

## ANGLE OF ATTACK SYSTEM

Tom D. Finley  
NASA Langley Research Center  
Hampton, Virginia

This presentation describes the work done toward making measurements of model pitch and roll attitude in the National Transonic Facility (NTF). The effort is divided between two approaches: (1) an inertial measurement that is an extrapolation of existing technology into a cryogenic environment, and (2) an optical technique developed by Boeing Aerospace Company, which is presently under contract to NASA to design, fabricate, and demonstrate a system capable of working in the NTF environment. This presentation describes the approaches, their promise and limitations, and the work done in each area up to the present. It also includes a summary of the status of each approach and plans for further work.

## NTF MODEL ATTITUDE MEASUREMENT REQUIREMENTS

	PITCH	ROLL
RANGE	-13 + 30°	± 180°
ACCURACY	.01°	.03°
RESPONSE	1 sec	1 sec

### BASIC APPROACHES

#### INERTIAL SYSTEMS

OPERATION

ENVIRONMENTAL PACKAGE

MODEL REQUIREMENTS

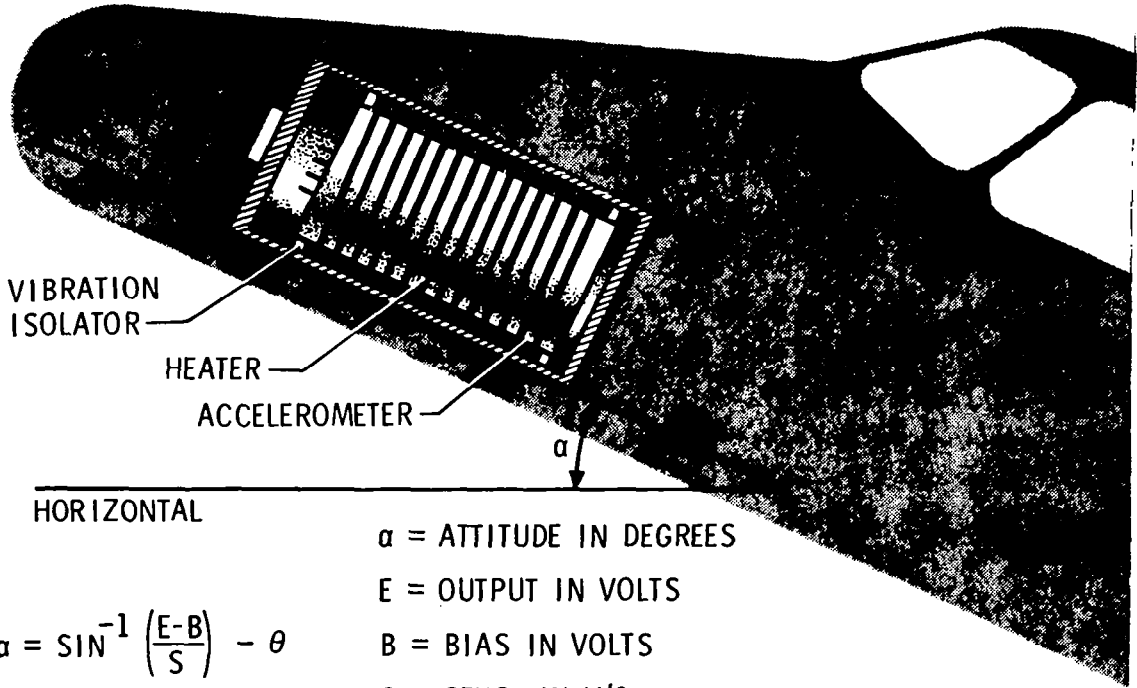
#### OPTICAL SYSTEMS

OPERATION

MODEL REQUIREMENTS

### OTHER CONSIDERATIONS

## MEASURING PITCH ATTITUDE WITH AN ACCELEROMETER



$$\alpha = \sin^{-1} \left( \frac{E-B}{S} \right) - \theta$$

$\alpha$  = ATTITUDE IN DEGREES

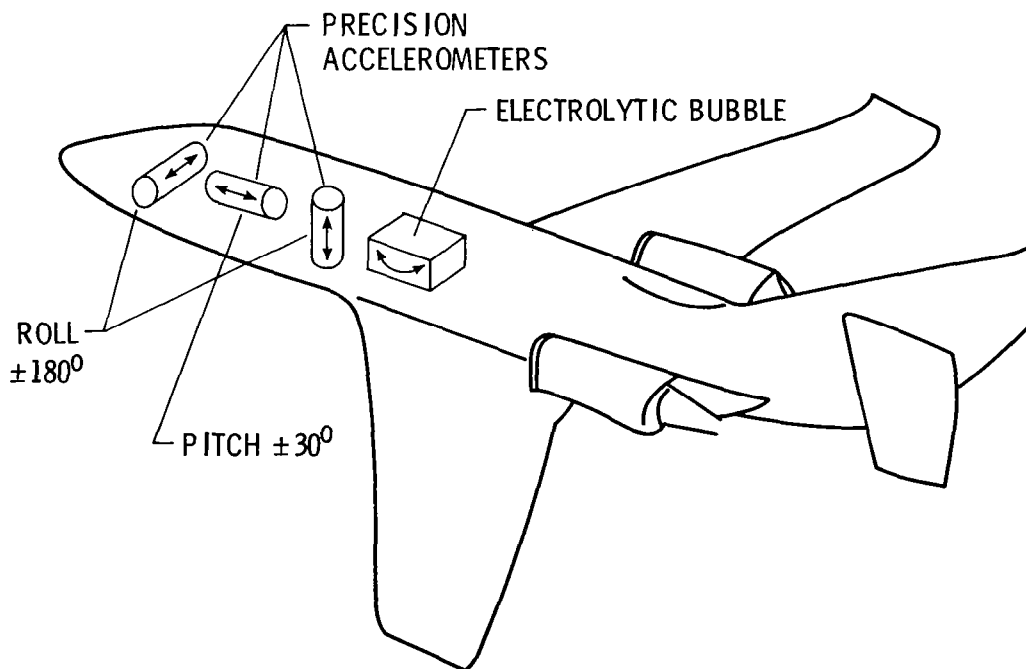
E = OUTPUT IN VOLTS

B = BIAS IN VOLTS

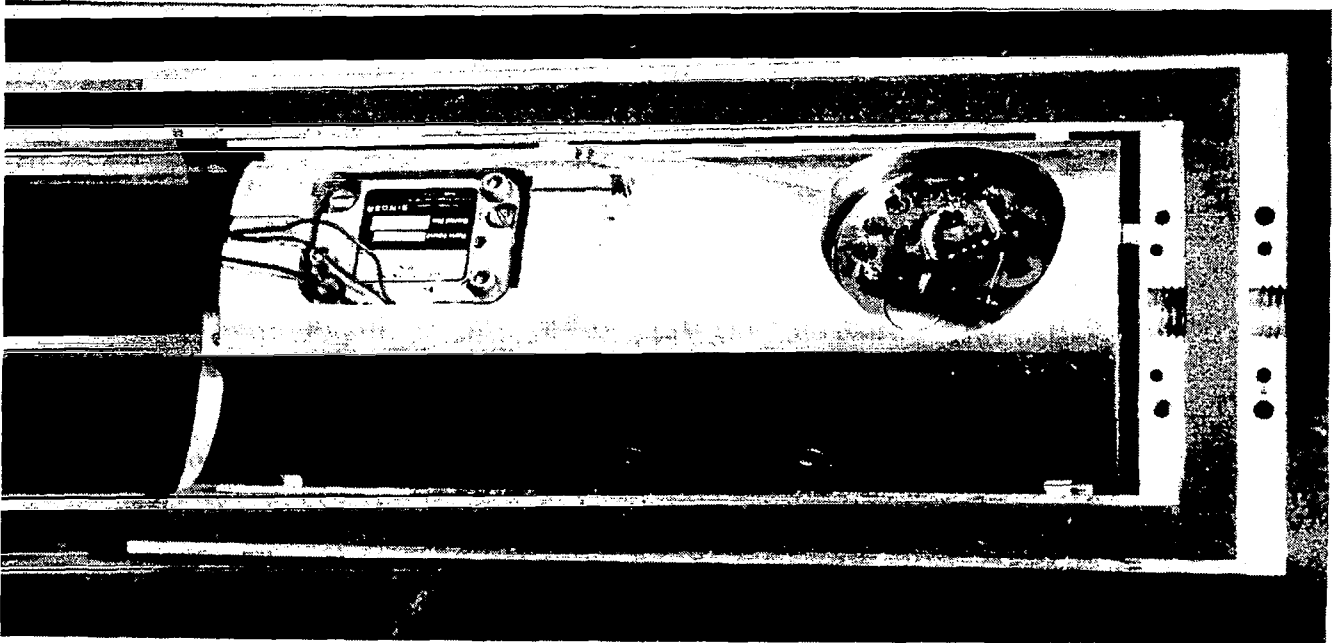
S = SENS. IN V/G

$\theta$  = MISALINEMENT IN DEGREES

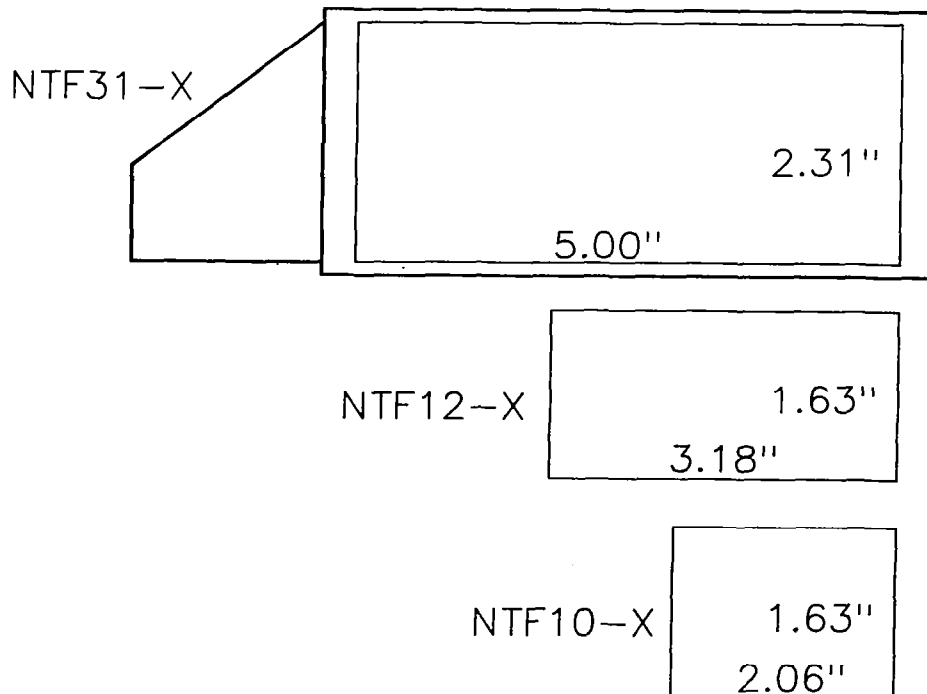
## NTF MODEL ATTITUDE MEASUREMENT



INSIDE VIEW OF NTF31-X INERTIAL PACKAGE



NTF INERTIAL PACKAGES



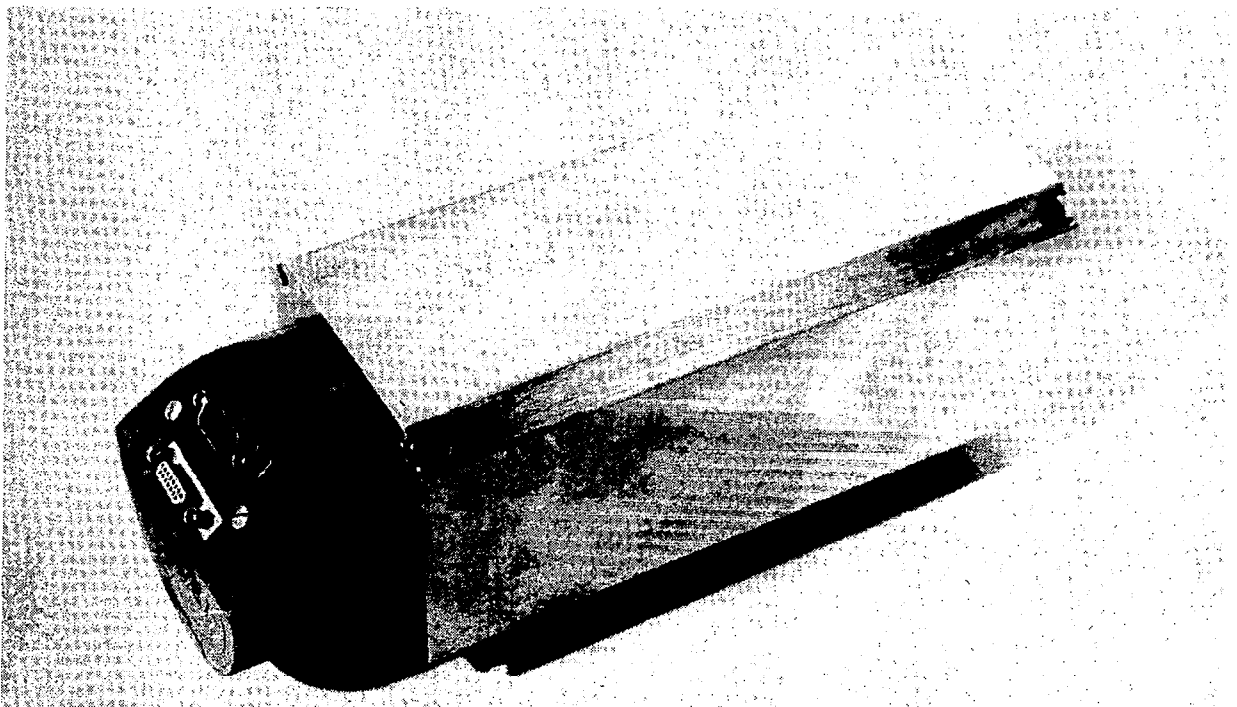
# NTF PACKAGES

NTF31-X • 3 ACCELEROMETERS & 1 BUBBLE  
• MEASURES PITCH & ROLL  
• 30 WIRES

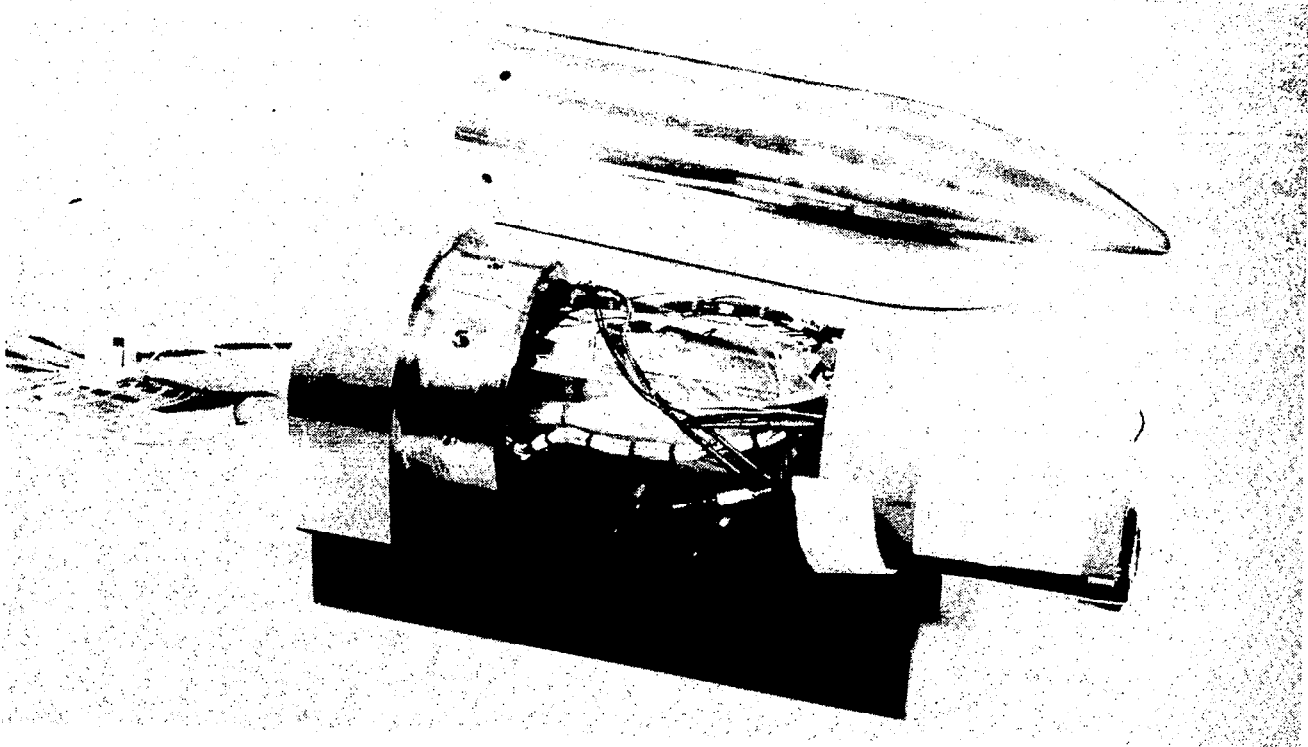
NTF12-X • 1 ACCELEROMETER & 2 BUBBLES  
• MEASURES PITCH  
• 15 WIRES

NTF10-X • 1 ACCELEROMETER  
• MEASURES PITCH  
• 10 WIRES

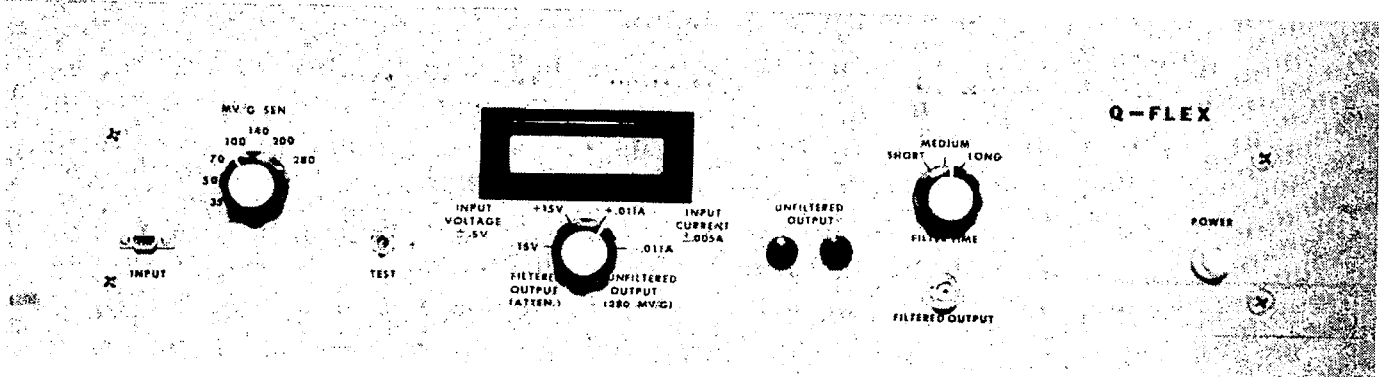
NTF31-X INERTIAL PACKAGE



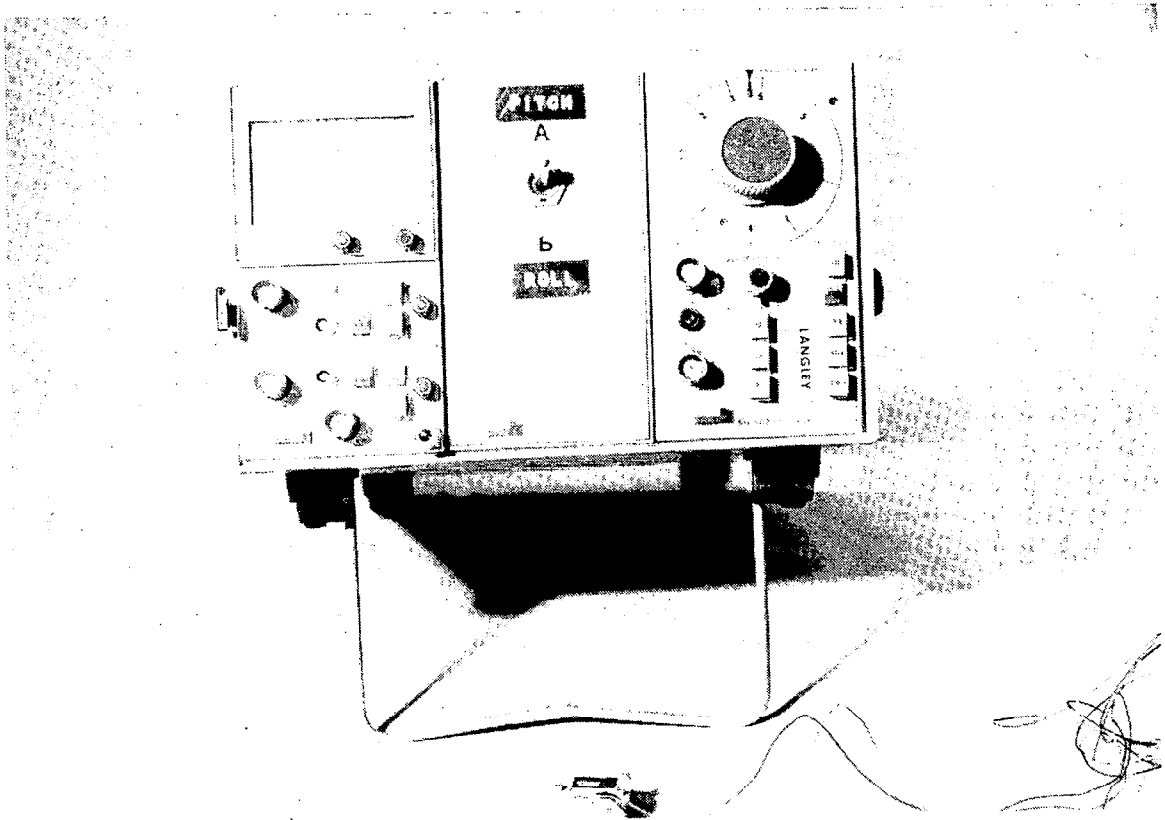
# INSTRUMENTATION MOCKUP FOR PATHFINDER I MODEL



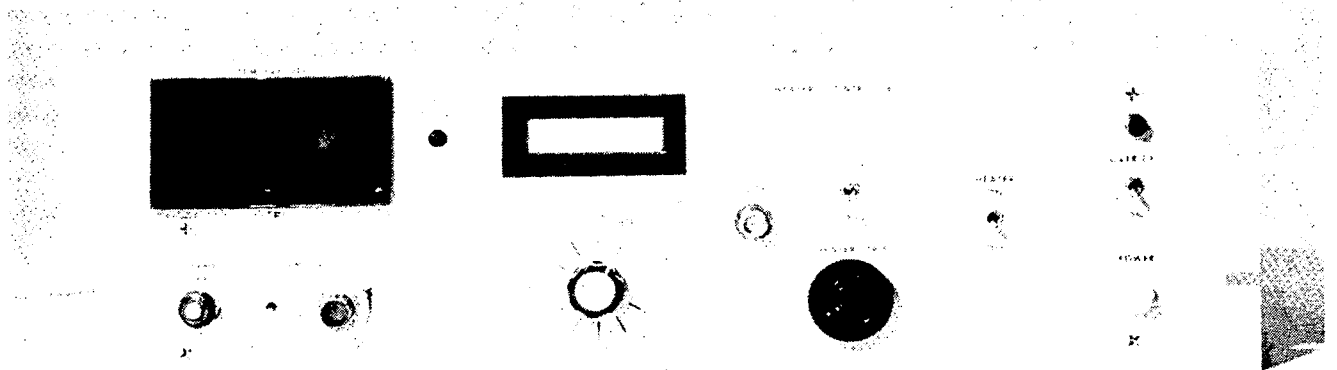
## ACCELEROMETER POWER SUPPLY



# OUTPUT MONITOR FOR ACCELEROMETER



# HEATER CONTROL BOX

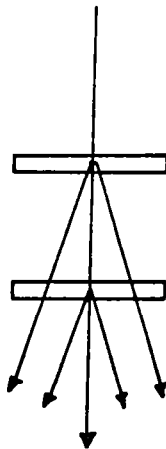




## LIMITATIONS OF ACCELEROMETERS

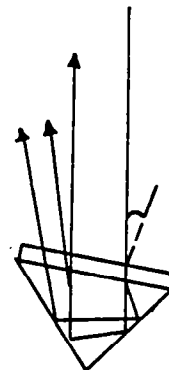
- DYNAMICS
- SLOW RESPONSE
- LABOR – INTENSIVE
- FRAGILE INSTRUMENTS
- LARGE PACKAGE (AND WIRES) IN MODEL
- MULTIPLE UNITS REQUIRED TO MEASURE 2 AXES

## HOLOGRAPHIC ANGLE SENSOR



TRANSMISSION

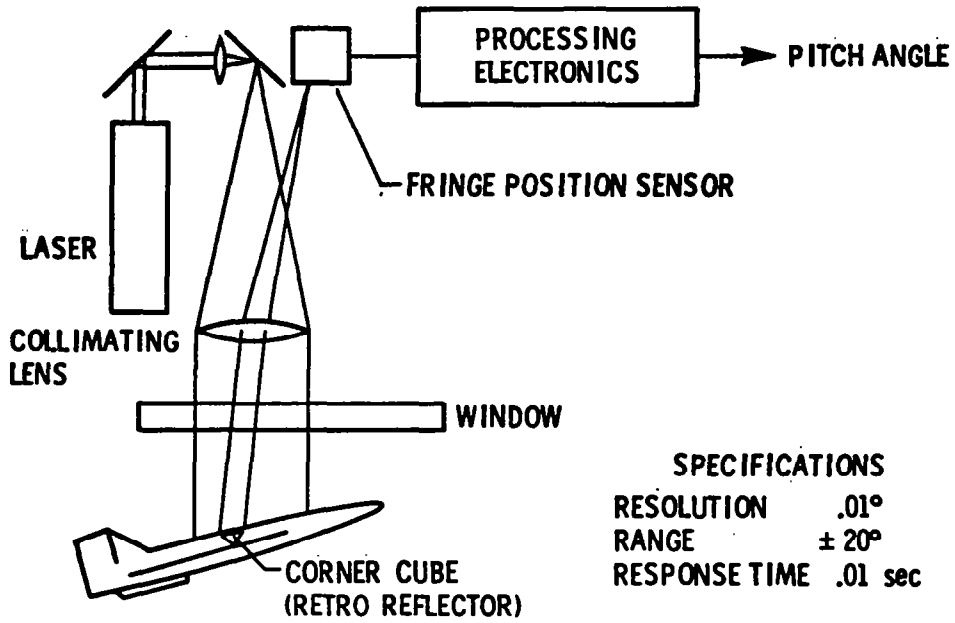
HOLOGRAMS



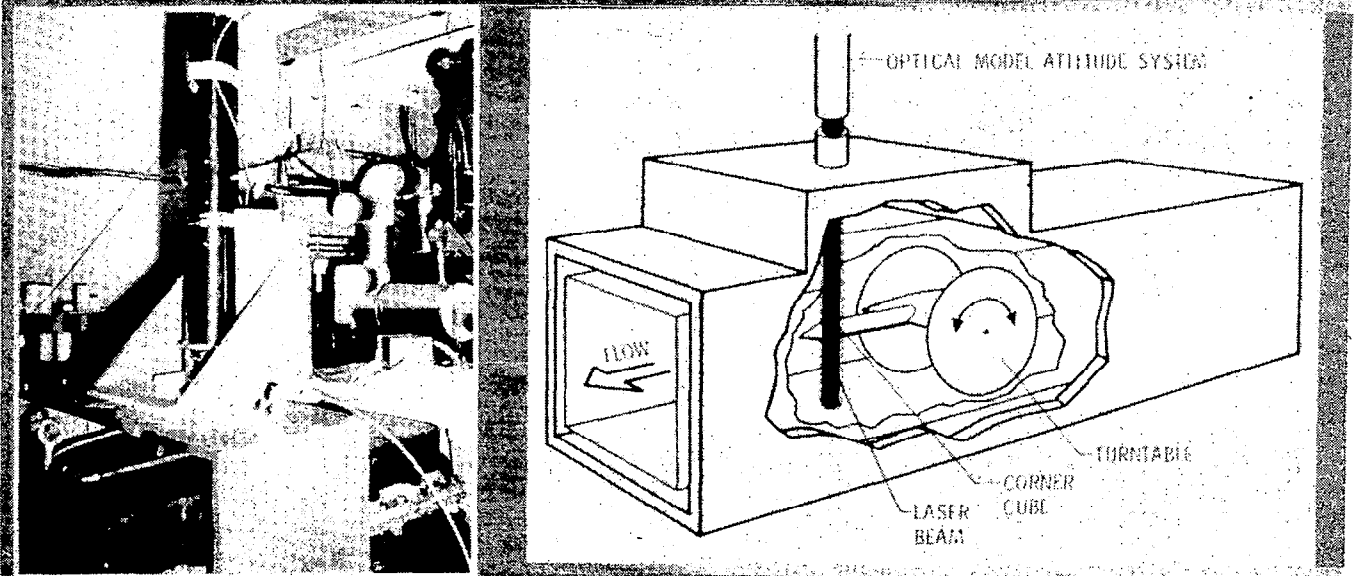
RETROREFLECTOR

REFLECTION

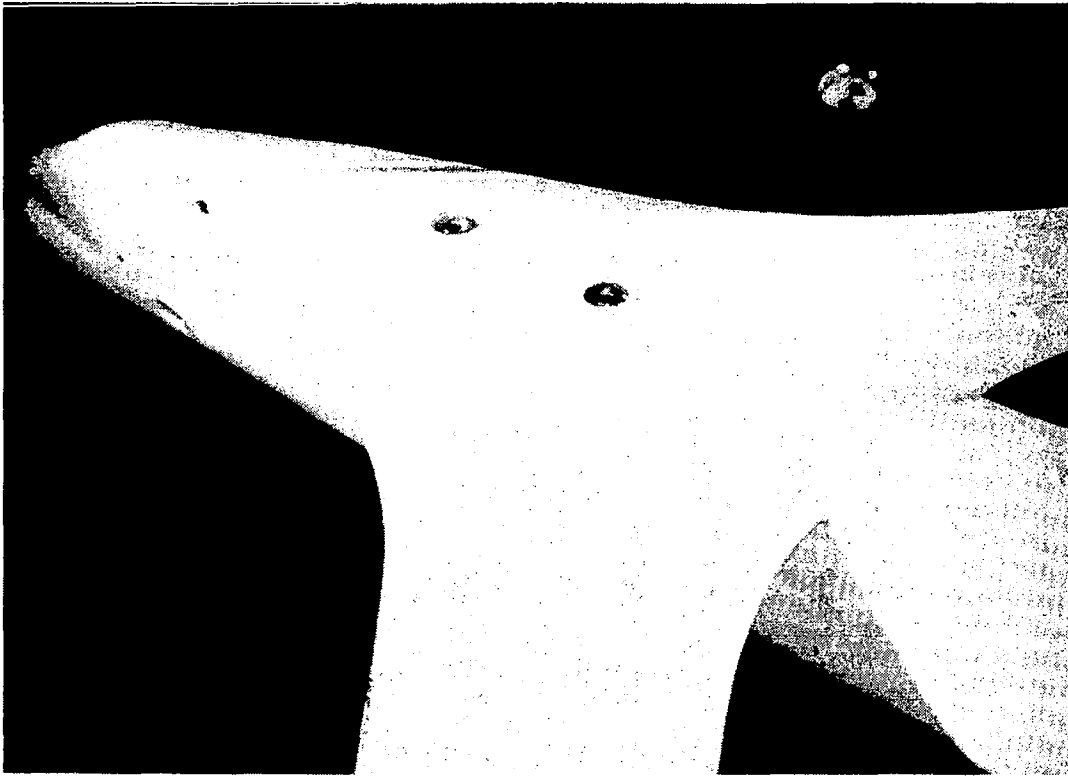
## OPTICAL ANGLE SENSOR



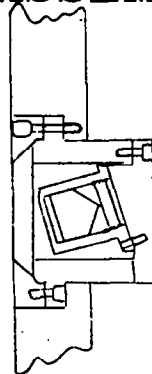
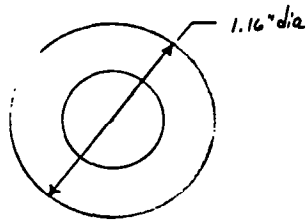
## OPTICAL SYSTEM IN 0.3 METER TUNNEL



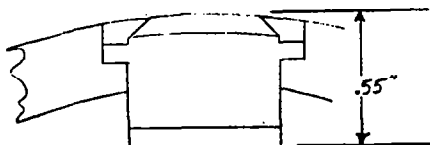
RETROREFLECTOR MOUNTED IN WIND TUNNEL MODEL



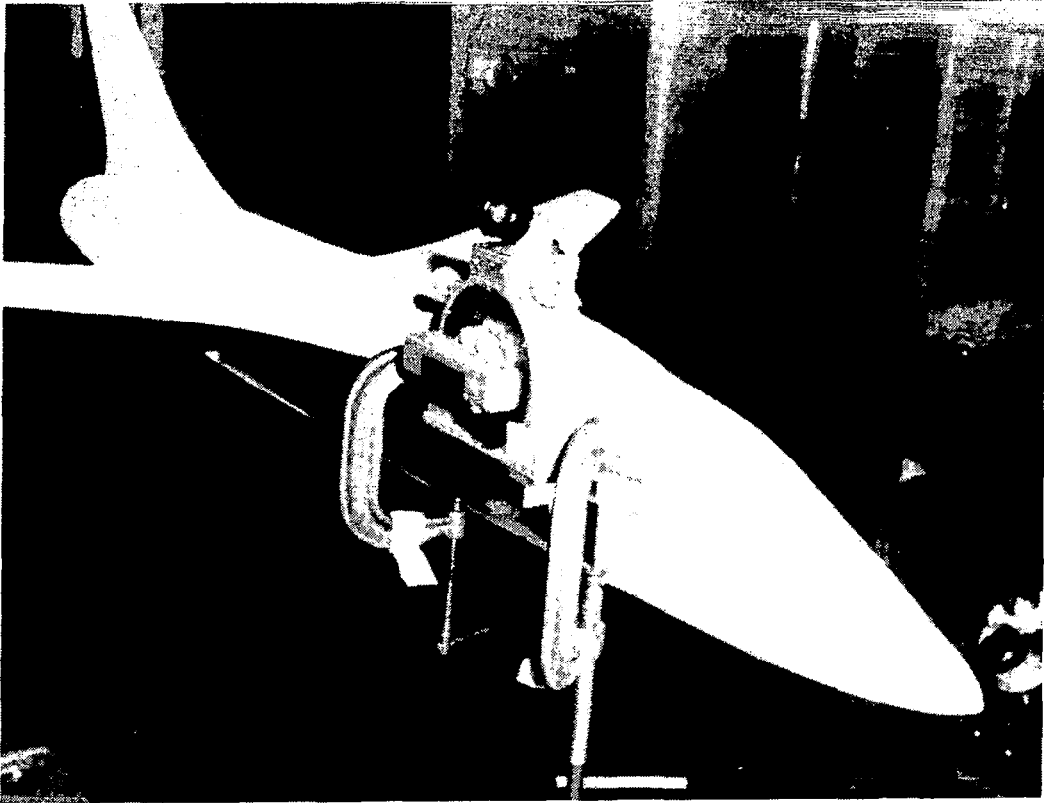
RETROREFLECTOR ASSEMBLY



RETROREFLECTOR ASSEMBLY



## LEVELING SETUP FOR WIND TUNNEL MODEL



## CONCLUSIONS

1. A RAPID, ACCURATE OPTICAL SYSTEM WILL BE AVAILABLE
2. INERTIAL PACKAGES WILL ALSO BE AVAILABLE
3. MODEL DESIGN AND FABRICATION WILL BE MORE DIFFICULT THAN WITH CONVENTIONAL MODELS