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Proposed 60-cm multichannel Solar Vacuum Telescope of UPSO, Naini Tal

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Abstract. The proposed Solar Vacuum Telescope (SVT) having equatorial mount will be equipped with 60 cm (f/15) vacuum Gregorian tube, 35-cm vacuum refractor tube and two 15-cm refractor telescopes. The SVT will consist of :

(1) 60-cm (focal length 900-cm) Gregorian vacuum tube with four channels to install four filters (6563 Å, 3933 Å, continuum 5500 Å, and tunable filter range 4200 - 6000 Å).

(2) 35-cm (focal length 900-cm) refractor vacuum tube with two Lyot filters wavelength 5324 Å, pass band (PB) 0.15 Å and 4861 Å, PB 0.12 Å, and KD*P crystals for simultaneous measurements of solar magnetic fields of solar active regions at two heights.

(3) Two 15-cm refractor telescopes will have following facilities :
The first 15-cm refractor will have following imaging systems :
A - Full disk imaging (image size : 10 mm) in Solar Hα,
B - Full disk imaging (image size : 10 mm) in white light,
C - Full disk for solar guider, and
D - Full disk imaging (image size : 28 mm) in 10830 Å.

The second 15-cm (focal length 225-cm) refractor will be equipped with Hα (passband : 3Å) filter for prominence monitoring.

1. Scientific objectives and telescope details

The principal scientific objective of the proposed 60-cm SVT is to study the active Sun. Study of sunspots, faculae, plages, flares and prominences using photographic, photoelectric, CCD and magnetographic techniques with high temporal and spatial resolutions is planned to be carried out. These studies help us in identifying such changes which lead to flare eruptions. Also, observations revealing stretching, shearing and twisting of the magnetic field lines, due to increasing or decreasing magnetic energy content of the region can be studied.

With some of the following objectives in mind, we have proposed a 60 cm Solar Vacuum Telescope (SVT), to be procured and installed, during the ninth plan period :

(1) Registration of preflare, during flare and postflare changes during the course of evolution of

the flare. Time sequence filtergrams and magnetograms at higher spatial and temporal resolutions will help us in understanding the flare phenomenon.
(2) Registration of the magnetic changes in sunspots or active groups i.e., observations revealing stretching, shearing and twisting of magnetic field lines.
(3) To study the nature of magnetic field structures in which acceleration and transport of particles occur.
(4) To study in detail the filament and prominences and their mechanisms.

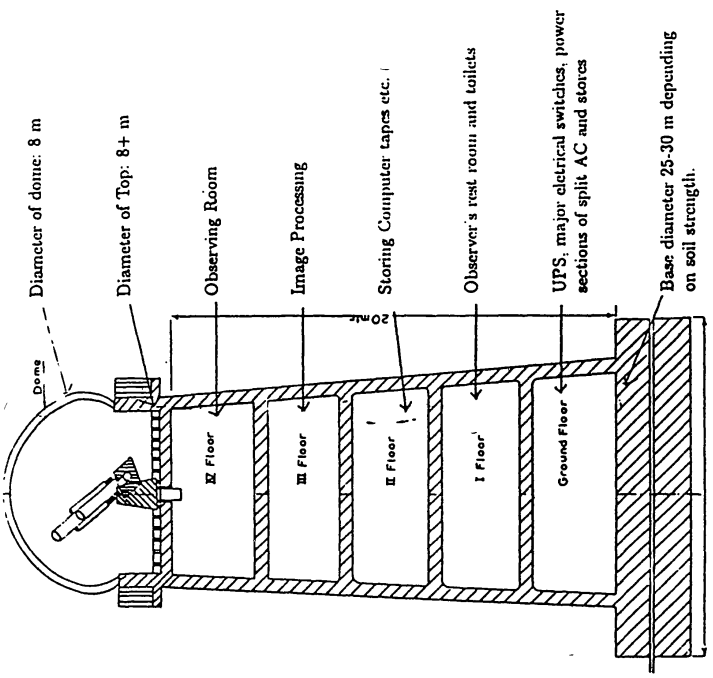
The proposed 60 cm, (focal length 900-cm) SVT will be an equatorial telescope. A 35 cm, (focal length 900-cm) vacuum refractor and two 15 cm refractors will be mounted on the 60-cm SVT tube. The focal lengths of 60 cm SVT and 35-cm refractor are 900 cm to achieve same plate scale. Most recently a group of scientists from Canary Islands have observed sunspots flux tubes of about 0.3 arcsec. To achieve 0.3 arcsec spatial resolution, the aperture of the proposed SVT should be 60 cm. The temporal resolution of the CCD camera for the flare observation will be 25 msec. The detail of SVT is given in the detailed project report of "Modern Optical facilities at Devasthal, near Naini Tal, Uttar Pradesh State Observatory, Naini Tal (1997). The total cost of the SVT, building including dome and backend instruments is about Rs.10 crores. Sketch diagrams of the SVT and its tower is given in Fig. 1. The optical diagram of the SVT is shown in the Fig. 2. The specifications of the SVT given below are tentative and final parameters will be decided at the time of placing order after detailed discussions. The main features of the proposed SVT are :

1. 60 cm SVT :

(a) 60-cm f/2.5 primary zerodur mirror
(b) Gregorian secondary mirror would result in 900 cm effective focal length of the telescope and will give 0.2 arcsec diffraction limited resolution in a field of view of 5 arcminute diameter.
(c) Final images of 8.5 mm × 8.5 mm area will correspond to 195 × 195 arc sec^2.
(d) With the help of dichroic beam splitters and prisms, the solar image will be divided into four channels to install four filters namely, Hα (6563 Å PB 0.5 Å), Ca II K (3933 Å PB 1.2 Å), Continuum (5500 Å PB 30-50 Å) and a narrow band tunable filter (4200 Å to 6000 Å). The arrangement will allow simultaneous observations of the active regions in four wavelengths.

2. 35 cm vacuum refractor :

(a) Refractor's clear aperture is 36 cm (f. 1. 280 cm); with a Barlow lens the effective focal length will be enlarged to 900 cm.
(b) 8.5 mm image will correspond to 195 arcsec. Thus plate scales of 60-cm SVT and 35-cm refractor are almost the same.
(c) A beam splitter, two KD*P modulators and two birefringent filters at 5324 Å (PB 0.15 Å) and 4861 Å (PB 0.12 Å) will be used on this refractor to obtain simultaneous vector magnetograms.
(d) The measurements of Stokes parameters (I, Q, U, V) and radial velocities at photospheric and chromospheric heights will be made simultaneously.



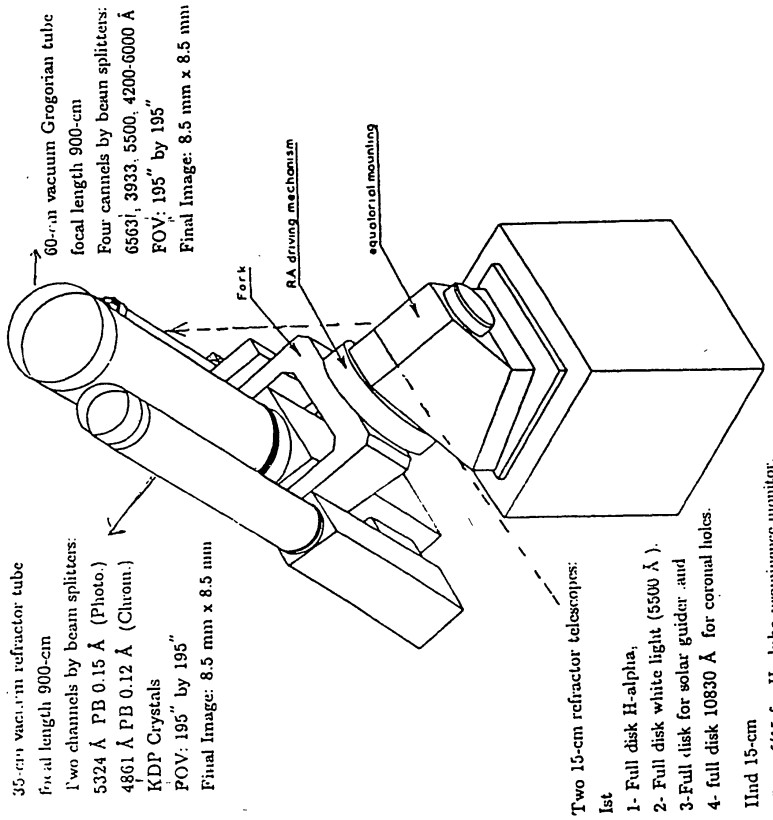


Figure 1. Sketch diagrams of the proposed SVT and it's tower

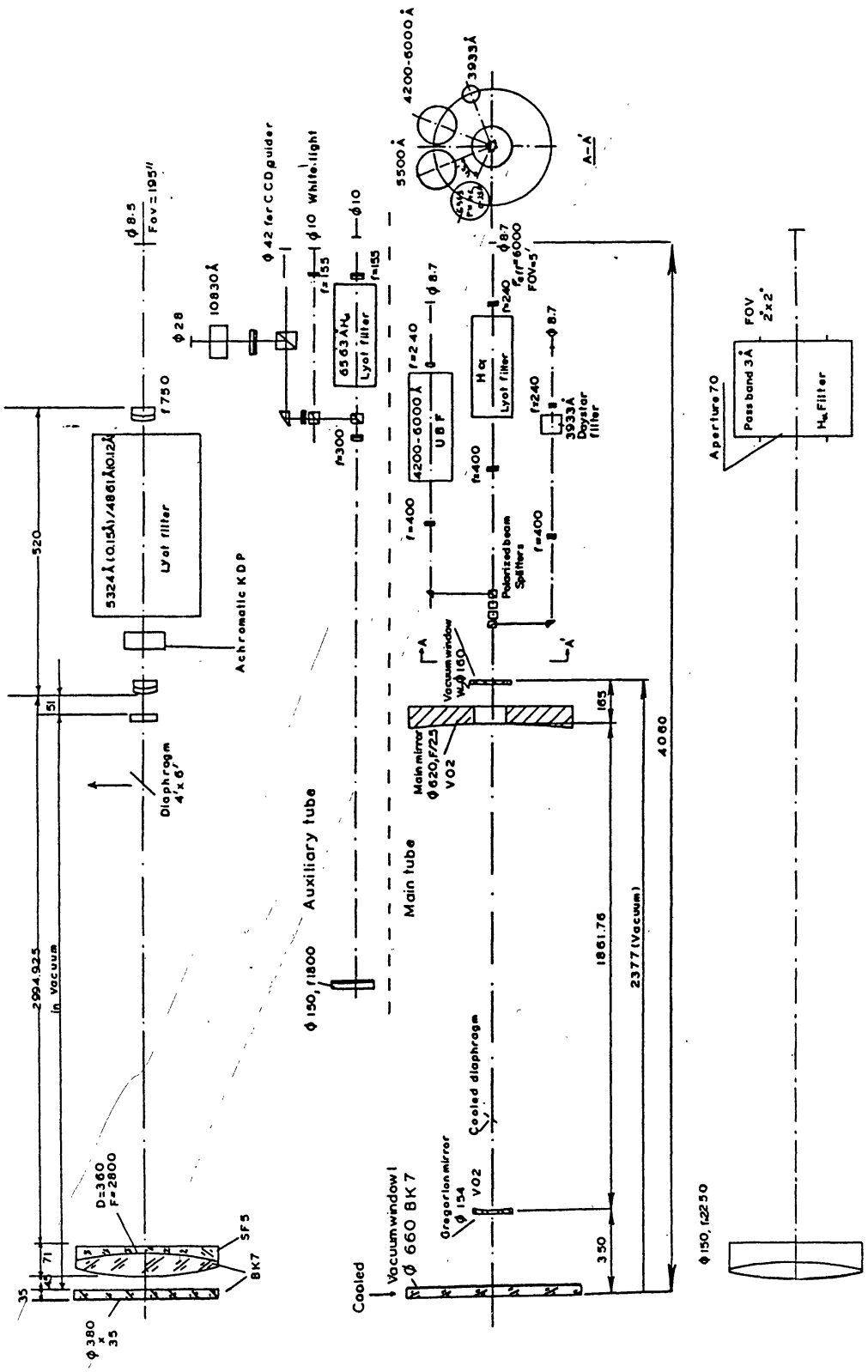


Figure 2. The optical diagram of the proposed SVT alongwith 35 cm refractor, vector magnetograph and two 15 cm refractors for full disk imaging, guider and prominence monitor.

3. First 15-cm refractor :

15-cm, f/12 refractor, with the help of beam splitters, collimating and camera lenses will be used for the following purposes :
(i) full disk imaging in Hα (image size 10 mm)
(ii) full disk imaging in white light (image size 10 mm)
(iii) full disk imaging in 10830 Å HeI (image size 28 mm)
(iv) Solar guider (image size 42 mm)

4. Second 15-cm refractor :

This refractor will be equipped with a 70 mm aperture Hα filter (PB 3 Å) and a CCD imaging system which will allow us to image 2 × 2 degree field at a spatial resolution of about 5 arcsecond. The system will be used as prominence monitor.

5. CCD systems :

To achieve higher spatial resolution we have opted for 16 bit CCD camera for SVT backend instruments. A total of eight CCD systems will be used at various focal planes of SVT. The specifications of the CCD systems are given below :
(i) CCD having 512 × 512 pixels, square pixel size of 15μ, 16-bit A/D convertor and a read out rate of 1-4 mega pixels/sec (4 Nos.)
(ii) CCD having 512 × 512 pixels, square pixel size of 24μ, 16-bit A/D convertor and a read out rate of 1-4 mega / sec (2 Nos.)
(iii) CCD having 2048 × 2048 pixels, square pixel size of 15μ, 16-bit A/D convertor and a read out rate of 0.5-1 mega pixels / sec (1 Nos.)
(iv) CCD having 2048 × 2048 pixels, square pixel size of 24μ, 16-bit A/D convertor and a read out rate of 1 mega pixels / sec (1 Nos.)

6. Computer systems :

Several Sun Sparc computer systems with adequate memory, disk space and archiving facilities will be required to operate the CCDs and collect enormous amount of data. Suitable computing facilities for data analysis will also be required.

Acknowledgements

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