THE NEW SOLAR SUBMILLIMETER-WAVE TELESCOPE PROJECT(SST)

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In the range of submillimeter to infra-red wavelengths the characteristics of Solar emissions from the disc, active regions and flares are essentially unknown because only few observations have been carried out in the past. Excess far-IR thermal emissions from active regions have been detected by a balloon borne experiment (Degiacomi *et al.*,1984). One first attempt to measure flare emissions in the far-IR was inconclusive (Hudson, 1972). Unusual intense flare emissions was qualitatively found at 250 GHz, using an optical telescope (Clark and Park, 1968). Further flare measurements were obtained at millimeter wave frequencies below 100 GHz most of them suffering from unsufficient sensitivity and time resolution. Several large and small bursts exhibited spectra suggesting peak emission at frequencies above 100 GHz(Croom,1970; Cogdell, 1972; Shimabukuro, 1972; Kaufmann *et al.*, 1985; Correia *et al.*, 1992).

There are strong observational and theoretical indications stressing the need for measurements of the solar activity in the wide submillimeter to infrared region (see reviews by Kaufmann, 1988; Falciani,1988). Figure 1 summarizes our current knowledge of the solar flare emission spectrum. The various curves in the submm and IR range were derived from model calculations not verified by reliable observations. Thermal models were proposed assuming sources optically thick at mm-waves and thin at shorter wavelengths, explaining a possible flattening of the submm spectrum (Shimabukuro, 1970); or to explain white light continuum flare emission by sources optically thin in the visible, and thick in the IR (extending to the submm range) (Ohki and Hudson, 1975). Synchrotron models were put foward to explain white light flares with an important emission component in the IR (Stein and Ney, 1963; Shklovsky, 1964). The fast several (tens of milliseconds) spikes observed at mm-waves and hard X-rays might be explained by the emission of ultrarelativistic electrons (emitting mostly in the IR), with inverse Compton action accounting for the hard X-ray spikes and the fast time scales (Kaufmann *et al.*, 1986).

In order to gain the lacking insight into the solar emission in the submm-IR range a new solar telescope is planned. It will operate at two frequencies, tuned to transparent

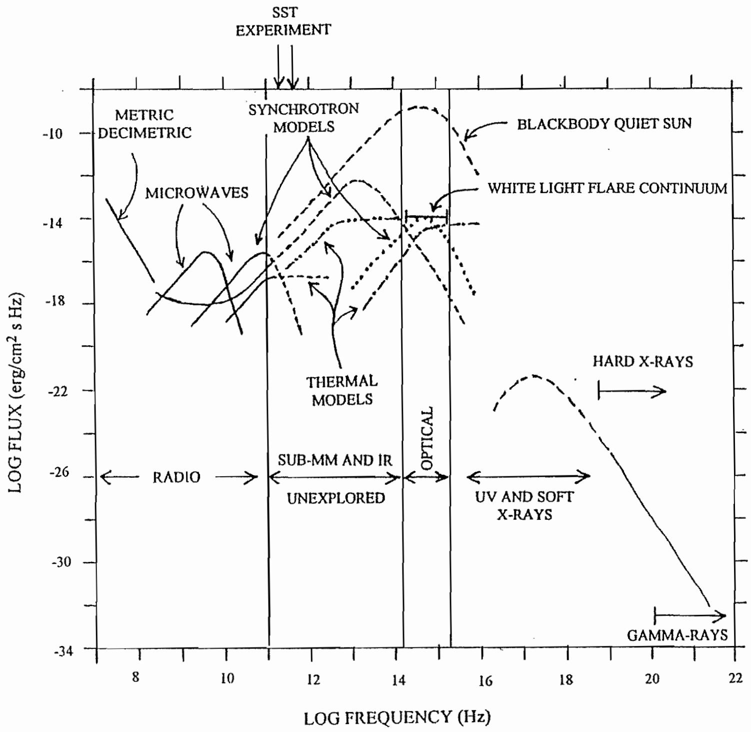

Fig. 1. Spectra of solar flare emissions, from radio to gamma rays. Fluxes are for sources assumed small compared to antenna beams (i.e. few arcmin), except for the blackbody background which is integrated over the solar disc.

atmospheric windows positioned at the high quality site of El Leoncito in the Argentinian Andes, near San Juan, Argentina. This mountain site has almost 300 clear days per year, most of them with a very low total water vapor content, ranging from 0.5 to 3 mm (Filloy and Arnal, 1991). The atmospheric transmission windows for El Leoncito were calculated by Kampfer (1991), indicating the best operating frequencies centered at 210 and 405 GHz. Figure 2 shows predicted atmospheric transmission for the 390-420 GHz band, for 45 degrees elevation angle, 0.55mm of precipitable water content and 10% of relative humidity.

The solar submm-wave telescope (SST) concept evolved from the experience with the large antenna of Itapetinga for solar observations at mm-waves (Kaufmann *et al.*, 1982), and flare dynamic imaging at 48 GHz with multiple beams (Georges *et al.*, 1989; Herrmann *et al.*, 1992; Costa *et al.*,1993). A compromise between the field of view and spatial and temporal resolution was achieved by a beam size of the order of a few arcminutes (typical diameter of an active region) and a sufficient sensitivity for small events of a fraction of a s.f.u. at a high time resolution of 1 millisecond. Figure 3 shows a simplified diagram of the SST, using a 1.4-m dish inside a radome. A Cassegrain focal array will feed one receiver at 405 GHz and three at 210 GHz providing beamwidths of 3 arcmin and 1.5 arcmin, respectively. The correlation of the multiple beam response to the burst emission allows the determination of its spatial location within arcseconds, similar to the technique successfully used at 48 GHz (see example shown in Figure 4).

The SST proposal submitted to S. Paulo State research agency FAPESP is currently under consideration. Complementary resources will be provided by IAP (University of Bern), IAFE (Buenos Aires, Argentina), CASLEO (San Juan, Argentina), CRAAE (universities of S. Paulo, Campinas, Mackenzie and the national space institute INPE), and NUCATE (Campinas State University).

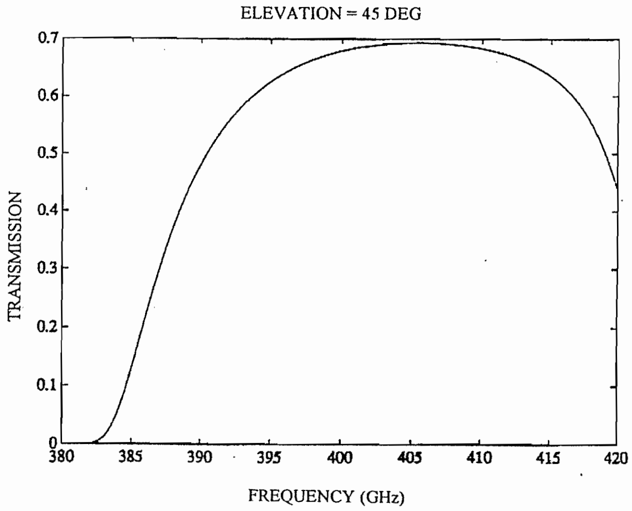

Fig.2 Atmospheric transmission at the 390-420 GHz band predicted for El Leoncito, at 45 degrees of elevation, on an optimum day (Kampfer, 1991)

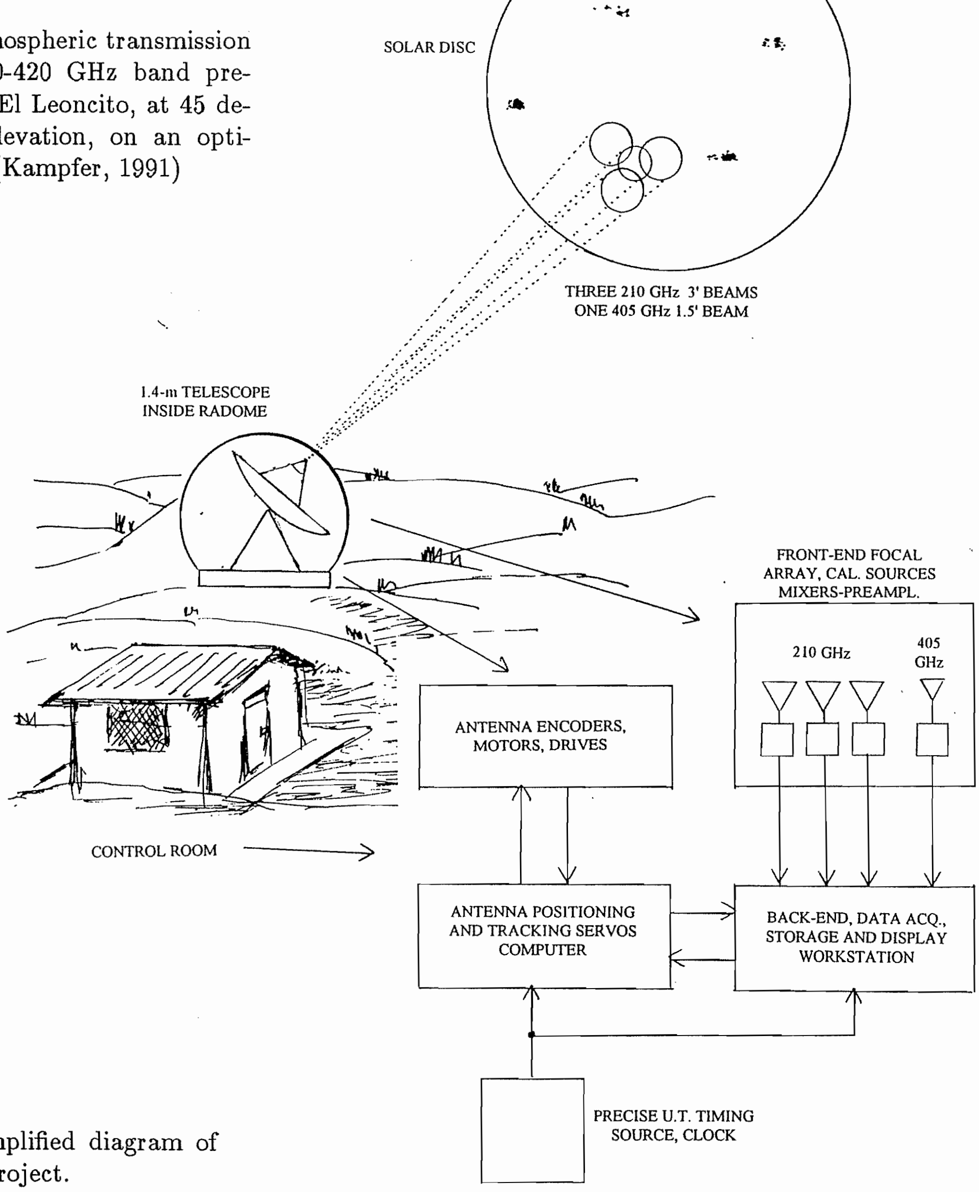

Fig.3 Simplified diagram of the SST project.

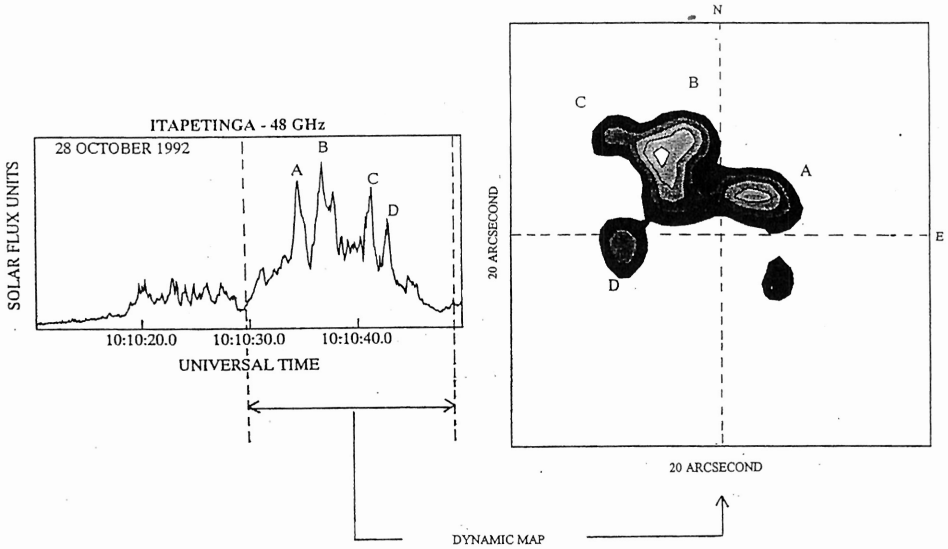

Fig.4 Example of flare spikes' spatial location obtained at 48 GHz with the multiple beam system at the Itapetinga 13.7-m antenna (from Correia *et al.*, 1994). Similar capabilities are planned with the 210/405 GHz focal array of the SST.

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