Update: New Airborne Gas Chromatograph for NASA airborne platforms

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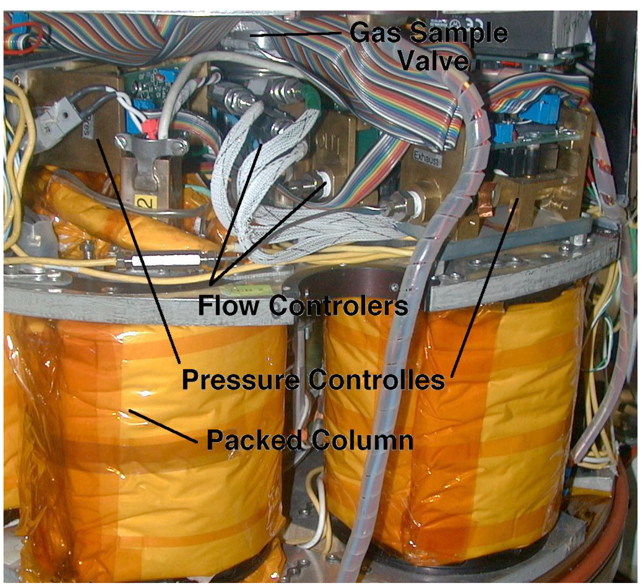
Abstract**:** This paper updates the progress on our new airborne gas chromatograph described at last year's ESTC conference. The final configuration of the new airborne gas chromatograph includes one mass selective and four electron capture gas chromatographic channels. Test flights are scheduled for the NASA ER-2 aircraft in May 2002 and for the NASA WB-57F in late June 2002. Our instrument, PAN and other Trace Hydrohalocarbon ExpeRiment (PANTHER), will participate on the NASA CRYSTAL-FACE experiment from southern Florida in July 2002.

I. INTRODUCTION

This paper is an update of Elkins et al., [1] presented at last year's ESTC conference in Maryland. The two papers describe our plans for the next generation airborne GC called PAN (peroxyacetyl nitrate) and other Trace Hydrohalocarbons ExpeRiment (PANTHER). The PANTHER instrument has gone through a final configuration process to operate on the NASA ER-2 and WB-57F platforms.

II. EXPERIMENTAL

Gas chromatography is simply separation and detection of individual components in a gas or liquid mixture. Precise control of temperature, pressure, and flow are paramount to high precision work. Two different types of columns are used: metal packed columns and glass capillary columns. Two different gas chromatographic detectors are used in the PANTHER instrument and include the electron capture detector (ECD) and the mass selective detector (MSD). PANTHER will use a unique modular design to reduce the size and mass of the gas chromatographic components (Fig. 1).



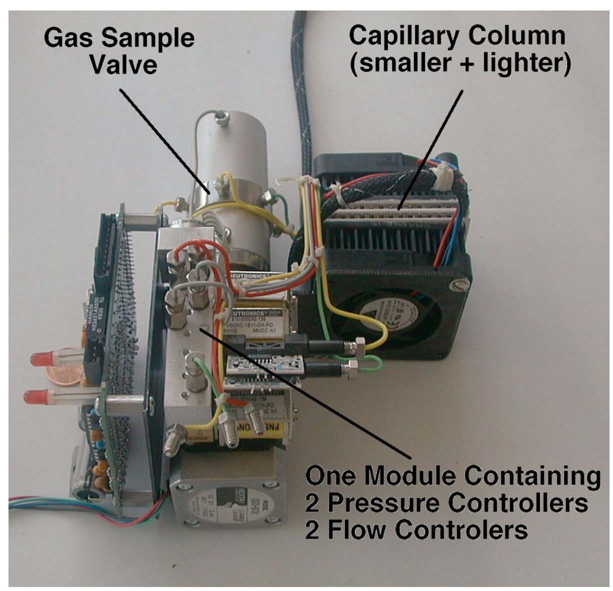


Fig. 1 Left hand photo shows density of components on our balloon GC, LACE, and the right hand photo shows the new modular design for PANTHER.

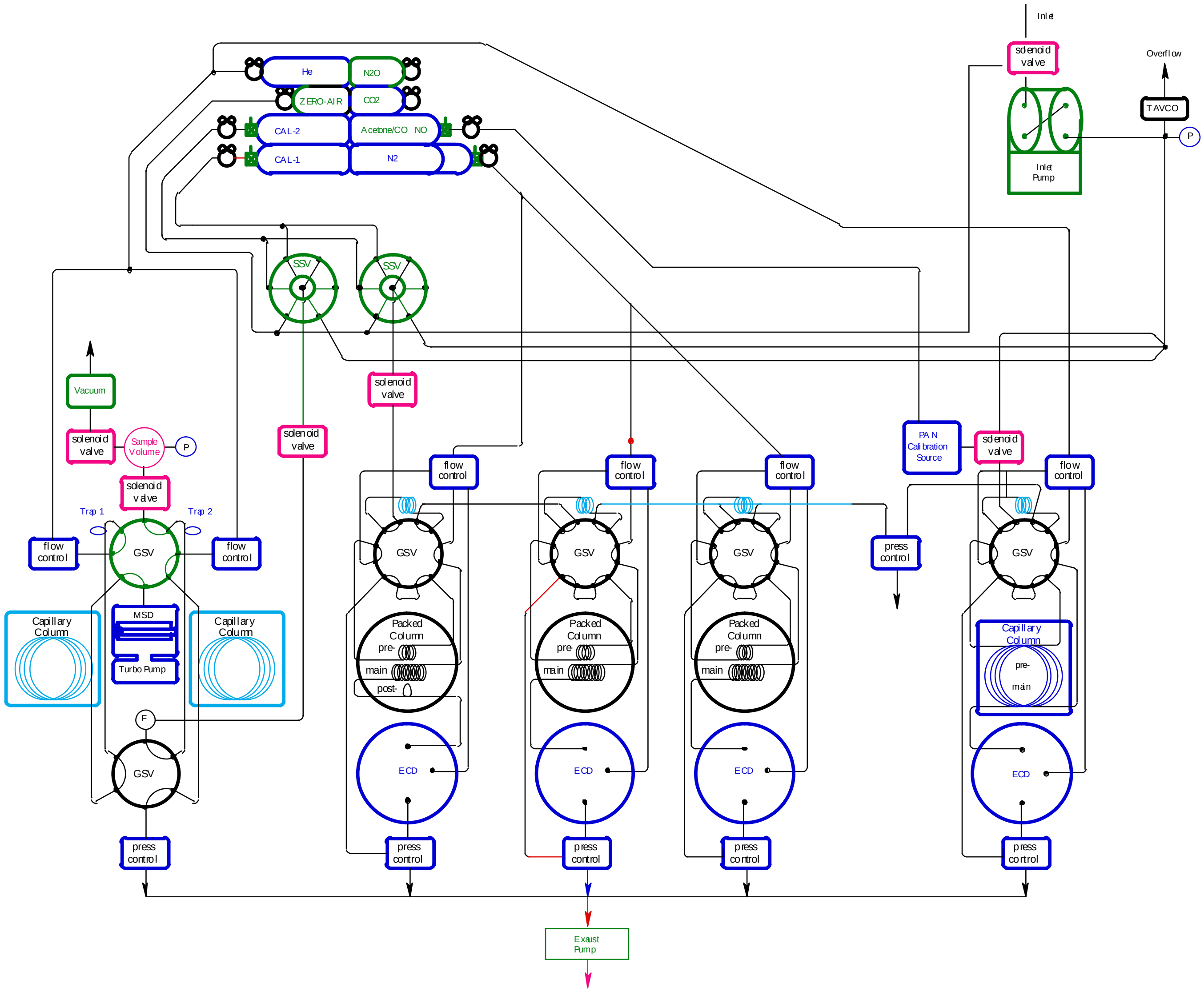


Fig. 2 Plumbing diagram for the new airborne gas chromatograph, PANTHER. The current configuration has 4 electron capture detectors (ECD) and one mass selective detector (MSD). Gas sampling valves (GSV) control the injection and loading of constant volume samples. The stream selection valves controls the selection of standards and air to the GSVs.

The new module (Fig. 1, right hand photo) incorporates one gas sampling valve (GSV), two pressure controllers, two flow controllers, and column oven. Additional gas chromatographic channels can be added or exchanged to add different or new gases using different columns and detector configurations [1].

The target molecules are acetone on the mass selective detector (MSD), and hydrogen (H_2), methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), CFC-12 (CCl_2F_2), halon-1211 ($CBrClF_2$), CFC-11 (CCl_3F), CFC-113 (CCl_2F-$CClF_2$), and PAN on the electron capture detectors (ECDs). The sampling frequency will be between 60 and 120 seconds. The accuracy of measurement will be 2% or better except 10% for PAN. The precision of measurement will be 1% or better for most gases, but will be 5% for PAN.

Plumbing of the carrier gases that provide the baseline signal for the columns and detectors is important for rapid sampling (Fig. 2). The final configuration of PANTHER will have four ECDs and one MSD. Two inert carrier gases are used including nitrogen for the ECDs and helium for the MSD. Nitrous oxide (N_2O) doping of the nitrogen carrier gas at 15-35 parts per million (ppm) enhances the sensitivity of atmospheric H_2, CO, and CH_4 on the ECD [2,3]. Carbon dioxide (CO_2) will be added (~5000 ppm) as a doping gas into the nitrogen carrier for atmospheric N_2O [4] since pure nitrogen carrier gas yields no signal for N_2O [2]. A mixture of acetone, CO, and nitric oxide (NO) will be used for the PAN calibration source.

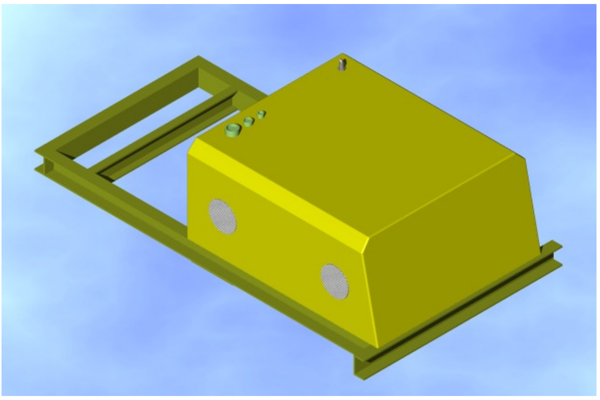


Fig. 3 Outside enclosure of the PANTHER instrument for the NASA ER-2 aircraft.

III. PACKAGING OF PANTHER

The enclosure for PANTHER will measure 24" wide x 28" long x 15" high. The package will weigh 200 lbs. The power consumption will be 1 kw (2 kw peak). The enclosure can be mounted in the upper Q-bay of the NASA ER-2 aircraft or the transition pallet of the NASA WB-57F aircraft.

IV. CONCLUDING REMARKS

Rapid sampling airborne GCs, some with different types of columns and detectors, are becoming more common on airborne platforms. Our earlier airborne gas chromatograph (ACATS-IV) has just completed a 17,500 km journey in Russia from Moscow to Khabarovsk and back in the summer of 2001 on the Trans-Siberian Railway to estimate Asian emissions of ozone-depleting and greenhouse gases. Our future plans include use of PANTHER on trains, vans, balloons, and ground-based stations.

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