Final Report

HARD X-RAY IMAGING GRAPHICS DEVELOPMENT AND LITERATURE SEARCH

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INTRODUCTION

From June 1990 through June 1991, work was performed under the NASA contract NAS8-36955. During this time the three objectives of the contract were completed.

1.) A comprehensive literature search of imaging technology and coded aperture imaging as well as relevant topics relating to solar flares.

2.) An analysis of random number generators.

3.) Programming simulation models of hard x-ray telescopes.

All programs are compatible with NASA/MSFC Space Science Laboratory VAX Cluster and are written in VAX FORTRAN and VAX IDL (Interactive Data Language).

LITERATURE SEARCH

A literature search was conducted using the Redstone Scientific Information Center. All relevant materials were collected and indexed according to topic and chronology. These materials were used to support the research of x-ray telescopes as well as hard x-ray emissions from solar flares. (See Appendix A for a list of all reference materials.)

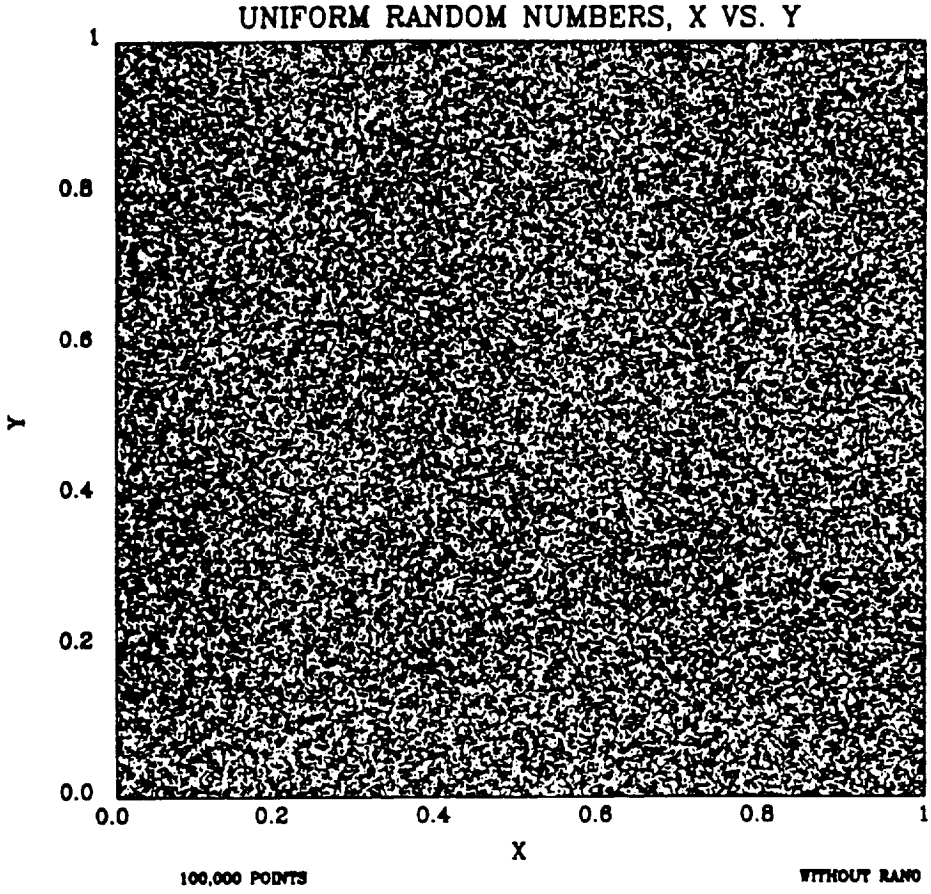
RANDOM NUMBER GENERATORS

In order to simulate an x-ray telescope, random photons must be generated. It was necessary to insure that the random number generator used in the simulations was indeed random. Since the programs were to be written in FORTRAN, the reliability of FORTRAN's random number generator was investigated.

Two types of programs were created for this task: one using a uniform distribution and the other using a gaussian distribution. IDL programs were then created to display the information. The resulting graphs were then checked for any recognizable patterns.

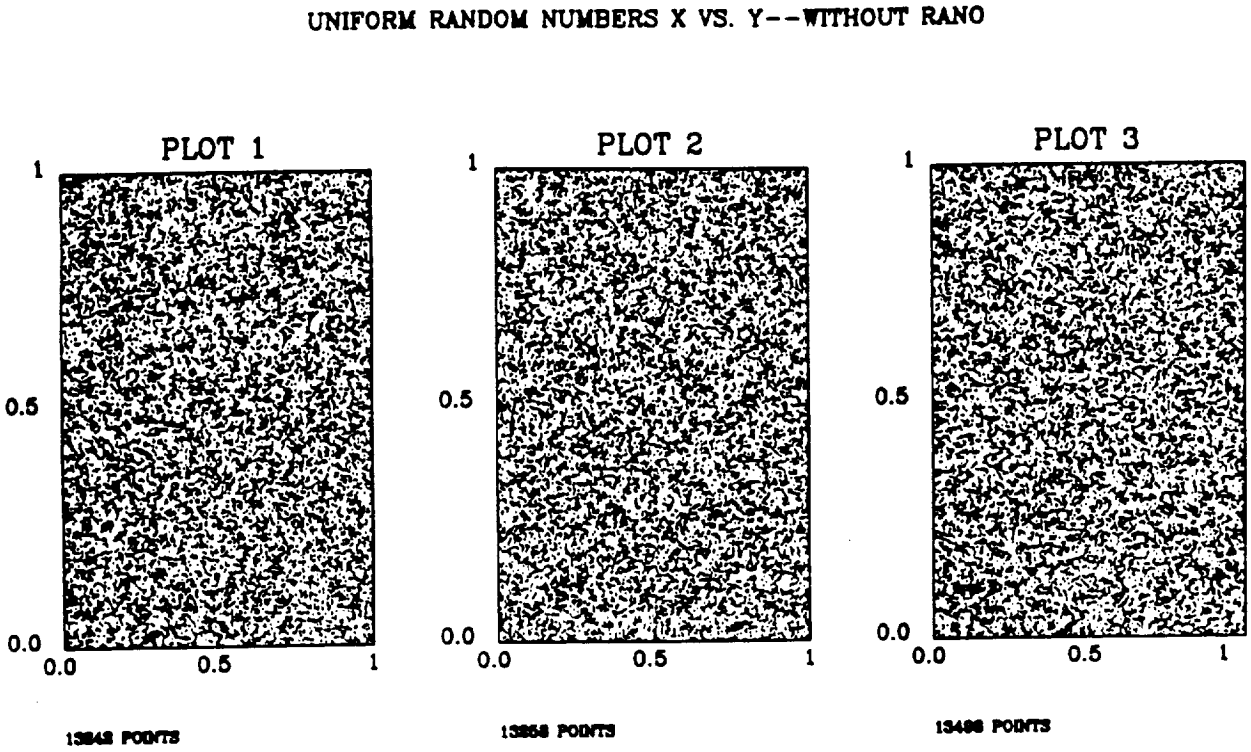
FORTRAN's procedure for generating random numbers, RAN, will generate numbers between 0 and 1. The program WORAN.FOR calls upon RAN to select a random number. It then sequentially assigns the number to either an x or y coordinate. Lastly the program writes these numbers to a data file. The IDL program WORVECTOR.PRO reads this data file and proceeds to plot the x coordinates versus the y coordinates (Figure 1). It was deduced that there were no patterns present.

Figure 1



Another check on the uniform distribution required that a random grid be chosen and from there random x and y coordinates determined. This process would establish the effectiveness of RAN when a few random numbers are required. Using a process similar to the one used in WORAN.FOR, the program TRIWORAN.FOR was created. The IDL program TRIPLOT.PRO was then used to display the information (Figure 2). Again, no patterns were observed.

Figure 2



To create a gaussian distribution, RAN was used to generate random numbers with an average of zero and a standard deviation of one. This was accomplish in the program GARAN.FOR. Two IDL program were written to display the information. GAUSS.PRO generates a histogram plot of the data points and compares it to the predicted value (Figure 3). GAUSSIAN.PRO generates a scatter plot of the data points and again compares them to the predicted gaussian curve (Figure 4). By looking at the gaussian scatter plot, no patterns can be seen.

In all cases, no patterns can be seen. From this it was determined that FORTRAN's random number generator would be adequate for generating random photons for the x-ray telescope simulations. Initially it was thought that an additional subroutine, RAN0, would have to be added to all programs to increase the reliability of the random number generator. Each of the tests mentioned above were performed with and without RAN0. It was determined that RAN0 did not significantly improve the random number generator and was therefore dismissed.

Figure 3

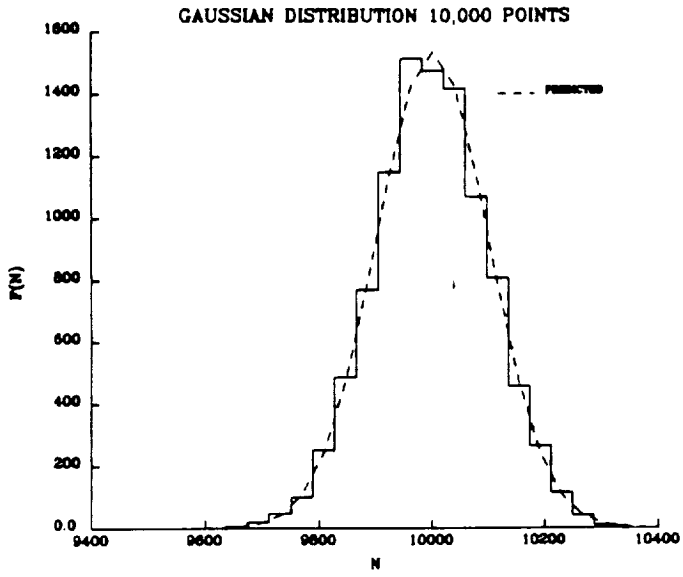
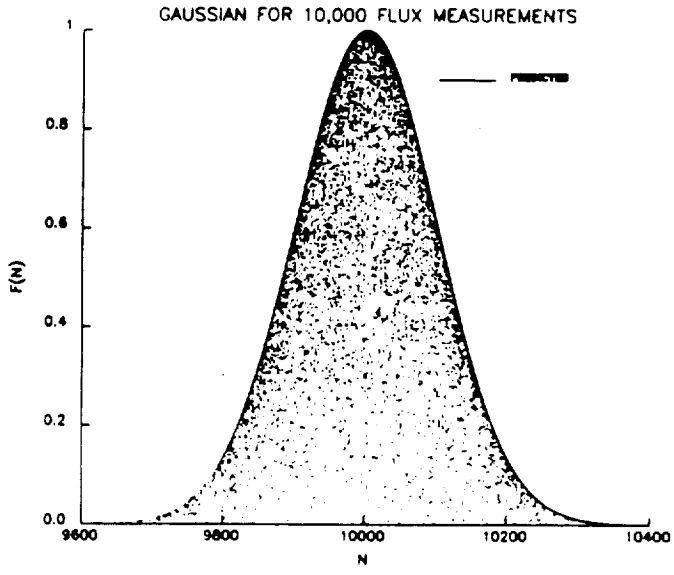


Figure 4



APPENDIX A

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