Power-laws and Solar Flares

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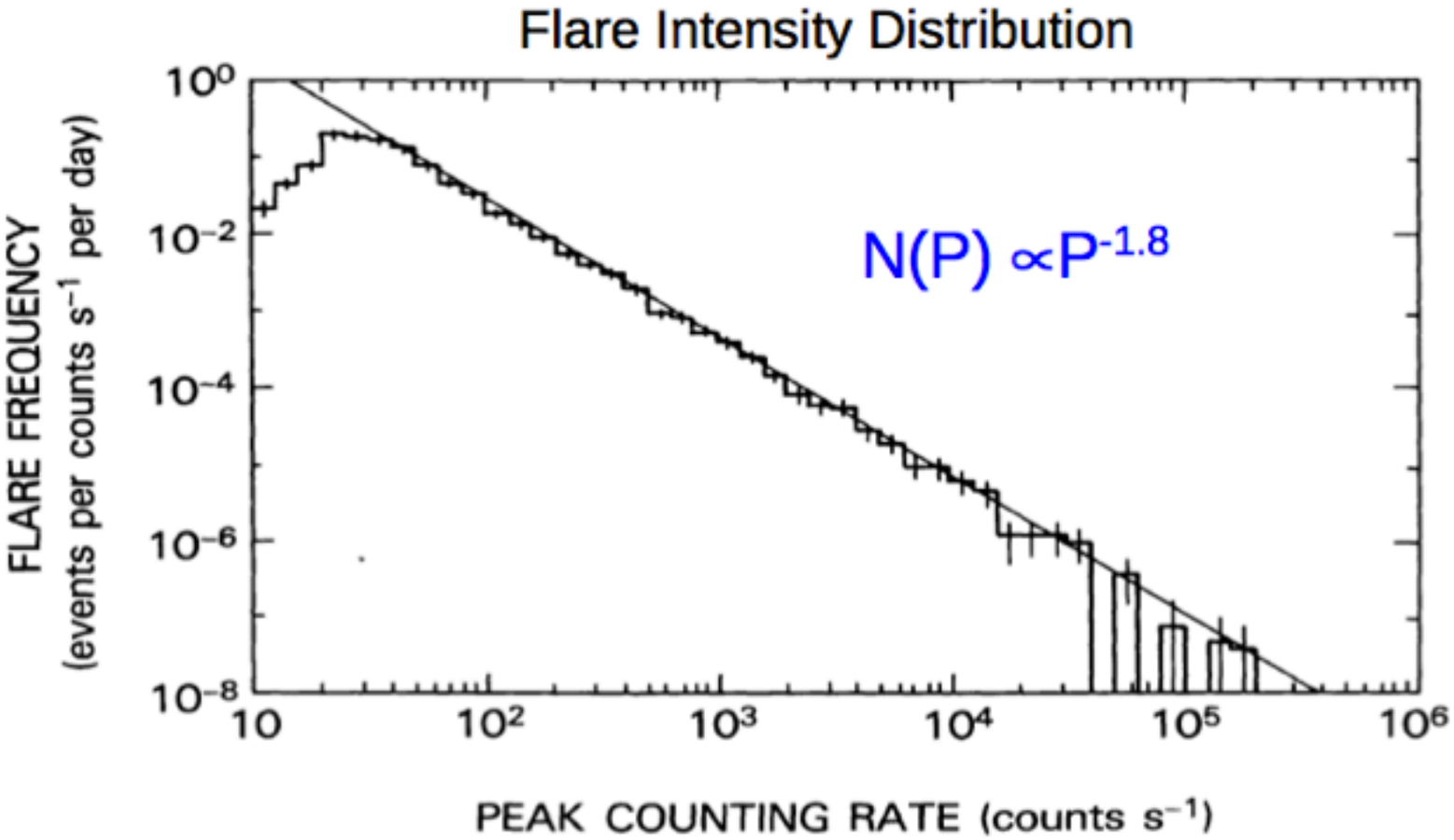
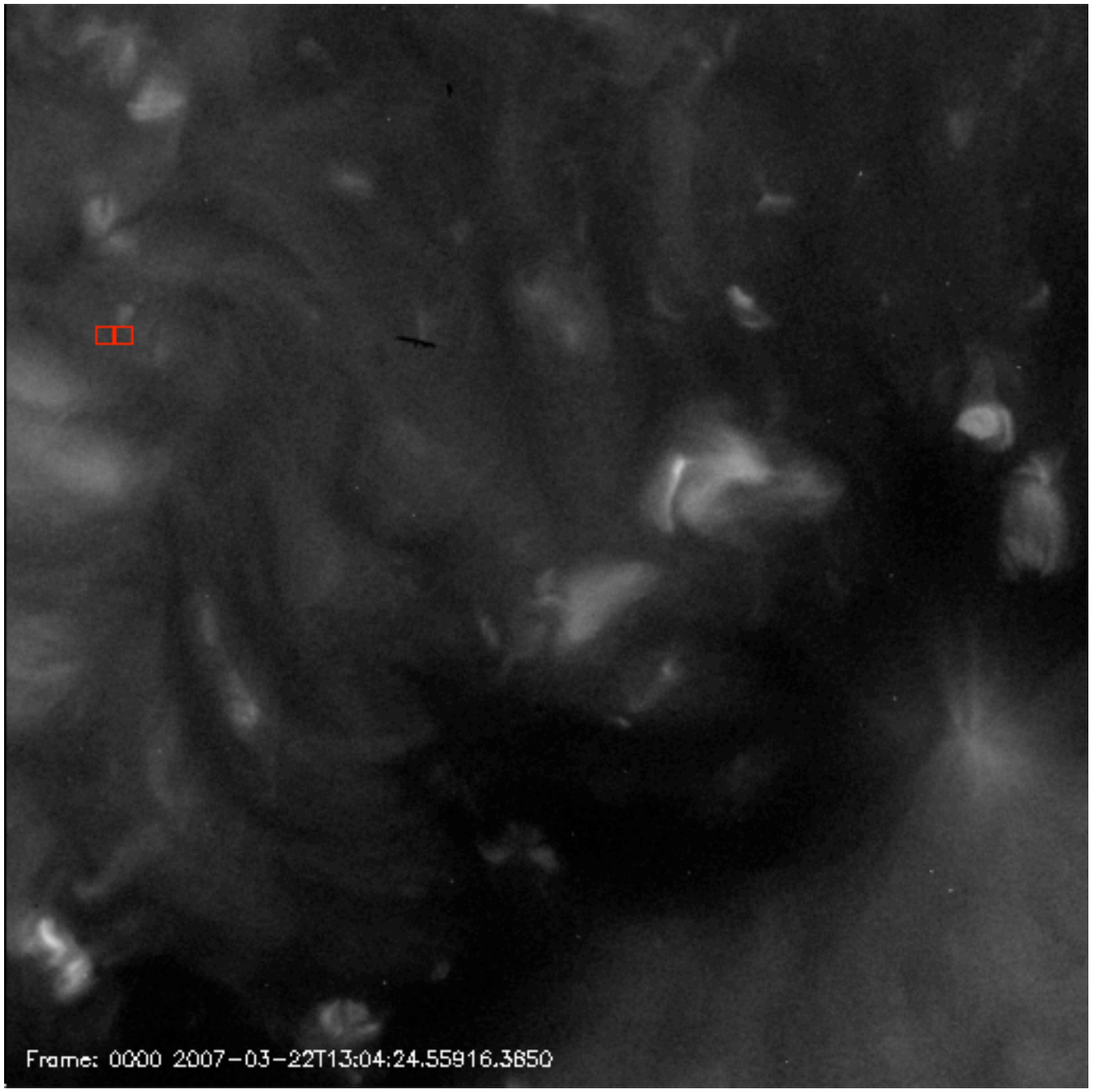
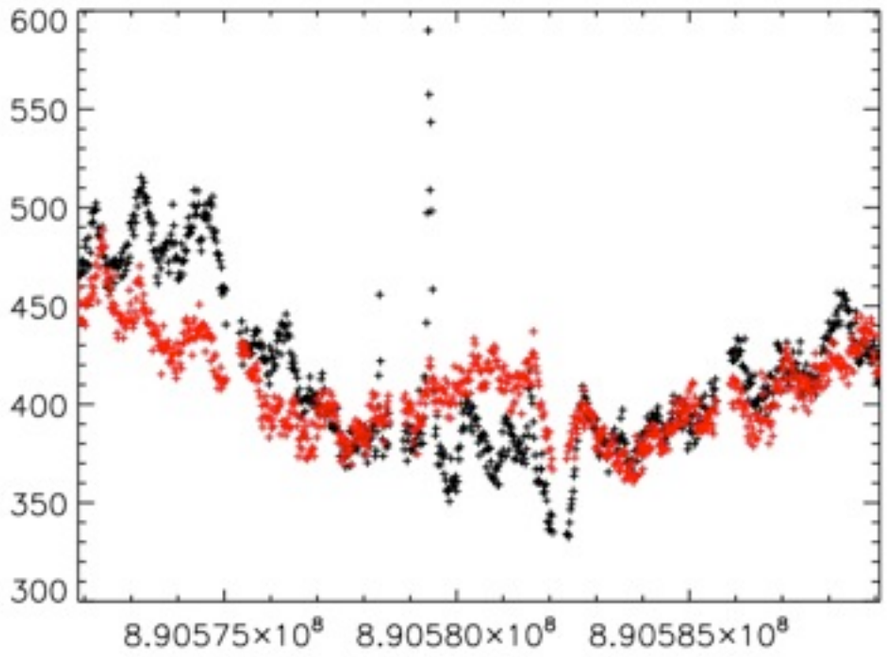


(figure from *Solar Physics*, B. R. Dennis, 1985; lifted from "Introduction to Solar Flares" presentation by Gordon D. Holman, NASA Goddard Space Flight Center)

Peak intensity of regular solar flares follows power-law distribution with alpha=1.8. Do weaker flares have the same distribution?

Data from XRT on Hinode





Difficulty: Detecting flare events in the presence of variable background

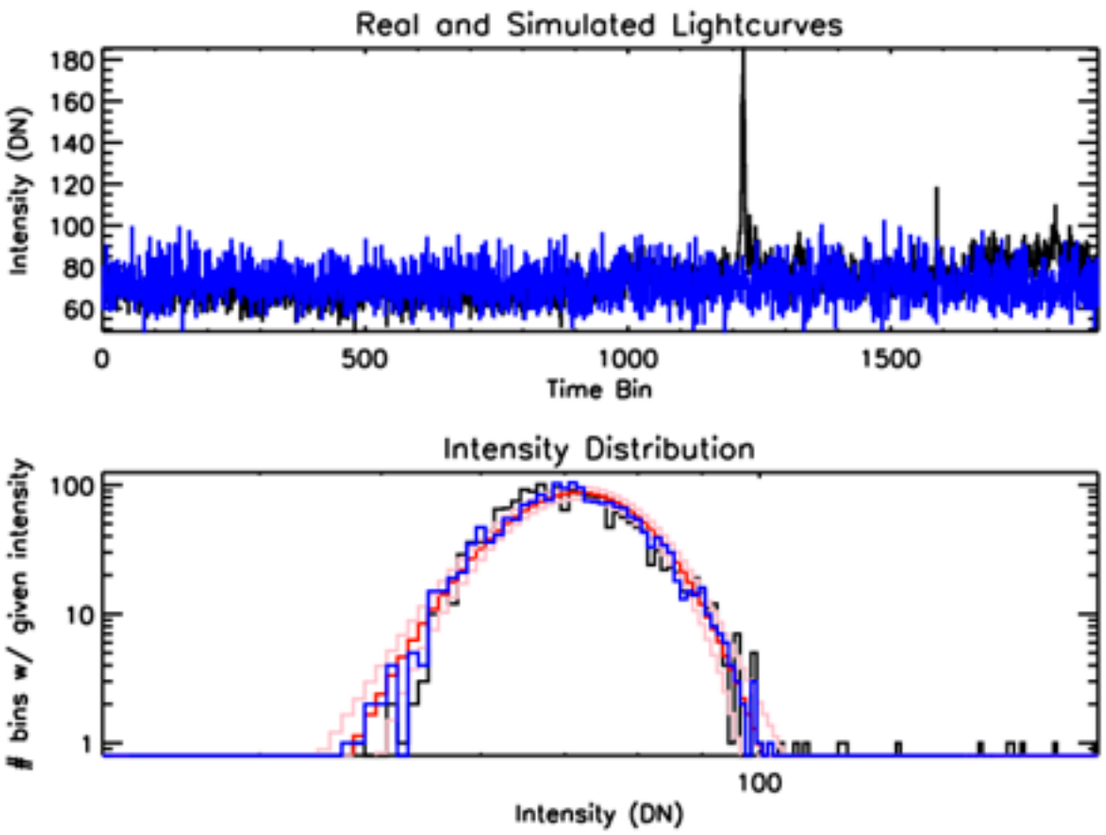
Flare Detection Strategies

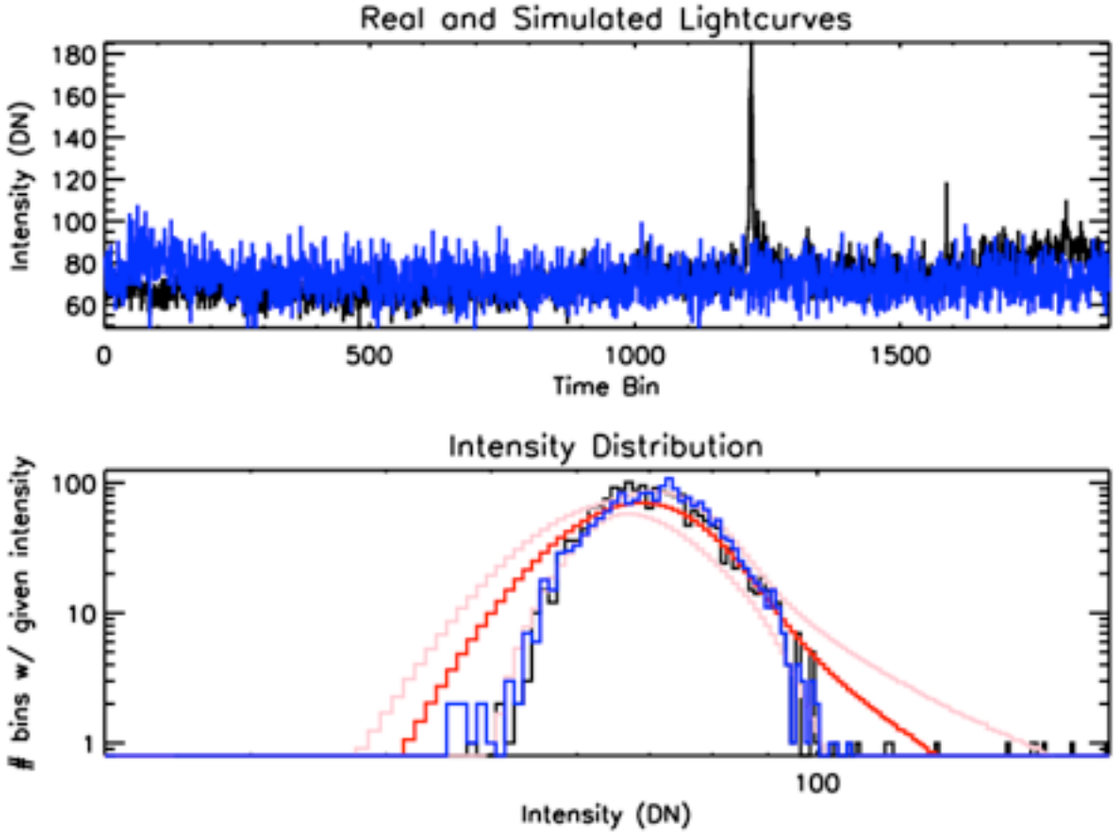
Currently we use 2 detection methods based on

* time derivatives
* segmenting based on significant minima

and use simulated lightcurves to optimize parameter values.

We want to try Alex Blocker's wavelet method!





black = observed, blue = best match

Is this alpha=1.8 or alpha=2.5? Monte Carlo simulations to find the best match to count rate distributions, BUT: can find a good match regardless of alpha!

Can we use comparison with simulated datasets to constrain alpha?

- Higher Criticism statistics:

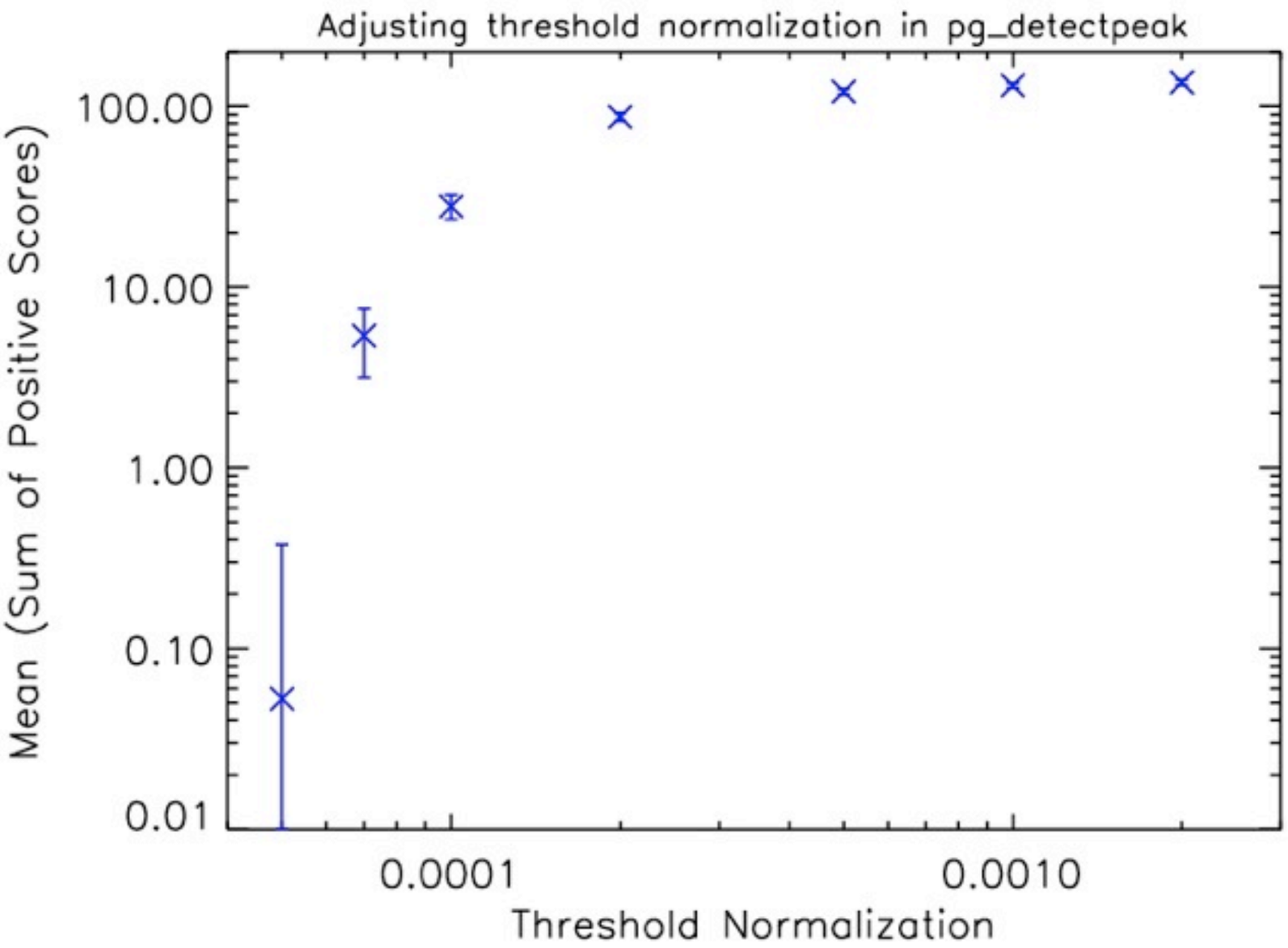
$$HC_{.05,n} = \sqrt{n}[(\text{Fraction Significant at } .05) - .05]/\sqrt{.05 \times .95}$$

(Jiashun Jin, Purdue University)

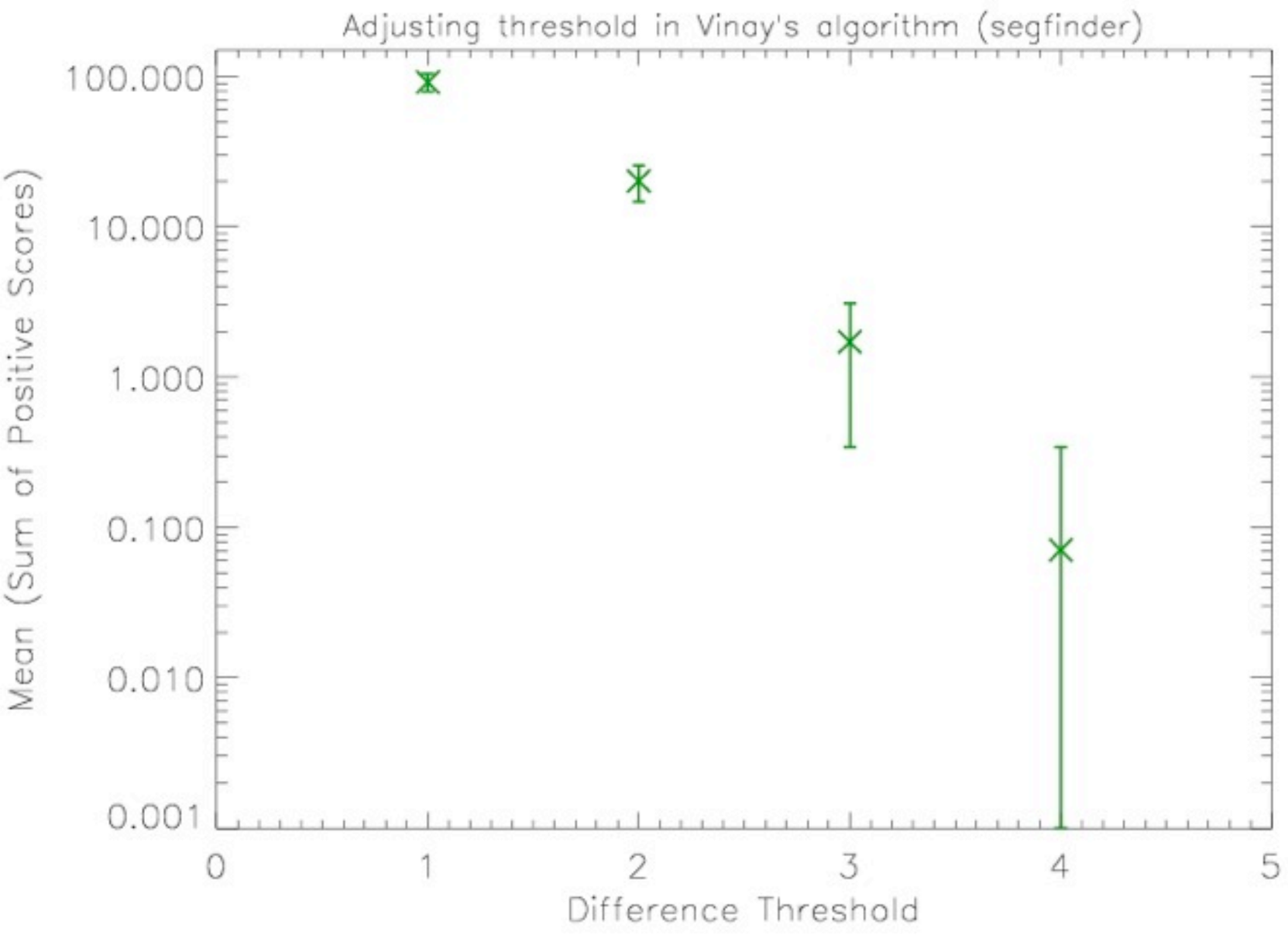
and typically,

$$\text{Reject } H_0 \text{ if and only if } \quad HC_{.05,n} \geq 2$$

- Define range of acceptable Chi-square values and see what % of simulations are in that range for given alpha?



smooth LC w/ fixed-width Gaussian; look at where derivative crosses certain thresholds to find flare start and end (parameters: smoothing width, 3 thresholds, threshold normalization factor)



Loess smoothing on LC; define segments as intervals between consecutive minima, merge segments if adjacent extrema statistically indistinguishable (parameters: smallest scale for smoothing, S/N threshold for merging adjacent segments)