

HANDS-ON SESSION

PULSAR TIMING BASICS



MARTA BURGAY - INAF CAGLIARI

TIMING RECIPE

Predicting ToAs on the basis of a model



.par file

Measuring ToAs from repeated observations



.ar files; .std file; .tim file

Creating timing residuals

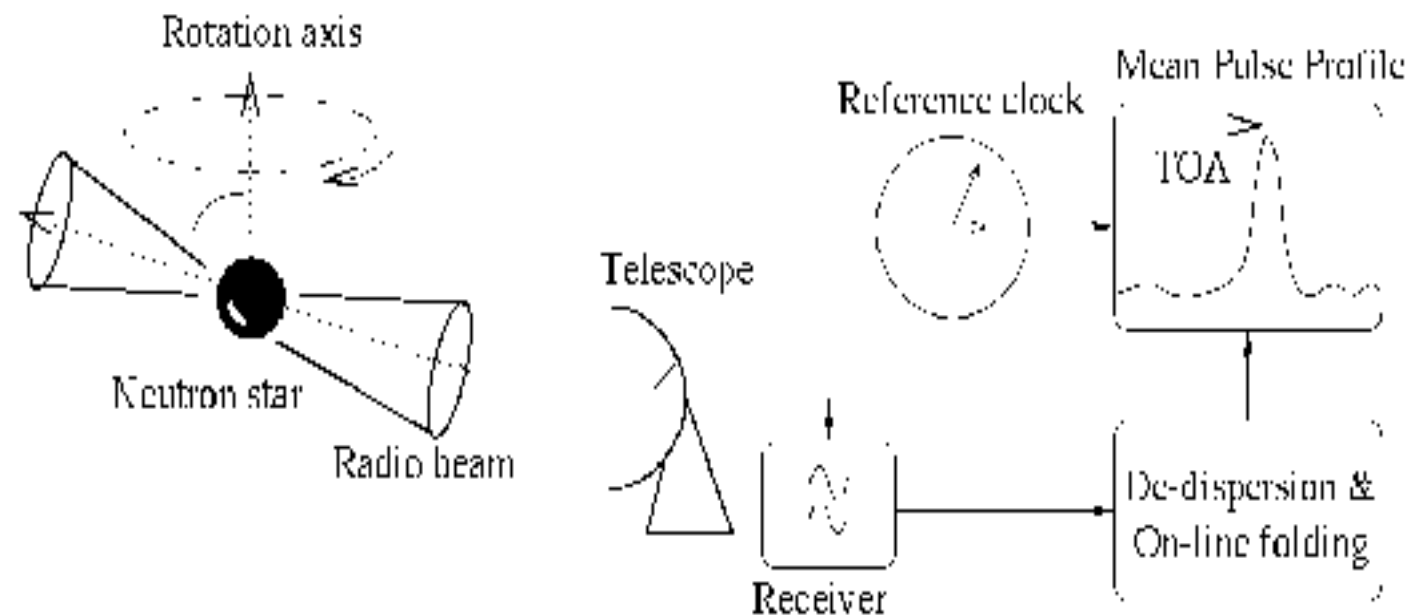


.par and .tim file in tempo2

Fitting for model parameters to remove trends



tempo2 GUI for fitting



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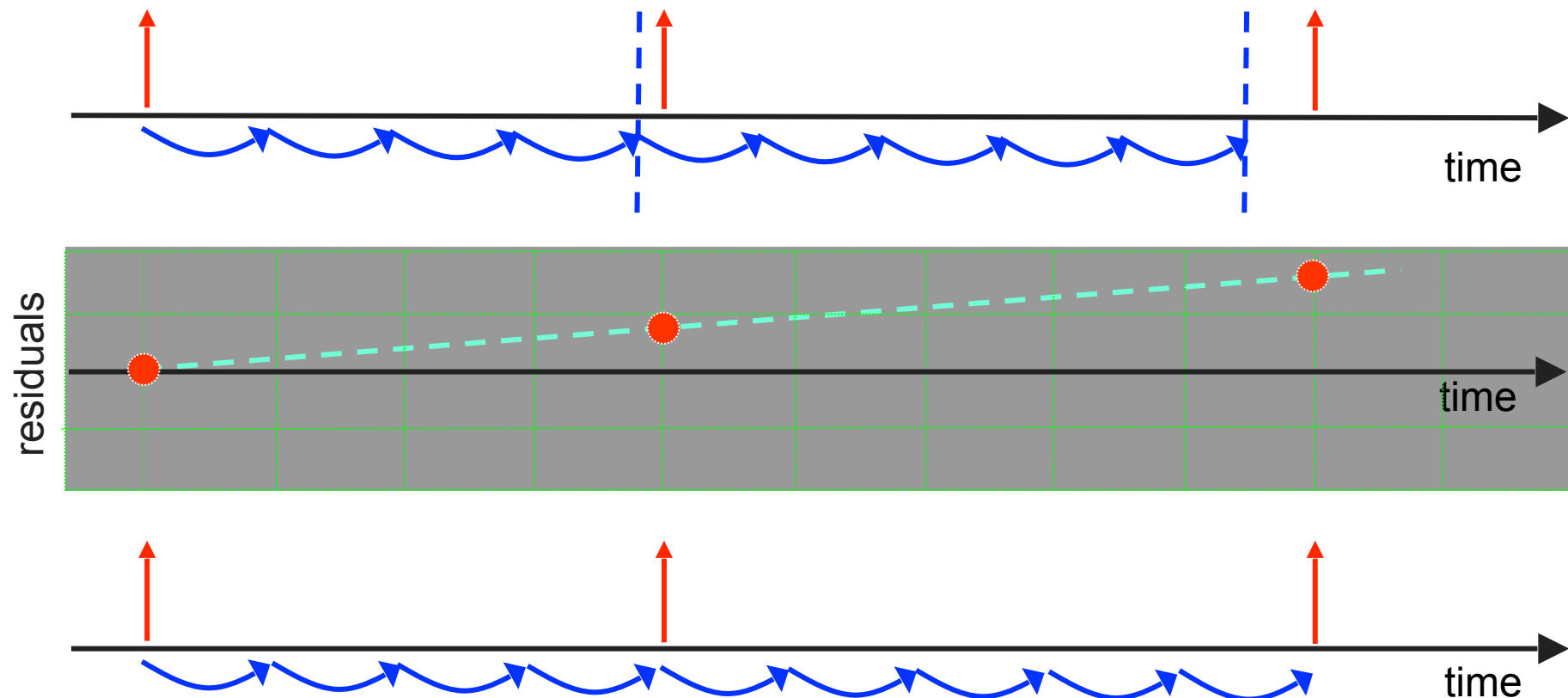


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```
PSRJ      J0737-3039A
RAJ        07:37:51.248419
DECJ       -30:39:40.71431
DM         48.916
PEPOCH     53156.0
F0         44.054069392744
F1         -3.4156E-15
PMRA       -3.82
PMDEC      2.13
POSEPOCH   54100
DMEPOCH    58831.82232
BINARY     DDS
PB         0.10225156248
ECC         0.0877775
A1         1.415032
T0         53155.9074280
OM         87.0331
OMDOT      16.89947
EPHEM      DE405
PBDOT      -1.252E-12
RM         120.46
PX         0.87
GAMMA      0.0003856
SINI       0.99974
M2         1.2489
```

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PSRJ	J0737-3039A
RAJ	07:37:51.248419
DECJ	-30:39:40.71431
DM	48.916
PEPOCH	53156.0
F0	44.054069392744

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tempo2 GUI for fitting

PSRJ	J0737-3039A
RAJ	07:37:51.2
DECJ	-30:39:40.7
DM	48.9
PEPOCH	53156.0
F0	44.05406

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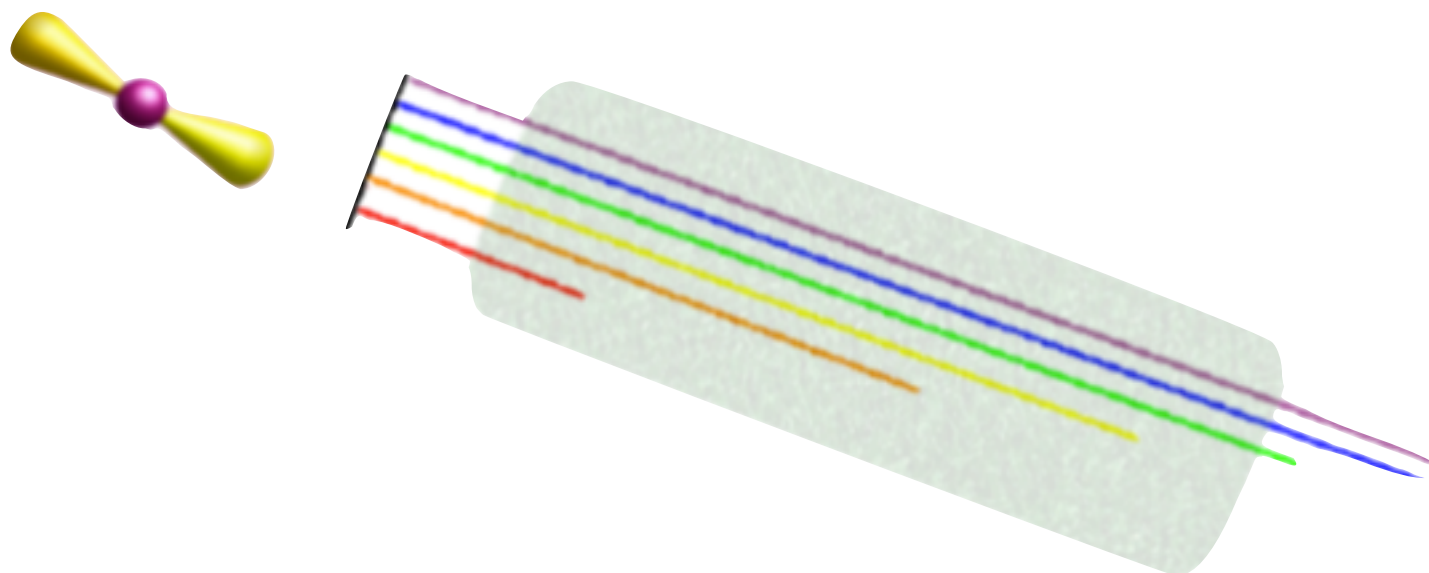
.par and .tim file in tempo2

Fitting for model parameters to remove trends



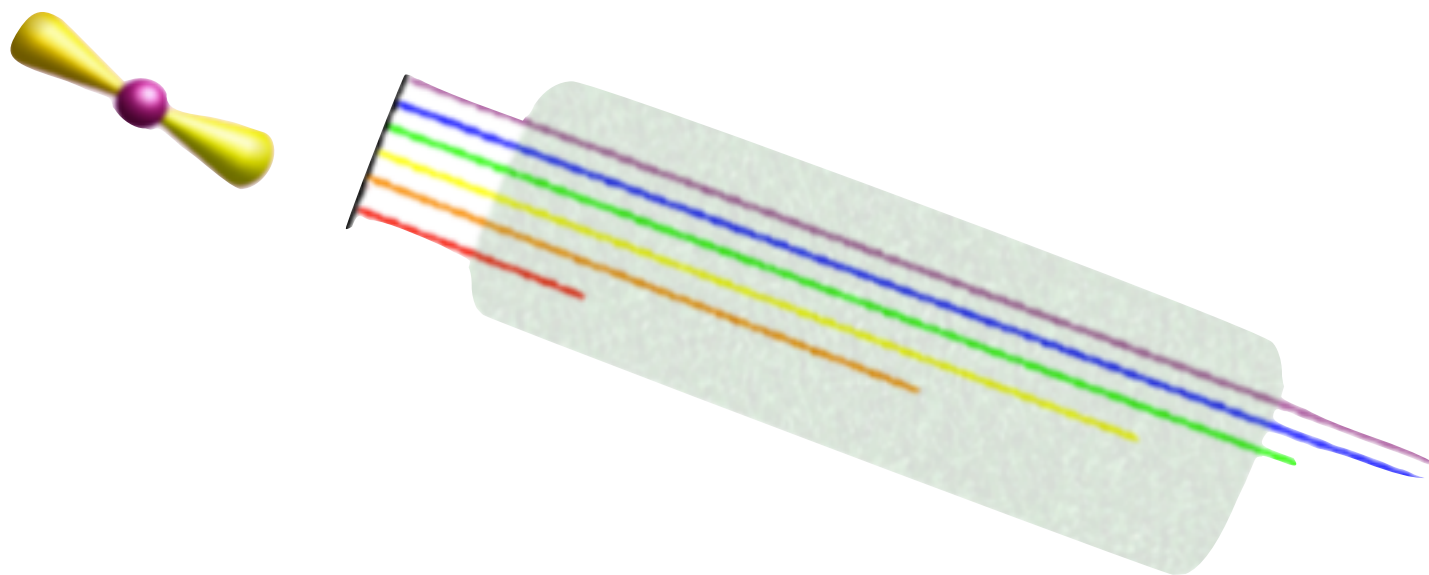
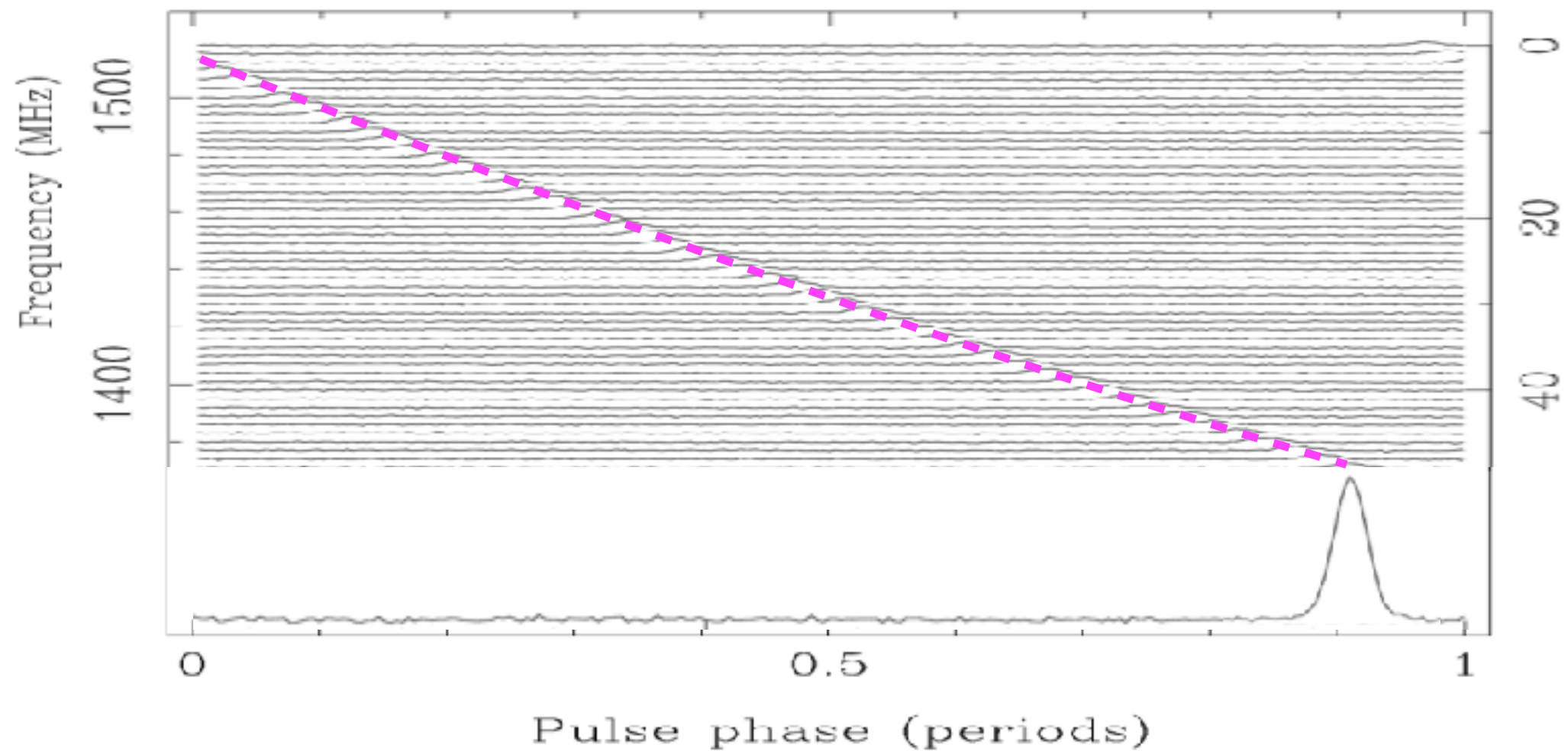
tempo2 GUI for fitting

PSRJ	J0737-3039A
RAJ	07:37:51.2
DECJ	-30:39:40.7
DM	48.9
PEPOCH	53156.0
F0	44.05406



$$\Delta t = \frac{e^2}{2\pi m_e c} \frac{\int_0^d n_e dl}{f^2} \propto \frac{DM}{f^2}$$
$$DM = \int_0^d n_e dl$$

TIMING RECIPE



$$\Delta t = \frac{e^2}{2\pi m_e c} \frac{\int_0^d n_e dl}{f^2} \propto \frac{DM}{f^2}$$

$$DM = \int_0^d n_e dl$$

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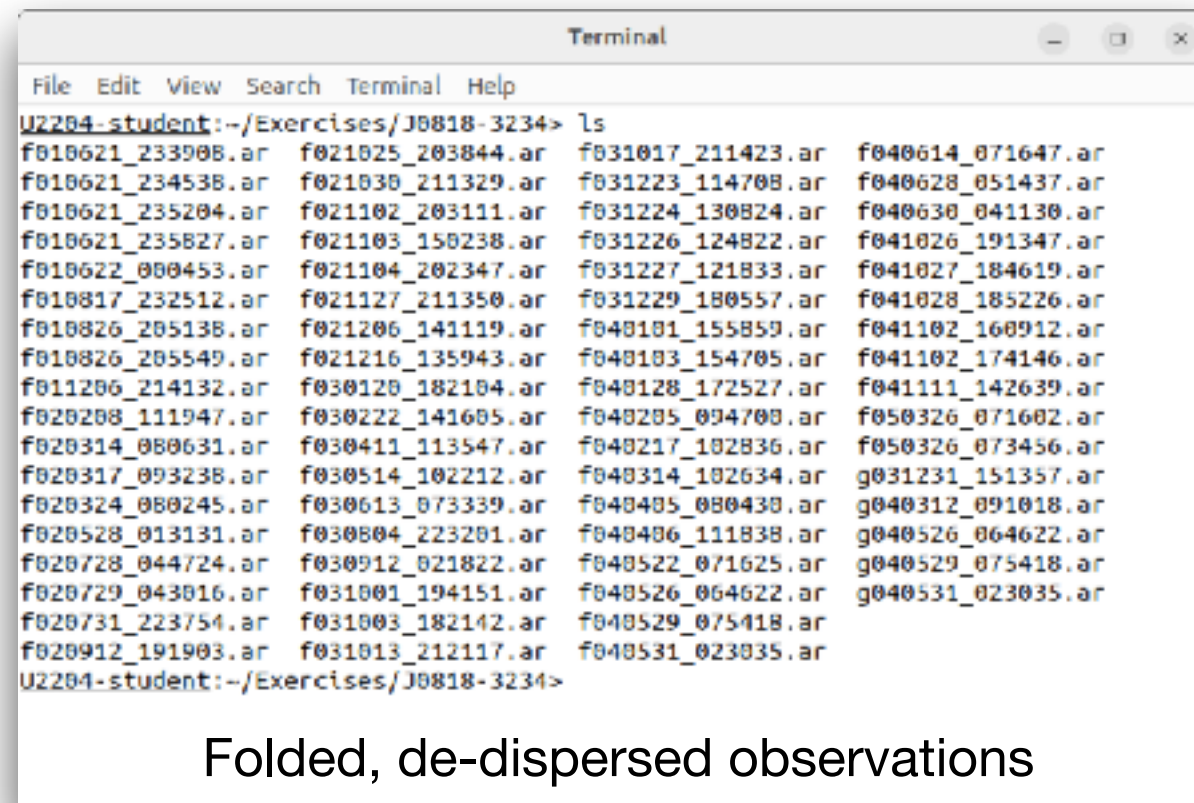


.par and .tim file in tempo2

Fitting for model parameters to remove trends



tempo2 GUI for fitting



```
Terminal
File Edit View Search Terminal Help
U2204-student:~/Exercises/J0818-3234> ls
f010621_233908.ar  f021025_203844.ar  f031017_211423.ar  f040614_071647.ar
f010621_234538.ar  f021030_211329.ar  f031223_114708.ar  f040628_051437.ar
f010621_235204.ar  f021102_203111.ar  f031224_130824.ar  f040630_041130.ar
f010621_235827.ar  f021103_150238.ar  f031226_124822.ar  f041026_191347.ar
f010622_000453.ar  f021104_202347.ar  f031227_121833.ar  f041027_184619.ar
f010817_232512.ar  f021127_211350.ar  f031229_180557.ar  f041028_185226.ar
f010826_205138.ar  f021206_141119.ar  f040101_155859.ar  f041102_160912.ar
f010826_205549.ar  f021216_135943.ar  f040103_154705.ar  f041102_174146.ar
f011206_214132.ar  f030120_182104.ar  f040128_172527.ar  f041111_142639.ar
f020208_111947.ar  f030222_141605.ar  f040205_094700.ar  f050326_071602.ar
f020314_080631.ar  f030411_113547.ar  f040217_102836.ar  f050326_073456.ar
f020317_093238.ar  f030514_102212.ar  f040314_102634.ar  g031231_151357.ar
f020324_080245.ar  f030613_073339.ar  f040405_080430.ar  g040312_091018.ar
f020528_013131.ar  f030804_223201.ar  f040406_111838.ar  g040526_064622.ar
f020728_044724.ar  f030912_021822.ar  f040522_071625.ar  g040529_075418.ar
f020729_043016.ar  f031001_194151.ar  f040526_064622.ar  g040531_023035.ar
f020731_223754.ar  f031003_182142.ar  f040529_075418.ar
f020912_191903.ar  f031013_212117.ar  f040531_023035.ar
U2204-student:~/Exercises/J0818-3234>
```

Folded, de-dispersed observations

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.ar files; .std file; .tim file

Creating timing residuals

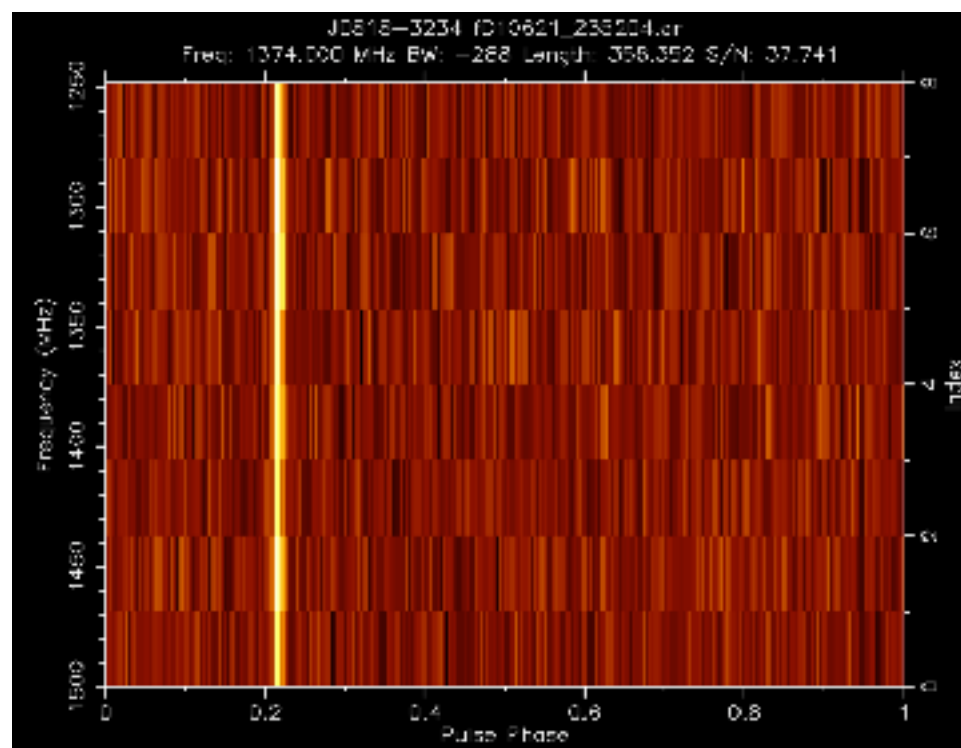
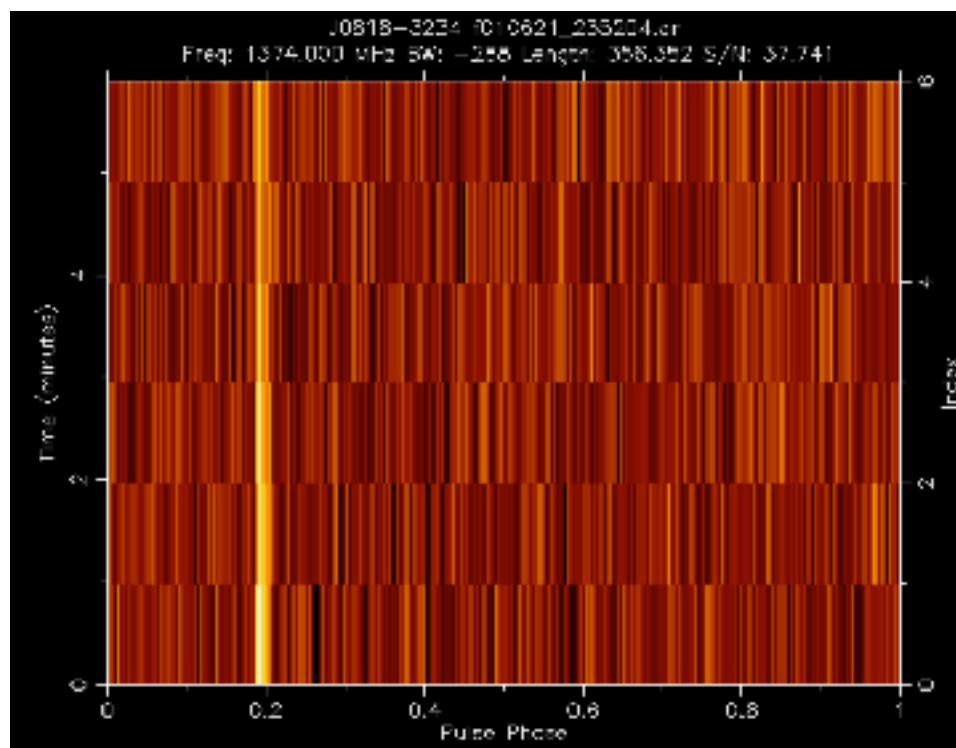


.par and .tim file in tempo2

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tempo2 GUI for fitting



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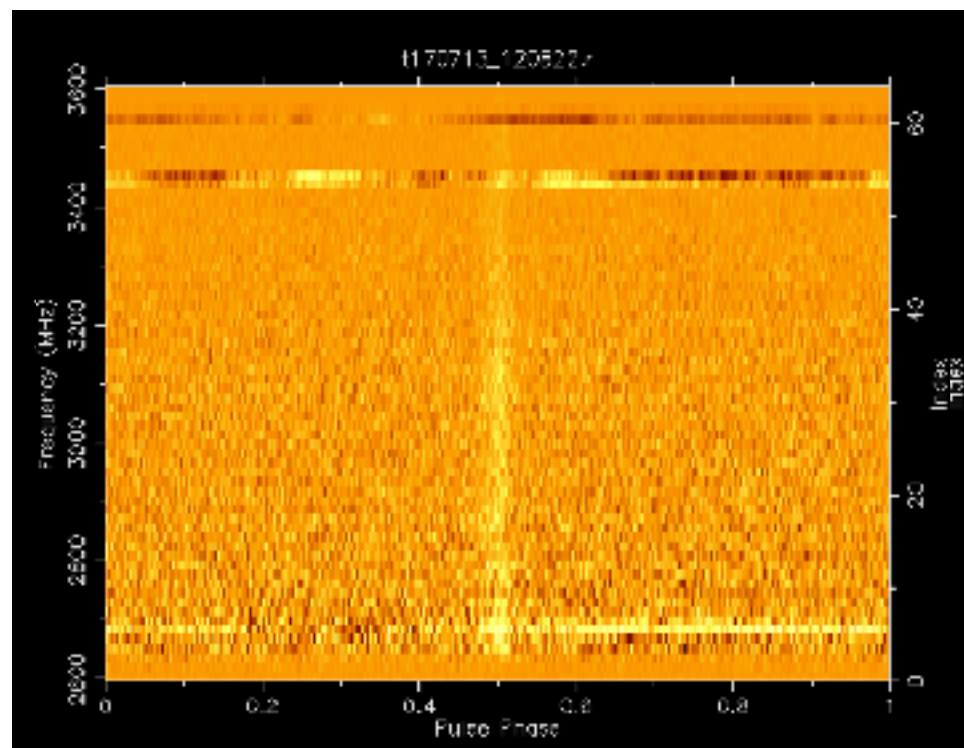
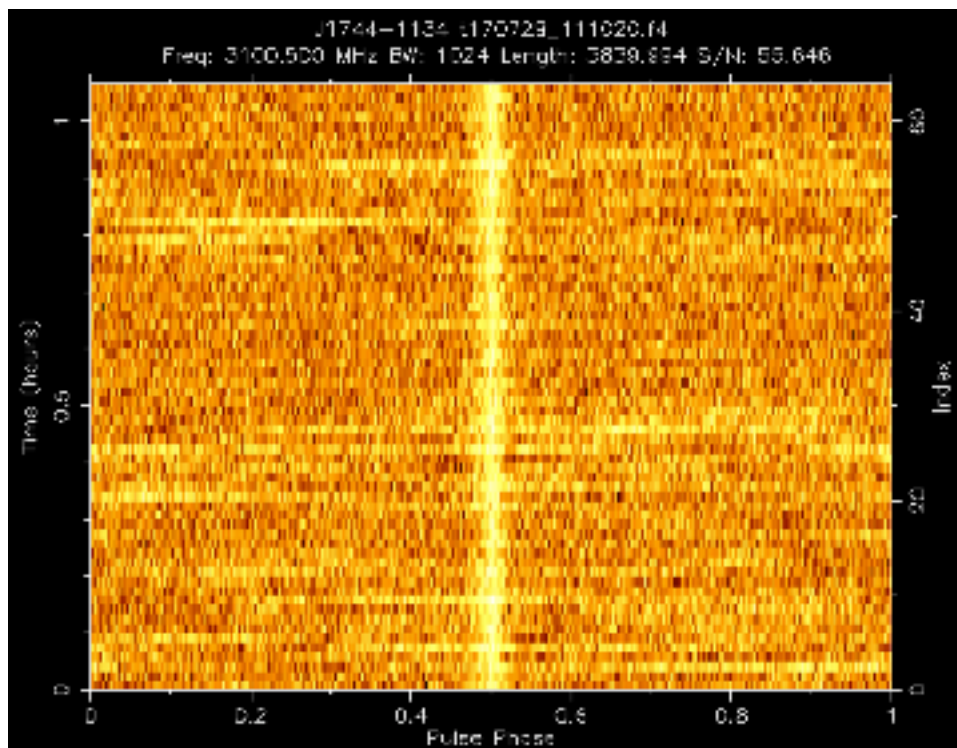


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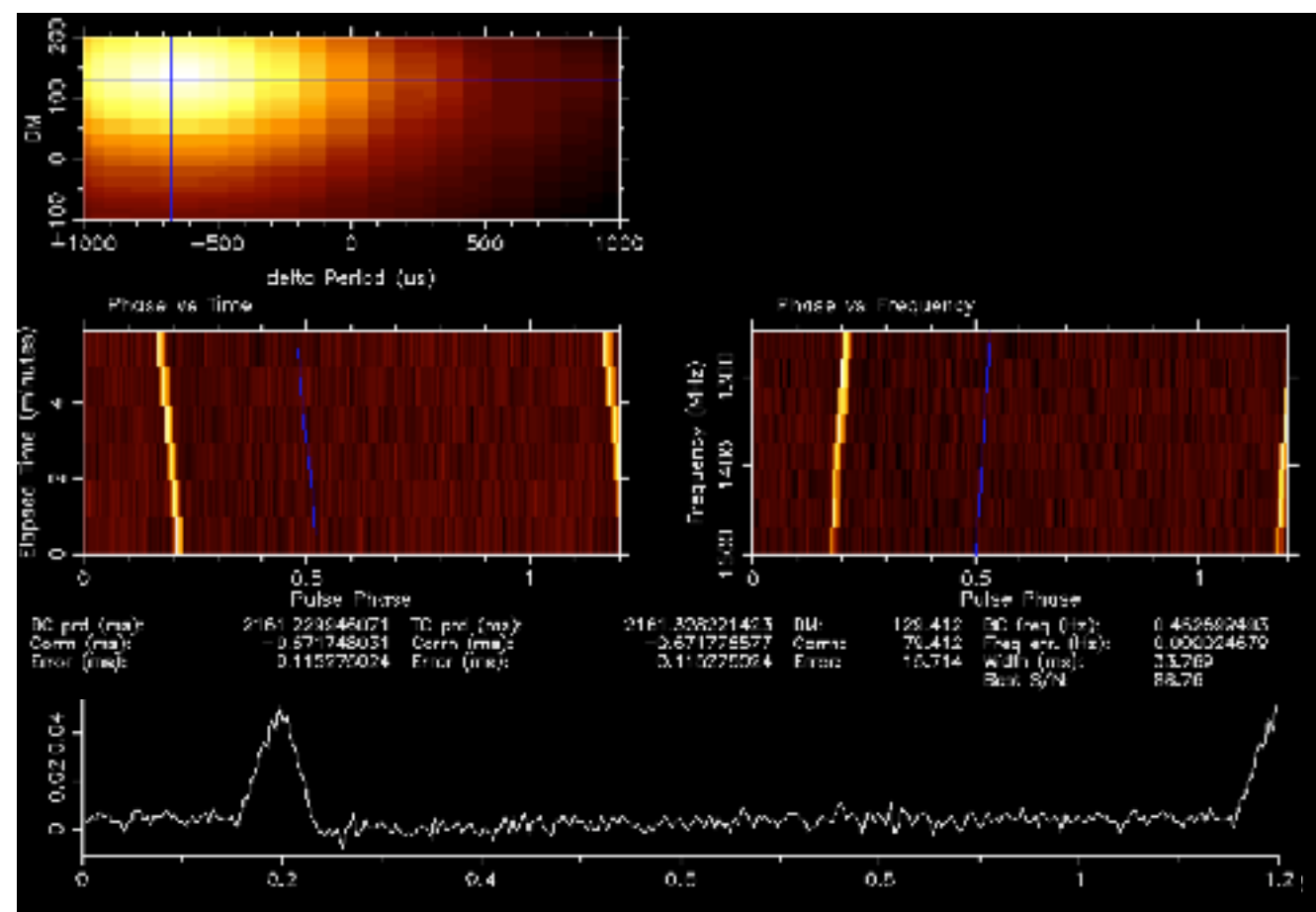


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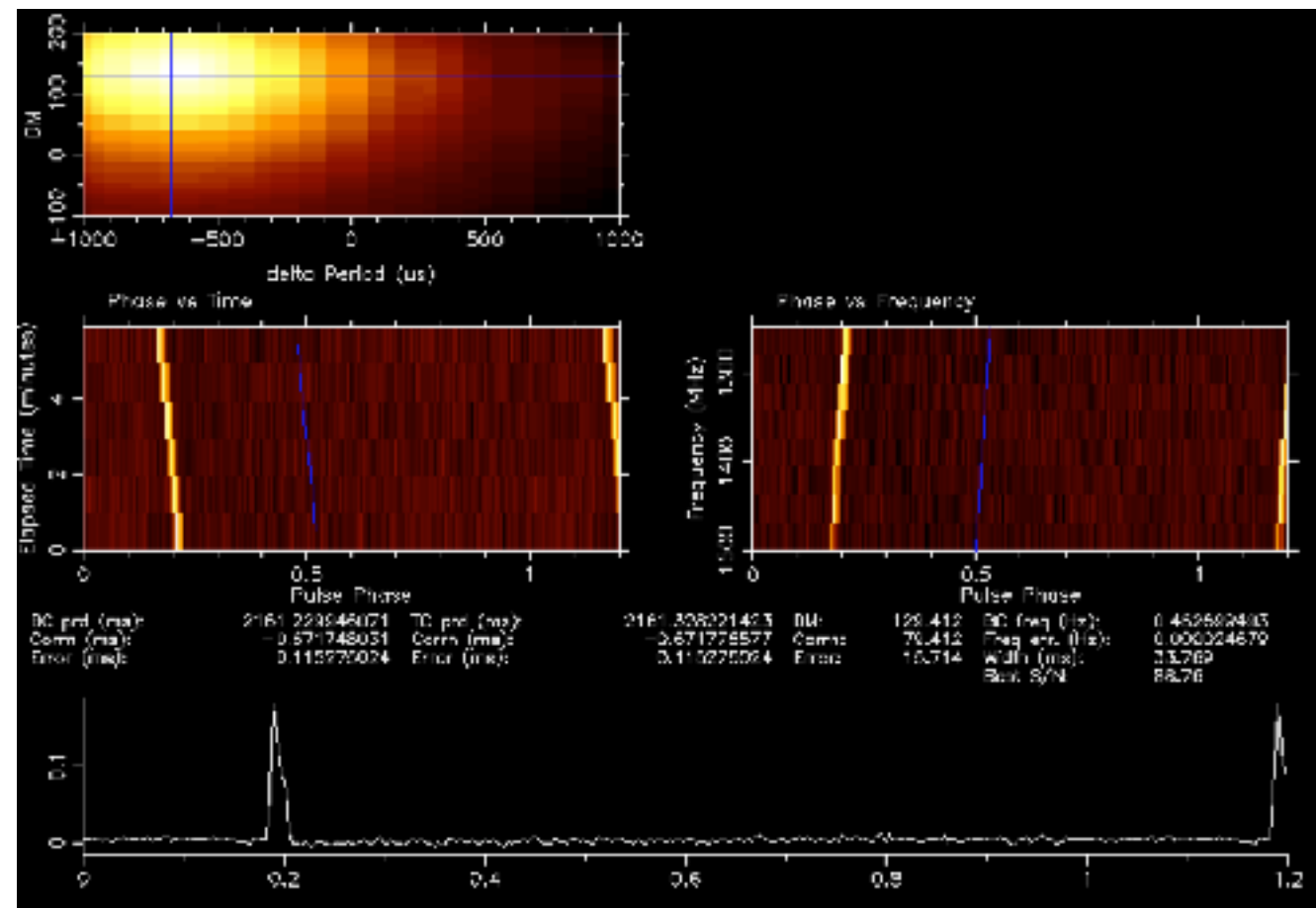
.ar files; .std file; .tim file

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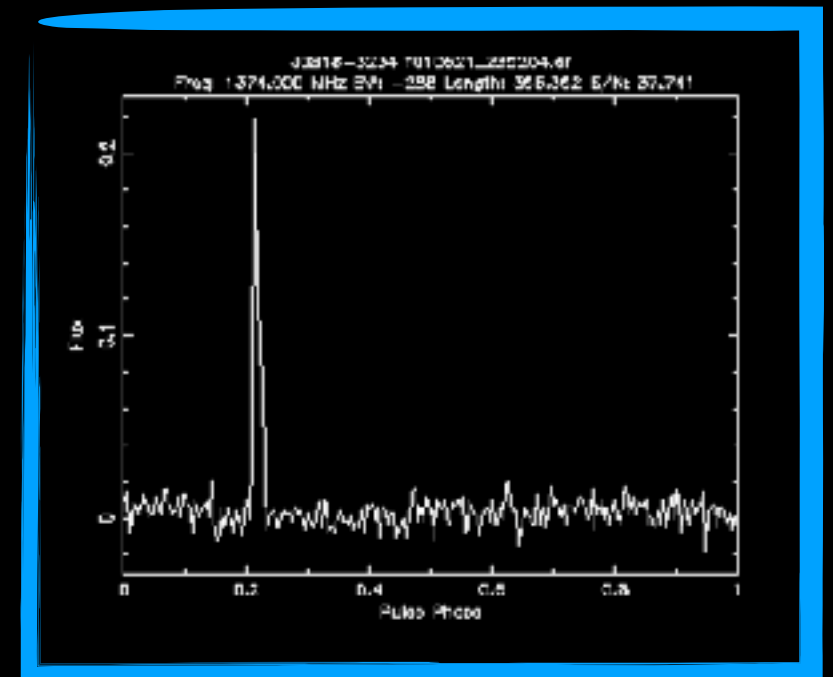
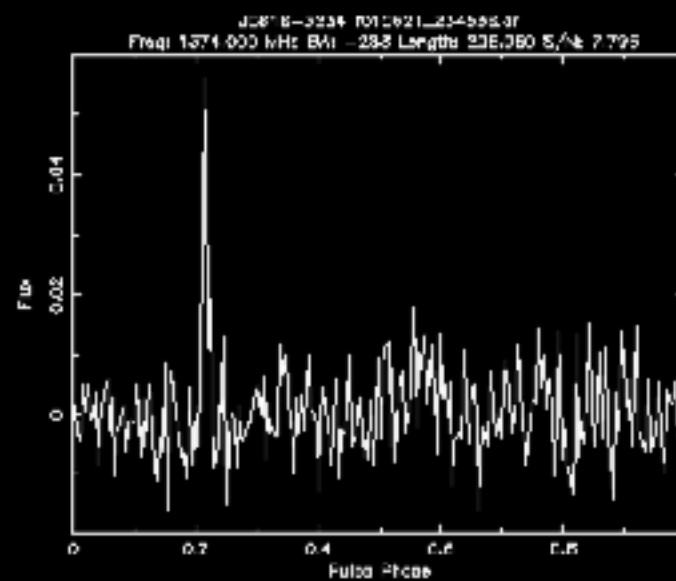
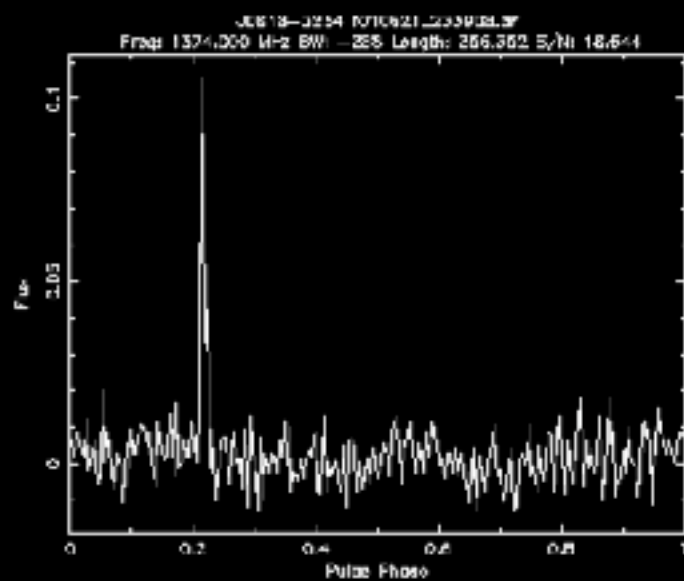


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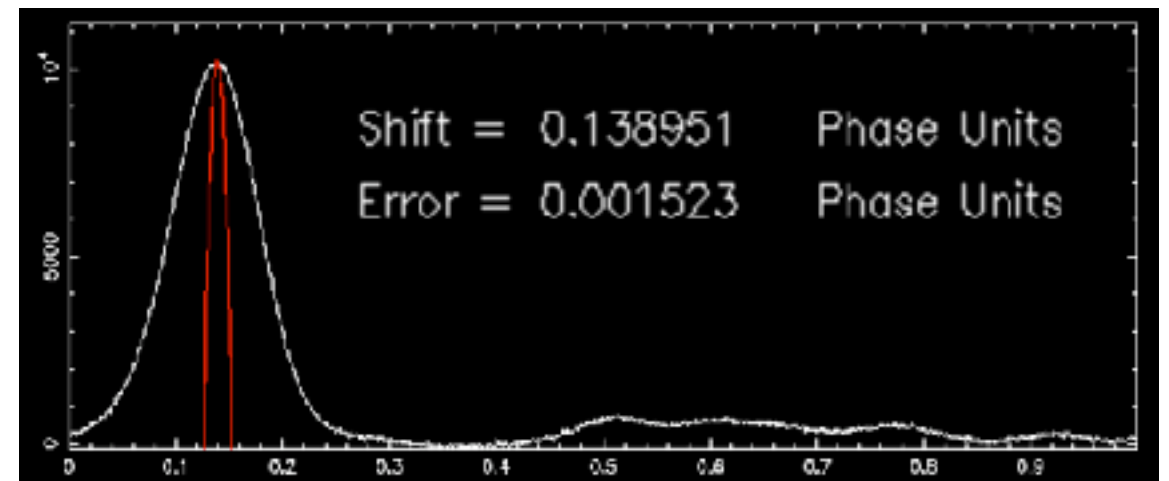
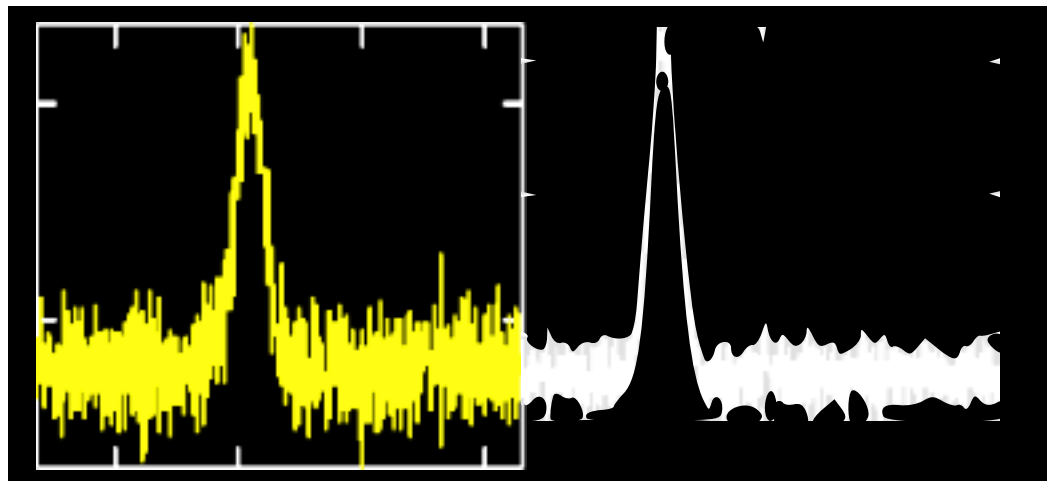


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```
f020208_111947.FT 1374.000000 52313.472808477289871 344.391 7
f020314_080631.FT 1374.000000 52347.338593804824382 322.867 7
f020317_093238.FT 1374.000000 52350.398389728652204 319.800 7
f020324_080245.FT 1374.000000 52357.335968029078125 281.859 7
f020528_013131.FT 1374.000000 52422.064278339956922 287.976 7
f020728_044724.FT 1374.000000 52483.200325383905147 346.227 7
f020729_043016.FT 1374.000000 52484.188414614546913 303.338 7
f020731_223754.FT 1374.000000 52486.943727453949447 357.520 7
f020912_191903.FT 1374.000000 52529.805607014779715 390.334 7
f021025_203844.FT 1374.000000 52572.860947132312351 469.180 7
f021030_211329.FT 1374.000000 52577.885061398919065 448.355 7
f021102_203111.FT 1374.000000 52580.855704340108757 393.143 7
f021103_150238.FT 1374.000000 52581.627505062265288 337.798 7
f021104_202347.FT 1374.000000 52582.850539622582822 533.124 7
f021127_211350.FT 1374.000000 52605.885298713013077 488.790 7
f021206_141119.FT 1374.000000 52614.591900801735587 323.225 7
f021216_135943.FT 1374.000000 52624.583846287383317 330.285 7
```

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```
f010621_235204.t3f4 1482.000000 52081.995215876563359 354.093 7
f010621_235204.t3f4 1410.000000 52081.995216169506138 346.168 7
f010621_235204.t3f4 1338.000000 52081.995216528333341 288.759 7
f010621_235204.t3f4 1266.000000 52081.995216938532383 300.698 7
f010621_235204.t3f4 1482.000000 52081.996591738450284 359.871 7
f010621_235204.t3f4 1410.000000 52081.996592038341283 343.371 7
f010621_235204.t3f4 1338.000000 52081.996592394737412 291.050 7
f010621_235204.t3f4 1266.000000 52081.996592809618748 322.037 7
f010621_235204.t3f4 1482.000000 52081.997942586560272 579.933 7
f010621_235204.t3f4 1410.000000 52081.997942881587931 347.495 7
f010621_235204.t3f4 1338.000000 52081.997943238190543 296.446 7
f010621_235204.t3f4 1266.000000 52081.997943650825067 354.063 7
```

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.par file

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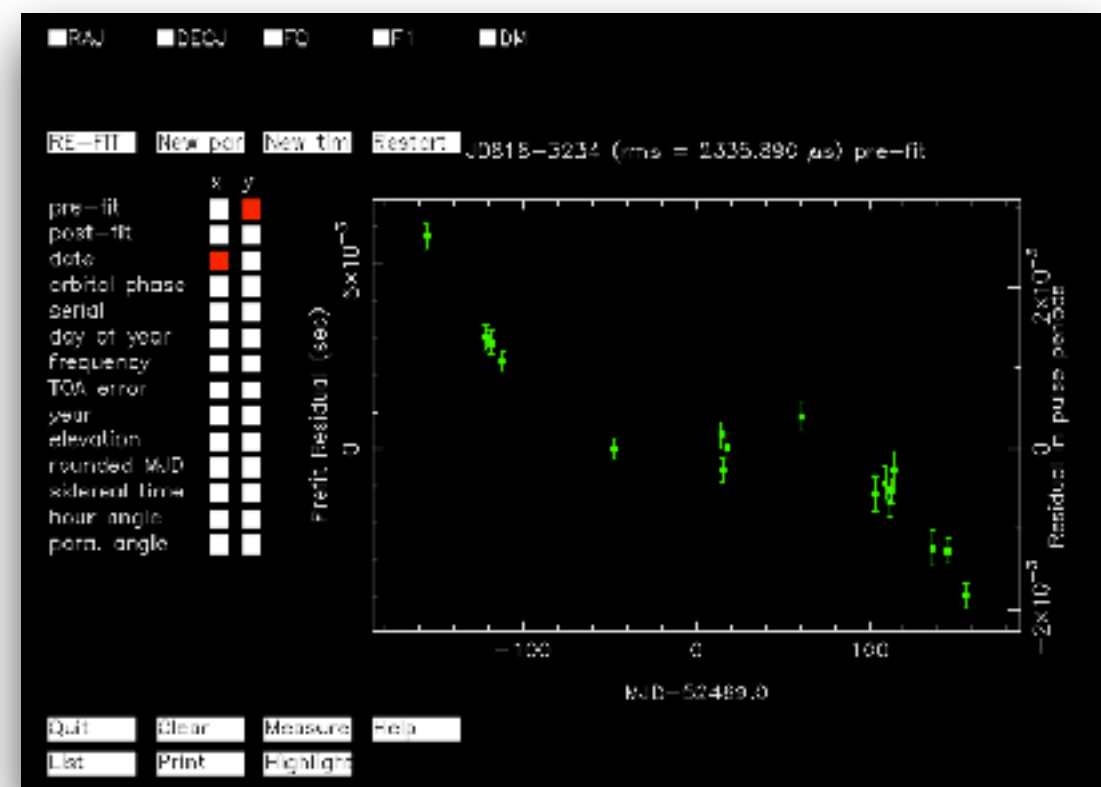
.par and .tim file in tempo2

Fitting for model parameters to remove trends



tempo2 GUI for fitting

```
Terminal
File Edit View Search Terminal Help
j2204-student:~/Exercises/J0818-3234> tempo2 -gr plk -f myfile.par myfile.tim
```



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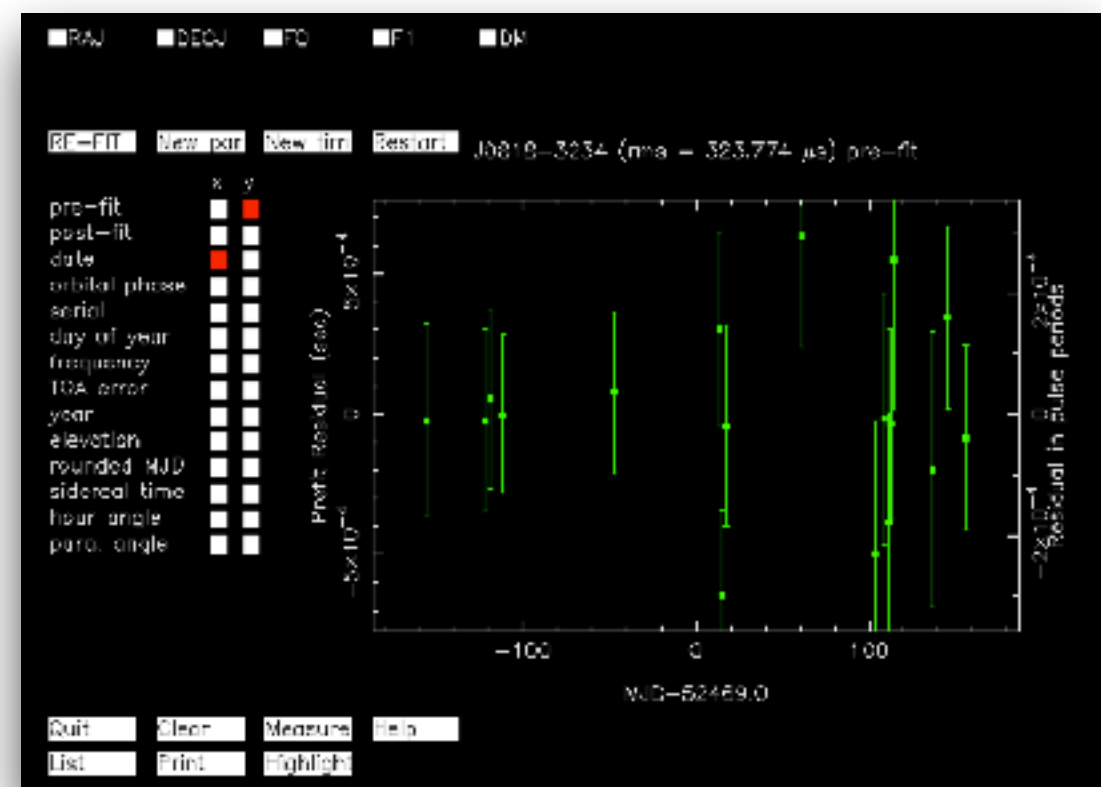
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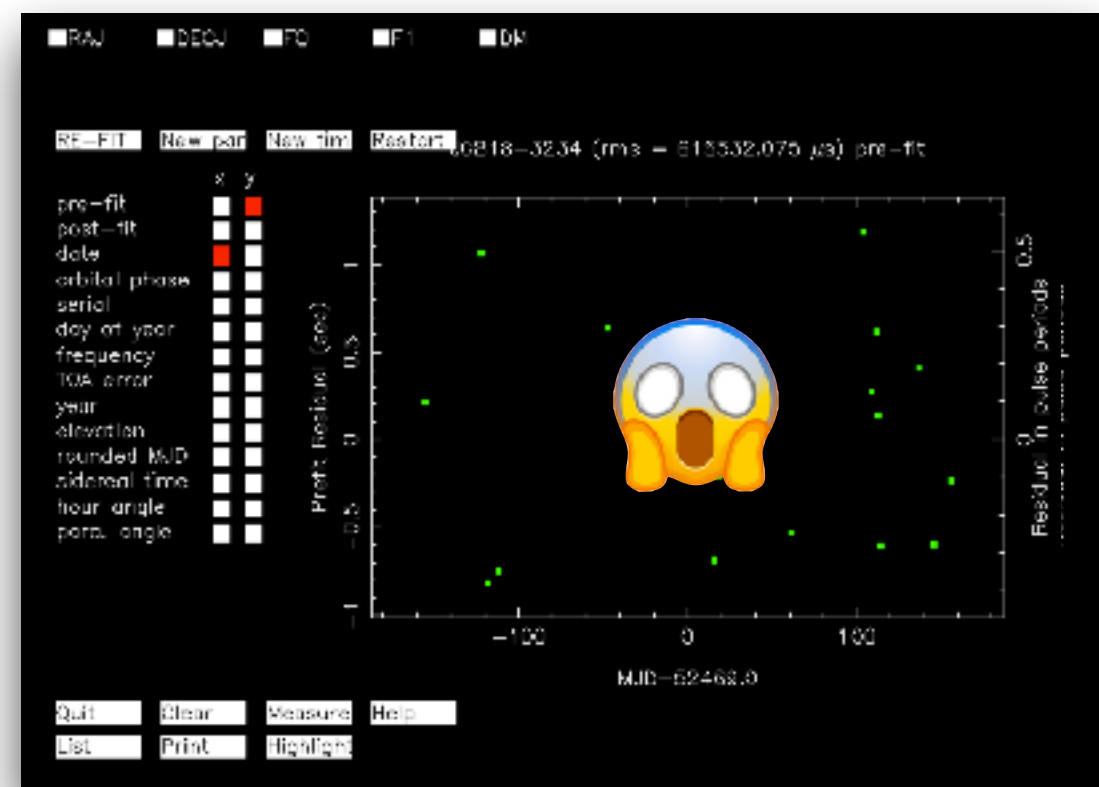
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```



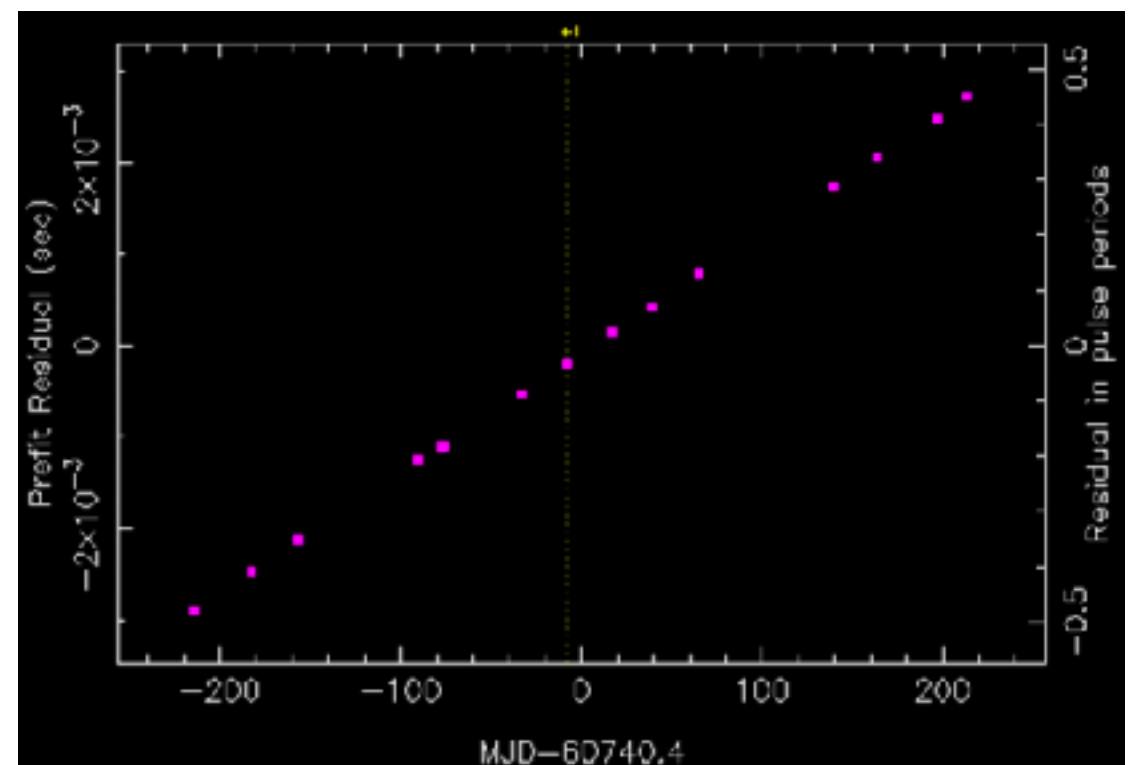
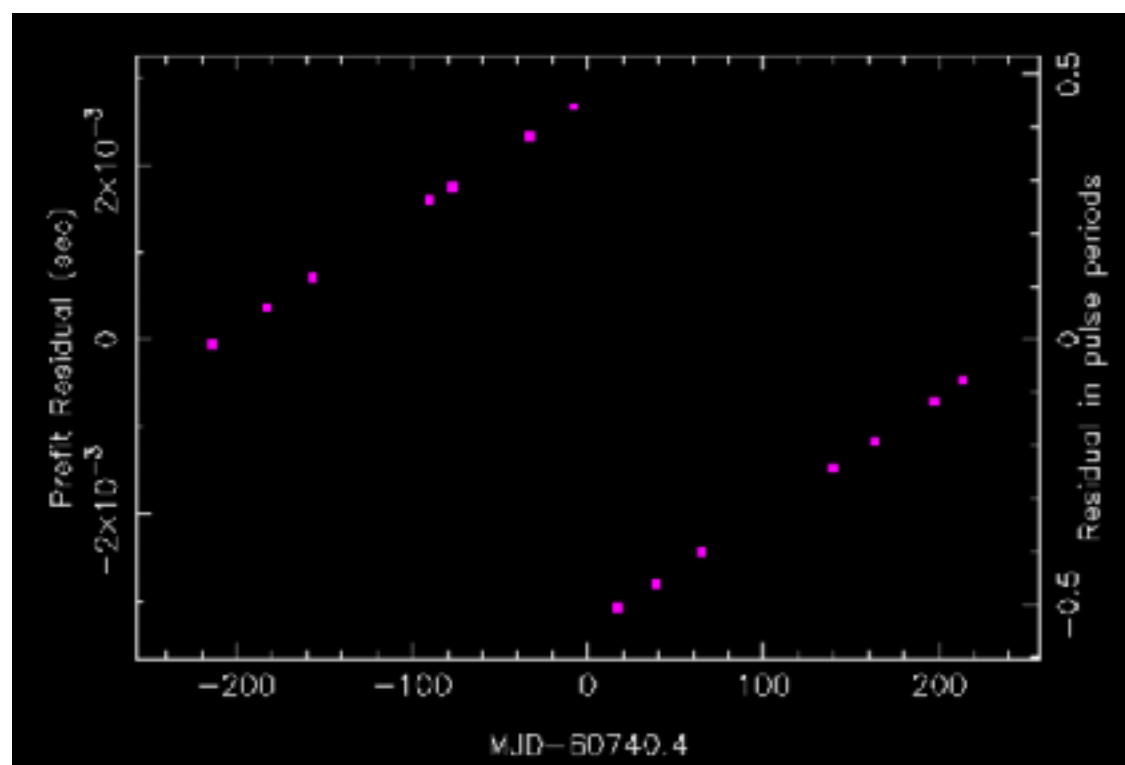
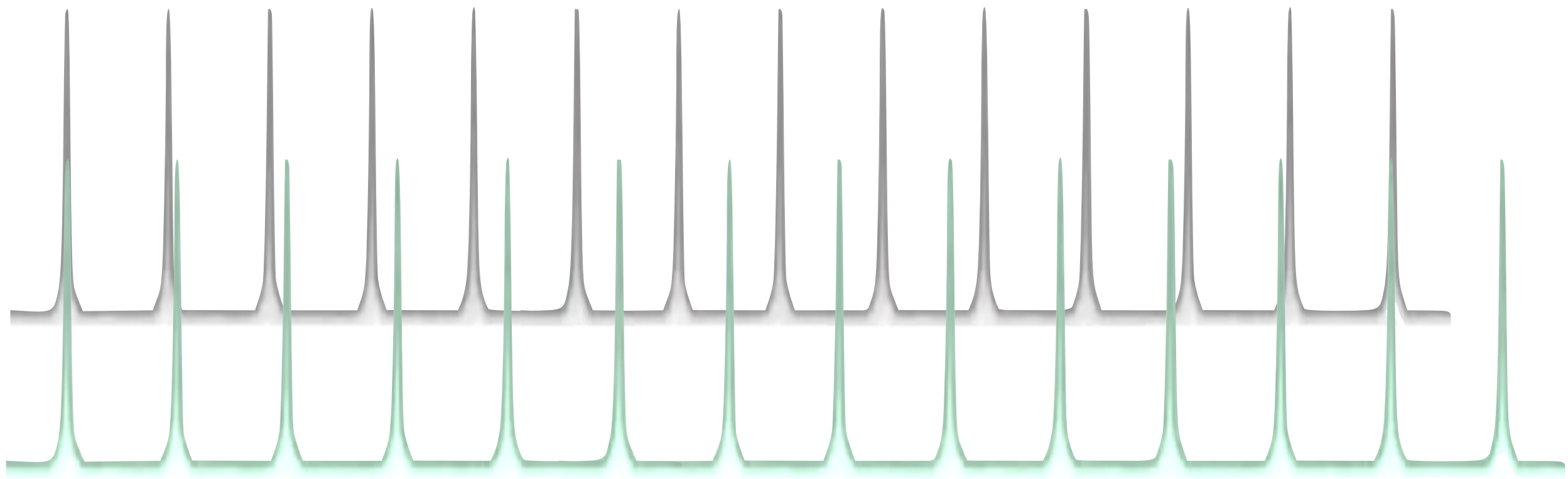
EXERCISE 1

Playing with an already solved pulsar

```
> cd TimingData/fakePSR
> ls
> tempo2 -gr fake -f fakePSR.par
    [cadence 14 days, 1 obs per day, random ha,
    3-4 years around PEPOCH, noise 1e-4]
> tempo2 -gr plk -f fakePSR.par
> emacs fakePSR.par
```

Modify parameters in .par file and see what happens!
Repeat on extra parameters for fakePSR2.par

Rotation count



EXERCISE 2

Time a pulsar from scratch (see email for details)

```
> cd TimingData/Jxxxxx-xxxx
> ls
> vap -c name,ra,dec,dm,period,length,nsup,nchan *.ar
> pav -[FY,GT,dGT,DFT] *.ar
> ls | xargs -n 1 pazi
> psrstat -jDFTp -Qq -c off=minimum:smooth=mean:width=.5
  -c snr=pdmp,snr *.pazi
> pam -FT -e std best_profile.pazi
> pam -F -t n -e zFtn *pazi
> pat -s best_profile.std *zFtn > my file.tim
> pdmp file.pazi
> emacs my file.par
> tempo2 -gr plk myfile.par myfile.tim
```

EXERCISE 2

Time a pulsar from scratch (see email for details)

```
> cd TimingData/Jxxxxx-xxxx
> ls
> vap -c name,ra,dec,dm,period,length,nsup,nchan *.ar
> pav -[FY,GT,dGT,DFT] *.ar
> ls | xargs -n 1 pazi
> psrstat -jDFTp -Qq -c off=minimum:smooth=mean:width=.5
  -c snr=pdmp,snr *.pazi
> pam -FT -e std best_profile.pazi
> pam -F -t n -e zFtn *.pazi
> pat -s best_profile.std *zFtn > my file.tim
> pdmp file.pazi
> emacs my file.par
> tempo2 -gr plk myfile.par myfile.tim
> psrcat -E Jxxxxx-xxxx
```