The wavelength calibration

1. Presentation of the Spectroscopic Global Iterative Solution
2. The problem of divergence
3. The study of non-divergence of SGIS

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1. The presentation of the Spectroscopic Global Iterative Solution (SGIS)

- No on-board calibration device (e.g. calibration lamp)
  - ➢ No specific observation for the calibration
  - ➢ Not possible to compare to an “instrumental” reference source

- Possible alternative: The Spectroscopic Global Iterative Solution
  - ➢ Idea = Use sources observed by the RVS instrument
    Use reference sources (i.e. bright and stable stars)

- Measure the evolution of the instrument with its own observations:

Large number of stable reference sources (about $4{,}6.10^5$ V<12)

\+ Same evolution of the characteristics of the reference sources

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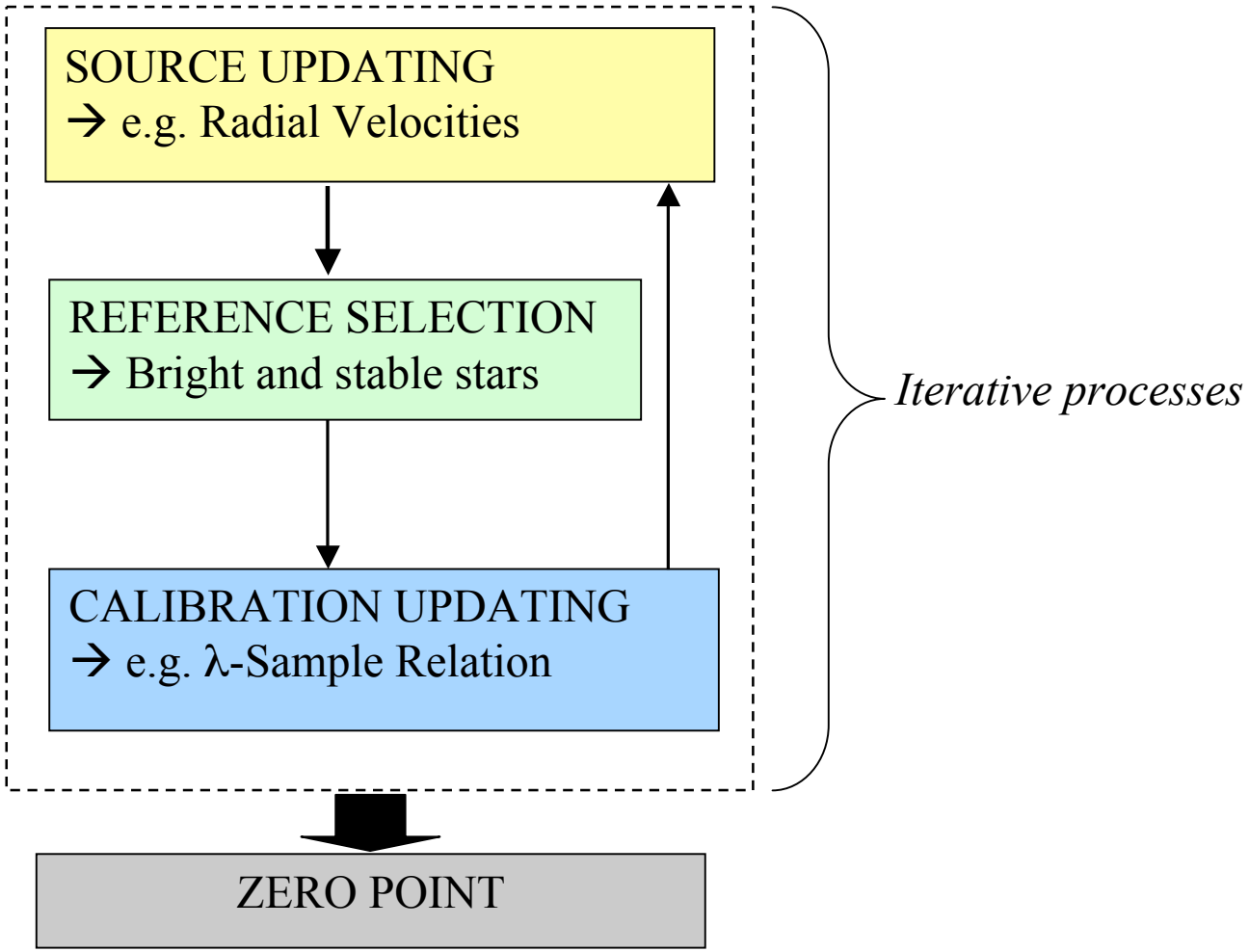
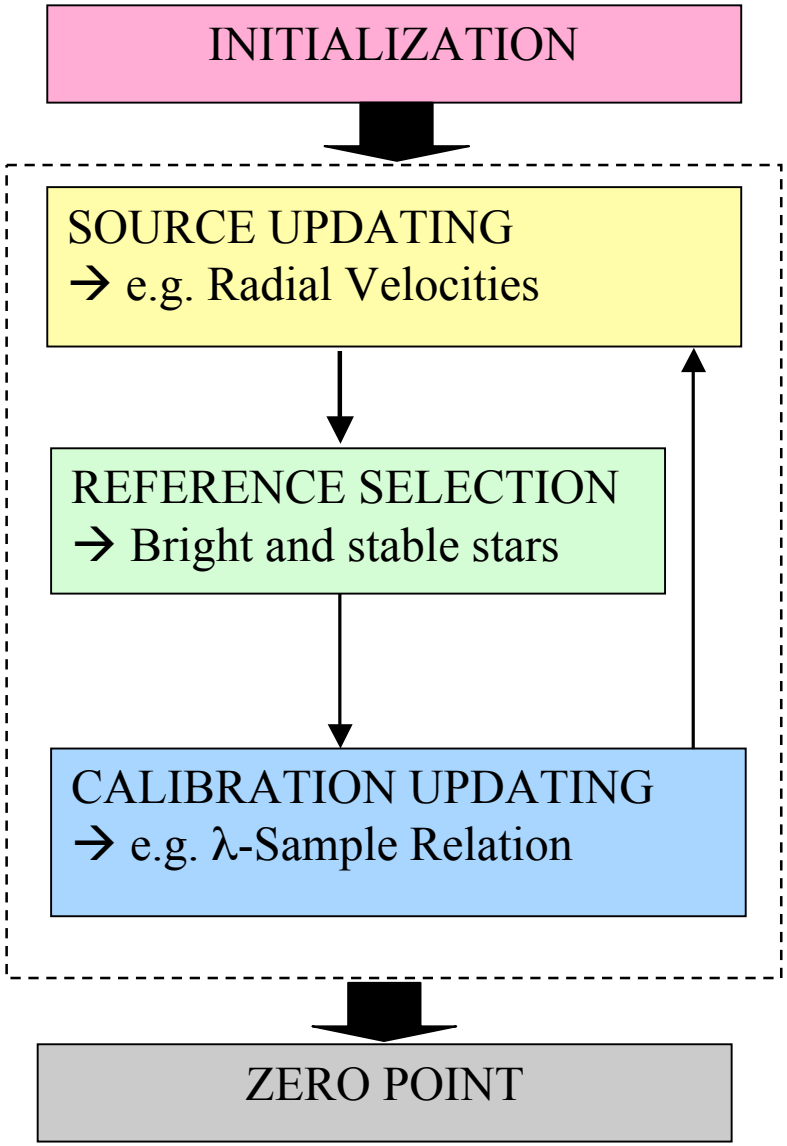
= Evolution of the characteristics of the instrument

- Analogy with ground spectrograph ➡ Locations of stellar lines
- These locations depend upon 2 parameters:
  - → Radial velocity of the sources (RV)
  - → Spectral dispersion law





Source Updating phase:
Derivation of the Radial Velocity of the sources by a cross-correlation algorithm.

Reference Selection phase:
Qualify a source (or not) as a reference

Calibratation updating phase:
Calibrate the RVS spectral dispersion law
= Associate a wavelength to a sample

$$\lambda_s = F(s)$$

= 1 per calibration unit

- JAVA development of the first version of the SGIS prototype
  - ➢No reference selection phase (all reference)
  - ➢No zero point correction phase

- Test of non-divergence of the prototype
  → Initializing the spectral dispersion law with the true value

- Input data:

Kurucz RVS-like spectra (R=11500)
1000 G5V stars (e.g. RV = 0km/s)
Observed 10 times over 100 days of mission
True spectral dispersion law

- GEPI/GAIA-RVS/TN/018 coming soon!

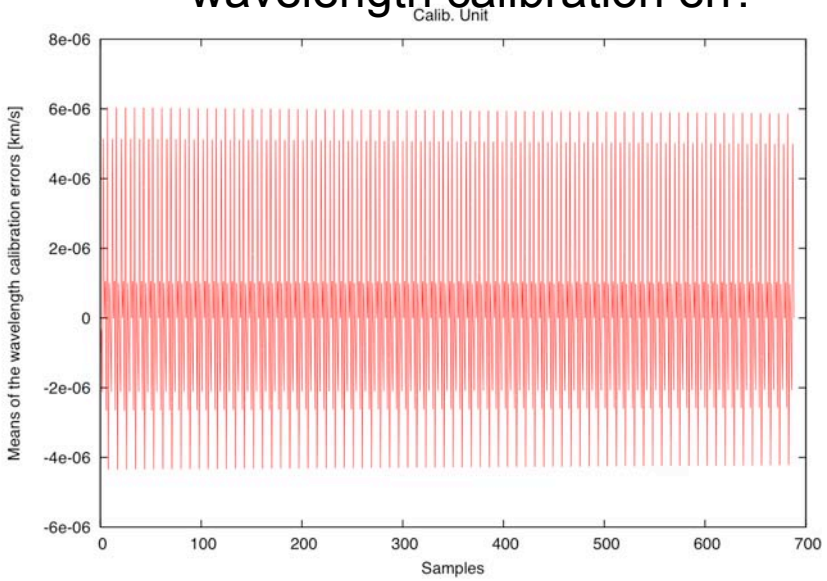
1.5. The first results of prototype of SGIS

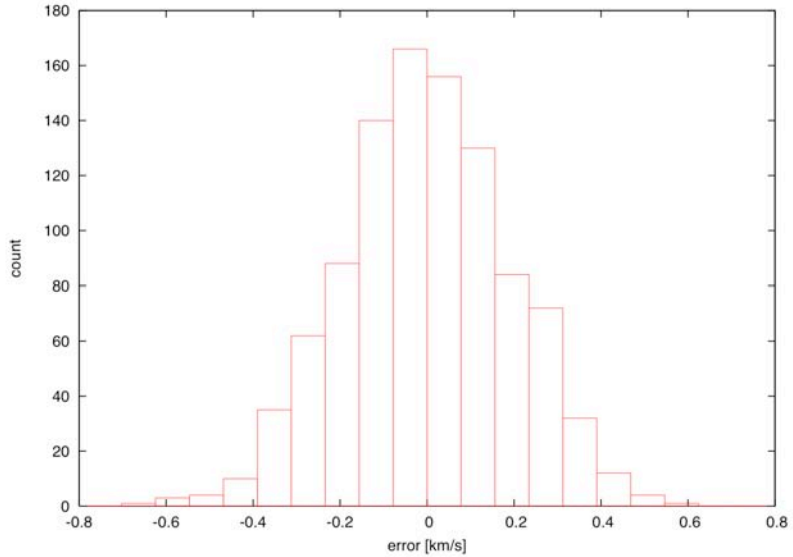
CU6-WG-IAP-06-03-06

wavelength calibration err.

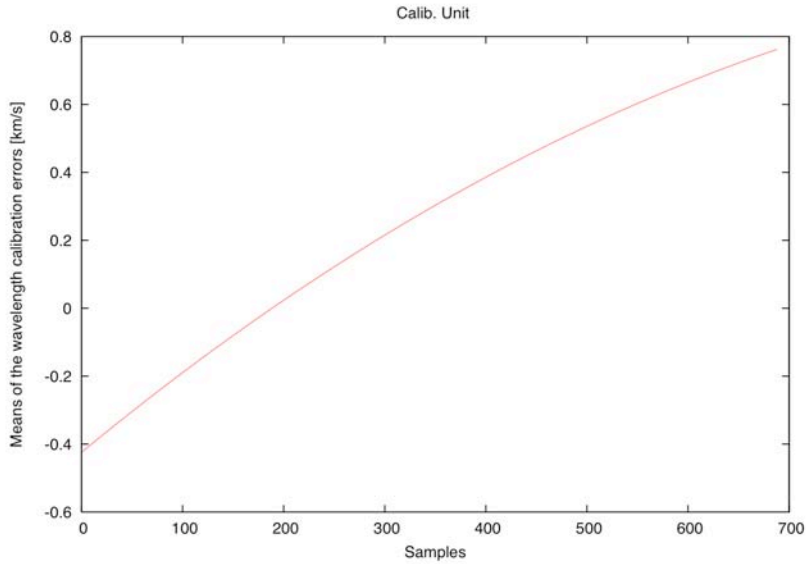
RV err. distribution

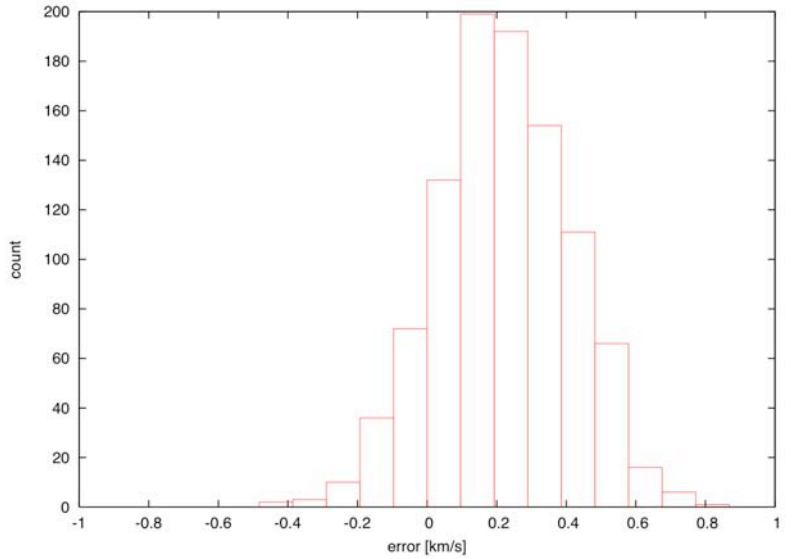
Iter. 0 - after source updating





Iter. 1 - after source updating

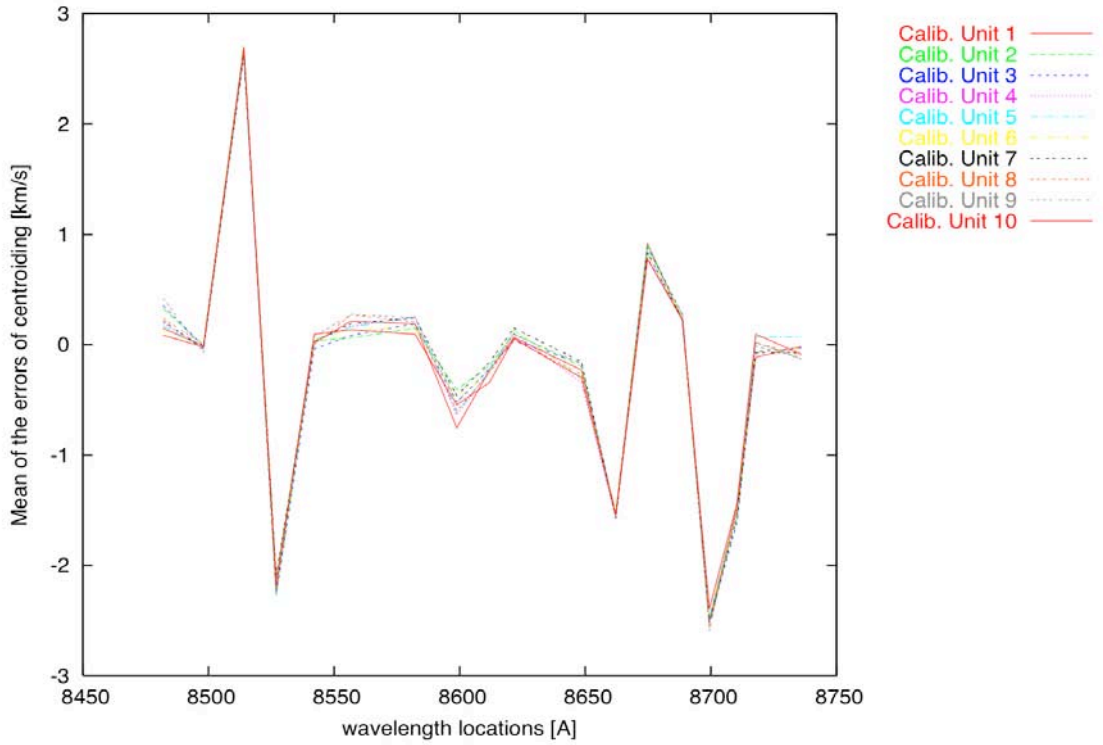




2. The problem of the divergence

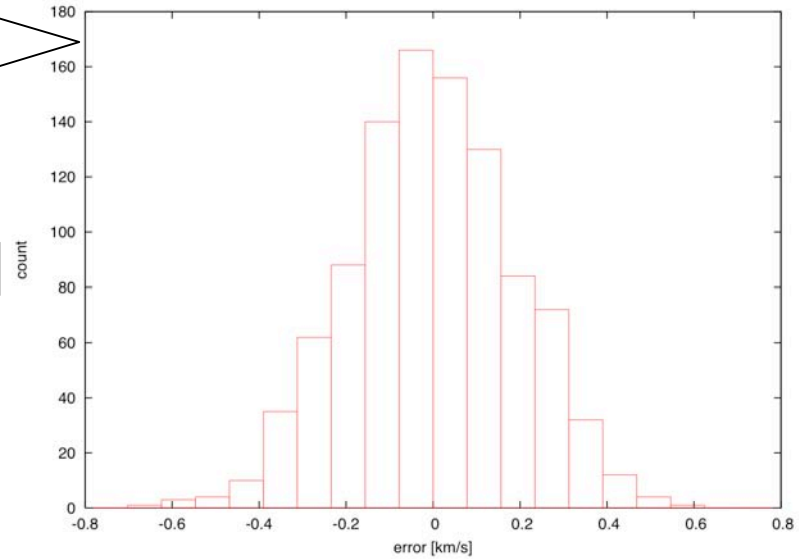
- More diagnostics → Problem located!
- The calibration updating phase needs to identifies reference lines in spectra (i.e. fluxes as a function of samples)

  = Need to locate the centroid of the lines
- Results of the centroiding method of the SGIS prototype:

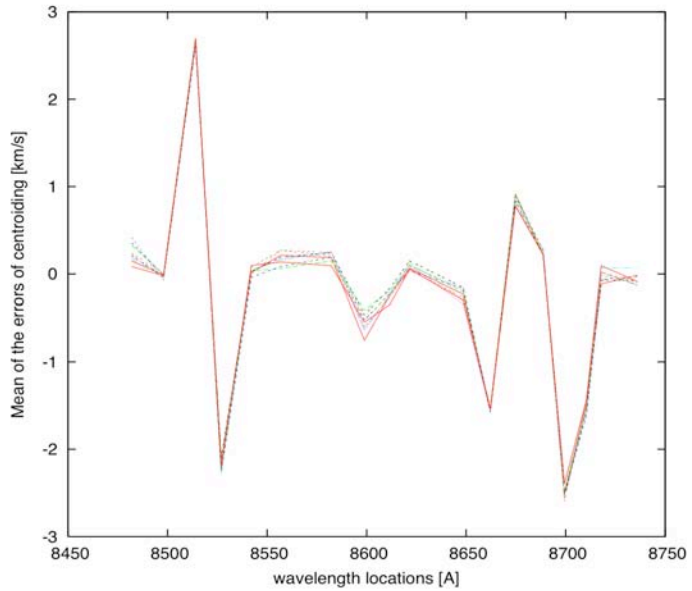


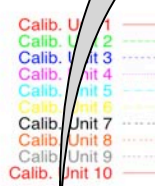
- Systematic effects!!!
- No compensations!!!
- About -0.2 km/s

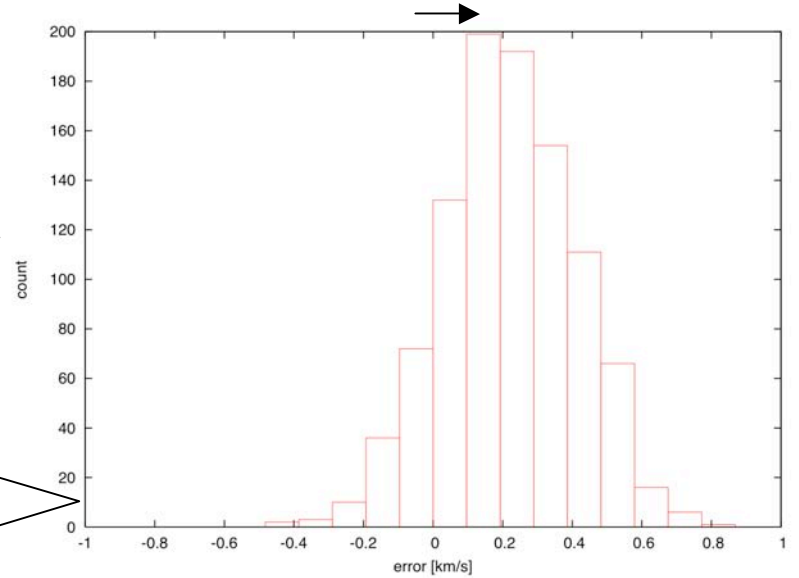
RV err. distribution at iteration 0



Centroiding err. distribution







RV err. distribution at iteration 1

- Correct the divergence of the iterative process:
  - ➢ Correct the centroiding error

    Calibrate the centroiding method on RVS-like synthetic spectra

  - ➢ Change the centroiding method

    Use a profile fitting method (cross-correlation like)

- Before the correction of the centroiding effect, the non-divergence and the convergence of the SGIS must be proved!!!

3. The study of non-divergence of SGIS

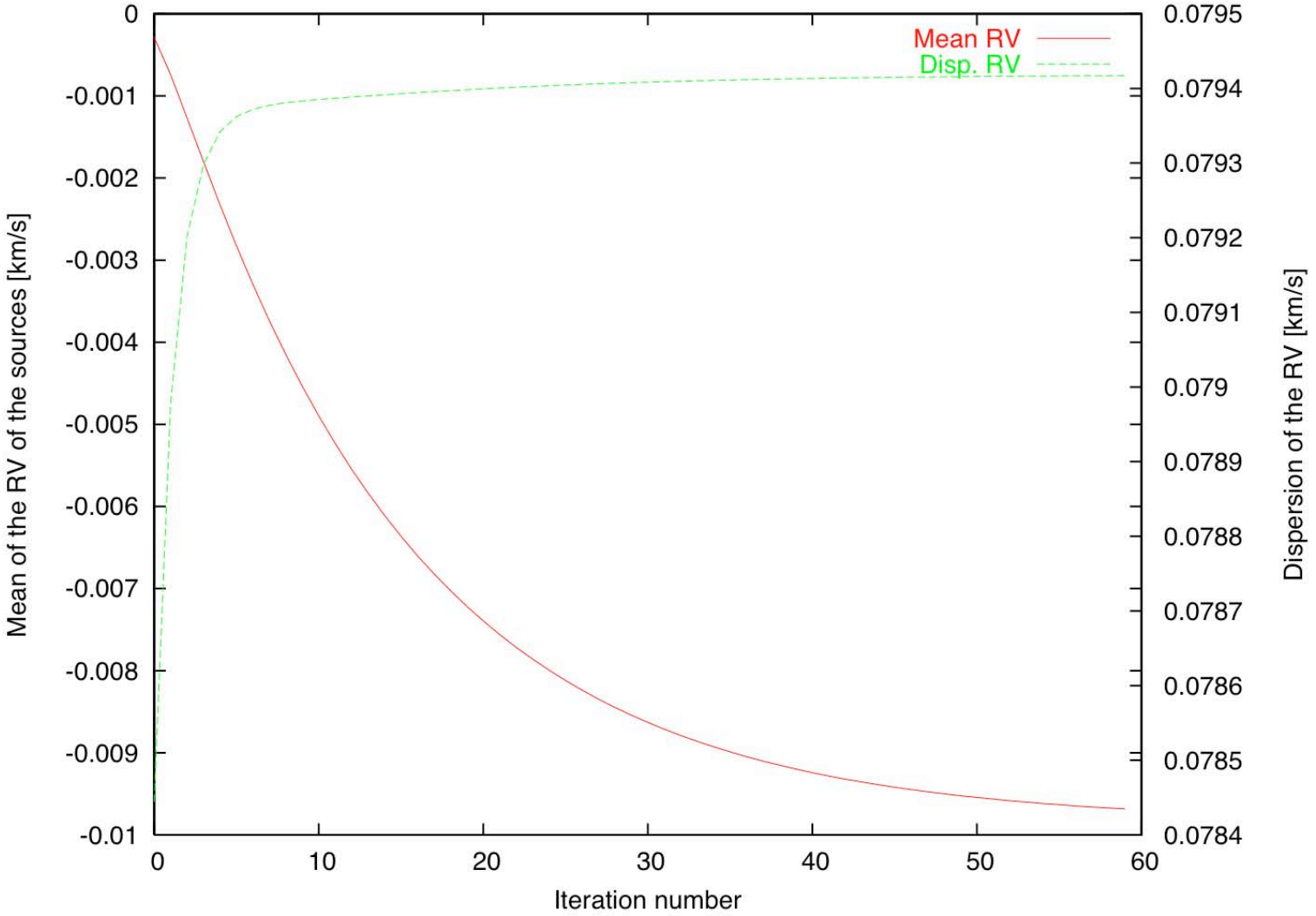
- Non-divergence test = True spectral dispersion law as starting point

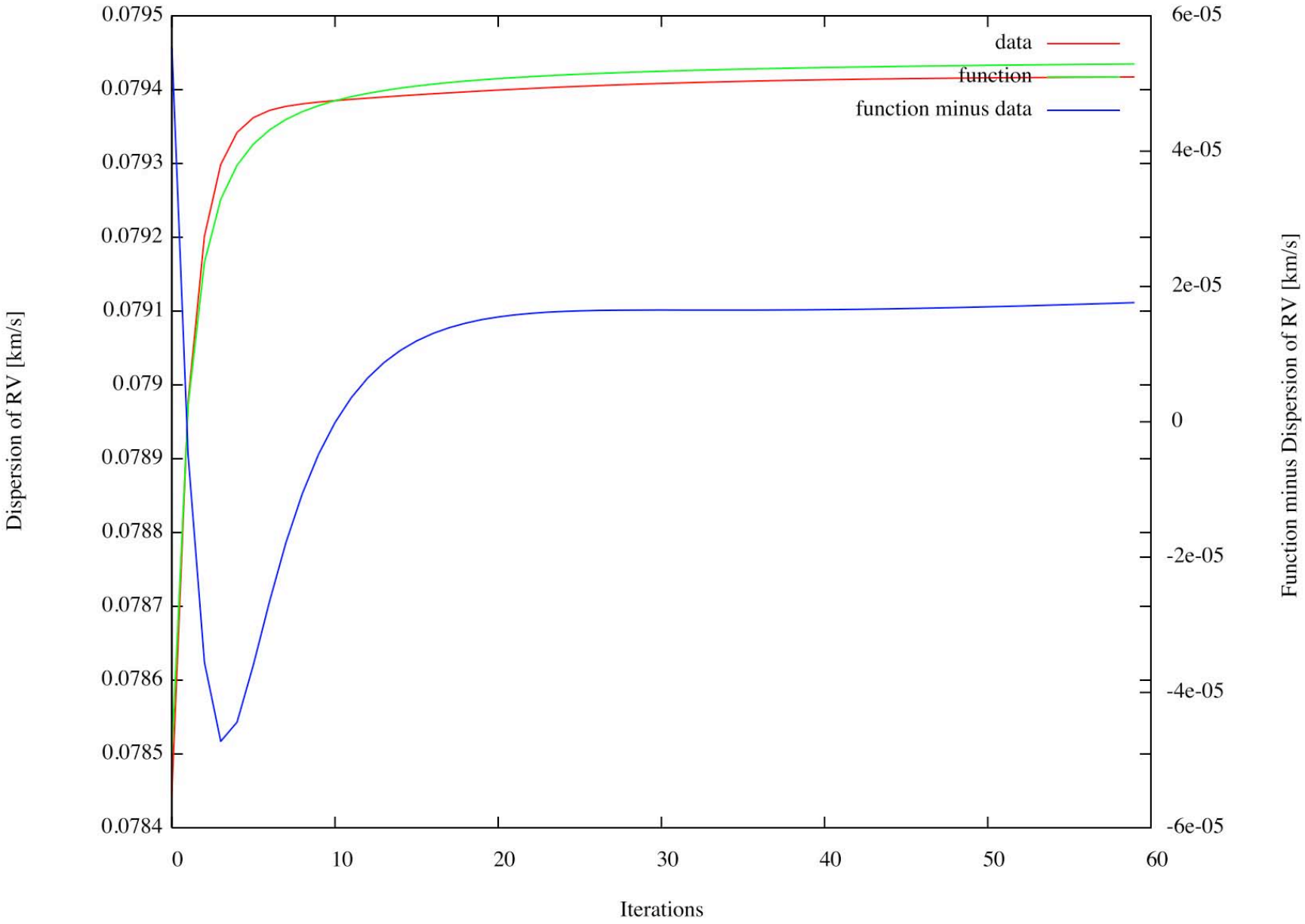
  = Best performances of SGIS

- Divergence of the prototype comes from the centroiding method
  - ➢ Idea: skip the centroiding step (instead the centroiding calibration or profile fitting method)

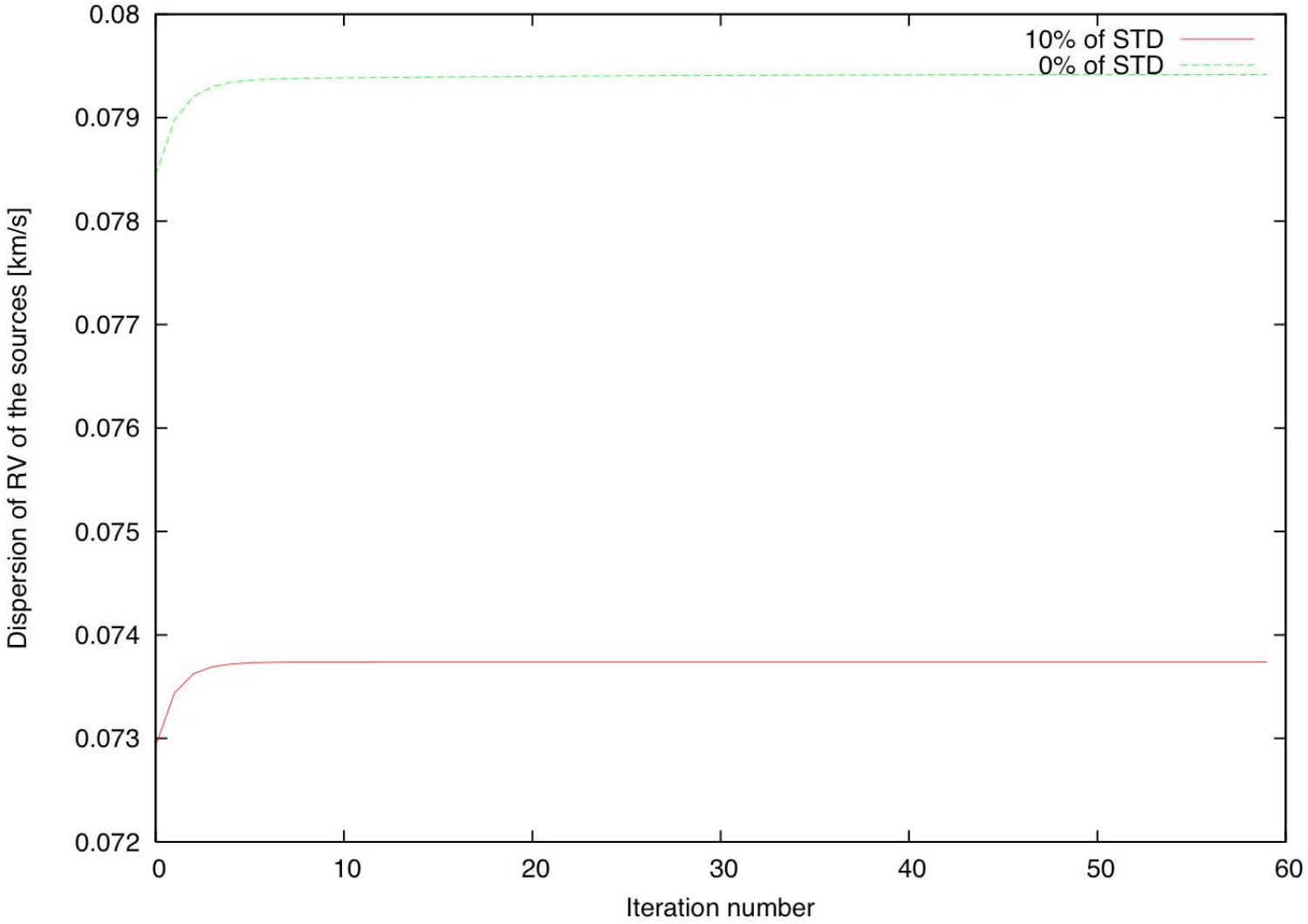
- Perform the prototype without centroiding effect
  - ➢ Use directly the true centroid of the lines

- Should validate the non-divergence of SGIS

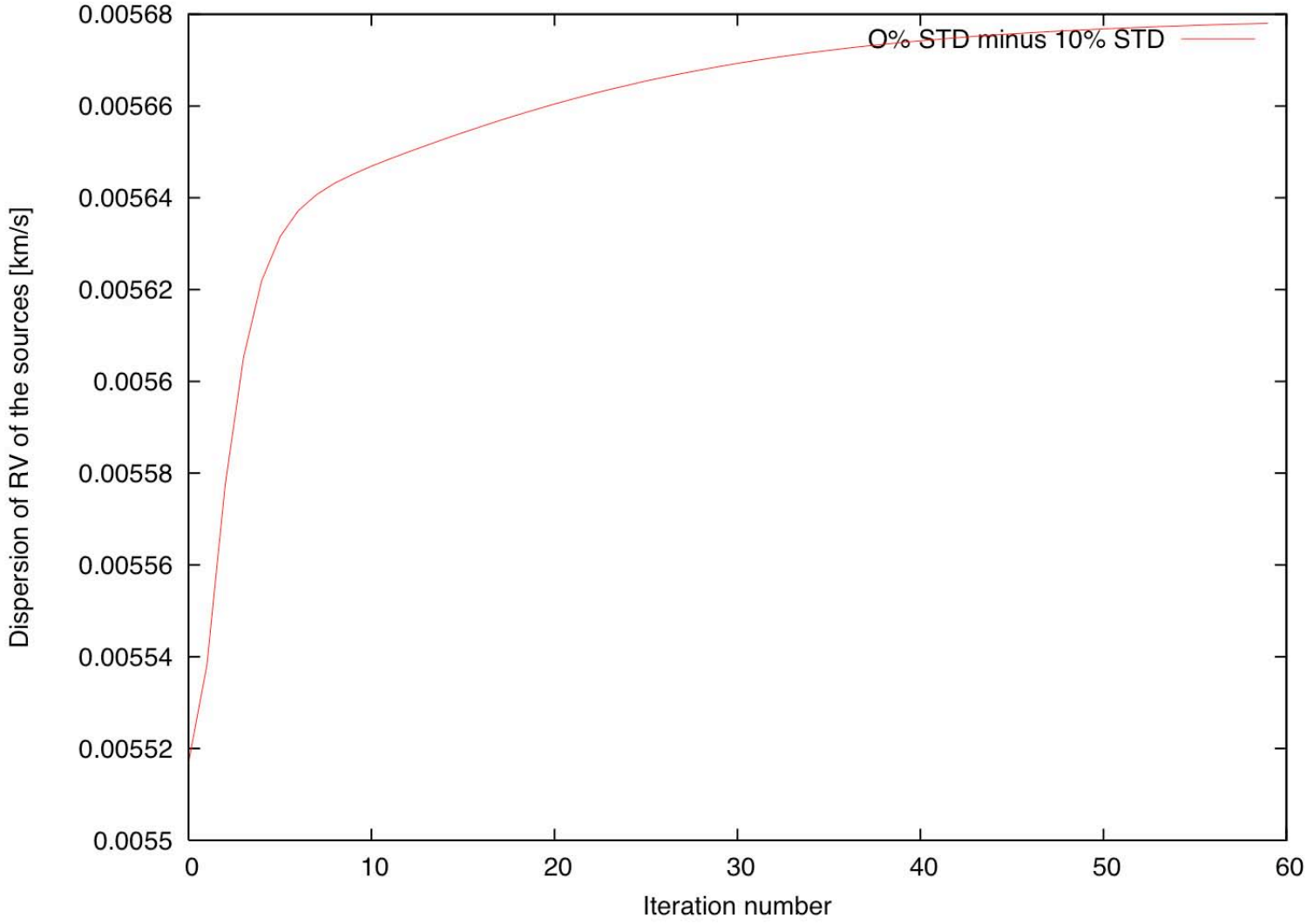

Mean RV
Disp. RV
Mean of the RV of the sources [km/s]
Dispersion of the RV [km/s]
Iteration number
0
-0.001
-0.002
-0.003
-0.004
-0.005
-0.006
-0.007
-0.008
-0.009
-0.01
0.0795
0.0794
0.0793
0.0792
0.0791
0.079
0.0789
0.0788
0.0787
0.0786
0.0785
0.0784
0
10
20
30
40
50
60

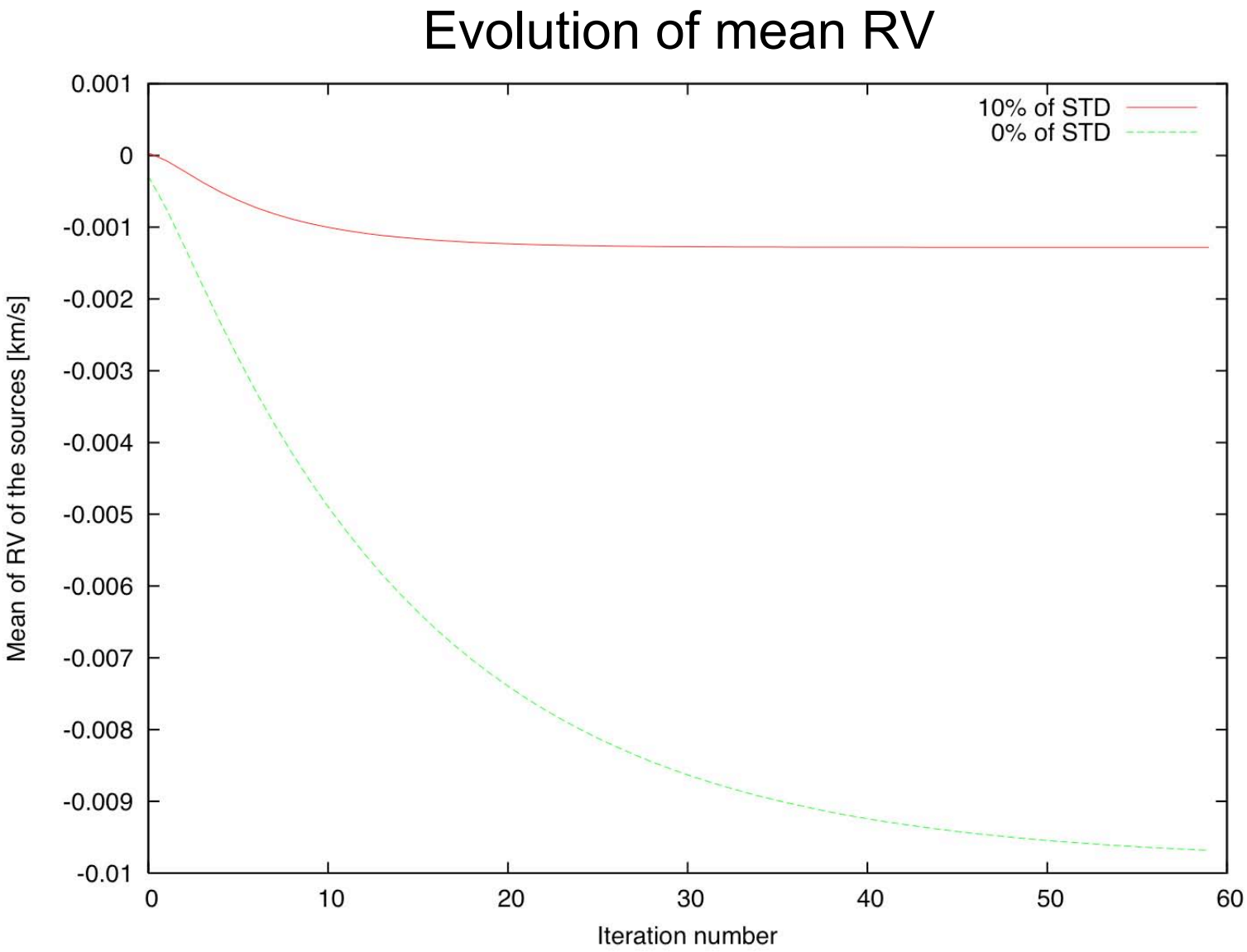

data
function
function minus data
Dispersion of RV [km/s]
Function minus Dispersion of RV [km/s]
Iterations
0.0795
0.0794
0.0793
0.0792
0.0791
0.079
0.0789
0.0788
0.0787
0.0786
0.0785
0.0784
6e-05
4e-05
2e-05
0
-2e-05
-4e-05
-6e-05
0
10
20
30
40
50
60

Evolution of dispersions of RV



Disp. 0% std. Minus Disp. 10% std.




Evolution of mean RV
10% of STD
0% of STD
Mean of RV of the sources [km/s]
Iteration number
0.001
0
-0.001
-0.002
-0.003
-0.004
-0.005
-0.006
-0.007
-0.008
-0.009
-0.01
0
10
20
30
40
50
60

- Study of robustness of the non-divergence
  - Consider random errors on the true centroids
  - Play on the max. amplitude of these errors
  - Observe the behaviour of the prototype

- Study of convergence of the prototype
  - Not initialize the spectral dispersion law with true values
  - Observe the behaviour of the prototype over iterations