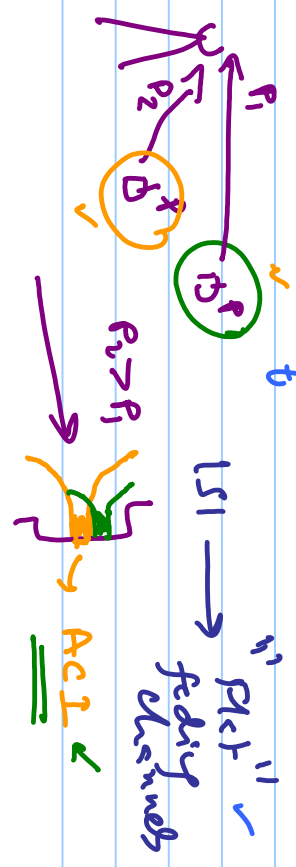
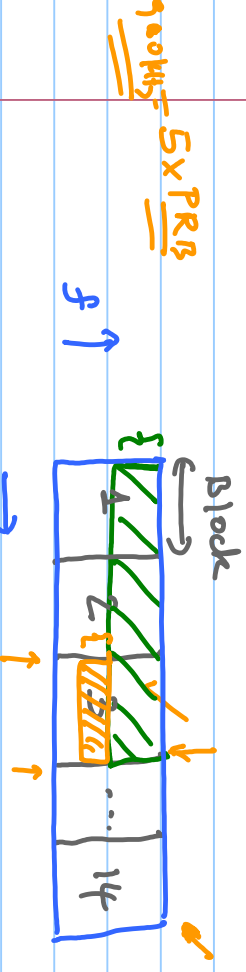


→ MIMO Technology Overview

$$ML \frac{X}{X_r} \rightarrow \begin{matrix} L, G \\ \vec{y} = H \vec{x} + N \end{matrix}$$

\vec{y} → every "n" \vec{y}_n
 \vec{x} → every "n" \vec{x}_n
 N → every "n" N_n

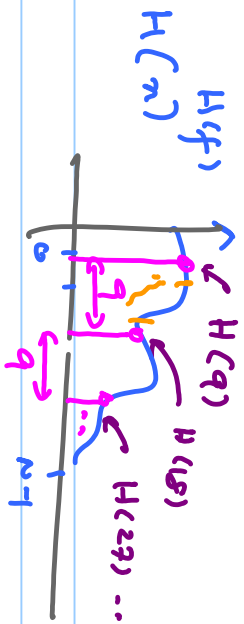
(*) OFDM channel estimation Recog.



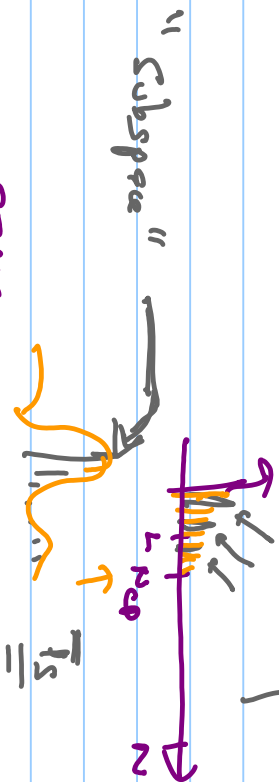
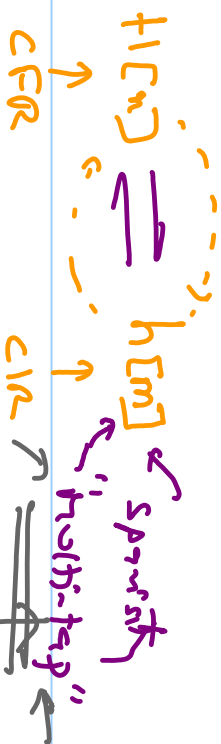
→ (x) Flexibility in Resource Allocation

URLLC → $EMBS$ → complexity scales only linearly with BW
 → 5x12 2180FHg

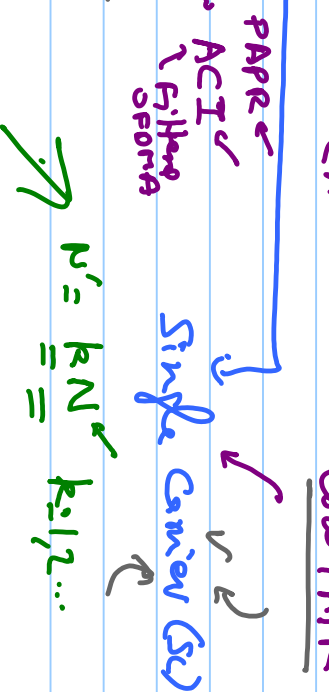
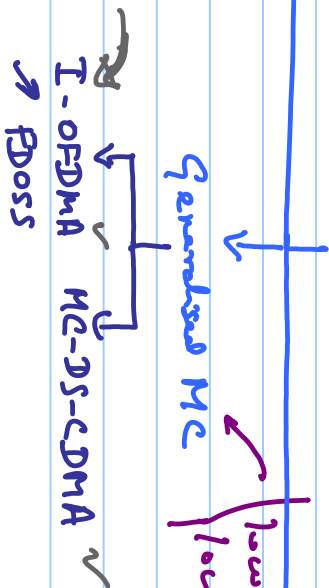
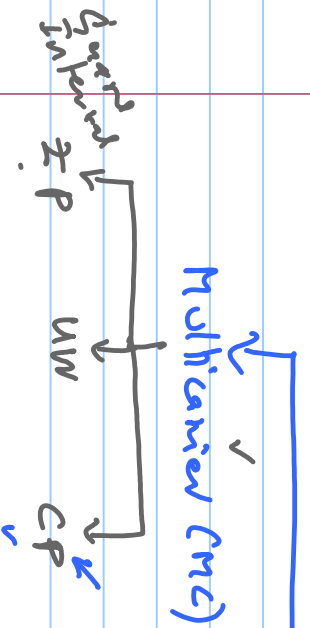
(*) CP (Guard time) Gives error recovery ability to handle "interference" → restores orthogonality



$$N = 1024$$



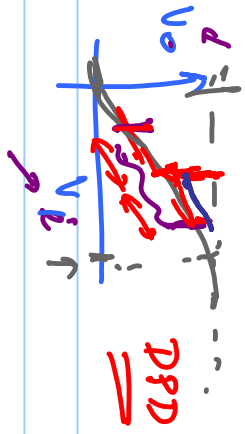
Block Multiplication



- FBMC
- UMC
- WOLA AWE-OFDMA

Low PAPR

$$N' = kN' = k \cdot 1, 2, \dots$$



$$P_{APR} \approx \frac{\max |y_{cm}|^2}{E[|y_{cm}|^2]}$$

γ_c

$$\approx \frac{\max_{N'} |y_{cm}|^2}{\sum_{N'} |y_{cm}|^2}$$

SRRC waveform \rightarrow PAPR \approx 3 dB ✓

LTE 10MHz \rightarrow PAPR \approx 10 dB

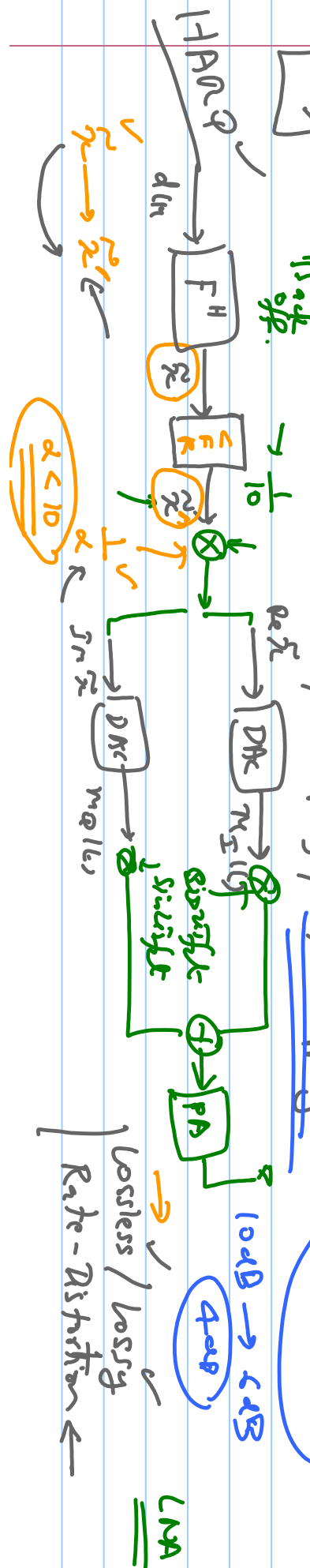
6dB Backup

PAPR reduction / clipping / soft-clipping.

CFR

10dB \rightarrow 4dB

LNA



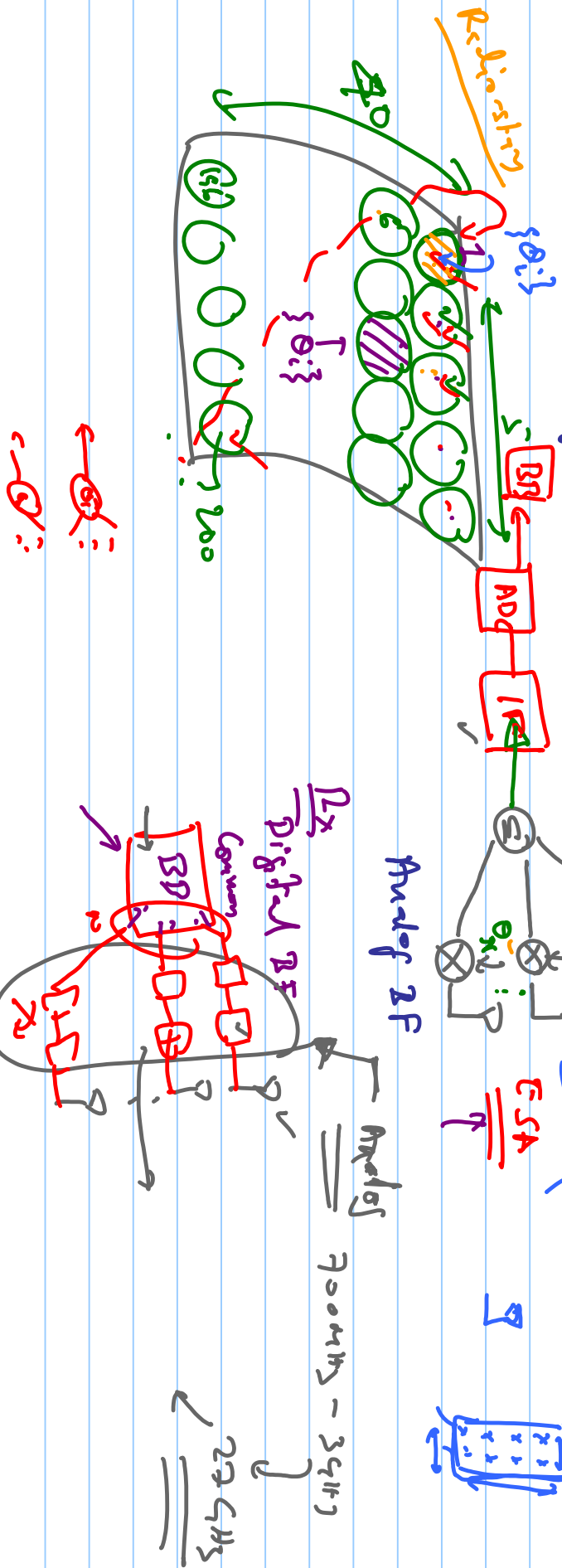
Wiener

MIMO-OFDM

?

Radio-Abstrahlung

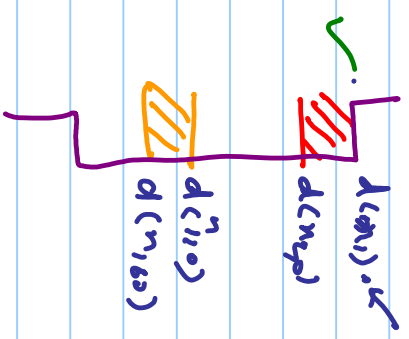
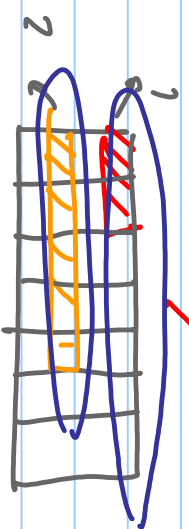
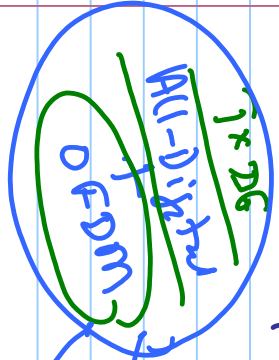
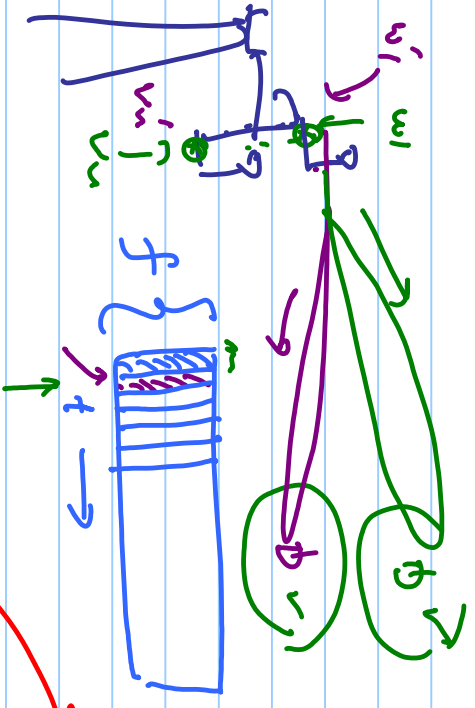
1940's → Array Detection!



Digital

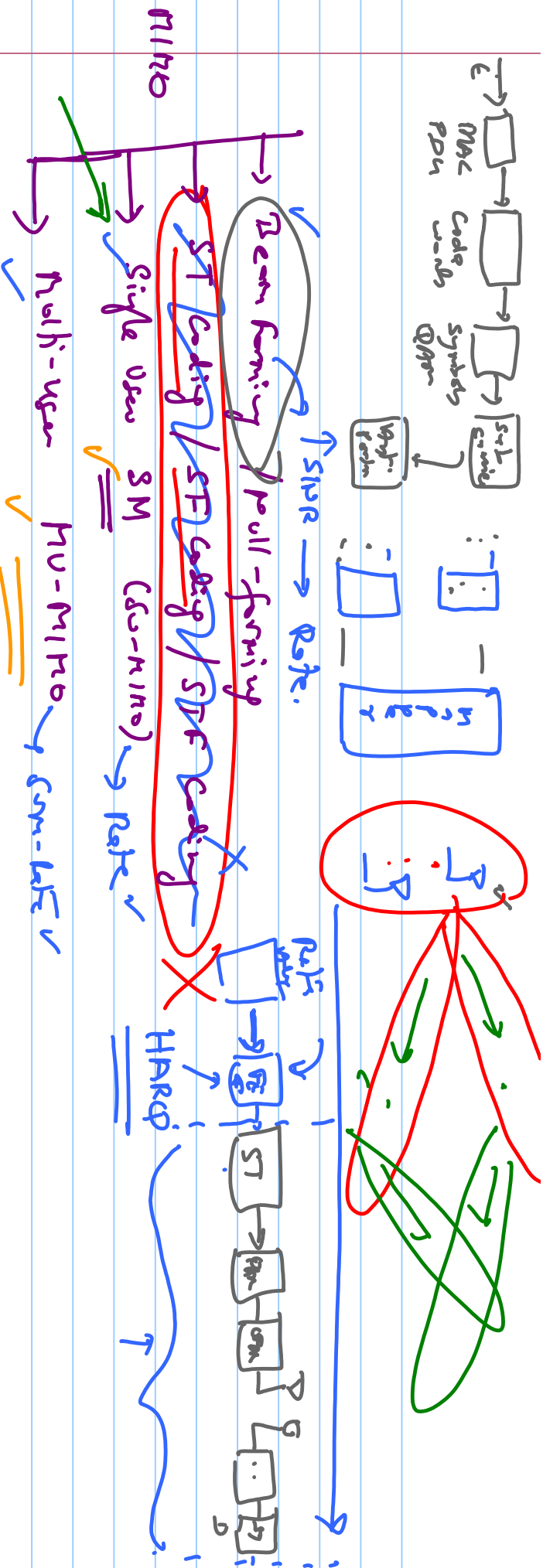
Tx Beamforming ?

OFDM/A → TDMA x



weights → "Before the IFFT"





$$Rate \propto W \cdot \log_2(1 + \frac{SINR}{\gamma})$$

\mathbb{R}

$$y = Hx + N$$

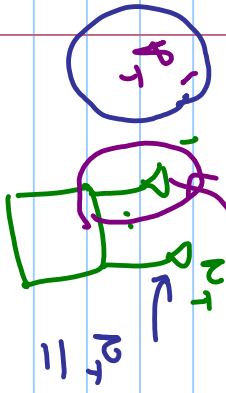
slow

$$E[|H|^2] = 1$$

$$\frac{|H|^2 P_r}{(w \cdot N_0)}$$

$hT \rightarrow N_0$

σ_{r_2}

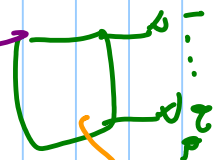


\log_2

$$y = Hx + N$$

$N_T \times N_T$

rank?



$N_T \geq N_T$

$$R_{SISO} = w \log_2 \left(1 + \frac{P_r}{(w N_0)} \right)$$

$$R_{MIMO} = N_T \cdot w \log_2 \left(1 + \frac{P_r/N_T}{(w N_0)} \right)$$