Seeing the Unseen
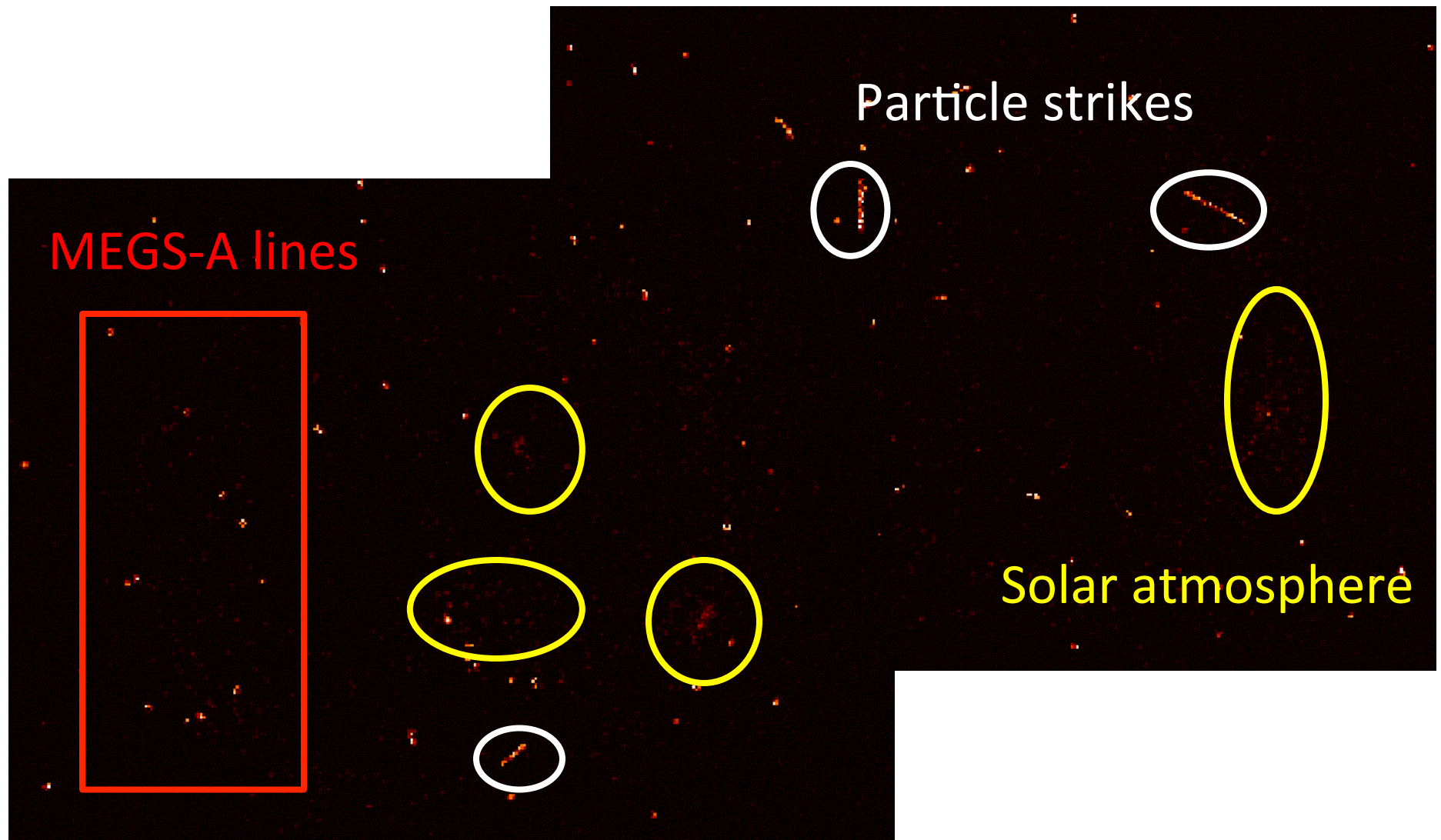## SAM Detection, Calibration, and Future Spectra
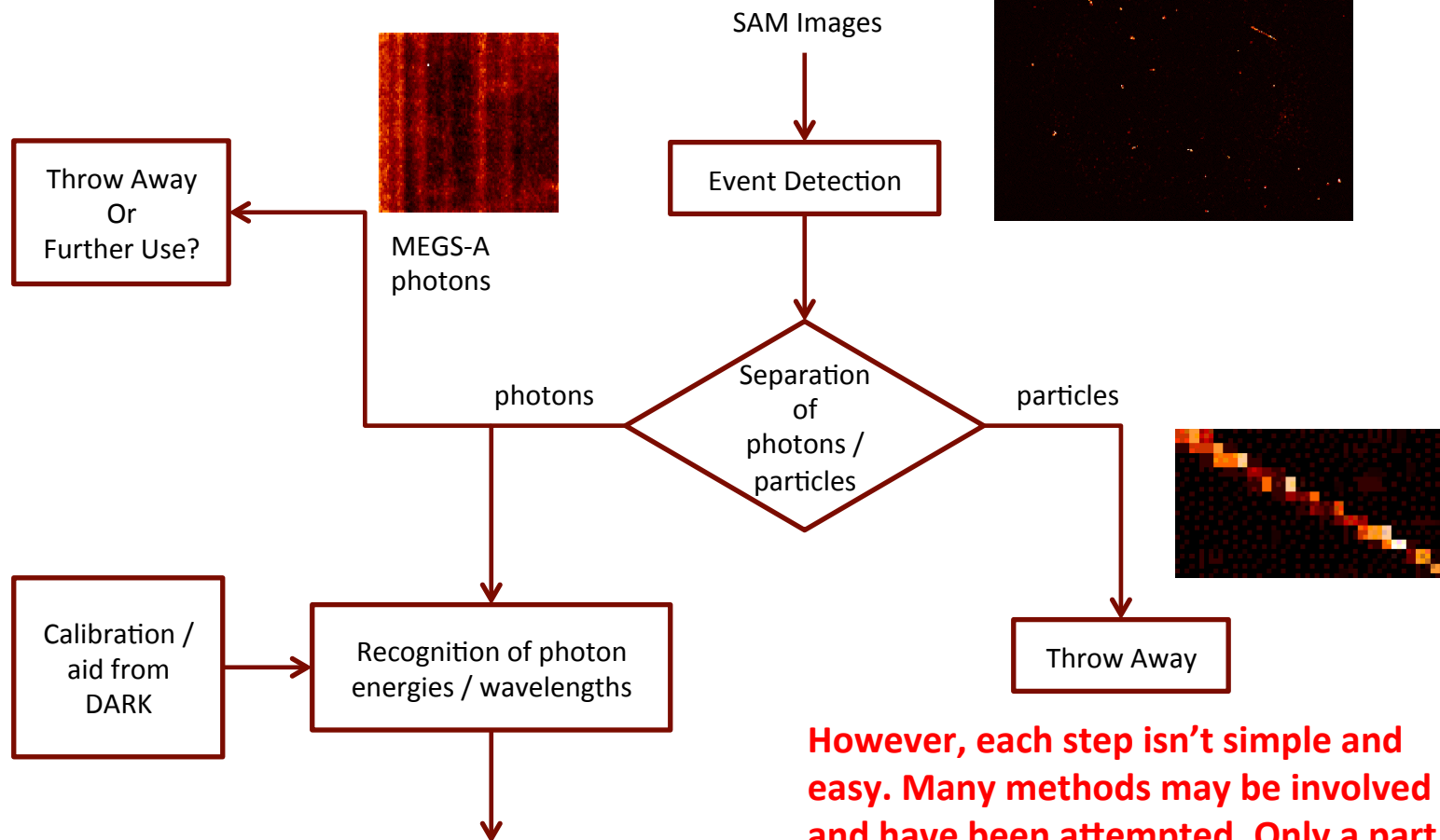
Cissi Lin, Scott Bailey

Virginia Tech

EVE Science Conference

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What's on SAM?

General Procedure/Goal with SAM Data

SAM Images

→

Event Detection

→

Separation of photons / particles

photons →

particles →

Throw Away

MEGS-A photons

Throw Away Or Further Use?

Calibration / aid from DARK → Recognition of photon energies / wavelengths

↓

Solar Irradiance < 7 nm

However, each step isn't simple and easy. Many methods may be involved and have been attempted. Only a part of them are presented in this presentation.

Past, Present, & Future

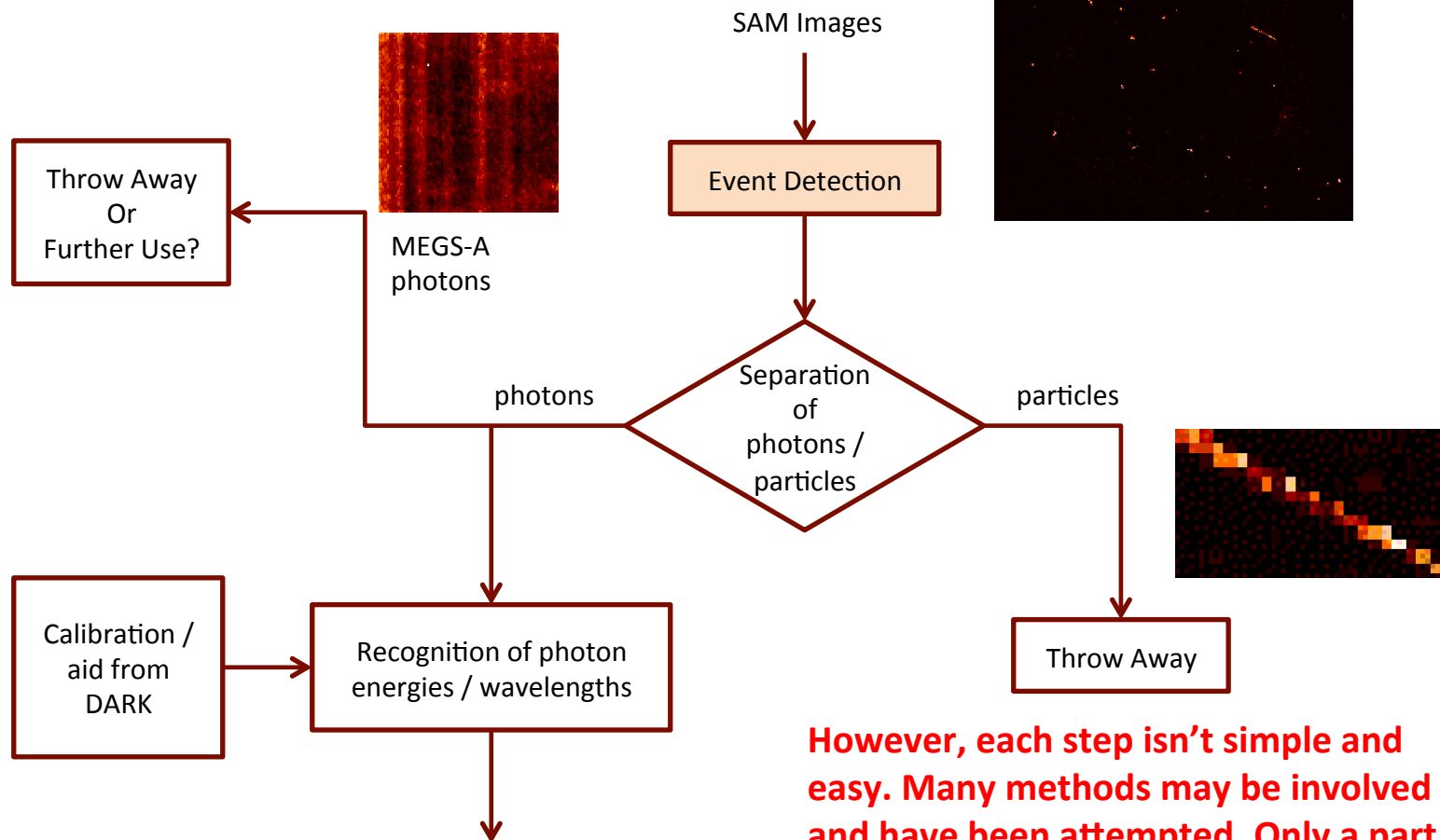|	Detecting Methods		Separation of Photons/Particles					
Name	Monotonically decreasing edges	Nearest-neighbor search	Image-wise			Energy-wise (Spectrum-wise)	Frame-wise	
			Spatial Ratio	Edge occurrence	X location	Probability correcting	Keeping median/smaller	5-frame study
Concept	A well-defined edge for a peak (all pixel values monotonically decreasing from the peak).	Search around the neighborhood to pick up every adjacent pixel with qualified intensity.	A hit usually possesses a certain shape on the image, usually narrow.	When particle hits CCD, it leaves a trace and therefore peak at the either end is expected.	Weight an event according to averaged locations of MEGS-A lines	Detection on both SAM image and dark image produces two spectra. Use dark one to correct SAM one.	Particle always has high energy. To remove those with higher energy.	Compare 5 consecutive frames and study the outliers (peaks).
Criteria / method	p = minimal pixel value got picked up n = maximal noise floor peak > p starts detection; detection stops after edge drops below n	threshold = (minimal pixel value) 5.0 Any pixel with value threshold will be picked up.	threshold_area = 0.7 Ratio of occupying area in an event box > 0.7 is considered a true photon event.	Pixel of maximal value in the NN detected event falls on one edge of the event box = particle hit	The locations of MEGS-A lines , which are obtained by applying detection method on quite-sun images without any further screening and summed up over one day for high SNR.	SAM image: 320 x 240 Dark image: 480 x 160 Solar spectrum = SAM spectrum - estimated probability distribution of dark spectrum * (total # of events detected in SAM)	Compare each pixel in the consecutive 3(2) frames and keep the median(smaller) one to reform an entire frame.	Peak value = ? Peak width = ?
Pros	A single photon hit would probably look like this.	This picks up an event with its exact shape.	It removes hits having shape close to 45 degrees.	A lot of particle hits can be removed and active regions are better preserved compared to SR results.	Minimize effects of MEGS-A lines on SAM	TBD (to be discovered since we don't have comparison to such detailed spectra)		This is more like a study of frame-wise behavior at each pixel.
Cons	However, this fails to grab the complete events if multiple hits take into place. This picks up the entire event box rather than event itself (comp. NN)	It can possibly pick up a strong event which contains many photon strikes.	The assumption failed when the shape of the event is close to || X or Y axis. From images, it removes part of active regions.		Missing photon events overlapping with MEGS-A lines	TBD	This would fail to detect any real energetic photon from the Sun.	
Better for			Particles but also part of the ARs	Particles but also part of the ARs	MEGS-A lines			

Glossary

- DN: data number
- Event: a cluster of pixels detected, may be a photon/particle event
- Event box: a rectangular box containing the event described by x and y
- SAM image: solar disc, 320x240 pixels
- DARK: dark strip, 480x160 pixels
- Extracted image/anti-image

General Procedure/Goal with SAM Data

SAM Images

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Throw Away
Or
Further Use?

MEGS-A
photons

photons

Separation
of
photons /
particles

particles

Throw Away

Calibration /
aid from
DARK

Recognition of photon
energies / wavelengths

Solar Irradiance < 7 nm

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Nearest-Neighbors Search

- Using the idea of the nearest-neighbors search to extract events by their exact shapes
- Start searching from the nearest neighbors!
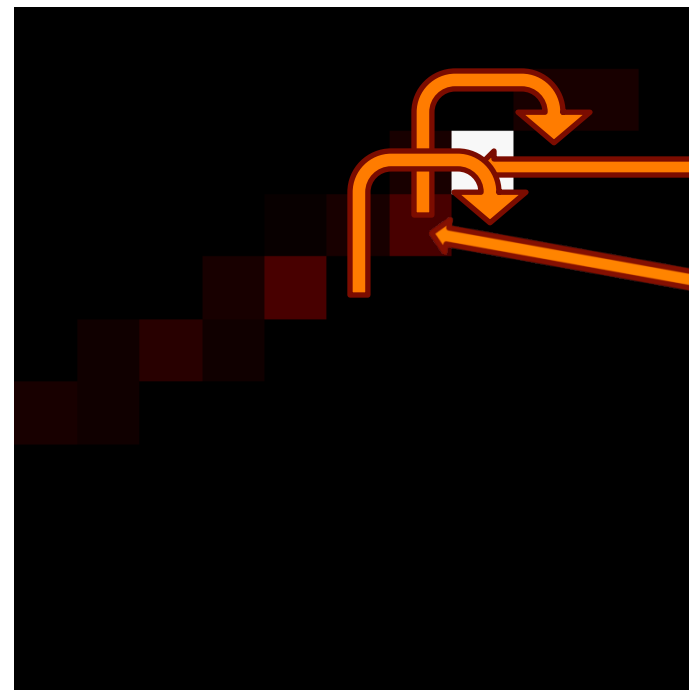
2. Search the nearest 8 cells

1. Peak detected!

3. Qualified* cell found!

4. Search the nearest 8 cells again!

... going on to every adjacent cells till every qualified cells are visited.

*Qualified = value of the pixel (cell) >= threshold and < 500

General Procedure/Goal with SAM Data
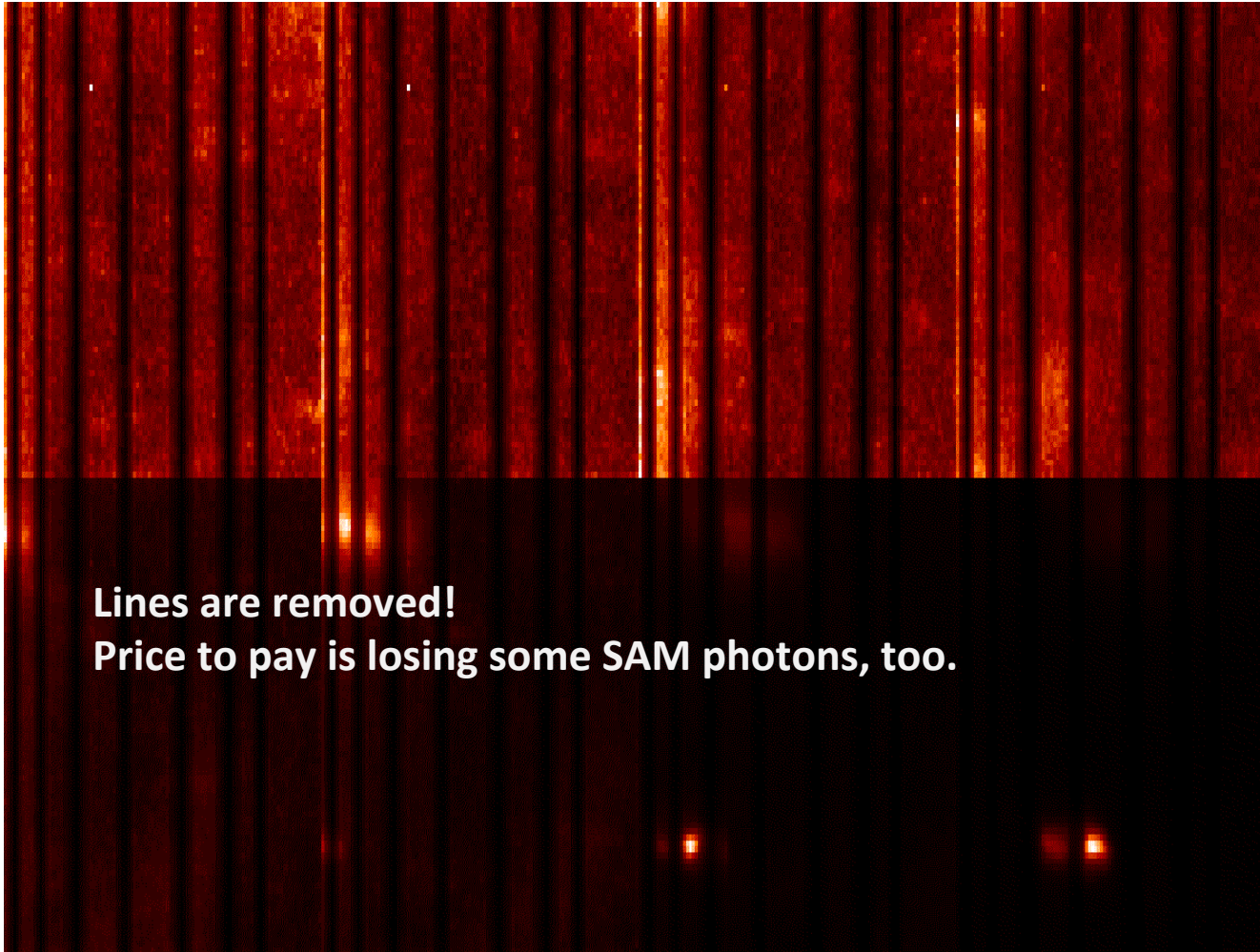
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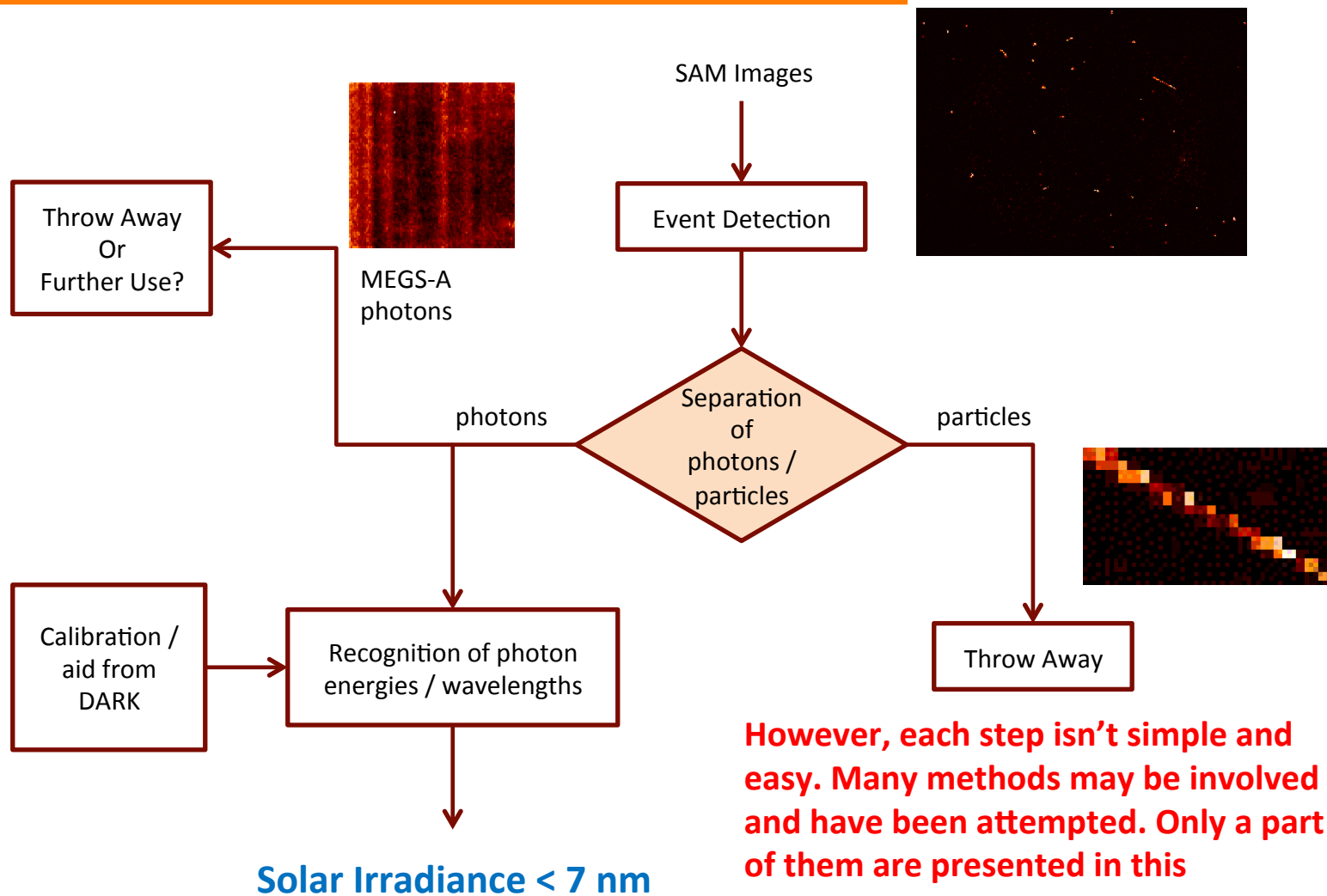
Spatial Ratio

- ## What do I mean?

Peak value in this neighborhood
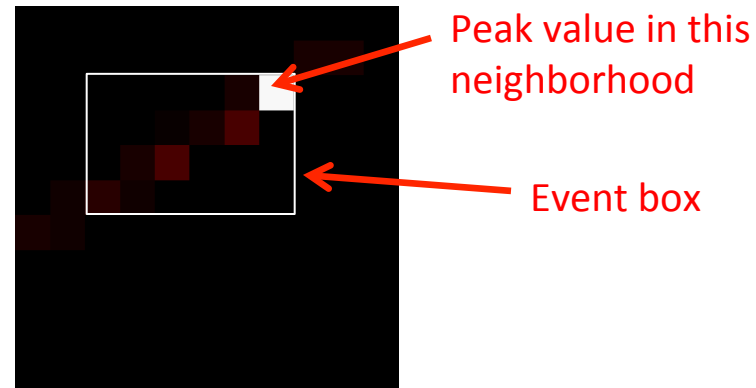
Event box

- ## Filtering criteria:

  - (# of occupied pixels / # of pixels in the event box) >= 0.7 ➜ true photon event

  - (# of occupied pixels / # of pixels in the event box) < 0.7 ➜ particle hit

- ## Best filtering while event lies 45 degrees from X or Y axis

MEGS-A Lines

We are simply detecting MEGS-A spectrum!

MEGS-A Lines
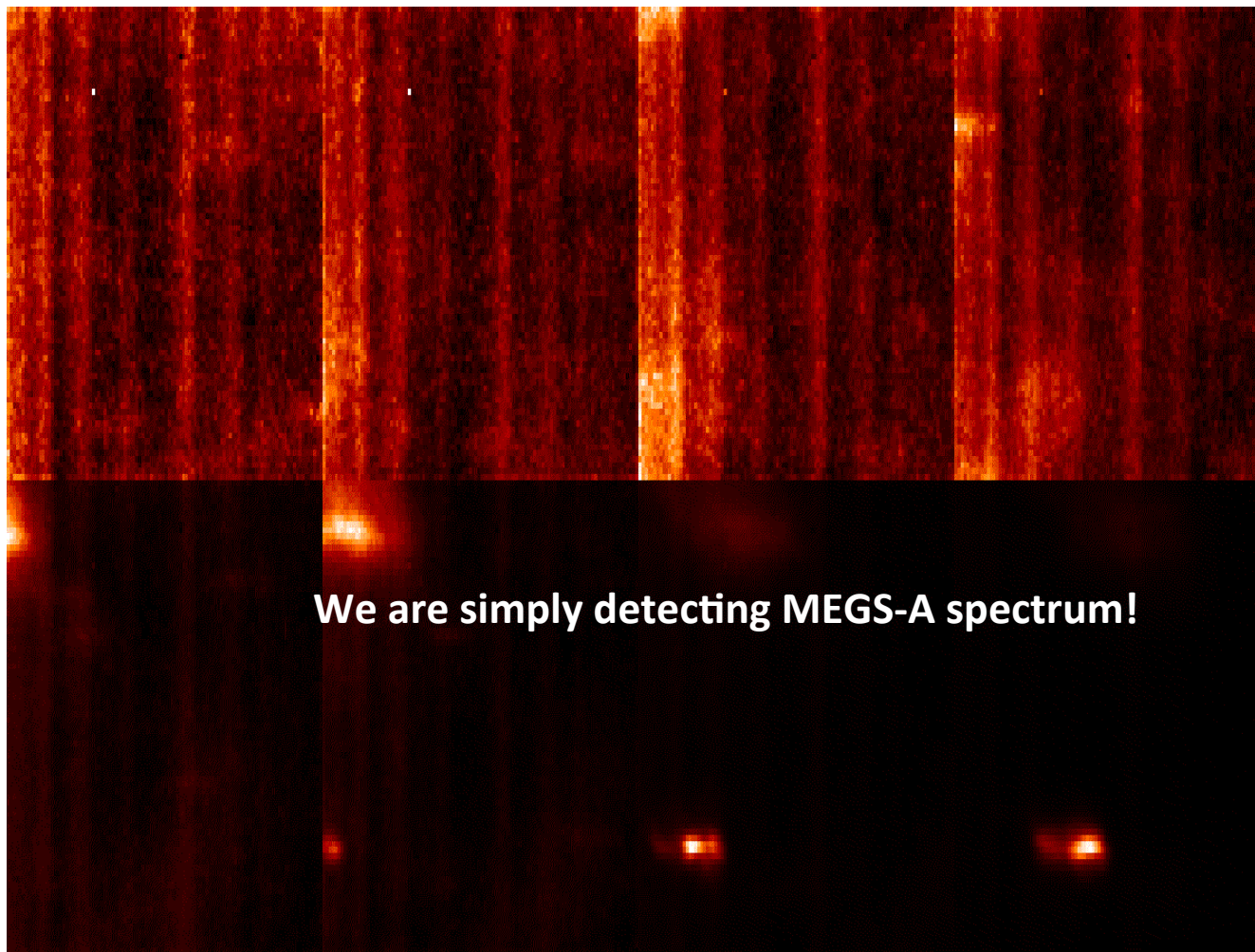
es on SAM
during quiet
ated as
ses for
events.

Lines are removed!
**Price to pay is losing some SAM photons, too.**

Multiple-Photon Events

- Size of most detected events are larger than 2x2 pixels.

- This is a chicken-and-egg problem.

- Assume a photon averagely distributes its energy on 3 CCD pixels
- Multiple-photon mode on when detected peaks are not adjacent to each other

Quiet Sun

- Time periods for investigating the quiet sun in 2010:

    - Day 135 – 142 (active region showed up at the end)

    - Day 280 – 285

    - Day 303 – 305

- A small area at the center of the solar disc is used for the study.
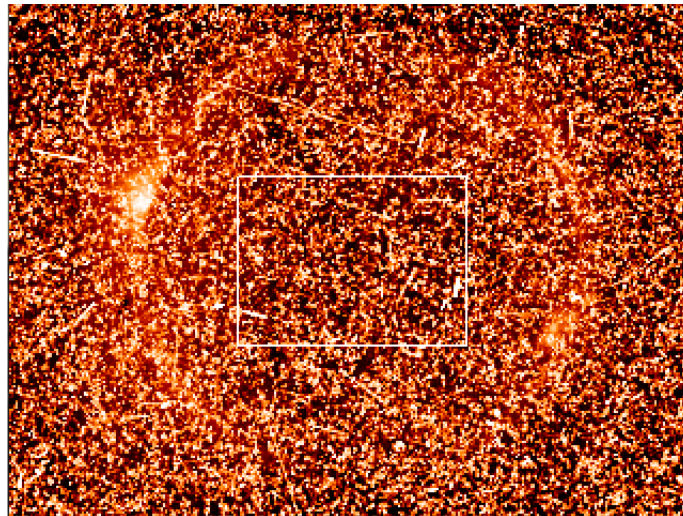
SAM Irradiance
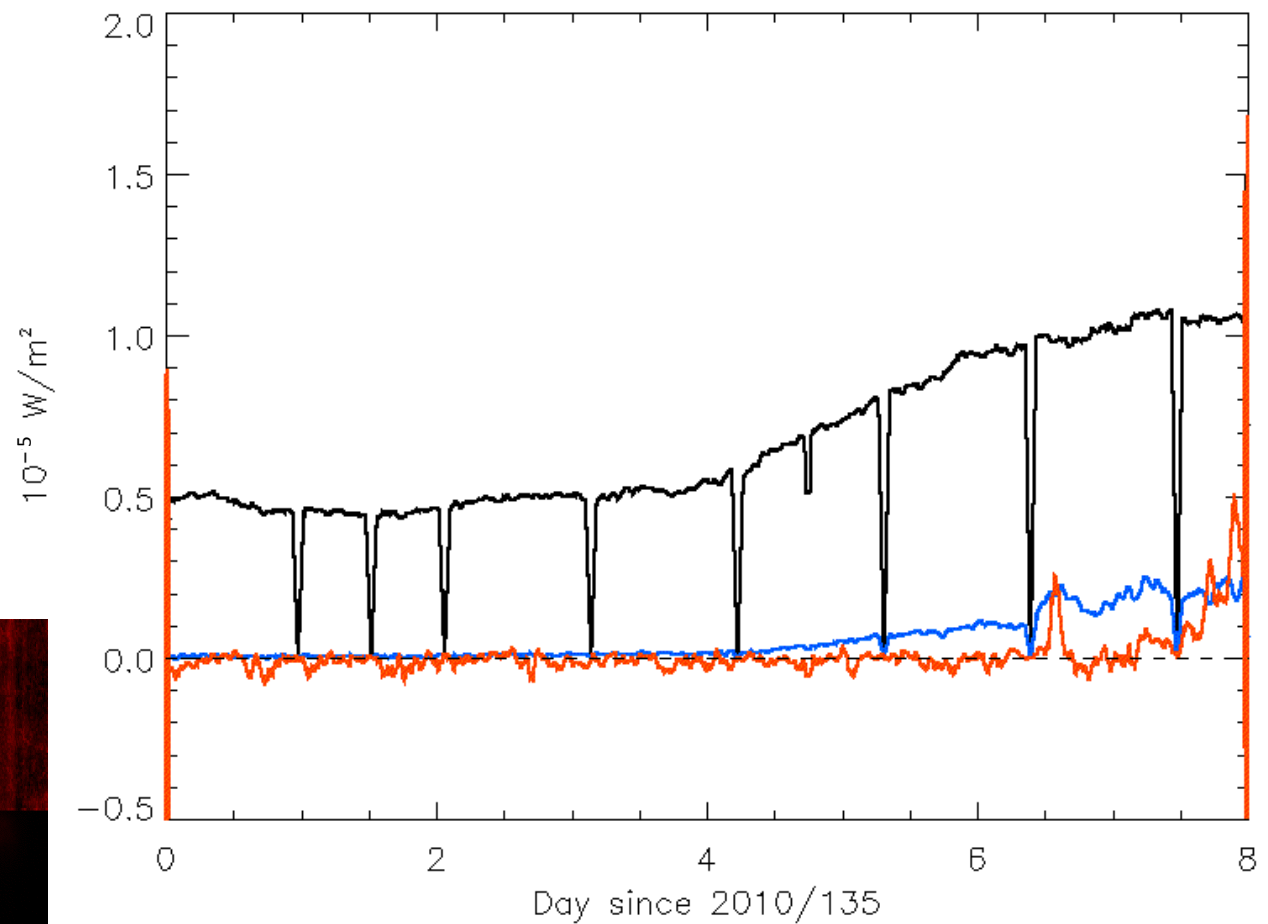
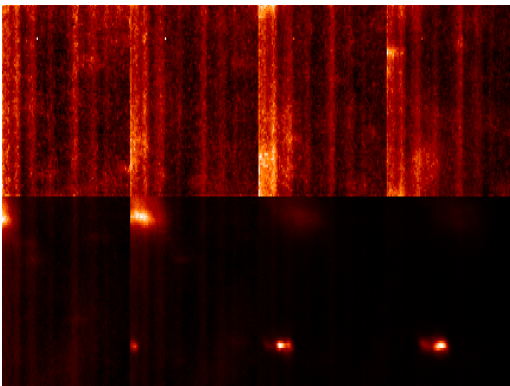20 – 100 DN
180 – 900 eV
1.4 – 6.9 nm
100 – 200 DN
900 – 1800 eV
0.7 – 1.4 nm
200 – 1000 DN
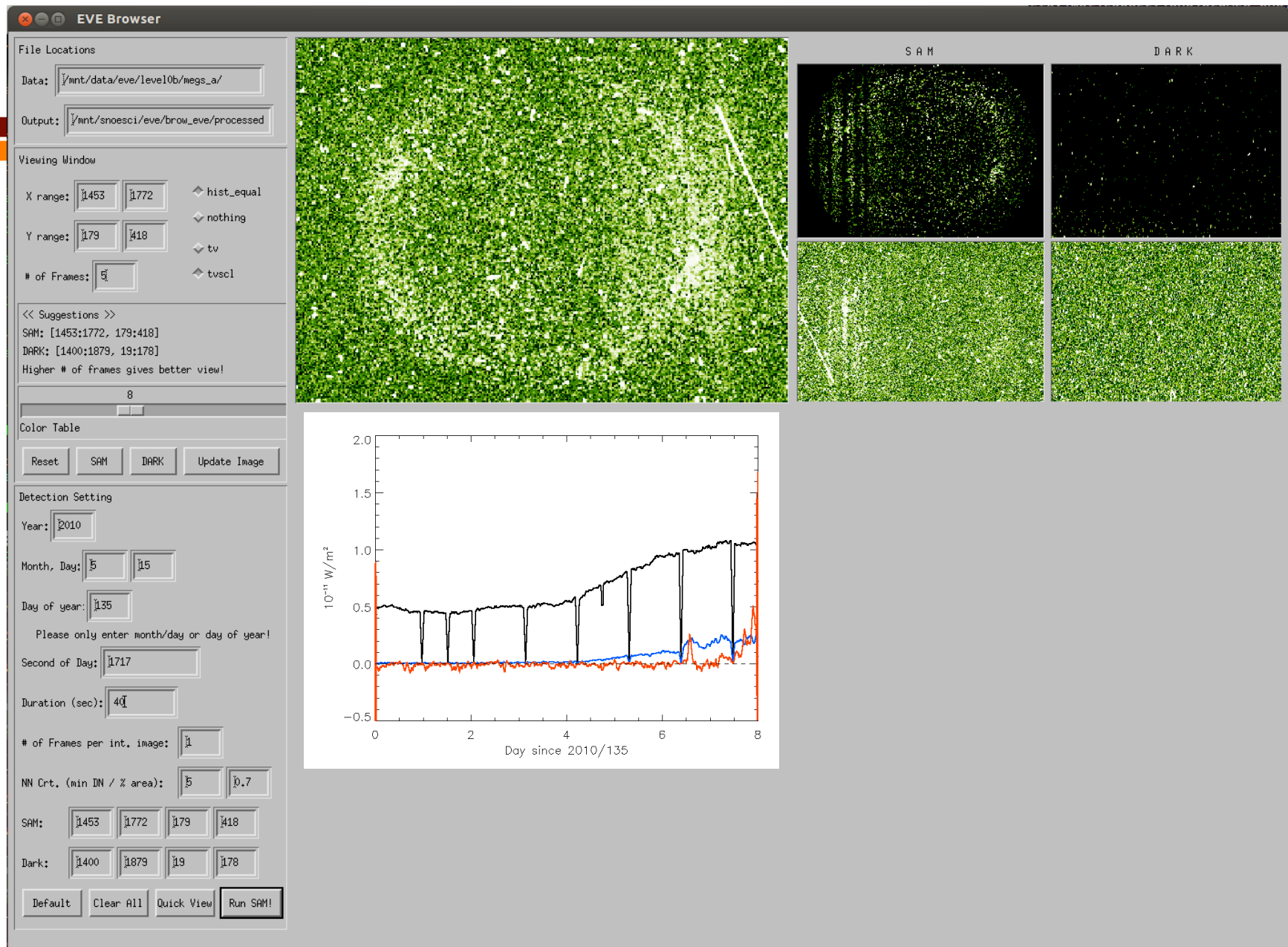1.8 – 9 keV
0.14 – 0.7 nm

browse_eve (or browse_sam?)

- Currently-underdevelopment GUI data browser
- To make analyzing SAM easier and integrated results seen visually

Conclusions

- Currently, we are aiming to validate SAM results with ESP irradiance (at 1 – 7 nm).

- We still hope for resolving SAM spectrum after properly dealing with each issue and being able to feed SAM irradiance/spectrum to the atmospheric models for space weather studies.