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DEVELOPMENT OF A HIGH SPEED CCD CAMERA SYSTEM FOR THE OBSERVATION OF SOLAR Hα FLARES

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ABSTRACT

We have developed and tested a CCD camera (100 × 100 pixels) system for observing Hα images of the solar flares with time resolution > 25 msec. The 512 × 512 pixels image of CCD camera at 2 Mpixels/sec can be recorded at the rate of more than 5 frame/sec while 100 × 100 pixels area image can be obtained 40 frames/sec. The 100 × 100 pixels image of CCD camera corresponds to 130 × 130 $arc - sec^2$ of the solar disk.

Key Words : Solar Hα flares- High speed CCD camera-Millisecond time resolution

I. INTRODUCTION

The major effort of solar physics during the solar cycles 21 and 22 has been directed towards observations of flares with high time resolution. The study of high time resolution data will lead us in understanding the rapid fluctuations of the emission of radiation from solar flares which in turn will provide a promising approach for probing the plasma processes that are responsible for solar flare. According to Kiplinger(1983) the high-time resolution HXRBS instrument aboard SMM recorded hundreds of X-ray spikes of less than 1 s duration with rise and decay times of some tens of milliseconds. The existence of millisecond duration spikes in HXR offers the opportunity to correlate variation of different energies on time scales that are considearbly less than one second. The time resolution of the HXRBS instrument on SMM satellite was 1 ms while the minimum time resolution of Hα observation so far obtained was 100 ms (Kiplinger et al.,1988). The Hα emission line (λ6563 Å) can provide spatial information more accurately compared to HXR. Moreover, there is a good temporal correlation between the Hα and hard X-ray time profiles. In CCD study of Hα fluctuations, Kampher and Magun (1983) have shown that there is a component of the Hα emission which shows impulsive variations is coincident with microwave spikes. However, with a time resolution of only 1.4 s, coincidences could only be established to within 2 s. This study also concludes that the impulsive phase of an Hα flare is characterized by fast and succesive brightenings of many flare points with point size of 1 arc-sec or less. Detailed observations in Hα can provide a wealth of diagnostic information on different physical processes. Calculations of the sensitivity of Hα profiles to electron beam fluctuations by Canfield and Gayley (1985) describe the temproal response of the spectral line. An instantaneous injection of an electron beam into the chromosphere is expected to produce an impulsive rise in Hα intensity over the entire line profile on a chromospheric heating timescale, $t_h \approx 10$ ms.

Keeping the above fact in mind we have developed a high speed CCD camera system for the observations of solar flares with time resolution of 25ms.

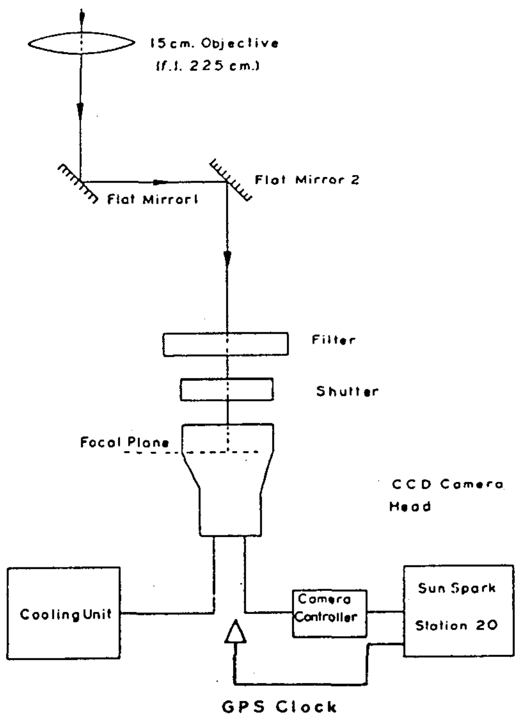

Fig. 1.— Schemetic diagram of a 15-cm Coude' refractor and backend instrument for flare observations.

II. INSTRUMENT FOR OBSERVING Hα FLARES AND DISCUSSIONS

In Figure 1 we have shown the schemetic diagram of a 15-cm Coude' refractor telescope and backend CCD camera system for solar flare observations. The instrument developed for the solar flare observations employs a CCD camera, Sun Sparc stations-20 computer and a GPS (global position system) clock for accurate

Table 1. The performance of the High Speed Solar flare CCD camera with various pixels.

Image Area (pixels)	frames per second
100 × 100	40
200 × 200	20
512 × 512	5

timings. At the back of Daystar Hα filter with 0.5 Åpassband and the shutter the CCD camera system is installed at the focus of refractor. This CCD camera system employs a CCD chip EEV37 (512 × 512 pixels, pixel sizes $15\mu^2$. The camera controller of the system has variable read out rate from 0.5 to 4.0 Mega pixels/sec with 12 bit (4096 grey levels) resolution. At present, the CCD system has maximum read out rate of 2M pixels/sec. The 4.0 Mpixels/sec readout card will be installed and tested by the end of 1996. The software, which controls the working of camera controller is installed on Sun Sparc Station 20, 50 Hz computer having 7.3GB disk capacity and 14 GB Cartridge drive. A GPS (Global position system) clock is connected to Sun Sparc 20 computer to record time with an accuracy of 1 ms in header of the each flare image. The CCD chip is cooled to -25 ° C by a liquid circulator unit connected to head of the camera system. The high speed CCD camera system has been tested for observations of solar Hα flares. In Table 1 we have shown the performence of the solar Hα CCD camera with various pixels areas. The spatial resolution of the system is 1.3 arcsec per pixel which can be considered good for the flare observations.

In light of the above we feel that our CCD camera system is the fastest flare monitoring system and is about four times faster than the system of Kiplinger et al (1988) which is 8 bit (256 grey level) CID camera. The observing cost of this system is about $ 1 per Gigabyte flare data.

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REFERENCES

Canfield R. C., Gayley K. 1985, Rapid Fluctuation in Solar Flares, NASA, CP 2449. p249.

Kampher N., Magun, A. 1983, ApJ, 274, 910.

Kiplinger A. L., Dennis B. R., Emslie A. G., Frost K. J., Orwig L. E. 1983, ApJ, 265, L99.

Kiplinger A. L., Dennis B. R., Orwig L. E., Chen P. C. 1988, Flare Research at the Next Solar Maximum (Eds. R. C. Canfield & B. R. Dennis) p.214.