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Active Transmission Loss Measurement

A Call-Up Under the Noise Monitoring Standing Offer

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Defence R&D Canada – Atlantic

Contract Report
DRDC Atlantic CR 2004-268
March 2005

Canada

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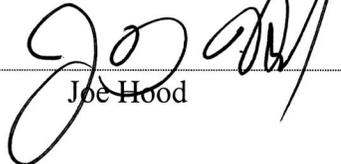
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Contract Report

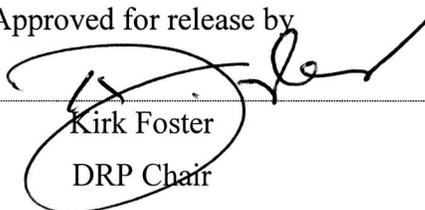**DRDC Atlantic CR 2004-268**
March 2005

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Abstract

This report documents the work done to aid in the analysis of Transmission Loss (TL) data collected during QUEST Trial Q246. During this call-up, Frequency Modulated (FM) pulses received by the Endeavour were measured and the signal processing gain recorded for two environmental runs. The calibrated TL results require further adjustment for the source level and receiver sensitivity. The analysis work done under this call-up reused processes developed during the "Data Processing and Analysis Support to Measure Active Signal Levels" call-up (Integrated Passive/Active Concept Testbed [IMPACT] Standing Offer No. W7707-021973/001/HAL, Requisition No. W7707-03-2304). There, FM pulse receive levels, as seen at the target, were measured from Q246 data. This work included providing small enhancements to the existing Interactive Data Language (IDL)-based Software Tools for Analysis and Research (STAR) software, based on recommendations generated during previous call-ups. These tasks involved the generation or enhancement of reusable software components, allowing future work to be performed more efficiently. The STAR suite was then used to perform data analysis including test and measurement tasks.

Résumé

Le présent rapport décrit les travaux effectués pour faciliter l'analyse des données de perte de transmission recueillies lors de l'essai QUEST Q246. Dans le cadre du présent contrat lié à une commande subséquente, des impulsions modulées en fréquence (FM) reçues par le navire auxiliaire des Forces canadiennes (NAFC) Endeavour ont été mesurées, et le gain obtenu lors du traitement de signaux a été enregistré pour deux essais environnementaux. Les résultats étalonnés de la perte de transmission requièrent un ajustement supplémentaire pour ce qui est du niveau de la source et de la sensibilité du récepteur. Les travaux d'analyse effectués dans le cadre du présent contrat ont repris les processus mis au point lors des travaux « *Data Processing and Analysis Support to Measure Active Signal Levels* » (Soutien au traitement et à l'analyse des données pour mesurer les niveaux des signaux actifs) (*Integrated Passive/Active Concept Testbed* [IMPACT], banc d'essai multistatique intégré actif/passif, offre à commandes N^o W7707-021973/001/HAL, demande N^o W7707-03-2304). Lors des travaux liés à cette demande, les niveaux de réception des impulsions FM, mesurés à la position de la cible, ont été déterminés à partir des données Q246. Ces travaux comprenaient des améliorations de petite échelle des outils logiciels d'analyse et de recherche (STAR pour *Software Tools for Analysis and Research*) existants fondés sur le language IDL (*Interactive Data Language*), en fonction des recommandations présentées antérieurement dans le cadre d'autres commandes subséquentes. Ces travaux ont également requis l'élaboration ou l'amélioration de composants logiciels réutilisables, ce qui permettra d'effectuer les travaux de façon plus efficace à l'avenir. La suite STAR a ensuite été utilisée pour effectuer l'analyse de données et aussi pour la réalisation d'essais et la prise de mesures.

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Executive summary

Background

DRDC Atlantic has ongoing research efforts in active sonar. Specifically, projects such as the IMPACT (Integrated Multistatic Passive Active Concept Testbed) and TIAPS (Towed Integrated Active-Passive Sonar System) generate a significant volume of acoustic data. It is critical that targets be instrumented with both acoustic and non-acoustic sensors so that an understanding of the performance of demonstration systems can be achieved.

The goal of the work presented in this contract report was to generate estimates of transmission loss between and active source and the target of interest. The focus of this work was data collected in a 1998 collaborative trial involving Canada and the UK. By considering the parameters of the sonar equation, such as transmission loss, the limits of sonar performance can be investigated.

Results

This contract has extended previous results to include the relative vessel geometries and transmitter characteristics in order to estimate transmission loss. Unfortunately, as source levels were not available, the transmission loss results are only relative, not absolute. A significant portion of the effort was directed towards enhancing the signal processing and analysis software.

Significance

With the transmission loss analyzed, a sonar equation analysis can be undertaken to investigate the performance limits of a TIAPS system.

The enhancements to the analysis packages STAR (Software Tools for Analysis and Research) and SPPACS (Signal Processing Package) greatly improve DRDC Atlantic's ability to analyze acoustic data, with supporting non-acoustic data, in a timely manner.

Future Plans

The analyzed results will provide a basis for sonar equation analysis of the trial and provide insight into the potential performance of an Operational TIAPS-like system.

The suite of tools developed under this contract will be used for further studies of active sonar performance in order to validate both IMPACT and TIAPS.

Hood, Joe, Brad Glessing, and Olivier Beslin, 2004. Active Transmission Loss Measurement, DRDC Atlantic CR 2004-268. Defence R&D Canada - Atlantic

Sommaire

Introduction

RDDC Atlantique mène actuellement des recherches sur les sonars actifs. Plus précisément, des projets comme IMPACT (*Integrated Passive/Active Concept Testbed*, banc d'essai multistatique intégré actif/passif) et TIAPS (*Towed Integrated Active-Passive Sonar*, sonar actif-passif intégré remorqué) génèrent un volume important de données acoustiques. Pour qu'il soit possible de comprendre le rendement des systèmes de démonstration, il est primordial que les cibles soient dotées à la fois de capteurs acoustiques et non acoustiques.

Le but des travaux exposés dans le présent rapport, découlant d'un contrat, était de générer des estimations de la perte de transmission entre une source active et la cible choisie. Il est possible d'analyser les limites de rendement d'un sonar en utilisant la perte de transmission et les autres paramètres de l'équation sonar.

Résultats

Les travaux effectués dans le cadre d'un contrat précédent portaient sur l'analyse des niveaux de réception associés à l'émission active du TIAPS VP2 (réseau de projecteurs verticaux) au cours d'un essai en mer réalisé en 1998, qui faisait appel à un aéronef de patrouille maritime (APATMAR) utilisant le processeur IMPACT et au NAFC Endeavour utilisant un système semblable au TIAPS. Les travaux réalisés dans le cadre du présent contrat ont permis, quant à eux, d'aller plus loin et d'inclure les géométries relatives des navires et les caractéristiques des émetteurs afin d'estimer la perte de transmission. Une partie importante des travaux visait l'amélioration des logiciels d'analyse et de traitement de signaux.

Portée

Après avoir analysé la perte de transmission, on peut entreprendre une analyse utilisant l'équation sonar pour étudier les limites de rendement d'un système TIAPS.

L'amélioration des systèmes d'analyse STAR (*Software Tools for Analysis and Research*, outils logiciels d'analyse et de recherche) et SPPACS (*Signal Processing Package*, ensemble de traitement de signaux) améliore considérablement la capacité de RDDC Atlantique à analyser les données acoustiques, en tenant compte des données non acoustiques complémentaires et ce, dans les délais requis.

Recherches futures

Les résultats permettront l'analyse de l'essai au moyen de l'équation sonar et donneront un aperçu du rendement que pourrait offrir un système opérationnel semblable au TIAPS.

La suite d'outils produits dans le cadre du présent contrat servira à d'autres études de rendement du sonar actif afin de valider les systèmes IMPACT et TIAPS.

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1.   Introduction

This final report outlines the work done under Noise Monitoring Software Regional Individual Standing Offer (RISO) No. W7707-032293/001/HALActive Transmission Loss Measurement Call-up No. W7707-4-2523. This work was performed at Defence Research and Development Canada (DRDC) - (Atlantic) under the direction of the Scientific Authority (SA), Jim Theriault, from approximately May 2004 to August 2004.

1.1 Overview

The objective of this call-up was to provide small enhancements to existing signal level measurement software and to perform bulk signal level measurement for a series of pings generated during two environmental runs on QUEST Trial Q246. Software enhancement requirements were based on recommendations generated during previous call-ups.

1.2 Background

1.2.1 STAR

The STAR suite was developed to support general research and analysis objectives at DRDC Atlantic. The primary objectives of the STAR suite are:

- Provide scientific grade analysis tools that allow for efficient, detailed quantitative and qualitative analysis of a data set.

- Support synergy between DRDC groups and the Department of National Defence (DND) by providing a common software base for analysis. This synergy encourages inter-group communication and simplifies user training, analysis process development, documentation and data portability.

- Support cost and analysis efficiency by providing software reuse and common tools and data formats. Examples of efficiency would be using the output of analysis from one group to feed the inputs of another, or using common software components to lower the development cost of several custom analysis tools.

All STAR components are currently implemented using IDL, though the design is not restricted to IDL. The name STAR reflects the generic nature of the software. Applications in the STAR suite are built using a combination of reusable and custom components that meet the requirements of each task. The layered design and common components allow for rapid and logical development of new capabilities. Though currently focused on sonar data processing and analysis, the tools are capable of expanding to meet other analysis and research requirements.

1.2.2 Signal Processing Package (SPPACS)

The Signal Processing Package (SPPACS) is a group of software programs that are based on the C programming language and is implemented on Linux-based Personal Computers (PC). Each program provides a specific processing function and a series of programs can be chained together to create a custom-processing stream using the command line or scripts. The output from SPPACS is stored in DREA formatted data files. SPPACS has slowly evolved to its present day state due to the efforts of several MacDonald Dettwiler and Associates Ltd. (MacDonald Dettwiler) personnel over the last 4 years.

SPPACS has been used to perform a number of mid-trial and post-trial processing functions, such as the post-trial study of multistatic trial data and the mid-trial analysis of the Q265 sonobuoy test trial. SPPACS only performs data manipulation and does not provide an interface to examine the results. The processed data output is often imported into other applications that enable data display and are used to perform the detailed analysis of the results such as the STAR suite.

The SPPACS software suite consists of two types of software. One type is runtime executables that can be used to process DRDC Atlantic data files in a number of ways, including data management and signal processing. Each program performs a specific function and the programs are designed so that they can be used in conjunction to perform more complex processing tasks. The software has proven to be very useful in simplifying data management and sonar processing tasks by providing a set of tools from which to build the necessary processing streams. These streams can be run from the command line or assembled into scripts to perform batch-processing tasks allowing for large amounts of data to be automatically processed. The second form of the software is a group of library functions that can be used by other programs to efficiently perform standard tasks. These library functions are extensively used by the runtime software, but can also used for other applications. There are now three types of libraries. The first are utility routines for performing tasks, such as header manipulation and command line parsing. The second are signal processing modules termed signal processing library (SPLIB). These are low-level modules that each perform a low level signal-processing task. A new SPPACS module typically consists of one or more SPLIB modules linked together with a SPPACS user interface. The final library type is a sonar processing module termed sonar library (SONLIB). These are more complex modules that combine several SPLIB modules to create a complex sonar module, such as passive processing. More generically reusable software was generated by separating the SPLIB and SONLIB modules from SPPACS. SPLIB and SONLIB are independent of the data header format, timestamping method, etc. and are suitable for integration in real time processing systems.

SPPACS is also supported by a set of signal processing libraries known at the Fastest Fourier Transform in the West (FFTW). These free open-source libraries provide optimized signal processing functions helping to ensure that the SPPACS software runs as efficiently as possible, while providing a significant reduction in coding effort.

Despite the work performed to continue to develop SPPACS and to place SPPACS under version control, formal test cases did not exist that allow users to confirm the correct operation of the software once compiled and installed. This lack of formal testing has

occurred due to limited resource allocation and subsequent scope management on previous development contracts.

2. Work Overview

This section presents an overview of the tasked work and a summary of the work that was completed. The development requirements for this call-up are listed in Table 1. Data processing and analysis was performed under this call-up. This included converting the Non-Acoustic Data (NAD) into STAR format data, processing trial and test data using SPPACS scripting and data analysis.

As this contract was restricted by a limitation of expenditure and the contract objectives were ambitious, not all requirements were completely implemented, though substantial progress was made. All development requirements were met and only a portion of the trial data was not analyzed due to data availability, as discussed in section 3.3. MacDonald Dettwiler worked with the SA to ensure that the call-up deliverables were satisfactory allowing trade-offs to be made, as required.

Several accomplishments described in this contract rely on work conducted under other contracts. By sharing a common code base several contracts were able to reduce the amount of effort required to meet their individual requirements and realise more contract requirements with the available funds.

The following work was completed to address the requirements listed in Table 1:

- A toolbar was created to address the data navigation enhancement requirements. This widget was designed to be reusable and can be easily integrated with new analysis displays. It can be integrated as a floating toolbar in a separate window (as shown in Figure 1) or as an attached toolbar within an analysis window.
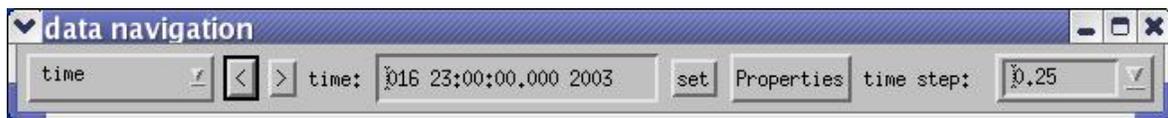
Figure 1. *Data Navigation Dialog*

- An investigation was conducted to determine the feasibility of opening an Energy Time Indicator (ETI) and power spectra analysis window simultaneously, but with different file sources. A solution and an estimation for the amount of work required to implement it are provided in section 4.

- The data handling library was modified to allow the tactical database to access its contents using pointers. This work addressed the database query speed optimization requirement.

- Parameters were added to the user scripts to allow the user to set the font size for the analysis windows. This work addressed the display improvement requirement.

A detailed description of the technical aspects related to the work performed under this contract can be found in the primary STAR reference, "Support to Multistatic FM Data Processing – The SPPACS / STAR Data Analysis Process and Toolset". This document provides details, such as the algorithms used to perform the various analysis measurements, and proposes a complete analysis process that should offer significant improvements in efficiency to DRDC Atlantic.

Table 1. Contract Requirements

REQUIREMENT TITLE	ASSOCIATED REQUIREMENTS
Spectral Energy Processing:	• The contractor shall generate SPPACS processing script(s) that process the provided raw data using the same methodology as used for the previous call-up. • These scripts shall be tuned and tested for the specific trial data using the same methodology as the previous call-up.

Data Navigation Enhancement:	• The contractor shall enhance the STAR data navigation to include the following functions:
	
	    o Jump ahead/back a user specified number of seconds.
	
	    o Jump ahead/back to a user specified time. This time will be applied to the first data request and all other requests will be aligned to it according to the current settings.
	
	    o Jump to the next/previous main blast. This will be done by getting all main blasts and determining the first main blast before the first current request start time of after the first current request end time. This time will be applied to the first request and all other requests will be aligned to it according to current settings.
	
	    o Modify the ping step, ping length and tweak parameters at runtime.
	
	    o Realign requests based on the first request's start time, receiver and beam along with user specified alignment.

Display Synchronization:	• The contractor shall investigate the feasibility of opening an ETI and power spectra analysis window simultaneously but with different file sources. Data navigation would slave the windows to use the same requests (other than the source file). An estimate shall be produced. • If determined feasible after the consultation with the SA the option shall be implemented under this call-up.
Speed Optimization:	• The STAR shall be enhanced to query the database in place using pointers. This will require extension of the data handling library.
Display Improvement:	• Increase the default font size and allow the user to specify the font size in the user script (or at runtime if feasible).

3. Data Processing and Analysis

The data processing and analysis involved several tasks, including:

- Conversion of NAD to STAR format

- Processing trial and test data using SPPACS scripting

- Data Analysis

Each of these tasks is described in more detail in the following subsections.

3.1   NAD Formatting

NAD was required to annotate any data measurements with range and bearing data. RV3 (HMCS Anticosti) was set as both the source and target ship within STAR. RV3 towed a UK source system (echo repeater) and served as the source for the transmission loss measurements.   RV2 (CFAV Endeavour) was the receiver. As part of Data Processing and Analysis Support to Measure Active Signal Levels Call-Up Requisition No. W7707-03-2304, STAR NAD-formatted data was created. This involved converting the provided American Standard Code for Information Interchange (ASCII)-based files with each platform's position over time to the STAR NAD format using the process described in, "Support to Multistatic FM Data Processing – The SPPACS / STAR Data Analysis Process and Toolset." This existing NAD was copied from the Q246_TL_study/NAD directory. In addition, new files were created for:

- Source / Target data (RV3)

- Receiver – Set to match existing RV2 positional information; this provided the required geometric data for 'Echo' measurements.

- Ping – This file was modified to ensure proper association of the Source to the processed data for cross-referencing.

During this time the source ship was stationary while RV2 and its associated towed array transited on radials around the source.

3.2   Data Processing

The SA provided raw data files from Q246. It was decided with the SA to process all data covering the period: 5 June 98, 09:00 to 6 June 13:00 (Julian Days 156 and 157). RV3 Waveform choices were:

- 2 second Hyperbolic Frequency Modulated (HFM) pings from 750 Hz to 850 Hz

- 2 second HFM pings from 1250 Hz to 1300 Hz

The objective of the data processing was to create conventionally beamformed ETI data in order to measure each HFM ping's energy level as a function of time, bearing and range.

Thirty-three beams were formed resulting in beam time series data. The beam time series data was then further processed to form short-term LOFARGRAM, correlation time series and energy time series (ETI) data. Each of these processing streams is described in the following paragraphs with more detail available in the trial processing scripts currently located in //spray/bigdisk/Q246_TL_study/scripts. These scripts were largely duplicates of previous analysis scripts that were adjusted for the requirements of this task.

3.2.1 Data Pre-Processing

The raw data files were modified to repair problems with the data header. This included changing the date/time block and sampling rate:

- Date and sampling frequency were fixed in raw files using the script "fix_raw_data".

- The time in the raw file's header was manually repaired using the SPPACS program "sp_ph" (patch header). Usage example: sp_ph -d --time " 03:33:00" -f q246_05JUN98_0333.dat). Here the '-d' denotes that a DAT32 formatted file was being modified.

3.2.2 Correlation Time Series

For this processing stream the waveforms of interest were written into a replica directory. All beamformed time series data files were then correlated against these replicas to produce correlation time series data. These output data files were not used significantly for this contract. LOFARGRAM data gives more information to visually recognise the FM pulse of interest amongst other signals.

3.2.3 LOFARGRAM Processing

This stream was used to resolve the individual ping types in a LOFARGRAM to aid visual recognition and analysis of the pulses of interest. It proved very useful in identifying various ping types, multi-path and simultaneous source transmissions. The script "gram_gen" was set to cover the frequency range 700 to 1400 Hz. RV3 Waveform choices (HFM 750-850 Hz 2s and HFM 1250-1300 Hz 2s) were transmitted on minute zero of a 5 minute cycle and were readily identified using data from this processing stream and the STAR power spectra analysis application for data viewing.

3.2.4 Energy Time Series

Two streams were used to measure the received signals ("echo levels") of both pulse types:

- HFM 750-850 Hz 2s (script "eti_750_850")

- HFM 1250-1300 Hz 2s (script "eti_1250_1300")

Note: For calibration purposes, the way ETI time series is calculated in SPPACS program is summarized in the following lines.

It is known that ETIs can be readily calculated in the time domain. However, the SPPACS program calculates ETIs in the frequency domain in order to reject the energy that does not belong to the HFM pulse bandwidth.

The time domain energy level is classically given by:

$$ETI(t) \equiv \int_{t}^{t+T} V^2(\tau)d\tau \tag{1}$$

where t is the time, T is the integration time window and $V(t)$ is the voltage signal.

The voltage signal is given by:

$$V(t) \equiv v_{LSB}s(t) \tag{2}$$

where v_{LSB} is the voltage level of the least significant bit and $s(t)$ is the sampled normalized signal.

Introducing F_s, the sampling frequency and N, the number of time samples of the integration time window, the discrete time domain expression of ETI is then given by:

$$ETI(t) = \frac{v_{LSB}^2}{F_s} \sum_{n=0}^{N-1} s_n^2 \tag{3}$$

where $\{s_n\}$ is the time series of the normalized signal $s(t)$.

The conventional definition of the Discrete Fourier Transform (DFT) $\{\hat{S}_k\}$ of the time series $\{s_n\}$, for an N sample window is given by:

$$\hat{S}_k \equiv \sum_{n=0}^{N-1} s_n e^{-2j\pi\frac{nk}{N}} \tag{4}$$

$$s_n \equiv \frac{1}{N} \sum_{k=0}^{N-1} \hat{S}_k e^{2j\pi\frac{nk}{N}} \tag{5}$$

The FFTW library called by the SPPACS program uses this conventional definition.

Using this convention, Parseval's formulae is expressed in a discrete form as follows:

$$\frac{\left(\sum_{k=0}^{N-1} \hat{S}_k^2\right)}{\left(\sum_{n=0}^{N-1} s_n^2\right)} = N \tag{6}$$

Using equations (3) and (6), ETI can be calculated in the frequency domain as follows:

$$ETI(t) = 2\frac{v_{LSB}^2}{NF_s} \sum_{n=0}^{N/2-1} \left|\hat{S}_k\right|^2 \tag{7}$$

This last expression is used in SPPACS program to calculate ETI. In the summation over the frequency bins, only the signal frequency bins are retained.

ETI is also amplified by the array gain: 10*LOG10 (Number of receiver).

Care must be taken in interpreting the results. This processing does not yield calibrated levels in the water, but allows a ping-to-ping comparison.

3.3 Data Analysis

Data analysis was conducted in two stages. During the first stage the analyst, Olivier Beslin, identified and selected each ping for measurement using the STAR ETI Analysis application. During the second stage, Microsoft Excel was used to format and plot the ASCII log produced by STAR, and generate plots of the data.

All plots generated during the second stage of analysis are provided in Annex A. This section presents a short summary of the results.

Figure of Annex A presents the geographic pattern followed by the receiver, RV2, during the subject trial runs. This pattern can be divided into six legs:

- Leg 1: Constant angle at 180 degrees (Series "Constant@180Deg")

- Leg 2: Changing from 180 to 90 degrees (Series "ChangingFrom180To90Deg")

- Leg 3: Constant angle at 90 degrees (Series "Constant@90Deg")

- Leg 4: Constant angle at 0 degrees (No data available for this leg)

- Leg 5: Changing from 331 to 275 degrees (Series "ChangingFrom331To275Deg")

- Leg 6: Constant angle at 275 degrees (Series "Constant@275Deg")

RV3 was stationed at the center of the pattern.

Unfortunately, we were unable to find data to analyse received levels for leg 4. Data was missing between 05 June 98 19:56 and 06 June 98 04:04. This data was found on Digital Linear Tapes (DLT) provided by the SA, but the sample rate and number of channels was different than the other supplied data, making it suspect. The SA agreed that this data should not be processed as part of the contract and initiated an action to re-transcribe data for that portion of the trial.

Figure presents the RV3 bearing relative to RV2 versus time for the HFM pulses and "1250-1300 Hz". The same figure was obtained for "750-850 Hz". Data was plotted using five series corresponding to legs 1 to 3 and 5 to 6. (No data available for leg 4.) As expected, it can be seen that both pulses yield the same bearings.

Figure A-3 presents the RV2 to RV3 range versus time. As with the bearing plots, the two pulses provide the same range measurement. It can be seen that the range over time is consistent with the butterfly pattern presented in Figure.

Figure A-4 and Figure A-5 present the received level versus range, for the five previously defined legs. Both plots show the same trends, which is logical, as the pulse frequency bands are similar and both pulses were transmitted simultaneously. Significant variations (10 dB) can be observed for successive points, thus no clear spreading loss law can be derived from these plots. Moreover, the variation of the measured ranges is too small (20 km to 55 km) to show a significant variation in the spreading loss within a 10 dB precision. However, a noticeable peak was observed during leg 3 at a range of ~40 km. This peak is significant as the received level increases and decreases around it consistently versus time and range. No environmental data was available to the analyst, but this peak may signify a significant difference in propagation conditions on this leg due to a change in the water mass or due to some other cause such as a diurnal effect.

Figure A-6 and Figure A-7 present the received level versus time for the five legs. These plots provide information on the ping-to-ping variation. Some of this measurement may be due to

spatial scalloping loss as no effort was made to interpolate between beams during measurement. Instead the beam with the maximum signal level was used for measurement.

4.   Display Synchronization

An investigation was conducted to determine the feasibility of opening an ETI and power spectra analysis window simultaneously, but with different file sources. These displays would then remain synchronized as the analyst navigates through the data providing the useful LOFARGRAM visualization and the corresponding ETI data necessary for quantitative signal energy level analysis. This section provides the requirements and a possible solution for the requirement.

4.1.1 Requirements information

The following requirements were requested under the call-up's Statement of Work (SOW):

- The contractor shall investigate the feasibility of opening an ETI and power spectra analysis window simultaneously, but with different file sources. Data navigation would slave the windows to use the same requests (other than the source file). An estimate shall be produced.

- If determined feasible, after consultation with the SA, the option shall be implemented under this call-up.

4.1.2 Software Design information

This section describes design modifications and development work required to implement an analysis display with multiple windows. Several components would have to be modified within the code base in order to achieve this type of arrangement. A new initialization script and macro that provides both ETI and power spectra settings would have to be written. The data models would have to be linked using a new synchronization model that would receive callbacks from one data model and issue requests to the other data model. Both analysis windows would have to be initialized with the same set of models (position, context, contact, etc) and separate data models (time series and power spectra). This requires that the model initialization be decoupled from the analysis (ETI and power spectra) windows to allow the application to create one set of models before creating the windows.

Figure 2 shows how the components could be configured to synchronize the two displays. In this example the ETI display is issuing requests. The ETI data model would issue a callback to a synchronization model. The synchronization model would create and issue requests to the power spectra data model.
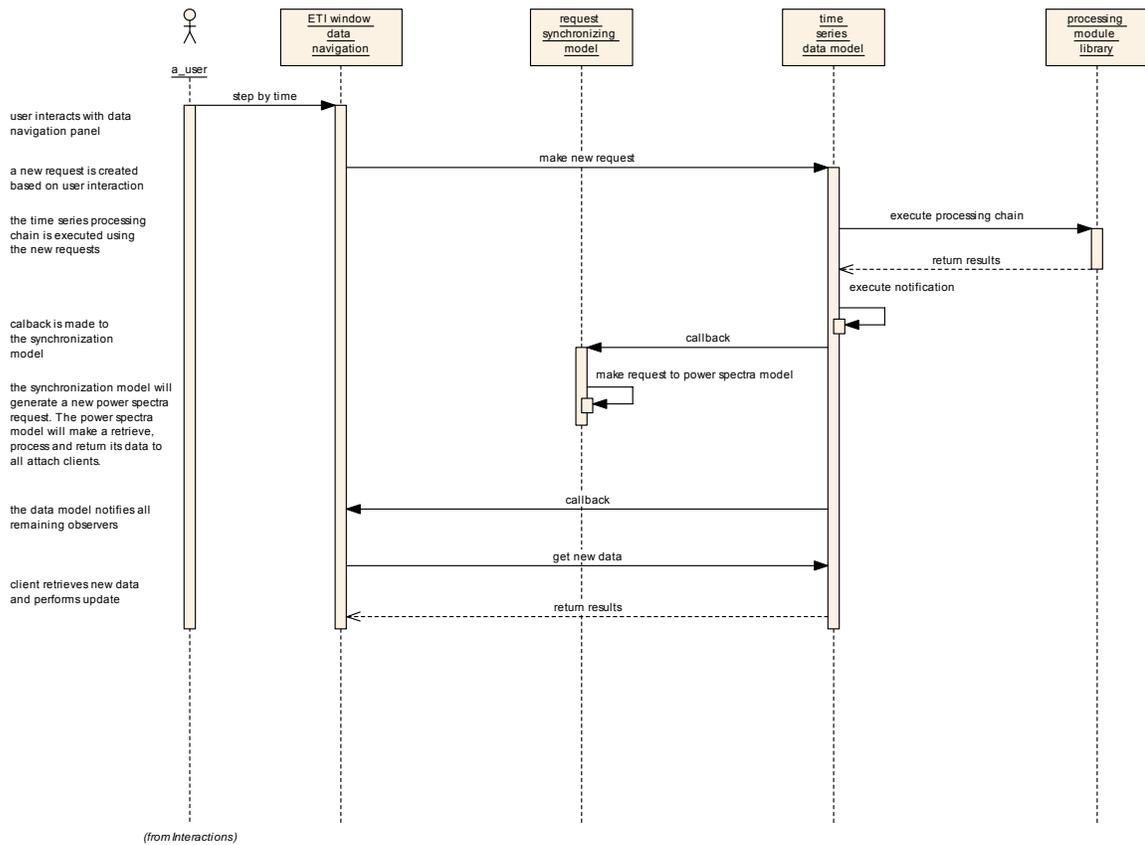
Figure 2. Window Synchronization Sequence Diagram

4.1.3 Estimate

Most of the components required for the proposed approach can be reused from previous projects. The higher-level controlling components, as describe earlier, need to be re-written to allow the displays to synchronize correctly. They include:

- User script – handles custom settings (blend of ETI and power spectra user scripts).

- ETI window – creates an ETI plot canvas and manages ETI window events.

- Power spectra window – creates a power spectra canvas and manages power spectra window events.

- Model initialization module – creates the models that are required as input for ETI and power spectra window initialization.

- Initialization module – will initialize the model initialization module and the window modules.

- Synchronization model – issues second synchronization request to data models.

In addition some system level testing is required to ensure that the application operates correctly. In total this approach will require approximately 40 hours to implement.

5. Maintain Configuration Management

STAR and SPPACS are maintained using the Concurrent Versioning System (CVS). The most recent release version is maintained and bug fixes are applied to that version, as required, ensuring that a stable release is always available. Simultaneously, software enhancements are applied to the development version and bug fixes are merged with this version. Once a call-up nears completion, or a release of the software is otherwise required, a new release version is branched off of the development stream for final integration, release testing and delivery.

The Environmental Acoustic Data Acquisition (EADAQ) system and the Noise Monitoring Software are maintained in a similar manner using the RAZOR configuration management tool.

STAR (includes SPPACS) release 4.4.0 (tag star_release_4_4_0) was created under this contract to serve as a baseline while the analysis work was being conducted. This allows development to continue on the trunk of the distribution. The trunk usually contains newly implemented software, which may not be stable enough to allow for operational use.

6. Track Software Issues

Defect Tracking Systems allow users to keep track of outstanding bugs in their product effectively. STAR and SPPACS issue tracking is performed using a web accessible tool called Bugzilla. This tool can be accessed using a secure web interface at https://star.iotek.ns.ca. Once the appropriate security procedures, detailed on the web page, have been followed, users and developers can use this site to add, view or modify issues related to the software packages. If required, the EADAQ and Noise Monitoring Software packages can also be added to the site.

A breakdown of the current issues for the STAR and SPPACS distributions are shown in Table 2. The total number of unresolved issues is shown in the NEW/ASSIGNED/ REOPENED column. The total number of opened issues is broken into two classes of severity. Issues classified as BLOCKER/CRITICAL/MAJOR are issues that should be addressed in the short term. Blockers are always addressed immediately to ensure that the user community can continue with their work. Issues classified as NORMAL/ MINOR/TRIVIAL are issues that can be dealt with in the long term.

Table 2. Distribution Issue Summary (24/08/2004)

PRODUCT	NEW/ASSIGNED/ REOPENED (TOTAL)	BLOCKER/CRITICAL/ MAJOR	NORMAL/MINOR/ TRIVIAL
SPPACS	28	1	27
STAR	44	3	41

The following gives a more detailed description of the SPPACS BLOCKER/ CRITICAL/MAJOR column:

- Issue # 284 (major) **fails DAT32 byteswap case.** The utility is attempting to read the extra gains using the original header, which may be in a different byte-order than the platform.

The following list gives a more detailed description of the STAR BLOCKER/ CRITICAL/MAJOR column:

- Issue # 193 (critical) **tacplot does not cleanup before exiting**. The work around for this issue is to run heap_gc after the analysis window has closed.

- Issue # 107 (major) **problems capturing close button**. A solution exists for this but has only been incorporated into the tactical plot.

- Issue # 295 (major) **capture screen doesn't work correctly.** The Capture Screen button does a screen capture on the analysis window and not the tactical plot.

7.   References

1. Final Report for the Data Processing and Analysis Support to Measure Active Signal Levels, DRDC Report, March 2004

2. Support to Multistatic FM Data Processing – The SPPACS / STAR Data Analysis Process and Toolset

Annex A: Received Level Plots
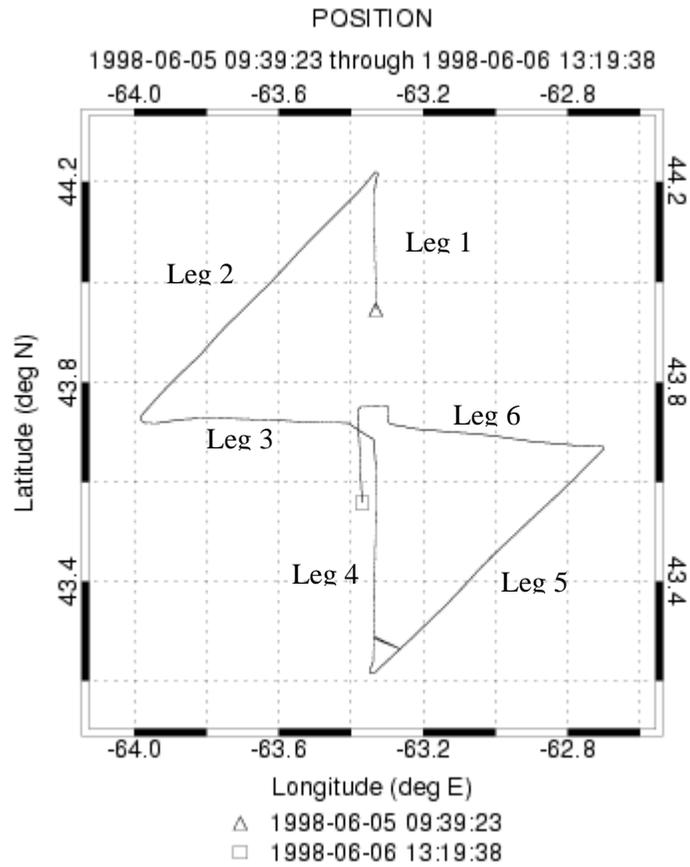
Figure A-1. *Legs Definitions*

Bearing vs Time
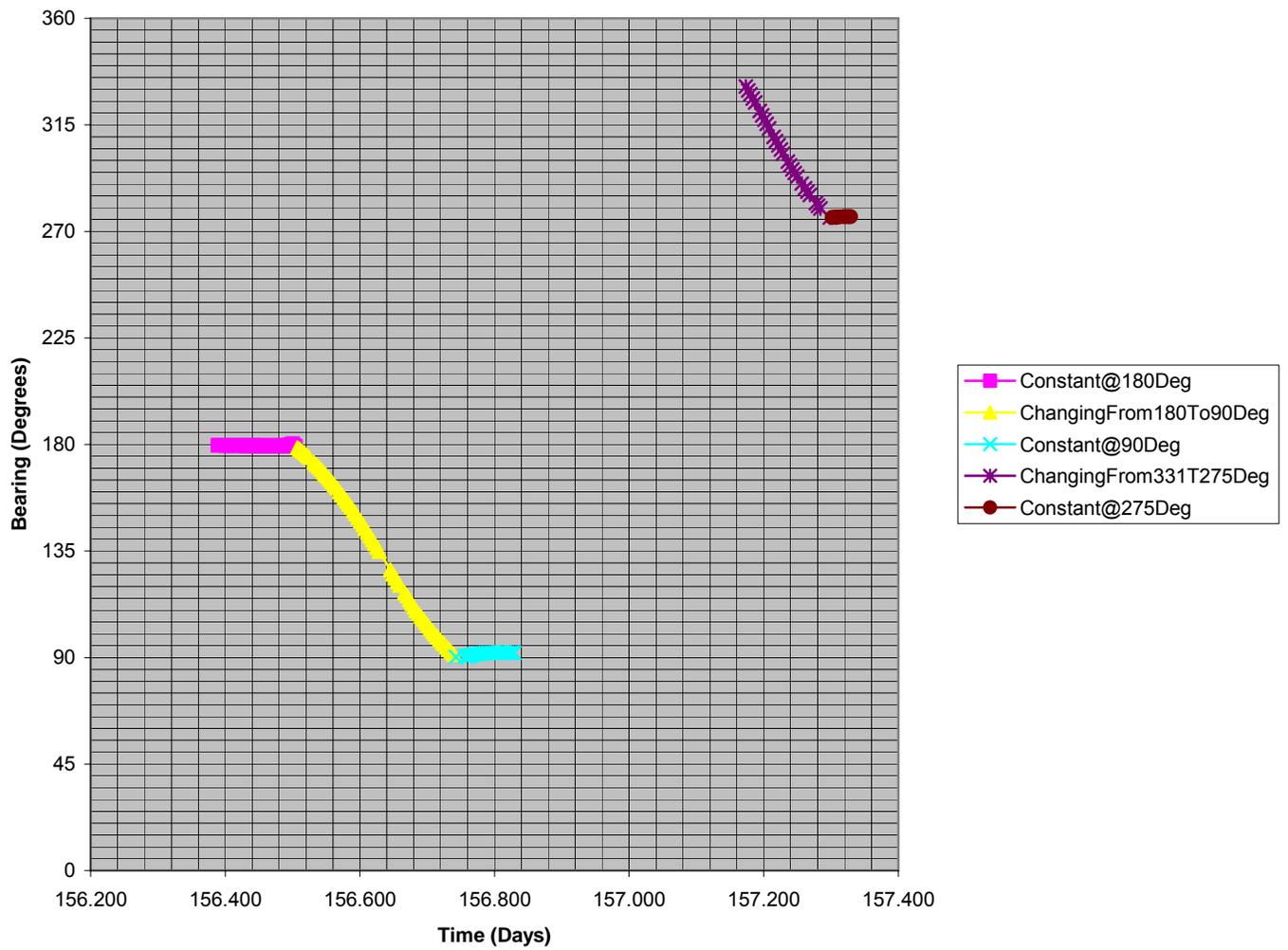
Figure A-2. Bearing from RV2 to RV3 versus Time

Range vs. Time
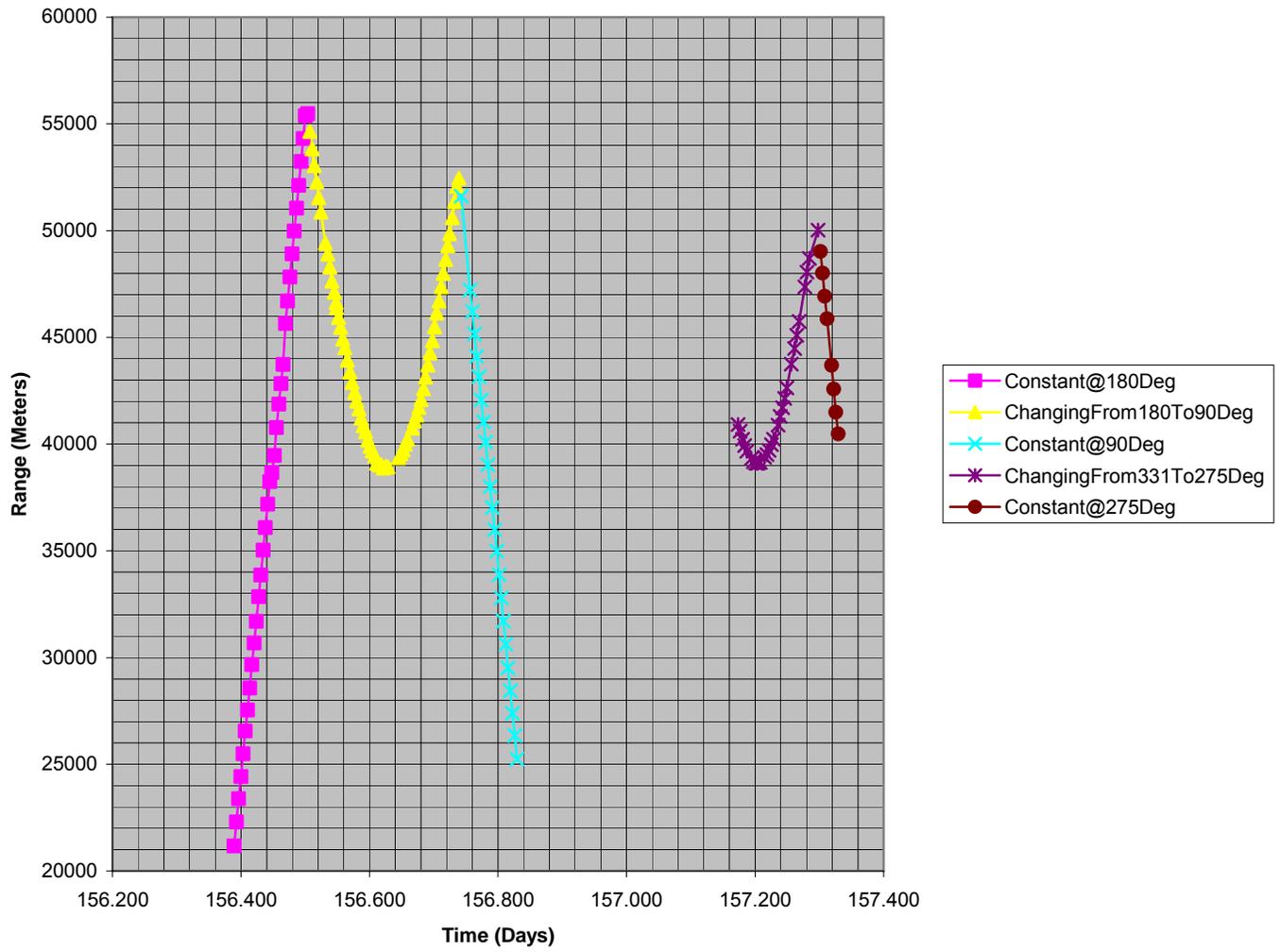
Figure A-3. *Range versus Time*

Level vs. Range (HFM 750-850)
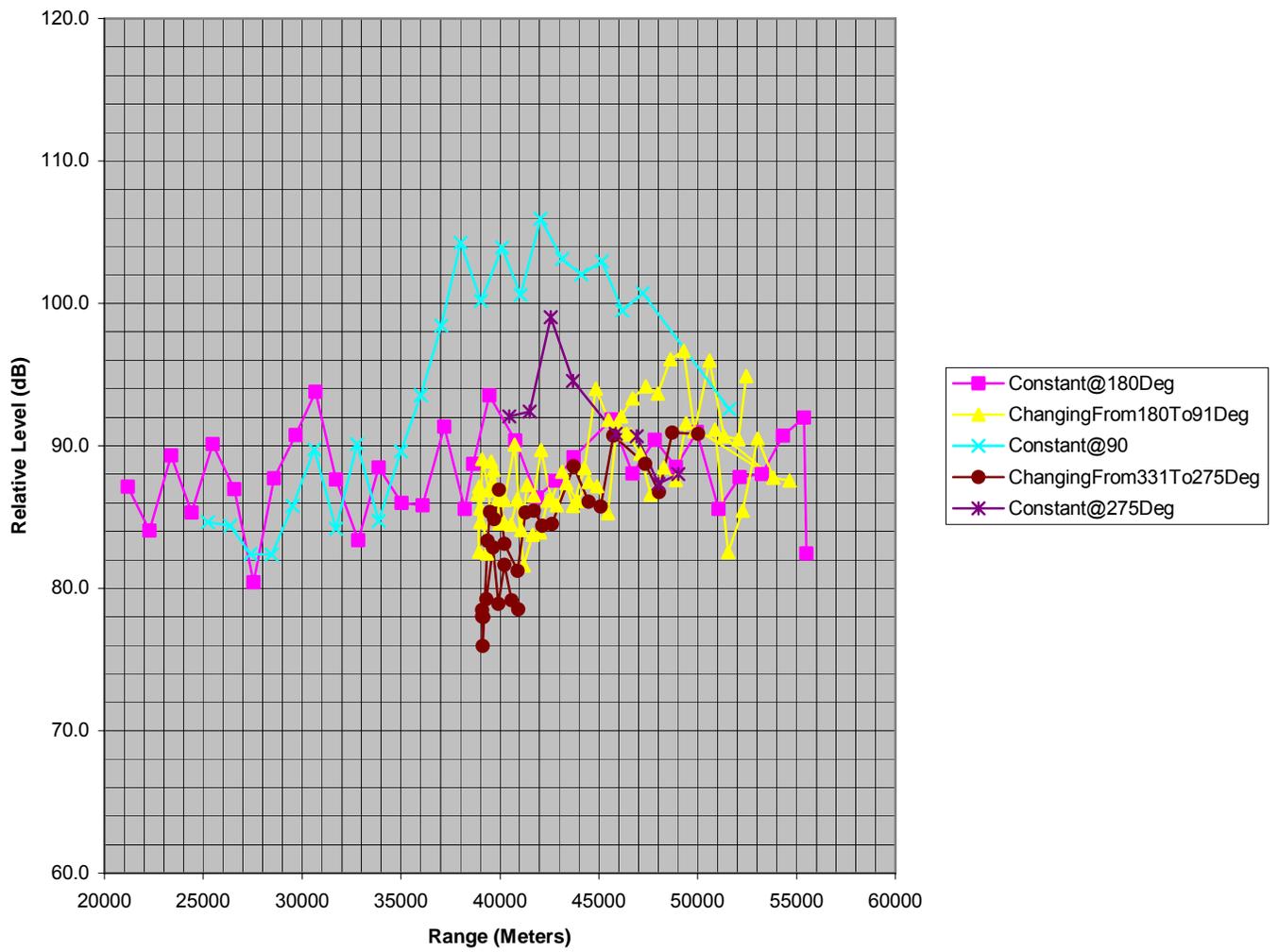
Figure A-4. *Level versus Range (HFM 750-850)*

Level vs. Range (HFM 1250-1300)
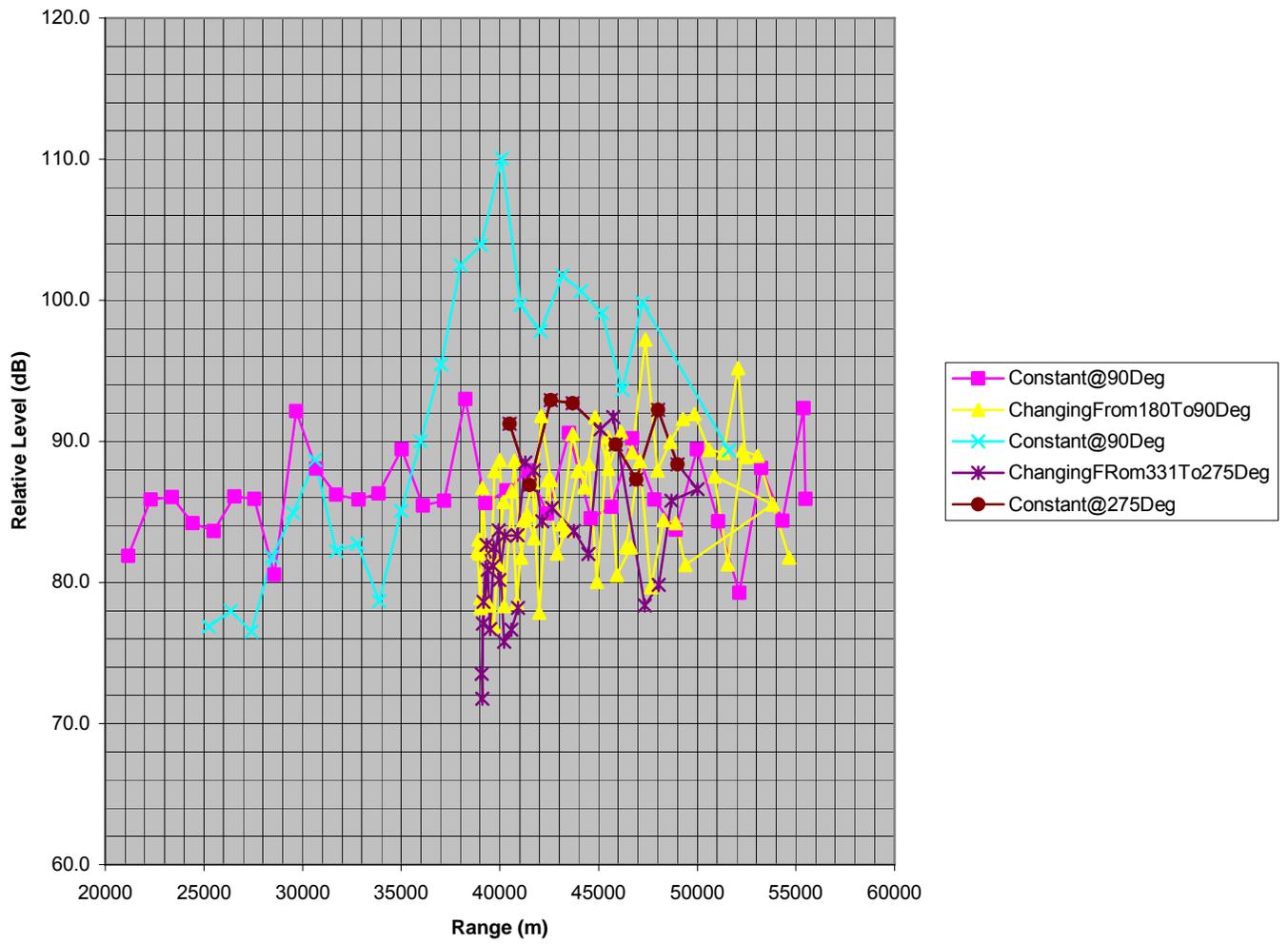
Figure A-5. Level versus Range (HFM 1250-1300)

Level vs. Time (750-850)
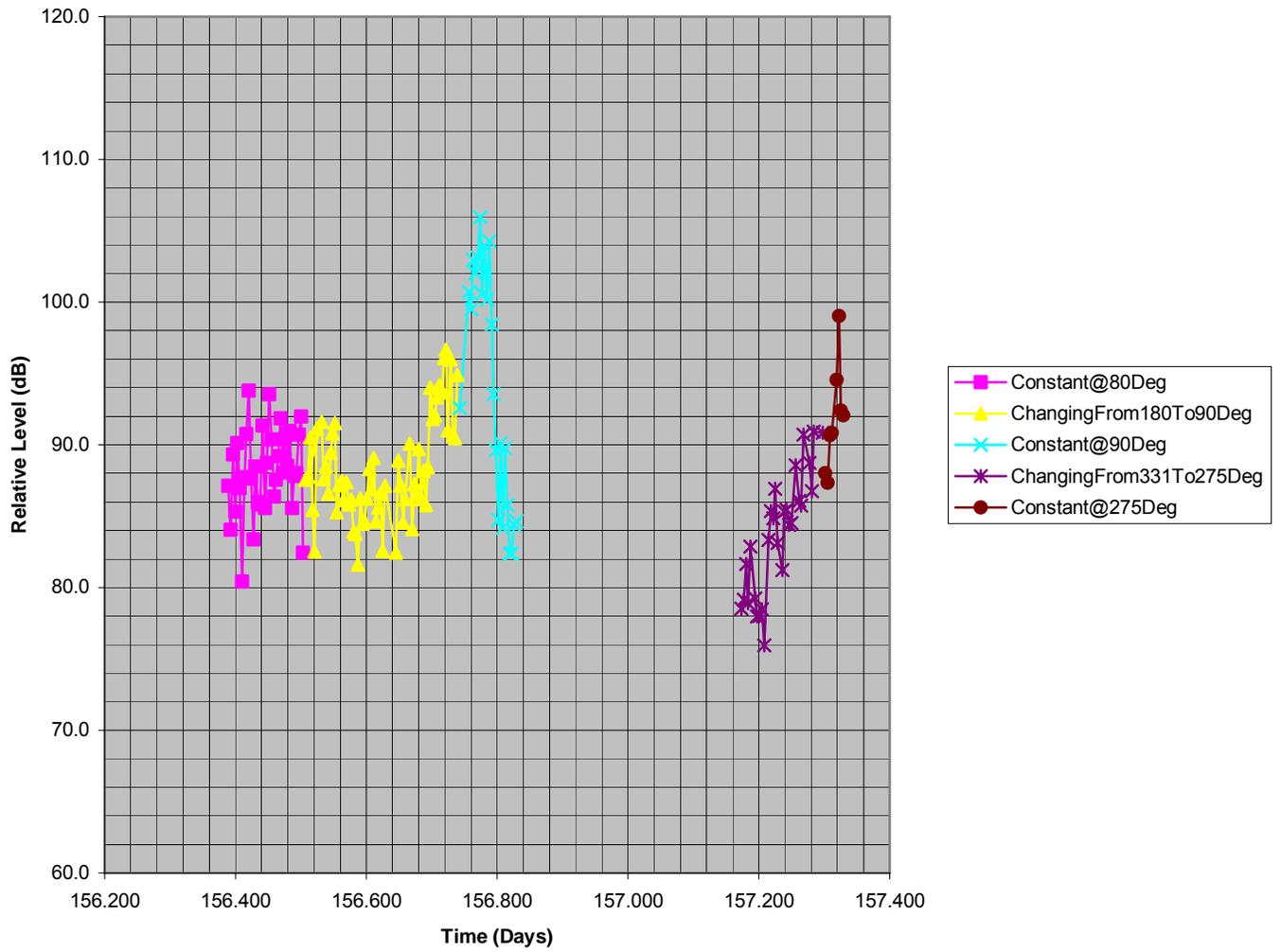
Figure A-6. Level versus Time (HFM 750-850)

Level Vs. Time (HFM 1250-1300)
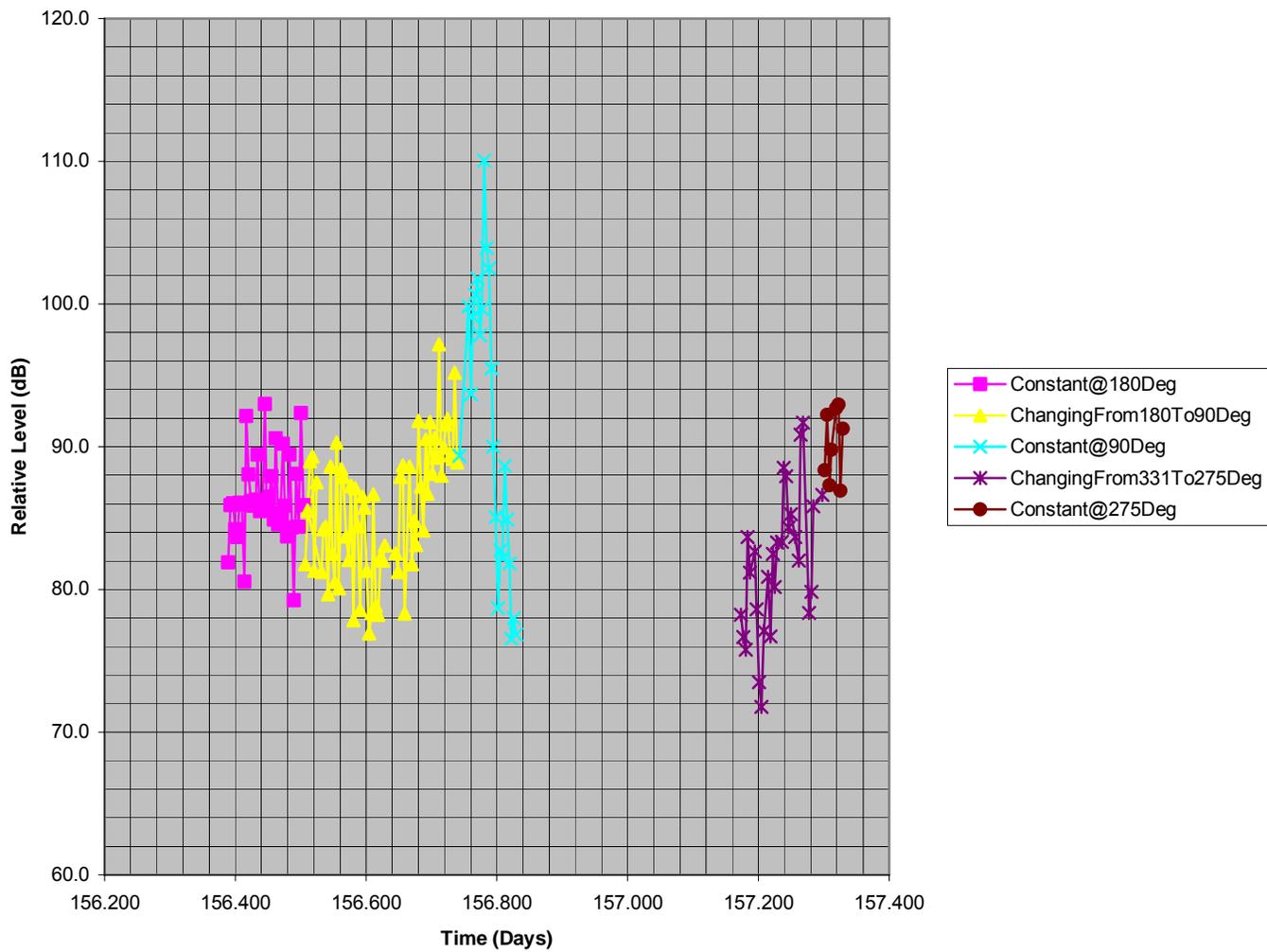
Figure A-7. Level versus Time (HFM 1250-1300)

List of symbols/abbreviations/acronyms/initialisms

ASCII	American Standard Code for Information Interchange
CVS	Concurrent Versioning System
DFT	Discrete Fourier Transform
DLT	Digital Linear Tape
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DREA	Defence Research Establishment Atlantic
DRP	Document Review Panel
EADAQ	Environmental Acoustic Data Acquisition
ETI	Energy Time Indicator
FFTW	Fastest Fourier Transform in the West
FM	Frequency Modulated
HFM	Hyperbolic Frequency Modulated
IDL	Interactive Data Language
IMPACT	Integrated Multistatic Passive/Active Concept Testbed
NAD	Non-Acoustic Data
PC	Personal Computer
RISO	Regional Individual Standing Offer
SA	Scientific Authority
SONLIB	Sonar Library
SPLIB	Signal Processing library
SPPACS	Signal Processing Package
STAR	Software Tools for Analysis and Research
TL	Transmission Loss

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This report documents the work done to aid in the analysis of Transmission Loss (TL) data collected during QUEST Trial Q246. During this call-up, Frequency Modulated (FM) pulses received by the Endeavour were measured and the signal processing gain recorded for two environmental runs. The calibrated TL results require further adjustment for the source level and receiver sensitivity. The analysis work done under this call-up reused processes developed during the "Data Processing and Analysis Support to Measure Active Signal Levels" call-up (Integrated Passive/Active Concept Testbed [IMPACT] Standing Offer No. W7707-021973/001/HAL, Requisition No. W7707-03-2304). There, FM pulse receive levels, as seen at the target, were measured from Q246 data. This work included providing small enhancements to the existing Interactive Data Language (IDL)-based Software Tools for Analysis and Research (STAR) software, based on recommendations generated during previous call-ups. These tasks involved the generation or enhancement of reusable software components, allowing future work to be performed more efficiently. The STAR suite was then used to perform data analysis including test and measurement tasks.

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