

Scanning sky monitor (SSM)

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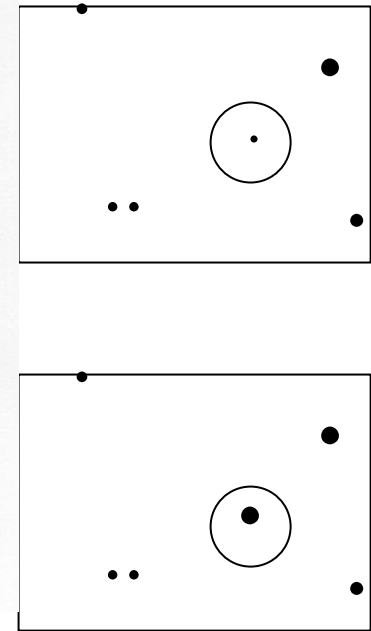
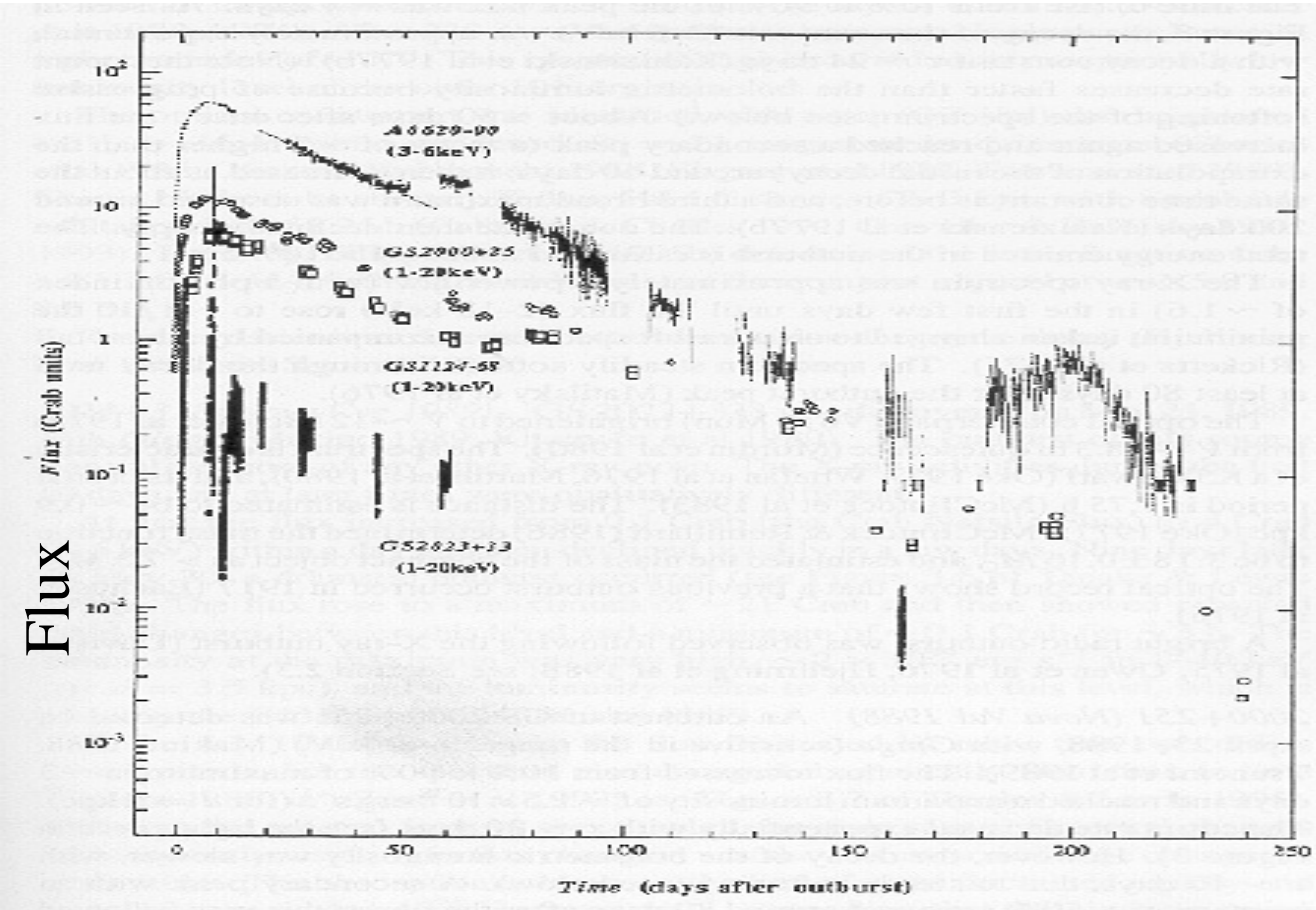
Role of an X-ray sky monitor

- To detect, locate and monitor x-ray transients.
 - **Detection of ‘new’ transients-** sources hitherto below detection level- sudden increase in intensity by a factor of **100 or more** can even be 10000 times
 - **X-ray novae, Soft X-ray transients, outbursts etc.**
- Provides unique opportunity to study these objects over a large dynamic range, for a single source, within few months.

L - 10^{33} erg/s to 10^{38} erg/s; dM/dt

- Can occur any time and any region of the sky
- Time scales rise- few days; decay- few months
- Study of mass transfer in accretion discs and the processes causing instabilities.

Light curves of X-ray novae



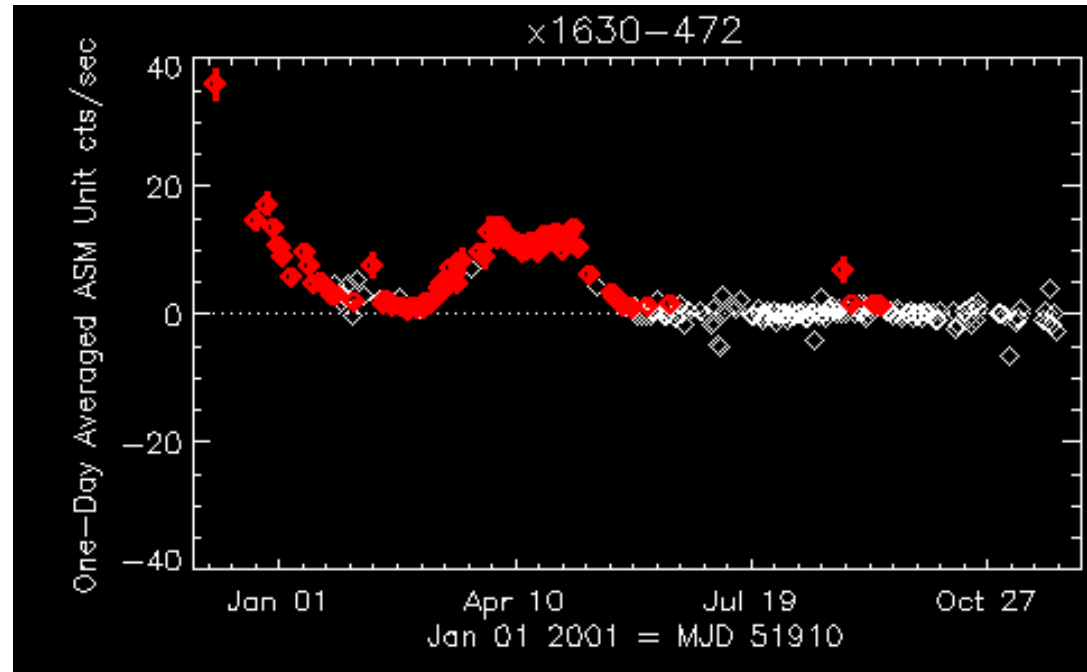
Time in days

Role of an X-ray sky monitor

- To monitor known/ recurrent x-ray transients.
 - Increase in intensity of known X-ray sources – **Potential targets for ASTROSAT.**
 - Recurrent outbursts in known transient sources – **Black hole binaries.**
- Monitor known bright sources
 - sampling time few minutes
 - several samples/day; monitor for many months.
- To alert other instruments for detailed studies
 - Based on analysis of SSM data

Alert for the intensity level of known variable sources

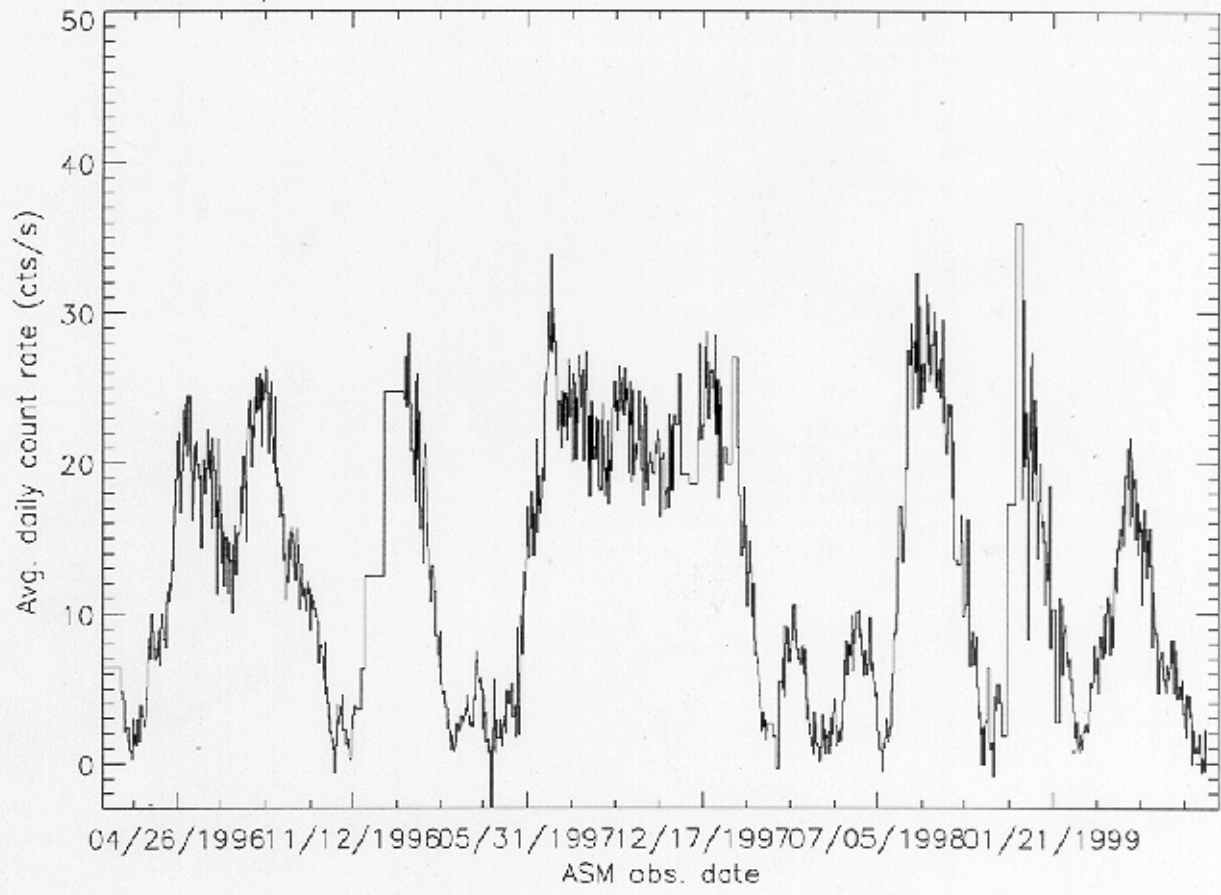
- Many binaries exhibit
 - Increase in intensities which are not as high as in X-ray novae



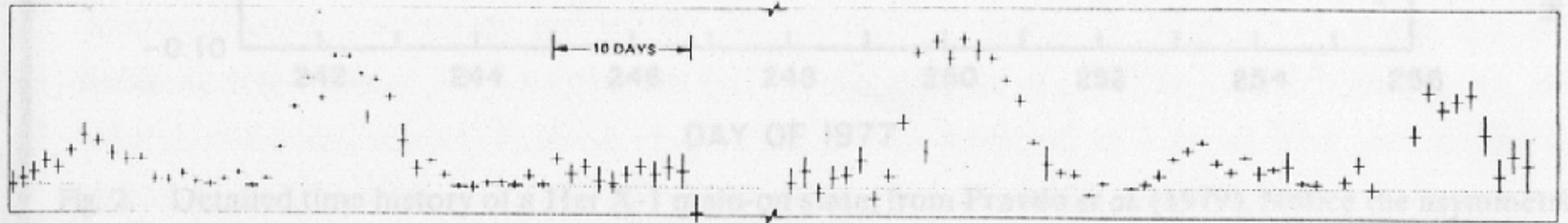
Study known bright sources over long time scales

- **Supra orbital period in HMXBs**
 - **Precession period of disc/neutron star**
- **Long term cycles in LMXBs**
 - **Mass transfer instabilities?**
- **Irregular variations**
- **Pulsar studies**
 - **Spin up/down phases of pulsars; depends on source in the FOV, samples/day**

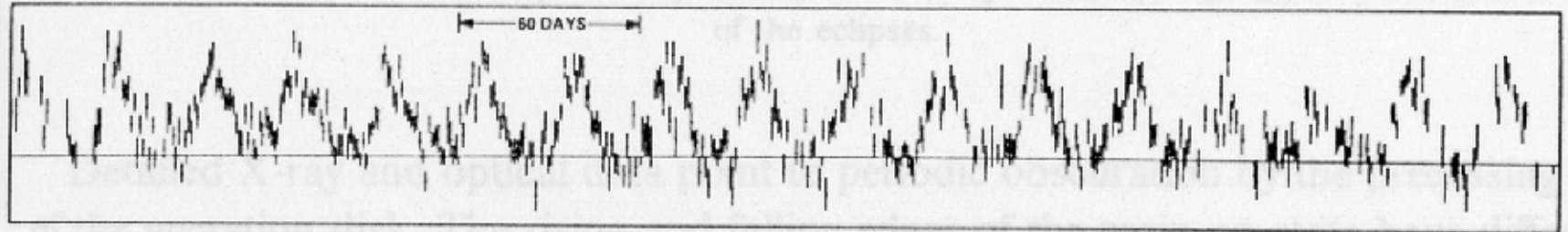
X1705-440 - ASM data.



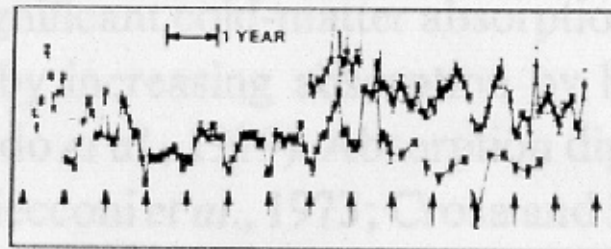
HER X-1



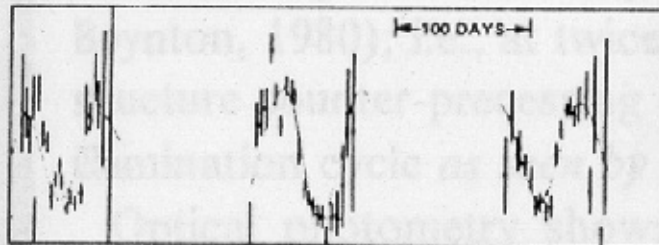
LMC X-4



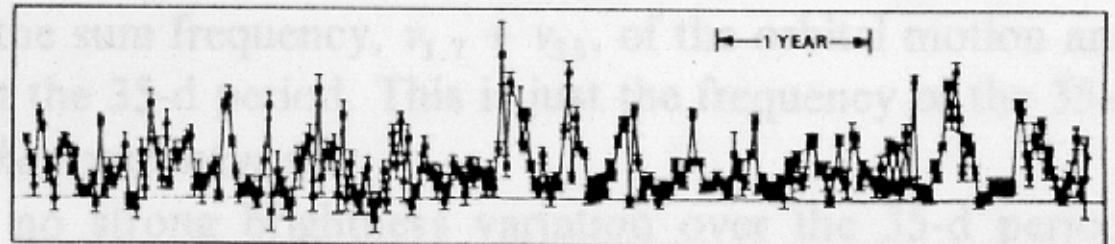
CYG X-1



SMC X-1



CEN X-3



Types of Data

- Temporal data; Intensity vs time
 - Rise time, Decay time, Duration; (dM/dt , α)
 - Precursors; Secondary maxima; Lead Lag etc (trigger)
 - Quasi periodic oscillations (R_g , ISCO)
 - Peak luminosities, Recurrence time (Process of outburst)
- Spectral data; Intensity as a function of energy
 - Black body/Power law;
 - Soft/hard components
 - Emission lines, absorption features
- Positional data; Spatial position in sky co-ordinates.
 - **Optical- binary period, inclination, masses of the components; accretion rate; presence of disc**
 - **Radio- outburst delayed w.r.t x-rays. Synchrotron bubbles, jets**

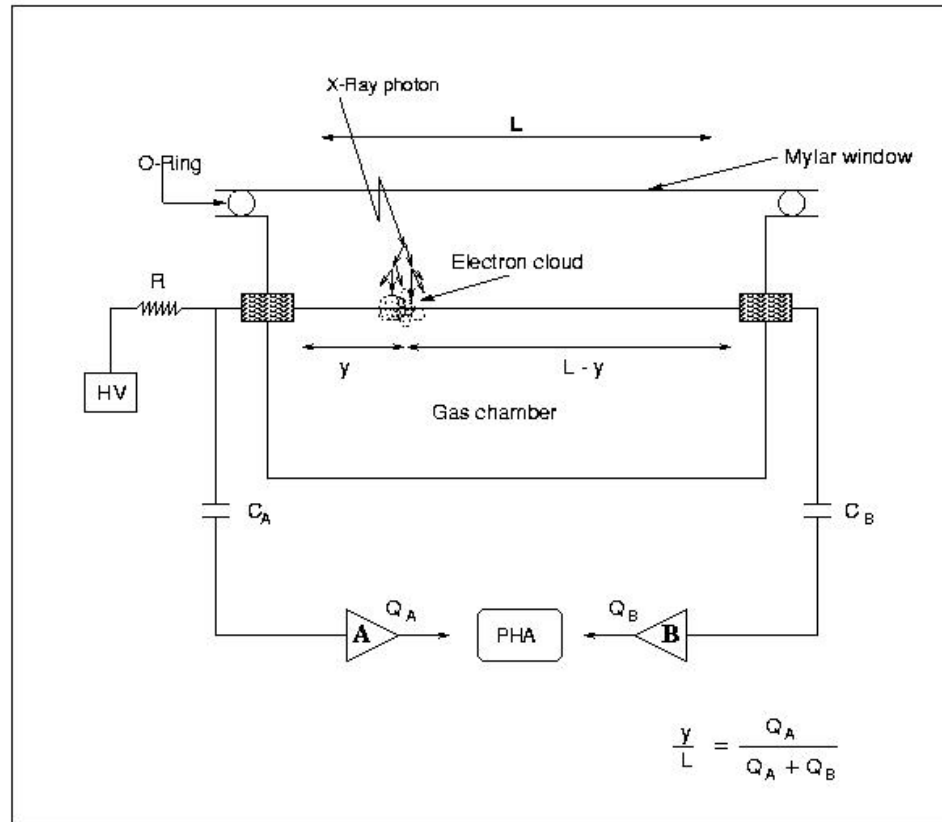
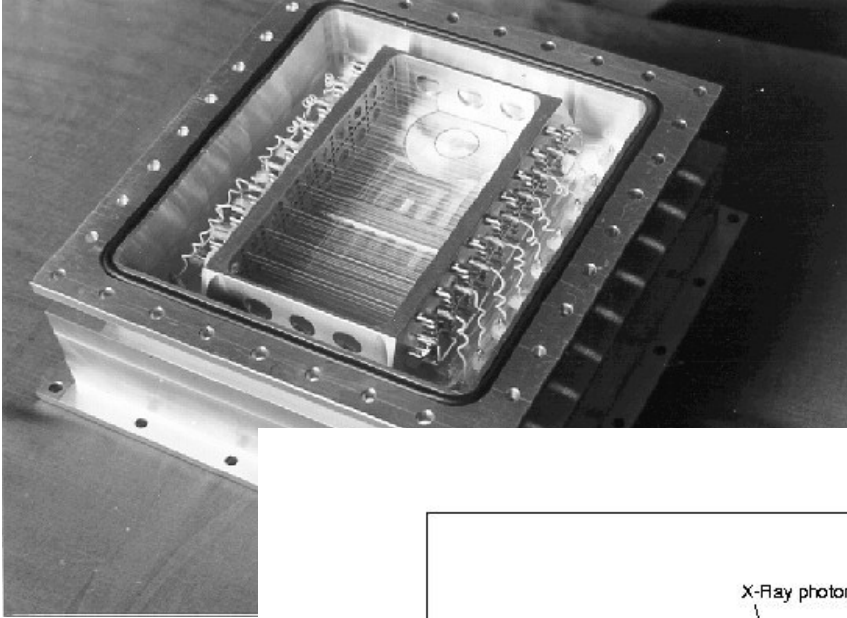
Instruments on ASTROSAT for various data

- Temporal data; Intensity vs time
 - Rise time, Decay time, Duration, Peak luminosities, Recurrence time
 - Precursors; Secondary maxima; Lead Lag etc
 - Quasi periodic oscillations
 - **(SSM, LAXPC, SXT)**
- Spectral data; Intensity as a function of energy
 - Black body/Power law. **(UVIT, SXT, LAXPC, CZT)**
 - Soft/hard components
- Positional data; Spatial position in sky co-ordinates.
 - Position in the sky; Source confusion
 - **(Initially SSM; Follow up UVIT, SXT, Ground based observatories)**

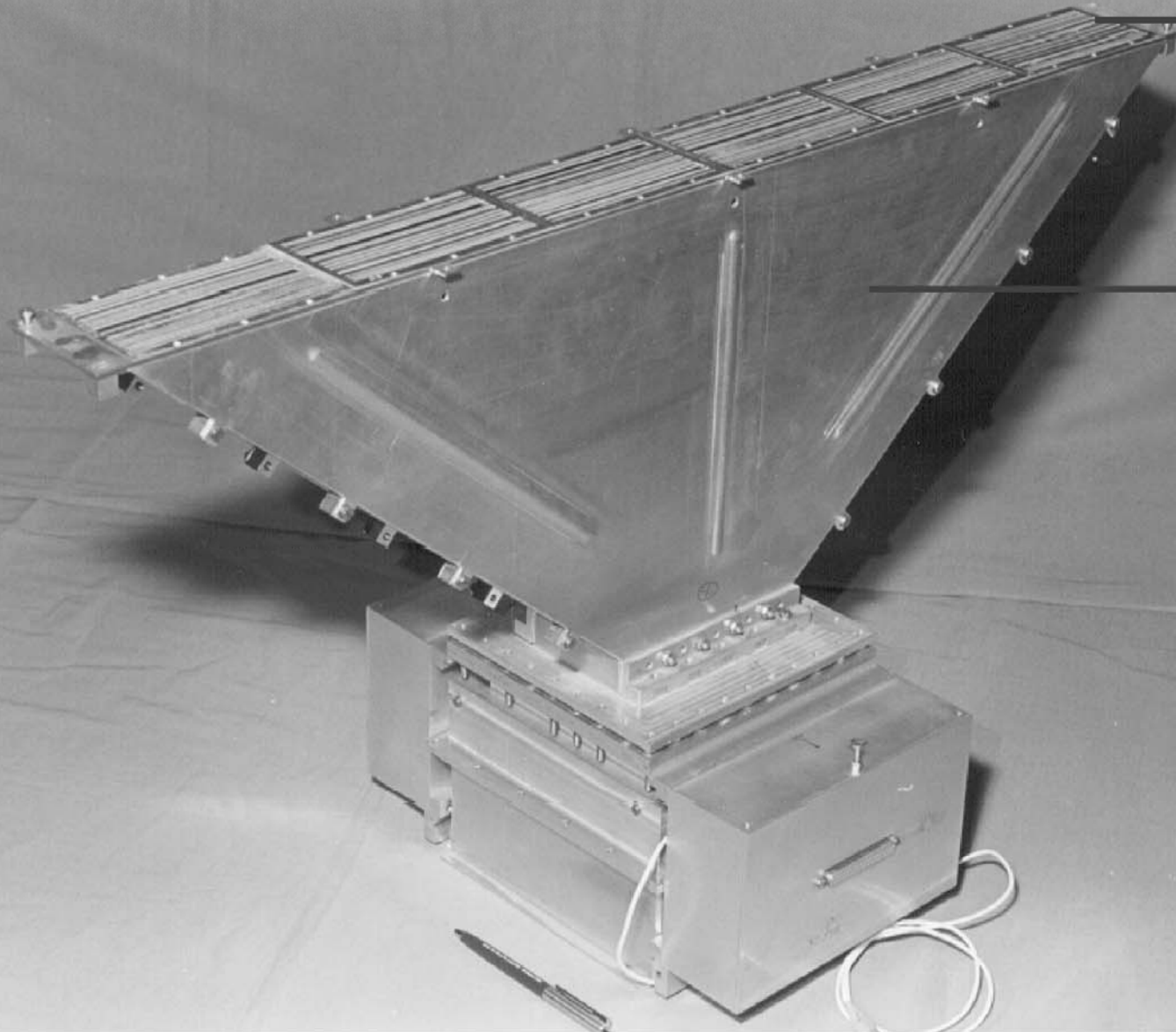
Scanning Sky monitor (SSM)

1-D coded mask position-sensitive detector

- **Detectors: proportional counters with resistive anodes;**
Ratio of signals on either ends of anode gives position.
 - **Energy range** **2-10 keV**
 - **Position resolution** ~ **few arc minutes**
 - **Field of view** **~ 10° X 90°**
- **Payload Weight < 50 kg** (excluding mounting platform)
- **Onboard memory - 400 Mbyte/3counters /2 Orbits**
- **Power- 32W** (regulated) **(Excluding power for mechanism)**
- **- 47 W** (raw power)



SCANNING SKY MONITOR (Engg. Model)



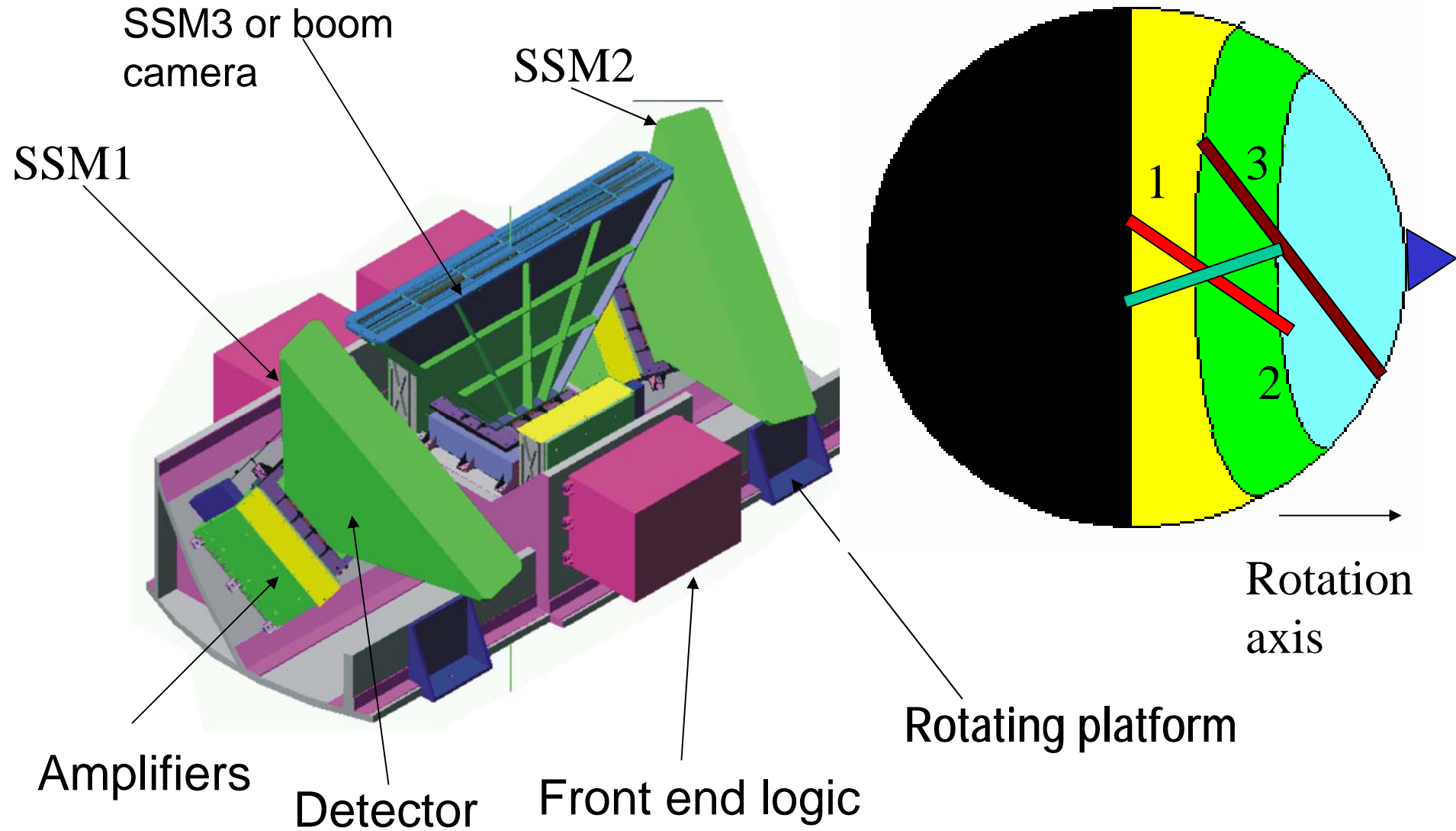
Scanning arrangement

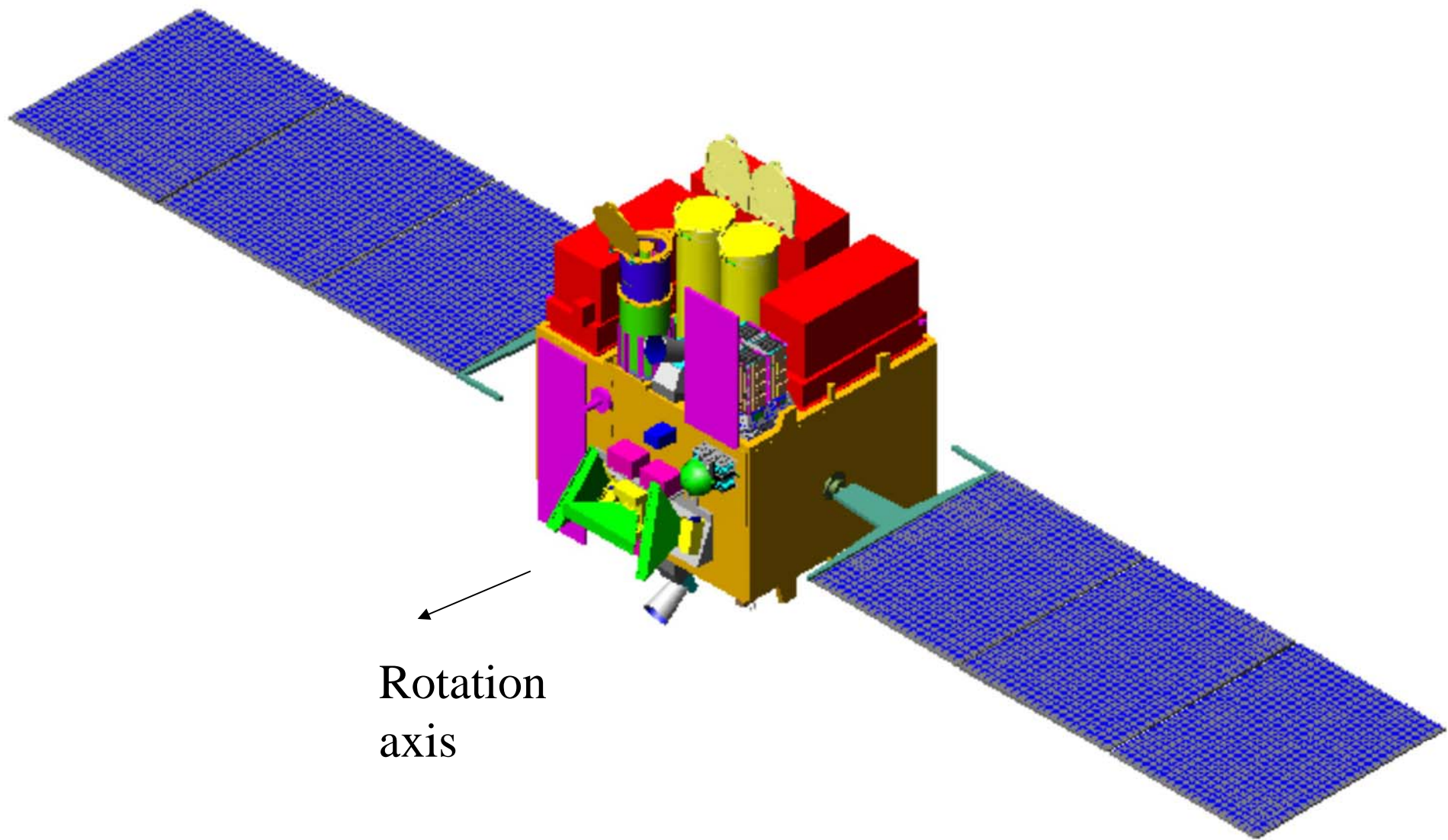
- Most other experiments on ASTROSAT are pointed to a specific object for relatively long periods of time (~hours to days).
- Scanning mechanism necessary for monitors to scan the sky multiple times per day.
- Monitors to be mounted on a platform which can have scanning capability by means of ‘step and stare’ mode of rotation in clockwise and anti-clockwise direction alternately
- FOV of two monitors forms an ‘X’ in the sky(SSM1 and 2). Third detector views the perpendicular direction (SSM3).

Scanning arrangement

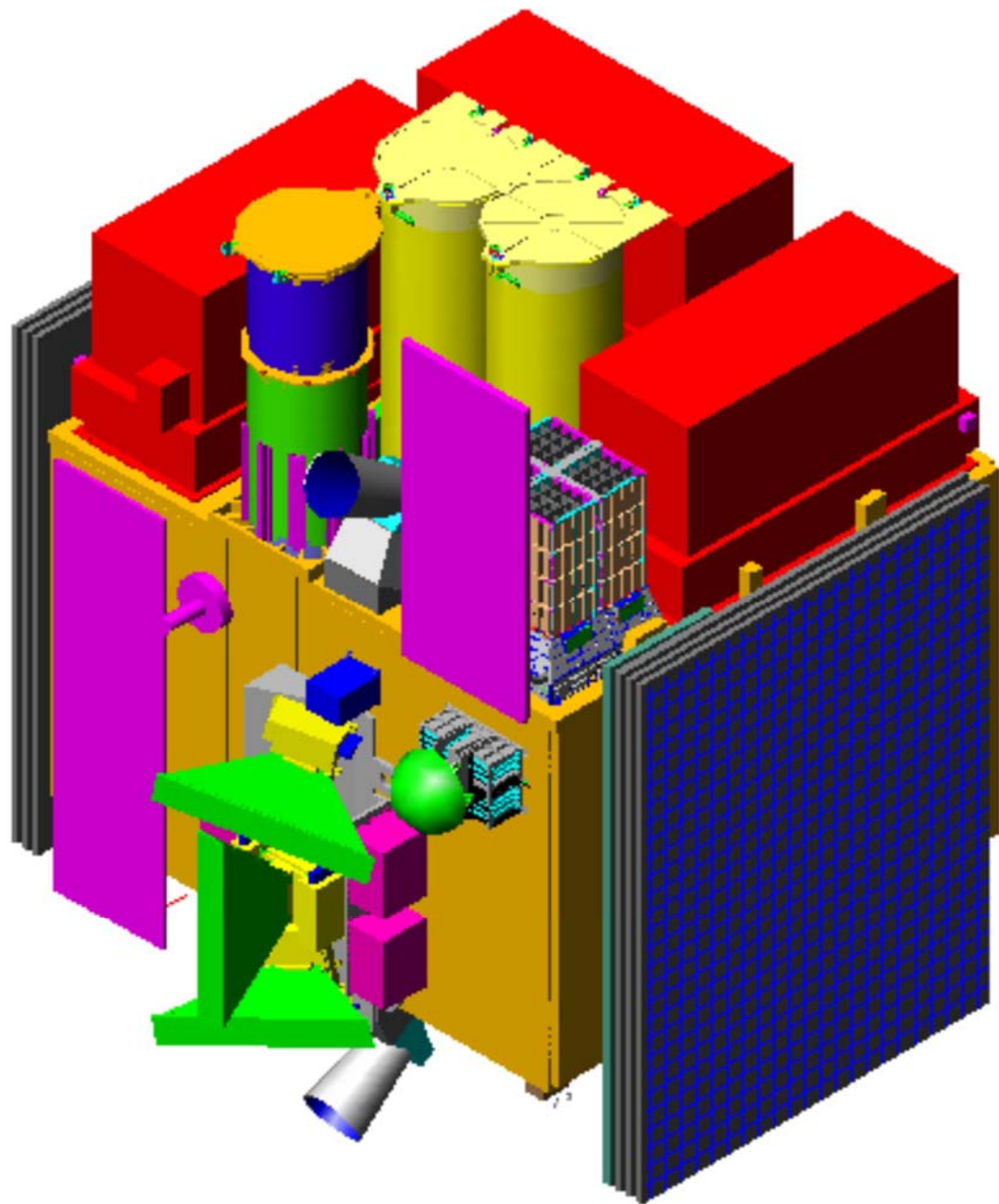
- Two SSMs forming an 'X' FOV canted away from the S/C by 45 deg. To avoid occultation by S/C and solar panels and also sun in the FOV. No long boom
- With this cant only half the sky available
- Due to accommodation problems within the heat shield, height of coded mask of the above two SSMs lesser than the central SSM- poorer resolution, larger FOV
- Cross FOV for all detectors also available

Scanning Sky Monitor (SSM)





Rotation
axis

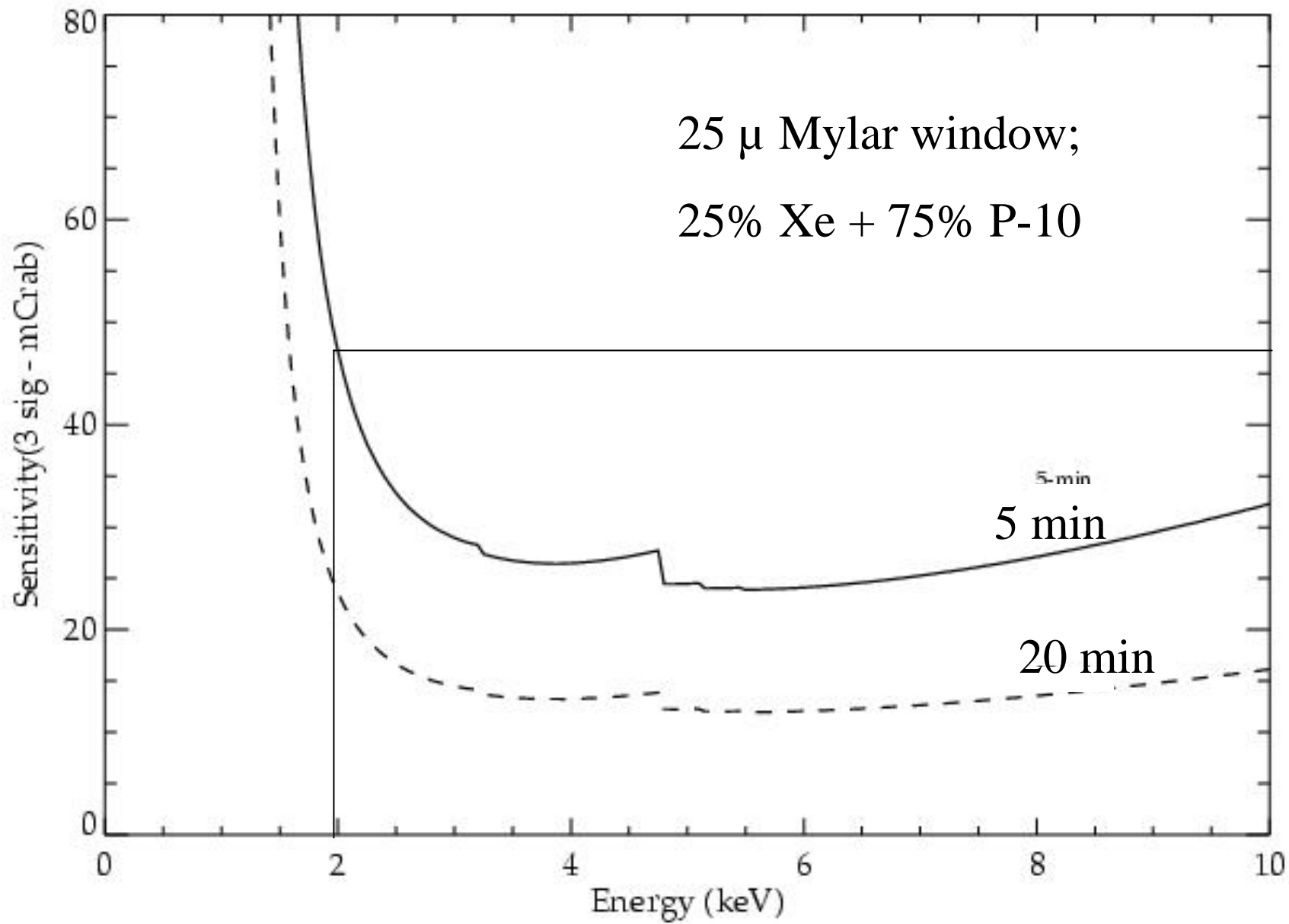


Scanning Sky monitor (SSM)

- Specifications achieved:
 - Energy range **2-10 keV**
 - Position resolution **~ 0.8 mm (FWHM) at 6 keV**
 - Field of view **~ 11° X 90° (FWHM effective)**
 - Gas used **25% Xe + 75 % P10 at 800 torr**
 - Sensitivity **~30 mCrab (5 min. integ.)**
 - Energy resolution **18% at 6 keV**
- Data R/O : Event based; Left and right o/p of every event time tagged and stored in onboard memory.
 - Time resolution **0.1ms**
 - Time stamping with UT **better than 10ms**
 - Count rate capability **5000c/s**
- Rotation capability – 10 degree step, stare time typically 10min. Single rotation will take about 6 hours
- Stare time variable from 2-24 minute

Sensitivity

- Sensitivity
 - Individual SSMs sensitive down to 20 mCrab sources for 10 minute pointing
- Effects due to source confusion
 - In areas of source confusion, sensitivity may worsen by a factor of 2
- Position Resolution capability for new sources
 - Along the position sensitive wire it will be ~ 11 to 14 arc minute FWHM. Worse position resolution for SSM1 and 2 compared to SSM3
 - When source is bright and without source confusion, exact position of source can be improved to ~ 5-8 arc min.
 - Source position across wires will depend on number of SSMs which will detect it, and scan capability



Constraints of operating SSM

- HV to SSMs have to be switched OFF at high background regions- SAA, particle regions and albedo
- Sun not to be in the FOV
- 10 minute stare time required by UVIT. Cannot do fast scans normally. Can be done when UVIT is switched OFF
- Few local occultations from subsystems (PAA, Solar panel, Star sensor) may exist and have to be evaluated.

Thank you