批量处理数据的代码，2020年10月21日

In [12]:

```
# 导入必要的包
import os
import numpy as np
import pandas as pd
import datetime
```

In [11]:

```
# 自己练习
def file_name(file_dir):
    for root, dirs, files in os.walk(file_dir):
        print(root)
        print(dirs)     # root下的子目录
        print(files)    # root下的文件
        print('\n\n')


# 测试
file_name("./expData_201909/20190911")
```

```
./expData_201909/20190911
['exp_02', 'xxx_01']
['exp_20190911_0.txt', 'exp_20190911_1.txt', 'exp_20190911_2.txt', 'exp_20191017_
1.txt', '测试数据行数是否为801.xlsx']



./expData_201909/20190911\exp_02
['CG', 'EXP']
['exp_20190911_6.txt', 'exp_20190911_7.txt', 'exp_20190911_8.txt', 'exp_20191017_
1.txt']



./expData_201909/20190911\exp_02\CG
[]
['exp_20191017_1.txt']



./expData_201909/20190911\exp_02\EXP
[]
['exp_20190911_6.txt', 'exp_20190911_7.txt', 'exp_20190911_8.txt']



./expData_201909/20190911\xxx_01
[]
['exp_20190911_3.txt', 'exp_20190911_4.txt', 'exp_20190911_5.txt']
```

我感觉os.walk()会读取根目录下的子目录，子目录下的子子目录，递归地执行下去，直到搜索到全部的文件夹！

In [12]:

```
# 测试
path = "./expData_201909/20190911"
files = os.listdir(path)
# 查看
type(files), len(files)
```

Out[12]:

```
(list, 7)
```

In [13]:

```
files
```

Out[13]:

```
['exp_02',
 'exp_20190911_0.txt',
 'exp_20190911_1.txt',
 'exp_20190911_2.txt',
 'exp_20191017_1.txt',
 'xxx_01',
 '测试数据行数是否为801.xlsx']
```

函数os.listdir(path)会返回一个列表，里面是path目录下的文件夹和文件的文件名

下面是一个比较好用的函数

In [14]:

```
import os

def file_name(file_dir):
    L=[]
    for root, dirs, files in os.walk(file_dir):
        for file in files:
            if os.path.splitext(file)[1] == '.txt':
                L.append(os.path.join(root, file))
    return L
```

In [15]:

```
# 测试
mylist = file_name(path)
# 查看
type(mylist), len(mylist)
```

Out[15]:

```
(list, 15)
```

In [16]:

```
mylist
```

Out[16]:

```
['./expData_201909/20190911\\exp_20190911_0.txt',
 './expData_201909/20190911\\exp_20190911_1.txt',
 './expData_201909/20190911\\exp_20190911_2.txt',
 './expData_201909/20190911\\exp_20191017_1.txt',
 './expData_201909/20190911\\exp_02\\exp_20190911_6.txt',
 './expData_201909/20190911\\exp_02\\exp_20190911_7.txt',
 './expData_201909/20190911\\exp_02\\exp_20190911_8.txt',
 './expData_201909/20190911\\exp_02\\exp_20191017_1.txt',
 './expData_201909/20190911\\exp_02\\CG\\exp_20191017_1.txt',
 './expData_201909/20190911\\exp_02\\EXP\\exp_20190911_6.txt',
 './expData_201909/20190911\\exp_02\\EXP\\exp_20190911_7.txt',
 './expData_201909/20190911\\exp_02\\EXP\\exp_20190911_8.txt',
 './expData_201909/20190911\\xxx_01\\exp_20190911_3.txt',
 './expData_201909/20190911\\xxx_01\\exp_20190911_4.txt',
 './expData_201909/20190911\\xxx_01\\exp_20190911_5.txt']
```

上面自定义的函数 file_name(path)会返回path目录下全部.txt文件的文件名，放在一个list当中

In [17]:

```
# 获取子目录，到CG和EXP子目录
def subdir_name(file_dir):
    L1=[]
    for root, dirs, files in os.walk(file_dir):
        for subdir in dirs:
            # step1.获取一级目录
            curdir = os.path.join(root, subdir)
            # step2.进入一级目录，添加二级目录
            for subroot, subdirs, subfiles in os.walk(curdir):
                for subsubdir in subdirs:
                    L1.append(os.path.join(subroot, subsubdir))
    return L1
```

In [18]:

```
# 测试
path = "./expData_201909/20190912"
mylist3 = subdir_name(path)
mylist3
```

Out[18]:

```
['./expData_201909/20190912\\exp_01\\CG',
 './expData_201909/20190912\\exp_01\\EXP',
 './expData_201909/20190912\\exp_02\\CG',
 './expData_201909/20190912\\exp_02\\EXP',
 './expData_201909/20190912\\exp_03\\CG',
 './expData_201909/20190912\\exp_03\\EXP',
 './expData_201909/20190912\\exp_04\\CG',
 './expData_201909/20190912\\exp_04\\EXP']
```

OK!我的想法是先计算出参考数据，后面再搞批量处理的部分

In [19]:

```
# 样品盒参考数据
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder'
```

In [20]:

```
os.listdir(path)
```

Out[20]:

```
['1-1', '2-1', '3-1', '4-1', '5-1', '6-1']
```

In [24]:

```
# 自己测试
file_list = []
for subdir in os.listdir(path):
    # print(subdir)
    subdir_path = os.path.join(path, subdir)  # 组合成绝对路径
    print(subdir_path)
#     for file in os.listdir(subdir_path):
#         file_list.append(os.path.join(subdir_path, file))

# 查看
# file_list
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\1-1
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\2-1
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\3-1
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\4-1
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\5-1
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\6-1
```

In [15]:

```
# ==================================准备一些必要的自定义函数=================================
=====

# 自定义一个函数，用于计算信号幅值 Magnitude(dB)
def calMag(Vi, VQ):
    """
    功能：由 x,y 两个一维 numpy 数组，逐行（两个元素）进行计算Magnitude(dB)
    要求：提前执行 import numpy as np
    日期：2019-12-14
    """
    return 20 * np.log10(((Vi ** 2 + VQ ** 2) ** 0.5) / 1000)


# 自定义一个函数，用于求取相位角 Phase angle(° )
def calPhase(Vi, VQ):
    """
    功能：由 x,y 两个一维 numpy 数组，逐行（两个元素）进行计算“反正切”
    要求：提前执行 import numpy as np
    日期：2019-12-14
    """
    # return np.arctan2(y, x) * 180 / np.pi
    return np.arctan2(VQ, Vi) * 180 / np.pi
```

In [16]:

```
# 下面需要写一个函数，根据txt文件名，可计算幅值和相位角数据
def getData_txt(filepath):
    '''
    输入：OM2S2采集的txt文件的路径
    输出：幅值(Magnitude)和相位角(Phase angle)的ndarray
    作者：张津阳
    2020年10月21日
    '''
    # step 1.读取数据
    names = ['id', 'Vi', 'VQ', 'ST', 'AT', 'RH']
    df1 = pd.read_csv(filepath, names = names, index_col='id')

    # step 2.从 df1 中索引出 'Vi'列 和 'VQ'列
    df1_Vi = df1['Vi']
    df1_VQ = df1['VQ']

    # step 3.用 0.1 mv 替代原数据中的 0 值
    df1_Vi = df1_Vi.replace(0, 0.1)
    df1_VQ = df1_VQ.replace(0, 0.1)

    # step 4.考虑到后续的数学运算，将 dataframe --> numpy数组 会更加方便
    arr1_Vi = df1_Vi.values
    arr1_VQ = df1_VQ.values

    # step 5.调用自定义函数，计算幅值(Magnitude)和相位角(Phase angle)
    arr1_Mag = calMag(arr1_Vi, arr1_VQ)
    arr1_Phase = calPhase(arr1_Vi, arr1_VQ)

    return arr1_Mag, arr1_Phase
```

In [32]:

```
# 先测试下
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm'

for file in os.listdir(path):
    file_path = os.path.join(path, file)
    print(file_path)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm\exp_20200723_226.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm\exp_20200723_227.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm\exp_20200723_228.txt
```

In [17]:

```
# 目前的思路，要写一个自定义函数，比如说给到包含txt文件的目录
def refData_singleThickness(path):
    '''
    输入：保存某一厚度样品盒参考数据的文件夹路径，如：'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm'
    输出：三次重复试验数据分别计算出的幅值数据和相位角数据
    作者：张津阳
    日期：2020年10月21日
    '''
    Mag_list = []
    Phase_list = []

    for file in os.listdir(path):
        # step 1.合成txt文件名
        file_path = os.path.join(path, file)
        print(file_path)                            # 测试用
        # step 2.调用自定义函数，计算幅值和相位角
        Mag, Phase = getData_txt(file_path)
        # step 3.向空列表添加数据
        Mag_list.append(Mag)
        Phase_list.append(Phase)

    return Mag_list, Phase_list
```

In [33]:

```
Mag_list_1cm, Phase_list_1cm = refData_singleThickness(path)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm\exp_20200723_226.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm\exp_20200723_227.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/1cm\exp_20200723_228.txt
```

In [34]:

```
# 查看列表
type(Mag_list_1cm), len(Mag_list_1cm), type(Phase_list_1cm), len(Phase_list_1cm)
```

Out[34]:

```
(list, 3, list, 3)
```

In [35]:

```
# 查看列表中的元素
type(Mag_list_1cm[0]), Mag_list_1cm[0].shape, type(Phase_list_1cm[0]), Phase_list_1cm[0].shape
```

Out[35]:

```
(numpy.ndarray, (801,), numpy.ndarray, (801,))
```

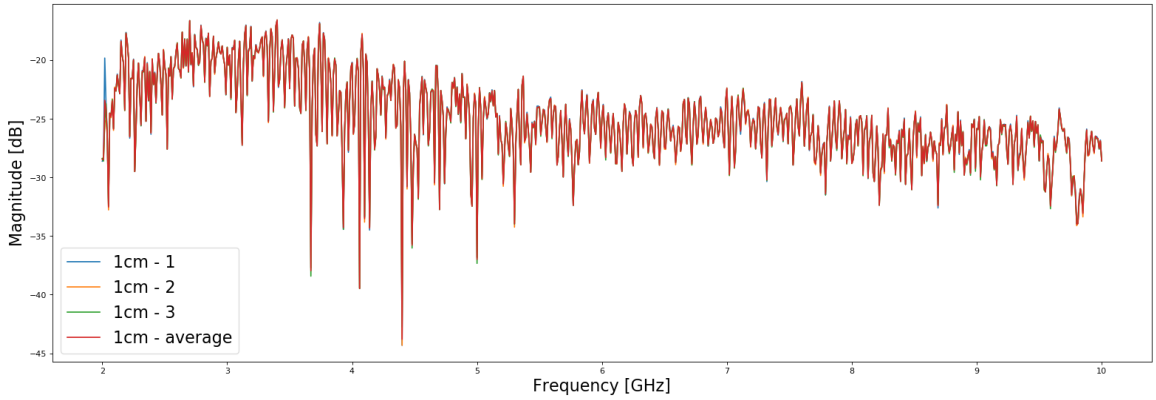
In [37]:

```
# 求下平均值
Mag_list_1cm_mean = (Mag_list_1cm[0]+Mag_list_1cm[1]+Mag_list_1cm[2])/3
```

画图查看

In [38]:

```
# 画图查看?
import matplotlib.pyplot as plt

arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 8), dpi=80)

plt.plot(arr_freq
         ,Mag_list_1cm[0]
         ,label = '1cm - 1'
        )

plt.plot(arr_freq
         ,Mag_list_1cm[1]
         ,label = '1cm - 2'
        )

plt.plot(arr_freq
         ,Mag_list_1cm[2]
         ,label = '1cm - 3'
        )

plt.plot(arr_freq
         ,Mag_list_1cm_mean
         ,label = '1cm - average'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Magnitude [dB]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



In [69]:

```
# 自定义一个函数，处理全部的参考数据
def refData_allThickness(path):
    '''
    输入：存放全部厚度样品盒参考数据的路径，如：'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder'
    输出：每种厚度样品盒的参考数据（取三次平均后的），包括幅值数据和相位角数据
    作者：张津阳
    日期：2020年10月21日
    '''
    # names = ['freq']
    # Mag_avg_list = []
    # Phase_avg_list = []
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 Mag 数据
    df2 = df1.copy()              # 用给Phase数据

    for file in os.listdir(path):
        # names.append(file)                      # 准备用作列名
        file_path = os.path.join(path, file)  # 组合出绝对路径
        # 调用自定义函数，计算三次重复测得的幅值和相位角
        Mag_list, Phase_list = refData_singleThickness(file_path)
        # 三次平均
        Mag_avg = (Mag_list[0] + Mag_list[1] + Mag_list[2]) / 3
        Phase_avg = (Phase_list[0] + Phase_list[1] + Phase_list[2]) / 3
        # 追加数据
        # Mag_avg_list.append(Mag_avg)
        # Phase_avg_list.append(Phase_avg)
        df1[file] = pd.DataFrame(Mag_avg)
        df2[file] = pd.DataFrame(Phase_avg)

    # 保存数据
    path1 = os.path.join(path, 'refData_Mag.csv')
    path2 = os.path.join(path, 'refData_Phase.csv')
    df1.to_csv(path1
               ,index=False
              )
    df2.to_csv(path2
               ,index=False
              )

    return df1, df2     # df1是Mag数据，(801,6)；df2是Phase数据，(801,6)
```

In [49]:

```
# 测试用
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder'

subdir_list = []
subsirs = []
for subdir in os.listdir(path):
    subsirs.append(subdir)
    subdir_path = os.path.join(path, subdir)
    print(subdir_path)
    subdir_list.append(subdir_path)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\6cm
```

In [42]:

```
subdir_list[0]
```

Out[42]:

```
'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\\1cm'
```

In [43]:

```
subdir_list[5]
```

Out[43]:

```
'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\\6cm'
```

In [50]:

```
subsirs
```

Out[50]:

```
['1cm', '2cm', '3cm', '4cm', '5cm', '6cm']
```

In [51]:

```
type(subsirs[0])
```

Out[51]:

```
str
```

In [45]:

```
arr_freq.shape
```

Out[45]:

(801,)

In [61]:

```
df = pd.DataFrame(arr_freq,columns=['freq'])
df.head()
```

Out[61]:

	freq
0	2.00
1	2.01
2	2.02
3	2.03
4	2.04

In [62]:

```
df2 = df.copy()
df2.shape
```

Out[62]:

(801, 1)

In [63]:

```
df2.insert(df2.shape[1],'d',df)
```

In [64]:

```
df2.shape
```

Out[64]:

(801, 2)

In [66]:

```
df.shape
```

Out[66]:

(801, 1)

In [67]:

```
path1 = os.path.join(path, 'refData_Mag.csv')
print(path1)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sa
mple_holder\refData_Mag.csv
```

In [68]:

```
path1
```

Out[68]:

```
'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-s
ample_holder\\refData_Mag.csv'
```

In [70]:

```
# 测试
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder'

df_Mag, df_Phase = refData_allThickness(path)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\1cm\exp_20200723_226.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\1cm\exp_20200723_227.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\1cm\exp_20200723_228.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\2cm\exp_20200723_229.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\2cm\exp_20200723_230.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\2cm\exp_20200723_231.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\3cm\exp_20200723_232.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\3cm\exp_20200723_233.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\3cm\exp_20200723_234.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\4cm\exp_20200723_235.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\4cm\exp_20200723_236.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\4cm\exp_20200723_237.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\5cm\exp_20200723_238.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\5cm\exp_20200723_239.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\5cm\exp_20200723_240.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\6cm\exp_20200723_241.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\6cm\exp_20200723_242.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder\6cm\exp_20200723_243.txt
```

In [71]:

```
df_Mag.shape, df_Phase.shape
```

Out[71]:

```
((801, 7), (801, 7))
```

In [72]:

```
df_Mag.head()
```

Out[72]:

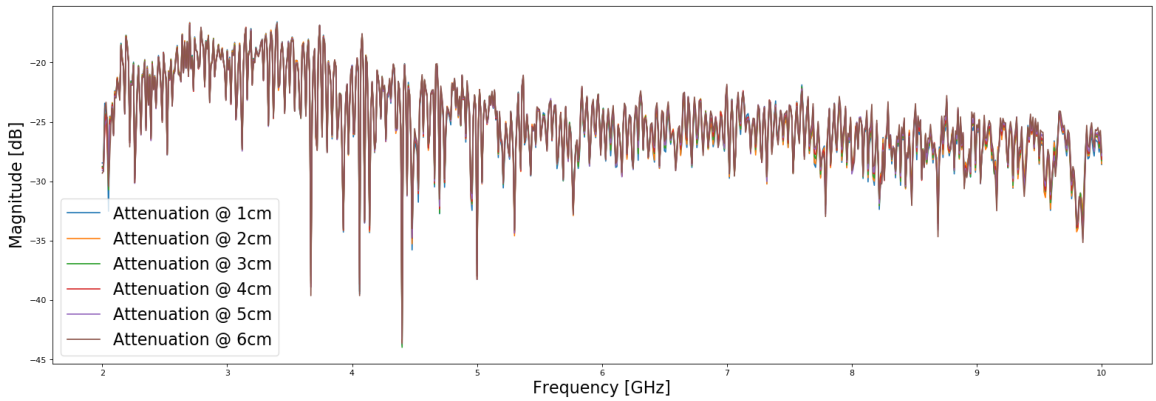
	freq	1cm	2cm	3cm	4cm	5cm	6cm
0	2.00	-28.454065	-28.820662	-28.750020	-28.891305	-29.062282	-29.310724
1	2.01	-28.454065	-28.820662	-28.820662	-28.960820	-29.145096	-29.153768
2	2.02	-23.418741	-25.456951	-24.523269	-25.293156	-25.317845	-23.850367
3	2.03	-24.170530	-24.723717	-24.262664	-24.354170	-24.952919	-23.342110
4	2.04	-26.373291	-26.570419	-24.768732	-26.781945	-24.636193	-25.137584

In [75]:

```
# 画图看下？
df_1cm = df_Mag['1cm']
df_2cm = df_Mag['2cm']
df_3cm = df_Mag['3cm']
df_4cm = df_Mag['4cm']
df_5cm = df_Mag['5cm']
df_6cm = df_Mag['6cm']

arr_1cm = df_1cm.values
arr_2cm = df_2cm.values
arr_3cm = df_3cm.values
arr_4cm = df_4cm.values
arr_5cm = df_5cm.values
arr_6cm = df_6cm.values
```

In [76]:

```
# 画图观察
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 8), dpi=80)

plt.plot(arr_freq
         ,arr_1cm
         ,label = 'Attenuation @ 1cm'
        )

plt.plot(arr_freq
         ,arr_2cm
         ,label = 'Attenuation @ 2cm'
        )

plt.plot(arr_freq
         ,arr_3cm
         ,label = 'Attenuation @ 3cm'
        )

plt.plot(arr_freq
         ,arr_4cm
         ,label = 'Attenuation @ 4cm'
        )

plt.plot(arr_freq
         ,arr_5cm
         ,label = 'Attenuation @ 5cm'
        )

plt.plot(arr_freq
         ,arr_6cm
         ,label = 'Attenuation @ 6cm'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Magnitude [dB]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



In [79]:

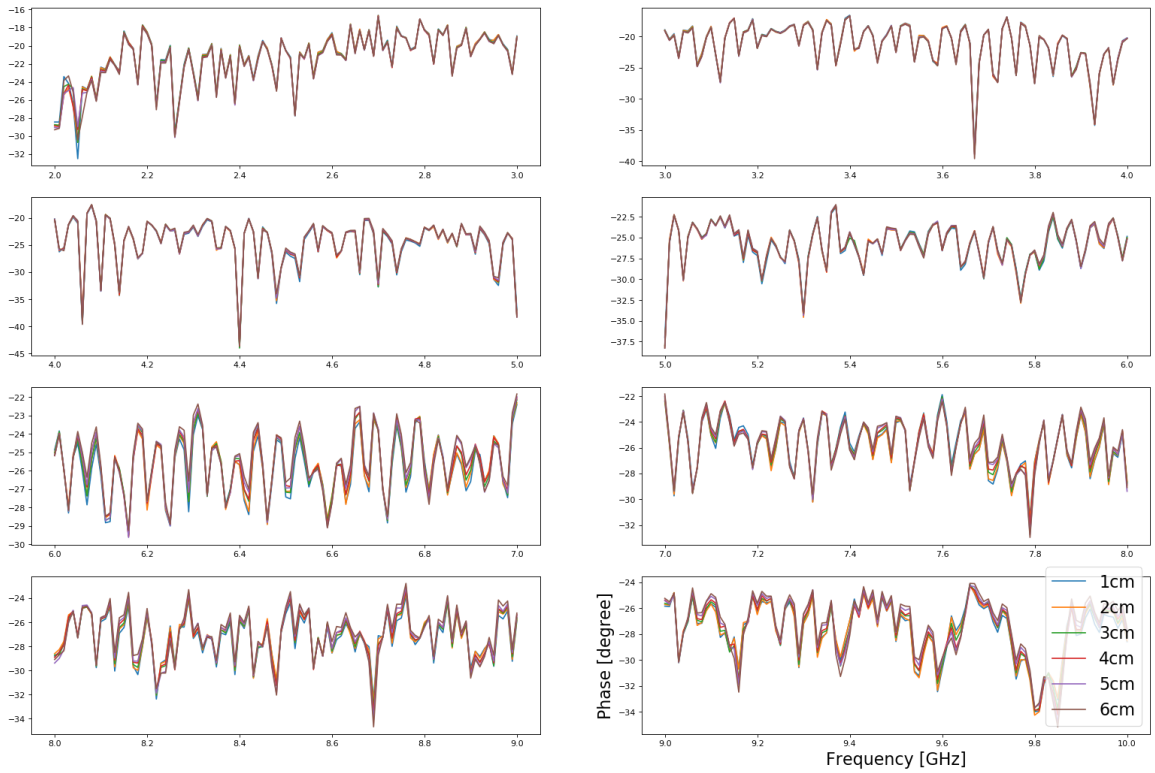
```
# 画一下分段的
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 16), dpi=80)

# set figure # 1
plt.subplot(421)
plt.plot(arr_freq[0:101]
         ,arr_1cm[0:101]
         ,label = '1cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_2cm[0:101]
         ,label = '2cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_3cm[0:101]
         ,label = '3cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_4cm[0:101]
         ,label = '4cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_5cm[0:101]
         ,label = '5cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_6cm[0:101]
         ,label = '6cm'
        )

# set figure # 2
plt.subplot(422)
plt.plot(arr_freq[100:201]
         ,arr_1cm[100:201]
         ,label = '1cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_2cm[100:201]
         ,label = '2cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_3cm[100:201]
         ,label = '3cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_4cm[100:201]
         ,label = '4cm'
        )
```

```
plt.plot(arr_freq[100:201]
         ,arr_5cm[100:201]
         ,label = '5cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_6cm[100:201]
         ,label = '6cm'
        )

# set figure # 3
plt.subplot(423)
plt.plot(arr_freq[200:301]
         ,arr_1cm[200:301]
         ,label = '1cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_2cm[200:301]
         ,label = '2cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_3cm[200:301]
         ,label = '3cm'
        )
plt.plot(arr_freq[200:301]
         ,arr_4cm[200:301]
         ,label = '4cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_5cm[200:301]
         ,label = '5cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_6cm[200:301]
         ,label = '6cm'
        )

# set figure # 4
plt.subplot(424)
plt.plot(arr_freq[300:401]
         ,arr_1cm[300:401]
         ,label = '1cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_2cm[300:401]
         ,label = '2cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_3cm[300:401]
         ,label = '3cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_4cm[300:401]
         ,label = '4cm'
```

```
        )

plt.plot(arr_freq[300:401]
         ,arr_5cm[300:401]
         ,label = '5cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_6cm[300:401]
         ,label = '6cm'
        )

# set figure # 5
plt.subplot(425)
plt.plot(arr_freq[400:501]
         ,arr_1cm[400:501]
         ,label = '1cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_2cm[400:501]
         ,label = '2cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_3cm[400:501]
         ,label = '3cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_4cm[400:501]
         ,label = '4cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_5cm[400:501]
         ,label = '5cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_6cm[400:501]
         ,label = '6cm'
        )

# set figure # 6
plt.subplot(426)
plt.plot(arr_freq[500:601]
         ,arr_1cm[500:601]
         ,label = '1cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_2cm[500:601]
         ,label = '2cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_3cm[500:601]
         ,label = '3cm'
        )
```

```
plt.plot(arr_freq[500:601]
         ,arr_4cm[500:601]
         ,label = '4cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_5cm[500:601]
         ,label = '5cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_6cm[500:601]
         ,label = '6cm'
        )

# set figure # 7
plt.subplot(427)
plt.plot(arr_freq[600:701]
         ,arr_1cm[600:701]
         ,label = '1cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_2cm[600:701]
         ,label = '2cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_3cm[600:701]
         ,label = '3cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_4cm[600:701]
         ,label = '4cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_5cm[600:701]
         ,label = '5cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_6cm[600:701]
         ,label = '6cm'
        )

# set figure # 8
plt.subplot(428)
plt.plot(arr_freq[700:801]
         ,arr_1cm[700:801]
         ,label = '1cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_2cm[700:801]
         ,label = '2cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_3cm[700:801]
```

```
         ,label = '3cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_4cm[700:801]
         ,label = '4cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_5cm[700:801]
         ,label = '5cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_6cm[700:801]
         ,label = '6cm'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Magnitude [dB]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



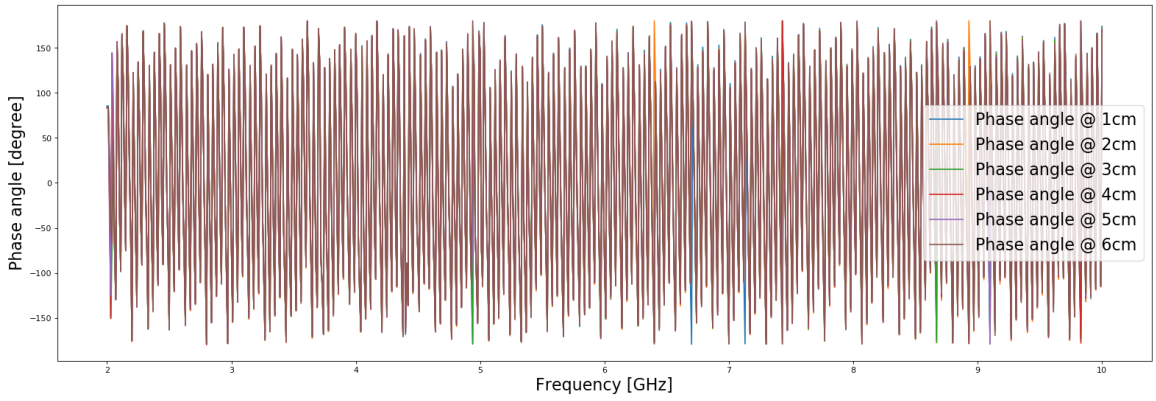
下面画Phase数据

In [77]:

```
# Phase数据
df_Phase_1cm = df_Phase['1cm']
df_Phase_2cm = df_Phase['2cm']
df_Phase_3cm = df_Phase['3cm']
df_Phase_4cm = df_Phase['4cm']
df_Phase_5cm = df_Phase['5cm']
df_Phase_6cm = df_Phase['6cm']

arr_Phase_1cm = df_Phase_1cm.values
arr_Phase_2cm = df_Phase_2cm.values
arr_Phase_3cm = df_Phase_3cm.values
arr_Phase_4cm = df_Phase_4cm.values
arr_Phase_5cm = df_Phase_5cm.values
arr_Phase_6cm = df_Phase_6cm.values
```

In [78]:

```
# 画图观察
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 8), dpi=80)

plt.plot(arr_freq
         ,arr_Phase_1cm
         ,label = 'Phase angle @ 1cm'
        )

plt.plot(arr_freq
         ,arr_Phase_2cm
         ,label = 'Phase angle @ 2cm'
        )

plt.plot(arr_freq
         ,arr_Phase_3cm
         ,label = 'Phase angle @ 3cm'
        )

plt.plot(arr_freq
         ,arr_Phase_4cm
         ,label = 'Phase angle @ 4cm'
        )

plt.plot(arr_freq
         ,arr_Phase_5cm
         ,label = 'Phase angle @ 5cm'
        )

plt.plot(arr_freq
         ,arr_Phase_6cm
         ,label = 'Phase angle @ 6cm'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Phase angle [degree]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



In [80]:

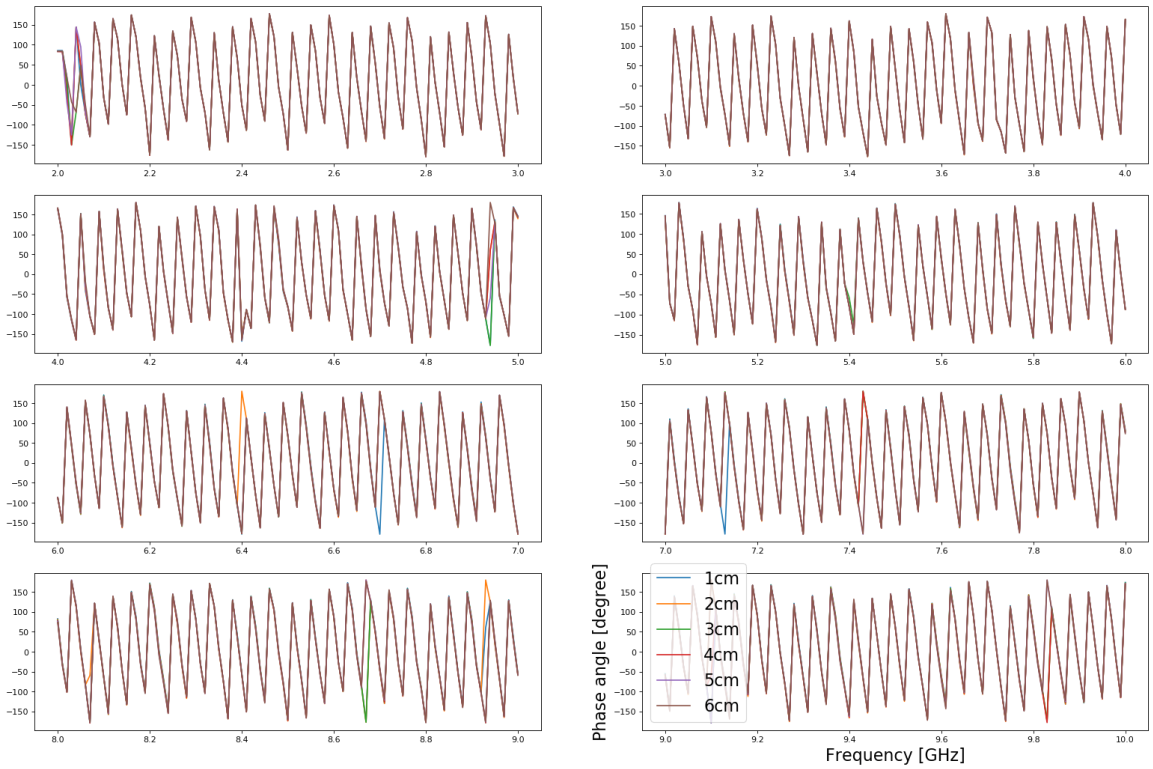
```
# 分段画一下
# 画一下分段的
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 16), dpi=80)

# set figure # 1
plt.subplot(421)
plt.plot(arr_freq[0:101]
         ,arr_Phase_1cm[0:101]
         ,label = '1cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_Phase_2cm[0:101]
         ,label = '2cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_Phase_3cm[0:101]
         ,label = '3cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_Phase_4cm[0:101]
         ,label = '4cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_Phase_5cm[0:101]
         ,label = '5cm'
        )

plt.plot(arr_freq[0:101]
         ,arr_Phase_6cm[0:101]
         ,label = '6cm'
        )

# set figure # 2
plt.subplot(422)
plt.plot(arr_freq[100:201]
         ,arr_Phase_1cm[100:201]
         ,label = '1cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_Phase_2cm[100:201]
         ,label = '2cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_Phase_3cm[100:201]
         ,label = '3cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_Phase_4cm[100:201]
         ,label = '4cm'
        )
```

```
plt.plot(arr_freq[100:201]
         ,arr_Phase_5cm[100:201]
         ,label = '5cm'
        )

plt.plot(arr_freq[100:201]
         ,arr_Phase_6cm[100:201]
         ,label = '6cm'
        )

# set figure # 3
plt.subplot(423)
plt.plot(arr_freq[200:301]
         ,arr_Phase_1cm[200:301]
         ,label = '1cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_Phase_2cm[200:301]
         ,label = '2cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_Phase_3cm[200:301]
         ,label = '3cm'
        )
plt.plot(arr_freq[200:301]
         ,arr_Phase_4cm[200:301]
         ,label = '4cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_Phase_5cm[200:301]
         ,label = '5cm'
        )

plt.plot(arr_freq[200:301]
         ,arr_Phase_6cm[200:301]
         ,label = '6cm'
        )

# set figure # 4
plt.subplot(424)
plt.plot(arr_freq[300:401]
         ,arr_Phase_1cm[300:401]
         ,label = '1cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_Phase_2cm[300:401]
         ,label = '2cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_Phase_3cm[300:401]
         ,label = '3cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_Phase_4cm[300:401]
```

```
         ,label = '4cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_Phase_5cm[300:401]
         ,label = '5cm'
        )

plt.plot(arr_freq[300:401]
         ,arr_Phase_6cm[300:401]
         ,label = '6cm'
        )

# set figure # 5
plt.subplot(425)
plt.plot(arr_freq[400:501]
         ,arr_Phase_1cm[400:501]
         ,label = '1cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_Phase_2cm[400:501]
         ,label = '2cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_Phase_3cm[400:501]
         ,label = '3cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_Phase_4cm[400:501]
         ,label = '4cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_Phase_5cm[400:501]
         ,label = '5cm'
        )

plt.plot(arr_freq[400:501]
         ,arr_Phase_6cm[400:501]
         ,label = '6cm'
        )

# set figure # 6
plt.subplot(426)
plt.plot(arr_freq[500:601]
         ,arr_Phase_1cm[500:601]
         ,label = '1cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_Phase_2cm[500:601]
         ,label = '2cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_Phase_3cm[500:601]
         ,label = '3cm'
        )
```

```
plt.plot(arr_freq[500:601]
         ,arr_Phase_4cm[500:601]
         ,label = '4cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_Phase_5cm[500:601]
         ,label = '5cm'
        )

plt.plot(arr_freq[500:601]
         ,arr_Phase_6cm[500:601]
         ,label = '6cm'
        )

# set figure # 7
plt.subplot(427)
plt.plot(arr_freq[600:701]
         ,arr_Phase_1cm[600:701]
         ,label = '1cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_Phase_2cm[600:701]
         ,label = '2cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_Phase_3cm[600:701]
         ,label = '3cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_Phase_4cm[600:701]
         ,label = '4cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_Phase_5cm[600:701]
         ,label = '5cm'
        )

plt.plot(arr_freq[600:701]
         ,arr_Phase_6cm[600:701]
         ,label = '6cm'
        )

# set figure # 8
plt.subplot(428)
plt.plot(arr_freq[700:801]
         ,arr_Phase_1cm[700:801]
         ,label = '1cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_Phase_2cm[700:801]
         ,label = '2cm'
        )

plt.plot(arr_freq[700:801]
```

```
         ,arr_Phase_3cm[700:801]
         ,label = '3cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_Phase_4cm[700:801]
         ,label = '4cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_Phase_5cm[700:801]
         ,label = '5cm'
        )

plt.plot(arr_freq[700:801]
         ,arr_Phase_6cm[700:801]
         ,label = '6cm'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Phase angle [degree]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



2020年11月5日，继续处理数据

In [ ]:

```
# 1.我先把需要处理的文件夹列一下
path1 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720'
path2 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200721'
path3 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200722'
path4 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723'
```

In [2]:

```
# 测试用
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720'

subdir_list = []
subsirs = []
for subdir in os.listdir(path):
    subsirs.append(subdir)
    subdir_path = os.path.join(path, subdir)
    print(subdir_path)
    subdir_list.append(subdir_path)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15
```

In [3]:

```
# 测试
subdir_list[2]
```

Out[3]:

```
'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720
\\MC-15'
```

In [4]:

```
# 测试用
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC-11.3
9'

subdir_list = []
subsirs = []
for subdir in os.listdir(path):
    subsirs.append(subdir)
    subdir_path = os.path.join(path, subdir)
    print(subdir_path)
    subdir_list.append(subdir_path)
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\6cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\exp_20200720_19.txt
```

In [5]:

```
# 自定义一个函数，只计算某个含水率文件夹内（比如说 MC-11.39）的衰减和相移，好吧，先加载之前保存的参考数据
path_Mag='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Mag.csv'
path_Phase='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Phase.csv'

df_Mag = pd.read_csv(path_Mag)
df_Mag.head()                    # 查看
```

Out[5]:

	freq	1cm	2cm	3cm	4cm	5cm	6cm
0	2.00	-28.454065	-28.820662	-28.750020	-28.891305	-29.062282	-29.310724
1	2.01	-28.454065	-28.820662	-28.820662	-28.960820	-29.145096	-29.153768
2	2.02	-23.418741	-25.456951	-24.523269	-25.293156	-25.317845	-23.850367
3	2.03	-24.170530	-24.723717	-24.262664	-24.354170	-24.952919	-23.342110
4	2.04	-26.373291	-26.570419	-24.768732	-26.781945	-24.636193	-25.137584

In [6]:

```
# 查看
df_Mag.shape
```

Out[6]:

```
(801, 7)
```

In [13]:

```
# 测试
df_Mag['3cm'].head()
```

Out[13]:

```
0   -28.750020
1   -28.820662
2   -24.523269
3   -24.262664
4   -24.768732
Name: 3cm, dtype: float64
```

In [14]:

```
# 测试
arr_3cm = df_Mag['3cm'].values
arr_3cm.shape
```

Out[14]:

```
(801,)
```

In [10]:

```
# 测试，读取相位Phase数据
df_Phase = pd.read_csv(path_Phase)
# 查看
df_Phase.head()
```

Out[10]:

	freq	1cm	2cm	3cm	4cm	5cm	6cm
0	2.00	85.445520	83.659808	84.241997	83.077615	83.480198	83.290163
1	2.01	85.445520	83.659808	83.659808	82.466535	83.416853	83.972648
2	2.02	18.522404	-21.572737	3.206074	-26.750861	-45.496039	18.542382
3	2.03	-149.242700	-124.550249	-149.907089	-150.583531	-125.376702	-42.823537
4	2.04	144.323592	143.371479	-68.227715	143.880659	144.351562	-68.518844

In [11]:

```
# 查看
df_Phase.shape
```

Out[11]:

```
(801, 7)
```

In [24]:

```
# 继续考虑自定义函数，只计算某个含水率文件夹内（比如说 MC-11.39）的衰减和相移，好吧，先加载之前保存的参考数据
def expData_allThickness(path, path_Mag, path_Phase, save_csv=False, mc_folder='MC'):
    '''
    输入：存放各厚度下试验数据的路径，如：'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC-11.39'
    输出：每种厚度下的试验数据（减去参考数据后），包括衰减数据A和相移数据Phi
    作者：张津阳
    日期：2020年11月5日
    '''
    # names = ['freq']
    # Mag_avg_list = []
    # Phase_avg_list = []

    # 读取不同厚度样品盒对应的参考数据
    df_Mag = pd.read_csv(path_Mag)
    df_Phase = pd.read_csv(path_Phase)

    # 准备数据“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 Mag 数据
    df2 = df1.copy()              # 用给Phase数据

    for file in os.listdir(path):
        # names.append(file)                    # 准备用作列名
        file_path = os.path.join(path, file)  # 组合出绝对路径

        # 调用自定义函数，计算 样品 五次重复 测得的试验数据（幅值和相位角）
        Mag_list, Phase_list = refData_singleThickness(file_path)

        #====================================== Part 1 衰减计算 ================================
        # 取出对应厚度的参考数据
        Mag_ref = df_Mag[file].values
        print(file)                       # 调试用，之后可以注释掉！

        for index in range(len(Mag_list)):
            # 先组合出列名
            name = mc_folder + '_' + file + '-' + str(index+1)   # file 是 '1cm' '2cm' '3cm' '4cm' '5cm' '6cm' 中的一种

            # 试验数据
            Mag_exp = Mag_list[index]

            # 计算衰减 A
            arr_A = Mag_exp - Mag_ref

            # 保存数据到 dataframe
            df1[name] = pd.DataFrame(arr_A)

        #====================================== Part 2 相移计算 ================================
        # 取出对应厚度的参考数据
        Phase_ref = df_Phase[file].values

        for index in range(len(Phase_list)):
            # 先组合出列名
            name = mc_folder + '_' + file + '-' + str(index+1)
            # 提取试验数据
```

```
            Phase_exp = Phase_list[index]
            # 计算相移
            arr_Phi = Phase_exp - Phase_ref
            # 保存数据到 dataframe
            df2[name] = pd.DataFrame(arr_Phi)



        # 三次平均
        # Mag_avg = (Mag_list[0] + Mag_list[1] + Mag_list[2]) / 3
        # Phase_avg = (Phase_list[0] + Phase_list[1] + Phase_list[2]) / 3


        # 追加数据
        # Mag_avg_list.append(Mag_avg)
        # Phase_avg_list.append(Phase_avg)
        # df1[file] = pd.DataFrame(Mag_avg)
        # df2[file] = pd.DataFrame(Phase_avg)

    # 上面的for循环结束!
    # 保存数据
    if save_csv:
        # 保存衰减数据
        filename1 = mc_folder + '_A.csv'
        path1 = os.path.join(path, filename1)
        df1.to_csv(path1
                   ,index=False
                  )
        # 保存相移数据
        filename2 = mc_folder + '_Phi.csv'
        path2 = os.path.join(path, filename2)
        df2.to_csv(path2
                   ,index=False
                  )

    return df1, df2     # df1是衰减A数据; df2是相移Phi数据
```

In [12]:

```
# 测试
fruits = ['banana', 'apple',  'mango']
thickness = '1cm'
for index in range(len(fruits)):
    name = thickness + '-' + str(index+1)
    print(name, fruits[index])
```

```
1cm-1 banana
1cm-2 apple
1cm-3 mango
```

In [19]:

```
# 是不是要测试一下上面的自定义函数!
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC-11.39'
path_Mag='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Mag.csv'
path_Phase='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Phase.csv'

df_A, df_Phi = expData_allThickness(path, path_Mag, path_Phase, True, 'MC-11.39')
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\1cm\exp_20200720_1.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\1cm\exp_20200720_2.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\1cm\exp_20200720_3.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\1cm\exp_20200720_4.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\1cm\exp_20200720_5.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\2cm\exp_20200720_10.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\2cm\exp_20200720_6.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\2cm\exp_20200720_7.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\2cm\exp_20200720_8.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\2cm\exp_20200720_9.txt
2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\3cm\exp_20200720_11.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\3cm\exp_20200720_12.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\3cm\exp_20200720_13.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\3cm\exp_20200720_14.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\3cm\exp_20200720_15.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\4cm\exp_20200720_16.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\4cm\exp_20200720_17.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\4cm\exp_20200720_18.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\4cm\exp_20200720_20.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\4cm\exp_20200720_21.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\5cm\exp_20200720_22.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\5cm\exp_20200720_23.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\5cm\exp_20200720_24.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\5cm\exp_20200720_25.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\5cm\exp_20200720_26.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\6cm\exp_20200720_27.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\6cm\exp_20200720_28.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\6cm\exp_20200720_29.txt
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\6cm\exp_20200720_30.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720/MC
-11.39\6cm\exp_20200720_31.txt
6cm
```

In [20]:

```
df_A.shape
```

Out[20]:

```
(801, 31)
```

测试过，上面的自定义函数应该没问题

In [25]:

```
# 接下来继续自定义函数，将每个试验日获取的不同含水率样品的数据读出来

# 继续考虑自定义函数，只计算某个含水率文件夹内（比如说 MC-11.39）的衰减和相移，好吧，先加载之前保存的参考数据
def expData_singleDay(path, path_Mag, path_Phase, save_csv=False, date_folder='2020'):
    '''
    输入：每一个试验日所测试验数据的路径，如：'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720'
    输出：每一个试验日不同含水率样品的试验数据（衰减数据A和相移数据Phi）
    作者：张津阳
    日期：2020年11月5日
    '''

    # 准备数据“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 衰减 数据
    df2 = df1.copy()               # 用给 相移 数据


    for folder in os.listdir(path):     # file 如：'MC-11.39'   'MC-13'    'MC-15'

        file_path = os.path.join(path, folder)  # 组合出带含水率信息的路径

        # 下面两条语句调试用，之后可以注释掉！
        print(folder)
        print(df1.shape)   # 检查数据有没有成功插入到 df1 中

        # 调用自定义函数，计算 某一种含水率样品 在各个厚度下 测得的试验数据（衰减和相移）
        df_A, df_Phi = expData_allThickness(file_path, path_Mag, path_Phase, False, folder)

        # 删除掉频率列
        new_df_A = df_A.drop('freq', axis=1)
        new_df_Phi = df_Phi.drop('freq', axis=1)

        # 向 df1 df2 追加数据
        df1 = pd.concat([df1, new_df_A], axis=1)
        df2 = pd.concat([df2, new_df_Phi], axis=1)


    # 上面的for循环结束！
    # 保存数据
    if save_csv:
        # 保存衰减数据
        filename1 = 'EXP_' + date_folder + '_A.csv'
        path1 = os.path.join(path, filename1)
        df1.to_csv(path1
                   ,index=False
                  )
        # 保存相移数据
        filename2 = 'EXP_' + date_folder + '_Phi.csv'
        path2 = os.path.join(path, filename2)
        df2.to_csv(path2
                   ,index=False
                  )

    return df1, df2     # df1是衰减A数据；df2是相移Phi数据
```

In [23]:

```
# 测试一下上面的 试验日的 自定义函数!
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720'
path_Mag='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Mag.csv'
path_Phase='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Phase.csv'

df_A, df_Phi = expData_singleDay(path, path_Mag, path_Phase, True, '20200720')
```

```
MC-11.39
(801, 1)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\1cm\exp_20200720_1.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\1cm\exp_20200720_2.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\1cm\exp_20200720_3.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\1cm\exp_20200720_4.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\1cm\exp_20200720_5.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\2cm\exp_20200720_10.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\2cm\exp_20200720_6.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\2cm\exp_20200720_7.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\2cm\exp_20200720_8.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\2cm\exp_20200720_9.txt
2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\3cm\exp_20200720_11.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\3cm\exp_20200720_12.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\3cm\exp_20200720_13.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\3cm\exp_20200720_14.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\3cm\exp_20200720_15.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\4cm\exp_20200720_16.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\4cm\exp_20200720_17.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\4cm\exp_20200720_18.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\4cm\exp_20200720_20.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\4cm\exp_20200720_21.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\5cm\exp_20200720_22.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\5cm\exp_20200720_23.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\5cm\exp_20200720_24.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\5cm\exp_20200720_25.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\5cm\exp_20200720_26.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\6cm\exp_20200720_27.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\6cm\exp_20200720_28.txt
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\6cm\exp_20200720_29.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\6cm\exp_20200720_30.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-11.39\6cm\exp_20200720_31.txt
6cm
MC-13
(801, 31)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\1cm\exp_20200720_32.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\1cm\exp_20200720_33.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\1cm\exp_20200720_34.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\1cm\exp_20200720_35.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\1cm\exp_20200720_36.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\2cm\exp_20200720_37.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\2cm\exp_20200720_38.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\2cm\exp_20200720_39.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\2cm\exp_20200720_40.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\2cm\exp_20200720_41.txt
2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\3cm\exp_20200720_42.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\3cm\exp_20200720_43.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\3cm\exp_20200720_44.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\3cm\exp_20200720_45.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\3cm\exp_20200720_46.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\4cm\exp_20200720_47.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\4cm\exp_20200720_48.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\4cm\exp_20200720_49.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\4cm\exp_20200720_50.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\4cm\exp_20200720_51.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\5cm\exp_20200720_52.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\5cm\exp_20200720_53.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\5cm\exp_20200720_54.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\5cm\exp_20200720_55.txt
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\5cm\exp_20200720_56.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\6cm\exp_20200720_57.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\6cm\exp_20200720_58.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\6cm\exp_20200720_59.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\6cm\exp_20200720_60.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-13\6cm\exp_20200720_61.txt
6cm
MC-15
(801, 61)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\1cm\exp_20200720_62.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\1cm\exp_20200720_63.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\1cm\exp_20200720_64.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\1cm\exp_20200720_65.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\1cm\exp_20200720_66.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\2cm\exp_20200720_72.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\2cm\exp_20200720_73.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\2cm\exp_20200720_74.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\2cm\exp_20200720_75.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\2cm\exp_20200720_76.txt
2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\3cm\exp_20200720_67.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\3cm\exp_20200720_68.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\3cm\exp_20200720_69.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\3cm\exp_20200720_70.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\3cm\exp_20200720_71.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\4cm\exp_20200720_77.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\4cm\exp_20200720_78.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\4cm\exp_20200720_79.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\4cm\exp_20200720_80.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\4cm\exp_20200720_81.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
```

```
-15\5cm\exp_20200721_85.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\5cm\exp_20200721_86.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\5cm\exp_20200721_87.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\5cm\exp_20200721_88.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\5cm\exp_20200721_89.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\6cm\exp_20200721_90.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\6cm\exp_20200721_91.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\6cm\exp_20200721_92.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\6cm\exp_20200721_93.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720\MC
-15\6cm\exp_20200721_94.txt
6cm
```

上面的自定义函数，测试应该也没问题！

In [ ]:

```
# 1.我先把需要处理的文件夹列一下
# path1 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200720'
# path2 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200721'
# path3 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200722'
# path4 = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723'

# path_list = [path1, path2, path3, path4]

date_list = ['20200720', '20200721', '20200722', '20200723']
```

In [27]:

```
# 继续自定义函数，处理全部试验日的数据
def expData_allDay(path, path_Mag, path_Phase, date_list, save_csv=False):
    '''
    输入：批量处理全部试验日所测试验数据的路径，如：'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup'
    输出：全部试验日不同含水率样品的试验数据（衰减数据A和相移数据Phi）
    作者：张津阳
    日期：2020年11月5日
    '''

    # 准备数据“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 衰减 数据
    df2 = df1.copy()              # 用给 相移 数据

    for index in range(len(date_list)):

        exp_date = date_list[index]

        print(exp_date)  # 调试语句，后面可以注释掉！
        print(df1.shape)   # 检查数据有没有成功插入到 df1 中

        # 组合出路径，最后是带日期的那种！
        folder_path = os.path.join(path, exp_date)

        # 调用自定义函数
        df_A, df_Phi = expData_singleDay(folder_path, path_Mag, path_Phase, False, exp_date)

        # 删除掉频率列
        new_df_A = df_A.drop('freq', axis=1)
        new_df_Phi = df_Phi.drop('freq', axis=1)

        # 向 df1 df2 追加数据
        df1 = pd.concat([df1, new_df_A], axis=1)
        df2 = pd.concat([df2, new_df_Phi], axis=1)


    # 上面的for循环结束！
    # 保存数据
    if save_csv:
        # 保存衰减数据
        filename1 = 'EXP_A.csv'
        path1 = os.path.join(path, filename1)
        df1.to_csv(path1
                   ,index=False
                  )
        # 保存相移数据
        filename2 = 'EXP_Phi.csv'
        path2 = os.path.join(path, filename2)
        df2.to_csv(path2
                   ,index=False
                  )

    return df1, df2     # df1是衰减A数据；df2是相移Phi数据
```

In [28]:

```
# 测试一下上面的 处理全部试验日数据的 自定义函数!
path = 'G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup'
path_Mag='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Mag.csv'
path_Phase='G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup/20200723-sample_holder/refData_Phase.csv'

date_list = ['20200720', '20200721', '20200722', '20200723']

df_A, df_Phi = expData_allDay(path, path_Mag, path_Phase, date_list, True)
```

```
20200720
(801, 1)
MC-11.39
(801, 1)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\1cm\exp_20200720_1.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\1cm\exp_20200720_2.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\1cm\exp_20200720_3.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\1cm\exp_20200720_4.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\1cm\exp_20200720_5.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\2cm\exp_20200720_10.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\2cm\exp_20200720_6.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\2cm\exp_20200720_7.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\2cm\exp_20200720_8.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\2cm\exp_20200720_9.txt
2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\3cm\exp_20200720_11.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\3cm\exp_20200720_12.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\3cm\exp_20200720_13.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\3cm\exp_20200720_14.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\3cm\exp_20200720_15.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\4cm\exp_20200720_16.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\4cm\exp_20200720_17.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\4cm\exp_20200720_18.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\4cm\exp_20200720_20.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\4cm\exp_20200720_21.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\5cm\exp_20200720_22.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\5cm\exp_20200720_23.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\5cm\exp_20200720_24.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\5cm\exp_20200720_25.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\5cm\exp_20200720_26.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\6cm\exp_20200720_27.txt
```

```
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\6cm\exp_20200720_28.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\6cm\exp_20200720_29.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\6cm\exp_20200720_30.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-11.39\6cm\exp_20200720_31.txt
6cm
MC-13
(801, 31)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\1cm\exp_20200720_32.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\1cm\exp_20200720_33.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\1cm\exp_20200720_34.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\1cm\exp_20200720_35.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\1cm\exp_20200720_36.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\2cm\exp_20200720_37.txt
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-13\2cm\exp_20200720_39.txt
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-13\2cm\exp_20200720_40.txt
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-13\3cm\exp_20200720_42.txt
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-13\3cm\exp_20200720_43.txt
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```

```
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5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-13\6cm\exp_20200720_57.txt
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-13\6cm\exp_20200720_58.txt
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6cm
MC-15
(801, 61)
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\4cm\exp_20200720_77.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\4cm\exp_20200720_78.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\4cm\exp_20200720_79.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\4cm\exp_20200720_80.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\4cm\exp_20200720_81.txt
```

```
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\5cm\exp_20200721_85.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\5cm\exp_20200721_86.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\5cm\exp_20200721_87.txt
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-15\5cm\exp_20200721_88.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\5cm\exp_20200721_89.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\6cm\exp_20200721_90.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\6cm\exp_20200721_91.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\6cm\exp_20200721_92.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\6cm\exp_20200721_93.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200720\MC
-15\6cm\exp_20200721_94.txt
6cm
20200721
(801, 91)
MC-18
(801, 1)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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-18\1cm\exp_20200721_102.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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-18\1cm\exp_20200721_105.txt
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-18\2cm\exp_20200721_107.txt
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-18\2cm\exp_20200721_108.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\2cm\exp_20200721_109.txt
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-18\2cm\exp_20200721_110.txt
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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-18\3cm\exp_20200721_112.txt
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-18\3cm\exp_20200721_113.txt
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-18\3cm\exp_20200721_114.txt
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-18\3cm\exp_20200721_115.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
```

```
-18\4cm\exp_20200721_116.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\4cm\exp_20200721_117.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\4cm\exp_20200721_118.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\4cm\exp_20200721_119.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\4cm\exp_20200721_120.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\5cm\exp_20200721_121.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-18\5cm\exp_20200721_123.txt
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-18\6cm\exp_20200721_128.txt
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-18\6cm\exp_20200721_129.txt
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(801, 31)
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-20\1cm\exp_20200721_132.txt
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-20\1cm\exp_20200721_133.txt
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-20\1cm\exp_20200721_134.txt
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-20\1cm\exp_20200721_135.txt
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-20\2cm\exp_20200721_138.txt
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
-20\3cm\exp_20200721_141.txt
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-20\4cm\exp_20200721_149.txt
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-20\5cm\exp_20200721_155.txt
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-20\6cm\exp_20200721_157.txt
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-20\6cm\exp_20200721_158.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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MC-23
(801, 61)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200721\MC
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MC-25
(801, 91)
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20200722
(801, 211)
MC-20-2
(801, 1)
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200722\MC
-20-2\6cm\exp_20200722_127.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200722\MC
-20-2\6cm\exp_20200722_128.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200722\MC
-20-2\6cm\exp_20200722_129.txt
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6cm
MC-23-2
(801, 31)
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(801, 331)
MC-10
(801, 1)
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(801, 31)
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G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-28-2\6cm\exp_20200723_222.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-28-2\6cm\exp_20200723_223.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-28-2\6cm\exp_20200723_224.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-28-2\6cm\exp_20200723_225.txt
6cm
MC-30-2
(801, 91)
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\1cm\exp_20200723_131.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\1cm\exp_20200723_132.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\1cm\exp_20200723_133.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\1cm\exp_20200723_134.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\1cm\exp_20200723_135.txt
1cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\2cm\exp_20200723_136.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
```

-30-2\2cm\exp_20200723_137.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\2cm\exp_20200723_138.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\2cm\exp_20200723_139.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\2cm\exp_20200723_140.txt
2cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\3cm\exp_20200723_141.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\3cm\exp_20200723_142.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\3cm\exp_20200723_143.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\3cm\exp_20200723_144.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\3cm\exp_20200723_145.txt
3cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\4cm\exp_20200723_146.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\4cm\exp_20200723_147.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\4cm\exp_20200723_148.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\4cm\exp_20200723_149.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\4cm\exp_20200723_150.txt
4cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\5cm\exp_20200723_151.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\5cm\exp_20200723_152.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\5cm\exp_20200723_153.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\5cm\exp_20200723_154.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\5cm\exp_20200723_155.txt
5cm
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\6cm\exp_20200723_156.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\6cm\exp_20200723_157.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\6cm\exp_20200723_158.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\6cm\exp_20200723_159.txt
G:/202006-202008_rice_experiment/database_info_txt_files_withid-Backup\20200723\MC
-30-2\6cm\exp_20200723_160.txt
6cm

In [29]:

```
# 查看
df_A.shape
```

Out[29]:

(801, 451)

In [30]:

```
df_Phi.shape
```

Out[30]:

(801, 451)

In [ ]:

```
#### 那么，批量处理数据的代码就基本完成了！！  2020年11月5日
#### 但是批量处理的结果又对不对呢？ 怎么验证？
#### 另外，VNA的数据的批量处理呢，明天继续搞VNA数据的批量处理
```

In [ ]:

```
#### 2020年11月6日，继续VNA数据的批量处理
```

1.先处理VNA参考数据

In [17]:

```
# 我目前的想法是写一个函数，专门用于处理 VNA采集的csv文件，只需要输入csv文件的路径就可以得到 ndarray类型的数据

def getData_csv(filepath):
    '''
    输入：VNA采集的csv文件的路径
    输出：中间一列的数据，类型：ndarray
    作者：张津阳
    日期：2020年10月10日
    '''

    # step 1.加载原数据
    df = pd.read_csv(filepath
                     ,header=None
                     ,delimiter='\t'
                    )
    # step 2.去掉前3行
    df_drop = df.drop([0, 1, 2], axis=0)

    # step 3.拆分dataframe
    df_drop_split = df_drop[0].str.split(',', expand=True)

    # step 4.修改列名
    df_drop_split.columns = ['Frequency', 'Formatted Data', 'Formatted Data.1']

    # step 5.修改行索引 index
    df_drop_split.index = range(len(df_drop_split))

    # step 6.使用df.astype()强制类型转换
    df_drop_split['Formatted Data'] = df_drop_split['Formatted Data'].astype('float')

    # step 7.获取其中的有效数据，也就是中间一列
    data = df_drop_split['Formatted Data'].values

    return data
```

In [18]:

```
# 目前的思路，要写一个自定义函数，处理某一厚度下的csv数据
def VNA_refData_singleThickness(path):
    '''
    输入：保存某一厚度样品盒参考数据的文件夹路径，如：'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/1cm'
    输出：三次重复试验的数据（幅值、相位角、扩展相位角）
    作者：张津阳
    日期：2020年11月6日
    '''
    Mag_list = []
    Phase_list = []
    expandPhase_list = []

    for file in os.listdir(path):
        # step 1.合成txt文件名
        file_path = os.path.join(path, file)
        print(file_path)                          # 测试用

        # step 2.调用自定义函数，计算VNA测得的数据，格式是 numpy 的 ndarray
        data = getData_csv(file_path)

        # step 3.追加数据
        if 'MAG' in file:
            # Mag_list.append(file_path)
            Mag_list.append(data)        # 幅值

        elif 'EXPAND' in file:
            # expandPhase_list.append(file_path)
            expandPhase_list.append(data)        # 扩展相位角

        else:
            # Phase_list.append(file_path)
            Phase_list.append(data)         # 相位角

    return Mag_list, Phase_list, expandPhase_list
```

In [2]:

```
# 测试用
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolde
r/1cm'

subdir_list = []
subsirs = []
for subdir in os.listdir(path):
    subsirs.append(subdir)
    subdir_path = os.path.join(path, subdir)
    print(subdir_path)
    subdir_list.append(subdir_path)
```

```
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_03_S21_PHASE.CSV
```

In [3]:

```
subsirs[0]
```

Out[3]:

```
'1CM_01_S21_EXPANDPHASE.CSV'
```

In [8]:

```
if 'EXPAND' in subsirs[0]:   # 注意 python区分大小写，expand 与 EXPAND 不一样
    print('发现扩展相位')
```

```
发现扩展相位
```

In [13]:

```
# 测试用
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolde
r/1cm'

Mag_list, Phase_list, expandPhase_list = VNA_refData_singleThickness(path)
```

```
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder/1cm\1CM_03_S21_PHASE.CSV
```

In [14]:

```
# 查看
Mag_list
```

Out[14]:

```
['G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_01_S21_LOGMAG.CSV',
 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_02_S21_LOGMAG.CSV',
 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_03_S21_LOGMAG.CSV']
```

In [15]:

```
# 查看
Phase_list
```

Out[15]:

```
['G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_01_S21_PHASE.CSV',
 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_02_S21_PHASE.CSV',
 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_03_S21_PHASE.CSV']
```

In [16]:

```
# 查看
expandPhase_list
```

Out[16]:

```
['G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_01_S21_EXPANDPHASE.CSV',
 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_02_S21_EXPANDPHASE.CSV',
 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sam
pleHolder/1cm\\1CM_03_S21_EXPANDPHASE.CSV']
```

这说明可以区分开各文件

In [21]:

```
# 自定义一个函数，处理全部的参考数据
def VNA_refData_allThickness(path):
    '''
    输入：存放VNA测得的各个厚度样品盒参考数据的路径
          如：'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder'
    输出：每种厚度样品盒的参考数据（取三次平均后的），包括幅值数据、相位角数据、扩展相位角数据
    作者：张津阳
    日期：2020年11月6日
    '''

    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 Mag 数据
    df2 = df1.copy()              # 用给Phase数据
    df3 = df1.copy()              # 用给ExpandPhase数据

    for file in os.listdir(path):   # 6种厚度，理论上讲就是循环 6 次
         # 组合出绝对路径，file 是 '1cm' or '2cm' or '3cm' or '4cm' or '5cm' or '6cm'
        file_path = os.path.join(path, file)
        print(file) # 调试用，后面可以注释掉！

        # 调用自定义函数，计算三次重复测得的幅值和相位角
        Mag_list, Phase_list, expandPhase_list = VNA_refData_singleThickness(file_path)

        # 三次平均
        Mag_avg = (Mag_list[0] + Mag_list[1] + Mag_list[2]) / 3
        Phase_avg = (Phase_list[0] + Phase_list[1] + Phase_list[2]) / 3
        expandPhase_avg = (expandPhase_list[0] + expandPhase_list[1] + expandPhase_list[2]) / 3

        # 追加数据
        df1[file] = pd.DataFrame(Mag_avg)
        df2[file] = pd.DataFrame(Phase_avg)
        df3[file] = pd.DataFrame(expandPhase_avg)

    # 保存数据
    path1 = os.path.join(path, 'VNA_refData_Mag.csv')
    path2 = os.path.join(path, 'VNA_refData_Phase.csv')
    path3 = os.path.join(path, 'VNA_refData_expandPhase.csv')

    df1.to_csv(path1
               ,index=False
              )
    df2.to_csv(path2
               ,index=False
              )
    df3.to_csv(path3
               ,index=False
              )


    return df1, df2, df3     # df1是Mag数据，(801,6)；df2是Phase数据，(801,6)
```

In [22]:

```
# 测试一下上面的自定义函数!
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolde
r'

df_Mag, df_Phase, df_expandPhase = VNA_refData_allThickness(path)
```

```
1cm
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\1cm\1CM_03_S21_PHASE.CSV
2cm
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\2cm\2CM_03_S21_PHASE.CSV
3cm
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\3cm\3CM_03_S21_PHASE.CSV
4cm
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
```

```
eHolder\4cm\4CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\4cm\4CM_03_S21_PHASE.CSV
5cm
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\5cm\5CM_03_S21_PHASE.CSV
6cm
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_01_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_01_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_01_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_02_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_02_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_02_S21_PHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_03_S21_EXPANDPHASE.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_03_S21_LOGMAG.CSV
G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/Sampl
eHolder\6cm\6CM_03_S21_PHASE.CSV
```

In [ ]:

```
#### 反正格式是没问题，excel中查看也正常，但是数据的计算需要后面绘图、分析才能直到对不对！

#### 下一步：有了参考数据，可以开始考虑做试验数据的批量处理了！
```

开始做试验数据的批量处理，2020年11月7日

In [36]:

```
# 继续考虑自定义函数，只计算某个含水率文件夹内（比如说 MC-11.39）的衰减和相移，好吧，先加载之前保存的参考数据
def VNA_expData_allThickness(path, path_Mag, path_Phase, path_expandPhase, save_csv=False, mc_folder='MC'):
    '''
    输入：VNA对某一含水率样品在各个厚度获取的试验数据的路径，如：'G:/202006-202008_rice_experiment/rice experiment-20200626/20200720-TraceData/MC-11.39'
    输出：某一含水率样品在各个厚度下的试验数据（减去参考数据后），包括衰减数据A、相移数据Phi、以及由Expand Phase计算的Phi
    作者：张津阳
    日期：2020年11月7日
    '''

    # 读取不同厚度样品盒对应的参考数据
    df_Mag = pd.read_csv(path_Mag)
    df_Phase = pd.read_csv(path_Phase)
    df_expandPhase = pd.read_csv(path_expandPhase)

    # 准备数据“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 Mag 数据
    df2 = df1.copy()               # 用给Phase数据
    df3 = df1.copy()               # 用给Expand Phase数据

    for file in os.listdir(path):

        file_path = os.path.join(path, file)  # 组合出绝对路径
        print(file)  # 调试用，后面可以注释掉！
        print(df1.shape) # 检查数据有没有成功插入 df1, df2, df3 中

        # 调用自定义函数，计算VNA测得的数据，格式是 numpy 的 ndarray
        expData = getData_csv(file_path)

        # 切割字符串
        str_list = file.split('.')
        csv_name = str_list[0]

        # 1.先判断是哪种厚度
        if '1CM' in csv_name:

            # 处理1cm样品的数据
            refData_Mag = df_Mag['1cm'].values
            refData_Phase = df_Phase['1cm'].values
            refData_expandPhase = df_expandPhase['1cm'].values


            if 'MAG' in csv_name:
                data = expData - refData_Mag
                df1[mc_folder + csv_name] = pd.DataFrame(data)    # Mag数据
            elif 'EXPAND' in csv_name:
                data = expData - refData_expandPhase
                df3[mc_folder + csv_name] = pd.DataFrame(data)    # ExpandPhase数据
            else:
                data = expData - refData_Phase
                df2[mc_folder + csv_name] = pd.DataFrame(data)    # Phase数据


        elif '2CM' in csv_name:
```

```
            # 处理2cm样品的数据
            refData_Mag = df_Mag['2cm'].values
            refData_Phase = df_Phase['2cm'].values
            refData_expandPhase = df_expandPhase['2cm'].values

            if 'MAG' in csv_name:
                data = expData - refData_Mag
                df1[mc_folder + csv_name] = pd.DataFrame(data)    # Mag数据
            elif 'EXPAND' in csv_name:
                data = expData - refData_expandPhase
                df3[mc_folder + csv_name] = pd.DataFrame(data)    # ExpandPhase数据
            else:
                data = expData - refData_Phase
                df2[mc_folder + csv_name] = pd.DataFrame(data)    # Phase数据

        elif '3CM' in csv_name:

            # 处理3cm样品的数据
            refData_Mag = df_Mag['3cm'].values
            refData_Phase = df_Phase['3cm'].values
            refData_expandPhase = df_expandPhase['3cm'].values

            if 'MAG' in csv_name:
                data = expData - refData_Mag
                df1[mc_folder + csv_name] = pd.DataFrame(data)    # Mag数据
            elif 'EXPAND' in csv_name:
                data = expData - refData_expandPhase
                df3[mc_folder + csv_name] = pd.DataFrame(data)    # ExpandPhase数据
            else:
                data = expData - refData_Phase
                df2[mc_folder + csv_name] = pd.DataFrame(data)    # Phase数据

        elif '4CM' in csv_name:

            # 处理4cm样品的数据
            refData_Mag = df_Mag['4cm'].values
            refData_Phase = df_Phase['4cm'].values
            refData_expandPhase = df_expandPhase['4cm'].values

            if 'MAG' in csv_name:
                data = expData - refData_Mag
                df1[mc_folder + csv_name] = pd.DataFrame(data)    # Mag数据
            elif 'EXPAND' in csv_name:
                data = expData - refData_expandPhase
                df3[mc_folder + csv_name] = pd.DataFrame(data)    # ExpandPhase数据
            else:
                data = expData - refData_Phase
                df2[mc_folder + csv_name] = pd.DataFrame(data)    # Phase数据

        elif '5CM' in csv_name:

            # 处理5cm样品的数据
            refData_Mag = df_Mag['5cm'].values
            refData_Phase = df_Phase['5cm'].values
            refData_expandPhase = df_expandPhase['5cm'].values

            if 'MAG' in csv_name:
                data = expData - refData_Mag
                df1[mc_folder + csv_name] = pd.DataFrame(data)    # Mag数据
            elif 'EXPAND' in csv_name:
                data = expData - refData_expandPhase
```

```
                df3[mc_folder + csv_name] = pd.DataFrame(data)    # ExpandPhase数据
            else:
                data = expData - refData_Phase
                df2[mc_folder + csv_name] = pd.DataFrame(data)    # Phase数据

        elif '6CM' in csv_name:

            # 处理6cm样品的数据
            refData_Mag = df_Mag['6cm'].values
            refData_Phase = df_Phase['6cm'].values
            refData_expandPhase = df_expandPhase['6cm'].values

            if 'MAG' in csv_name:
                data = expData - refData_Mag
                df1[mc_folder + csv_name] = pd.DataFrame(data)    # Mag数据
            elif 'EXPAND' in csv_name:
                data = expData - refData_expandPhase
                df3[mc_folder + csv_name] = pd.DataFrame(data)    # ExpandPhase数据
            else:
                data = expData - refData_Phase
                df2[mc_folder + csv_name] = pd.DataFrame(data)    # Phase数据

        else:
            print('出现异常文件!')


    # 上面的for循环结束!  应该是有多少个csv文件，循环就执行多少次!
    # 保存数据
    if save_csv:

        # 注意!  先获取上一级目录
        parent_path = os.path.abspath(os.path.join(path, "..."))

        # 保存衰减数据
        filename1 = 'VNA_' + mc_folder + '_A.csv'
        path1 = os.path.join(parent_path, filename1)
        df1.to_csv(path1
                   ,index=False
                  )

        # 保存相移数据
        filename2 = 'VNA_' + mc_folder + '_Phi.csv'
        path2 = os.path.join(parent_path, filename2)
        df2.to_csv(path2
                   ,index=False
                  )

        # 保存 由扩展相位角 Expand Phase 计算出的 相移 Phi
        filename3 = 'VNA_' + mc_folder + '_Phi_by_expandPhase.csv'
        path3 = os.path.join(parent_path, filename3)
        df3.to_csv(path3
                   ,index=False
                  )


    return df1, df2, df3     # df1是衰减A数据；df2是相移Phi数据；df3是由扩展相位角 Expand Phase
计算出的 相移 Phi
```

In [23]:

```
# 测试
str1 = '1CM_SAMPLE01_S21_LOGMAGE.csv'

thickness = str1.split('_', 1)
```

In [24]:

```
thickness
```

Out[24]:

```
['1CM', 'SAMPLE01_S21_LOGMAGE.csv']
```

In [25]:

```
thickness = str1.split('_')
thickness
```

Out[25]:

```
['1CM', 'SAMPLE01', 'S21', 'LOGMAGE.csv']
```

In [26]:

```
thickness = str1.split('.')
thickness
```

Out[26]:

```
['1CM_SAMPLE01_S21_LOGMAGE', 'csv']
```

In [27]:

```
thickness[0]
```

Out[27]:

```
'1CM_SAMPLE01_S21_LOGMAGE'
```

In [29]:

```
# 测试
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200720-TraceData/MC-11.39'
parent_path = os.path.abspath(os.path.join(path, "..."))
print(parent_path)
```

```
G:\202006-202008_rice_experiment\rice experiment-20200626\20200720-TraceData
```

In [31]:

```
# 测试一下，上面的自定义函数，处理某个含水率下，各个厚度的试验数据（由VNA采集的）
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200720-TraceData/MC-11.39'
path_Mag = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/VNA_refData_Mag.csv'
path_Phase = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/VNA_refData_Phase.csv'
path_expandPhase = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/VNA_refData_expandPhase.csv'

df_A, df_Phi, df_Phi_EP=VNA_expData_allThickness(path, path_Mag, path_Phase, path_expandPhase, True, 'MC-11.39')

# 记得整理文件夹里的文件，移动掉无关的csv文件！
print('Done!')
```

```
1CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 1)
1CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 1)
1CM_SAMPLE01_S21_PHASE.CSV
(801, 2)
1CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 2)
1CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 2)
1CM_SAMPLE02_S21_PHASE.CSV
(801, 3)
1CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 3)
1CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 3)
1CM_SAMPLE03_S21_PHASE.CSV
(801, 4)
1CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 4)
1CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 4)
1CM_SAMPLE04_S21_PHASE.CSV
(801, 5)
1CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 5)
1CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 5)
1CM_SAMPLE05_S21_PHASE.CSV
(801, 6)
2CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 6)
2CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 6)
2CM_SAMPLE01_S21_PHASE.CSV
(801, 7)
2CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 7)
2CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 7)
2CM_SAMPLE02_S21_PHASE.CSV
(801, 8)
2CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 8)
2CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 8)
2CM_SAMPLE03_S21_PHASE.CSV
(801, 9)
2CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 9)
2CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 9)
2CM_SAMPLE04_S21_PHASE.CSV
(801, 10)
2CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 10)
2CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 10)
2CM_SAMPLE05_S21_PHASE.CSV
(801, 11)
3CM_SAMPLE01_S21_EXPANDPHASE.CSV
```

```
(801, 11)
3CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 11)
3CM_SAMPLE01_S21_PHASE.CSV
(801, 12)
3CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 12)
3CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 12)
3CM_SAMPLE02_S21_PHASE.CSV
(801, 13)
3CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 13)
3CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 13)
3CM_SAMPLE03_S21_PHASE.CSV
(801, 14)
3CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 14)
3CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 14)
3CM_SAMPLE04_S21_PHASE.CSV
(801, 15)
3CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 15)
3CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 15)
3CM_SAMPLE05_S21_PHASE.CSV
(801, 16)
4CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 16)
4CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 16)
4CM_SAMPLE01_S21_PHASE.CSV
(801, 17)
4CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 17)
4CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 17)
4CM_SAMPLE02_S21_PHASE.CSV
(801, 18)
4CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 18)
4CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 18)
4CM_SAMPLE03_S21_PHASE.CSV
(801, 19)
4CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 19)
4CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 19)
4CM_SAMPLE04_S21_PHASE.CSV
(801, 20)
4CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 20)
4CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 20)
4CM_SAMPLE05_S21_PHASE.CSV
(801, 21)
5CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 21)
```

```
5CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 21)
5CM_SAMPLE01_S21_PHASE.CSV
(801, 22)
5CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 22)
5CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 22)
5CM_SAMPLE02_S21_PHASE.CSV
(801, 23)
5CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 23)
5CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 23)
5CM_SAMPLE03_S21_PHASE.CSV
(801, 24)
5CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 24)
5CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 24)
5CM_SAMPLE04_S21_PHASE.CSV
(801, 25)
5CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 25)
5CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 25)
5CM_SAMPLE05_S21_PHASE.CSV
(801, 26)
6CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 26)
6CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 26)
6CM_SAMPLE01_S21_PHASE.CSV
(801, 27)
6CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 27)
6CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 27)
6CM_SAMPLE02_S21_PHASE.CSV
(801, 28)
6CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 28)
6CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 28)
6CM_SAMPLE03_S21_PHASE.CSV
(801, 29)
6CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 29)
6CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 29)
6CM_SAMPLE04_S21_PHASE.CSV
(801, 30)
6CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 30)
6CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 30)
6CM_SAMPLE05_S21_PHASE.CSV
(801, 31)
Done!
```

In [32]:

```
# 测试
df_A.shape, df_Phi.shape, df_Phi_EP.shape
```

Out[32]:

((801, 31), (801, 31), (801, 31))

In [37]:

```
# 接下来继续自定义函数，将每个试验日VNA获取的不同含水率样品的数据读出来

# 继续考虑自定义函数，只计算某个含水率文件夹内（比如说 MC-11.39）的衰减和相移，好吧，先加载之前保存的参考数据
def VNA_expData_singleDay(path, path_Mag, path_Phase, path_expandPhase, save_csv=False, date_folder='2020'):
    '''
    输入：每一个试验日VNA所测试验数据的路径，如：'G:/202006-202008_rice_experiment/rice experiment-20200626/20200720-TraceData'
    输出：每一个试验日不同含水率样品的VNA试验数据（衰减数据A、相移数据Phi、以及由Expand Phase计算的相移Phi）
    作者：张津阳
    日期：2020年11月7日
    '''

    # 准备数据“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 衰减 数据
    df2 = df1.copy()               # 用给 相移 数据
    df3 = df1.copy()               # 由 Expand Phase计算出的 Phi

    for folder in os.listdir(path):  # folder 如：'MC-11.39'   'MC-13'    'MC-15'

        file_path = os.path.join(path, folder)  # 组合出带含水率信息的路径

        # 下面两条语句调试用，之后可以注释掉！
        print(folder)
        print(df1.shape)   # 检查数据有没有成功插入到 df1 中


        # 调用自定义函数，计算 某一种含水率样品 在各个厚度下 测得的试验数据（衰减和相移）
        df_A, df_Phi, df_Phi_EP=VNA_expData_allThickness(file_path, path_Mag, path_Phase, path_expandPhase, False, folder)


        # 删除掉频率列
        new_df_A = df_A.drop('freq', axis=1)
        new_df_Phi = df_Phi.drop('freq', axis=1)
        new_df_Phi_EP = df_Phi_EP.drop('freq', axis=1)


        # 向 df1 df2 df3 追加数据
        df1 = pd.concat([df1, new_df_A], axis=1)
        df2 = pd.concat([df2, new_df_Phi], axis=1)
        df3 = pd.concat([df3, new_df_Phi_EP], axis=1)


    # 上面的for循环结束！ 应该是有几个含水率的文件夹，循环就执行多少次！
    # 保存数据
    if save_csv:

        # 先获取上一级目录
        parent_path = os.path.abspath(os.path.join(path, ".."))

        # 保存衰减数据
        filename1 = 'VNA_EXP_' + date_folder + '_A.csv'
        path1 = os.path.join(parent_path, filename1)
        df1.to_csv(path1
                   ,index=False
```

```
                )

        # 保存相移数据
        filename2 = 'VNA_EXP_' + date_folder + '_Phi.csv'
        path2 = os.path.join(parent_path, filename2)
        df2.to_csv(path2
                   ,index=False
                  )

        # 保存 由 Expand Phase计算的 相移 Phi
        filename3 = 'VNA_EXP_' + date_folder + '_Phi_by_expandPhase.csv'
        path3 = os.path.join(parent_path, filename3)
        df3.to_csv(path3
                   ,index=False
                  )


    return df1, df2, df3     # df1是衰减A数据；df2是相移Phi数据；df3是由扩展相位角 Expand Phase
计算出的 相移 Phi
```

In [34]:

```
# 测试上面的自定义函数
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200720-TraceData'
path_Mag = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/VNA_refData_Mag.csv'
path_Phase = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/VNA_refData_Phase.csv'
path_expandPhase = 'G:/202006-202008_rice_experiment/rice experiment-20200626/20200723-TraceData/SampleHolder/VNA_refData_expandPhase.csv'

df_A, df_Phi, df_Phi_EP=VNA_expData_singleDay(path, path_Mag, path_Phase, path_expandPhase, True, '20200720')

# 记得整理文件夹里的文件，移动掉无关的csv文件！
print('Done!')
```

```
MC-11.39
(801, 1)
1CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 1)
1CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 1)
1CM_SAMPLE01_S21_PHASE.CSV
(801, 2)
1CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 2)
1CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 2)
1CM_SAMPLE02_S21_PHASE.CSV
(801, 3)
1CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 3)
1CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 3)
1CM_SAMPLE03_S21_PHASE.CSV
(801, 4)
1CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 4)
1CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 4)
1CM_SAMPLE04_S21_PHASE.CSV
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1CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 5)
1CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 5)
1CM_SAMPLE05_S21_PHASE.CSV
(801, 6)
2CM_SAMPLE01_S21_EXPANDPHASE.CSV
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2CM_SAMPLE01_S21_LOGMAGE.CSV
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2CM_SAMPLE01_S21_PHASE.CSV
(801, 7)
2CM_SAMPLE02_S21_EXPANDPHASE.CSV
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2CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 7)
2CM_SAMPLE02_S21_PHASE.CSV
(801, 8)
2CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 8)
2CM_SAMPLE03_S21_LOGMAGE.CSV
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(801, 10)
2CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 10)
2CM_SAMPLE05_S21_PHASE.CSV
```

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(801, 11)
3CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 11)
3CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 11)
3CM_SAMPLE01_S21_PHASE.CSV
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(801, 12)
3CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 12)
3CM_SAMPLE02_S21_PHASE.CSV
(801, 13)
3CM_SAMPLE03_S21_EXPANDPHASE.CSV
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3CM_SAMPLE05_S21_LOGMAGE.CSV
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4CM_SAMPLE01_S21_PHASE.CSV
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4CM_SAMPLE02_S21_LOGMAGE.CSV
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4CM_SAMPLE02_S21_PHASE.CSV
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(801, 20)
4CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 20)
4CM_SAMPLE05_S21_PHASE.CSV
(801, 21)
```

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5CM_SAMPLE01_S21_EXPANDPHASE.CSV
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5CM_SAMPLE01_S21_PHASE.CSV
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(801, 23)
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(801, 29)
6CM_SAMPLE04_S21_PHASE.CSV
(801, 30)
6CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 30)
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MC-13
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1CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 2)
1CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 2)
1CM_SAMPLE02_S21_PHASE.CSV
(801, 3)
1CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 3)
1CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 3)
1CM_SAMPLE03_S21_PHASE.CSV
(801, 4)
1CM_SAMPLE04_S21_EXPANDPHASE.CSV
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1CM_SAMPLE04_S21_LOGMAGE.CSV
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(801, 11)
```

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3CM_SAMPLE02_S21_LOGMAGE.CSV
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3CM_SAMPLE03_S21_EXPANDPHASE.CSV
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3CM_SAMPLE03_S21_LOGMAGE.CSV
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3CM_SAMPLE04_S21_LOGMAGE.CSV
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4CM_SAMPLE01_S21_PHASE.CSV
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4CM_SAMPLE05_S21_PHASE.CSV
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5CM_SAMPLE01_S21_EXPANDPHASE.CSV
```

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5CM_SAMPLE01_S21_PHASE.CSV
(801, 22)
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5CM_SAMPLE02_S21_LOGMAGE.CSV
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5CM_SAMPLE02_S21_PHASE.CSV
(801, 23)
5CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 23)
5CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 23)
5CM_SAMPLE03_S21_PHASE.CSV
(801, 24)
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5CM_SAMPLE04_S21_LOGMAGE.CSV
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6CM_SAMPLE05_S21_LOGMAGE.CSV
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6CM_SAMPLE05_S21_PHASE.CSV
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MC-15
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1CM_SAMPLE03_S21_EXPANDPHASE.CSV
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1CM_SAMPLE03_S21_LOGMAGE.CSV
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2CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 10)
2CM_SAMPLE05_S21_PHASE.CSV
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3CM_SAMPLE01_S21_EXPANDPHASE.CSV
```

```
(801, 11)
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3CM_SAMPLE01_S21_PHASE.CSV
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3CM_SAMPLE05_S21_LOGMAGE.CSV
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4CM_SAMPLE04_S21_PHASE.CSV
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4CM_SAMPLE05_S21_LOGMAGE.CSV
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4CM_SAMPLE05_S21_PHASE.CSV
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5CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 21)
```

```
5CM_SAMPLE01_S21_LOGMAGE.CSV
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5CM_SAMPLE01_S21_PHASE.CSV
(801, 22)
5CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 22)
5CM_SAMPLE02_S21_LOGMAGE.CSV
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5CM_SAMPLE02_S21_PHASE.CSV
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(801, 23)
5CM_SAMPLE03_S21_LOGMAGE.CSV
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(801, 27)
6CM_SAMPLE02_S21_LOGMAGE.CSV
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6CM_SAMPLE02_S21_PHASE.CSV
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6CM_SAMPLE04_S21_PHASE.CSV
(801, 30)
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(801, 30)
6CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 30)
6CM_SAMPLE05_S21_PHASE.CSV
(801, 31)
Done!
```

In [35]:

```
df_A.shape, df_Phi.shape, df_Phi_EP.shape
```

Out[35]:

```
((801, 91), (801, 91), (801, 91))
```

In [ ]:

```
# 试验日的列表

date_list = ['20200720', '20200721', '20200722', '20200723']
```

In [38]:

```
# 继续自定义函数，处理全部试验日的数据
def VNA_expData_allDay(path, path_Mag, path_Phase, path_expandPhase, date_list, save_csv=False
):
    '''
    输入：批量处理全部试验日VNA所测试验数据的路径，如：'G:/202006-202008_rice_experiment/rice ex
periment-20200626'
    输出：全部试验日不同含水率样品的试验数据（衰减数据A、相移数据Phi、以及由Expand Phase计算的相
移Phi）
    作者：张津阳
    日期：2020年11月7日
    '''

    # 准备数据“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 衰减 数据
    df2 = df1.copy()               # 用给 相移 数据
    df3 = df1.copy()               # 用给 由 Expand Phase 计算的 相移Phi

    for index in range(len(date_list)):

        exp_date = date_list[index]

        exp_date = exp_date + '-TraceData'

        print(exp_date)  # 调试语句，后面可以注释掉！
        print(df1.shape)   # 检查数据有没有成功插入到 df1 中

        # 组合出路径，最后是带日期的那种！
        folder_path = os.path.join(path, exp_date)

        # 调用自定义函数
        df_A, df_Phi, df_Phi_EP=VNA_expData_singleDay(folder_path, path_Mag, path_Phase, path_ex
pandPhase, False, exp_date)

        # df_A, df_Phi = expData_singleDay(folder_path, path_Mag, path_Phase, False, exp_date)

        # 删除掉频率列
        new_df_A = df_A.drop('freq', axis=1)
        new_df_Phi = df_Phi.drop('freq', axis=1)
        new_df_Phi_EP = df_Phi_EP.drop('freq', axis=1)

        # 向 df1 df2 df3 追加数据
        df1 = pd.concat([df1, new_df_A], axis=1)
        df2 = pd.concat([df2, new_df_Phi], axis=1)
        df3 = pd.concat([df3, new_df_Phi_EP], axis=1)


    # 上面的for循环结束！ 应该是 试验日列表 date_list 里面有几个日期，循环就执行多少次！
    # 保存数据
    if save_csv:

        # 保存衰减数据
        filename1 = 'VNA_EXP_A.csv'
        path1 = os.path.join(path, filename1)
        df1.to_csv(path1
                   ,index=False
                  )
        # 保存相移数据
        filename2 = 'VNA_EXP_Phi.csv'
```

```
        path2 = os.path.join(path, filename2)
        df2.to_csv(path2
                   ,index=False
                  )
        # 保存由Expand Phase计算的Phi
        filename3 = 'VNA_EXP_Phi_by_expandPhase.csv'
        path3 = os.path.join(path, filename3)
        df3.to_csv(path3
                   ,index=False
                  )


    return df1, df2, df3     # df1是衰减A数据；df2是相移Phi数据；df3是由扩展相位角 Expand Phase 计算出的 相移 Phi
```

In [39]:

```
# 测试用
path = 'G:/202006-202008_rice_experiment/rice experiment-20200626'
# 修改了参考数据的路径，注意！注意！
path_Mag = 'G:/202006-202008_rice_experiment/rice experiment-20200626/SampleHolder/VNA_refData_Mag.csv'
path_Phase = 'G:/202006-202008_rice_experiment/rice experiment-20200626/SampleHolder/VNA_refData_Phase.csv'
path_expandPhase = 'G:/202006-202008_rice_experiment/rice experiment-20200626/SampleHolder/VNA_refData_expandPhase.csv'
# 试验日的列表
date_list = ['20200720', '20200721', '20200722', '20200723']


df_A, df_Phi, df_Phi_EP = VNA_expData_allDay(path, path_Mag, path_Phase, path_expandPhase, date_list, True)



# 记得整理文件夹里的文件，移动掉无关的csv文件！！！
print('Done!')

# 运行了得有 7，8秒才跑完
```

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20200721-TraceData
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2CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 9)
2CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 9)
2CM_SAMPLE04_S21_PHASE.CSV
(801, 10)
2CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 10)
2CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 10)
2CM_SAMPLE05_S21_PHASE.CSV
(801, 11)
3CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 11)
3CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 11)
3CM_SAMPLE01_S21_PHASE.CSV
```

```
(801, 12)
3CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 12)
3CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 12)
3CM_SAMPLE02_S21_PHASE.CSV
(801, 13)
3CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 13)
3CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 13)
3CM_SAMPLE03_S21_PHASE.CSV
(801, 14)
3CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 14)
3CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 14)
3CM_SAMPLE04_S21_PHASE.CSV
(801, 15)
3CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 15)
3CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 15)
3CM_SAMPLE05_S21_PHASE.CSV
(801, 16)
4CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 16)
4CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 16)
4CM_SAMPLE01_S21_PHASE.CSV
(801, 17)
4CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 17)
4CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 17)
4CM_SAMPLE02_S21_PHASE.CSV
(801, 18)
4CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 18)
4CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 18)
4CM_SAMPLE03_S21_PHASE.CSV
(801, 19)
4CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 19)
4CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 19)
4CM_SAMPLE04_S21_PHASE.CSV
(801, 20)
4CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 20)
4CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 20)
4CM_SAMPLE05_S21_PHASE.CSV
(801, 21)
5CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 21)
5CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 21)
5CM_SAMPLE01_S21_PHASE.CSV
(801, 22)
```

```
5CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 22)
5CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 22)
5CM_SAMPLE02_S21_PHASE.CSV
(801, 23)
5CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 23)
5CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 23)
5CM_SAMPLE03_S21_PHASE.CSV
(801, 24)
5CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 24)
5CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 24)
5CM_SAMPLE04_S21_PHASE.CSV
(801, 25)
5CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 25)
5CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 25)
5CM_SAMPLE05_S21_PHASE.CSV
(801, 26)
6CM_SAMPLE01_S21_EXPANDPHASE.CSV
(801, 26)
6CM_SAMPLE01_S21_LOGMAGE.CSV
(801, 26)
6CM_SAMPLE01_S21_PHASE.CSV
(801, 27)
6CM_SAMPLE02_S21_EXPANDPHASE.CSV
(801, 27)
6CM_SAMPLE02_S21_LOGMAGE.CSV
(801, 27)
6CM_SAMPLE02_S21_PHASE.CSV
(801, 28)
6CM_SAMPLE03_S21_EXPANDPHASE.CSV
(801, 28)
6CM_SAMPLE03_S21_LOGMAGE.CSV
(801, 28)
6CM_SAMPLE03_S21_PHASE.CSV
(801, 29)
6CM_SAMPLE04_S21_EXPANDPHASE.CSV
(801, 29)
6CM_SAMPLE04_S21_LOGMAGE.CSV
(801, 29)
6CM_SAMPLE04_S21_PHASE.CSV
(801, 30)
6CM_SAMPLE05_S21_EXPANDPHASE.CSV
(801, 30)
6CM_SAMPLE05_S21_LOGMAGE.CSV
(801, 30)
6CM_SAMPLE05_S21_PHASE.CSV
(801, 31)
Done!
```

In [40]:

```
# 检查
df_A.shape, df_Phi.shape, df_Phi_EP.shape
```

Out[40]:

```
((801, 451), (801, 451), (801, 451))
```

In [41]:

```
# 列名中缺了  含水率 + '_' + 厚度 + 样品编号

# 查看
df_A.head()
```

Out[41]:

	freq	MC-11.391CM_SAMPLE01_S21_LOGMAGE	MC-11.391CM_SAMPLE02_S21_LOGMAGE	11.391CM
0	2.00	-0.744662	-0.754585	
1	2.01	-0.853672	-0.872617	
2	2.02	-1.027952	-1.025918	
3	2.03	-1.104980	-1.092981	
4	2.04	-1.056007	-1.021674	

5 rows × 451 columns

In [ ]:

```
# 改进之处：
# 1.列名中缺了  含水率 + '_' + 厚度 + 样品编号
# 2.是不是应该把批量处理数据的代码，我主要指的是自定义函数，单独整理出来，否则看着太乱！
# 3.为了后续的建模，是不是需要把厚度、和含水率数据也加入到csv文件中？
```

到此，数据的批量处理就告一段落了！

2020年11月8日，把数据整理成后续建模的格式

In [2]:

```
# 先尝试着来做，反正已经有csv文件了，不用太慌！

path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_A.csv'
path_Phi = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_Phi.csv'

df_A = pd.read_csv(path_A)
```

In [3]:

```
# 查看
df_A.shape
```

Out[3]:

(801, 451)

In [4]:

```
# 查看
df_A.head()
```

Out[4]:

	freq	MC-11.39_1cm-1	MC-11.39_1cm-2	MC-11.39_1cm-3	MC-11.39_1cm-4	MC-11.39_1cm-5	MC-11.39_2cm-1	MC 11.39_2cm
0	2.00	-3.793472	-3.793472	-3.793472	-3.994812	-3.793472	-0.549722	-0.54972
1	2.01	-3.793472	-3.994812	-3.793472	-3.793472	-3.793472	-0.809020	-0.54972
2	2.02	-1.820192	-1.820192	-1.820192	-1.820192	-1.820192	3.003492	1.22957
3	2.03	0.028520	0.022881	0.028520	-2.150323	-2.150323	1.178922	1.15231
4	2.04	-2.831279	-2.831279	-2.831279	2.225641	-2.831279	-4.553408	-4.28615

5 rows × 451 columns

In [5]:

```
# 将'freq'列变成行索引index
df_A.set_index(['freq'], inplace=True)

df_A.shape
```

Out[5]:

(801, 450)

In [6]:

```
# 再查看下
df_A.head()
```

Out[6]:

freq	MC-11.39_1cm-1	MC-11.39_1cm-2	MC-11.39_1cm-3	MC-11.39_1cm-4	MC-11.39_1cm-5	MC-11.39_2cm-1	MC-11.39_2cm-2
2.00	-3.793472	-3.793472	-3.793472	-3.994812	-3.793472	-0.549722	-0.549722
2.01	-3.793472	-3.994812	-3.793472	-3.793472	-3.793472	-0.809020	-0.549722
2.02	-1.820192	-1.820192	-1.820192	-1.820192	-1.820192	3.003492	1.229571
2.03	0.028520	0.022881	0.028520	-2.150323	-2.150323	1.178922	1.152317
2.04	-2.831279	-2.831279	-2.831279	2.225641	-2.831279	-4.553408	-4.286150

5 rows × 450 columns

In [7]:

```
# 将数据转置
df_A_t = df_A.T

df_A_t.head()  # 查看
```

Out[7]:

freq	2.00	2.01	2.02	2.03	2.04	2.05	2.06	2
MC-11.39_1cm-1	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-2	-3.793472	-3.994812	-1.820192	0.022881	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-3	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-4	-3.994812	-3.793472	-1.820192	-2.150323	2.225641	1.533503	-0.235971	-0.049
MC-11.39_1cm-5	-3.793472	-3.793472	-1.820192	-2.150323	-2.831279	6.513927	-0.235971	-0.172

5 rows × 801 columns

In [8]:

```
# 对 Phi数据也执行上面的步骤
# 1.读取数据
df_Phi = pd.read_csv(path_Phi)
# 2.将'freq'列变成行索引index
df_Phi.set_index(['freq'], inplace=True)
# 3.转置
df_Phi_t = df_Phi.T

df_Phi_t.shape
```

Out[8]:

(450, 801)

In [9]:

```
# 查看
df_Phi_t.head()
```

Out[9]:

freq	2.00	2.01	2.02	2.03	2.04	2.05	2.06
MC-11.39_1cm-1	-50.453500	-50.453500	-77.738257	326.472485	-8.154452	-23.174291	-9.703197
MC-11.39_1cm-2	-50.453500	-52.421652	-77.738257	327.395090	-8.154452	-23.174291	-9.703197
MC-11.39_1cm-3	-50.453500	-50.453500	-77.738257	326.472485	-8.154452	-23.174291	-9.703197
MC-11.39_1cm-4	-52.421652	-50.453500	-77.738257	32.147148	33.828798	-23.174291	-9.703197
MC-11.39_1cm-5	-50.453500	-50.453500	-77.738257	32.147148	-8.154452	-64.188696	-9.703197

5 rows × 801 columns

In [10]:

```
# 那 df_A_t 与 df_Phi_t 执行 concat会顺利吗?
df_A_Phi = pd.concat([df_A_t, df_Phi_t], axis=1)

df_A_Phi.shape
```

Out[10]:

(450, 1602)

In [11]:

```
# 查看下
df_A_Phi.head()
```

Out[11]:

freq	2.00	2.01	2.02	2.03	2.04	2.05	2.06	2
MC-11.39_1cm-1	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-2	-3.793472	-3.994812	-1.820192	0.022881	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-3	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-4	-3.994812	-3.793472	-1.820192	-2.150323	2.225641	1.533503	-0.235971	-0.049
MC-11.39_1cm-5	-3.793472	-3.793472	-1.820192	-2.150323	-2.831279	6.513927	-0.235971	-0.172

5 rows × 1602 columns

In [12]:

```
# 先保存下csv文件，然后用EXCEL打开看下

path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_Phi.csv'

df_A_Phi.to_csv(path)

print('Done!')
```

Done!

In [ ]:

```
# 自己做一个含水率标签和含水率测定值的对照表！

# 真实含水率的数据，记录在：
# C:\Users\15222\Documents\工作周记-韦老师\202006-稻谷实验\20200715-不同厚度样品质量记录.xlsx 的sheet2中
```

2020年11月9日，继续做数据的整合

In [3]:

```
# 先读取 2020年11月8日晚上整合的A和Phi的数据
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_Phi.csv'
df_A_Phi = pd.read_csv(path)
df_A_Phi.shape  # (450, 1603)
```

Out[3]:

(450, 1603)

In [4]:

```
# 查看
df_A_Phi.head()  # 第一列应该是用作行索引index的
```

Out[4]:

	Unnamed: 0	2.0	2.01	2.02	2.03	2.04	2.05	2.06	
0	MC-11.39_1cm-1	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.
1	MC-11.39_1cm-2	-3.793472	-3.994812	-1.820192	0.022881	-2.831279	1.533503	-0.235971	-0.
2	MC-11.39_1cm-3	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.
3	MC-11.39_1cm-4	-3.994812	-3.793472	-1.820192	-2.150323	2.225641	1.533503	-0.235971	-0.(
4	MC-11.39_1cm-5	-3.793472	-3.793472	-1.820192	-2.150323	-2.831279	6.513927	-0.235971	-0.

5 rows × 1603 columns

In [5]:

```
# 重新读取数据
df_A_Phi = pd.read_csv(path, index_col=[0])
df_A_Phi.shape
```

Out[5]:

(450, 1602)

In [6]:

```
# 再查看下
df_A_Phi.head()
```

Out[6]:

	2.0	2.01	2.02	2.03	2.04	2.05	2.06	2
MC-11.39_1cm-1	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-2	-3.793472	-3.994812	-1.820192	0.022881	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-3	-3.793472	-3.793472	-1.820192	0.028520	-2.831279	1.533503	-0.235971	-0.172
MC-11.39_1cm-4	-3.994812	-3.793472	-1.820192	-2.150323	2.225641	1.533503	-0.235971	-0.049
MC-11.39_1cm-5	-3.793472	-3.793472	-1.820192	-2.150323	-2.831279	6.513927	-0.235971	-0.172

5 rows × 1602 columns

In [7]:

```
# 含水率数据的读取
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'

df_mc = pd.read_excel(path_mc, index_col='mark')

df_mc.shape
```

Out[7]:

```
(15, 1)
```

In [8]:

```
# 查看
df_mc.head()
```

Out[8]:

	mc
mark	
MC-11.39	12.567
MC-13	13.877
MC-15	15.440
MC-18	18.027
MC-20	20.563

In [10]:

```
# 查看
df_mc.index
```

Out[10]:

```
Index(['MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25',
       'MC-20-2', 'MC-23-2', 'MC-25-2', 'MC-30-1', 'MC-10', 'MC-28-1',
       'MC-28-2', 'MC-30-2'],
      dtype='object', name='mark')
```

In [12]:

```
# 查看
type(df_mc.index), type(df_mc.index[0])
```

Out[12]:

```
(pandas.core.indexes.base.Index, str)
```

In [17]:

```
# 测试
if 'MC-20_' in 'MC-20-2_1cm-1':
    print('存在')
else:
    print('不存在')
```

不存在

In [16]:

```
# 获取元素值
df_mc.at['MC-11.39', 'mc']
```

Out[16]:

12.567

In [20]:

```
# 查看元素类型
type(df_mc.at['MC-11.39', 'mc'])
```

Out[20]:

numpy.float64

In [18]:

```
# 使用字典
thickness_dict = {'1cm':1.0, '2cm':2.0, '3cm':3.0, '4cm':4.0, '5cm':5.0, '6cm':6.0}
# 测试
thickness_dict['1cm']
```

Out[18]:

1.0

In [19]:

```
# 查看
type(thickness_dict['1cm']) # 与含水率数据的类型不一致，算了还是用pandas读取xlsx吧
```

Out[19]:

float

In [26]:

```
# 厚度数据的读取
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'

df_thickness = pd.read_excel(path_thickness, index_col='mark')

df_thickness
```

Out[26]:

	thickness
mark	
1cm	1
2cm	2
3cm	3
4cm	4
5cm	5
6cm	6

In [27]:

```
# 查看
df_thickness.at['1cm', 'thickness'], type(df_thickness.at['1cm', 'thickness'])
```

Out[27]:

```
(1, numpy.int64)
```

In [14]:

```
# 再看下 df_A_Phi的行索引
type(df_A_Phi.index), len(df_A_Phi.index), df_A_Phi.index[0], type(df_A_Phi.index[0])
```

Out[14]:

```
(pandas.core.indexes.base.Index, 450, 'MC-11.39_1cm-1', str)
```

In [28]:

```
# 要写一个双重循环了！  下面的循环非常重要！！
'''
日期：2020年11月9日
功能：为df_A_Phi.csv数据后面添加 厚度、含水率 数据
作者：张津阳
输出：目的将合并后的数据，输出到一个新的文件 df_A_Phi_thickness_mc.csv
'''
# 导入必要的包
import os
import numpy as np
import pandas as pd
import datetime

## 先读取 2020年11月8日晚上整合的A和Phi的数据
path_A_Phi = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_Phi.csv'
df_A_Phi = pd.read_csv(path_A_Phi, index_col=[0]) #这里注意！参数 index_col=[0] 将第'0'列作为行索引index
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
df_mc = pd.read_excel(path_mc, index_col='mark')
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'
df_thickness = pd.read_excel(path_thickness, index_col='mark')

## 定义 含水率‘序列’数据、厚度‘序列’数据 的容器
mc_value_list = []
thickness_value_list = []

## 双重循环，形成 含水率‘序列’数据、厚度‘序列’数据
for i in range(len(df_A_Phi.index)):
    index_name = df_A_Phi.index[i]    # 1.先获取行索引（是个str，如 MC-11.39_1cm-1）

    for j in range(len(df_mc.index)):
        mc_mark = df_mc.index[j] + '_'      # 获取含水率标签（同时也是行索引，如 MC-11.39、MC-20-2）
                                            # '_'是为了区分 MC-20_ 与 MC-20-2_
        if mc_mark in index_name:

            mc_value = df_mc.at[df_mc.index[j], 'mc']  # 获取 df_mc 中的元素值

            mc_value_list.append(mc_value)   # 追加数据

    for k in range(len(df_thickness.index)):
        thickness_mark = df_thickness.index[k]   # 获取厚度标签
        if thickness_mark in index_name:
            thickness_value = df_thickness.at[thickness_mark, 'thickness']
            thickness_value_list.append(thickness_value)


## 合并数据
# 1.类型转换 list -> dataframe
df_mc_value = pd.DataFrame(mc_value_list)
df_thickness_value = pd.DataFrame(thickness_value_list)
# 2.为了合并，先修改行索引
df_mc_value.set_index(df_A_Phi.index, inplace=True)
df_thickness_value.set_index(df_A_Phi.index, inplace=True)
# 3.修改列名
df_thickness_value.rename(columns={0:'thickness'}, inplace=True)
df_mc_value.rename(columns={0:'mc'}, inplace=True)
```

```
# 4.合并数据  A数据(801列) + Phi数据(801列) + 厚度(1列) + 含水率(1列)
df_A_Phi_thickness_mc = pd.concat([df_A_Phi, df_thickness_value, df_mc_value], axis=1)  # 450 x
 1604


## 保存数据到csv文件
today = datetime.date.today()
filename = 'df_A_Phi_thickness_mc' + '_' + str(today) + '.csv'
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/' + filename

df_A_Phi_thickness_mc.to_csv(path)  # 列名 header (default True), 行索引 index (default True)


print('Done!')

## 2020年11月12日，自己又在脑中检查了一遍上面的代码，应该没有问题！
```

```
Done!
```

In [29]:

```
# 查看
len(mc_value_list), len(thickness_value_list)
```

Out[29]:

```
(450, 450)
```

In [30]:

```
# 把厚度数据和含水率数据与 A和Phi的数据合并到一起！
df_mc_value = pd.DataFrame(mc_value_list)
df_thickness_value = pd.DataFrame(thickness_value_list)
```

In [31]:

```
# 查看
df_mc_value.shape, df_thickness_value.shape
```

Out[31]:

```
((450, 1), (450, 1))
```

In [32]:

```
# 为了合并，先修改行索引
df_A_Phi.index
```

Out[32]:

```
Index(['MC-11.39_1cm-1', 'MC-11.39_1cm-2', 'MC-11.39_1cm-3', 'MC-11.39_1cm-4',
       'MC-11.39_1cm-5', 'MC-11.39_2cm-1', 'MC-11.39_2cm-2', 'MC-11.39_2cm-3',
       'MC-11.39_2cm-4', 'MC-11.39_2cm-5',
       ...
       'MC-30-2_5cm-1', 'MC-30-2_5cm-2', 'MC-30-2_5cm-3', 'MC-30-2_5cm-4',
       'MC-30-2_5cm-5', 'MC-30-2_6cm-1', 'MC-30-2_6cm-2', 'MC-30-2_6cm-3',
       'MC-30-2_6cm-4', 'MC-30-2_6cm-5'],
      dtype='object', length=450)
```

In [33]:

```
# 修改行索引
df_mc_value.set_index(df_A_Phi.index, inplace=True)
df_thickness_value.set_index(df_A_Phi.index, inplace=True)
```

In [34]:

```
# 查看
df_mc_value.head()
```

Out[34]:

	0
MC-11.39_1cm-1	12.567
MC-11.39_1cm-2	12.567
MC-11.39_1cm-3	12.567
MC-11.39_1cm-4	12.567
MC-11.39_1cm-5	12.567

In [36]:

```
df_mc_value.tail(10)
```

Out[36]:

	0
MC-30-2_5cm-1	28.163
MC-30-2_5cm-2	28.163
MC-30-2_5cm-3	28.163
MC-30-2_5cm-4	28.163
MC-30-2_5cm-5	28.163
MC-30-2_6cm-1	28.163
MC-30-2_6cm-2	28.163
MC-30-2_6cm-3	28.163
MC-30-2_6cm-4	28.163
MC-30-2_6cm-5	28.163

In [37]:

```
# 查看
df_thickness_value.head()
```

Out[37]:

	0
MC-11.39_1cm-1	1
MC-11.39_1cm-2	1
MC-11.39_1cm-3	1
MC-11.39_1cm-4	1
MC-11.39_1cm-5	1

In [38]:

```
# 查看
df_thickness_value.tail(10)
```

Out[38]:

	0
MC-30-2_5cm-1	5
MC-30-2_5cm-2	5
MC-30-2_5cm-3	5
MC-30-2_5cm-4	5
MC-30-2_5cm-5	5
MC-30-2_6cm-1	6
MC-30-2_6cm-2	6
MC-30-2_6cm-3	6
MC-30-2_6cm-4	6
MC-30-2_6cm-5	6

In [41]:

```
# 列命名
df_thickness_value.rename(columns={0:'thickness'}, inplace=True)
df_mc_value.rename(columns={0:'mc'}, inplace=True)
```

In [42]:

```
# 再次查看
df_thickness_value.head()
```

Out[42]:

	thickness
MC-11.39_1cm-1	1
MC-11.39_1cm-2	1
MC-11.39_1cm-3	1
MC-11.39_1cm-4	1
MC-11.39_1cm-5	1

In [43]:

```
df_mc_value.head()
```

Out[43]:

	mc
MC-11.39_1cm-1	12.567
MC-11.39_1cm-2	12.567
MC-11.39_1cm-3	12.567
MC-11.39_1cm-4	12.567
MC-11.39_1cm-5	12.567

In [44]:

```
# 合并数据  A数据(801列) + Phi数据(801)列 + 厚度(1列) + 含水率(1列)
df_A_Phi_thickness_mc = pd.concat([df_A_Phi, df_thickness_value, df_mc_value], axis=1)

df_A_Phi_thickness_mc.shape
```

Out[44]:

```
(450, 1604)
```

In [45]:

```
# 保存到 csv文件中

path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_Phi_thickness_mc.csv'

df_A_Phi_thickness_mc.to_csv(path)  # 列名 header (default True), 行索引 index (default True)

print('Done!')
```

```
Done!
```

In [ ]:

```
# 这样保存的csv文件有一个问题，就是列名会自动变成0，解决方法：在合并之前，先把 df_thickness_value 、 df_mc_value 命名

# 好了已经解决 df_thickness_value 和 df_mc_value 列名为0的问题了
```

In [ ]:

```
#### 到此，数据的批量处理是不是已经完成了呢？？  那下午继续处理 VNA的数据合并？？

#### 不不不，我觉得，合并后的数据只是用于建模，而A Phi单独分开的数据，则可以用于绘图分析
```

In [46]:

```
## 做一下5次样品重复的平均

df_A_Phi.index
```

Out[46]:

```
Index(['MC-11.39_1cm-1', 'MC-11.39_1cm-2', 'MC-11.39_1cm-3', 'MC-11.39_1cm-4',
       'MC-11.39_1cm-5', 'MC-11.39_2cm-1', 'MC-11.39_2cm-2', 'MC-11.39_2cm-3',
       'MC-11.39_2cm-4', 'MC-11.39_2cm-5',
       ...
       'MC-30-2_5cm-1', 'MC-30-2_5cm-2', 'MC-30-2_5cm-3', 'MC-30-2_5cm-4',
       'MC-30-2_5cm-5', 'MC-30-2_6cm-1', 'MC-30-2_6cm-2', 'MC-30-2_6cm-3',
       'MC-30-2_6cm-4', 'MC-30-2_6cm-5'],
      dtype='object', length=450)
```

In [51]:

```
sum(map(lambda x : 'MC-30-1_1cm' in x , df_A_Phi.index))
```

Out[51]:

```
5
```

In [50]:

```
## 先组合出 ‘含水率_厚度’

## 查看下
df_mc.index
```

Out[50]:

```
Index(['MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25',
       'MC-20-2', 'MC-23-2', 'MC-25-2', 'MC-30-1', 'MC-10', 'MC-28-1',
       'MC-28-2', 'MC-30-2'],
      dtype='object', name='mark')
```

In [52]:

```
df_thickness.index
```

Out[52]:

```
Index(['1cm', '2cm', '3cm', '4cm', '5cm', '6cm'], dtype='object', name='mark')
```

In [86]:

```
# 读一下 衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_A.csv'
# path_Phi = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_Phi.csv'

df_A = pd.read_csv(path_A, index_col='freq')
```

In [54]:

```
# 查看
df_A.shape
```

Out[54]:

```
(801, 450)
```

In [87]:

```
# 查看
df_A.head()
```

Out[87]:

freq	MC-11.39_1cm-1	MC-11.39_1cm-2	MC-11.39_1cm-3	MC-11.39_1cm-4	MC-11.39_1cm-5	MC-11.39_2cm-1	MC-11.39_2cm-2
2.00	-3.793472	-3.793472	-3.793472	-3.994812	-3.793472	-0.549722	-0.549722
2.01	-3.793472	-3.994812	-3.793472	-3.793472	-3.793472	-0.809020	-0.549722
2.02	-1.820192	-1.820192	-1.820192	-1.820192	-1.820192	3.003492	1.229571
2.03	0.028520	0.022881	0.028520	-2.150323	-2.150323	1.178922	1.152317
2.04	-2.831279	-2.831279	-2.831279	2.225641	-2.831279	-4.553408	-4.286150

5 rows × 450 columns

In [56]:

```
# 查看
df_A.columns
```

Out[56]:

```
Index(['MC-11.39_1cm-1', 'MC-11.39_1cm-2', 'MC-11.39_1cm-3', 'MC-11.39_1cm-4',
       'MC-11.39_1cm-5', 'MC-11.39_2cm-1', 'MC-11.39_2cm-2', 'MC-11.39_2cm-3',
       'MC-11.39_2cm-4', 'MC-11.39_2cm-5',
       ...
       'MC-30-2_5cm-1', 'MC-30-2_5cm-2', 'MC-30-2_5cm-3', 'MC-30-2_5cm-4',
       'MC-30-2_5cm-5', 'MC-30-2_6cm-1', 'MC-30-2_6cm-2', 'MC-30-2_6cm-3',
       'MC-30-2_6cm-4', 'MC-30-2_6cm-5'],
      dtype='object', length=450)
```

In [57]:

```
sum(map(lambda x : 'MC-30-1_1cm' in x , df_A.columns))
```

Out[57]:

5

In [75]:

```
for i in range(2,5):
    print(i)
```

2
3
4

In [23]:

```
'''
日期：2020年11月9日
功能：将衰减数据表EXP_A.csv中，每种厚度的5次样品重复数据取平均，得到平均频谱数据，用于绘频谱图，和进一步分析
作者：张津阳
'''
# 导入必要的包
import os
import numpy as np
import pandas as pd
import datetime

## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
df_mc = pd.read_excel(path_mc, index_col='mark')
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'
df_thickness = pd.read_excel(path_thickness, index_col='mark')
## 衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_A.csv'
df_A = pd.read_csv(path_A, index_col='freq')   # shape: 801 × 450

## 定义装 平均频谱数据 的“容器”
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
df_A_mean = pd.DataFrame(arr_freq, columns=['freq'])

for j in range(len(df_mc.index)):
    mc_mark = df_mc.index[j] + '_'      # 获取含水率标签（同时也是行索引，如 MC-11.39、MC-20-2）

    for k in range(len(df_thickness.index)):
        thickness_mark = df_thickness.index[k]  # 获取厚度标签（如 1cm、2cm）

        mark = mc_mark + thickness_mark         # 组合出 “含水率_厚度”

        number = sum(map(lambda x : mark in x , df_A.columns))  # 理论上，每次循环中的number应该都为5

        # ****************** 计算平均频谱数据 *****************

        df_temp = df_A[mark + '-1']    # 初始数据，如 df_A['MC-11.39_1cm-1']

        for index in range(1, number):

            #参考:  name = mc_folder + '_' + file + '-' + str(index+1)
            name = mark + '-' + str(index+1)    # 组合出列名，如 'MC-11.39_1cm-2' ... 'MC-11.39_1cm-5'

            df_temp += df_A[name]      # 循环求和

        df_temp /= number       # 求平均

        # ****************************************************

        #df_temp.set_index(df_A_mean.index, inplace=True)  # 行索引index不一致的话，一会儿没法添加!
                                                           # pandas的Series没有 set_index()方法
        df_temp.index = range(len(df_A_mean.index))        # 等价于 df_temp.index = range(801)

        df_A_mean[mark] = df_temp  # 添加数据
```

```
# 保存到csv文件
today = datetime.date.today()
filename = 'df_A_mean' + '_' + str(today) + '.csv'
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/' + filename
df_A_mean.to_csv(path, index=False)  # 列名 header (default True), 行索引 index (default True)
print('Done!')

## 2020年11月12日，自己又在脑中检查了一下上面的代码，应该没问题！
```

Done!

In [17]:

```
# 测试
'MC'.lower()
```

Out[17]:

'mc'

In [7]:

```
# 2020年11月15日，检查求平均的做法
df = pd.DataFrame(np.random.randint(10, size=(4,5)))
df.head()
```

Out[7]:

	0	1	2	3	4
0	9	8	8	5	4
1	7	5	4	6	1
2	0	1	1	8	8
3	5	6	0	0	8

In [8]:

```
df_temp = df[0]
for i in range(1, len(df.columns)):
    df_temp += df[i]
df_temp /= len(df.columns)

df_temp.head()
```

Out[8]:

```
0    6.8
1    4.6
2    3.6
3    3.8
Name: 0, dtype: float64
```

In [11]:

```
print(df_temp.index)
print(df[1].index)
```

```
RangeIndex(start=0, stop=4, step=1)
RangeIndex(start=0, stop=4, step=1)
```

In [6]:

```
df_temp.dtype
```

Out[6]:

```
dtype('float64')
```

将上面的循环整理成一个自定义函数

In [15]:

```
def get_average_spectrum_from_OM2S2(path_A, path_mc, path_thickness, parent_path, save_csv=Fals
e, data_type='Attenuation'):
    '''
    日期：2020年11月9日
    功能：将衰减数据表EXP_A.csv中，每种厚度的5次样品重复数据取平均，得到平均频谱数据，用于绘频谱
图，和进一步分析
    作者：张津阳
    重写：2020年11月14日
    原因：想把函数的功能扩展到能处理 A or Phi 的数据
    '''
    ## 衰减数据（当然，后面会扩展到不只针对衰减数据、而且可以处理相移数据 Phi）
    df_A = pd.read_csv(path_A, index_col='freq')   # shape: 801 × 450
    ## 含水率数据
    df_mc = pd.read_excel(path_mc, index_col='mark')
    ## 厚度数据
    df_thickness = pd.read_excel(path_thickness, index_col='mark')

    ## 定义装 平均频谱数据 的“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df_A_mean = pd.DataFrame(arr_freq, columns=['freq'])           # numpy -> dataframe，同时指
定列名！

    flag = 1  # 用作计数标记

    for j in range(len(df_mc.index)):

        mc_mark = df_mc.index[j] + '_'      # 获取含水率标签（同时也是行索引，如 MC-11.39、MC-20-
2、MC-30-1）

        for k in range(len(df_thickness.index)):

            thickness_mark = df_thickness.index[k]  # 获取厚度标签（如 1cm、2cm）

            mark = mc_mark + thickness_mark         # 组合出 “含水率_厚度”，如 MC-11.39_1cm

            number = sum(map(lambda x : mark in x , df_A.columns))  # 理论上，每次循环中的numbe
r应该都为5

            if number == 5:
                print(flag, '成功发现5条待求平均的频谱！')
                flag += 1    # 计数增加
            else:
                print(mark, ' ,该标识对应的频谱不是5条，请检查！')
                return

            # ****************** 计算平均频谱数据 *****************

            first_column = mark + '-1'

            if first_column in df_A.columns:

                # print(df_A[first_column].index)  # 测试语句，结果：Float64Index([ 2.0, 2.01,
 2.02,..., 9.99, 10.0], dtype='float64', name='freq', length=801)

                df_temp = df_A[first_column]    # ** 初始数据，如 df_A['MC-11.39_1cm-1']

                # print(df_temp.index) # 测试语句，结果：Float64Index([ 2.0, 2.01, 2.02,..., 9.9
9, 10.0], dtype='float64', name='freq', length=801)
            else:
```

```
                print(first_column, ' ,该初始列名不存在，请检查！')
                return  # 结束程序

            # 循环求和
            for index in range(1, number):
                #参考： name = mc_folder + '_' + file + '-' + str(index+1)
                name = mark + '-' + str(index+1)    # 组合出列名，如 'MC-11.39_1cm-2' ... 'MC-1
1.39_1cm-5'

                if name in df_A.columns:
                    df_temp += df_A[name]      # 循环求和 （Series具有，在数学操作中，自动对齐索
引！！！）
                else:
                    print(name, ' ,该列名不存在，请检查！')
                    return         # 结束程序

            df_temp /= number       # 求平均
            # print('type(df_temp)', type(df_temp))  # 测试语句，想看下df_temp是Series还是datafr
ame，后面可以注释掉！
            # 结果：<class 'pandas.core.series.Series'>, df_temp果然是 Series

            # ******************************************************

            # df_temp.set_index(df_A_mean.index, inplace=True)  # 行索引index不一致的话，一会儿
没法添加！ 注意： pandas的 Series没有 set_index()方法

            # print(df_A_mean.index)   # 测试语句，结果：RangeIndex(start=0, stop=801, step=1)
            df_temp.index = range(len(df_A_mean.index))        # 等价于 df_temp.index = range(80
1)，目的是：对齐索引
            # print(df_temp.index)  # 测试语句，结果：RangeIndex(start=0, stop=801, step=1)

            df_A_mean[mark] = df_temp  # 添加数据 （先对齐索引，再添加数据）


    # 保存到csv文件
    if save_csv:
        today = datetime.date.today()
        filename = 'OM2S2' + '-' + 'Average_' + data_type.lower() + '_spectrum' + '-' + str(toda
y) + '.csv'
        path = os.path.join(parent_path, filename)
        df_A_mean.to_csv(path, index=False)  # 列名 header (default True)，行索引 index (defaul
t True)
        print('File save done!')
    else:
        print('File not save!')

    return df_A_mean
```

2020年11月14日 晚，测试上面的自定义函数

In [19]:

```
## 2020年11月14日 晚，测试上面的自定义函数

#---------------------------------输入参数-----------------------------------------------
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_A.csv'
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary/test'  # 测试目录

OM2S2_average_A_spectrum = get_average_spectrum_from_OM2S2(path_A, path_mc, path_thickness, pare
nt_path, True, 'Attenuation')
```

1 成功发现5条待求平均的频谱!
2 成功发现5条待求平均的频谱!
3 成功发现5条待求平均的频谱!
4 成功发现5条待求平均的频谱!
5 成功发现5条待求平均的频谱!
6 成功发现5条待求平均的频谱!
7 成功发现5条待求平均的频谱!
8 成功发现5条待求平均的频谱!
9 成功发现5条待求平均的频谱!
10 成功发现5条待求平均的频谱!
11 成功发现5条待求平均的频谱!
12 成功发现5条待求平均的频谱!
13 成功发现5条待求平均的频谱!
14 成功发现5条待求平均的频谱!
15 成功发现5条待求平均的频谱!
16 成功发现5条待求平均的频谱!
17 成功发现5条待求平均的频谱!
18 成功发现5条待求平均的频谱!
19 成功发现5条待求平均的频谱!
20 成功发现5条待求平均的频谱!
21 成功发现5条待求平均的频谱!
22 成功发现5条待求平均的频谱!
23 成功发现5条待求平均的频谱!
24 成功发现5条待求平均的频谱!
25 成功发现5条待求平均的频谱!
26 成功发现5条待求平均的频谱!
27 成功发现5条待求平均的频谱!
28 成功发现5条待求平均的频谱!
29 成功发现5条待求平均的频谱!
30 成功发现5条待求平均的频谱!
31 成功发现5条待求平均的频谱!
32 成功发现5条待求平均的频谱!
33 成功发现5条待求平均的频谱!
34 成功发现5条待求平均的频谱!
35 成功发现5条待求平均的频谱!
36 成功发现5条待求平均的频谱!
37 成功发现5条待求平均的频谱!
38 成功发现5条待求平均的频谱!
39 成功发现5条待求平均的频谱!
40 成功发现5条待求平均的频谱!
41 成功发现5条待求平均的频谱!
42 成功发现5条待求平均的频谱!
43 成功发现5条待求平均的频谱!
44 成功发现5条待求平均的频谱!
45 成功发现5条待求平均的频谱!
46 成功发现5条待求平均的频谱!
47 成功发现5条待求平均的频谱!
48 成功发现5条待求平均的频谱!
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File save done!
```

In [20]:

```
## 2020年11月14日 晚，测试上面的自定义函数，使用 Phi的数据

#---------------------------------输入参数-----------------------------------------------
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_Phi.csv'    # 使用 Phi 的数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary/test'  # 测试目录

OM2S2_average_Phi_spectrum = get_average_spectrum_from_OM2S2(path_A, path_mc, path_thickness, parent_path, True, 'PhaseShift')
```

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File save done!
```

好好检查上面的函数

2020年11月15日，继续测试上面的自定义函数

In [16]:

```
## 2020年11月15日 11点03分，测试上面的自定义函数，使用 A的数据

#---------------------------------输入参数-----------------------------------------------
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/EXP_A.csv'
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary/test'  # 测试目录

OM2S2_average_A_spectrum = get_average_spectrum_from_OM2S2(path_A, path_mc, path_thickness, pare
nt_path, True, 'Attenuation')
```

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File save done!
```

In [89]:

```
# 查看
df_A_mean
```

Out[89]:

	freq	MC-11.39_1cm	MC-11.39_2cm	MC-11.39_3cm	MC-11.39_4cm	MC-11.39_5cm	MC-11.39_6cm	MC-13_1cm
0	2.00	-3.833740	-0.549722	3.768829	7.838111	7.276698	9.401389	-4.213962
1	2.01	-3.833740	-0.653441	3.839289	7.900534	7.335240	9.244433	-4.014669
2	2.02	-1.820192	1.563539	2.735516	5.546476	3.284564	3.631551	-0.739384
3	2.03	-0.844145	0.658403	1.497446	3.569401	2.084478	2.652344	-1.013579
4	2.04	-1.819895	-2.984150	-6.027533	2.795317	1.163047	4.302964	-3.954196
...	...	...	...	...	...	...	...	...
796	9.96	-1.267036	-5.308018	-10.991550	-8.086860	-7.082638	-13.084861	-1.889559
797	9.97	-1.680730	-4.706192	-5.883372	-6.341238	-8.791146	-19.052059	-2.358906
798	9.98	0.805099	-1.122872	-4.106948	-6.818162	-9.851678	-13.109581	0.248157
799	9.99	0.407749	-3.039540	-7.471341	-11.085529	-7.167515	-10.434757	-0.236243
800	10.00	0.445829	-4.553338	-9.863467	-6.229996	-6.504442	-10.792080	-0.248093

801 rows × 91 columns

In [91]:

```
# 保存一下，平均频谱数据


path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean.csv'

df_A_mean.to_csv(path, index=False)  # 列名 header (default True)，行索引 index (default True)

print('Done!')
```

```
Done!
```

In [1]:

```
# python中获取当前日期
import datetime
today=datetime.date.today()
print(today)
```

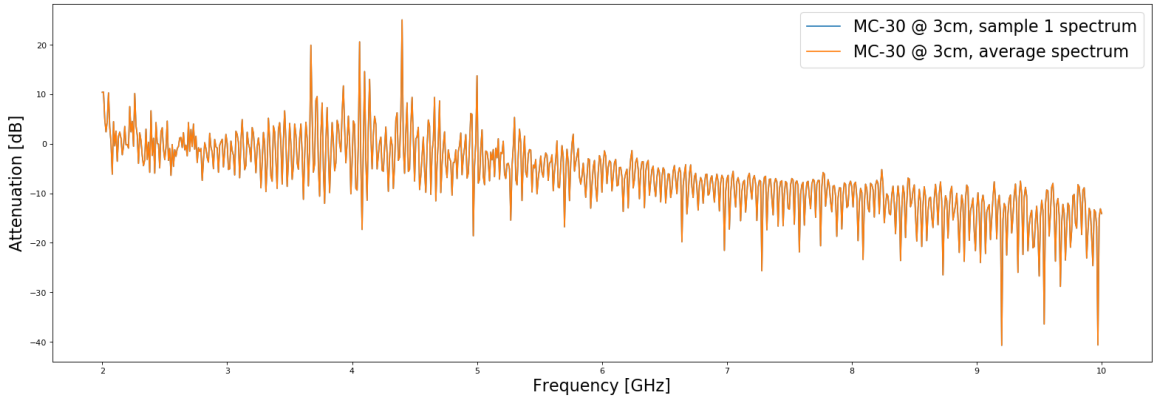
```
2020-11-10
```

In [92]:

```
# 画图看下
import matplotlib.pyplot as plt
```

In [122]:

```
# 画图
# plt.plot(df_A_mean['MC-30-1_1cm'])

arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 8), dpi=80)

plt.plot(arr_freq
         ,df_A['MC-30-1_3cm-1']
         ,label = 'MC-30 @ 3cm, sample 1 spectrum'
        )

plt.plot(arr_freq
         ,df_A_mean['MC-30-1_3cm']
         ,label = 'MC-30 @ 3cm, average spectrum'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Attenuation [dB]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



In [123]:

```
# 把3cm的数据准备出来?
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
df_spectrum = pd.DataFrame(arr_freq, columns=['freq'])            # 装平均频谱数据

list1 = ['MC-10_3cm'
         ,'MC-11.39_3cm'
         ,'MC-13_3cm'
         ,'MC-15_3cm'
         ,'MC-18_3cm'
         ,'MC-20_3cm'
         ,'MC-23_3cm'
         ,'MC-25_3cm'
         ,'MC-28-1_3cm'
         ,'MC-30-1_3cm'
        ]

for index in range(len(list1)):
    df_spectrum[list1[index]] = df_A_mean[list1[index]]

print('Done!')
```

Done!

In [124]:

```
# 查看
df_spectrum.head()
```

Out[124]:

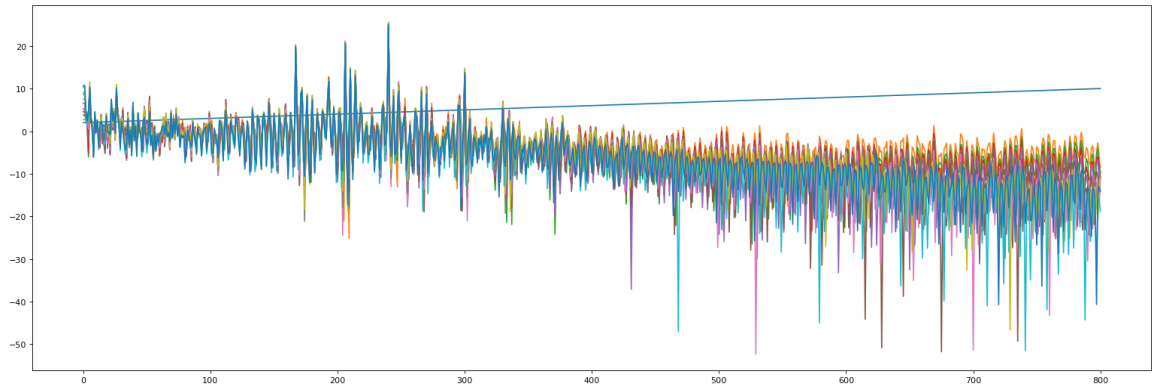
	freq	MC-10_3cm	MC-11.39_3cm	MC-13_3cm	MC-15_3cm	MC-18_3cm	MC-20_3cm	MC-23_3cm	MC-25_3cm
0	2.00	2.694342	3.768829	4.533448	5.222904	6.525884	7.540138	8.626135	9.070503
1	2.01	2.800079	3.839289	4.659345	5.260869	6.575675	7.610780	8.688379	9.086250
2	2.02	2.586575	2.735516	3.050696	3.175425	3.691132	4.048566	4.489225	4.482801
3	2.03	1.503836	1.497446	1.925023	1.723854	2.879009	3.227593	3.853586	4.488493
4	2.04	-1.986650	-6.027533	-5.163187	-1.669155	-2.338461	0.428671	2.509803	2.351551

In [126]:

```
plt.figure(figsize=(24, 8), dpi=80)
plt.plot(df_spectrum)
```

Out[126]:

```
[<matplotlib.lines.Line2D at 0x1f7edb98c88>,
 <matplotlib.lines.Line2D at 0x1f7edbb3088>,
 <matplotlib.lines.Line2D at 0x1f7edbb3248>,
 <matplotlib.lines.Line2D at 0x1f7edbb3408>,
 <matplotlib.lines.Line2D at 0x1f7edbb3608>,
 <matplotlib.lines.Line2D at 0x1f7edbb3808>,
 <matplotlib.lines.Line2D at 0x1f7edbb39c8>,
 <matplotlib.lines.Line2D at 0x1f7edbb3c08>,
 <matplotlib.lines.Line2D at 0x1f7edbb35c8>,
 <matplotlib.lines.Line2D at 0x1f7edbb37c8>,
 <matplotlib.lines.Line2D at 0x1f7edb69d88>]
```



斜线应该是频率'freq'列

In [60]:

```
# 怎么5列求平均值

data = {'水果':['苹果','梨','草莓'],
        '数量':[3,2,5],
        '价格':[10,9,8],
         '利润':[4,7,9],
        }
df = pd.DataFrame(data)
print(df)
```

```
   水果  数量  价格  利润
0  苹果   3  10   4
1   梨   2   9   7
2  草莓   5   8   9
```

In [62]:

```
df_test = (df['数量'] + df['价格'] + df['利润'])/3
print(df_test)
```

```
0    5.666667
1    6.000000
2    7.333333
dtype: float64
```

In [73]:

```
df_temp = df['数量']

list1 = ['价格', '利润']

for i in range(len(list1)):
    df_temp += df[list1[i]]

print(df_temp)
```

```
0    17
1    18
2    22
Name: 数量, dtype: int64
```

In [77]:

```
df_temp /= 3
print(df_temp)
```

```
0    5.666667
1    6.000000
2    7.333333
Name: 数量, dtype: float64
```

In [63]:

```
# 查看
df_A['MC-30-1_1cm-1'].head()
```

Out[63]:

```
freq
2.00   -1.810039
2.01   -2.081412
2.02   -2.156462
2.03   -1.005022
2.04   -8.616117
Name: MC-30-1_1cm-1, dtype: float64
```

In [67]:

```
type(df_A['MC-11.39_1cm-1'])
```

Out[67]:

```
pandas.core.series.Series
```

In [68]:

```
arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
df1 = pd.DataFrame(arr_freq, columns=['freq']) # 用给 衰减 数据
```

In [79]:

```
df_A['MC-11.39_1cm-1'].index = range(801)
```

In [80]:

```
df1['MC-11.39_1cm-1'] = df_A['MC-11.39_1cm-1']
```

In [70]:

```
df1.shape
```

Out[70]:

(801, 2)

In [81]:

```
df1
```

Out[81]:

	freq	MC-11.39_1cm-1
0	2.00	-3.793472
1	2.01	-3.793472
2	2.02	-1.820192
3	2.03	0.028520
4	2.04	-2.831279
...	...	...
796	9.96	-1.071929
797	9.97	-1.515196
798	9.98	0.972770
799	9.99	0.668049
800	10.00	0.725989

801 rows × 2 columns

In [76]:

```
arr1 = df_A['MC-11.39_1cm-1'].values

arr1.shape
```

Out[76]:

(801,)

2020年11月10日，选出绘制频谱的数据

In [7]:

```
# 读取数据
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean.csv'

df_A_mean = pd.read_csv(path)

df_A_mean.head()
```

Out[7]:

	freq	MC-11.39_1cm	MC-11.39_2cm	MC-11.39_3cm	MC-11.39_4cm	MC-11.39_5cm	MC-11.39_6cm	MC-13_1cm	1
0	2.00	-3.833740	-0.549722	3.768829	7.838111	7.276698	9.401389	-4.213962	0.
1	2.01	-3.833740	-0.653441	3.839289	7.900534	7.335240	9.244433	-4.014669	0.
2	2.02	-1.820192	1.563539	2.735516	5.546476	3.284564	3.631551	-0.739384	1.
3	2.03	-0.844145	0.658403	1.497446	3.569401	2.084478	2.652344	-1.013579	-0.
4	2.04	-1.819895	-2.984150	-6.027533	2.795317	1.163047	4.302964	-3.954196	-4.

5 rows × 91 columns

In [8]:

```
df_A_mean.shape
```

Out[8]:

```
(801, 91)
```

In [9]:

```
# 准备取数据
mc_mark_list = ['MC-10_3cm'
                ,'MC-11.39_3cm'
                ,'MC-13_3cm'
                ,'MC-15_3cm'
                ,'MC-18_3cm'
                ,'MC-20_3cm'
                ,'MC-23_3cm'
                ,'MC-25_3cm'
                ,'MC-28-1_3cm'
                ,'MC-30-1_3cm'
               ]

arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
df_spectrum = pd.DataFrame(arr_freq, columns=['freq'])

for index in range(len(mc_mark_list)):

    df_spectrum[mc_mark_list[index]] = df_A_mean[mc_mark_list[index]]


# 查看
df_spectrum.shape
```

Out[9]:

(801, 11)

In [10]:

```
# 查看
df_spectrum.head()
```

Out[10]:

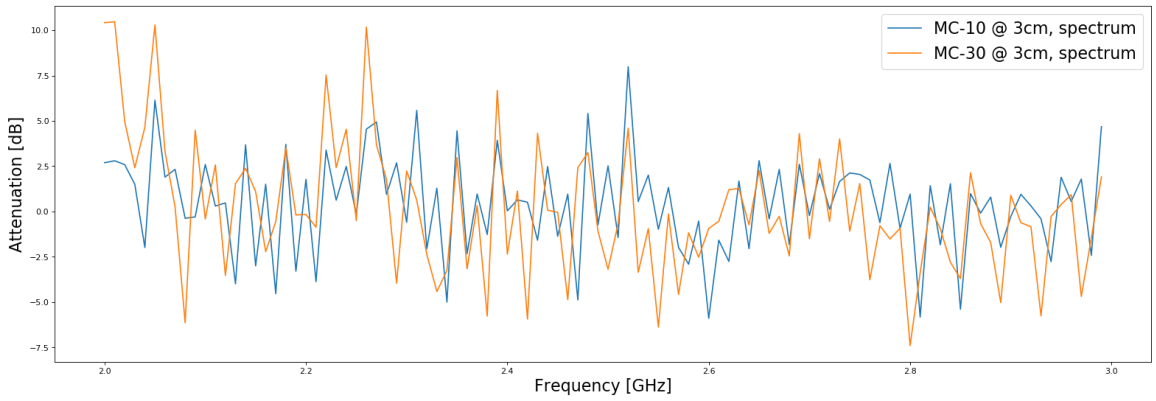
	freq	MC-10_3cm	MC-11.39_3cm	MC-13_3cm	MC-15_3cm	MC-18_3cm	MC-20_3cm	MC-23_3cm	MC-25_3cm
0	2.00	2.694342	3.768829	4.533448	5.222904	6.525884	7.540138	8.626135	9.070503
1	2.01	2.800079	3.839289	4.659345	5.260869	6.575675	7.610780	8.688379	9.086250
2	2.02	2.586575	2.735516	3.050696	3.175425	3.691132	4.048566	4.489225	4.482801
3	2.03	1.503836	1.497446	1.925023	1.723854	2.879009	3.227593	3.853586	4.488493
4	2.04	-1.986650	-6.027533	-5.163187	-1.669155	-2.338461	0.428671	2.509803	2.351551

In [11]:

```
#
import matplotlib.pyplot as plt
```

In [17]:

```
# 画图查看
# arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)

plt.figure(figsize=(24, 8), dpi=80)

plt.plot(df_spectrum['freq'][0:100]
         ,df_spectrum['MC-10_3cm'][0:100]
         ,label = 'MC-10 @ 3cm, spectrum'
        )

plt.plot(df_spectrum['freq'][0:100]
         ,df_spectrum['MC-30-1_3cm'][0:100]
         ,label = 'MC-30 @ 3cm, spectrum'
        )

plt.xlabel('Frequency [GHz]', fontsize=20)
plt.ylabel('Attenuation [dB]', fontsize=20)
plt.legend(fontsize=20)
plt.show()
```



In [19]:

```
# 先保存df_spectrum，然后去Origin里面分析
df_spectrum.to_csv('G:/202006-202008_rice_experiment/20201108_data_summary/df_spectrum.csv', index=False)
print('Done!')
```

Done!

2020年11月12日，继续做数据分析

In [1]:

```
# 导入必要的包
import os
import numpy as np
import pandas as pd
import datetime
```

In [22]:

```
## 自定义函数，提取频谱数据，用于后续的分析
def get_spectrum_data(path, mc_mark_list, parent_path, path_mc, thickness='3cm', save_csv=False
, data_type='OM2S2'):
    '''
    功能：从平均谱线数据中提取不同含水率样品在某一厚度下的频谱数据，用于后续的绘图分析等等
    输入：path -- 平均谱线数据的路径，如：'G:/202006-202008_rice_experiment/20201108_data_summar
y/df_A_mean.csv'
          mc_mark_list  --  含水率标识的列表，如 ['MC-10', 'MC-11.39', 'MC-20', 'MC-20-2', 'MC-28
-1', 'MC-28-2']
          thickness  -- 确定要提取的是哪种厚度下的数据
          parent_path  -- 如：'G:/202006-202008_rice_experiment/20201108_data_summary'
    输出：
    作者：张津阳
    日期：2020年11月12日 上午！
    一改：2020年11月13日 晚上！
    '''
    # 提示信息
    print('当前处理的数据类型：', data_type)

    # 平均谱线数据
    df_A_mean = pd.read_csv(path)

    # 含水率数据
    df_mc = pd.read_excel(path_mc, index_col='mark')

    # 为将要提取出来的数据准备“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df_spectrum = pd.DataFrame(arr_freq, columns=['freq'])

    # 组合出与df_A_mean中对应的列名
    name_list = []
    mc_value_list = []   # 取含水率值，将来在Origin中绘图时，用作comments

    for index in range(len(mc_mark_list)):


        if mc_mark_list[index] in df_mc.index:

            # 含水率正确！
            if thickness in ['1cm', '2cm', '3cm', '4cm', '5cm', '6cm']:

                # 厚度正确！ 这才可以拼接列名
                name = mc_mark_list[index] + '_' + thickness
                print(name)  # 调试用，后面可以注释掉！
                name_list.append(name) # 添加数据

                mc_value = df_mc.at[mc_mark_list[index], 'mc']    # 获取元素值
                mc_value_list.append(str(mc_value))   # 添加含水率数据（字符串格式），用作df_spe
ctrum的列名

            else:
                print(thickness, '错误！请检查该厚度标识！')  # 打印出错提示信息

                return

        else:
            print(mc_mark_list[index], '错误！请检查该含水率标识！')  # 打印出错提示信息

            return
```

```
        # 拼接列名
        # name = mc_mark_list[index] + '_' + thickness


        # 检查含水率标识有没有错误!
#         if name in df_A_mean.columns:
#             print(name)  # 调试用，后面可以注释掉!
#             name_list.append(name) # 添加数据
#         else:
#             print(mc_mark_list[index], '错误! 请检查该含水率标识!')  # 打印出错提示信息
#             return



    # 提取数据
    for index in range(len(name_list)):

        df_spectrum[mc_value_list[index]] = df_A_mean[name_list[index]]  # 向 df_spectrum 追加数据

        print('提取: ', name_list[index])




    # 提取结束，检查提取结果!
    print('df_spectrum.shape: ', df_spectrum.shape)

    # 保存文件
    if save_csv:

        today = datetime.date.today() # 日期信息

        if data_type == 'VNA':
            filename = 'VNA_df_spectrum' + '_' + thickness + '_' + str(today) + '.csv'  # 合成出文件名
        else:
            filename = 'df_spectrum' + '_' + thickness + '_' + str(today) + '.csv'  # 合成出文件名

        filepath = os.path.join(parent_path, filename)   # 合成文件路径

        df_spectrum.to_csv(filepath, index=False)  # 列名 header (default True)，行索引 index (default True)

        print('File save done!')

    # 运行结束!
    print('run over!')

    return df_spectrum
```

测试一下下面的自定义函数

In [13]:

```
# 2020年11月12日 下午
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean.csv'
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'
mc_mark_list = ['MC-10', 'MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25', 'MC-28-1', 'MC-30-1']

df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, '3cm', False)

df_spectrum.shape
```

```
MC-10_3cm
MC-11.39_3cm
MC-13_3cm
MC-15_3cm
MC-18_3cm
MC-20_3cm
MC-23_3cm
MC-25_3cm
MC-28-1_3cm
MC-30-1_3cm
提取： MC-10_3cm
提取： MC-11.39_3cm
提取： MC-13_3cm
提取： MC-15_3cm
提取： MC-18_3cm
提取： MC-20_3cm
提取： MC-23_3cm
提取： MC-25_3cm
提取： MC-28-1_3cm
提取： MC-30-1_3cm
df_spectrum.shape: (801, 11)
run over!
```

Out[13]:

```
(801, 11)
```

In [14]:

```
# 查看
df_spectrum.head()
```

Out[14]:

	freq	MC-10_3cm	MC-11.39_3cm	MC-13_3cm	MC-15_3cm	MC-18_3cm	MC-20_3cm	MC-23_3cm	MC-25_3cm
0	2.00	2.694342	3.768829	4.533448	5.222904	6.525884	7.540138	8.626135	9.070503
1	2.01	2.800079	3.839289	4.659345	5.260869	6.575675	7.610780	8.688379	9.086250
2	2.02	2.586575	2.735516	3.050696	3.175425	3.691132	4.048566	4.489225	4.482801
3	2.03	1.503836	1.497446	1.925023	1.723854	2.879009	3.227593	3.853586	4.488493
4	2.04	-1.986650	-6.027533	-5.163187	-1.669155	-2.338461	0.428671	2.509803	2.351551

In [15]:

```
# 进行错误测试
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean.csv'
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'
mc_mark_list = ['MC-10', 'MC-11.39', 'MC-25', 'MC-28', 'MC-30']

df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, '3cm', False)

df_spectrum.shape
```

```
MC-10_3cm
MC-11.39_3cm
MC-25_3cm
MC-28 错误！请检查该含水率标识！

---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-15-2d7d9d577e81> in <module>
      6 df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, '3cm',
False)
      7
----> 8 df_spectrum.shape

AttributeError: 'NoneType' object has no attribute 'shape'
```

In [20]:

```
# 2020年11月12日 下午 修改了上面的自定义函数后，重新测试下！
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean.csv'
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'
mc_mark_list = ['MC-10', 'MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25', 'MC-28-1', 'MC-30-1']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'


df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, '3cm', False)

df_spectrum.shape
```

```
MC-10_3cm
MC-11.39_3cm
MC-13_3cm
MC-15_3cm
MC-18_3cm
MC-20_3cm
MC-23_3cm
MC-25_3cm
MC-28-1_3cm
MC-30-1_3cm
提取： MC-10_3cm
提取： MC-11.39_3cm
提取： MC-13_3cm
提取： MC-15_3cm
提取： MC-18_3cm
提取： MC-20_3cm
提取： MC-23_3cm
提取： MC-25_3cm
提取： MC-28-1_3cm
提取： MC-30-1_3cm
df_spectrum.shape:  (801, 11)
run over!
```

Out[20]:

```
(801, 11)
```

In [21]:

```
# 查看
df_spectrum.head()
```

Out[21]:

	freq	9.553	12.567	13.877	15.44	18.027	20.563	22.52	25.28
0	2.00	2.694342	3.768829	4.533448	5.222904	6.525884	7.540138	8.626135	9.070503
1	2.01	2.800079	3.839289	4.659345	5.260869	6.575675	7.610780	8.688379	9.086250
2	2.02	2.586575	2.735516	3.050696	3.175425	3.691132	4.048566	4.489225	4.482801
3	2.03	1.503836	1.497446	1.925023	1.723854	2.879009	3.227593	3.853586	4.488493
4	2.04	-1.986650	-6.027533	-5.163187	-1.669155	-2.338461	0.428671	2.509803	2.351551

In [25]:

```
## 那我再重新运行一下，生成平均频谱数据的代码，df_A_mean_xxxx.csv，然后重新调用自定义函数
#----------------------------    输入参数   -------------------------
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean_2020-11-12.csv' #使用新生成的平均频谱数据
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'
mc_mark_list = ['MC-10', 'MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25', 'MC-28-1', 'MC-30-1']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
#---------------------------- 调用自定义函数 -------------------------
df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, '3cm', False)
#---------------------------- 查看 ---------------------------------
df_spectrum.shape
```

```
MC-10_3cm
MC-11.39_3cm
MC-13_3cm
MC-15_3cm
MC-18_3cm
MC-20_3cm
MC-23_3cm
MC-25_3cm
MC-28-1_3cm
MC-30-1_3cm
提取： MC-10_3cm
提取： MC-11.39_3cm
提取： MC-13_3cm
提取： MC-15_3cm
提取： MC-18_3cm
提取： MC-20_3cm
提取： MC-23_3cm
提取： MC-25_3cm
提取： MC-28-1_3cm
提取： MC-30-1_3cm
df_spectrum.shape:  (801, 11)
run over!
```

Out[25]:

```
(801, 11)
```

In [26]:

```
# 查看
df_spectrum.head()
```

Out[26]:

	freq	9.553	12.567	13.877	15.44	18.027	20.563	22.52	25.28
0	2.00	2.694342	3.768829	4.533448	5.222904	6.525884	7.540138	8.626135	9.070503
1	2.01	2.800079	3.839289	4.659345	5.260869	6.575675	7.610780	8.688379	9.086250
2	2.02	2.586575	2.735516	3.050696	3.175425	3.691132	4.048566	4.489225	4.482801
3	2.03	1.503836	1.497446	1.925023	1.723854	2.879009	3.227593	3.853586	4.488493
4	2.04	-1.986650	-6.027533	-5.163187	-1.669155	-2.338461	0.428671	2.509803	2.351551

In [27]:

```
#---------------------------- 调用自定义函数 ， 这次要生成csv文件了！ ------------------------
df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, '3cm', True)
```

```
MC-10_3cm
MC-11.39_3cm
MC-13_3cm
MC-15_3cm
MC-18_3cm
MC-20_3cm
MC-23_3cm
MC-25_3cm
MC-28-1_3cm
MC-30-1_3cm
提取： MC-10_3cm
提取： MC-11.39_3cm
提取： MC-13_3cm
提取： MC-15_3cm
提取： MC-18_3cm
提取： MC-20_3cm
提取： MC-23_3cm
提取： MC-25_3cm
提取： MC-28-1_3cm
提取： MC-30-1_3cm
df_spectrum.shape:  (801, 11)
File save done!
run over!
```

In [4]:

```
# 测试！
list1 = ['MC-11.39_1cm', 'MC-13_1cm']

str1 = 'MC-11.39_1cm'

if str1 in list1:
    print(str1)
```

```
MC-11.39_1cm
```

In [6]:

```
# 测试
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean.csv'

df_A_mean = pd.read_csv(path)

df_A_mean.columns
```

Out[6]:

```
Index(['freq', 'MC-11.39_1cm', 'MC-11.39_2cm', 'MC-11.39_3cm', 'MC-11.39_4cm',
       'MC-11.39_5cm', 'MC-11.39_6cm', 'MC-13_1cm', 'MC-13_2cm', 'MC-13_3cm',
       'MC-13_4cm', 'MC-13_5cm', 'MC-13_6cm', 'MC-15_1cm', 'MC-15_2cm',
       'MC-15_3cm', 'MC-15_4cm', 'MC-15_5cm', 'MC-15_6cm', 'MC-18_1cm',
       'MC-18_2cm', 'MC-18_3cm', 'MC-18_4cm', 'MC-18_5cm', 'MC-18_6cm',
       'MC-20_1cm', 'MC-20_2cm', 'MC-20_3cm', 'MC-20_4cm', 'MC-20_5cm',
       'MC-20_6cm', 'MC-23_1cm', 'MC-23_2cm', 'MC-23_3cm', 'MC-23_4cm',
       'MC-23_5cm', 'MC-23_6cm', 'MC-25_1cm', 'MC-25_2cm', 'MC-25_3cm',
       'MC-25_4cm', 'MC-25_5cm', 'MC-25_6cm', 'MC-20-2_1cm', 'MC-20-2_2cm',
       'MC-20-2_3cm', 'MC-20-2_4cm', 'MC-20-2_5cm', 'MC-20-2_6cm',
       'MC-23-2_1cm', 'MC-23-2_2cm', 'MC-23-2_3cm', 'MC-23-2_4cm',
       'MC-23-2_5cm', 'MC-23-2_6cm', 'MC-25-2_1cm', 'MC-25-2_2cm',
       'MC-25-2_3cm', 'MC-25-2_4cm', 'MC-25-2_5cm', 'MC-25-2_6cm',
       'MC-30-1_1cm', 'MC-30-1_2cm', 'MC-30-1_3cm', 'MC-30-1_4cm',
       'MC-30-1_5cm', 'MC-30-1_6cm', 'MC-10_1cm', 'MC-10_2cm', 'MC-10_3cm',
       'MC-10_4cm', 'MC-10_5cm', 'MC-10_6cm', 'MC-28-1_1cm', 'MC-28-1_2cm',
       'MC-28-1_3cm', 'MC-28-1_4cm', 'MC-28-1_5cm', 'MC-28-1_6cm',
       'MC-28-2_1cm', 'MC-28-2_2cm', 'MC-28-2_3cm', 'MC-28-2_4cm',
       'MC-28-2_5cm', 'MC-28-2_6cm', 'MC-30-2_1cm', 'MC-30-2_2cm',
       'MC-30-2_3cm', 'MC-30-2_4cm', 'MC-30-2_5cm', 'MC-30-2_6cm'],
      dtype='object')
```

In [7]:

```
# 查看
type(df_A_mean.columns)
```

Out[7]:

```
pandas.core.indexes.base.Index
```

In [10]:

```
str1 = 'MC-28-1_1cm'

if str1 in df_A_mean.columns:
    print(str1)
else:
    print('不在，含水率标识不对')
```

```
MC-28-1_1cm
```

In [16]:

```
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
df_mc = pd.read_excel(path_mc, index_col='mark')
```

In [18]:

```
str1 = 'MC-28-1'

if str1 in df_mc.index:
    print(str1)
else:
    print('不在，含水率标识不对')
```

MC-28-1

2020年11月13日，整理出一个自定义函数，求VNA测得的平均频谱数据

In [5]:

```
# 导入必要的包
import os
import numpy as np
import pandas as pd
import datetime
```

In [19]:

```
'''
功能：将VNA获得的衰减数据表VNA_EXP_A.csv中，每种厚度的5次样品重复数据取平均，得到平均频谱数据，
用于绘频谱图，和进一步分析
作者：张津阳
'''
def get_average_spectrum_from_VNA(path_A, path_mc, path_thickness, parent_path, save_csv=False
):
    '''
    输入：path_A ------  VNA采集的衰减数据VNA_EXP_A.csv文件的路径
         path_mc ------  含水率数据路径
         path_thickness ------ 厚度数据路径
         parent_path   ------- 将来保存平均频谱数据文件的目录

    输出：输出VNA平均频谱数据（csv文件）
    作者：张津阳
    日期：2020年11月13日
    '''
    ## 衰减数据
    df_A = pd.read_csv(path_A, index_col='freq')   # shape: 801 × 450
    ## 含水率数据
    df_mc = pd.read_excel(path_mc, index_col='mark')
    ## 厚度数据
    df_thickness = pd.read_excel(path_thickness, index_col='mark')


    ## 定义装 平均频谱数据 的“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df_A_mean = pd.DataFrame(arr_freq, columns=['freq'])

    flag = 1

    for j in range(len(df_mc.index)):
        # mc_mark = df_mc.index[j] + '_'      # 获取含水率标签（同时也是行索引，如 MC-11.39、MC-20-2）
        mc_mark = df_mc.index[j]

        for k in range(len(df_thickness.index)):
            thickness_mark = df_thickness.index[k]  # 获取厚度标签（如 1cm、2cm）



            if mc_mark == 'MC-30-1':
                mark = 'MC-30' + thickness_mark.upper() # VNA数据列名把 MC-30-1 都写成 MC-30了，所以要这样操作一下！
            else:
                mark = mc_mark + thickness_mark.upper()  # 组合出 “含水率 厚度（要大写字母）”，如 MC-101CM

            number = sum(map(lambda x : mark in x , df_A.columns))  # 理论上，每次循环中的number应该都为5

            if number == 5:
                print(flag, '成功发现5条待求平均的频谱！')
                flag += 1
            else:
                print(mark, ' ,该标识对应的频谱不是5条，请检查！')

            # ****************** 计算平均频谱数据 *****************
```

```
            first_column = mark + '_SAMPLE01_S21_LOGMAGE'

            if first_column in df_A.columns:
                df_temp = df_A[first_column]    # 初始数据，如 df_A['MC-11.391CM_SAMPLE01_S21_LOGMAGE']
            else:
                print(first_column, ' ,该初始列名不存在，请检查！')
                return  # 结束程序

            for index in range(1, number):

                # name = mark + '-' + str(index+1)    # 组合出列名，如 'MC-11.39_1cm-2' ... 'MC-11.39_1cm-5'
                name = mark + '_SAMPLE0' + str(index+1) + '_S21_LOGMAGE'   # 组合出列名，如 'MC-11.391CM_SAMPLE05_S21_LOGMAGE'

                if name in df_A.columns:
                    df_temp += df_A[name]      # 循环求和
                else:
                    print(name, ' ,该列名不存在，请检查！')
                    return  # 结束程序

            df_temp /= number       # 求平均

            # ****************************************************

            #df_temp.set_index(df_A_mean.index, inplace=True)  # 行索引index不一致的话，一会儿没法添加！
                                                               # pandas的Series没有 set_index()方法
            df_temp.index = range(len(df_A_mean.index))        # 等价于 df_temp.index = range(801)

            new_column = mc_mark + '_' + thickness_mark

            df_A_mean[new_column] = df_temp  # 添加数据




    # 保存到csv文件
    if save_csv:
        today = datetime.date.today()
        filename = 'VNA_df_A_mean' + '_' + str(today) + '.csv'
        path = os.path.join(parent_path, filename)
        df_A_mean.to_csv(path, index=False)  # 列名 header (default True)，行索引 index (default True)
        print('File save done!')
    else:
        print('File not save!')

    return df_A_mean

    ## 2020年11月12日，自己又在脑中检查了一下上面的代码，应该没问题！
```

In [8]:

```
## 测试上面的自定义函数

## 由VNA采集的衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_EXP_A.csv'
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'

parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'

# 调用
VNA_df_A_mean = get_average_spectrum_from_VNA(path_A, path_mc, path_thickness, parent_path, False)

print('Done!')
```

```
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成功发现5条待求平均的频谱!
MC-20-26CM_SAMPLE02_S21_LOGMAGE  ,该列名不存在，请检查!
Done!
```

In [9]:

```
## 测试上面的自定义函数，更新了文件为：VNA_EXP_A_Update.csv

## 由VNA采集的衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_EXP_A_Update.csv'
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'

parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'

# 调用
VNA_df_A_mean = get_average_spectrum_from_VNA(path_A, path_mc, path_thickness, parent_path, Fal
se)

print('Done!')
```

```
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成功发现5条待求平均的频谱!
MC-23-21CM_SAMPLE04_S21_LOGMAGE  ,该列名不存在，请检查!
Done!
```

In [10]:

```
## 测试上面的自定义函数，更新了文件为：VNA_EXP_A_Update.csv

## 由VNA采集的衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_EXP_A_Update.csv'
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'

parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'

# 调用
VNA_df_A_mean = get_average_spectrum_from_VNA(path_A, path_mc, path_thickness, parent_path, Fal
se)

print('Done!')
```

成功发现5条待求平均的频谱！
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成功发现5条待求平均的频谱！
MC-30-11CM ,该标识对应的频谱不是5条，请检查！

```
MC-30-11CM_SAMPLE01_S21_LOGMAGE  ,该初始列名不存在，请检查！
Done!
```

In [14]:

```
## 测试上面的自定义函数，更新了文件为：VNA_EXP_A_Update.csv

## 由VNA采集的衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_EXP_A_Update.csv'
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'

parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'

# 调用
VNA_df_A_mean = get_average_spectrum_from_VNA(path_A, path_mc, path_thickness, parent_path, Fal
se)

print('Done!')
```

成功发现5条待求平均的频谱！
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成功发现5条待求平均的频谱！
File not save!
Done!
```

In [15]:

```
# 目前貌似是运行成功了，那我来查看一下！
VNA_df_A_mean.head()
```

Out[15]:

	freq	MC-11.39_1cm	MC-11.39_2cm	MC-11.39_3cm	MC-11.39_4cm	MC-11.39_5cm	MC-11.39_6cm	MC-13_1cm	1
0	2.00	-0.758022	-0.329150	1.531331	3.491012	2.828735	3.745941	-0.949128	-0.
1	2.01	-0.879338	-0.279596	2.020220	4.380427	3.668144	4.845454	-1.086076	-0.
2	2.02	-1.030508	-0.202671	2.612275	5.251253	4.429669	5.872542	-1.247333	0.
3	2.03	-1.100776	-0.059734	3.124154	5.780957	4.766717	6.474708	-1.303990	0.
4	2.04	-1.043502	0.113508	3.349044	5.686027	4.521604	6.462667	-1.239930	0.

5 rows × 91 columns

In [21]:

```
## 测试上面的自定义函数，更新了文件为：VNA_EXP_A_Update.csv ，增加了提示的 flag

## 由VNA采集的衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_EXP_A_Update.csv'
## 含水率数据
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
## 厚度数据
path_thickness = 'G:/202006-202008_rice_experiment/20201108_data_summary/thickness.xlsx'

parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'

# 调用
VNA_df_A_mean = get_average_spectrum_from_VNA(path_A, path_mc, path_thickness, parent_path, True)

print('Done!')
```

1 成功发现5条待求平均的频谱!
2 成功发现5条待求平均的频谱!
3 成功发现5条待求平均的频谱!
4 成功发现5条待求平均的频谱!
5 成功发现5条待求平均的频谱!
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61 成功发现5条待求平均的频谱!

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62 成功发现5条待求平均的频谱!
63 成功发现5条待求平均的频谱!
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72 成功发现5条待求平均的频谱!
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76 成功发现5条待求平均的频谱!
77 成功发现5条待求平均的频谱!
78 成功发现5条待求平均的频谱!
79 成功发现5条待求平均的频谱!
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85 成功发现5条待求平均的频谱!
86 成功发现5条待求平均的频谱!
87 成功发现5条待求平均的频谱!
88 成功发现5条待求平均的频谱!
89 成功发现5条待求平均的频谱!
90 成功发现5条待求平均的频谱!
File save done!
Done!
```

In [23]:

```
### 继续下一个自定义函数，抽取VNA的平均频谱中的数据，组成待绘图分析的频谱数据！

### 等等，我自己好好想一下，我是不是已经把VNA获取的平均频谱 处理成 与OM2S2获取的平均频谱 具有相同的格式了（列名一致）
### 好像确实，列名都一致了，那么是不是不需要再单独去自定义函数来提取频谱数据了呢，直接用11月12日定义过的函数就行了吧！
### 那么，我下面就来试下！
#
#
#

## 使用VNA平均频谱数据，如：VNA_df_A_mean_yyyy-mm-dd.csv
#----------------------------    输入参数   -------------------------
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_df_A_mean_2020-11-13.csv' #使用VNA数据生成的平均频谱数据
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'
mc_mark_list = ['MC-10', 'MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25', 'MC-28-1', 'MC-30-1']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
#---------------------------- 调用自定义函数 -------------------------
VNA_df_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, '3cm', True, 'VNA')
#---------------------------- 查看 ---------------------------------
VNA_df_spectrum.shape
```

```
当前处理的数据类型： VNA
MC-10_3cm
MC-11.39_3cm
MC-13_3cm
MC-15_3cm
MC-18_3cm
MC-20_3cm
MC-23_3cm
MC-25_3cm
MC-28-1_3cm
MC-30-1_3cm
提取： MC-10_3cm
提取： MC-11.39_3cm
提取： MC-13_3cm
提取： MC-15_3cm
提取： MC-18_3cm
提取： MC-20_3cm
提取： MC-23_3cm
提取： MC-25_3cm
提取： MC-28-1_3cm
提取： MC-30-1_3cm
df_spectrum.shape:  (801, 11)
File save done!
run over!
```

Out[23]:

```
(801, 11)
```

In [24]:

```
# 查看一下，2020年11月13日
VNA_df_spectrum.head()    # 好吧，明天到 Origin里面画一下由VNA数据提取出来的，用于绘图分析的频谱数据
```

Out[24]:

	freq	9.553	12.567	13.877	15.44	18.027	20.563	22.52	25.28	2
0	2.00	1.506412	1.531331	1.882912	1.882777	2.472353	2.947840	3.432479	3.642277	4.1
1	2.01	1.925624	2.020220	2.438431	2.459020	3.134508	3.694662	4.282163	4.520787	4.9
2	2.02	2.457358	2.612275	3.087303	3.097977	3.867678	4.525837	5.157598	5.416755	5.6
3	2.03	2.948875	3.124154	3.630802	3.595193	4.400057	5.100764	5.713403	5.965348	5.9
4	2.04	3.194333	3.349044	3.852644	3.725880	4.484534	5.164895	5.687836	5.920495	5.5

In [1]:

```
# 测试！
'1cm'.upper()
```

Out[1]:

'1CM'

In [4]:

```
# 检查
## 衰减数据
path_A = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_EXP_A.csv'
df_A = pd.read_csv(path_A, index_col='freq')    # shape: 801 × 450
```

In [5]:

```
# 查看
df_A.head()
```

Out[5]:

freq	MC-11.391CM_SAMPLE01_S21_LOGMAGE	MC-11.391CM_SAMPLE02_S21_LOGMAGE	11.391CM_S
2.00	-0.744662	-0.754585	
2.01	-0.853672	-0.872617	
2.02	-1.027952	-1.025918	
2.03	-1.104980	-1.092981	
2.04	-1.056007	-1.021674	

5 rows × 450 columns

In [6]:

```
# 看看每一个列名中是不是都有 LOGMAGE
number = sum(map(lambda x : 'LOGMAGE' in x , df_A.columns))

print(number)
```

450

In [12]:

```
str1 = 'xiaomi'
if str1 == 'xiaomi':
    print('相等')
```

相等

2020年11月14日，继续批量处理数据的自定义函数

In [ ]:

```
## 准备写一个从平均频谱数据中取出，同一含水率，不同厚度下的数据 的自定义函数
```

In [11]:

```
## 自定义函数，提取频谱数据，用于后续的分析
def get_spectrum_data(path, mc_mark_list, parent_path, path_mc, thickness_list=['3cm'], save_csv
=False, data_type='Attenuation', equipment='OM2S2'):
    '''
    功能：从平均谱线数据中提取不同含水率样品在某一厚度下的频谱数据，用于后续的绘图分析等等
    输入：path -- 平均谱线数据的路径，如：'G:/202006-202008_rice_experiment/20201108_data_summar
y/df_A_mean.csv'
          mc_mark_list  --  含水率标识的列表，如 ['MC-10', 'MC-11.39', 'MC-20', 'MC-20-2', 'MC-28
-1', 'MC-28-2']
          thickness  -- 确定要提取的是哪种厚度下的数据
          parent_path  -- 如：'G:/202006-202008_rice_experiment/20201108_data_summary'
    输出：按含水率、厚度提取出的频谱数据(dataframe格式)
    作者：张津阳
    日期：2020年11月12日 上午！
    一改：2020年11月13日 晚上！
    '''
    # 提示信息
    print('当前处理的数据类型: {0} - {1}'.format(equipment, data_type))

    # 平均谱线数据
    df_A_mean = pd.read_csv(path)

    # 含水率数据
    df_mc = pd.read_excel(path_mc, index_col='mark')

    # 为将要提取出来的数据准备“容器”
    arr_freq = np.around(np.arange(2.00, 10.01, 0.01), decimals=2)
    df_spectrum = pd.DataFrame(arr_freq, columns=['freq'])

    #----------------------Part 1. 组合出要提取的数据的列名----------------------------------
-------
    name_list = []
    mc_value_list = []   # 取含水率值，将来在Origin中绘图时，用作comments

    for index in range(len(mc_mark_list)):

        if mc_mark_list[index] in df_mc.index:

            # 含水率正确！
            for j in range(len(thickness_list)):

                if thickness_list[j] in ['1cm', '2cm', '3cm', '4cm', '5cm', '6cm']:

                    # 厚度正确！ 这才可以拼接列名
                    name = mc_mark_list[index] + '_' + thickness_list[j]

                    print('待提取', name)  # 调试用，后面可以注释掉！

                    name_list.append(name) # 添加列名！


                    mc_value = np.around(df_mc.at[mc_mark_list[index], 'mc'], decimals=3)     #
 获取元素值（并保留3位小数）

                    mc_value_list.append(str(mc_value) + '% ' + thickness_list[j])   # 添加含水
率、厚度信息（字符串格式），用作df_spectrum的列名

                    # 其实，mc_value_list的元素，与 name 就是把 含水率 从标签数据 变成了 实测值
，这一点区别而已
```

```
            else:
                print(thickness, '错误！请检查该厚度标识！')  # 打印出错提示信息

                return

        else:
            print(mc_mark_list[index], '错误！请检查该含水率标识！')  # 打印出错提示信息

            return



    #-----------------Part 2. 从平均频谱数据 df_A_mean 提取数据 到 df_spectrum 中 ----------------
    for index in range(len(name_list)):

        df_spectrum[mc_value_list[index]] = df_A_mean[name_list[index]]  # 向 df_spectrum 追加数据

        print('完成提取：', name_list[index])

    # 提取结束，检查提取结果！
    print('数据提取结束，结果：')
    print('df_spectrum.shape: ', df_spectrum.shape)




    #----------------Part 3. 保存文件 ------------------------------------------------------------
    if save_csv:

        today = datetime.date.today() # 日期信息


        if len(thickness_list) == 1:
            # Case 1: 如果就一种厚度
            spectrum_info = equipment + '-' + data_type + '_spectrum'    # 频谱信息（设备、数据类型）
            data_info = thickness_list[0] + '-' + str(len(mc_mark_list)) + '_mc' # 数据信息（厚度、几种含水率）
            # filename = spectrum_info + '-' + data_info + '-' + str(today) + '.csv'  # 合成出文件名
        else:
            if len(mc_mark_list) == 1:
                # Case 2: 如果不止一种厚度，而就一种含水率
                spectrum_info = equipment + '-' + data_type + '_spectrum'    # 频谱信息（设备、数据类型）
                data_info = str(len(thickness_list)) + '_thickness' + '-' + mc_mark_list[0] # 数据信息（几种厚度、含水率）
                # filename = spectrum_info + '-' + data_info + '-' + str(today) + '.csv'  # 合成出文件名
            else:
                # Case 3: 不止一种厚度，也不止一种含水率
                spectrum_info = equipment + '-' + data_type + '_spectrum'    # 频谱信息（设备、数据类型）
                data_info = str(len(thickness_list)) + '_thickness' + '-' + str(len(mc_mark_list)) + '_mc' # 数据信息（几种厚度、几种含水率）
                # filename = spectrum_info + '-' + data_info + '-' + str(today) + '.csv'  # 合成出文件名
```

```
        # 合成出文件名
        filename = spectrum_info + '-' + data_info + '-' + str(today) + '.csv'

        filepath = os.path.join(parent_path, filename)   # 合成文件路径

        df_spectrum.to_csv(filepath, index=False)  # 列名 header (default True), 行索引 index
(default True)

        print('File save done!')

    # 运行结束!
    print('run over!')

    return df_spectrum
```

In [12]:

```
## 2020年11月14日，测试上方的自定义函数

## Case 1. 测试，一种厚度，多个含水率
#----------------------------    输入参数    -------------------------
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_df_A_mean_2020-11-13.csv' #使用VNA数据生成的平均频谱数据
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary/test' # 我新建了一个test文件夹，存放测试生成的csv文件
mc_mark_list = ['MC-10', 'MC-11.39', 'MC-13', 'MC-15', 'MC-18', 'MC-20', 'MC-23', 'MC-25', 'MC-28-1', 'MC-30-1']
thickness_list = ['4cm']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
#---------------------------- 调用自定义函数 -------------------------
VNA_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, thickness_list, True, 'Attenuation', 'VNA')
#---------------------------- 查看 ---------------------------------
VNA_spectrum.shape
```

```
当前处理的数据类型: VNA - Attenuation
待提取 MC-10_4cm
待提取 MC-11.39_4cm
待提取 MC-13_4cm
待提取 MC-15_4cm
待提取 MC-18_4cm
待提取 MC-20_4cm
待提取 MC-23_4cm
待提取 MC-25_4cm
待提取 MC-28-1_4cm
待提取 MC-30-1_4cm
完成提取： MC-10_4cm
完成提取： MC-11.39_4cm
完成提取： MC-13_4cm
完成提取： MC-15_4cm
完成提取： MC-18_4cm
完成提取： MC-20_4cm
完成提取： MC-23_4cm
完成提取： MC-25_4cm
完成提取： MC-28-1_4cm
完成提取： MC-30-1_4cm
数据提取结束，结果：
df_spectrum.shape:  (801, 11)
File save done!
run over!
```

Out[12]:

```
(801, 11)
```

In [13]:

```
## Case 2. 测试，多种厚度，一个含水率
#----------------------------    输入参数   -------------------------
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_df_A_mean_2020-11-13.csv' #使用VNA数据生成的平均频谱数据
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary/test' # 我新建了一个test文件夹，存放测试生成的csv文件
mc_mark_list = ['MC-28-1']   # 其实是对应含水率最高的样品
thickness_list = ['1cm', '2cm', '3cm', '4cm', '5cm', '6cm']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
#---------------------------- 调用自定义函数 -------------------------
VNA_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, thickness_list, True, 'Attenuation', 'VNA')
#---------------------------- 查看 ----------------------------------
VNA_spectrum.shape
```

```
当前处理的数据类型: VNA - Attenuation
待提取 MC-28-1_1cm
待提取 MC-28-1_2cm
待提取 MC-28-1_3cm
待提取 MC-28-1_4cm
待提取 MC-28-1_5cm
待提取 MC-28-1_6cm
完成提取： MC-28-1_1cm
完成提取： MC-28-1_2cm
完成提取： MC-28-1_3cm
完成提取： MC-28-1_4cm
完成提取： MC-28-1_5cm
完成提取： MC-28-1_6cm
数据提取结束，结果：
df_spectrum.shape:  (801, 7)
File save done!
run over!
```

Out[13]:

```
(801, 7)
```

In [14]:

```
## Case 3. 测试，多种厚度，多个含水率
#----------------------------    输入参数   -------------------------
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/VNA_df_A_mean_2020-11-13.csv' #使用VNA数据生成的平均频谱数据
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary/test' # 我新建了一个test文件夹，存放测试生成的csv文件
mc_mark_list = ['MC-11.39', 'MC-20', 'MC-28-1']   # 其实是对应含水率最高的样品
thickness_list = ['3cm', '4cm']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
#---------------------------- 调用自定义函数 -------------------------
VNA_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, thickness_list, True, 'Attenuation', 'VNA')
#---------------------------- 查看 ---------------------------------
VNA_spectrum.shape
```

```
当前处理的数据类型: VNA - Attenuation
待提取 MC-11.39_3cm
待提取 MC-11.39_4cm
待提取 MC-20_3cm
待提取 MC-20_4cm
待提取 MC-28-1_3cm
待提取 MC-28-1_4cm
完成提取： MC-11.39_3cm
完成提取： MC-11.39_4cm
完成提取： MC-20_3cm
完成提取： MC-20_4cm
完成提取： MC-28-1_3cm
完成提取： MC-28-1_4cm
数据提取结束，结果：
df_spectrum.shape:  (801, 7)
File save done!
run over!
```

Out[14]:

```
(801, 7)
```

三种 Case都测试过了，没问题，下面拿OM2S2的数据试下

In [15]:

```
## 取 OM2S2 采集的平均频谱数据 ，测试 Case 2. 多种厚度，一个含水率
#----------------------------    输入参数   ------------------------
path = 'G:/202006-202008_rice_experiment/20201108_data_summary/df_A_mean_2020-11-12.csv'  # 使用由 OM2S2获取的平均频谱数据
parent_path = 'G:/202006-202008_rice_experiment/20201108_data_summary'
mc_mark_list = ['MC-28-1']   # 其实是对应含水率最高的样品
thickness_list = ['1cm', '2cm', '3cm', '4cm', '5cm', '6cm']
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
#---------------------------- 调用自定义函数 ------------------------
OM2S2_spectrum = get_spectrum_data(path, mc_mark_list, parent_path, path_mc, thickness_list, True, 'Attenuation', 'OM2S2')
#---------------------------- 查看 ---------------------------------
OM2S2_spectrum.shape
```

```
当前处理的数据类型: OM2S2 - Attenuation
待提取 MC-28-1_1cm
待提取 MC-28-1_2cm
待提取 MC-28-1_3cm
待提取 MC-28-1_4cm
待提取 MC-28-1_5cm
待提取 MC-28-1_6cm
完成提取： MC-28-1_1cm
完成提取： MC-28-1_2cm
完成提取： MC-28-1_3cm
完成提取： MC-28-1_4cm
完成提取： MC-28-1_5cm
完成提取： MC-28-1_6cm
数据提取结束，结果：
df_spectrum.shape:  (801, 7)
File save done!
run over!
```

Out[15]:

(801, 7)

In [16]:

```
## 查看
OM2S2_spectrum.head()
```

Out[16]:

	freq	29.193% 1cm	29.193% 2cm	29.193% 3cm	29.193% 4cm	29.193% 5cm	29.193% 6cm
0	2.00	-0.572319	4.961962	10.718941	11.059255	10.643088	8.472242
1	2.01	-0.591789	4.976557	10.808046	11.116960	10.686971	8.270470
2	2.02	-1.078167	2.723341	2.564913	4.219810	3.402764	3.369011
3	2.03	-2.268783	1.516611	1.339543	-0.732791	0.253065	0.909149
4	2.04	-3.958767	-3.285991	3.914232	2.722528	4.540143	2.891791

In [ ]:

```
####  后面的任务：
# 1.求 Phi 数据的平均频谱数据；
# 2.看下上面的提取衰减频谱的函数是不是可以用于 Phi频谱的提取！
```

In [3]:

```
# 测试
# thickness_list = ['3cm', '4cm', '5cm']
thickness_list = ['3cm']
for j in range(len(thickness_list)):
    print(thickness_list[j])
```

3cm

In [6]:

```
# 测试
path_mc = 'G:/202006-202008_rice_experiment/20201108_data_summary/moisture_content.xlsx'
df_mc = pd.read_excel(path_mc, index_col='mark')

df_mc.head()
```

Out[6]:

mark	mc
MC-11.39	12.567
MC-13	13.877
MC-15	15.440
MC-18	18.027
MC-20	20.563

In [8]:

```
# 查看
type(df_mc.at['MC-13', 'mc']), np.around(df_mc.at['MC-13', 'mc'], decimals=3)
```

Out[8]:

(numpy.float64, 13.877)

In [10]:

```
# 测试，格式化输出
print('当前处理的数据类型: {0} - {1}'.format('OM2S2', 'Phase shift'))
```

当前处理的数据类型: OM2S2 - Phase shift

In [ ]:

```

```