HIGH RESOLUTION AIRBORNE GRAVITY GRADIOMETER BASED ON AN ORTHOGONAL MASS QUADRUPOLE

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The Gedex Airborne Gravity Gradiometer (AGG) uses an orthogonal quadrupole responder (OQR) developed at the University of Western Australia with support from Rio Tinto. The OQR design is based on pairs of balance beams orientated at 90 degrees to one another, with each beam supported on a micro-flexure. A gradient along the length of a beam in the gravitational acceleration component that is perpendicular to the beam axis and the web axis will generate a small torque about the flexure. With two orthogonal beams, rotations of the base will result in both beams rotating in a common direction compared to the base, whereas the beams will rotate in opposite, or differential, directions due to gravity gradients. The differential rotation arises because of the properties of the gravity gradient tensor. The sensor can thus in principle distinguish between base rotations and gravity gradients. Additionally the beams are designed such that the center of rotation about the supporting flexures coincides with the location of the center of mass of the beams. This eliminates rotational response of the beams when subjected to linear accelerations. Thus the OQR configuration provides a sensor that is inherently insensitive to both rotational and linear accelerations of the support.

However, the practical world has a habit of complicating seemingly simple situations. The first design challenge is that fabrication of the beams and the supporting flexures has to be done to very stringent tolerances, which has only recently become possible with the development of technologies such as Electric Discharge Machining (EDM). The second major obstacle is that there are higher order terms in the response of the sensing elements that can be driven by base vibrations and aircraft motions. These require mounting the sensor on an isolation system designed to provide a very low
level of disturbance to the gradiometer. In the Gedex development this isolation system is based on technology developed by the Canadian Space Agency (CSA) over the past decade. The CSA has flown isolation systems on the Russian Mir space station and on the US space shuttle, and is currently developing two versions for the International Space Station (ISS). Gedex is adapting this technology for airborne use.

When the full set of error terms are examined it becomes clear that they can be classified into three main groups, one of which is sensor independent, one of which is sensor specific, and one group that depend on a combination of parameters, some sensor independent and some sensor specific. In the case of the Gedex gradiometer mounted on the isolation system in an aircraft, these error terms combine to give a resolution of one Eotvos at one sample per second, corresponding to a spatial sampling resolution of 50m for a platform translating at 100 knots (~50m/s). This paper will provide an overview of the total AGG system design, and a summary of the predicted performance.