Contract NAS2-14042
MCR-94-1322

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**FINAL REPORT**

January 1997

# Miniature Comet Ice and Dust Experiment (Mini-CIDEX)

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LOCKHEED MARTIN

MCR-94-1322

# FINAL REPORT

**for the**

# MINIATURE COMET ICE AND DUST EXPERIMENT (Mini-CIDEX)

JANUARY 1997

PIDDP CONTRACT NO: NAS2-14042

Submitted to NASA

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Moffett Field, CA 94035-1000

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# FINAL REPORT FOR THE MINI-CIDEX PIDDP

## INTRODUCTION

This document reports the extent of the progress attained by Lockheed Martin Astronautics (LMA) in the development of equipment designed for the miniature Comet Ice and Dust EXperiment (mini-CIDEX) on NASA contract No. NAS2-14042 from the Ames Research Center (ARC).

This report is in two parts. The first part summarizes progress in chronological order. The contents of the first part have been extracted from the monthly reports submitted by LMA to ARC over the duration of the program. The second part is a summary of the designs that were extracted from the mini-CIDEX contract designs and implemented into mission studies performed under different funding but in parallel to the mini-CIDEX contract time period. These second part activities were not performed under contract No. NAS2-14042; however, they are included in this report to show how it was intended that the mini-CIDEX be used on actual mission spacecraft.

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# FINAL REPORT FOR THE MINI-CIDEX PIDDP

## PART 1 - CHRONOLOGICAL FLOW OF THE MINI-CIDEX DEVELOPMENT

### 3/94 PROGRESS IN MARCH 1994

This is the initial monthly progress report for the mini-CIDEX instrument Development program. After negotiations were competed, the mini-CIDEX Contract was initiated on march 9, 1994 and initial activities at Martin Marietta were expended in setting up the program. Program startup Paperwork was completed by contracts personnel. Cost management personnel reworked the spend plan to accommodate the schedule and availability of funding as it was understood after negotiations.

The program manager, spent time in re-spreading the Program's hours to:

1. Move concept definition hours earlier into may 1994 so that this early Design effort can be used in support of upcoming discovery mission Proposal efforts; and

2. Move some fabrication and assembly hours out past February 1995 to keep our spending level within the cap discussed during Negotiations.

### 4/94 PROGRESS IN APRIL 1994

The program manager spent the last weeks of April and the first weeks of May on vacation. Consequently there is not much progress to report for April.

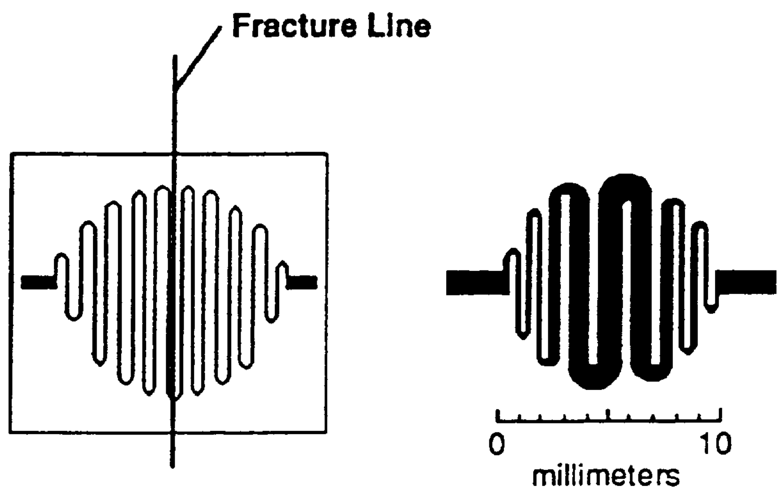
The heater test samples made for the original CIDEX contract were located and brought to the mini-CIDEX Program. Activities were initiated to locate and gather the equipment used to test the GC heater.

### 5/94 PROGRESS IN MAY 1994

Telecons were carried out in May between ARC and MMC to discuss revisions to the program plan. As a result. the Mini-CIDEX Program plan was reworked to bring design concept studies forward. The purpose of reordering the planned activities was to give us the opportunity to investigate how the mini-CIDEX might look and how it might interface with possible comet rendezvous spacecraft such as the one being studied for the Comet Coma Chemical Composition (C4) mission (a candidate Discovery mission) or the Rosetta mission spacecraft.

1. GC System Progress

Before the original CIDEX contract was canceled, we had tested a uniform platinum heater pattern on alumina. The round pattern was composed of uniform thickness strips of platinum and was sputtered onto a rectangular piece of alumina (see diagram below). That heater reached 700'C and then broke down the middle. During the test. we viewed the heat pattern with a heat sensitive video camera and stored the video on tape as the heater current was raised. A hot bar developed right down the center of the heater and the heater eventually broke in the middle of that hot bar. One of our first tasks to perform in developing the GC heaters for miniCIDEX is to try a heater pattern that is graduated so as to promote a more uniform heating of the alumina substrate. So we have started development of a heater with the graduated pattern shown below. Artwork was started in our Micro-Electronics Laboratory (MEL) for that heater




**Uniform Pattern** **Graduated Pattern**

## 6/94 PROGRESS IN JUNE 1994

An informal telephone discussion was carried out in June between ARC and MMC to relate progress in the development of the GC heater/sample collection substrate.

1. GC System Progress

A negative of the graduated heater pattern discussed in last month's report has been laid down in copper on alumina. Further work will be performed on it in July.

An alternate method of providing the heater for the GC sample is being considered. It appears attractive to try using resistance temperature detectors (RTD's) made of platinum, tungsten, or other metal as heater/temperature sensors. Some of these devices are used to measure very high temperatures (>700°C for platinum and >1 200°C for tungsten) and should be able to survive as heaters to those temperatures. Several RTD vendors were contacted in June and some of their literature has been received. A couple of them would accommodate making low resistance versions of their sensors that could be used as heaters.

2. SCAT Assembly Progress

The SCAT concept layouts were just begun at the end of June. The main theme of the concept is that all sample collection surfaces will be distributed about the edge of a 30 cm diameter disc rather than treated as individually handled planchets in the original CIDEX fashion.

## 7/94 PROGRESS IN JULY 1994

1. GC System Progress

Four identical heater patterns on four different substrates were made using the copper negative process described in last month's report. Platinum was laid down over a negative layer of copper. Then the copper was etched away from under the platinum. That caused the platinum over the copper to come free and left only the positive pattern of platinum on the substrate. Two of the substrates were 25 mil alumina, one was 50 mil alumina, and the last was 25 ml zirconia. These heaters have not yet been tested.

A Resistance Temperature Detector (RTD) sample with a 0°C resistance of 10Ω was obtained from Rosemount Engineering. That device is shown in Figure 1 in the test fixture that was used to operate the sensor as a heater. The fixture served to enclose the sensor to minimize heat loss. The fixture, with the sensor in it, was installed in a vacuum chamber, the chamber was evacuated, and the heater tests were performed there. The sensor was operated at 800°C for several hours. 1.8 Watts were required to maintain temperature under the described conditions. The engineer who obtained the sensor and performed the tests, Ludwig Wolfert, then went on vacation. The tests will be resumed when he gets back in August.

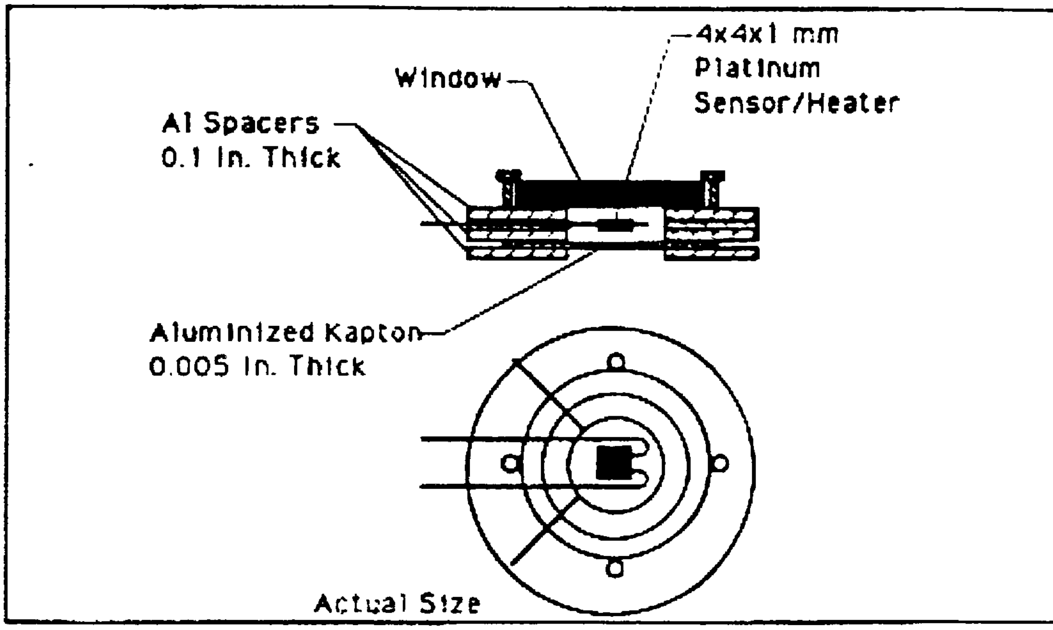



Figure 1 Platinum RTD used as Heater In Test Fixture

These preliminary tests on using an RTD as a heater were very encouraging. Ludwig was able to exceed our 750°C requirement for the GC heater very easily. There are a few caveats, however.

a. The RTD hasn't been tested in a gaseous atmosphere yet. This should not be a problem other than to cause the power needed to maintain temperature to be increased.

b. The RTD is 4x4x1 mm in size and may not be as large as we all would like. Ludwig will investigate obtaining a 6x6x1 mm RTD when he gets back.

c. The RTD surface may not be very efficient in collecting comet dust material. We will be looking into incorporating maze-like, high temperature material (metal gauze's and velour's) traps on the comet side of the RTD

d. We would ultimately like to attain 1000°C or higher at the comet sample. We will push the test temperatures higher after we have obtained our in-gas temperature test data

2. SCAT Assembly Progress

Two SCAT concept layouts are shown in Figures 2 and 3. Each concept shows the SCAT as a simple wheel with sample collection surfaces around the perimeter. Two sets of collection surfaces are shown at the perimeter. The outermost set collects samples for the GC subsystem and incorporates heater/sensor devices at each location. The inner set of surfaces is used to collect samples for the XRF subsystem; and since they may include vicids and organic materials to enhance collection characteristics, they will not be used in the GC

The first concept shows the collection wheel aligned parallel to the front surface of the mini-CIDEX. This concept is quite simple but does use more space for the SCAT mechanisms inside mini-CIDEX than does the second concept which shows the SCAT wheel tilted and with a beveled edge. The tilted sample wheel appears to be more space efficient but is also more complicated. In the interest of minimizing costs, we have chosen the simpler parallel wheel as the primary SCAT design.

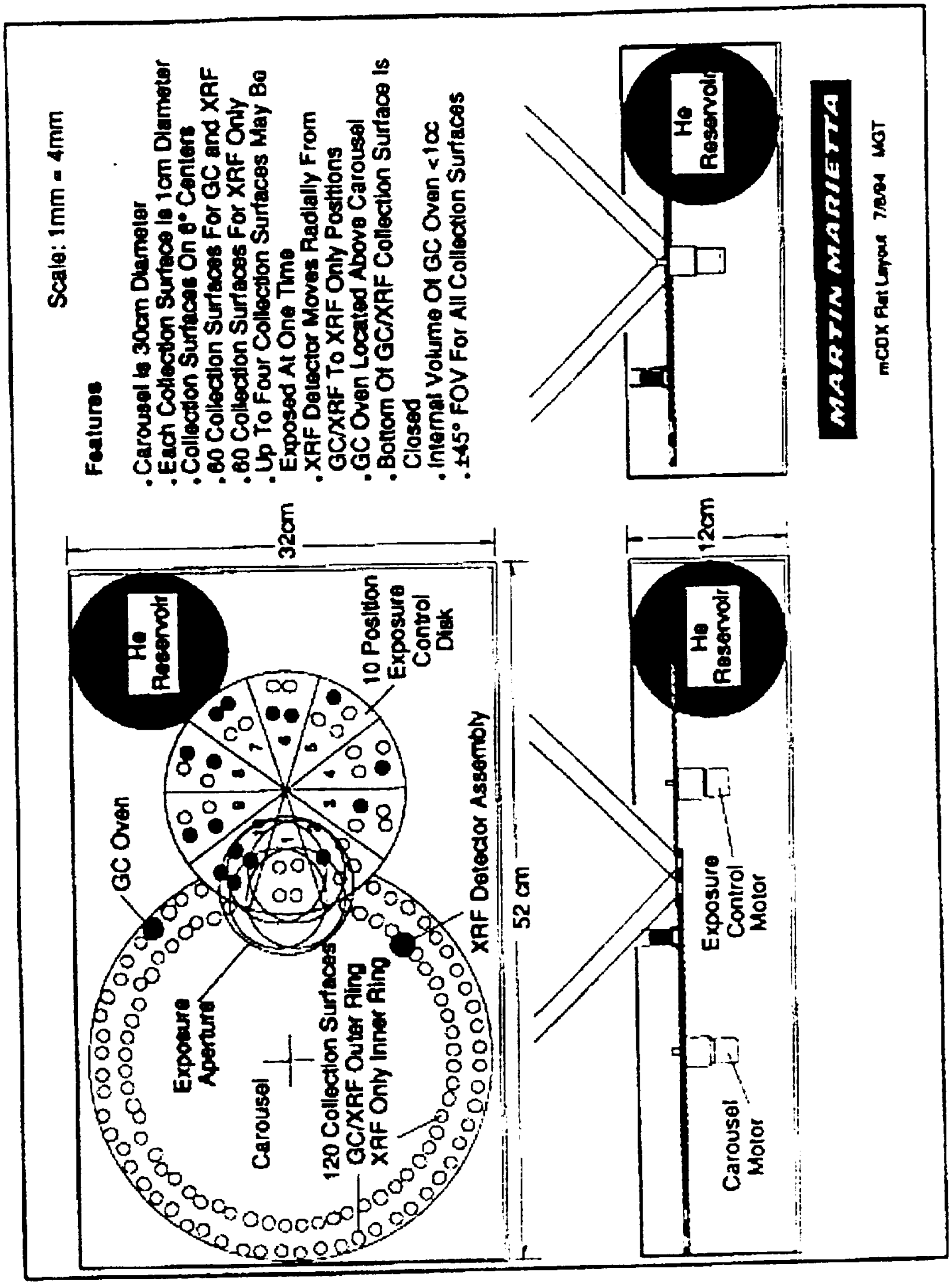



Figure 2 mini-CIDEX Concept using Flat Carrousel

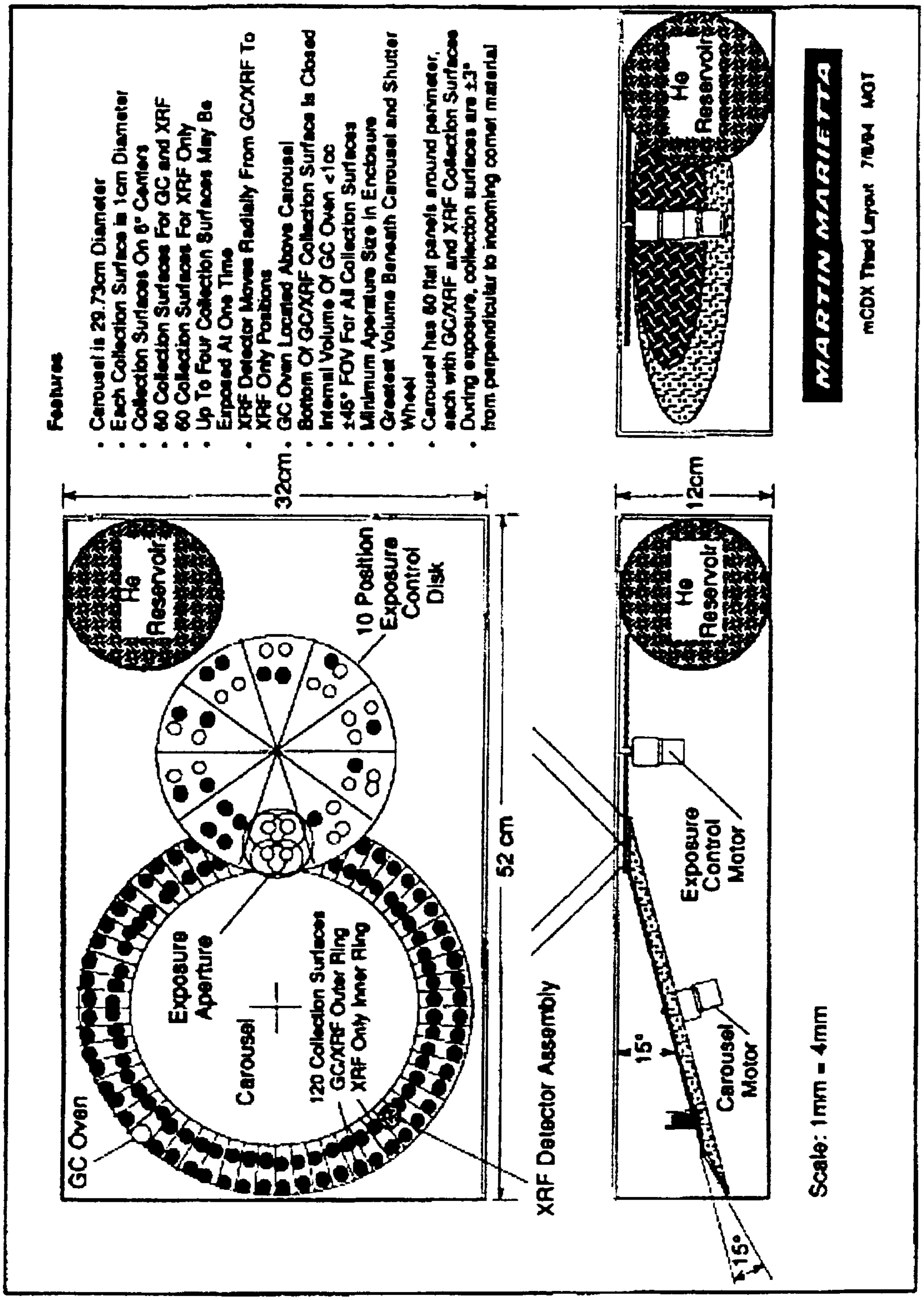
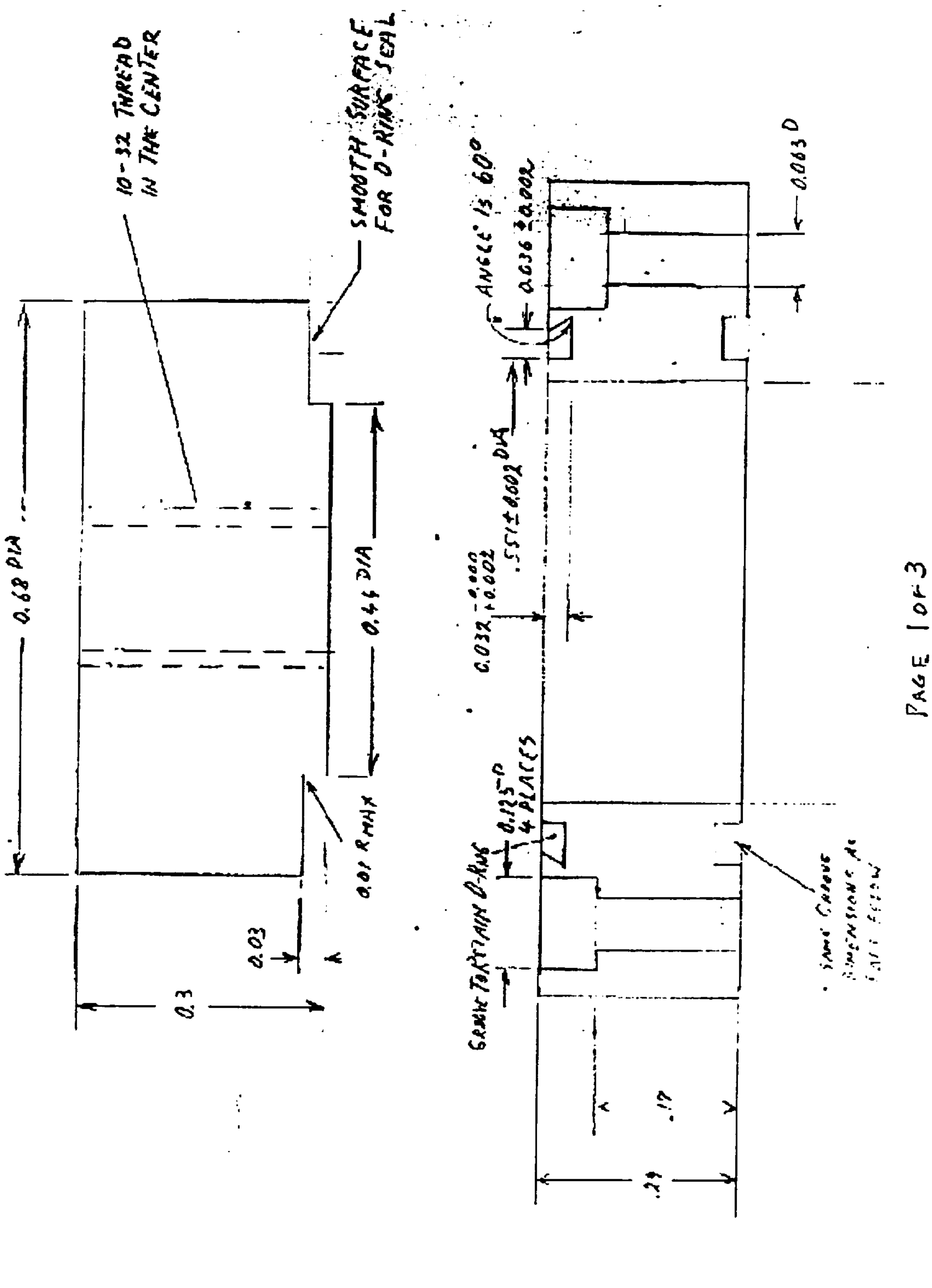


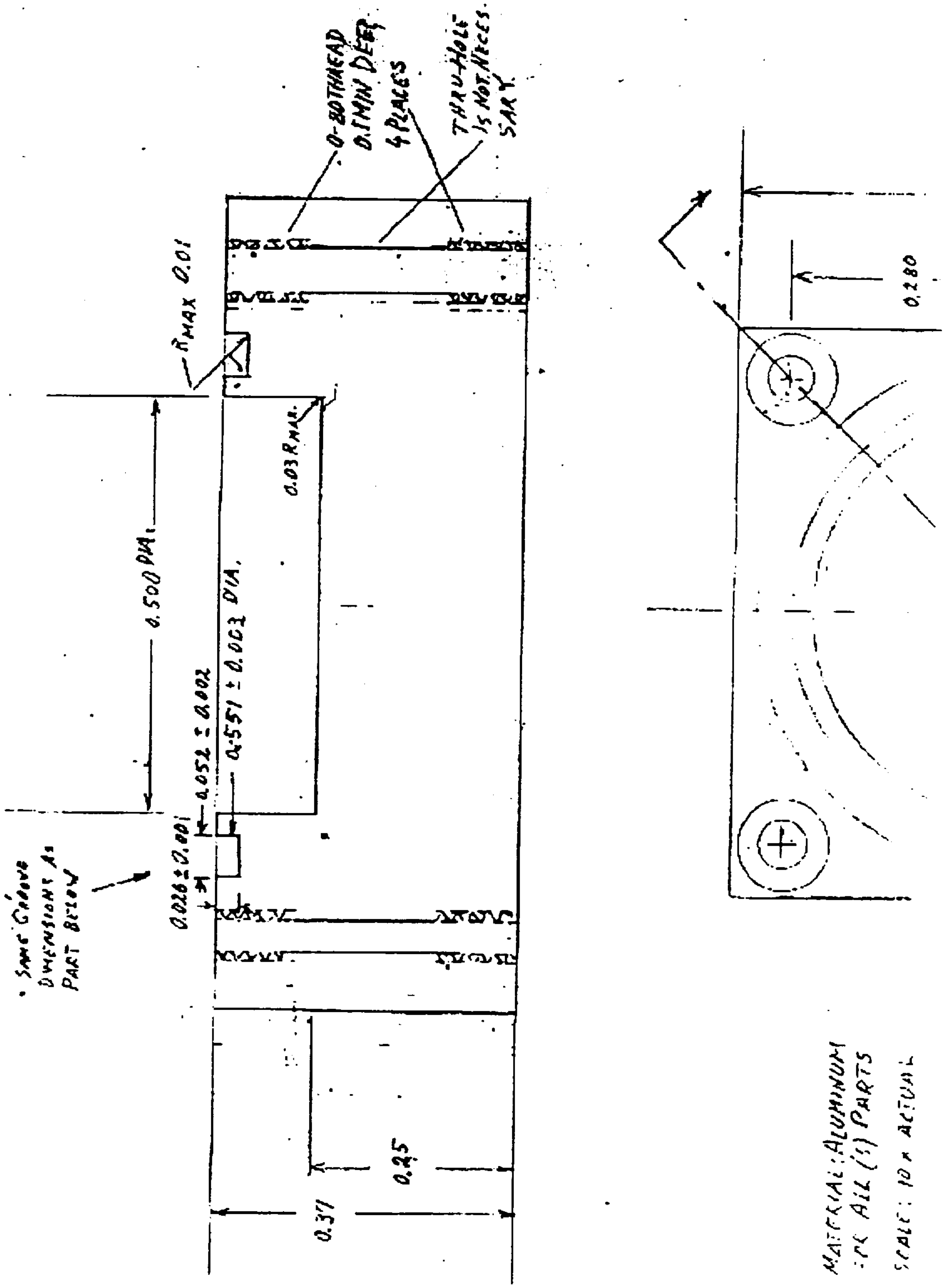

Figure 3 mini-CIDEX Concept using Tilted Carrousel

## 8/94 PROGRESS IN AUGUST 1994

1. GC System Progress

An oven design using a Rosemount RTD as a sensor/heater was sketched up and has been submitted to the model shop for fabrication. This oven concept must accommodate the RTD as the active element and consequently the design is somewhat different from the oven built on the CIDEX CRAF contract.

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SAME GROOVE
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PAGE 2 OF 3
MATERIAL: ALUMINUM
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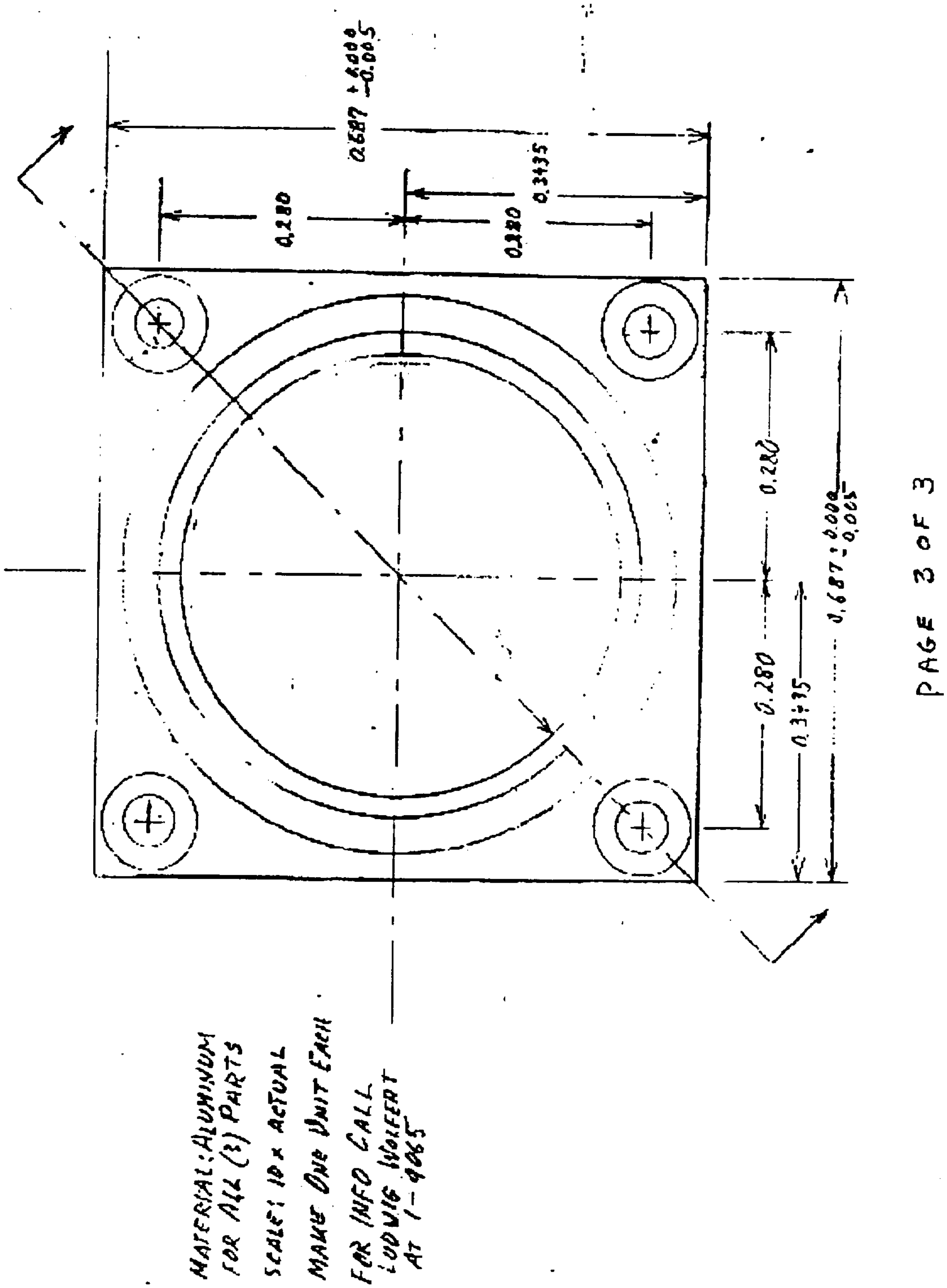
SCALE: 10 x ACTUAL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PAGE 3 OF 3
MATERIAL: ALUMINUM FOR ALL (3) PARTS
SCALE: 10 x ACTUAL
MAKE ONE UNIT EACH
FOR INFO CALL LUDWIG WOLFERT AT 1-4065

## 9/94 PROGRESS IN SEPTEMBER 1994

1. GC System Progress

Tests with the RTD Rosemount model MB 118 showed that the alumina-coated platinum resistor can have a temperature near 800°C when air of atmospheric pressure surrounds the GC heater/sensor.

To capture micron sized particles, special coatings of the heater/sensor are needed. In addition a metallic cover of the ceramic part is desirable to minimize temperature gradients on the GC heater/sensor surface at high gas pressures. Gold plating of the heater/sensor was chosen because this inert metal has good thermal conductivity (2.5W/cmK), its melting point is at 1063°C and 4 to 10 micron thick deposits of gold blacks have provided good (80%) capture rates for 1-8 micron particles over the velocity range of 50-200 m/s (JPL D-8241). Gold is a soft metal and it should be possible to bond mechanical mazes to gold. Our approach to plating the resistor with a gold layer which is approximately 0.01 inch thick is as follows.

a. Clean the resistor.

b. Cover the electrical leads and sputter a 1000 A thick layer of gold on the surface of the ceramic resistor body.

c. Cover the resistor leads with "micro stop" and electroplate with gold.

Initial tests indicate good gold adherence of the gold plated parts up to temperatures of 800~C.

The model of the preliminary oven design using a sensor/heater similar to Rosemount RTD model 118MB was built. A test model of a mechanism to close and seal the GC heater was designed and built. The principle of operation is shown in Figure 1. One thin elastic beam positions the cover for the GC heater above the GC heater's position for sample analysis. The height of the upper elastic beam is controlled by a screw which is turned by a geared stepping motor. To close the GO heater the upper elastic arm pushes against a small steel ball which is attached in the

center of the lid's top. During closing the lid positions itself to achieve a good seal to the 0-ring on top of the GC heater.

1.3 XRF System Progress

No progress to report for the month of September 1994.

1.4 SCAT Assembly Progress

A breadboard of the SCAT with a GC oven and associated oven-sealing-mechanism was built (Figure 2). To achieve better positioning accuracy, upgrades with worm gear drive or geneva drive are under evaluation.