IPAG Institut de Planétologie et d'Astrophysique de Grenoble	PNR-MAN-PNDRS Revision : 2.2 Date : 2019-01-07

IPAG

PIONIER USER MANUAL
AND
DATA REDUCTION MANUAL (PNDRS)

Jean-Baptiste Lebouquin (Jean-Baptiste.Lebouquin@obs.ujf-grenoble.fr)
Institut d'Astronomie et d'Astrophysique

Author : Jean-Baptiste Le Bouquin Institute : IPAG	Signature : Date :
Approved by : Institute : IPAG	Signature : Date :
Released by : Institute : IPAG	Signature : Date :

CHANGE RECORD

REVISION	DATE	AUTHOR	SECTIONS/PAGES AFFECTED
	REMARKS		
1.0	2014-09-02	JB Le Bouquin	all
	Created		
1.1	2014-09-23	JB Le Bouquin	Add section on installation
1.2	2014-10-23	JB Le Bouquin	all
	Correct bug about installation procedure		
2.0	2015-01-05 JB Le Bouquin & S Guieu		
	Version for the RAPID camera		
2.1	2015-02-15 JB Le Bouquin		
	Comments from Antoine Merand.		
2.2	2019-01-07 JB Le Bouquin		
	Add the command line options.		

TABLE OF CONTENTS

1 Introduction

1.1 Object

This manual contains a synthetic description on how to reduce PIONIER data with PNDRS.

1.2 Reference documents

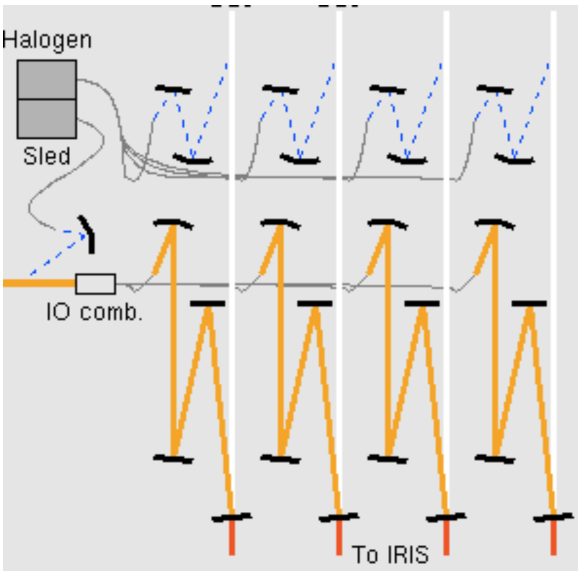
[1] PNR-MAN-OperationManual – PIONIER Operation Manual

1.3 Abbreviations and Acronyms

AIT	Assembly, Integration and Tests
ACS	Alignment Control System (Tip/Tilt piezo)
BOB	Breaker of Observing Blocks
CAU	Calibration and Alignment Unit
DFE	Detector Front-End Electronics
DCS	Detector Control Station
DL	Delay Lines
ICS	Instrument Control Software
INS	Instrument
DET	Detector
GRIL	Groupe de Recherche et de Réalisation Instrumentales du LAOG
IRIS	Infrared Image Sensor
ISS	Interferometer Software Supervisor
IPAG	Institut de Planetologie et d'Astrophysique de Grenoble
IOBC	Integrate Optics Beam Combiner
LAOG	Laboratoire d'AstrOphysique de Grenoble
LAN	Local Area Network
MARCEL	Multi-beam Alignment, Reference and Calibration (IR) Emitter for the (VLTI) Laboratory
OB	Observing Block
PIONIER	Precision Integrated Optics Near-infrared Imaging ExpeRiment
PIONIER-BSP	Baseplate (the plate to feed PIONIER with the internal source)
PIONIER-FO	Feeding-Optics (The H or the K dichroics)
RMN	Reflective Memory Network
RTD	Real Time Display
SCP	Service Connection Point
VLT	Very Large Telescope
VLTI	Very Large Telescope Interferometer

2 PIONIER overview

PIONIER is a four telescope interferometric combiner operating in the H band. It has a small spectral resolution capability (few spectral channels). It is located in the former VINCI table.



It has four arms containing, optical path scanners, tip/tilt mirrors, shutter and fiber injectors. A dichroic stage slides into position to allow the telescope beams to be injected into the fibers and then into the interferometric combiner.

The interferometric combination is done via an integrated optics beam combiner called 4T ABCD.

There are two spectral resolutions possible in H band: “FREE” (~5) and “GRISM” (~45).

PIONIER interferograms are temporally encoded thanks to scanning mirrors that modulate the optical path difference. The four telescopes form 6 baselines, and each of them is coded into 4 outputs (ABCD), resulting in a total of 24 interferograms.

2.1 An observing sequence

A typical PIONIER observation is composed of

- a telescope preset;
- an instrumental setup;
- a fringe acquisition which requires
  - a) nexp exposures of nscan interferograms (typical 5 exp or 100 scans)
  - b) one dark exposure
  - c) a kappa matrix (measuring each beam individually = 4 exposures)

The observation of calibration stars is interleaved with the observations of the science star, all with the same instrumental setup. For instance, a typical sequence would be CAL1-SCI-CAL2-SCI-CAL1.

A spectral calibration is nearly identical to a normal observation but on the internal light. These fringes are used as Fourier Transform Spectrometer to measure the effective wavelength of each channel with an accuracy of about 1.5% (systematic).

2.2 PIONIER fringe acquisition

Interferograms are temporally encoded by the mean on the internal piezo. The four outputs of a given baseline (so called A B C and D) are combined together into a single interferogram per baseline that is displayed in the RTD_SCOPE. PIONIER uses these signals to do “coherencing”, that is to maintain the fringes within the scan length once the operator has found them. The corresponding corrections are performed internally with the long scanning piezos.

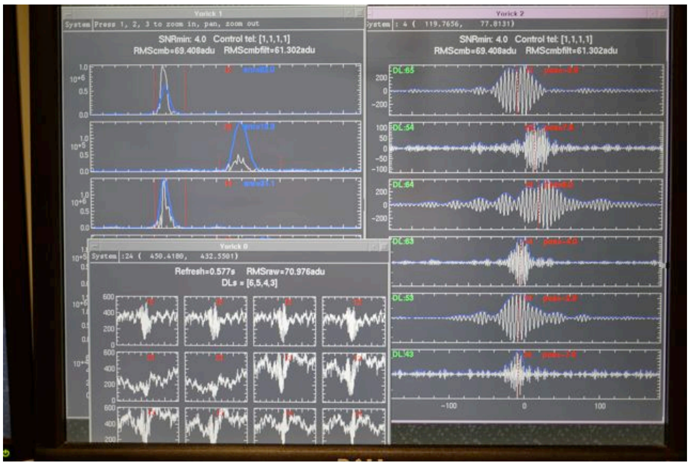


Figure 1 : Fringes displayed in the RTD_SCOPE

2.3 PIONIER data reduction

The PIONIER data reduction pipeline ***pndrs*** is installed in the offline machine (*astrov@wvgoff*). It is also available upon request (contact: Jean-Baptiste.Lebouquin@obs.ujf-grenoble.fr) and regularly updated. It provides science ready data for most of the science cases that do not correspond to extreme conditions. The final product is an OIFITS file containing calibrated squared visibilities and closure phases.

During normal operation at night, the data are transferred to the offline machine (*astrov@wvgoff*) and reduce with the pipeline to monitor the quality of the data and decide of the observing strategy accordingly. The script `pndrsPipeline` loops through the coming data and proceeds with reduction and calibration while providing pdf files that allow data quality assessment diagnostics.

Starting September 2013, the raw data are available from the ESO archive:
http://archive.eso.org/eso/eso_archive_main.html

3 Observing sequence and calibration plan

3.1 Observing modes

The offered parameters are the following:

- DISP.NAME = FREE, GRISM
- DET.DIT = 0.5, 0.75, 1.0, 1.5, 2.0, 3.0ms
- DET.GAIN = HIGH, MEDIUM

These parameters are not offered and should be kept at the default values:

- *INS.MODE=OBSERV-H*
- *NDITSKIP=1*
- *SCAN.ST=TRUE*
- *SCAN.STROKE=40e-6*
- *TRK.GAIN=0.5*
- *TRK.ST=1*

3.2 Selecting the correct setup depending of brightness and weather

Tableau 1 : Typical DIT for various observing setups in the H-band.

Corr. Mag.	**DET.GAIN**	*GRISM*	*FREE*
H<0	LOW	Not commissioned	
H<2	MEDIUM	0.5ms	
H<4	HIGH	0.5ms	
H<6	HIGH	0.75ms	
H<6.5	HIGH	1ms	0.75ms
H<7	HIGH	1.5ms	1ms
H<7.5	HIGH	2ms	1.5ms
H<8	HIGH		2ms

possible saturation
coherence time <3ms
coherence time >3ms
coherence time >6ms

The correlated magnitudes are given for a target at low airmass (<1.5), and bright in the visible (V<11) so that the guiding system is working properly. Otherwise the sensivity is degraded. Here are some recommended setups for peculiar sciences:

Imaging a Mira star with H~0, but very resolved:
The strategy to observe very bright/resolved targets is currently unknown, and should be defined with dedicated commissioning time. The main issue is the poor dynamic of the RAPID detector in the tested modes.
DISP.NAME = GRISM
DET.DIT = 0.5ms
DET.GAIN=LOW (no commissioned)
The calibration plan is currently unknown. It is not sure that these observations can be calibrated with KIII stars at H~3 in the same setup. A possible strategy is to observe the science (bright resolved) star with GAIN=LOW, and the calibration (fainter unresolved) star with GAIN=HIGH.

Accurate diameter of a marginally resolved target at H~3:
DISP.NAME = GRISM
DET.DIT = 0.5ms

DET.GAIN= MEDIUM
The observations can be calibrated with KIII stars at H~3 in the same setup.

Observation of targets fainter than H>4:
DISP.NAME = GRISM or FREE
DET.DIT = 0.5 to 3ms
DET.GAIN= HIGH
These observations can be calibrated with KIII stars in the same setup.

Use of the UTs:
This table has never been build for the UTs because not enough time was available. Based on past experiences, the GAIN is raised by ~1.5mag but the modes >6ms should be avoided because of the vibrations.

3.3 Spectral calibration

The spectral calibration is proved to be accurate at 2% and is stable over the night. The spectral calibration depends on the following parameters:

- DISP.NAME

Especially, the spectral calibration is independent from the parameter READOUT.MODE and NREADS. **The calibration of the spectral dispersion is under Paranal responsibility. The spectral dispersion is calibrated once per day in all offered setups.**

3.4 Transfer function calibration

The atmospheric and instrumental response is called the transfer function. The transfer function depends on the following parameters:

- Time, atmospheric conditions, position on sky…
- DISP.NAME
- DET.GAIN
- DET.DIT

In service mode, it is enforced to calibrate the transfer function by performing CAL-SCI-CAL sequences, with strictly the same setup.

3.5 Kappa-matrix calibration

The kappa-matrix is proved to be stable over several hours because it is related to the internal routing inside the IOBC. But it depends on the following parameters:

- DISP.NAME
- DET.GAIN
- DET.DIT

In service mode, it is enforced to calibrate the kappa-matrix once per CAL-SCI-CAL sequence, in the brightest star of the sequence. An average flux level >15adu is mandatory to measure properly the kappa-matrix.

3.6 Detector dark calibration

It is critical to monitor the detector dark to obtain an accurate photometric calibration and hence robust visibilities. It depends on the following parameters:

- Time, electronic temperature
- DISP.NAME
- DET.GAIN
- DET.DIT

In service mode it is enforced to calibrate the detector dark within each OB, with a single DARK exposure containing the same number of scan as a fringe exposure.

4 Preparing OBs

4.1 Aspro2

PIONIER is not included in p2pp so far. The only way to prepare OBs is to use the tool Aspro2 from the JMMC: http://www.jmmc.fr/aspro_page

- Enter your list of targets, including calibrators
- Go to "target Editor" to declare the calibrator and associate them with the targets
- Put the correct date and configuration, check the observability
- Go to "File > Export targets to Observing Blocks"

The instrumental setup is not included in the OBs so far (DISP.NAME). You should write this information in the README file.

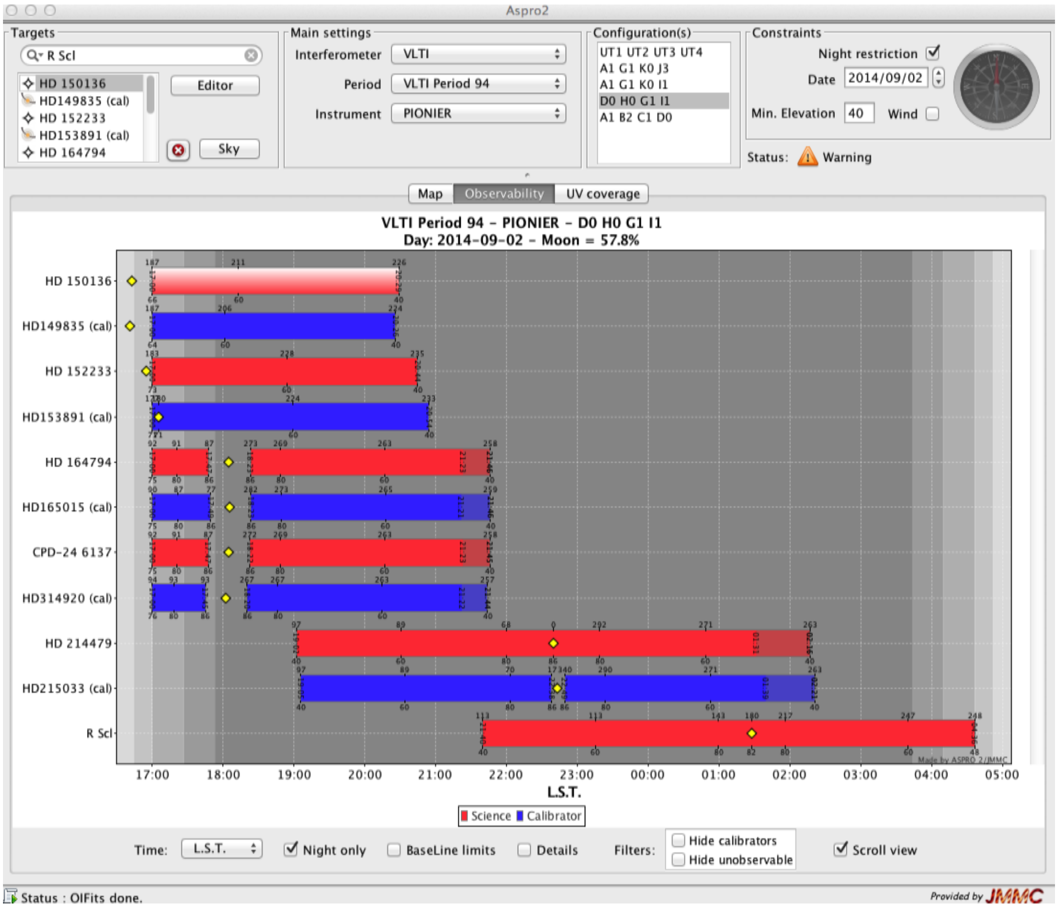


Figure 2 : Aspro2 with Observability chart of targets and calibrators.

5 Searching for calibration stars

5.1 Position on sky : ±3deg (goal) or ±10deg (loose)

The past years of experience with PIONIER have shown that the transfer function instability is mainly dominated by complicated polarization effects in the VLTI optical train, coupled with the internal polarization of PIONIER. Therefore the calibrators should be nearby on-sky. The separation should be less than 3deg to ensure accuracy at the 2% level on the V2 and 1deg on the CP.

5.2 H-band magnitude (±1mag)

At first order, the transfer function is independent from the target brightness. But we recall that **the instrument mode should be strictly identical for science and calibrator**. Once the NDREAD has been optimized for the science, it should be kept for the calibrator. The main difficulty is the very small dynamic range of the FOWLER mode of PIONIER. This means that typically the calibrator should be within 1mag (as well as within the magnitude limit).

5.3 Spectral types : KIII

Early type stars (O to F) should be avoided because their multiplicity fraction is very high. Evolved late type stars (MIII) should be avoided because they often have extended dust/molecular shells around.

1. Past years of experience with PIONIER have shown that K giants (KIII) are the most suitable calibrators. If none within 3deg, enlarge the search to 6deg.
2. If no KIII could be found, discard the filtering on luminosity class (consider all K, not only KIII). Then select a nearby K star with low proper motion.

5.4 Using SearchCal from JMMC

This tool is available at: http://www.jmmc.fr/searchcal_page
We recommend:

- Enter your target, specify the baseline, the H-band.
- Specify the mode FAINT with a search radius of 360min (~6deg)
- Search for calibrators with a delta Mag ±2
- Use the filters to keep only stars matching the criteria defined above
- Select 2 calibrators
- If none are available, relax some constrains (first accuracy on V2, then distance, magnitude, luminosity class, spectral types…). Try to **understand** why you cannot fulfill all of them simultaneously.

5.5 Peculiar case: resolved very bright star (H<H)

STILL NOT COMMISSIONED :
Imaging bright, large, evolved stars is a routine use of PIONIER. But it is impossible to find calibrators with similar magnitude because stars with spectral types K or latter are resolved with the longest baselines of VLTI. These programs often use the mode GRISM with GAIN=LOW because targets are bright, and because one needs a huge dynamical range to capture the small visibilities. The limiting magnitude of this mode is H~1, which is not enough to reach unresolved calibration stars (H~3). Consequently we recommend to observe the science with GAIN=LOW but to calibrate by observing unresolved KIII (H~3) with GAIN=HIGH. Unfortunately the sky density is poor and it is impossible to meet the 3deg requirement.

5.6 Peculiar case: faint stars (H>6)

Actually, according to our experience this is the most straightforward situation to search for calibration stars. At this magnitude, any KIII will be almost unresolved and therefore can be considered as a good calibrator, even if they are not in the catalogs from Merand and Borde. At these magnitudes, the sky is dense enough to easily find KIII stars within 3deg around every target. Obviously, few of them may appear to be multiple, so it is a good practice to execute a CAL-SCI-CAL sequence with two different calibrators.

5.7 Peculiar case: the Adaptive Optics on the UTs

The influence of the Adaptive Optics (MACAO) on the PIONIER transfer function has never been investigated. Ideally, one would favor calibrators with similar V-band magnitude than the science target, to ensure the AO is working with comparable performances. But this is often impossible. Here we are in the “unknown” and everybody is welcome to provide feedback.

6 Installation of pndrs

6.1 Getting the sources

The PIONIER data reduction software is called `pndrs`. It is written in the scripting language "yorick". It relies on the library "yoco". The easiest way to install them is to grab the sources directly from the svn repositories:

```
svn co https://forge.osug.fr/svn//ipag-sw/YOCO/trunk/yoco
svn co https://forge.osug.fr/svn/ipag-sw/PIONIER/trunk/pndrs
```

6.2 Declare the installation directory

You should declare the installation variable $INTROOT in your bash profile. Note that *$INTROOT/bin* and *$INTROOT/yorick/bin* should be in the path, both at the installation time and at the runtime. So you better put these lines in your bachrc:

```
export INTROOT=$HOME/Software
export PATH=$INTROOT/bin:$INTROOT/yorick/bin:$PATH
```

This INTROOT can be shared with other software. It can be the same as for the AMBER data reduction software `amdlib` for instance. This INTROOT should have permission to write at the installation time.

6.3 Compile and install

To compile and install, just run the following commands:

```
cd yoco/distrib; ./install.sh;
cd ../../;
cd pndrs/distrib; ./install.sh;
```

If you already have `amdlib` installed in the INTROOT, you don't need to re-install "yorick" (answer "N" to the corresponding question), but you can safely answer "Y" to all others questions. Otherwise you can safely answer "Y" to all questions. It wills eventually install "yorick" in the INTROOT directory.

6.4 What are the pndrs commands:

Here the two useful commands:
`pndrsReduce` : Reduce all RAW data into uncalibrated OIFITS files.
`pndrsCalibrate` : Calibrate all uncalibrated OIFITS files into calibrated OIFITS files.

To be used when observing:
`pndrsPipeline` : Run the reduction and calibration steps in loop, to be used at Paranal for Quick Look. Don't use this for the offline data reduction as it contains peculiar directory specification for Paranal.

Other commands, generally never used:
`pndrsInspectRawData` : Overview of the scans in a RAW file, allow selection.
`pndrsInspectRawData` : Run the previous command in all files, allow selection.
`pndrs` : start yorick shell and include the pndrs scripts, for interactive use.

7 From RAW data to Uncalibrated OIFITS

The first step is to reduce the raw data ("scanned fringes") into uncalibrated measurement of the visibilities and closure phases. This step is done file-per-file, that is each FRINGE exposure in the raw directory will have a corresponding file in product directory. Note that, unlike in AMBER, this step also includes the averaging over the ~100 scan that compose a standard exposure. This step is rather long (1h for an entire night). However, the default reduction (so called abcd mode) is proved to be quite robust. **It is very recommended to trust it blindly.**

7.1 Running the reduction

Several versions of the data reduction are implemented. However, they are all experimental except the default one, called "abcd". Note that it is called "abcd" even if the data have been acquired with the –AC mode or with the 4T-AC-H combiner (12 outputs).

```
cd /data/pionier/2013-06-06
pndrsReduce
```

This script performs the following steps:

1- Loop into files to build a log of the night
2- Compute the kappa-matrix from all shutter-sequences taken
3- Compute the wavelength tables of each spectral calibration taken (internal light)
4- Loop on all raw FRINGE files and compute uncalibrated OIFITS

7.2 Command line option

The reduction script has the following options in the command line

```
pndrsReduce -o
```

will overwrite the existing reduced files if any. By default, the reduction will skip already reduced files.

```
pndrsReduce -calibrate
```

will automatically run the calibration script at the end of the reduction script.

7.3 Checking the reduction

The script creates the following outputs:

`2013-06-06_v2.52_calib/PIO*kappaMatrix.fits`
`2013-06-06_v2.52_calib/PIO*kappaMatrix*pdf`

They are the kappa-matrix recorded into FITS files, with some plots to check the reduction. The full ESO header of the first exposure is copied into the product file and is updated with PRO.CATG=KAPPA_MATRIX.

`2013-06-06_v2.52_calib/PIO*spectralCalib.fits`
`2013-06-06_v2.52_calib/PIO*spectralCalib*pdf`

They are the spectral calibration files (wavelength tables), with some plots to check the reduction. The full ESO header of the first exposure is copied into the product file and is updated with PRO.CATG=SPECTRAL_CALIB.

`2013-06-06_v2.52_abcd/PIO*oidata.fits`

They are the uncalibrated OIFITS files. There is one file per RAW exposure. The 100 scans are already averaged into a single measurement. The full ESO header of the RAW exposure is copied into this product file and is updated with PRO.CATG=OIDATA_RAW.

`2013-06-06_v2.52_abcd/PIO*.pdf`
They are the plots of the intermediate steps of the data reduction. Most important among are:
`2013-06-06_v2.52_abcd/PIO*psd*.pdf` ⇒ Averaged Power Spectral Densities
`2013-06-06_v2.52_abcd/PIO*snr*.pdf` ⇒ SNR and piston per scan

`2013-06-06_v2.52_abcd/PIO*log.txt`
They contain the log of the `pndrsReduce` script when working this is file. Look at this log to understand why the reduction failed to produce OIFITS files for some observations.

8 From Uncalibrated OIFITS to Calibrated OIFITS

The second step is to calibrate the observation of science objects with the observation of calibration stars. This step is performed “globally”, that is all the uncalibrated OIDATA_RAW oifits are loaded first, then the script search for consistent sequences (same setup, same DIT, same wavelength table…), and then each sequence is calibrated independently with the calibration star that could be find within it. This step is rather short (1min for an entire night). However, the calibration is a delicate task, which requires human intervention to check the outputs and refine the parameters. **It is very recommended to NOT trust it blindly.**

8.1 Running the calibration

```
cd /data/pionier/2013-06-06_v2.52_abcd
pndrsCalibrate
```

This script performs the following steps:

1- Load all the uncalibrated OIDATA_RAW files (*oidata.fits)
2- Look for calibration stars by matching the coordinates with catalogs. That is every object that has an entry is flagged as “calibrator”.
3- Write few summary of the night in text files.
4- Execute the user-defined script `2013-06-06_pndrsScript.i` if any.
5- Identify consistent sequences based on instrument setup (NREADS, DISP.NAME…)
6- For each of these sequences, hereafter called setup:
    a. Compute discrete estimates of the transfer function with the observation of calibration stars (taking into account their diameters).
    b. Interpolate this transfer function and calibrate all observations of this setup, including the observations of science object and calibration object.
    c. Write TF estimates (OIDATA_TF) and calibrated sciences products (OIDATA_CALIBRATED) individually for each template.
    d. Write plots about the calibration sequence of this setup.
    e. Go to next setup.
7- Plots some overall summary of the calibration of the night (all setups together).
8- Loop on object:
    a. Write a single calibrated OIFITS file per object, with all observation of the night.
    b. Plots overall summary of these calibrated data (vis2, t3phi, uv-plane).

Remember: **It is very recommended to NOT trust it blindly. The significance of the results of the calibration is the sole responsibility of the user.**

8.2 Command line option

The calibration script has the following option in the command line

```
pndrsCalibrate --averageFiles=1   # default
pndrsCalibrate --averageFiles=0
```

If set to 1, the consecutive files of an Observation Block are averaged together into a single measurement point before running the calibration.

8.3 Checking the calibration (critical)

The script creates the following outputs:

`2013-06-06_v2.52_abcd/2013-06-06_log.txt`

It contains the entire log of the `pndrsCalibrate` script. Look at this log to understand why the script did not calibrate some OIFITS files.

`2013-06-06_v2.52_abcd/2013-06-06_oiDiam.fits`
It contains the list of all object with its diameter found by matching the Borde, Merand and JSDC catalogs. The flag "isCal = 0/1" specifies if this object should be used as science or calibration. The calibration script does NOT override this file if it exists already.

`2013-06-06_v2.52_abcd/PIO*_oidataCalibrated.fits`
They are the final, calibrated OIFITS files on the science objects, one per template. The file contains either NEXP measurement (into a single OIFITS structure) or a single measurement if the files have been averaged (see next sections). It contains the ESO header of the last file of the template sequence, updated with PRO.CATG=OIDATA_CALIBRATED.

`2013-06-06_v2.52_abcd/PIO*_oidataTf.fits`
They are the TF estimates on the calibration stars, one per template. The file contains either NEXP measurement (into a single OIFITS structure) or a single measurement if the files have been averaged (see next sections). It contains the ESO header of the last file of the template sequence, updated with PRO.CATG=OIDATA_TF.

`2013-06-06_v2.52_abcd/2013-06-06_TF_vis2_setupX_binY.pdf`
`2013-06-06_v2.52_abcd/2013-06-06_TF_t3phi_setupX_binY.pdf`
They contain the calibration plot of the spectral bin Y of the setup X (a setup being defined as a consistent sequence of observation). It shows the discrete estimates of the transfer function in black dots, the interpolation in black lines and the observations of science objects in colors.

`2013-06-06_v2.52_abcd/2013-06-06_TF_vis2_lbdBinAvg.pdf`
`2013-06-06_v2.52_abcd/2013-06-06_TF_t3phi_lbdBinAvg.pdf`
They contain a summary of the calibration of all setups of the night. It shows an average of few spectral channels in the middle of the band. This is mainly for summary. Quantitative checks should be done with the "per setup per bin" plots.

`2013-06-06_v2.52_abcd/2013-06-06_SCI_XXXX_oidataCalibrated.fits`
`2013-06-06_v2.52_abcd/2013-06-06_SCI_XXXX_*pdf`
`2013-06-06_v2.52_abcd/2013-06-06_CAL_YYYY_oidataCalibrated.fits`
`2013-06-06_v2.52_abcd/2013-06-06_CAL_YYYY_*.pdf`
They contain the calibrated OIFITS data for each object. Note that the observations of calibration star are calibrated too, so they are scientifically meaningless.

8.4 Interacting and fine-tuning the calibration: pndrsScript.i

All the possible interaction and fine-tuning of the calibration steps are done with the scripting capability of `pndrsCalibrate`. This is done iteratively by:

1- Looking at the plots generated by the calibration (Sec. 8.2)
2- Creating or editing the following script file:
   `2013-06-06_v2.52_abcd/2013-06-06_pndrsScript.i`
3- Re-running the calibration

This script is executed by `pndrsCalibrate` after loading the uncalibrated OIFITS files and after loading the oiDiam files, but before performing all the steps related to calibration. Consequently, the following structures are defined at runtime: oiVis2, oiVis, oiT3, oiArray, oiLog, oiTarget, oiDiam… It is possible to implement in the script all the powerful functions of the `oiFitsUtils.i` library. Here we summarize the most important and straightforward functions and keywords.

The reason for this choice of scripting is to enforce the user to record all the "tricks" he had to use. Once build, the script allows reproducing exactly the same data calibration at any time from the reduced OIFITS. Somehow, for given night, it is more important to backup this script than the calibrated data themselves.

It is a good practice to write a comment with the function `yocoLogInfo` explaining each step of the script. These comments are forwarded to the log of `pndrsCalibrate`.

8.5 Changing an object from science ⇔ calibration

Use the function `oiFitsSetTargetAsCalib` and `oiFitsSetTargetAsScience` in the script `2013-06-06_pndrsScript.i`. The diameter and its errors are specified in [mas].

```
yocoLogInfo,"Change some SCI to CAL and some CAL to SCI";

oiFitsSetTargetAsCalib, oiDiam, oiTarget, target="HD101917",
 diam=0.67, diamErr=0.1;

oiFitsSetTargetAsScience, oiDiam, oiTarget, target="MCW_1234";
```

8.6 Ignoring some observations

Use the function `oiFitsFlagOiData` in the script `2013-06-06_pndrsScript.i`. The wavelength interval (wlimit, microns), the baseline (base, string) and the time interval (tlimit, MJD) can be omitted to discard all observations matching the criteria. The structure oiVis2, oiT3 and oiVis can be omitted in order to not discard the corresponding observations.

```
yocoLogInfo,"Discard some observations";

oiFitsFlagOiData, oiWave, oiArray, oiVis2, oiT3, oiVis,
  wlimit=[1.6,1.7], base="*G1*", tlimit=[56093.366,56093.368];

oiFitsFlagOiData, oiWave, oiArray, oiVis2, oiT3, oiVis,
  wlimit=[1.6,1.7];

oiFitsFlagOiData, oiWave, oiArray, oiVis2, , ,
 base="A1-G1";
```

8.7 Changing the interpolation laws

Specific keywords can be defined in the script `2013-06-06_pndrsScript.i`. They will be forwarded accordingly to the functions that perform the calibration. The possible values are the following: "interp", "smooth", "average", "linear", "quadratic". If the number of points is not sufficient to perform the requested interpolation, then the transfer function is simply averaged.

```
yocoLogInfo, "Change the interpolation laws";

vis2TfMode = "smooth";
t3TfMode = "linear";
visTfMode  = "average";
```

8.8 Splitting the night

Use the function `oiFitsSplitNight` in the script `2013-06-06_pndrsScript.i`. You can define precisely the MJD you want to cut by looking at the summary of the night `2013-06-06_summaryFull.txt` which contains the MJD of each observation.

```
yocoLogInfo, "Split the night to isolate SCI-CAL sequences";

cc = [56132.0429,  56132.1069,  56132.1651,  56132.3596];
oiFitsSplitNight, oiWave, oiVis2, oiVis, oiT3, tsplit=cc;
```

It is recommended to split the night when the observations have been performed at very different position on sky. If possible, one can split the different science objects into dedicated sequences (like CAL-SCI1-CAL-SCI1-CAL // CAL-SCI2-CAL).

8.9 Averaging the 5 consecutive exposure (one OB)

A normal PIONIER OB contains five consecutive exposures. Since the super-synthesis is small during this time, it is often possible to average them into a single measure with better SNR. It also reduces the final amount of data to be dealt with for the analysis, and reduce the amount of correlation. To make this average, use the function `oiFitsGroupAllOiData` in the script `2013-06-06_pndrsScript.i`.

However, the 5 consecutives exposures are also quite interesting got guess the quality of the observations and the stability of the transfer function. Consequently, it is recommended to not group the files when running the calibration step for the first times, but only when the calibration script is well defined (cut, selection…).

```
yocoLogInfo, "Group consecutive oiData";

oiFitsGroupAllOiData, oiVis2, oiVis, oiT3, oiLog;
```

For some objects, the super-synthesis effect is too fast and it is not possible to average the consecutive files. This is mainly true for wide binaries. In this case, it is possible to split the array containing the data before averaging, and then re-build the full data array. Doing so the data recorded on these stars are not averaged.

```
yocoLogInfo, "Group consecutive oiData except for HD168112";

oiFitsSplitArrays, oiArray, oiTarget, oiVis2, oiVis2_1,
 oiT3, oiT3_1, target=["HD168112"];

oiFitsGroupAllOiData, oiVis2, oiVis, oiT3, oiLog;

oiFitsGrowArrays, oiVis2, oiVis2_1, oiT3, oiT3_1, oiVis, oiVis_1;
```