# Instrument Development



Our Problem

Steve´s Problem

Your Problem

← Concept

← CDR

← PDR

← FDR

← Construction

Lots of fun
(weeping and teeth gnashing)

← P.s.Tests

← Engineering Com.

← Science Com.

← Early Science

← Shared Risks

← Science

…

Junkyard

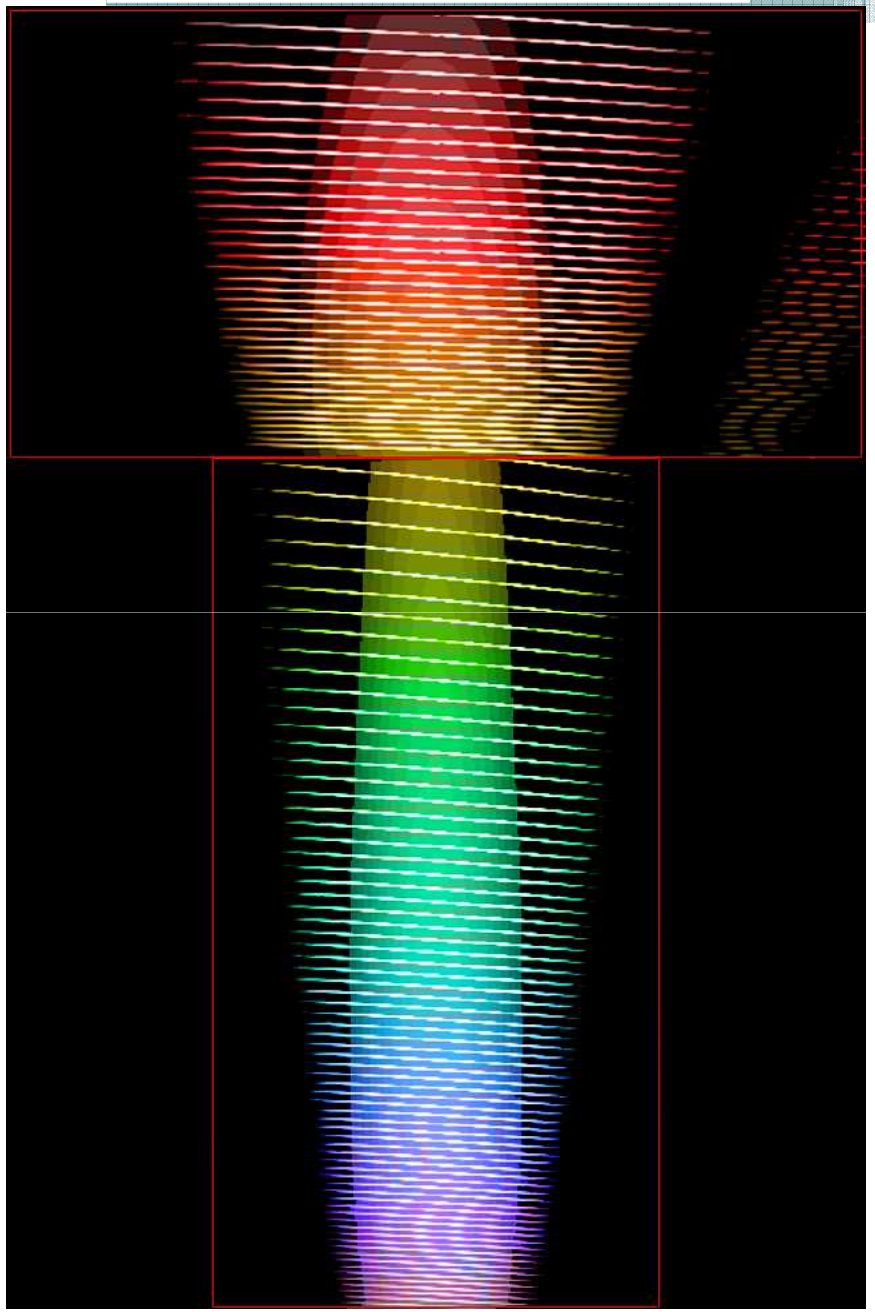

# Observing with STELES

Bruno Castilho

LNA LABORATÓRIO NACIONAL DE ASTROFÍSICA

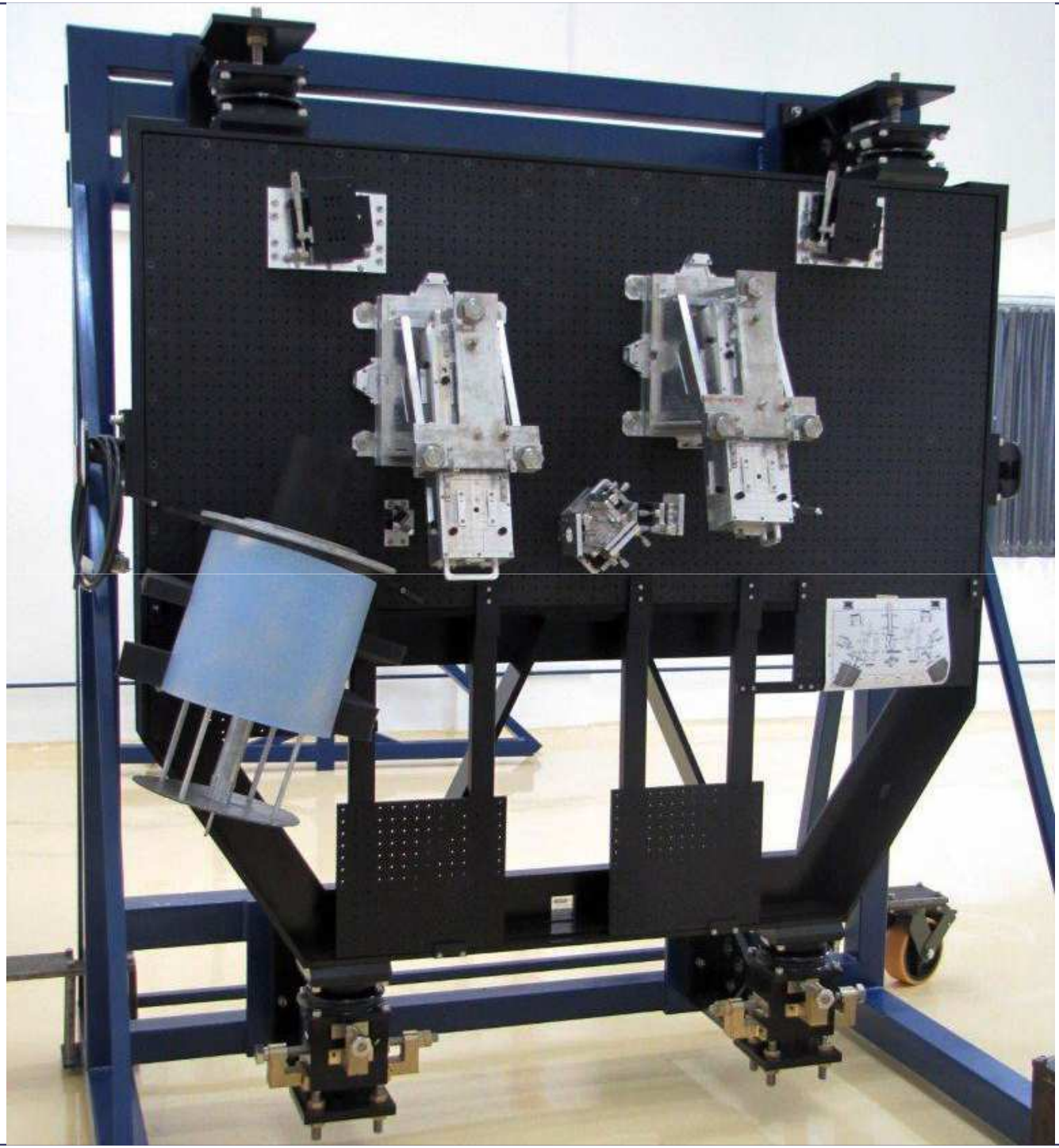
# STELES

- λλ - 300-890nm (in one shot)
- R4 echelle gratings
  50k (75K narrow slits)
- 2 independent slits
  0.8” (0.5-5”)
  8.0” (0.5-20”)
- CCD - 2 x 4096x2048
  - graded coating
- Reduction pipeline

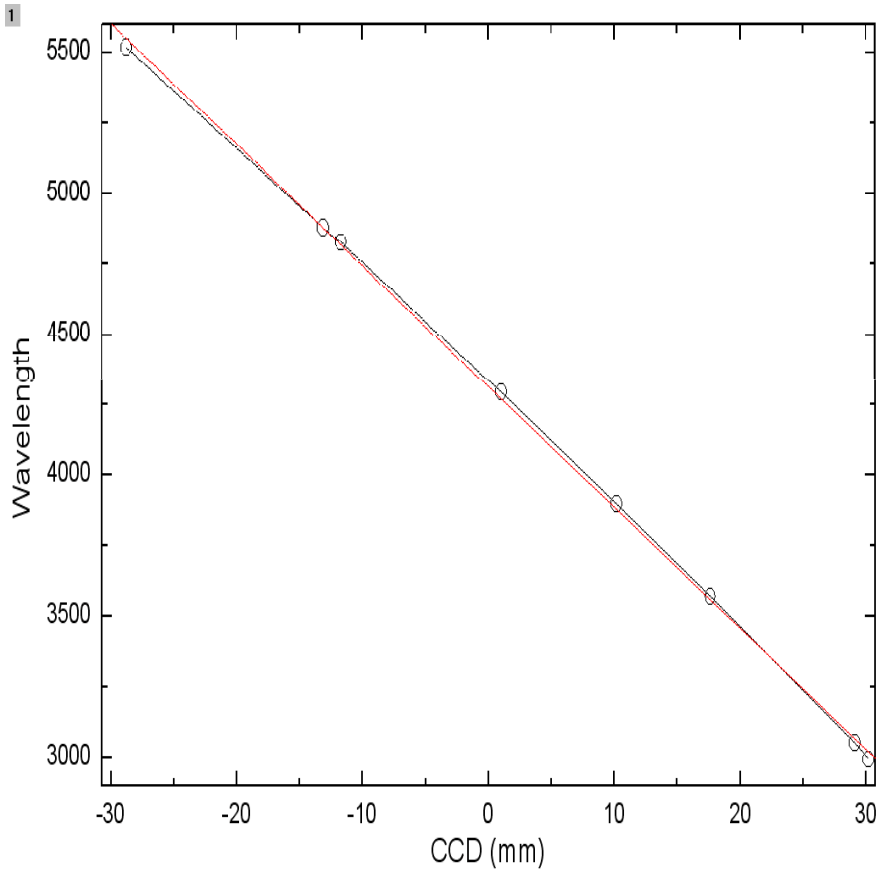


# Status

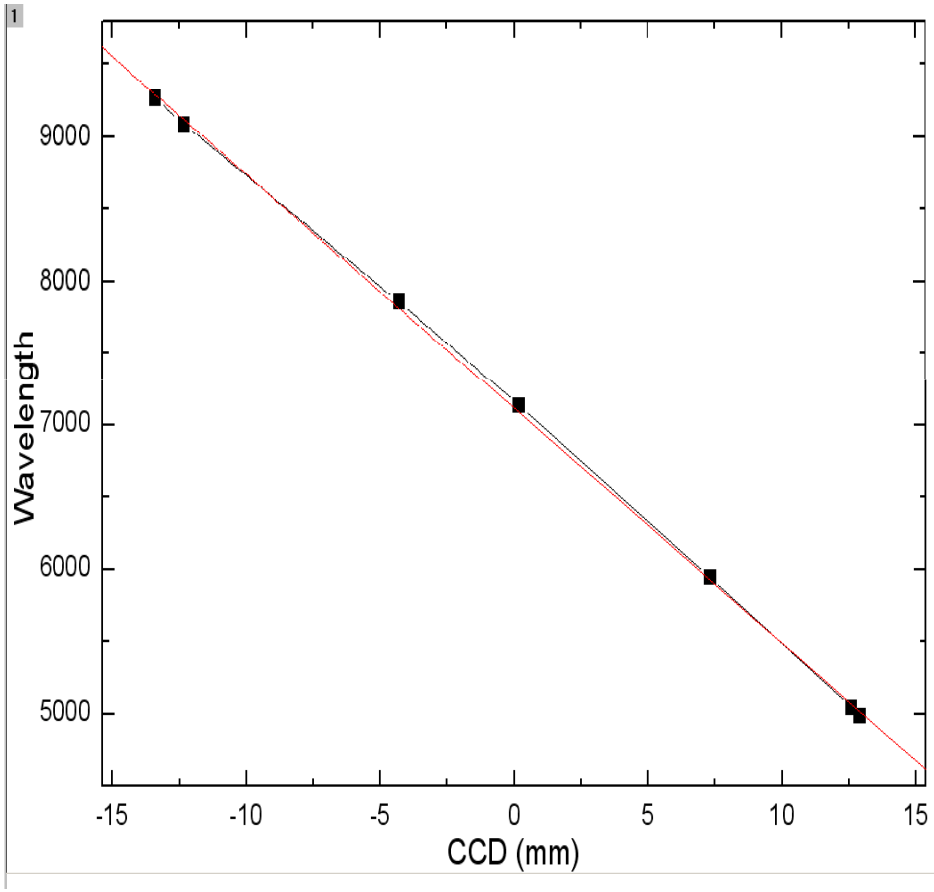
- Optics 100% - arrived, to be tested
- CCDs 100% - at CTIO, in characterization
- Dewars design finished, to be fabricated at CTIO
- Mechanics fabrication 50%
  - imported parts 80% arrived, 20% ordered
  - in fabrication at LNA and contractors
- Electronics 75% arrived
- Data reduction - see poster 26



# Spectral format / Detectors
## Gradient Coating Format



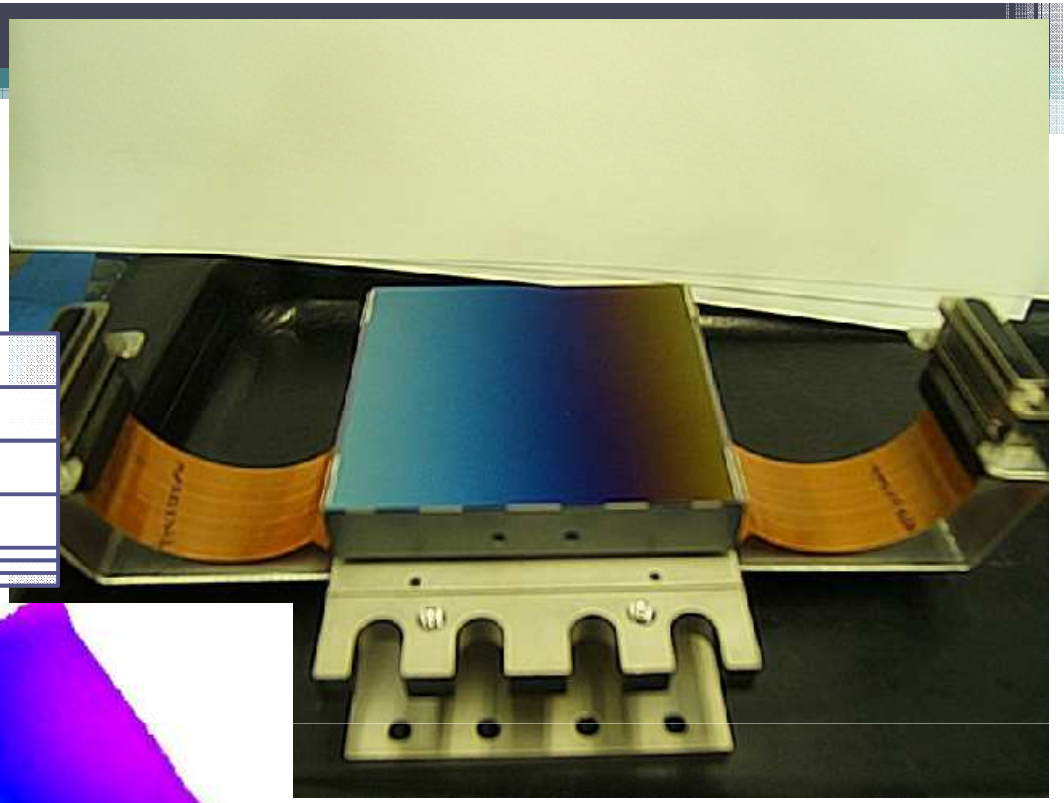

Blue chip

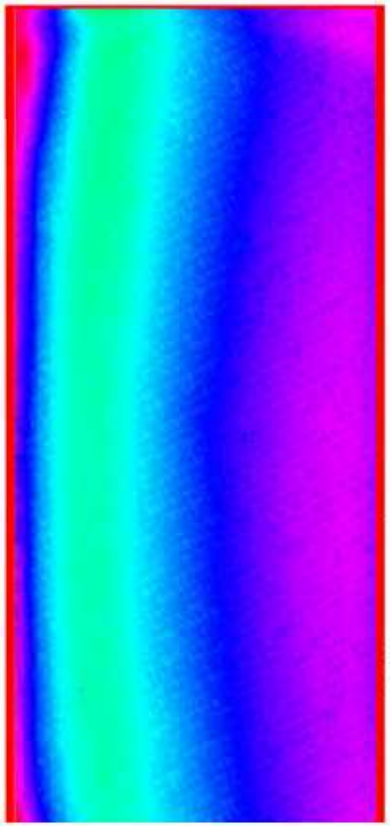


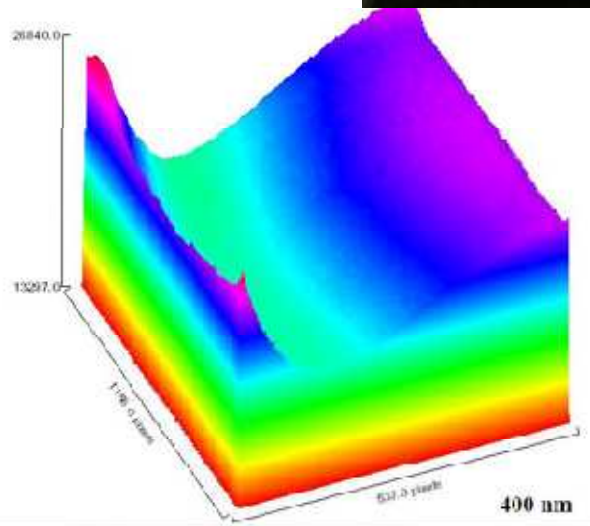

Red chip

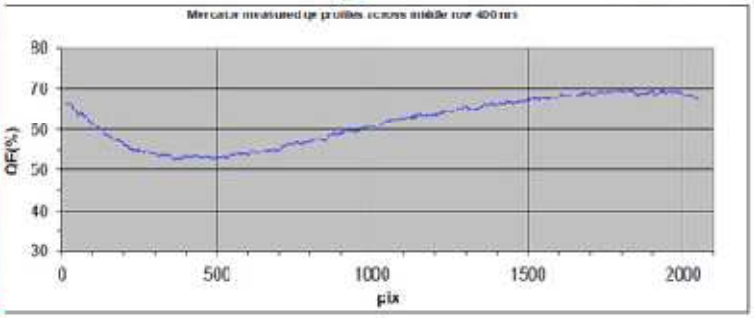
# Spectral format / Detectors
# Results for coating

| Other consumers: |
| --- |
| CCD42-90 2kX4k5 pixels to Mercator telescope |
| CCD231-84 4k4k pixels to SAO (Harvard) |
| CCD231-84 set of 25 devices for ESO MUSE project |



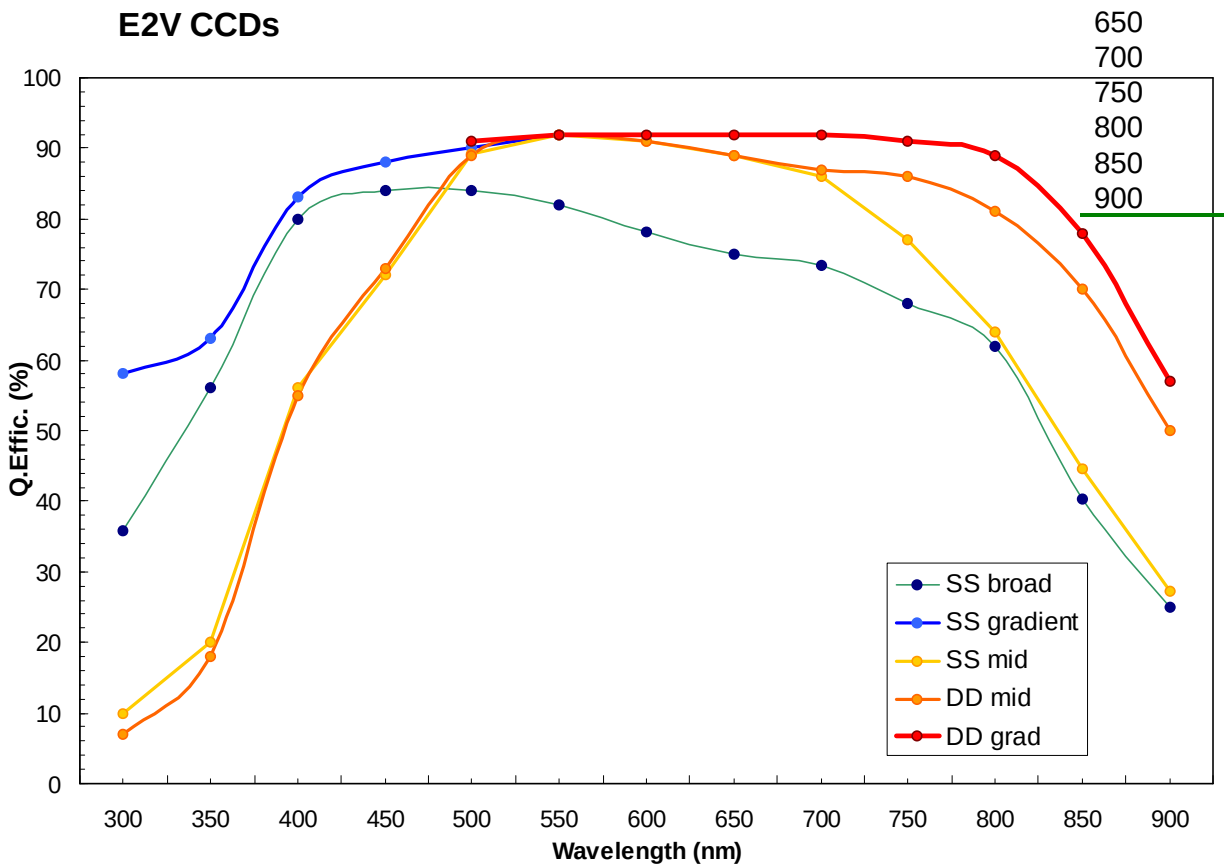




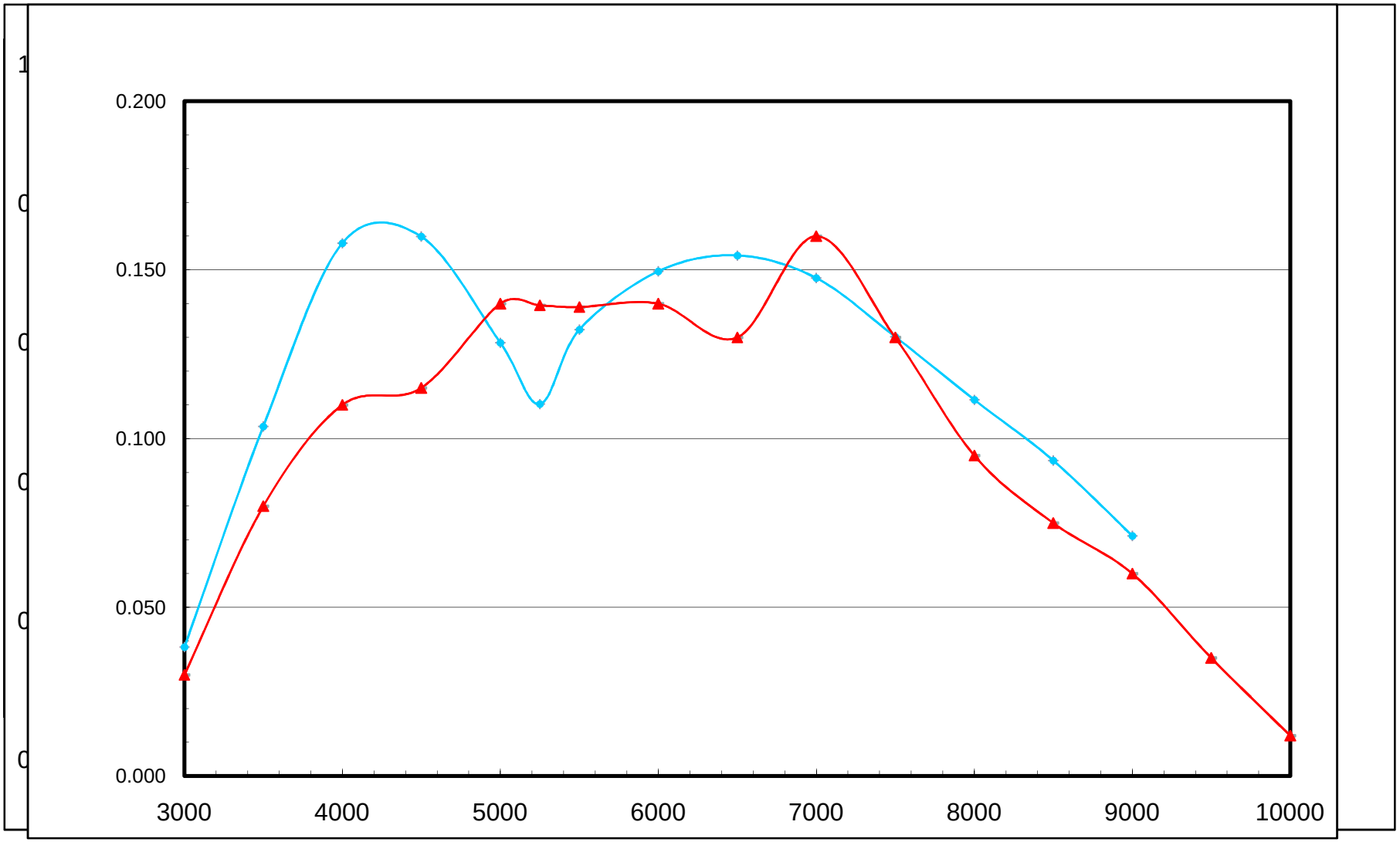
# Spectral format / Detectors
# Expected QEf

| E2V 44-82 -100deg | | | | | |
|---|---|---|---|---|---|
| | SS broad | SS grad | SS mid | DD mid | DD grad |
| 300 | 36 | **58** | 10 | 7 | |
| 350 | 56 | **63** | 20 | 18 | |
| 400 | 80 | **83** | 56 | 55 | |
| 450 | 84 | **88** | 72 | 73 | |
| 500 | 84 | **90** | 89 | 89 | 91 |
| 550 | 82 | **92** | 92 | **92** | 92 |
| 600 | 78 | | 91 | **91** | 92 |
| 650 | 75 | | 89 | **89** | 92 |
| 700 | 73 | | 86 | **87** | 92 |
| 750 | 68 | | 77 | **86** | 91 |
| 800 | 62 | | 64 | **81** | 89 |
| 850 | 40 | | 45 | **70** | 78 |
| 900 | 25 | | 27 | **50** | 57 |

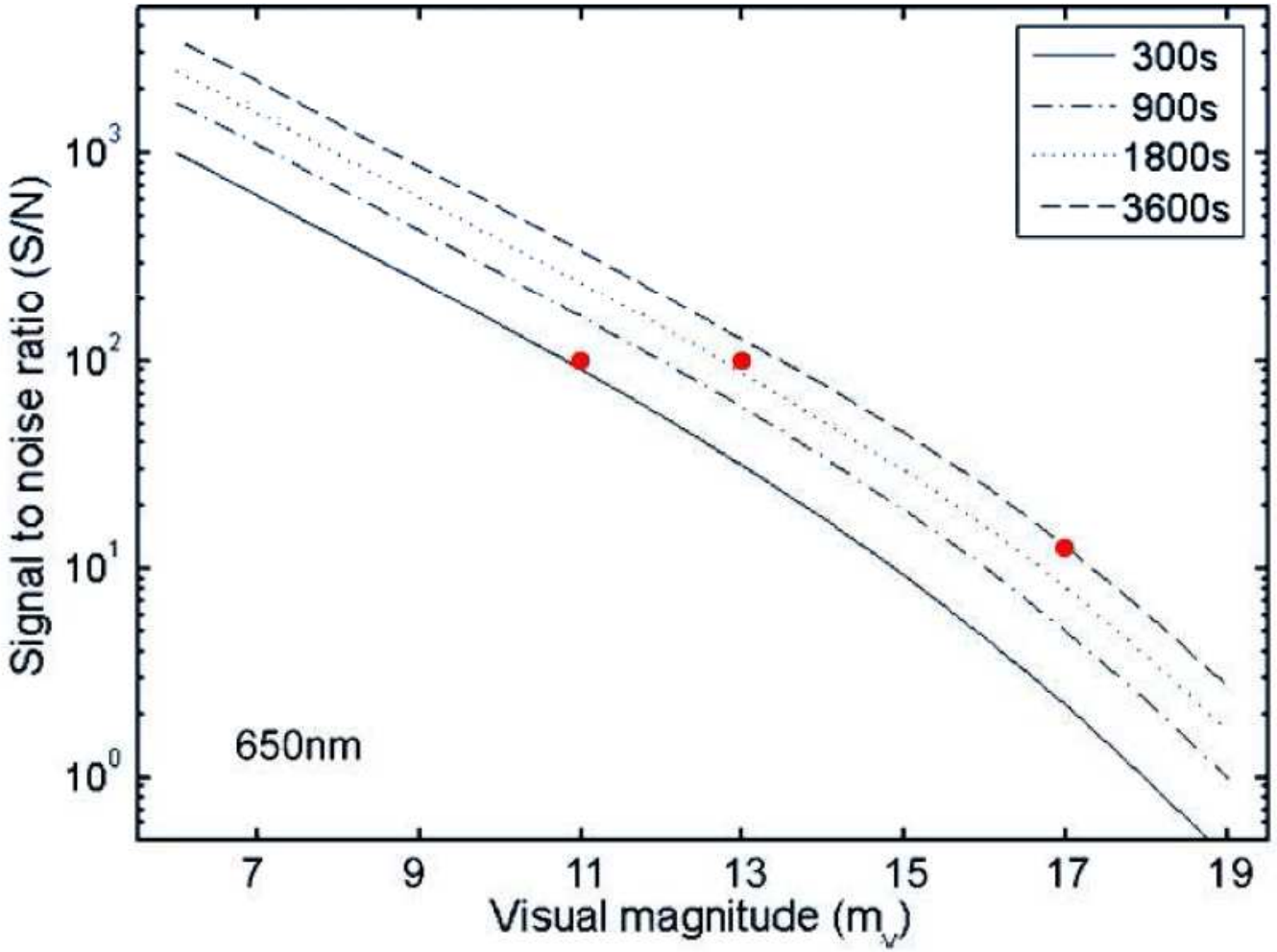



Based on E2V test sheets and previsions

# Efficiency


0.200
0.150
0.100
0.050
0.000
3000
4000
5000
6000
7000
8000
9000
10000

# Efficiency




| M v | S/N | T(min) |
|---|---|---|
| 11 | 100 | 5 |
| 13 | 100 | 30 |
| 17 | 12 | 60 |

650nm
0.8”
dark time

# STELES

## Exposure Time Calculator
## SOAR Telescope Echelle Spectrograph

Online help for SPECTIME

(•) Signal-to-noise ratio: 100 ( ) Integration time in seconds: 720

Maximum time per single exposure (seconds): 1200

Central wavelength: 4500 From 3000 to 5399 [A] data is computed for Channel A
From 5400 to 9000 [A] data is computed for Channel B

Slit width in arcsecs (+) or pixels (-): 0.8 Dichroic: Da

Filter: None

Detector binning (dispersion): 1

Seeing (arcsecs): 0.8 Airmass: 1.0

Lunar Phase (0-14 days from new moon, 0 = new, 14 = full): 0=new

Describe the source with the following parameters. The power law index is only used if the source spectrum is set to Fλ_power or Fν_power. Setting the power law index to 0 is equivalent to a flat spectrum for that particular power law function. If the value of the wavelength of the source flux is set to INDEF then the central wavelength value above is used. The wavelength of the source flux is ignored for source units = U, B, V, R, I.

Source spectrum: Blackbody Temperature (K) for blackbody source: 6000 Power law index: 0

Wavelength (λ) of source flux or magnitude: INDEF Source flux or magnitude: 12 Units of source flux or magnitude: B

E(B-V) (reddening of source in magnitudes): 0

Detector: MIT/LL Help for Detector Type

Execute Reset

sediyama@efei.br

sptime

Object spectrum: Blackbody spectrum of temperature 6000. K
Reference wavelength: 5500. Angstroms
Reference flux: V = 12. (6.03E-14 ergs/s/cm^2/A)
Sky spectrum: Cerro Pachon
Moon phase: 0
Extinction:
Airmass: 1.
Seeing: 0.8" (FWHM)

Telescope: Slit
Area: 13.2 m^2, Scale: 3.144 arcsec/mm
Spectrograph: STELES
Collimator:
Focal length = 0.85 m
Apertures: Slit with Gaussian profile
Size: 0.80" x 21.63", 0.254 x 6.88 mm, 4.2 x 100.0 pixels
Filter: Dichroic A
Disperser: Echelle
Central order = 104
Central wavelength = 4500. Angstroms
Central dispersion = 2.66 Angstroms/mm, 0.0399 Angstroms/pixel
Ruling = 41 lines/mm
Blaze = 76.0 deg
Grating tilt = 76.1 degrees
Grating magnification = 0.96
Using predicted efficiencies
Crossdisperser: VPH
Central order = 1
Central wavelength = 4500. Angstroms
Central dispersion = 2.66 Angstroms/mm
Ruling = 1200 lines/mm
Blaze = 14 deg
Grating tilt = 16.2 degrees
Grating magnification = 0.86
Using tabulated efficiencies
Camera:
Focal length = 0.215 m, Resolution = 3. pixels
Detector: MIT/LL
Pixel size: 15 microns, 0.19"
Number of pixels = 2048
Read noise = 0.0 e-, Gain = 1.0 e-/DN, Dark = 0. e-/s

Source pixels: 14 pixels (3xFWHM seeing disk)
Background pixels: 89 pixels

WARNING: Orders overlap

---- Results for 919.61s exposure at 4500. Angstroms ----

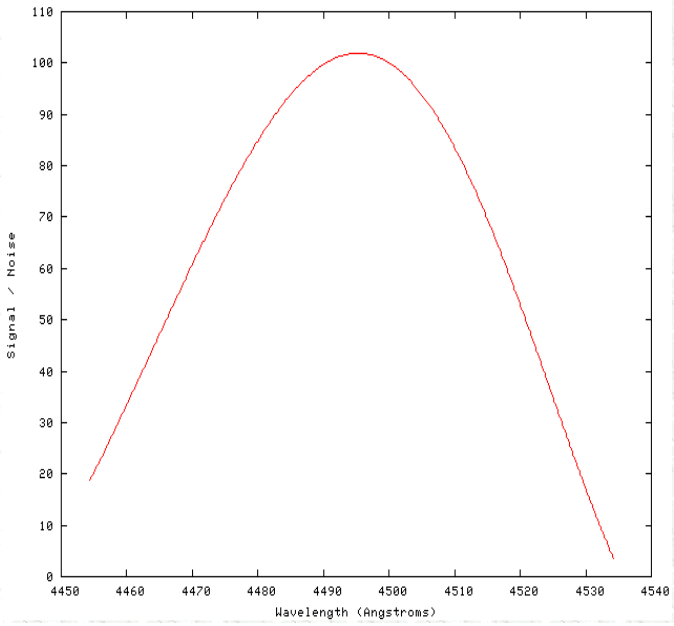
Source flux: 0.0141 photons/s/cm^2/A (AB=12.4)
Background flux: 2.71E-6 photons/s/cm^2/A (over source pixels)

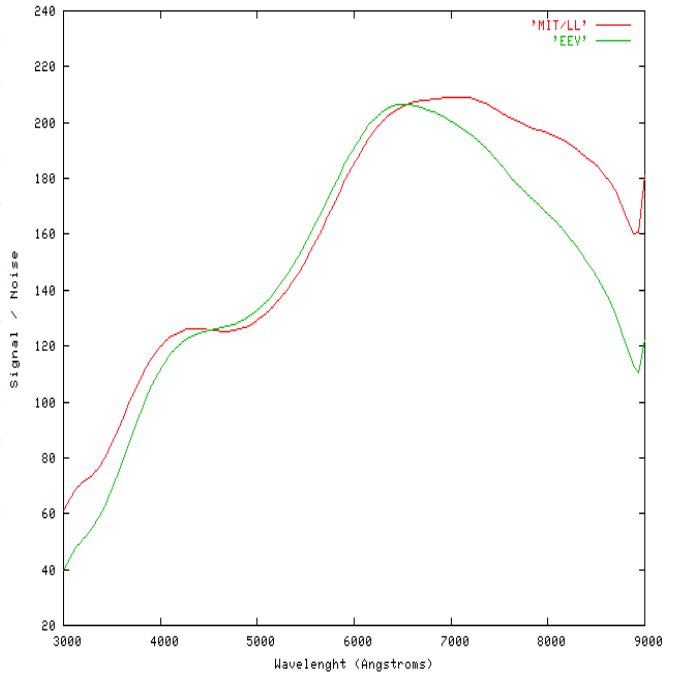
| Transmision/Efficiencies: | indivdual | cumulative |
|---|---|---|
| Telescope | 75.8% | 75.8% |
| Aperture (seeing=0.8") | 62.4% | 47.3% |
| Filter | 97.6% | 46.2% |
| Spectrograph | 44.3% | 20.5% |
| Disperser | 84.2% | 17.2% |
| Detector DQE | 87.0% | 15.0% |

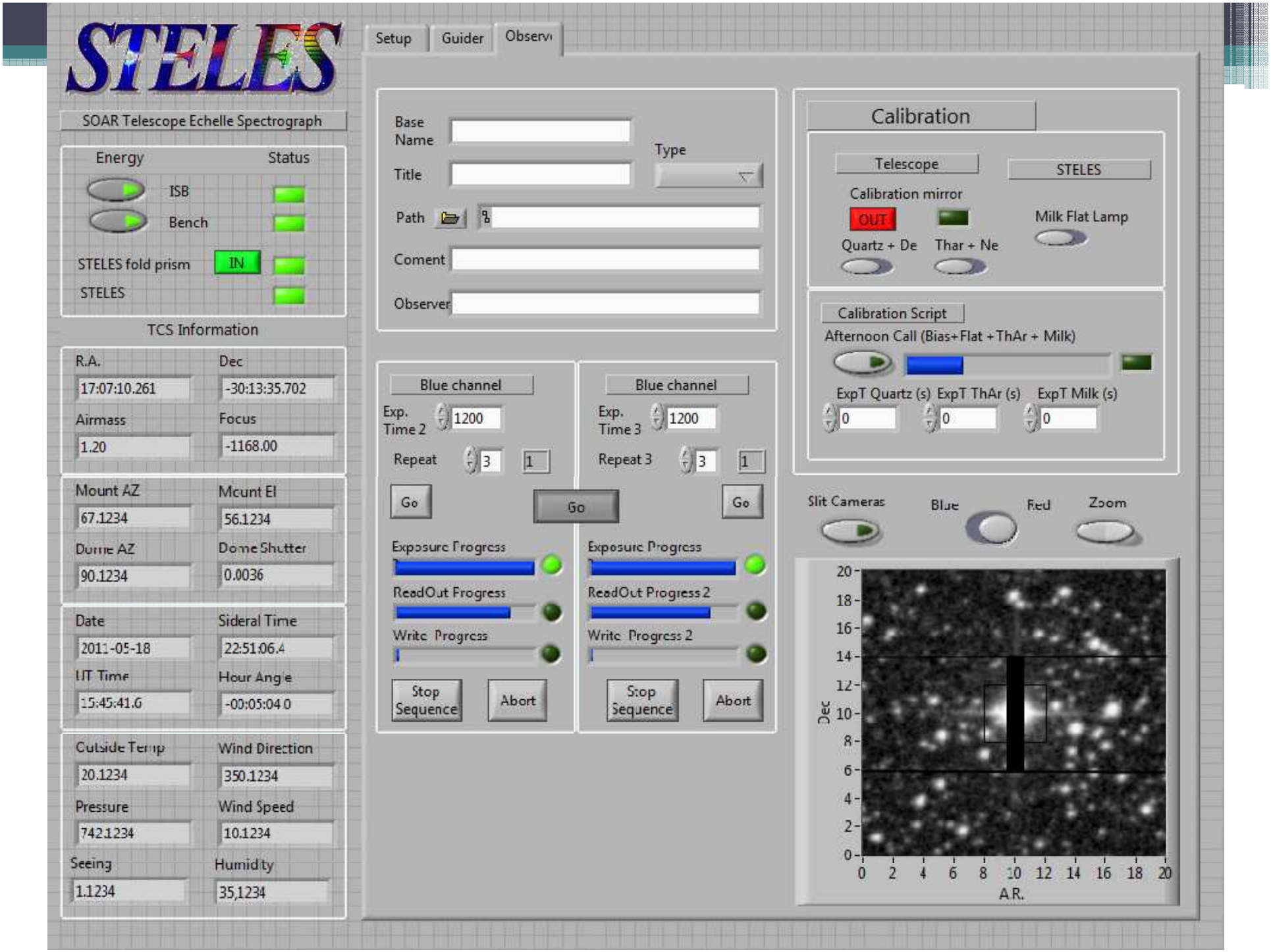
| Statistics per exposure per pixel: | e- | sigma |
|---|---|---|
| Source | 10001 | 100.0 |
| Background | 1 | 1.0 |
| Dark | 0 | 0.0 |
| Readout | | 0.0 |
| Net | 10002 | 100.0 |

Signal-to-Noise Statistics:
100 per exposure per pixel
223 per exposure per 0.208 Angstroms (5 pixel) resolution element

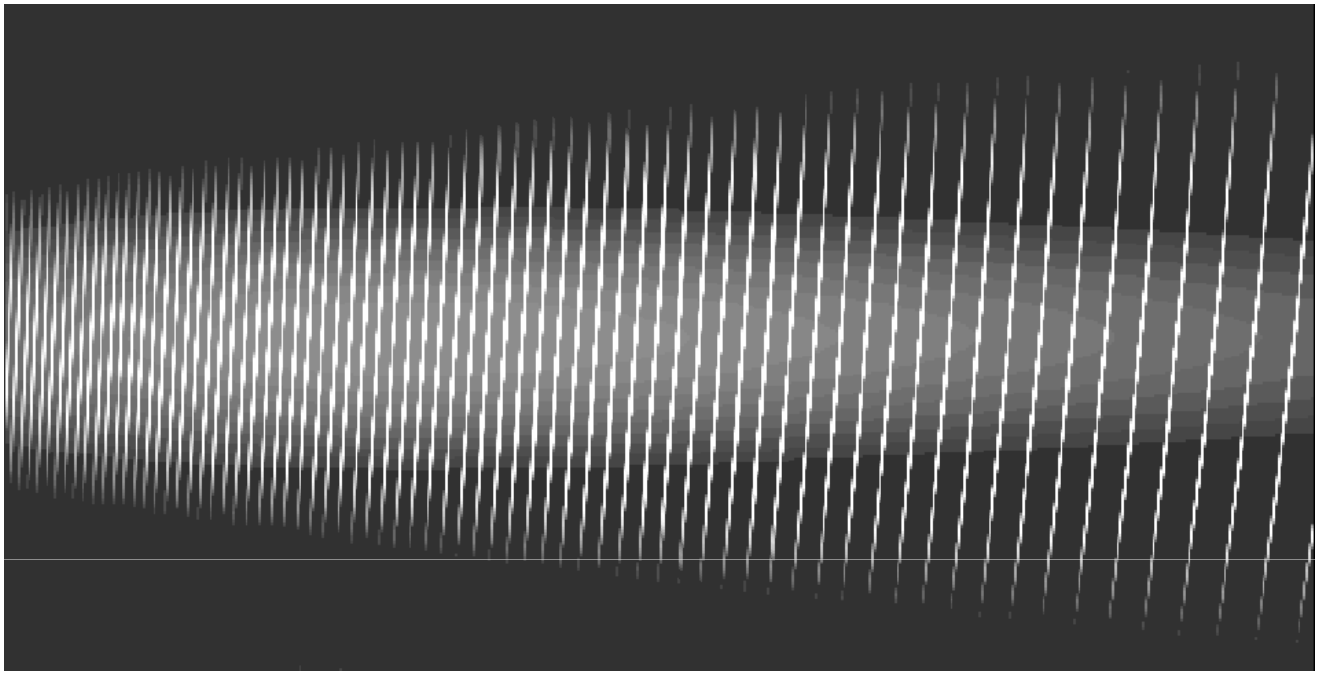
Exposure time: 919.61s (0:15:19.6)

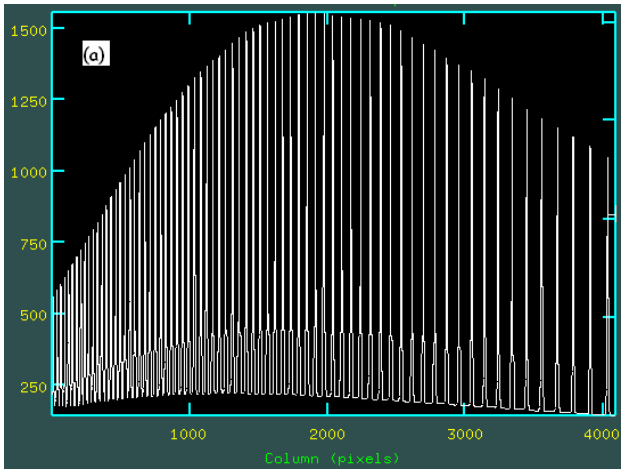


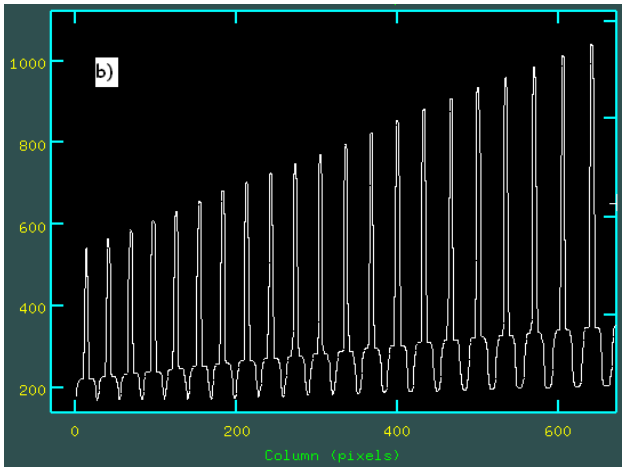




STELES
SOAR Telescope Echelle Spectrograph
Energy
Status
ISB
Bench
STELES fold prism
IN
STELES
TCS Information
R.A.
17:07:10.261
Dec
-30:13:35.702
Airmass
1.20
Focus
-1168.00
Mount AZ
67.1234
Mount El
56.1234
Dome AZ
90.1234
Dome Shutter
0.0036
Date
2011-05-18
Sideral Time
22:51:06.4
UT Time
15:45:41.6
Hour Angle
-00:05:04.0
Outside Temp
20.1234
Wind Direction
350.1234
Pressure
742.1234
Wind Speed
10.1234
Seeing
1.1234
Humidity
35,1234
Setup
Guider
Observ
Base Name
Type
Title
Path
Coment
Observer
Blue channel
Exp. Time 2
1200
Repeat
3
1
Go
Exposure Progress
ReadOut Progress
Write Progress
Stop Sequence
Abort
Blue channel
Exp. Time 3
1200
Repeat 3
3
1
Go
Exposure Progress
ReadOut Progress 2
Write Progress 2
Stop Sequence
Abort
Calibration
Telescope
STELES
Calibration mirror
OUT
Milk Flat Lamp
Quartz + De
Thar + Ne
Calibration Script
Afternoon Call (Bias+Flat +ThAr + Milk)
ExpT Quartz (s)
ExpT ThAr (s)
ExpT Milk (s)
0
0
0
Slit Cameras
Blue
Red
Zoom
Dec
A.R.
0
2
4
6
8
10
12
14
16
18
20

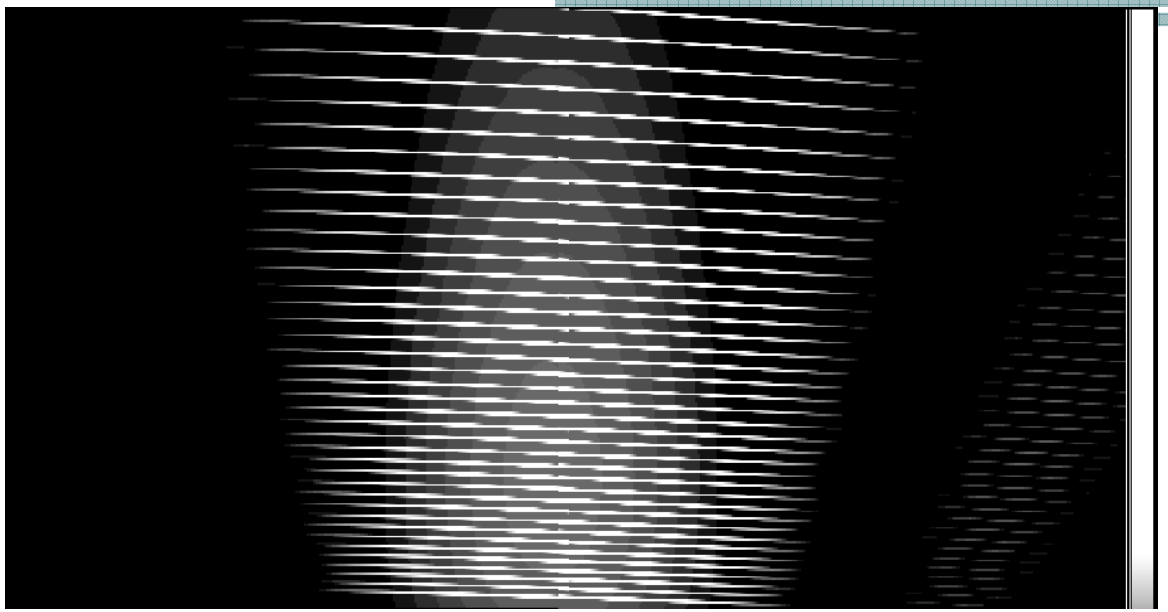
# Blue

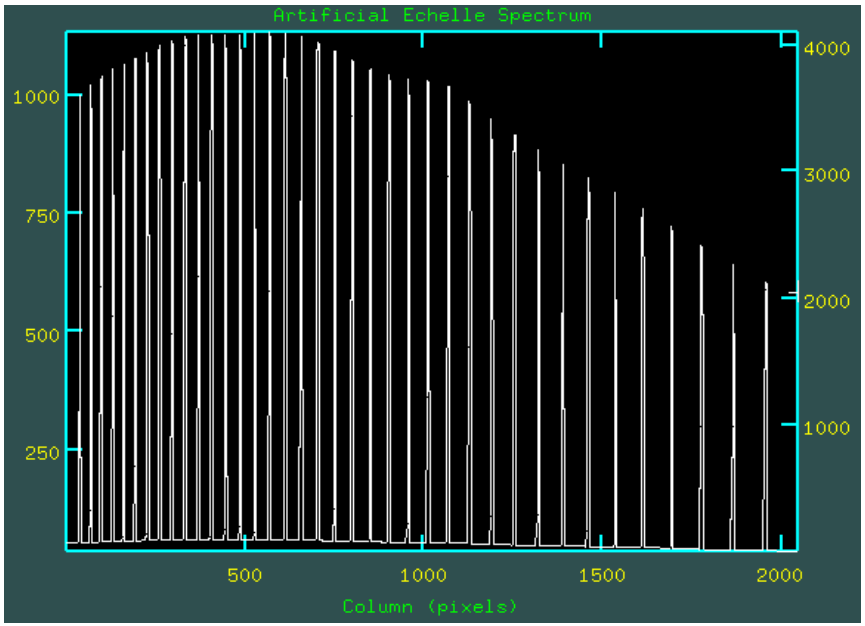


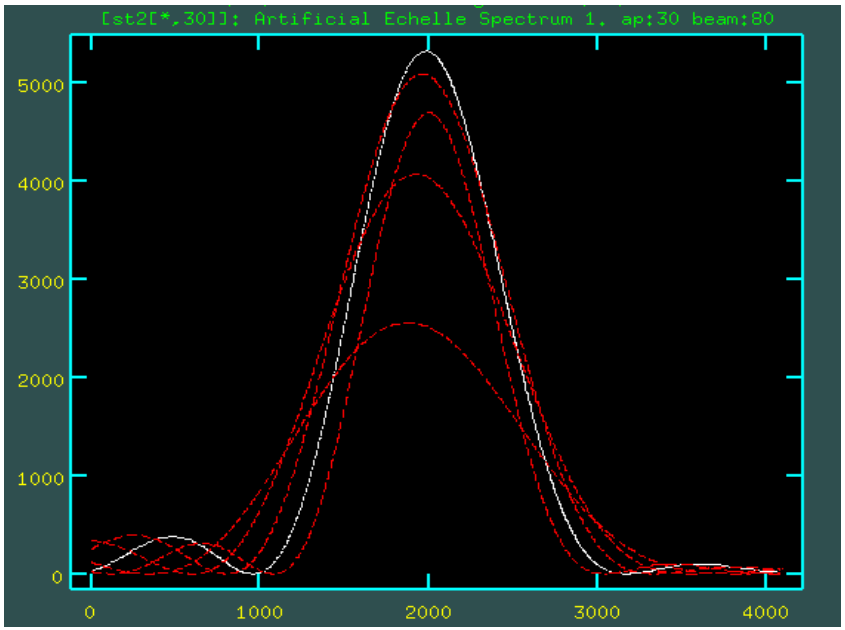

(a)
1500
1250
1000
750
500
250
1000
2000
3000
4000
Column (pixels)


b)
1000
800
600
400
200
0
200
400
600
Column (pixels)

# Red




Artificial Echelle Spectrum
1000
750
500
250
4000
3000
2000
1000
500
1000
1500
2000
Column (pixels)

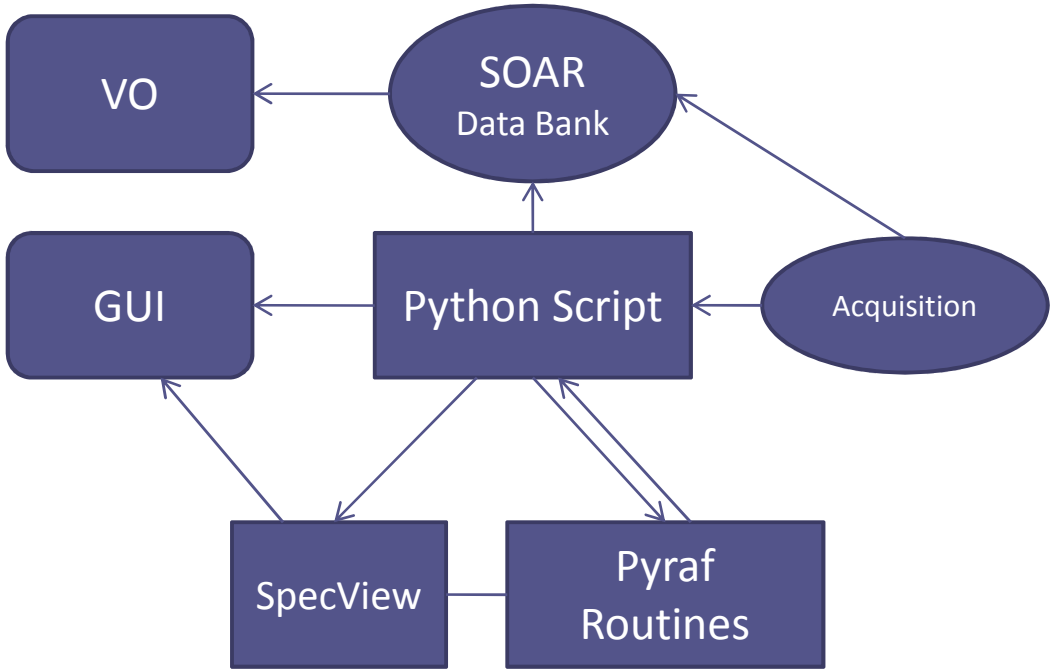

[st2[*,30]]: Artificial Echelle Spectrum 1, ap:30 beam:80
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000

# Data Reduction - Structure

First light – IRAF script, tests and early science

Pine line – optimized based on the first data

Poster 36
M.B. Fernandes



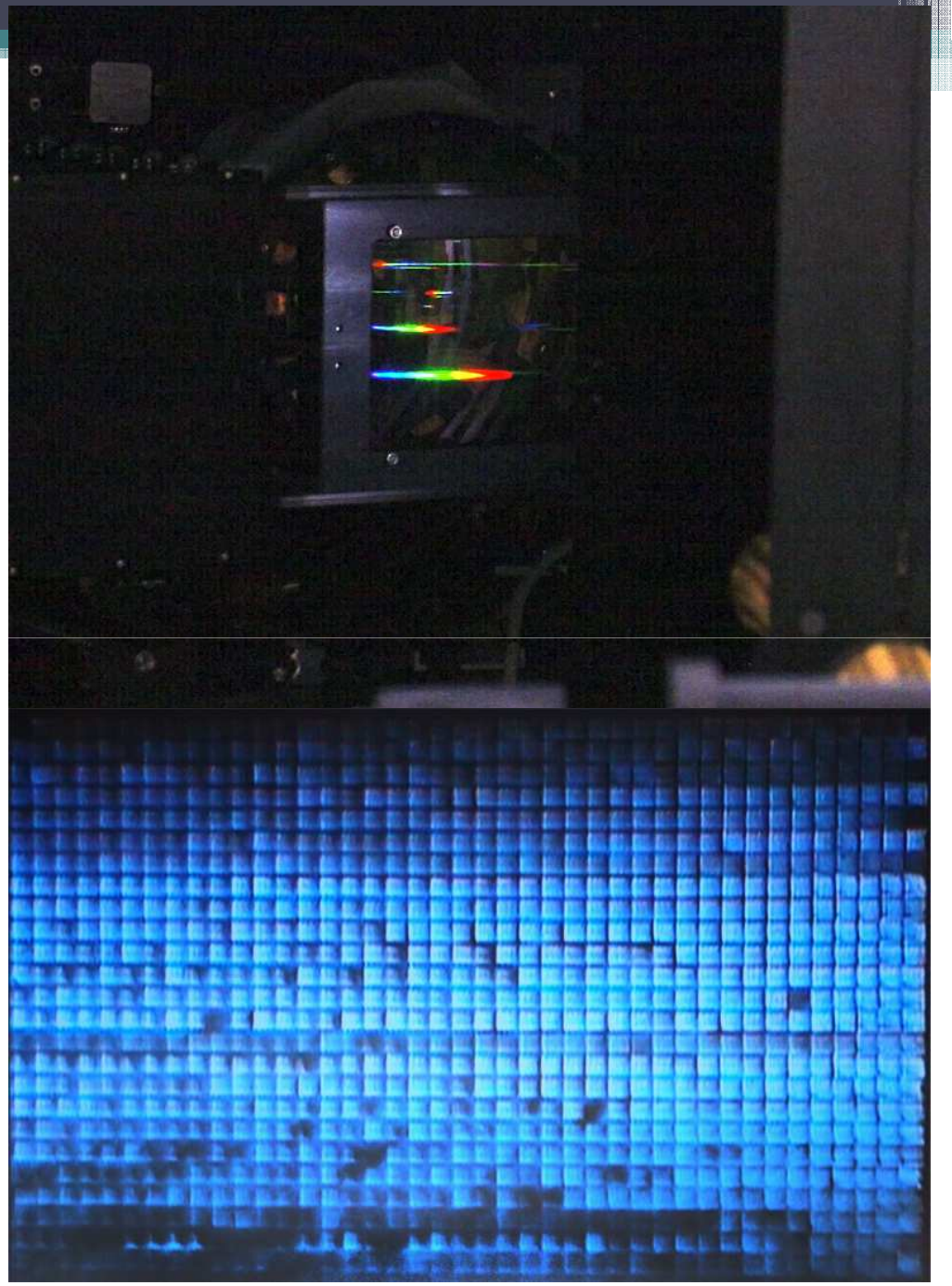

# Observing with SIFS

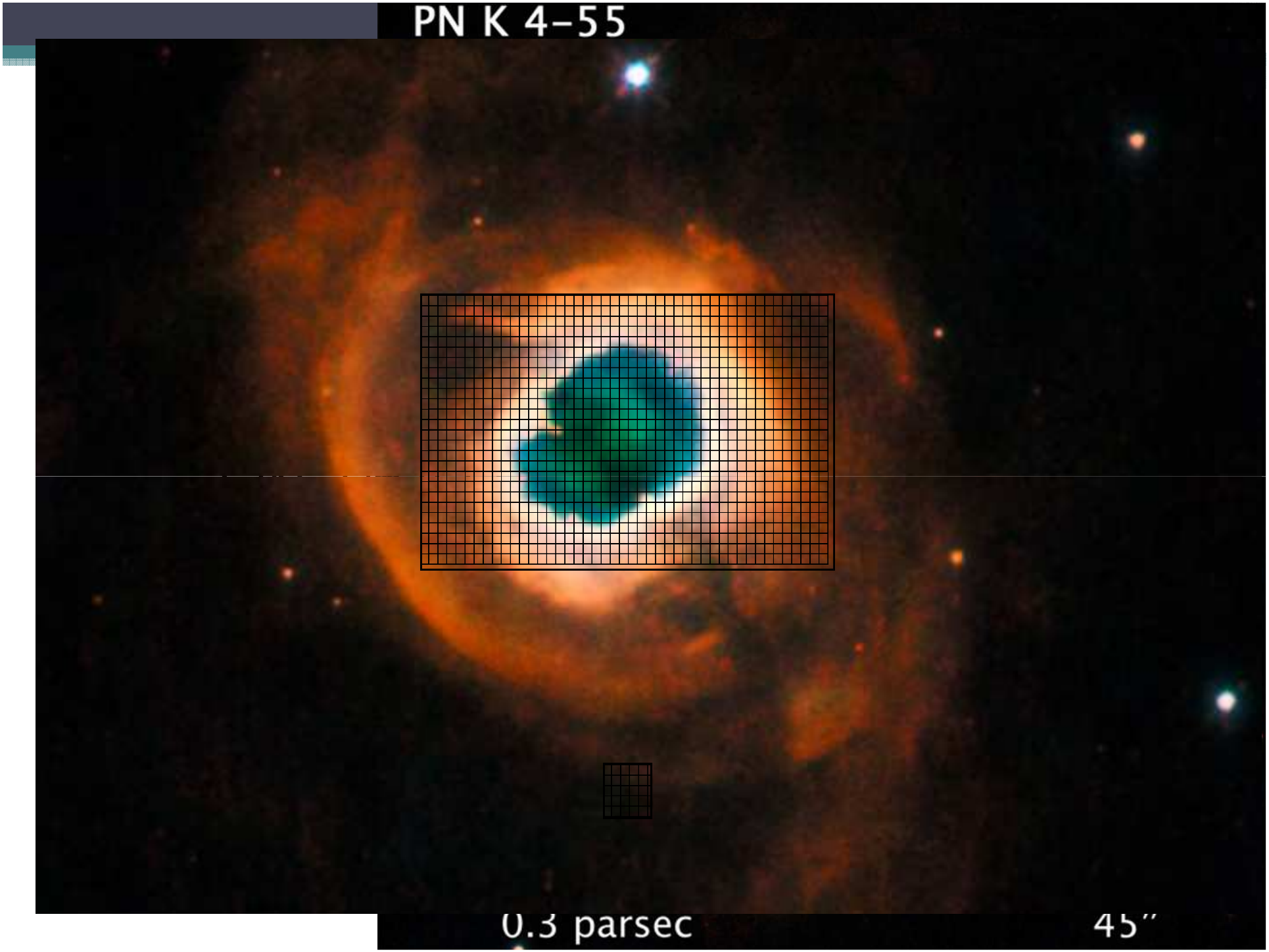
Bruno Castilho

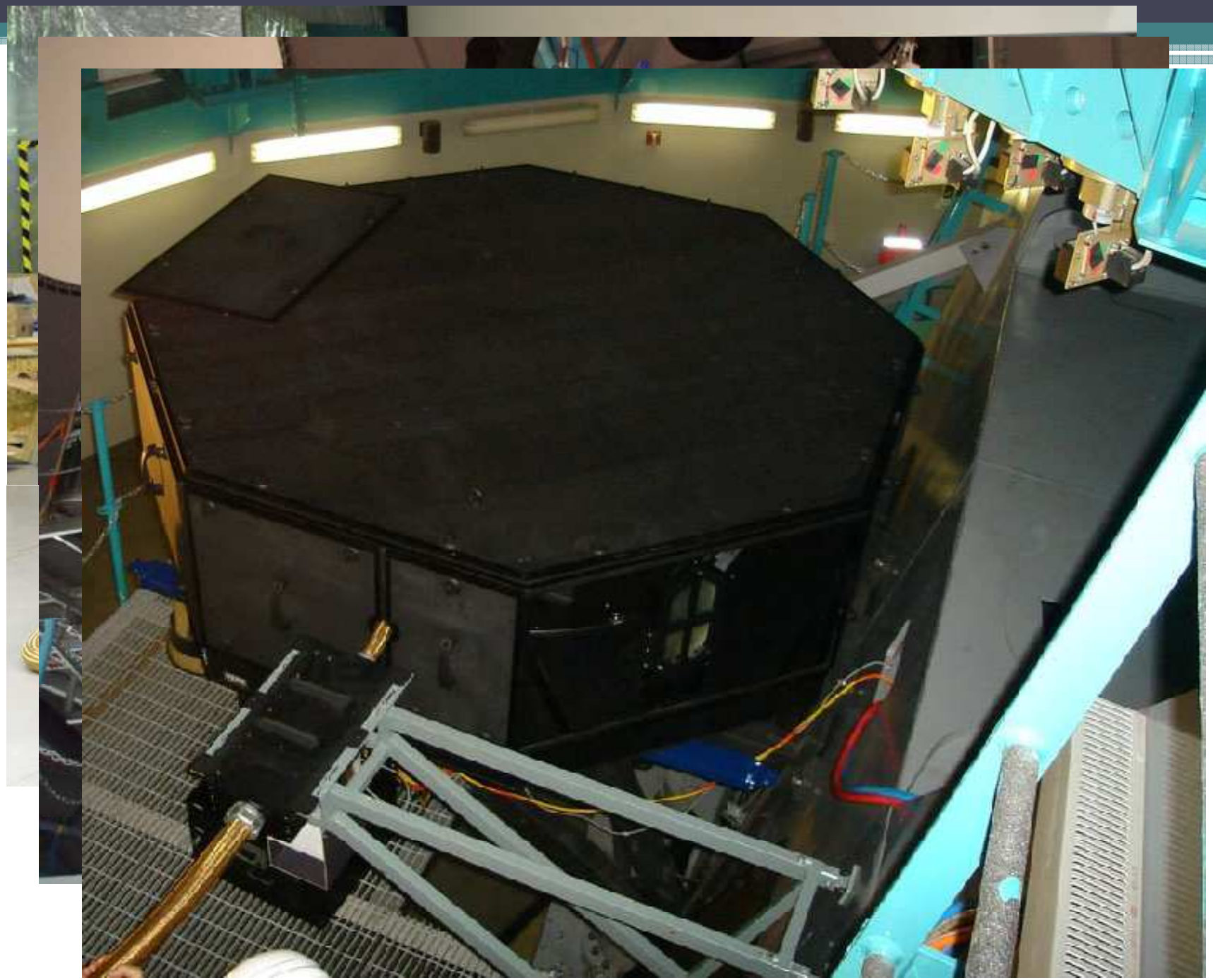
LNA LABORATÓRIO NACIONAL DE ASTROFÍSICA

# SIFS

- IFU (1300 – 26 x 50)
  7.8 x 15 @ 0.3"
  3.9 x 7.5 @ 0.15"
- VPH gratings
  1,000-40,000
- CCD E2V 4096x4096
- λλ 320-850nm



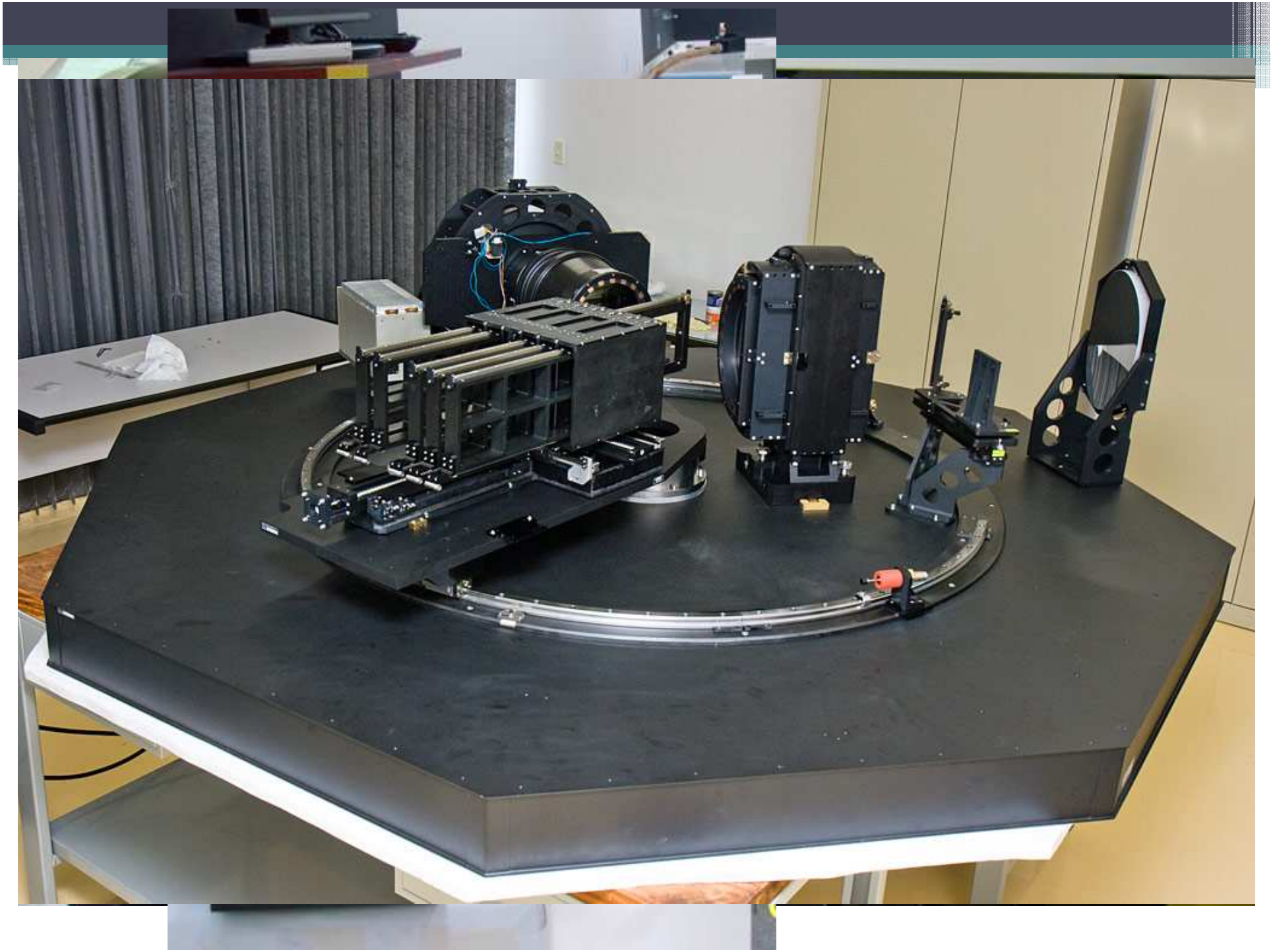

PN K 4-55
0.3 parsec
45″



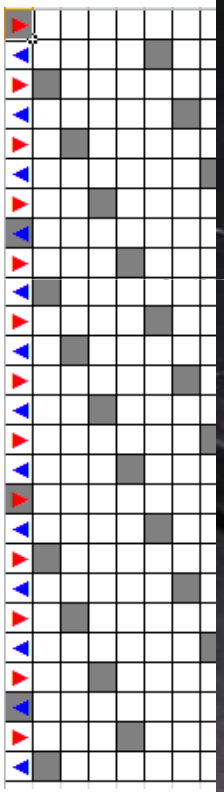
# SIFS units

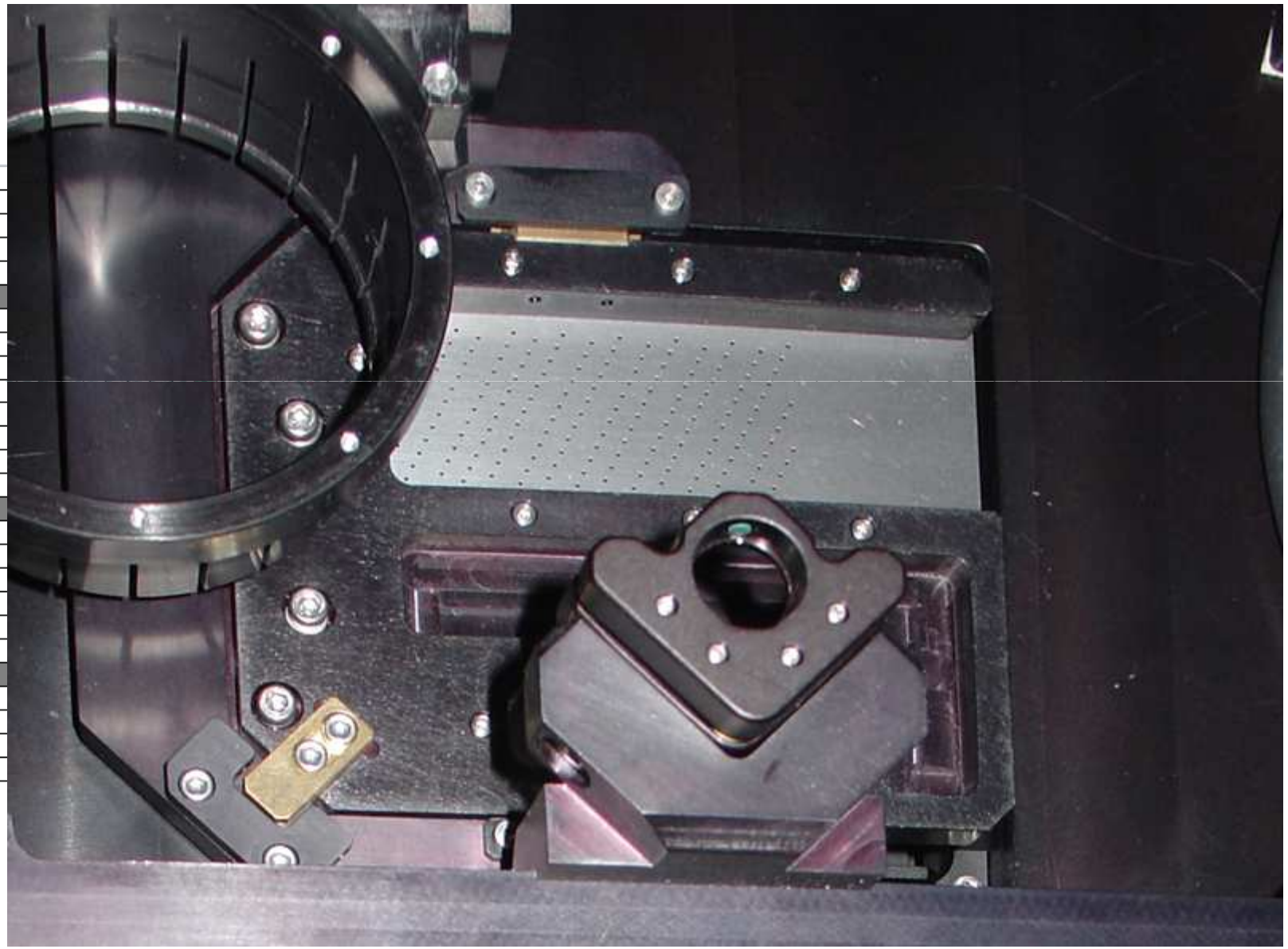
- Fore-optics
  - Magnification — 7.8x15 @ 0.3“, 3.9x7.5 @ 0.15"
  - Filters — 4 positions + focus camera
  - Mask — clear, nod & shuffle, 8 flat positions
- Bench Spectrograph
  - Gratings, grating angle — 5 gratings, 1 clear (max 53deg)
  - Camera focus, camera angle — remotely controlled focus
  - Milk Flat — possible upgrade

*More on poster 26 Cesar Oliveira*



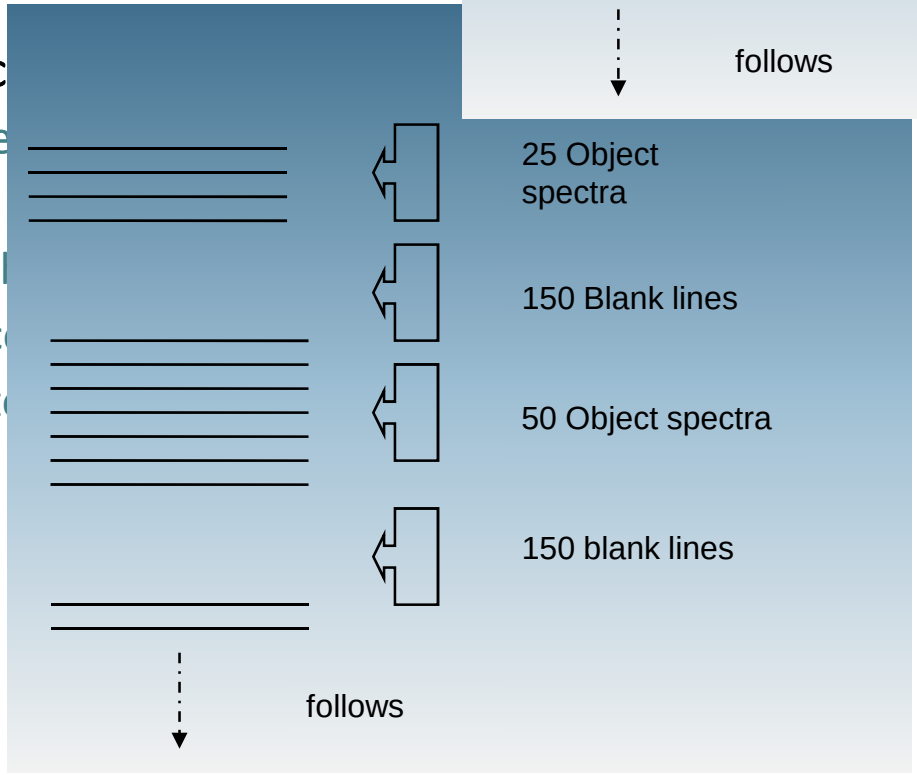
# SIFS

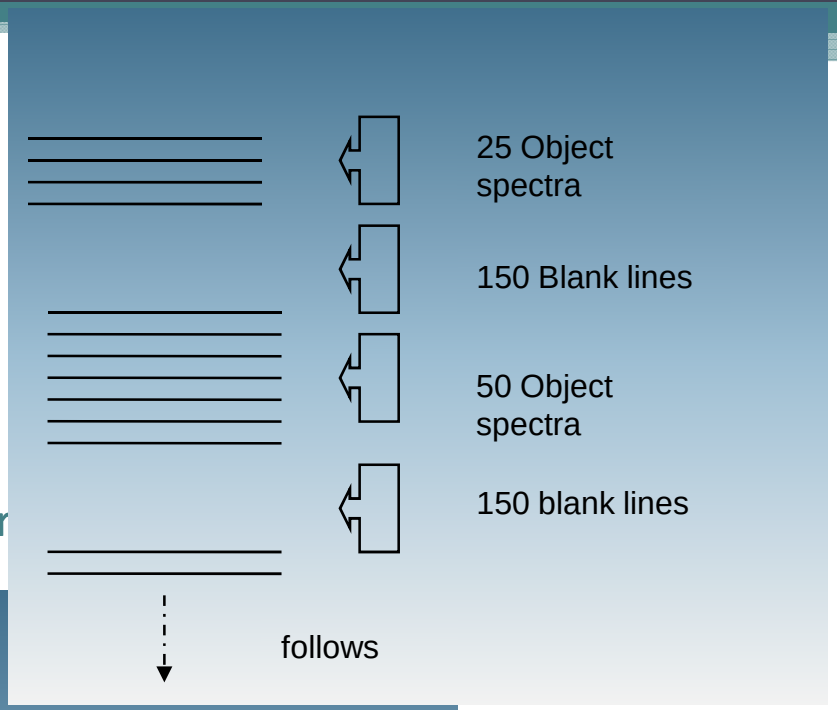




# SIFS nod & shuffle

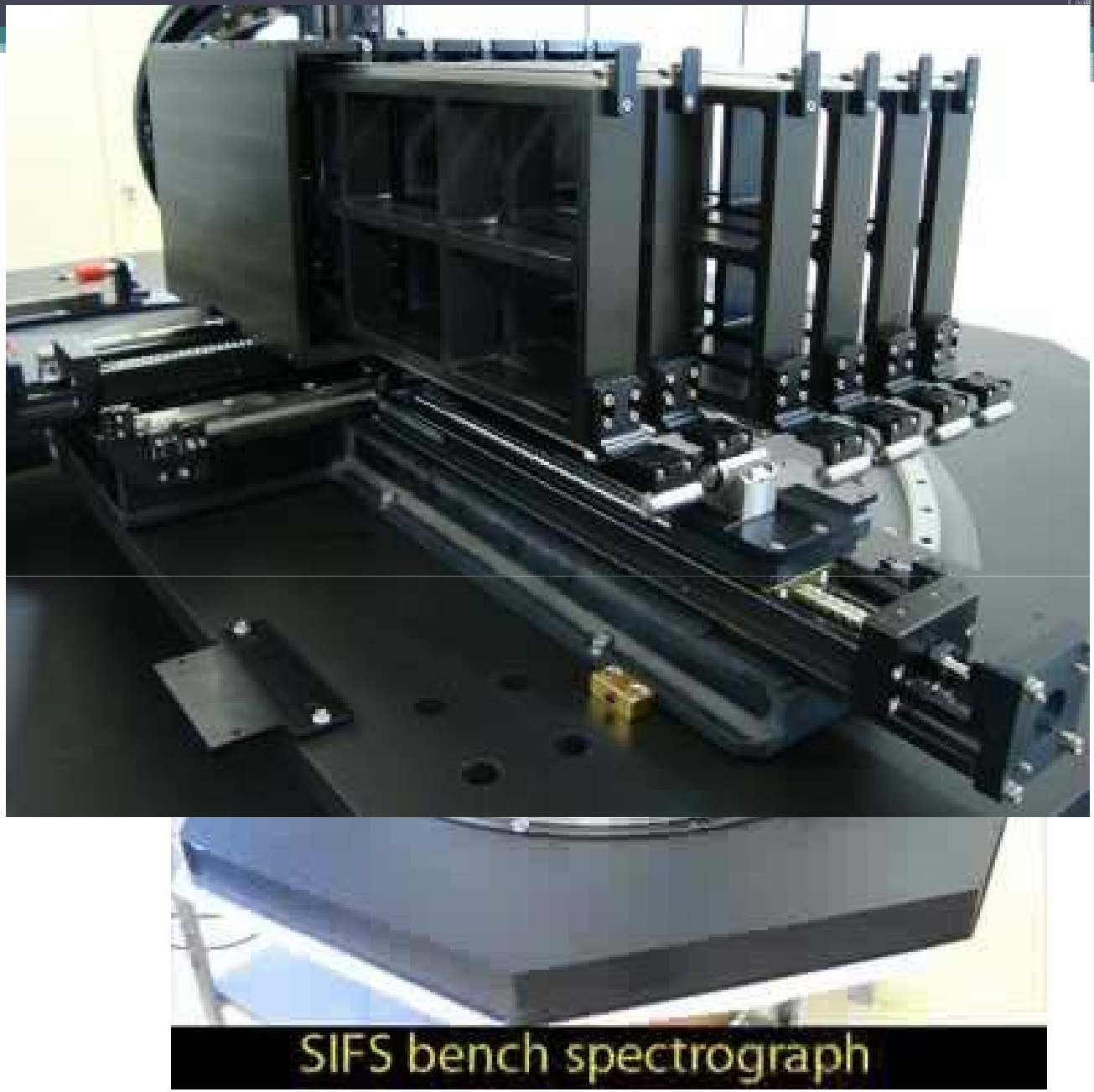
- Electronic nod & shuffle
  - Upgrade to be implemented in the futur
- Foreoptics mask c
  - Object is recorde
  - That give us:
  - Then we move cl
  - Point now telesc
  - Return charges t
  - Repeat...



# Gratings

- VPHs
  - (1) = 700
  - (2) = 1500
  - (3) = 2200
  - (4) = 2600
  - (5) = 3000
  - (6) = clear

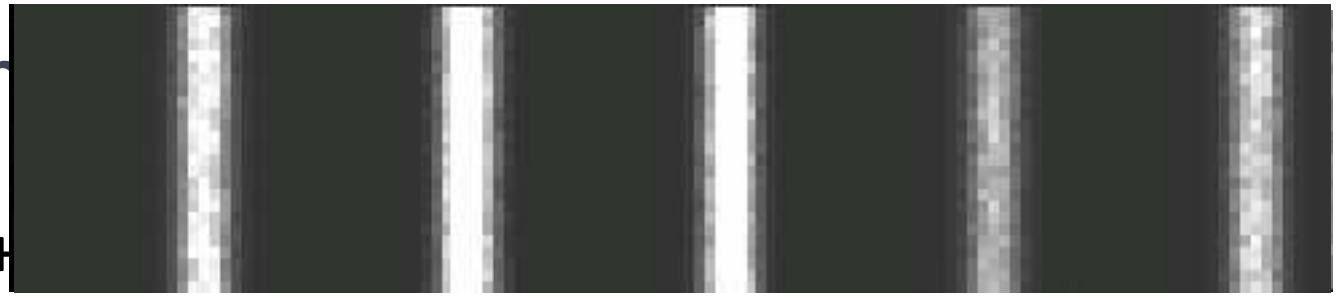


# SIFS Phase I & II tools

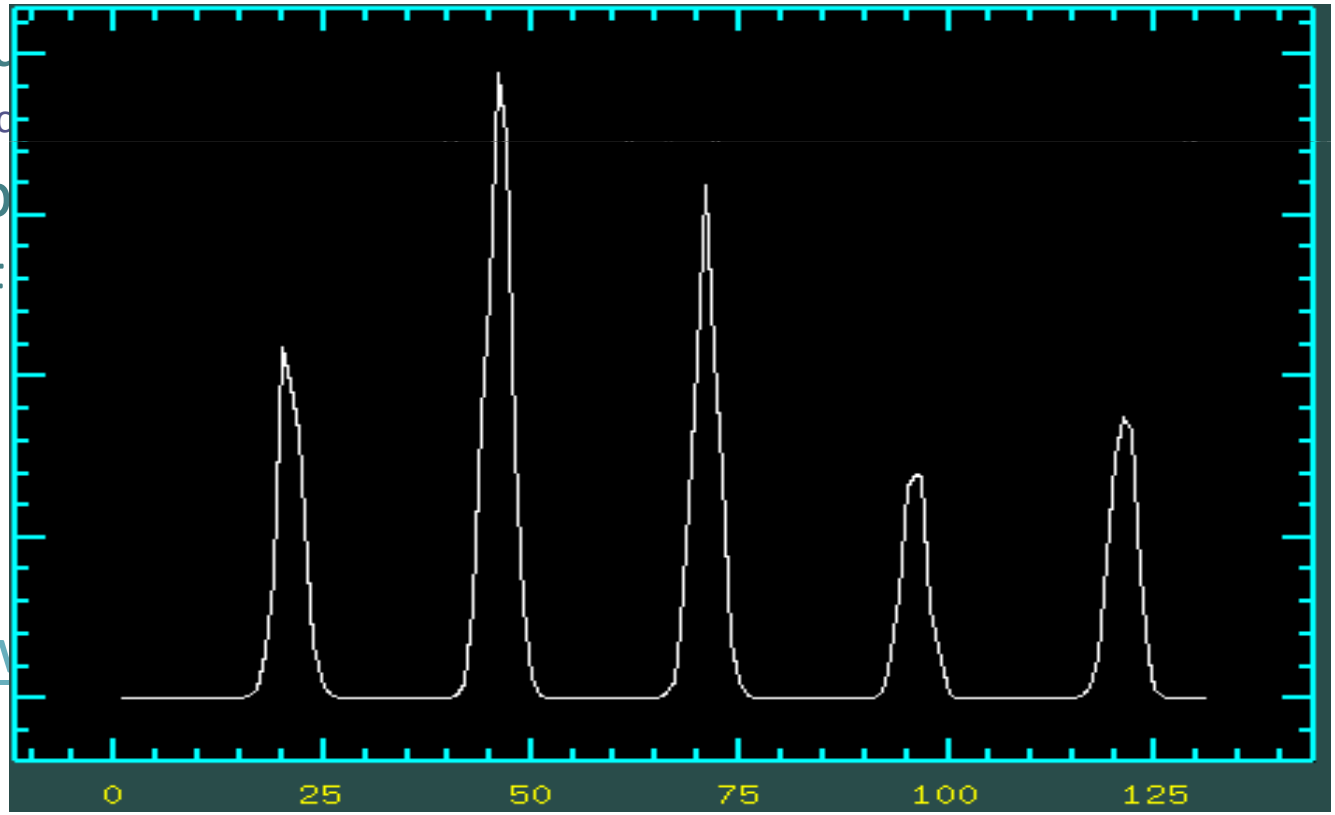
- Exposure Time Calculator
  - Not implemented – need commissioning data
- Image simulator
  - Simulate necessary files for test data reduction
    - Can be used to simulate results at observation planning
- Gratings software
  - Central Wavelength + Resolution

    ➔ Grating number + grating angle

# Image sir



- Python 2 +
  - Open sou
    - (Linux, Unic
  - Fiber sep
  - Object, F
  - http://w

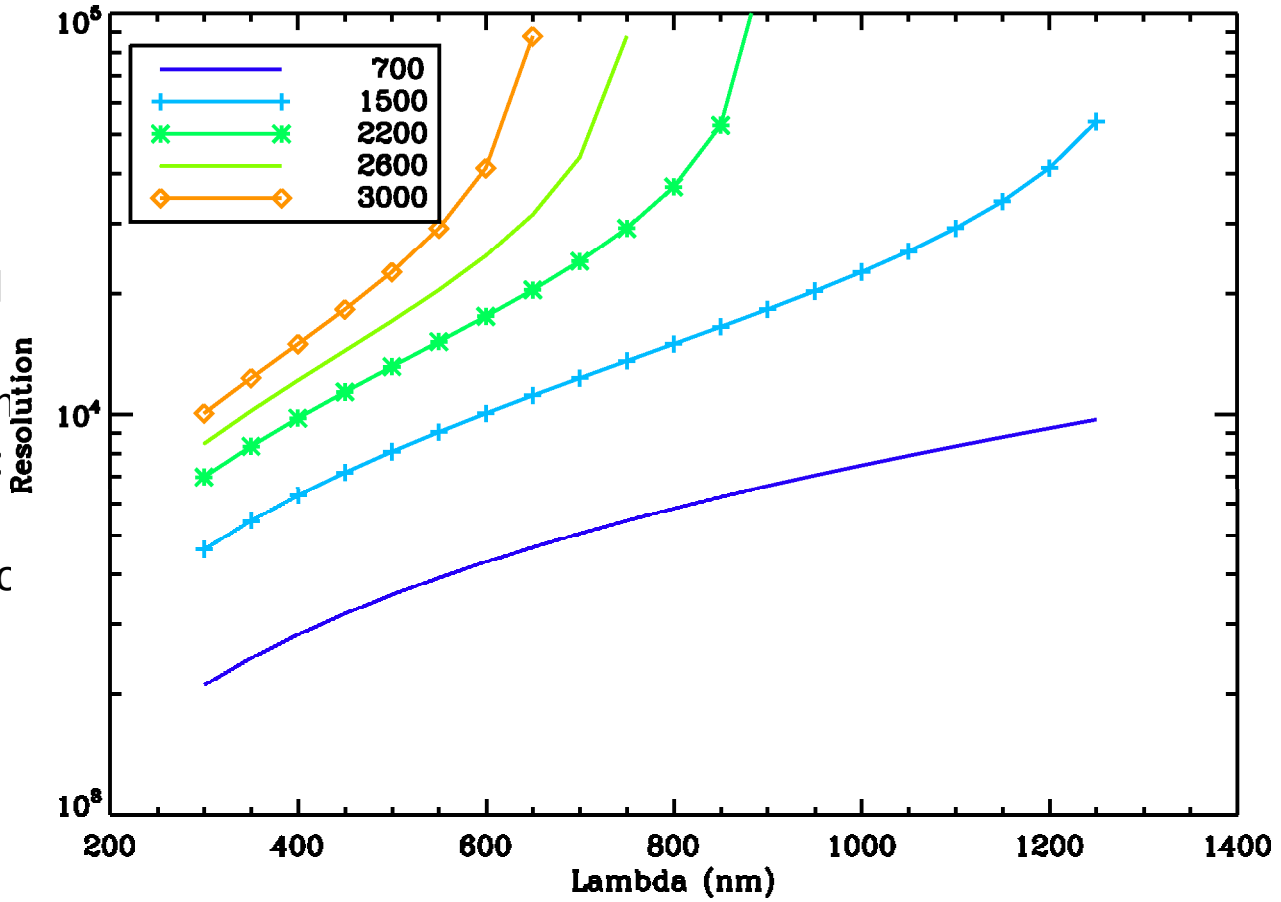


# SIFS Phase

Please enter the desired

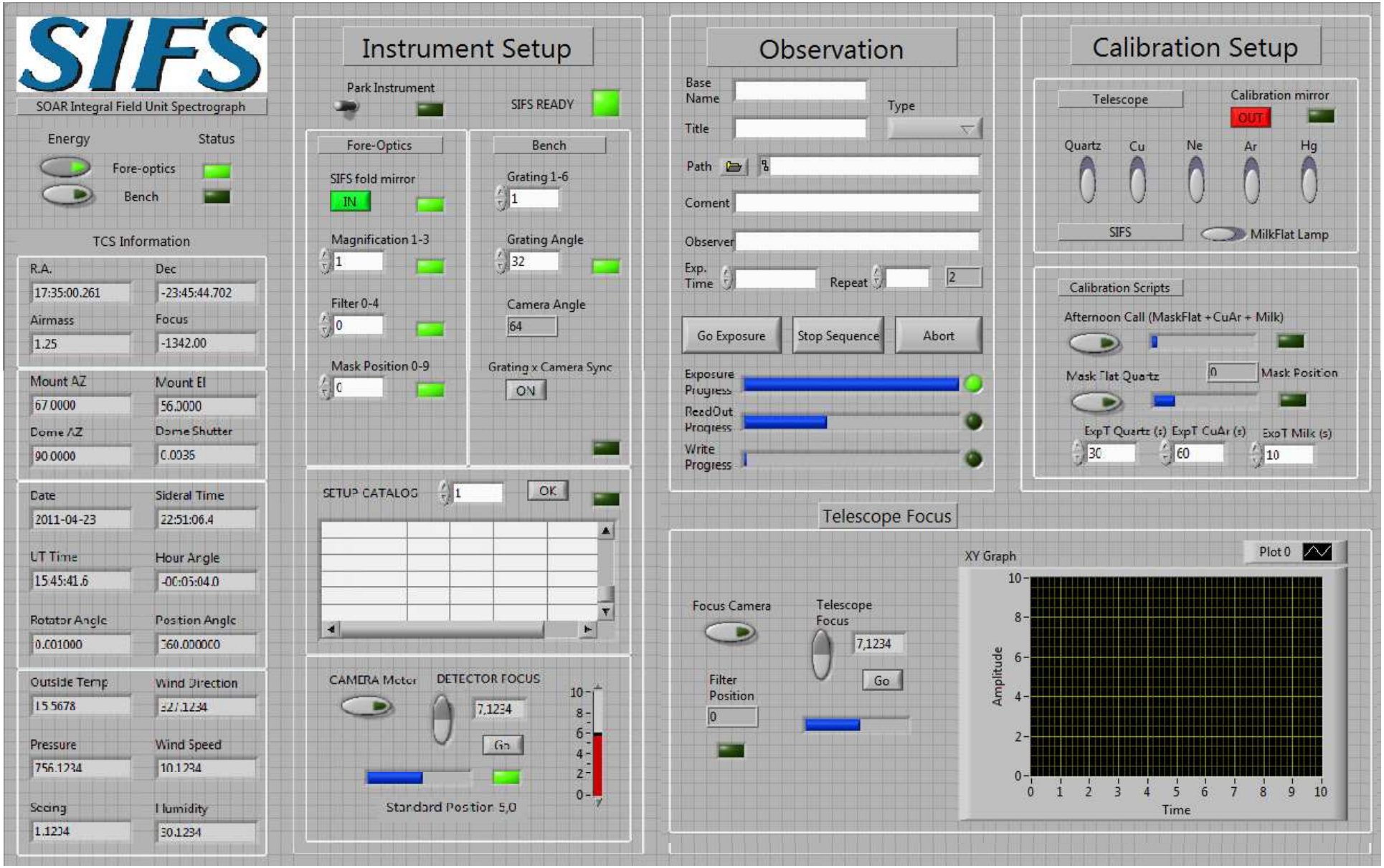
'Chosen Central Wavelen
'Chosen Resolution :

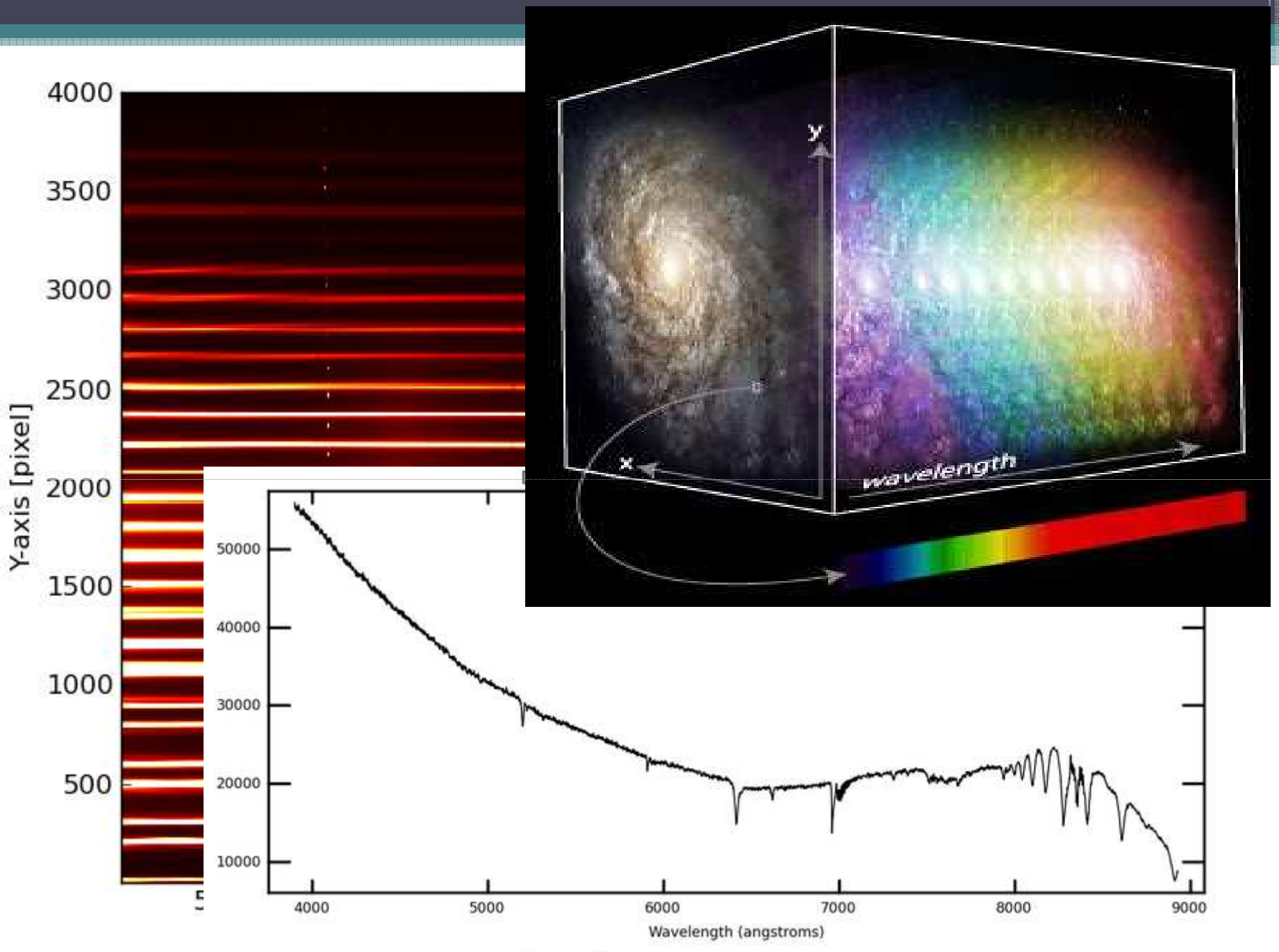
'Possible configuration fc
'------------------------'
'| Grating line density
'| Grating angle
'| Resolution (dif. limit)
'| Resolution (1 fiber)
'| Resolution (1 pixel) |
'| Dispersion (A/mm) |
'| Dispersion (A/pix) |
'| Spectral coverage (A) |



# SIFS GUI

- Labview
  - Following SOAR guidelines
  - TCS data for visualization
  - Instrument setup
  - Calibration
  - Centering / Focus
  - Observing


SIFS
SOAR Integral Field Unit Spectrograph
Energy
Status
Fore-optics
Bench
TCS Information
R.A.
Dec
17:35:00.261
-23:45:44.702
Airmass
Focus
1.25
-1342.00
Mount AZ
Mount El
67.0000
56.3000
Dome AZ
Dome Shutter
90.0000
0.0035
Date
Sideral Time
2011-04-23
22:51:06.4
UT Time
Hour Angle
15:45:41.6
-00:05:04.0
Rotator Angle
Postion Angle
0.001000
360.000000
Outside Temp
Wind Direction
15.5678
327.1234
Pressure
Wind Speed
756.1234
10.1234
Seeing
Humidity
1.1234
30.1234
Instrument Setup
Park Instrument
SIFS READY
Fore-Optics
SIFS fold mirror
IN
Magnification 1-3
1
Filter 0-4
0
Mask Position 0-9
0
Bench
Grating 1-6
1
Grating Angle
32
Camera Angle
64
Grating x Camera Sync
ON
SETUP CATALOG
1
OK
CAMERA Motor
DETECTOR FOCUS
7.1234
Go
Standard Postion 5.0
Observation
Base Name
Type
Title
Path
Coment
Observer
Exp. Time
Repeat
2
Go Exposure
Stop Sequence
Abort
Exposure Progress
ReadOut Progress
Write Progress
Calibration Setup
Telescope
Calibration mirror
OUT
Quartz
Cu
Ne
Ar
Hg
SIFS
MilkFlat Lamp
Calibration Scripts
Afternoon Call (MaskFlat +CuAr + Milk)
Mask Flat Quartz
0
Mask Position
ExpT Quartz (s)
ExpT CuAr (s)
ExpT Milk (s)
30
60
10
Telescope Focus
Focus Camera
Telescope Focus
7.1234
Go
Filter Position
0
XY Graph
Plot 0
Amplitude
Time


4000
3500
3000
2500
2000
1500
1000
500
Y-axis [pixel]
y
x
wavelength
50000
40000
30000
20000
10000
4000
5000
6000
7000
8000
9000
Wavelength (angstroms)