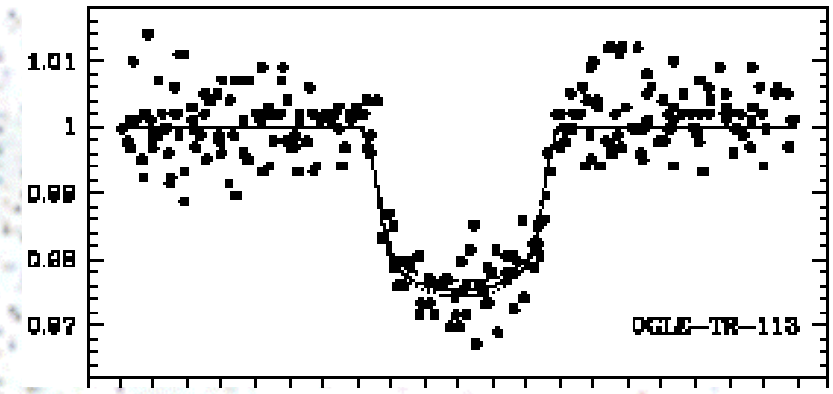
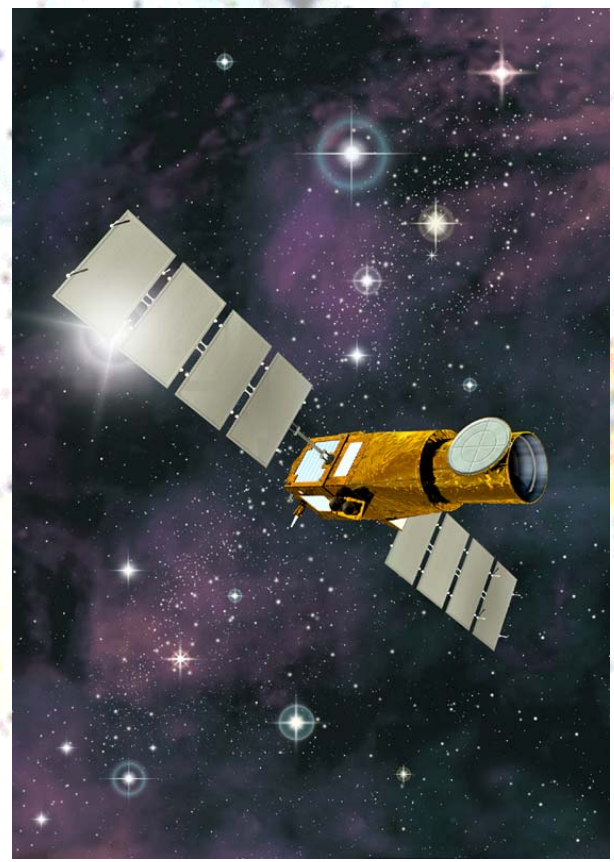
# Matched filter algorithm for transit detection for the COROT mission



Work done in partnership with P.Bordé, A.Léger and M.Ollivier (IAS)

# The different routines

INTERPOLATION OF MISSING DATA

CORRELATION SURFACE

DETERMINATION OF THE SIGNAL TO NOISE OF THE DETECTION

Without interpolated data

LOW FREQUENCY FILTERING

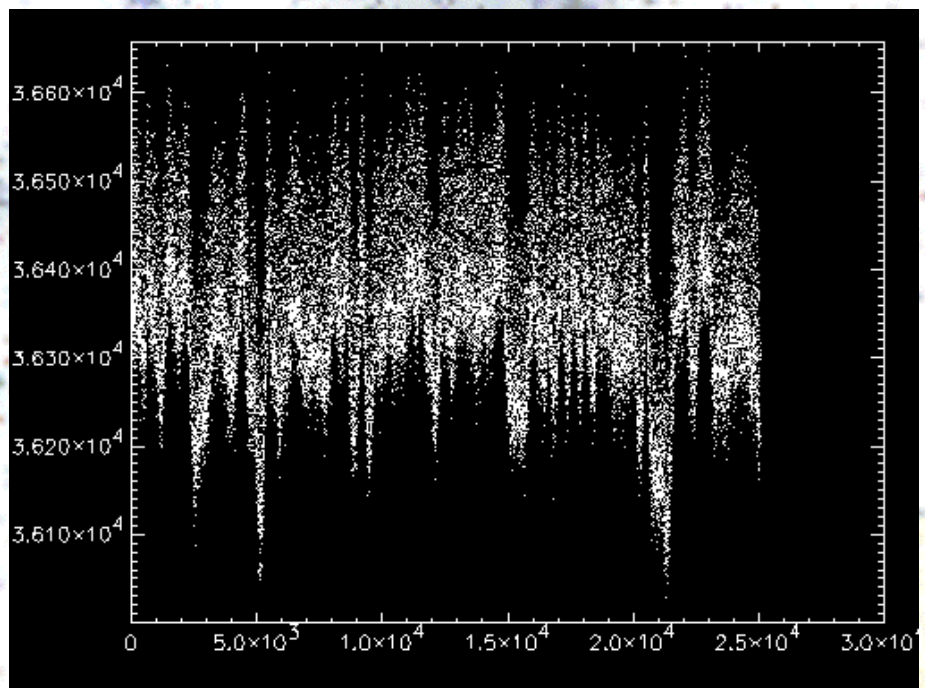
SATELLITE ORBITAL PERIOD FILTERING

CHARACTERIZATION OF THE EVENT

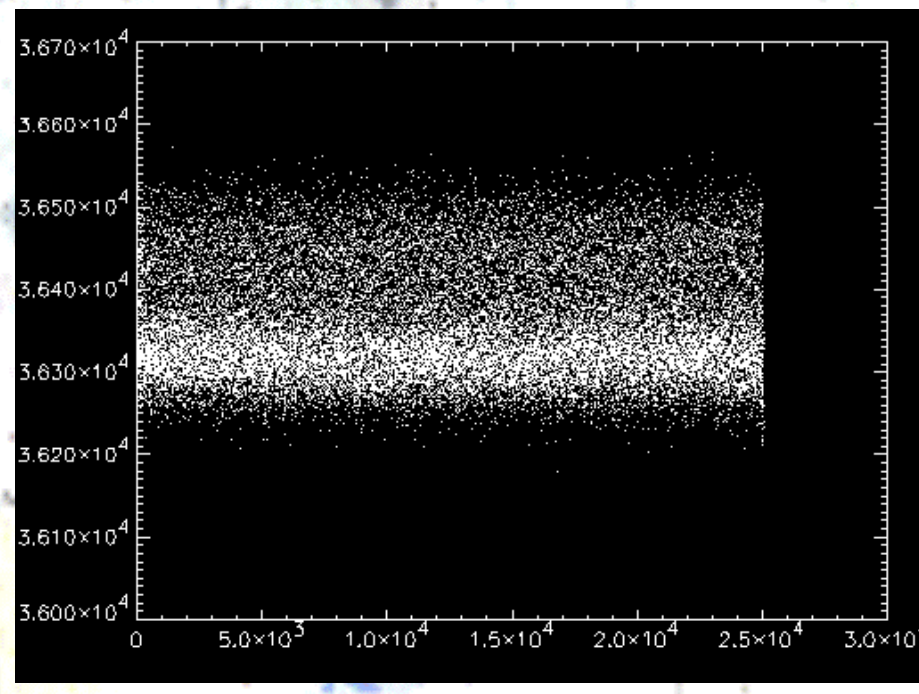
With interpolated data

# Low Frequences Filtering

Filtering of low frequences by convolution with a Hanning window



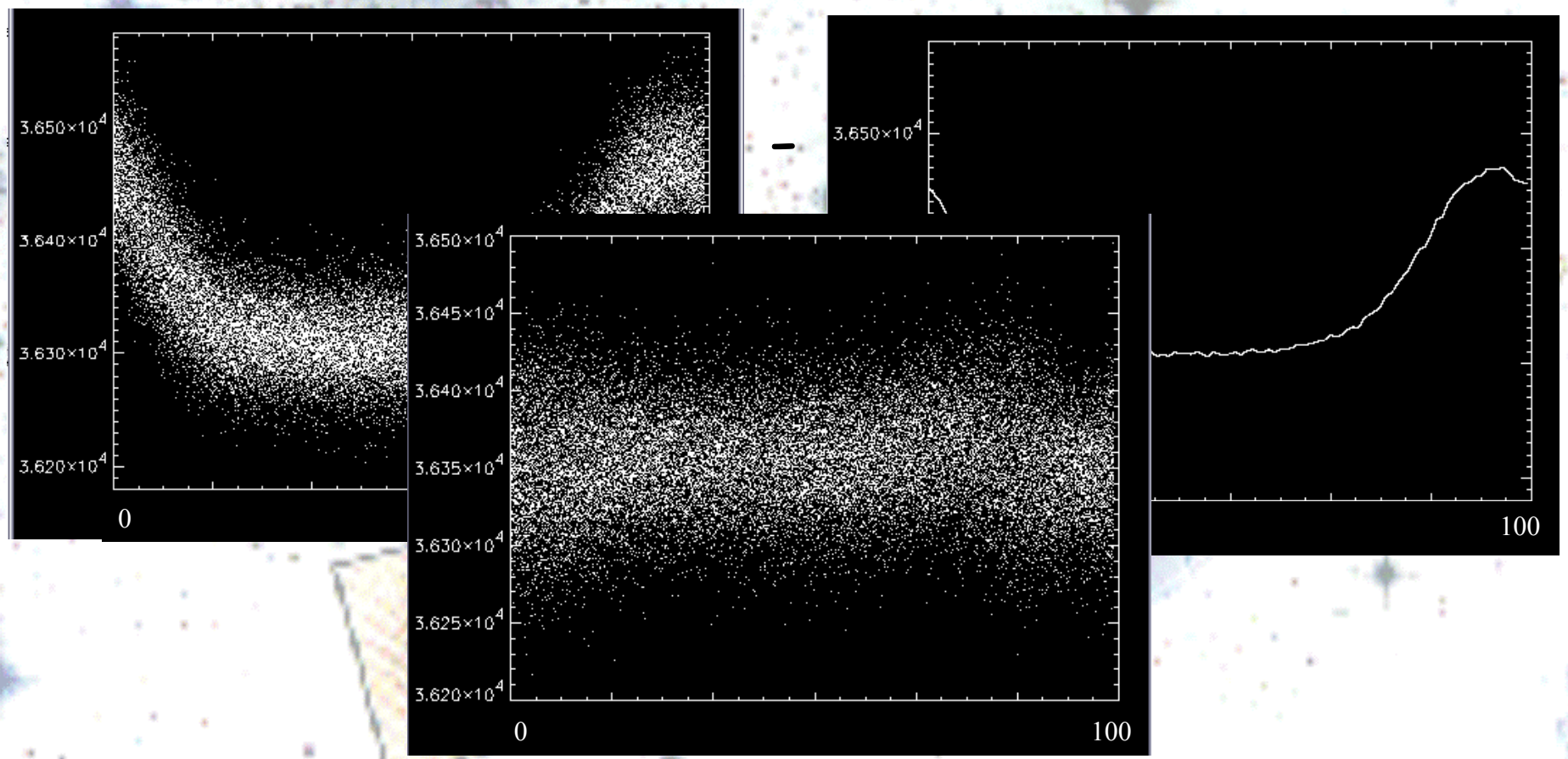

*Unfiltered lightcurve*




*Lightcurve filtered from low frequences*

# Substraction of the satellite orbital period

Folding data to orbital period and substraction of a running averaging fitting curve



# Construction of a Correlation surface

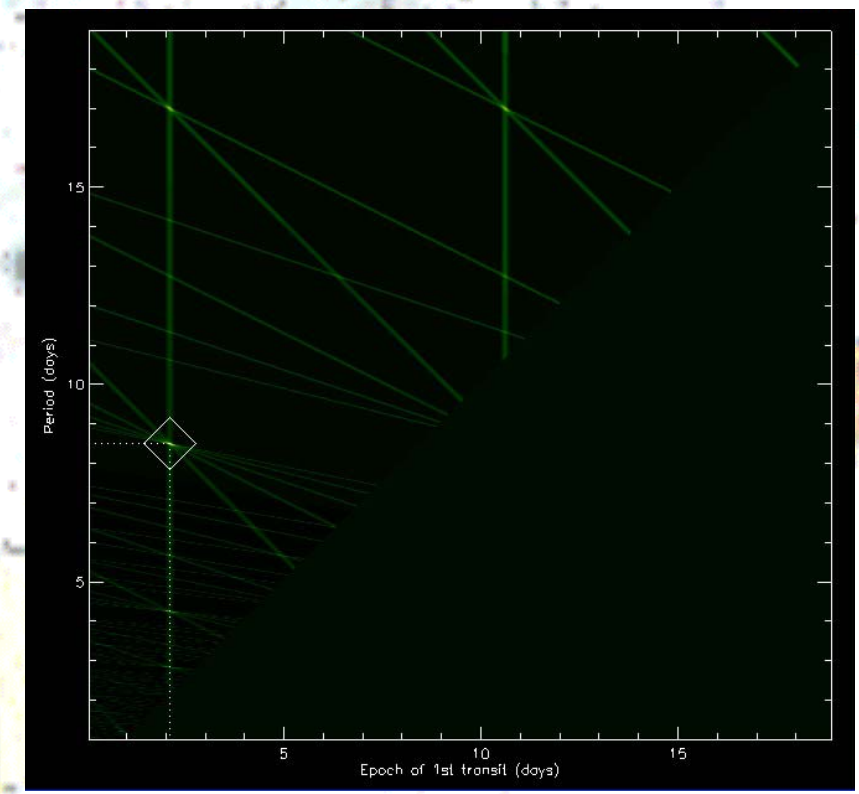
Intercorrelation with test curves

Grid of two parameters :
-Period T from 1 to 50 days
-Epoch of the first event τ from 0 to T

The length of transit tested is a function of the period tested

Possibility of binning measure points to increase the algorithm speed.

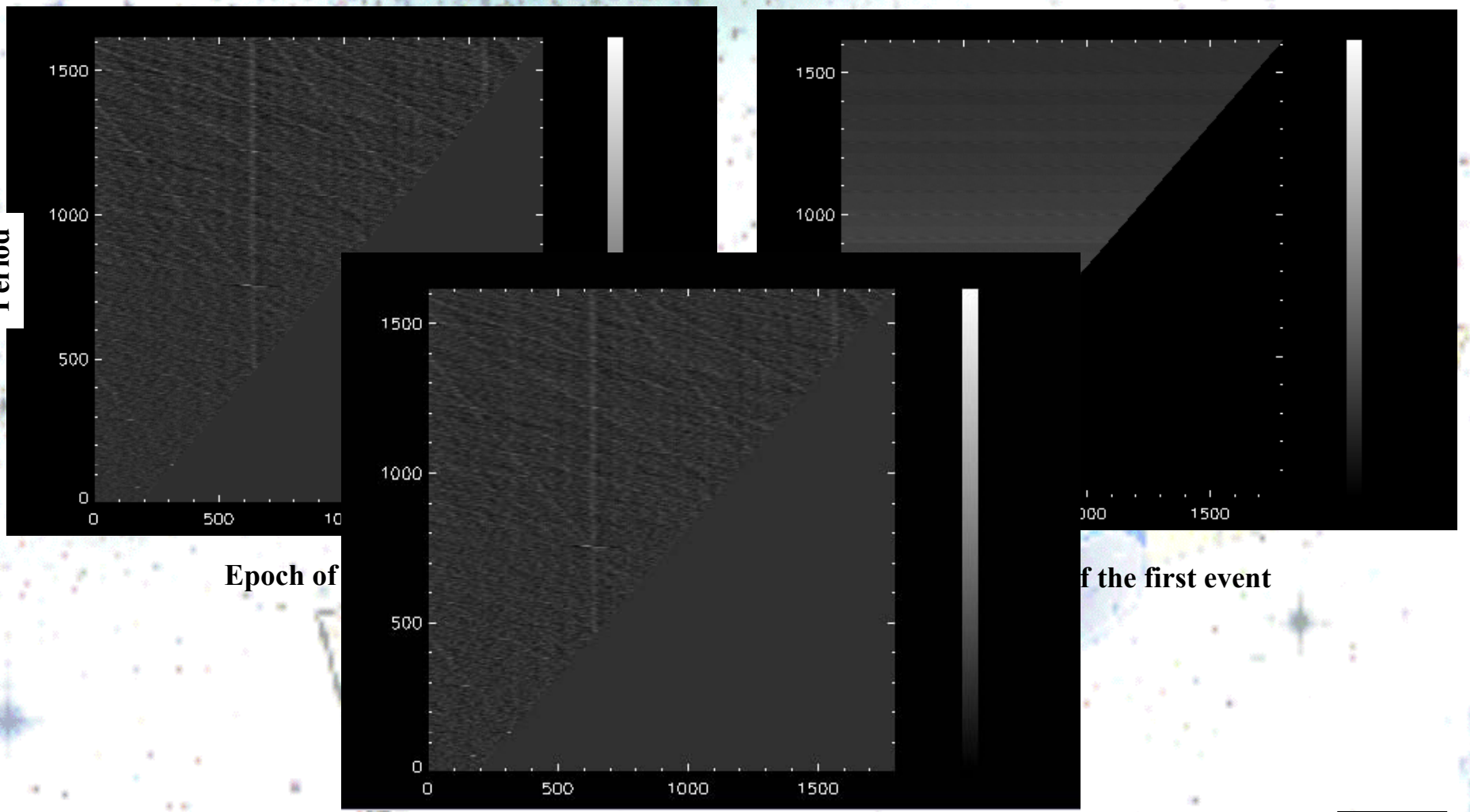
## Correlation surface for a signal-only lightcurve




**Epoch of the first event**

# Construction of a Correlation surface

Correlation surface x $\sqrt{(\text{Number of measures contributing to the correlation})}$

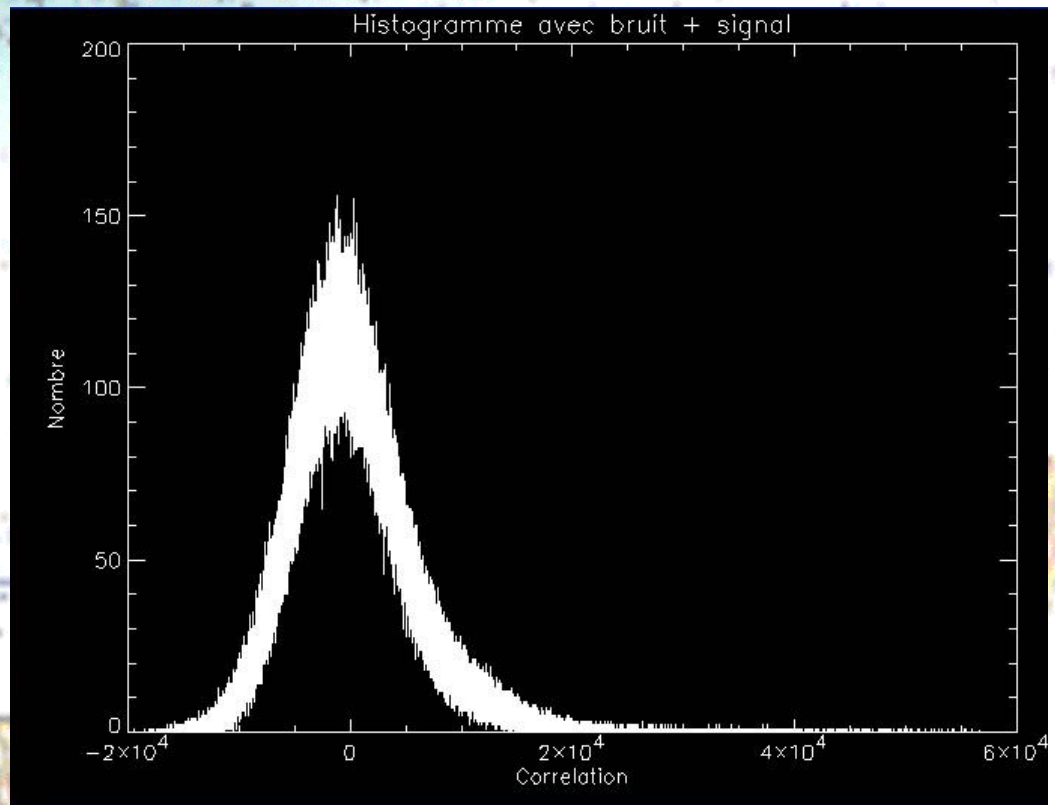


# Estimation of the Signal to Noise Ratio of the Detection

Estimation of Standard deviation of the correlation surface.

Empirical method to select the detection treshold

2 conditions to be selected as candidate :
- Signal to noise value over 7 sigma
- No non harmonic signal value within 2 sigma of the maximum value



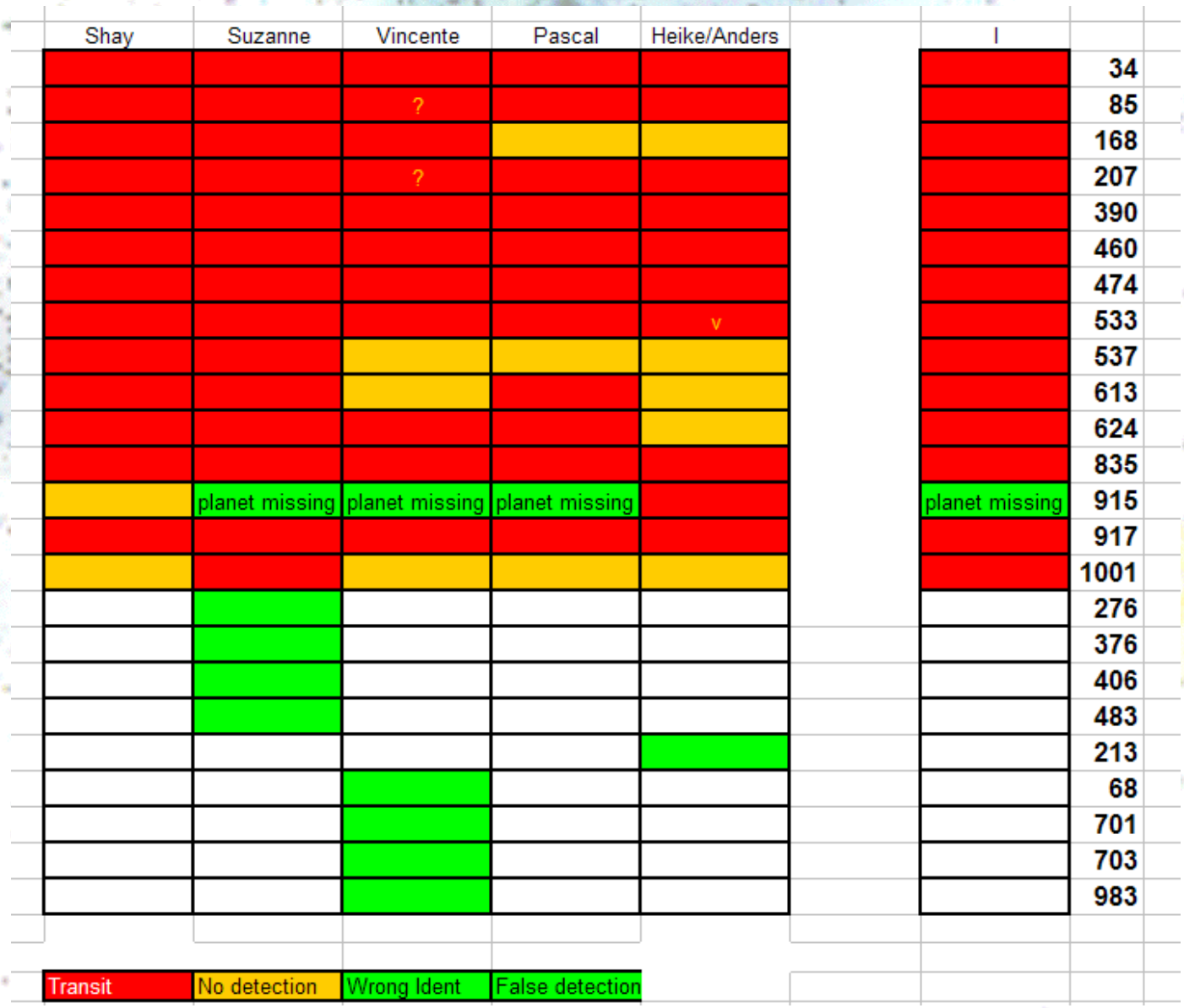

*Histogram of the correlation value (for a lightcurve with Transit and noise)*

# Characteristics of the method

+ Specifically dedicated to transit search
  - designed to detect single as well as periodic events
  - only compares what could be transit signals, not any periodic events with each others
+ No interpolation for missing data and minimal signal modifications - Each measure point has the same contribution
+ Fully automated / No visual examination step

- Two filtering steps for detrending the lightcurves
- Quite slow to compute
- No use of systematic effects common to all lightcurves (considers them already removed…)

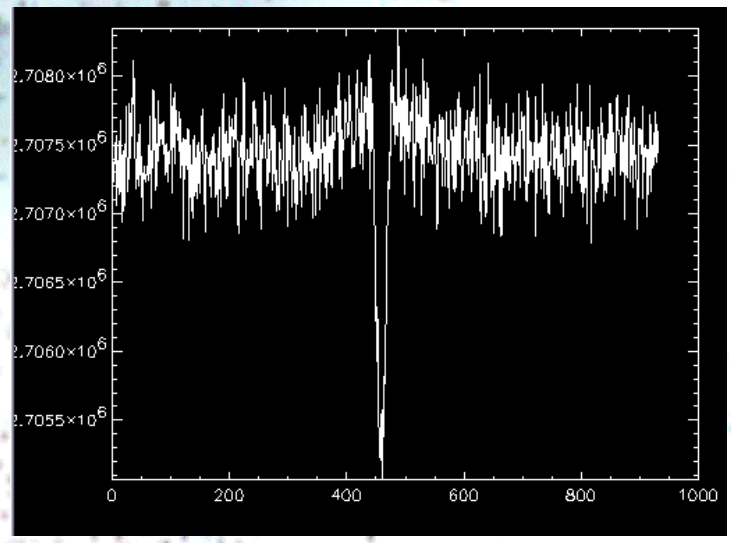
# Results on Blind test curves

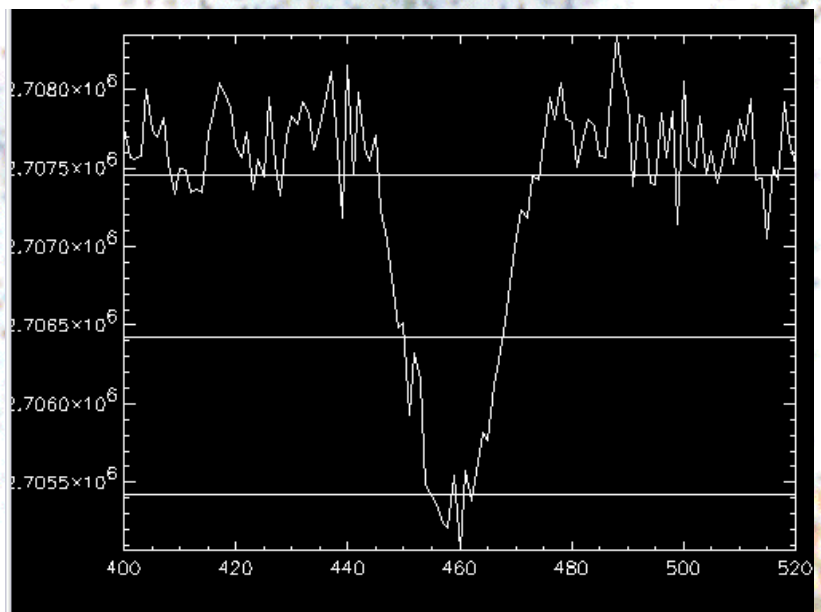



False transit
discrimination

# Characterization of the event

Filtered curve folded to the period found



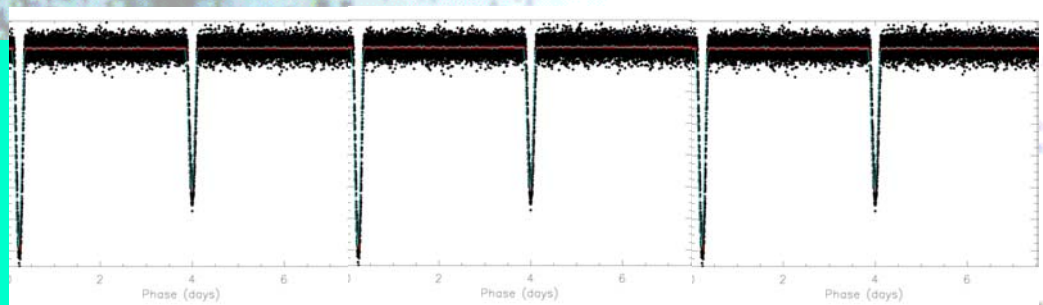

Iterative procedure to estimate :
-the low level
-the width at half height
-the length
-the shape
of the event

# False transit discrimination …

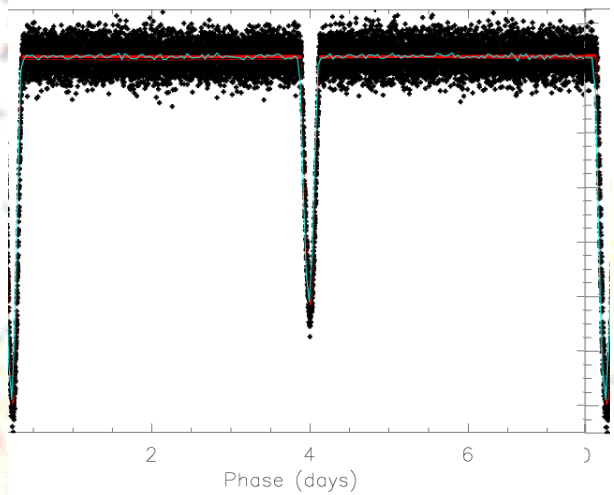
Bayesian method to discriminate blends with the lightcurve:

Characterized event
- Event length
- Shape of the event
- Depth of the event

Secondary eclipse (for short period events)
- Exploration of the folded curve at Period/2

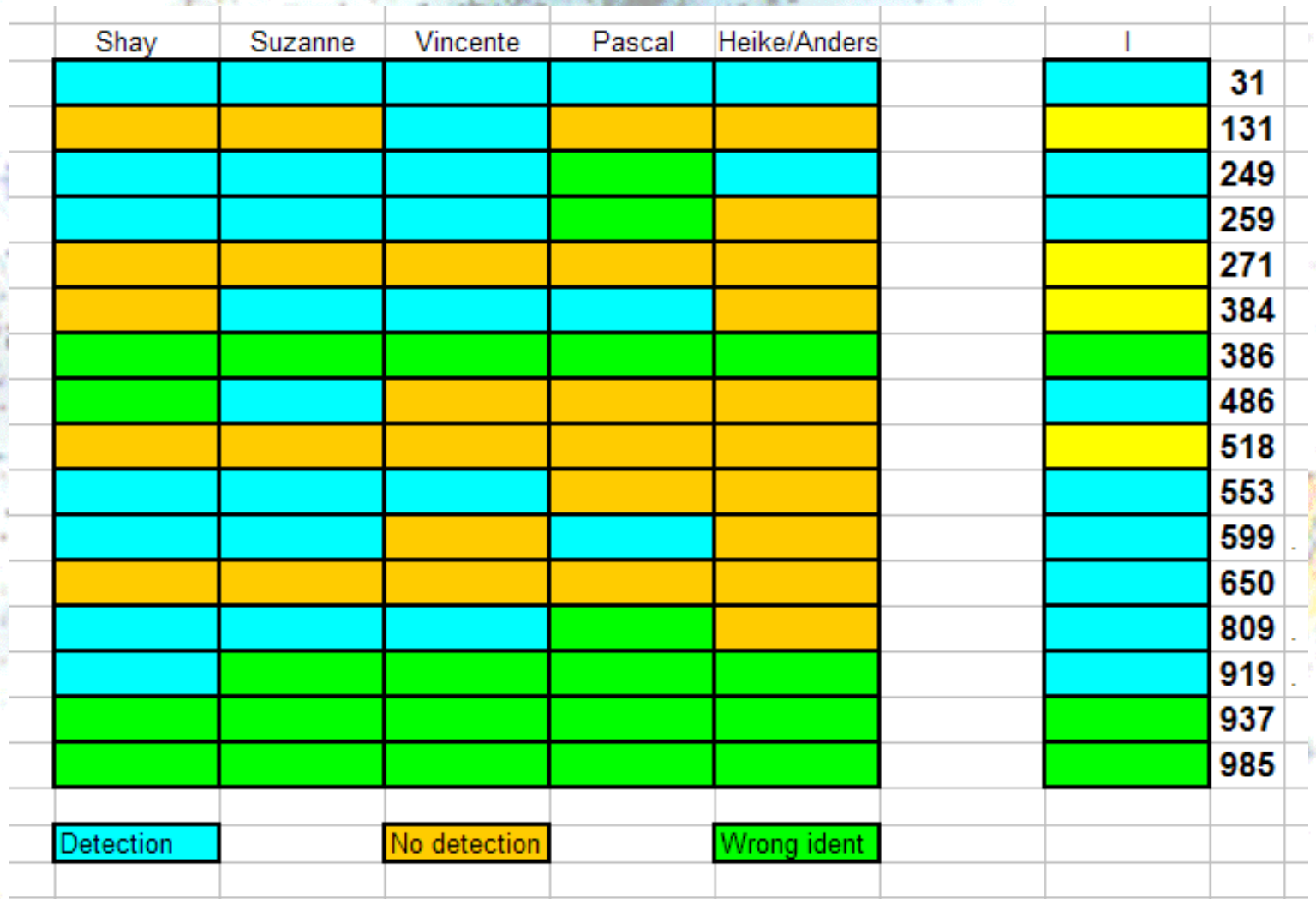



*Lightcurve with secondary eclipses*




*Lightcurve folded to its period*

# Results on blend Blind test curves



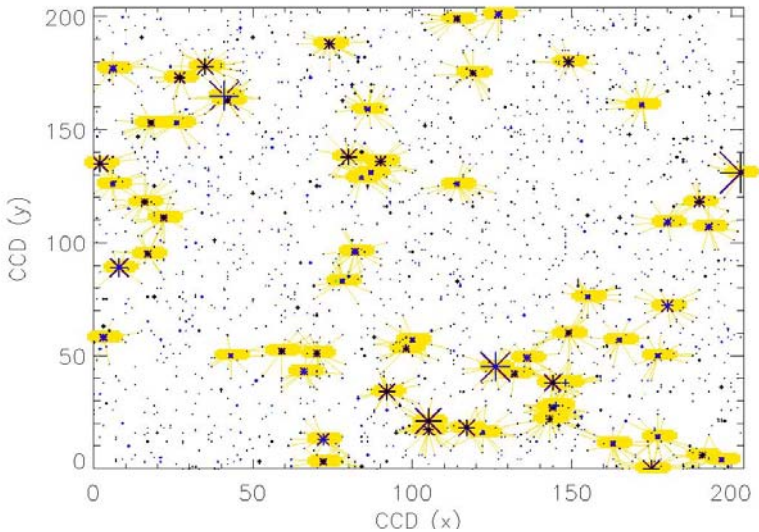
# Coupling with Corotlux program

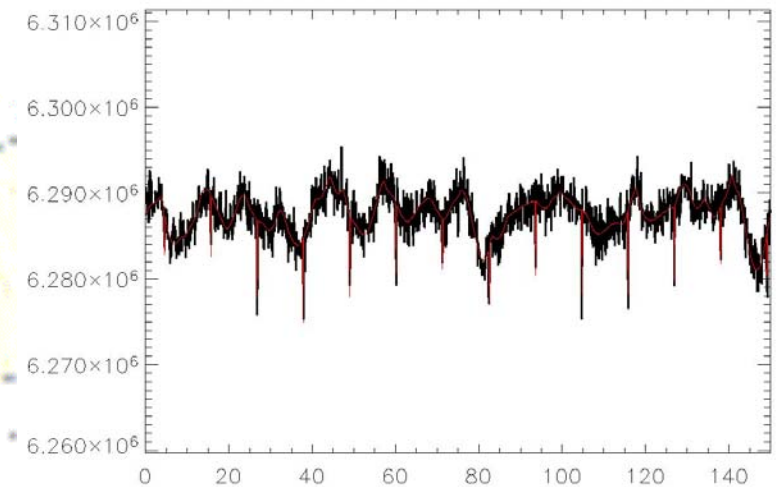
COROTLUX generates a field of stars similar to COROT

Test applied:

Among the 100 deepest events in the different lightcurves of a classical field, I have tested my algorithm to see how many false transits are detected as false and how many are not.

… relative success



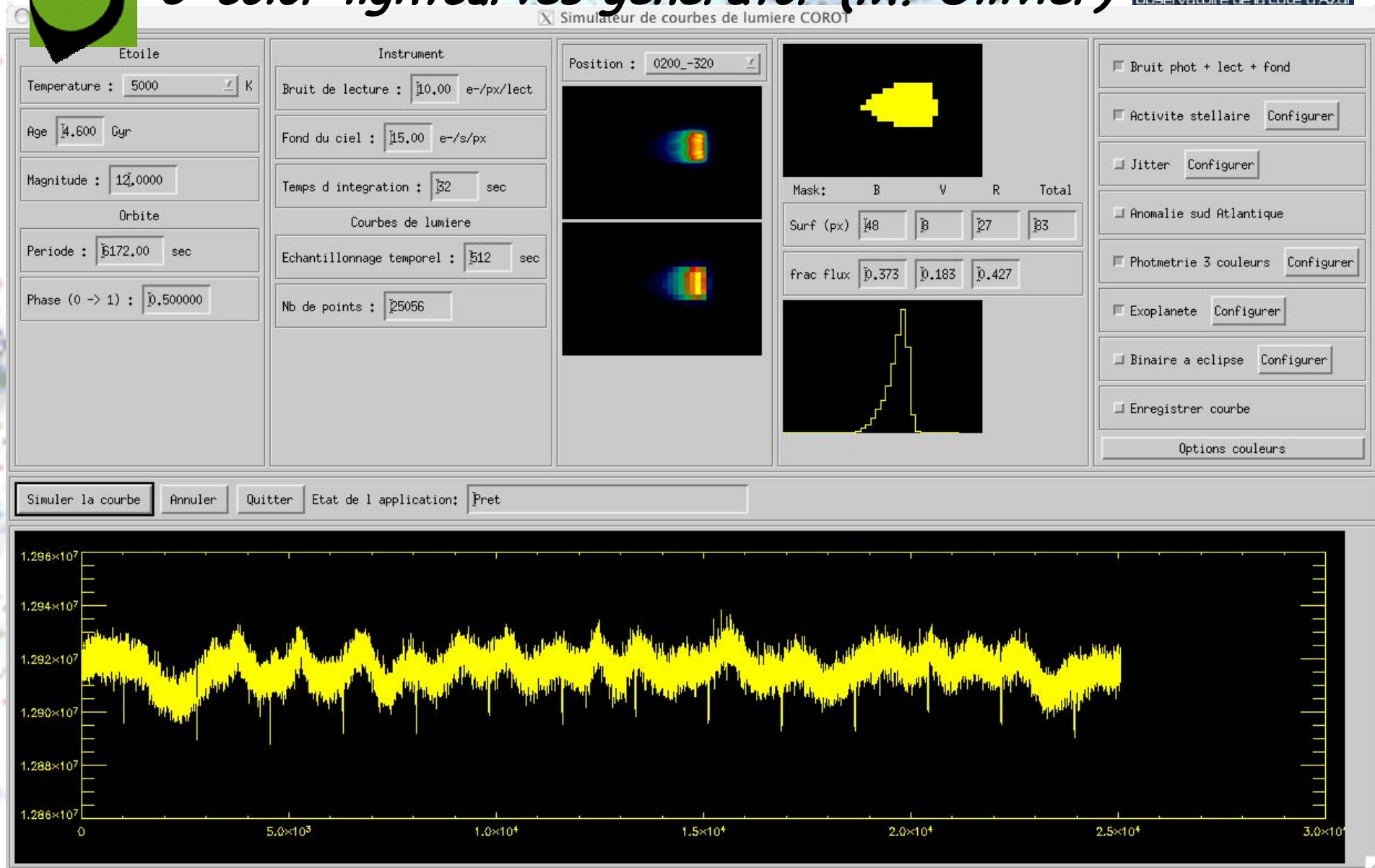



# Color lightcurves simulator

Takes into account :

- Quantum and electronic noises
- Stellar activity (S. Aigrain 's model)
- South Atlantic Anomaly
- Transiting Planet
- Position on the CCD
- Dedicated readout mask
- Jitter (to finalize)
- Possibility to compute 3 color lightcurves by correlating spectral canals.

# 3-color lightcurves generator (M. Ollivier)



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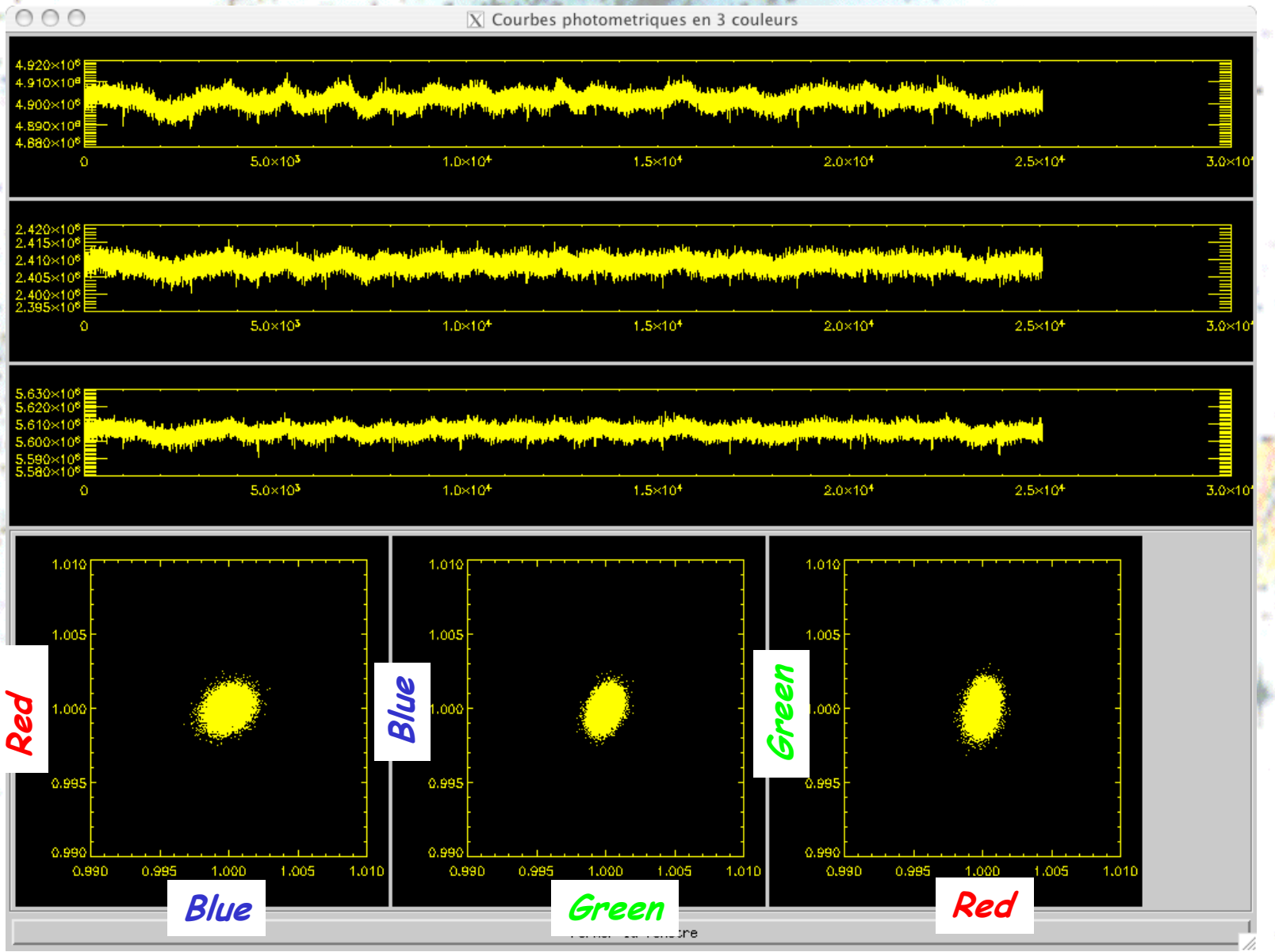

# Current status and prospectives

Efficient Matched Filter Algorithm

- we are currently developing it for polychromatic lightcurves analysis
- we have to study connection with systematic removal methods

Independant color lightcurves generator (used as a algorithm development and testing tool)

In-Lightcurve blends elimination research

Coupled with Corotlux program for statistical estimation of transit detected vs reminding blends