HRC Acceptance Testing

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Aug 07, 2006

Summary

A detailed acceptance test for the HRC has been performed. A regression test shows that BOT is giving the correct answers. The new features (exposure expansion, pointing adjustments, actual duration usage, and visualization) are all functioning properly, and for the most part, BOT can handle error conditions gracefully and provides meaningful feedback to the users.

One enhancement to the Detailed Summary is proposed, BOT crashes (exception thrown) when the CONFIG is missing, there are two values of GAIN that should not be processed by BOT (they are unsupported) but are, and there are two configuration (ACQ mode and use of polarizers) that, while supported, should be unsupported in BOT; all of these have PRs filed.

Three issues with the Aladin display have been found – a slight misalignment of the BOT overlay with the DSS image, a failure to display all sub-exposures, and a broken link in the Aladin spreadsheet; all of these are known issues with PRs or DRs previously filed.

The unsupported mode (GAIN, ACQ mode, and use of polarizers) issues, as well as the failure to display all sub-exposures, should be corrected prior to the release of the tool for HRC usage.

Introduction

For this test, the following target and exposure was used:

Target: G191-B2B – 05h 05m 30.6119s, +52^{o} 49’ 45.95”
(Note that this is slightly off from nominal position of the star)

Exposure: ACS/HRC, ACCUM, F555W, HRC, 100s, CR-SPLIT=NO, GAIN=2

When appropriate, modifications to the exposure (e.g. POS TARG) are detailed below.

This target/exposure was used to perform the following:

Test	Definition
Regression	Comparison with old VTT/BOT
New features	Exposure expansion, pointing adjustment, actual duration, visualization
Exception	Bad exposure, unsupported exposure (network query and cancel

Handling	operations were performed with the ACS/SBC)

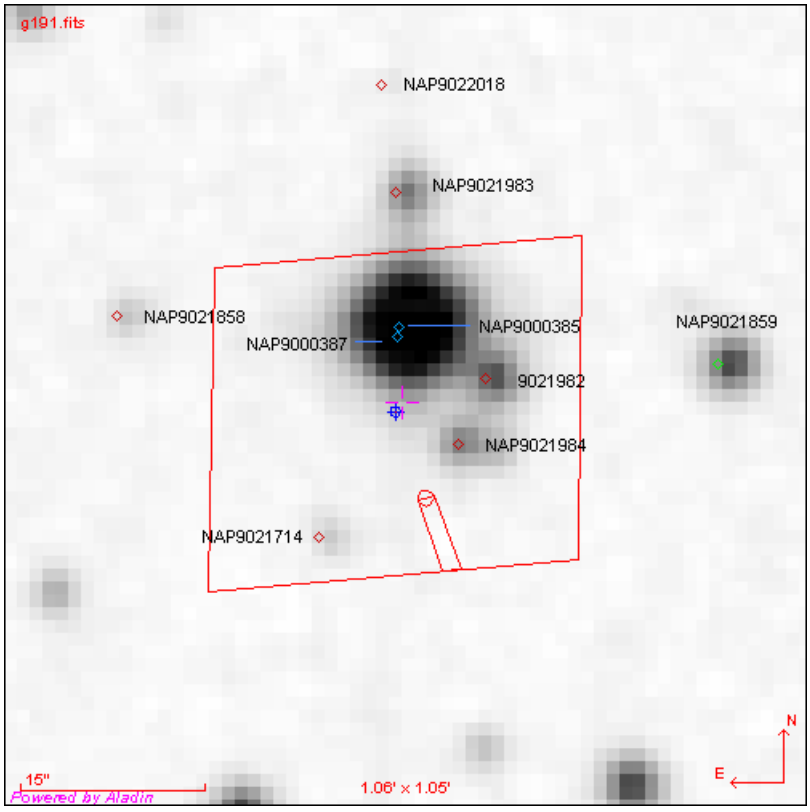
For certain tests, both the tabular and graphic output products are included for ease of comparison with future test results.

Regression Test

The test exposure was run through both the VTT/BOT and the new BOT/Aladin interface. Both methods used a search radius of 26.4", and the exact same stars were found in both cases; the magnitudes and derived count rates were identical. The 9 objects detected (2 Science, 1 Safe, 6 Unknown) were:

GSC2 ID	RA (05 05)	Dec (+52)	F	J	V	B-V	Type	VTT	New
NAP9000385	30.5968	49 52.68	11.84	11.45	11.69	-0.62	**O5V**	x	x
NAP9000387	30.6069	49 51.92	---	---	11.68	-0.25	**O5V**	x	x
NAP9021714	31.2701	49 36.12	19.03	20.35	---	---	not a star	x	x
NAP9021858	33.0508	49 53.18	18.81	20.48	---	---	not a star	x	x
NAP9021859	27.8199	49 50.20	16.37	17.42	16.85	0.37	F0V	x	x
NAP9021982	29.8387	49 48.73	16.82	22.16	---	---	not a star	x	x
NAP9021983	30.6445	50 3.23	17.22	18.56	---	---	not a star	x	x
NAP9021984	30.0681	49 43.51	17.57	22.16	---	---	not a star	x	x
NAP9022018	30.7848	50 11.67	20.21	22.16	---	---	not a star	x	x

The field map, showing the objects found, is given below.



In the figure, all objects were found by the VTT/BOT.

Issue
There appears to be a slight misalignment between the BOT overlay and the DSS image, which is 0.2" in both RA and Dec. The RA offset is consistent (the BOT overlay is always east of the star), while the Dec offset is sometimes north and sometimes south. This discrepancy is small enough (0.2 pixels) to be of no concern, but is covered under APT-VTT DR 1170.

There are two optional parameters that impact the BOT results, and should be displayed in the exposure summary section (upper right) of the details page. CR-SPLIT determines the actual exposure time that will be used (if not specified, then the default value of 2 should be shown), and GAIN determines the trigger limits (again, if not given, the default value of 2 should be shown); this issue is covered under APT-BOT PR 56382.

New Features

Exposure Expansion

For the HRC, there are three ways for exposures to be expanded – use of the CR-SPLIT optional parameter, number of iterations greater than 1, and the use of a pattern; it is also possible to combine these methods (i.e. CR-SPLIT and pattern). The following cases were tested:

CR-SPLIT	Num. of Iter.	Pattern	Number of sub-exposures	Original Exp. Time	Exp.Time Predicted	Exp. Time Used by BOT
NO (=1)	1	no	1	100s	100s	100s
DEF (=2)	1	no	2	100s	50s	50s
3	1	no	3	100s	33.3s	33.3s
2	1	no	2	100s	50s	50s
NO (=1)	3	no	3	100s	100s	100s
NO (=1)	1	yes	4x1	100s	100s	100s
DEF (=2)	1	yes	2x2	100s	50s	50s

In each case, BOT created the correct number of sub-exposures, and modified the given exposure time correctly. As with the SBC, Aladin did display the BOT overlays, although there was only 1 image plane shown for the CR-SPLIT and number of iterations cases, unlike the Pattern case where each sub-exposure was its own plane. Since the CR-SPLIT and number of iterations planes would all be, by definition, identical, showing only 1 plane is acceptable (however, if the actual duration field was used, a problem could result).

Pointing Adjustment

There are 3 different types of pointing adjustments valid for the HRC – POS TARG, PATTERN, and use as a PARALLEL instrument.

POS TARG

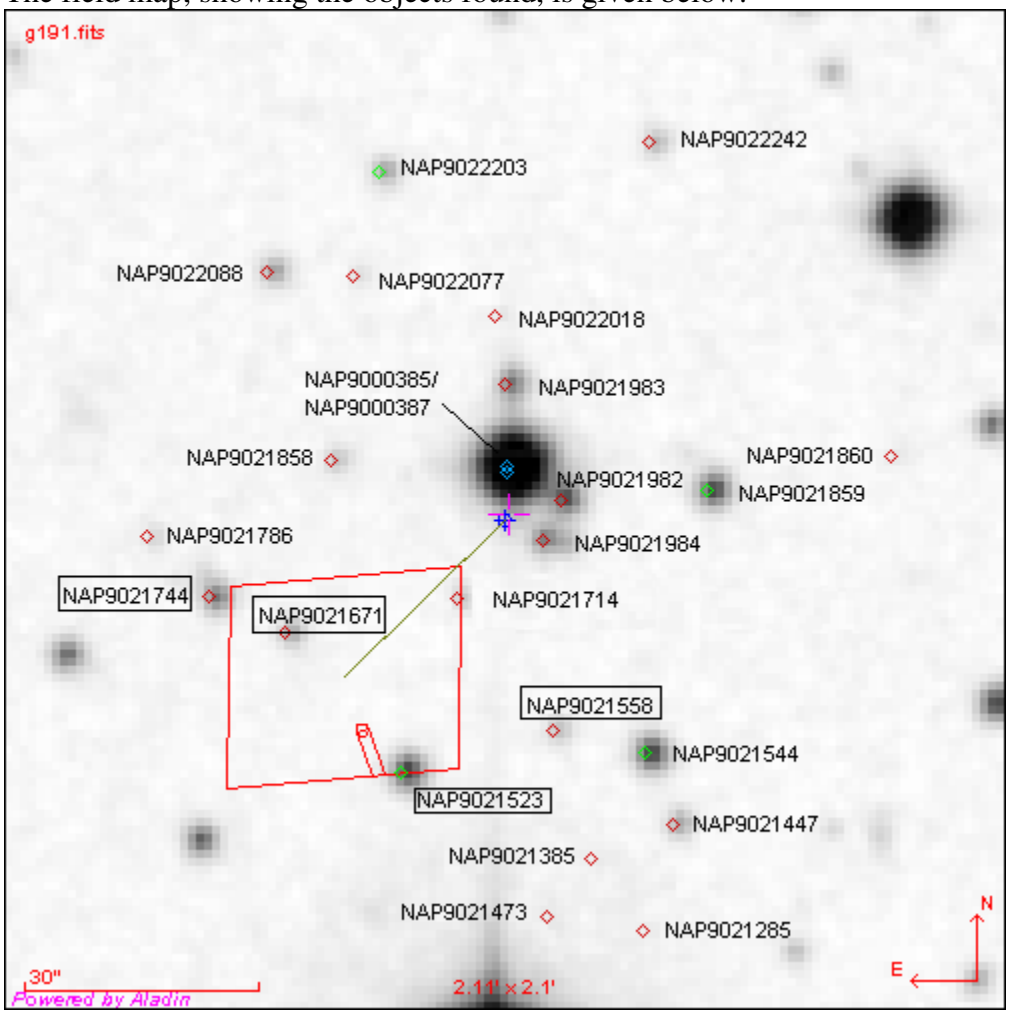
For this test, the standard exposure was modified by adding a POS TARG of X=-20” and Y=-20”. The direction of the POS TARG is important in this test, and in order to be able to simply predict the size of the POS TARG motion, the motion must be in the same direction as the "Search Radius Vector" which is defined as the point from the fiducial to the outermost corner of the Aperture; for the HRC this is the lower left corner. A selection in a different direction makes the calculation of the motion vector more complicated.

The test exposure was run through both the VTT/BOT and the new BOT/Aladin interface. The VTT/BOT used a search radius of 26.4”, and only did analysis at the exact pointing (i.e. it assumed ORIENT=0). The new BOT increased the search radius by 28.2” to 54.6”, which resulted in a circle being analyzed to support any possible ORIENT value; based on the size of the POS TARG, this increase in search radius is exactly what was predicted (i.e. SQRT(20*20 + 20*20) = 28.2). With the increased search radius, the new BOT analyzed more objects than the VTT/BOT, but all objects in the VTT/BOT were detected, and for those objects, the magnitudes and derived count rates were identical.

The 24 objects detected (2 Science, 4 Safe, 18 Unknown) were:

GSC2 ID	RA (05 05)	Dec (+52)	F	J	V	B-V	Spec. Type
NAP9021523	32.0052	49 14.15	16.3	17.85	17.02	0.72	G5V
NAP9021671	33.6567	49 31.37	18.36	20.37	---	---	not a star
NAP9021714	31.2701	49 36.12	19.03	20.35	---	---	not a star
NAP9021744	34.7154	49 35.81	17.09	18.8	---	---	not a star
NAP9000385	30.5968	49 52.68	11.84	11.45	11.69	-0.62	**O5V**
NAP9000387	30.6069	49 51.92	---	---	11.68	-0.25	**O5V**
NAP9021285	28.5996	48 54.64	20.26	---	---	---	not a star
NAP9021385	29.3488	49 3.70	19.98	---	---	---	not a star
NAP9021447	28.2105	49 8.15	18.4	19.69	---	---	not a star
NAP9021473	29.9553	48 56.09	19.97	---	---	---	not a star
NAP9021544	28.6232	49 16.96	16.37	17.3	16.8	0.29	A5V
NAP9021558	29.9115	49 19.67	18.87	20.18	---	---	not a star
NAP9021786	35.5867	49 43.14	19.47	20.76	---	---	not a star
NAP9021858	33.0508	49 53.18	18.81	20.48	---	---	not a star
NAP9021859	27.8199	49 50.20	16.37	17.42	16.85	0.37	F0V
NAP9021860	25.2752	49 54.84	20.14	---	---	---	not a star
NAP9021982	29.8387	49 48.73	16.82	---	---	---	not a star
NAP9021983	30.6445	50 3.23	17.22	18.56	---	---	not a star
NAP9021984	30.0681	49 43.51	17.57	---	---	---	not a star
NAP9022018	30.7848	50 11.67	20.21	---	---	---	not a star
NAP9022077	32.7828	50 16.40	19.79	22.33	---	---	not a star
NAP9022088	33.9734	50 16.81	18.13	19.8	---	---	not a star
NAP9022203	32.4531	50 29.57	18.29	19.61	18.9	0.55	F5V
NAP9022242	28.6863	50 33.77	18.73	20.54	---	---	not a star

The field map, showing the objects found, is given below.



In the figure, the objects in boxes were found by the VTT/BOT. The new objects are all in the area that is expected.

Pattern

For this test, the standard exposure was modified by putting it in a PATTERN (an HRC-DITHER-LINE with 3 points with a 10" spacing at an orientation of 225°). The orientation of the pattern is important in this test, since in order to be able to simply predict the size of the PATTERN motion, the motion must be in the same direction as the "Search Radius Vector" which is defined as the point from the fiducial to the outermost corner of the Aperture; for the SBC this is the lower left corner. A selection in a different orientation makes the calculation of the motion vector more complicated.

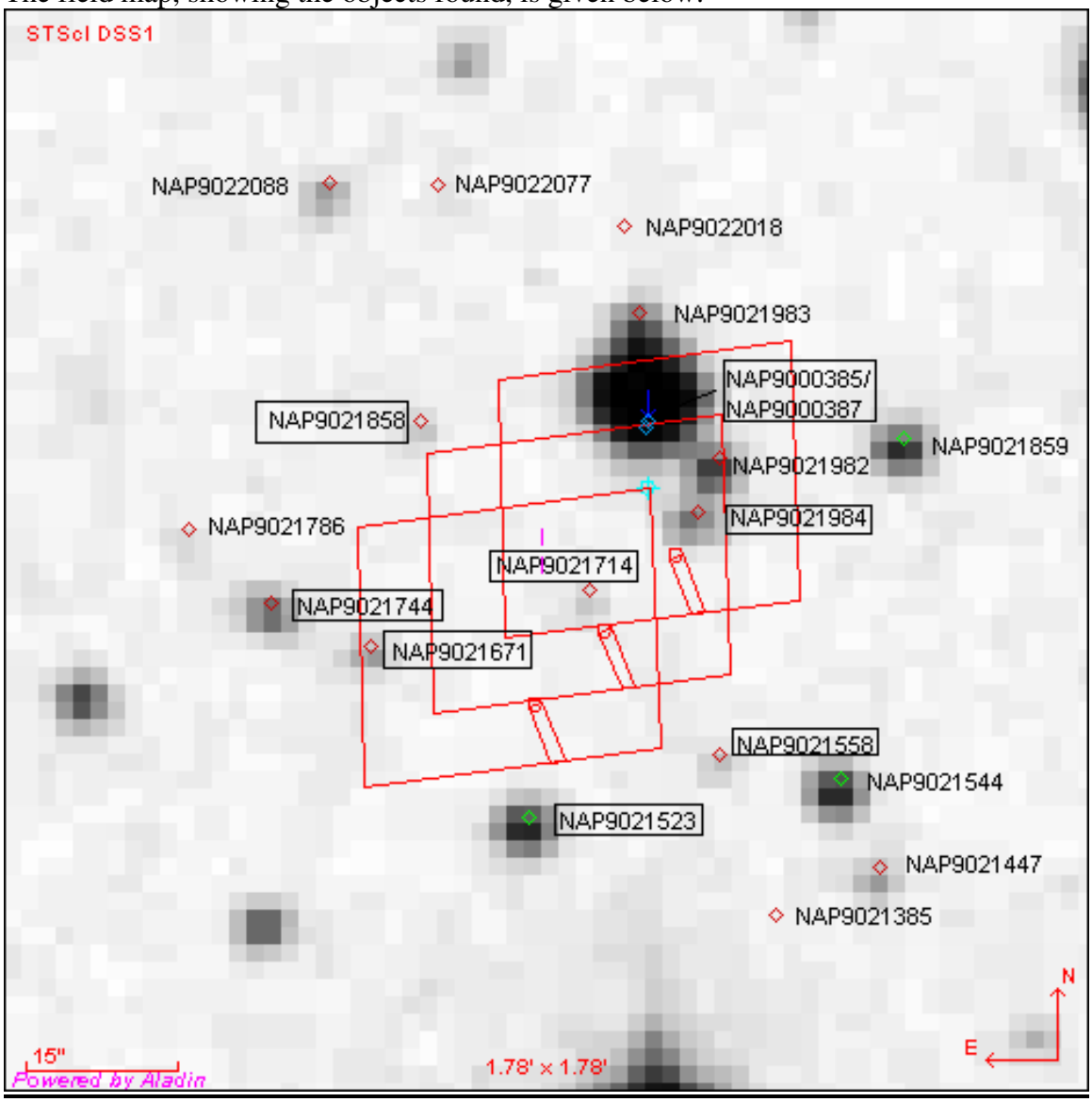
The test exposure was run through both the VTT/BOT and the new BOT/Aladin interface. The VTT/BOT used a search radius of 26.4", and only did analysis as if there were no pattern. The new BOT did 3 searches – one for the initial pointing (with the standard 26.4" search radius) and one for each of the two pattern points (with the search radius increased to 36.6" and 46.8"); all objects in the initial pointing were included in

the larger pattern pointing report, as expected. The expanded search radius was calculated to be 36.6” and 46.8” for the non-central pattern points; this was in error by 0.2” for each point (10.2” separation instead of 10.0”), which is an acceptable level of accuracy. With the increased search radius, the new BOT analyzed more objects than the VTT/BOT, but all objects in the VTT/BOT were detected, and for those objects, the magnitudes and derived count rates were identical.

The 19 objects detected (2 Science, 3 Safe, 14 Unknown) were:

GSC2 ID	RA (05 05)	Dec (+52)	F	J	V	B-V	Spectral Type
NAP9000385	30.5968	49 52.68	11.84	11.45	11.69	-0.62	**O5V**
NAP9000387	30.6069	49 51.92	unknown	unknown	11.68	-0.25	**O5V**
NAP9021523	32.0052	49 14.15	16.3	17.85	17.02	0.72	G5V
NAP9021558	29.9115	49 19.67	18.87	20.18	unknown	unknown	not a star
NAP9021671	33.6567	49 31.37	18.36	20.37	unknown	unknown	not a star
NAP9021714	31.2701	49 36.12	19.03	20.35	unknown	unknown	not a star
NAP9021744	34.7154	49 35.81	17.09	18.8	unknown	unknown	not a star
NAP9021858	33.0508	49 53.18	18.81	20.48	unknown	unknown	not a star
NAP9021984	30.0681	49 43.51	17.57	unknown	unknown	unknown	not a star
NAP9021385	29.3488	49 3.70	19.98	---	---	---	not a star
NAP9021447	28.2105	49 8.15	18.4	19.69	---	---	not a star
NAP9021544	28.6232	49 16.96	16.37	17.3	16.8	0.29	A5V
NAP9021786	35.5867	49 43.14	19.47	20.76	---	---	not a star
NAP9021859	27.8199	49 50.20	16.37	17.42	16.85	0.37	F0V
NAP9021982	29.8387	49 48.73	16.82	---	---	---	not a star
NAP9021983	30.6445	50 3.23	17.22	18.56	---	---	not a star
NAP9022018	30.7848	50 11.67	20.21	---	---	---	not a star
NAP9022077	32.7828	50 16.40	19.79	22.33	---	---	not a star
NAP9022088	33.9734	50 16.81	18.13	19.8	---	---	not a star

The field map, showing the objects found, is given below.



In the figure, the objects in boxes were found by the VTT/BOT. The new objects are all in the area that is expected.

Parallel

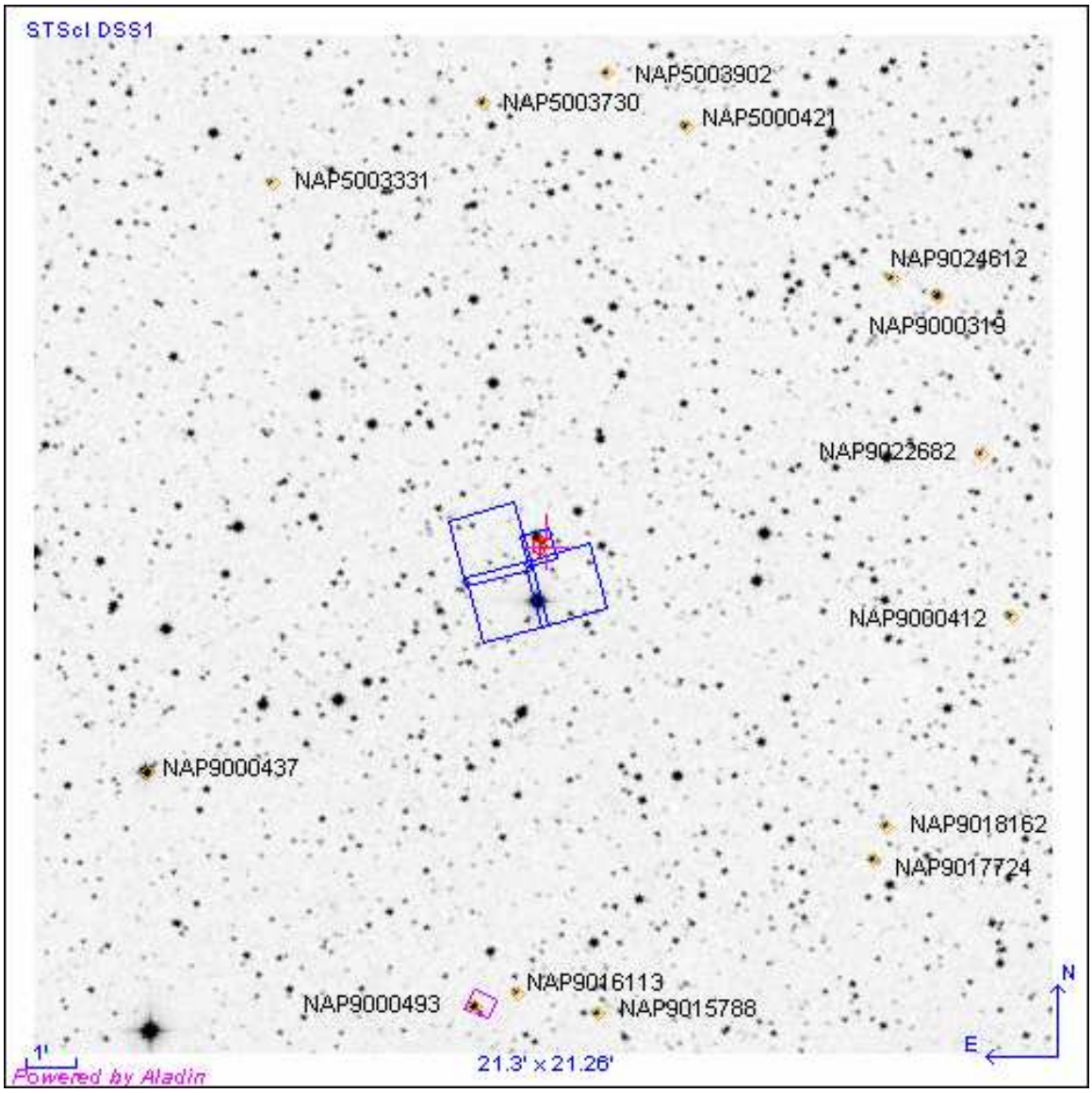
For this test, the standard exposure was modified making it be a coordinated parallel observation with a WPFC2 prime exposure. The test exposure was run through the new BOT/Aladin interface only; the old VTT/BOT did not take the position of the parallel aperture into account when performing its checking. The search radius used by BOT was 9.41'. The separation between the PC and HRC is 9.03', and after adding 0.44' for the standard search radius, the approximate search radius BOT should have used is 9.47', very close to what was actually used. Given that the apertures are not aligned along the

Search Radius Vector (described above), this small difference (especially given that BOT uses a larger radius) is not important.

A total of 402 stars were found in the new BOT, so the table below only lists the science concerns (14). The objects detected were:

GSC2 ID	RA (05)	Dec (+52)	F	J	V	B-V	Type
NAP5000421	05 9.8646	57 55.50	13.47	14.3	13.86	0.23	A5V
NAP5003331	06 4.0164	57 2.99	14.85	16.1	15.42	0.52	F5V
NAP5003730	05 36.1898	58 29.64	14.24	15.57	14.85	0.57	F5V
NAP5003902	05 19.9558	59 0.70	14.47	16.39	15.38	0.97	K0V
NAP9000319	04 37.7069	54 26.89	12.94	13.95	13.41	0.35	F0V
NAP9000412	04 29.6451	48 7.56	13.87	15.18	14.47	0.56	F5V
NAP9000437	06 22.1153	45 32.76	10.4	12.55	11.44	1.13	K0V
NAP9000493	05 40.5056	40 46.37	12.54	14.2	13.31	0.79	G5V
NAP9015788	05 24.6834	40 34.57	14.04	15.12	14.54	0.4	F0V
NAP9016113	05 34.9977	41 2.02	14.52	15.82	15.11	0.55	F5V
NAP9017724	04 48.3472	43 25.78	14.41	15.67	14.99	0.53	F5V
NAP9018162	04 46.5528	44 5.07	14.35	16.25	15.24	0.97	K0V
NAP9022682	04 32.8229	51 19.27	14.75	15.78	15.22	0.37	F0V
NAP9024612	04 43.6833	54 49.18	14.23	15.83	14.97	0.76	G5V

The field map, showing the objects found, is given below.



Actual Duration

There are three ways in which the HRC can use actual durations – a CR-SPLIT exposure, a pattern exposure, and a number of iterations greater than 1 exposure. For this test, the second piece of a CR-SPLIT, the third piece of the pattern, and the third piece of a number of iterations=3 exposure will have the actual duration set to 100s, 200s, and 200s, respectively.

CR-SPLIT

An examination of the BOT details shows that the revised exposure time for the second piece of the CR-SPLIT was detected by the tool, and that value was used in the determination of the total counts from the stars; for the other pieces of the CR-SPLIT, the exposure time of 33.33s was used.

Pattern
An examination of the BOT details shows that the revised exposure time for the third piece of the pattern was detected by the tool, and that value was used in the determination of the total counts for the stars; for the other pieces of the pattern, the exposure time of 100s was used.

Number of iterations
An examination of the BOT details shows that the revised exposure time for the third piece of the pattern was detected by the tool, and that value was used in the determination of the total counts for the stars; for the other pieces of the pattern, the exposure time of 100s was used.

Issue
For CR-SPLIT and number of iterations, only the first sub-exposure is shown in Aladin. If there were different actual durations, both sub-exposures would need to be display, as they could have different answers. This is a problem is covered in APT-BOT OPR 56136, and *should be corrected prior to the release of the tool for HRC usage.*

Visualization

There are many aspects to this test, most of which have already been verified by the previous testing. The following items have been verified with in HRC:

- Science Concern objects are visible in the BOT overlay
- Visibility of Science Concern objects can be toggled on and off
- Selection of individual Science Concern objects, with details appearing in spreadsheet

Issue
Aladin spreadsheet name link to an external html page with more details fails for the GSC2; this is covered with APT-VTT DR 1197.

Exception Handling

There are four types of exception handling to be tested; Network Query Error and Cancel Ongoing Operations have been verified in the SBC testing.

Bad Exposure Parameters

In this case, three copies of the simple exposure are processed at once, with the middle copy missing the aperture name, spectral element, and exposure time (in separate runs). When processed, the first and third exposure complete normally, while the second exposure has an error (unable to load exposure) indicating that the exposure is in error.

Issue - Config missing
In this case, three copies of the simple exposure are processed at once, with the middle copy missing the config (instrument/detector). When processed, the BOT crashes (with

an exception thrown) when the second exposure is processed; this is covered in APT-BOT PR 56383.

Unsupported Exposures

There are no unsupported apertures for the HRC. There are 2 unsupported GAIN values (1 and 8), and one unsupported spectral elements (CLEAR). When CLEAR is used, an appropriate error message is given.

Issue – Unsupported mode incorrectly supported in BOT

The use of GAIN of 1 and 8 are unsupported modes for the HRC, but BOT processes them anyway. The use of GAIN impacts the trigger limits, so these GAIN values should NOT be processed by BOT; these are covered in APT-BOT PR 56384, and *should be corrected prior to the release of the tool for HRC usage.*

Issue – Supported modes that should be unsupported in BOT

Use of the polarizers in ACCUM mode, and use of ACQ mode are both fully supported configurations. However, the polarizers impact the count rate (reduce it substantially), while the use of ACQ modes greatly limits the field of view (and puts the occulting finger in the field). These modes should be considered UNSUPPORTED in BOT; these are covered in APT-BOT PR 56384, and *should be corrected prior to the release of the tool for HRC usage.*