DISPLAY RESEARCH - PILOT RESPONSE WITH THE "FOLLOW-ME" BOX DISPLAY

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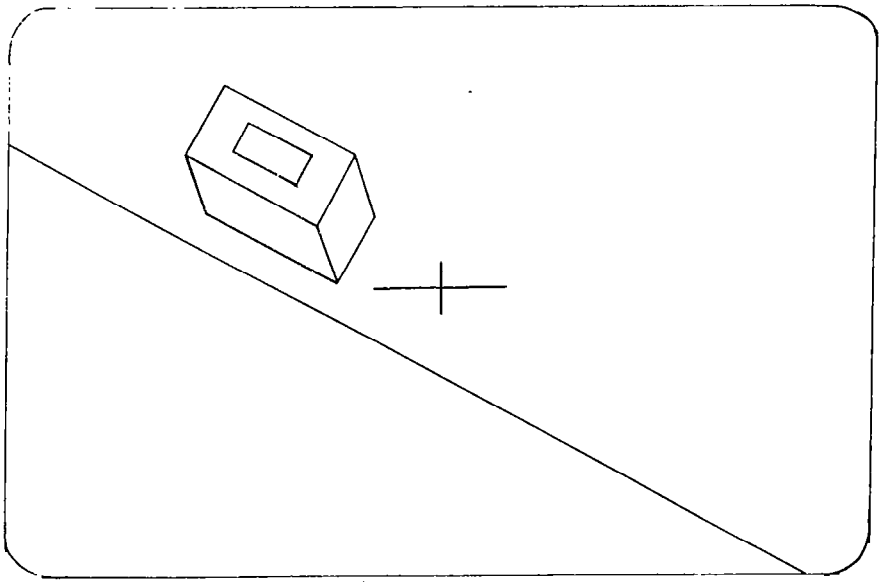
Abstract

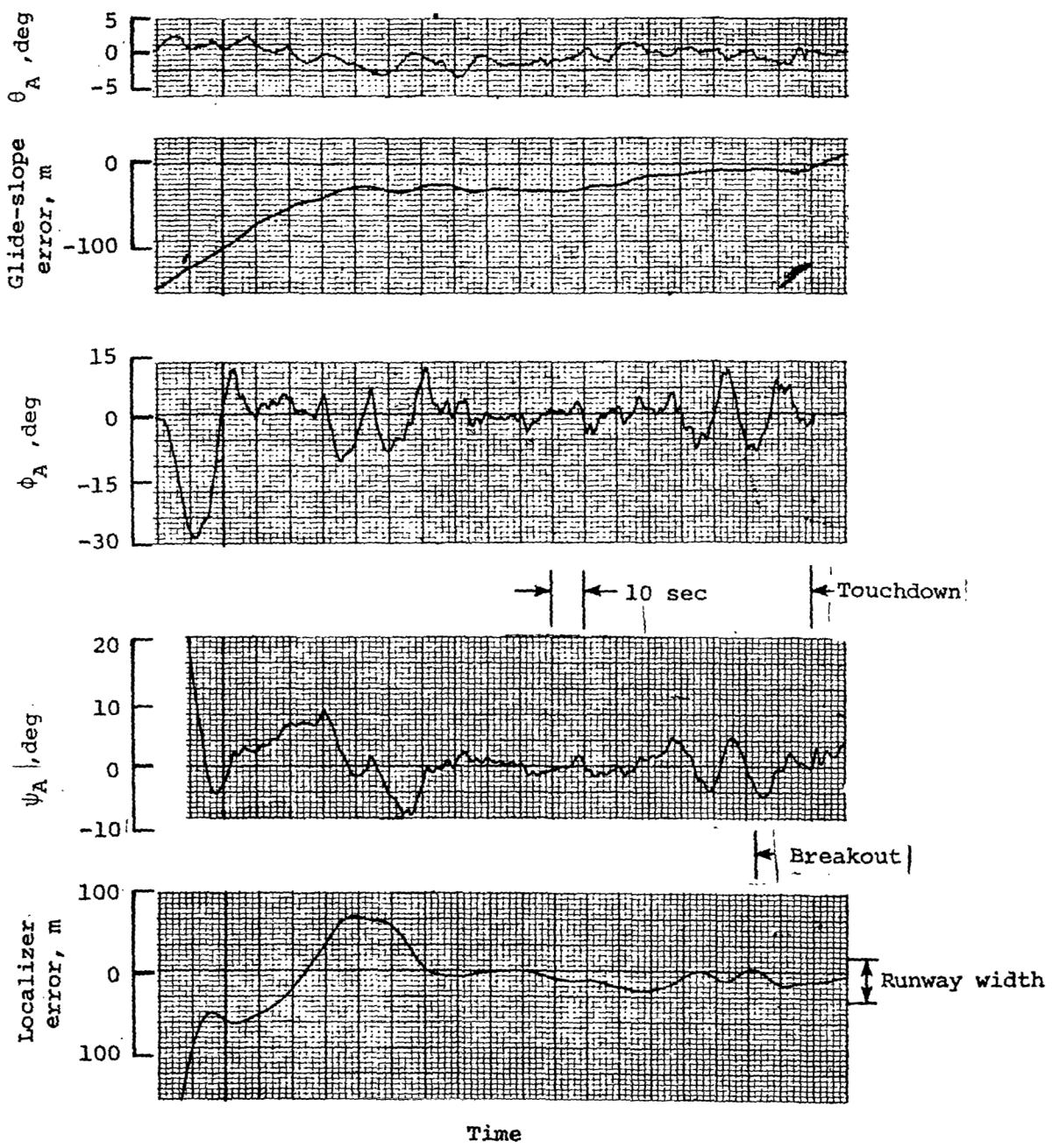
As a part of the Single Pilot Instrument Flight Rule program at Langley Research Center, a study of display configurations and their effect on pilot-aircraft system response has been undertaken. This investigation includes an examination of conventional displays to provide a set of data that can be used for comparison with advanced displays. The study also encompasses the examination of an advanced display design that includes the use of a digital computer and a cathode ray tube to provide a drawing of a three-dimensional box. The results of these studies, which show the improvement in system performance that can be obtained with the advanced display, will be presented. For the most part, these studies were conducted using the General Aviation Simulator, but verification of the results with the advanced display was also obtained from flight tests.

The "follow me" box display, shown in the first figure, combines all of the attitude, displacement and flight director information required to control the aircraft to a designated line in one symbol. As a result of this integration of information, a very high pilot-aircraft-display system frequency can be obtained. To illustrate the factors involved, consider the approach made using a conventional Horizontal Situation Indicator shown in the second figure. This time history shows the long periods obtained with the conventional display, and the loss of system damping that occurs when the aircraft is close to touchdown. These characteristics are depicted further in the third figure, which shows the system lateral frequency and damping both for conventional displays and for the box display. The system frequencies are quite low with the conventional displays, but are very high with the box display. The superior landing approaches that can be obtained with the box display are shown in the next three figures, which provide a comparison of results obtained with the box display and conventional displays.

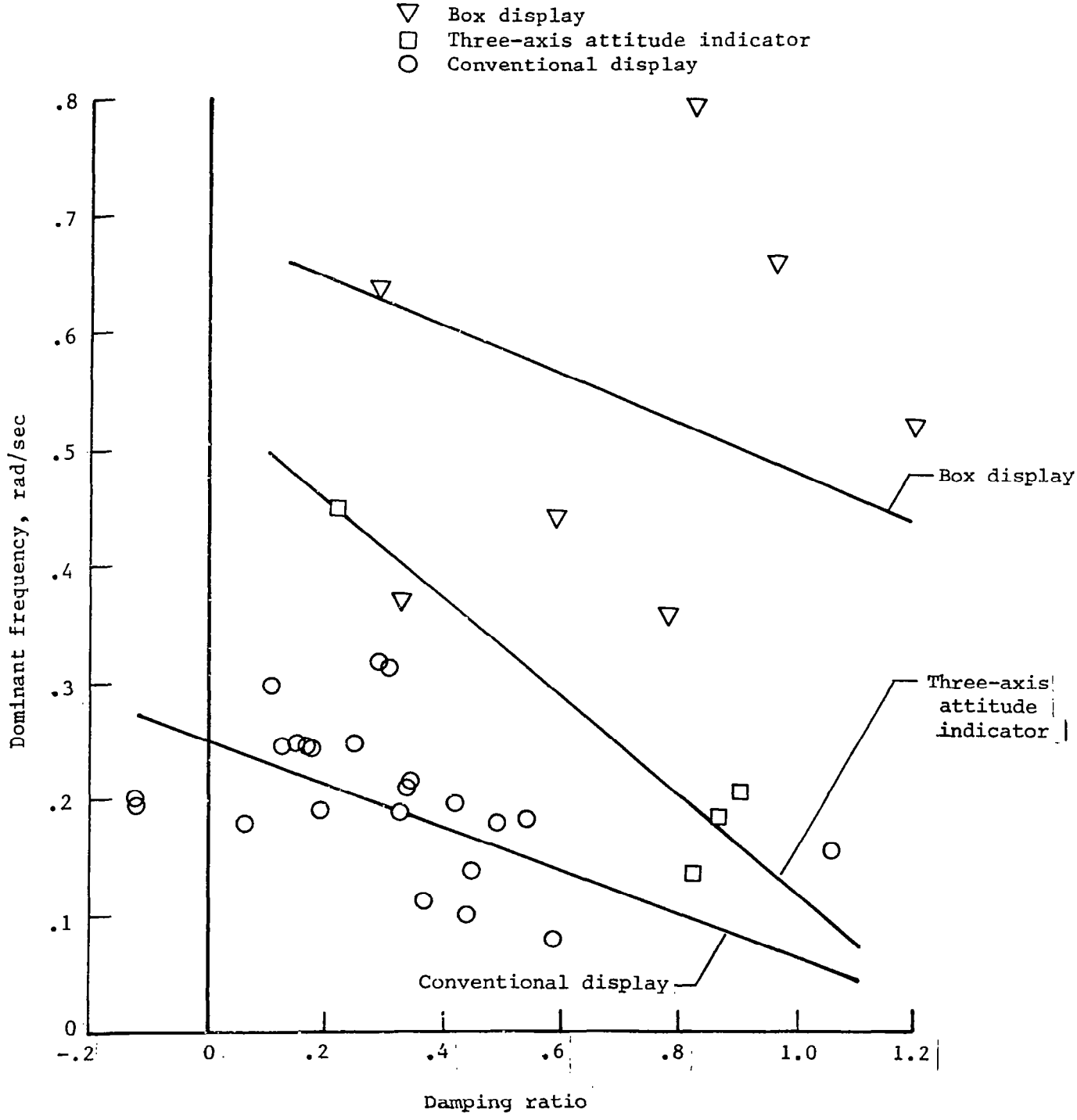
The ground tracks shown on the last figure illustrate other features that can be obtained with the box display. These are the enroute system response that is obtained with low pilot workload, the complex guidance in the terminal area, the short, curved, descending, precisely controlled final approach that can be obtained when the box display is combined with an MLS landing system, the go-around guidance, and the unique holding pattern guidance. These guidance features were obtained with the use of two boxes (so that the pilot could go from one to the next), a change in display sensitivity (by a factor of 20) between the enroute segment and the final approach, and, in addition to the sliding boxes, the use of stationary boxes at certain waypoints.



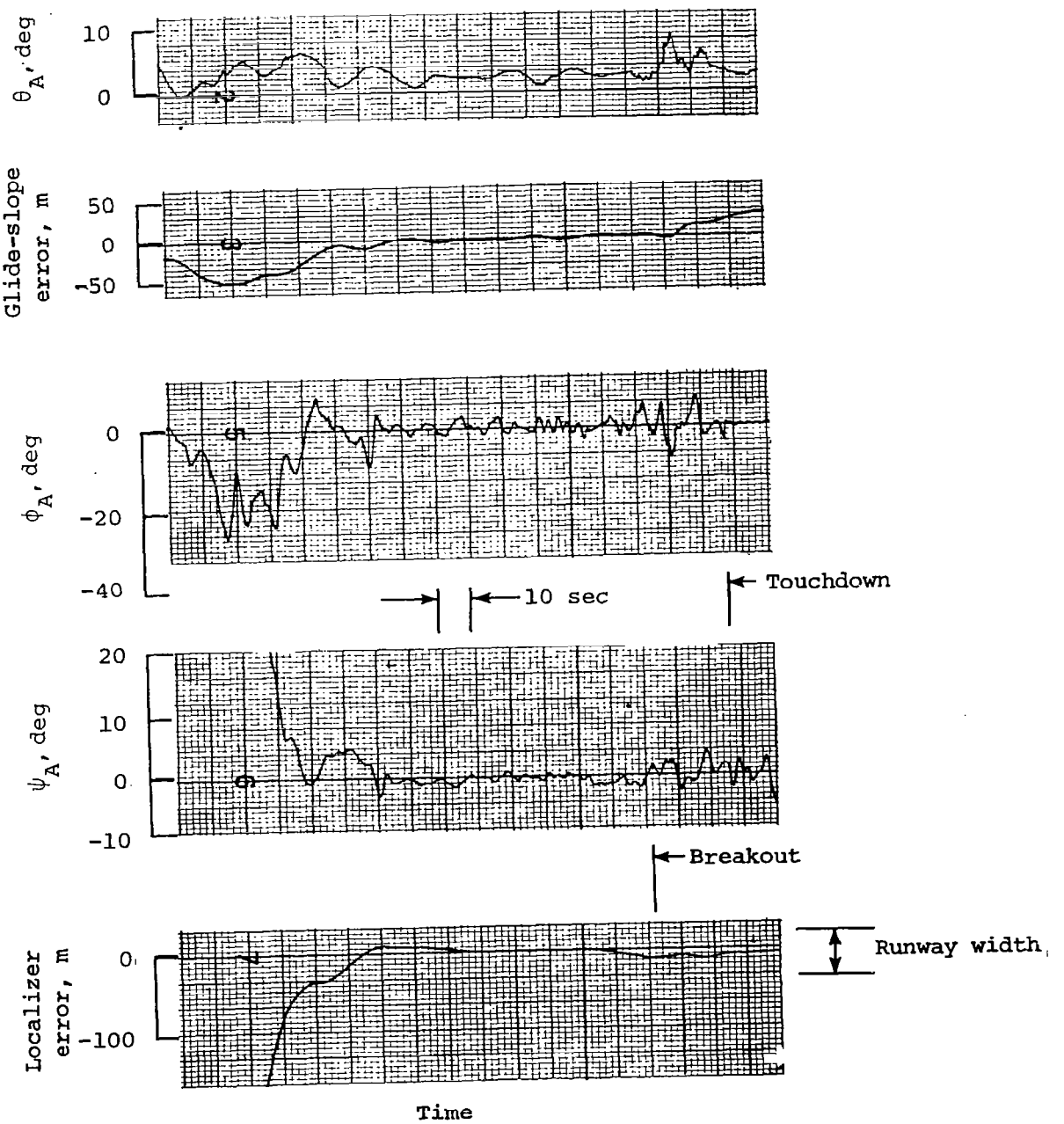
"Follow me" box display. The aircraft is below and to the right of the desired path, and is climbing and banked to the left so as to get behind the box.



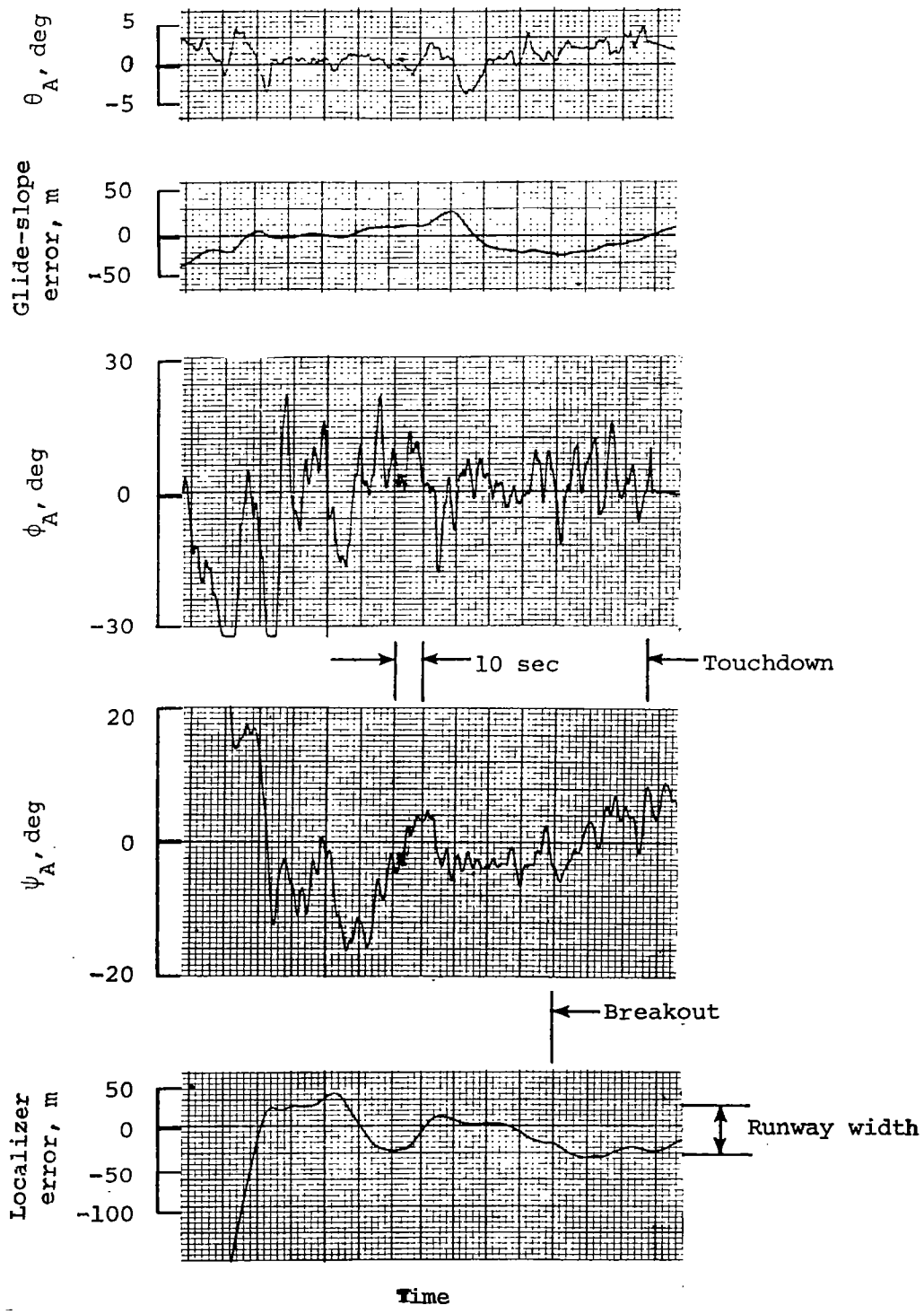
Final approach using conventional Horizontal Situation Indicator by subject 8; no winds.



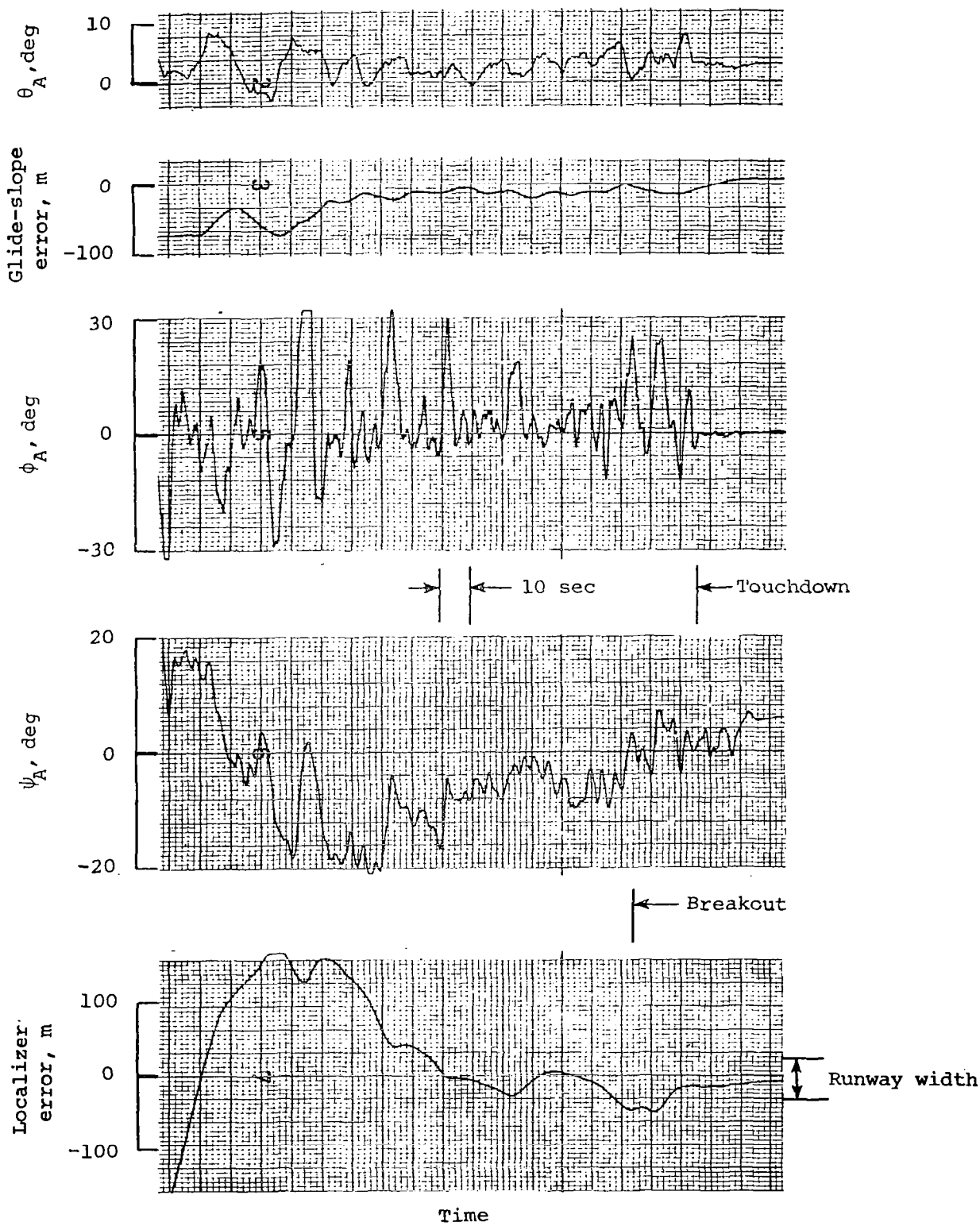
Dominant frequency and damping ratio of pilot-aircraft-instrument system.



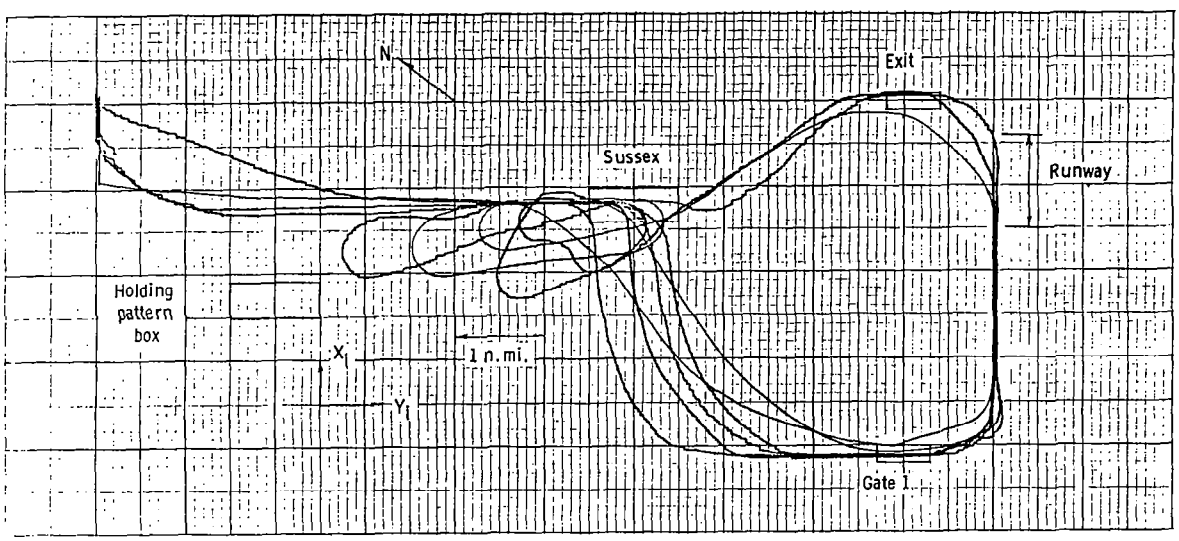
Final approach using box display by subject 4; no winds.



Final approach using box display by subject 4; thunderstorm wind shear condition.



Final approach using conventional Horizontal Situation Indicator by subject 4; thunderstorm wind shear condition.



Ground tracks of complete flight for three subjects.