The CoRoT Data : the pipelines and their evolution philosophy

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The CoRoT data philosophy

- N0 data generated at CNES
- 2 successives correction pipelines
  - N0➔N1 : corrections applied all along to incoming data : N1 data
  - N1➔N2 : corrections requiring a complete run overwiew
- Correction only if the effect is identified/ modeled/quantified
- No blind corrections (systematics removal)

N0 – N1 pipeline

- **Seismo field** (corrections applied in the following order)
  1- **Elimination of the aliasing** (cross talk): done by using patterns measured in the calibration phase
  2- elimination of the residues of **offset and background** (background correction is on-board)
  3- correction of the duration of the exposure and absolute dating
  4- **jitter corrections** using high resolution PSF

See

- **Exo field** (corrections applied in the following order)
  1- **Elimination of the aliasing** (cross talk): done by using patterns measured in the calibration phasesubtraction of the
  2- **Elimination of the offset** and of the **background** obtained as the **median** of the observed **backgrounds** in order to eliminate the hot pixels in the background light curves
  3- on the chromatic light curves, **computation of the white light**
  4- correction of the duration of the exposure and absolute dating
  5- **jitter corrections** using medium resolution PSF

See

- **Both fields** (corrections applied in the following order after specific seismo and exo corrections)
  1- Correction of relativistic aberration via the modification of the focal equivalent to the dilatation (resp contraction) of the field of the of view
  2- Detection of energetic particle impacts : a point is considered as an impact when the difference between the signal and the median calculated on a sliding window is higher then 5 σ. Data are not modified at that step, a warning is included in the data
  3- Orbital events are indicated taking into account the absolute date of the data : SAA, inbound and outbound Earth eclipses

N1 - N2 pipeline

- Both seismo and exo data :
  - Translation from UTC to heliocentric time basis
  - The diminution of the quantum efficiency will be compensated
  - The effect of the changing of the CCD temperature will be corrected

- Seismo data
  - Resampling from a 1s basis to a 32s (raw)
  - Resampling to regular heliocentric time basis (hel)
  - Elimination of the discontinuity due the the changing of the on-board mask (helreg)
- Exo data,
  - Merging of 512s and 32s files
  - Hot pixels are detected and flagged
  - Creation of a 'windescriptor' file containing an extraction of the on-board full image, the size of the on-board mask and some useful information about the observed target.

N2 seismo data status

bit 0	« false »	(0)	The data are valid flux measurement
bit 0	« true »	(1)	The data are considered as out of range (*e.g.* energetic particle impact or glitch). Corresponds to OVER=1 in N1 products
bit1	« true »	(2)	The data is invalid. Either the original value was a spare value (default value) or no images were accumulated (EXPORANK=0). Corresponds to OVER=2 in N1 products
bit2	« true »	(4)	Flux acquired when crossing SAA
bit3	« true »	(8)	Interpolated measurement
bit4	« true »	(16)	Discontinuity detected in the Light Curve
bit5	« true »	(32)	Discontinuity due to change of CCD mask
bit6	« true »	(64)	Flux extracted from imagette
bit7	« true »	(128)	New hot pixel detected
bit8	« true »	(256)	At the time of the data, the satellite was entering earth penombra (orbital event 3 : light to penombra transition). Corresponds to OVER=8 in N1 products
bit9	« true »	(512)	At the time of the data, the satellite was entering light (orbital event 6 : penombra to light transition). Corresponds to OVER=16 in N1 products
bit10	« true »	(1024)	The jitter excursion was greater than the maximum authorized value. The original value is replaced by a calculated value. Corresponds to OVER=32 in N1 products

N2 exo data status

Type: unsigned long integer (32 bits)

bit0	« false »	(0)	The data is a valid flux measurement
bit0	« true »	(1)	Cosmic event detected by the N0-N1 pipeline
bit1	« true »	(2)	Spare value detected by the N0-N1 pipeline
bit2	« true »	(4)	Flux acquired when crossing SAA (N0-N1)
bit3	« true »	(8)	Flux perturbed by Earth eclipse (inbound)
bit4	« true »	(16)	Flux perturbed by Earth eclipse (outbound)
bit5	« true »	(32)	Flux acquired when crossing SAA (N1-N2)
bit7	« true »	(128)	New hot pixel detected
bit10	« true »	(1024)	Flux flagged as an “incorrect value” by the flight s/w (VALIDFLUX=1, when applicable)
bit11	« true »	(2048)	Flux flagged as an “incorrect value” by the flight s/w (VALIDFLUX=2, when applicable)

Distributed seismo data

Run	co-Is version	Corrections
IRa01	1.0	Cross-talk corrections using ground-measured patterns The correction of the offsets and of the Backgrounds are improved from these on-baord Rough jitter correction : the line of sight is continuous by segments
LRc01 ; SRc01	1.1 ; 1.2	PSF are computed with better parameters Gain is correctly taken into account (the gain is different for each half-CCD)
LRa01 ; SRa01	1.3 ; 1.4	The values of the different gains on different half CCD is taken into account on every different product Better jitter correction : the excursion is computed continually on the whole run
SRc02 : SRa02 ; LRa02	1.8	Correction of the discontinuity caused by the breakdown of DPU1, also on the datation of the data Warning on the data where the jitter excursion can't corrected ; in this case, the value is interpolated Correction of minor bugs on the STATUS word (valid/invalid data)
LRc02 ; LRc03 ; LRc04	1.9 ; 2.1	Incorporation of the flag for inbound and outbound of the earth eclipses
LRa03 ; SRa03 ; LRc05 ; LRc06 ; SRa05	3.0	SAA and earth eclipses flags are coherent between N1 and N2 pipe-lines Only positive impacts are marked (instead of positive and negative) **The effect of the diminution of the quantum efficiency is corrected**
LRa05 ; LRc07 ; LRc08 ; SRa04 LRa04 : LRa06 ; LRc09	3.1 ; 3.2 3.3	**New jitter correction : the relativistic aberration is taken into account through the variation of the focal of the telescope** The changes of the temperatures of the CCDs are corrected

Distributed exo data from on-board lightcurves (EN2_STAR)

Run	co-Is version	Corrections
Older versions, not to be used any more	1.1	Cross-talk corrections, offset substraction, backgrounds subtraction. Very rough jitter correction on chromatic light-curves No jitter corrections on mono-chromatic light-curves
	1.2 1.3	Gain is correctly taken into account (the gain is different for each half-CCD) Lacking information is added in the headers of the file
	1.4	Incorporation of the flag for inbound and outbound of the earth eclipses Correction of the discontinuity caused by the breakdown of DPU1
	2.0	**White Flux is computed on CHROMatic light curves by adding the 3 "colors"** **New calculation of the line of sight based on the computation of the PSF**
IRa01 LRc01 SRc01 LRa01 SRa01 SRc02 SRa02 LRa02 LRc02 LRc03	2.1 2.1b	SAA and earth eclipses flags are coherent between N1 and N2 pipe-lines Only positive impacts are marked (instead of positive and negative)
LRc04 LRa03 SRa03 LRc05 LRa05 LRc07 LRa04 LRc06 LRc09	2.2	Better PSF determination due to hot pixel elimination before calculation
SRa05 SRa04 LRc08	3.0	**New jitter correction : the relativistic aberration is taken into account through the variation of the focal of the telescope**
LRa06 SRc03	3.1	The correction of the jumps of the CCD temperature is applied after the correction of the loss of global efficiency.

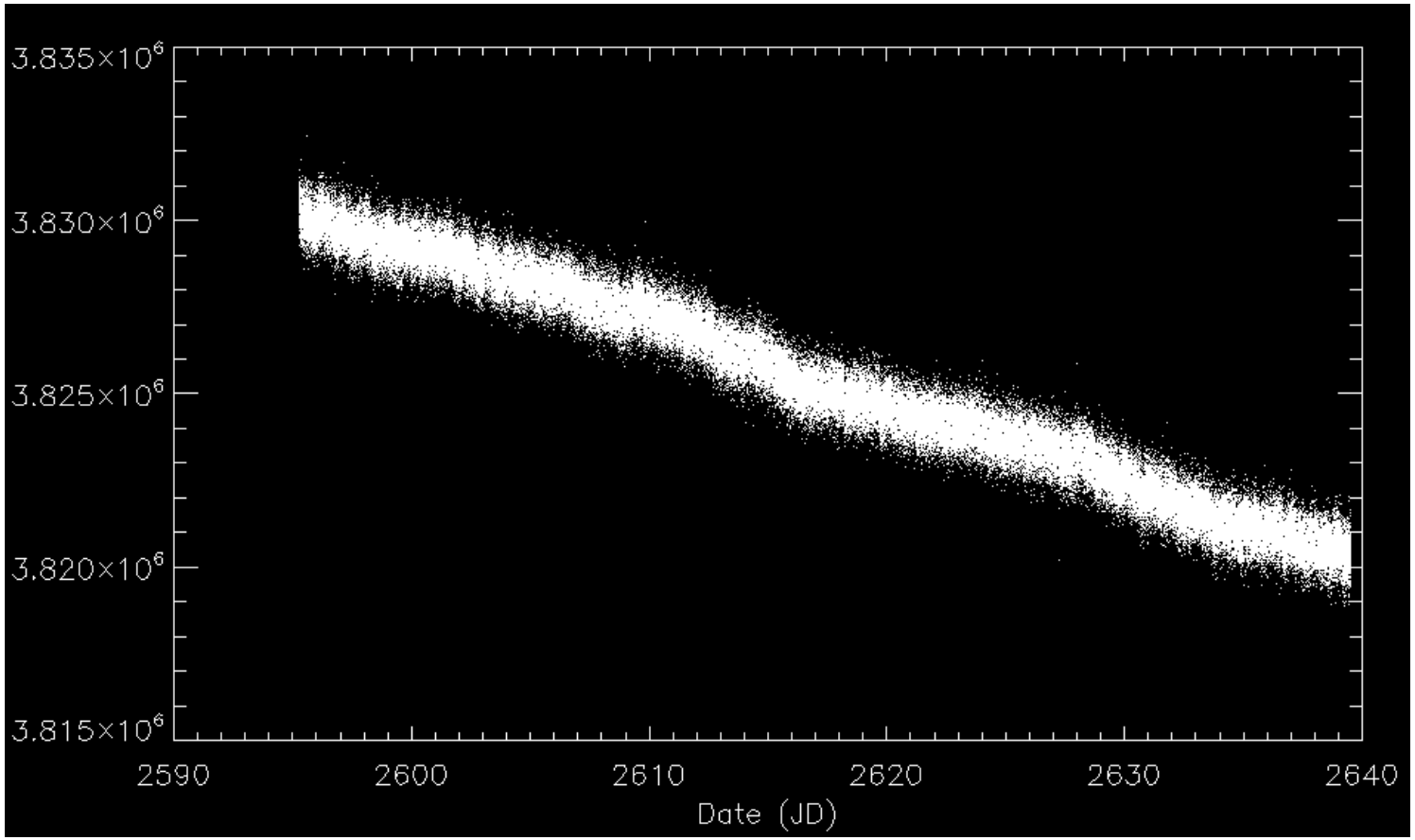
Distributed exo data from on-board imagettes (EN2_STAR_IMAG)

Run	co-Is version	Corrections
IRa01 SRc01 LRa01 LRc02 LRa02	1.0 1.0b 1.1	Calculation of light curves from on board imagettes. The cross-talk is corrected, the offset subtracted, as well as the background. The algorithm is based on the determination of a significant mask The reconstruction is performed using the LOS.
LRc01 SRa01 SRc02 SRa02 LRc03 LRc04 LRa03 SRa03 LRc05 LRc06 LRa04 LRa05 LRc07 SRc03 LRc08 SRa04 SRa05 LRa06	1.2	Improvements of the STATUS word and of the position of the orbital events Information in WINDESCRIPTORs are read directly from Ecocat via aweb service
LRc09	2.0	**Major change : the centroid of the spread image is calculated and its coordinates are given in two new columns** Improved corrections of the jitter The jumps of the CCD temperature are corrected ; their date and the quality of each correction is given in the primary header. The global loss of efficiency is corrected (TBC) The number of pixels of the reconstructed colours contain are integers
	2.1	To be implemented : better background corrections including the level of the dark current according to the position of the star

Evolution of the pipelines

- Ageing of the instrument
  - Loss of detection chain efficicency due to radiation (decrease of flux with time
  - Charge transfer inefficiency
  - Increase of the dark current
  - Effect of temperature variation

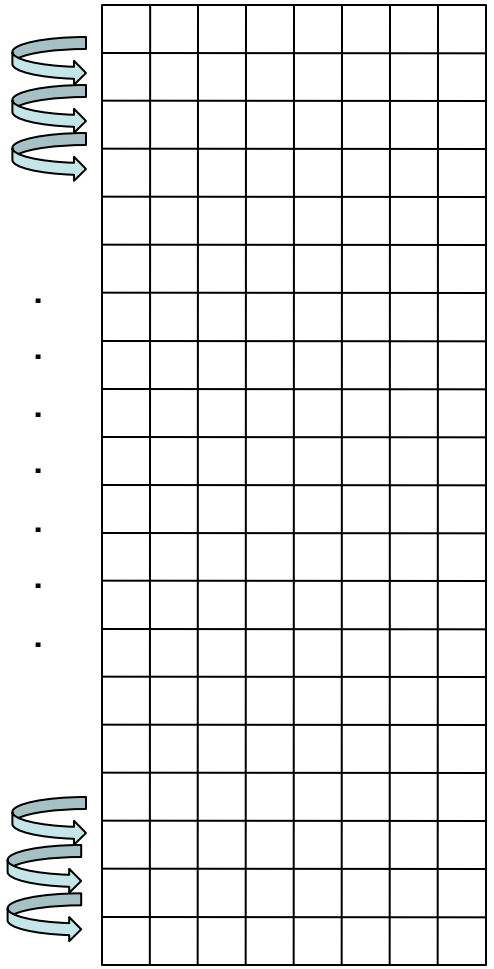
Loss of detection chain efficiency



Cf. Alexis Deru's talk

Charge transfer inefficiency

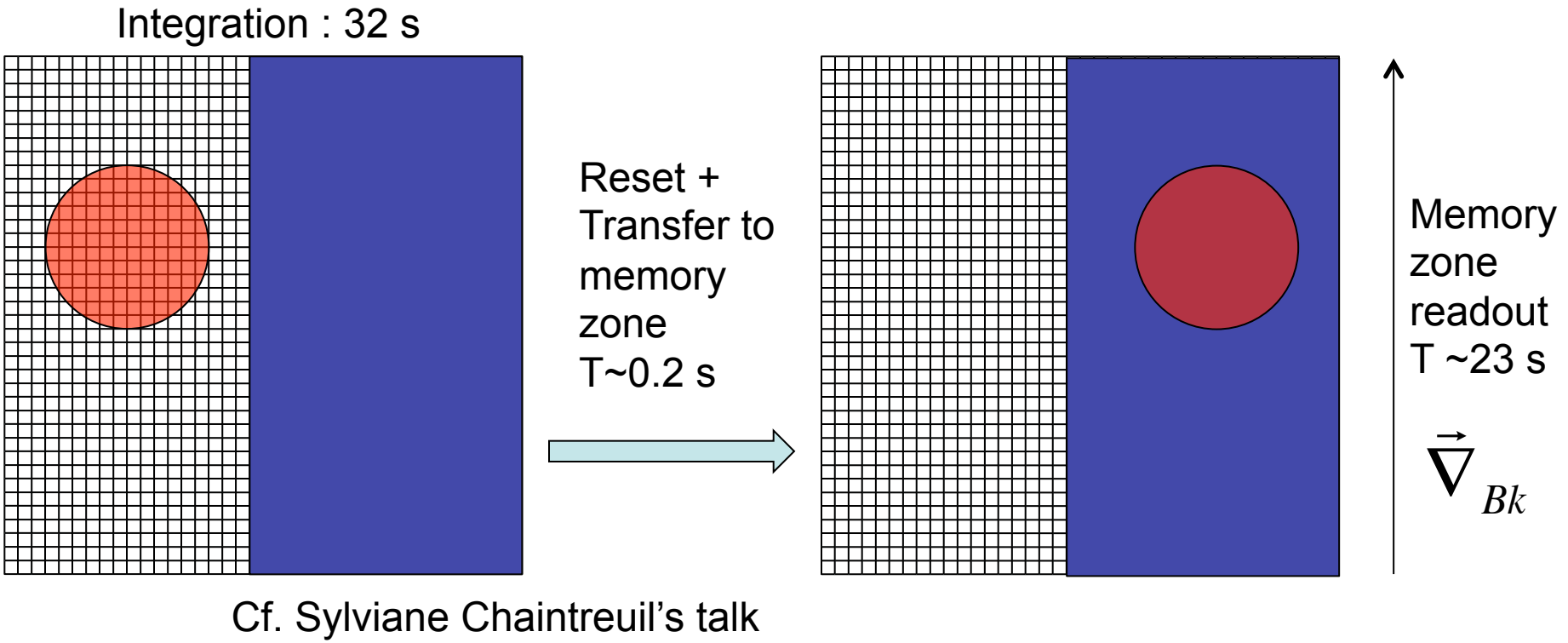
- CTI = 1-CTE
- CTI= 10^{-4} for STIS (HST) after 7 years at alt = 500 km
- Loss of about 10% max of the e- during the readout process, i.e 0.11 mag for a 1K CCD
- Strongly depends on the detector type and the instrument altitude
- Cannot be seen on the CoRoT star windows
- Cannot be seen on the CoRoT background windows



Dark current

- Negligible at CoRoT's launch
- Increase with time (and radiation exposition)

A slope appears on the background due to the readout time



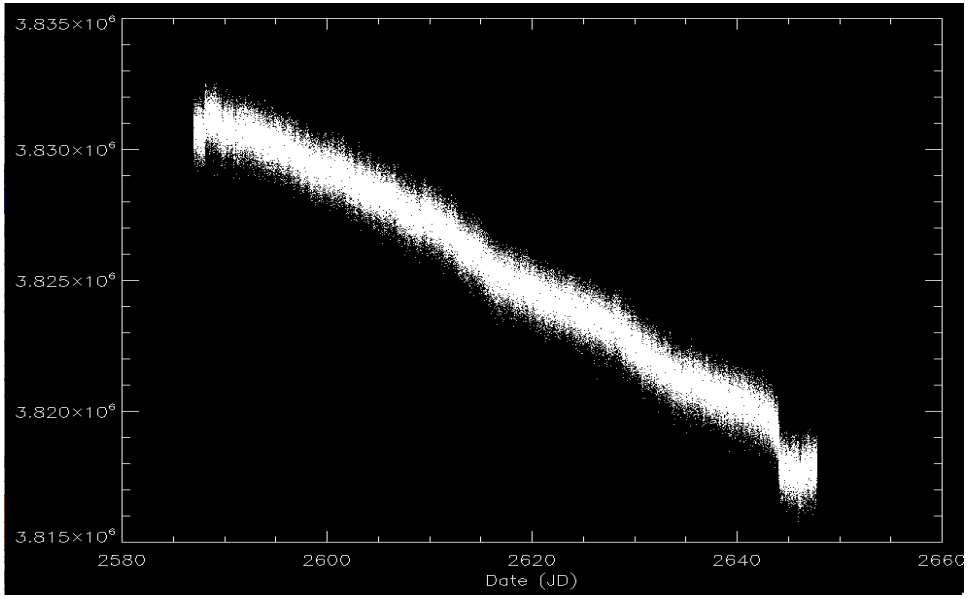
Cf. Sylviane Chaintreuil's talk

Effects of the temperature

- An increase of T lead to an increase of the thermal motion
  - The dark current increases with T
  - The quantum efficiency increases with T
- Need to correct the lightcurve from the variations of T
- Evolution of T correction with time.
- Cf. Sylviane's talk.

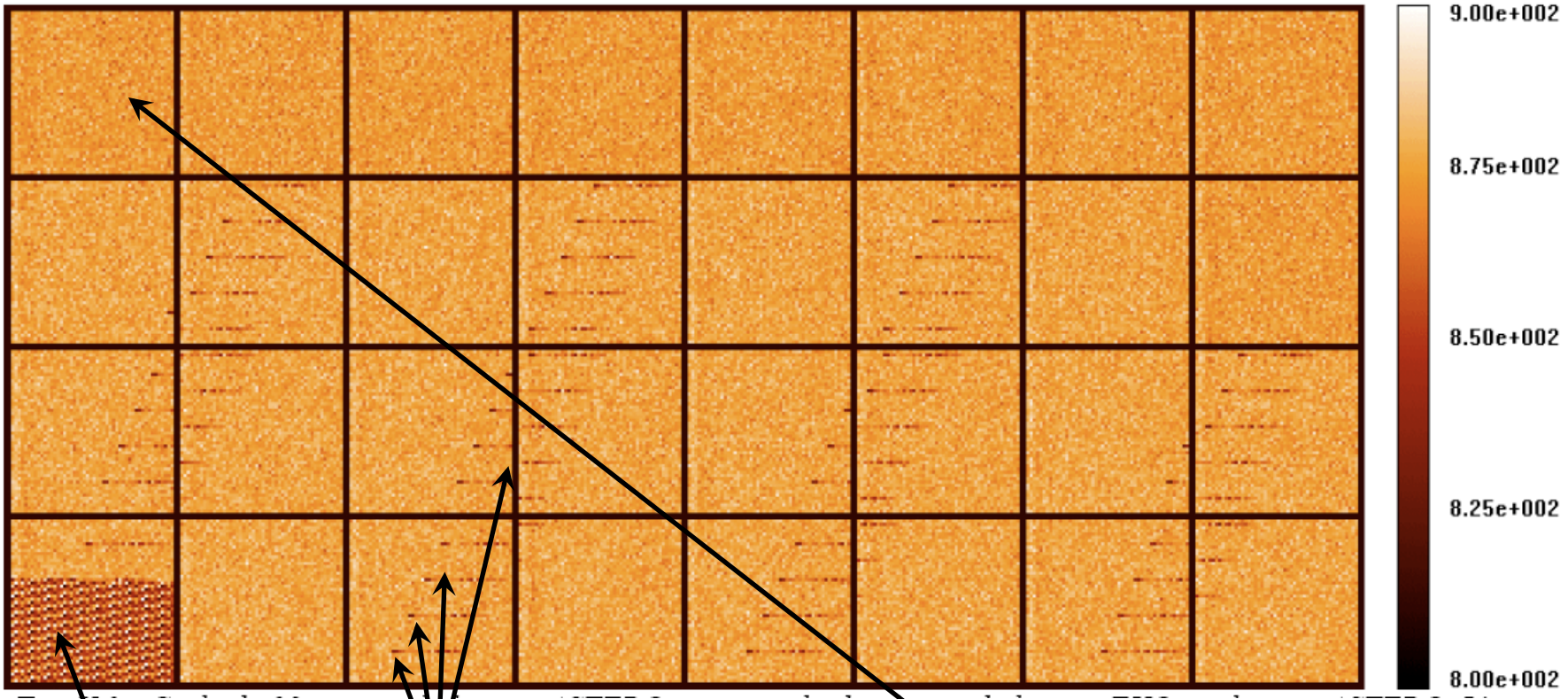
Evolutions of the pipeline and future work

- Seismo data : correction of flux increase at the beginning of a run



- Test of data process robustness on seismo and exo data
- Creation of a new level of correction on exo data for seismo use (to be discussed
- Your input …

Influence of exo process on seismo CCD



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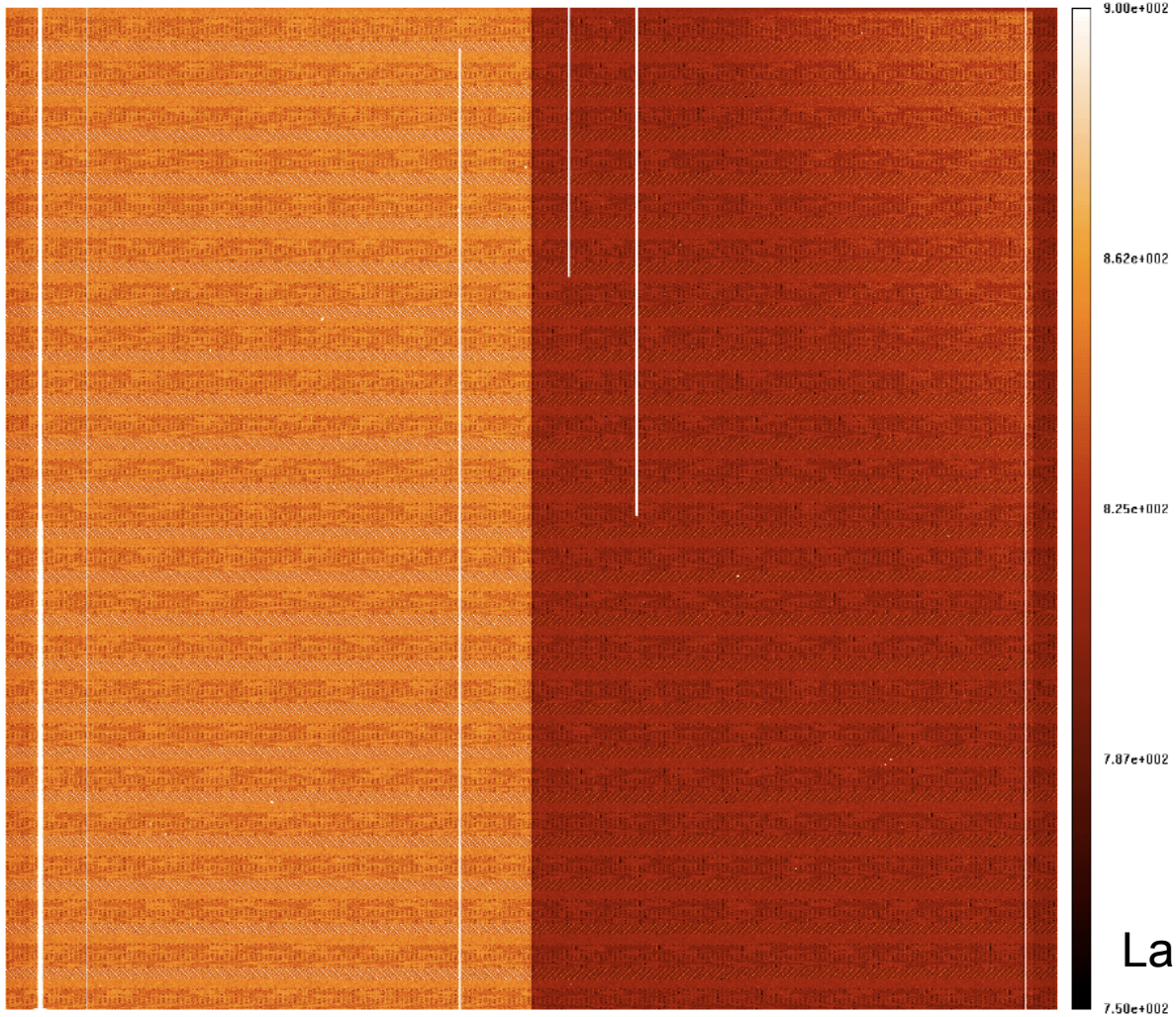
Influence of the seismo process on the exo CCD



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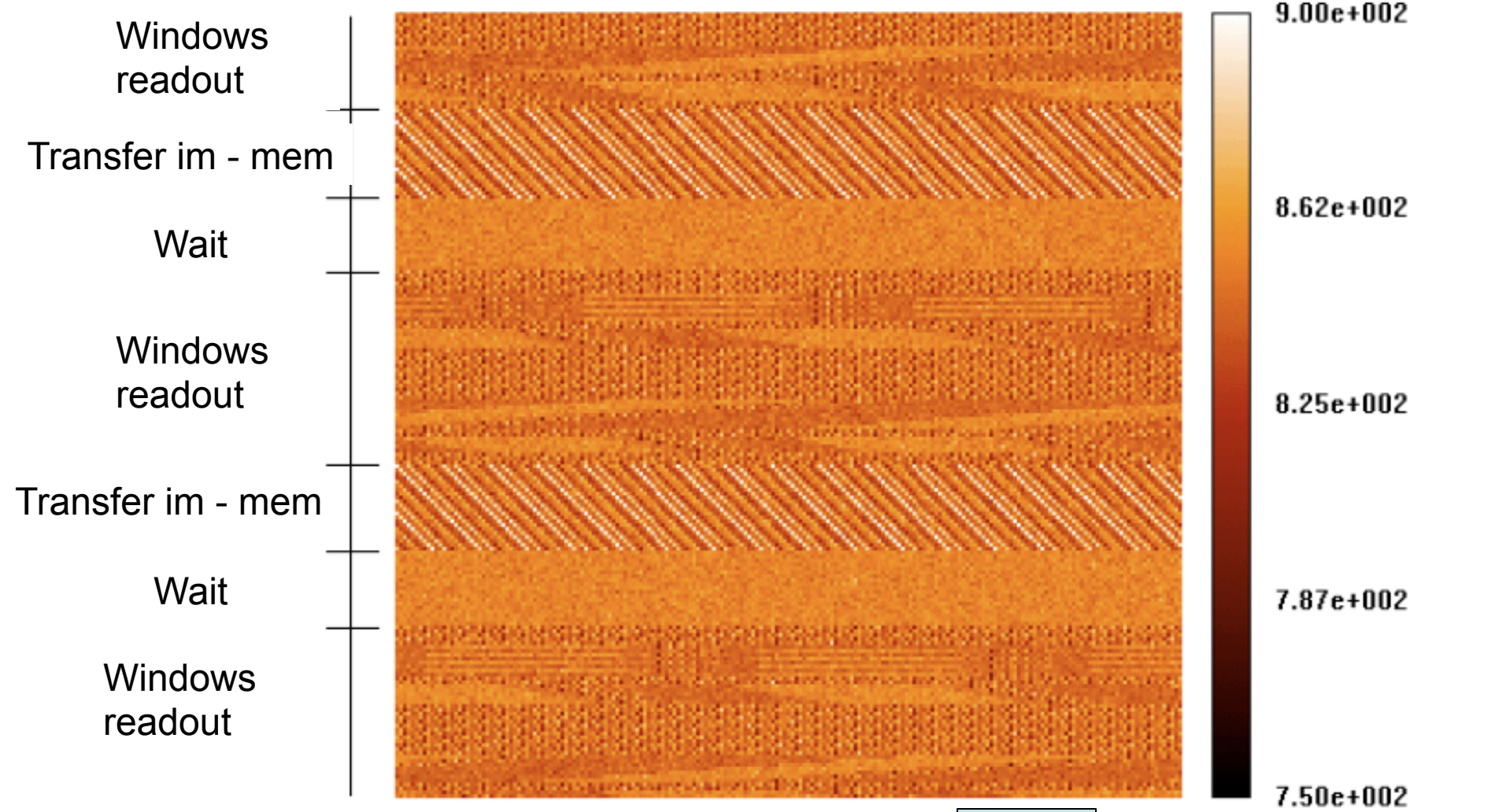
Influence of the seismo process on the exo CCD (2)



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