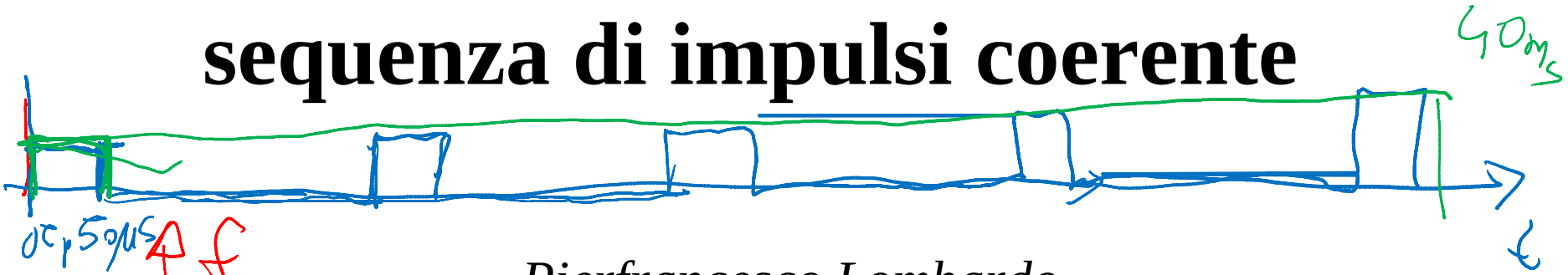
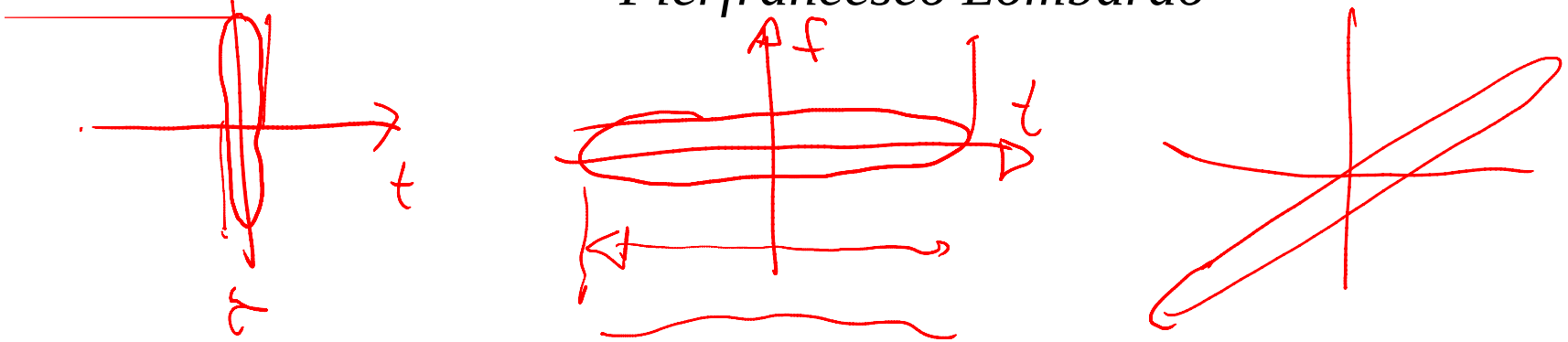
$T_{tot} \geq 40\,ms$ $\quad$ 7,5 Km = max blind range = $\frac{c\tau_p}{2}$

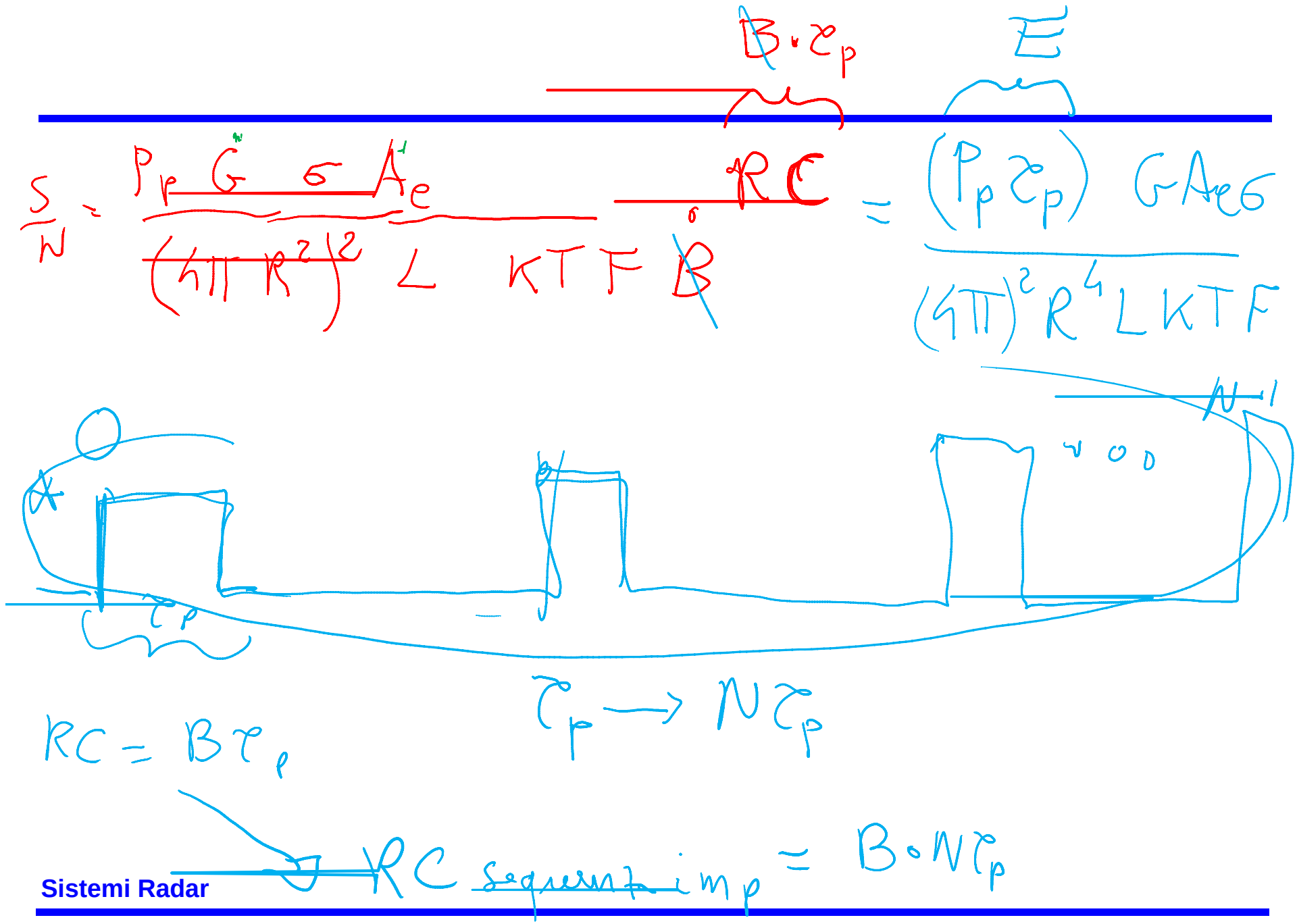
$\tau_p \leq \frac{2 \cdot 7{,}5\,Km}{3 \cdot 10^8\,m/s} = \frac{15 \cdot 10^3\,m}{3 \cdot 10^8\,m/s} = 50\,10^{-6}\,s = 50\,\mu s$

Funzione di ambiguità della sequenza di impulsi coerente

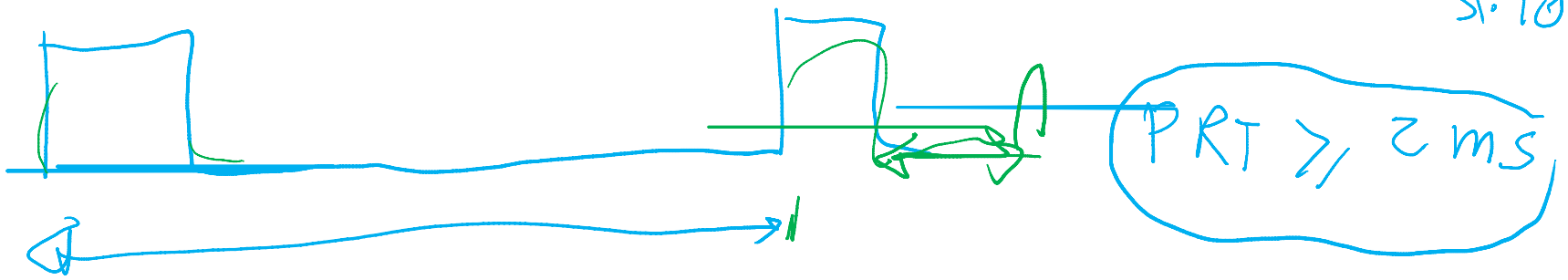


Pierfrancesco Lombardo




B·τp
E
S/N = Pp G σ Ae / (4π R²)² L KTF B
RC = (Pp τp) GAeσ / (4π)² R⁴ LKTF
N-1
0
τp
τp → N τp
RC = B τp
RC sequenza imp = B·N τp

$R_{max} \simeq 300\,Km \longrightarrow PRT \geq \frac{2 \cdot 3 \cdot 10^3}{3 \cdot 10^8}$



$PRT \geq \frac{2}{c} R_{max} + \tau_p$

$\frac{2}{c}$

spesso $\gg \tau_p$

$\simeq \frac{2}{c} R_{max}$

$N = \frac{t_{o.t}}{PRT} \simeq \frac{40\,ms}{2\,ms} \simeq 20$ impulsi

$PRF = \frac{1}{PRT}$

Energia del singolo impulso

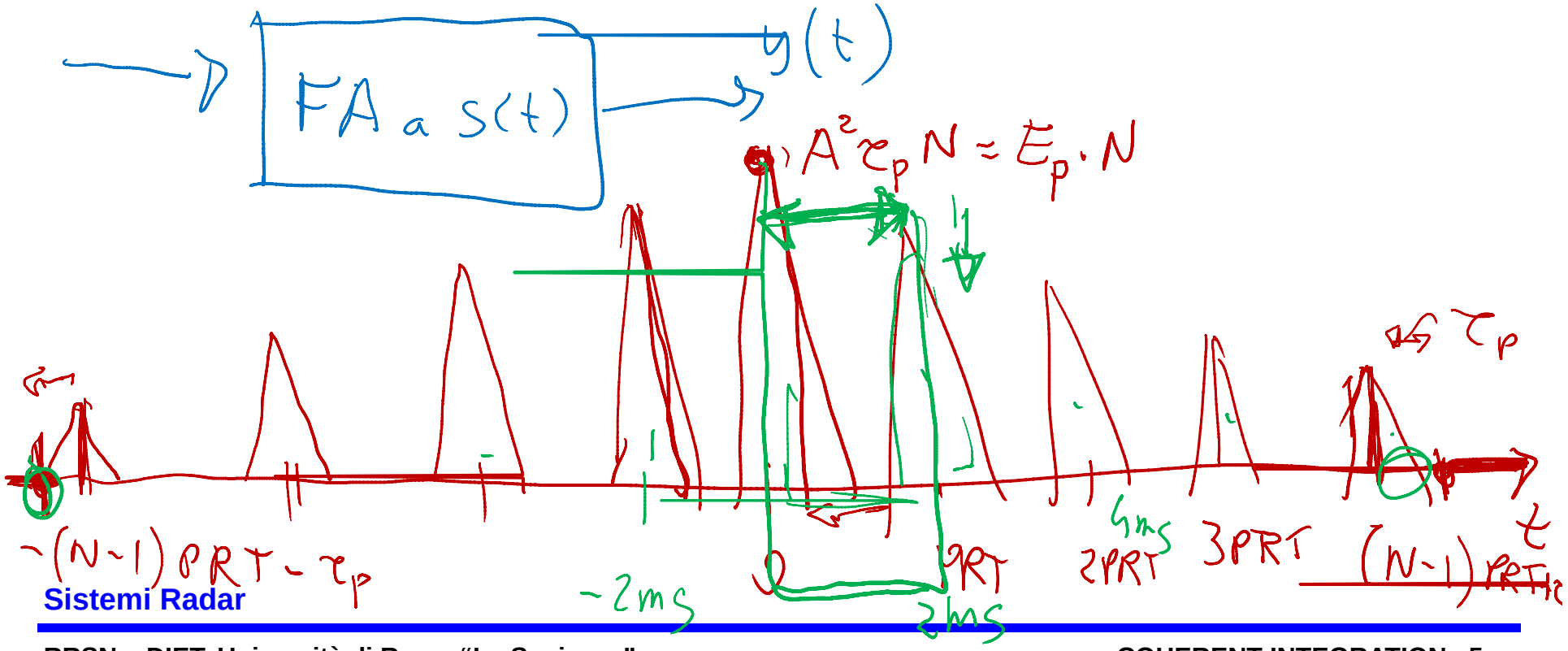
$$\frac{S}{N} = \frac{(P_t \tau_p)\, G A_e \sigma}{(4\pi)^2 R^4 L K T F} \propto N$$

$$S/N\Big|_{Sing.\,imp} \simeq \frac{S}{N}\Big|_0$$

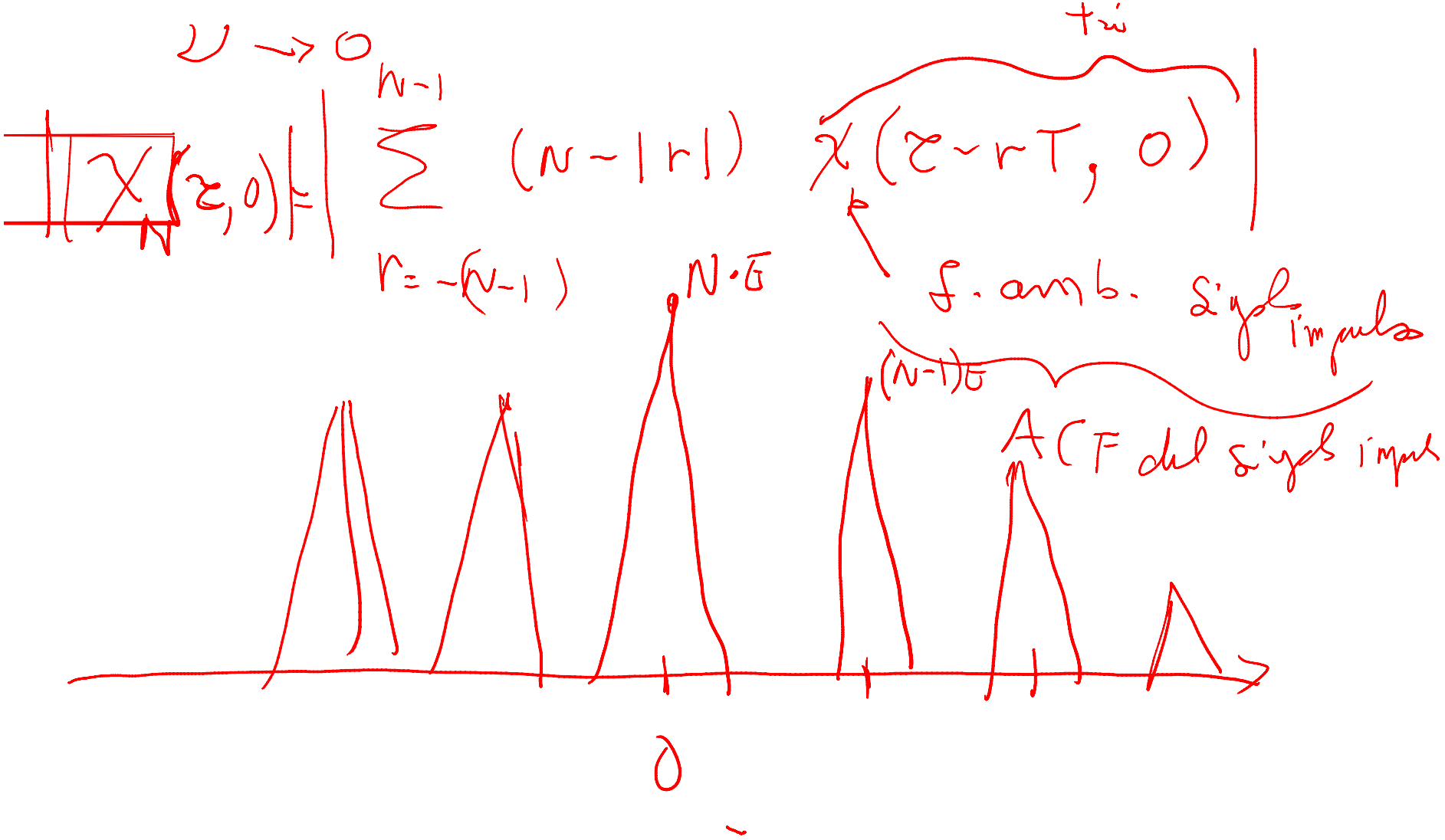
$$P_{fa} = 10^{-6},\ P_d \simeq 0,9 \longrightarrow \frac{S}{N} \simeq 13\,dB$$

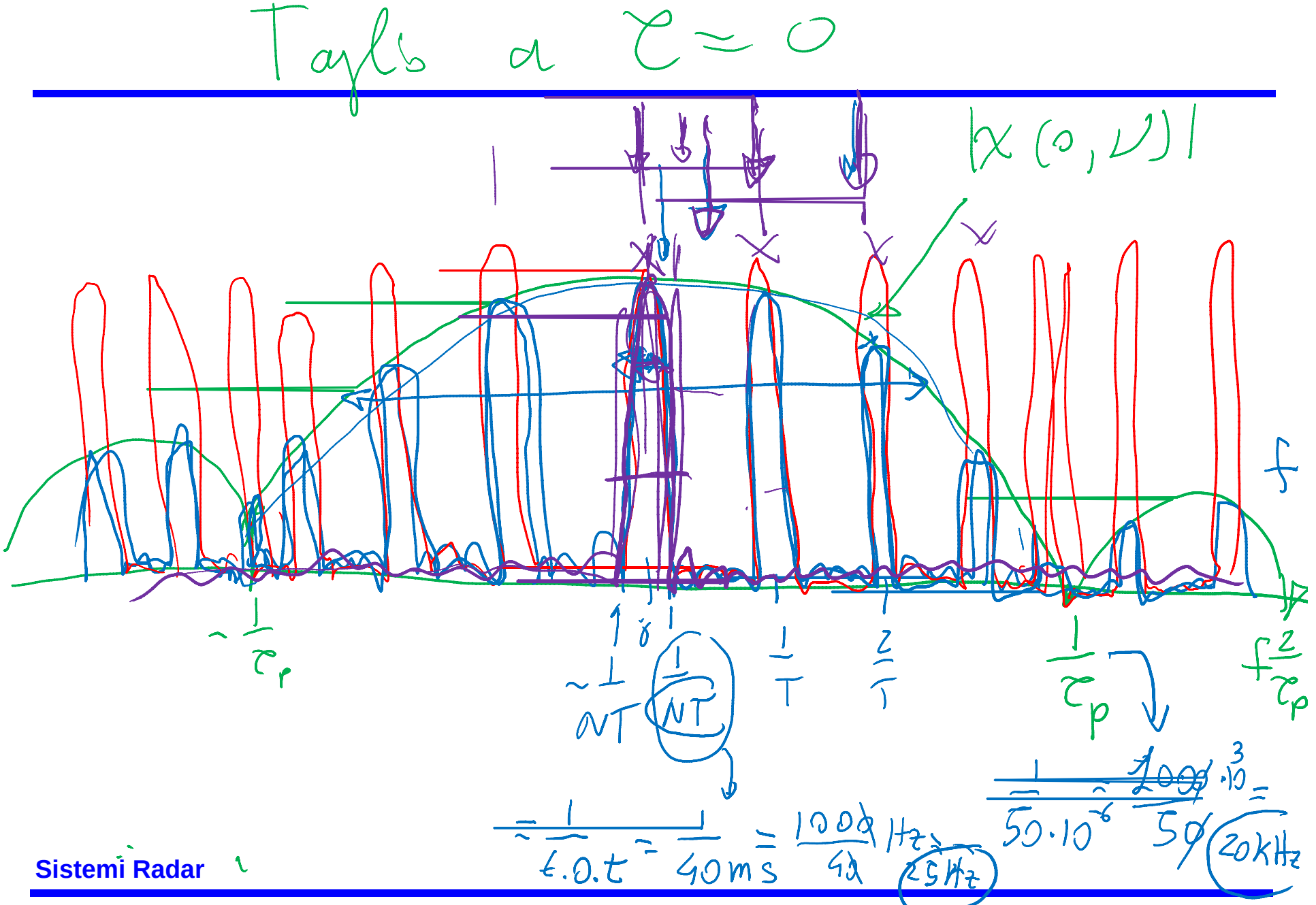
$$\frac{S}{N}\Big|_{Sing.\,imp\,dB} = 13\,dB - 10\log_{10}(N) = 0\,dB$$

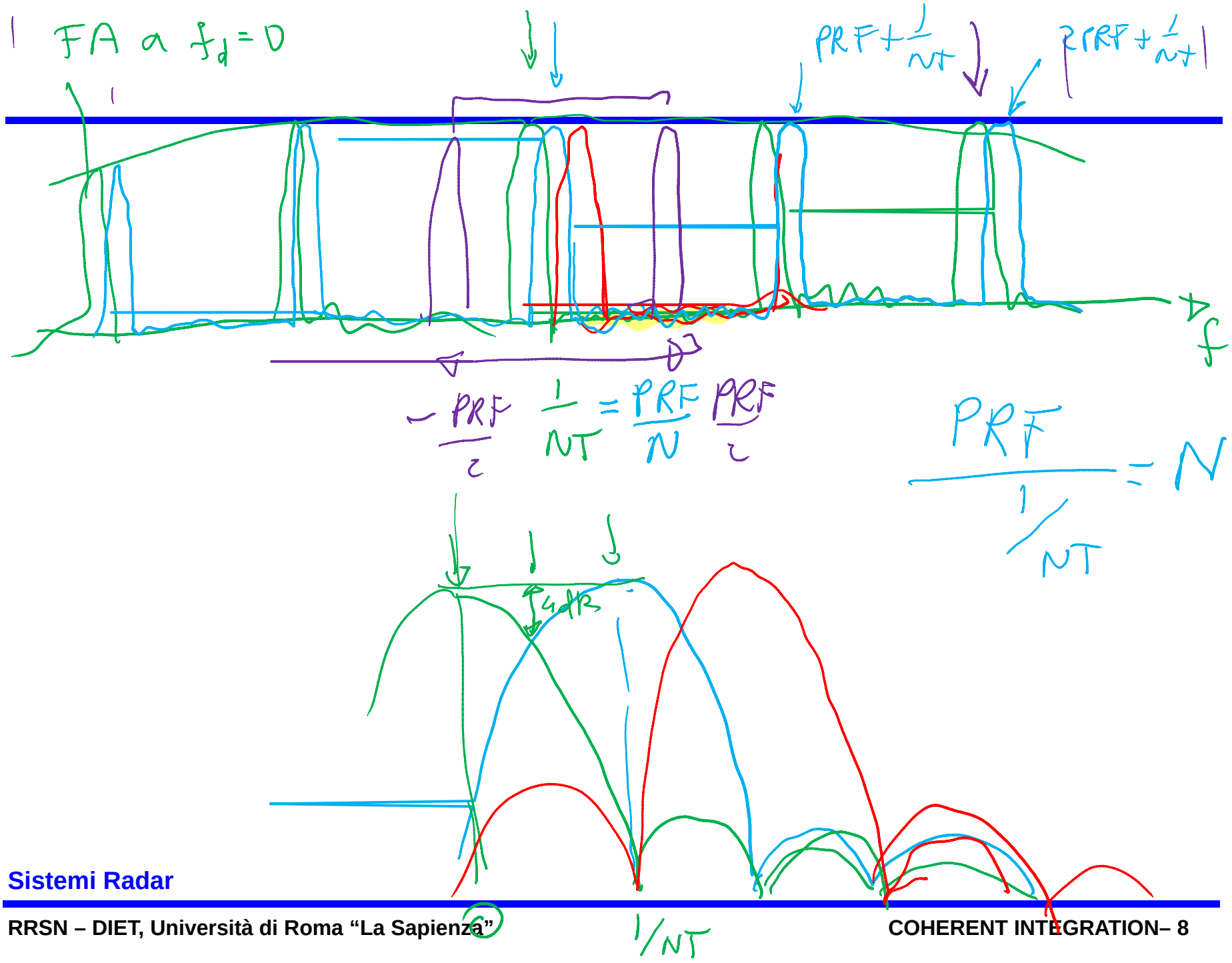

s(t)
50 μs
2ms
A
τp
0
PRT
2PRT
3PRT
(N-1)PRT+τp


FA a s(t)
y(t)
A²τpN ≈ Ep·N
τp
-(N-1)PRT-τp
-2ms
PRT
2ms
2PRT
4ms
3PRT
(N-1)PRT+τp
t

Taglio per $\nu = 0$ $T = PRT$




Taylor a τ ≈ 0
|χ(0,ν)|
f
1/τp
1/NT
NT
1/T
2/T
1/τp
f 2/τp
1/(4.0.t) = 1/40ms = 1000 Hz/40 = 25Hz
50.10^-6
50
20kHz

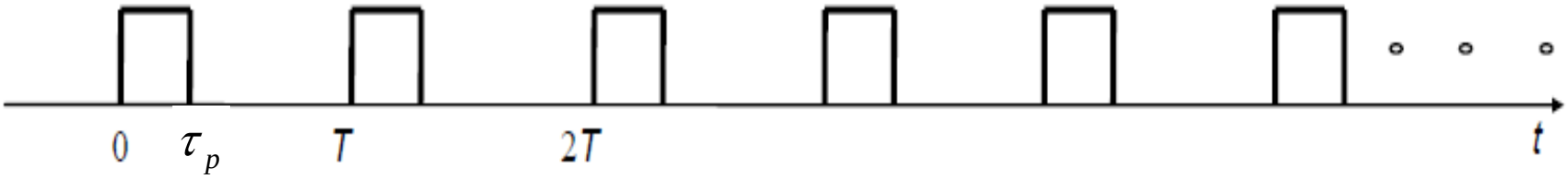

1 FA a $f_d = 0$
PRF + 1/NT
2 PRF + 1/NT
f_d
$-\frac{PRF}{2}$ $\frac{1}{NT} = \frac{PRF}{N}$ $\frac{PRF}{2}$
$\frac{PRF}{1/NT} = N$
4dB
1/NT

Sequenza coerente di impulsi

- **Sequenza coerente di N impulsi** di durata τ_p e tempo di ripetizione (PRT) T:

$$s_{0N}(t) = \sum_{n=0}^{N-1} s_0(t - n \cdot T)$$

$$s_0(t) = \frac{1}{\sqrt{\tau_p}} e^{j\phi(t)} \, rect_{\tau_p}\left(t - \frac{\tau_p}{2}\right)$$



- **Filtro adattato alla sequenza di N impulsi**

$$\left|\chi(\tau,\nu)\right| = \left| \int_{-\infty}^{\infty} s_{0N}(t)\; s_{0N}^{*}(t+\tau)\; e^{j2\pi\nu t}\, dt \right|$$

Funzione di ambiguità della sequenza (I)

$$\left|\chi_N(\tau,\nu)\right| = \left| \int_{-\infty}^{\infty} s_{0N}(t)\, s_{0N}^*(t+\tau)\, e^{j2\pi\nu t} dt \right| = \left| \int_{-\infty}^{\infty} \sum_{n=0}^{N-1} s_0(t-n\cdot T) \sum_{k=0}^{N-1} s_0^*(t+\tau-k\cdot T)\, e^{j2\pi\nu t} dt \right| =$$

$$= \left| \sum_{n=0}^{N-1}\sum_{k=0}^{N-1} \int_{-\infty}^{\infty} s_0(t-n\cdot T)\, s_0^*(t+\tau-k\cdot T)\, e^{j2\pi\nu t} dt \right| = \qquad t - nT = t'$$

$$= \left| \sum_{n=0}^{N-1}\sum_{k=0}^{N-1} e^{j2\pi\nu nT} \int_{-\infty}^{\infty} s_0(t')\, s_0^*[t'+\tau+(n-k)\cdot T]\, e^{j2\pi\nu t'} dt' \right| = \qquad t = t'+nT$$

$$0 \le n \le N-1$$

$$0 \le k \le N-1$$

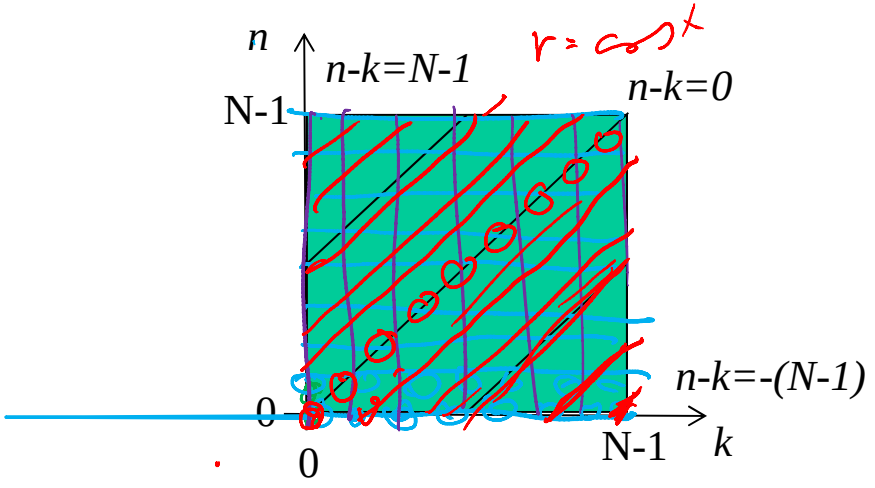
$$= \left| \sum_{n=0}^{N-1} \sum_{n-k=-n}^{N-1-n} e^{j2\pi\nu nT}\, \chi[\tau+(n-k)T,\nu] \right| =$$

$$-(N-1) \le n-k \le N-1$$

$$= \left| \sum_{r=-(N-1)}^{N-1} \sum_{n=\max\{0,\, r\}}^{N-1-\min\{0,r\}} e^{j2\pi\nu nT}\, \chi[\tau+rT,\nu] \right| =$$

$$= \left| \sum_{r=-(N-1)}^{N-1} \frac{\sin[\pi\nu(N-|r|)T]}{\sin[\pi\nu T]}\, \chi[\tau+rT,\nu] \right| =$$

$$= \left| \sum_{r=-(N-1)}^{N-1} \frac{\sin[\pi\nu(N-|r|)T]}{\sin[\pi\nu T]}\, \chi[\tau-rT,\nu] \right|$$



Funzione di ambiguità della sequenza (II)

$$\left|\chi_N(\tau,\nu)\right| = \left| \sum_{r=-(N-1)}^{N-1} \frac{\sin[\pi\nu(N-|r|)T]}{\sin[\pi\nu T]} \chi[\tau - rT, \nu] \right|$$

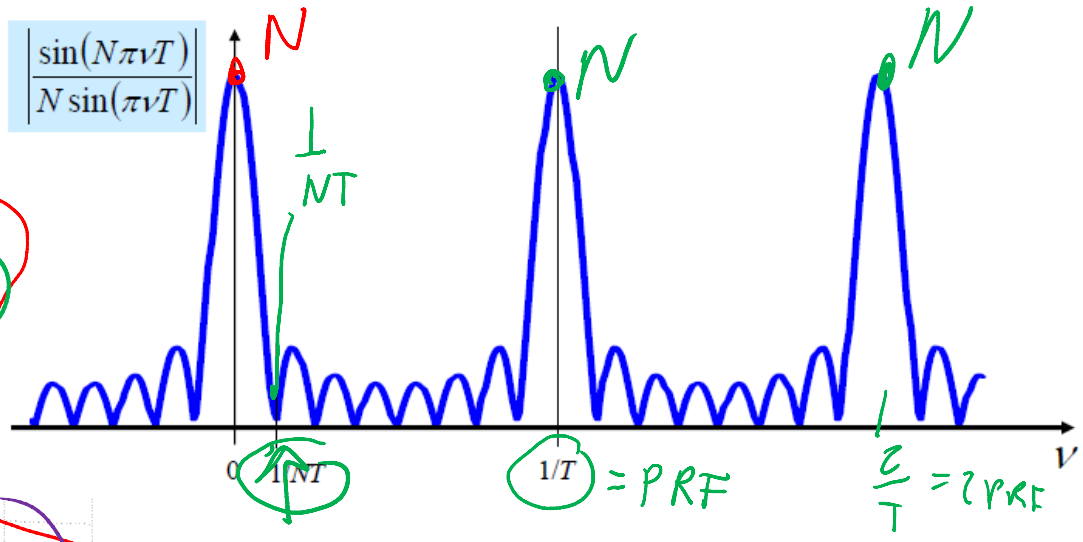
$$\lim_{x\to 0} \frac{\sin(Nx)}{\sin x} \Rightarrow N$$

$N - |r|$

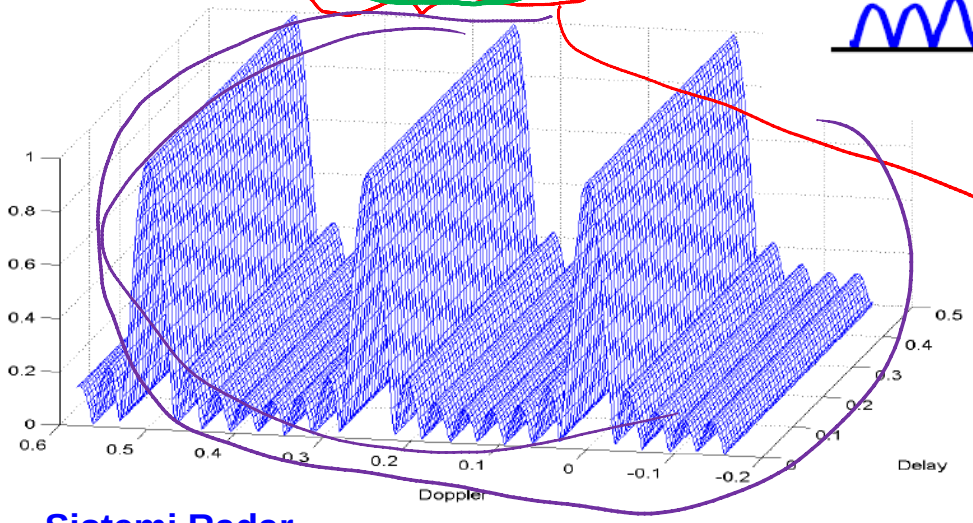
$$\tau \le T - \tau_P \quad \Leftrightarrow \quad k = 0$$

$$\left|\chi_N(\tau,\nu)\right| = \left| \frac{\sin[\pi\nu N)T]}{\sin[\pi\nu T]} \right| \cdot \left|\chi[\tau,\nu]\right|$$

$$\left|\frac{\sin(N\pi\nu T)}{N\sin(\pi\nu T)}\right|$$

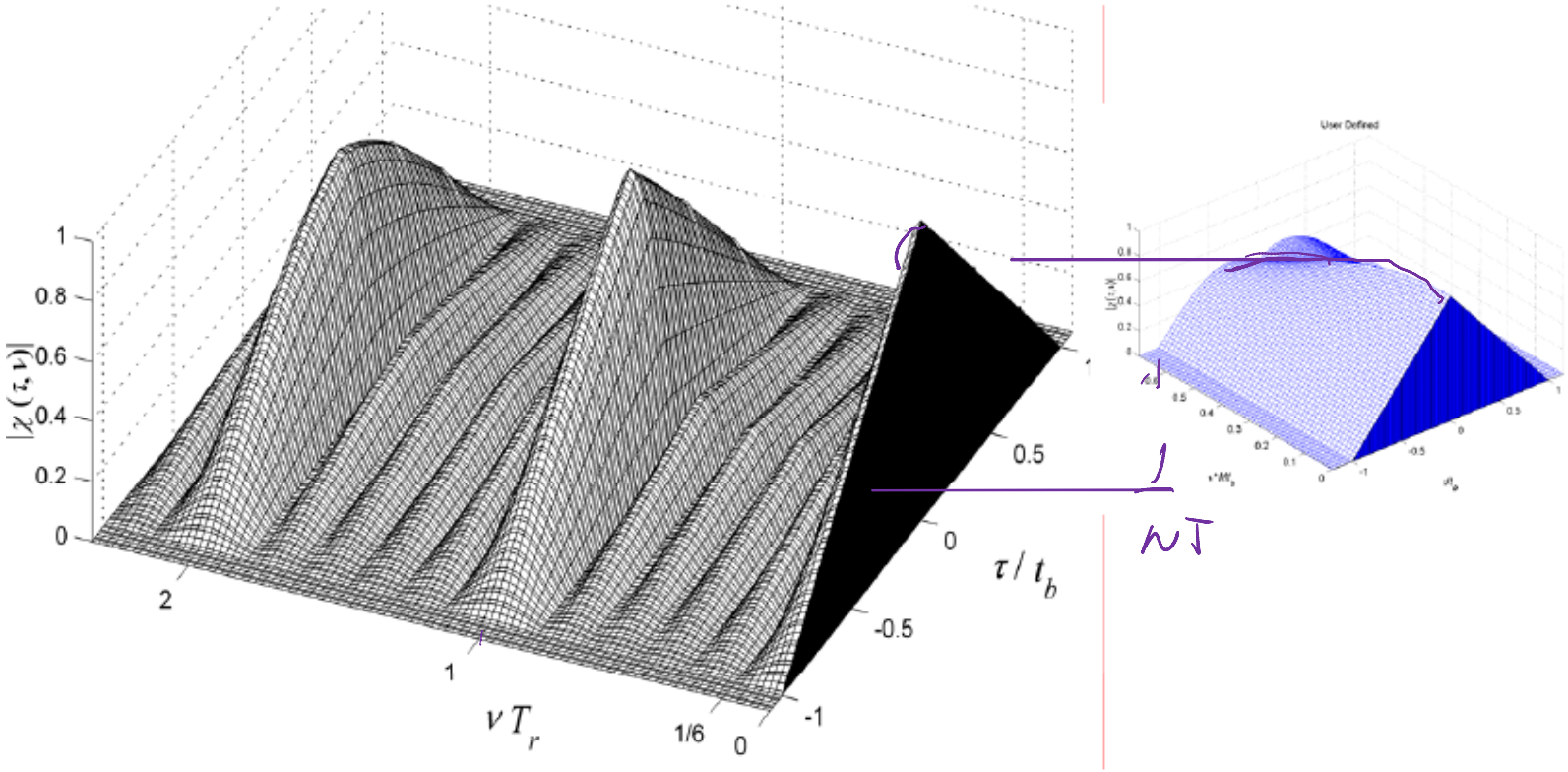


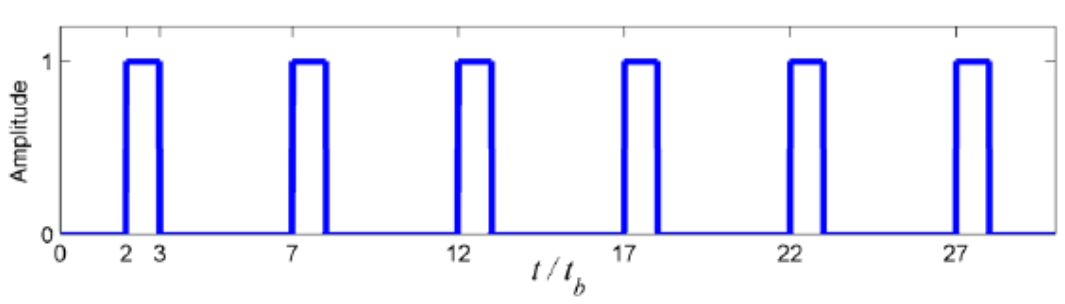
$\pi\nu NT = \pi 1$ $\quad \nu = \frac{1}{NT}$



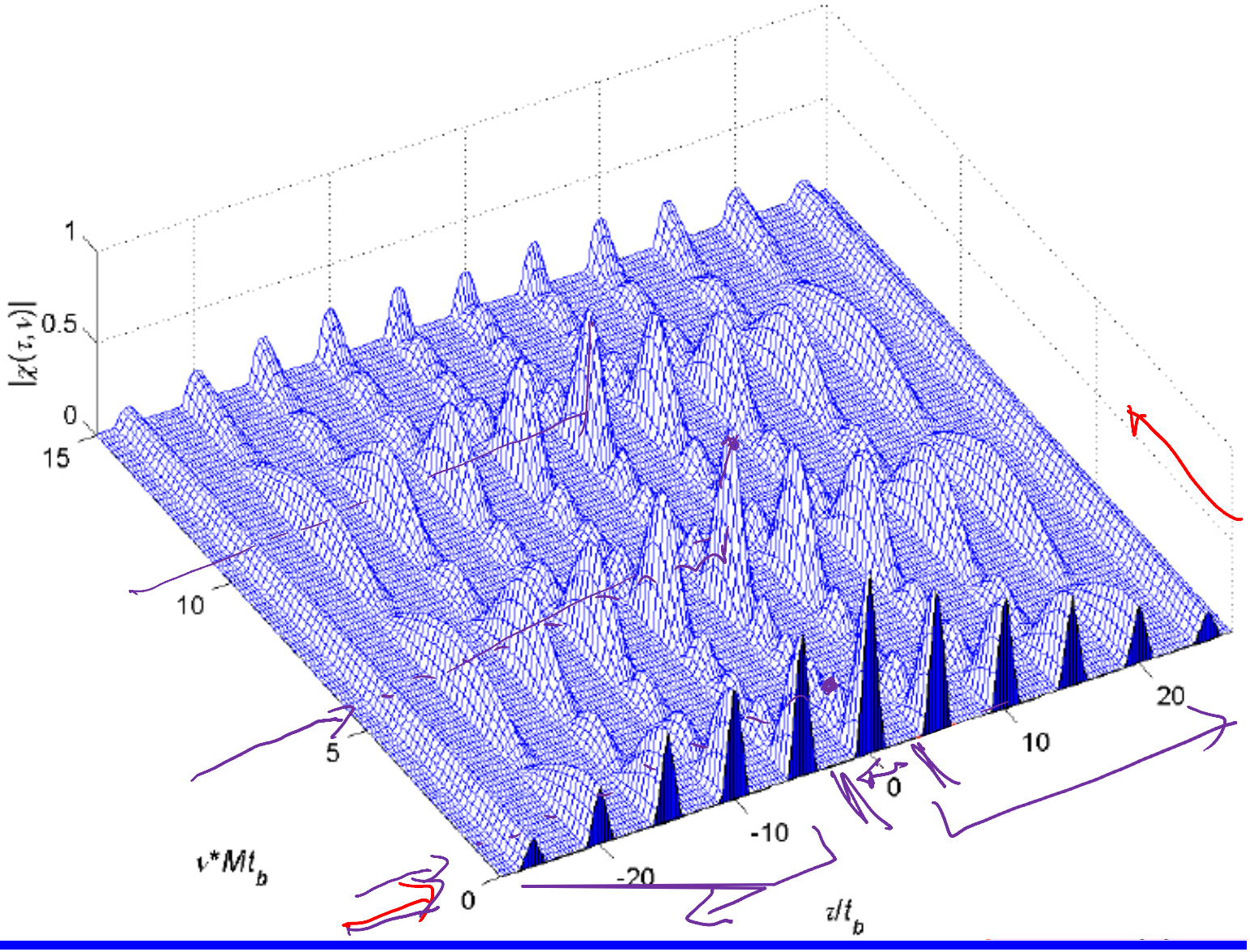
$\nu T = kT$ $\quad \nu = \frac{k}{T}$

Funzione di ambiguità della sequenza (III)





Funzione di ambiguità della sequenza (IV)



Funzione di ambiguità della sequenza (IV)

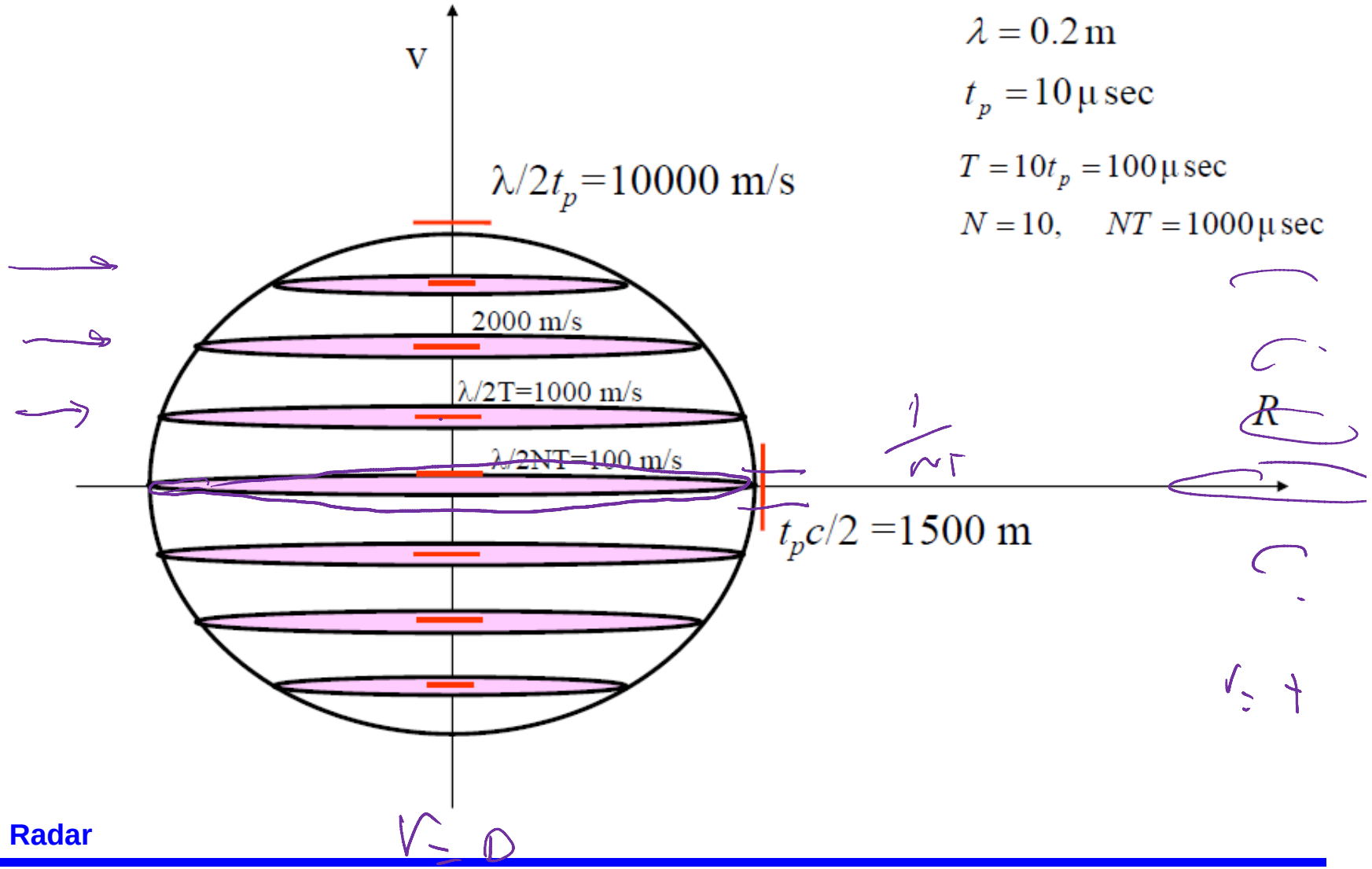
$f_c = 1500\,\text{MHz}$

$\lambda = 0.2\,\text{m}$

$t_p = 10\,\mu\text{sec}$

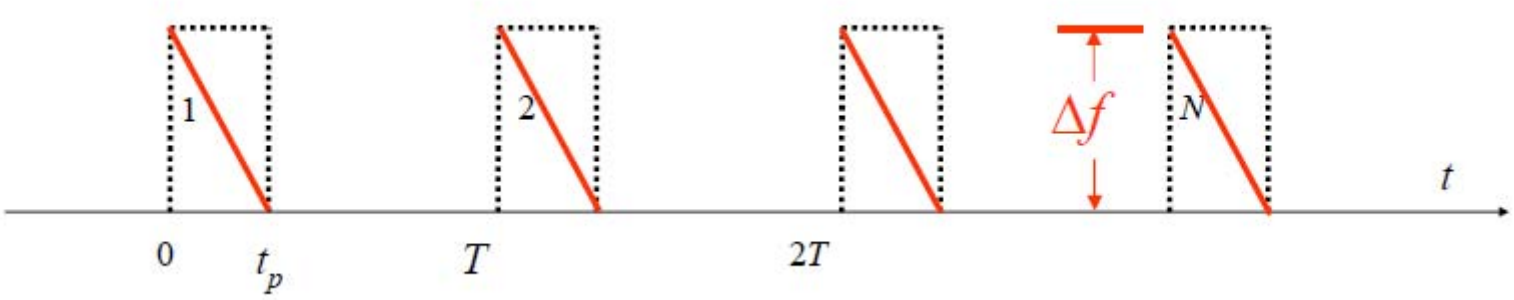
$T = 10 t_p = 100\,\mu\text{sec}$

$N = 10, \quad NT = 1000\,\mu\text{sec}$



Funzione di ambiguità della sequenza (V)

Sequenza di chirp

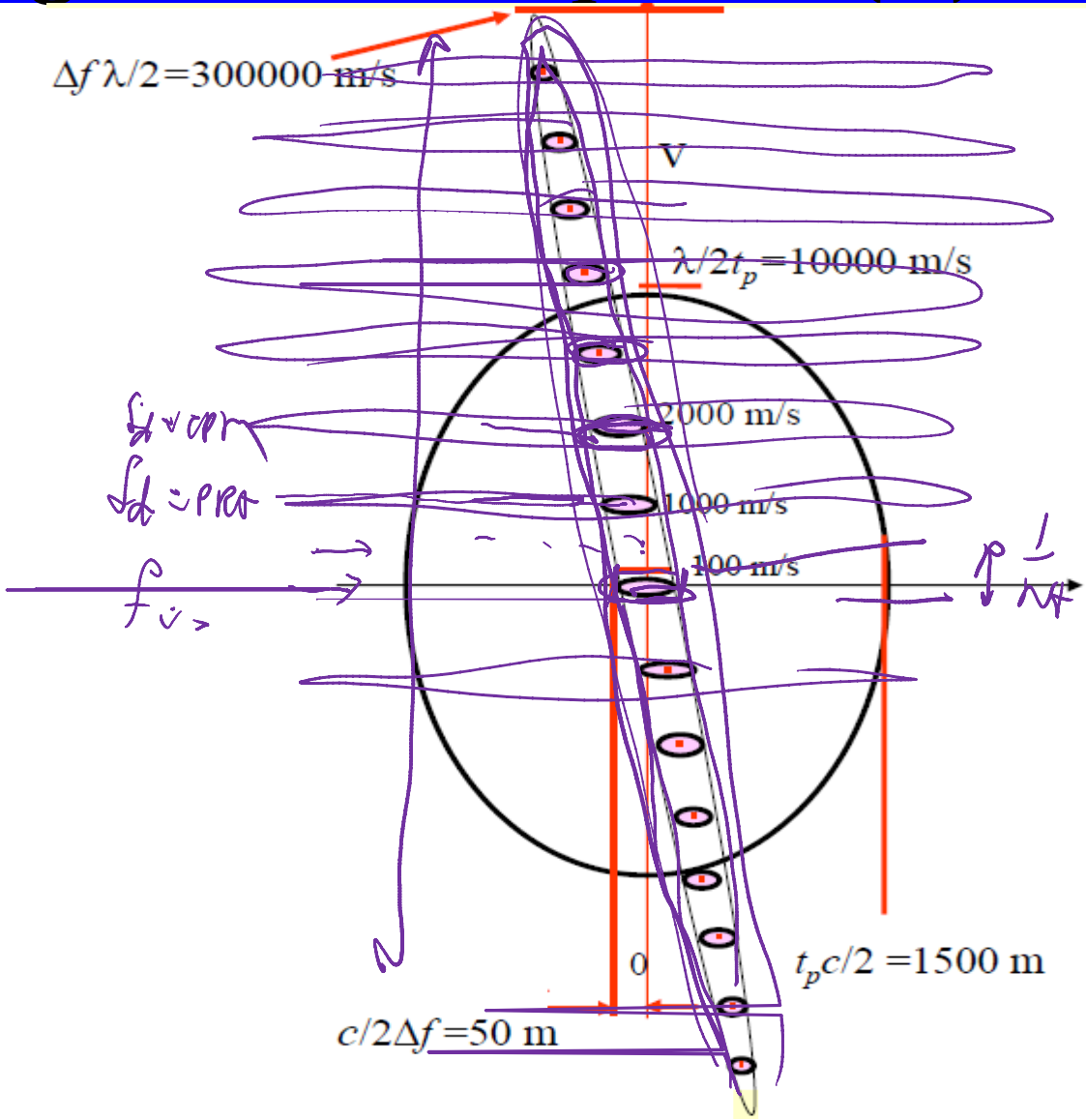


$$\text{Compression ratio} = t_p \Delta f = 30$$

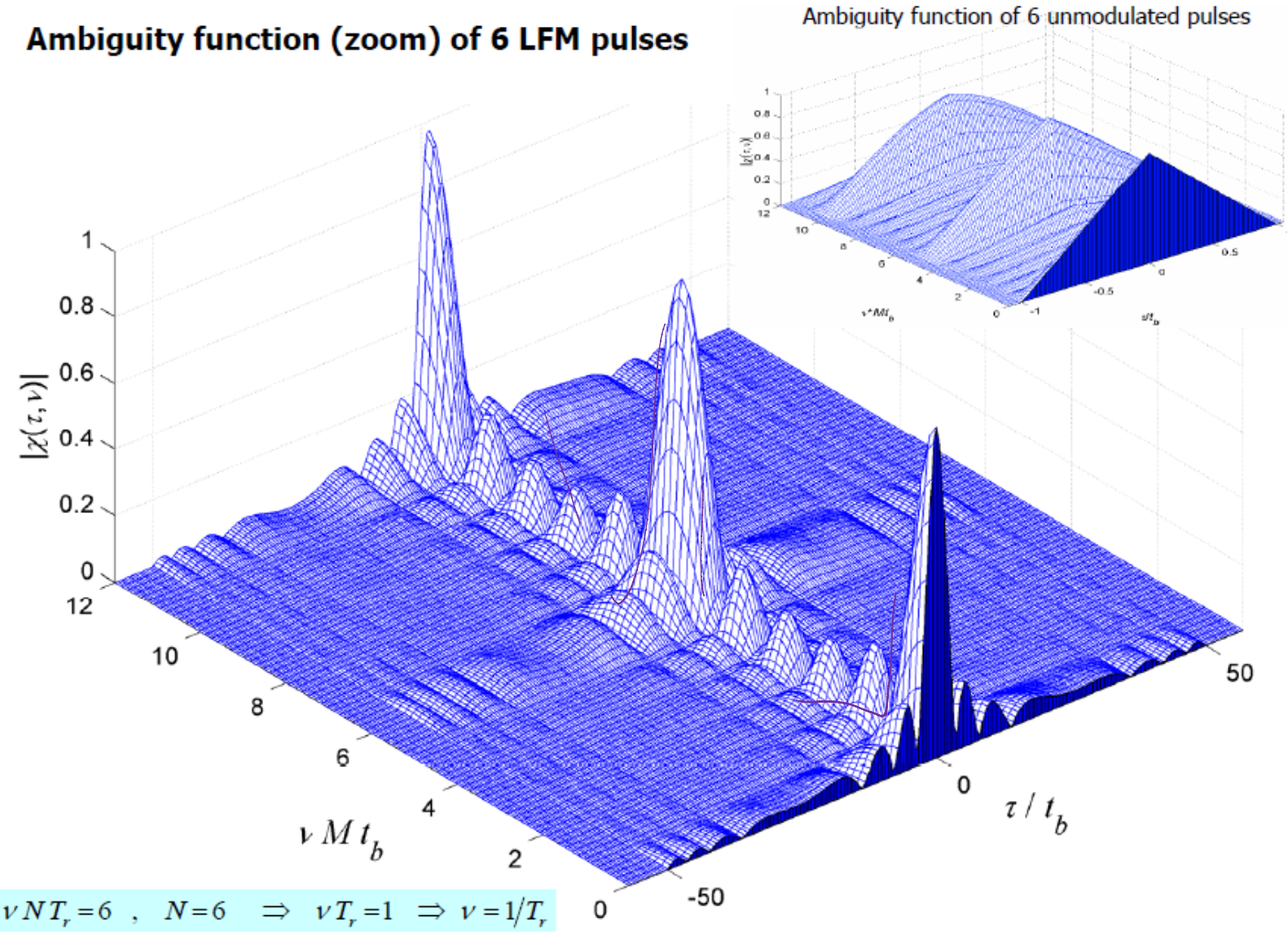
$$\Delta f = 30 / t_p = 30 / 10^{-5} = 3\,\text{MHz}$$

Funzione di ambiguità della sequenza (V)

Sequenza di chirp

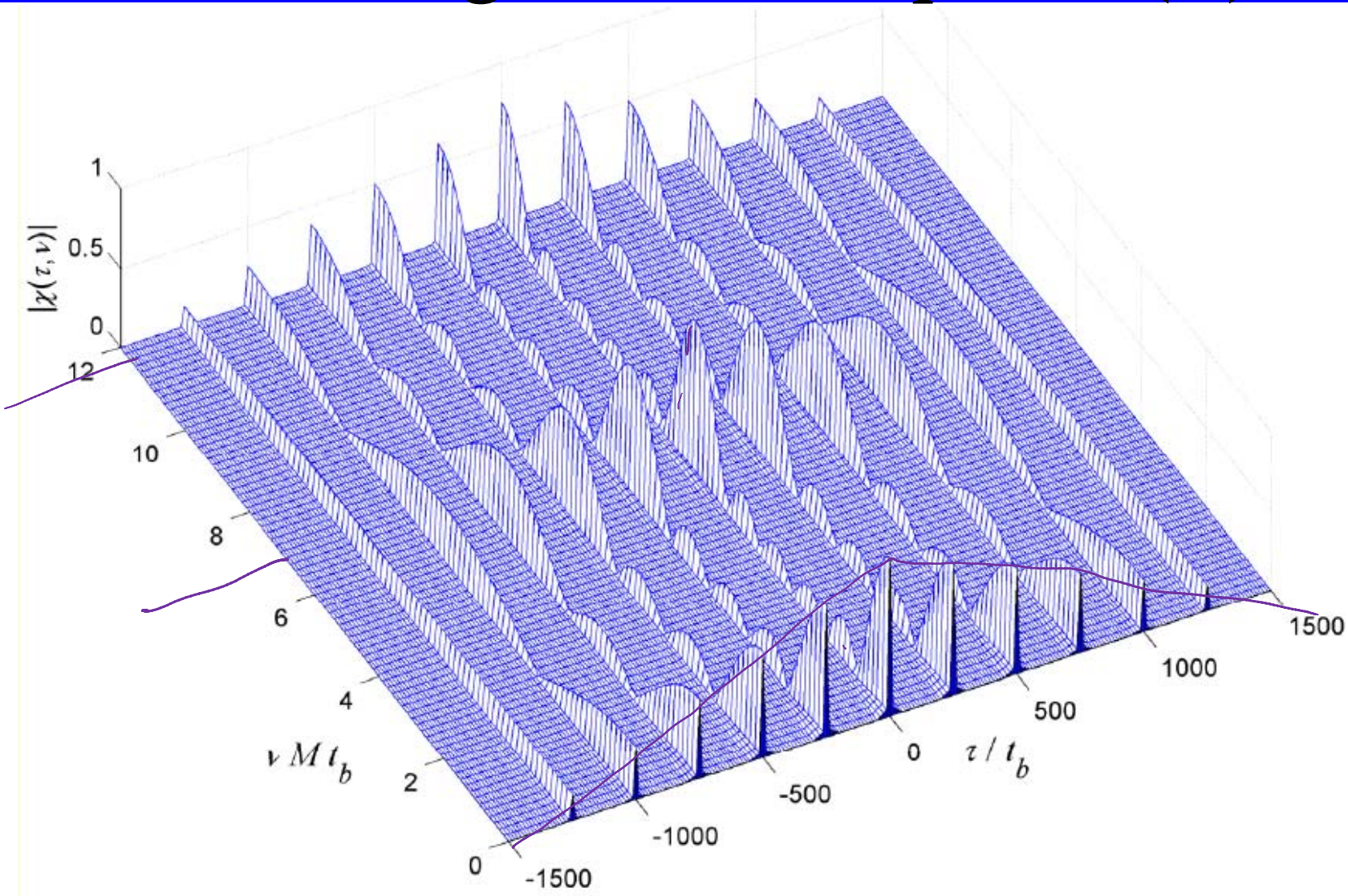


Funzione di ambiguità della sequenza (V)



Sistemi Radar $\nu N T_r = 6 \;,\; N = 6 \;\Rightarrow\; \nu T_r = 1 \;\Rightarrow\; \nu = 1/T_r$

Funzione di ambiguità della sequenza (V)



Funzione di ambiguità della sequenza (V)

N >> 1