SDC-IT
SGS Processing Functions integration and release

6° Meeting Euclid Italia - Roma – 19th January 2023

M. Frailis

on behalf of SDC-IT team

PF development and integration

- Performance verification rehearsal #1 preparation and deliveries (2 phases)
  - Increase the integration and maturity of NIR and SIR calibration pipelines (new or updated calibration pipelines)
  - More realistic simulated data and observation sequences (following the calibration framework)
  - External Operation team running all involved pipelines and requiring the operational user manual for each PF
  - Interaction with the IOT for each produced calibration product
- Provided releases: **NIR PF 2.1.1**, **SIR PF 3.0.0** (phase 1) and **3.0.2** (phase 2), **MER PF 9.0.1** (phase 1) and **9.0.2** (phase 2)
- PF data model updates for DM 9.1 (LE1, NIR, SIR, MER, LE3)

PF documentation

- Review and update of documents for the SGS Readiness Review, for each PF
  - PF Software Design Document (**SDD**)
  - PF Validation Plan and Software Test specification (**STS**), with the support from ALTEC
    - Consistency checks with the PF Requirements Specification Document (**RSD**)
    - Checking if clear validation criteria defined, if possible with True or False results
    - Checking the usability of the test scripts
  - PF Software Test Reports (**STR**), supported by ALTEC
  - SDC PA/QA report
- PF Software User Manual (**SUM**)
  - Documenting science pipelines and calibration pipelines
  - Pipeline interfaces (input and output ports)
  - Triggering criteria (per calibration block)
  - Estimate of hardware resources for each calblock (based on current profiling)

PF Data Quality Check pipelines

- Quick validation of groups of data products
- Common approach for NIR and SIR, first designed by D. Tavagnacco
- Contribution to the MER DQC

NIR Example

Quick analysis of NIR calibrated Frames images and catalogs from wide observations.

Test implemented:

1. RMS Astrometry under control
2. check number of objects in each dither
3. Checking the number of pixels flagged for each specific flavor, highlighting bad and invalid-flagged pixels
4. Photometry:
   a. check consistence of the two models
   b. verify behavior of PSF photometry
   c. check error magnitudes for faint/bright sources
   d. verification of the dynamical magnitude range

NIR DQC Report

Check Astrometry RMS

Description
Check the RMS of the Astrometry for all Calibrated Images of the PPO.
The acceptance treshold is set to 0.2 ArcSec. A value above this limit must be rejected.

	Filenames
Calibrated Images	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-0_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-1_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-2_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-3_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-4_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-5_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-6_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-7_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-8_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-9_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-10_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-11_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-12_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-13_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-14_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-15_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-16_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-17_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-18_01.xml
	EUC_NIR_SCIENCE_8_SIM-PV-023_R1_H_V003-cal_images_xml-19_01.xml

	AstIRms1 (mArcSec)	AstIRms2 (mArcSec)	AstRRms1 (mArcSec)	AstRRms2 (mArcSec)
RMS	20.72	20.75	22.17	22.05
	20.72	20.75	21.97	22.27
	20.72	20.75	22.14	22.46
	20.72	20.75	22.18	21.93
	20.72	20.75	21.95	22.17
	20.72	20.75	22.17	22.32
	20.72	20.75	22.22	22.10
	20.72	20.75	22.02	22.25
	20.72	20.75	22.47	21.60
	20.72	20.75	22.03	22.41
	20.72	20.75	22.03	21.98
	20.72	20.75	22.37	22.06
	20.72	20.75	21.99	22.07
	20.72	20.75	21.90	21.79
	20.72	20.75	22.08	22.41
	20.72	20.75	22.38	21.90
	20.72	20.75	22.15	22.06
	20.72	20.75	22.08	21.99
	20.72	20.75	22.09	21.90
	20.72	20.75	21.94	22.19

Results
No value above the threshold 0.2 ArcSec for the Astrometry RMS.

PF software maturity evaluation

- Software Maturity Level evaluation completed for NIR, SIR and MER (LE3 was already OK)

NIR PF ML: ML3A
Science: ML3A
Technical/Interfaces: ML3A
Quality: ML3A with actions

SIR PF ML: ML3A
Science: ML3A
Technical/Interfaces: ML3A
Quality: ML3A with actions

MER PF ML: ML3A
Science: ML3A
Technical/Interfaces: ML3B
Quality: ML3A

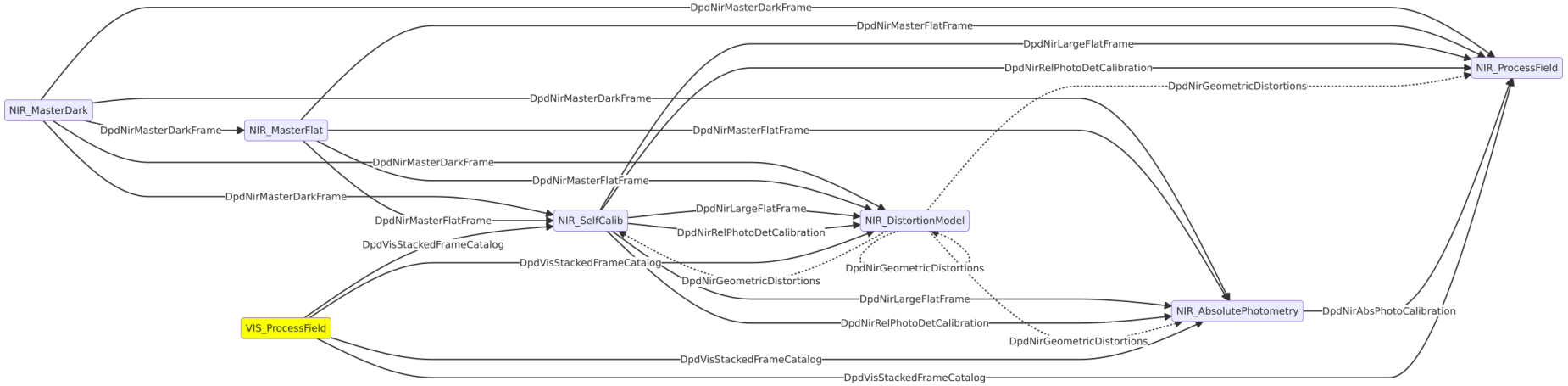
Science
* science needs (requirements)
* scientific validation

Technical/Interfaces
* Data Model
* Internal interfaces
* software design
* technical validation
* compatibility to Euclid Environment

Quality
* Documentation Quality
* Code Quality

NIR PF for PV Rehearsal 1 tests

NIR calibration and science pipelines dependency graph



CALBLOCK	NIR PF Pipelines	Comment
CALBLOCK-PV-001	NIR_SelfCalib, NIR_ProcessScience	Self-calibration field
CALBLOCK-PV-002	NIR_AbsolutePhotometry	Photometric standards
CALBLOCK-PV-006	NIR_ProcessScience_background	Background model
CALBLOCK-PV-010	NIR_MasterFlat	NISP LED flats
CALBLOCK-PV-012	NIR_MasterDark	Dark current
CALBLOCK-PV-023	NIR_ProcessScience	Dense field

NIR PF resources

Wide field science processing

Executable name	Cores	RAM (GB)	Walltime (hours)
NIR_runInitialize	1	< 2	< 1
maskBadpixels	1	< 2	< 1
maskSaturation	1	< 2	< 1
correctNonlinearity	1	< 3	< 1
darkSubtraction	1	< 3	< 1
NIR_cr_rejection	1	< 2	< 1
NIR_apply_flat_field_correction	1	< 3	< 1
NIR_Apply	1	< 3	< 1
NIR_estimate_background	1	< 2	< 1
NIR_PSFModelling(dither)	1	< 2	< 1
NIR_DoastromProgram	1	< 3	< 1
NIR_calculate_relative_exposures	1	< 2	< 1
NIR_apply_relative_calibrations	1	< 2	< 1
NIR_ApplyAbsolutePhotometry	1	< 2	< 1
NIR_mask_gscl	1	< 3	< 1
DitherCatalogExtraction	1	< 2	< 1
NIR_DoresamplProgram	1	< 3	< 1
CrRejectMulti	1	< 4	< 1
NIR_DostackProgram	1	< 5	< 1
StackedCatalogExtraction	1	< 6	< 1
NIR_CreateScientificDpds	1	< 6	< 1

Workdir size < 80 GB
Total walltime 1 hour

Self-cal field science processing

Executable name	Cores	RAM (GB)	Walltime (hours)
NIR_PSFModelling(dither)	1	< 3	< 3
NIR_DoastromProgram	1	< 3	< 2
NIR_calculate_relative_exposures	1	< 20	< 9
NIR_DoresamplProgram	1	< 4	< 3
CrRejectMulti	1	< 5	< 6
NIR_DostackProgram	1	< 10	< 2
NIR_PSFModelling(stack)	1	< 2	< 1
StackedCatalogExtraction	1	< 10	< 1
NIR_CreateScientificDpds	1	< 10	< 1

Workdir size < 1 TB
Total walltime < 8 hours

Main NIR Process Field pipeline resources

- Several steps of the pipeline are performed in parallel on each exposure (e.g. pre-processing)
- The hardware resources for NIR mainly depend on two aspects:
  a) the final size of the co-added image, which depends on the sky area covered (RAM);
  b) the total number of input exposures (more I/O operations, higher walltime)

Calibration pipelines

- Most demanding calblock: CALBLOCK-PV-002 (Absolute photometric standards)
  - ✓ Calib. Pipeline: NIR Absolute Photometric Calibration
  - ✓ Number of input exposure: 768
  - ✓ Walltime: 35 hours

SIR PF development and integration 1

- Calibration pipelines
  - **Optical calibration (OPT)**: run performed on the self-calibration field (CALBLOCK-PV-001)
    - input catalog: True Universe (during PV1) or MER catalog
  - **Curvature calibration (CRV)**: run performed in PV1 on the self-calibration, just using the True Universe input catalog
  - **Center of Rotation**: not run (lack of sims) in PV1 (CALBLOCK-PV-019), now tested and ready
  - **Relative Flux calibration**: not run in PV1 (on the self-cal field), now tested and ready
  - **Absolute Flux calibration**: not run in PV1 (CALBLOCK-PV-003), now optimization of resources completed and ready

- All calib. pipelines integrated into IAL pipelines and tested with PPOs (Pipeline Processing Orders) on SDC-IT-DEV

SIR PF development and integration 2

- Main scientific pipeline
  - Development/testing: new version (develop branch) to be tested every 15 days
  - Major improvement on:
    - memory consumption for spectra decontamination
    - improve grism tilt computation
    - improve DataQuality for most of the Processing Elements (tasks)
    - 1D location tables (i.e. spectra location): to be adjusted according to object mag and size
    - unit test coverage to achieve Maturity Level proposed actions

SIR current resources (Wide observation):

- Up to Spectra Extraction + Spectra combination:
  - Walltime ~ 15 hours
  - Max RAM: 18 GB (Combination step)

MER development 1: photometry

Standard implementation:

T-phot uses cut-outs of sources from the detection high-resolution image (VIS) as priors, to build fitting templates of sources in low-resolution images (NIR, EXT), using a convolution kernel created from the PSFs.

The output is considered to be the "total flux"; this is an assumption based on the accuracy of the priors (segmentation, PSFs) and of the method.

Convolution

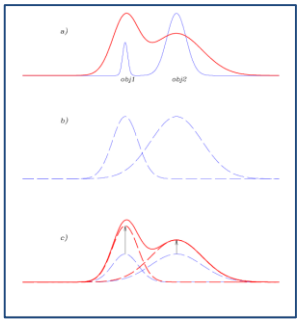
HRI cutout

Fitting template

$$k = FFT^{-1}[FFT(PSF_{LRI})/FFT(PSF_{HRI})]$$

$$PSF_{LRI} = k * PSF_{HRI}$$

Fit



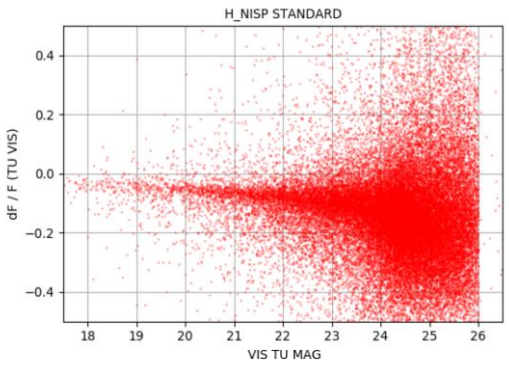
$$\chi^2 = \sum \left[\frac{I(m,n) - M(m,n)}{\sigma(m,n)} \right]^2$$

Improvements:

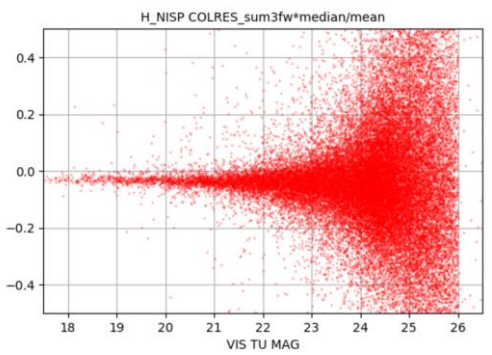
#1: We use t-phot to compute **color terms** between the high- and the low-resolution bands. The total fluxes in the low-resolution bands are computed adding the color terms to the high-resolution band total fluxes. This technique cures the issue of missing flux from faint extended wings.

#2: **Re-addition of residuals** to cure sub-optimal fit in case of contamination from neighboring sources.

2021



2022



S.Galeotta, T.Vassallo, E.Merlin, E.Romelli

MER development and performance

- MER photometry and PSF:
  - The PSF models for the EXT stacks are evaluated for each VIS-detected source through a linear combination of the position-dependent PSF models of the single epoch frames contributing to the stack
  - But there is no PSF model available for a subset (~15%) of the MER-detected sources: for these we use the nearest neighbor
  - We are struggling to quantify the effect of the resulting imprecision of the PSF models for this subset on the MER photometry: lack of consistent dataset for all bands

MER current resources:

- Single tile processing on a Wide observation
  - Walltime: ~ 21h30'
  - Max RAM: 32 GB
- Processing of deep observations doubles the walltime (due to increase of I/O operations)

Additional activities

- LE1 NISP Processor validation (before releasing to SOC)
- Catalog reduction pipelines: **PF CP_CatalogReduction** which starting from MER + SPE, SHE and PHZ catalogs produces reduced input catalogs for LE3-CL e LE3-WL
- Collaboration with the **Local Universe SWG**: MER runs on custom VIS only datasest
- Maintainance of the **LE3_GC_PowerSpectrum** and **LE3_GC_Bispectrum** codes
  - DM interfaces updates to match version 9.0.3 definitions
  - mean density interpolation schema implemented (under testing)
  - Currently discussing roadmap to MA3B which will likely happen before launch

Next activities and issues

- Performance Verification rehearsal 2 preparation
  - Additional NIR and SIR calibration pipelines to be integrated
    - Persistence calibration and masking
    - Non-linearity calibration pipeline
    - SIR wavelength dispertion (CALBLOCK-PV-009)
    - Sync code with the updated MDB models (e.g. detector layout SIM update)

- Integration activity is still an iterative process requiring a continuous interaction between SDC and OU teams
  - Most of the pipelines now require hours of computation
  - Tests performed by the developer at task level miss several interface issues
  - Inherent complexity of the SGS infrastructure
- SIM data delivery has still significant delays and this compresses the schedule on the other PFs
- MER has waited several months in order to have a small field with a consistent set of data from all bands

The SDC-IT team

- M. Frailis (SDC Lead and DEV Lead for NIR)
- D. Busonero (SDC Validation team)
- S. Galeotta (SDC-DEV Lead for MER and LE3)
- G. Maggio (SDC Infra Sys Admin)
- D. Maino (SDC Scientific Coordinator, SIR)
- M. Moresco (SDC-DEV Lead for SPE)
- E. Romelli (SDC-DEV team: MER ,LE3, ICR Tool)
- F. Rizzo (SDC-DEV team: NIR and LE3)
- G. Taffoni (SDC-PROD Infra Manager)
- D. Tavagnacco (SDC-DEV Lead for SIR, LE3, ICR Tool)
- T. Vassallo (SDC-DEV team: MER and LE3)
- C. Vuerli (SDC PA/QA Lead)

AND

the ALTEC team