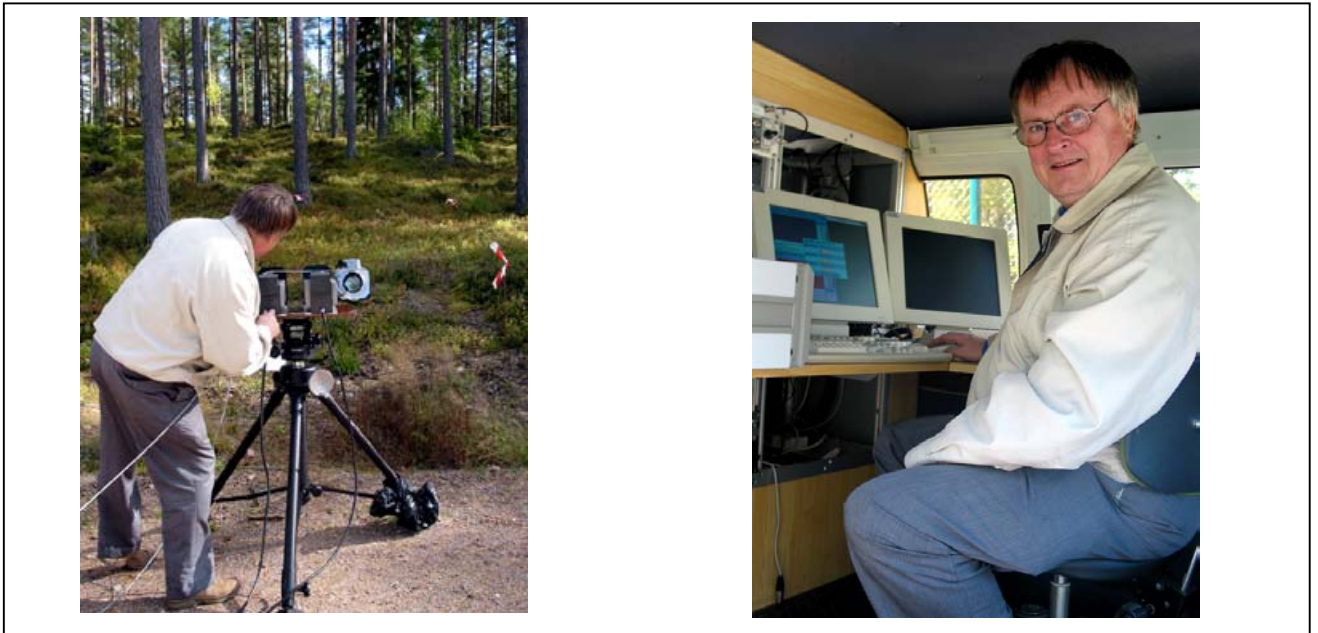




Anders Tengbom and Magnus Karlsson



TEST AND EVALUATION

- **Polarisation, Göran Forsell, FOI**

Oktober 2004

Send list

Ert tjänsteställe, handläggare

Ert datum

Er beteckning

Vårt tjänsteställe, handläggare

Vårt föregående datum

Vår föregående beteckning

UtvE, övlt Anders Tengbom, 0381-175 58,
070-627 28 41

Test of FOI polarisation equipment

1. Background

The background of the test was an inquiry from FOI regarding support to develop polarisation equipment for locating mines and tripwires. The support should be in form of a practicable test of present equipment's possibilities in a user environment.

2. The polarisation equipment

The equipment consists of two IR cameras, Thermovision 900. One of the cameras is working in the 3-5 μ m (SW) waveband and the other in the 8-12 μ m (LW) waveband. The cameras had polarisation filters in front of the lenses and the images was taken in different polarisation angles (also unpolarised). The images were then compared and analysed.

3. Description of the tests

3.1 Point of time

The tests were carried out 2003-09-23—24.

3.2 Test surfaces

In total, eleven different test surfaces were prepared. Every test surface was three metres wide and eight metres deep. The following types of terrain were chosen:

- Forest terrain, berry sprigs
- Road bank, covered in grass
- Forest terrain, berry sprigs, four pronounced stones
- Forest terrain, berry sprigs
- Road bank, covered in grass, one metre high vegetation in the rear end
- Roadway, gravel
- Forest terrain, berry sprigs, wheel tracks
- Forest terrain, grass and stones
- Forest terrain, sparsely overgrown, flat ground
- Forest terrain, sparsely overgrown, high grass (0.5 m), flat ground
- Bare moraine, flat ground

3.3 Objects used on the different surfaces:

- PMA 1
- PMA 2
- PMA 2 without pressure spider
- PMA 2 camouflaged
- Camouflaged pressure spider (PMA 2)

- PMR 2- rod + mine body on the ground
- PMR 2 taut wire
- PMA 3 camouflaged
- PMA 3PMR 2, loosely lying wire
- Submunition 120 mortar
- Fishing line, taut
- Tripwire, loosely lying
- NATO wire, loosely lying
- NATO wire, taut
- Tiltrod for anti-tank mine
- Pressure spider for anti-tank mine
- Anti-tank mine m/718
- Anti-tank mine m/741
- 20 mm projectile
- Fragmentation 60x130mm
- Anti-personnel mine m/692
- Anti-personnel mine m/731
- Glass bottle 33 cl
- Tail for 80 mortar projectile
- Hand grenade m/75
- Tin can
- Barbed wire

3.4 Combinations

Combinations of surface-type and object is evident from appendix 1.

4. Testing method

The content of the test surfaces was unknown to the operator. For two days the operator took images of each test surface. Analysis of the images was then carried out at FOI.

5. Result

Number of objects in the boxes	48		Of which 12 wires
Number of objects indicated	81		
Correctly indicated	13	16%	Of which 1 wire
Doubtfully indicated	7	9%	
Incorrectly indicated	61	75%	
Missed objects	28	58%	

6. Summary / Discussion

The polarised images have been difficult to translate into reality, protocol and ordinary images. This brings a certain uncertainty regarding exact positions. Placed objects are measured with an accuracy of 15-25 cm. As a result great tolerance have been granted when indicating the different objects.

One of the difficulties has been to judge the position of the object in depth. Objects 5 – 10 metres away is very difficult for the system to detect. In the rear parts of the images one pixel represents 1-3 cm, which results in small objects being difficult to distinguish.

Although the main part of the objects have been lying on the surface, the system has not been able to locate more than approximately 10%. A few objects have been buried with only the fuze or part of the fuze visible. The main part of the objects have been concealed by some sort of vegetation, which has not made the localisation easier. The equipment can not see through grass or heather. A long exposure time of the camera has meant that grass moving in the wind has given rise to great indications and disturbed the localisation.

With the present equipment it is very difficult to distinguish man-made objects from the surrounding terrain. It has not been possible to locate wires.

Our opinion is that analysis of the images is very time-consuming.

Possible improvements are to use higher resolution and shorter exposure time.

With the capacity of the present equipment as a base the localisation is better and more securely done visually (using binoculars). SWEDEC therefor has a hard time to see how the system could contribute to mine and UXO localisation in a rational and cost-effective way. We also have difficulties in finding practical applications for such a system.

Anders Tengbom

Send list:

FOI

As orientation:

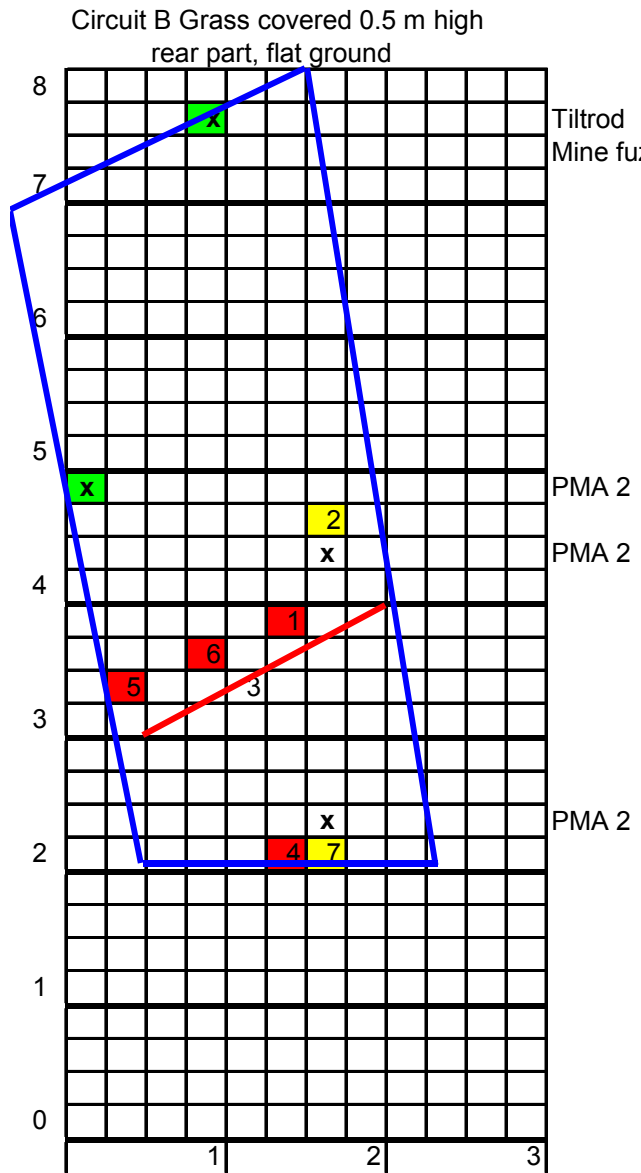
Ing 2

Within SWEDEC:

ITEP

UtvE (3 ex)

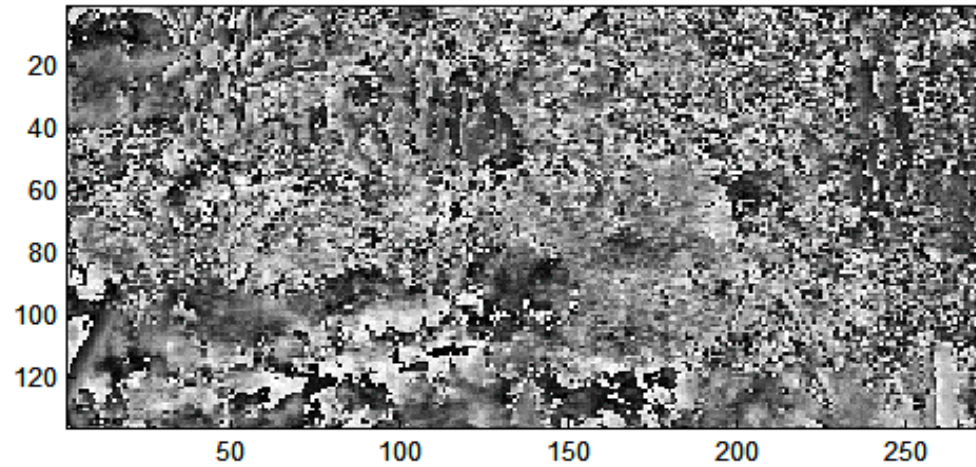
APPENDIX



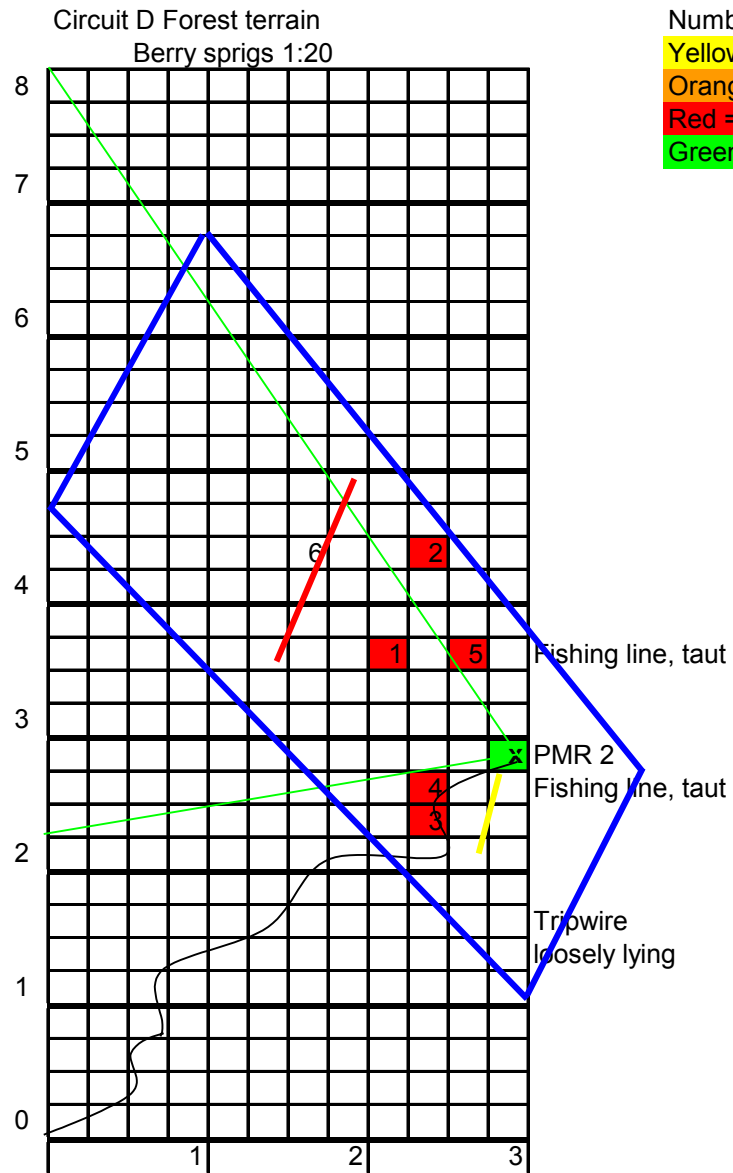
Number of objects=4
 Yellow = correct = 2
 Orange = doubtfully correct = 0
 Red = incorrect = 5
 Green = missed = 2



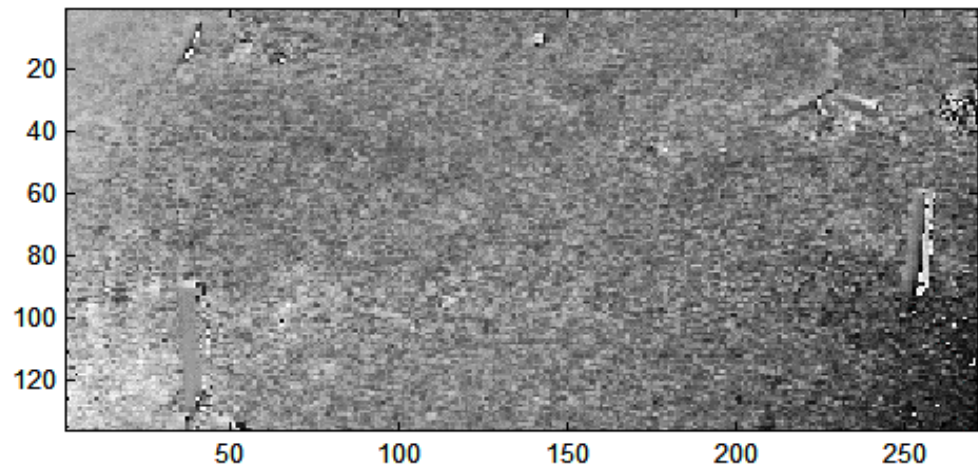
B Theta LW



APPENDIX

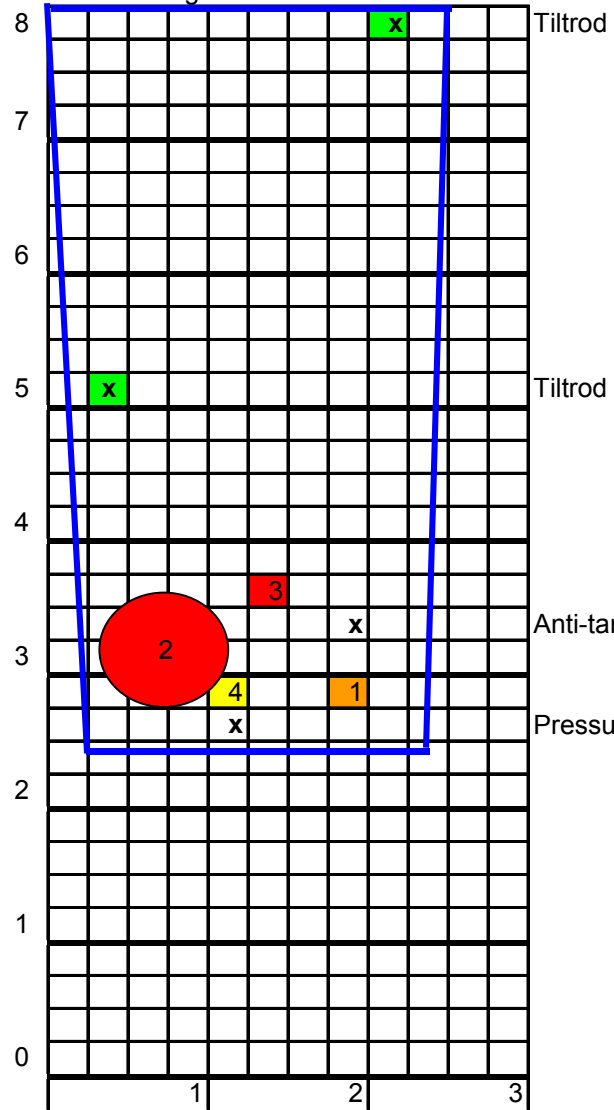


D hela theta LW



APPENDIX

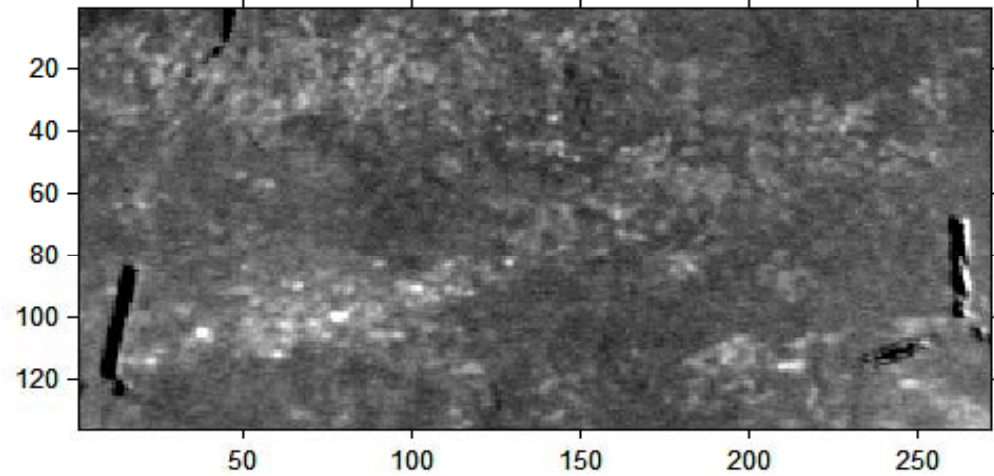
Circuit E Grass, 1m high vegetation in rear part
Flat ground



Number of objects=4
 Yellow = correct = 1
 Orange = doubtfully correct rätt =
 Red = incorrect = 2
 Green = missed = 2

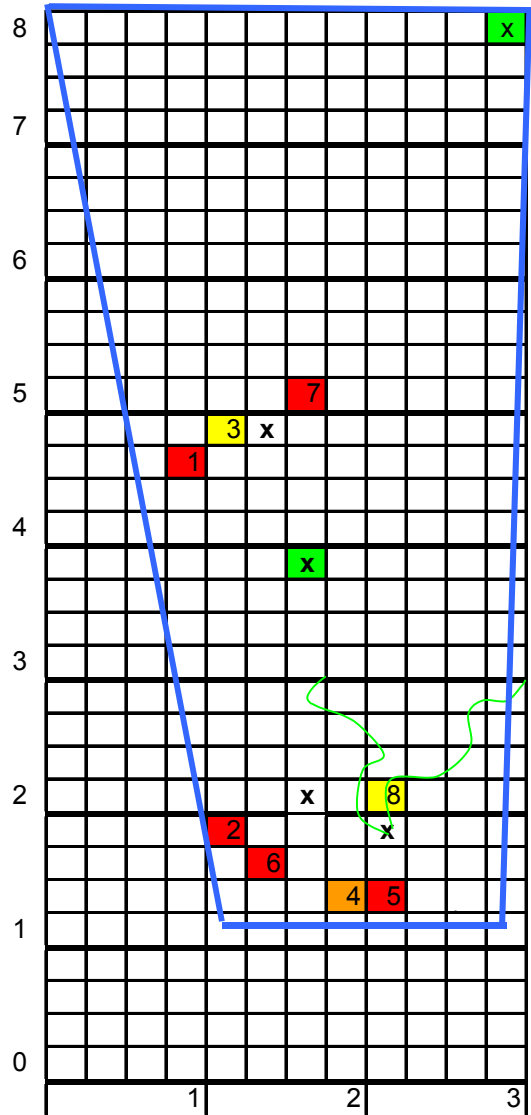


E diff LW



APPENDIX

Circuit F Roadway



Anti-tank mine m/718,741

Anti-tank mine m/ 718, 741

20 mm proj

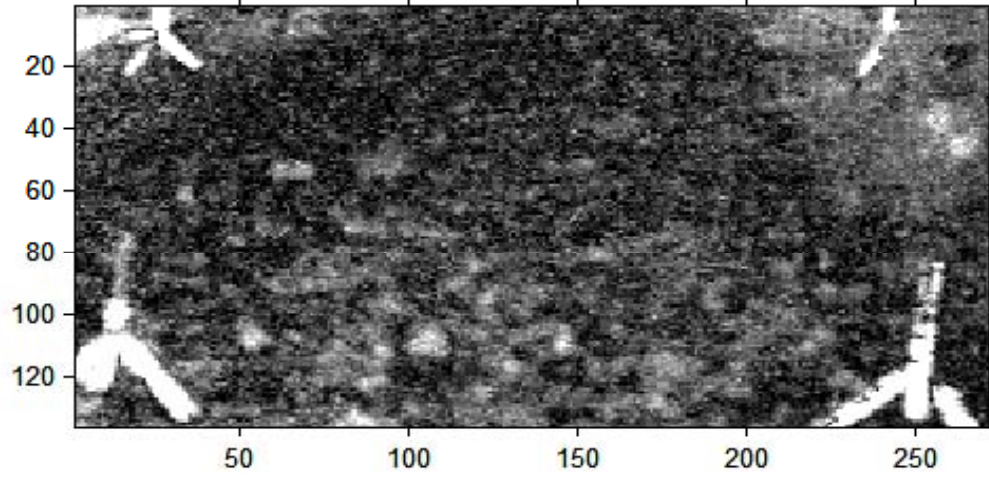
Fragmentation 60x130 mm
Anti-personnel mine m/ 692, 731
loose wires

Number of objects=5+2(wire)
 Yellow = correct = 2
 Orange = doubtfully correct = 1
 Red = incorrect = 5
 Green = missed = 2+2

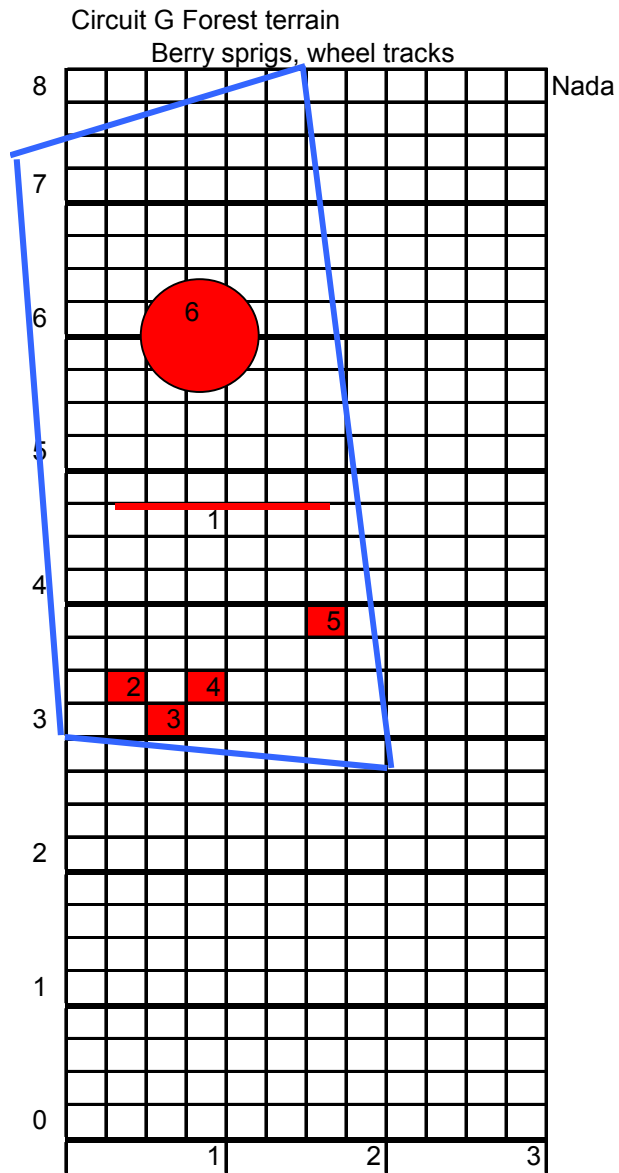
90



F DoLP LW



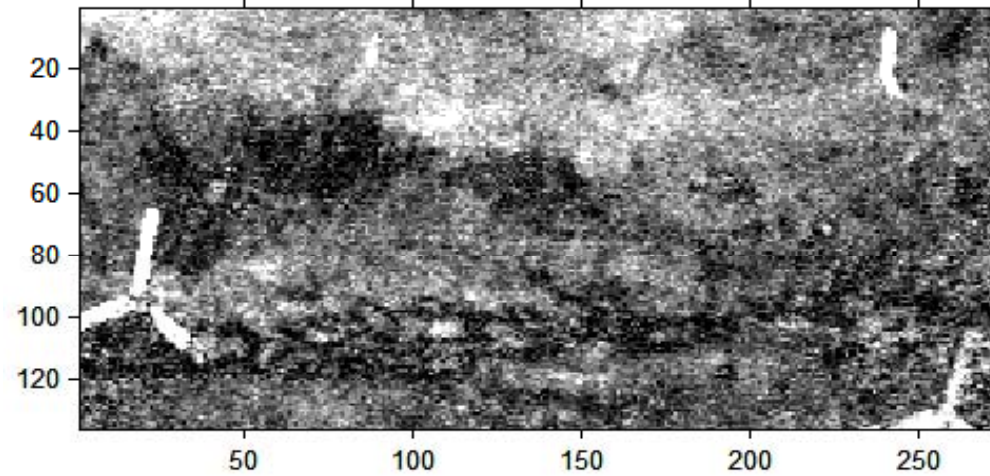
APPENDIX



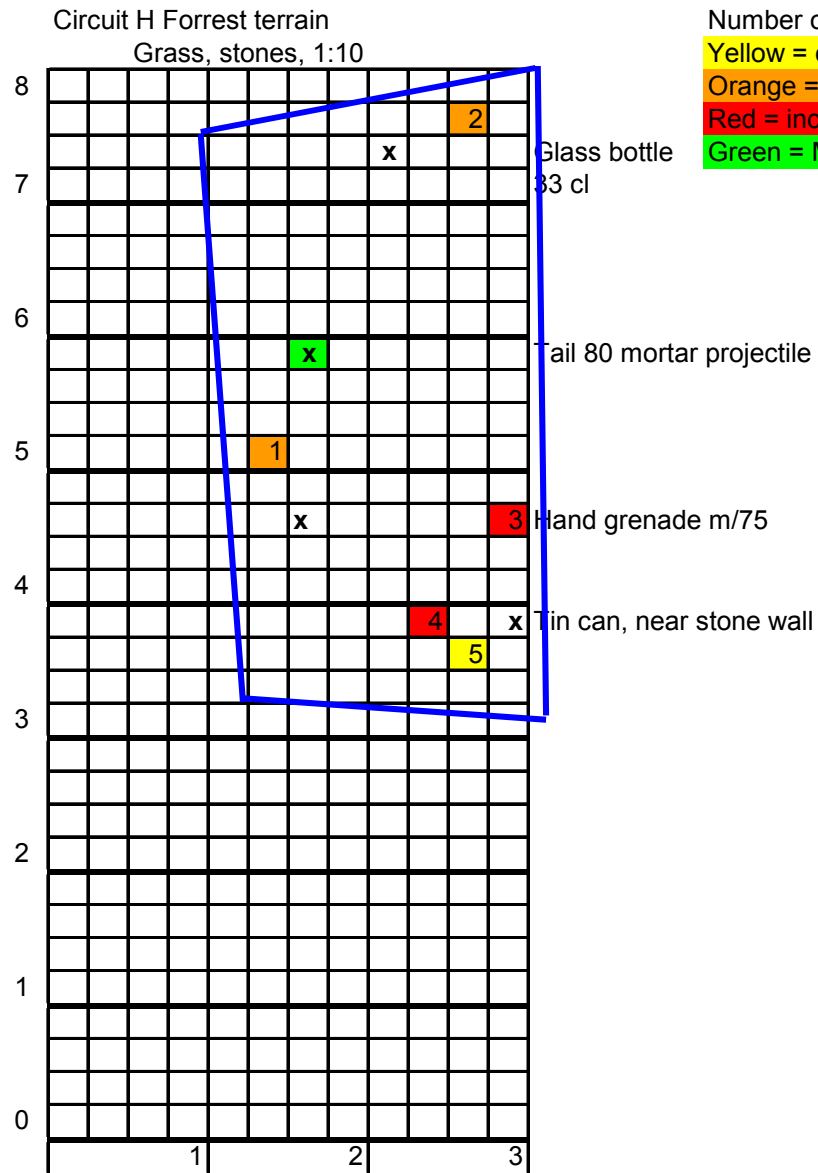
Number of objects=0
Yellow = correct = 0
Orange = doubtfully correct = 0
Red = incorrect = 6
Green = missed = 0



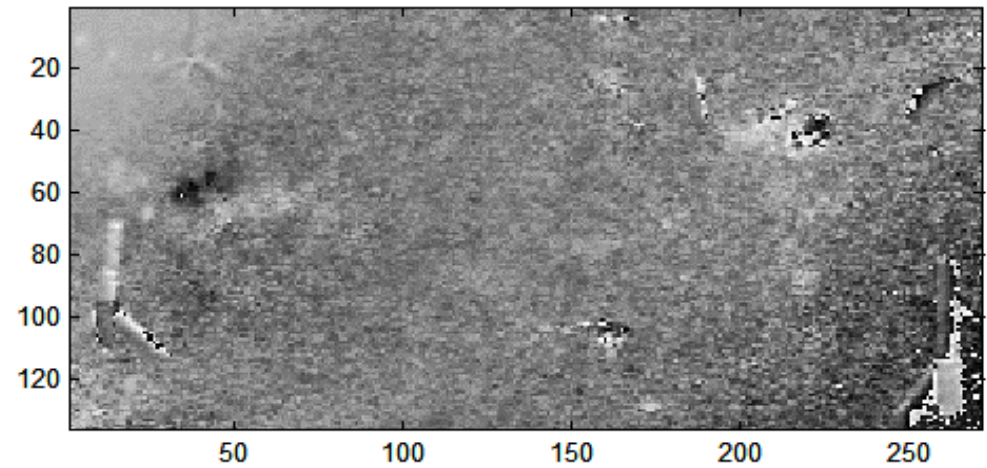
G framre DoLP LW



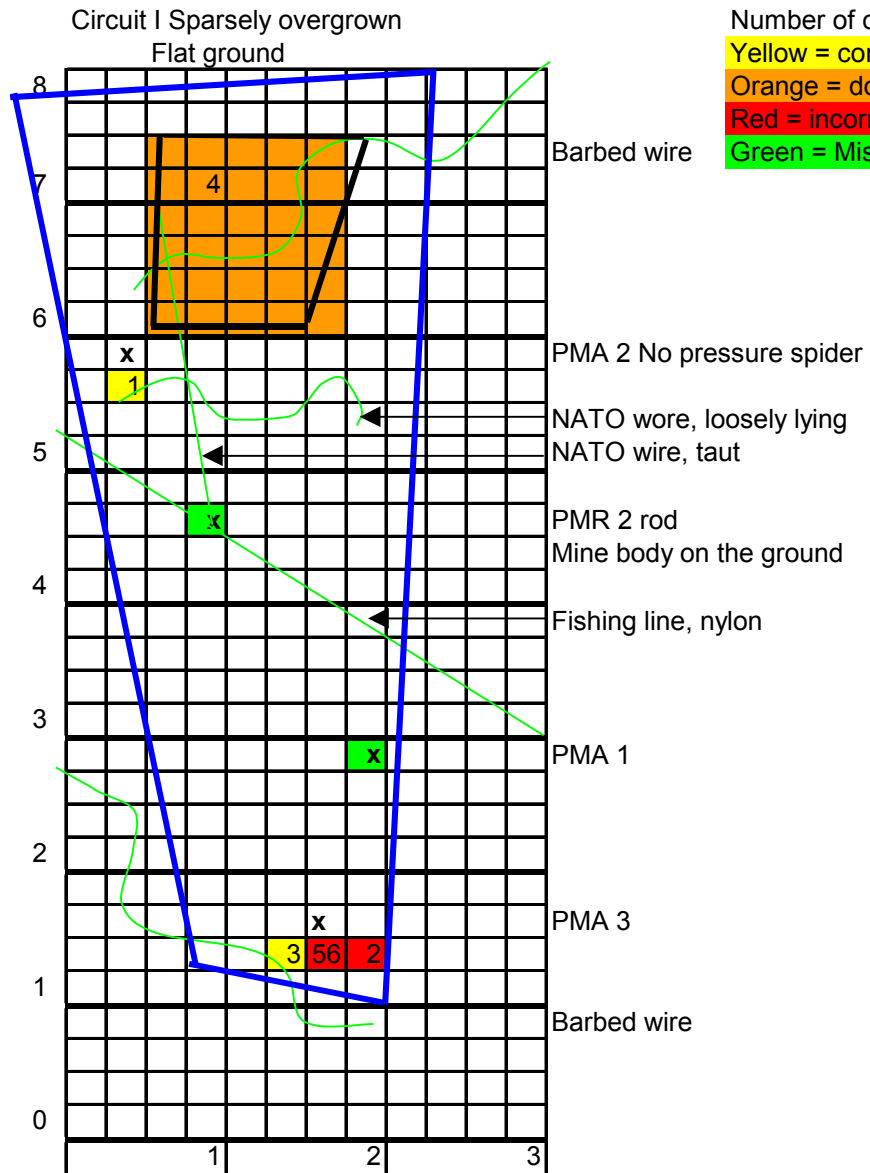
APPENDIX



H theta LW



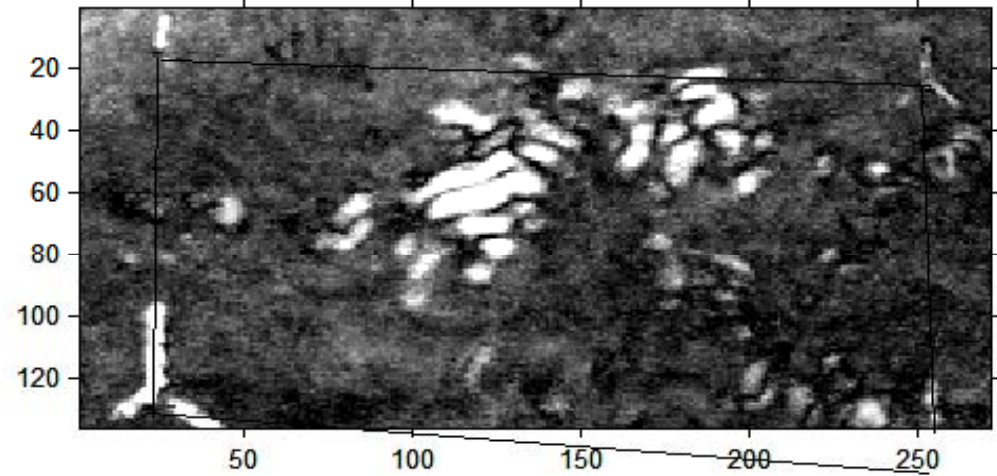
APPENDIX



Number of objects=4+5(wire)
 Yellow = correct = 2
 Orange = doubtfully correct = 1(+1)
 Red = incorrect = 3
 Green = Missed = 2(+3)

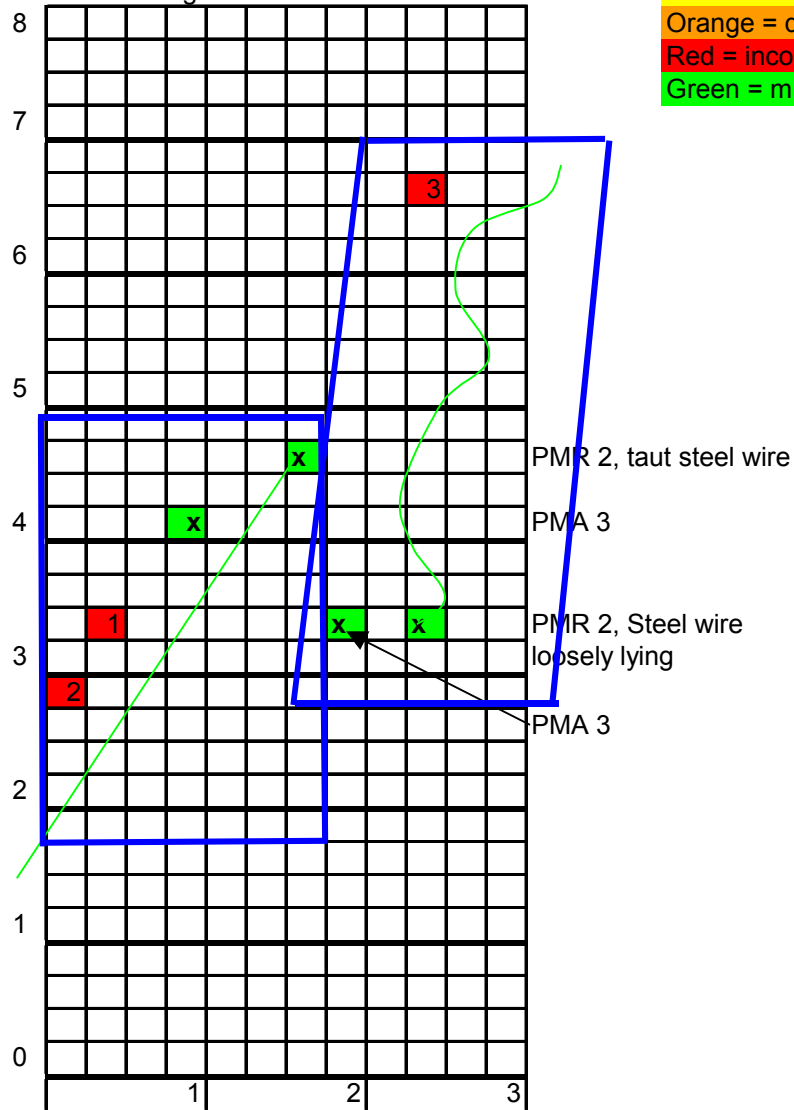


I DoLP LW

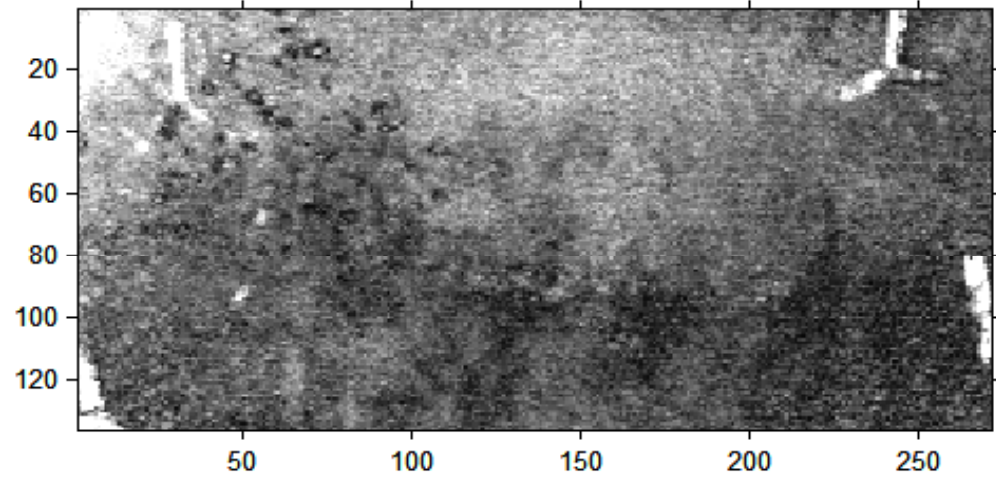


APPENDIX

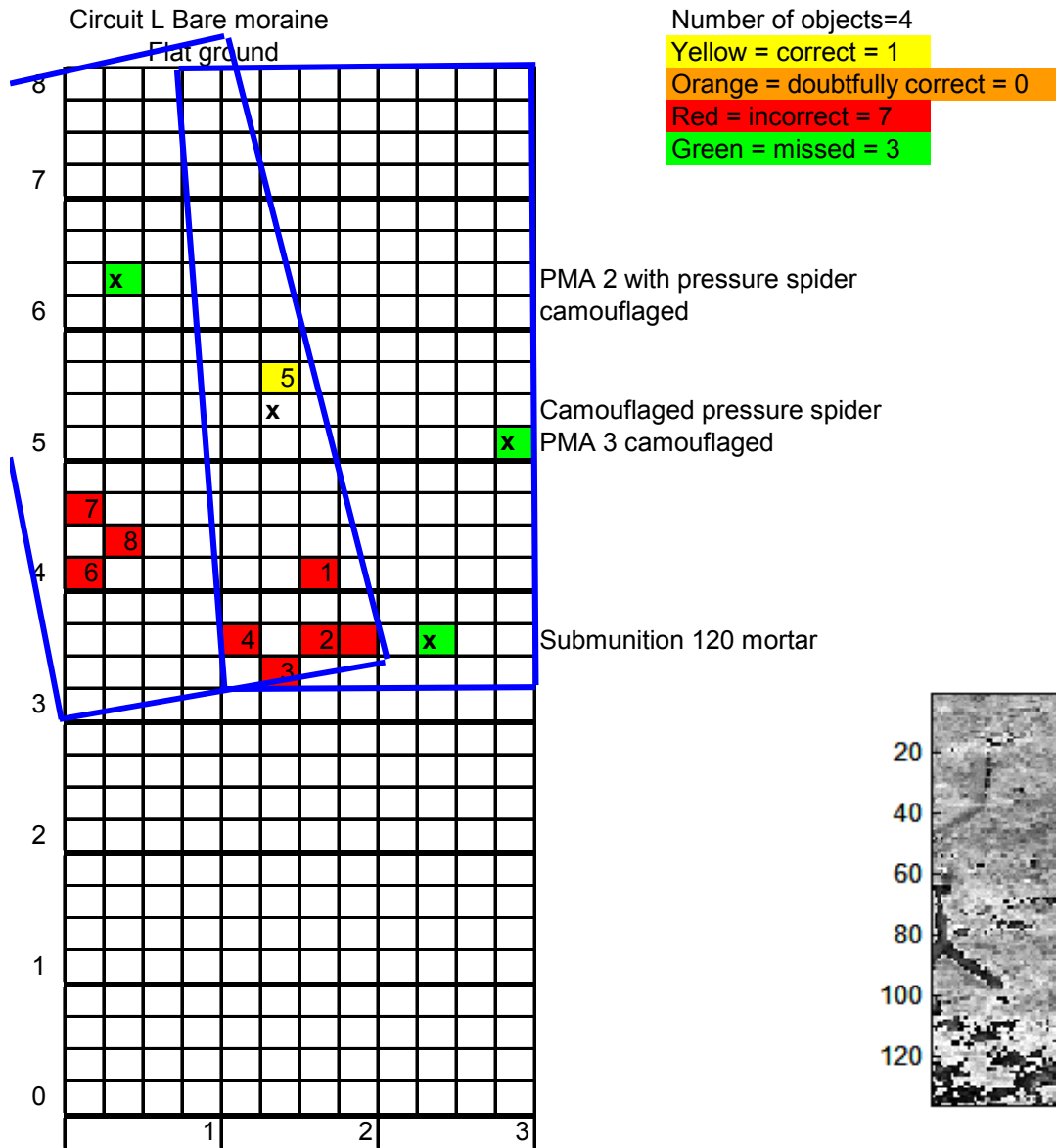
Circuit K High (0.5 m), dry grass
Flat ground



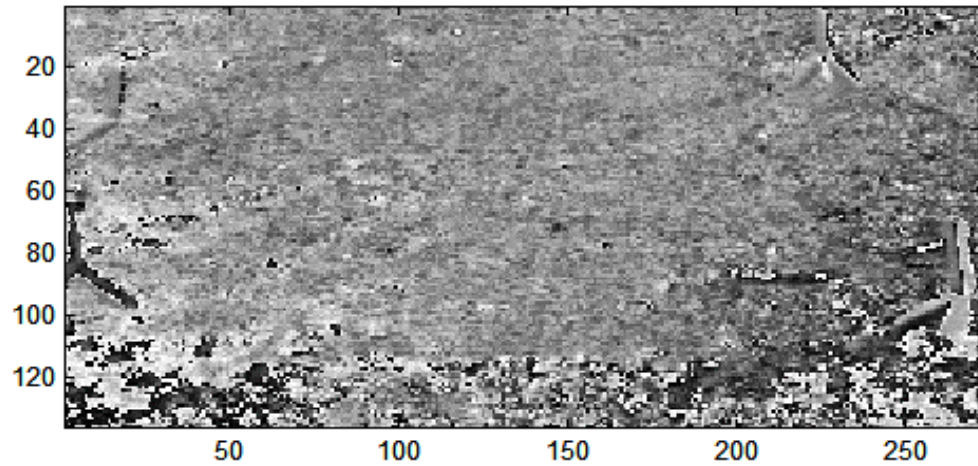
K v nedre DoLP LW



APPENDIX



L 03 theta LW



APPENDIX