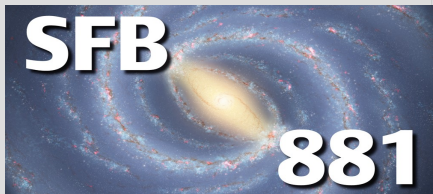
S.PA.C.E.

a new code for Teff, Log g and [X/H] estimation

Corrado Boeche

Astronomisches Rechen-Institut
Heidelberg



S.PA.C.E.

a new code for Teff, Log g and [X/H] estimation

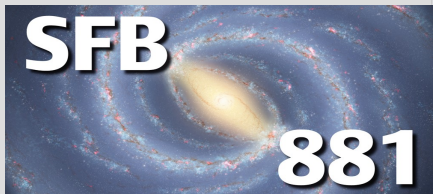
Stellar

Parameters and

Chemical abundances

Estimator

Corrado Boeche

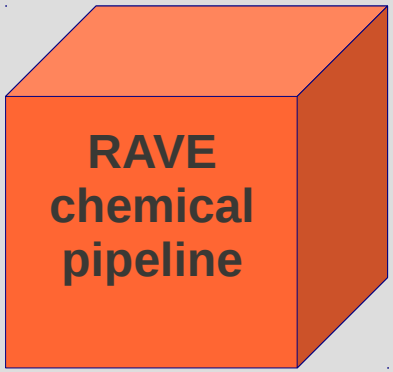


S.PA.C.E.

a new code for Teff, Log g and [X/H] estimation

input

- normalized spectrum
- wavelength range
- resolution (guess)
- Teff
- log g
- [m/H] (guess)



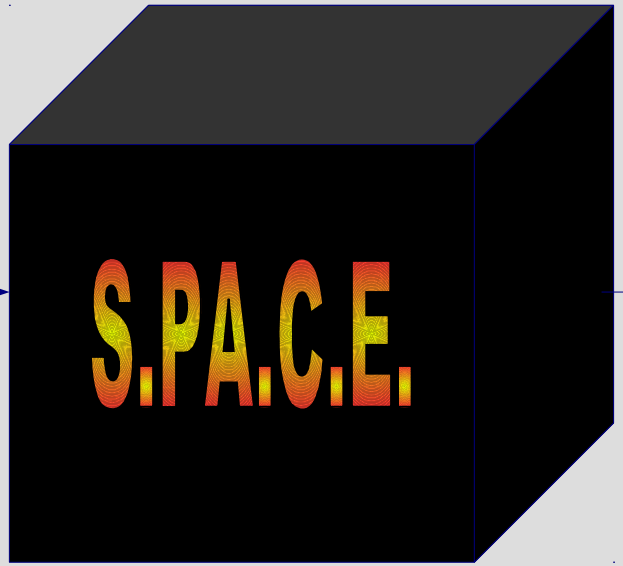
output

chemical abundances
[Fe/H], [Mg/H],[Al/H][Si/H],
[Ti/H],[Ni/H]

SPACE is the evolution of the RAVE chemical pipeline

input

- normalized spectrum
- wavelength range
- resolution (guess)



output

Teff
log g
chemical abundances
[Fe/H],[Mg/H],[Al/H],[Si/H],
[Ca/H],[Ti/H],[Cr/H],[Ni/H]
and more....

Corrado Boeche

SFB 881

Wavelength ranges presently covered by S.PA.C.E

(~4500 absorption lines)

SPACE (now) SPACE (coming soon) SPACE (now)

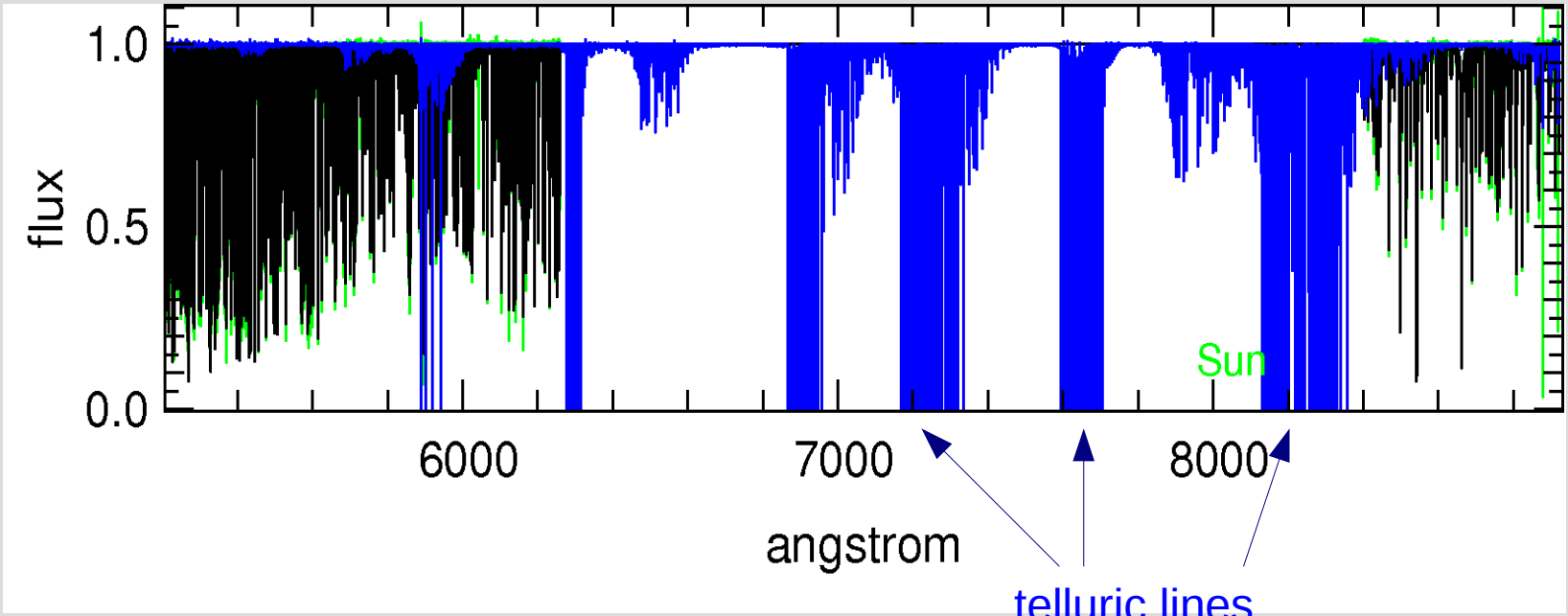
HR10 GES

HR21 GES

High res 4MOST High res 4MOST

Gaia,RAVE

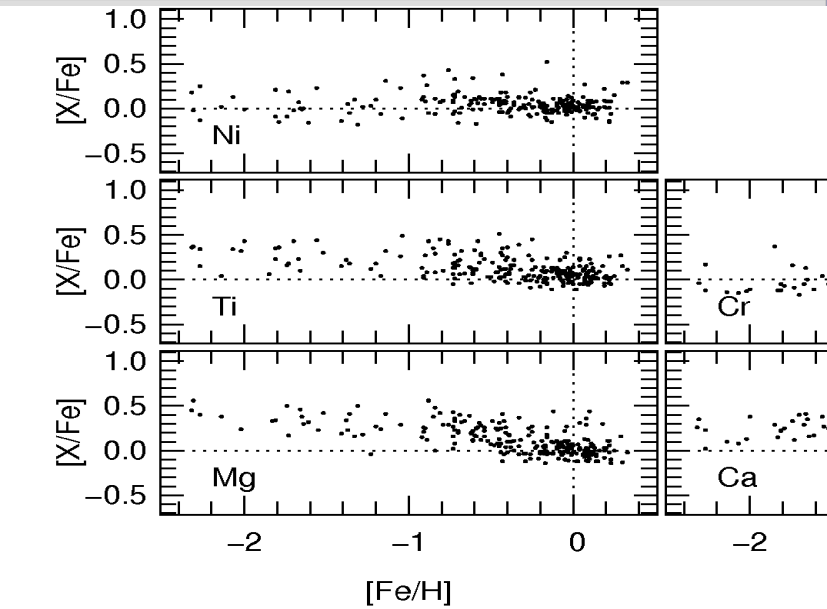
Low res 4MOST, WEAVE

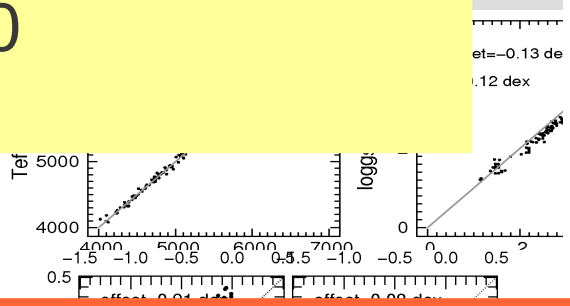


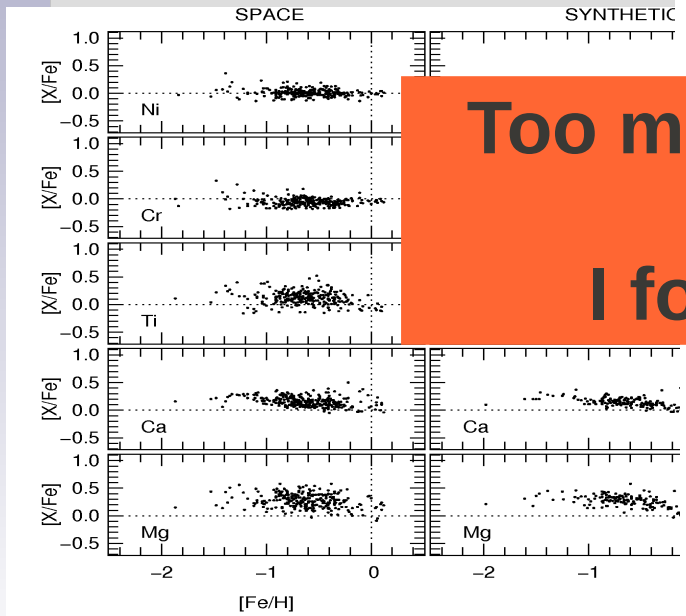
(preliminary) Tests performed on:

Synthetic spectra,ELODIE spectra
S4N spectra at

R=5000,20000
S/N(pix)=30, 50, 100

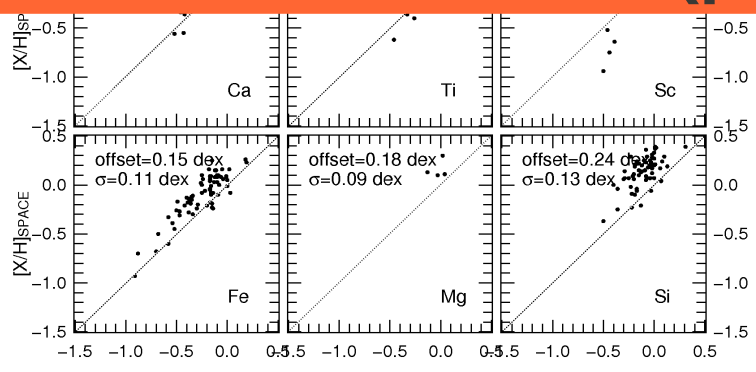


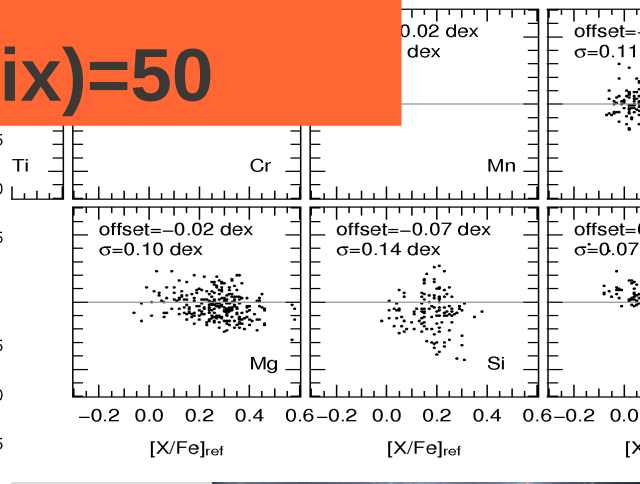




Too many plots to show in 15 mins!!!

I focus on R=5000 S/N(pix)=50





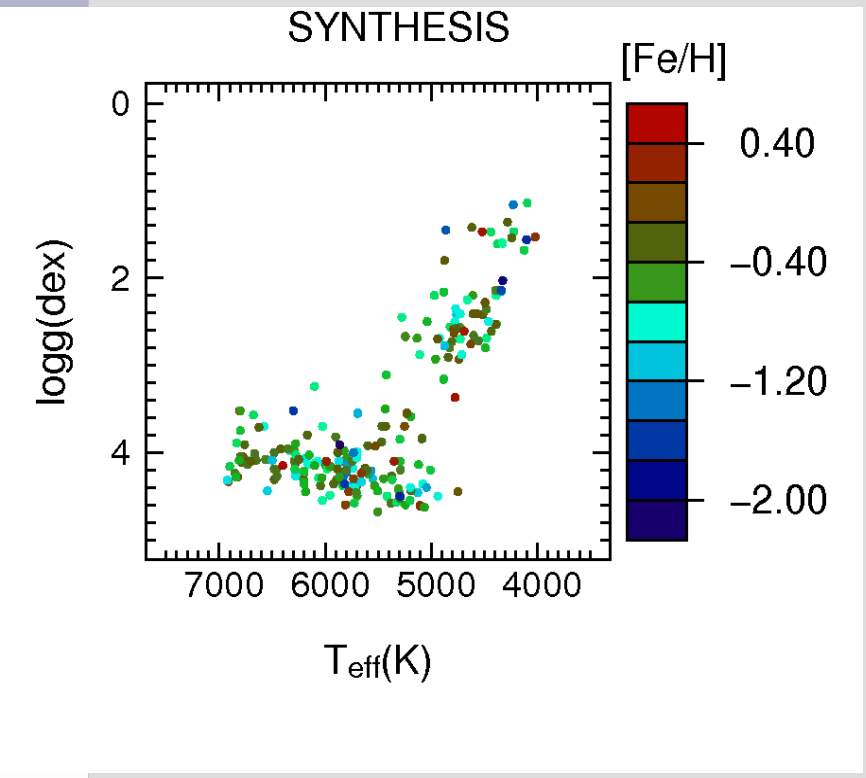
Test on synthetic spectra: the sample

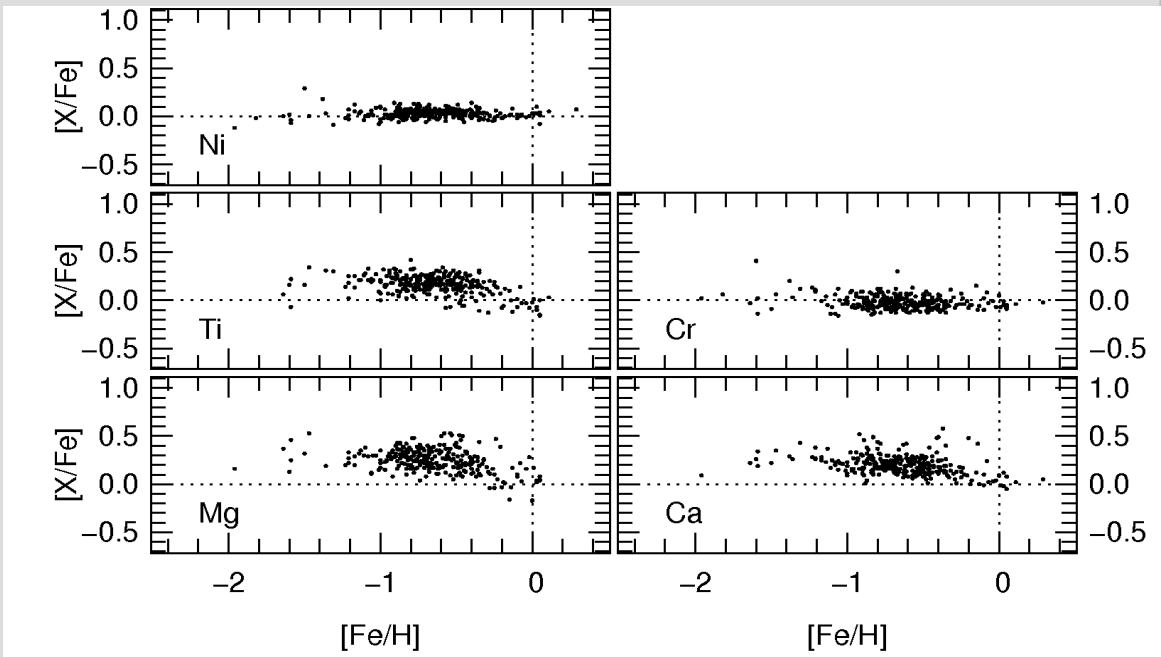
600 spectra synthesized with MOOG and having:

- Teff and logg from ELODIE spectra library (randomly chosen)

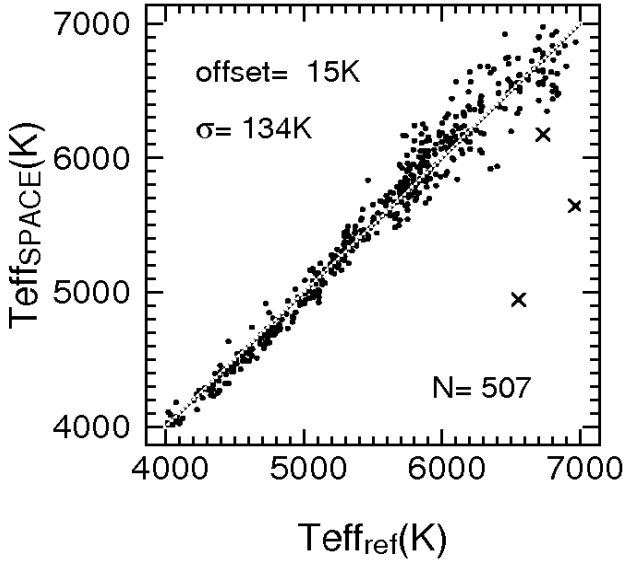
- 21 elemental abundances from Reddy et al. 2006 (randomly associated to Teff and logg)

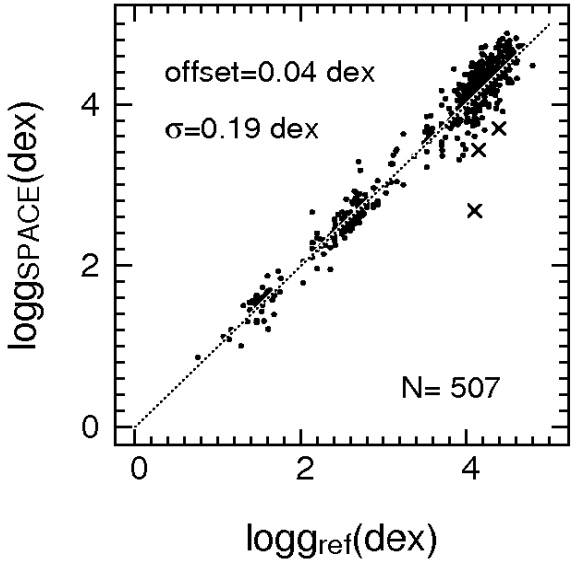
in order to have realistic stellar parameters and chemical abundances

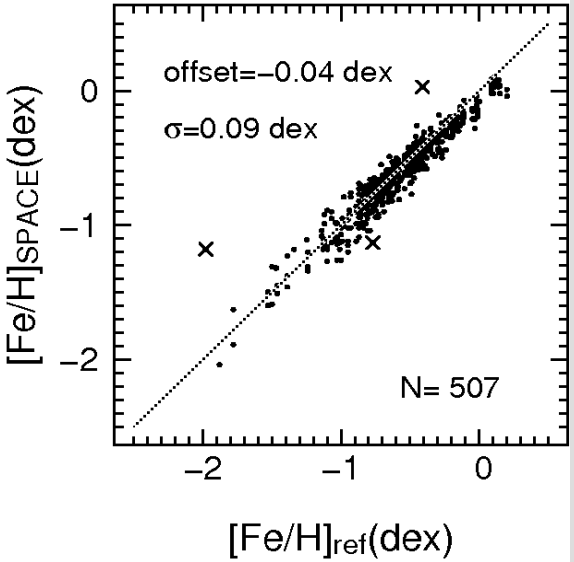


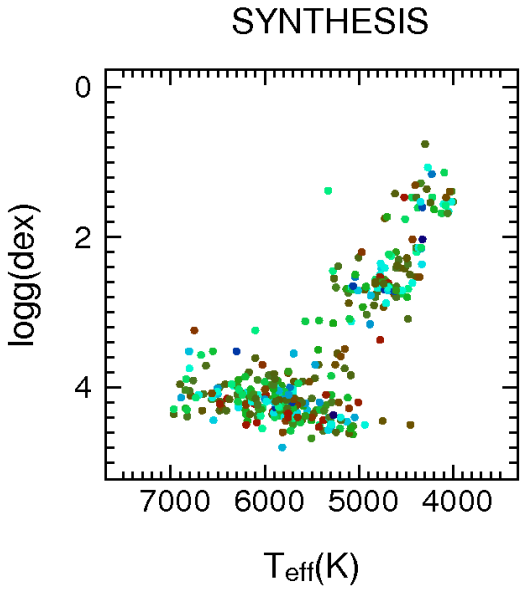


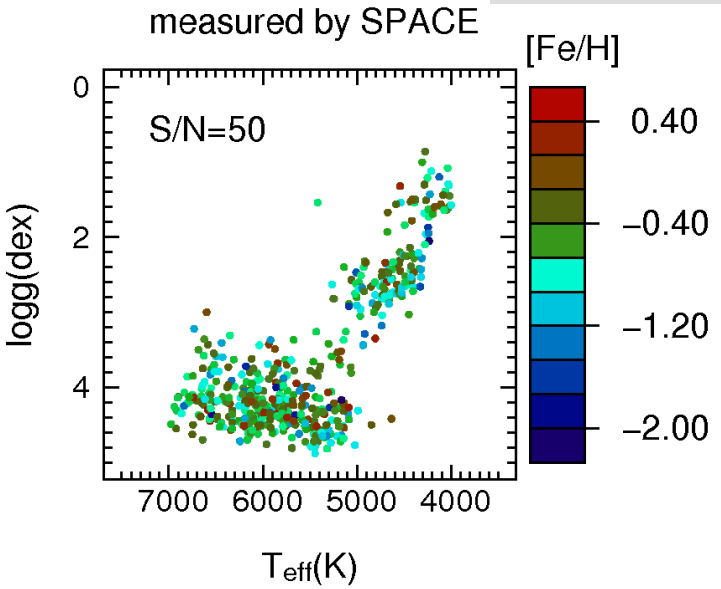
Test on synthetic spectra: results for R=5000 S/N(pix)=50 0.35A/pix W=5212-6260Å





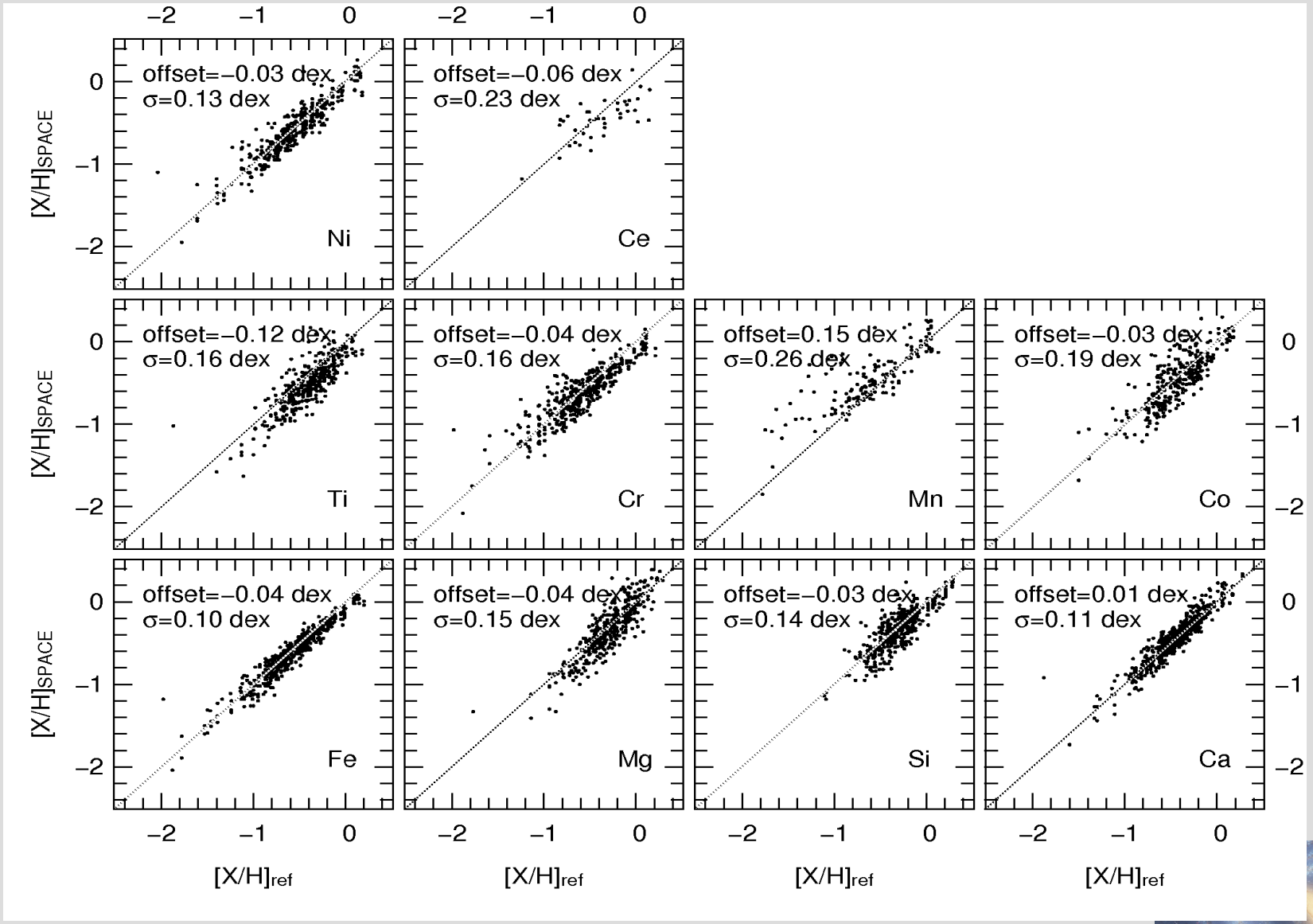




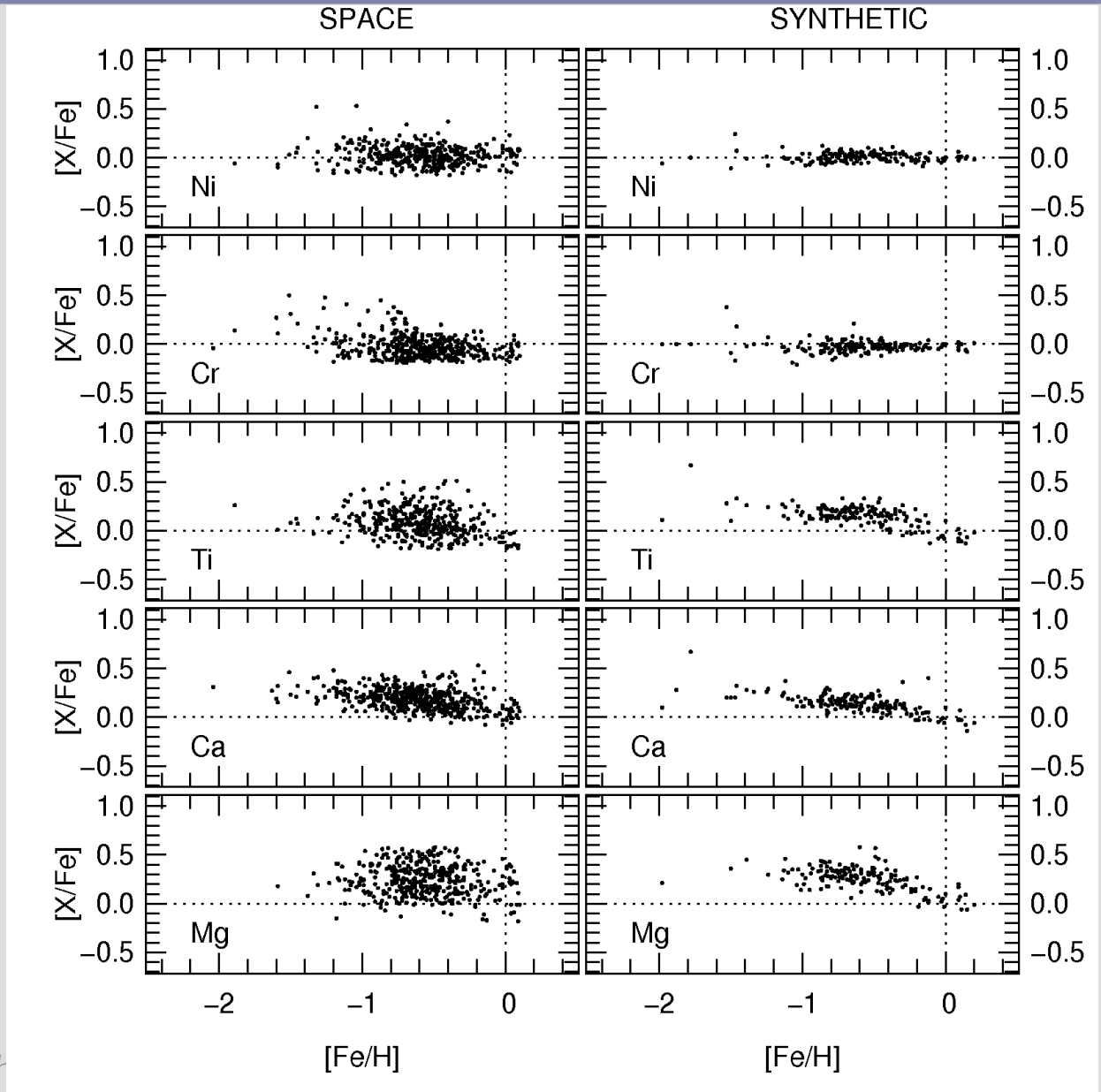


Corrado Boeche

Test on synthetic spectra: results for R=5000 S/N(pix)=50 0.35A/pix W=5212-6260Å

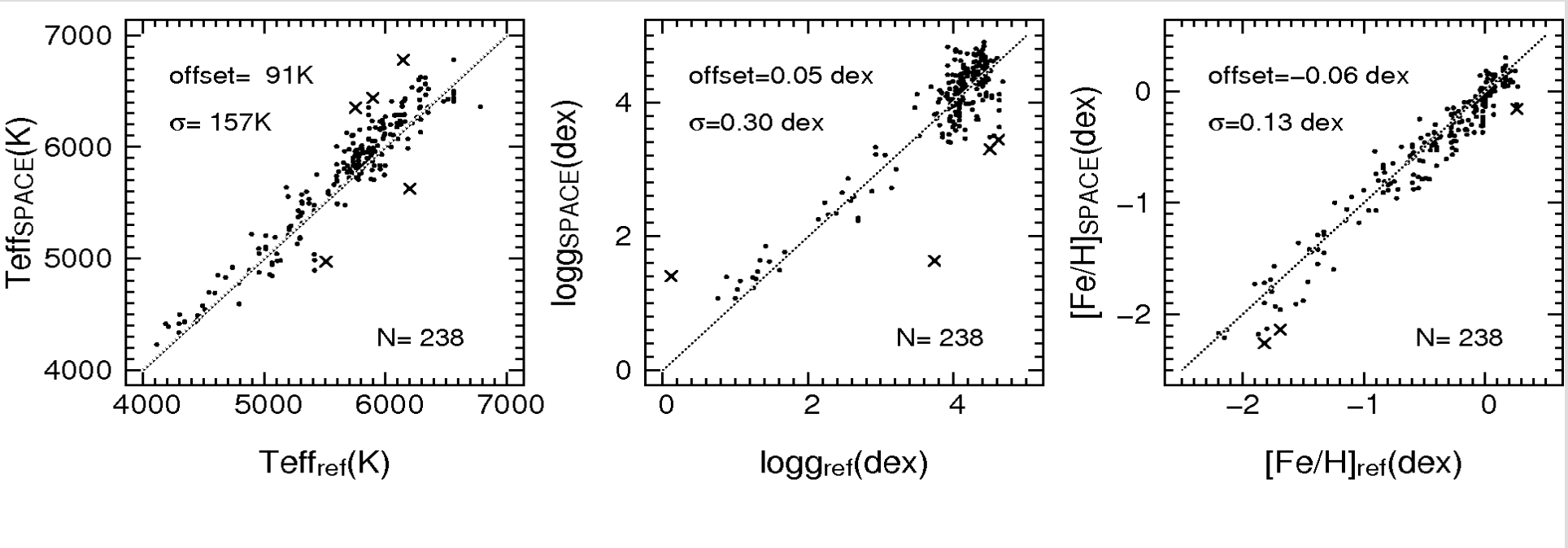


Test on synthetic spectra: results for R=5000 S/N(pix)=50 0.35A/pix W=5212-6260Å



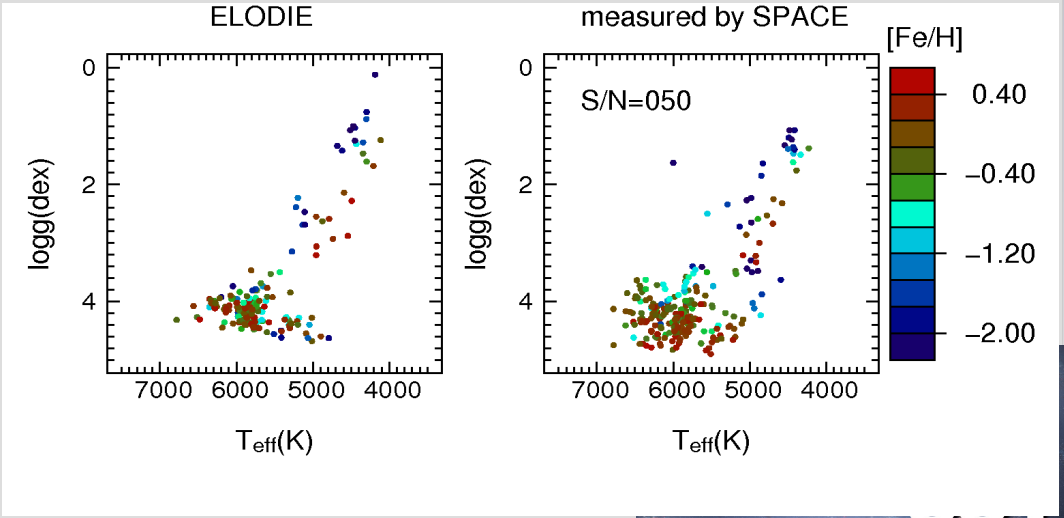
SFB 881

Test on ELODIE spectra: results for R=5000 S/N(pix)=50 0.35A/pix W=5212-5619Å



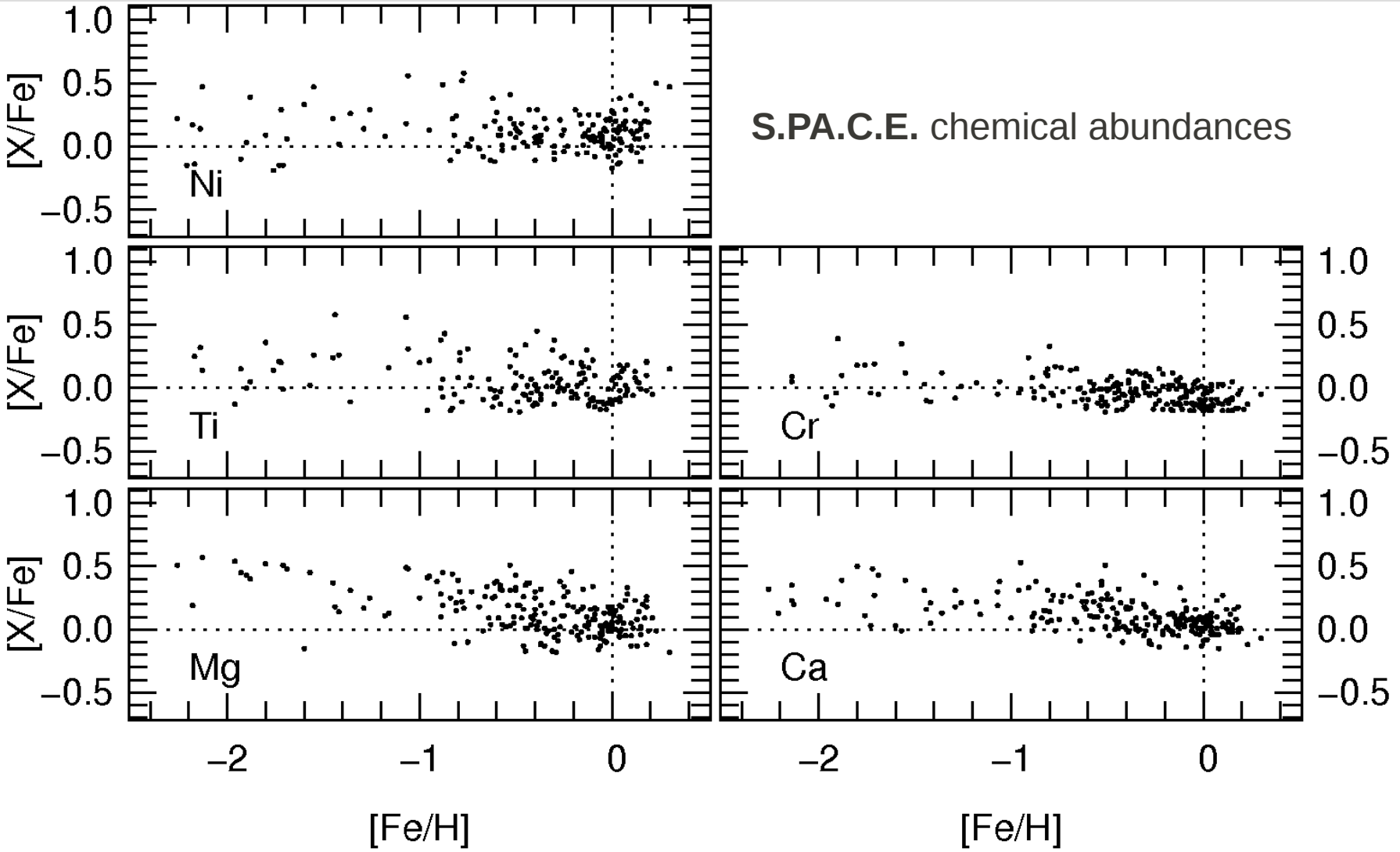
Remember that:

$$\sigma = \sqrt{\sigma_{ref}^2 + \sigma_{SPACE}^2}$$



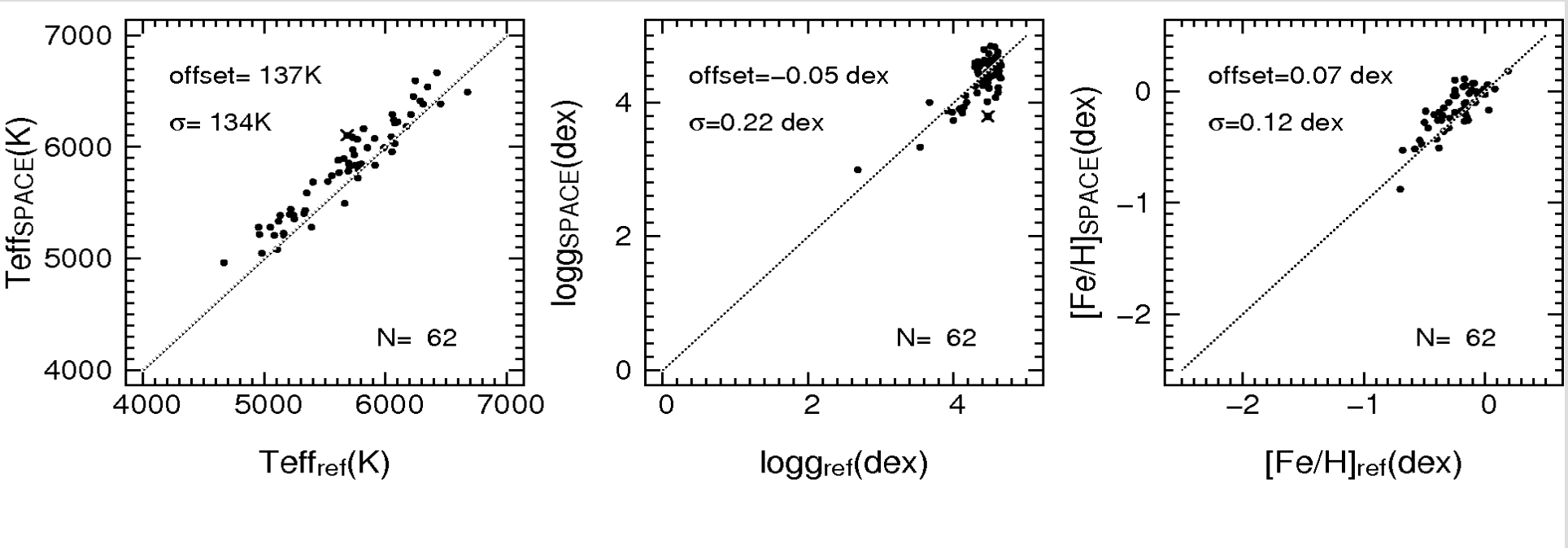
Corrado Boeche

Test on ELODIE spectra: results for R=5000 S/N(pix)=50 0.35A/pix 5212-5619Å



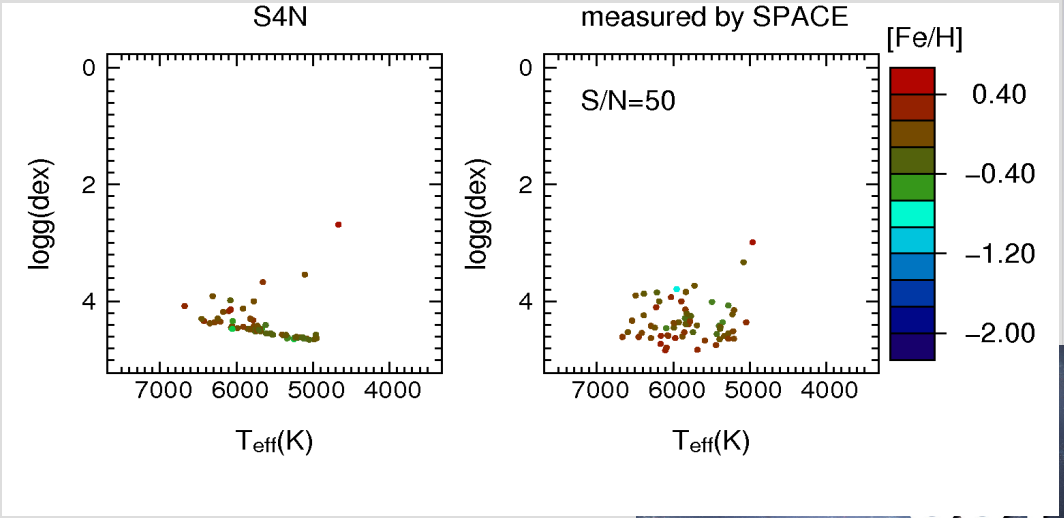
Test on S4N spectra(Allende Prieto et al. 2004):

results for R=5000 S/N(pix)=50 0.35A/pix W=5212-5619Å



Remember that:

$$\sigma = \sqrt{\sigma_{ref}^2 + \sigma_{SPACE}^2}$$

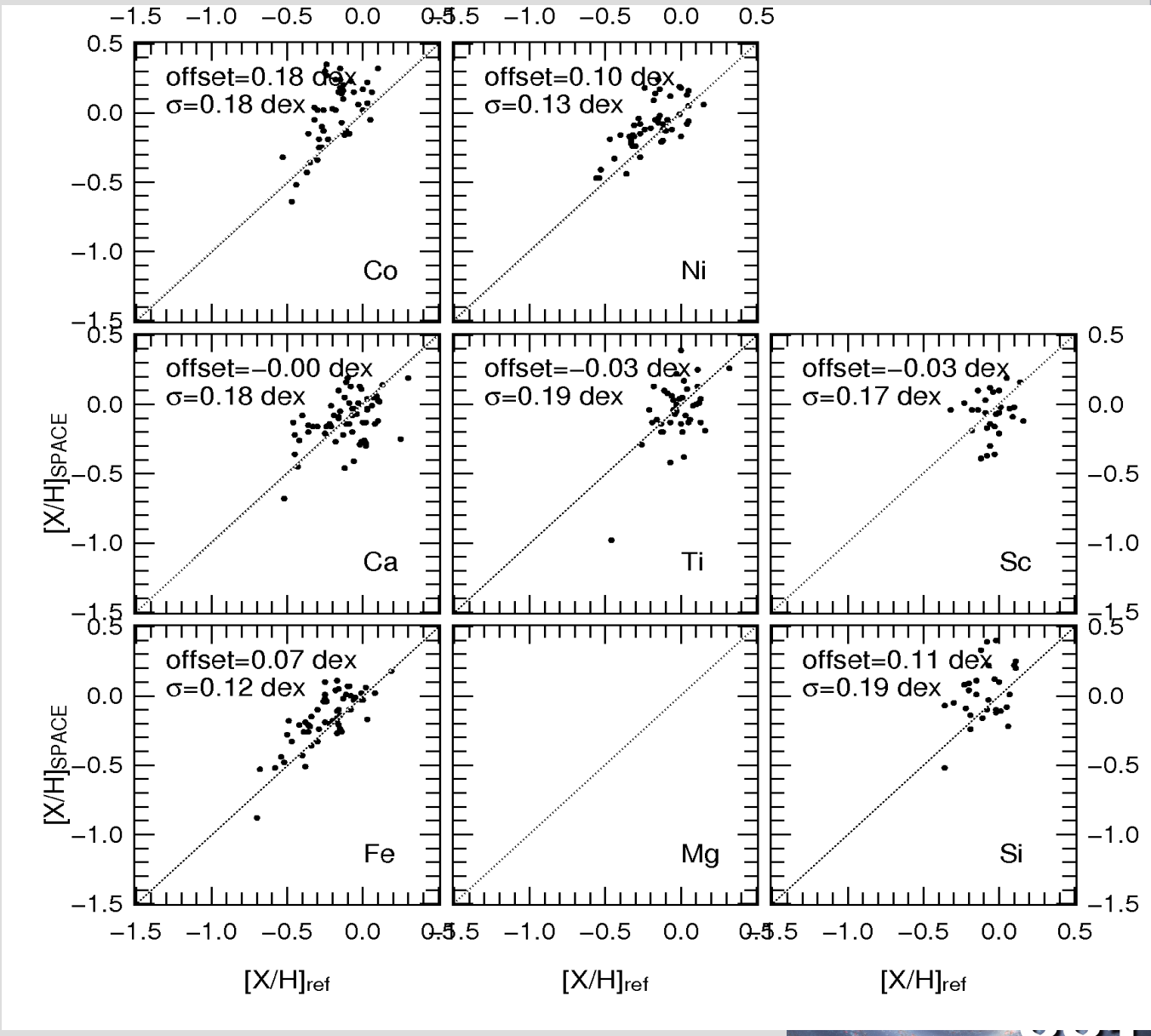


Corrado Boeche

Test on S4N spectra(Allende Prieto et al. 2004):

results for R=5000 S/N(pix)=50 0.35A/pix W=5212-5619Å

S/N(pix)=50



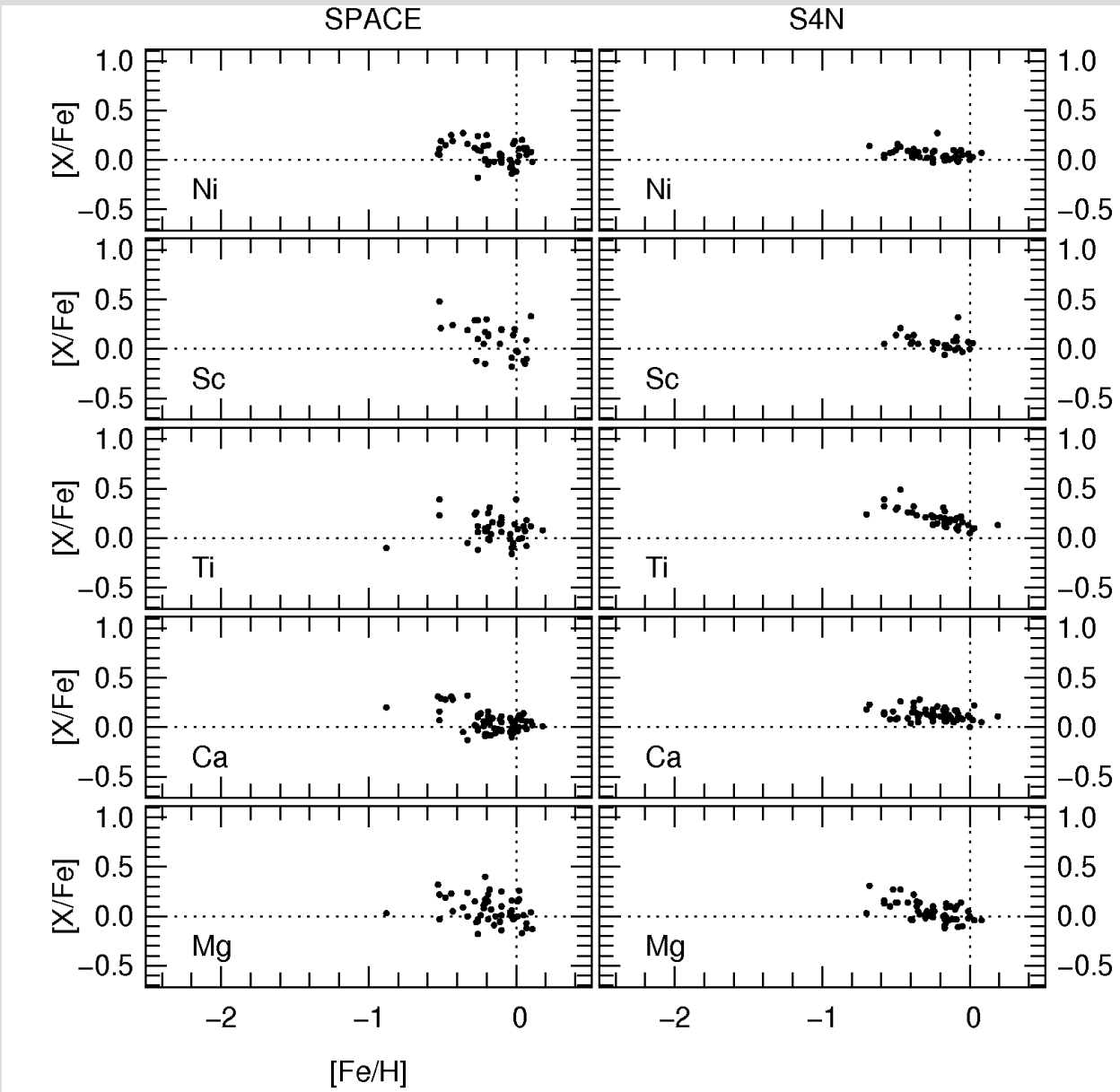
Remember that:

$$\sigma = \sqrt{\sigma_{ref}^2 + \sigma_{SPACE}^2}$$

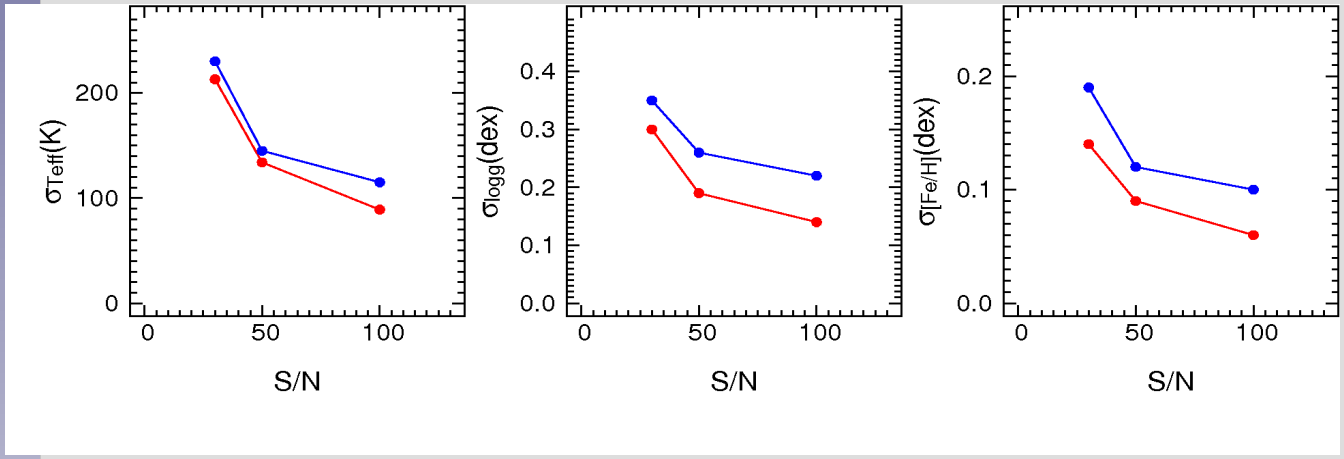
Test on S4N spectra(Allende Prieto et al. 2004):

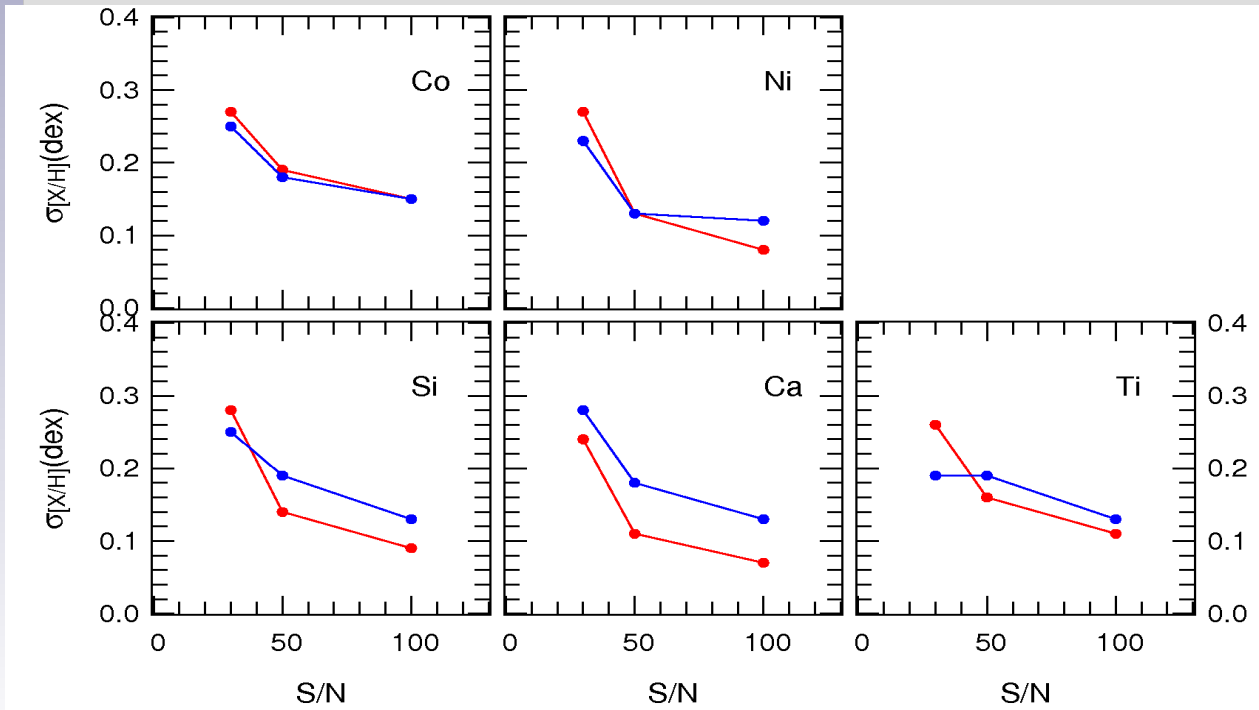
results for R=5000 S/N(pix)=50 0.35A/pix W=5212-5619Å

S/N(pix)=50



Summary: expected errors for R=5000





ELODIE-S4N spectra (5212-5619Å range) (upper limit errors)

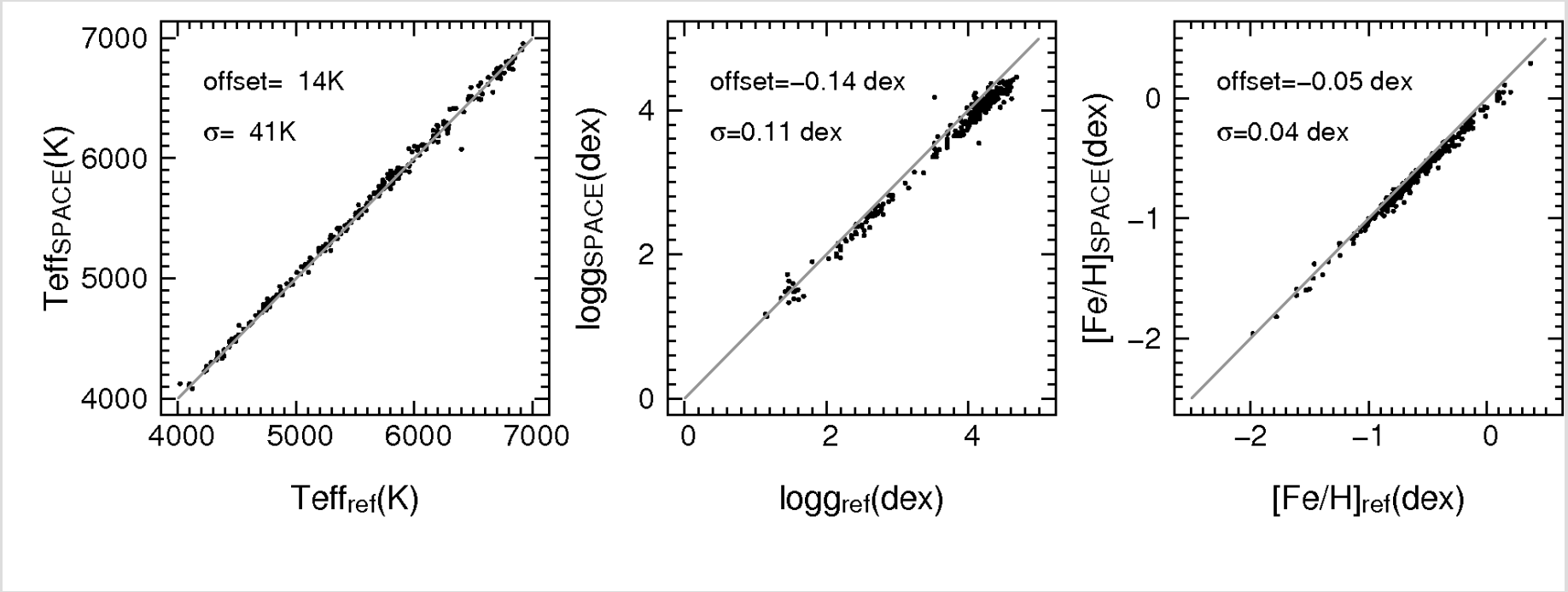
SYNTHETIC spectra (5212-6260Å range) (lower limit errors)

the true errors lie between the red and the blue lines

SFB 881

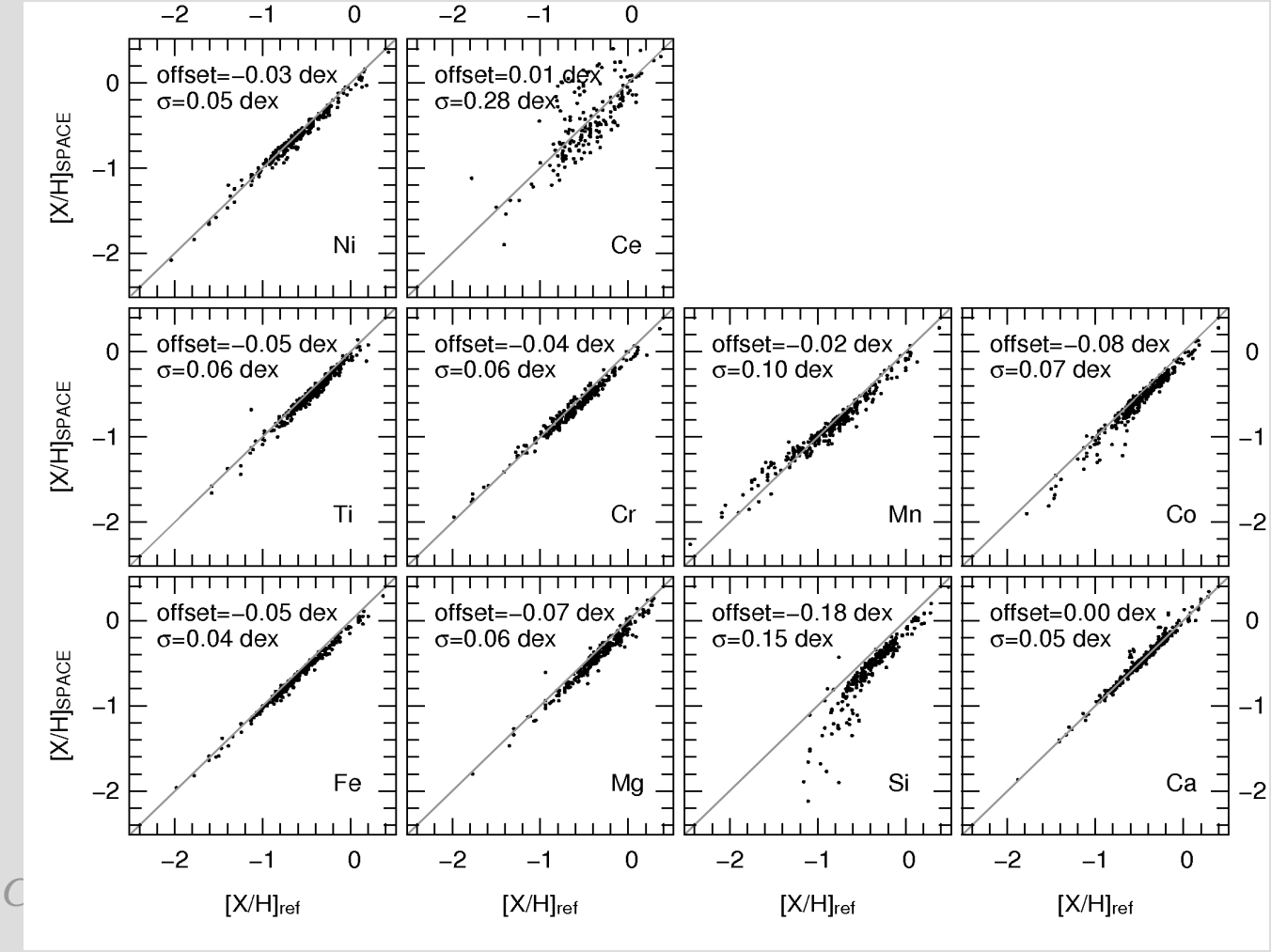
Test on synthetic spectra: results for R=20000 S/N(pix)=100

Test for Gaia-ESO Survey: W=5339-5619Å, 0.05Å/pix (HR10 Giraffe spectra)



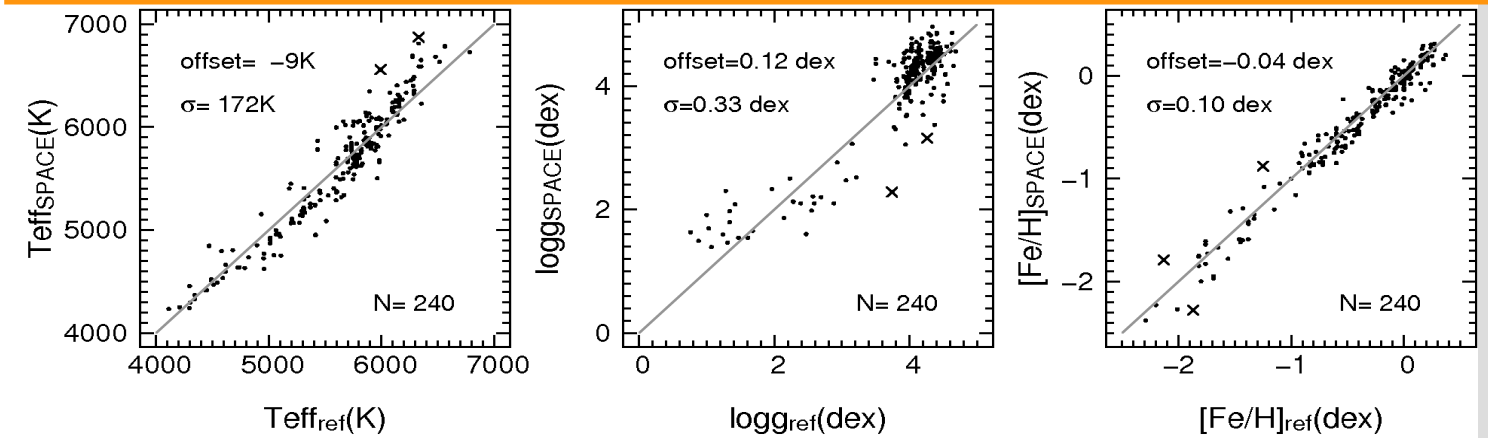
Test on synthetic spectra: results for R=20000 S/N(pix)=100

Test for Gaia-ESO Survey: W=5339-5619Å, 0.05Å/pix (HR10 Giraffe spectra)



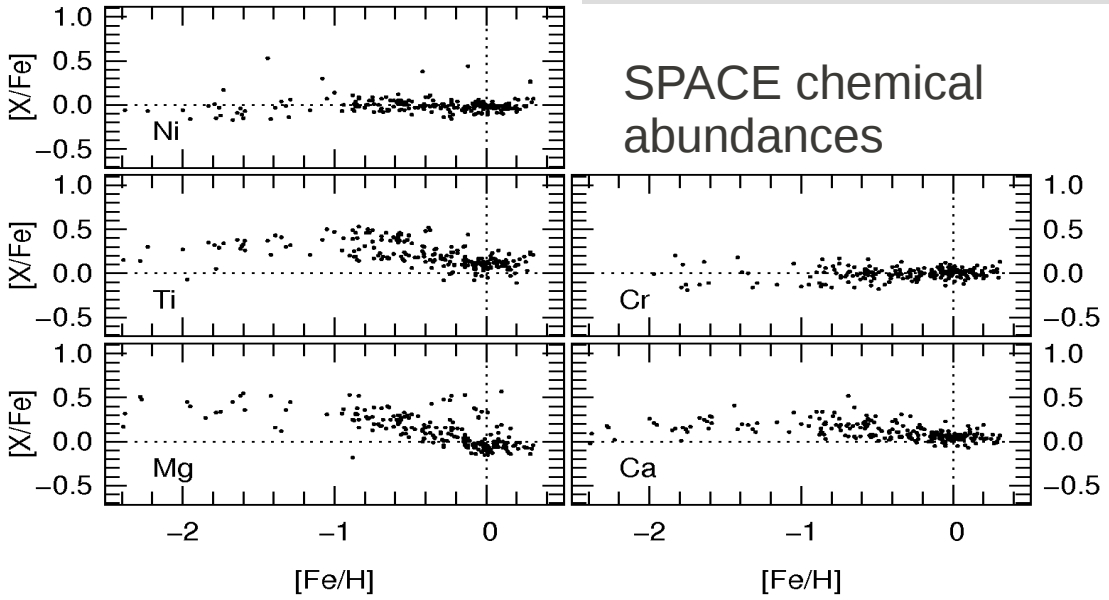
Test on ELODIE spectra: R=20000 S/N(pix)=100

Test for Gaia-ESO Survey: W=5339-5619Å, 0.05Å/pix (HR10 Giraffe spectra)



Remember that:

$$\sigma = \sqrt{\sigma_{ref}^2 + \sigma_{SPACE}^2}$$



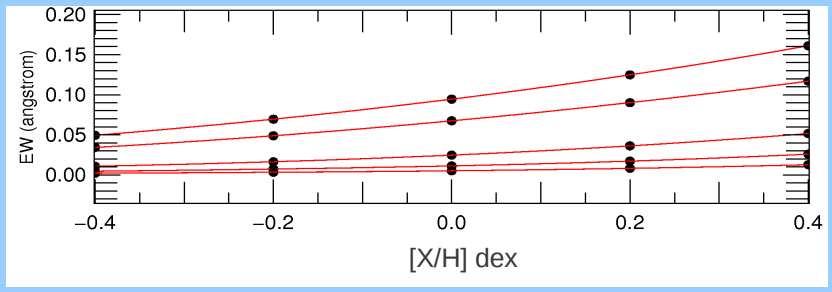
SPACE chemical abundances

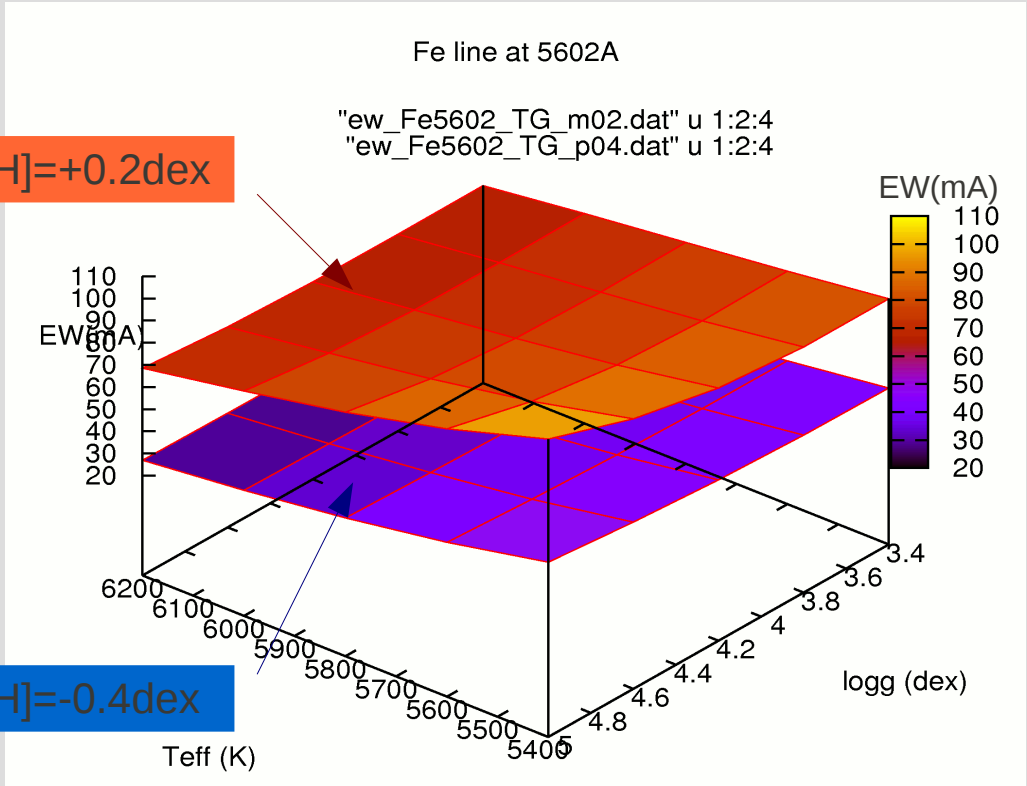
Corrado Boeche

How does S.PA.C.E. work?
Generalized Curve Of Growth (GCOG)

Curve of growth (COG): it is function of [X/H] when Teff and log g are fixed

$$EW = COG([X/H])$$



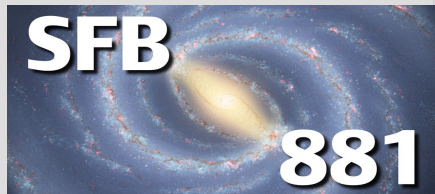


[Fe/H]=+0.2dex

[Fe/H]=-0.4dex

Generalized COG (GCOG): the EW depend also from Teff and log g

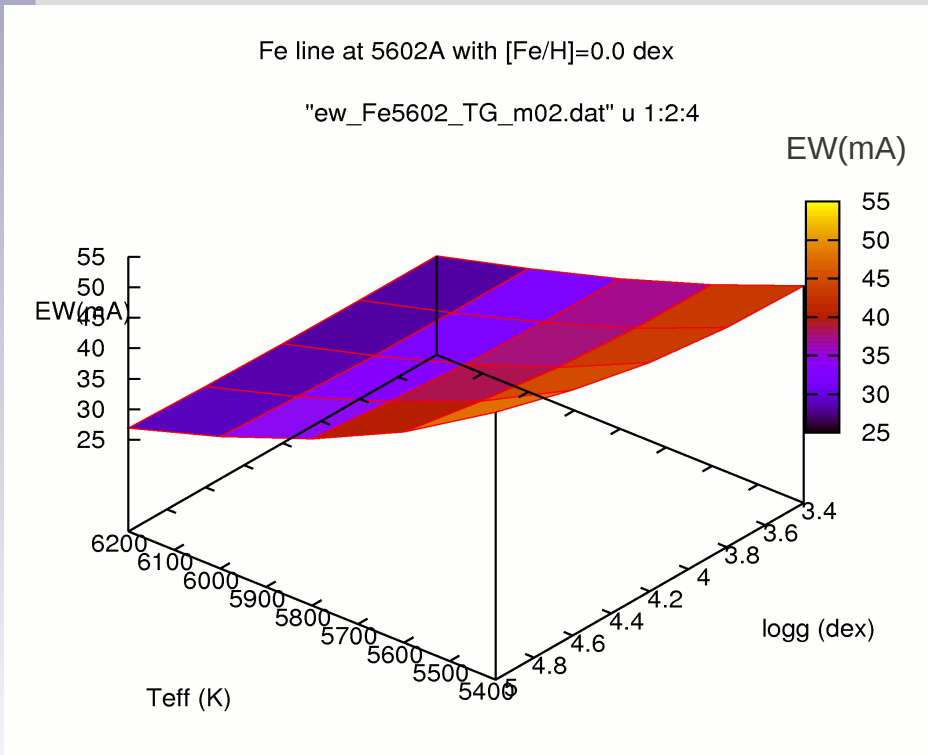
$$EW = GCOG(T_{eff}, \log g, [X/H])$$



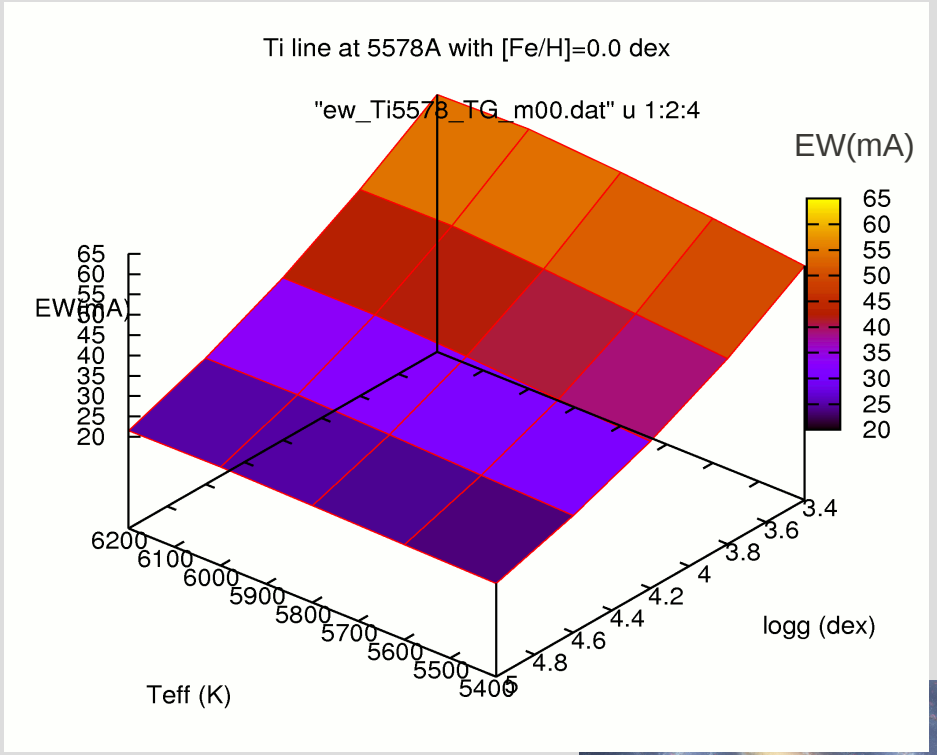
How does S.PA.C.E. work?
Generalized Curve Of Growth (GCOG)

Test for Gaia-ESO Survey: W=5339-5619Å, 0.05Å/pix (HR10 Giraffe spectra)

[Fe/H]=0.0dex w=5602A

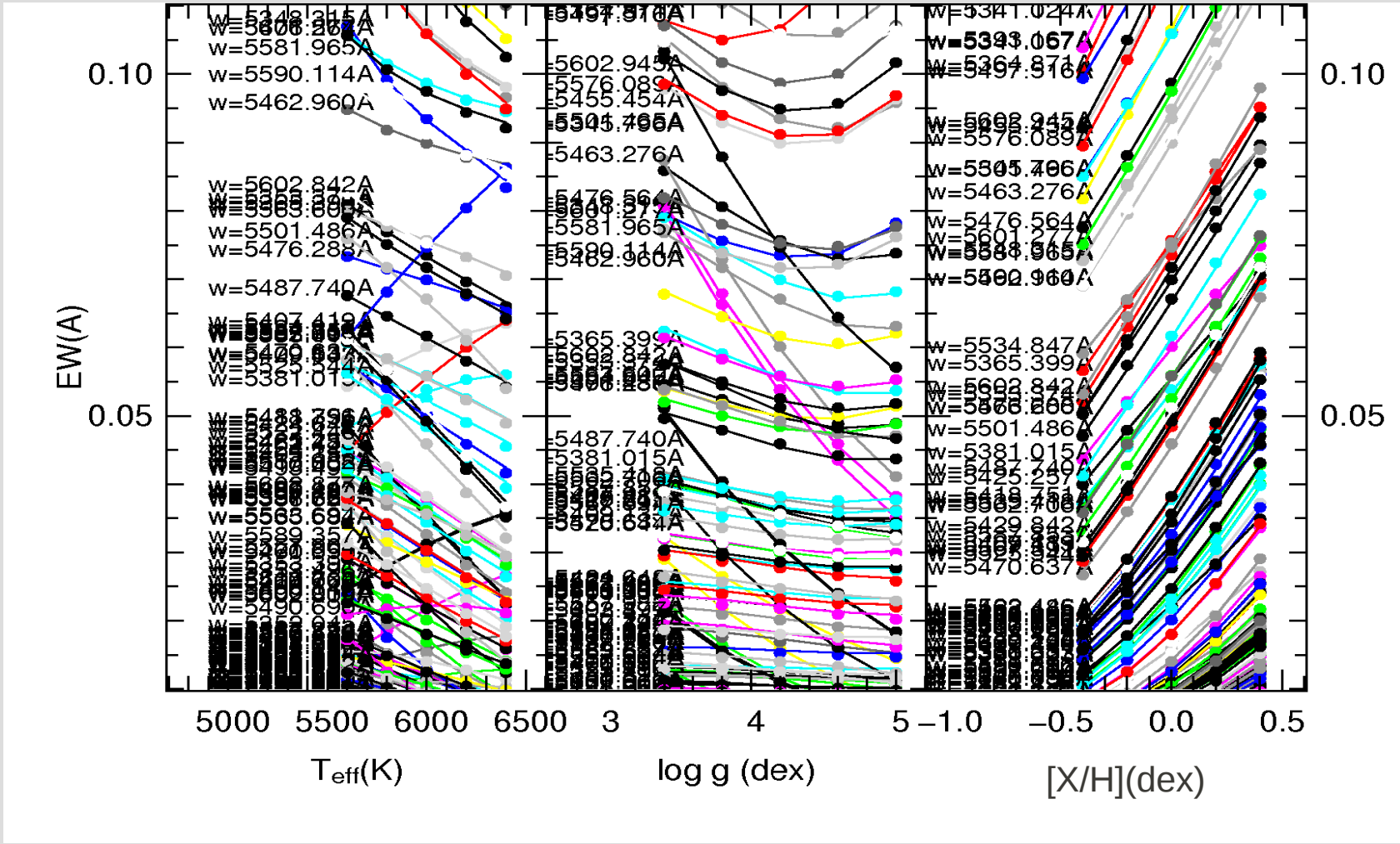


[Ti/H]=0.0dex w=5578A



How does S.PA.C.E. work?

Generalized Curve Of Growth (GCOG)



logg and [X/H] constant

Teff and [X/H] constant

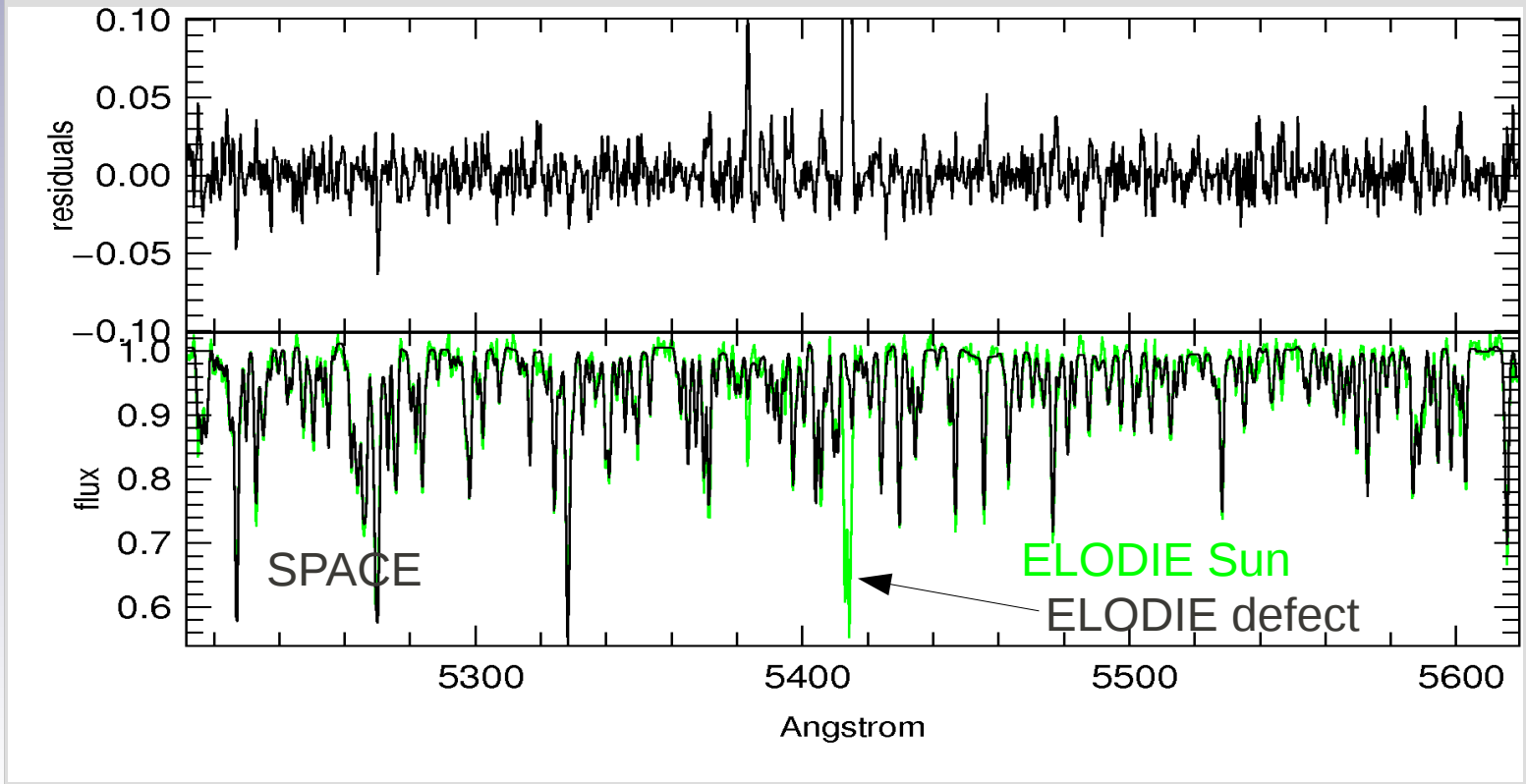
Teff and logg constant

How does S.PA.C.E. work?

• SPACE get the EW of every visible line through the GCOGs, reconstructs the lines with the adopted line profile, and explore the parameters space (Teff,logg,[X/H]) looking for the best match with the observed spectrum

• parameters ranges covered Teff(K) [4000,7000], logg (dex) [0,5], [X/H] (dex) [-2.4,+0.4]

• the oscillator strengths of the lines have been astrophysically corrected (4497 atomic and molecular lines over ~1400 A wavelength range)



R=5000
S/N=100

Reconstructed model
Teff=5831K
logg=4.47dex
[Fe/H]=-0.03dex

SFB 881

Summary

S.PA.C.E. is a new code which estimates stellar parameters and chemical abundances in one shot (processing time 10-20 sec per spectrum)

It render reliable stellar parameters and chemical abundances with precision which depend on the element, spectral resolution and S/N

It is a young code, there is plenty of room for improvements:

- optimize the GCOG grid
- optimize the function which approximate the GCOG
- improve the line profile (very important!)
- improve the line list
- extend the operational wavelength range
- treatment of the strong lines (i.e. CaII triplet, HI lines)

I plan to release **S.PA.C.E.**, hoping it
can be a useful tool for spectral analysis (timescale 6months-1 year)