

PACS SPECTROMETER SPATIAL CALIBRATION

A. Contursi

Herschel Calibration workshop
18-20 January ESAC

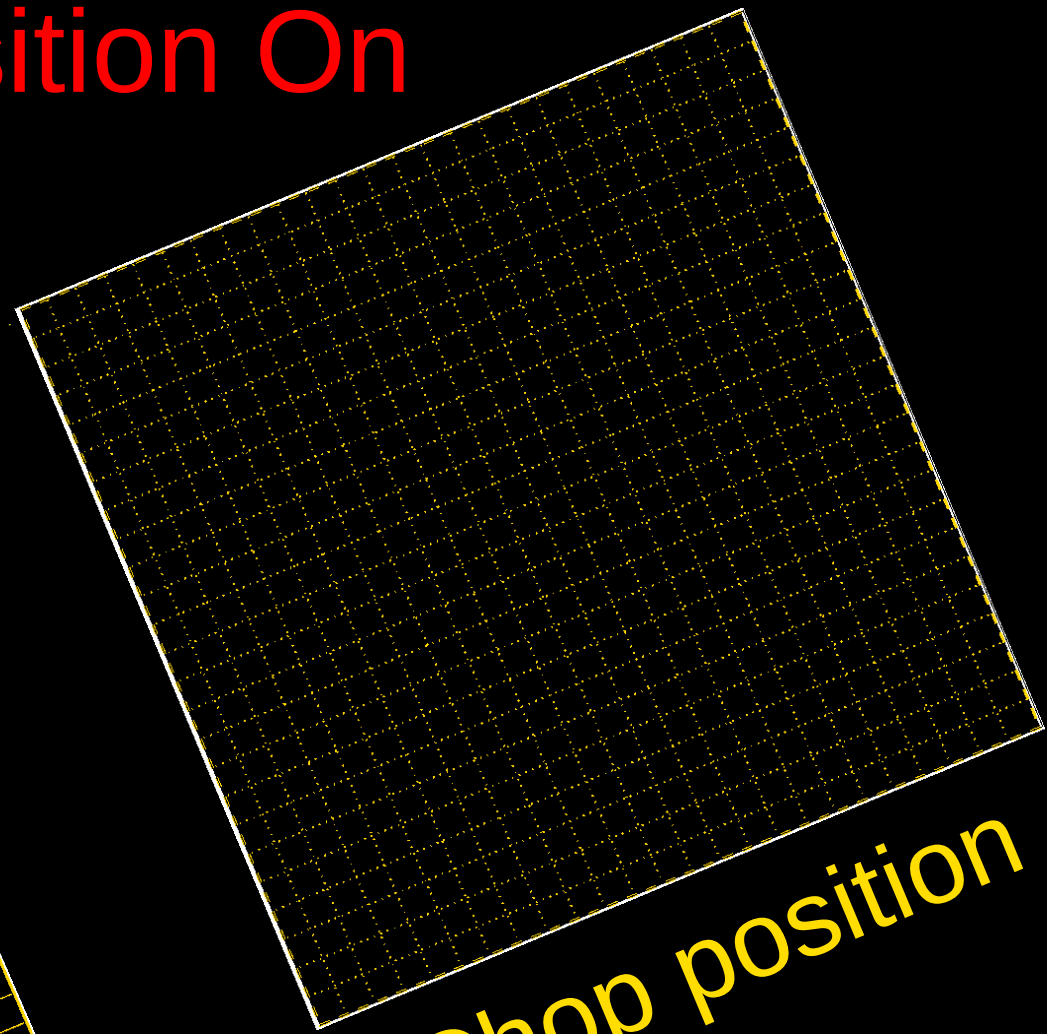
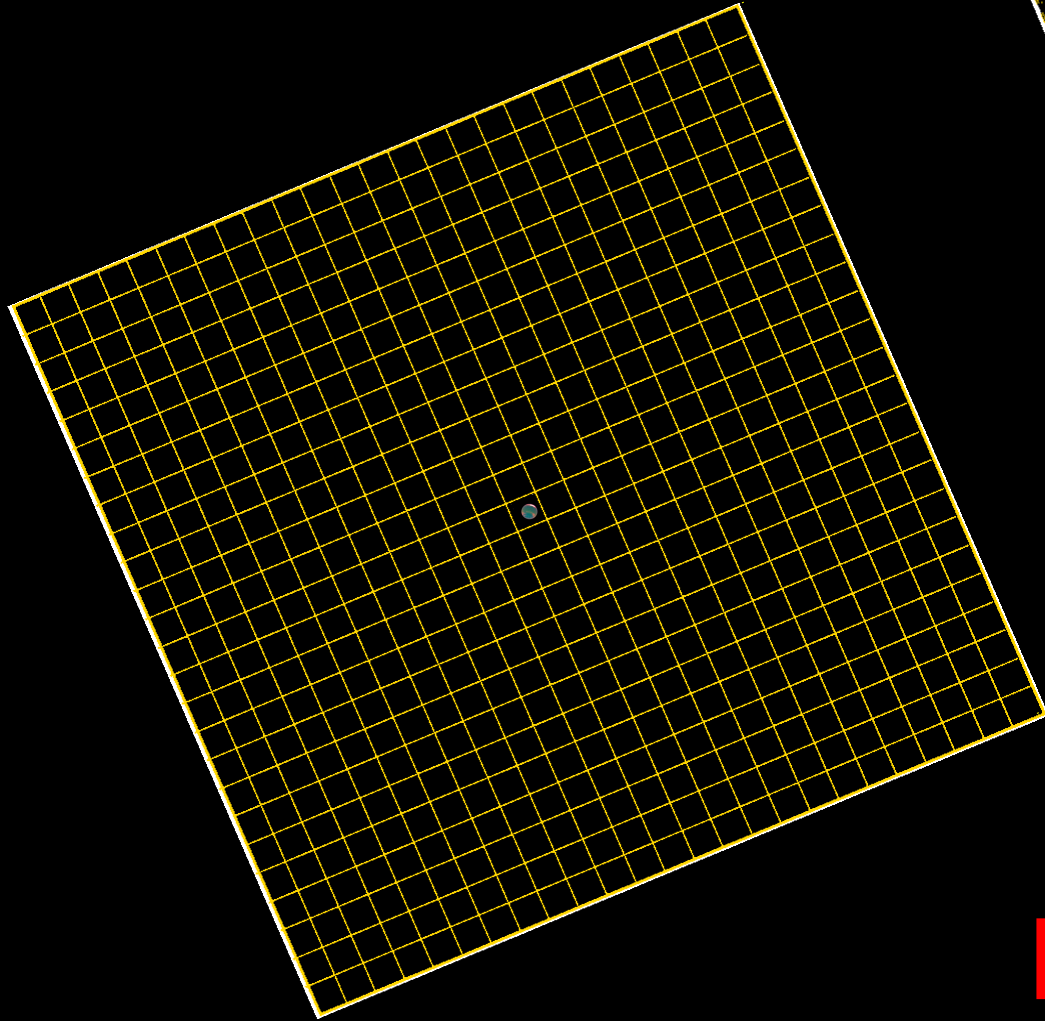
Spatial Calibration Observations summary

- 40x40 chopped raster at chopper position 0 on Neptune, step size both direction 2.5 arcsec
- 25x25 Chopped raster at chopped position \pm Small, same step size
- 25x25 Chopped raster at chopped position \pm Medium, same step size
- 25x25 Chopped raster at chopped position \pm Large, same step size

All 7 on Neptune at 62 and 125 μm

Example of one 25x25 raster Execution

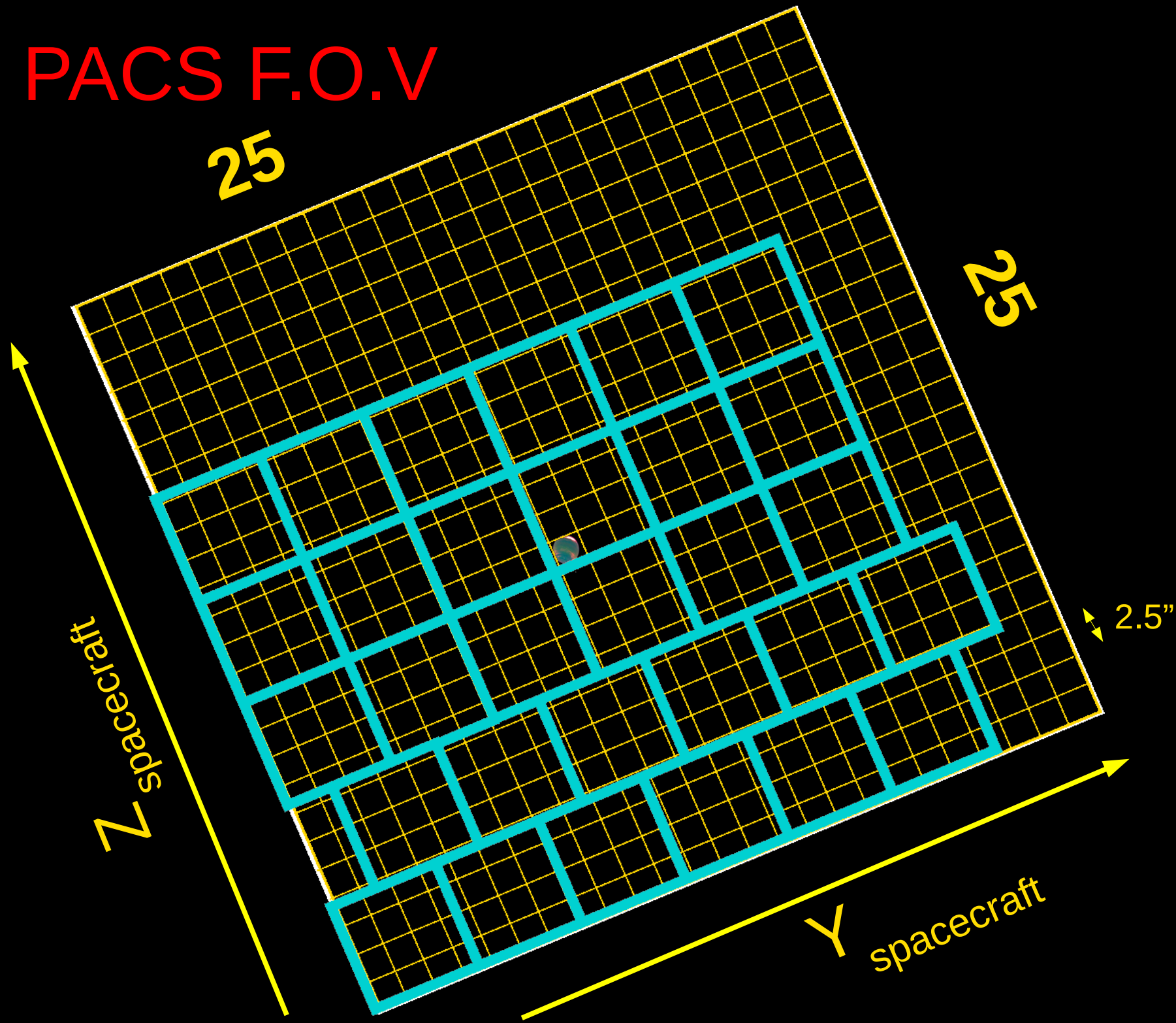
For each raster position On
and OFF



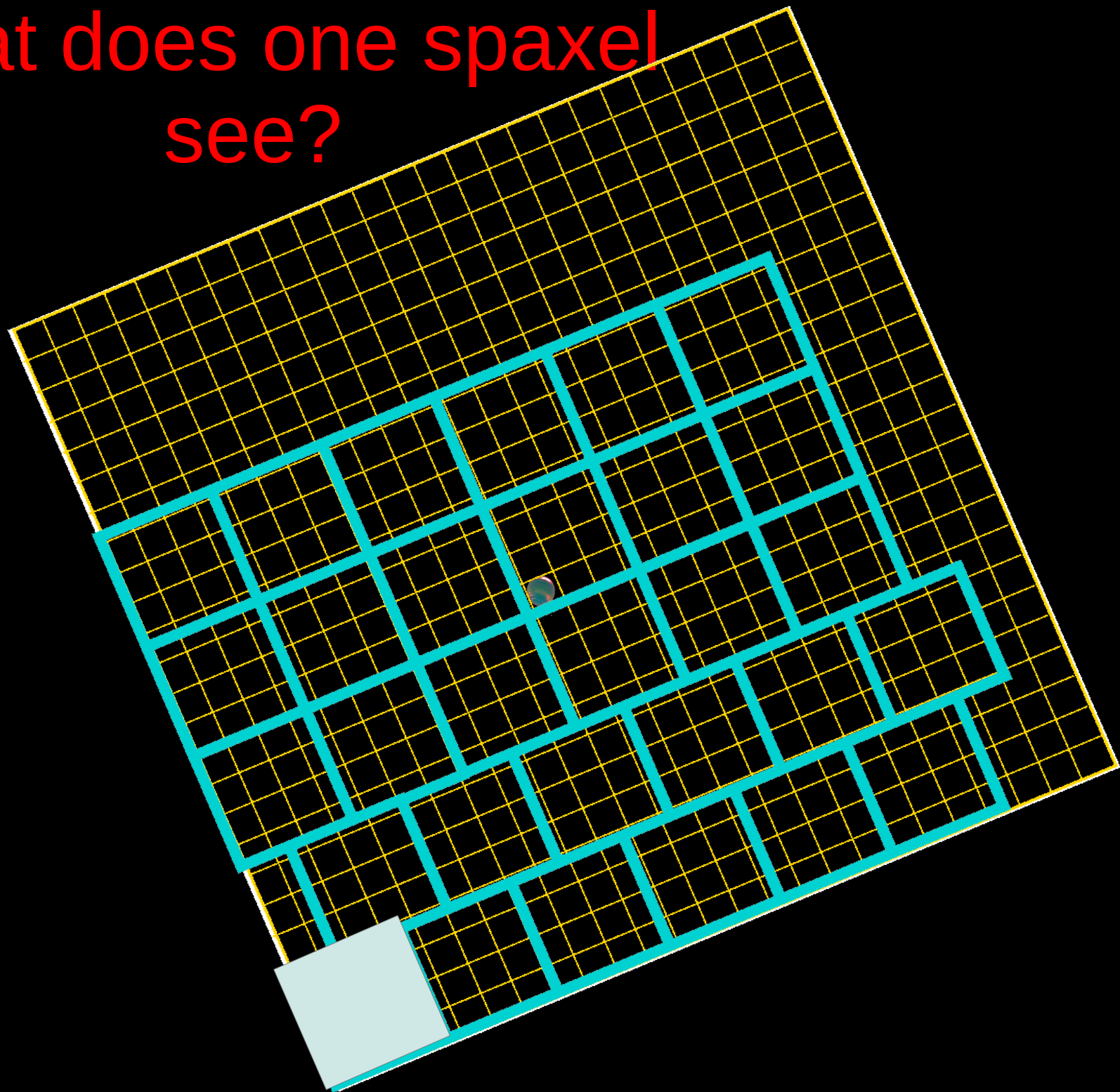
Chop position

No Nodding

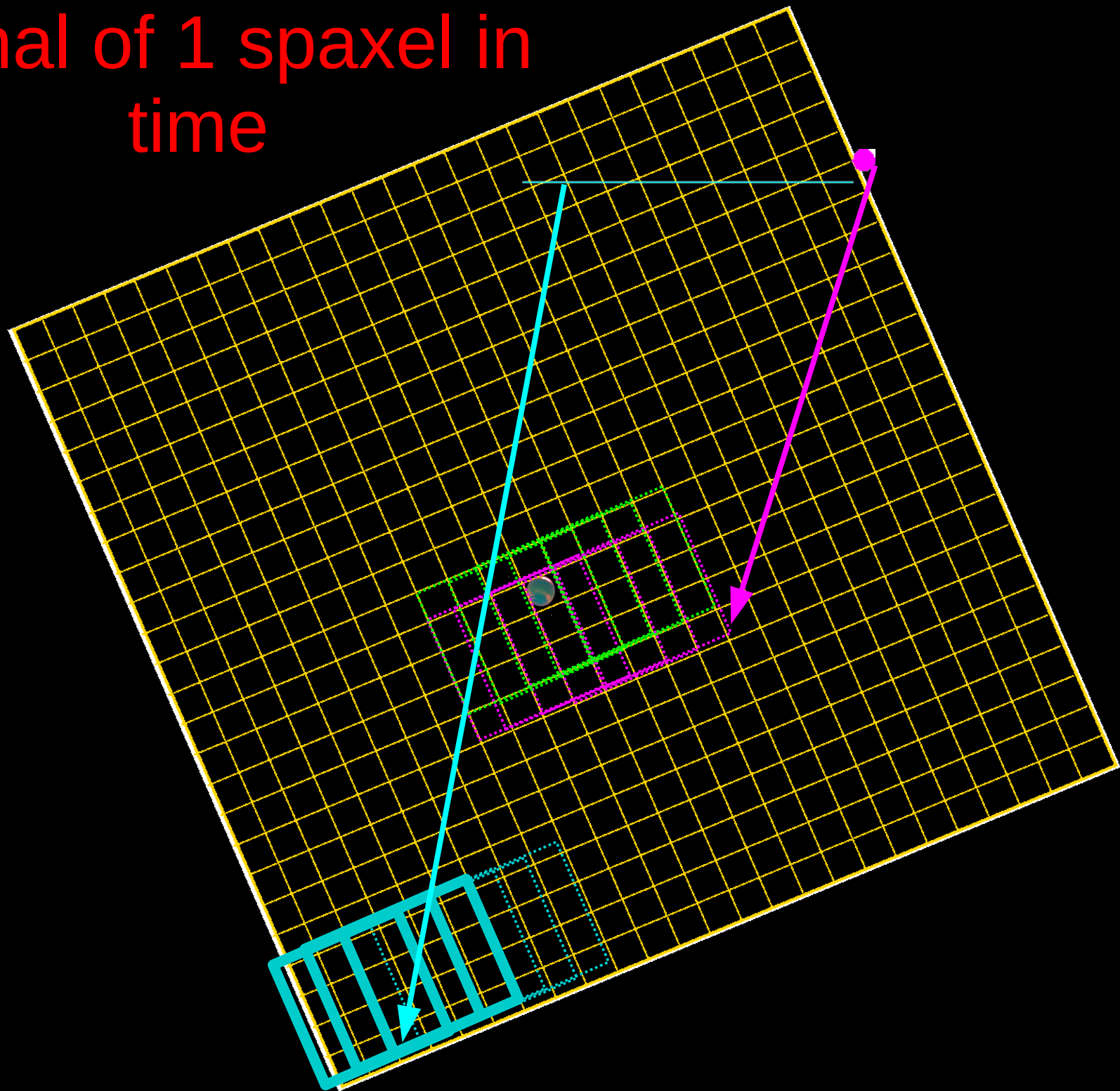
PACS F.O.V

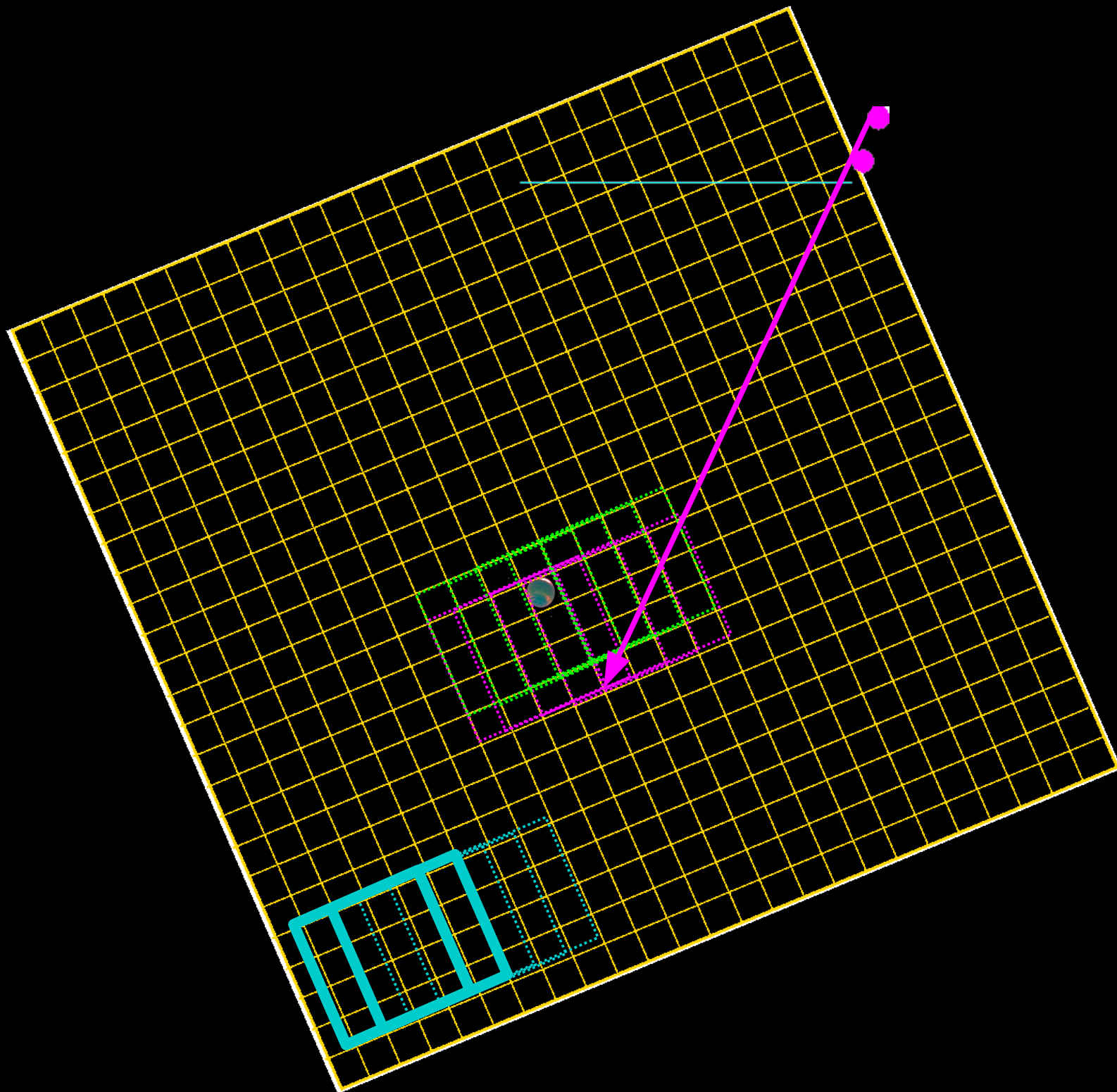


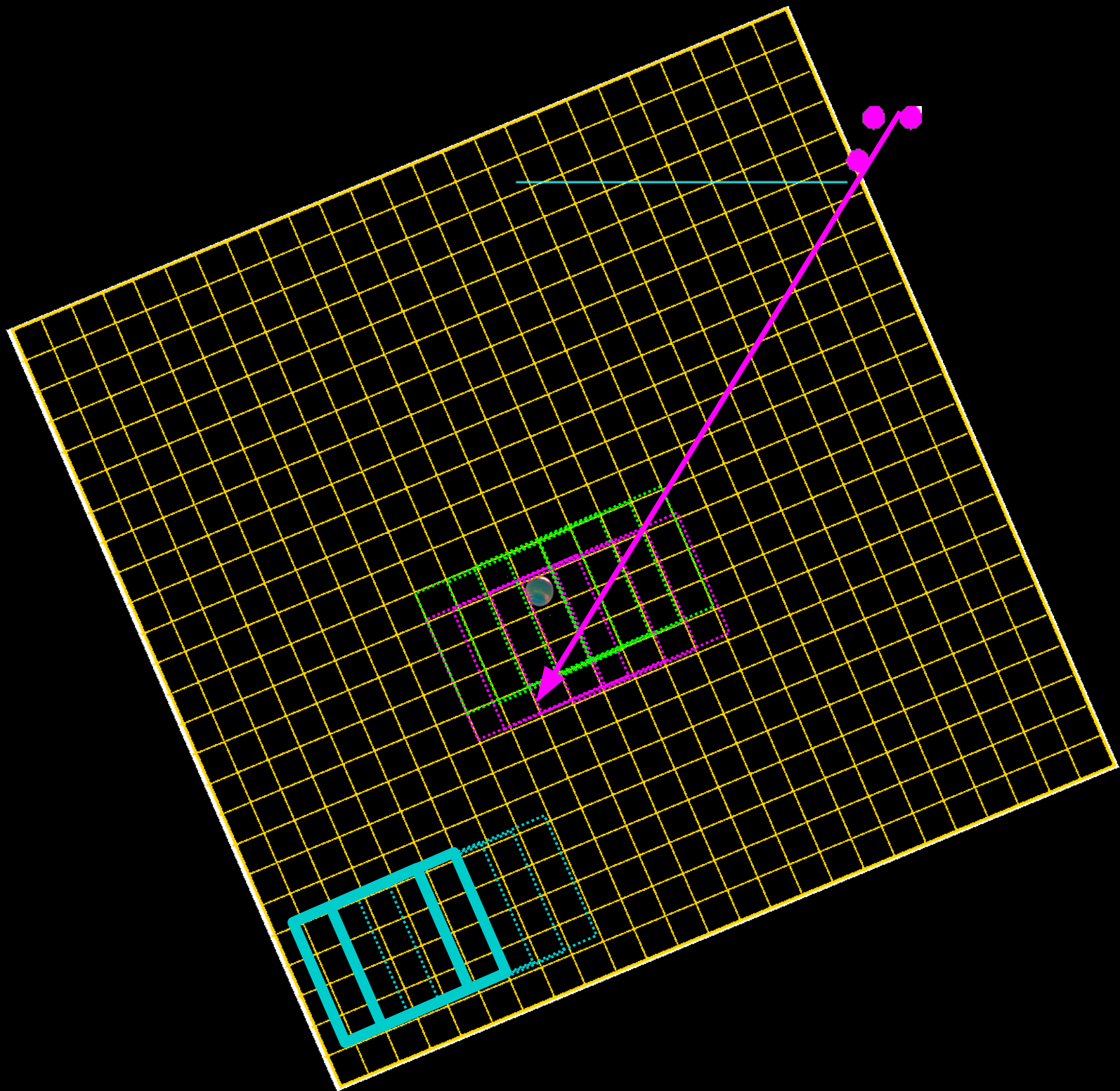
What does one spaxel
see?

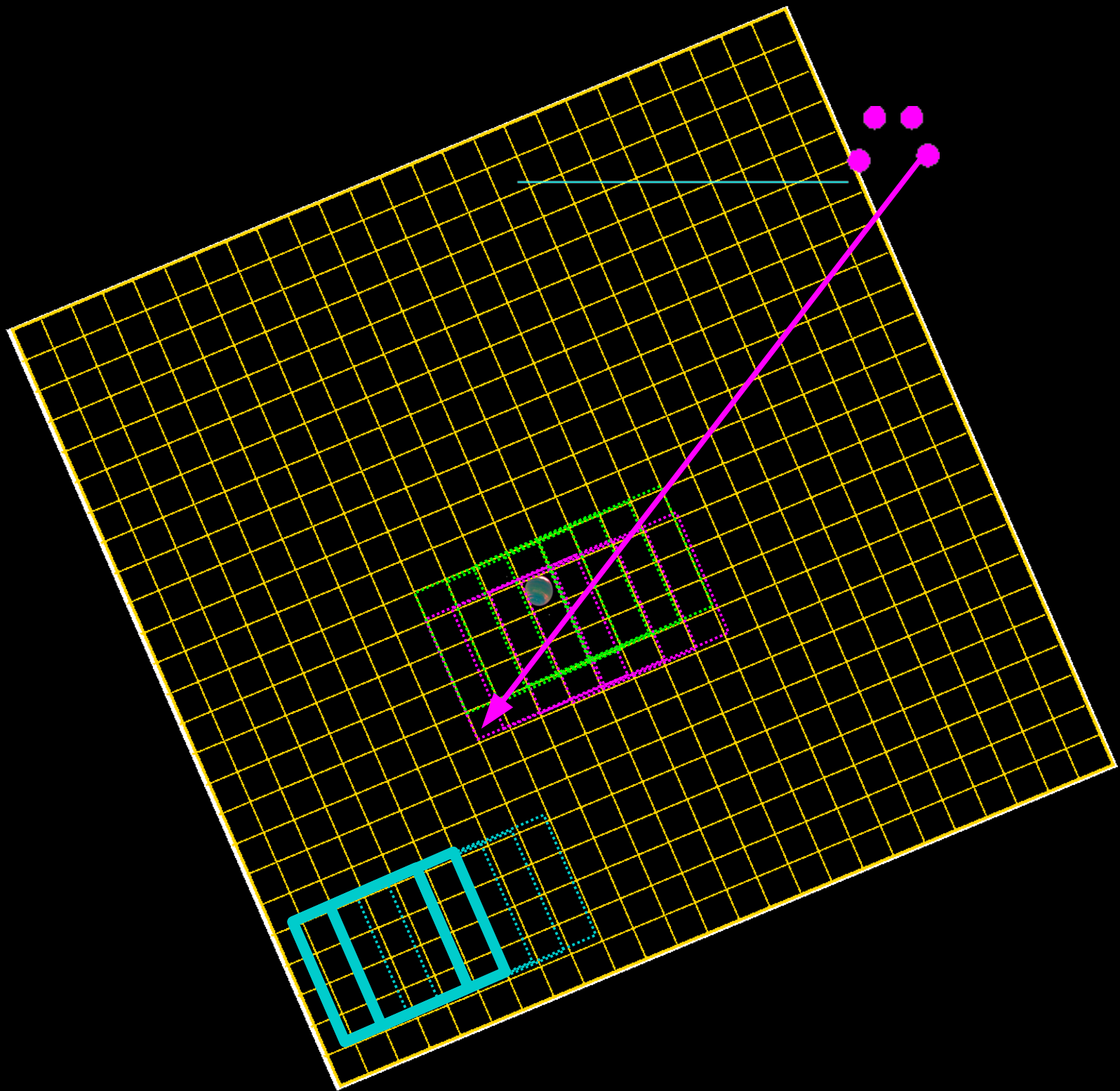


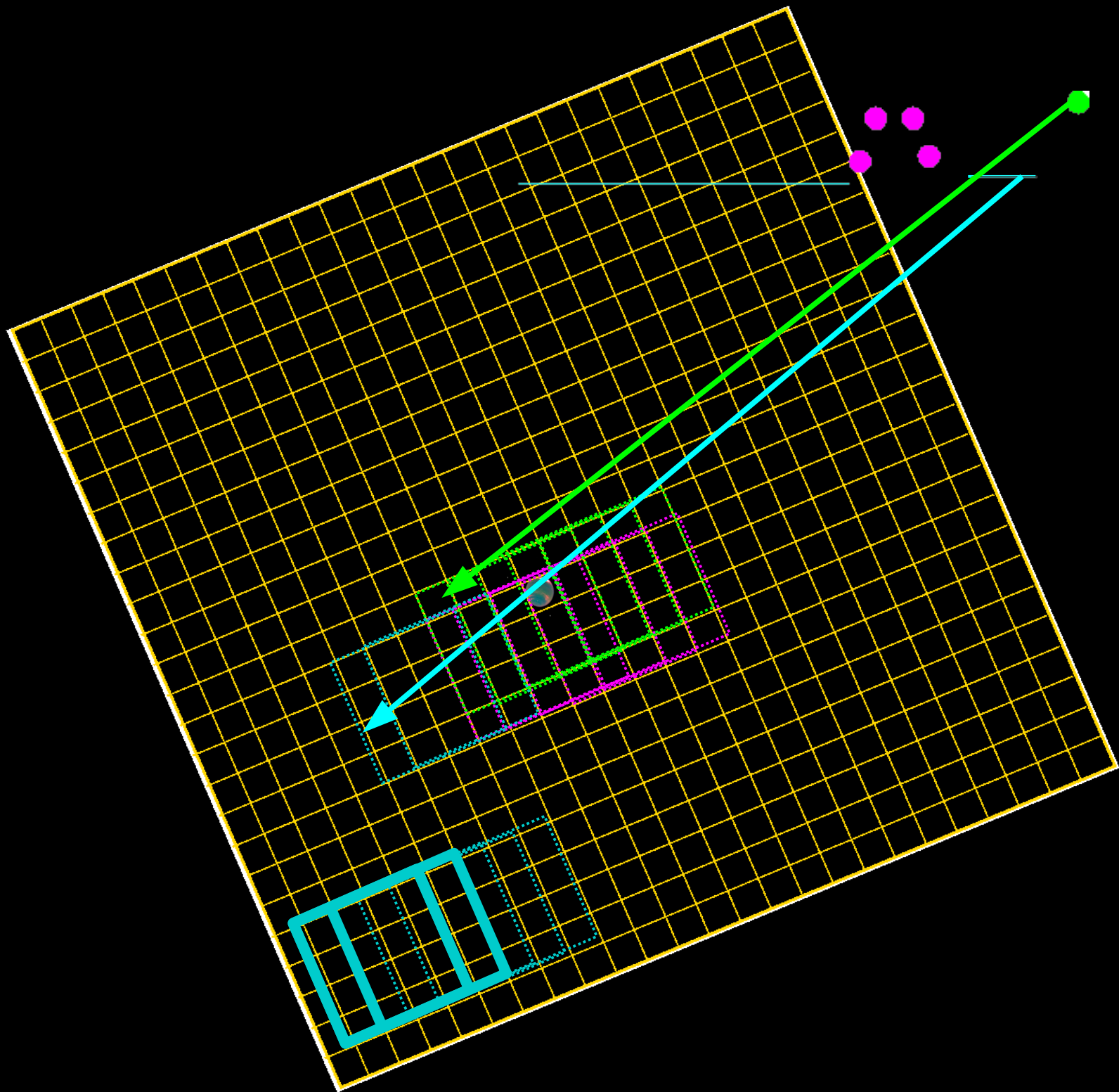
Signal of 1 spaxel in
time

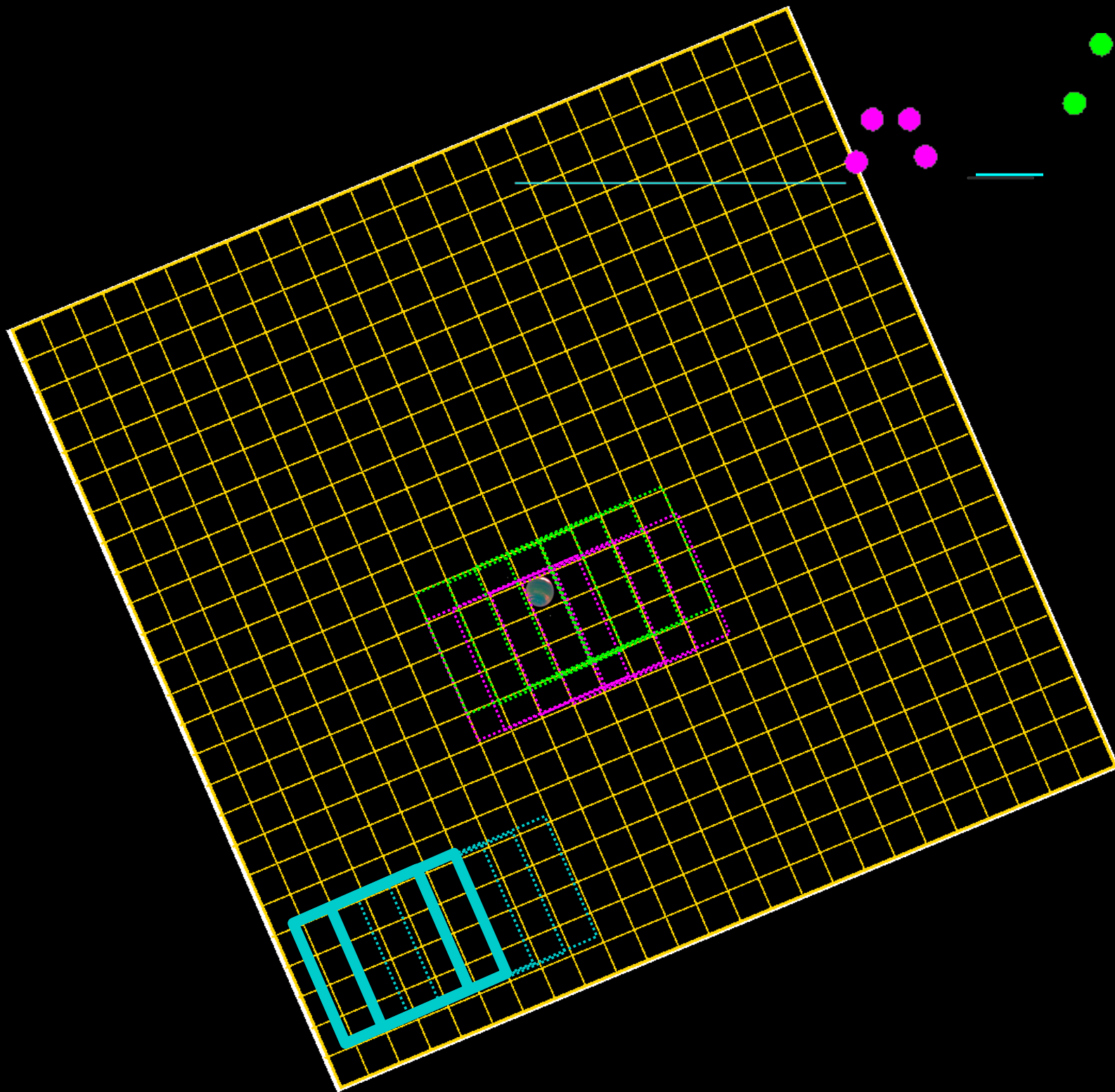




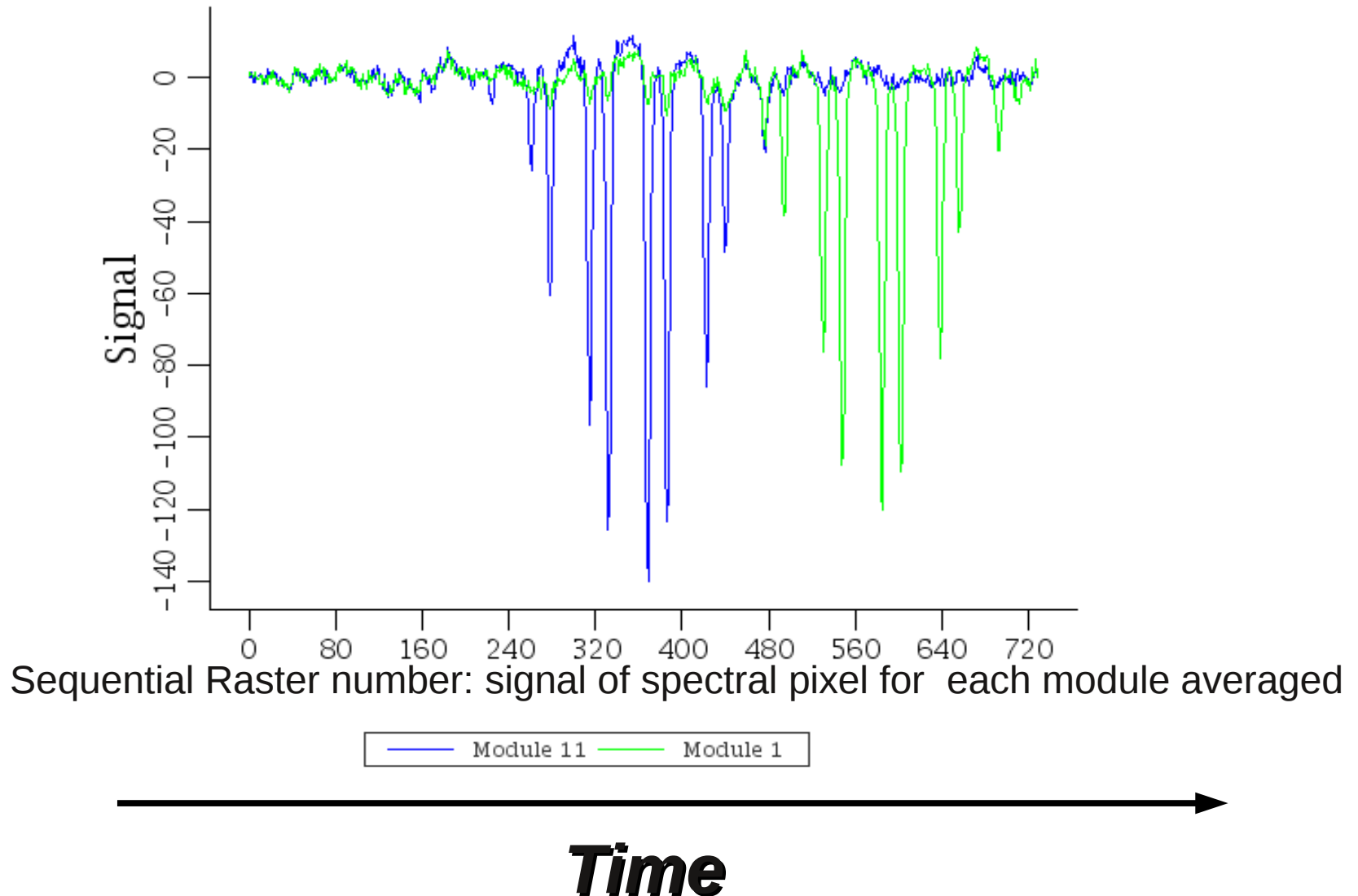




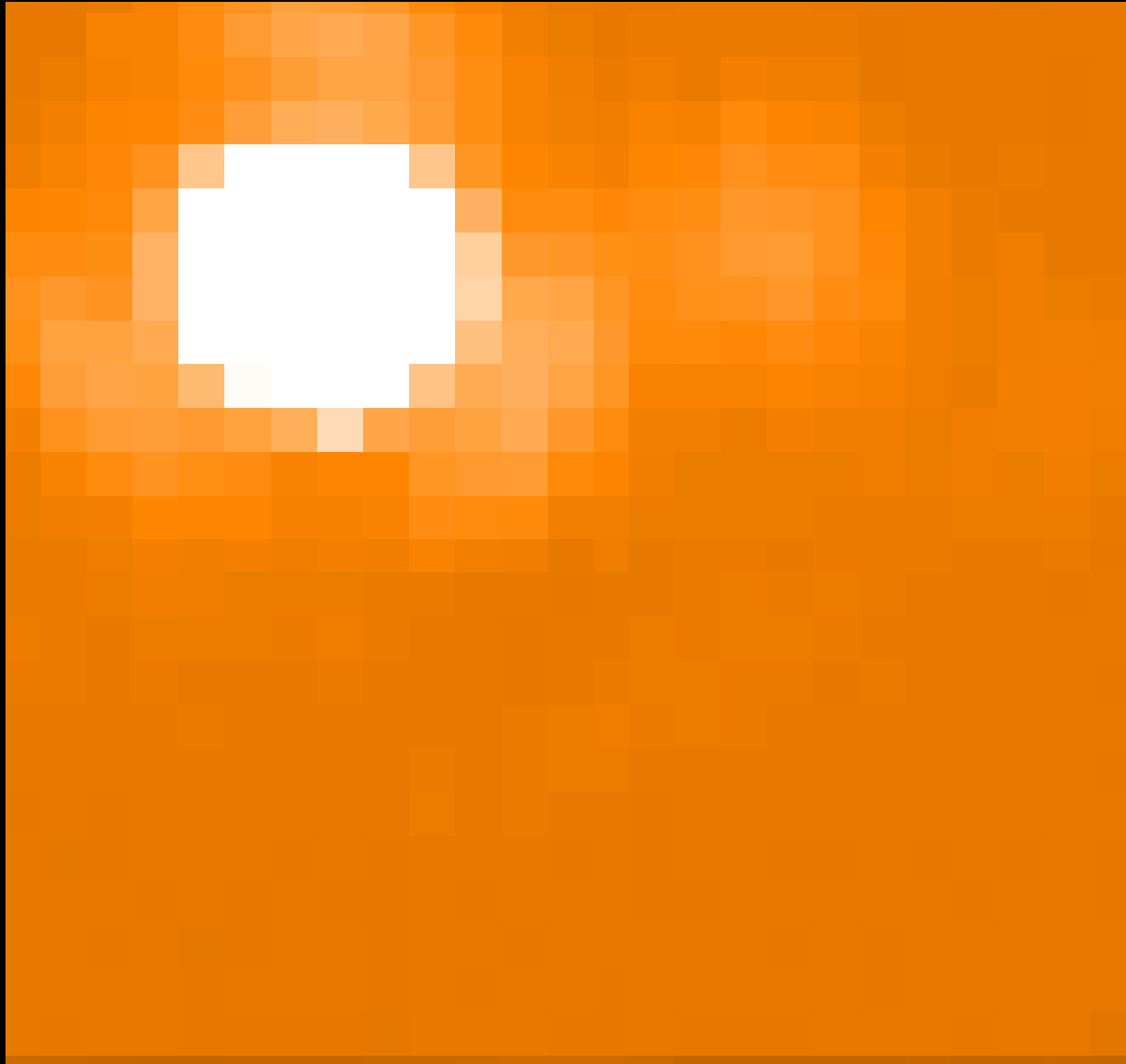




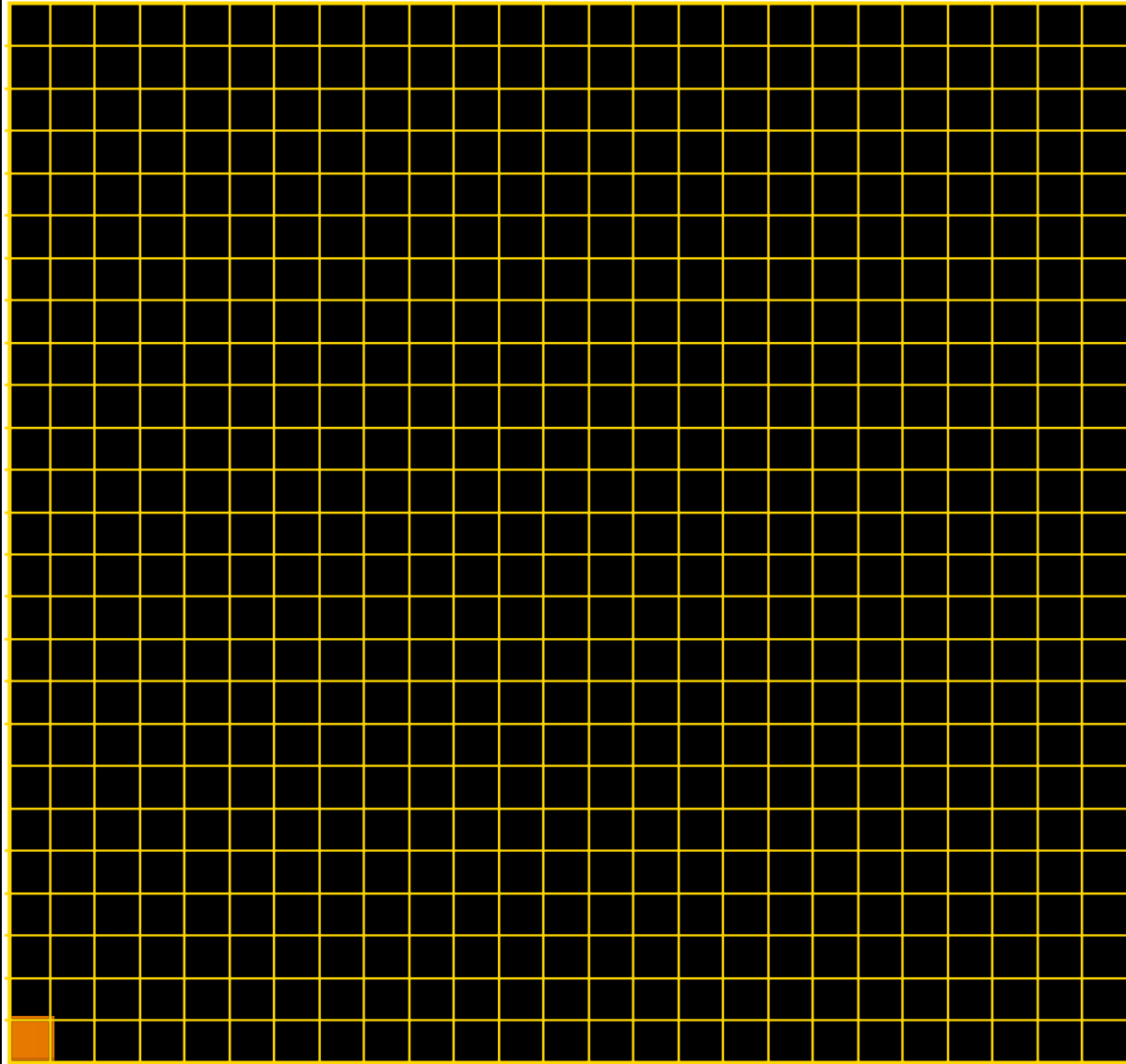
Example of (inverted) signal seen from two spaxels during the raster execution



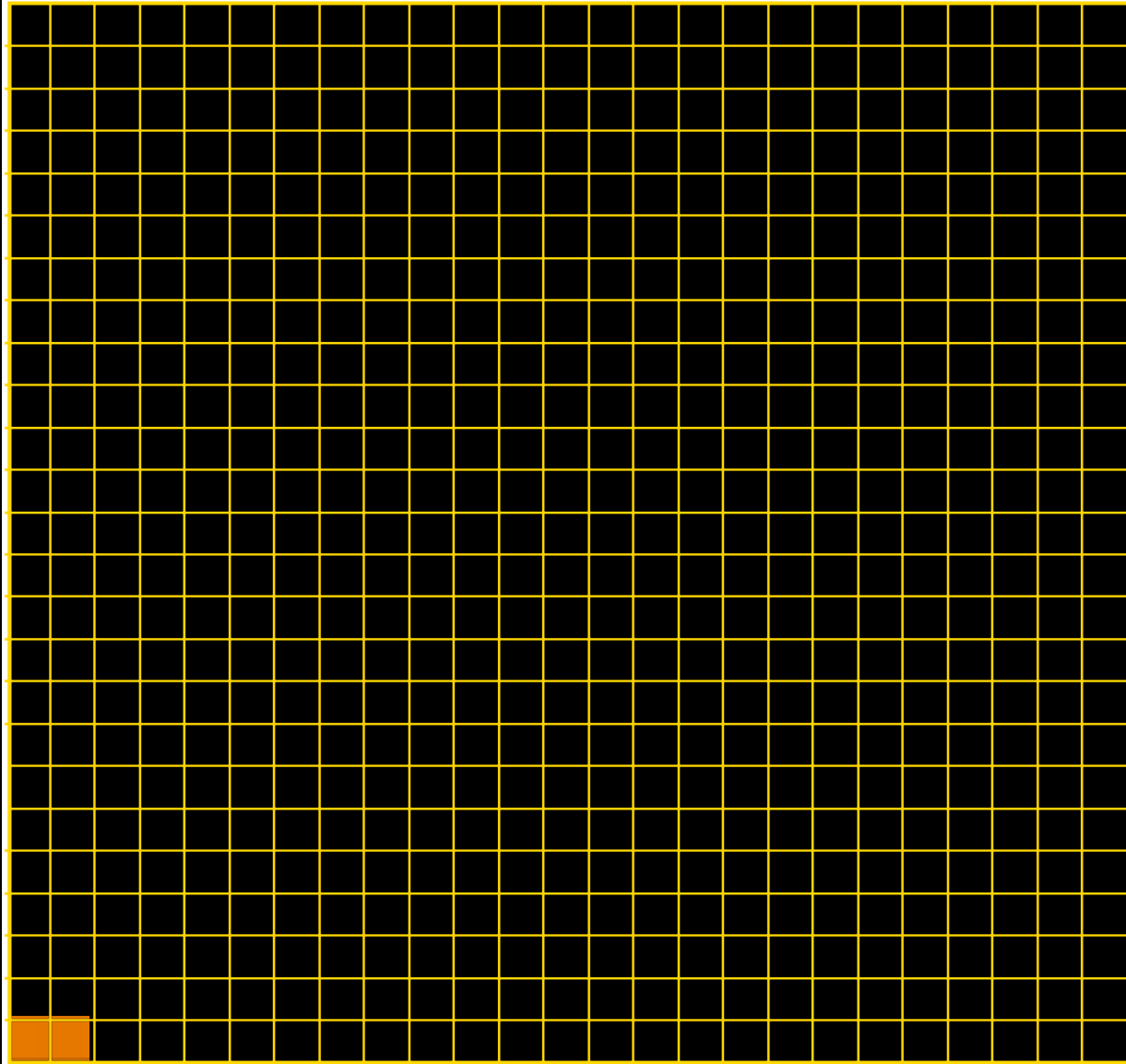
Reconstruction of what each spaxel sees



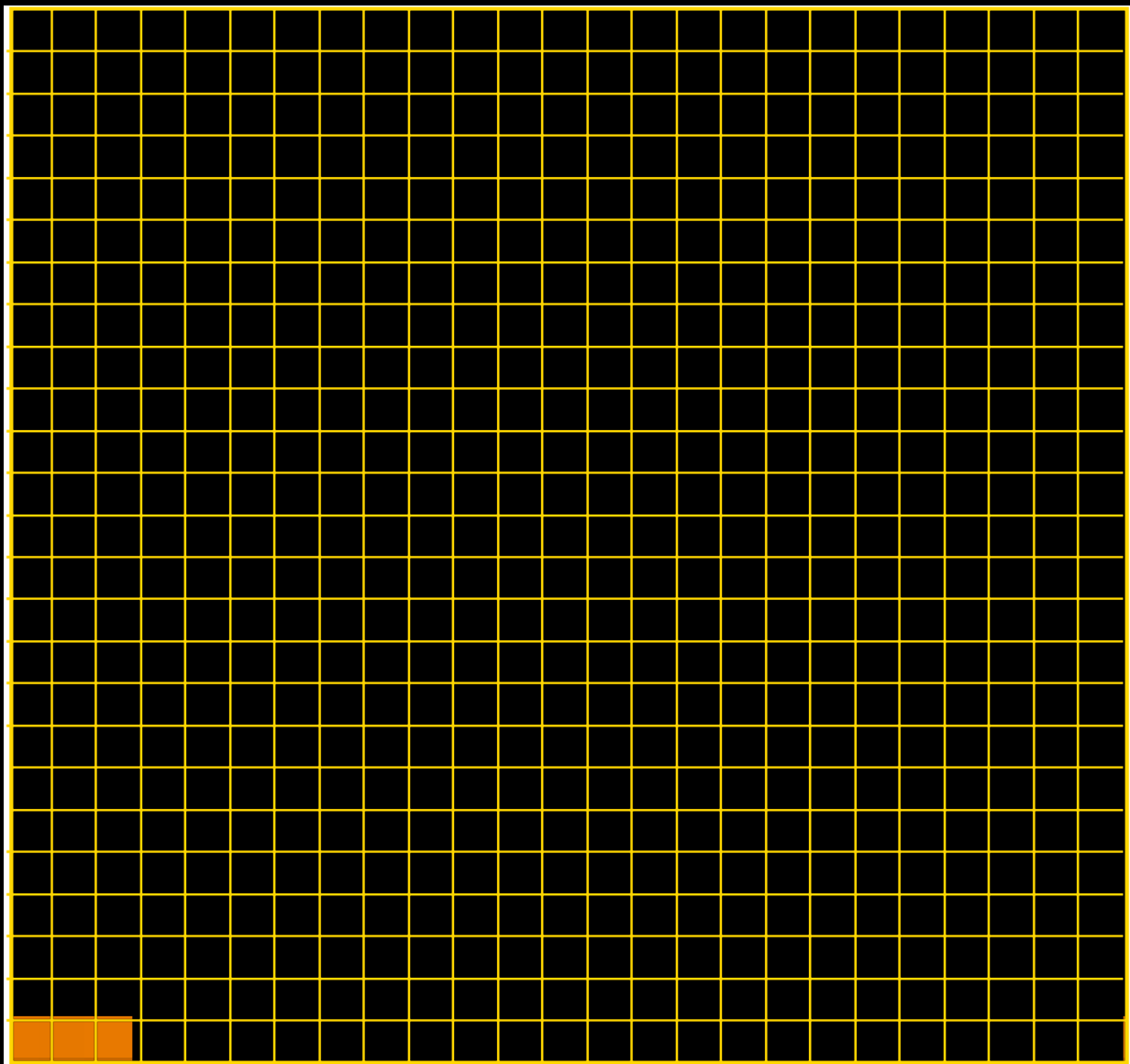
First Raster Position



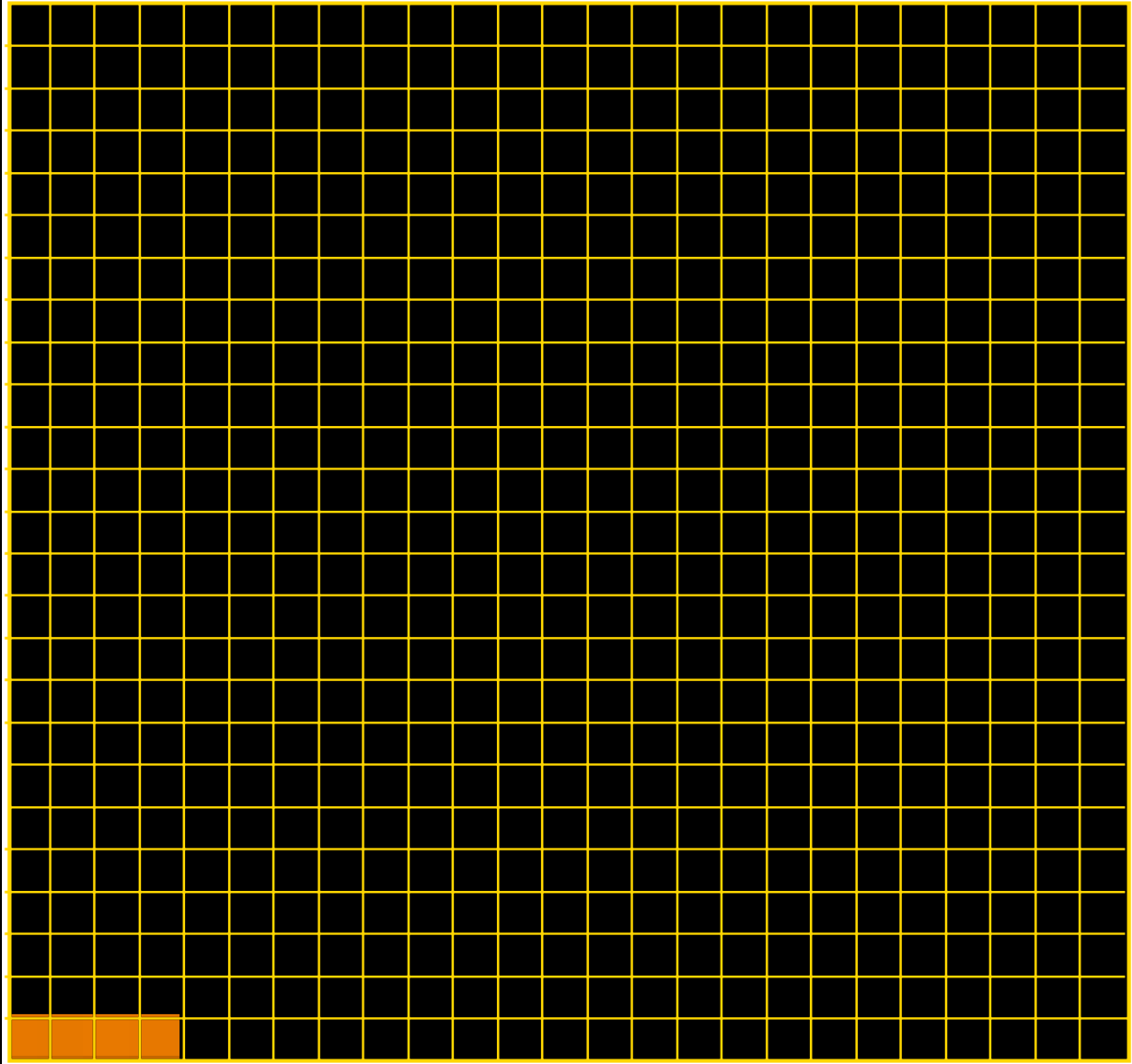
Second Raster Position



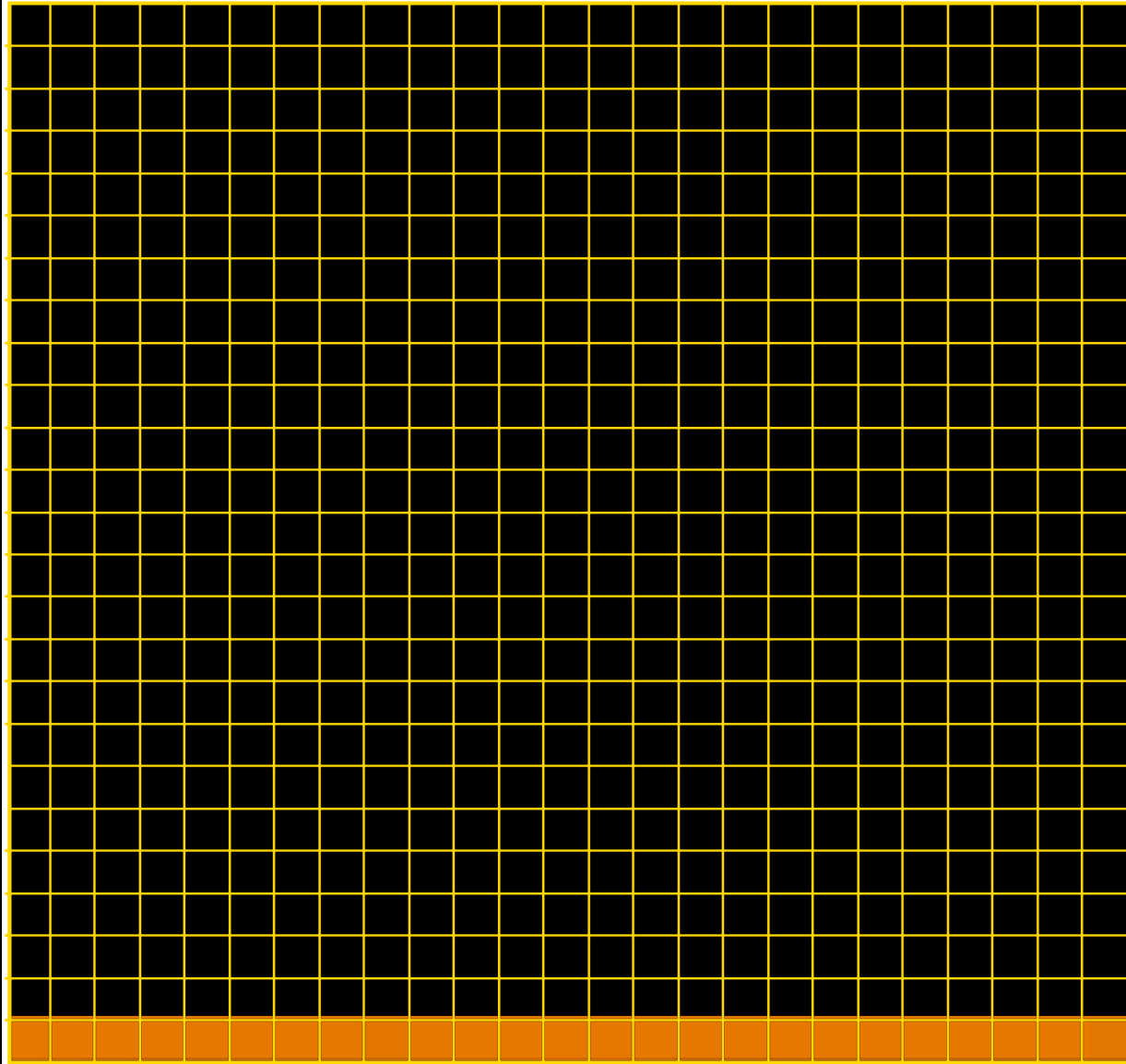
3....



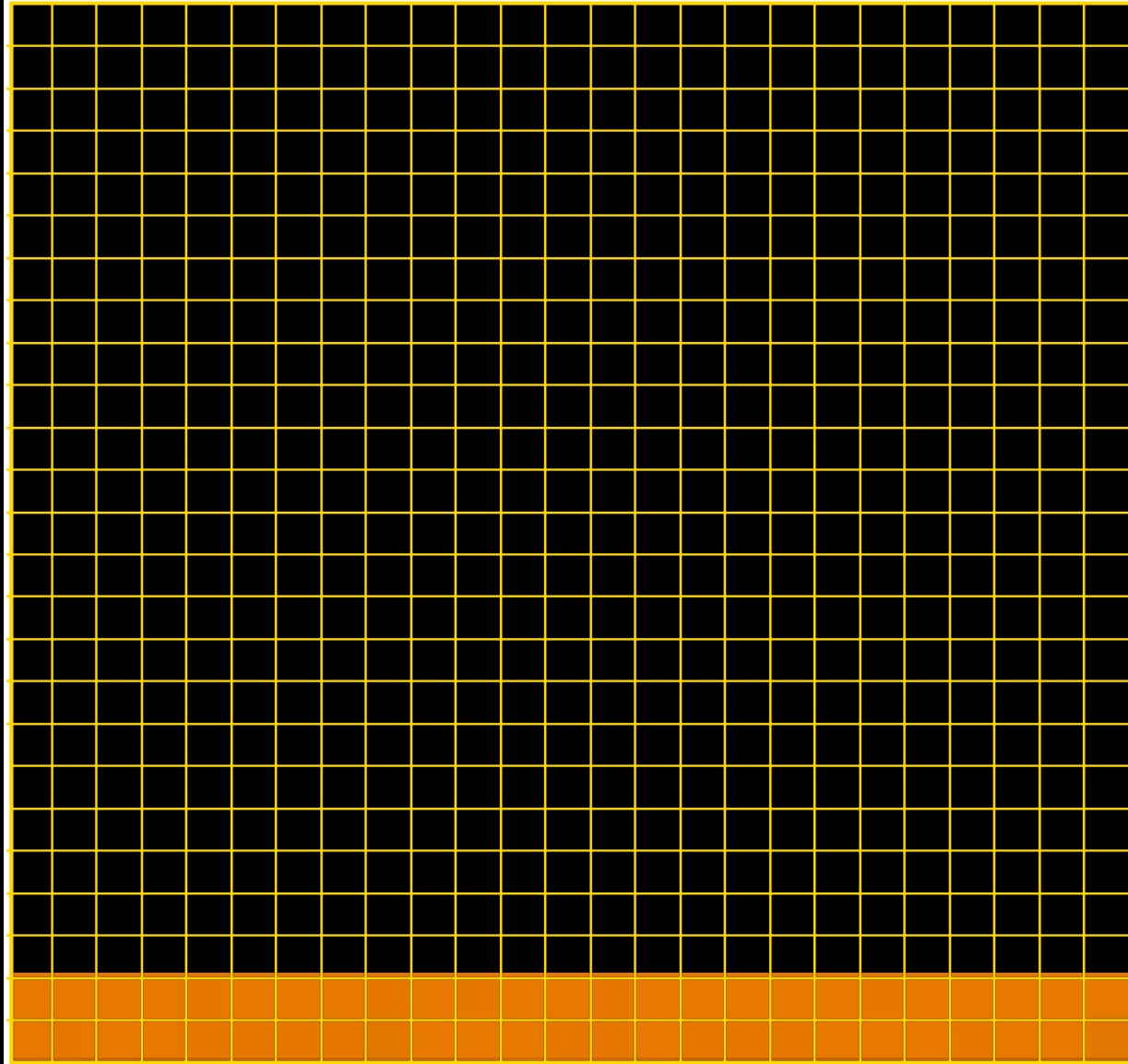
4....



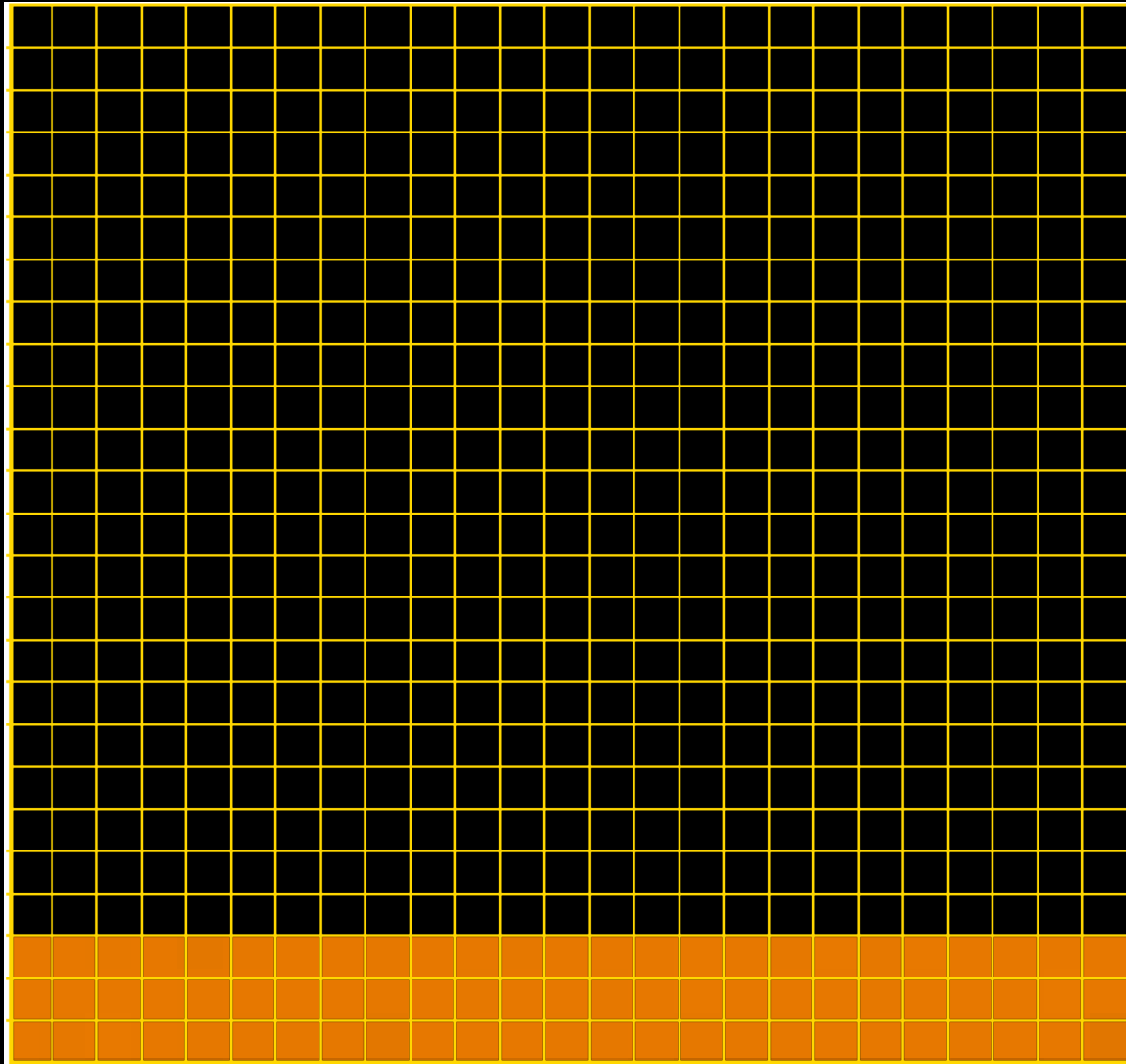
25....



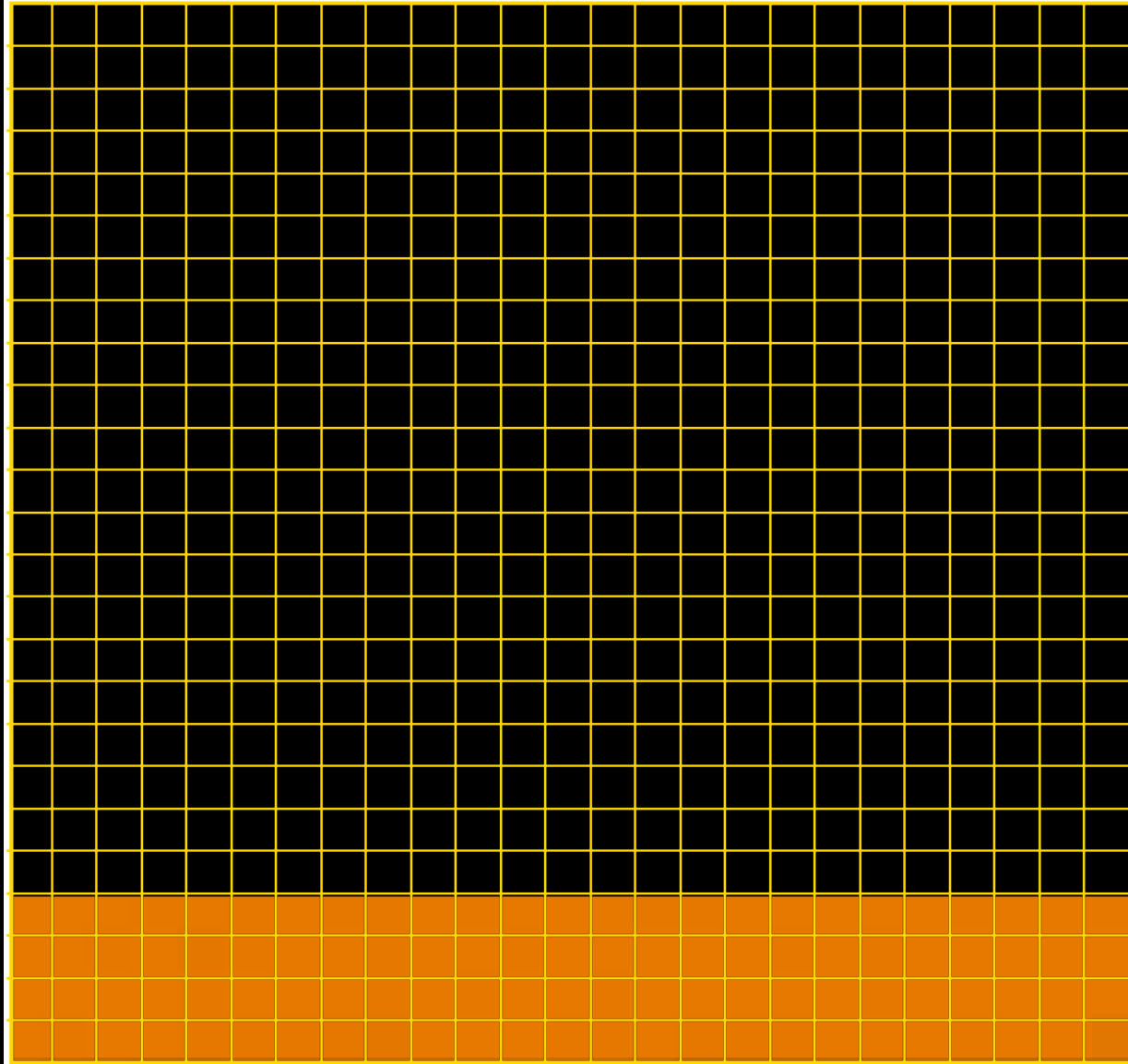
25x2....



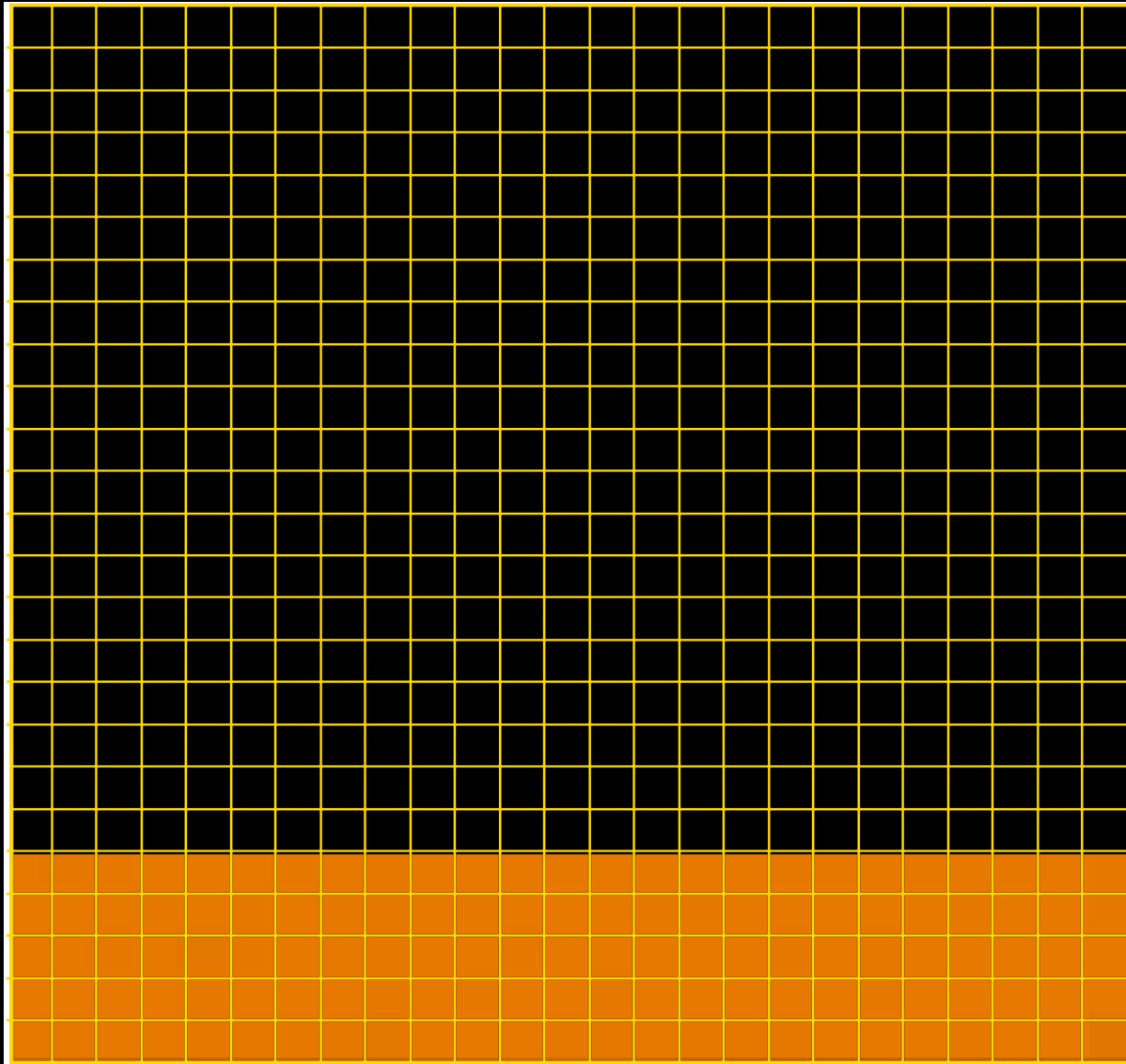
25x3....



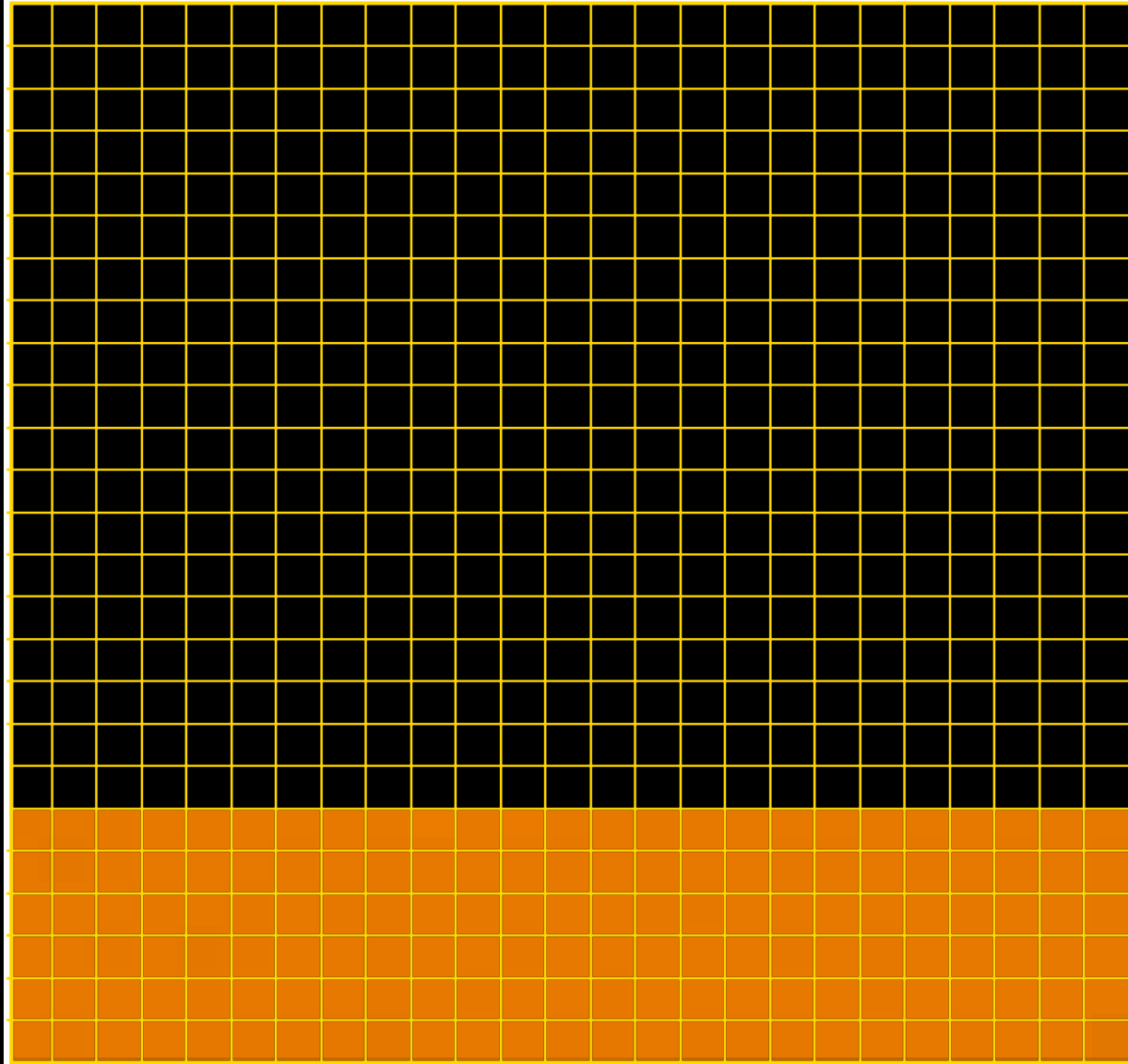
25x4....



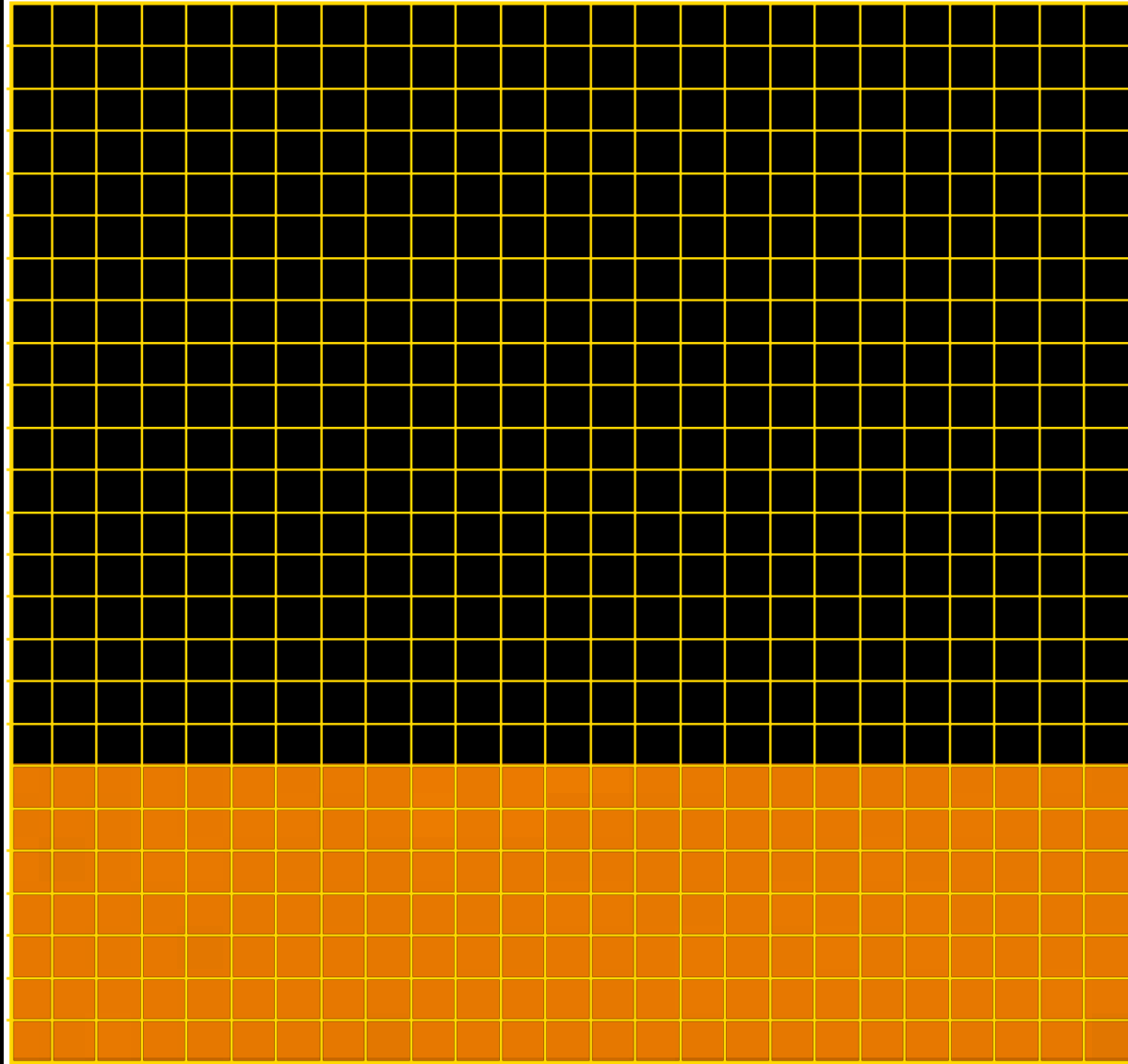
25x5....



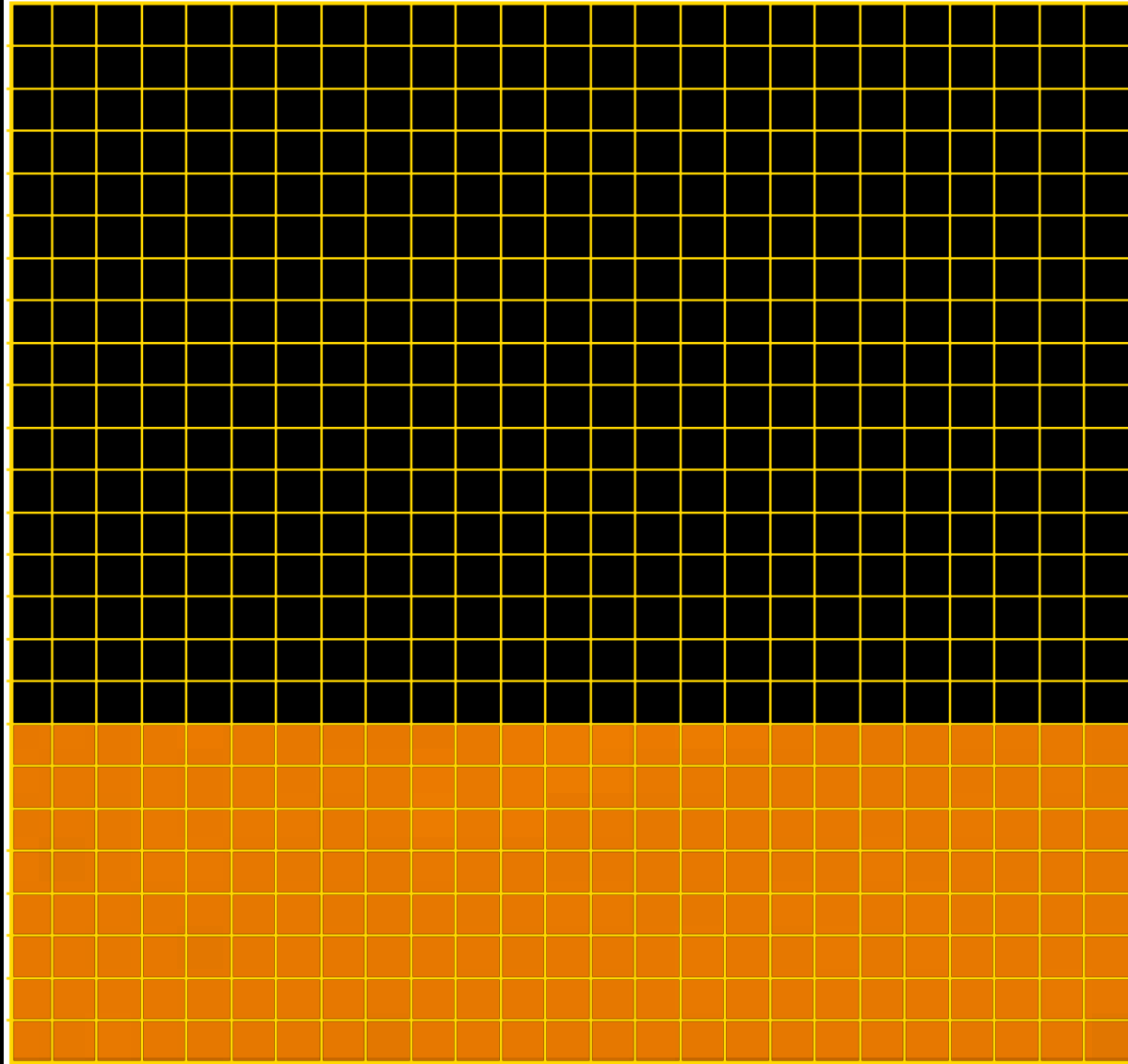
25x6....



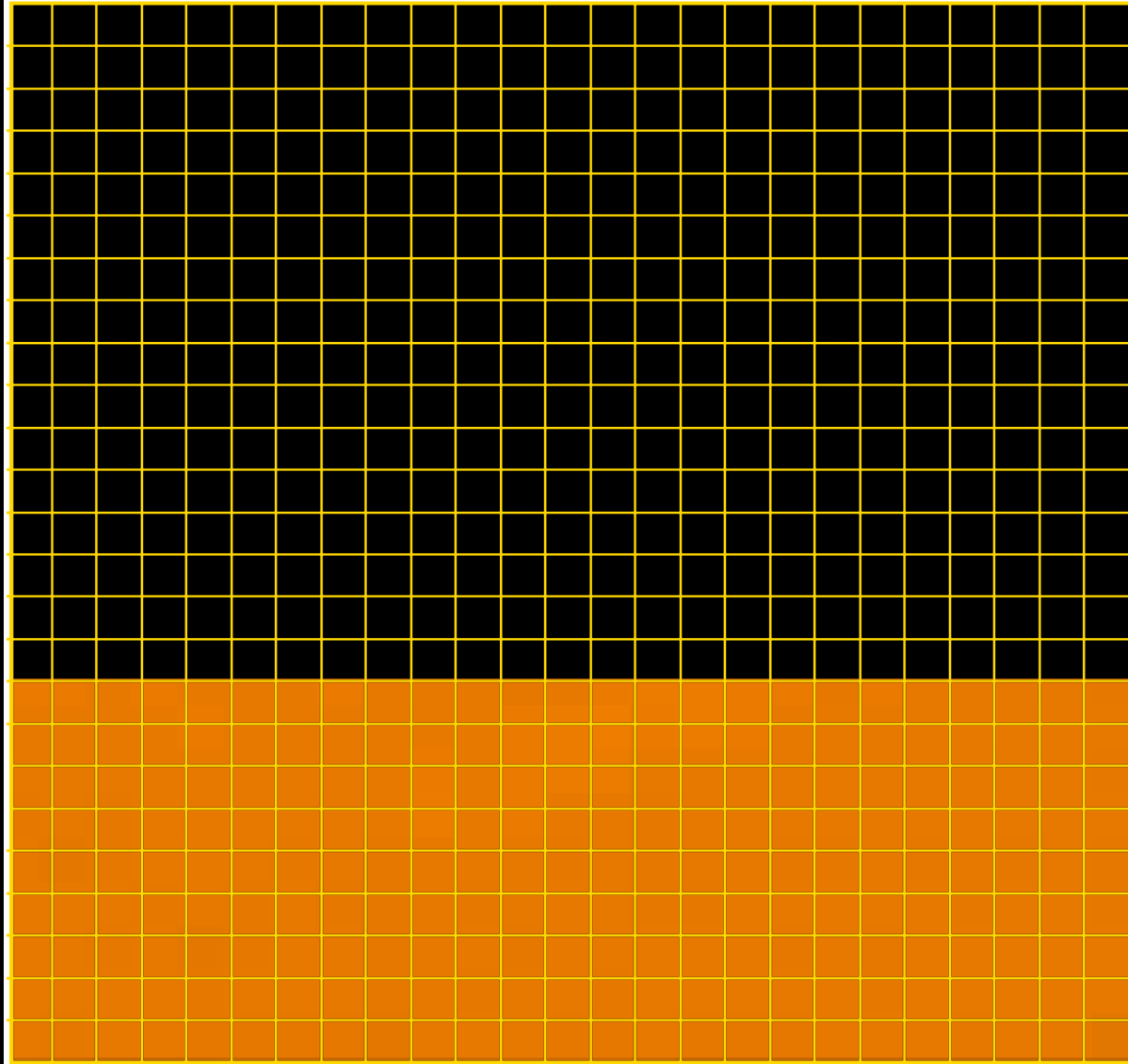
25x7....



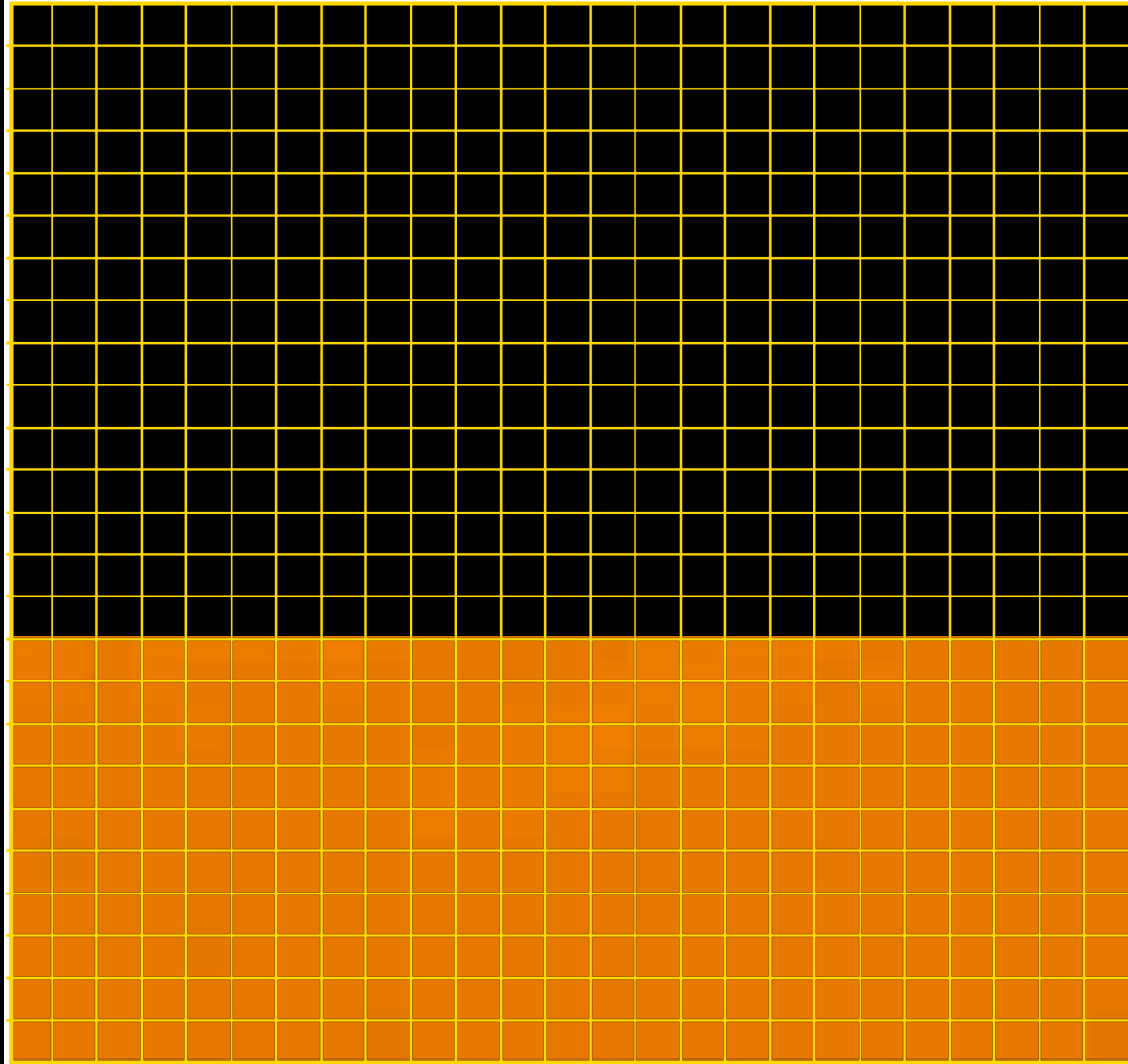
25x8....



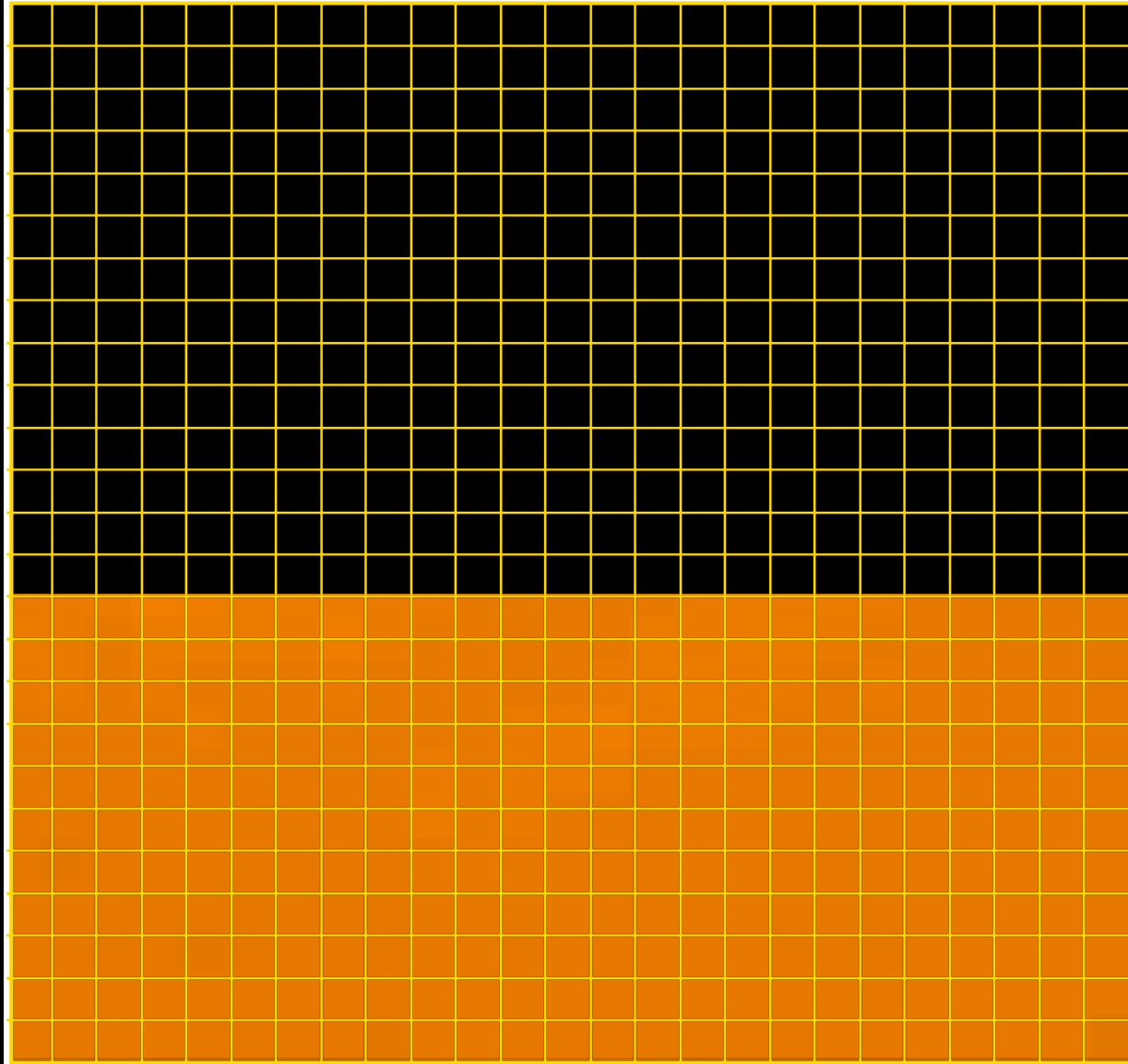
25x9....



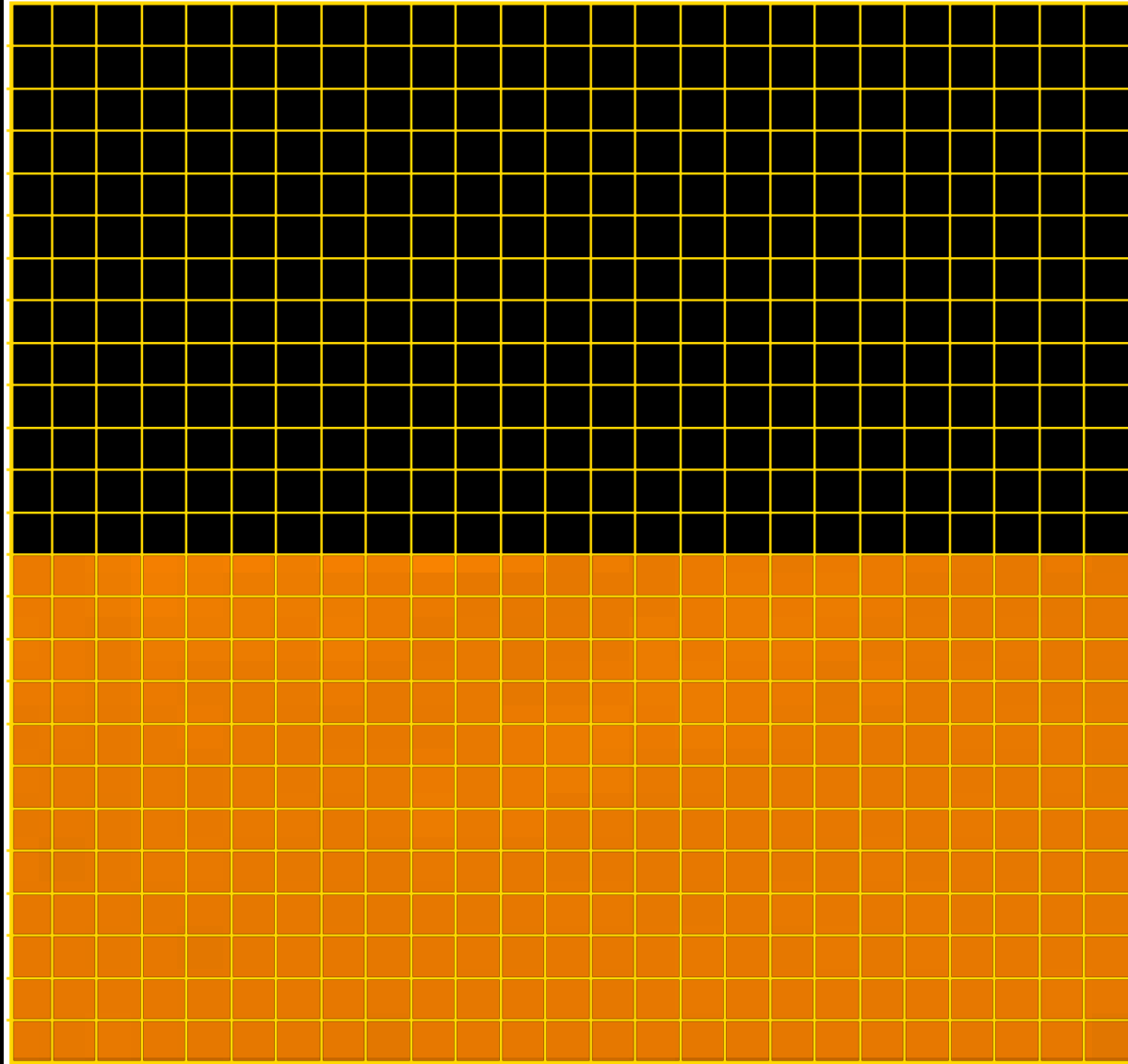
25x10....



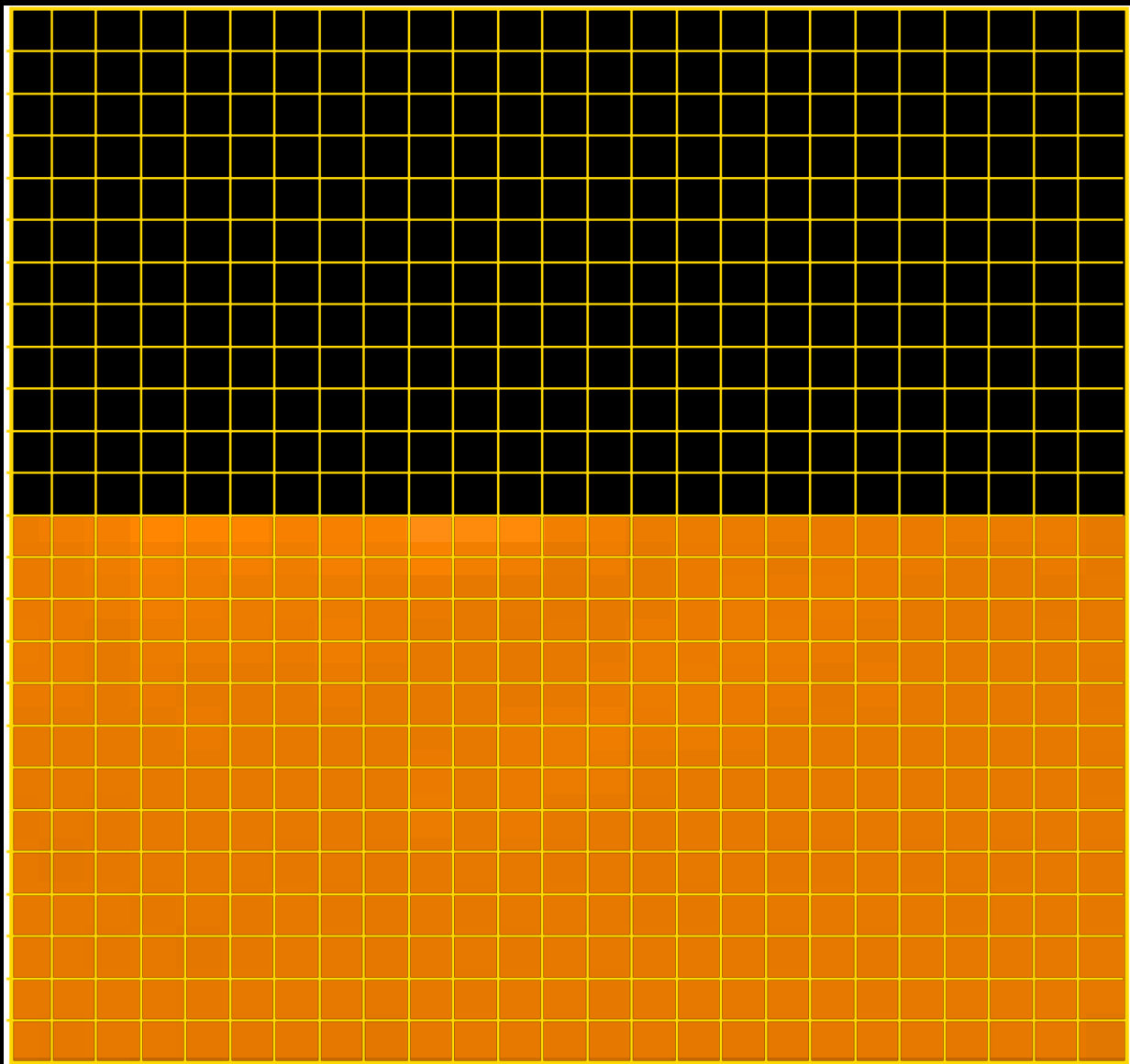
25x11....



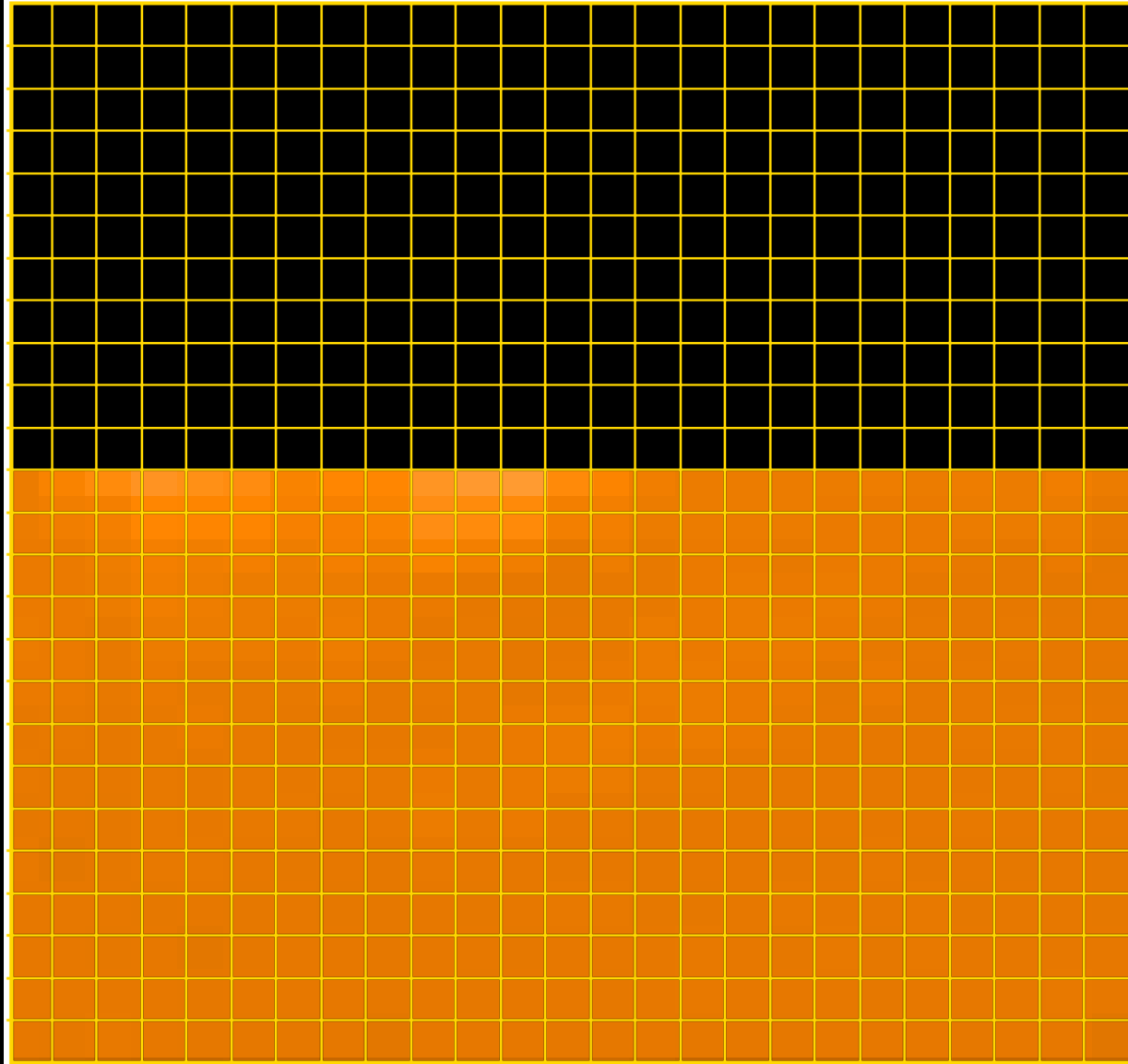
25x10\2....



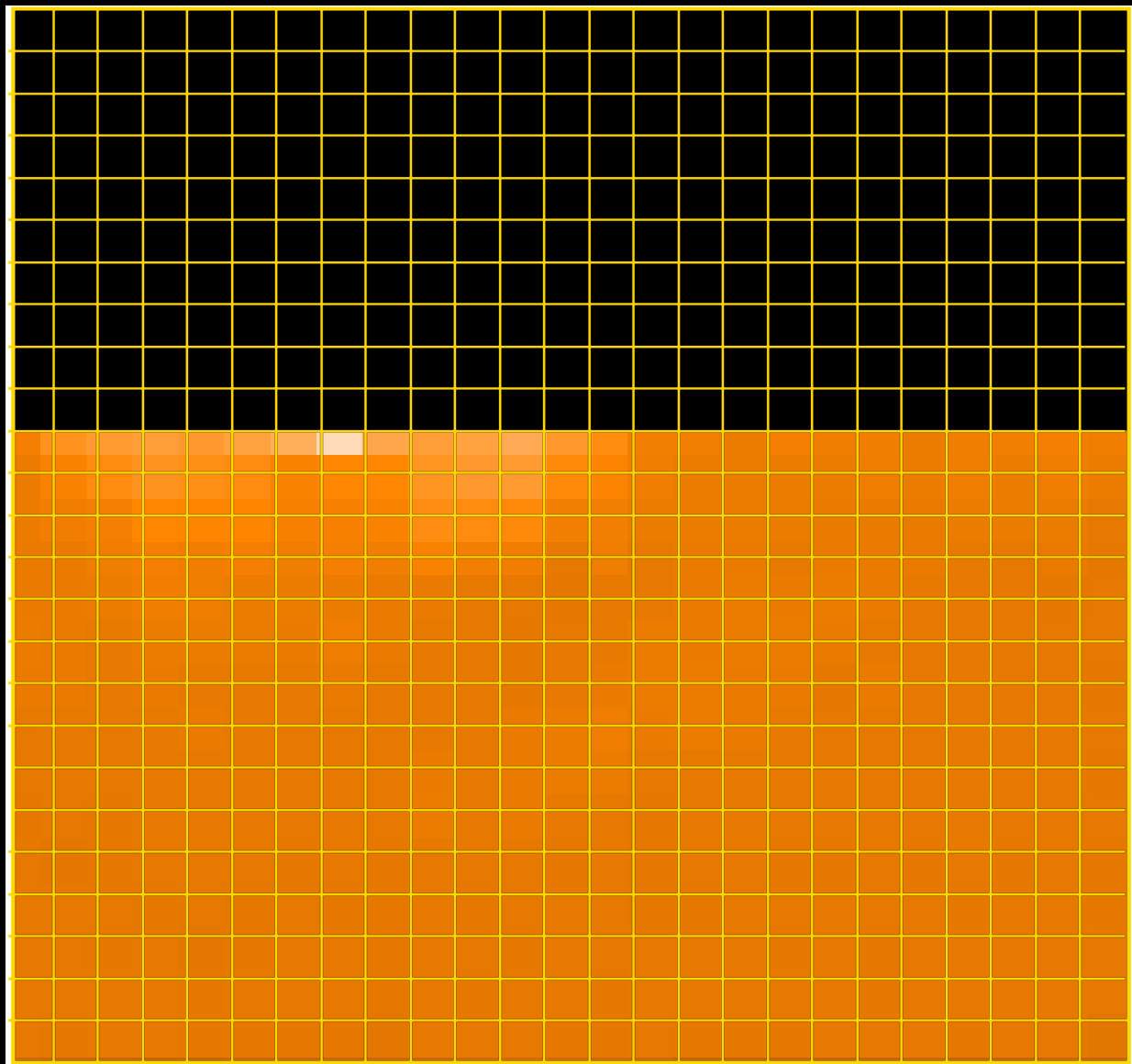
25x13....



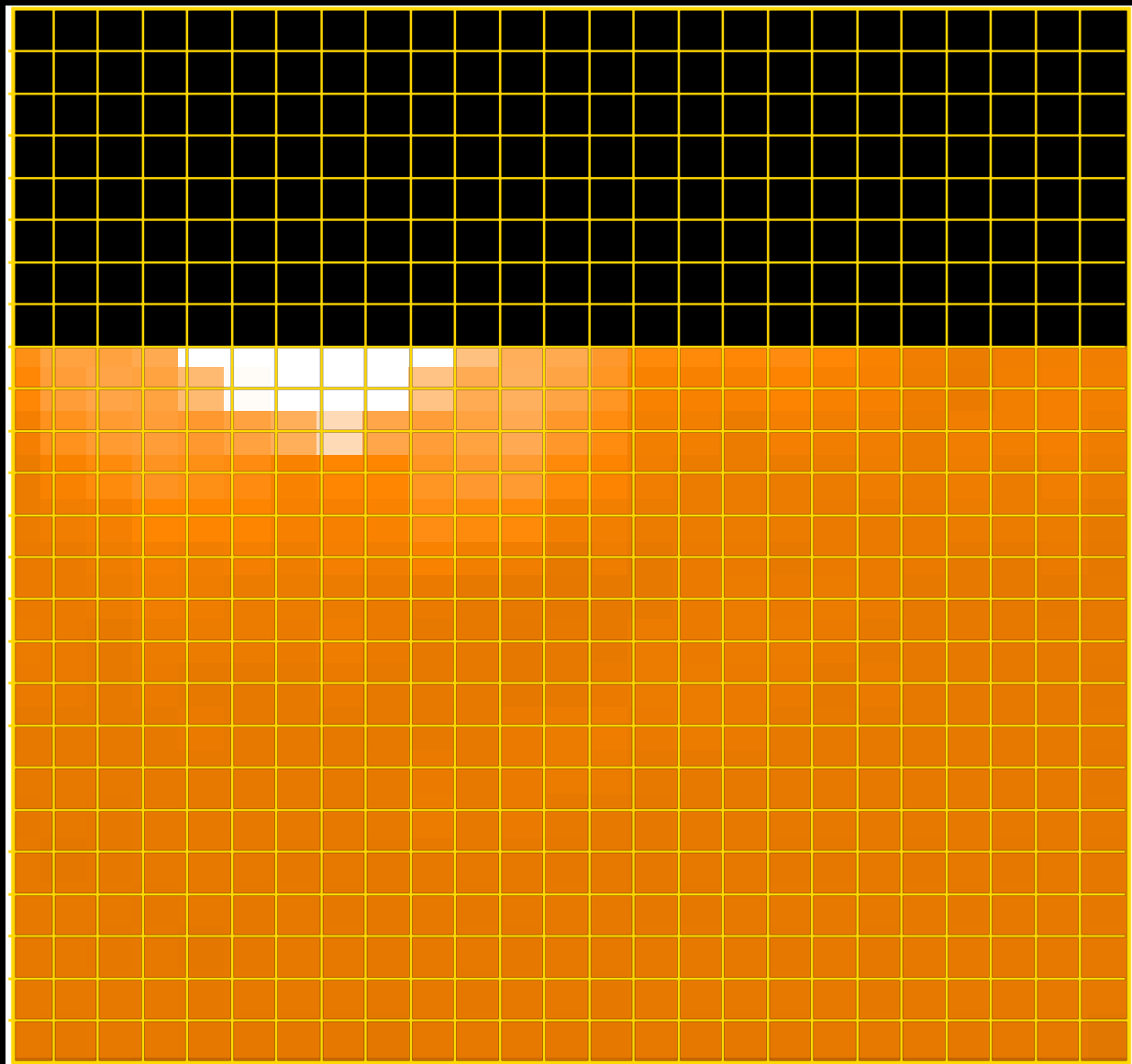
25x14....



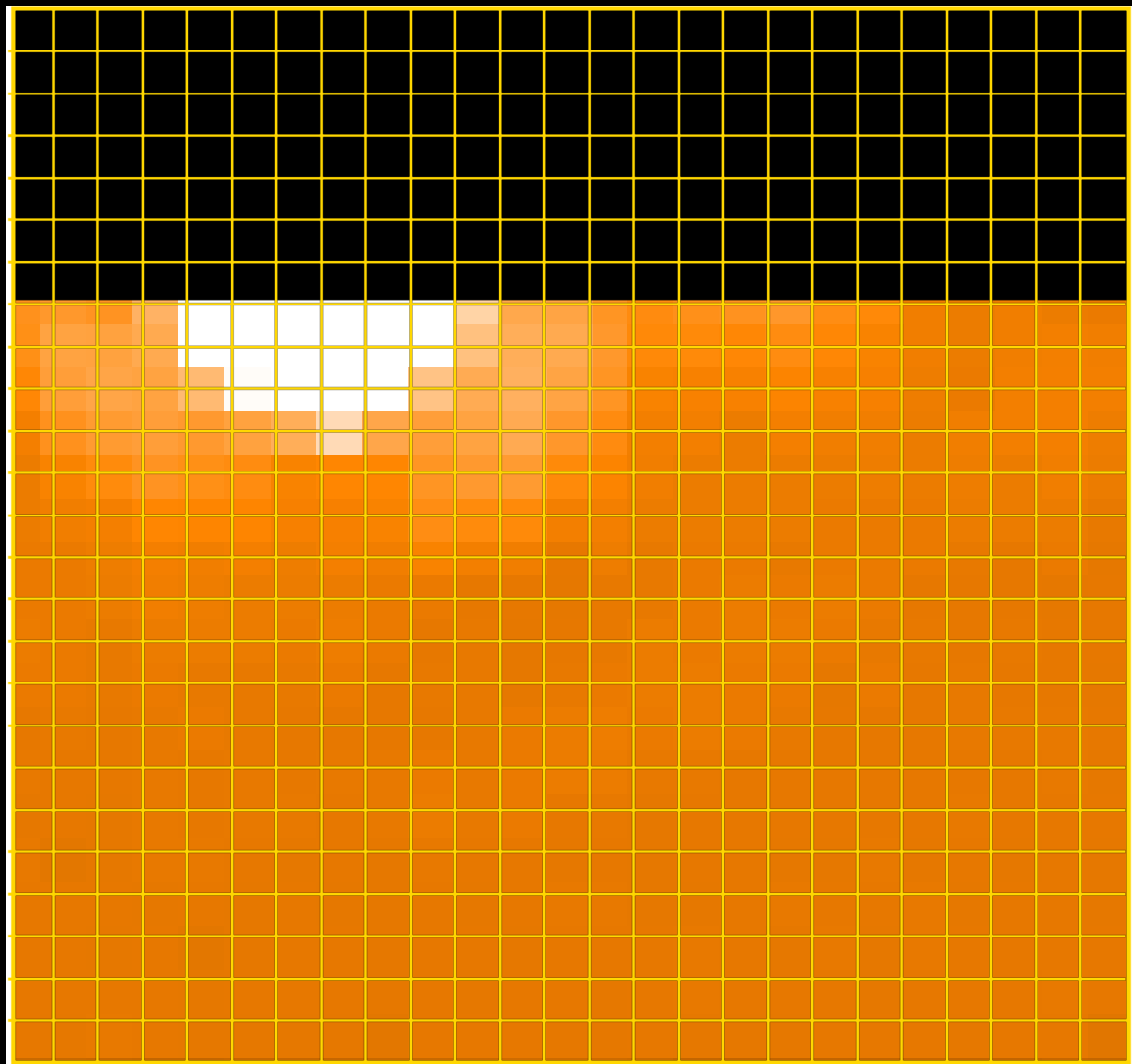
25x15....



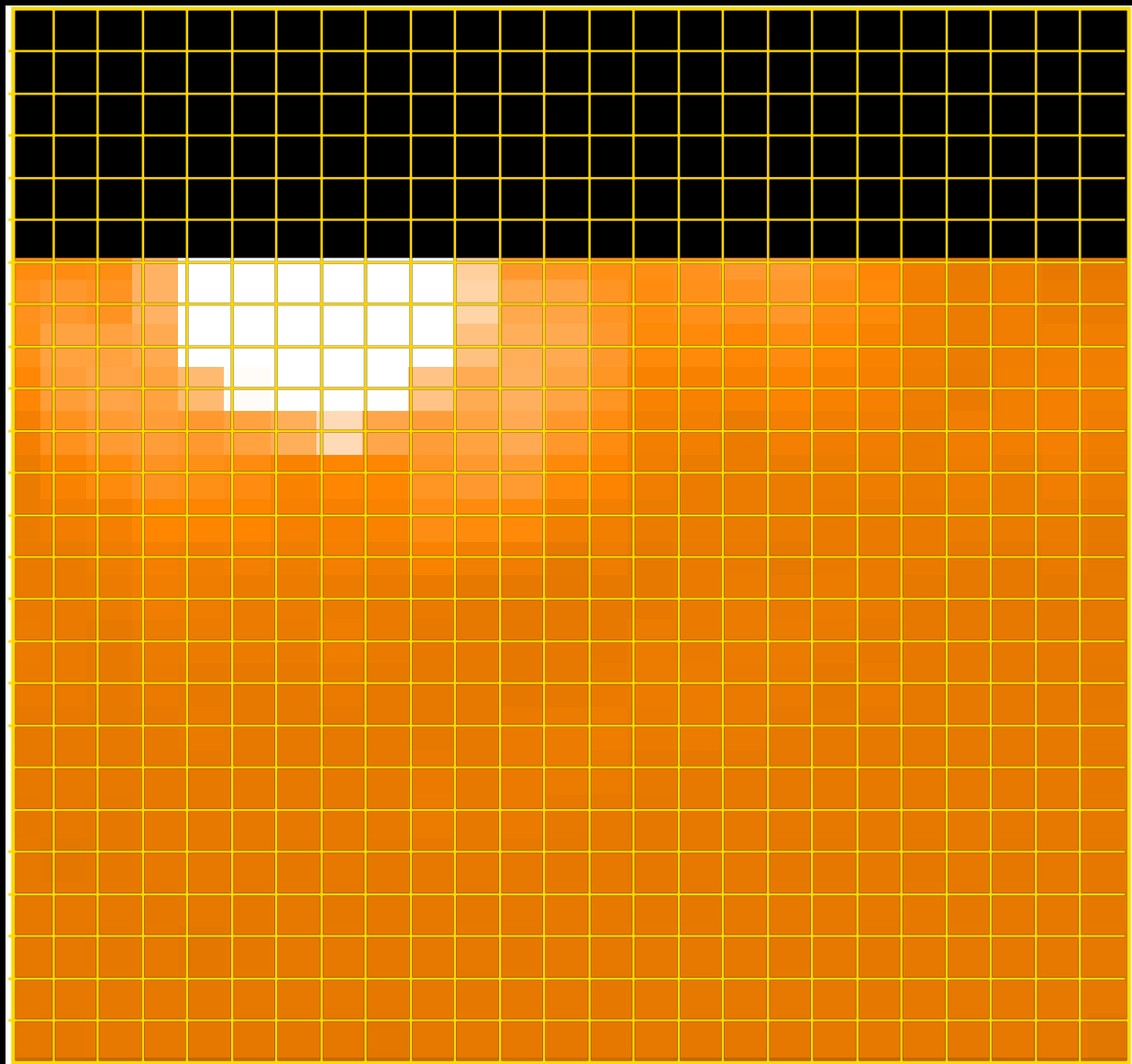
25x17....



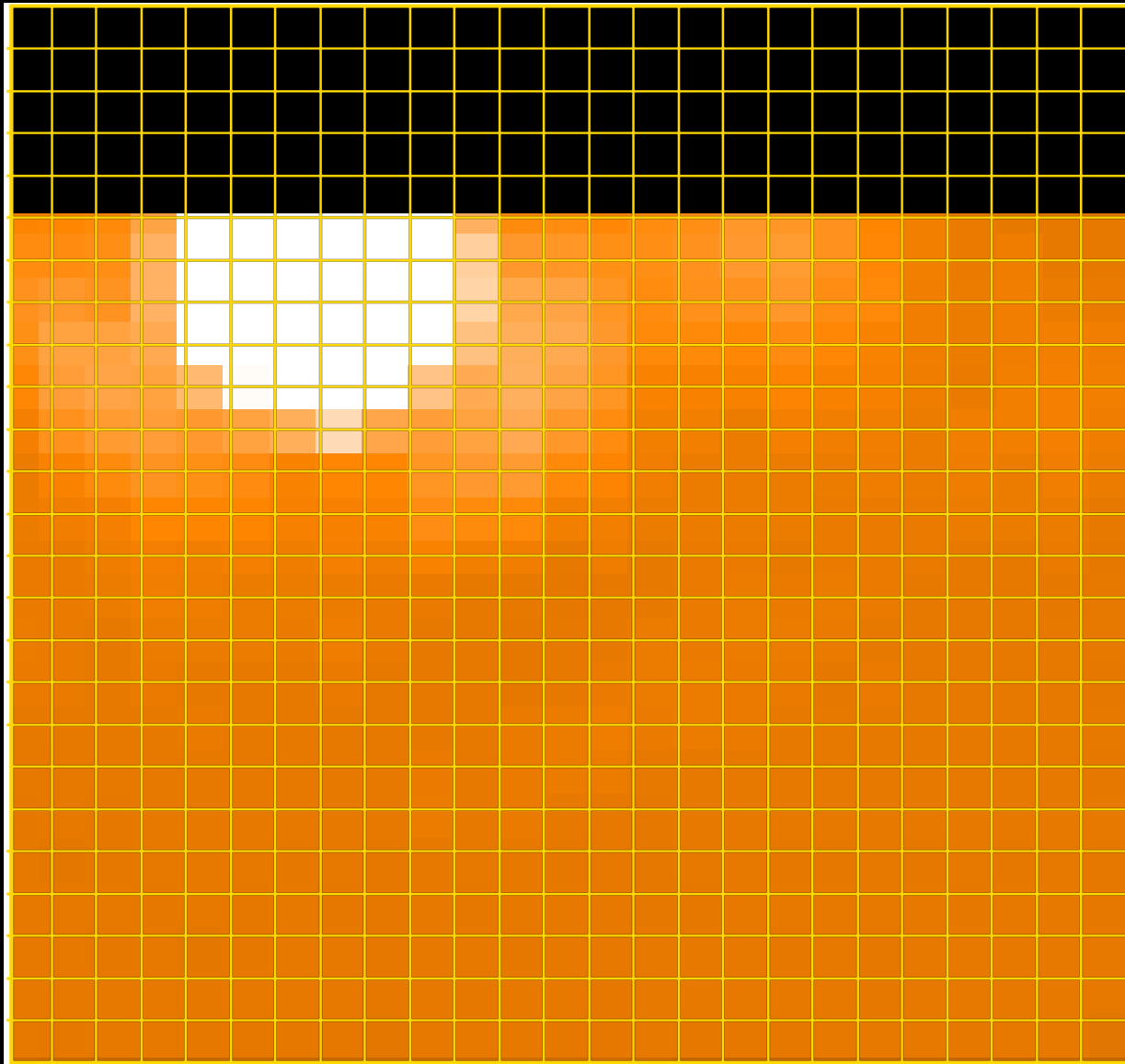
25x18....



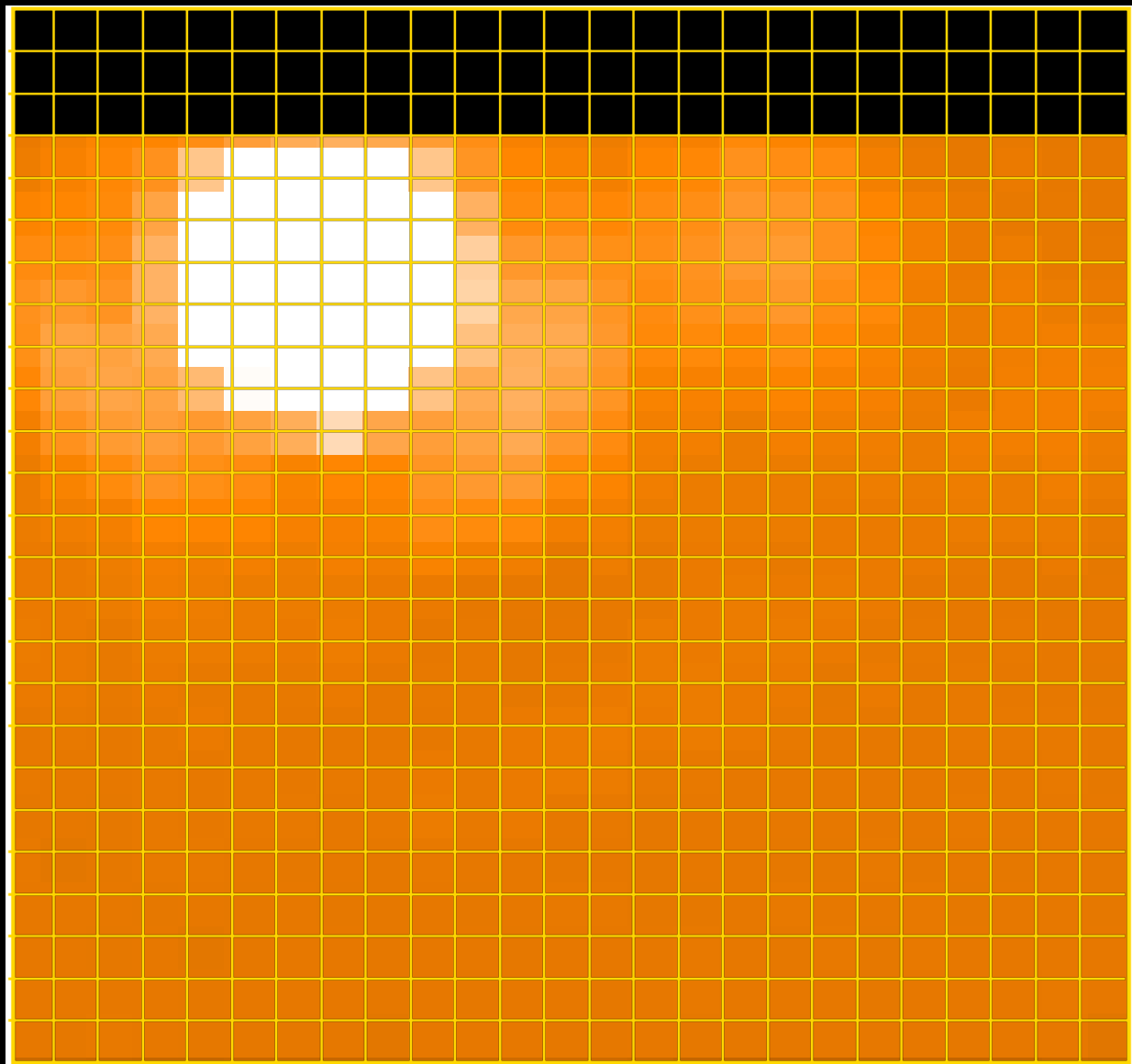
25x19....



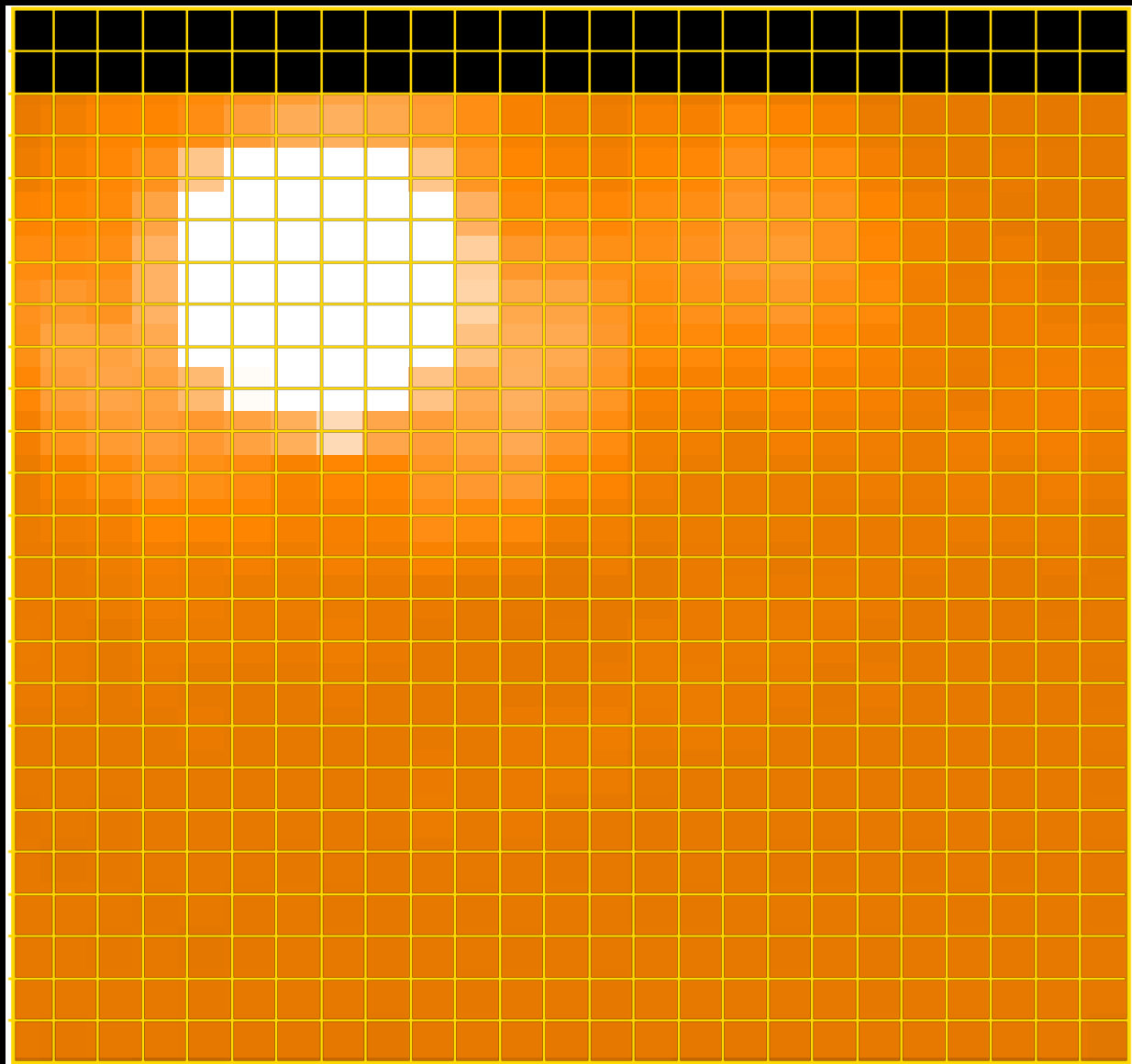
25x20....



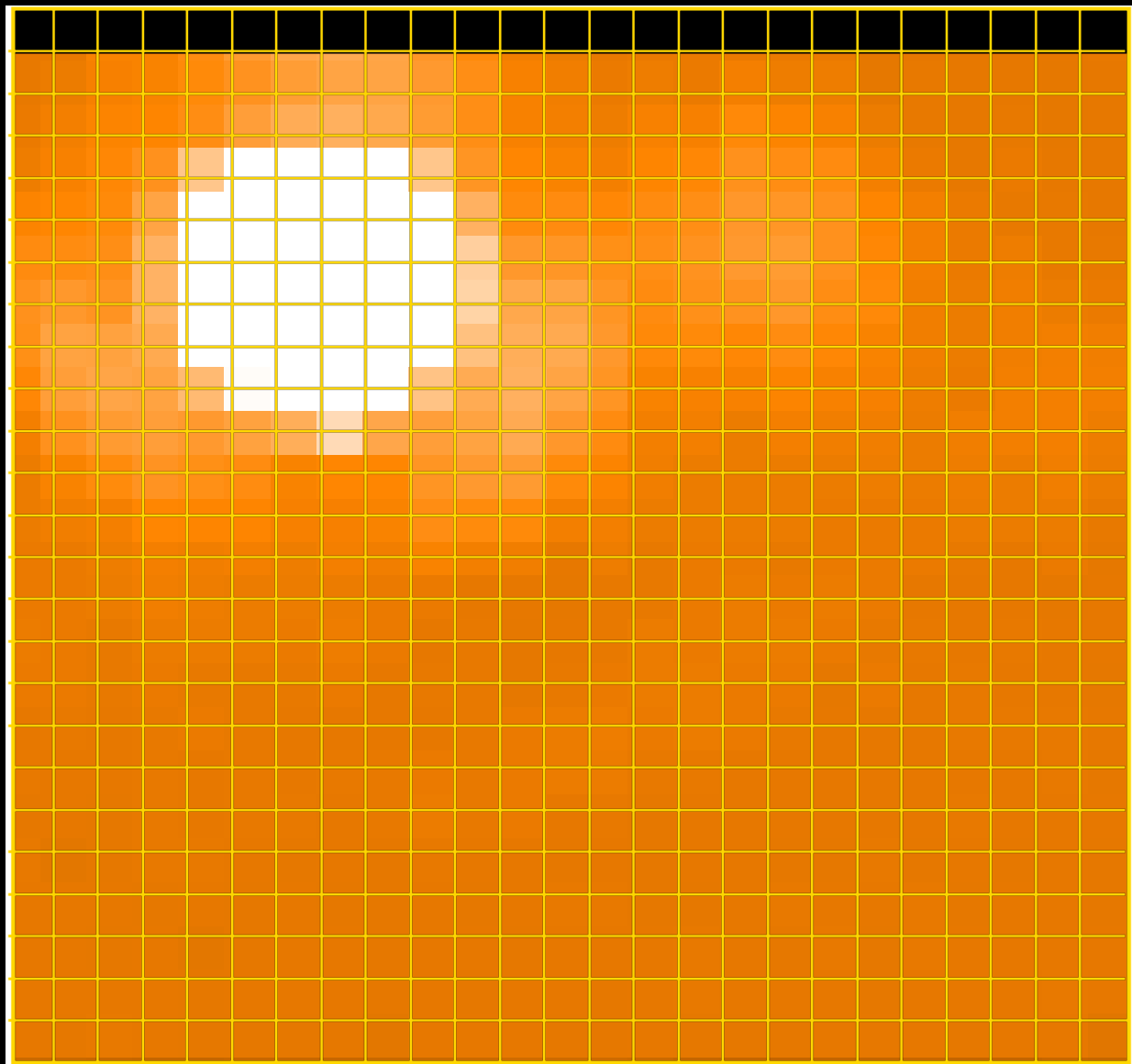
25x22....



25x23....

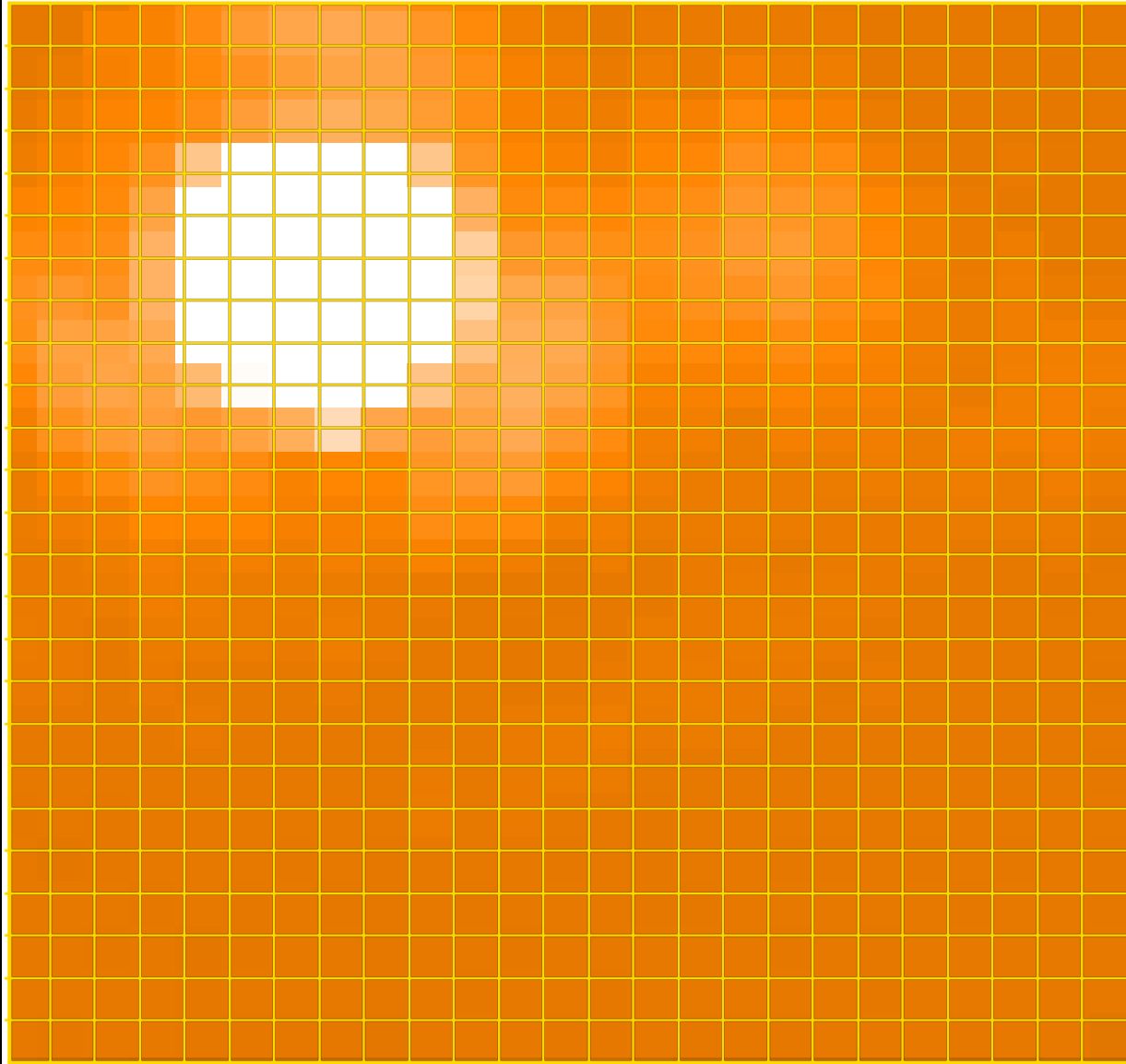


25x24....

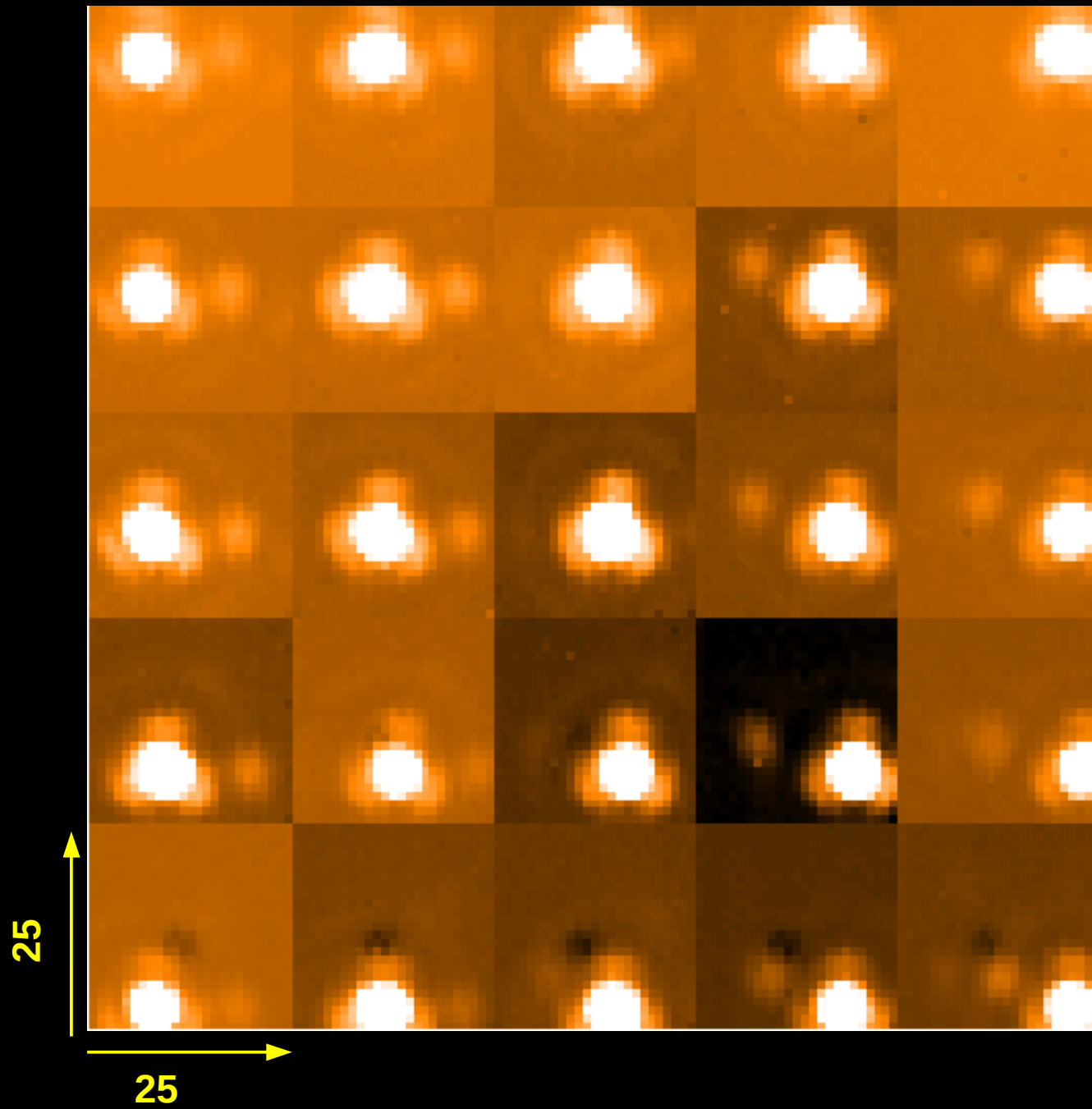


25x25....completed

The image is built
in RASTER COORDINATES
It is NOT the sky
reconstructed Neptune image!!!!

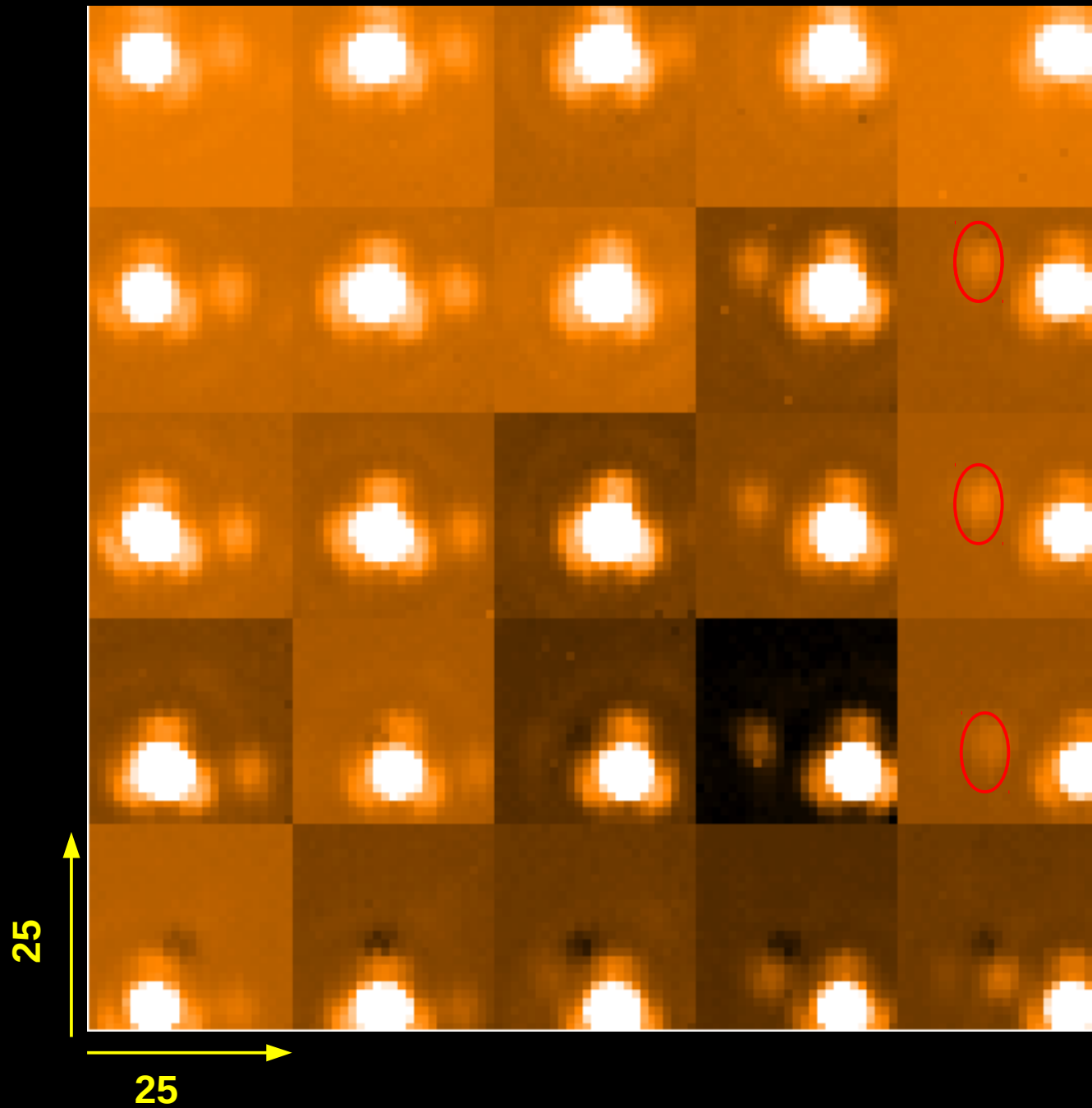


What do all spaxels see?



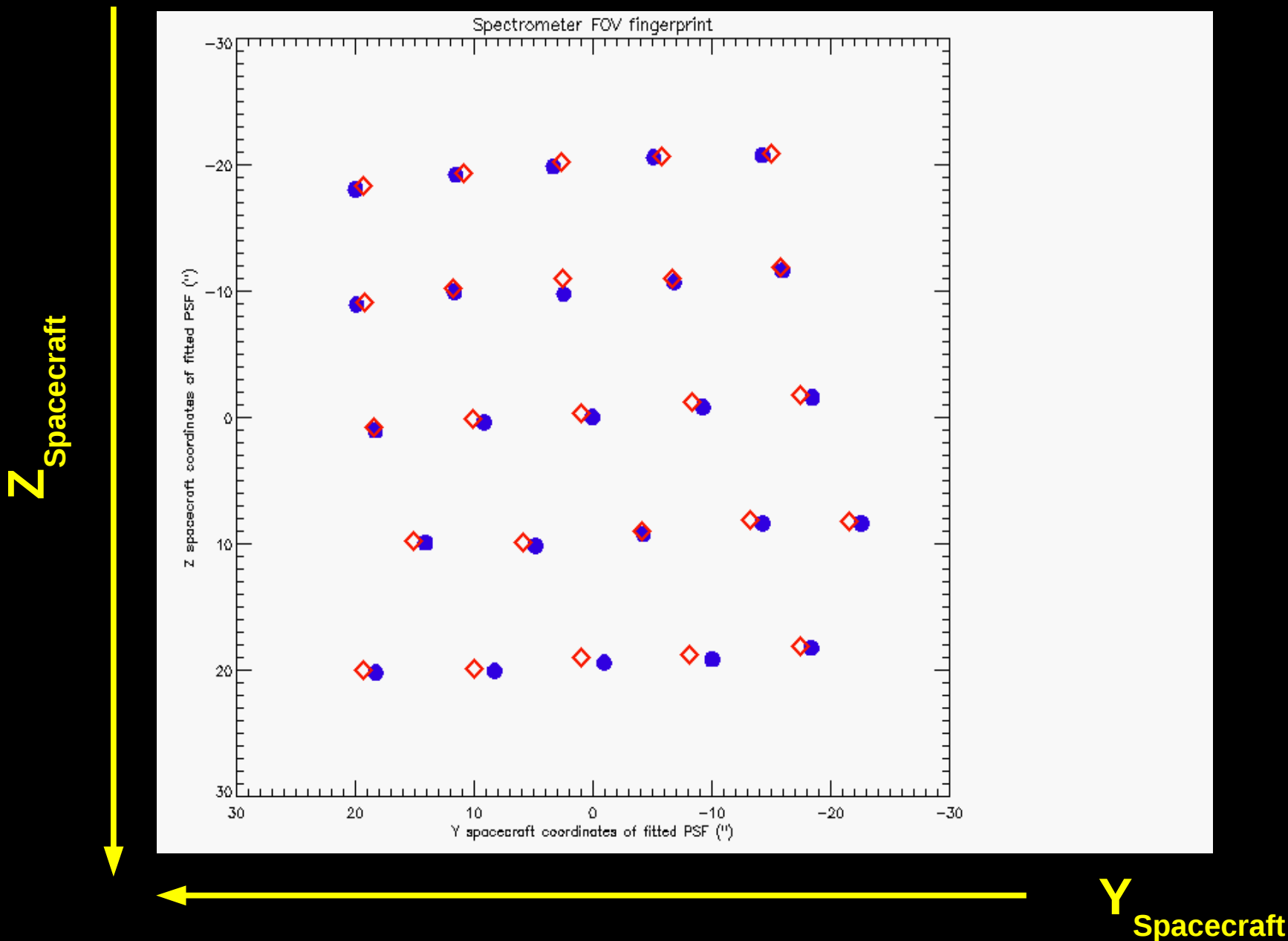
Since these are not the reconstructed images of Neptune in the sky we do not call them PSF but **Beam efficiencies**

Gohsts!!!! (See H. Feuchtgruber presentation)

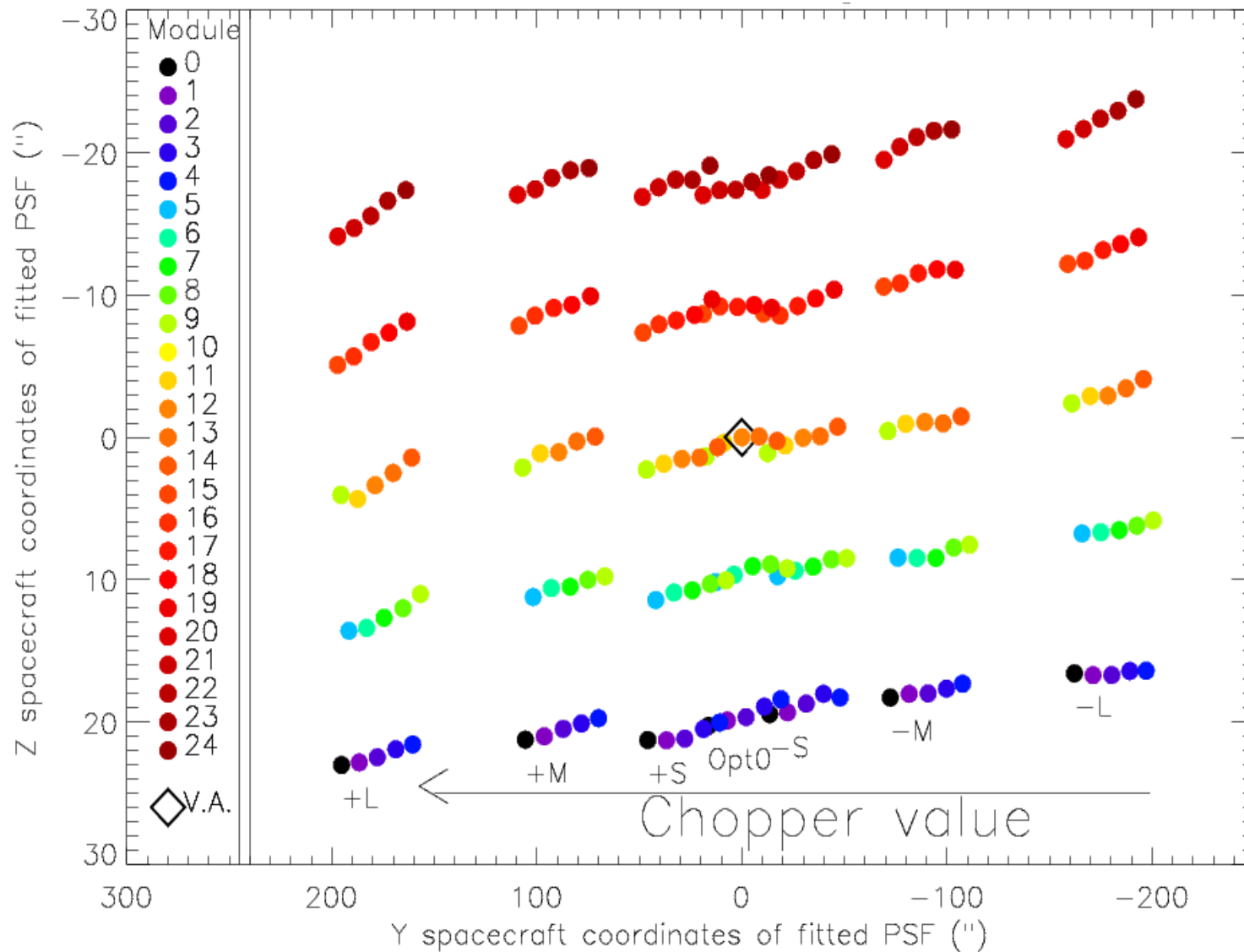


Determination of the position of each spaxel

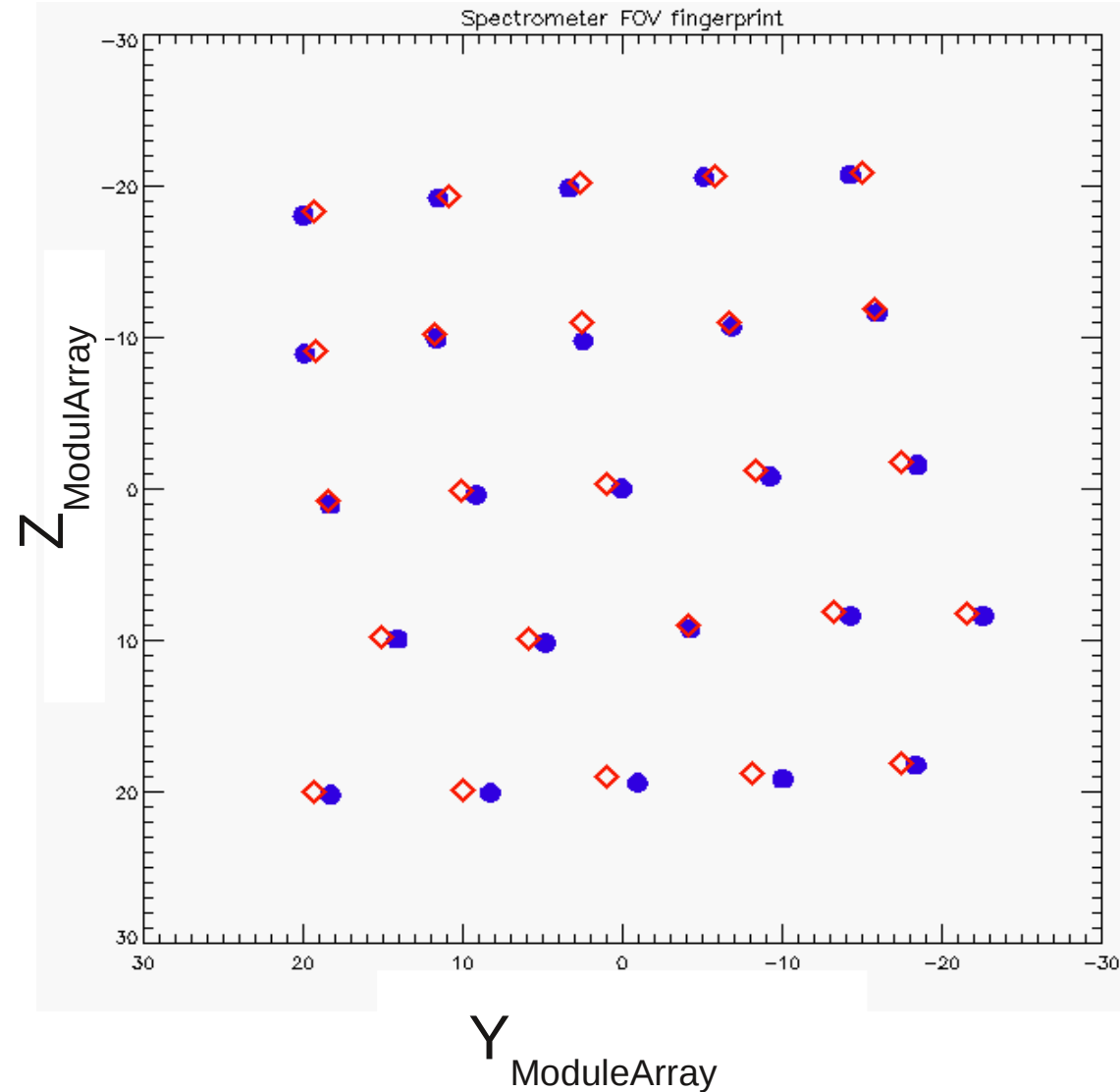
Gaussian fit to the PSF seen in each spaxel



If this is done for each raster at each chopper position....



ModuleToArray Calibration File



A cal. file that per each spaxel lists the offset in arcsec in the YZ spacecraft coordinate reference system with respect to our virtual aperture (V.A.).

The V.A. is the central spaxel in the BLUE channel.

ArrayToInstrument Calibration file

A cal. file that describes the position of a given spaxel at ANY chopper angle α

$$Z_{\text{fit}} = \sum_{i=0}^N \sum_{j=0}^M \sum_{k=0}^O a_{ijk} Z_{\text{ModuleArray}}^i Y_{\text{ModuleArray}}^j \alpha$$

$$Y_{\text{fit}} = \sum_{i=0}^N \sum_{j=0}^M \sum_{k=0}^O b_{ijk} Z_{\text{ModuleArray}}^i Y_{\text{ModuleArray}}^j \alpha$$

The cal file contains the coefficients a_{ijk} , b_{ijk} and polynomial degrees (N,M,O) obtained from the best fit to the data.

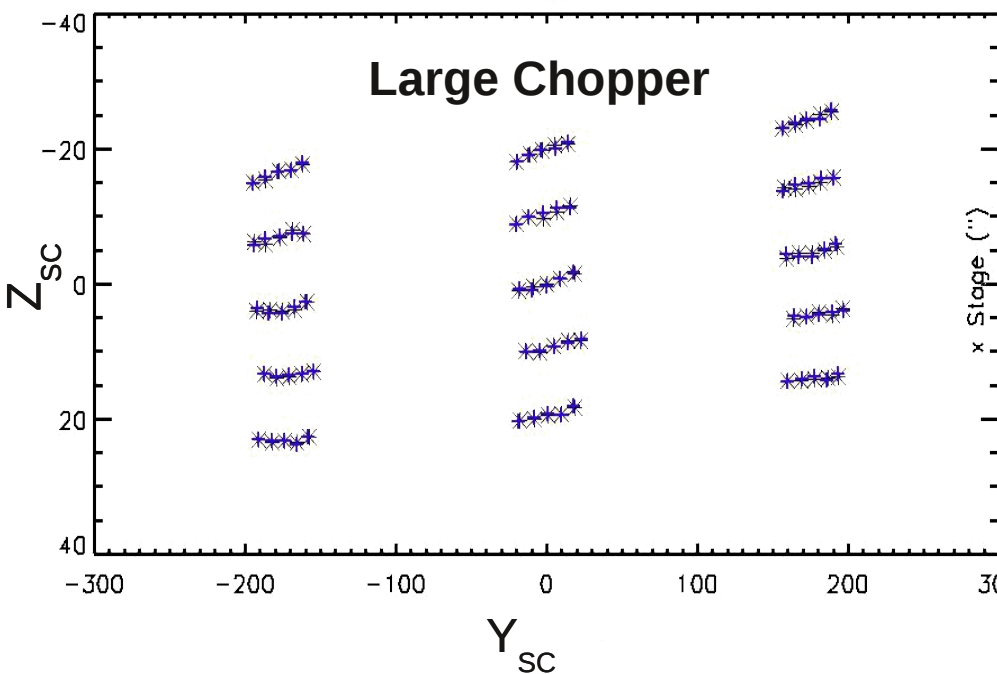
It was not possible to fit all 7 chopper positions at once with the desired accuracy.

Therefore we fit chopper position zero with the \pm Small, \pm Medium and \pm Large separately (3 ModuleToArray and 3 ArrayToInstrument Calibration files are then used.)

Fit results

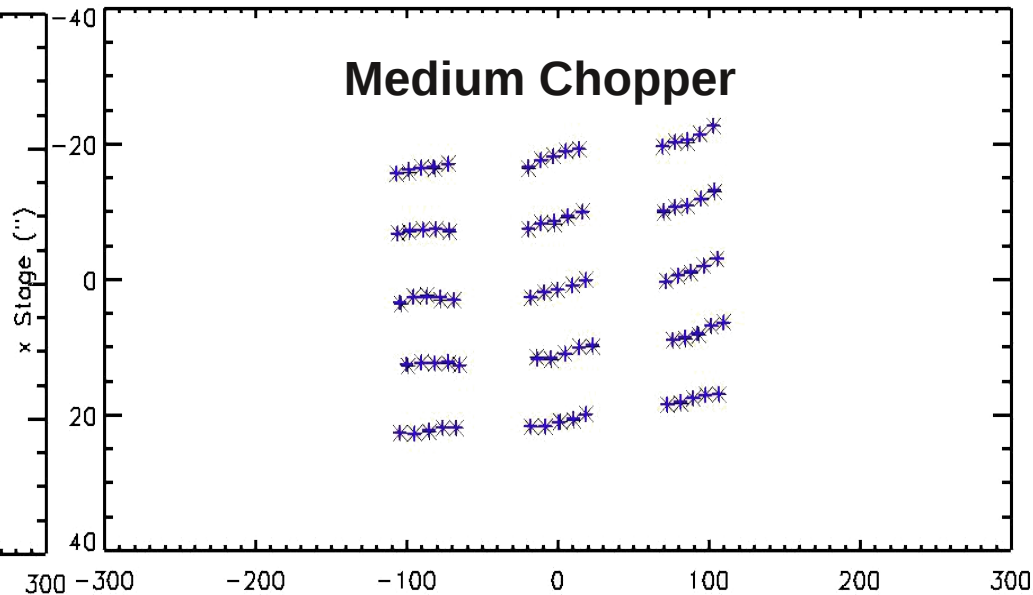
BLUE

Large Chopper



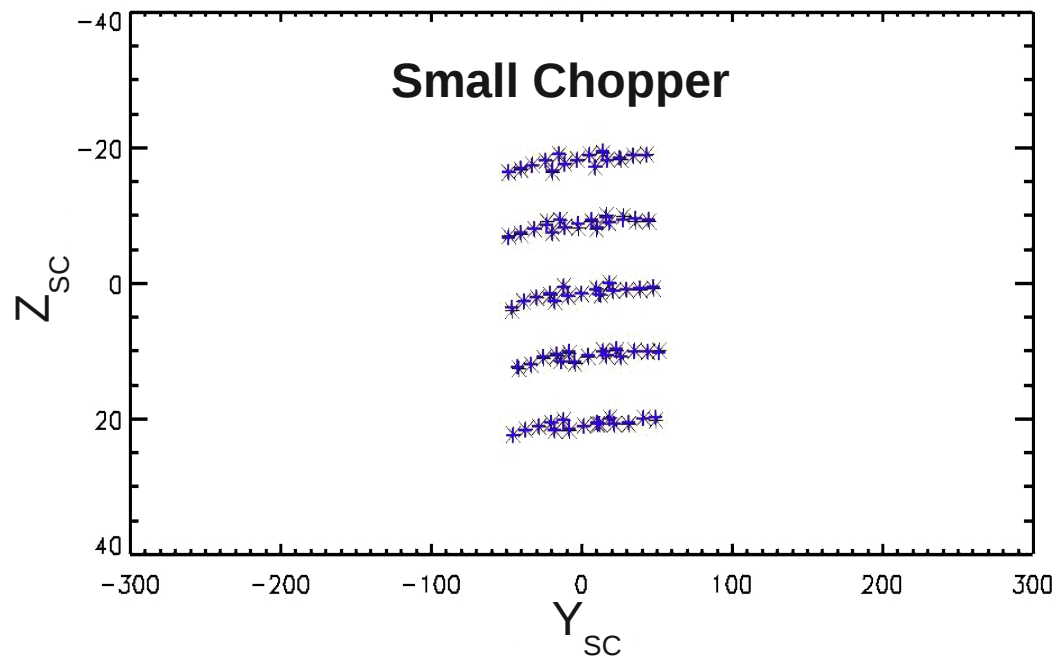
BLUE

Medium Chopper



BLUE

Small Chopper



M=2
N=2
O=2



Fit



Data

How these are used in HIPE?

- ◆ From the pointing product the boresight coordinates of each frame are translated in virtual aperture coordinates.
- ◆ Using the Roll angle they are transformed in ZY Spacecraft reference system.
- ◆ Applying the formula given before, using the ModuleToArray and ArrayToInstrument calibration files, reading the chopper position from the data, the ZY spacecraft coordinates of each spaxel for each frame is then calculated.
- ◆ Using Roll Angle the Ra and Dec of each pixel are calculated back

NOTE: all spectral pixel of the same spaxel have the same Ra and Dec!!!!

Spectral dependency (1)

- ◆ Thanks to the Neptune brightness is has been possible to build the beam efficiencies for each spectral channel.
- ◆ We could therefor repeat the same process for each spectral pixel and recover different Ra and Dec also for each spectral pixel.
- ◆ This requires changes in the specAssingRaDec task which has been developed in a different task currently called SpecAssignRaDecTest task.
- ◆ However, because of the final rebinning of the data cube, there is no significant differences between the Ra and Dec associated with each spaxel of the final rebinned cube using the two calibrations.
- ◆ This is why we currently do not offer the spectral dependency.
- ◆ Current testing on 3-D drizzling method makes use of this feature, to verify whether the spectral dependency can improve final product.

Spectral dependency (2)

- ◆ There is also another possible spectral dependency we need to verify: that on the grating position.
- ◆ We have verified with many other similar observations on different sources at many wavelengths that there is no dependency of the Spatial calibration from the grating position.

PACS SPECTROMETER BEAM EFFICIENCIES

Observations summary

Additional 6 25x25 chopped raster on Neptune at chopper position zero at the following wavelengths

λ	Band	Notes
55 μm	B2A	
62 μm	B2A	(40x40 @ chop 0 raster used for the Spatial cal. determination)
68 μm	B2A	
68 μm	B3A	
73 μm	B2B	
75 μm	B2B	
94 μm	B2B	
125 μm	R1	(40x40 @ chop 0 raster used for the Spatial cal determination)
136 μm	R1	
145 μm	R1	
150 μm	R1	
168 μm	R1	
187 μm	R1	
204 μm	R1	

First Beam efficiency delivery (July 2011)

- ◆ Per each of the observed wavelengths the beam efficiency of the *central spaxel* has been made available to the users.
- ◆ Each beam is normalized to its pick value and it is in pixel (i.e. raster) coordinates.
- ◆ They are at the following address:

<http://herschel.esac.esa.int/twiki/bin/view/Public/PacsCalibrationWeb?template=viewprint>

Under the tar file called:

[PCalSpectrometer_Beams_v1.tar.gz](#)

Second Beam efficiency delivery (January 2012)

- ◆ Per each of the observed wavelengths the beam efficiency of the ALL spaxels will be made available to the users (cubes of 25x25x25 or 25x25x40).
- ◆ Each beam is normalized to the FITTED pick value and it is in *SKY* coordinates for P.A. = 0 with pixelsize = 2.5 arcsec (i.e. the raster size step).

Example of delivered Beams

