where $\Delta F$ is the frequency excursion, $F_m$ the modulation frequency, $c$ the light velocity, $\lambda$ the wavelength, $R$ the radar-target distance ($R < R_{\text{max}}$) and $V$ the radial velocity of the target. The first part $F_r$ of equation (1) only depends on the range $R$, and the second part $F_d$ is the Doppler frequency introduced by the radial velocity $V$. In order to solve the distance-velocity ambiguity, a triangular modulation function is applied (see Fig. 1 (a)). Considering the modulation slope, the shift introduced by the Doppler effect is added (negative slope) or subtracted (positive slope). Thus the sum and the difference of $F_d$ allow to determine without ambiguity the distance and velocity of the target (see Fig. 1 (b)). An example of

![Triangular modulation function](image)

**Fig. 1** Triangular modulation function. (a) The time delay $\tau$ is the time of flight between the radar and the target. The vertical shift is the Doppler frequency introduced by the radial velocity. (b) Frequency difference between transmitted and received signals. The sum and the difference of $F_d$ allow to estimate the distance $R$ and the radial velocity $V$ of the target.

radar power spectra obtained with the IMPALA radar is presented in Fig. 2. Four targets are detected within the radar beam: three stationary targets and a moving one. This figure illustrates a well known problem of LFM CW radar: under certain conditions, the frequency matching step may lead to target mismatching, and thus may result in the creation of ghost targets [21]. One objective of the tracking step is to identify and eliminate these ghost targets.

![Power spectrum](image)

**Fig. 2** Example of radar power spectra. Blue: positive slope of the modulation. Red: negative slope. Four targets are detected: three stationary (A, B and C marks) and a moving one (D mark).