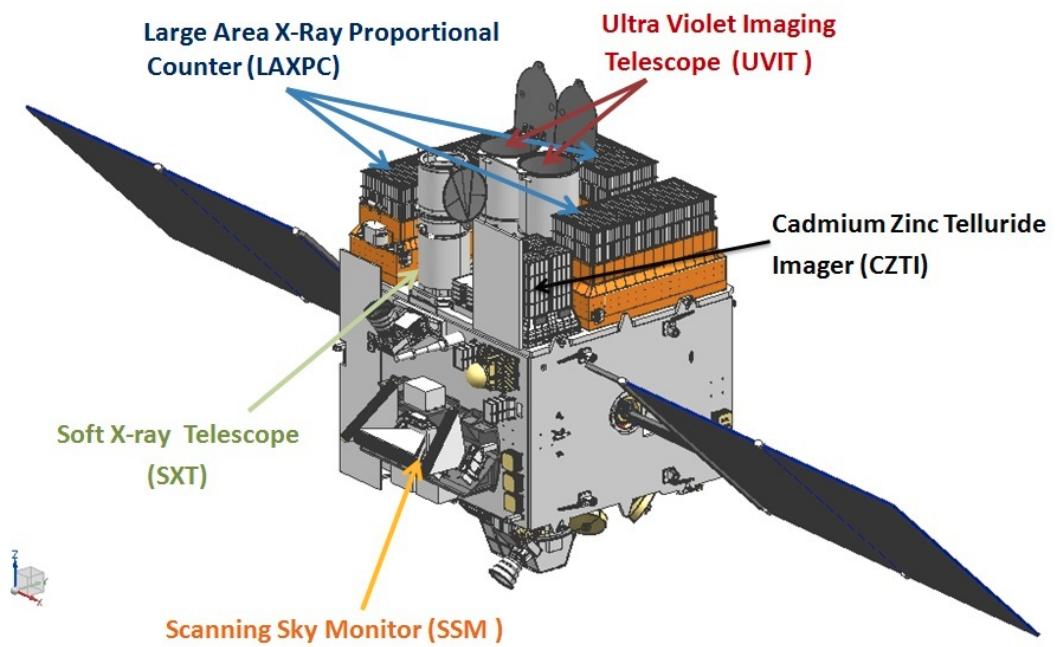


## AstroSAT Data Analysis



1. Download the laxpcl1 and backshift package from  
[https://www.tifr.res.in/~astrosat\\_laxpc/LaxpcSoft.html](https://www.tifr.res.in/~astrosat_laxpc/LaxpcSoft.html)



**AstroSat**  
Department of Astronomy & Astrophysics, TIFR  
Launched on September 28, 2015

**Home** LaxpcSoft is developed at TIFR/IUCAA (for more details, see respective README files). All the LAXPC science publications so far has used this software package. It contains total five packages plus response files of three LAXPC detectors:

- laxpcl1 & backshift (Main)
- Response files of three laxpc detectors
- Fits\_event\_make
- Fits FreqLag
- Fits Spectrum
- Fits lightcurve

**Instrument**

**Specifications**

**Ground Calibration**

**Publication**

**LAXPC Software**

**In-orbit Calibration**

**First Light**

**Observations**

**Gallery**

**Contact**

Log of [Gain & HV](#) in LAXPC Detectors.

[Checksum files for Gain & HV](#)

LAXPC Level-1 Data can be analysed with LaxpcSoft code, which can be downloaded from link below.

[laxpcl1 & backshiftv3, version 3.4.3, Release:07May2022  
\(md5:3b9fc82dd8ef8694bd11cad2a26e14c4\)](#)

Older release versions are [here](#)

**laxpcl1 & backshift (Main)**

The tar file contains main packages and files for analysing level-1 data from the LAXPC instrument. The software includes two Fortran programs:

laxpcl1.f To process the level-1 data and generate the event file, light curve, spectrum for source and background as well as GTI file

backshift.f To apply gain shift to align the background spectrum with the source spectrum and identify the required response file

2. Also download the response file for LAXPC10 and LAXPC20 from same webpage

backshift.f To apply gain shift to align the background spectrum with the source spectrum and identify the required response file

for more details, check the readme files for these programs (readme.laxpcl1 readme.backshift). makefiles are provided to compile the program using gfortran or ifort compilers:  
makefile.gfortran for gfortran compiler  
makefile.ifort for the INTEL ifort compiler  
For other compilers the makefile can be appropriately modified.

These programs are mostly written in Fortran-77 but they do use some features of Fortran 90 and hence will not work with f77 or equivalent compilers. No external library other than the standard Fortran libraries are required.

Rename the required version of makefile to 'makefile' and compile the program using  
make laxpcl1  
make backshift  
The executable file is produced with extension .e

[Response file for LAXPC10 detector \(Release:14Feb2019\)](#)  
(md5:5a100305a9ac2ed36f8e891badb669ae )

[Response file for LAXPC20 detector with offset\(Release:23Apr2021\)](#)  
(md5: 8932fd38a6f260af5adfd79548a3b38b)

[Response file for LAXPC20 detector \(Release:14Feb2019\)](#)  
(md5:c0fb661c20b19d2b560caf0dc077149a )

[Response file for LAXPC30 detector \(Release:14Feb2019\)](#)  
(md5:ec72331a1dddc7c6b1f64285f7e5294d )

[Link to Software page on ASTROSAT Science Support Cell](#)

Please acknowledge use of software with "*LaxpcSoft software is used for analysis*" in your science publication.

### 3. To install the software

```
mkdir laxpcsoft
cd laxpcsoft
tar -xvf filename.tar.gz
cp makefile.gfortran makefile
make laxpcl1
make backshiftv3
```

### 4. Download the data from

[https://astrobrowse.issdc.gov.in/astro\\_archive/archive/Home.jsp](https://astrobrowse.issdc.gov.in/astro_archive/archive/Home.jsp)

5. Login id is required to download the data. If you have an account then login otherwise make an account.



## Welcome to ISRO Science Data Archive for AstroSat Mission

The science data from observations made by the instruments on board the spacecraft are available for download after the [proprietary period](#) from this portal.

**ASTROSAT** is India's first dedicated multi wavelength space observatory. This scientific satellite mission endeavours for a more detailed understanding of our universe. AstroSat observes universe in the optical, Ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum. Multi-wavelength observations of ASTROSAT are further extended with co-ordinated observations using other spacecraft and ground based observations.

AstroSat with a lift-off mass of about 1513 kg was launched by India's Polar Satellite Launch Vehicle (PSLV) on 28th September 2015 into a 650 km circular orbit with an inclination of 6 deg. The spacecraft control centre at Mission Operations Complex (MOX) of ISRO Telemetry, Tracking and Command Network (ISTRAC) at Bangalore carries out the spacecraft health monitoring and control operations. The science data from the spacecraft is downloaded at a dedicated ground station established at Byalalu , Bengaluru and the data is made available to the users through the co-located Indian Space Science Data Centre ( ISSDC). Science data processing, archival and dissemination are carried from ISSDC, the nodal point for the interface with the global scientific and user community.

AstroSat is a proposal -driven, multi -wavelength observatory operated by Indian Space Research Organization (ISRO). ISRO releases periodic calls for proposal submission. Users can submit proposals for operating the science instruments on board using the web based utility AstroSat Proposal Processing System [APPS](#) hosted at ISSDC. The science data along with the related software for processing can be [downloaded from this portal](#)

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6. Enter the source details in Search form enter source name



### WELCOME : rsharmaphys

SEARCH

Object Name	Cen X-3	e.g. M31 or sirius
RA	170.31276	
DEC	-60.62394	
Coordinate System	Resolve by Simbad OR Resolve by NED	
Search Radius	1.0	degree
Search Results Formats	<input type="radio"/> Released Data <input checked="" type="radio"/> Formatted Text <input type="radio"/> VOTable	
Instrument/Mode Selection	<input type="checkbox"/> ALL <input type="checkbox"/> SXT <input type="checkbox"/> UVIT <input checked="" type="checkbox"/> LAXPC Photon Counting Mode                Photon Counting Mode                Broad Band Counting Mode FW                Integration Mode                Event Mode Fast Counter Mode                CZTI Normal Mode	
Principal Investigator		
Orbit Number		

---

If Simbad and NED are unable to resolve the source, one can look for the source in the source list and select.

**Search Results Formats**

Formatted Text  VOTable

Released Data

**Instrument/Mode Selection**

<input type="checkbox"/> ALL	<input type="checkbox"/> UVIT	<input checked="" type="checkbox"/> LAXPC	<input type="checkbox"/> CZTI
<input type="checkbox"/> SXT	Photon Counting Mode	Broad Band Counting Mode	Normal Mode
Photon Counting Mode	Integration Mode	Event Mode	
FW		Fast Counter Mode	

**Principal Investigator**

**Orbit Number**  Principal Investigator

**Observation Date**  To

**Observation start date**  In Last One Week  In Last One Month

**Observation ID**

**Source Name**

**Proposal ID**

**Proposal Type**

**Time On Source**

Less Than  (Mins.)

More Than  (Mins.)

Between  and  (Mins.)

- Download the Level 1 (L1) data for obs-ID=A02\_111T01\_9000000954 and orbit cycle= 6956



WELCOME : rsharmaphys

Search results for :- INSTRUMENT : LXP and RA : 170.31276 and DEC : -60.624

1-25 OBSERVATIONS out of 83 rows

Home	Download Dataset	Product Details	Sky Map	Proposal Id	Target Id	Observation Id	PI Name	Orbit	Version	L2 Pipeline Version	Source Name	RA	DEC	Instrument	Date Of Observation	Release Date	Modes
AstroSat HandBook	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000900	nirmal	6638	1.0	-	Cen X-3 170.315792	-60.623	LXP	19-Dec-2016	25-Sep-2018	BB,EA	
Search	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000900	nirmal	6640	1.0	-	Cen X-3 170.315792	-60.623	LXP	19-Dec-2016	25-Sep-2018	BB,EA	
Software Downloads	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000900	nirmal	6641	2.0	-	Cen X-3 170.315792	-60.623	LXP	19-Dec-2016	25-Sep-2018	BB,EA	
Instruments	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000954	nirmal	6950	1.0	-	Cen X-3 170.315792	-60.623	LXP	09-Jan-2017	25-Sep-2018	BB,EA	
11T01_9000000954LXP1	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000954	nirmal	6951	1.0	-	Cen X-3 170.315792	-60.623	LXP	09-Jan-2017	25-Sep-2018	BB,EA	
ALADIN VIEW	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000954	nirmal	6952	1.0	-	Cen X-3 170.315792	-60.623	LXP	09-Jan-2017	25-Sep-2018	BB,EA	
Signout	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000954	nirmal	6953	1.0	-	Cen X-3 170.315792	-60.623	LXP	09-Jan-2017	25-Sep-2018	BB,EA	
	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000954	nirmal	6956	2.0	-	Cen X-3 170.315792	-60.623	LXP	09-Jan-2017	25-Sep-2018	BB,EA	
	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000986	nirmal	7217	1.0	-	Cen X-3 170.315792	-60.623	LXP	27-Jan-2017	25-Sep-2018	BB,EA	
	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000986	nirmal	7219	1.0	-	Cen X-3 170.315792	-60.623	LXP	27-Jan-2017	25-Sep-2018	BB,EA	
	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000986	nirmal	7220	1.0	-	Cen X-3 170.315792	-60.623	LXP	27-Jan-2017	25-Sep-2018	BB,EA	
	Q L1 L2 ♦ ♦ ♦	<input type="checkbox"/>	<input checked="" type="checkbox"/>	A02_111	T01	A02_111T01_9000000986	nirmal	7221	1.0	-	Cen X-3 170.315792	-60.623	LXP	27-Jan-2017	25-Sep-2018	BB,EA	

Sometimes merged data is stored in the last orbit. Then download only last orbit data.

- Unzip the download directory:

*for f in \*.zip; do unzip \$f; done;*

9. Check the path of your level 1 directory which will be the input directory.

```
$ pwd
```

10. Now everything will be run in the laxpcsoft directory and all output will be in the same directory.

11. Edit the input path to level 1 data in *findfile* in the laxpcsoft\* directory.

```
# find /mnt/Data/Data/level-2/ -name "*00000$1*.??" | grep -v lxp2 | grep -v lxp3 | grep -v issdc | grep -v "gti$" | grep -v "frt$" | grep -v "pha$" | grep -v "orb$" | grep -v "att$" | grep -v "lbt$" | grep -v frame | sort > ls2
# find /mnt/Data/Data/level-1/ -name "*00000$1lxp1EA_level1.fits" | sort > ls1
#find /mnt/Data/Data/level-1/ -name "*00000$1*.*" | grep -v lxp2 | grep -v lxp3 | grep -v issdc | grep -v "gti$" | grep -v "frt$" | grep -v "xml$" | grep -v "hk$" | grep -v "orb$" | grep -v "txt$" | grep -v "bti$" | grep -v "aux1" | grep -v "aux2" | grep -v frame | grep -v ".tar" | sort > ls1
find home/rsharma/X-ray workshop/day5_astrosat/*000$1* -name "*00000$1*.*" | grep -v lxp2 | grep -v lxp3 | grep -v issdc | grep -v "gti$" | grep -v "frt$" | grep -v "xml$" | grep -v "hk$" | grep -v "orb$" | grep -v "txt$" | grep -v "bti$" | grep -v "aux1" | grep -v "aux2" | grep -v frame | grep -v ".tar" | sort > ls1
#find /mnt/Data/Data/level-1/forD/*000$1* -name "*00000$1*.*" | grep -v lxp2 | grep -v lxp3 | grep -v issdc | grep -v "gti$" | grep -v "frt$" | grep -v "xml$" | grep -v "hk$" | grep -v "orb$" | grep -v "txt$" | grep -v "bti$" | grep -v "aux1" | grep -v "aux2" | grep -v frame | grep -v ".tar" | sort > ls1
```

---

12. Then run

```
sh findfile 954
```

13. This will create ls1 file which will show the input level 1 files with full path

14. Replace ls1 with laxpcl1.inp

```
mv ls1 laxpcl1.inp
```

15. Create a gti.inp with zero time.

```
echo "0" > gti.inp
```

16. Now run ./laxpcl1 with default parameters.

```
rsharma:~/laxpcsoft$ ./laxpcl1.e
Type lxp,tbin,anode [1 1.0 0]
/
Type channel range for light curve [0 1023]
/
Type No. of channels in spectrum: 1024/512/256 [           512 ]
/
Type uld bin,Earth occultation, event flag [-1 1 2]
/
```

17. It will create the lxp1level2.gti. Now replace lxp1level2.gti to gti.inp

```
mv lxp1level2.gti gti.inp
```

18. Set the correct background according to date of observation in **back4.inp** file

```
backfit.lxp10jan17  
backlxp10mar16ul1.pha  
backlxp10mar16ul2.pha  
backlxp10mar16ul3.pha  
backlxp10mar16ul4.pha  
backlxp10jan17.pha  
backfit3.lxp10mar16
```

19. Now rerun the ./laxpcl1

20. Run ./backshiftv3

```
rsharma@.../laxpcsoft$ ./backshiftv3.e  
type lxp,anode,id [1 0 0] /  
9 9 483  
background jan17 chosen  
Source-ch= 232.1 back-ch= 238.3 shift= -6  
11 0.80000000000000001137  
Type time-bin, channel range for light curve, nul [1 0 1023 -1] shift= -6  
66 1188 apr17 may be closer in gain del= 0.800000  
23 4 Mean 69 count rate: 288.0 287.9 ratio= 1  
type .pha file name [ lxp1level2back.pha ] 316 -0.1033333333333362  
/ change in count rate= 5.6261781731302563  
9 9 483 Response-ch= 24691 shift= -7.0  
background jan17 chosen use the response file lx10cshm07v1.1.rmf  
Source-ch= 232.1 back-ch= 238.3 shift=/laxpcsoft$  
11 0.80000000000000001137  
apr17 may be closer in gain del= 0.80000000000000001137  
Mean count rate: 288.0 287.9 ratio= 1.000  
2 316 -0.1033333333333362  
change in count rate= 5.6261781731302563  
Response-ch= 239.1 shift= -7.0  
use the response file lx10cshm07v1.1.rmf  
rsharma@.../laxpcsoft$
```

21. For energy filtering use the rmf file to know about channel-energy relation

22. You can also use software provided by IUCAA and barycentre code (**AS1bary**) can be downloaded from [http://astrosat-ssc.iucaa.in/data\\_and\\_analysis](http://astrosat-ssc.iucaa.in/data_and_analysis)

23. Run as1bary for barycentric corrections

*axBary - Usage:*

*/home/rsharma/as1bary/as1bary -i orbitFile -f inputDataFile [-o outFile]  
[-ra RA] [-dec DEC] [-ref refFrame]*

Useful inputs from the terminal: For **laxpcl1**

**lxp,tbin,ian**

lxp: S. No. of LAXPC detector (1-3)

tbin: Time bin for light curve in seconds

ian: Anodes to be used for light curve/ spectrum (0-10)

ian=0: all main anodes (A1-7) are used

ian=1: Top layer (A1+A2)

ian=3: Second layer (A3+A4)

ian=2,4-10: The respective anode

**icl,icu** : The range of Channel no. to be used in light curve (0-1023)

default is icl=0, icu=1023, type "/" to use default

**nca** : No. of channels to be used in spectrum (256/512/1024)

Always use the default value. To use default type '/'

**nul,je,iev** : To use default type '/'

Useful inputs from the terminal: For **backshifty3**

**lxp, ian, idi**

lxp: S. No. of LAXPC detector (1-3)

ian: Anodes to be used for light curve/ spectrum (0-10), same as laxpcl1

idi: To control the removal of diurnal oscillation

idi=0 apply the correction (only if duration is long enough)

any other value will suppress the correction

**tbin lcl lcu nul**

tbin: Time bin used for generating the light curve

lcl,lcu: Channel range used for light curve (between 0 1023)

nul: flag to fit low energy background. Use nul=-2 for using fit to layer 1  
background for channels 0-200 (< about 20 keV)

**filename:** To use default type '/'