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# IIINSTRUMENT Pipeline User Manual

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| N.N. | Far out in the uncharted backwaters of the unfashionable end of the western spiral arm of the Galaxy |

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# 1 Introduction

*This template contains the basic layout of the User Manual and comments/instructions in "red" on how the different sections should be filled. They also indicate which parts are provided by ESO. These comments should be removed from the final document. If there are questions regarding the template, the instructions or the intended content of certain sections, please get in touch with your ESO contact person.*

## 1.1 Scope

The examples on running individual pipeline recipes in this manual use the *EsoRex* command and manually created list of input files. Several interfaces to automatically organise the data, create the list of input files and execute the pipeline recipes in the proper sequence are available, see the ESO Pipeline web page *https://www.eso.org/pipelines* for details.

## 1.2 Acknowledgements

## 1.3 Stylistic conventions

Throughout this document the following stylistic conventions are used:

| | |
|---|---|
| **bold** | in text sections for commands and other user input which has to be typed as shown |
| *italics* | in the text and example sections for parts of the user input which have to be replaced with real contents |
| `teletype` | in the text for FITS keywords, program names, file paths, and terminal output, and as the general style for examples, commands, code, etc |

In example sections expected user input is indicated by a leading shell prompt.

In the text **bold** and *italics* may also be used to highlight words.

## 1.4 Notational Conventions

Hierarchical FITS keyword names, appearing in the document, are given using the dot–notation to improve readability. This means, that the prefix "HIERARCH ESO" is left out, and the spaces separating the keyword name constituents in the actual FITS header are replaced by a single dot.

# 2 Related Documents

## 2.1 Applicable Documents

[AD01] ESO-XXXXXX 1.0 TBD

## 2.2 Reference Documents

[RD01] ESO-XXXXXX IIINSTRUMENT User Manual

# 3 Definitions, Acronyms and Abbreviations

| | |
|---|---|
| CalibDB | Calibration Database |
| CPL | Common Pipeline Library |
| CCD | Charge Coupled Device |
| DFS | Data Flow System |
| DRS | Data Reduction System |
| ESO | European Southern Observatory |
| EsoRex | ESO Recipe Execution Tool |
| FITS | Flexible Image Transport System |
| FOV | Field Of View |
| GUI | Graphical User Interface |
| LSF | Line Spread Function |
| IIINSTRUMENT | TODO |
| OB | Observation Block |
| pixel | picture element (of a raster image) |
| PSF | Point Spread Function |
| QC | Quality Control |
| SDP | Science Data Product |
| SOF | Set Of Frames |
| TBD | To be defined |
| TBC | To be confirmed |
| VLT | Very Large Telescope |
| WCS | World Coordinate System |

# 4 Overview

*Document overview and purpose goes here*

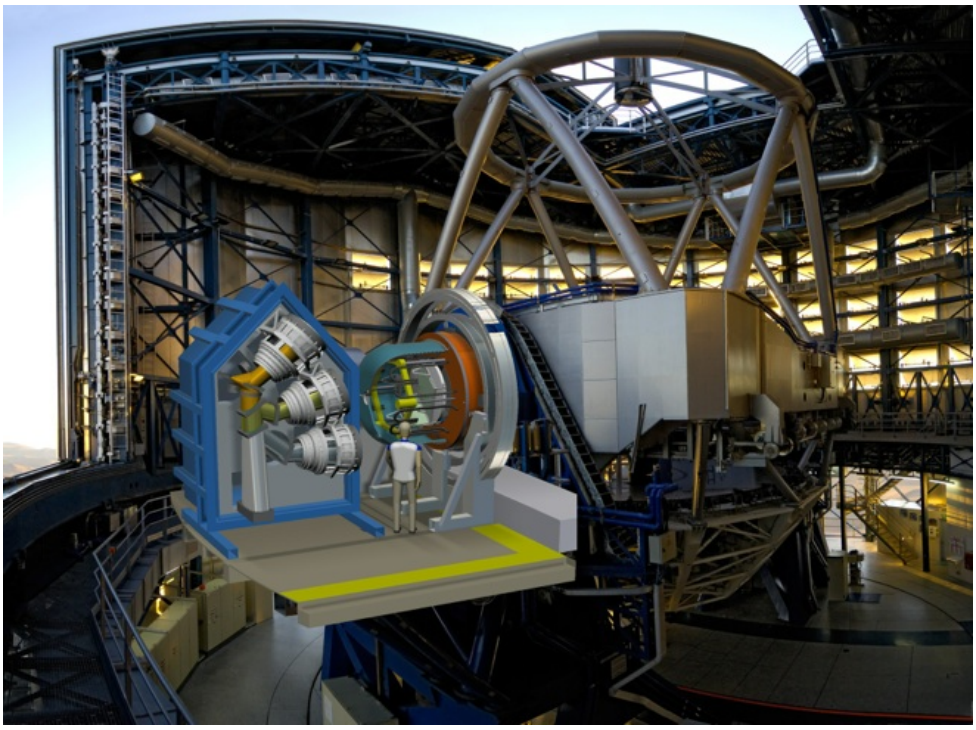


**Figure 5.1:** Graphical representations of IIINSTRUMENT.

# 5 The IIINSTRUMENT Instrument

*Instrument overview, description of instrument modes, etc.*

# 6 Quick Start

*Cookbook-like description of pipeline recipes and their usage*

## 6.1 The IIINSTRUMENT Pipeline Recipes

*Overview and/or summary of available pipeline recipes, i.e. list of available pipelines and a brief (one-liner) description of its purpose.*

## 6.2 Running the IIINSTRUMENT Pipeline Recipes

### 6.2.1 Getting Started with EsoRex

*Basic description of EsoRex. Contents will partially be provided by ESO, example follows.*

*EsoRex* is a command-line tool which can be used to execute the recipes of all standard VLT/VLTI instrument pipelines. With *EsoRex* in your path, the general structure of an *EsoRex* command line is

```
1> esorex [esorex options] [recipe [recipe options] [sof [sof]...]]
```

where options appearing before the recipe name are options for *EsoRex* itself, and options given after the recipe name are options which affect the recipe.

All available *EsoRex* options can be listed with the command

```
1> esorex --help
```

and the full list of available parameters of a specific recipe can be obtained with the command

```
1> esorex --help <recipe name>
```

The output of this command shows as parameter values the current setting, i.e. all modifications from a configuration file or the command line are already applied.

The listing of all recipes known to *EsoRex* can be obtained with the command

```
1> esorex --recipes
```

The last arguments of an *EsoRex* command are the so-called *set-of-frames*. A *set-of-frames* is a simple text file which contains a list of input data files for the recipe. Each input file is followed by an unique identifier (frame classification or frame tag), indicating the contents of this file. The input files have to be given as an absolute path, however *EsoRex* allows the use of environment variables so that a common directory prefix can be abreviated. Individual lines may be commented out by putting the hash character (#) in the first column. An example of a *set-of-frames* is shown in the following:

```
1> cat bias.sof
/data/iiinstrument/raw/IIINSTRUMENT.2019-03-29T09:48:53.153.fits BIAS
$RAW_DATA/IIINSTRUMENT.2019-03-29T09:50:36.645.fits BIAS
$RAW_DATA/IIINSTRUMENT.2019-03-29T09:52:16.513.fits BIAS
$RAW_DATA/IIINSTRUMENT.2019-03-29T09:53:47.996.fits BIAS
#$RAW_DATA/IIINSTRUMENT.2019-03-29T09:55:04.515.fits BIAS
```

These *set-of-frames* files will have to be created by the user using a text editor, for instance. Which classification has to be used with which recipe will be shown in section 6.3

Finally, if more than one *set-of-frames* is given on the command-line *EsoRex* concatenates them into a single *set-of-frames*.

## 6.3 Data Organization

*Outline of how to organize IIINSTRUMENT data, i.e. how to get to a correct SOF file, which classification tags are accepted by the recipes and how they are defined in terms of header keywords.*

# 7 Known Issues

*Know issues, problems and limitations related to the **current release** of the pipeline (if possible with a work-around) go here.*

# 8 IIINSTRUMENT Data Description

*Description of the different raw frames processed by the pipeline, including data classification and association keywords (cf. example)*

## 8.1 Bias

Frame tag: `BIAS`
Processed by: `iiinstrument_mbias`

| Classification Keywords | Association Keywords | Remarks |
|---|---|---|
| `DPR.CATG = CALIB` | `DET.CHIP.ID` | Detector chip identification |
| `DPR.TYPE = BIAS` | `SEQ.ARM` | Spectrograph identification |
| | `DET.READ.CURID` | Detector read-out mode |

An example is shown in Table 8.1.

# 9 Static Calibration Data

*Description of the different static data files needed (line catalog for instance), including data classification and association keywords (cf. example).*

## 9.1 Line Catalog

Frame Tag: `LINE_CATALOG`
Classification keywords: `PRO.CATG = LINE_CATALOG`

| Column Name | Column Type | Description |
|---|---|---|
| `Lambda` | float | Line wavelength nm |
| `Flux` | float | Relative line flux |
| `Ion` | string | Ion from which the line originates |
| `Quality` | int | Quality flag (0: undetected line, 1: etc.) |
| `Comment` | string | Optional column for further remarks |

**Table 9.1:** A line catalog

An example is shown in Table 9.1.

**Figure 10.1:** The IIINSTRUMENT "Assocoation Map" showing the required and optional input for each recipe.

# 10 Data Reduction

*Description and of the data reduction process from raw files to the final product, including walk-through of a standard data reduction session.*

## 10.1 The IIINSTRUMENT Date Reduction Pipeline

The IIINSTRUMENT association map is shown in Figure 10.1.

# 11 Recipe Reference

*Recipe reference with detailed description of input frames, parameters products and provided QC information (see example below).*

## 11.1 iiinstrument_mbias

### 11.1.1 Description

### 11.1.2 Input Frames

| Frame Tag | Type | Count | Description |
|---|---|---|---|
| BIAS | raw | 3 (min) | Raw bias |
| BAD_PIXEL_TABLE | calib | 1 (opt) | Table of a priori known bad pixel locations |

### 11.1.3 Product Frames

| Default File Name | Frame Tag | Description |
|---|---|---|
| master_bias.fits | MASTER_BIAS | Master bias frame |
| bad_pixel_mask.fits | BAD_PIXEL_MASK | Bad pixel mask |

### 11.1.4 Quality Control Parameters

| | |
|---|---|
| `QC.BIAS.MASTER.AVG` | Average pixel value of the master bias frame |
| `QC.BIAS.MASTER.MED` | Median pixel value of the master bias frame |
| `QC.BIAS.MASTER.RMS` | RMS of the master bias frame |

### 11.1.5 Recipe Parameters

| Parameter | Type | Values | Description |
|---|---|---|---|
| stack-method | string | average, median, **ksigma** | Stacking method |
| clip-low | double | **3.** | Low sigma threshold for *ksigma* pixel rejection method |

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| Parameter | Type | Values | Description |
|---|---|---|---|
| clip-high | double | **3.** | High sigma threshold for *ksigma* pixel rejection method |

# 12 Algorithms

*The first part contains the detailed discussion and the mathematical description of the used algorithms. The second part contains the recipe algorithm, i.e. a high-level description of the recipe flow-chart and how it changes for different parameter settings.*

## 12.1 General Algorithms

## 12.2 Recipes Algorithms

# A Installation

ESO pipelines can be installed via several methods, depending on your OS, most of which facilitate easy installation, upgrade and removal. Please see the *ESO Data Reduction Pipelines and Workflow Systems* page (*https://www.eso.org/pipelines*).

*Installation instructions for the different package types offered by ESO and build instructions for experienced users. This part will be filled by ESO to a large extent.*

## A.1 System Requirements

## A.2 Installing the IIINSTRUMENT Pipeline

## A.3 Building the IIINSTRUMENT Pipeline

### A.3.1 Build Requirements

# B Troubleshooting

*Hints on diagnosing problems and possible work-arounds or debug settings.*