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6th Sentinel2 validation team Meeting
ESRIN, 12-14/09/2023

InterDetector Management for Copernicus Sentinel2 L1C products

Emmanuel Hillairet [1], Silvia Enache [1], Sébastien Clerc [2], Antoine Burie [1],
Rosario Quirino Iannone [3], Valentina Boccia [4], Ferran Gascon [4]

(1) CS Group, Toulouse, France
(2) ACRI-ST, Sophia-Antipolis, France
(3) Rhea Group, Frascati, Italy
(4) European Space Agency, ESRIN, Frascati, Italy

6th S2VT meeting : Interdetector Management

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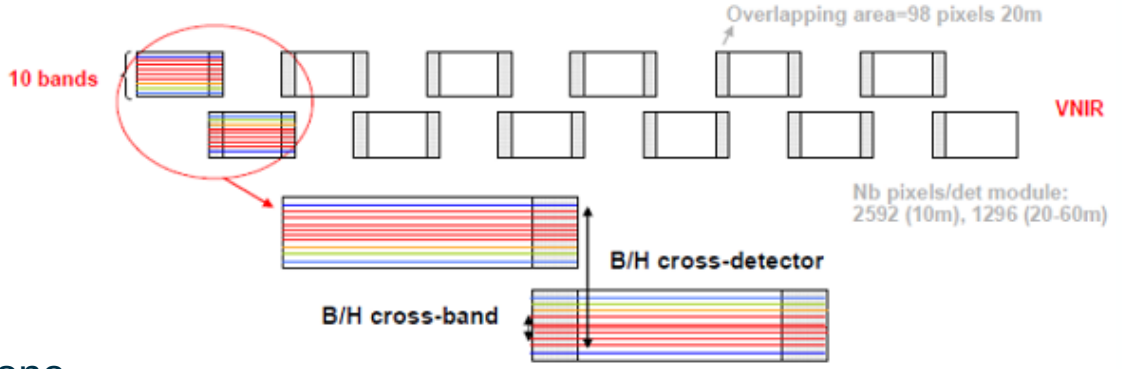
OUTLINES :

- Role and history of the interdetector management
- Issues of the actual strategy
- New proposed strategy
- Simulated results
- Conclusions, and way forward

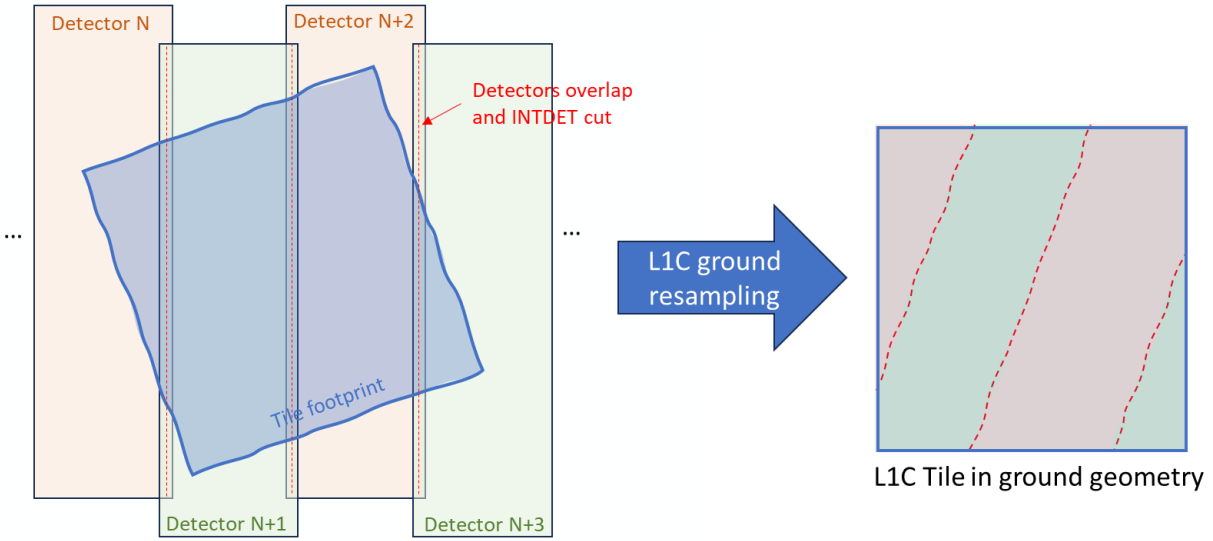
Role of INTDET parameter in the L1C reprojection algorithm :

- VNIR and SWIR focal planes of S2 MultiSpectral Instrument (MSI) are made of 12 staggered detectors with overlap between detectors :



- **GIPP INTDET :** processing parameter (one for each band) to decide, for each L1C pixel, from which L1B detector it is coming.
  It solves the ambiguity on the overlap area, defining a deterministic **sew line**.

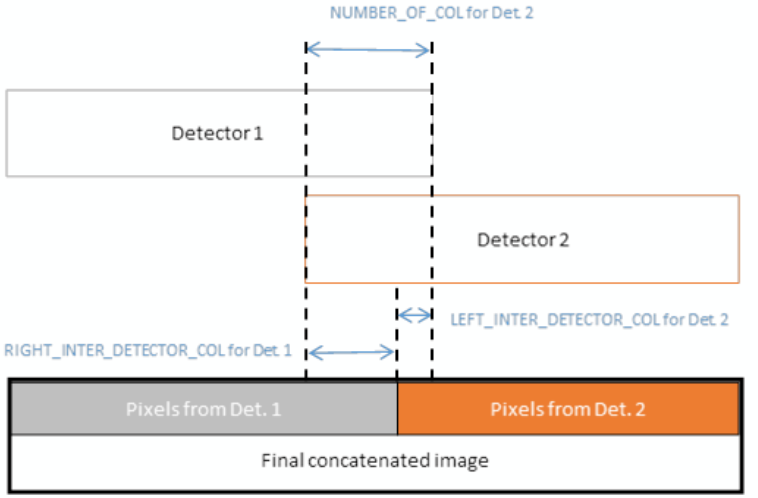
- **L1C DETFOO mask** is giving the detector origin of each L1C pixel, for each band.



L1B focal plane geometry

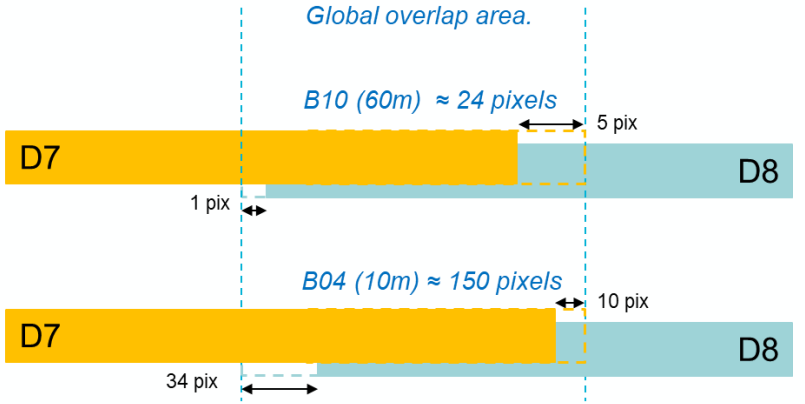
History :

- **Historical CNES GIPP** (statically computed from viewing directions)
  Used in Ground Processing Prototype (for In orbit Test)
  Fully ballanced : RIGHT_INTER_DETECTOR_COL for Det N = LEFT_INTER_DETECTOR_COL for Det N+1
  Computed independantly for each band.



- **Upto end 2021 : Mismatch in IPF code :** the CNES GIPP was not properly applied
  Always pixels from left detector are used in the overlap (until right border of the detector)

- **From 2022 (and all products from Collection1) : Modification of the strategy**
  MPC Modification of the GIPP to optimise the sew line thickness :
  ⇒ But impossible to « statically » cut all bands in the same place in L1C
  ⇒ Actual GIPP discards some columns at right border of the detector,
  but cut is still not fully balanced between left/right detectors.



Schema for actual GIPP management on some bands.

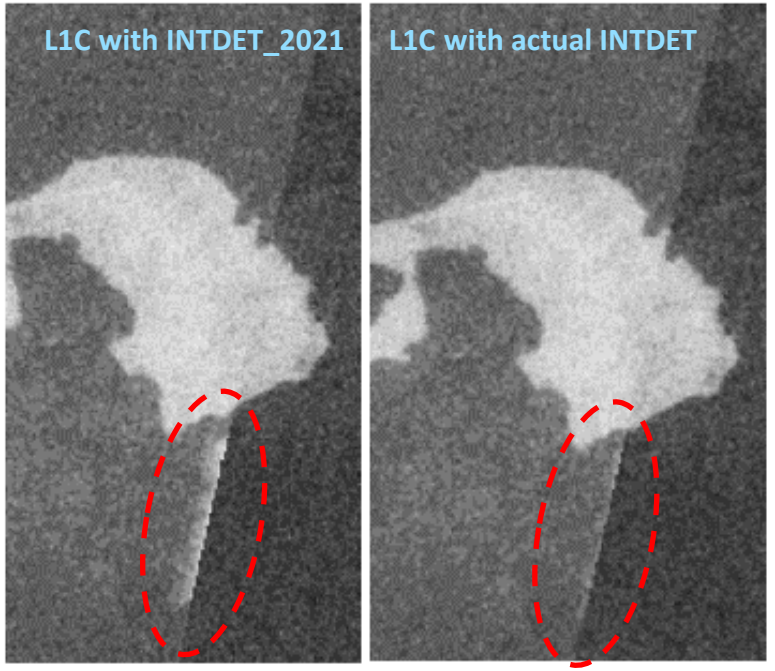
Analysis of the actual Strategy : issues revealed by not well-balanced strategy.

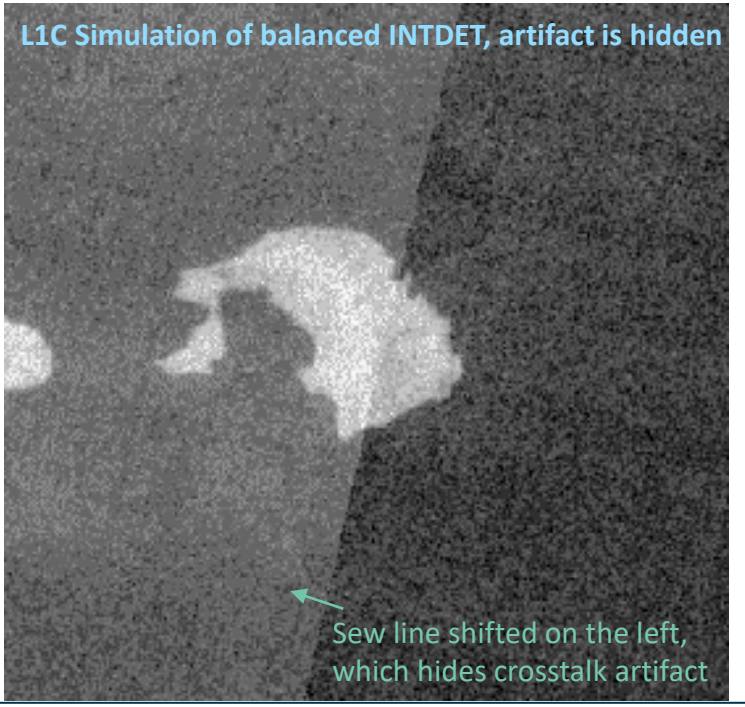
- Some radiometric artifacts may appear at borders of each detectors :
  - Column dependant crosstalk, difficult to modelize,
  - Artifacts in the spectral responses,
  - …

⇒ *Artefacts are often known, but difficulties to modelize an accurate correction or to apply it (time consuming algorithms)*

⇒ Recovering a better balanced strategy for the Interdetector management will hide part of these artifacts in L1C.

(example of B11 to B10 inaccurately modelized crosstalk at border of detector)





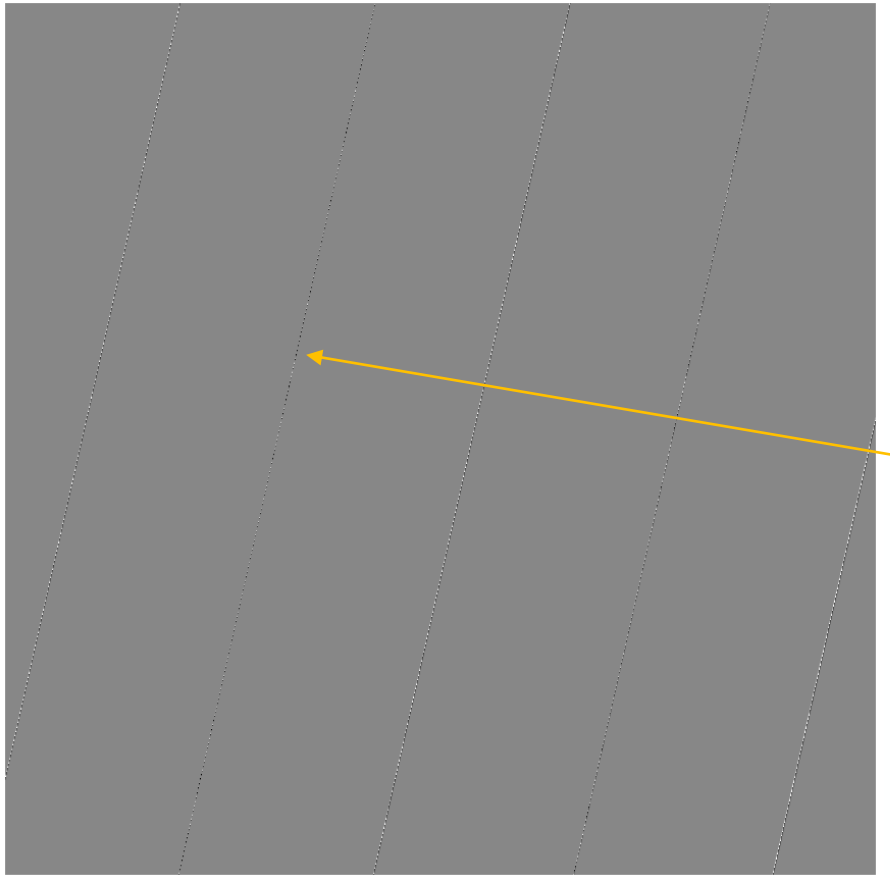
Analysis of the actual Strategy : Notion of “sew-line thickness”.

- **Notion of sew line thickness in L1C :**

  The width of the L1C area in which all the bands are not coming from the same L1B Detector

  Sew line is graphically estimated from DETFOO masks using a reference band (Bref)

Charm El Cheik : T36RXR_20220917 S2B (whole tile and extract)



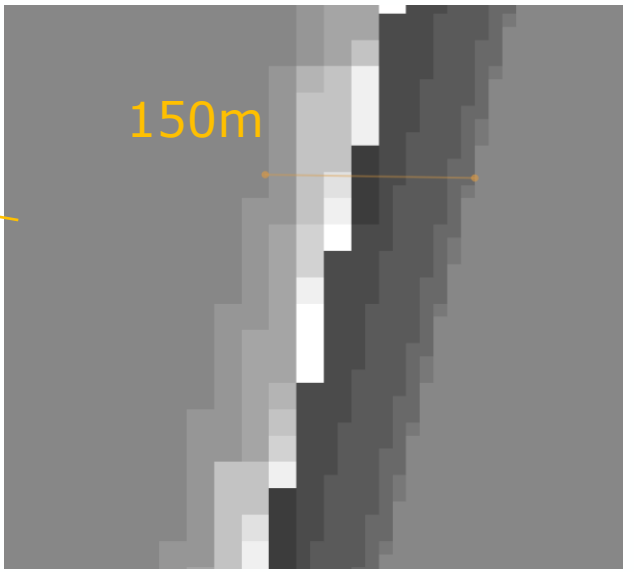
Pixel for which major part of bands come from detector index > index of Bref

...

Pixel for which all bands come from same detector

...

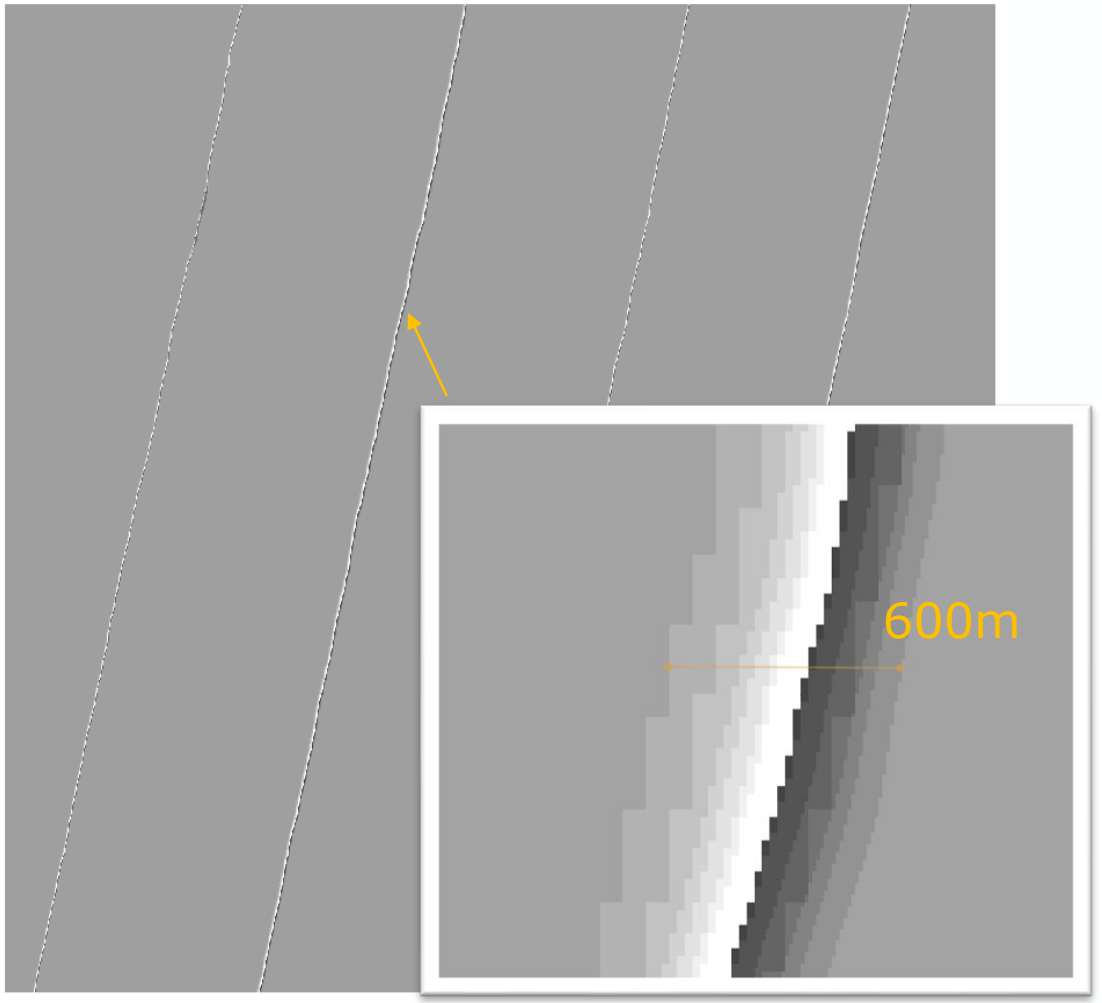
Pixel for which major part of bands come from detector index < index of Bref



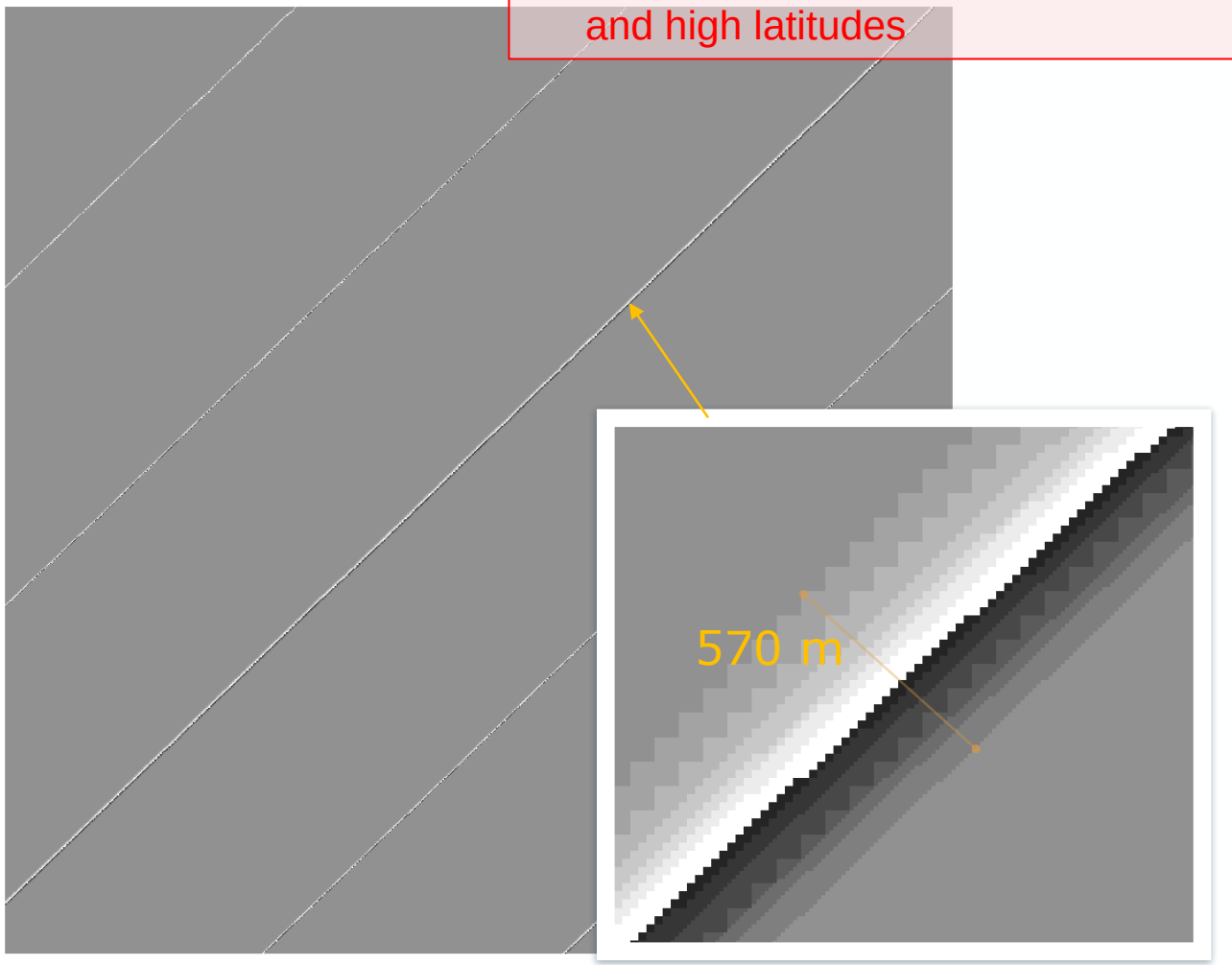
Analysis of the actual Strategy : Notion of “sew-line thickness”.

- Sew-line wider for S2A (vs S2B)
- Worst cases on mountains and high latitudes

Himalaya (T36RXR_20220917 S2A)



Svalbard S2A (T33XVH)



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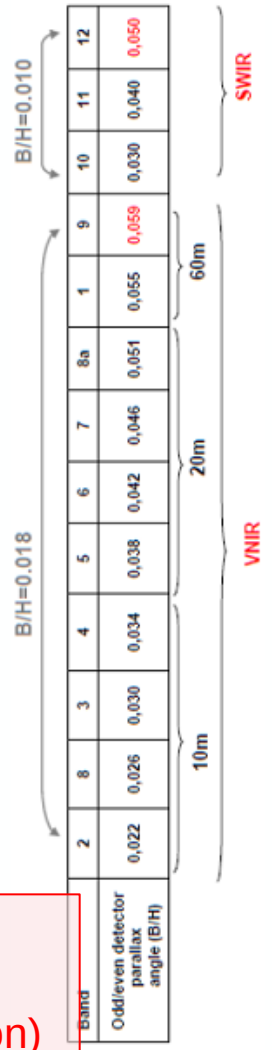
Analysis of the actual Strategy : Inconsistencies in the sew line area

Strong inconsistencies between bands of the same pixel in the sew-line area, in terms of :

- Time of acquisition, solar angles
- Viewing angles : strong parallax (stereoscopic) effect between bands

	B01	B02	B03	B04	B05	B06	B07	B08	B8A	B09	B10	B11	B12
B01		16,5	12,5	10,5	8,5	6,5	4,5	2	14,5	2	12,5	7,5	2,5
B02	38,5		4	6	8	10	12	14,5	2	18,5	4	9	14
B03	42,5	26		2	4	6	8	10,5	2	14,5	0	5	10
B04	44,5	28	32		2	4	6	8,5	4	12,5	2	3	8
B05	46,5	30	34	36		2	4	6,5	6	10,5	4	1	6
B06	48,5	32	36	38	40		2	4,5	8	8,5	6	1	4
B07	50,5	34	38	40	42	44		2,5	10	6,5	8	3	2
B08	53	36,5	40,5	42,5	44,5	46,5	48,5		12,5	4	10,5	5,5	0,5
B8A	40,5	24	28	30	32	34	36	38,5		16,5	2	7	12
B09	57	40,5	44,5	46,5	48,5	50,5	52,5	55	42,5		14,5	9,5	4,5
B10	42,5	26	30	32	34	36	38	40,5	28	44,5		5	10
B11	47,5	31	35	37	39	41	43	45,5	33	49,5	35		5
B12	52,5	36	40	42	44	46	48	50,5	38	54,5	40	45	

*Table on stereoscopic effect between bands (B/H * 1000) in inter(yellow) and intra(blue) –detector configuration*



In the sew-line area :
- Possible strong visual rainbow effect over the clouds
- Generation of uncertainties and complexity in the L2 and user applications (sunglint correction, cloud detection)

New proposed strategy : implementation

To have a better balance between left and right detector

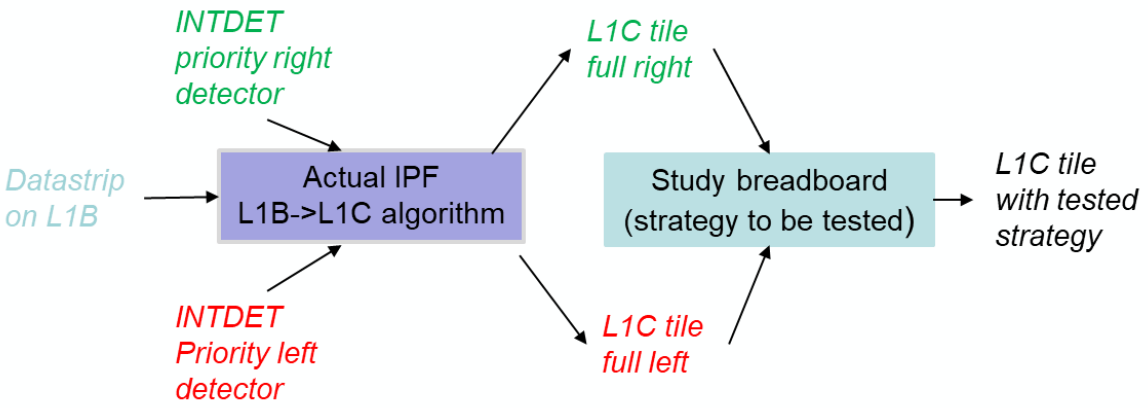
To ensure that, for each L1C pixel, all bands come from the same detector.

Choice of a Master band (60m band : B10 is a good candidate, the closest to the middle of the focal plane)

1. *The master band is resampled first, using a "balanced" INTDET GIPP, generating the master DETFOO*
2. *Then all the bands are resampled using the same master DETFOO*

⇒ New strategy is generating strong changes in the IPF L1C modules sequencing.

⇒ Thus, a "Study Breadboard" has been developed first (outside IPF) to prototype new results on L1C products. Breadboard is using IPF L1C output parameterized with INTDET GIPP prioritizing the left/right detectors.



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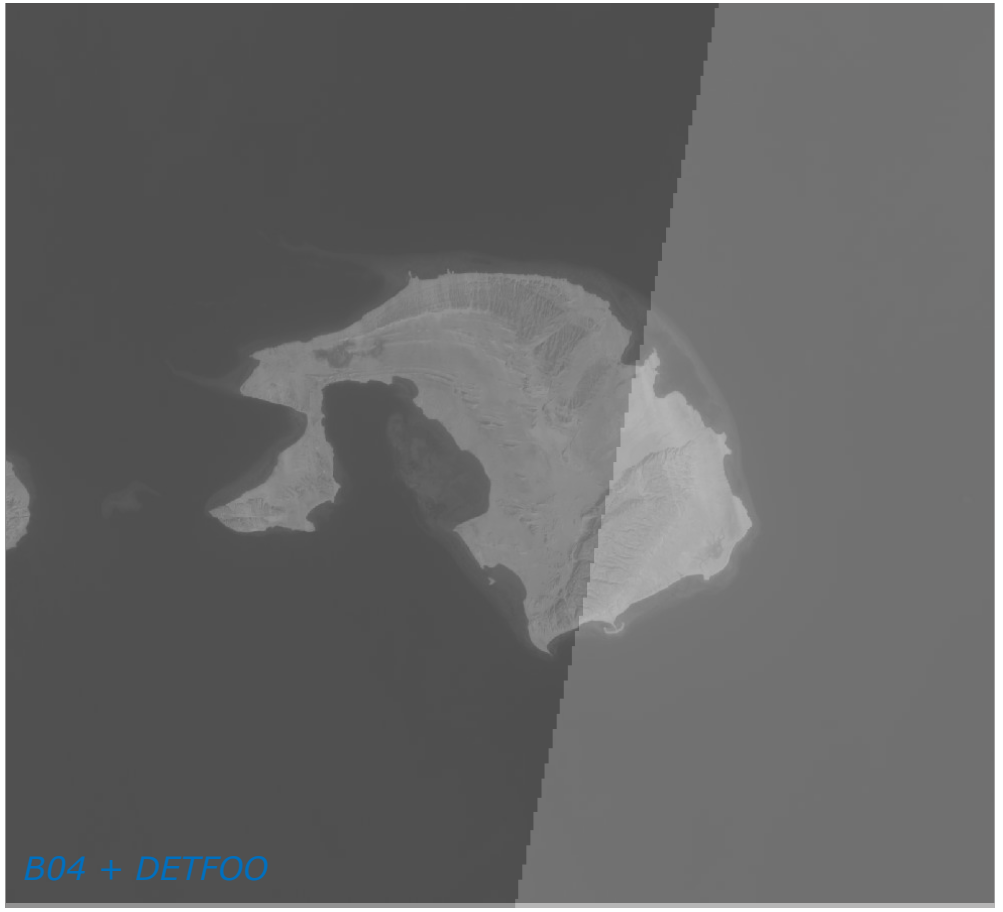
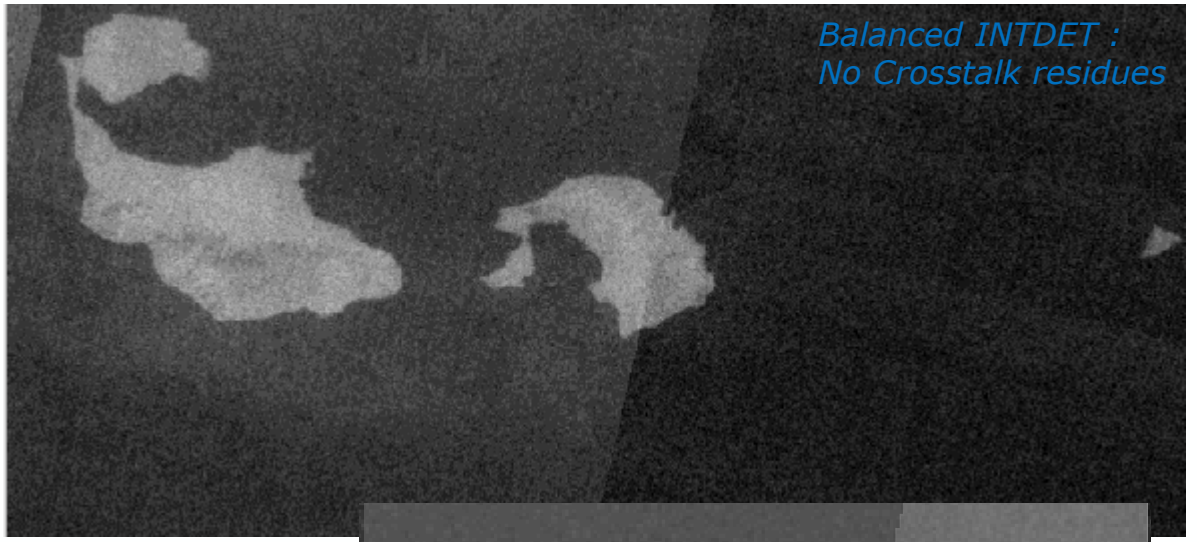
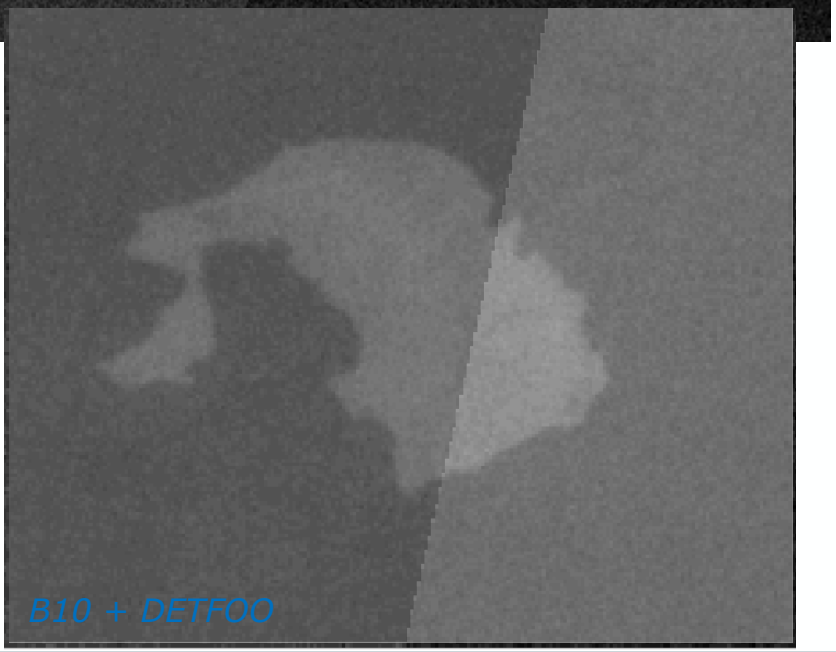
New proposed strategy: prototyped results

Charm El Cheik (B04 and B10)
with balanced INTDET and B10 as master DETFOO





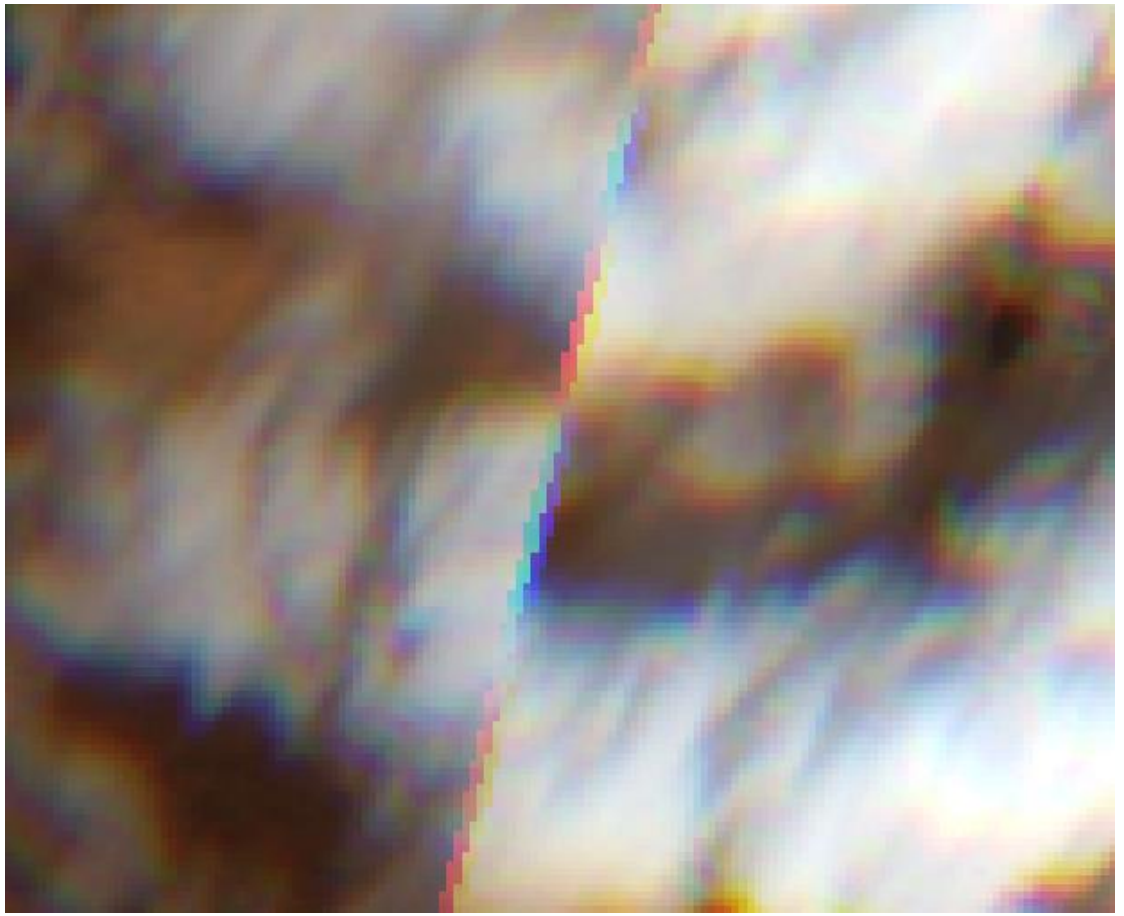


Images + DETFOO
in transparency.
=> All bands,
same sew line

New proposed strategy: prototyped results

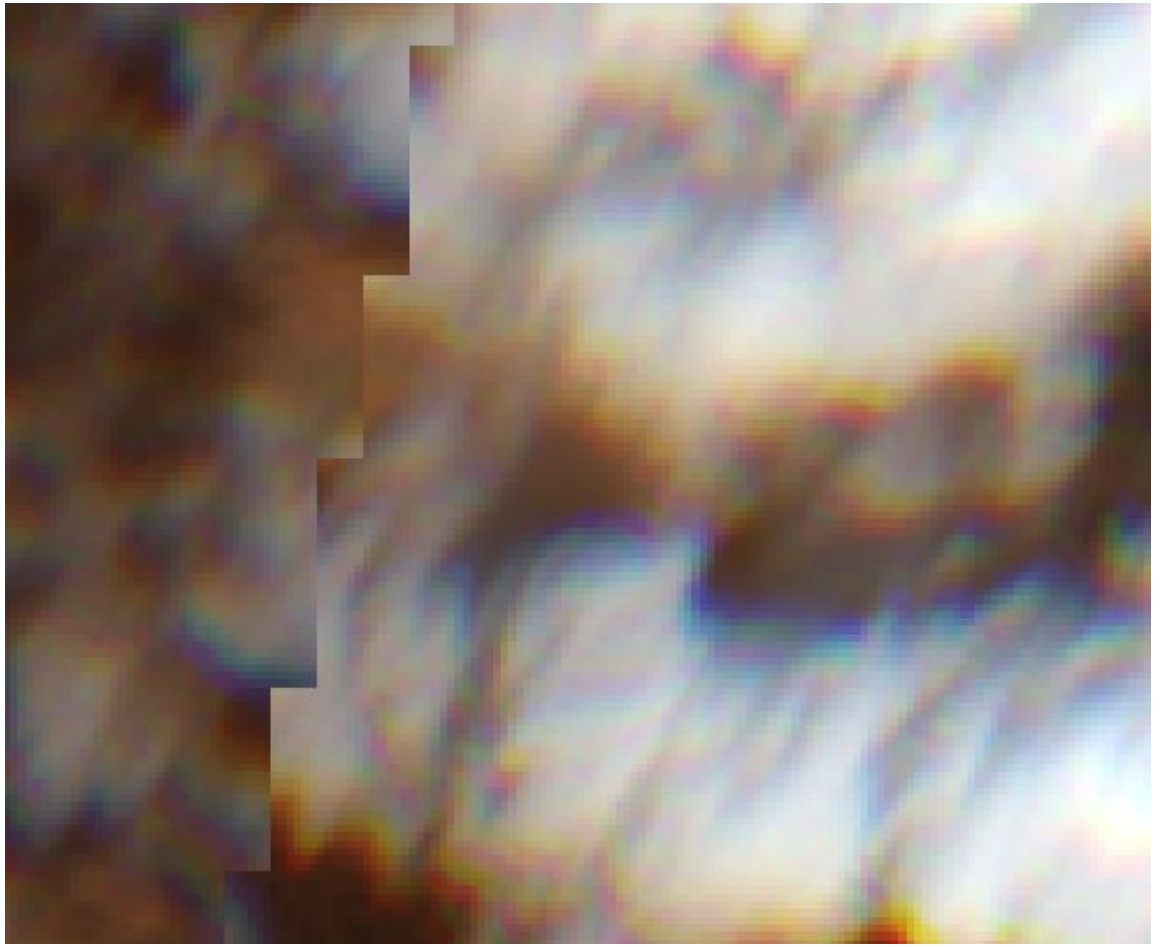
Actual product (collection 1) in True Colors on clouds

- *Strong rainbow effect at sew line*



Same acquisition area with new strategy

- *Rainbow effect disappear*
- *Still minimal rainbow/blur effect on cloud texture (inevitable)*
- *Crenellation visible at 10m (Master band shall be a 60m band)*



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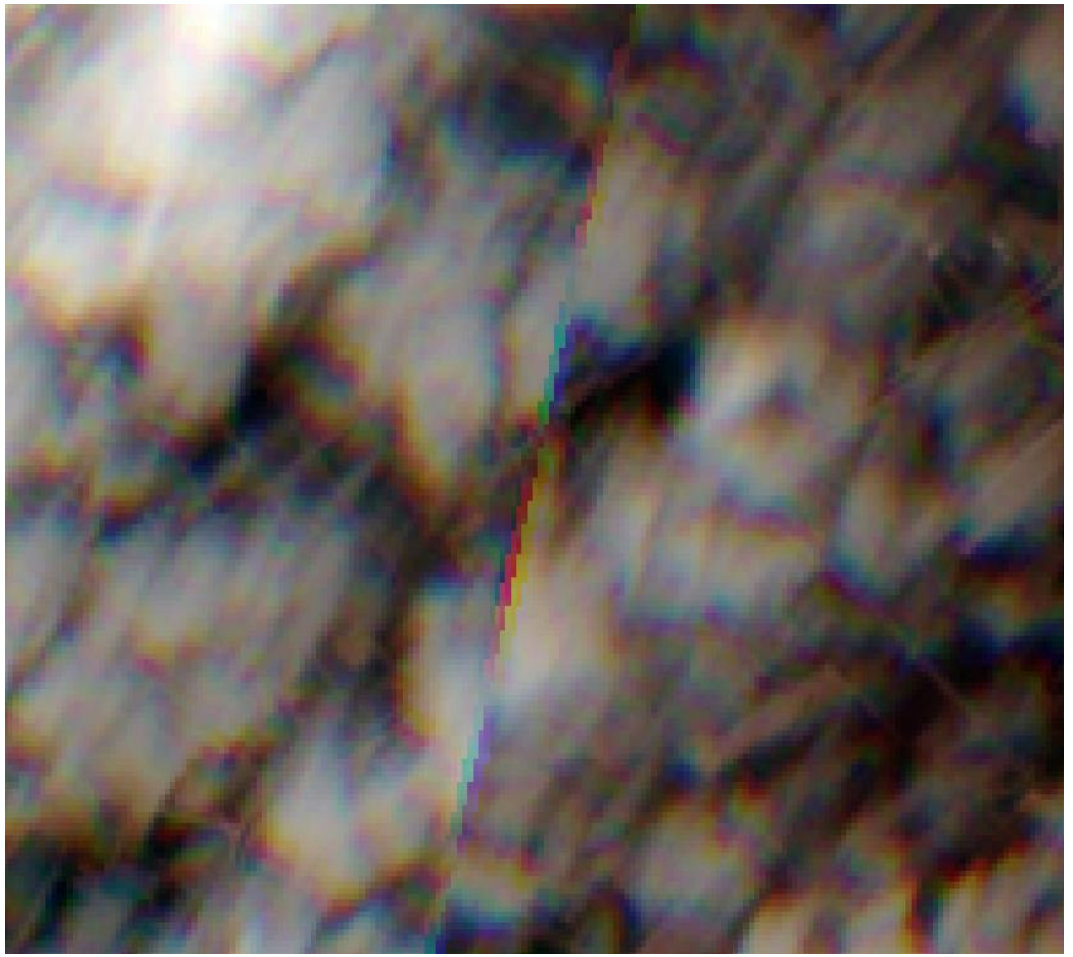

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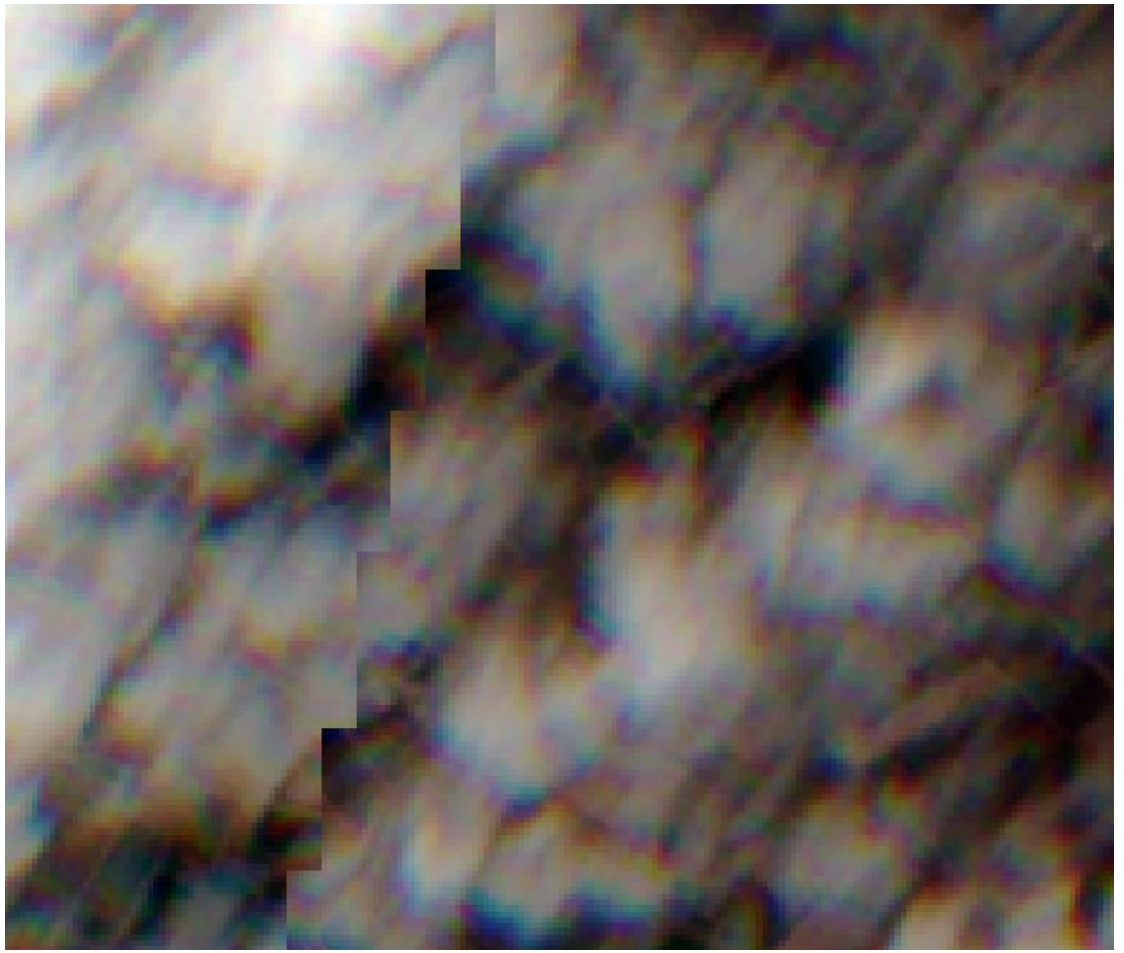

Conclusions :

New proposed strategy is considered of great interest :

- Balance between left/right detectors => reduce impact of artefacts at borders of detectors
- Same sew-line for all bands : no more strong parallax effects between bands
  => Helpful for L2 algorithms and user applications.
  => reducing rainbow artifacts on clouds.

Potential drawbacks to be assessed during end of study.

Way forward (under Opt-MPC responsibility):

- Test several situations (worst cases, with actual largest sew-lines).
- Study potential drawbacks.
- Implement new strategy in IPF prototype.
- Validate the new algorithm to be implemented in operational chains.

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Thank You

Emmanuel Hillairet,
CS-Group, OPT-MPC Team,
emmanuel.hillairet@csgroup.eu

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