

Quasi-periodic Pulsations in Radio Emissions and Their Solar Origins

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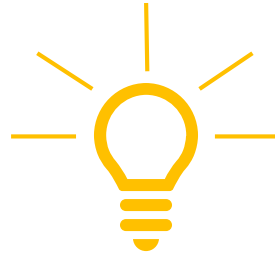
8/30/2019 @NTHU

Outline

1. Introduction
2. Target event
3. Summary

Introduction

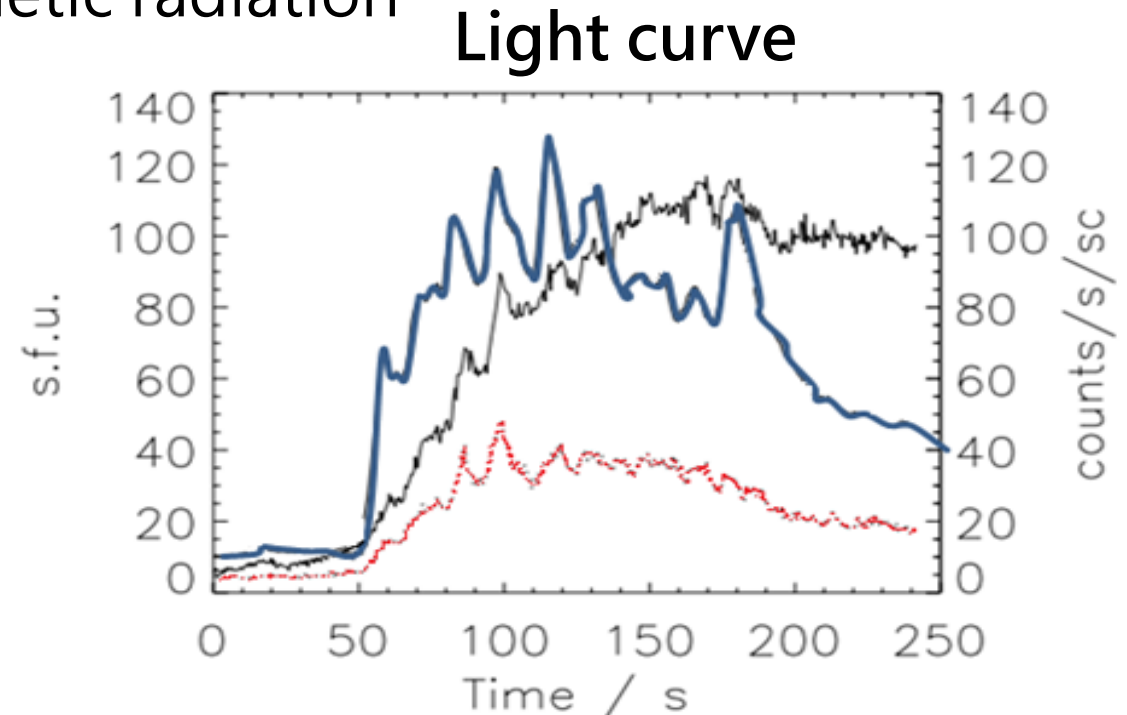
Motivation



Introduction

QPP (Quasi-periodic Pulsation)

- Observed:
 - Every frequency of electromagnetic radiation
 - Every phase of Solar flare



Introduction

Data – Chinese Solar Broadband Radio Spectrometers (SBRS)

- **Location:** north of the Huairou Reservoir
- **Instrument:**
 - 3 spectrometers
 - 1 single frequency receiver
- **Temporal resolution:** 0.2 s & 8 ms
- **Frequency:**
 - 1.10-1.34 GHz, spectral resolution: 4 MHz
 - **2.6-3.8 GHz, spectral resolution: 10 MHz (2011-2013)**
 - 5.2-7.6 GHz, spectral resolution: 20 MHz



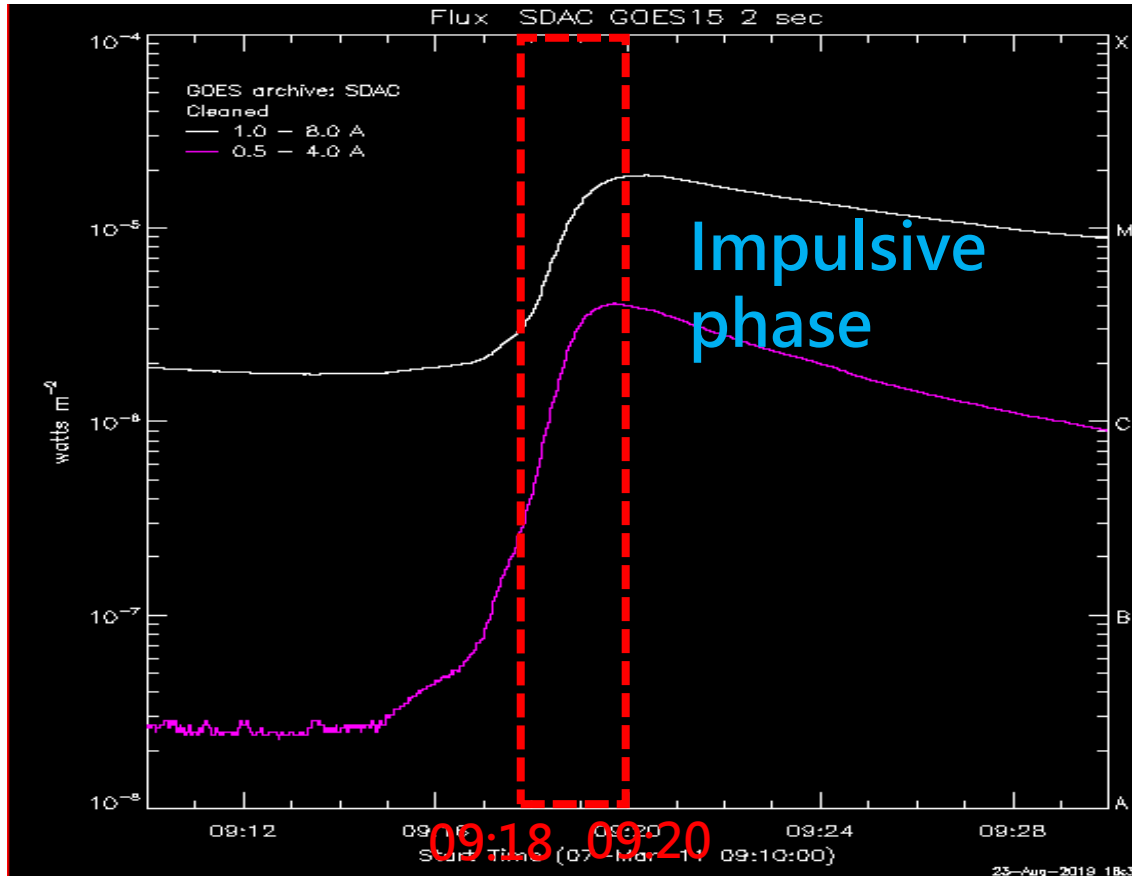
Target Event

QPP #1

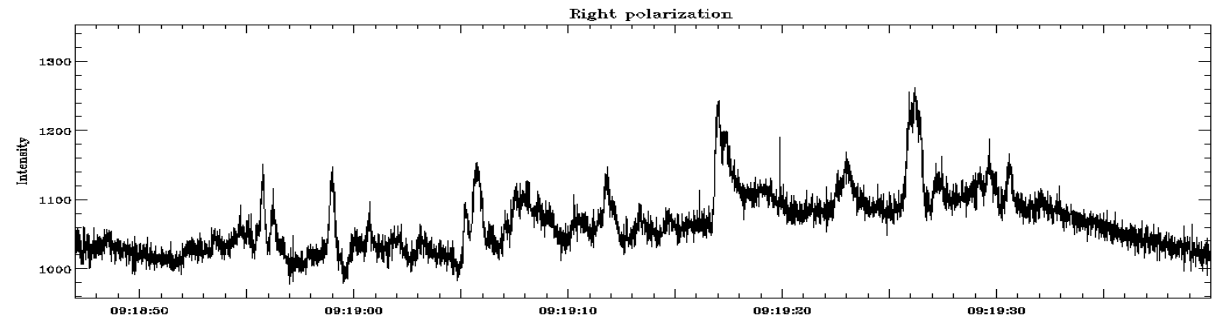
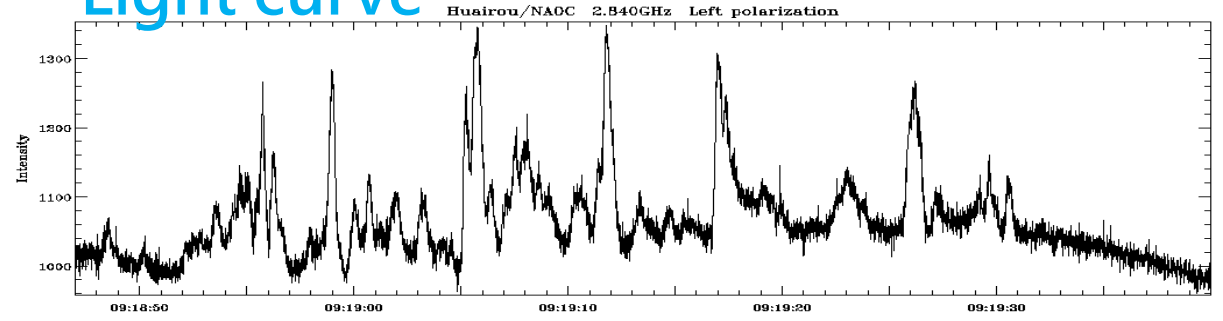
2011/03/07

09:18:47-09:19:30 UT

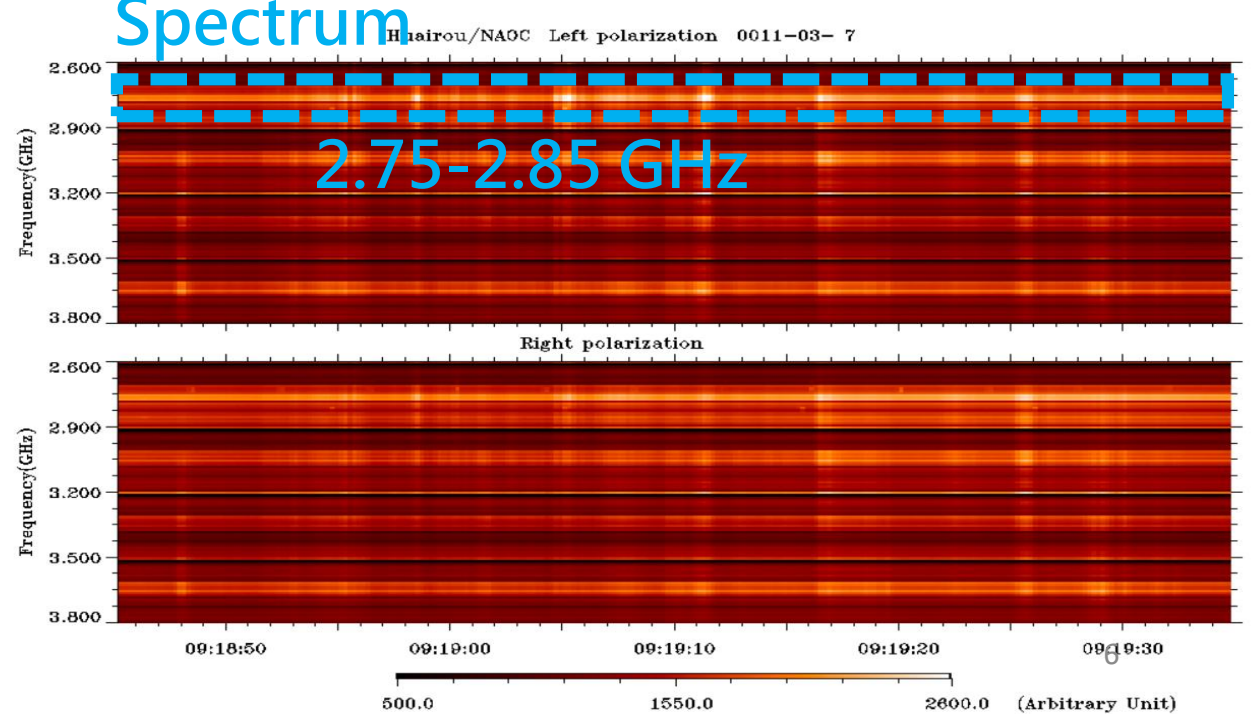
(8 ms)



Light curve



Spectrum



Target Event

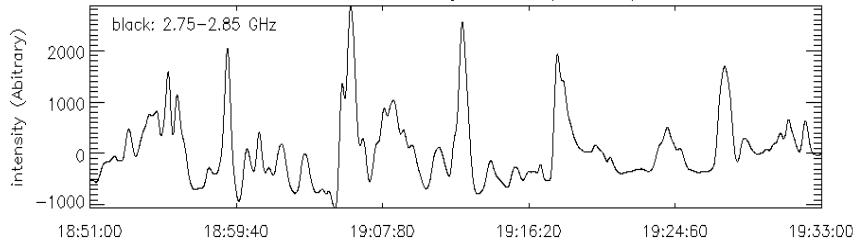
QPP #1 FFT

2011/03/07

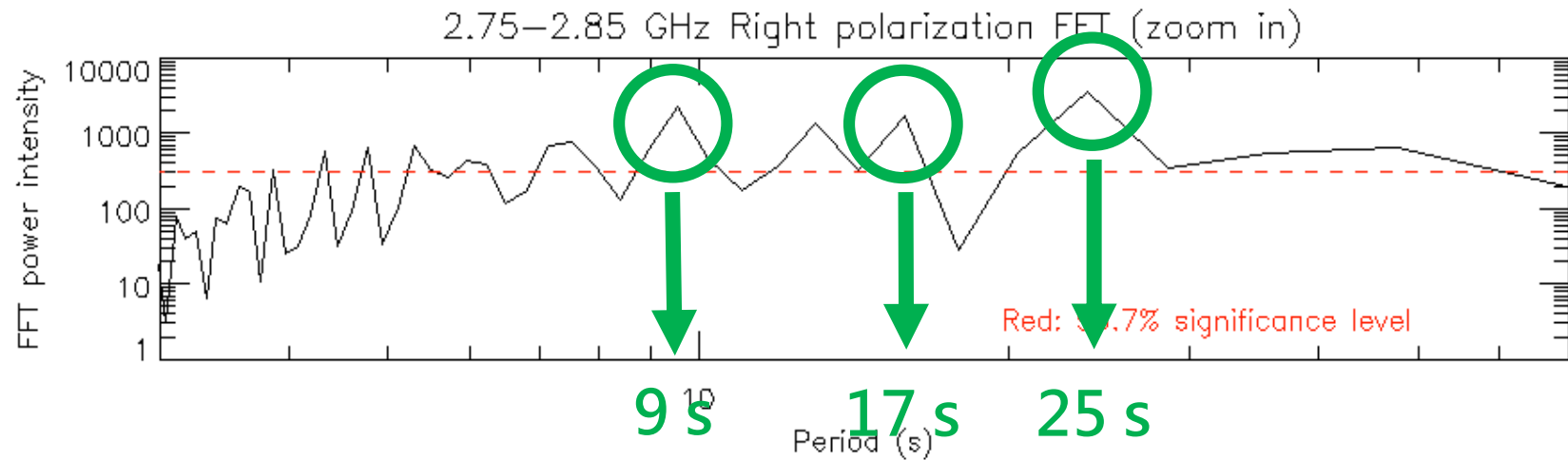
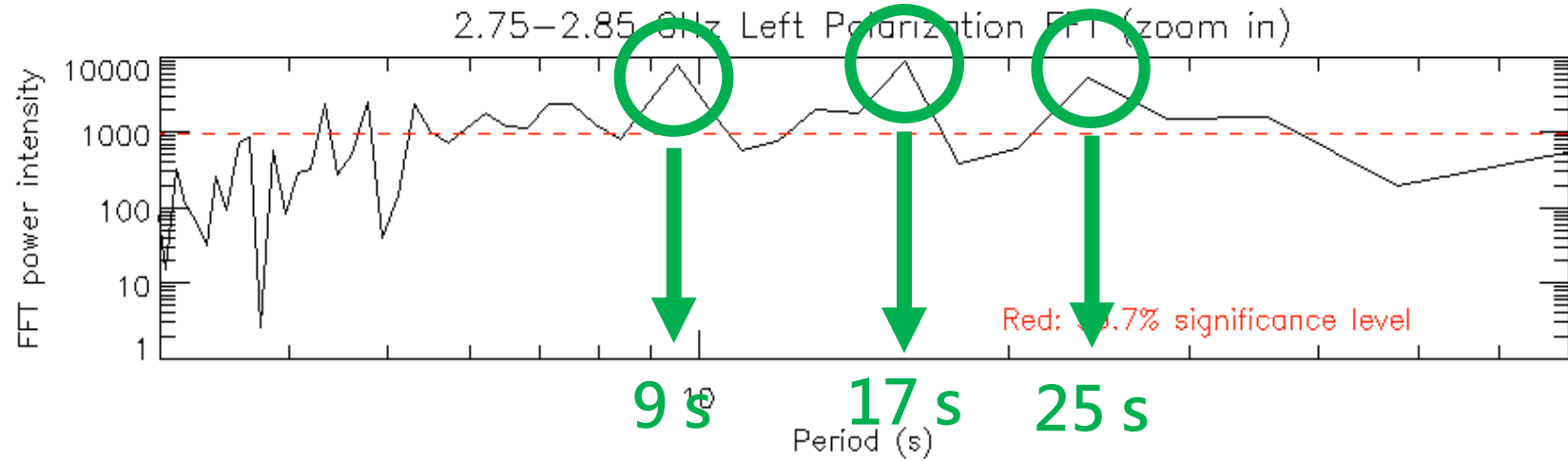
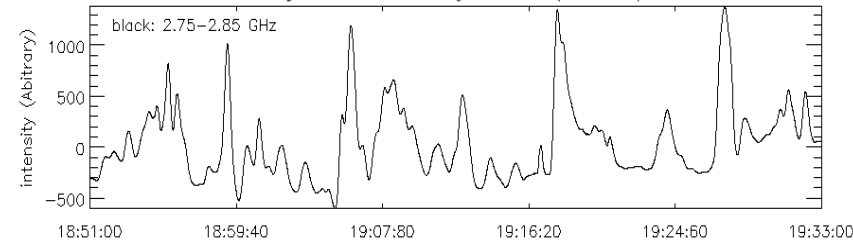
09:18:47-09:19:30 UT
(8 ms)

Light curve

Left Polarization Light Curve (zoom in)



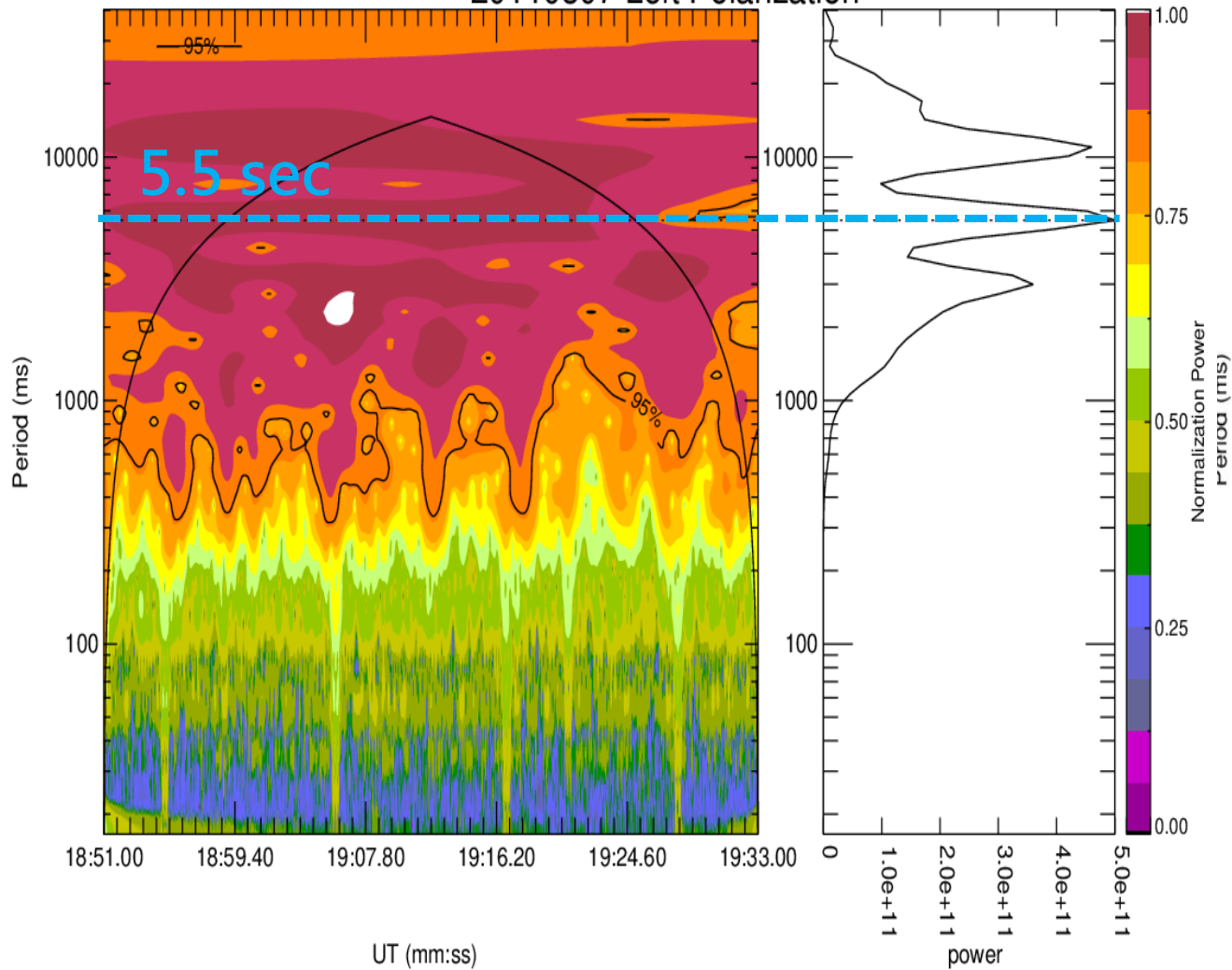
Right Polarization Light Curve (zoom in)



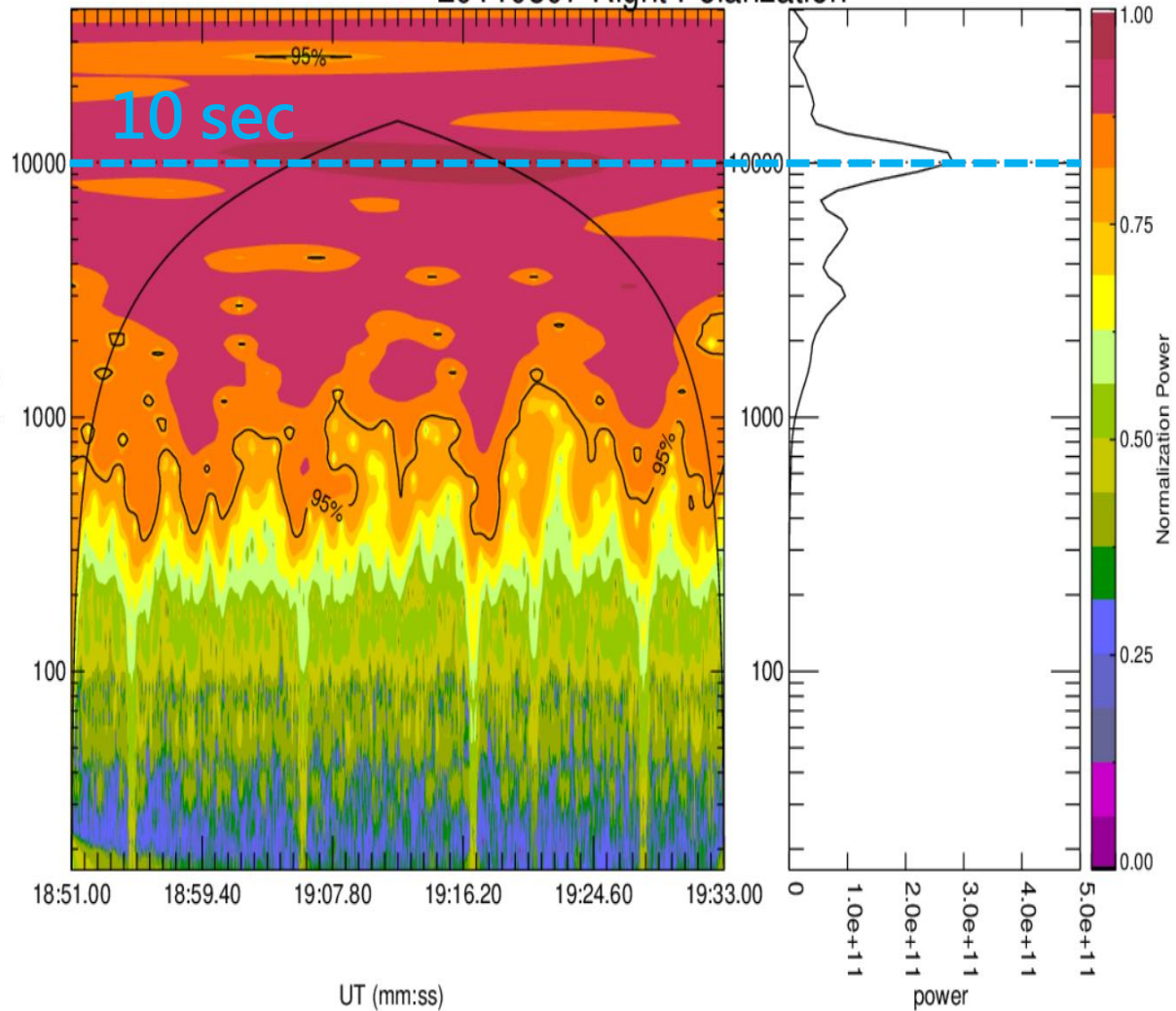
Target Event QPP #1 wavelet

2011/03/07
09:18:47-09:19:30 UT
(8 ms)

20110307 Left Polarization

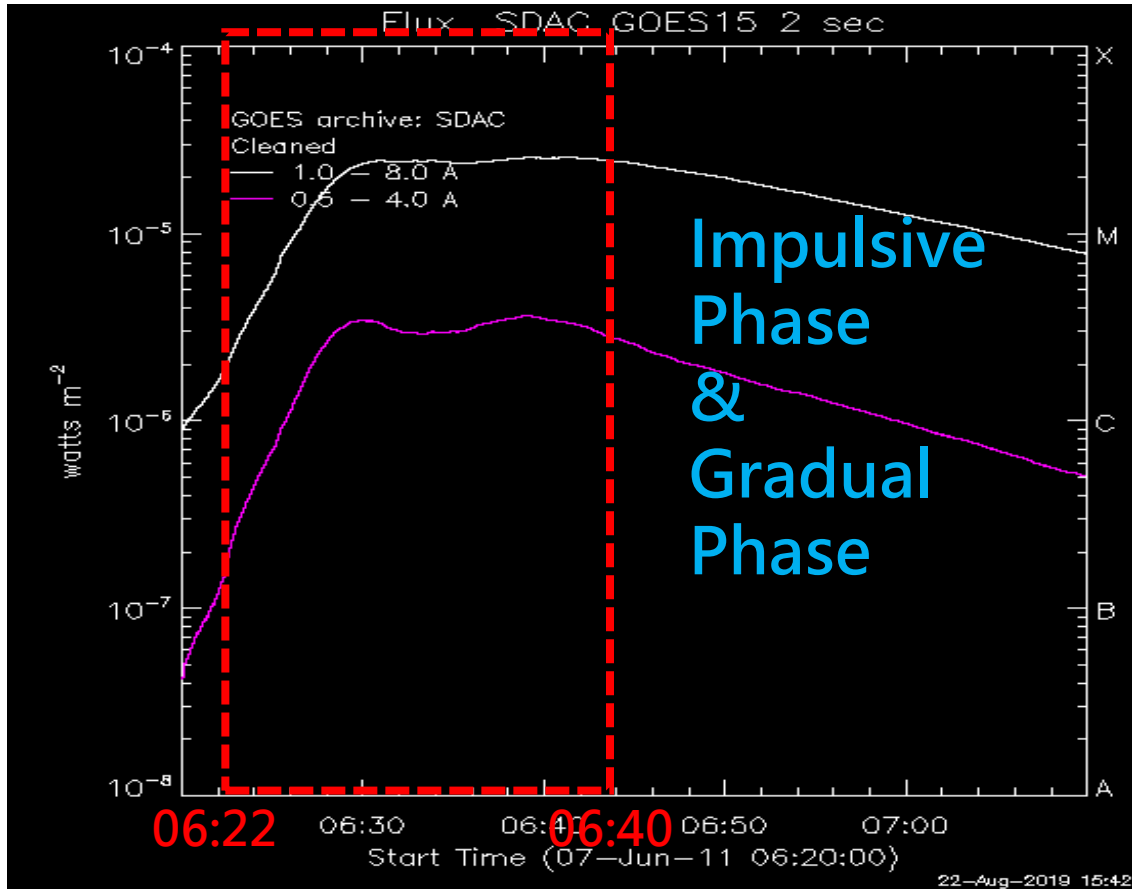


20110307 Right Polarization

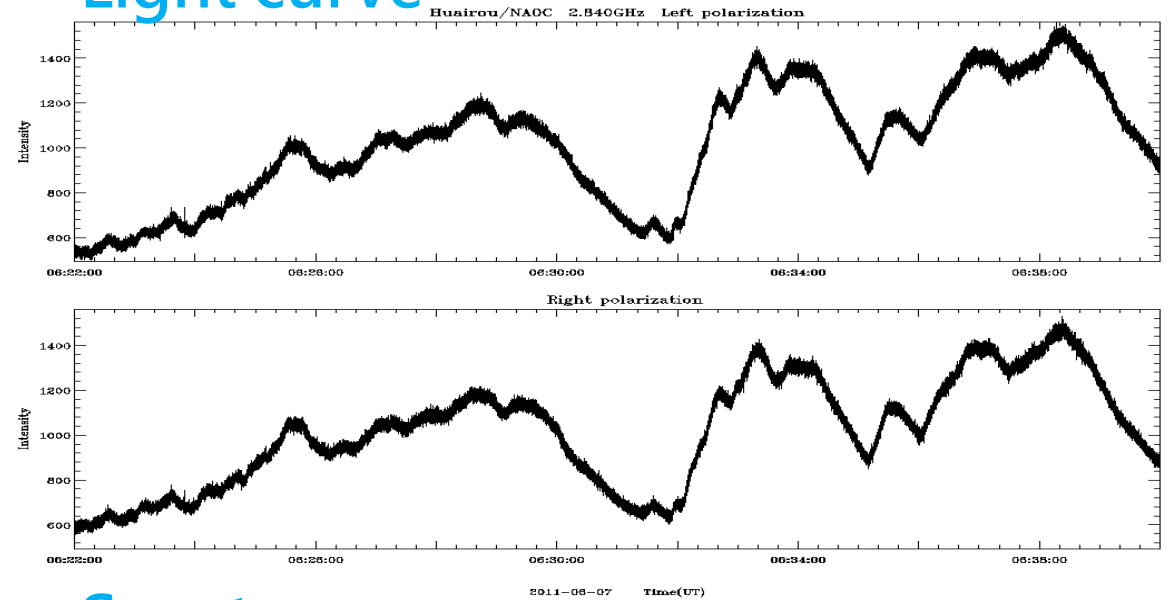


Target Event

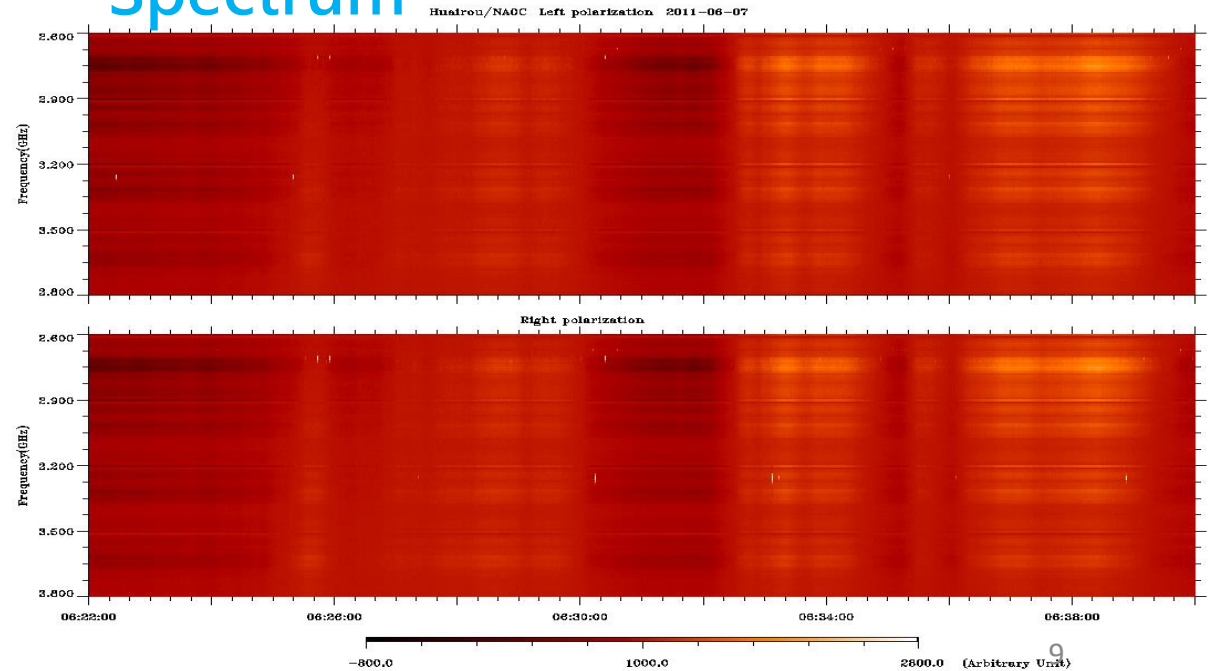
QPP #2 2011/06/07
06:22-06:40 UT
(8 ms)



Light curve



Spectrum



Target Event

QPP #2 FFT

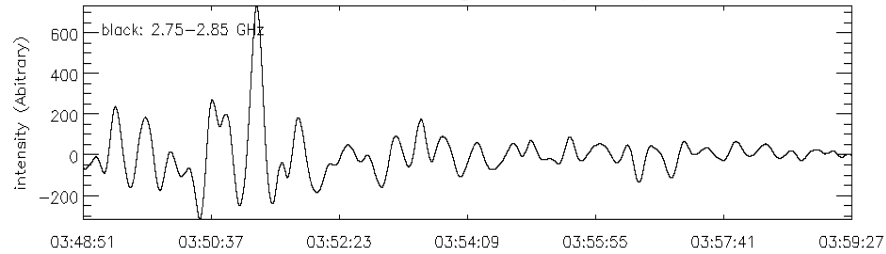
2011/06/07

06:22-06:40 UT

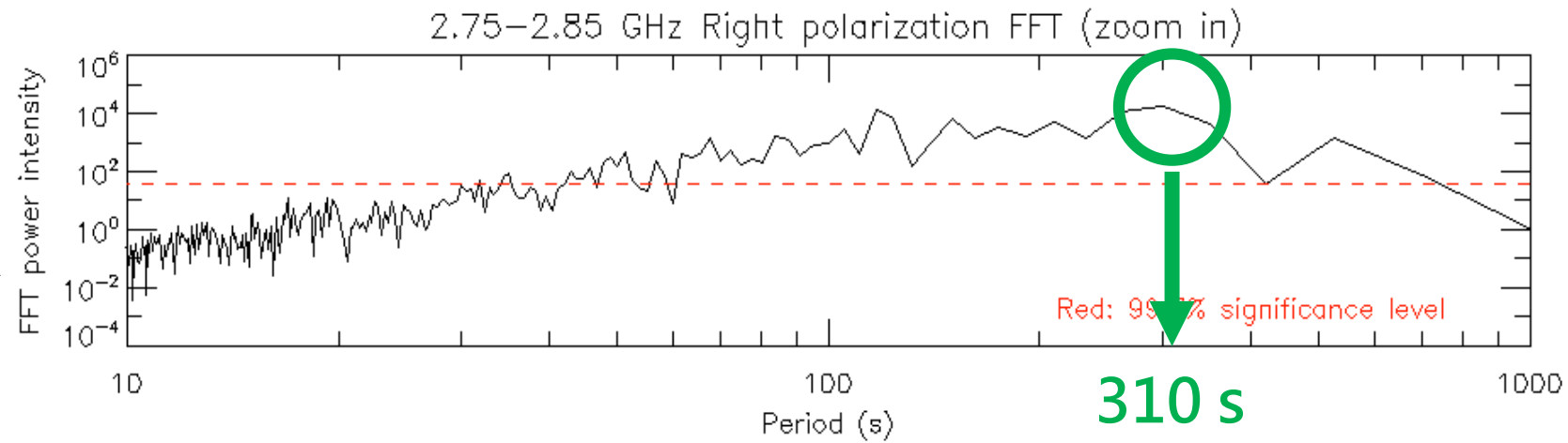
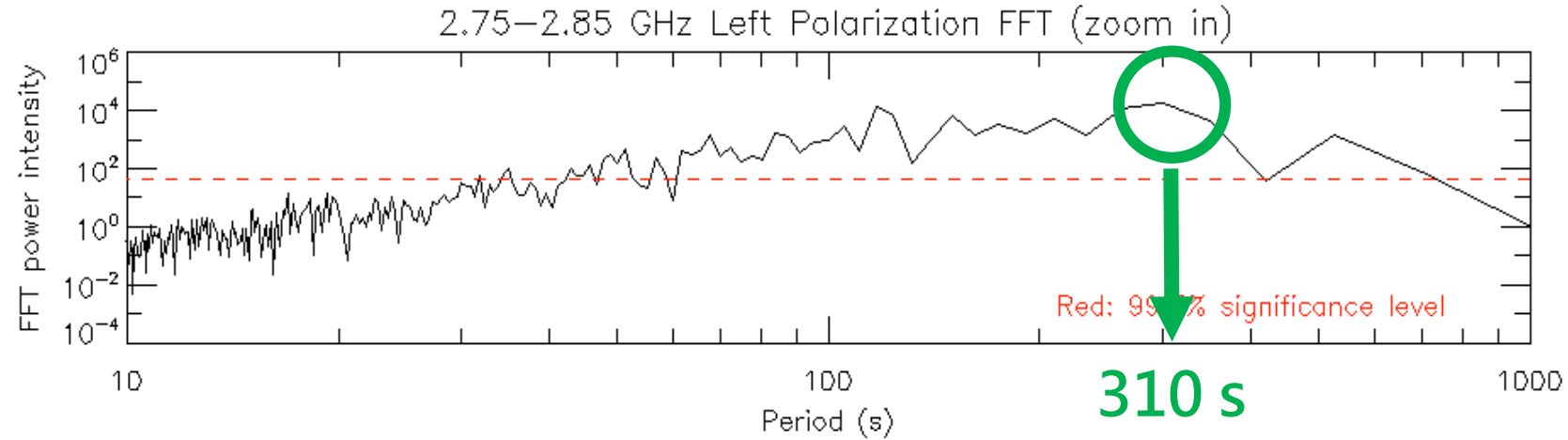
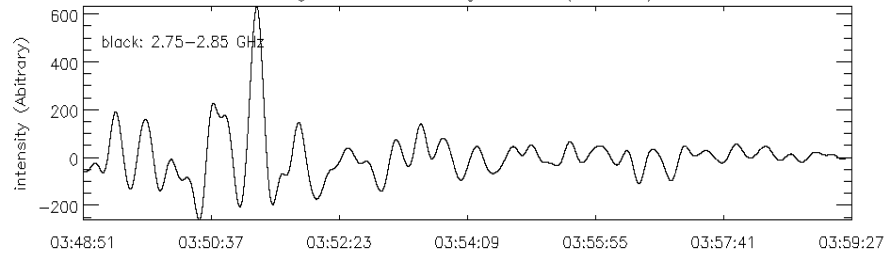
(8 ms)

Light curve

Left Polarization Light Curve (zoom in)



Right Polarization Light Curve (zoom in)

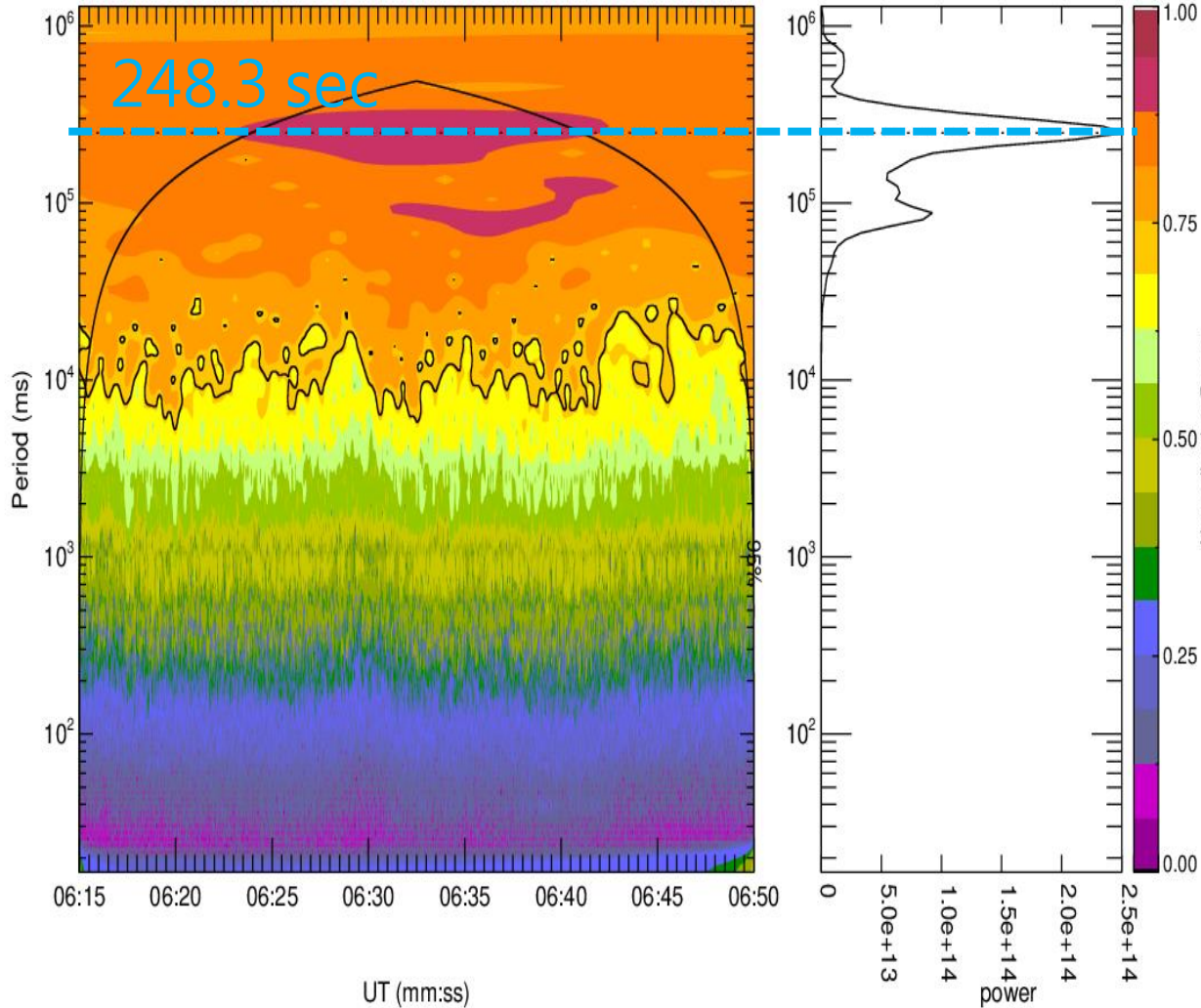


Target Event

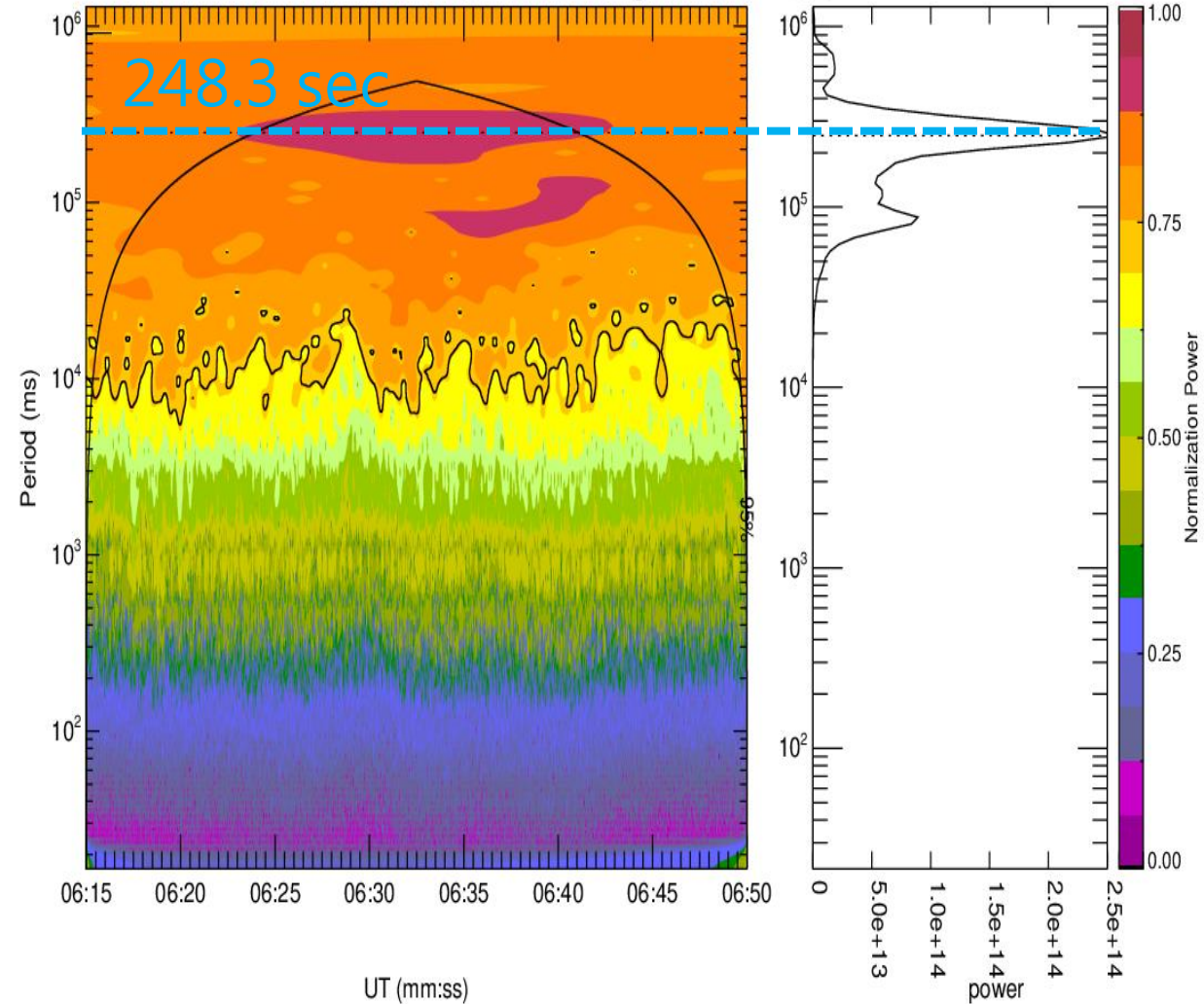
QPP #2 wavelet

2011/06/07
06:22-06:40 UT
(8 ms)

20110607 Left Polarization

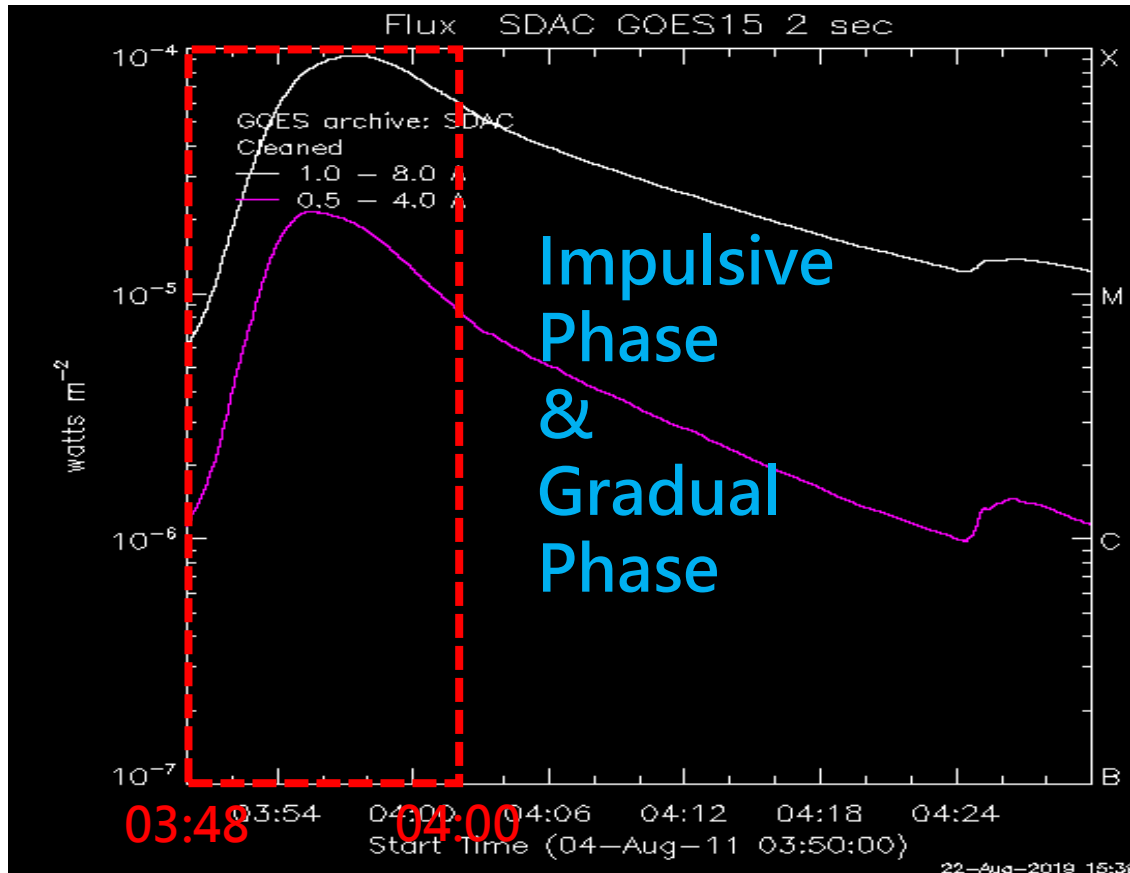


20110607 Right Polarization

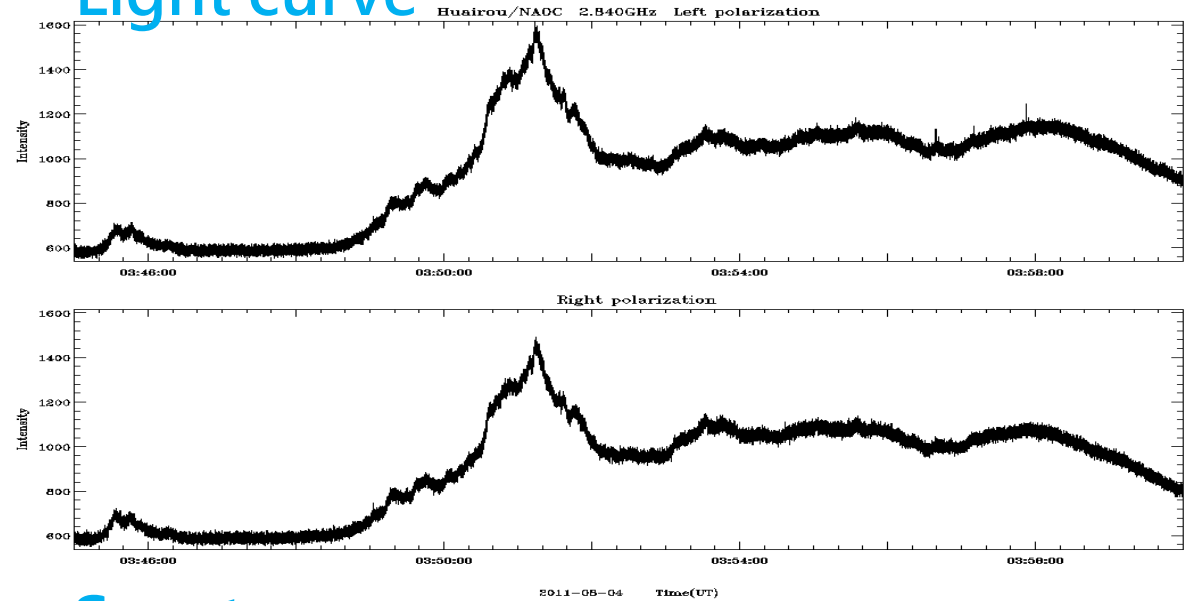


Target Event

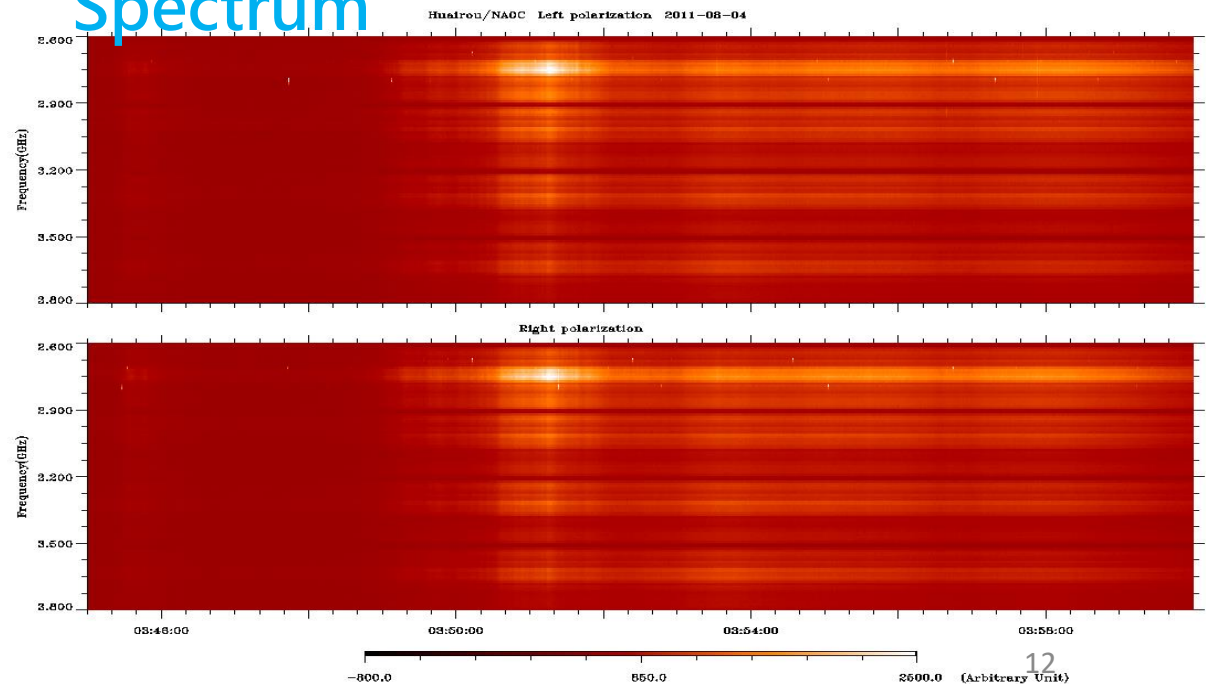
QPP #3 2011/08/04
03:48-04:00 UT
(8 ms)



Light curve



Spectrum



Target Event

QPP #3 FFT

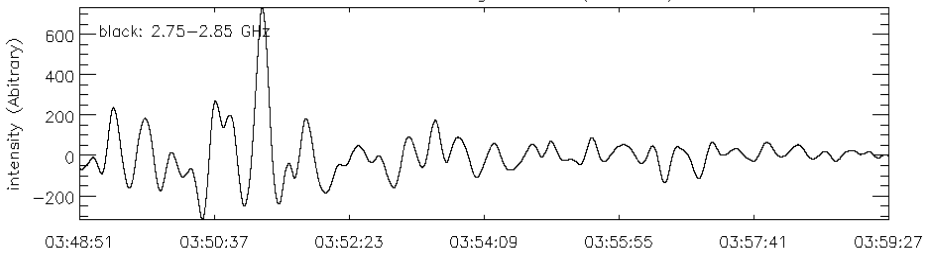
2011/08/04

03:48-04:00 UT

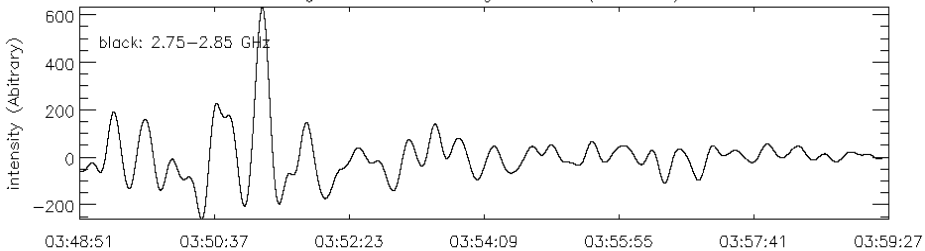
(8 ms)

Light curve

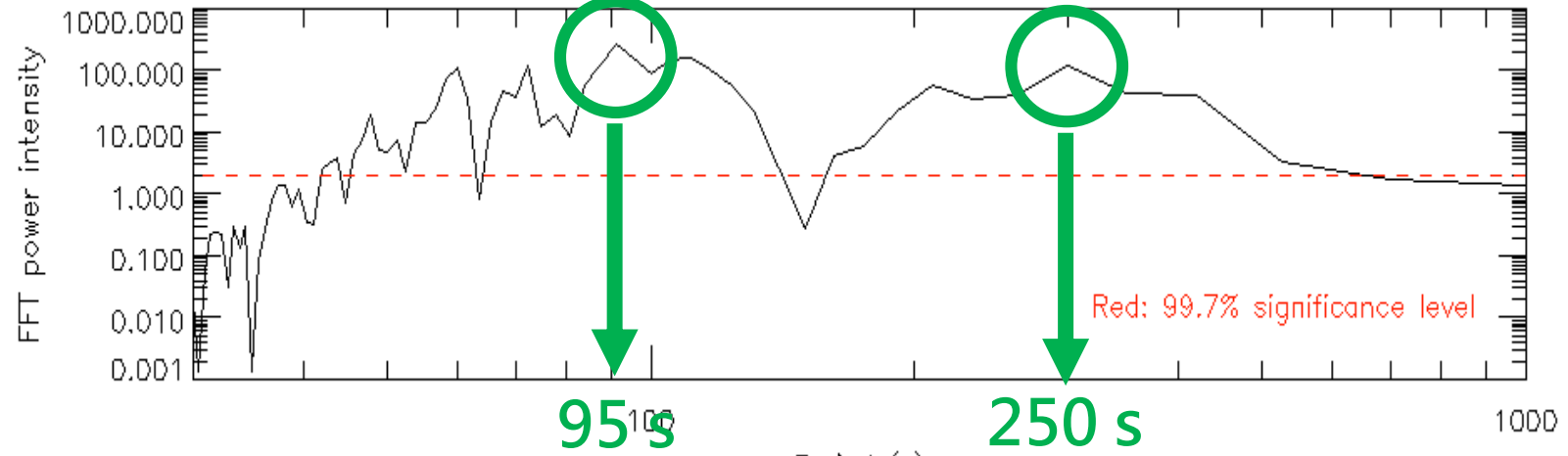
Left Polarization Light Curve (zoom in)



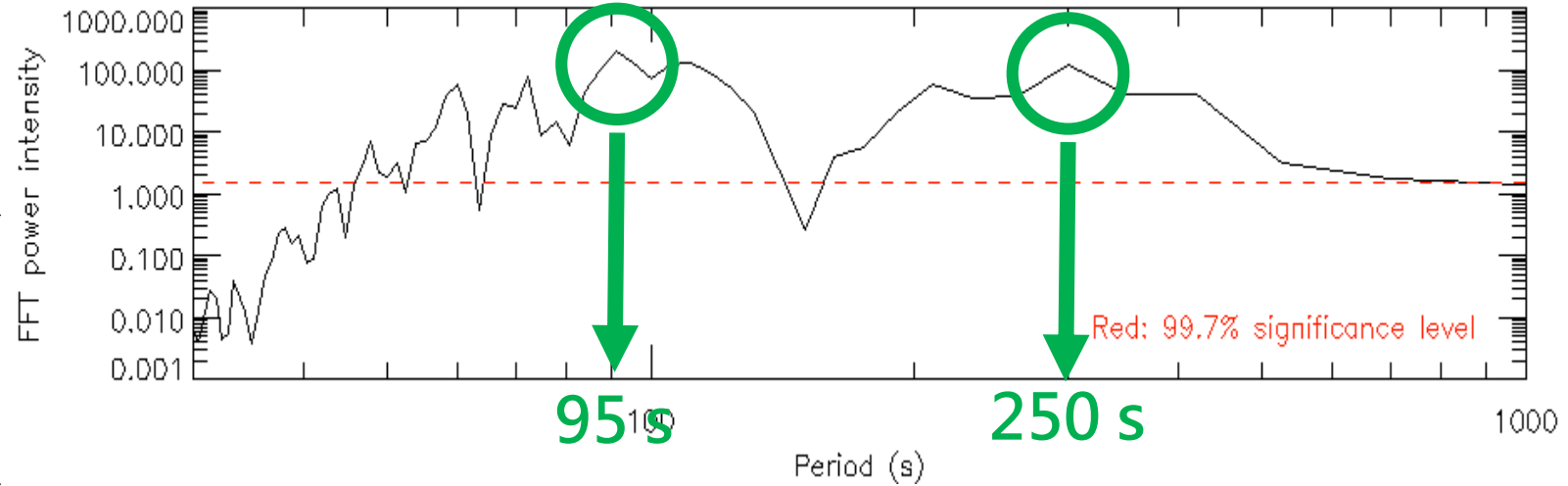
Right Polarization Light Curve (zoom in)



2.75-2.85 GHz Left Polarization FFT (zoom in)



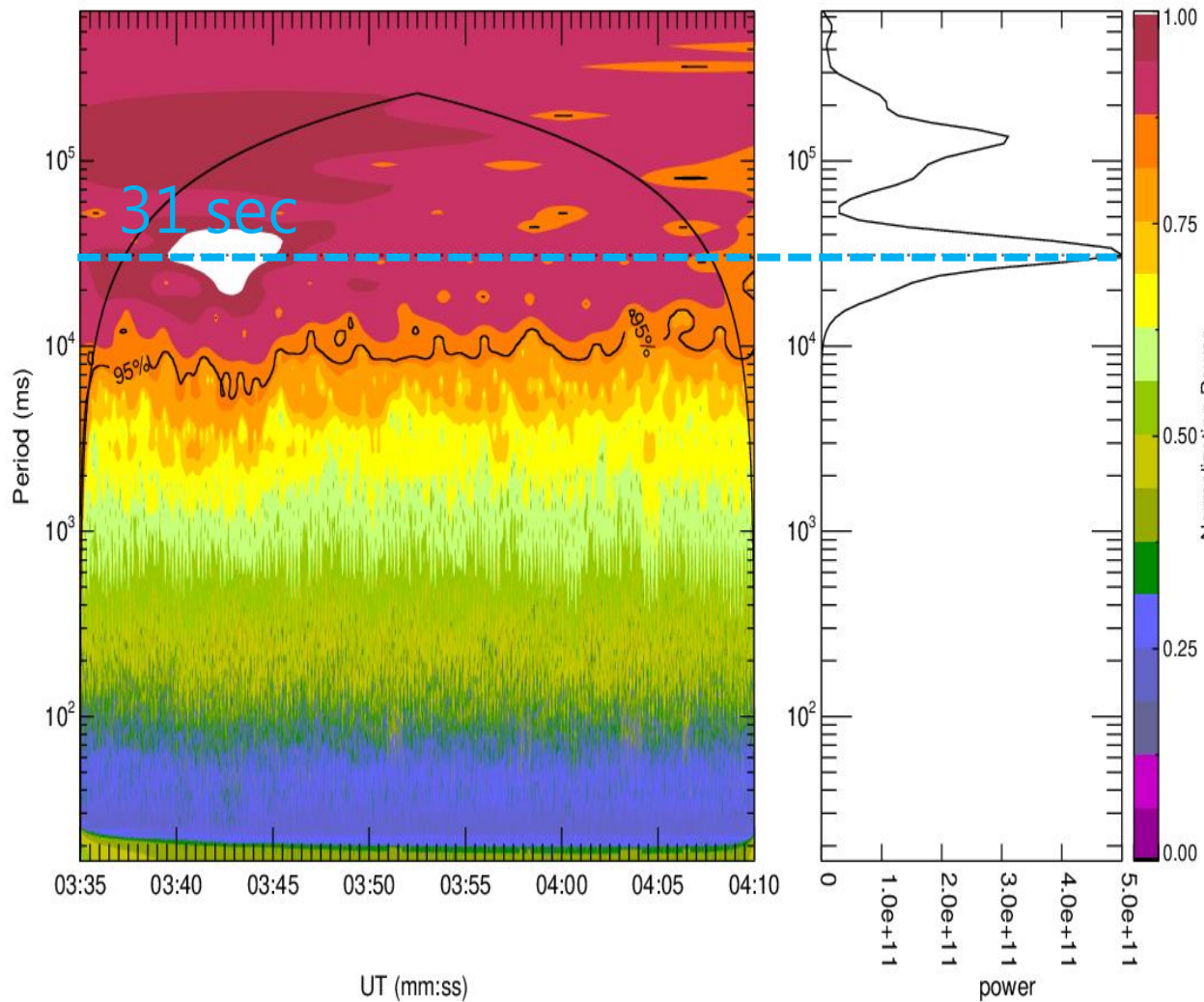
2.75-2.85 GHz Right polarization FFT (zoom in)



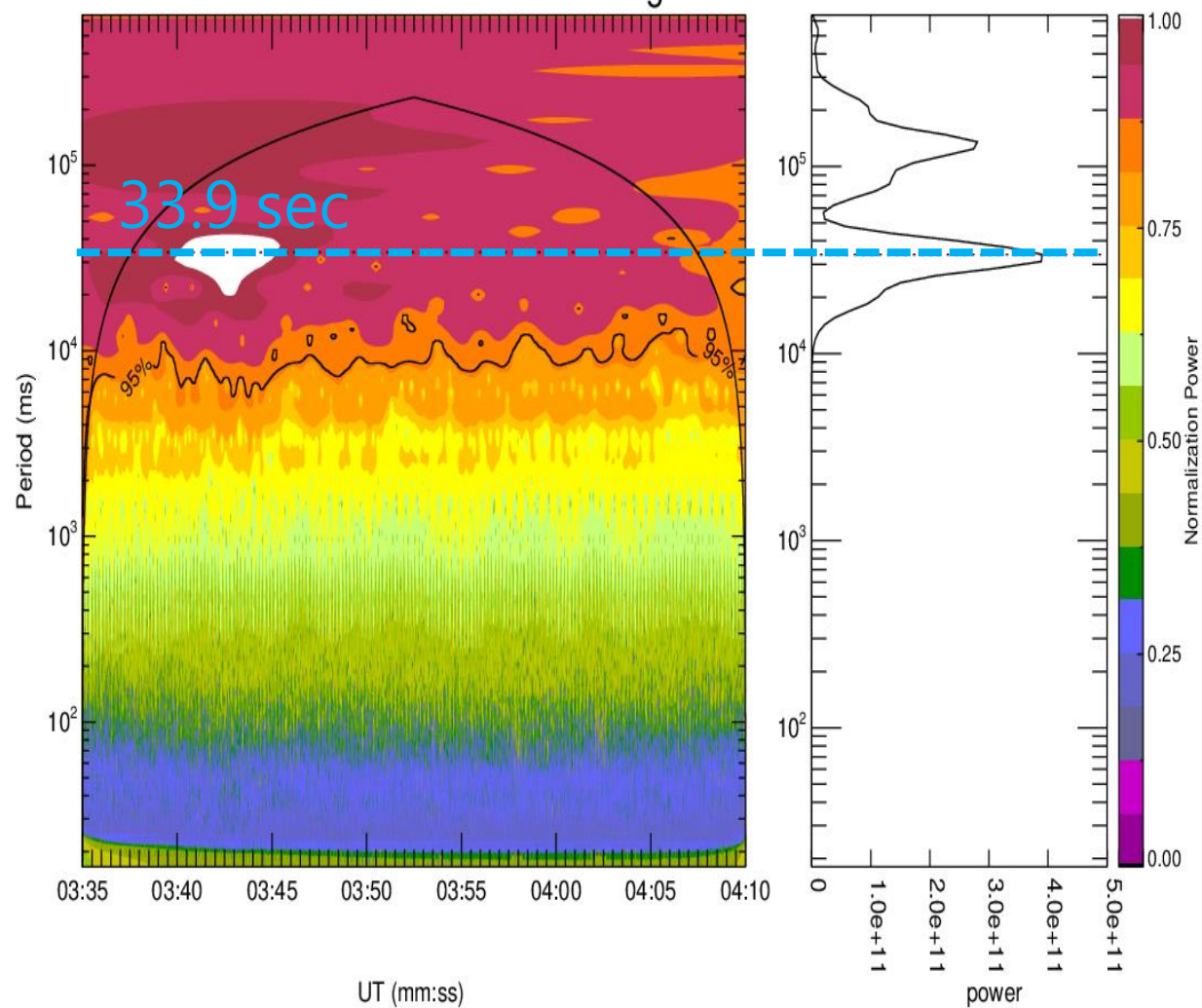
Target Event QPP #3 wavelet

2011/08/04
03:48-04:00 UT
(8 ms)

20110804 Left Polarization



20110804 Right Polarization



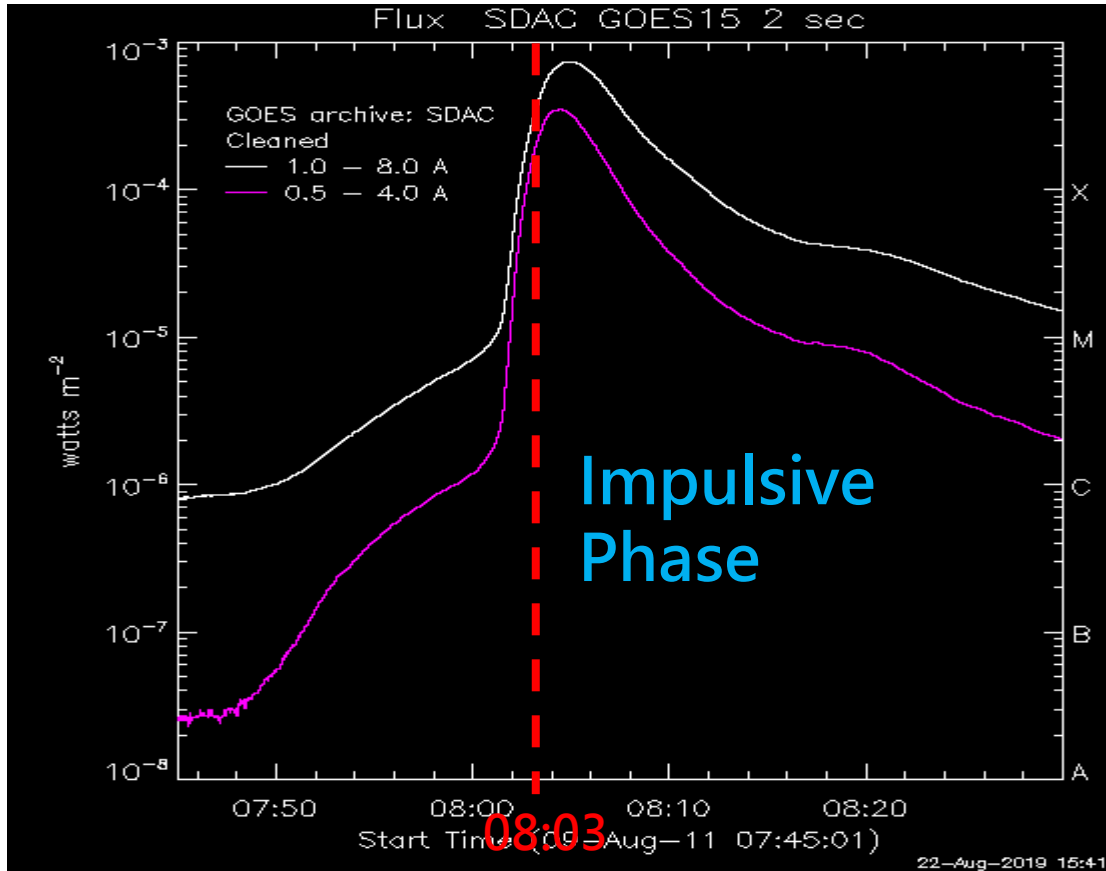
Target Event

QPP #4

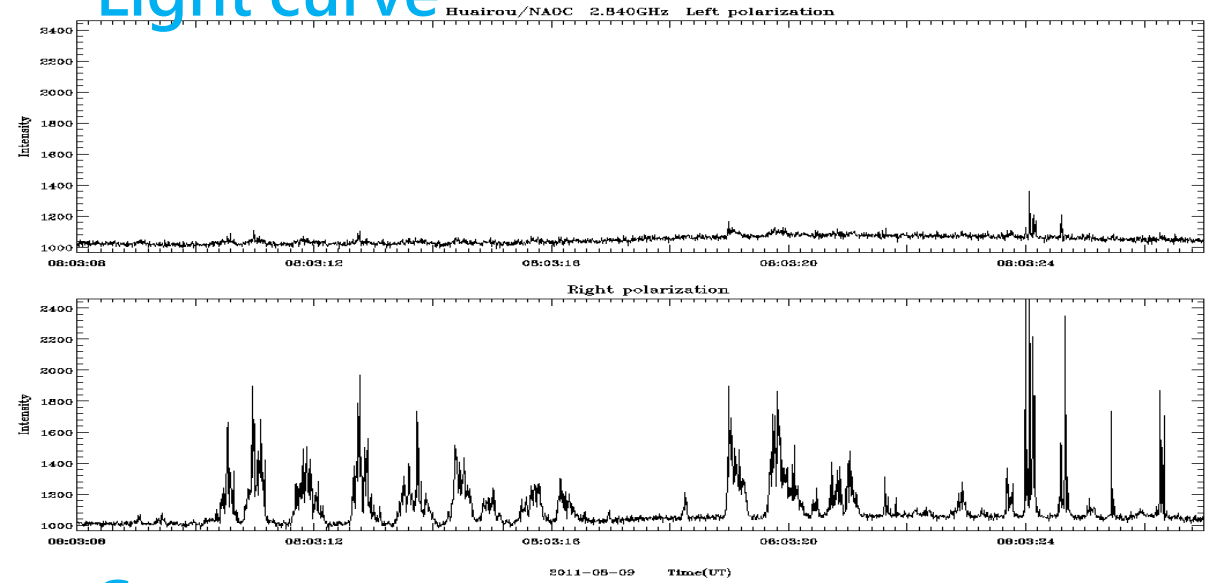
2011/08/09

08:03:09-08:03:29 UT

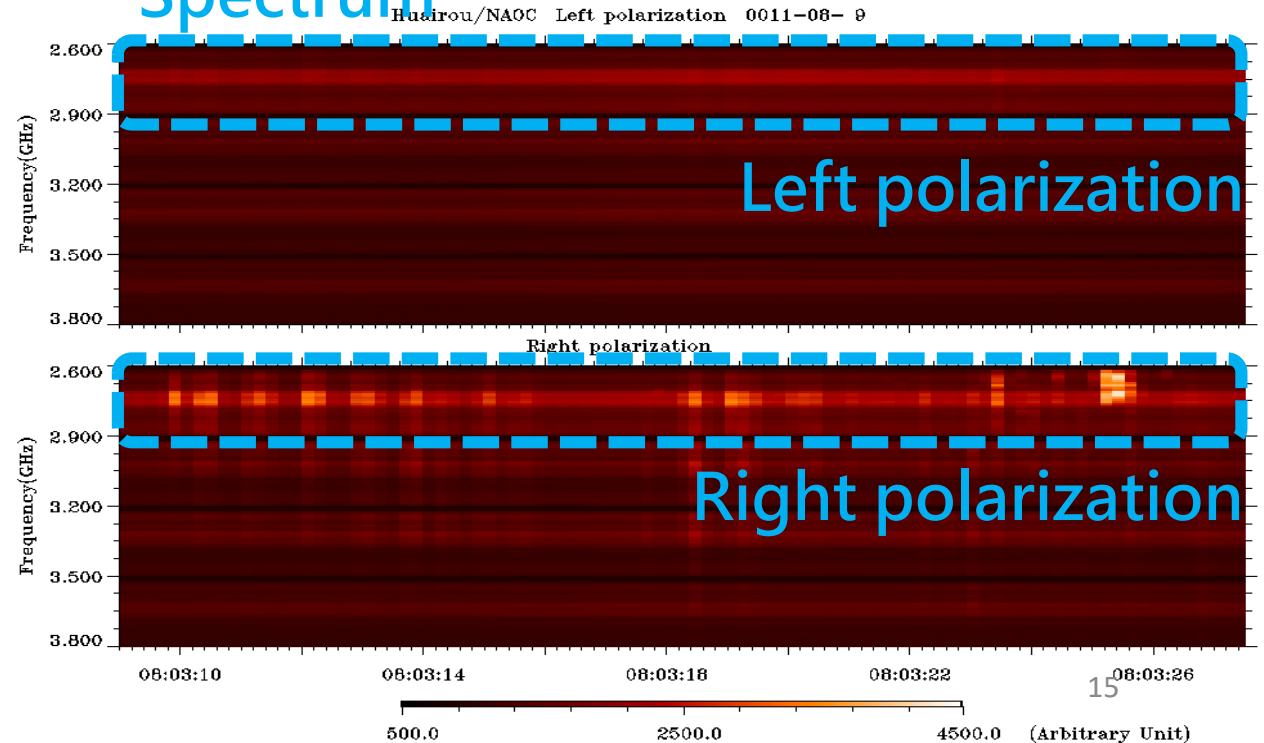
(8 ms)



Light curve



Spectrum



Target Event

QPP #4 FFT

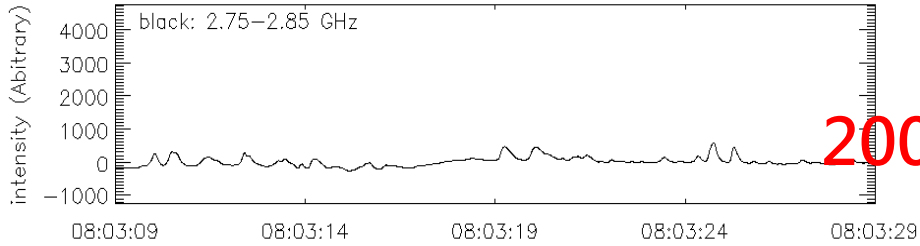
2011/08/09

08:03:09-08:03:29 UT

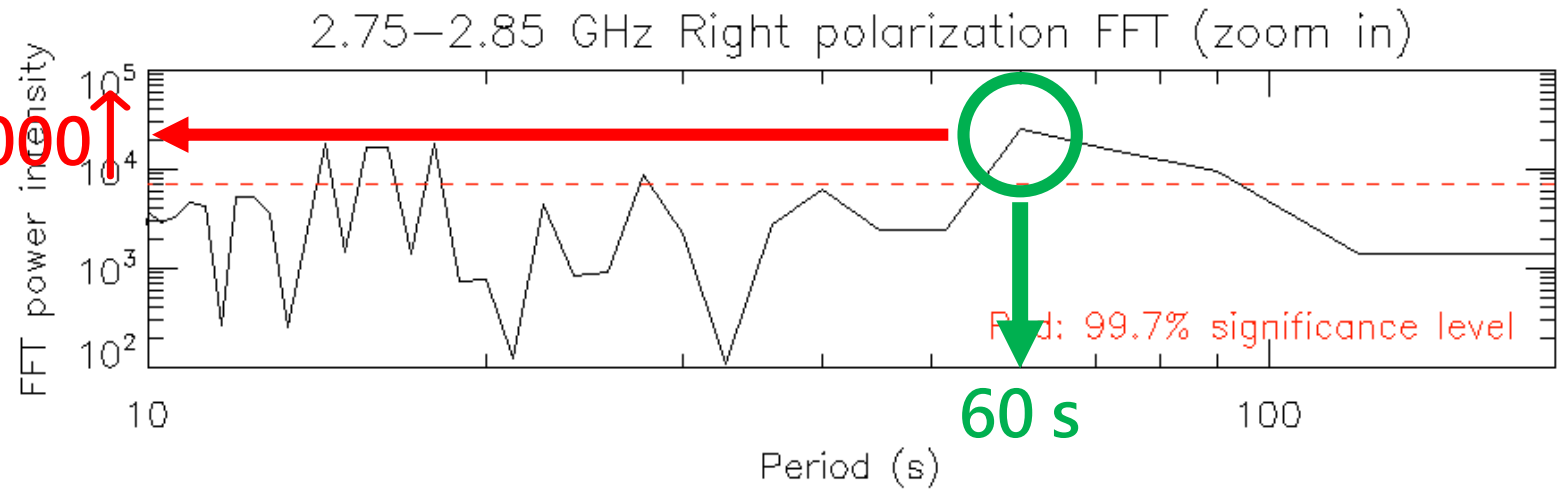
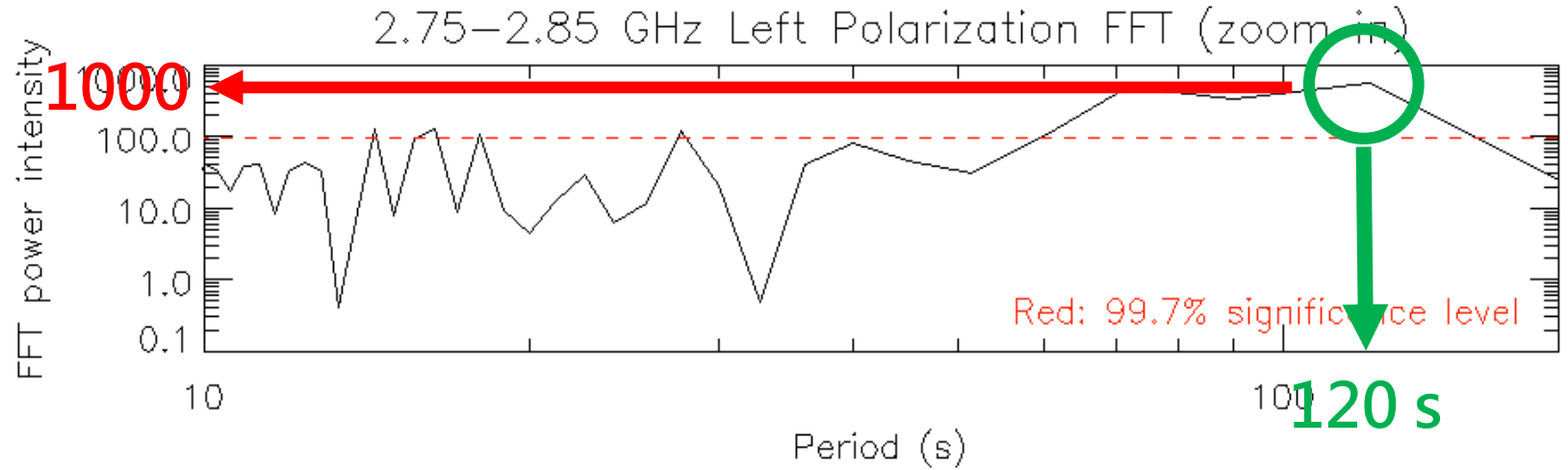
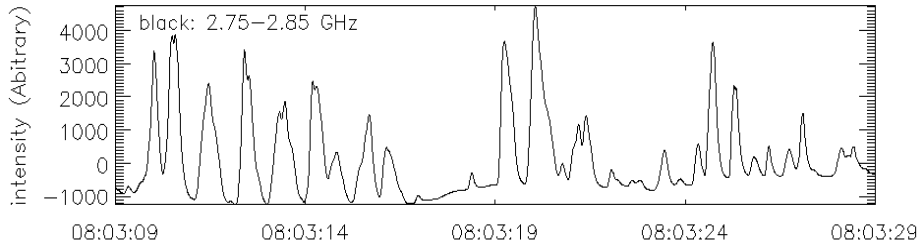
(8 ms)

Light curve

Left Polarization Light Curve (zoom in)



Right Polarization Light Curve (zoom in)



Target Event

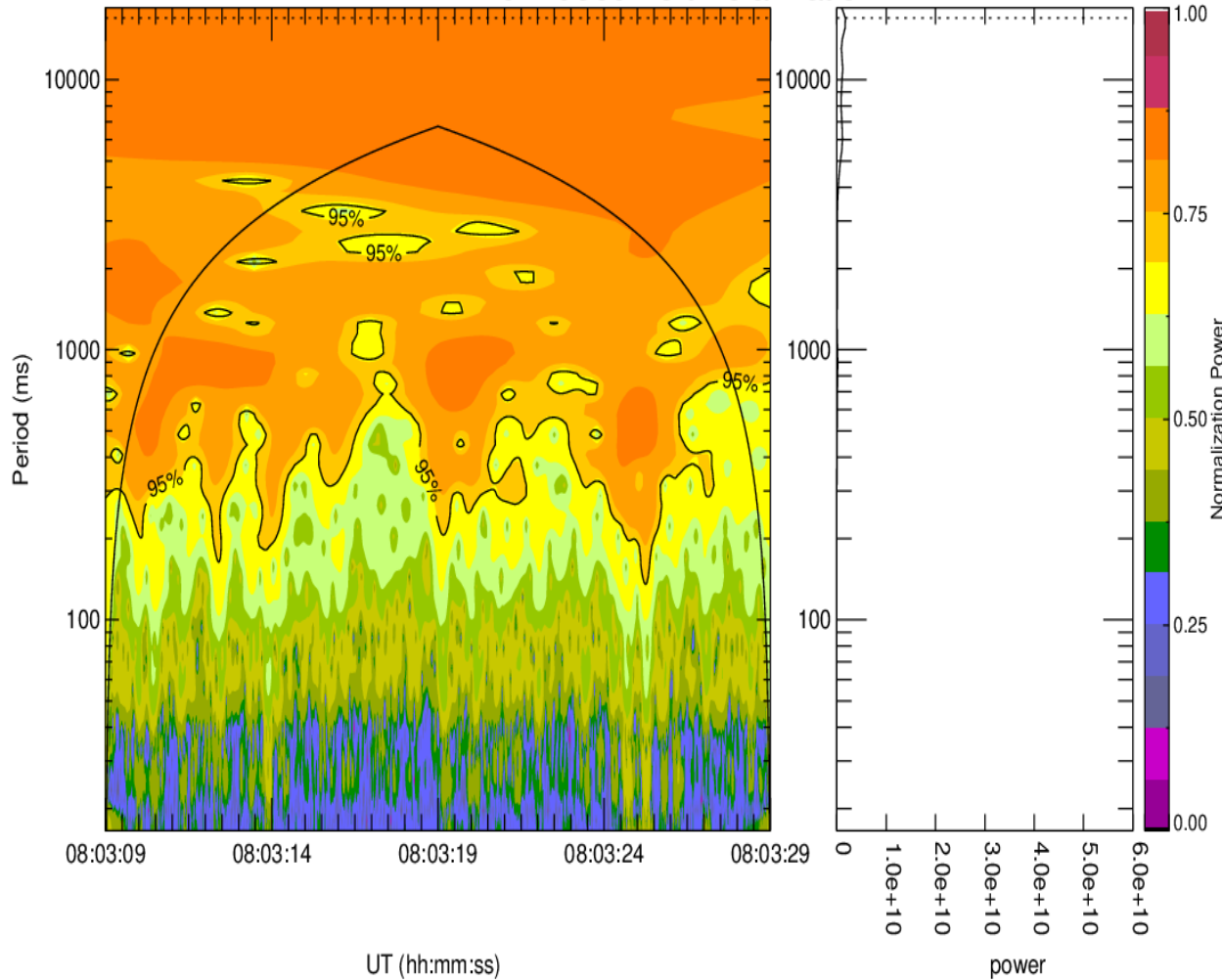
QPP #4 wavelet

2011/08/09

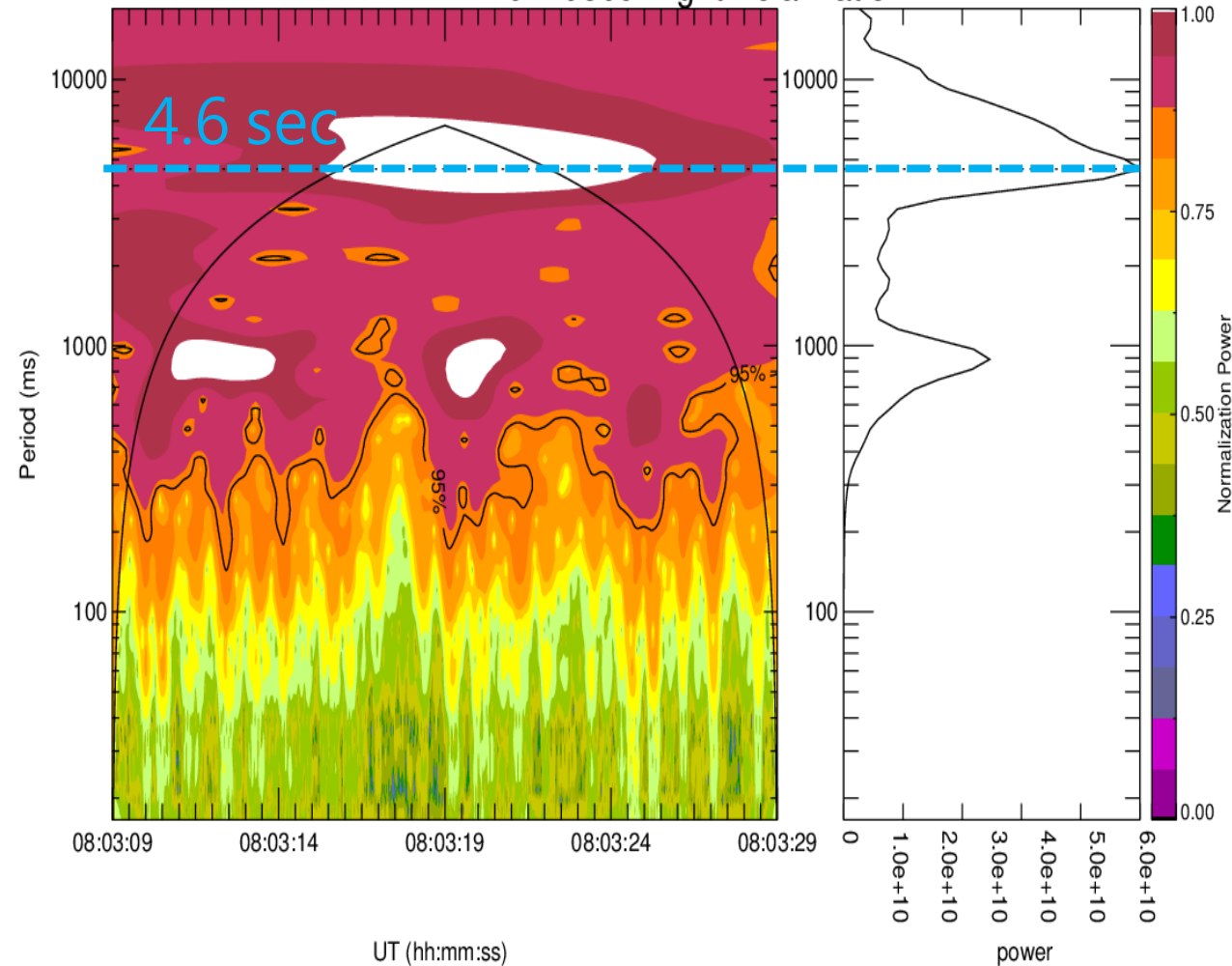
08:03:09-08:03:29 UT

(8 ms)

20110809 Left Polarization



20110809 Right Polarization



Summary

- Most FFT analysis have not have clear period.
- Result of FFT and wavelet cannot match correctly.
- Wavelet analysis show reliable period of each event.
- Integral of power of wavelet match with the light curve.

Date	FFT	Wavelet
3/7/2011	9,17,25 sec (L&R)	5.5 sec (L),10 sec (R)
6/7/2011	310 sec (L&R)	248.3 sec (L&R)
8/4/2011	95,250 sec (L&R)	31 sec(L),33.9sec (R)
8/9/2011	120 sec (L),60 sec (R)	X (L),4.6 sec (R)

Reference

- A.R. Inglis, V.M. Nakariakov, V.F. Melnikov, *Astron. Astrophys.* 487, 1147 (2008)
- Tan, B. L., Yan, Y. H., Tan, C. M., & Liu, Y. Y. 2010, *ApJ*, 723, 25

Thanks for your listening