IRC data & imaging pipeline

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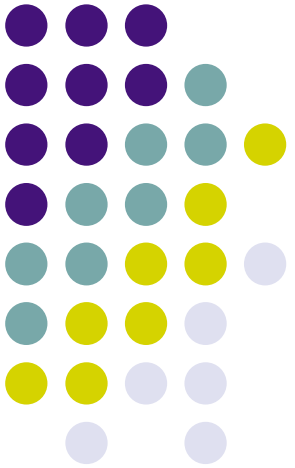
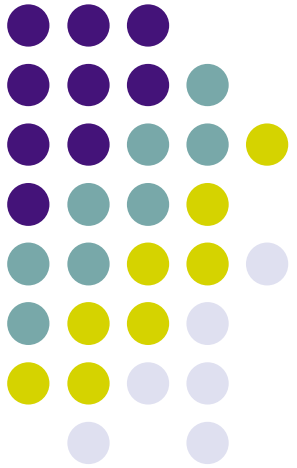
& IRC team

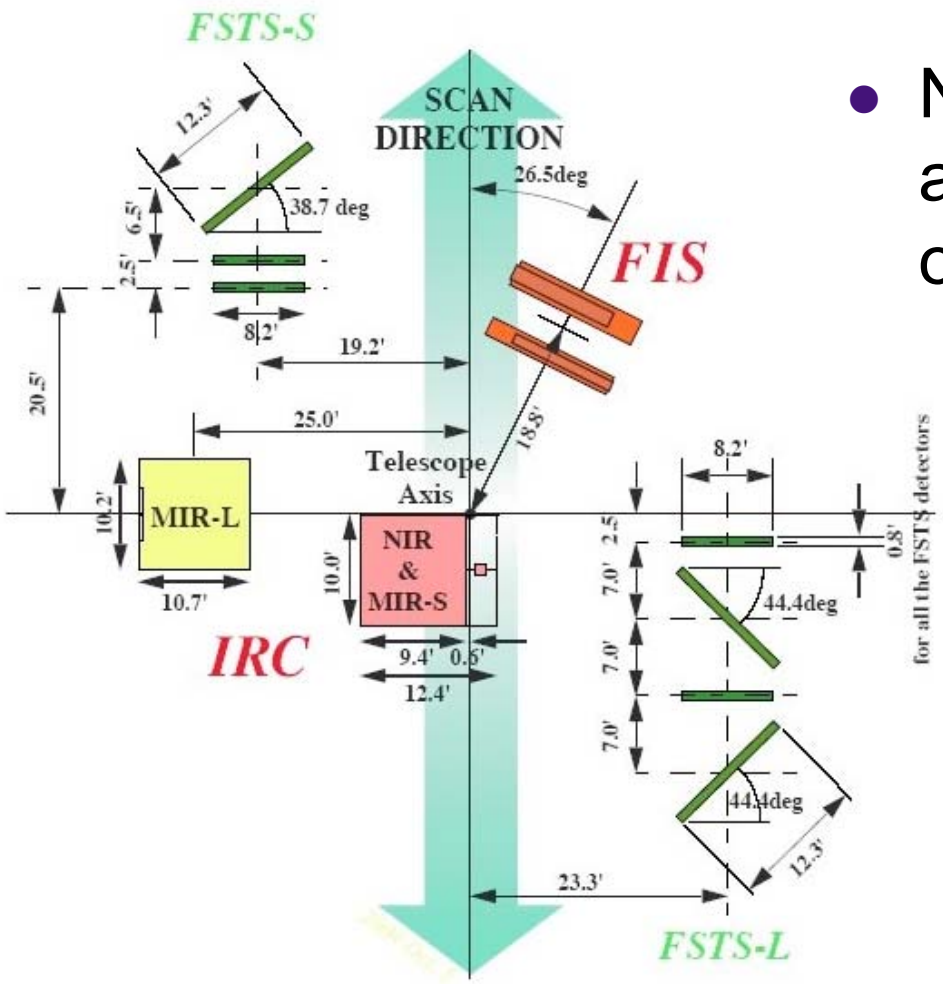


Part 1: IRC data



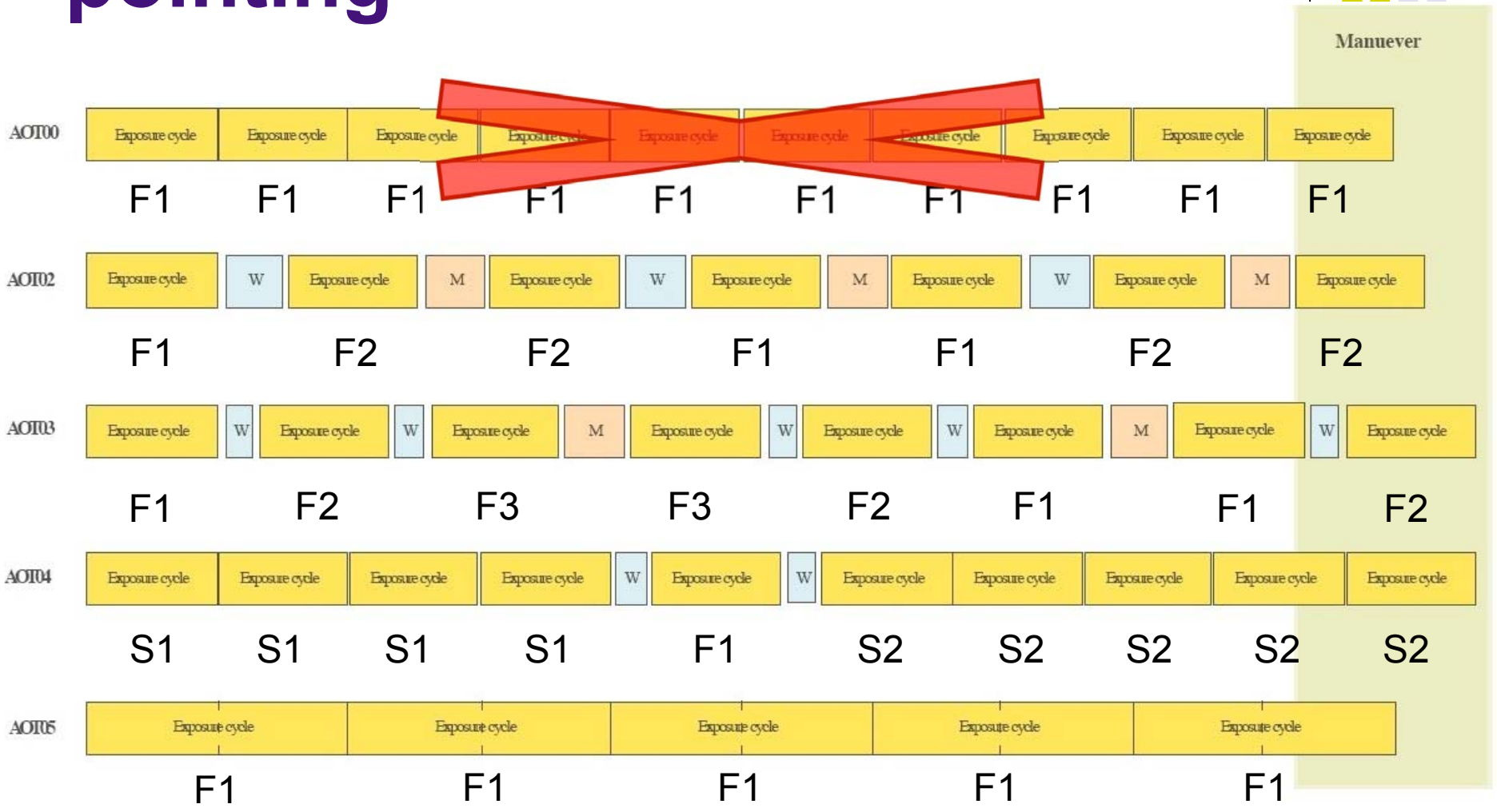
- Focal plane layout
- Observational sequence
- Structure of IRC fits files
- Current status and characteristics/problems

Focal-plane layout

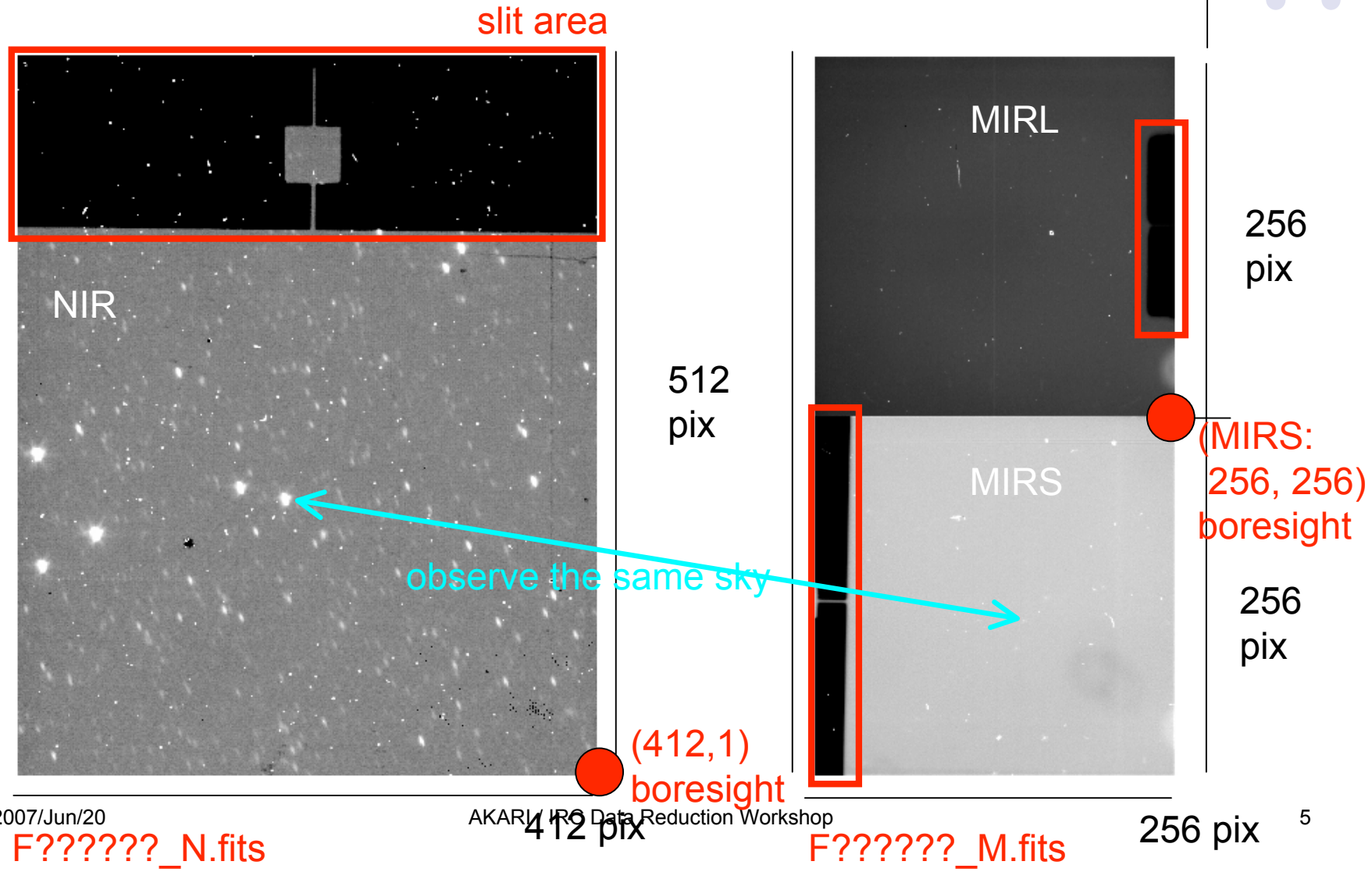


- Note that NIR&MIR-S and MIR-L does not observe the same sky.

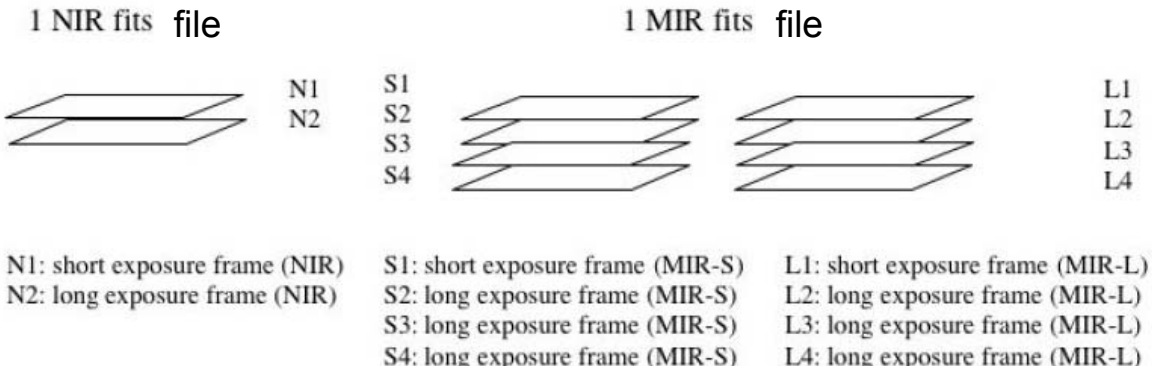
Observation sequence in one pointing



What you will get = rawdata



Structure of IRC fits files



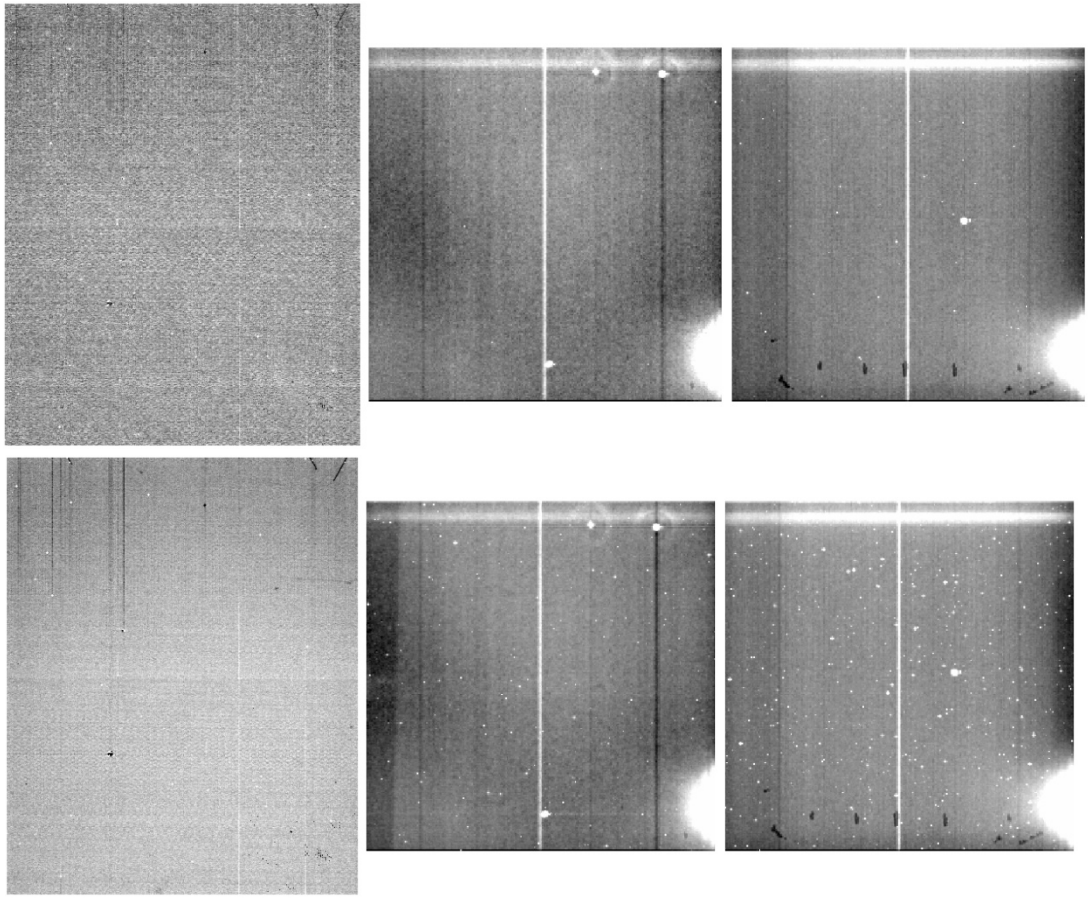
- The IRC FITS data is not a usual 2D one. A raw data FITS file is created for each Exposure Cycle during a pointing for the NIR and combined MIR-S/MIR-L channels. (i.e. 1 NIR FITS file and 1 MIR FIT file = 2 FITS files per Exposure Cycle). The filename format is given as F***** N.fits or F***** M.fits, where ***** is a distinct incremental reference number.
- A NIR raw fits data file is a data cube containing 2 frames within it, corresponding to one short and one long exposure.
- Each MIR raw FITS file contains 4 frames within it (one short and three long exposures) for both the MIR-S and MIR-L channels respectively making a total of 8 frames per MIR FITS file per Exposure Cycle.

Difference from the familiar fits files (summary)

- 3-dimensional
  - 1 NIR fits file contains:
    - 1 short exposure frame
    - 1 long exposure frame
  - 1 MIRS fits file contains:
    - 1 short exposure frame for MIRS and MIRL
    - 3 short exposure frame for MIRS and MIRL
- MIRS and MIRL do not observe the same sky, but they are stored in one fits file.

Current status and characteristics/problems (1)

- The number of hot pixels are increasing

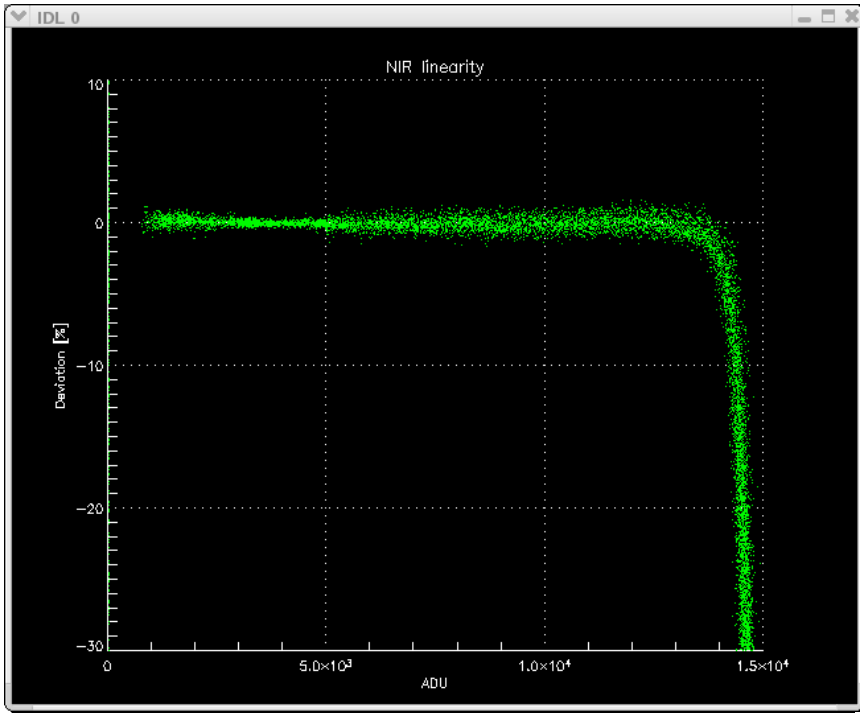


PV phase
(April)
dark image

4 months Later
(August)
dark image

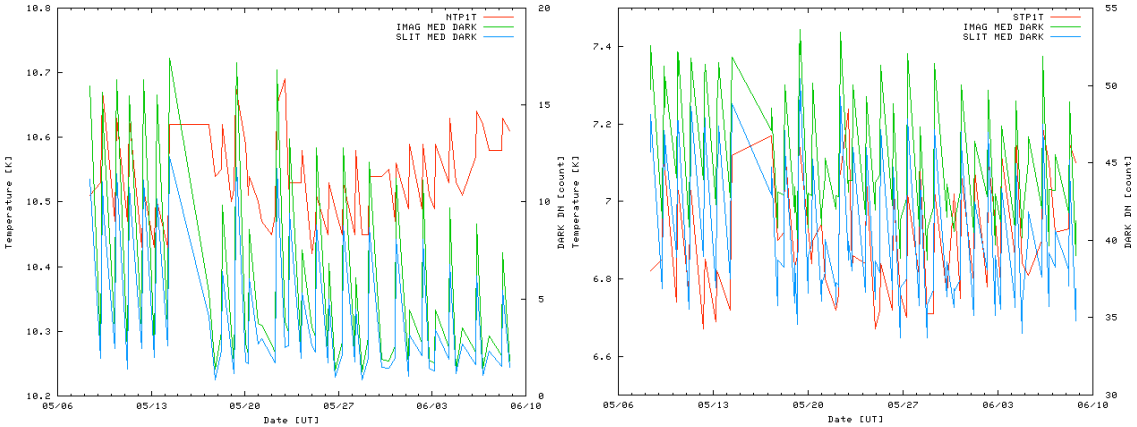
Current status and characteristics/problems (2)

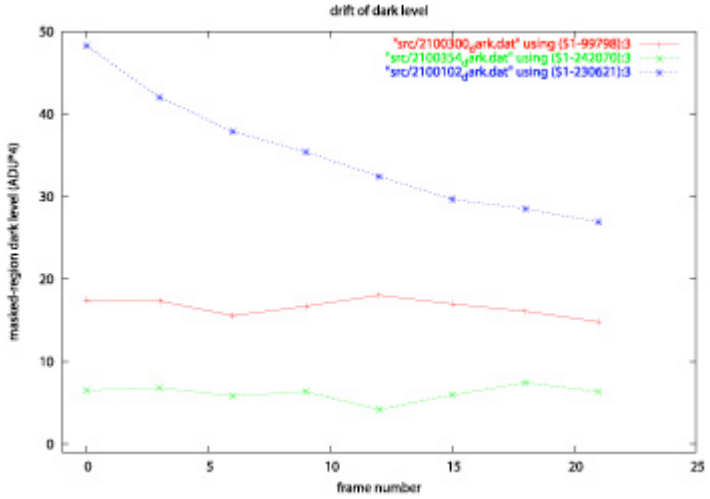
- Detector linearity
  - measured with IRC installed in the laboratory and in flight like configuration
  - measurements were made with calibration lamp that illuminates detector and an increasing range of integration times
  - after the correction, the deviation from the ideal linear curve is better than 5% at the DN of 12000 and 30000 in NIR and MIR, respectively



Current status and characteristics/problems (3)

- Dark and/or Bias stability
  - dark level is NOT stable during 1 pointing.
  - super-dark images were made with pre-dark data taken in LMC survey. They are “shifted”, i.e., add/subtract a certain constant, by checking slit area in each image, and then subtracted.
  - NIR: no apparent correlation with detector temperature
  - MIR: weak correlation with detector temperature
  - dark level is very high after passing SAA



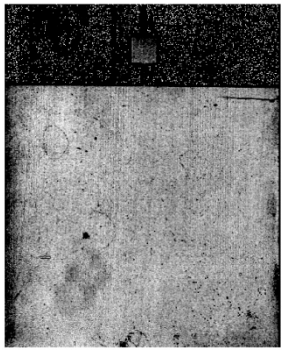


data from Dr. Wada

Current status and characteristics/problems (4)

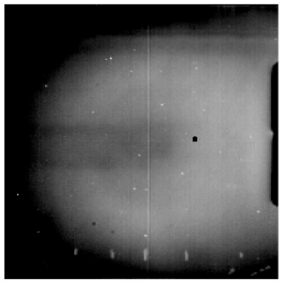
- Flat field
  - NIR
    - NEP survey data
    - S/N : about 10
  - MIR
    - NEP survey data
    - S/N : more than 100
- Stray light
  - present in all detectors
  - unexpected high background probably due to external (Earth) light, which is not uniform over the FOV (MIR-L)
  - flat-field are affected
  - observation of diffuse background will suffer

N4 : +- 5%



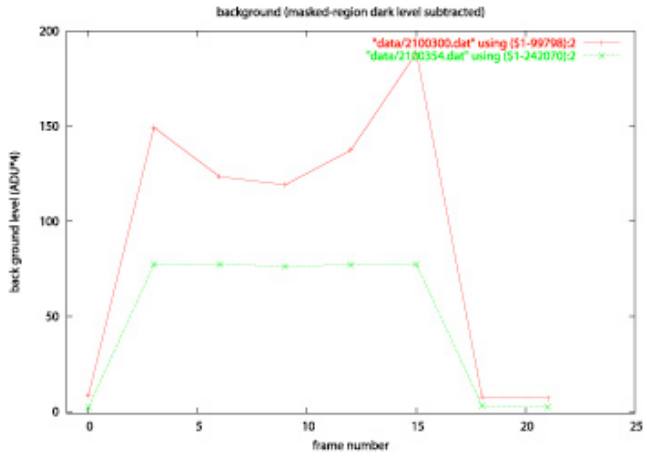
S11: +- 10%

L24: +- 10%



Unidentified object

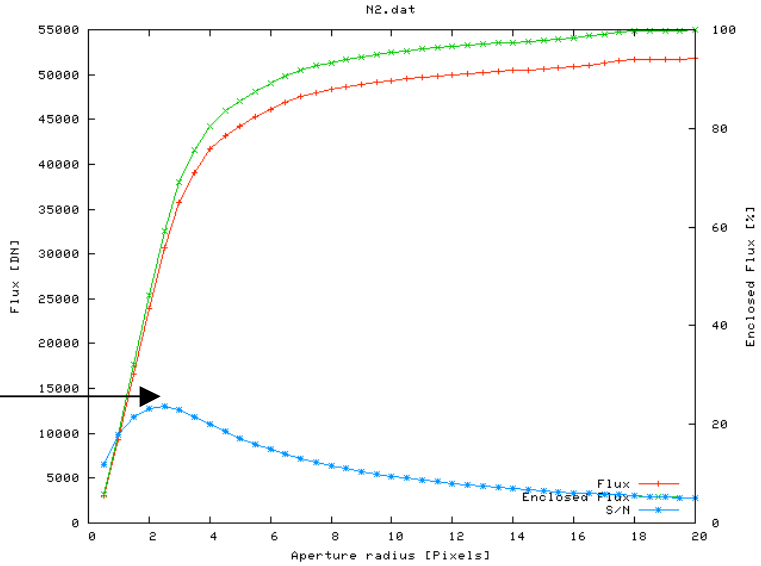
Disappeared after 8th January 2007



data from Dr. Wada

Current status and characteristics/problems (5)

- Aperture Correction
  - IRC flux calibration were made by observing standard stars (point source)
  - we assume that all flux are come into certain radii (10 and 7.5 pixels for NIR and MIR).
  - these radii are large compared to S/N optimal apertures
  - the amount of flux enclosed in these radii is still UNKNOWN (i.e., flux calibration for diffuse source is still unknown)
  - aperture corrections must be applied when using different apertures
  - we will provide aperture corrections, but observers are encouraged to see their own curves-of-growth because the PSF differs from pointing to pointing



$$Signal = Const * EE(r_{aperture})$$

$$Noise = \sqrt{\sum_{i}^{N_{pixel}} noise_i^{\,2}} = \sqrt{N_{pixel}} * noise_{pixel}$$

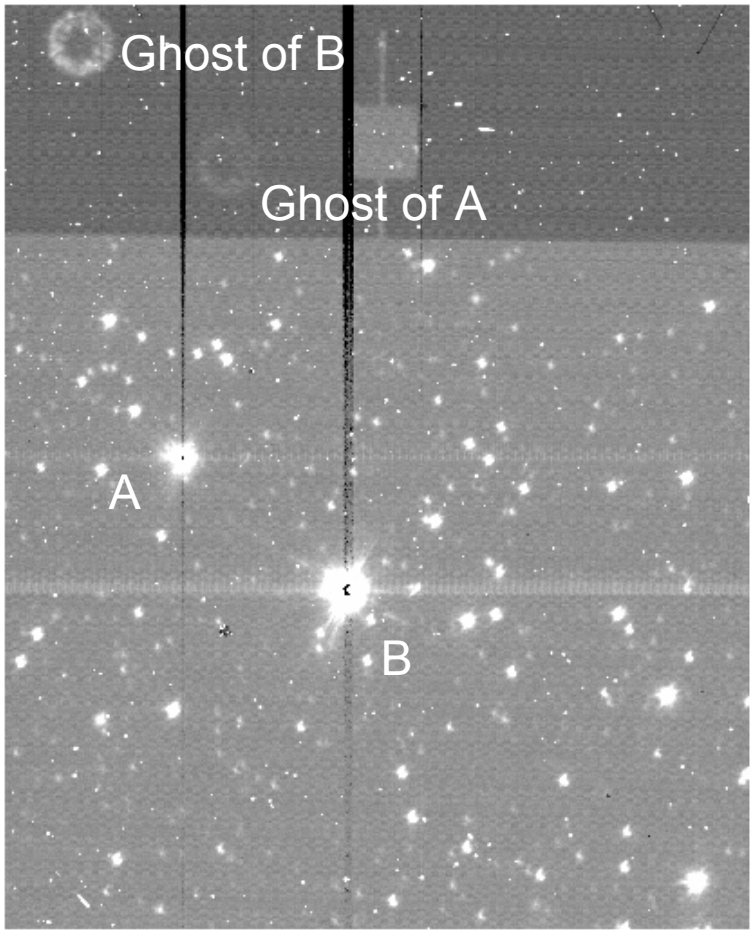
$$N_{pixel} = \pi * r_{aperture}^2$$

$$\frac{Signal}{Noise} = \frac{Const}{\sqrt{\pi}\, noise_{pixel}} * \frac{EE(r_{aperture})}{r_{aperture}}$$

i.e., S/N ∝ EE(r)/r

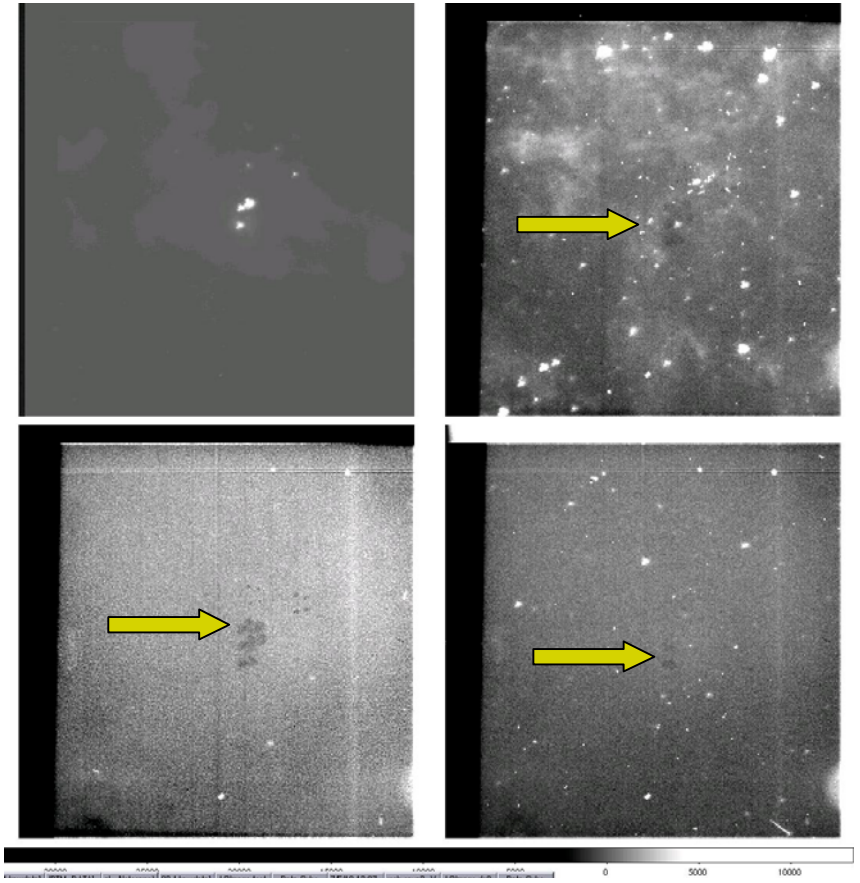
Current status and characteristics/problems (6)

- Ghost in slit-area
  - NG slit-spectroscopic data would be damaged if bright stars were present in the imaging area.
  - Details → Ohyama-san's presentation.

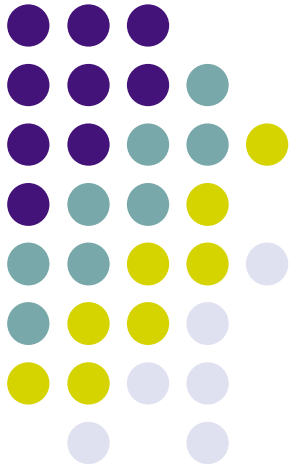


Current status and characteristics/problems (7)

- Latent in MIR-S&L
  - Flat changes after observing very bright stars.
  - A few % decrease
  - Last for several (up to 8) hours

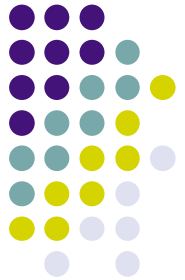


Part 2: IRC imaging pipeline



- Requirements
- Outline
- Structure
- What you will get
- Things not included yet

Requirements



- Unix (Linux, BSD, OSX, Solaris)
- Perl
- GCC3.0 or later
- IRAF version 2.12.2 or later
  - Imaging pipeline may work on Intel-Mac PC, although it is not fully tested.

Outline of pipeline

- Red Box (pre-pipeline processor)
  - header formatting
  - ***Make observing log***

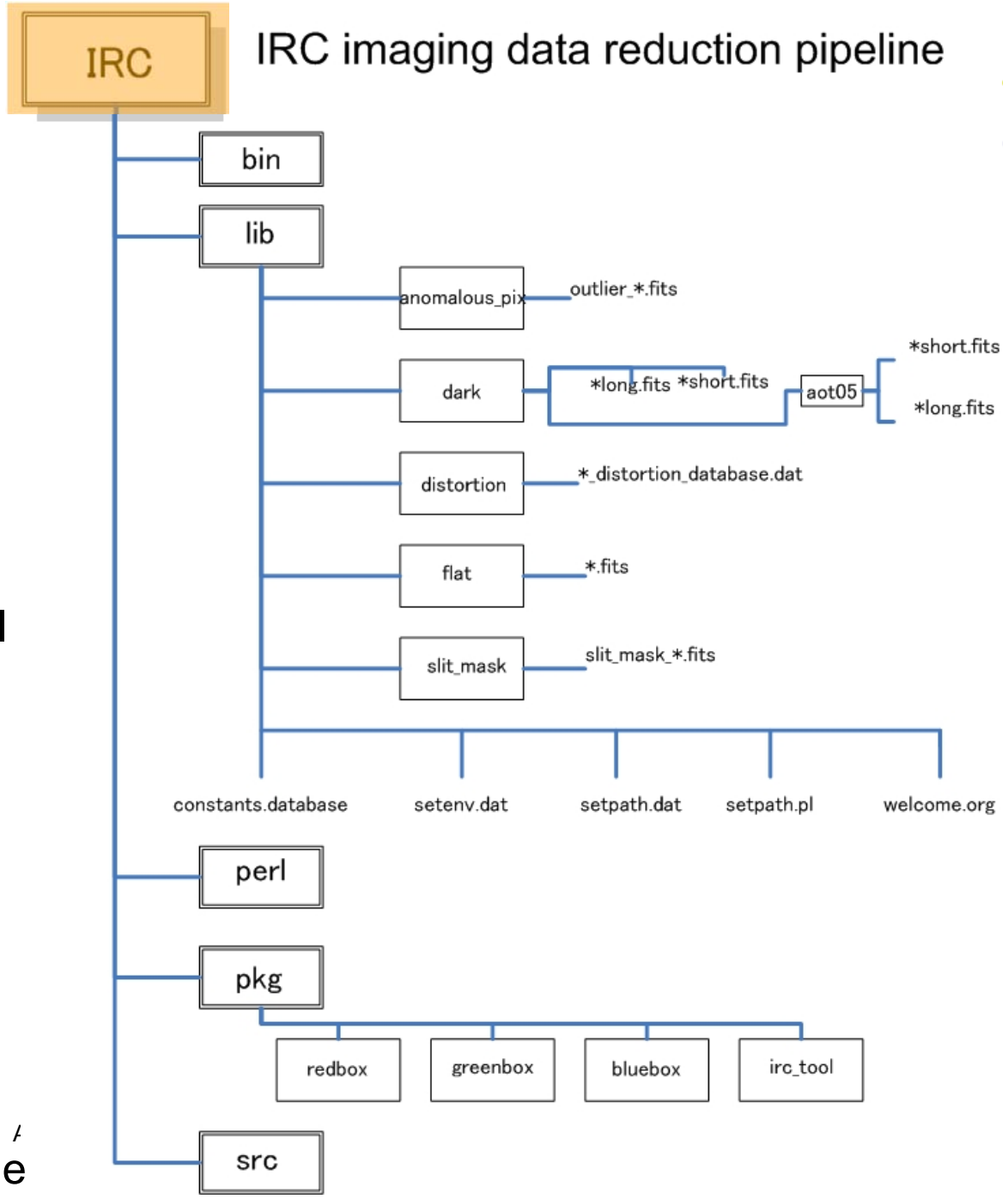
} prepipeline

- Green Box (pipeline processor)
  - instrumental signature correction
    - wraparound, fowler/bit-shift renormalization
    - dark subtraction, linearization, flat fielding, distortion correction etc.
  - ***Make Basic Data***
- Blue Box
  - co-add dithered images (multi-pointing compliant)
  - ***Make Post Basic Data***

} pipeline

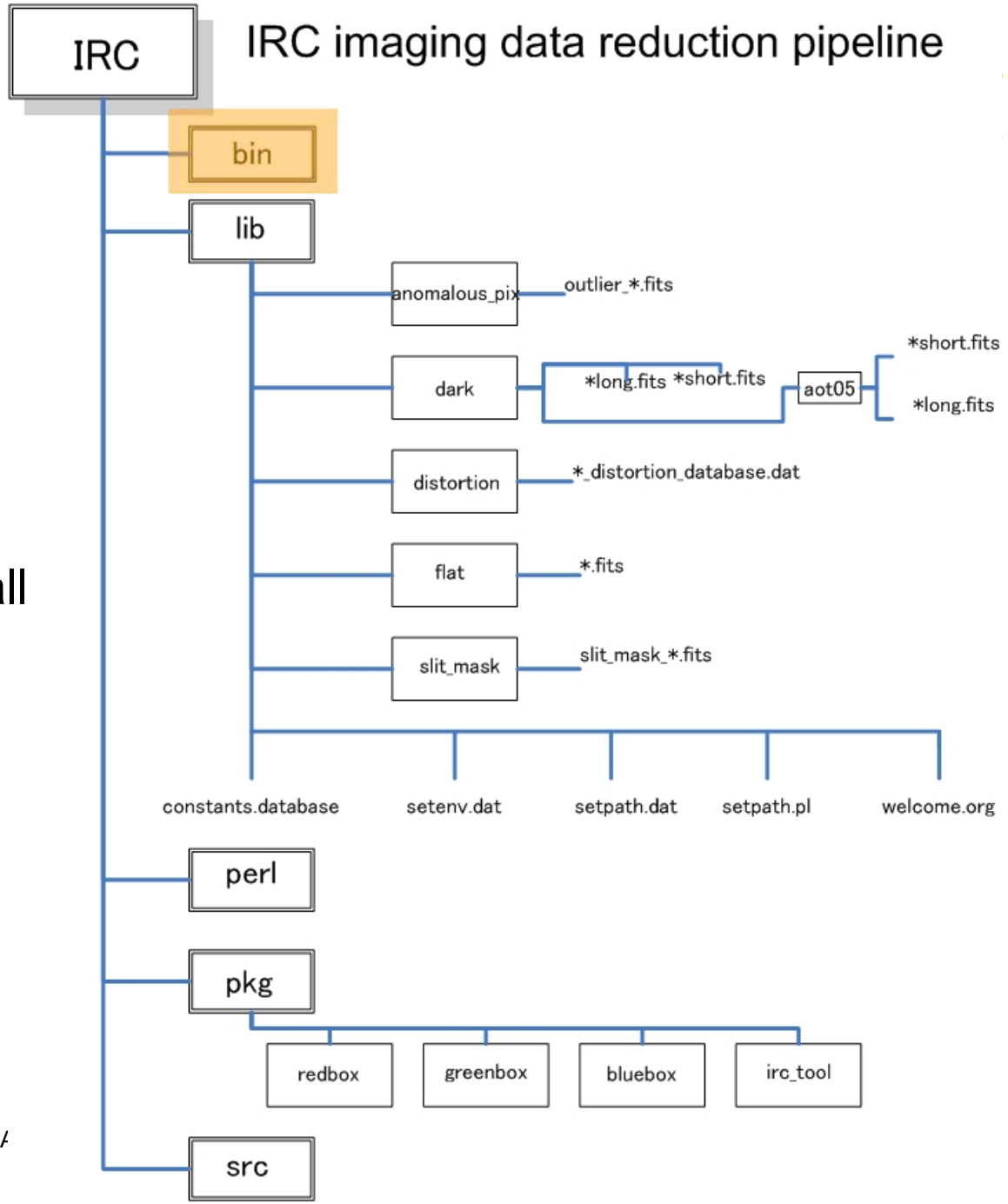
Structure of pipeline(1)

- irc
  - irc.cl
    - package root
  - load.cl
    - iraf packages preloaded in irc.cl
  - pipeline.cl
    - pipeline
  - prepipeline.cl
    - prepipeline
  - unlearn_all.cl
    - unlearn iraf parameters
  - welcome.txt
    - welcome message



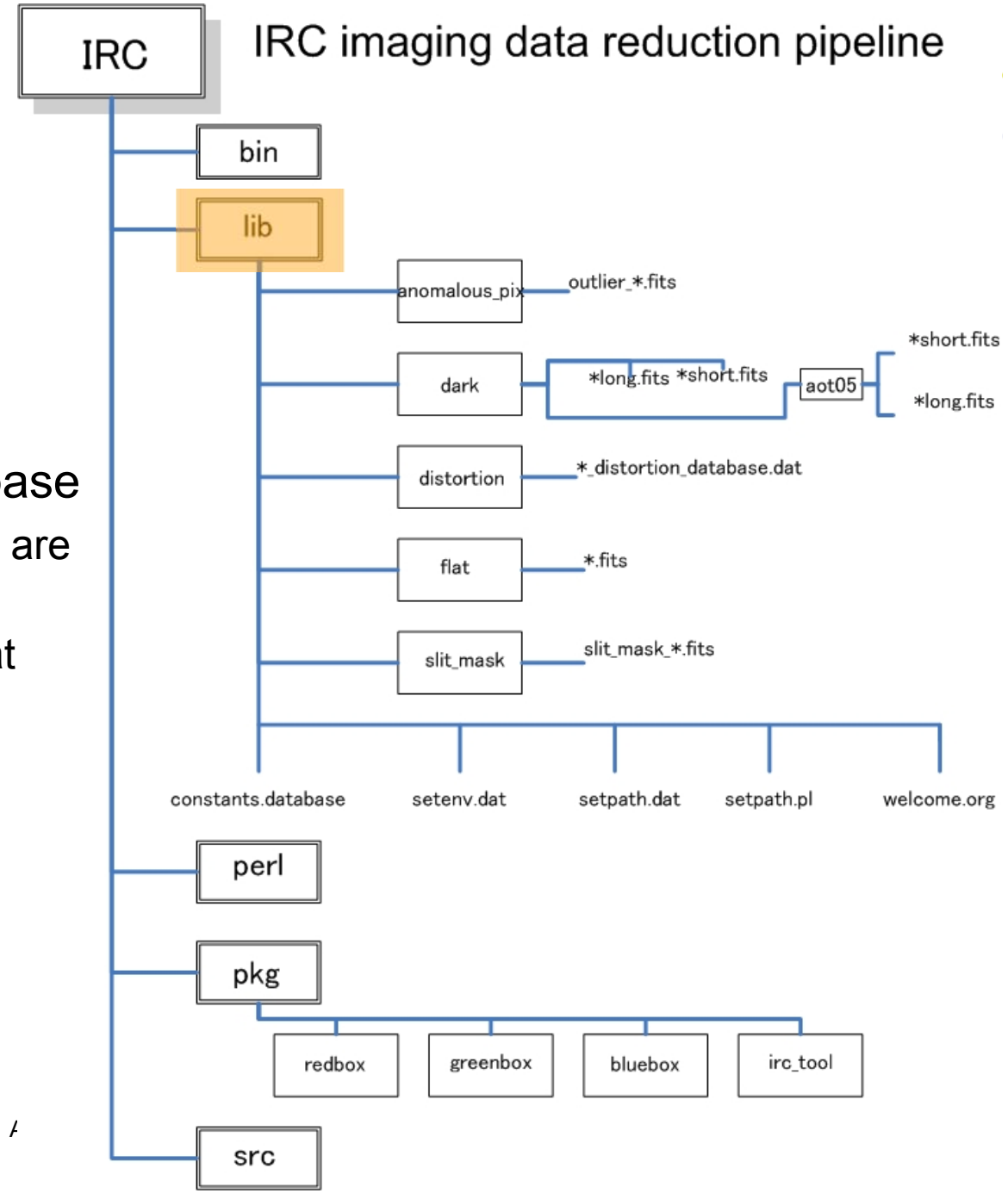
Structure of pipeline(2)

- binary
  - binary files
    - convert2mass
      - used in putwcs
    - convert2mass_all
      - used in putwcs
    - lonesome
      - used in calcshift
    - mkflatpair
      - used in flat
    - mkpair
      - used in coadd



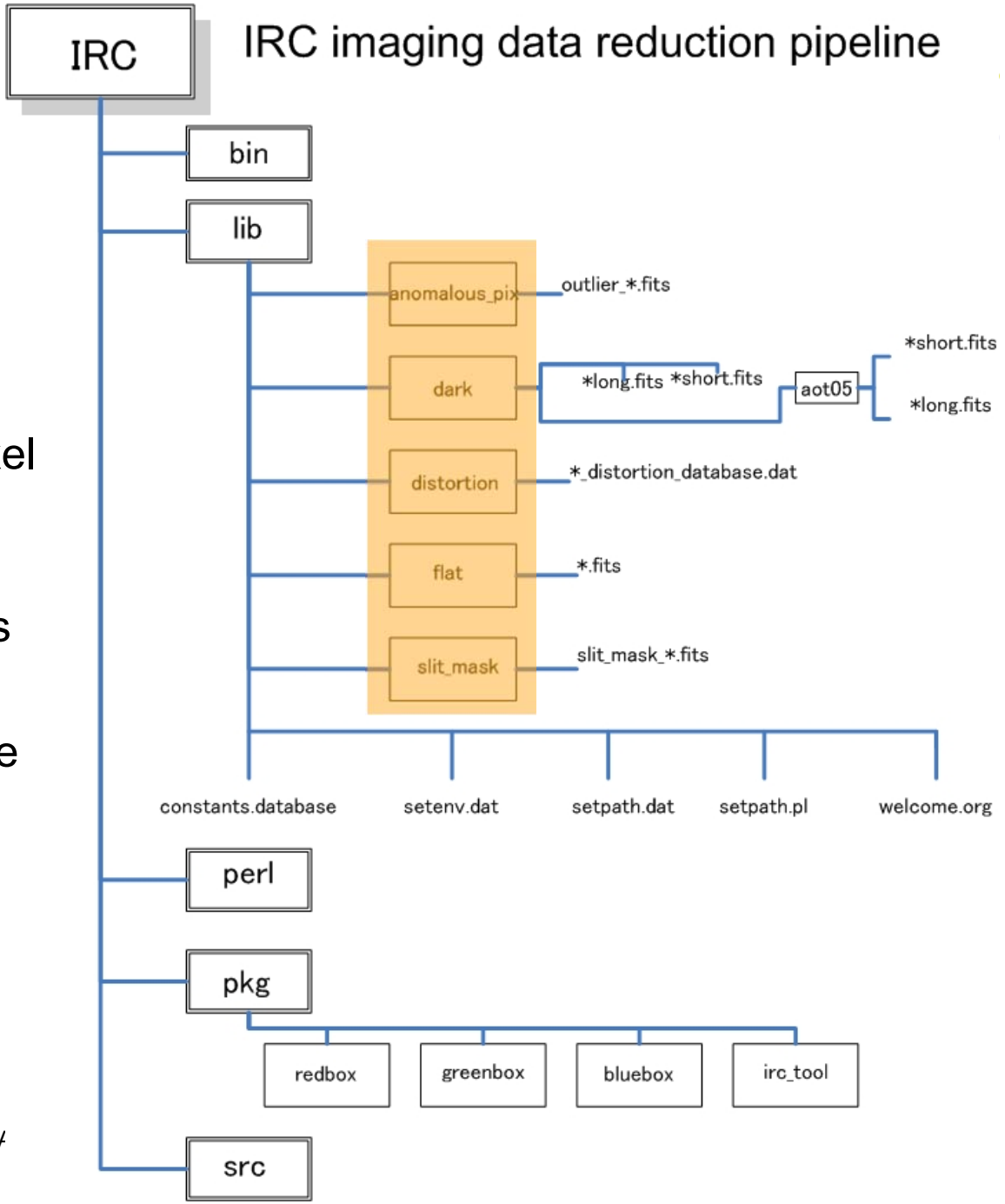
Structure of pipeline(3)

- lib
  - library files
    - constants.database
      - all irc constants are in this file.
      - you can edit it at your own risk
    - setenv.dat
    - setpath.dat
    - setpath.pl
    - welcome.org



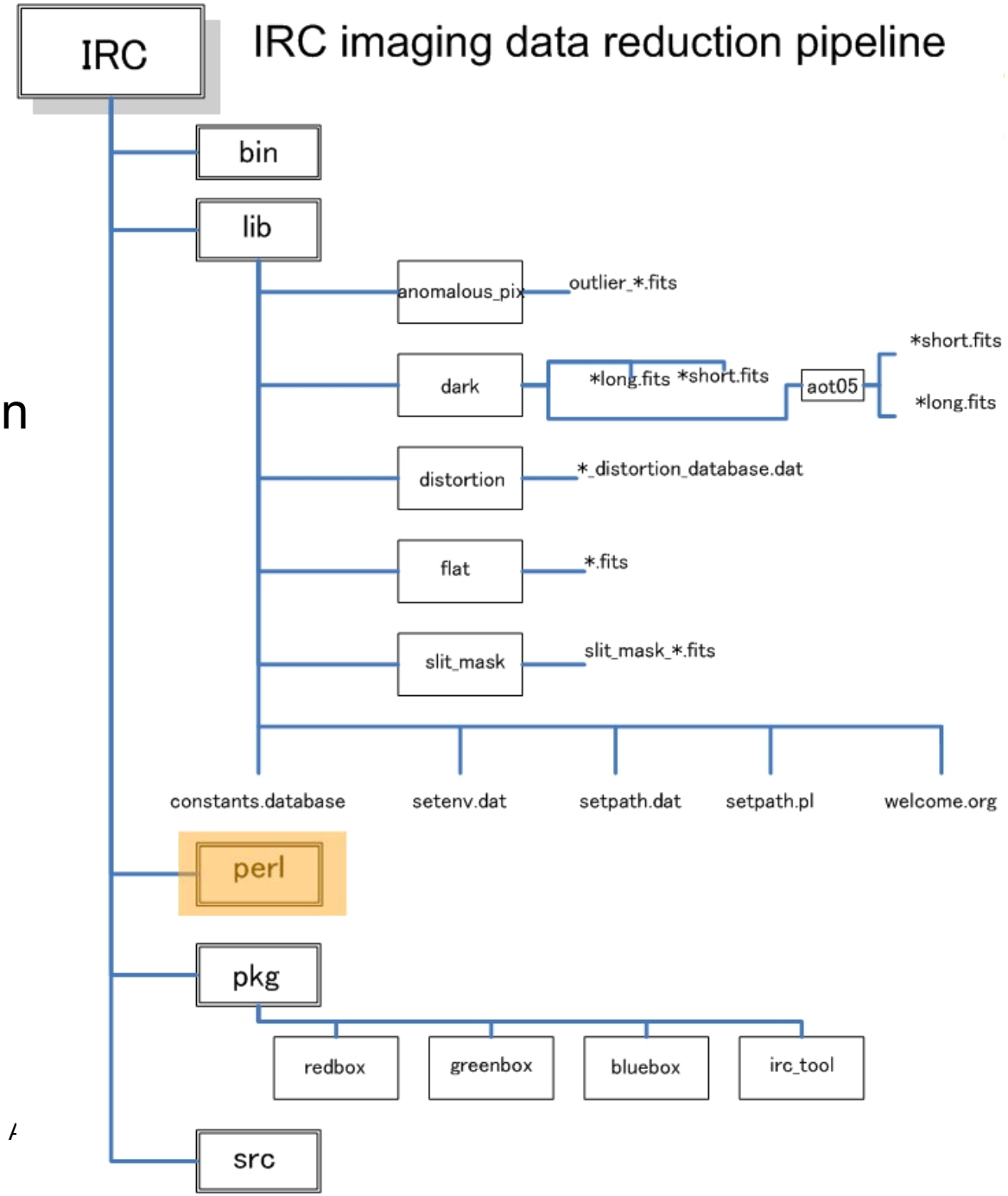
Structure of pipeline(4)

- lib - subdirectories
  - anomalous_pix
    - known hot/bad pixel map images
  - dark
    - super-dark images
  - distortion
    - distortion database
  - flat
    - super-flat images
  - slit_mask
    - slit-area mask images



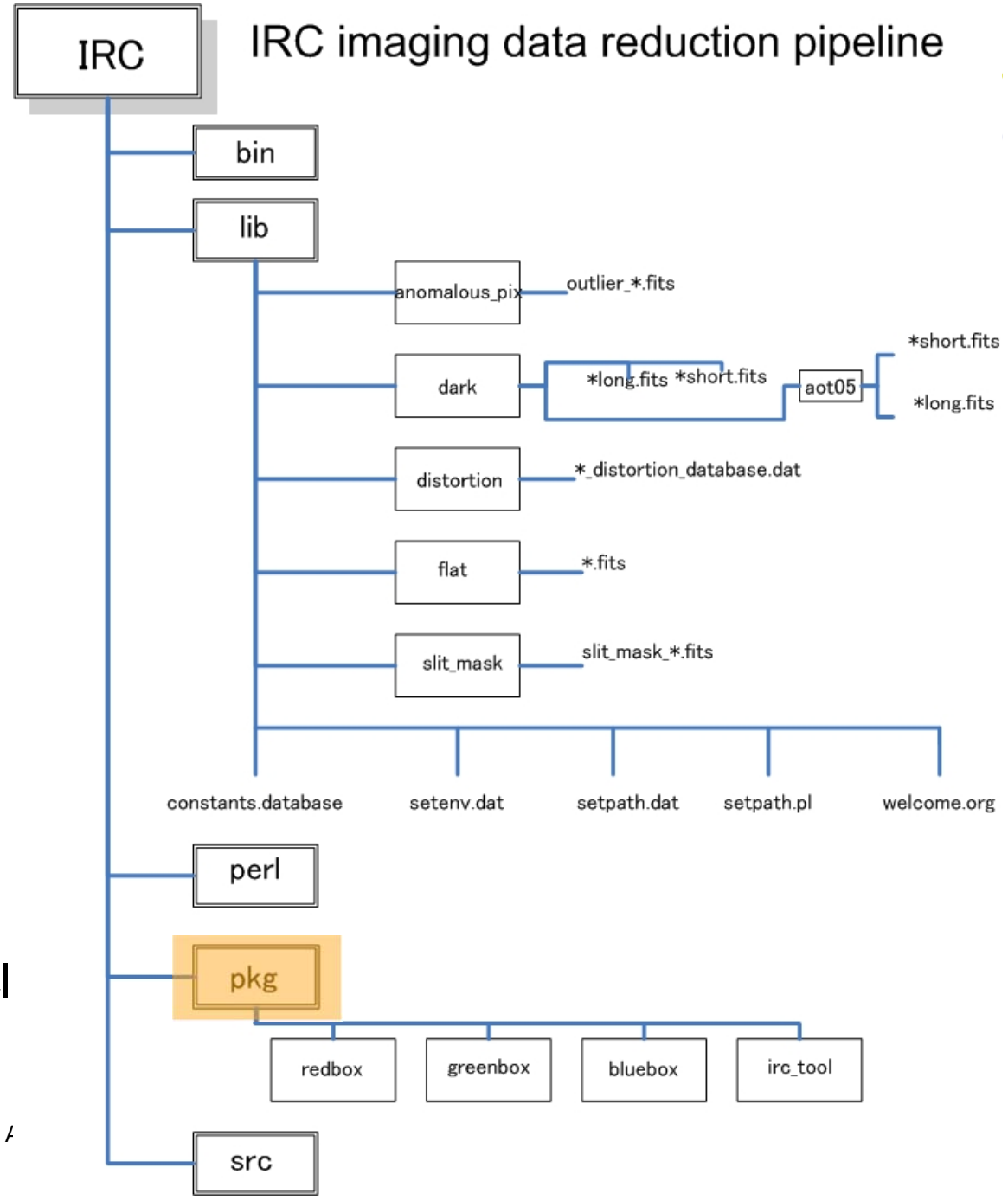
Structure of pipeline(5)

- perl
  - perl scripts used in pipeline



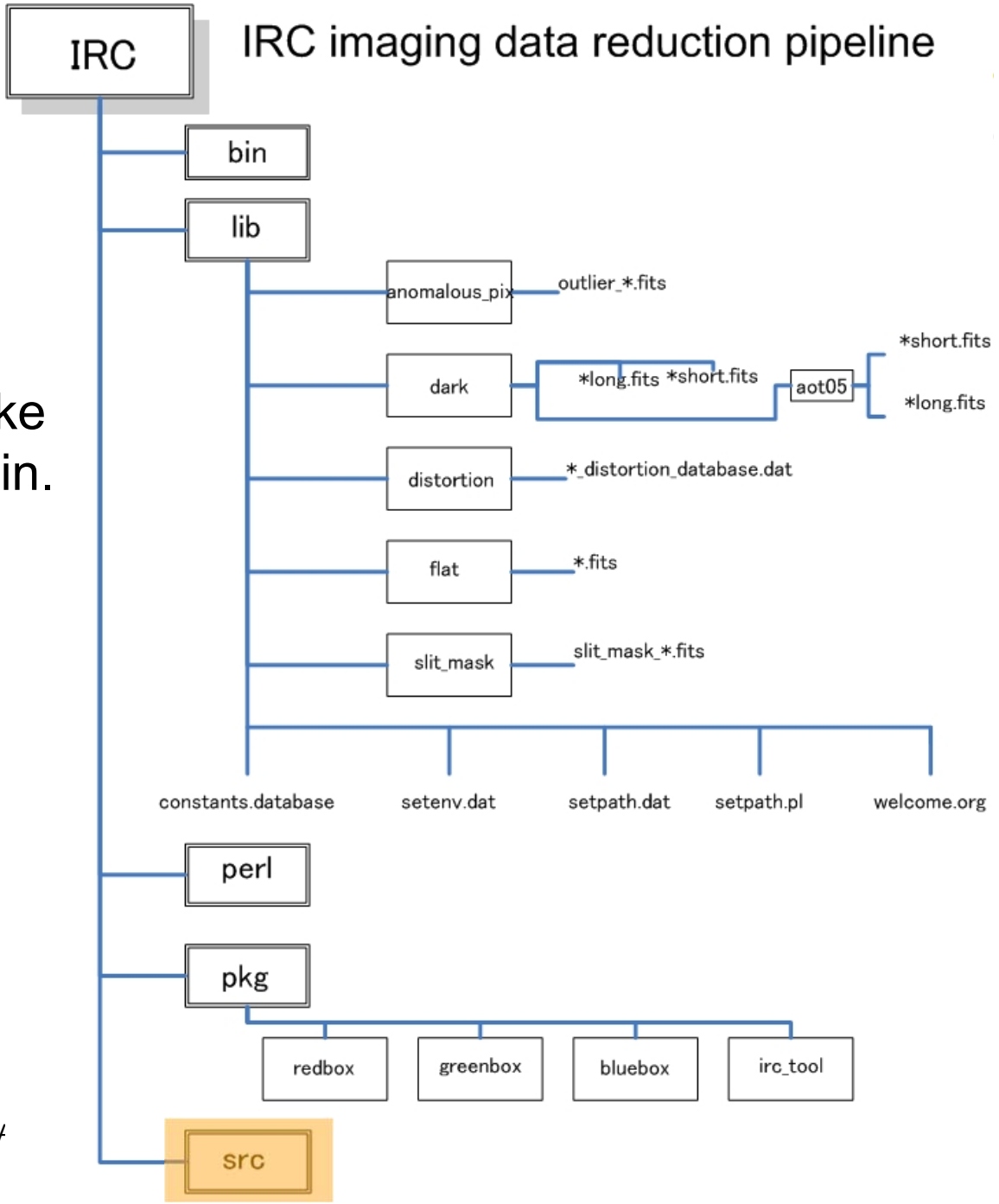
Structure of pipeline(6)

- pkg
  - redbox
    - prepipeline
  - greenbox
    - pipeline
  - bluebox
    - pipeline (coadd)
    - putwcs.cl
  - irc_tool
    - coaddLusingS.cl



Structure of pipeline(7)

- src
  - source files to make binary files in irc/bin.
  - written in C.



What you get from the pipeline

- Basic Data
  - single image
    - The unit of resultant image is in [DN]
      - absolute calibration is not applied
      - [DN] depends only on exposure time, i.e., you can compare data among any AOTs and short/long exposure images by only considering the difference of exposure times.
      - a table to convert from [DN/sec] to [Jy] for each filter is supplied by Dr. Tanabe.
    - Calibrated:
      - linearization applied
      - dark subtracted (using super-dark or self-dark)
      - flat-fielding applied (using super-flat)
      - distortion corrected

What you get from the pipeline

- Post Basic Data
  - coadded image for each filter
    - Sometimes pipeline fails to coadd MIRL (L15, L18W, L24) images.
      - However, there is a help tool that uses MIRS shift/rotation to co-add MIRL images.
    - Basic WCS is supplied in the header by default
      - Pipeline can automatically match 2mass sources to improve accuracy by using a tool (not applied by default. this is an option).
      - sometimes the tool fails to match 2mass sources(L15, L18W, L24)
      - Accuracy is
        - Better than 30 arcsec after pipeline (WCSROOT=AOCS)
        - Depends on β because of aberration
        - Better than 3 arcsec after matching 2mass sources (WCSROOT=2MASS)
        - Depentds on how many stars were matched

What you get from the pipeline

- Other files (0)
  - irclog
    - created by prepipeline
    - observing log
  - darklist.before
    - created by prepipeline
    - a list that contains the name of dark images taken before observation.
    - required if you want to use selfdark image instead of super-dark

What you get from the pipeline

- Other files (1)
  - F??????????_[NSL]00[1-4].fits
    - created by prepipeline
    - split 3D raw fits files into usual 2D ones.
    - headers are overwritten
      - CPIX1&2
      - FILTER
    - almost equals to raw data except for dimension and headers.

What you get from the pipeline

- Other files (2)
  - f*F??????????_[NSL]00[1-4].fits
    - created by pipeline just before coadd process.
    - all things are calibrated
      - dark, flat, linearity, distortion, etc…
    - Basic Data

What you get from the pipeline

- Other files (3)
  - Sf*F??????????_[NSL]00[1-4].fits
    - f*F??????????_[NSL]00[1-4].fits
      - 412x512 (256x256) : NIR (MIRS&L)
    - copy it to big frame
      - 1024x1024 (512x512) : NIR (MIRS&L)
  - Sf*F??????????_[NSL]00[1-4].fits.coo.1
    - result files of source detection
    - contains xy coordinate and arbitral brightness
  - Sf*F??????????_[NSL]00[1-4].fits.shift
    - result files of calcshift.cl
    - database file to correct shift and rotation

What you get from the pipeline

- Other files (4)
  - RSf*F??????????_[NSL]00[1-4].fits
    - rotation and shift corrected

What you get from the pipeline

- Other files (5)
  - long(short)_exp.input
    - list file containing the name of pair files for long/short exposure.
  - pair000?_[filtername].list
    - list file containing the name of files taken by filtername filter.
  - pair000?_[filtername].list_long(short)
    - split pair000?_[filtername].list according to exposure time (long/short).
  - pair000?_[filtername].list_long(short).shift & shift.0
    - contains dx[pix],dy[pix],dr[deg] (relative to the “first” image), and # of stars matched to calculate dx,dy,dr.
  - pair000?_[filtername].list_long(short).combine
    - contains filename that were combined to create coadded images. Note that images with outlier sky levels were excluded from the coaddition.

What you get from the pipeline

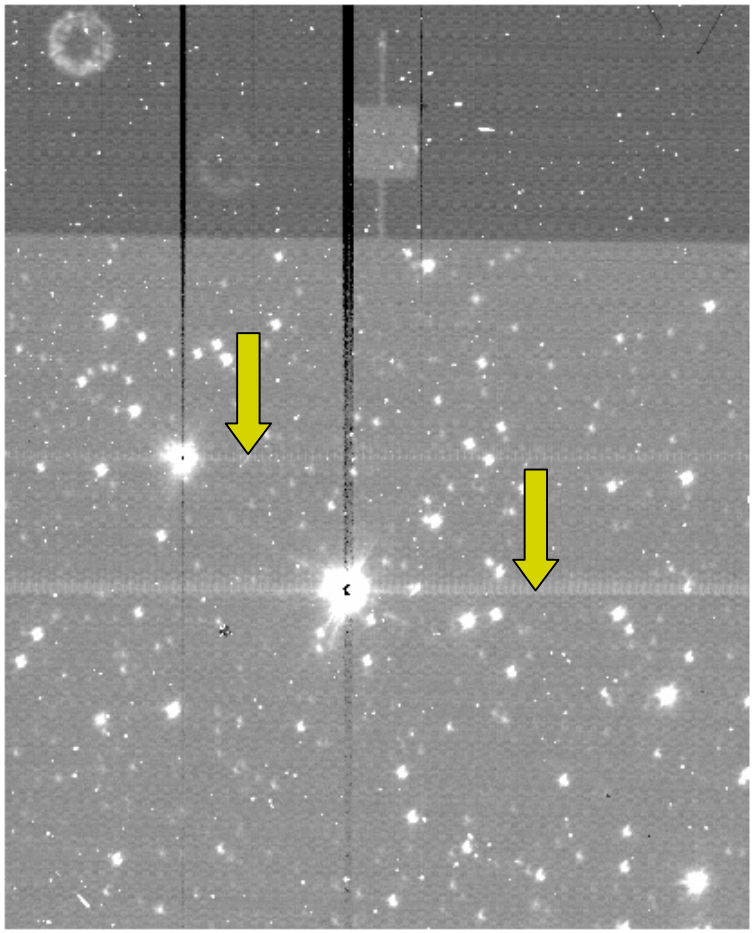
- Other files (6)
  - files in logs
    - calcshift.log
      - log of calcshift.cl
      - see for the rms of x and y linear fit results.
    - skypair000?_[filtername].list_(long/short)
      - log file of adjust_sky.cl that shows mean,median,mode of the sky level, and sigma.
      - any files with outlier sky level will be excluded from the combine process.

What you get from the pipeline

- Other files (7)
  - files in stacked_IM
    - Objectname_[filtername]_(long/short).fits
      - result
      - post basic data
    - pIObjectname_[filtername]_(long/short).fits
      - NCOMBINE – values in each pixel = exposure map
    - sigmaObjectname_[filtername]_(long/short).fits
      - standard deviation of each pixel

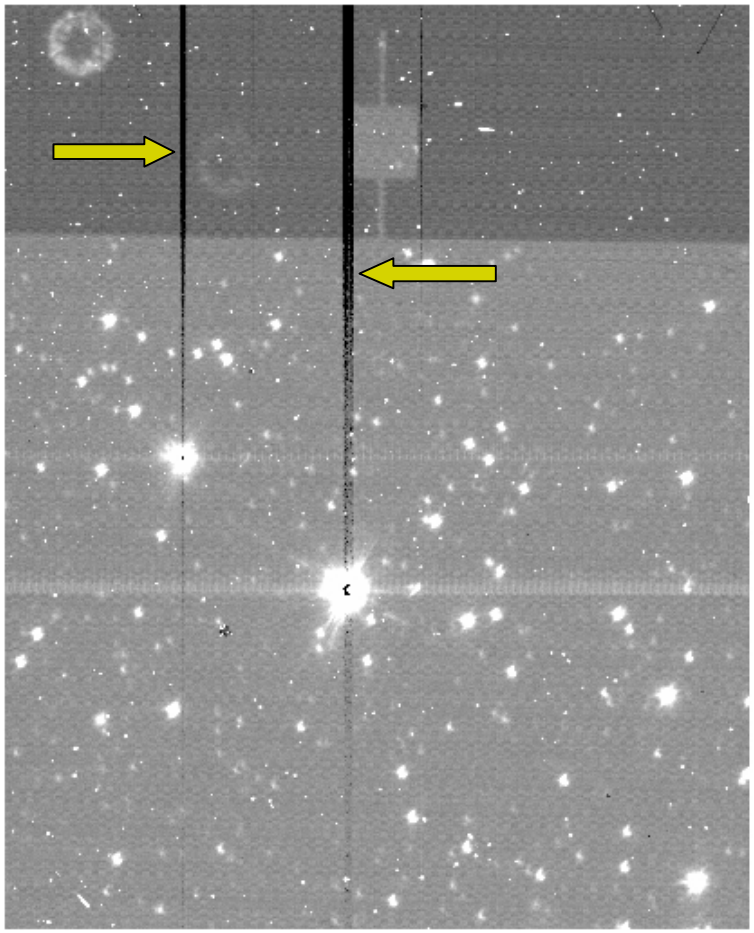
Things not included yet (1)

- Muxbleed
  - present in NIR
  - trail of bright pixels in read direction every 4th column



Things not included yet (2)

- Column Pulldown
  - present in NIR
  - different above and below source



Things not included yet (3)

- Ghost in imaging-area
  - present in all detectors
  - position and strength differ from detector to detector and also from filter to filter.
  - strongest (~ 4% of parent source) in S11
  - caused by internal reflections in beam splitter and also lenses.