The Magnetic Evolution of Coronal Hole Bright Points

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Introduction

Space weather refers to the state of the heliosphere and the geospace environment that are caused primarily by solar activity. Coronal mass ejections and flares originate in active regions and filaments close to the solar surface and can cause geomagnetic storms and solar energetic particles events, which can damage both spacecraft and ground based systems that are critical for society's well-being. Coronal bright points are small-scale magnetic regions on the sun that seem to be similar to active regions, but are about an order of magnitude smaller.

Due to their shorter lifetime, the complete evolutionary cycle of these mini active regions can be studied, from the time they appear in extreme-ultraviolet (EUV) images to the time they fade. We are using data from the Solar Dynamics Observatory (SDO) to study both the coronal EUV flux and the photospheric magnetic field and compare them to activities of the coronal bright point.

Methodology

SDO data were obtained via the Virtual Solar Observatory (VSO). We used AIA 193 Å images of the full disk of the sun with 1 min cadence (Figure.1 top left), and magnetograms (maps of the line of sight photospheric magnetic field, Figure 1 top right) with 45 s cadence. We are tracking a region of 300x300 arcseconds close to disk center using the IDL mapping software for about 20h on 2016-12-16 (red box in Figure 1, top). The selected target region is a coronal hole, seen as a dark region in AIA 193 Å (see Figure 1 left middle), with a coronal bright point that is located close the coronal hole boundary as shown in Figure 1. We calculate the average EUV and magnetic flux of each frame and plot the average flux versus time (Figure 2).

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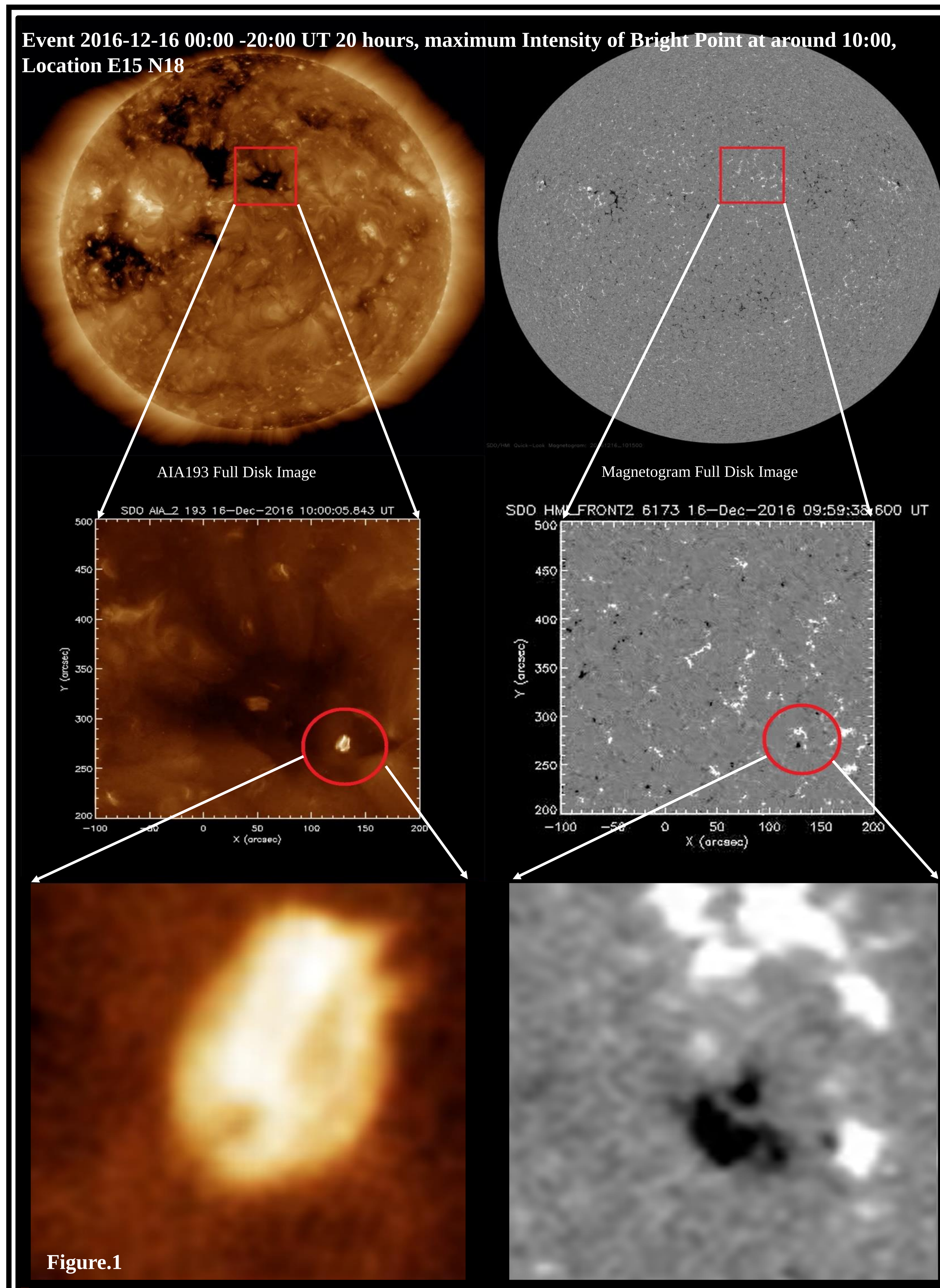

Figure.1

Result

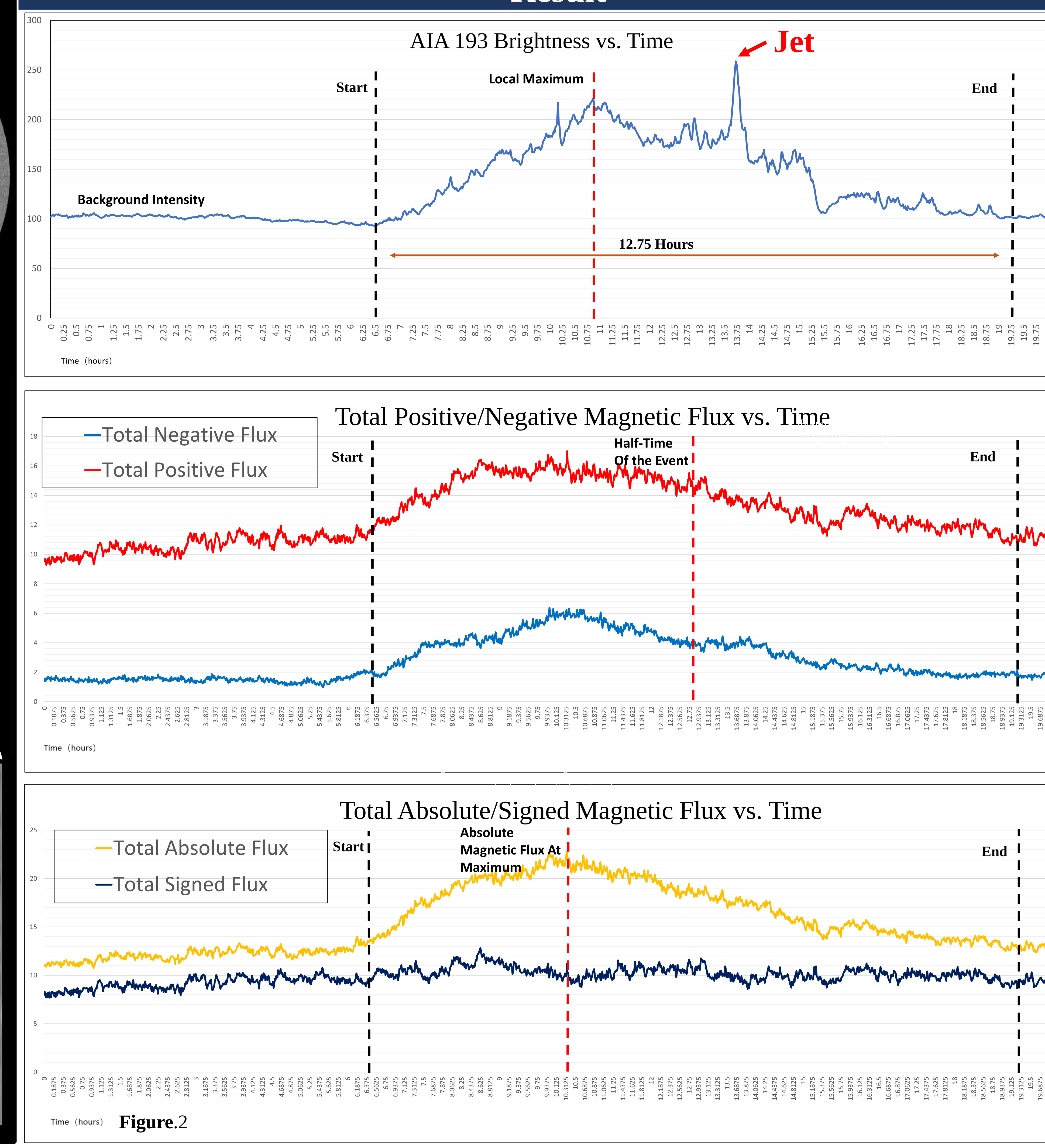

Figure.2

Result & Discussion

Figure 2 shows the integrated intensity in AIA 193 Å of the box in Figure 1 (bottom) which contains the bright point as a function of time. At about 6.5 h the intensity starts to increase which we consider the starting time of the bright point. It reaches its overall maximum intensity at around 10.75h. At around 13.75h is a strong increase in intensity which is due to a jet that is launched from the bright point (these jets are the miniature versions of large-scale CMEs). The middle and bottom plots of figure 2 show the evolution of the photospheric magnetic field. The positive and negative polarity averaged over the box are shown in the middle panel, the integrated signed and unsigned flux in the bottom panel. Both polarities increase with the emergence of the bright point and as the signed flux stays constant, both polarities are balanced throughout the evolution of the bright point.

During the time the bright points fades (downward part of the AIA intensity curve), the magnetic flux also decreases and both EUV intensity and magnetic flux reach background level at around the same time (end of event is at 19.25h). Movies of the magnetic field show that the magnetic flux converges and the flux eventually cancels, reaching the same positive background level as before the emergence.

It is also noteworthy that the jet event happens during the cancellation phase of the bright points lifetime. Almost all numerical models of jets in bright points use flux emergence as underlying process to produce the jets. Our observation disagrees with this mechanism. We are currently studying several additional bright points, getting statistics on duration, flux evolution and jets. In a future study we will also analyze the photospheric flows connected with the coronal bright point evolution.