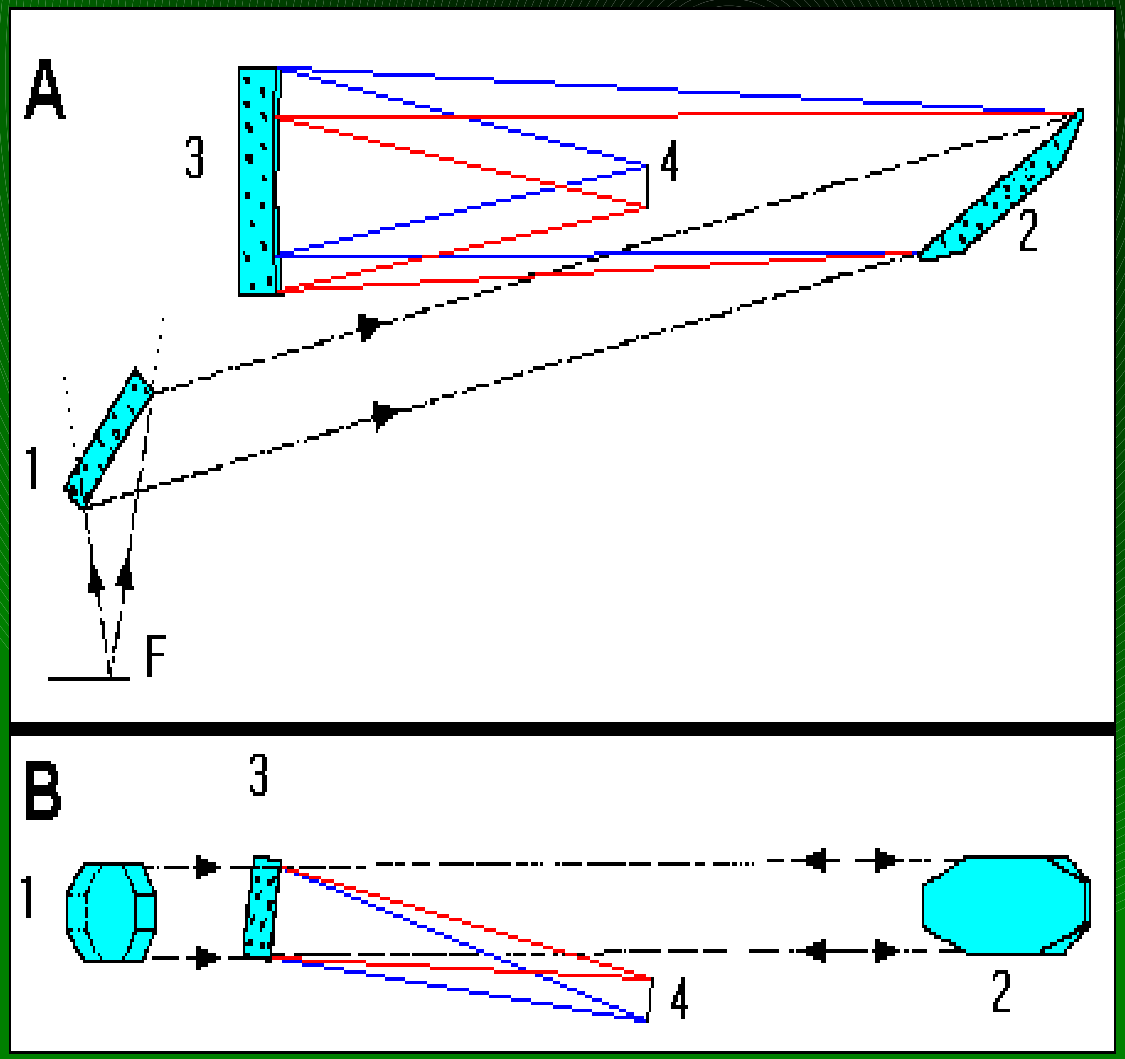
Echelle spektrumok kiredukálása IRAF-ban

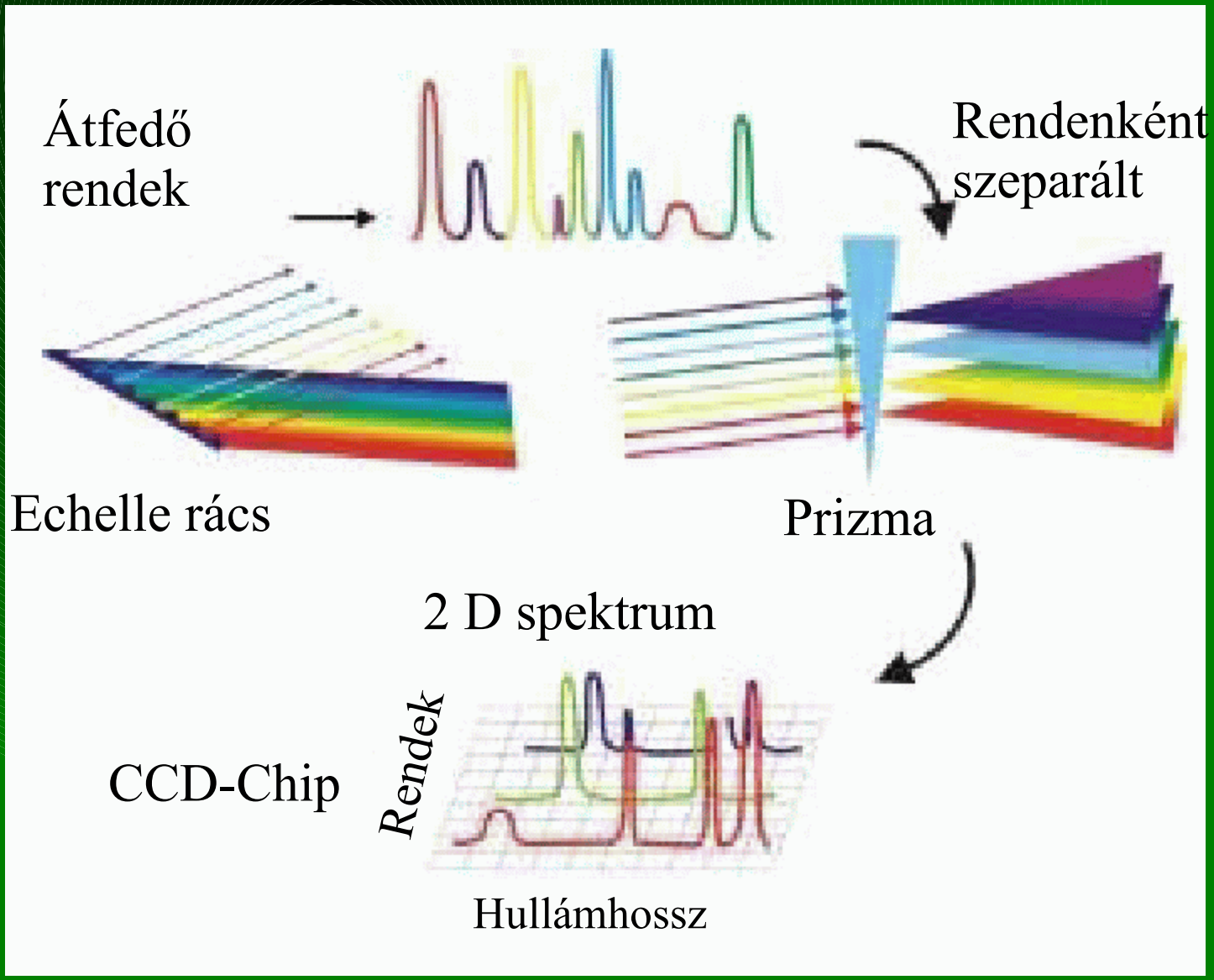
Echelle spektrográf



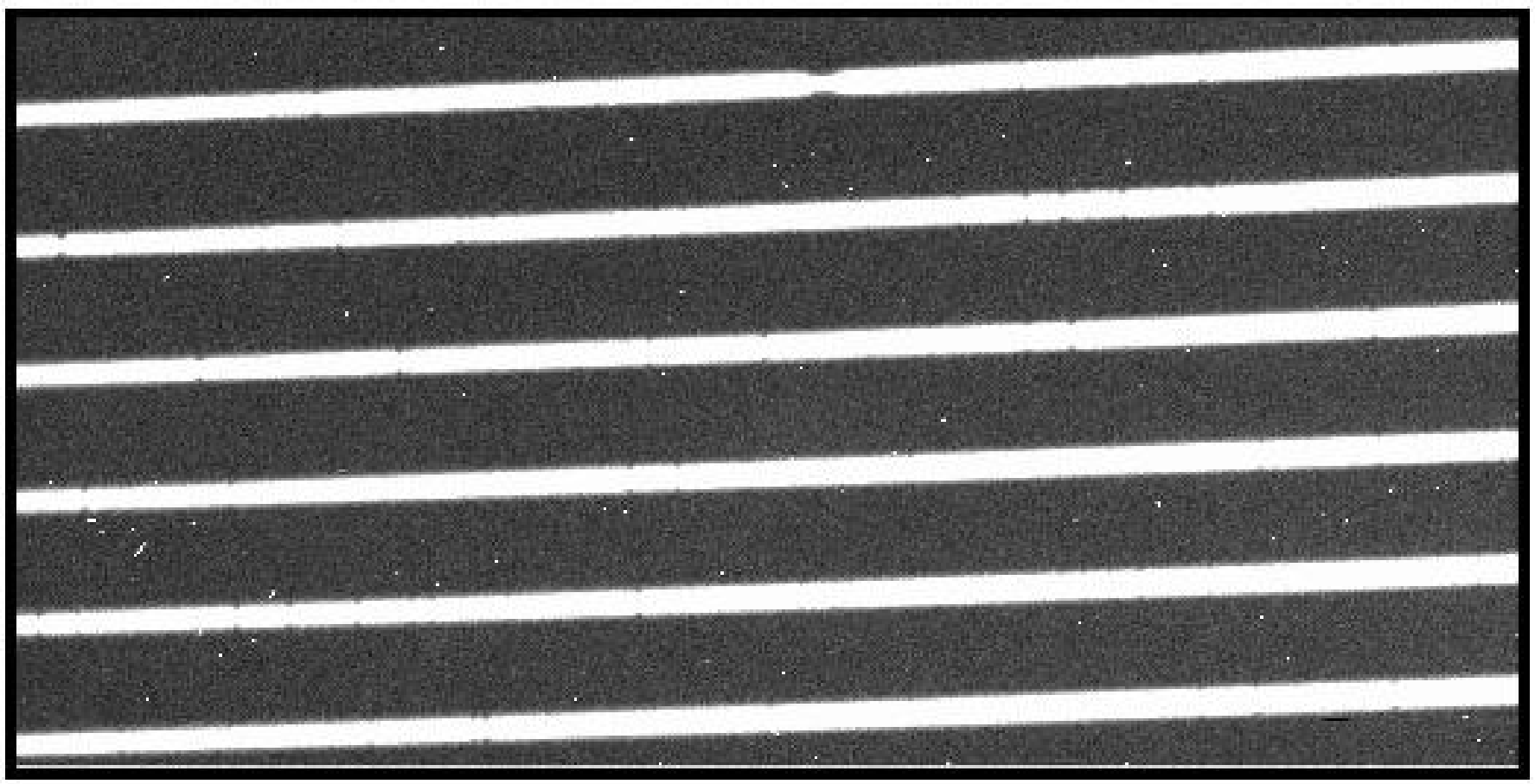
- Kollimátor
- Rács
- Kamera tükör(kereszt-diszperziós elem)
- Detektor (spektrum)

F: A főtükör fókuszába helyezett belépő rés

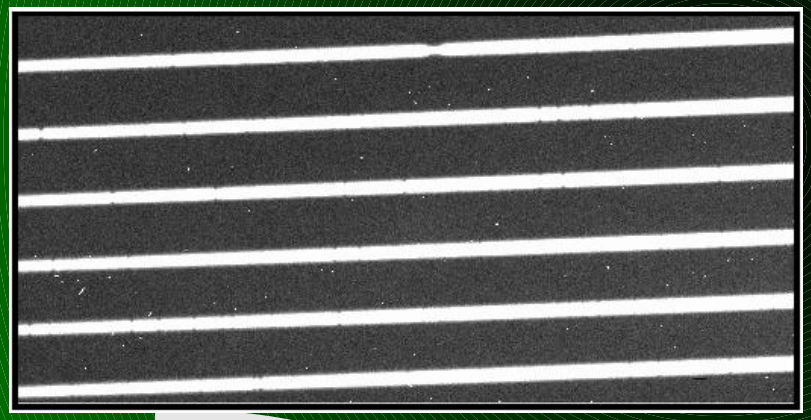
Leképezés


Átfedő
rendek
Rendenként
szeparált
Echelle rács
Prizma
2 D spektrum
CCD-Chip
Rendek
Hullámhossz

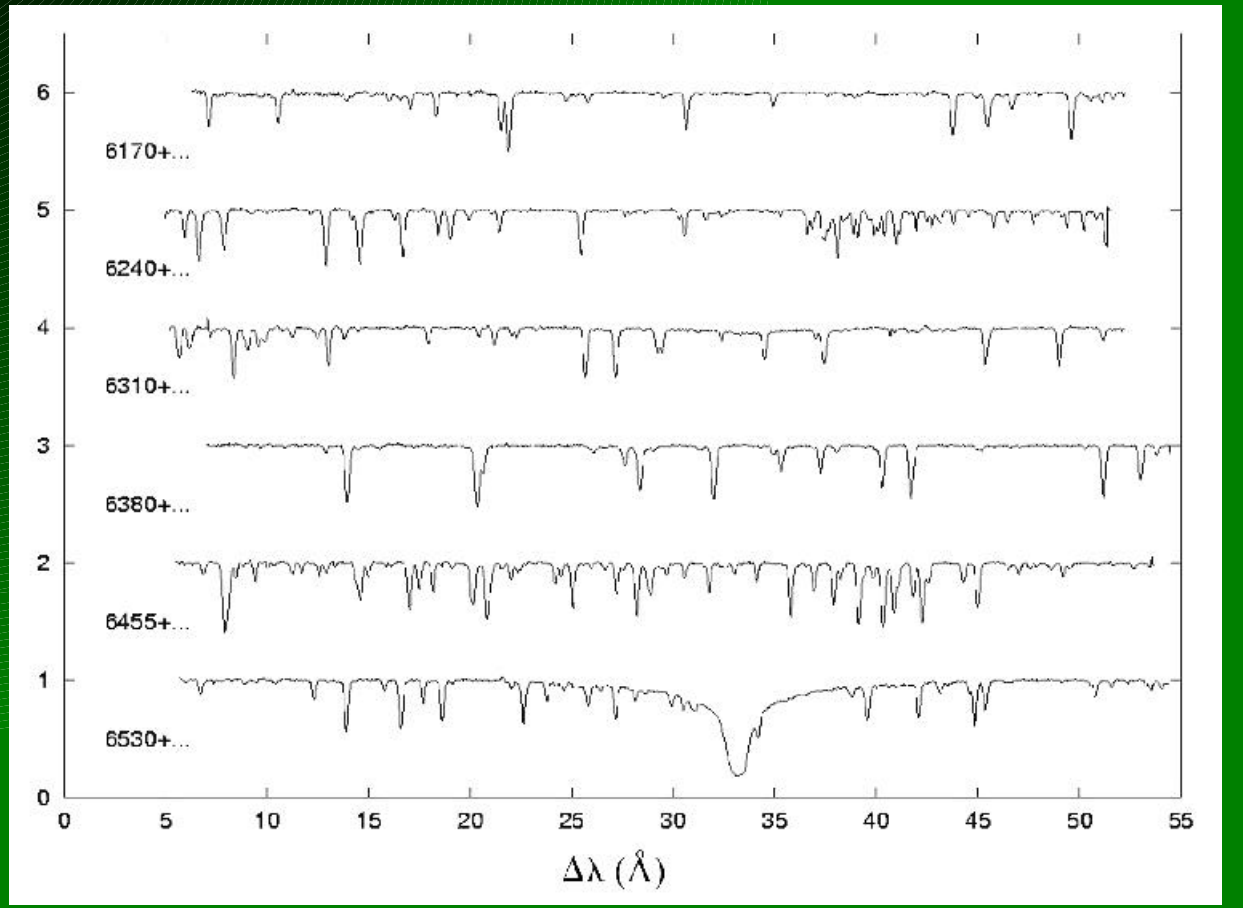
"Nyers" echelle spektrum



Honnan – hova



Redukálatlan kép

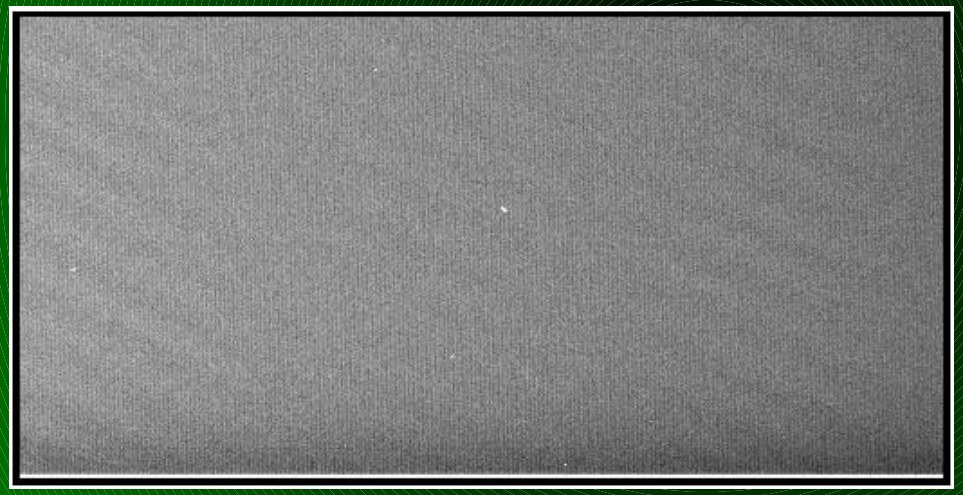


Kontinum normált,
hullámhossz-kalibrált spektrum

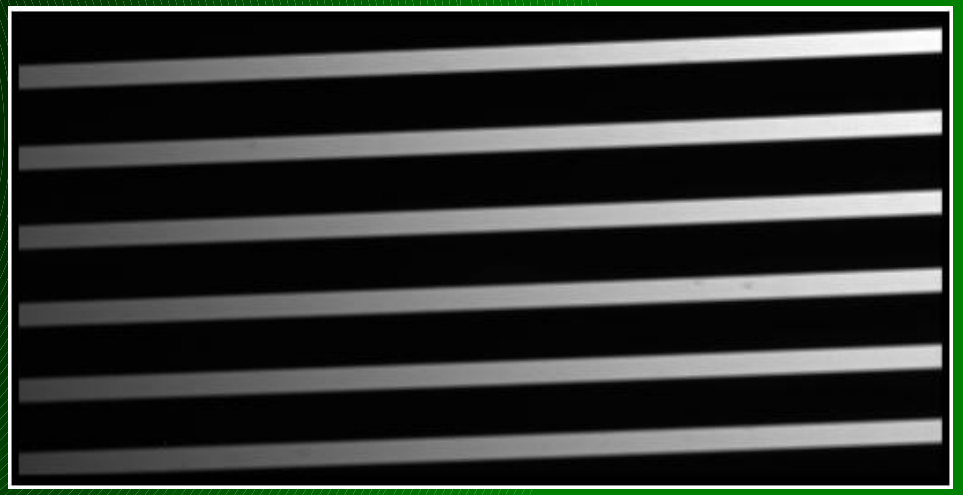
A spektrumok feldolgozása

- Szükséges felvételek:
  - *Objektum spektruma*
  - *Spektrállámpa spektruma* (Hullámhossz kalibráláshoz)
  - *Bias-kép* (0 expozíciós időnél adott pixelhez hány elektron tartozik)
  - *Flatfield-kép* (Az egyes pixelek eltérő érzékenységének figyelembe vételéhez)

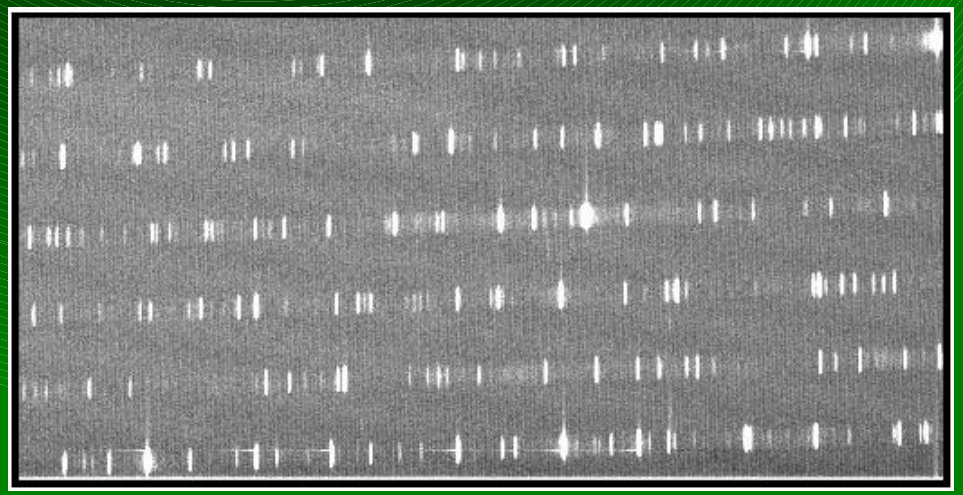
Korrigáló és kalibráló képek



Bias-kép



Flat-kép



Th-Ar spektrállámpa spektruma

Bias korrekció

Átlagolt bias-kép elkészítése:

noao => imred => ccdred => **zerocombine**

```
szkati@triton:~
                                   I R A F
                    Image Reduction and Analysis Facility
PACKAGE = ccdred
   TASK = zerocombine

input   =           @fits.list  List of zero level images to combine
(output =                Zero) Output zero level name
(combine=             average) Type of combine operation
(reject =              minmax) Type of rejection
(ccdtype=                zero) CCD image type to combine
(process=                  no) Process images before combining?
(delete =                  no) Delete input images after combining?
(clobber=                  no) Clobber existing output image?
(scale  =                none) Image scaling
(statsec=                    ) Image section for computing statistics
(nlow   =                   0) minmax: Number of low pixels to reject
(nhigh  =                   1) minmax: Number of high pixels to reject
(nkeep  =                   1) Minimum to keep (pos) or maximum to reject (neg)
(mclip  =                 yes) Use median in sigma clipping algorithms?
(lsigma =                  3.) Lower sigma clipping factor
(hsigma =                  3.) Upper sigma clipping factor
(rdnoise=                  0.) ccdclip: CCD readout noise (electrons)
More
                                                      ESC-? for HELP
```

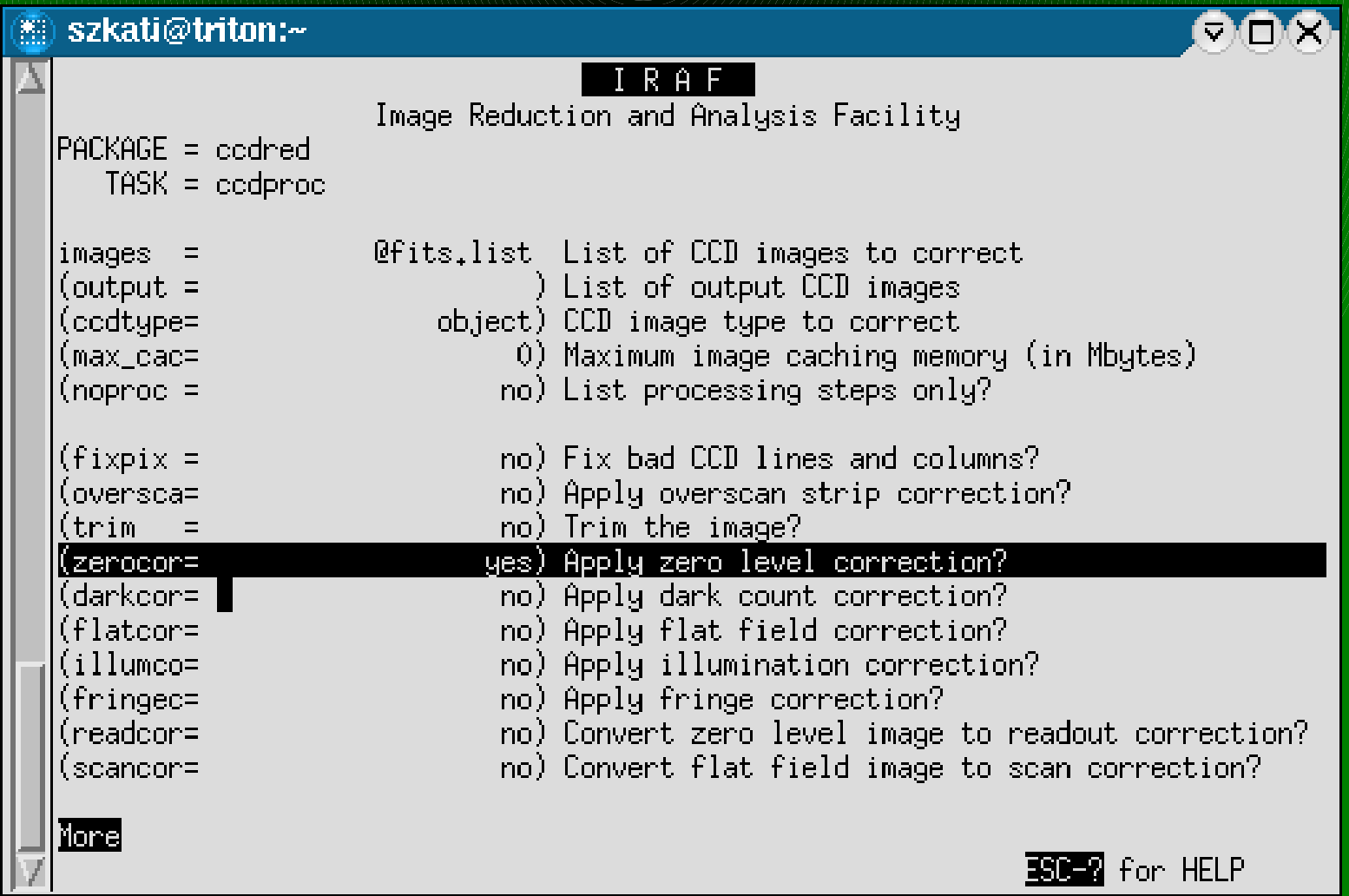
=> bemenő file

=> kimenő file

=> kombináció típusa

Bias korrekció

A képek bias korrekciója:
noao => imred => ccdred => ccdproc



Minden nemre (no) van állítva, kivéve: zerocor

Bias korrekció

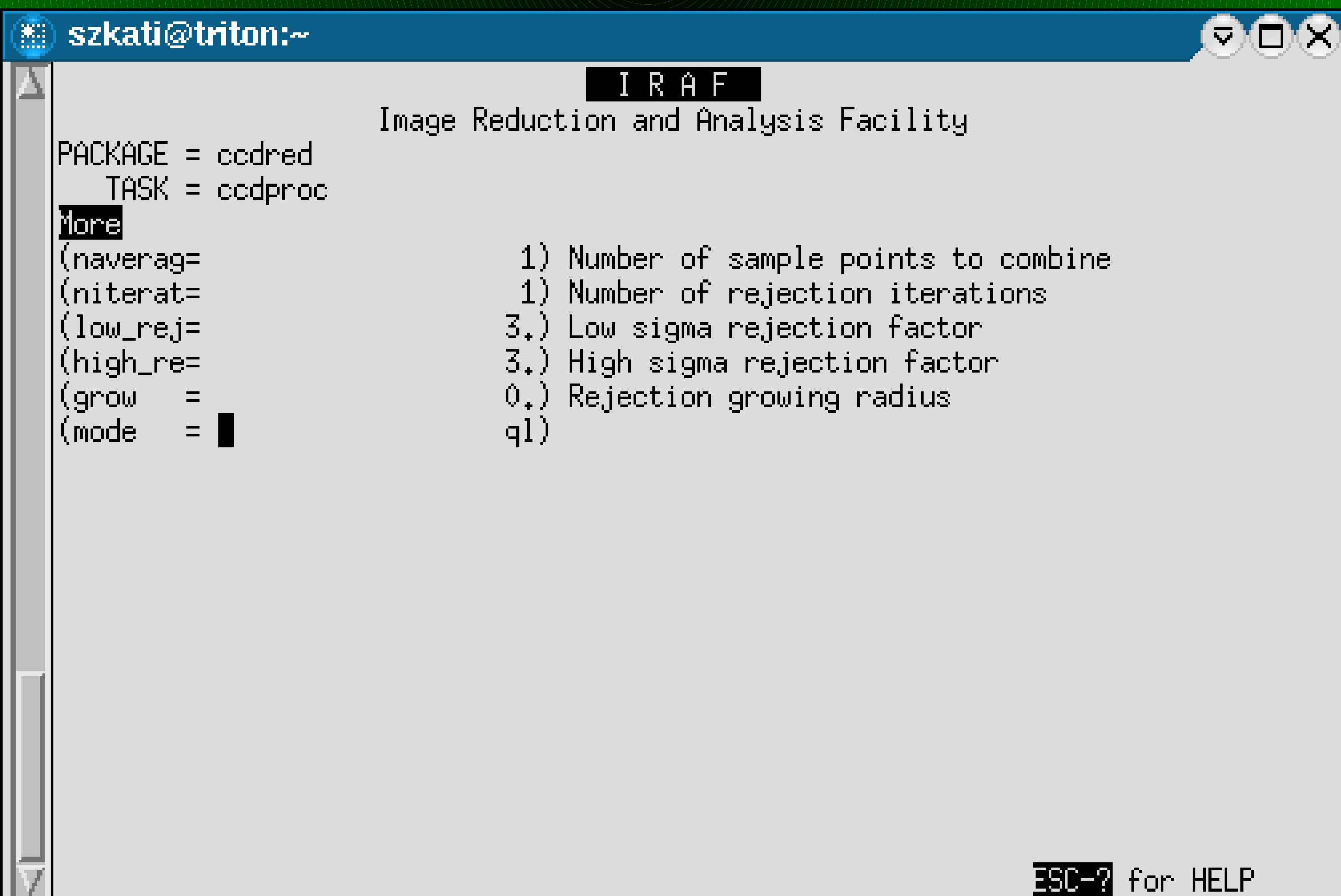
A képek bias korrekciója:
noao => imred => ccdred => ccdproc

```
szkati@triton:~
                                    I R A F
                     Image Reduction and Analysis Facility
PACKAGE = ccdred
   TASK = ccdproc
More
(readaxi=                 column) Read out axis (column|line)
(fixfile=                       ) File describing the bad lines and columns
(biassec=                       ) Overscan strip image section
(trimsec=                       ) Trim data section
(zero   =                   Zero) Zero level calibration image
(dark   =                       ) Dark count calibration image
(flat   =                       ) Flat field images
(illum  =                       ) Illumination correction images
(fringe =                       ) Fringe correction images
(minrepl=                     1.) Minimum flat field value
(scantyp=              shortscan) Scan type (shortscan|longscan)
(nscan  =                      1) Number of short scan lines

(interac=                     no) Fit overscan interactively?
(functio=               legendre) Fitting function
(order  =                      1) Number of polynomial terms or spline pieces
(sample =                      *) Sample points to fit
More
                                                            ESC-? for HELP
```

Bias korrekció

A képek bias korrekciója:

noao => imred => ccdred => ccdproc



Bias korrekció

A képek bias korrekciója:
noao => imred => ccdred => ccdproc

szkati@triton:~

```
                    I R A F
        Image Reduction and Analysis Facility
PACKAGE = ccdred
   TASK = ccdproc

images  =           @fits.list  List of CCD images to correct
(output =                    ) List of output CCD images
(ccdtype=                flat) CCD image type to correct
(max_cac=                   0) Maximum image caching memory (in Mbytes)
(noproc =                  no) List processing steps only?

(fixpix =                  no) Fix bad CCD lines and columns?
(oversca=                  no) Apply overscan strip correction?
(trim   =                  no) Trim the image?
(zerocor=                 yes) Apply zero level correction?
(darkcor=                  no) Apply dark count correction?
(flatcor=                  no) Apply flat field correction?
(illumco=                  no) Apply illumination correction?
(fringec=                  no) Apply fringe correction?
(readcor=                  no) Convert zero level image to readout correction?
(scancor=                  no) Convert flat field image to scan correction?

More
                                                    ESC-? for HELP
```

Kozmikus sugár korrekció

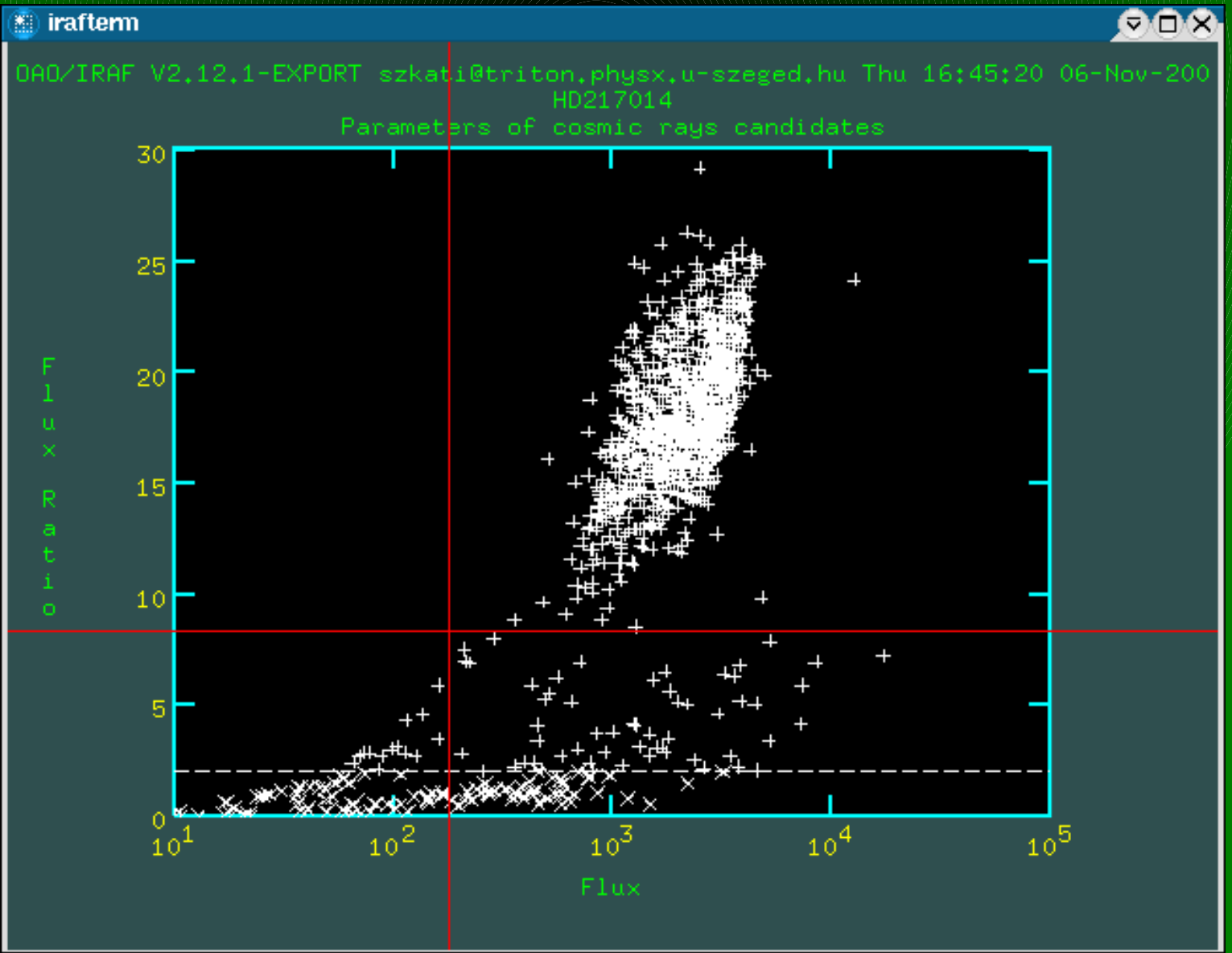
A kozmikus sugár korrekciója:
noao => imred => crutil => cosmicrays

szkati@triton:~

```
                                IRAF
                  Image Reduction and Analysis Facility
PACKAGE = crutil
   TASK = cosmicrays

input   =                51Peg  List of images in which to detect cosmic rays
output  =            51Peg_korr  List of cosmic ray replaced output images (optio
(crmasks=                       ) List of bad pixel masks (optional)

(thresho=                   25.) Detection threshold above mean
(fluxrat=                    2.) Flux ratio threshold (in percent)
(npasses=                    5) Number of detection passes
(window =                    5) Size of detection window

(interac=                  yes) Examine parameters interactively?
(train  =                   no) Use training objects?
(objects=                      ) Cursor list of training objects
(savefil=                      ) File to save train objects
(plotfil=                      ) Plot file
(graphic=              stdgraph) Interactive graphics output device
(cursor =                      ) Graphics cursor input
answer  =                  yes  Review parameters for a particular image?
More
                                                        ESC-? for HELP
```

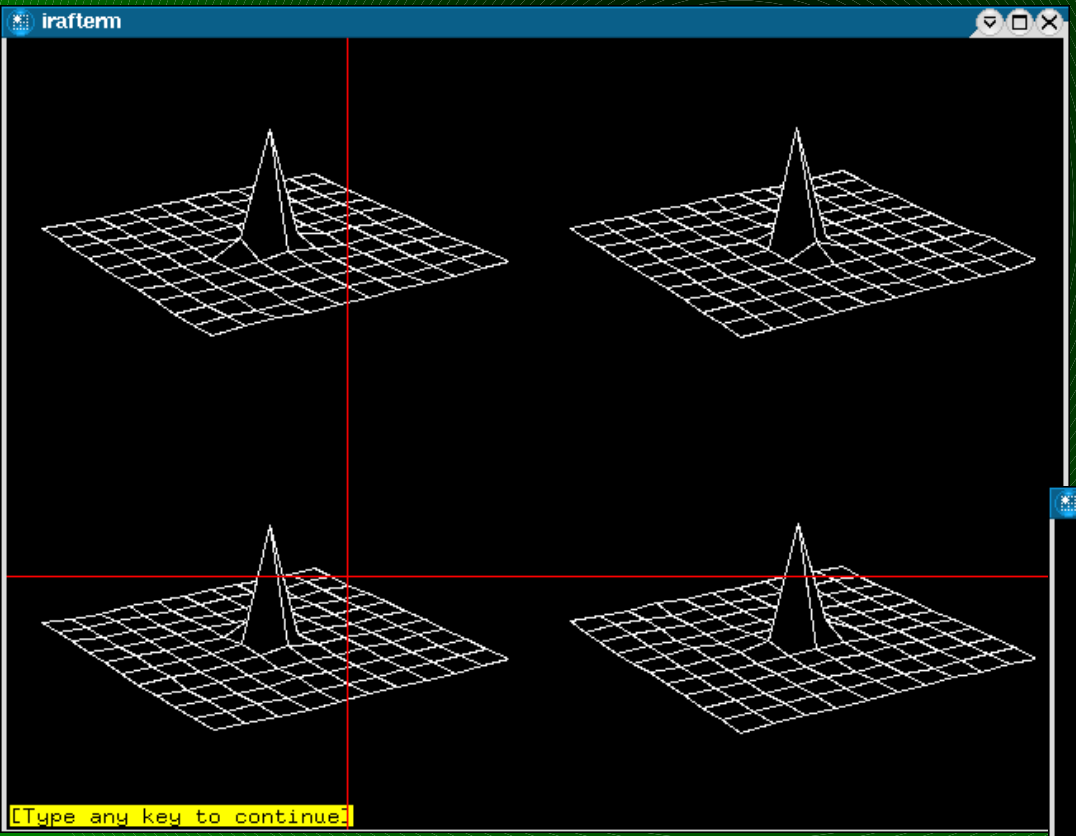
Kozmikus sugár korrekció

noao => imred => crutil => cosmicrays

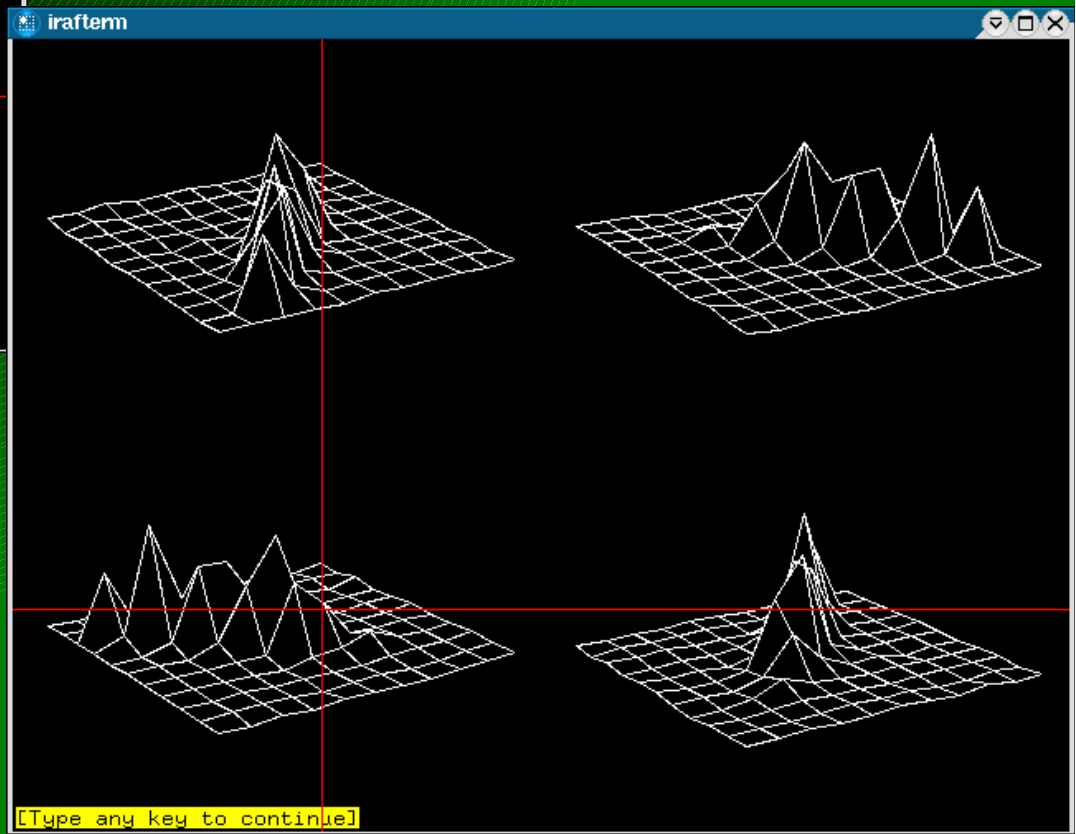


t: szint megemelése
d: pont törlése
s: profil megnézése

Kozmikus sugár korrekció

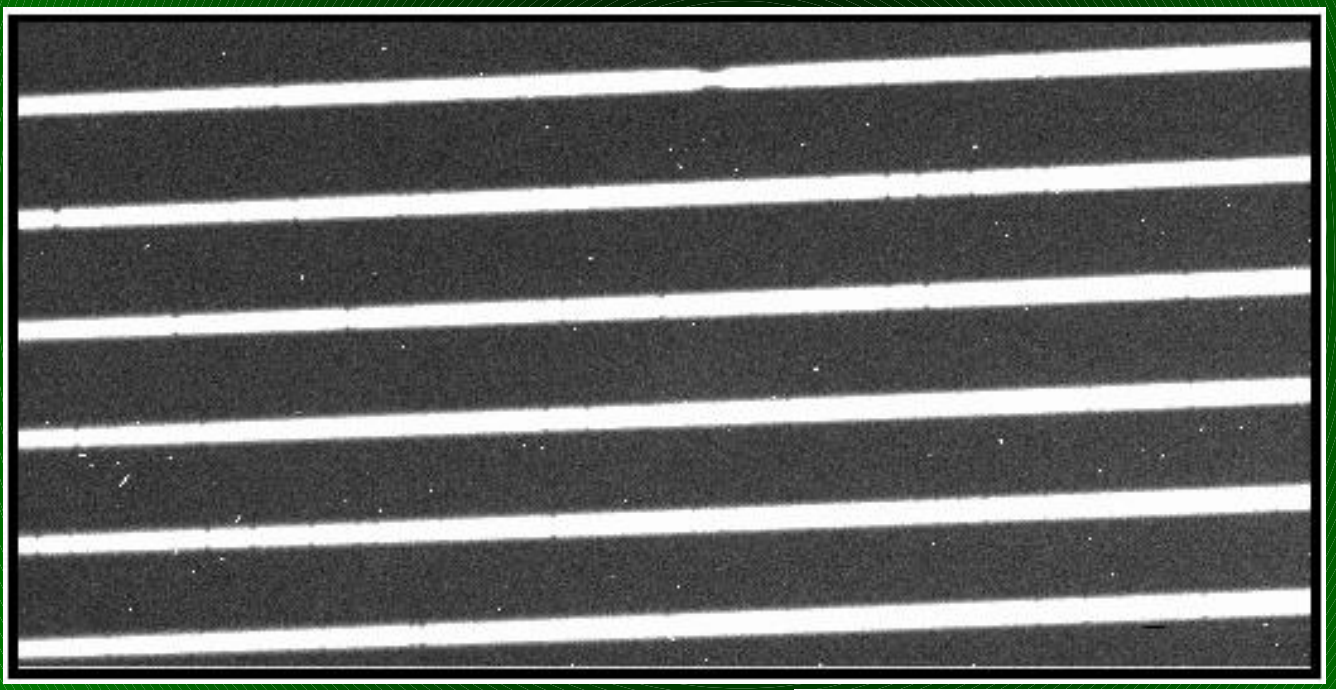


Kozmikus sugár

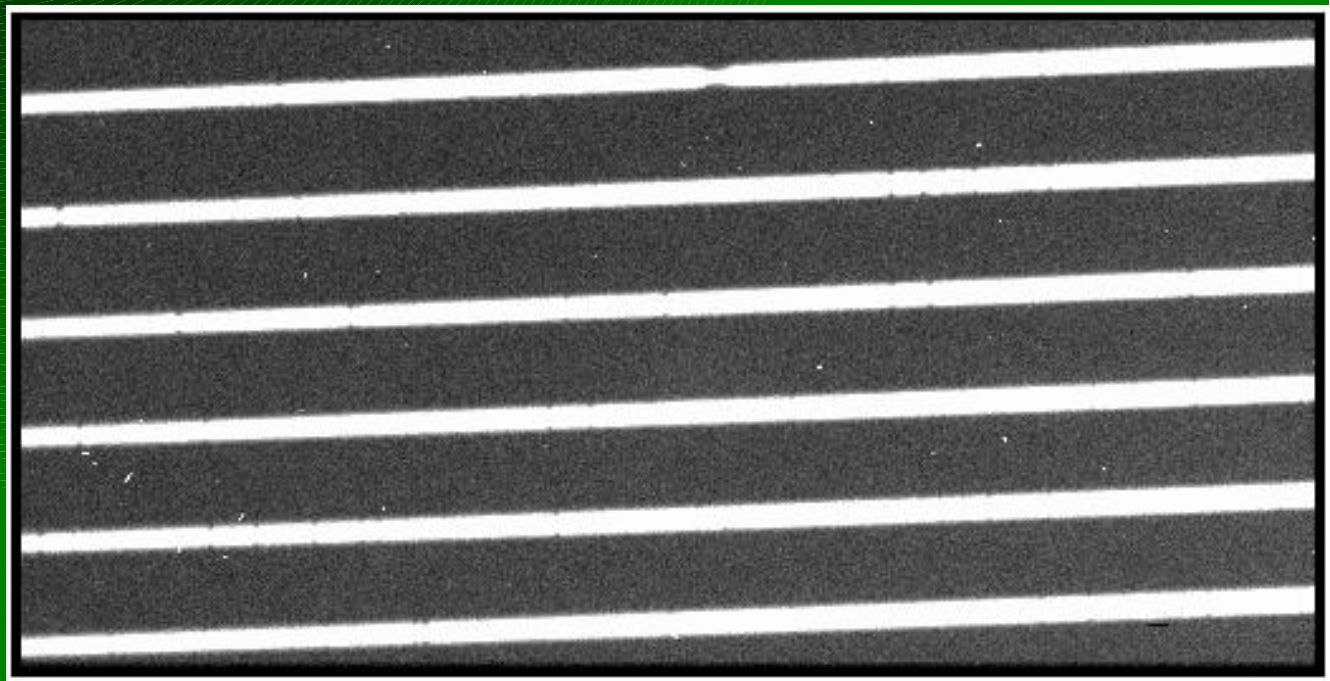


Oldalról beeső kozmikus sugár

Kozmikus sugár korrekció



"Nyers" kép



Korrigált kép

Flatfield-kép

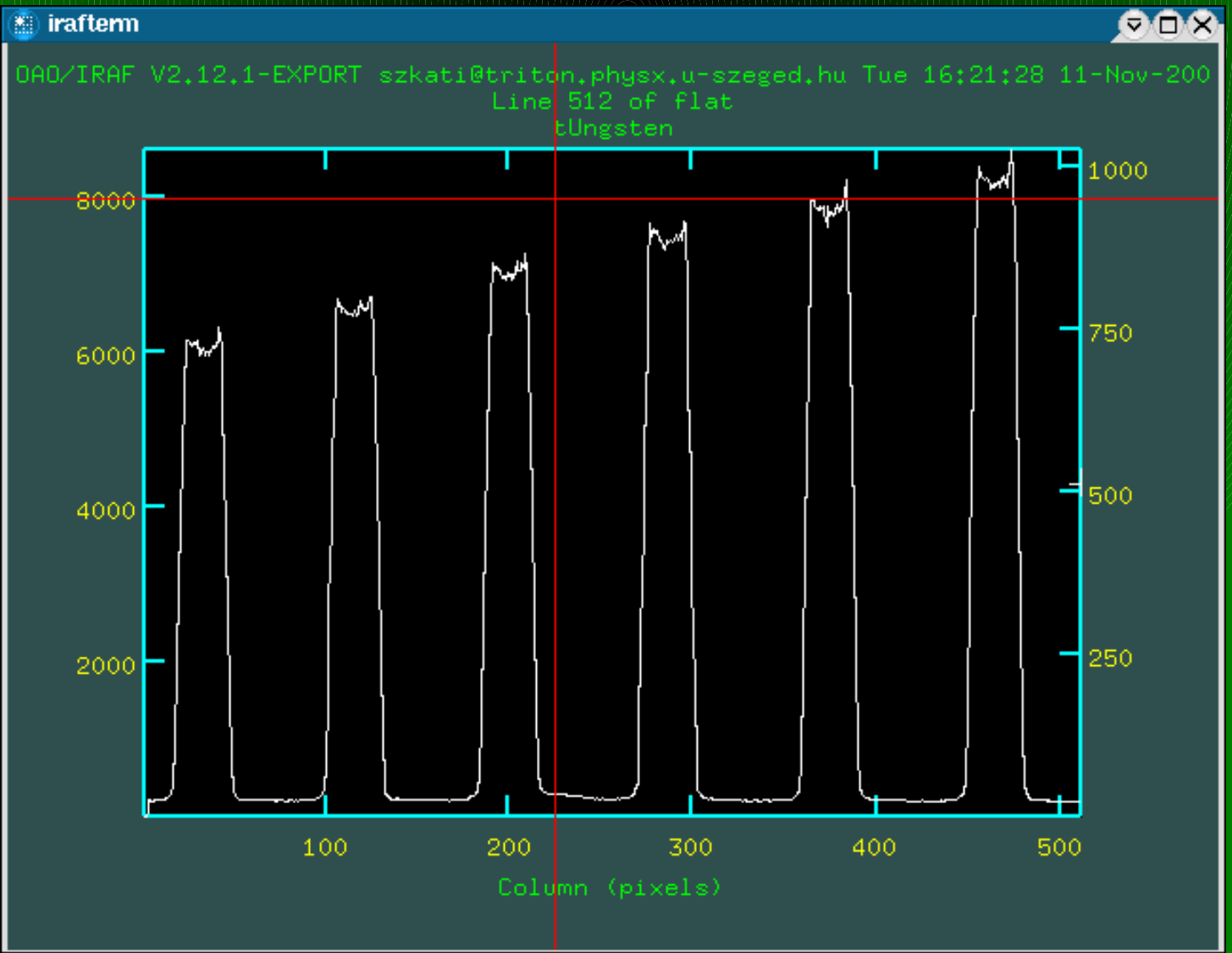
- Átlagolt flat kép elkészítése:
noao => imred => ccdred => flatcombine

szkati@triton:~

```
                                  IRAF
                    Image Reduction and Analysis Facility
PACKAGE = ccdred
   TASK = flatcombine

input   = ▉          @fits.list  List of flat field images to combine
(output =                 flat) Output flat field root name
(combine=               median) Type of combine operation
(reject =              ccdclip) Type of rejection
(ccdtype=                 flat) CCD image type to combine
(process=                   no) Process images before combining?
(subsets=                   no) Combine images by subset parameter?
(delete =                   no) Delete input images after combining?
(clobber=                   no) Clobber existing output image?
(scale  =                 mean) Image scaling
(statsec=                     ) Image section for computing statistics
(nlow   =                    1) minmax: Number of low pixels to reject
(nhigh  =                    1) minmax: Number of high pixels to reject
(nkeep  =                    1) Minimum to keep (pos) or maximum to reject (neg)
(mclip  =                  yes) Use median in sigma clipping algorithms?
(lsigma =                   3.) Lower sigma clipping factor
(hsigma =                   3.) Upper sigma clipping factor
More
                                                  ESC-? for HELP
```

Flatfield-kép

Implot flat:



Apetúra szélessége:
apedit.width=<érték>
Apertúrák szeparációja:
apfind.minsep=<érték>

apresize.ylevel=0.5
apresize.bkg=no

Flatfield-kép

noao => imred => echelle => apflatten

szkati@triton:~

```
                                  IRAF
                  Image Reduction and Analysis Facility
PACKAGE = echelle
   TASK = apflatten

input   = ▉                flat  List of images to flatten
output  =                  Flat  List of output flatten images
(apertur=                      ) Apertures
(referen=                      ) List of reference images

(interac=                   yes) Run task interactively?
(find   =                   yes) Find apertures?
(recente=                   yes) Recenter apertures?
(resize =                   yes) Resize apertures?
(edit   =                   yes) Edit apertures?
(trace  =                   yes) Trace apertures?
(fittrac=                   yes) Fit traced points interactively?
(flatten=                   yes) Flatten spectra?
(fitspec=                   yes) Fit normalization spectra interactively?

(line   =                 INDEF) Dispersion line
(nsum   =                    10) Number of dispersion lines to sum or median
More
                                                    ESC-? for HELP
```

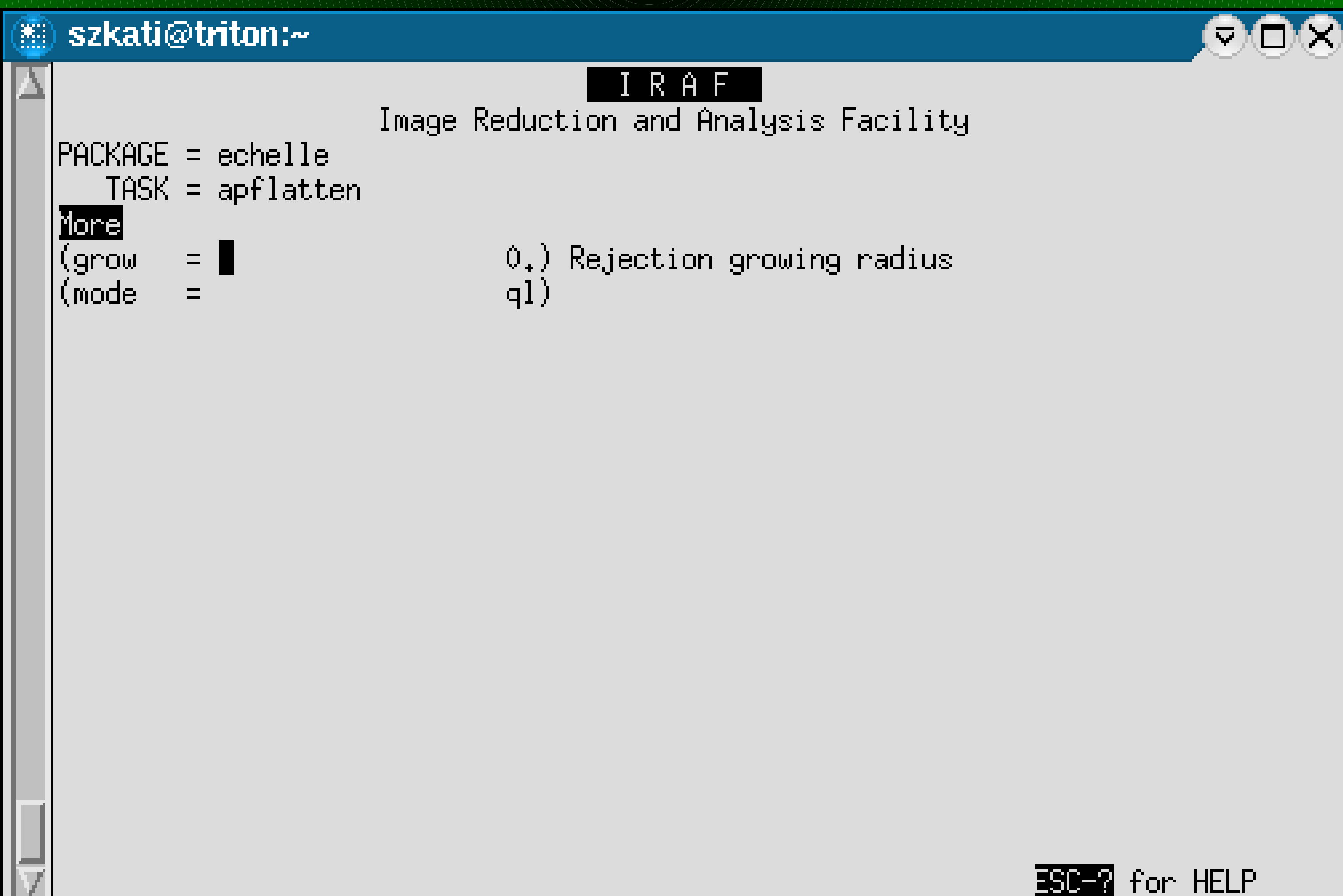
Flatfield-kép

noao => imred => echelle => apflatten

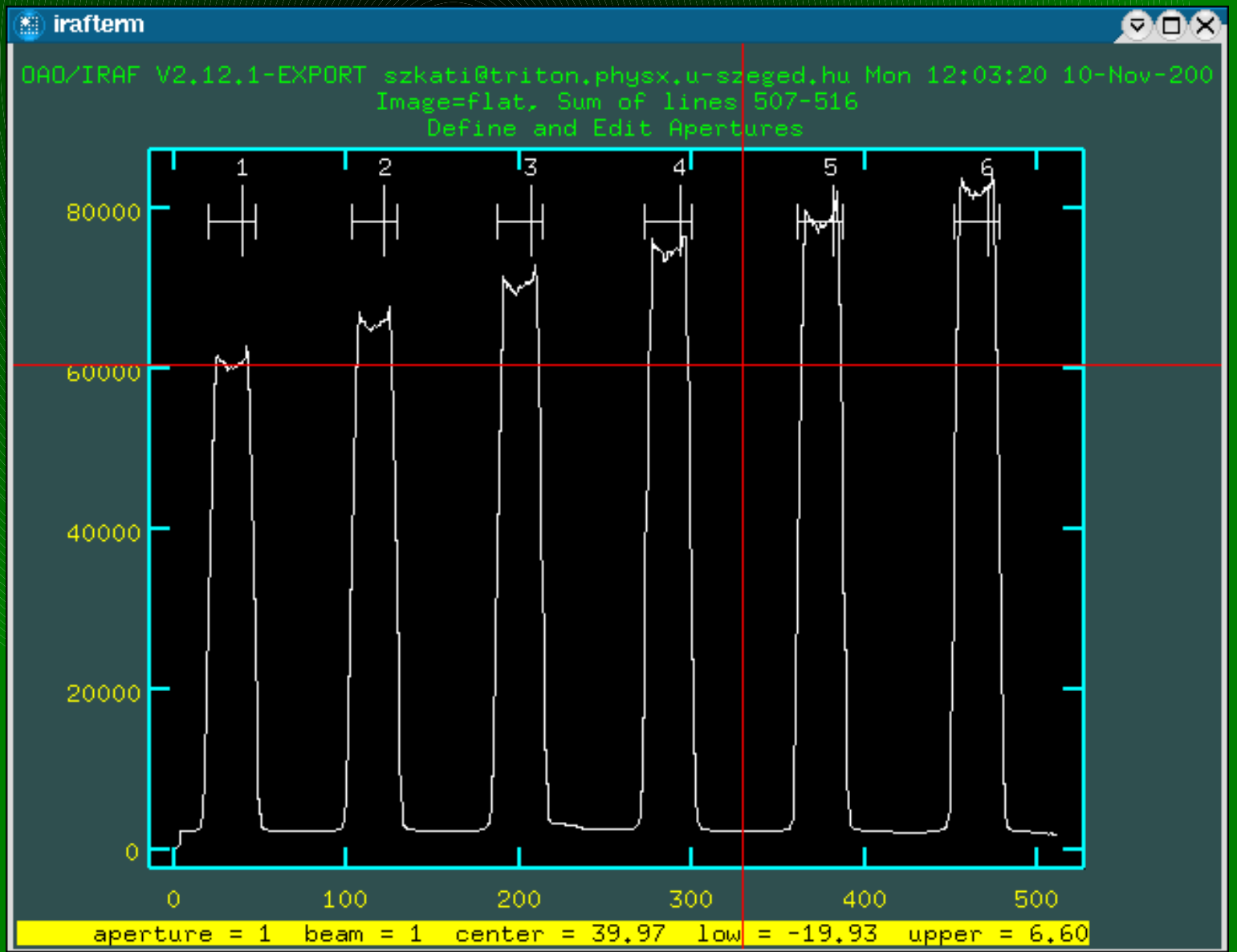
```
szkati@triton:~
                                    I R A F
                    Image Reduction and Analysis Facility
PACKAGE = echelle
   TASK = apflatten
More
(thresho=                     10.) Threshold for flattening spectra

(pfit   =                  fit1d) Profile fitting type (fit1d|fit2d)
(clean  =                     no) Detect and replace bad pixels?
(saturat=                  INDEF) Saturation level
(readnoi=                     0.) Read out noise sigma (photons)
(gain   =                     1.) Photon gain (photons/data number)
(lsigma =                     4.) Lower rejection threshold
(usigma =                     4.) Upper rejection threshold

(functio=               legendre) Fitting function for normalization spectra
(order  =                      5) Fitting function order
(sample =                      *) Sample regions
(naverag=                      1) Average or median
(niterat=                     10) Number of rejection iterations
(low_rej=                     3.) Lower rejection sigma
(high_re=                     3.) High upper rejection sigma
More
                                                             ESC-? for HELP
```

Flatfield-kép

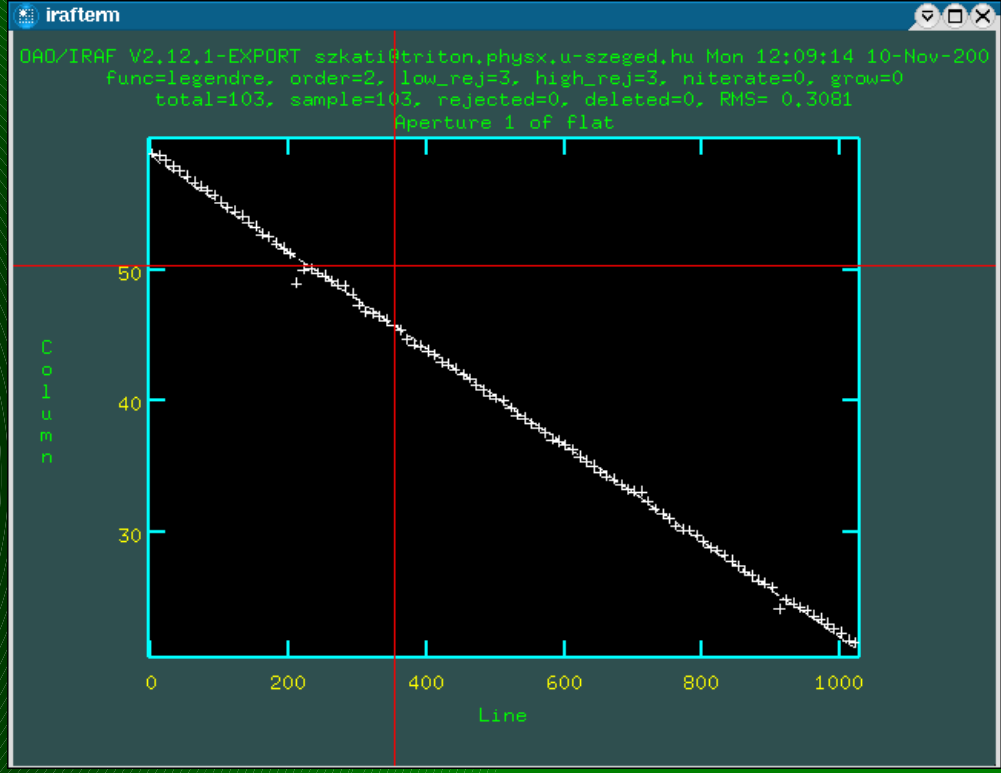
noao => imred => echelle =>
apflatten

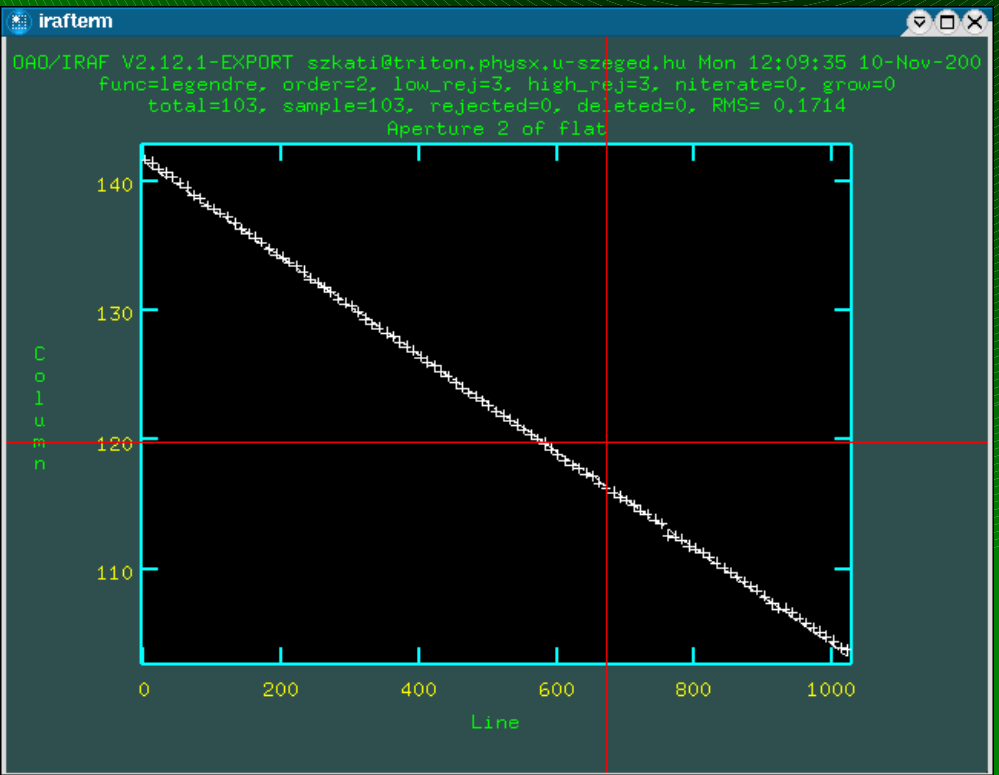


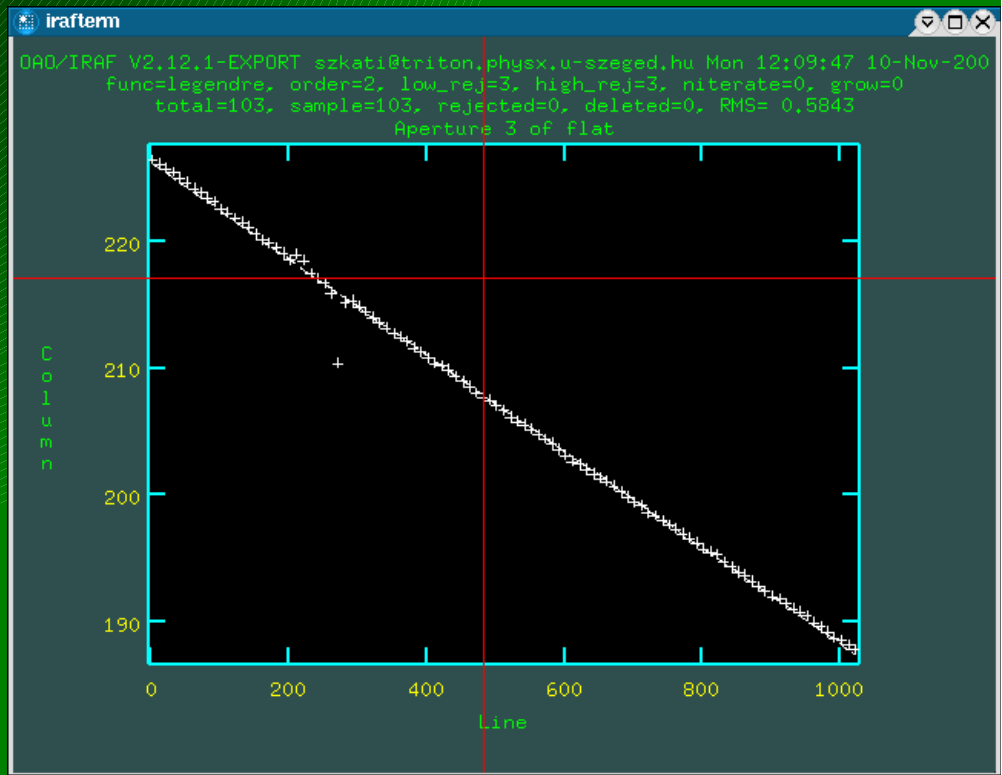
Flatfield-kép => apertúrák



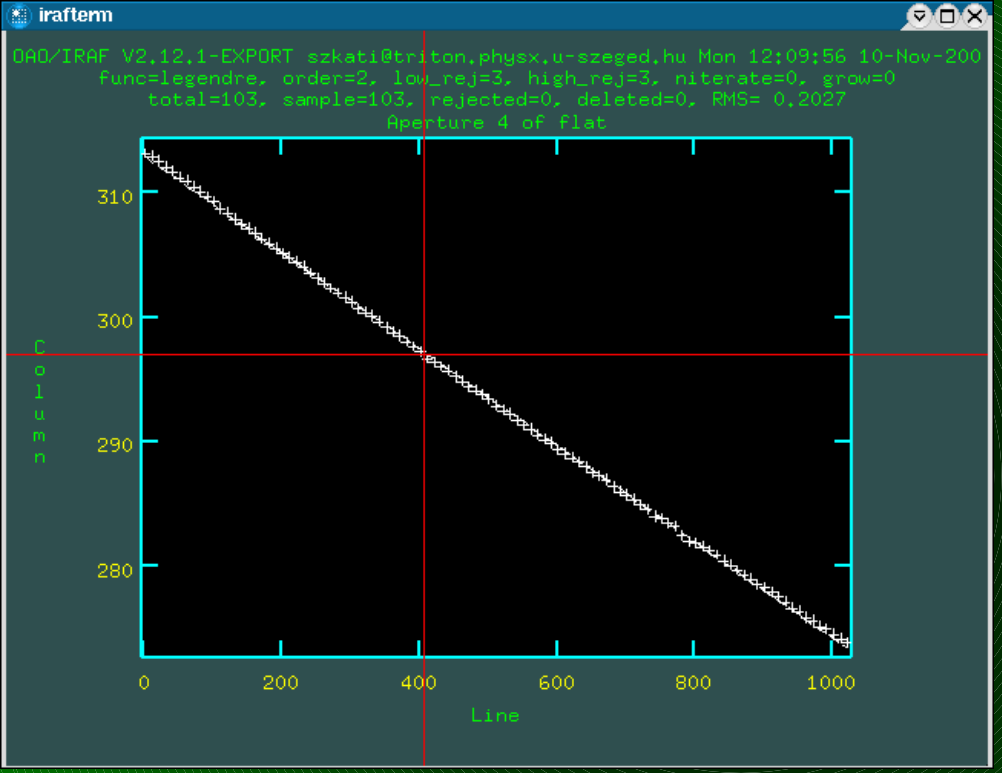
Apertúrák követése

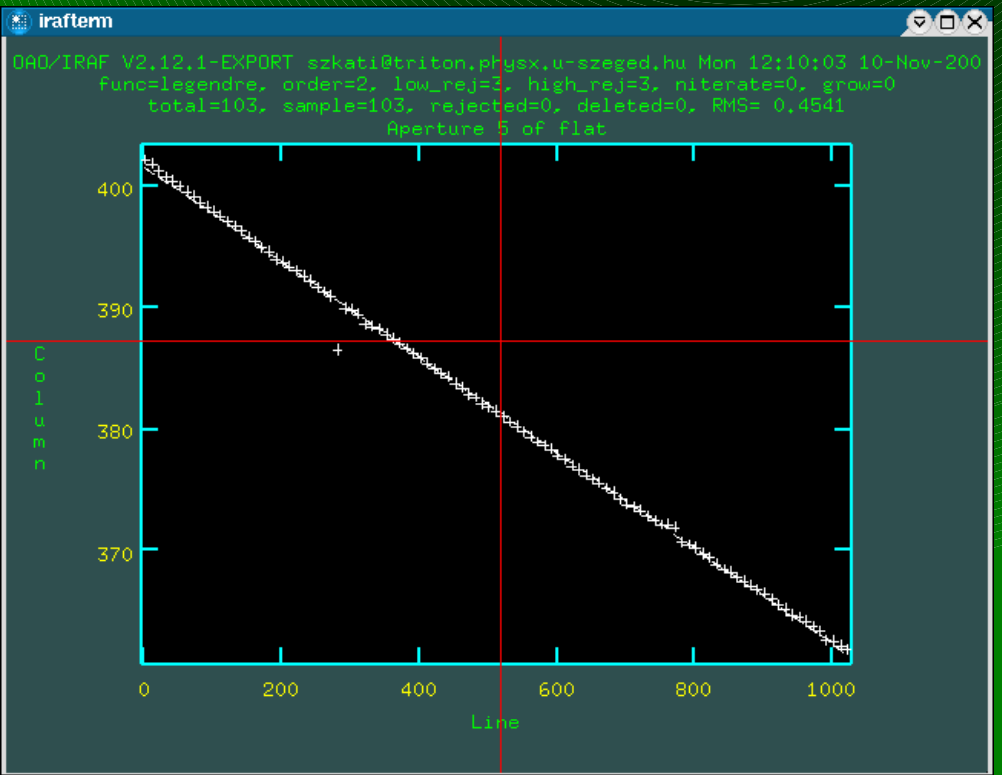


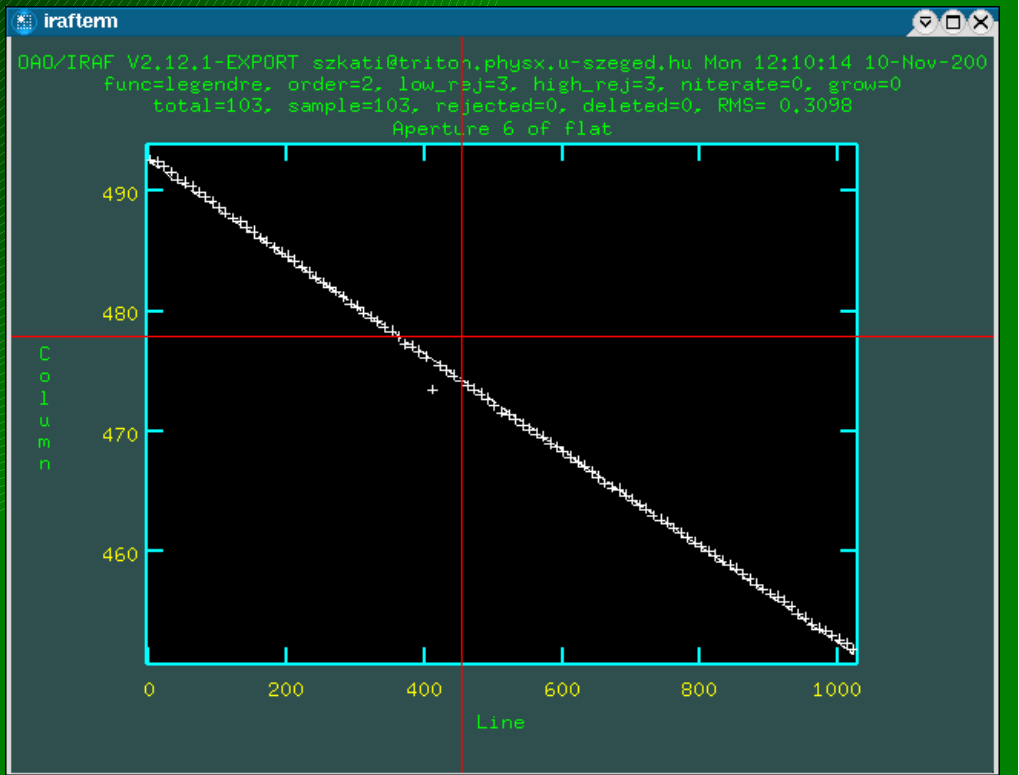




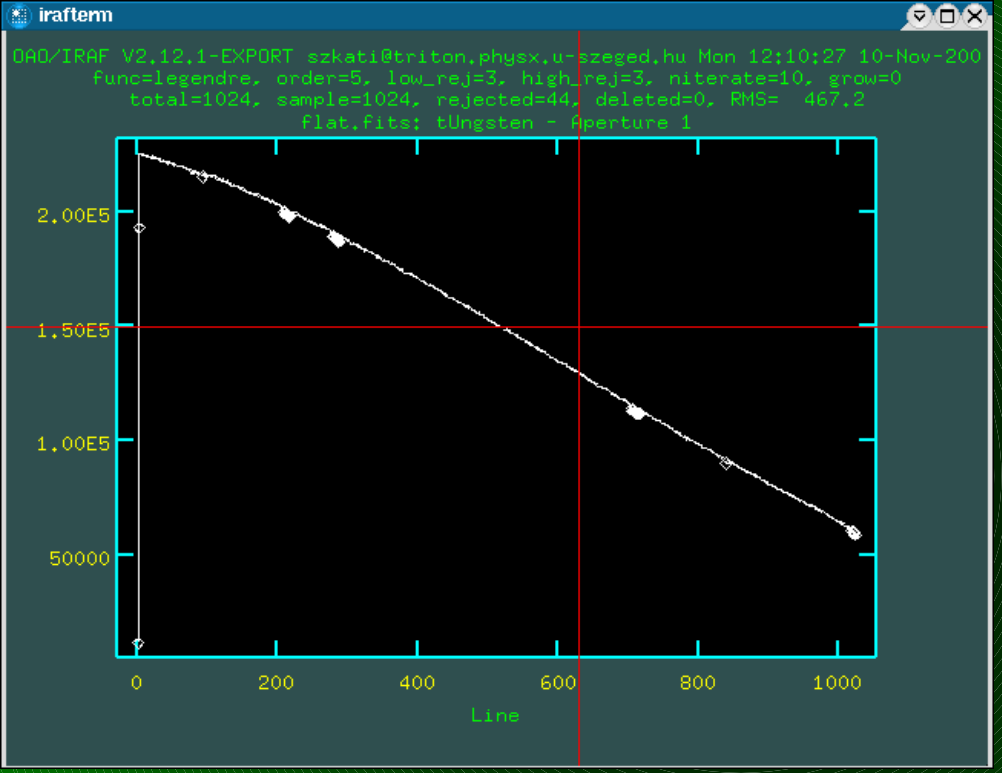
Apertúrák követése

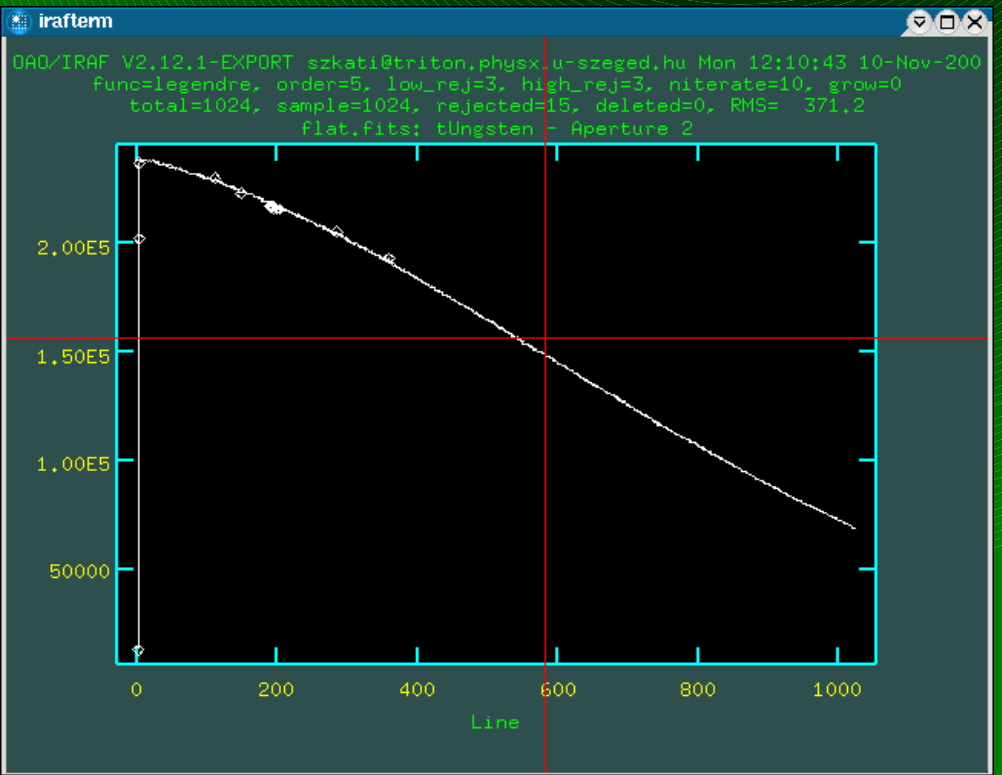


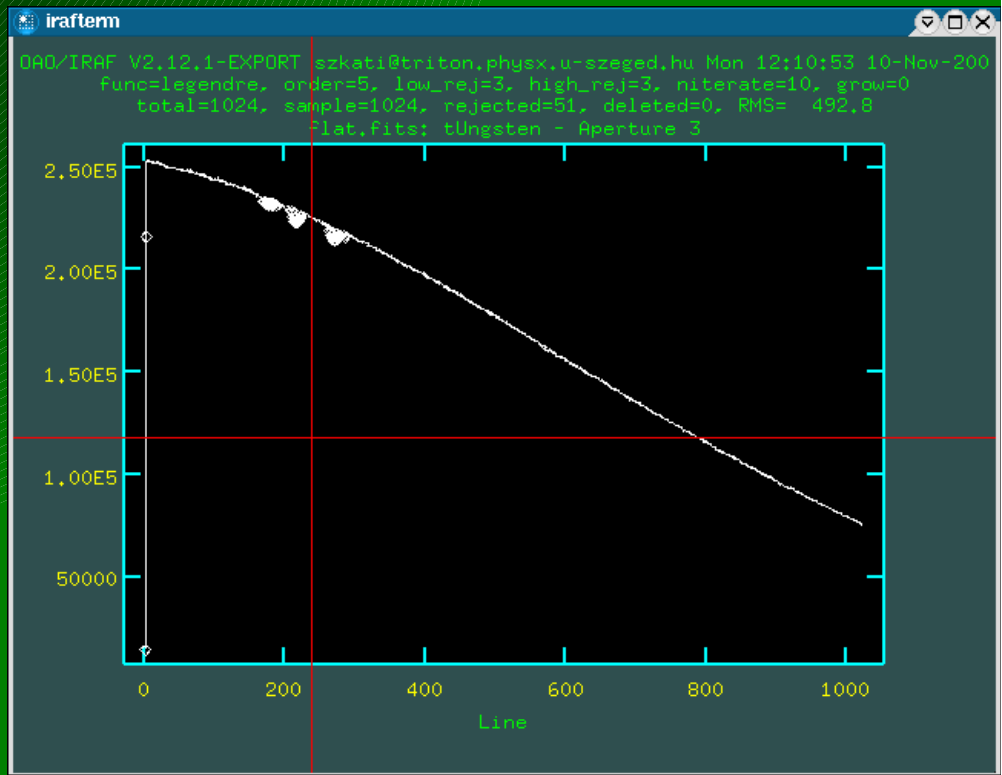




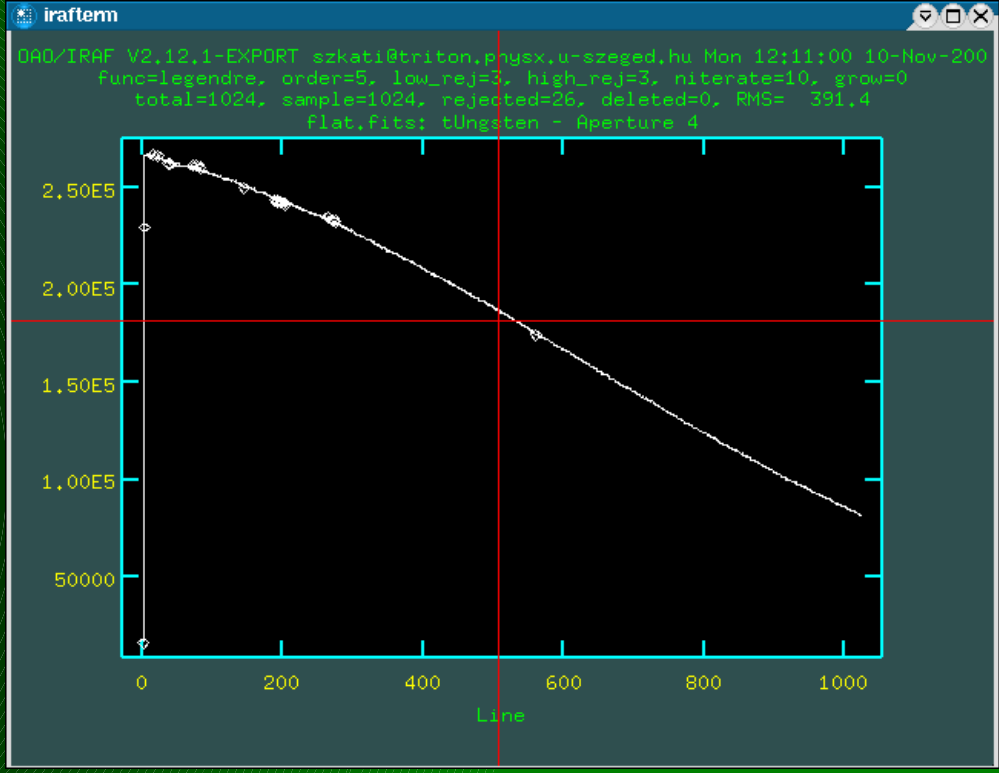
Apertúrák illesztése

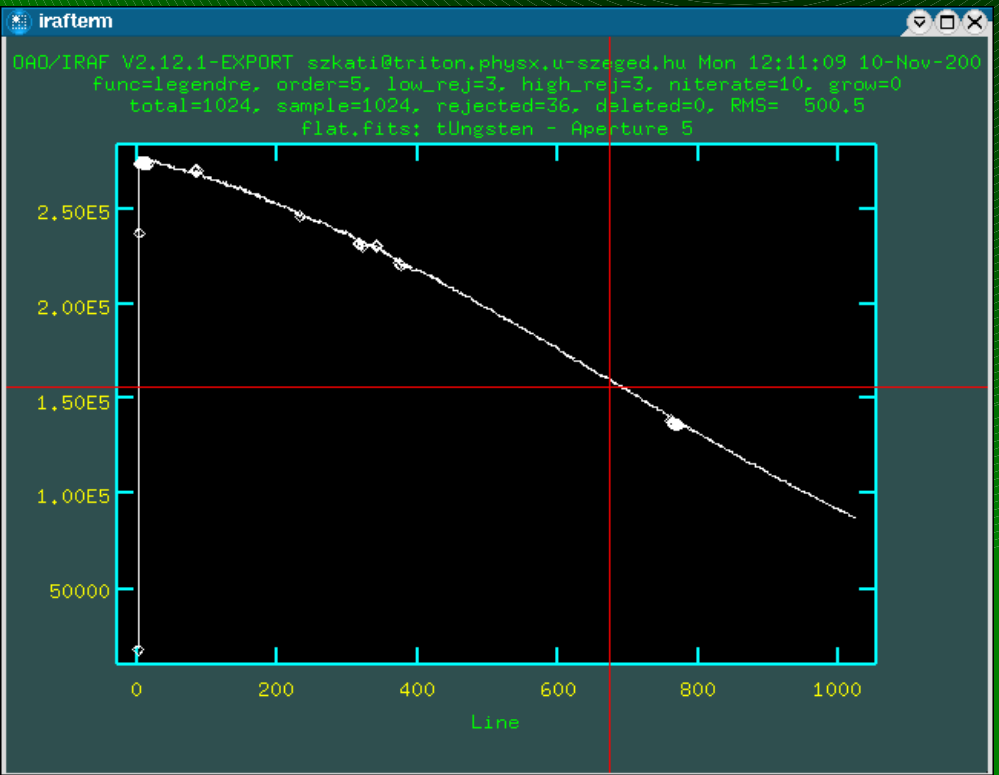


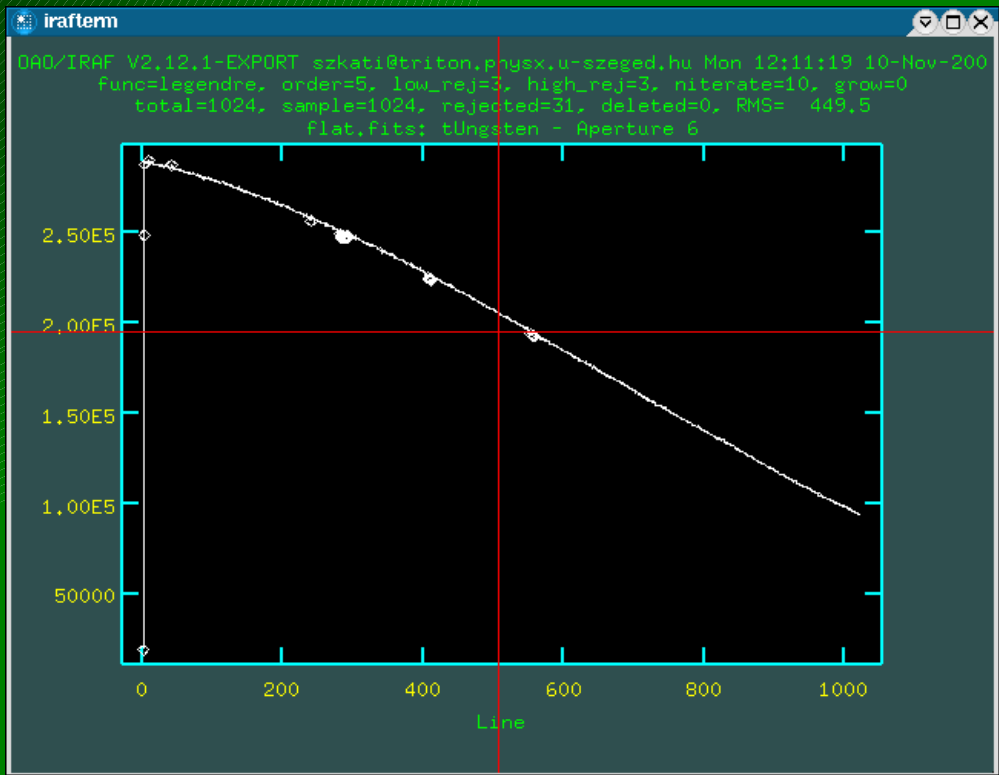




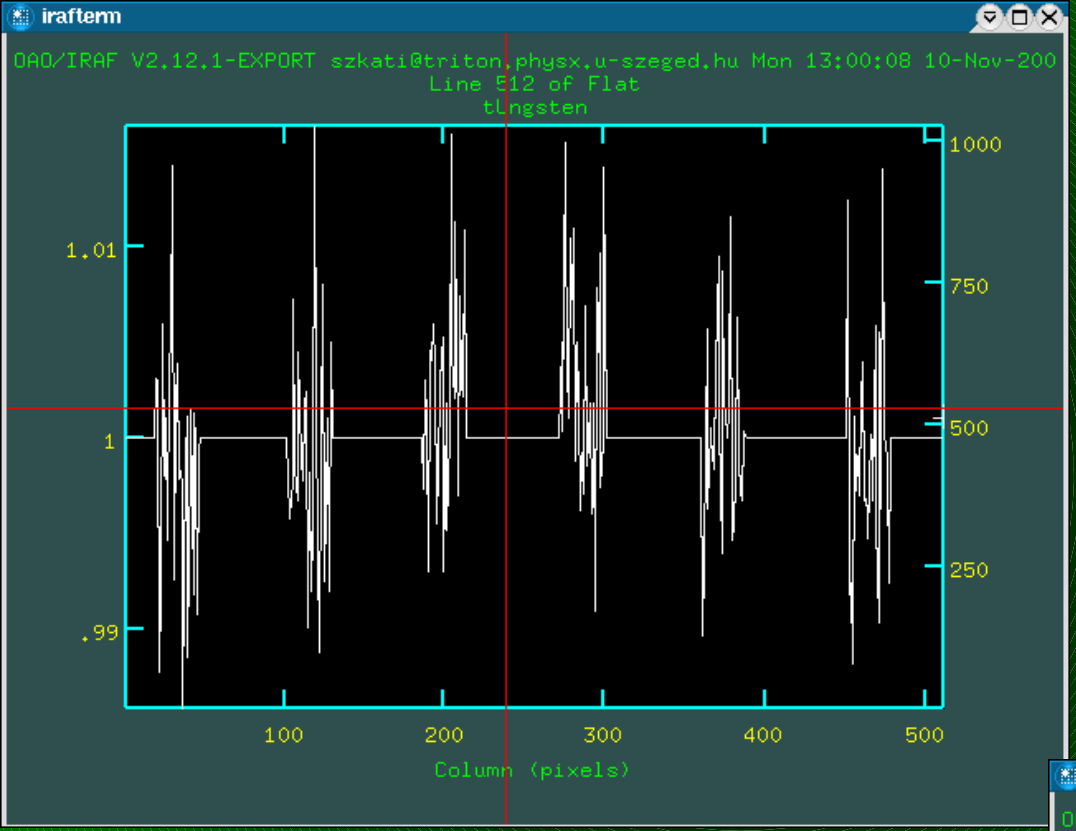
Apertúrák illesztése

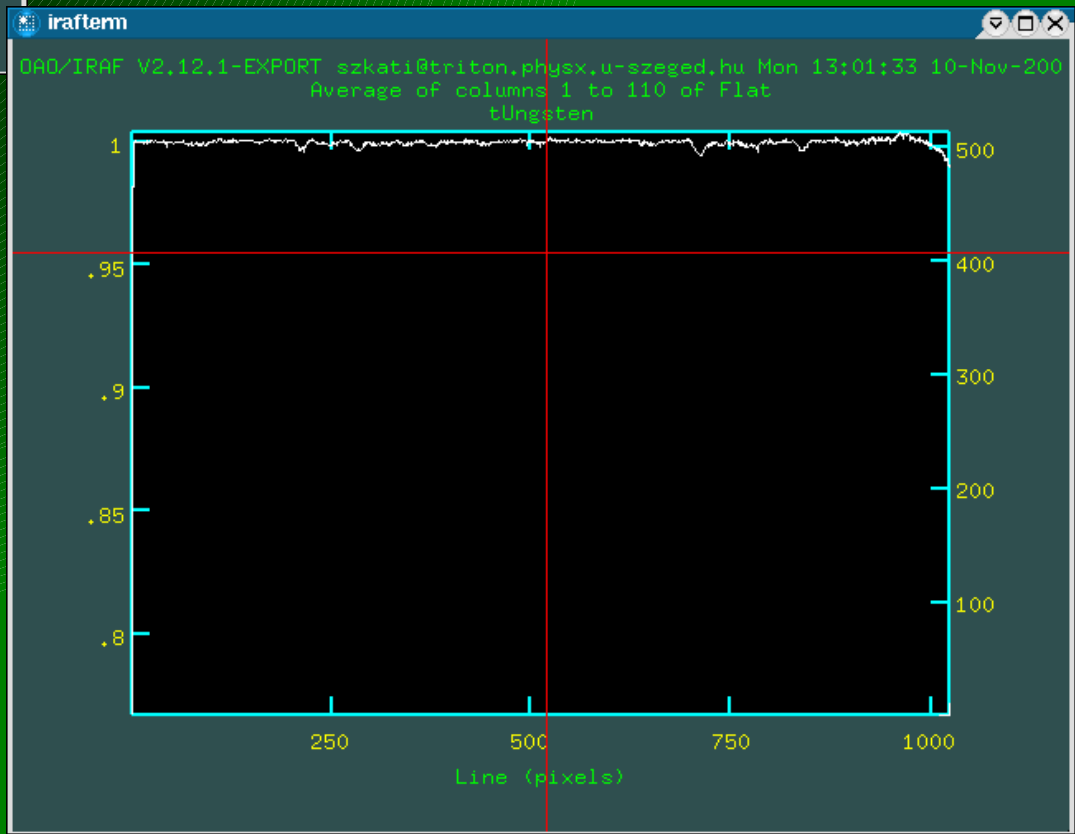






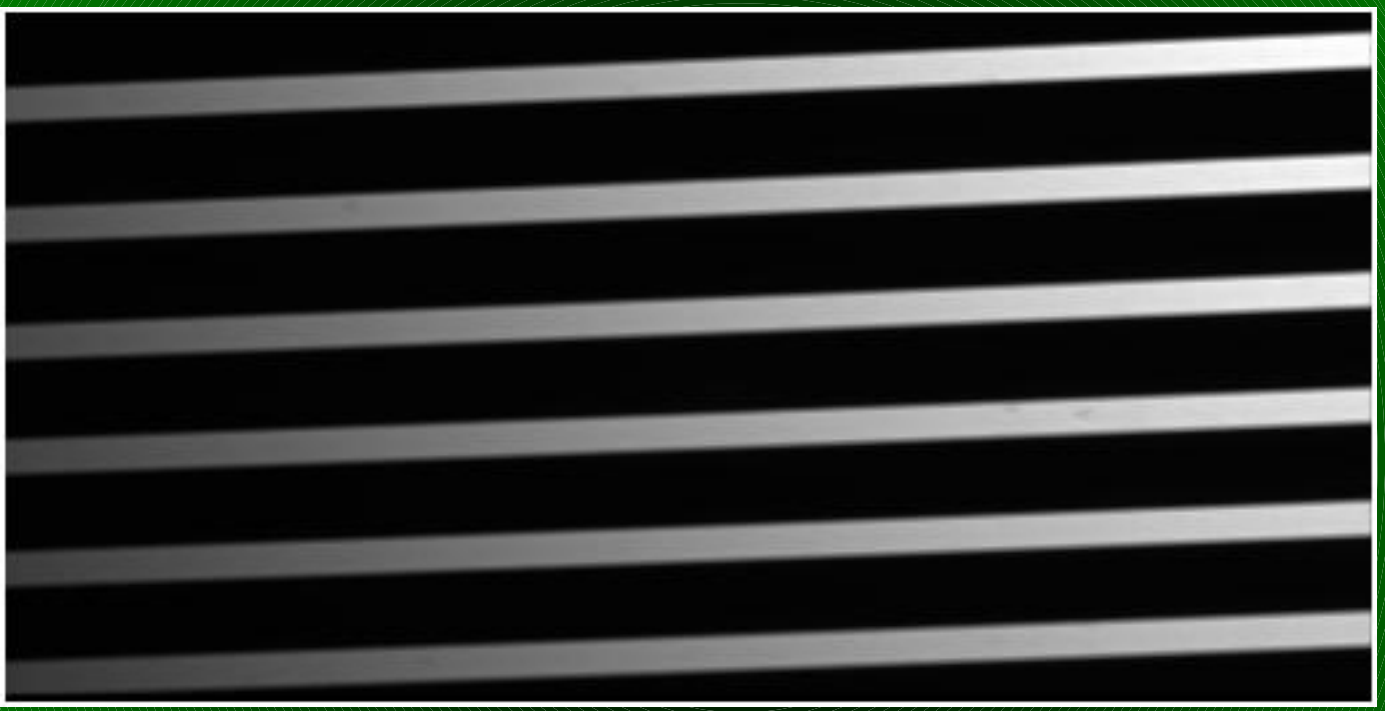
Korrigált Flatfield-kép



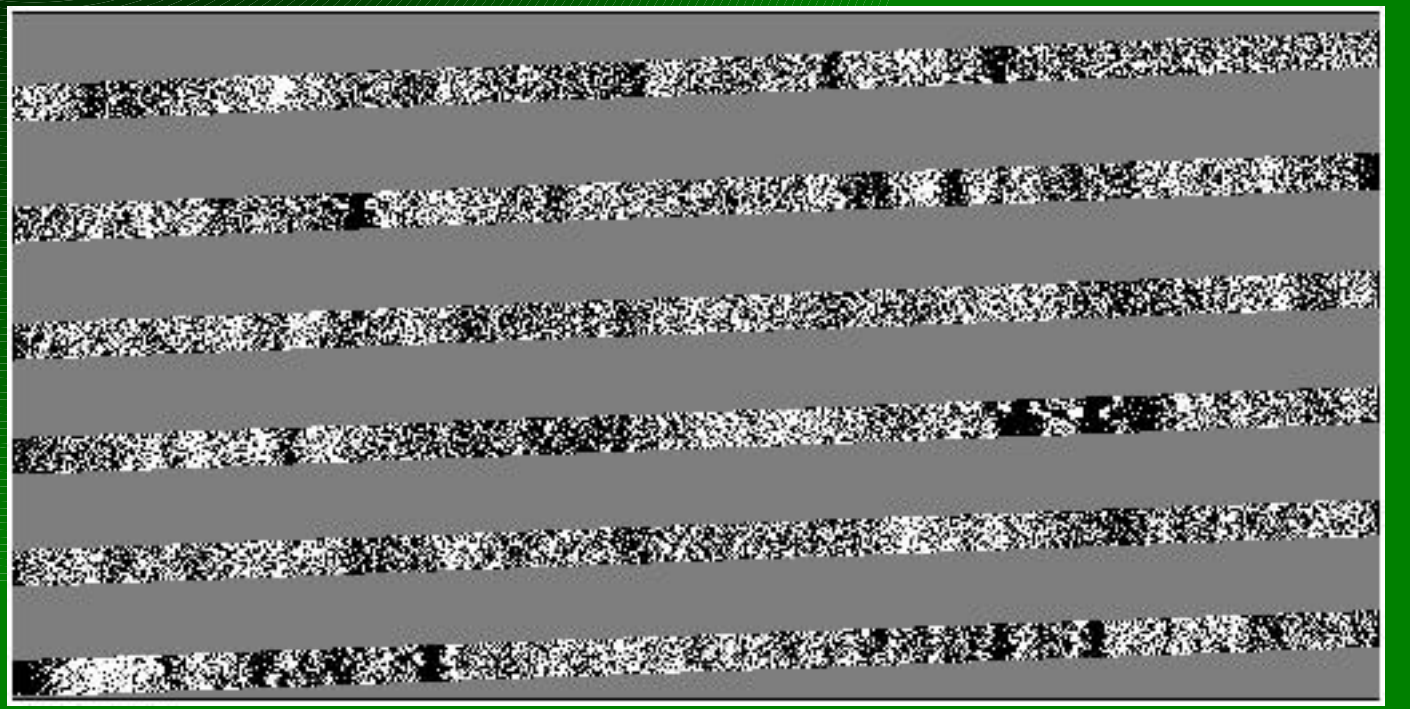


Implot Flat;
:c oszlop

Flatfield-kép



Eredeti átlagolt flat-kép



Korrigált flat-kép

Flatfield-korrekció

Noao => imred => ccdred => ccdproc

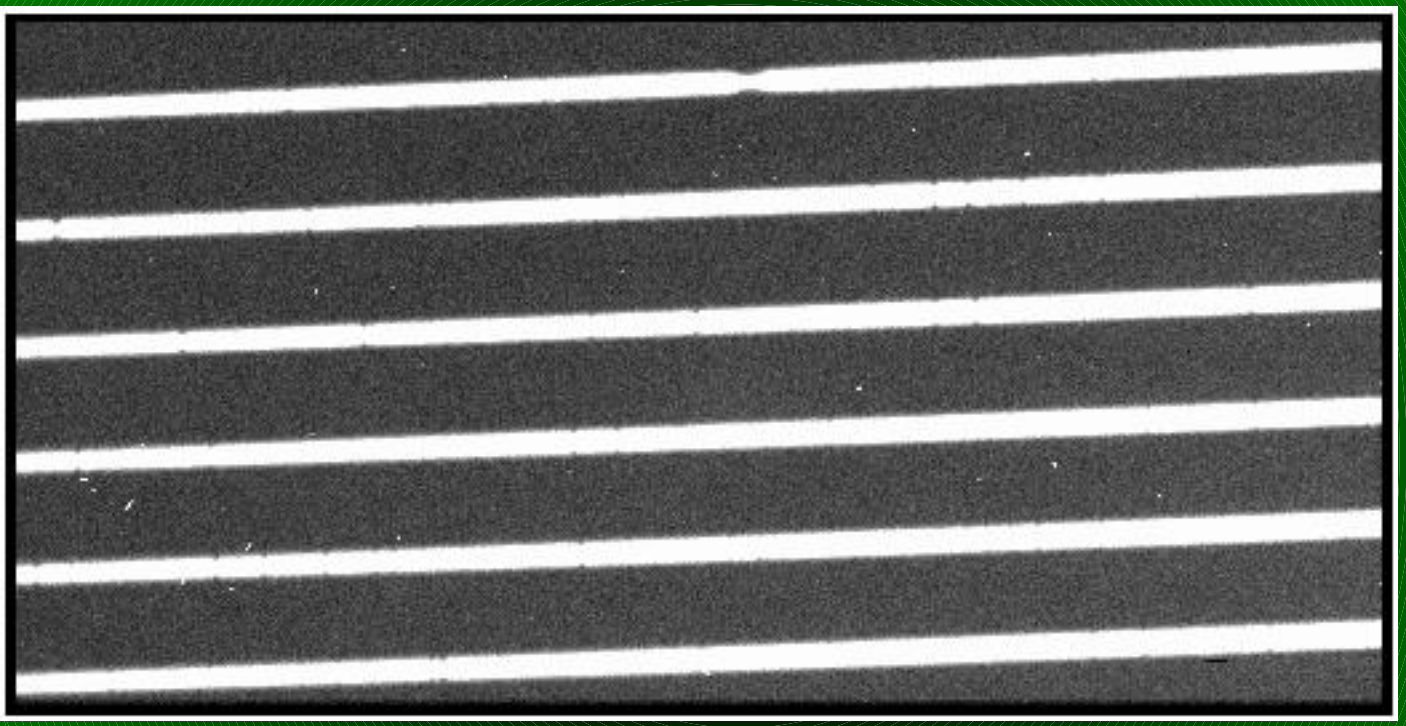
```
szkati@triton:~
                                    I R A F
                    Image Reduction and Analysis Facility
PACKAGE = ccdred
   TASK = ccdproc

images  =              51Peg_korr  List of CCD images to correct
(output =                        ) List of output CCD images
(ccdtype=                  object) CCD image type to correct
(max_cac=                       0) Maximum image caching memory (in Mbytes)
(noproc =                      no) List processing steps only?

(fixpix =                      no) Fix bad CCD lines and columns?
(oversca=                      no) Apply overscan strip correction?
(trim   =                      no) Trim the image?
(zerocor=                      no) Apply zero level correction?
(darkcor=                      no) Apply dark count correction?
(flatcor=                     yes) Apply flat field correction?
(illumco=                      no) Apply illumination correction?
(fringec=                      no) Apply fringe correction?
(readcor=                      no) Convert zero level image to readout correction?
(scancor=                      no) Convert flat field image to scan correction?

More
                                                            ESC-? for HELP
```

Flatfield-korrekció

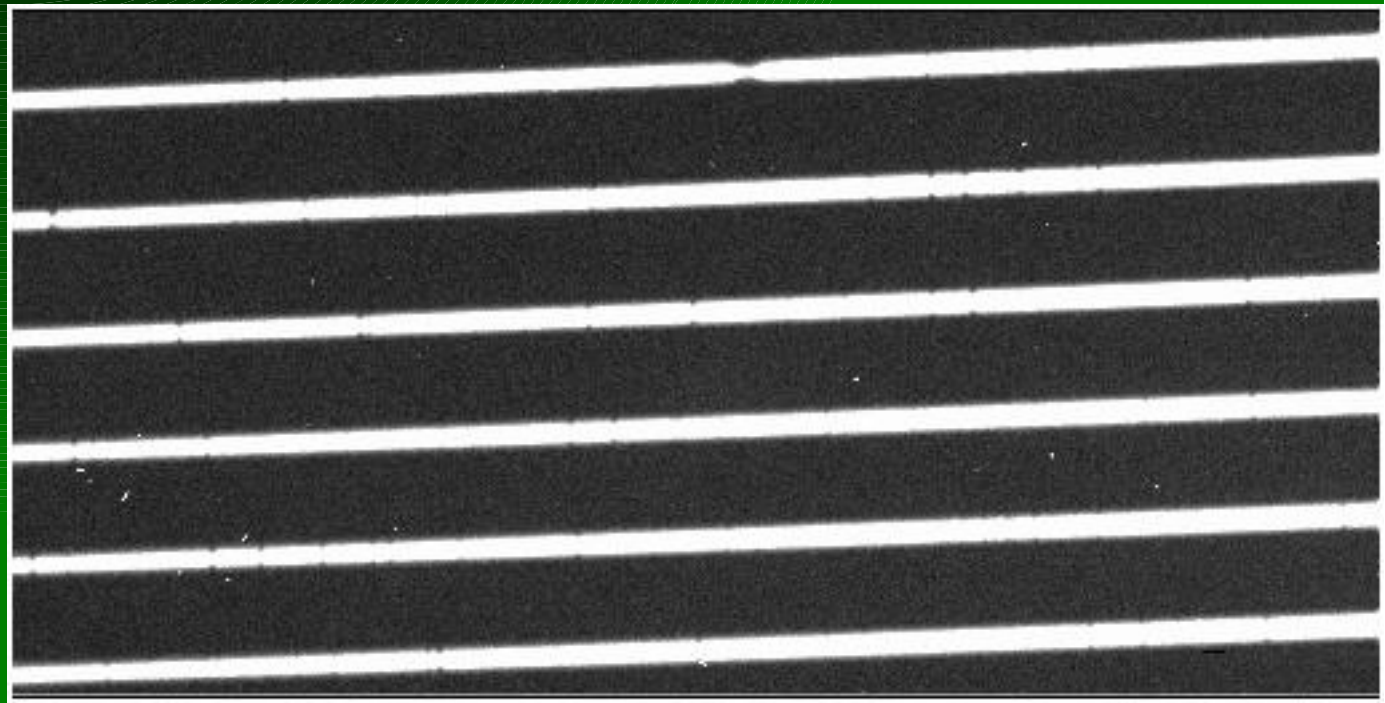
Noao => imred => ccdred =>
ccdproc

```
szkati@triton:~
                                  I R A F
                    Image Reduction and Analysis Facility
PACKAGE = ccdred
   TASK = ccdproc
More
(readaxi=               column) Read out axis (column|line)
(fixfile=                     ) File describing the bad lines and columns
(biassec=                     ) Overscan strip image section
(trimsec=                     ) Trim data section
(zero   =                     ) Zero level calibration image
(dark   =                     ) Dark count calibration image
(flat   =                 Flat) Flat field images
(illum  =                     ) Illumination correction images
(fringe =                     ) Fringe correction images
(minrepl=                   1.) Minimum flat field value
(scantyp=            shortscan) Scan type (shortscan|longscan)
(nscan  =                    1) Number of short scan lines

(interac=                   no) Fit overscan interactively?
(functio=             legendre) Fitting function
(order  =                    1) Number of polynomial terms or spline pieces
(sample =                    *) Sample points to fit
More
                                                          ESC-? for HELP
```

Flatfield-korrekció



Korrigálatlan kép



Korrigált kép