BlueSi

25.04.2024

Martin Wendt (UP)

BlueSi – Data Simulation

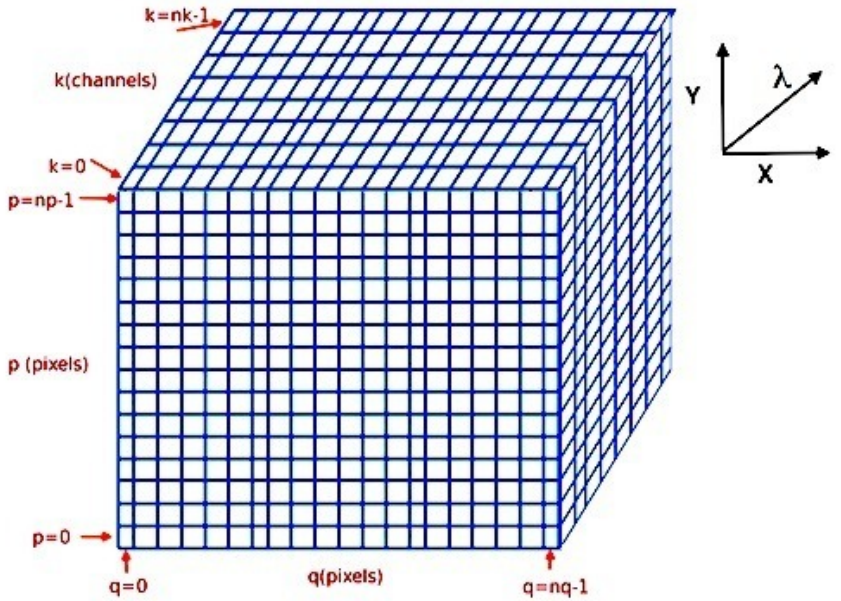
BlueSi:

Creating full scale and full feature cubes
as expected from the BlueMUSE data reduction
pipeline.

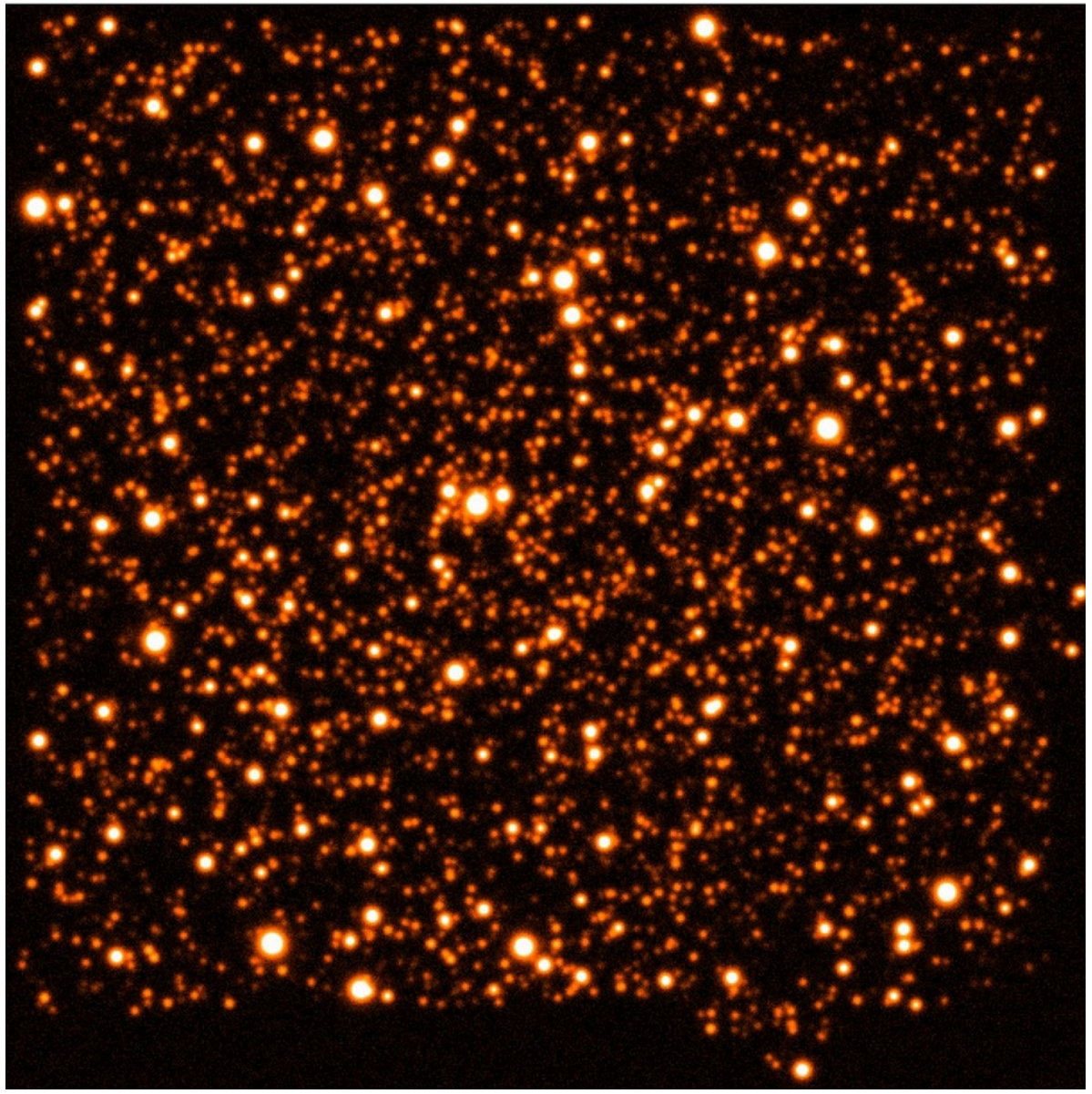
Technical specs as close as feasible.
All data content is simulated.

Level of detail on cube level (*)
(no CCD simulation or light path renderin

BUT including environmental conditions.



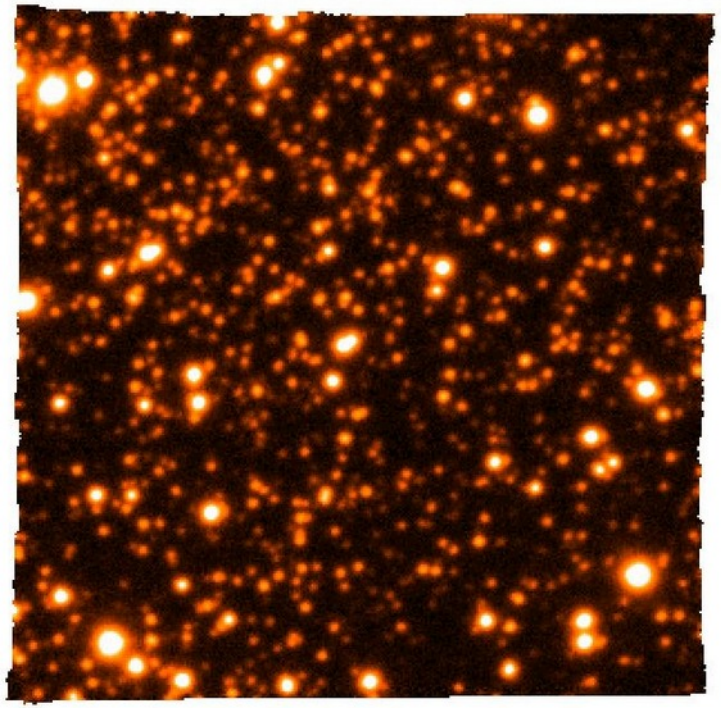
BlueSi – Data Simulation



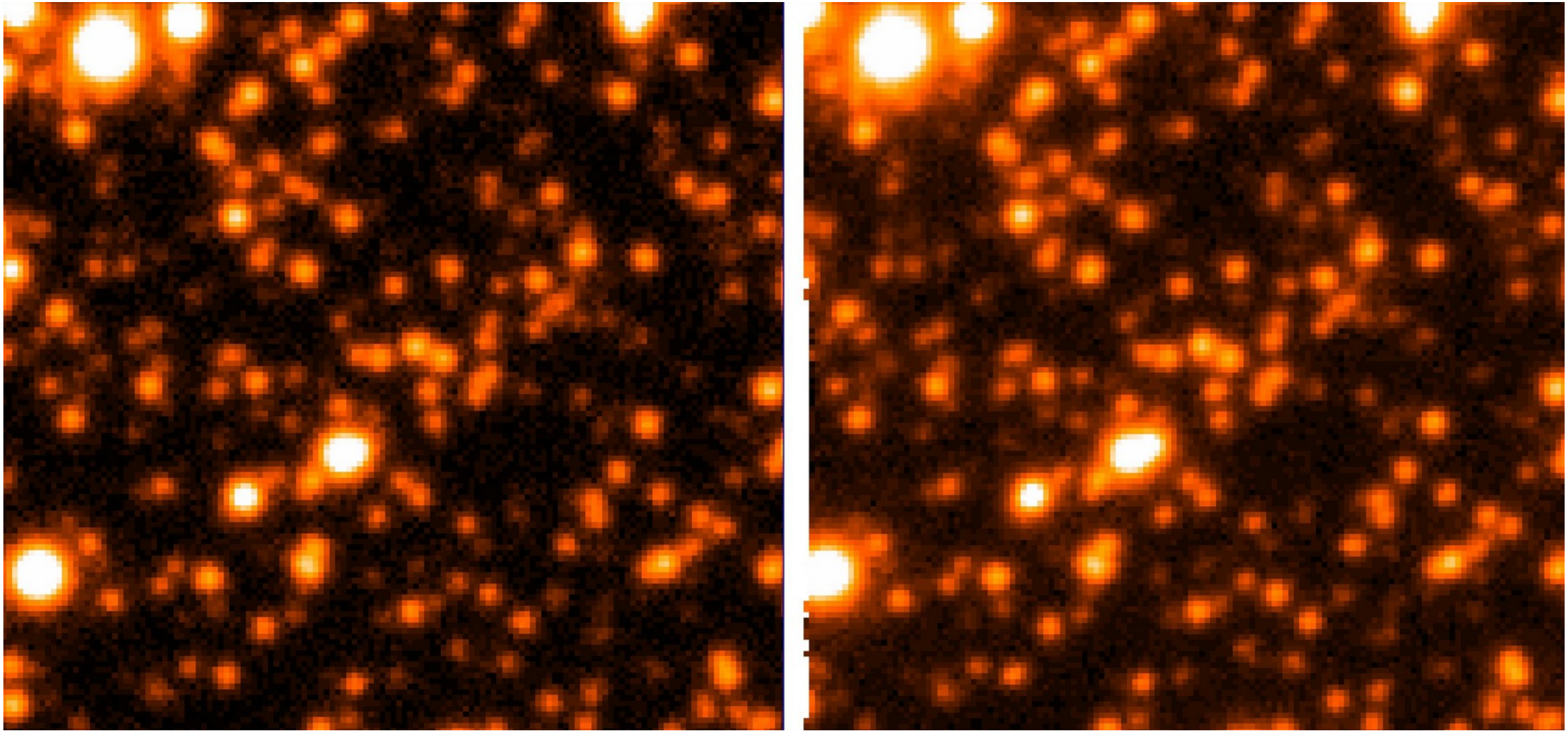
Globular Cluster NGC3201
Left: 4x4 FOVs BlueSi in ‘MUSE’ mode.

Right:
1 FOV real MUSE data.

data+scene:
Sven Martens



BlueSi – Data Simulation



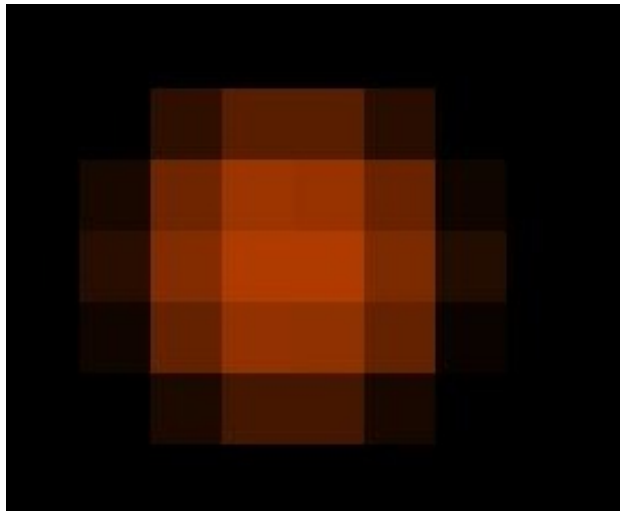
A single ‘slice’ with identical scale/cuts. Simulated vs real.

BlueSi – Data Simulation

Why?

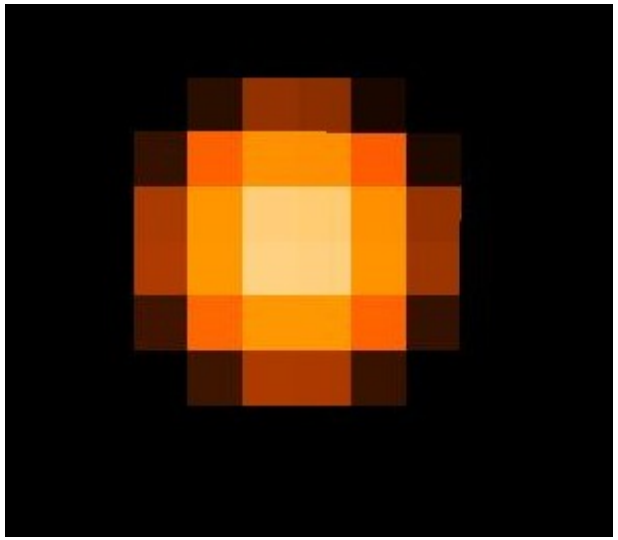
- science feasibility tests
- flexing tool chains and analysis tools
- tuning required S/N, sky, moon, Obs
- learning about BlueMUSE’s strengths & quirks

BlueSi – Data Simulation (A430)

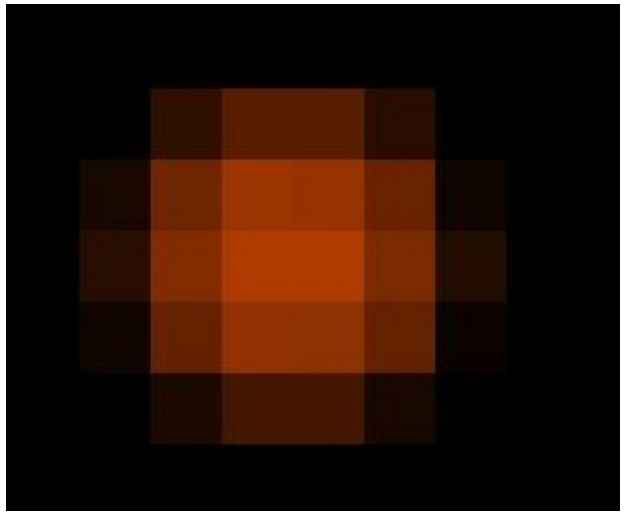


For example:
rectangular pixels.

Top: single obs, ‘in X’
Bottom: added ‘X’ and ‘Y’



BlueSi – Data Simulation (A430)



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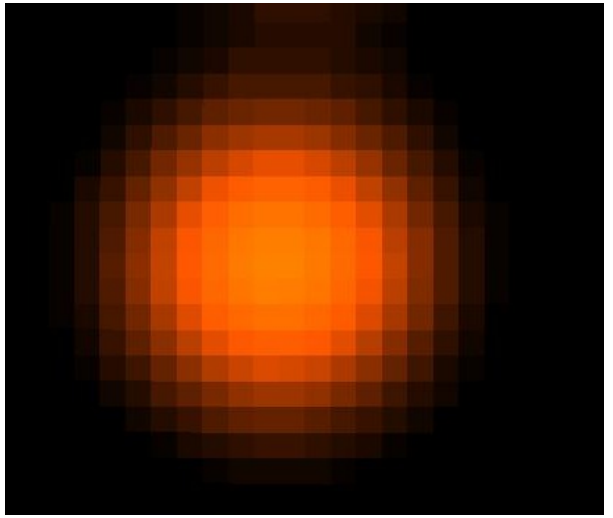
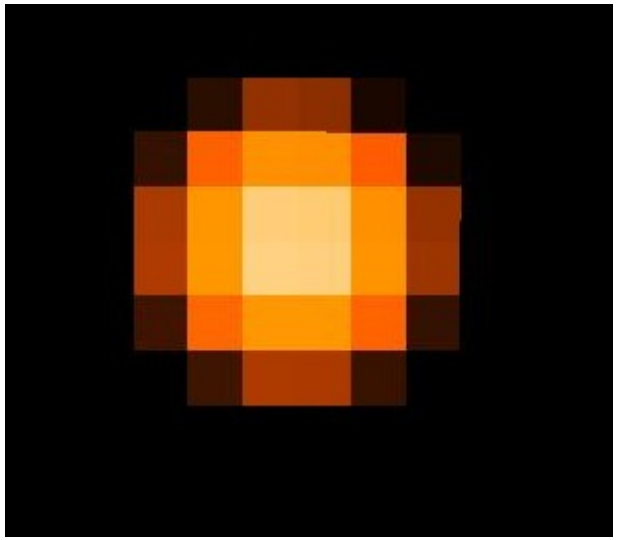
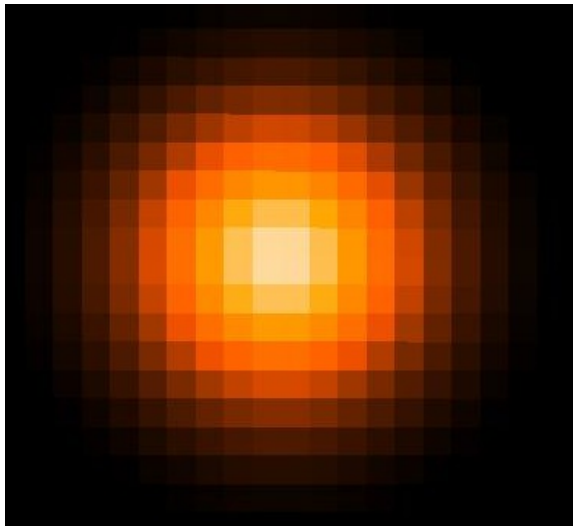
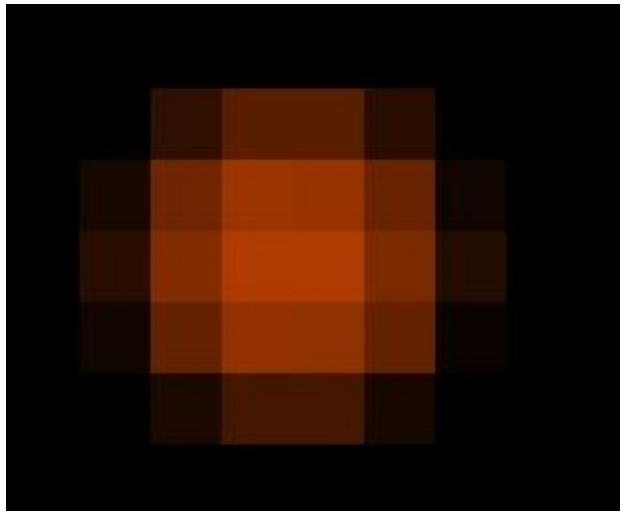






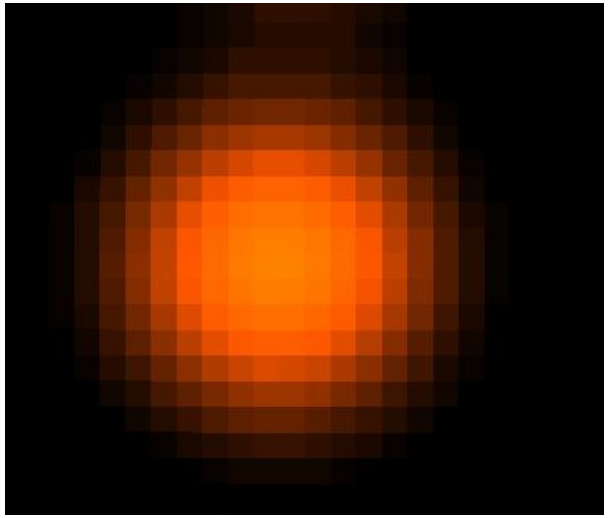
BlueSi – Data Simulation (A430)

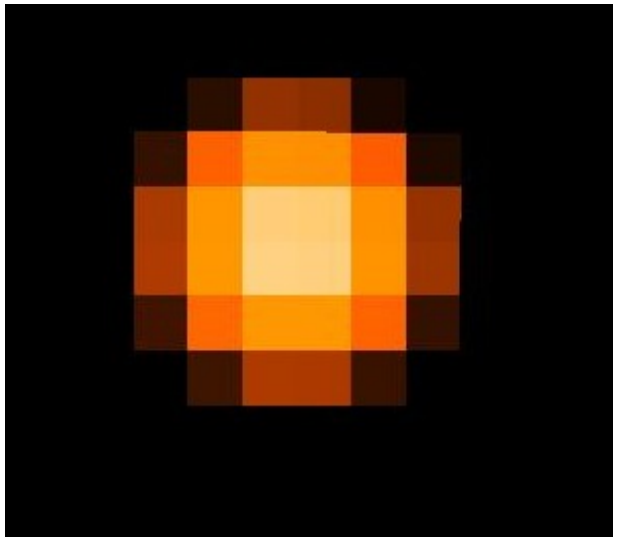


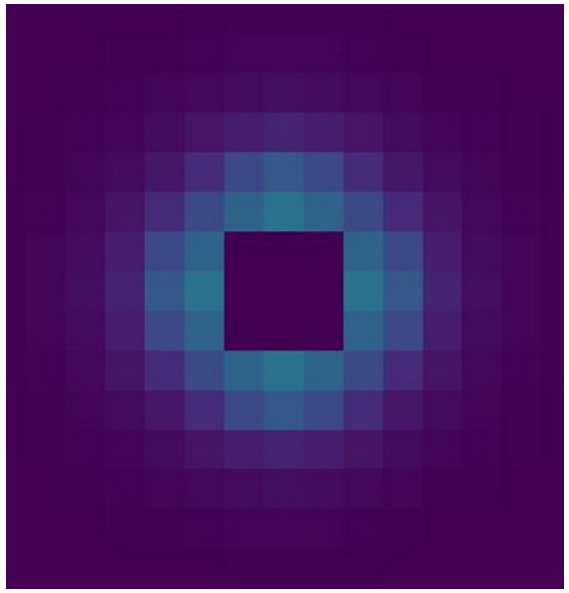
For example:
rectangular pixels.

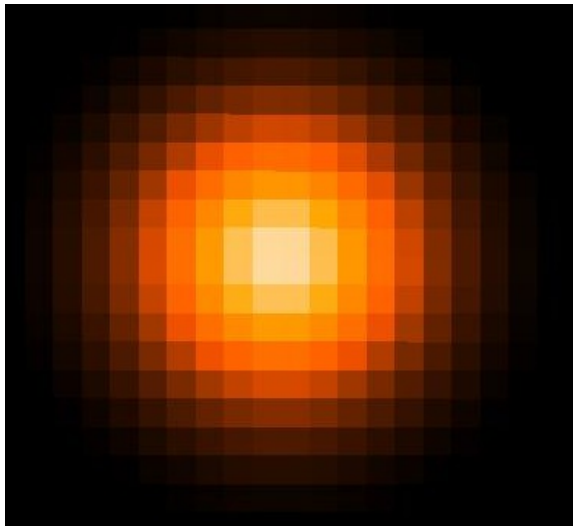
Top: single obs, ‘in X’
Bottom: added ‘X’ and ‘Y’

‘X&Y’ – square pixels



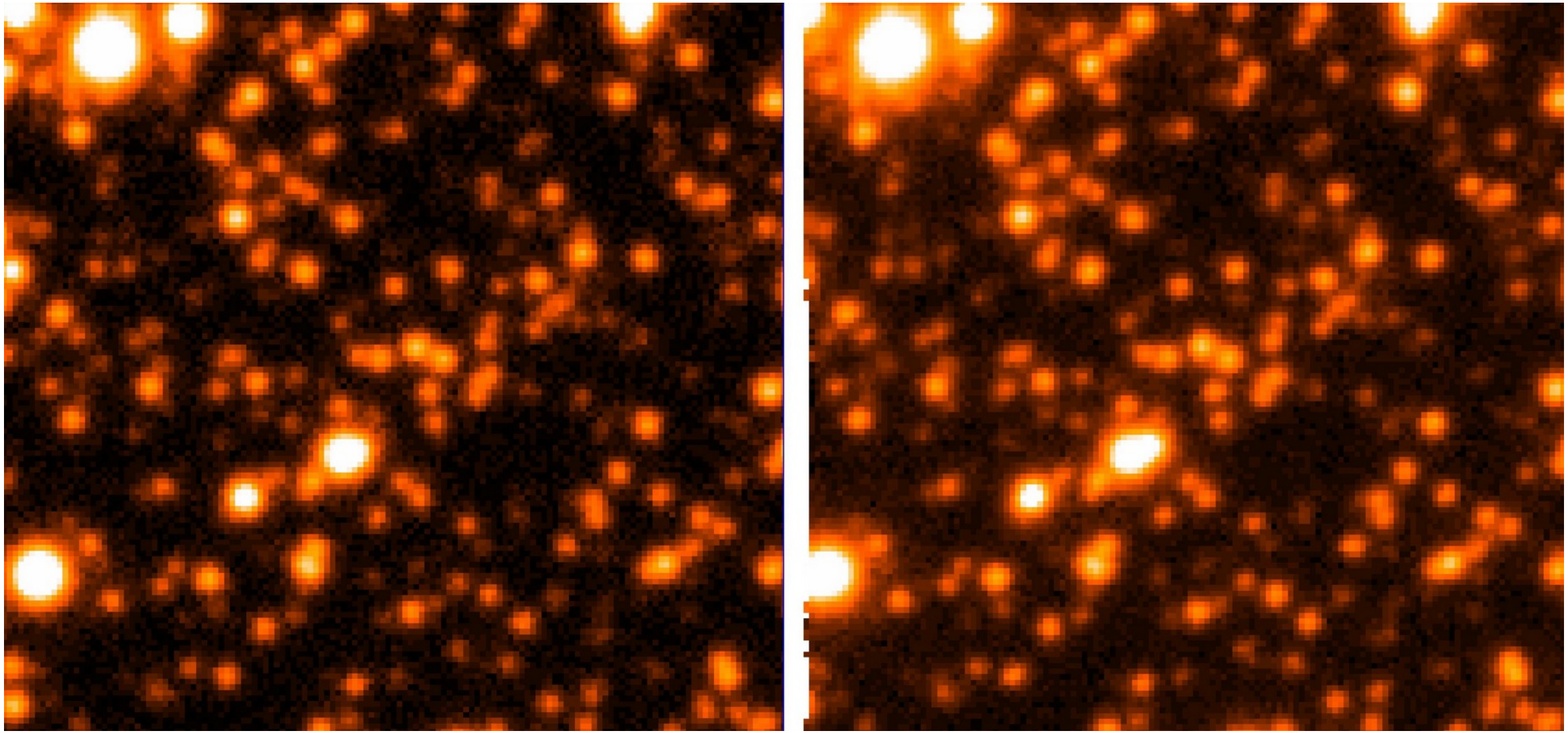




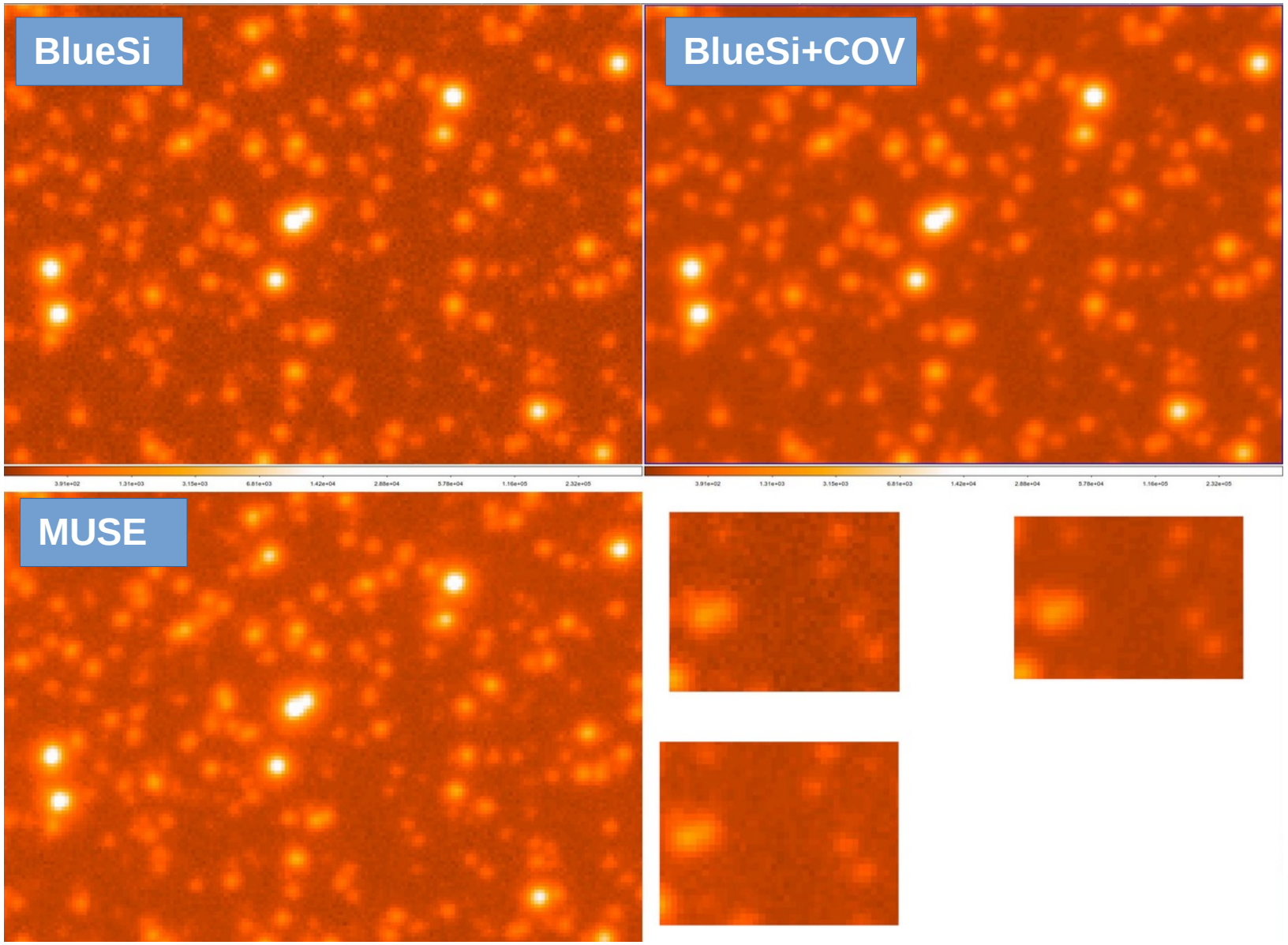


BlueSi – Data Simulation (A430)

Example #2: noise characteristics.



BlueSi – Data Simulation (A430)



example #2

Granularity of noise.
Impact of covariances derived from 3D autocorrelation in observed noise.

Work in progress…
(+ DRS,
Peter Weilbacher)

BlueSi – Data Simulation

Why?
- science feasibility tests
- flexing tool chains and analysis tools
- tuning required S/N, sky, moon, Obs
- learning about BlueMUSE's strengths & quirks

What (is being done)?
- a (Python) code reading in a scene definition and creating one (or several) data cubes

…coming up next…

BlueSi – Data Simulation

What (is being done)?

```
wav_min   = 3500.0                  #lower wavelength limit (AA)
wav_max   = 6000.0                  #upper wavelength limit (AA)
R         = 4000.0»   »             #Resolution at 5000 AA
d_lambda = 0.66                     #constant bin size (AA)
pixsize   = 0.2                     #detector pixel size (arcsec)
namebase = 'out/talk_small_blue'    #name base of generated cubes
instrument = 'BlueMUSE'             #or BlueMUSE
seeing    = 0.9                     #parameter for PSF (arsec)
airmass   = 1.1                     #parameter for PSF
skytable = 'skytable_30dor.fits'    #sky model
psf_beta = 2.5                      #parameter for PSF
psf_l0    = 22                      #parameter for PSF (m)
cpus      = 0                       #number of cpus used
raw_dump = yes                      #write cube before PSF/LSF/NOISE
var_ext   = yes                     #add variance extension
do_lsf    = yes                     #render and write LSF
debug_lsf = no                      #plot LSF and insert delta peaks + fit
do_psf    = yes                     #render and write PSF
do_noise = yes                      #render and write final noise cube
add_sky   = no                      #keep sky emission in data?
nexp    = 4                         #number of exposures
texp   = 600                        #exposures time per exposure (sec)
readout   = 3                       #readout noise level (e-)
dark   = 3.0                        #dark current (e-/hour)
saturation = 65535                  #16bit saturation I assume
input_type = 'scene/scene_big30dor.conf' #scene/file or raw/file BlueSi cube
rectangular = 'yes'
rect_mode = 'x'
```

A simple external configuration file.
→ contains conditions

Usually not specific to the science case!

BlueSi – Data Simulation

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rectangular = 'yes'
rect_mode = 'x'
```

A simple external configuration file.
→ contains conditions

Usually not specific to the science case!

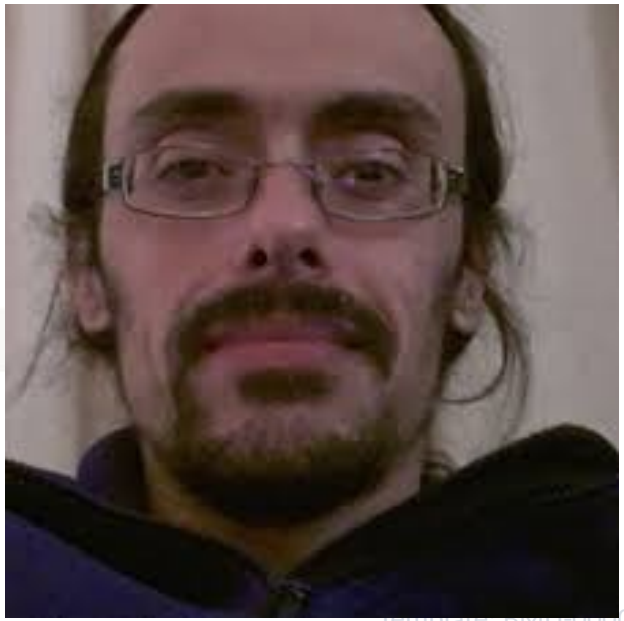
raw input or new scene?

BlueSi – Data Simulation

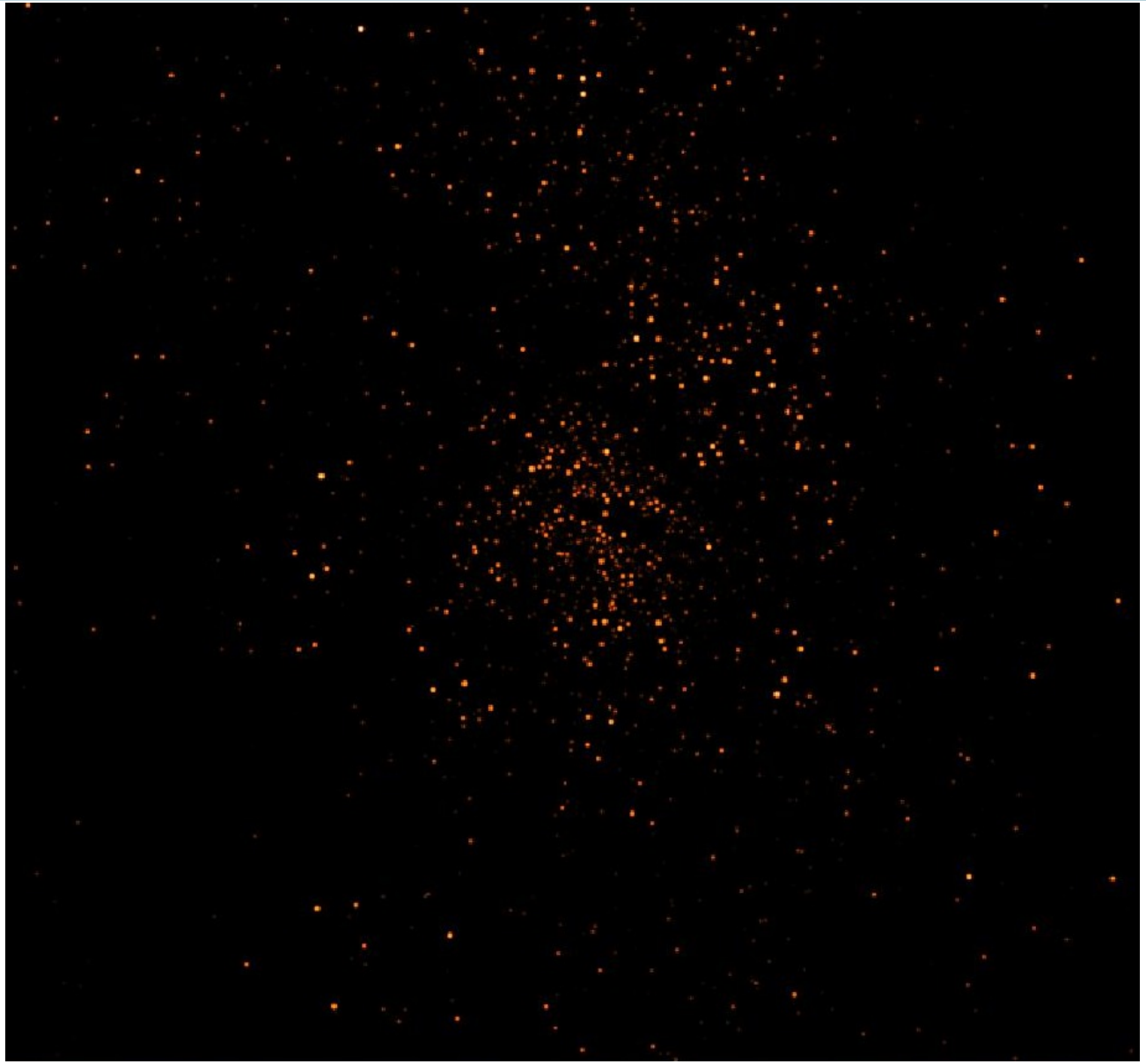
What (is being done)?

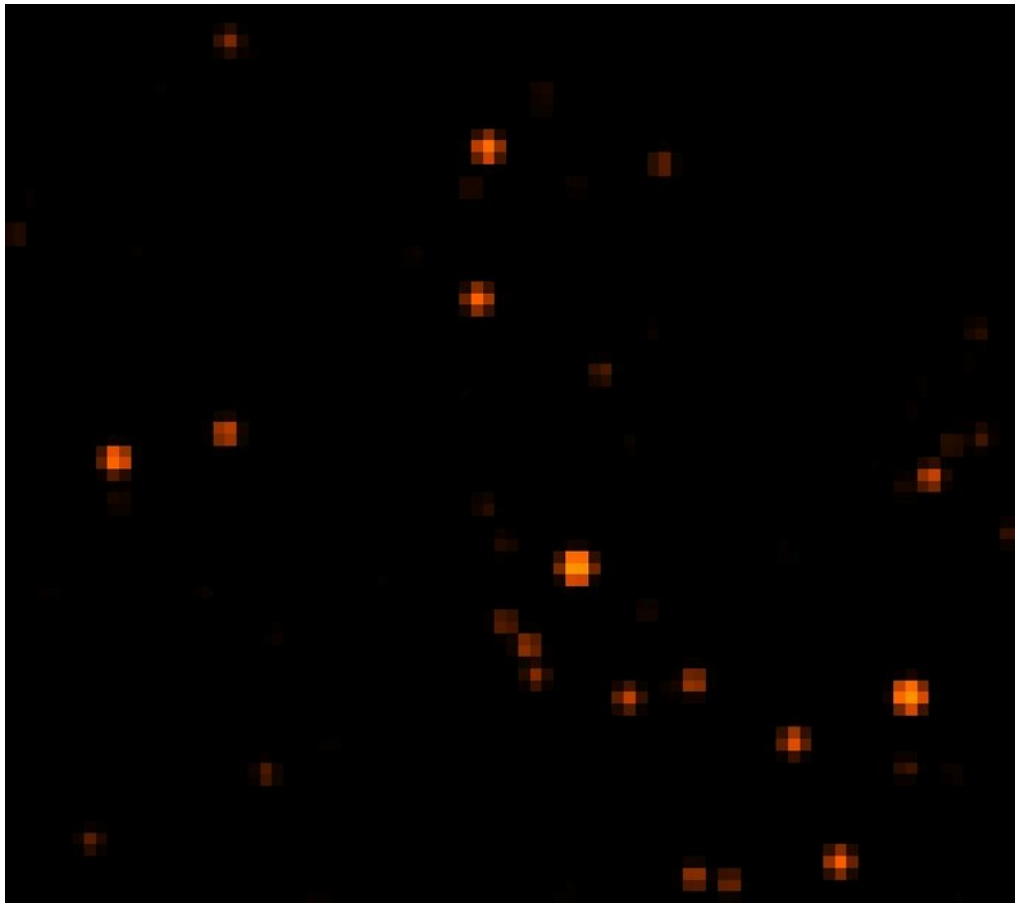
```
fov = 'all'                    #'reg/file.reg' or 'all'
objectfile = '30dor/30Dor_BlueSi_HST_catV220224_compl.csv' #ASCII list
objectdir  = '30dor/FITS' #directory of spectra
maxcount = 10                  #only plot this number of objects, -1 = inf
vrad     = yes                 #apply radial shifts from table
vac2air = no                   #apply air refraction to model spectra
extinction = yes               #apply extinction to whole frame
Ebv = 0.39                     #E(B-V)
simulated_object = '30Dor'
model_spectra_packaging = 'Rodriguez,Norberto'
scene_file_creator      = 'Wendt,Martin'
scene_type = '30dor'
```

Another file: describing the science scene.
(unless a ‘raw’ cube is being used)



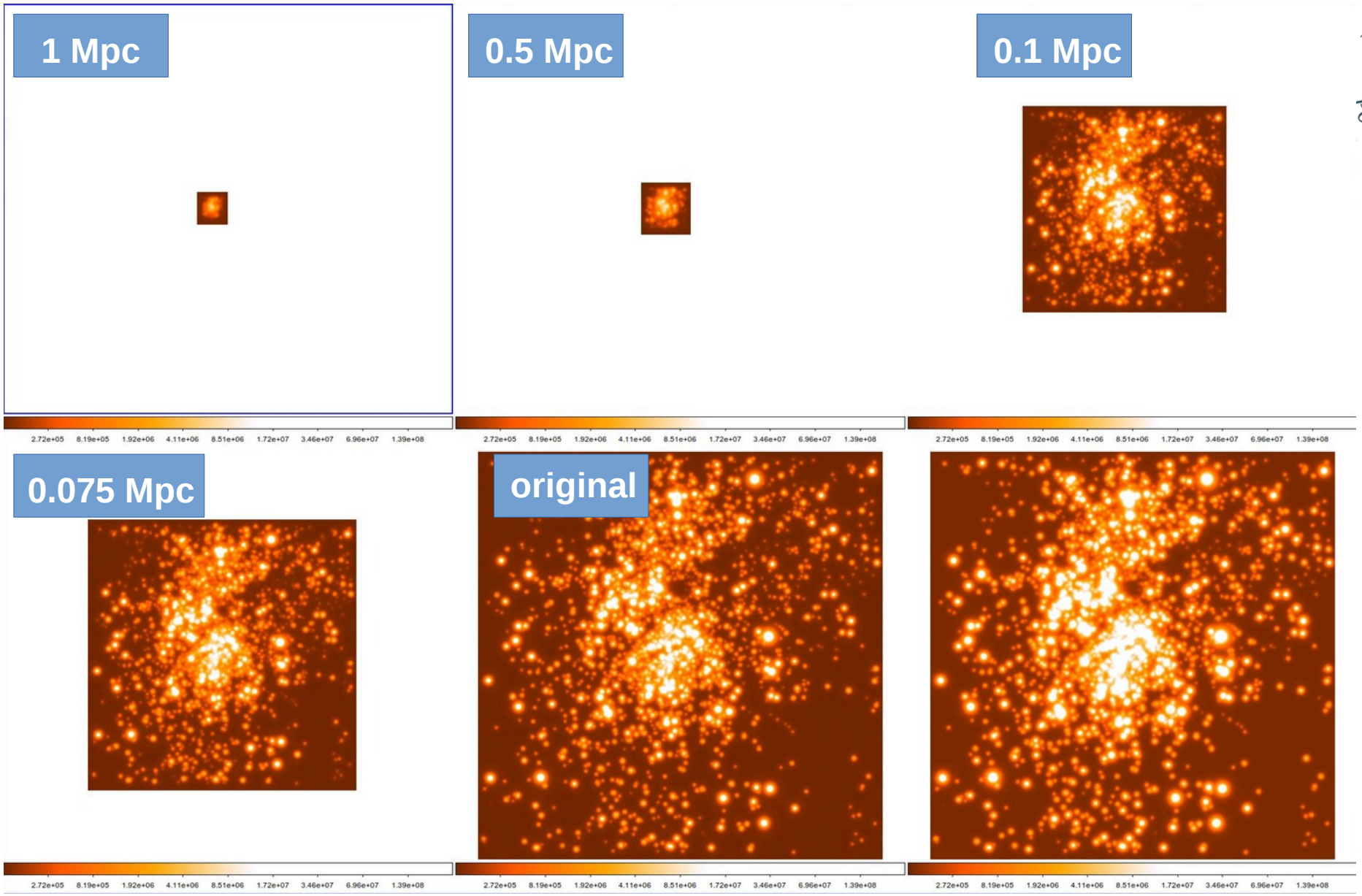
BlueSi – Data Simulation (A430)





A ‘raw’ cube:
no LSF, PSF, sky, noise
(sub-pixel placement)

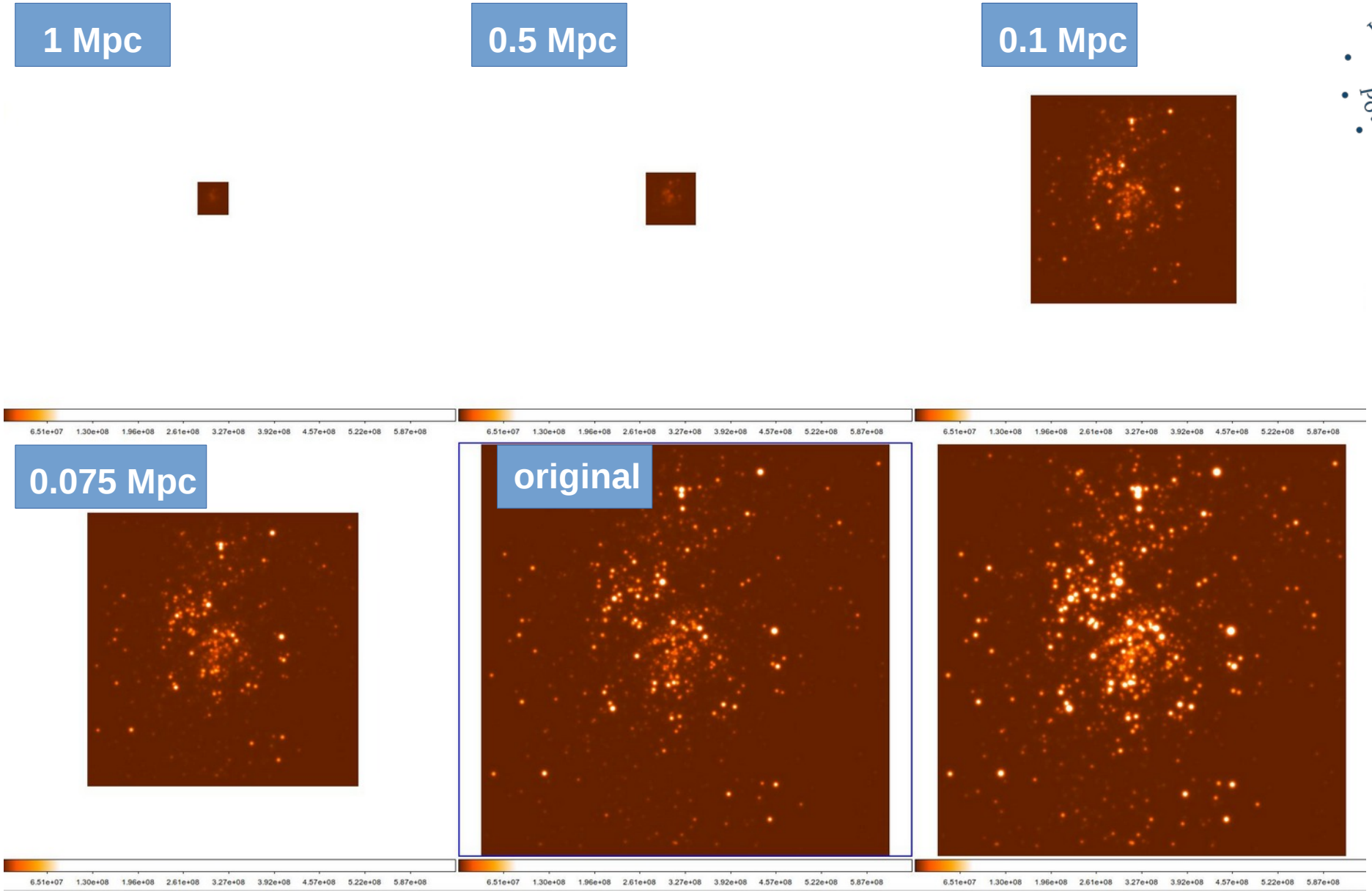
BlueSi – Data Simulation (A430)



BlueSi:
full cubes of
30 Dor at
different
distances
In MUSE mode.

Bottom right:
BlueMUSE mode

BlueSi – Data Simulation (A430)



here in linear scale.

(magnitudes scaled with distance by Norberto)

BlueSi – Data Simulation

Why?
- science feasibility tests
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What (is being done)?
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…coming up next…

How can my science interest be covered?

BlueSi – Data Simulation

What (is being done)?

```
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objectdir  = '30dor/FITS' #directory of spectra
maxcount = 10               #only plot this number of objects, -1 = inf
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vac2air = no                #apply air refraction to model spectra
extinction = yes            #apply extinction to whole frame
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model_spectra_packaging = 'Rodriguez,Norberto'
scene_file_creator      = 'Wendt,Martin'
scene_type = '30dor'

```

Another file: describing the science scene.
(unless a ‘raw’ cube is being used)

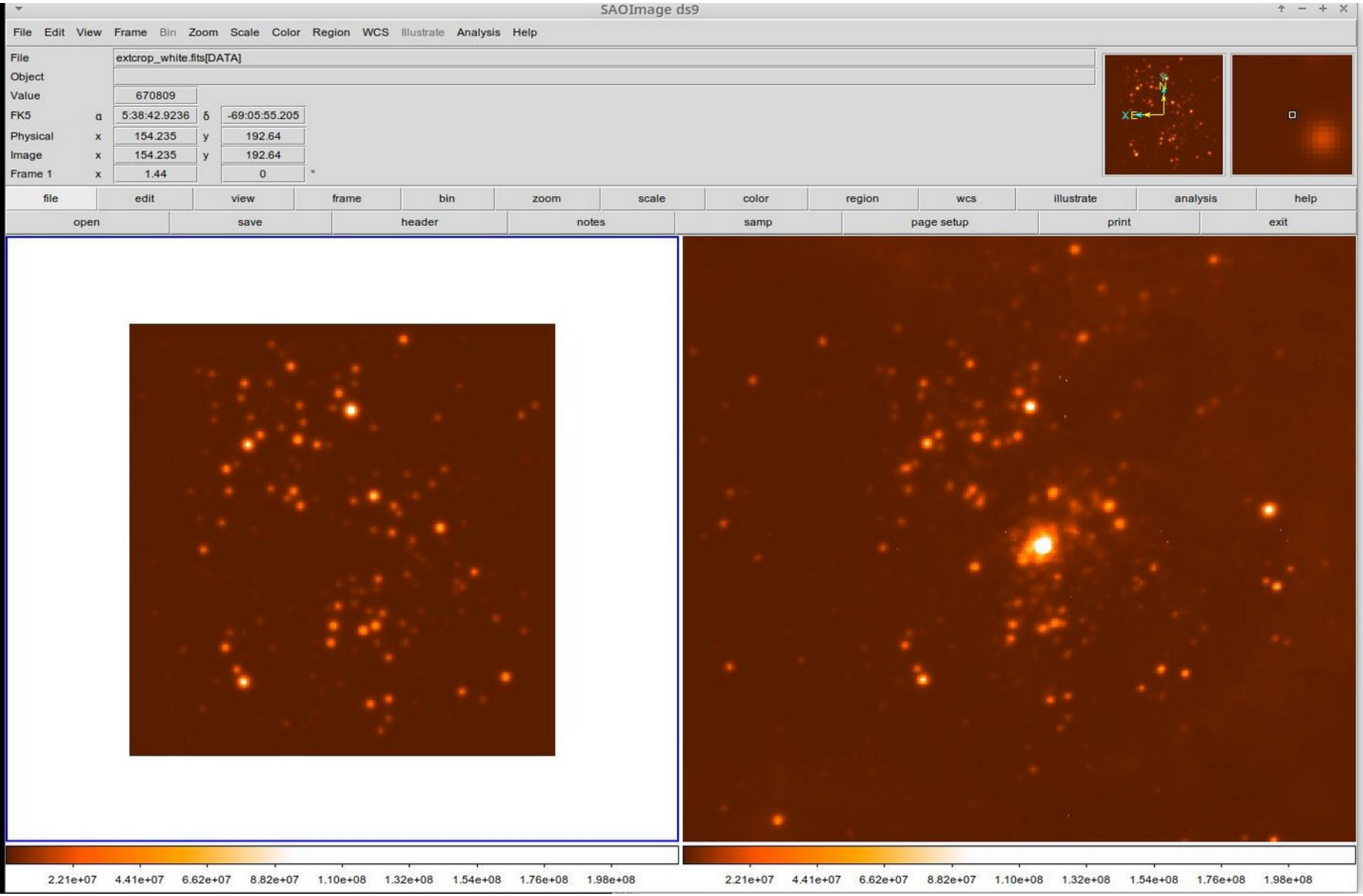
BlueSi – Data Simulation (A430)

```
#HTTP,RAJ2000,DEJ2000,F555mag,vsini,vra,model
053853.129-690702.50,84.721371,-69.117361,18.42099952697754,10.0,265.0,BG19000g425v2.vis.7.fits
053853.078-690703.49,84.721158,-69.117636,20.761999130249023,160.0,275.0,lte09400-4.50-0.0.PHOENIX-ACES-AGSS-COND-2011-HiRes.fits
053850.694-690703.33,84.711225,-69.117592,17.864999771118164,150.0,265.0,BG21000g425v2.vis.7.fits
053850.018-690705.32,84.708408,-69.118144,17.216999053955078,10.0,265.0,BG24000g425v2.vis.7.fits
053849.927-690705.28,84.708029,-69.118133,17.13599967956543,280.0,305.0,BG25000g425v2.vis.7.fits
053849.660-690704.32,84.706917,-69.117867,20.481000900268555,70.0,265.0,lte10000-4.50-0.0.PHOENIX-ACES-AGSS-COND-2011-HiRes.fits
053848.435-690704.69,84.701812,-69.117969,18.312999725341797,180.0,235.0,BG20000g425v2.vis.7.fits
053852.699-690651.55,84.719579,-69.114319,22.80500030517578,130.0,295.0,lte06900-4.50-0.0.PHOENIX-ACES-AGSS-COND-2011-HiRes.fits
053847.602-690705.85,84.698342,-69.118292,17.128999710083008,420.0,285.0,BG25000g425v2.vis.7.fits
053849.853-690657.94,84.707721,-69.116094,18.555999755859375,10.0,295.0,BG19000g425v2.vis.7.fits
```

A plain CSV input file + all the required synthetic spectra
- wavelength coverage BlueMUSE (+MUSE)
- spectral resolution / sampling
- air / vacuum

\+ physical models / algorithms
- extinction (universal)
- rotation broadening?
- LAE model? (Tanya, John)

BlueSi – Data Simulation (A430)

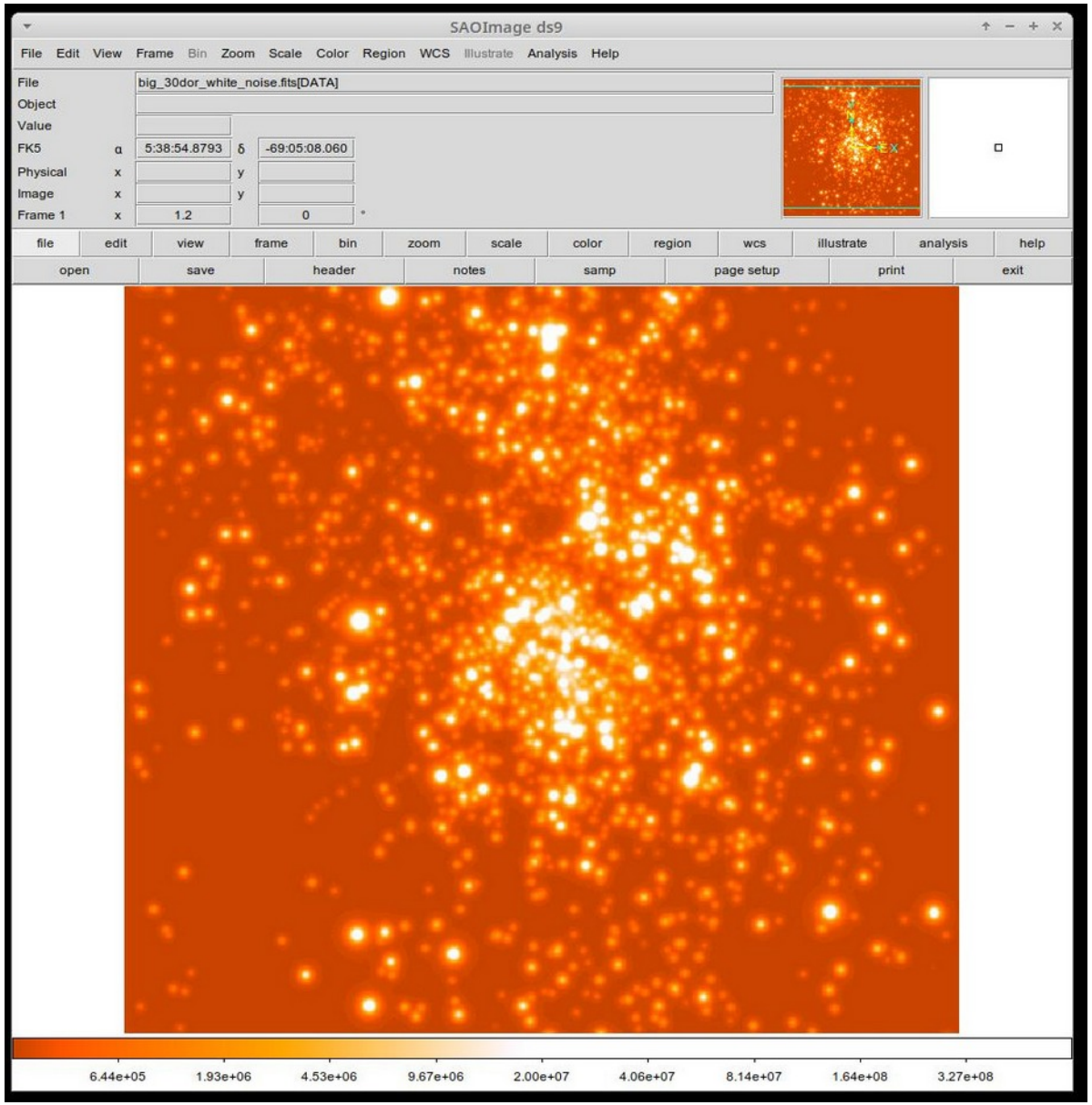


30 Dor scene #1 from Norberto

left:BlueSi
right: MUSE

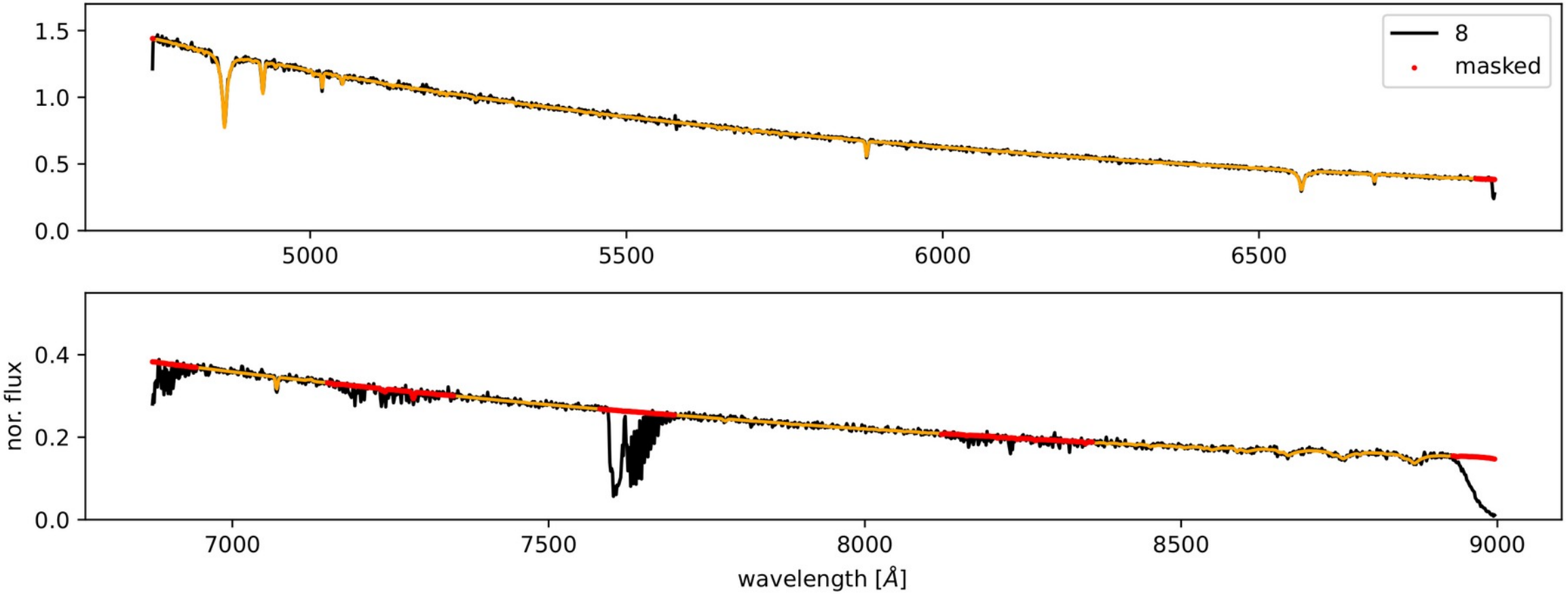
Scene based on fully analysed objects only.

BlueSi – Data Simulation (A430)



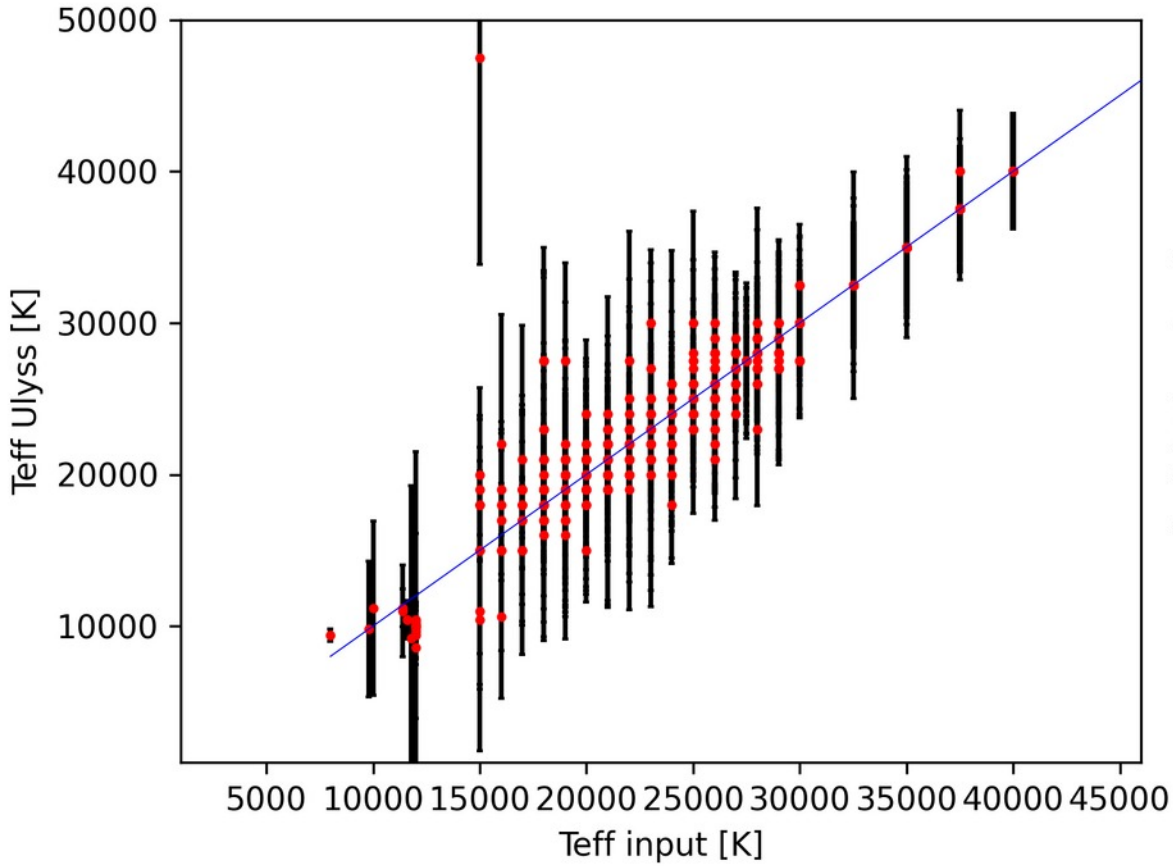
BlueSi now:
based on photometric HST catalog.
Estimation of the stellar parameters based on the colors and synthetic isochrones (no Teff, log(g)).
~ 3,000 stars (Tlusty + PHOENIX)

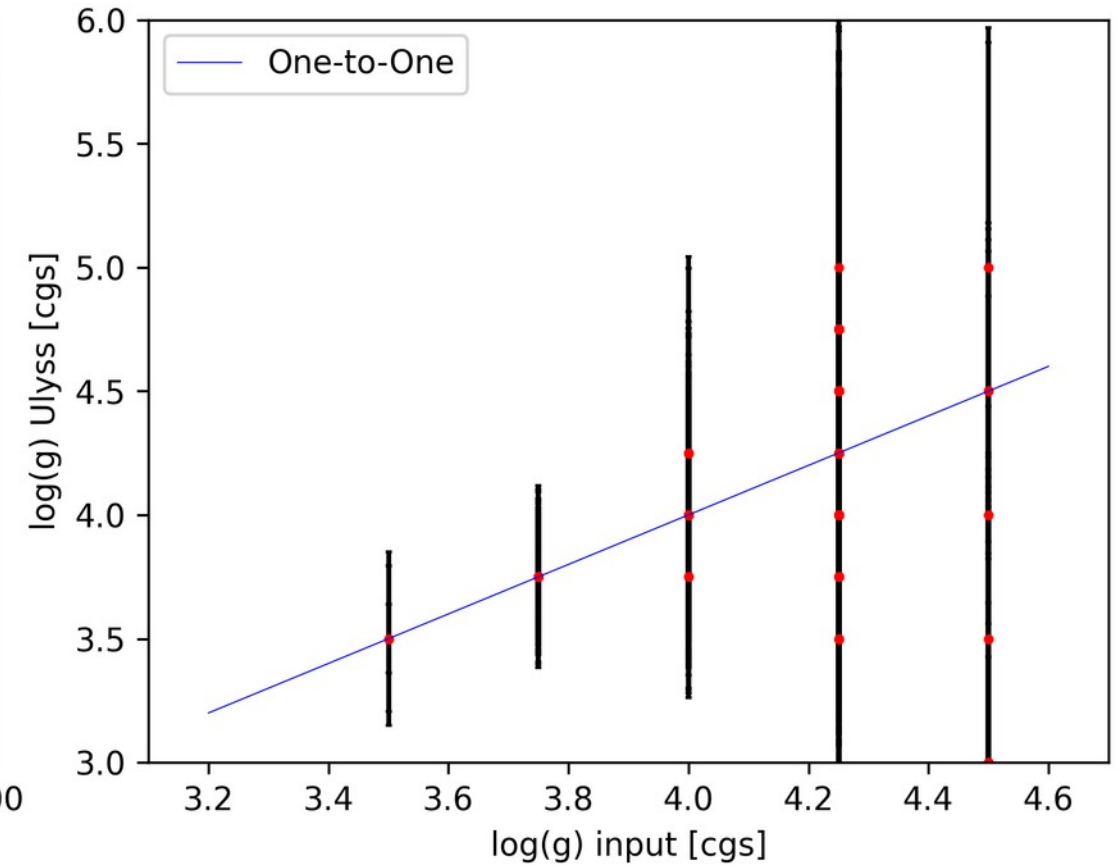
BlueSi – Data Simulation (A430)



Exemplary extracted spectrum from BlueSi cube in MUSE mode and model fit by Norberto.

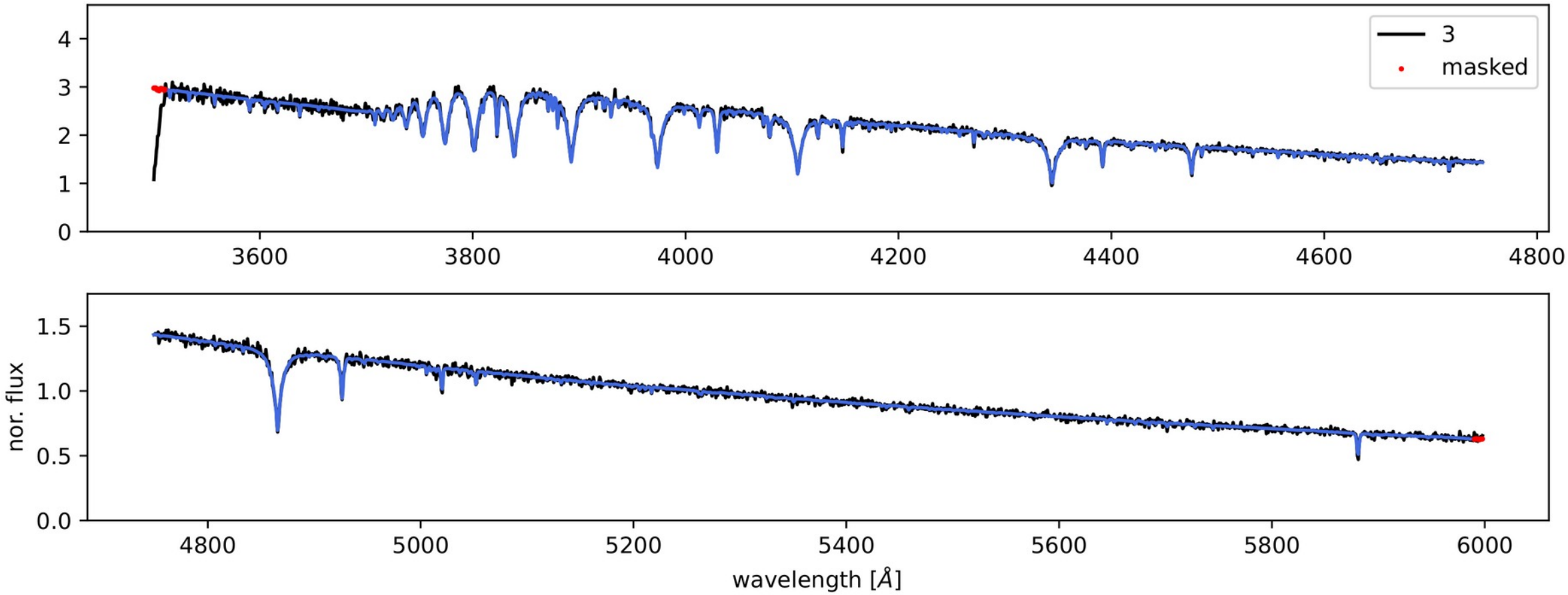
BlueSi – Data Simulation (A430)





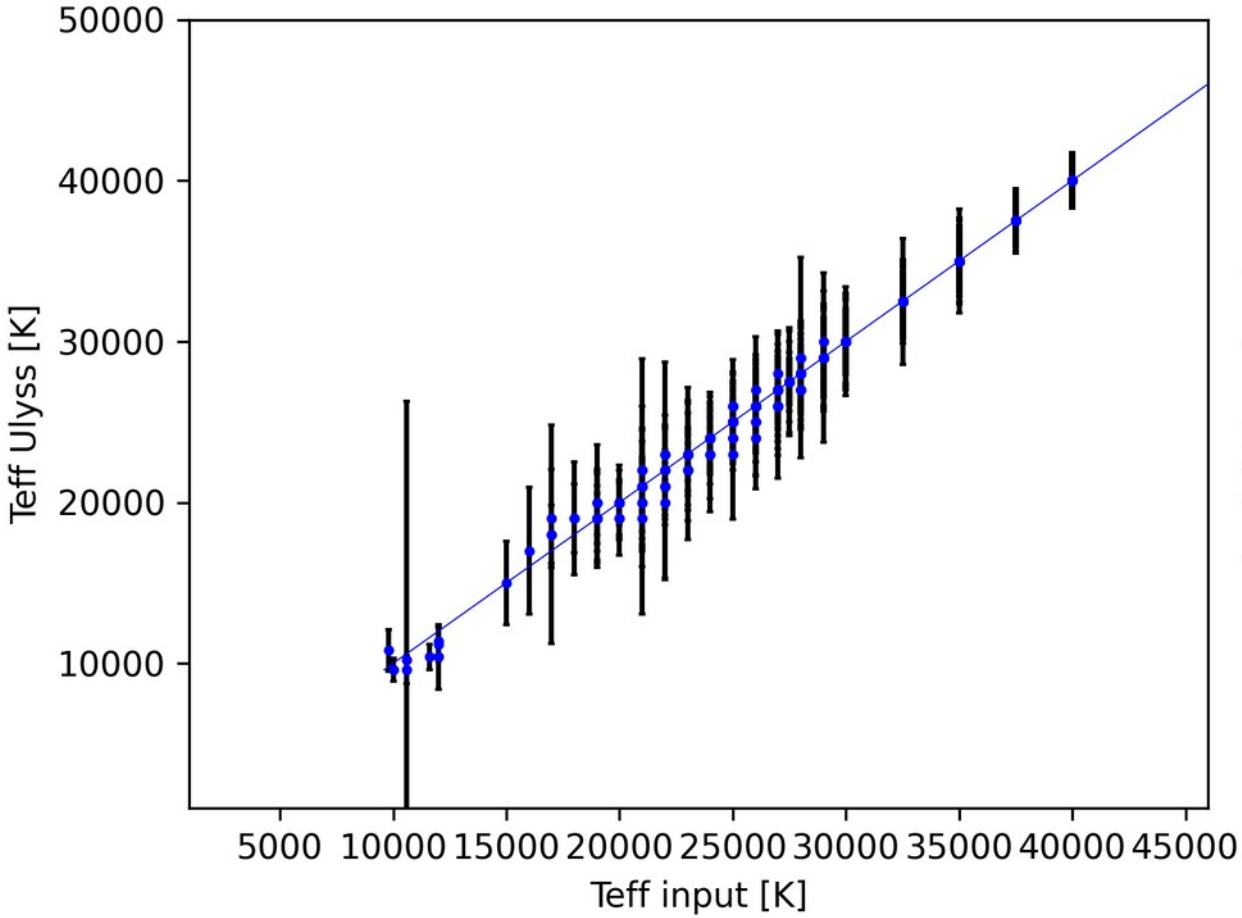
First input-output comparison for MUSE specs by Norberto.

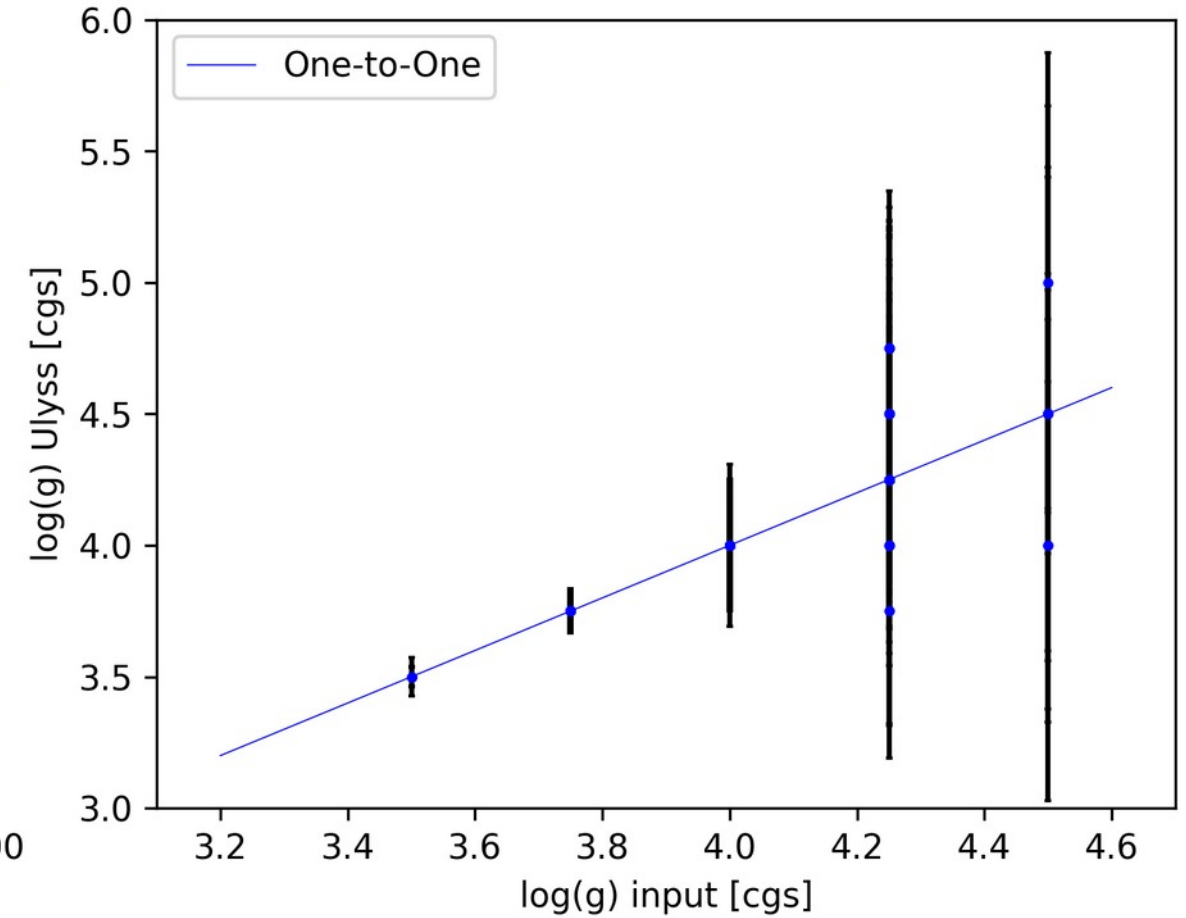
BlueSi – Data Simulation (A430)



Exemplary extracted spectrum from BlueSi cube in amazing BlueMUSE mode and model fit by Norberto.

BlueSi – Data Simulation (A430)





Input-output comparison for the BlueMUSE cube by Norberto.

BlueSi – Data Simulation (A430)

What is next?

- test methods/tools/science on exisiting simulations (stars)
- extend 30 Dor (diffuse gas)
- CREATE NEW SCIENCE objects (SpinSim?, other input)
- Simulation of:
  - → specific technical parameters
    - * ADC?
    - * spectral/spatial variation LSF/PSF
    - * rectangular pixels
  - → specific observing conditions
    - * exposure times
    - * sky models