A UCSD-RAO INFRARED SPECTROMETER

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ABSTRACT In a collaborative program between the University of Calgary and
UCSD, we are constructing an infrared spectrometer and electronics systems for the operation of infrared array detectors.

A Czerny-Turner infrared spectrometer has been designed for use with a linear IR
array from the Aerojet Electronic Systems Division of Gen Corp. The spectrometer
will give complete coverage between 7 and 14 μm with two movable gratings;
centered on 8.6 μm, one grating will give R ~250, the other will be centered on 12.0
μm and give R ~155. A gold-coated flat will give alternate imaging capability for
optical testing and alignment purposes. The linear array has Bi-doped Si detectors of
about 40% quantum efficiency at 10 μm; it performs well at 5 μm and is usable to
2μm; the long wavelength cutoff is at 18 μm. The electronics will also support an As-
doped 20x64 array of impurity-band conduction (IBC) design, having higher
efficiency and lower noise, and sensitivity out to 20 μm. The camera in which the
array is to be housed is being constructed by CASS-UCSD. The 20x64 array will be
operated between 4 and 13 μm initially, and later to 20 μm. We assume a Littrow
configuration: incident ray normal to blaze of grating, and a blaze angle (angle
between blaze normal and grating normal) α. The Littrow configuration requires that
the incident and diffracted beams be separated. As per the UCSD Golden Gopher, the
incident beam is over, the diffracted beam under the grating. The resulting slight
curvature in the spectrum at the detector is tolerable because the out-of-grating plane
angle is small. The physical size of the detector and the f/ratio of the telescope
determine the scale of the system. The spectrograph parameters are shown in Table
I. The linear detector array for the spectrometer has the following properties, assuming
a chopping rate of 10 Hz: 128 pixels @ 206 μm/pixel; capacitance, 100 pf; well
depth, 10⁶ e⁻; integration time, 50ms/frame; read out noise, 10⁴ e⁻; read out rate, 10
μs/pixel or 1.3 ms/frame; dynamic range, 10⁴. The data acquisition system, based on
the 68000 microprocessor operating at 12 MHz with no wait states, has a 486-25
MHz host computer. The Data Acquisition System (DAS) modes of operation are: (a)
a stare mode, where the integration time is preset in the range 1 μs-1.7 s. A 32-bit co-
add buffer can hold about 1⁰ of data; (b) a chopping mode, where data are flushed out
of the detector into one of two buffers (star or sky) at the end of the chop cycle. The
co-add buffers hold $1-2^8$ of data; (c) a *chop and nod mode*, a 4-channel operation, where 4 buffers are used for co-adding up to about $\sim 4^8$ of data; (d) a *test mode*, where signal from all 128 detectors are summed and output to the 486 at the end of each integration for the purpose of maximizing signal; and (e) an *overflow test mode*, where each of 128 elements is examined for saturation, to enable maximum integration to be determined. In any of the modes, the sky counts may be subtracted from the source counts (except for the *stare mode*). The result may be divided by the integration time to produce a normalized output. This work was supported by grants to EFM, TAC, and DJIF from NSERC of Canada.

![Block diagram of the spectrometer electronics](image)

**Figure 1** - Block wiring diagram for the UCSD-RAO IRS.

### Table I - UCSD-RAO IRS Parameters

$\sigma = 203 \, \mu m$, so that 1 resolution element = 0.406 mm

<table>
<thead>
<tr>
<th>Parameter/Grating</th>
<th>1</th>
<th>2</th>
</tr>
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<tbody>
<tr>
<td>$\lambda_{blaze}$</td>
<td>8.6 $\mu m$</td>
<td>12 $\mu m$</td>
</tr>
<tr>
<td>$\alpha$ (blaze angle)</td>
<td>26.7$^\circ$</td>
<td>17.5$^\circ$</td>
</tr>
<tr>
<td>$\delta$ (grooves/mm)</td>
<td>105/mm</td>
<td>50/mm</td>
</tr>
<tr>
<td>N (no. lines)</td>
<td>2730</td>
<td>1300</td>
</tr>
<tr>
<td>$rld$</td>
<td>0.0851 $\mu m/mm$</td>
<td>0.1907 $\mu m/mm$</td>
</tr>
<tr>
<td>$d\lambda$ (resolution elmt.)</td>
<td>0.0345 $\mu m$</td>
<td>0.0774 $\mu m$</td>
</tr>
</tbody>
</table>