Stellar population synthesis and gas kinematics

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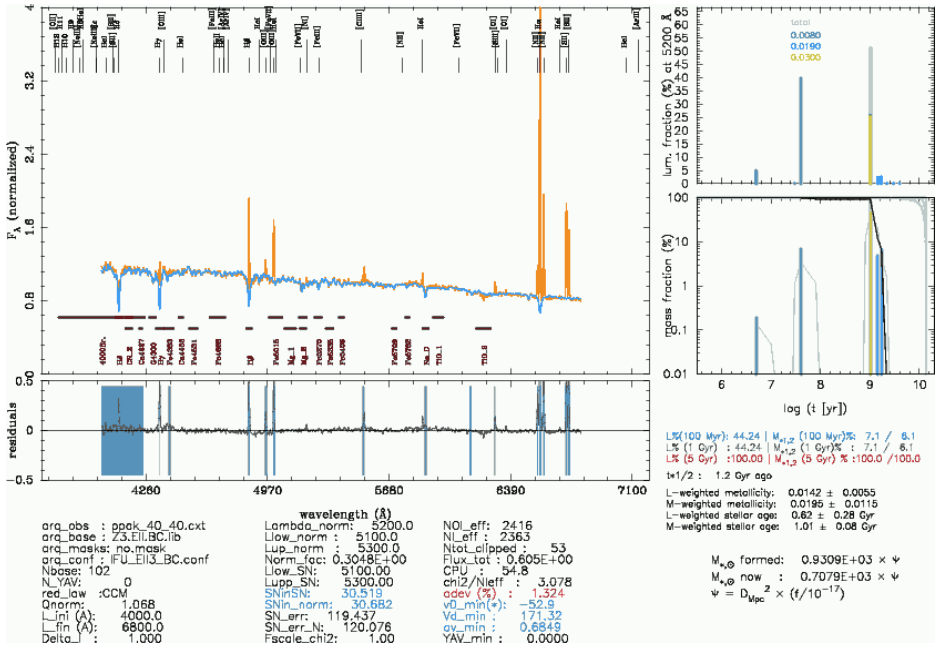


Outline

1. Fitting an emission line
2. A practical example
3. What next?

$$I(\lambda) = I_{\mathrm{continuum}}(\lambda) + I_{\mathrm{line}}(\lambda)$$

Stellar population synthesis



Linear combination

$$I_{\mathrm{continuum}}(\lambda) = \sum_i \alpha_i B_i(\lambda)$$

What can go wrong?

- Stellar basis
- Minimisation
- Non-linear parameters

Line fitting

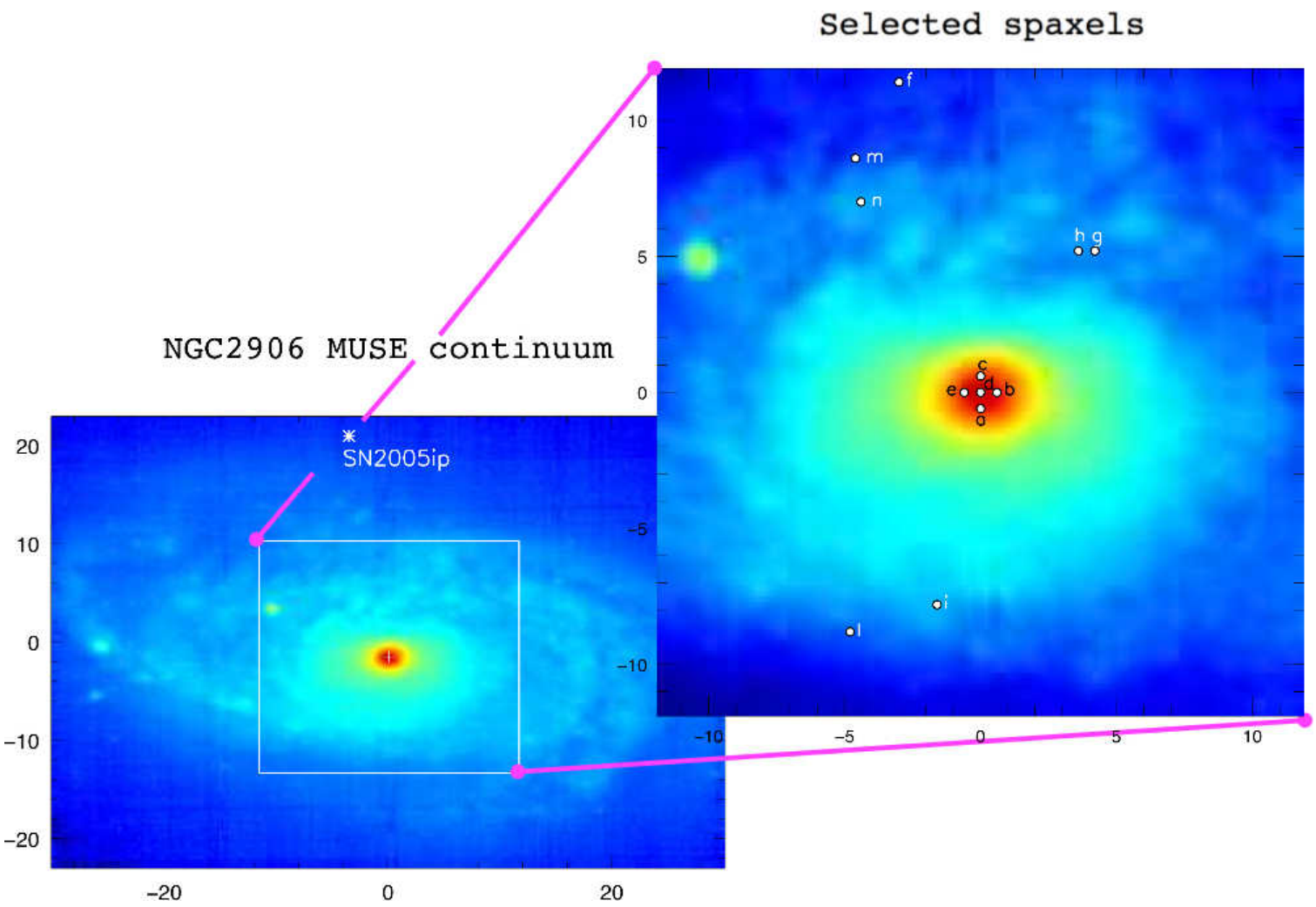
Model parameters

$$I_{\rm line}(\lambda) = F_0 \frac{e^{-\frac{(\lambda-\lambda_0)}{2\sigma^2}}}{\sqrt{2\pi}\sigma}$$

- Line flux: F_0
- Central wavelength: $\lambda_0 = (1 + \frac{v}{c})\lambda_{\rm rest}$
- Velocity dispersion: σ
- [Residual continuum: $a + b\lambda$]

Constraints

- Flux ratios
- v
- σ


Selected spaxels
NGC2906 MUSE continuum
SN2005ip
f
m
n
h
g
c
d
e
b
a
i
l
10
5
0
−5
−10
20
10
0
−10
−20

Subtraction methods

No subtraction

- Original raw data

Starlight + STELIB-BC03 (221)

- Chabrier + Pad94
- $Z = 10^{-4} - 0.05$
- $t = 0 - 20$ Gyr

Starlight + STELIB-MILES (66)

- Chabrier + Pad94
- $Z = 0.004 - 0.05$
- $t = 0.001 - 18$ Gyr

pPXF + MILES (46)

- Salpeter + Pad00
- $Z = 4 \times 10^{-4} - 0.03$
- $t = 0.1 - 18$ Gyr

Fit3D + Granada-MILES (156)

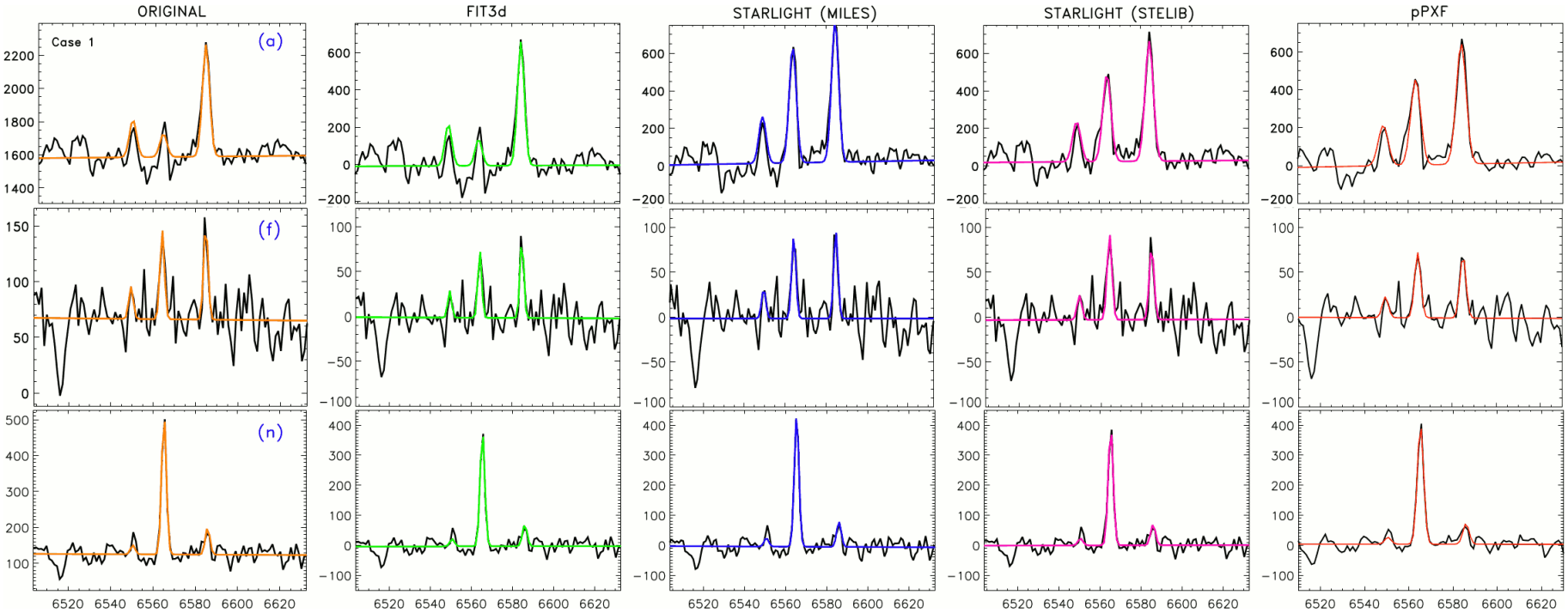
- Salpeter + Pad00
- $Z = 0.002 - 0.03$
- $t = 0.001 - 13$ Gyr

Line fitting

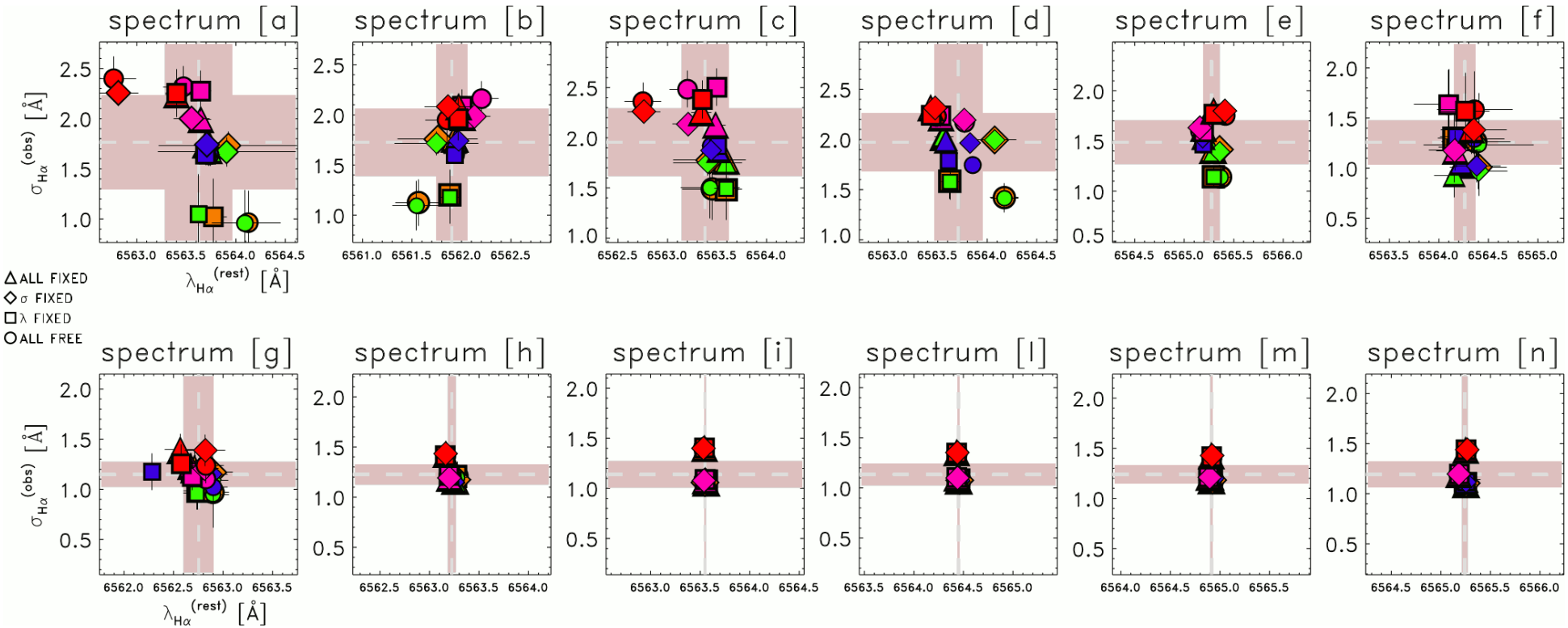
Constraints

- Case 1: v and σ fixed
- Case 2: σ fixed
- Case 3: v fixed
- Case 4: no constraint

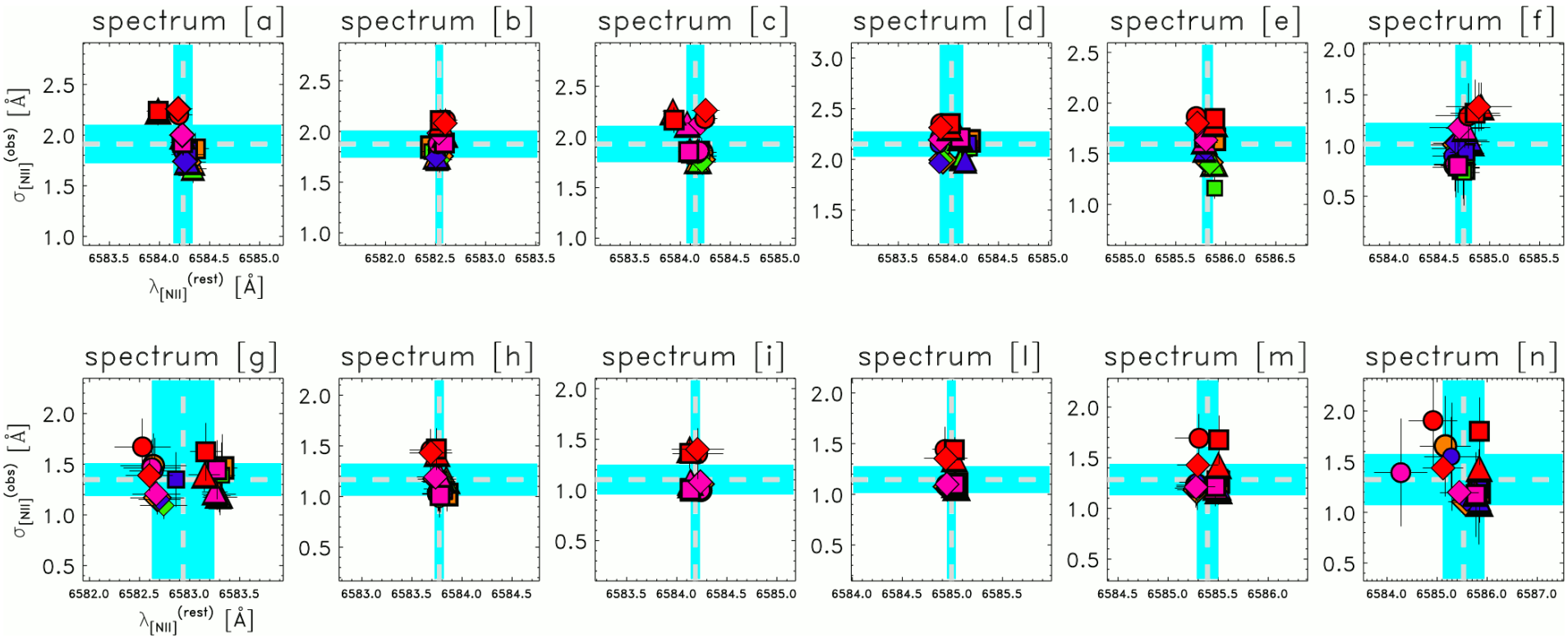
Sample fits


ORIGINAL
FIT3d
STARLIGHT (MILES)
STARLIGHT (STELIB)
pPXF
Case 1
(a)
(f)
(n)
6520 6540 6560 6580 6600 6620

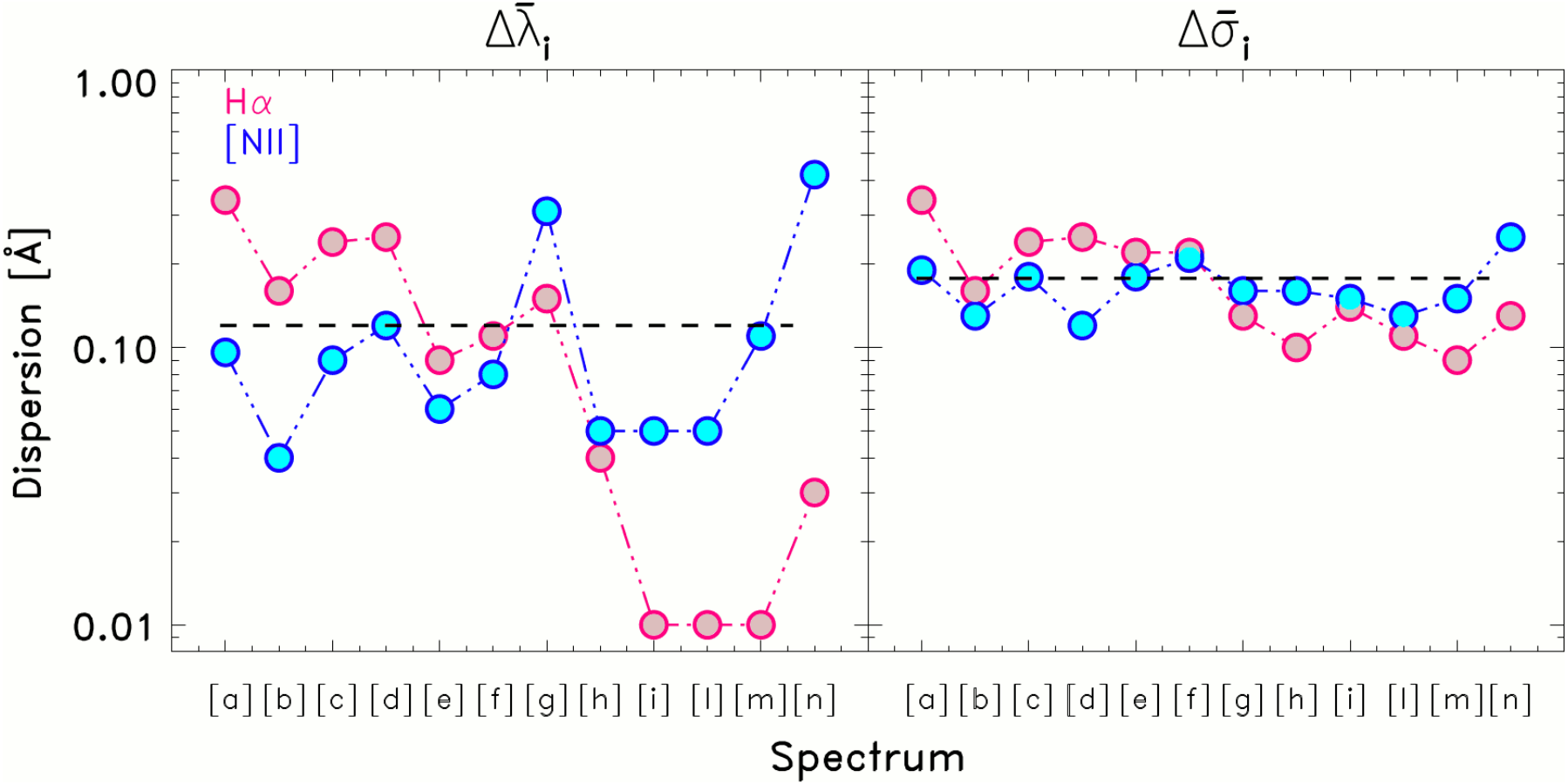
Individual spaxels (Hα)



Individual spaxels (NII)



Statistical errors

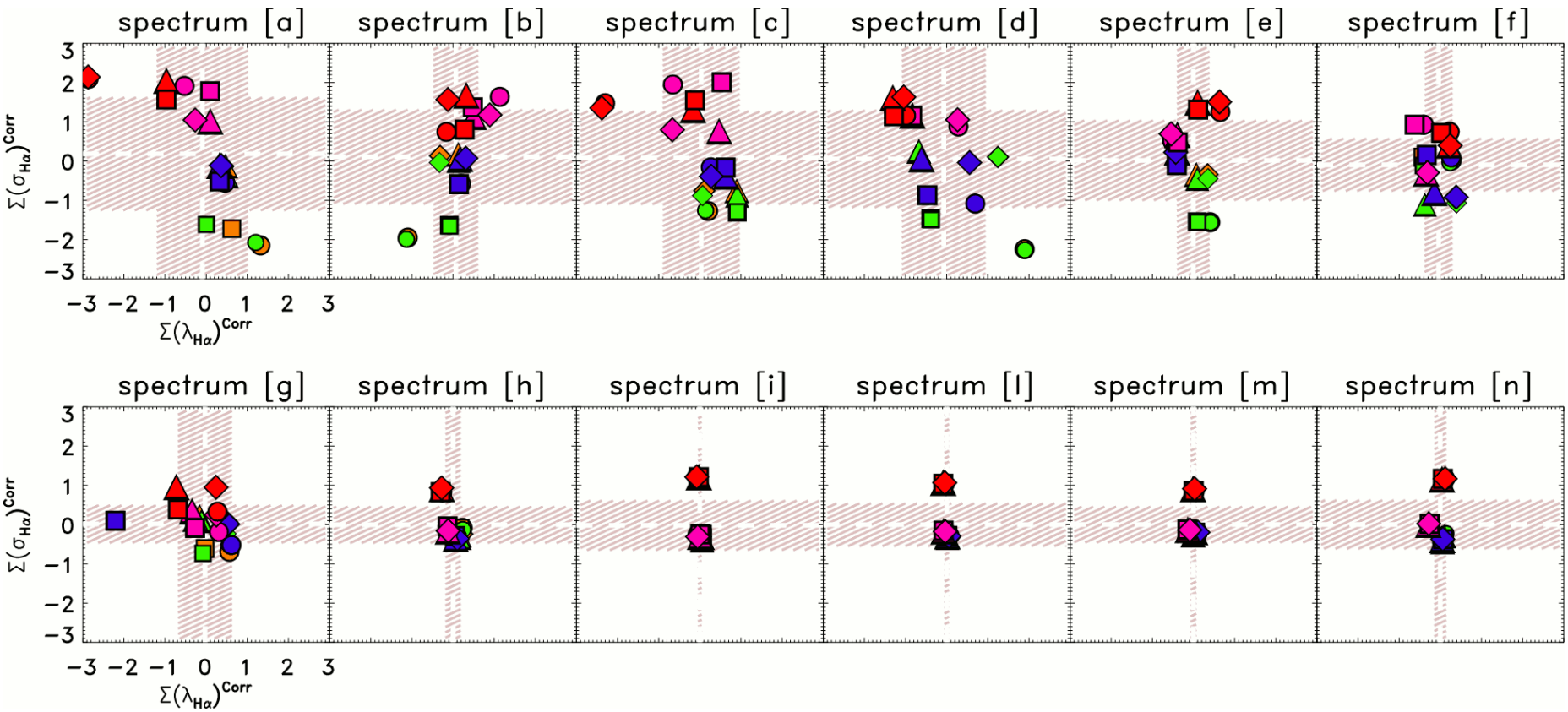


A simple prescription

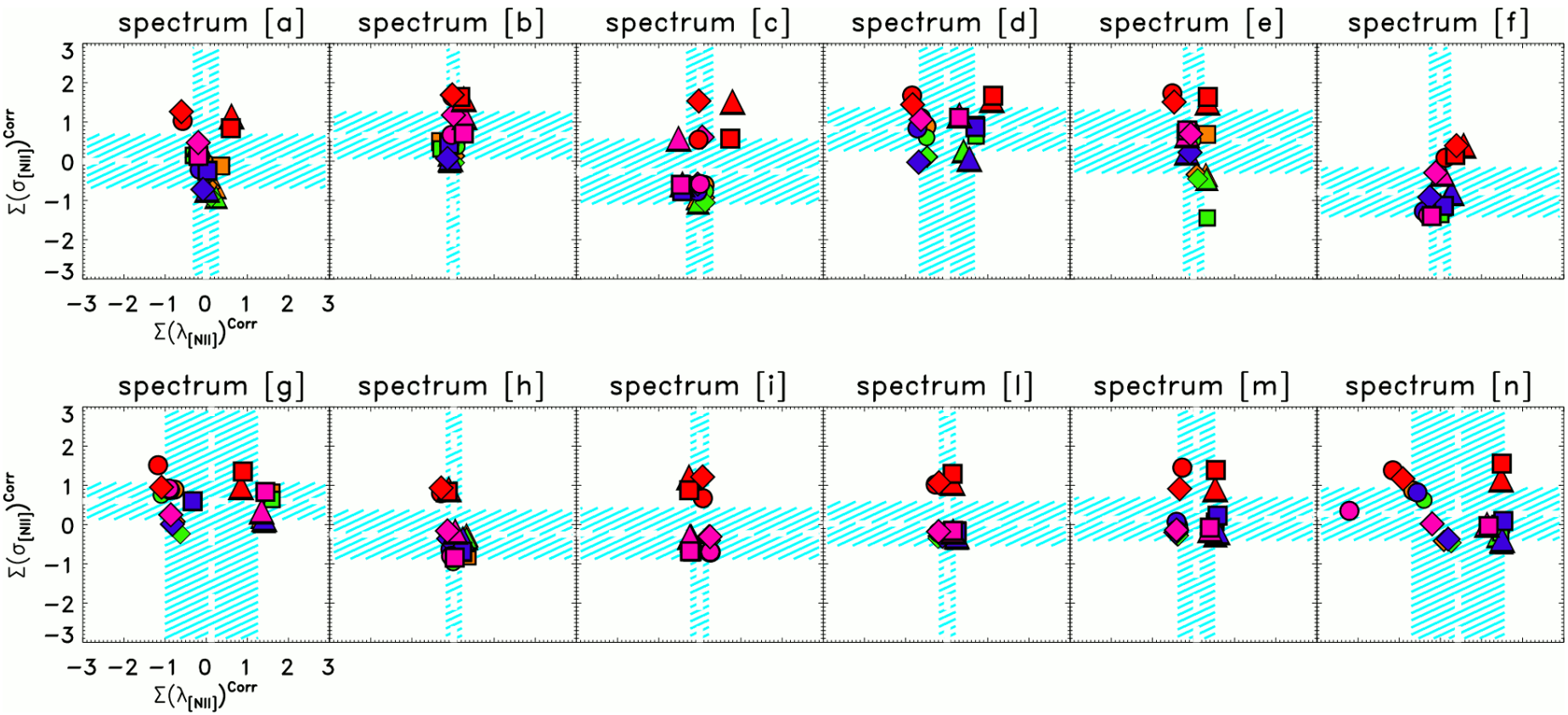
Statistical uncertainty

$$\Delta_{\rm SPS} \sim [0.1 - 0.2]\ \Delta_{\rm inst}$$

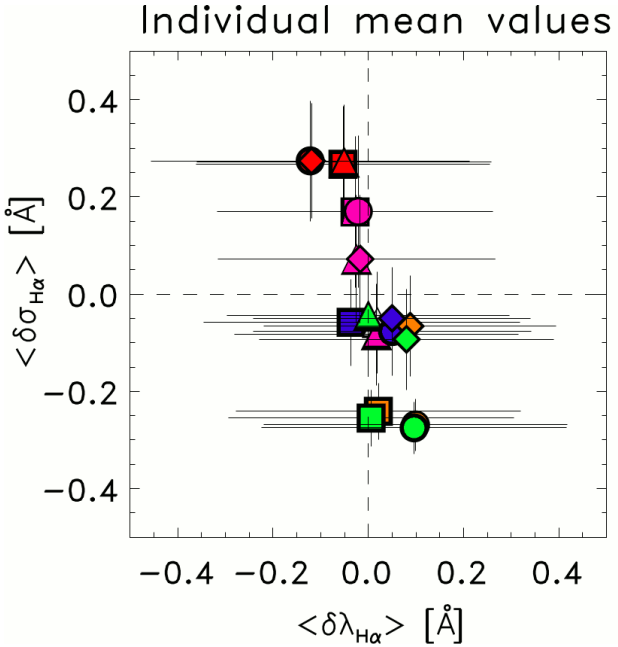
A simple prescription

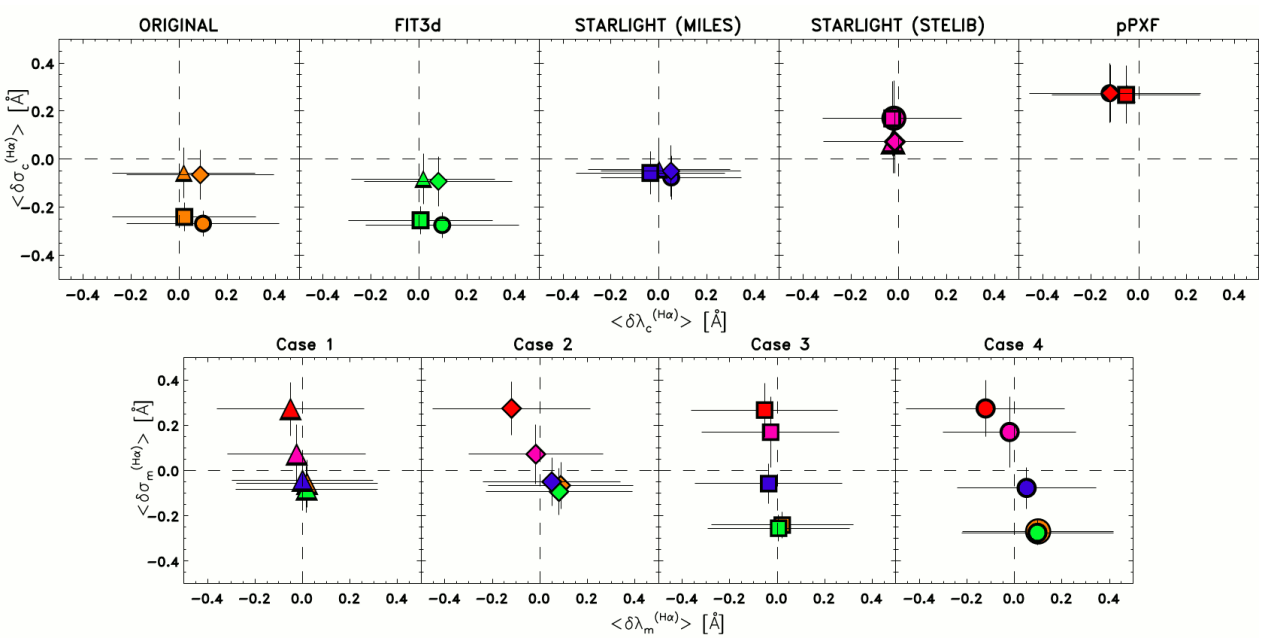


A simple prescription

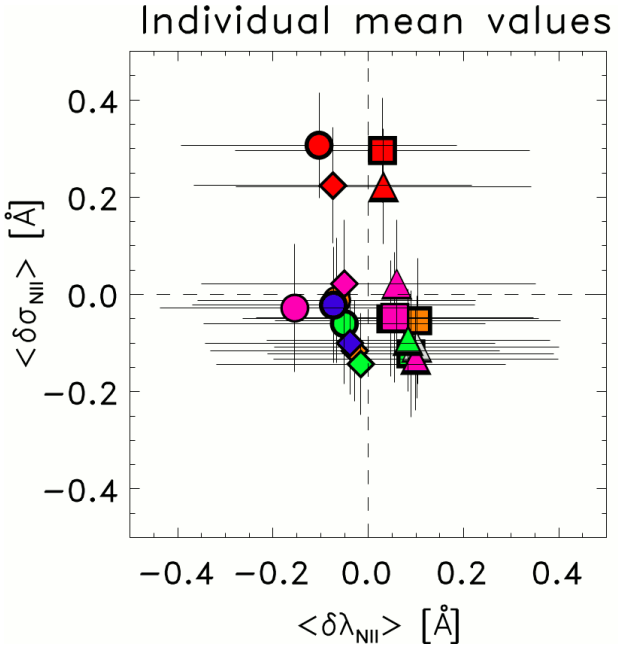


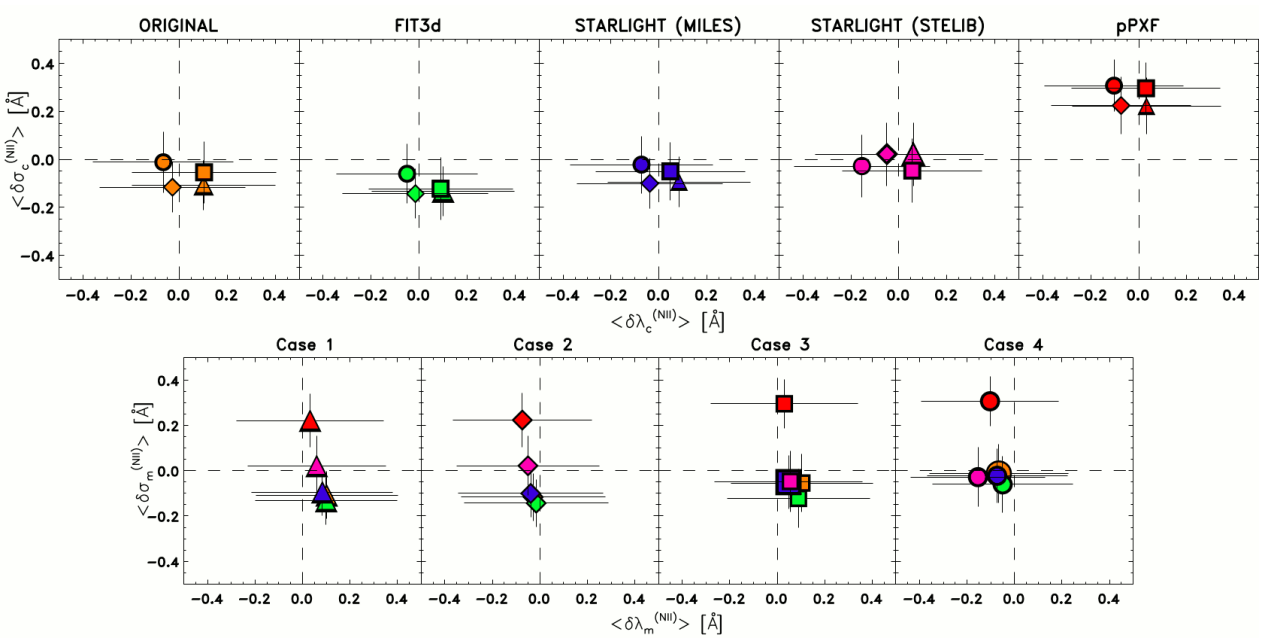
Systematic effects





Systematic effects







Spectral resolution (FWHM)

Instruments

- PMAS/PPAK V500: 6.0 Å
- V1200/MUSE: 2.6 Å
- WEAVE/MEGARA: 0.3 – 1.3 Å

Stellar libraries

- STELIB: 3.0 Å
- MILES: 2.5 Å

Gas motion

1000 K	3 km/s	0.14 Å
10^4 K	9 km/s	0.47 Å

Two approaches

Statistical uncertainty

$$\Delta_{\rm SPS} \sim [0.1 - 0.2]\ \Delta_{\rm inst}$$

Thank you!

Better models

- Continuum
  - stellar libraries
  - [non-stellar continuum]
- Line profiles
  - gas motion
  - [radiative transport]

Better statistics

- Synthetic tests
- Model errors