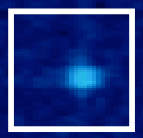
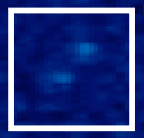
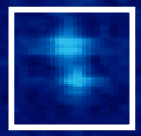
On-board data handling for DMS



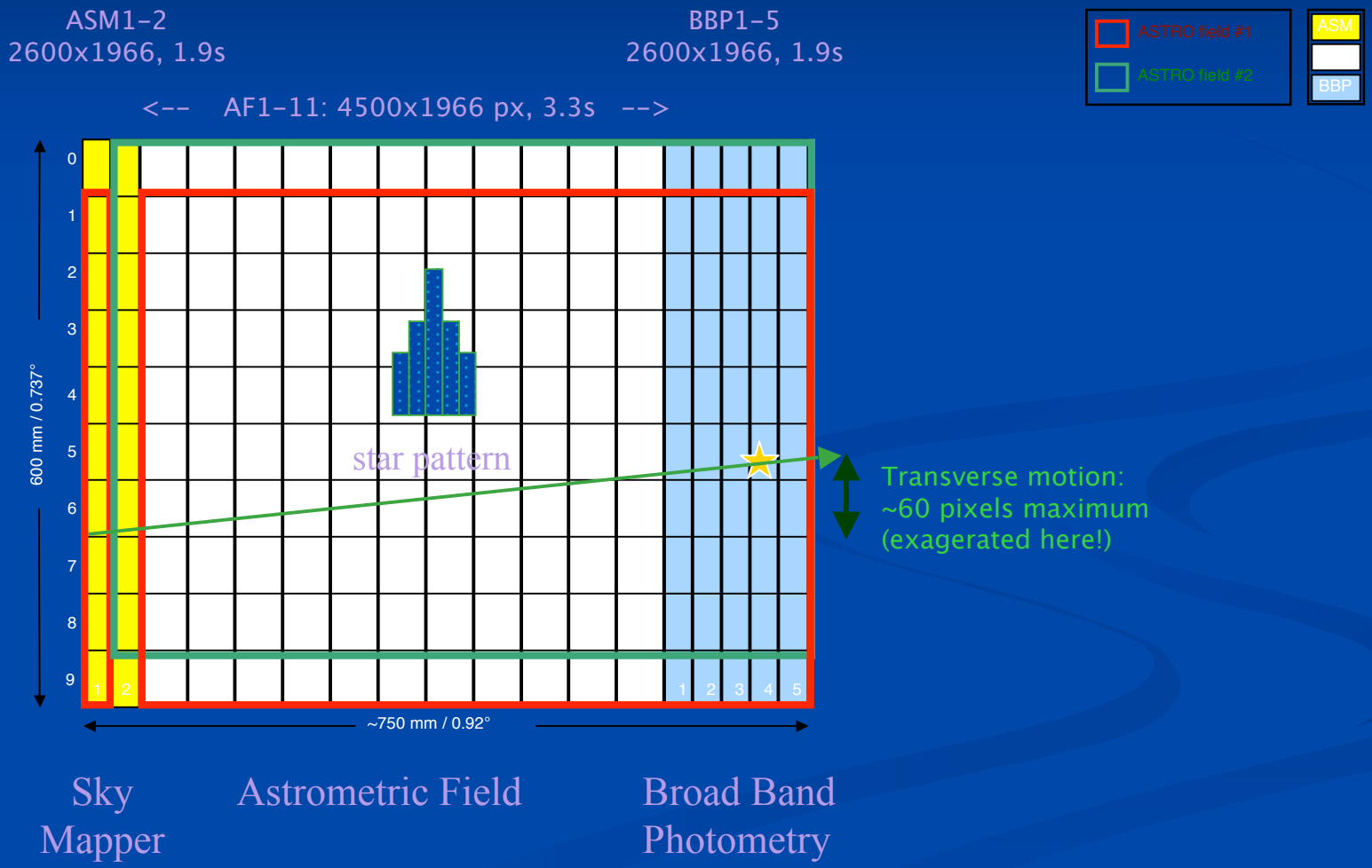
Frédéric Arenou



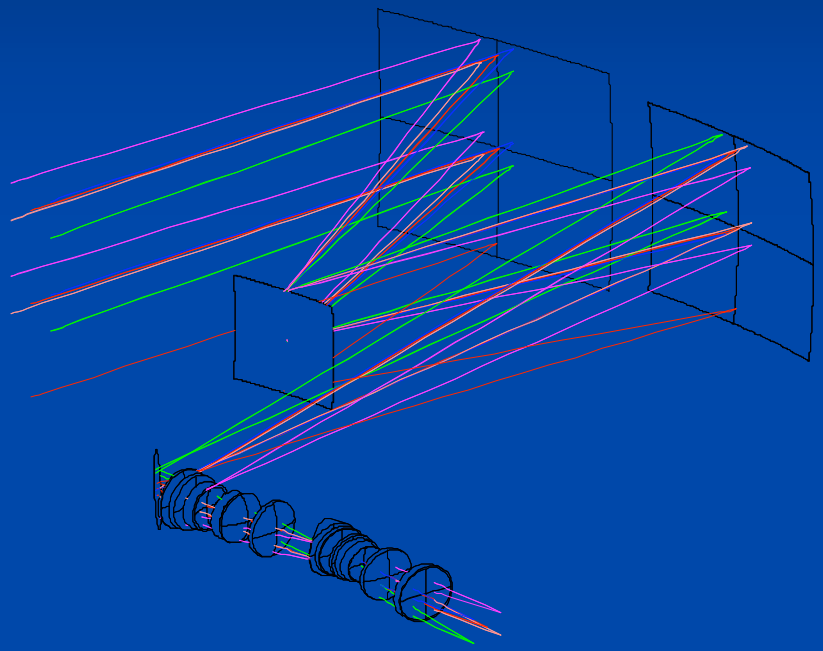


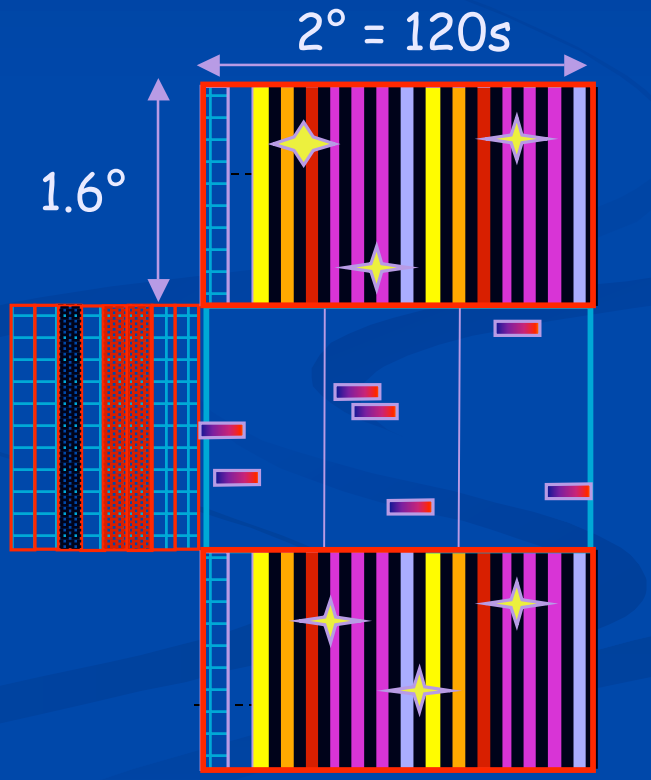
The instruments

Astrometric focal plane

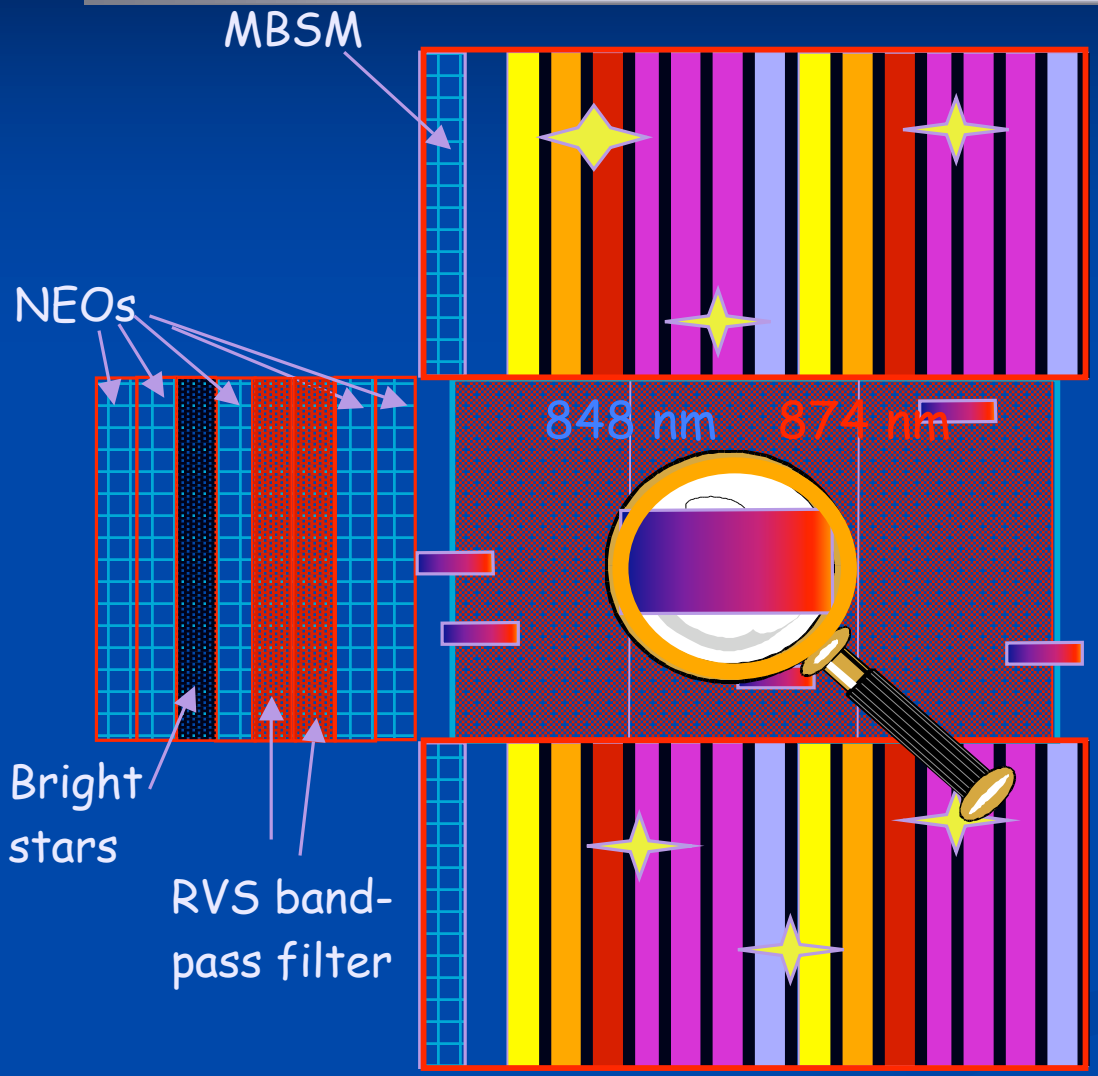


Spectrometer and MBP/RVS focal plane

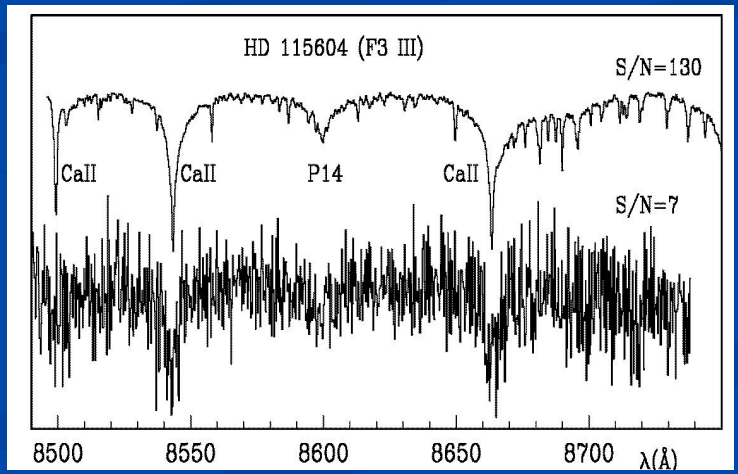




Spectro field



- Confirmation and redundancy
  - For spectro sky mapper
- Two MBP fields
  - 1+15 CCDs =1+11 filters TBC

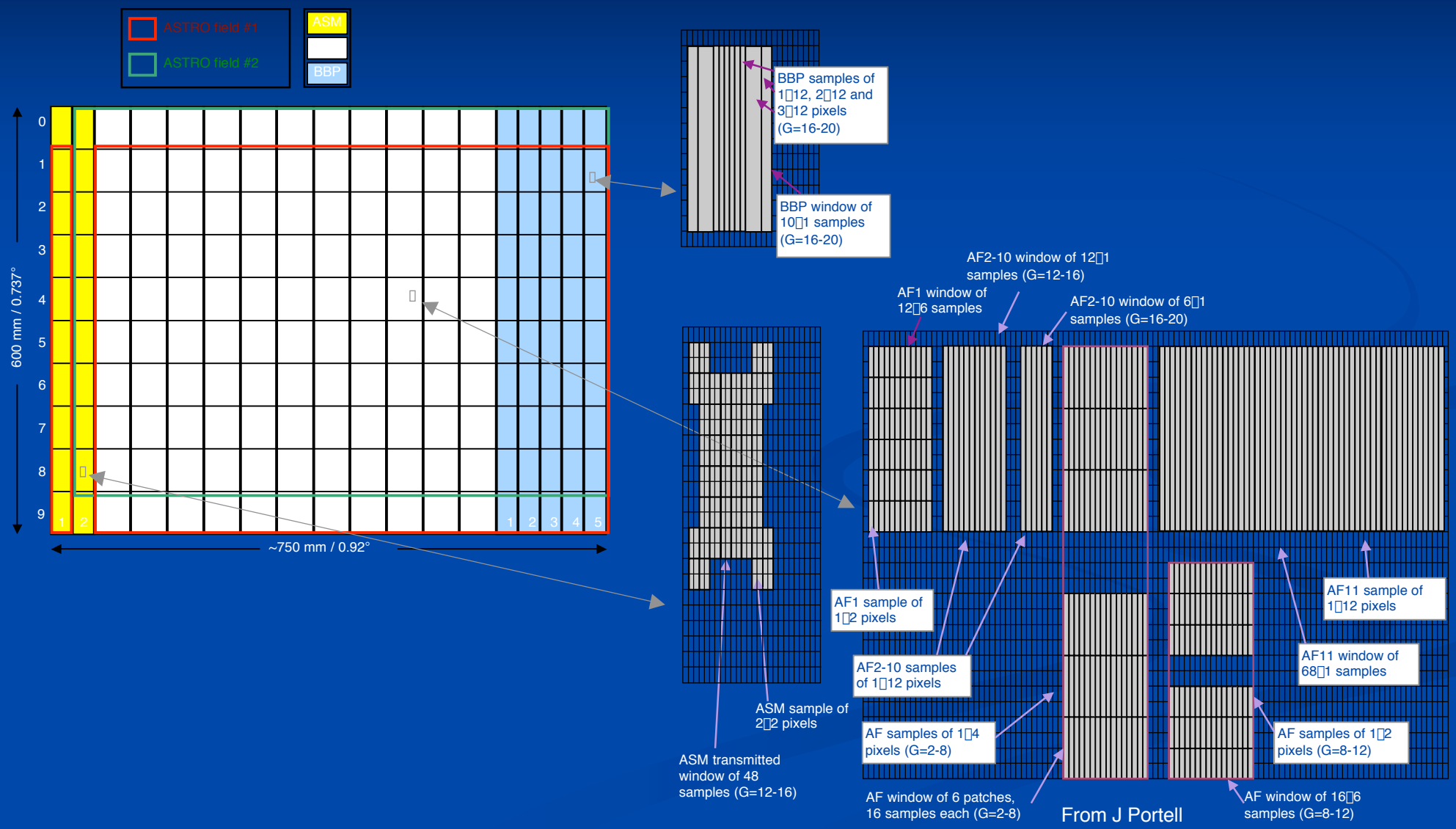


Sampling

Sampling and patches

- Scientific Requirements
  - Highest precision along-scan
  - Highest signal/noise: smallest read-out noise: electronic binning
  - Enough flux per object for on-ground reconstruction
- Technical Constraints
  - CPU: limited instantaneous number of objects
  - Telemetry: small number of patches, size of patches
  - Number of samples AC fixed by the max. density
    - $\sim 3.10^6$ in astro
    - $\sim 10^5$ in MBP, RVSM
- Sampling design now steady

Sampling in the astrometric field

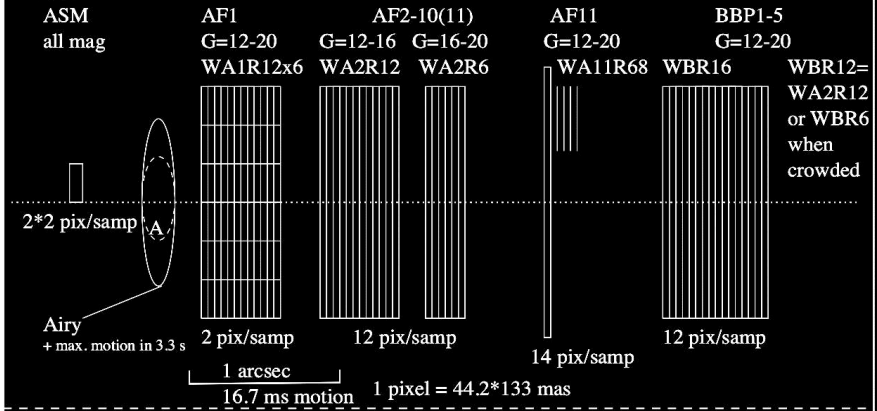


Sampling in Astro and MBP

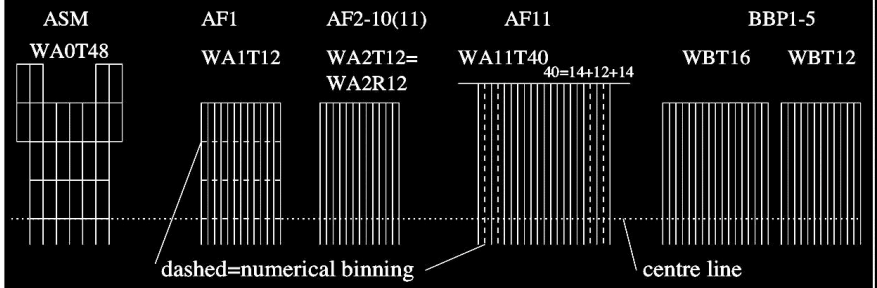
A Sampling in Astro - Scheme C - see CUO-113

ASM = Astro Sky Mapper; AF = Astrometric Field; BBP = Broad-Band Photometer
Windows: WAn for ASM, AF; WBn for BBP; WMn for MBP; WYnn with distance Y=nn
e.g.: WA1R12x6 for AF1= read 12x6 samples; WA2T6= transmit 6 samples; WA0T= transmit for ASM

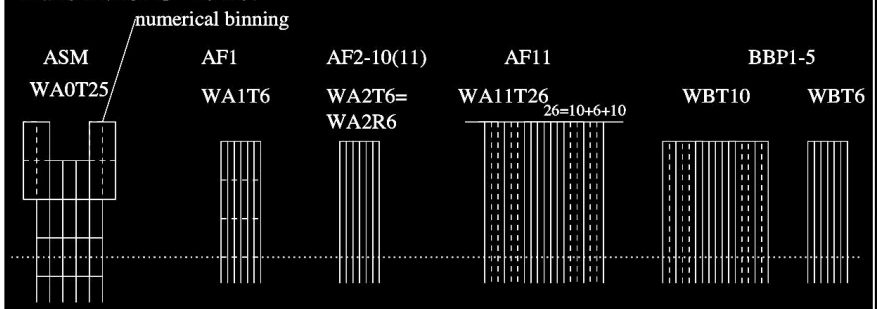
Read:



Transmit for G=12-16:

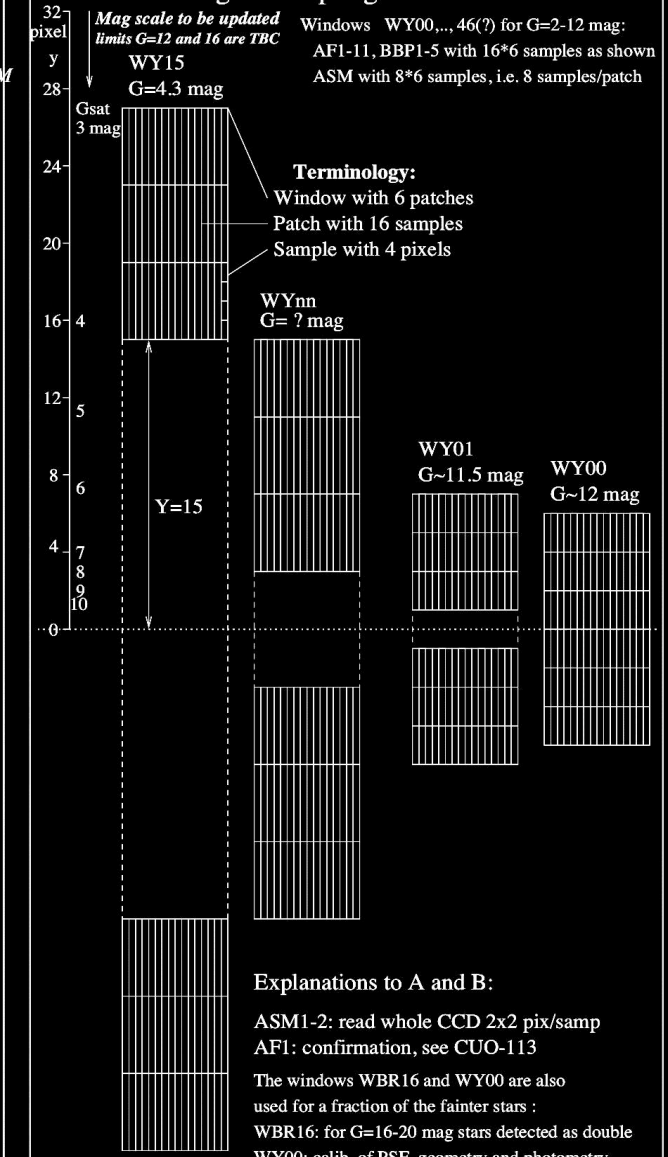


Transmit for G=16-20:



Copenhagen University Observatory - E. Hoeg - 21 October 2002

B G=2-12 mag Sampling in Astro - Scheme C



Windows WY00,.., 46(?) for G=2-12 mag:
AF1-11, BBP1-5 with 16*6 samples as shown
ASM with 8*6 samples, i.e. 8 samples/patch

Explanations to A and B:

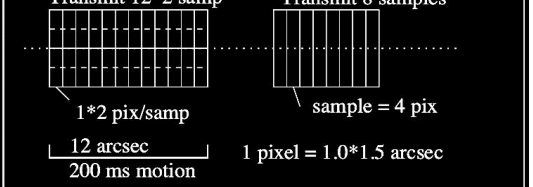
ASM1-2: read whole CCD 2x2 pix/samp
AF1: confirmation, see CUO-113

The windows WBR16 and WY00 are also used for a fraction of the fainter stars :
WBR16: for G=16-20 mag stars detected as double
WY00: calib. of PSF, geometry and photometry for G=12-20, see Section 2 of CUO-113

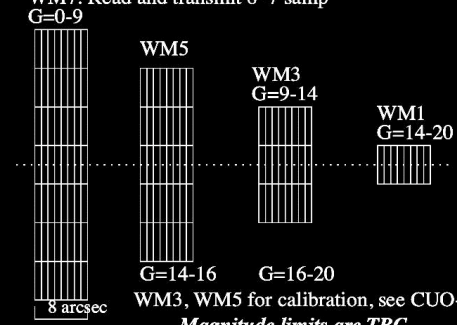
samp11

C Sampling in MBP

MBSM = Medium-Band Sky Mapper
MBP = Medium-Band Photometer



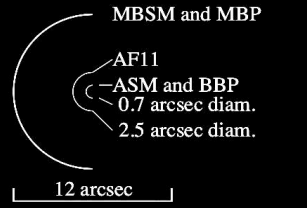
Calibration with 3 windows WM7, 5, 3 for G=0-20 mag:
WM7: Read and transmit 8*7 samp



WM3, WM5 for calibration, see CUO-91
Magnitude limits are TBC

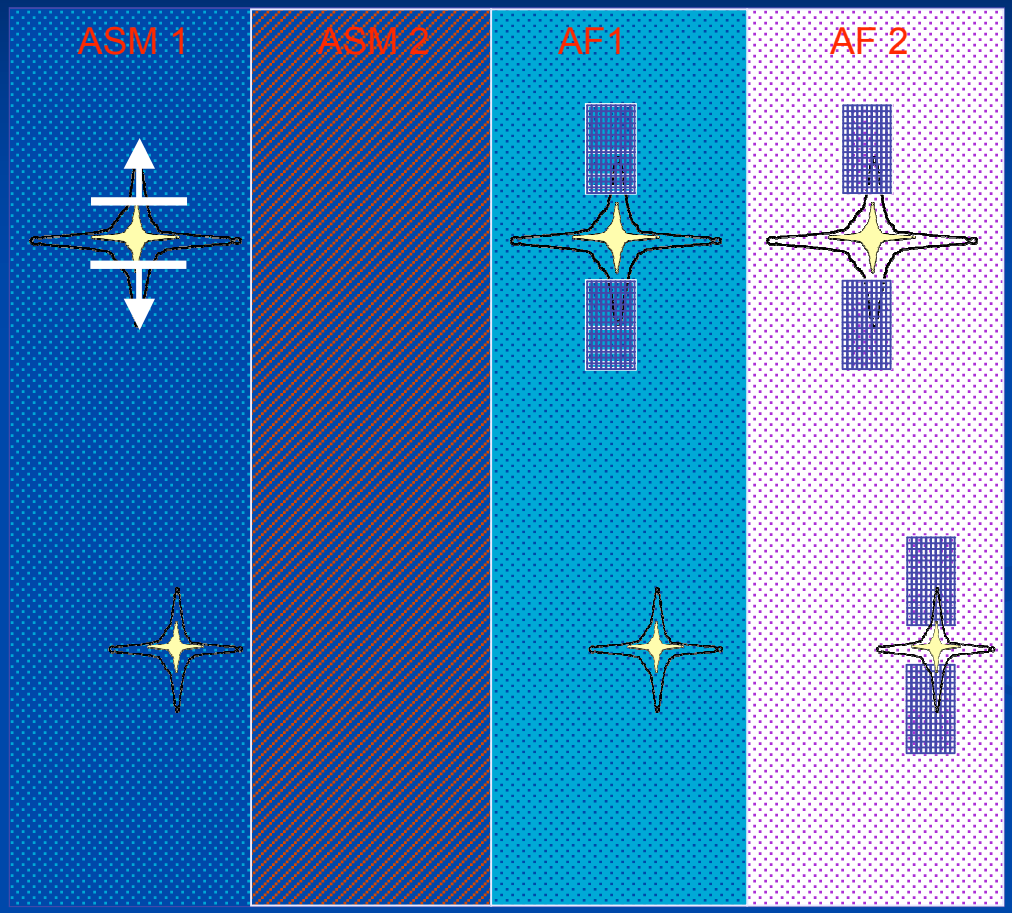
D Imaging around detected stars

Detection in G-band
and multi-colour photometry



CUO - 21 Oct. 2002

Bright stars (E.Høg)



The space between windows is determined by ASM1

No saturated samples are downloaded

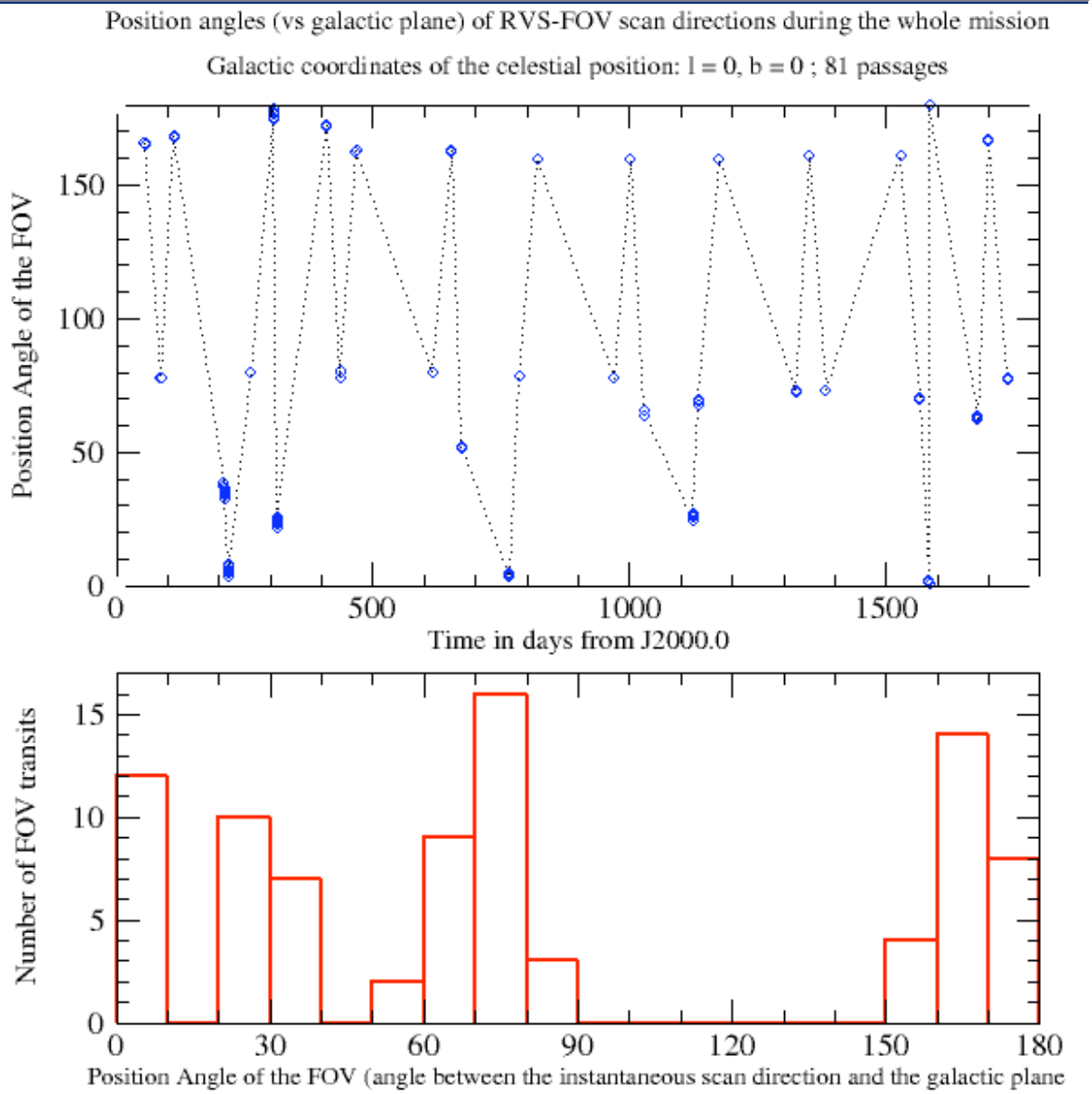
GAIA-CUO-100,
AAEB-FACB-01
GAIA-BCN-JP-001

CCD study uses gates and 1x1 samples

The scanning law

Scanning directions

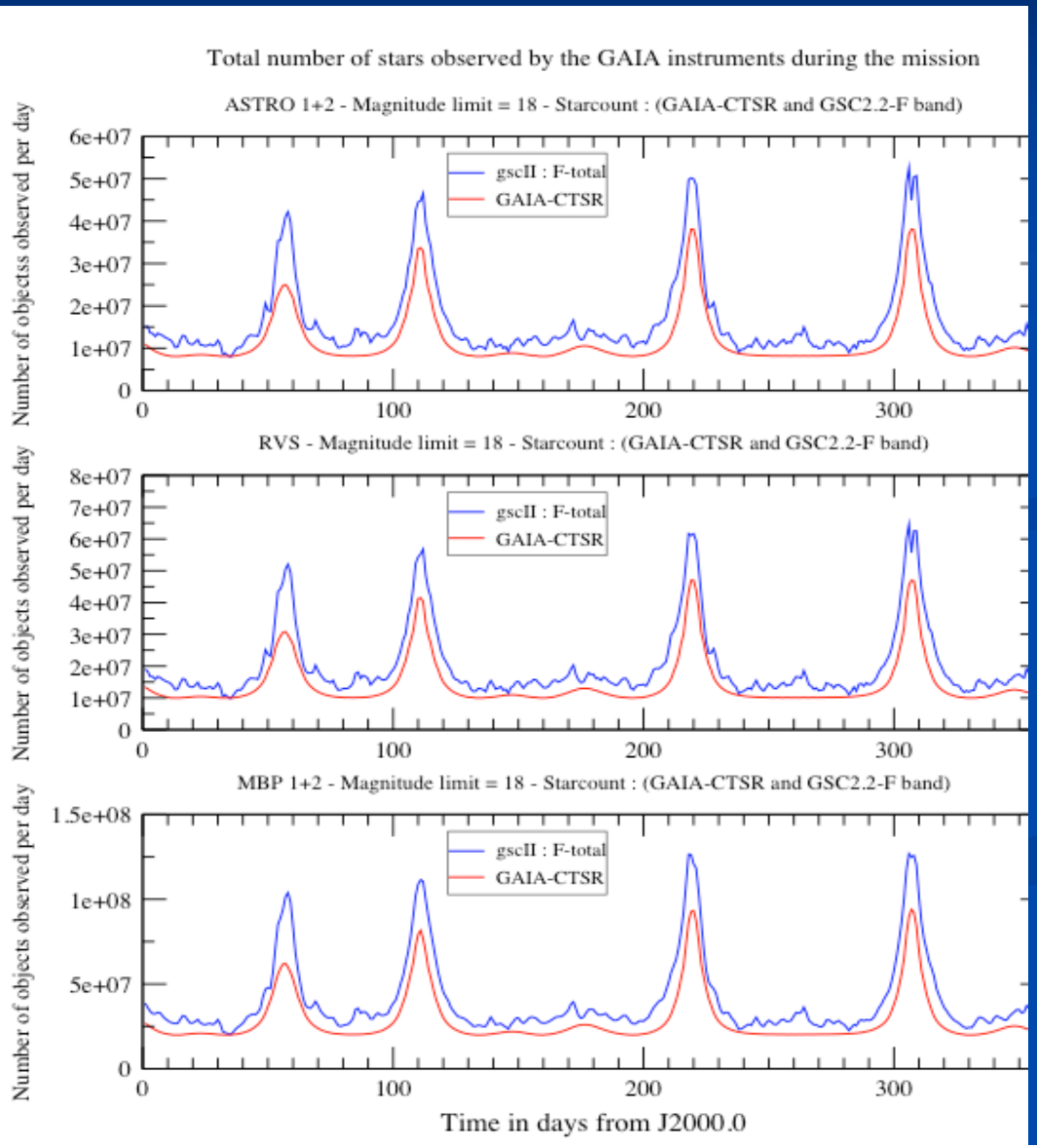
- Far from being uniform…
- Render detection of some couples difficult



From Y. Viala

Peaks and valleys

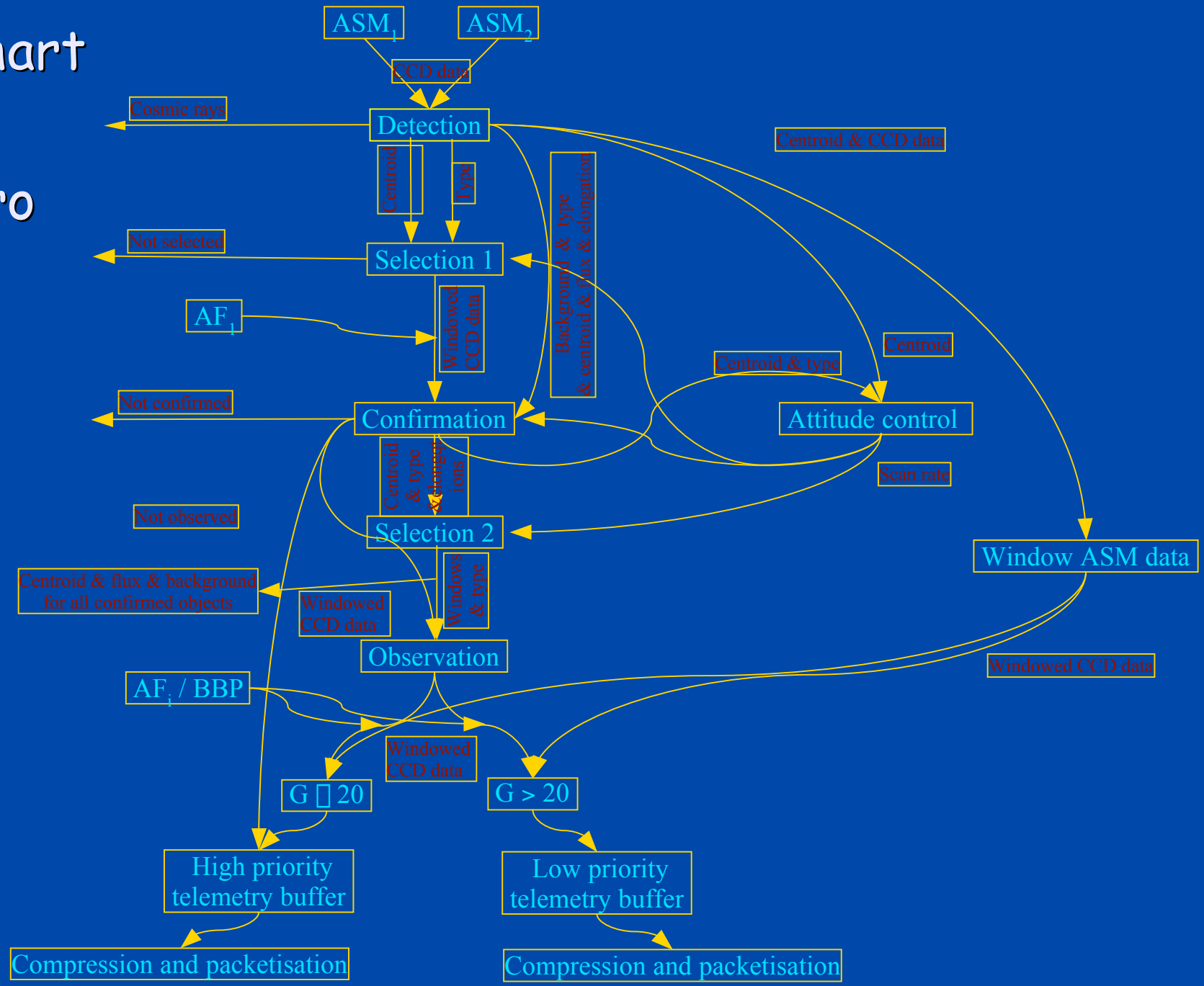
- Telemetry by Yves Viala
- Using GSC II
- Astro and MBP to be extrapolated to G=20
- Data peaks are due to great circles along the galactic plane
- Between two data peaks, stars fainter than 20 could be sent (second priority)



From Y. Viala

Observing strategy

Flowchart in astro



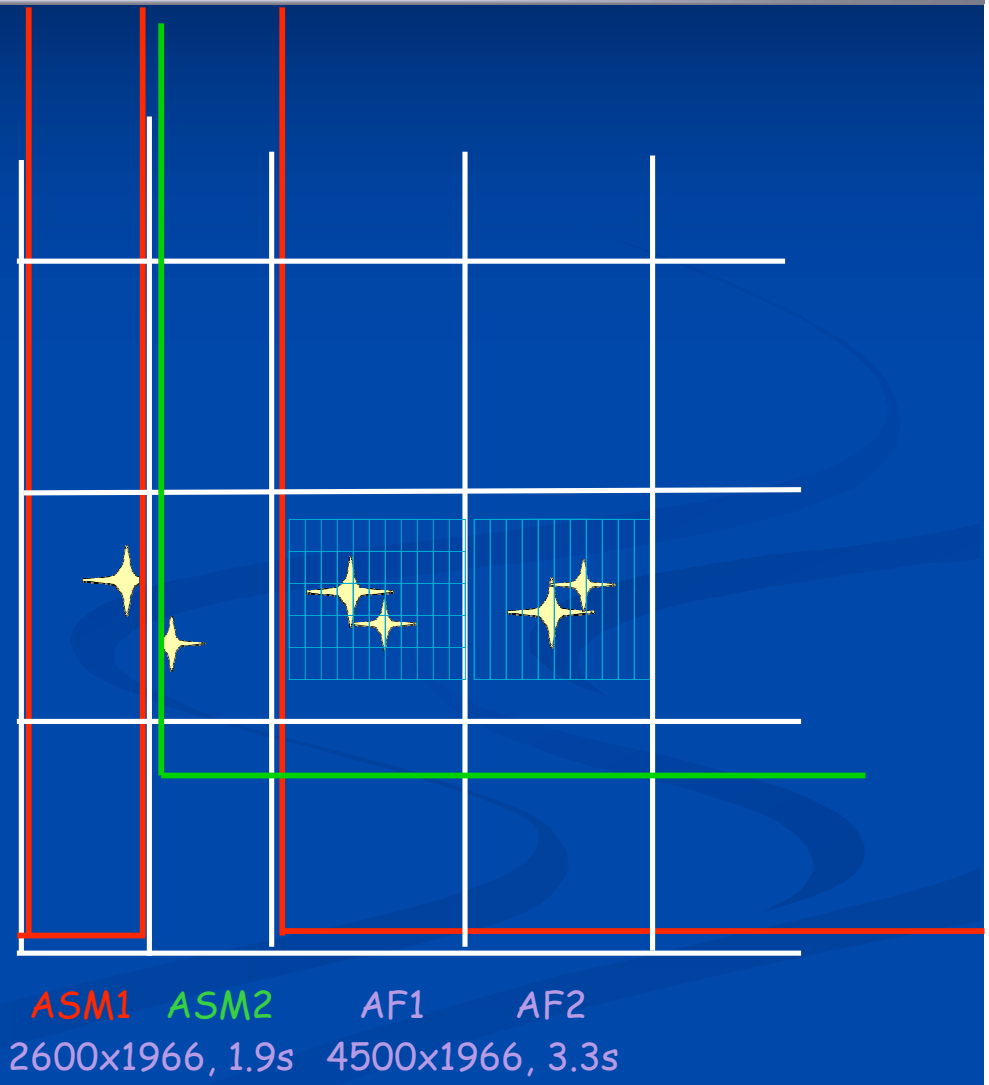
From S. Mignot

Constraints

- Scientific Requirements
  - Highest precision along-scan
  - Highest signal/noise : smallest read-out noise : electronic binning
  - Enough flux per object for on-ground reconstruction (two close objects)
- Technical Constraints
  - CPU: limited instantaneous number of objects
  - Telemetry: small number of patches, size of patches
  - Number of samples AC fixed by the max. density
    - 3.10^6 in astro
    - $\sim 10^5$ in MBP, TBC
- DMS need to get components into patches
  - Companions should be detected to be in AF1 (otherwise secondary not observed)
  - Companions can further be detected in AF1
  - Companions should be correctly centred
- Particles (TBC)
  - Cosmic rays
  - Solar protons
  - For 4% time at sunspot maximum, rate could be much larger than star rate
  - Two levels of rejection:
    - Shape
    - AF1 confirmation
  - Isolated particles give less constraints than those superimposed on stars (fake DMS)

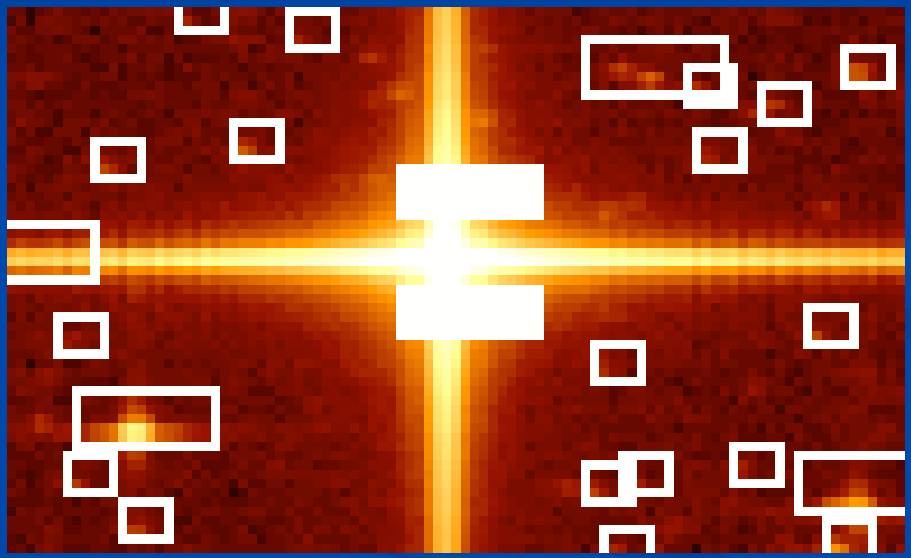
Window allocation

- Confirmation
  - Detection algorithm is run on the AF1 window.
  - Cross-matching based on centroid position
  - If cross-matching fails: false detection
  - A larger AF1 window for NEOs when low density?
- Scan rate and prediction of positions
  - If one object in ASM and one in AF1 and object identified as star, then delta position is added to a list for scan rate computation
  - If delta position too large and object elongated and low density, then followed as NEO; else the scan rate is used to predict the position of object
- Allocation of windows
  - It may happen that the edge of CCD is reached, then download only AF1-5
  - It may happen that ASM1 and ASM2 objects overlap so the allocation of windows needs to take this into account



Placement and selection

- Placement of windows
  - Maximum number of samples allowed per row
  - None of its samples overlap with other windows
  - May be overlapping in AF1
  - So that a shift (no more of 2 pixels) is allowed (for DMS)
- Selection
  - First-read first-kept basis
  - When bright star can't be observed, last faint windows may be suppressed
  - Except if faint star is a companion to the bright star in which case both should be obtained



Patches for double stars (S. Söderhjelm)

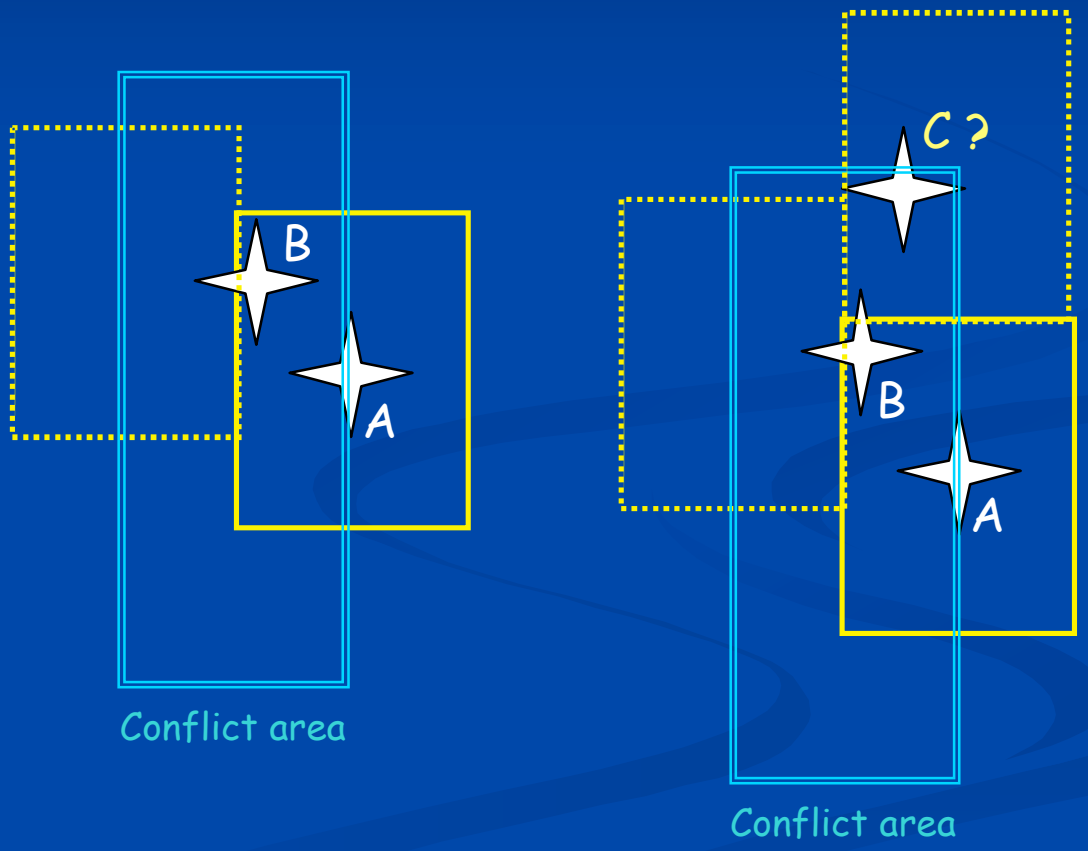
- Proposal for Gaia 2 design
- Patch sizes

	single	double
G < 12	(3+3) 16x4	idem
12<G<17	16x14	16x14
G>17	6x10	16x14

- Adopted for tracking
  - G< 12: it is looked into the 6 spike patches and if there is a companion inside a patch: if priority to bright stars is assumed, the bright star patch is kept; otherwise the patch of the first to arrive is kept.
  - 12<G<17: if along-scan and across-scan separation are <= 14 pixels, one patch is taken, centered on the geocentre else two patches are taken, with the single star patch size
  - G > 17: if along-scan and across-scan separation are <= 8 pixels, one patch centered on the geocentre else two small patches are taken

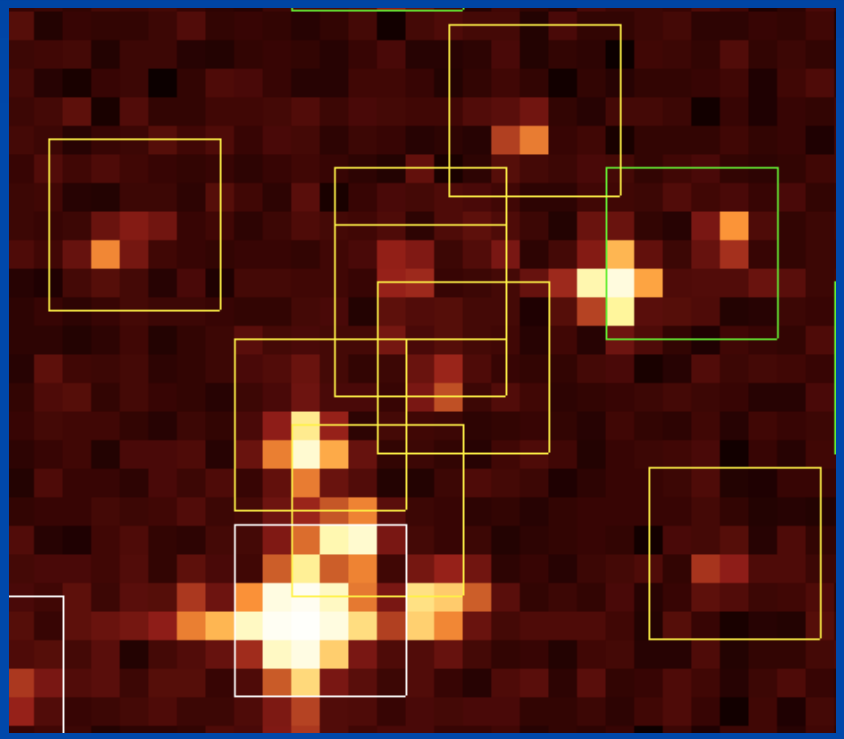
Proposal for DMS patches (E. Høg)

- Window allocation for double stars
  - First in, first kept
- Complexity
  - Adaptation to multiple stars
  - Dense areas in astro
  - Galactic plane in MBP/spectro
  - Increase of telemetry



DMS treatment

- Which model is the best?
- Tests have to be done for multiples

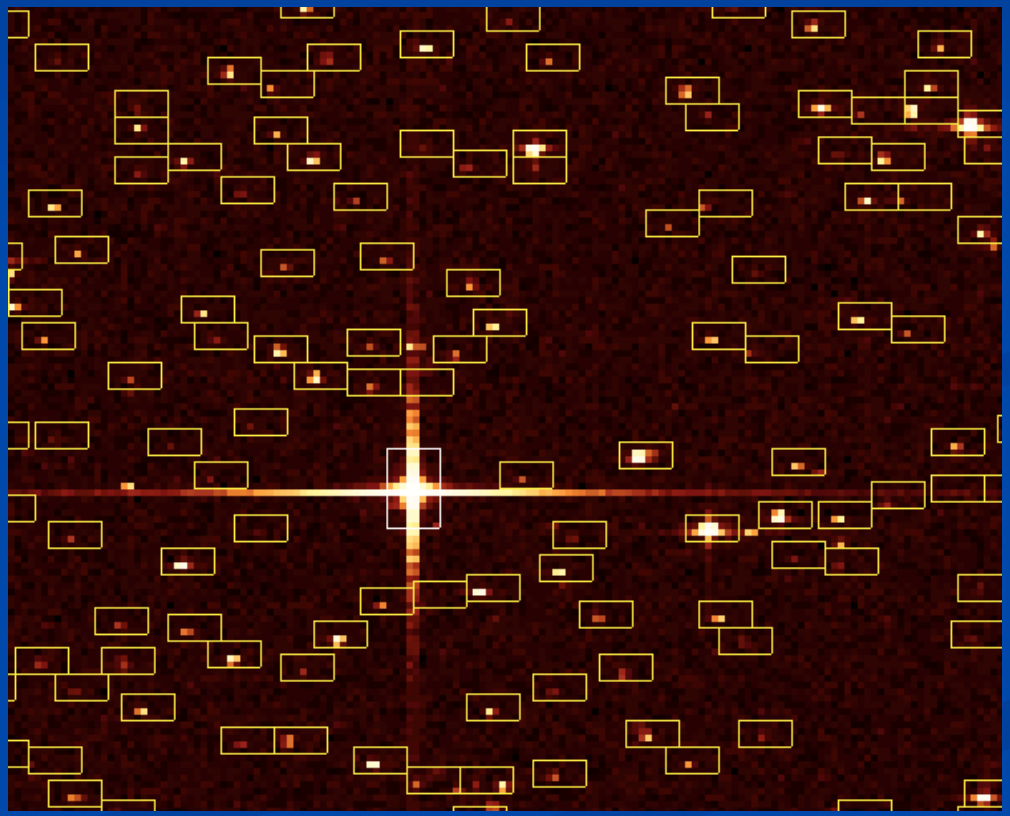


- Observing strategy for special objects
  - one (or two) supplementary windows may be allocated
  - allocation of supplementary windows may also occur after the AF1 (better resolution, better S/N, 12x6 samples)
- Window placement for multiple objects
  - Barycenter in ASM compared to AF1 barycenter
  - If no object is found in the AF1 window, ASM detection is considered as false
  - If less objects in AF1, ASM is considered as containing cosmic ray and AF1 position is adopted
  - If more objects in AF1 and total flux larger, the ASM is considered as reference (cosmic ray)
  - Cosmic rays perturb all this

MBP and RVS

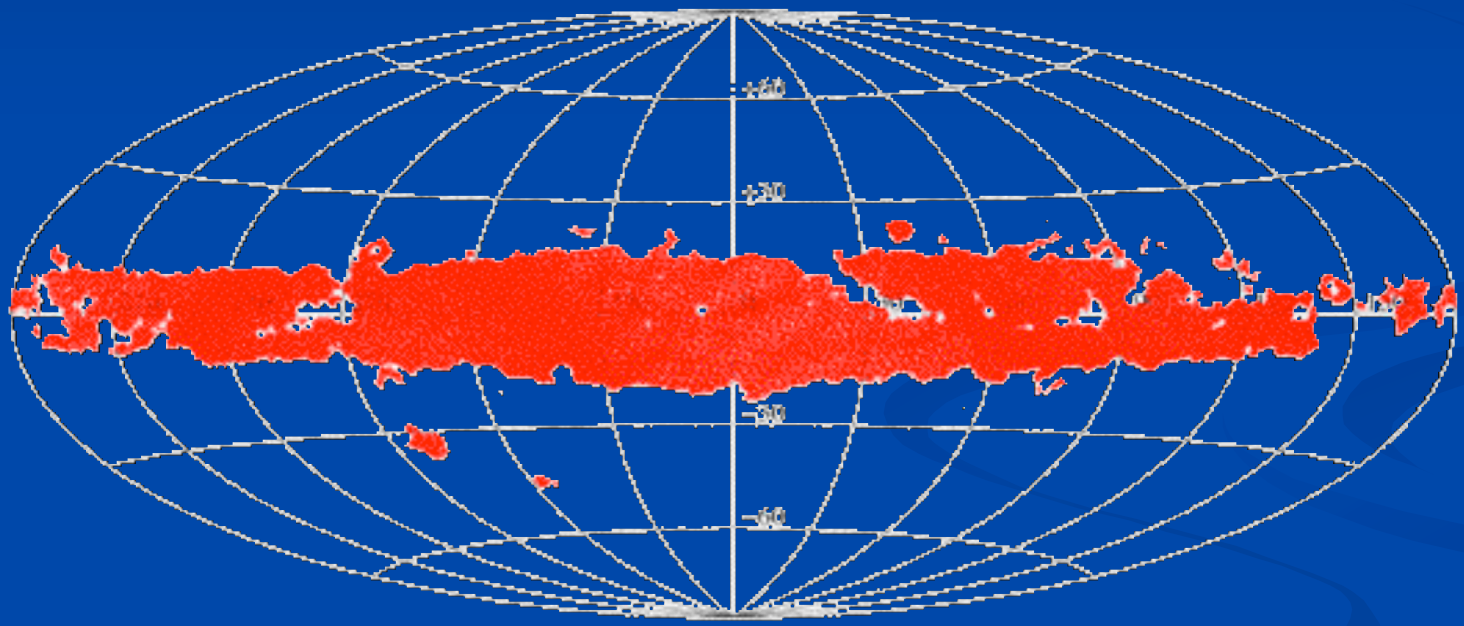
MBSM/RVSM

- In MBP
  - Confirmation using the flux sum of 15 MBP?
- Strategy in RVSM
  - Detections then cross-correlations,
  - Up to a density of 100 000 stars/deg2
  - NEOs recognised by their velocity
- A lot of DMS even in non-crowded fields



RVS full CCDs

- Design now consolidating: baseline R=11500, 3 CCDs, tilt mecanism
- When crowding is such high that the RVS CCD should be entirely downloaded:



- Galactic coordinates, limiting magnitude=17, R=11500, row/spectrum=2
- Means a *lot* of superimposed spectra
- Dedicated reduction for DMS

From Y. Viala

Status

- Requirement document for on-board processing to be issued mid-april
- Implementation done 6 months ago
  - Currently uses Staffan's patches
  - Implements part of these requirements only
  - Needs coding with better standards
- Recent effort has been put on detection
- Next 6 months devoted to implementation of these requirements
  - Needs for tests, in particular multiple stars
  - Perturbation by level of particles
  - Complexity in MBSM/RVSM