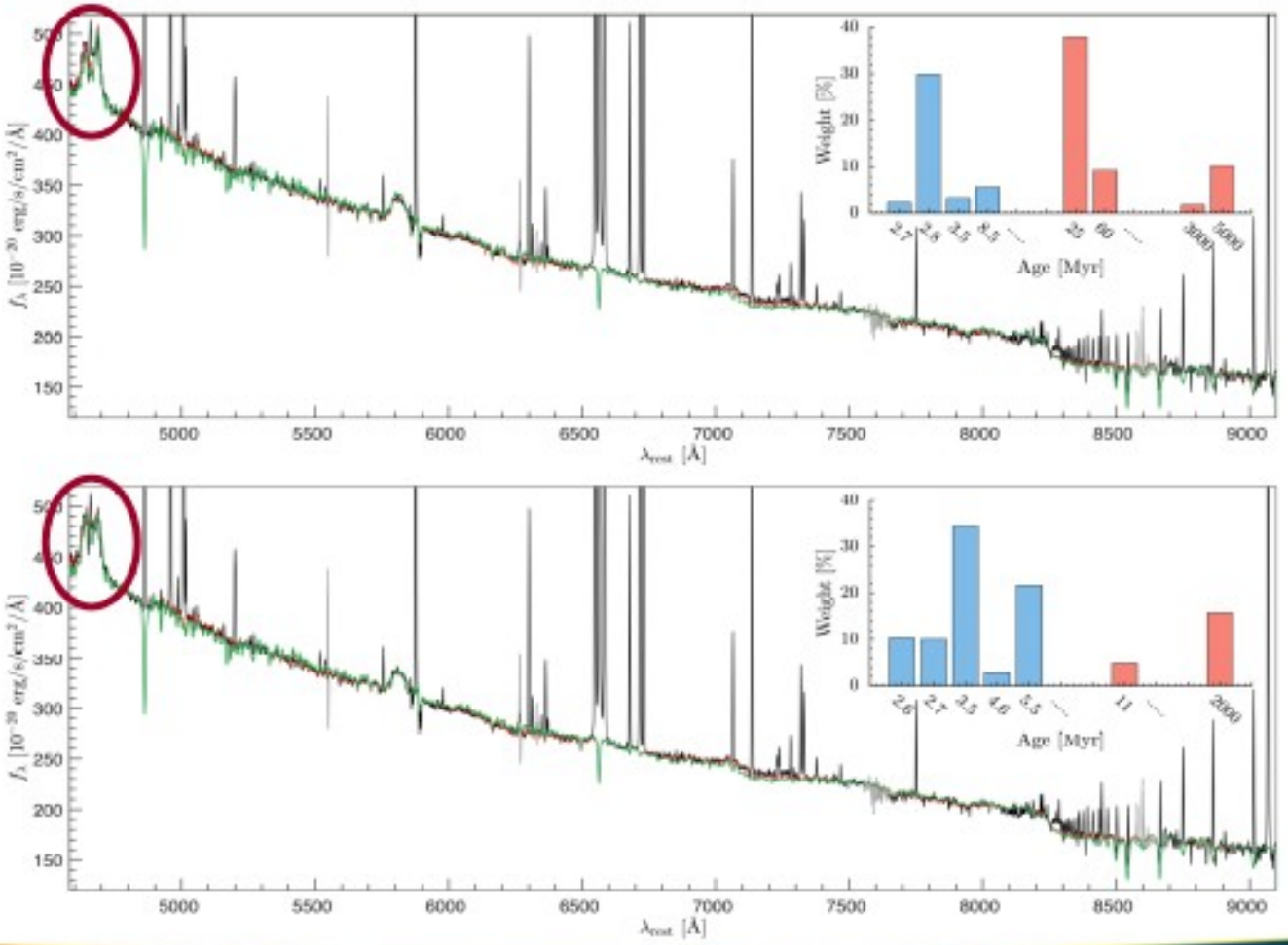
Blue wavelengths in red
Successes and Failures

Peter Weilbacher

BlueMUSE Science workshop, Nov 10, 2020

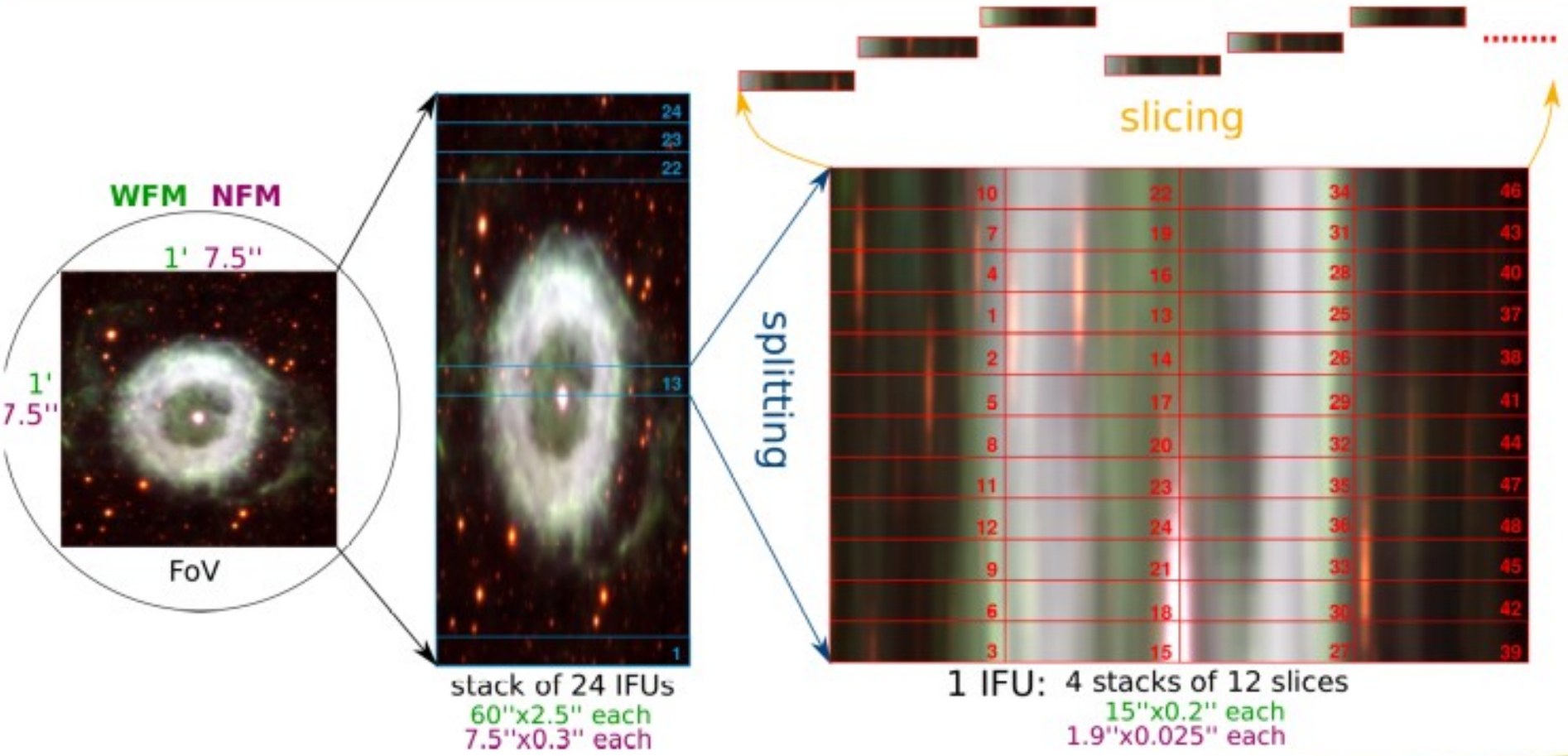
MUSE extended mode (WFM-NOAO-E)



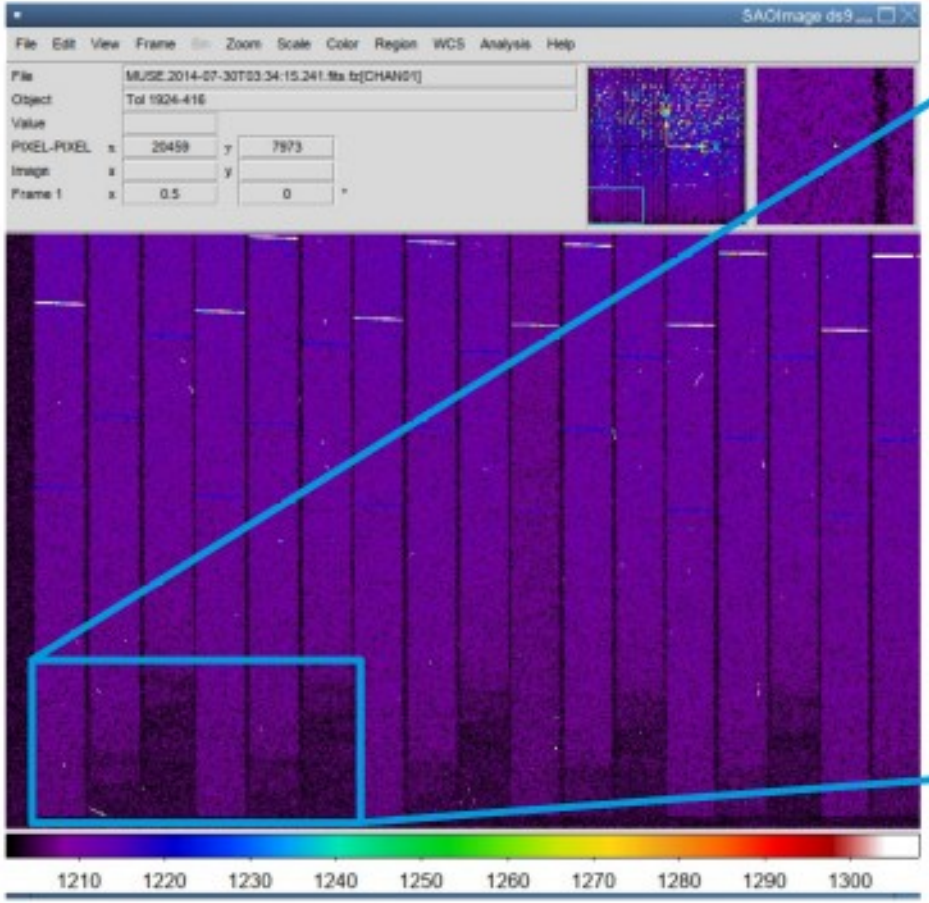
Gunawardhana et al.
2020MNRAS.497.3860G

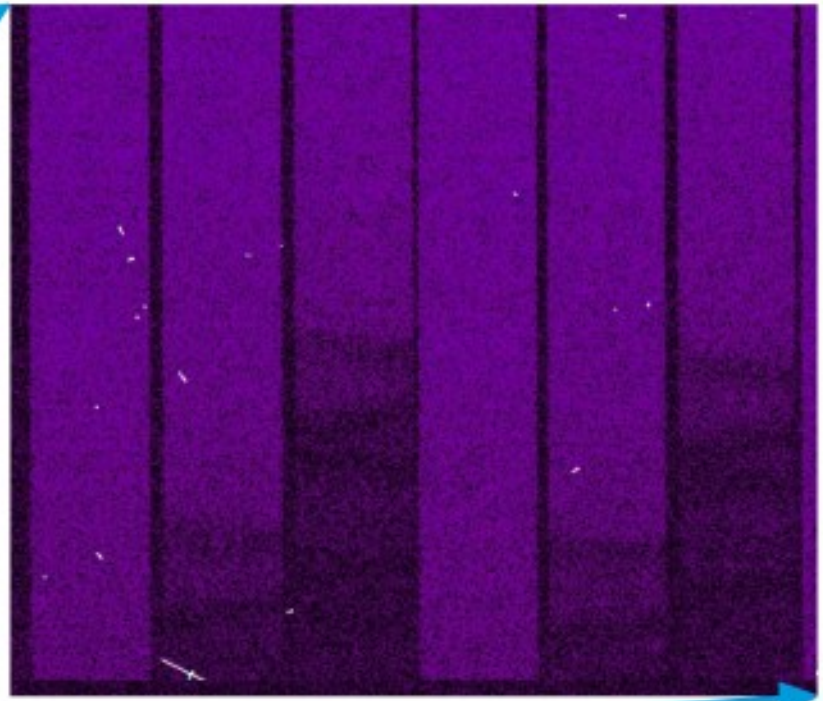
Telescope	VLT UT4 Yepun
Instrument Type	Optical Integral Field Spectrograph
Wavelength range	(4650)4800 – 9300 Å
Resolution	R ~ 1800 – 3600
Field of view	contiguous 1' x 1' (WFM)
Detectors	24 deep depletion CCDs (e2v), 4k x 4k
Sampling	0.2'' x 0.2'' x 1.25 Å (WFM)
Throughput	35% (14% at extreme wavelengths)

MUSE optical system

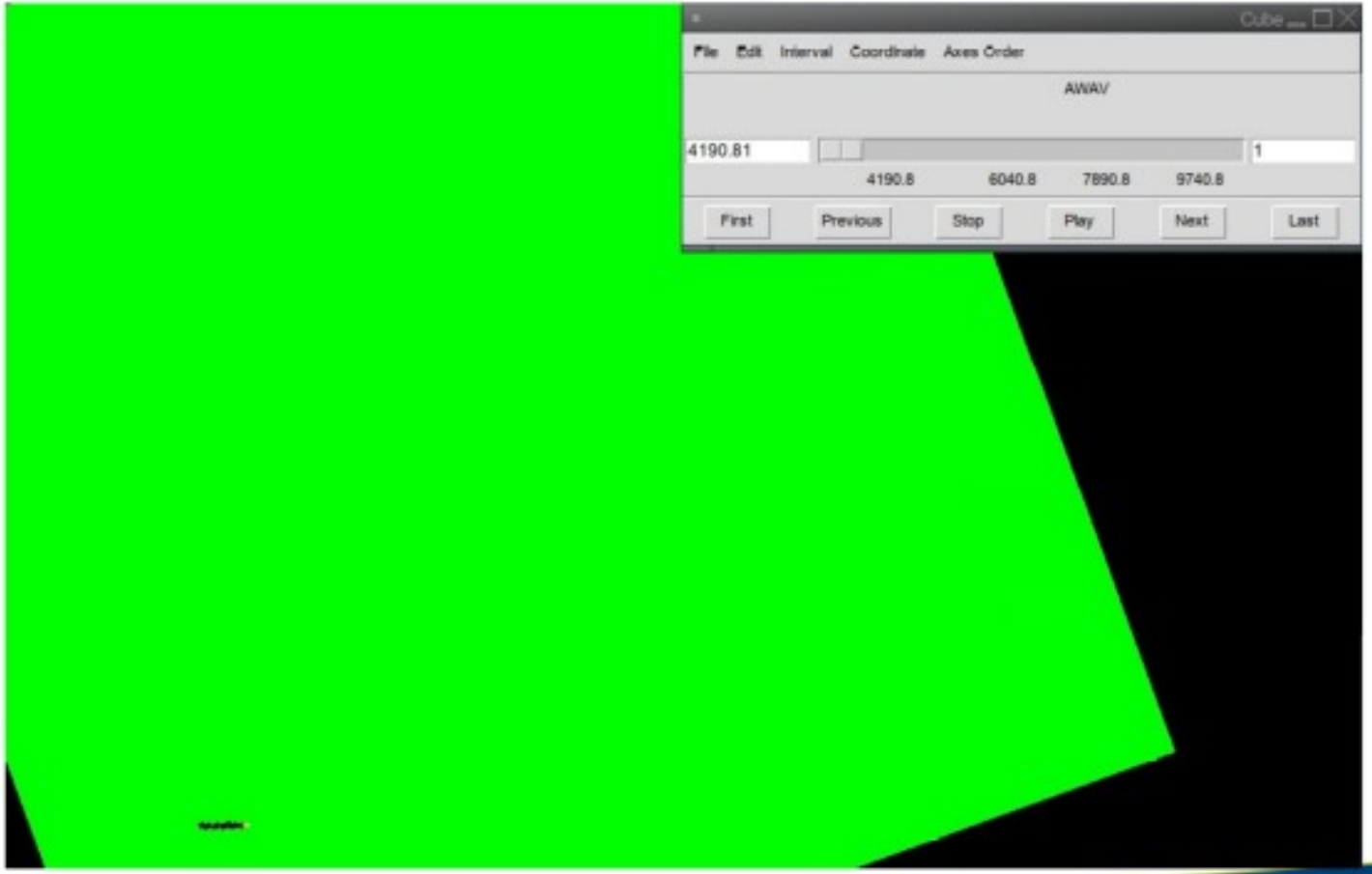


Raw data (WFM-NOAO-E)





Telescope	VLT UT4 Yepun
Instrument Type	Optical Integral Field Spectrograph
Wavelength range	**~4200 - 9740 Å for WFM-NOAO-E**
Resolution	R ~ 1800 – 3600
Field of view	contiguous 1' x 1' (WFM)
Detectors	24 deep depletion CCDs (e2v), 4k x 4k
Sampling	0.2'' x 0.2'' x 1.25 Å (WFM)
Throughput	35% (14% at extreme wavelengths)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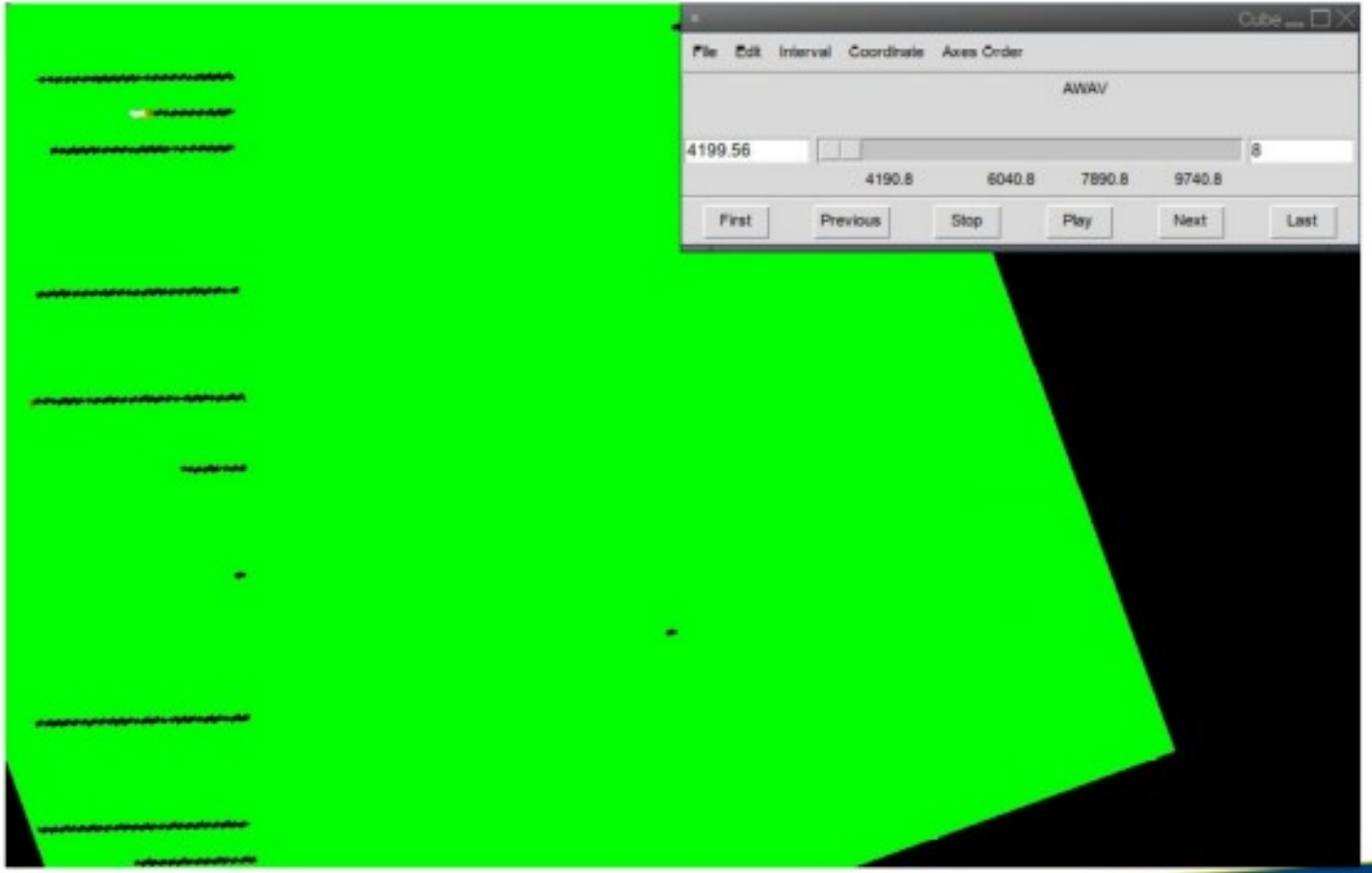
4190.8 6040.8 7890.8 9740.8
First Previous Stop Play Next Last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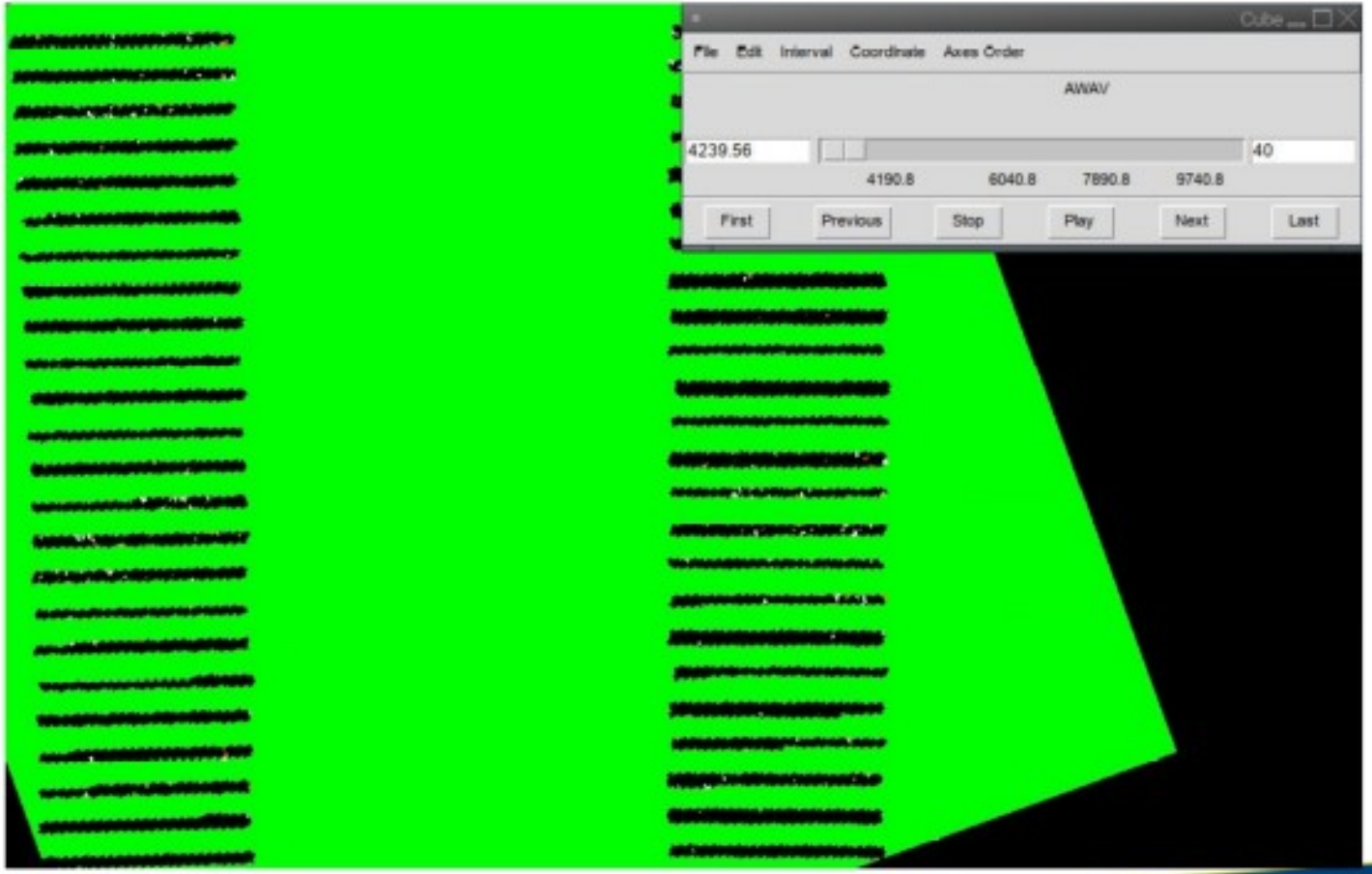
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Next
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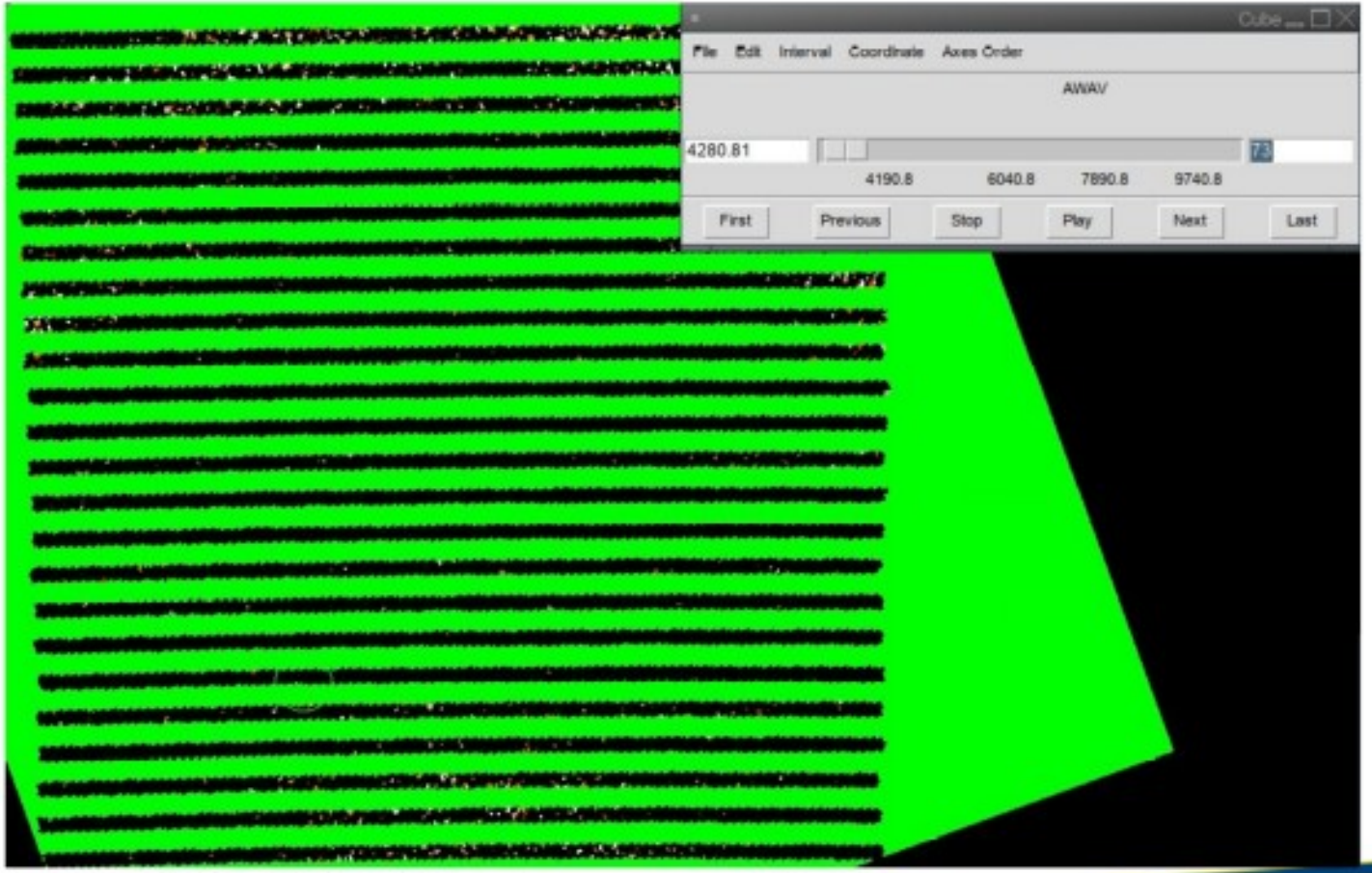
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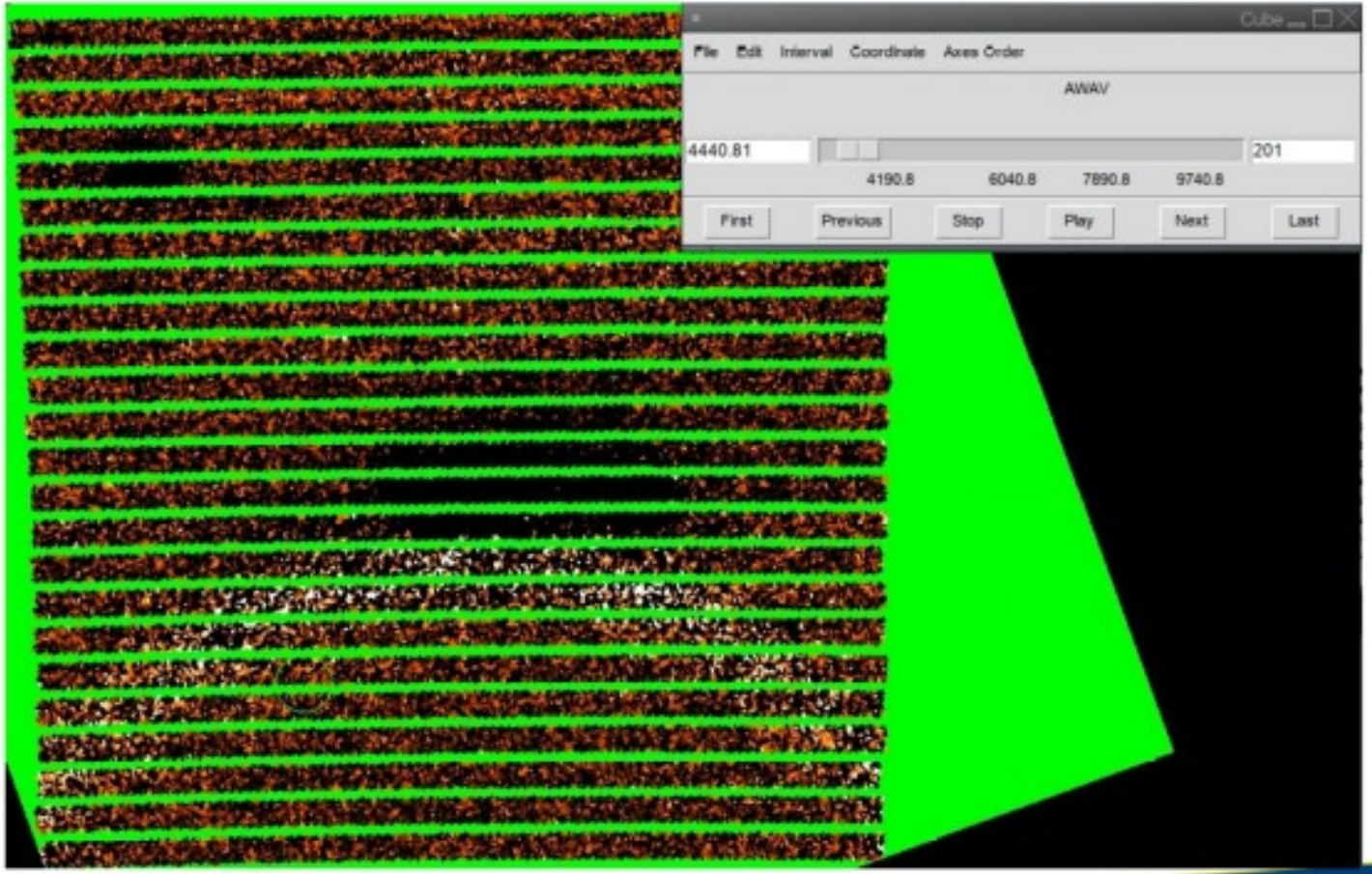
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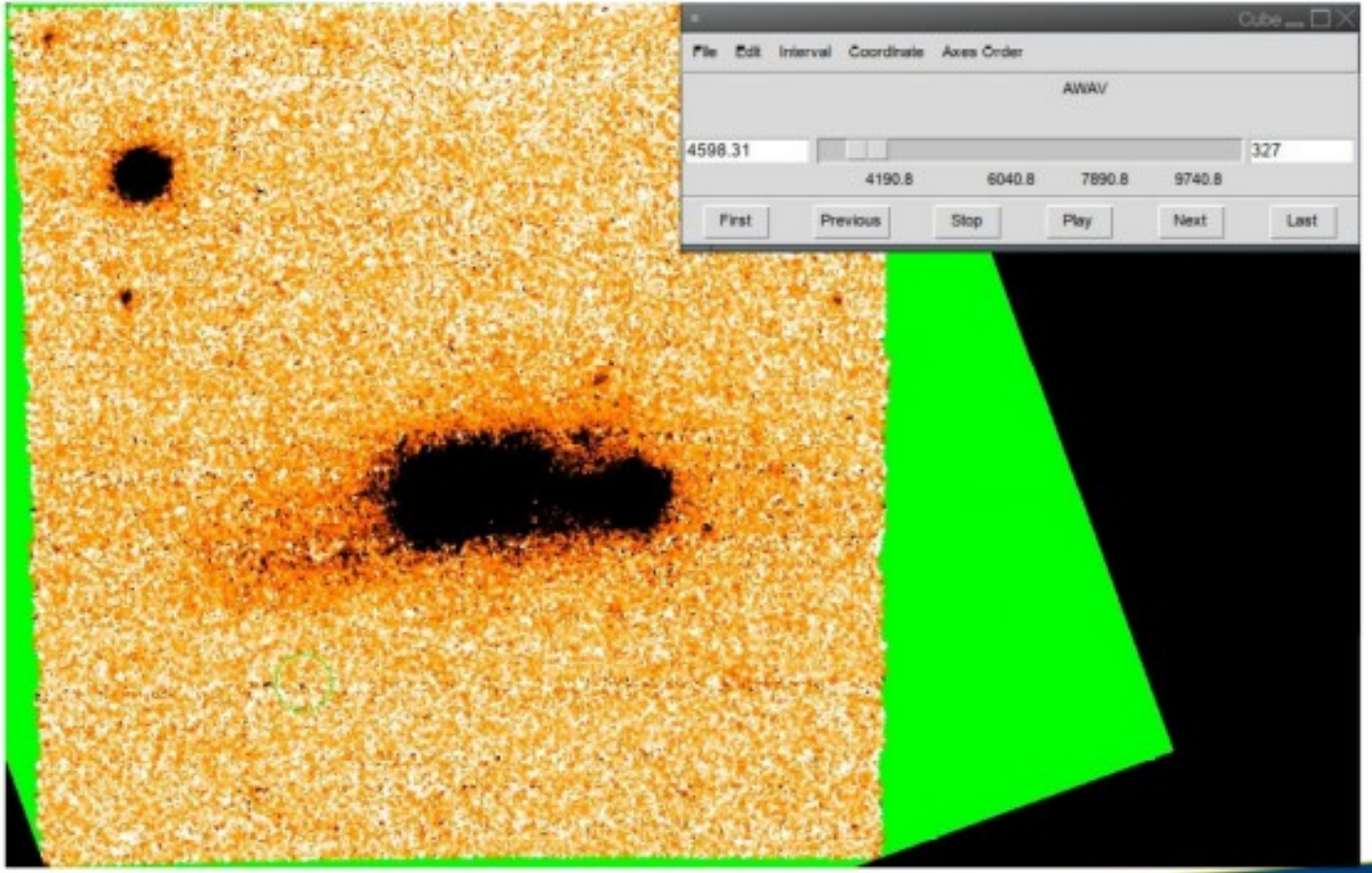
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AWAV
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4190.8
6040.8
7890.8
9740.8
First
Previous
Stop
Play
Next
Last

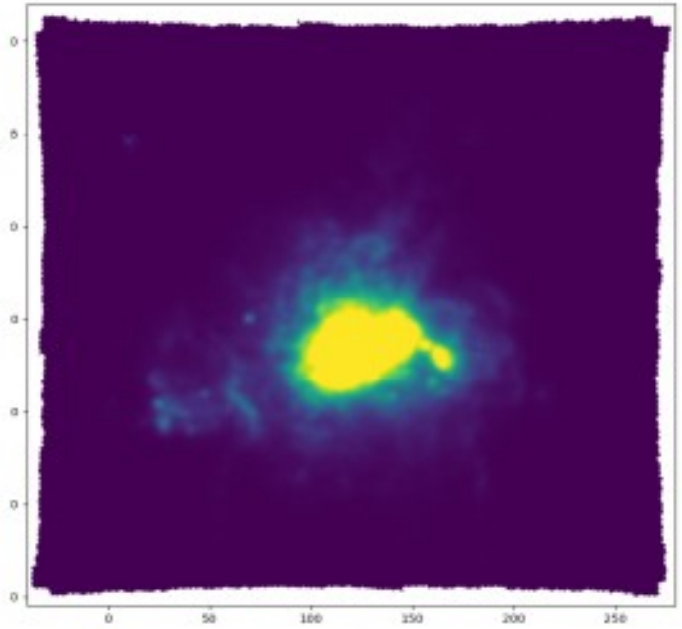
Tol 1924-416 = ESO 338-IG04

- observed in Comm2B (end of July 2014)
- WFM-NOAO-E
- 4x900s exposure time
- 4 rotations
- reduced with `--crop=false`
- standard star with spatial dithering

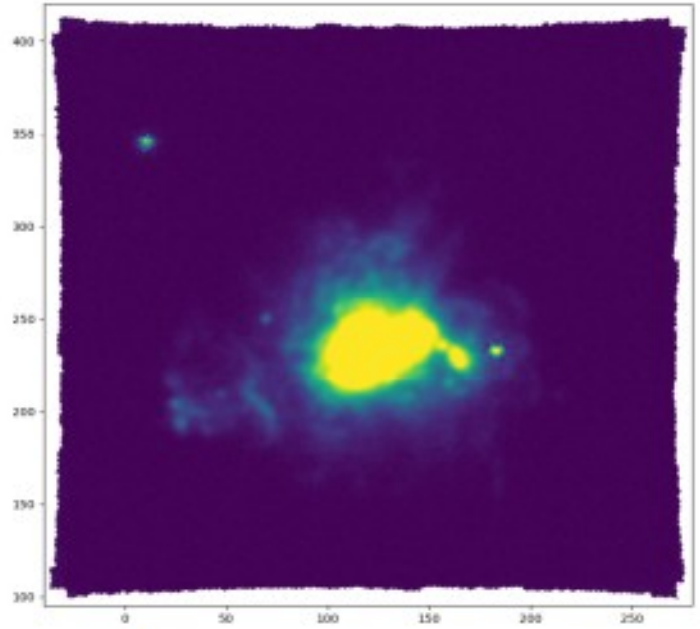
  –> testing for “super-E” mode

Is it useful?

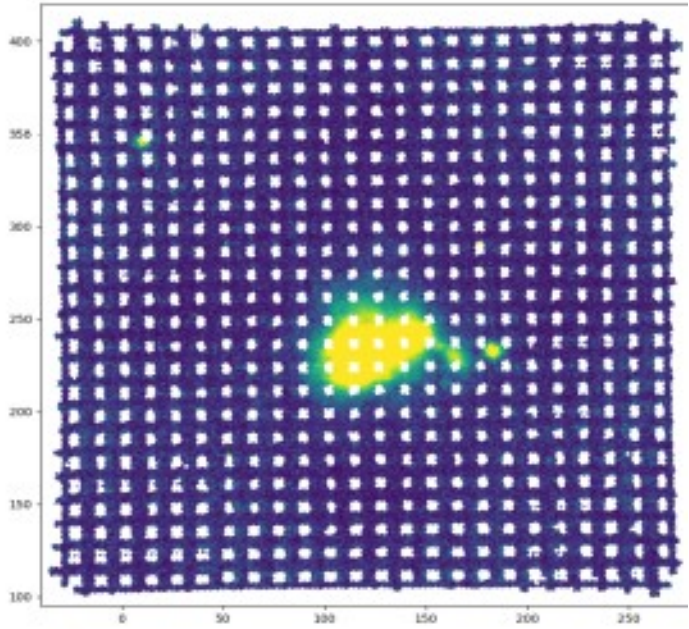
Is it useful? Fluxes (Balmer lines)



Hα

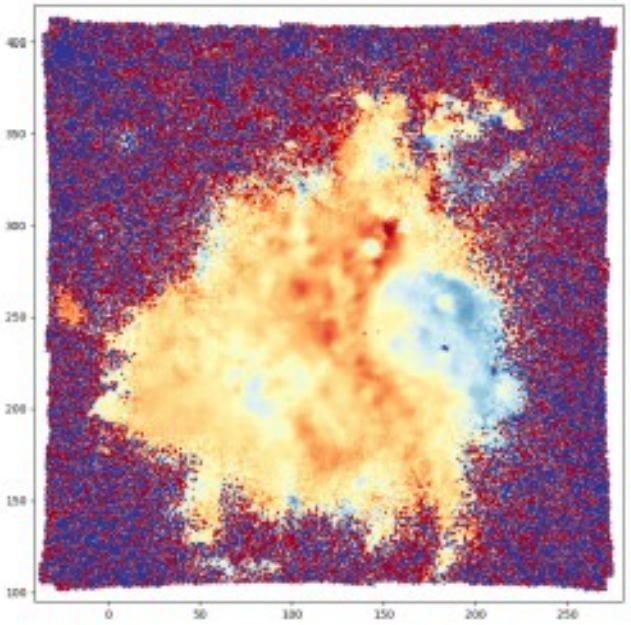


Hβ

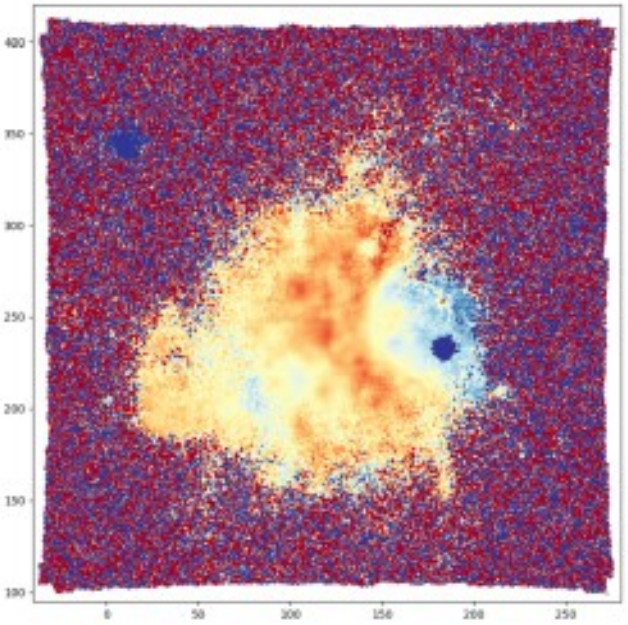


Hγ

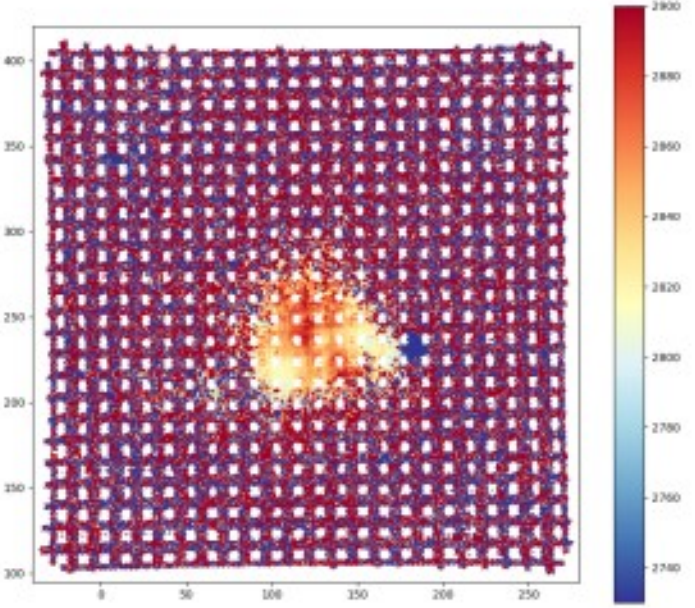
Is it useful? Velocities



Hα

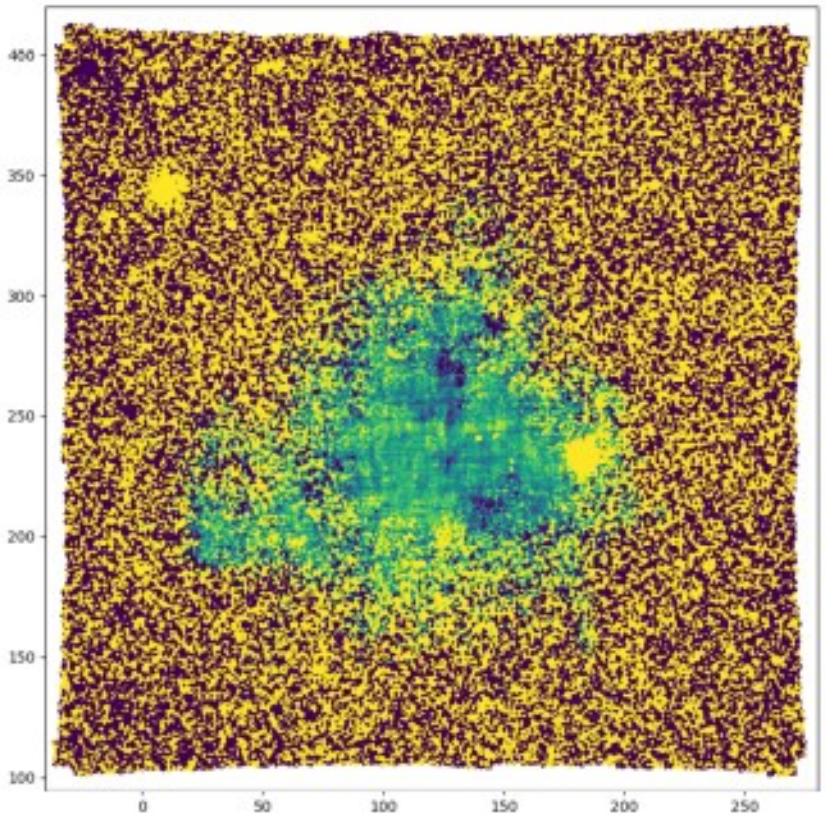


Hβ

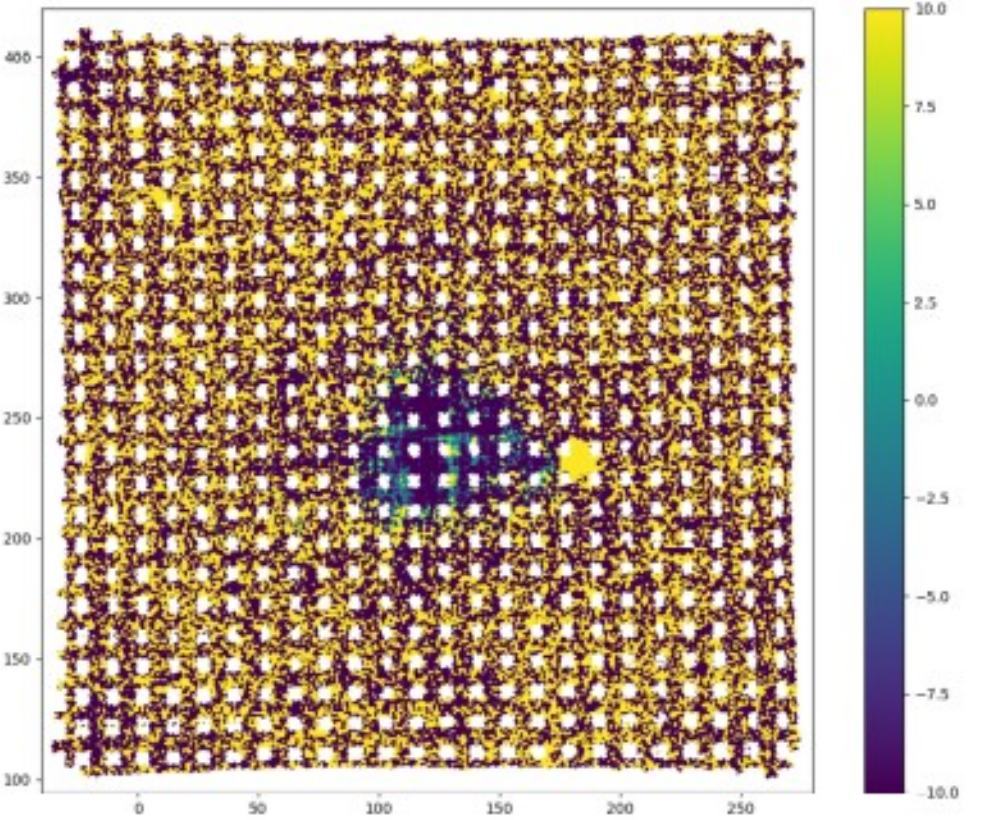


Hγ

Is it useful? Velocities

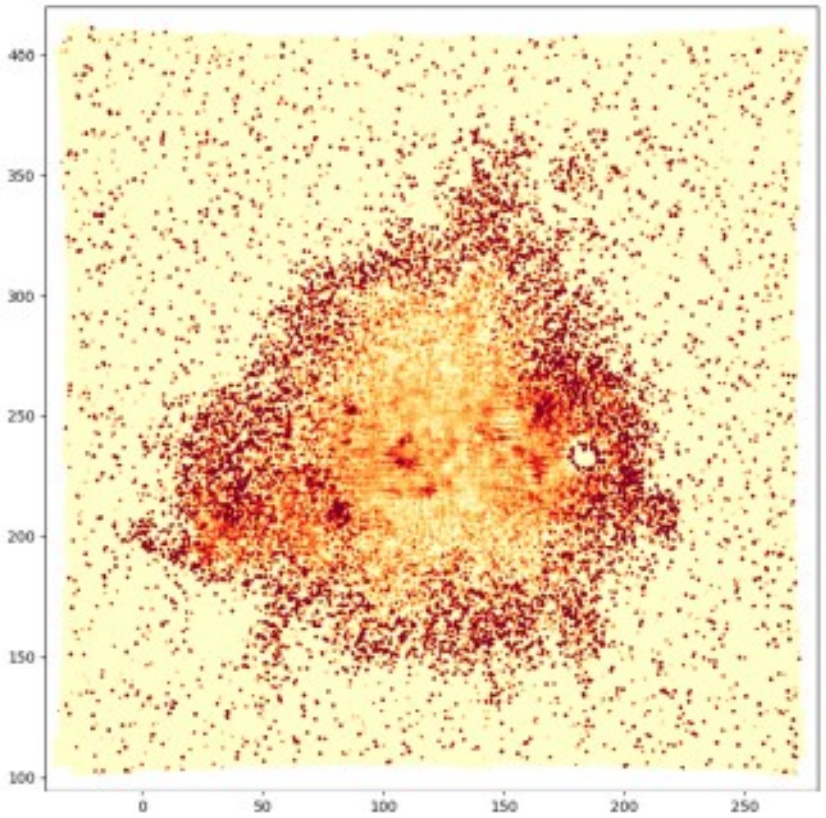


v(Hα) - v(Hβ)

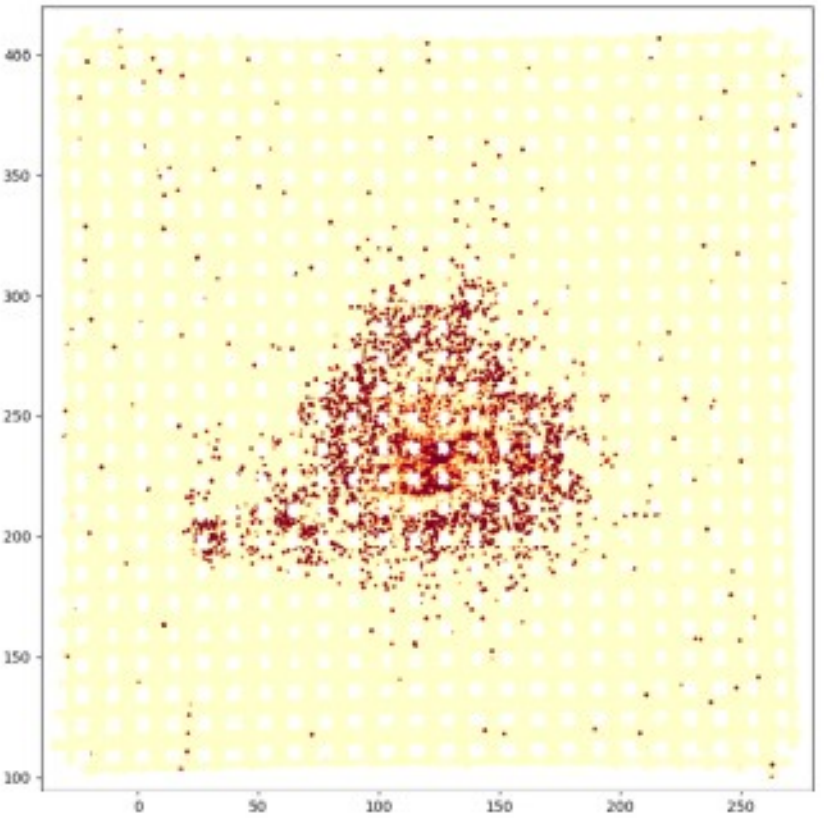


v(Hβ) - v(Hγ)

Is it useful? Extinction

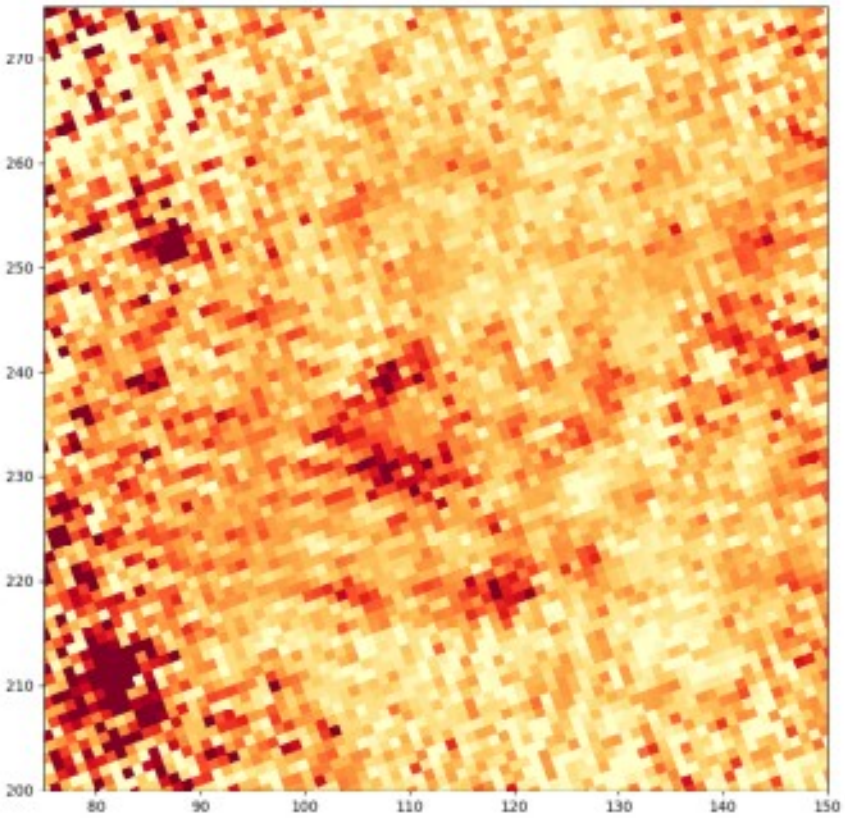


E(B-V) from Hα/Hβ

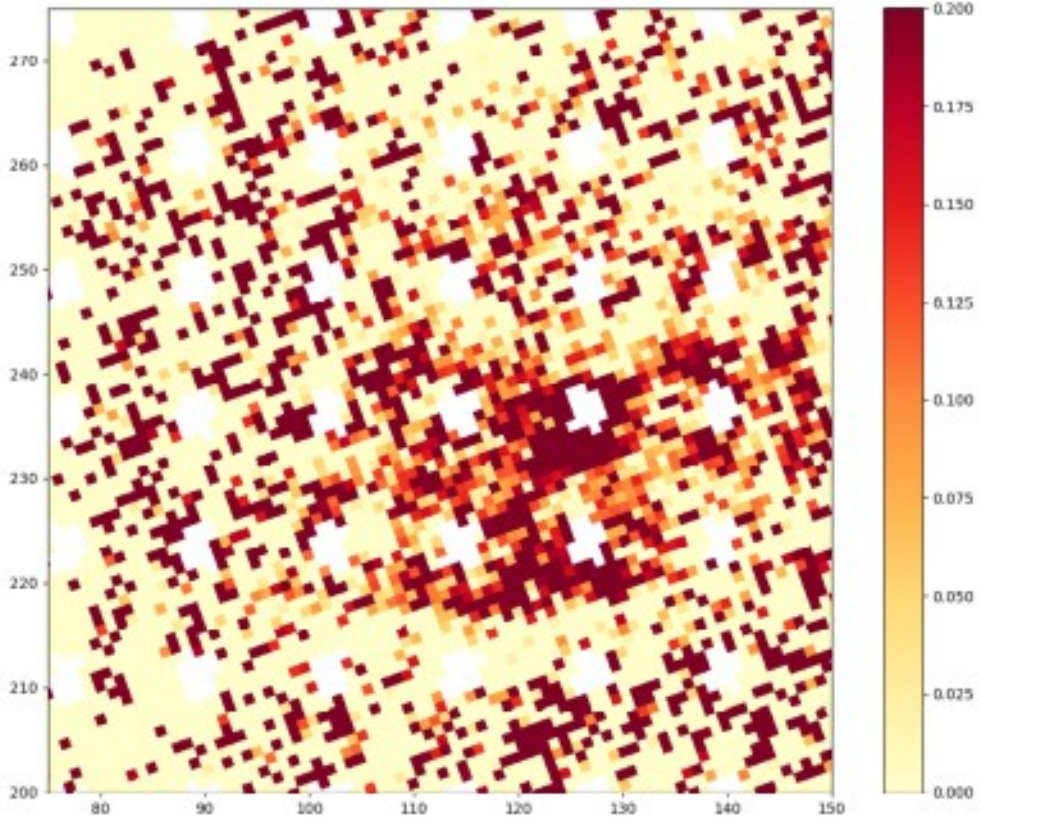


E(B-V) from Hβ/Hγ

Is it useful? Extinction

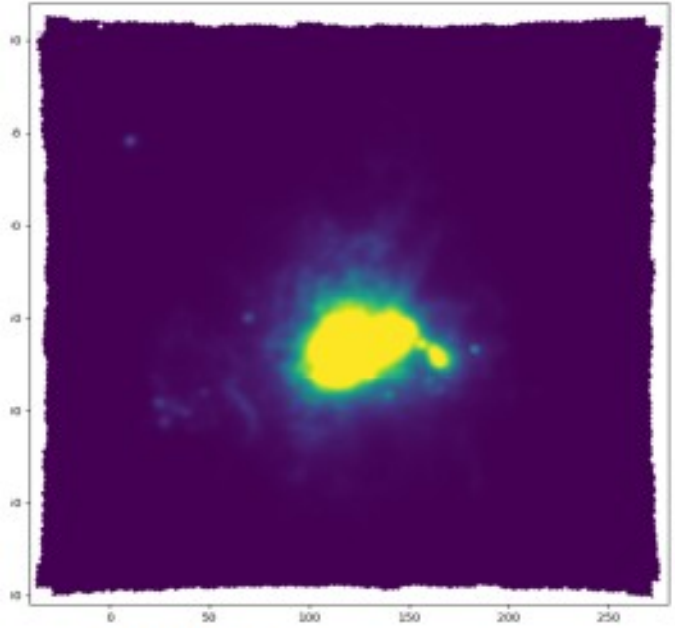


E(B-V) from Hα/Hβ

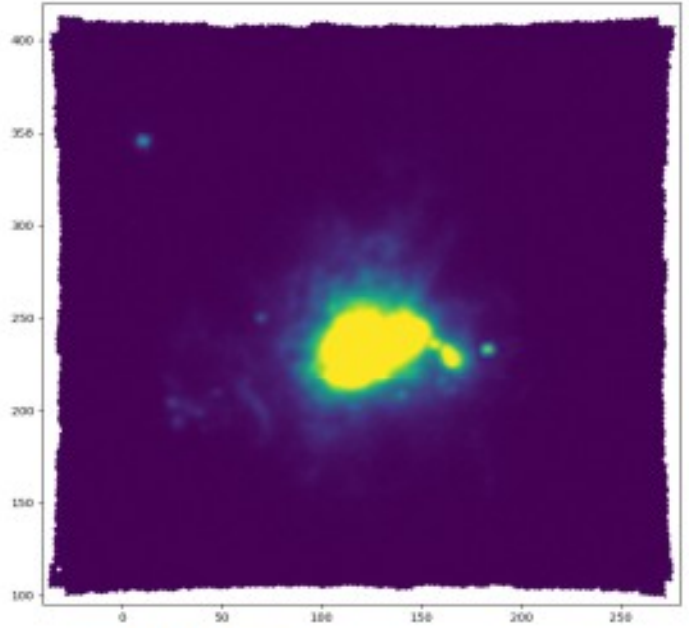


E(B-V) from Hβ/Hγ

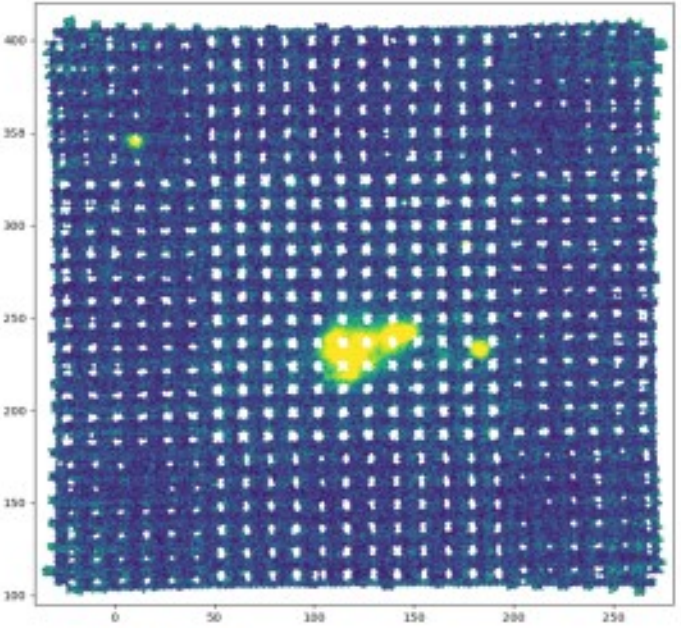
Is it useful? Fluxes ([OIII] lines)



[OIII]5007

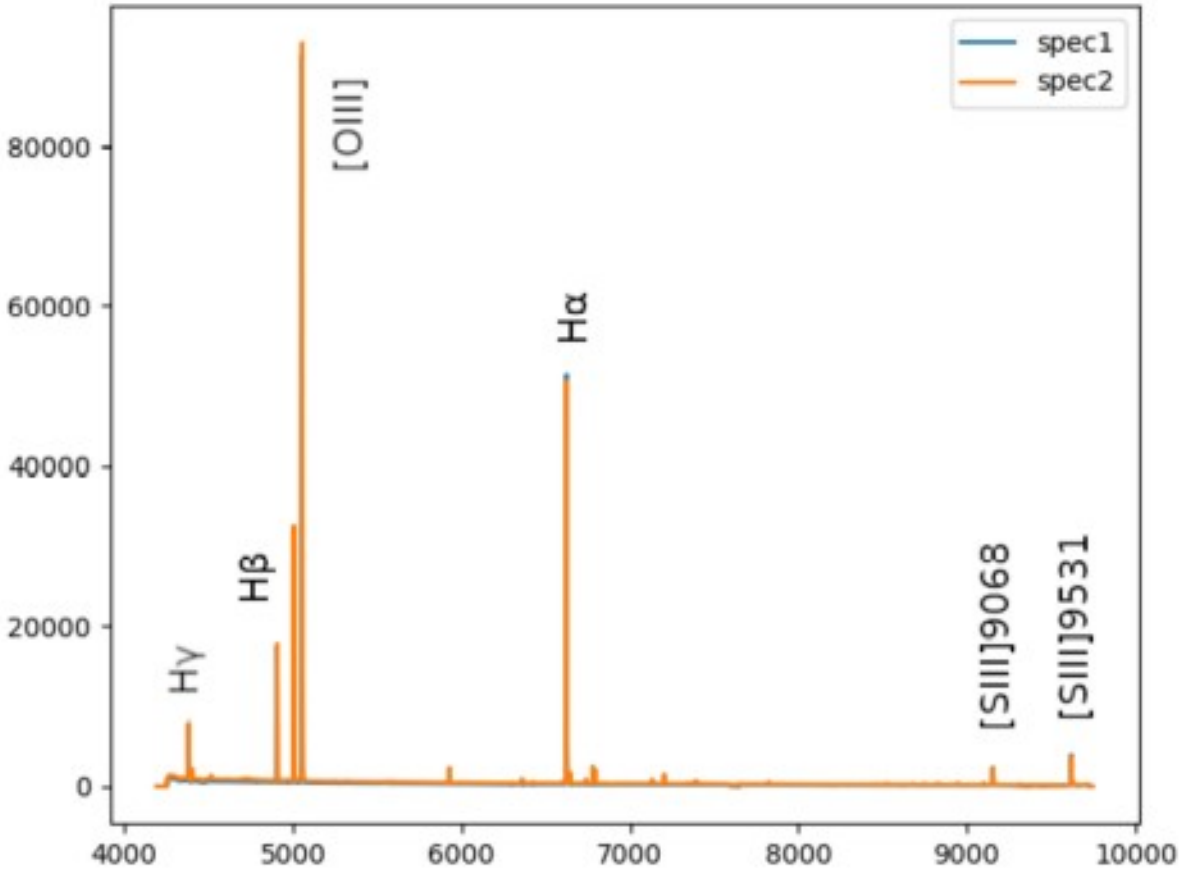


[OIII]4959

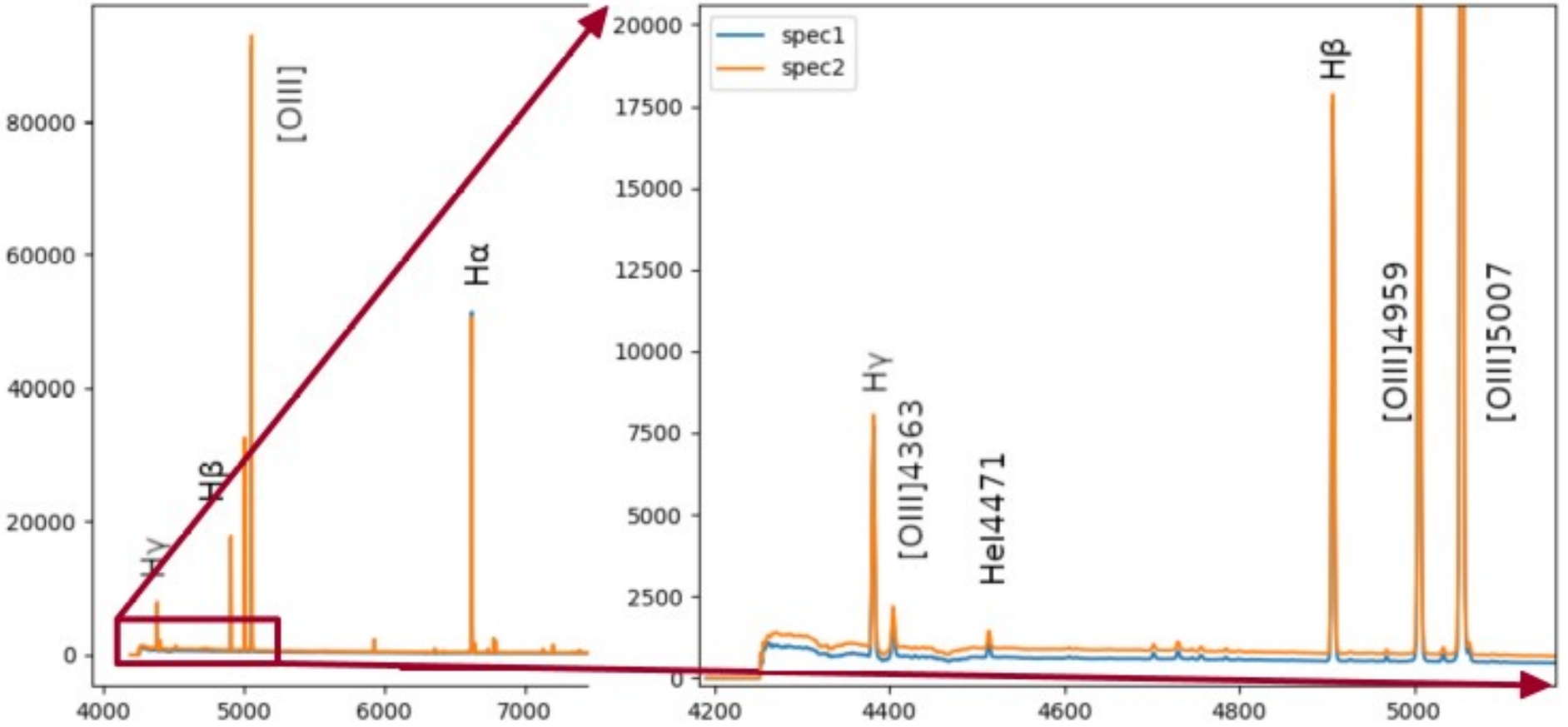


[OIII]4363

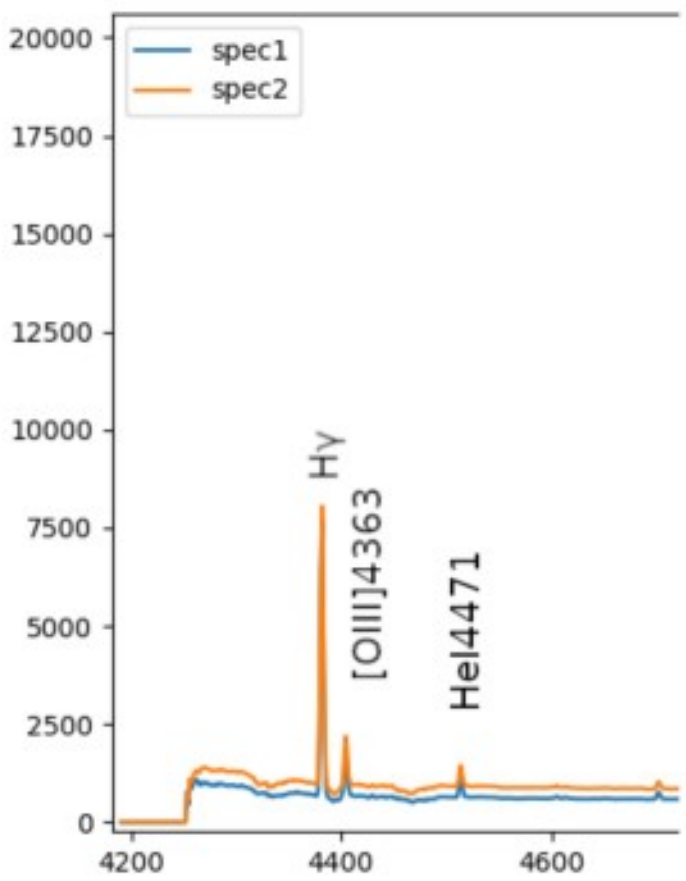
Is it useful? Spectra

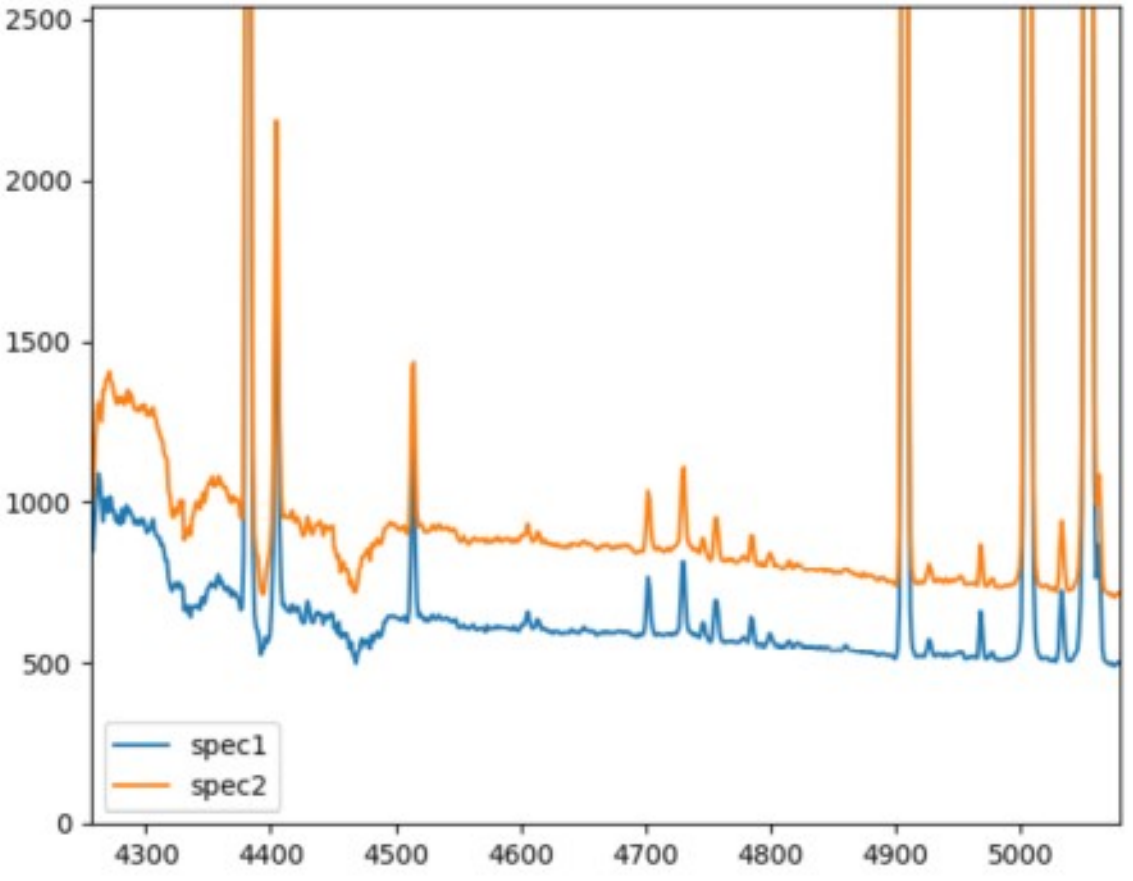


Is it useful? Spectra

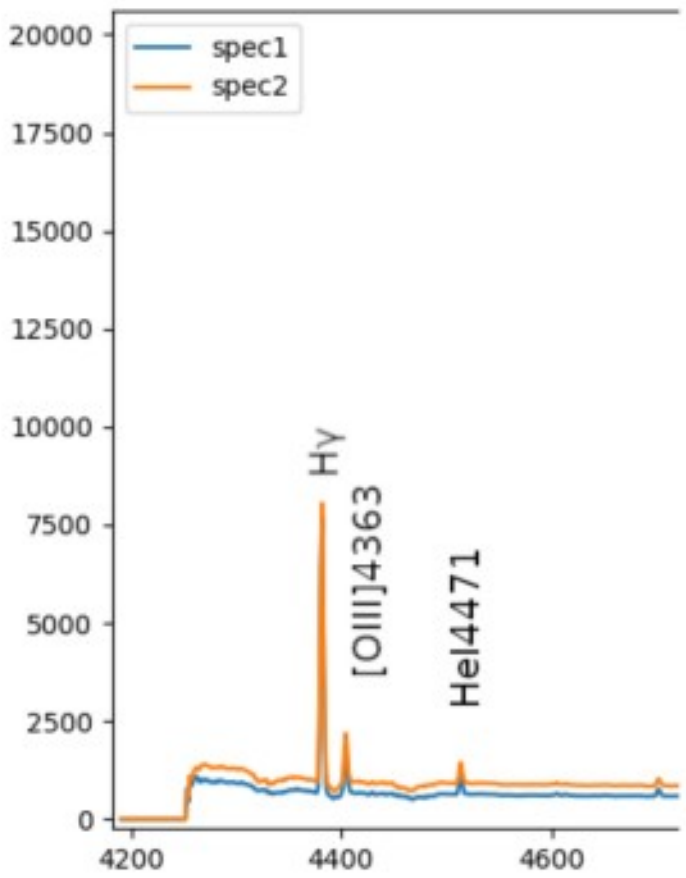


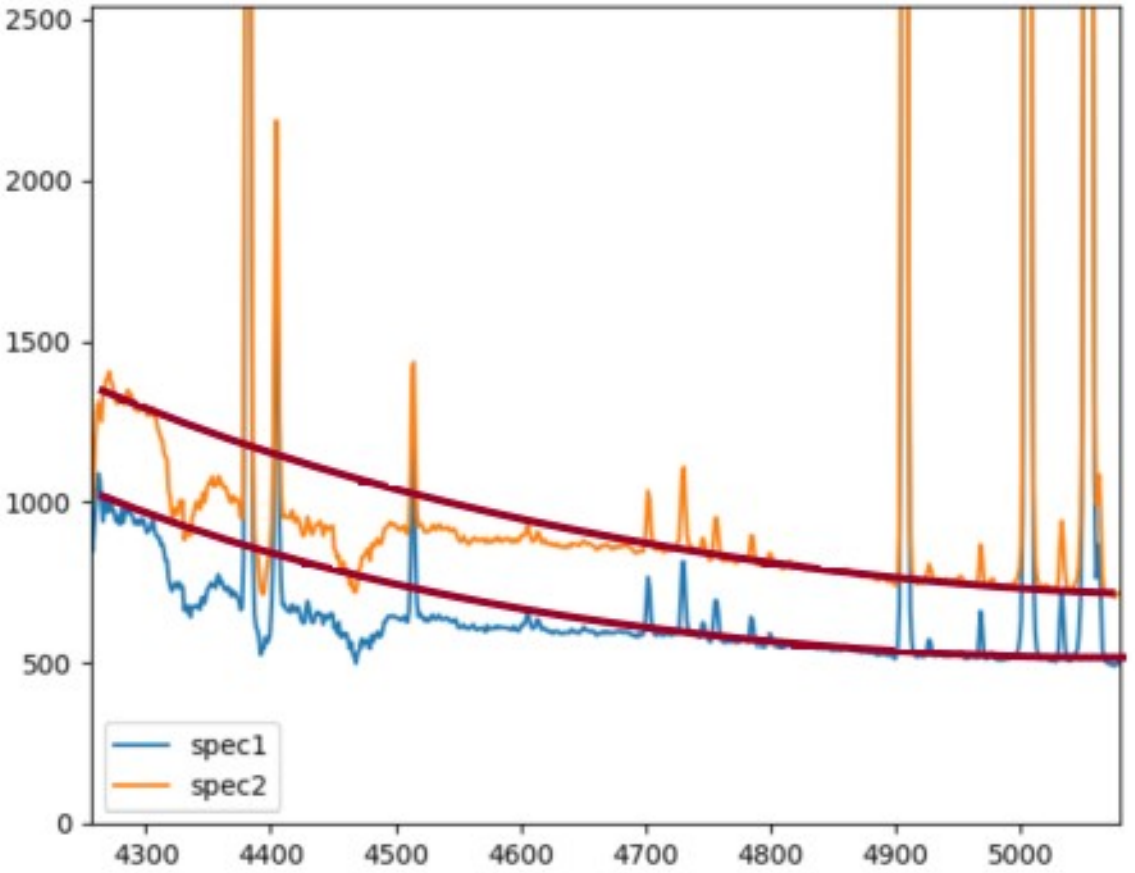
Is it useful? Spectra



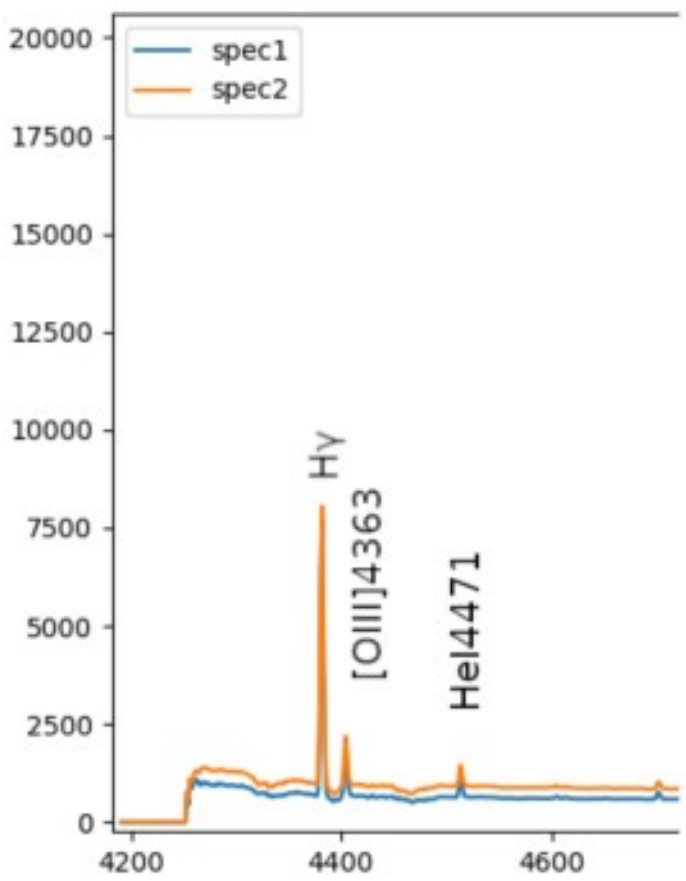


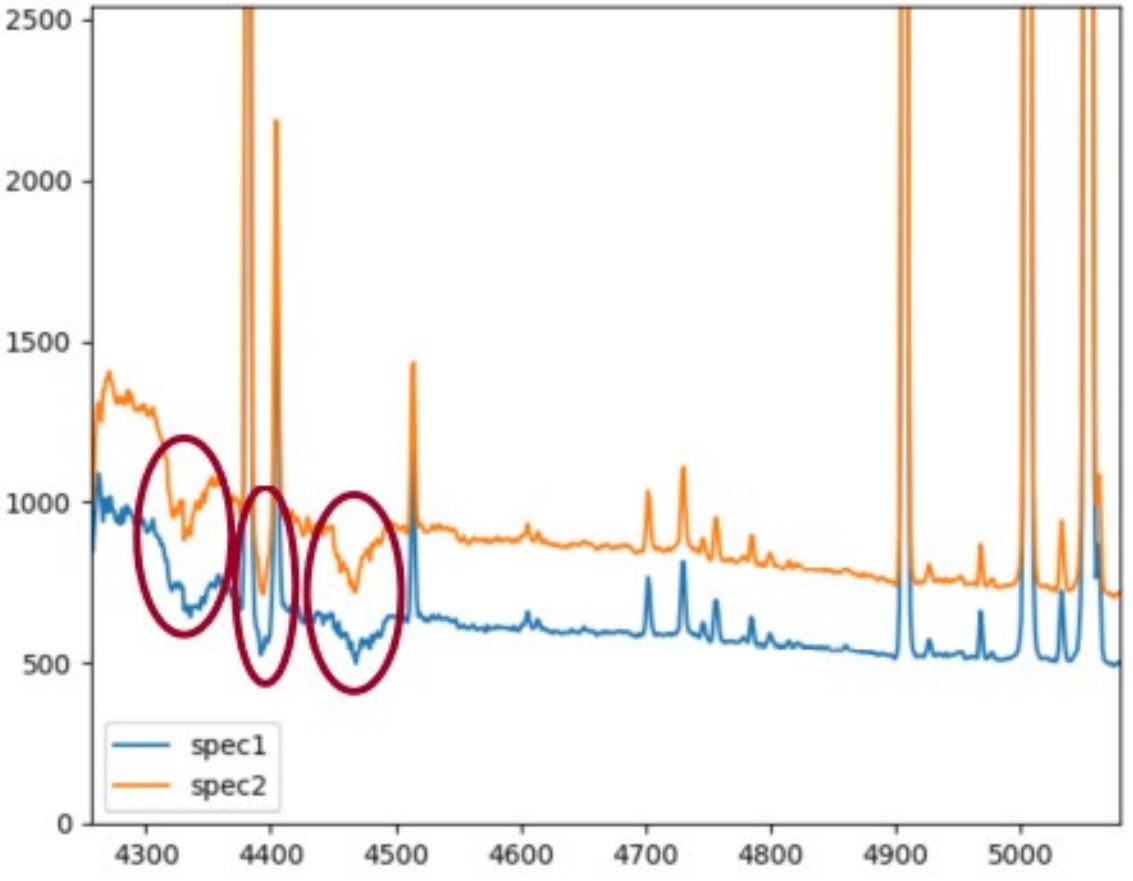
Is it useful? Spectra



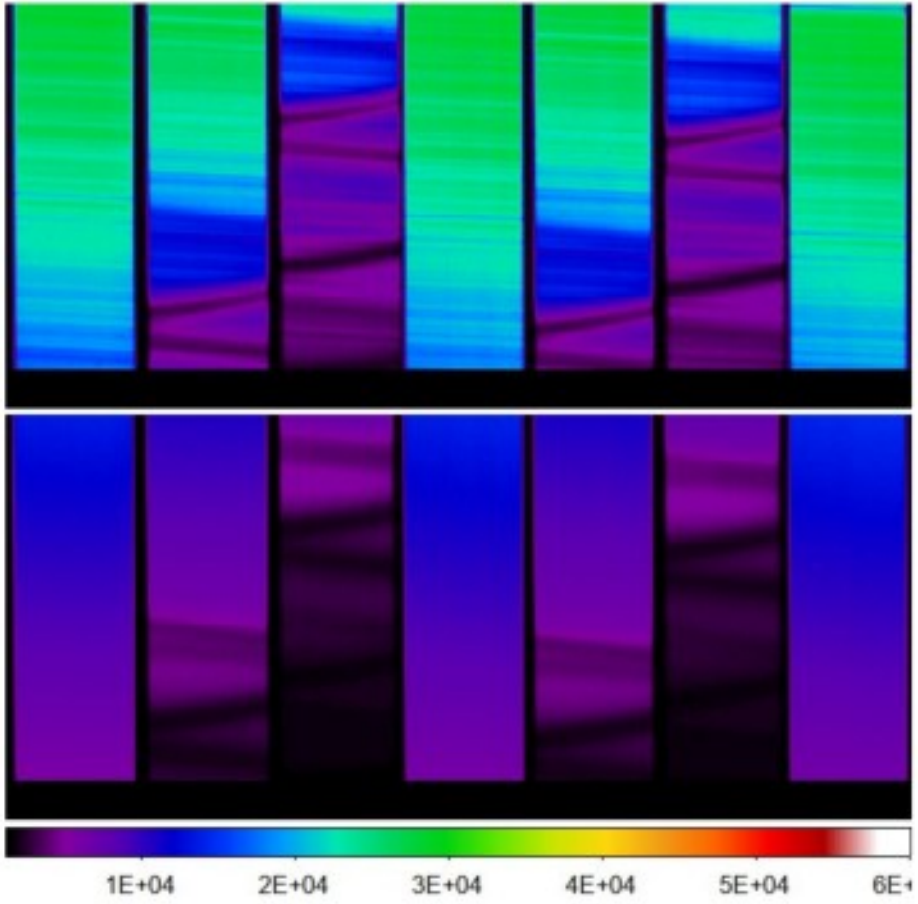


Is it useful? Spectra



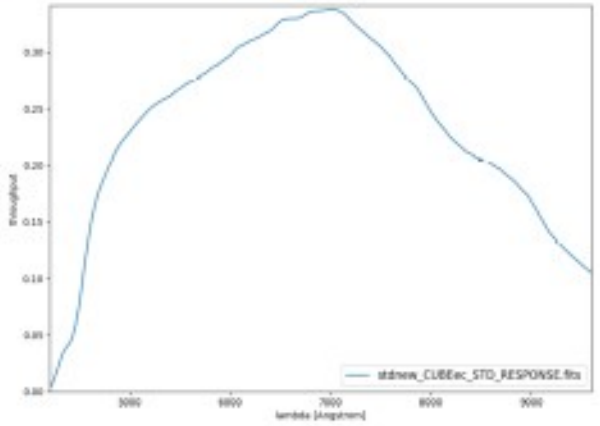


Flat-fields

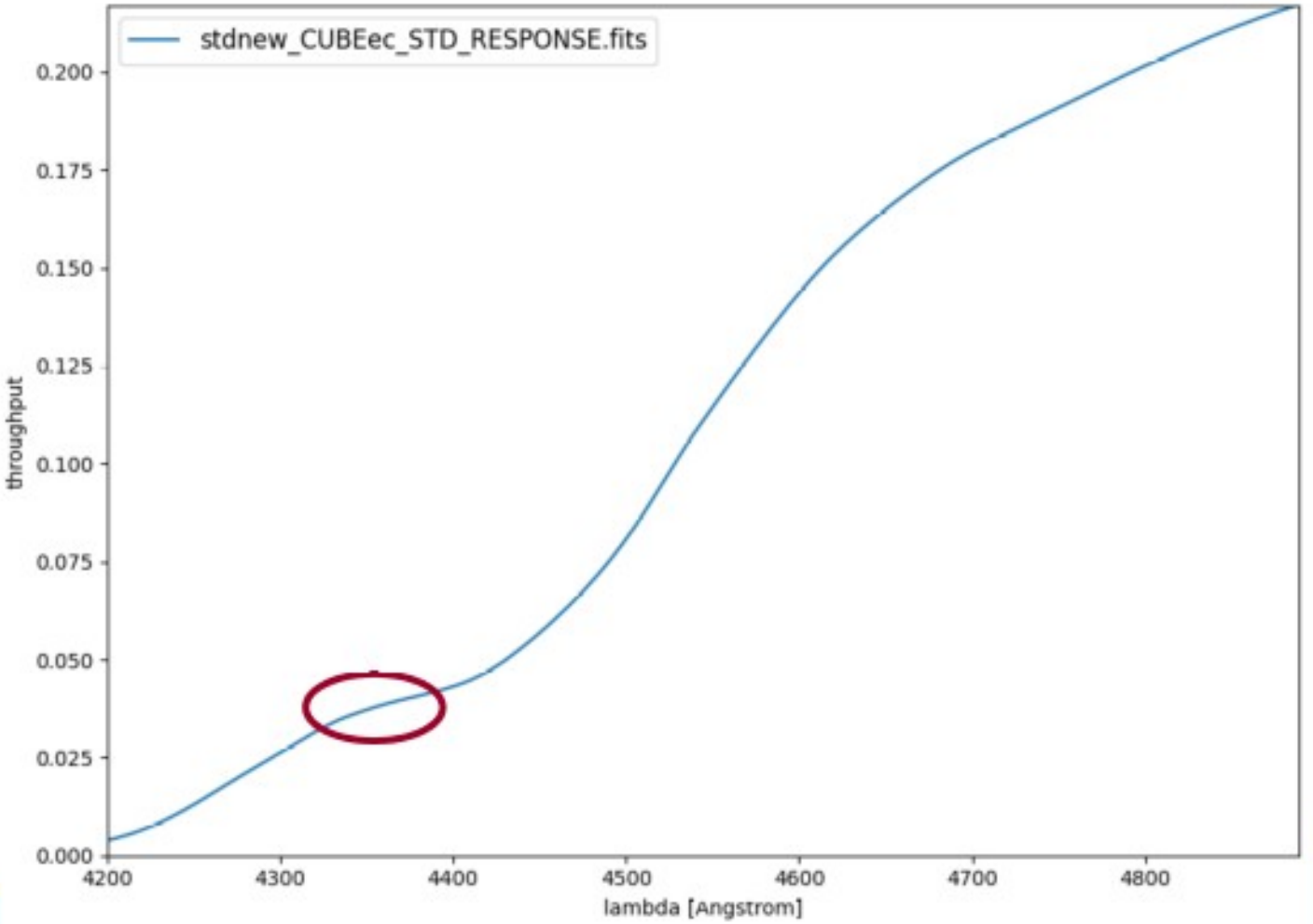


- absorption artifacts
- due to coating?
- changes with time
- different between internal calibrations (lamp-flats) and on-sky exposures (e.g. sky-flats)

Throughput

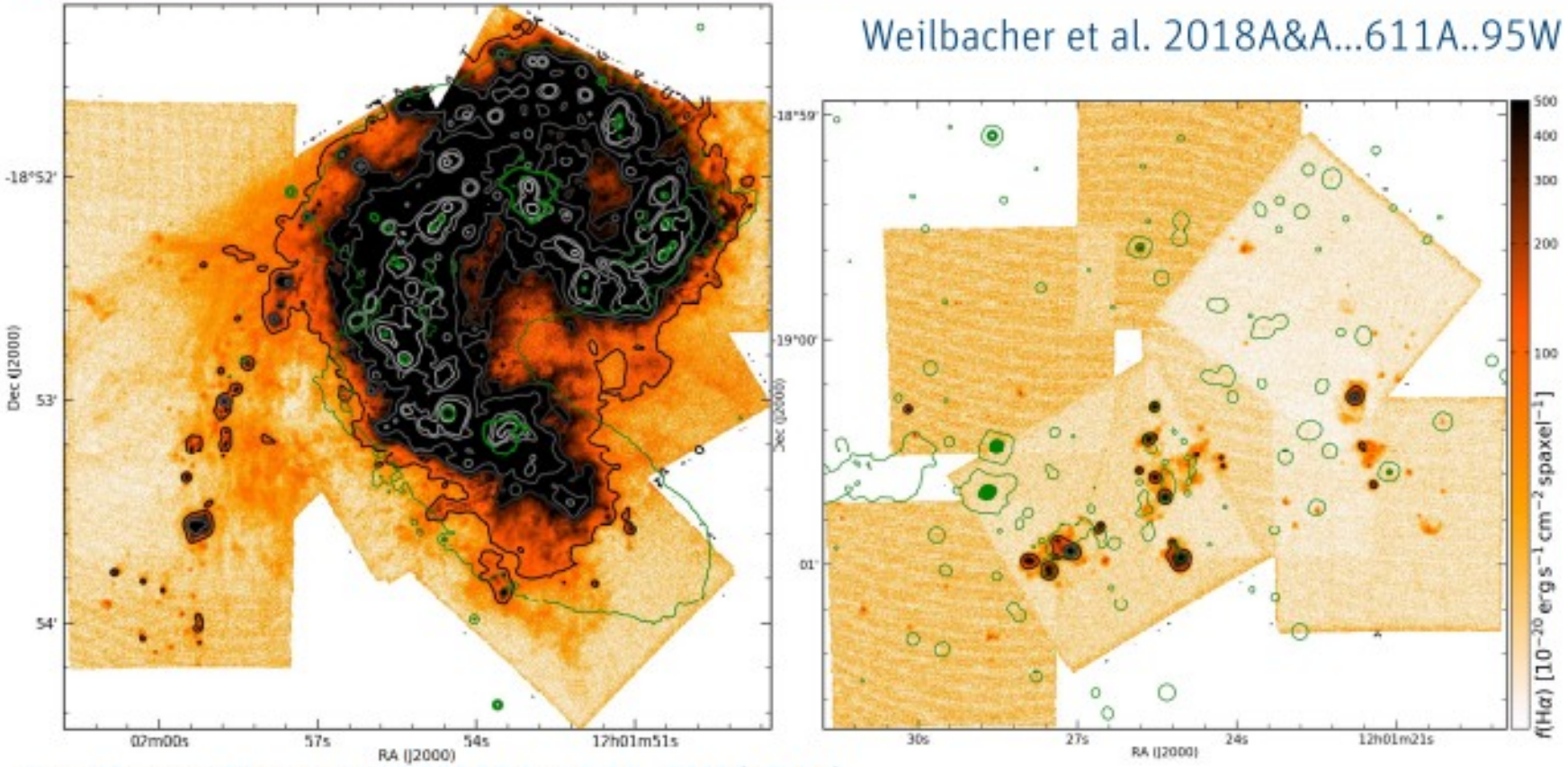


- peak throughput ~34%
- down to 3-4% around Hβ and [OIII]4363
  –> actually only 1-2% because of 1/3 coverage
- **BlueMUSE will give ~35% at the same wavelength!**



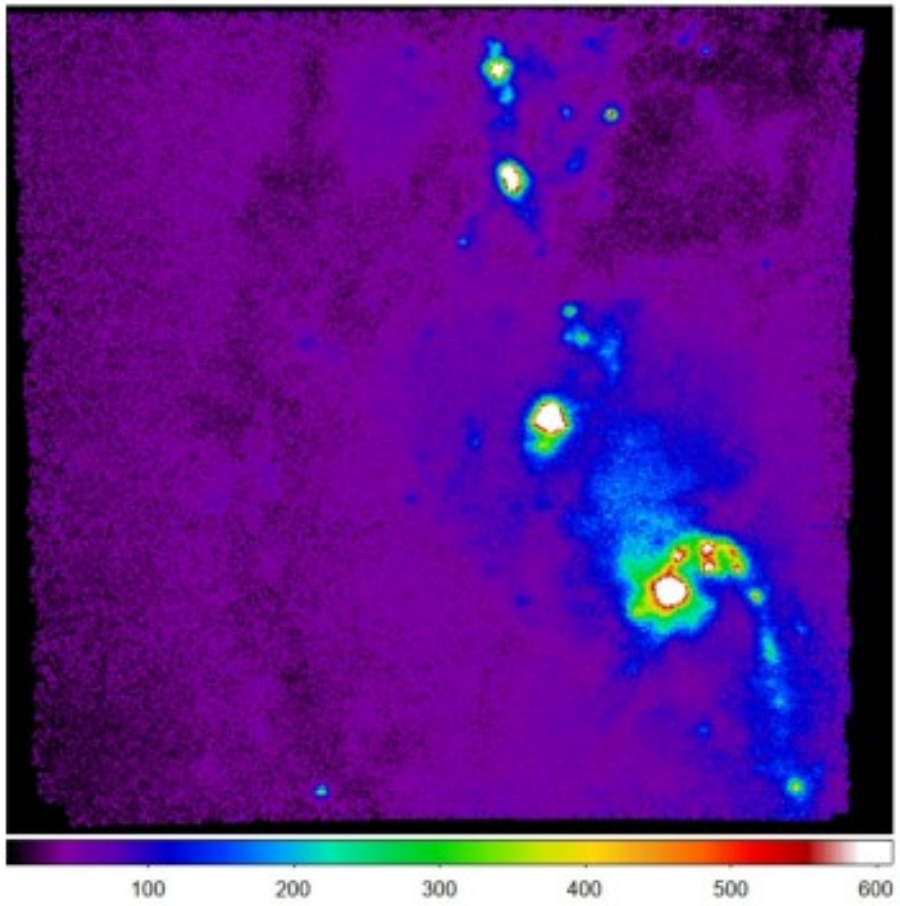
Antennae Galaxy (NGC 4038/39): MUSE Hα maps

Weilbacher et al. 2018A&A...611A..95W



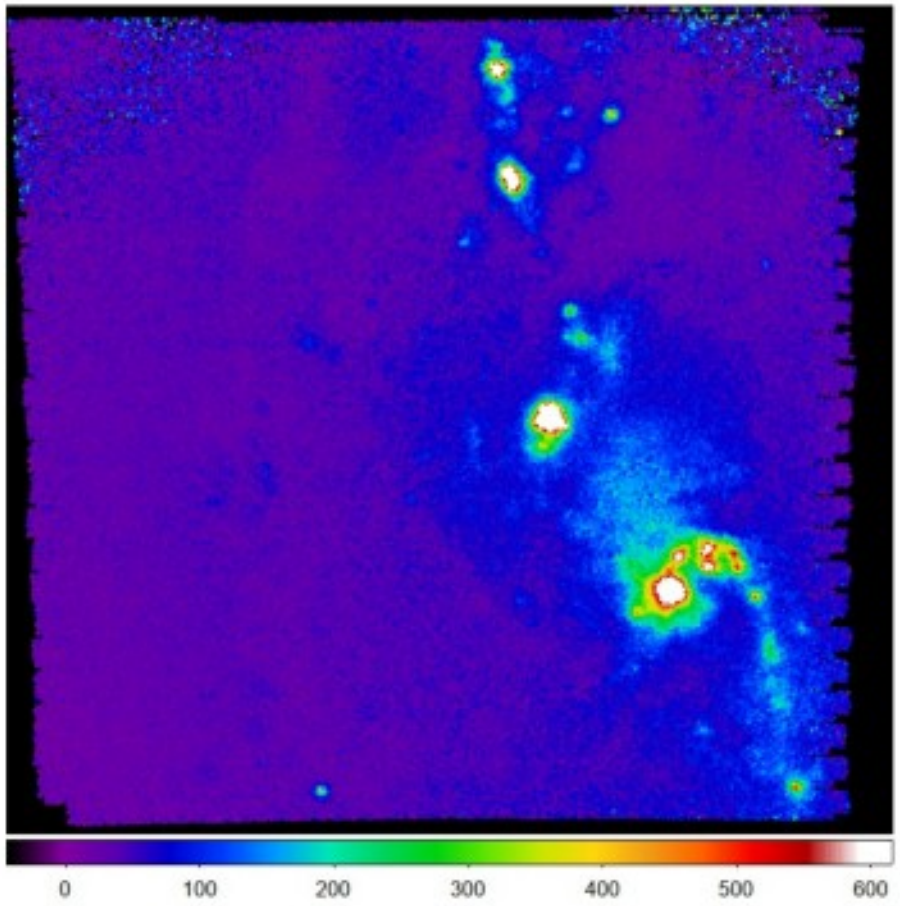
also: Monreal Ibero et al. 2018A&A...615A..33M (xDIBs)
Gunawardhana et al. 2020MNRAS.497.3860G (modeling and WR features)

Antennae Galaxy



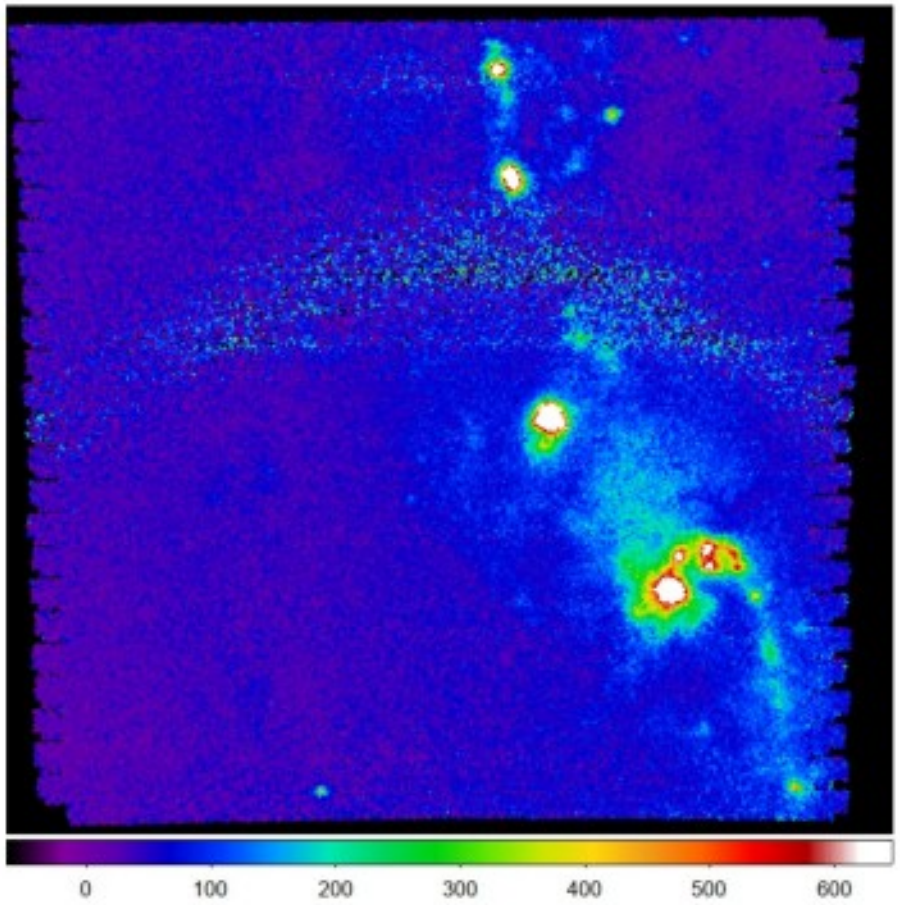
- field “Center02”
- going backwards:
  - 4600 Å

Antennae Galaxy



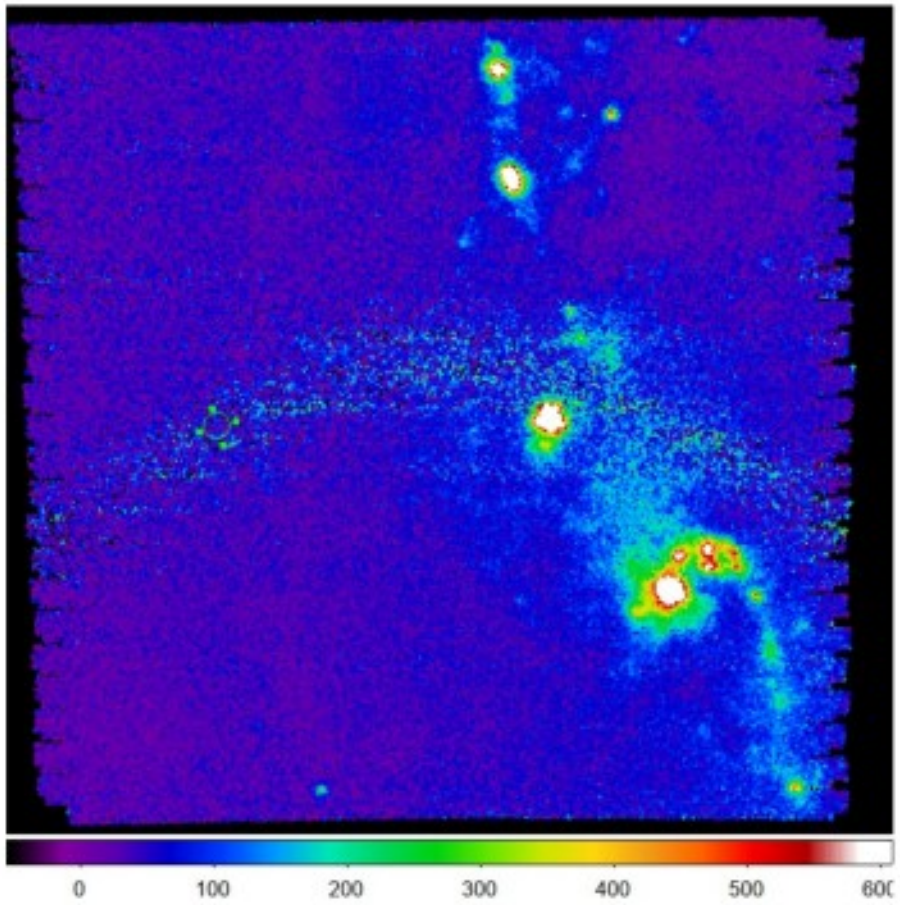
- field “Center02”
- going backwards:
  - 4550 Å

Antennae Galaxy



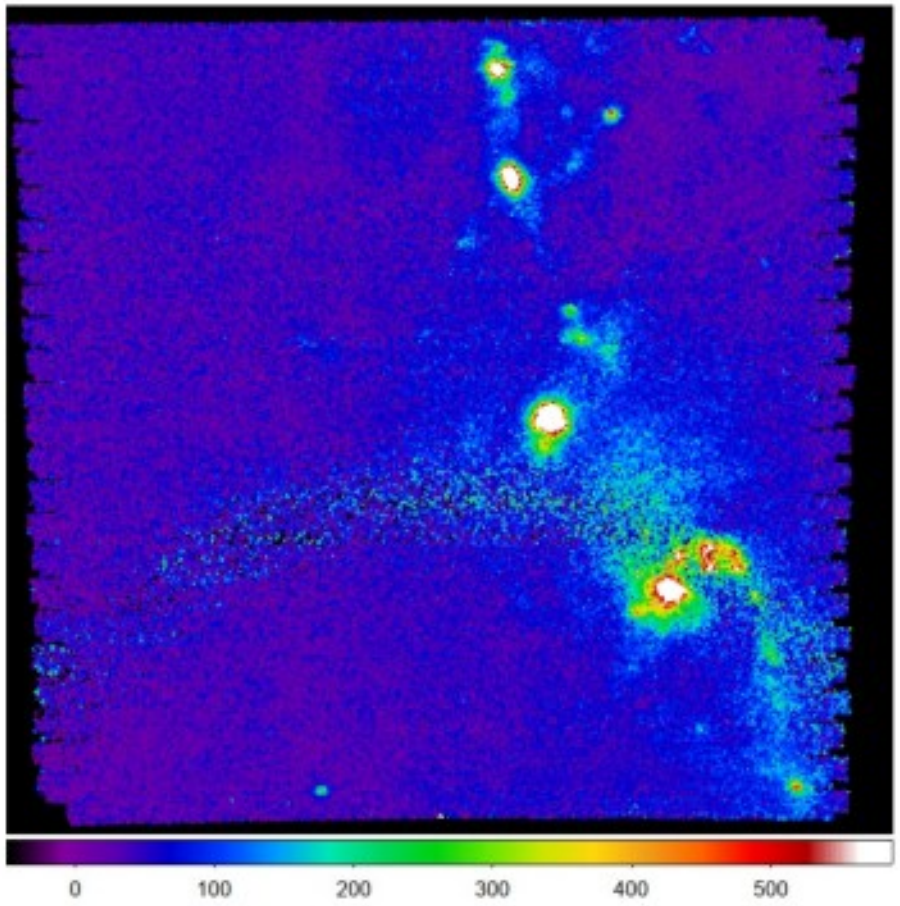
- field “Center02”
- going backwards:
  - 4500 Å

Antennae Galaxy



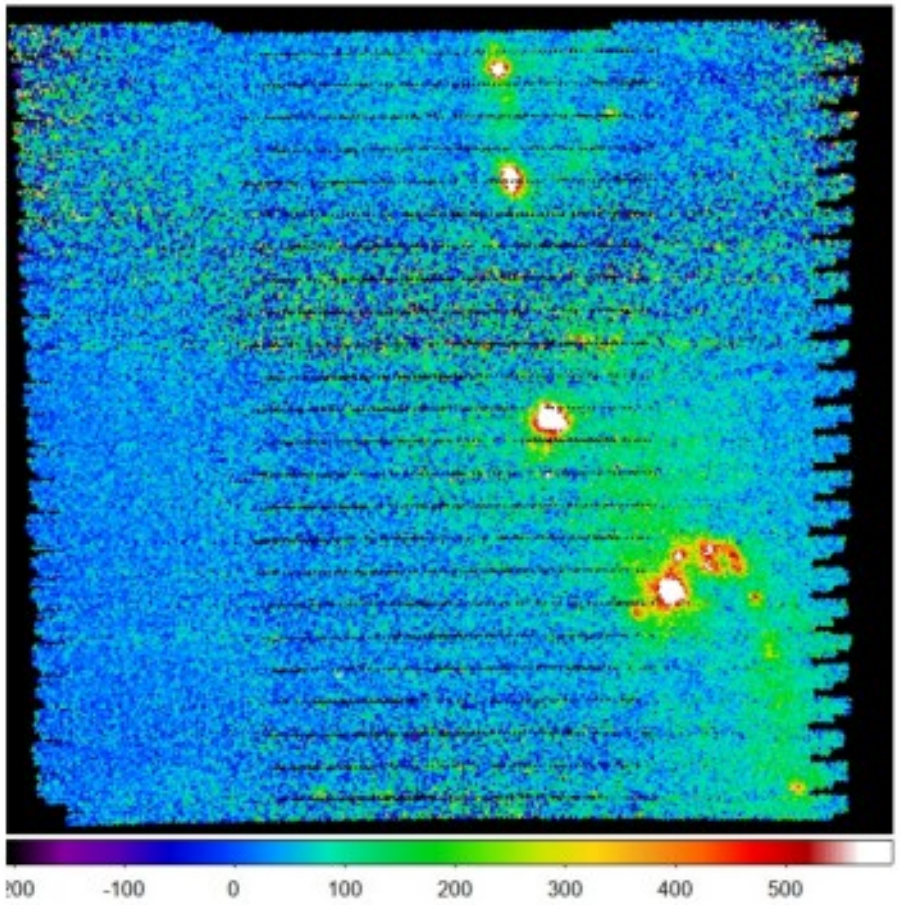
- field “Center02”
- going backwards:
  - 4475 Å

Antennae Galaxy



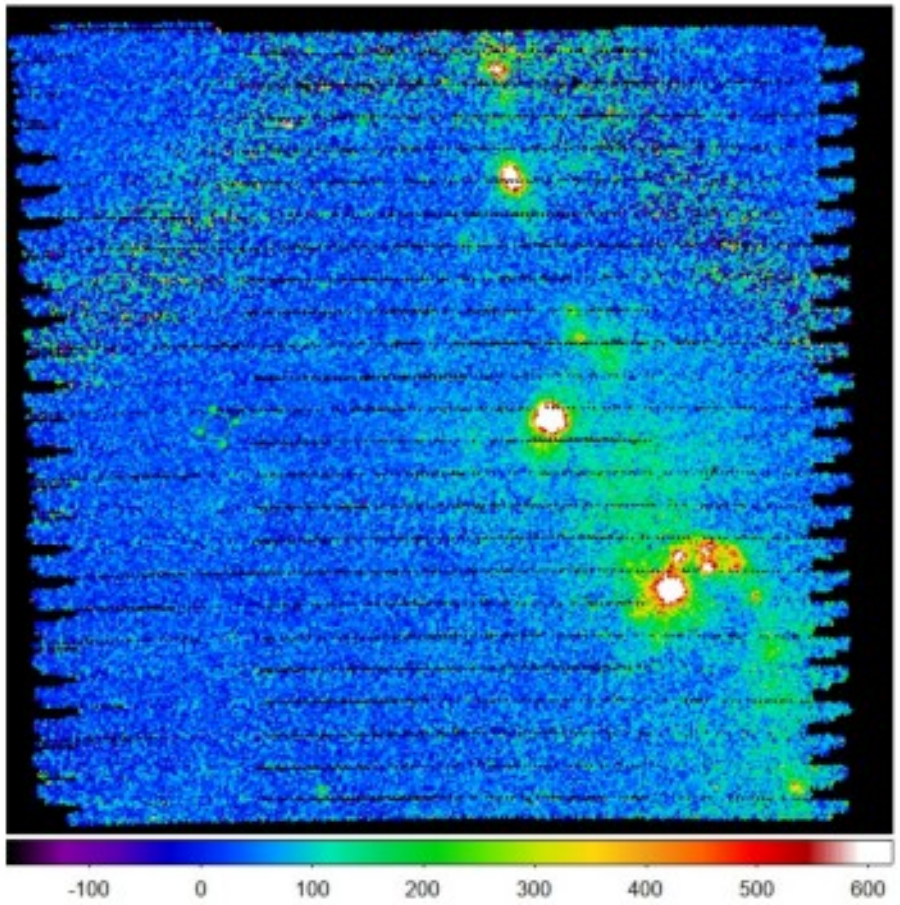
- field “Center02”
- going backwards:
  - 4450 Å

Antennae Galaxy



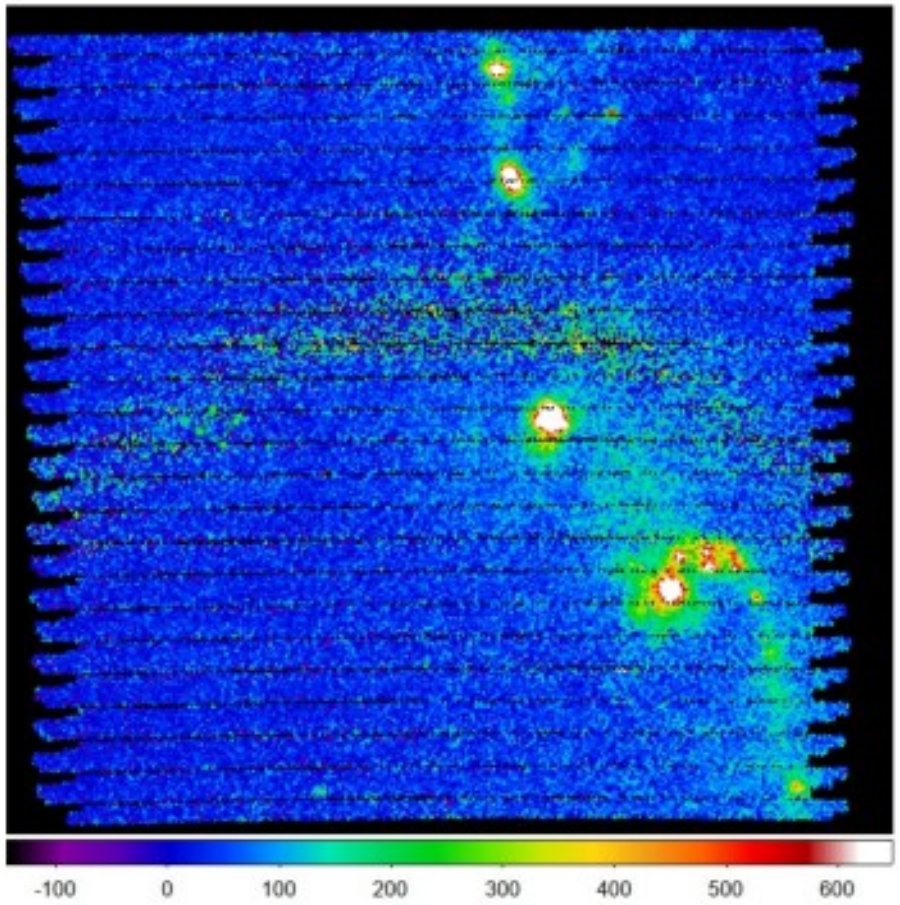
- field “Center02”
- going backwards:
  - 4400 Å

Antennae Galaxy



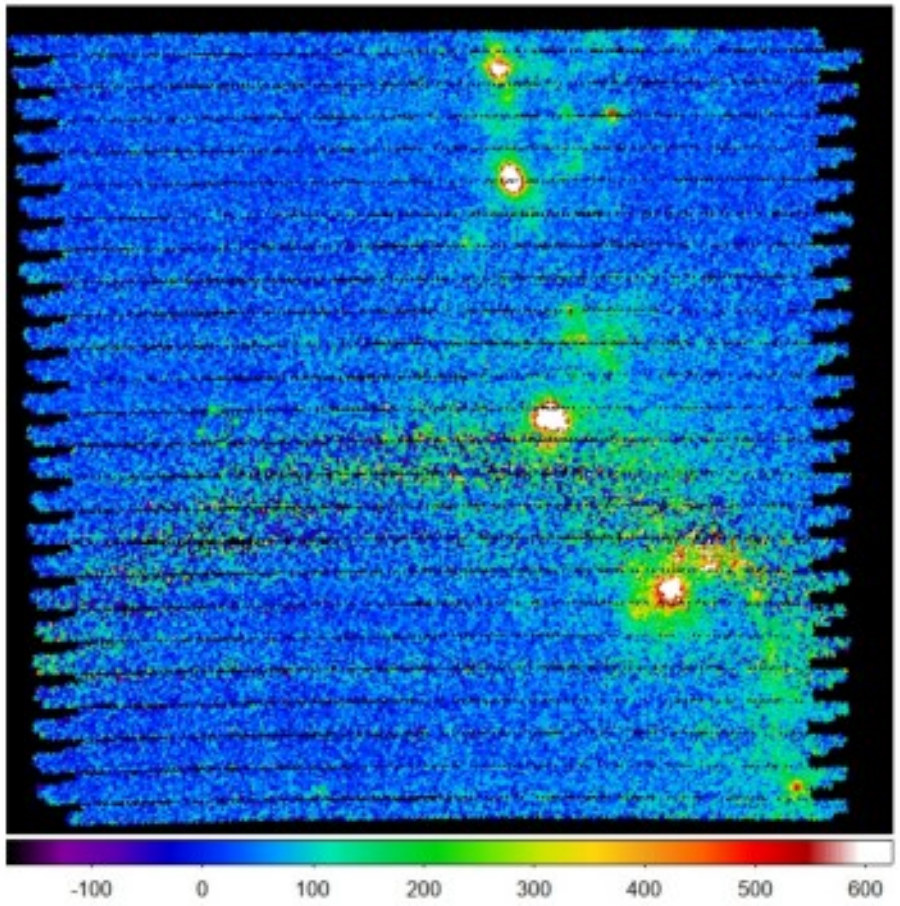
- field “Center02”
- going backwards:
  - 4375 Å

Antennae Galaxy



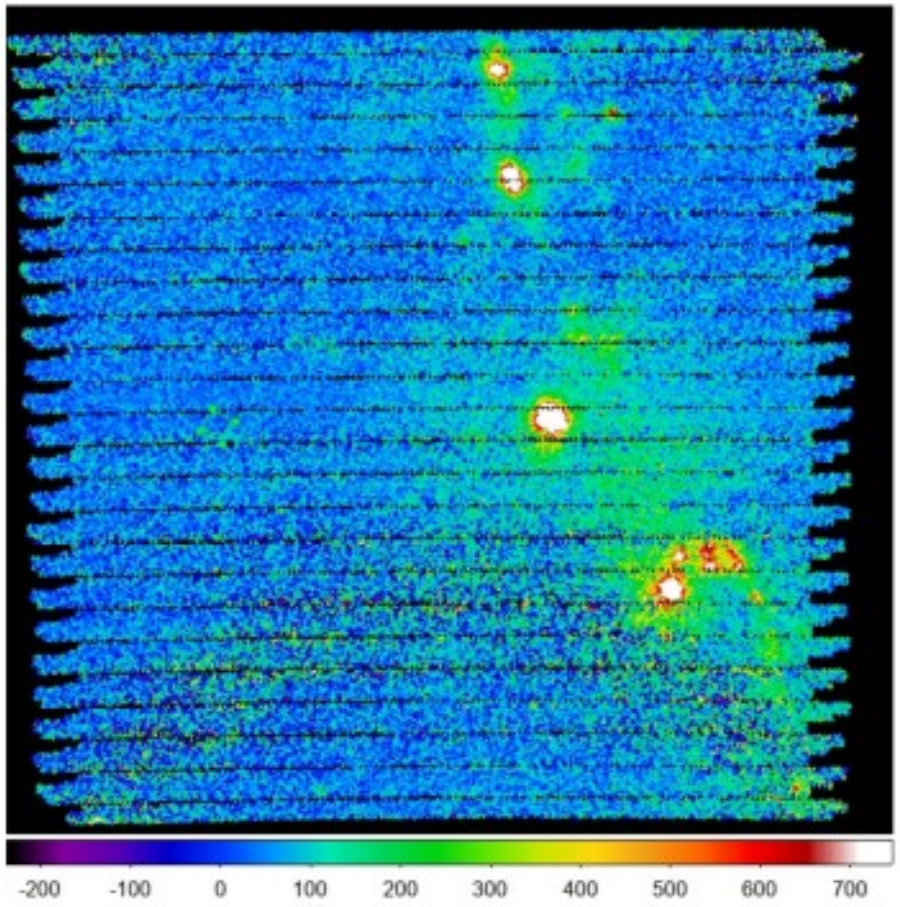
- field “Center02”
- going backwards:
  - 4350 Å

Antennae Galaxy



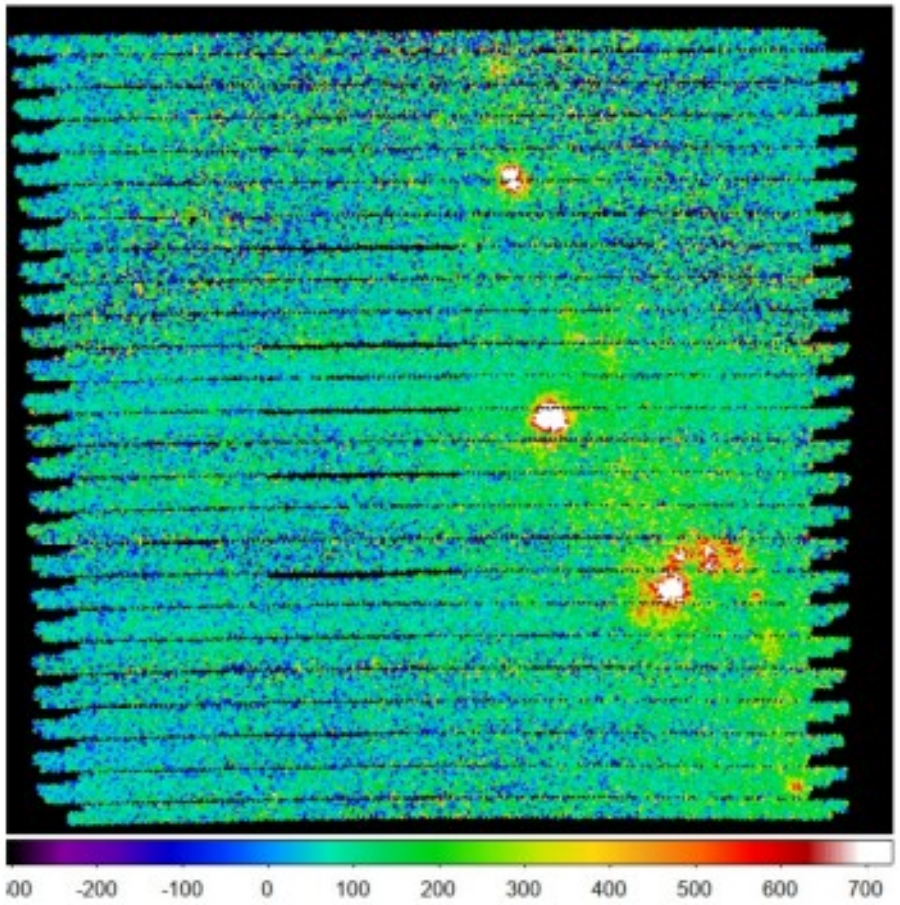
- field “Center02”
- going backwards:
  - 4325 Å

Antennae Galaxy



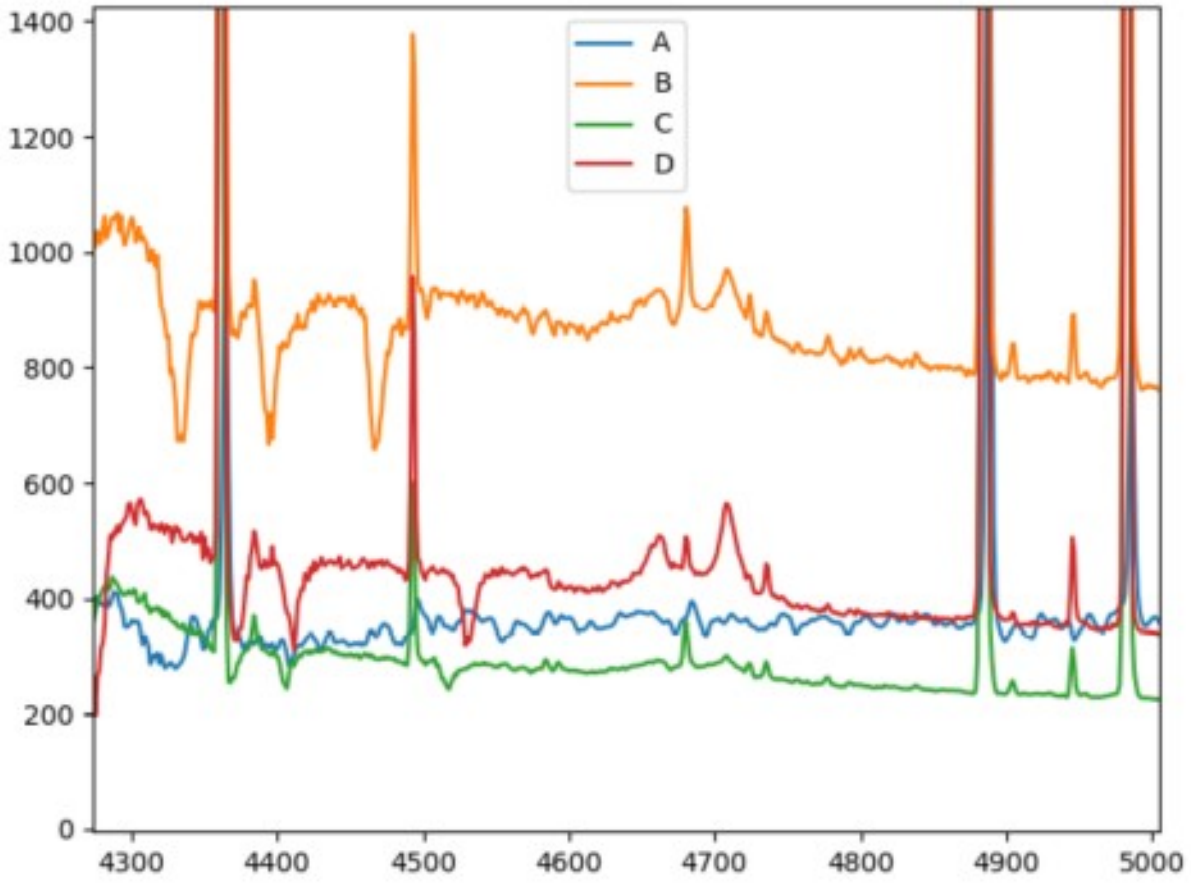
- field “Center02”
- going backwards:
  - 4300 Å

Antennae Galaxy



- field “Center02”
- going backwards:
  - 4275 Å

Antennae Galaxy: Spectra



- field “Center02”
- spectra of brightest HII regions
  - regions A, B, C, and D
- HeI 4471 and Hβ clear
- [OIII]4363 doubtful
- strong artifacts visible

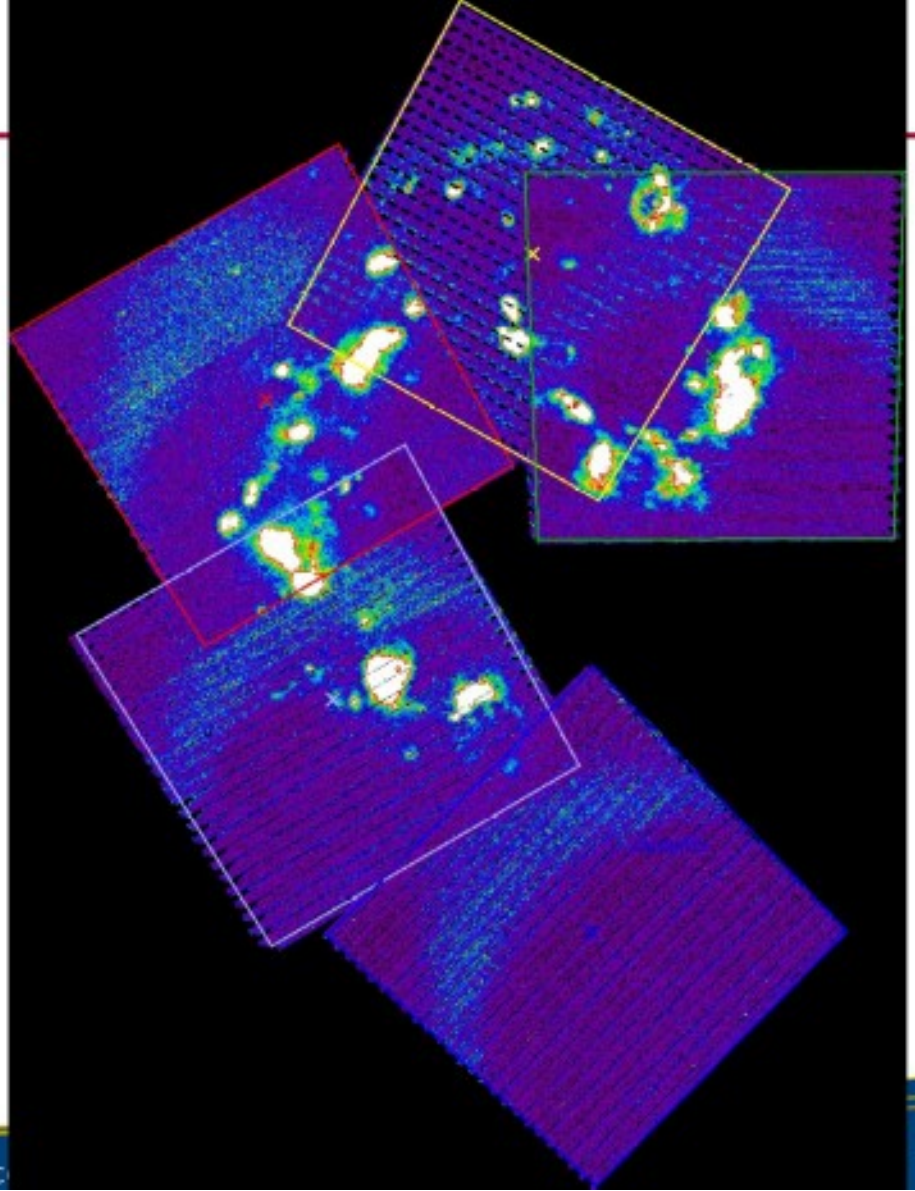
Antennae Galaxy

- Hγ flux map
  (showing only early observations)
- careful dithering in 4 fields

  –> still imperfect coverage

- Is it useful?

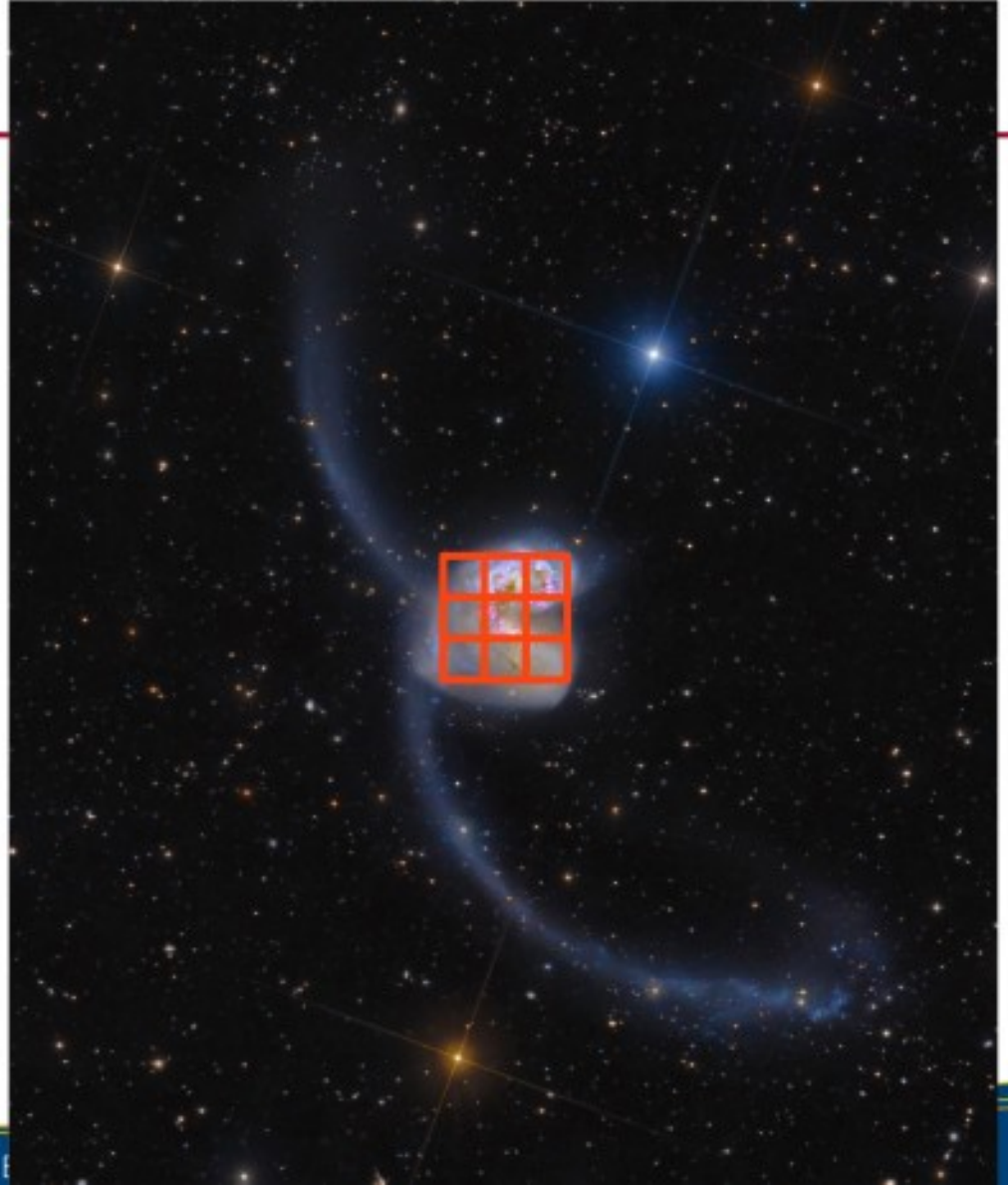
  –> No!



AIP

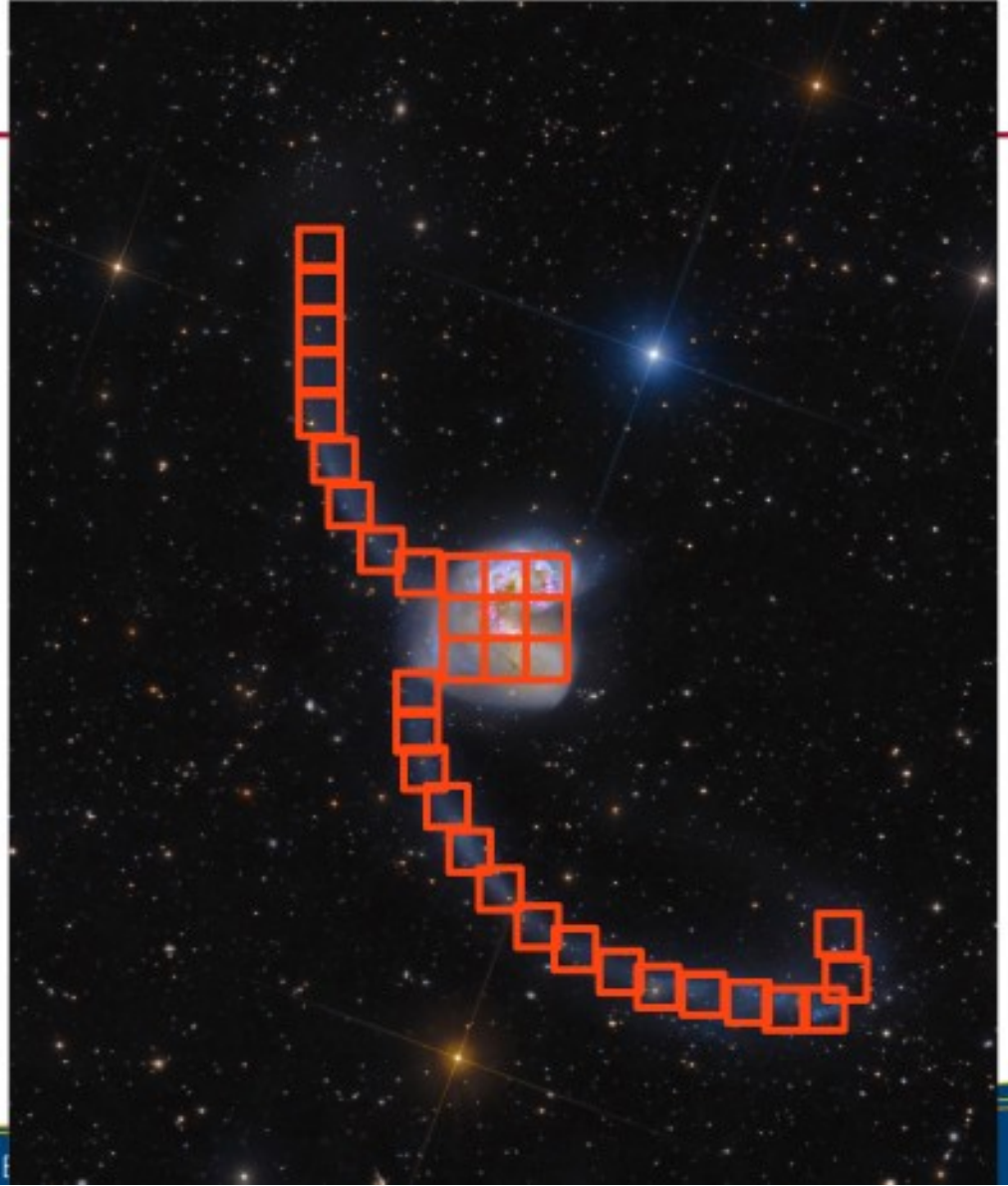
Antennae Galaxy

- ~9 MUSE pointings cover the center



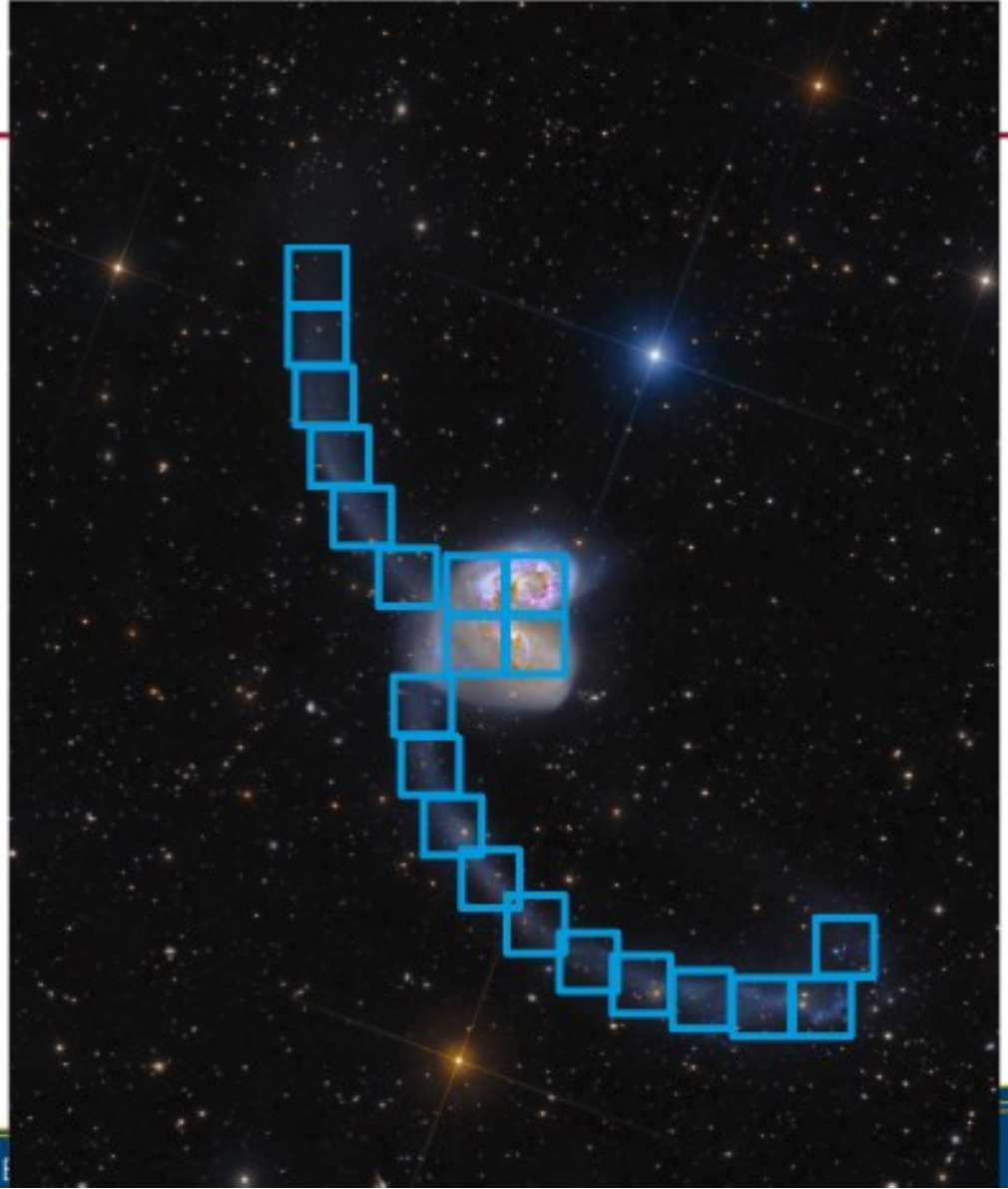
Antennae Galaxy

- ~9 MUSE pointings cover the center
- ~25 MUSE pointings cover both tidal tails



Antennae Galaxy

- ~9 MUSE pointings cover the center
- ~25 MUSE pointings cover both tidal tails
- ~4 BlueMUSE pointings (1.4'x1.4') cover the center
- ~17 BlueMUSE pointings for both tidal tails



AIP

Summary

- MUSE already has partial coverage to ~4300Å
- very low throughput but can be used to *detect* emission lines
- with some luck, can build complete fields at blue wavelengths
- calibration problems: actual *measurements* are problematic

- BlueMUSE is desperately needed to get proper [OIII]4363 measurements at subsolar metallicities
- will give us [OII] densities and more reliable O+ abundances
- improved spectral resolution will give us better insight into feedback mechanisms
- with larger FOV will be able to investigate larger parts of tidal features