How to detect the spectroscopic binaries in the GES?

T. Merle & S. Van Eck, on behalf of WG14

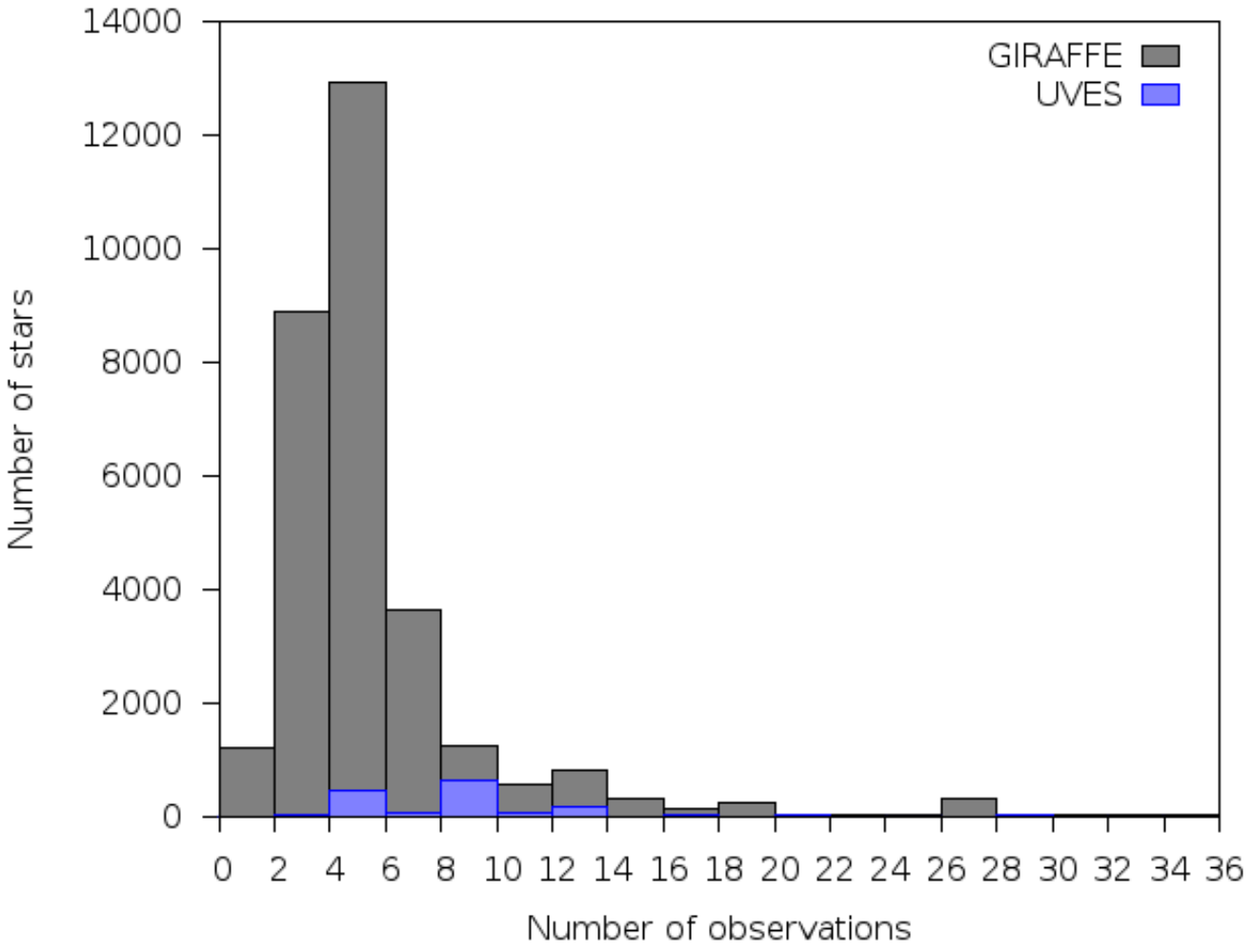
2014-11-13 – GES Second Science Meeting – Porto

Statistics of iDR2: GIRAFFE and UVES

- iDR2: use of the individual unstacked spectra (GIRAFFE + UVES)

- GIRAFFE
  - 145496 spectra
  - 30532 stars

- UVES
  - 13453 spectra
  - 1597 stars

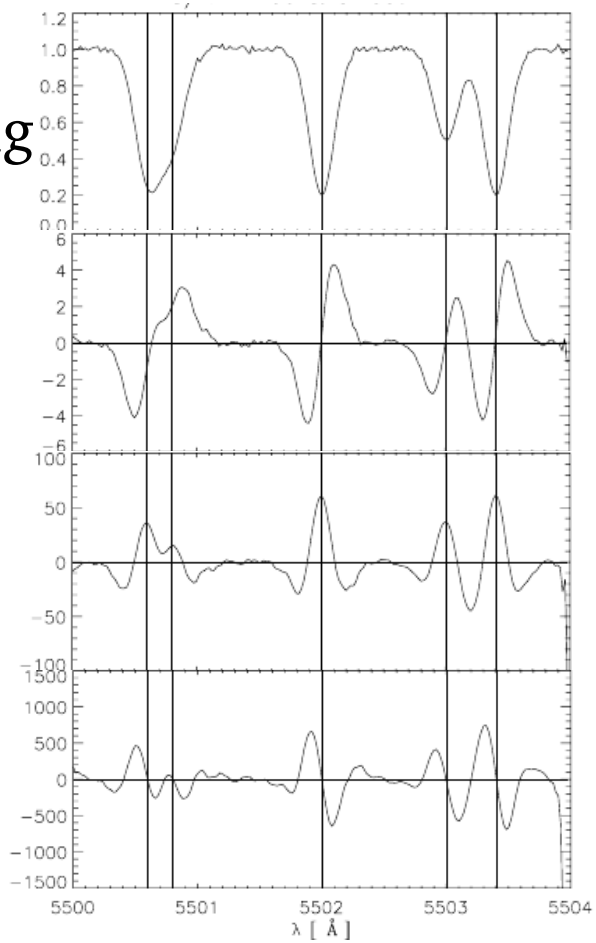


The successive derivatives of the CCFs is used to detect peaks

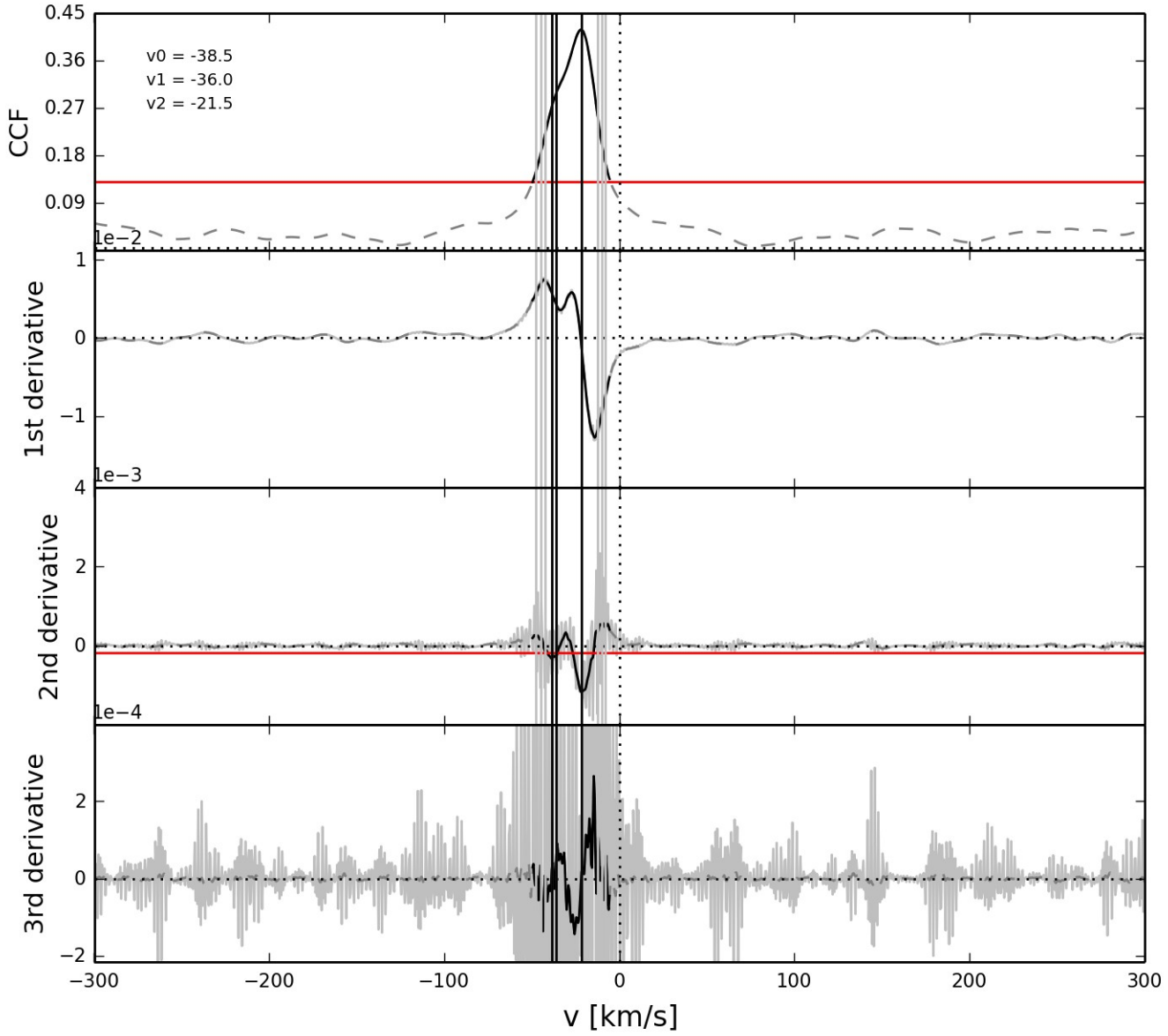
- CCF = Cross Correlation Function
- For GIRAFFE spectra: CCFs computed by pipelines at CASU (Lewis et al., in prep.) using synthetic spectra templates from U. Munari.
- For UVES spectra: CCFs computed by INAF—Arcetri (Sacco et al., in prep.) using GES synthetic grid from de Laverny et al. 2012.

- Basic idea from the ARES code

  (Sousa et al. 2007 A&A 469, 783)



The cut frequency is empirically adjusted

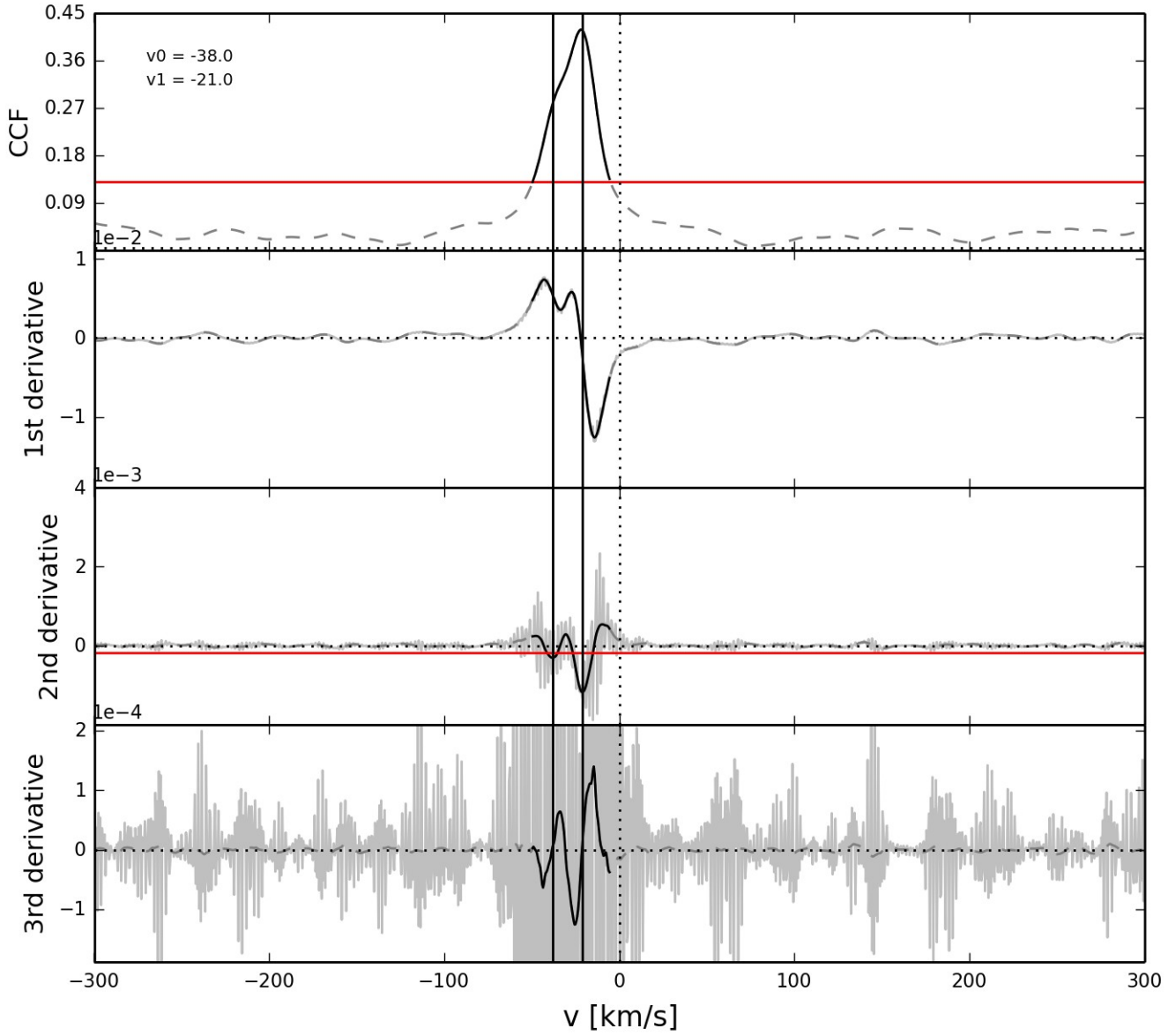


3rd order Butterworth Low-pass filter

First parameter:

Frequency cut of the filter for smoothing the successive derivatives of the CCF

The cut frequency is empirically adjusted



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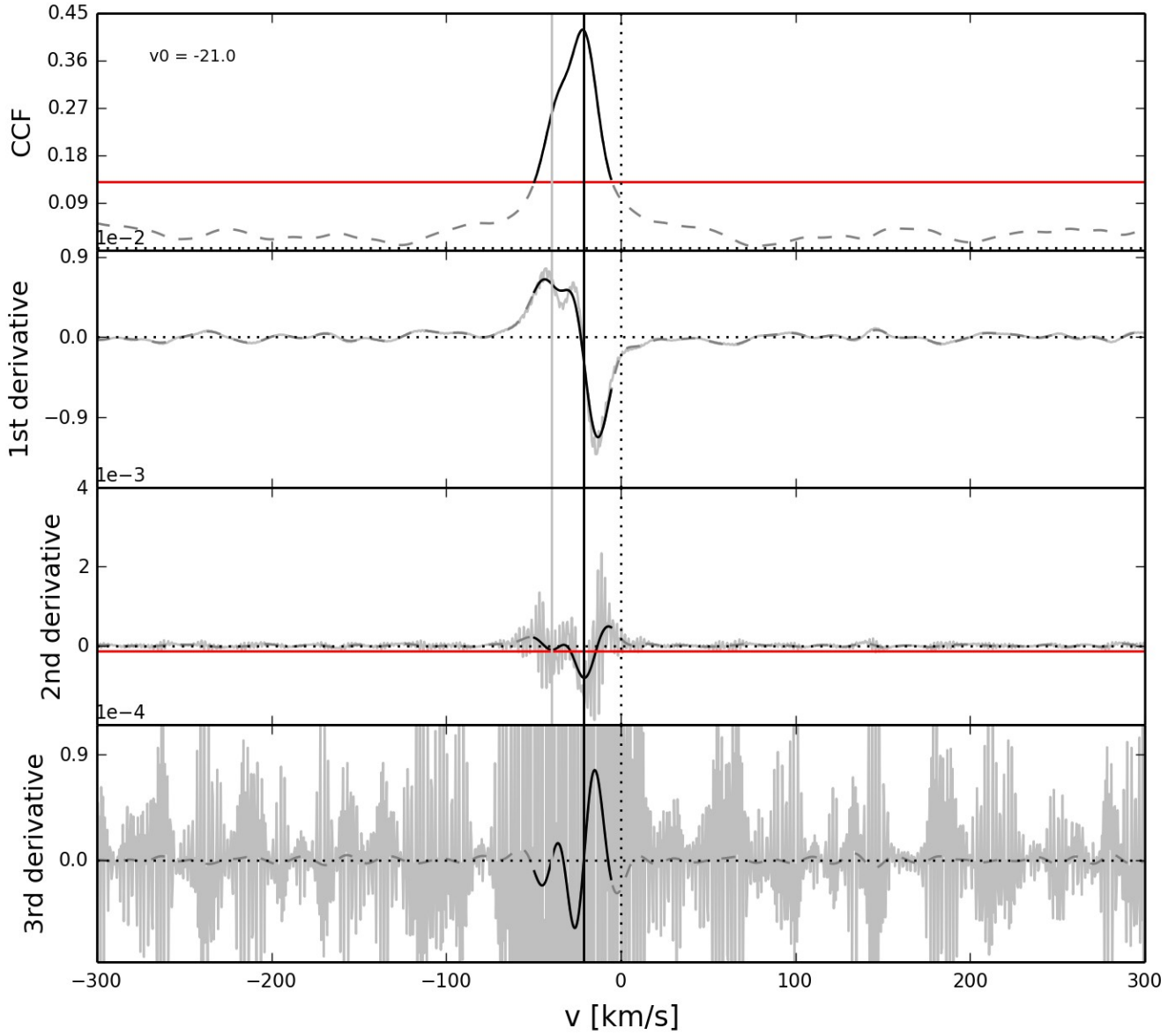

3rd order Butterworth Low-pass filter

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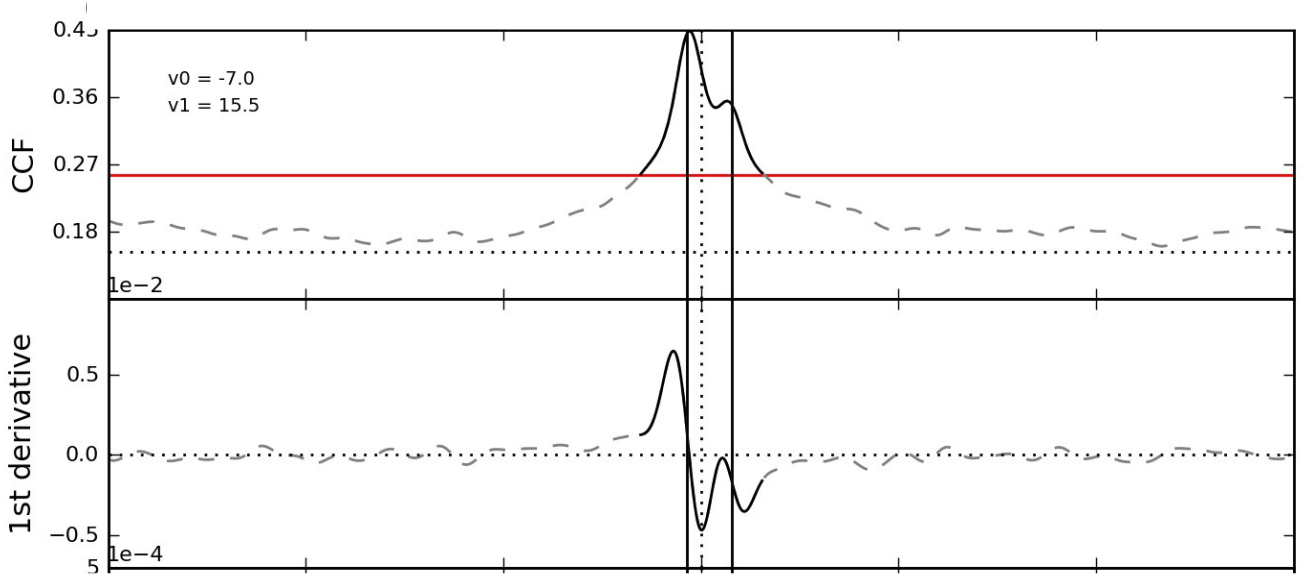
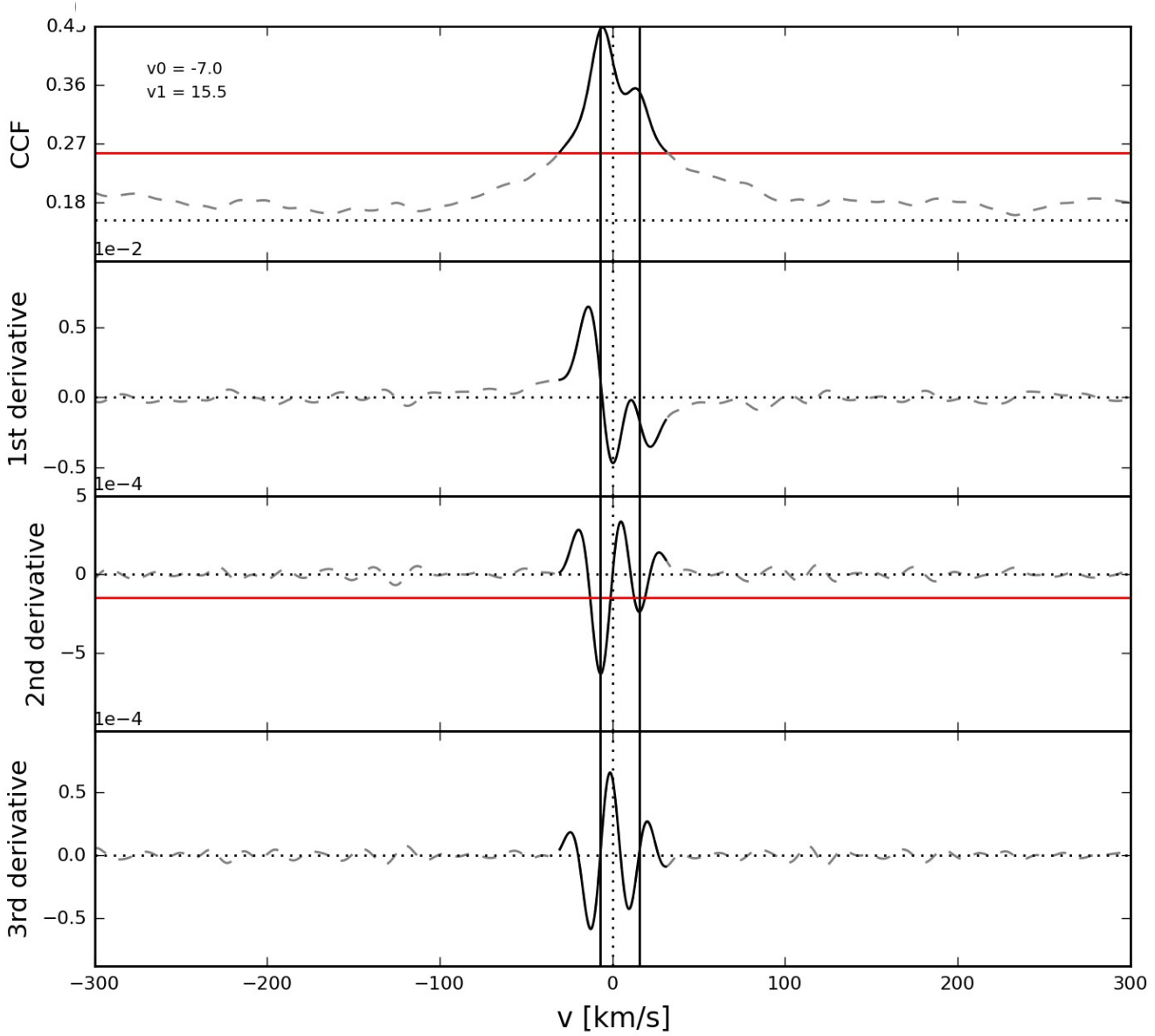
Frequency cut of the filter for smoothing the successive derivatives of the CCF

Second CCF derivatives give the positions of the close double peaks



Second CCF derivatives give the positions of the close double peaks



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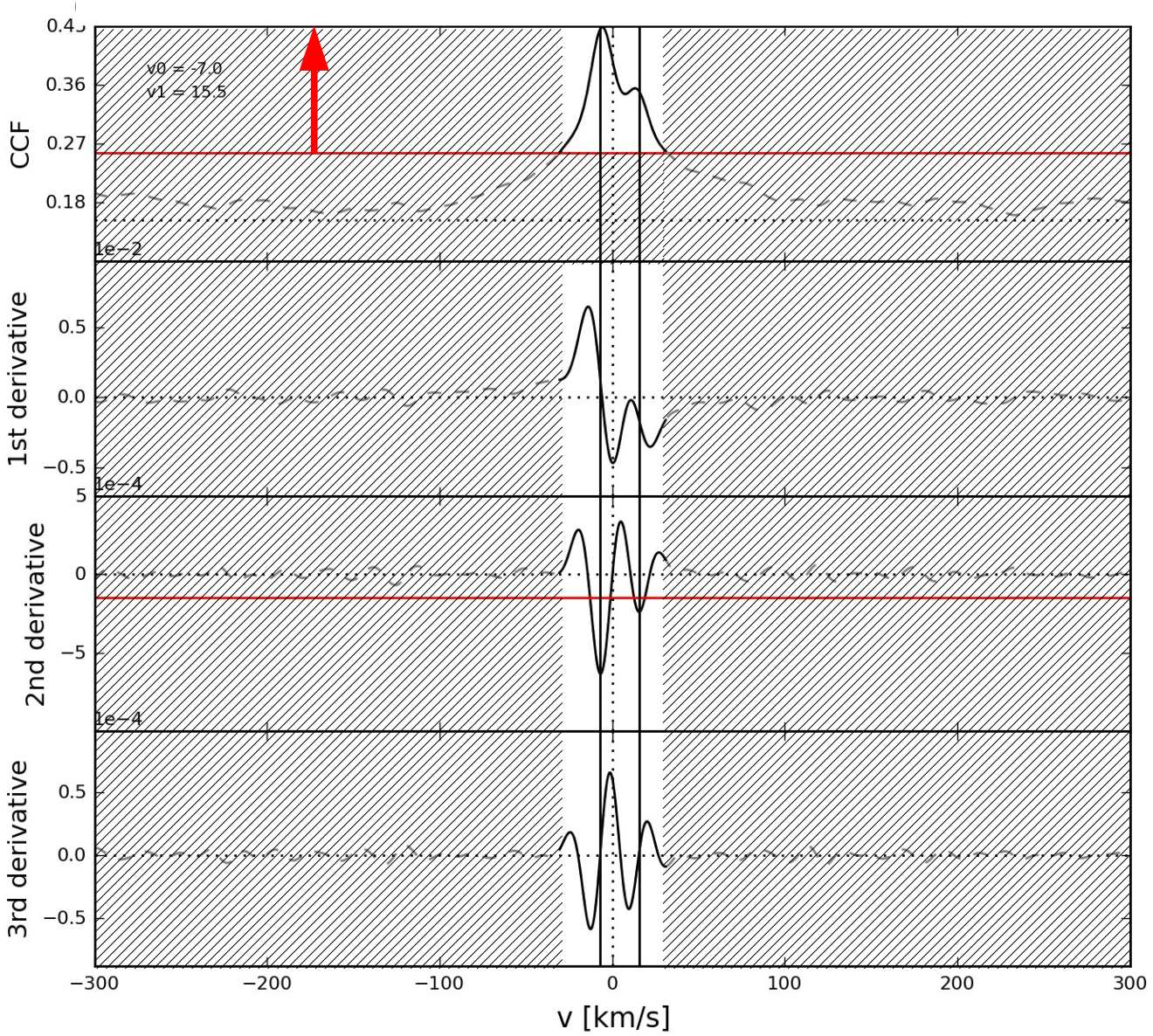
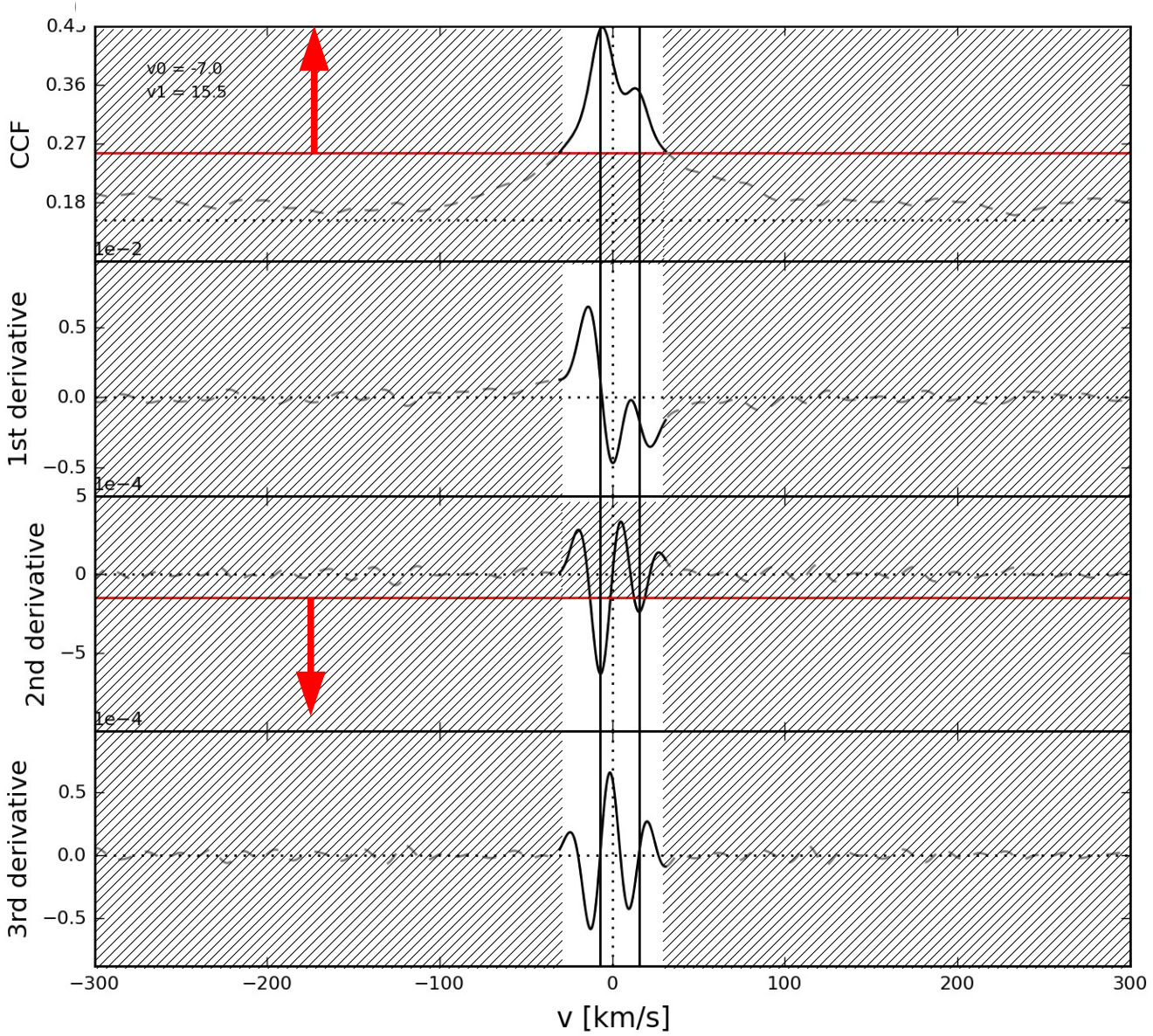


2nd parameter:

Threshold on the CCF

Second CCF derivatives give the positions of the close double peaks



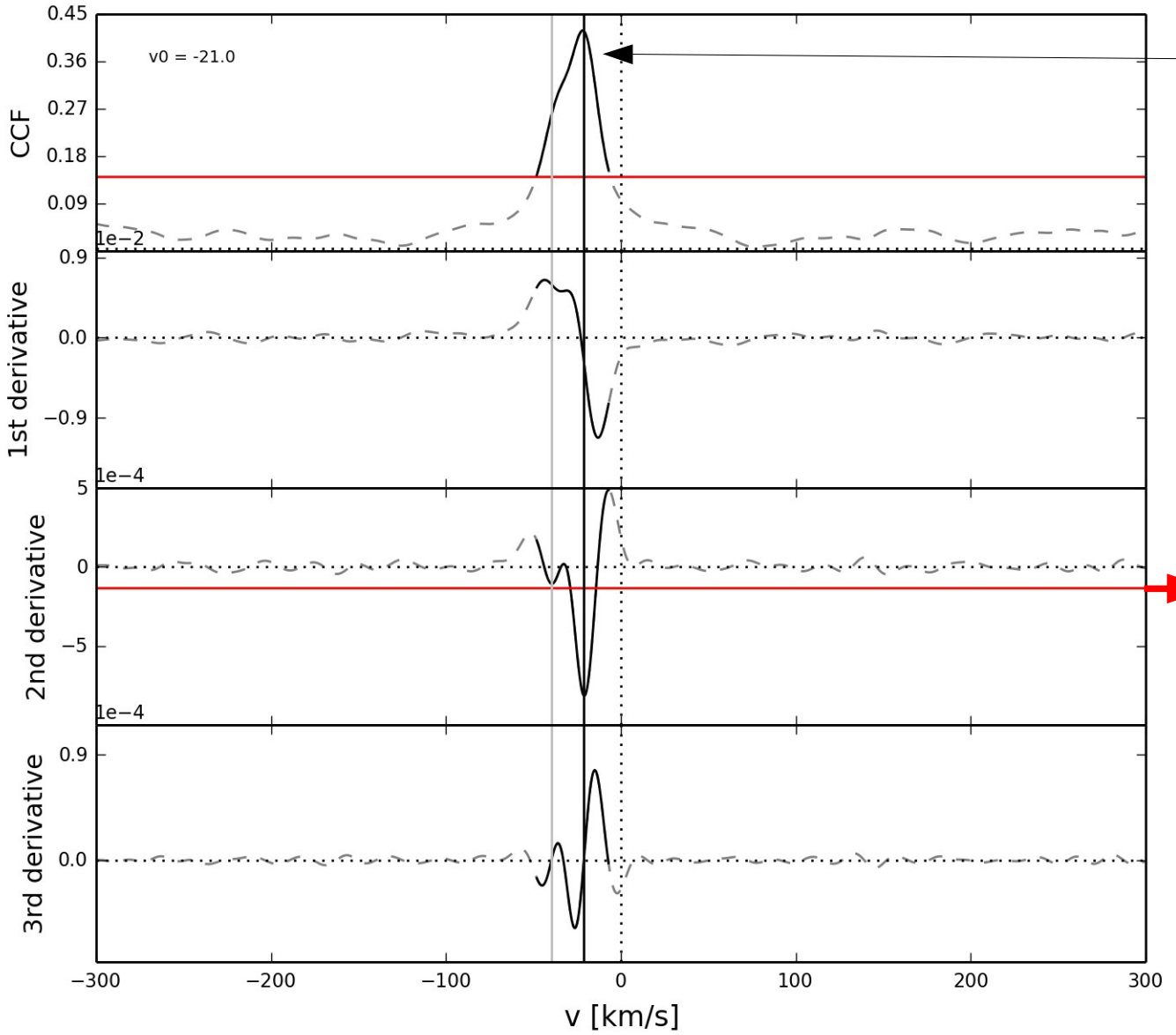
2nd parameter:

Threshold on the CCF

3rd parameter:

Threshold on the 2nd derivative

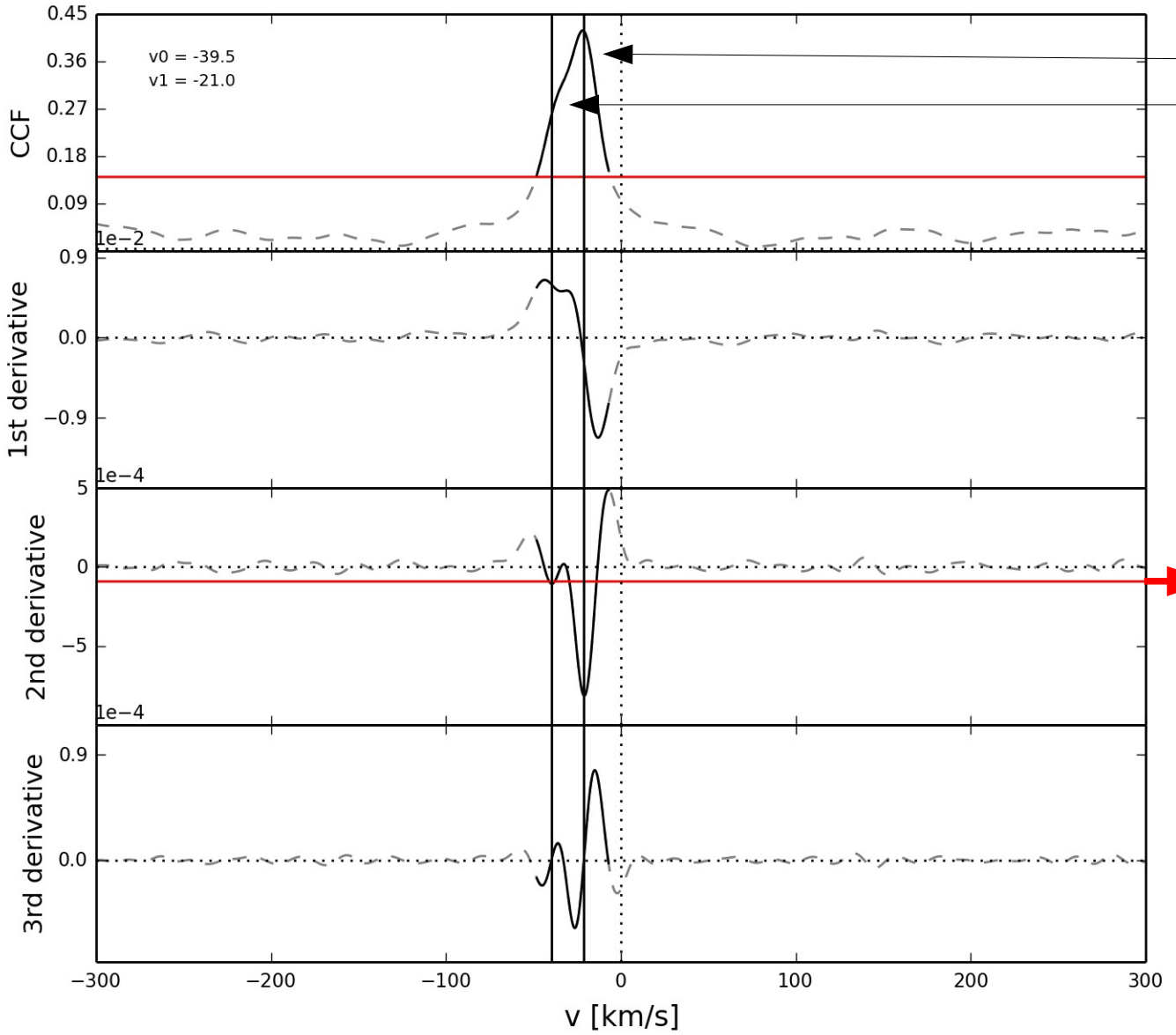
Close double peaks are easily detected



1 peak detected

Threshold on the 2nd derivative = 10 % of the full amplitude

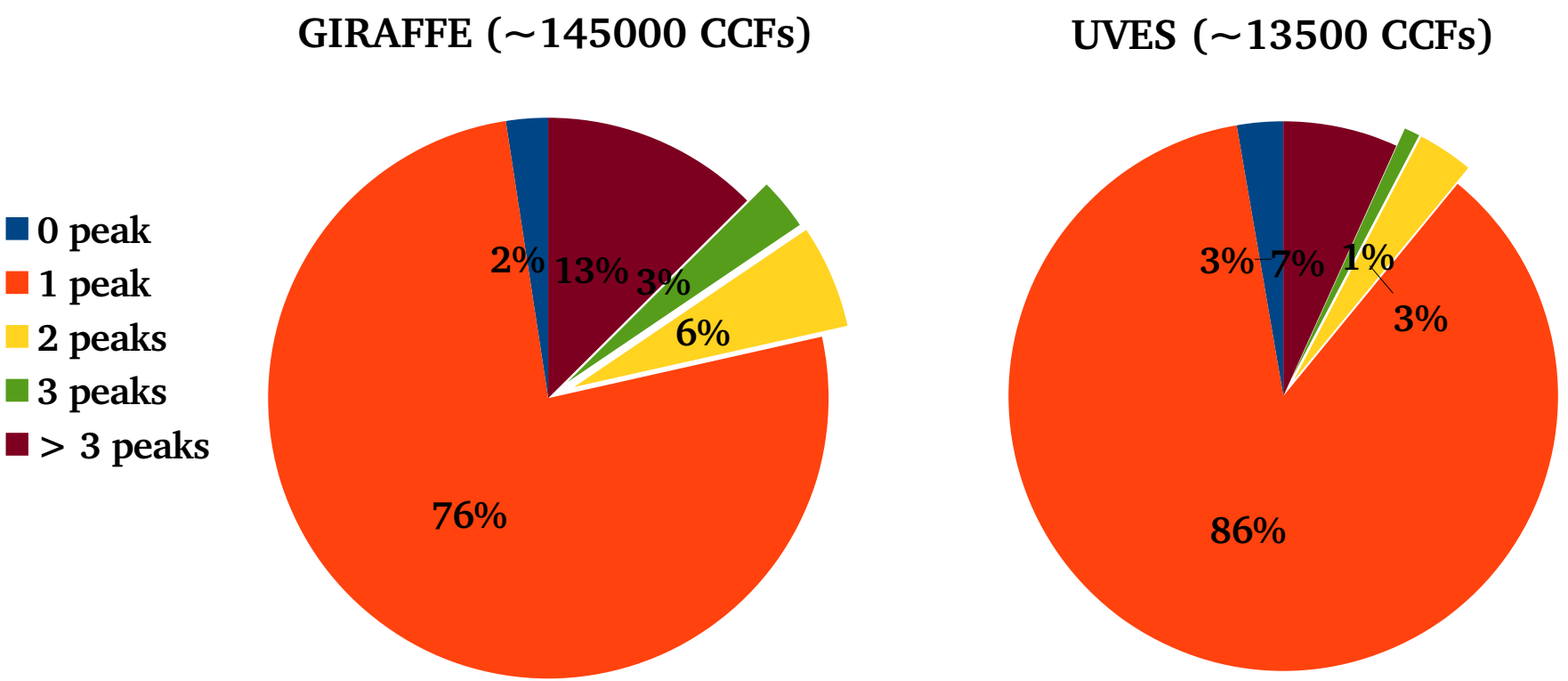
Close double peaks are easily detected



2 peaks detected

Threshold on the 2nd derivative = 7 % of the full amplitude

Raw results of the automatic peaks detection



Automatic SB2/3 classification in DR2.1: GIRAFFE and UVES

The strongest criterium:

Same number of peaks for all observations in all setups

Stars	GIRAFFE	%	UVES	%
SB2 candidates	**412**	**1.3**	**32**	**2.0**
SB3 candidates	47	0.1	2	0.1
Total stars	30532	100	1597	100

The weakest criterium:

At least one N-peaked CCF per star (with N = 2 or 3)

Stars	GIRAFFE	%	UVES	%
SB2 candidates	4346	14.2	132	8.3
SB3 candidates	2953	9.7	64	4.0
Total stars	30532	100	1597	100

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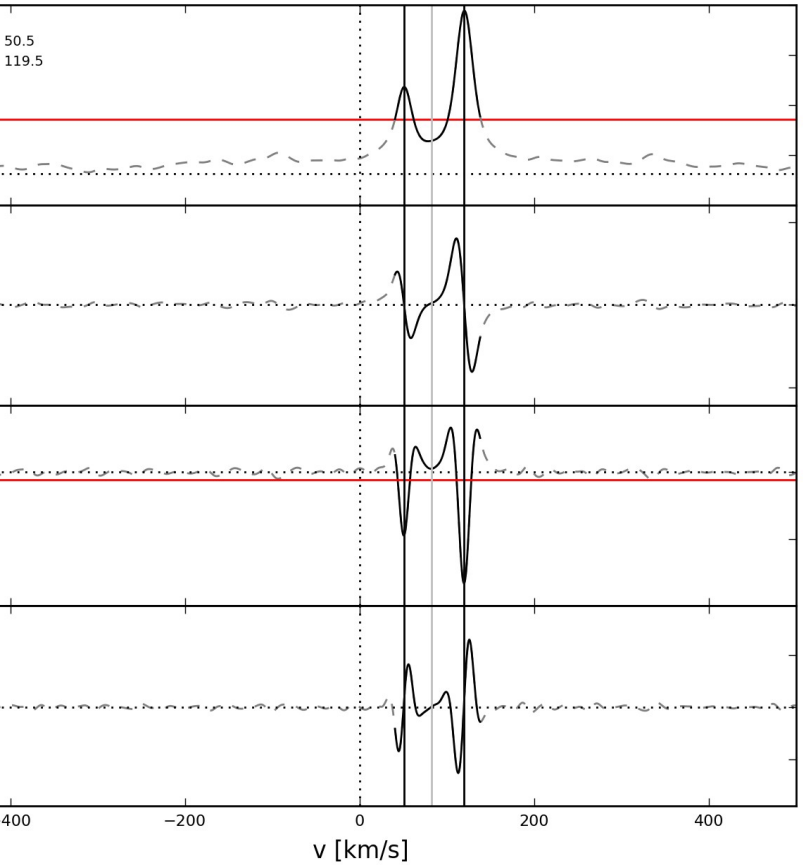
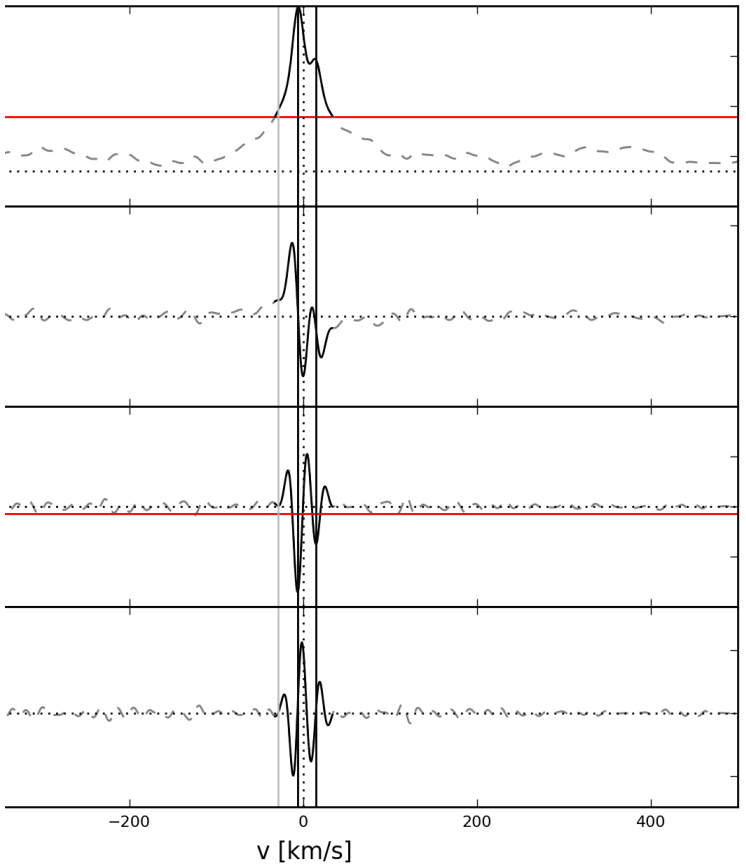
UVES SB2 candidates: visual inspection

32 candidates / 1597 stars (2.1 %)

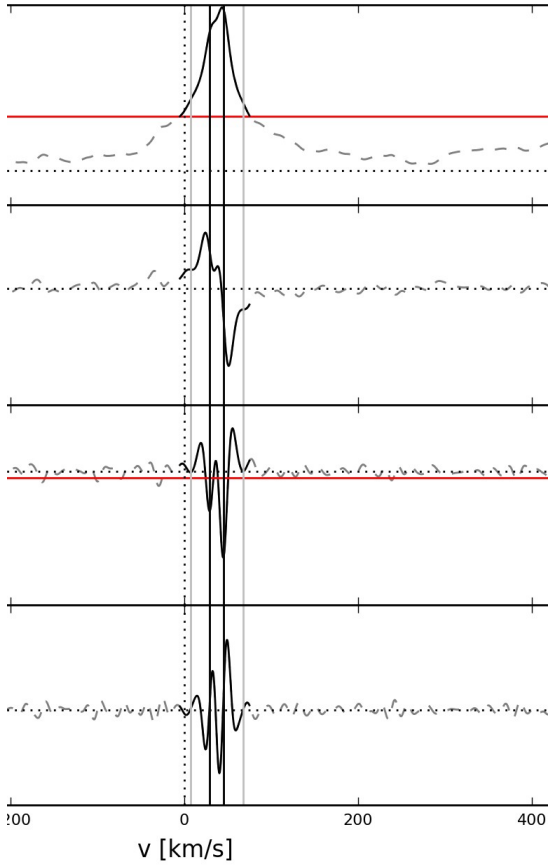
The strongest criterium:
Same number of peaks for all observations in all setups



Probable detection
Confidence flag A
6 (0.4 %)



Possible detection
Confidence flag B
14 (0.9 %)

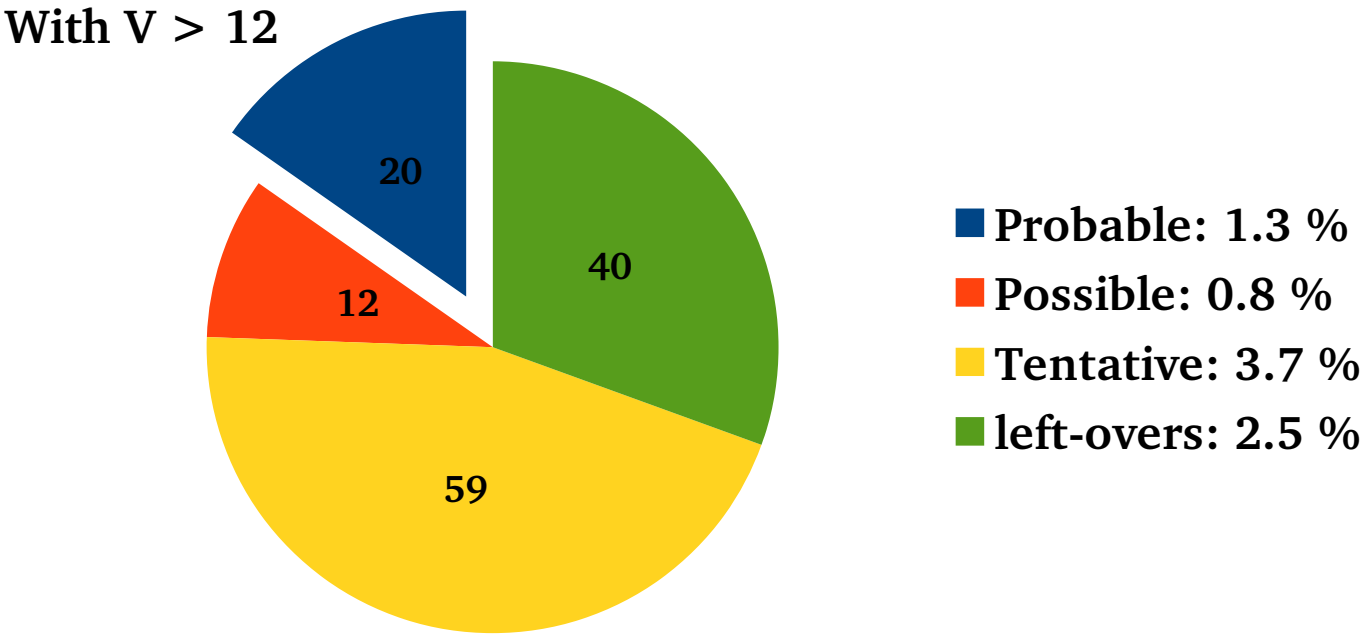


Tentative detection
Confidence flag C
12 (0.8 %)

UVES SB2 candidates: visual inspection

The weakest criterium:
At least one double-peaked CCF per star

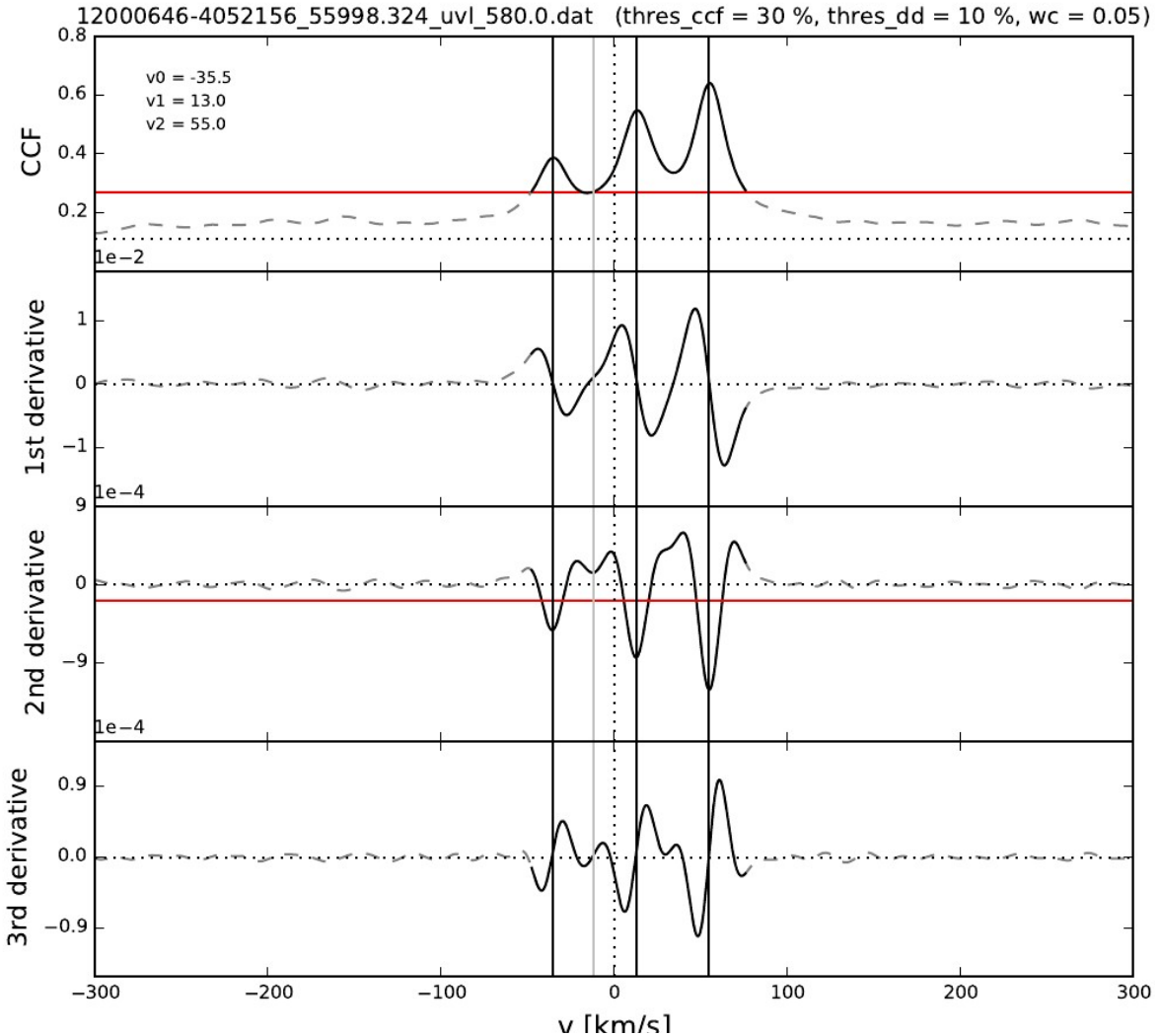
132 candidates / 1597 stars (8.3 %)



1 example of UVES SB3 candidate

The strongest criterium:

Same number of peaks for all observations in all setups



8 CCFs with 3 peaks detections
(but the same night)

Not in Simbad
(within a radius of 2 arcmin)

GES_MW
APASS photometry
V = 14.31 ± 0.06
From Fibinfo extension
RV = 12.5 ± 0.6 km/s

RV_SB2 = 1

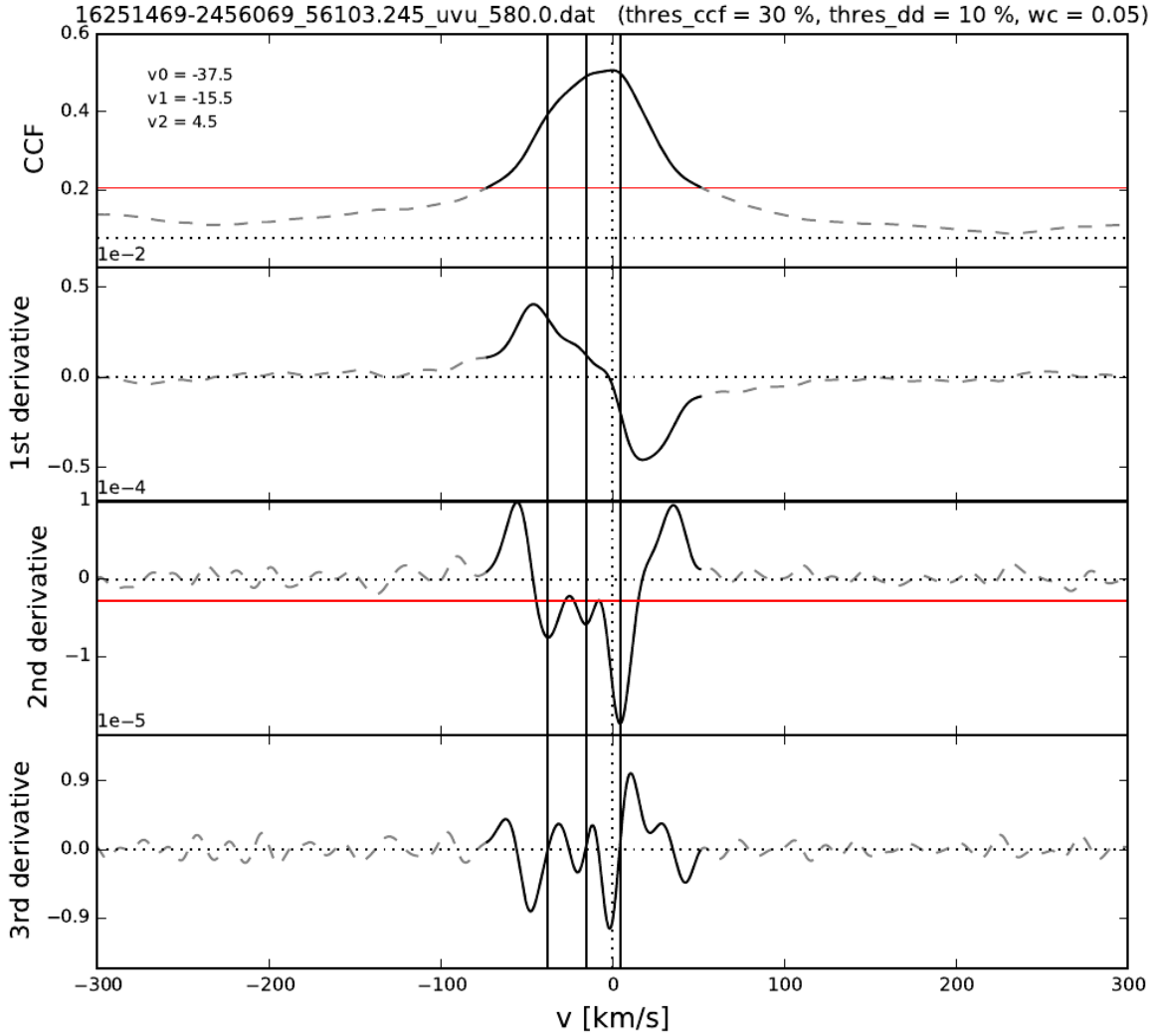
TMPL_TEFF = 5000 K
TMPL_LOGG = 4
TMPL_FEH = -1

Recommended parameters
T_{eff} = 6058 ± 250 K
Log g = 4.54 ± 0.53
[Fe/H] = -0.40 ± 0.33

Fake UVES SB3

The strongest criterium:

Same number of peaks for all observations in all setups



4 CCFs with 3 peaks detection (but the same night)

V ~12.9

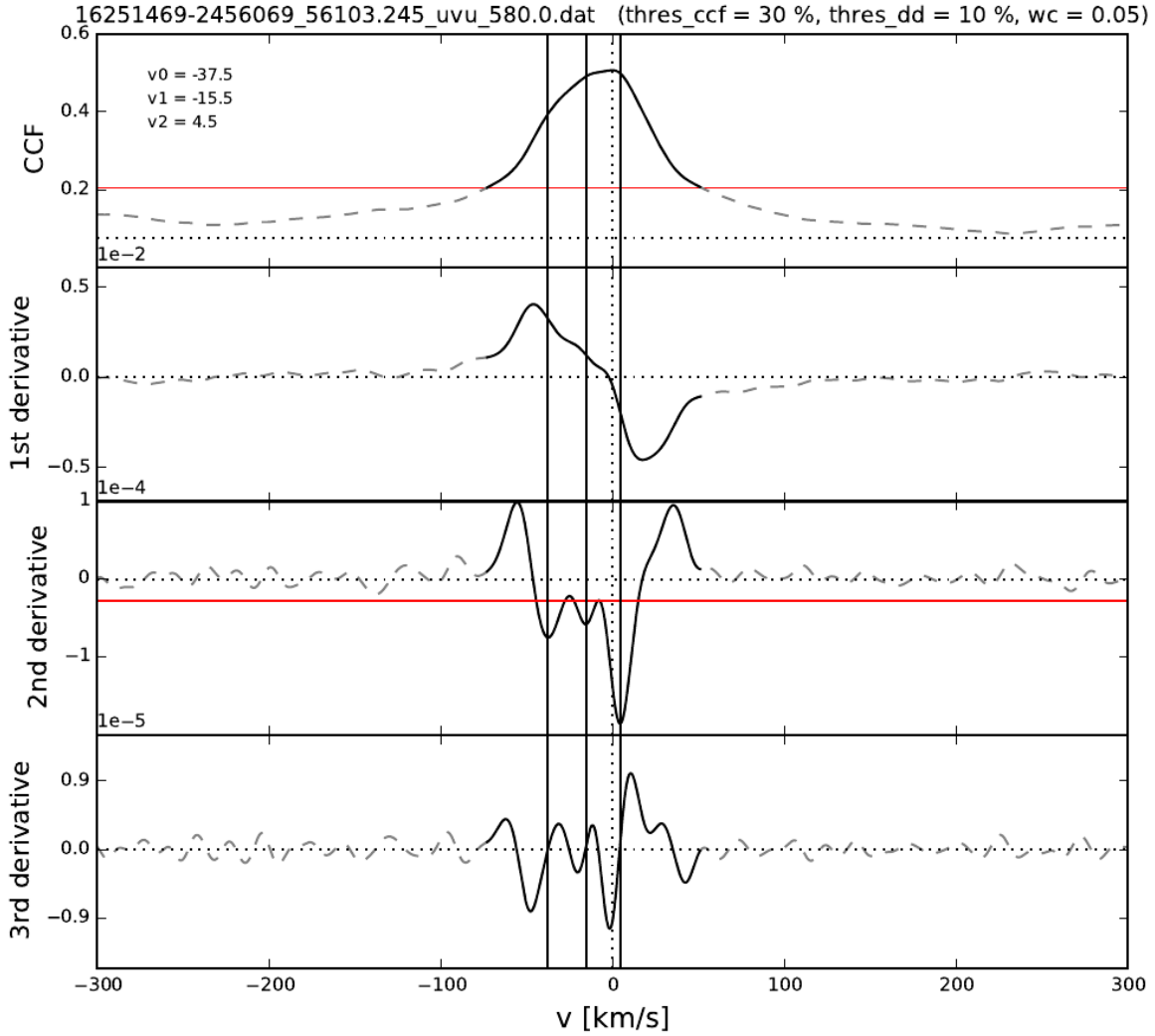
Object: TARGET_38

RV=-3.34 ± 0.60 km/s

Fake UVES SB3

The strongest criterium:

Same number of peaks for all observations in all setups



4 CCFs with 3 peaks detection (but the same night)

V ~12.9
Object: TARGET_38
RV=-3.34 ± 0.60 km/s

Simbad identification:
d = 6.24"

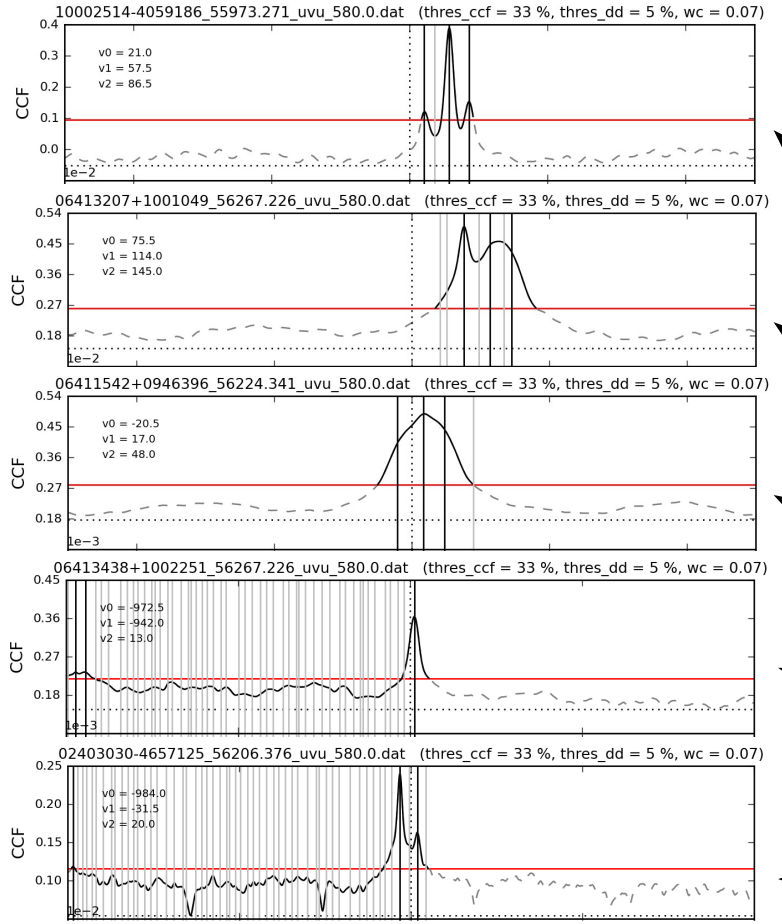
2MASS J16251469-2456069

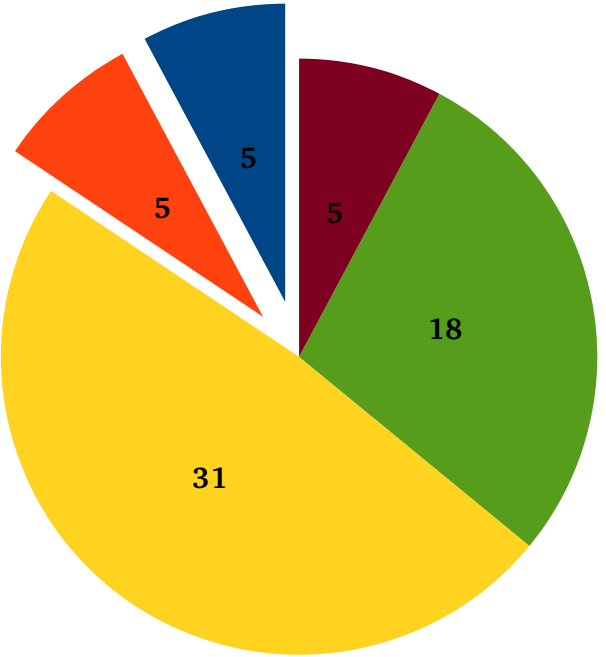
Known as T Tau-type Star

UVES SB3 candidates: visual inspection

The weakest criterium:

At least one triple-peaked CCF per star





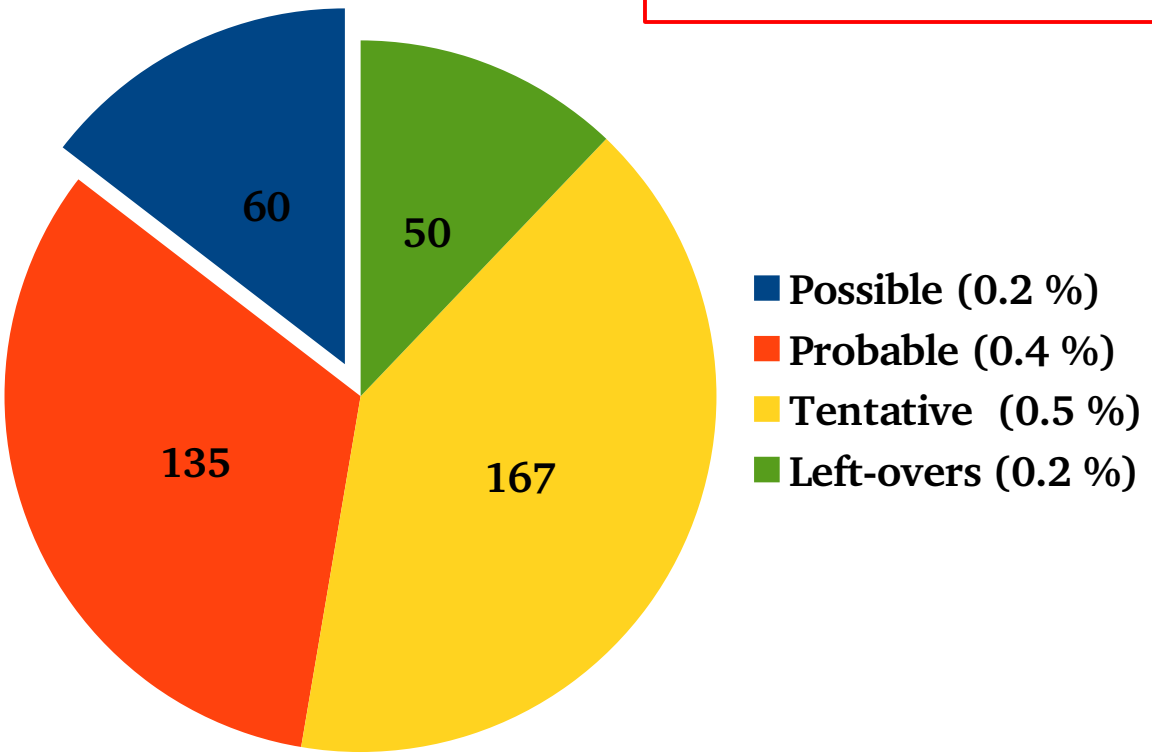
- **Probable: 0.3 %**
- **Possible: 0.3 %**
- **Tentative: 1.9 %**
- **outliers: 1.1 %**
- **SB2 candidates 0.3 %**

GIRAFFE SB2 candidates: visual inspection

The strongest criterium:

Same number of peaks for all observations in all setups

412 candidates / 30532 stars (2%)



Conclusions

- The successive derivatives of the CCFs are used
  to automatically detect peaks and asymmetries in the CCFs of the GES spectra

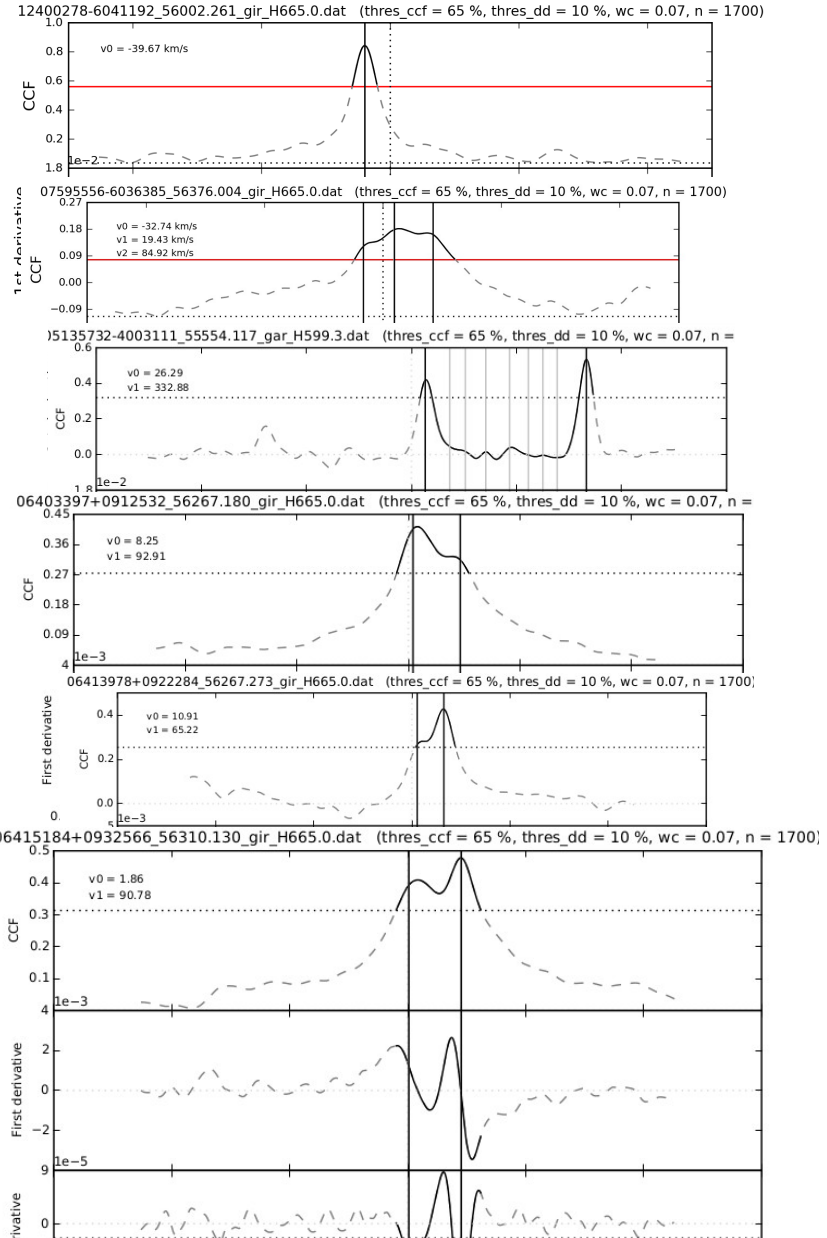
- UVES: **20 SB2, 1 SB3** (among 1597 stars)

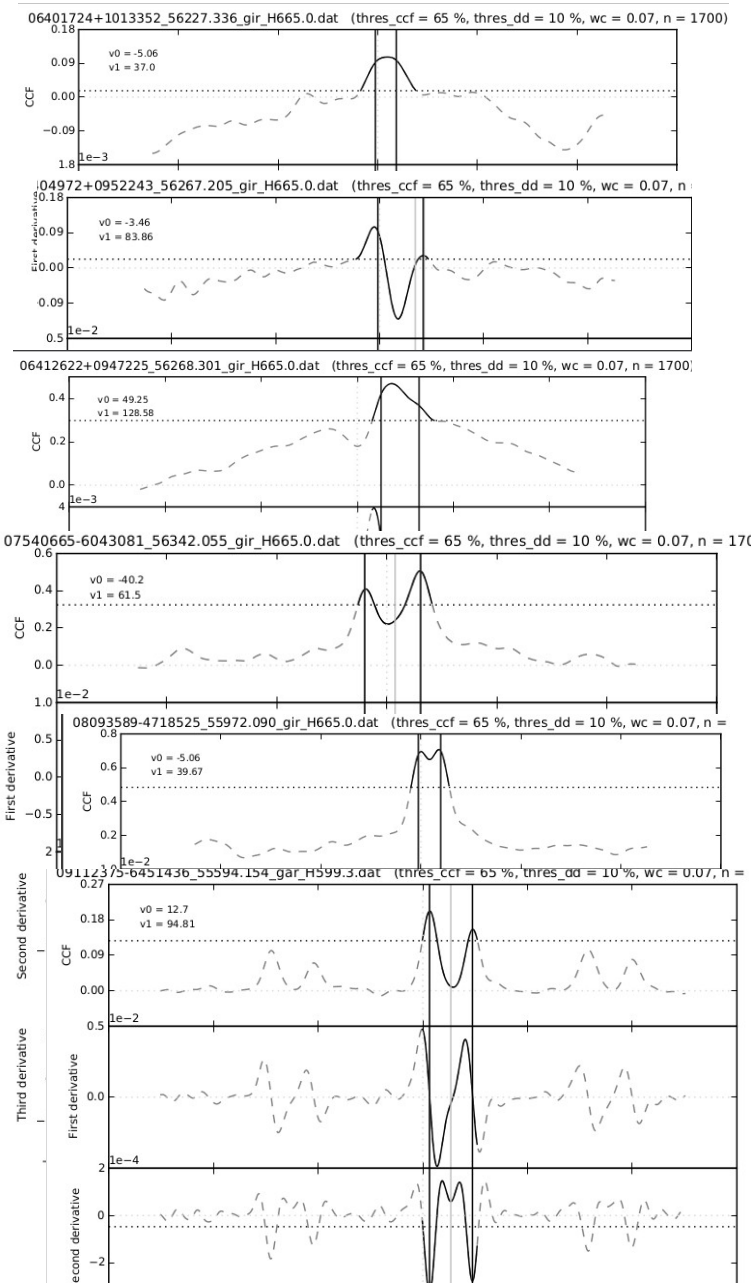
- GIRAFFE: **60 SB2**, no clear SB3 for the moment (among 30 532 stars)

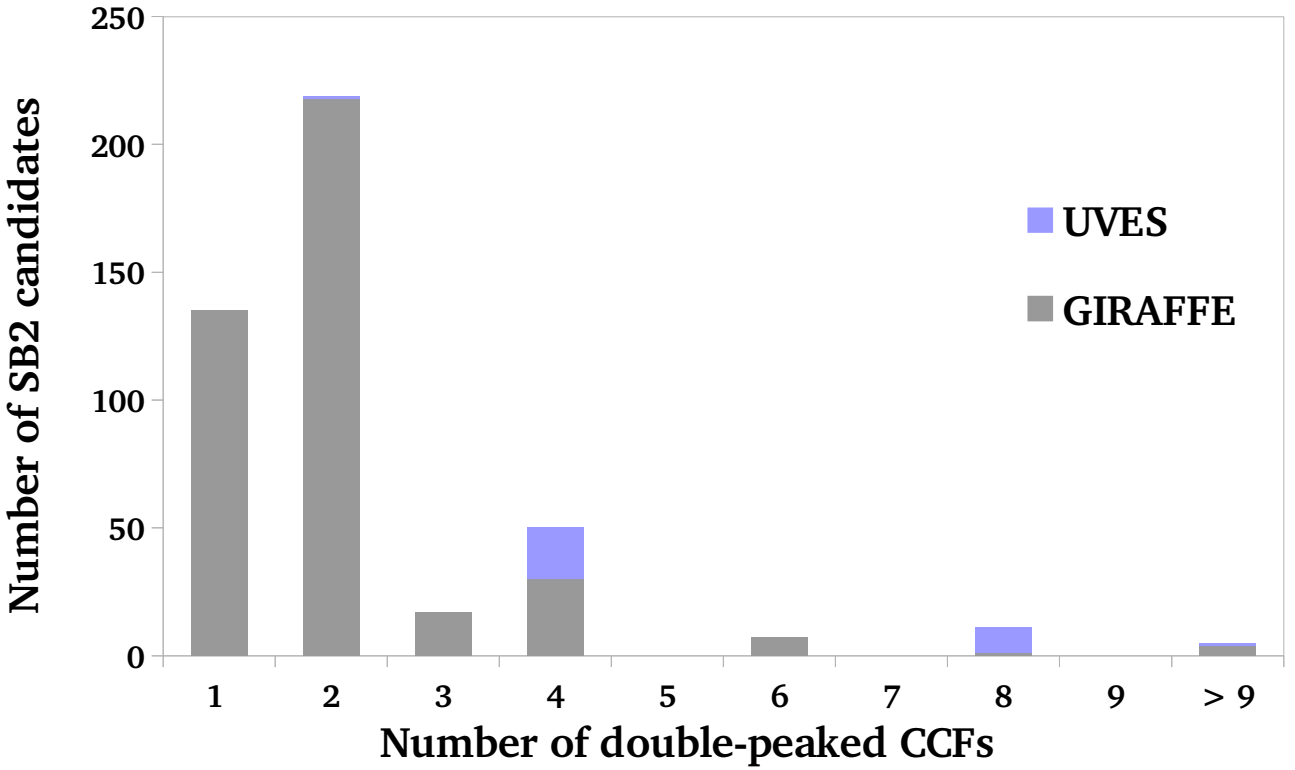
- SB1: work in progress (preliminary results: 4 clear candidates in UVES)

- **Future improvements:**
  - Measurement of the peak widths
  - Code parameters fine-tuning **(cut frequency, threshold on CCF and 2nd derivative,** grating specific parameters)
  - Detection efficiency based on Monte-Carlo simulations

GIRAFFE SB2 candidates: the zoo



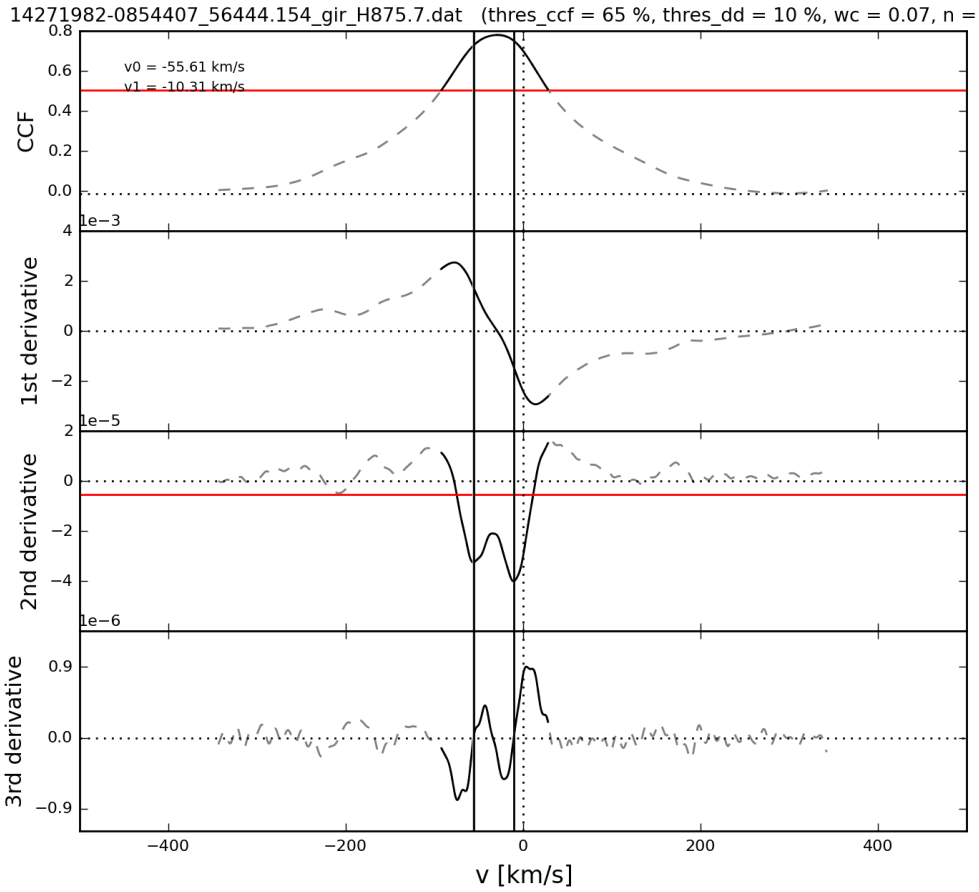


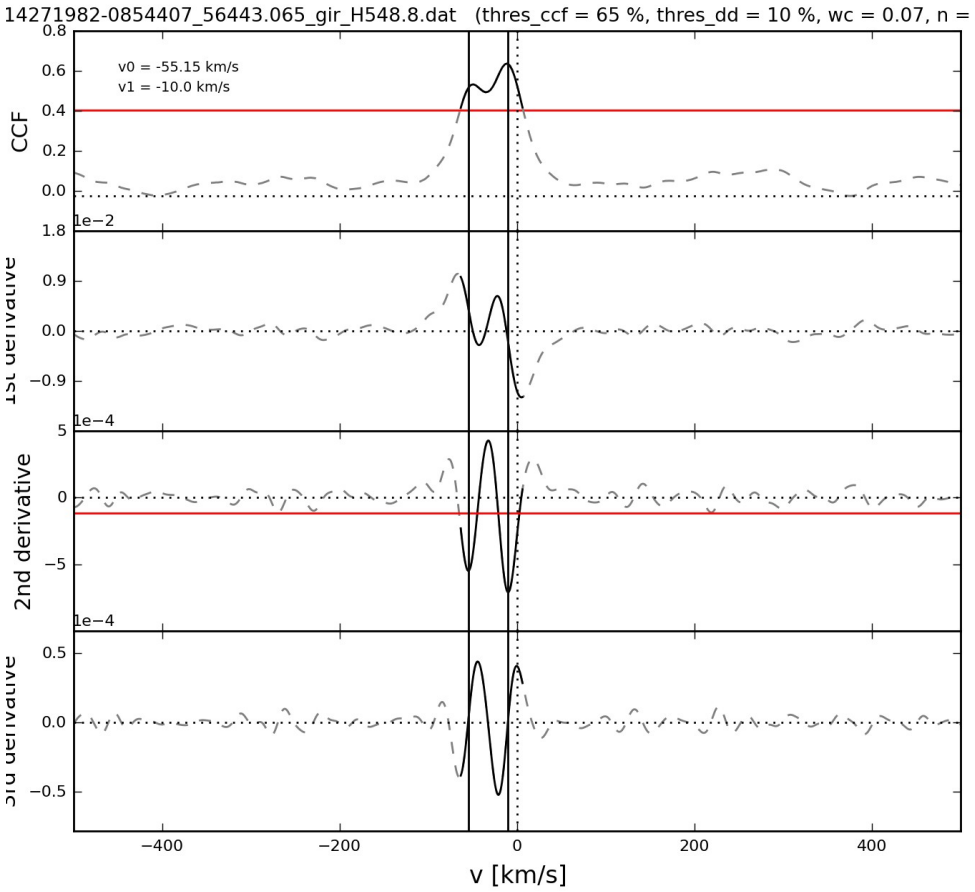


Most UVES SB2 have 4 observations

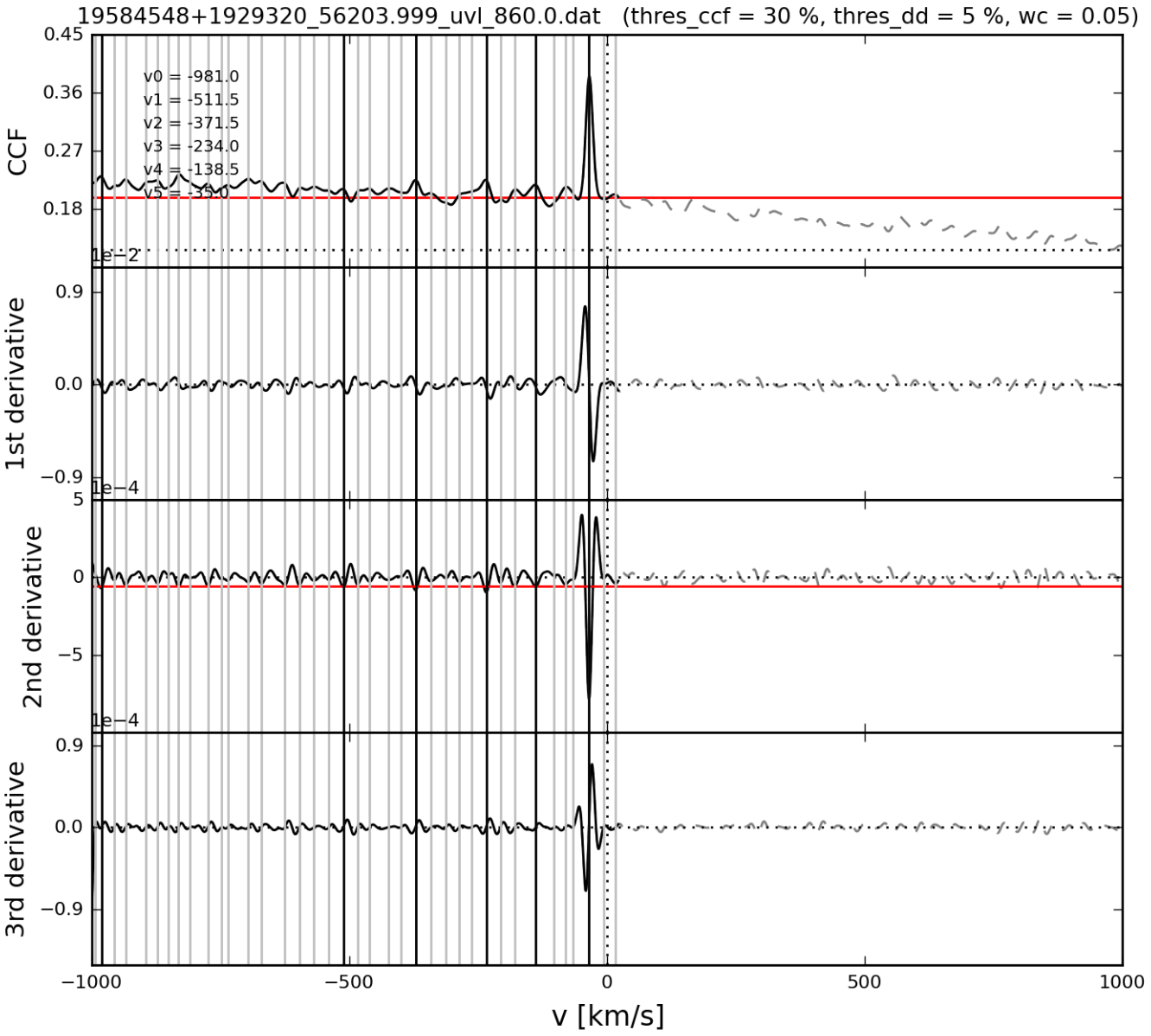
Most of GIRAFFE SB2 have 2 observations

Fitting the code parameters





Some issues...


19584548+1929320_56203.999_uvl_860.0.dat (thres_ccf = 30 %, thres_dd = 5 %, wc = 0.05)
CCF
v0 = -981.0
v1 = -511.5
v2 = -371.5
v3 = -234.0
v4 = -138.5
v5 = -35.0
1e−2
1st derivative
1e−4
2nd derivative
1e−4
3rd derivative
v [km/s]