RADIOLOCATION

Pulsed Radar (V)

Pulse integration

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Course Contents

Pulsed Radar

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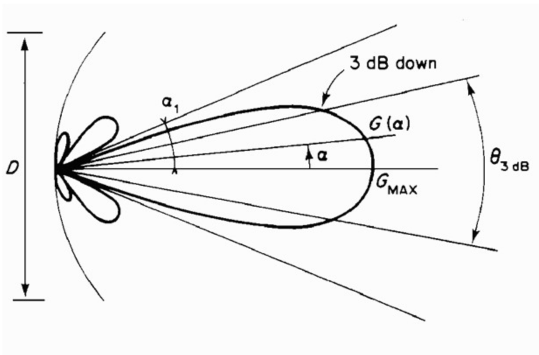
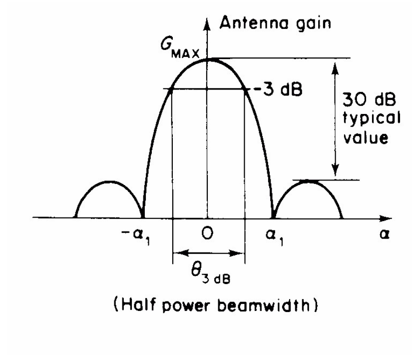
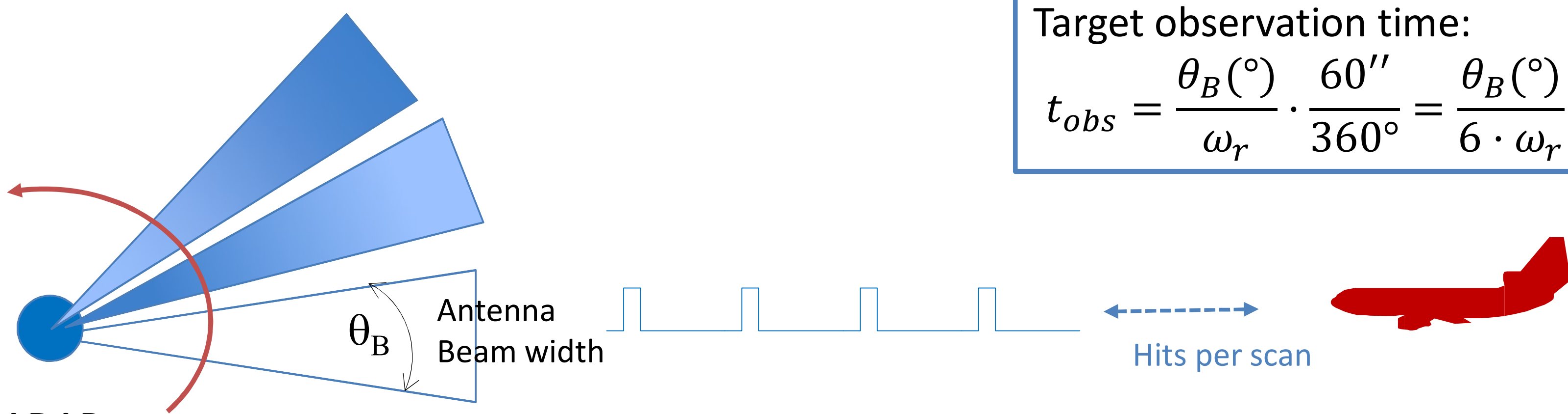
Hits per scan





Target observation time:

$$t_{obs} = \frac{\theta_B(°)}{\omega_r} \cdot \frac{60''}{360°} = \frac{\theta_B(°)}{6 \cdot \omega_r}$$



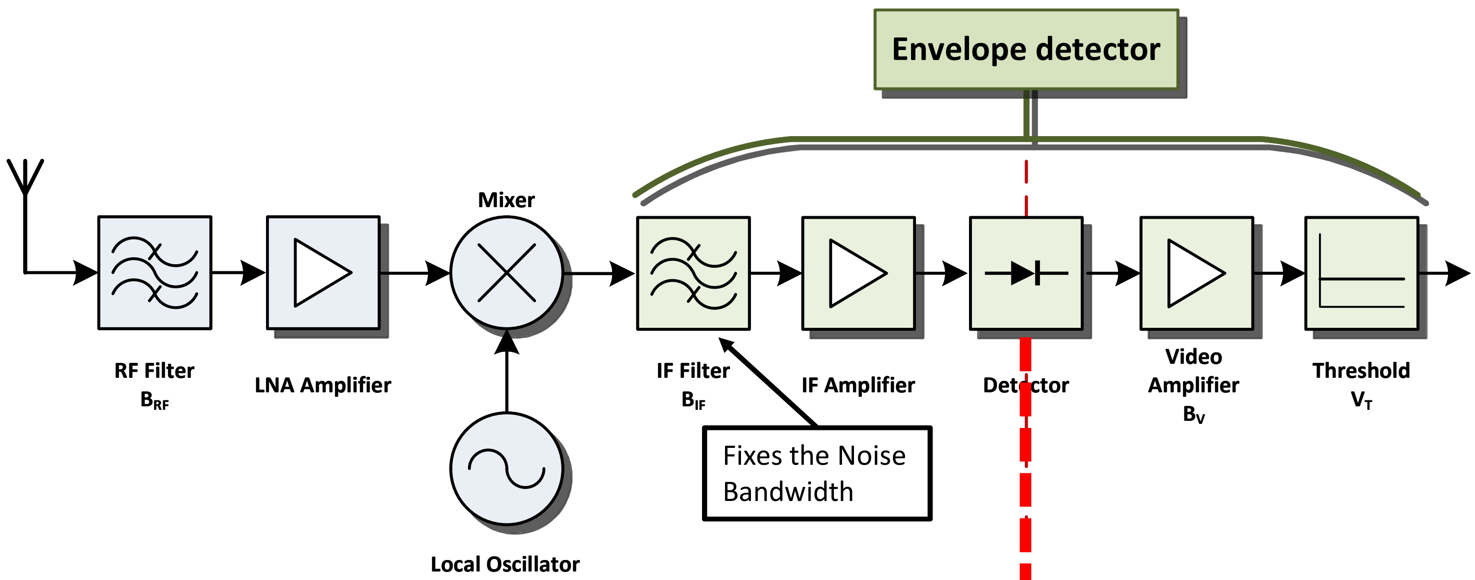
RADAR
Antenna, *with an angular rotation speed of ω_r (rpm)*

Number of pulses received from the target per scan:

$$n = \frac{t_{obs}}{T} = \frac{\theta_B(°)}{6 \cdot \omega_r} \cdot PRF \qquad \text{(hits/scan)}$$

Pulse integration

A pulse Integrator is an improvement technique by using multiple received pulses.

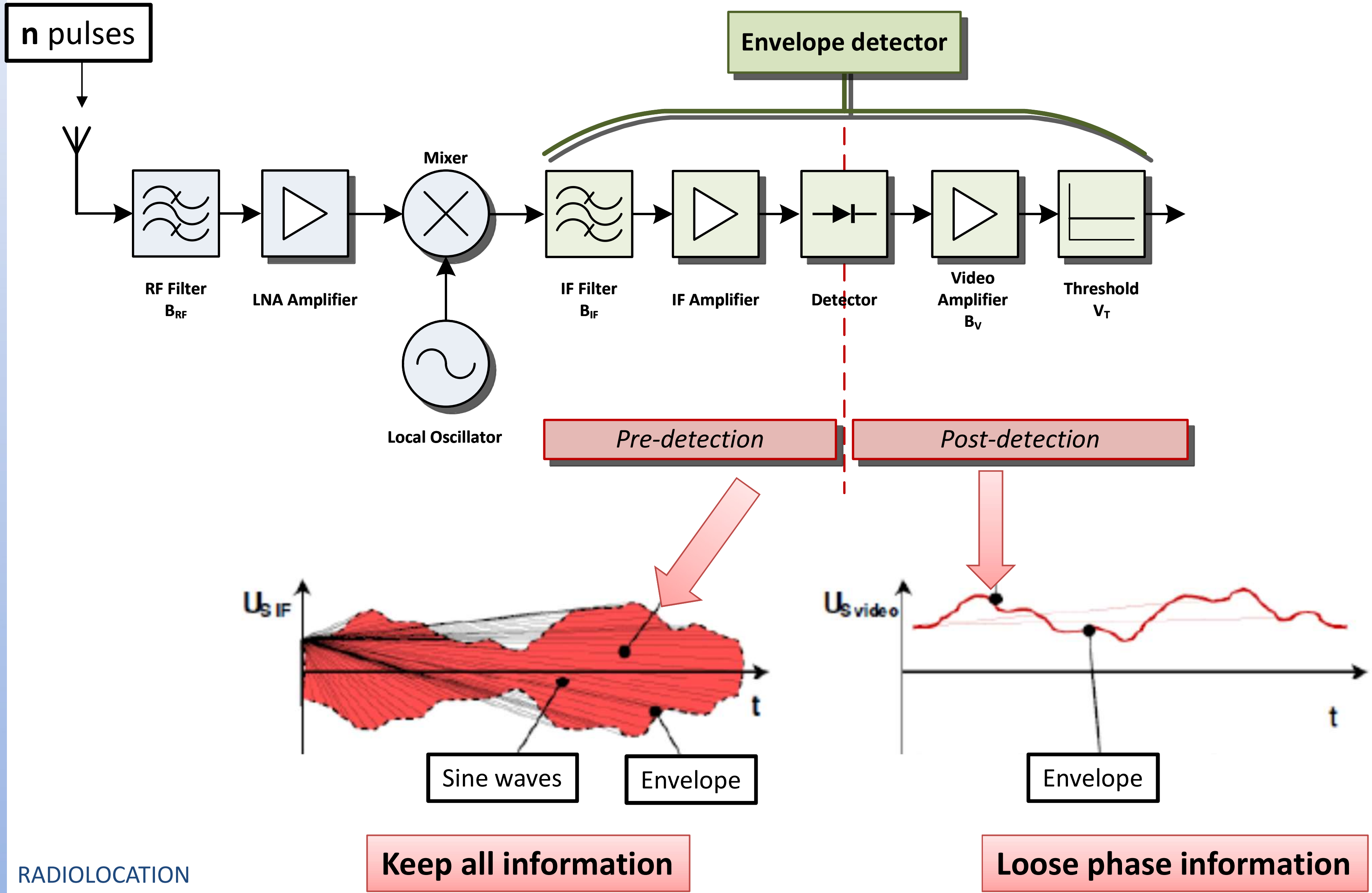


Depending on the location of the pulse Integrator in the signal processing chain, this process is referred to as:

Coherent integration (Pre-detection)

Incoherent integration (Post-detection)

Pulse integration



Pulse integration

Integrating pulses increases the (S/N).
That minds that for the same R_{max}, the required (S/N) is less than without pulse integration.

$$(S/N)_n \geq \frac{1}{n}(S/N)_1 \quad \text{(linear)}$$

If coherent:

$$(S/N)_n = \frac{1}{n}(S/N)_1$$

Maximum of efficiency

If incoherent

$$(S/N)_n > \frac{1}{n}(S/N)_1$$

Pulse Integration evaluation

Efficiency of integration

$$E_i(n) = \frac{(S/N)_1}{n \cdot (S/N)_n}$$

$E_i(n) \leq 1$

Improvement integration factor

$$I_i(n) = n \cdot E_i\ (n) = \frac{(S/N)_1}{(S/N)_n}$$

$I_i(n) \leq n$

Number of equivalent integrated pulses

$$n_{eq} = n \cdot E_i\ (n)$$

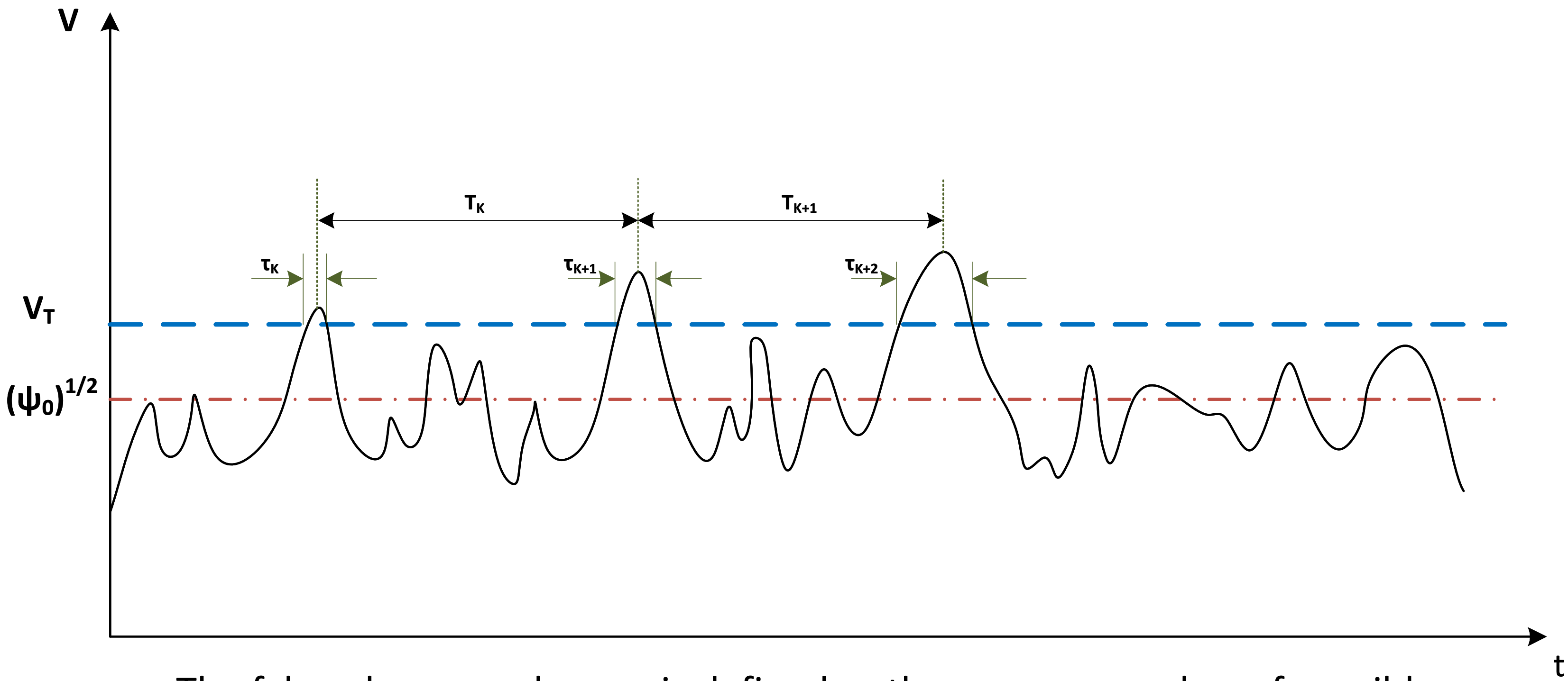
- If coherent integration, $n_{eq} = n$
- If incoherent integration, $n_{eq} < n$

Integration losses

$$L_i(n)\ (dB) = -10 \log E_i(n)$$

$L_i(n) \geq 0\ dB$

False-alarm number



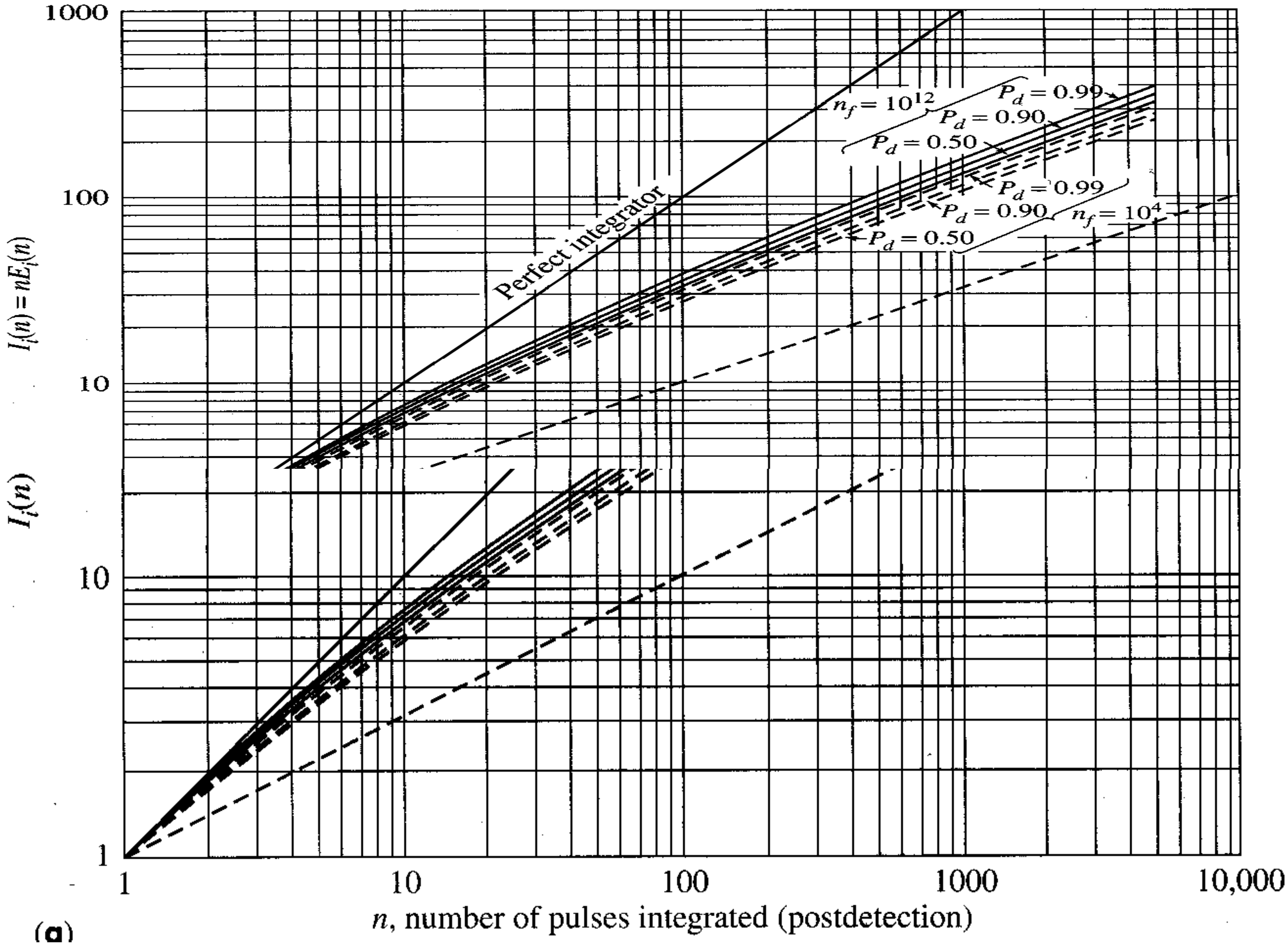
The false-alarm number **n_f**, is defined as the average number of possible decisions between false alarms events:

$$n_f = \frac{T}{\tau} \cdot PRF \cdot T_{FA} = \frac{T_{FA}}{\tau}$$

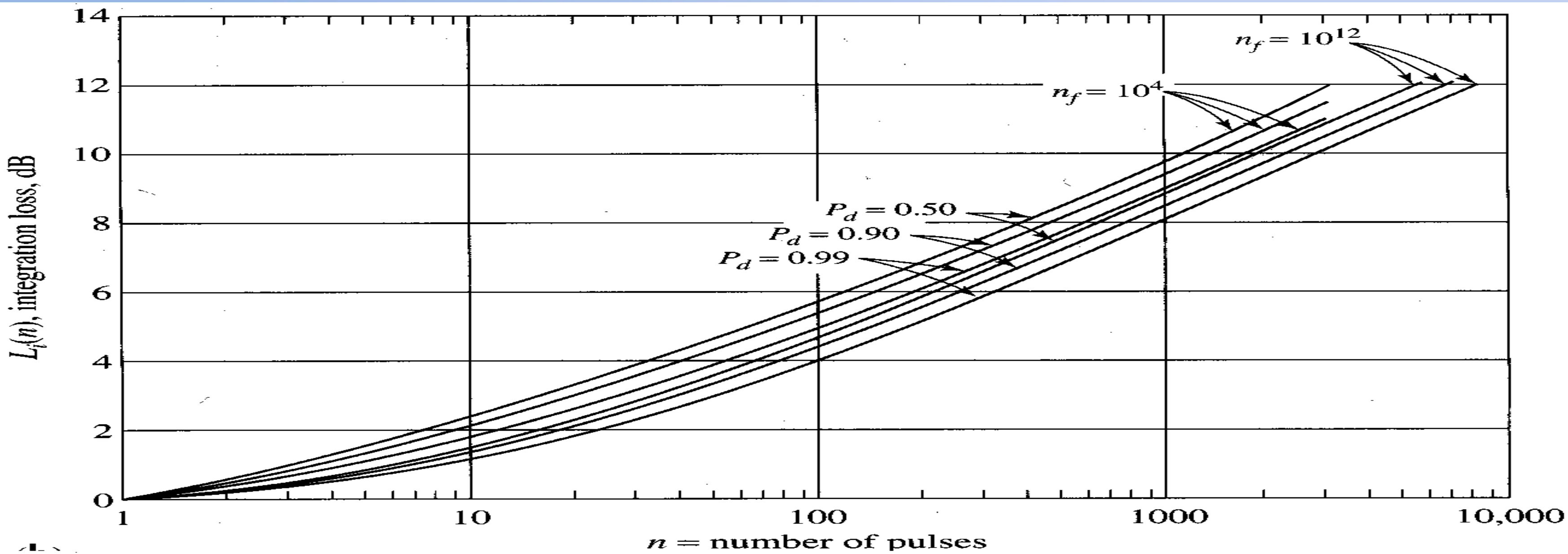
If $\tau \cong \frac{1}{B}$, then $P_{FA} = (T_{FA}B)^{-1}$, and

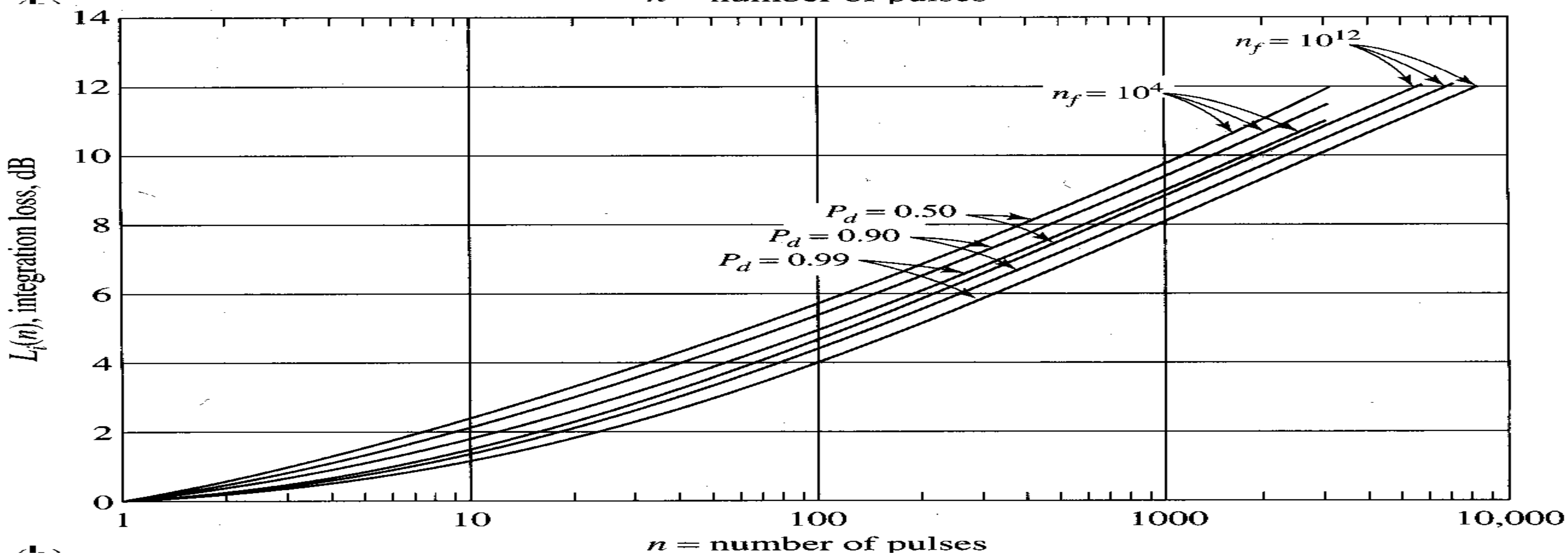
$$\boldsymbol{n_f = \frac{1}{P_{FA}}}$$

Improvement integration factor



Integration losses





Empirical expressions

Empirical expression for the Improvement factor, from Peebles:

$$[I_i(n)]_{dB} = 6{,}79(1 + 0{,}235P_D)\left(1 - \frac{\log P_{FA}}{46{,}6}\right)\log(n)[[1 - 0{,}14\log(n) + 0{,}01831(\log(n))^2]]$$

Empirical expression for the $(S/N)_n$ in dB, from Albersheim:

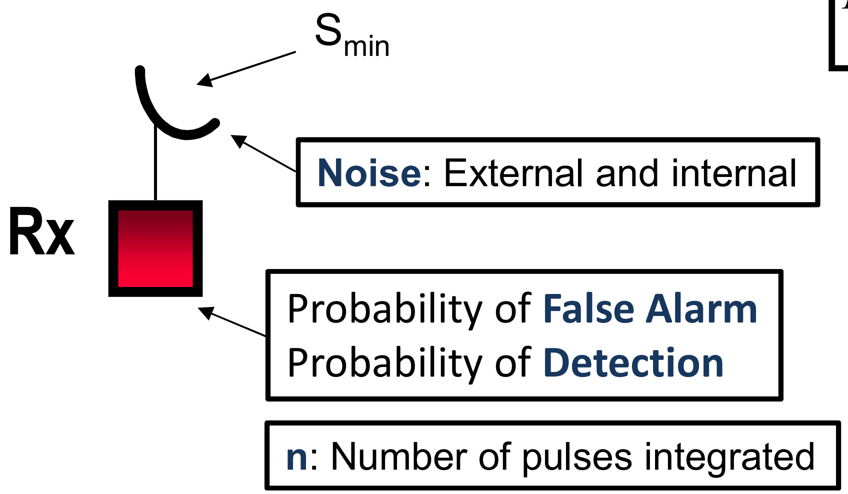
$$(S/N)_{n_{dB}} = -5\log(n) + \left(6{,}2 + \frac{4{,}54}{\sqrt{n + 0{,}44}}\right) \cdot \log(A + 0{,}12 \cdot A \cdot B + 1{,}7 \cdot B\ )$$

with

$$A = \ln\left(\frac{0{,}62}{P_{FA}}\right); \qquad \text{and} \qquad B = \ln\left(\frac{P_D}{1 - P_D}\right)$$

Radar equation with pulse integration

$$R_{max}^{4} = \frac{P_t G \sigma A_{eff}}{(4\pi)^2 k T_0 B F (S/N)_1}$$



$$R_{max}^{4} = \frac{P_t G \sigma A_{eff}}{(4\pi)^2 k T_0 B F (S/N)_n} = \frac{P_t G \sigma A_{eff} \boldsymbol{n E_i(n)}}{(4\pi)^2 k T_0 B F \boldsymbol{(S/N)_1}}$$