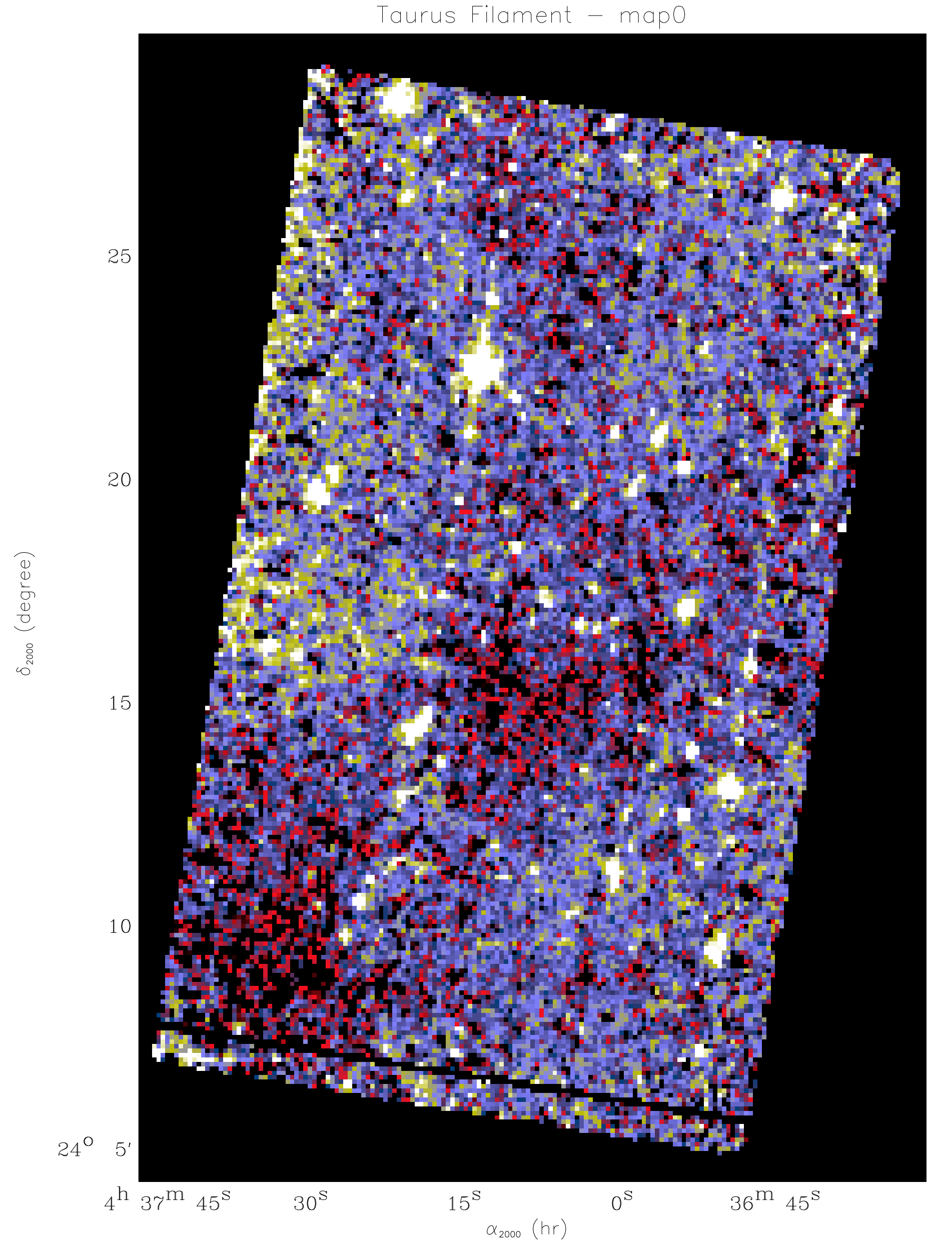
Variable Flat and High frequency correction

Marc-Antoine Miville-Deschênes
Institut d'Astrophysique Spatiale

Introduction

- ISOCAM images are affected by many high frequency defects
  - Slow glitches
  - Residual Fast glitches
  - Ghosts of point sources
  - Temporal flat variations.
- This is a real problem for
  - Small scale structures
  - Low contrast images
- To address this problem we have developped
  - Time-dependent flat field.
  - Second order deglitcher.
  - Point sources extractor.

Everything is base on the fact that a sky position has been observed by several ISOCAM pixels.



Taurus Filament – map0
25
20
15
10
24° 5′
δ2000 (degree)
4h 37m 45s
30s
15s
0s
36m 45s
α2000 (hr)

Variable Flat

- Why a variable flat ?
  - To correct slow glitches, ghosts, ...
  - To correct temporal flat variations.
- How does it work ?

$$I_{obs} = F\,(Zody + Object)$$

we supposed the zodiacal light to be constant all over the observation.

  - We compute a first estimate of the $Object$: Obj_{est}.
  - We compute a first estimate of the $Flat$: F_{est}.
  - We substract $Obj_{est} \times F_{est}$ from the data:

$$\begin{aligned} Back &= I_{obs} - Obj_{est} \times F_{est} \\ &= F \times Zody + [F \times Object - F_{est} \times Obj_{est}] \end{aligned}$$

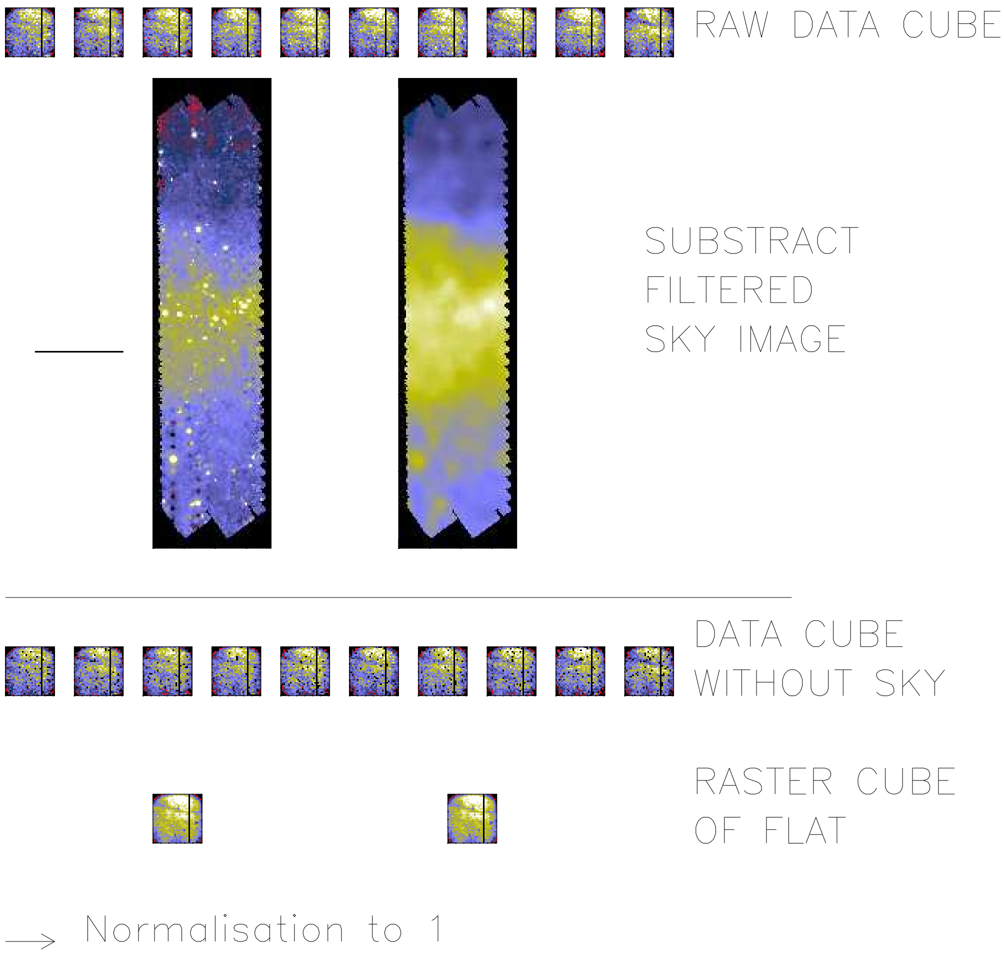
Then the flat is

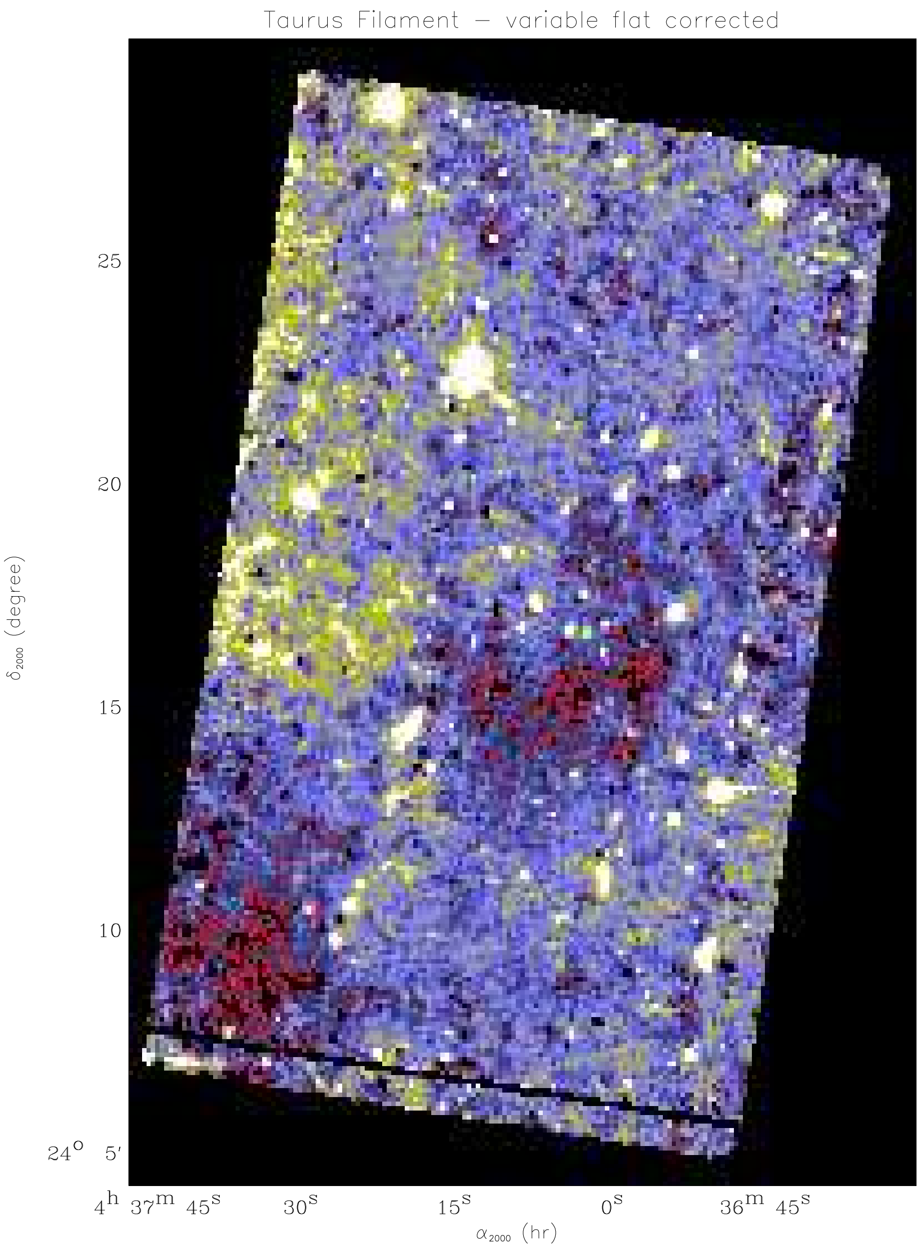
$$F(x, y, t) = \frac{Back(x, y, t) - \delta(x, y, t)}{Zody}$$

To avoid the object small scale structures to enter the flat we do a temporal smoothing:

$$F(x, y, t) = \left\langle \frac{Back(x, y, t) - \delta(x, y, t)}{Zody} \right\rangle_{t-\Delta t:t+\Delta t}$$

VARIABLE FLAT




Taurus Filament – variable flat corrected
25
20
15
10
24° 5′
δ_{2000} (degree)
4h 37m 45s
30s
15s
0s
36m 45s
α_{2000} (hr)

Bad Pixels Identification (noise reducer)

- Why ?
  - Flag residual FAST glitches
  - Flag residual Slow Glitches
  - Flag residual Flat deformation

- How does it work ?

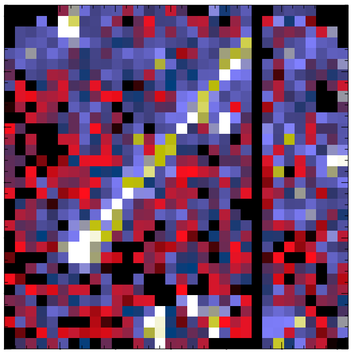
$$I_{obs}(x, y, t) = F(x, y, t) \times Sky(x, y, t)$$

  - Substract *smoothed* Best Sky estimate.

$$Residu(x, y, t) = \frac{I_{obs}}{F(x, y, t)} - Sky_{est}(x, y, t)$$

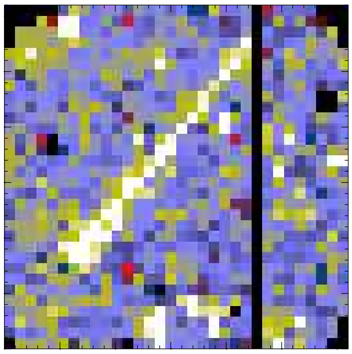
  - Flag pixels in $Residu(x, y, t)$ above (under) a given threshold.
  - Reconstruct the image without flagged pixels.
- Drawback: it removes point sources.....

BAD PIXELS

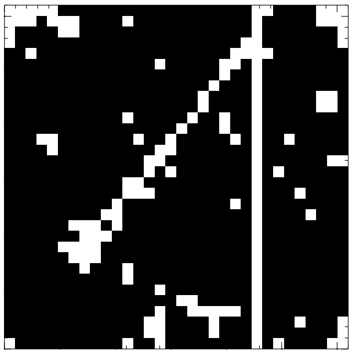


RASTER IMAGE

FLAT CORRECTED

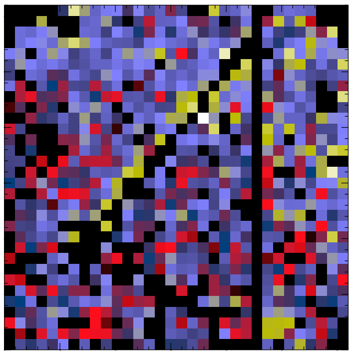


SKY SUBSTRACTED



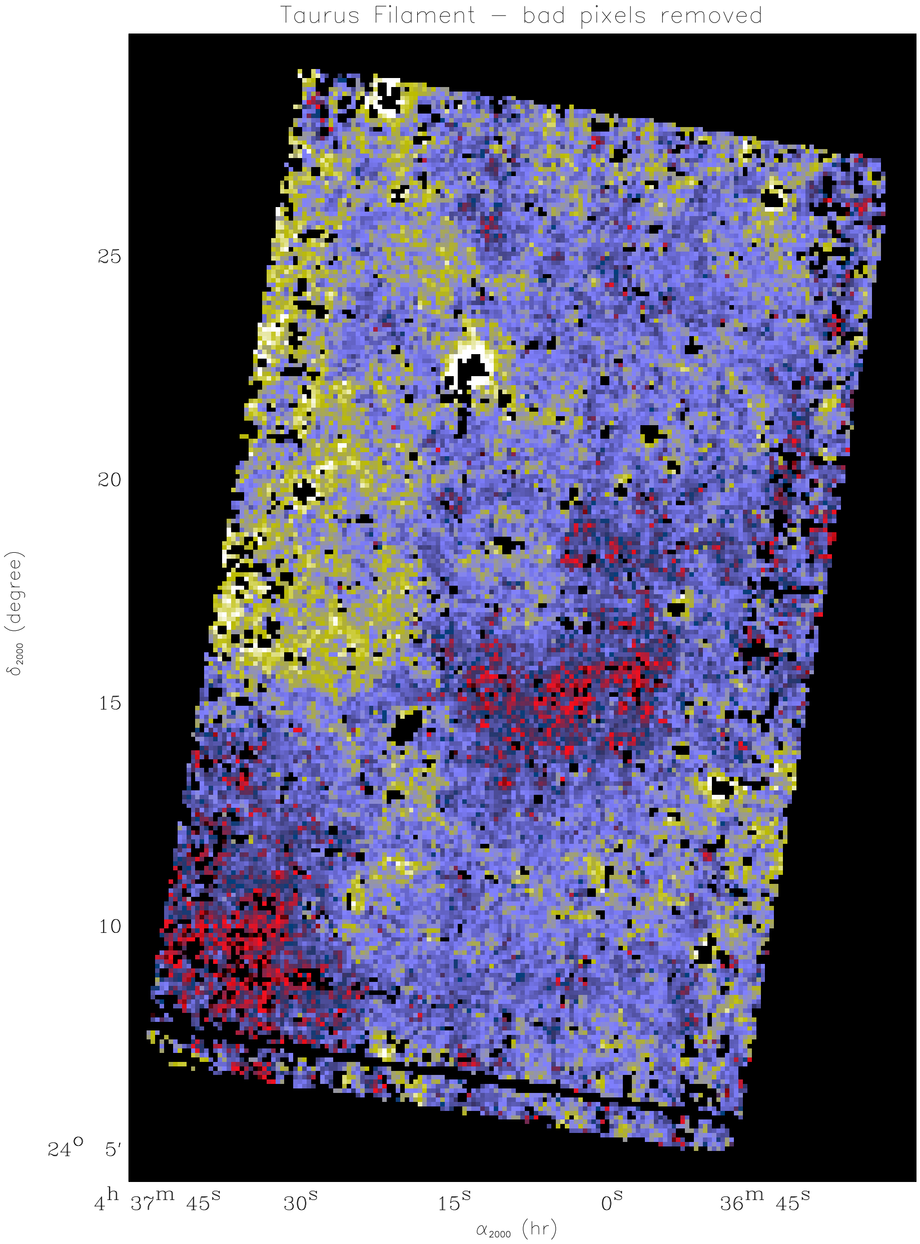
IDENTIFY

BAD PIXELS



FLAG IN

RASTER IMAGE

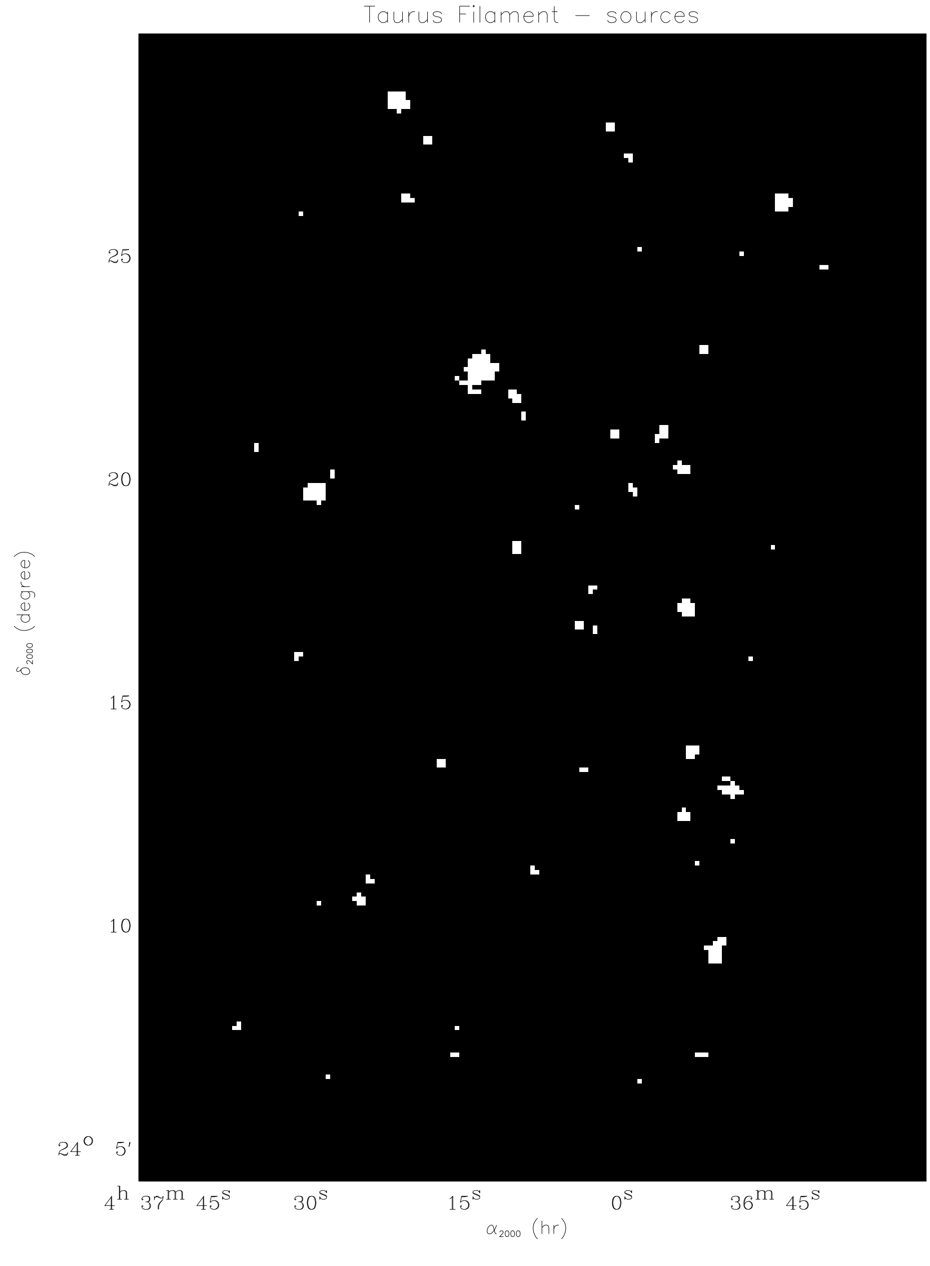


Taurus Filament — bad pixels removed
25
20
15
10
24° 5′
δ2000 (degree)
4h 37m 45s
30s
15s
0s
36m 45s
α2000 (hr)

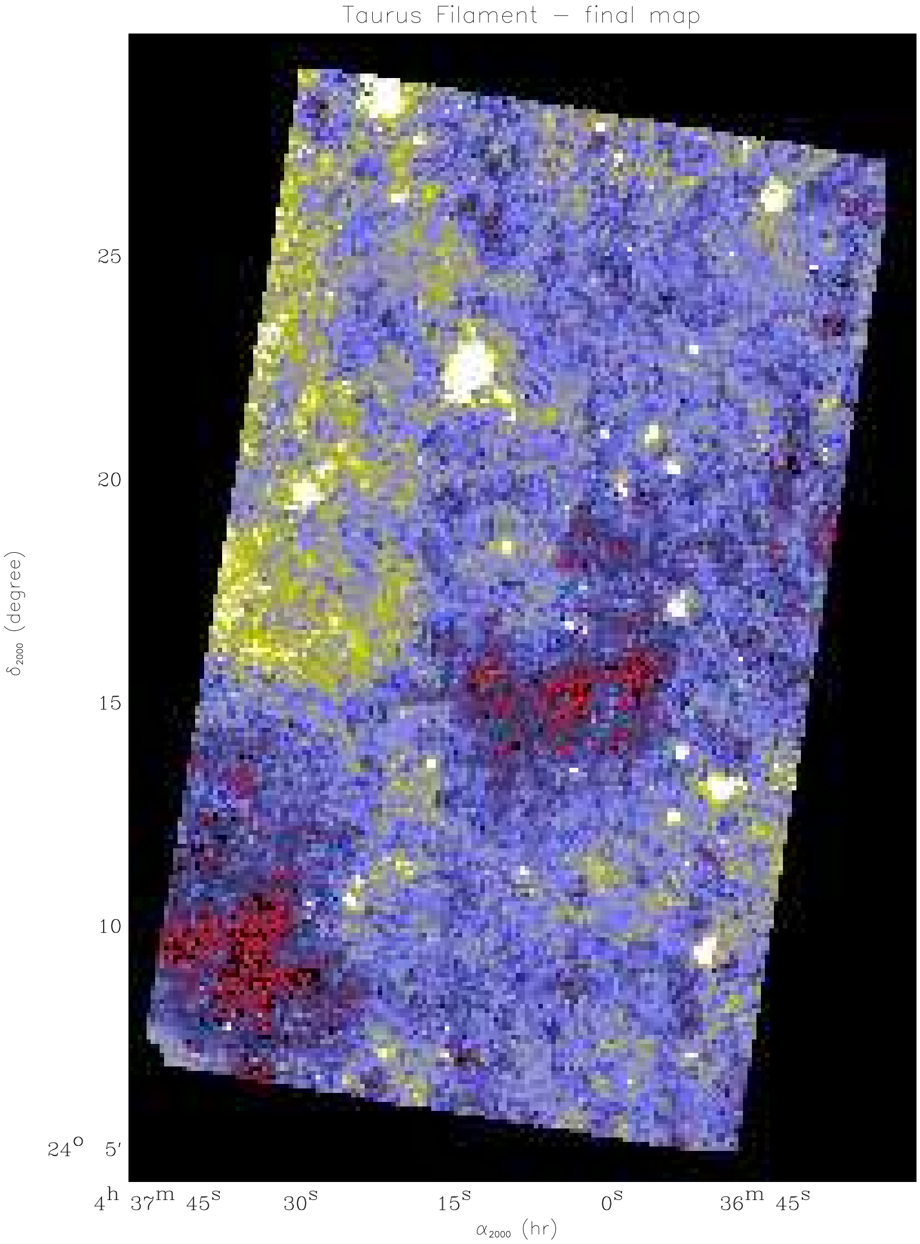
Source extractor

A source is detected when it has been seen several times by different pixels.

- Substract *smoothed* Best Sky estimate from the flat-fielded data cube.
- Project each readout on (α, δ).
- A source is detected at (α, δ) if
  - more than 66% of the pixels are above 2σ
  - At least 2 pixels are above 3σ
- Glitches are not detected by this technique.

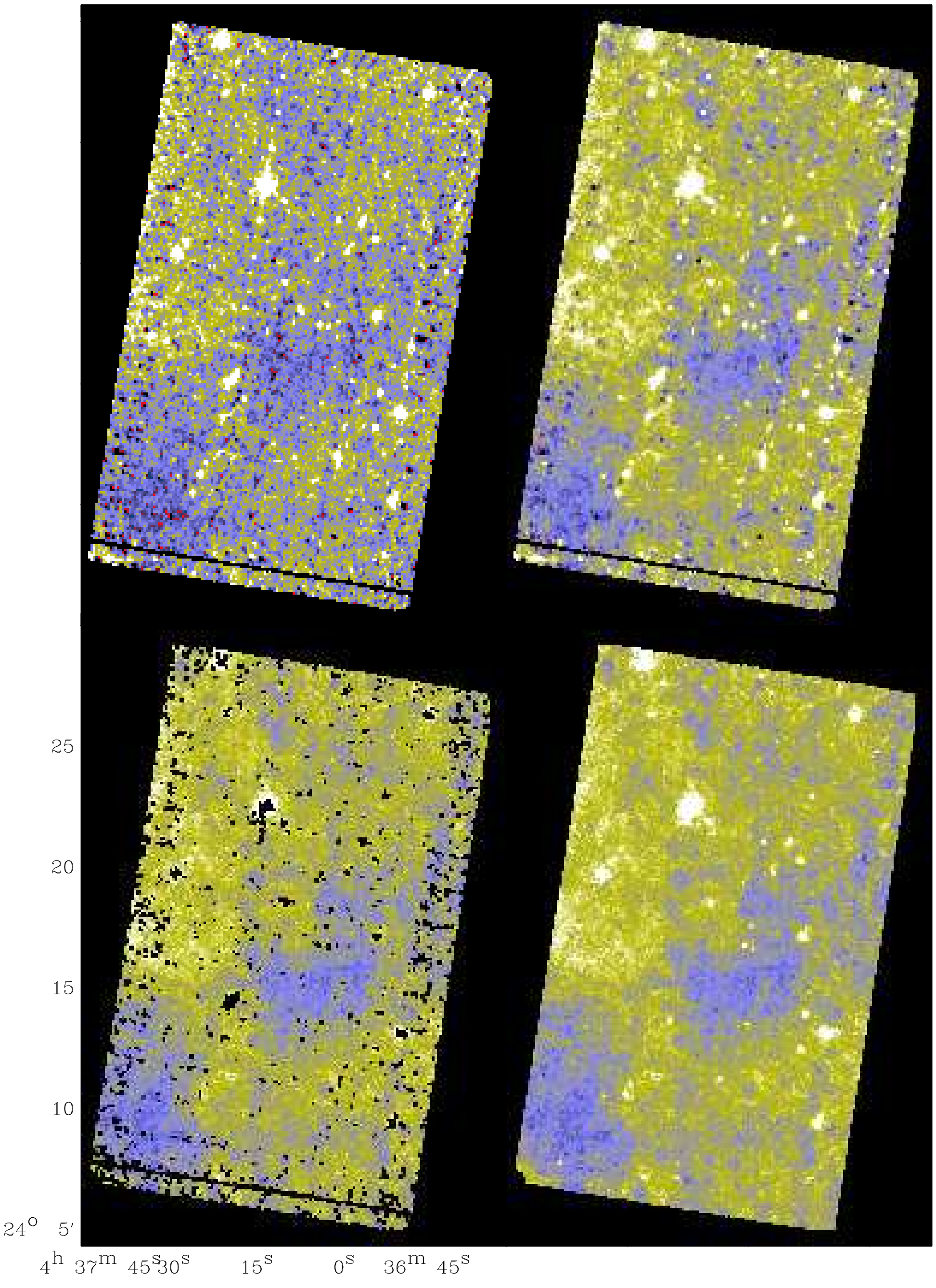


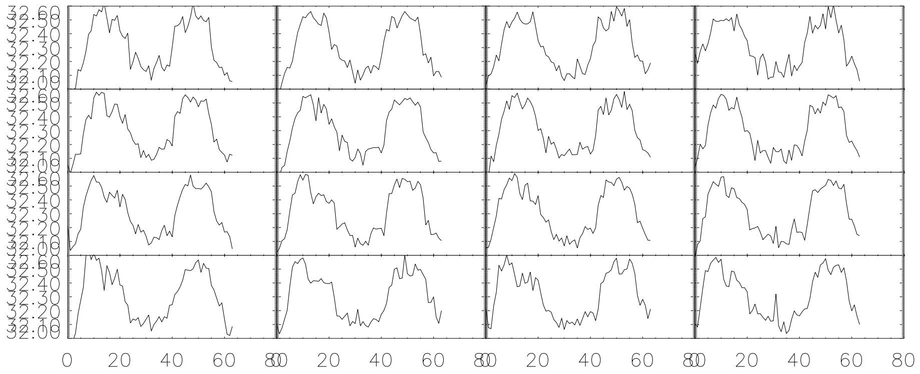
Taurus Filament − sources
25
20
15
10
24° 5′
δ2000 (degree)
4h 37m 45s
30s
15s
0s
36m 45s
α2000 (hr)

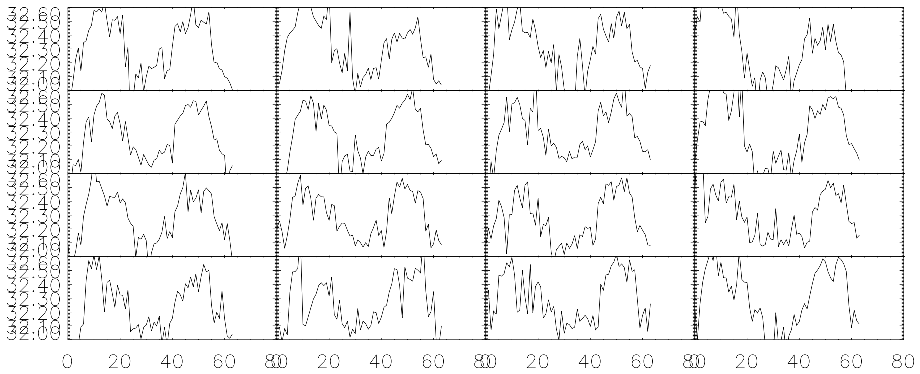


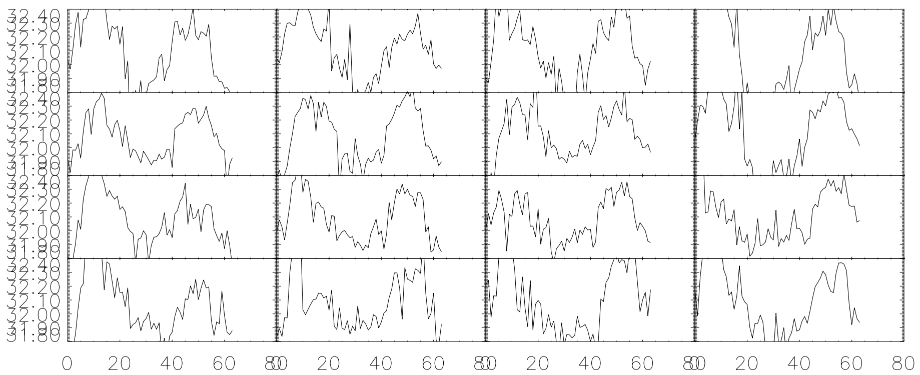
Taurus Filament – final map
25
20
15
10
24° 5′
δ_{2000} (degree)
4h 37m 45s
30s
15s
0s
36m 45s
α_{2000} (hr)

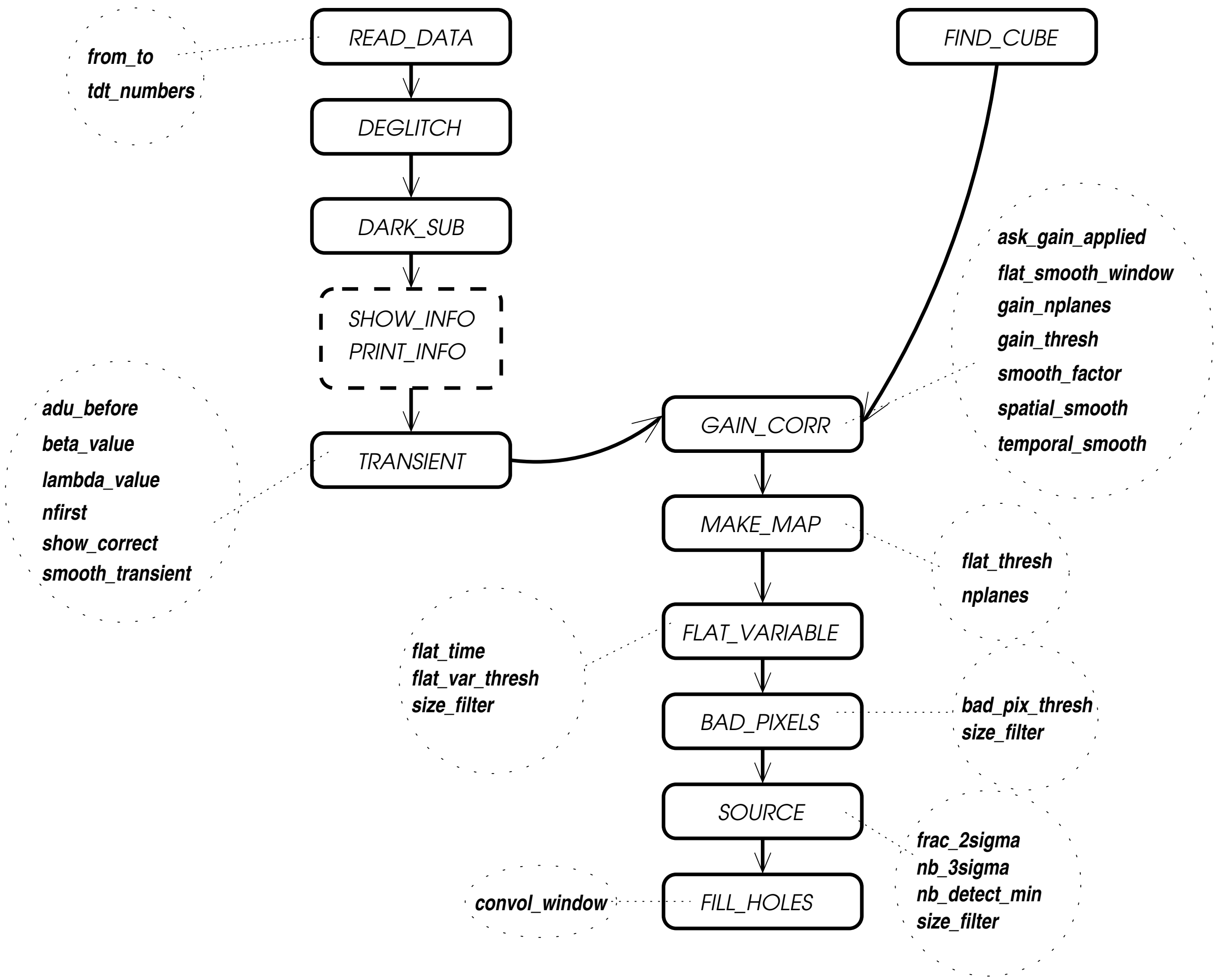
Taurus Filament LW2










READ_DATA
from_to
tdt_numbers
DEGLITCH
DARK_SUB
SHOW_INFO
PRINT_INFO
TRANSIENT
adu_before
beta_value
lambda_value
nfirst
show_correct
smooth_transient
FIND_CUBE
GAIN_CORR
ask_gain_applied
flat_smooth_window
gain_nplanes
gain_thresh
smooth_factor
spatial_smooth
temporal_smooth
MAKE_MAP
flat_thresh
nplanes
FLAT_VARIABLE
flat_time
flat_var_thresh
size_filter
BAD_PIXELS
bad_pix_thresh
size_filter
SOURCE
frac_2sigma
nb_3sigma
nb_detect_min
size_filter
FILL_HOLES
convol_window