

Healy Cruise HLY10TB/HLY10TC ADCP:

ADCP Acquisition and Processing Settings

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Revision History

mid-June, 2010	original, very crude document. submitted on board Healy
July 1, 2010	broken out into part 1 of 3 (ADCP Acquisition and Processing Settings)
July 20, 2010	remove “draft” designation

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1 Introduction

USCGC Healy has two Doppler current profilers made by Teledyne RDI. These instruments are used to calculate ocean currents beneath the ship. Historically, data acquisition was performed by the manufacturer's software, “VmDAS”. On the 2010 Healy transit HLY10TC from Honolulu to Dutch Harbor, a different system (University of Hawaii Data Acquisition System, UHDAS) was installed and configured. Data from HLY10TB (Seattle to Honolulu) were collected with VmDAS; data from HLY10TC were the first collected with UHDAS. It is expected that UHDAS will be the primary ADCP acquisition/processing system starting in the 2010 deployment season.

1.1 Computer

The computer is a 1-U rackmount computer running linux Ubuntu 8.04 (Hardy Heron). All data input through a PCI serial interface (Digi Neo). Acquisition is done with a combination of Python and C; processing is a combination of C, Matlab, and Python.

1.2 ADCPS

The Healy has a 75kHz phased array ADCP (“Ocean Surveyor”, denoted OS75). That has been in place since 2002. A 150kHz phased array (“OS150”) loaned by Univ Alaska, Fairbanks, was installed prior during winter in-port and checked out by RDI during the first cruise of the year (HLY10TA). During the winter in-port a new cable run was built. The OS150 cable uses this new conduit.

2 Data from HLY10TB

Data from HLY10TB (Seattle to Honolulu) were collected with VmDAS using:

ADCP settings	OS150	OS75
blank interval	6m	16m
broadband bin size	NA	NA
broadband number of bins	NA	NA
narrowband bin size	8m	16m
barrowband number of bins	55	60
bottom track	off	off
ping rate	“as fast as possible”	“as fast as possible”
positions (“NAV”) from...	POSMV (COM 7) \$INGGA	POSMV (COM 7) \$INGGA
attitude (“RPH”) from ...	Ashtech (COM 5) \$GPPAT??	Ashtech (COM 5) \$GPPAT???
EA (in text file)	EA02834	EA04342
VmDAS version	1.46	1.46
OS firmware	23.17	23.17
short term average (STA)	120 sec	120 sec
long term average (LTA)	300 sec	300 sec

3 Data from HLY10TC

The cruise comprised 20 segments, collected with a variety of acquisition and processing parameters. Segments were determined by debugging or troubleshooting needs, to distinguish chunks with large gaps (i.e. when the ADCP was secured), or to test settings or feeds.

3.1 UHDAS Data Acquisition:

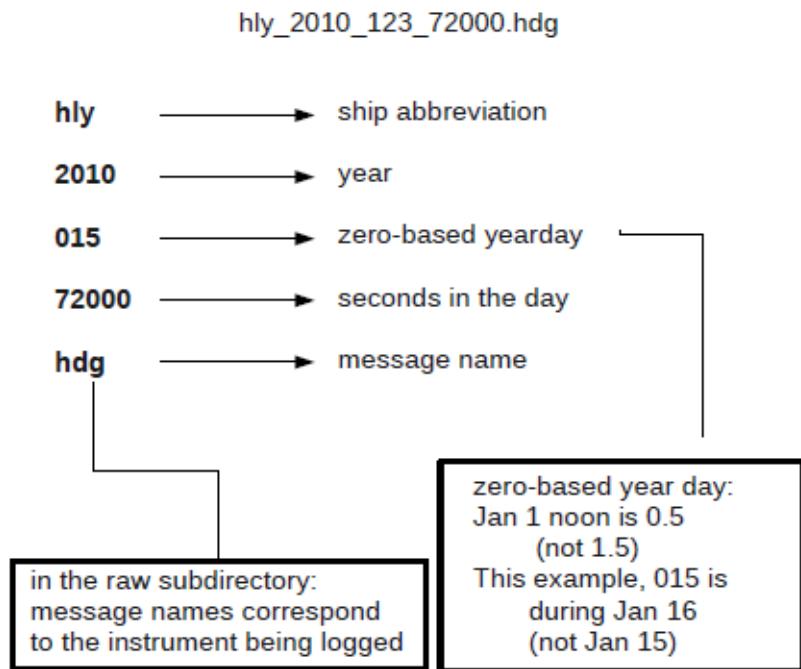
Data for scientists:

There are three categories of data, all located in the logging directory, /home/data/[CRUISEID]:
ADCP logging directories

subdirectory	contents	importance	back up for...
raw	all raw data	critical	<ul style="list-style-type: none">◦ archiving◦ scientists who ask for it
rbin	intermediate files	nice to have	anyone who gets raw
gbin	intermediate files	nice to have	anyone who gets raw
proc	<ul style="list-style-type: none">◦ final processing◦ codas database◦ underway figure archive◦ matlab files	final product	science CDs after cruise

Data in the “raw” subdirectory are organized with one directory per serial port.
Files start when data acquisition starts, and roll over on every 2-hour boundary thereafter.

Serial directory	instrument	suffix	messages
ashpaq5	Ashtech adu5	paq	\$GPGGA,\$GPPAT
gpsnav	Pcode gps	gps	\$GPGGA
gyro	Sperry mk39	hdg	\$INHDT
gyro2	Sperry mk27	hdg	\$HEHDT
os150	RDI adcp (150kHz)	raw, log, log.bin	(binary adcp data + log files)
os75	RDI adcp (75kHz)	raw, log, log.bin	(binary adcp data + log files)
posmv	POSMV	pmv	\$PASHR,\$INGGA



Naming convention for UHDAS raw files

3.2 UHDAS (CODAS) data processing parameters

The processing component of UHDAS is called “CODAS” (Common Ocean Data Access System). Extensive documentation about CODAS processing exists

- at sea, on ships with UHDAS installed (<http://currents>)
- on land (http://currents.soest.hawaii.edu/docs/adcp_doc/index.html)

UHDAS data acquisition results in four directories, representing different stages of acquisition/processing. 'Raw', described above, consists of timestamped NMEA messages. Subdirectories 'rbin' and 'gbin' are intermediate (parsed) versions of data in 'raw'. The 'proc' directory contains one directory tree for each instrument+pingtype being processed. This directory tree and the processing steps that occur in it, are described in the CODAS documentation.

Processing is done with Python and Matlab. Parameters used by Matlab are found in each processing directory in files such as:

- proc/os150nb/config/HLY10TC_cfg.m
- proc/os150nb/config/HLY10TC_proc.m

The same processing parameters (transducer depth, transducer alignment angle, and serial messages used for position and heading) are contained in the file:

- `raw/config/procsetup_onship.py`

Processing parameters used during the original HLYT10TC segments are in the Appendix. Data north of Oahu were preprocessed in one large segment, “HLY10TC_rationalized”. It has the same directory structure as a single, whole cruise, collected at sea.

4 Appendices

4.1 Appendix: HLY10TC ADCP Cruise segments (time ranges)

cruise name	date range	comment
HLY10TC_01	2010/05/31 20:05 to 2010/06/01 04:35	getting acquainted: os75bb+nb, os150bb+nb; lots of bins; ashtech suffix misconfigured. figure-8 cruise track southwest of Oahu (POSMV cal)
HLY10TC_02	2010/06/01 04:39 to 2010/06/01 05:31	fewer bins (to avoid editing bug), fix ashtech name. (cruise originally misnamed HLY10C_02). renamed to HLY10TC_02 after done). still figure-8 posmv cals
HLY10TC_03	2010/06/01 05:43 to 2010/06/01 15:33	oops; still wrong ashtech specification. secured overnight for em122 troubleshooting efforts. ping again in the morning for a couple of hours. (cruise originally misnamed to HLY10C_03). renamed to HLY10TC_03 after done). more posmv cals (figure8)
HLY10TC_04	2010/06/01 15:36 to 2010/06/02 05:47	try 4m bins bb/nb for os150 , 8m bins bb/nb for os75 during this em122 alignment test. cruise originally misnamed to HLY10C_04). renamed to HLY10TC_04 after done).
HLY10TC_05	2010/06/02 05:48 to 2010/06/02 20:42	still SW of Oahu, transit to Kaena Point. try defaults = os150bb (4m), os150nb (8m) , os75nb (16m) ; posmv for accurate heading, gyro for heading (still “bridge heading switch”)
HLY10TC_06	2010/06/02 20:43 to 2010/06/03 06:50	start clean cruise name for northbound transit to first survey. same settings as HLY10TC_05
HLY10TC_07	2010/06/03 15:44 to 2010/06/03 19:36	secured overnight for Steve R. to work on gyro feeds. reboot near the end of this leg to clear one serial port. start of 26.4N survey
HLY10TC_08	2010/06/03 19:39 to 2010/06/03 22:10	now logging with both gyros.
HLY10TC_09	2010/06/03 22:16 to 2010/06/05 00:36	finish survey; head north.
HLY10TC_10	2010/06/05 02:54 to 2010/06/05 06:00	switch to using posmv for position
HLY10TC_11	2010/06/05 06:04 to 2010/06/06 06:49	test using posmv for position and heading, add os75bb for testing
HLY10TC_12	2010/06/06 06:51 to 2010/06/06 07:22	fix bugs; try again (test using posmv for position and heading). test new ser_bin. oops, posmv down.
HLY10TC_13	2010/06/06 07:26 to 2010/06/07 05:43	back to correcting heading (gyro-->posmv) gpsnav for positions. testing new workaround for after effects of new ser_bin
HLY10TC_14	2010/06/07 07:05 to 2010/06/08 18:47	another new ser_bin; take out last night's fixes. last leg into Dutch Harbor for parts
HLY10TC_15	2010/06/08 18:49 to 2010/06/09 19:58	survey south of Dutch Harbor, start with os75nb 16m bins, os150nb 8m bins (switch to os75nb 8m bins, os150nb 4m bins)

HLY10TC_16	2010/06/09 20:01 to 2010/06/10 22:53	keep highres, then switch back to defaults. quietness occurred during this leg
HLY10TC_17	2010/06/11 00:21 to 2010/06/11 04:34	new leg. why not? (why?)
HLY10TC_18	2010/06/11 04:35 to 2010/06/11 04:50	oops; had ashtech as heading device
HLY10TC_19	2010/06/11 04:50 to 2010/06/11 20:21	overnight, shallow survey: use all default settings; os150nb (4m), os75nb (8m), posmv for position and heading.
HLY10TC_quiet	2010/06/11 22:51 to 2010/06/11 22:58	2 5-minute ensembles during em122 acoustic interference test
HLY10TC_20	2010/06/12 02:04 to 2010/06/12 12:52	last night: use all default settings (final test). os150nb (4m), os75nb (8m), posmv for position and heading.

4.2 Appendix: HLY10TC ADCP Processing parameters

name	heading (reliable)	best position	hcorr_inst (accurate)	h_align os75	h_align os150
HLY10TC_01	gyro hdg	gpsnav gps	ashtech	43	28.5
HLY10TC_02	gyro hdg	gpsnav gps	ashpaq5	43.0	28.5
HLY10TC_03	gyro hdg	gpsnav gps	ashpaq5	43.0	28.5
HLY10TC_04	gyro hdg	gpsnav gps	posmv1	43	28.5
HLY10TC_05	gyro hdg	gpsnav gps	posmv1	43	28.5
HLY10TC_06	gyro hdg	gpsnav gps	posmv	43.0	28.5
HLY10TC_07	gyro hdg	gpsnav gps	posmv	43.0	28.5
HLY10TC_08	gyro hdg	gpsnav gps	posmv	43.0	28.5
HLY10TC_09	gyro hdg	gpsnav gps	posmv	43	28.5
HLY10TC_10	gyro hdg	posmv pmv	posmv	43	28.5
HLY10TC_11	posmv pmv	posmv pmv	(none)	43	28.5
HLY10TC_12	posmv pmv	posmv pmv	(none)	43	28.5
HLY10TC_13	gyro hdg	gpsnav gps	posmv	43.4	28.4
HLY10TC_14	gyro hdg	gpsnav gps	posmv	43.4	28.4
HLY10TC_15	gyro hdg	gpsnav gps	posmv	43.4	28.4
HLY10TC_16	gyro hdg	gpsnav gps	posmv	43.4	28.4
HLY10TC_17	gyro hdg	gpsnav gps	posmv	43.4	28.4
HLY10TC_18	posmv pmv	posmv gps	ashpaq5	43.4	28.4
HLY10TC_19	posmv pmv	posmv gps	(none)	43.4	28.4
HLY10TC_quiet	posmv pmv	posmv gps	(none)	43.4	28.4
HLY10TC_20	posmv pmv	posmv gps	(none)	43.4	28.4
HLY10TC_rationalized (reprocessed segments HLY10TC_[06 -20])	posmv pmv	posmv gps	(none)	43.4	28.4

4.3 Appendix: HLY10TC ADCP acquisition parameters

```

c= chunk number
N= number of files in chunk
decimal day start, end
BT= bottom track status (on, off)
(ping, Number of bins, bin size (m), blank (m), pulse (m))
reboot before segment (*)

c      N      startdd    enddd      BT      (ping, N, Size, Blank, Pulse)(ping, N, Size, Blank, Pulse)

----- HLY10TC_01 -----
[os75]
c=0  N=6  150.837292  151.191521  off   ('bb', 80, 8.0, 10.0, 8.0)  ('nb', 70, 16.0, 10.0, 16.0)
[os150]
c=0  N=6  150.837269  151.191537  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 70, 8.0, 5.0, 8.0)
----- HLY10TC_02 -----
[os75]
c=0  N=2  151.194334  151.229957  off   ('bb', 50, 8.0, 10.0, 8.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=2  151.194319  151.229997  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_03 -----
[os75]
c=0  N=4  151.238580  151.648116  off   ('bb', 50, 8.0, 10.0, 8.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=4  151.238565  151.648111  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_04 -----
[os75]
c=0  N=2  151.650052  151.693894  off   ('bb', 50, 8.0, 10.0, 8.0)  ('nb', 30, 8.0, 10.0, 8.0)
c=1  N=2  151.694702  151.814048  off   ('bb', 30, 8.0, 10.0, 8.0)  ('nb', 30, 8.0, 10.0, 8.0)
c=2  N=6  151.815283  152.241563  off   ('bb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=2  151.650039  151.693880  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 4.0, 5.0, 4.0)
c=1  N=2  151.694689  151.814046  off   ('bb', 40, 4.0, 5.0, 4.0)  ('nb', 40, 4.0, 5.0, 4.0)
c=2  N=6  151.815289  152.241560  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_05 -----
[os75]
c=0  N=9  152.242149  152.862512  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=9  152.242155  152.862514  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_06 -----
[os75]
c=0  N=8  152.863700  153.285182  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=8  152.863706  153.285175  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_07 -----
[os75]
c=0  N=6  153.655867  153.809909  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
c=1  N=1  153.811715  153.816986  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=6  153.655873  153.809895  off   ('bb', 40, 8.0, 5.0, 8.0)  ('nb', 40, 8.0, 5.0, 8.0)
c=1  N=1  153.811722  153.816993  off   ('bb', 40, 8.0, 5.0, 8.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_08 -----
[os75]
c=0  N=3  153.819055  153.923822  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=3  153.819060  153.923819  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_09 -----
[os75]
c=0  N=2  153.927775  154.057538  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
c=1  N=12 154.139167  155.025161  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0  N=2  153.927781  154.057547  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
c=1  N=12 154.139172  155.025162  off   ('bb', 75, 4.0, 5.0, 4.0)  ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_10 -----
[os75]

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c=0 N=3 155.121070 155.250163 off ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0 N=3 155.121075 155.250155 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_11 -----
[os75]
c=0 N=1 155.253020 155.269246 off ('nb', 30, 16.0, 10.0, 16.0)
c=1 N=1 155.269760 155.298210 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=2 N=1 155.308618 155.324195 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=3 N=1 155.325692 155.325775 off ('nb', 30, 16.0, 10.0, 16.0)
c=4 N=13 155.326270 156.284389 off ('bb', 45, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0 N=2 155.253026 155.298216 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=1 N=15 155.308603 156.284369 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_12 -----
[os75]
c=0 N=1 156.285749 156.307573 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0 N=1 156.285733 156.307550 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_13 -----
[os75]
c=0 N=7 156.310272 156.767370 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=1 N=1 156.767939 156.768022 off ('nb', 30, 16.0, 10.0, 16.0)
c=2 N=2 156.768609 156.858055 off ('bb', 45, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=3 N=2 156.895800 156.958493 off ('bb', 45, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=4 N=4 156.964696 157.238506 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0 N=8 156.310257 156.768021 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=1 N=2 156.768594 156.858058 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=2 N=2 156.895785 156.958487 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=3 N=4 156.964681 157.238533 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_14 -----
[os75]
c=0 N=19 157.295784 158.782918 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
[os150]
c=0 N=19 157.295769 158.782947 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
----- HLY10TC_15 -----
[os75]
c=0 N=2 158.784477 158.805463 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=1 N=1 158.806142 158.806764 on ('bb', 50, 8.0, 10.0, 0.0)
c=2 N=7 158.807362 158.917832 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=3 N=1 158.918303 158.981413 off ('nb', 30, 8.0, 10.0, 8.0)
c=4 N=4 158.981861 159.218239 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 8.0, 10.0, 8.0)
c=5 N=4 159.226213 159.280569 off ('bb', 40, 8.0, 10.0, 8.0) ('nb', 40, 8.0, 10.0, 8.0)
c=6 N=1 159.288029 159.289987 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 30, 16.0, 10.0, 16.0)
c=7 N=26 159.291271 159.716340 off ('bb', 40, 8.0, 10.0, 8.0) ('nb', 40, 8.0, 10.0, 8.0)
c=8 N=30 159.717265 159.762875 off ('nb', 30, 16.0, 10.0, 16.0)
c=9 N=1 159.763291 159.766457 off ('bb', 40, 8.0, 10.0, 8.0) ('nb', 40, 8.0, 10.0, 8.0)
c=10 N=1 159.769998 159.770635 off ('nb', 70, 16.0, 10.0, 16.0)
c=11 N=18 159.771664 159.784101 off ('nb', 70, 16.0, 10.0, 16.0)
c=12 N=2 159.784757 159.832486 off ('nb', 40, 8.0, 10.0, 8.0) ('nb', 40, 8.0, 10.0, 8.0)
[os150]
c=0 N=8 158.784462 158.908109 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=1 N=8 158.909747 159.235383 on ('bb', 40, 4.0, 5.0, 4.0) ('nb', 40, 4.0, 5.0, 4.0)
c=2 N=2 159.236660 159.251652 off ('bb', 60, 4.0, 5.0, 4.0) ('nb', 40, 4.0, 5.0, 4.0)
c=3 N=1 159.252553 159.280571 off ('bb', 60, 4.0, 5.0, 4.0) ('nb', 60, 4.0, 5.0, 4.0)
c=4 N=1 159.288014 159.290000 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=5 N=26 159.291259 159.716339 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 60, 4.0, 5.0, 4.0)
c=6 N=30 159.717271 159.762853 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=7 N=1 159.763280 159.766437 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
c=8 N=20 159.769994 159.784079 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 70, 8.0, 5.0, 8.0)
c=9 N=2 159.784745 159.832511 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
----- HLY10TC_16 -----
[os75]
c=0 N=3 159.834083 159.971771 off ('bb', 40, 8.0, 10.0, 8.0) ('nb', 40, 8.0, 10.0, 8.0)
c=1 N=6 159.976432 159.990266 off ('nb', 30, 16.0, 10.0, 16.0)
c=2 N=6 159.990765 159.996060 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 80, 16.0, 10.0, 16.0)
c=3 N=2 160.001082 160.007120 off ('nb', 30, 16.0, 10.0, 16.0)
c=4 N=5 160.008333 160.024911 off ('bb', 80, 8.0, 10.0, 8.0) ('nb', 80, 16.0, 10.0, 16.0)
c=5 N=3 160.025534 160.246196 off ('bb', 40, 8.0, 10.0, 8.0) ('nb', 40, 8.0, 10.0, 8.0)
c=6 N=2 160.248310 160.262508 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 50, 8.0, 10.0, 8.0)
c=7 N=5 160.264211 160.270060 off ('bb', 80, 8.0, 10.0, 8.0) ('nb', 80, 16.0, 10.0, 16.0)
c=8 N=17 160.271492 160.953507 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 50, 8.0, 10.0, 8.0)
[os150]

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c=0 N=3 159.834072 159.971771 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
c=1 N=15 159.976438 160.009256 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=2 N=9 160.009660 160.024928 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 80, 8.0, 5.0, 8.0)
c=3 N=3 160.025523 160.246206 off ('bb', 75, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
c=4 N=2 160.248296 160.262496 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
c=5 N=9 160.264183 160.270058 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 75, 8.0, 5.0, 8.0)
c=6 N=17 160.271479 160.953518 off ('bb', 70, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
----- HLY10TC_17 -----
[os75]
c=0 N=4 161.015125 161.190557 off ('bb', 50, 8.0, 10.0, 8.0) ('nb', 50, 8.0, 10.0, 8.0)
[os150]
c=0 N=3 160.954769 161.014581 on ('bb', 75, 4.0, 5.0, 4.0) ('nb', 40, 8.0, 5.0, 8.0)
c=1 N=4 161.015125 161.190566 on ('bb', 70, 4.0, 5.0, 4.0) ('nb', 70, 4.0, 5.0, 4.0)
----- HLY10TC_18 -----
[os75]
c=0 N=2 161.191297 161.201470 off ('nb', 50, 8.0, 10.0, 8.0)
[os150]
c=0 N=2 161.191292 161.201475 off ('nb', 70, 4.0, 5.0, 4.0)
----- HLY10TC_19 -----
[os75]
c=0 N=10 161.202025 161.848285 off ('nb', 50, 8.0, 10.0, 8.0)
[os150]
c=0 N=10 161.202020 161.848283 off ('nb', 70, 4.0, 5.0, 4.0)
----- HLY10TC_20 -----
[os75]
c=0 N=6 162.086297 162.536740 off ('nb', 50, 8.0, 10.0, 8.0)
[os150]
c=0 N=6 162.086292 162.536731 off ('nb', 70, 4.0, 5.0, 4.0)

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