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Anders Gustavsson, Tommy Jonsson, Björn Larsson, Mikael Lundberg,  
and Gunnar Stenström

## CARABAS-II Campaign Vidsel 2002

### Flight Report



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**Base data report**

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	<b>Report title</b> CARABAS-II Campaign Vidsel 2002. Flight Report			
<b>Abstract (not more than 200 words)</b> CARABAS-II conducted an extensive data collection at RFN Vidsel in northern Sweden between 30 May and 12 June 2002. The present report documents the flight missions performed as well as imaging geometries and radar waveforms used.				
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<b>Nyckelord</b> CARABAS, SAR, VHF, vegetationsgenomlysning, markmållspaning, flygrapport			
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# 1 INTRODUCTION

The CARABAS-II [1] airborne synthetic aperture radar (SAR) conducted an extensive data collection in northern Sweden between 30 May and 12 June, 2002. The collection area was within the missile test range RFN Vidsel. The present report documents the flight missions performed with CARABAS-II as well as imaging geometries and waveforms used by the radar.

Funding for the data collection was mainly provided by FMV (Swedish Defence Materiel Administration) as part of the CARABAS-III prestudy phase I. Part of the data collection, however, was also funded by DARPA (Defence Advanced Research Program Agency) under a bilateral research cooperation (TRDP-US-SW-D-98-0003).

The main objective of the data collection was to provide CARABAS-II data for performance evaluation, in particular for evaluation of change detection [2]. Results may be found in the change detection analysis report [3], and additional documentation in the ground data [4] and forest [5] reports.

The CARABAS-II Vidsel 2002 campaign was also part of a larger demonstration with a MALE UAV (Medium Altitude Long Endurance Unmanned Aerial Vehicle). The demo was managed by SSC (Swedish Space Corporation) and FMV. The UAV operated out from Kiruna airport. The UAV was equipped with a high-resolution microwave radar with SAR and ground moving target indication (GMTI) modes as well as electro-optical and infrared sensors. UAV flights were performed on 3, 4 and 6 June and operated over RFN Vidsel, the nearby rocket test range Esrange, and an air corridor in between. Although the UAV experiment mainly focused on practicing operation of a UAV, it also enabled sensor tests and cross-evaluation to be performed. A comparison between the capabilities of CARABAS-II and the UAV sensors may be found in [6].

## 2 RADAR SETTINGS

The CARABAS-II radar can be configured in a multiple of ways to support different experiment and measurement scenarios. The radar settings used during the Vidsel 2002 campaign were the same for all flight passes and are given in Table 1.

**Table 1. The CARABAS-II radar settings used during Vidsel 2002.**

Transmitted power (peak)	500 W
Pulse modulation	Non-linear FM
Frequency sub-bands	35 (36 including RFI-sniff)
Frequency step	1.875 MHz
Centre frequencies	21.25 - 85 MHz
Pulse repetition frequency	5000 Hz
Pulse length	15 $\mu$ s
Maximum range	26.4 km
Transmit notch	74.8 – 75.2 MHz
RFI sniff	On

### 3 IMAGING GEOMETRIES

A number of different imaging geometries were used to collect data during different operating conditions. The imaging geometries used during Vidsel 2002 are listed in Table 2.

The geometry is defined by incidence angle and altitude, whereas range is calculated from the following equation

$$\text{range} = \frac{\text{altitude}}{\cos(\text{incidence angle})}$$

Geometries 1-5 were defined to have the same range from the flight track to the aim point but with varying incidence angle. The flight altitude varies accordingly depending on the incidence angle. Five incidence angles between 58° and 75° therefore resulted in flight altitudes in the range 6.4 to 3.1 km. The reason for keeping the range constant for these geometries was to ensure equal signal energy after coherent integration.

Each flight pass is defined by its aim point, flight heading, radar look direction and pass length centered on the aim point. The eight aim points used during Vidsel 2002 are given in Table 3.

**Table 2. Imaging geometries used during VIdsel 2002. The parameter values are defined at the aim point.**

Imaging geometry	Range (km)	Incidence angle	Altitude (km)
1	12	58°	6.36
2	12	63°	5.45
3	12	68°	4.50
4	12	72°	3.71
5	12	75°	3.11
6	11.5	61.5°	5.50
7	9.9	68°	3.71
8	9.1	72°	2.81

**Table 3. Aim point locations used during Vidsel 2002. The plane coordinates (x,y,h) are defined in the Swedish geodetic system “Rikets Nät” (RT90 2.5 gon V).**

Aim Point	Coordinates		
	x	y	h
1	7368400	1654400	480 m
2	7352000	1656000	560 m
3	7355536	1659536	570 m
4	7359071	1663071	550 m
5	7362607	1666607	530 m
6	7352900	1661100	630 m
7	7358400	1655400	460 m
8	7315174	1698125	179 m

## 4 FLIGHT DAYS AND MISSIONS

The flight campaign Vidsel 2002 was conducted during the period 30 May – 12 June. Table 4 summarizes the actual flight missions and the main activities for each day during the campaign.

Deployment codes (A1-A6) are documented in the ground data report [4], and aim points are given in Table 3.

In the following sections, each flight day and mission are summarized with flight pass parameters in a table and a graphical illustration of the flight tracks.

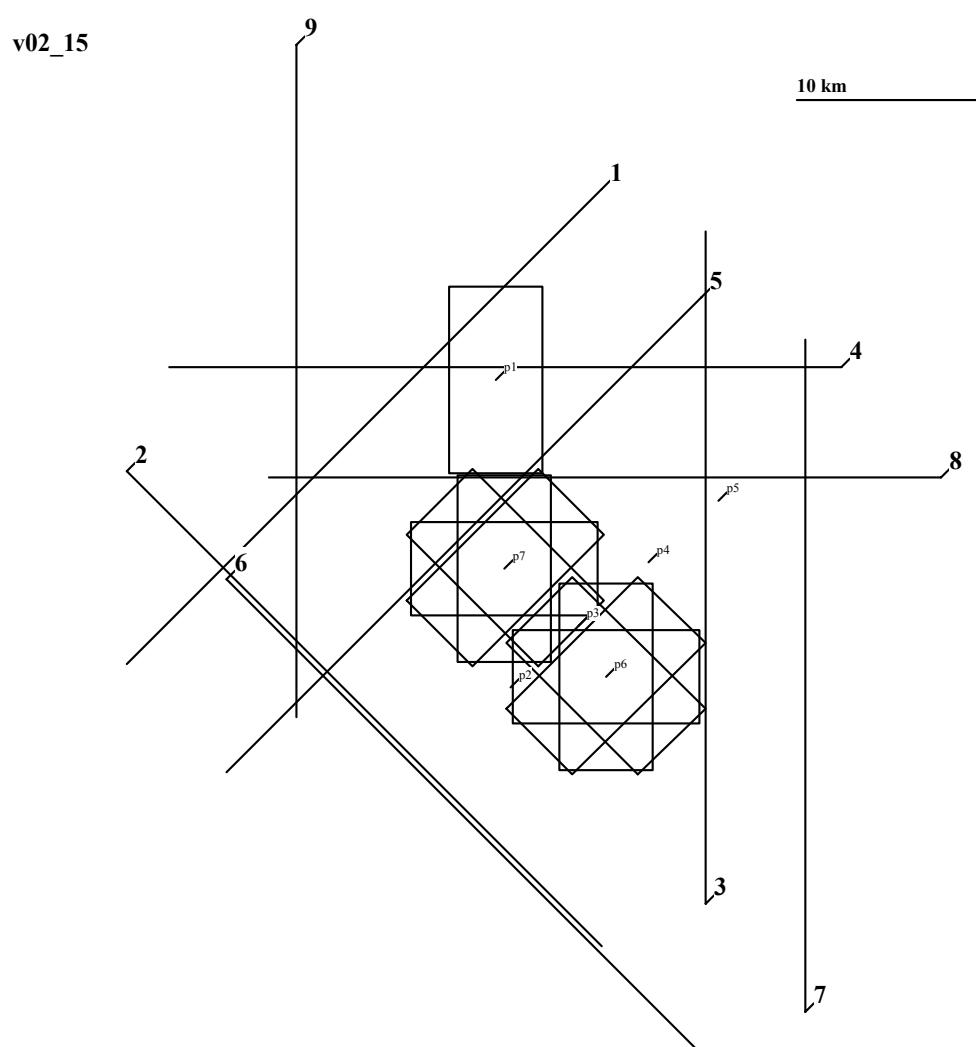
**Table 4. Summary of the flight missions performed during Vidsel 2002.**

Day	Time	Mission	Aim Point	Deploy.	Comments
30/5 Thursd	16-18	15	7,6	T0/B0	2h transfer: Linköping - Vidsel
31/5 Friday	11-13	9	1	F2/A5	
	14-16	7	1	F2/A5	
1/6 Saturday					Down day
2/6 Sunday	03-05	14	1	F2/A5	Night flight
	06-08	8	1	F2/A5	
3/6 Monday	08-10	6			Corrupt data due to recorder problems
	15-17	16	1,6	F1,T1/B1	
4/6 Tuesday					Cancelled mission due to thunderstorms
5/6 Wednes					Down day
6/6 Thursd	08-10	13	1	F3/A6	Pass 7,8 missed due to airspace conflicts
	15-17	18	7,2-5	T3	
7/6 Friday	8-10	11	1	F3/A6	Pass 9 at FL200 instead of FL170
	10-12	12	1	F3/A6	
8/6 Saturday					Down day
9/6 Sunday					Down day
10/6 Mond	11-13	2	1	A1	
	15-17	3	1	A2	
11/6 Tuesd	11-13	4	1	A3	
	15-17	5	1	A4	
12/6 Wedn	11-13	19,20	2-5,8		2h transfer: Vidsel - Linköping

## 4.1 Thursday 30 May 2002

**Table 5.** Flight mission 15 on 30 May 2002.

Pass	Heading ( $^{\circ}$ )	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	2	7	L	T0
2	135	20	2	7	L	T0
3	0	20	2	7	L	T0
4	270	20	2	7	L	T0
5	225	20	2	6	L	B0
6	135	20	2	6	L	B0
7	0	20	2	6	L	B0
8	270	20	2	6	L	B0
9	180	20	2	1	L	Trihedral

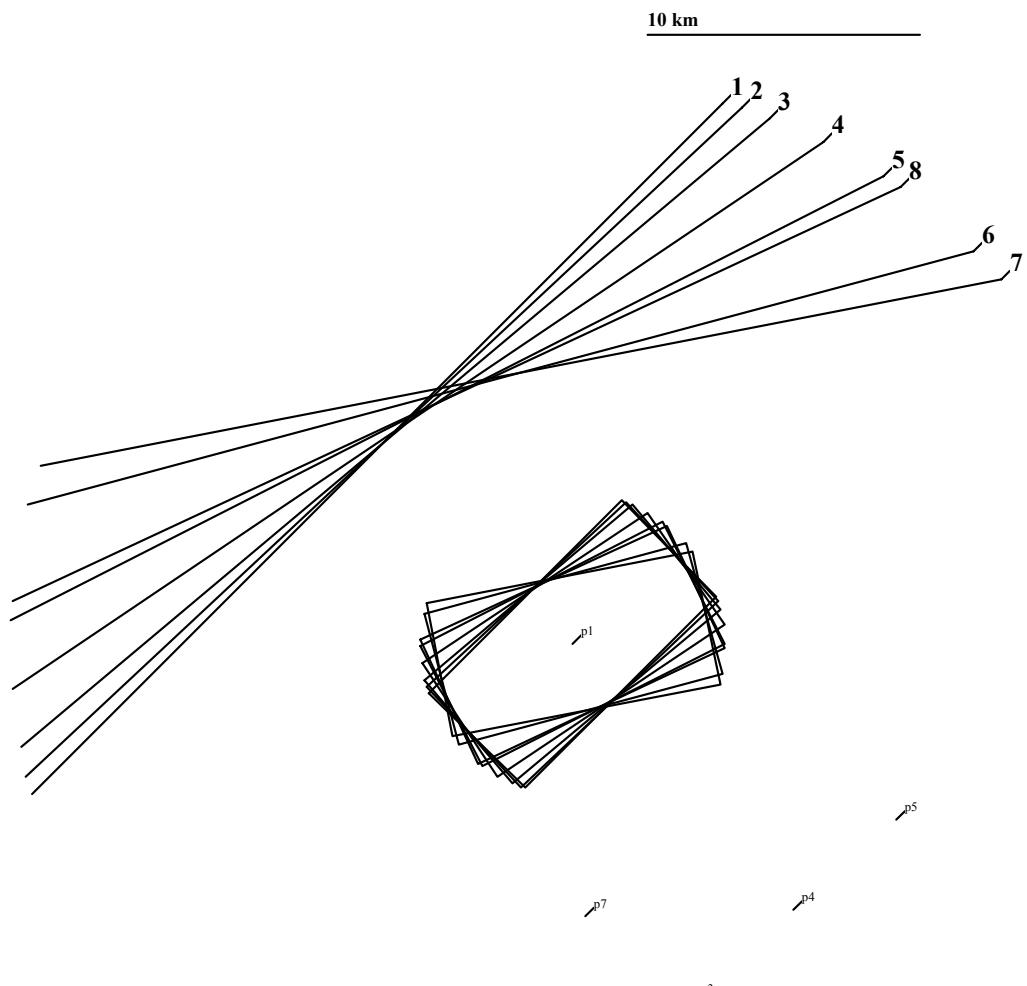


## 4.2 Friday 31 May 2002

**Table 6.** Flight mission 9 on 31 May 2002.

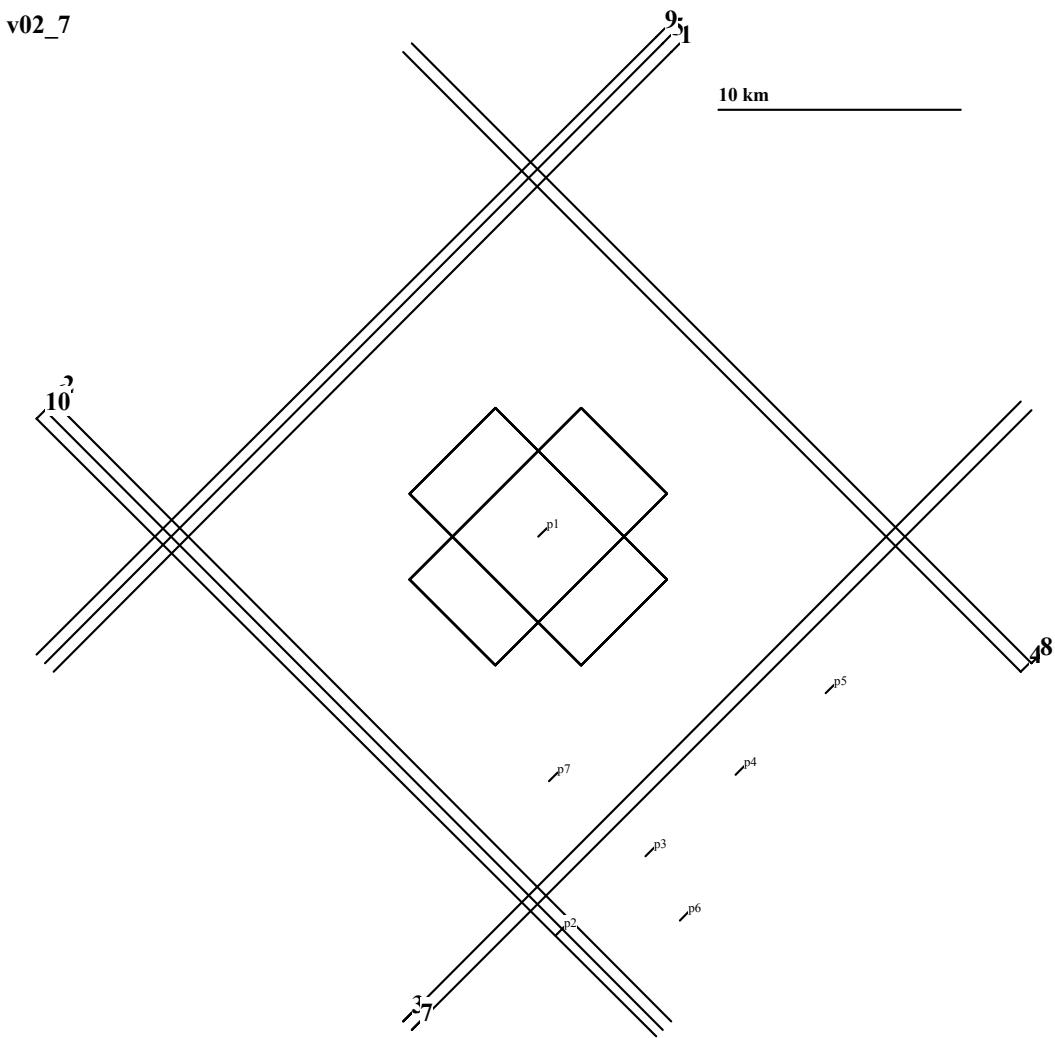
Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	1	1	L	F2/A5
2	227	20	1	1	L	F2/A5
3	230	20	1	1	L	F2/A5
4	236	20	1	1	L	F2/A5
5	243	20	1	1	L	F2/A5
6	255	20	1	1	L	F2/A5
7	259	20	1	1	L	F2/A5
8	245	20	1	1	L	F2/A5

v02\_9



**Table 7. Flight mission 7 on 31 May 2002.**

<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	225	20	1	1	L	F2/A5
2	135	20	1	1	L	F2/A5
3	45	20	1	1	L	F2/A5
4	315	20	1	1	L	F2/A5
5	225	20	2	1	L	F2/A5
6	135	20	2	1	L	F2/A5
7	45	20	2	1	L	F2/A5
8	315	20	2	1	L	F2/A5
9	225	20	3	1	L	F2/A5
10	135	20	3	1	L	F2/A5

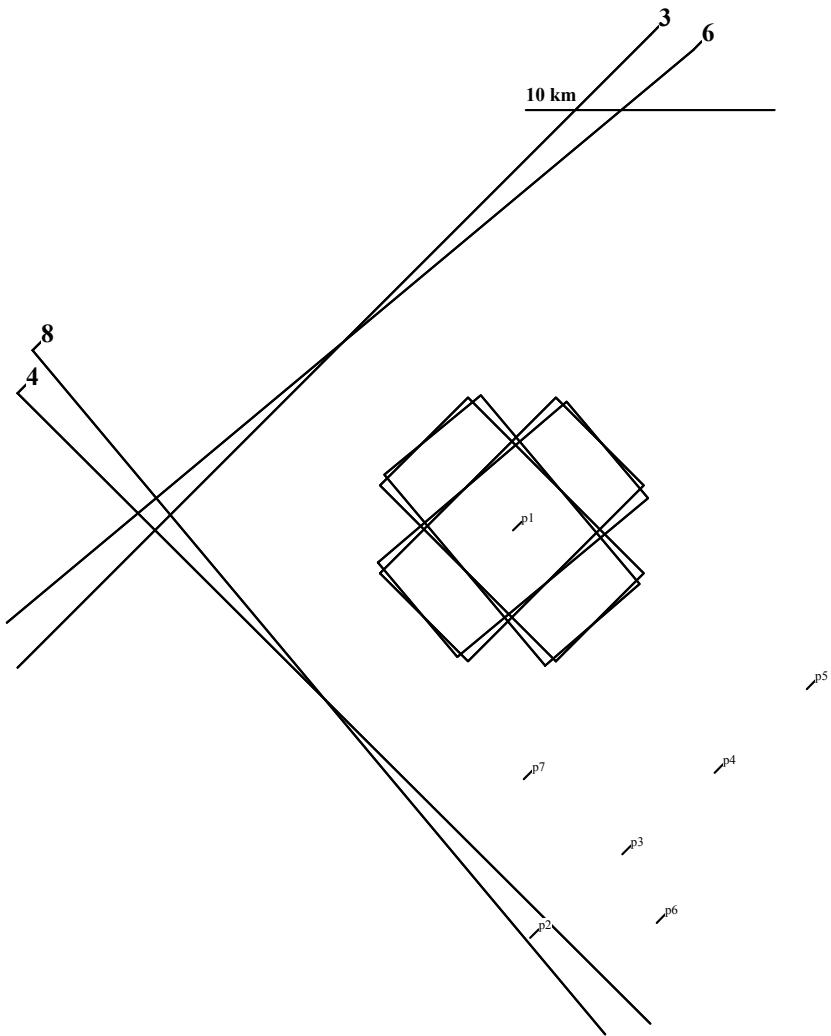


### 4.3 Sunday 2 June 2002

**Table 8.** Flight mission 14 on 2 June 2002.

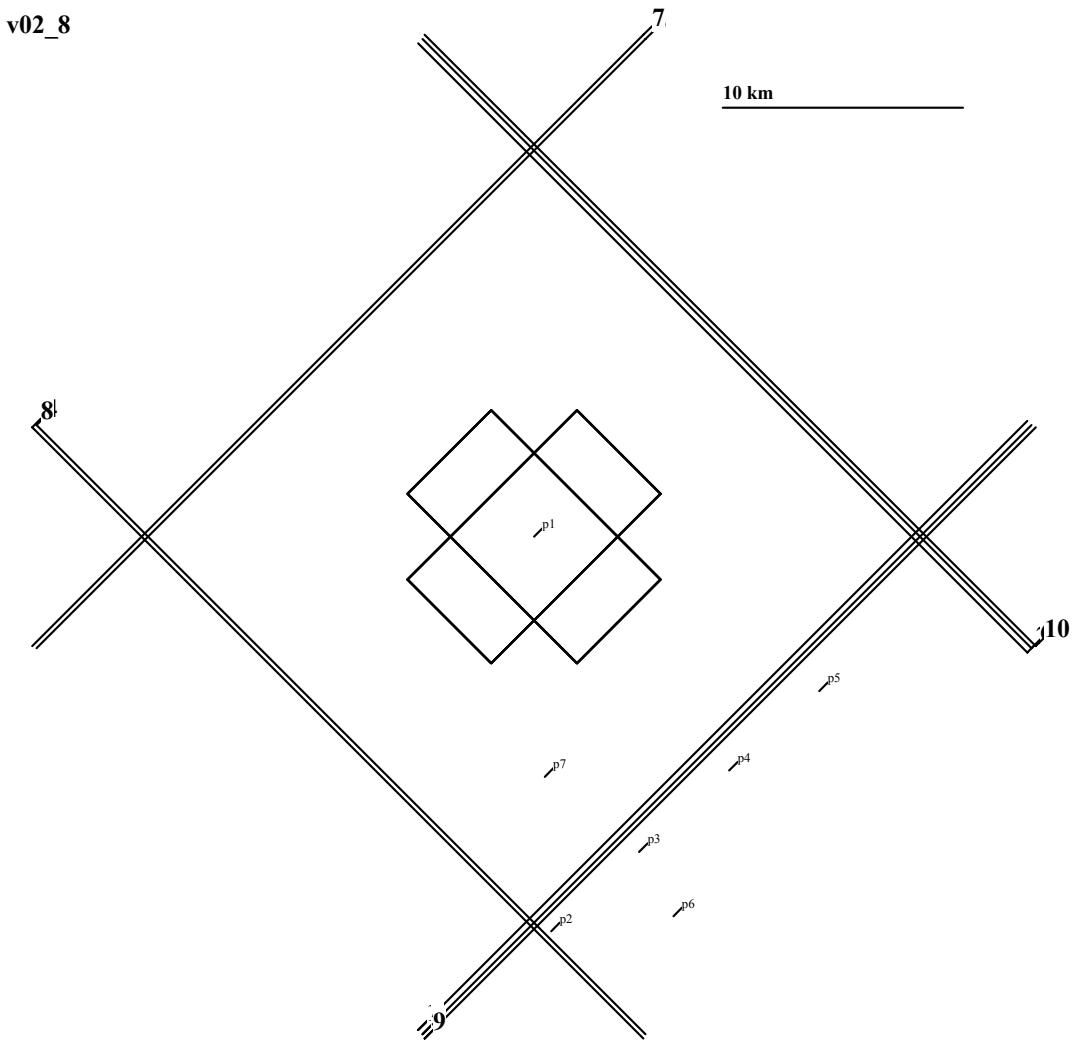
Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	1	1	L	F2/A5
2	135	20	1	1	L	F2/A5
3	225	20	1	1	L	F2/A5
4	135	20	1	1	L	F2/A5
5	230	20	1	1	L	F2/A5
6	230	20	1	1	L	F2/A5
7	140	20	1	1	L	F2/A5
8	140	20	1	1	L	F2/A5

v02\_14



**Table 9. Flight mission 8 on 2 June 2002.**

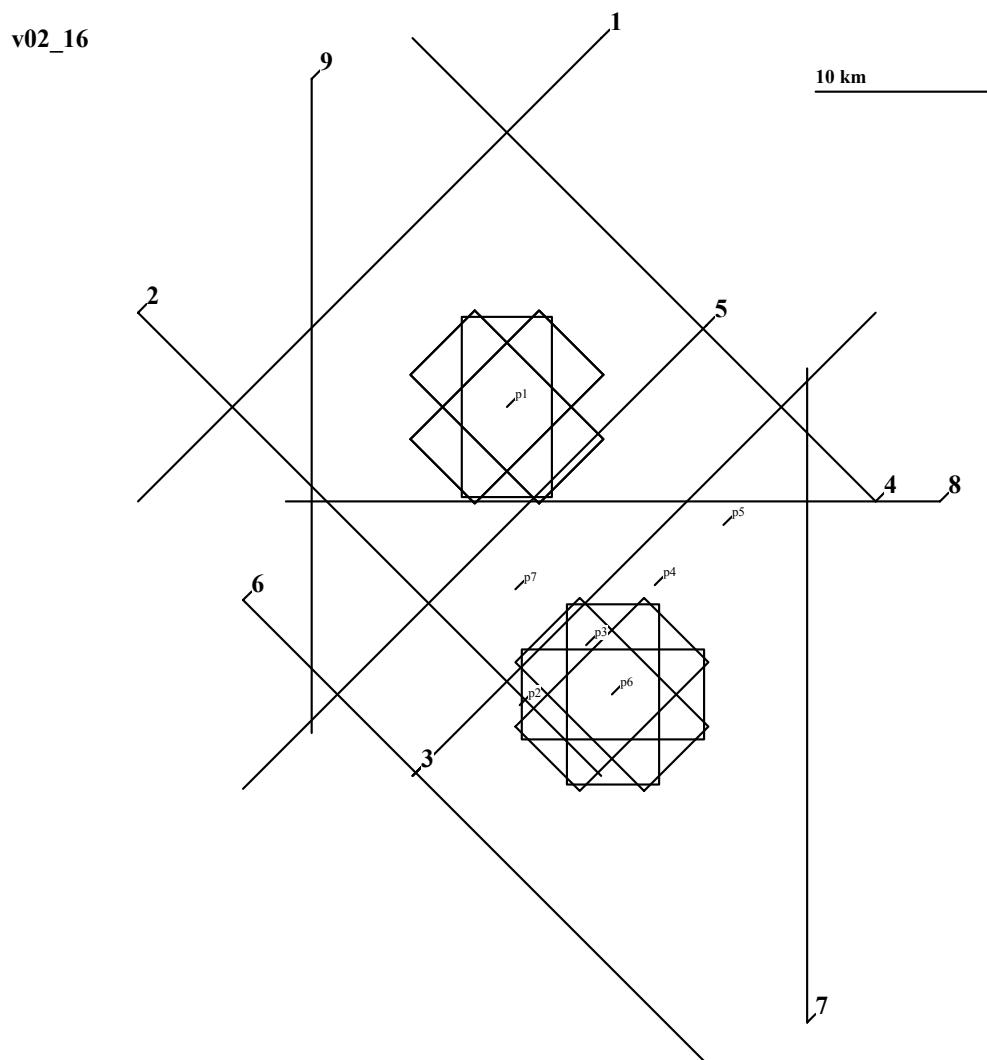
<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	45	20	3	1	L	F2/A5
2	315	20	3	1	L	F2/A5
3	225	20	4	1	L	F2/A5
4	135	20	4	1	L	F2/A5
5	45	20	4	1	L	F2/A5
6	315	20	4	1	L	F2/A5
7	225	20	5	1	L	F2/A5
8	135	20	5	1	L	F2/A5
9	45	20	5	1	L	F2/A5
10	315	20	5	1	L	F2/A5



## 4.4 Monday 3 June 2002<sup>1</sup>

**Table 10.** Flight mission 16 on 3 June 2002.

Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	2	1	L	F1
2	135	20	2	1	L	F1
3	45	20	2	1	L	F1
4	315	20	2	1	L	F1
5	225	20	2	6	L	T1/B1
6	135	20	2	6	L	T1/B1
7	0	20	2	6	L	T1/B1
8	270	20	2	6	L	T1/B1
9	180	20	2	1	L	Trihedral



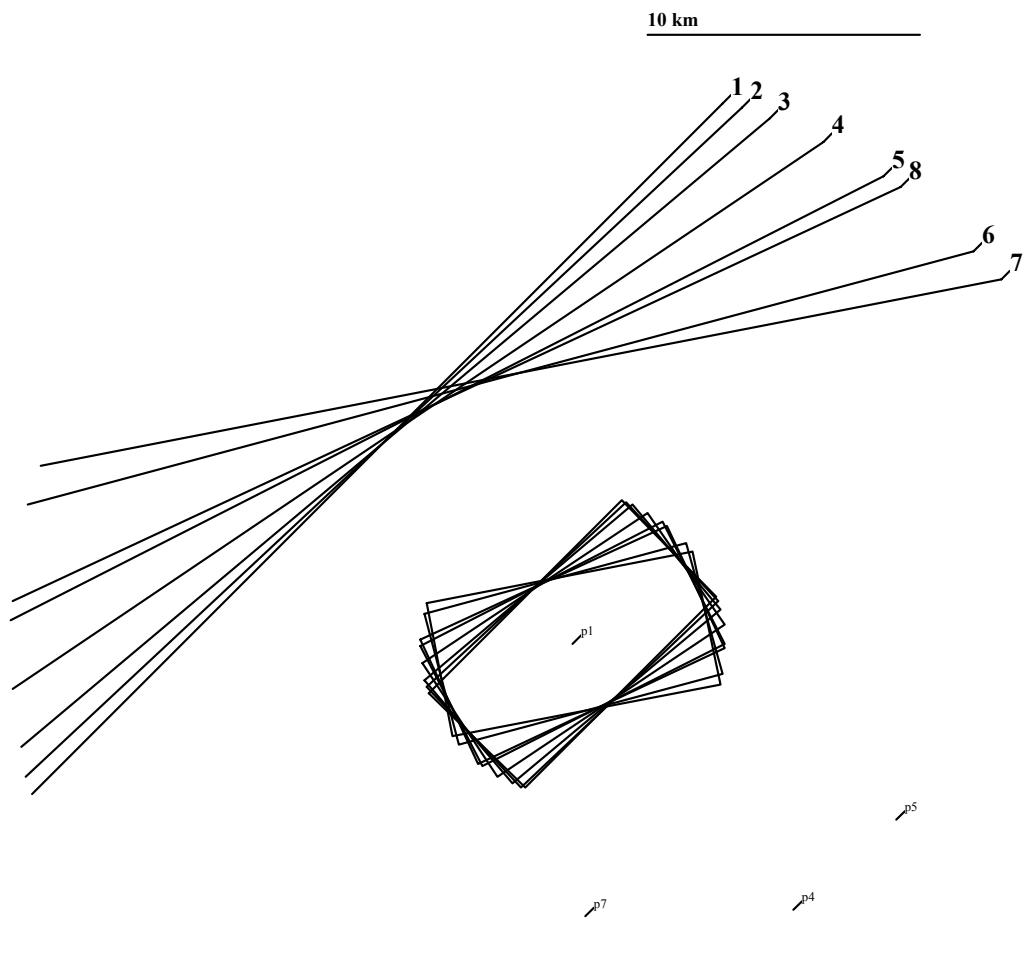
<sup>1</sup> Flight mission 6 on 3 June 2002 resulted in mostly corrupt radar data due to recorder problems. The four imaging passes were, however, repeated in flight mission 18 as passes 5 to 8.

## 4.5 Thursday 6 June 2002

**Table 11.** Flight mission 13 on 6 June 2002.

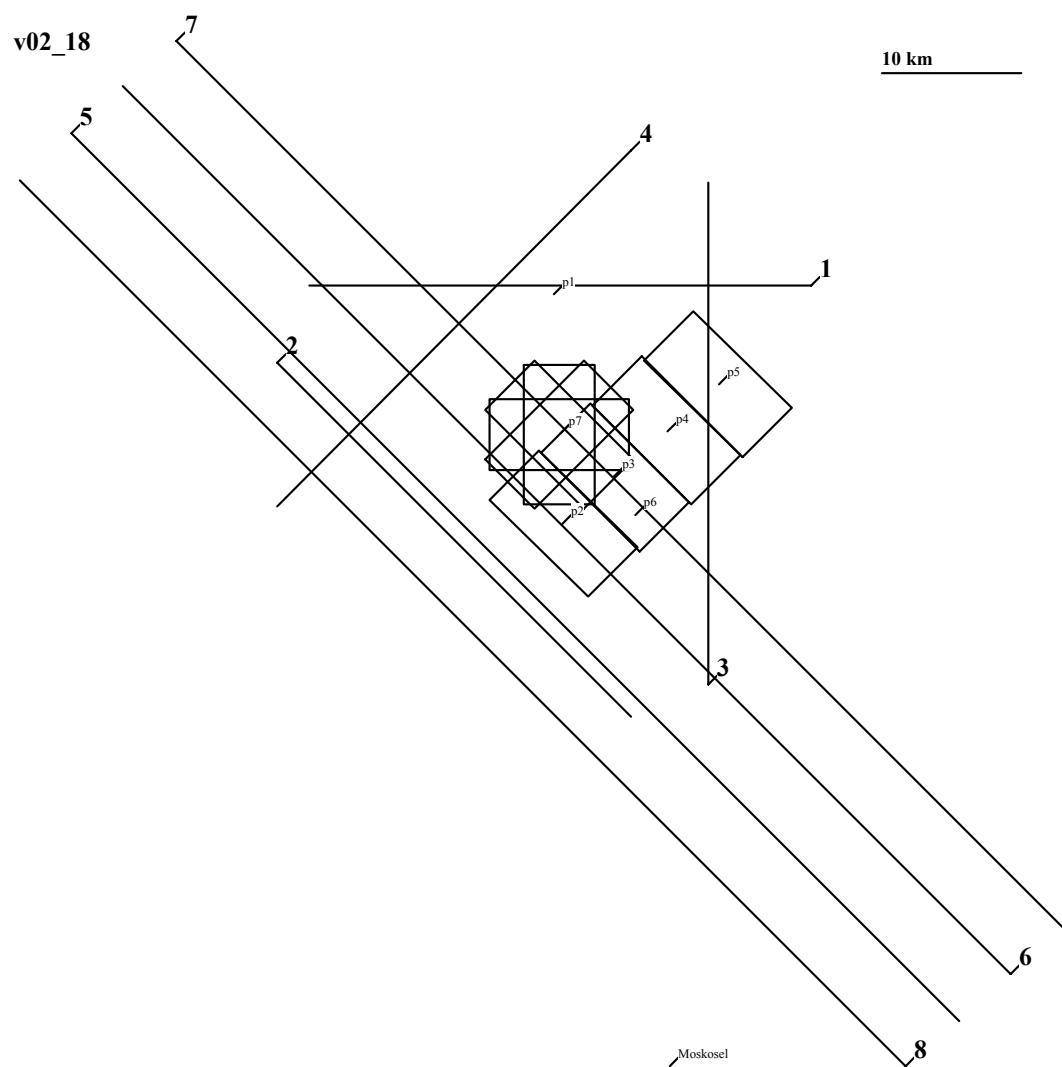
Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	1	1	L	F3/A6
2	227	20	1	1	L	F3/A6
3	230	20	1	1	L	F3/A6
4	236	20	1	1	L	F3/A6
5	243	20	1	1	L	F3/A6
6	255	20	1	1	L	F3/A6
7	259	20	1	1	L	F3/A6
8	245	20	1	1	L	F3/A6

v02\_13



**Table 12. Flight mission 18 on 6 June 2002.**

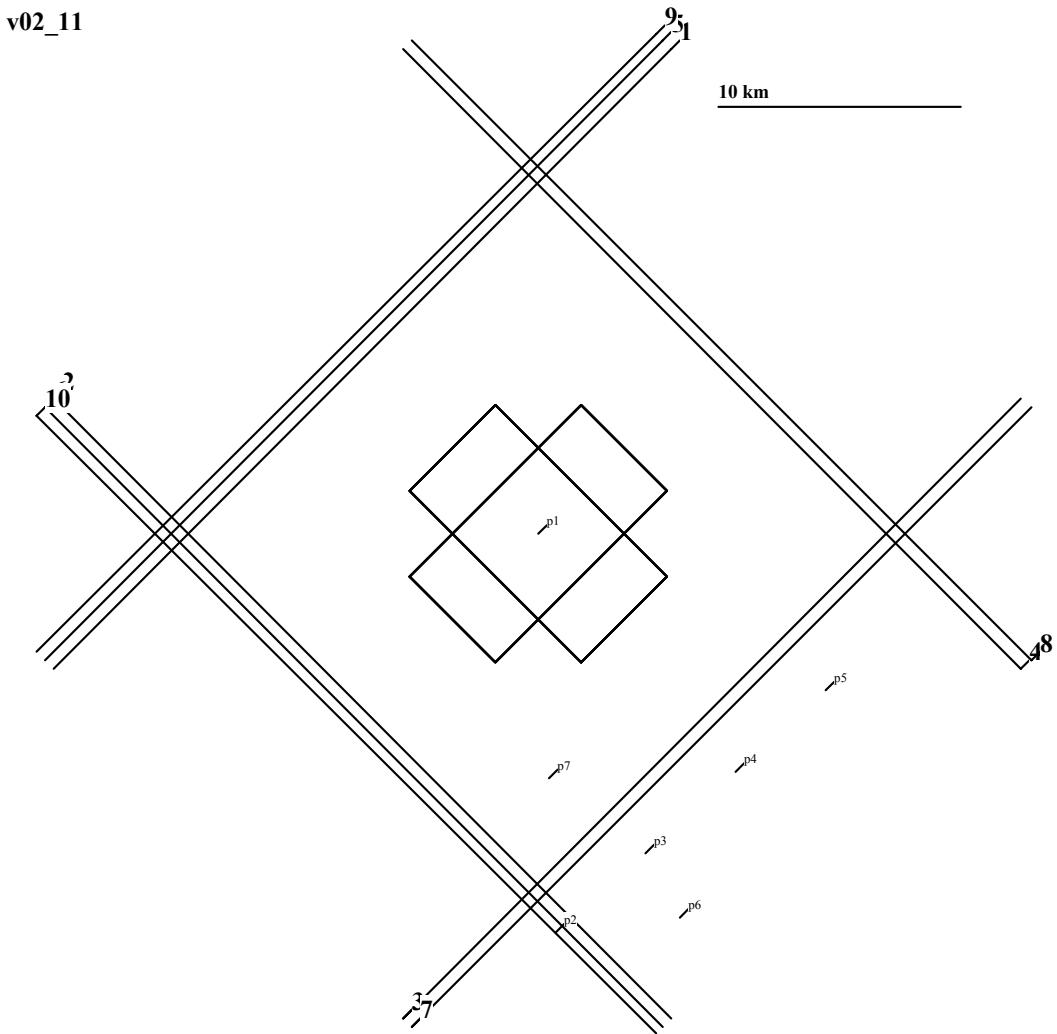
<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	270	20	2	7	L	T3
2	135	20	2	7	L	T3
3	0	20	2	7	L	T3
4	225	20	2	7	L	T3
5	135	50	6	3	L	none
6	315	50	6	4	R	none
7	135	50	6	5	L	none
8	315	50	6	2	R	none



## 4.6 Friday 7 June 2002

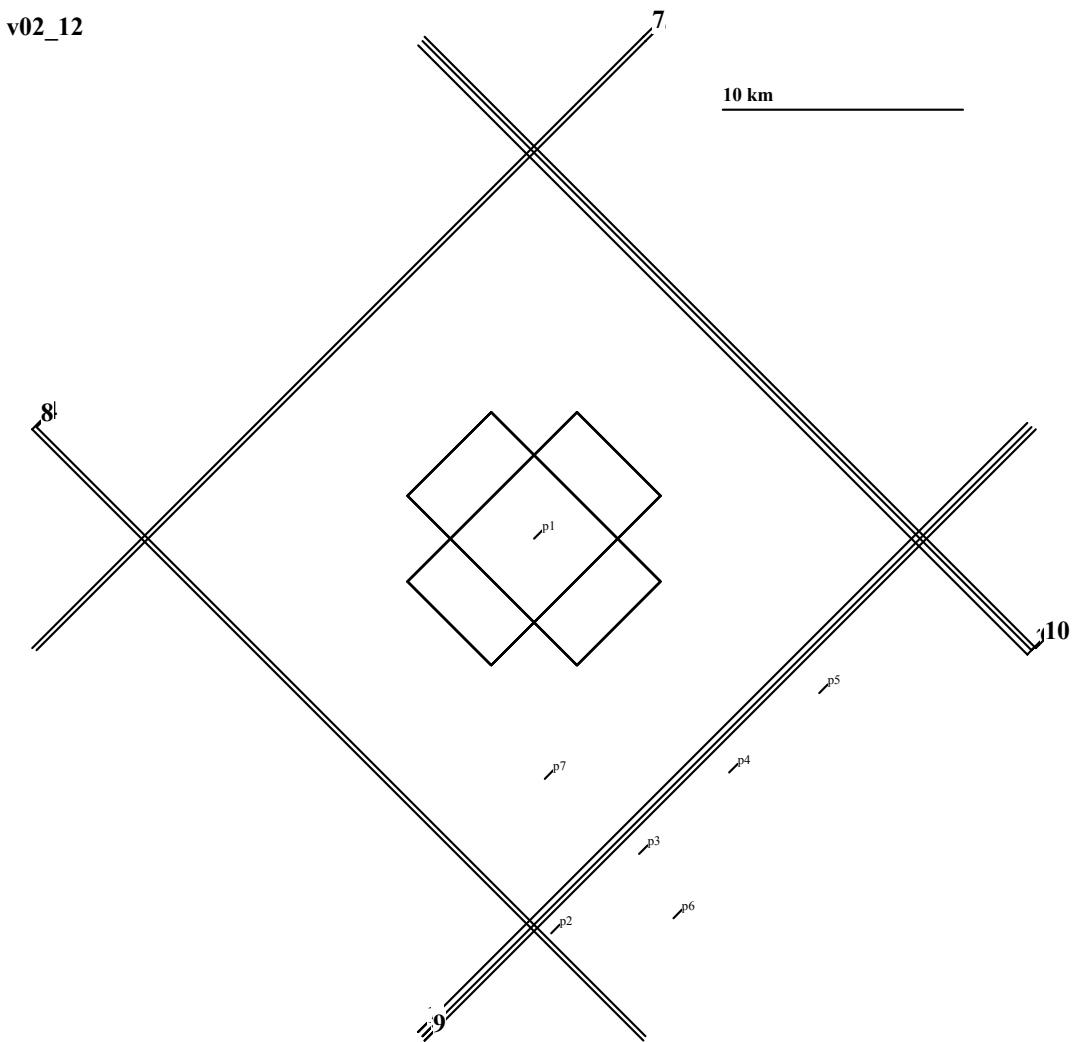
**Table 13.** Flight mission 11 on 7 June 2002.

Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	1	1	L	F3/A6
2	135	20	1	1	L	F3/A6
3	45	20	1	1	L	F3/A6
4	315	20	1	1	L	F3/A6
5	225	20	2	1	L	F3/A6
6	135	20	2	1	L	F3/A6
7	45	20	2	1	L	F3/A6
8	315	20	2	1	L	F3/A6
9	225	20	3	1	L	F3/A6
10	135	20	3	1	L	F3/A6



**Table 14. Flight mission 12 on 7 June 2002.**

<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	45	20	3	1	L	F3/A6
2	315	20	3	1	L	F3/A6
3	225	20	4	1	L	F3/A6
4	135	20	4	1	L	F3/A6
5	45	20	4	1	L	F3/A6
6	315	20	4	1	L	F3/A6
7	225	20	5	1	L	F3/A6
8	135	20	5	1	L	F3/A6
9	45	20	5	1	L	F3/A6
10	315	20	5	1	L	F3/A6

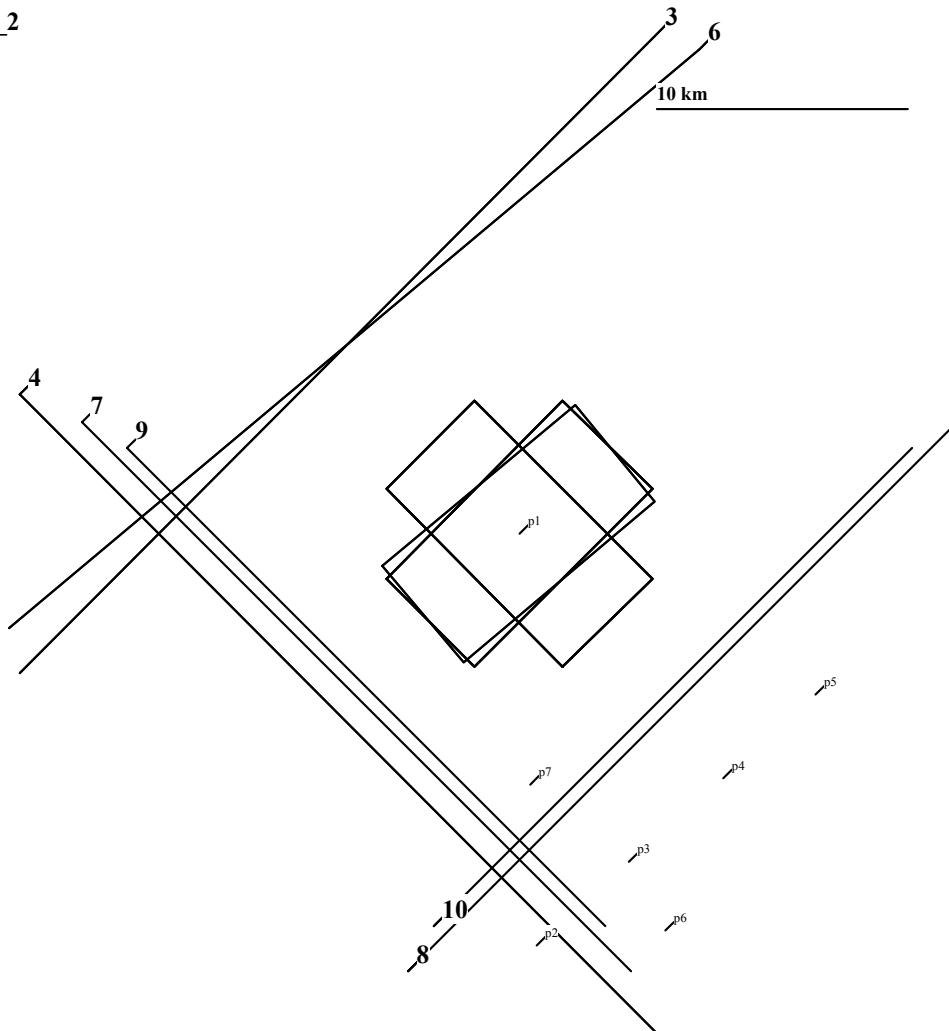


## 4.7 Monday 10 June 2002

**Table 15.** Flight mission 2 on 10 June 2002.

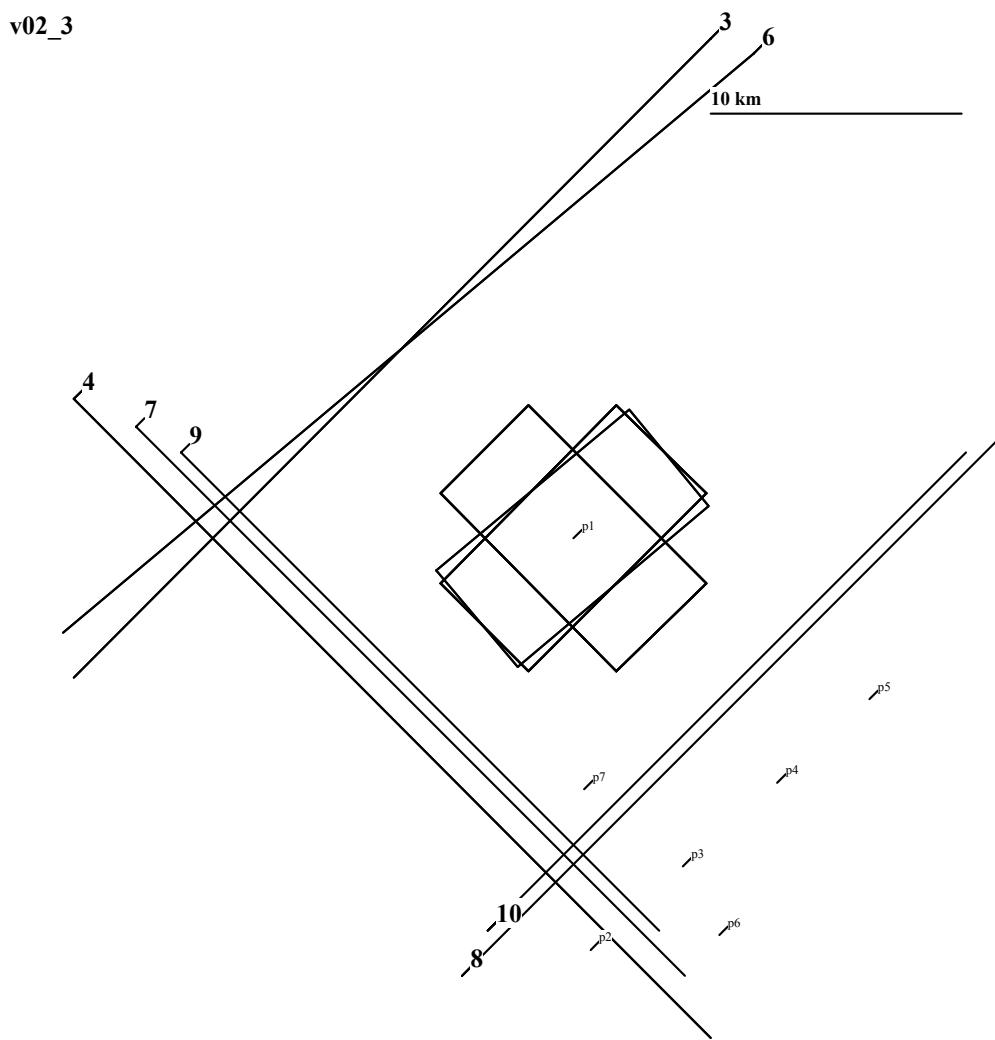
Pass	Heading ( $^{\circ}$ )	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	1	1	L	A1
2	135	20	1	1	L	A1
3	225	20	1	1	L	A1
4	135	20	1	1	L	A1
5	230	20	1	1	L	A1
6	230	20	1	1	L	A1
7	135	17	7	1	L	A1
8	45	17	7	1	L	A1
9	135	15	8	1	L	A1
10	45	15	8	1	L	A1

v02\_2



**Table 16. Flight mission 3 on 10 June 2002.**

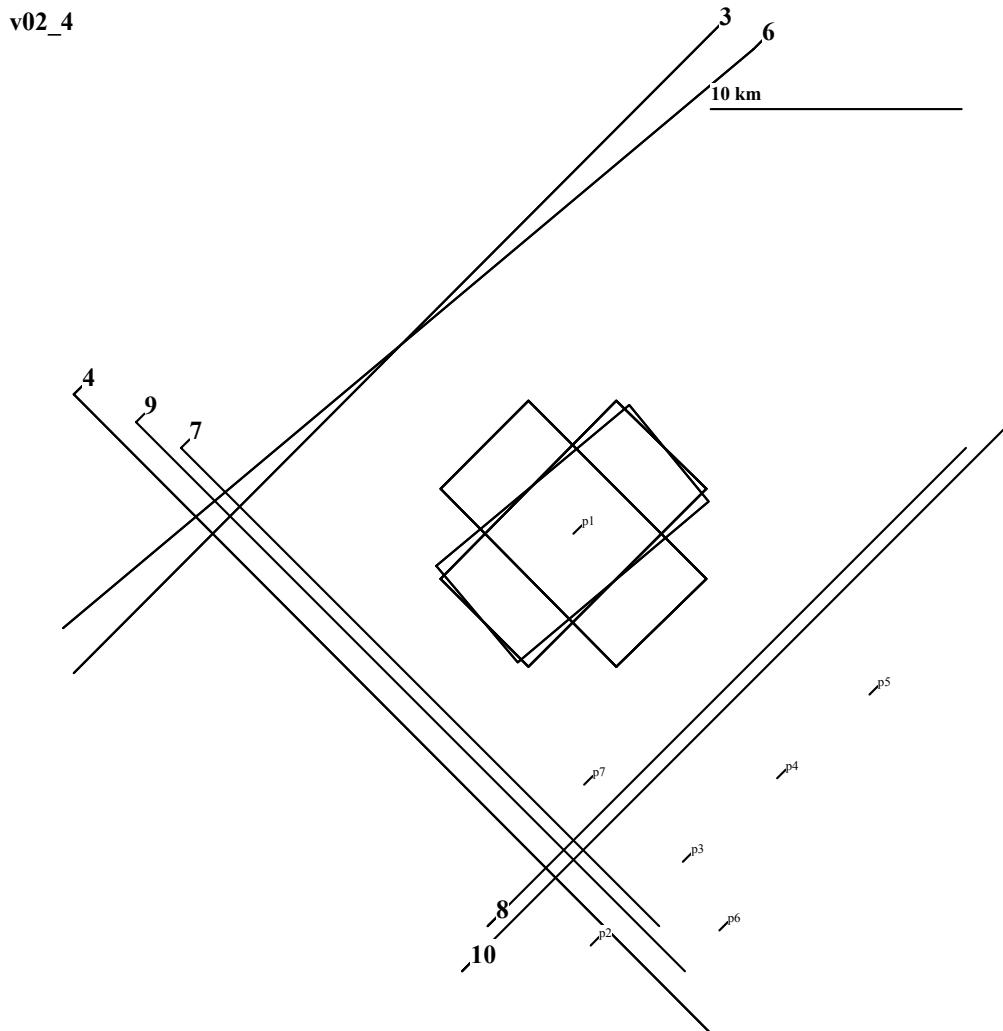
<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	225	20	1	1	L	A2
2	135	20	1	1	L	A2
3	225	20	1	1	L	A2
4	135	20	1	1	L	A2
5	230	20	1	1	L	A2
6	230	20	1	1	L	A2
7	135	17	7	1	L	A2
8	45	17	7	1	L	A2
9	135	15	8	1	L	A2
10	45	15	8	1	L	A2



## 4.8 Tuesday 11 June 2002

**Table 17.** Flight mission 4 on 11 June 2002.

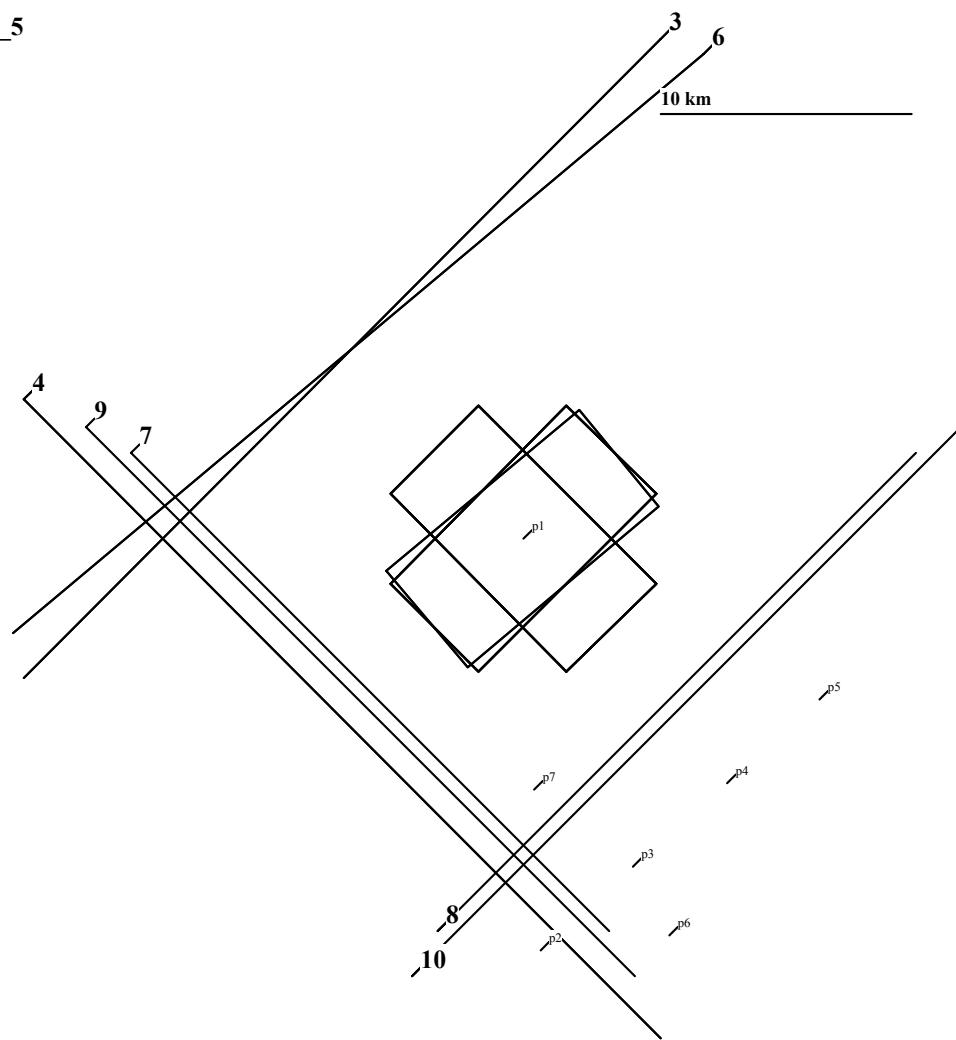
Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	225	20	1	1	L	A3
2	135	20	1	1	L	A3
3	225	20	1	1	L	A3
4	135	20	1	1	L	A3
5	230	20	1	1	L	A3
6	230	20	1	1	L	A3
7	135	15	8	1	L	A3
8	45	15	8	1	L	A3
9	135	17	7	1	L	A3
10	45	17	7	1	L	A3



**Table 18. Flight mission 5 on 11 June 2002.**

<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	225	20	1	1	L	A4
2	135	20	1	1	L	A4
3	225	20	1	1	L	A4
4	135	20	1	1	L	A4
5	230	20	1	1	L	A4
6	230	20	1	1	L	A4
7	135	15	8	1	L	A4
8	45	15	8	1	L	A4
9	135	17	7	1	L	A4
10	45	17	7	1	L	A4

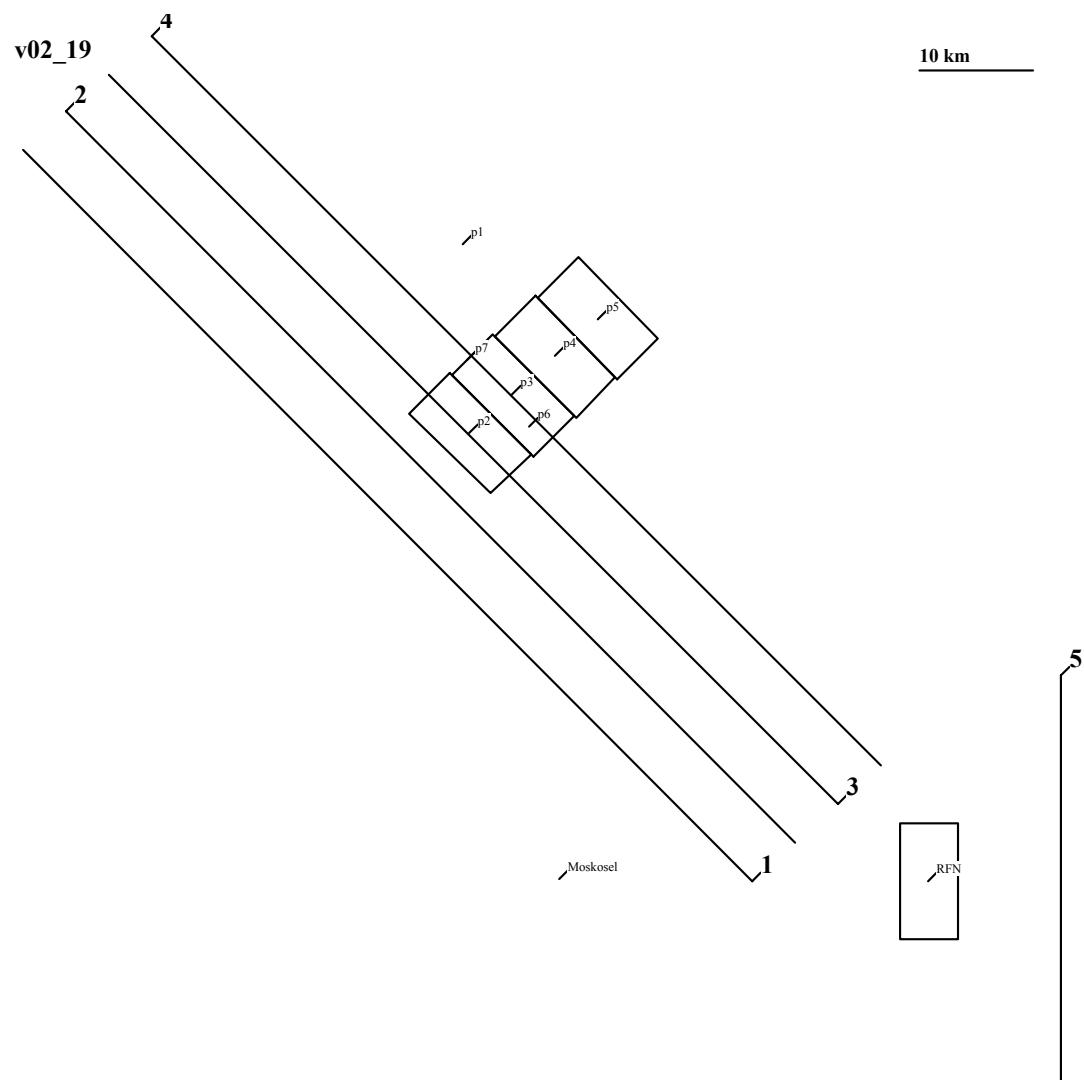
v02\_5



## 4.9 Wednesday 12 June 2002

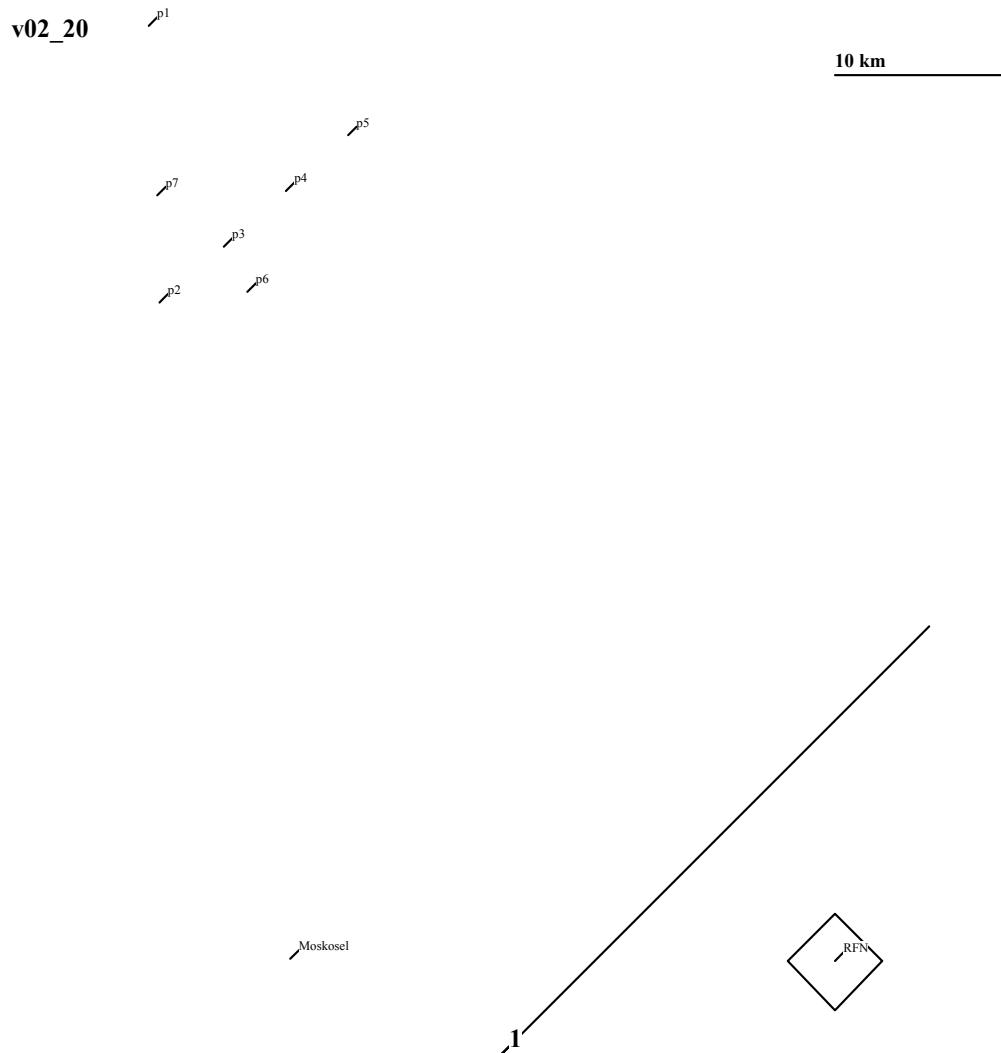
**Table 19.** Flight mission 19 on 12 June 2002.

Pass	Heading (°)	Length (n.m.)	Geometry	Aim Point	Look Dir (L/R)	Deployment
1	315	50	6	2	R	none
2	135	50	6	3	L	none
3	315	50	6	4	R	none
4	135	50	6	5	L	none
5	180	20	5	8	R	none



**Table 20. Flight mission 20 on 12 June 2002.**

<i>Pass</i>	<i>Heading (°)</i>	<i>Length (n.m.)</i>	<i>Geometry</i>	<i>Aim Point</i>	<i>Look Dir (L/R)</i>	<i>Deployment</i>
1	045	20				



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