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
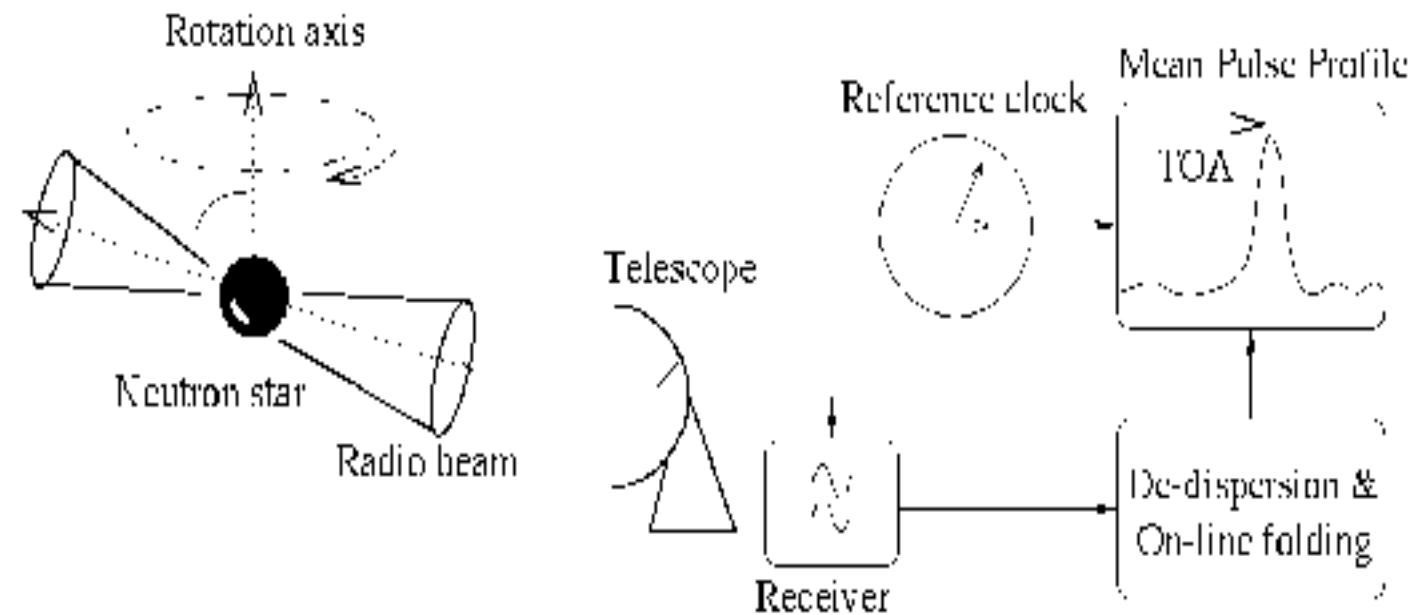
Creating timing residuals ➡ .par and .tim file in tempo2

Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

TIMING RECIPE

Predicting ToAs on the basis of a model ➡ .par file

Measuring ToAs from repeated observations ➡ .ar files; .std file; .tim file

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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
```
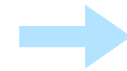
TIMING RECIPE

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

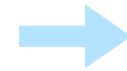Fitting for model parameters to remove trends   ➡️   tempo2 GUI for fitting

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

TIMING RECIPE

Predicting ToAs on the basis of a model ➡ .par file

Measuring ToAs from repeated observations ➡ .ar files; .std file; .tim file
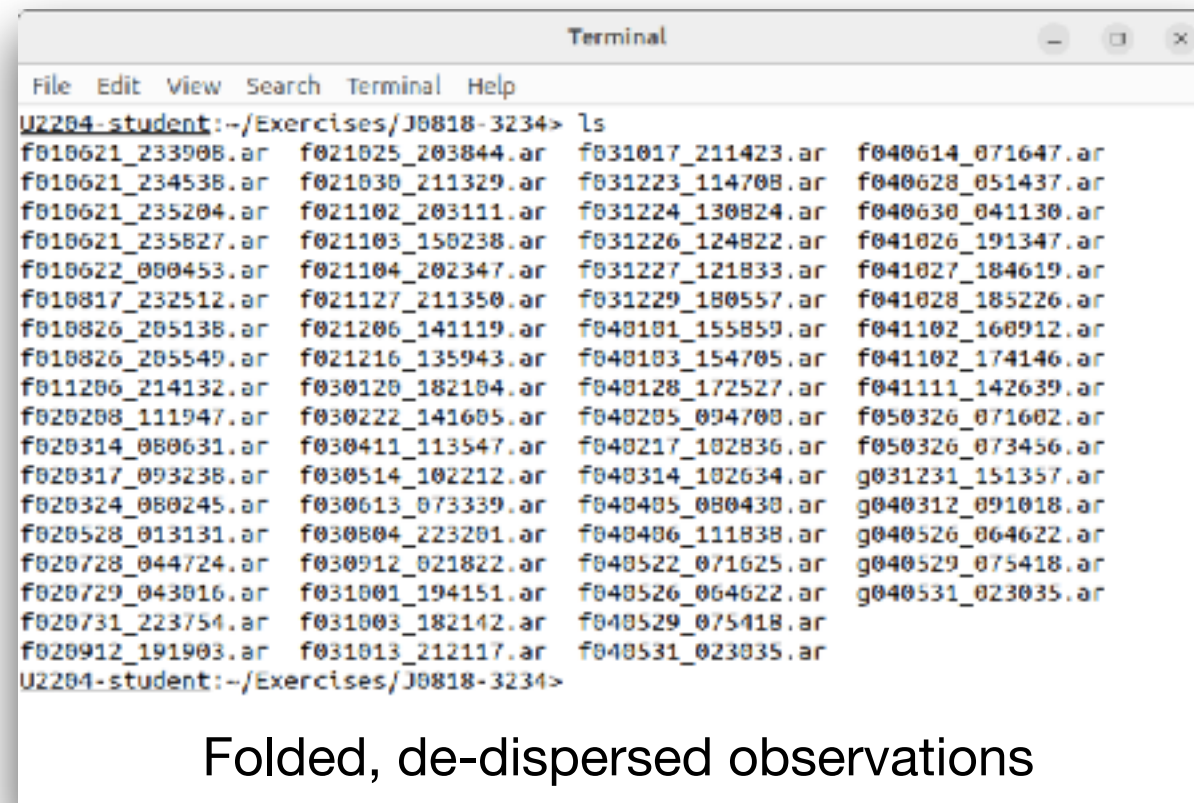
Creating timing residuals ➡ .par and .tim file in tempo2

Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

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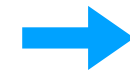
TIMING RECIPE

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

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

Folded, de-dispersed observations

TIMING RECIPE

Predicting ToAs on the basis of a model   ➡   .par file

Measuring ToAs from repeated observations   ➡   **.ar files;** .std file; .tim file

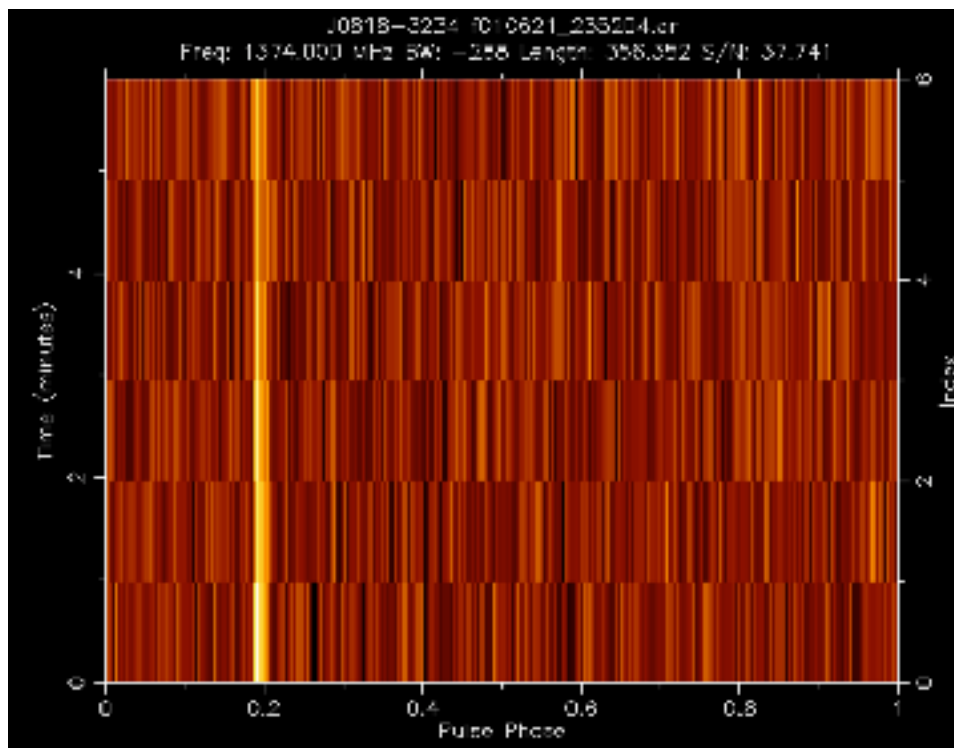Creating timing residuals   ➡   .par and .tim file in tempo2

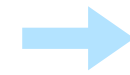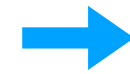Fitting for model parameters to remove trends   ➡   tempo2 GUI for fitting

TIMING RECIPE
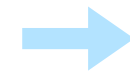
Predicting ToAs on the basis of a model   ➡️   .par file

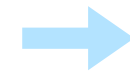Measuring ToAs from repeated observations   ➡️   .ar files; .std file; .tim file
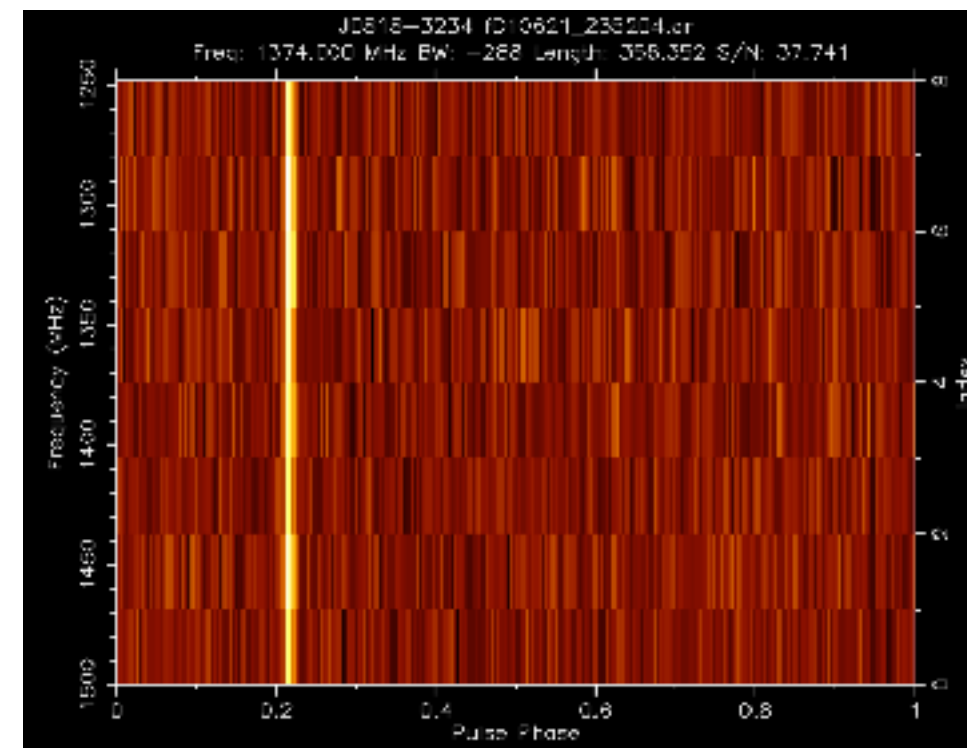
Creating timing residuals   ➡️   .par and .tim file in tempo2

Fitting for model parameters to remove trends   ➡️   tempo2 GUI for fitting

TIMING RECIPE

Predicting ToAs on the basis of a model ➡ .par file

Measuring ToAs from repeated observations ➡ **.ar files;** .std file; .tim file
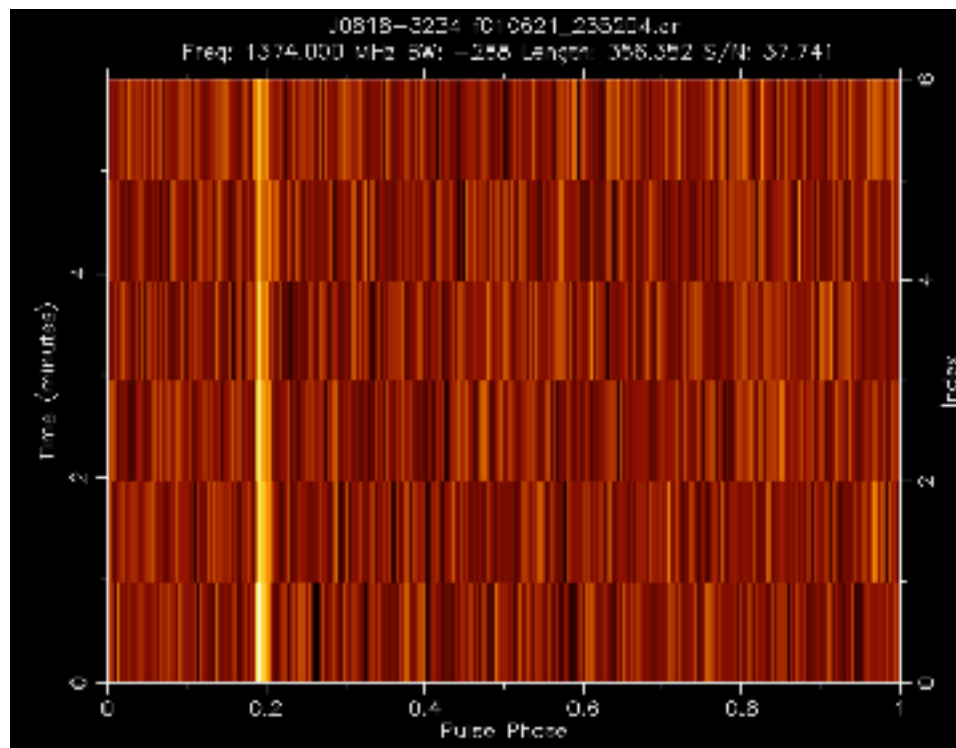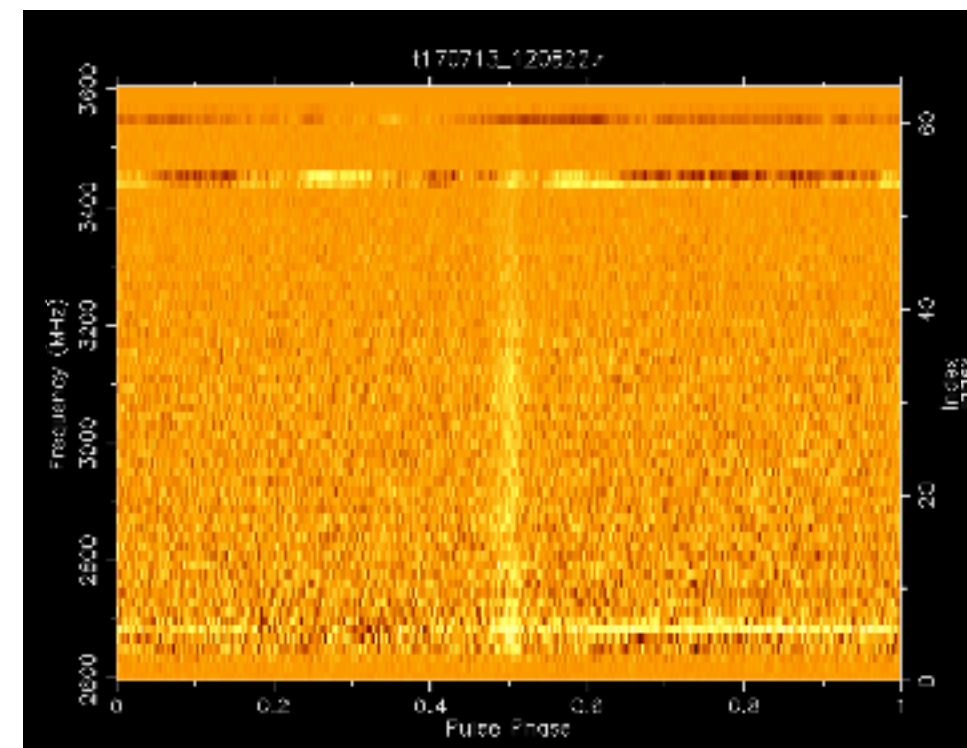
Creating timing residuals ➡ .par and .tim file in tempo2

Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

TIMING RECIPE

Predicting ToAs on the basis of a model ➡ .par file

Measuring ToAs from repeated observations ➡ **.ar files;** .std file; .tim file
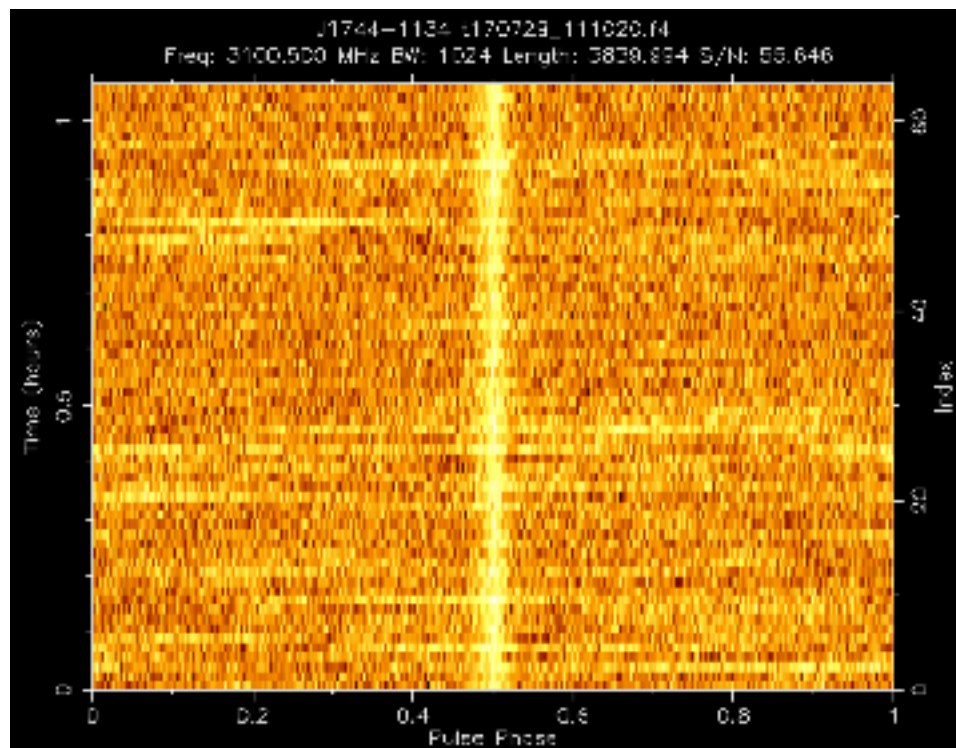
Creating timing residuals ➡ .par and .tim file in tempo2

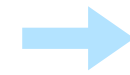Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

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
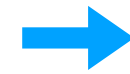
TIMING RECIPE

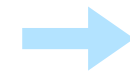Predicting ToAs on the basis of a model ➡ .par file
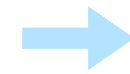
Measuring ToAs from repeated observations ➡ .ar files; .std file; .tim file
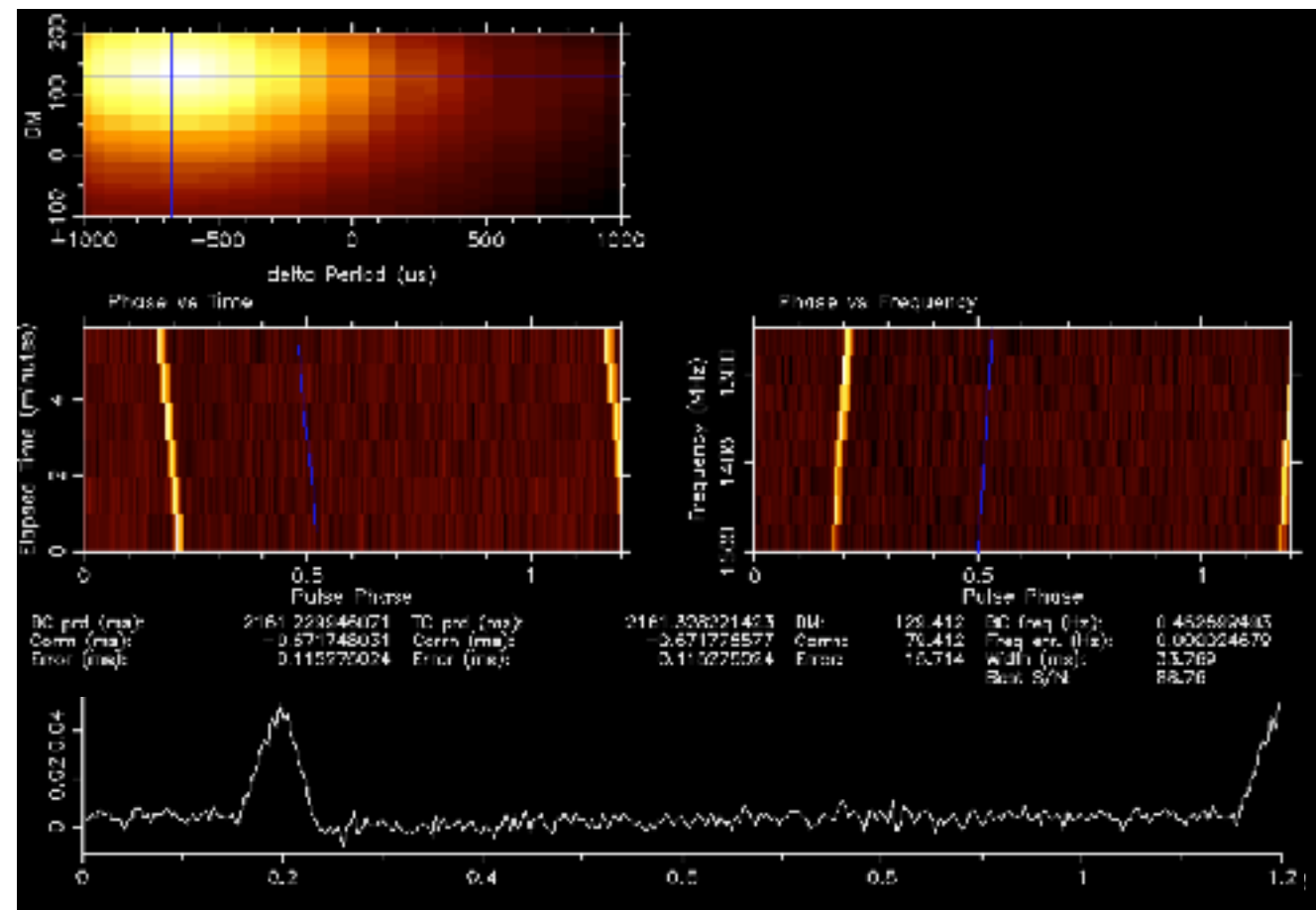
Creating timing residuals ➡ .par and .tim file in tempo2

Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

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

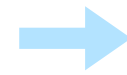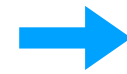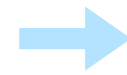Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

TIMING RECIPE

Predicting ToAs on the basis of a model   ➡   .par file

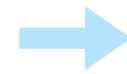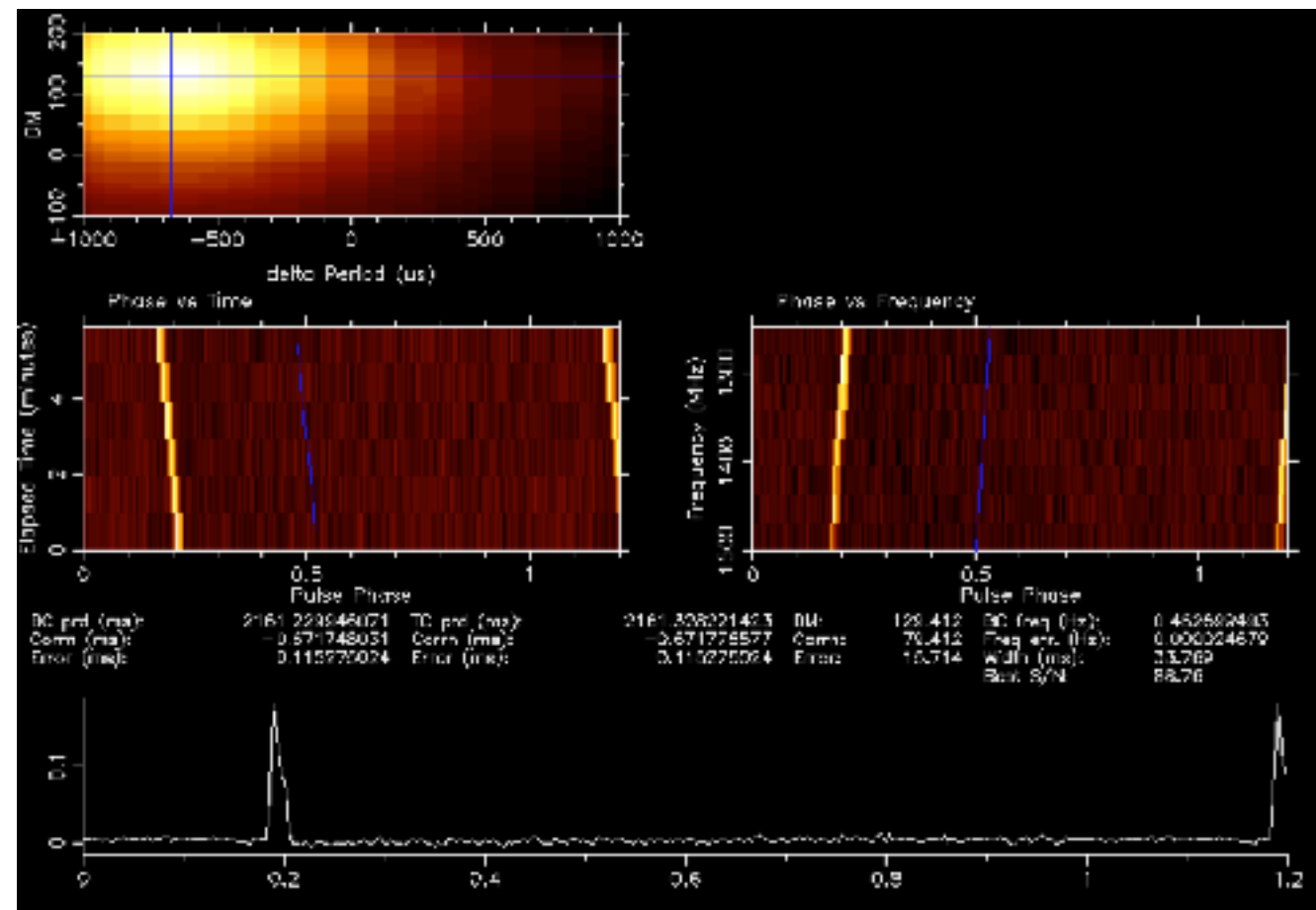Measuring ToAs from repeated observations   ➡   .ar files; .std file; .tim file

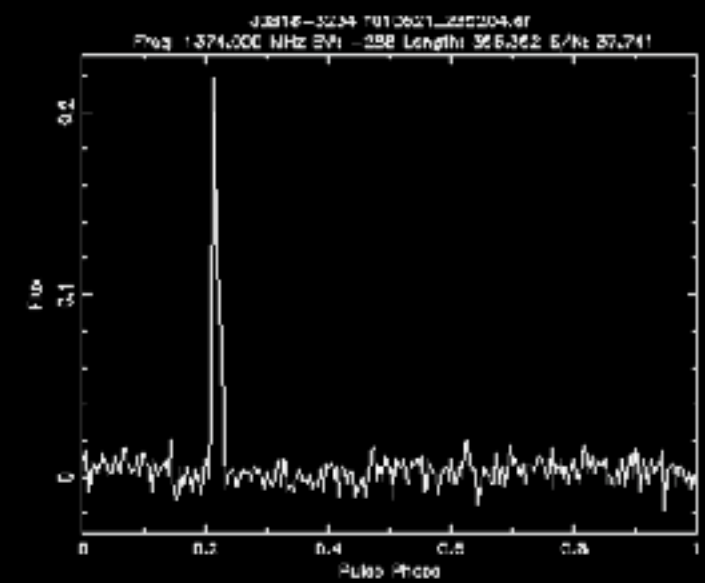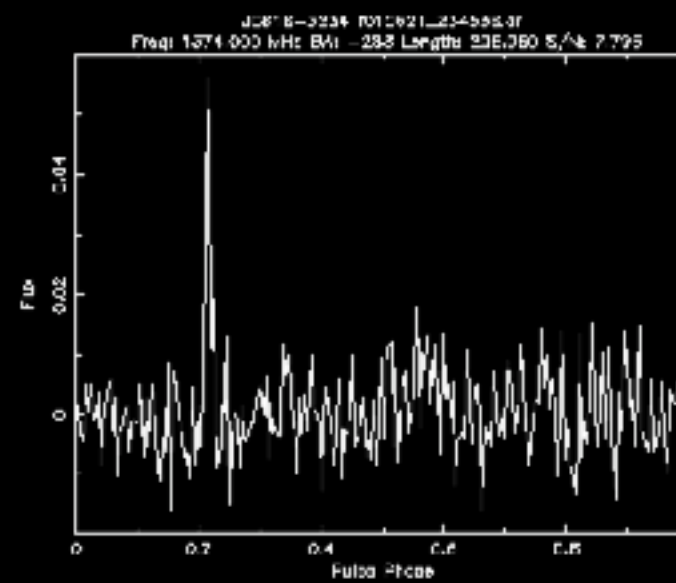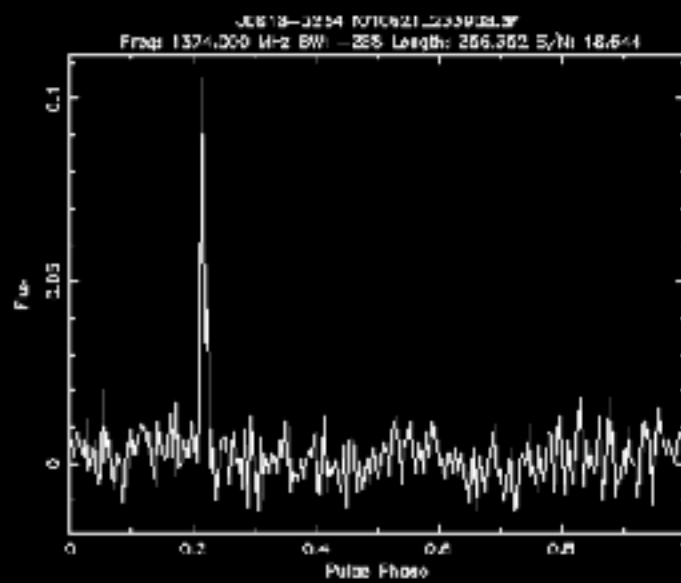Creating timing residuals   ➡   .par and .tim file in tempo2
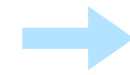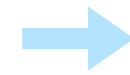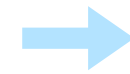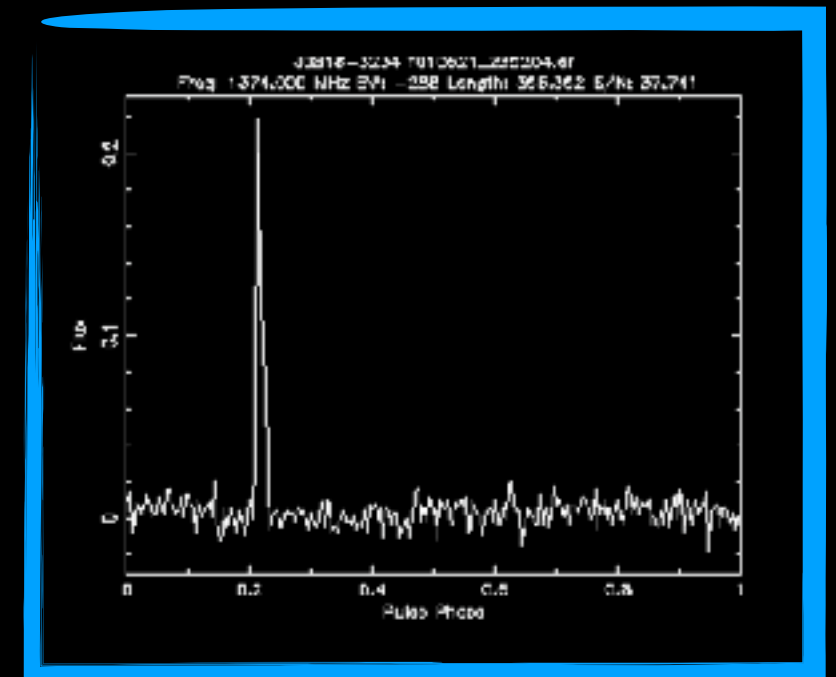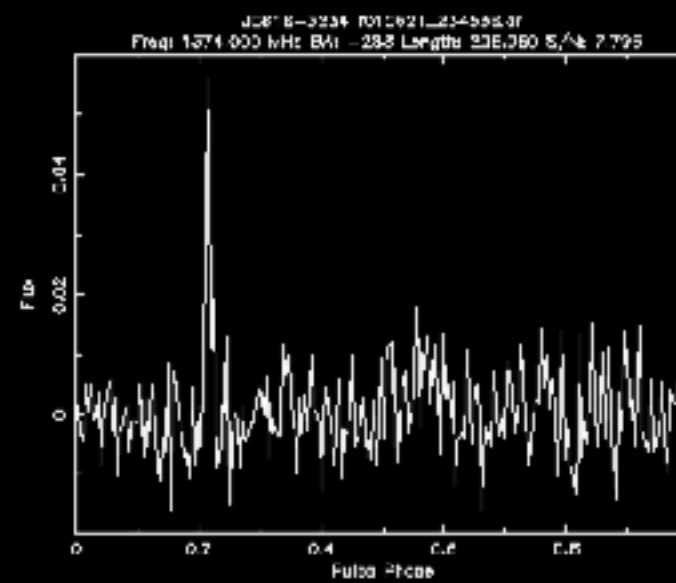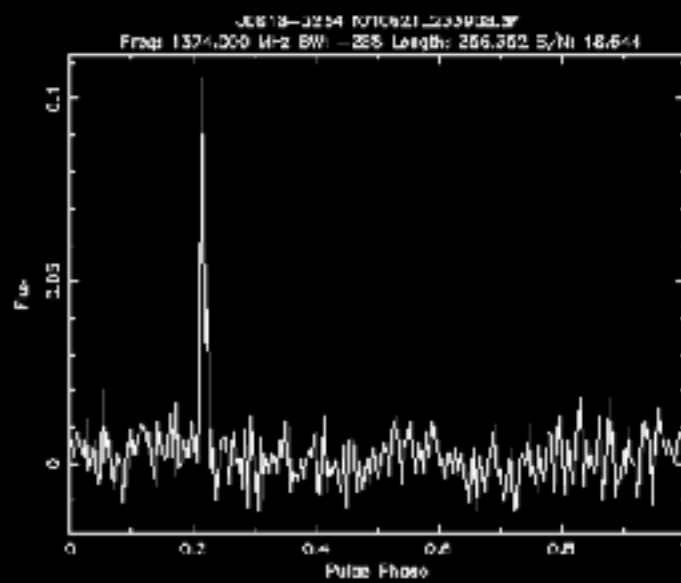
Fitting for model parameters to remove trends   ➡   tempo2 GUI for fitting

```
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
```

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

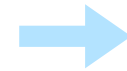Fitting for model parameters to remove trends   ➡️   tempo2 GUI for fitting

```
f010621_235204.t3f4  1482.000000  52081.9952215876563359  354.093   7
f010621_235204.t3f4  1410.000000  52081.9952216169506138  346.168   7
f010621_235204.t3f4  1338.000000  52081.9952216528333341  288.759   7
f010621_235204.t3f4  1266.000000  52081.9952216938532383  300.698   7
f010621_235204.t3f4  1482.000000  52081.9965917384502842  359.871   7
f010621_235204.t3f4  1410.000000  52081.9965920383412833  343.371   7
f010621_235204.t3f4  1338.000000  52081.9965923947374126  291.050   7
f010621_235204.t3f4  1266.000000  52081.9965928096187487  322.037   7
f010621_235204.t3f4  1482.000000  52081.9979425865602722  579.933   7
f010621_235204.t3f4  1410.000000  52081.9979428815879314  347.495   7
f010621_235204.t3f4  1338.000000  52081.9979432381905436  296.446   7
f010621_235204.t3f4  1266.000000  52081.9979436508250677  354.063   7
```

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

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

TIMING RECIPE

Predicting ToAs on the basis of a model ➡ .par file

Measuring ToAs from repeated observations ➡ .ar files; .std file; .tim file
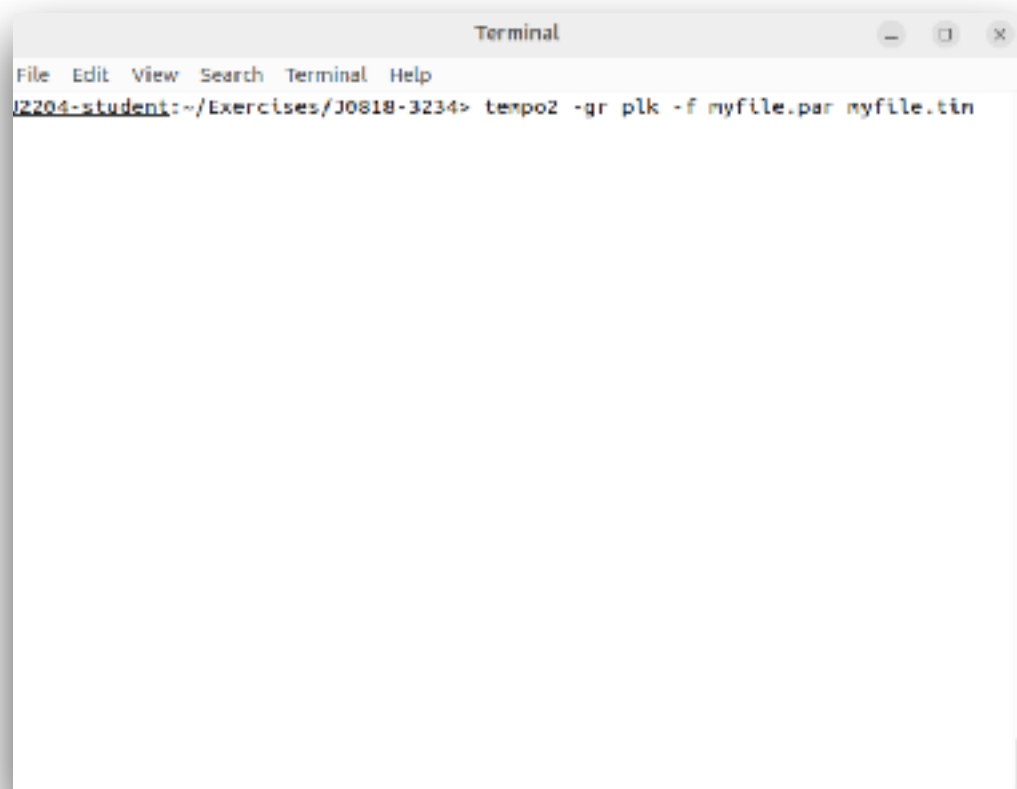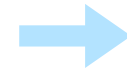
Creating timing residuals ➡ .par and .tim file in tempo2

Fitting for model parameters to remove trends ➡ tempo2 GUI for fitting

TIMING RECIPE

Predicting ToAs on the basis of a model ➡️ .par file

Measuring ToAs from repeated observations ➡️ .ar files; .std file; .tim file
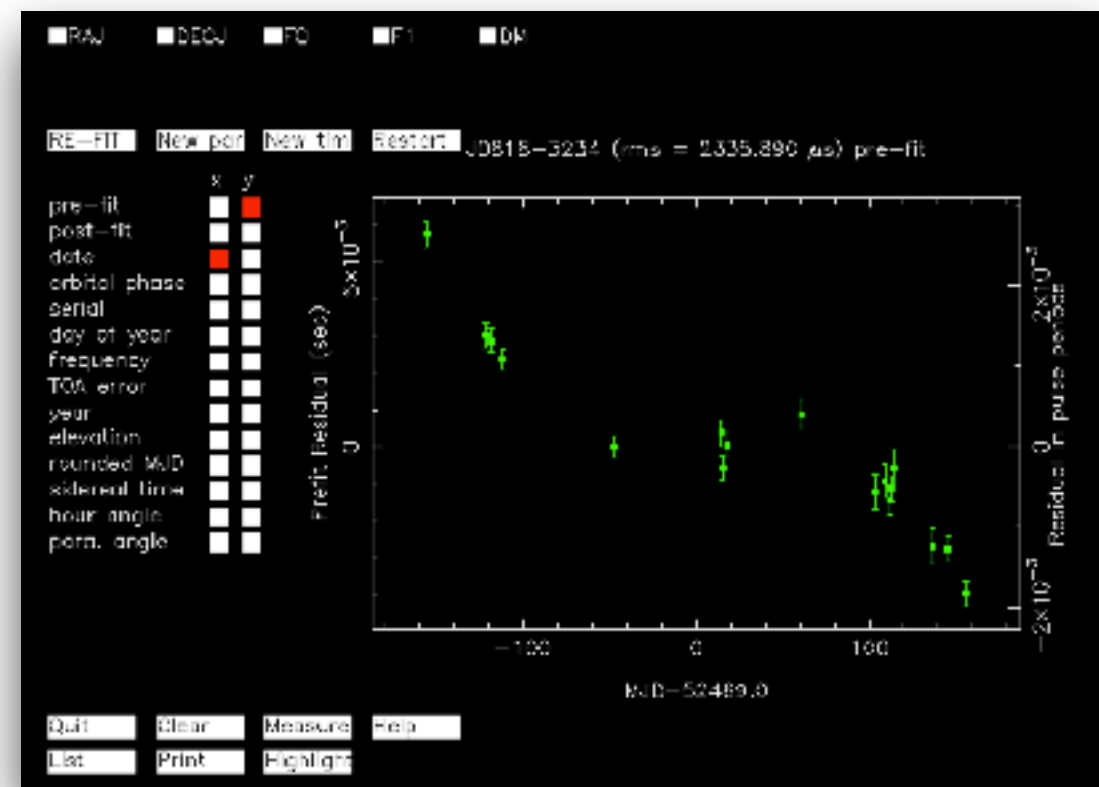
Creating timing residuals ➡️ .par and .tim file in tempo2
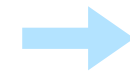
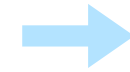Fitting for model parameters to remove trends ➡️ tempo2 GUI for fitting

TIMING RECIPE

Predicting ToAs on the basis of a model ➡️ .par file

Measuring ToAs from repeated observations ➡️ .ar files; .std file; .tim file
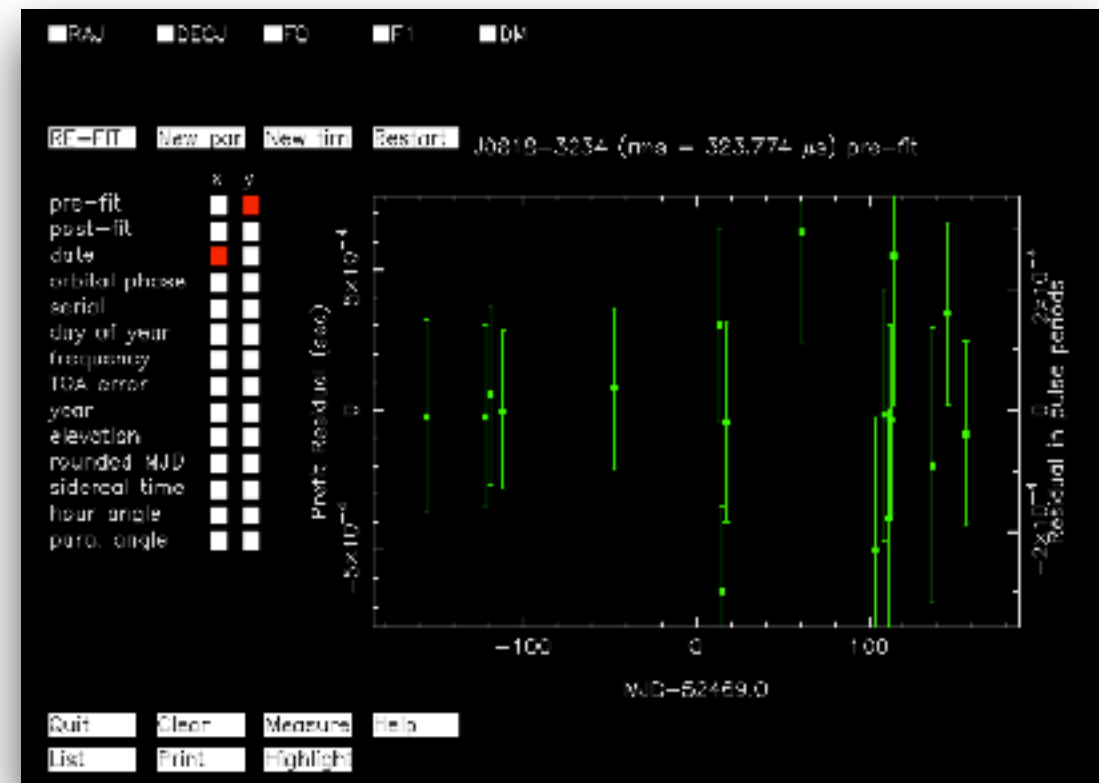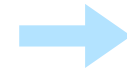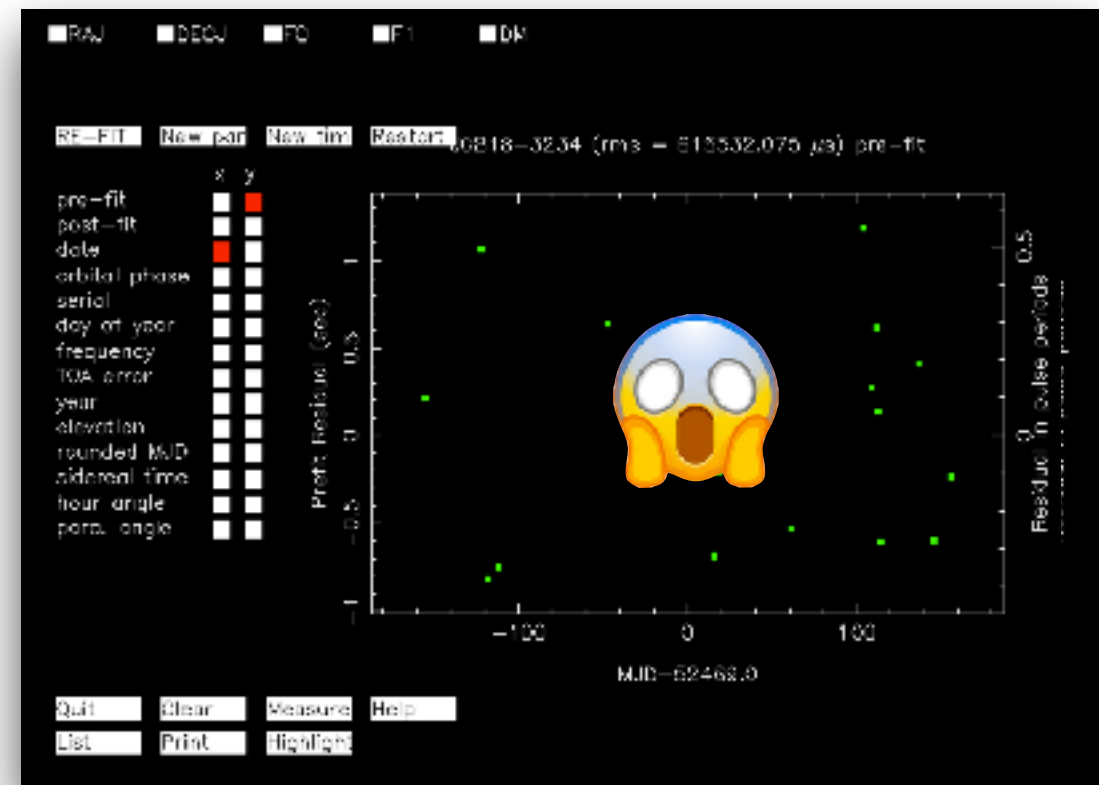
Creating timing residuals ➡️ .par and .tim file in tempo2

Fitting for model parameters to remove trends ➡️ tempo2 GUI for fitting

EXERCISE 1

Playing with an already solved pulsar

```
> cd Exercises/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 fakePAR.simulate

> emacs fakePSR,par
```

modify parameters in .par file and see what happens!

EXERCISE 2

Time a pulsar from scratch

```
> cd Exercises/Jxxxx-xxxx
> ls
> vap -c name,ra,dec,dm,period,length,nsub,nchan *.ar
> pav -[FY,GT,dGT,DFT] *.ar
> ls | xargs -n 1 pazi
> snr *.pazi
> pam -FT -e std best_profile.pazi
> pat -s best_profile.std *pazi > my file.tim
> pdmp file.pazi
> emacs my file.par
> tempo2 -gr plk myfile.par myfile.tim
```

EXERCISE 2

Time a pulsar from scratch

```
> cd Exercises/Jxxxx-xxxx
> ls
> vap -c name,ra,dec,dm,period,length,nsub,nchan *.ar
> pav -[FY,GT,dGT,DFT] *.ar
> ls | xargs -n 1 pazi
> snr *.pazi
> pam -FT -e std best_profile.pazi
> pat -s best_profile.std *pazi > my file.tim
> pdmp file.pazi
> emacs my file.par
> tempo2 -gr plk myfile.par myfile.tim
> psrcat -E Jxxxx-xxxx
```