# MAAT Concept

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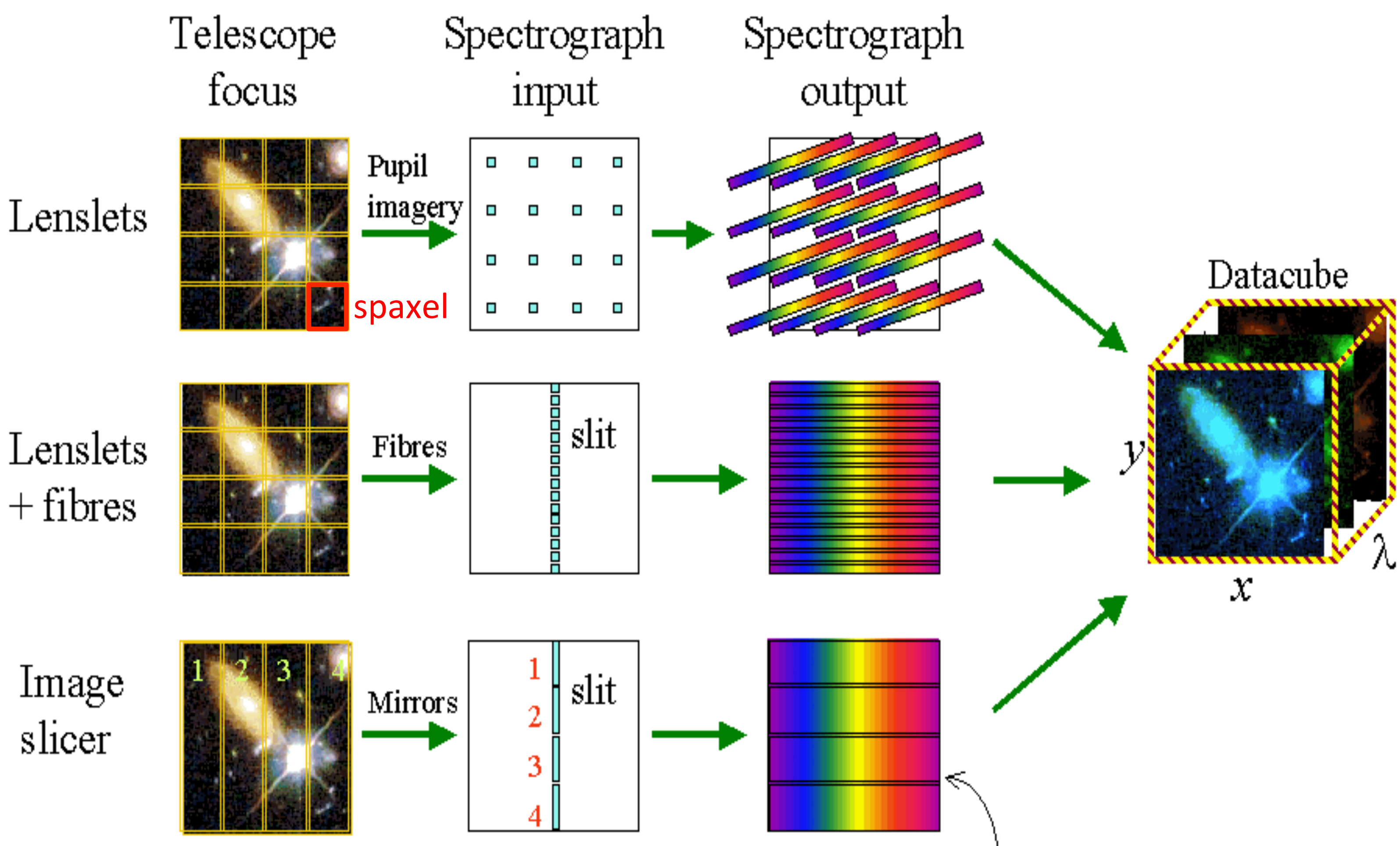
AAO-MQ
MAAT workshop 05/05/2020



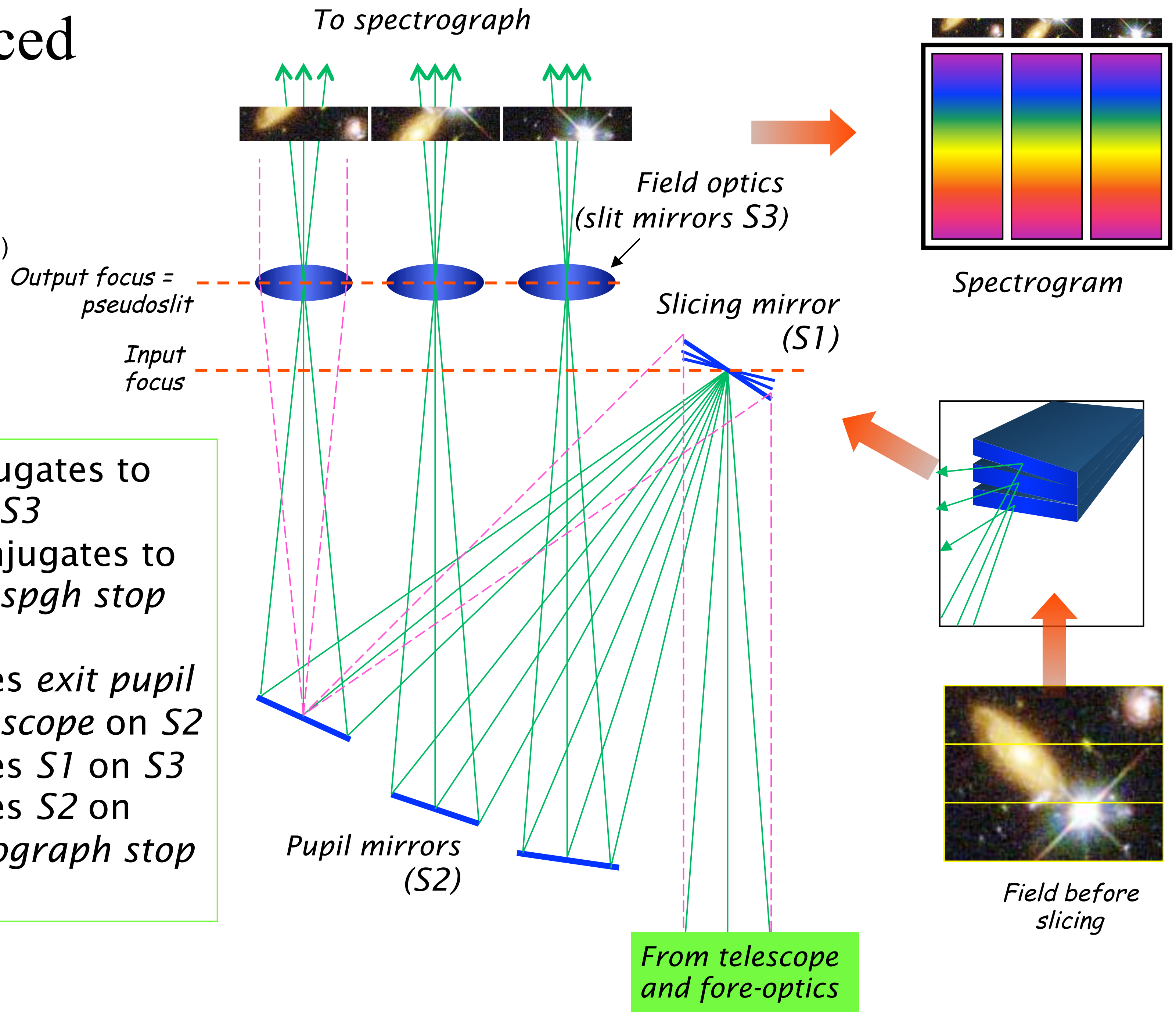

Microslices:
Lenslets +
Image slicer

*Only the image slicer retains spatial information within each slice/sample → highest information density in the datacube*

Adaptive
spectral
sampling

# Advanced Image Slicer

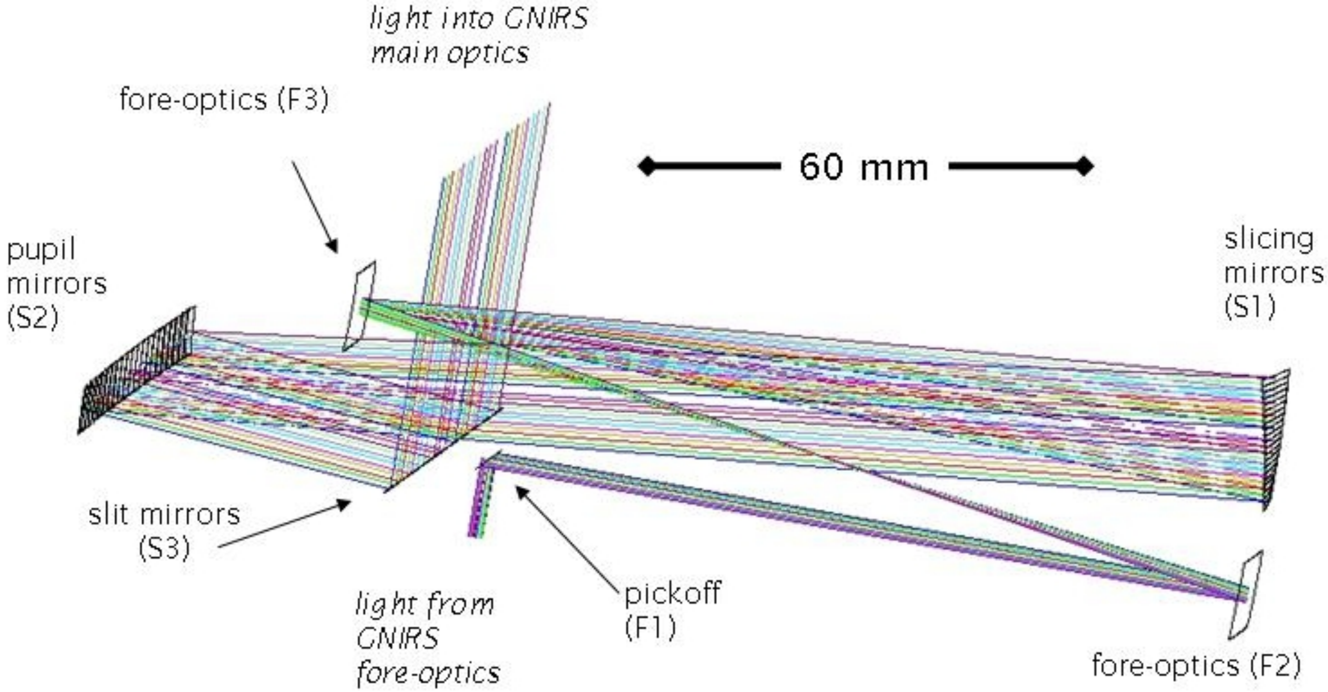
R. Content (1997)



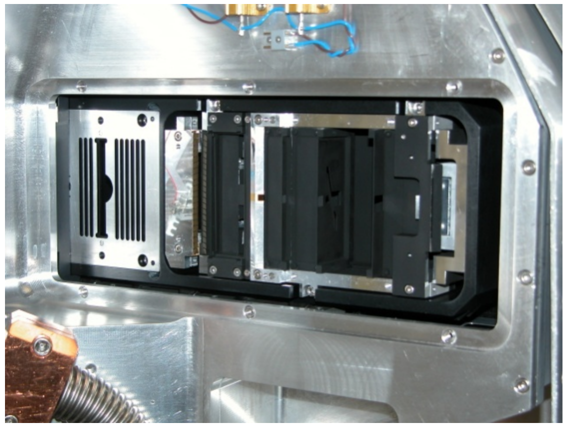

*Sky* conjugates to
*S1* and *S3*
*Pupil* conjugates to
*S2* and *spgh stop*

*S1* images *exit pupil of telescope* on *S2*
*S2* images *S1* on *S3*
*S3* images *S2* on *spectrograph stop*

# GNIRS-IFU

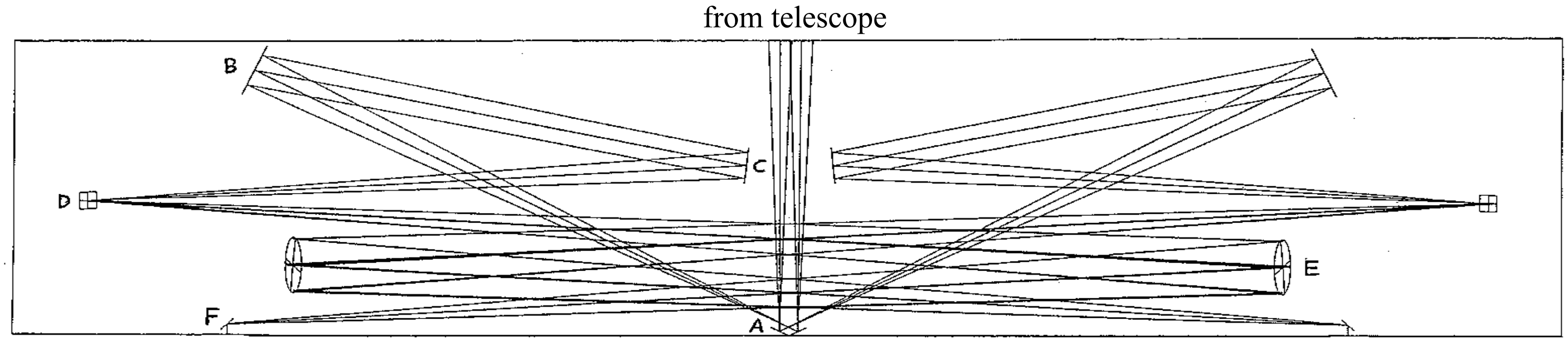



**GNIRS-IFU** on Gemini-south
worked with 1st GNIRS
0.15" x 0.15" spaxels
3" x 5" field



Optical design: Robert Content
Mechanical design: Marc Dubbeldam

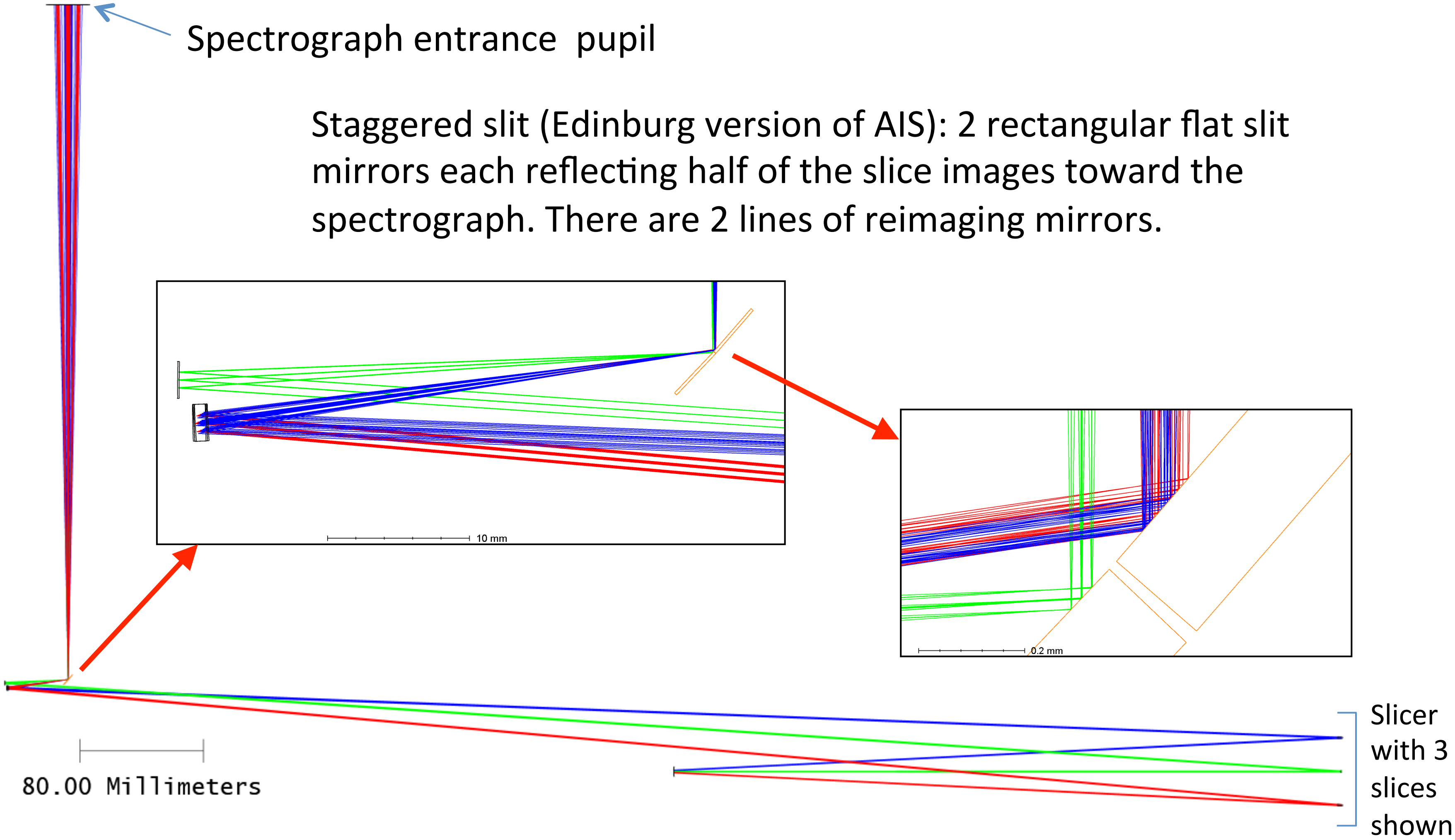
# A GMOS Slicer Design of 1996



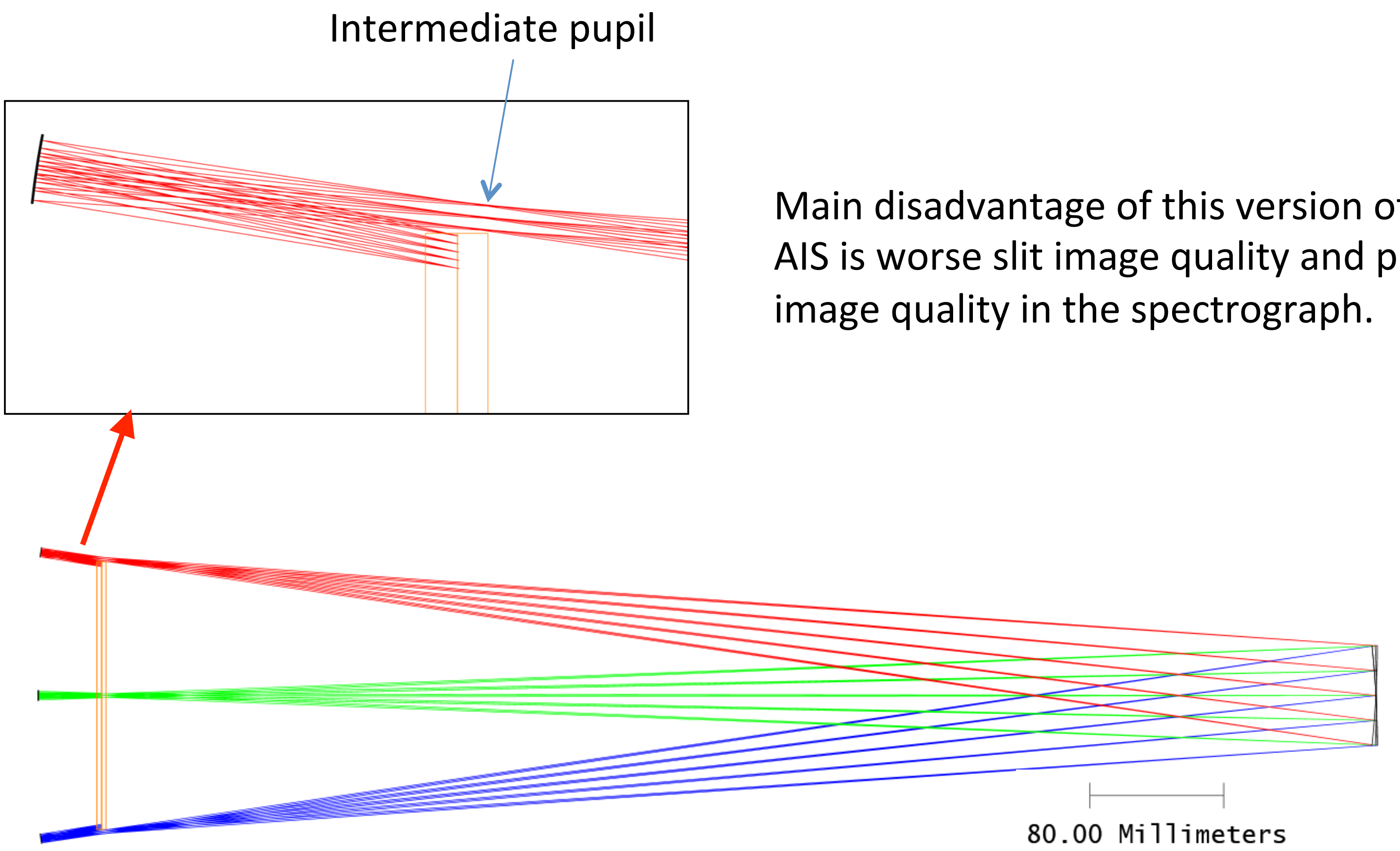

A cut of an image slicer, with 2 slits in the spectrum direction, which would suit the Gemini Multi-Object Spectrographs. The box is 60 x 248 mm. The light enters the box by a hole in the top and forms the sky image on the bottom, which is the mask of the spectrograph. A field splitter (A) cut the light in two parts, each hitting successively the mirrors B and C which re-image the light on the slicing mirror D. The light from each slice then hits its pupil mirror E and field mirror F before forming an image on a slit of the spectrograph mask.

# MAVIS slicer system 1: side view

Staggered slit (Edinburg version of AIS): 2 rectangular flat slit mirrors each reflecting half of the slice images toward the spectrograph. There are 2 lines of reimaging mirrors.



# MAVIS slicer system 1: top view




Main disadvantage of this version of the AIS is worse slit image quality and pupil image quality in the spectrograph.

# Basics of MAAT

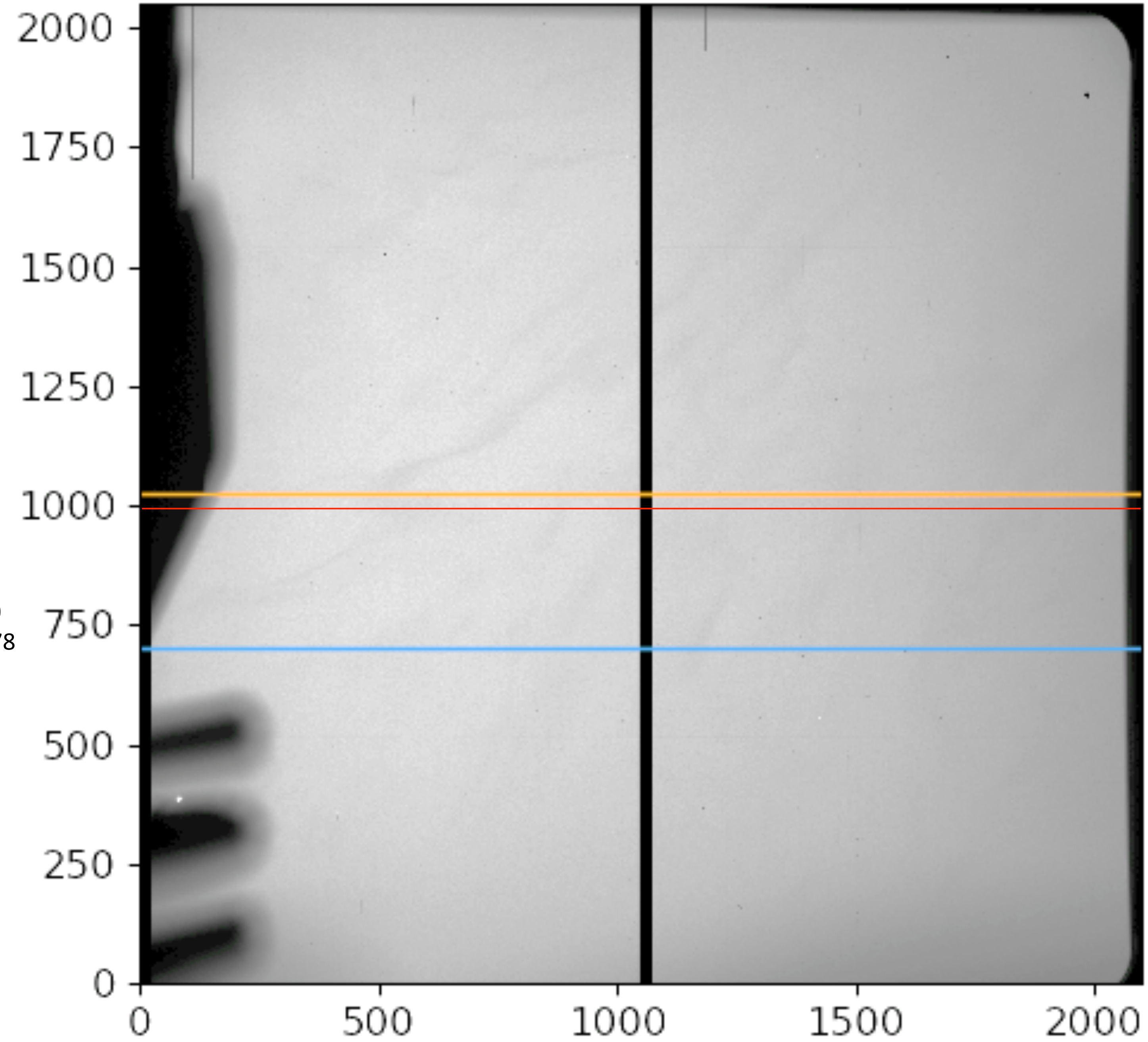
- Advanced Image Slicer concept.
- 33 slices:
  - 0.303” x 14.2”.
  - 0.8 mm wide on slicer.
- Field of 14.2” x 10.0”.
- Slit length: 8.08’. The slit length can be a bit longer than with a slit mask because of the box structure that hold everything together.
- Small length with vignetting (3.35”) but it is in a corner and T > 80% everywhere.
- Spaxel size:
  - Standard readout: 0.127” x 0.303”.
  - 2 x 1 pixel readout: 0.254” x 0.303”.
- Spectral element: 2.4 pixel wide.
- Assuming 0.3” image quality, which is larger than the PSF from the as-designed aberrations, resolution is 1.6 times higher with slicer than 0.6” slit.

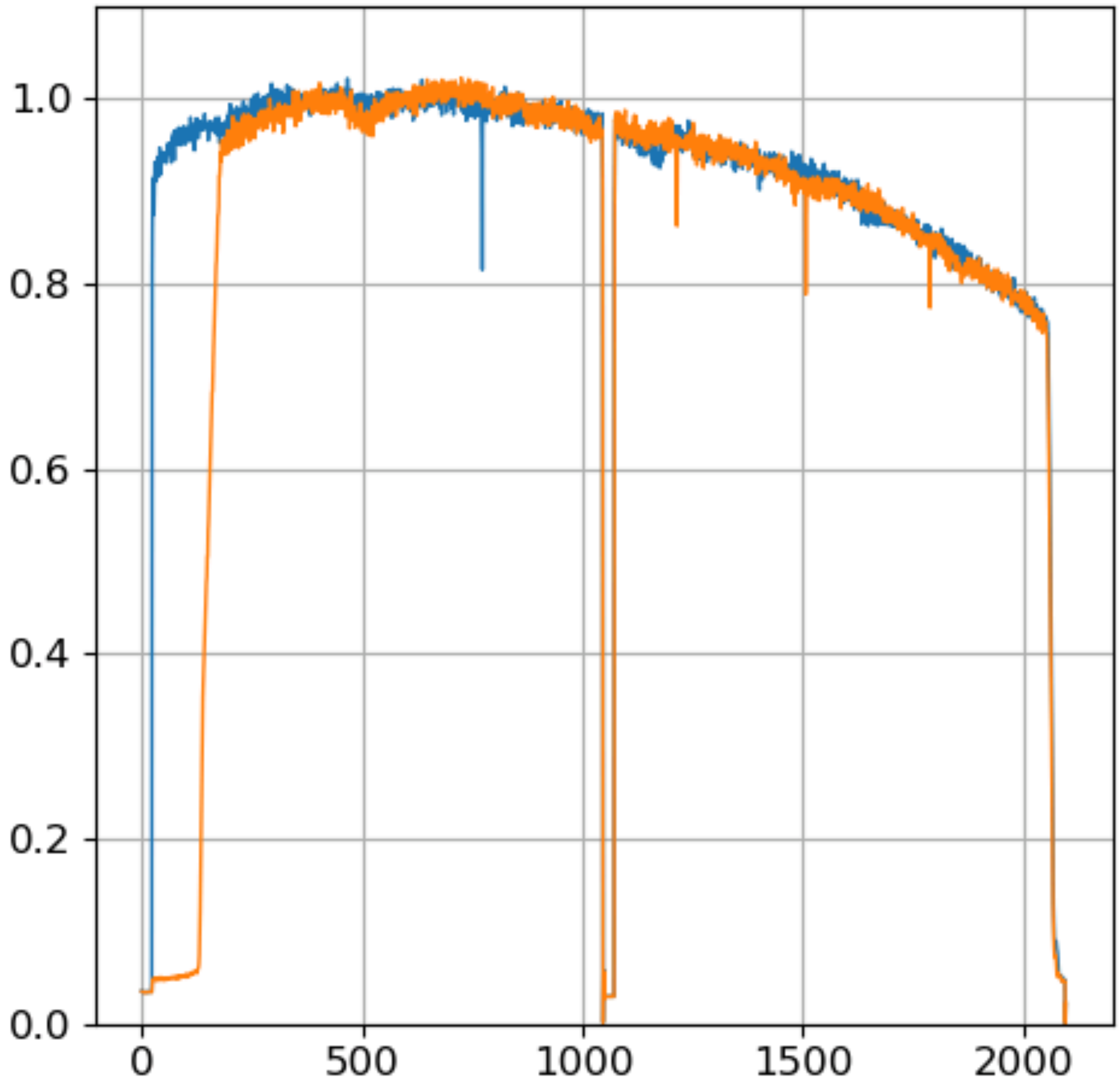
3.18-3.07=0.11 → 14 bigpix

1024.7
0.39

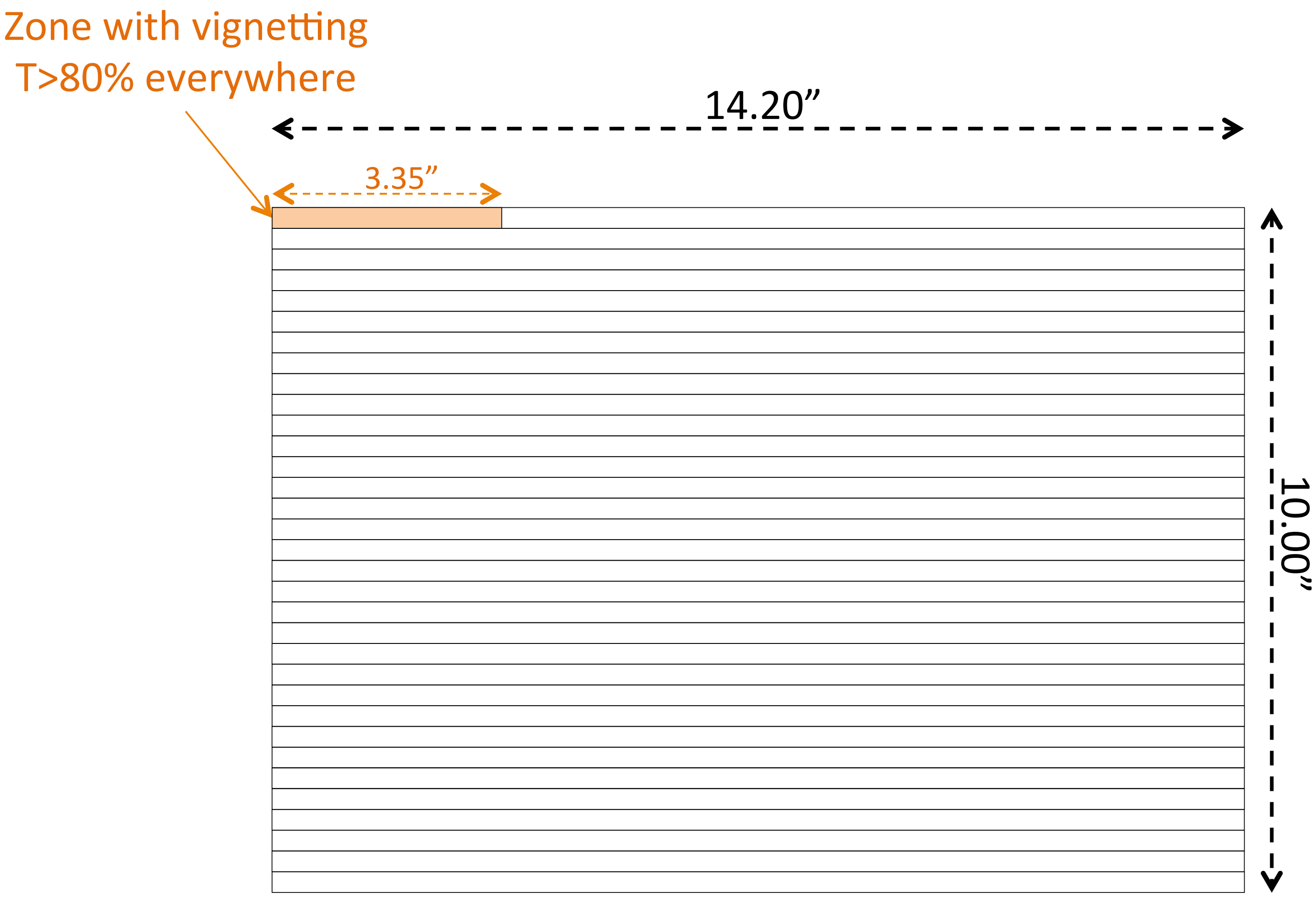
1250
2.17

750
-1.78



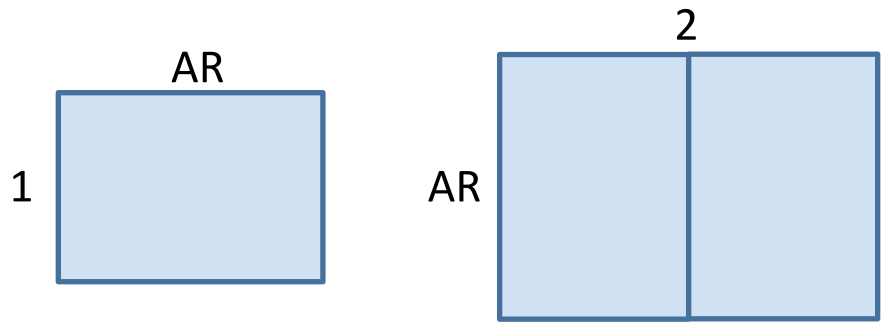


1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000

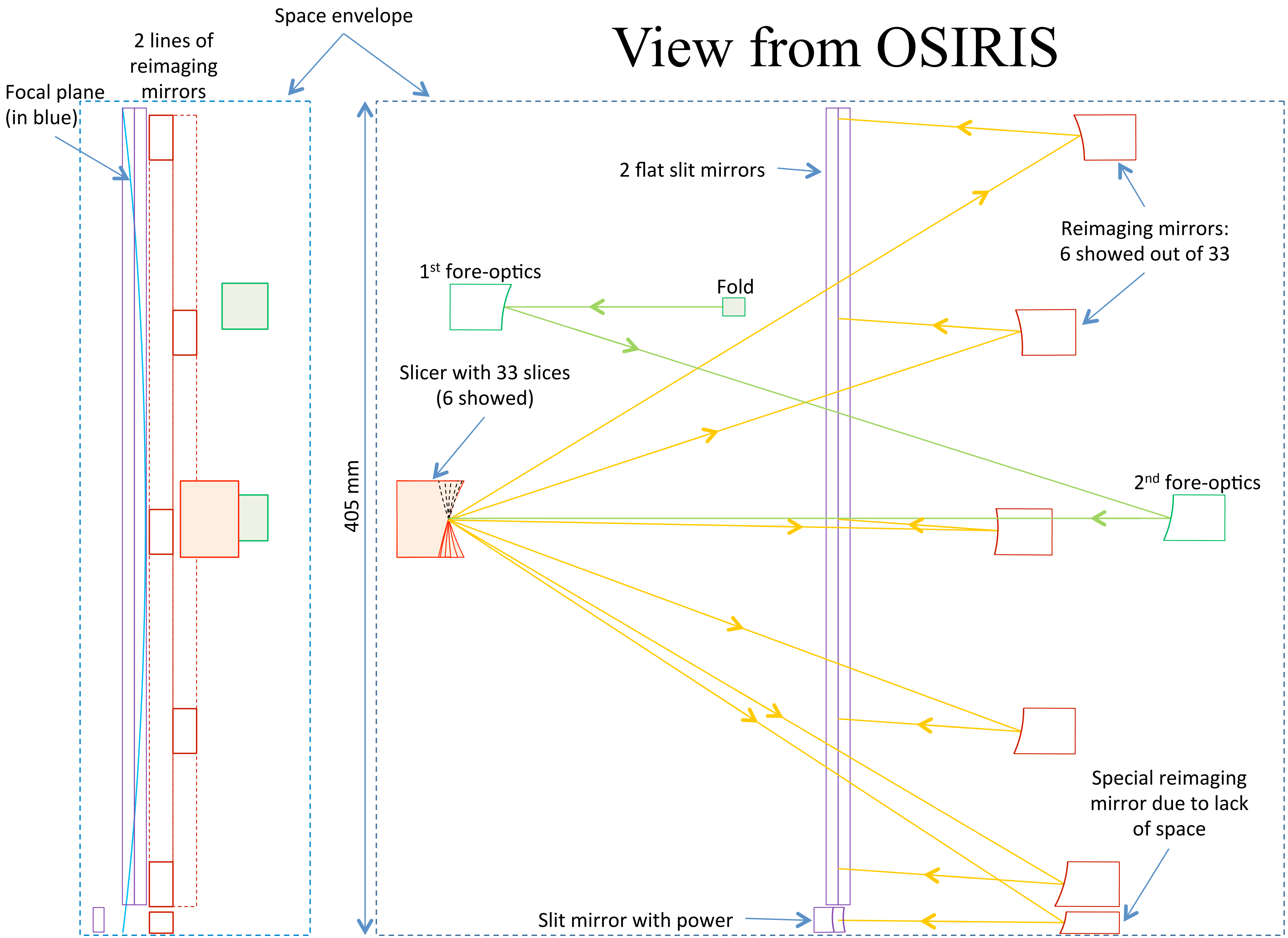

Zone with vignetting
T>80% everywhere
14.20”
3.35”
10.00”

# Slicer aspect ratio

- A typical astronomical object will have a width and a length so a square field is not optimum but what is the best aspect ratio?
- If the object is too large for the field, a second image will have to be taken. We want the same optimum aspect ratio for the total image obtained by merging these 2 images.
- Since the ratio is the same for one or 2 merged images, the optimum ratio is Sqrt(2).




AR/1 = 2/AR → AR = Sqrt(2)



View from OSIRIS
Space envelope
2 lines of reimaging mirrors
Focal plane (in blue)
2 flat slit mirrors
Reimaging mirrors: 6 showed out of 33
1st fore-optics
Fold
Slicer with 33 slices (6 showed)
405 mm
2nd fore-optics
Special reimaging mirror due to lack of space
Slit mirror with power

# Design challenges

- No show stopper but some points need attention.
- Precise slit length and position.
- Very curved slit: Position of each re-imaging mirror can be used to rotate the image. Still, possible small defocus at the edges of each slice but focal ratio very slow (F/16.3).
- Defocus on flat slit mirrors due to curved slit. Slit more “staggered” which may slightly reduce the spectral length when spectra touch the edge of the detector. Possible mitigating solution under study using a new idea developed for MAVIS.
- Tilted slit: direction of beam before flat slit mirrors must be carefully calculated.
- Large incident angle on edge re-imaging mirrors: aberrations. Toroidal re-imaging mirrors may be necessary. Another solution is a flat mirror at the end of the box to double its optical size.

# Improving OSIRIS image quality

- OSIRIS was designed for 0.6” slit but slices are nearly 2 times smaller.
- Assuming a spectrograph typical image quality of half the slit width, so 0.3”, the resolution is 1.6 time higher with the slicer than the 0.6” slit but the image quality can be worse than 0.3”.
- The 33 re-imaging mirrors of the slicer system can be used to correct some of the OSIRIS aberrations it they can be precisely measured.
- Measurements can be made using 2 masks each with a line of small holes at the slit position but out of focus, one before the telescope focal plane, the other after.

# Conclusion

- No drawback. OSIRIS characteristics makes it possible to have a slicer system.
- Careful design must be made but I have a long experience in IFU design.
- Measurement of the OSIRIS aberrations will be necessary to maximize the resolution by adding counter-aberrations to the re-imaging mirrors.