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MEMORANDUM

MEMO #38

To: SMA Team

From: B. Bruckman WRB

Date: 13 September 1990

Subject: Evaluation of Nasmyth vs. Coudé

The following presents choices between the Nasmyth and Coudé for each of the individual criteria mentioned in my 28 August memo and an added criteria for transportability. Based upon this I recommend the Nasmyth approach because it offers better overall performance especially in the critical areas of thermal phase stability and pointing accuracy. Please review and comment.

Cost: Relative cost data for the two choices is not readily available. The difference between the two approaches will most certainly not be more than 100 k per antenna with the Nasmyth costing less. If the choice cannot be made based on other criteria, we will do a detailed cost evaluation using an outside vendor.

Clear choice: Nasmyth

There is no question that the Nasmyth will cost less.

Effect on locked rotor resonance: The inertias for the two designs will be calculated and compared after each design has been optimized to meet the pointing and surface accuracy requirements.

Clear choice: Coudé

Distance from elevation axis to the reflector vertex is approximately 1.7 meters for Nasmyth and 1.3 meters for the Coudé. This corresponds to an approximate drop in locked rotor resonant frequency (LRRF) of 25 % for the elevation axis other parameters being equal. For the azimuth axis with the Coudé design, the receiver cabin is fixed so that its inertia is not rotating. Also, the distance between the reflector vertex and the el axis effects the azimuth inertia significantly at lower elevation angles. However, these affect the azimuth LRRF by less than 15%.

Thermal performance: The effects of thermal performance on pointing accuracy, surface accuracy, and phase stability will be examined for both designs.

Clear choice for pointing/phase stability: Nasmyth

The lower profile and shorter optical path of the Nasmyth will provide better thermal performance. With steel mounts for the beam waveguide and subreflector the variation in phase per degree C for the Coudé is 66.5 microns for the 9.5 m optical path from the secondary to the mirror feeding the receiver. It will not be practical to maintain the temperature variation to better than .5 C, so the expected phase variation is 34 microns for this portion of the path. With the Nasmyth the optical path from the secondary to the mirror which feeds the receiver is 5.3 m and the expected phase variation is 18.6 microns. If we use carbon fiber to support the secondary and beamwave guide the corresponding numbers are 9.7 microns and 5.3 microns. This is only the error for this portion of the optical path. Phase variations for the total path will be somewhat greater. This assumes a CTE of 7 ppm for steel and 2 ppm for CFRP.

With a steel pedestal the temperature gradient from one side of the pedestal base to the other will cause a pointing error. Assuming a .5 degree F gradient, the pointing error from this effect for the Nasmyth is .65 arc-sec. For the Coudé this effect gives a pointing error of 2 arc-sec.

No clear choice for surface accuracy. Both designs should have approximately the same performance.

Wind performance: The criteria for wind performance will be the amount of wind torque about the drive axes. i. e. designs will be developed that meet requirements for surface accuracy and pointing accuracy for gravity and wind loads, and then the resulting wind torques for the two designs will be evaluated relative to one another.

Clear choice: Coudé

The wind torques about the elevation drive axis is directly proportional to the distance between the elevation axis and the vertex of the reflector. So the elevation wind torque is approximately 25% less for the Coudé and pointing error due to drive windup will be 25%. This component of the pointing error is on the order of 1 arc-sec so we are looking at an approximate improvement of .25 arc-sec.

Reliability: The two designs will be evaluated to determine the effect on the reliability and durability of the antennas. This evaluation will be qualitative.

No clear choice.

The Nasmyth requires a cable wrap which creates reliability problems. However, the Coudé requires additional mirrors which may have durability problems.

Optical performance: Both designs will be examined to determine their effects on overall antenna efficiency, polarization, and chopping capabilities.

Clear choice: Nasmyth clear choice for efficiency.

Fewer mirrors means less loss. The overall difference in antenna efficiency will be at least 2%.

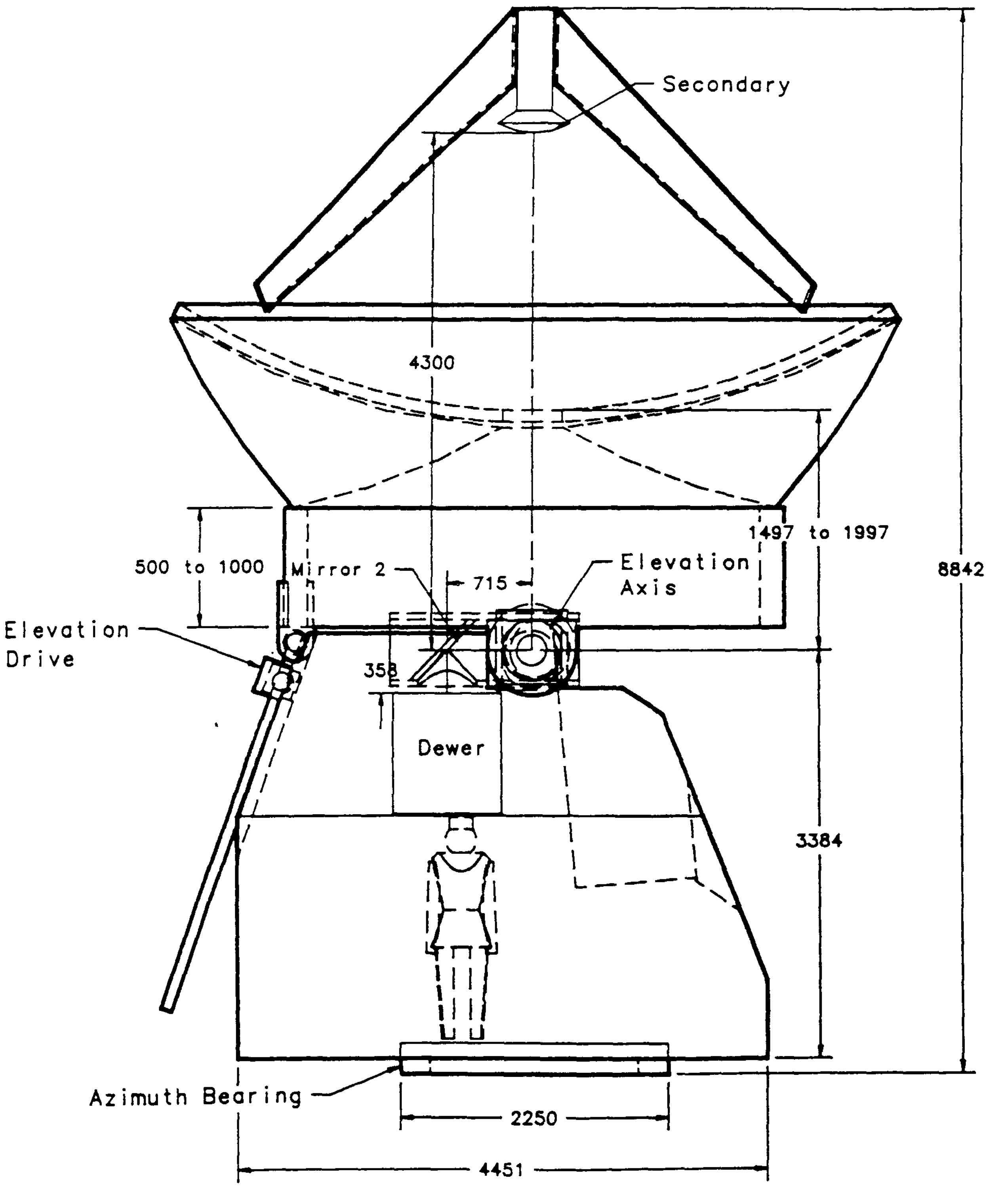
No clear choice for polarization or chopping capabilities. Both designs have about the same problems.

Transportability: Both designs will be evaluated for ease of transport.

Clear choice: Nasmyth

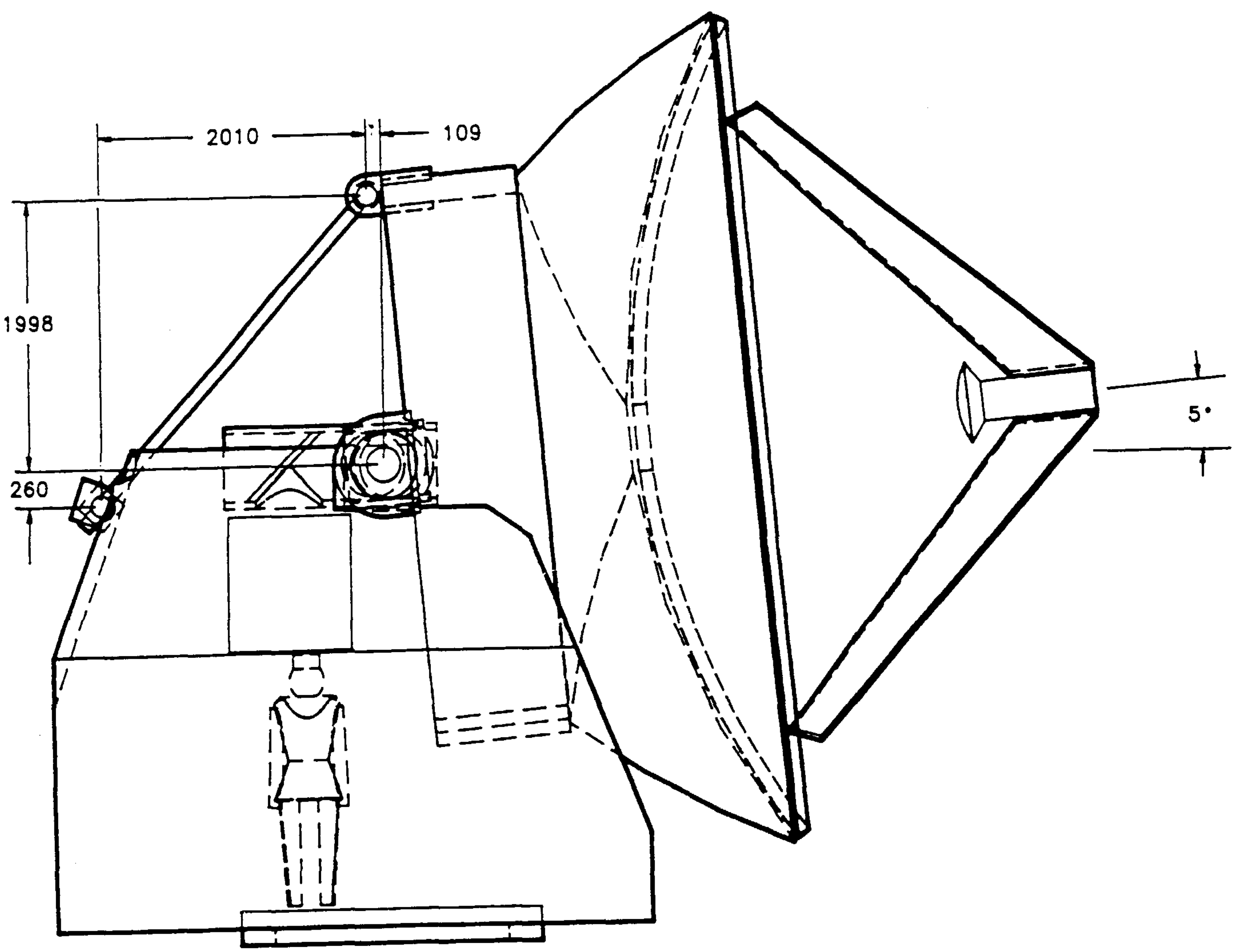
The lower profile and lower weight of the Nasmyth definitely make it easier to transport.

NASMYTH



Secondary
4300
8842
1497 to 1997
500 to 1000
Mirror 2
715
Elevation
Axis
Elevation
Drive
358
Dewer
3384
Azimuth Bearing
2250
4451

NASMYTH



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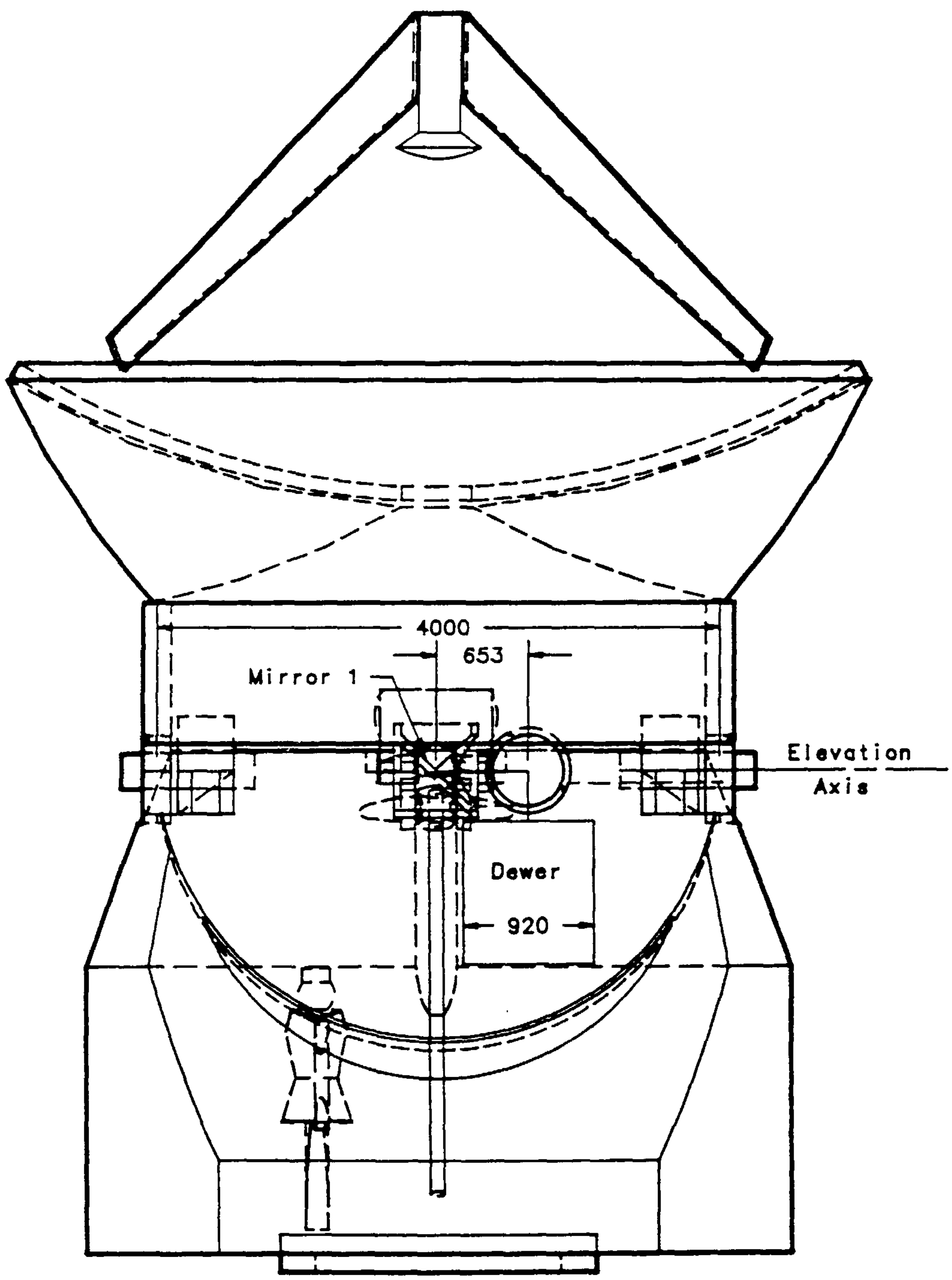

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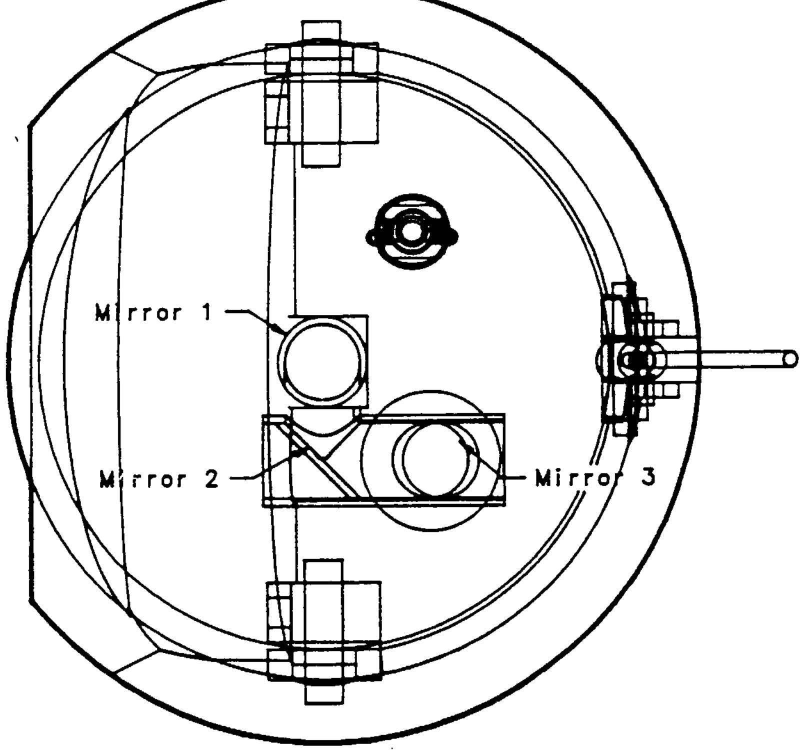
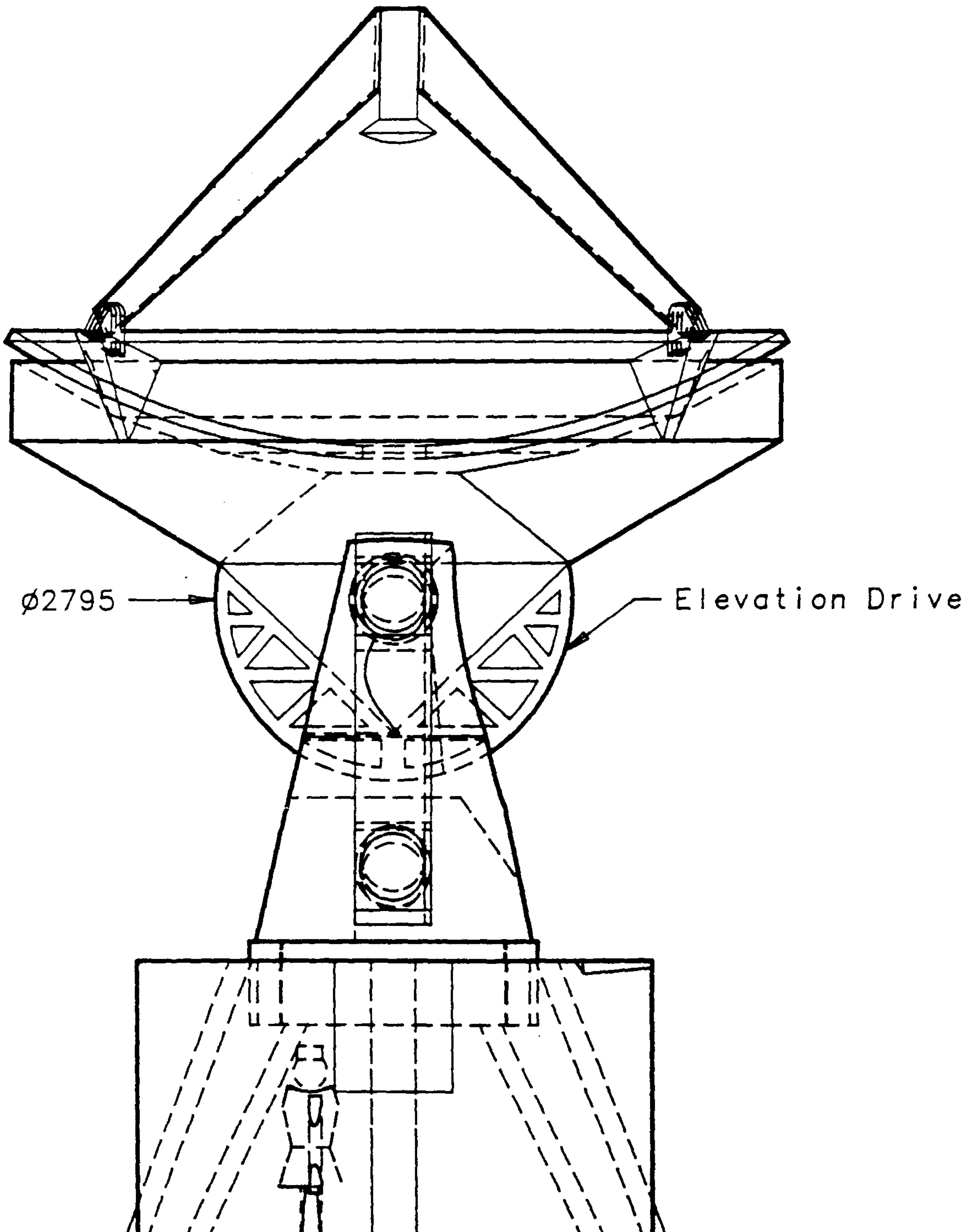
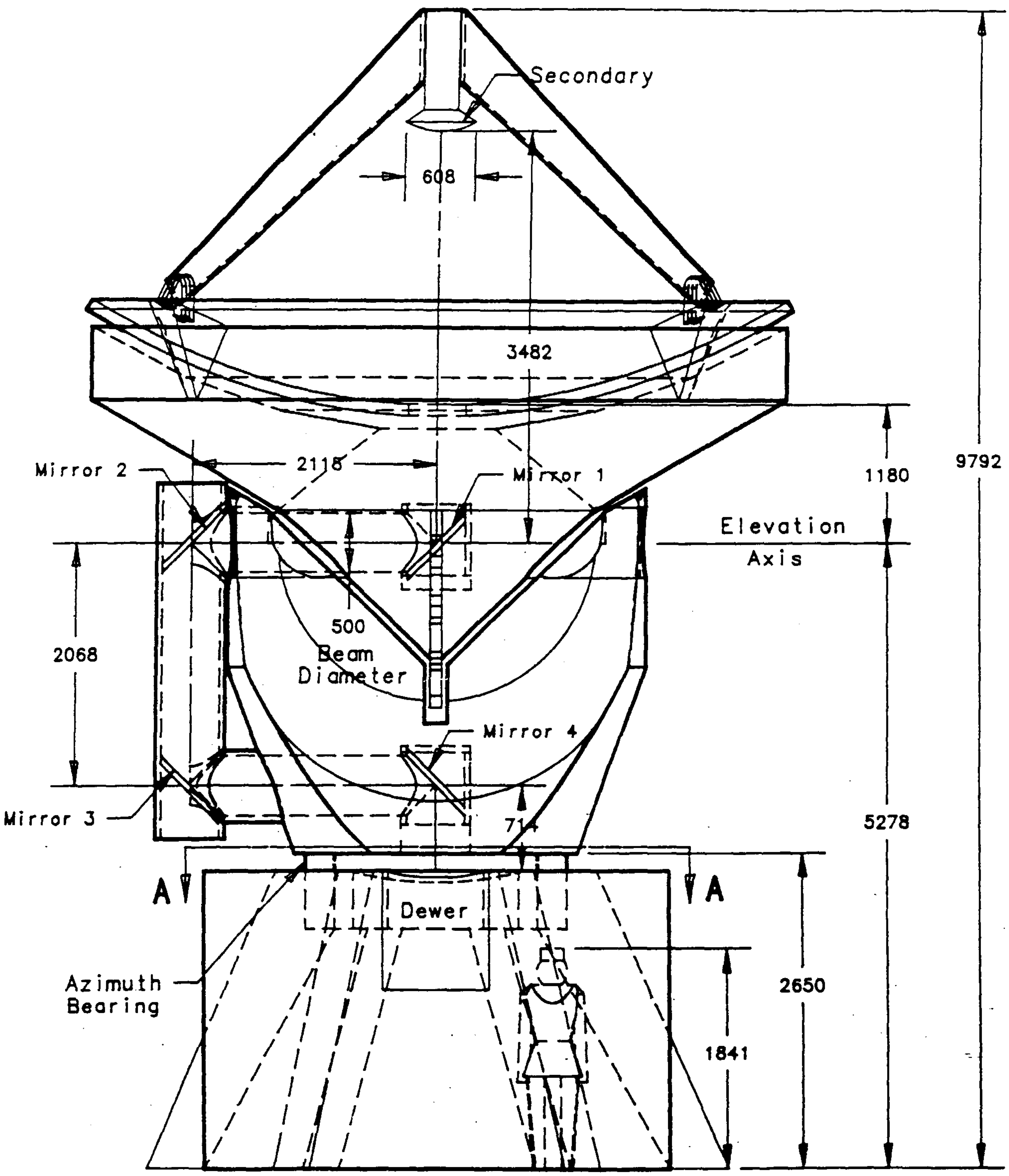


COUDE



COUDE



Secondary
608
3482
9792
Mirror 2
2118
Mirror 1
1180
Elevation
Axis
2068
500
Beam
Diameter
Mirror 4
Mirror 3
714
5278
A
A
Dewer
Azimuth
Bearing
2650
1841

COUDE