LAMOST 2D DATA REDUCTION

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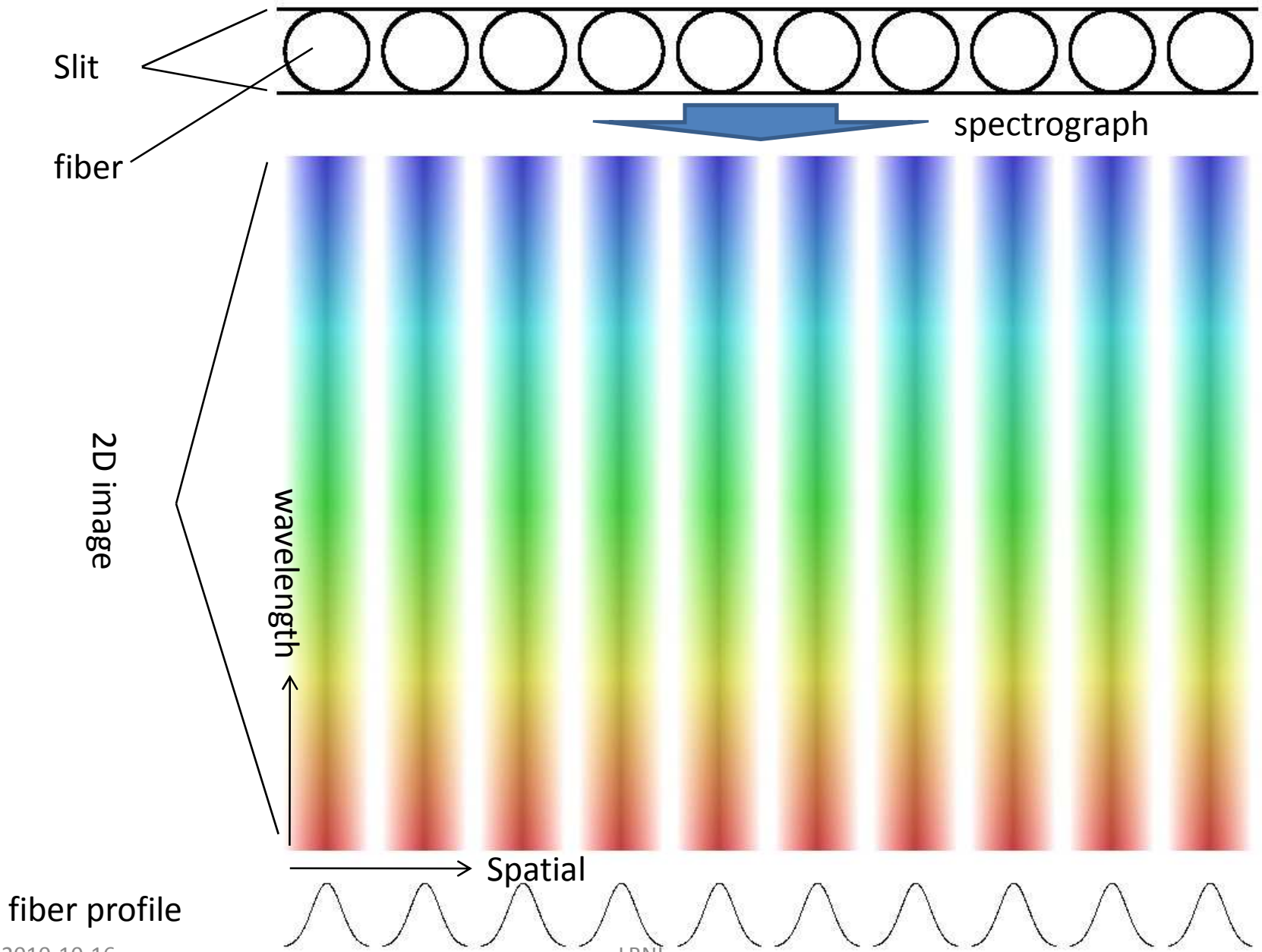
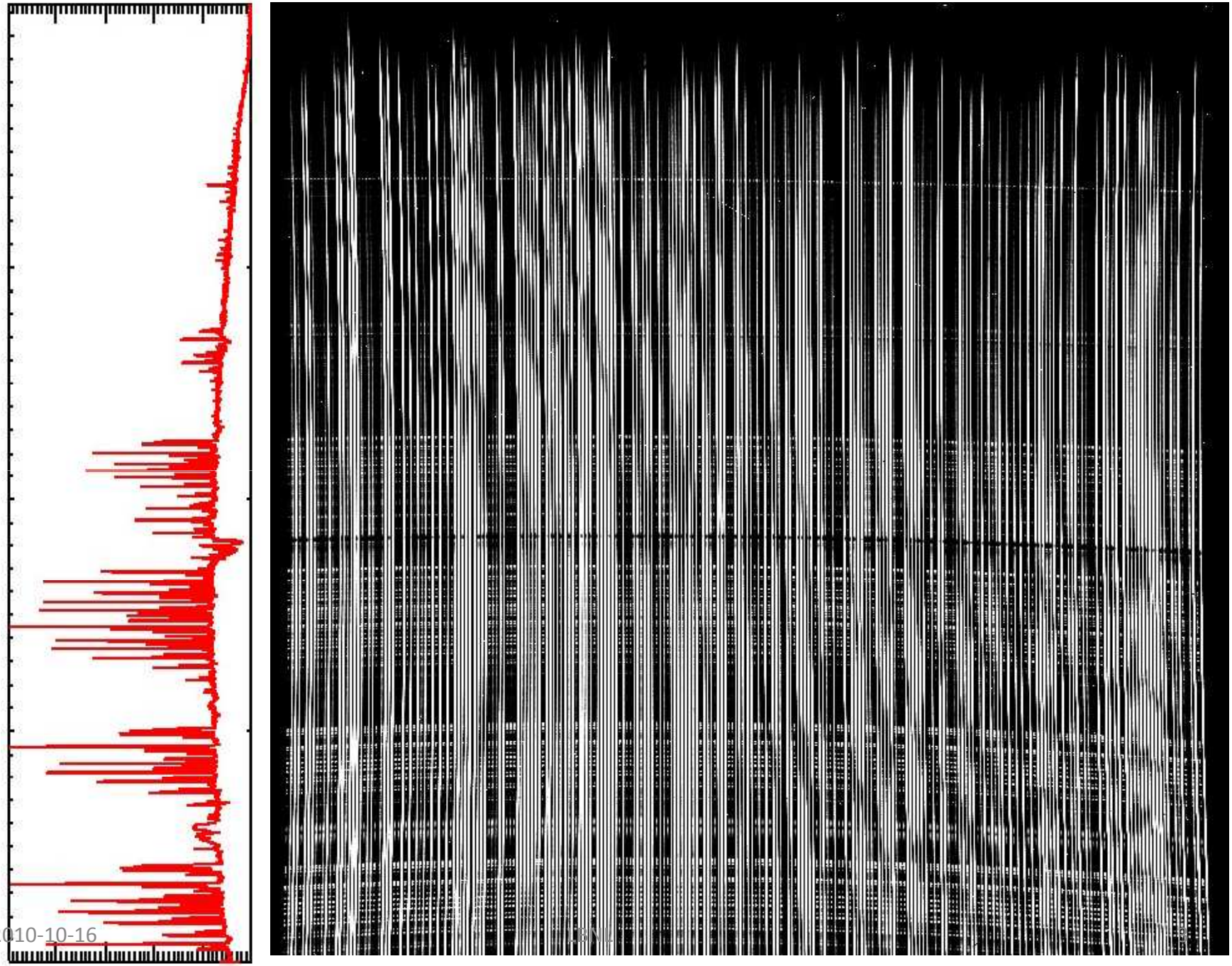
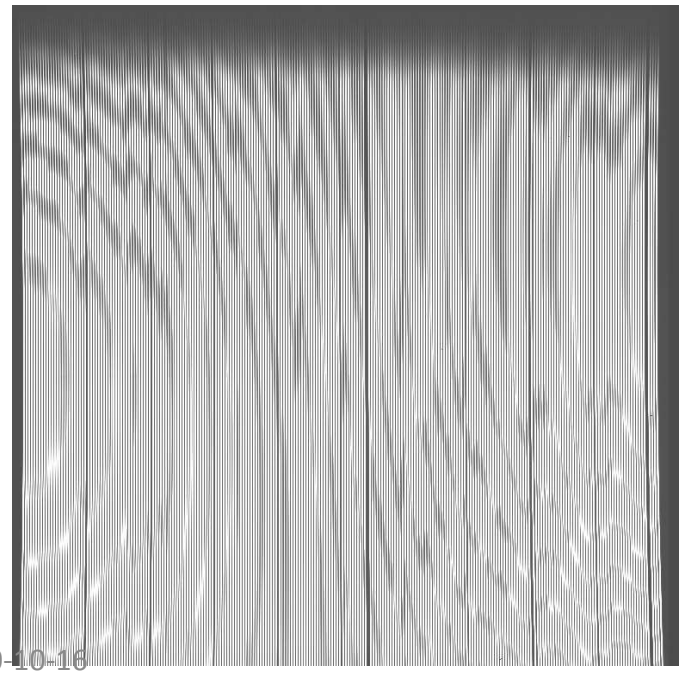
LAMOST team

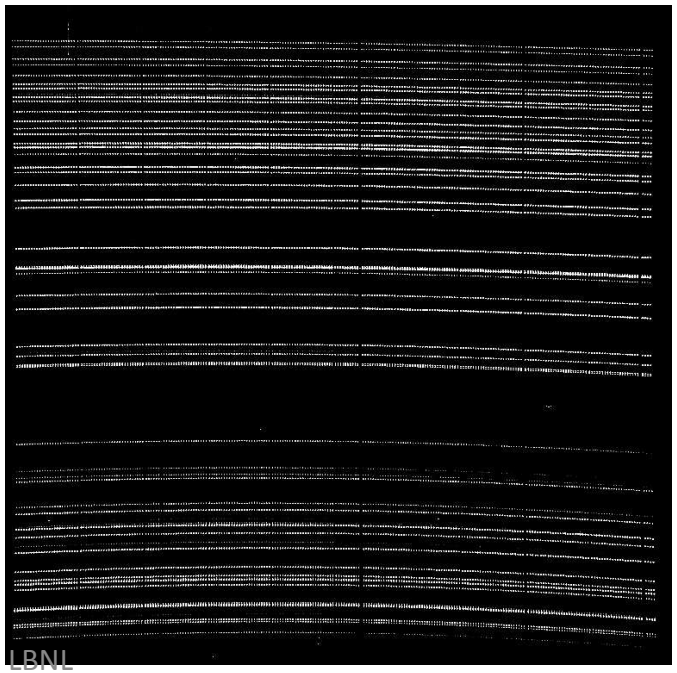

Slit
fiber
spectrograph
2D image
wavelength
Spatial
fiber profile



Raw images

- Science targets
- Screen flat fiber throughput
- Arc lamp wavelength calibration





Principle

$$O(i,\lambda) = [O_0(i,\lambda) + s(\lambda)]H(i,\lambda)$$

$$i = 1,2,\cdots,250 \qquad \lambda = \lambda_1, \lambda_2, \cdots, \lambda_{4136}$$

where

$$H(i,\lambda) = \mathrm{T}(\lambda)L(i,\lambda)$$

so

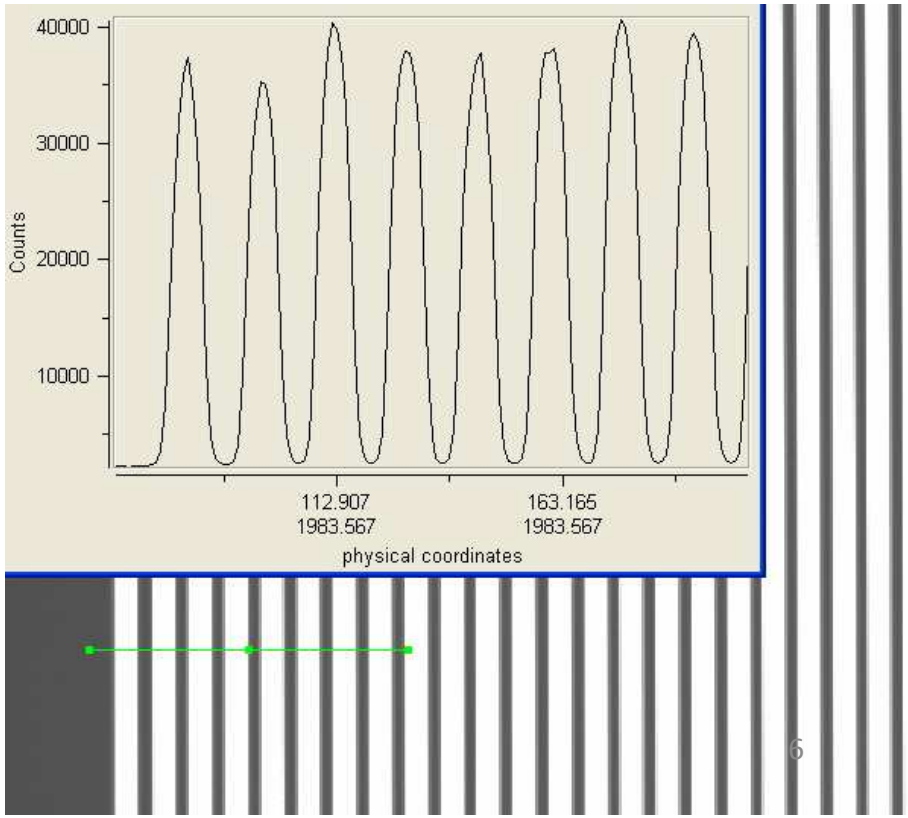
$$\boxed{O(i,\lambda)} = [O_0(i,\lambda)\boxed{\mathrm{T}(\lambda)} + \boxed{\mathrm{s}(\lambda)\mathrm{T}(\lambda)}]\boxed{\mathrm{L}(i,\lambda)}$$

$$O(i,\lambda) = [O_0(i,\lambda)\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

Fiber trace - *i*

- By screen flat
- Get each profile center by centroid
- Fit the centroids

  By polynomical

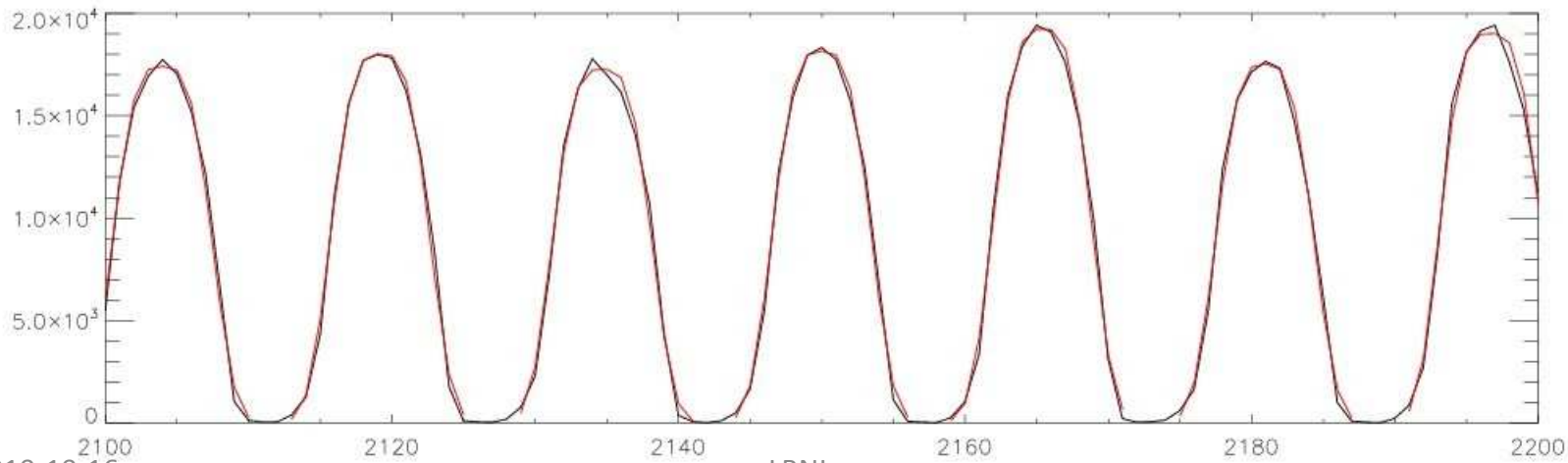


$$O(i,\lambda) = [O_0(i,\lambda)\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

Flux extraction

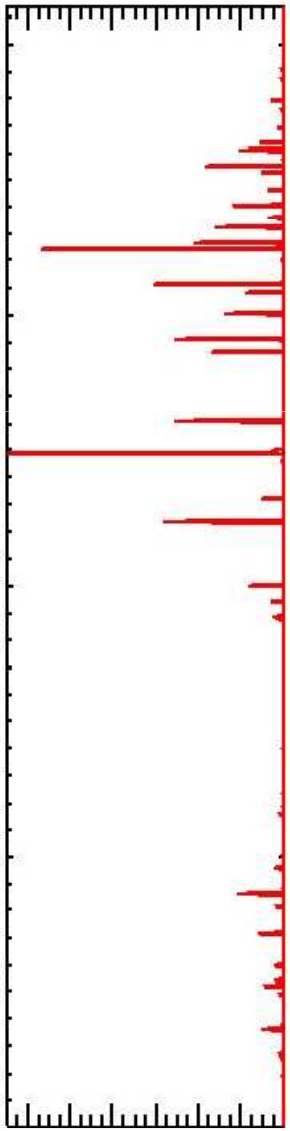
- Aperture
- Weighted aperture
- Profile fitting
- 2d profile fitting

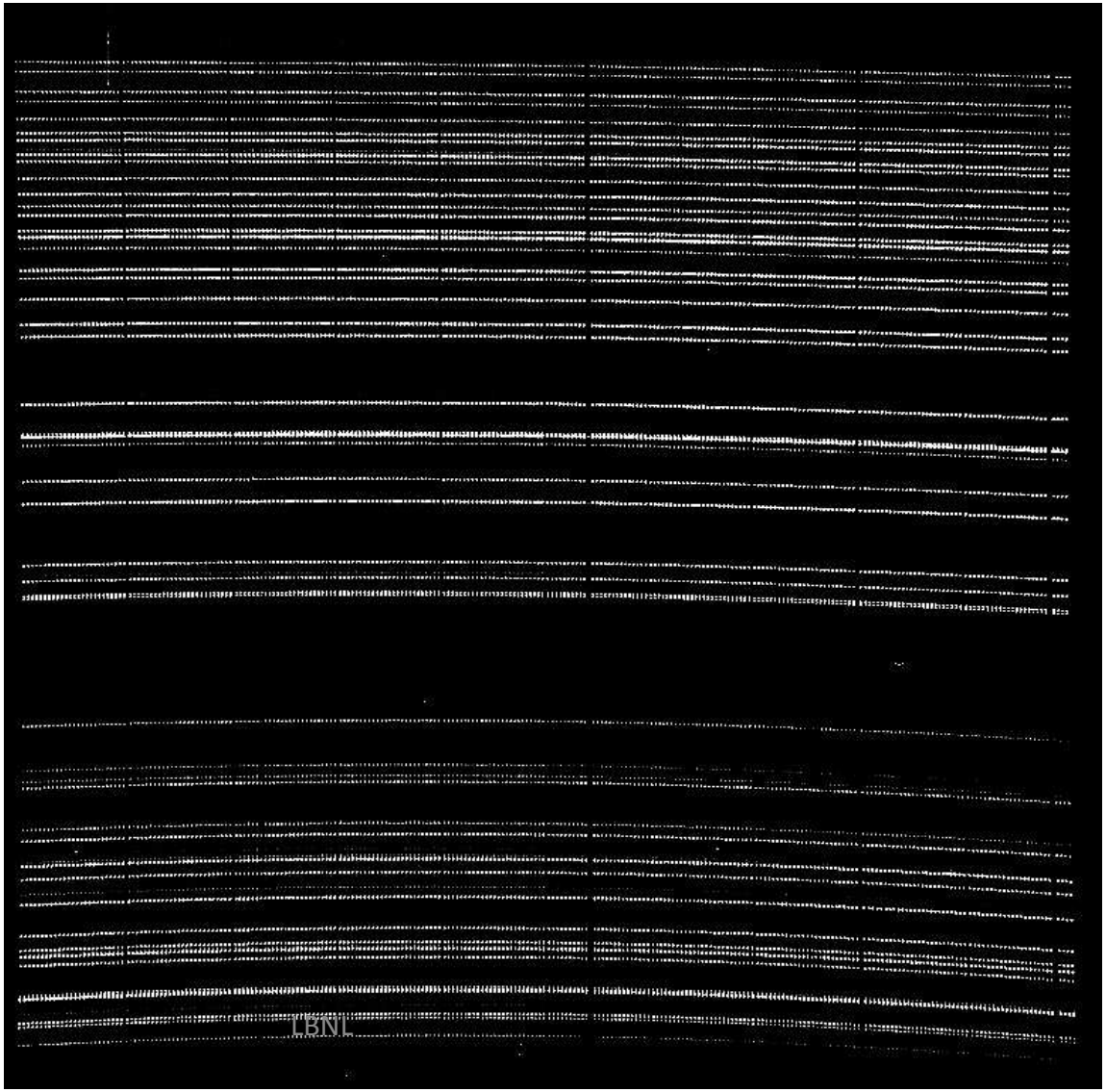
$$f(x) = a \cdot e^{-\frac{(x-b)^c}{c \cdot d^c}}$$



$$O(i,\lambda) = [O_0(i,\lambda)\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

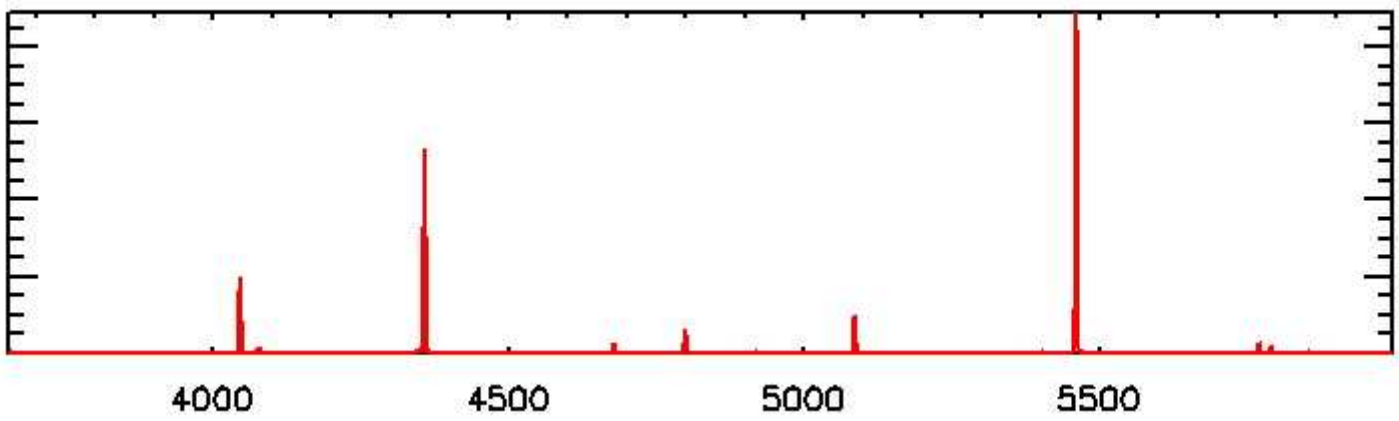
Wavelength calibration - λ





Example (blue side)

- Calibrate a center fiber, such as 125th
- Based on: logλ~pixel (grating)
- Fit line center and laboratorial lambda
- Loop through other fibers



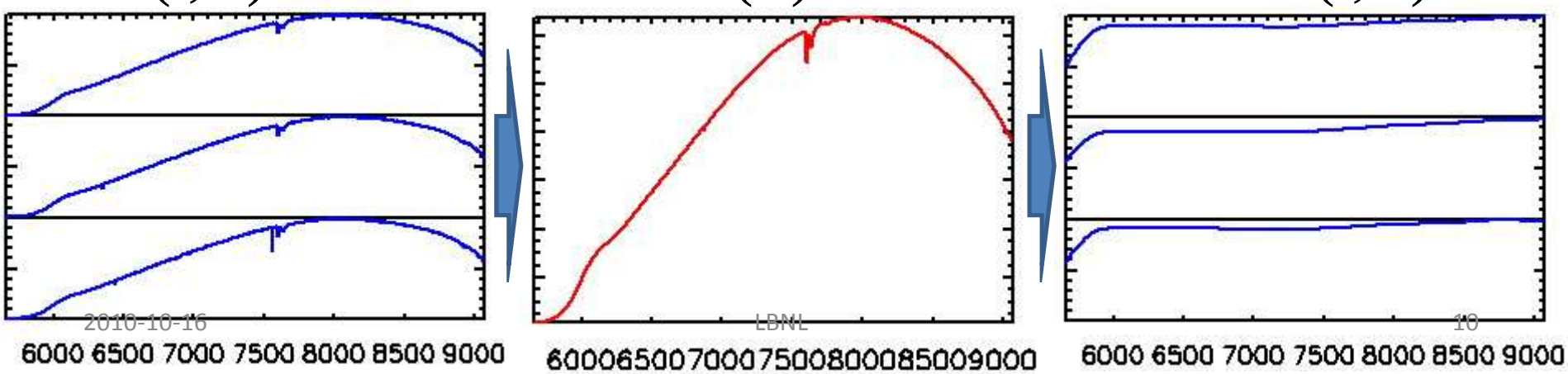
$$O(i,\lambda) = [O_0(i,\lambda)\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

Screen flat – $L(i,\lambda)$

$$F(i,\lambda) = F(\lambda)H(i,\lambda) = F(\lambda)T(\lambda)L(i,\lambda)$$

$$\left.\begin{matrix} F(1,\lambda) \\ F(2,\lambda) \\ \vdots \\ F(n,\lambda) \end{matrix}\right\} \Rightarrow \underbrace{\overline{F(\lambda)}}_{=F(\lambda)T(\lambda)} \Rightarrow \left\{\begin{matrix} L(1,\lambda) = F(1,\lambda)/\overline{F(\lambda)} \\ L(2,\lambda) = F(2,\lambda)/\overline{F(\lambda)} \\ \vdots \\ L(n,\lambda) = F(n,\lambda)/\overline{F(\lambda)} \end{matrix}\right.$$

$F(i,\lambda)$ $\qquad$ $\overline{F}(\lambda)$ $\qquad$ $L(i,\lambda)$

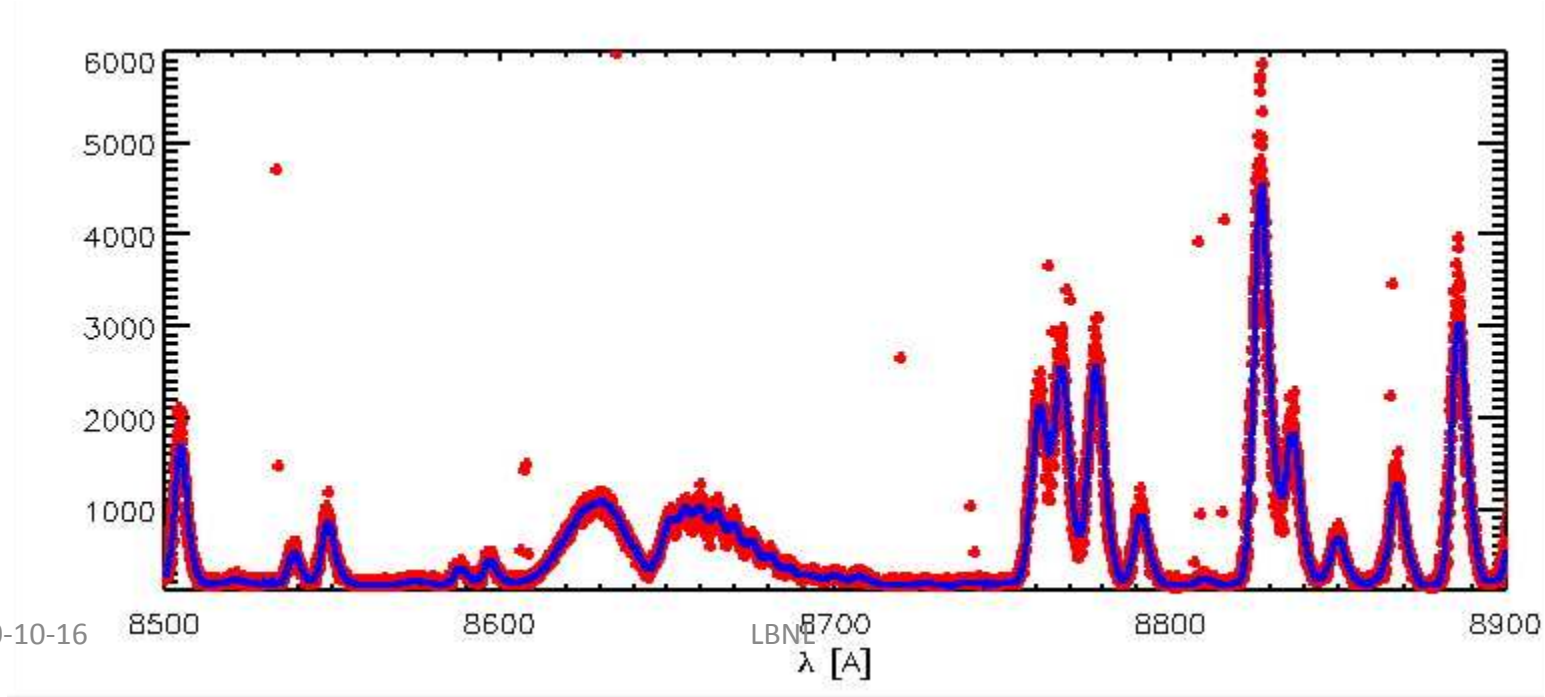


$$O(i,\lambda) = [O_0(i,\lambda)\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

Sky subtraction – $s(\lambda)T(\lambda)$

$$S(i,\lambda) = [\underbrace{O_0(i,\lambda)\mathrm{T}(\lambda)}_{=0} + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

- Several sky fibers
- B-spline fit

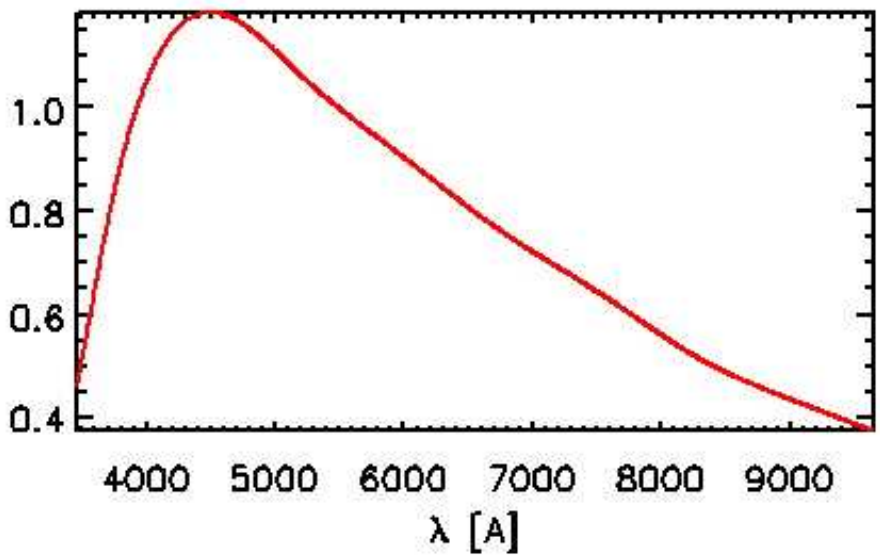


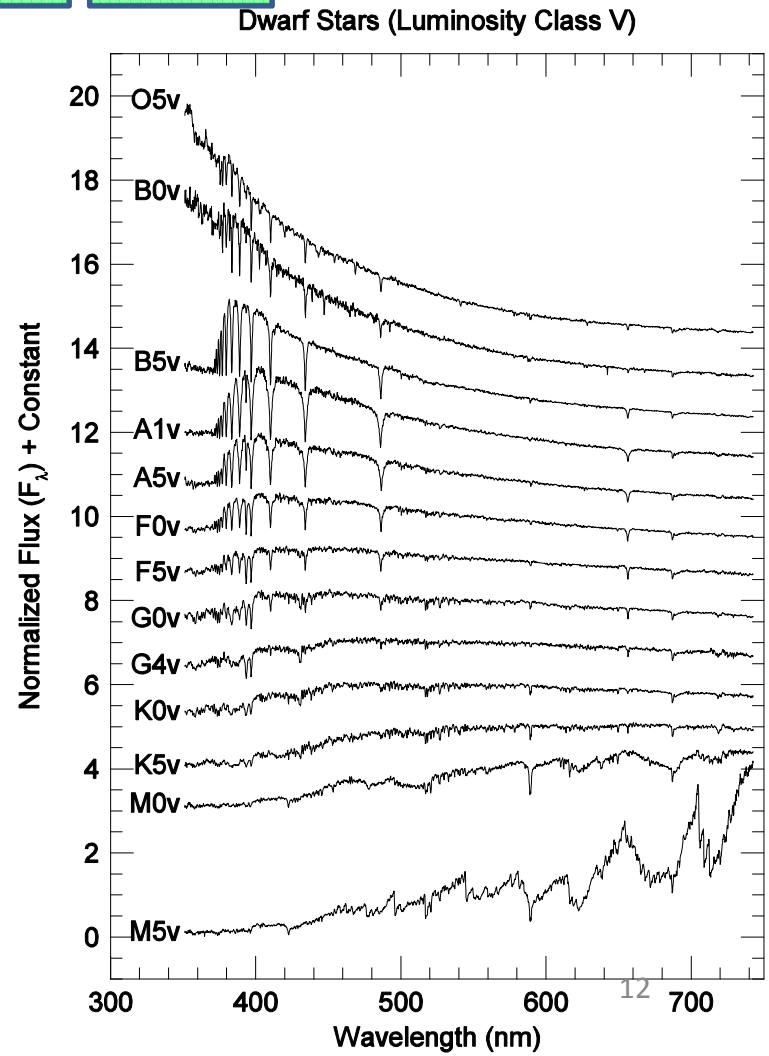
$$O(i,\lambda) = [O_0(i,\lambda)\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

Flux calibration – $T(\lambda)$

$$C(i,\lambda) = [\underbrace{C_0(i,\lambda)}_{\text{template}}\mathrm{T}(\lambda) + s(\lambda)\mathrm{T}(\lambda)]\mathrm{L}(i,\lambda)$$

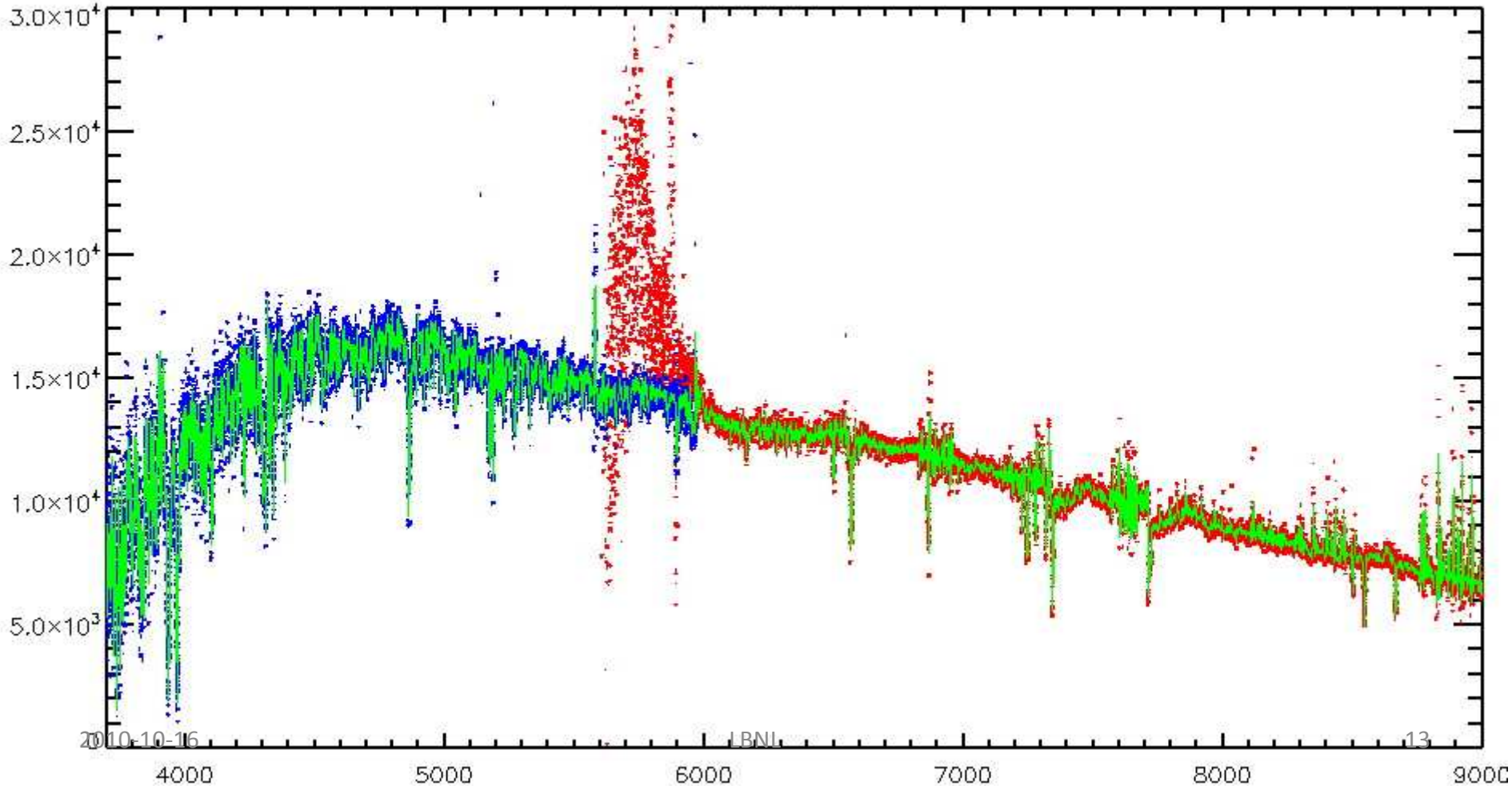
- Select F8v star as standard
- 5 or more standard stars



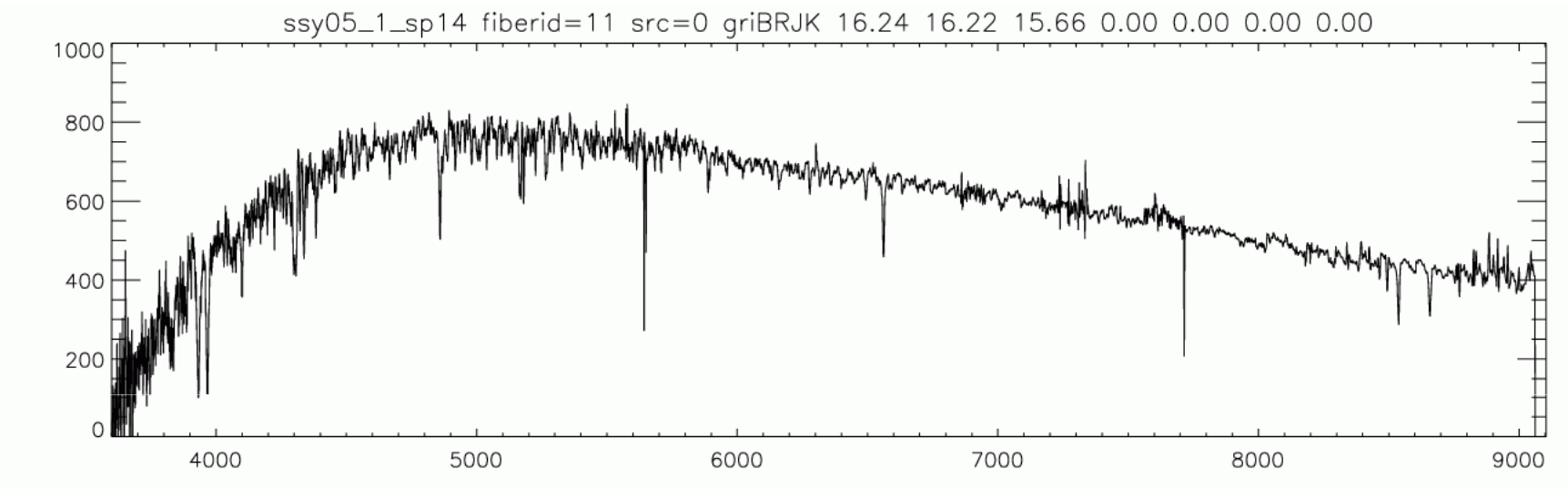


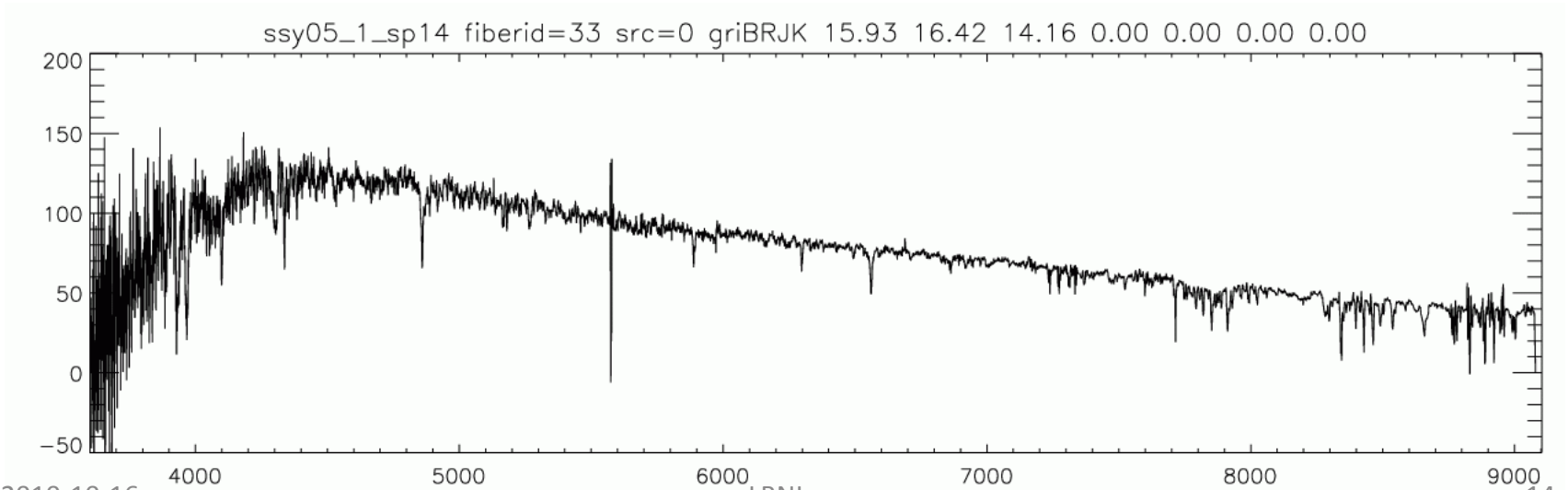
Spectrum combination

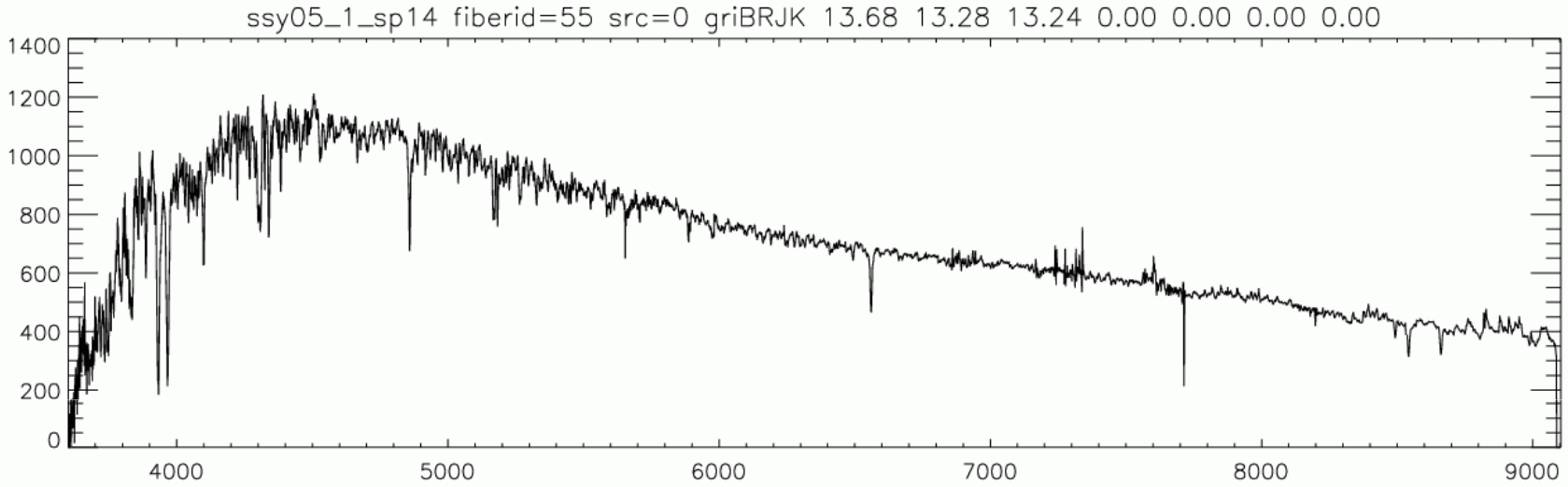
- B-spline fitting

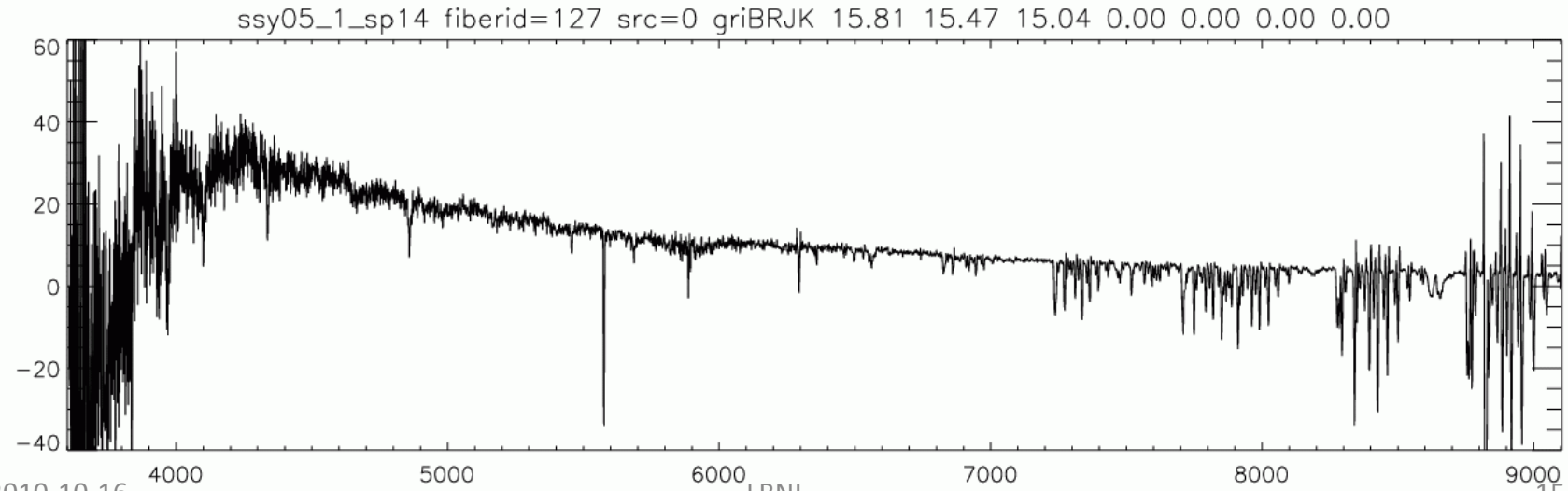


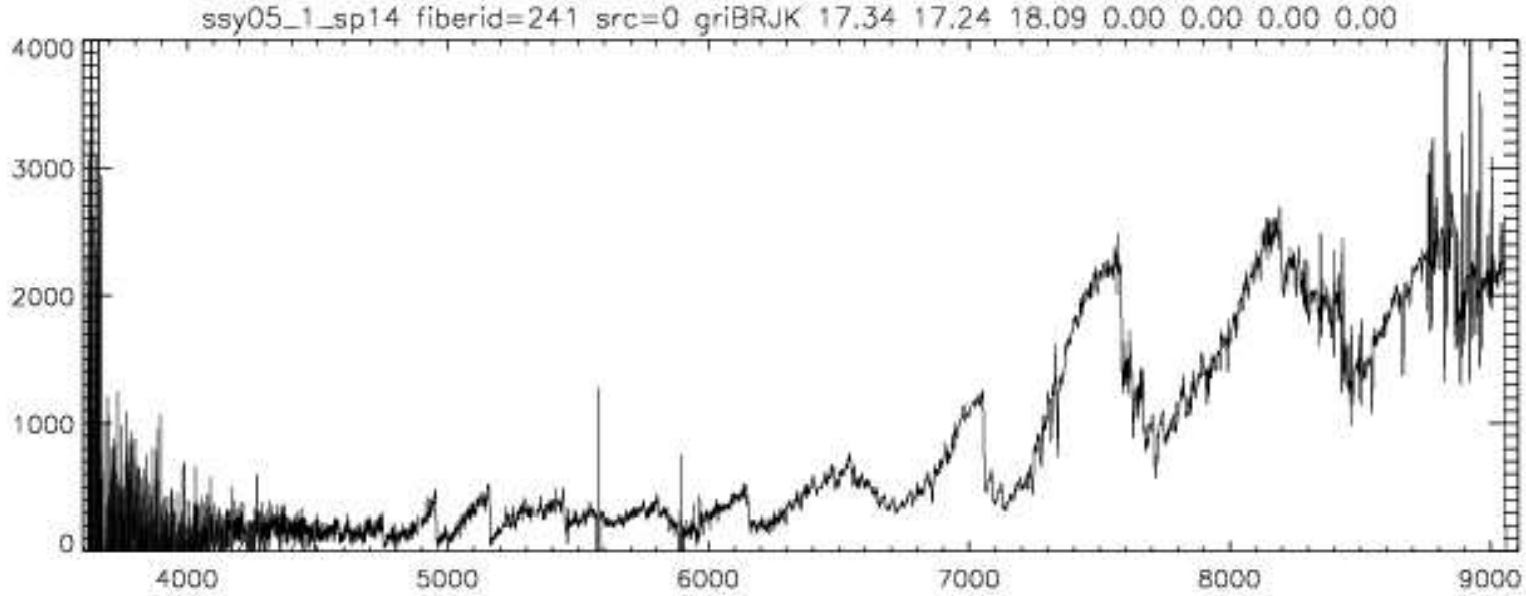
Samples

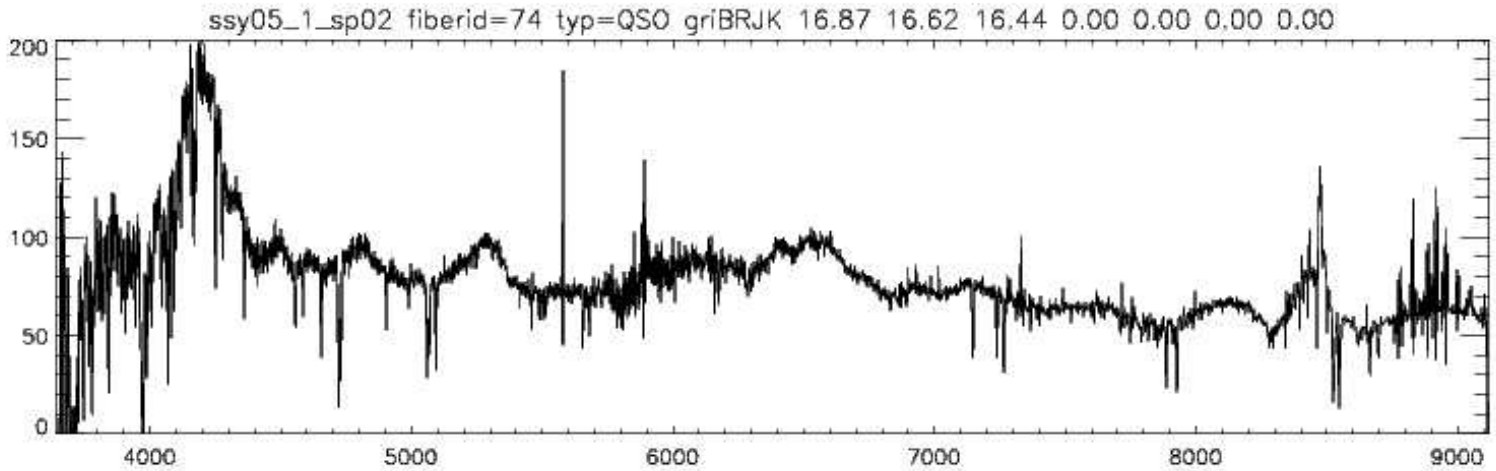

ssy05_1_sp14 fiberid=11 src=0 griBRJK 16.24 16.22 15.66 0.00 0.00 0.00 0.00
1000
800
600
400
200
0
4000
5000
6000
7000
8000
9000


ssy05_1_sp14 fiberid=33 src=0 griBRJK 15.93 16.42 14.16 0.00 0.00 0.00 0.00
200
150
100
50
0
−50
4000
5000
6000
7000
8000
9000


ssy05_1_sp14 fiberid=55 src=0 griBRJK 13.68 13.28 13.24 0.00 0.00 0.00 0.00
1400
1200
1000
800
600
400
200
0
4000
5000
6000
7000
8000
9000


ssy05_1_sp14 fiberid=127 src=0 griBRJK 15.81 15.47 15.04 0.00 0.00 0.00 0.00
60
40
20
0
−20
−40
4000
5000
6000
7000
8000
9000


ssy05_1_sp14 fiberid=241 src=0 griBRJK 17.34 17.24 18.09 0.00 0.00 0.00 0.00
4000
3000
2000
1000
0
4000
5000
6000
7000
8000
9000


ssy05_1_sp02 fiberid=74 typ=QSO griBRJK 16.87 16.62 16.44 0.00 0.00 0.00 0.00
200
150
100
50
0
4000
5000
6000
7000
8000
9000

Problem list

- Low S/N at the ends of spectrum
- Flux extraction
- Screen flat is not perfect
- Sky emission line profiles vary
- Fiber positioning accuracy
- Flux calibration need be approved

Thank you!