```
clear all
format compact

M = 4; %repetitions per bit
N = 256; %max number of tones or subcarriers
Zl = 6; %number of low freq zero tones
Zs = 13*M; %number of Shively tones
ZH = 15; %number of unused high freq tones
P = round(Zs/M) %number of repeating bits


K = 3*10^7 %number of DMT symbols to simulate. 1e-6 is 3min, 1e-7 is 30min
PAR = zeros(1,K);
PARz = zeros(1,K); %Zero tones
PARs = zeros(1,K); %Shively
PARg = zeros(1,K);

tic
for k=1:K
    if mod(k,10^6)==0
        k
        toc
        tic
    end

    bits = sign(randn(1,P));
    repeat_bits = kron(bits,ones(1,M));

    X = .707*(sign(randn(1,N-Zl)) + j*sign(randn(1,N-Zl))); %random 4QAM symbols
    X(64-Zl) = 1; %model constant pilot

    Xz = X;
    Xz(end-Zs-ZH+1:end)=0;
    Xs = Xz;
    Xs(end-Zs-ZH+1:end-ZH)=repeat_bits;


    Y  = [zeros(1,Zl),  X, 0, fliplr(conj(X )), zeros(1,Zl-1)];
    Yz = [zeros(1,Zl), Xz, 0, fliplr(conj(Xz)), zeros(1,Zl-1)];
    Ys = [zeros(1,Zl), Xs, 0, fliplr(conj(Xs)), zeros(1,Zl-1)];
    y  = ifft(Y);
    yz = ifft(Yz);
    ys = ifft(Ys);

    Ave = (y*y')/length(y);

    Peak = max(y.*y);
    Peakz = max(yz.*yz);
    Peaks = max(ys.*ys);


    PAR(k)  = 10*log10(Peak);    %PAR for 4QAM IFFT output
    PARz(k) = 10*log10(Peakz);    %PAR for 4QAM IFFT output with zero tones
    PARs(k) = 10*log10(Peaks);    %PAR for 4QAM IFFT output with Shively tones
    PARg(k) = 10*log10(max(randn(1,2*N).^2)); %PAR of a Gaussian symbol with 2*N points

end
```

```
PAR  = real(PAR + 10*log10(2*N)); %normalize to correct for Matlab IFFT power loss of 2N
PARz = real(PARz + 10*log10(2*N));
PARs = real(PARs + 10*log10(2*N));
PARg = real(PARg + 10*log10((N-Zl)/N)); %normalize Guassian power to N-Zl tones out of N


Axis = 6:0.4:20;

Np = hist(PAR,Axis);
Ng = hist(PARg,Axis);
Nz = hist(PARz,Axis);
Ns = hist(PARs,Axis);

figure(2)
semilogy(Axis,1-cumsum(Np)/K,':o','LineWidth',2,'MarkerSize',9,Axis,1-
cumsum(Ng)/K,'r-','LineWidth',2,'MarkerSize',10,Axis,1-cumsum(Nz)/K,'b-*',
'MarkerSize',12,'LineWidth',2,Axis,1-cumsum(Ns)/K,'-+',
'LineWidth',2,'MarkerSize',10)
set(gca,'fontsize',18)
xlabel('PAR (dB)','fontsize',18)
ylabel('Clipping Probability per DMT symbol','fontsize',18)
leg = legend('Scenario 1: 250 QAM4 Carriers','Scenario 2: Gaussian process',
'Scenario 3: 182 QAM4 Carriers',
'Scenario 4: 182 QAM4 Carriers & 52 Shively Carriers')
set(leg,'fontsize',18)
grid on,shg
axis([7 17 32/K 1])
```