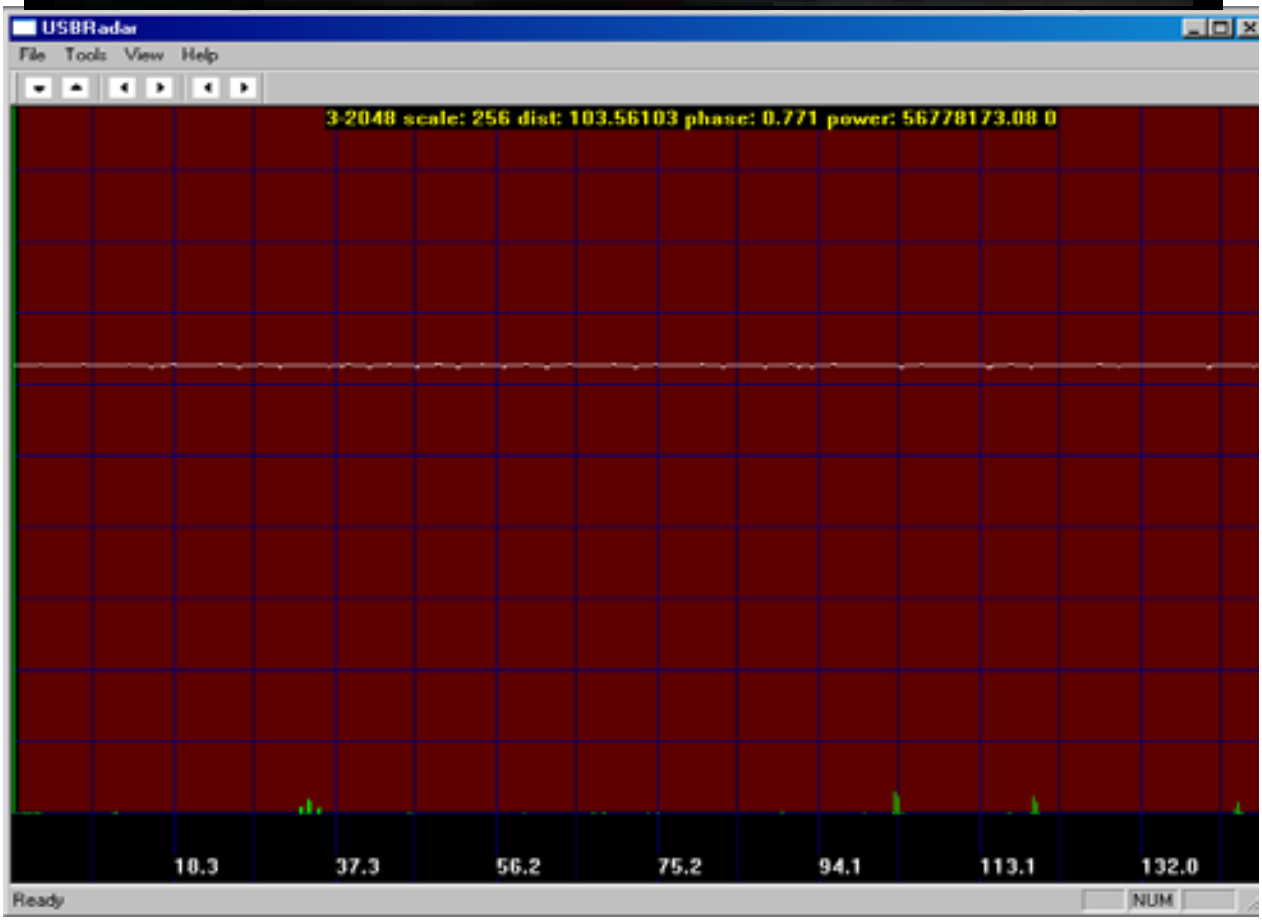
The man and train.



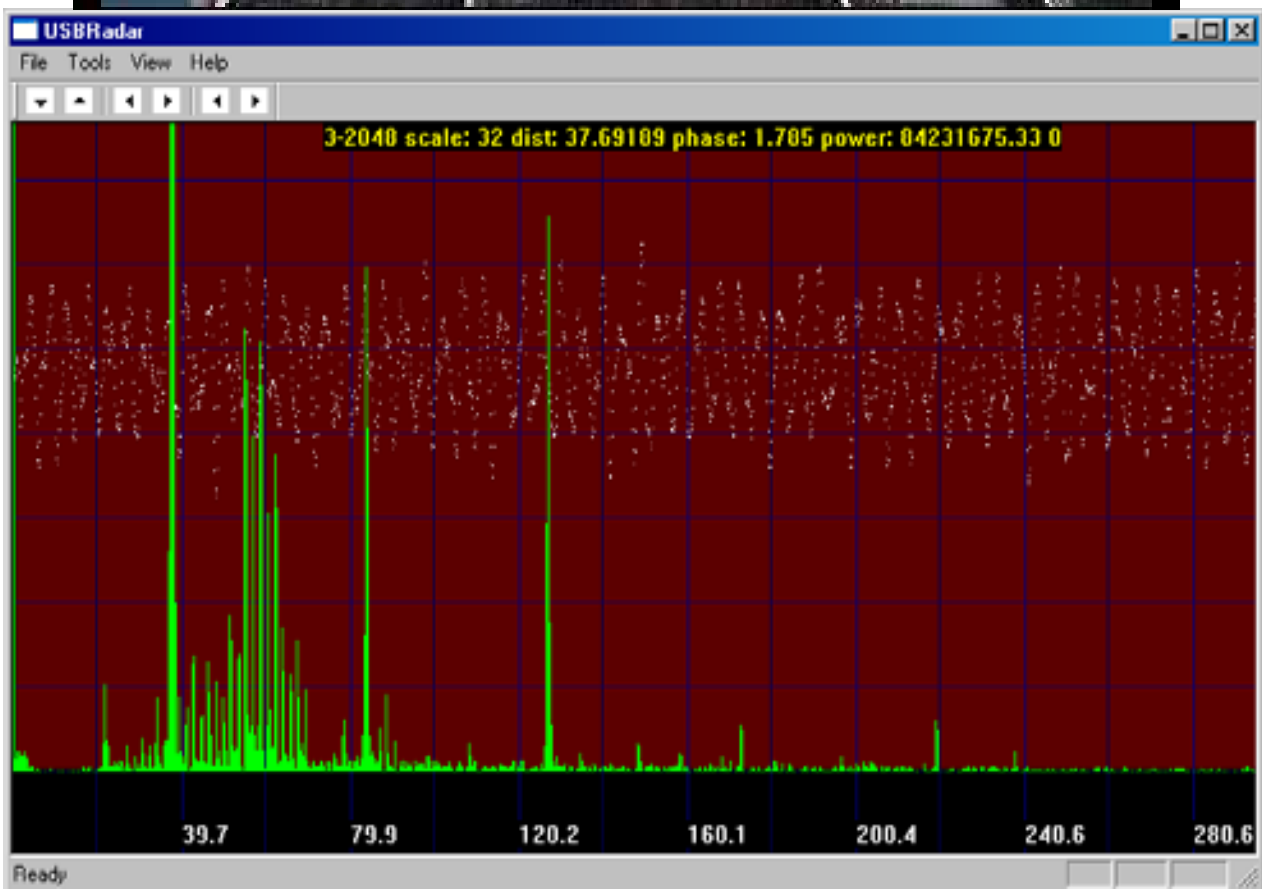
Enter in straight tunnel.



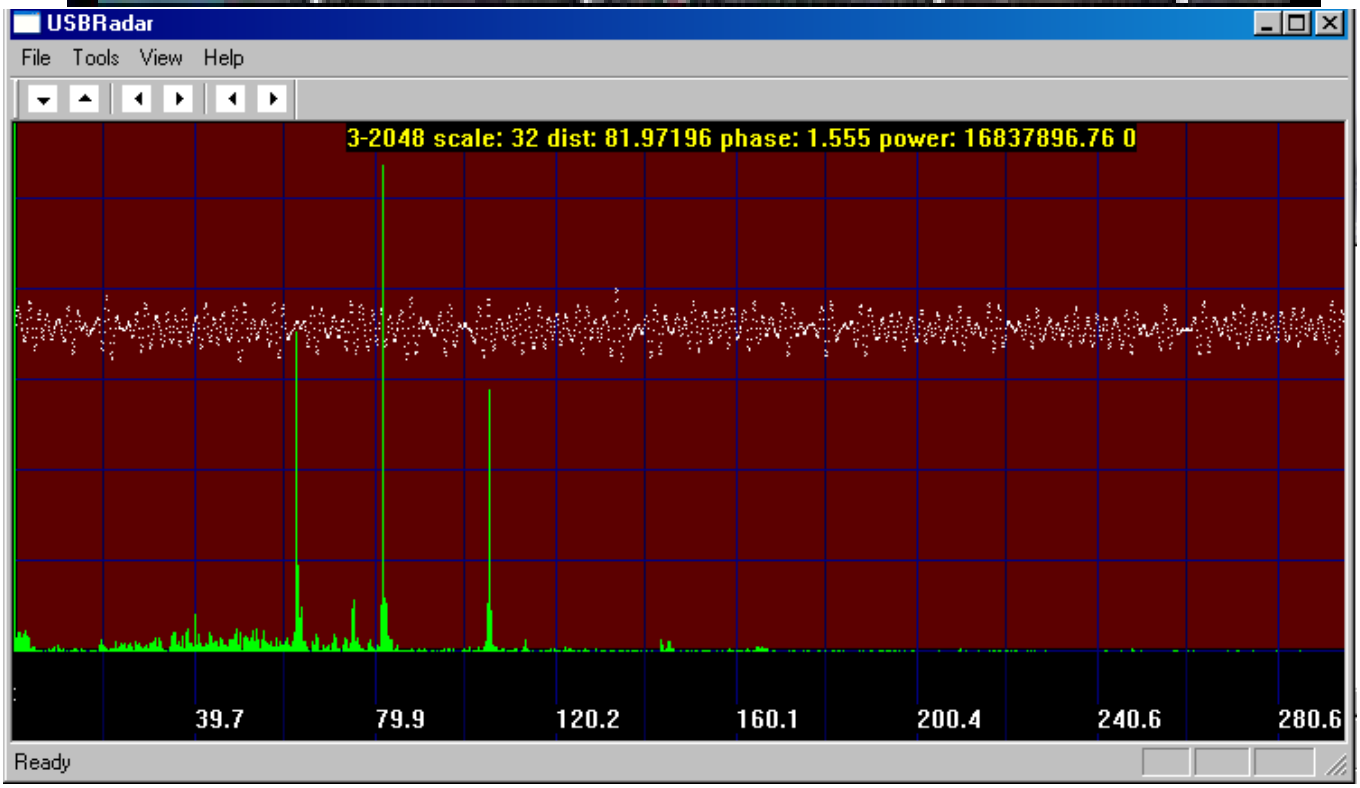
Into straight tunnel.



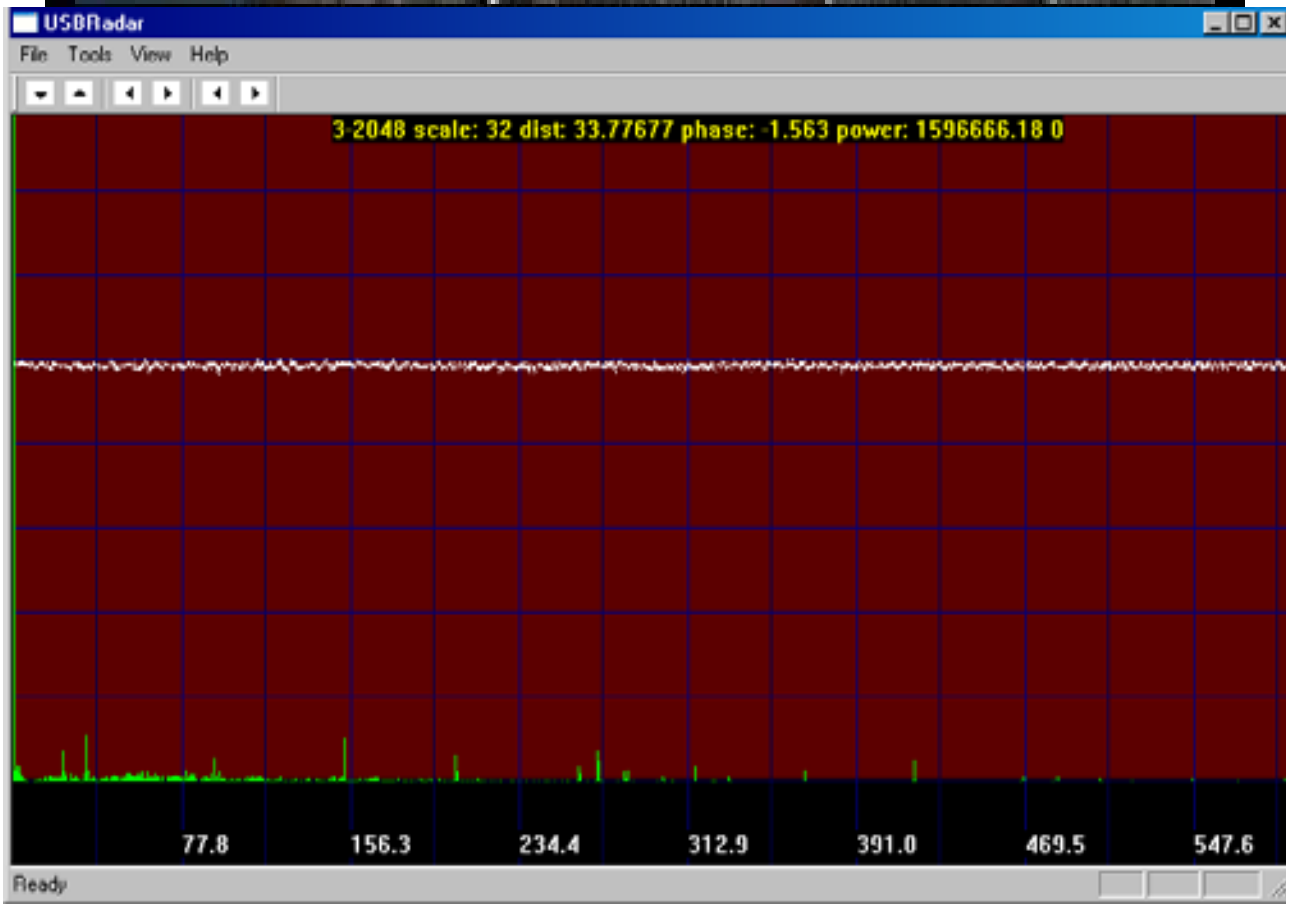
The right band.



The left bend.



Straight way.



Straight way.