Steps of SXT data analysis :

Installation and use of SXT data reduction software:
https://www.tifr.res.in/~astrosat_sxt/dataanalysis.html
http://astrosat-ssc.iucaa.in/?q=sxtData

Sample data: Crab (Observation ID : 9000000778, Observation Date : 8th November 2019)
Data archive: https://astrobrowse.issdc.gov.in/astro_archive/archive/Home.jsp

unzip the level1 data using the command:
>unzip LEVL1AS1SXT20161108A02_090T01_9000000778_06050.zip
>unzip LEVL1AS1SXT20161108A02_090T01_9000000778_06051.zip
It generates directory 20161108_A02_090T01_9000000778_level1 which contains level1 files of all the orbits.

Now initialize the heasoft and run sxtpipeline and provide the required information in the sxtpipeline.
>heainit
>sxtpipeline
```
================================================================
                Running ASTROSAT SXT PIPELINE
Task : SXTPIPELINE   Version : 1.4b   Release Date : 2019-01-03
================================================================
Name of Input 'sxtpipeline' Configuration File : [] : AS1SXT_Level2_pipeline_config.fits
Name of Input Directory : [] : /home/user_name/20161108_A02_090T01_9000000778_level1
Name of Output Directory : [] : ./
```

This task generates level2 products like event file, lightcurve, image and spectrum etc. for all the orbits separately.
For example:
we can see following files in 20161108_A02_090T01_9000000778_level2/sxt/06051/sxt.01
AS1A02_090T01_9000000778sxtPC00_level2_br_earth_remove.xco
AS1A02_090T01_9000000778sxtPC00_level2_cl.evt
AS1A02_090T01_9000000778sxtPC00_level2_cl_sxtproducts.xco
AS1A02_090T01_9000000778sxtPC00_level2.evt
AS1A02_090T01_9000000778sxtPC00_level2.img
AS1A02_090T01_9000000778sxtPC00_level2.lc
AS1A02_090T01_9000000778sxtPC00_level2.pha
AS1A02_090T01_9000000778sxtPC00_level2_region.reg
AS1A02_090T01_9000000778sxtPC00_level2_sxtscreen.xco .

Merging of event files of all orbits:
Go inside the directory 20161108_A02_090T01_9000000778_level2/sxt
and run the command
>ls -d -1 $PWD/*/*/*cl.evt > evtfilelist
This command generates a text file containing the full path of cleaned event files of all the orbits.

Now initialize Julia code and run following commands to merge the level2 event files.
Installation of Julia software: http://astrosat-ssc.iucaa.in/?q=sxtData
https://www.tifr.res.in/~astrosat_sxt/dataanalysis.html

>julia

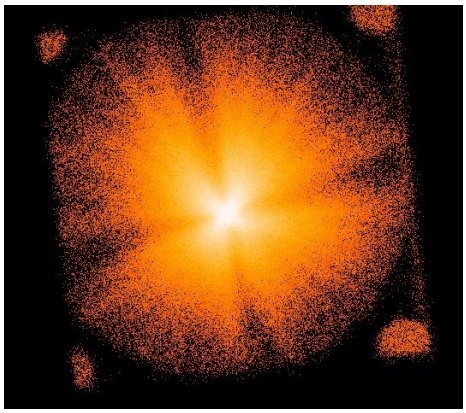
_

```
   _       _ _(_)_     |  Documentation: https://docs.julialang.org
  (_)     | (_) (_)    |
   _ _   _| |_  __ _   |  Type "?" for help, "]?" for Pkg help.
  | | | | | |/ _` |  |
  | | |_| | | (_| |  |  Version 1.0.5 (2019-09-09)
 _/ |\__'_|_|_|\__'_|  |  Official https://julialang.org/ release
|__/                   |
julia> using SXTTools

julia> sxt_l2evtlist_merge("evtfilelist","sxt_merged_cl.evt")
julia>exit()
```

This task generates merged event file sxt_merged_cl.evt

After this, we use XSELECT to generate lightcurve, image and spectrum. XSELECT is available within HEASOFT package. We do not need to install it separately. Following is a sample example of XSELECT session.

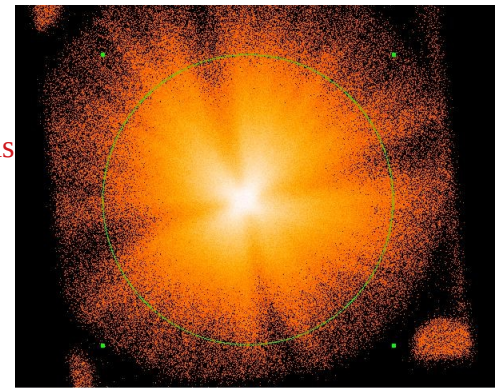


```
> xselect

                    **  XSELECT V2.4g  **

> Enter session name >[]  xsel
xsel:SUZAKU > read event sxt_merged_cl.evt
> Enter the Event file dir >[] ./
Got new mission: ASTROSAT
> Reset the mission ? >[]  yes
xsel:ASTROSAT-SXT-PC > extract all (This command generates an image, lightcurve and spectrum)
plot image (This command displays the image in ds9 window.)
```

Note: Now select the regions to correspond to source and background in the image (ds9 window). Then apply the region filter. Then again run "extract all" command to generate lightcurve, image and spectrum for the selected region. In general, 15 arcmin region from the centre of the source contains more than 95 percent source photons. Suppose we selected the 15 arcmin region from the centre of the source and save it as a file name "src_15arcmin.reg".



```
xsel:ASTROSAT-SXT-PC > filter reg src_15.reg
xsel:ASTROSAT-SXT-PC > extract all
```

The mean count rate for the lightcurve of the selected region is around 300 c/s. In general, we need to do pile-up correction for count rate higher than 40 c/s or flux greater than 200 mCrab in pc mode. https://www.tifr.res.in/~astrosat_sxt/instrument.html

In this case count rate becomes ~ 40 c/s after removal of 10.5 arcmin from the centre. Pile-up issue causes spectral hardening. One can check the changes in the spectral properties after removing some pixels from the centre and finds the optimum required amount of the region which needs to be excluded. So Now we draw the annulus region in ds9 in which we exclude inner 10.5 arcmin. We save this annulus region as a file name "src_15arcmin_excl_10p5.reg" again apply this region filter.

xsel:ASTROSAT-SXT-PC > filter reg src_15arcmin_excl_10p5.reg
xsel:ASTROSAT-SXT-PC > extract all
Now we save the spectrum
xsel:ASTROSAT-SXT-PC > save spectrum source_spectrum.pha

In the same way, we can select the background region and generate the background spectrum. If the source is very bright and we see that the whole field of view contains source photons. In that case, we can use background spectrum provided by SXT POC team.

Response files i.e. rmf and arf are also provided by SXT POC team.
https://www.tifr.res.in/~astrosat_sxt/dataanalysis.html .

SkyBkg_comb_EL3p5_Cl_Rd16p0_v01.pha (background spectrum)

sxt_pc_mat_g0to12.rmf (We have a single rmf file for both pc and fw mode)

SXT arf generation:

To generate arf files compatible with the source region, an SXT arf generation tool "sxtARFModule" is used. Its installation instructions are available at https://www.tifr.res.in/~astrosat_sxt/dataanalysis.html .

Following arf files are present along with arf generating software.

sxt_fw_excl00_v04_20190608.arf (fw mode)

sxt_pc_excl00_v04_20190608.arf (pc mode)

Readme file explains various ways to generate a new arf file using the standard arf file.

Example: using source spectrum

sxtARFModule --onlyceoff=0 -o ARFTESTS1 -m b -e RX1856_or15427_15444_merged_cl.evt –sxtpha=source_spectrum.pha -- sxtarf=sxt_pc_excl00_v04_20190608.arf –vigcorrflag=yes

here, "source_spectrum.pha" is a source spectrum generated by user and

"sxt_pc_excl00_v04_20190608.arf" is an arf file for pc mode downloaded from website.

We can use these files to do spectral fitting in xspec