

# **CORONAL AND INTERPLANETARY TYPE II RADIO EMISSIONS**

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## **ABSTRACT**

It is well established that type II radio bursts are caused by shocks that are associated with flares and coronal mass ejections (CMEs). However the detailed relationship between "metric" type II bursts observed at frequencies above about 10 MHz from the ground and the shocks expected to exist ahead of fast CMEs is a topic of continued debate. We have examined radio data from the Waves experiment on the Wind spacecraft in conjunction with ground-based data in order to investigate this relationship. We find many examples in the Waves 1-14 MHz data in which there are two shock-like phenomena that occur simultaneously at different frequencies with differing morphology. We conclude that type II bursts are flare related and separate from IP type II events that originate in the bow shocks of fast, large CMEs.

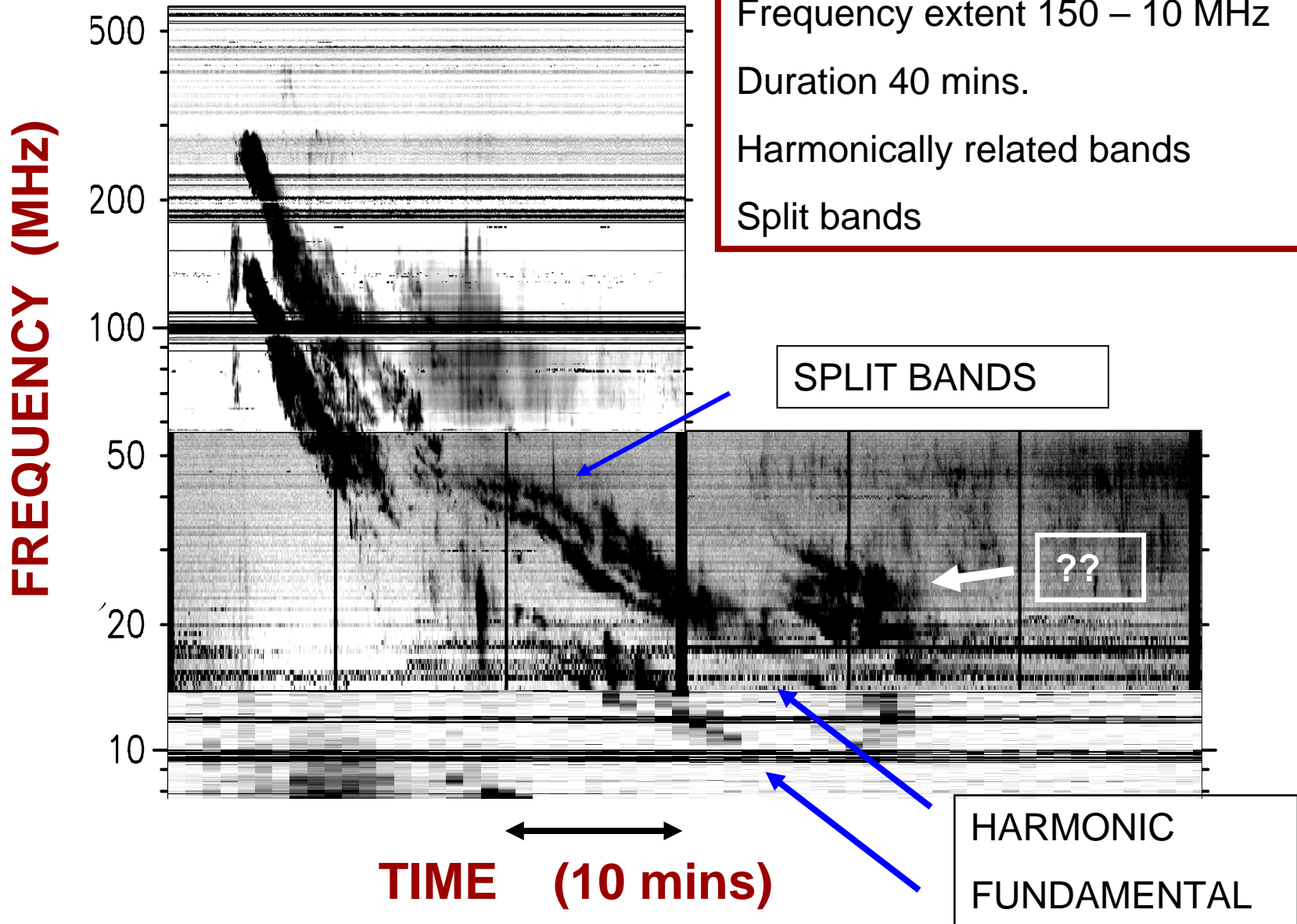
# “TYPICAL” TYPE II BURST

Frequency extent 150 – 10 MHz

Duration 40 mins.

Harmonically related bands

Split bands



**FIGURE 1** shows a dynamic spectrum combining data from three observatories; 570-57 MHz Culgoora, 57-14 MHz BIRS and 14-8 MHz Waves. This event (that occurred Nov. 1 2003) shows the features that identify a type II burst. It is not typical in the sense that:

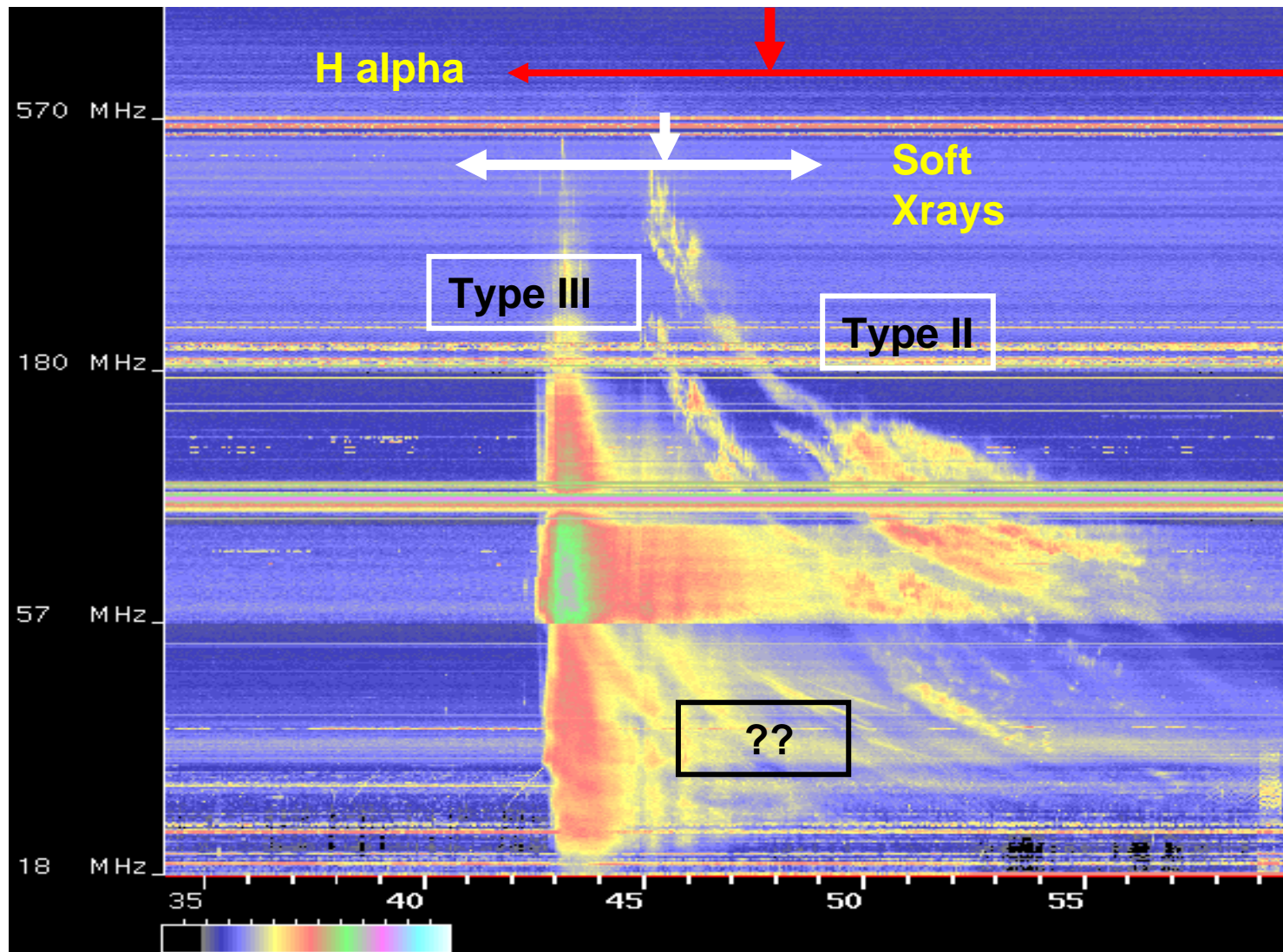
a) starting frequencies are usually below 100 MHz

b) ending frequencies are usually above 20 MHz

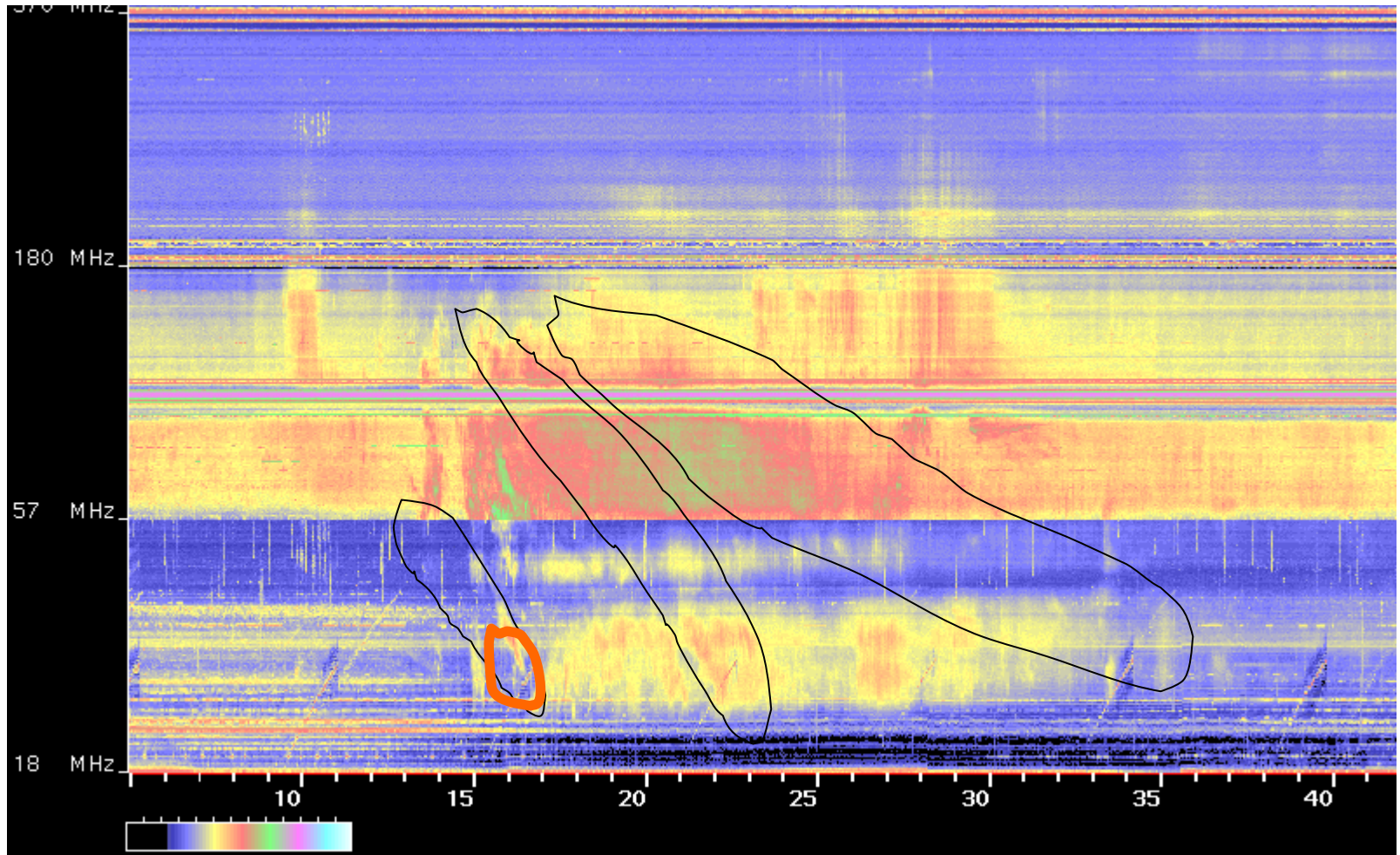
c) durations are more like 10 minutes

c) fast drift emissions (type III bursts) often occur in a distinct group before the onset of the type II burst.

**FIGURE 2** illustrates another type II burst as displayed in the standard format from the Culgoora observatory. This event is the closest I could find to the “typical” activity as shown in textbook cartoons in which there is a group of type III bursts followed by a type II burst. The vertical arrows indicate maximum intensity of the flare emissions; the horizontal lines give the durations. **It is important to note that the bursts appear to have a common origin near the start of the flare.** Note the additional unidentified activity marked by question marks near the type III.



**FIGURE 2**

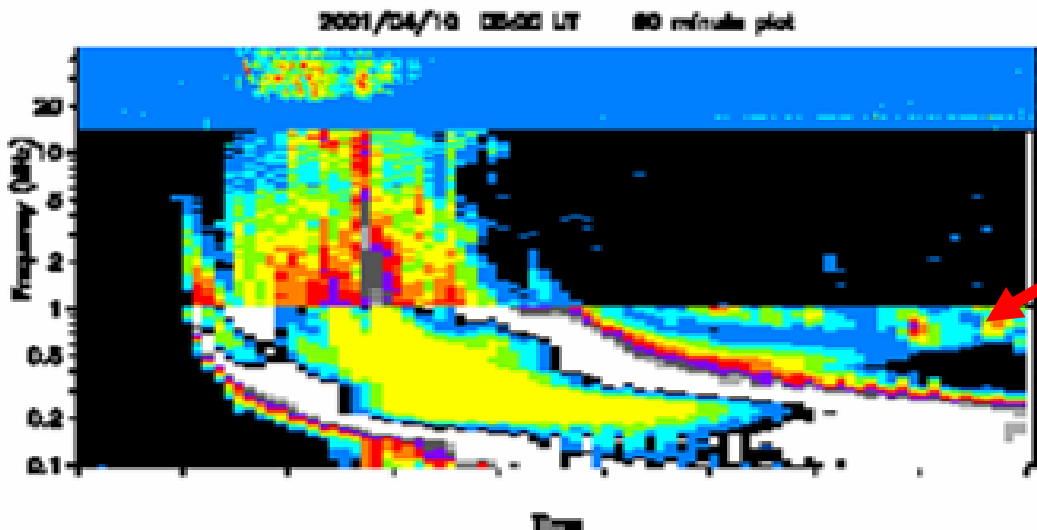


**TYPE II BURST DEFINITION BY FOUR OBSERVATORIES**

**FIGURE 3**

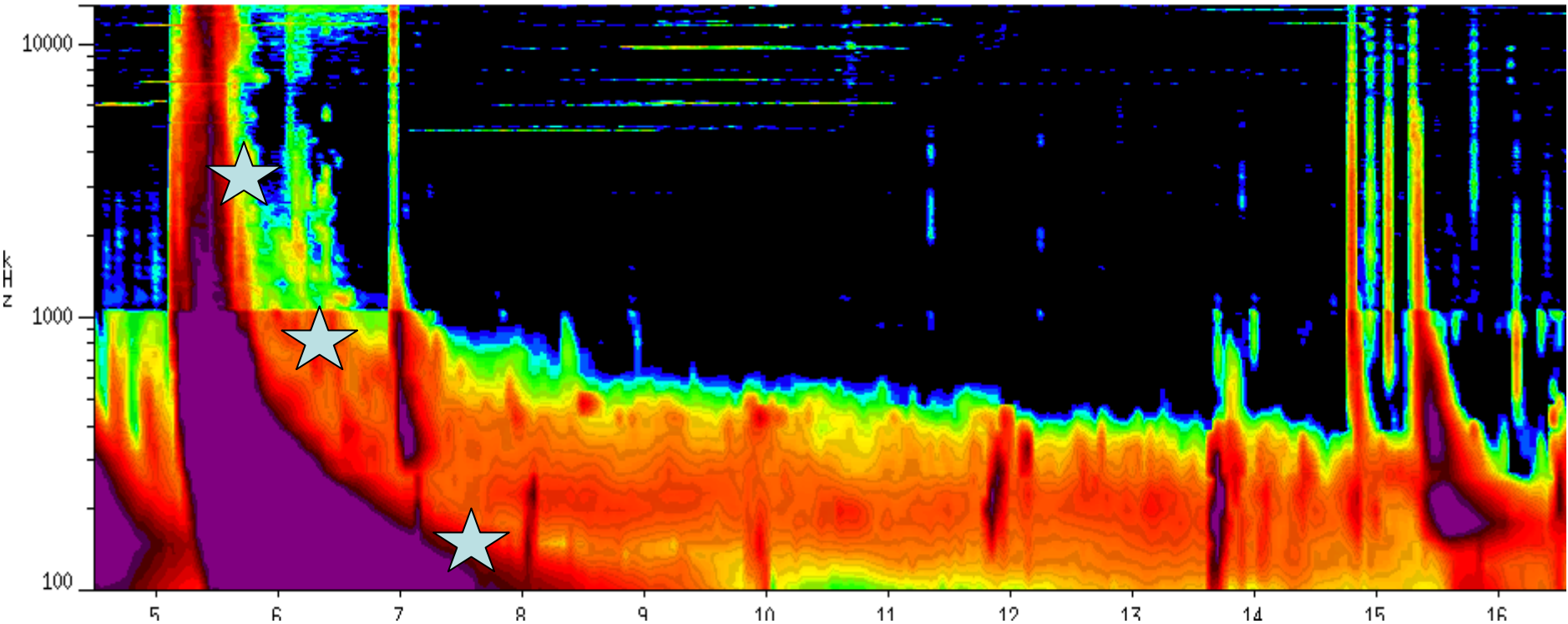
**FIGURE 3** shows a more typical dynamic spectrum for an energetic event. The X2/3B flare lasted more than 3 hours in Halpha. There is no clear type II signature and yet a type II burst was reported by four observatories at the times and frequencies indicated. The dominant activity was wispy type III.

**FIGURE 4a** shows what was observed at low frequencies by the Waves experiment on Wind. This is a very, intense type III burst! But there is something else ...



**FIGURE 4a**

Wind Waves RAD1+RAD2 receiver; 2001/4/10



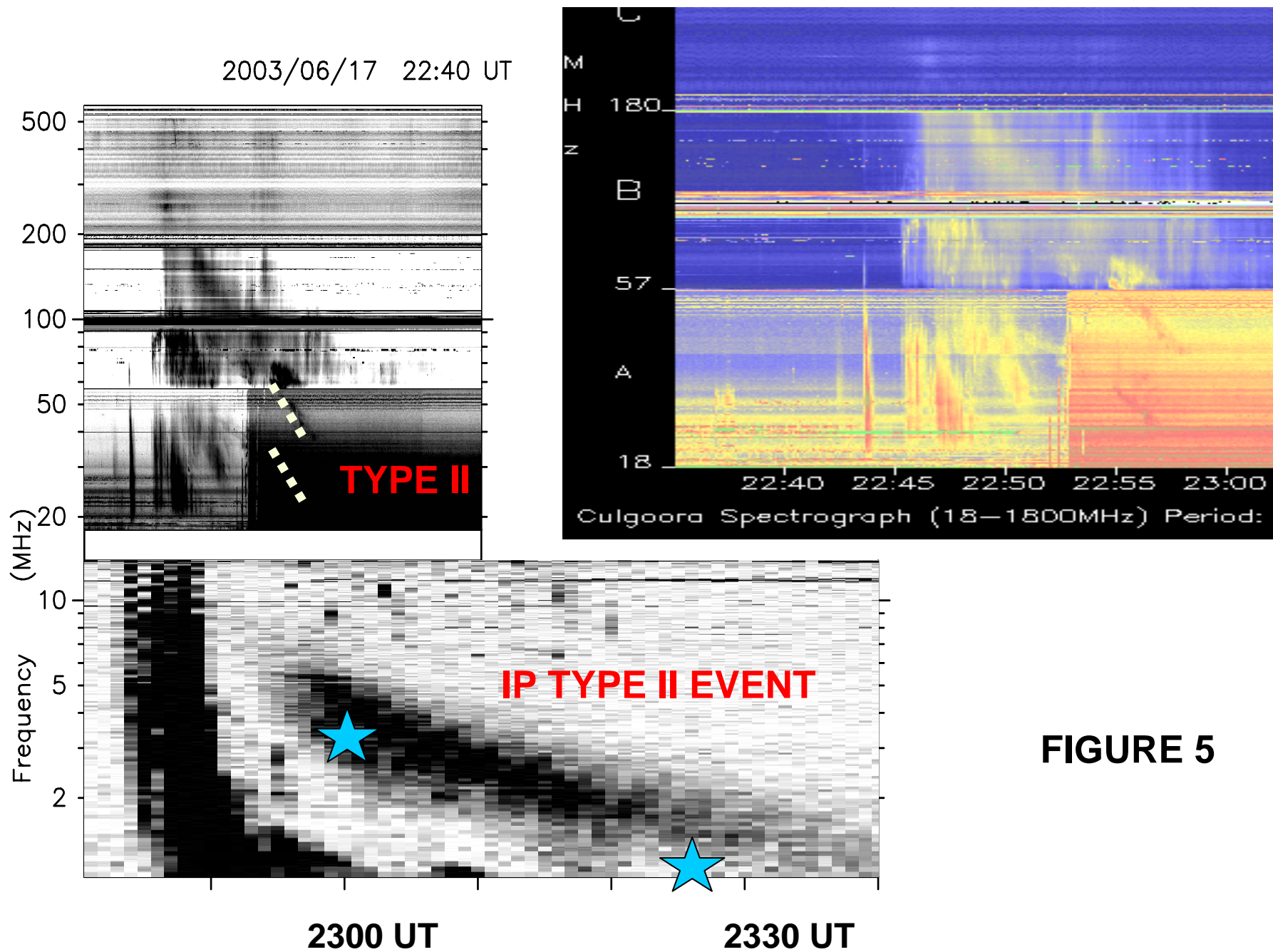
**IP TYPE II EVENT – CAUSATIVE CME TRAVELLED AT ~2400 km/s**

Approximate location of CME leading edge shown by stars

**FIGURE 4b**

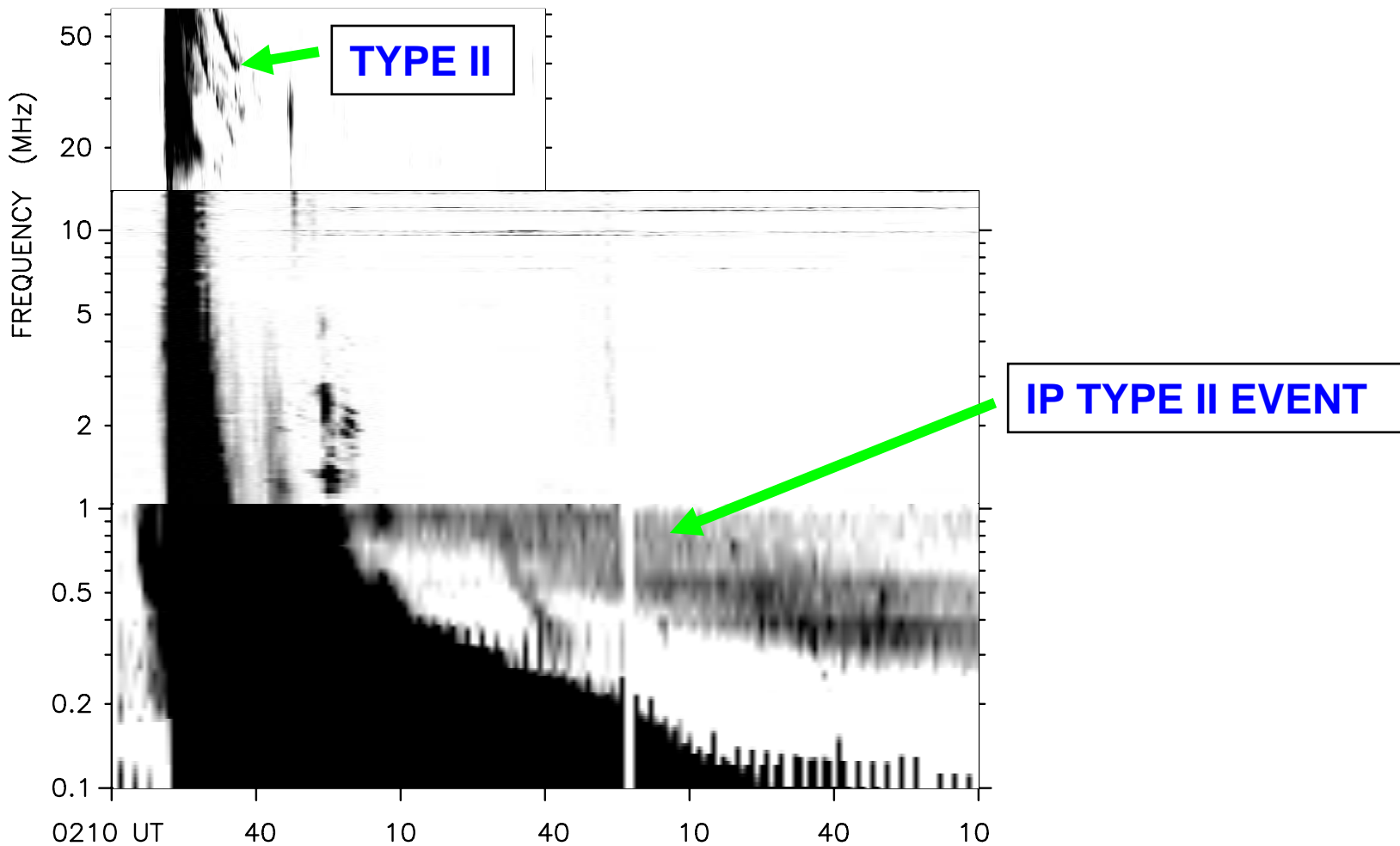
**FIGURE 4b** shows an extended period of Waves data. The broad band starting around 3 MHz is an IP type II event. These were first identified in the 1980's using data from the ISEE-3 radio astronomy experiment. They were found to be associated with the fastest and largest CMEs and to have drift rates consistent with being generated by CME driven shocks. Although not shown it is very unlikely that the narrow-banded features seen in the ground based data could be the high frequency component of the IP shock event.

**FIGURE 5** shows data for another event where the fact that the type II burst and the IP type II event are separate phenomena is more obvious. In the B/W plot the type II is hard to see in the Culgoora data (which has an instrumental problem). It is replicated in the colour plot. The stars show approximately the relative position of the CME leading edge assuming a density model for the corona.



**FIGURE 5**

2003/05/31 02:10 UT 180 minute plot



In **FIGURE 6** the type II burst and the IP type II event are unlikely to be caused by the same shock.

## **SUMMARY**

**Type II bursts seen in the approximate frequency range 200 – 1 MHz are related to flares. They are caused either by blast waves or are driven by flare ejecta. They do not provide information about speeds of interplanetary shocks.**

**IP type II events originate from shocks driven by CMEs. The emission is more intense the faster the shock but only the fastest events create emission detectable by present instruments.**