Faraday tomography

tutorial

exercise part

RM synthesis

tutorial

The instruction of RM synthesis, RM CLEAN and QU-fit are described in README

RM synthesis

tutorial

1. make dirty FDF using 1 delta function FDF model
   (700-1800 MHz)

command

$ python syn.py data/d1.txt -fmin=700 -fmax=1800

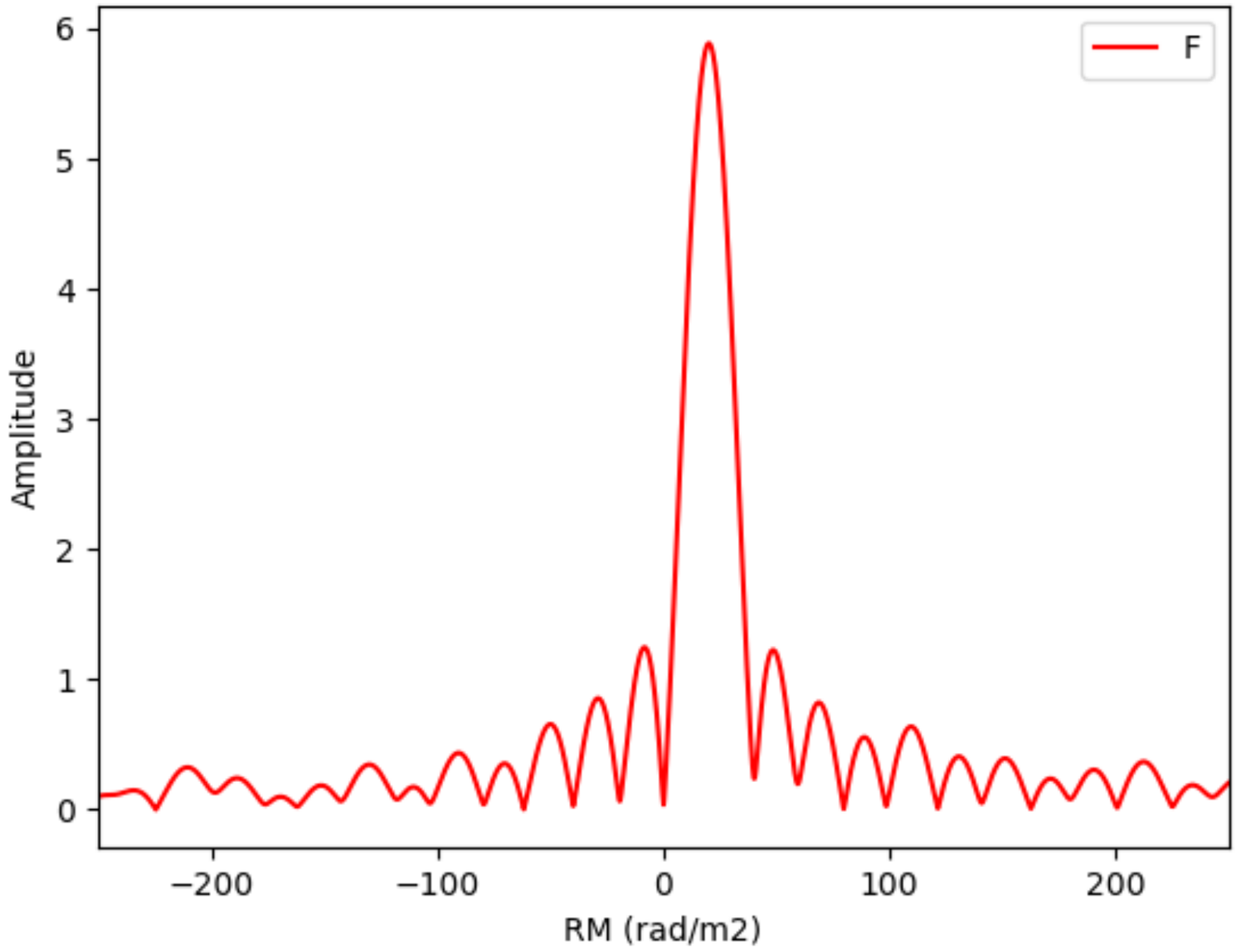
syn.py : file name

data/d1.txt : the path and name of input data

-fmin=700 : minimum frequency [MHz]

-fmax=1800 : maximum frequency [MHz]

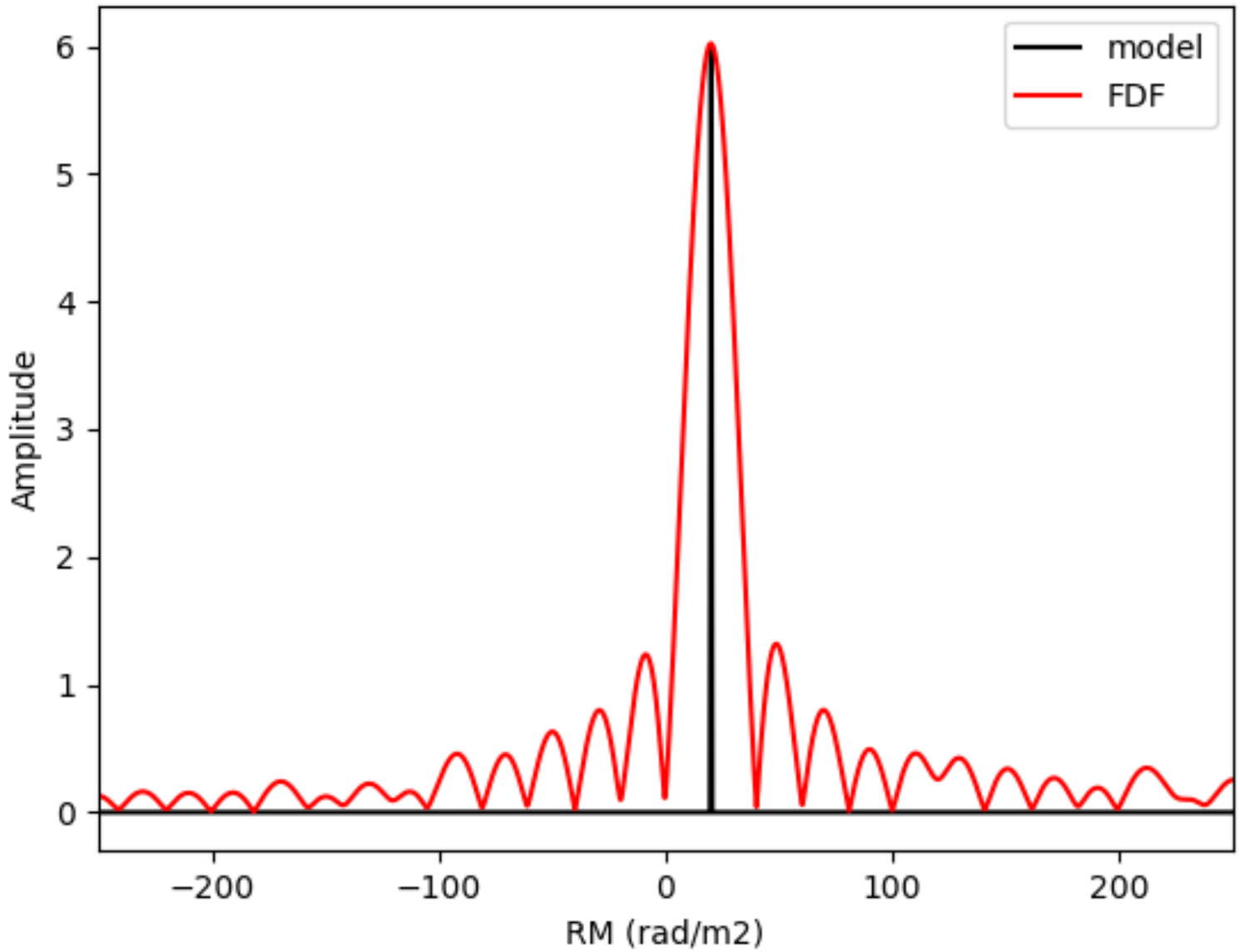
RM synthesis



dirty FDF produces sidelobes and widths ~ FWHM

$$\text{FWHM} = \frac{2\sqrt{3}}{\lambda^2_{max} - \lambda^2_{min}}$$

RM synthesis



dirty FDF produces sidelobes and widths ~ FWHM

$$\mathrm{FWHM} = \frac{2\sqrt{3}}{\lambda^2_{max} - \lambda^2_{min}}$$

RM synthesis

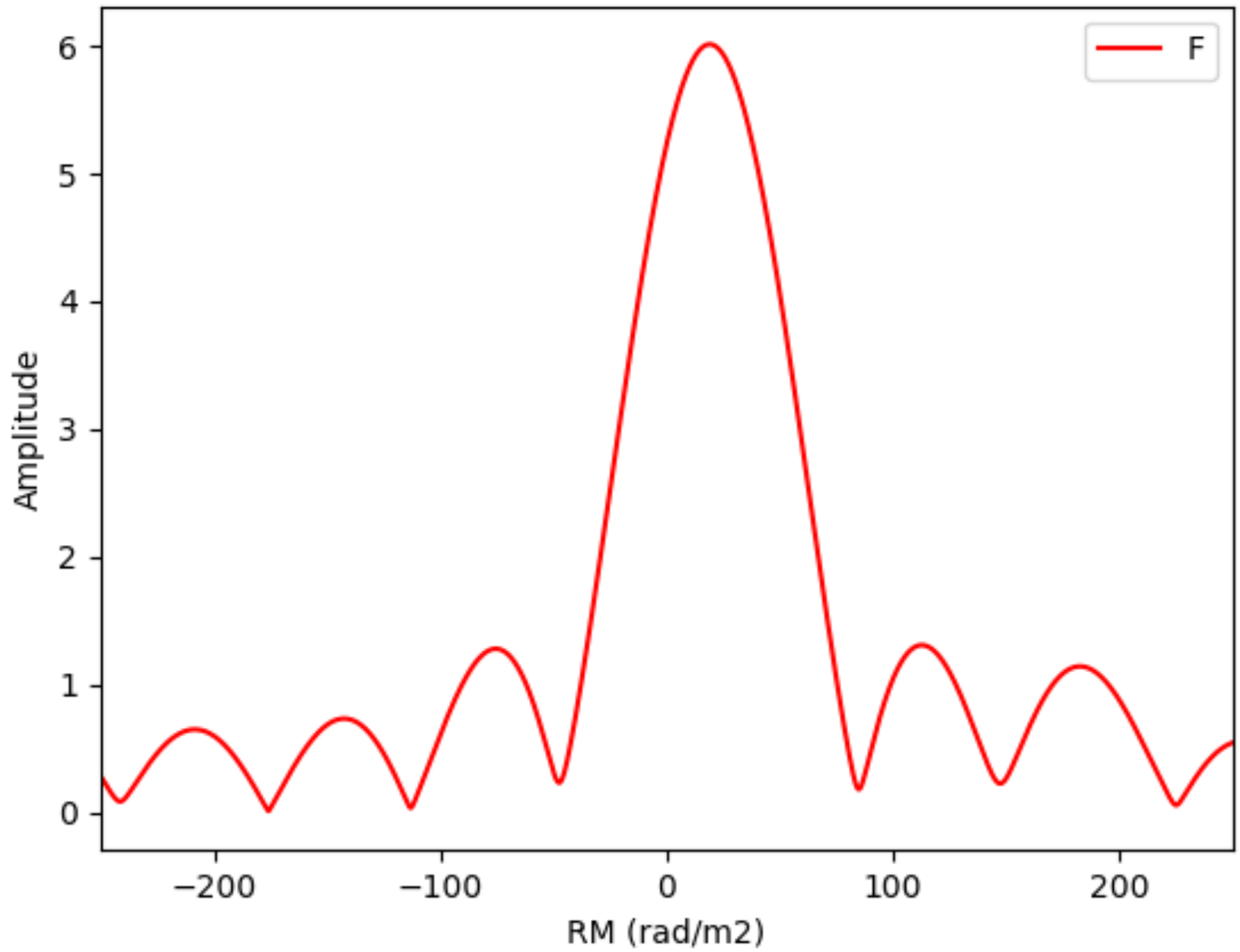
tutorial

2. make dirty FDF using 1 delta function FDF model
   (1100-1800 MHz)

command

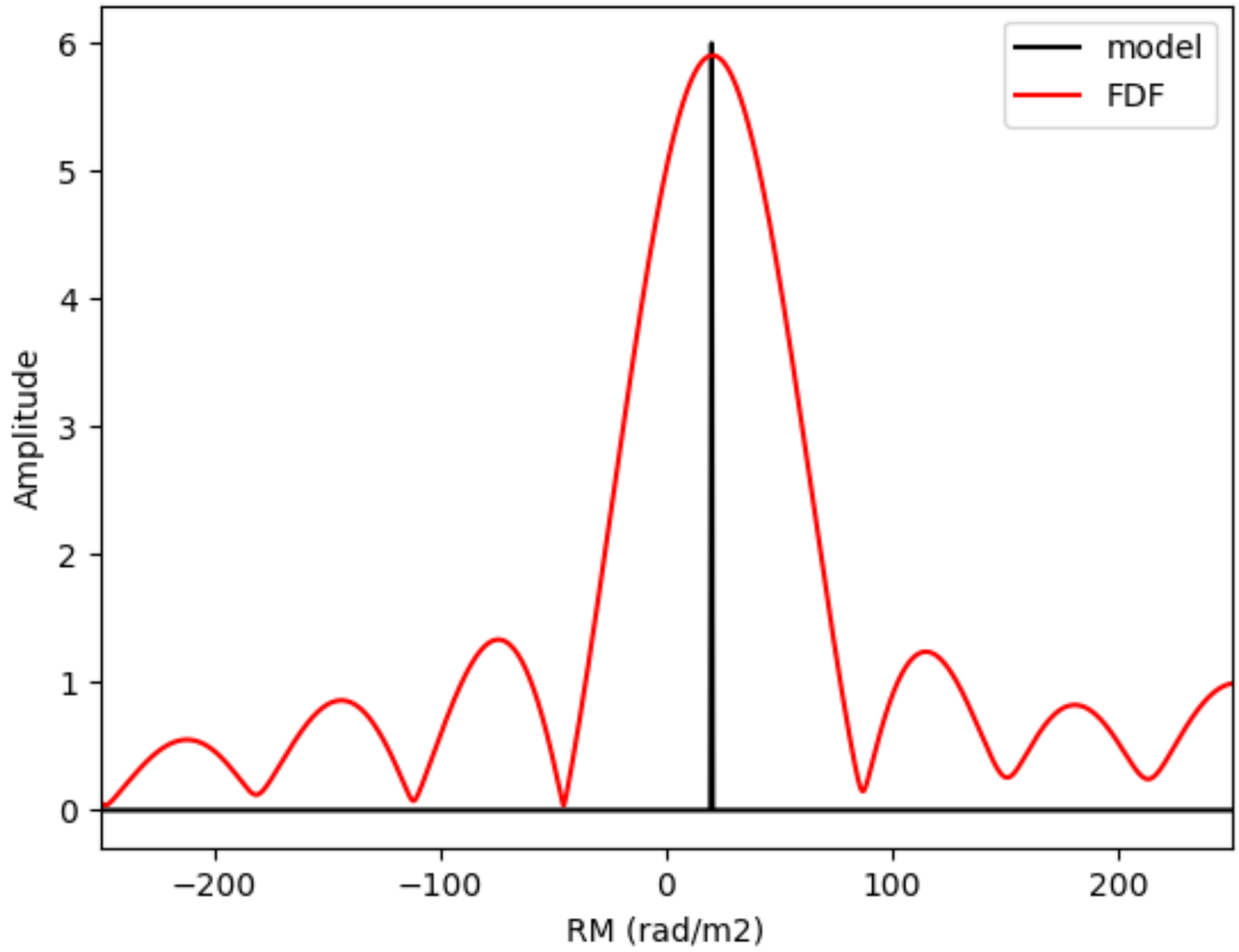
```
$ python syn.py data/d1.txt -fmin=1100 -fmax=1800
```

RM synthesis



the width is depends on the frequency coverage

RM synthesis



the width is depends on the frequency coverage

RM synthesis

tutorial

3. make dirty FDF using 1 delta function FDF model

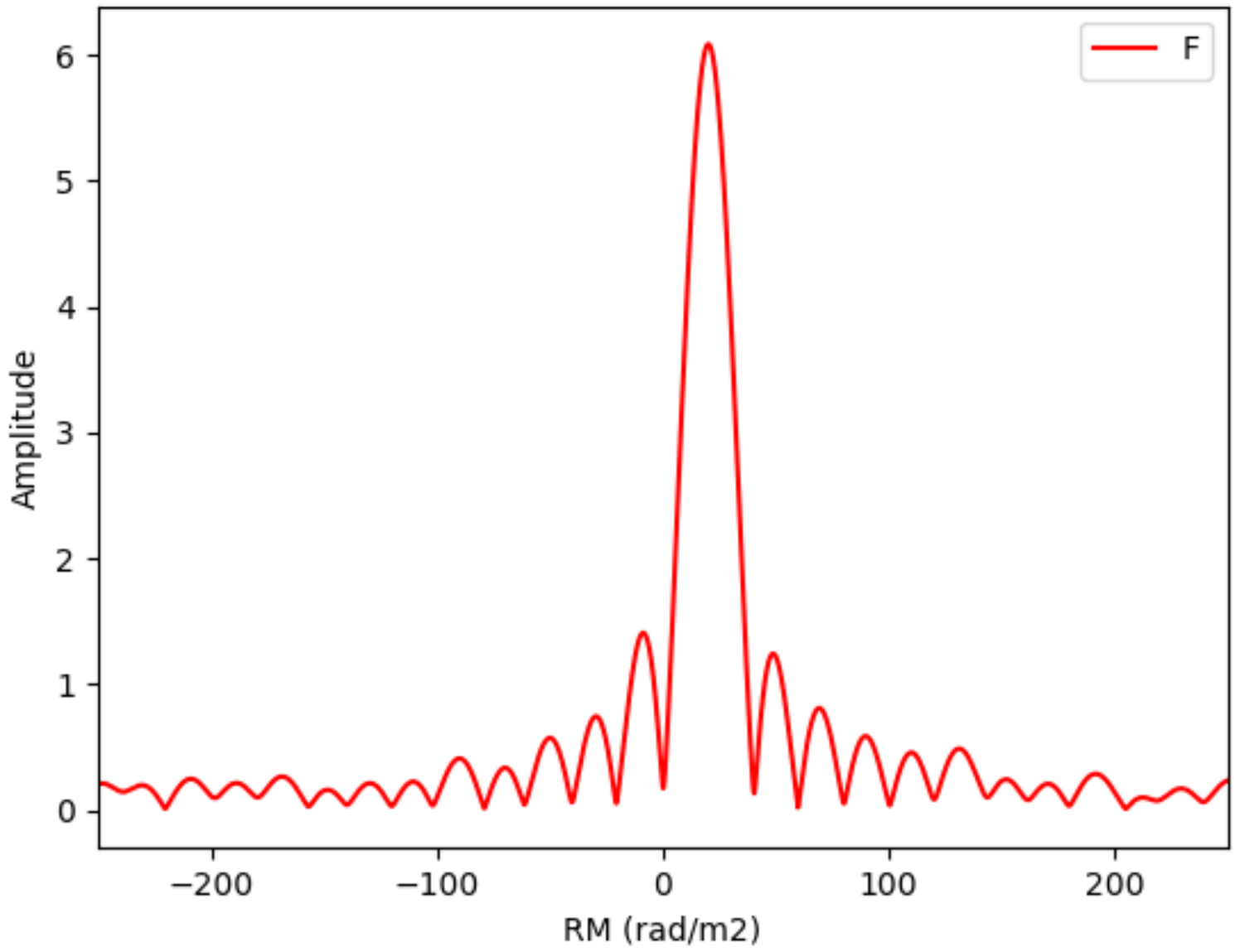
(651-1024 MHz)

-> same FWHM value of 700-1800MHz but using different frequency band

command

```
$ python syn.py data/d1.txt -fmin=651 -fmax=1024
```

RM synthesis



the result is depends on the FWHM value

RM synthesis

practice

1. Let's make dirty FDF of 1delta function model
   using d1.txt with various frequency coverage you choose

   - What happens when you change maximum frequency (f_max)
     with fixing minimum frequency (f_min)?
   - What happens when you change f_min with fixing f_max?

$ python syn.py data/d1.txt -fmin= -fmax=****

you can choose any frequency band
from 100MHz-9GHz

f_min is more effective because the FWHM is described as
the difference of the $\lambda^2_{max}, \lambda^2_{min}$

RM synthesis

practice

2. Let's make dirty FDF of 2 delta function model
   using d2.txt with various frequency coverage you choose

- When does the dirty FDF have one peak or two peaks
  varying the frequency band?

command

$ python syn.py data/d2.txt -fmin= -fmax=****

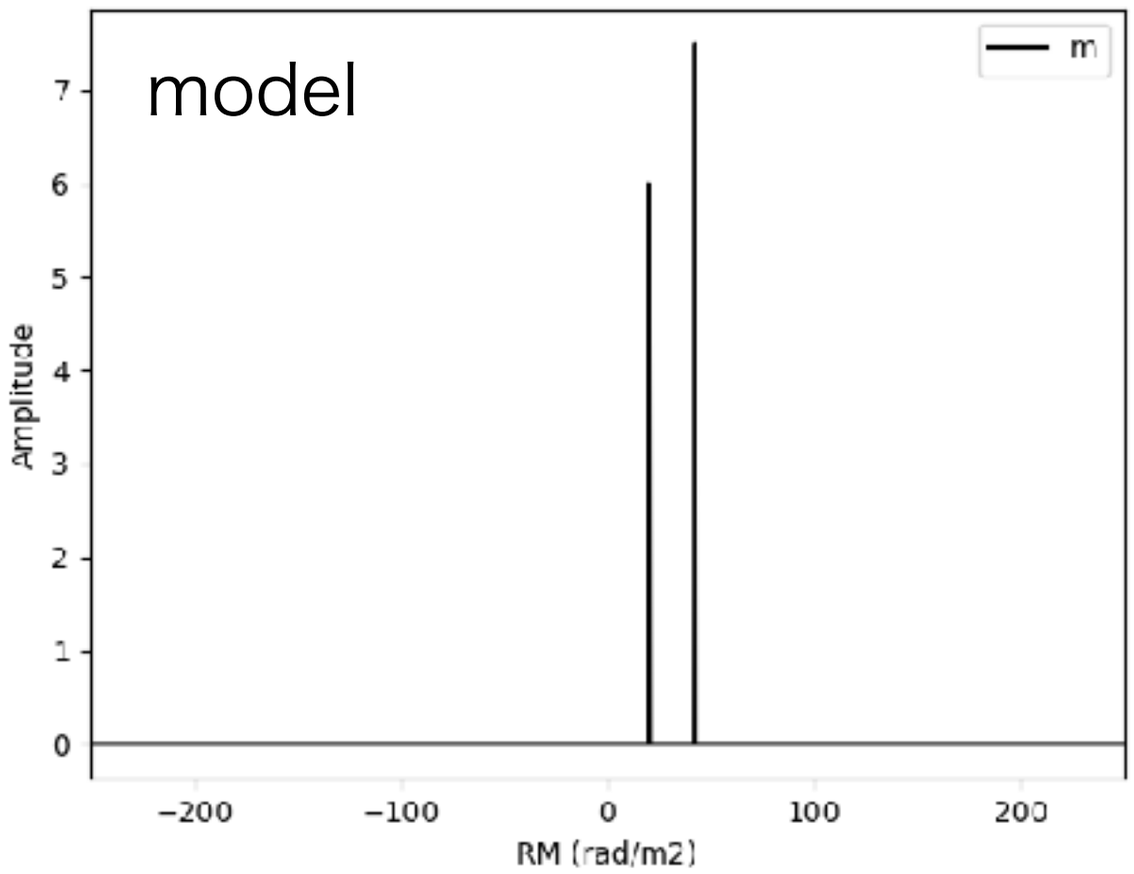
you can choose any frequency band
from 100MHz-9GHz

RM synthesis

practice

2. Let's make dirty FDF of 2 delta function model
   using d2.txt with various frequency coverage you choose

- When does the dirty FDF have one peak or two peaks
  varying the frequency band?



RM synthesis

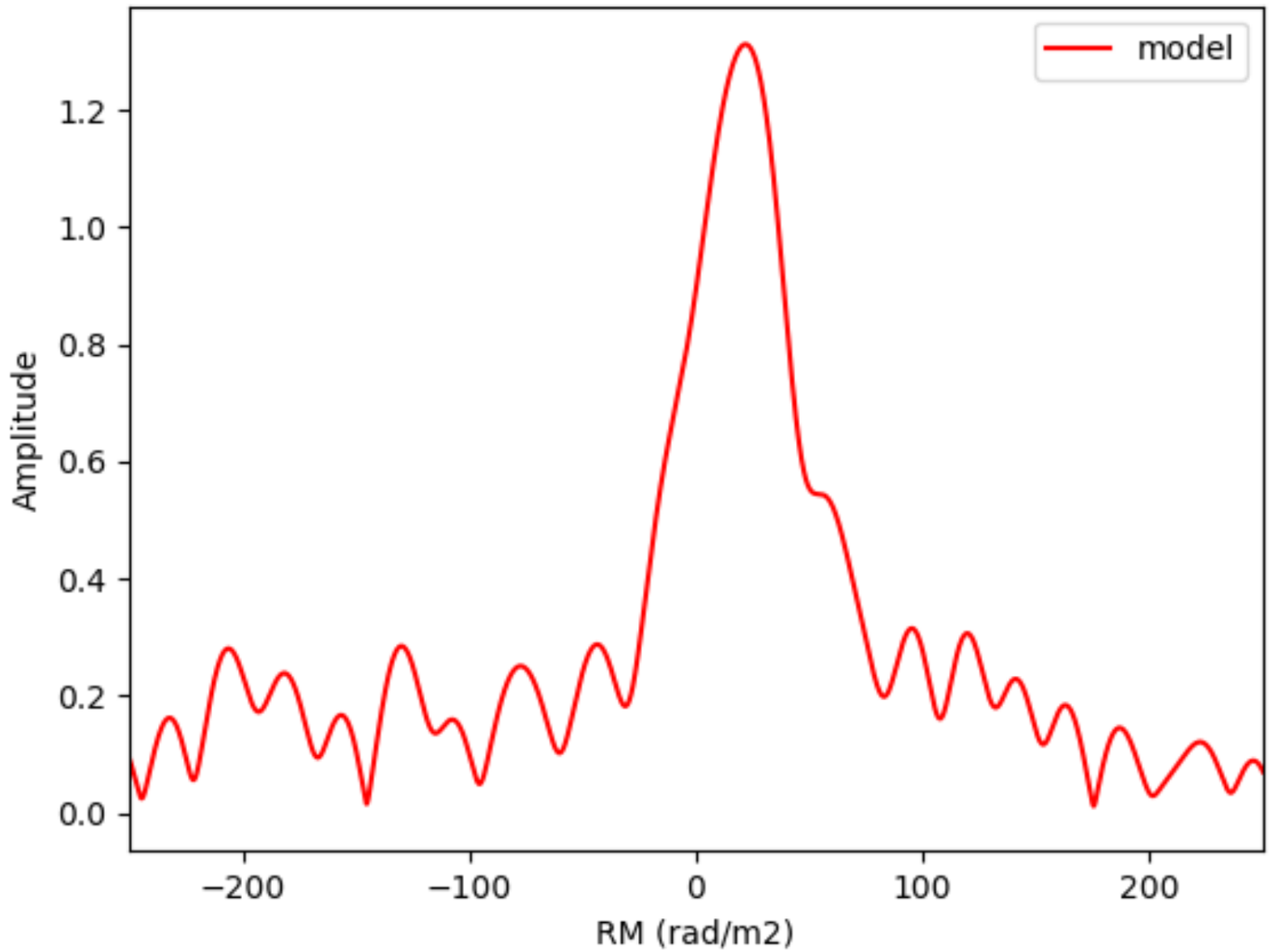
tutorial

3. Let's make dirty FDF of 1 Gaussian function model
   (700-1800 MHz)

command

$ python syn.py data/g1a.txt -fmin=700 -fmax=1800

RM synthesis



RM synthesis

practice

3. Let's make dirty FDF of 1 Gaussian function model
   using the mock data g1b.txt and g1c.txt

- How the results change with regard to the relation between
  the width of Gaussian function and that of FWHM?

command

$ python syn.py data/g1b.txt -fmin=700 -fmax=1800

$ python syn.py data/g1c.txt -fmin=700 -fmax=1800

RM CLEAN

tutorial

RM CLEAN

tutorial

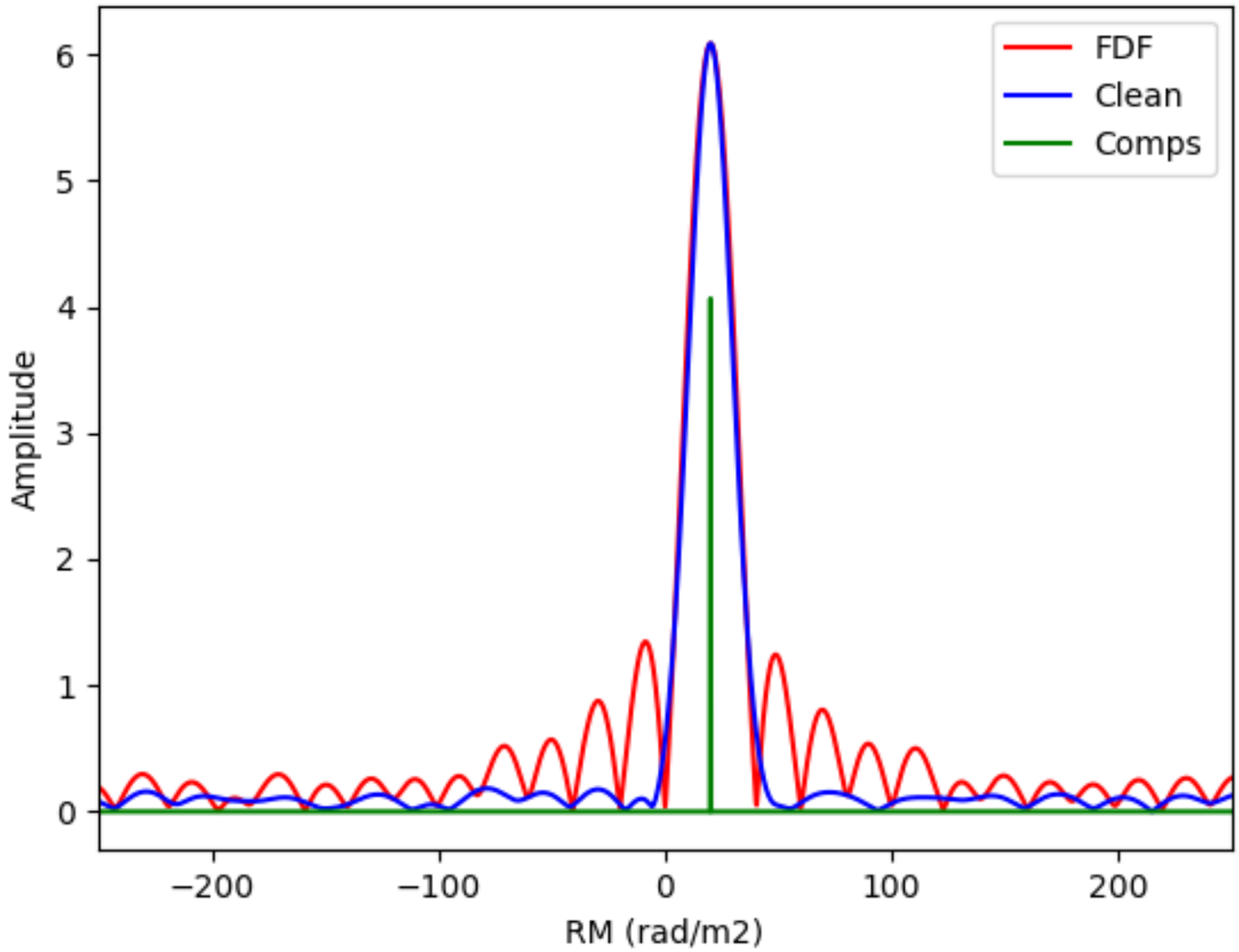
1. make cleaned FDF using 1 delta function FDF model
   (700-1800 MHz)

command

$ python clean.py data/d1.txt -fmin=700 -fmax=1800 -c=1

-c=1 : threshold of RM CLEAN
default is a twice as the variance of side lobe
(-c=2)

RM CLEAN



side lobes are removed in cleaned FDF

RM CLEAN

practice

1. Please make sure that RM CLEAN removes the sidelobes
   using d2.txt with various frequency coverage you choose

command

$ python clean.py data/d1.txt -fmin= -fmax=** -c=***

you can choose any frequency band
and threshold

QU-fit

tutorial

the program is included fortran code

command

```
$ ./fortcomp.sh
```

QU-fit

tutorial

1. reconstruct FDF using 1 delta function FDF model
   (700-1800 MHz) fitted by 1 delta function

command

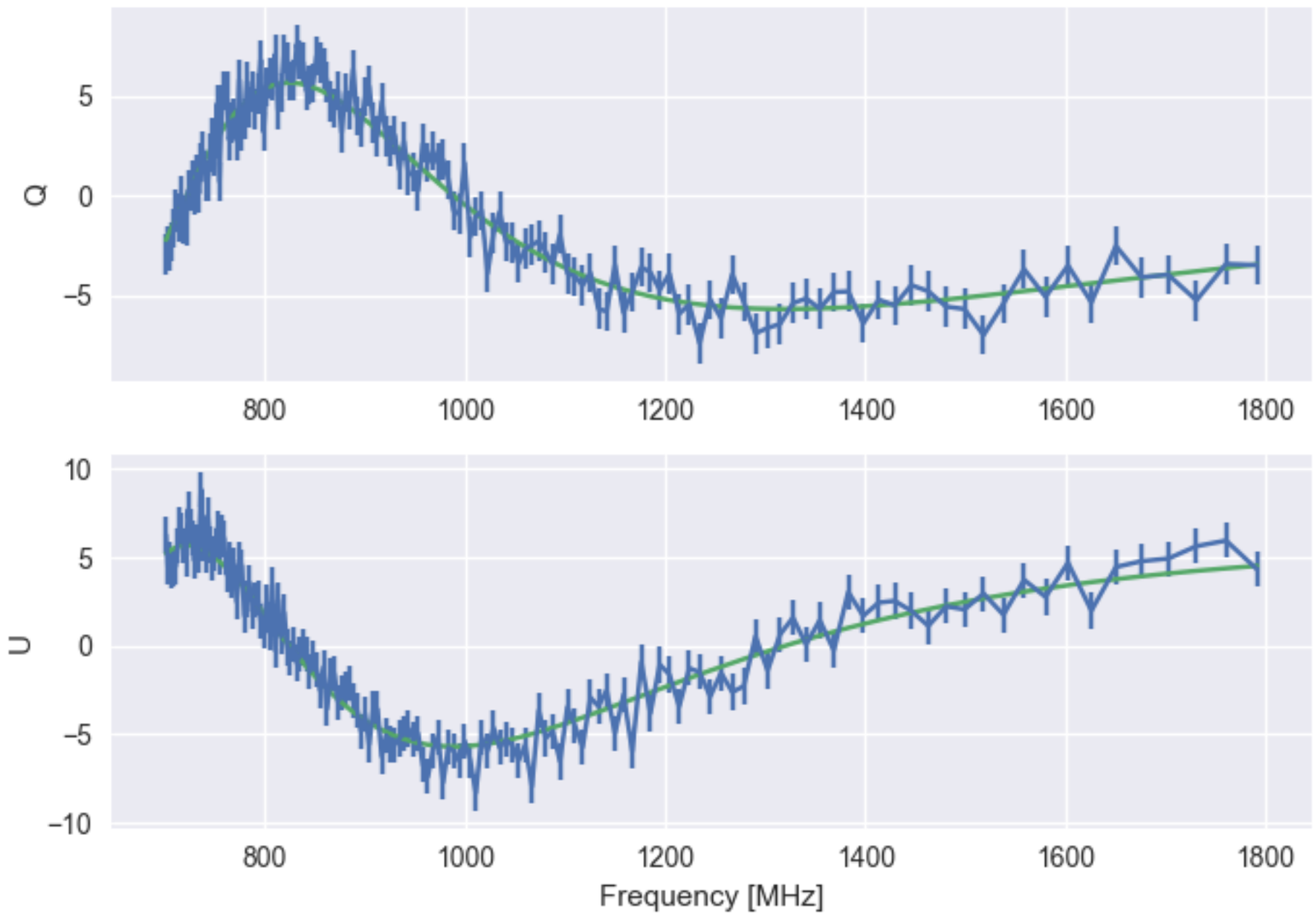
$ python qumc.py data/d1.txt -fmin=700 -fmax=1800 -d=1 -n=10000 -b=0.2

-d=1 : fit the mock data with 1 delta function

-n : the maximum step number

-b : the ratio of burn-in

QU-fit


Q
5
0
−5
800
1000
1200
1400
1600
1800
U
10
5
0
−5
−10
800
1000
1200
1400
1600
1800
Frequency [MHz]

QU-fit

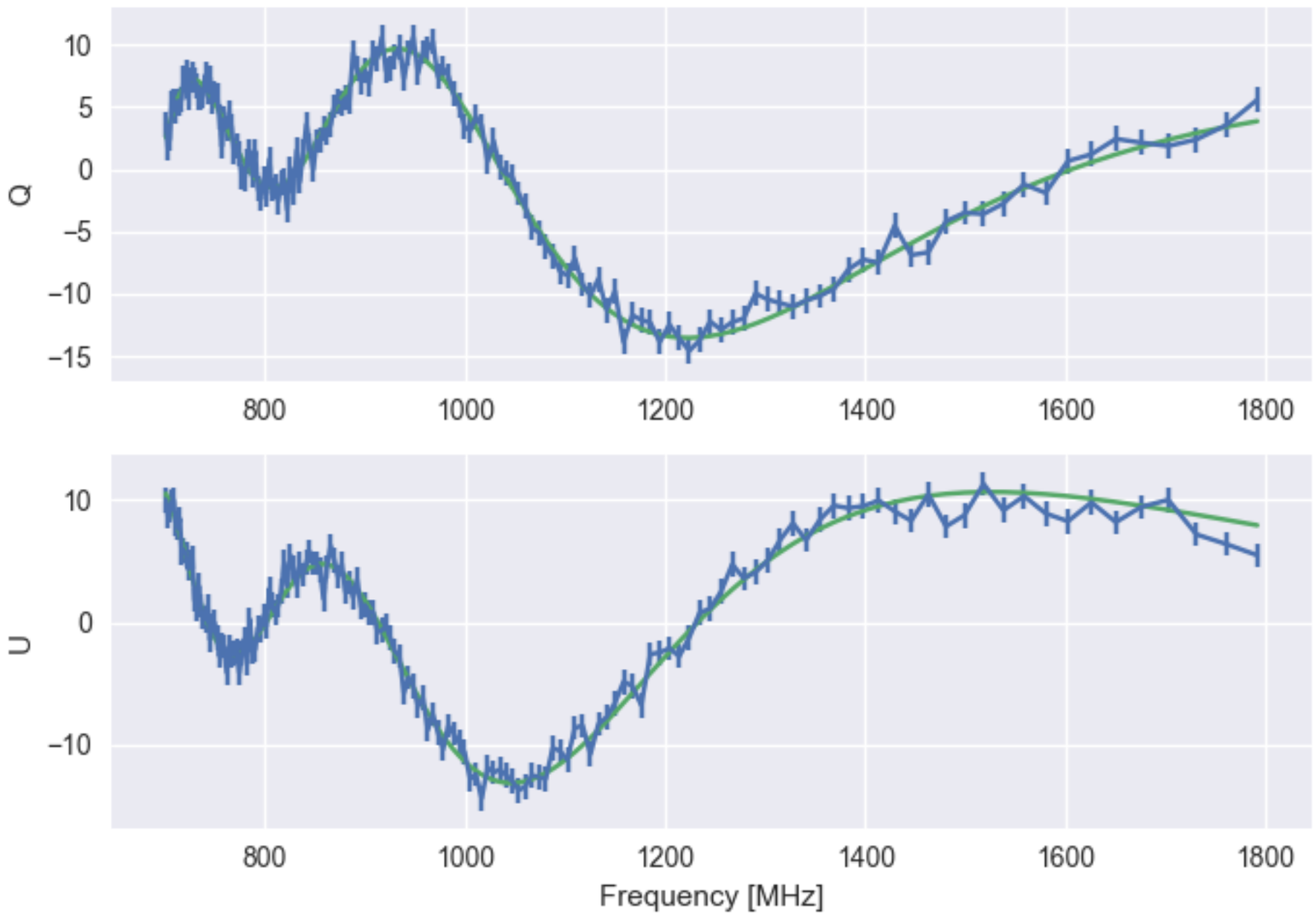
tutorial

2. reconstruct FDF using 2 delta function FDF model
    (700-1800 MHz) fitted by 2 delta function

command

$ python qumc.py data/d2.txt -fmin=700 -fmax=1800 -d=2 -n=10000 -b=0.2

QU-fit


Q
10
5
0
−5
−10
−15
800
1000
1200
1400
1600
1800
U
10
0
−10
800
1000
1200
1400
1600
1800
Frequency [MHz]

QU-fit

practice

1. reconstruct FDF using 2 delta function FDF model
   using d2.txt with various frequency coverage you choose
   fitted by 1~4 delta function(s)

command

$ python qumc.py data/d2.txt -fmin= -fmax=** -d=** -n=** -b=****

please check the chi-square value and BIC for each fit model

χ^2 : d1_____, d2_____, d3_____, d4_____

BIC : d1_____, d2_____, d3_____, d4_____

and also make sure that best fit model parameters are correct

QU-fit

practice

2. reconstruct FDF using 2 gaussian function FDF model
   using g2.txt with various frequency coverage you choose
   fitted by 1~4 gaussian function(s)

command

$ python qumc.py data/g2.txt -fmin= -fmax=** -g=** -n=** -b=****

please check the chi-square value and BIC for each fit model

χ^2 : g1_____, g2_____, g3_____, g4_____

BIC : g1_____, g2_____, g3_____, g4_____

and also make sure that best fit model parameters are correct