IDL Binary Grid Search

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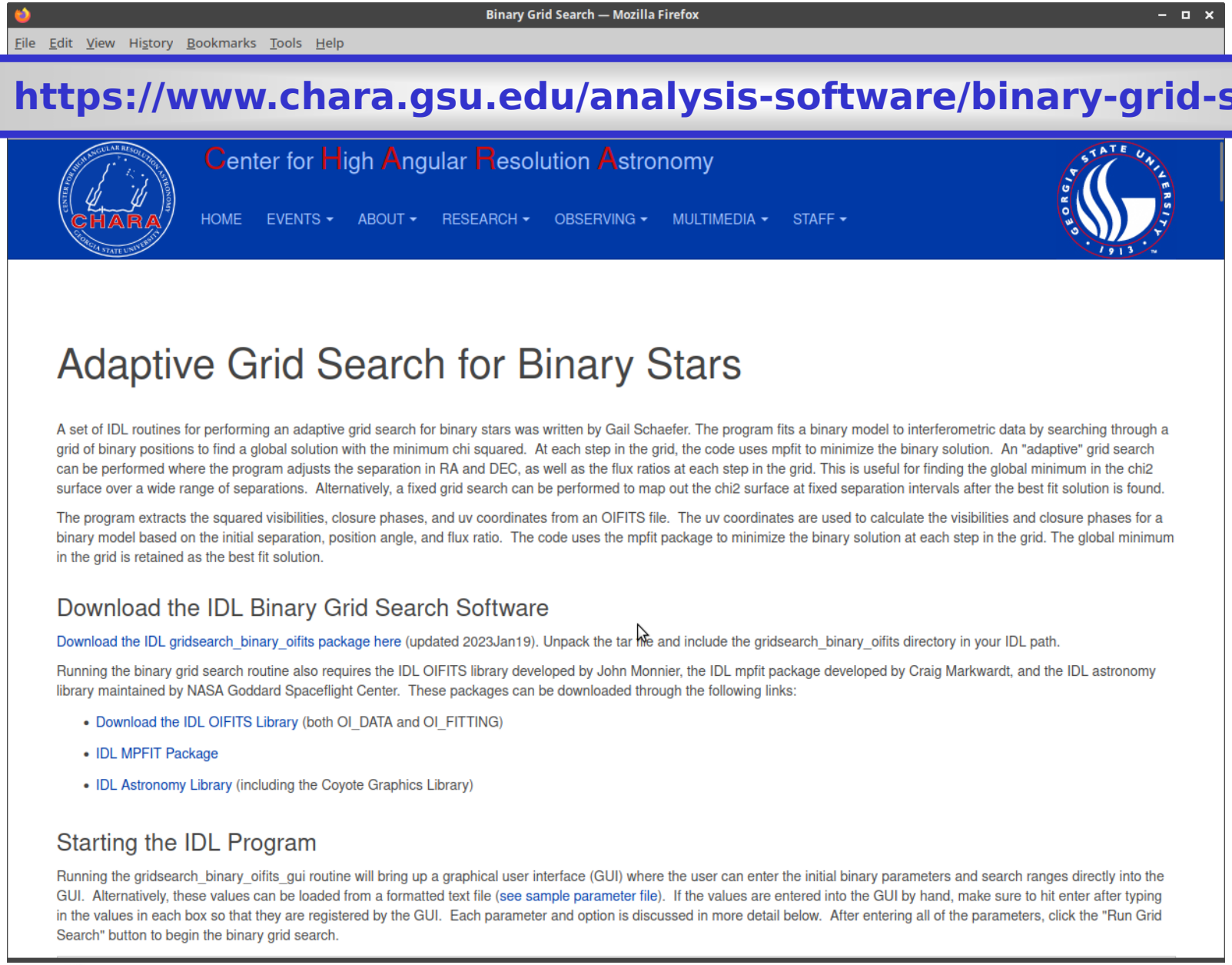
CHARA Array of
Georgia State University

https://www.chara.gsu.edu/analysis-software/binary-grid-search



MIRC-X Data on Iota Peg
MIRC Data on Sig Ori

- Copy Iota Peg data to local directory:
  - cp /dbstorage/workshop_data/MIRCX_iotaPeg_Anugu_2020/* .
    - 2018Oct22_01_MIRCX_iotaPeg_Anugu_2020.fits
    - 2018Oct22_02_MIRCX_iotaPeg_Anugu_2020.fits
    - 2018Oct22_03_MIRCX_iotaPeg_Anugu_2020.fits
    - 2018Oct22_04_MIRCX_iotaPeg_Anugu_2020.fits
    - 2018Oct22_05_MIRCX_iotaPeg_Anugu_2020.fits
    - 2018Oct22_06_MIRCX_iotaPeg_Anugu_2020.fits
    - 2018Oct22_07_MIRCX_iotaPeg_Anugu_2020.fits
- Copy Sig Ori data to local directory:
  - cp /dbstorage/workshop_data/MIRC_sigOri_Schaefer_2016/* .
    - 2011Sep29_01_MIRC_sigOri_Schaefer_2016.oifits

Examine Iota Peg and Sig Ori Data - OIFitsExplorer

- Activate virtual environment on vnc:
  - Type “source workshop” at vnc terminal prompt
- Examine Files Using OIFitsExplorer
  - Type “OIFitsExplorer”
  - Load OIFITS Files for Iota Peg
  - What signatures do you see in the data?
    - Binary?
    - Resolved diameter?
    - Background flux?

MIRC-X Data on Iota Peg
MIRC Data on Sig Ori

- Iota Peg – Binary + primary with resolved diameter
  - Anugu et al. 2020, AJ, 160, 158
- Sig Ori – Binary with incoherent flux from wide companion
  - Schaefer et al. 2016, AJ, 152, 213

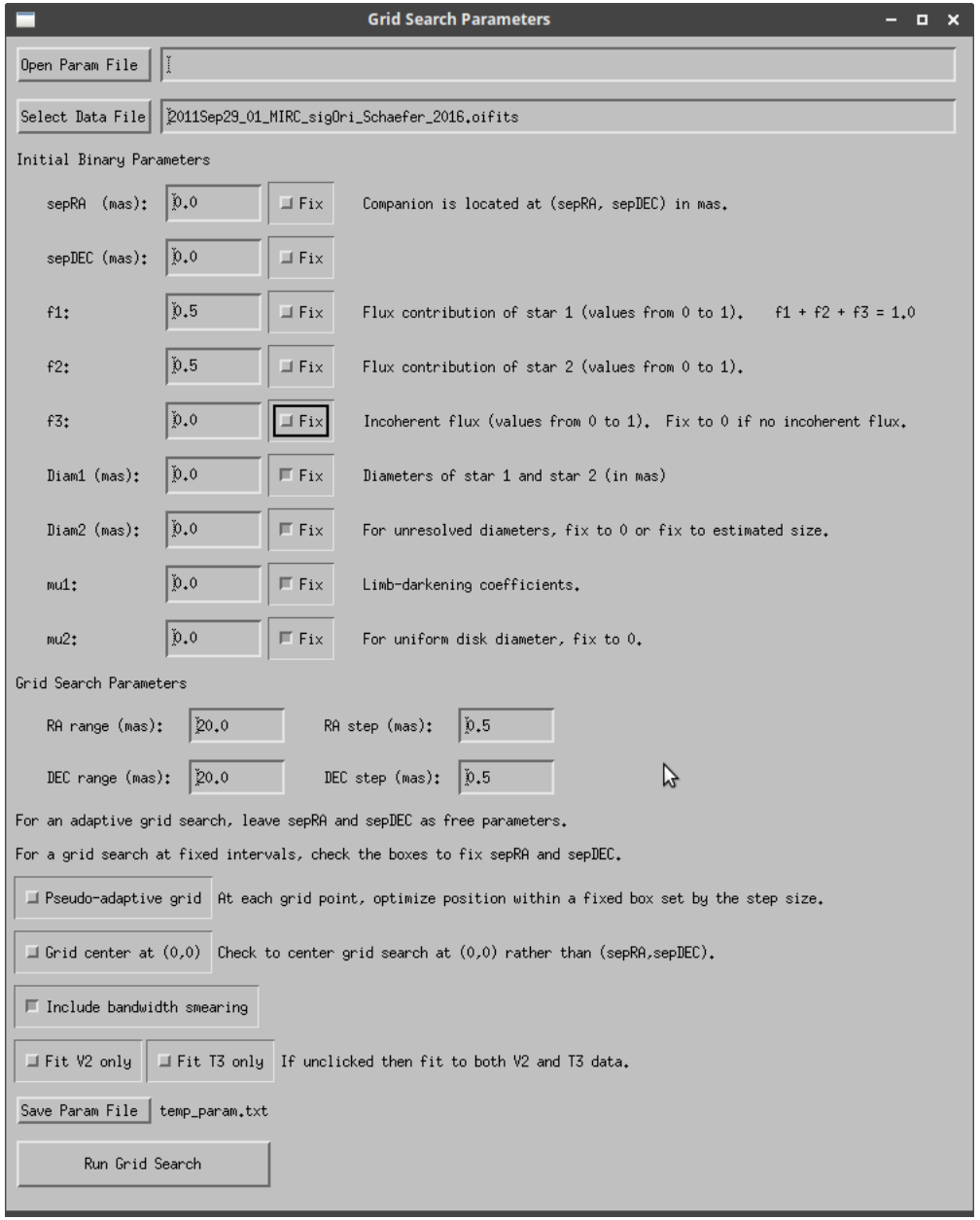
Merging Data Files

- IDL Grid Search read in only a single file
- Merge OIFITS files using merge_oidata.pro
  - IDL with Asto package and Gail Schaefer's Binary Grid Search scripts loaded.
  - IDL> merge_oidata, outfile='Iota_Peg_Merged.fits', infiles=['2018Oct22_06_MIRCX_iotaPeg_Anugu_2020.fits', '2018Oct22_07_MIRCX_iotaPeg_Anugu_2020.fits']
- Merged output file: Iota_Peg_Merged.fits

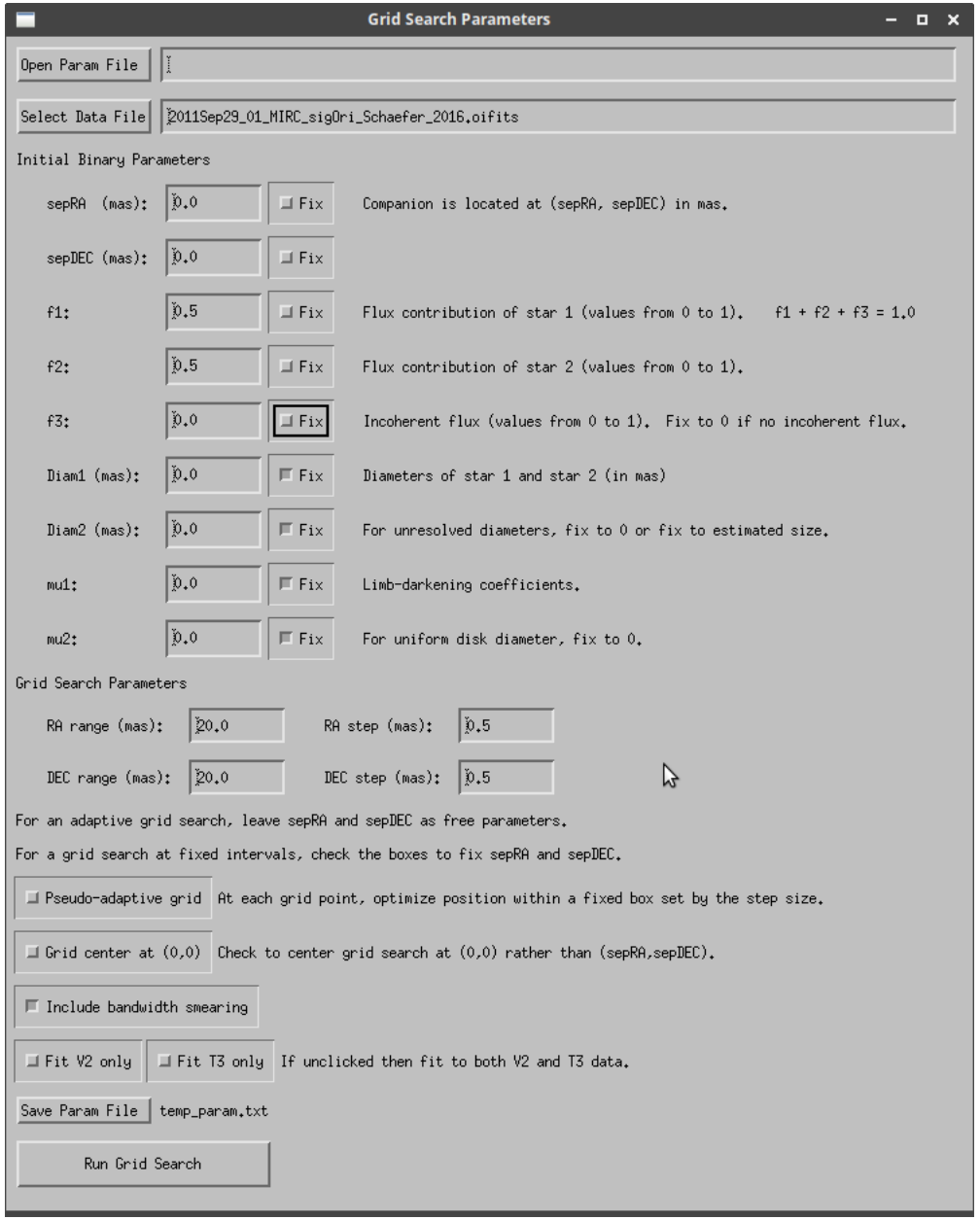
Starting IDL Grid Search Procedure

- Start IDL with grid search dependencies loaded:
  - Type “binarygs_idl” at vnc terminal prompt
- Start IDL grid search procedure:
  - IDL> gridsearch_binary_oifits_gui

NOTE: Hit enter after entering new values!

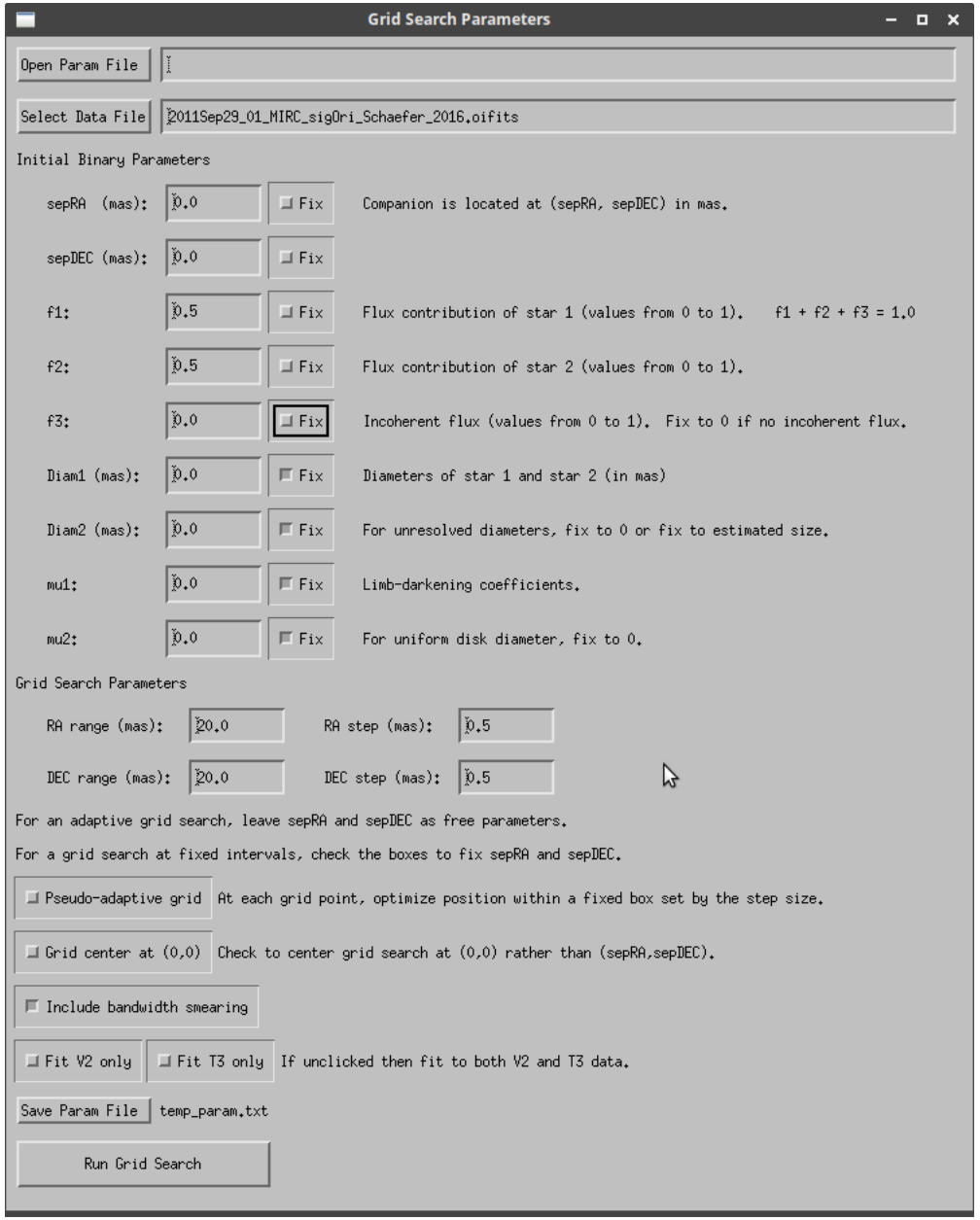


Load OIFITS File



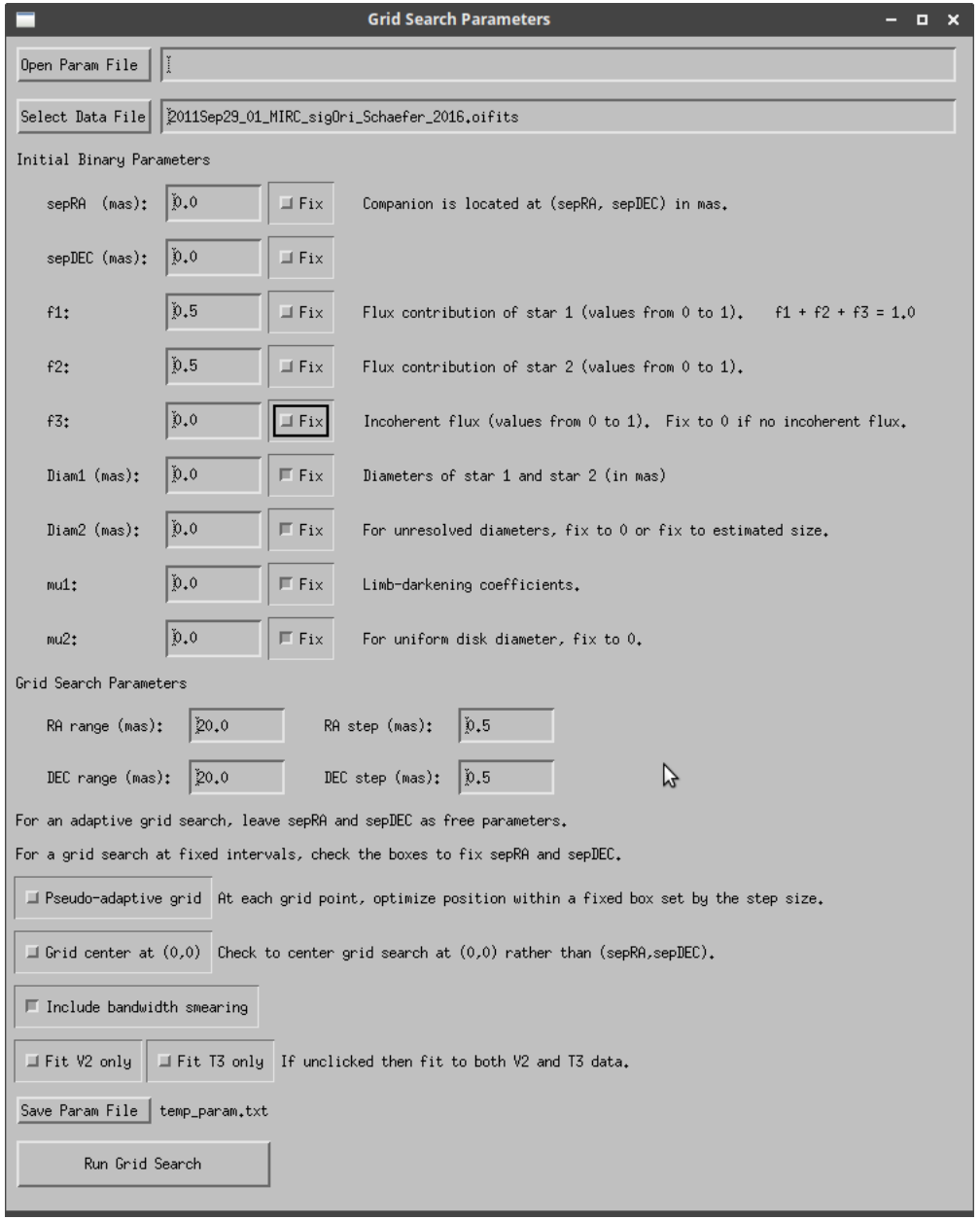
NOTE: Iota Peg files are big and take a long time to fit. Sig Ori file will give faster results.

Initial Binary Separation in RA and DEC



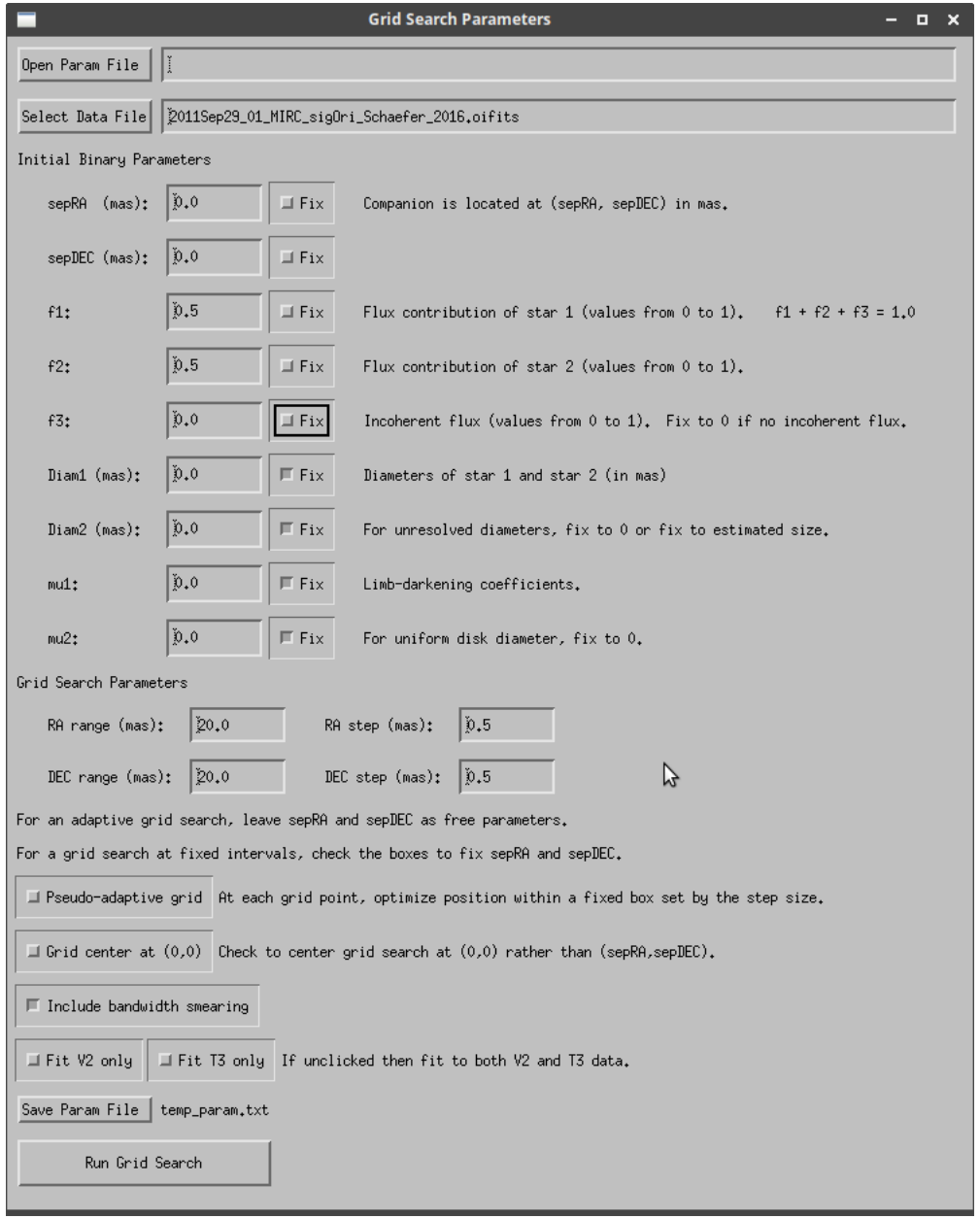
Initial Flux Contributions

- Fraction of flux in each component (0 – 1)
- Total sums to 1
- Unclick the fix button for f3 to solve for incoherent background flux

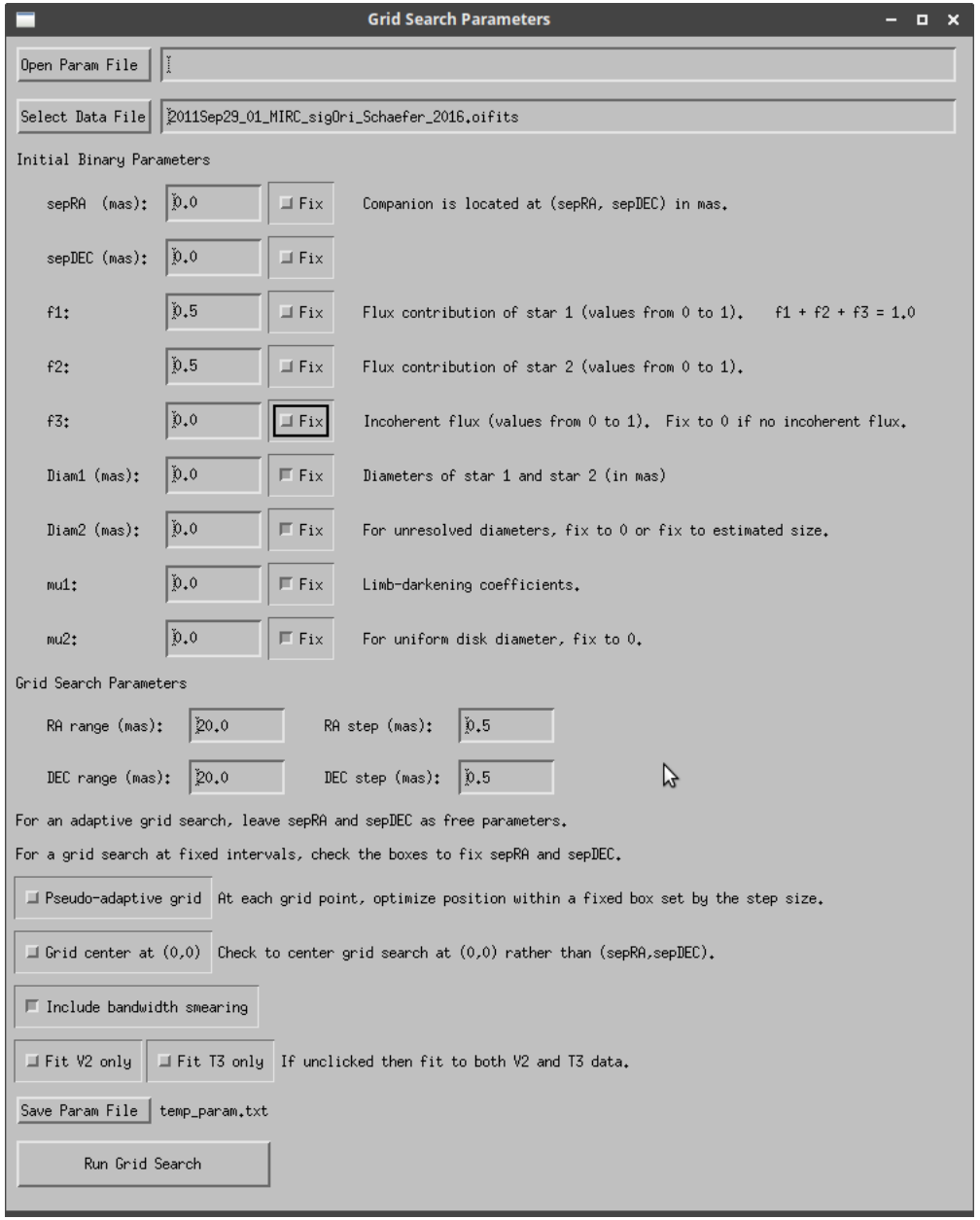


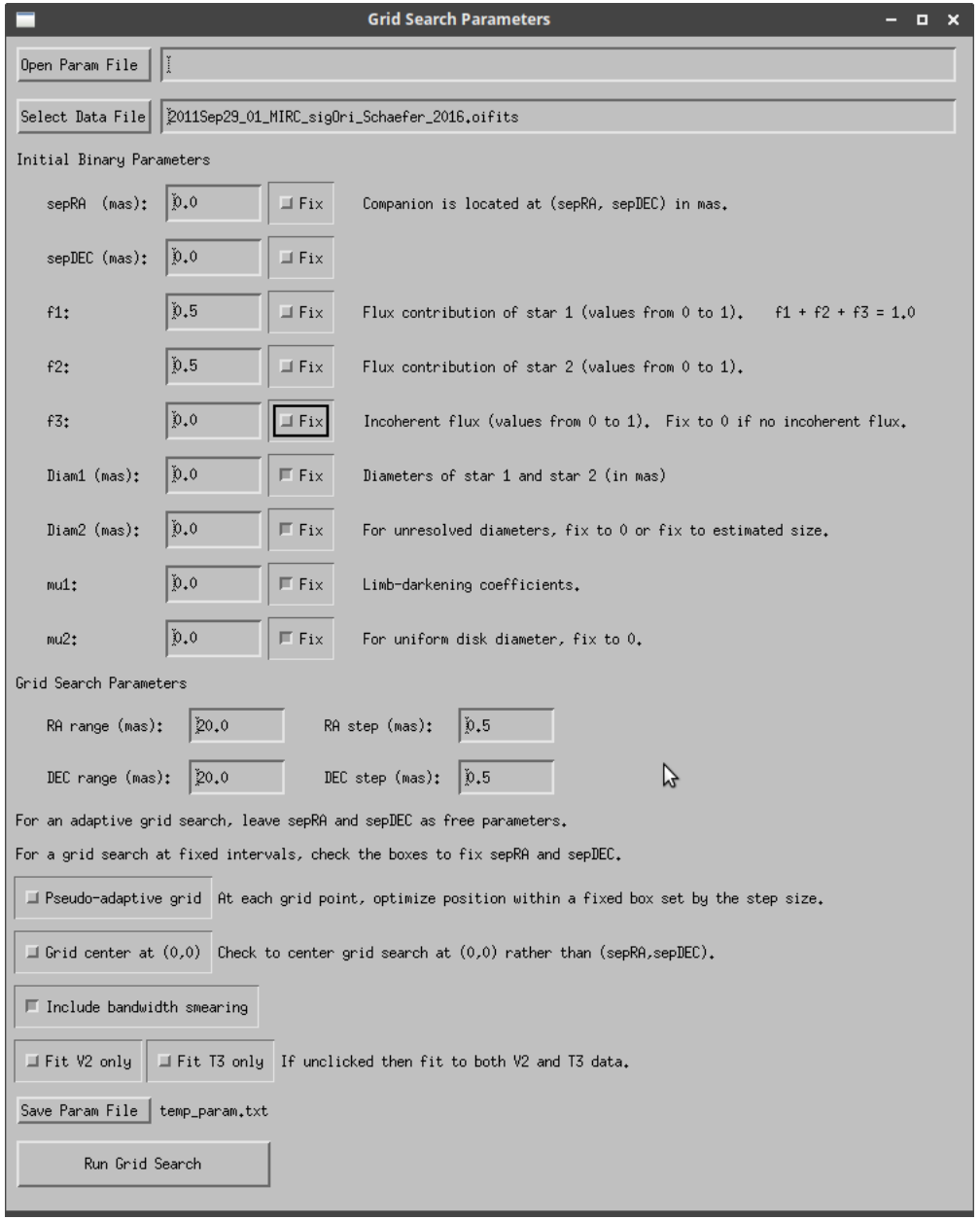
Initial Diameters:

- Unclick Fix button if you want to solve for the diameter
- Unresolved star = 0 mas



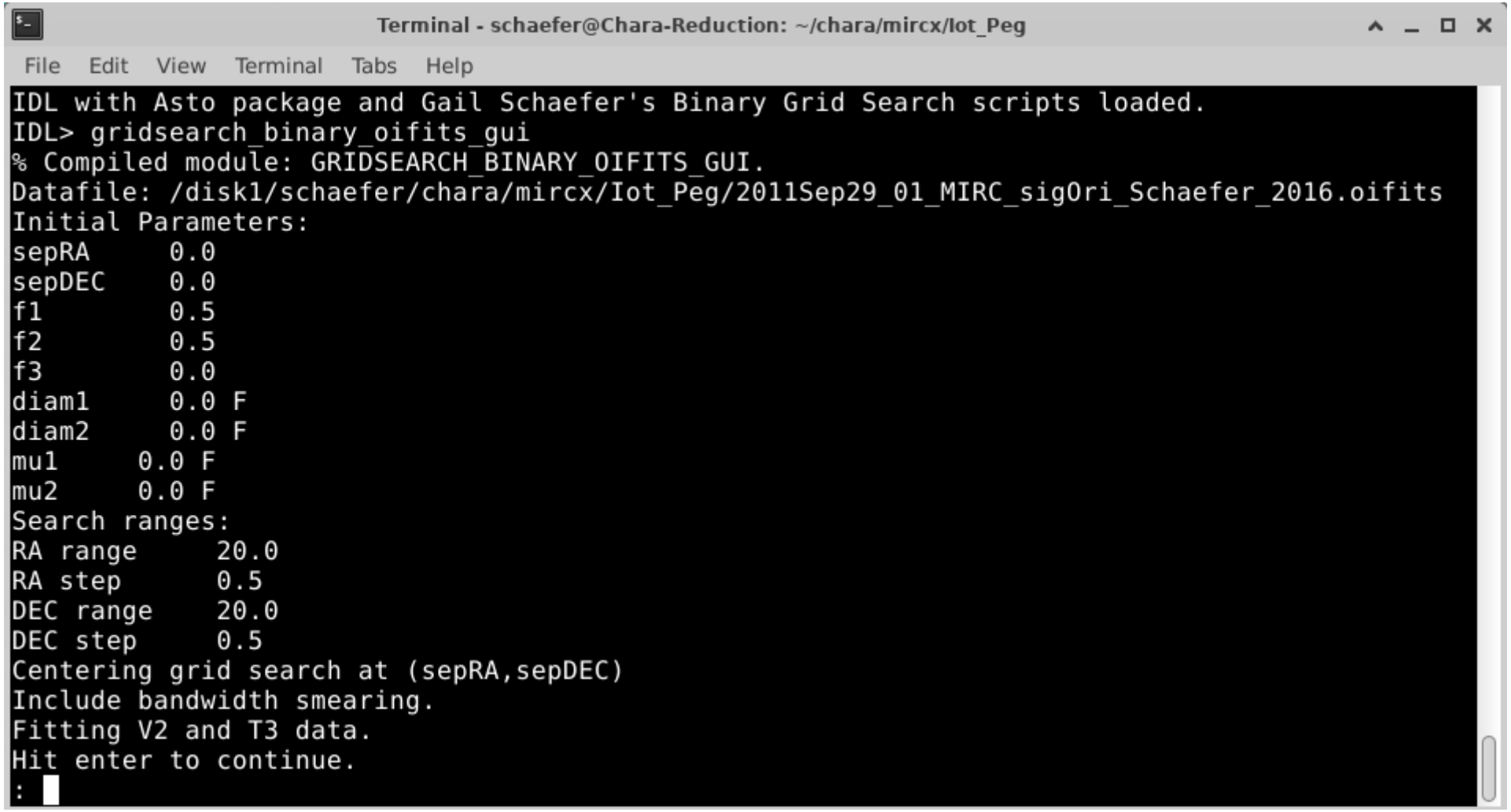
Search Range and Step Size





Click “Run Grid Search”

Hit Enter to start grid search…. then wait…



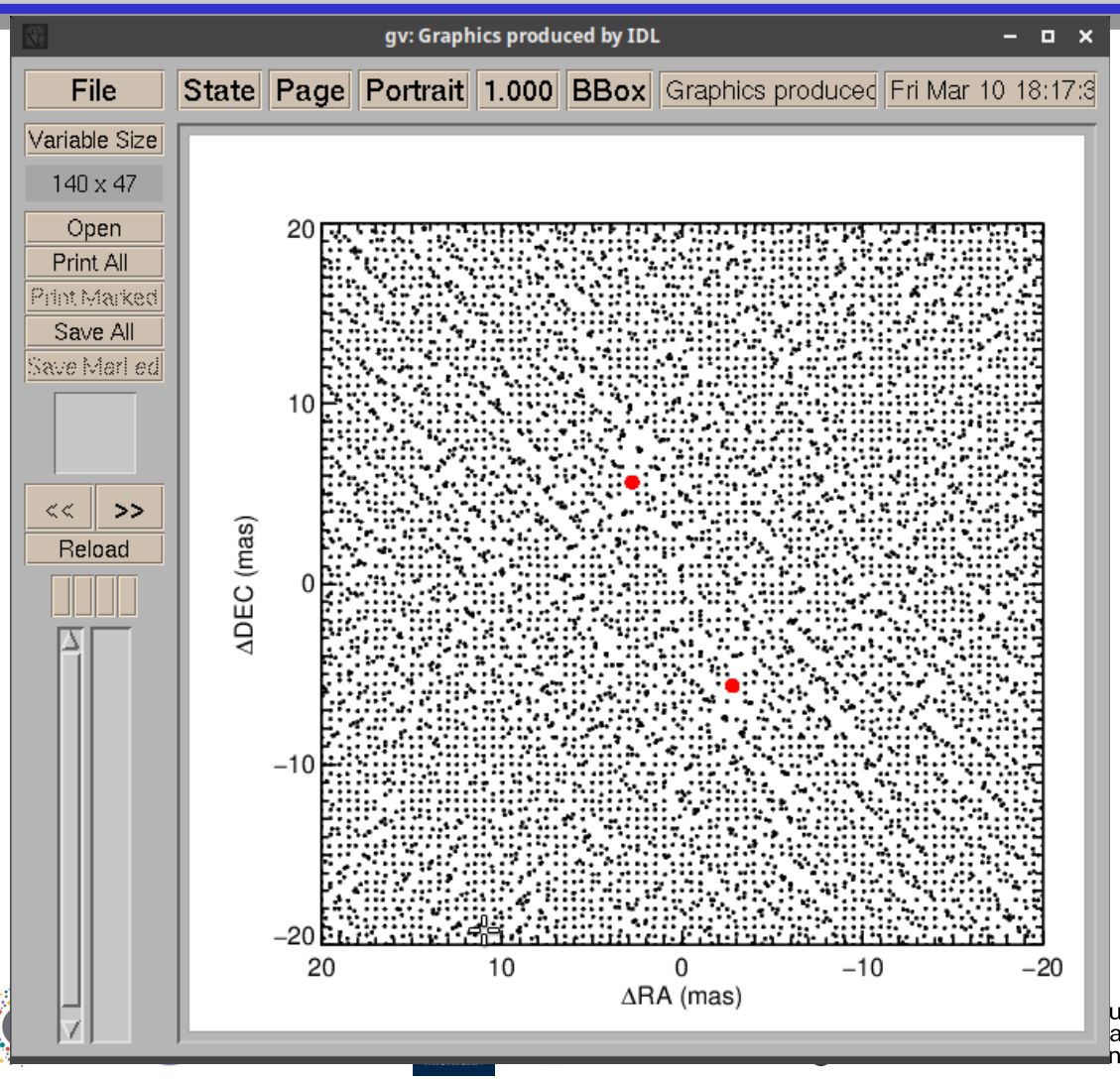
Final Results are printed to the screen

Terminal - schaefer@Chara-Reduction: ~/chara/mircx/Iot_Peg

File Edit View Terminal Tabs Help

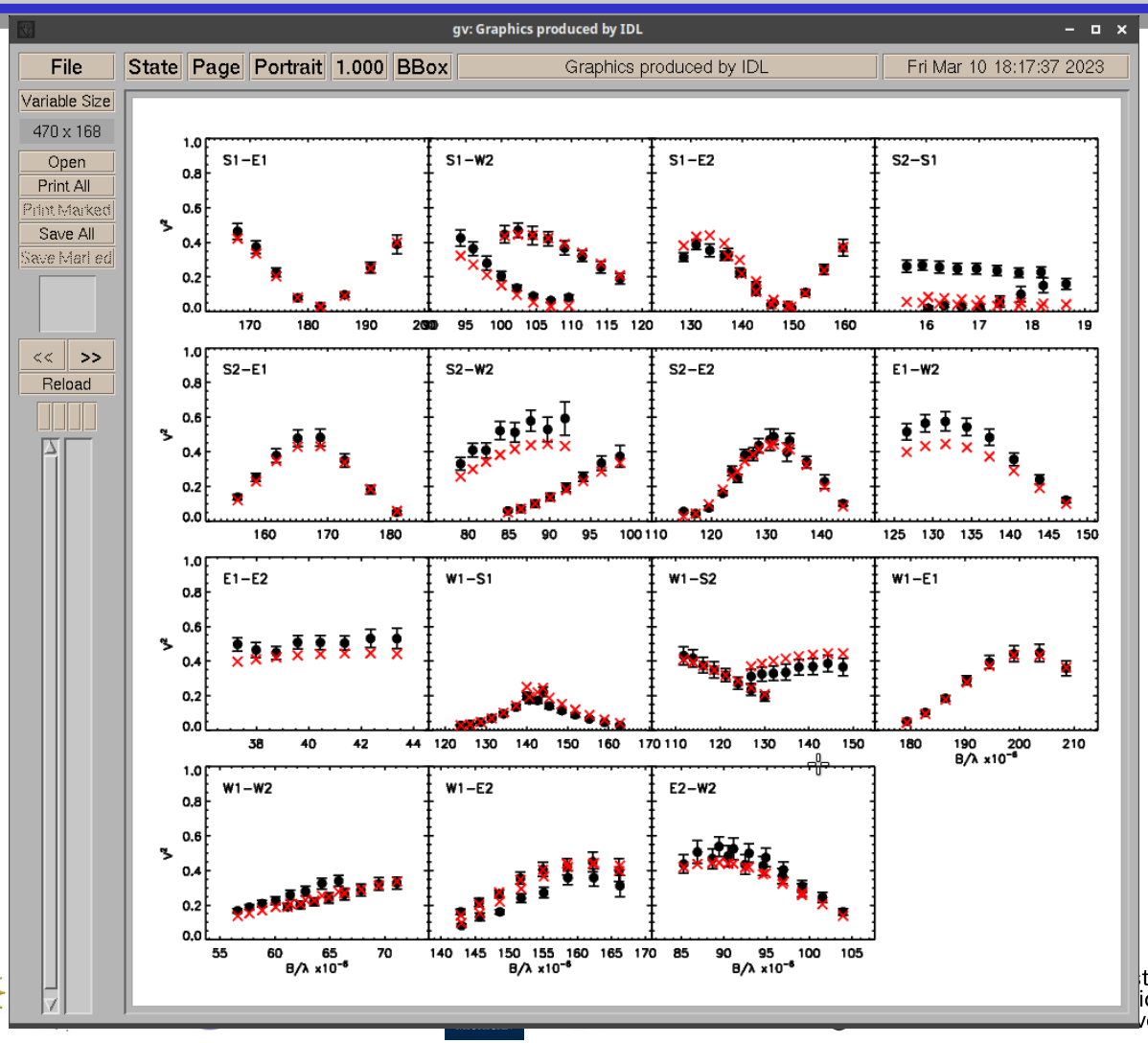
```
------------------------------------------------------------
Data file: /disk1/schaefer/chara/mircx/Iot_Peg/2011Sep29_01_MIRC_sigOri_Schaefer_2016.oifits
Best fit total(resid^2) from mpfit:        1848.9745
All chi2:       1848.9745         440       4.2505161
V2 chi2:       916.45145         200       4.6997510
T3 chi2:       932.52305         240       3.9681832
Number of free parameters:           5
Parameter Error
sepRA         -2.7699620    0.0019796831
sepDEC        -5.6180827    0.0025241986
f1            0.41709432    0.0035853982
f2            0.25053392    0.0025564735
f3            0.33237176      -0.0000000
diam1          0.0000000      -0.0000000
diam2          0.0000000      -0.0000000
mu1            0.0000000      -0.0000000
mu2            0.0000000      -0.0000000
Close pair separation:          6.2638281 +/-     0.0024273430
Close pair position angle:         206.24533 +/-      0.019184321
Close pair fratio (f2/f1):       0.60066491 +/-     0.0080142562
Flux ratio of wide component relative to primary:       0.79687433
Error ellipse - major, minor, PA:    0.0026494696    0.0018086002       155.43016
------------------------------------------------------------
Add systematic calibration uncertainties in quadrature with formal errors:
- MIRC: 0.25% uncertainty in wavelength scale (Monnier et al. 2012)
- MIRC: 5% uncertaintiy in visibility calibration
Total error ellipse - major, minor, PA:      0.015883143     0.010842266       155.43016
Total errors in f1, f2, f3:      0.011087303    0.0067382514     0.016726036
Total errors in diam1, diam2:        0.0000000       0.0000000
------------------------------------------------------------
Wavelength correction factor:  1.0000    -- No wavelength correction
Fit includes bandwidth smearing.
Fitting V2 and T3 data.
```

Look at chi2 map: gv temp.eps



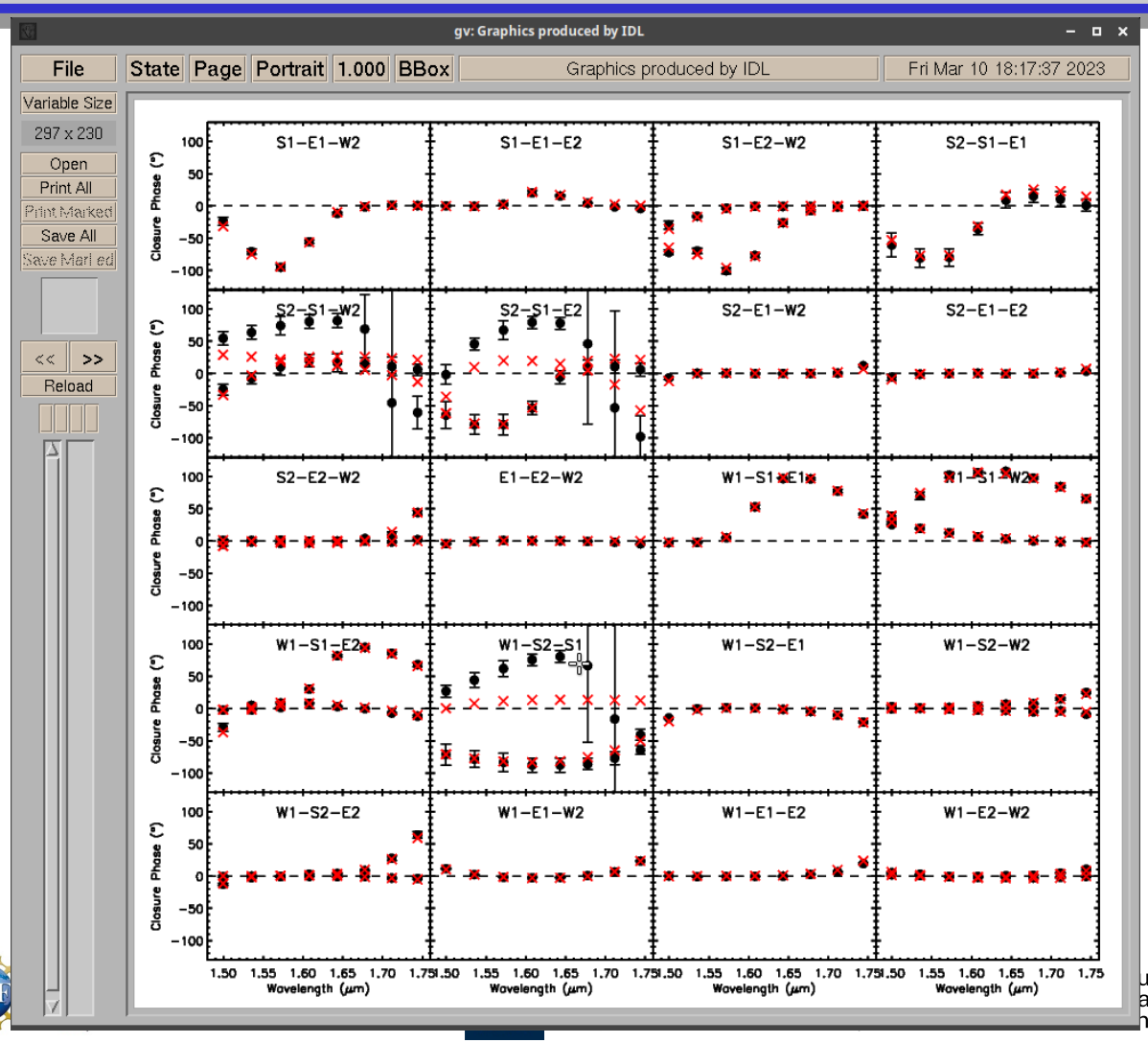
Look at fit to visibilities:

gv 2011Sep29_01_MIRC_sigOri_Schaefer_2016_vis2.eps



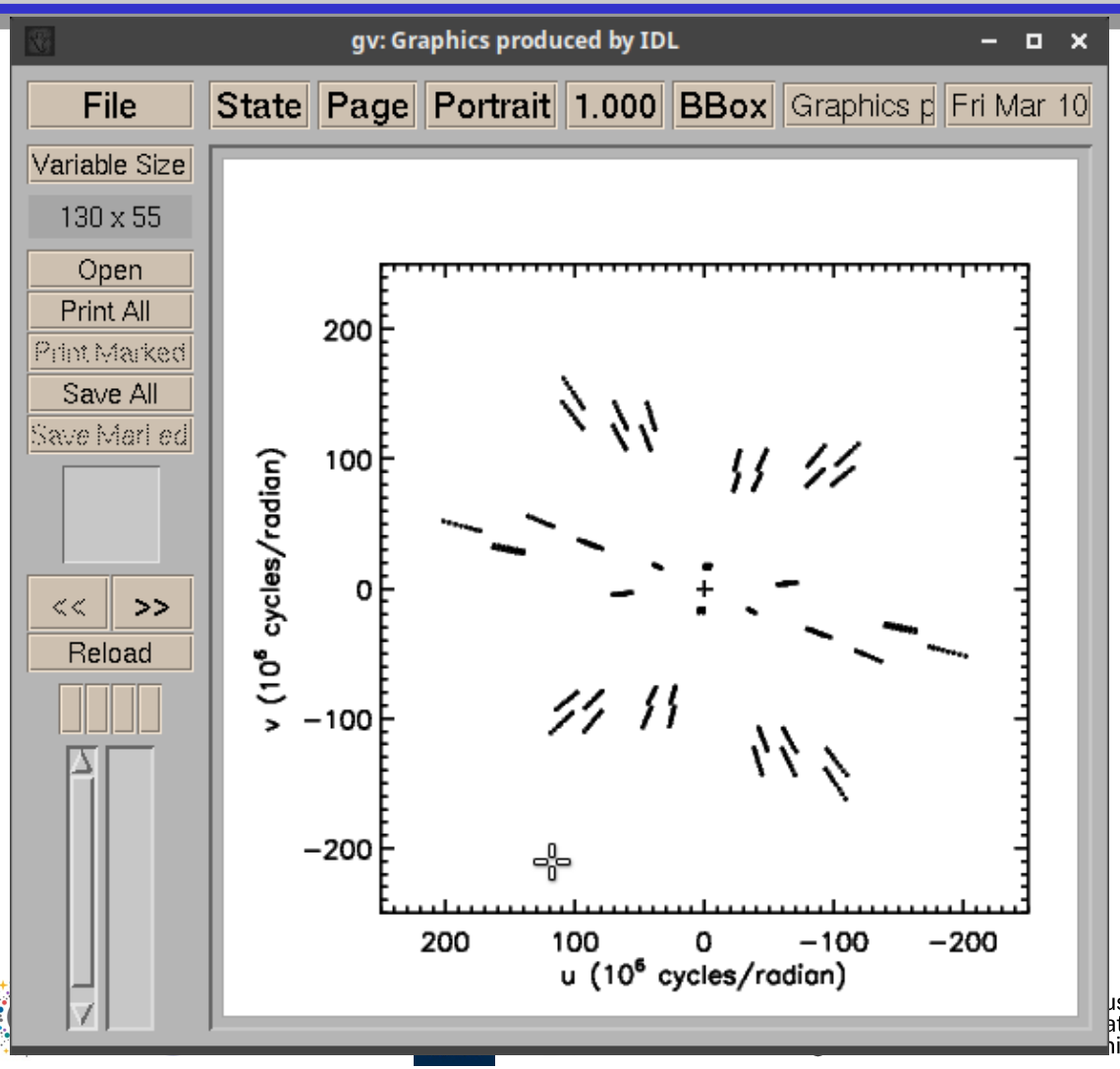
Look at fit to closure phases:

gv 2011Sep29_01_MIRC_sigOri_Schaefer_2016_t3.eps



Look at uv coverage:

gv 2011Sep29_01_MIRC_sigOri_Schaefer_2016_uv_lam.eps



Additional Questions/Tasks

- Why are there two solutions in the chi2 map?
  - Hint: Run a smaller fit centered on each solution.
  - Compare flux ratios for each solution.
- Map out detail of the chi2 map near the solution
  - Set sepRA and sepDEC to the best fit value
  - Click fixed box sepRA and sepDEC to hold values fixed at each step in the grid
  - Use small search range (few times error bars) and small step size