Chinese concept for SKA

Kilometre-square Area Radio Synthesis Telescope

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Abstract

The collecting area of a telescope is a figure of merit of that instrument's capability. A Five hundred meter Aperture Spherical Telescope (FAST) is proposed to be built in the unique karst area of southwest China, and will act, in a sense, as a prototype for the Square Kilometre Array (SKA). It will be over twice as large as the Arecibo radio telescope coupled with much wider sky coverage. FAST can be seen as an "Arecibo-type with active main reflector", the telescope is "pointed" by moving the feed cabin, while the reflector surface is deformed in synchronism with the feed pointing motion. Feasibility study on FAST key technologies has been made successfully as a key project in the Chinese Academy of Sciences (CAS) since 1999. It should be remembered that if we have twice as much sensitivity, for uniformly distributed object we will look twice as far in space, and should find eight times as many objects.

Introduction

Chinese astronomers are planning to build a set of large (Arecibo-style) spherical reflectors by making use of the extensively existing karst landforms, which are bowlshaped limestone sinkholes named after Karst, a Jugoslavian geologist. We refer this as Kilometre-square Area Radio Synthesis Telescope (KARST) approach. KARST would be consisted of about 30 individual elements, each of roughly 200 m in diameter. As a forerunner for the KARST, the FAST is planned to be constructed as a National Megascience Project of China, with an estimated cost of ~60 *M US$* around the year 2006.

It is well known that the central part of a spherical surface deviates little from a parabolic as a proper focal length is chosen, based on which, a novel design for a giant spherical reflector is proposed. The illuminated part of the spherical reflector (Fig.1) is to be continuously adjusted to fit a paraboloid of revolution in real time by actuated active control, synchronous with the motion of the feed while tracking an object. A standard feed system can then be adopted to achieve a broad bandwidth and full polarization capability through the total elimination of spherical aberrations.

FAST reflector, as shown in Fig.1, is a spherical cap with a radius of R ~ 300 *m* and an opening up to 500 *m* in diameter. The effective aperture of ~300 *m* is illuminated by the feed moving on the focus surface halfway from reflector to its center. Since the focal length of FAST is to be set < *R/2*, a portion of the parabola lies above the sphere. Then the two curves have three points of intersection, the first being at the common point of tangency (the point of osculation) and two more points, on opposite sides of the first, that move away from it. Somewhere between these points and the point of osculation the displacement between the two curves clearly reaches a maximum. The geometrical configuration will enable the FAST to have a larger sky coverage (> 40° zenith angle) than the Arecibo telescope (~ 20° zenith angle), and the simplified feed system will continuously cover most of the frequency range between 100 and 2000 *MHz*, with capability up to 5 or even 8 *GHz* depending upon the cost.

The telescope is “pointed” by moving the focus cabin and adjusting simultaneously the shape of the illuminated area. A new design for the feed-support structure (Fig. 2) has been proposed by using six suspended cables connected to mechanical servo-control systems, which integrates optical, mechanical and electronic technologies, will effectively reduce the cost of the support structure and control system. The whole system will mainly consist of three parts: firstly, the six cables will be driven by six sets of servo-mechanisms controlled by a central computer, so that the movement of the focus cabin along its caustic trajectory can be realized. Given the difference between the apparent and required positions, where the feed (cabin) should point, the central computer will drive each servo-mechanism to adjust the position of the feed. Secondly, a group of receivers with multi-beam feeds will be mounted on a stabilizer in the focus cabin. This is to provide a second adjustment, since the cabin driven by cables alone may not achieve the pointing accuracy required. A laser ranging system, being the third part, will be adopted to accurately measure the position of the feed in real time. The information will be fed back to the central computer for global loop control.

The FAST obviously will achieve, as a single dish, the largest collecting area in the world.

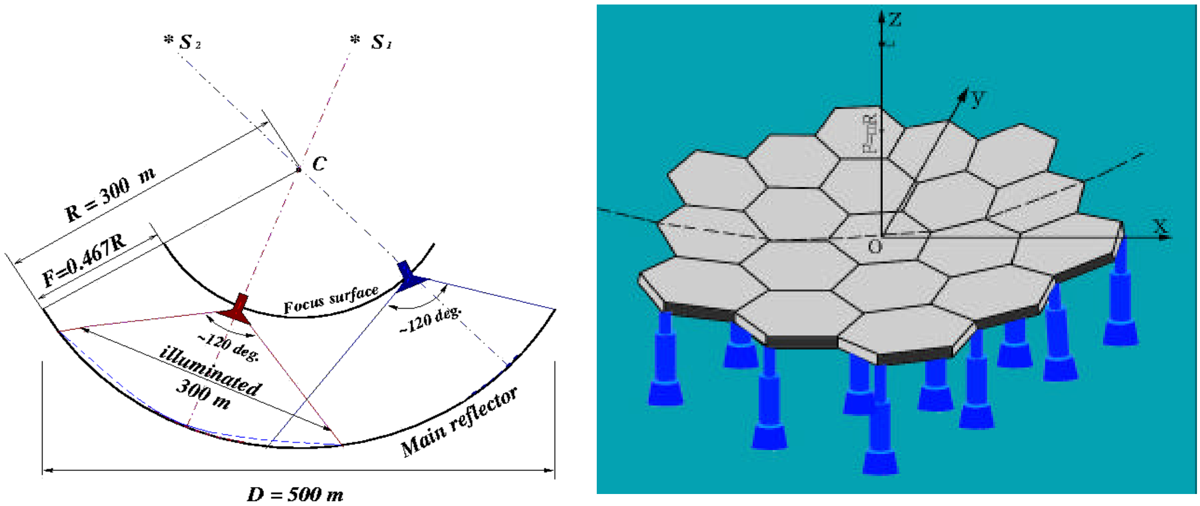

Fig.1 FAST geometrical configuration and active main reflector

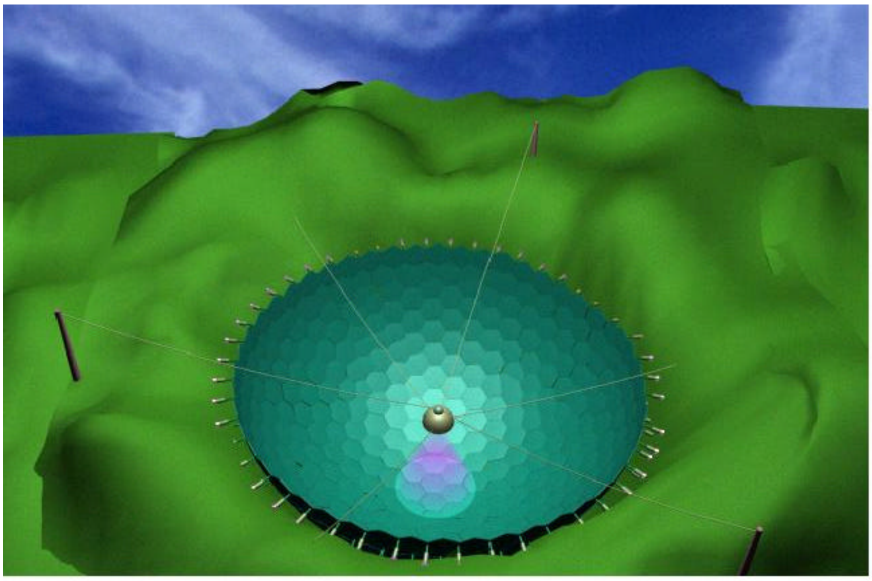

Fig.2 Cable support system without a platform and FAST concept