2.1 *Passive Bistatic Radar*

1. Definitions
2. Some early examples
3. Issues

Passive Bistatic Radar (PBR)

- In general, bistatic radar systems will use dedicated radar transmitters with explicit control over location, modulation, scan pattern, etc.

- However, it is also possible to use other transmissions that just happen to be there. These are known as *illuminators of opportunity*, and the technique is sometimes known as *passive bistatic radar* (PBR), *hitchhiking*, *parasitic radar* or *passive coherent location* (PCL).

- Also, the term *commensal radar* (literally, ‘from the same table’) has recently been introduced.

- Such transmissions may be other radars (*hitchhiking*), or they may be communications, broadcast or navigation signals. In these days of spectral congestion there are more and more such transmissions, and they are often high-power and sited to give wide coverage.

- The low-level coverage of broadcast and communications will in general be very good, though the coverage at higher elevation angles may not be so good.

Passive Bistatic Radar (PBR)

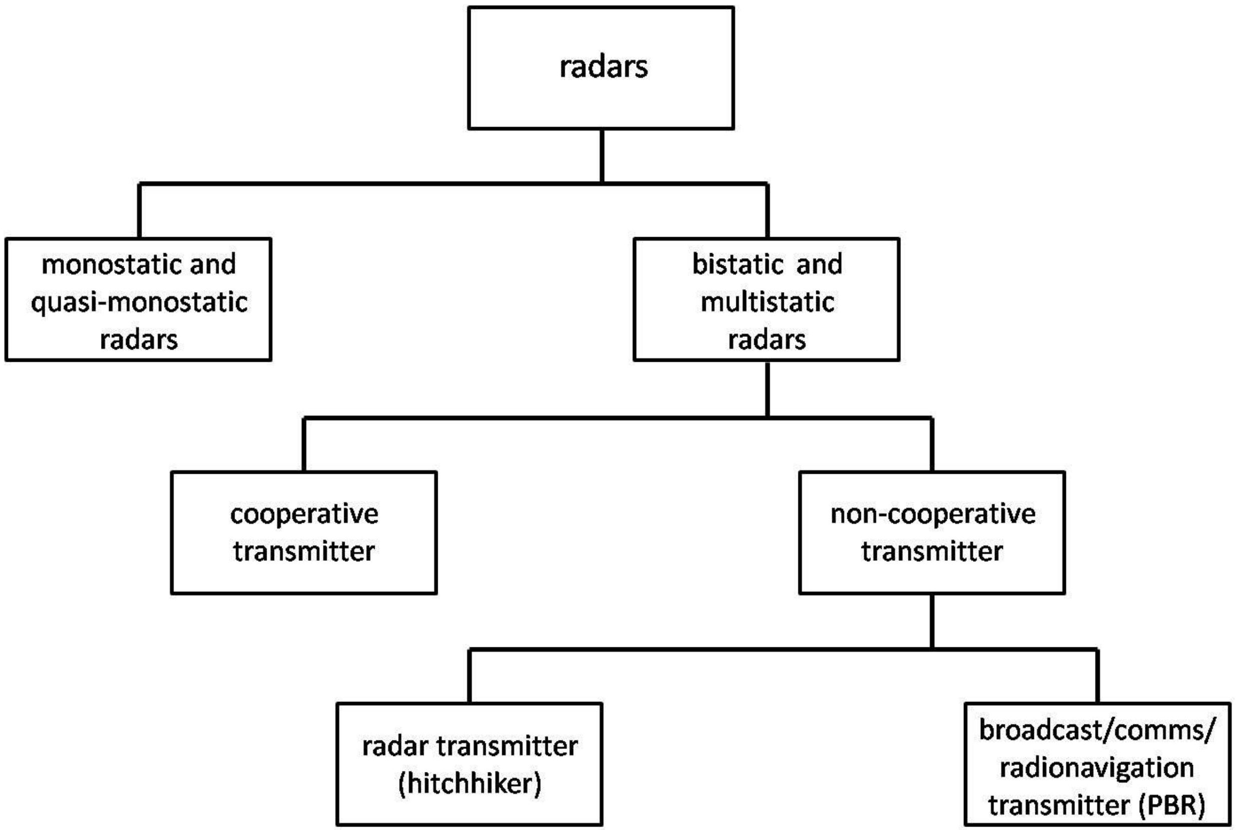
- They also allow use of parts of the spectrum (VHF, UHF, …) that are not normally available for radar purposes – where there may be a counter-stealth advantage (in addition to the potential counter-stealth advantage that comes from the bistatic geometry).

- As well as that, they do not cause any extra spectral pollution – which has led to the term. *green radar,* and no transmitting licence is needed.

- And the radar is potentially completely covert, so countermeasures against it may be very difficult.

- These advantages, and the low cost, have meant that the subject has been very suitable for research by university groups, and a great deal has been published in recent years.

Bistatic radar: taxonomy



The term *bistatic radar* was first coined by K.M. Siegel and R.E. Machol in 1952:
K.M. Siegel, 'Bistatic radars and forward scattering', *Proc. National Conference of Aeronautical Electronics*, 12–14 May 1958, pp286–290.

Terrestrial analog TV

PHYSICS

May Spot Airplanes With Television Receivers

"ENTIRELY possible" is the scientific verdict of radio engineers at the National Bureau of Standards to British dispatches citing the use of television receivers as "spotters" of airplanes.

While Army officials would not confirm reports that similar methods are being worked out for the military uses of the United States, it was admitted that secret research is underway to test other ways of spotting airplanes than by the present sound detection methods.

Since television broadcasts have been in progress over London it has been noted that when airplanes are flying in the vicinity there are produced "ghost" images in the television receivers. These "ghosts" are caused by reflection of the television waves from the metal airplane surface. Thus the reflected waves arrive at the television receivers at a slightly different time than the ordinary waves. The result is a dual image of the scene being transmitted. The image of the plane itself is not received.

According to British reports the displacement of the "ghost" image has been correlated with the distance of the plane away from the television receivers. A system has been worked out whereby television receivers on England's eastern coast could thus serve as "spotters" for approaching enemy aircraft in time of war.

Whether the plan can be worked out in complete detail and serve a valuable military use is for the future to decide, but in principle the method is an almost exact counterpart of the system of determining airplane altitude by having the plane send down to the ground a beam of radio waves and then having the plane pick up the signals of the reflected waves. This method was announced by Dr. E. F. W. Alexanderson of the General Electric Company in 1928.

For the television case, in contrast, the waves go up, strike the plane, and are picked up by ground receivers. By multiple receivers and methods of triangulation it is believed the altitude of the plane and its approximate direction and distance could be worked out.

In another analogy the television spotting system for planes can be called "upside-down" geophysical prospecting. In geology, metallic masses are located by reflected radio waves.

Science News Letter, April 23, 1938

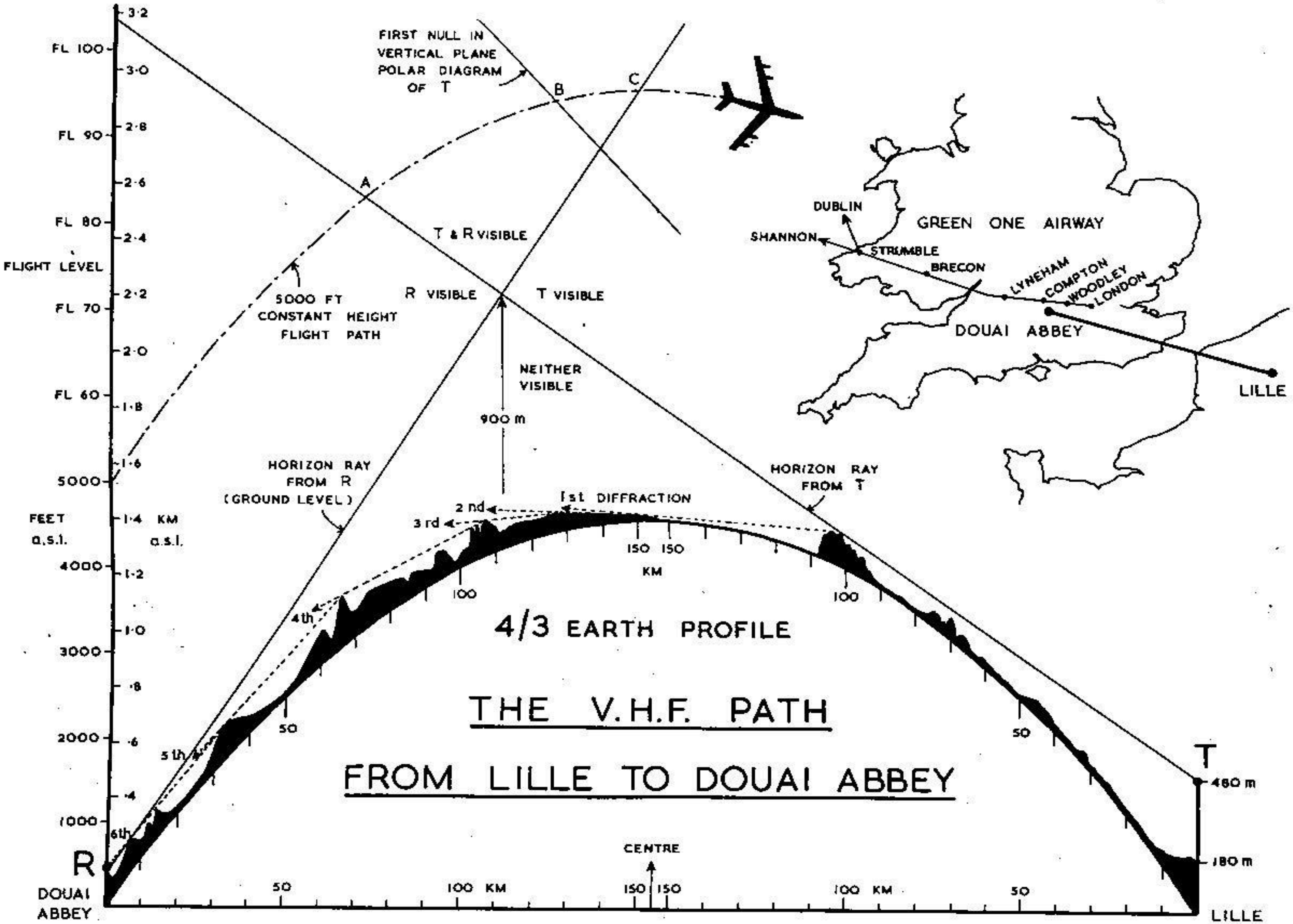


Fig. 1. The v.h.f. path from Lille to Douai Abbey. The curvature of the earth is drawn at 4/3 times its actual radius to allow for the normal effect of the atmosphere in bending v.h.f. signals. The inset map shows the radio path and the reporting points along the "Green One" airway which will be mentioned in Part II of the article. The detail of the diagram is discussed in the text.

TYPICAL RECORDINGS

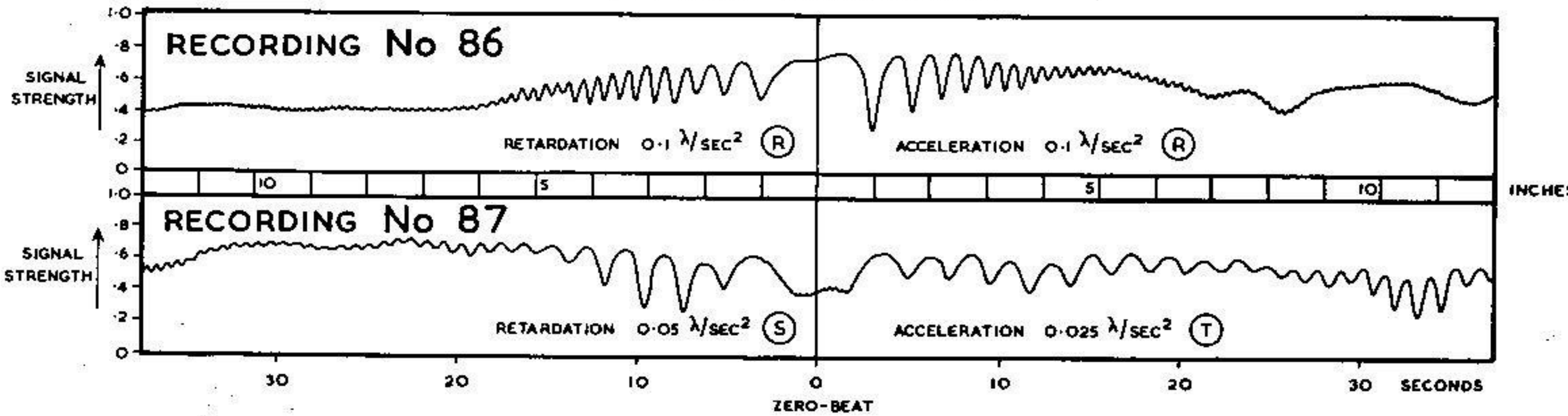


Fig. 2. Two typical recordings of "steam train" fading. The train halts briefly at the station where the variable frequency ripple passes through zero-beat. Each minimum in signal strength causes a surge of background noise in the receiver which sounds like the "chuff-chuff" of a steam train.

V. H. F. FADING OBSERVATIONS LILLE — DOUAI ABBEY

174·1 MCS

ANALYSIS OF RECORDINGS

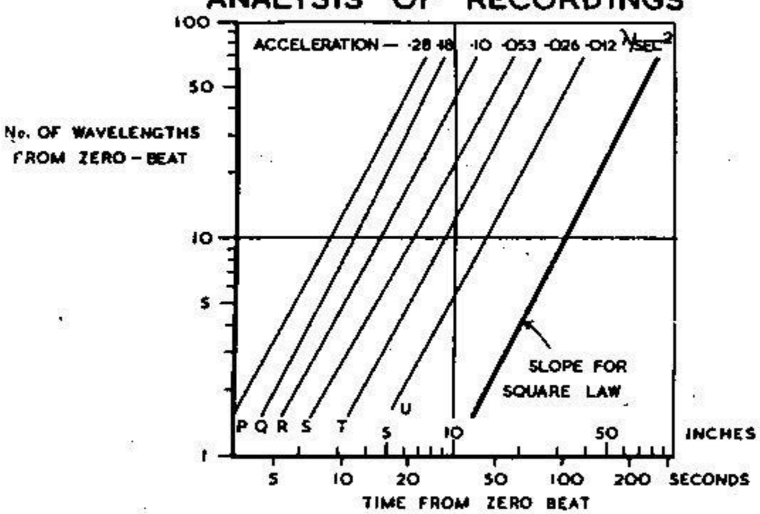


Fig. 3. An analysis of a large number of recordings of steam train fading. Each line P Q R S T U is representative of many recordings. All are seen to have a slope very nearly that of a "square law."

PATH LENGTH DATA CHART

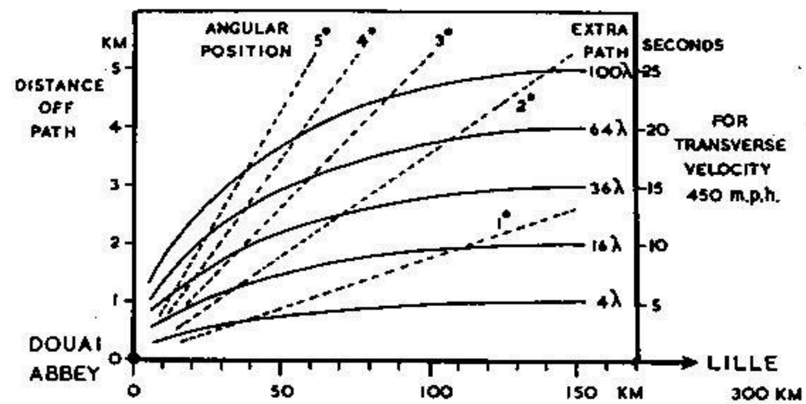
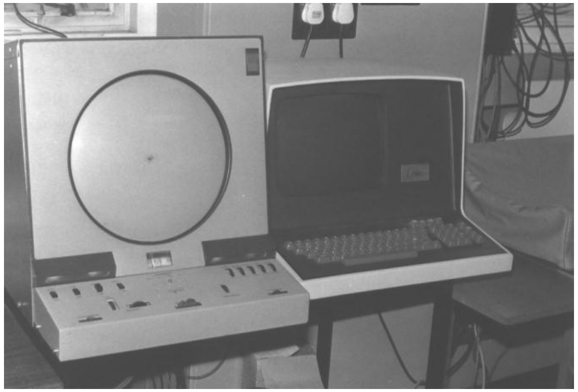
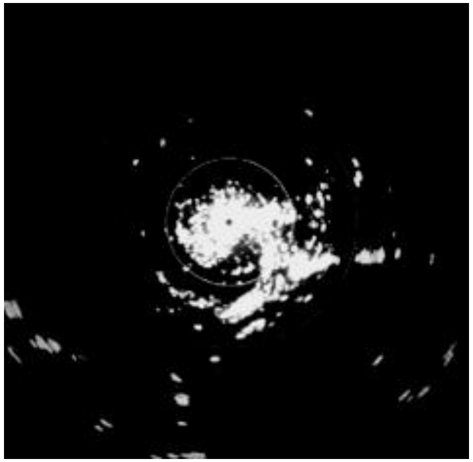
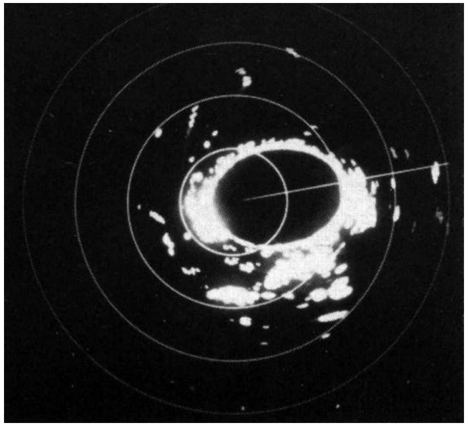


Fig. 4. Path length data chart showing how the length of the bounce-path increases as an aircraft moves off the direct path between Lille and Douai Abbey. The straight lines show the angular position of the aircraft from the receiver relative to the direction of Lille.

Early bistatic radar experiments at UCL







Schoenenberger, J.G. and Forrest, J.R., ‘Principles of independent receivers for use with co-operative radar transmitters’, *The Radio and Electronic Engineer*, Vol.52, No.2, pp93-101, February 1982.

Griffiths, H.D. and Carter, S.M., ‘Provision of moving target indication in an independent bistatic radar receiver’; *The Radio and Electronic Engineer*, Vol.54, No.7/8, pp336-342, July/August 1984 .

Issues

- What sources can we use, and how should we choose them ?
- What system configurations and what form of processing are appropriate ?
- What are the most appropriate applications ?
- How do we assess performance, and what performance is achievable ?

Properties of illuminators of opportunity

power density at target	coverage	waveform
▪ $\Phi = \dfrac{P_T G_T}{4\pi R_T^2}$ ▪ vertical-plane coverage	▪ spatial coverage ▪ temporal coverage ▪ revisit time ▪ number and spacing of txs ▪ geometry: forward scatter ?	▪ frequency ▪ bandwidth ▪ ambiguity function ▪ presence of CW carrier