UVIT Deep survey planning

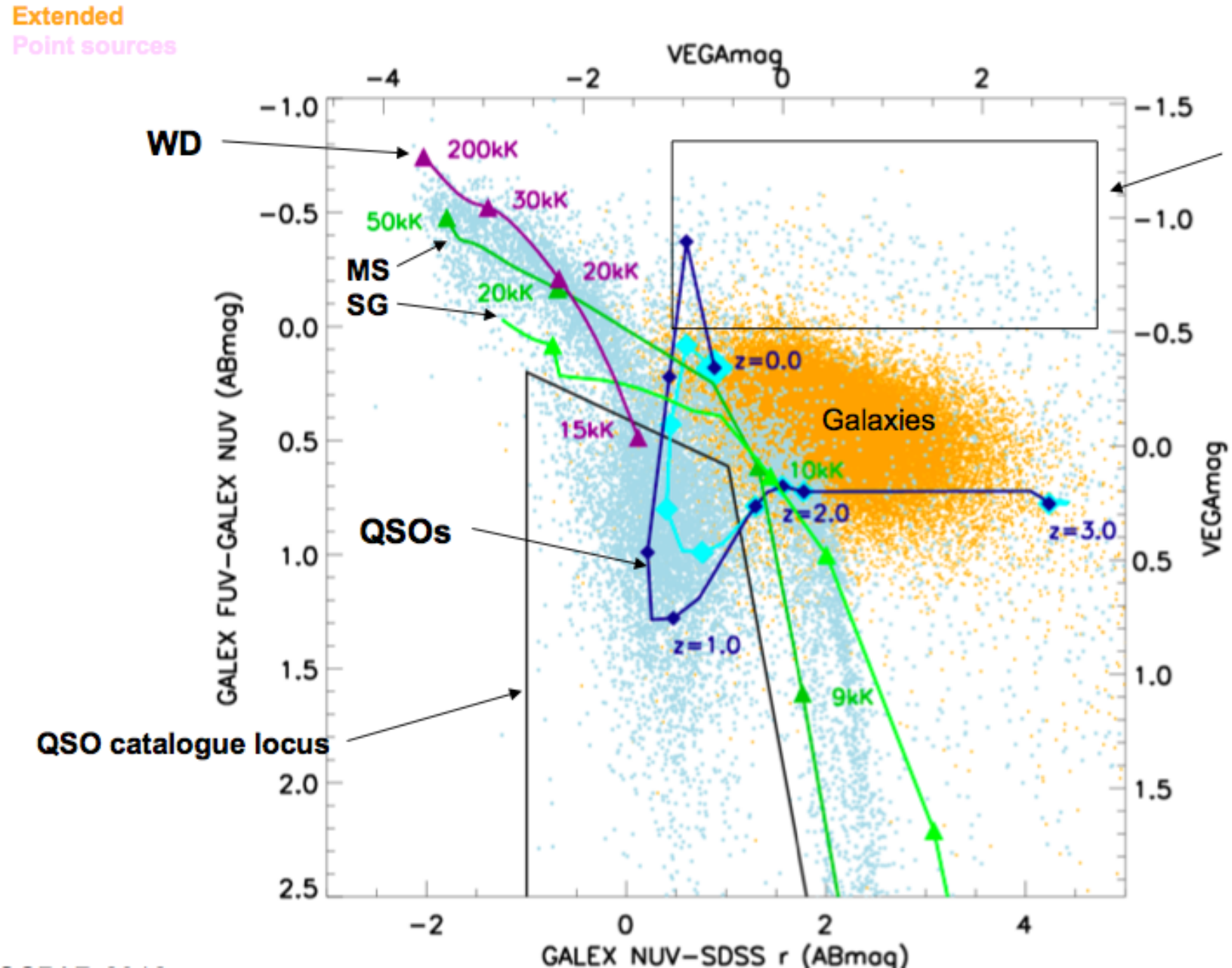
1. UVIT is eminently suitable for deep cosmological surveys, with wide field, ~1" spatial resolution, and a suite of filters.

2. UV colours add very powerful and unique diagnostics for different populations, as demonstrated by GALEX data. This kind of `survey' data can be accumulated from all archived observations. Luciana Bianchi is running models with UViT filters.

3. Exposure time estimates for faint objects are uncertain with UV background. But they are long and need to be calibrated. ETC under revision to improve this

4. We need to decide what survey region(s) to do. There are several deep surveys with other wavelengths and telescopes that are candidates. Synergy with other surveys is potentially very important.

GALEX shallow survey colours. UVIT diagnostics will be more powerful



Example: Subaru/Galex Observations

- The SDF is at ~13 h 24 m ,+27 deg 29’
- (857.5 arcmin sq; UVIT field is ~ 600)
- Optical data Suprime-Cam in B, V, R, I, z bands
- NUV data are from *GALEX (1750–2750 Å)*
- *Exposure* 138,176 s
- 37,802 objects detected in the NUV
- Depth m˜27.0 (3sigma); ~ 8000 NUV-dropouts
- Source density is ~ 10/sq.arcmin

UVIT NUV to reach mag 25

- The count rate for a star with ABmag = 20 through the Silica filter is ~ 1/s
- If the total area for the PSF is taken as 3 sq", the background counts are ~ 4.5 X 10^-3/s or equivalent to an object with AB-mag ~ 24.8.
- *To get a S/N of 5 for a AB-mag = 25 source through Silica filter, an exposure of is ~ 6000 s is required.*
- *UV sky is dark, and dropping below 280 nm*
- *Required exposures are:*

  ~ 9000 s for the filters 280-250 nm and 260-230 nm, and ~ 30000 s for for the filter 210-230 nm.
- **Total exposure of ~ 54000 s/field or 27 orbits**

UVIT FUV to mag 25

- The count rates in units of 10^-4/ s:

Filter	CaF2	BaF2	Sapphire	Silica
Star AB-mag 25	13.8	10.0	8.25	1.5
Backgd. (3 sq")	8.1	0.54	0.005	0.005

- *To get a S/N of 5 for a AB-mag = 25*

Filter	*CaF2*	*BaF2*	*Sapphire*	*Silica*
Exp. (10^4 s)	*2.9*	*2.5*	*3.0*	*16.6*

- **Total exposure of ~ 8.4X10^4 s/field or ~ 42 orbits for CaF2, BaF2, and Sapphire filters .**

These exposures are similar to those given by the Calgary ETC. They are long and demanding and thus need to be verified or modified by a pilot program in a suitable field.

Way forward

1. We should do some kind of pilot program first, to really establish what the S/N and exposure times and filters should be.

2. We should do a pilot during the baseline time and a full survey later, having learned techniques and exposures required. But it could also provide some spectacular baseline science.

3. One efficient way to do a trial would be to expose during one of the expected long observations by the X-ray teams. We need to see if any suitable (high latitude) X-ray fields are proposed.

4. Baseline science goals could include UV morphology and dust in distant galaxies, mapping of stellar populations, emission line gas in clusters at redshift ~0.2, globular cluster populations of lower redshift galaxies, star-formation in active galaxies,…

Subaru Deep Field Imaging with UVIT

Astrosat Meeting on Baseline Science
Feb. 6-7, 2014
IIA, Bengaluru
S N Tandon, J Hutchings

Galex Observations

The SDF (Kashikawa et al. 2004), centred at (J2000) = 13 h 24 m 38.9 s d(J2000) = +27 deg 29’26 “

is a deep wide-field (857.5 arcmin sq) extragalactic survey with optical data obtained from Suprime-Cam (Miyazaki et al. 2002), the prime-focus camera mounted on the Subaru Telescope (Iye et al. 2004). It was imaged with *GALEX in the NUV(1750–2750 Å)* with a total integration time of 138,176 s. 37,802 objects are detected in the full NUV image down to a depth of ˜27.0 mag (3sigma,7.5” diameter aperture).

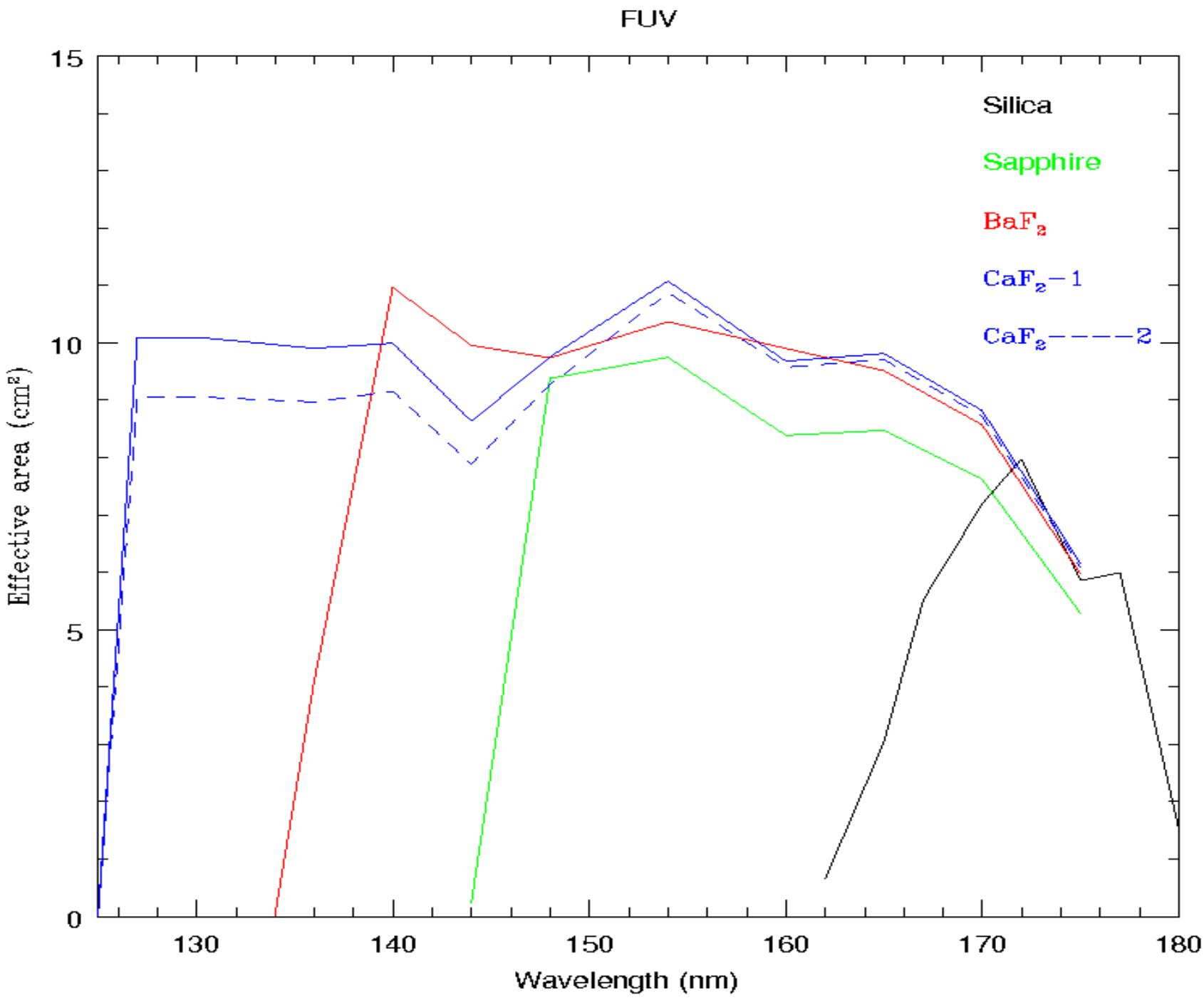
We note that GALEX has several times worse image quality, and no filters.

FUV Background for UVIT

- FUV Background
- Data taken from Astrosat Handbook
- At 1304 A (OI) count rate is 573/s for the full field with an effective area of 10 sq cm
- At 1356 A (OI) count rate is 42/s for the full field with an effective area of 10 sq cm From
- 1700-1750 A, Zodiac emission gives ~0.5 /s for an effective area of 5 sq cm
- *Thus the total background is 2.7 X 10^-4 counts /sq.arcsec/s for the CaF2 filter, and 1.8X10^-5 counts/ sq.arcsec/s for the BaF2 filter , OR*
- *" ~ 8 x 10^-4 counts and ~ 3 X10^-5 counts respectively for CaF2 and BaF2 filters for the full PSF of 3 sq.arcsec."*
- b) Count rate for a star with AB-mag=16 is 5.5 c/s with CaF2 filter and is 4 c/s with BaF2 filter (3.3 c/s for Sapphire; 0.6 c/s for silica)
- c) **For a star of AB-mag = 23.6 (26) the count rate is nearly equal to the background for CaF2 (BaF2) filter.**

NUV Background for UVIT

- Taken from Astrosat Handbook (UVIT-section)
- The background is primarily from Zodiac dust
- The background varies by up to a factor 3 with direction
- The of background in units erg/(A sqcm s sqarcsec)
- 10^-17.8 at 3000 A 10^ - 18.8 at 2500, and 10^– 19.5 at 2000 A(9.93 X10^-12 erg/ph)
- In units of Photons/(A sqcm s sqarcsec)
- 2.4X10^-7 at 3000 A 2.0X10^-8 at 2500 A , and 3.2 X10^-9 at 2000 A
- NUV=Silica filter gives average area of 40 sq cm for 2000-2500 and of 20 sq cm for 2500-3000
- The total count rate of the photons is thus = 20X500 (2.4 +0.2)X10^-7/2 + 40X500 (2.0 + 0.32) X10^-8/2 = 1.5 X 10^-3 per (s sqarcsec)
- *The total count rate for the full field is ~ 3000/s.*
- The count rate for a star with AB-mag = 20 through the Silica filter is ~ 1/s
- If the total area for the PSF is taken as 3 sqarcsec, the background counts are ~ 4.5 X 10^-3/s or equivalent to an object with AB-mag ~ 24.8.
- To get a S/N of 5 for a AB-mag = 25 source through Silica filter, an exposure of is ~ 6000 s is required.
- As the background is small for wavelengths below 2800 A, the required exposures are:
- ~ 9000 s for the filters 280-250 nm and 260-230 nm, and ~ 30000 s for for the filter 210-230 nm.


FUV
Silica
Sapphire
BaF2
CaF2—1
CaF2----2
Effective area (cm2)
0
5
10
15
130
140
150
160
170
180
Wavelength (nm)

Sample Images of LBG: NUV, B , and V