

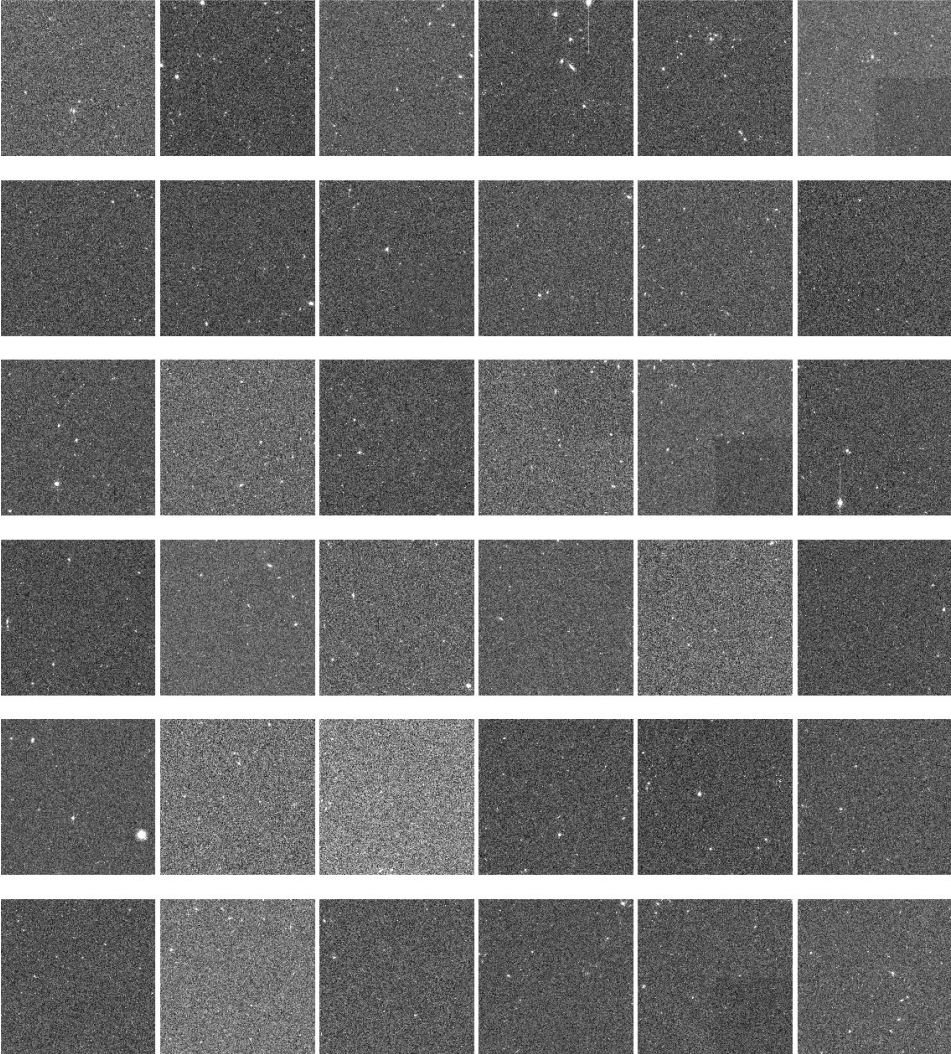
Euclid's SSOs Detection Pipeline Porting and Integration in ESA Datalabs

Aurelien Verdier – Swiss National Trainee
ESA/ESAC - Euclid
2022

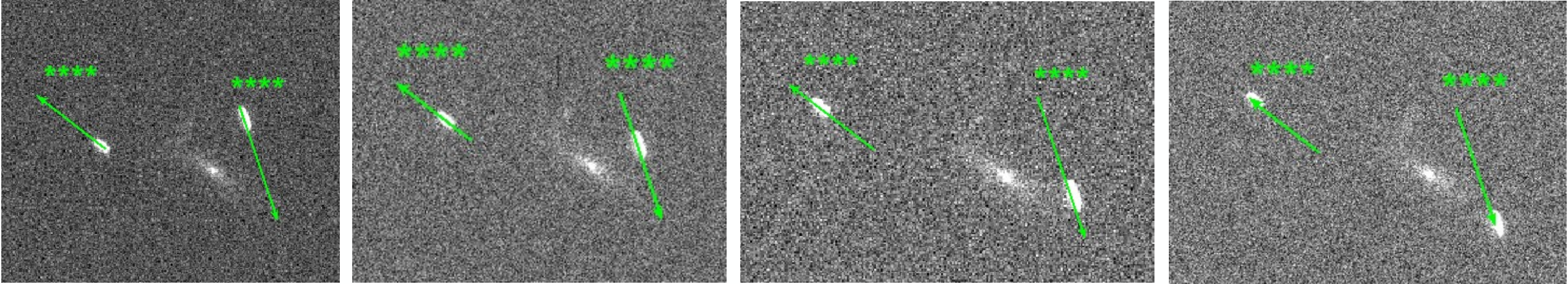
- Offer valuable data for Solar System science from spectral energy distribution
- Space Awareness: Need to detect possible threats
- SSOs can be source of minerals

- Detect Asteroids in Euclid Images
- Two types of velocity:
 - Fast SSOs (> 10 arcsec/h)
 - Slow SSOs (< 10 arcsec/h)
- Fast SSOs: Machine learning methods
- Slow SSOs: Source extraction and astrometry methods
- Pipeline at ESAC: Focus on slow SSOs
- We want to be as fast as possible to be able to send alerts

Quick Look at the Data



Quick Look at the Data



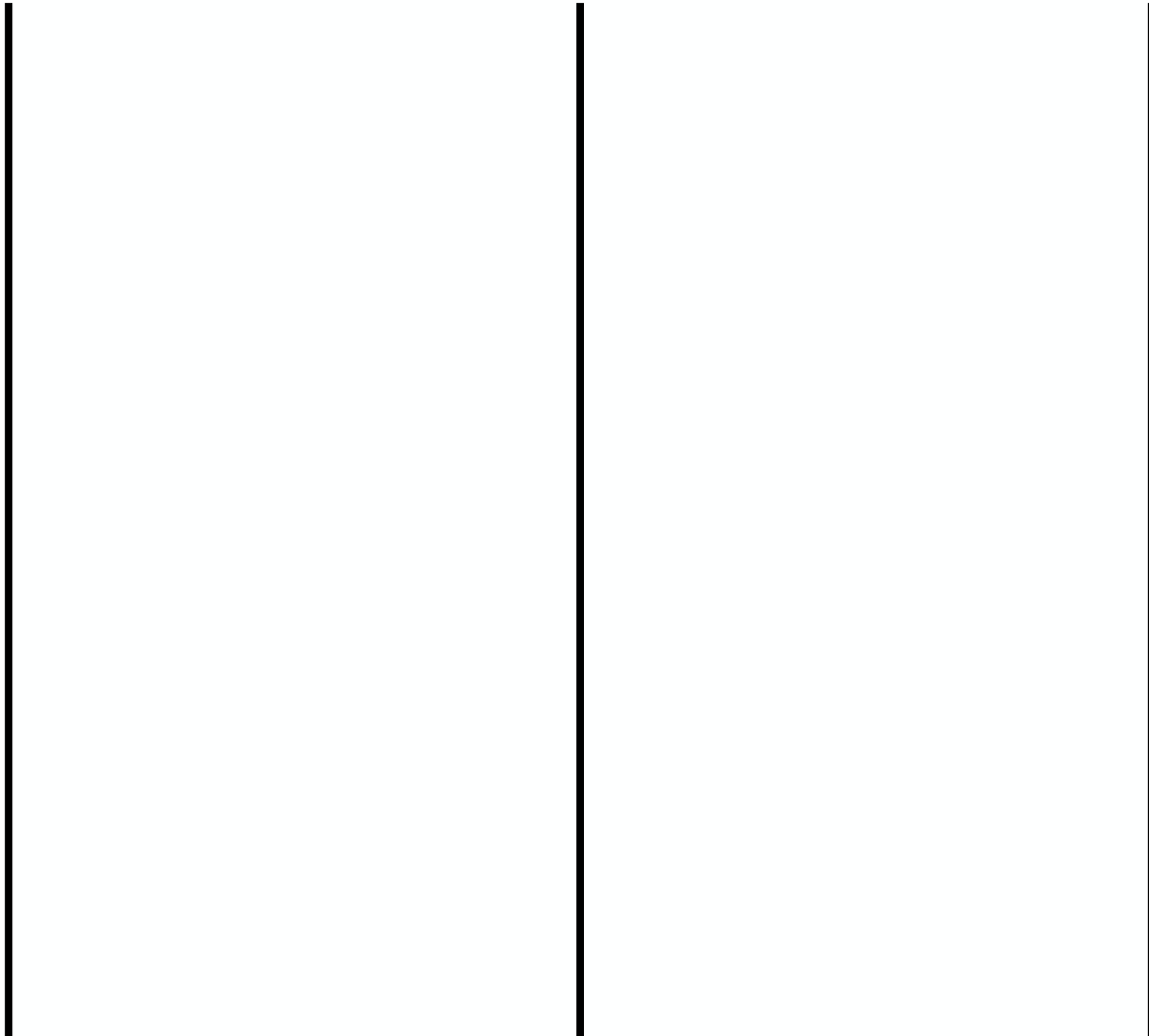
- Use of SourceExtractor and Scamp
- SourceExtractor: A lot of parameters can be modified to detect as much SSOs as possible
- Scamp: Is complementary to SourceExtractor (same author) and can find astrometric solutions

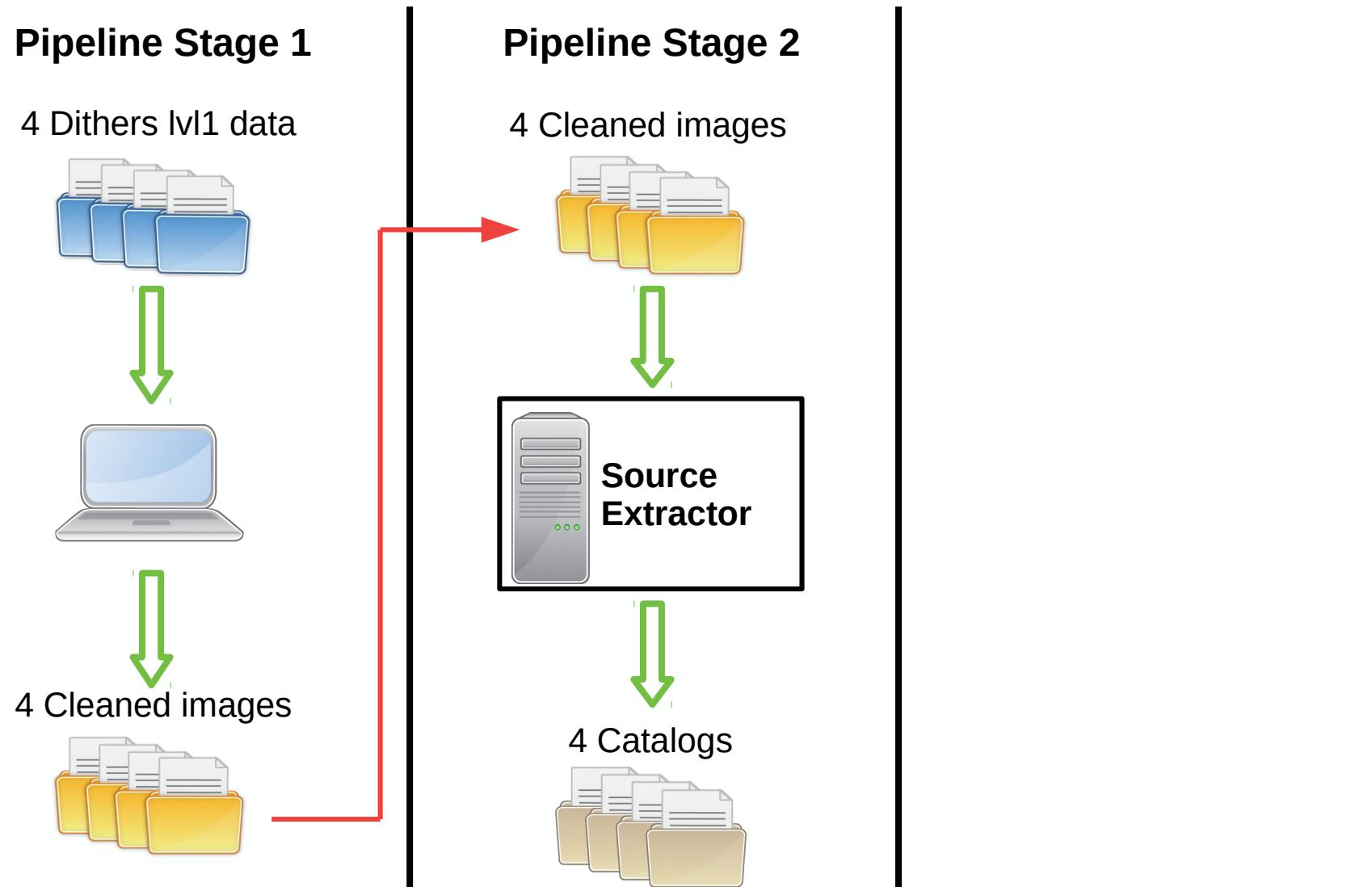
Pipeline Stage 1

4 Dithers lvl1 data

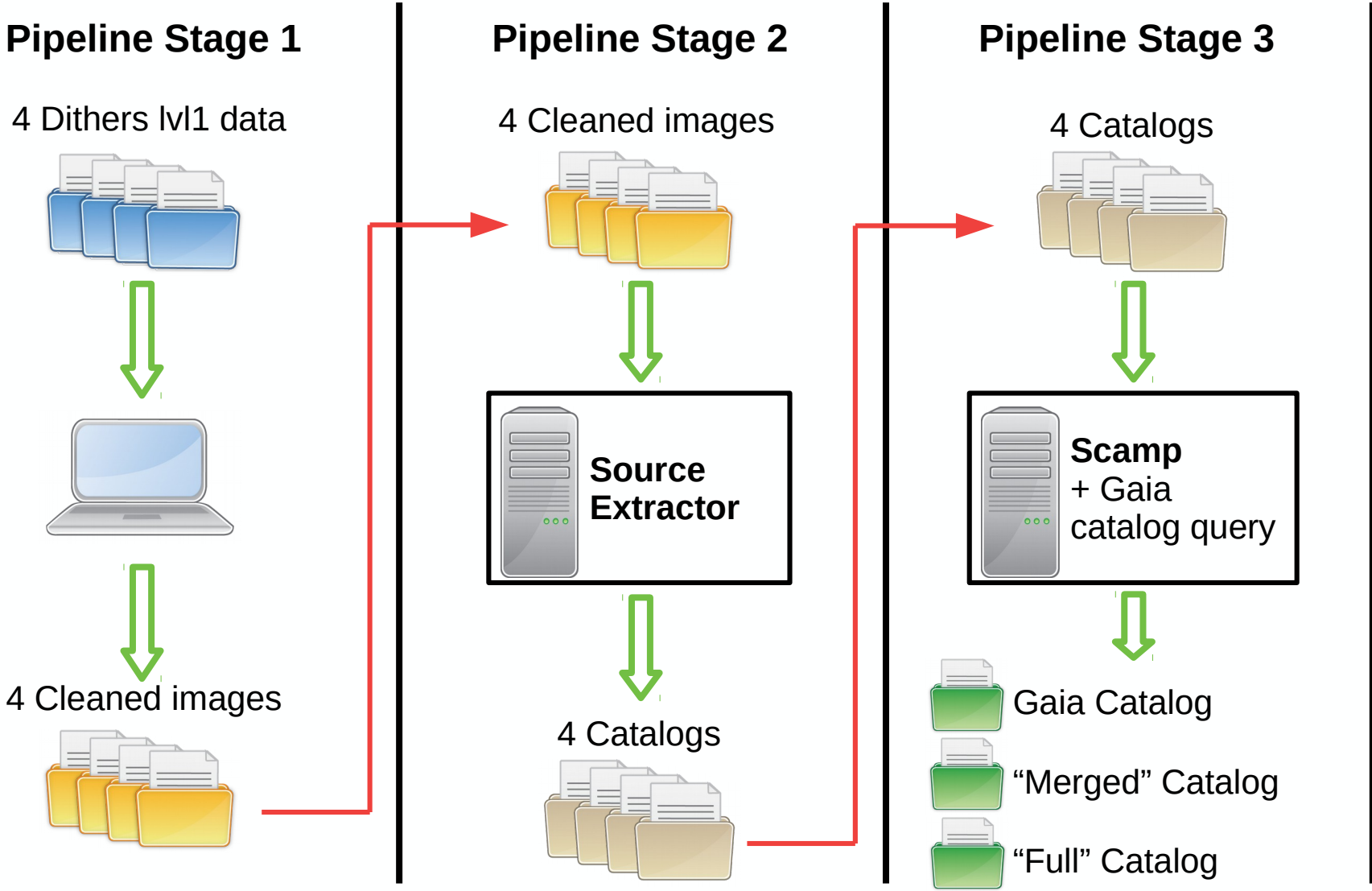


4 Cleaned images

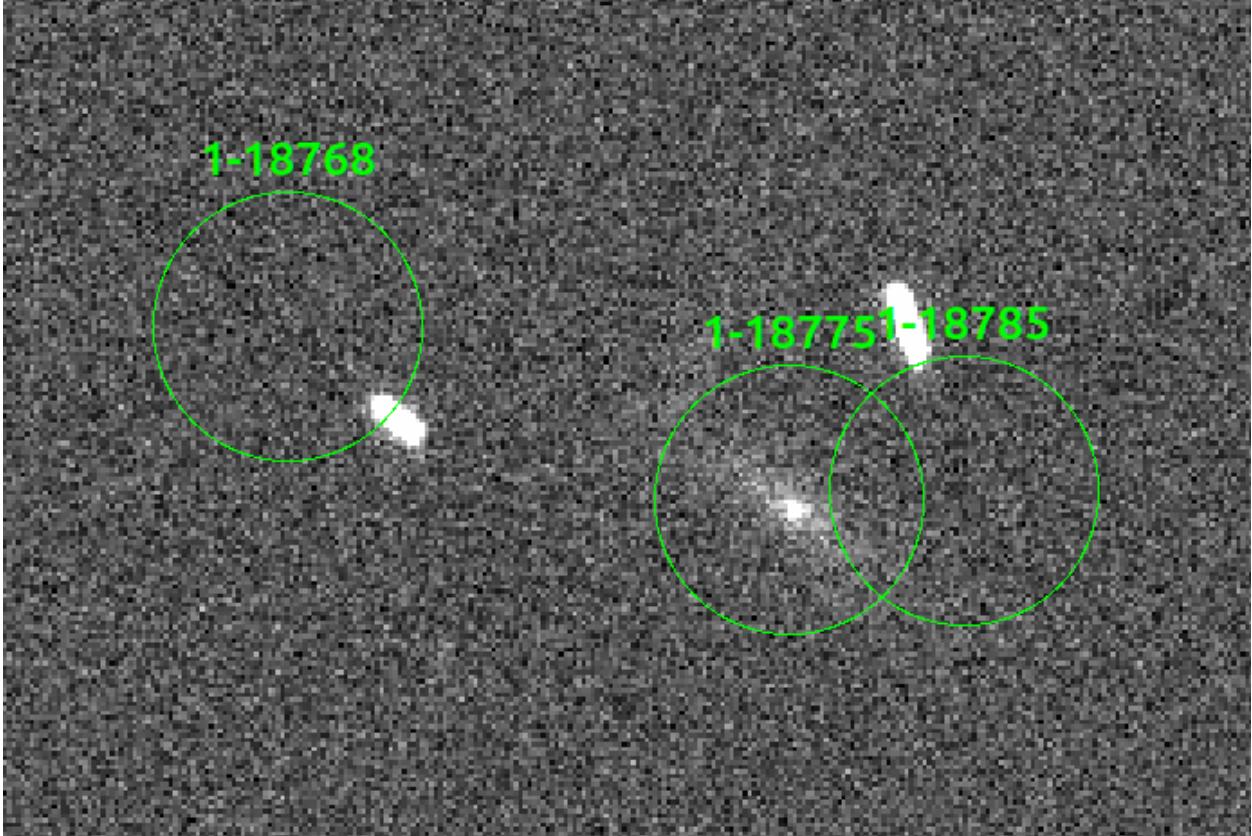
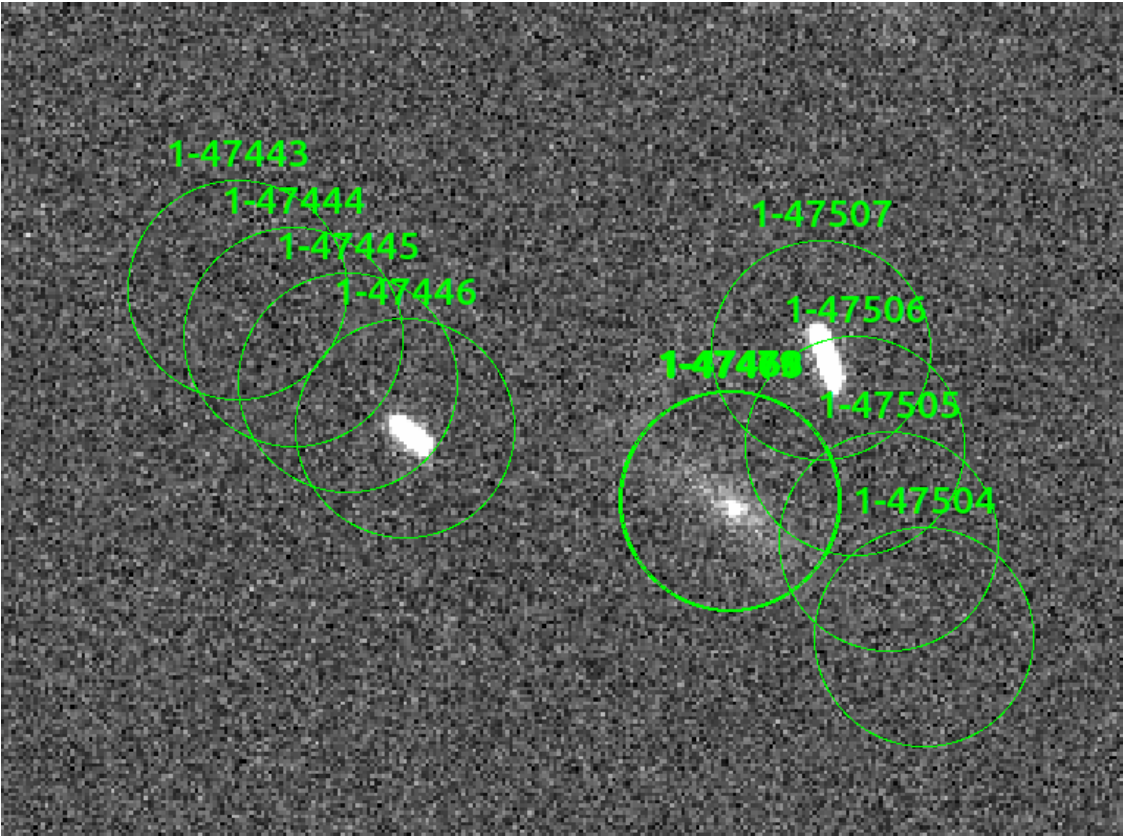




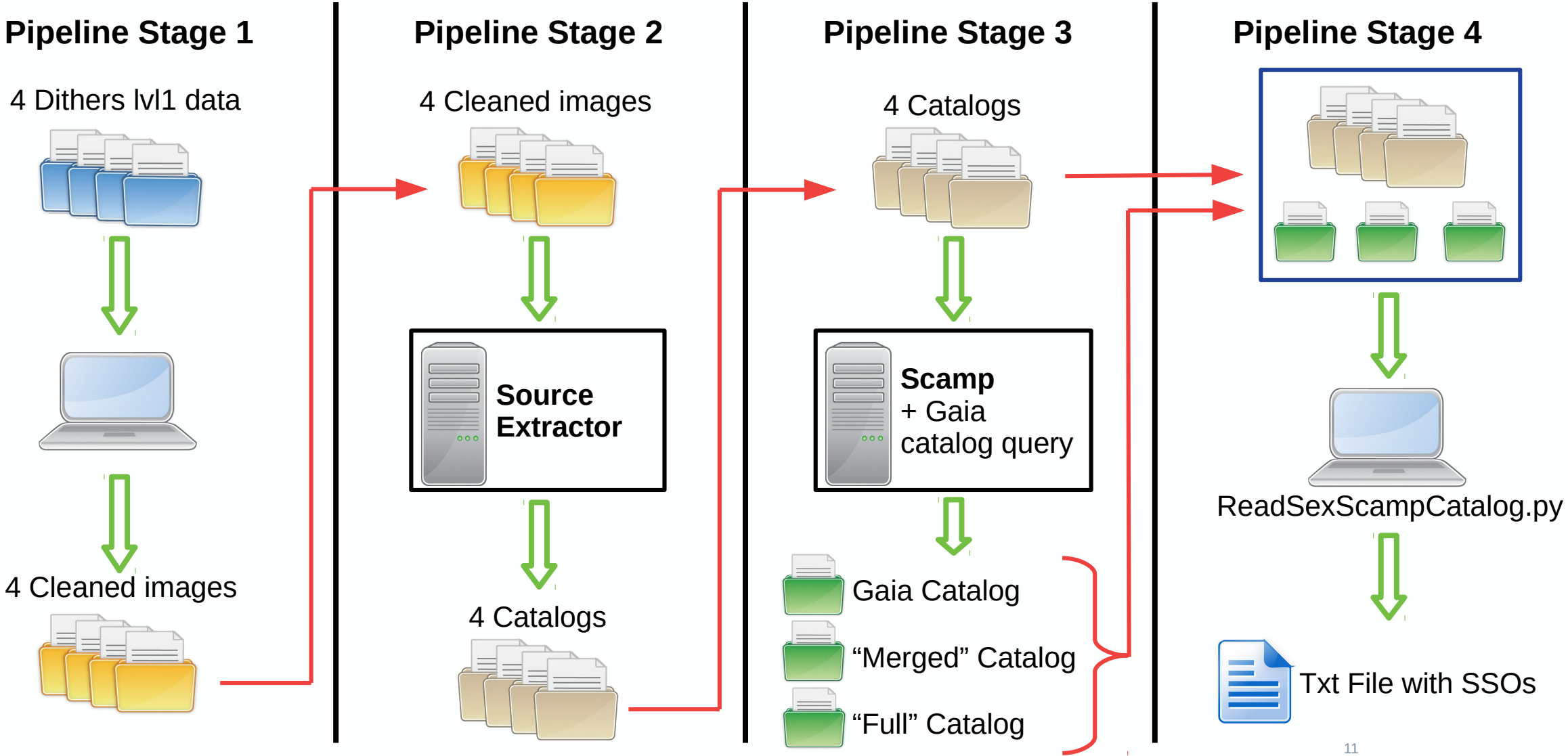
Original Pipeline

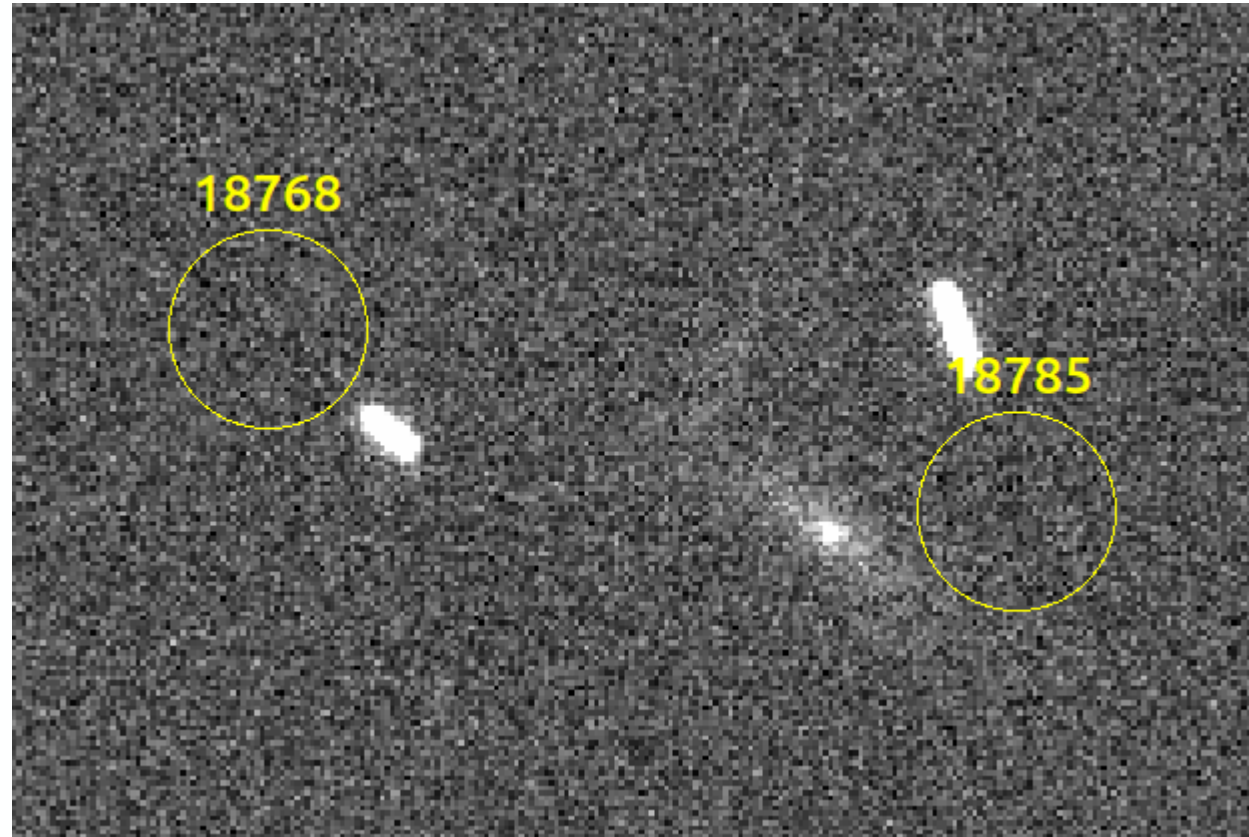


Merged vs Full

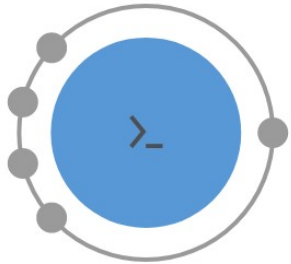


Original Pipeline



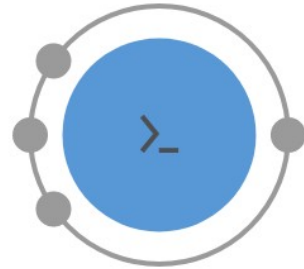


Pipeline Stage 1



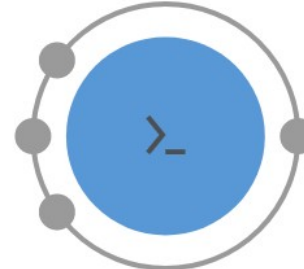
Clean Images

Pipeline Stage 2



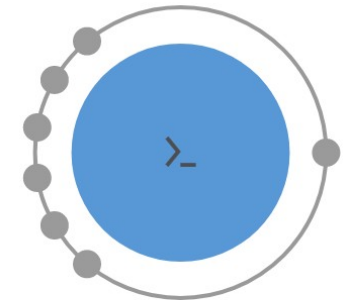
SExtractor

Pipeline Stage 3



Scamp

Pipeline Stage 4




Read Catalogues

Pipelines

- + Launch new pipeline
- ↗ Open pipeline editor
- ? Help

Sort by newest first ▾


Select all

 **SSODetect (Multi step) [o.o.3]**

The Euclid mission has been designed to map the dark universe, by observing the shape of billions of galaxies. However the survey pattern in repeated sequences of four dithered exposures in broadband filters is well-adapted to detect Solar System Objects (SSOs) out of the Euclid plane. Given its exquisite PSF (FWHM=0.18 arcsec) the VIS instrument can detect SSOs down to very low proper motions and very faint magnitudes.

[euclid](#)

🕒 00:00:03 📅 a day ago

 **SSODetect (Multi step) [o.o.2]**

The Euclid mission has been designed to map the dark universe, by observing the shape of billions of galaxies. However the survey pattern in repeated sequences of four dithered exposures in broadband filters is well-adapted to detect Solar System Objects (SSOs) out of the Euclid plane. Given its exquisite PSF (FWHM=0.18 arcsec) the VIS instrument can detect SSOs down to very low proper motions and very faint magnitudes.

[euclid](#)

🕒 00:16:29 📅 a month ago

Showing 1 to 2 out of 2 runs [Previous](#) [Next](#)

Launch the Pipeline



Input(s)

- [1] **VIS Data (Directory)** Directory with 4 fits images.
data/euclid/DATA [Browse](#)
- [2] **Observation ID (string)**
OBsID
- [3] **Log Cal (string)** Log Cal file name.
CalibrationLog.txt
- [4] **Calibration (Directory)** Calibration files directory.
data/euclid/CALIBRATION [Browse](#)
- [5] **Source code directory (Directory)** Provide a path to source code.
SOURCE_CODE_WCSFIT [Browse](#)

Output

- Detected SSOs (Directory)** txt file with all SSOs detected
out [Browse](#)

Identifier

SSODetect (Multi step)

Schedule

[Add schedule](#)

Notification

[Add notification](#)

Keywords

euclid x
New keyword [Add keyword](#)

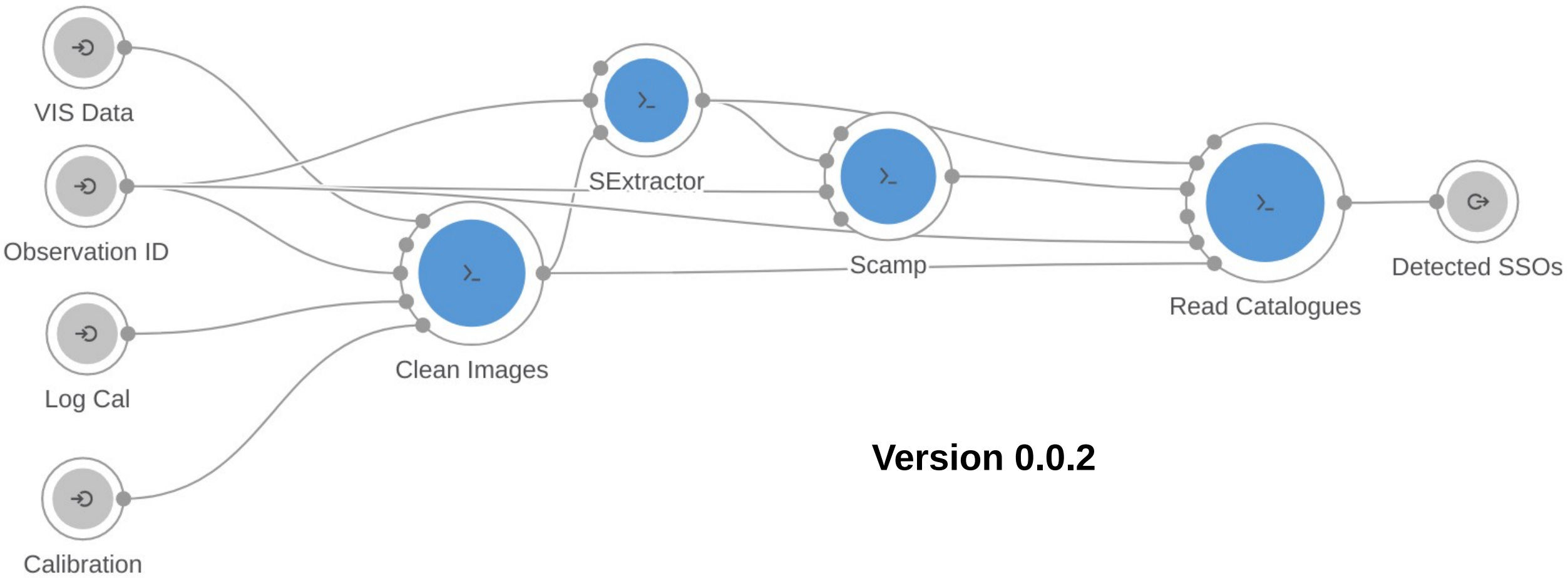
Default image

Default image tag [Browse](#)

[✓ Launch pipeline](#)



Integration in PIPEMAN



Version 0.0.2

Integration in PIPEMAN



Execution **Logs** Parameters Graph Code

Pipeline logs ▼

```
7
8 pdated. Running SSODetect.py.
9 SSODetect - <module> - INFO -
10 SSODetect - <module> - INFO -
11 SSODetect - <module> - INFO - SSODetect
12 SSODetect - <module> - INFO - (SSODetect)
13 SSODetect - <module> - INFO - SSODetect
14 SSODetect - <module> - INFO - )
15 SSODetect - <module> - INFO - SSODetect
16 SSODetect - <module> - INFO -
17 A function "dtf2d" yielded 1 of "dubious year (Note 6)" [astropy._erfa.core]
18 SSODetect - <module> - INFO - Start at : 2022-10-19 08:51:41
19 SSODetect - <module> - INFO - Reading the configuration file: ssodetect.config
20 SSODetect - <module> - INFO - -----
21 SSODetect - <module> - INFO - Settings...
22
```





SSODetect (Multi step) [o.o.2]

The Euclid mission has been designed to map the dark universe, by observing the shape of billions of galaxies. However the survey pattern in repeated sequences of four dithered exposures in broadband filters is well-adapted to detect Solar System Objects (SSOs) out of the Euclid plane. Given its exquisite PSF (FWHM=0.18 arcsec) the VIS instrument can detect SSOs down to very low proper motions and very faint magnitudes.

euclid

🕒 00:16:29 📅 a month ago

Pipeline Stage 1

4 Dithers lvl 1 data



4 Cleaned images



Pipeline's Modifications

Pipeline Stage 1

4 Dithers lvl 1 data

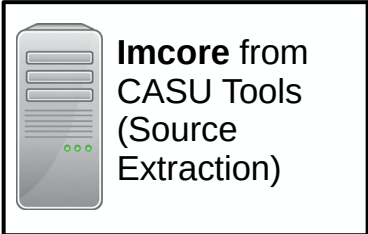


4 Cleaned images



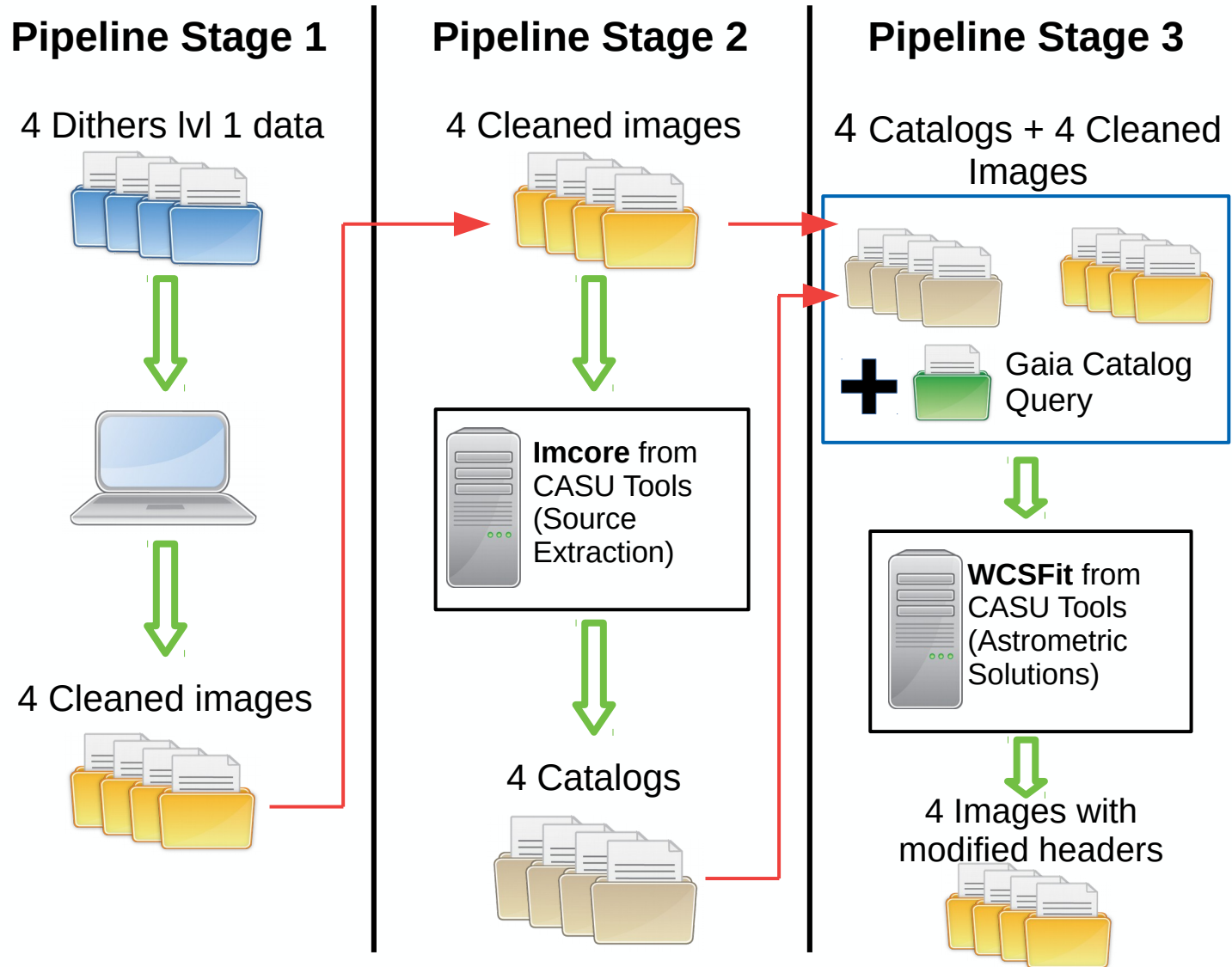
Pipeline Stage 2

4 Cleaned images

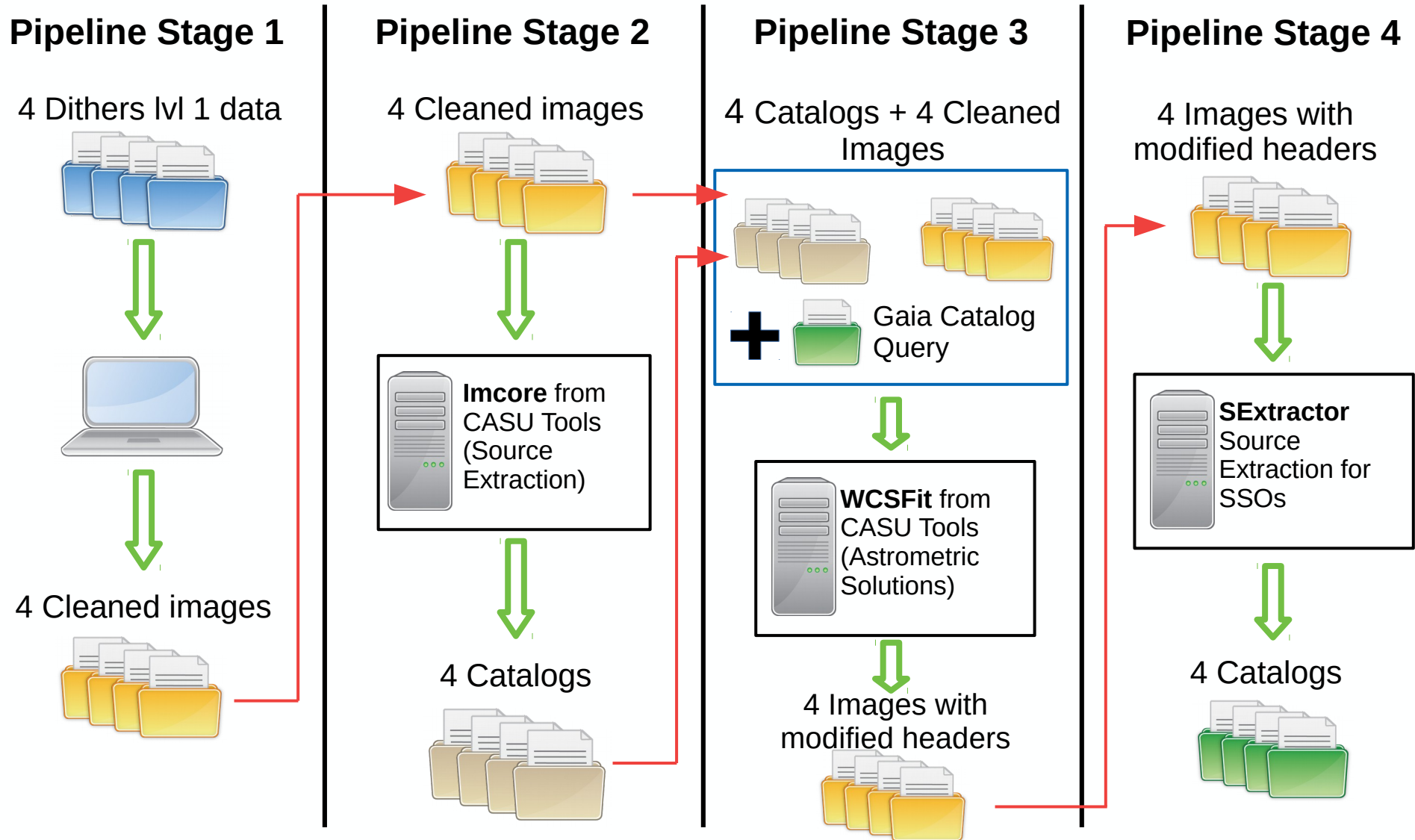


4 Catalogs





Pipeline's Modifications



Pipeline's Modifications

Pipeline Stage 1

4 Dithers lvl 1 data

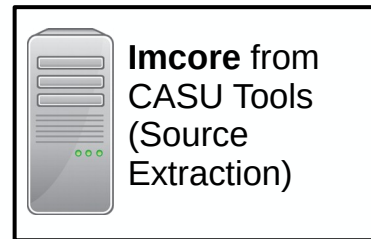


4 Cleaned images



Pipeline Stage 2

4 Cleaned images



4 Catalogs



Pipeline Stage 3

4 Catalogs + 4 Cleaned Images



+ Gaia Catalog Query



4 Images with
modified headers



Pipeline Stage 4

4 Images with
modified headers



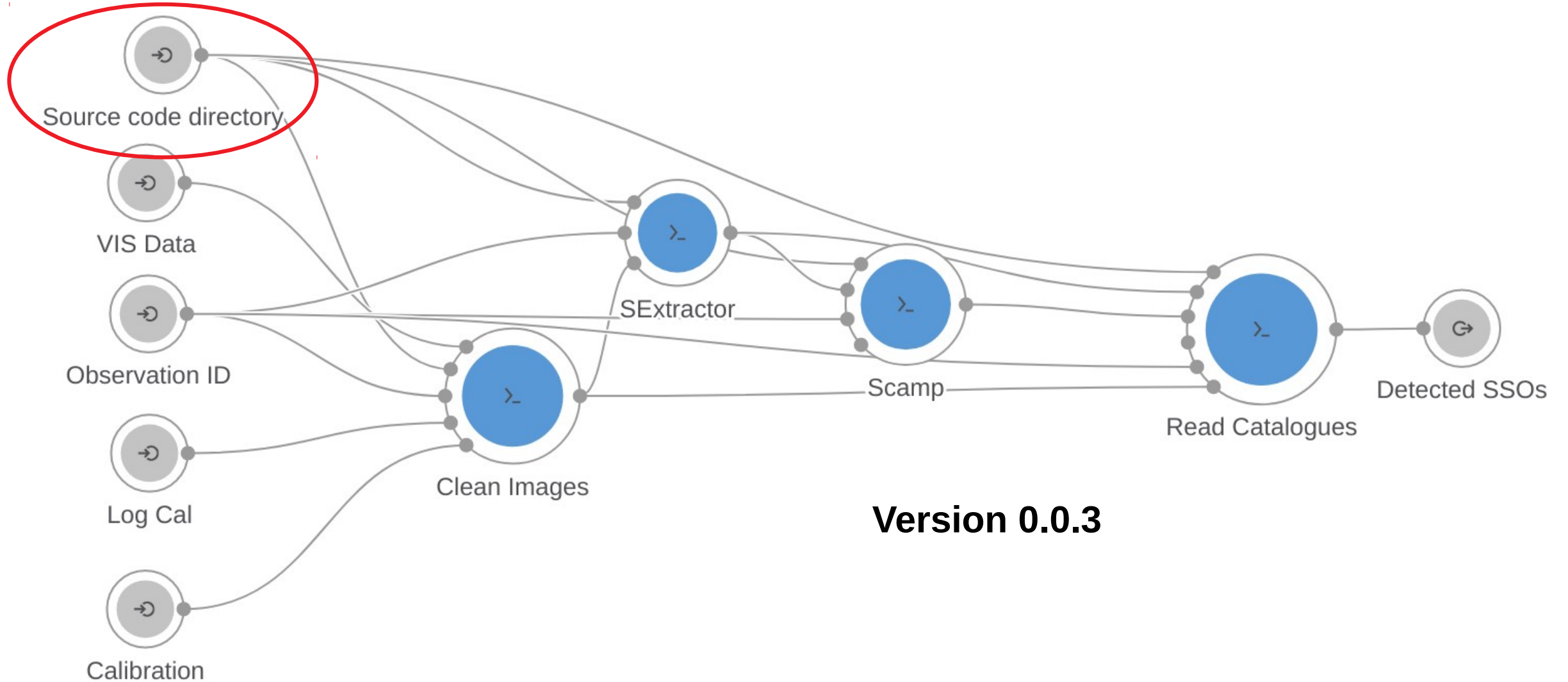
4 Catalogs



Last Pipeline Stage from Achilles

- Replace SourceExtractor by Imcore
- Replace Scamp by WCSFit
- Modify the code in each node (SSODetect.py)
- Modify the configuration file (ssodetect.config)
- Modify the number of steps
- Add/Remove packages in the environment

Access the Source Code



Version 0.0.3

Access the Source Code

Workspace

▼ SOURCE_CODE_WCSFIT

> MODELS

SSODetect.py

SSODetect.log

ssodetect.config

SExtractorTools.pyc

SExtractorTools.py

ReadSexScampCatalogues.pyc

ReadSexScampCatalogues.py

ReadSexScampCatalogues.log

mylib.pyc

mylib.py

myfile.pyc

myfile.py

manage_elvis.pyc

manage_elvis.py

manage_elnisp.pyc

manage_elnisp.py

linearfit.pyc

linearfit.py

cosmic_elvis.pyc

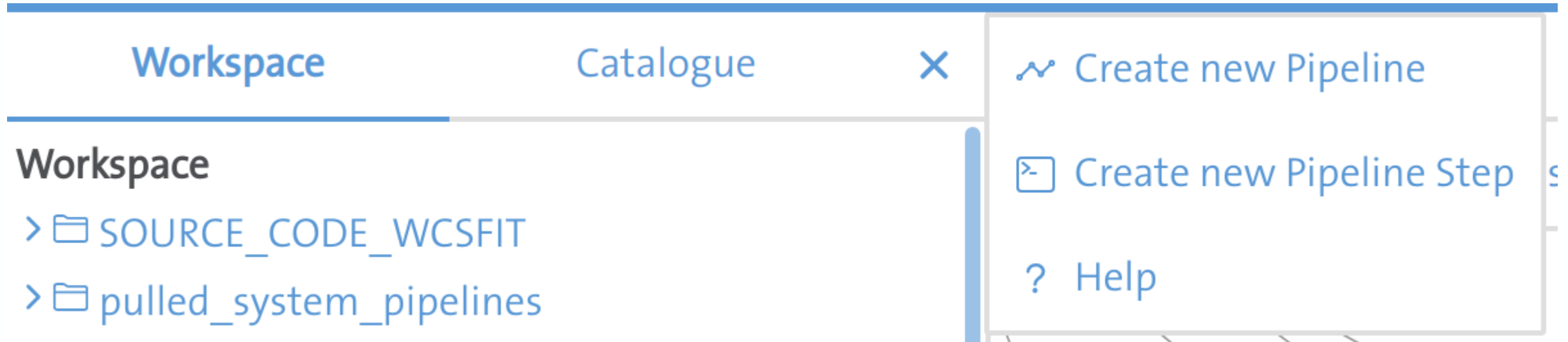
cosmic_elvis.py

←→ Can modify the code

←→ Can modify the configuration file

←→ Can modify final step

Add a Pipeline Step



The screenshot shows a software interface with two tabs: 'Workspace' and 'Catalogue'. The 'Workspace' tab is active and displays a tree view with two folders: 'SOURCE_CODE_WCSFIT' and 'pulled_system_pipelines'. A context menu is open over the 'pulled_system_pipelines' folder, containing three items: 'Create new Pipeline' (with a wavy line icon), 'Create new Pipeline Step' (with a folder icon containing a plus sign), and 'Help' (with a question mark icon).

Add a Pipeline Step

Create new Pipeline Step ×

Create a standalone Pipeline Step.

Use this option if you intend to push the Step to the Catalogue, and incorporate the Step into several Pipelines.

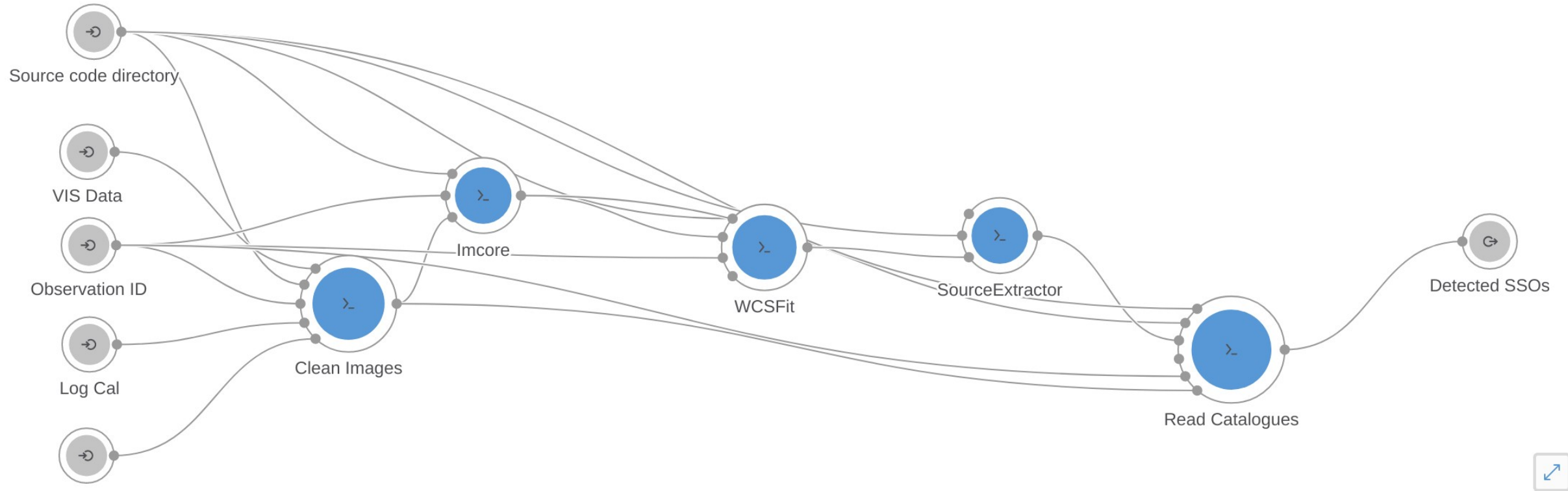
Create Pipeline Step into existing Pipeline.

Use this option if the Step is private to the Pipeline. Drag-and-drop it to the Pipeline graph.

Select Pipeline

Pipeline Step name

Add a Pipeline Step



- How to install CASUTools on the environment to be able to use Imcore and WCSFit ?
- Same questions for python packages
- Some small bugs

- Done via the Dockerfile
- Build an image and push it to registry
- Update the docker for each pipeline step
- I don't have the access to do it so... They did it for me !

```
FROM python:2.7.18

RUN /usr/local/bin/python -m pip install --upgrade pip

RUN pip install numpy>=1.7.1 && \
    pip install astropy>=1.3.0 matplotlib>=1.2.0 scipy>=0.12.1 fitsio>=1.0.5 \
    astroscrappy>=1.0.5 natsort>=5.4.1 logging>=0.4.9.6 astropy-helpers>=2.0.11 \
    photutils>=0.3 configparser>=4.0.2 \
    astromatic_wrapper>=0.0.dev250

ARG SCAMP_VERSION=2.7.8

RUN apt-get update && \
    apt-get -y install sextractor gettext-base fftw3-dev libatlas-base-dev && \
    wget -nv https://github.com/astromatic/scamp/archive/refs/tags/v$SCAMP_VERSION.zip -O scamp.zip && \
    unzip scamp.zip && \
    cd scamp-$SCAMP_VERSION && \
    sh autogen.sh && \
    ./configure && make && make install && \
    cd ~ && rm -rf scamp* && \
    apt-get remove -y fftw3-dev libatlas-base-dev && \
    apt-get autoremove && \
    rm -rf /var/lib/apt/lists/*

WORKDIR /src
COPY SOURCE_CODE /src

RUN ln -s /usr/bin/sextractor /usr/bin/sex && \
    ln -s /usr/bin/sextractor /usr/local/bin/sex && \
    chmod 777 -R /src

ENV ROOT_PATH=/src
```

Thank you for your attention !