Progress Report of the New Solar Submm-Wave Telescope (SST) Installation

Pierre KAUFMANN,[1,2] Andreas MAGUN,[3] Hugo LEVATO,[4] Marta ROVIRA,[5] Kaspar ARZNER,[3]
Emilia CORREIA,[1,6] Joaquim E.R. COSTA,[1,6] Carlos G. GIMÉNEZ DE CASTRO,[7] Niklaus KÄMPFER,[3]
Jean-Pierre RAULIN,[7] Eric ROLLI,[7] and Adriana V.R. SILVA[7]

[1] *CRAAE (Mackenzie, INPE, USP, UNICAMP) Instituto Presbiteriano Mackenzie, Rua da Consolação, 896, 01302-000 São Paulo, SP, Brazil*
[2] *Mackenzie*
[3] *Institute of Applied Physics, University of Bern, Sidlestrasse 5, CH-3012, Switzerland*
[4] *Complejo Astrónomico El Leoncito, CC. 467, 5400, San Juan, Argentina*
[5] *Instituto de Astrónomia y Física del Espacio, CC. 67, Sucursal 28, 14 28, Buenos Aires, Argentina*
[6] *INPE*
[7] *FAPESP Post-doctoral Fellow*

Abstract

The Solar Sub-Millimeter wave Telescope (SST) is now in its final stage of construction and a definite schedule has been established. The 1.5 m diameter reflector has been completed and presents an excellent surface with a deviation of 18 microns (r.m.s.). The reflector construction employed the new "slumping" technique (Martin et al. 1998). The SST building, including one 3.4 m gore-tex radome and a room for optical imaging spectrographs (from IAP, Bern and OV, UFRJ, Brasil), has been completed now at El Leoncito, San Juan, Argentina. Numerous electrical, electronical, mechanical tests, as well as software tests, have been performed at the IAP, Bern, Switzerland, and at Itapetinga, Brasil. The SST was assembled in Bern, consisting of the 1.5 m reflector, four 210 and two 405 GHz radiometers, the positioner, the interface box between the reflector and the radiometers, and the counter-weights. Part of the tests and integration of the SST is beeing done at Bern, with a co-participation of researchers and technicians of CRAAE and CASLEO. The shipment of the SST to El Leoncito will be in February 1999, and the final installation is scheduled for the period March-May 1999.

The SST project received main financial support from the Brazilian Agency FAPESP (Proc. 93/3321-7), complemented by funds from the IAFE and CASLEO/CONICET, Argentina, and the IAP, Switzerland.

Key words: Instruments — Sun: activity — Sun: corona

1. Introduction

We present the current status of the Solar Submm-wave Telescope (SST Project) installation. The SST is the first instrument designed to observe the solar continuum radiation at submm wavelengths. The two operating frequencies have been selected in the center of atmospheric windows at 210 GHz and 405 GHz. A preliminary outline of the project has been presented by Kaufmann et al. (1994), and a progress report was presented at CESRA meeting (Kaufmann et al. 1997). Special attention will be paid to the observation of solar flare emission, with high sensitivity (about 0.1 s.f.u.) and high temporal (1 ms) resolution. A compromise is made between these specifications and the antenna diameter of 1.5 m which produces beams covering a typical solar active region of a few arcminutes size. At 210 GHz a multiple receiver focal array will produce partial overlapping beams, allowing the determination of positions of flare emission sources, when small compared to the HPBW, with an angular accuracy of a few arcseconds, as well as unambiguous flux determinations. This principle has already been used successfully for solar observations at 48 GHz (Georges et al. 1989, Herrmann et al. 1993, Costa et al. 1995, Gimenez de Castro et al. 1998). At 405 GHz two receivers will be used, in single or beamswitching mode observations. One of these receivers will have an additional intermediate frequency channel for the simultaneous measurement of an atmospheric ClO line at 390 GHz in absorption against the solar emission (Kämpfer et al. 1997).

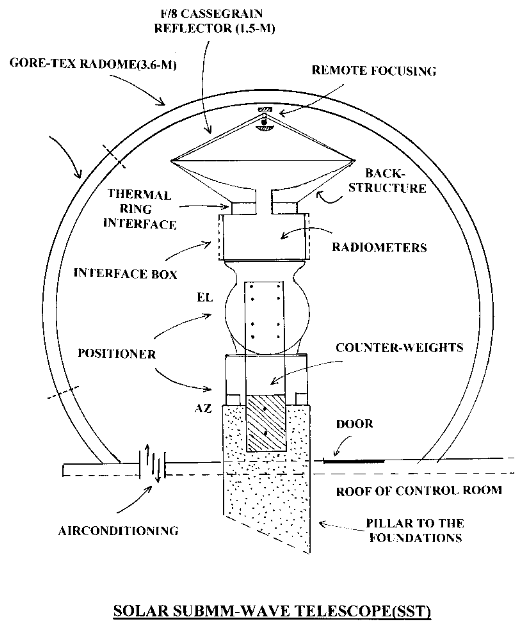
F/8 CASSEGRAIN
REFLECTOR (1.5-M)
GORE-TEX RADOME(3.6-M)
REMOTE FOCUSING
BACK-
STRUCTURE
THERMAL
RING
INTERFACE
RADIOMETERS
INTERFACE BOX
EL
POSITIONER
COUNTER-WEIGHTS
AZ
DOOR
ROOF OF CONTROL ROOM
AIRCONDITIONING
PILLAR TO THE
FOUNDATIONS
SOLAR SUBMM-WAVE TELESCOPE(SST)

Fig. 1..

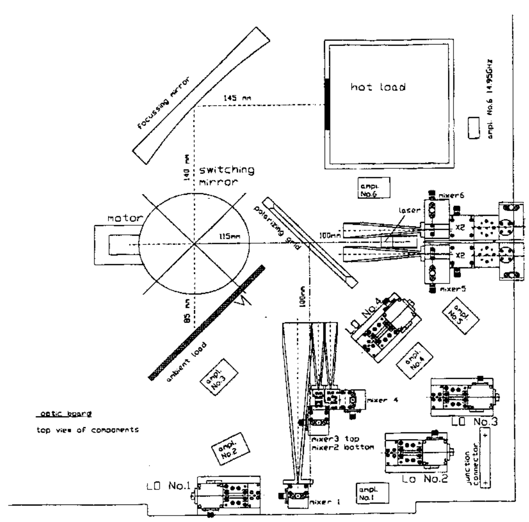
focussing mirror
hot load
145 mm
switching
mirror
motor
115mm
polarizing grid
100mm
laser
mixer6
mixer5
ambient load
LO No.4
mixer 4
LO No.3
optic board
top view of components
mixer3 top
mixer2 bottom
LO No.2
junction
connector
LO No.1
mixer 1

Fig. 2..

Table 1. Principal technical characteristics of SST.

Subsystem	Description	Manufacturer	Notes
Reflector	1.5 m Cassegrain, f/D=8, aluminium surface, backstructure and thermal interface ring. Built using new "slumping" technique (Martin et al. 1998). Measured Mechanical accuracy 18μ r.m.s	University of Arizona Steward Observatory Tucson, AZ, USA	Subreflector can be focused axially. Delivered in March 1998.
Receivers (405 GHz)	2 receivers, optimum feed-horn taper; system noise temperatures $\sim$ 3000 K; 2 IF-channels for solar (0.5-1.5 GHz DSB) and ClO line (390 GHz) measurements (14.3-14.7 GHz)	RPG-Radiometer Physics, Meckenheim, Germany	HPBW of approx. 2 arcmin. Delivered in May 1997
Receivers (210 GHz)	4 receivers, one with optimum feed-horn taper, three in cluster with small taper; producing beams overlapping at half-power points; system temperature $\sim$ 3000 K; IF 0.5-1.5 GHz, DSB	RPG-Radiometer Physics, Meckenheim, Germany	HPBW of approx. 4 arcmin. Delivered in May 1997
Positioner	El-Az, inductosyns, 3.6 arcsec. accuracy and 12 arcsec. repeatability; max. speed 2 deg.sec^{-1}, max. accel. 2 deg.sec^{-2}	ORBIT Advanced Technologies Netanya, Israel	Astronomical pointing calibrations may improve measured specs. Delivered November 1996
Radome	2.7 m height, 3.3 m diameter, Gore-Tex membrane on metal space frames	ESSCO Concord, MA, USA	high transparency for submm waves. Delivered February 1997

Figure 1 summarizes the principal components of the SST. It will placed on the roof of the control room, with the antenna positioner supported by a concrete pillar rooted in the rock underlying the building. For weather and heat radiation protection the SST will operate inside a thermally controlled gore-tex radome. Figure 2 shows the geometrical setup of the receivers, as seen from the top. A motor-controlled mirror is used to select the signal from the antenna or the two calibration loads. The two observing frequencies are separated from the incoming signal by a polarization grid letting the transmission in one polarization to the 450 GHz feed-horns, and reflecting the other polarization plane into the 210 GHz feed-horns' array. All SST subsystems have been built, accepted, and are presently assembled at the Institute of Applied Physics, University of Bern, Bern, Switzerland, and are undergoing several tests of hardware and software developments, before their shipment to Argentina, in February 1999.

Table 1 shows the basic technical characteristics of the system, as well as the manufacturers and the delivery dates.

The SST will operate at the El Leoncito Astronomical Complex, CASLEO in the Argentinean Andes (province of San Juan). Its high altitude of 2500 m, the very low atmospheric water vapour content and the nearly 300 clear days per year will provide atmospheric transparency for submm waves. Most of the days during the 6 cooler months have a total water vapour content considerably less than 1 mm (Filloy and Arnal, 1991).

The main technical and scientific objectives of the SST project can be summarized as follows:

- Explosive component of solar flares:
  - spectral component in the submm wave range
  - fast time structures, resolution $\sim$ 1 ms, flux $\geq$ 0.1 sfu
  - existence of genuine submm-IR emission component
  - correlation to other solar observations (radio, optical, X-rays)
  - angular positions of bursts emission at 210 GHz
- Quiet sun:
  - evolution of active regions

  - disk temperature, center, limbs
  - monitoring of solar submm wave diameter

- Propagation experiments:
  - atmospheric absorption
  - irregular refraction, "seeing", use of bacon transmitters, solar limb tracking
  - search for ClO at 390 GHz (N. Kämpfer, PI)

- System performance:
  - beam patterns determination (beacons, planets, moon, sun)
  - SST parameters versus radome thermalization

- Optical spectographs fast photometry/imaging in Hα, Hϵ and Ca lines (Wülser and Marti 1989, Rolli and Magun 1994).

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