# TIME VARIATION OF THE GLOBAL SOLAR MAGNETIC FIELD INFERRED FROM THE SUN'S SHADOW AS SEEN IN 10 TeV COSMIC RAYS

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## 1. Introduction

Air shower arrays with high counting rates at high altitude provide a unique means for the study of the time dependence of the Sun's shadow as seen in cosmic rays (Amenomori et al. 1992). With the Tibet-I array, operated from 1990 to 1993 at Yangbajing (4300m), we detected for the first time the influence of the solar and interplanetary magnetic fields (IMF) on the Sun's shadow. In this experiment the Sun's shadow seen by 10 TeV cosmic rays was found at a position 0.°7 away from the position of the Sun. This large displacement is considered to be caused by IMF which changed considerably in 1990-1993, near maximum, and during the declining phase of solar activity (cycle 22). A new Tibet-II array, enlarged in 1994, with a seven times larger effective area than the Tibet-I, has been operating since 1995 and allows us to observe the Sun's shadow every 3-4 months. The solar activity, being in the most quiet phase now in 1995-1997, will return to more active phase in 1998. Here, we present some results obtained in 1996 with Tibet-II array.

## 2. Yearly Variation of the Sun's Shadow

In the previous papers (Amenomori et al. 1993, 1994, 1996), we showed that the position of the Sun's shadow is not only largely displaced from the apparent Sun's center but also varies with change of solar activity as shown in Fig. 1 in 1991-1993. The data in the "away" and "toward" sectors of IMF gave also fairly different positions of the Sun's shadow. The strength of the solar magnetic field by Stanford Mean Solar Magnetic Field (NOAA/USAF 1997), and the mean sunspot number reached the maximum in 1991 and decreased rapidly, although IMF measured by IMP-8 (NASA 1997) at the Earth's orbit was rather stable.

The first ten months data with the Tibet-II array in 1995-1996 gives a deep Sun's shadow whose position is almost at the apparent Sun's center (Fig. 1), consistent with a quiet phase of solar activity. No clear difference between the "away" and "toward" fields is seen in contrast with the results in 1991-1993. This may be interpreted by an ill-defined sector separation in 1995-1996.



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## 3. Summary

Using the data obtained in 1995-1996 with the Tibet-II array, we found the Sun's shadow almost at the apparent Sun's position, although it is largely displaced, and moves from year to year, in 1991-1993.

The continuous observation of the Sun's shadow with the Tibet-II array can provide a new clue for understanding the three-dimensional configuration of the global solar magnetic field under the influence of the coming solar activity cycle 23 with a predicted maximum around the year 2000.

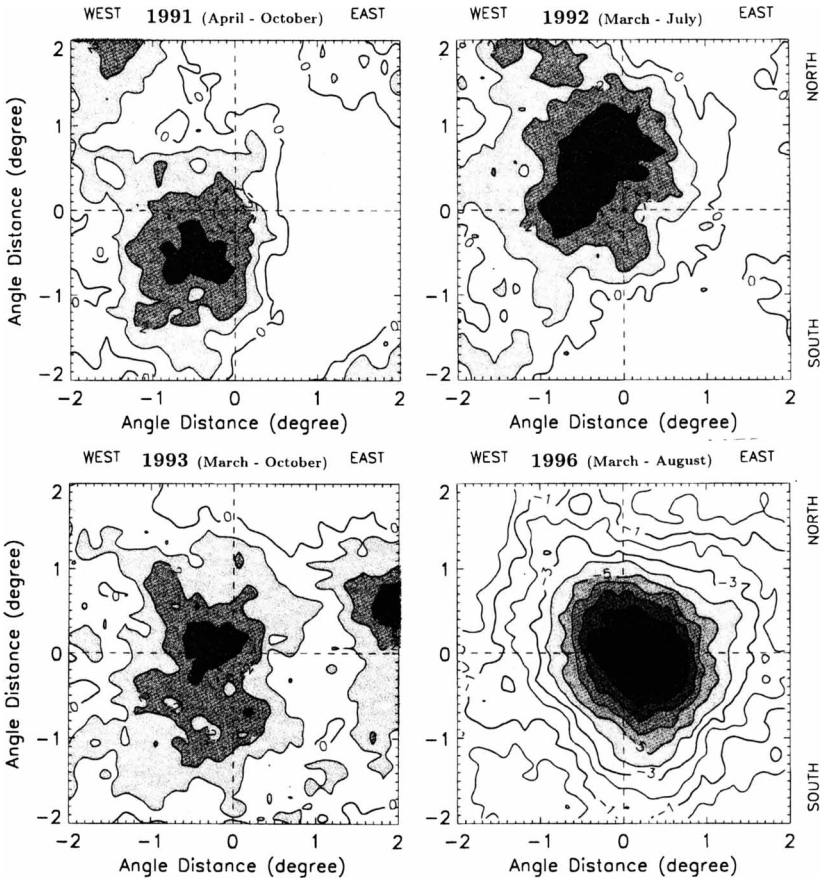


Fig. 1 Yearly variation of the position of the Sun's shadow from 1991 to 1996.

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