Radial velocities
&
stellar parameter estimates
for Giraffe data

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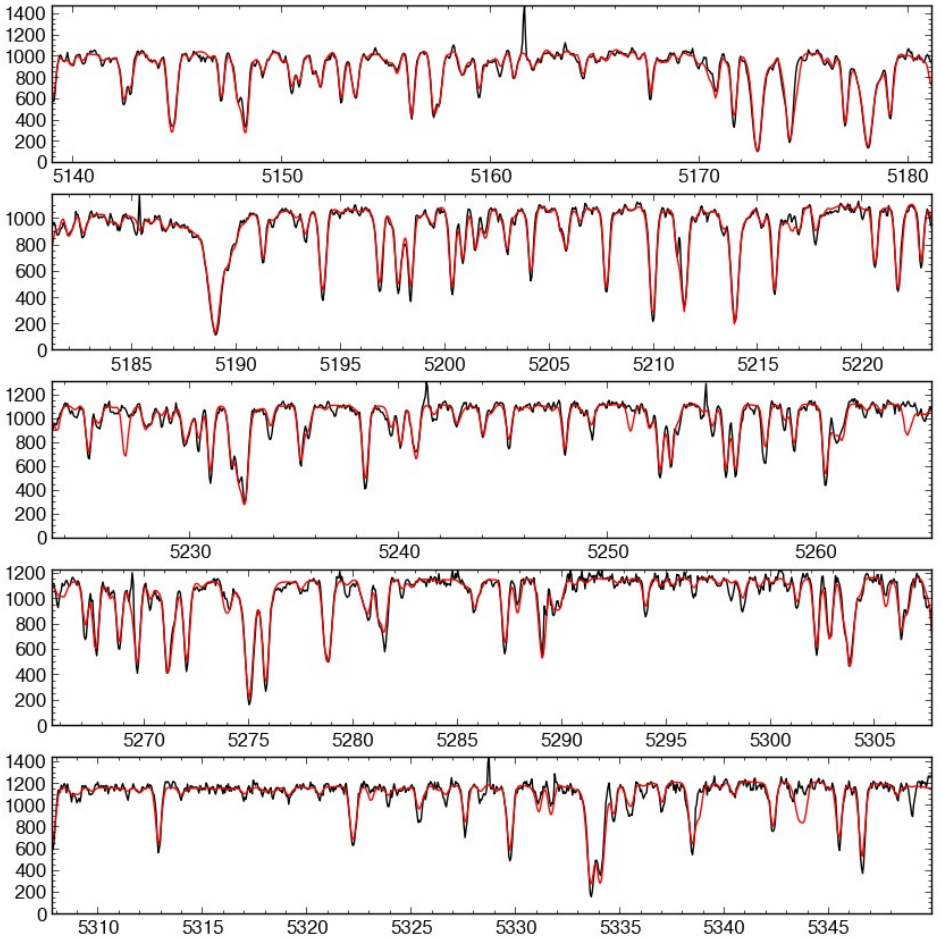
The data flow

Input data:
- Keele + CASU reductions
- Individual frames (no cosmic ray masking)
- Stacked frames
- Final frames (CASU reductions only – 120e3 spectra)

Output Data:
- Estimates of the stellar parameters
- RV estimates and errors
- Best-fit template spectrum with continuum fitted
- Possible emission lines
- Goodness-of-fit estimates
- Diagnostic plots for each fit



Internals

- Code written in python

- Dataversion, fitversion strings for every run. Code versions are stored in git

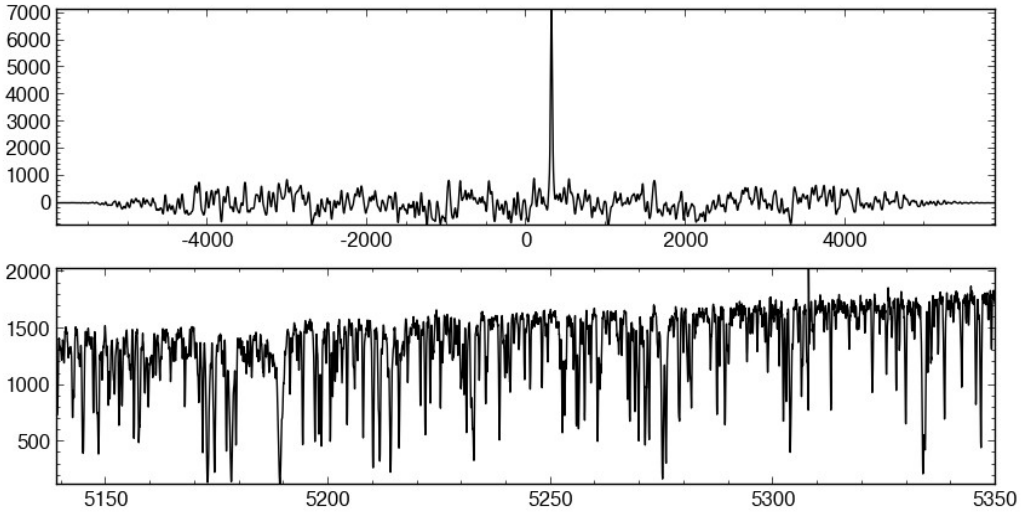
- File headers, FIBINFO table contents and fit results are stored in the database together with versions.
  Allows easy querying.

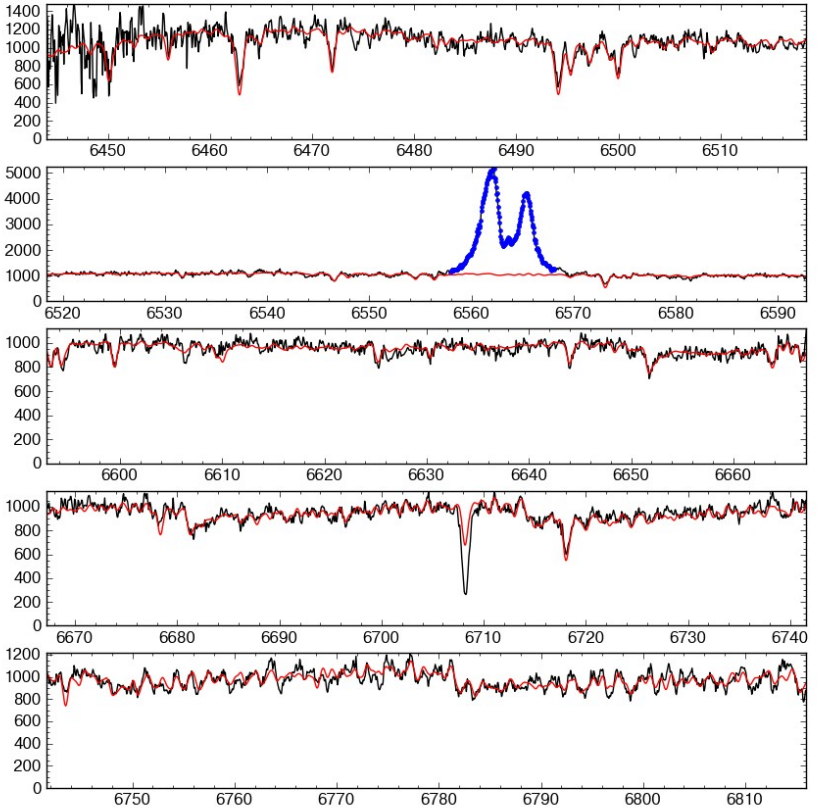
- The same code runs on Keele, CASU and ESO data

Fitting procedure (1)

- Masking:
  Emission lines in HR14, HR15
  low S/N regions in some blue setups
  Tellurics in HR21
  Unmasked cosmics/defects

- Cross-correlation :
  Use subset of templates (pre-FFTed)
  Standard cross-correlation with padding, apodising.
  Find the best template to use it for the next step



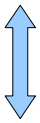


Fitting procedure (2)

- χ^2 fit of the spectra

Two main iterations:

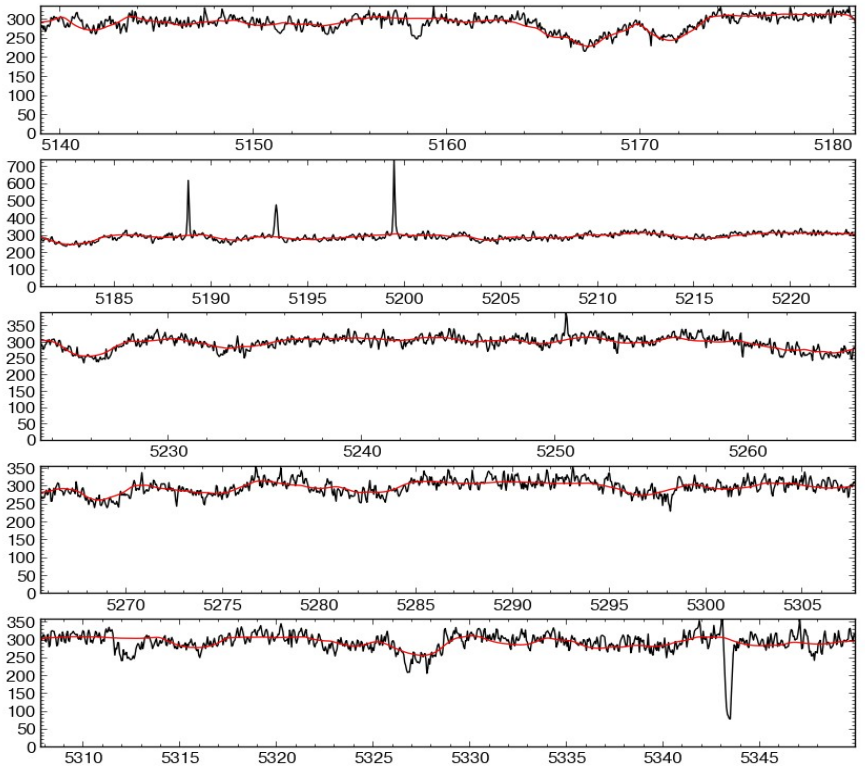
- Template fit: chi-square minimisation over the grid of templates with RV fixed. Continuum is fitted simultaneously.



- RV fit: chi-square minimisation with template fixed

For high S/N spectra the fits are repeated with the rotation velocity parameter free.

- RV errors are obtained from the chi-square behaviour around the minimum



- The Munari grid is still used
  Linear n-D interpolation between grid points.
- The stellar rotation is implemented by convolving the spectrum with the rotation kernel

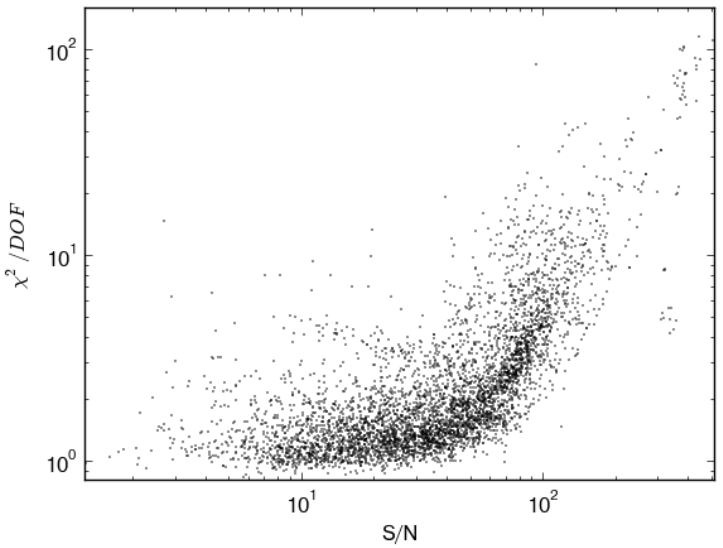
VELCLASS FITS extensions/QA

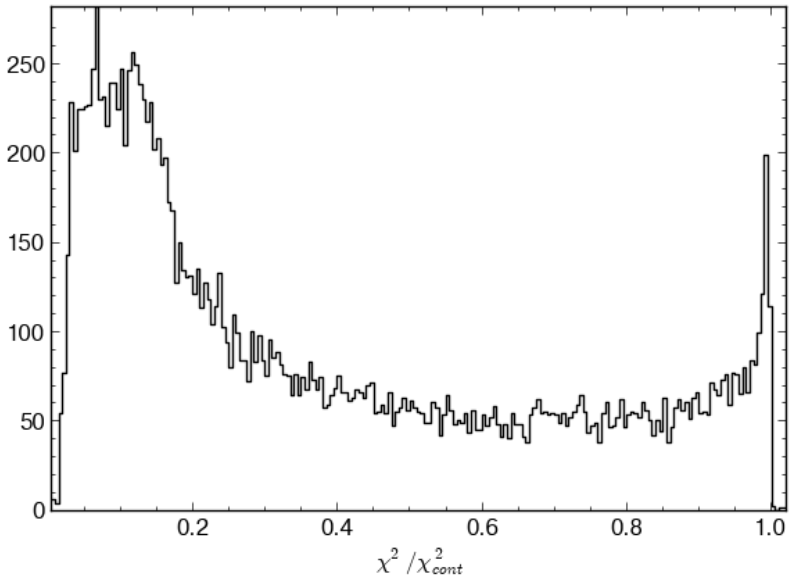
- Each spectrum is processed individually:
  E.g. no comparisons with previous epochs is done at that stage

- If the S/N is less than 2, LOWSN is being put as class

- The decision whether to mark a star as a “STAR” is based on
  S/N, chi^2, distance to the best fit template
  Comparison of the chi^2 vs chi^2 of the continuum only fit
  Known problems: Outliers/non-masked cosmics in the spectra

- 0.2 km/s is added to the velocity errors (the realistic precision floor)





Photometry

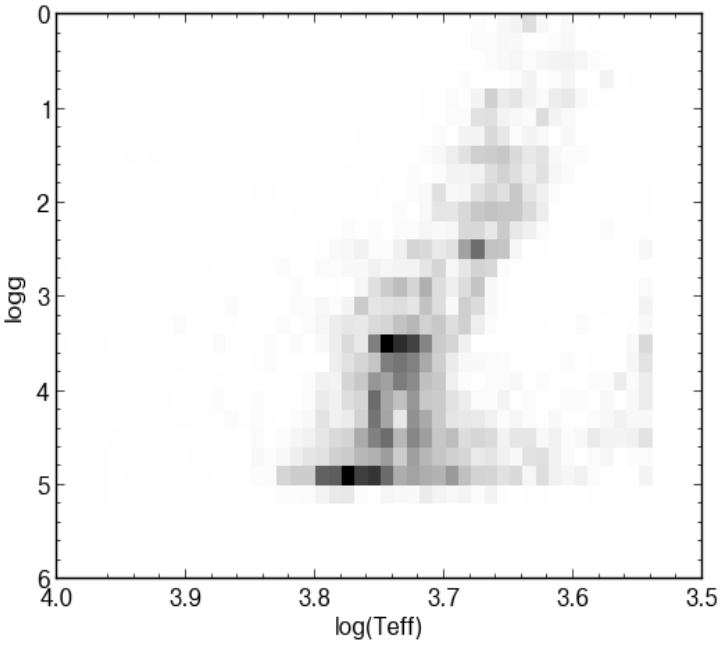
• Every spectrum with (Ra, Dec) get the photometric measurement and proper motion attached

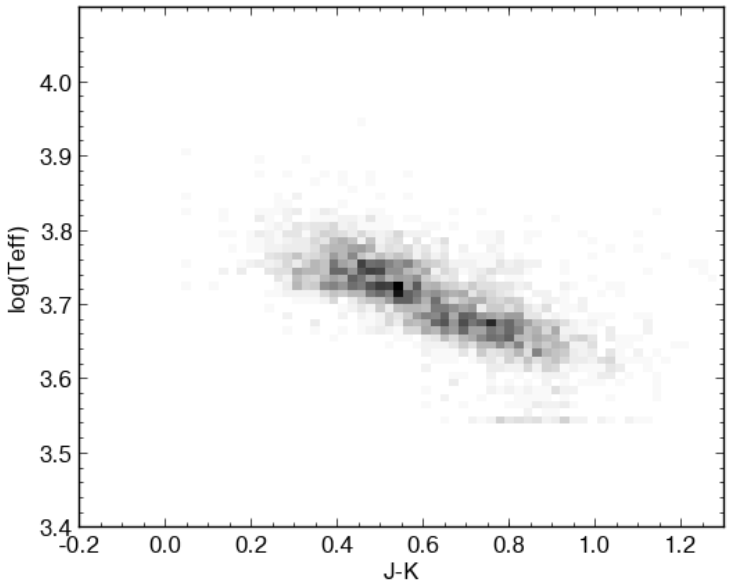
• Cross-match automatically with 2MASS, VHS, UKIDSS, UCAC, SDSS, APASS, PPMXL
• Attach all the magnitudes, PMs and matching distances
• Will probably not work for benchmark stars (high PM, bright stars)
• No additional data quality checks

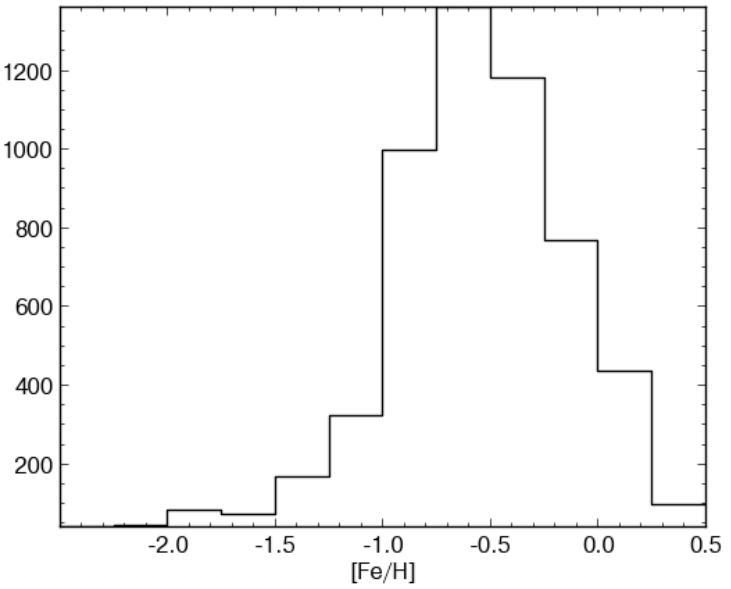
• Very patchy coverage for several surveys (except 2MASS and PPMXL and UCAC)
• I was asked to put E(B-V)(Schegel) into the catalogs

Measured parameters

- Reasonable Teff log(g), [Fe/H] distributions
- Problem: focusing on grid nodes (grid step defines the precision).







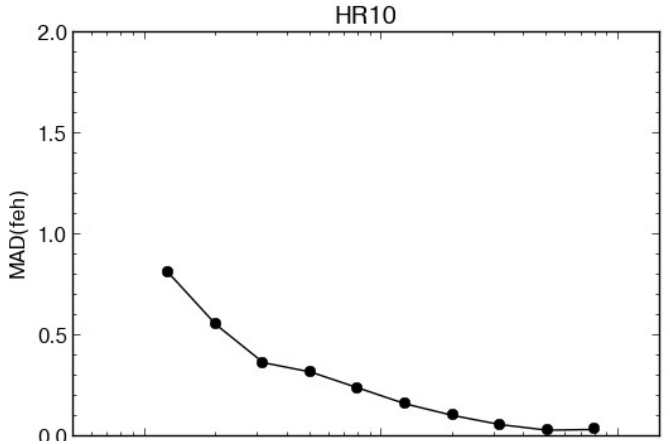
Random errors of logg, logTeff from repeated observations with the same setup

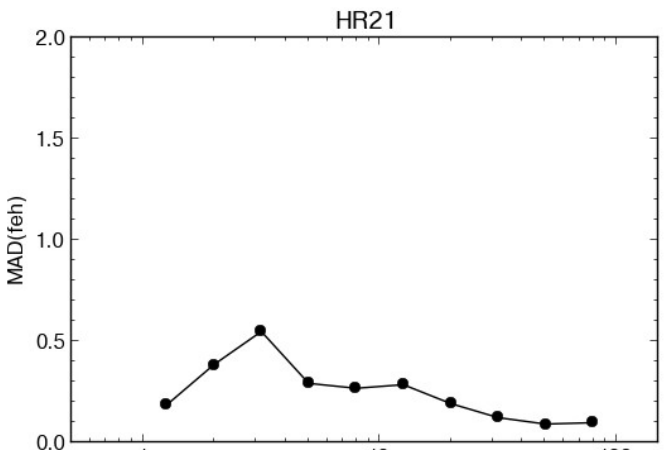
Fe/H

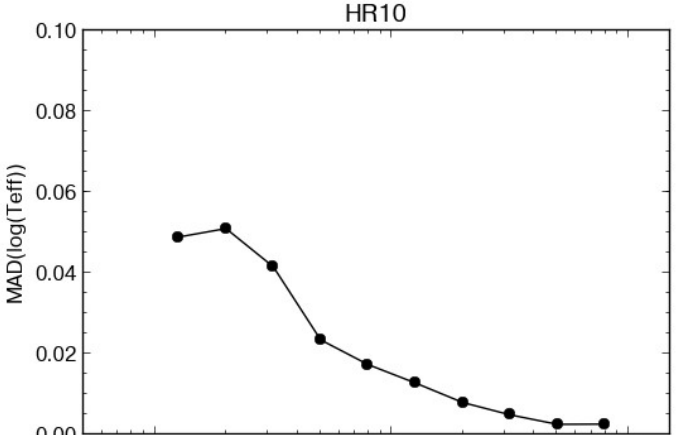
log(Teff)

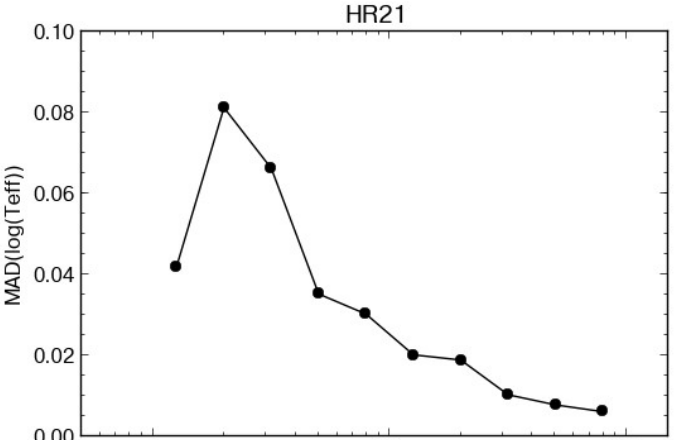
log(g)

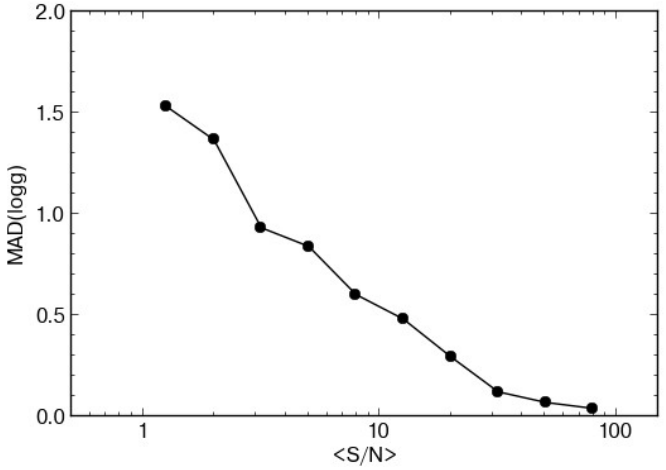
MAD vs S/N

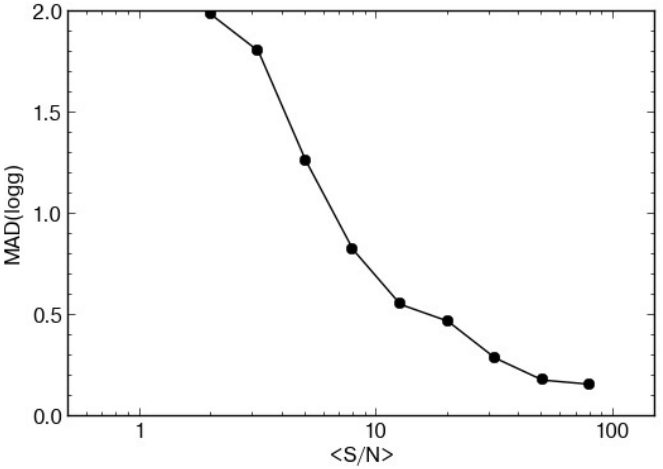






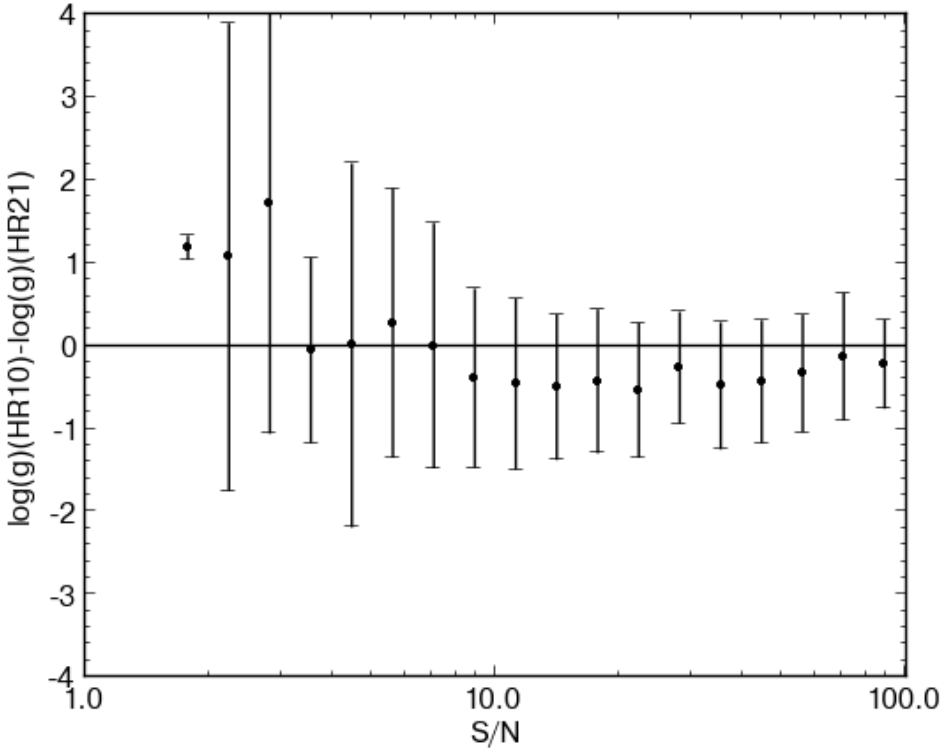


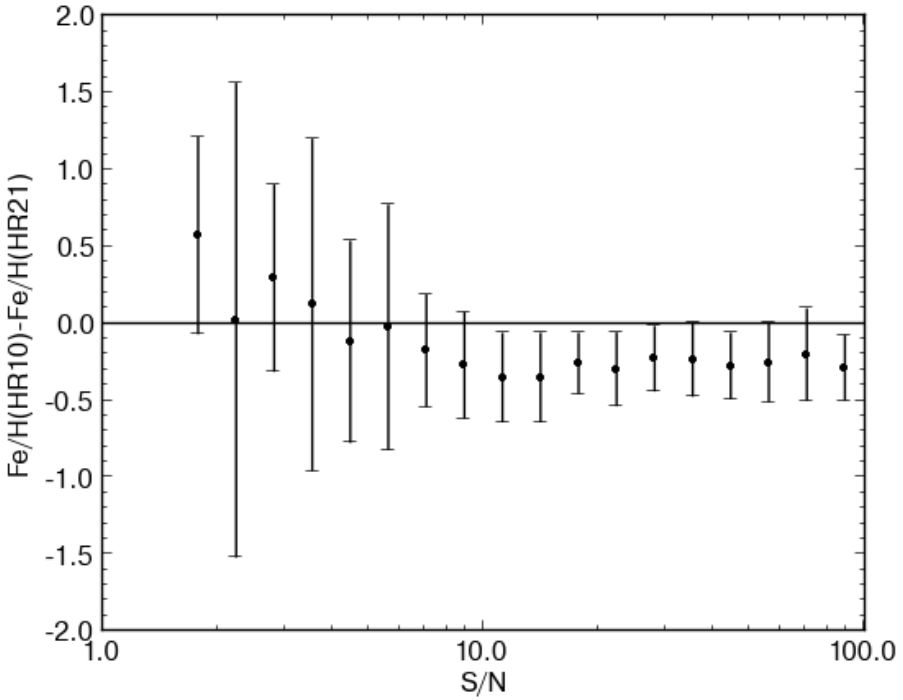




Repeated observations, different setups

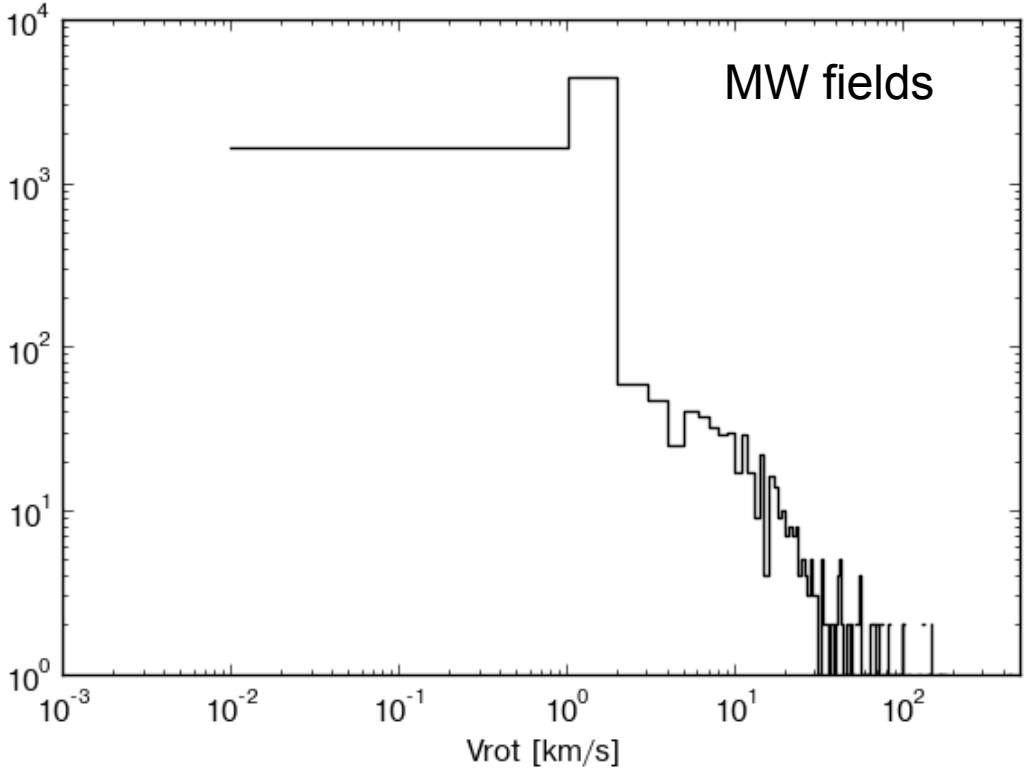
Clear systematic differences
between parameter determination
from HR10 and HR21



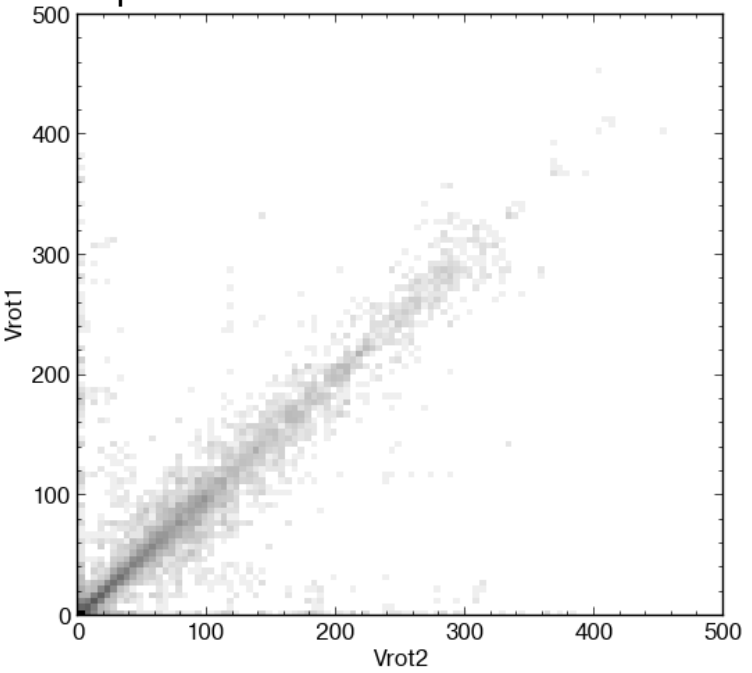


Rotation velocities

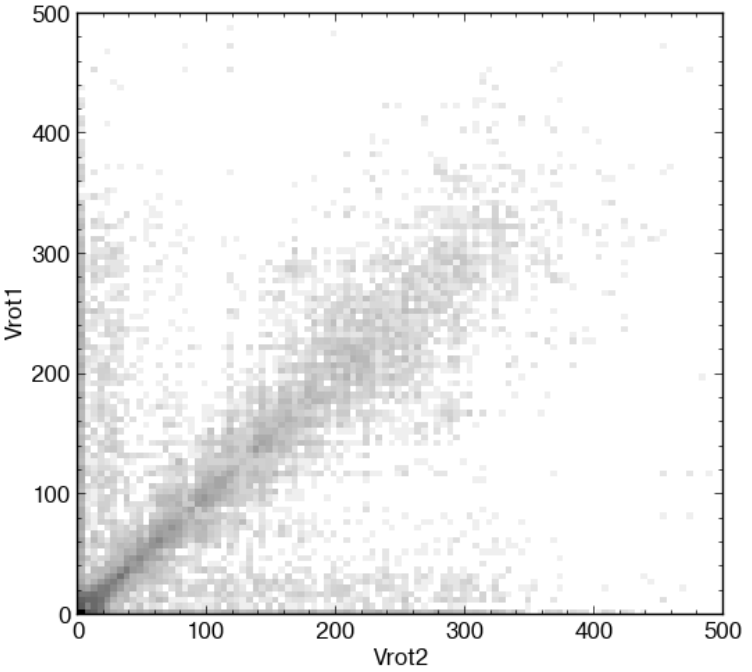
HR10



Repeated observations with the same HR



Repeated observations with different HR

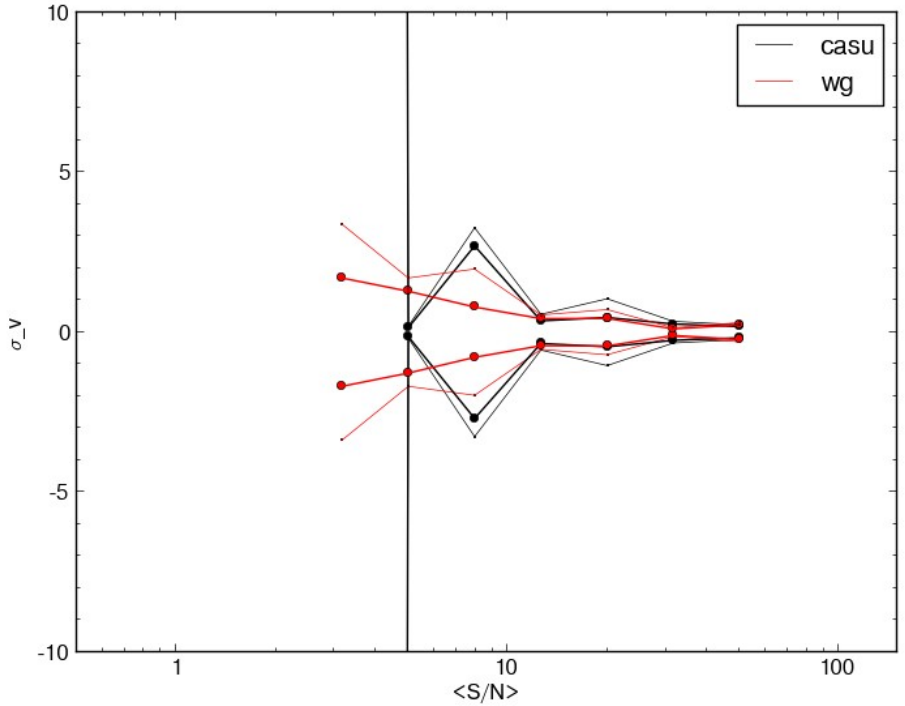


- Rotation velocities are reasonably well determined
- For MW fields Vrot ~ 0
- Problems: All Vrot <~2-3 insignificant

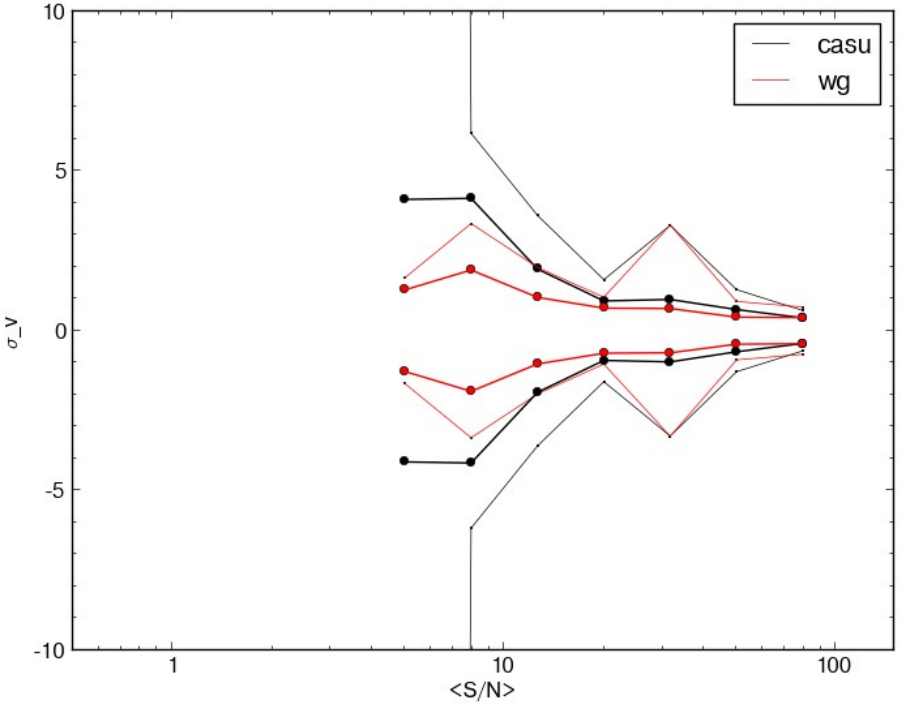
RVs (HR10, HR21)

Velocity precision as function of S/N:
Repeated observations separated by > 12 hours

HR10

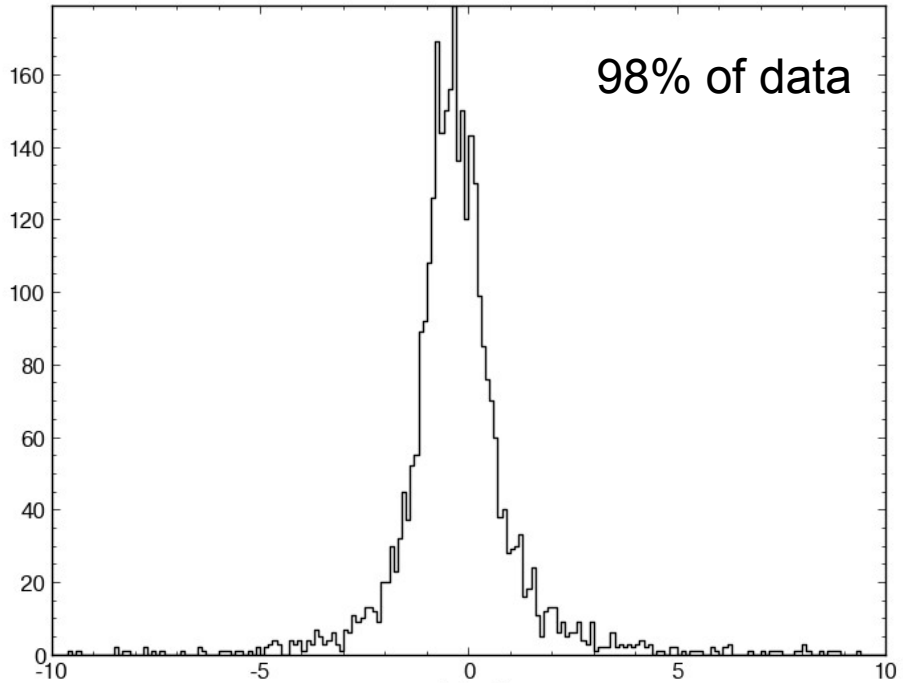


HR21

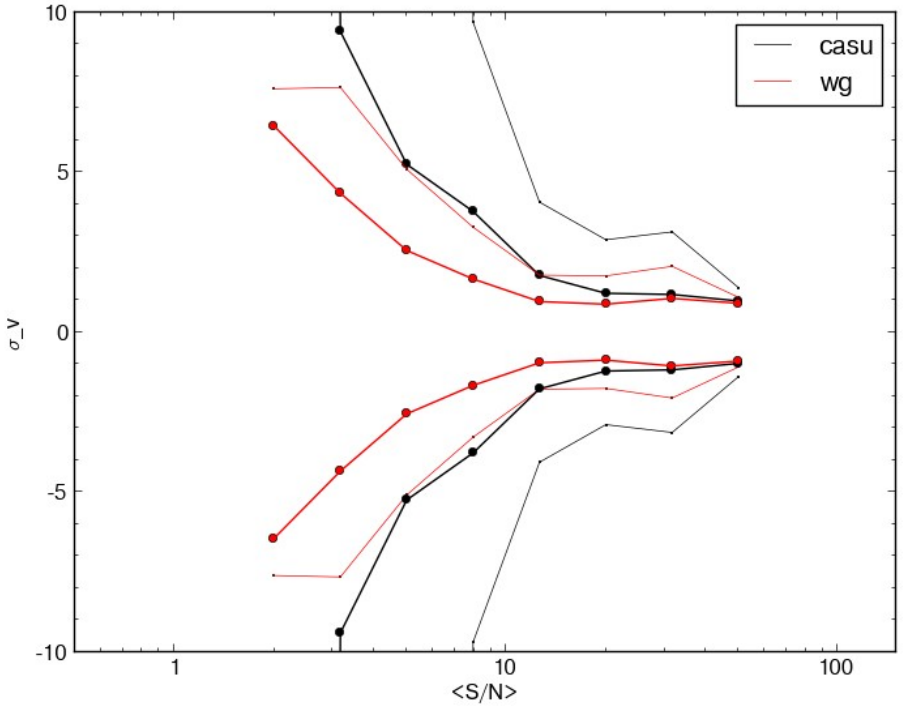


Thick lines 1-sigma intervals
Thin lines - 95% intervals

RVs HR10 vs HR21 for final stacked GES MW fields



Vel(HR10)-Vel(HR21)

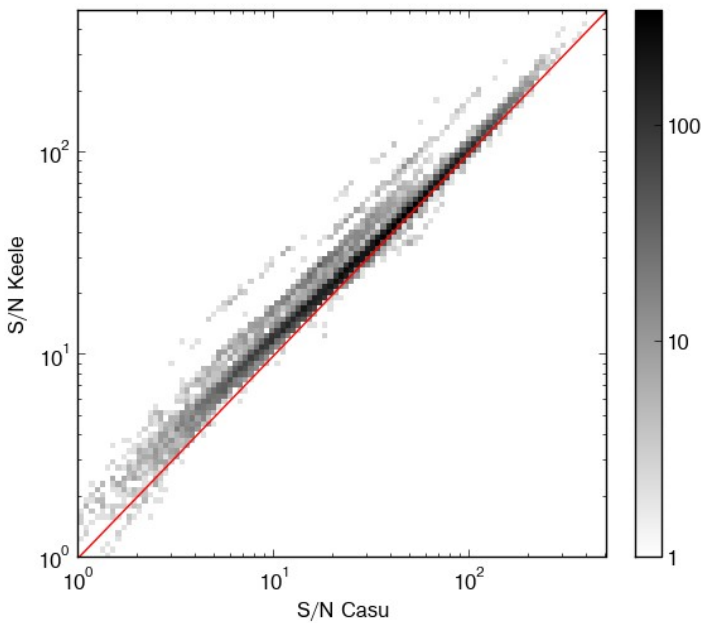


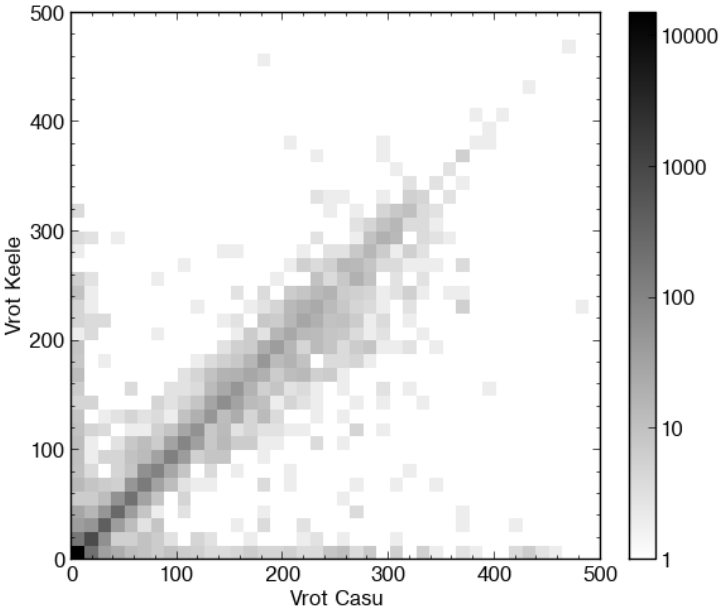
- Small offsets 0.2-1 km/s between HR10 and HR21 (dependent on which corrections to apply sky/simcal)

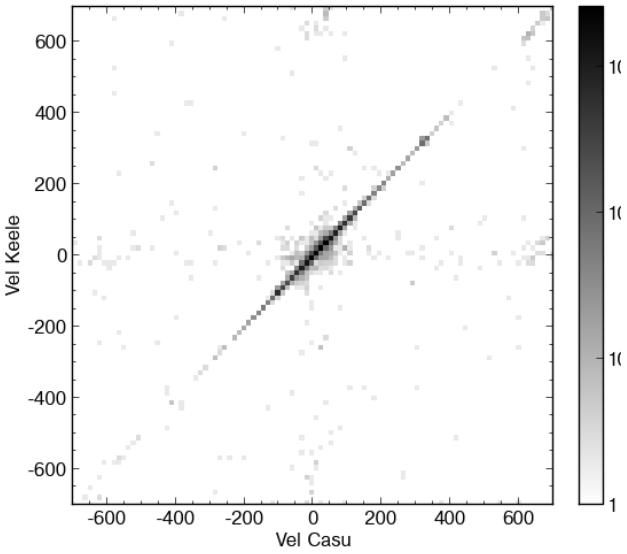
- The difference in velocities is often dominated by systematics (template mismatch)

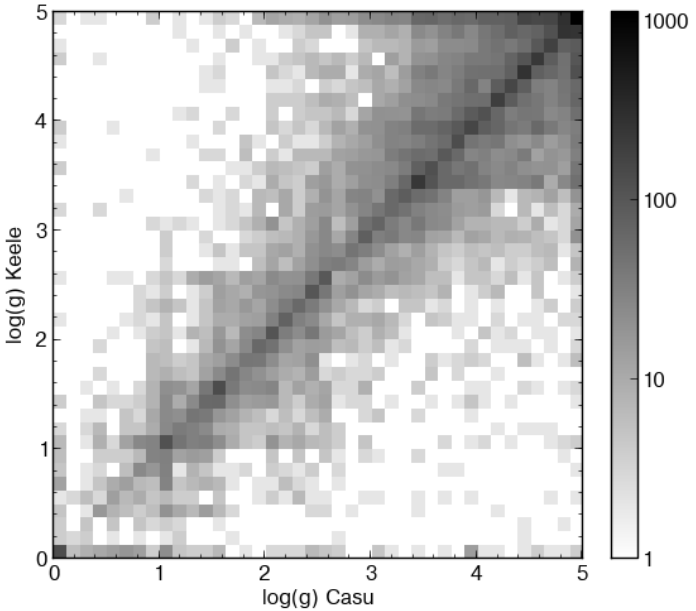
CASU ↔ Keele comparison

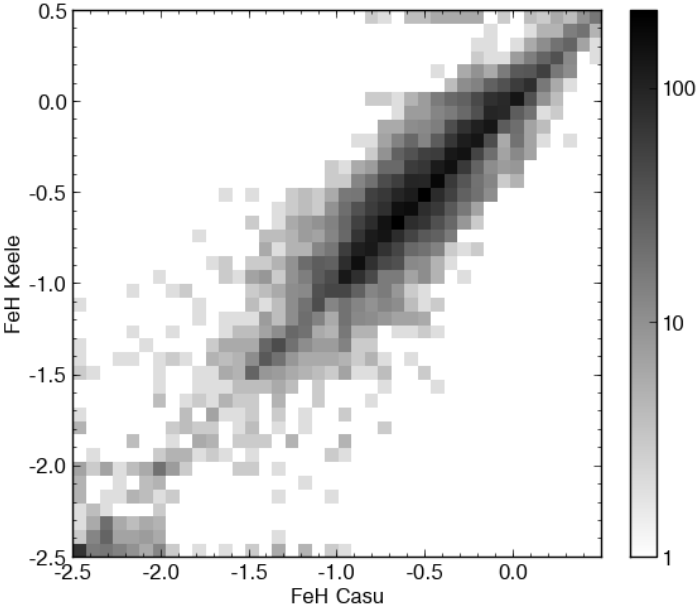
- Overall good agreemen
- Slight S/N difference ~10%
- No major discrepancies
- Small offsets in RV





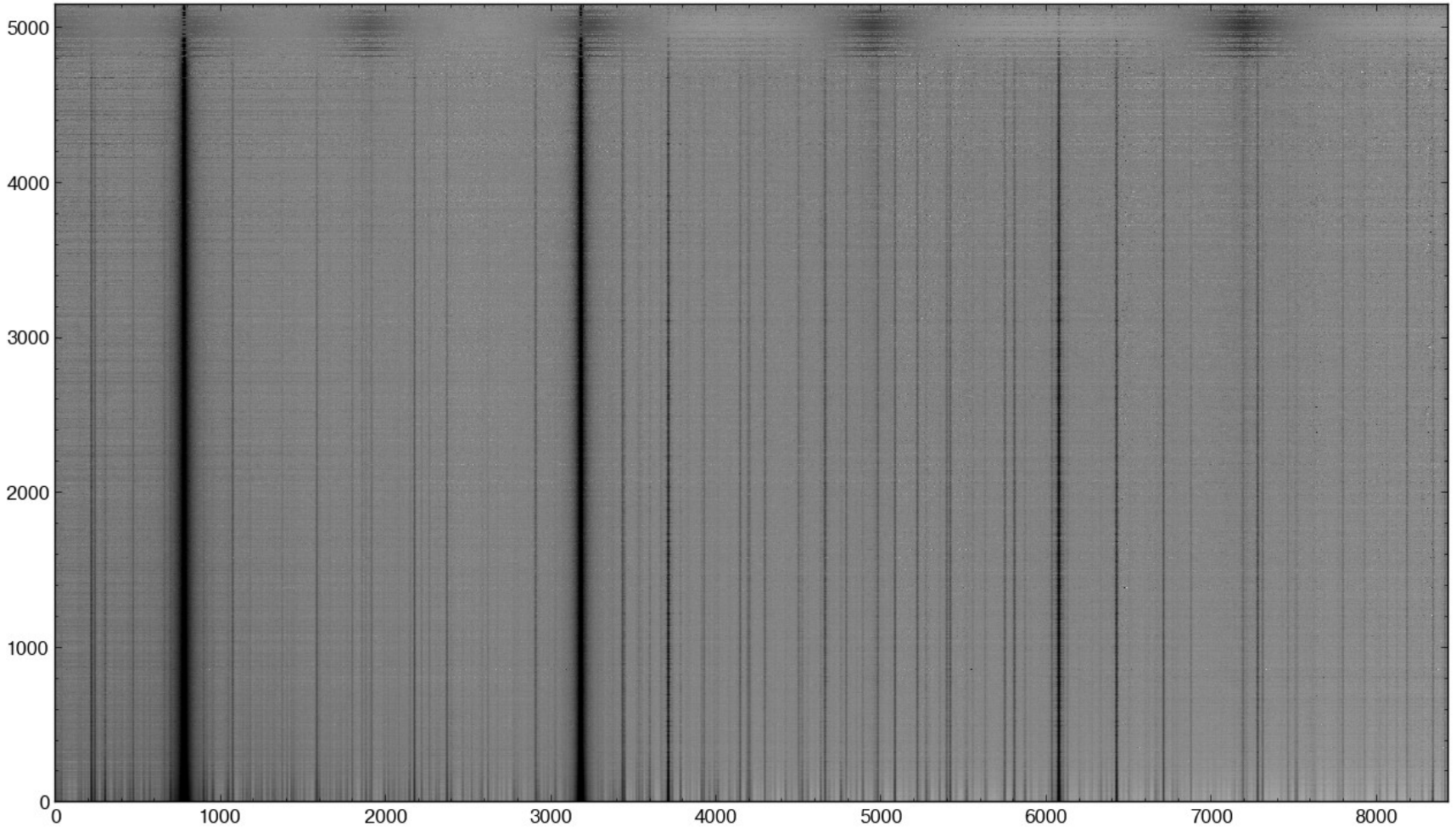






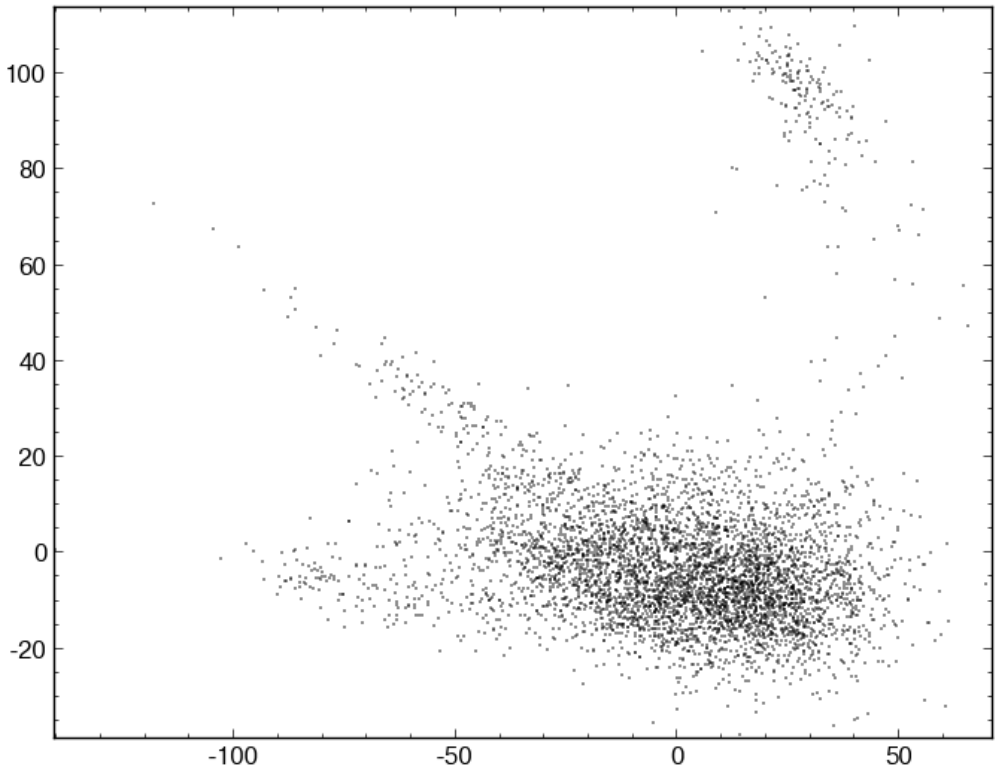
Non-parametric classification (work in progress)

- RV aligned spectra
- Normalized



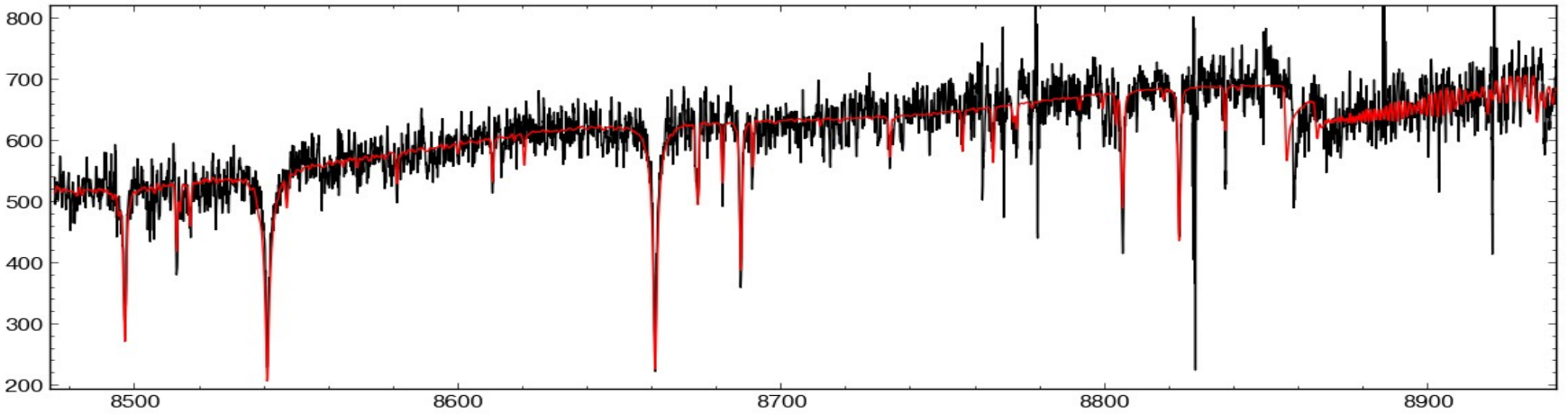
PCA/HMF

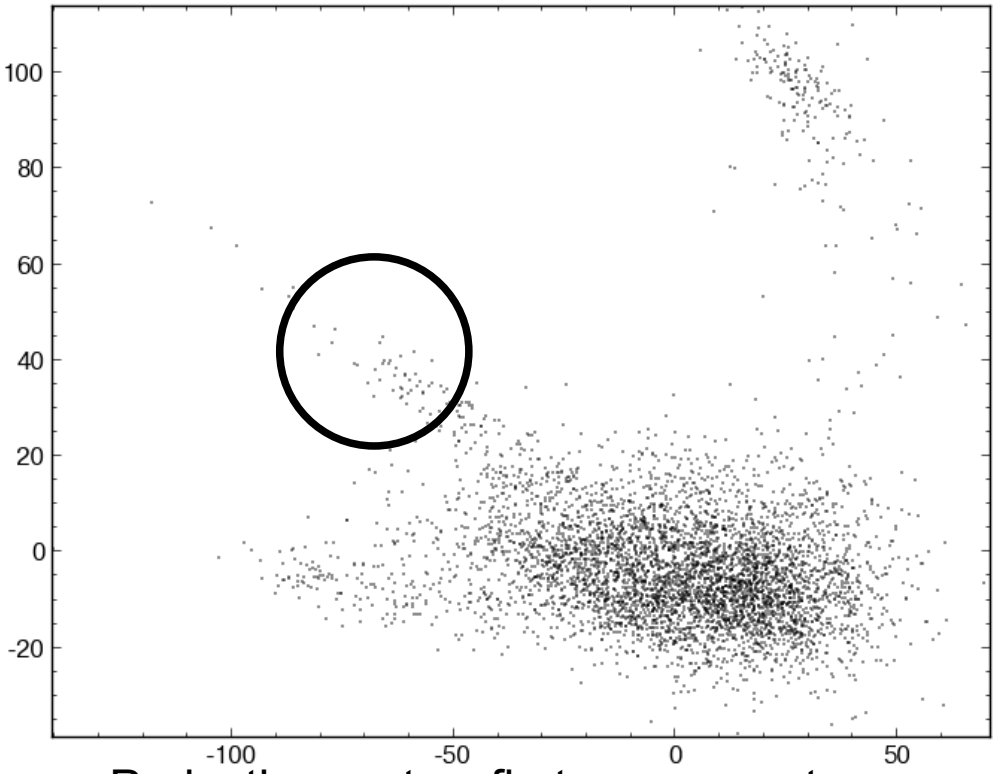
- We perform PCA/HMF with 10 components
- Roughly 5000 stars



Projection on two first components

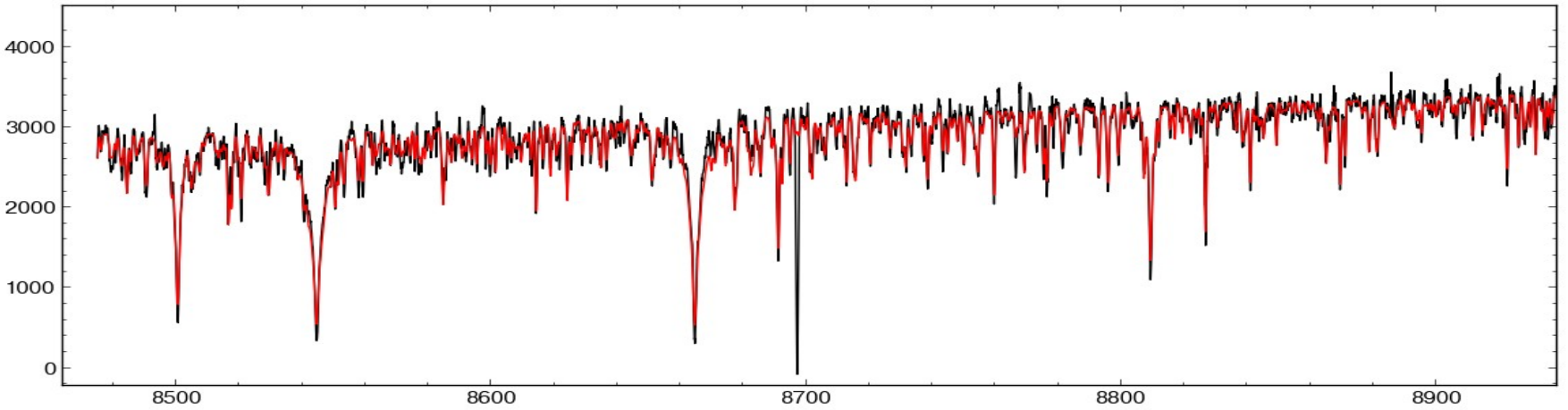
PCA/HMF

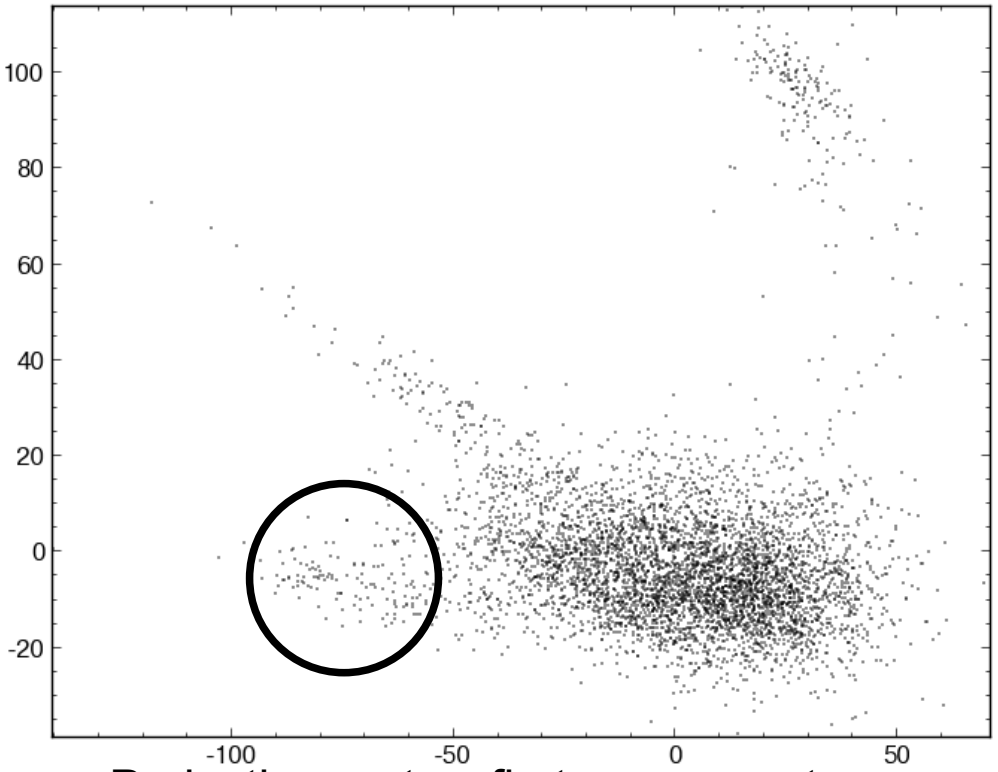




Projection on two first components

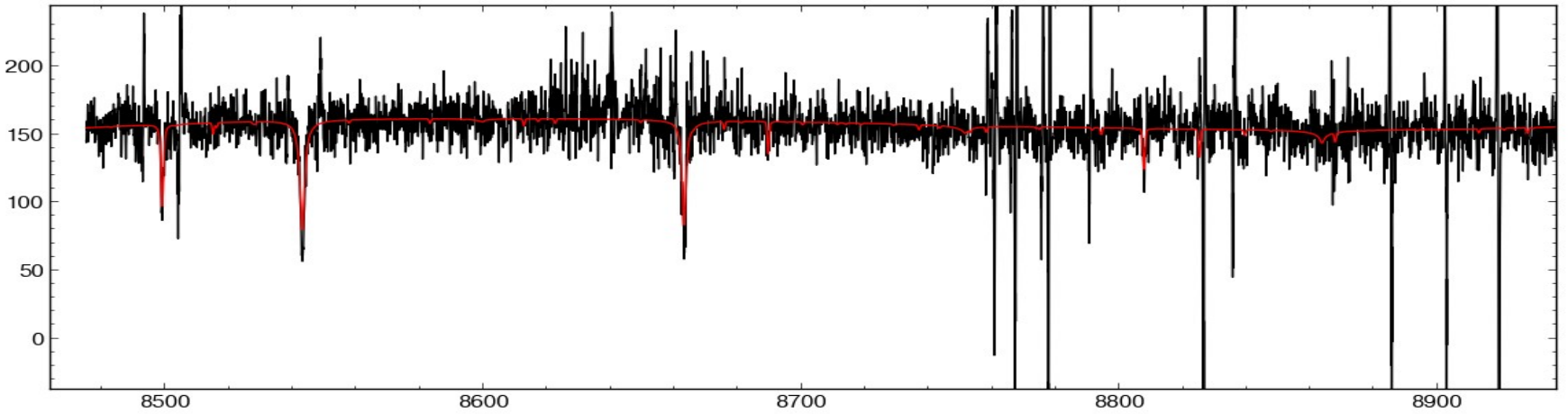
PCA/HMF

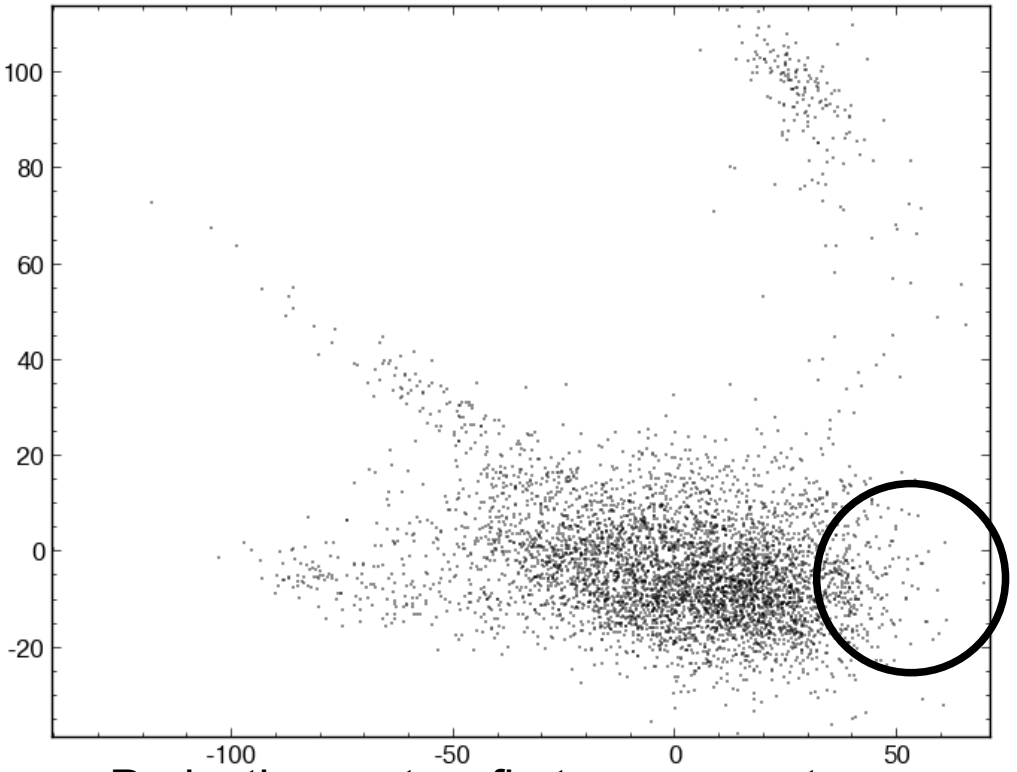




Projection on two first components

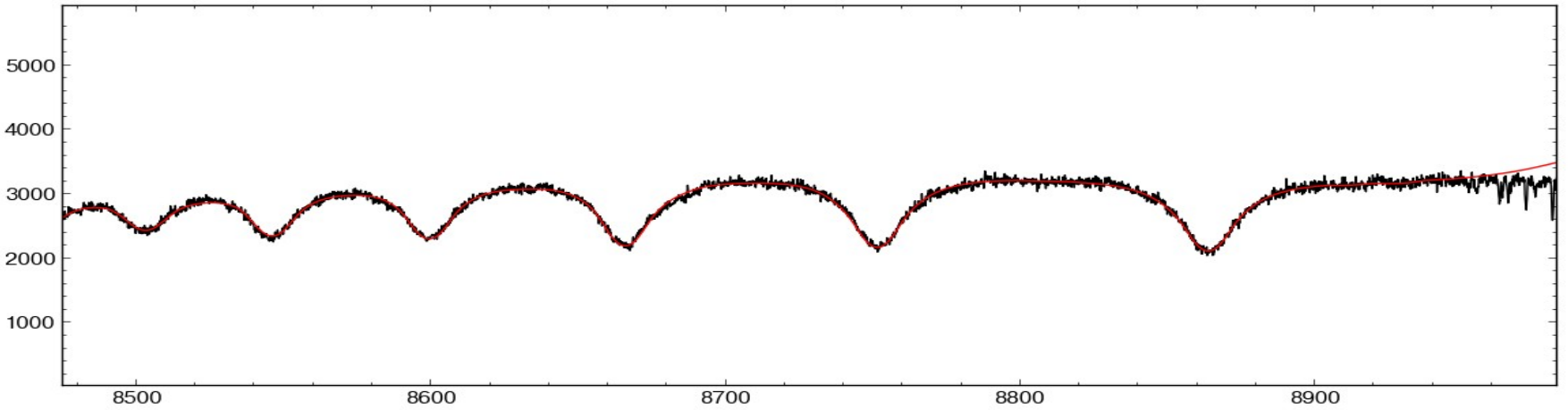
PCA/HMF

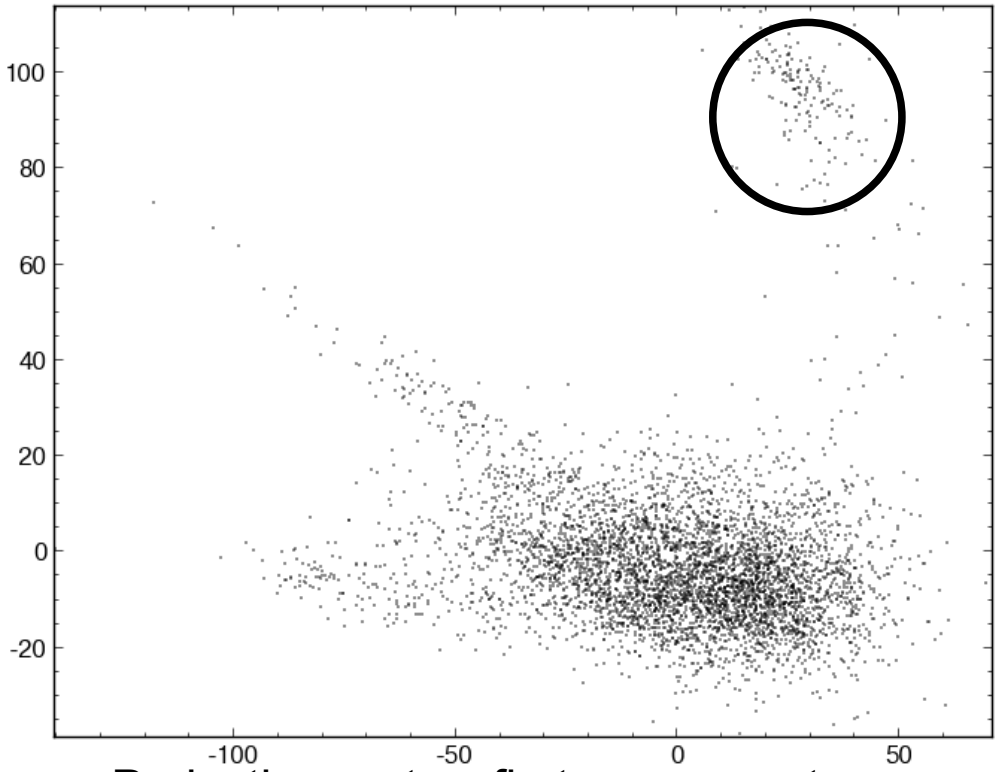




Projection on two first components

PCA/HMF





Projection on two first components

Things to be done, problems

- Masks used for the fitting, emission lines –> save into the DB, put in the products
- Best fit spectrum has to be put in the products.
- Replace the template grid
- Solve the remaining velocity offset issues.
- Use the Vrot fit only if chi-square improves significantly
- Objects with RV variation
- Points with inconsistent HR10 and HR21 – to be identified and marked as a separate step
- QC with Keele data – establish a standard set of tests to detect quality problems