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C-band PARC manual

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TNO Physics and Electronics
Laboratory

P.O. Box 96864
2509 JG The Hague
Oude Waalsdorperweg 63
The Hague, The Netherlands

Fax +31 70 328 09 61
Phone +31 70 326 42 21

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J.S. Groot

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ABSTRACT (UNCLASSIFIED)

For the calibration of air- and spaceborne radars commonly used in remote sensing a PARC (Polarimetric Active Radar Calibrator) can be used. This report presents measurement results of the radar cross section, crosstalk level etc. of a C-band PARC developed at TNO-FEL. The results are used to infer guidelines for the use of this PARC.

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SAMENVATTING (ONGERUBRICEERD)

Voor de kalibratie van remote sensing radars kan een PARC (Polarimetrische Actieve Radar Calibrator) gebruikt worden. Dit rapport bevat meetresultaten van de radardoorsnede, overspraak etc. van een C-band PARC ontwikkeld op het TNO-FEL. De resultaten worden gebruikt om een checklist op te stellen voor het gebruik van de PARC.

1 INTRODUCTION

For the calibration of air- and spaceborne radars commonly used in remote sensing one needs point targets with an RCS (Radar Cross Section) which is large compared to the background RCS, because the calibration accuracy gets worse with decreasing target/background RCS ratio [Ulaby *et al*, 1982]. Although trihedral corner reflectors can be used for this purpose, the physical dimensions become unacceptable large (>2 m) when the RCS exceeds 40 dBm^2, especially at the lower frequencies.

The calibration of polarimetric radars (radars which measure the complete complex scattering matrix [van Zyl *et al.*, 1987]) necessitates the use of a point target with non-vanishing off-diagonal elements. The scattering matrix of a trihedral corner reflector is a constant times the unit matrix, so this cannot be used. The scattering matrix of a dihedral corner reflector exhibits non-vanishing off-diagonal elements after rotating the reflector about the line of sight [Freeman *et al.*, 1988]. However, the small beamwidth of such a reflector in combination with the sometimes unpredictable flight path of an airborne radar complicates its pointing.

An alternative for dihedral and trihedral corner reflectors is a PARC. A PARC (Polarimetric Active Radar Calibrator) consists basically of a high-gain amplifier connected between two linearly polarized horn antennas [Brunfeldt and Ulaby, 1984; Freeman *et al.*, 1988] . Because the RCS depends on the gain of the amplifier and the horn antennas, the RCS can be made quite large. By rotating the horn antennas about the line of sight the off-diagonal scattering elements can be made non-zero.

In 1991 a C-band (5.66 cm) PARC was built at TNO-FEL. A description of the electronic and mechanical construction is provided by [Jansen, 1991] . It also includes some measurement results of parts of the PARC. In 1992 measurements were done in an anechoic chamber at TNO-FEL [Nennie, 1992] with the PARC in the same configuration as that used in real remote sensing experiments. The results will be used for the calibration with the PARC of the data obtained in this kind of experiments.

Chapter 2 of this report contains some theory necessary to understand the measurement results provided in chapter 3. Chapter 4 provides the user with a checklist to use for the PARC deployment in future remote sensing experiments. Final conclusions and recommendations are given in Chapter 5.

2 PARC THEORY

2.1 General considerations

A simplified scheme of the PARC developed and built at TNO-FEL is shown in Fig.2.1. It will be used throughout this report. When a radar transmits radiation towards the PARC, the receive antenna with gain G_a intercepts part of it. The resulting signal is amplified by the amplifier with gain G_e. The output signal is attenuated by a variable attenuator (attenuation A_v), and transmitted by the transmit antenna which is identical to the receive antenna. In reality, the amplifier consists of three stages, with the attenuator inserted between the first and second stage.

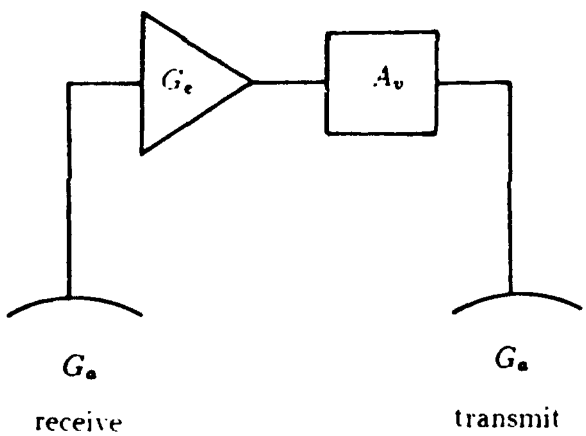


Figure 2.1: Simplified scheme of the TNO-FEL PARC.

The PARC developed at TNO-FEL uses standard gain horn antennas. Fig.2.2a shows a drawing of the PARC's horn antennas which point into the same direction. It is possible to rotate the horn antennas about the line of sight. This alters the scattering matrix of the PARC. Commonly used antenna polarization configurations are HH-polarization, VV-polarization and orthogonal polarization.

The HH-polarization configuration is used to calibrate an HH-polarized radar. The polarization of both antennas is horizontal in this case. A horn antenna with a rectangular aperture transmits predominantly linearly polarized radiation in the main direction perpendicular to the horn aperture. The polarization direction is parallel to the short side of a rectangular antenna aperture. So HH-polarization is produced when the short sides of both horns are parallel to the horizontal (ground). VV-polarization is accomplished by rotating the horns over 90°. The RCS σ which an HH- (VV-)

polarized radar measures in case the PARC is HH- (VV-) polarized is [Brunfeldt and Ulaby, 1984]

$$\sigma = \frac{\lambda^2}{4\pi}\frac{G_e G_a^2}{A_v}. \tag{2.1}$$

λ is the wavelength in meters, while the amplifier gain and attenuation are dimensionless. Obviously, a VV-polarized radar measures a very small RCS of an HH-polarized PARC. This small RCS consists of two contributions, due to imperfections of both the PARC transmit antenna and the radar receive antenna. For example, although the PARC transmit antenna is horizontally polarized, it will nevertheless transmit a small amount of vertically polarized radiation.

Fig.2.2b gives an example of the orthogonal configuration. This is a drawing of the horn apertures, when looking from the front into the horns. The polarizations of the horn antennas are orthogonal. This configuration can be used to calibrate polarimetric radar systems, because the off-line scattering matrix elements of the PARC as measured by the radar are generally non-zero. By altering angle α the orientations of the linear antenna polarizations change, and hence the scattering matrix changes. For example, $\alpha = 0°$ gives horizontal receive polarization and vertical transmit polarization. The scattering matrix of the PARC is for a certain α

$$\mathrm{S} = \sqrt{\sigma}\begin{pmatrix} \sin\alpha\cos\alpha & \sin^2\alpha \\ -\cos^2\alpha & -\sin\alpha\cos\alpha \end{pmatrix}, \tag{2.2}$$

with σ given by Eq.(2.1). The equation shows that the scattering matrix of an orthogonal PARC is a-symmetric, as opposed to that of most other (natural) targets.

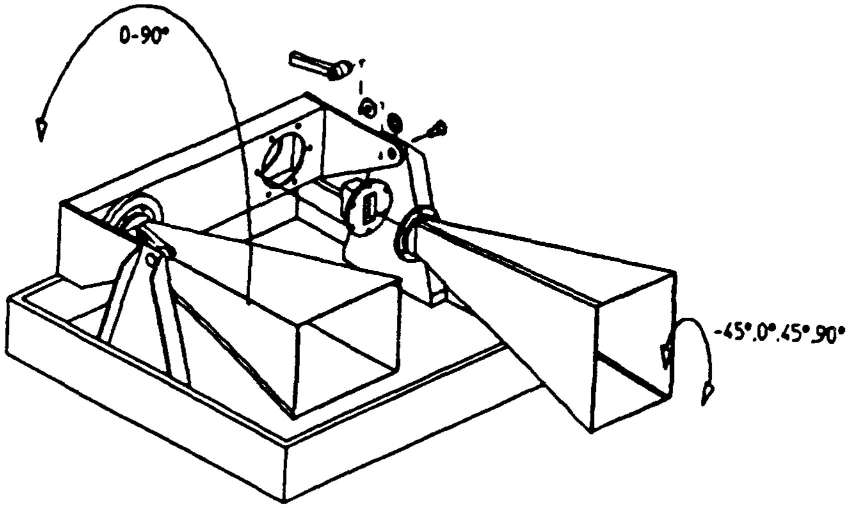
As an example, assume that an HV-polarized radar system (horizontal receive polarization, vertical transmit polarization) measures the RCS σ_m of the PARC. The normalized polarization vector [Groot, 1991] of the receive antenna is $\hat{\mathbf{p}}_t = (1\ \ 0)^{\mathrm{T}}$, and of the transmit antenna $\hat{\mathbf{p}}_r = (0\ \ 1)^{\mathrm{T}}$. The RCS is:

$$\sigma_m = |\hat{\mathbf{p}}_r \cdot \mathbf{S}\hat{\mathbf{p}}_t|^2 \tag{2.3}$$

$$= \left|\begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot \sqrt{\sigma}\begin{pmatrix} \sin\alpha\cos\alpha & \sin^2\alpha \\ -\cos^2\alpha & -\sin\alpha\cos\alpha \end{pmatrix}\begin{pmatrix} 0 \\ 1 \end{pmatrix}\right|^2 \tag{2.4}$$

$$= \sigma\sin^4\alpha. \tag{2.5}$$

For $\alpha = 90°$ it turns out that $\sigma_m = \sigma$, because the receive polarization of the PARC is the same as the send polarization of the radar, and the send polarization of the PARC is the same as the



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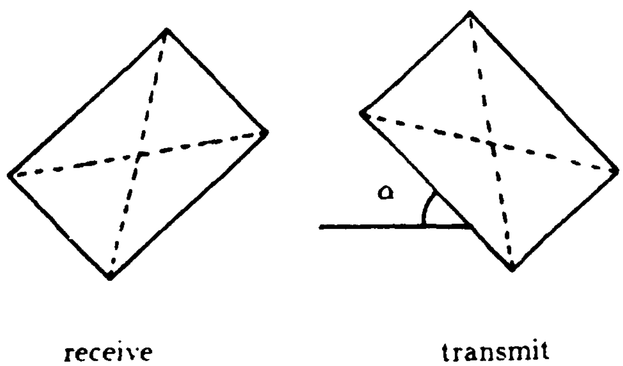

b

Figure 2.2: (a) Drawing of the PARC antennas, (b) Antenna apertures for the orthogonal configuration.

receive polarization of the radar. On the contrary, $\sigma_m = 0$ for $\alpha = 0°$. For $\alpha = 45°$ a value $\sigma_m = \sigma/4 \doteq \sigma_m - 6$ dBm^2 results. Table 2.1 summarizes the results for an HH-, VV-, HV- and VH-polarized radar system. For example, a VV-polarized radar system measures an RCS of σ - 6 dBm^2 for an $\alpha = 45°$ PARC.

α	$\sigma_{m,HH}$ dBm^2	$\sigma_{m,VV}$ dBm^2	$\sigma_{m,HV}$ dBm^2	$\sigma_{m,VH}$ dBm^2
0°	0	0	0	σ
45°	σ - 6	σ - 6	σ -6	σ - 6
90°	0	0	σ	0

Table 2.1: Measured RCS of an orthogonal PARC.

2.2 Design criteria for the TNO-FEL PARC

The desired RCS of the PARC developed at TNO-FEL was σ=45 dBm^2. Because standard gain horn antennas were used with G_a= 20 dB, the amplifier gain had to be G_e= 41 dB (see Fig.2.1 and Eq.(2.1)). Another design criterion was that the PARC should be suitable for the calibration of the C-band radar systems of which some relevant system parameters are given in Table 2.2.

system	P dBW	G dB	r_{min} km	f GHz	Δf MHz	P_{in} dBm
ERS-1	37	46	825	5.3	15.5	-32
SIR-C	32	43	250	5.3	20	-30
AIRSAR (JPL)	30	23	9	5.3	40	-23
PHARS	22	23	5	5.25	31	-26
PHARUS	28	23	5	5.3	40	-20
DUTSCAT	-6	29	0.25	5.3	10	-22

Table 2.2: Radar system characteristics.

Explanation of the quantities shown in the table:

- P peak transmitted power [dBW]
- G gain of the transmit antenna [dB]
- r_{min} expected minimal distance between radar and object in future experiments [km]
- f central frequency [GHz]
- Δf maximum bandwidth [MHz]
- P_{in} power input to the PARC amplifier [dBm] (see Eq.(3.1))

In addition to this a limit was posed on the the polarization isolation. It turned out that to obtain the desired 40-50 dB polarization isolation one should not use standard gain horns but corrugated horns, for example. However, due to the limited financial budget available standard gain horns had to be used.

3 MEASUREMENT RESULTS

Several measurements with the C-band PARC (5.3 GHz frequency, 5.66 cm wavelength) developed at TNO-FEL were performed [Jansen, 1991]. The results, including those of RCS measurements performed by [Nennie, 1992] in an anechoic chamber, are given in this chapter.

3.1 Power consumption

The amplifier of the PARC consists of three stages. The last stage (power amplifier) consumes most of the power. This stage is normally switched off. The power consumption in this stand-by mode is 8 W. As soon as a radar signal is detected by a detection circuit the power amplifier is activated, thereby raising the power consumption to 19 W [1]. The PARC is fed by two rechargeable batteries of 12 V, 5.7 Ah each in series. So the PARC can function for 17 hours in stand-by mode, and 7 hours when continuously transmitting (at room temperature).

Consequently, the PARC should be deployed not sooner than 12 hours before an overflight.

3.2 Linearity

Assume that the power input to the amplifier of the PARC is P_{in} [dBm]. The amplifier gain G_e is independent of the input level for a wide range of values (linear region). However, if P_{in} becomes too high, G_e becomes smaller (compression). The difference between this smaller value and the nominal gain for the PARC is plotted in Fig.3.1. The 1 dB compression point is near P_{in}= -20 dBm. This is in good agreement with the figure of -21 dBm given by the manufacturer for the first amplifier stage, indicating that the compression is due to the first stage only.

With the figures and units given in Table 2.2, the power P_{in} input to the amplifier for the radar systems mentioned can be computed with

$$P_{in} = P + G - 20\log r - 56.9 \text{ [dBm]}, \tag{3.1}$$

in which a wavelength of 5.66 cm is assumed and a PARC antenna gain G_a= 20 dB. The resulting values are also given in Table 2.2. Noting from Fig.3.1 that the 0.1 dB compression point occurs

[1] A switch is provided to bypass the detection circuit in order to put the PARC continuously in this operative (high power consumption) mode. The two switch positions are labeled PULSE (detection circuit enabled) and CW (detection circuit bypassed). Normally, this switch should be left in the PULSE position.

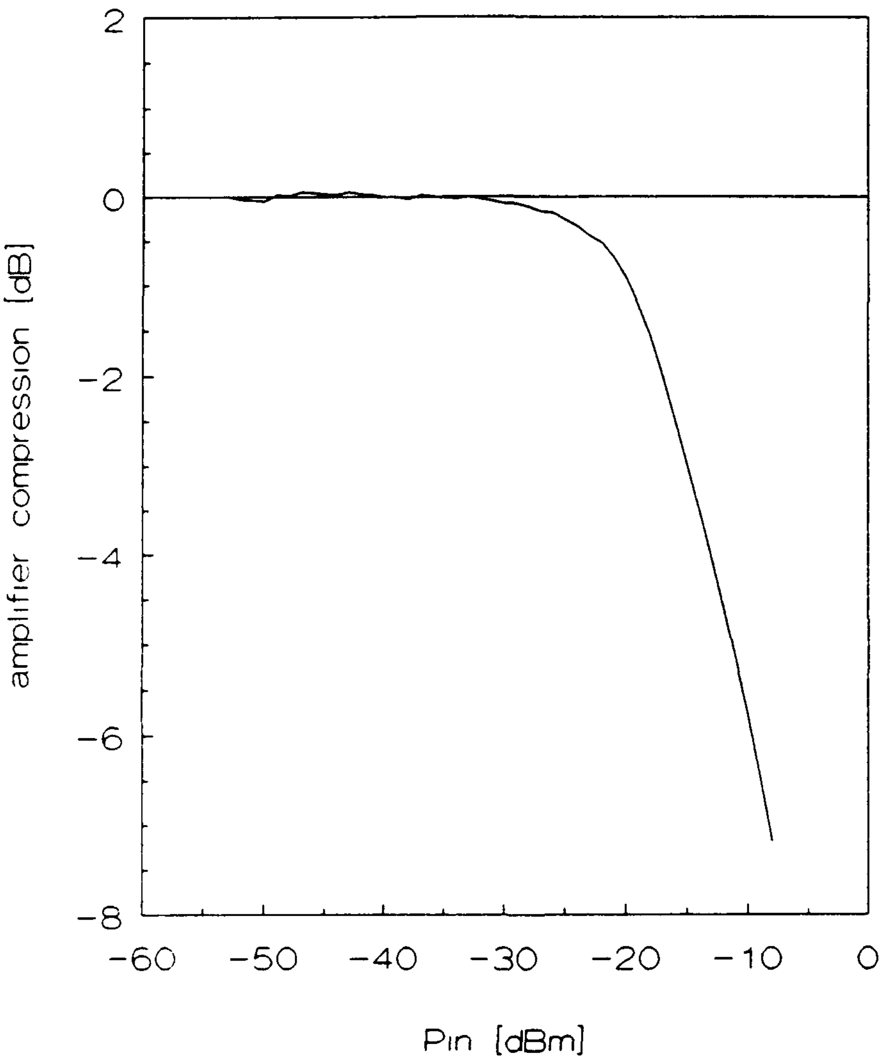

Figure 3.1: Compression as a function of input power P_{in}.

at P_{in}= -28 dBm it is clear that measurements involving the satellite based ERS-1 or space shuttle based SIR-C present no problems. However, the airborne systems can, depending on the distance between the radar and the PARC. Furthermore note that Eq. 3.1 is valid when the radar transmit and PARC receive antenna are equally polarized. The input power is 3 dB lower when the polarization orientations differ by 45°, for example.

It can be concluded that before deployment of the PARC the expected value of P_{in} has to be computed with Eq.(3.1), taking the polarizations of the radar transmit and PARC receive antennas into account. If it exceeds -28 dBm a suitable attenuator should be inserted between the receive antenna and the amplifier of the PARC, lowering its RCS accordingly.

3.3 Crosstalk

Crosstalk is the phenomenon that some of the power transmitted by the PARC leaks back into the receive antenna. The crosstalk level was measured by injecting a signal with power P_{in} [mW] into the transmit antenna, and measuring the output power P_{out} [mW] of the receive antenna (no amplifier was connected between the antennas). The crosstalk $c = P_{out}/P_{in}$ is given in Table 3.1 for some polarization configurations of the PARC antennas. The measurements were performed in the 5.2-5.4 GHz frequency range.

β_t deg.	β_r deg.	c
0	0	$< 10^{-6}$
45	45	$< 10^{-7}$
90	90	$< 10^{-7}$
90	45	$< 10^{-7}$
90	0	$< 10^{-7}$

Table 3.1: Crosstalk measurement results for 5 polarization configurations.

β_t and β_r are the angles between the horizontal and the polarization of the transmit and receive antenna, respectively. Table 3.1 shows that the crosstalk is less than 10^{-7} in all cases except for horizontal co-polarization. The measurements were performed in free space. It was not possible to determine crosstalk levels below 10^{-7} with the experimental setup used.

A large amount of crosstalk could eventually make the PARC oscillate. Small crosstalk levels change the RCS of the PARC. The exact change depends on the crosstalk level, the amplifier and horn antenna gains, and the phase difference between the crosstalk and incoming signal. Because the phase relation is unknown, it is only possible to compute a lower bound (out of phase addition of crosstalk and incoming signal) and upper bound (in phase addition) for this change. To do this, assume that the PARC RCS is σ without, and σ' with crosstalk. It can be shown that σ' is contained in the interval given by the implicit equation

$$\sigma' = \sigma \left(1 \pm 2\sqrt{cg_e \frac{\sigma'}{\sigma}}\right) / (1 - cg_e) . \tag{3.2}$$

σ and σ' are both expressed in m^2, while the amplifier gain g_e and the crosstalk c are dimensionless. The equation shows that the maximum error increases for increasing cross-talk c and amplifier gain g_e. The equation can be solved iteratively for σ'. Assuming an amplifier gain of g_e= 41 dB and RCS σ= 45 dBm^2 leads to 44.7< σ' <45.3 dBm^2 for c=10^{-7}, and 44.1< σ' <46.0 dBm^2 for c=10^{-6}.

It is clear that the cross- and VV-polarized configurations present no problems, while for HH-polarization the crosstalk is too large.

3.4 Frequency response

The antennas, amplifier etc. of the PARC have a finite bandwidth. This implies that its RCS depends on the frequency. It is desirable that the RCS varies by no more than ±0.1 dB over the 5.23-5.32 GHz range covered by the radar systems of Table 2.2.

Fig.3.2 shows two measured frequency response curves of the PARC. The curves result from time gated measurements. The one that fluctuates most was measured with a time span of 20 ns (≙ range gate of 3 m), the other one with a 10 ns span (≙ 1.5 m). Because more reflections by the surroundings are included in the 3 m than the 1.5 m range gate, the corresponding curve fluctuates more. However, the variation is well within ±0.1 dB over the 5.23-5.32 GHz range in both cases, as desired.

3.5 Radar cross section measurements

RCS measurements were made for 4 different polarization configurations of the PARC antennas and the antennas of the measurement set used. These are:

HH - both the PARC and measurement set HH polarized.
VV - as HH with VV-polarization.

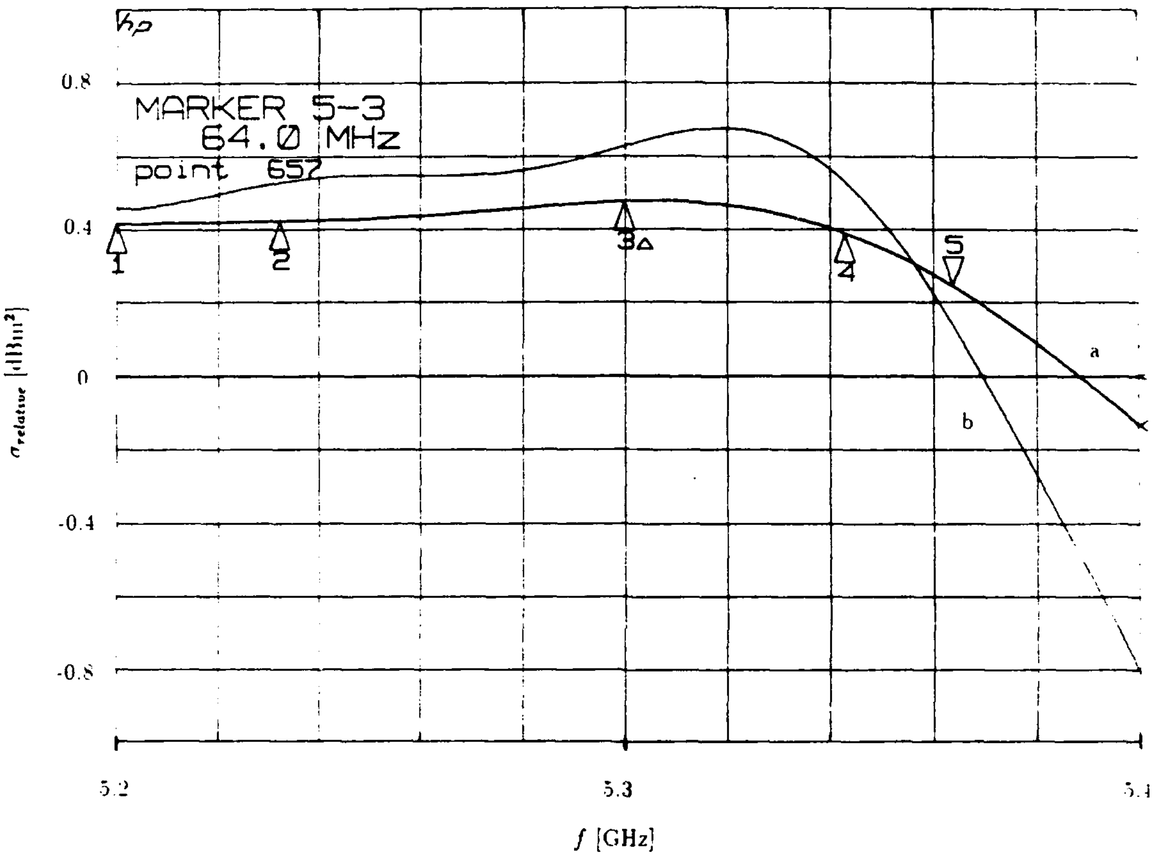

Figure 3.2: Frequency response curves for (a) 10 ns time gate, (b) 20 ns time gate.

diagonal - PARC cross-polarized (α=45° in Fig.2.2), measurement set VV-polarized.
cross - PARC HH polarized, measurement set VV-polarized.

The RCS at boresight for the different polarization configurations and several attenuator settings is given in Table 3.2.

attenuation dB	σ_{HH} dBm^2	σ_{VV} dBm^2	$\sigma_{diagonal}$ dBm^2	σ_{cross} dBm^2
0	41.9	41.9	35.6	7.9
5	36.4	35.7		
10	31.4	30.1		
15	26.3	25.0		
20	20.3	19.7	15.7	

Table 3.2: Boresight RCS measurement results for 4 polarization configurations and several attenuator settings.

The table shows that the maximum co-polarized RCS values σ_{HH} and σ_{VV} are 3.1 dBm^2 below the value of 45 dBm^2 wanted. Furthermore, the attenuator steps are not always 5 dB, but vary between 5.1 and 6.2 dB. Also the difference between the like-polarized RCS values and $\sigma_{diagonal}$ is not exactly 6 dBm^2, as should be the case, but is in between 6.3 (0 dB attenuation) and 4 dBm^2 (20 dB attenuation).

Figures 3.3 ... 3.6 show the RCS as a function of incidence angle for the four polarization configurations. The incidence angle is 0° at boresight (incidence perpendicular to the PARC antenna apertures). Because of the antenna symmetry, the RCS curve is symmetric around 0°. Therefore the curves are only given for positive incidence angles.

The first three figures show that the RCS gradually decreases for an increasing incidence angle, as expected. An unexpected feature is that the difference between curves for different attenuator settings depends on the incidence angle for HH polarization. The difference between the 0 dB and 5 dB attenuation curves for the HH configuration is 6.3 dBm^2 at 0°, but only 4.9 dBm^2 at 15°. This could be due to a residual (passive) reflection by the PARC. The possible effect of such a reflection is to increase the RCS, the increase being larger for a small RCS. As an overall result the angular response broadens for higher attenuator settings (smaller RCS), in accordance with Fig. 3.3. However, this does not explain why this phenomenon is only present at HH-polarization.

Comparing Fig.3.3 to Fig.3.6 reveals that the polarization isolation of the PARC exceeds 34 dB.

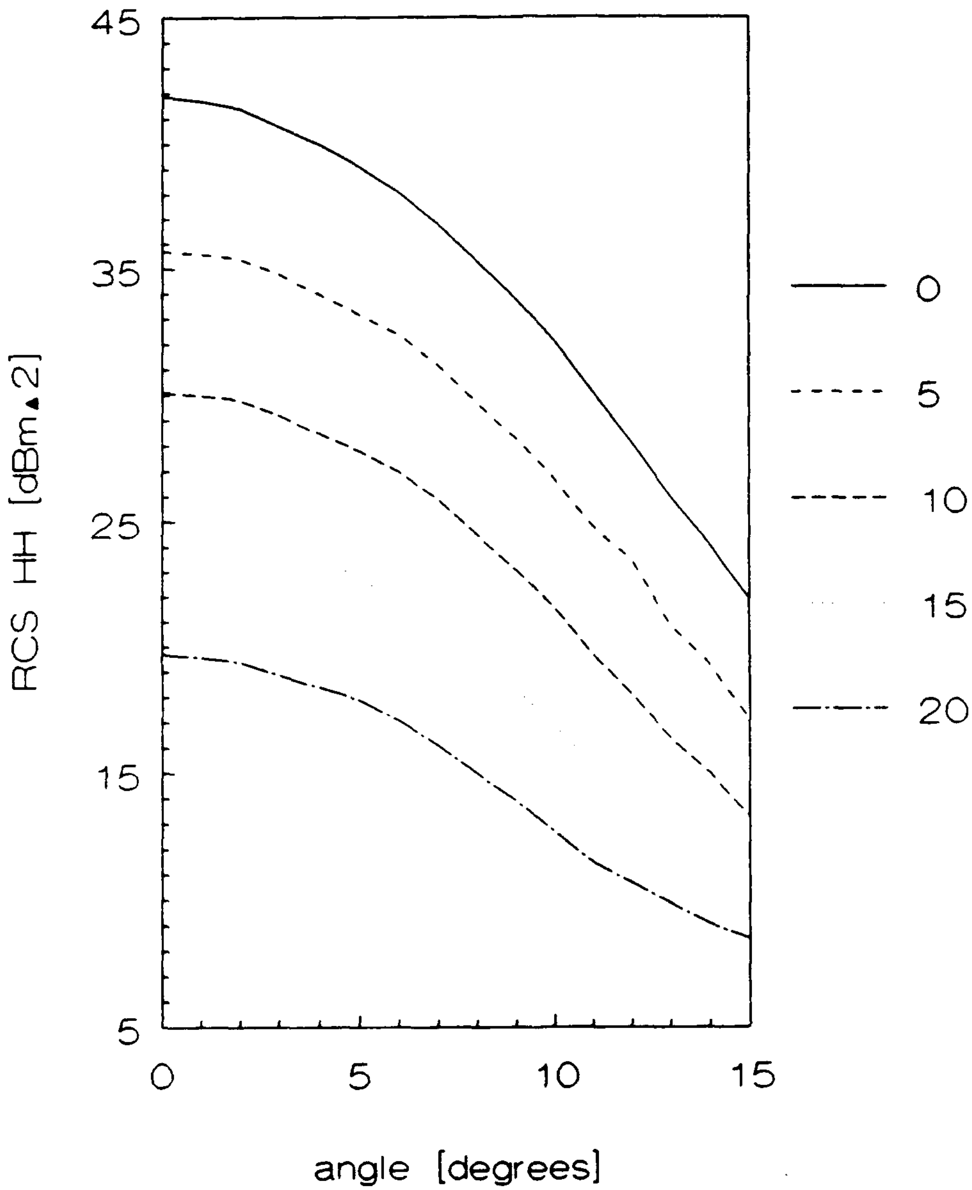

Figure 3.3: Angular response for the HH configuration, attenuator settings 0, 5, 10, 15 and 20 dB.

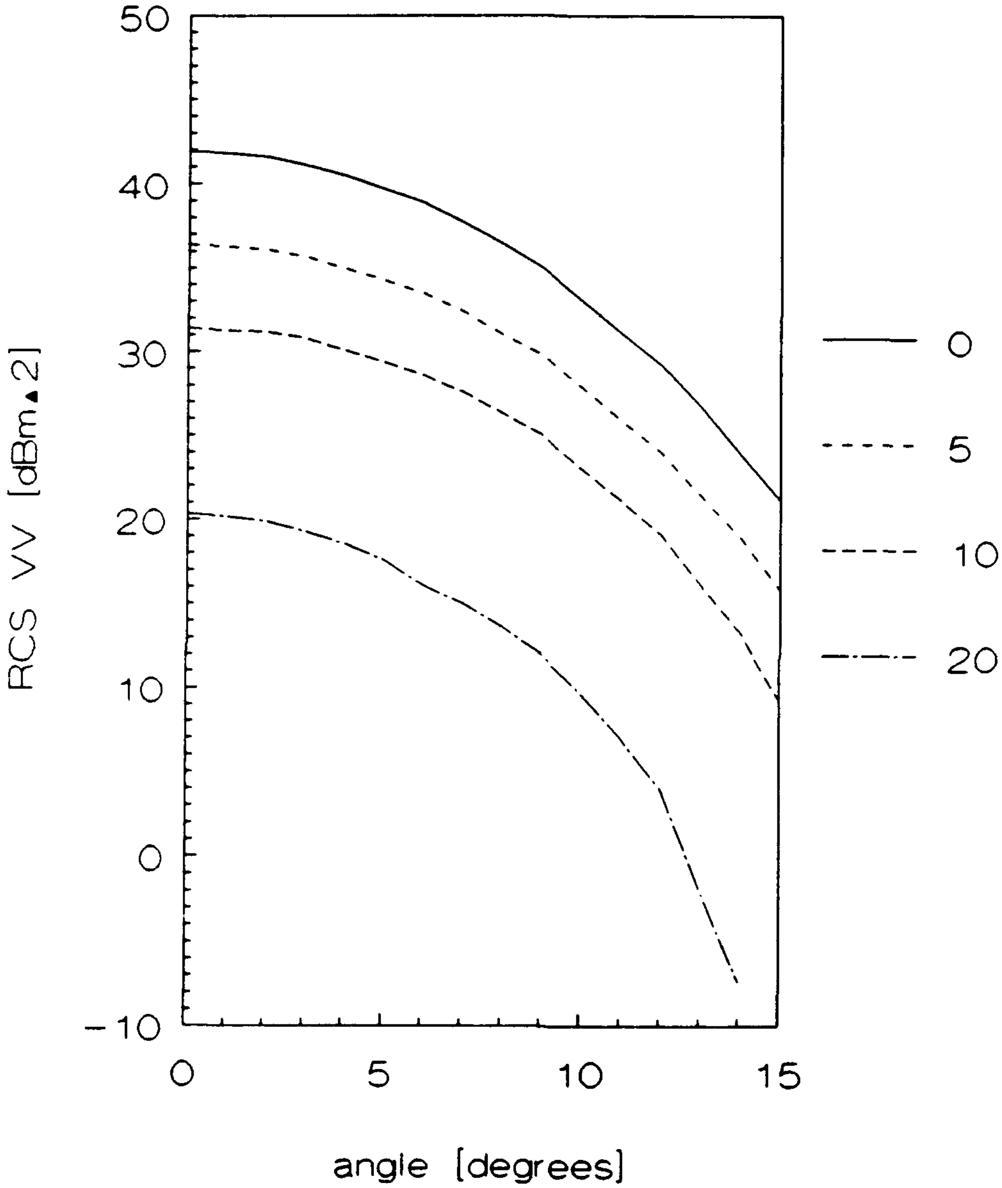

Figure 3.4: Angular response for the VV configuration, attenuator settings 0, 5, 10 and 20 dB.

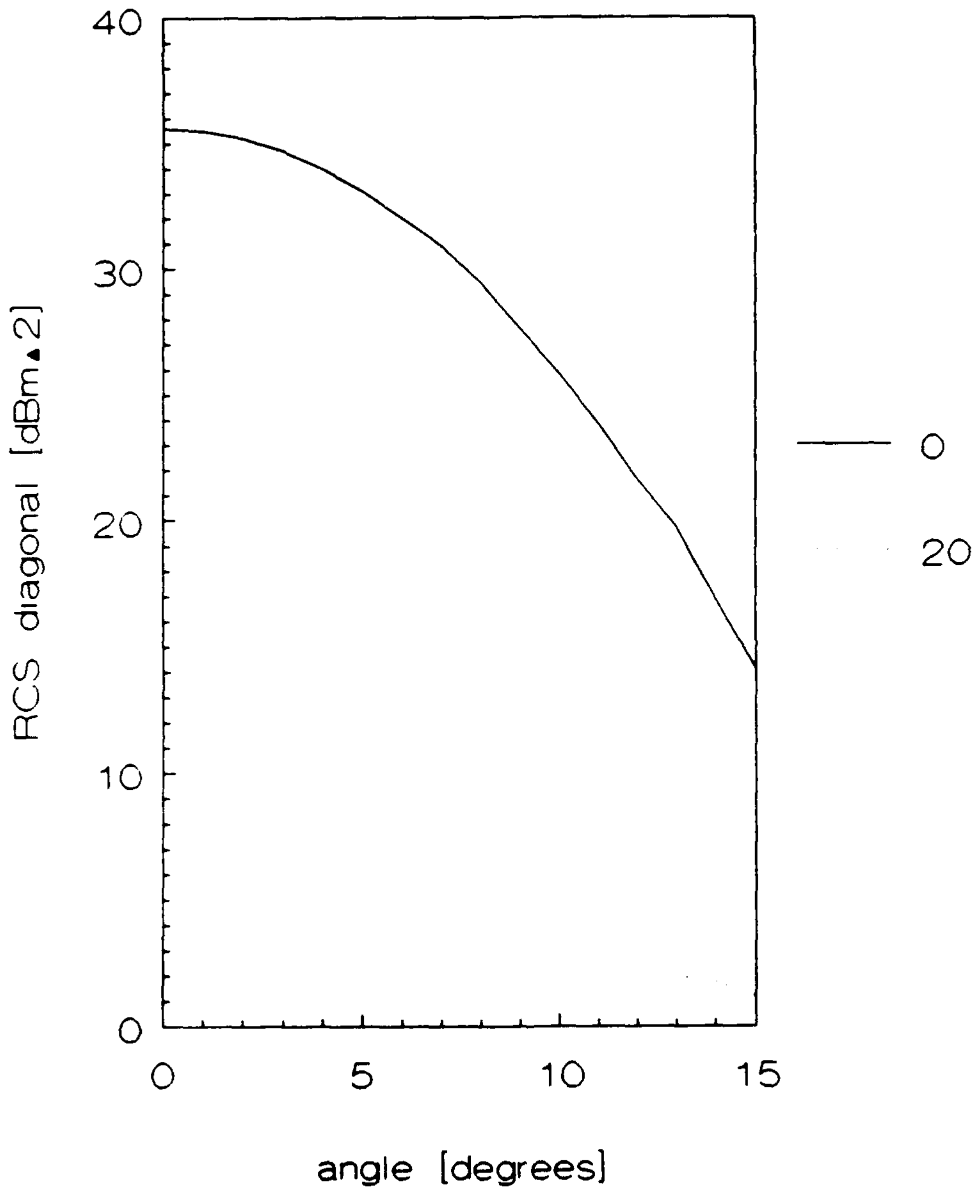

Figure 3.5: Angular response for the diagonal configuration, attenuator settings 0 and 20 dB.

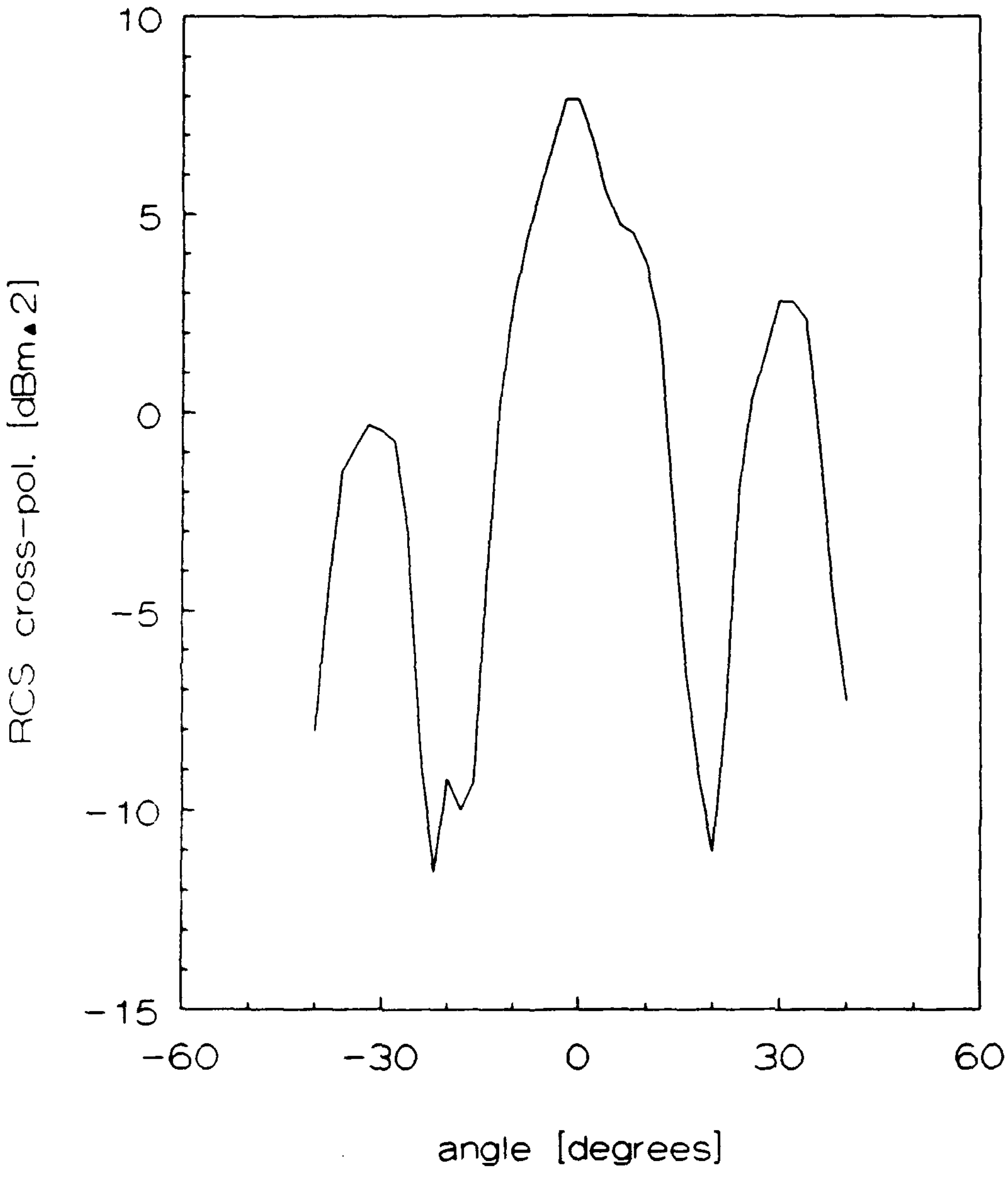

Figure 3.6: Angular response for the cross-polarized configuration, attenuator setting 0 dB only.

3.6 Time delay

The total time delay of the PARC is 12.0 ns. This is the time difference between the (small) reflection by the front of the antennas and the 'electronic reflection'. When a radar is used to measure the distance between the radar and the antenna front, this gives an 1.8 m too high value.

4 DEPLOYMENT CHECKLIST

This chapter gives a checklist to be used for the deployment of the PARC. Performing the checks ensures that the PARC is operated properly. It is assumed that the polarization and other parameters like those of Table 2.2 of the radar to be calibrated are known.

CHECKLIST

1. *Radar saturation.* The radar should not be saturated by the PARC. This should be checked, by using the PARC RCS, system parameters and the radar formula. The attenuator setting can be used to lower the PARC RCS, if needed.

2. *PARC saturation.* The PARC should not be saturated by the radar. With Eq.3.1 and the radar system parameters (including its polarization and that of the PARC) it is possible to determine whether saturation occurs. If so, an attenuator should be inserted between the receive antenna and amplifier of the PARC.

3. *Bandwidth.* The radar system bandwidth should be within the ± 0.2 dB bandwidth of the PARC.

4. *Polarization.* The polarization of the PARC should match the polarization of the radar in the case of an HH- or VV-polarized radar. Because of the relatively high crosstalk and the anomalous incidence angle dependence of the RCS in the HH configuration it is recommended to use the PARC in an orthogonal configuration (α=45° in Fig.2.2) for an HH-radar. For the calibration of polarimetric radars the PARC should also be orthogonally polarized.

5. *Field deployment.* When the batteries of the PARC are fully charged the PARC should be deployed no more than 12 hours before the overflight . The antennas should of course point to the flight path of the radar. Finally, the power switch of the PARC should be in the 'ON' position, the other switch in the 'PULSE' position.

5 CONCLUSIONS AND RECOMMENDATIONS

The measurements of several system parameters of the PARC indicate that it is well suited for the calibration of airborne radars. The checklist of the preceding section should be used before its deployment.

The crosstalk is too high in the HH configuration. It can be lowered by increasing the distance between the antennas or the insertion of an isolating material between the horns. However, alteration of the PARC configuration necessitates performing the measurements again.

When another PARC would be designed an amplifier should be selected with its 0.1 dB compression point at -20 dB (assuming the same receive antenna would be used). The use of corrugated horns is recommended to achieve a better polarization isolation. Finally, attention should be paid to achieve crosstalk values below 3×10^{-8}.

REFERENCES

[1] R.K. Moore F.T. Ulaby and A.K. Fung.
Microwave Remote Sensing, volume II.
Addison-Wesley, 1982.

[2] H.A. Zebker J.J. van Zyl and C. Elachi.
Imaging radar polarization signatures: Theory and observation.
Radio Science, 22(4):529–543, July-August 1987.

[3] D.R. Brunfeldt and F.T. Ulaby.
Active reflector for radar calibration.
IEEE Transactions on Geoscience and Remote Sensing, GE-22(2):165–169, 1984.

[4] C. Werner A. Freeman and Y. Shen.
Calibration of multipolarization imaging radar.
In *Proc. IGARSS'88, Edinburg, Scotland*, pages 335–339, September 1988.

[5] A. Jansen.
Polarimetrische aktieve radar calibrator (PARC) voor C-band.
Technical report, TNO-FEL, 1991.
draft.

[6] F.A. Nennie, 1992.
private communications.

[7] J.S. Groot.
Introduction to radar polarimetry.
Technical Report FEL-91-B122, TNO-FEL, April 1991.

P. Hoogeboom
(Group Leader)

J.S. Groot
(Author)

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FOR THE CALIBRATION OF AIR- AND SPACEBORNE RADARS COMMONLY USED IN REMOTE SENSING A PARC (POLARIMETRIC ACTIVE RADAR CALIBRATOR) CAN BE USED. THIS REPORT PRESENTS MEASUREMENT RESULTS OF THE RADAR CROSS SECTION, CROSSTALK LEVEL ETC. OF A PARC DEVELOPED AT TNO-FEL. THE RESULTS ARE USED TO INFER GUIDELINES FOR THE USE OF THIS PARC.

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