

读取数据

```
clear;
NUMarm1=readmatrix('arm1.txt');
NUMarm2=readmatrix('arm2.txt');
NUMarm3=readmatrix('arm3.txt');
NUMarm4=readmatrix('arm4.txt');
NUMarm5=readmatrix('arm5.txt');
NUMboard1=readmatrix('board1.txt');
NUMboard2=readmatrix('board2.txt');
fs=1000; %采样频率
f_cutoff = 260; %MPU6050内置低通滤波器截止频率
load("filter.mat");
```

重采样

```
tarm1=NUMarm1(:,1)/1e6;
tarm2=NUMarm2(:,1)/1e6;
tarm3=NUMarm3(:,1)/1e6;
tarm4=NUMarm4(:,1)/1e6;
tarm5=NUMarm5(:,1)/1e6;
tboard1=NUMboard1(:,1)/1e6;
tboard2=NUMboard2(:,1)/1e6;
xarm1=NUMarm1(:,3)/2^15*8*9.8;
xarm2=NUMarm2(:,3)/2^15*8*9.8;
xarm3=NUMarm3(:,3)/2^15*8*9.8;
xarm4=NUMarm4(:,3)/2^15*8*9.8;
xarm5=NUMarm5(:,3)/2^15*8*9.8;
xboard1=NUMboard1(:,3)/2^15*8*9.8;
xboard2=NUMboard2(:,3)/2^15*8*9.8;
Xarm1=resample(xarm1,tarm1,fs,1,1);
Xarm2=resample(xarm2,tarm2,fs,1,1);
Xarm3=resample(xarm3,tarm3,fs,1,1);
Xarm4=resample(xarm4,tarm4,fs,1,1);
Xarm5=resample(xarm5,tarm5,fs,1,1);
Xboard1=resample(xboard1,tboard1,fs,1,1);
Xboard2=resample(xboard2,tboard2,fs,1,1);
Xboard3=bandstop4(Xboard2);
Xboard4=bandstop2_77(bandstop2_83(Xboard2));
X={Xarm1,Xarm2,Xarm3,Xarm4,Xarm5,Xboard1,Xboard2,Xboard3,Xboard4};
yarm1=NUMarm1(:,2)/2^15*8*9.8;
yarm2=NUMarm2(:,2)/2^15*8*9.8;
yarm3=NUMarm3(:,2)/2^15*8*9.8;
yarm4=NUMarm4(:,2)/2^15*8*9.8;
yarm5=NUMarm5(:,2)/2^15*8*9.8;
yboard1=NUMboard1(:,2)/2^15*8*9.8;
yboard2=NUMboard2(:,2)/2^15*8*9.8;
Yarm1=resample(yarm1,tarm1,fs,1,1);
Yarm2=resample(yarm2,tarm2,fs,1,1);
Yarm3=resample(yarm3,tarm3,fs,1,1);
Yarm4=resample(yarm4,tarm4,fs,1,1);
Yarm5=resample(yarm5,tarm5,fs,1,1);
Yboard1=resample(yboard1,tboard1,fs,1,1);
```

```

Yboard2=resample(yboard2,tboard2,fs,1,1);
Yboard3=bandstop4(Yboard2);
Yboard4=bandstop2_77(bandstop2_83(Yboard2));
Y={Yarm1,Yarm2,Yarm3,Yarm4,Yarm5,Yboard1,Yboard2,Yboard3,Yboard4};
zarm1=NUMarm1(:,4)/2^15*8*9.8;
zarm2=NUMarm2(:,4)/2^15*8*9.8;
zarm3=NUMarm3(:,4)/2^15*8*9.8;
zarm4=NUMarm4(:,4)/2^15*8*9.8;
zarm5=NUMarm5(:,4)/2^15*8*9.8;
zboard1=NUMboard1(:,4)/2^15*8*9.8;
zboard2=NUMboard2(:,4)/2^15*8*9.8;
Zarm1=resample(zarm1,tarm1,fs,1,1);
Zarm2=resample(zarm2,tarm2,fs,1,1);
Zarm3=resample(zarm3,tarm3,fs,1,1);
Zarm4=resample(zarm4,tarm4,fs,1,1);
Zarm5=resample(zarm5,tarm5,fs,1,1);
Zboard1=resample(zboard1,tboard1,fs,1,1);
Zboard2=resample(zboard2,tboard2,fs,1,1);
Zboard3=bandstop4(Zboard2);
Zboard4=bandstop2_77(bandstop2_83(Zboard2));
Z={Zarm1,Zarm2,Zarm3,Zarm4,Zarm5,Zboard1,Zboard2,Zboard3,Zboard4};

```

分析振动强度

```

XAver=[mean(xarm1),mean(xarm2),mean(xarm3),mean(xarm4),mean(xarm5),mean(xboard1),mean(xboard2),va
XRMSE=sqrt([var(xarm1),var(xarm2),var(xarm3),var(xarm4),var(xarm5),var(xboard1),var(xboard2),va
YAver=[mean(yarm1),mean(yarm2),mean(yarm3),mean(yarm4),mean(yarm5),mean(yboard1),mean(yboard2),va
YRMSE=sqrt([var(yarm1),var(yarm2),var(yarm3),var(yarm4),var(yarm5),var(yboard1),var(yboard2),va
ZAver=[mean(zarm1),mean(zarm2),mean(zarm3),mean(zarm4),mean(zarm5),mean(zboard1),mean(zboard2),va
ZRMSE=sqrt([var(zarm1),var(zarm2),var(zarm3),var(zarm4),var(zarm5),var(zboard1),var(zboard2),va
RMSE=[XRMSE;YRMSE;ZRMSE];
%总振动强度
RMSE=[norm(RMSE(:,1)),norm(RMSE(:,2)),norm(RMSE(:,3)),norm(RMSE(:,4)),norm(RMSE(:,5)),norm(RMSE

```

分析转速稳定性

```

speedarm11=NUMarm1(:,5);
speedarm12=NUMarm1(:,6);
speedarm21=NUMarm2(:,5);
speedarm22=NUMarm2(:,6);
speedarm31=NUMarm3(:,5);
speedarm32=NUMarm3(:,6);
speedarm41=NUMarm4(:,5);
speedarm42=NUMarm4(:,6);
speedarm51=NUMarm5(:,5);
speedarm52=NUMarm5(:,6);
speedboard11=NUMboard1(:,5);
speedboard12=NUMboard1(:,6);
speedboard21=NUMboard2(:,5);
speedboard22=NUMboard2(:,6);
speedarm11=speedarm11(~isnan(speedarm11));
speedarm12=speedarm12(~isnan(speedarm12));

```

```

speedarm21=speedarm21(~isnan(speedarm21));
speedarm22=speedarm22(~isnan(speedarm22));
speedarm31=speedarm31(~isnan(speedarm31));
speedarm32=speedarm32(~isnan(speedarm32));
speedarm41=speedarm41(~isnan(speedarm41));
speedarm42=speedarm42(~isnan(speedarm42));
speedarm51=speedarm51(~isnan(speedarm51));
speedarm52=speedarm52(~isnan(speedarm52));
speedboard11=speedboard11(~isnan(speedboard11));
speedboard12=speedboard12(~isnan(speedboard12));
speedboard21=speedboard21(~isnan(speedboard21));
speedboard22=speedboard22(~isnan(speedboard22));
mspeedarm1=[mean(speedarm11),mean(speedarm12)];
mspeedarm2=[mean(speedarm21),mean(speedarm22)];
mspeedarm3=[mean(speedarm31),mean(speedarm32)];
mspeedarm4=[mean(speedarm41),mean(speedarm42)];
mspeedarm5=[mean(speedarm51),mean(speedarm52)];
mspeedboard1=[mean(speedboard11),mean(speedboard12)];
mspeedboard2=[mean(speedboard21),mean(speedboard22)];
vspeedarm1=[var(speedarm11),var(speedarm12)];
vspeedarm2=[var(speedarm21),var(speedarm22)];
vspeedarm3=[var(speedarm31),var(speedarm32)];
vspeedarm4=[var(speedarm41),var(speedarm42)];
vspeedarm5=[var(speedarm51),var(speedarm52)];
vspeedboard1=[var(speedboard11),var(speedboard12)];
vspeedboard2=[var(speedboard21),var(speedboard22)];

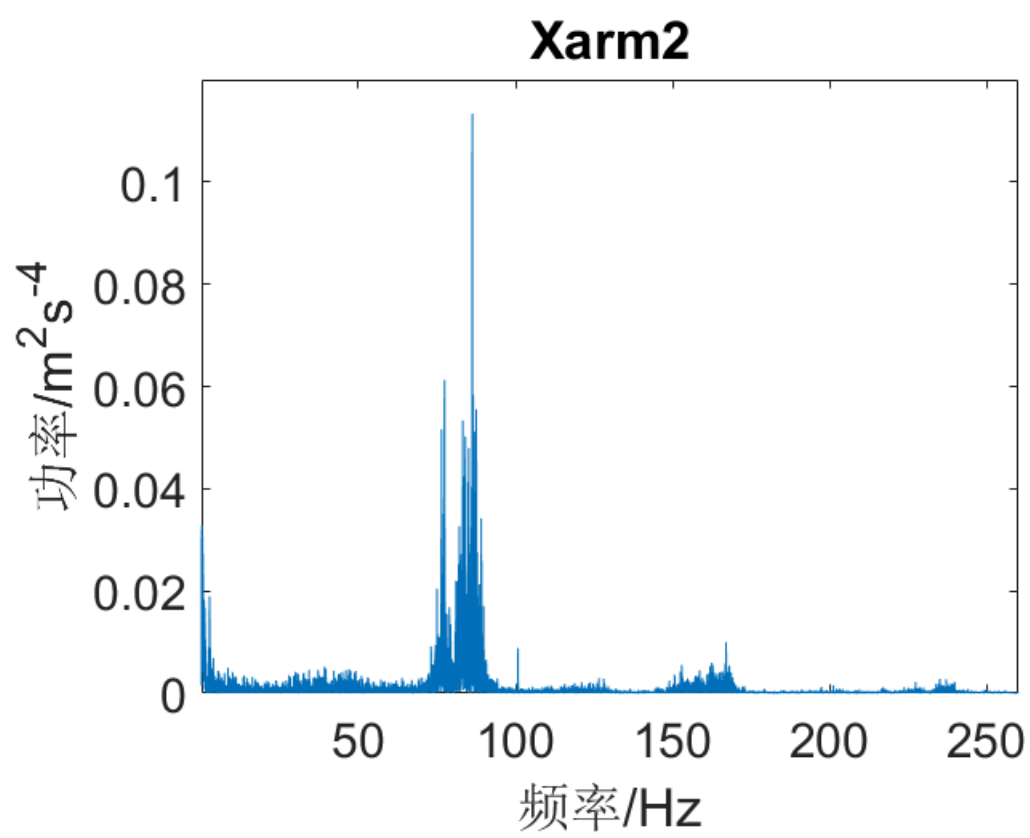
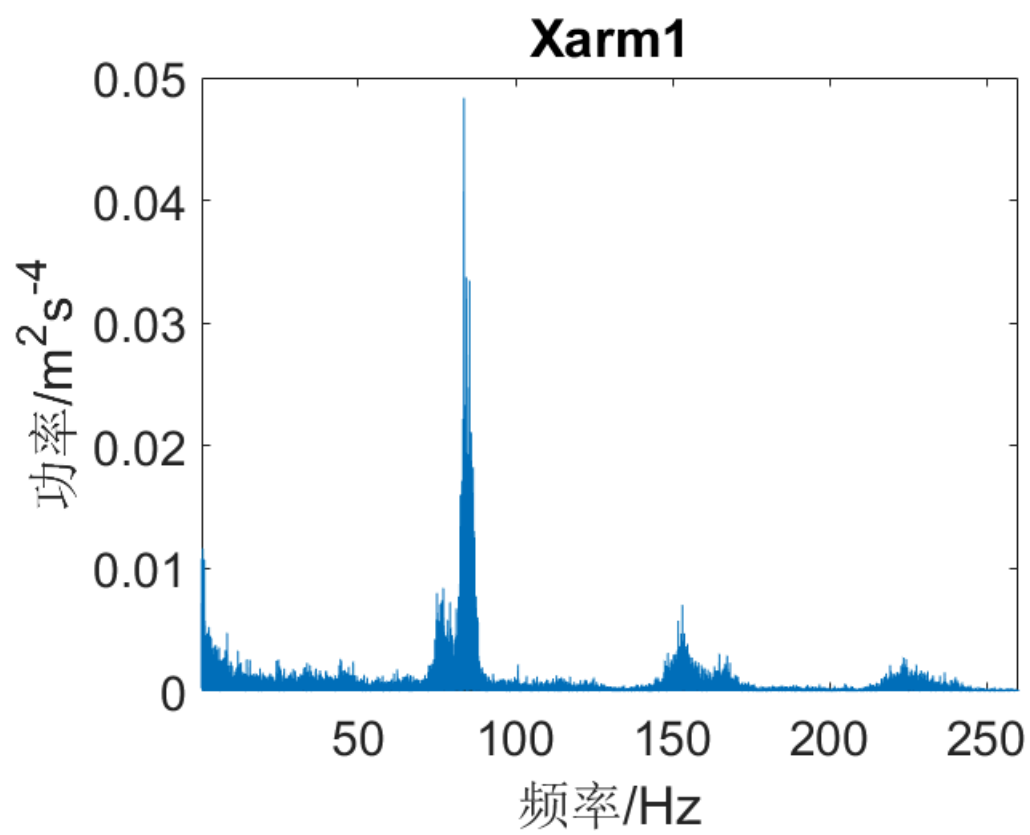
```

绘制频谱。由于测量均值不为0，因此频谱的极低频分量很高，为了突出显示无人机运动信号和振动信号，绘图时x轴从0.1Hz开始。

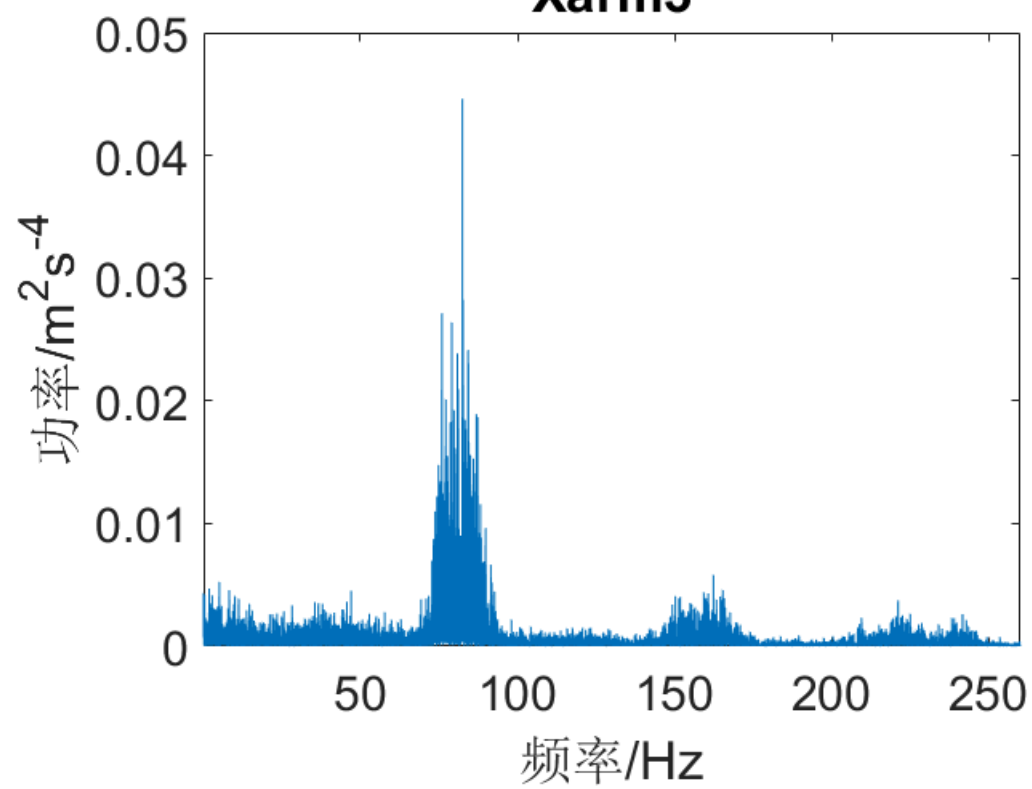
```

clf;
for i = 1:5
    figure(i);[pxx,f]=periodogram(X{1,i},[],[],fs,'power');plot(f,pxx);
    set(gca, 'xlim', [0.1, f_cutoff], 'FontSize',18);
    xlabel('频率/Hz','FontSize',18) % x-axis label
    ylabel('功率/m^2s^-^4','FontSize',18) % y-axis label
    title(['Xarm',int2str(i)]);
end

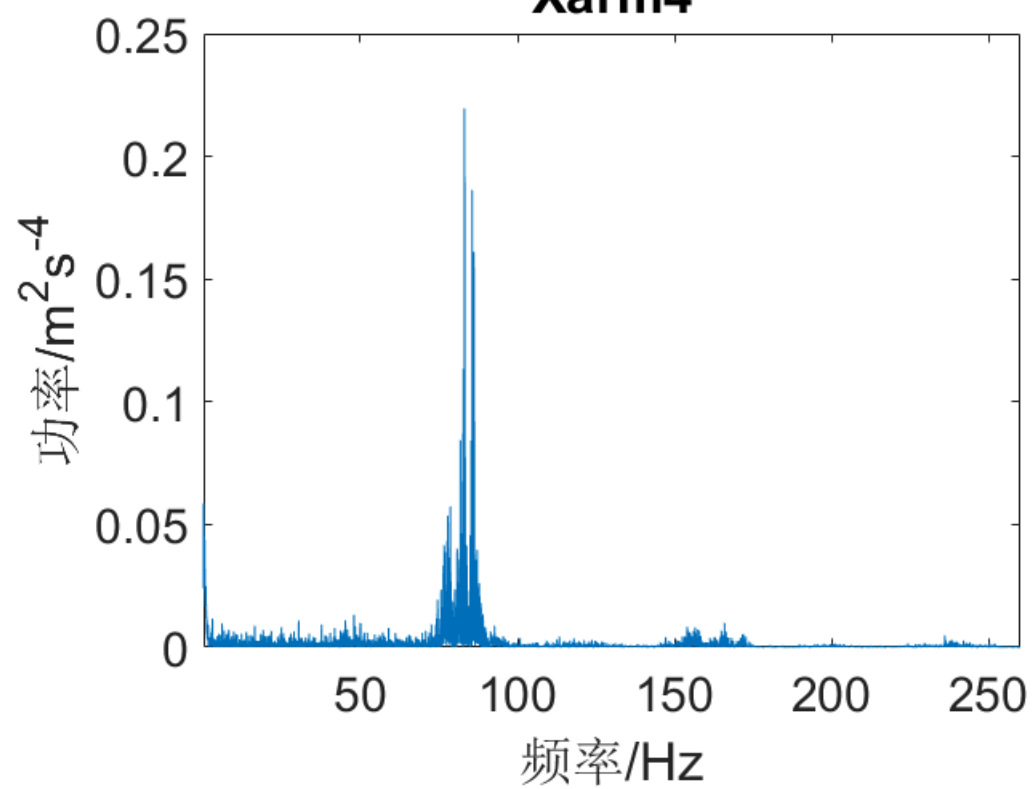
```

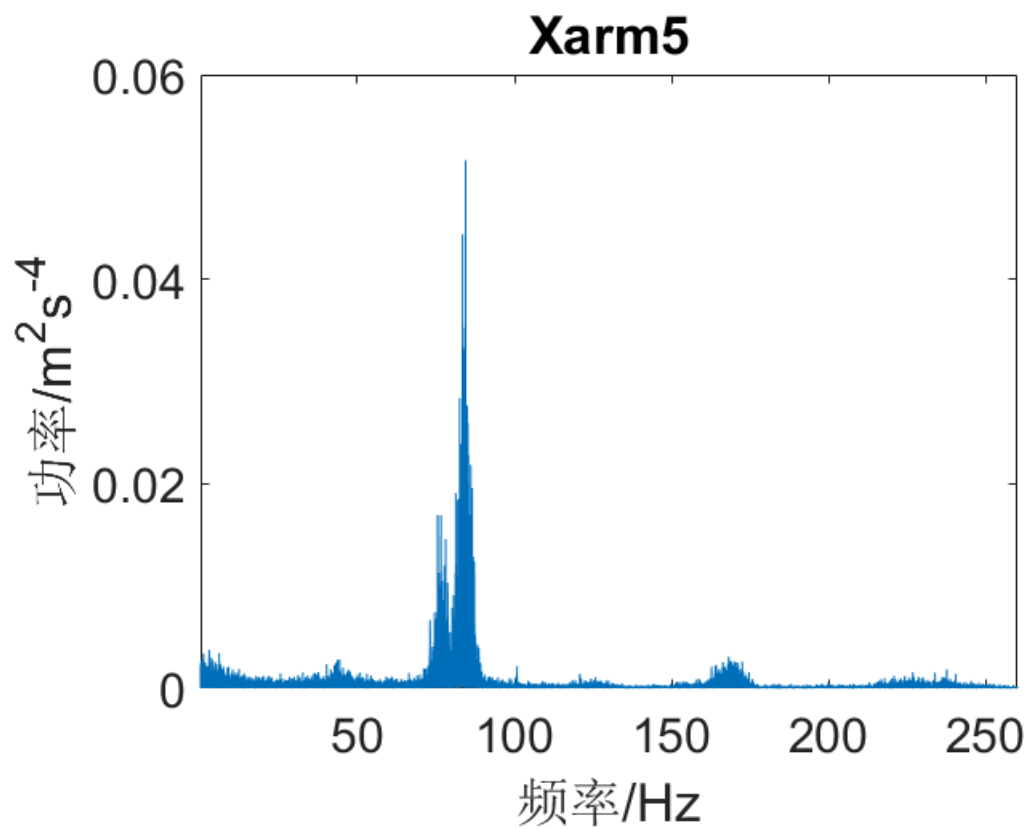


Xarm3



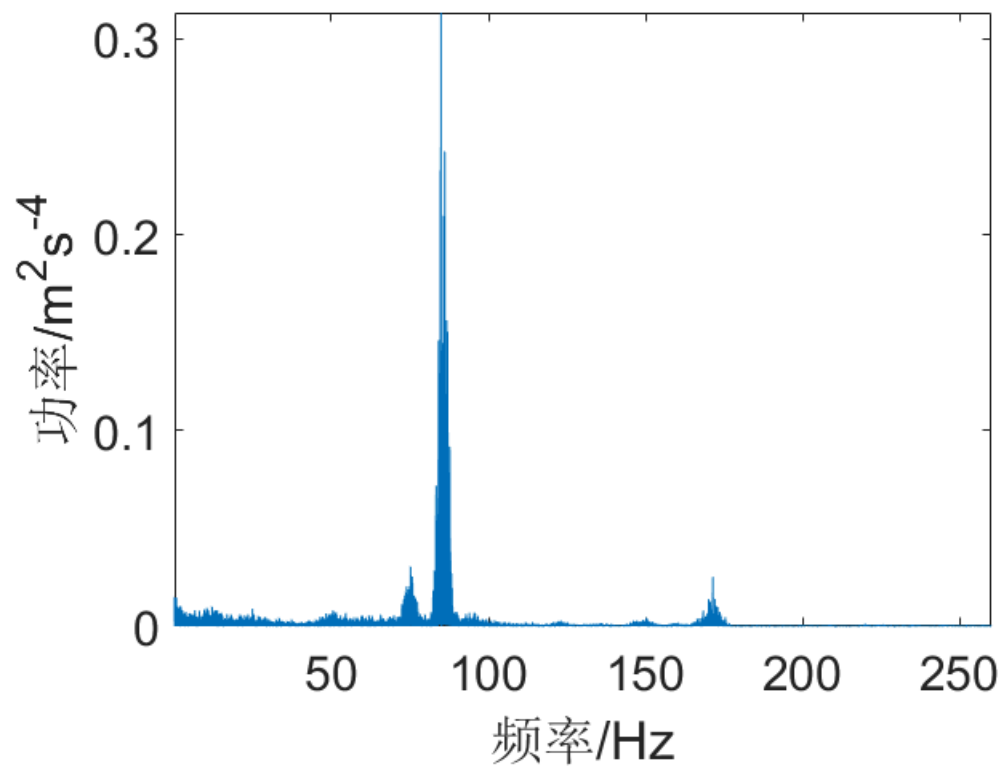
Xarm4



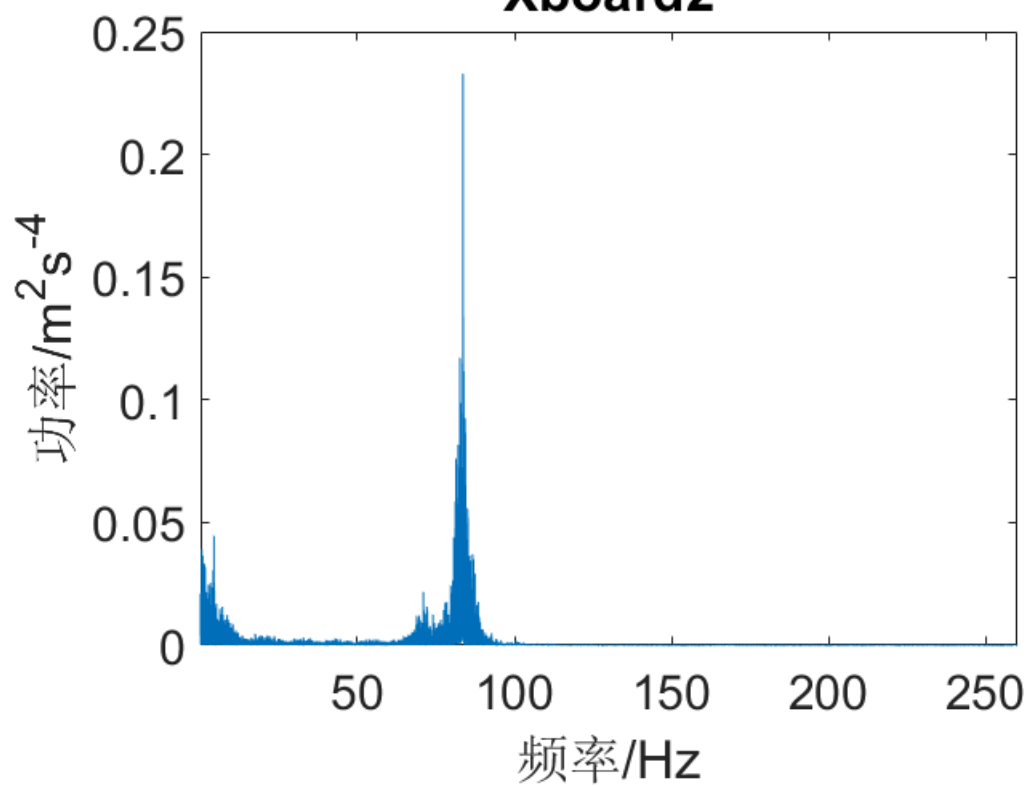


```
for i = 1:4
    figure(i+5);[pxx,f]=periodogram(X{1,i+5},[],[],fs,'power');plot(f,pxx);
    set(gca, 'xlim', [0.1, f_cutoff],'FontSize',18);
    xlabel('频率/Hz','FontSize',18) % x-axis label
    ylabel('功率/m^2s^-4','FontSize',18) % y-axis label
    title(['Xboard',int2str(i)]);
end
```

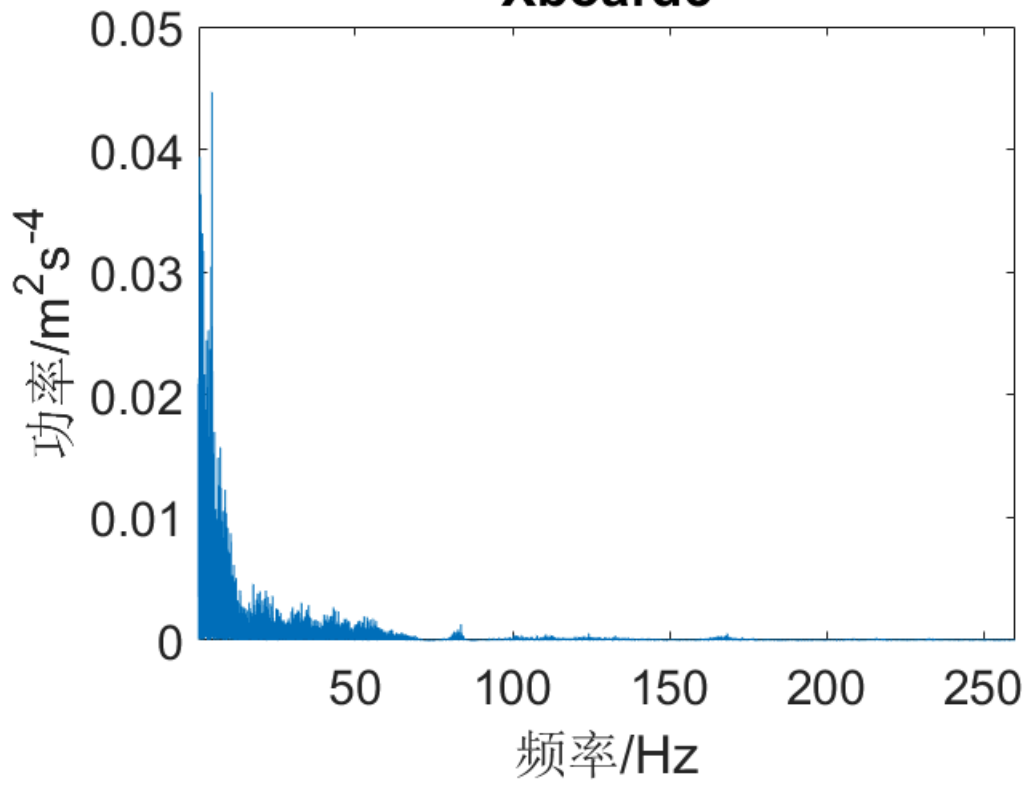
Xboard1



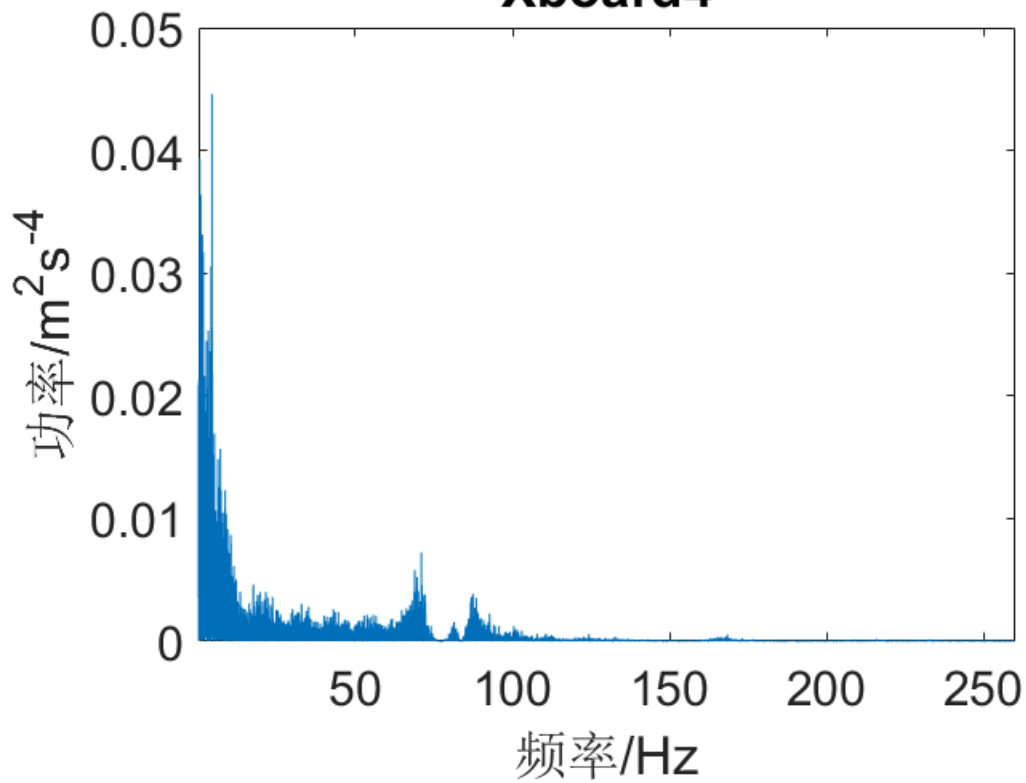
Xboard2



Xboard3



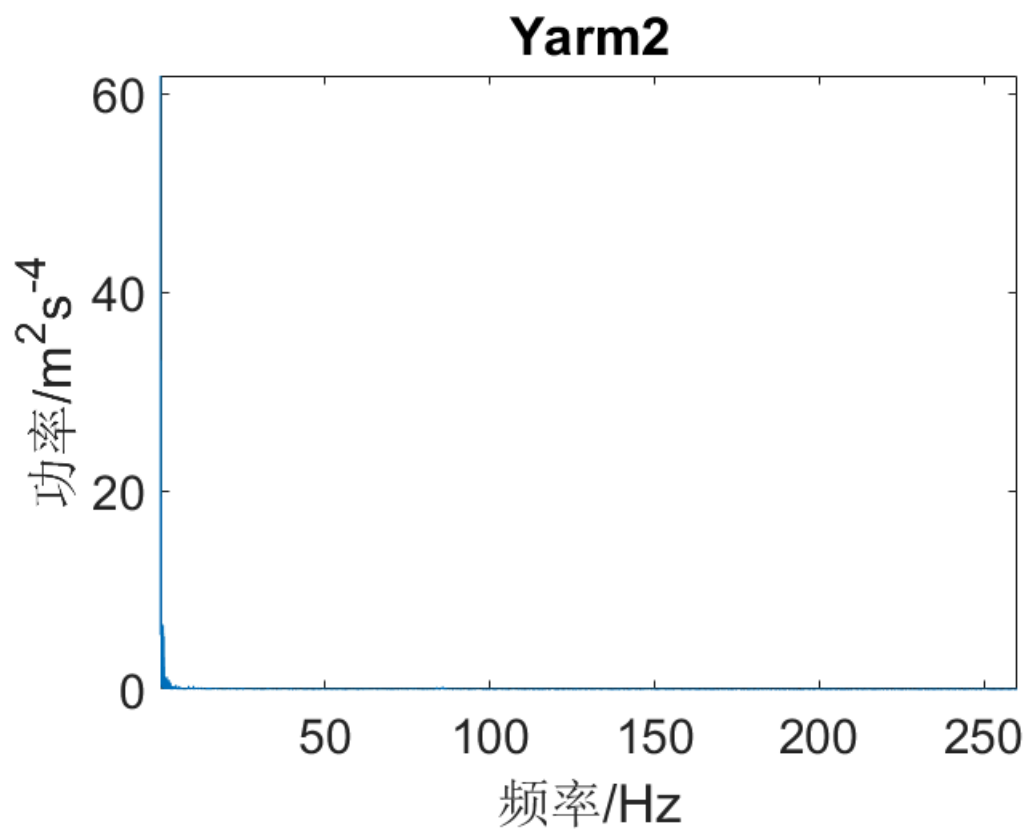
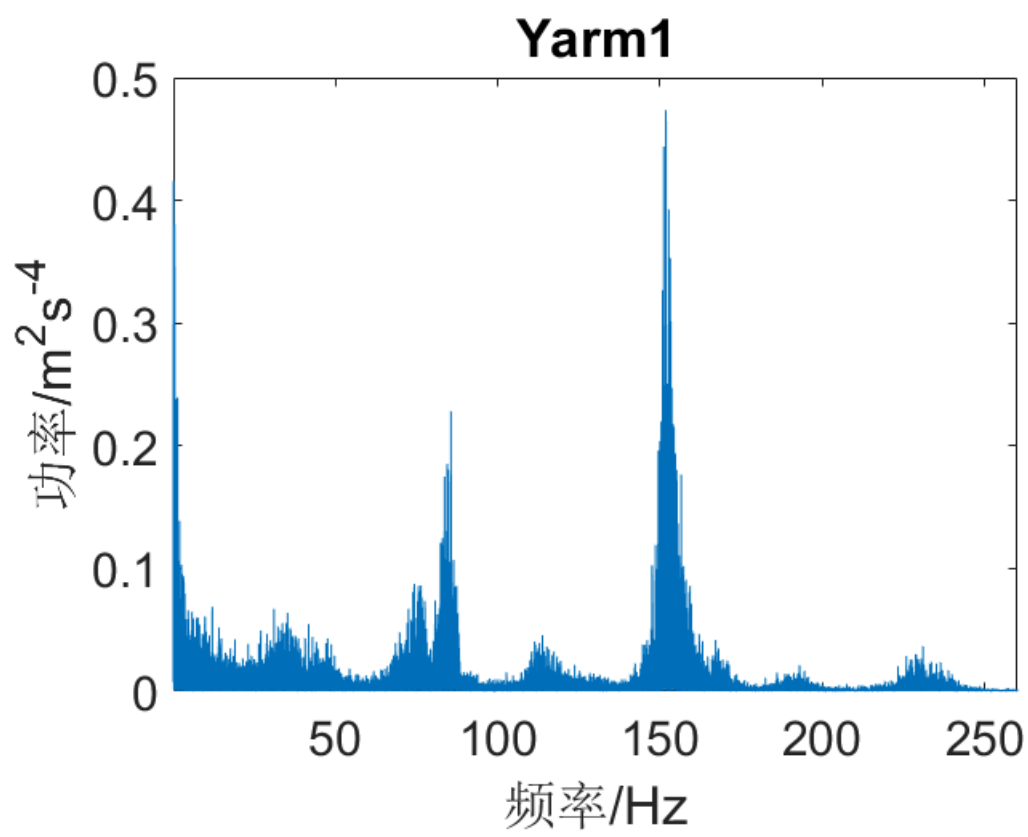
Xboard4



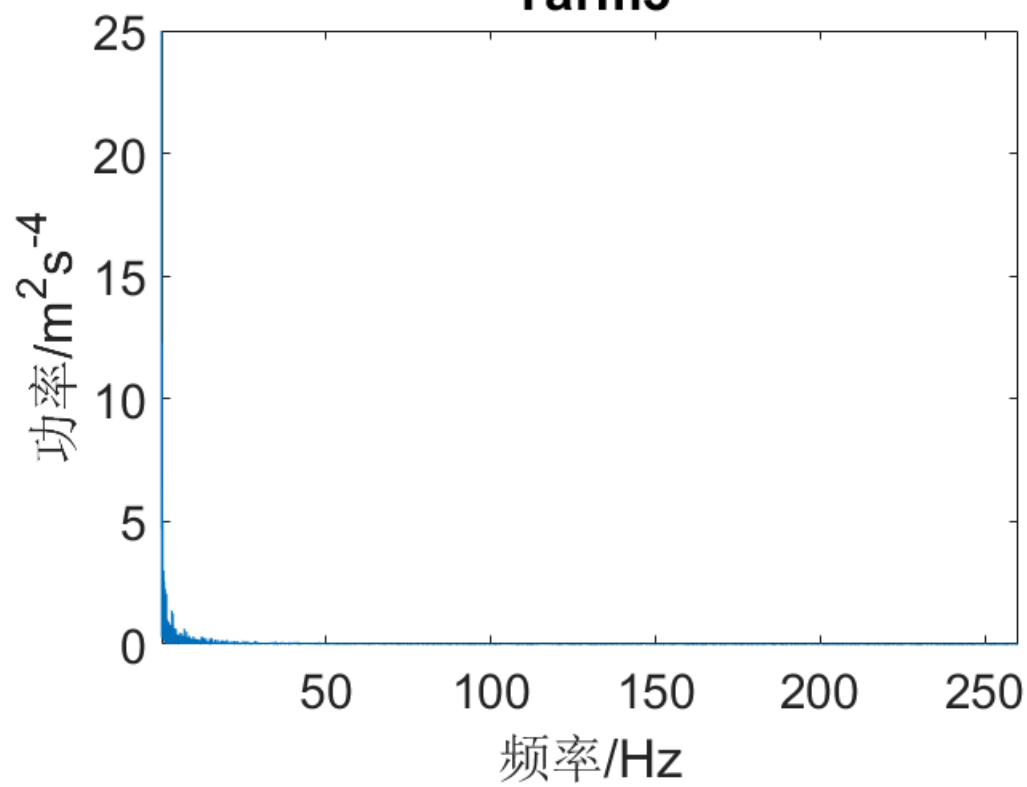
```
for i = 1:5
    figure(i+9);[pxx,f]=periodogram(Y{1,i},[],[],fs,'power');plot(f,pxx);
    set(gca, 'xlim', [0.1, f_cutoff],'FontSize',18);
    xlabel('频率/Hz','FontSize',18) % x-axis label
```



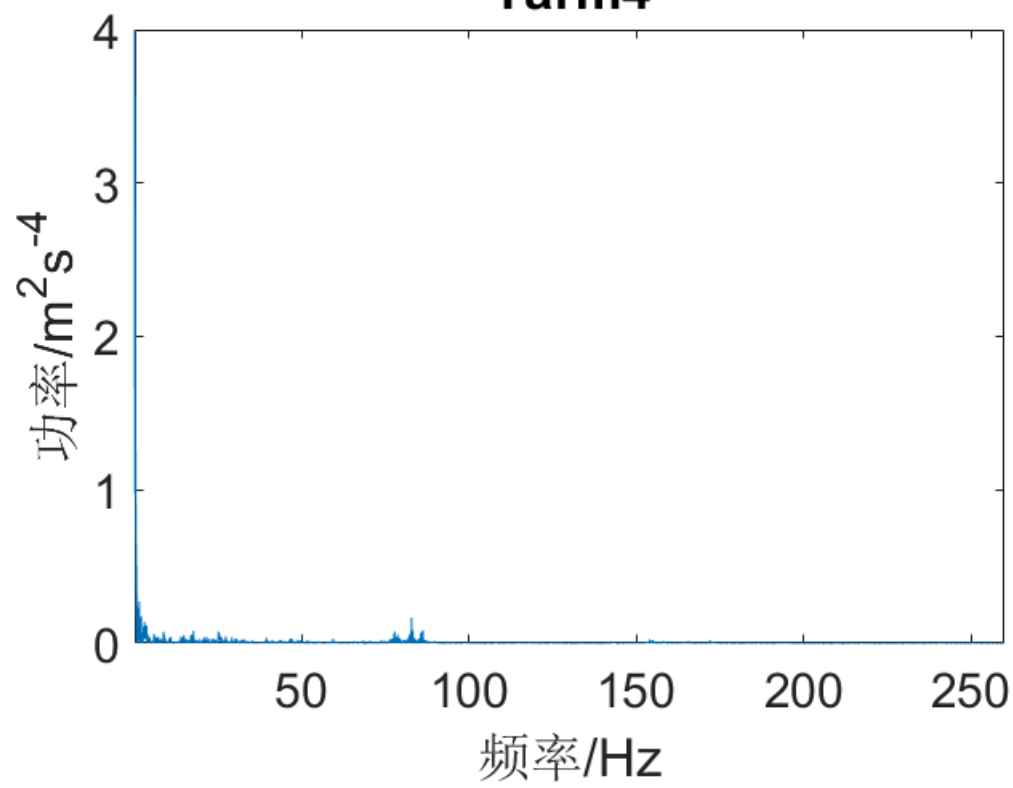
```
ylabel('功率/m^2s^-4','FontSize',18) % y-axis label  
title(['Yarm',int2str(i)]);  
end
```

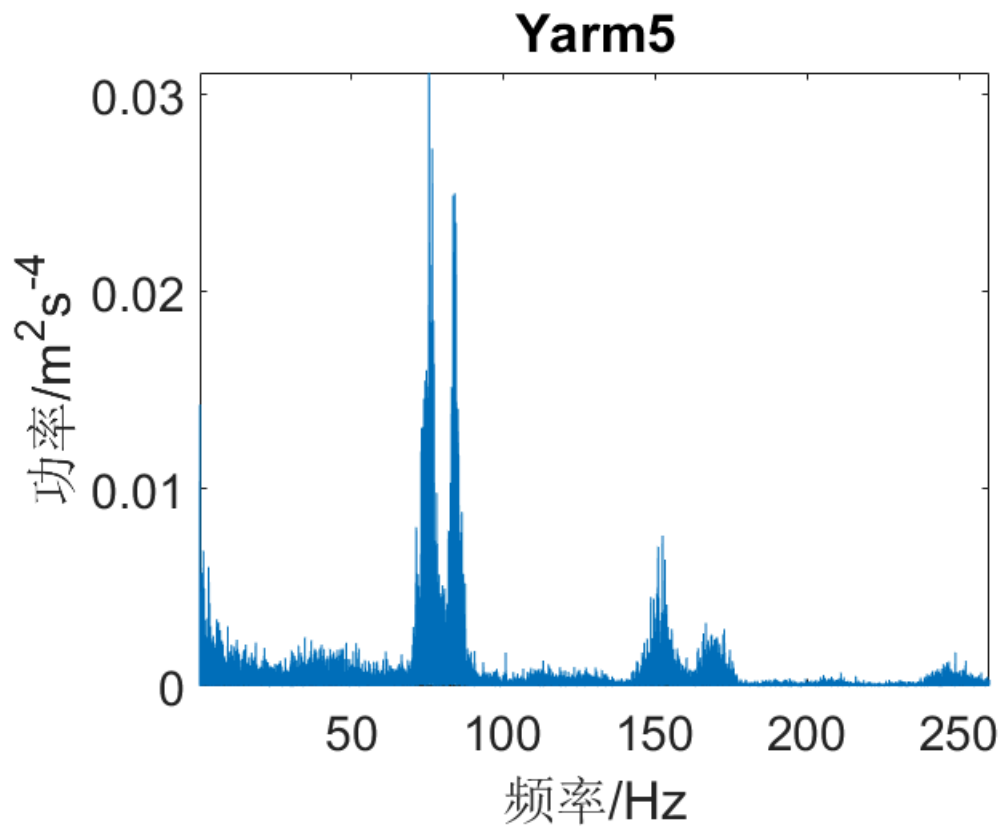


Yarm3



Yarm4



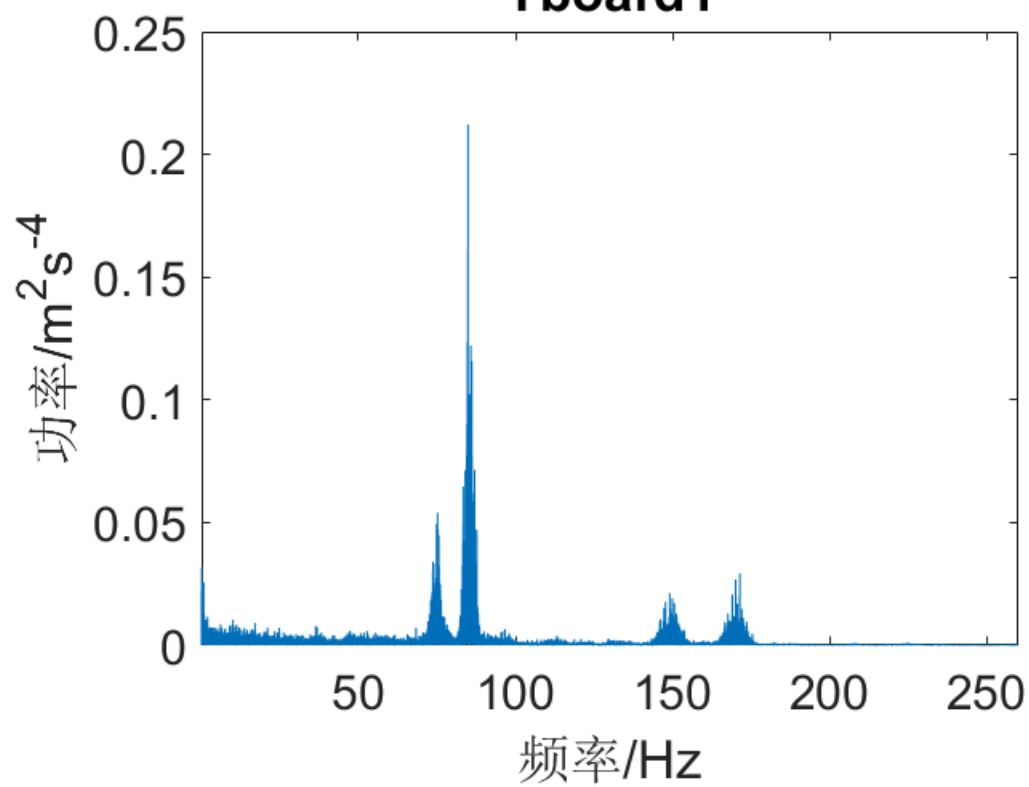


```

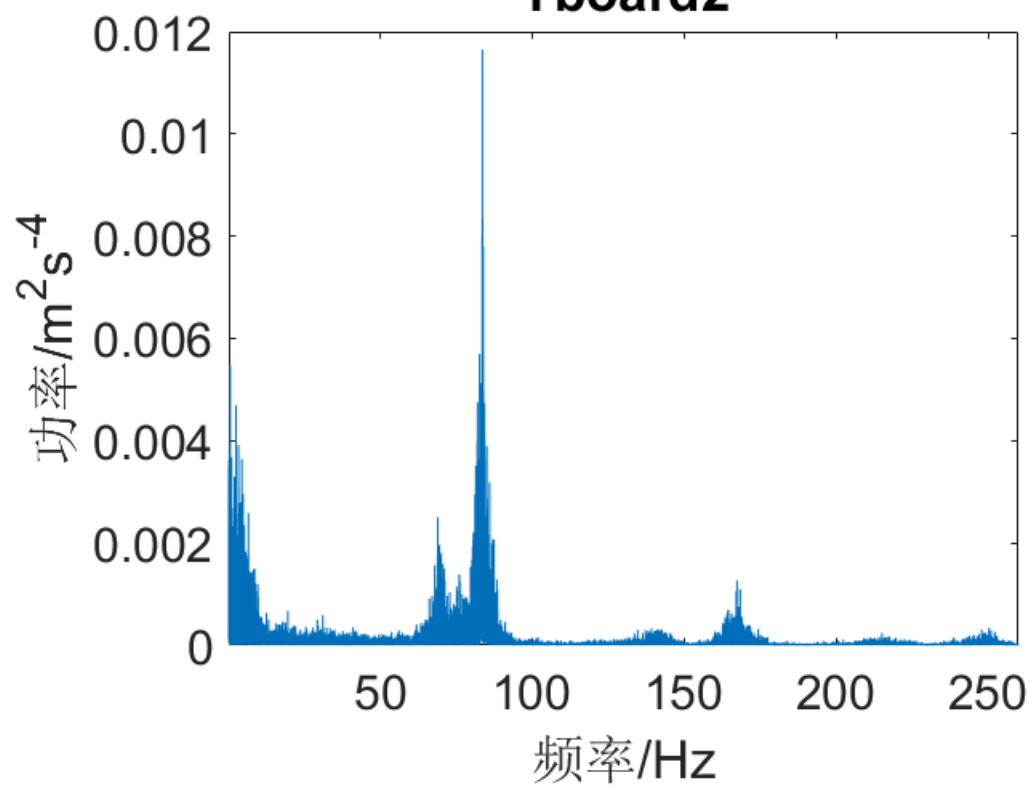
for i = 1:4
    figure(i+9+5);[pxx,f]=periodogram(Y{1,i+5},[],[],fs,'power');plot(f,pxx);
    set(gca, 'xlim', [0.1, f_cutoff],'FontSize',18);
    xlabel('频率/Hz','FontSize',18) % x-axis label
    ylabel('功率/m^2s^-4','FontSize',18) % y-axis label
    title(['Yboard',int2str(i)]);
end

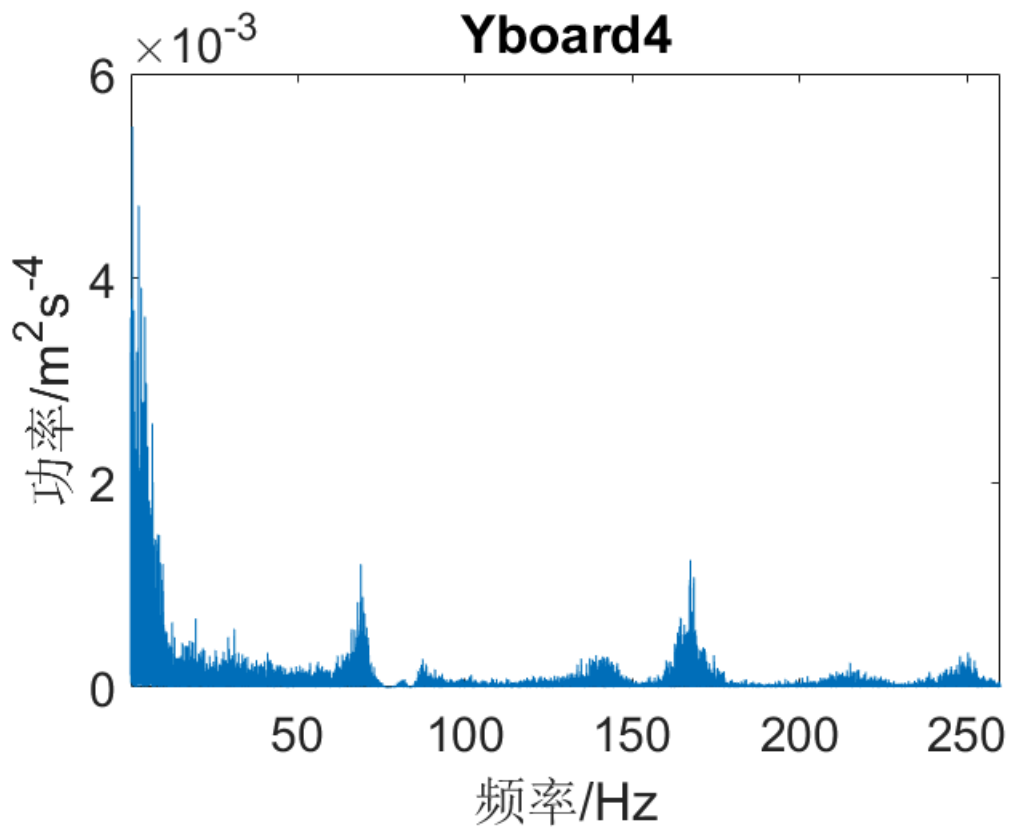
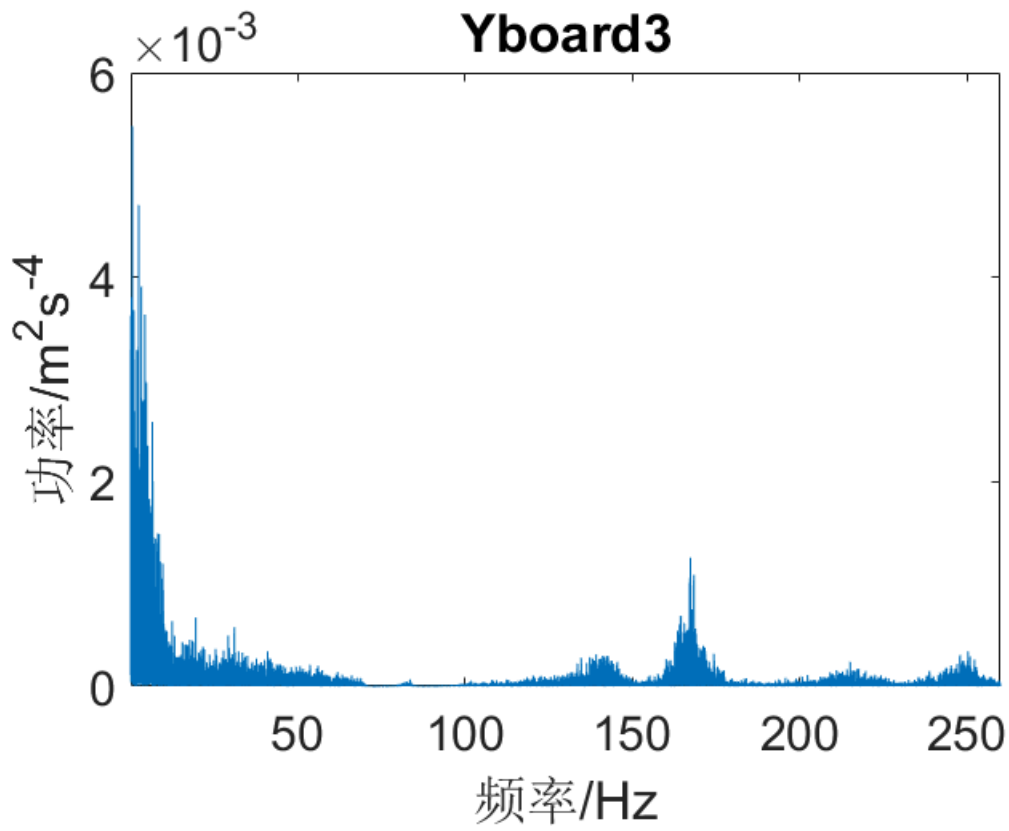
```

Yboard1



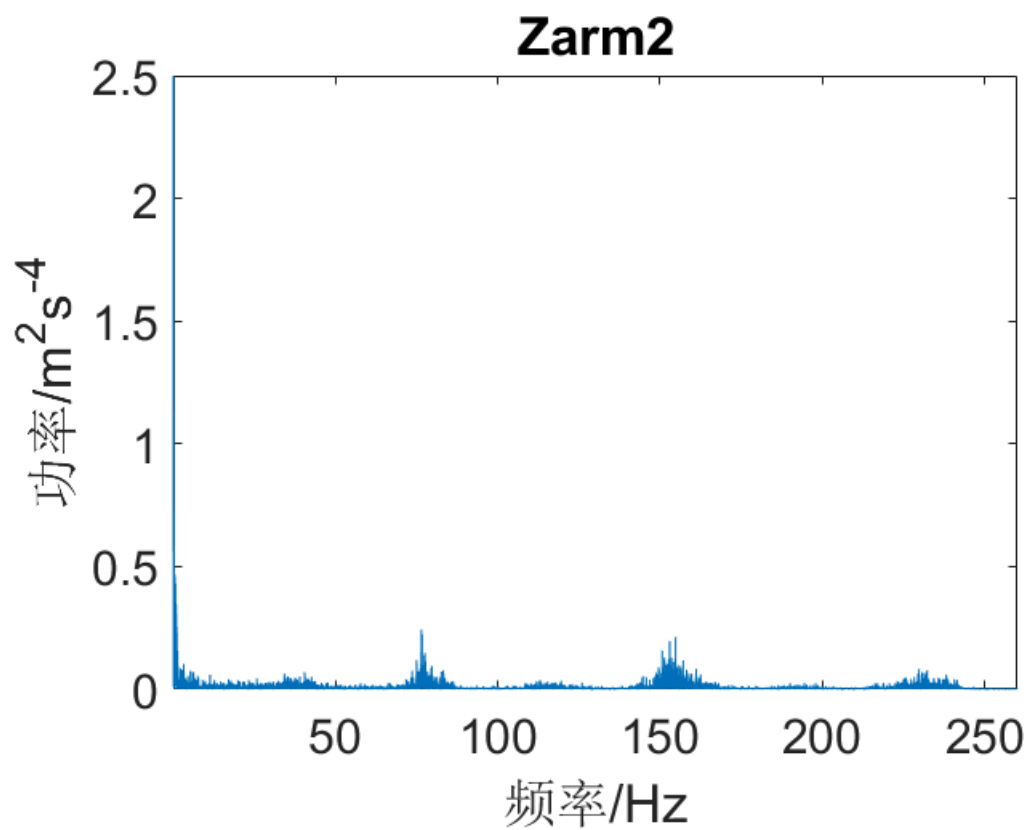
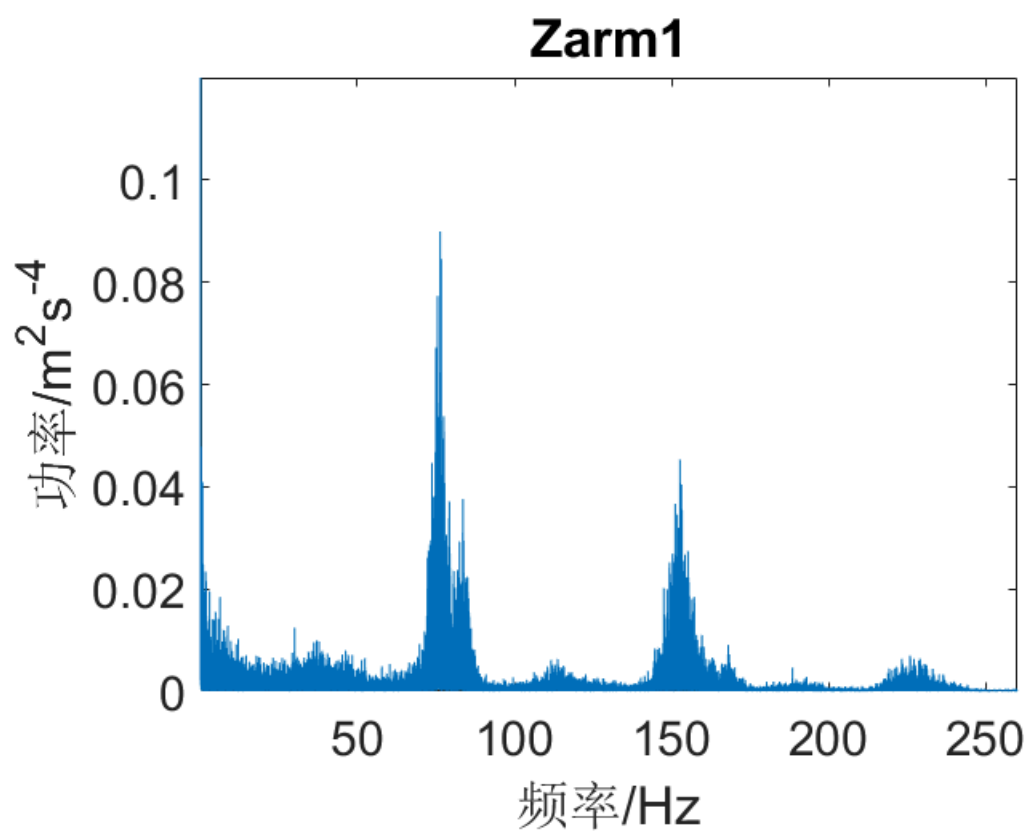
Yboard2

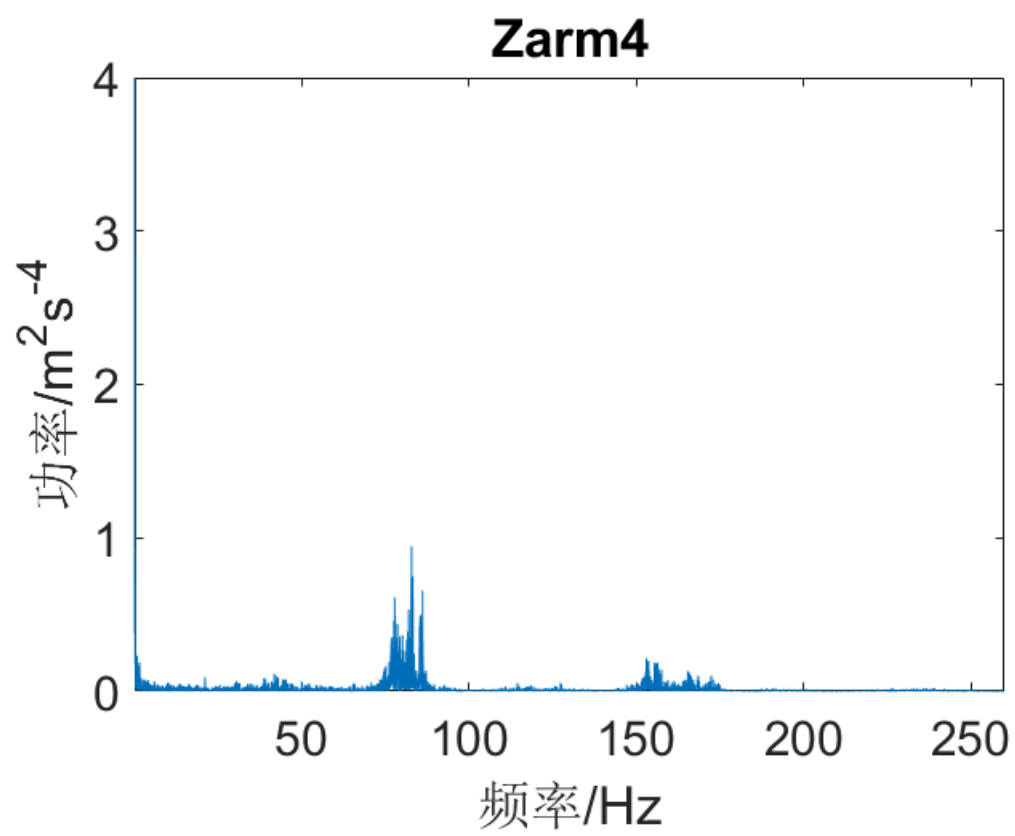
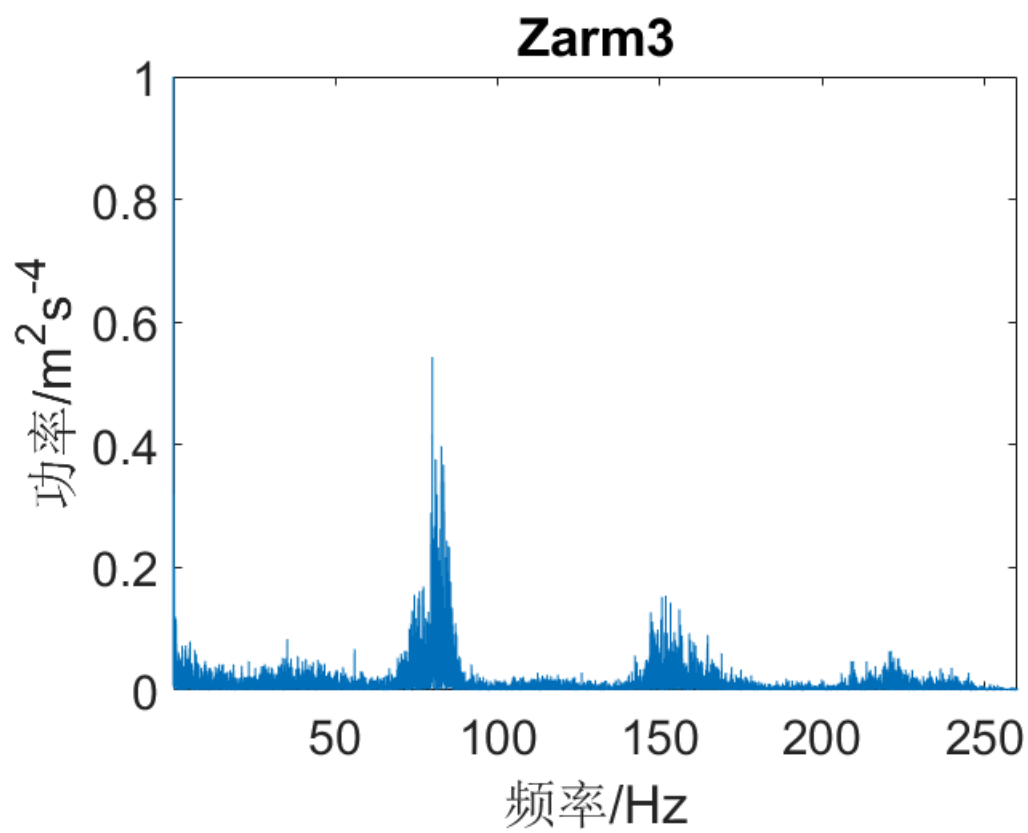


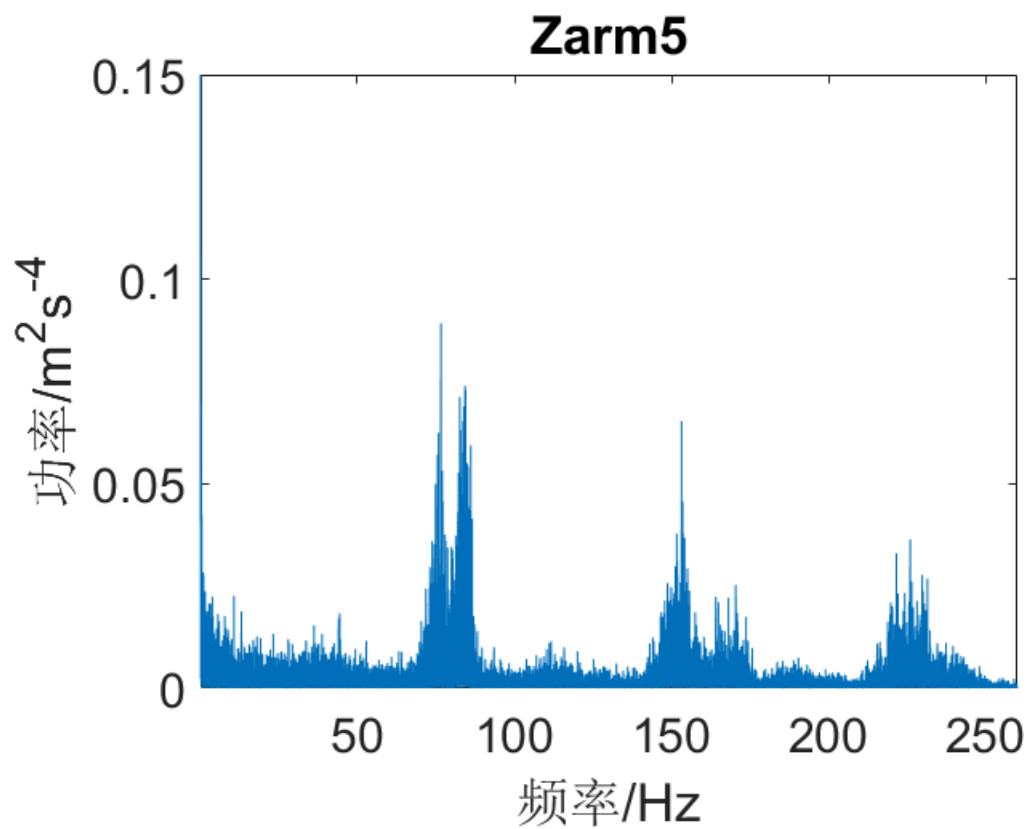


```
for i = 1:5
    figure(i+9*2);[pxx,f]=periodogram(Z{1,i},[],[],fs,'power');plot(f,pxx);
    set(gca, 'xlim', [0.1, f_cutoff],'FontSize',18);
    xlabel('频率/Hz','FontSize',18) % x-axis label
```

```
ylabel('功率/m^2s^-4','FontSize',18) % y-axis label  
title(['Zarm',int2str(i)]);  
end
```



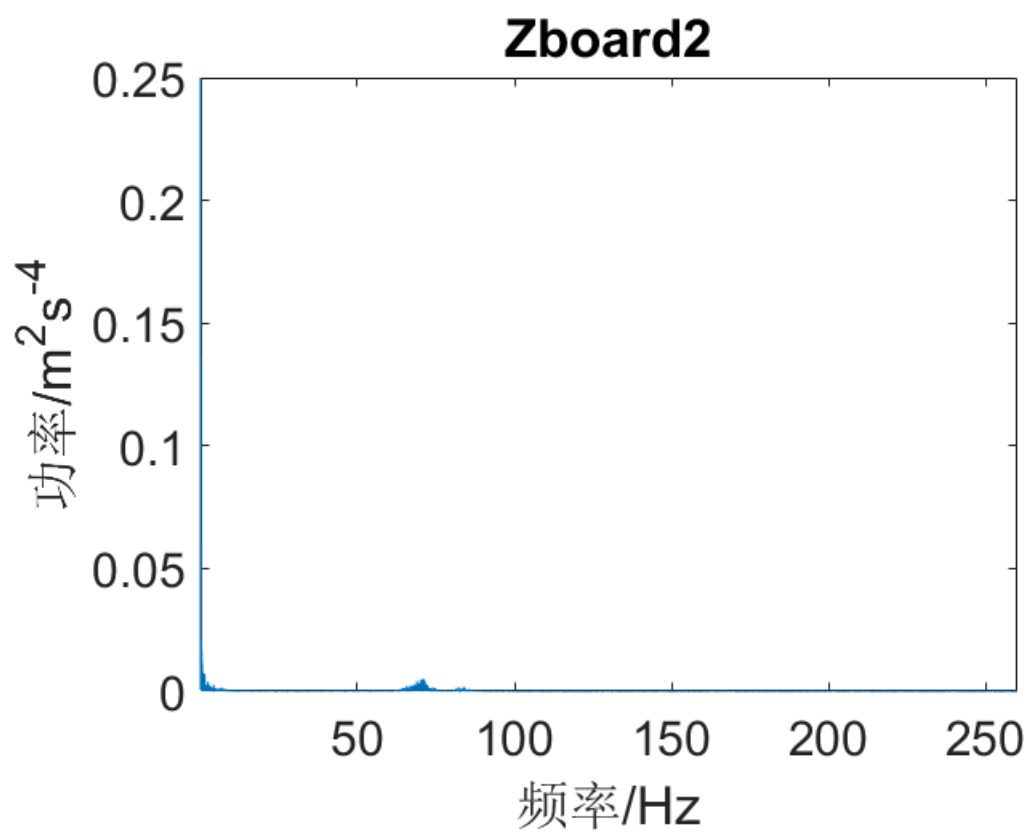
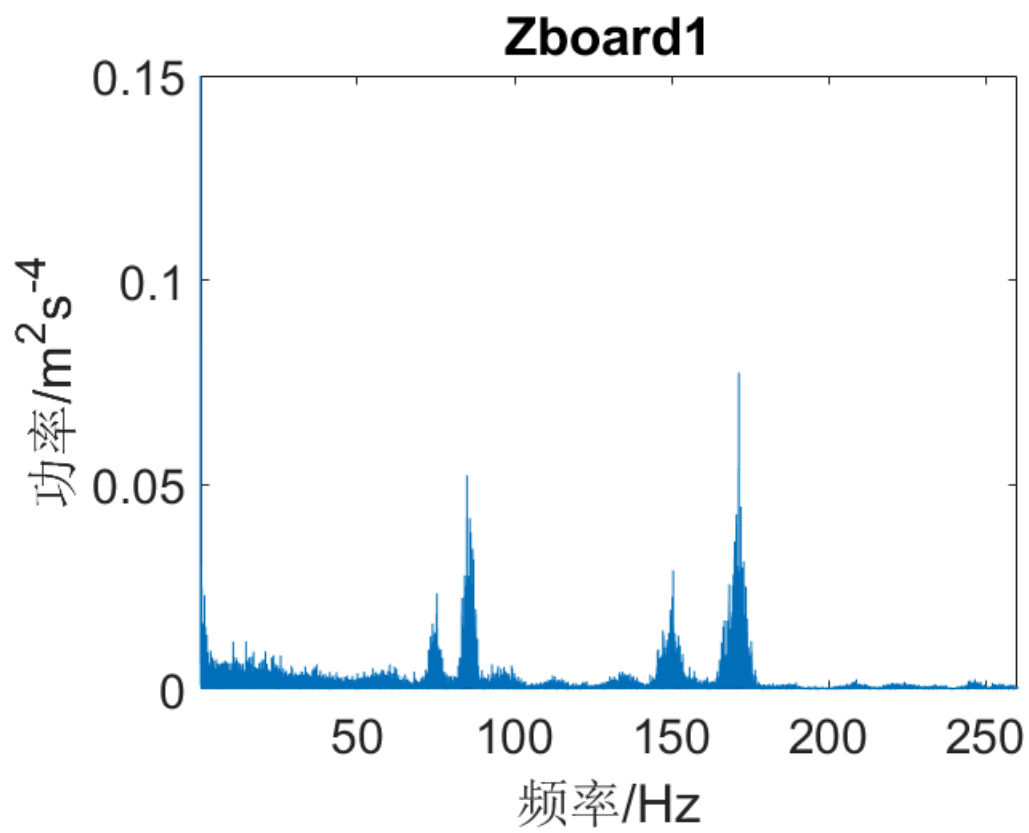


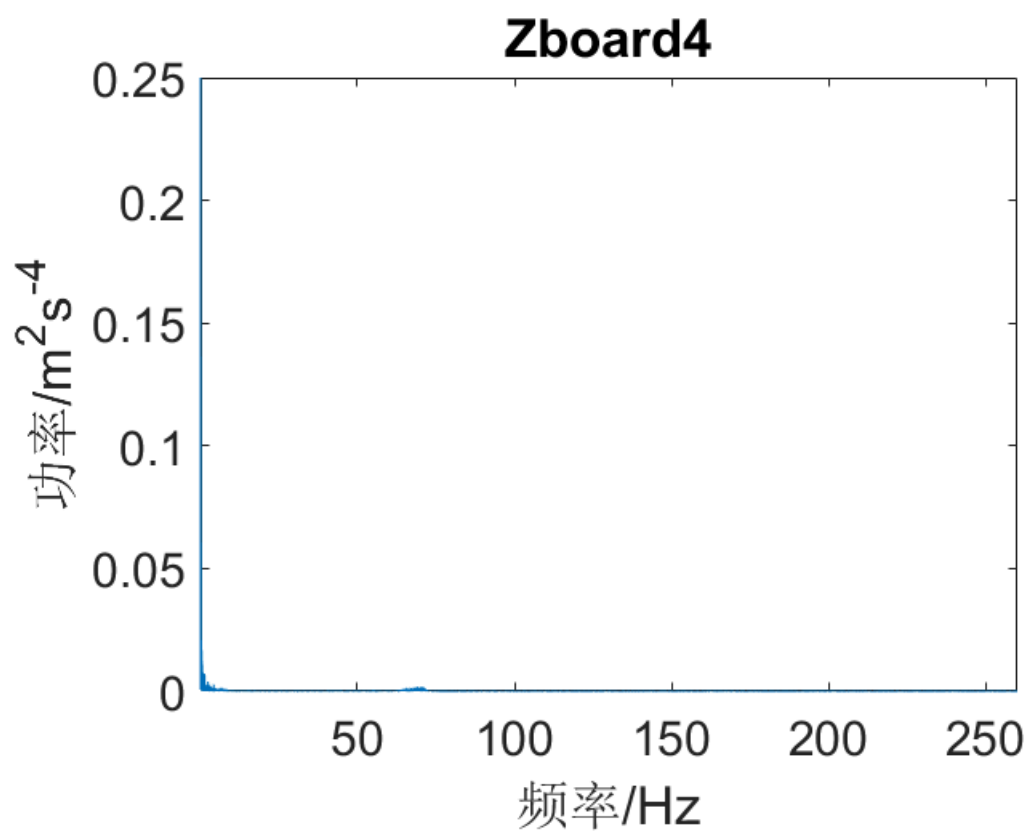
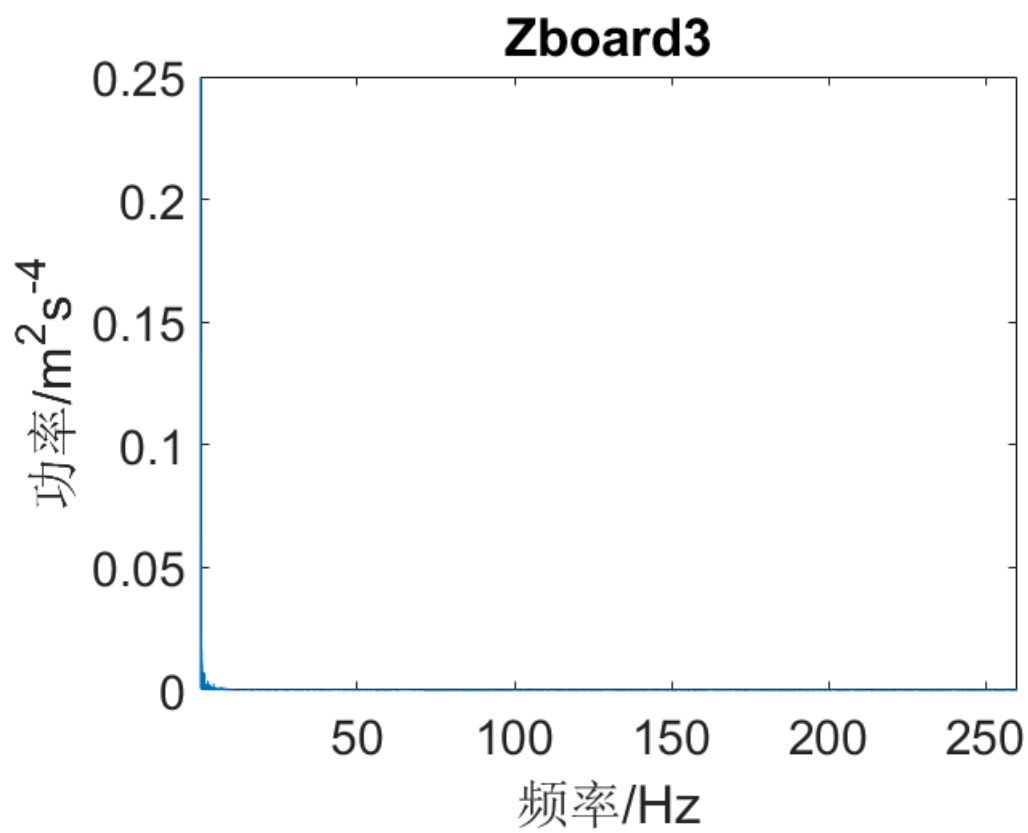


```

for i = 1:4
    figure(i+9*2+5);[pxx,f]=periodogram(Z{1,i+5},[],[],fs,'power');plot(f,pxx);
    set(gca, 'xlim', [0.1, f_cutoff], 'FontSize',18);
    xlabel('频率/Hz','FontSize',18) % x-axis label
    ylabel('功率/m^2s^-4','FontSize',18) % y-axis label
    title(['Zboard',int2str(i)]);
end

```

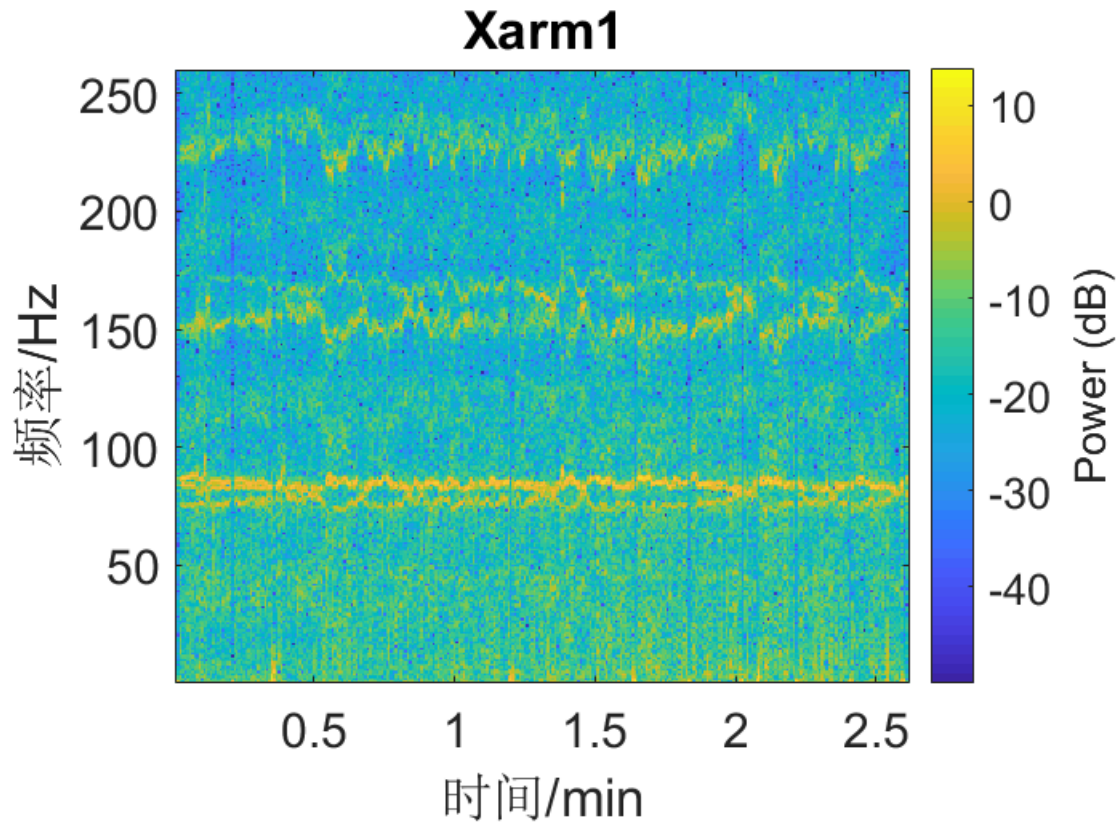


使用短时傅里叶变换绘制时频图。飞行器真实运动信号在极低频的分量很高，为了突出显示振动分量，绘图时x轴从2Hz开始。

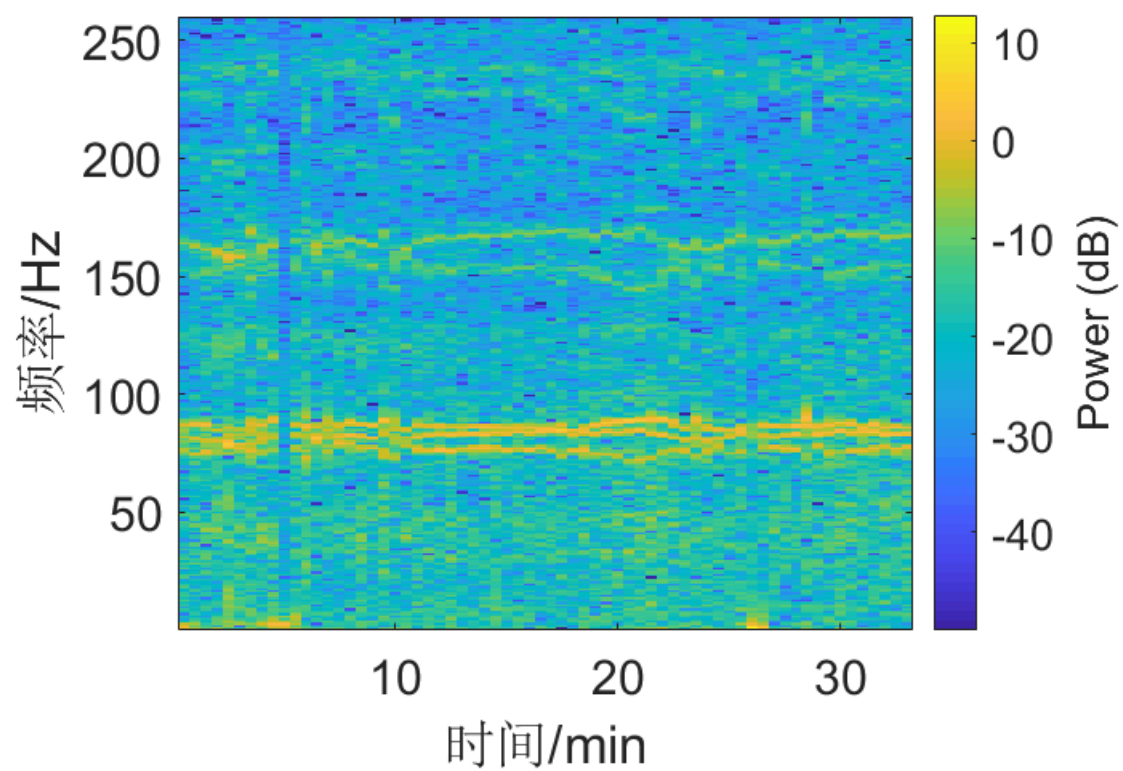
```

for i = 1:5
    figure(9*3+i);spectrogram(X{1,i},fs,fs/2,[],fs,'yaxis','Power','MinThreshold',-50);
    set(gca, 'ylim', [0.1, f_cutoff],'FontSize',18);
    xlabel('时间/min','FontSize',18) % x-axis label
    ylabel('频率/Hz','FontSize',18) % y-axis label
    title(['Xarm',int2str(i)]);
end

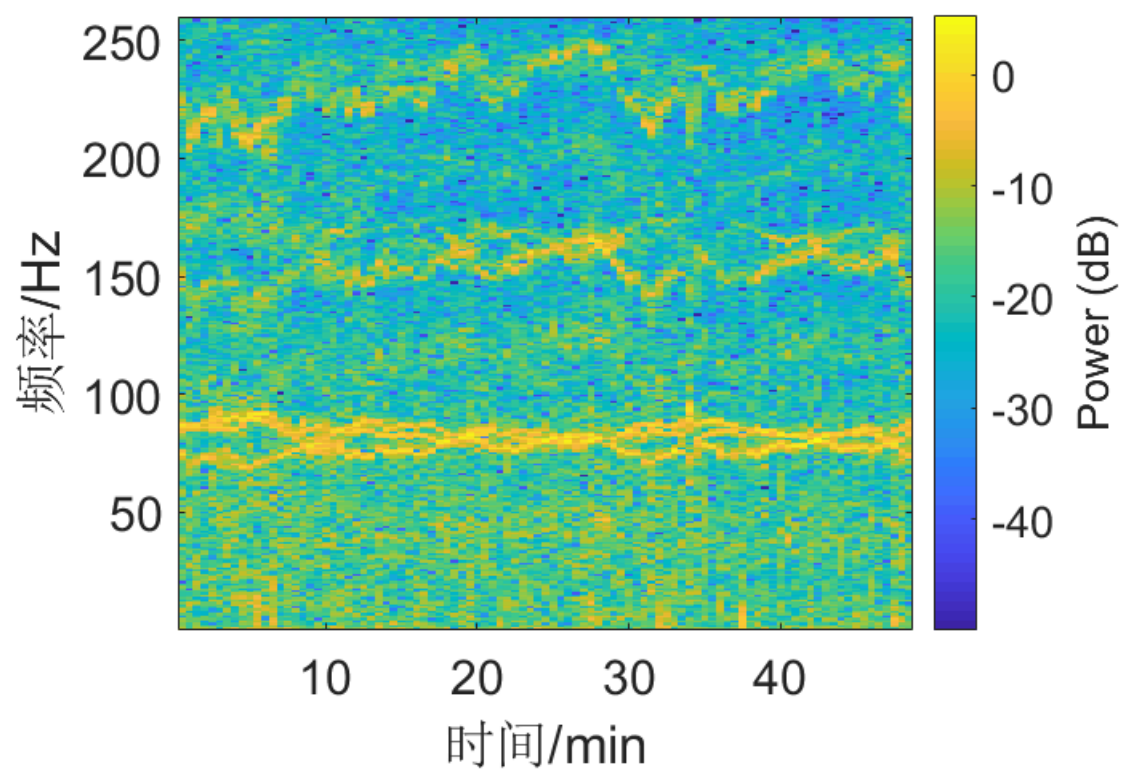
```



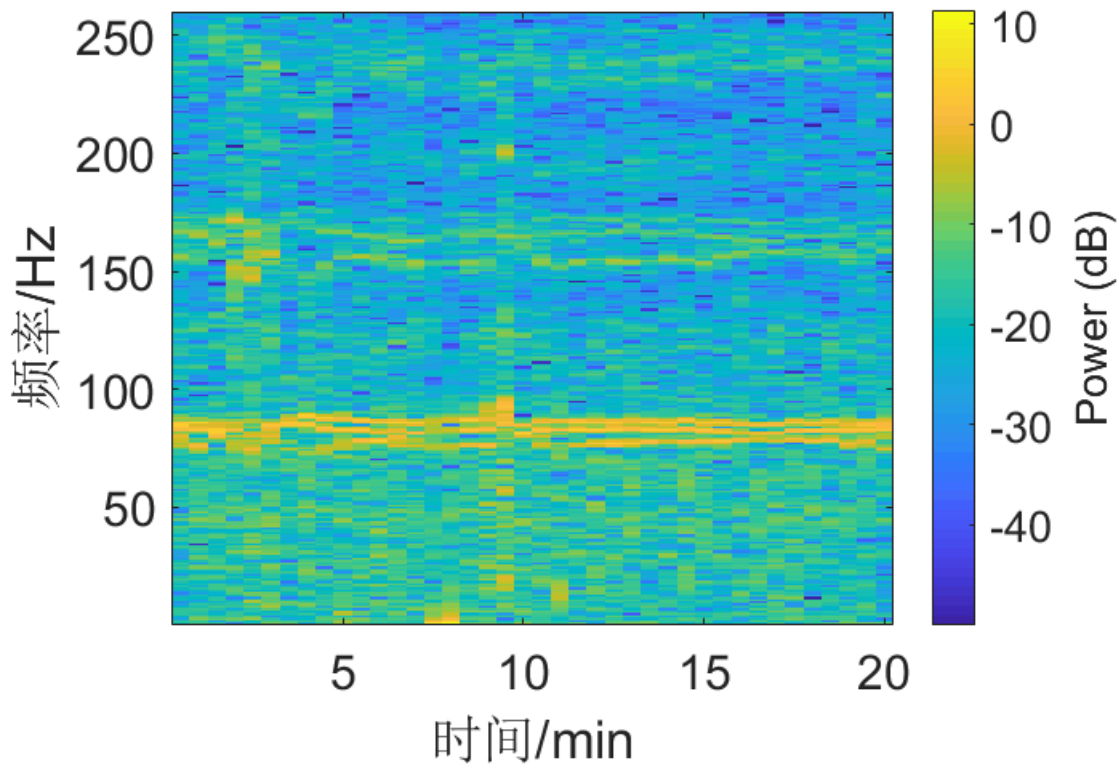
Xarm2



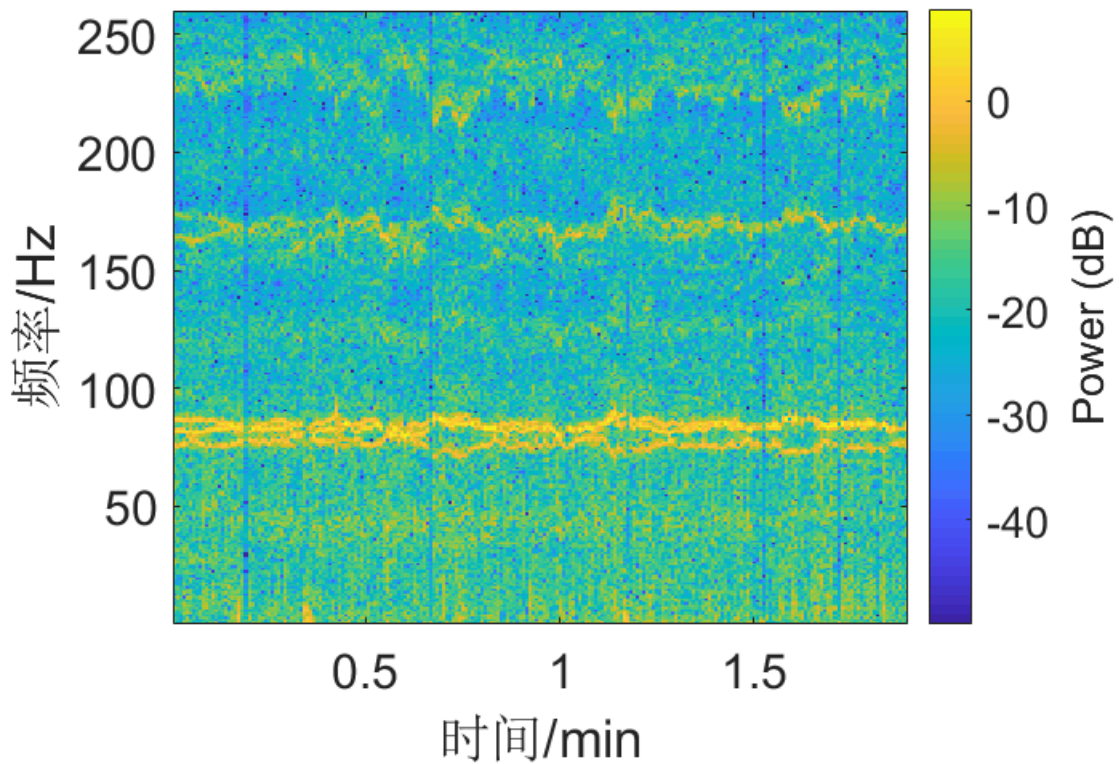
Xarm3



Xarm4



Xarm5

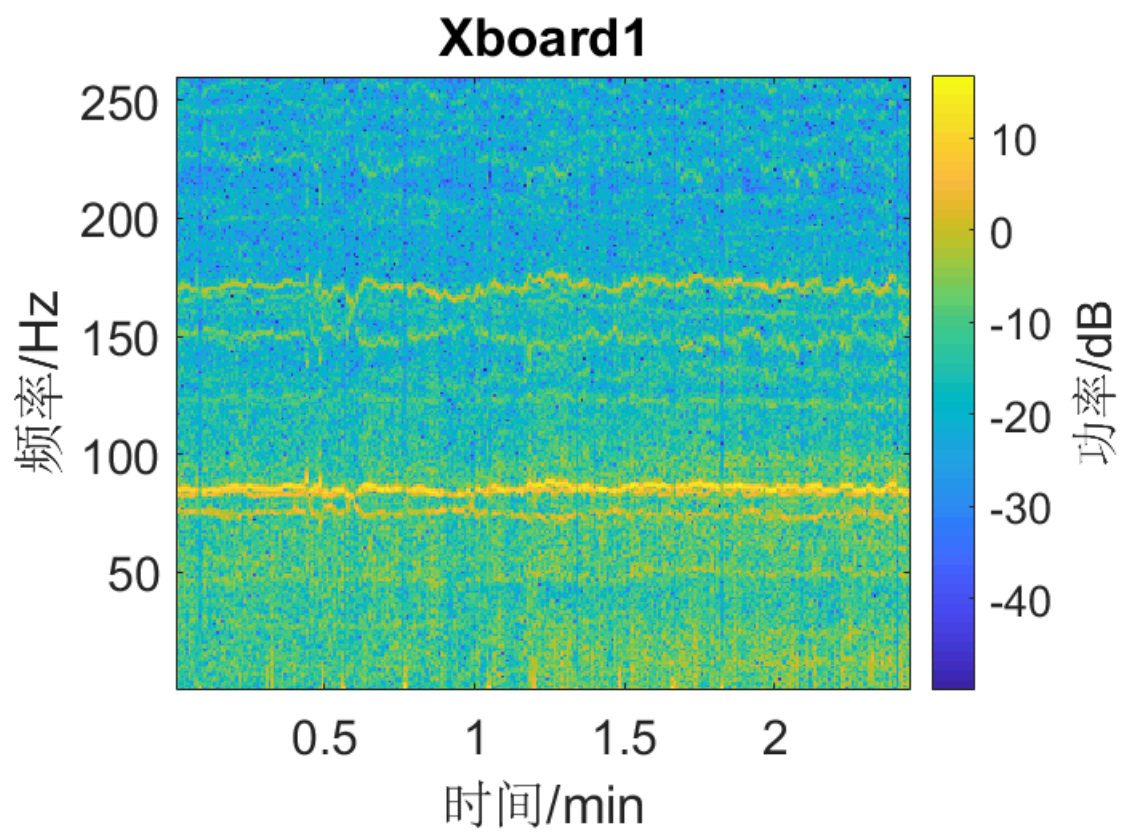


```
for i = 1:4
    figure(9*3+5+i);spectrogram(X{1,i+5},fs,fs/2,[],fs,'yaxis','Power','MinThreshold',-50);
    set(gca, 'ylim', [0.1, f_cutoff],'FontSize',18);
    xlabel('时间/min','FontSize',18) % x-axis label
```

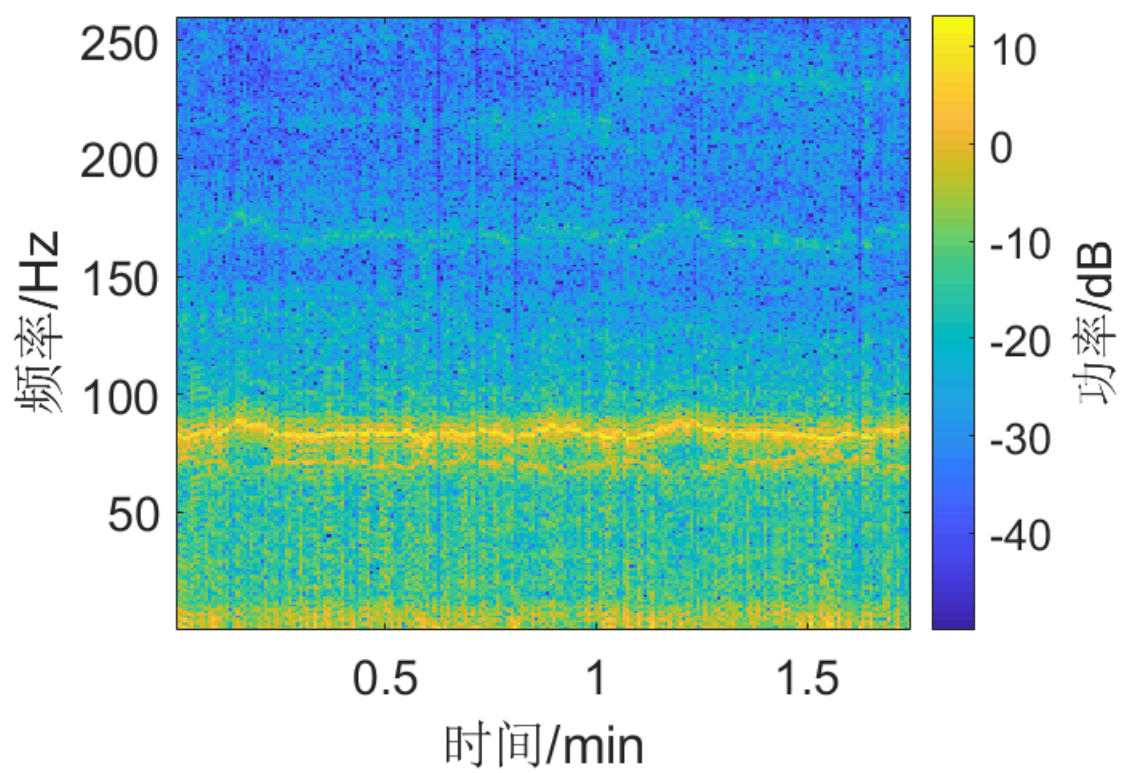
```

ylabel('频率/Hz','FontSize',18) % y-axis label
h = colorbar;
ylabel(h, '功率/dB','FontSize',18);
title(['Xboard',int2str(i)]);
end

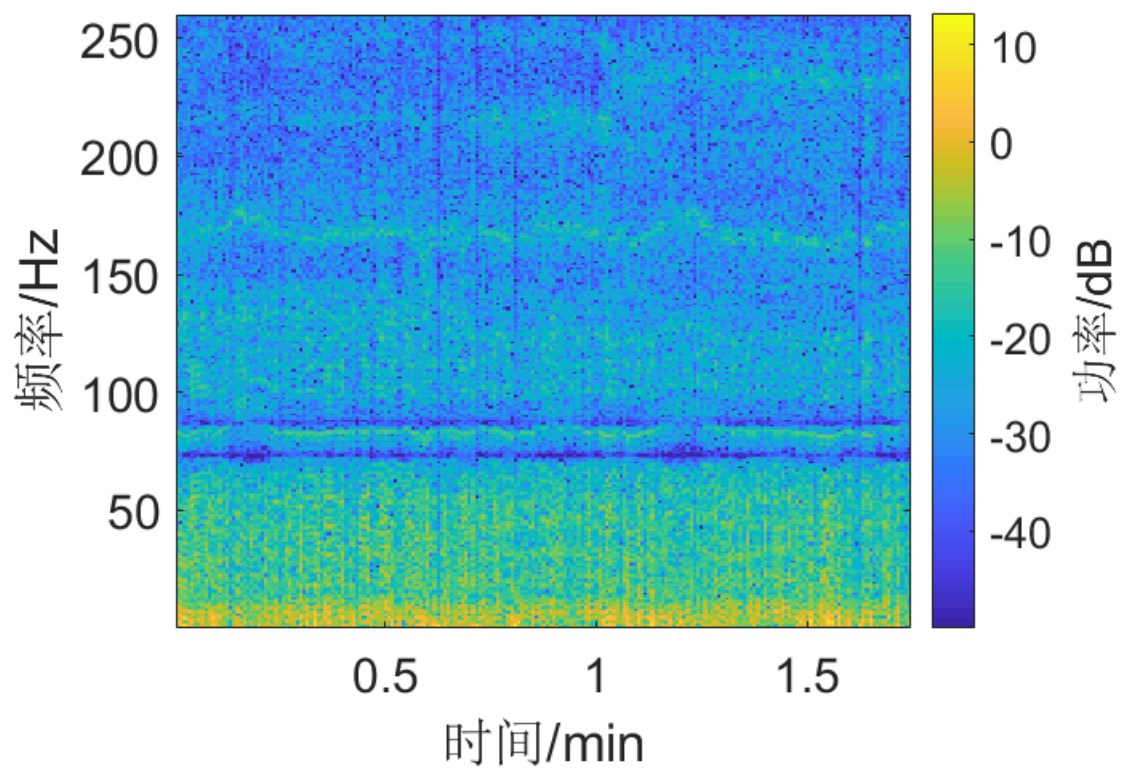
```

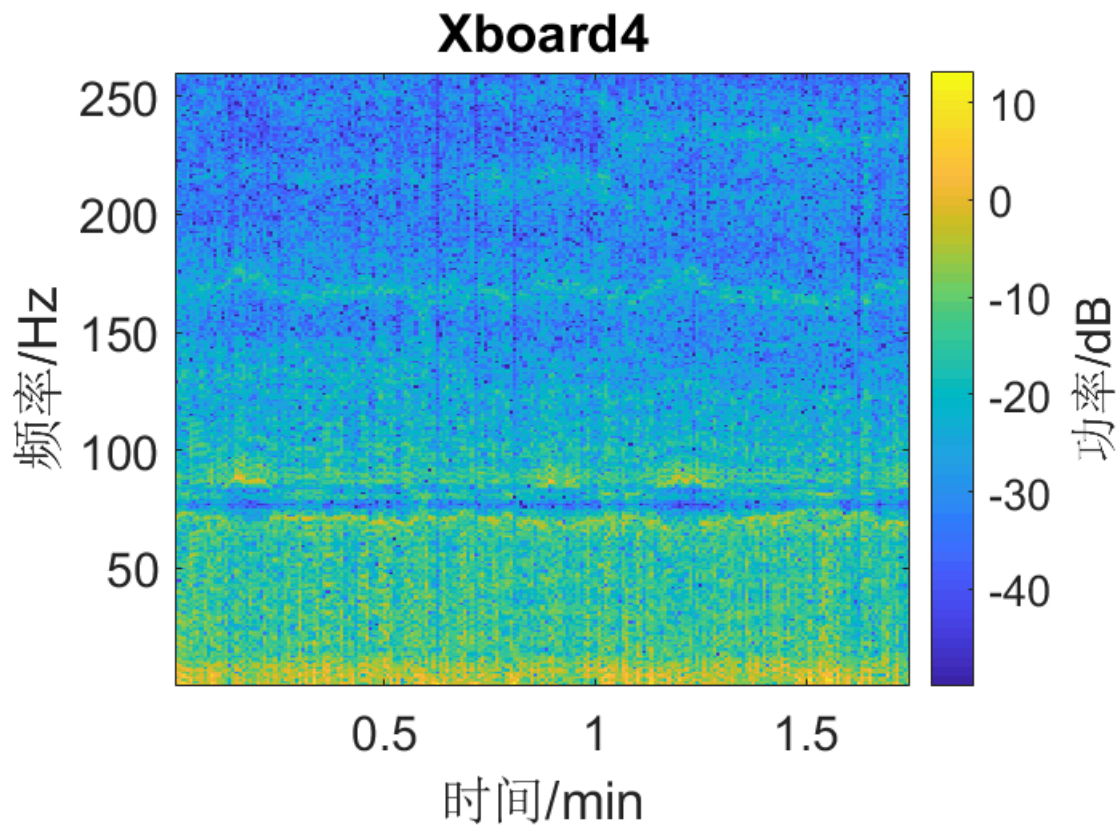


Xboard2



Xboard3



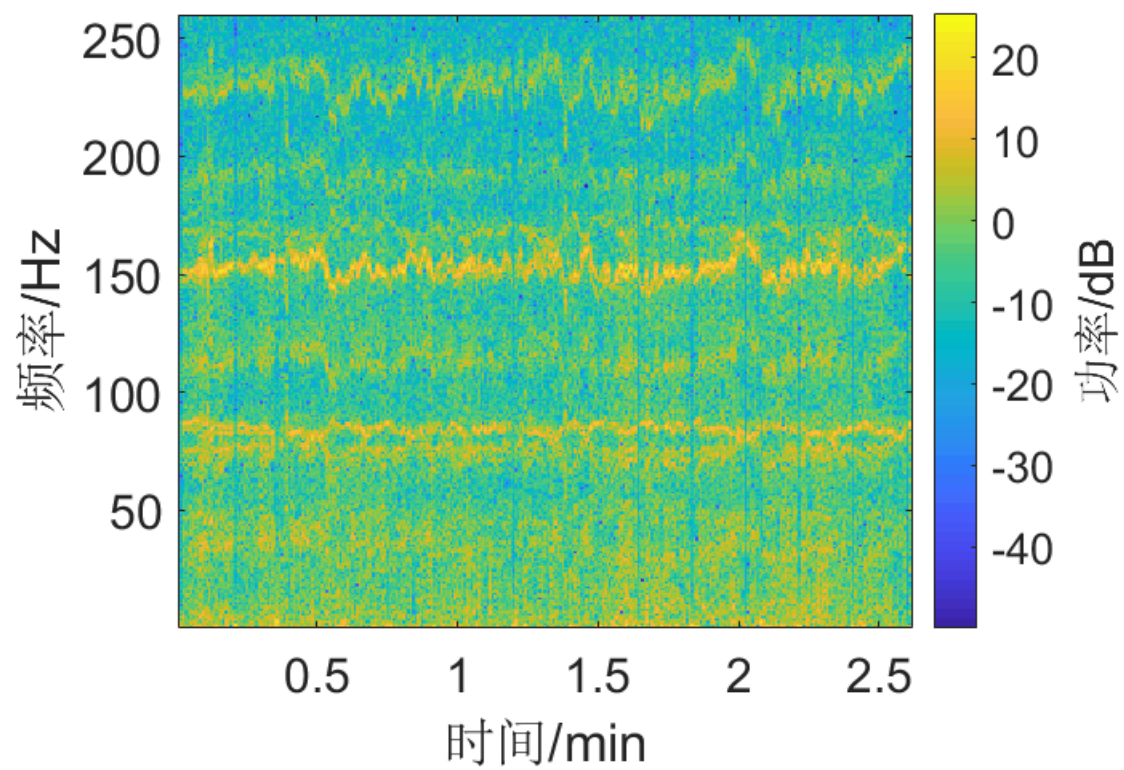


```

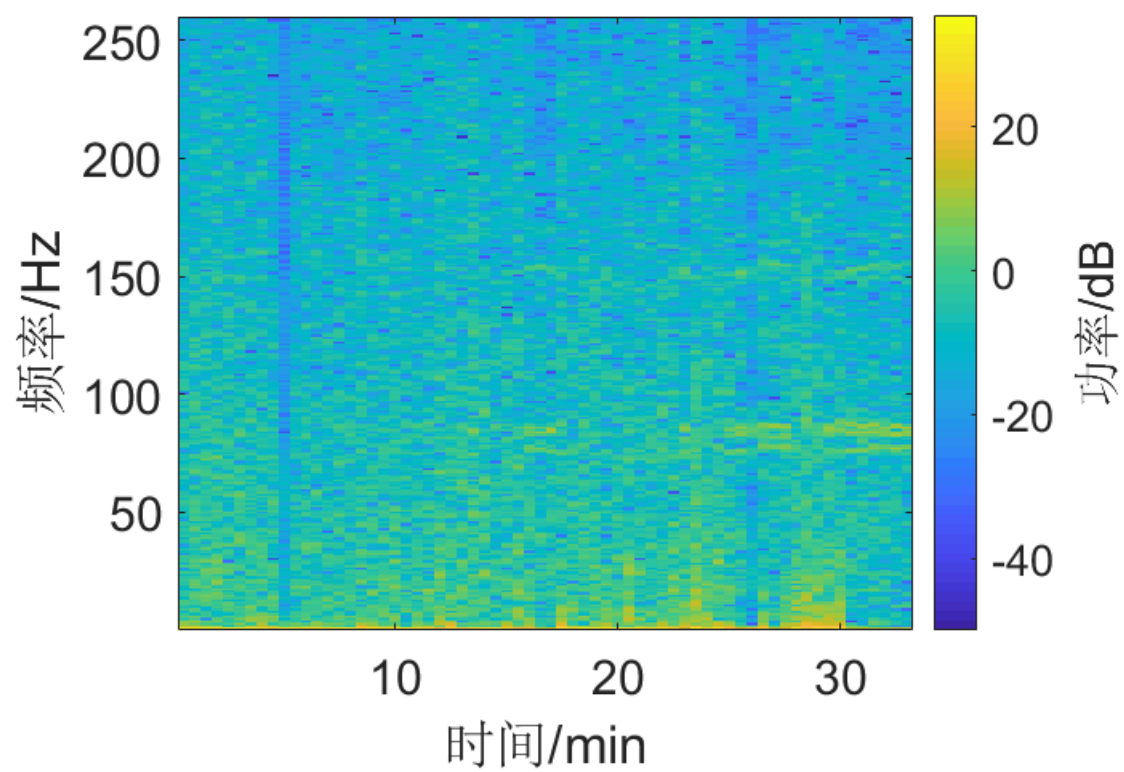
for i = 1:5
    figure(9*4+i);spectrogram(Y{1,i},fs,fs/2,[],fs,'yaxis','Power','MinThreshold',-50);
    set(gca, 'ylim', [0.1, f_cutoff],'FontSize',18);
    xlabel('时间/min','FontSize',18) % x-axis label
    ylabel('频率/Hz','FontSize',18) % y-axis label
    h = colorbar;
    ylabel(h, '功率/dB','FontSize',18);
    title(['Yarm',int2str(i)]);
end

```

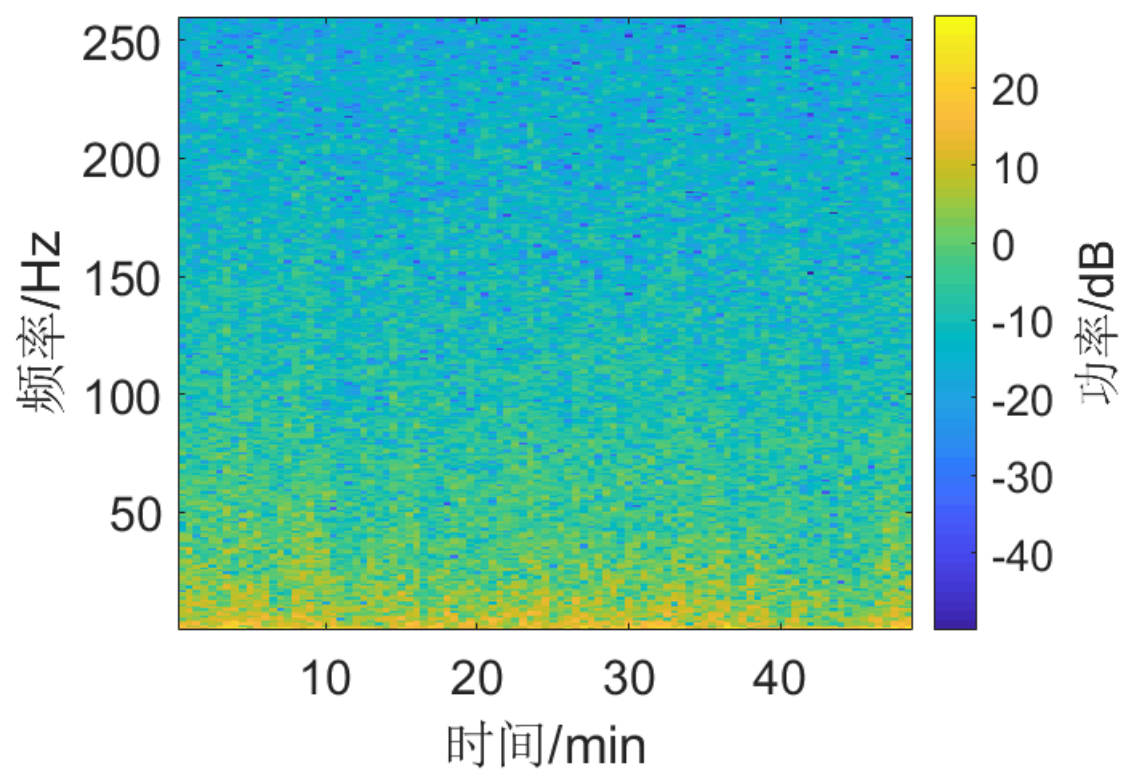

Yarm1



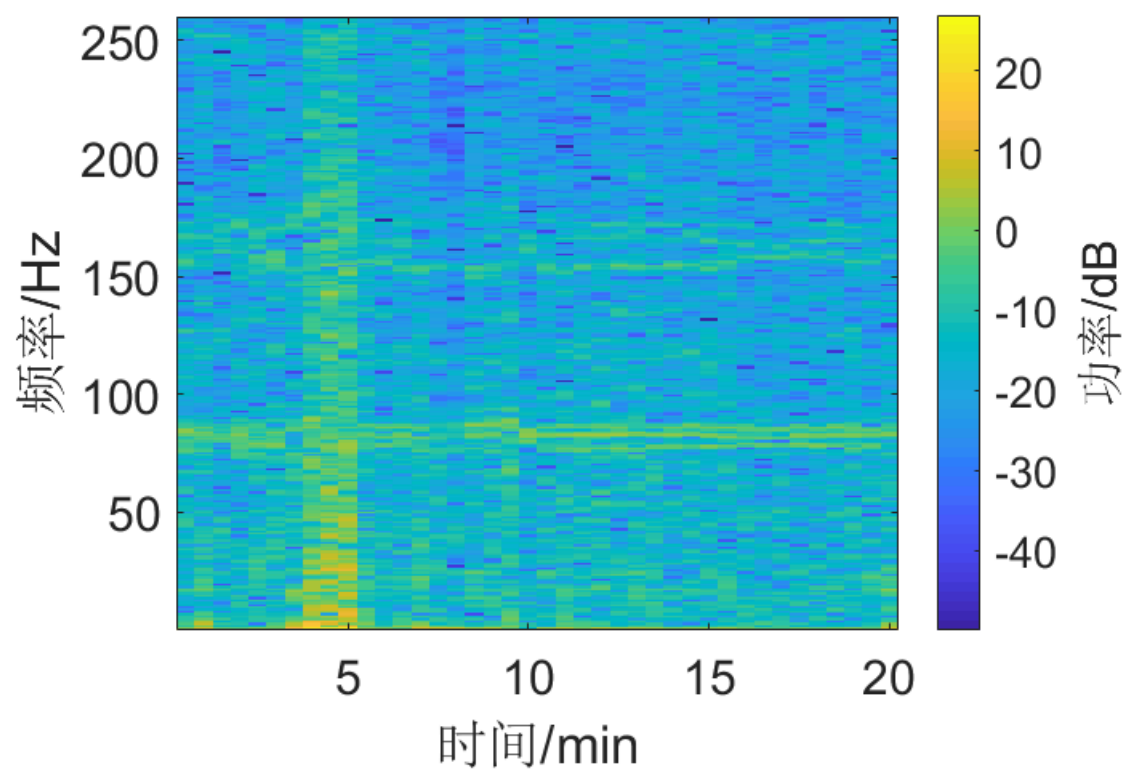
Yarm2

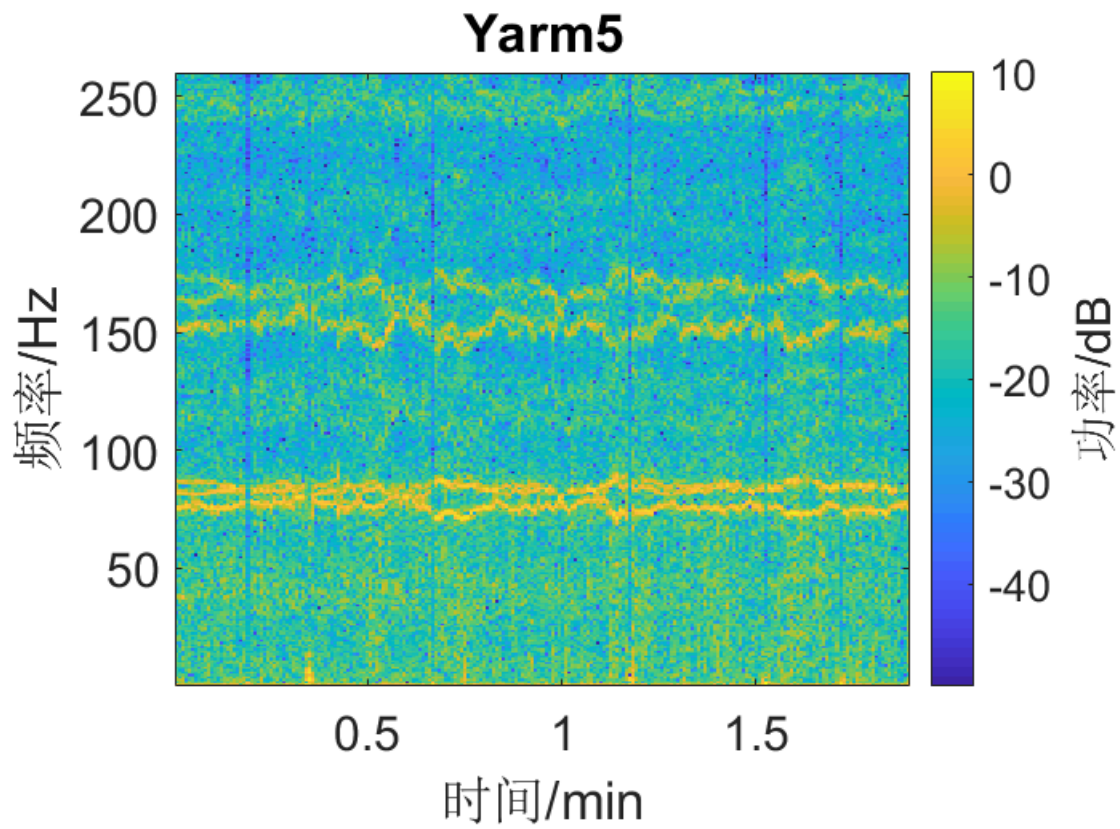


Yarm3



Yarm4



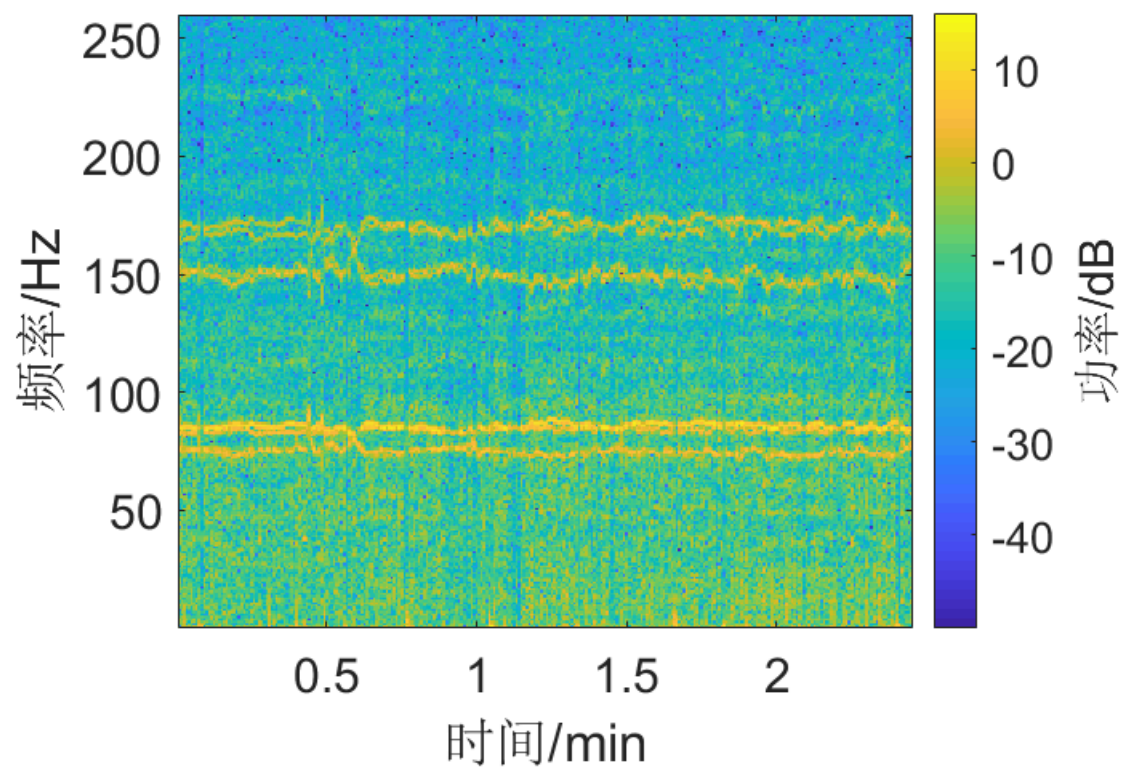


```

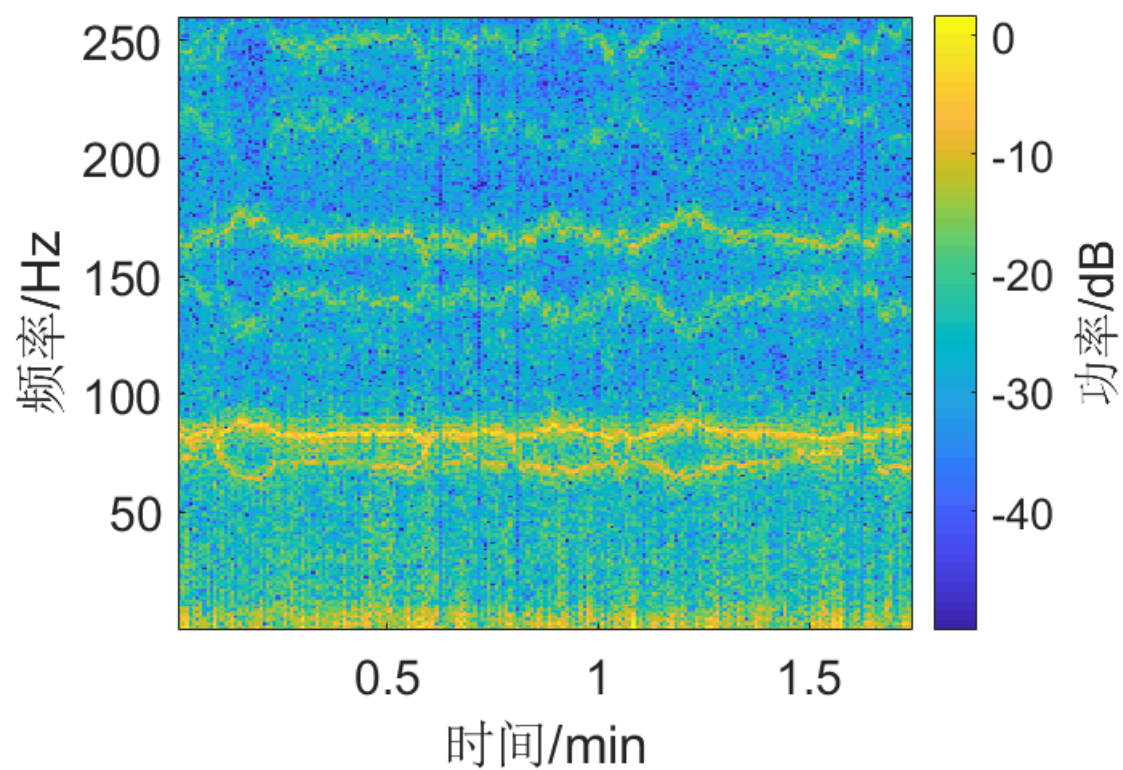
for i = 1:4
    figure(9*4+5+i);spectrogram(Y{1,i+5},fs,fs/2,[],fs,'yaxis','Power','MinThreshold',-50);
    set(gca, 'ylim', [0.1, f_cutoff],'FontSize',18);
    xlabel('时间/min','FontSize',18) % x-axis label
    ylabel('频率/Hz','FontSize',18) % y-axis label
    h = colorbar;
    ylabel(h, '功率/dB','FontSize',18);
    title(['Yboard',int2str(i)]);
end

```

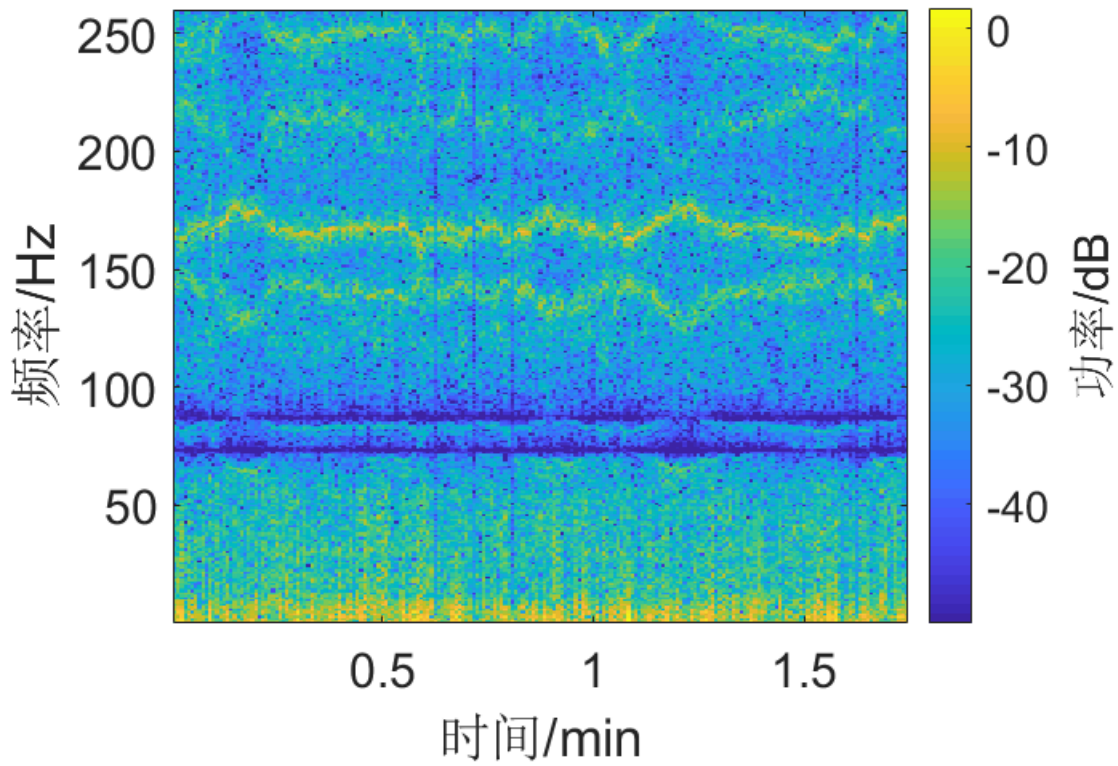

Yboard1



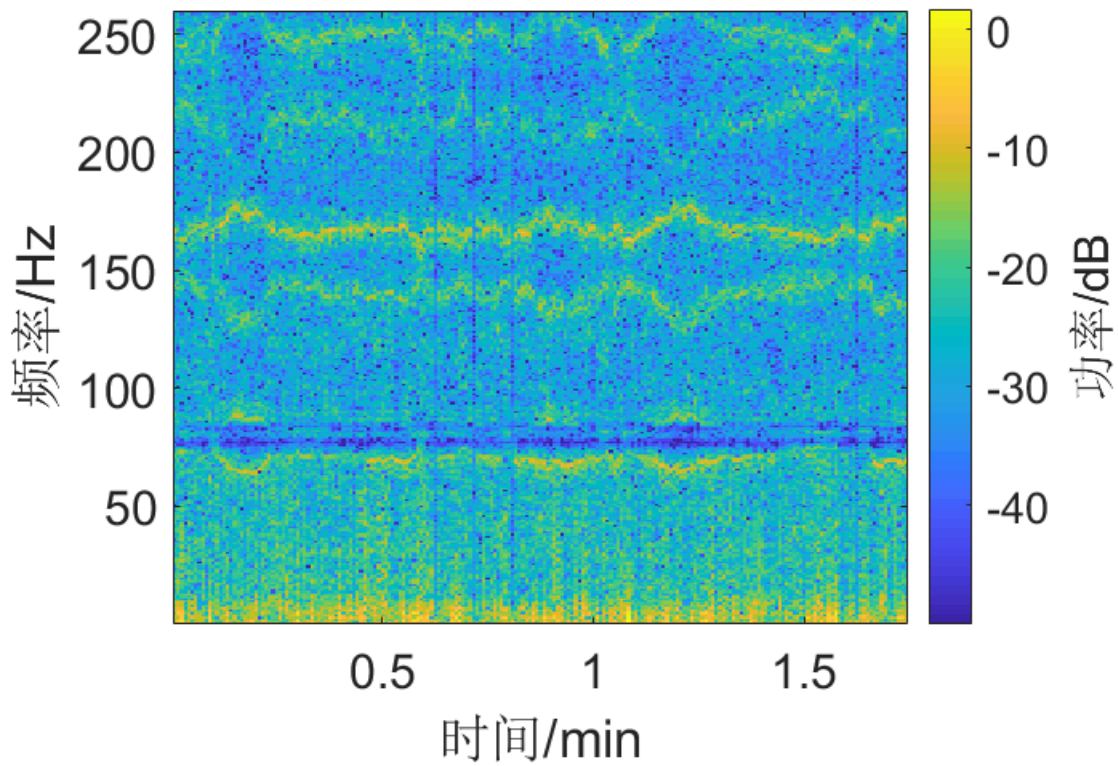
Yboard2



Yboard3



Yboard4

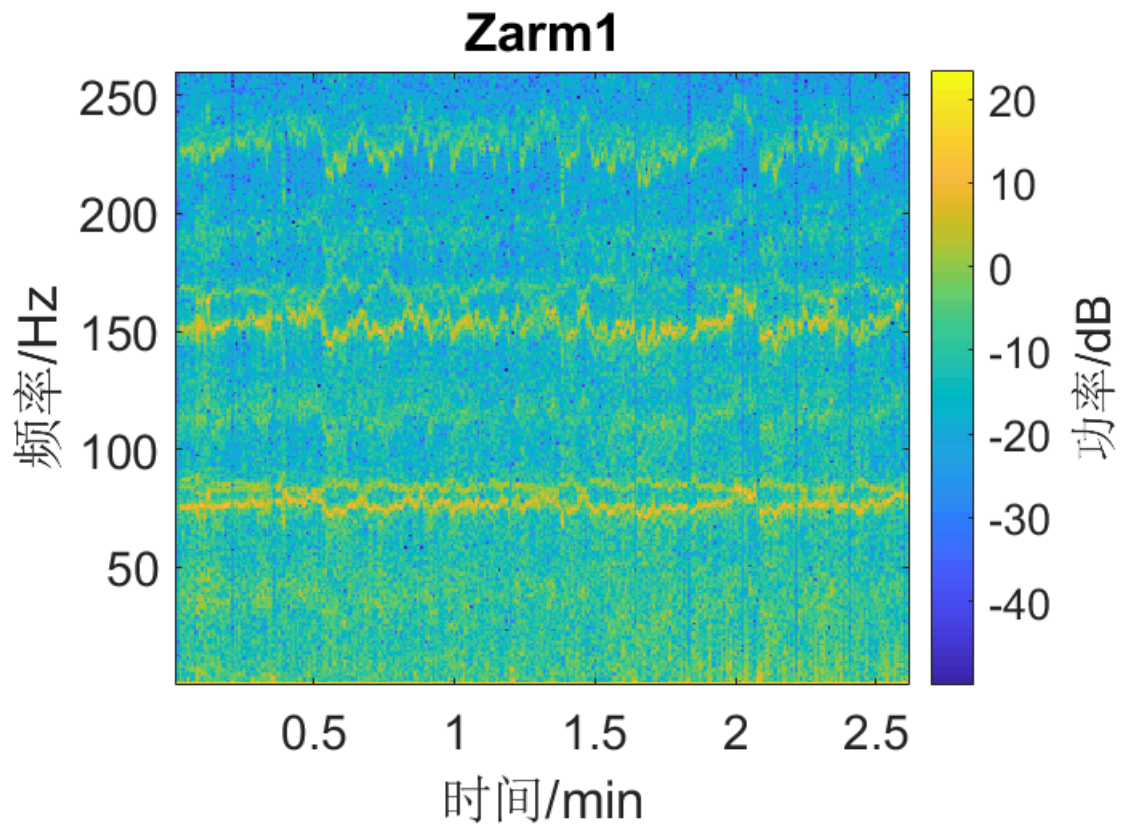


```
for i = 1:5
    figure(9*5+i);spectrogram(Z{1,i},fs,fs/2,[],fs,'yaxis','Power','MinThreshold',-50);
    set(gca, 'ylim', [0.1, f_cutoff],'FontSize',18);
    xlabel('时间/min','FontSize',18) % x-axis label
```

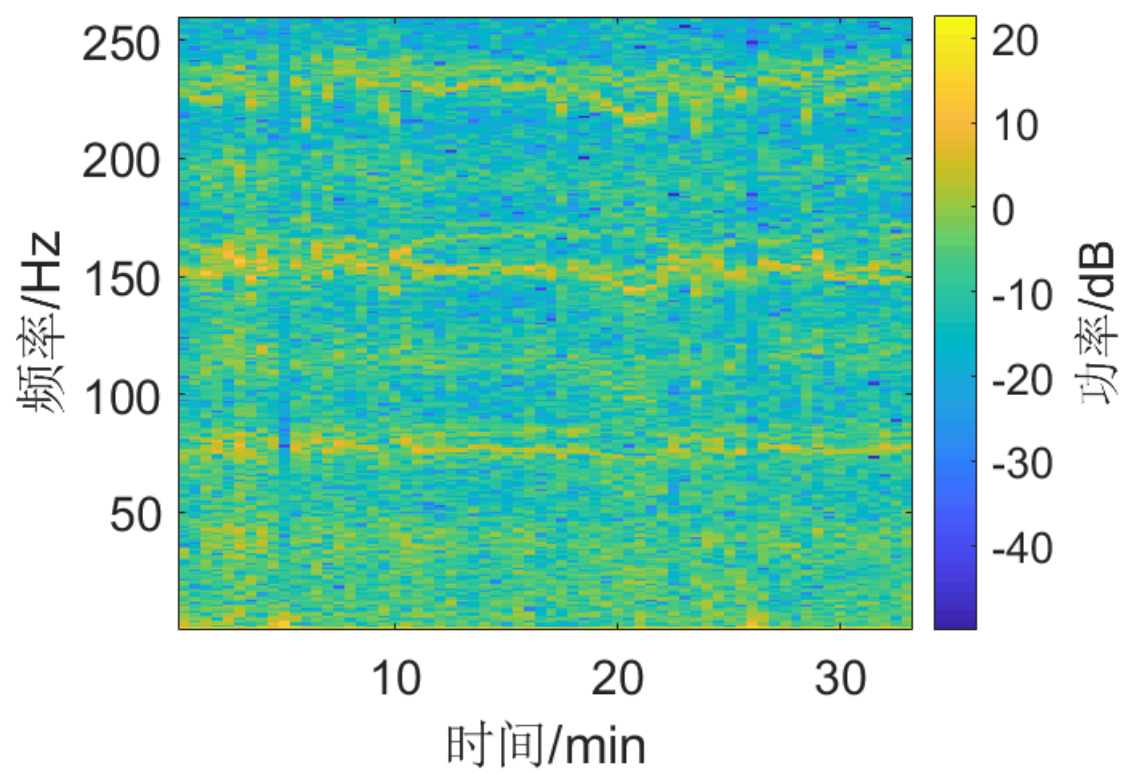
```

ylabel('频率/Hz','FontSize',18) % y-axis label
h = colorbar;
ylabel(h, '功率/dB','FontSize',18);
title(['Zarm',int2str(i)]);
end

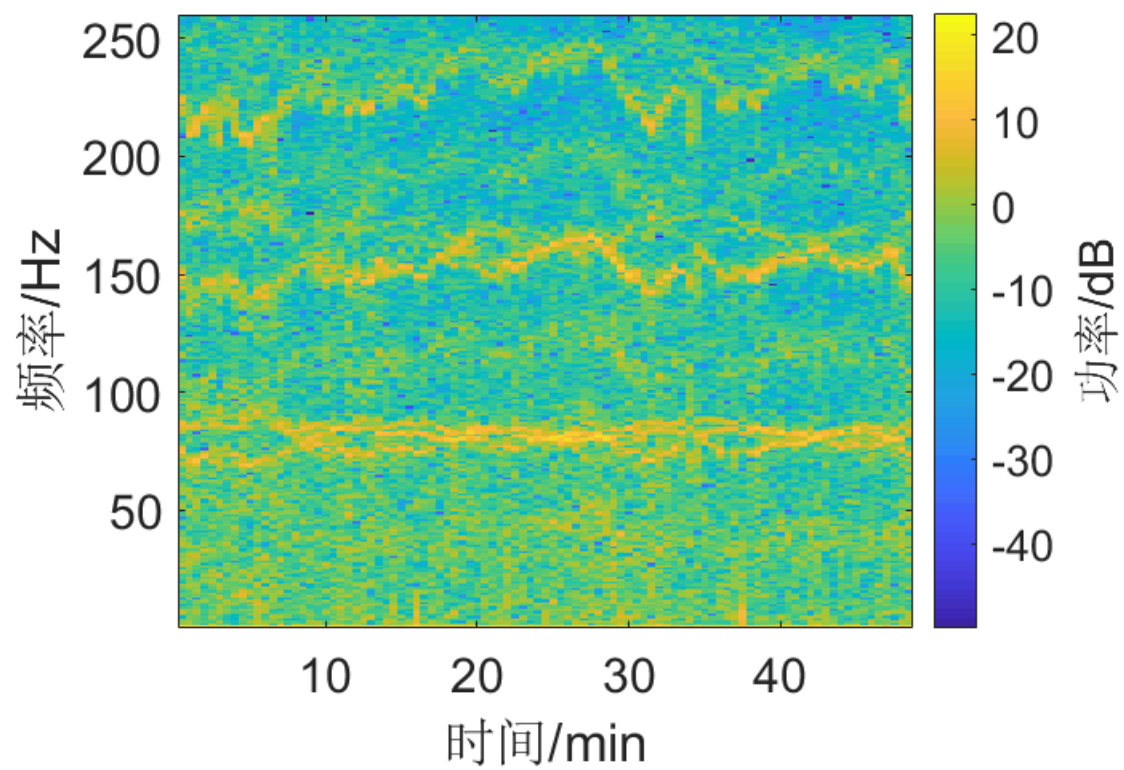
```



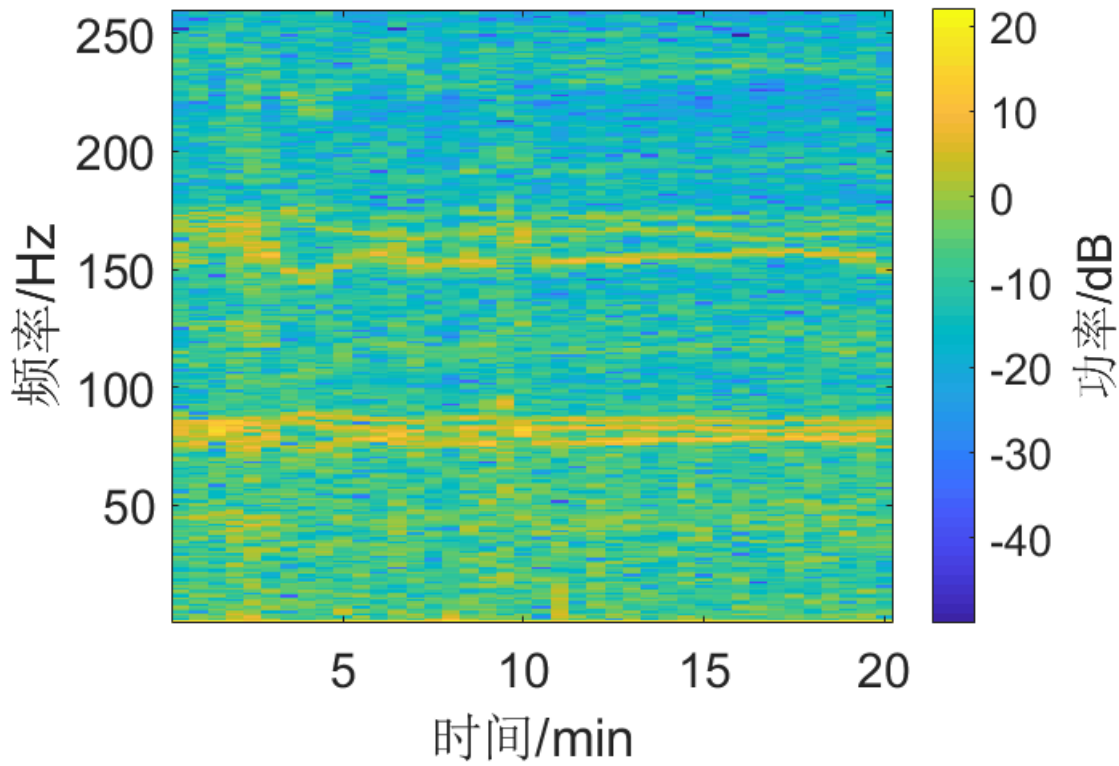
Zarm2



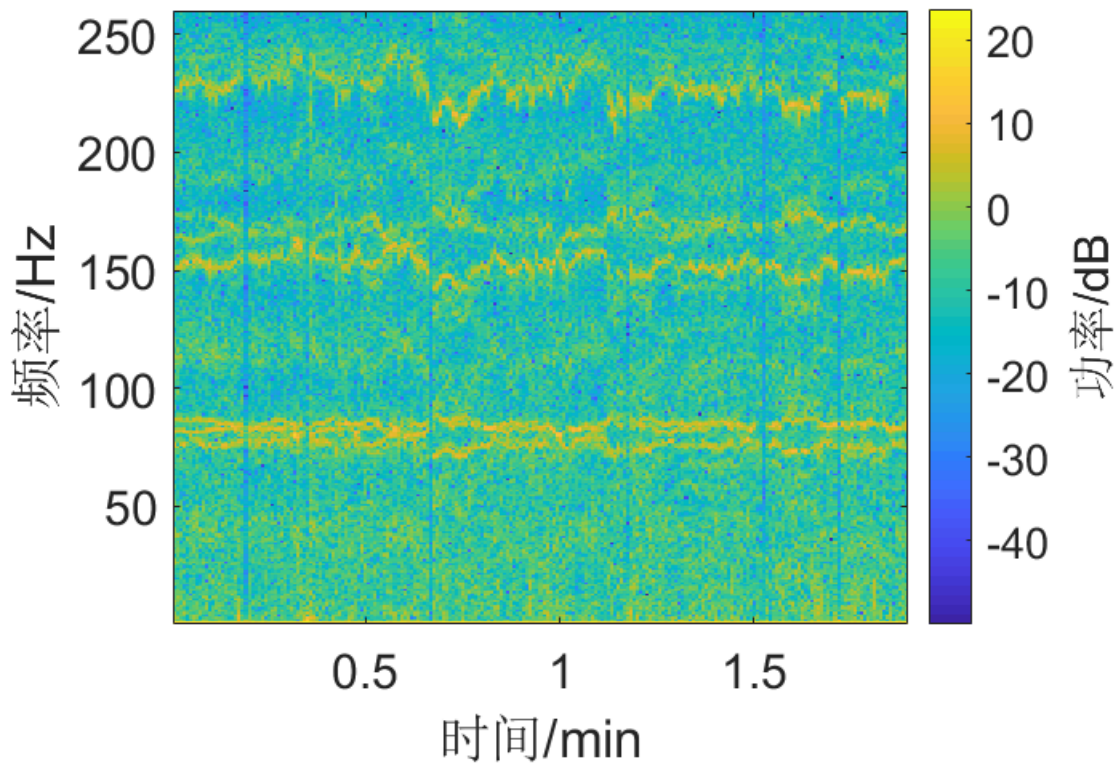
Zarm3



Zarm4



Zarm5



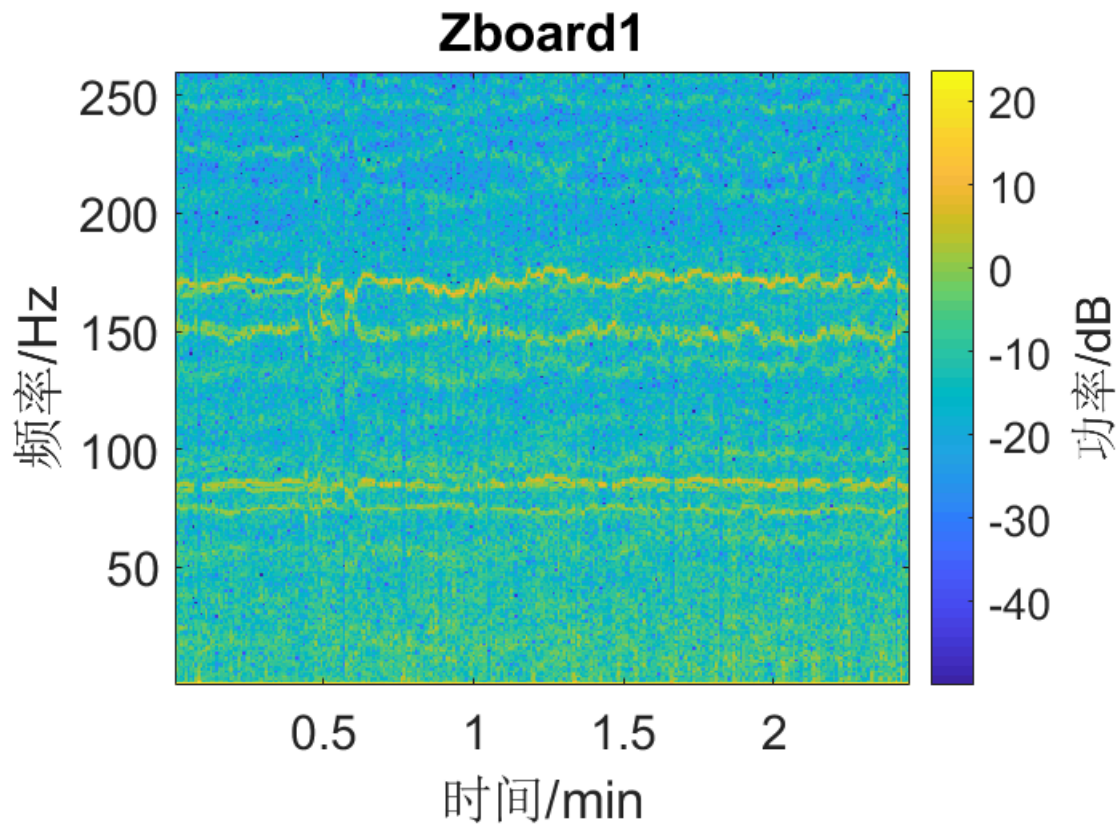
```
for i = 1:4
    figure(9*5+5+i);spectrogram(Z{1,i+5},fs,fs/2,[],fs,'yaxis','Power','MinThreshold',-50);
    set(gca, 'ylim', [0.1, f_cutoff],'FontSize',18);
    xlabel('时间/min','FontSize',18) % x-axis label
```



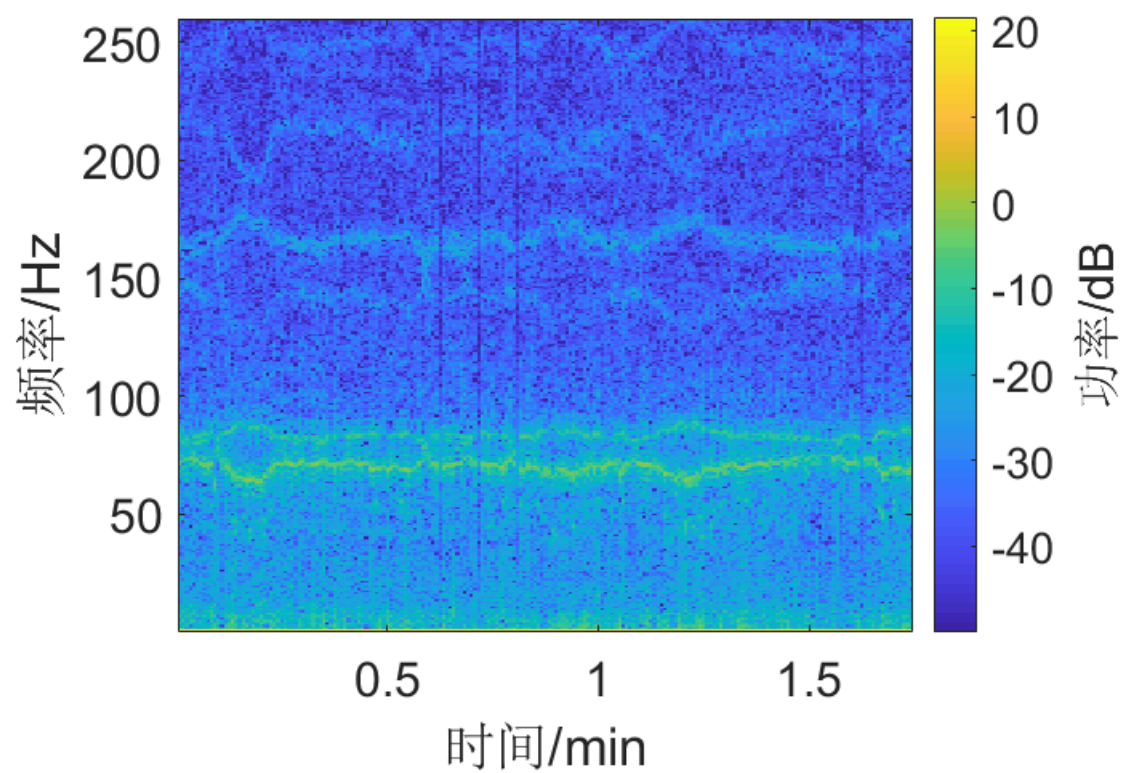
```

ylabel('频率/Hz','FontSize',18) % y-axis label
h = colorbar;
ylabel(h, '功率/dB','FontSize',18);
title(['Zboard',int2str(i)]);
end

```



Zboard2



Zboard3

