The Trend Filtering Algorithm

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Introduction

- Why we need trend-filtering?
  - - fake trends, systematics can hide or change the real signal (e.g. Planetary transits)
  - - better signal-to-noise ratio
- Trends due to:
  - Instrument
  - Data Reduction
  - Datapoints have measured during nights → 1 cycle/day signal (usually these are the strongest)
  - Yearly changes
  - Changes in temperature, seeing, etc. during observation

Trend Filtering Algorithm

- Kovács, G., Bakos, G. Á., & Noyes, R. W., 2005, MNRAS, 356, 557
- Target star/lightcurve and a bunch of template stars

- Principle: if there is a trend in the target time series, so as in some template time series, then the algorithm subtracts it from the target

1) Discrete Fourier Transformation (DFT) - sinusoidal signals
2) Box-Fitting Least Squares (BLS) - transits (trapezoidal signal)
   - Kovács, G., Zucker, S. & Mazeh, T. 2002, A&A, 391, 369

The method

- Choose template stars
- Create linear combination of all template LCs, which fits to the target LC the best
- Choose the weigths of template LCs in the filter function with simple least-squares criterion
- Restore the signal form (ie. subtract systematics: compute the scalar products of the traget and template time series and a correction parameter (weight) → subtract that from the target time series)

Starting Parameters

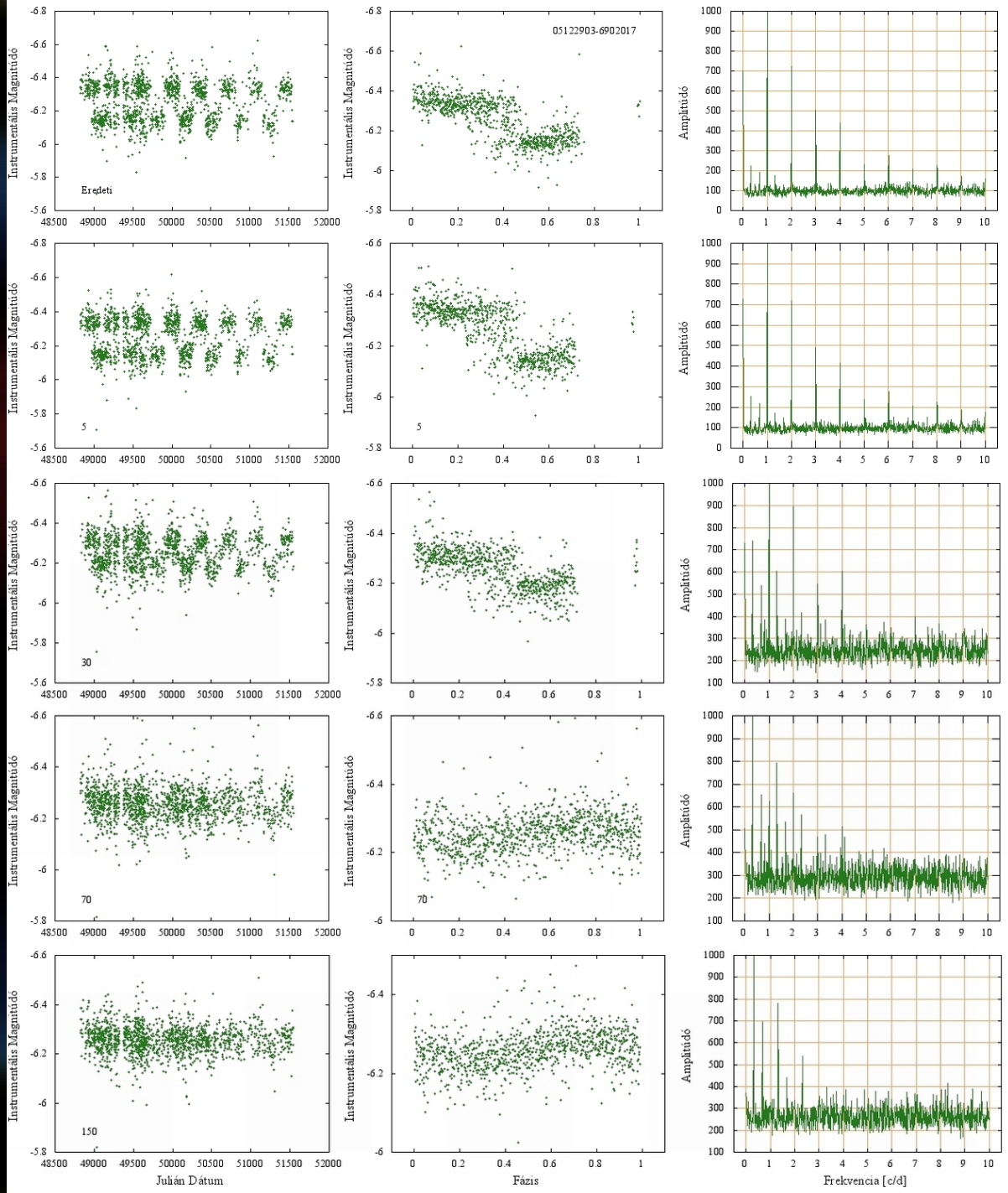
- 36 parameters which you can change in the parameter file, for example:
  - Number of template datapoints
  - Template selection parameters (sigma clipping, minimal magnitude, minimal number of points, etc.)
  - Number of frequency steps
  - Other DFT/BLS parameters
- What is useful to know about TFA:
  - Fortran code
  - Slooow
  - Already contains BLS → you will get a bunch of candidates

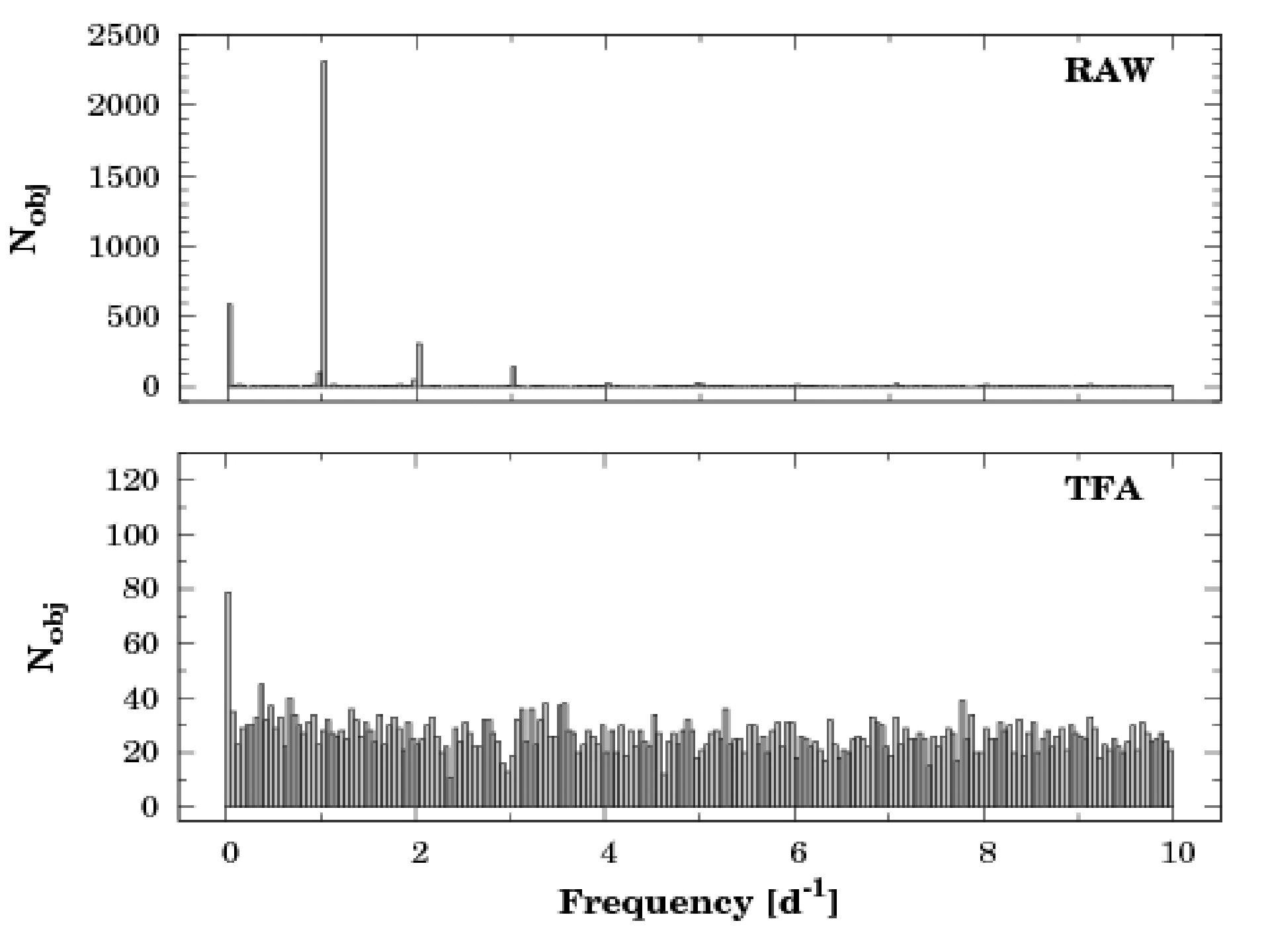
Why do we not filter out real signals?

- It is unlikely that real signal/variation is very similar and happens at the same time
- Only problem I experienced: long-periodic/aperiodic variables → disortion of the signal can happen sometimes
  - You do not know, whether it is real or not

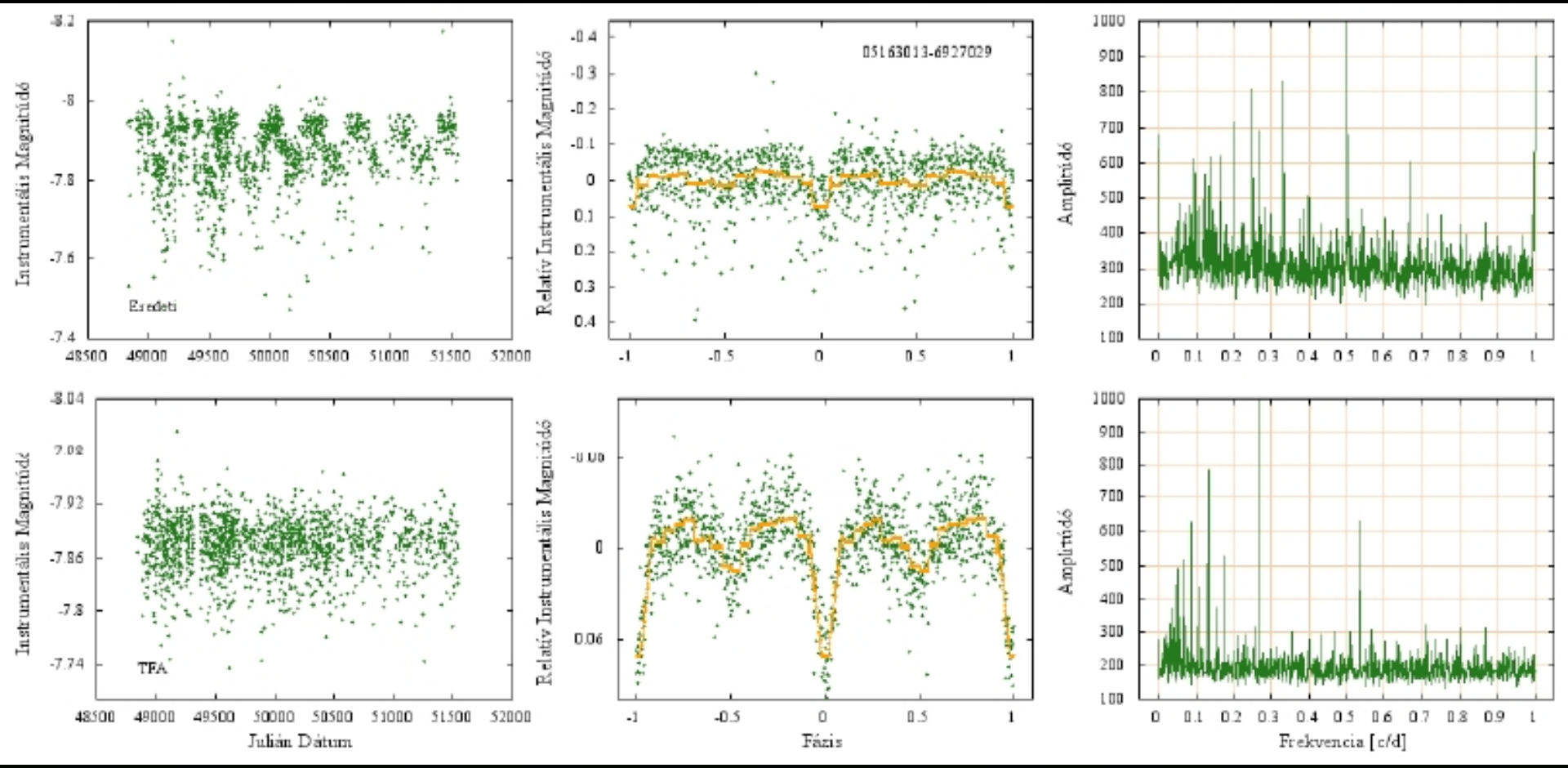
TFA vs. Sysrem

- Sysrem: Tamuz, O.; Mazeh, T.; Zucker, S., 2005, MNRAS, 356, 1466
- Basically the same idea
- The difference: how to choose the template stars
  - TFA: grid based on position (and magnitude)
  - Sysrem: all * (?)
- Different exoplanet surveys use them
  - TFA: HATNet

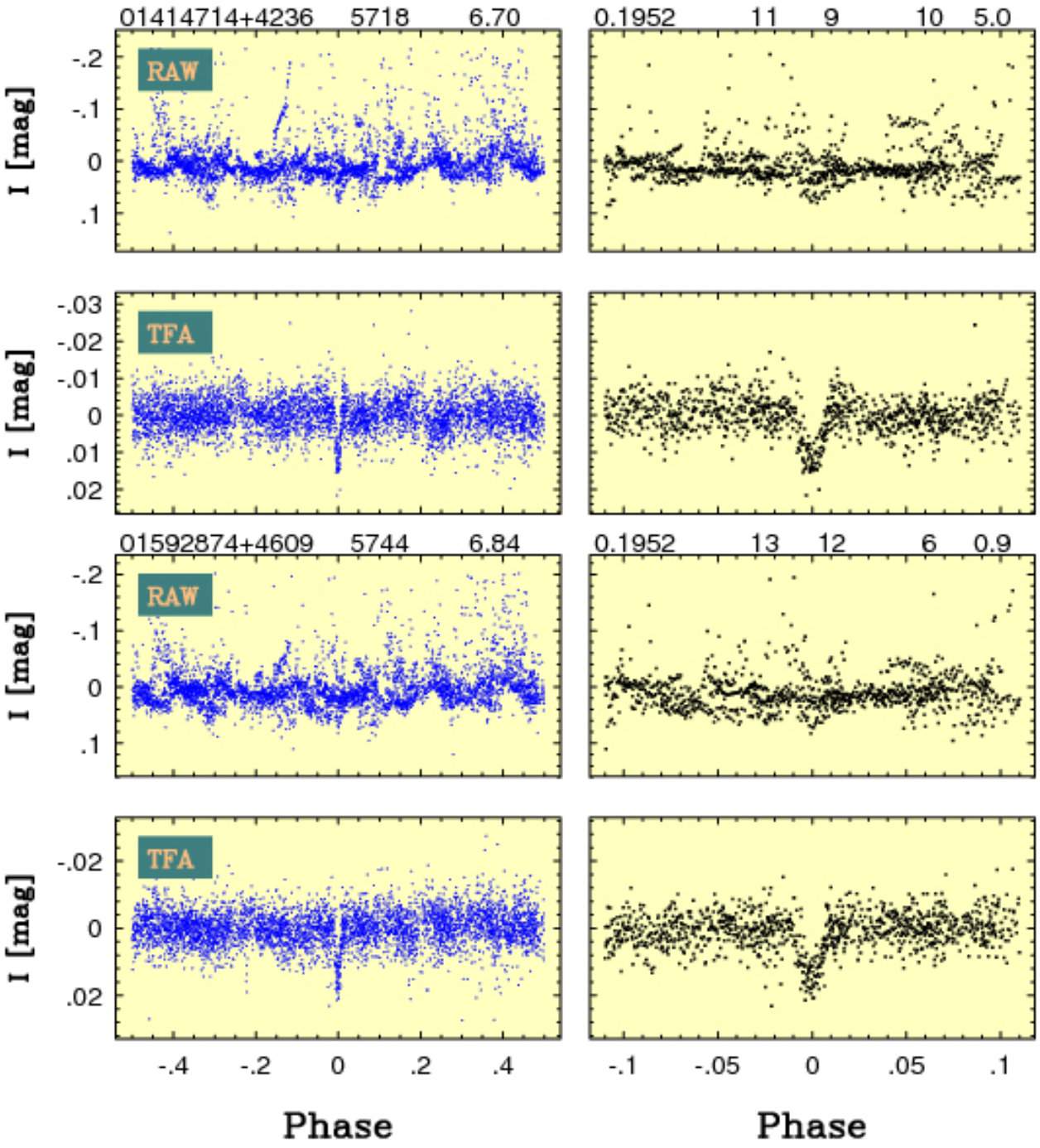

05122903-6902017
Eredeti
5
5
30
70
70
150
Instrumentális Magnitúdó
Amplitúdó
Julián Dátum
Fázis
Frekvencia [c/d]


RAW
TFA
N_{obj}
N_{obj}
2500
2000
1500
1000
500
0
120
100
80
60
40
20
0
0
2
4
6
8
10
Frequency [d^{-1}]

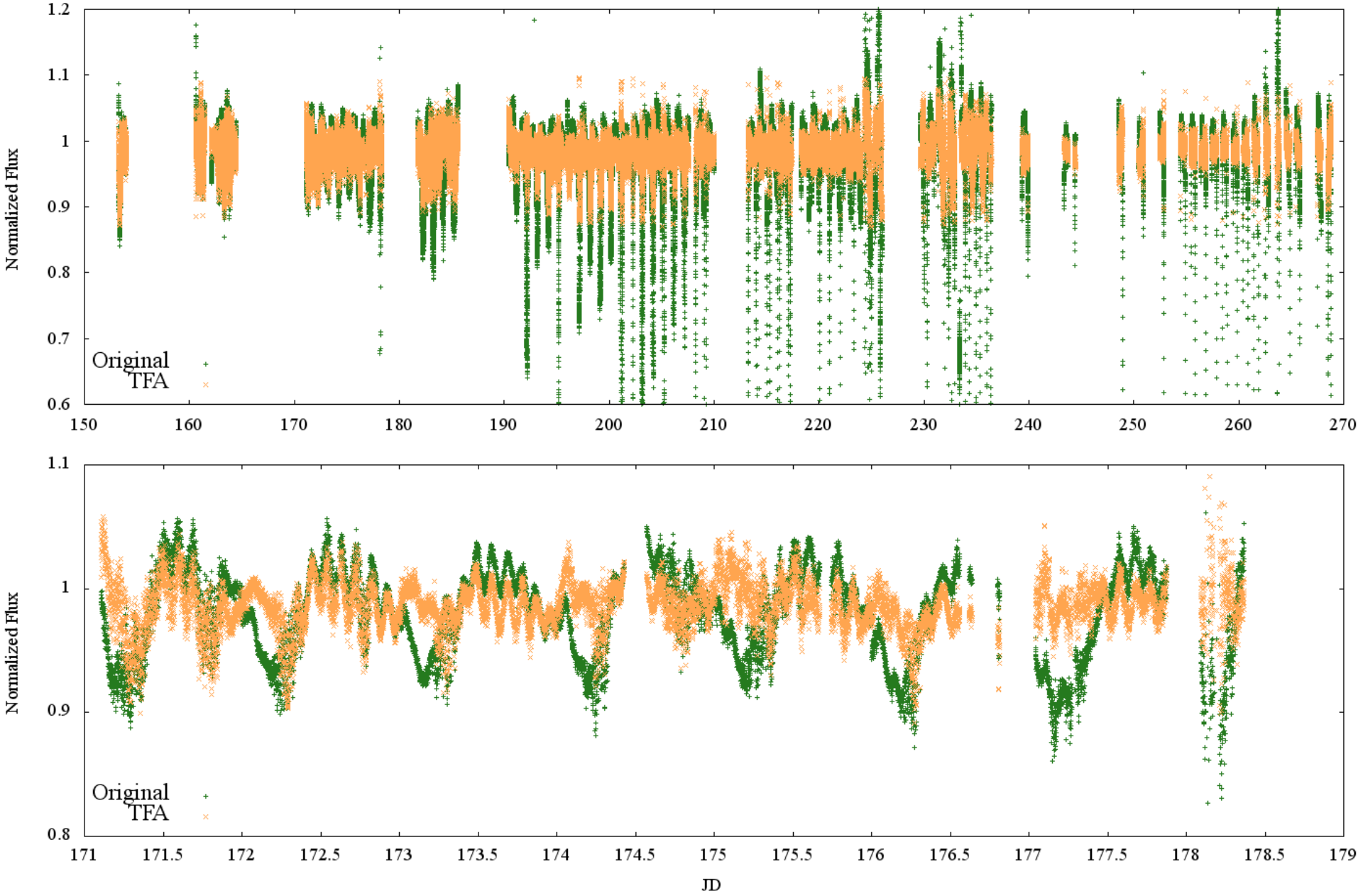
Eclipsing Binary -- 0.267228 c/d -- SNR = 31.7 /MACHO/



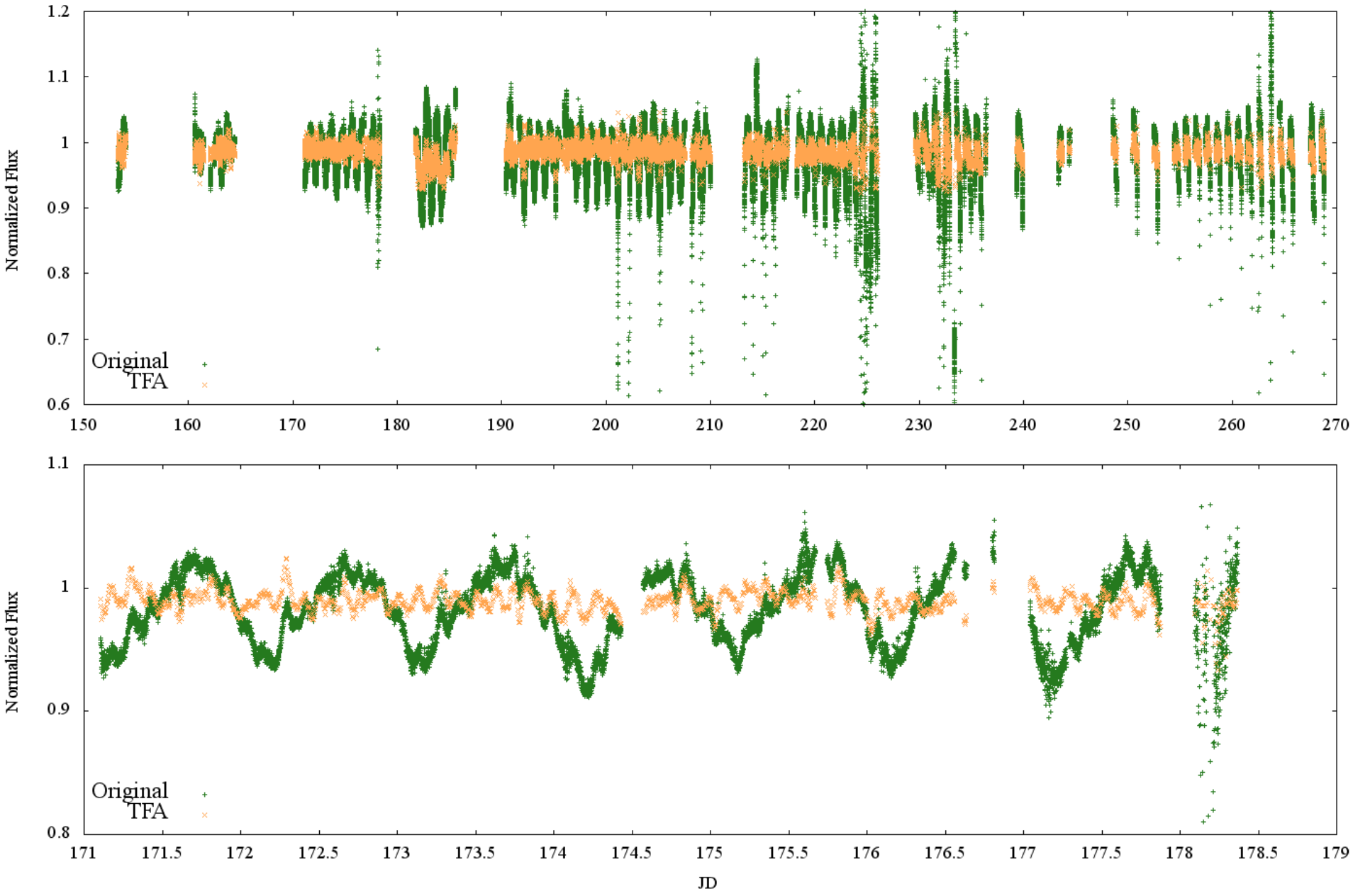
HATNet


01414714+4236 5718 6.70
0.1952 11 9 10 5.0
RAW
TFA
01592874+4609 5744 6.84
0.1952 13 12 6 0.9
RAW
TFA
I [mag]
Phase
Phase

ASTEP South


Normalized Flux
1.2
1.1
1
0.9
0.8
0.7
0.6
Original
TFA
150
160
170
180
190
200
210
220
230
240
250
260
270
Normalized Flux
1.1
1
0.9
0.8
Original
TFA
171
171.5
172
172.5
173
173.5
174
174.5
175
175.5
176
176.5
177
177.5
178
178.5
179
JD

ASTEP South



0.5013476 c/d -- SNR = 10.6 /ASTEP South/

