AKARI/IRC images from pointed observations (Phase 1&2) ver.1 public release

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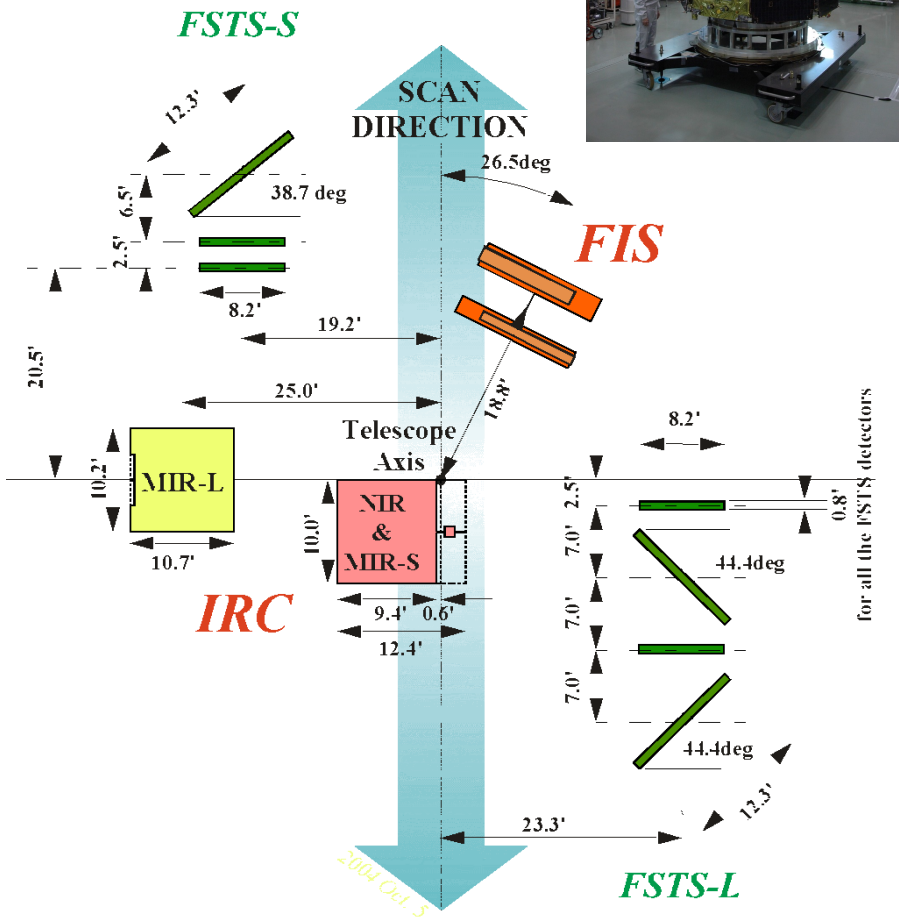
Introduction

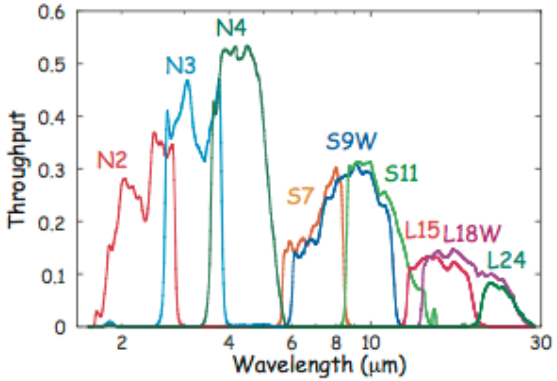
- Japanese IR satellite "AKARI"
  - Mirror ~ 70cm
  - Launch: 2006/02/22, Termination: 2011/11/24
  - Phase 1&2: 2006/05-2007/08, with liquid He, NIR--FIR
  - Phase 3: NIR only
- Instruments
  - Infrared Camera (IRC)
  - Far-Infrared Surveyor (FIS)

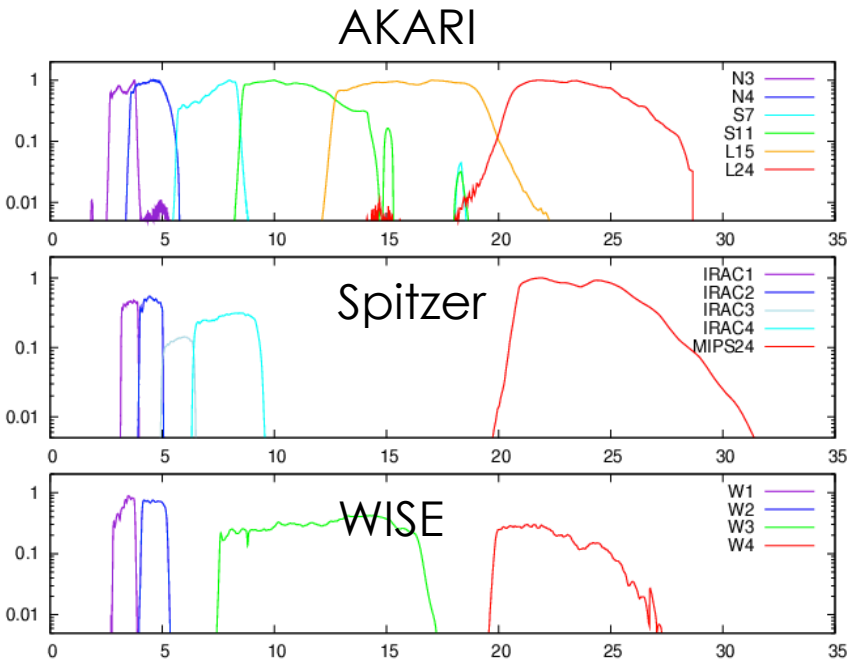


Introduction

- InfraRed Camera: IRC
  - channels: NIR, MIR-S, -L
  - filters: N2, N3, N4, S7, S9W, S11, L15, L18W, L24
    - covering 2~27μm continuously
    - stars, PAH features, dust continuum etc.
  - FoV~10', PSF~5"
    - FoV of MIR-L is ~20' away from thost of NIR and MIR-S

Onaka et al. (2010)

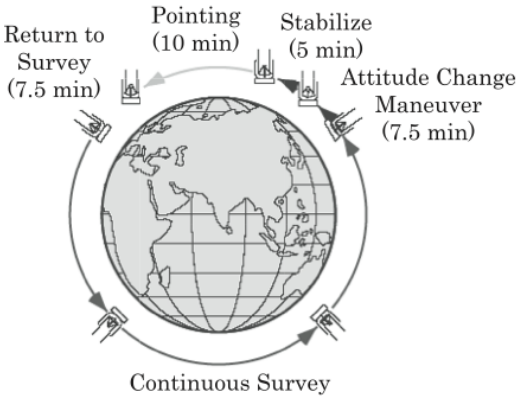




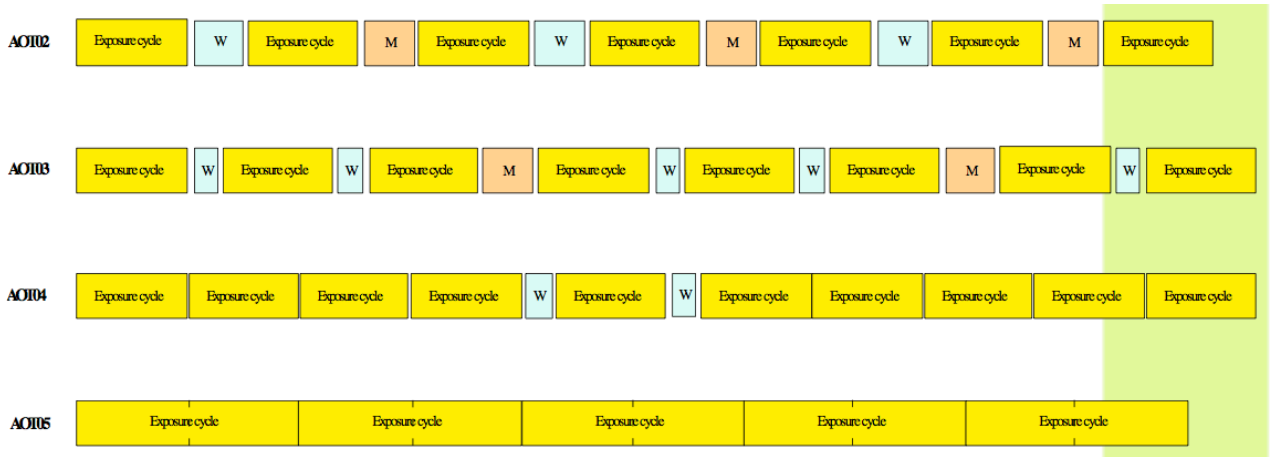
Introduction

- Pointed observations
  - ~10 minutes per observation (excluding maneuvers)
  - Astronomical Observation Template: AOT

	filter/ch	dithering	# MIR-L long
IRC02	2	Y	9 or 12
IRC03	3	Y	6 or 9
IRC04	1+spec		3
IRC05	1	N	30

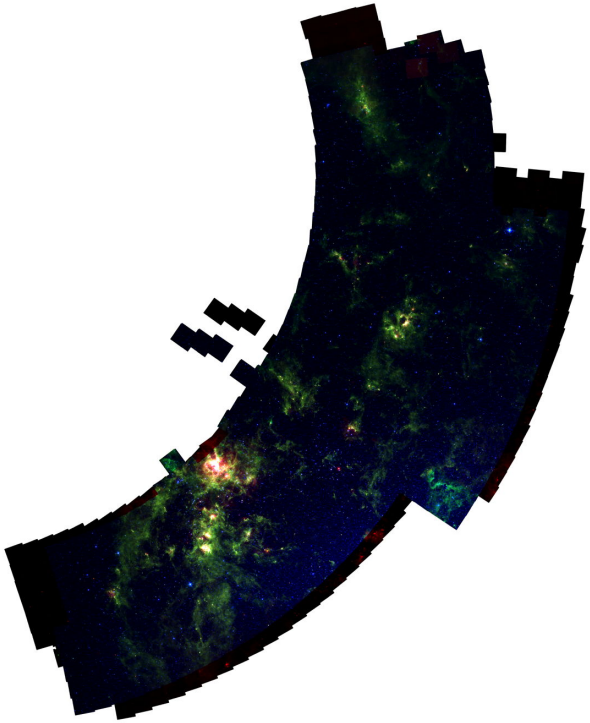


Murakami et al. (2007)



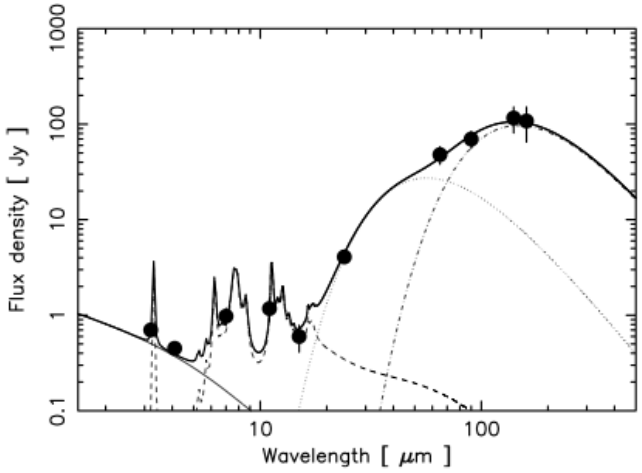
Previous studies

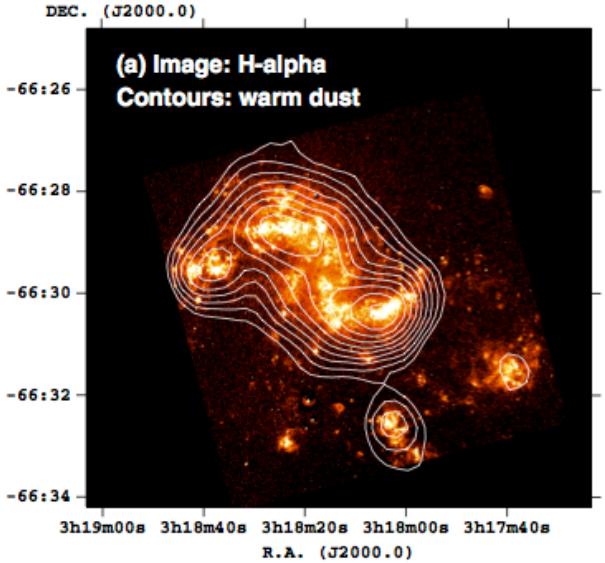
- Large Surveys
  - LMC
    - photometric catalog (Kato et al. 2012)
    - spectroscopic catalog (Shimonishi et al. 2013)
  - NEP
    - photometric catalog (Murata et al. 2013, Kim et al. 2012)
    - PAH galaxies at z~1 (Takagi et al. 2010)

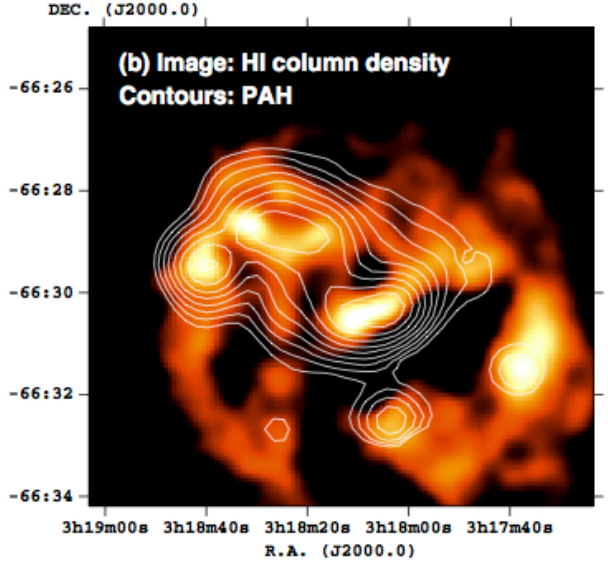


N3, S7, L15 images of LMC

Previous studies

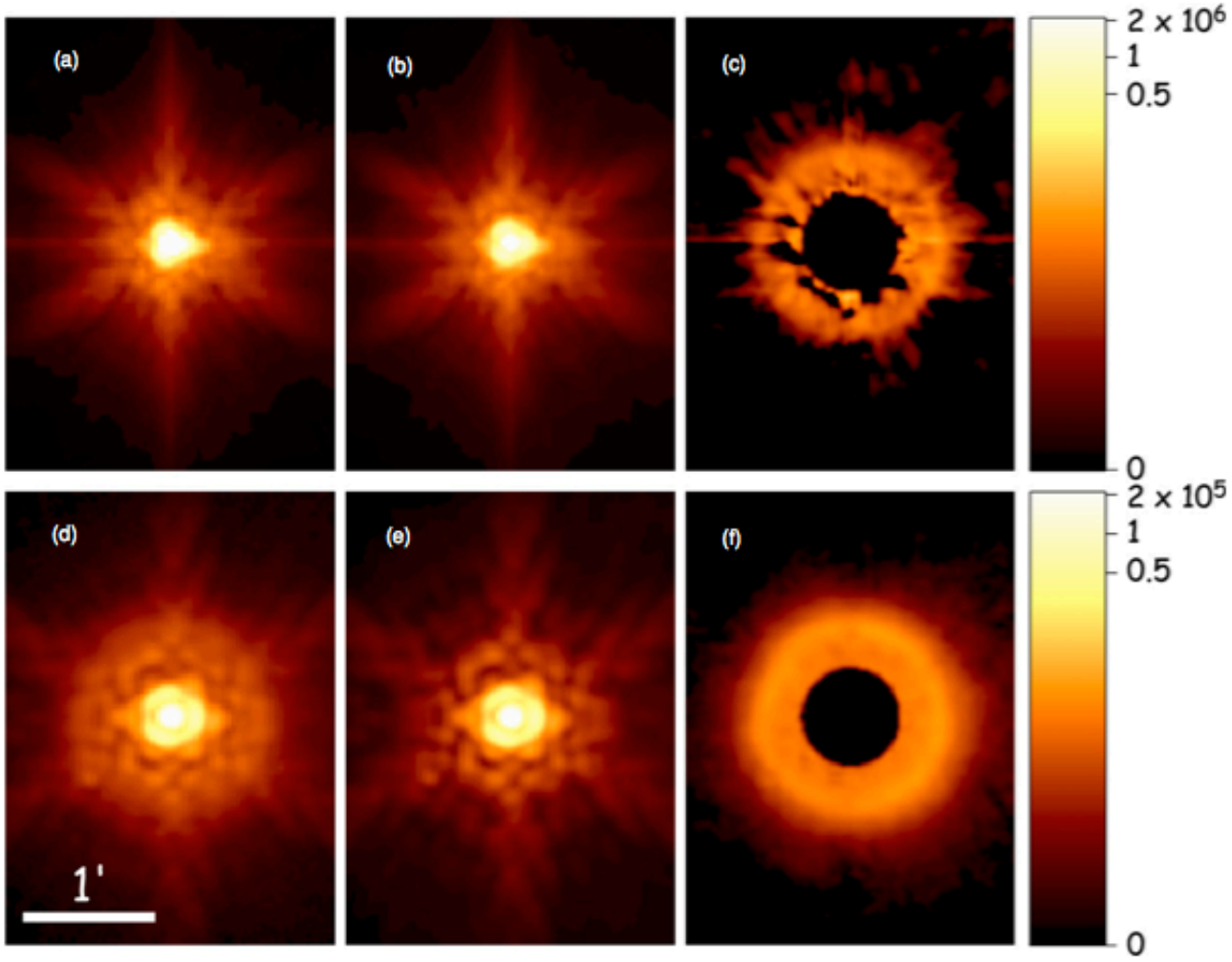






SED and images of nearby galaxy NGC1313 (Suzuki et al. 2013)

observed PSF observed-PSF=detached shell



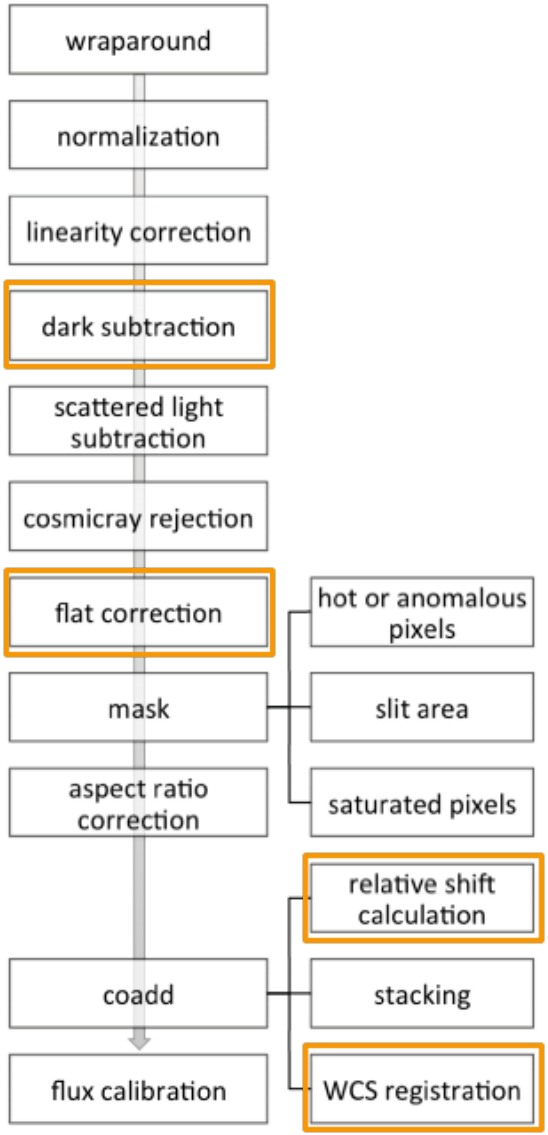
L15 (top) and L24 (bottom) images of AGB star U Ant (Arimatsu et al. 2011).
PSF are available from AKARI observers website (http://www.ir.isas.jaxa.jp/AKARI/Observation/).

Introduction

- Current status of data
  - raw data and the toolkit to reduce them are open to public
  - processed images with older toolkit are included in the raw data package, but only for quick look purpose
- New release of processed images (Phase 1&2)
  - updating the toolkit
  - process the data with the latest toolkit

IRC imaging toolkit

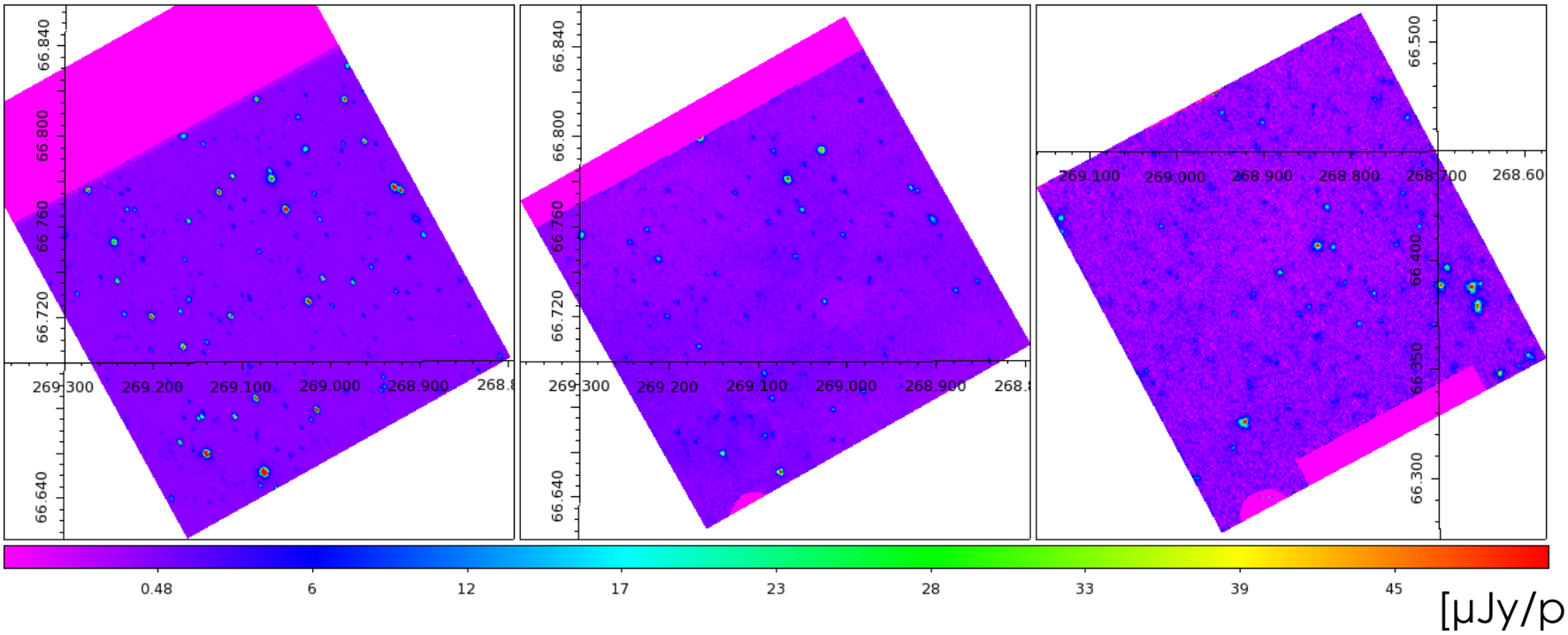
- A package of IRAF tasks
  - with some perl and .c programs
- Recent updates
  - new MIR-S and -L dark frames for each ObsID
  - new MIR-S flat
  - hot pixel masking
  - more reliable stacking and WCS matching



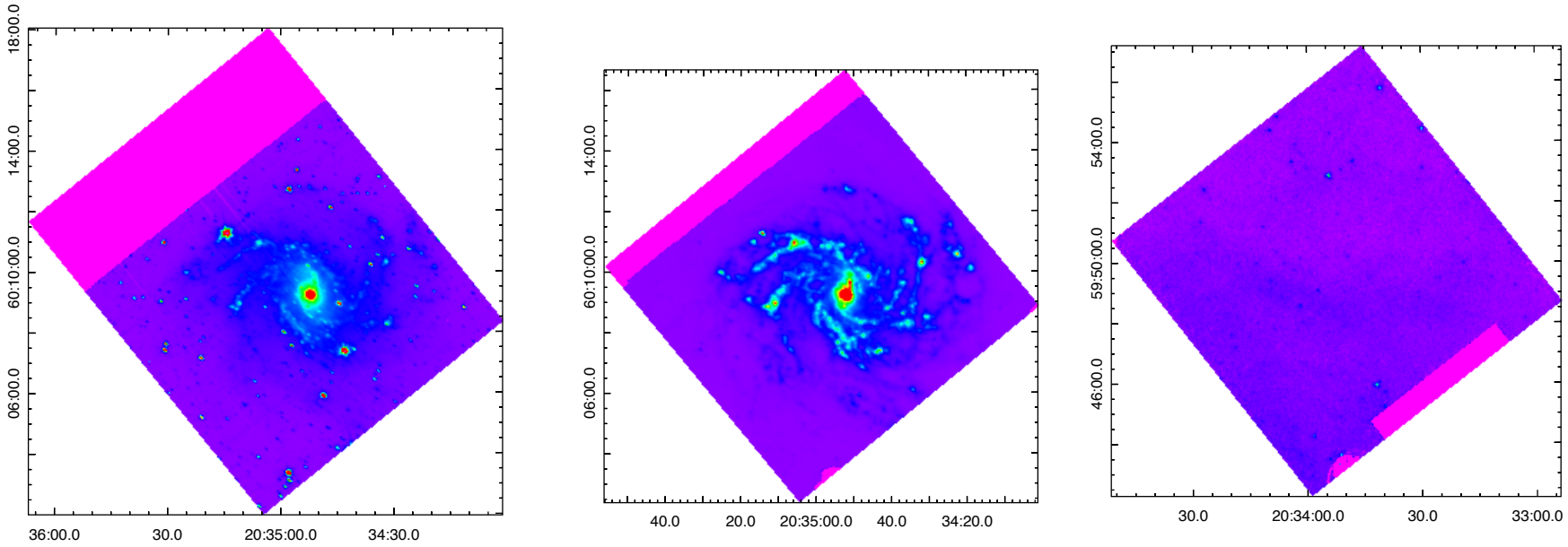
outline of calibration flow

Sample of processed images

N2 S9W L18W

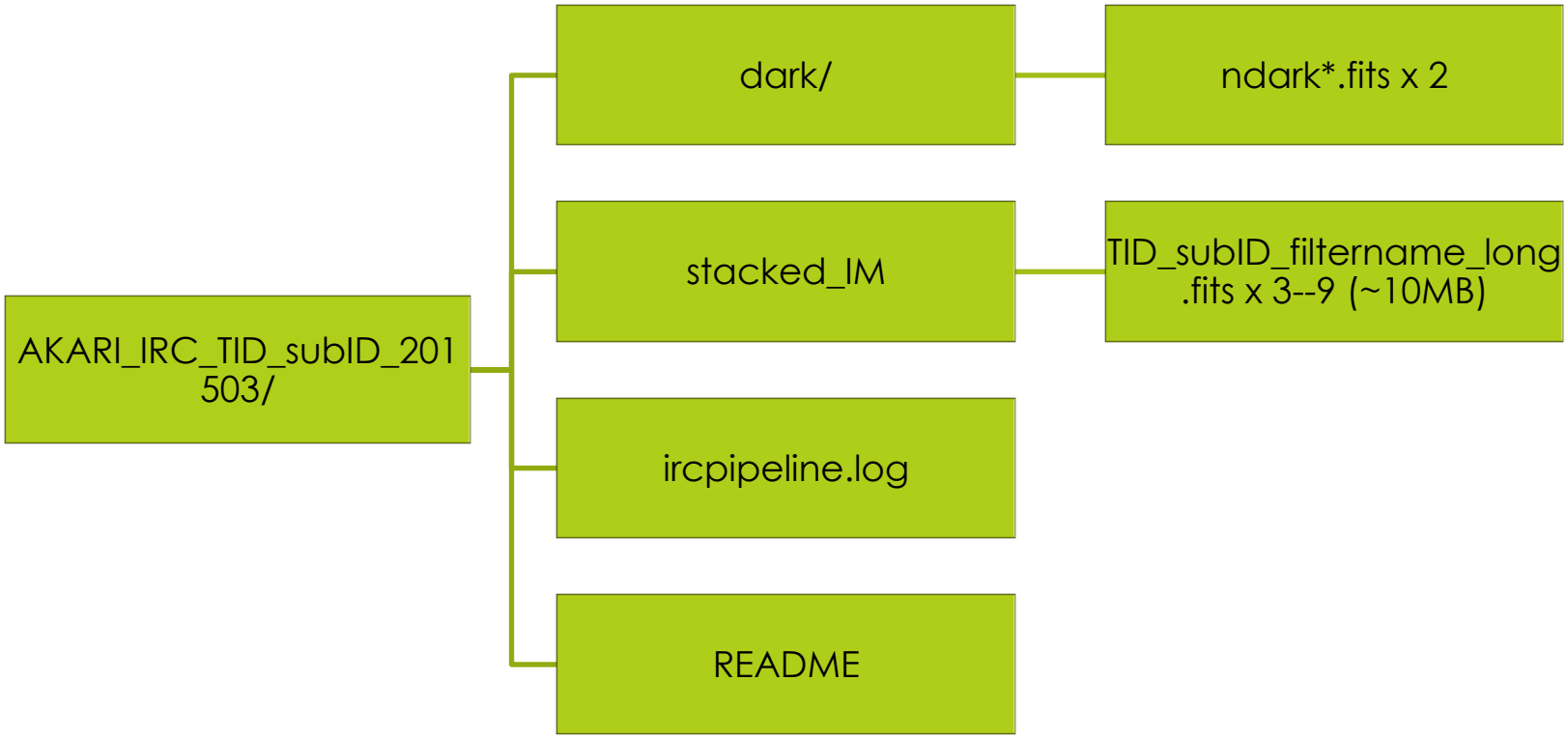


Another sample …



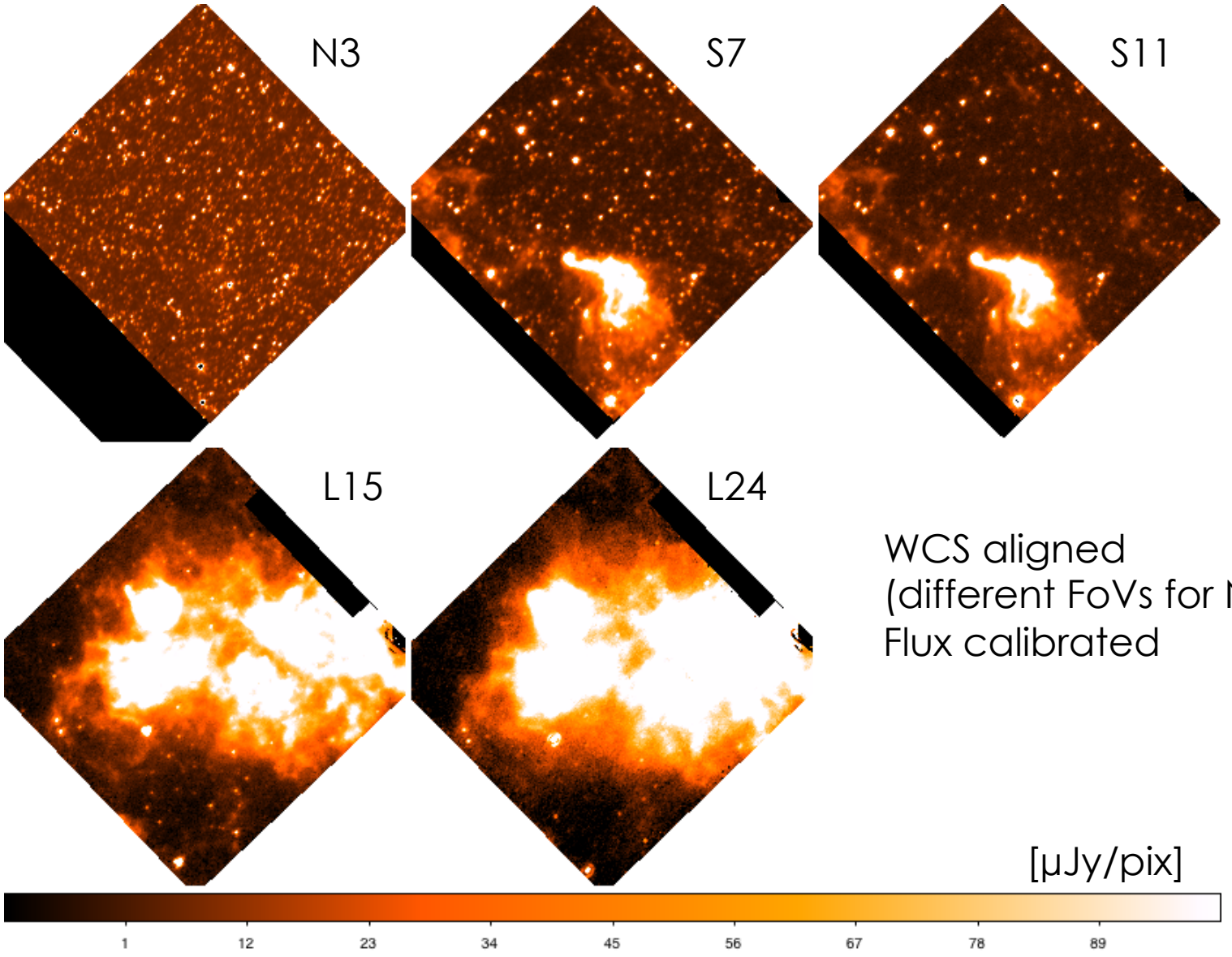
Sample of processed images (N3, S11, and L15 from left to right) from a pointed observation toward a nearby spiral galaxy NGC 6946 in the NIR and MIR-S FoVs. Coordinates are R.A. and Dec. (J2000). The flux ranges presented are [-10,100], [-100,1000], and [-20,200] μJy/pix for N3, S11, and L15, respectively. Magenta area are masked pixels mostly due to the slit for spectroscopic observations.

Processed data package



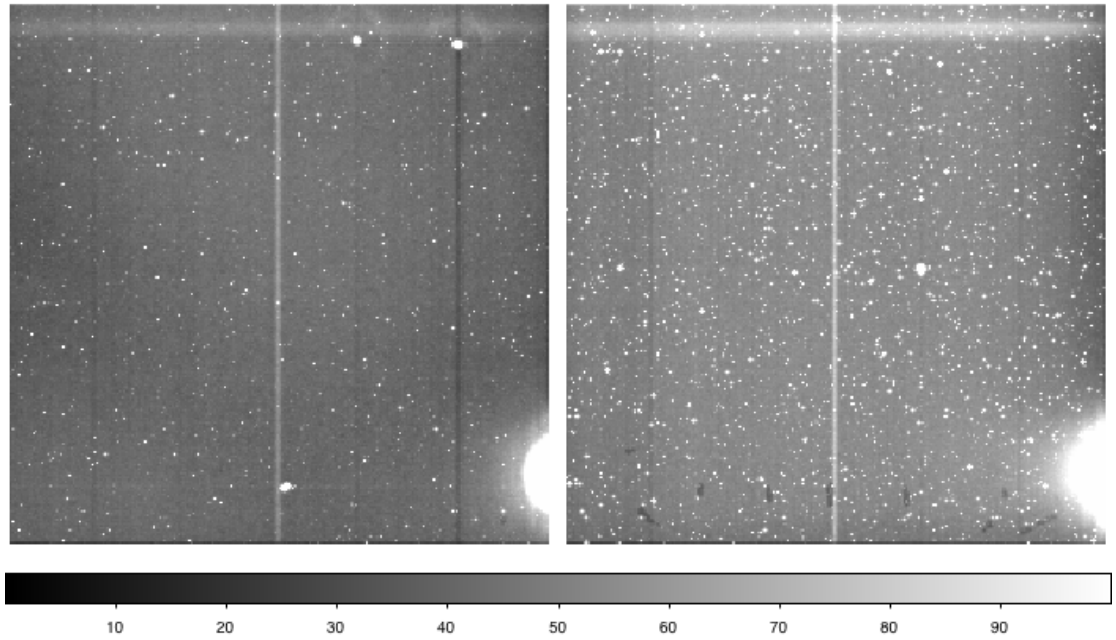
One package for one ObsID (TID_subID, e.g. 1234567_123)

Example: AKARI_IRC_2211413_001_201503/stacked_IM/*.fits



WCS aligned
(different FoVs for N&S and L)
Flux calibrated

New dark frames for MIR-S and -L long exposures under dark/



ircpipeline.log

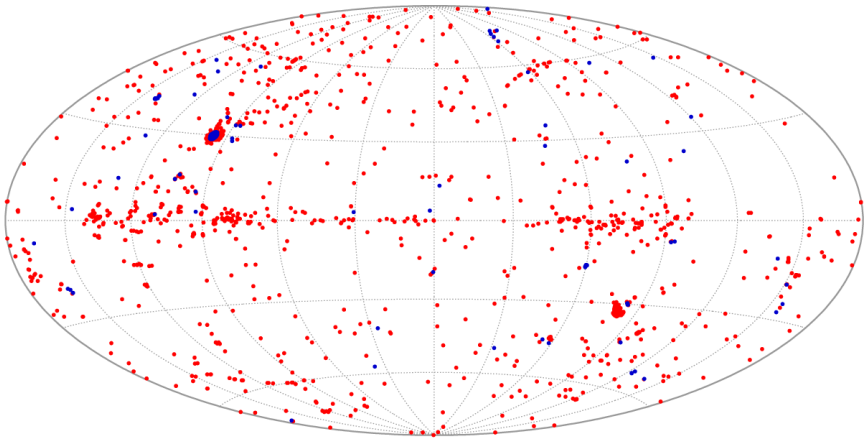
```
## ENVIRONMENTS ##
OS: CentOS Linux release 7.0.1406 (Core)
Perl:
This is perl 5, version 16, subversion 3 (v5.16.3) built for x86_64-linux-thread-mi
ulti

IRAF V2.16.1 Oct 2013
IRC toolkit: ver.150002 in /home/irc/src/iraf/v2.16.1/extern/irc/


## PROCESS LOGS ##

- 2015/02/16 11:32:42
prepipeline(ircconst=constants.database,verbose=no,pllog=ircpipeline.log)
- 2015/02/16 11:32:42
 ircslice(ircconst=constants.database,verbose=no)
- 2015/02/16 11:33:10
 mkirclog(ircconst=constants.database,verbose=no)
- 2015/02/16 11:33:17
 'irclog' and 'darklist.before' created

- 2015/02/16 11:33:17
pipeline1(ircconst=constants.database,obslog=irclog,cosmicray=yes,interactive=no,di
eltemp=yes,verbose=no,blankvalue=-9999.9,darktype=ne,darkfile=dark.list,smdark=yesi
,delsmd=yes,subsky=yes,subLscat=yes,pllog=ircpipeline.log)
- 2015/02/16 11:33:17
 makelist(logfile=irclog)
- 2015/02/16 11:33:18
 wraparound(ircconst=constants.database,logfile=irclog,prefixs=,deltemp=no,verbosei
=no)
- 2015/02/16 11:33:20
 ircnorm(ircconst=constants.database,logfile=irclog,prefixs=w,deltemp=yes,verbose=i
no)
- 2015/02/16 11:36:58
 linearity(ircconst=constants.database,logfile=irclog,prefixs=nw,deltemp=yes,verboi
se=no)
- 2015/02/16 11:40:33
 dark(ircconst=constants.database,darkfile=dark.list,logfile=irclog,prefixs=lnw,dai
rktype=ne,deltemp=yes,verbose=no,smdark=yes,delsmd=yes)
- 2015/02/16 11:42:06
 scatt_light(ircconst=constants.database,logfile=irclog,prefixs=Dlnw,deltemp=yes,vi
erbose=no)
- 2015/02/16 11:45:27
 cosmic_ray(ircconst=constants.database,logfile=irclog,prefixs=cDlnw,deltemp=yes,vi
erbose=no)
- 2015/02/16 11:48:47
 flat(ircconst=constants.database,logfile=irclog,prefixs=CcDlnw,blank=-9999.9,delti
emp=yes,verbose=no,subsky=yes,subLscat=yes,pllog=ircpipeline.log)
```

README

```
1. File information
-------------------

<directories>
   dark/         : contains neighbor dark frames for MIR-S and -L
   stacked_IM/   : contains calibrated and stacked images

<files>
   ircpipeline.log  : process logs
   README           : this file


2. Observation summary
----------------------

   Target ID               : 2211413
   Sub ID                  : 001
   Pointing ID             : 2211413
   Object Name             : LMC-FIELD413
   Proposal ID             : LSLMC
   PI Name                 : LSLMC Team
   Observation Category    : LS
   Target Position (R.A.)  : 82.044    [degree]
   Target Position (Dec.)  : -69.846   [degree]
   Observation AOT         : IRC02
   AOT Parameter           : b;N
   IRC Mode                : MAIN
   Observation Start       : 2007-04-27T08:03:19
   Observation End         : 2007-04-27T08:33:19

   Please refer to the IRC Data Users Manual for deltails of
   the summary information.


3. Process summary
------------------

   MIR-S Ghost Warning         : Yes
   MIR-S memory effect Warning : No
   MIR-L memory effect Warning : No

   Stacked Images Summary
      Filt, Nall, Ncom, Shiftty, WCSROOT, WCSERR, WCSNS, RAcenter, DEcenter
      L15     12    12  COADD    WISE     0.9546     15   81.1801  -69.6775
      L24     12    12  COADD    WISE     0.9572     10   81.1811  -69.6729
      N3       4     4  COADD    2MASS    0.4978    157   82.1073  -69.8628
      S11     12    12  COADD    WISE     0.4619     28   82.0836  -69.8504
      S7      12    12  COADD    WISE     0.3635     42   82.0841  -69.8513
```

Summary of all-data processing

- ~4000 IDs from Phase 1&2
  - including spectroscopic observations and parallel observations
- Typical sensitivity
  - better than WISE all-sky
  - comparable to SINGS



Target positions in the Galactic coordinates (red=imaging, blue=spec)

Typical sky rms [μJy/pix] from NEP observations during 2006/08-2007/04

	N2	N3	N4	S7	S9W	S11	L15	L18W	L24
IRC03	0.11	0.079	0.078	0.65	0.70	1.1	2.0	1.9	4.0
IRC05	0.061	0.043	0.042	0.38	0.54	0.75	1.2	1.1	2.6

1 pix = 0.723", 1.17", 1.19", for NIR, MIR-S, and -L, respectively.

Sensitivity Comparison

	3.4	4.6	12	22
WISE 5σ	0.068	0.098	0.86	5.4

	N3	N4	S11	L24
IRC05 5σ	0.011	0.011	0.17	0.58

5σ for photometry [mJy]
WISE: http://wise2.ipac.caltech.edu/docs/release/allsky/
apertures for AKARI images from Tanabe et al. (2008)

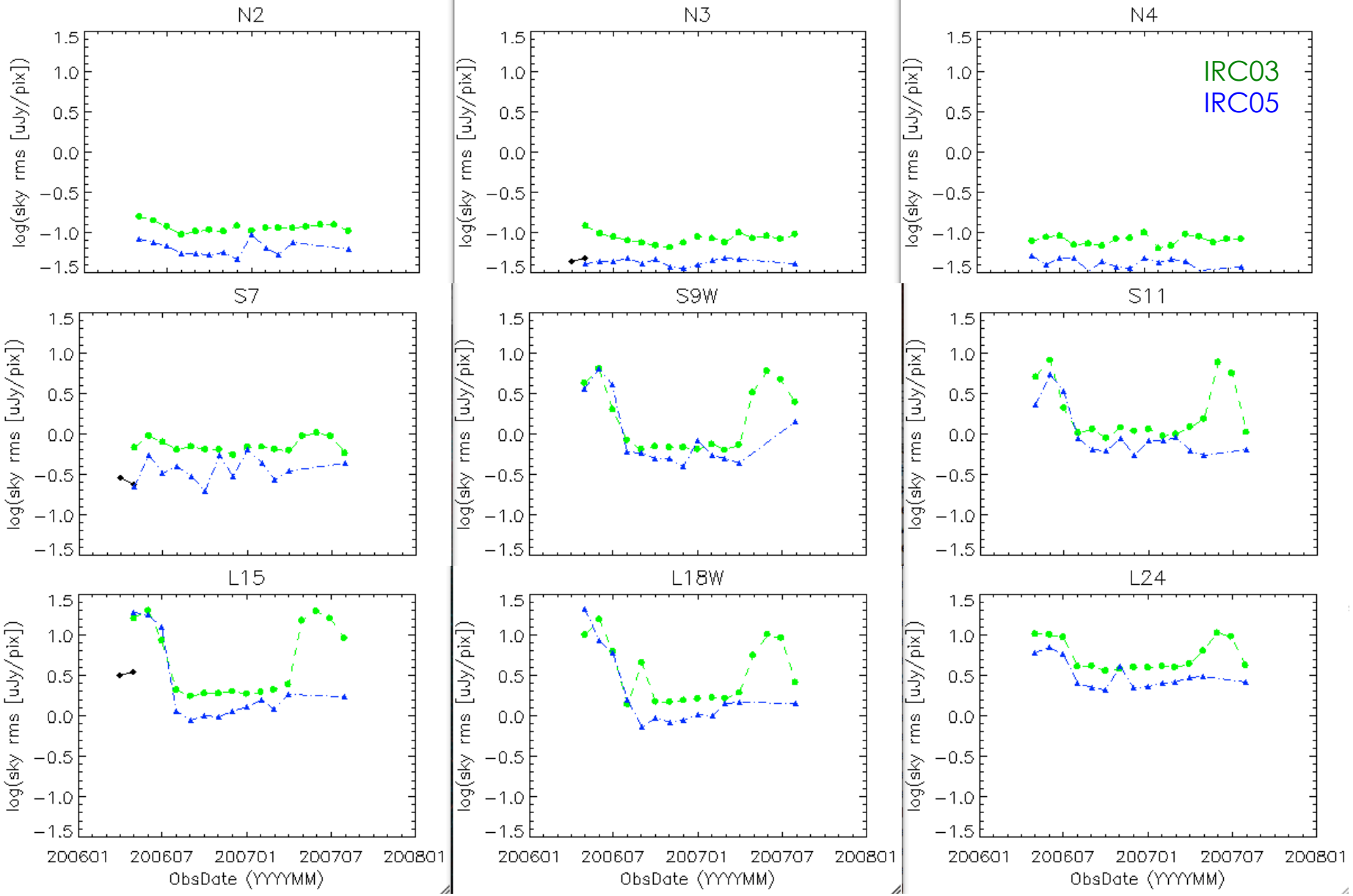
	3.6	4.5	8.0	24
SINGS 3σ	0.02	0.03	0.12	0.2

	N3	N4	S7	L24
IRC05 3σ	0.010	0.010	0.035	0.23

Expected 3σ sensitivity [MJy/sr] (Kennicutt et al. 2003)

AKARI/IRC images from pointed observations (Phase 1&2) ver.1

March 31, 2015



Typical sky rms [μJy/pix] and its time variation from NEP observations

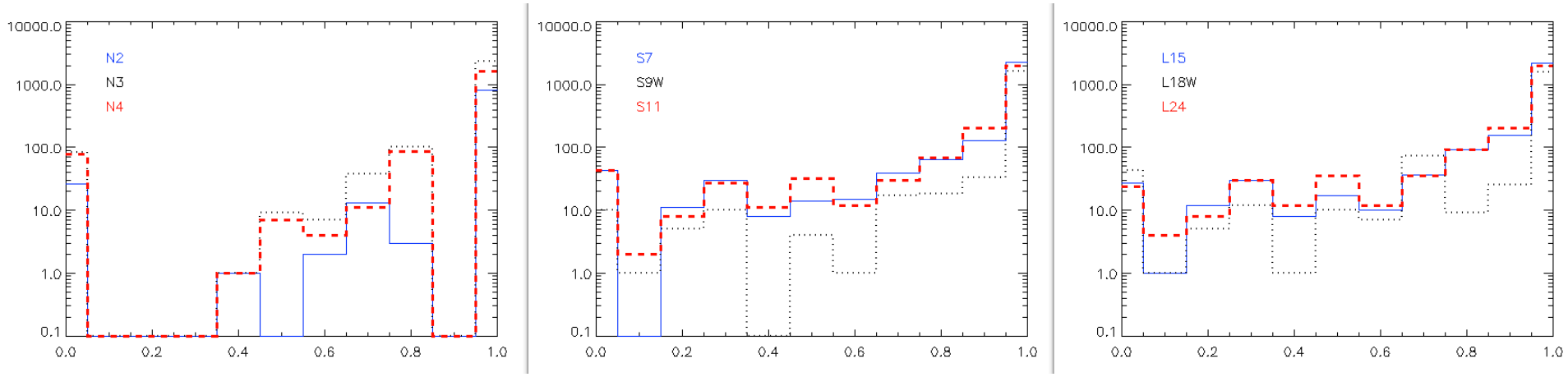
Summary of all-data processing

- Stacking success rate
  - average of (Ncomb/Nall) > 94%
- WCS success rate
  - WCS matching by the toolkit: rates decrease with wavelength
  - visual check: ~1% of "Good" are in fact false matching

success rate of WCS matching (before visual checking)

	N2	N3	N4	S7	S9W	S11	L15	L18W	L24
Good	829	2467	1718	2331	1674	2212	2218	1317	1266
Bad	13	45	26	238	66	175	356	390	1140
G/(G+B)	0.99	0.99	0.99	0.91	0.96	0.93	0.86	0.77	0.53

Ncomb/Nfrall



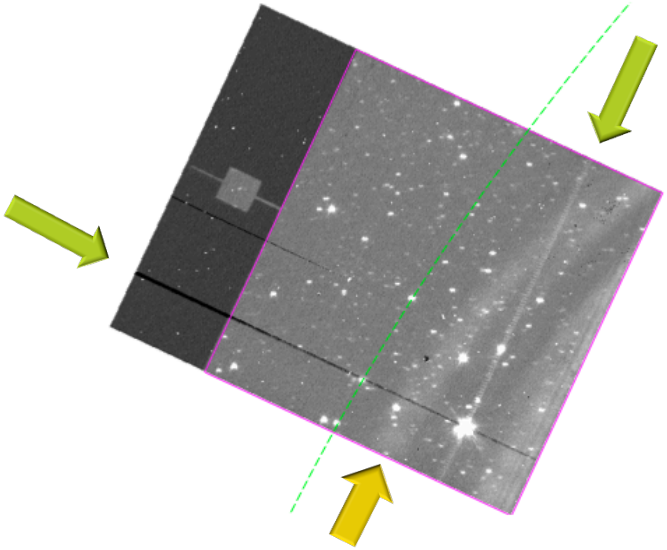
Nfrall: the number of frames taken during the observation
Ncomb: the number of frames used for stacking

How to retrieve

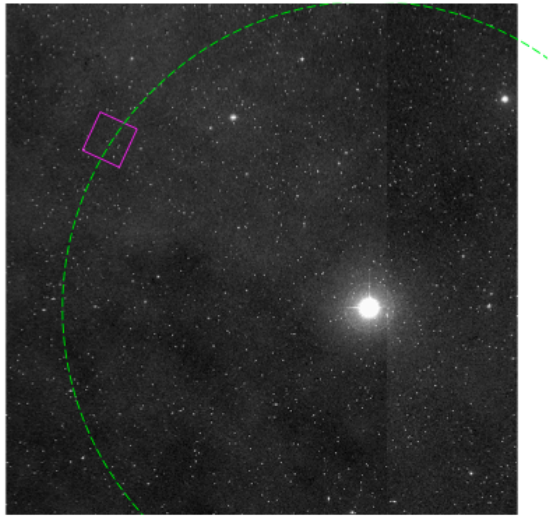
- Currently
  - AKARI observers page (as a portal)
    - http://www.ir.isas.jaxa.jp/AKARI/Observation/
  - data release webpage
    - http://www.ir.isas.jaxa.jp/AKARI/Archive/Images/IRC_Images/
  - raw data package from DARTS
    - http://darts.isas.jaxa.jp/astro/akari/akarilog/top.do
- In future
  - C-SODA (ISAS/JAXA)
  - JVO (NAOJ)

Remaining issues

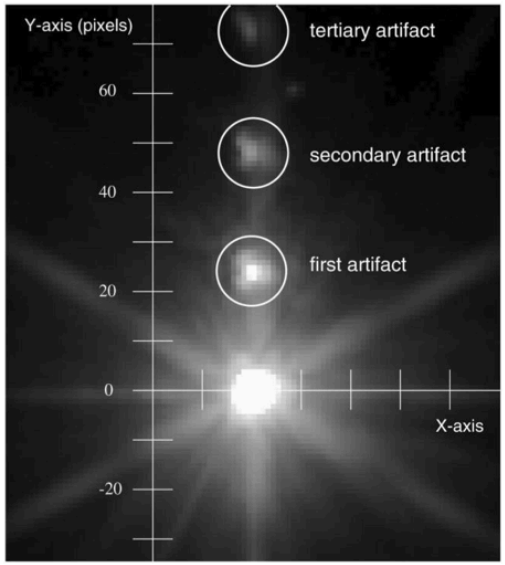
- NIR column pulldown & muxbleed



- Ghosts
  - large-scale: r ~ 1.2deg
  - small-scale: ~arcmin

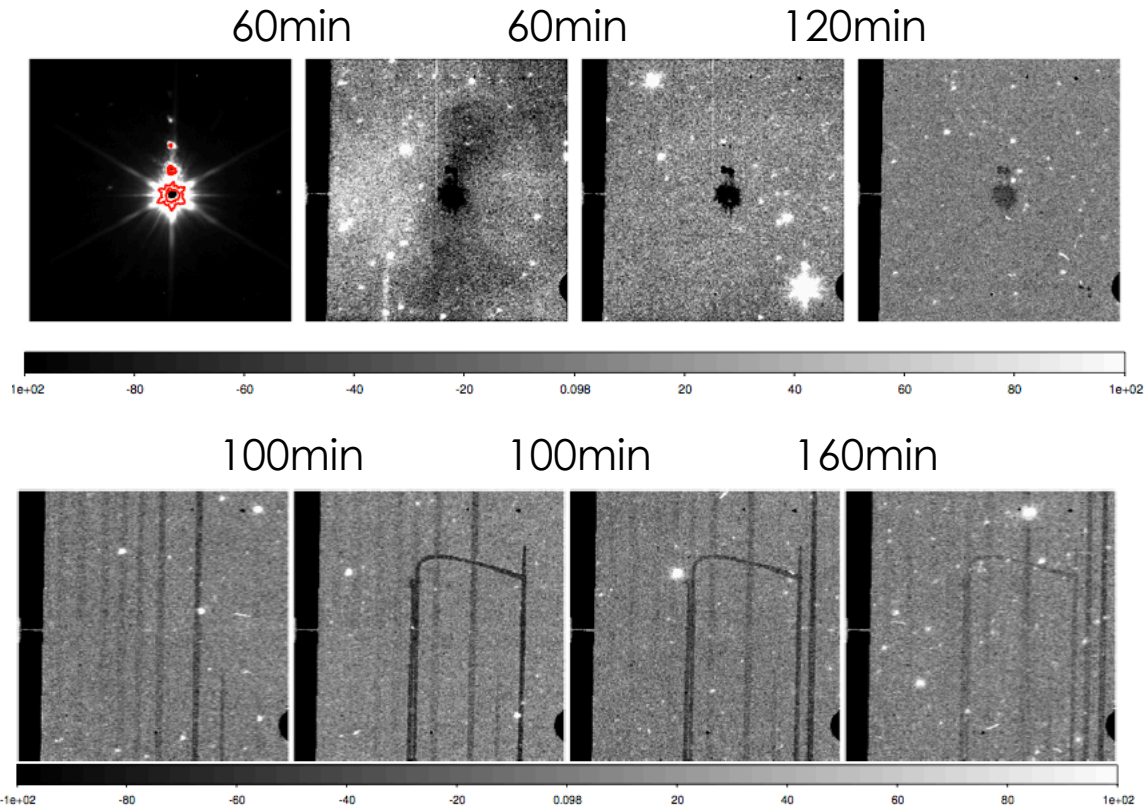


background: DSS IR



Arimatsu et al. (2011)

Remaining issues

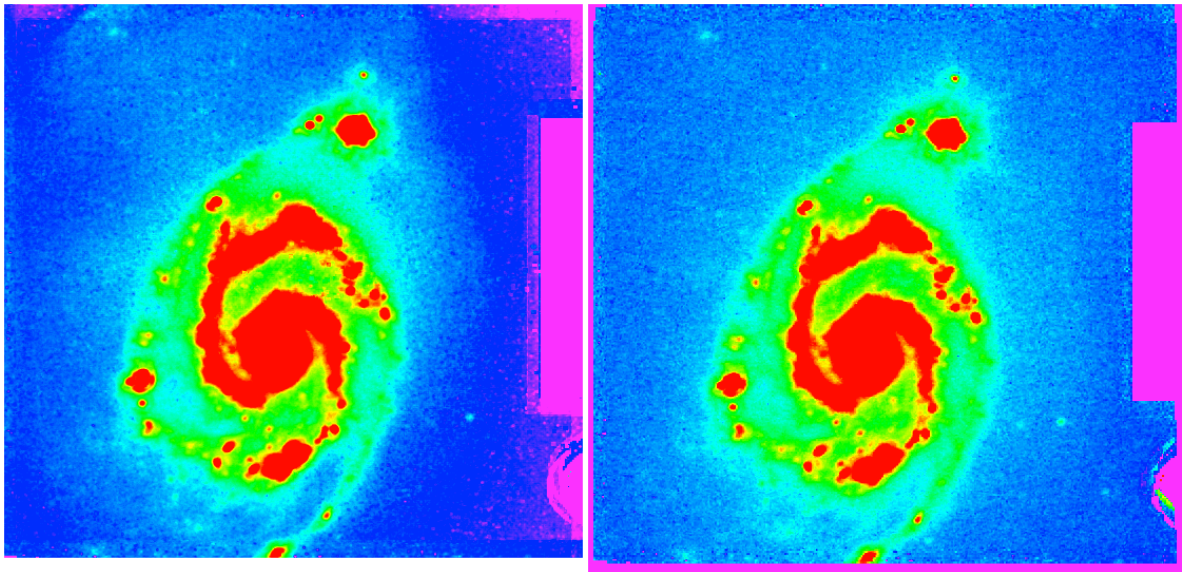


- MIR memory effect
  - decrease of sensitivity after observing bright object
  - from pointed observation
    - warning in README
    - tasks available in the toolkit
  - from slow-scan or all-sky survey

Remaining issues

- Earthshine Light
  - stray light from the Earth limb
  - strongest during the summer at high ecliptic latitude
  - tasks available in the toolkit

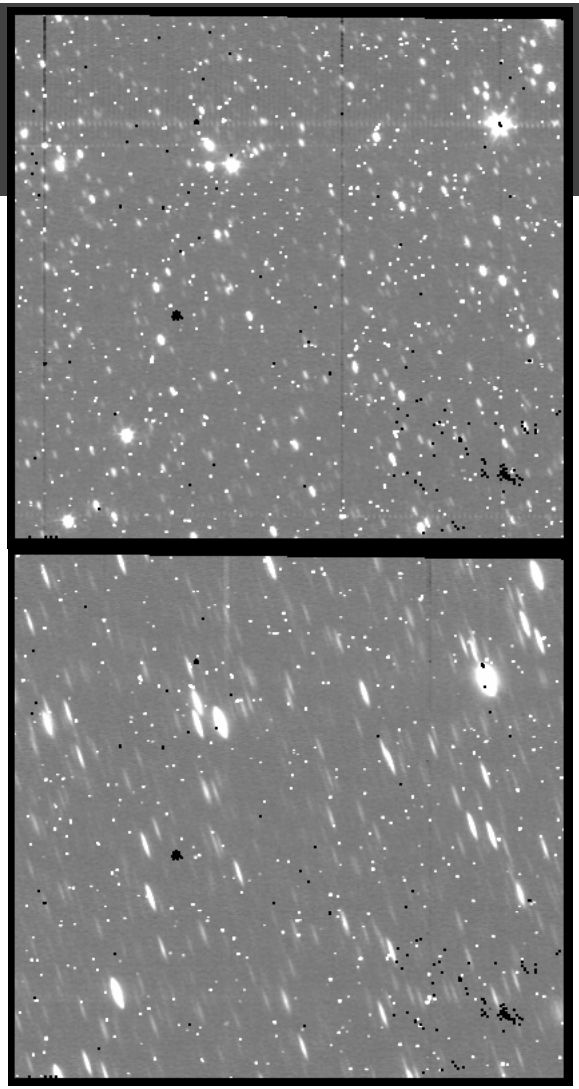
Egusa et al. (2013)



L24 stacked image without (left) and with (right) EL subtraction

Remaining issues

- Drifting
  - pointing accuracy of the telescope sometimes not good enough
  - elongated NIR PSFs
  - some MIR frames excluded from stacking



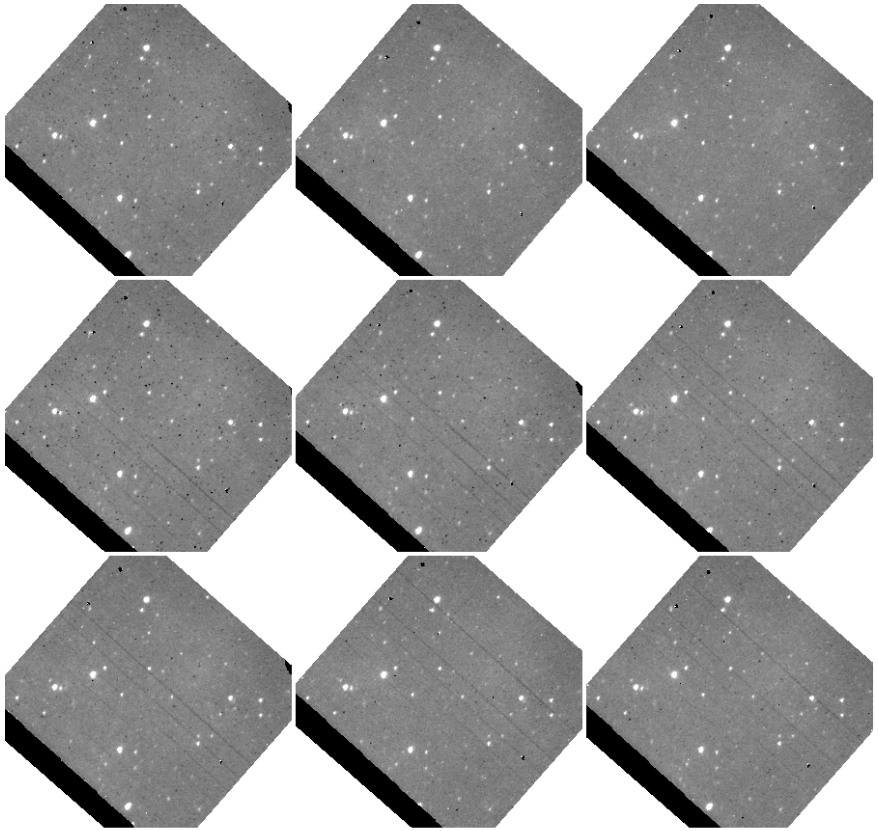
N3 frames from ObsID= 1320235_001 (top) and _002 (bottom)

Remaining issues

- WCS matching is not perfect
- check FITS header "WCSROOT" ! (also listed in README)
  - 2MASS/WISE: good
    - determined from 2MASS/WISE catalogs and passed the visual check
  - AOCS: sometimes not good enough
    - from the on-board attitude determination system
  - WRONG: bad
    - found to be wrong by the visual check
  - UNC: unconfirmed or uncertain
    - not confirmed by the visual check

WRONG or UNC may be updated in a future release

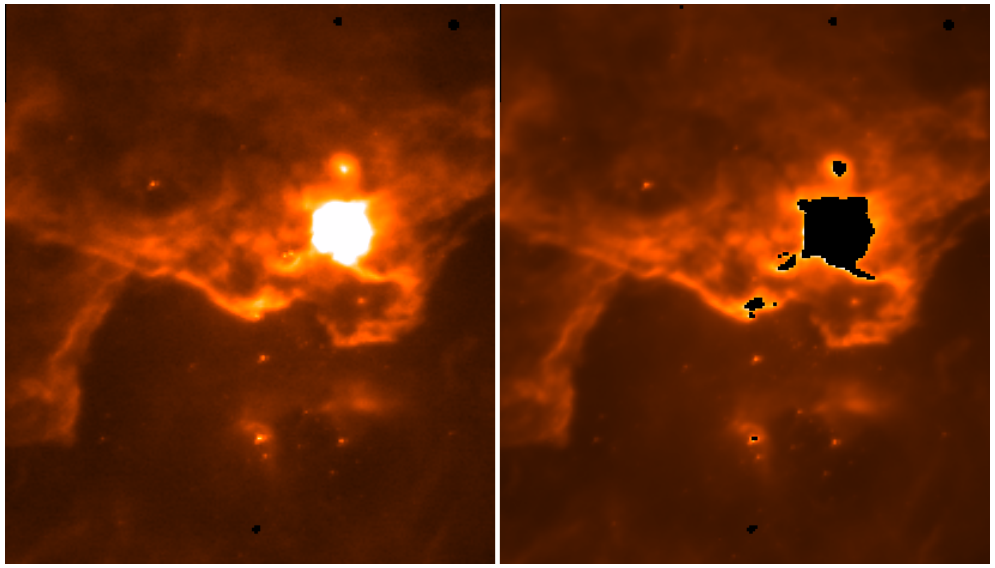
Remaining issues



S7 stacked images from ObsID=1300330_00*

- Multi-pointing
  - stacking frames from multiple IDs not supported in the toolkit yet

Remaining issues



S11 short (left) and long (right) exposure frames
black=masked area

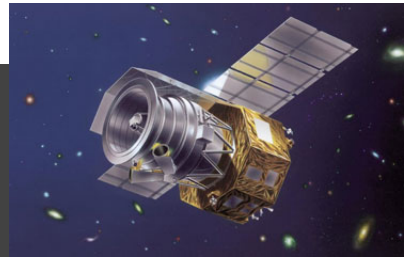
- Short-exposure frames
  - currently not used nor stacked
  - saturated pixels in long-exposure frames may be recovered

Table 1. Unit number and exposure time of each channel/exposure configuration.

Channel	Exposure	Unit number	t_{exp}
NIR	short	8	4.6752
	long	76	44.4144
	long (IRC05)	112	65.4528
MIR	short	1	0.5844
	long	28	16.3632

Tanabe et al. (2008)

Summary



- Toolkit
  - new dark frames
  - new flat frames
  - improved stacking
  - improved WCS
  - flux calibration
- Processed data
  - ~4000 IDs from Phase 1&2
- Data release
  - on March 31, 2015
  - interface will be revised and enhanced
- Documents
  - Data Users Manual
  - journal paper (Egusa et al., in prep.)