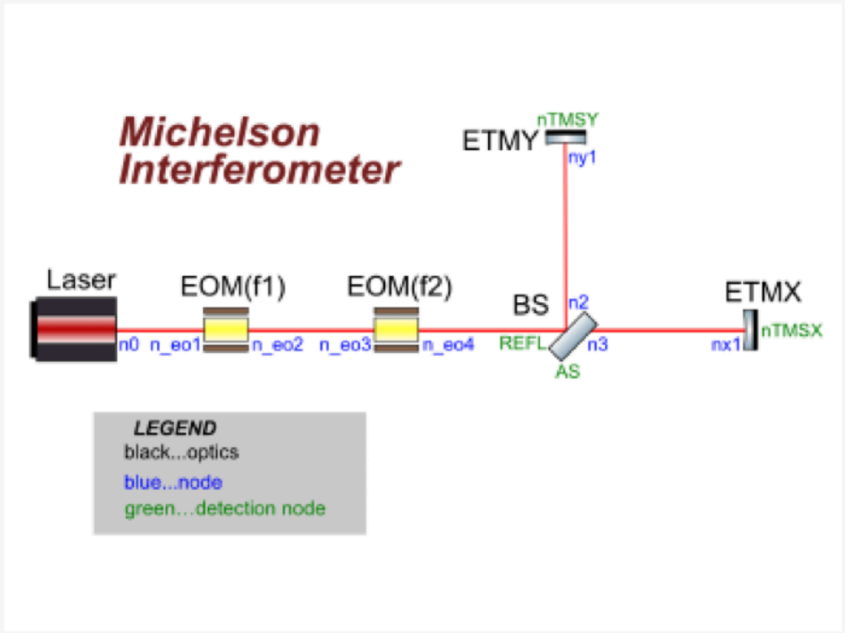
table of contents

Demonstration

Demo to calculate
BS demodulated signals
at REFL, AS, POP in DRFPMI

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

2. Select which DoF to move

DoF: BS

3. Select port (see the top figure)

REFL AS

n0 n_eo1 n_eo2 n_eo3 n_eo4

n2 n3 ny1 nx1 ny2 nx2

Plot | Check all important port | Check all port | Uncheck all port

xaxis range

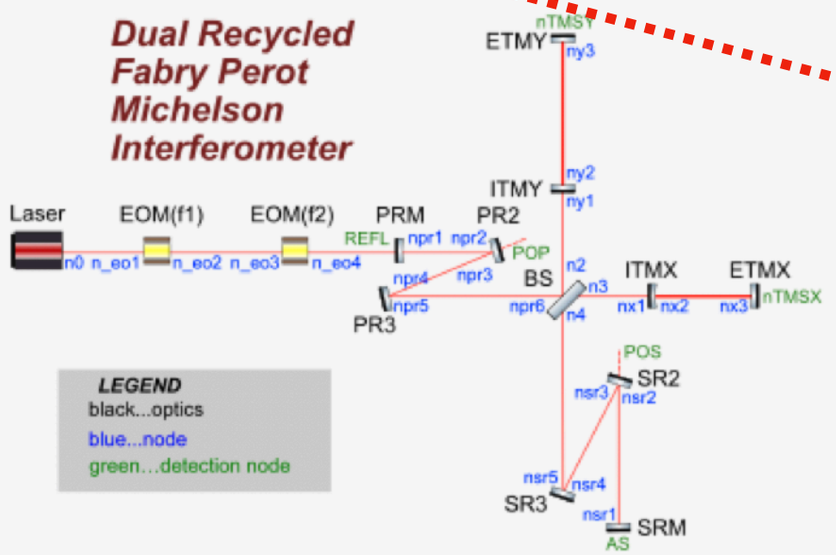
-180 to 180

overplot All PDs

When you launch the GUI, you will see a screen like this.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

2. Select which DoF to move

DoF DARM

3. Select port (see the top figure)

REFL AS POP nTMSY nTMSX POS

n0 n_eo1 n_eo2 n_eo3 n_eo4

npr1 npr2 npr3 npr4 npr5 npr6

nsr1 nsr2 nsr3 nsr4 nsr5

n2 n3 ny1 nx1 ny2 nx2 ny3 nx3

Plot | Check all important port | Check all port | Uncheck all port

xaxis range

-180 to 180

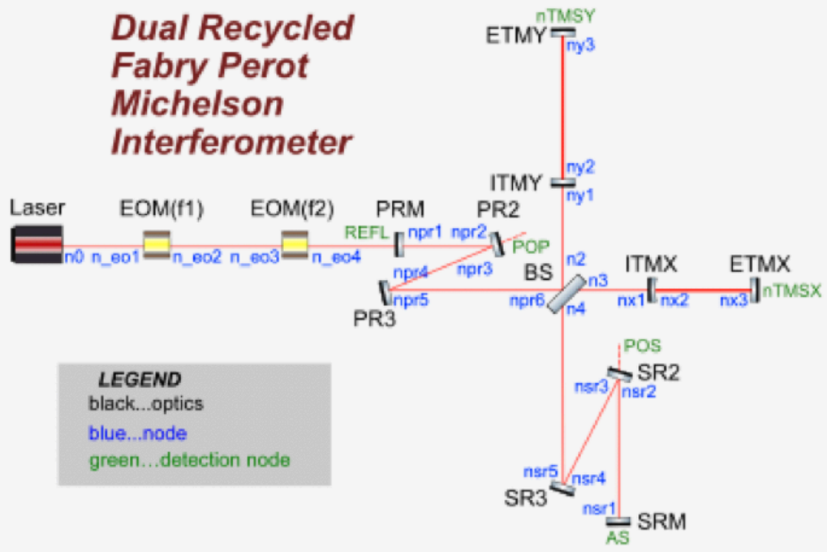
overplot All PDs

Step.1

Select interferometer configuration.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

Select PD type.

Power detector [W] | Amplitud detector | Demodulated signal

2. Select which DoF to move

DoF: DARM

3. Select port (see the top figure)

REFL AS POP nTMSY nTMSX POS

n0 n_eo1 n_eo2 n_eo3 n_eo4

npr1 npr2 npr3 npr4 npr5 npr6

nsr1 nsr2 nsr3 nsr4 nsr5

n2 n3 ny1 nx1 ny2 nx2 ny3 nx3

Plot | Check all important port | Check all port | Uncheck all port

xaxis range

-180 to 180

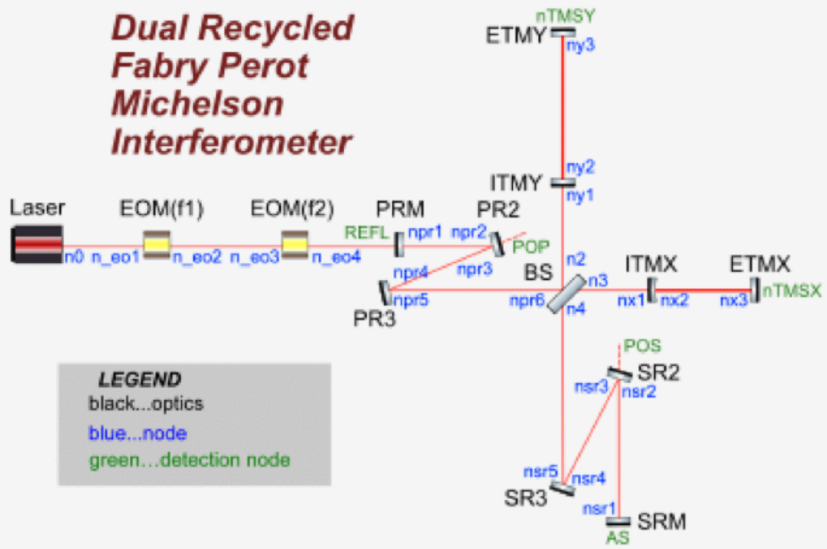
overplot All PDs

Step.2

Select simulation mode “Sweep”.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

(•) Sweep ( ) Transfer function

Select PD type.

( ) Power detector [W] ( ) Amplitud detector (•) Demodulated signal [A.U.]

if select "plot separately", pd results displayed all separately.

( ) overplot selected port output (•) plot separately

Which phase to plot?

[ ] DC (not demodulated signal) [ ] I1 [ ] Q1 [ ] I2 [ ] Q2

if you need other demodulation frequency, use these settings bellow.

[ ] I_freq01 [ ] Q_freq01 freq01 = 2*16.881M label name = 2f1

[ ] I_freq02 [ ] Q_freq02 freq02 = 3*16.881M label name = 3f1

note:

You can set the number of sidebands generated by the modulator in the IFO_param tab(default num 3),

so if you want to demodulate at a frequency such as 2f1 or 3f1, increase the number of sidebands.

Demodulation_phase [deg] 0

2. Select which DoF to move

DoF DARM

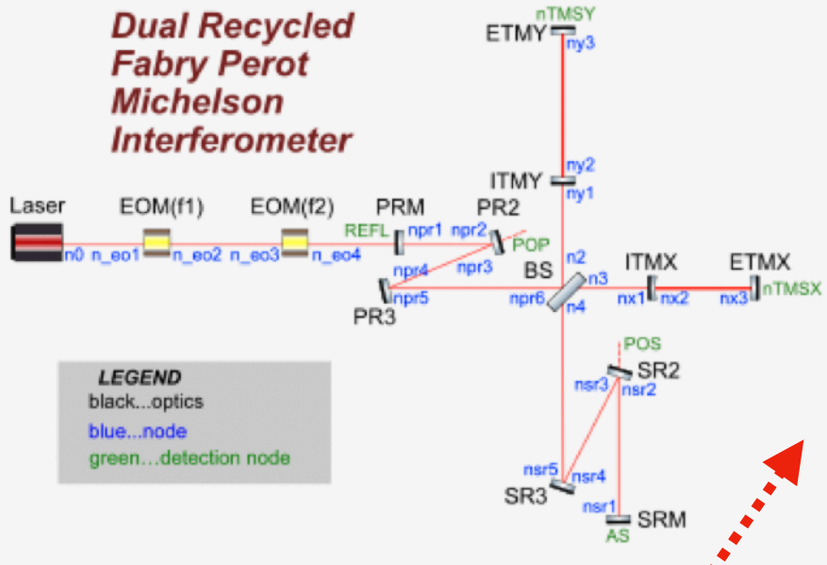
Step.3

Select PD type

“Demodulated signal”.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size

1. Select simulation mode.

Sweep | Transfer function

Select PD type.

Power detector [W] | Amplitud detector | Demodulated signal [A.U.]

if select "plot separately", pd results displayed all separately.

overplot selected port output | plot separately

Which phase to plot?

DC (not demodulated signal) | I1 | Q1 | I2 | Q2

if you need other demodulation frequency, use these settings bellow.

I_freq01 | Q_freq01 | freq01 = 2*16.881M | label name = 2f1

I_freq02 | Q_freq02 | freq02 = 3*16.881M | label name = 3f1

note:

You can set the number of sidebands generated by the modulator in the IFO_param tab(default num 3),

so if you want to demodulate at a frequency such as 2f1 or 3f1, increase the number of sidebands.

Demodulation_phase [deg] 0

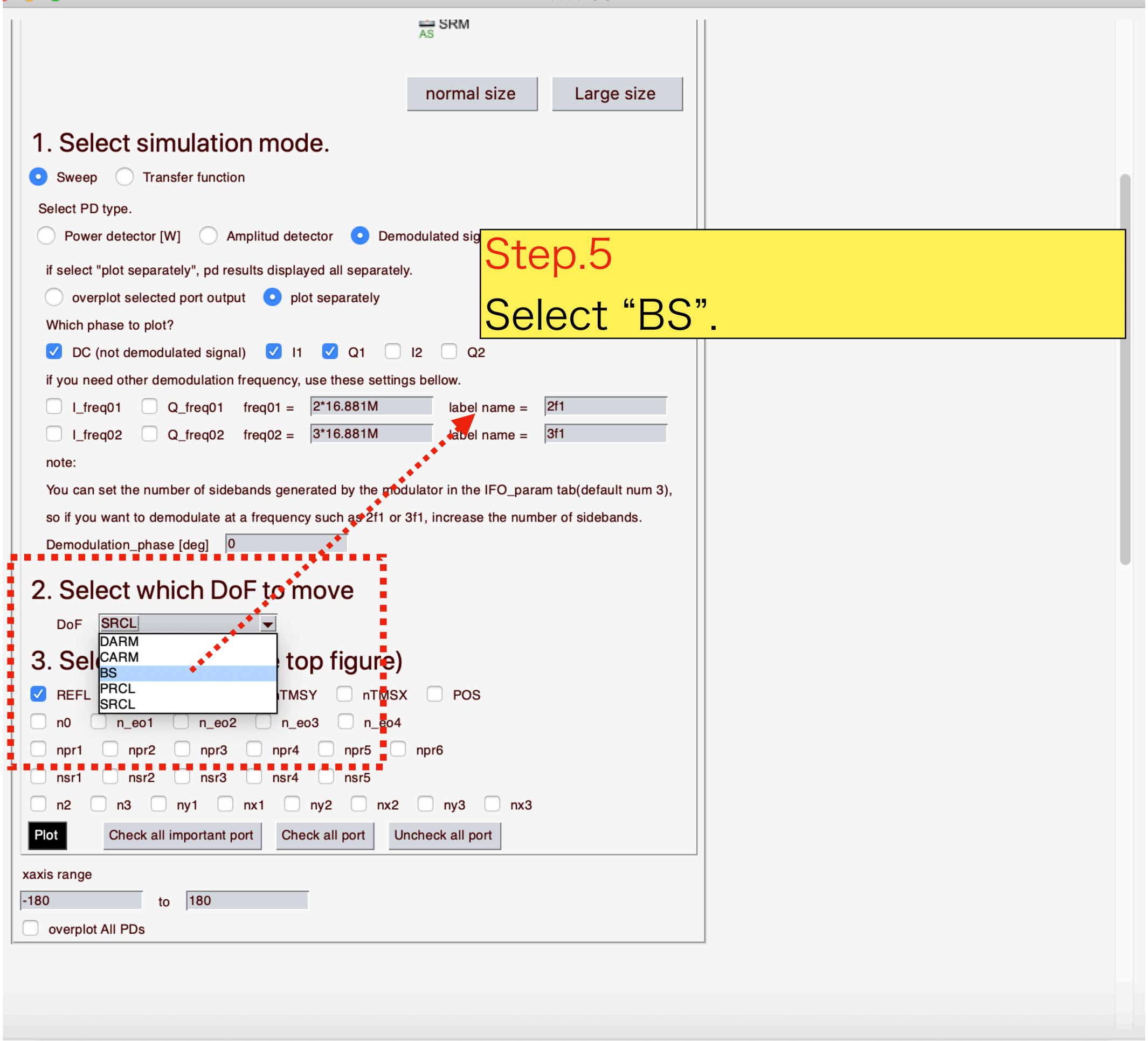
2. Select which DoF to move

DoF DARM

Step.4

Select DC and I1 and I2 as examples.

These are demodulation frequencies and phases.


SRM
AS
normal size
Large size
1. Select simulation mode.
Sweep
Transfer function
Select PD type.
Power detector [W]
Amplitud detector
Demodulated sig
if select "plot separately", pd results displayed all separately.
overplot selected port output
plot separately
Which phase to plot?
DC (not demodulated signal)
I1
Q1
I2
Q2
if you need other demodulation frequency, use these settings bellow.
I_freq01
Q_freq01
freq01 =
2*16.881M
label name =
2f1
I_freq02
Q_freq02
freq02 =
3*16.881M
label name =
3f1
note:
You can set the number of sidebands generated by the modulator in the IFO_param tab(default num 3),
so if you want to demodulate at a frequency such as 2f1 or 3f1, increase the number of sidebands.
Demodulation_phase [deg]
0
2. Select which DoF to move
DoF
SRCL
DARM
CARM
BS
PRCL
SRCL
3. Sel
top figure)
REFL
TMSY
nTMSX
POS
n0
n_eo1
n_eo2
n_eo3
n_eo4
npr1
npr2
npr3
npr4
npr5
npr6
nsr1
nsr2
nsr3
nsr4
nsr5
n2
n3
ny1
nx1
ny2
nx2
ny3
nx3
Plot
Check all important port
Check all port
Uncheck all port
xaxis range
-180
to
180
overplot All PDs
Step.5
Select “BS”.

finesse GUI

SRM
AS

normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

Select PD type.

Power detector [W] | Amplitud detector | Demodulated signal [A.U.]

if select "plot separately", pd results displayed all separately.

overplot selected port output | plot separately

Which phase to plot?

DC (not demodulated signal) | I1 | Q1 | I2 | Q2

if you need other demodulation frequency, use these settings bellow.

I_freq01 | Q_freq01 | freq01 = 2*16.881M | label name =

I_freq02 | Q_freq02 | freq02 = 3*16.881M | label name = 3f1

note:

You can set the number of sidebands generated by the modulator in the IFO_param tab(default num 3),

so if you want to demodulate at a frequency such as 2f1 or 3f1, increase the number of sidebands.

Demodulation_phase [deg] 0

2. Select which DoF to move

DoF BS

3. Select port (see the top figure)

REFL | AS | POP | nTMSY | nTMSX | POS

n0 | n_eo1 | n_eo2 | n_eo3 | n_eo4

npr1 | npr2 | npr3 | npr4 | npr5 | npr6

nsr1 | nsr2 | nsr3 | nsr4 | nsr5

n3 | ny1 | nx1 | ny2 | nx2 | ny3 | nx3

Plot | Check all important port | Check all port | Uncheck all port

-180 to 180

overplot All PDs

Step.6

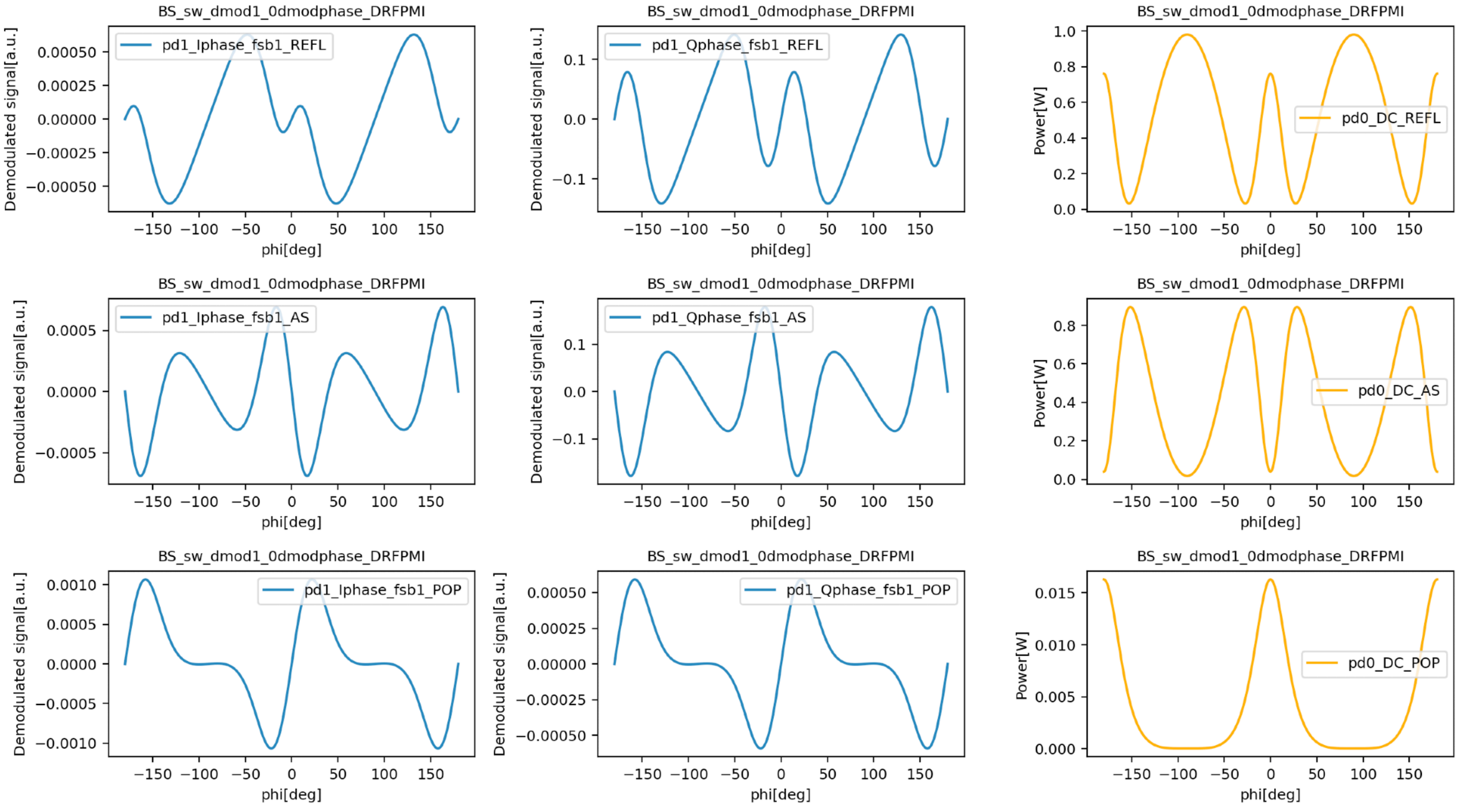
Select “REFL”, “AS”, “POP” as an example.

Step.7

Push “Plot” button.

Blue: Demodulated signals
Yellow: DC signals

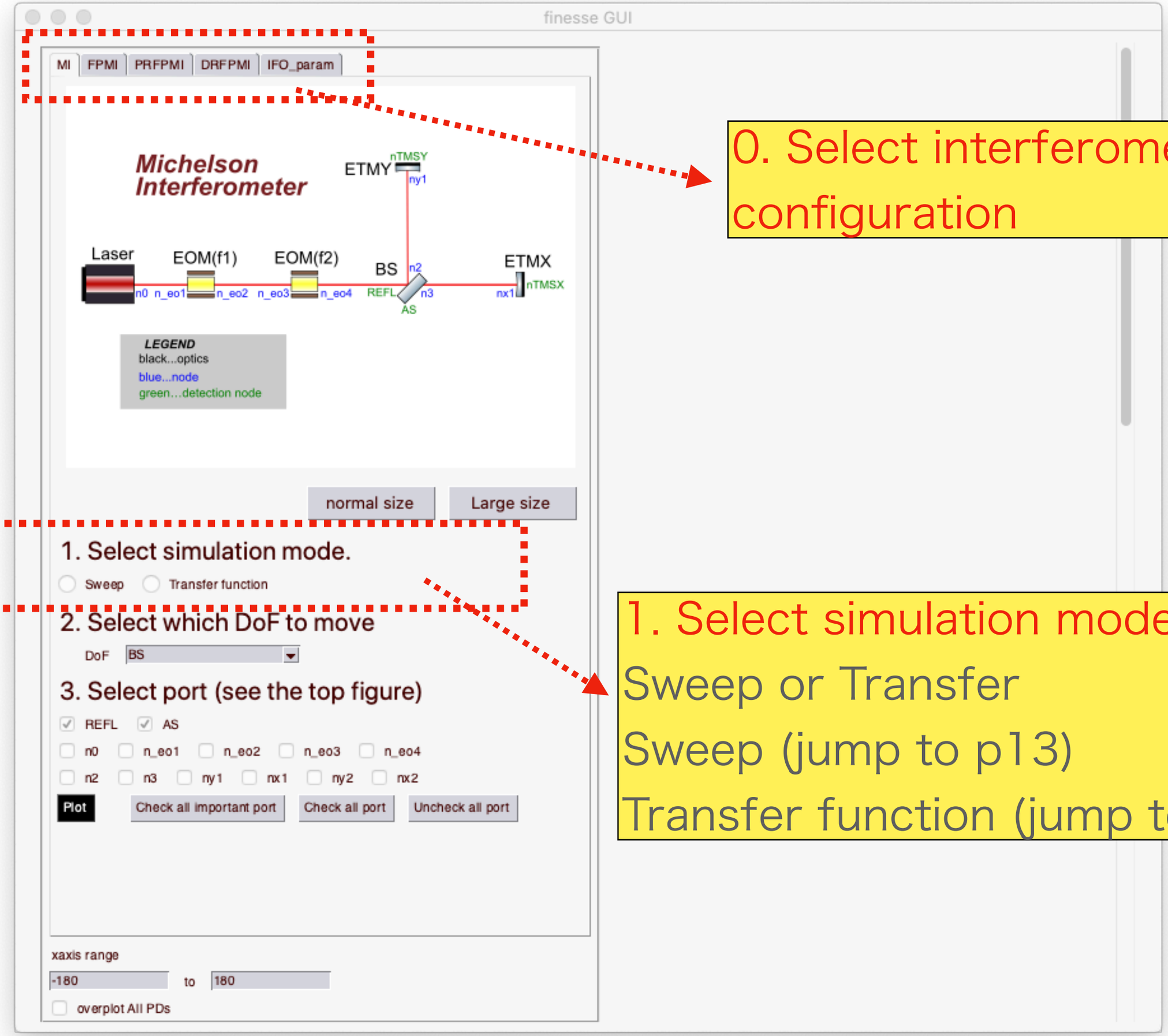
Figure 1

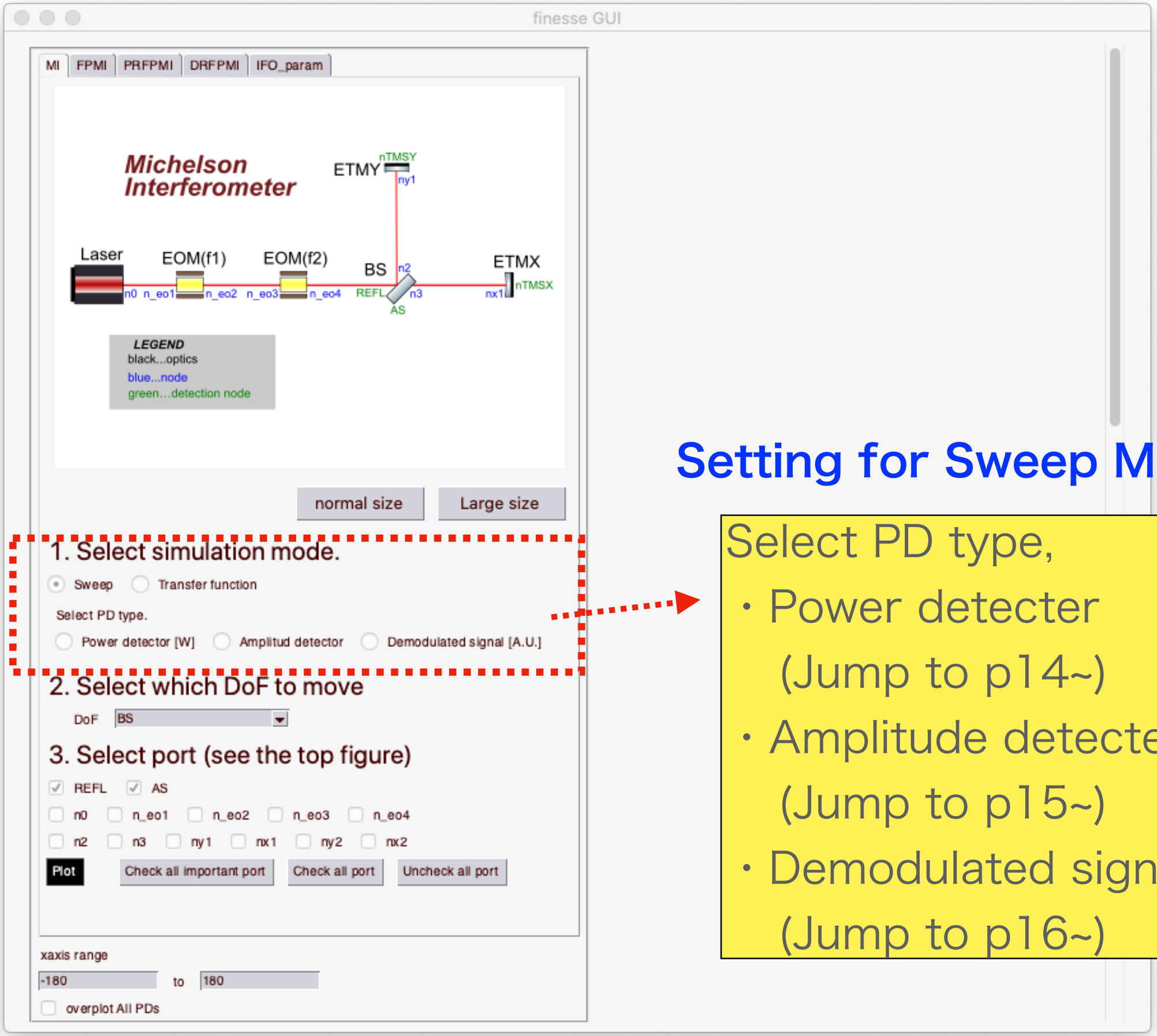


x=58.6409 y=-0.000160544

The demodulated signals are displayed.

Manual and all options

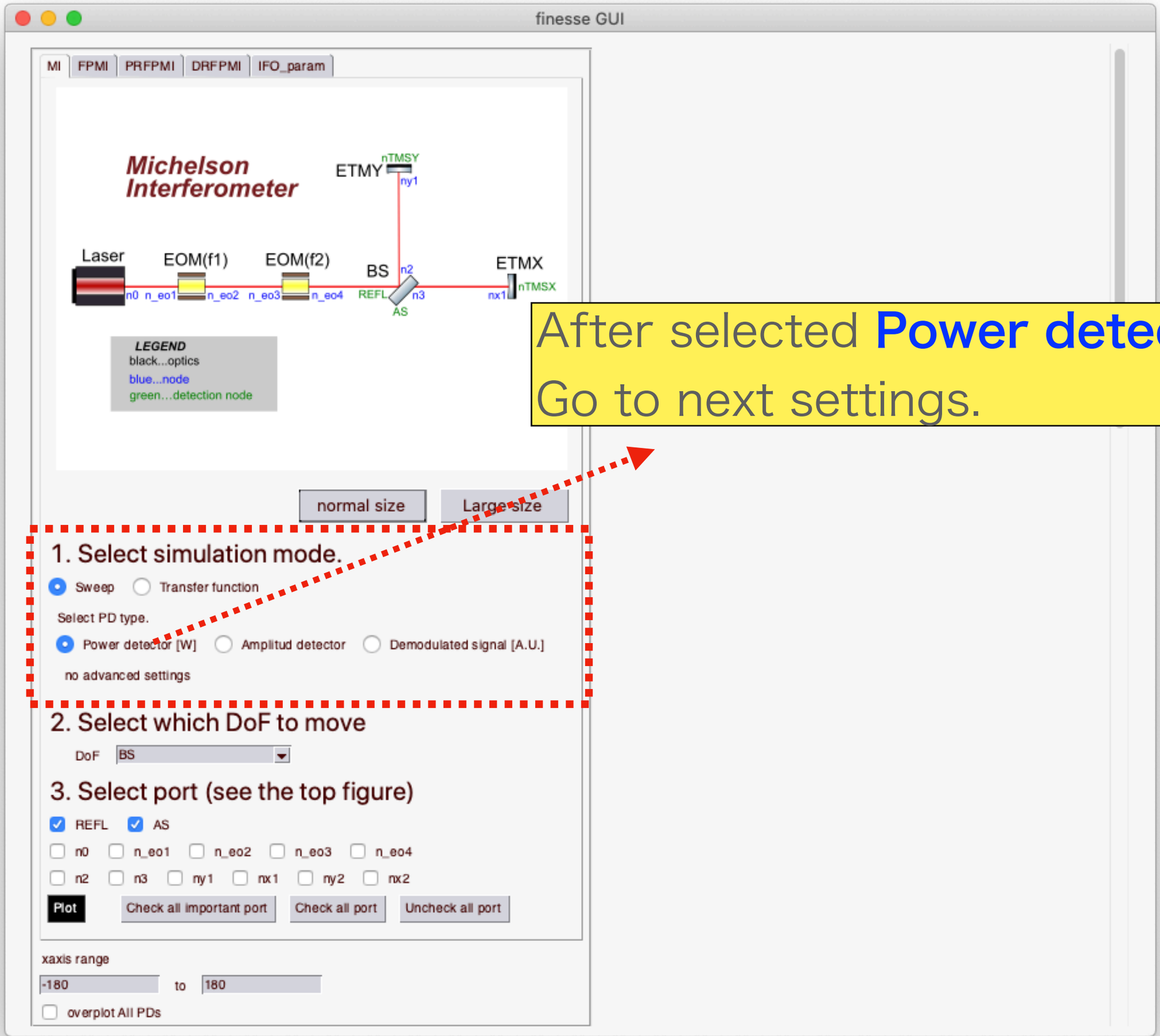

finesse GUI
MI
FPMI
PRFPMI
DRFPMI
IFO_param
Michelson Interferometer
ETMY
nTMSY
ny1
Laser
EOM(f1)
EOM(f2)
BS
n2
ETMX
nTMSX
n0
n_eo1
n_eo2
n_eo3
n_eo4
REFL
n3
AS
nx1
LEGEND
black...optics
blue...node
green…detection node
normal size
Large size
1. Select simulation mode.
Sweep
Transfer function
2. Select which DoF to move
DoF
BS
3. Select port (see the top figure)
REFL
AS
n0
n_eo1
n_eo2
n_eo3
n_eo4
n2
n3
ny1
nx1
ny2
nx2
Plot
Check all important port
Check all port
Uncheck all port
xaxis range
-180
to
180
overplot All PDs
0. Select interferometer configuration
1. Select simulation mode
Sweep or Transfer
Sweep (jump to p13)
Transfer function (jump to p17)



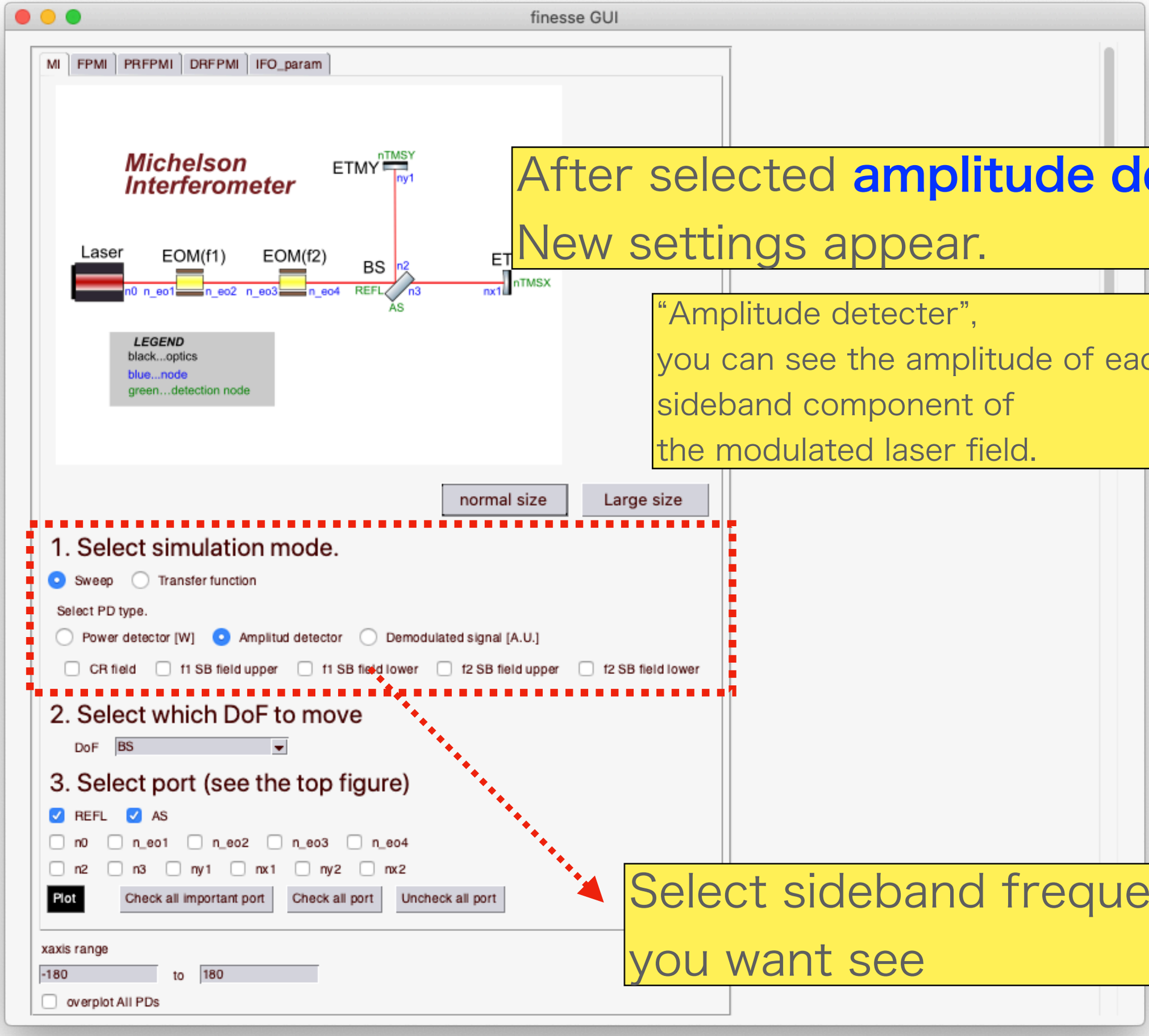
Setting for Sweep Mode

Select PD type,

- Power detecter
  (Jump to p14~)
- Amplitude detecter
  (Jump to p15~)
- Demodulated signal
  (Jump to p16~)



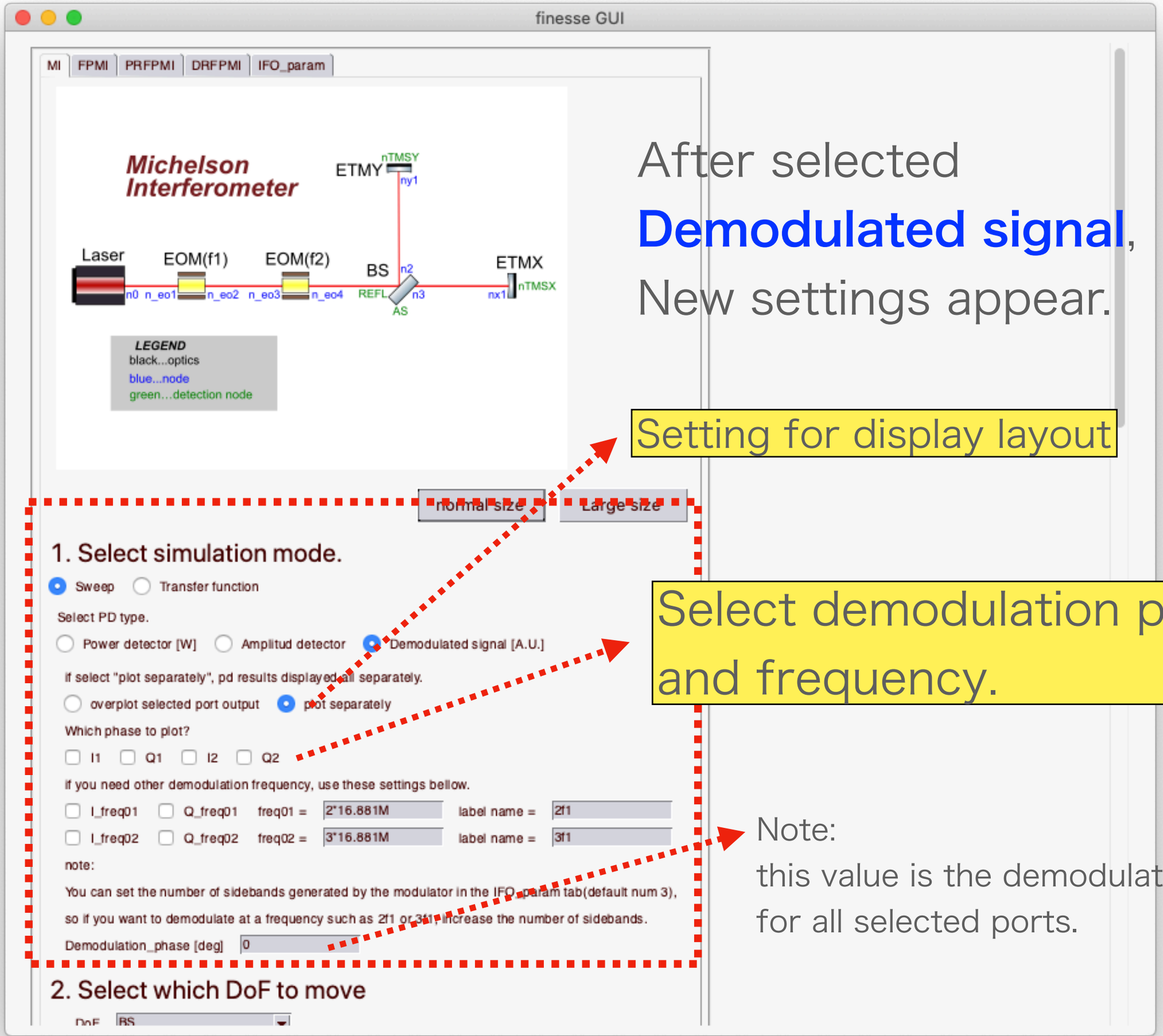
After selected **Power detecter**,
Go to next settings.



After selected **amplitude detecter**,
New settings appear.

"Amplitude detecter",
you can see the amplitude of each
sideband component of
the modulated laser field.

Select sideband frequencies
you want see



After selected
Demodulated signal,
New settings appear.

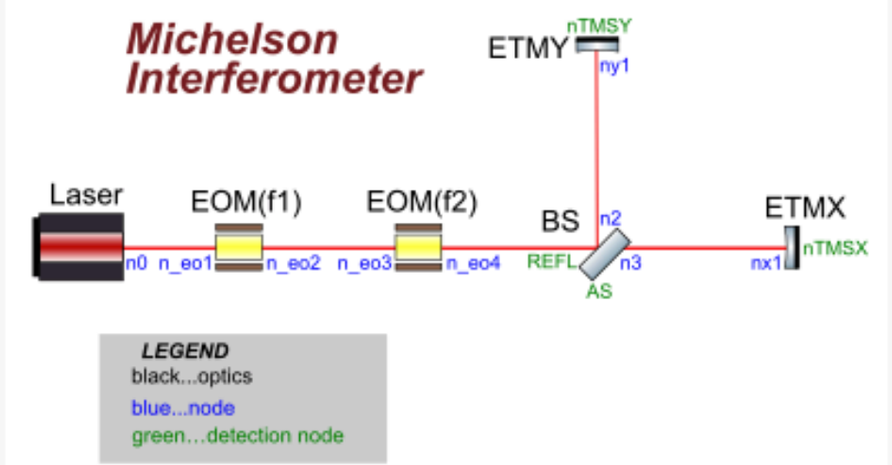
Setting for display layout

Select demodulation phase and frequency.

Note:
this value is the demodulation phase for all selected ports.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

Select PD type.

Power detector [W] | Demodulated signal

2. Select which DoF to move

DoF BS

3. Select port (see the top figure)

REFL AS

n0 n_eo1 n_eo2 n_eo3 n_eo4

n2 n3 ny1 nx1 ny2 nx2

Plot | Check all important port | Check all port | Uncheck all port

xaxis f[Hz]

0.01 to 1000

overplot All PDs

After selected

Transfer function,

Select PD type,

・Power detecter

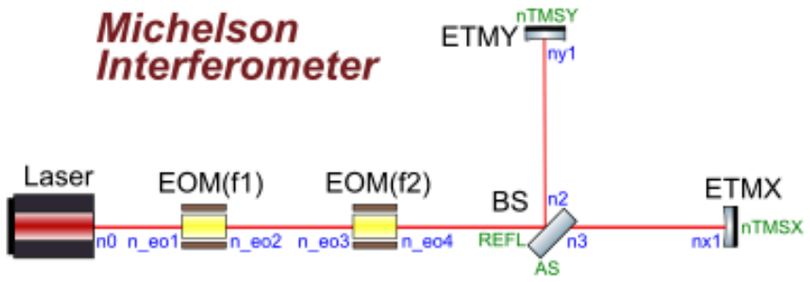
(Jump to p18~)

・Transfer function

(Jump to p19~)

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

Select PD type.

Power detector [W] | Demodulated signal

no advanced settings

2. Select which DoF to move

DoF: BS

3. Select port (see the top figure)

REFL AS

n0 n_eo1 n_eo2 n_eo3 n_eo4

n2 n3 ny1 nx1 ny2 nx2

Plot | Check all important port | Check all port | Uncheck all port

xaxis f[Hz]

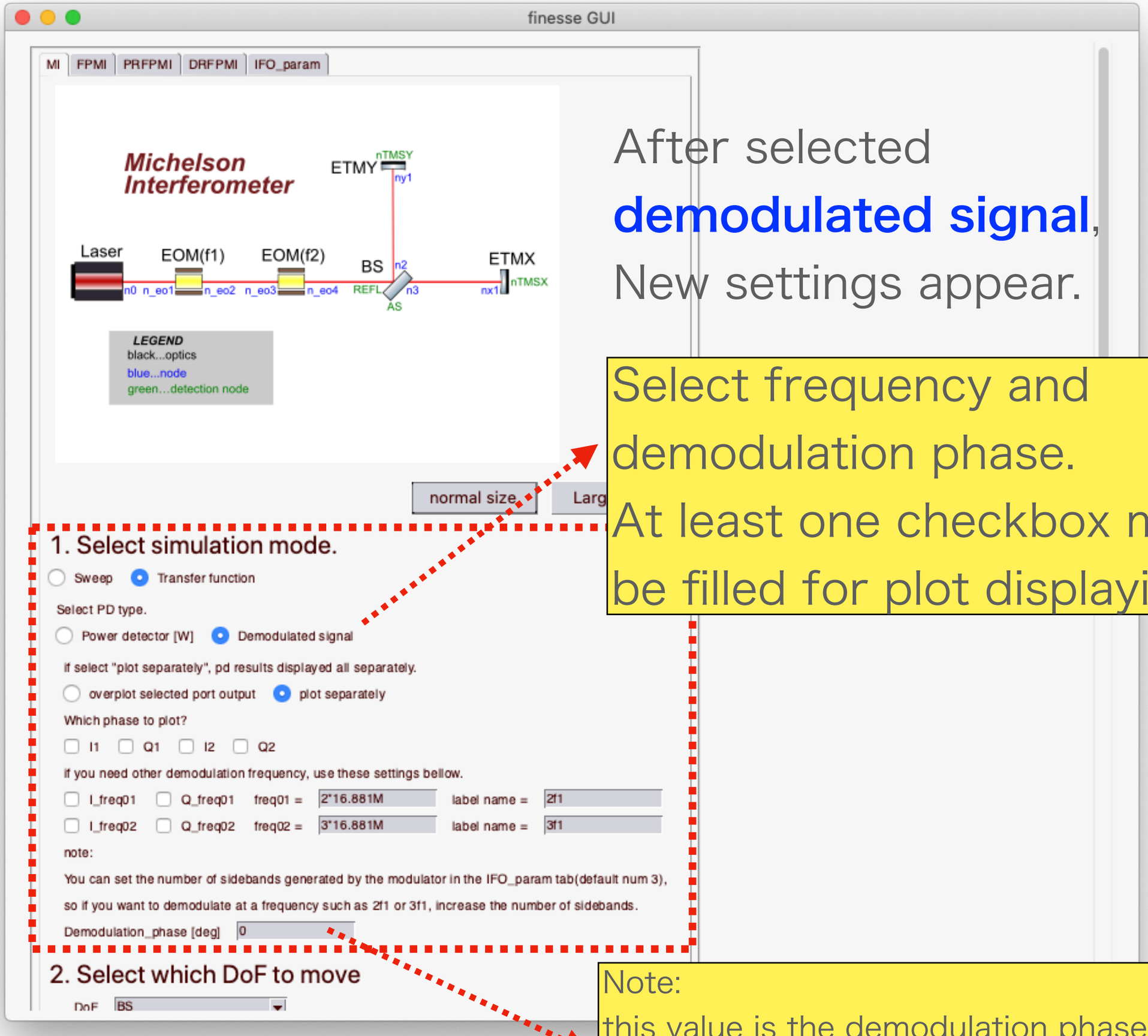
0.01 to 1000

overplot All PDs

After selected

Power detecter,

Go to next settings.



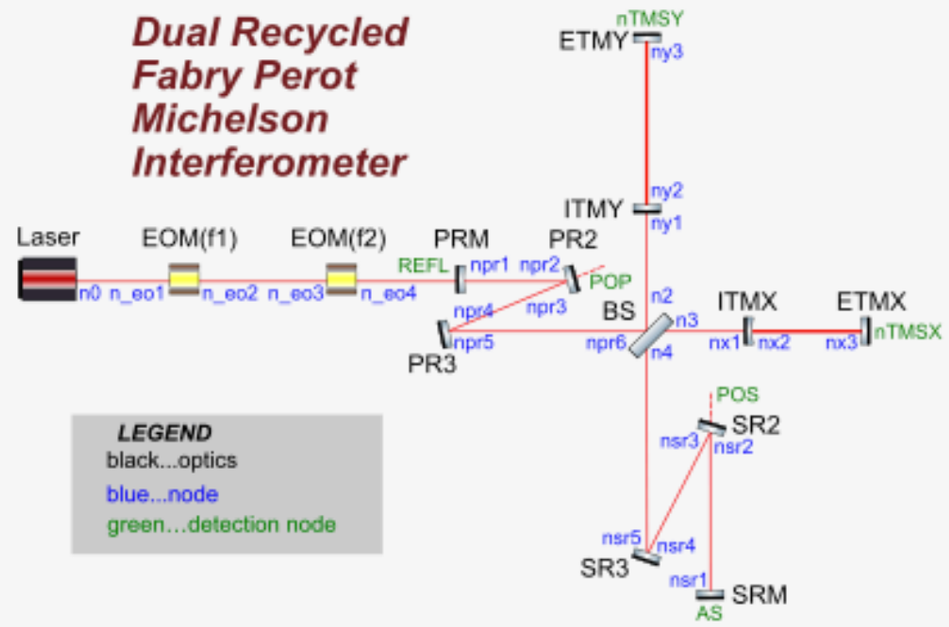
After selected **demodulated signal**, New settings appear.

Select frequency and demodulation phase.
At least one checkbox must be filled for plot displaying.

Note:
this value is the demodulation phase for all selected ports.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size

1. Select simulation mode.

Sweep | Transfer function

2. Select which DoF to move

DoF DARM

DARM
CARM
BS
PRCL
SRCL

3. Sel… top figure)

REFL … nTMSY nTMSX POS

n0 … n_eo4

npr1 npr2 npr3 npr4 npr5 npr6

nsr1 nsr2 nsr3 nsr4 nsr5

n2 n3 ny1 nx1 ny2 nx2 ny3 nx3

Plot | Check all important port | Check all port | Uncheck all port

xaxis f[Hz]

0.01 to 1000

overplot All PDs

2. Select which DoF to move

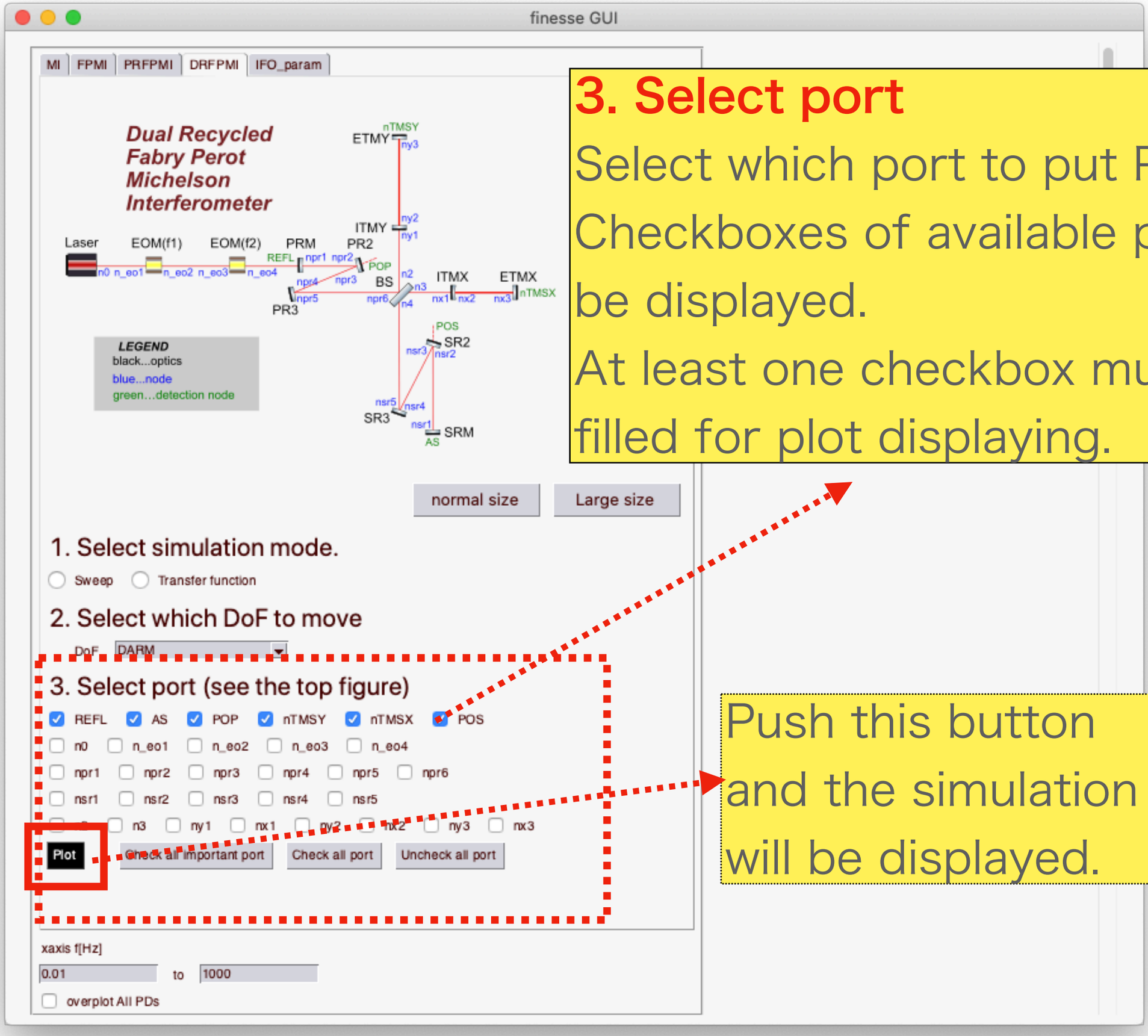
A list of available DoFs will be displayed.

Select a DoF from the list.

Attention

If you type DoF that is not in the list, an error will occur.

Be sure to select a DoF from the list.



3. Select port

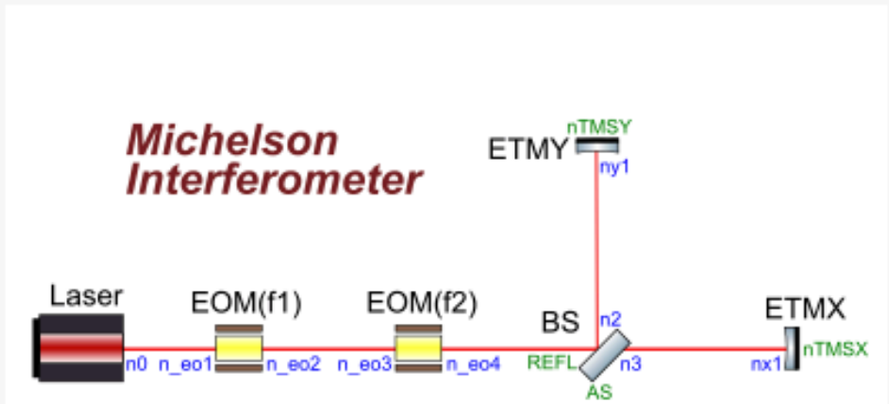
Select which port to put PDs on.
Checkboxes of available ports will be displayed.
At least one checkbox must be filled for plot displaying.

Push this button
and the simulation result
will be displayed.

Extra settings

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

2. Select which DoF to move

DoF BS

3. Select port (see the top figure)

REFL AS

n0 n_eo1 n_eo2 n_eo3 n_eo4

n2 n3 ny1 nx1 ny2 nx2

Plot | Check all important port | Check all port | Uncheck all port

xaxis range

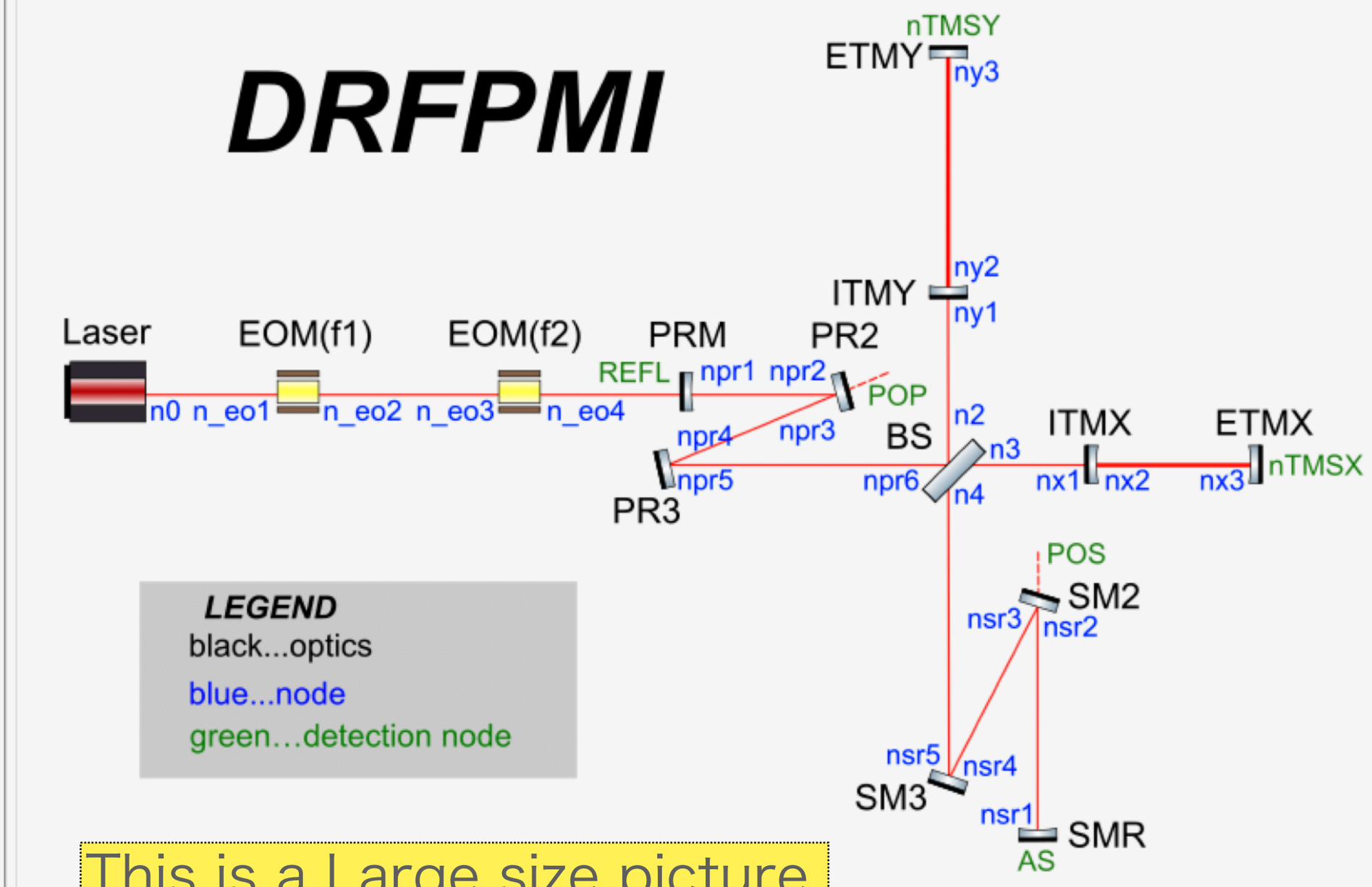
-180 to 180

overplot All PDs

Push these buttons, and the picture size will be changed.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | OPTION



This is a Large size picture.

normal size | Large size

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param

laser_power [W] 1

note: Reflectance and transmittance are values between 0 and 1.

BS mirror power transmittance	0.5
ITMX mirror power transmittance	0.004
ITMY mirror power transmittance	0.004
ETMX mirror power transmittance	5e-06
ETMY mirror power transmittance	5e-06
PRM mirror power transmittance	0.1
SRM mirror power transmittance	0.3
PR2 mirror power transmittance	500e-6
PR3 mirror power transmittance	50e-6
SR2 mirror power transmittance	500e-6
SR3 mirror power transmittance	50e-6
BS mirror power loss	0
ITMX mirror power loss	0
ITMY mirror power loss	0
ETMX mirror power loss	0
ETMY mirror power loss	0
PRM mirror power loss	45e-6
SRM mirror power loss	45e-6
PR2 mirror power loss	45e-6
PR3 mirror power loss	45e-6
SR2 mirror power loss	45e-6
SR3 mirror power loss	45e-6
modulation f1 frequency	16.881M
modulation f2 frequency	45.0159M
number of produced modulator sidebands	3

xaxis lin / xaxis log

yaxis lin / yaxis log

sampling num 1000

Which data you output?

kat file / plot data

xaxis range

-180 to 180

overplot All PDs

After selected this **OPTION tab**, the extra interferometer configuration will be displayed.

Change laser power [W]

Transmittance and loss can be changed.
Reflectivity is automatically set so that R+T+L=1.

You can change modulation frequencies.

You can change a max order of modulation sidebands.

You can change xaxis or yaxis plot scale.
If you push xaxis button, xaxis range will automatically set to default.

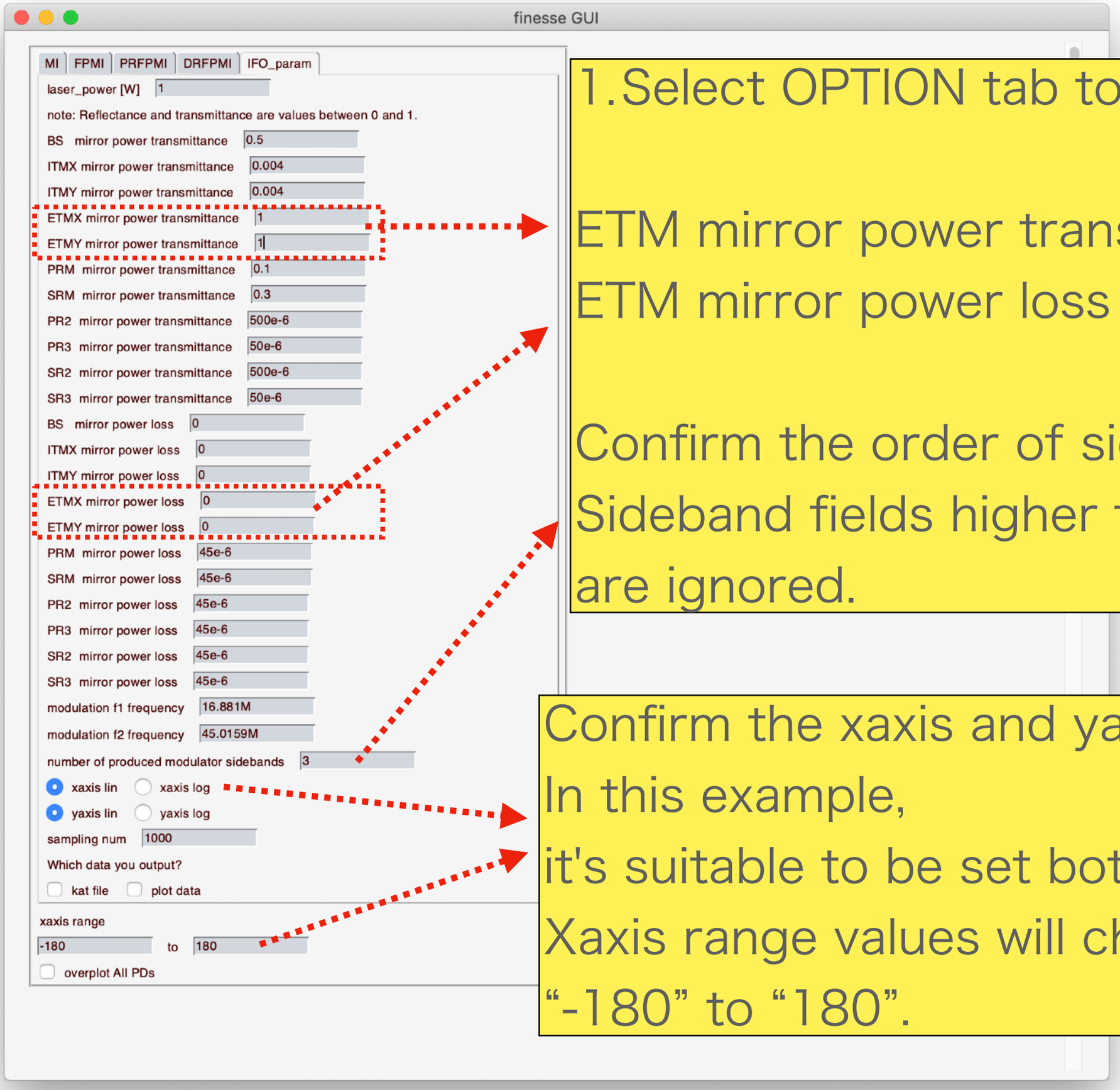
Number of data points

Simulation results can be exported.

- kat file
  export a Kat-format file that can be loaded by Finesse.
- plot data
  Export the simulation results in txt format.

Advanced Example
Demonstration

Demo to calculate Dual Recycled Michelson interferometer (DRMI) 3f SRCL demodulated signals.



1.Select OPTION tab to DRMI settings

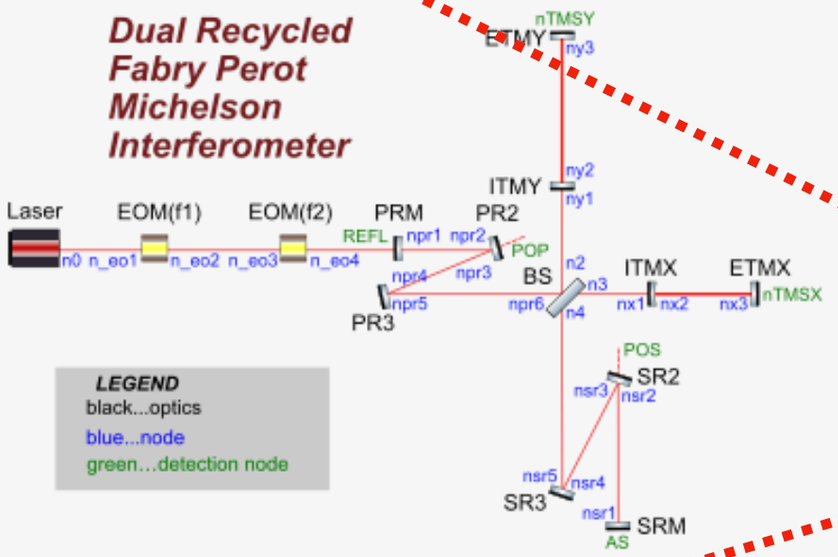
ETM mirror power transmittance -> 1
ETM mirror power loss -> 0

Confirm the order of sideband.
Sideband fields higher than this order are ignored.

Confirm the xaxis and yaxis scale.
In this example,
it's suitable to be set both values to “lin”.
Xaxis range values will change to
“-180” to “180”.

finesse GUI

MI | FPMI | PRFPMI | DRFPMI | IFO_param



normal size | Large size

1. Select simulation mode.

Sweep | Transfer function

Select PD type.

Power detector [W] | Amplitud detector | Demodulated signal [A.U.]

if select "plot separately", pd results displayed all separately.

overplot selected port output | plot separately

Which phase to plot?

DC (not demodulated signal) | I1 | Q1 | I2 | Q2

if you need other demodulation freqency, use these settings bellow.

I_freq01	Q_freq01	freq01 =	2*16.881M	label name =	2f1
I_freq02	Q_freq02	freq02 =	3*16.881M	label name =	3f1

note:

You can set the number of sidebands generated by the modulator in the IFO_param tab(default num 3),

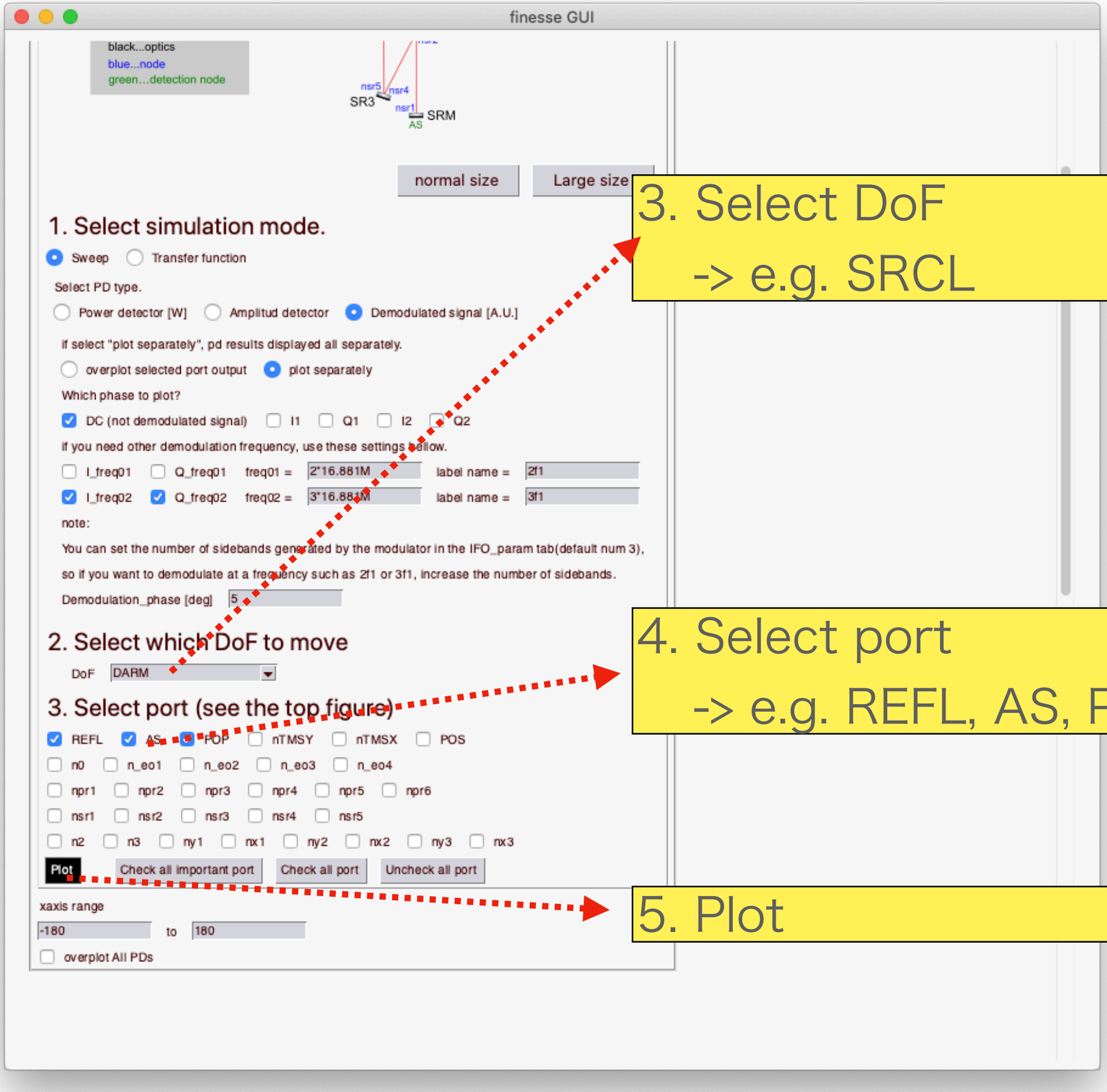
so if you want to demodulate at a frequency such as 2f1 or 3f1, increase the number of sidebands.

Demodulation_phase [deg] 5

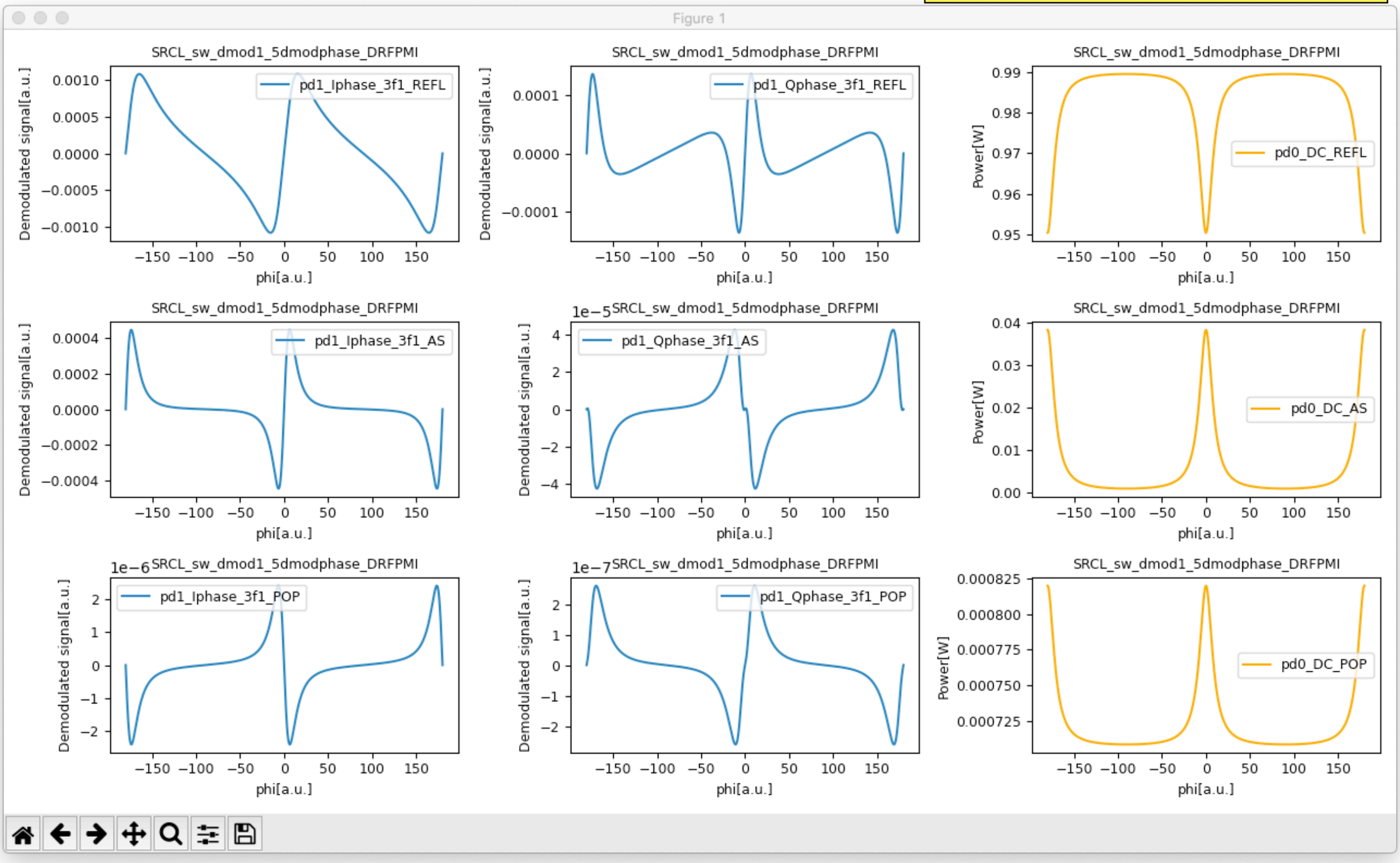
2. Select which DoF to move

DoF DARM

1. Select DRFPMI tab
2. Select simulation mode
   - -> Sweep
   - -> Demodulated signal
   - -> select demodulation frequency
     e.g. Check DC, I freq2, Q freq2 and input the demodulation frequency in the box on the right. You can also input the label name of the new signal.
   - -> select demodulation phase [deg]
     e.g. 5


finesse GUI
black...optics
blue...node
green…detection node
nsr5
nsr4
SR3
nsr1
SRM
AS
normal size
Large size
1. Select simulation mode.
Sweep
Transfer function
Select PD type.
Power detector [W]
Amplitud detector
Demodulated signal [A.U.]
if select "plot separately", pd results displayed all separately.
overplot selected port output
plot separately
Which phase to plot?
DC (not demodulated signal)
I1
Q1
I2
Q2
if you need other demodulation frequency, use these settings bellow.
I_freq01
Q_freq01
freq01 =
2*16.881M
label name =
2f1
I_freq02
Q_freq02
freq02 =
3*16.881M
label name =
3f1
note:
You can set the number of sidebands generated by the modulator in the IFO_param tab(default num 3),
so if you want to demodulate at a frequency such as 2f1 or 3f1, increase the number of sidebands.
Demodulation_phase [deg]
5
2. Select which DoF to move
DoF
DARM
3. Select port (see the top figure)
REFL
AS
POP
nTMSY
nTMSX
POS
n0
n_eo1
n_eo2
n_eo3
n_eo4
npr1
npr2
npr3
npr4
npr5
npr6
nsr1
nsr2
nsr3
nsr4
nsr5
n2
n3
ny1
nx1
ny2
nx2
ny3
nx3
Plot
Check all important port
Check all port
Uncheck all port
xaxis range
-180
to
180
overplot All PDs
3. Select DoF
-> e.g. SRCL
4. Select port
-> e.g. REFL, AS, POP
5. Plot

Blue: Demodulated signals
Yellow: DC signals



The result will be displayed.

Appendix

- Finesse

  http://www.gwoptics.org/finesse/

- git repository

  https://github.com/kokeyama/gw-finesse