A Preliminary Result of SSEPC : Equivalent Width Measurement Code

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CONTENTS

INTRODUCTION

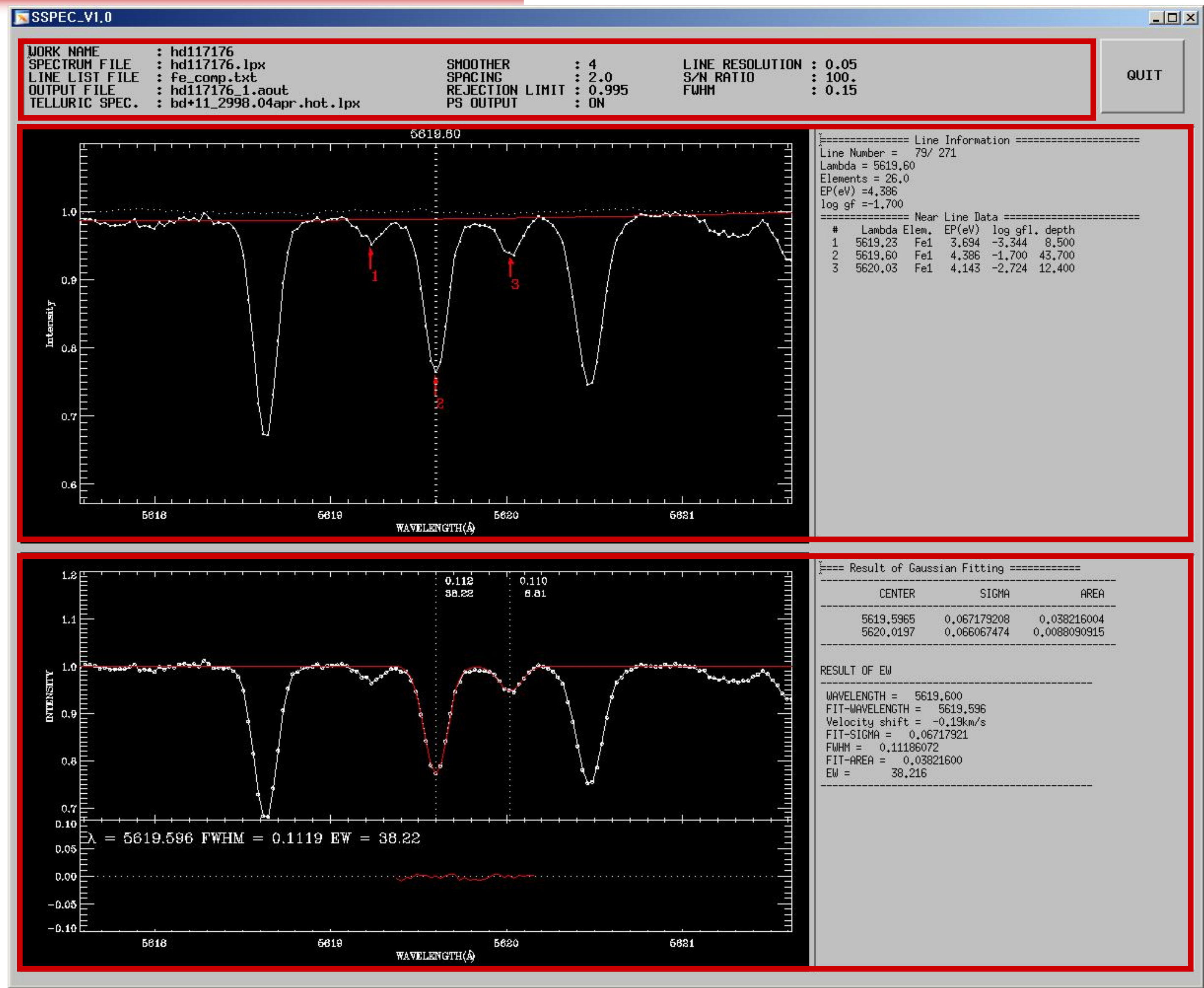
- Background
  - Need a large number of EW measurements for chemical composition study of the exoplanet systems
    - Quick and efficient method is required
  - Determination of the spectroscopic stellar parameters
    - Make use of the standard method of EW measurements to determine the parameter of stellar atmosphere model
  - ARES (Automatic Routine for line EW in stellar spectra)
    - S. G. Sousa et al. 2007, A&A, 469, 783
    - Get an idea to identify the lines using derivative function of spectrum
- Features
  - The code(tentative name, SSPEC) is written in IDL, using **`mpfit`** package and **`astron`** library
  - User can determine the continuum level interactively
  - Text output file is MOOG code(Sneden, 1973) form
  - Graphic output file is very useful to confirm the result after automatic measurements

USER INTERFACE

Title
parameters

Upper panel
Continuum fit
Near line data

Lower panel
Gaussian fit
EW results



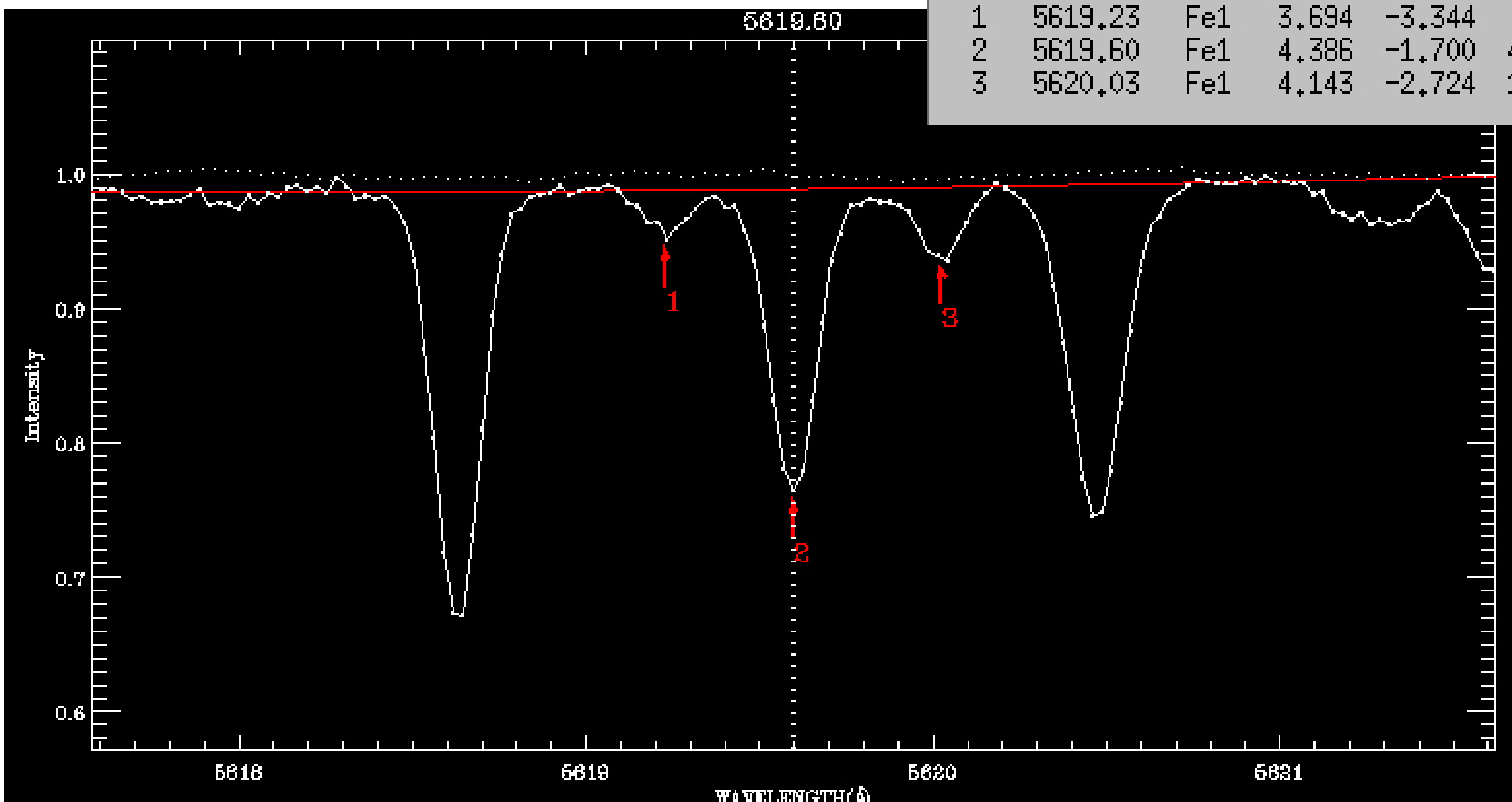
USER INTERFACE

Continuum fit region (upper panel)

Near line data : solar spectral line data
- available to change the line database file
- IDL array binary file

=============== Line Information ====================
Line Number = 79/ 271
Lambda = 5619.60
Elements = 26.0
EP(eV) =4.386
log gf =-1.700
=============== Near Line Data ======================

#	Lambda	Elem.	EP(eV)	log gfl.	depth
1	5619.23	Fe1	3.694	-3.344	8.500
2	5619.60	Fe1	4.386	-1.700	43.700
3	5620.03	Fe1	4.143	-2.724	12.400



USER INTERFACE

Gaussian fit region (lower panel)

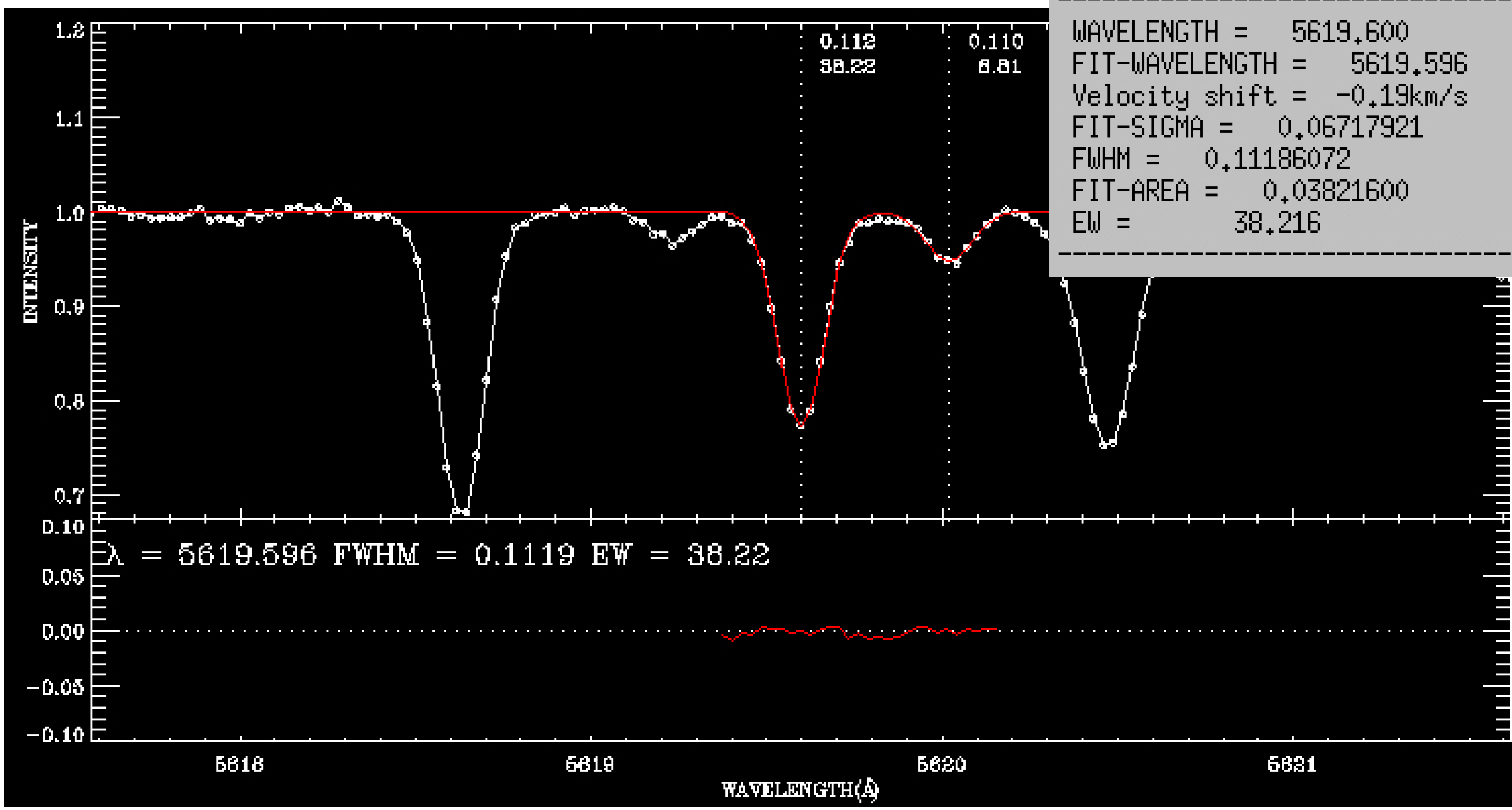
- Draw the fitting result and the residual values
- Show the information of deblended lines and the selected line

==== Result of Gaussian Fitting ============

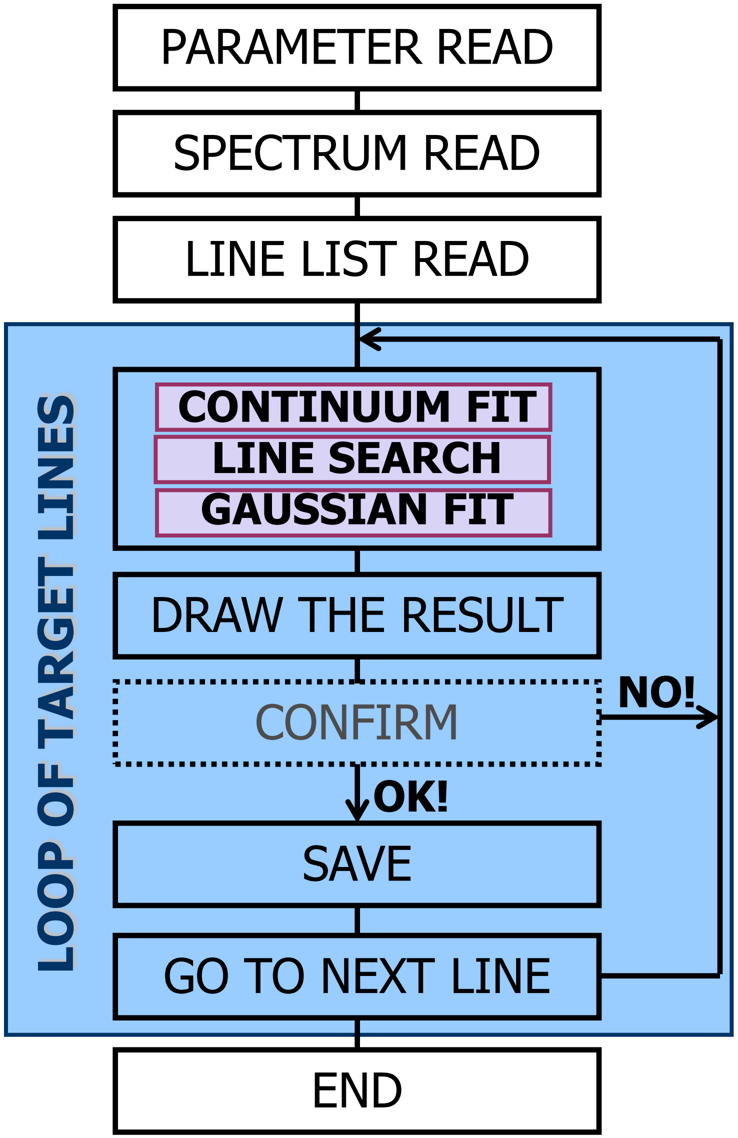
CENTER	SIGMA	AREA
5619.5965	0.067179208	0.038216004
5620.0197	0.066067474	0.0088090915

RESULT OF EW

WAVELENGTH = 5619.600
FIT-WAVELENGTH = 5619.596
Velocity shift = -0.19km/s
FIT-SIGMA = 0.06717921
FWHM = 0.11186072
FIT-AREA = 0.03821600
EW = 38.216



FLOW CHART & INPUT PARAMETERS



INPUT

Stellar spectrum (text form)

Telluric reference spectrum (optional)

Line list (text form)

Parameters

Spacing : define the size of local spectrum interval (Å)

Rejection limit : noise-criteria of continuum level (ratio)

Smoother : used for smoothing the derivative of profile (integer)

Line resolution : minimal distance between detected line (Å)

FWHM : the initial value of the Gaussian fitting width (Å)

ps output : 1 or 0 (graphic output file ON or OFF)

telluric reference : 1 or 0 (telluric ref. plot ON or OFF)

OS flag : X or WIN (linux Xterm or MS Windows)

PROCESS

- Read spectrum(1d or 2d) and line list file
  - Spectrum – wavelength / (echelle order) / intensity [2 or 3 columns]
  - Line list – wavelength / element / excitation potential / log *gf* [4 columns]
- Extract the local spectrum near the target line with ***spacing*** parameter
- Estimates the local continuum
  - Iteratively choose the points that are above (the fit of 2^{nd} order polynomial) X (***rejection limit*** parameter : cut-off ratio, typically 0.97~0.99)
- Search and distinguish the blended lines near the target line
  - Use relative maxima of the 2^{nd} derivative and zero points of 3^{rd} derivative
- Gaussian fitting with the center of detected lines and FWHM parameter
  - Define the fitting-region that is occupied by a cluster of the blended lines
- Draw and save the fitting result
- (interactive mode)
  - Change the local continuum level
    - Move the fitted curve up and down, and delete the irregular points
  - Determine whether you will save or not (graphic output and MOOG form text output)

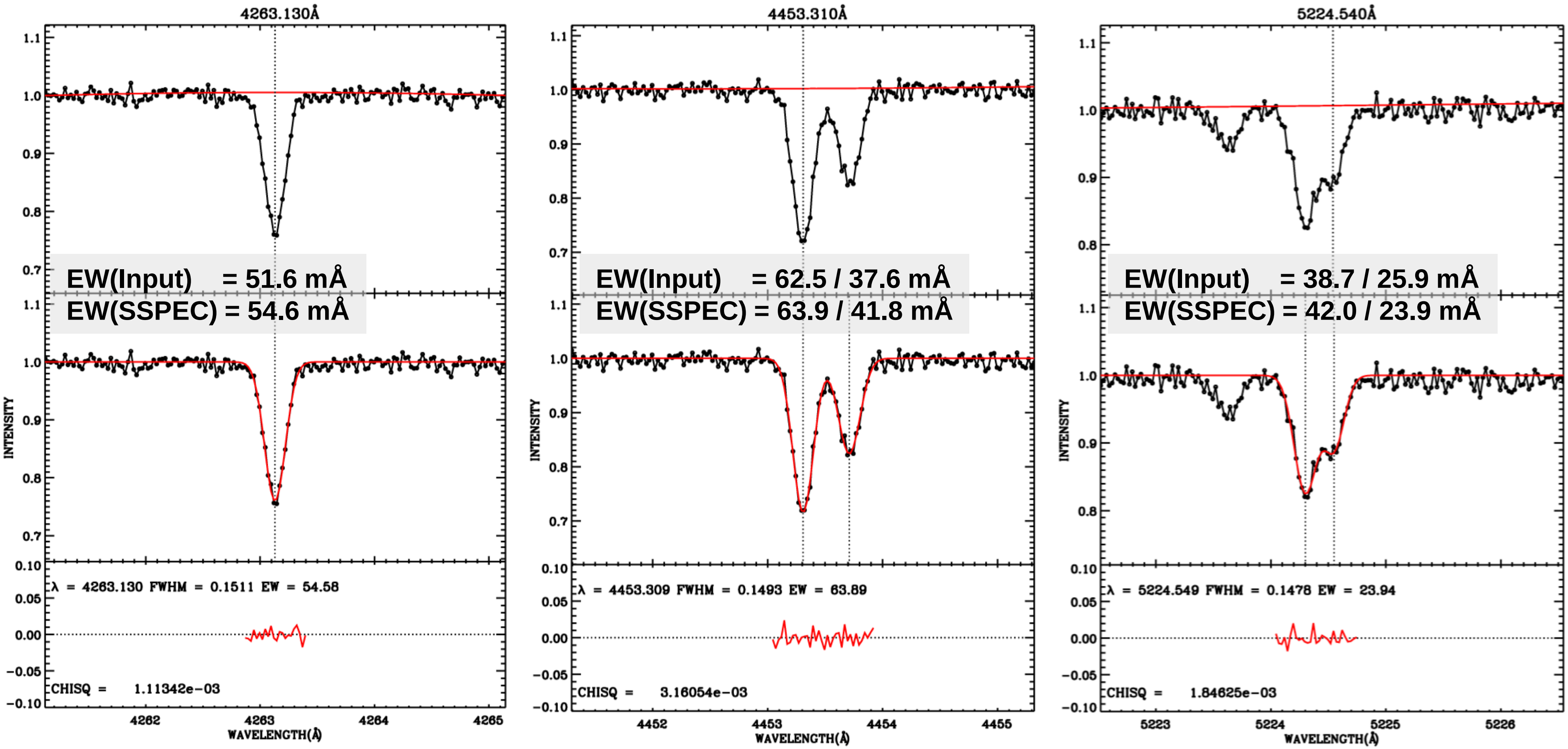
TESTING SSPEC : SYNTHESIZED SPEC.

- Synthesized spectrum
  - **Smoother = 3, 5, 7**
    - SSPEC parameter ; apply to derivatives of the line profile
  - **FWHM = 0.0, 0.1, 0.2, 0.3, 0.4, 0.5** (convolved parameter)
    - Reconstruct from solar spectrum data (FWHM, EW)
      - EW < ~100mÅ
      - FWHM = 0.06 ~ 0.09
      - Total lines : 187
    - Convolve with Gaussian profile of each FWHM
  - **SNR = 50, 100, 150, 200, 300, 500**
    - Add the Gaussian random noise
- Criteria of selected line
  - Not detected (the failure for line searching)
  - χ^2 of fitting results

TESTING SSPEC : SYNTHESIZED SPEC.

SNR = 100, FWHM = 0.2, smoother = 5

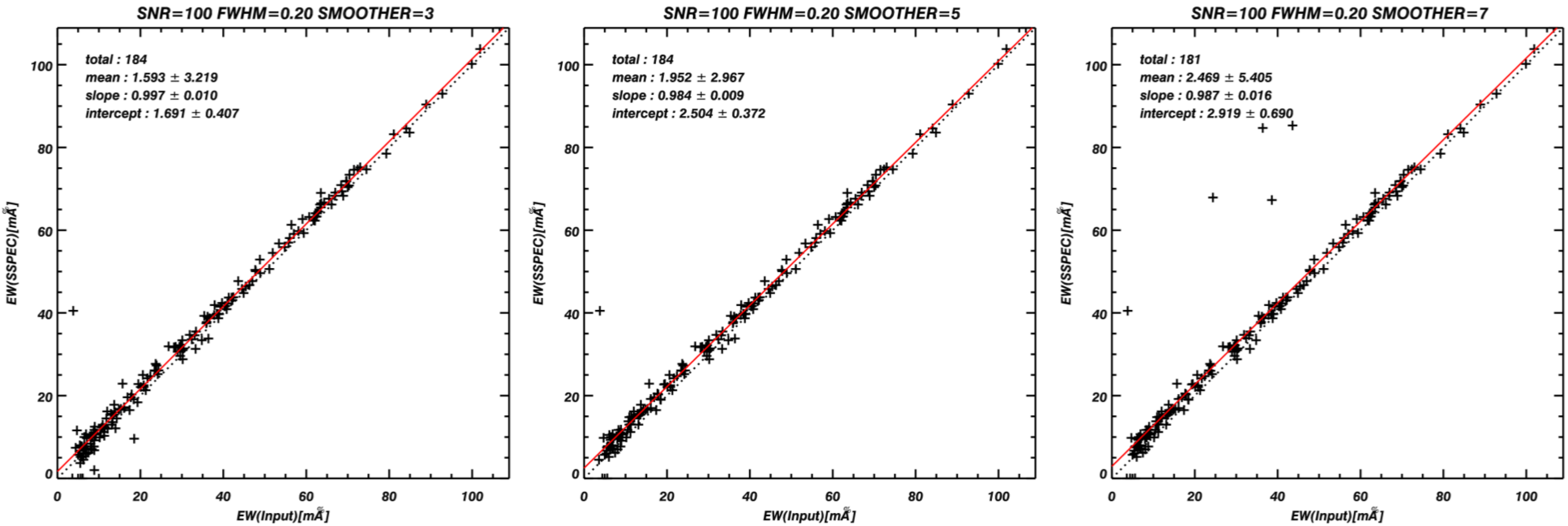
SSPEC output file



TESTING SSPEC : SYNTHESIZED SPEC.

SNR = 100, FWHM = 0.2

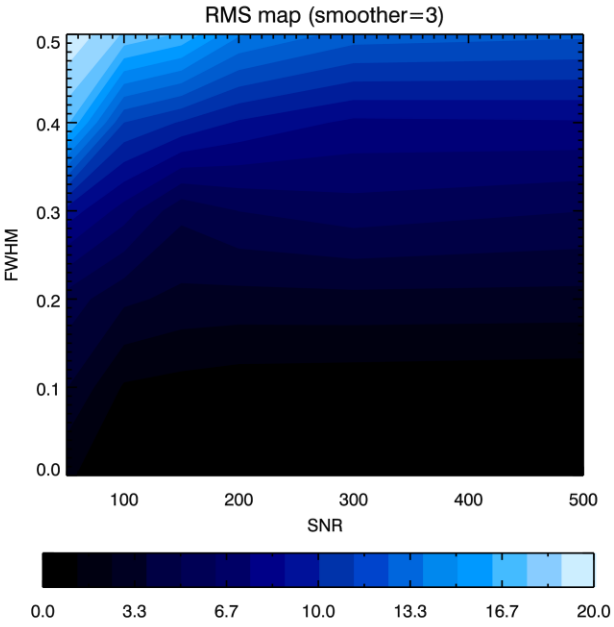
Comparing Plot
EW(Input) vs. EW(SSPEC)



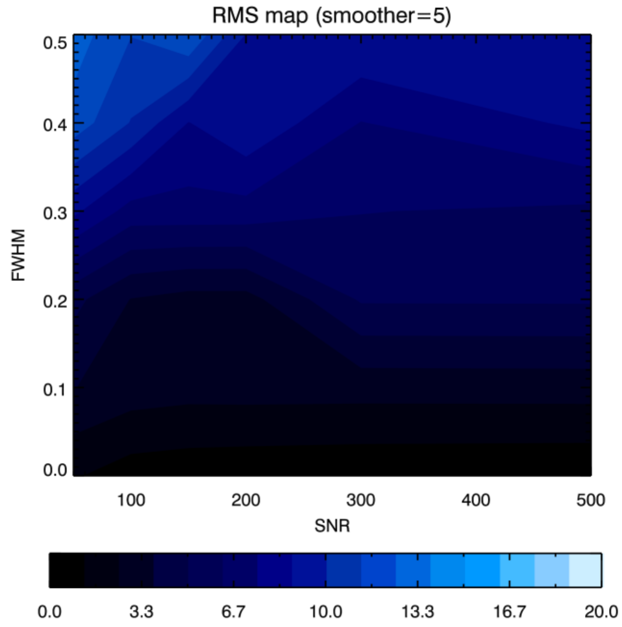
TESTING SSPEC : SYNTHESIZED SPEC.

RMS map for FWHM vs. SNR

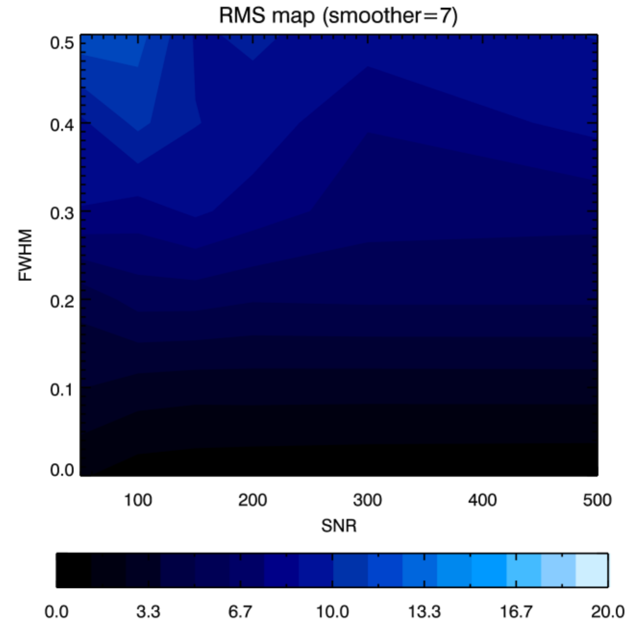
- **Smoother = 3**



- **Smoother = 5**



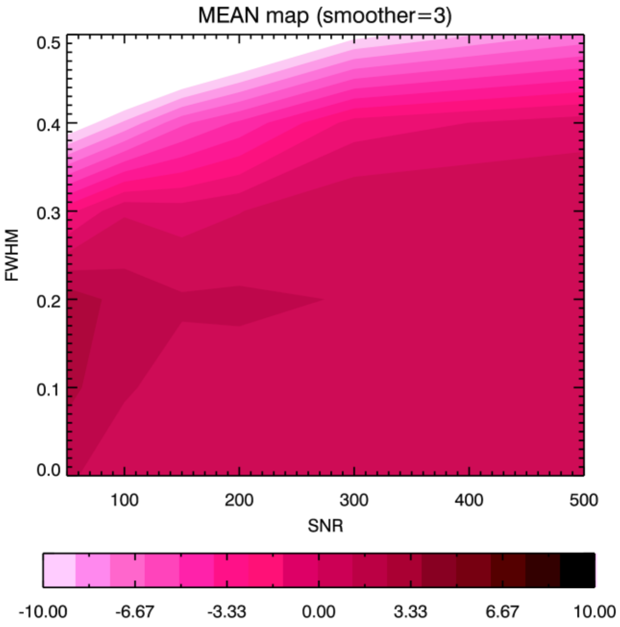
- **Smoother = 7**



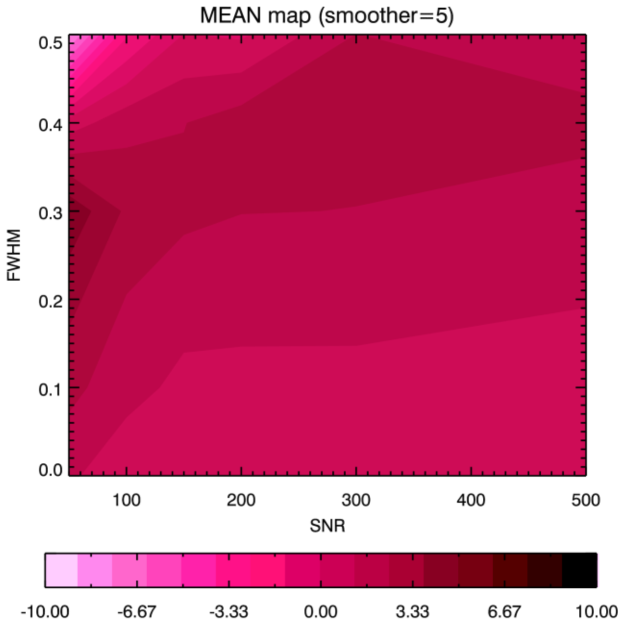
TESTING SSPEC : SYNTHESIZED SPEC.

MEAN map for FWHM vs. SNR

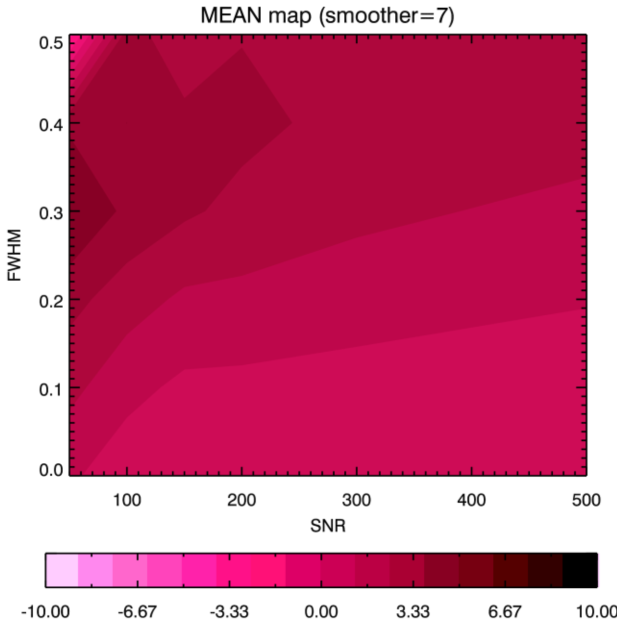
- **Smoother = 3**



- **Smoother = 5**



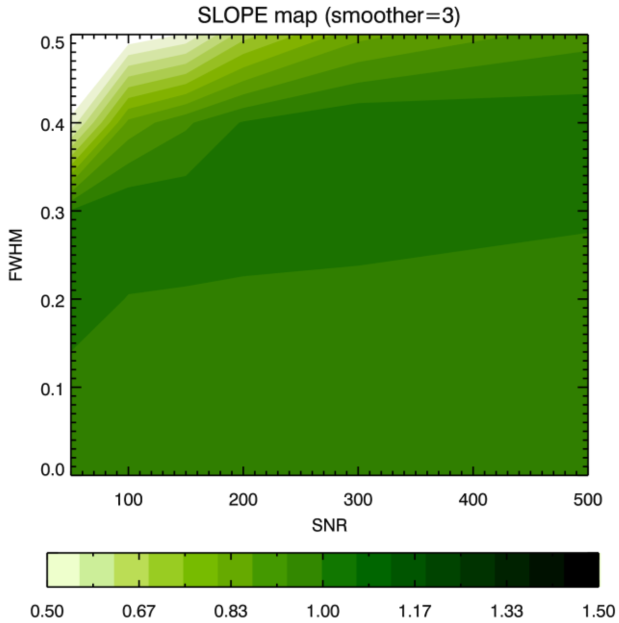
- **Smoother = 7**



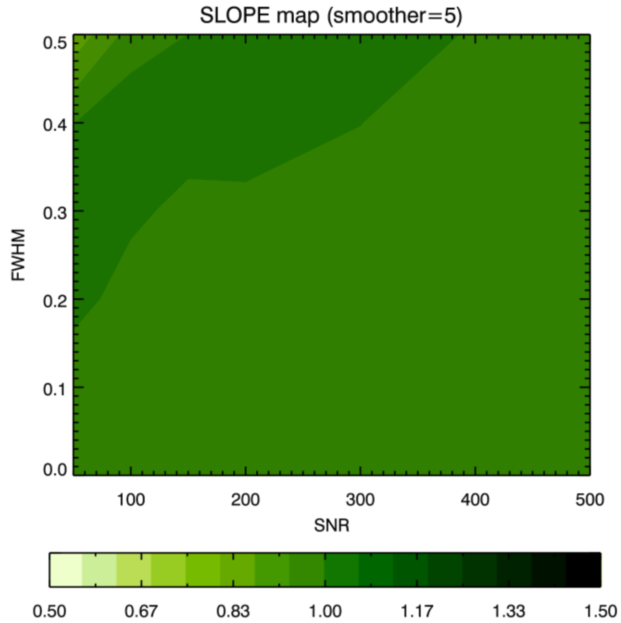
TESTING SSPEC : SYNTHESIZED SPEC.

SLOPE map for FWHM vs. SNR

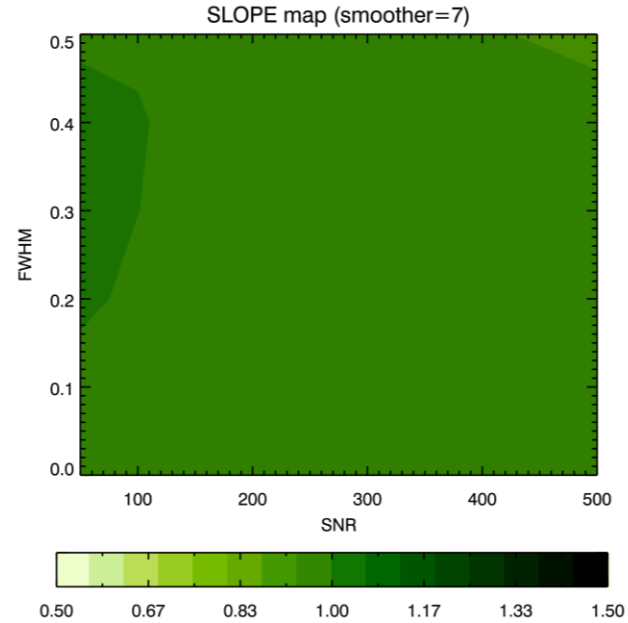
- **Smoother = 3**



- **Smoother = 5**



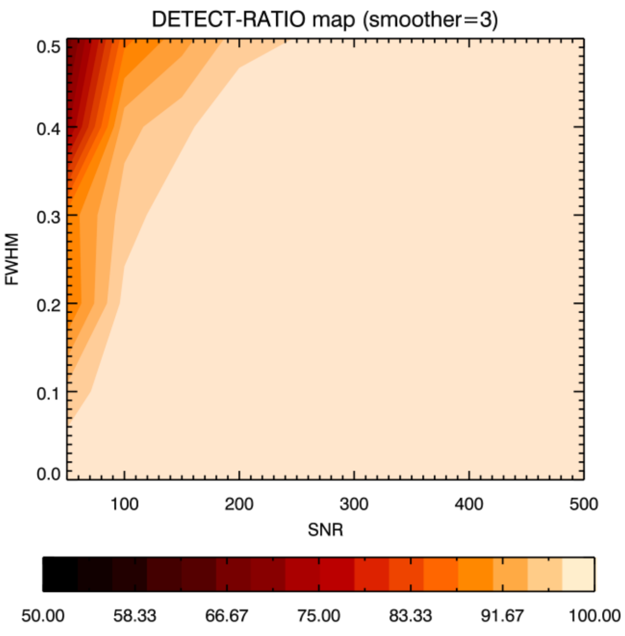
- **Smoother = 7**



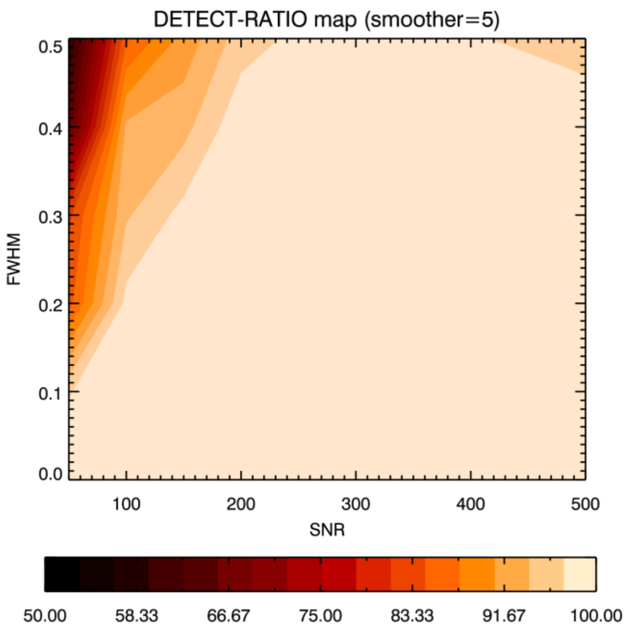
TESTING SSPEC : SYNTHESIZED SPEC.

DETECT-RATIO map for FWHM vs. SNR

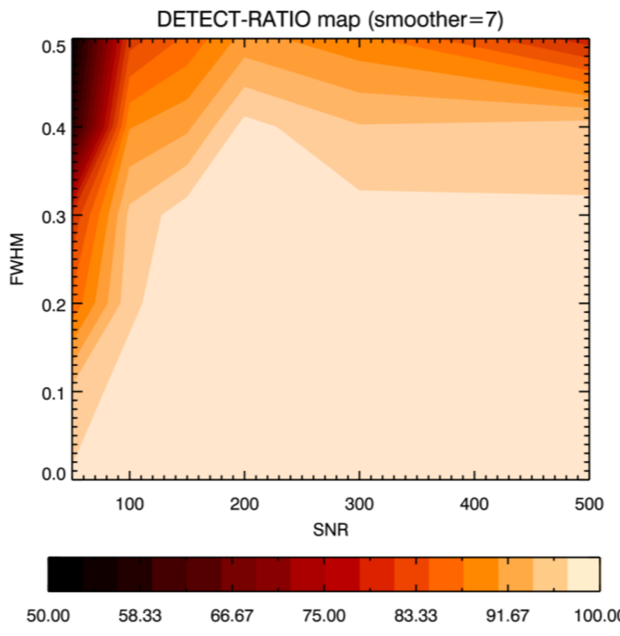
- **Smoother = 3**



- **Smoother = 5**

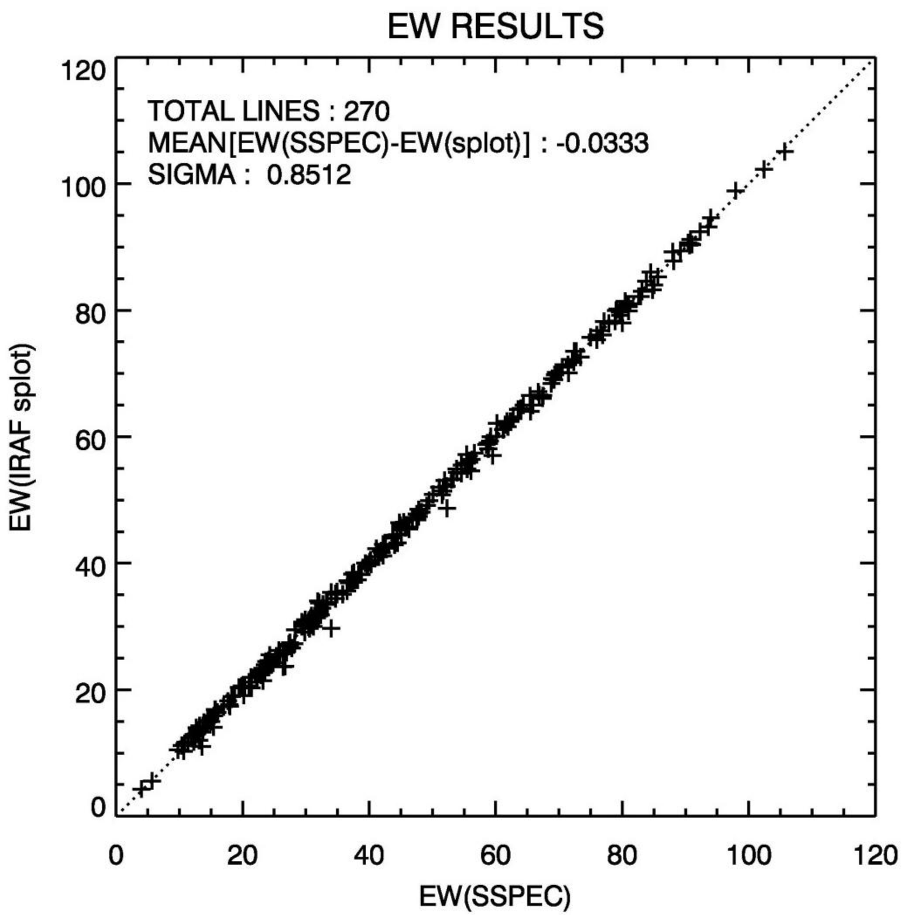


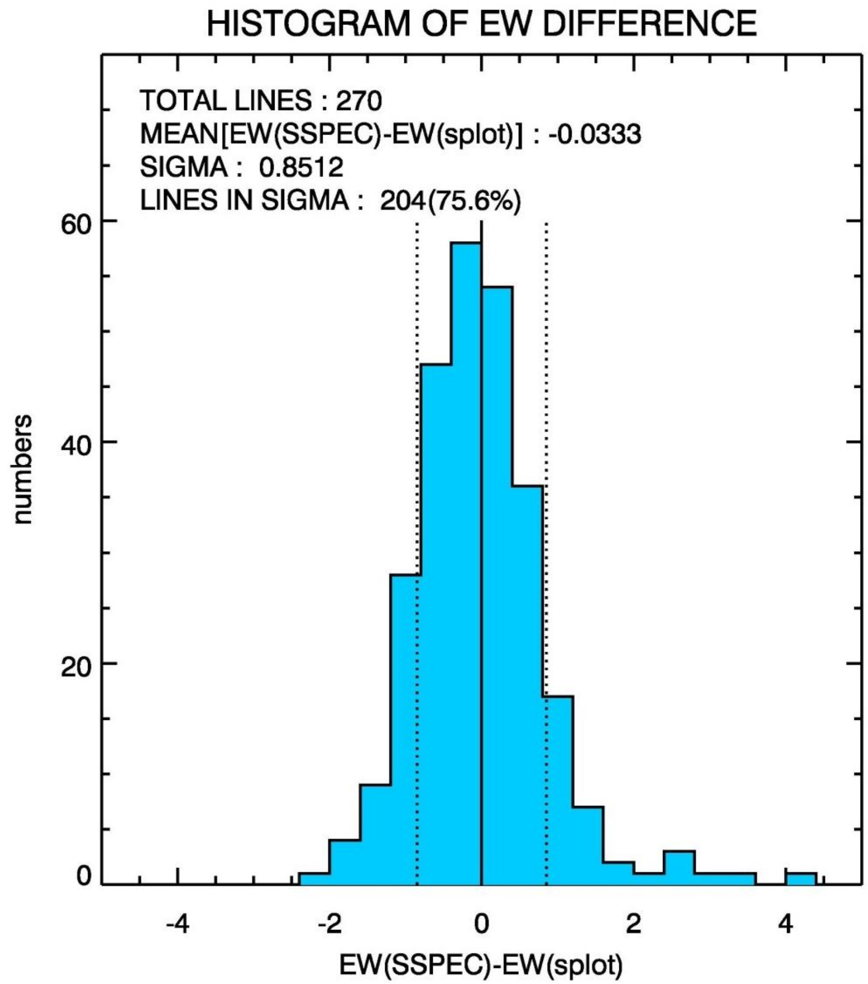
- **Smoother = 7**



TESTING SSPEC : HD117176 (BOES)

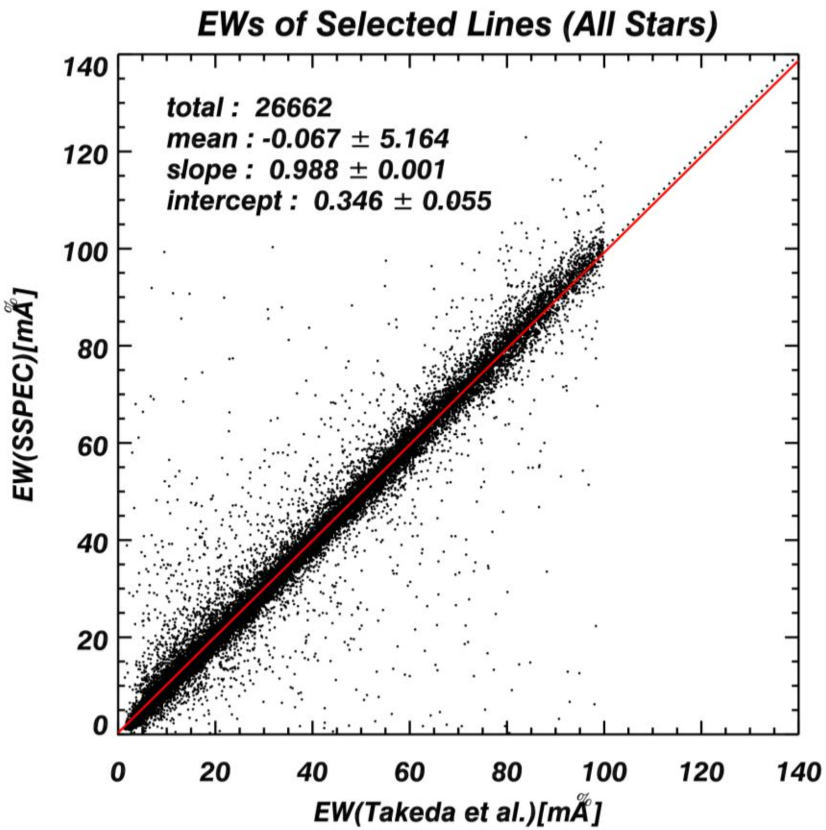
- SSPEC (automatic) vs. IRAF **splot** task(manual)
  - Smoother = 5

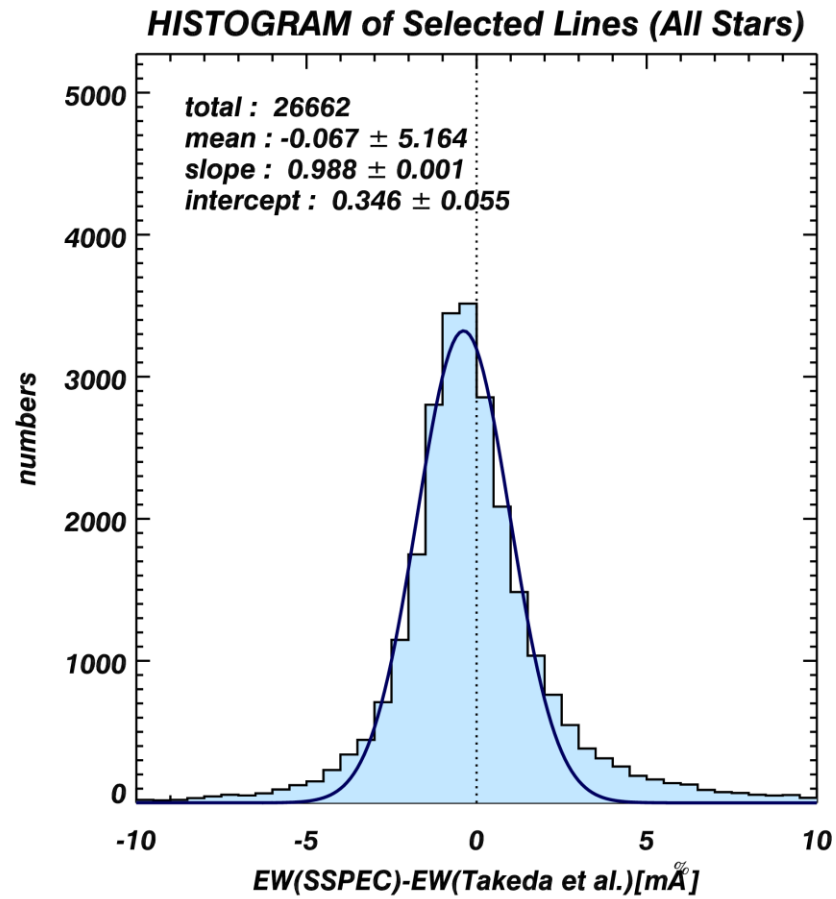




TESTING SSPEC : Takeda et al.

- SSPEC (automatic) vs. SPTOOL (Takeda et al., 2005)
  - Takeda et al. 2005, PASJ, 57, 27
  - Total Fe lines : 27334 / SSPEC : 26662 (98%)
  - Total stars : 160





SUMMARY

- We present the automatic code (SSPEC) of equivalent width measurement using IDL.
  - Add the mode to fit the continuum level manually
  - Show the spectral line data near the target line
  - Save the fitting result as the graphic output file
    - Confirm the automatic results
- We have tested the code
  - Using the synthesized spectrum for specific SNR and FWHM
  - Comparing the result of SSPEC with
    - the manual measurement of IRAF `splot` task with for the spectra of **BOES**
      - EW(SSPEC)-EW(splot) = -0.033 $\pm$ 0.851 (270)
    - the measurement of **SPTOOL** from **Takeda et al.(2005)**
      - EW(SSPEC)-EW(Takeda et al.) = -0.067 $\pm$ 5.164 (26662)
- Name
  - CAMEW (the Code for Automatic Measurement of Equivalent Width) ??

Thank you for your attention