Technical Evaluation Report
TAACOS: Detector Summary Images

Date:	October 1, 2002
Document Number:	COS-11-0017
Revision:	Initial Release
Contract No.:	NAS5-98043
CDRL No.:	SE-05

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Letter	ECO No.	Description	Check	Approved	Date
-		Initial Release			

Original Release Name: S. Penton	Date 4-2-02	**THE UNIVERSITY OF COLORADO** At Boulder **The Center for Astrophysics and Space Astronomy**			
Drawn:					
Reviewed:		Technical Evaluation Report **TAACOS: Detector Summary Images**			
Approved:					
		Size	Code Indent No.	Document No.	Rev
		A		COS-11-0017	-
		Scale: N/A			

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1. BACKGROUND

In this report, we use the "Target Acquisition Analysis for the Cosmic Origins Spectrograph (TAACOS)" simulation software, to present simulated detector summaries ("cheatsheets") for the NUV and FUV detectors. The original TAACOS reports assumed 6 µm "X" (dispersion, XD) by 15 µm "Y" (cross-dispersion, XD) digital elements on the FUV detectors. The FUV detectors have been modified to produce 25µm XD digital elements. We find that this does not change the effectiveness of any of the TA phases, but, obviously, does change the values of XD plate scales for the FUV detectors. This document assumes that the digital elements on the FUV detectors are 6x25 µm. See Rev A of COS-11-0016 for updated TAACOS analysis.

Detector cheatsheets are provided for all FUV gratings (g130m, g160m, and g140l), for both daytime and nighttime observations (including simulated Geocoronal emission). Due to the absence of substantial Geocoronal emission in the NUV bandpass, a single NUV cheatsheet is presented for the medium resolution gratings (g185m, g225m, g275m), and one for the low resolution grating (g230l).

PDF format versions of the COS cheatsheets, and additional information regarding the TAACOS project can be found at http://cos-arl.colorado.edu/TAACOS, or in COS-08-0011, COS-11-0014, COS-11-0016, and COS-11-0024.

2. APPLICABLE DOCUMENTS

The following documentation describes the algorithms and procedures proposed for HST/COS target acquisition. The referenced documents are of the revision in effect on the date of the release of this document

COS-01-0001	COS Science Operations Requirements Document (OP-01)
COS-08-0011	TAACOS: Target Acquisition Analysis for the COS (CASA)
COS-11-0014	Recommended Flight Software and Operations Changes based on the TAACOS Phase I Reports for the FUV and NUV Channels
COS-11-0016	TAACOS: FUV Phase I Report, Revision A
COS-11-0024	TAACOS: NUV Phase I Report
COS-11-0027	Target Acquisition with the TA1 Mirror
COS-FSW-001	Target Acquisition Concepts for COS (BATC)

3. LIST OF ACRONYMS AND ABBREVIATIONS

BOA	Bright Object Aperture
CAL	Calibrate Aperture Location
CASA	Center for Astrophysics and Space Astronomy
COS	Cosmic Origins Spectrograph
CU	University of Colorado @ Boulder
DD	Dispersion Direction
DCS	Detector Coordinate System
FUV	Far UltraViolet
HST	Hubble Space Telescope
IC	Image Coordinate system
IDL	Interactive Data Language
m	minute
LTAIMAGE	NUV TA routine to locate target image
LTAIMCAL	NUV TA routine to locate calibration image
MAMA	Multi-Anode Microchannel Array
NUV	Near UltraViolet
p	Pixel
PSF	Point Spread Function (of HST)
QSO	Quasi-Stellar Object
PtNe	Platinum-Neon (Wavelength Calibration Lamp)
PSA	Primary Science Aperture
RE	Resolution Element
s	second
TA	Target Acquisition
TAACOS	TA Analysis for COS
XD	Cross-Dispersion direction

4. FUV SIMULATED DETECTOR SUMMARIES

Figures 3-5 display TAACOS simulated detector summaries ("cheatsheets") for the three FUV gratings including simulated daytime Geocoronal emission. Figures 4-7 include nighttime Geocoronal emission. Also indicated in the summaries are:

- Spectral locations (wavecal and science spectrum) in the instrument coordinate system (IC, pixels) and the detector coordinate system (DCS, millimeters). The science spectrum is a simulated isolated quasi-stellar object (QSO) of $F_\lambda = 10^{-14}$ ergs/cm^2/s/Å. The G130M and G160M exposures simulate a 30-second exposure with a noiseless detector. The G140L cheatsheets contain a 20-second exposure. These are the exposures appropriate for dispersed light TA with a point source of this intensity.
- Simulated Geocoronal emission. Geocoronal airglow fills the science aperture, and therefore, has a more extended spatial profile than a point-source,
- The TA extraction subarrays used to exclude the Geocoronal airglow (see COS-01-0001, http://cos-arl.colorado.edu/OP01, for current subarray pixel boundaries),
- The lifetime adjustment regions of the wavecal and science spectra,
- The flat-field region of the detector,
- The cross-dispersion (XD) profiles of the detector segments,
- The relationship between the HST point spread function (PSF) and the PSA/BOA. This relationship is shown in the Aperture Coordinate System (ACS) in units of millimeters and arcseconds on the sky,
- The TA extraction subarrays used for Geocoronal emission exclusion, and
- Plate scales, pixel sizes and resolution element (RE) of the dispersion direction (DD) dimension.

These figures contain a significant amount of information. To minimize confusion, Figure 1 presents a description (key) for deciphering the FUV detector cheatsheets. The numbered items above the figure on the next page correspond to the indicated items on the miniaturized version of a FUV cheatsheet presented in Figure 1. The actual pixel values and ranges displayed for the FUV detectors are averages of the values observed for FUV01. For example, flat field images from FUV01 segment A display a Y-coordinate range of 370-771, while the segment B ranges from 260-656. The FUV cheatsheets given here have a Y-range of 315-714.

The FUV cheatsheets are available online in PDF format at the TAACOS website, http://cos-arl.colorado.edu/TAACOS/cheatsheets .

1) FUV Y axis in the Instrument Coordinate (IC) system. Units are 25µm (Y) pixels.
2) Detector areas not electronically sampled are shown as magenta crosshatched areas.
3) The upper X-axis in units of wavelength (Å) and millimeters (DCS). The A/B segments are also indicated. The X-axis has been compressed by a factor of ~14 compared to the y-axis (1).
4) The Pt-Ne wavelength calibration spectrum is shown in green.
5) The lifetime adjustment range of the calibration spectrum (green dashed lines).
6) The region of the detector uniformly illuminated by the flat-field lamp (red dashed lines).
7) The four COS apertures (red outlines). X-axis compression can be seen in the round PSA and BOA.
8) A simulated QSO spectrum.
9) Simulated Geocoronal emission is shown in grey.
10) Lifetime adjustment range of the science spectrum position (blue dashed lines).
11) Grating/Detector indication
12) The TA extraction boxes for each segment (black dashed lines)
13) Pixel sizes, plate scales and RE DD dimensions for the FUV detector.
14) The spatial relationship of the HST PSF and the COS BOA/PSA
15) The 9mm gap between the FUV segments (inactive).
16) The X-axis in IC (6µm pixels).
17) XD profiles of each segment before and after Geocoronal exclusion by the TA extraction subarrays.
18) The Y-axis in DCS (millimeters).

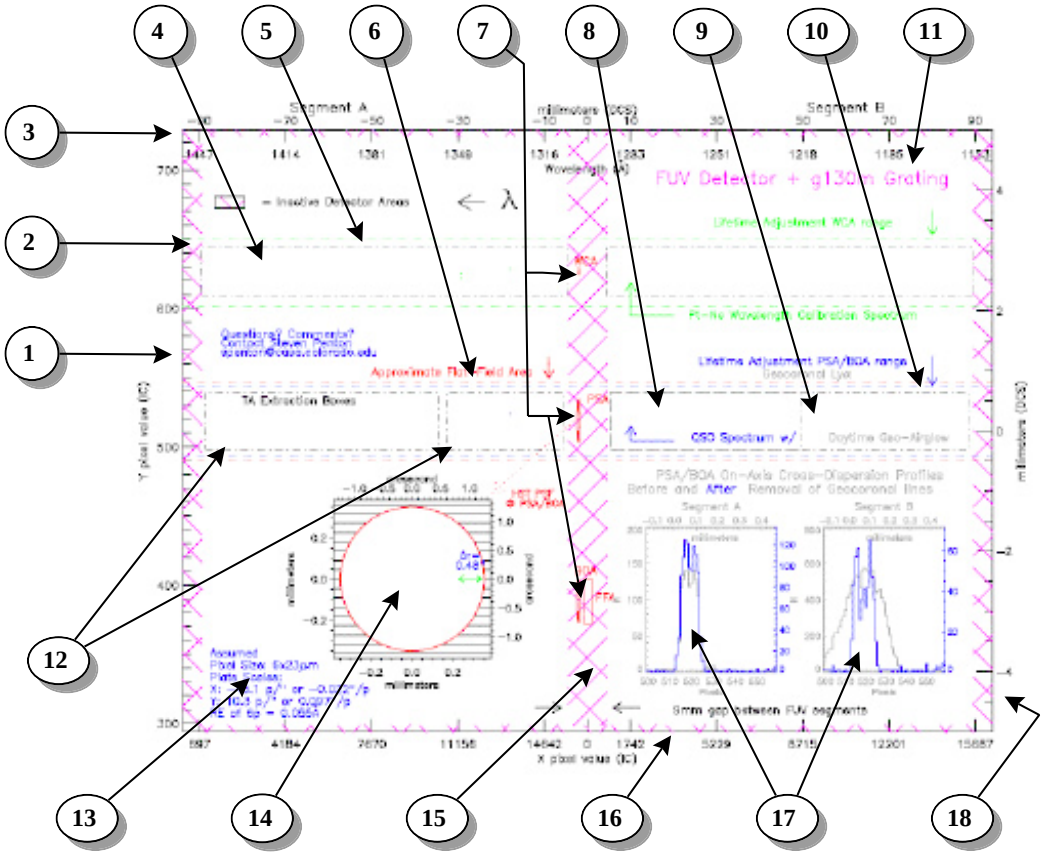

Figure 1: Description of the elements of the FUV Cheatsheets

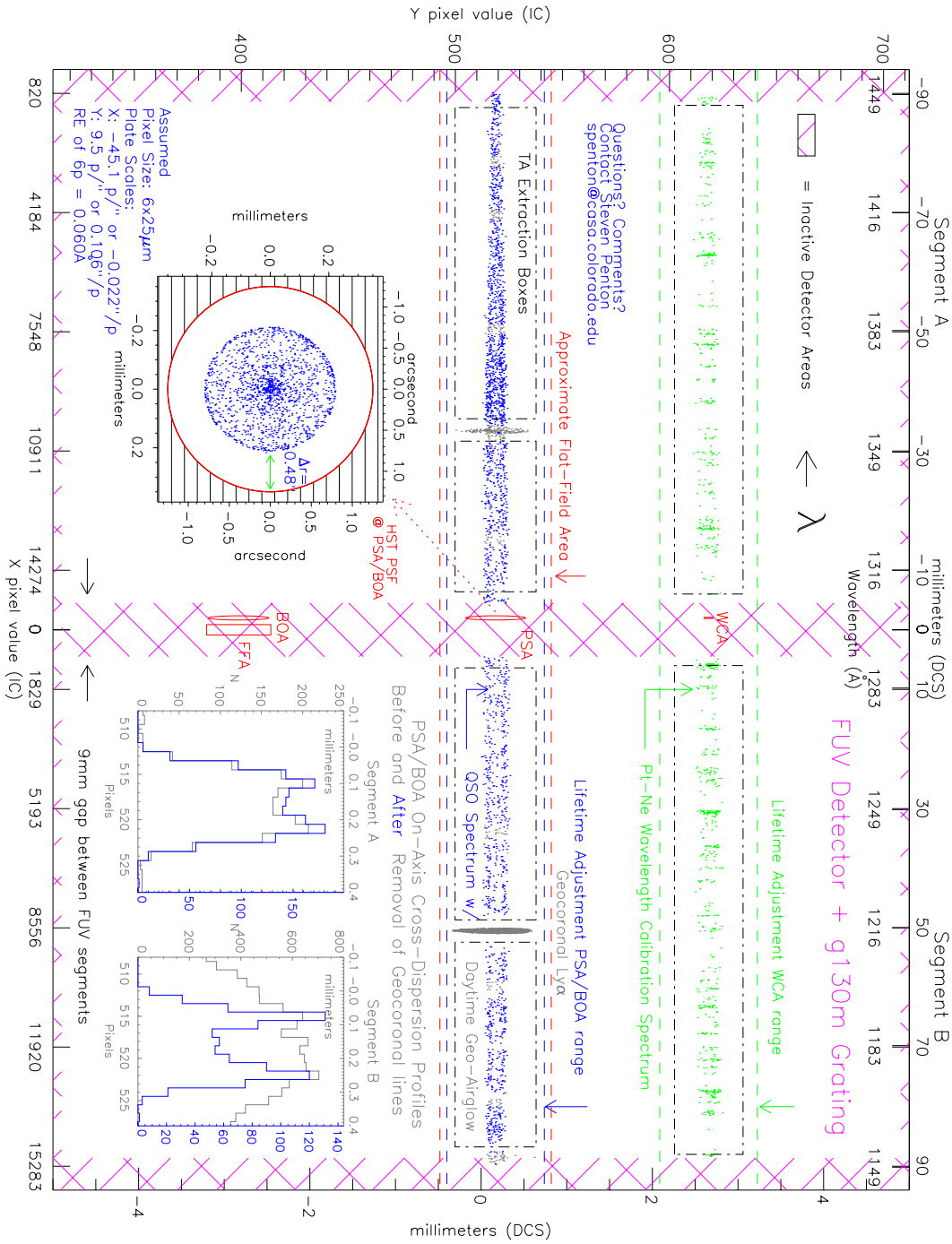

Figure 2: FUV G130M Daytime Simulated Detector Cheatsheet

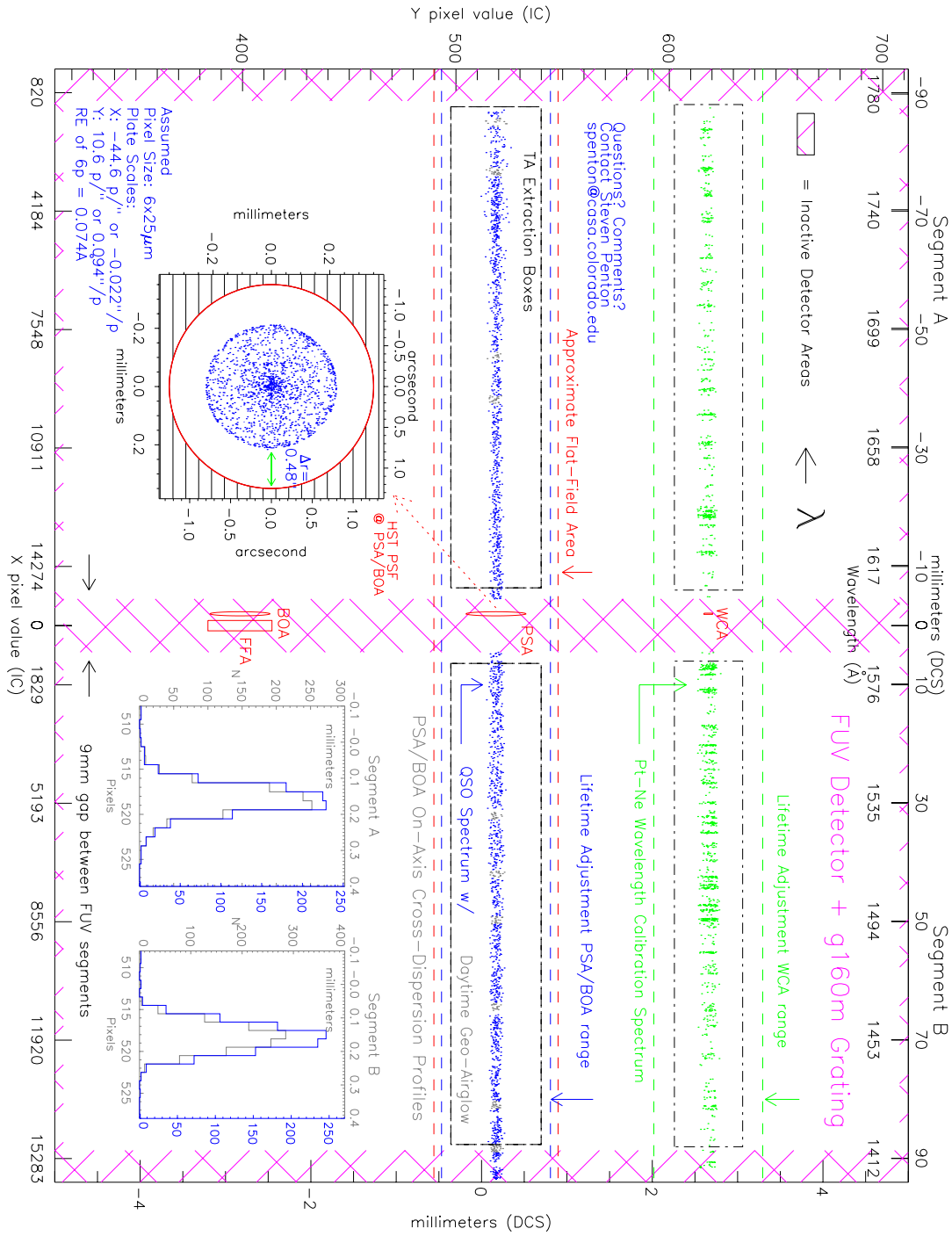

Figure 3: FUV G160M Daytime Simulated Detector Cheatsheet

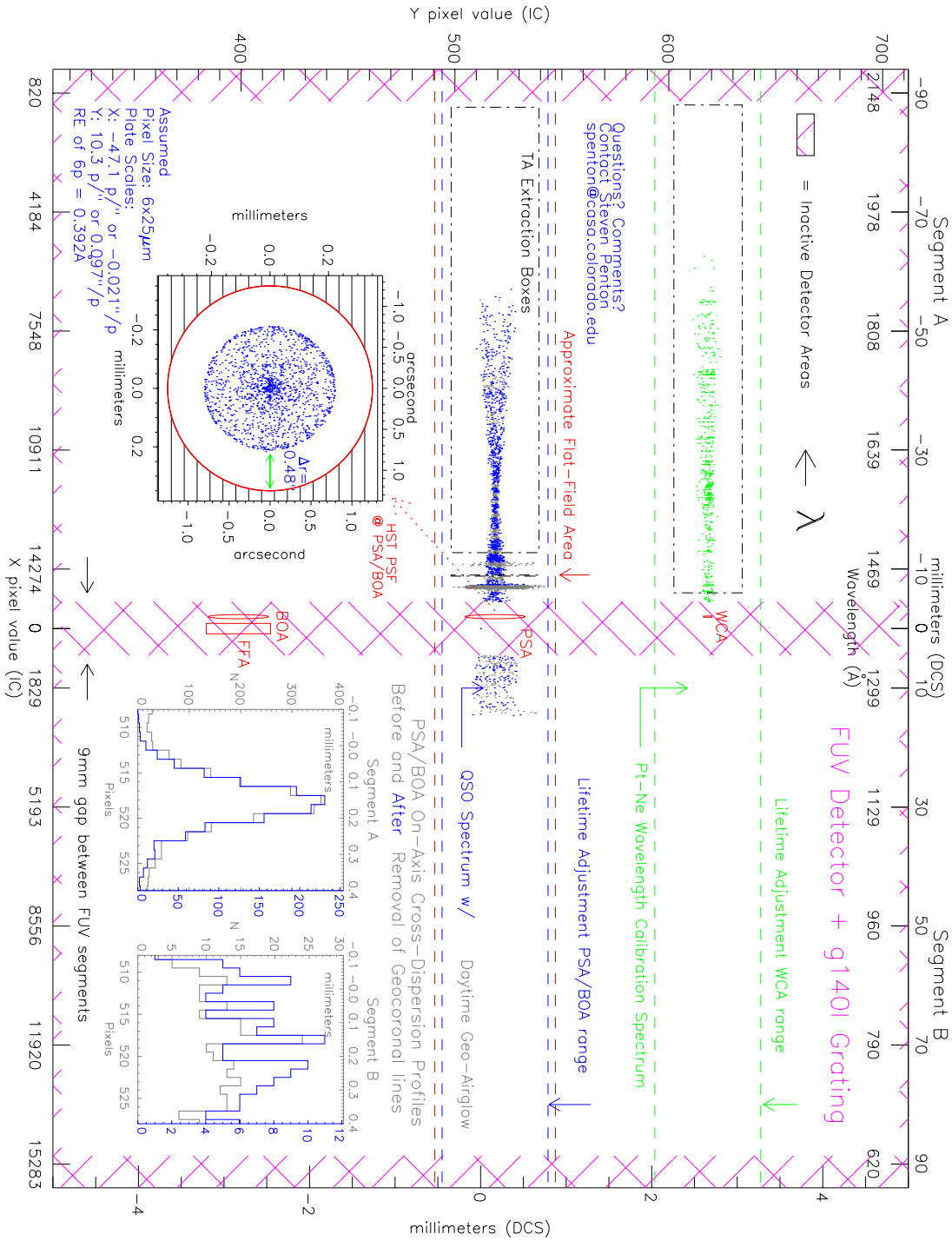

Figure 4: FUV G140L Daytime Simulated Detector Cheatsheet

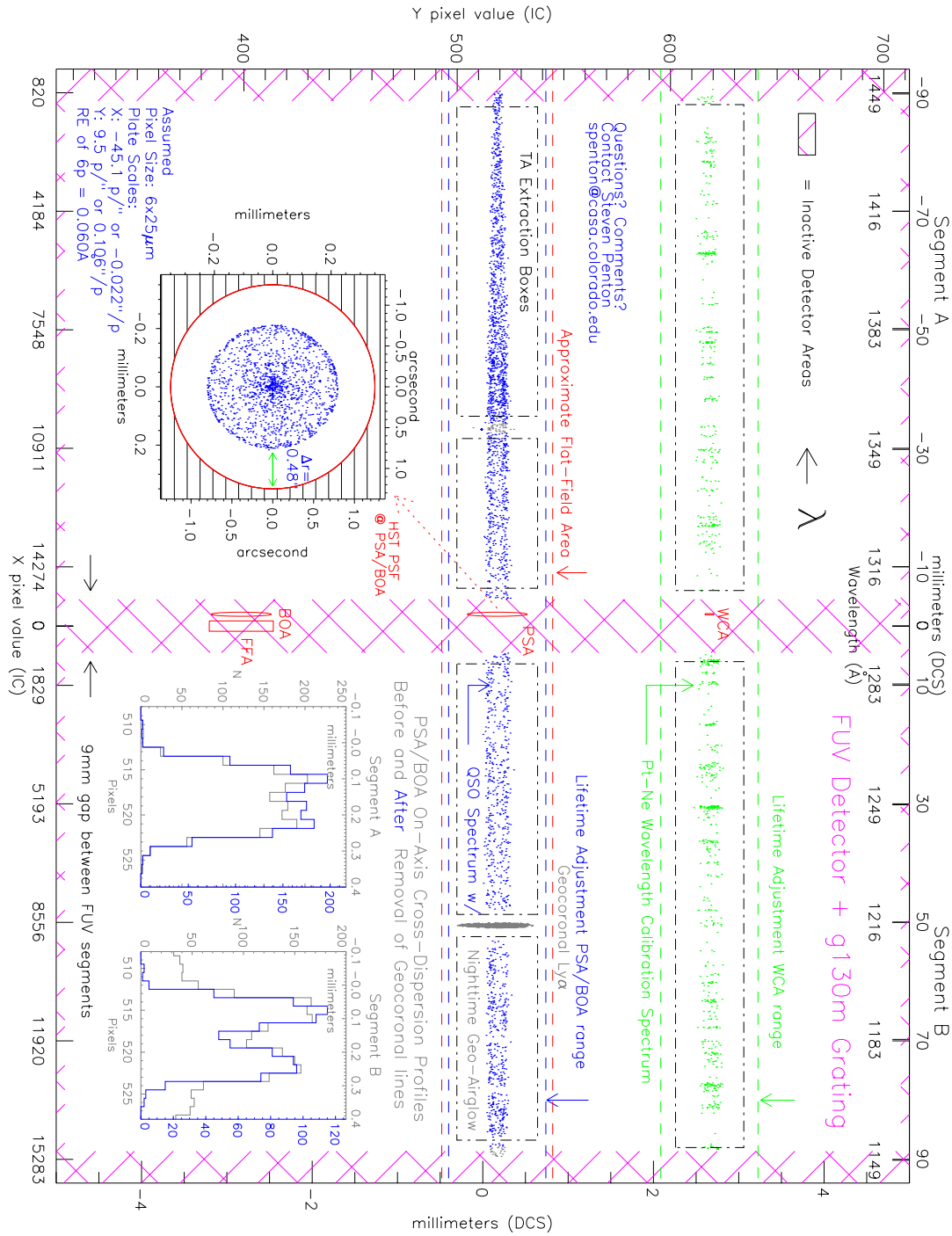

Figure 5: FUV G130M Nighttime Simulated Detector Cheatsheet

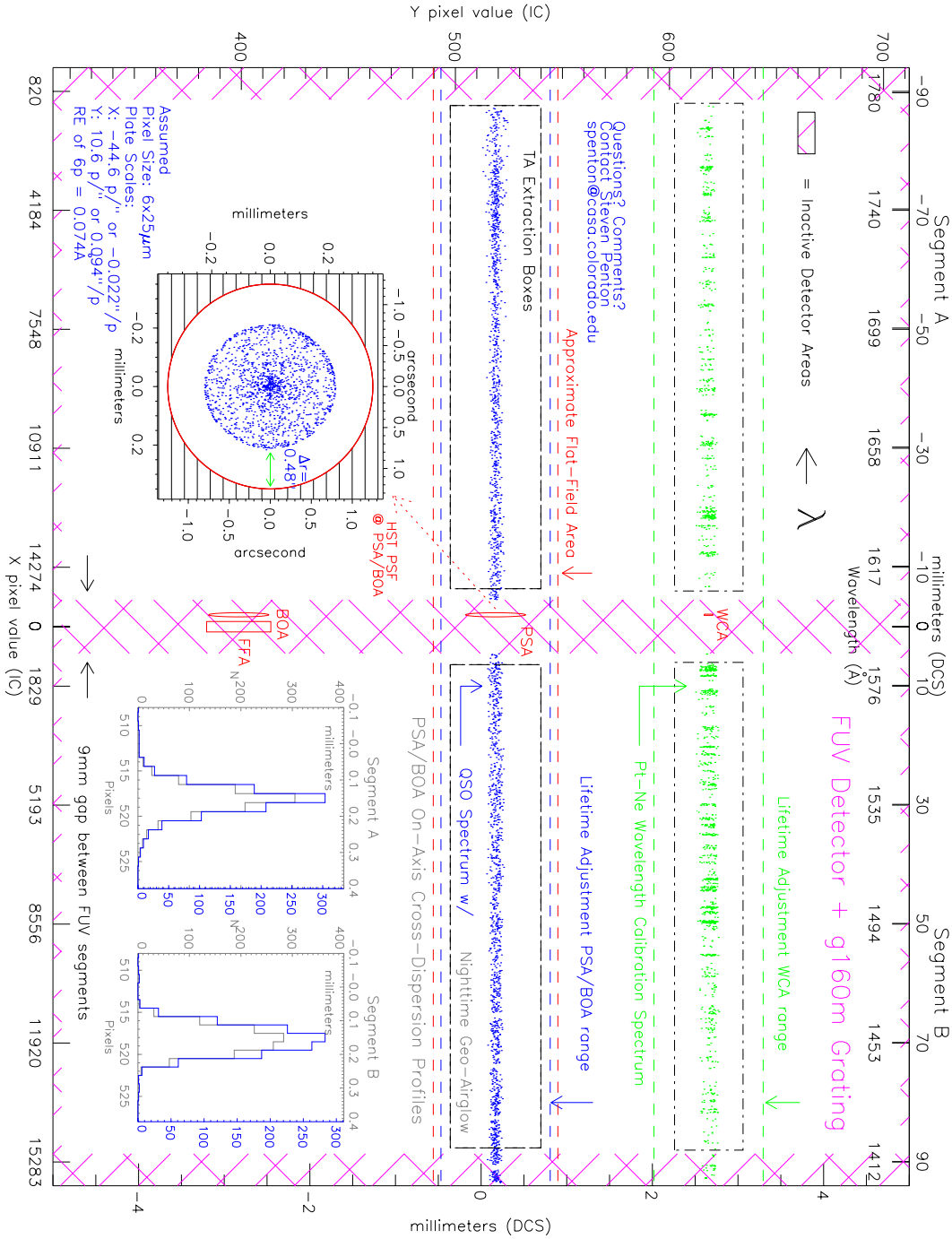

Figure 6: FUV G160M Nighttime Simulated Detector Cheatsheet

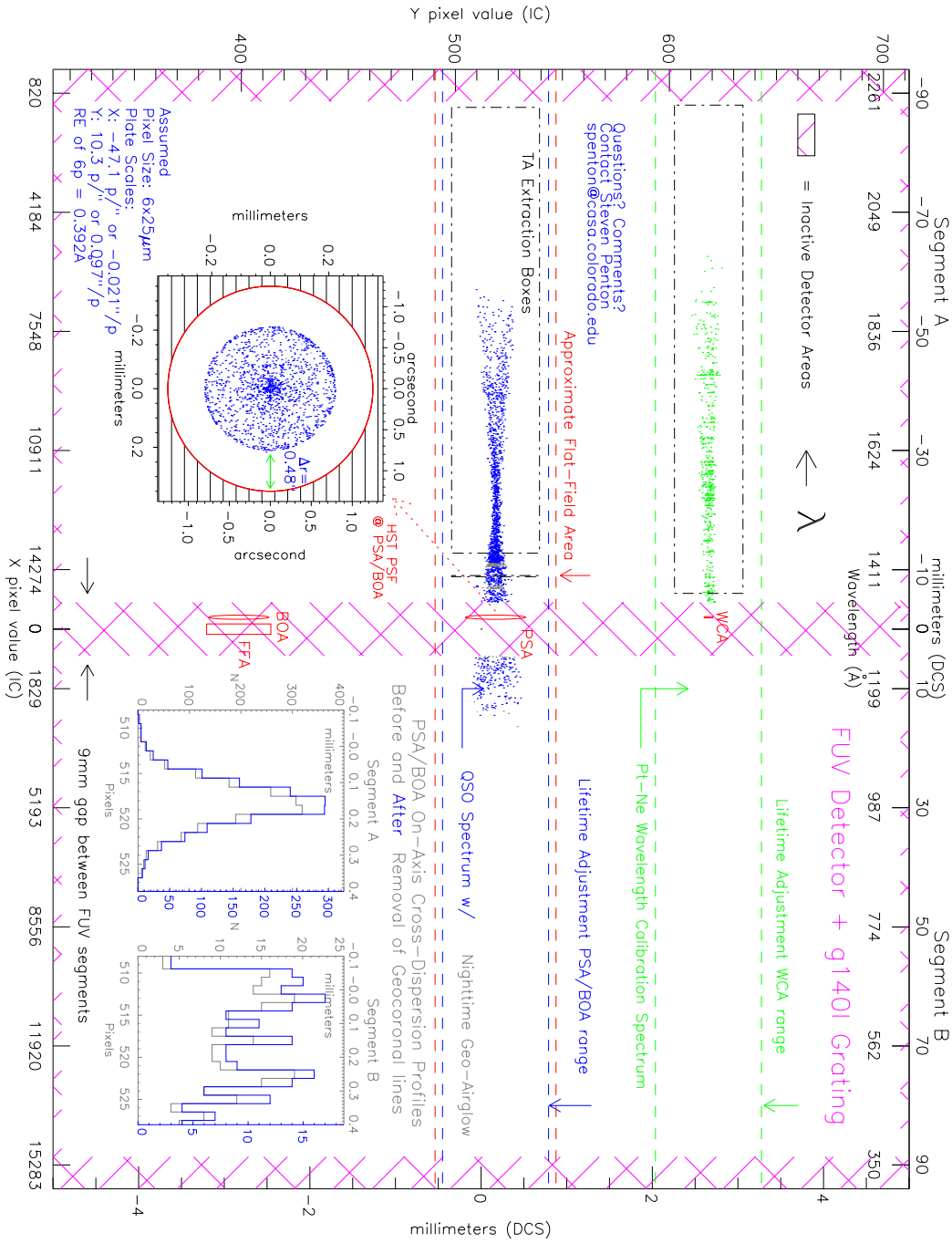

Figure 7: FUV G140L nighttime simulated detector cheatsheet

5. NUV SIMULATED DETECTOR SUMMARIES

Figures 8-11 display TAACOS simulated detector summaries ("cheatsheets") for the NUV detector and its' four gratings. These summaries are much simpler than the FUV cheatsheets, and are mostly self-explanatory. Features indicated on the summaries include:

- Spectral locations (wavecal and science spectrum). The science spectrum is a simulated isolated quasi-stellar object (QSO) of $F_\lambda = 10^{-14}$ ergs/cm^2/s/Å. The simulated G225M, G285M and G230L exposures are 20 seconds in duration, while the G185M spectrum is a simulated 30-second exposure. These are the exposures appropriate for dispersed light TA with a point source of this intensity (~1600 counts from the target). The wavelength calibration spectra are of varying duration as indicated in the figures. There are no Geocoronal emission lines in the bandpasses simulated, so separate daytime and nighttime simulations are not required. Also included on the summaries are:
- Simulated detector noise is included within the indicated TA extraction subarrays (see COS-01-0001 for current subarray pixel boundaries, http://cos-arl.colorado.edu/OP01).
- The cross-dispersion (XD) profiles of the various spectral stripes.
- Plate scales, pixel sizes and resolution element (RE) of the dispersion direction (DD) dimension.

The NUV cheatsheets are available online in PDF format at the TAACOS website, http://cos-arl.colorado.edu/TAACOS/cheatsheets .

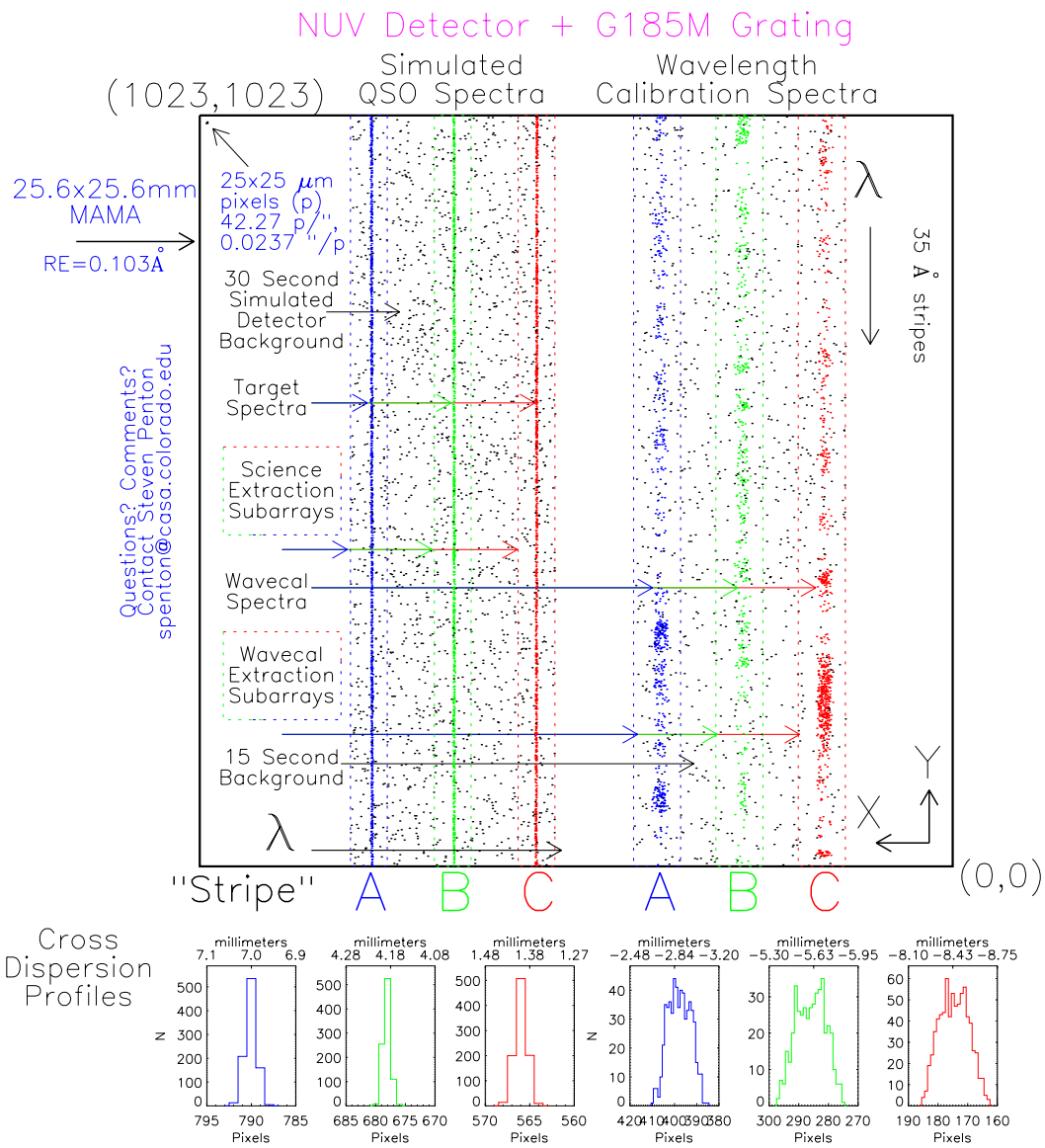

Figure 8: NUV G185M simulated detector cheatsheet. The three science spectral stripes are on the left, and are color-coded and labeled "A", "B", and "C". The corresponding wavelength calibration stripes are dispersed on the right side of the detector. The cross-dispersion ("Y") profiles of the six spectral stripes are shown along the bottom, in units of detector pixels and millimeters. Each G185M spectral stripe is approximately 35Å.

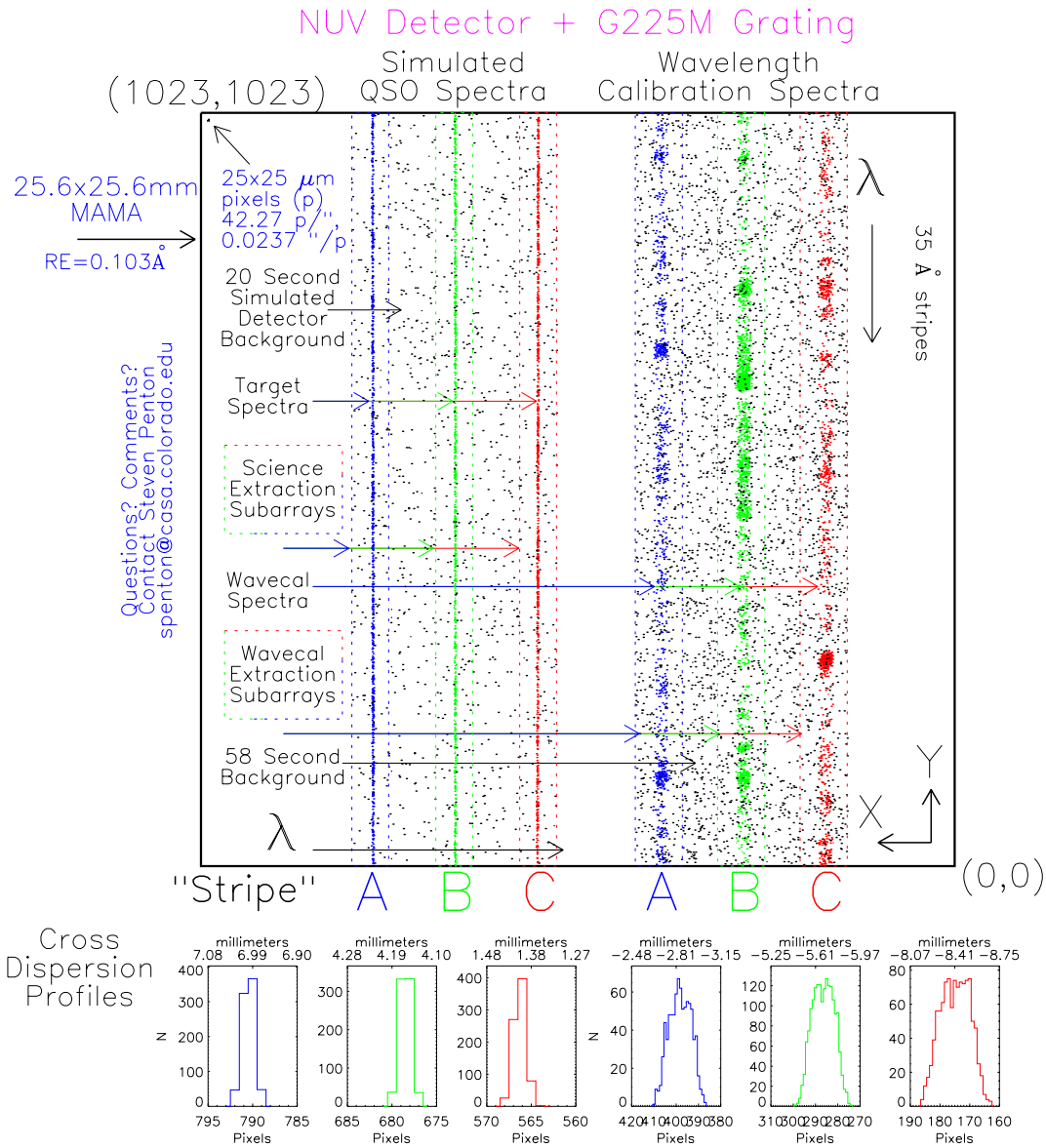

Figure 9: NUV G225M simulated detector cheatsheet. Each spectral stripe is approximately 35 Å.

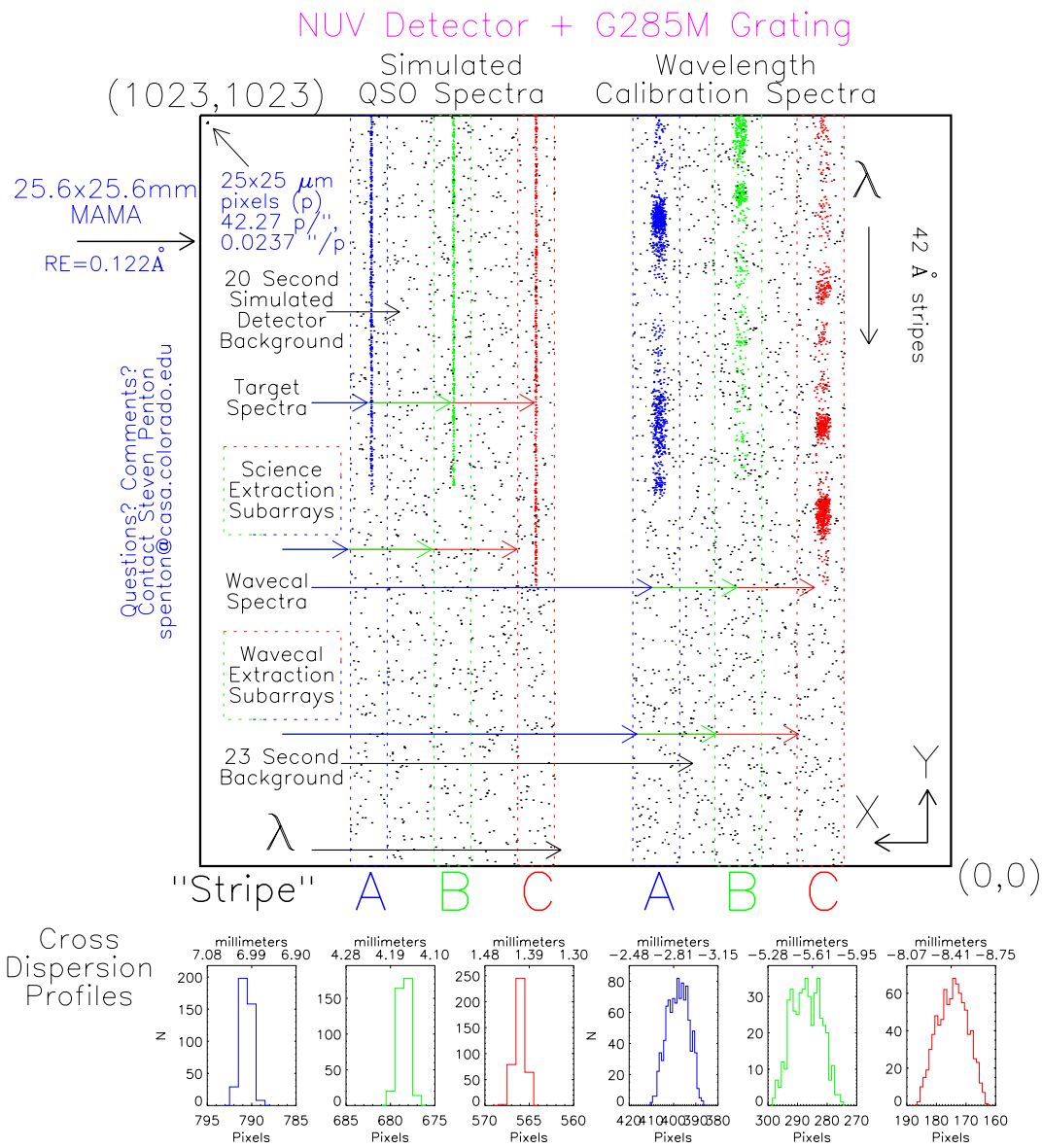

Figure 10: NUV G285M simulated detector cheatsheet. Each spectral stripe is approximately 42 Å.

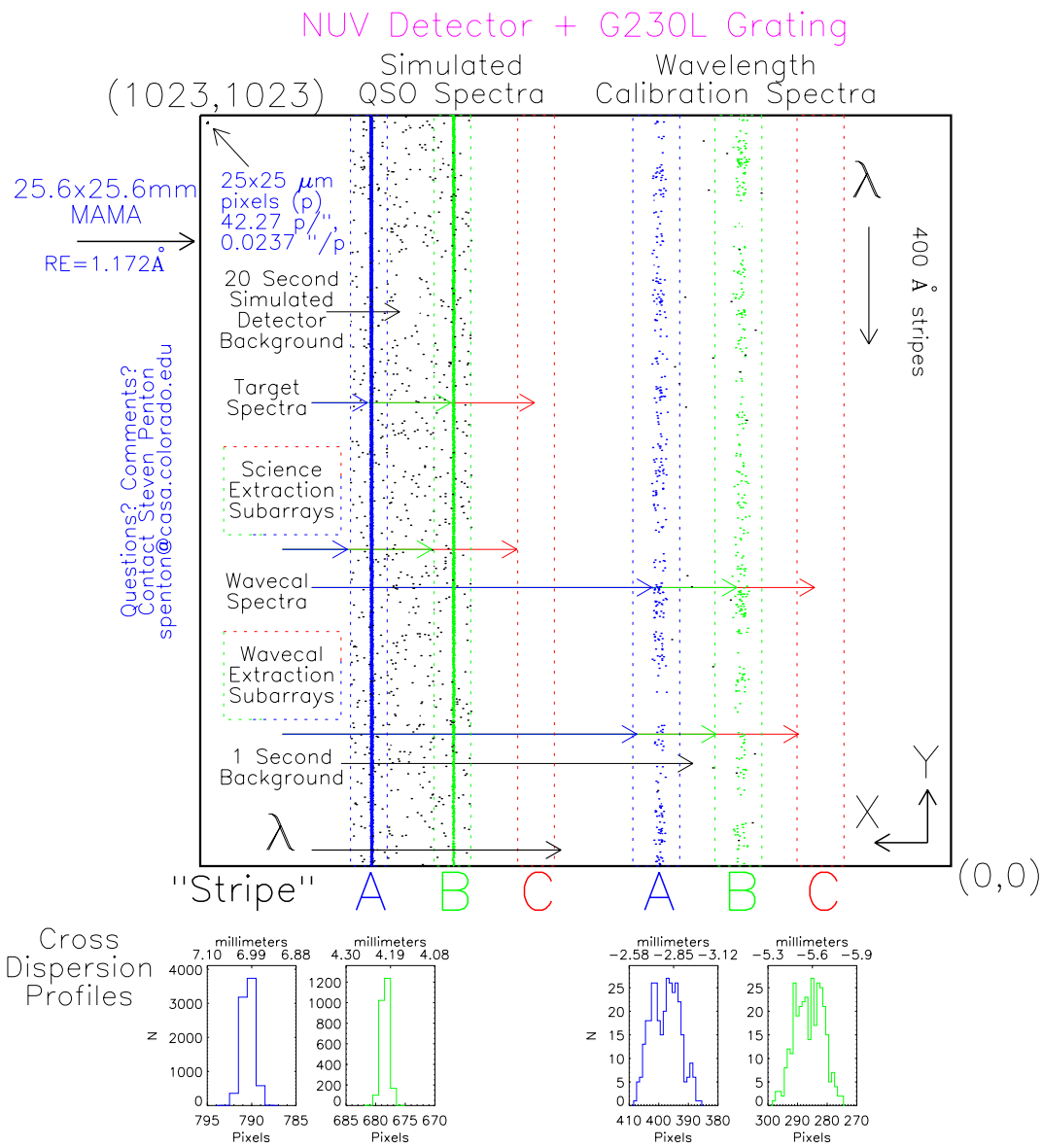

Figure 11: NUV G230L Simulated Detector Cheatsheet. Note the extremely low counts in the 'C' stripe, rendering it relatively useless for science exposures with this grating. Each spectral stripe is approximately 400 Å.

6. NUV+TA1 IMAGE MODE

As discussed in detail in COS-11-0027, the NUV channel of COS is capable of operating in 'image mode' by aligning mirrors on both OSM1 and OSM2. The OSM2 mirror is known as the TA1 mirror and is capable of assisting in target acquisition (TA). Figure 12 displays the location of the expected image of the wavelength calibration lamp spot (used in the TA routine LTIMCAL), an example target image (used in the TA routine LTAIMAGE), and the extraction boxes appropriate for TA. See COS-11-0027 for further details.

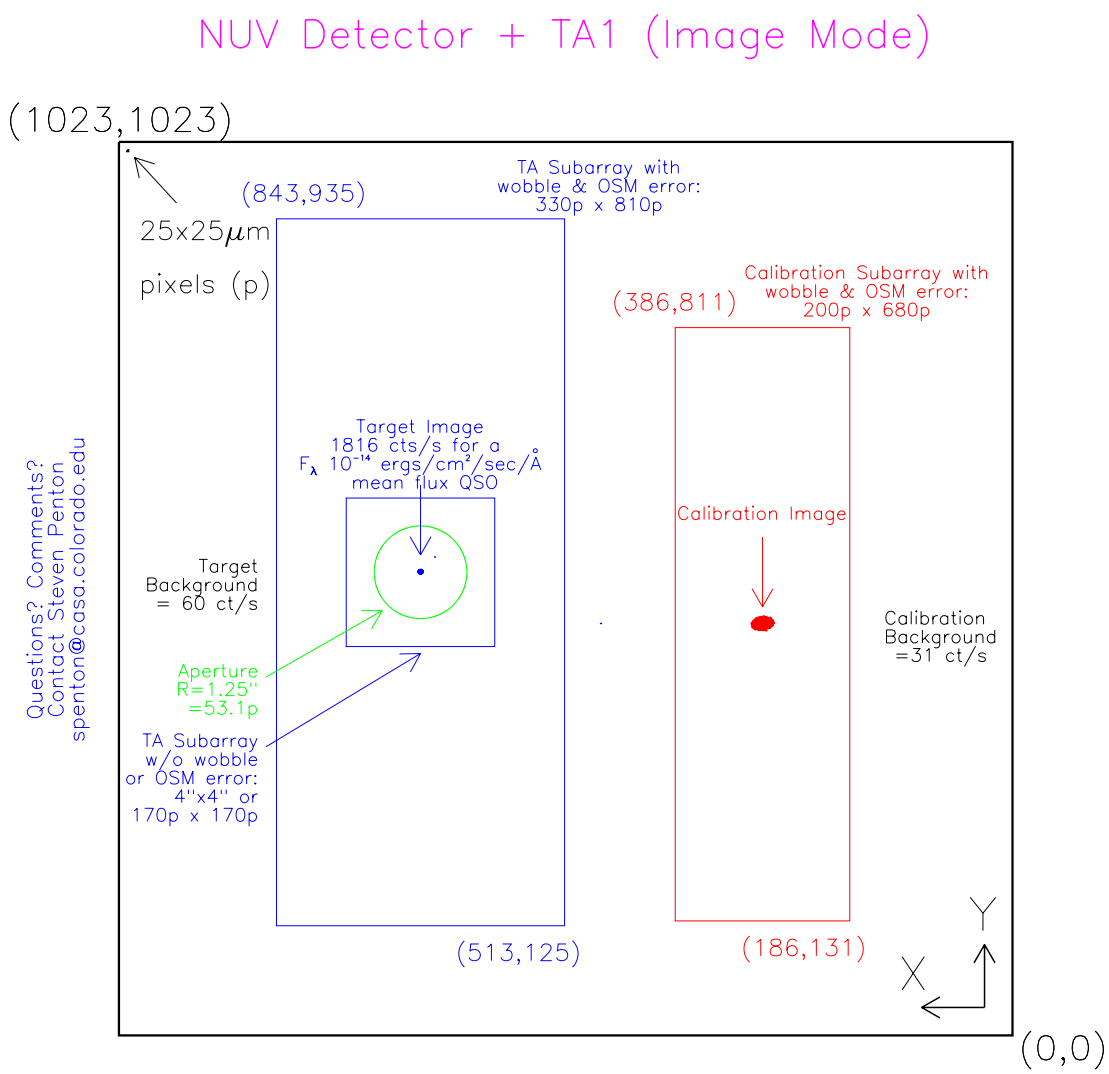

Figure 12: COS NUV + TA1 image mode summary. See COS-11-0027 for details.