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Sensitivity Testing on a Theater-Based Automatic Data Fusion Algorithm

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This report documents the test methodology and the results and analysis of specific tests for a developing U.S.Navy Correlator Tracker. In the Navy context, the correlator tracker provides locational and operational information of ships, submarines, aircraft and land-based forces, both friendly, neutral, commercial and of upmost important non-friendly targets or threats. The algorithm in question operates within a system known as the OSIS Baseline Upgrade (OBU) where OSIS stands for Ocean Surveillance Intelligence System. Due to the high volume of data, upwards of 5,000 reports an hour with up to 20,000 extant tracks, a large amount of data fusion is required to be done automatically with operator intervention to resolve ambiguities and computer error. Since it was determined that the algorithm, otherwise known as the Automatic Correlator Tracker (ACT) was intractable from the system in which it operates, test data had to be transported and run on the system at its development facility. This arrangement put time and data constraints on the analysis and therefore a tightly bound set of sensitivity tests had to be created specifically for the application. (KR) ←

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FOREWORD

This work was done under sponsorship of SPAWARSYSCOM, PMW 161. The author would like to thank the program managers during the time of this study, Mr. Stephen Arkin and CDR Edward Moore.

Some of the work referenced herein is currently available in draft form and is obtainable by government agencies upon request.

The author would like to thank Dr. Stephen Anderson, Dr. Kurt Askin, Mrs. Jennie Ehrhardt and Dr. Frank Perry for their assistance and guidance.

This report documents the test methodology and the results and analysis of specific tests for a developing U.S. Navy Correlator Tracker. A correlator tracker takes data from diverse sources in order to determine a coherent picture of the outside world. In the Navy context, the correlator tracker provides locational and operational information of ships, submarines, aircraft and land-based forces, both friendly, neutral, commercial and of upmost important non-friendly targets or threats. The algorithm in question operates within a system known as the OSIS Baseline Upgrade (OBU) where OSIS stands for Ocean Surveillance Intelligence System. Due to the high volume of data, upwards of 5,000 reports an hour with up to 20,000 extant tracks, a large amount of data fusion is required to be done automatically with operator intervention to resolve ambiguities and computer error. Since it was determined that the algorithm, otherwise known as the Automatic Correlator Tracker (ACT) was intractable from the system in which it operates, test data had to be transported and run on the system at its developmental facility. This arrangment put time and data constraints on the analysis and therefore a tightly bound set of sensitivity tests had to be created specifically for the application.

Sensitivity testing is defined as the determination of performance at the correlator tracker's most basic level. These tests then test how the data fusion is done when presented with fundamental evasive and basic maneuvers of targets. This included parallel tracks, crossing tracks and turning tracks. Many of these tests also provide a method to assess the robustness of the algorithm itself.

SENSITIVITY TESTING ON A THEATER-BASED AUTOMATIC DATA FUSION ALGORITHM

INTRODUCTION

The problem addressed herein is the construction of a comprehensive set of sensitivity tests for a data fusion correlator tracker algorithm. The data set and rationale are presented and the results of a run on an algorithm under development are presented. Sensitivity Tests have been used in previous NRL evaluations [1-3] but up until this time, due to virtually unlimited computing resources and algorithm availability, a tightly bound set of tests was never specified. This work can be viewed as a first step in creating a library of standard test scenarios to be used in evaluation of all similar algorithms.

This report documents the 1988 analysis results of the Naval Research Laboratory (NRL) Ocean Surveillance Intelligence System (OSIS) Baseline Upgrade (OBU) Automatic Correlator Tracker (ACT) evaluation. The results form a baseline of knowledge on how the OBU ACT (Patuxant River- 10/88) processes ELINT and spatial information as the algorithm and input parameters (distance, emitter characteristics) are changed. In addition, peculiarities were noted that may have algorithmic or software ramifications.

The ACT was tested for performance via a series of one to two track "sensitivity" scenarios. In all, around 225 of these tests were run. The results of the testing are summarized and discussed in the report. Refer to Appendix A for a complete listing of test results.

BACKGROUND

This report is on data runs made at the OBU Patuxent (PAX) River Developmental Facility in October, 1988 and was funded and coordinated by SPAWAR, PMW-161. The data was generated at NRL using MULTIGEN (MULTIple detection GENerator) to simulate ELINT data reports [4]. This data was then transported to PAX River and run on the OBU System by Fuentez System Concepts (FSC) personnel. Due to the dependence of the T/C on the unique hardware configuration of OBU, it is too expensive to transfer a copy of the T/C into NRL's T/C evaluation laboratory, and therefore data must be run on-site. The output of the OBU T/C is then down-loaded to a tape and transferred back to NRL for analysis.

Past work by NRL on the OBU evaluation and a knowledge of the developer's needs determined what testing should be done and ultimately gave clues as to why certain phenomenon occur in the output data. This past work included a written analysis of the OBU documentation and code entitled "Mathematical Analysis of the OBU Automatic Tracker/Correlator (May, 1987)" based on specifications written circa 1986. While NRL concluded that the ELINT model (TERESA) and the position/velocity models used in OBU were sound, the way the ACT was to handle the incorporation of observations was questionable. Specifically, at each stage,

> "OBU attempts to correlate Internal Contact Reports (ICRs) based on only one kind of information (spatial, ELINT, etc.). Previously considered types of information may have been used to prune the list of candidates, but among those which survive, all relative scores are ignored. An association which scores well on many Measures of Correlation (MOCs) should be considered a better candidate than an association that scores slightly better on one MOC and only marginally better on the others. This may lead to geo-graphically inconsistent tracks, where the ICR may have barely passed the Gross Range Check and then the TERESA test indicates the the ICR should be correlated to a track and a more

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detailed spatial test is never done."

Additionally, the report pointed out possible problems with the test for a new emitter (via the New Emitter Statistic), out of sequence data incorporation, the track linking (LINK) association rules (matched only by number of emitters/track), the Gross Range Check (GRC)'s incorporation of uncertainty ellipses and the disregard for report uncertainties in the multi-point track initiation module (CLUSTER). Since that report was written, several changes were made to the T/C which supposedly addressed these problems.

In February-March of 1988, the PAX River Developmental Facility (DF) was available for data runs and a study was completed which concluded that OBU was having trouble maintaining long, transitting tracks, thus creating some geographically unrealistic tracks and that the LINK and CLUSTER modules were responsible for creating a number of "garbage" tracks. These results were reported to SPAWAR in March of 1988.[2]

Based on this experience and knowing the T/C had undergone a significant change between February 1988 and October 1988, NRL and SPAWAR decided to rerun the February, 1988 data set in the October 1988 runs. In addition, a more detailed study of the effects of ELINT and geographic separation led to the creation of a set of a parallel tracks tests with repetitions of tests to account for any random unknown errors.

DESCRIPTION OF DATA

In total, three sets of data consisting of roughly 75 subsets of sensitivity tests and roughly 7000 reports were run in October 1988. A sensitivity test is defined as one or two ground-truth tracks or targets making at most one maneuver each. Each track in these tests is composed of 50 Internal Contact Reports (ICRs) arriving at a nearly constant rate of one per hour. The targets move at constant speed (20 knots/hour) along rhumb line courses. Each track was modeled as having only one emitter based loosely on DON/DON II radar characteristics with Pulse Repetition Interval (PRI) and Scan Rate (SR) values randomly drawn from a normal distribution - similar to the way in which OBU's ELINT correlator, TERESA, models its emitters. The reports come in via the SOSUS line as Selor Red reports generated by a CLASSIC WIZARD passive radar. The first two reports on each track include a unique attribute (NOSIC ID) which "forces" OBU to initiate that track. This removes any possible confounding problems due to reported multi-point track initiation (known as CLUSTER in OBU) problems. The motivation for this approach is that the largest and most complex scenario is composed of individual targets following courses that are composed of constant course and speed legs. The scenario's complexity will increase both as the time length of the legs decreases and as the density of targets increases. However it is clear that if a T/C is to handle large, complex scenarios it must first be able to handle the simple elements of which such a scenario is made. Indeed, in a very large scenario such as ECAP II (the NRL Mediterranean Scenario) it seems likely that if the time on leg is sufficiently large and the density is sufficiently low, the total performance will be predictable from the performance characteristic for the individual simple elements. The general characteristics of the data sets are reviewed in Table 1.

General Characteristics of NRL/OBU - PAX Data
~7000 reports/data set
~75 tests/data set
1-2 tracks/test
50 reports/track
Constant platform speed of 20 knots/hr
Emitters modeled approx. on DON/DONII
Reported by WIZARD
Rhumb line courses
PRI and SR values normal dist. draw

Table 1: *Characteristics of input data.*

Figure 1 on the following page summarizes the properties of the sensitivity tests used in the evaluation. The simplest ground truth scenario consists of a single target moving along at constant course and speed and turning half-way through the test. If a T/C cannot follow a simple single course change then there is no hope of it following a large number of targets through a large number of course changes.

Two targets can interact in a variety of ways. The simplest of these is to have the targets' courses cross while each target is in the middle of a constant course and speed leg. This test is called the Crossing Test. The interaction can be complicated if one or both targets also maneuver at the time of closest approach. One target maneuvering is covered in Straight-Turn Test. Both targets maneuvering at closest approach is known as the Turn-Turn Test. Finally, the Parallel Tracks Test (Figure 1.1 only) is actually a variation on Turn-Turn testing in which the targets courses do not cross at the point of intersection but continue in a parallel course. All of these tests are located in the Sensitivity Test Data Set (STDS) except for the Parallel Tracks test described in Figure 1.2 in Figure 1. The Parallel Tracks Data Set (PTDS) consists only of tests with the characteristics described in Figure 1.2. Instead of two targets approaching each other, and then running parallel, the tracks in PTDS run parallel throughout the test with the first fifteen reports given NOSIC IDs. This approach allows for proper initiation of a track at any geographic separation from its sister track without the motion model problems that are encountered with tests like Figure 1.1.

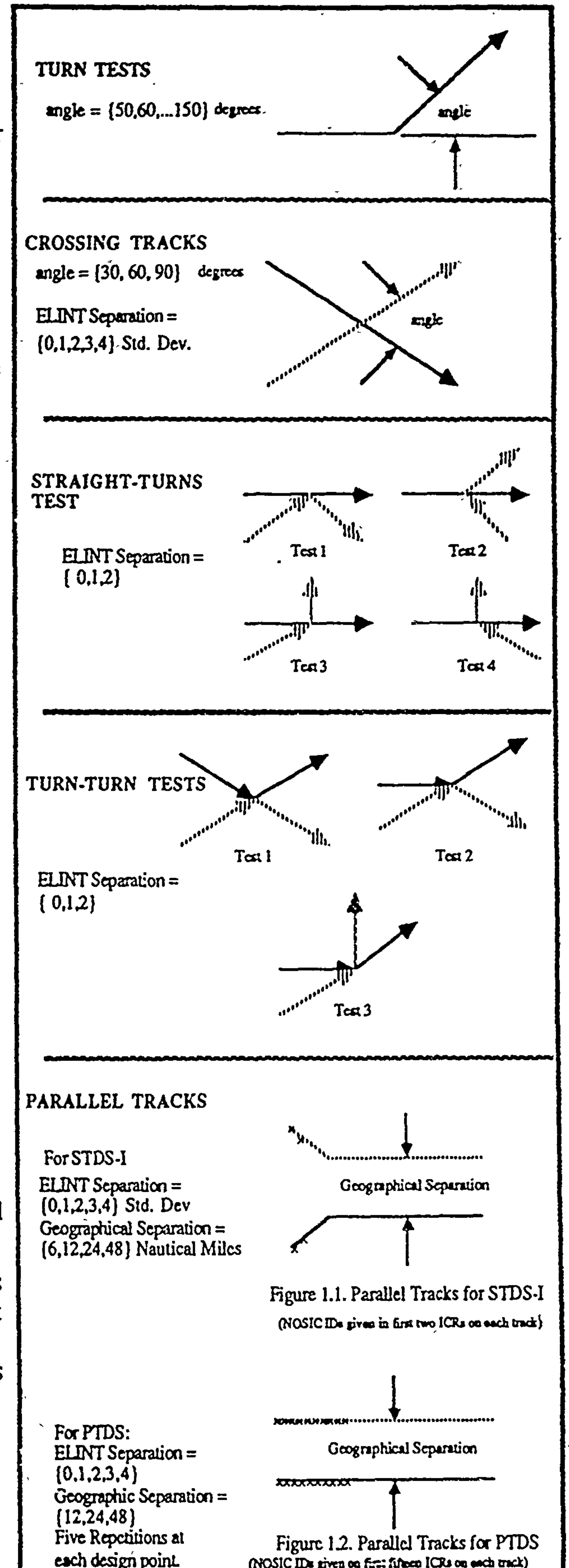

Figure 1: *Description of Sensitivity Tests*

Sensor Report Characteristics

ELINT separation is referred to in terms of standard deviations. If the first target has ELINT parameters drawn from a normal distribution with mean, μ, and standard deviation, σ, and the ELINT separation is N then the second target has ELINT parameters drawn from a normal distribution with mean $\mu + N\sigma$ and standard deviation σ. At 0 standard deviations separation, the two sets of ELINT attributes should be statistically indistinguishable. At 1 standard deviation separation, approximately 30% of the ELINT attributes in the reports are closer to the mean of the other target's ELINT attribute. At 4 standard deviations the two sets of ELINT attributes are almost completely separated.

In Figure 1, values for the different points of testing for ELINT are given for each test type. The Crossing Tracks Test and the Parallel Tracks Test had tests at

Important Parameter Settings for October, 1988 PAX/OBU Runs		
PARAMETER NAME	PS-1	PS-2
New Emitter Statistic Threshold	0.15	0.14
Elint Margin Threshold	0.14	0.50
New Track Threshold	0.95	0.70
Spatial Correlation On?	NO	YES
Spatial Margin Threshold	N.A.	0.30

Table 2: *Parameter Settings*

ELINT Separation of {0,1,2,3,4} while the Turns Tests had ELINT Separations of {0,1,2}.

Blocking of Tests

Since the intent of the STDS was to create the most diverse group of tests and system time constraints, there was blocking of tests to control for variablity. A properly blocked test would allow for statistical techniques to be used on the test data so judgements could be made about the effect of changing the data characteristics (ELINT, Geographic Separations). The PTDS used blocking to control for variability. Three similar sets of ground truth tracks were generated at geographic separation of 12, 24 and 48 nautical miles. Within each of these sets, data was generated which varied the ELINT separation by 0,1,2,3 and 4 standard deviations. At each of the resultant design points, five statistical repetitions were made creating a total of (3)(5)(5) = 75 tests.

PARAMETER SETTINGS

Two parameter setting were used in this test as shown in Table 2. Both STDS and PTDS were run under Parameter Setting-One (PS-1) and only STDS was run under Parameter Setting-Two (PS2). In its correlation process, OBU makes decisions at certain points to "trim" the list of candidate contact reports that could be correlated to a given track by computing a Measure of Correlation (MOC) and then checking whether the candidate is reasonable close to the best candidate. The notion of "reasonably close" depends on the parameters (or thresholds) in Table 2. In OBU terminology, this threshold is called the margin and is the minimum fraction of the best MOC at which a candidate will be retained. In the case of ELINT and Spatial tests, if only one report is left after this threshold test, that report is assigned to the track. If two or more candidates still exist, the ACT may perform more tests or declare the reports ambiguities. So, if this margin is decreased, one would expect an eventual higher ambiguity rate or a more "careful" tracker/correlator. For the New Emitter Statistic and the New Track Threshold, OBU is basically testing the hypothesis that a track could contain a new emitter or a report could really be a new track (based on the Spatial MOC). If these parameters are lowered, one would expect more new emitters being declared and more tracks created. Other OBU parameters that could have been "tweaked" include the Emitter Update Threshold which decides how the statistical attributes of a report should be divided among a multi-emitter track when there is a question as to which emitter a report belongs. For this test, the Emitter Update Threshold was set to 0.50 at both parameter settings. Another parameter known as Frustration Time is a Multi-Track Initiation (CLUSTER) parameter which specifies the amount of time that should elapse before which OBU will not consider a declared ambiguous report as a possible new track component. This was set at a large enough time so the parameter would have no effect on processing.

PARALLEL TRACKS DATA SET (PTDS) ANALYSIS

Table 3 summarizes results among individual tests. The first element in each row describes the test, PAX_PARA_*xyz* where *x* is the repetition number, *y* is the geographic separation (If *y*=1, Geo-Sep. = 12 nautical miles; If *y* =2, Geo-Sep = 24 n. m.; If *y*=3, Geo-Sep =

48) and z is the ELINT Separation (ranging over 0,1,2,3,4 Std. Deviation separation). The next column is labeled NOBS for Number of Observations Per Test (in this case each test had 96 reports divided among two tracks). The next column is the Ground Truth track count, labeled

PARALLEL TRACKS TEST - PARAMETER SETTING I

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
•PAX_PARA_110	96	2	2	1.0000	0.3333	0.6667	1.5000
•PAX_PARA_111	96	2	2	1.0000	0.3646	0.6354	3.0000
PAX_PARA_112	96	2	4	0.9630	0.4688	0.4375	8.5000
PAX_PARA_113	96	2	3	0.9868	0.7604	0.2083	7.5000
PAX_PARA_114	96	2	2	1.0000	0.7604	0.2396	5.0000
•PAX_PARA_120	96	2	2	1.0000	0.3333	0.6667	1.5000
PAX_PARA_121	96	2	4	0.9574	0.3542	0.5104	5.0000
PAX_PARA_122	96	2	3	0.9815	0.5000	0.4375	8.0000
PAX_PARA_123	96	2	2	1.0000	0.8750	0.1250	5.5000
PAX_PARA_124	96	2	2	1.0000	0.8125	0.1875	5.0000
PAX_PARA_130	96	2	4	0.9804	0.4583	0.4688	3.5000
PAX_PARA_131	96	2	4	1.0000	0.4896	0.4479	3.5000
PAX_PARA_132	96	2	2	1.0000	0.7917	0.2083	6.0000
PAX_PARA_133	96	2	3	1.0000	0.8646	0.1250	6.5000
PAX_PARA_134	96	2	2	1.0000	0.8854	0.1146	5.5000
•PAX_PARA_210	97	2	2	1.0000	0.2887	0.7113	1.0000
•PAX_PARA_211	97	2	2	0.9143	0.3299	0.6392	4.5000
PAX_PARA_212	97	2	2	1.0000	0.5567	0.4433	7.0000
PAX_PARA_213	97	2	3	0.9740	0.7526	0.2062	10.0000
PAX_PARA_214	97	2	2	1.0000	0.7629	0.2371	4.5000
•PAX_PARA_220	97	2	2	1.0000	0.2990	0.7010	1.0000
•PAX_PARA_221	97	2	2	0.9231	0.3711	0.5979	5.5000
PAX_PARA_222	97	2	3	0.9714	0.6701	0.2784	10.0000
PAX_PARA_223	97	2	3	0.9744	0.7629	0.1959	9.5000
PAX_PARA_224	97	2	2	1.0000	0.7938	0.2062	5.0000
•PAX_PARA_230	97	2	2	1.0000	0.3402	0.6598	1.0000
PAX_PARA_231	97	2	3	0.9524	0.3711	0.5670	3.5000
PAX_PARA_232	97	2	3	0.9828	0.5567	0.4021	9.5000
PAX_PARA_233	97	2	3	0.9868	0.7526	0.2165	9.5000
PAX_PARA_234	97	2	3	0.9870	0.7629	0.2062	9.5000
•PAX_PARA_310	96	2	2	1.0000	0.3125	0.6875	1.5000
PAX_PARA_311	96	2	4	0.8462	0.4167	0.4583	9.0000
PAX_PARA_312	96	2	3	0.9344	0.5625	0.3646	10.0000
PAX_PARA_313	96	2	3	0.9846	0.6458	0.3229	7.5000
PAX_PARA_314	96	2	3	0.9846	0.6458	0.3229	8.0000
•PAX_PARA_320	96	2	2	1.0000	0.3125	0.6875	1.5000
PAX_PARA_321	96	2	2	0.8136	0.5000	0.3854	12.0000
PAX_PARA_322	96	2	2	0.9688	0.6458	0.3333	8.0000
PAX_PARA_323	96	2	3	0.9848	0.6563	0.3125	7.0000
PAX_PARA_324	96	2	3	0.9851	0.6667	0.3021	8.5000
PAX_PARA_330	96	2	2	1.0000	0.5729	0.4271	3.5000
PAX_PARA_331	96	2	3	0.9123	0.5208	0.4063	6.0000
PAX_PARA_332	96	2	3	1.0000	0.6354	0.3333	5.5000
PAX_PARA_333	96	2	3	0.9859	0.6979	0.2604	8.5000
PAX_PARA_334	96	2	3	0.9861	0.7083	0.2500	8.0000
•PAX_PARA_410	96	2	2	0.9412	0.3333	0.6458	2.5000
PAX_PARA_411	96	2	2	0.9762	0.4271	0.5625	4.5000
PAX_PARA_412	96	2	3	0.9718	0.6667	0.2604	8.0000
PAX_PARA_413	96	2	2	1.0000	0.8333	0.1667	5.0000
PAX_PARA_414	96	2	2	1.0000	0.8021	0.1979	4.5000
•PAX_PARA_420	96	2	2	0.9118	0.3229	0.6458	3.0000
PAX_PARA_421	96	2	2	0.9783	0.4688	0.5208	5.5000
PAX_PARA_422	96	2	3	1.0000	0.6771	0.2917	7.5000
PAX_PARA_423	96	2	2	1.0000	0.8333	0.1667	5.0000
PAX_PARA_424	96	2	2	1.0000	0.8021	0.1979	4.5000
•PAX_PARA_430	96	2	2	0.9394	0.3229	0.6563	2.5000
PAX_PARA_431	96	2	2	1.0000	0.6563	0.3438	7.0000
PAX_PARA_432	96	2	3	1.0000	0.6771	0.2917	7.0000
PAX_PARA_433	96	2	2	1.0000	0.8958	0.1042	5.0000
PAX_PARA_434	96	2	2	1.0000	0.8958	0.1042	5.0000
•PAX_PARA_510	96	2	2	1.0000	0.3125	0.6875	1.0000
•PAX_PARA_511	96	2	2	1.0000	0.3125	0.6875	1.0000
PAX_PARA_512	96	2	2	0.9636	0.5521	0.4271	9.5000
PAX_PARA_513	96	2	2	0.9848	0.6771	0.3125	10.0000
PAX_PARA_514	96	2	2	1.0000	0.7813	0.2188	4.0000
•PAX_PARA_520	96	2	3	0.9697	0.3125	0.6563	2.0000
•PAX_PARA_521	96	2	3	0.9697	0.3125	0.6563	2.0000
PAX_PARA_522	96	2	2	0.9821	0.5729	0.4167	9.0000
PAX_PARA_523	96	2	2	0.9859	0.7292	0.2604	11.0000
PAX_PARA_524	96	2	2	1.0000	0.8125	0.1875	5.0000
PAX_PARA_530	96	2	2	1.0000	0.5000	0.5000	1.0000
PAX_PARA_531	96	2	2	1.0000	0.6250	0.3750	2.5000
PAX_PARA_532	96	2	2	0.9868	0.7813	0.2083	5.5000
PAX_PARA_533	96	2	2	0.9884	0.8854	0.1042	6.0000
PAX_PARA_534	96	2	2	1.0000	0.8854	0.1146	5.5000

Table 3. *Parallel Tracks Data Set - PS-I*

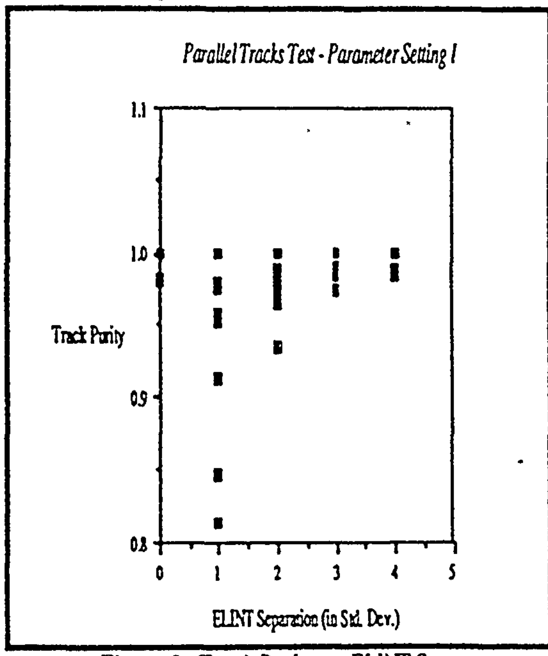

Figure 2. *Track Purity vs. ELINT Sep.*

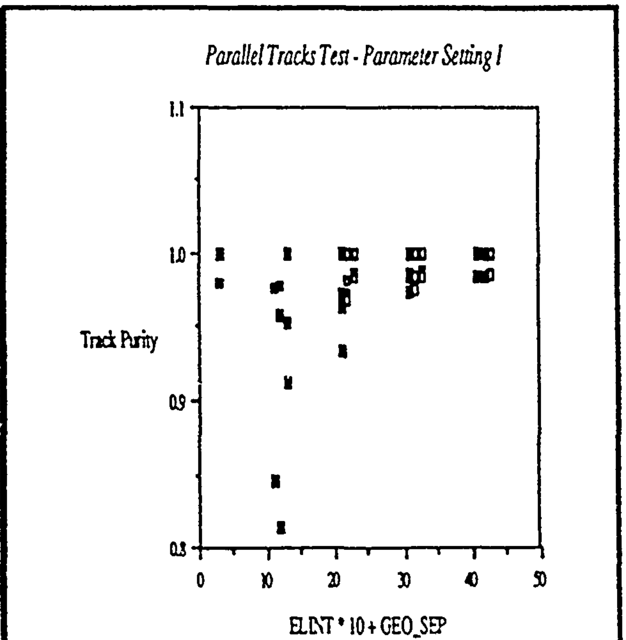

Figure 3. *Track Purity vs. ELINT/GEO*

PARALLEL TRACKS TEST - RUN ON NECTAR14

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PAX_PARA_110	96	2	2	0.7604	0.7604	0.0000	7.0000
PAX_PARA_111	96	2	2	0.8854	0.8854	0.0000	7.0000
PAX_PARA_112	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_113	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_114	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_120	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_121	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_122	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_123	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_124	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_130	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_131	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_132	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_133	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_134	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_210	97	2	2	0.7113	0.7113	0.0000	12.0000
PAX_PARA_211	97	2	2	0.8144	0.8144	0.0000	11.0000
PAX_PARA_212	97	2	2	0.9794	0.9794	0.0000	3.0000
PAX_PARA_213	97	2	2	0.9897	0.9897	0.0000	2.0000
PAX_PARA_214	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_220	97	2	2	0.9072	0.9072	0.0000	4.0000
PAX_PARA_221	97	2	2	0.9175	0.9175	0.0000	3.0000
PAX_PARA_222	97	2	2	0.9897	0.9897	0.0000	2.0000
PAX_PARA_223	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_224	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_230	97	2	2	0.9897	0.9897	0.0000	2.0000
PAX_PARA_231	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_232	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_233	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_234	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_310	96	2	2	0.5521	0.5521	0.0000	8.0000
PAX_PARA_311	96	2	2	0.7292	0.7292	0.0000	13.0000
PAX_PARA_312	96	2	3	0.9271	0.9167	0.0000	8.5000
PAX_PARA_313	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_314	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_320	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_321	96	2	2	0.9375	0.9375	0.0000	3.0000
PAX_PARA_322	96	2	2	0.9375	0.9375	0.0000	3.0000
PAX_PARA_323	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_324	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_330	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_331	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_332	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_333	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_334	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_410	96	2	3	0.8125	0.8021	0.0000	9.5000
PAX_PARA_411	96	2	3	0.9375	0.9271	0.0000	8.0000
PAX_PARA_412	96	2	2	0.9688	0.9688	0.0000	3.0000
PAX_PARA_413	96	2	2	0.9792	0.9792	0.0000	2.0000
PAX_PARA_414	96	2	2	0.9792	0.9792	0.0000	2.0000
PAX_PARA_420	96	2	3	0.9688	0.9583	0.0000	5.0000
PAX_PARA_421	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_422	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_423	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_424	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_430	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_431	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_432	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_433	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_434	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_510	96	2	3	0.5625	0.5521	0.0000	11.0000
PAX_PARA_511	96	2	3	0.9063	0.8958	0.0000	9.0000
PAX_PARA_512	96	2	3	0.9479	0.9375	0.0000	5.0000
PAX_PARA_513	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_514	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_520	96	2	3	0.9896	0.9792	0.0000	3.0000
PAX_PARA_521	96	2	3	0.7500	0.7396	0.0000	7.0000
PAX_PARA_522	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_523	96	2	3	0.9792	0.9688	0.0000	2.0000
PAX_PARA 524	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_530	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_531	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_532	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_533	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_534	96	2	3	1.0000	0.9896	0.0000	2.0000

Table 4: *NECTAR Results on PDTS*

NGT. There are only two tracks per test, so this number is always two. The fourth column, labeled NCT, is the Number of Constructed Tracks, i.e. the number of tracks that OBU believes is present in the geographic area of the test. As can be seen, OBU was occasionally creating extra tracks at this parameter setting, usually when the ELINT and Geo-Separation were relatively low. The next column, labeled TP, is the track purity measure. Track Purity is the percentage of reports in a track coming from a dominant uniquely associated ground truth track averaged over all constructed tracks. The next column, CAR, is the Correct Assignment Ratio, which is the percentage of ground truth reports assigned to a single,dominant constructed track averaged over all ground truth tracks. Ambiguity Rate (AR) is noted in the next column. And AVSGT in the final column, stands for the Average Segments Per Ground Truth which measures the amount of discontinuity in the assignment of ground truth reports averaged over all ground truths. For comparison purposes, refer to Table 4, which summarizes results of the same data (PTDS) as run on the NRL in-house Tracker/Correlator, NECTAR.

If one reviews the results of this test in Table 3, the high ambiguity rate is immediately noticeable. At PS-1, OBU has a low ELINT margin and no spatial correlation, so many of the reports in this test (roughly 40%) were declared ambiguous. Specifically, when the ELINT and Geographic separation are very low, OBU T/C becomes confused and will not assign reports. In fact, it was determined prudent to drop all tests from further analysis with an ambiguity rate greater than 60%. Since, the first 15 reports have unique I.Ds and each track has about 50 reports, an ambiguity rate of 60% or more would indicate that no correlation beyond the first 15 reports ever occurred. Again, most of these dropped tests were at low geographic and ELINT separation indices. In all, 17 tests were dropped - they are marked by stars in Table 3.

The remaining data were analyzed for trends. First, consider the graph in Figure 2. It can be seen that the min(Track Purity) goes up as the ELINT separation goes from one to four

Overall Performance on STDS			
Measure of Performance	PS-I	PS-II	NECTAR
Ambiguity Rate	0.4069	0.0757	Not Applicable
Track Purity	0.9507	0.8923	0.9091
Correct Assignment Ratio	0.5632	0.8060	0.9120
Average Segments per Ground Truth	7.67	8.84	2.9467

Table 5: *Overall Results for STDS*

(note: after the seventeen high-ambiguity tests were removed for ELINT separation = 0). It can also be shown analytically that the deviation from the mean within each ELINT separation is decreasing with ELINT separation. Unfortunately, due to the large ambiguity rate at PS-1, it would not be worthwhile to come up with regression equations for this relation, but it should be noted because it indicates that the T/C is acting "rationally" as one would normally expect this type of relation. One can also look at the separate effect of geographic separation by creating a function, [(ELINT Sep.)(10) + the enumerated value for Geographic Separation]. This is graphed in Figure 4. Basically this shows us that in addition to ELINT Separation increasing min(Track Purity), Geographic Separation appears to have a similar effect within the ELINT Separation divisions. Again, this can be interpreted that even with the "loose" parameterization of PS-1, the Tracker/Correlator is acting "rationally" given the aforementioned conditions. Similar effects are not as evident over the Average Segments Per Ground Truth, though perhaps with more repetitions, this widely varying parameter might be seen to center around a mid-point. However, one can see (as expected) that Ambiguity Rate decreases as geographic separation and ELINT separation increase. Again, this indicates that ACT is acting "rationally", though as compared with Table 4, not "optimally".

SENSITIVITY TEST DATA SET (STDS) ANALYSIS

The STDS results allow the analyst a chance to compare parameter settings. As can be seen in Table 5, the summary of test results, there was an unacceptable amount of ambiguities at Parameter Setting I (PS-I) as compared to Parameter Setting II (PS-II). Most likely, this is due to the low ELINT margin setting and the Spatial Correlation being turned off. For PS-I, with the high ambiguity rate, it is not surprising for the Track Purity to be high. Track Purity, afterall, is

SENSITIVITY TESTS

TURN TESTS

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PARAMETER SETTING I							
TURN_1_TEST	48	1	1	1.0000	0.8958	0.1042	4.0000
TURN_2_TEST	48	1	1	1.0000	0.8958	0.1042	4.0000
TURN_3_TEST	48	1	1	1.0000	0.8958	0.1042	4.0000
TURN_4_TEST	48	1	1	1.0000	0.8125	0.1875	6.0000
TURN_5_TEST	48	1	1	1.0000	0.7708	0.2292	8.0000
TURN_6_TEST	48	1	1	1.0000	0.8542	0.1458	3.0000
TURN_7_TEST	48	1	1	1.0000	0.8333	0.1667	4.0000
TURN_8_TEST	48	1	1	1.0000	0.8542	0.1458	3.0000
TURN_9_TEST	48	1	1	1.0000	0.8542	0.1458	3.0000
TURN10TEST	48	1	1	1.0000	0.5625	0.4375	5.0000
PARAMETER SETTING II							
TURN_1_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_2_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_3_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_4_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_5_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_6_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_7_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_8_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_9_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_10_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
NECTAR RUNS							
TURN_1_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_2_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_3_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_4_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_5_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_6_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_7_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_8_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_9_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_10_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000

Table 6: *Summary of Turn Tests*

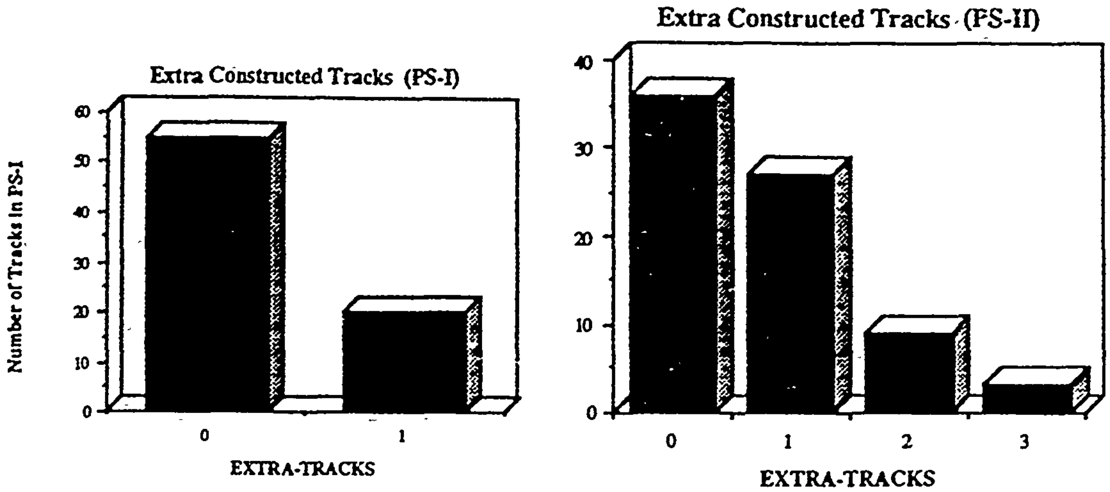

Figure 4: *Histograms for Number of Extra Constructed Tracks per Test*

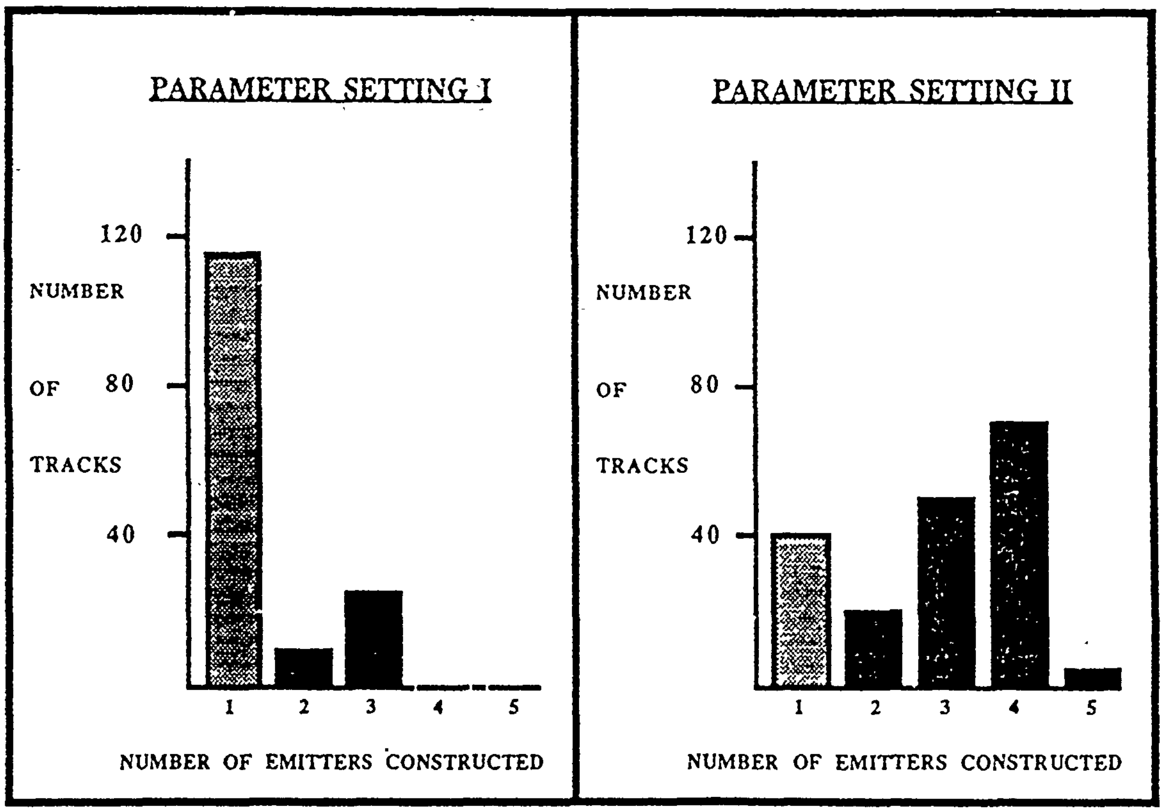

Figure 5: *Histograms for Number of Emitters Constructed per Track*

the measure of how many reports on a constructed track come from a single ground truth. In the case where the tracker/correlator is being very "picky", it will usually construct pure tracks. The Correct Assignment Ratio (CAR) is the measure of how well each ground-truth track was assigned to a constructed track. If TP = 1.00 and NCT = NGT then 1 - CAR = AR.

At PS-II, the overall numbers do look better, though still not up to par with our in-house tracker/correlator (NECTAR). (It should be noted that NECTAR does not declare ambiguities. Instead, when presented conflicting data, it will create multiple hypothesis and then retain each hypothesis until other data comes in to clarify the picture). At both parameter settings, it is noted that the Average Segments per Ground Truth is unreasonably high, as compared to NECTAR.

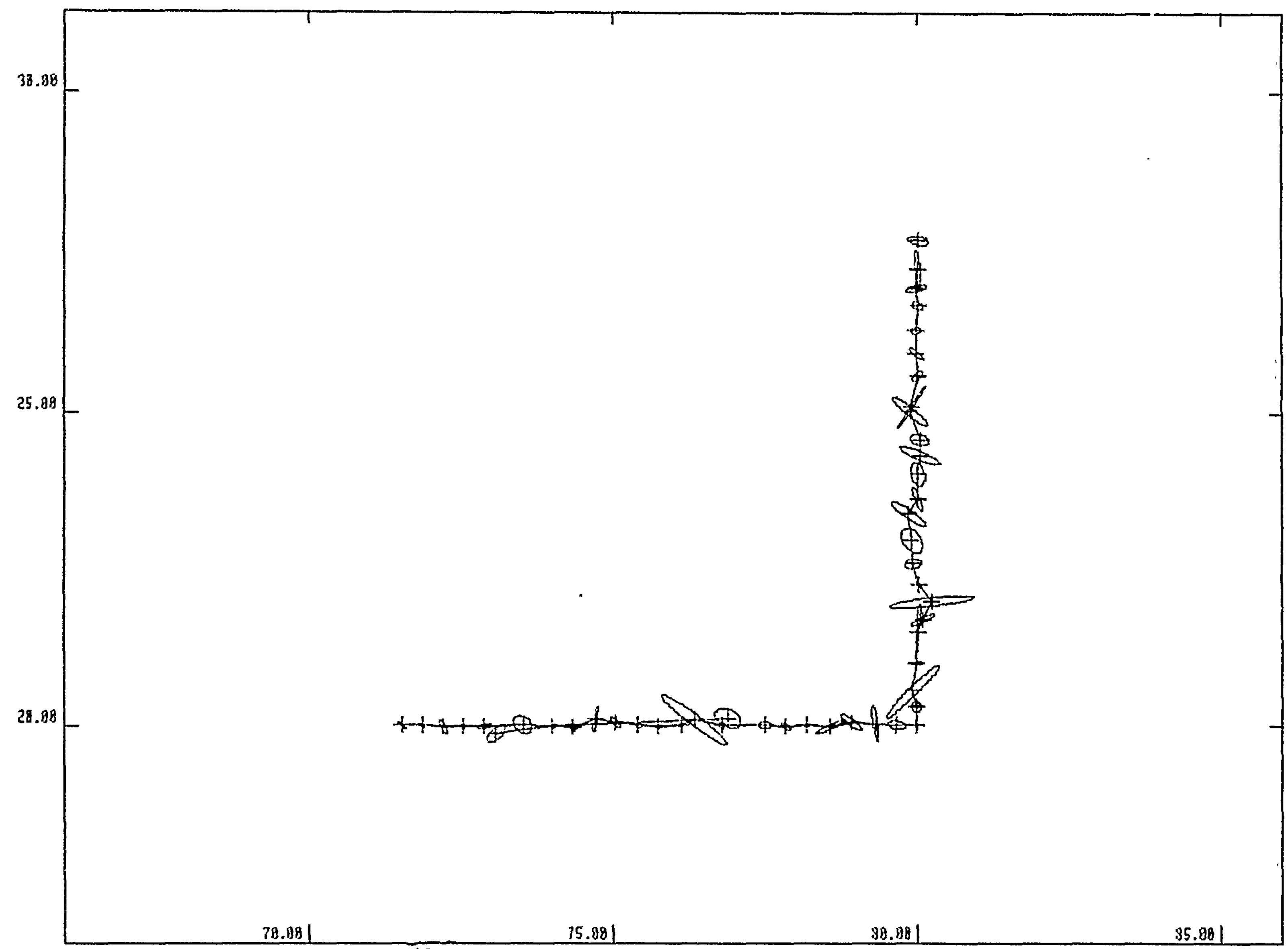

Figure 6: *Constructed Tracks for a Single Platform turning 90 degrees*

PS-II has a slightly higher overall AVSGT. This can be partly explained by the propensity of the ACT to declare new tracks at the given parameter settings. In Figure 4, histograms for the number of extra tracks per individual tests are drawn for the different parameter settings. In the case of PS-I, OBU only declared an extra track in 20 (out of 75) tests, however, at PS-II, when the New Track Threshold was raised from 0.14 to 0.50, OBU declared up to three extra tracks in 39 out of 75 tests.

Similarly, at PS-II, OBU was more prone to declare extra emitters on a track. In Figure 5, histograms for the number of emitters/track are drawn. At PS-I, where the New Emitter Statistic Threshold was 0.15, far fewer false emitters were declared than at PS-II, where the New Emitter Statistic was decreased to only 0.14. One could infer that the NEST is an extremely sensitive parameter. Generally, the New Emitter test occurs before any ELINT or spatial correlation, so it is hard to see how changes in those parameters would affect this result.

TP & CAR vs. ELINT Separation (PS-II)

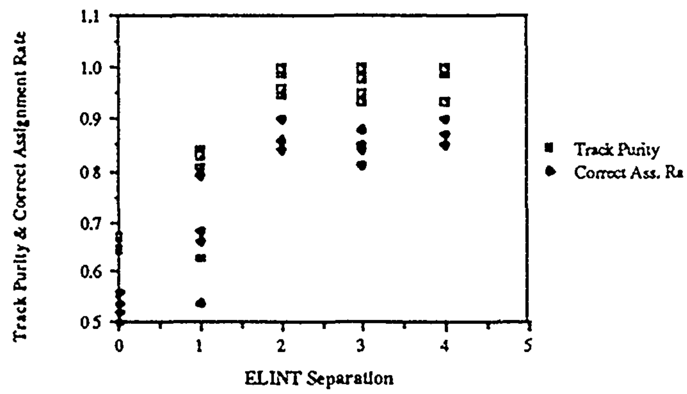

Figure 7: *Track Purity & CAR vs. ELINT Separation alone (Parallel Tracks, STDS, PS-II)*

SENSITIVITY TESTS
PARALLEL TRACKS

	NOBS	NGT	NCT	TP	CAR	AR
AVSGT						
PARAMETER SETTINGS I						
PARA_6_0_TEST	100	2	2	0.7561	0.3100	0.5900	8.0000
PARA_6_1_TEST	100	2	2	0.8627	0.4400	0.4900	13.0000
PARA_6_2_TEST	100	2	3	0.9804	0.4700	0.4900	11.0000
PARA_6_3_TEST	100	2	3	1.0000	0.4900	0.5000	10.0000
PARA_6_4_TEST	100	2	3	1.0000	0.4900	0.4800	10.5000
PARA_12_0_TEST	100	2	2	0.8788	0.2900	0.6700	8.0000
PARA_12_1_TEST	100	2	2	0.9070	0.3900	0.5700	10.5000
PARA_12_2_TEST	100	2	3	0.9643	0.4800	0.4400	13.0000
PARA_12_3_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_12_4_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_24_0_TEST	100	2	3	0.9286	0.2500	0.7200	6.0000
PARA_24_1_TEST	100	2	2	0.9268	0.3800	0.5900	10.0000
PARA_24_2_TEST	100	2	2	0.9811	0.5200	0.4700	11.0000
PARA_24_3_TEST	100	2	3	0.9831	0.5600	0.4100	12.5000
PARA_24_4_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_48_0_TEST	100	2	2	0.8438	0.2700	0.6800	6.5000
PARA_48_1_TEST	100	2	2	0.9574	0.4500	0.5300	11.5000
PARA_48_2_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_48_3_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_48_4_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARAMETER SETTING II						
PARA_6_0_TEST	100	2	2	0.6667	0.5200	0.2200	17.0000
PARA_6_1_TEST	100	2	2	0.8404	0.7900	0.0600	13.0000
PARA_6_2_TEST	100	2	3	0.9490	0.9000	0.0200	8.0000
PARA_6_3_TEST	100	2	3	0.9348	0.8400	0.0800	9.5^00
PARA_6_4_TEST	100	2	3	0.9368	0.8700	0.0500	10.00C0
PARA_12_0_TEST	100	2	2	0.6667	0.5400	0.1900	16.5000
PARA_12_1_TEST	100	2	5	0.8298	0.6800	0.0600	21.5000
PARA_12_2_TEST	100	2	3	0.9579	0.9000	0.0500	6.0000
PARA_12_3_TEST	100	2	2	0.9462	0.8800	0.0700	8.0000
PARA_12_4_TEST	100	2	4	0.9896	0.8500	0.0400	11.5000
PARA_24_0_TEST	100	2	2	0.6410	0.5000	0.2200	14.0000
PARA_24_1_TEST	100	2	3	0.8072	0.6600	0.1700	17.5000
PARA_24_2_TEST	100	2	2	0.9882	0.8400	0.1500	7.0000
PARA_24_3_TEST	100	2	2	0.9759	0.8100	0.1700	8.0000
PARA_24_4_TEST	100	2	2	1.0000	0.9000	0.1000	4.0000
PARA_48_0_TEST	100	2	2	0.6437	0.5600	0.1300	8.5000
PARA_48_1_TEST	100	2	3	0.6250	0.5400	0.1200	9.0000
PARA_48_2_TEST	100	2	2	1.0000	0.8600	0.1400	5.5000
PARA_48_3_TEST	100	2	3	1.0000	0.8500	0.1300	6.0000
PARA_48_4_TEST	100	2	2	1.0000	0.9000	0.1000	4.0000
NECTAR RUN						
PARA_6_0_TEST	100	2	2	0.6300	0.6900	0.0000	11.0000
PARA_6_1_TEST	100	2	2	0.7700	0.7700	0.0000	13.0000
PARA_6_2_TEST	100	2	3	0.9400	0.9300	0.0000	7.0000
PARA_6_3_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_6_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_12_0_TEST	100	2	2	0.6000	0.6000	0.0000	12.0000
PARA_12_1_TEST	100	2	2	0.8800	0.8800	0.0000	8.0000
PARA_12_2_TEST	100	2	2	0.9500	0.9500	0.0000	4.0000
PARA_12_3_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_12_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_0_TEST	100	2	2	0.7700	0.7700	0.0000	4.0000
PARA_24_1_TEST	100	2	2	0.8800	0.8800	0.0000	2.0000
PARA_24_2_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_3_TEST	100	2	2	1.0000	1.0000	0 0000	1.0000
PARA_24_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_0_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_1_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_2_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_3_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000

Table 7: *Summary of Parallel Tracks Test Results (STDS)*

Turn Test Results

The Turn Tests consisted of one target which turns at varying angles halfway through the

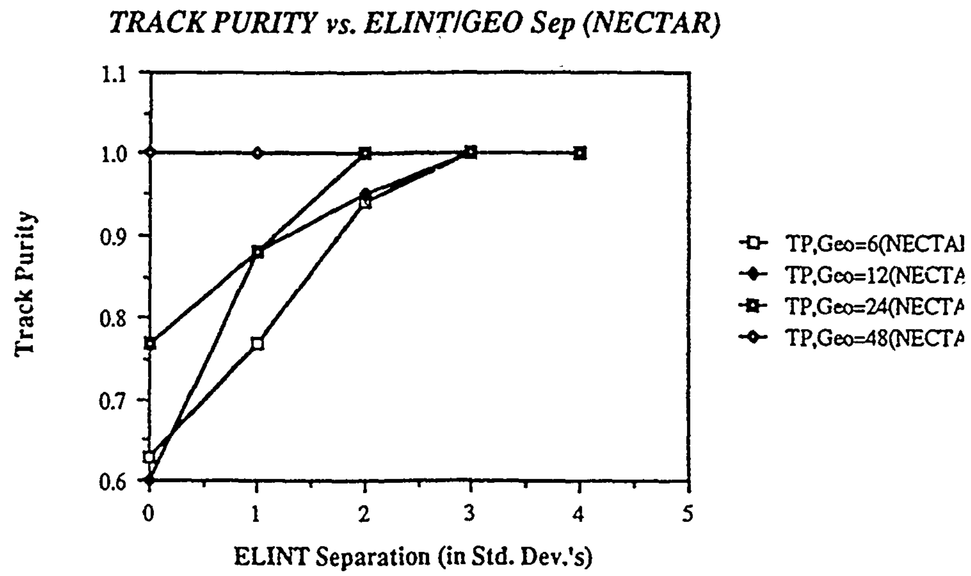

Figure 8: *Track Purity vs. ELINT/GEO Separation (NECTAR)*

scenario. The turn test results are summarized in Table 6. Examining the results specifically for PS-II, OBU does well in handling turns of varying degree. This particular subset of data had the same ELINT reports laid out over varying ground truths (specified in Figure 1), so the fact

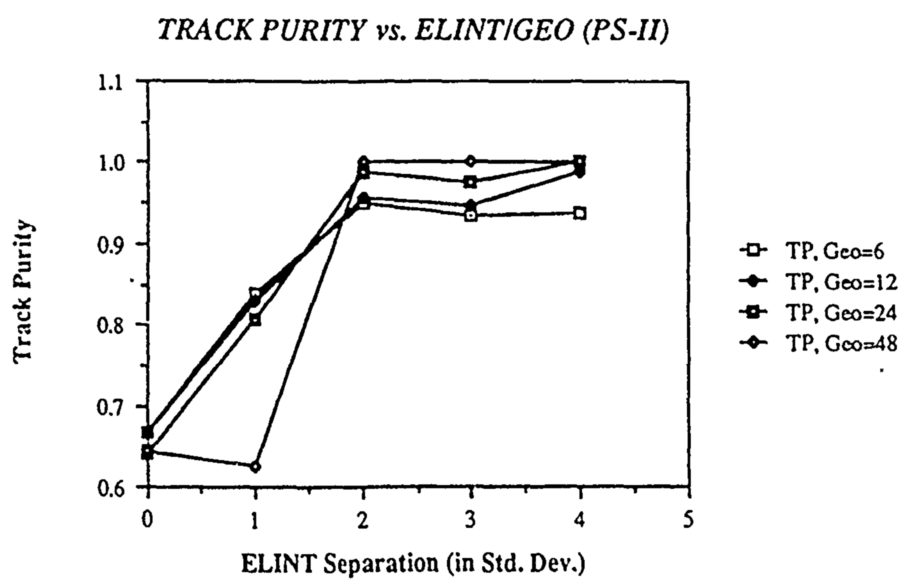

Figure 9: *Track Purity vs. ELINT/GEO (PS-II)*

that results were the same across each turns suggests that OBU is acting consistently in its assignment of reports to tracks. On each test though, OBU constructed an extra track. Figure 6 shows a typical turn test from the PS-II runs. While the majority of the reports were assigned to one track (green), a small track (red) also was constructed. Examination of the data indicated that the red track was a slight outlier from the green track data, so it is not entirely unreasonable to construct it. For the most part, these tests indicated that single turns do not confuse the motion model given ELINT distributions are sound.

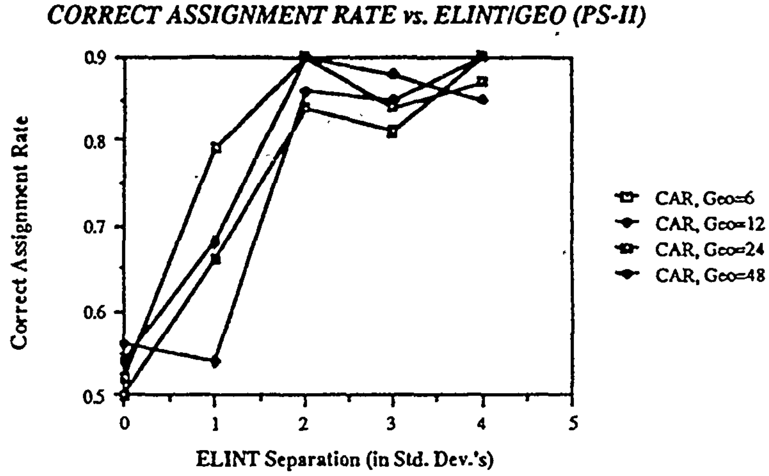

Figure 11: *Track Purity vs. ELINT by Geographic Separation (PS-II)*

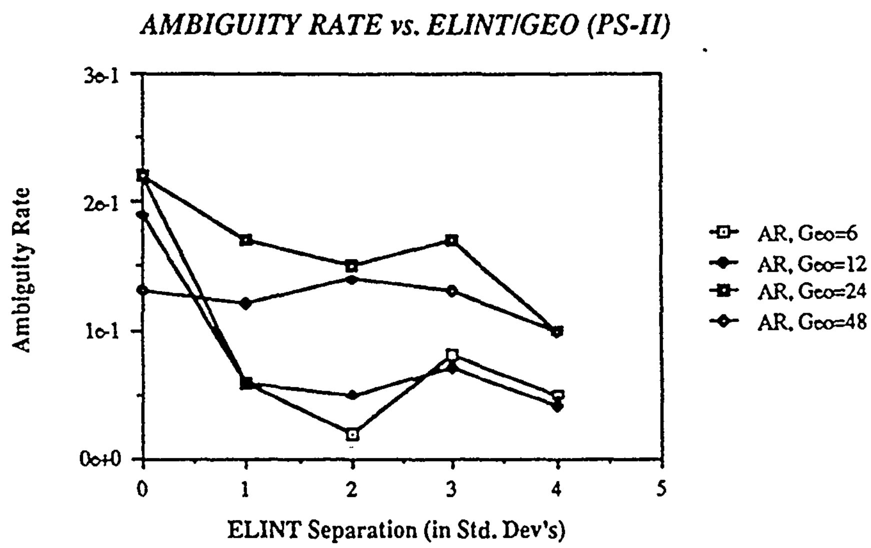

Figure 12:*Ambiguity Rate by ELINT Sep by Geographic Separation (PS,II)*

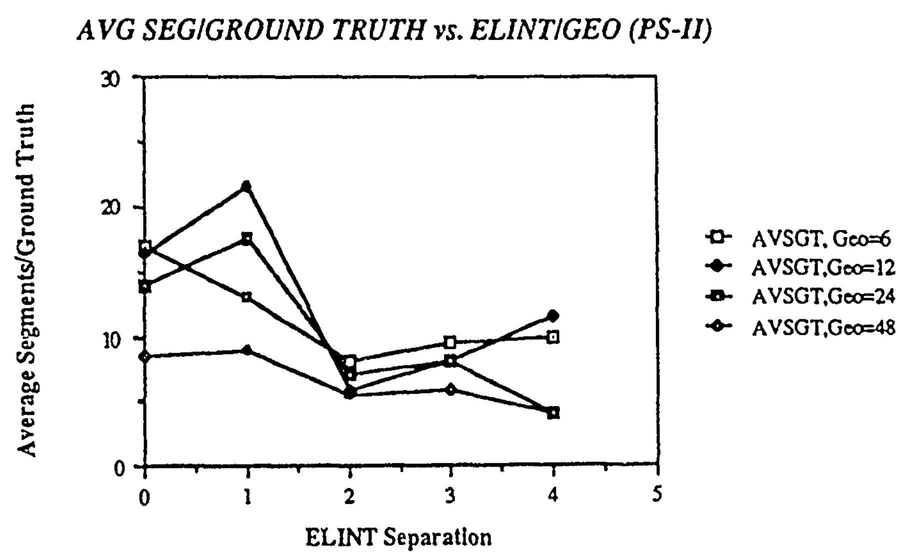

Figure 13: *Average Setments per Ground Truth by ELINT Separation by Geo Sep. (PS-II)*

Parallel Tracks Test Results

The Parallel Tracks Test is designed to check the ability of a T/C to keep target distinguished. The two targets start at widely separated GEO and move together. At this point the targets continue along parallel courses until the test ends. (Figure 1.1 shows the typical ground truth for these parallel tests.) The initial separation is required to allow the T/C to establish the fact that there are two distinct targets. Results are summarized in Table 7.

These ELINT/Spatial only runs were made for GEO separation of 6,12,24 and 48 nautical miles and ELINT attribute separation of 0,1,2,3 & 4. The high ambiguity rate in PS-I

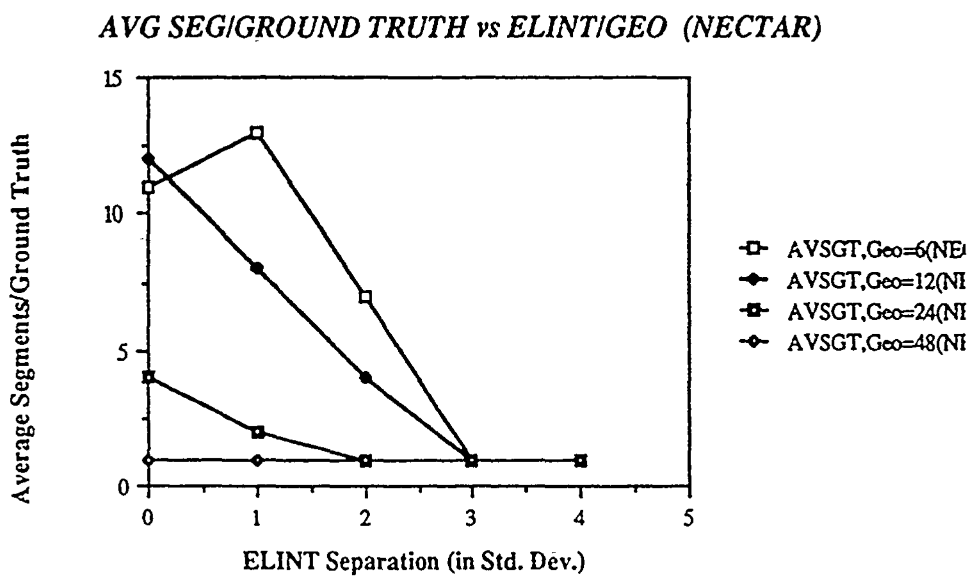

Figure 14: *Average Segments per Ground Truth by ELINT Sep. by Geo Sep (NECTAR)*

precludes any further analysis. However, in PS-II, one would expect results improve as GEO & ELINT increase. This holds for ELINT for the most part. For instance, in Figure 8, values for Track Purity (TP) and Correct Assignment Rate (CAR) are plotted with respect to ELINT alone. It is evident that at low ELINT Separation, TP and CAR are low and at ELINT separations greater than two standard deviations, the solution appears to improve. If one examines ELINT increases at each geographical separation, one would expect in a rational tracker/correlator that one can generate graphs similar to the NECTAR results as in Figure 8 where track purity is graphed over the four different geographic separations over ELINT separation. Generally, the TP increases faster when the GEO separation is higher. However, if we look at a similar graph for the OBU runs at PS-II, as in Figure 9, one can see that the geographical separation plays a similar role except that Track Purity does notreach 1.0 as often as it did for the NECTAR runs. Also, note the outlier when GEO=48, ELINT = 1. Here, the spatial separation should be large enough to prevent a low TP; however it appears that spatial information is not playing as large a role as it should. In Figure 10, the actual constructed tracks are graphed for GEO=48, ELINT=1. As can be seen, the predominant tracks "green" and "red", occasionally jump from one ground truth to the other. This can be explained by the simple fact, that the outlier ELINT reports on one track occasionally correspond with the ELINT distribution non the other track. Why similar behaviour is not witnessed at lower GEO separations is a good question. One would think that with more statistical repetitions, this test might prove to be more of an abberation than the norm.

Figures 11-14 graph CAR, Ambiguity Rate and Average Segments per Ground Truth over ELINT and GEO Separation for the PS-II test. In Figure 11, the point associated with GEO=48, ELINT =1 (Figure 11) is an outlier as well. Also, one would expect a quicker rise in

SENSITIVITY TESTS
CROSSING TESTS

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PARAMETER SETTING I							
CROSSING_30_0_TEST	98	2	2	0.9846	0.6531	0.3367	6.5000
CROSSING_30_1_TEST	98	2	3	1.0000	0.7857	0.2041	6.5000
CROSSING_30_2_TEST	98	2	2	1.0000	0.8163	0.1837	6.5000
CROSSING_30_3_TEST	98	2	2	1.0000	0.8163	0.1837	6.0000
CROSSING_30_4_TEST	98	2	2	1.0000	0.8265	0.1735	5.5000
CROSSING_60_0_TEST	98	2	2	1.0000	0.7449	0.2551	5.5000
CROSSING_60_1_TEST	98	2	2	1.0000	0.8163	0.1837	5.5000
CROSSING_60_2_TEST	98	2	2	1.0000	0.7857	0.2143	7.5000
CROSSING_60_3_TEST	98	2	2	1.0000	0.8265	0.1735	5.5000
CROSSING_60_4_TEST	98	2	2	1.0000	0.8265	0.1735	5.5000
CROSSING_90_0_TEST	98	2	2	1.0000	0.7551	0.2449	5.5000
CROSSING_90_1_TEST	98	2	3	1.0000	0.7143	0.2755	8.5000
CROSSING_90_2_TEST	98	2	2	1.0000	0.8163	0.1837	6.0000
CROSSING_90_3_TEST	98	2	2	1.0000	0.8163	0.1837	5.5000
CROSSING_90_4_TEST	98	2	2	1.0000	0.7143	0.2857	5.0000
PARAMETER SETTING II							
CROSSING_30_0_TEST	98	2	2	0.9890	0.9184	0.0714	3.5000
CROSSING_30_1_TEST	98	2	3	0.9783	0.8469	0.0612	8.0000
CROSSING_30_2_TEST	98	2	2	0.9894	0.9490	0.0408	4.0000
CROSSING_30_3_TEST	98	2	2	1.0000	0.9694	0.0306	2.5000
CROSSING_30_4_TEST	98	2	2	1.0000	0.9694	0.0306	2.5000
CROSSING_60_0_TEST	98	2	2	1.0000	0.9082	0.0918	4.0000
CROSSING_60_1_TEST	98	2	2	1.0000	0.9082	0.0918	4.0000
CROSSING_60_2_TEST	98	2	2	1.0000	0.9388	0.0612	4.0000
CROSSING_60_3_TEST	98	2	2	1.0000	0.9286	0.0714	4.0000
CROSSING_60_4_TEST	98	2	2	1.0000	0.9286	0.0714	4.0000
CROSSING_90_0_TEST	98	2	2	1.0000	0.9490	0.0510	3.5000
CROSSING_90_1_TEST	98	2	2	1.0000	0.9490	0.0510	3.5000
CROSSING_90_2_TEST	98	2	2	1.0000	0.9592	0.0408	3.0000
CROSSING_90_3_TEST	98	2	2	1.0000	0.9592	0.0408	3.0000
CROSSING_90_4_TEST	98	2	2	1.0000	0.9286	0.0714	4.0000
NECTAR RUNS							
CROSSING_30_0_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_30_1_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_30_2_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_30_3_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_30_4_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_60_0_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_60_1_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_60_2_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_60_3_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_60_4_TEST	98	2	2	1.0000	1.0000	0.0000	1.000
CROSSING_90_0_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_90_1_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_2_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_3_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_4_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000

Table 8: *Summarization of Crossing Tracks Test (STDS)*

all of these MOPs as ELINT and GEO are increased. In fact, GEO doesn't make as much a difference in many cases as it does in say the NECTAR runs. For instance, if one compares Figure 12 with Figure 13, this becomes evident. One would expect a "rational" Tracker/Correlator to act as it does in Figure 14 - i.e. at low GEO and low ELINT, there is greater segmentation and at high GEO and ELINT, the segmentation drops down to the number of ground truth segments (in this case, two).

Generally one can conclude at the parameter settings (PS-II), the T/C is ignoring alot of information by not taking into account spatial characteristics of the data.

Crossing Track Test Results

The Crossing Tracks Test is designed to check the T/C's ability to distinguish two targets whose paths cross. The Crossing Tracks Tests in the STDS used three angles, 30°, 60°, 90° (for a graphical representation, see Figure 1). There was one one repetition of each angle over five different ELINT Std. Dev. separation: {0,1,2,3,4}. The course itself ran for ~25 hours before the targets met.

A "correct" result for this test is successfully maintaining the identity of the two targets as they meet and then separate. Measures such as Track Purity (TP) and Correct Assignment Ratio (CAR) would not be expected to be perfect because some of the reports near the

SENSITIVITY TESTS
STRAIGHT TURN

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PARAMETER SETTING I							
STR_TURN_1_0_TEST	96	2	2	0.9677	0.3125	0.6771	3.0000
STR_TURN_1_1_TEST	96	2	3	0.9608	0.4688	0.4688	9.5000
STR_TURN_1_2_TEST	96	2	3	0.9821	0.5313	0.4167	11.0000
STR_TURN_2_0_TEST	96	2	2	0.5429	0.3958	0.2708	5.0000
STR_TURN_2_1_TEST	96	2	2	1.0000	0.7917	0.2083	5.0000
STR_TURN_2_2_TEST	96	2	2	1.0000	0.8438	0.1563	6.0000
STR_TURN_3_0_TEST	96	2	2	0.9821	0.5729	0.4167	7.5000
STR_TURN_3_1_TEST	96	2	2	0.9859	0.7292	0.2604	11.0000
STR_TURN_3_2_TEST	96	2	2	0.9863	0.7500	0.2396	10.0000
STR_TURN_4_0_TEST	96	2	2	1.0000	0.4063	0.5938	4.5000
STR_TURN_4_1_TEST	96	2	3	1.0000	0.6250	0.3438	9.0000
STR_TURN_4_2_TEST	96	2	2	1.0000	0.7292	0.2708	10.5000
PARAMETER SETTING II							
STR_TURN_1_0_TEST	96	2	5	0.6742	0.4583	0.0729	20.5000
STR_TURN_1_1_TEST	96	2	4	0.9375	0.8854	0.0000	9.0000
STR_TURN_1_2_TEST	96	2	4	1.0000	0.9167	0.0104	8.0000
STR_TURN_2_0_TEST	96	2	3	0.5402	0.4792	0.0938	6.5000
STR_TURN_2_1_TEST	96	2	3	1.0000	0.9479	0.0208	5.0000
STR_TURN_2_2_TEST	96	2	3	0.9894	0.9375	0.0208	6.0000
STR_TURN_3_0_TEST	96	2	3	0.9247	0.8646	0.0313	10.5000
STR_TURN_3_1_TEST	96	2	4	0.9375	0.8958	0.0000	9.0000
STR_TURN_3_2_TEST	96	2	4	1.0000	0.9167	0.0104	8.0000
STR_TURN_4_0_TEST	96	2	4	0.6264	0.5313	0.0521	9.5000
STR_TURN_4_1_TEST	96	2	3	0.6353	0.5208	0.1146	6.5000
STR_TURN_4_2_TEST	96	2	2	1.0000	0.9792	0.0208	1.5000
NECTAR RUN							
STR_TURN_1_0_TEST	96	2	2	0.5104	0.5104	0.0000	2.0000
STR_TURN_1_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_1_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_2_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_2_1_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_2_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_3_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_3_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_3_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_4_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_4_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_4_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000

Table 9: *Summary of Straight-Turn test results (STDS)*

intersection of two tracks could be legitimately assignable to either track. However, given the performance of spatial correlation at these parameter settings, that might not be as big of a problem as expected. Regardless of these considerations, the results are shown in Table 8.

OBU did fairly well on these tests, maintaining highly pure tracks while following the tracks after they crossed. At lower angles, such as 30°, OBU had more trouble than at the higher angles. In Figure 15, the constructed tracks for the test where angle=30°, ELINT separation = 1 standard deviation. This test was the only incidence in which OBU did not compare well with NECTAR results. As can be seen, the lower numbers are due to the red track. Examination of

SENSITIVITY TESTS
TURN-TURN TESTS

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PARAMETER SETTING I							
TURN_TURN_1_0_TEST	96	2	3	0.8667	0.3229	0.5313	8.0000
TURN_TURN_1_1_TEST	96	2	3	0.8500	0.2708	0.5833	7.5000
TURN_TURN_1_2_TEST	96	2	3	1.0000	0.4167	0.4688	11.0000
TURN_TURN_2_0_TEST	96	2	2	0.9677	0.3125	0.6771	3.0000
TURN_TURN_2_1_TEST	96	2	3	0.9821	0.5521	0.4167	8.5000
TURN_TURN_2_2_TEST	96	2	3	0.9608	0.4792	0.4688	11.0000
TURN_TURN_3_0_TEST	96	2	3	0.9677	0.2917	0.6771	5.0000
TURN_TURN_3_1_TEST	96	2	3	0.9600	0.4375	0.4792	10.0000
TURN_TURN_3_2_TEST	96	2	3	0.9818	0.5313	0.4271	10.0000
PARAMETER SETTING II							
TURN_TURN_1_0_TEST	96	2	3	0.9535	0.8333	0.1042	8.0000
TURN_TURN_1_1_TEST	96	2	2	0.9891	0.9479	0.0417	4.0000
TURN_TURN_1_2_TEST	96	2	2	0.9785	0.9479	0.0313	3.0000
TURN_TURN_2_0_TEST	96	2	5	0.9462	0.8229	0.0313	14.0000
TURN_TURN_2_1_TEST	96	2	3	0.9368	0.8854	0.0104	8.5000
TURN_TURN_2_2_TEST	96	2	4	1.0000	0.9167	0.0104	8.0000
TURN_TURN_3_0_TEST	96	2	4	0.5978	0.5000	0.0417	12.0000
TURN_TURN_3_1_TEST	96	2	3	0.9375	0.8958	0.0000	9.5000
TURN_TURN_3_2_TEST	96	2	4	0.9896	0.9167	0.0000	8.5000
NECTAR RUN							
TURN_TURN_1_0_TEST	96	2	3	0.6458	0.4896	0.0000	2.5000
TURN_TURN_1_1_TEST	96	2	3	0.6458	0.4896	0.0000	2.5000
TURN_TURN_1_2_TEST	96	2	3	1.0000	0.8542	0.0000	1.5000
TURN_TURN_2_0_TEST	96	2	2	0.5104	0.5104	0.0000	2.0000
TURN_TURN_2_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
TURN_TURN_2_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
TURN_TURN_3_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
TURN_TURN_3_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
TURN_TURN_3_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000

Table 10: *Summary of Turn-Turn Test Results (STDS)*

the data indicated this track was created by the CLUSTER routine out of ELINT outliers (ambiguities). One can speculate that had the ELINT and Spatial margin been higher, this probably would not have occurred.

Straight-Turn and Turn-Turn Testing Results

Straight-Turn tests involve two targets. One target moves on a straight course while the second makes one turn. Of all the possible ways a pair of tracks can be configured for the targets, four were selected for the study (see Figure 1). The turn for the second target occurred when the two targets have their closest approach.

Results for the Straight-Turn tests are summarized in Table 9. The first column lists name of the test, "STR TURN"; the second number is the number of type of straight-turn test (corr. to Figure 1); the third value is the ELINT Separation for the test while the rest of the columns correspond with the standard results format as discussed earlier. Comparing the results of PS-II with the NECTAR results, one can see that the straight-turn test was much more challenging for OBU at PS-II than the above crossing track tests especially at low ELINT separation. Specifically, STR_TURN_1_0, STR_TURN_1_1, STR_TURN_4_0 and STR_TURN_4_1 exhibit values that indicate that the ACT had problems with the data. Figure 16 is a graph of one of these tests and was representative of the problems that occurred in all tests. If one examines the figure, two major mistakes are immediately evident. In the first half of the "green" track, what looks like "stitching" has occured. Examination of the data indicates that this was caused by a track created by CLUSTERthat was later merged with the "green" track by LINK. This is a typical problem that can occur if LINK can not take into the account past history of a track. The other problem occurred when a " blue" track was overlayed on the "purple" track. Again, this was caused by CLUSTER. Why LINK did not eventually merge the track with the "purple" track is a matter of conjecture.

A Turn-Turn test involves two targets as well. Both make turns at the closest point of approach. Usually, this is one of the more difficult tests for a track/correlator. If one examines the results of this round of testing in Table 10 one can see that OBU's performance exceeded that of the NECTAR in some cases. As was shown earlier, OBU seems to follow turns very

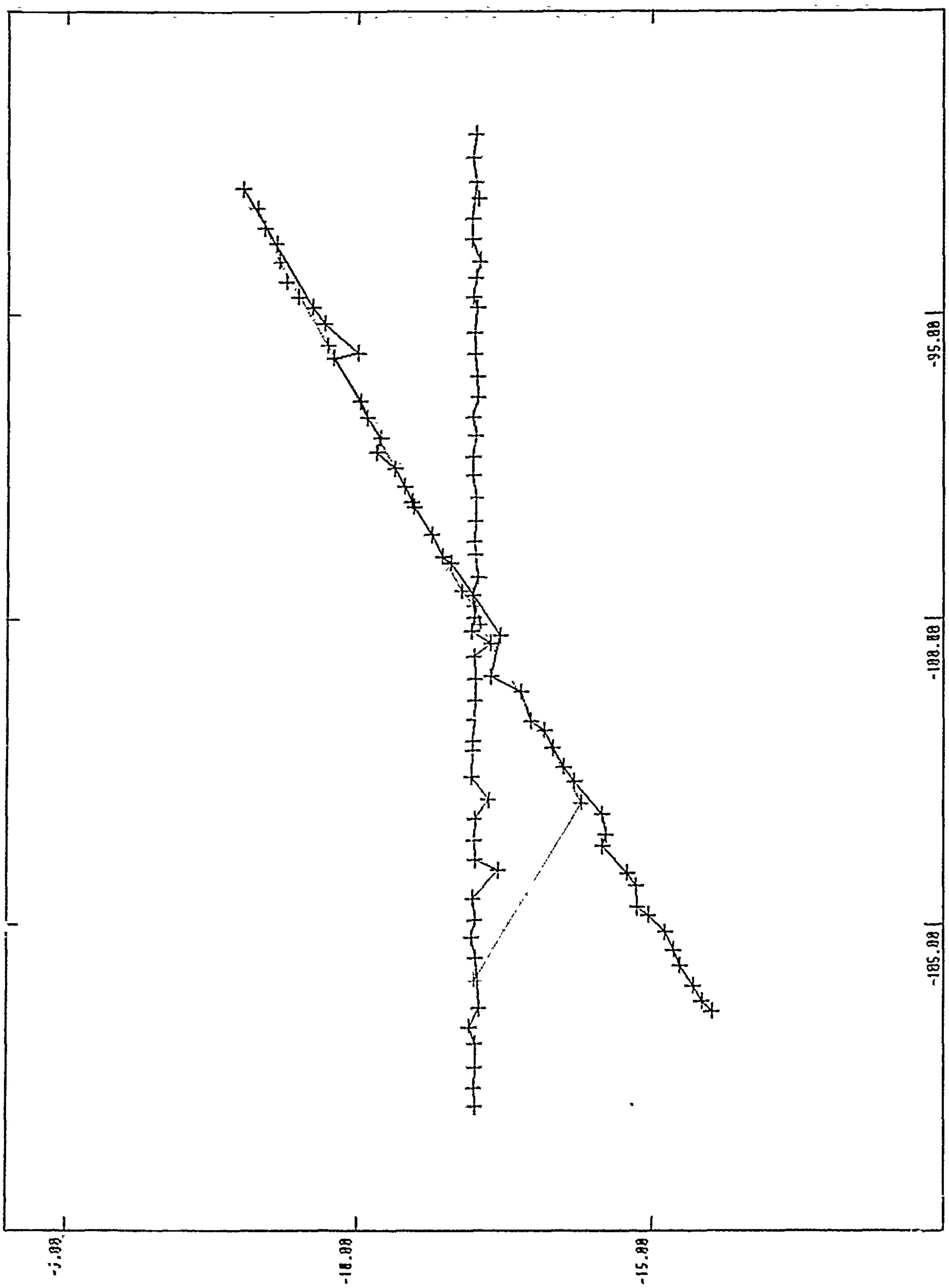

Figure 15: *Constructed Tracks for Crossing_30_1 test*

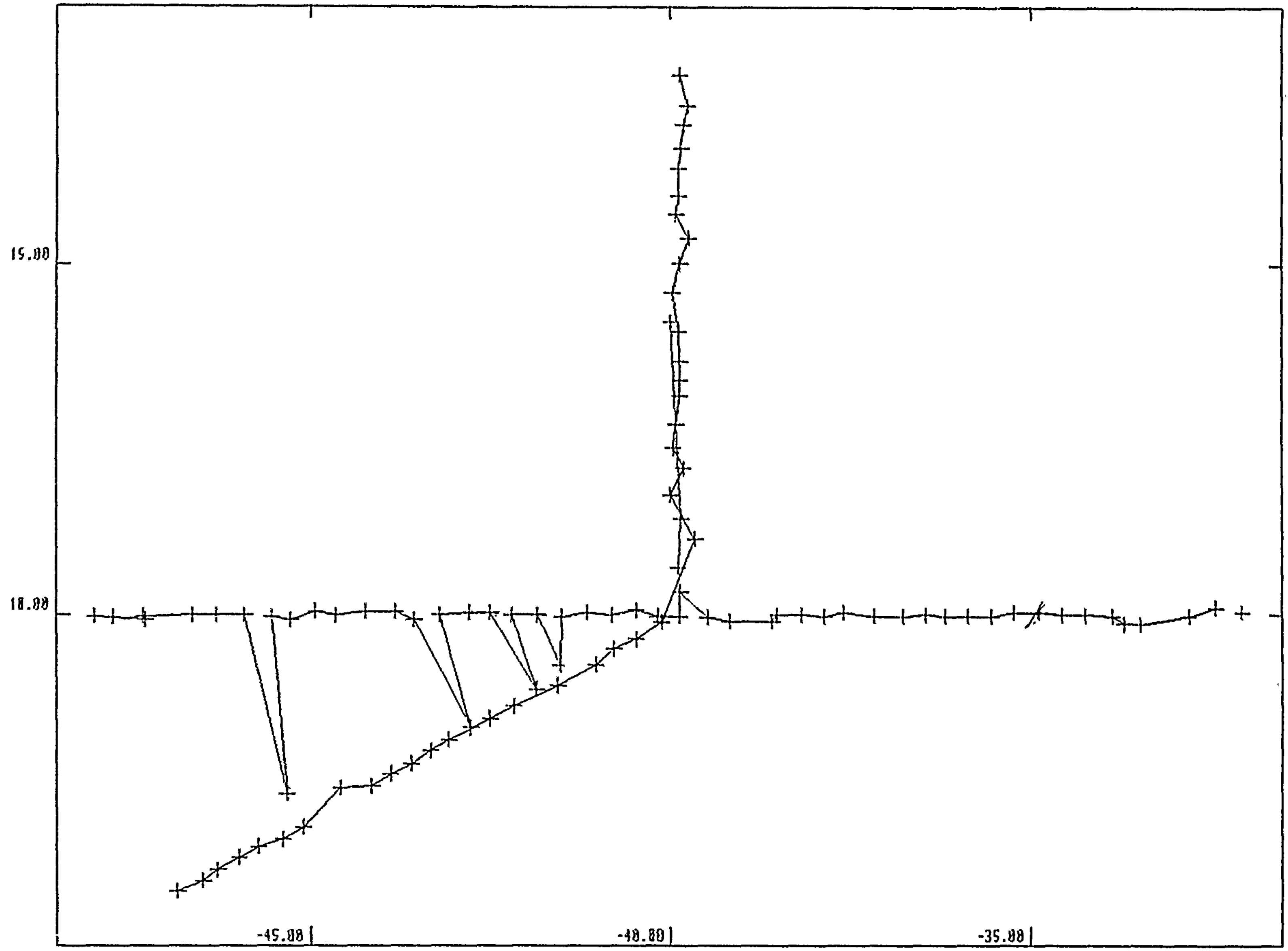

Figure 16: *Constructed Tracks for Str_turn_3_1_1 test*

well (see Turn Testing) while NECTAR does well maintaining straight tracks. This type of behavior is attributable to the different motion models used in the algorithms.

The only place where OBU did poorly t at PS-II was TURN_TURN_3_0. This was examined and it was found that CLUSTER/LINK interactions caused similar behavior to occur as was seen in Figure 16 and discussed above. It should be pointed out, though, that at the low ELINT separations, one would expect a 50% chance of failure in a "reasonable" T/C. The fact that OBU only failed once should be an encouraging one.

CONCLUSIONS

The methods used to evaluate the algorithm are sound and point the developer towards possible drawbacks in his algorithm to be considered for future development. The idea of standard sets of tests to test the data fusion algorithm at its most fundamental level is also prooved to be useful. It also behooves the evaluator to have other algorithms with which to baseline performance against.

As has been reiterated throughout this report, although OBU is making some "irrational" choices due to LINK and CLUSTER, the ELINT correlation seems to be functioning as well as can be expected at the current parameterization. This is contrary to previous testing results (March, 1988) on OBU where many irrational correlations and spatial jumping was observed. It would appear ELINT correlation-wise, OBU is on the proper track.

Based on our previous knowledge of TERESA and OBU, these results indicate that the parameters for ELINT and Spatial correlation should probably be higher. A future test would test these parameters around the 0.75 range. In fact, a proposal for future testing has been sent to SPAWAR and is included at the end of this report. Also attention should be paid to the New Emitter Statistic and New Track Threshold for proper tuning after the developer is convinced he is using sound ELINT and Spatial margins.

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APPENDIX A
DATA SUMMARY

SUMMARY FILE

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PAX_PARA_110	96	2	2	1.0000	0.3333	0.6667	1.5000
PAX_PARA_111	96	2	2	1.0000	0.3646	0.6354	3.0000
PAX_PARA_112	96	2	4	0.9630	0.4688	0.4375	8.5000
PAX_PARA_113	96	2	3	0.9868	0.7604	0.2083	7.5000
PAX_PARA_114	96	2	2	1.0000	0.7604	0.2396	5.0000
PAX_PARA_120	96	2	2	1.0000	0.3333	0.6667	1.5000
PAX_PARA_121	96	2	4	0.9574	0.3542	0.5104	5.0000
PAX_PARA_122	96	2	3	0.9815	0.5000	0.4375	8.0000
PAX_PARA_123	96	2	2	1.0000	0.8750	0.1250	5.5000
PAX_PARA_124	96	2	2	1.0000	0.8125	0.1875	5.0000
PAX_PARA_130	96	2	4	0.9804	0.4583	0.4688	3.5000
PAX_PARA_131	96	2	4	1.0000	0.4896	0.4479	3.5000
PAX_PARA_132	96	2	2	1.0000	0.7917	0.2083	6.0000
PAX_PARA_133	96	2	3	1.0000	0.8646	0.1250	6.5000
PAX_PARA_134	96	2	2	1.0000	0.8854	0.1146	5.5000
PAX_PARA_210	97	2	2	1.0000	0.2887	0.7113	1.0000
PAX_PARA_211	97	2	2	0.9143	0.3299	0.6392	4.5000
PAX_PARA_212	97	2	2	1.0000	0.5567	0.4433	7.0000
PAX_PARA_213	97	2	3	0.9740	0.7526	0.2062	10.0000
PAX_PARA_214	97	2	2	1.0000	0.7629	0.2371	4.5000
PAX_PARA_220	97	2	2	1.0000	0.2990	0.7010	1.0000
PAX_PARA_221	97	2	2	0.9231	0.3711	0.5979	5.5000
PAX_PARA_222	97	2	3	0.9714	0.6701	0.2784	10.0000
PAX_PARA_223	97	2	3	0.9744	0.7629	0.1959	9.5000
PAX_PARA_224	97	2	2	1.0000	0.7938	0.2062	5.0000
PAX_PARA_230	97	2	2	1.0000	0.3402	0.6598	1.0000
PAX_PARA_231	97	2	3	0.9524	0.3711	0.5670	3.5000
PAX_PARA_232	97	2	3	0.9828	0.5567	0.4021	9.5000
PAX_PARA_233	97	2	3	0.9868	0.7526	0.2165	9.5000
PAX_PARA_234	97	2	3	0.9870	0.7629	0.2062	9.5000
PAX_PARA_310	96	2	2	1.0000	0.3125	0.6875	1.5000
PAX_PARA_311	96	2	4	0.8462	0.4167	0.4583	9.0000
PAX_PARA_312	96	2	3	0.9344	0.5625	0.3646	10.0000
PAX_PARA_313	96	2	3	0.9846	0.6458	0.3229	7.5000
PAX_PARA_314	96	2	3	0.9846	0.6458	0.3229	8.0000
PAX_PARA_320	96	2	2	1.0000	0.3125	0.6875	1.5000
PAX_PARA_321	96	2	2	0.8136	0.5000	0.3854	12.0000
PAX_PARA_322	96	2	2	0.9688	0.6458	0.3333	8.0000
PAX_PARA_323	96	2	3	0.9848	0.6563	0.3125	7.0000
PAX_PARA_324	96	2	3	0.9851	0.6667	0.3021	8.5000
PAX_PARA_330	96	2	2	1.0000	0.5729	0.4271	3.5000
PAX_PARA_331	96	2	3	0.9123	0.5208	0.4063	6.0000
PAX_PARA_332	96	2	3	1.0000	0.6354	0.3333	5.5000
PAX_PARA_333	96	2	3	0.9859	0.6979	0.2604	8.5000
PAX_PARA_334	96	2	3	0.9861	0.7083	0.2500	8.0000
PAX_PARA_410	96	2	2	0.9412	0.3333	0.6458	2.5000
PAX_PARA_411	96	2	2	0.9762	0.4271	0.5625	4.5000
PAX_PARA_412	96	2	3	0.9718	0.6667	0.2604	8.0000
PAX_PARA_413	96	2	2	1.0000	0.8333	0.1667	5.0000
PAX_PARA_414	96	2	2	1.0000	0.8021	0.1979	4.5000
PAX_PARA_420	96	2	2	0.9118	0.3229	0.6458	3.0000
PAX_PARA_421	96	2	2	0.9783	0.4688	0.5208	5.5000
PAX_PARA_422	96	2	3	1.0000	0.6771	0.2917	7.5000
PAX_PARA_423	96	2	2	1.0000	0.8333	0.1667	5.0000
PAX_PARA_424	96	2	2	1.0000	0.8021	0.1979	4.5000
PAX_PARA_430	96	2	2	0.9394	0.3229	0.6563	2.5000
PAX_PARA_431	96	2	2	1.0000	0.6563	0.3438	7.0000
PAX_PARA_432	96	2	3	1.0000	0.6771	0.2917	7.0000
PAX_PARA_433	96	2	2	1.0000	0.8958	0.1042	5.0000
PAX_PARA_434	96	2	2	1.0000	0.8958	0.1042	5.0000
PAX_PARA_510	96	2	2	1.0000	0.3125	0.6875	1.0000

PAX_PARA_511	96	2	2	1.0000	0.3125	0.6875	1.0000
PAX_PARA_512	96	2	2	0.9636	0.5521	0.4271	9.5000
PAX_PARA_513	96	2	2	0.9848	0.6771	0.3125	10.0000
PAX_PARA_514	96	2	2	1.0000	0.7813	0.2188	4.0000
PAX_PARA_520	96	2	3	0.9697	0.3125	0.6563	2.0000
PAX_PARA_521	96	2	3	0.9697	0.3125	0.6563	2.0000
PAX_PARA_522	96	2	2	0.9821	0.5729	0.4167	9.0000
PAX_PARA_523	96	2	2	0.9859	0.7292	0.2604	11.0000
PAX_PARA_524	96	2	2	1.0000	0.8125	0.1875	5.0000
PAX_PARA_530	96	2	2	1.0000	0.5000	0.5000	1.0000
PAX_PARA_531	96	2	2	1.0000	0.6250	0.3750	2.5000
PAX_PARA_532	96	2	2	0.9868	0.7813	0.2083	5.5000
PAX_PARA_533	96	2	2	0.9884	0.8854	0.1042	6.0000
PAX_PARA_534	96	2	2	1.0000	0.8854	0.1146	5.5000

SUMMARY FILE (PS-I)

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
CROSSING_30_0_TEST	98	2	2	0.9846	0.6531	0.3367	6.5000
CROSSING_30_1_TEST	98	2	3	1.0000	0.7857	0.2041	6.5000
CROSSING_30_2_TEST	98	2	2	1.0000	0.8163	0.1837	6.5000
CROSSING_30_3_TEST	98	2	2	1.0000	0.8163	0.1837	6.0000
CROSSING_30_4_TEST	98	2	2	1.0000	0.8265	0.1735	5.5000
CROSSING_60_0_TEST	98	2	2	1.0000	0.7449	0.2551	5.5000
CROSSING_60_1_TEST	98	2	2	1.0000	0.8163	0.1837	5.5000
CROSSING_60_2_TEST	98	2	2	1.0000	0.7857	0.2143	7.5000
CROSSING_60_3_TEST	98	2	2	1.0000	0.8265	0.1735	5.5000
CROSSING_60_4_TEST	98	2	2	1.0000	0.8265	0.1735	5.5000
CROSSING_90_0_TEST	98	2	2	1.0000	0.7551	0.2449	5.5000
CROSSING_90_1_TEST	98	2	3	1.0000	0.7143	0.2755	8.5000
CROSSING_90_2_TEST	98	2	2	1.0000	0.8163	0.1837	6.0000
CROSSING_90_3_TEST	98	2	2	1.0000	0.8163	0.1837	5.5000
CROSSING_90_4_TEST	98	2	2	1.0000	0.7143	0.2857	5.0000
GEO_1_12_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
GEO_1_24_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
GEO_1_6_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
GEO_2_12_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
GEO_2_24_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
GEO_2_6_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
PARA_12_0_TEST	100	2	2	0.8788	0.2900	0.6700	8.0000
PARA_12_1_TEST	100	2	2	0.9070	0.3900	0.5700	10.5000
PARA_12_2_TEST	100	2	3	0.9643	0.4800	0.4400	13.0000
PARA_12_3_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_12_4_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_24_0_TEST	100	2	3	0.9286	0.2500	0.7200	6.0000
PARA_24_1_TEST	100	2	2	0.9268	0.3800	0.5900	10.0000
PARA_24_2_TEST	100	2	2	0.9811	0.5200	0.4700	11.0000
PARA_24_3_TEST	100	2	3	0.9831	0.5600	0.4100	12.5000
PARA_24_4_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_48_0_TEST	100	2	2	0.8438	0.2700	0.6800	6.5000
PARA_48_1_TEST	100	2	2	0.9574	0.4500	0.5300	11.5000
PARA_48_2_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_48_3_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_48_4_TEST	100	2	2	1.0000	0.5600	0.4400	11.0000
PARA_6_0_TEST	100	2	2	0.7561	0.3100	0.5900	8.0000
PARA_6_1_TEST	100	2	2	0.8627	0.4400	0.4900	13.0000
PARA_6_2_TEST	100	2	3	0.9804	0.4700	0.4900	11.0000
PARA_6_3_TEST	100	2	3	1.0000	0.4900	0.5000	10.0000
PARA_6_4_TEST	100	2	3	1.0000	0.4900	0.4800	10.5000
REF_1_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
REF_2_TEST	100	2	2	0.8387	0.2600	0.6900	7.5000
STR_TURN_1_0_TEST	96	2	2	0.9677	0.3125	0.6771	3.0000
STR_TURN_1_1_TEST	96	2	3	0.9608	0.4688	0.4688	9.5000
STR_TURN_1_2_TEST	96	2	3	0.9821	0.5313	0.4167	11.0000
STR_TURN_2_0_TEST	96	2	2	0.5429	0.3958	0.2708	5.0000
STR_TURN_2_1_TEST	96	2	2	1.0000	0.7917	0.2083	5.0000
STR_TURN_2_2_TEST	96	2	2	1.0000	0.8438	0.1563	6.0000
STR_TURN_3_0_TEST	96	2	2	0.9821	0.5729	0.4167	7.5000
STR_TURN_3_1_TEST	96	2	2	0.9859	0.7292	0.2604	11.0000
STR_TURN_3_2_TEST	96	2	2	0.9863	0.7500	0.2396	10.0000
STR_TURN_4_0_TEST	96	2	2	1.0000	0.4063	0.5938	4.5000
STR_TURN_4_1_TEST	96	2	3	1.0000	0.6250	0.3438	9.0000
STR_TURN_4_2_TEST	96	2	2	1.0000	0.7292	0.2708	10.5000
TRACK_INIT_TEST	156	4	5	0.6909	0.2949	0.6474	6.7500
TURN_10_TEST	48	1	1	1.0000	0.5625	0.4375	5.0000
TURN_1_TEST	48	1	1	1.0000	0.8958	0.1042	4.0000
TURN_2_TEST	48	1	1	1.0000	0.8958	0.1042	4.0000
TURN_3_TEST	48	1	1	1.0000	0.8958	0.1042	4.0000
TURN_4_TEST	48	1	1	1.0000	0.8125	0.1875	6.0000

TURN_5_TEST	48	1	1	1.0000	0.7708	0.2292	8.0000
TURN_6_TEST	48	1	1	1.0000	0.8542	0.1458	3.0000
TURN_7_TEST	48	1	1	1.0000	0.8333	0.1667	4.0000
TURN_8_TEST	48	1	1	1.0000	0.8542	0.1458	3.0000
TURN_9_TEST	48	1	1	1.0000	0.8542	0.1458	3.0000
TURN_TURN_1_0_TEST	96	2	3	0.8667	0.3229	0.5313	8.0000
TURN_TURN_1_1_TEST	96	2	3	0.8500	0.2708	0.5833	7.5000
TURN_TURN_1_2_TEST	96	2	3	1.0000	0.4167	0.4688	11.0000
TURN_TURN_2_0_TEST	96	2	2	0.9677	0.3125	0.6771	3.0000
TURN_TURN_2_1_TEST	96	2	3	0.9821	0.5521	0.4167	8.5000
TURN_TURN_2_2_TEST	96	2	3	0.9608	0.4792	0.4688	11.0000
TURN_TURN_3_0_TEST	96	2	3	0.9677	0.2917	0.6771	5.0000
TURN_TURN_3_1_TEST	96	2	3	0.9600	0.4375	0.4792	10.0000
TURN_TURN_3_2_TEST	96	2	3	0.9818	0.5313	0.4271	10.0000

SUMMARY FILE (PS-II)

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
CROSSING_30_0_TEST	98	2	2	0.9890	0.9184	0.0714	3.5000
CROSSING_30_1_TEST	98	2	3	0.9783	0.8469	0.0612	8.0000
CROSSING_30_2_TEST	98	2	2	0.9894	0.9490	0.0408	4.0000
CROSSING_30_3_TEST	98	2	2	1.0000	0.9694	0.0306	2.5000
CROSSING_30_4_TEST	98	2	2	1.0000	0.9694	0.0306	2.5000
CROSSING_60_0_TEST	98	2	2	1.0000	0.9082	0.0918	4.0000
CROSSING_60_1_TEST	98	2	2	1.0000	0.9082	0.0918	4.0000
CROSSING_60_2_TEST	98	2	2	1.0000	0.9388	0.0612	4.0000
CROSSING_60_3_TEST	98	2	2	1.0000	0.9286	0.0714	4.0000
CROSSING_60_4_TEST	98	2	2	1.0000	0.9286	0.0714	4.0000
CROSSING_90_0_TEST	98	2	2	1.0000	0.9490	0.0510	3.5000
CROSSING_90_1_TEST	98	2	2	1.0000	0.9490	0.0510	3.5000
CROSSING_90_2_TEST	98	2	2	1.0000	0.9592	0.0408	3.0000
CROSSING_90_3_TEST	98	2	2	1.0000	0.9592	0.0408	3.0000
CROSSING_90_4_TEST	98	2	2	1.0000	0.9286	0.0714	4.0000
GEO_1_12_TEST	100	2	2	0.6829	0.5600	0.1800	19.0000
GEO_1_24_TEST	100	2	2	0.6375	0.5100	0.2000	16.5000
GEO_1_6_TEST	100	2	2	0.6625	0.5300	0.2000	19.0000
GEO_2_12_TEST	100	2	2	0.6829	0.5600	0.1800	19.0000
GEO_2_24_TEST	100	2	2	0.6375	0.5100	0.2000	16.5000
GEO_2_6_TEST	100	2	2	0.6625	0.5300	0.2000	19.0000
PARA_12_0_TEST	100	2	2	0.6667	0.5400	0.1900	16.5000
PARA_12_1_TEST	100	2	5	0.8298	0.6800	0.0600	21.5000
PARA_12_2_TEST	100	2	3	0.9579	0.9000	0.0500	6.0000
PARA_12_3_TEST	100	2	2	0.9462	0.8800	0.0700	8.0000
PARA_12_4_TEST	100	2	4	0.9896	0.8500	0.0400	11.5000
PARA_24_0_TEST	100	2	2	0.6410	0.5000	0.2200	14.0000
PARA_24_1_TEST	100	2	3	0.8072	0.6600	0.1700	17.5000
PARA_24_2_TEST	100	2	2	0.9882	0.8400	0.1500	7.0000
PARA_24_3_TEST	100	2	2	0.9759	0.8100	0.1700	8.0000
PARA_24_4_TEST	100	2	2	1.0000	0.9000	0.1000	4.0000
PARA_48_0_TEST	100	2	2	0.6437	0.5600	0.1300	8.5000
PARA_48_1_TEST	100	2	3	0.6250	0.5400	0.1200	9.0000
PARA_48_2_TEST	100	2	2	1.0000	0.8600	0.1400	5.5000
PARA_48_3_TEST	100	2	3	1.0000	0.8500	0.1300	6.0000
PARA_48_4_TEST	100	2	2	1.0000	0.9000	0.1000	4.0000
PARA_6_0_TEST	100	2	2	0.6667	0.5200	0.2200	17.0000
PARA_6_1_TEST	100	2	2	0.8404	0.7900	0.0600	13.0000
PARA_6_2_TEST	100	2	3	0.9490	0.9000	0.0200	8.0000
PARA_6_3_TEST	100	2	3	0.9348	0.8400	0.0800	9.5000
PARA_6_4_TEST	100	2	3	0.9368	0.8700	0.0500	10.0000
REF_1_TEST	100	2	3	0.7051	0.5400	0.2200	18.0000
REF_2_TEST	100	2	2	0.6867	0.5700	0.1700	18.5000
STR_TURN_1_0_TEST	96	2	5	0.6742	0.4583	0.0729	20.5000
STR_TURN_1_1_TEST	96	2	4	0.9375	0.8854	0.0000	9.0000
STR_TURN_1_2_TEST	96	2	4	1.0000	0.9167	0.0104	8.0000
STR_TURN_2_0_TEST	96	2	3	0.5402	0.4792	0.0938	6.5000
STR_TURN_2_1_TEST	96	2	3	1.0000	0.9479	0.0208	5.0000
STR_TURN_2_2_TEST	96	2	3	0.9894	0.9375	0.0208	6.0000
STR_TURN_3_0_TEST	96	2	3	0.9247	0.8646	0.0313	10.5000
STR_TURN_3_1_TEST	96	2	4	0.9375	0.8958	0.0000	9.0000
STR_TURN_3_2_TEST	96	2	4	1.0000	0.9167	0.0104	8.0000
STR_TURN_4_0_TEST	96	2	4	0.6264	0.5313	0.0521	9.5000
STR_TURN_4_1_TEST	96	2	3	0.6353	0.5208	0.1146	6.5000
STR_TURN_4_2_TEST	96	2	2	1.0000	0.9792	0.0208	1.5000
TRACK_INIT_TEST	156	4	4	0.6149	0.7756	0.0513	10.0000
TURN_10_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_1_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_2_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_3_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_4_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000

TURN_5_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_6_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_7_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_8_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_9_TEST	48	1	2	1.0000	0.9167	0.0208	7.0000
TURN_TURN_1_0_TEST	96	2	3	0.9535	0.8333	0.1042	8.0000
TURN_TURN_1_1_TEST	96	2	2	0.9891	0.9479	0.0417	4.0000
TURN_TURN_1_2_TEST	96	2	2	0.9785	0.9479	0.0313	3.0000
TURN_TURN_2_0_TEST	96	2	5	0.9462	0.8229	0.0313	14.0000
TURN_TURN_2_1_TEST	96	2	3	0.9368	0.8854	0.0104	8.5000
TURN_TURN_2_2_TEST	96	2	4	1.0000	0.9167	0.0104	8.0000
TURN_TURN_3_0_TEST	96	2	4	0.5978	0.5000	0.0417	12.0000
TURN_TURN_3_1_TEST	96	2	3	0.9375	0.8958	0.0000	9.5000
TURN_TURN_3_2_TEST	96	2	4	0.9896	0.9167	0.0000	8.5000

NECTAR14 RUNS FROM 1/11/89

SUMMARY FILE

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
CROSSING_30_0_TEST	98	2	2	0.5000	0.5306	0.0000	2.0000
CROSSING_30_1_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_30_2_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_30_3_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_30_4_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_60_0_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_60_1_TEST	98	2	2	0.9898	0.9898	0.0000	2.0000
CROSSING_60_2_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_60_3_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_60_4_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_0_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_1_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_2_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_3_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
CROSSING_90_4_TEST	98	2	2	1.0000	1.0000	0.0000	1.0000
GEO_1_12_TEST	100	2	2	0.6100	0.6100	0.0000	12.5000
GEO_1_24_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
GEO_1_6_TEST	100	2	2	0.6300	0.6300	0.0000	13.5000
GEO_2_12_TEST	100	2	2	0.6100	0.6100	0.0000	12.5000
GEO_2_24_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
GEO_2_6_TEST	100	2	2	0.6700	0.6700	0.0000	12.5000
PARA_12_0_TEST	100	2	2	0.6800	0.6800	0.0000	14.5000
PARA_12_1_TEST	100	2	2	0.8500	0.8500	0.0000	10.0000
PARA_12_2_TEST	100	2	2	0.9700	0.9700	0.0000	3.0000
PARA_12_3_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_12_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_0_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_1_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_2_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_3_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_24_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_0_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_1_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_2_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_3_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_48_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
PARA_6_0_TEST	100	2	2	0.6600	0.6600	0.0000	14.5000
PARA_6_1_TEST	100	2	2	0.7700	0.7700	0.0000	12.5000
PARA_6_2_TEST	100	2	2	0.9500	0.9500	0.0000	5.0000
PARA_6_3_TEST	100	2	2	0.9900	0.9900	0.0000	2.0000
PARA_6_4_TEST	100	2	2	1.0000	1.0000	0.0000	1.0000
REF_1_TEST	100	2	2	0.6100	0.6100	0.0000	12.5000
REF_2_TEST	100	2	2	0.6100	0.6100	0.0000	12.5000
STR_TURN_1_0_TEST	96	2	2	0.5104	0.5104	0.0000	2.0000
STR_TURN_1_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_1_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_2_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_2_1_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_2_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_3_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_3_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_3_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
STR_TURN_4_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_4_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
STR_TURN_4_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
TRACK_INIT_TEST	156	4	1	0.3077	1.0000	0.0000	1.0000
TURN_10_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_1_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_2_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_3_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_4_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000

TURN_5_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_6_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_7_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_8_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_9_TEST	48	1	1	1.0000	1.0000	0.0000	1.0000
TURN_TURN_1_0_TEST	96	2	2	0.5104	0.5104	0.0000	2.0000
TURN_TURN_1_1_TEST	96	2	2	0.5104	0.5104	0.0000	2.0000
TURN_TURN_1_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
TURN_TURN_2_0_TEST	96	2	2	0.5104	0.5104	0.0000	2.0000
TURN_TURN_2_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
TURN_TURN_2_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000
TURN_TURN_3_0_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
TURN_TURN_3_1_TEST	96	2	2	0.9896	0.9896	0.0000	2.0000
TURN_TURN_3_2_TEST	96	2	2	1.0000	1.0000	0.0000	1.0000

THESE RUNS WERE MADE WITH THE CORRECTIONS TO NECTAR IN NECTAR14

SUMMARY FILE

	NOBS	NGT	NCT	TP	CAR	AR	AVSGT
PAX_PARA_110	96	2	2	0.7604	0.7604	0.0000	7.0000
PAX_PARA_111	96	2	2	0.8854	0.8854	0.0000	7.0000
PAX_PARA_112	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_113	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_114	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_120	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_121	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_122	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_123	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_124	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_130	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_131	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_132	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_133	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_134	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_210	97	2	2	0.7113	0.7113	0.0000	12.0000
PAX_PARA_211	97	2	2	0.8144	0.8144	0.0000	11.0000
PAX_PARA_212	97	2	2	0.9794	0.9794	0.0000	3.0000
PAX_PARA_213	97	2	2	0.9897	0.9897	0.0000	2.0000
PAX_PARA_214	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_220	97	2	2	0.9072	0.9072	0.0000	4.0000
PAX_PARA_221	97	2	2	0.9175	0.9175	0.0000	3.0000
PAX_PARA_222	97	2	2	0.9897	0.9897	0.0000	2.0000
PAX_PARA_223	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_224	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_230	97	2	2	0.9897	0.9897	0.0000	2.0000
PAX_PARA_231	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_232	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_233	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_234	97	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_310	96	2	2	0.5521	0.5521	0.0000	8.0000
PAX_PARA_311	96	2	2	0.7292	0.7292	0.0000	13.0000
PAX_PARA_312	96	2	3	0.9271	0.9167	0.0000	8.5000
PAX_PARA_313	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_314	96	2	2	0.9792	0.9792	0.0000	3.0000
PAX_PARA_320	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_321	96	2	2	0.9375	0.9375	0.0000	3.0000
PAX_PARA_322	96	2	2	0.9375	0.9375	0.0000	3.0000
PAX_PARA_323	96	2	2	0.9896	0.9896	0.0000	2.0000
PAX_PARA_324	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_330	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_331	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_332	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_333	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_334	96	2	2	1.0000	1.0000	0.0000	1.0000
PAX_PARA_410	96	2	3	0.8125	0.8021	0.0000	9.5000
PAX_PARA_411	96	2	3	0.9375	0.9271	0.0000	8.0000
PAX_PARA_412	96	2	2	0.9688	0.9688	0.0000	3.0000
PAX_PARA_413	96	2	2	0.9792	0.9792	0.0000	2.0000
PAX_PARA_414	96	2	2	0.9792	0.9792	0.0000	2.0000
PAX_PARA_420	96	2	3	0.9688	0.9583	0.0000	5.0000
PAX_PARA_421	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_422	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_423	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_424	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_430	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_431	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_432	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_433	96	2	3	1.0000	0.9479	0.0000	1.5000

PAX_PARA_434	96	2	3	1.0000	0.9479	0.0000	1.5000
PAX_PARA_510	96	2	3	0.5625	0.5521	0.0000	11.0000
PAX_PARA_511	96	2	3	0.9063	0.8958	0.0000	9.0000
PAX_PARA_512	96	2	3	0.9479	0.9375	0.0000	5.0000
PAX_PARA_513	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_514	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_520	96	2	3	0.9896	0.9792	0.0000	3.0000
PAX_PARA_521	96	2	3	0.7500	0.7396	0.0000	7.0000
PAX_PARA_522	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_523	96	2	3	0.9792	0.9688	0.0000	4.0000
PAX_PARA_524	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_530	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_531	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_532	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_533	96	2	3	1.0000	0.9896	0.0000	2.0000
PAX_PARA_534	96	2	3	1.0000	0.9896	0.0000	2.0000

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