

A comparison of solar flare
events using high-cadence
EVE/ESP irradiance
measurements

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This Talk

- A limited number (5) of short-time flares (Event #1 +) was used to concentrate on specific features that may be partially or totally invisible to the other SDO and EVE instruments/channels due to their lower data cadence.
- Accent on some flare features that are subjects of great interest if the images from AIA and HMI are taken at the moment when the feature is present or is in development.

What Flare Features are Points of our Interest

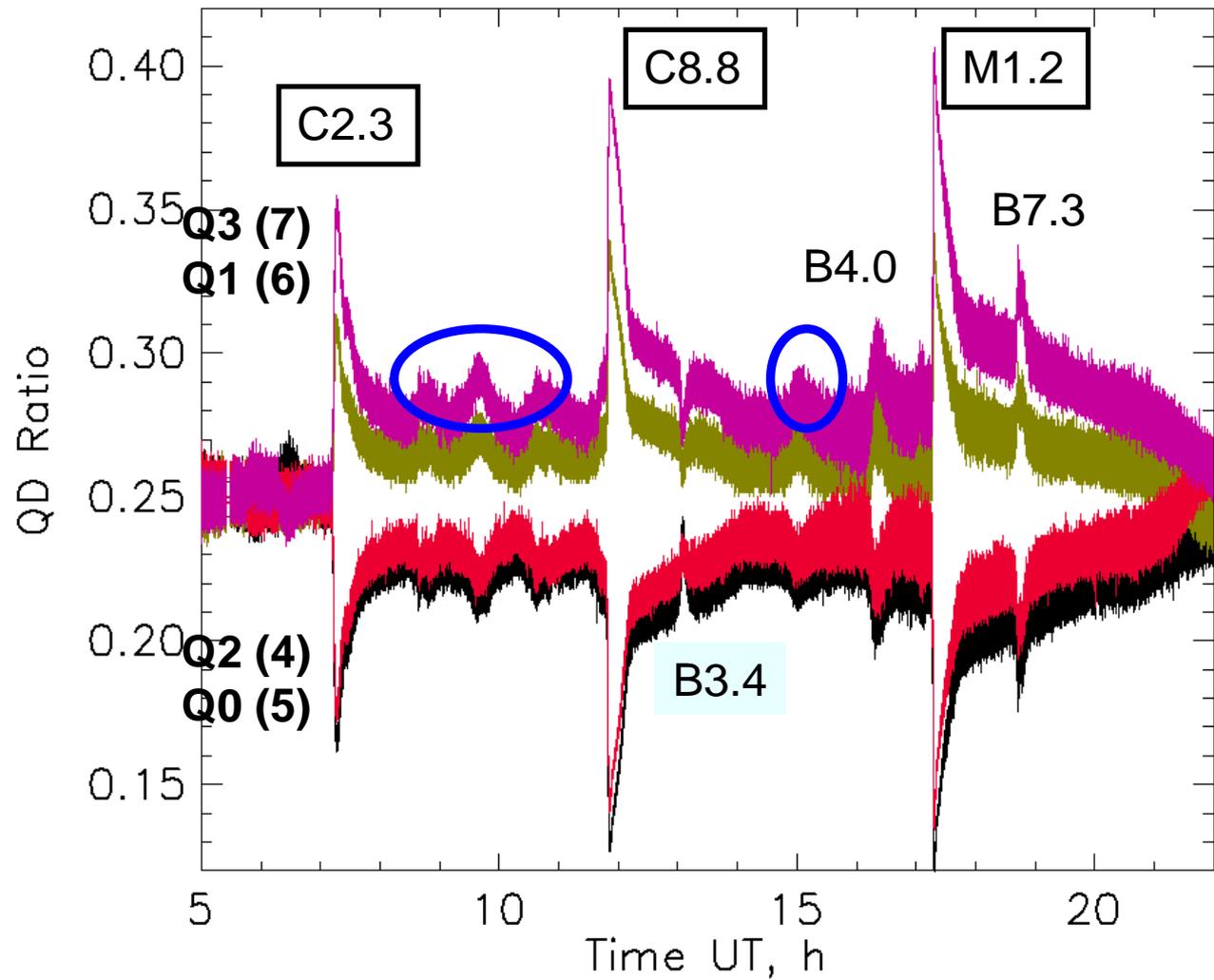
- The impulsive flare peak for the **30.4 nm band** occurs nearest in time to the X-ray flare peak detected by the **QD band**. For four of the five events (80%) it developed **earlier** than the X-ray peak of the flare.
- The impulsive flare **X-ray** profile shows some sub-second irradiance fluctuations.

QD (Four 0th-order Channels)

May 5, 2010 events. Four QD ratios to the 0th-order signal form a small latency **Flare Detector**. Any flare is detected by the simultaneous change of these QD ratios.

High-cadence QD data can be used to evaluate whether *small* irradiance changes from the same AR are new flares or they are the 'second peak' of the activity (blue ellipses) that follows the flare. Colors (from top to bottom) correspond to QD Q3 (Ch7), Q1 (Ch6), Q2 (Ch4), Q0 (Ch5).

Solar flare is defined as a sudden, rapid, and intense variation in brightness



Specific (Fast-Time) Features

Colors and data

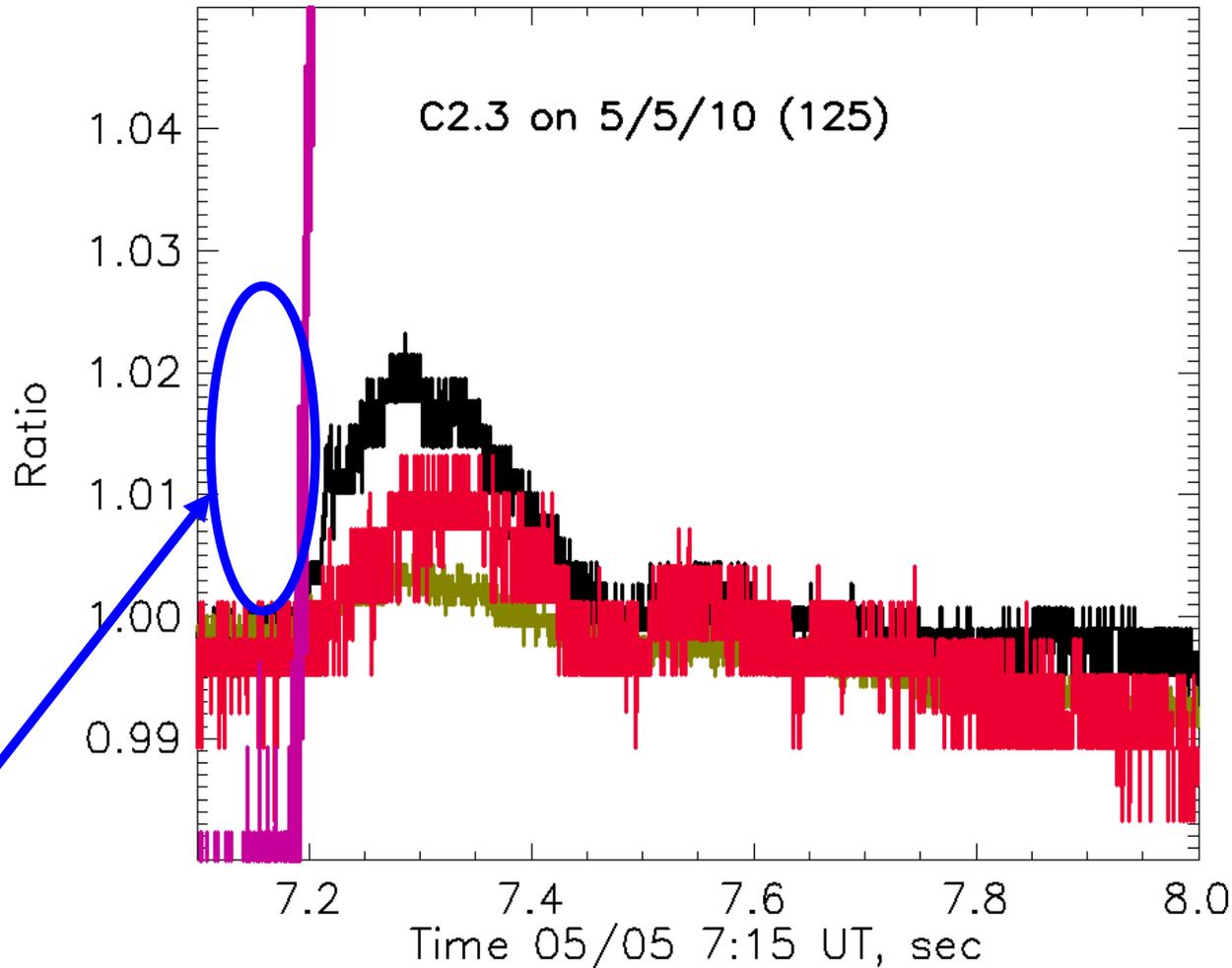
X-ray (magenta):
3.1 @ 7:16:55.926
UT

Ch30 (black):
1.023 @ 7:17:12.426

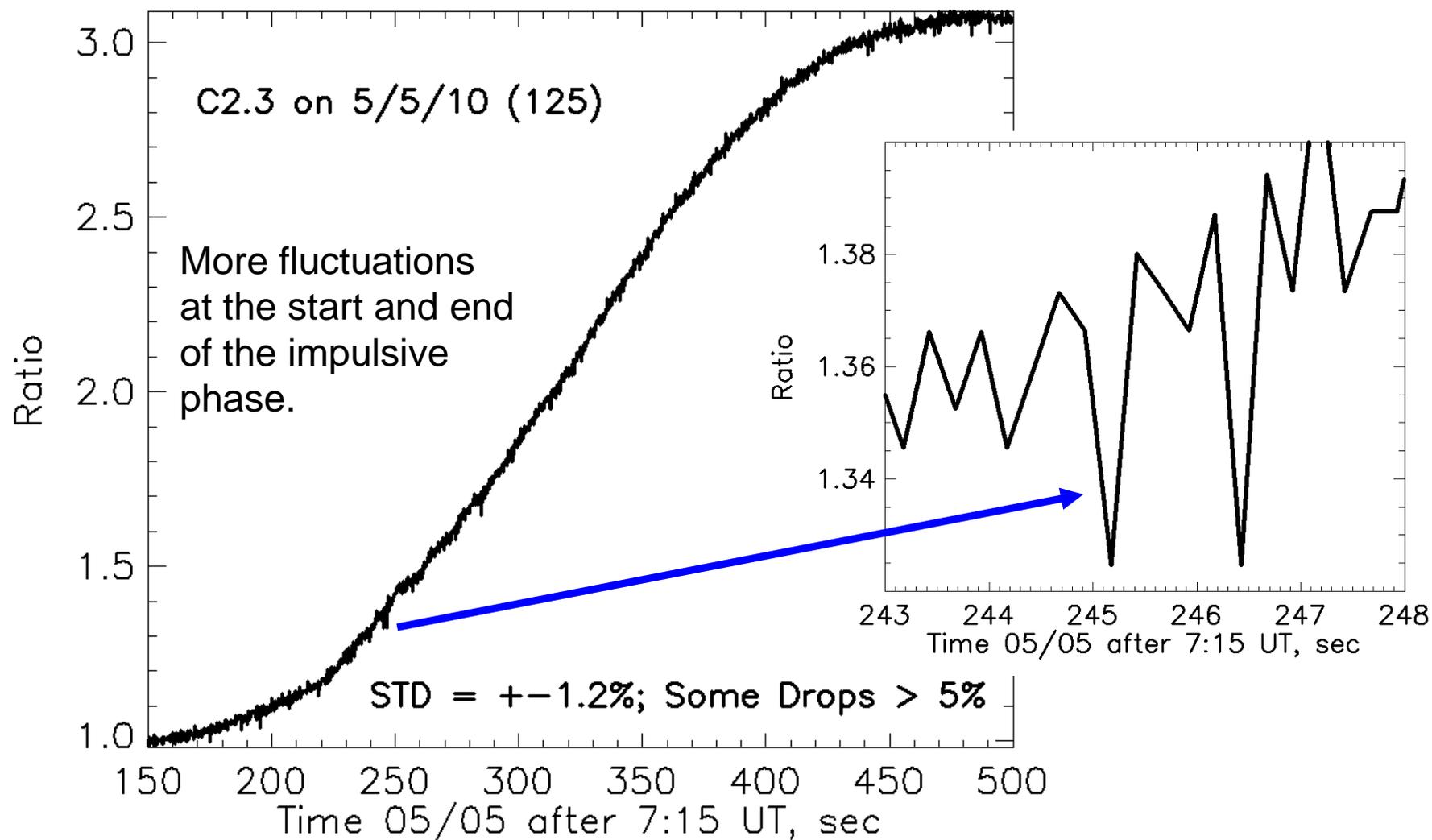
Ch26 (red):
1.013 @ 7:21:14

Ch18 (olive):
1.005 @ 7:17:40

Next slide



May 5, 2010 after 7:15 UT: Sub-second X-ray Fluctuations

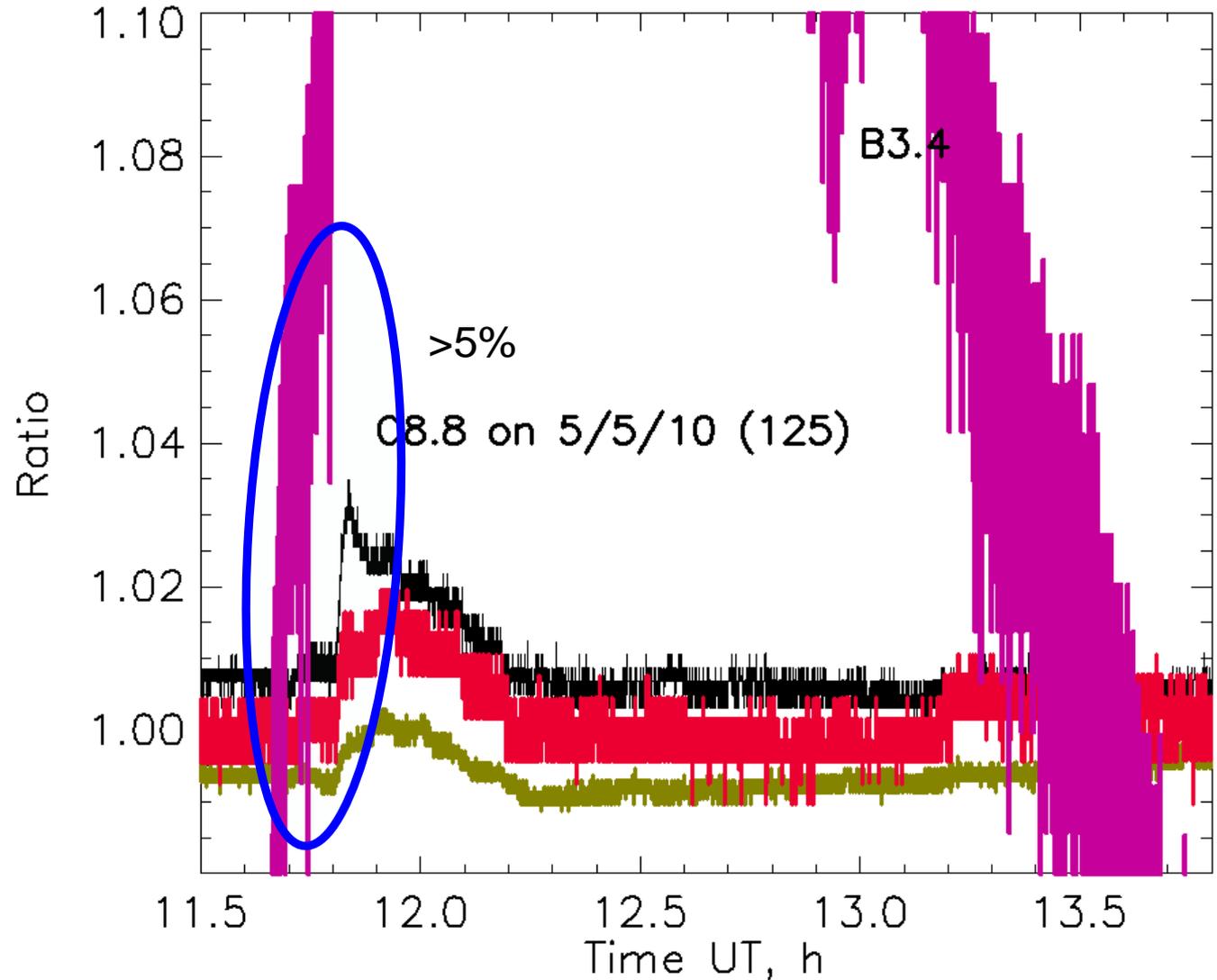


Are Those Fluctuations Real?

We say “YES” because:

- There are a number of fluctuations with amplitude $> 3\sigma$ during the impulsive and decaying phases. Statistically, one 3σ event could occur for about 1000 probes;
- Absolute irradiance change for same STD, e.g. 3% fluctuation is quite different for the quiet Sun and during the flare. Thus, it cannot be explained as some instrumental (or solar) noise when the absolute irradiance fluctuation is significantly larger than the noise.

Event 1: C8.8 Flare



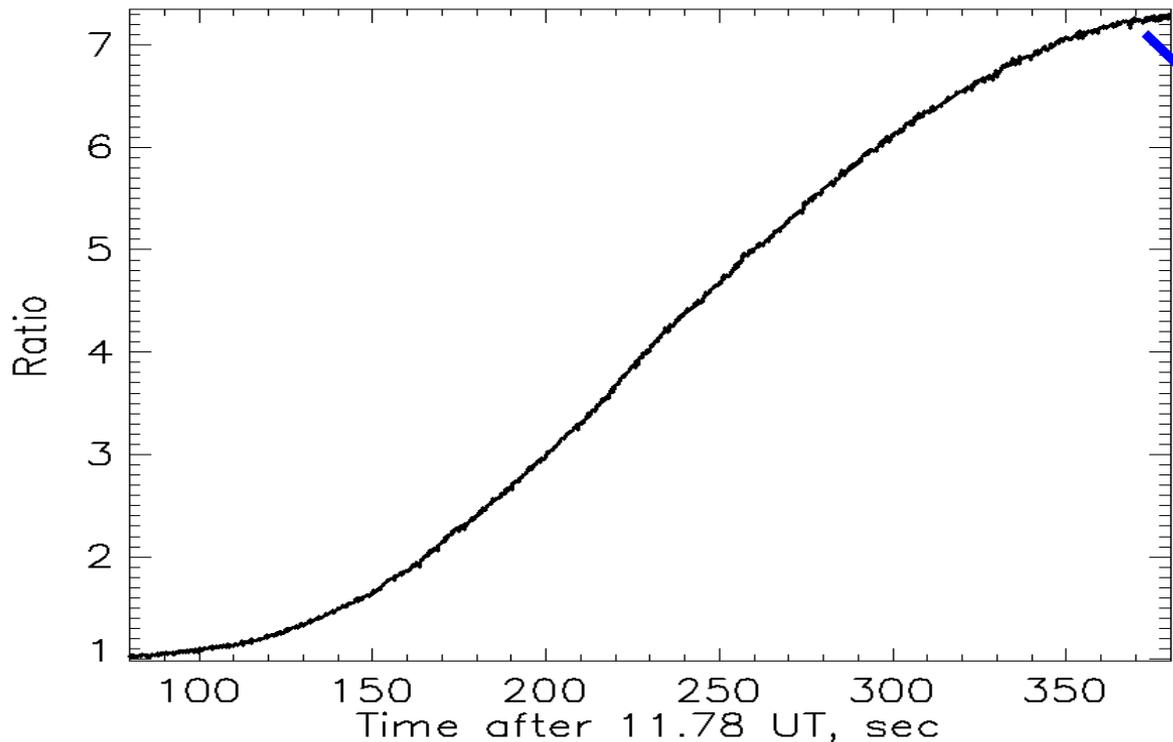
X-ray: **7.62**@
11:53:15.47 UT

•Ch30 **Earlier:**
1.09@11:50:09.47

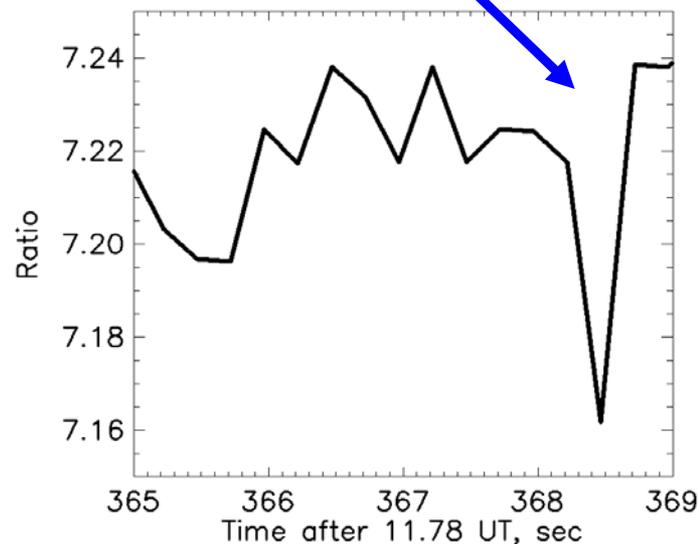
•Ch26:
1.02@11:58:18

•Ch18:
1.003@11:55:13

Event 1: X-ray Profile for C8.8 Flare



About 7%



May 5, 2010 event #1:
X-ray profiles consist of some sub-second irradiance fluctuations.

Real frequency could be higher and amplitude larger.
Could these fluctuations be used to determine the plasma's electrical resistivity changes near the reconnection boundary layer?

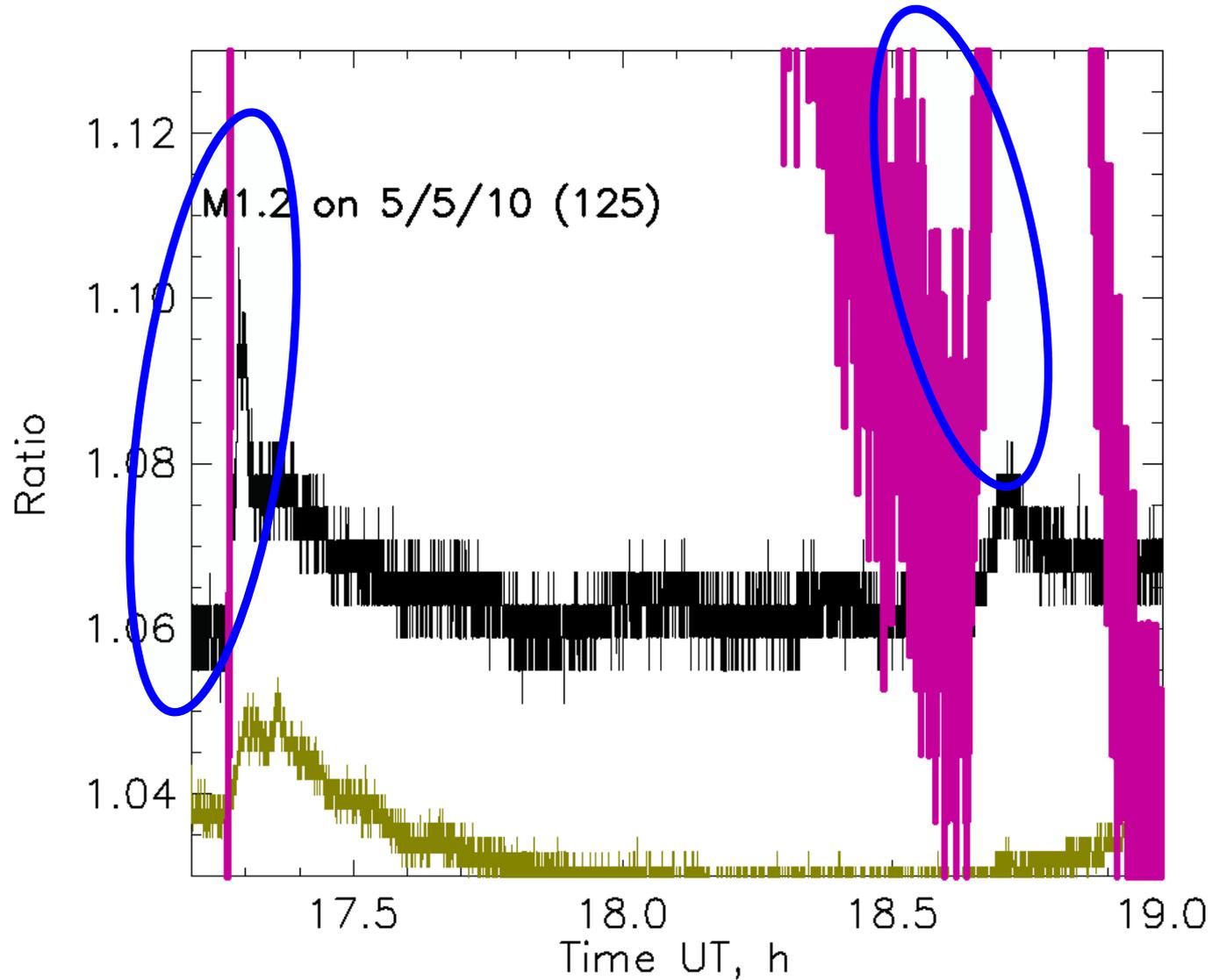
M1.2 and B7.3 Flares

X-ray: **10.52**@
17:19:58.52 UT

•Ch30 **Earlier:**
1.05@17:17:17.01

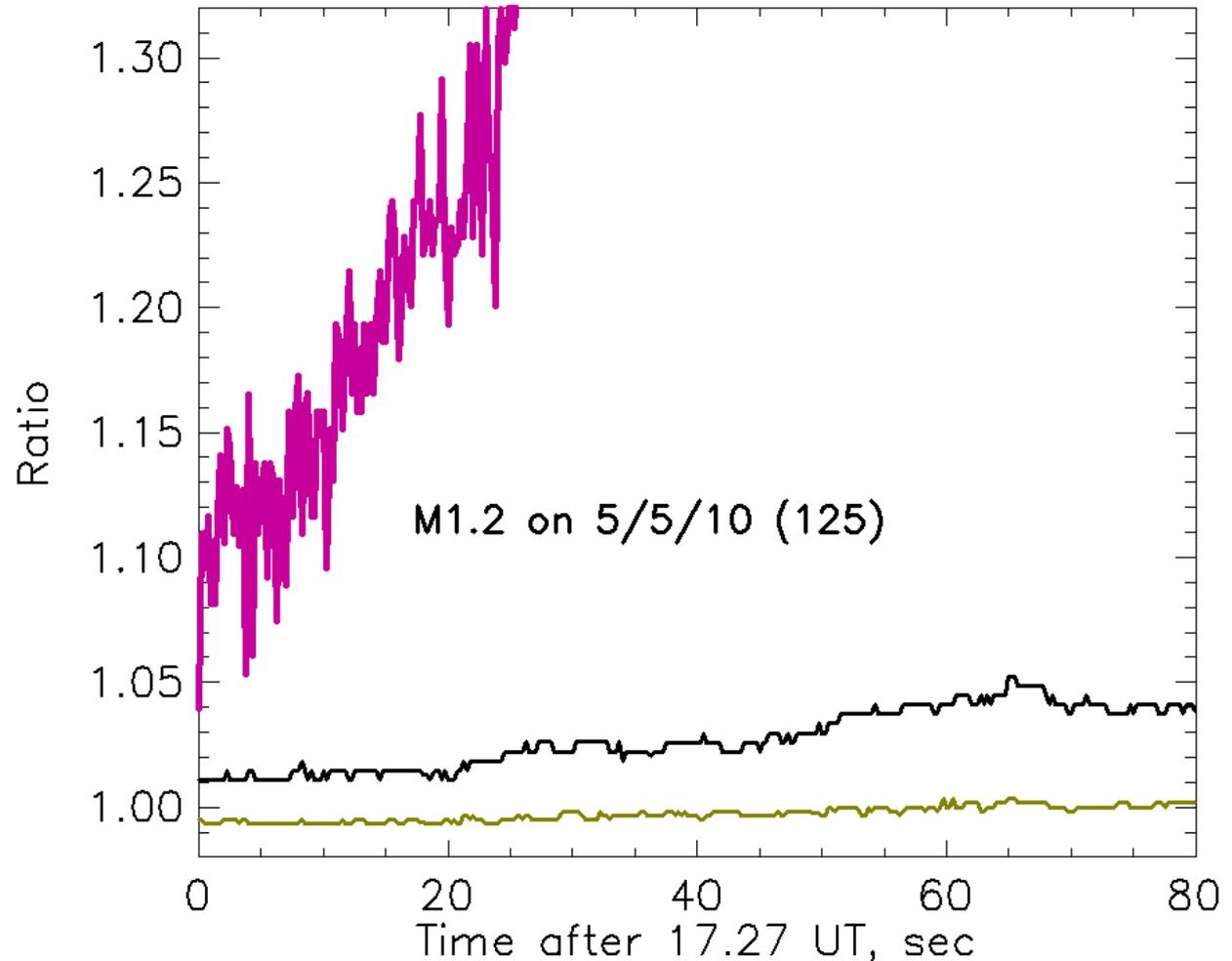
•Ch18:
1.05@17:21:39

Narrow (< 1 sec)
30.4 nm flare peak;
The peak is about 3
sec earlier than the
X-ray peak. What
specific AR's
conditions caused
another flare
during the decay
process? Could
AIA and HMI help?



How Important are Some Details of These Fluctuations?

ESP QD observable Characteristics:
amplitude, frequency, shape of the profile, e.g., some X-ray fluctuations are around the same irradiance level before the irradiance steps to a higher level.



Event Number 1/2

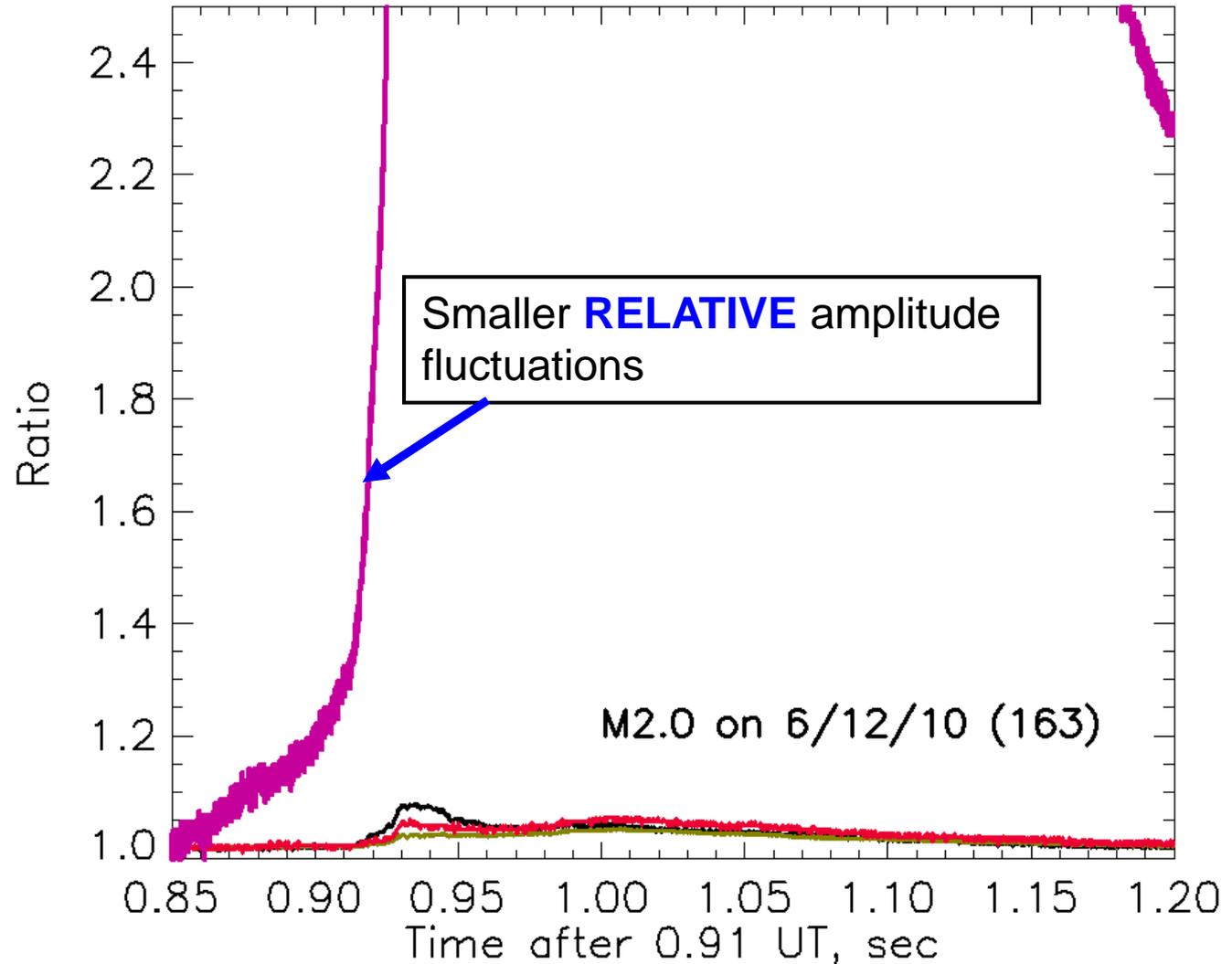
X-ray: **14.81** @
0:58:33.74 UT

Ch30 **Earlier:**
1.08 @ 0:56:05.89

•Ch26:
1.02 @ 0:59:52

•Ch18:
1.01 @ 1:00:15

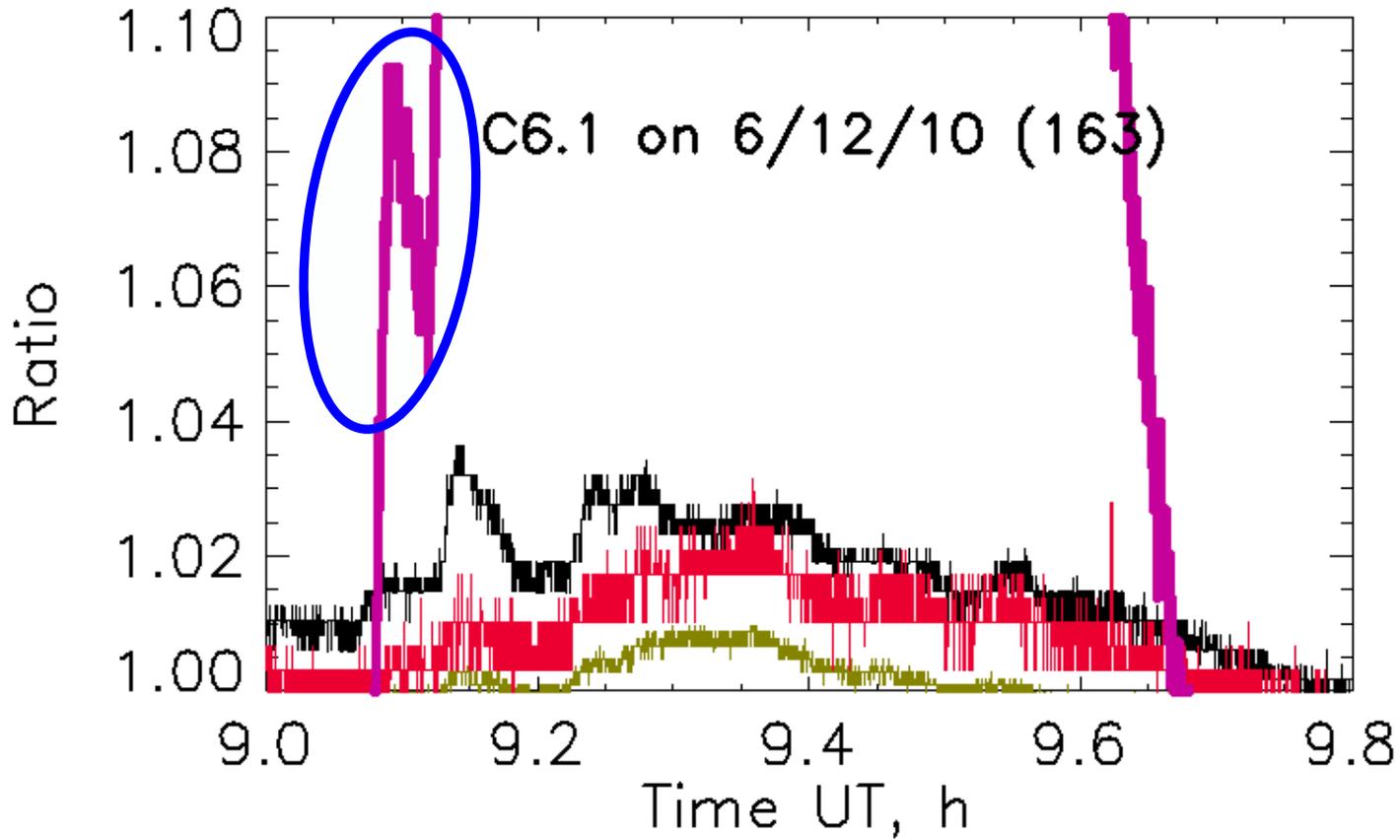
30.4 nm peak is 2.5 sec earlier than the X-ray peak;
For this larger flare, X-ray front profile shows smaller relative fluctuations but faster increase than in smaller class flares.



C6.1 Flare

- X-ray: **6.6**@
9:18:54 UT
- Ch30:
1.04@9:08:39
- Ch26:
1.03@9:21:32
- Ch18:
1.01@9:21:36

Double X-ray peak or another TFR: does the first 30.4 nm peak correspond to the first (small) X-ray peak? If so, why is its amplitude larger than the one related to the main peak?



Why Some 30.4 nm Peaks Occur Earlier than the Largest X-ray Peak?

Discussion:

30.4 nm peaks are related to both the intensity of the X-ray energy release and the HEIGHT, where the magnetic reconnection first occurs. Thus, they correspond to SOME (not always to the largest) X-ray energy release!

It would be interesting to see some close-to-the-limb AIA 30.4 nm flare images to determine if the time difference is related to the height where the flare starts.

A Wider Horizon-> More Questions

All these flare data were extracted from the ESP Level 1 data product available from this June.

This talk shows the great potential of ESP high-cadence data for generating (answering) these and future flare-related questions.

To be continued!