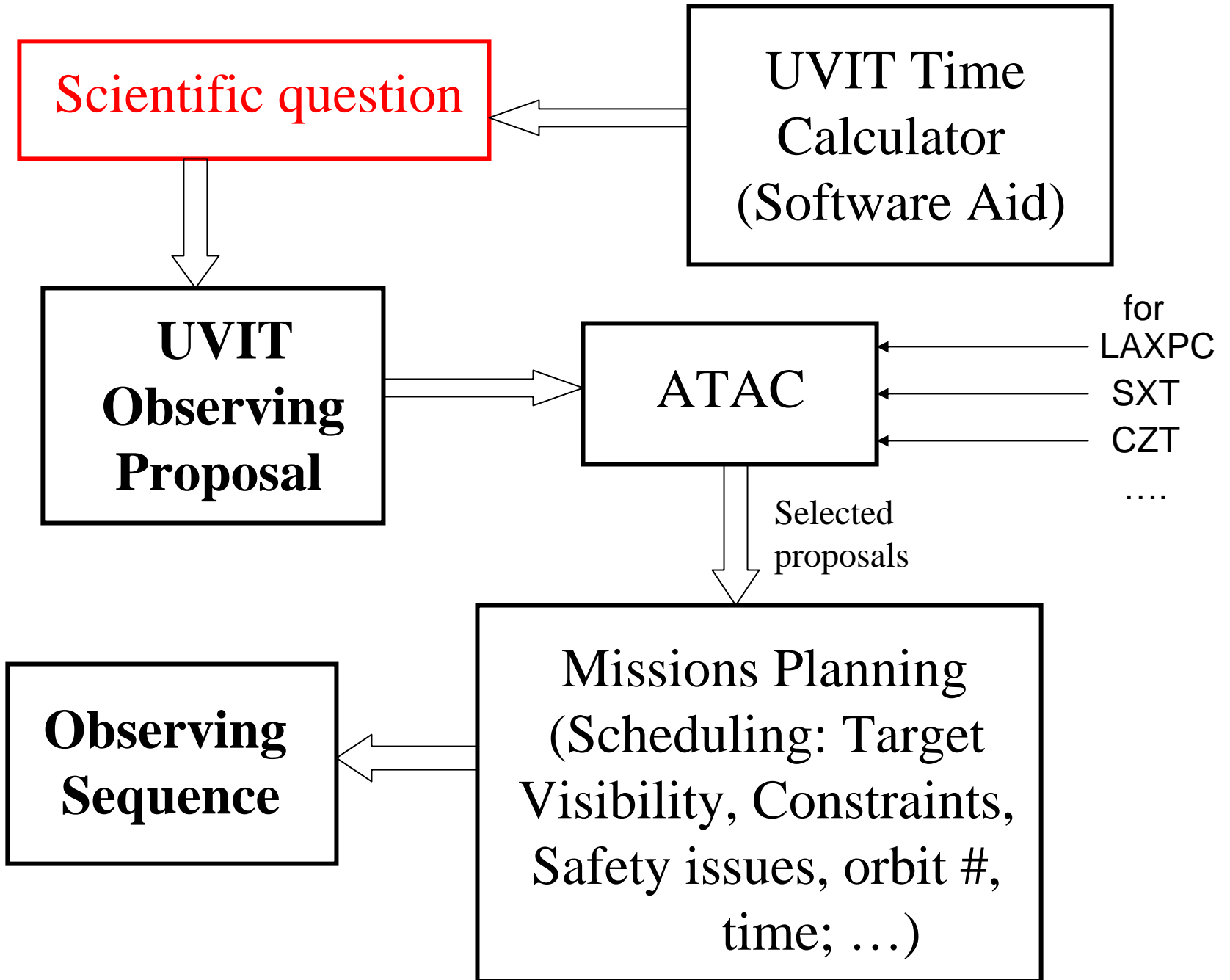
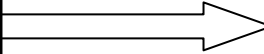


Observing with Ultra-Violet Imaging Telescope

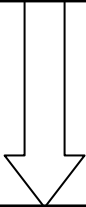
Swarna K Ghosh
(TIFR)



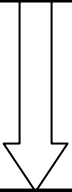
Observing Plan



Sequence of
Tele-commands

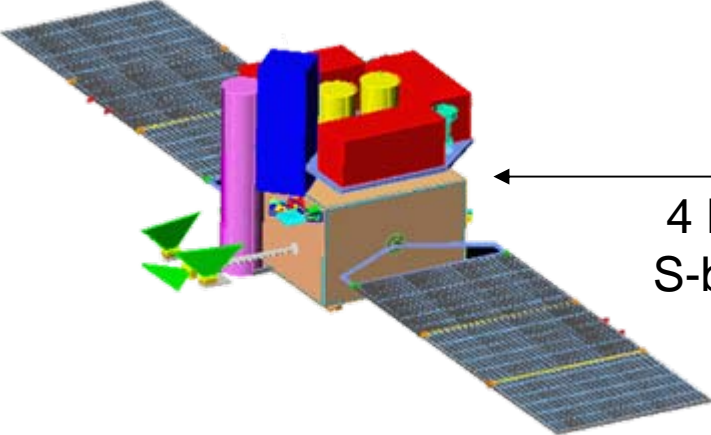


Ground Control



Command Transmission

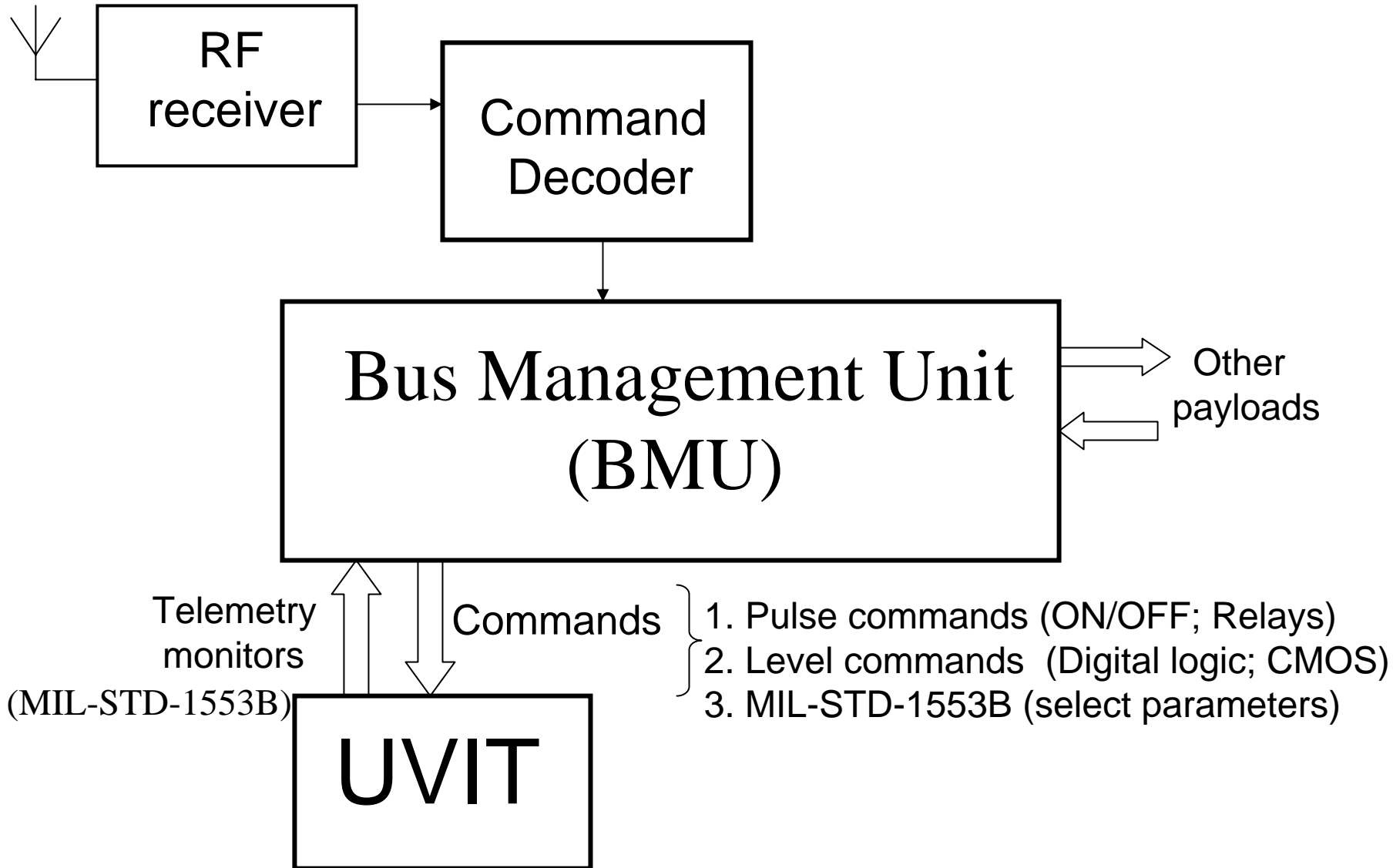
ASTROSAT



4 KBPS over
S-band RF link

Typical rate of command frames : ~ 5 /second

On-board spacecraft :



Examples of UVIT commands :

- Pulse : Raw Power Bus select (A/B)
Power ON/OFF for Detector Electronics,
Filter Wheel Drive, De-contamination Heaters, etc
Telescope Door Open;
- Level : Detector System RESET,
Enable / Disable Filter wheel motion,
'SAFE' parking of Filter wheel (light block),
Enable/Disable 'Override' for Emergency Flag,
(Emergency : Bright Object Detect = BOD)
- 1553B : Selectable parameters for Detector systems
(Imaging parameters, High Voltage Unit parameters)

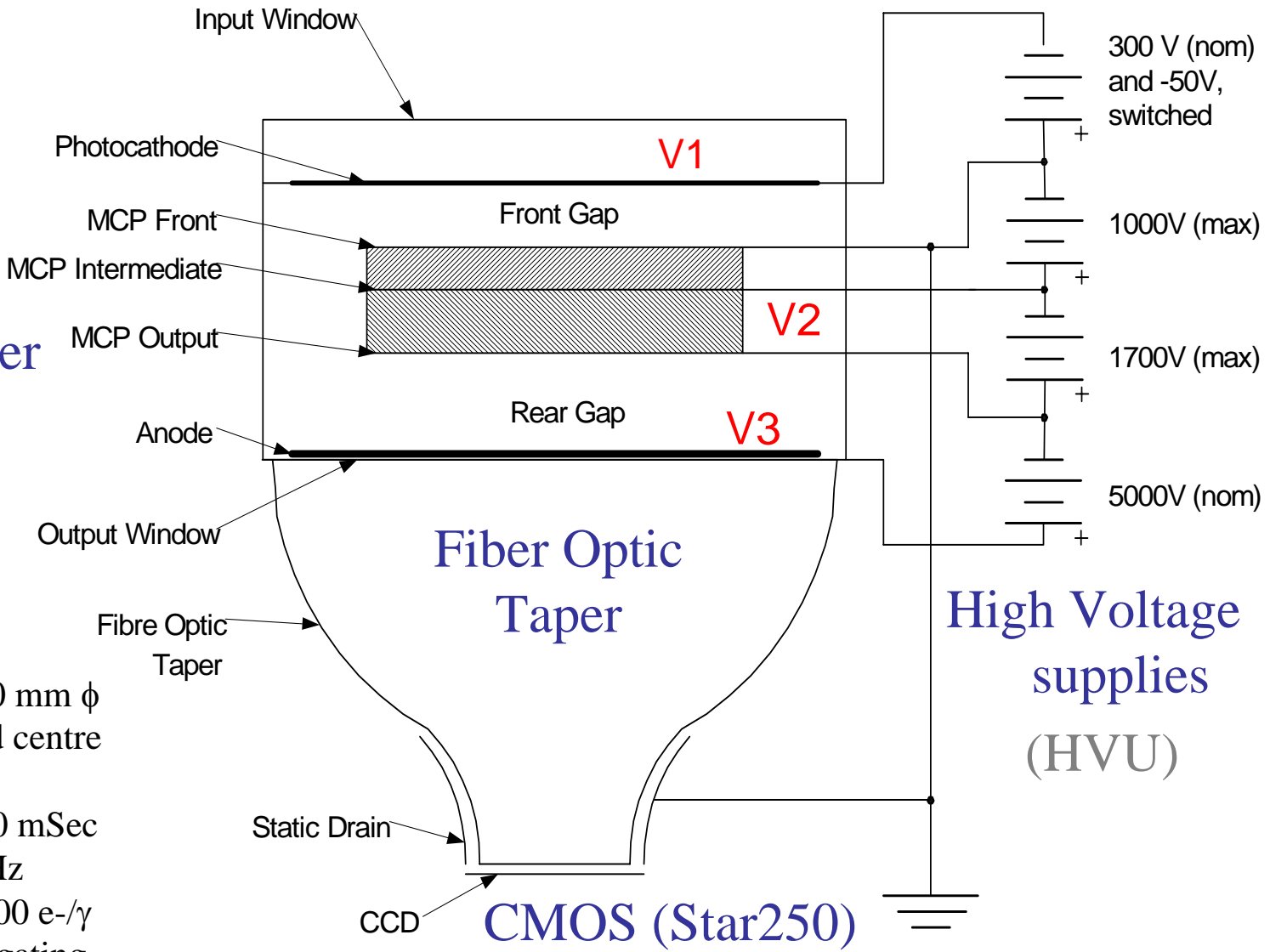
Positioning of the Filter wheel for observing through a particular Filter :

- select filter angle by DATA command;
- Enable wheel motion;
- Start wheel motion;
- Disable wheel motion (after $\Delta T \sim 15$ seconds);

**Components
in each
Detector**

Intensifier

(DM)



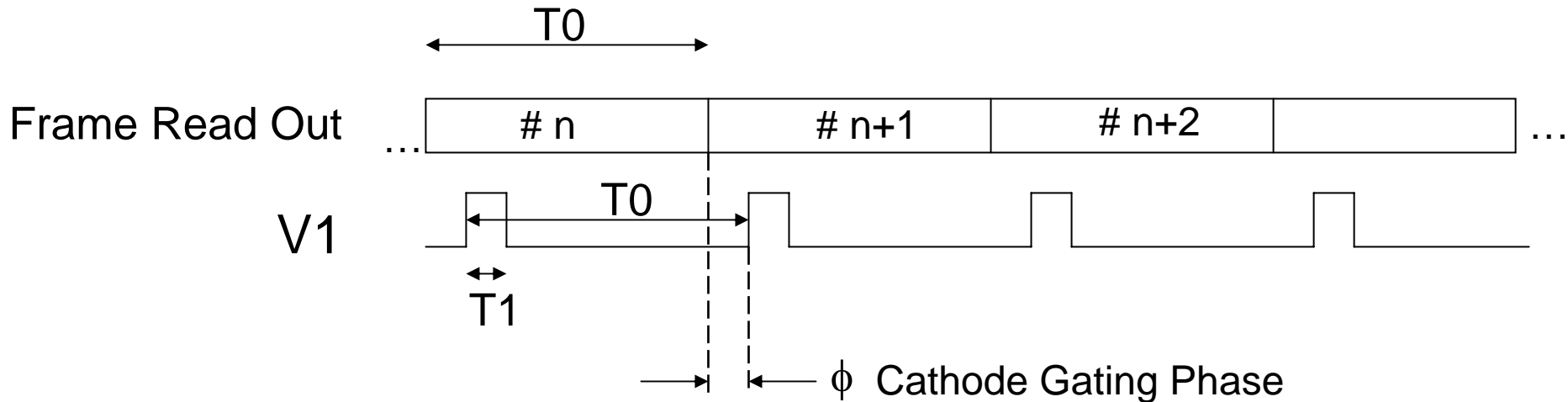
Imaging area : ~ 40 mm ϕ
 QE :> ~5% in band centre
 Pos. res. < 100 μ m
 Exposure : 10-1000 mSec
 Frame rate : > 20 Hz
 Gain : 2000 – 20,000 e-/ γ
 Safety : electronic gating

CMOS (Star250)

V1 : Cathode Gating
V2 : Gain

(Need High Voltage Power Supplies;
 up to 8000 V)

Neutral Density Filter by 'Cathode Gating' :



T_0, T_1, ϕ : Command selectable parameters;

ND Filter transmission 't' $\sim T_1 / T_0$

Due to rise / fall time effects of 'V1',

t (minimum) $\sim 1/5$ (@ ~ 30 Hz Frame Rate)

Crucial role of VIS channel :

UVIT requirement of pointing : ~ 1 arc second

Satellite pointing accuracy : ~ 3 arc minutes !

However, S/C drift is low : < 0.2 arc sec. / sec.

VIS channel images provide star field (27' dia.)

if read out at (or faster than) 1 Hz;

Use detected stars for off-line aspect re-construction;

At shorter than 1 sec. time scale, use satellite sensors (Rate Gyroscopes) to correct other effects like 'jitter';

Are there enough stars (VIS) for aspect fix ?

Expected number of stars brighter than Photographic Magnitude 'm_pg', per UVIT field of 0.2 square degrees (27' dia \rightarrow X 0.8) :

Galactic Latitude	'm_pg' =15.0	'm_pg' =14.0	'm_pg' =13.0	'm_pg' =12.0
0 deg.	259	103	39	15
+ -10 deg.	149	59	23	8.8
+ -30 deg.	57	26	11	4.6
+ -60 deg.	25	12	5.8	2.6
+ -90 deg.	18	10	4.8	2.1

Read out modes :

UV Channels (FUV, NUV): **Photon Counting**

(Frames read out fast enough; 29 Hz)

On-board 'Centroid-ing' of each detected photon;
photon list sent to ground;

VISIBLE Channel (VIS) :

Integration mode; too many photons per frame;

(Frames read out @ ~ 1 Hz)

Full image sent to ground;

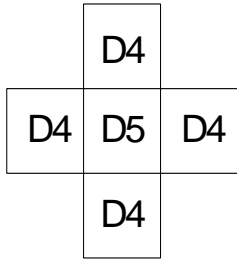
Command selectable parameters for typical observations (target dependent)

Integration time (per exposure)	: < 20 m-sec to 1 second;
Frame read out rate	: ~ 29 Hz full field (512x512), max. : ~ 200 Hz for 50 x 50 window;
Exposure stacking	: 1, 2, ..., 16
Window selection	: any rectangular part of 512x512
Centroid-ing Algorithm	: 3x3 cross, 3x3 square, 5x5 cross, 5x5 'circle'

Other parameters - (typically 'default' values OK)

Setting High Voltages (HVU),
Ramp up/down times for HVUs,
Mode (Photon counting, Integration, Dark frame: V1=OFF),
ND filter (attenuation & phase),
Safety related (HVU current limit; BOD logic;

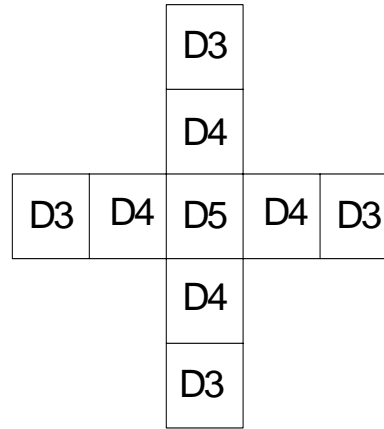
Choices for Centroid-ing Algorithms



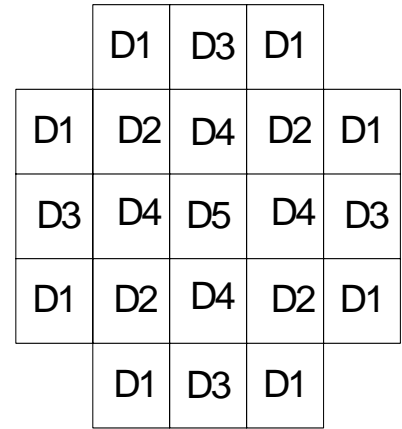
3X3 Cross



3X3 Square



5X5 Cross



5X5 Circle

States of UVIT Detector System :

-OFF

-Low Power (before/ after 'OFF', 'Standby')

-Standby

-Ramp Up

-Active

-Ramp Down

-Fail Safe (Single Event Latchup)

-Bright Object Detected (HV low; Alarm)

Normal command sequence :

Power ON → Low Power → Standby → Ramp Up
→ Active → (Start-Stop Imaging) x n
→ Ramp Down → Standby

Typical sequence of operations (over-heads !)

Large angle slew :

HV at low value;

Filters in 'block' position;

Satellite slew for target acquisition (peak ~ 0.4 deg/sec)
(target as well as slew path free of ALL constraints);

Turning ON for Observations :

NUV & FUV in Photon Counting mode, VIS on Integration;

Data collection begins;

Bright Object Detect logic ON;

Filter to selected position; (~ 15 seconds)

HV ramp up to selected value (~ 10 seconds);

Safety of UVIT Detectors

- Bright Object Detection logics → **shutdown till intervention from ground (Reset)**;
(during ‘window-ed’ mode in one channel, another channel continues to monitor full FoV)
- Planned ‘modulation’ for target fields with bright sources : Slow spiral motion (~10 arc sec max. radius); → **implication for very small selected window** ;

Absolute Timing Accuracy of UVIT :

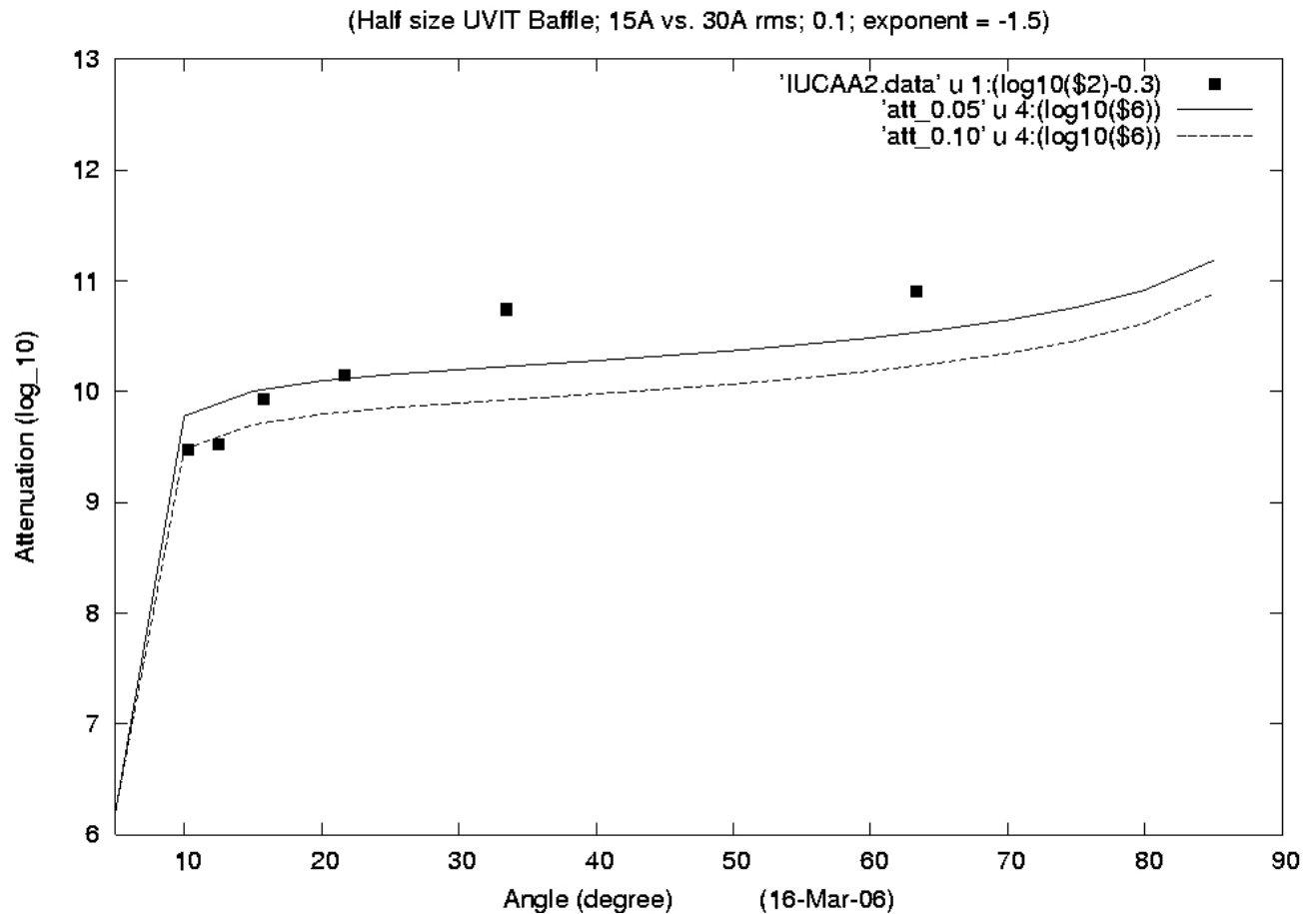
Original projected requirement :
better than 1 second

Using Onboard Timer pulses (PPS)
to calibrate UVIT's clock : < 10 mSec

Background due to nearby bright object : estimation from baffle efficiency

Large angles (> 10 deg.):

(filter specs to be folded)

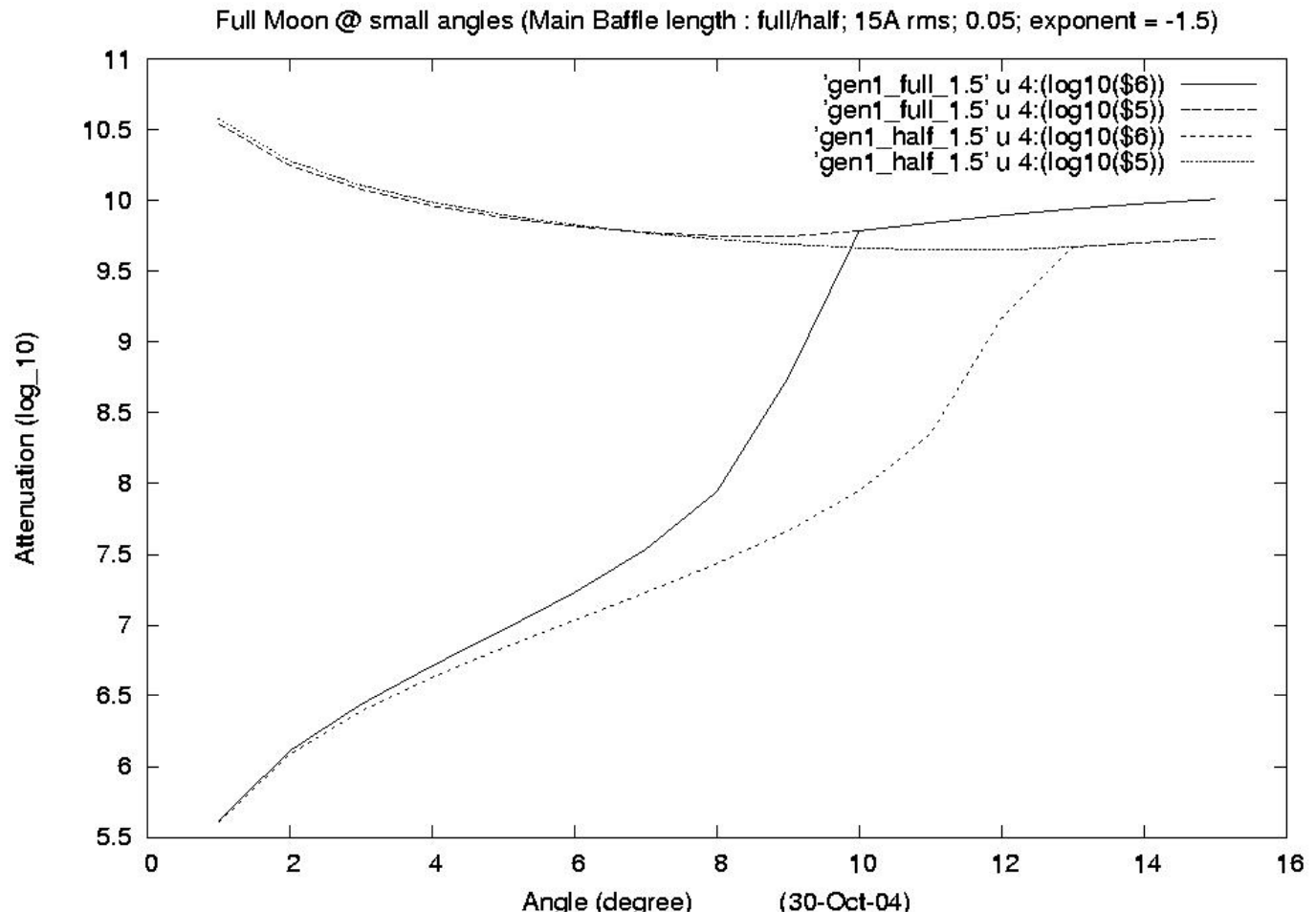


Background due to nearby bright object : estimation from baffle efficiency

#2

(filter specs to be folded)

Small angles (< 10 deg) :



Estimated loss of sensitivity near Earth's limb

Angle (deg.)	Background	sensitivity loss (mag.)
65	= 1.0	=0.00
32	1.7	0.29
10	780	3.6
8	1.3×10^6	7.6
6	5.0×10^9	12.1

Thank you !

Estimated loss of sensitivity near Earth's limb

Angle (deg.)	Background	sensitivity loss (mag.)
65	= 1.0	0.00
32	1.3	0.14
10	28	1.8
8	1120	3.8
6	7.1×10^4	6.0
