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**N91-24168**

Wind Shear Program in France

RADAR Performance Experiments  
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**EVALUATION OF 30 cm PROUST DOPPLER RADAR  
AND 5 cm RONSARD DOPPLER RADAR AT LOW HORIZONTAL  
TILT IN CLEAR AIR AND RAIN LOW LEVEL  
WIND SHEAR CONDITION**

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**(1) : DGAC/STNA, PARIS**

**(2) : CNET/CRPE, St MAUR**

**EVALUATION OF PROUST DOPPLER RADAR ( $\lambda = 30$  CM) AND RONSARD  
DOPPLER RADAR ( $\lambda = 5$  CM) AT LOW HORIZONTAL TILT IN CLEAR AIR AND  
RAIN LOW LEVEL WIND SHEAR CONDITION.**

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**Abstract :** Theoretical studies and experimental results obtained at Coulommiers airport have shown the capability of Proust radar to detect windshears, in clear air condition as well as in presence of clouds or rain. Several examples are presented:

- In a blocking highs situation we can clearly distinguish an atmospheric wave system at the Brunt-Vaisala frequency.
- In a situation of clouds without rain, we can see easily the limit between clear air and clouds.
- A last example shows a windshear associated with a gust front in rainy condition.

A comparison of 30 cm clear air radar Proust and 5 cm weather doppler radar Ronsard will allow to select the best candidate for windshear detection, taking into account the low sensibility to ground clutter of Ronsard radar.

**Résumé :** Les études théoriques et les résultats expérimentaux obtenus sur l'aéroport de Coulommiers ont mis en évidence la capacité du radar Proust à détecter les cisaillements de vent, aussi bien par ciel clair qu'en présence de nuages ou de pluie. Plusieurs exemples sont présentés :

- Dans une situation de blocage atmosphérique on distingue clairement un système d'ondes à la fréquence de Brunt-Vaisala.
- Dans une situation nuageuse sans pluie, on discerne aisément la limite entre l'air clair et la masse nuageuse.
- Un dernier exemple montre un cisaillement de vent lié à un front de rafale en situation de pluie.

Une comparaison du radar air clair 30 cm Proust et du radar doppler météorologique Ronsard permettra de sélectionner le meilleur candidat quant à la détection des cisaillements de vent, compte tenu de la moindre sensibilité du radar Ronsard aux échos de sol.

# **SUMMARY**

**I) CONTRACT BETWEEN DGAC AND CNET**

**II) PROUST AND RONSARD RADAR CHARACTERISTICS**

**III) RELATIONSHIP BETWEEN CLEAR AIR AND RAIN  
REFLECTIVITY**

**IV) EXPERIMENTAL RESULTS WITH PROUST RADAR**

**V) CONCLUSION**

# **CONTRACT BETWEEN CNET AND DGAC**

## **I-PHASE 1**

**Evaluating performances of "clear air" radars ( $\lambda = 30$  cm) for detection of wind shear to prevent hazardous situations to aircraft.**

## **II-PHASE 2**

**Comparison between PROUST ( $\lambda = 30$  cm) and RONSARD ( $\lambda = 5$  cm) radars for different meteorological conditions ( clear air, convection cells, clouds, rain,...etc).**

**Application to wind shear detection.**

**Experimentation : 12/90 ---> 12/91**

# PROUST AND RONSARD RADAR CHARACTERISTICS

	PROUST	RONSARD
WAVELENGTH (cm)	30	5,4
BEAMWIDTH(°)	5	0,9
PEAK POWER (KW)	4,5	250
PRF (khz)	6,4	0,75 ; 1,5 ; 3
MAX RANGE (km)	20	200 ; 100 ; 50
RANGE RESOLUTION(m)	600	200 ; 100 ; 50
FFT (points)	256	64
VELOCITY RANGE(m/s)	+/-16	+/-10 ; +/-20 ; +/-40
INCOHERENT INTEGRATION	4 to 32	1 to 128
TIME RESOLUTION (s)	5 to 40	0,17 to 22(with PRF <sub>2</sub> 3 KHz)
MINIMUM DETECTABILITY (DBZ)	-20	0

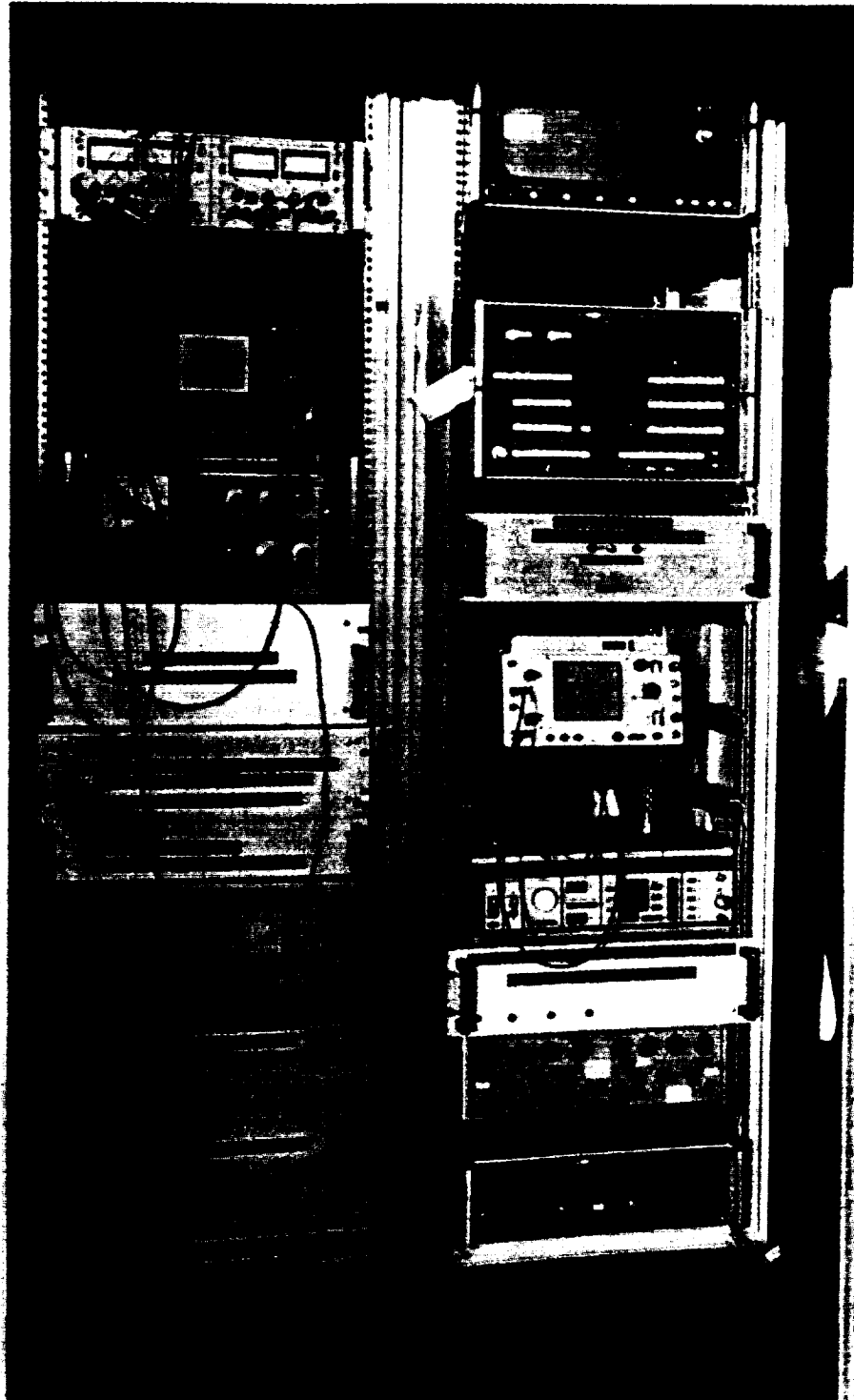
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PROUST RADAR AT COULOMMIERS AIRPORT

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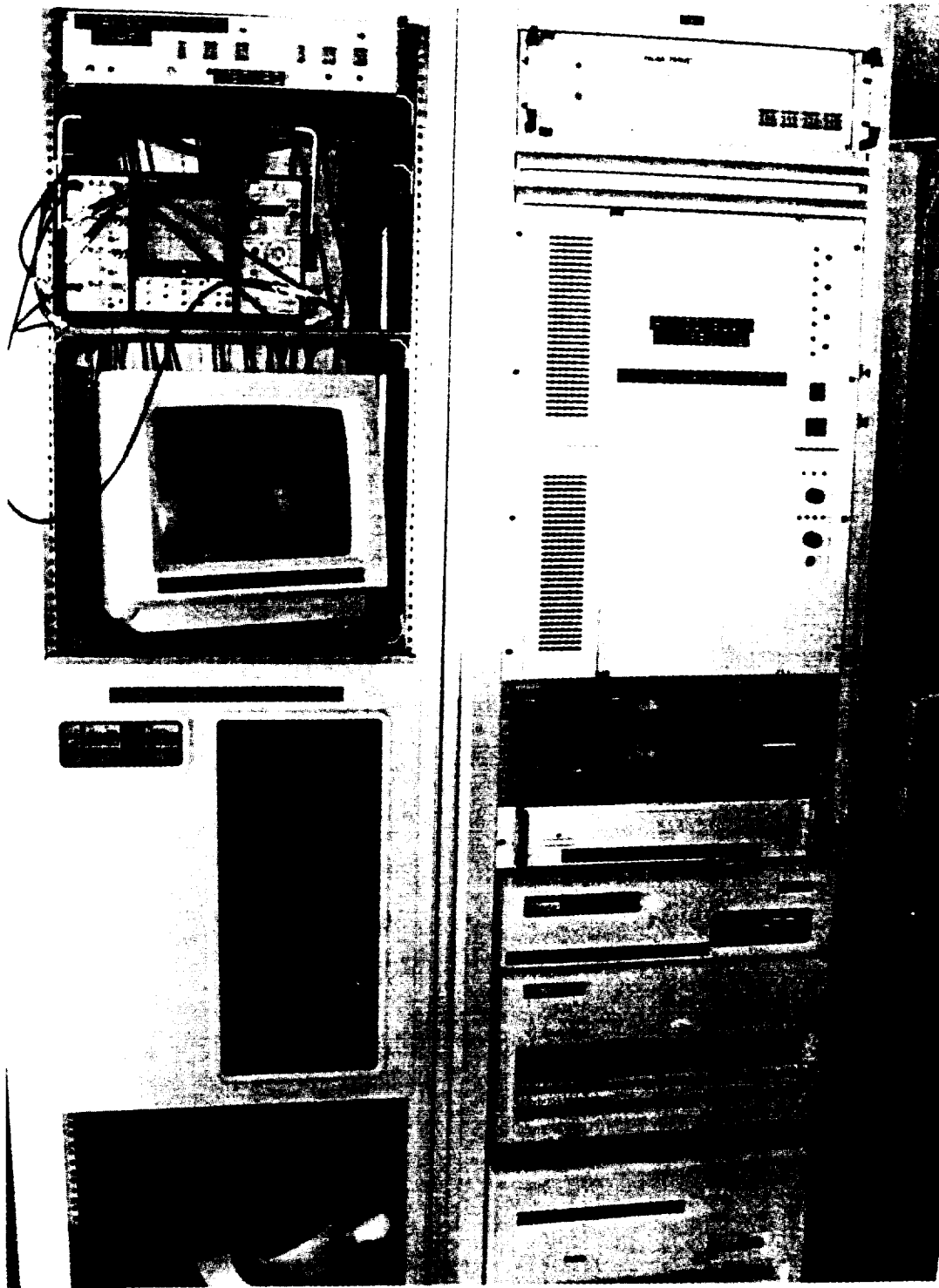
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TRANSMITTER AND RECEIVER UNITS OF PROUST RADAR

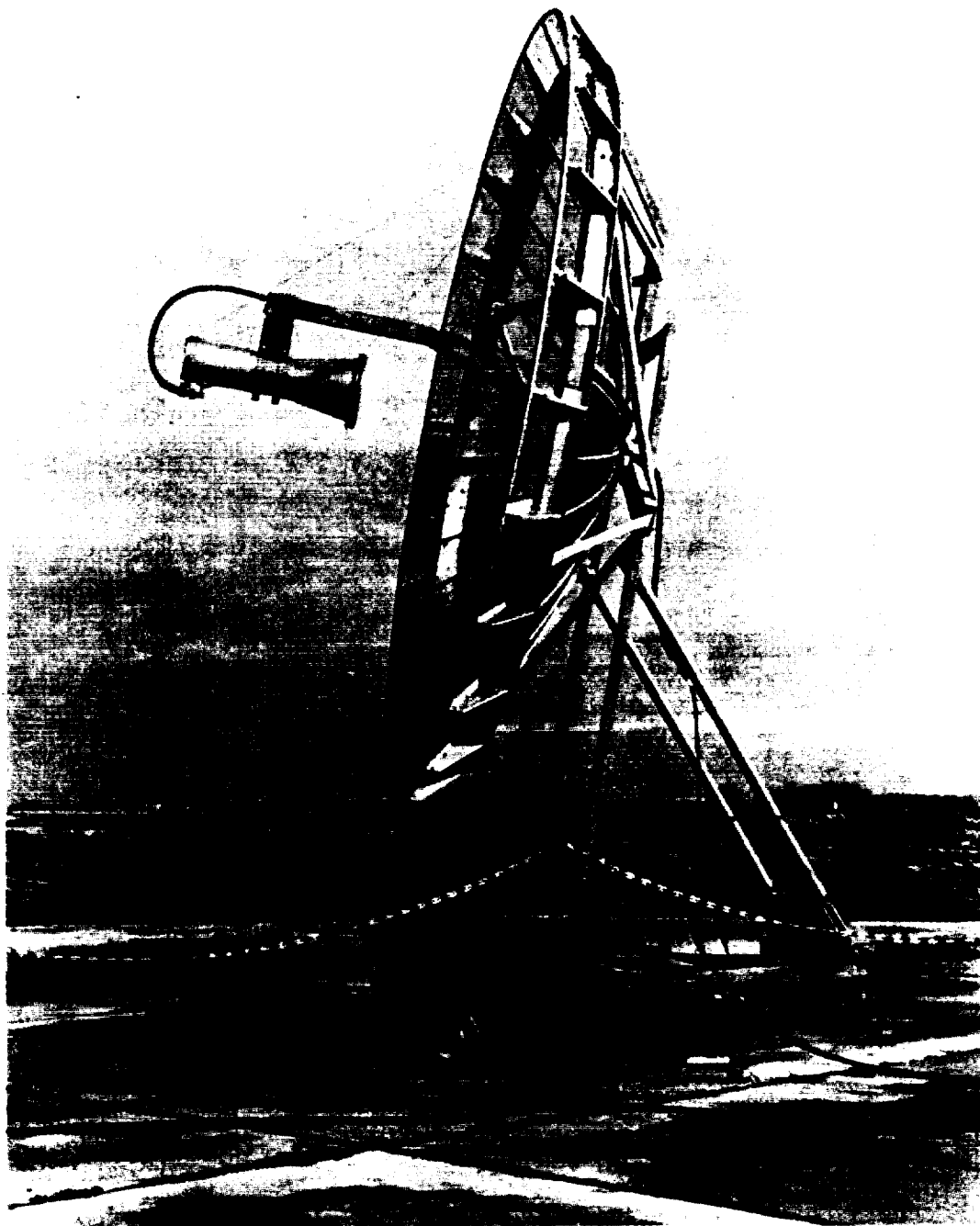


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NUMERICAL PROCESSING AND CONTROL UNITS OF PROUST  
RADAR

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4.6 m DIAMETER ANTENNA OF PROUST RADAR  
IN COULOMMIERS AIRPORT

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RONSARD RADAR

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# RAIN / CLEAR AIR REFLECTIVITY

## ATMOSPHERIC TURBULENCE

$$\eta(\lambda) = 0.38 C_n^2 \lambda^{-1/3}$$

$C_n^2$  ( $m^{-2/3}$ )  $\propto$  turbulence  
of refractive index

$$10^{-19} m^{-2/3} < C_n^2 < 10^{-13} m^{-2/3}$$

↓  
turbulence  
threshold

↓  
strong  
turbulence

## HYDROMETEORES

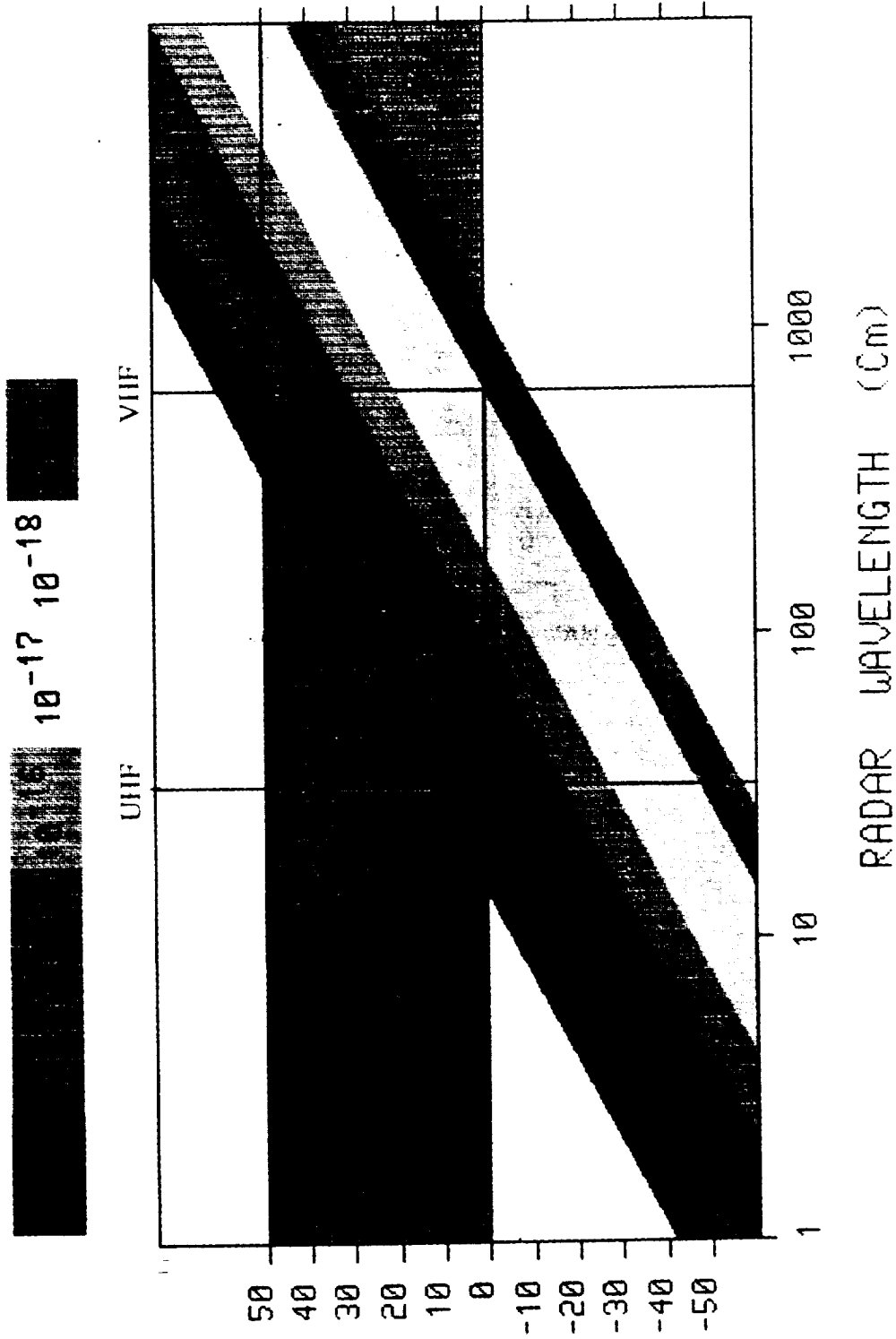
$$\eta(\lambda) = 0.93 \pi^5 / \lambda^4 Z_e$$

$Z_e$  ( $mm^6/m^3$ )  $\propto$  precipitation  
rate

$$0dBz < Z_e < 50dBz$$

↓                      ↓  
0,05 mm/h      100mm/h

$$Z_e = 1.34 \cdot 10^{15} C_n^2 \lambda^{11/3}$$



EQUIVALENT REFLECTIVITY (DBZ)

RELATIONSHIP BETWEEN EQUIVALENT REFLECTIVITY AND  $C_N^2$  (IN COLOR), VERSUS RADAR WAVELENGTH

# **EXPERIMENTAL RESULTS WITH PROUST RADAR**

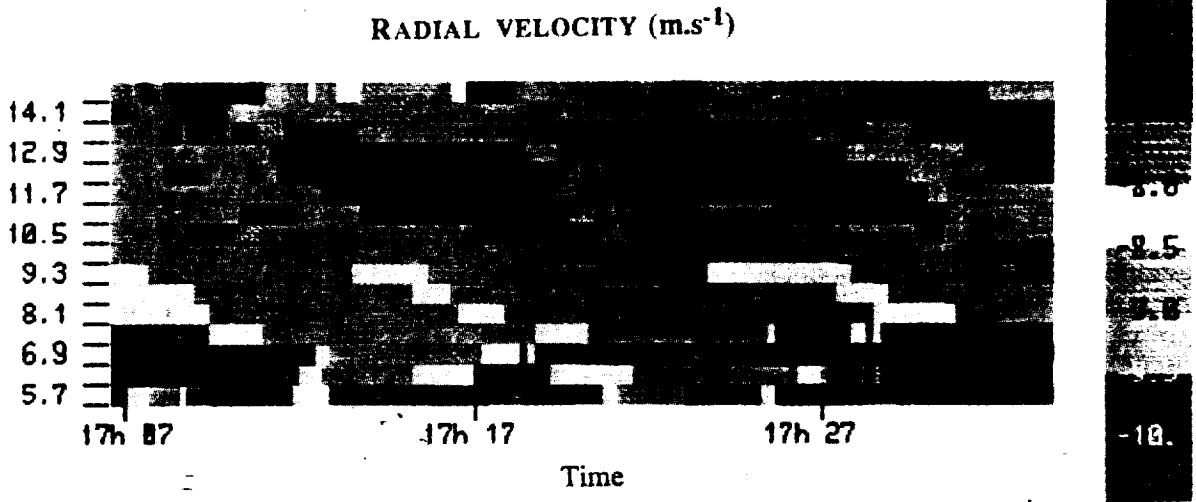
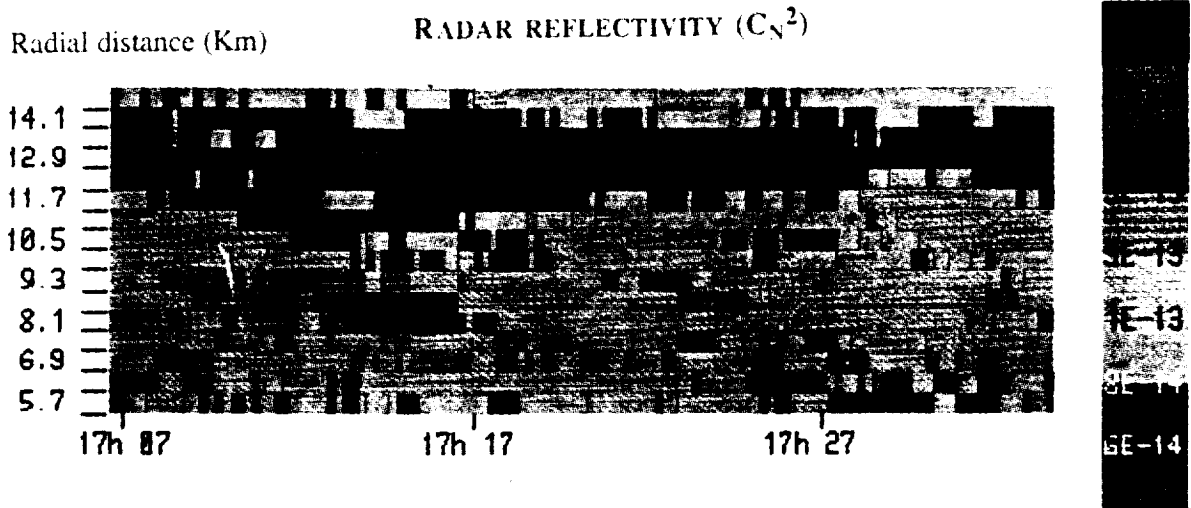
## **METEOROLOGICAL CONDITIONS**

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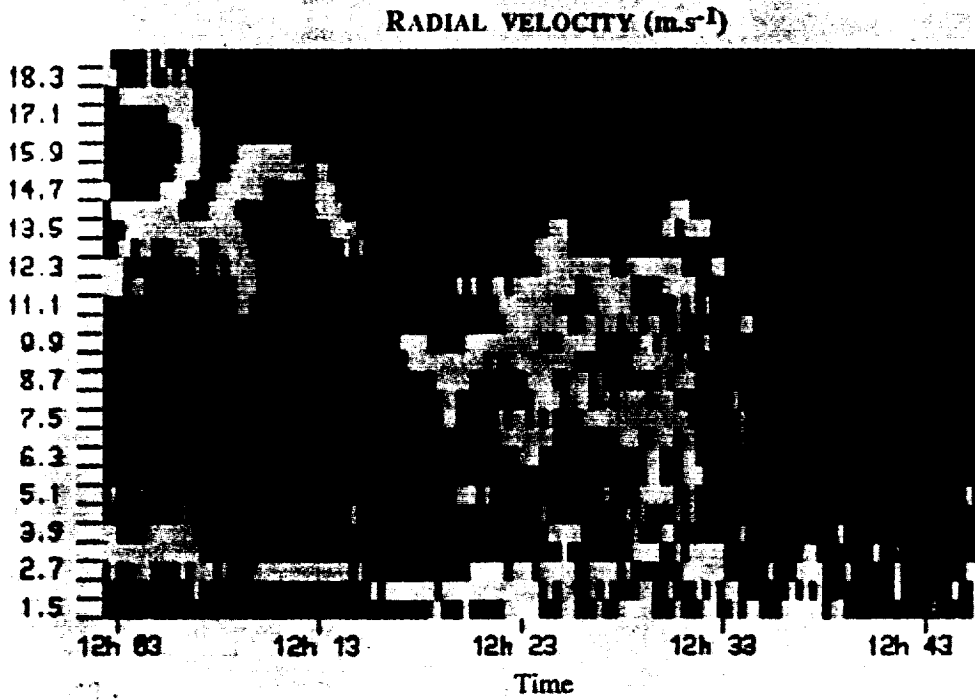
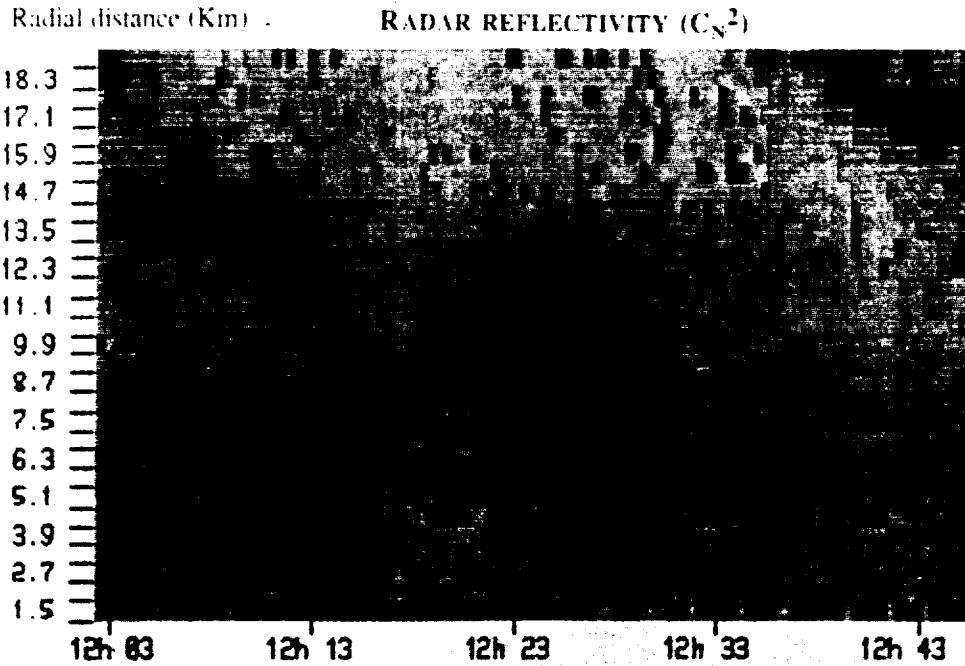
**- CLEAR AIR**

**- CLOUDS**

**- RAIN**



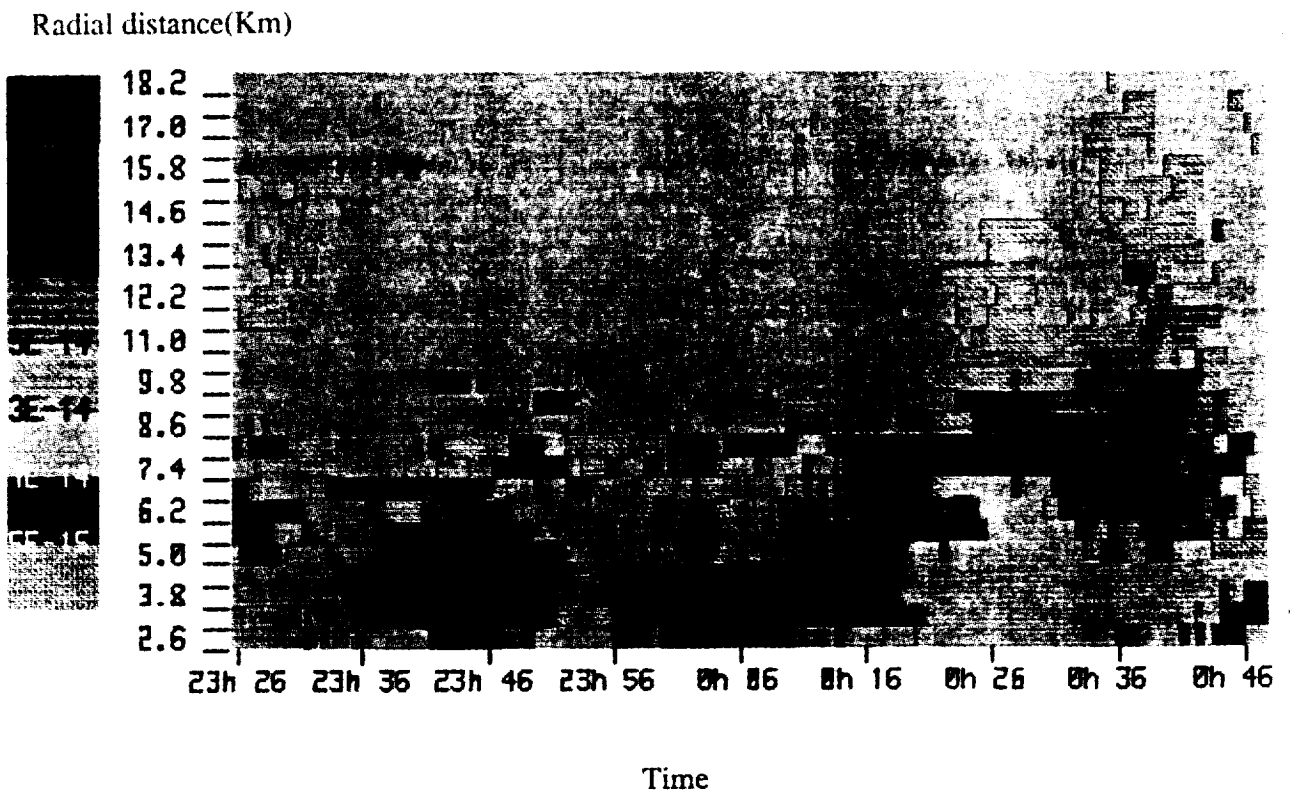
Radar reflectivity and radial velocity measured by PROUST radar in clear air at Coulommiers airport



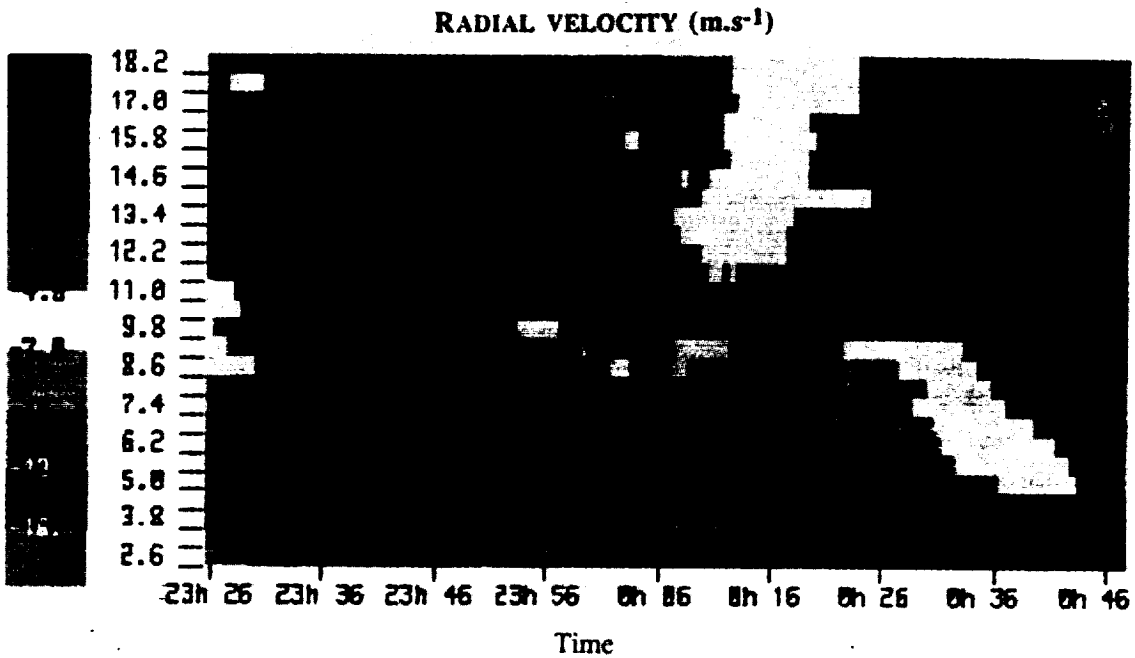
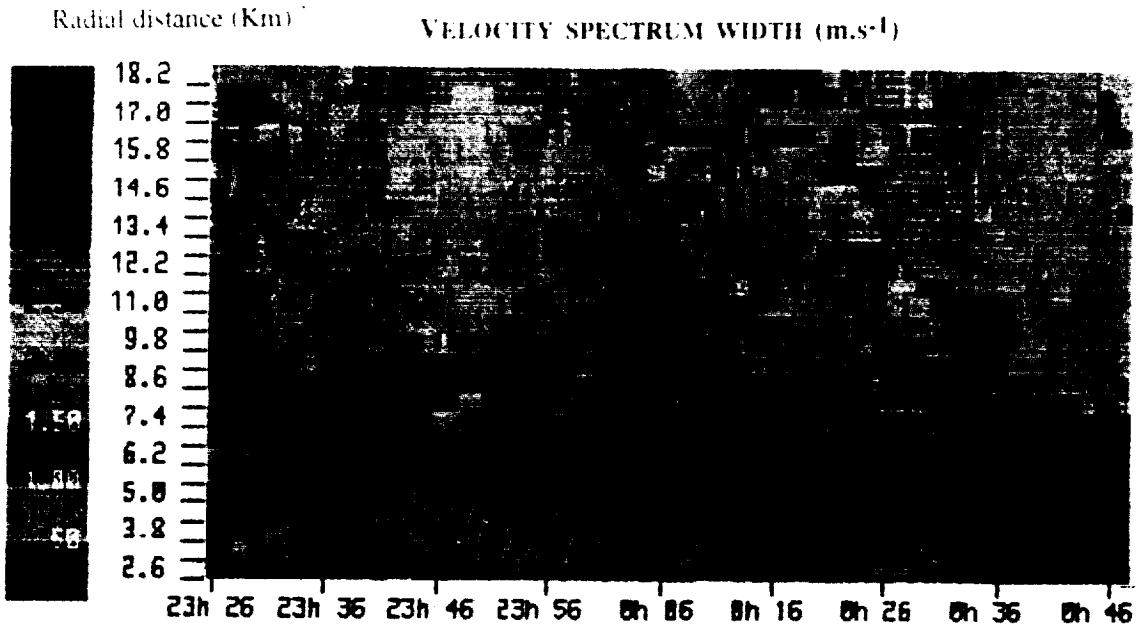
PROUST radar observation of clouds (Cu). The clouds contours are well defined by the radar reflectivity



RADAR REFLECTIVITY ( $C_N^2$ )



Radar reflectivity measured by PROUST radar in Coulommiers airport during a gust front



Velocity spectrum width and radial velocity obtained by PROUST radar in Coulommiers airport during a gust front

# CONCLUSION

**Experimental results have shown the capability of 30 cm wavelength PROUST radar to detect low level wind shears in all meteorological conditions (from - 20 DBZ clear air echoes to heavy rain).**

**But there are some limitations consisting essentially in the time resolution which is at least 5 s and the sensibility to ground clutter limiting the low elevation.**

**The comparison of its capabilities with those of 5 cm wavelength RONSARD radar which is less affected by ground clutter echoes will permit to select the best candidate.**

