

Swift/BAT GRB Temporal Analysis

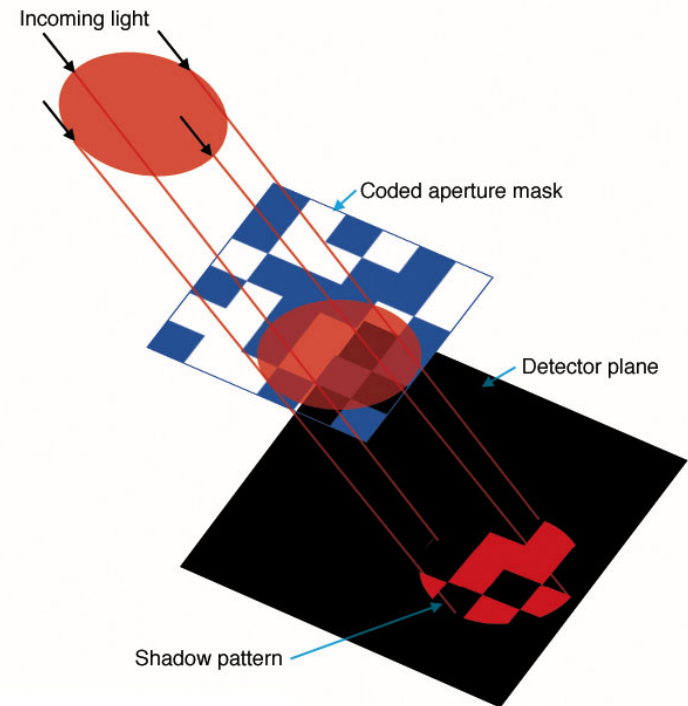
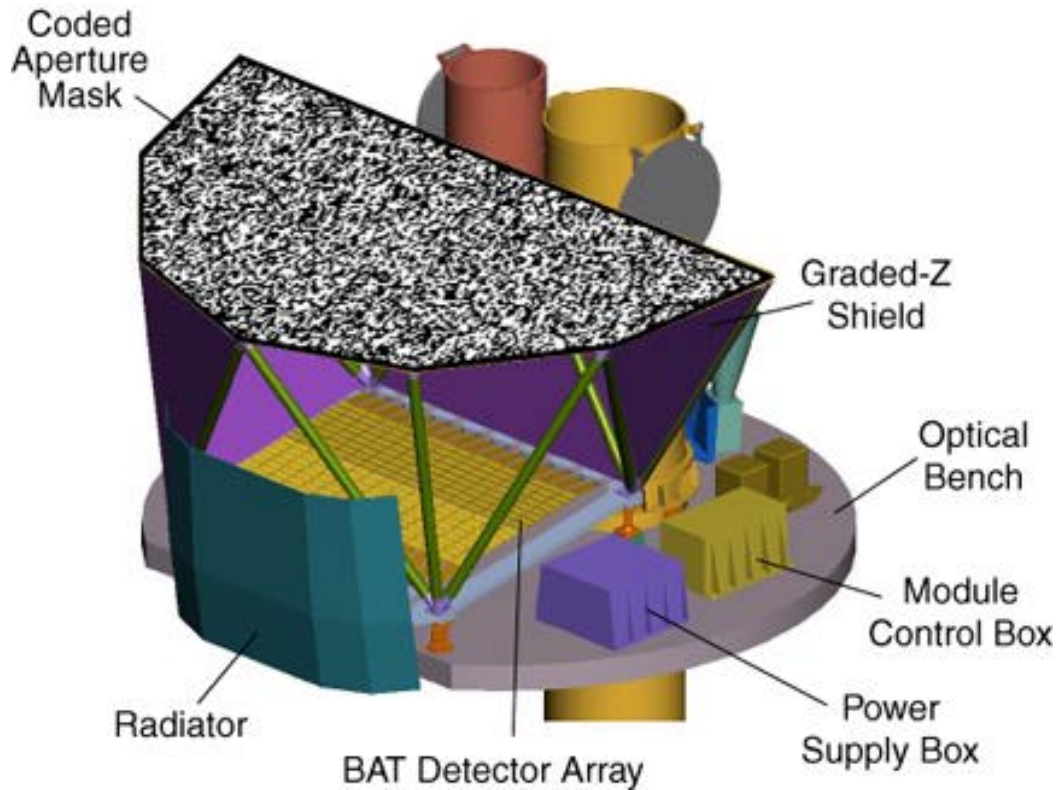
Amy Lien

Goddard Space Flight Center

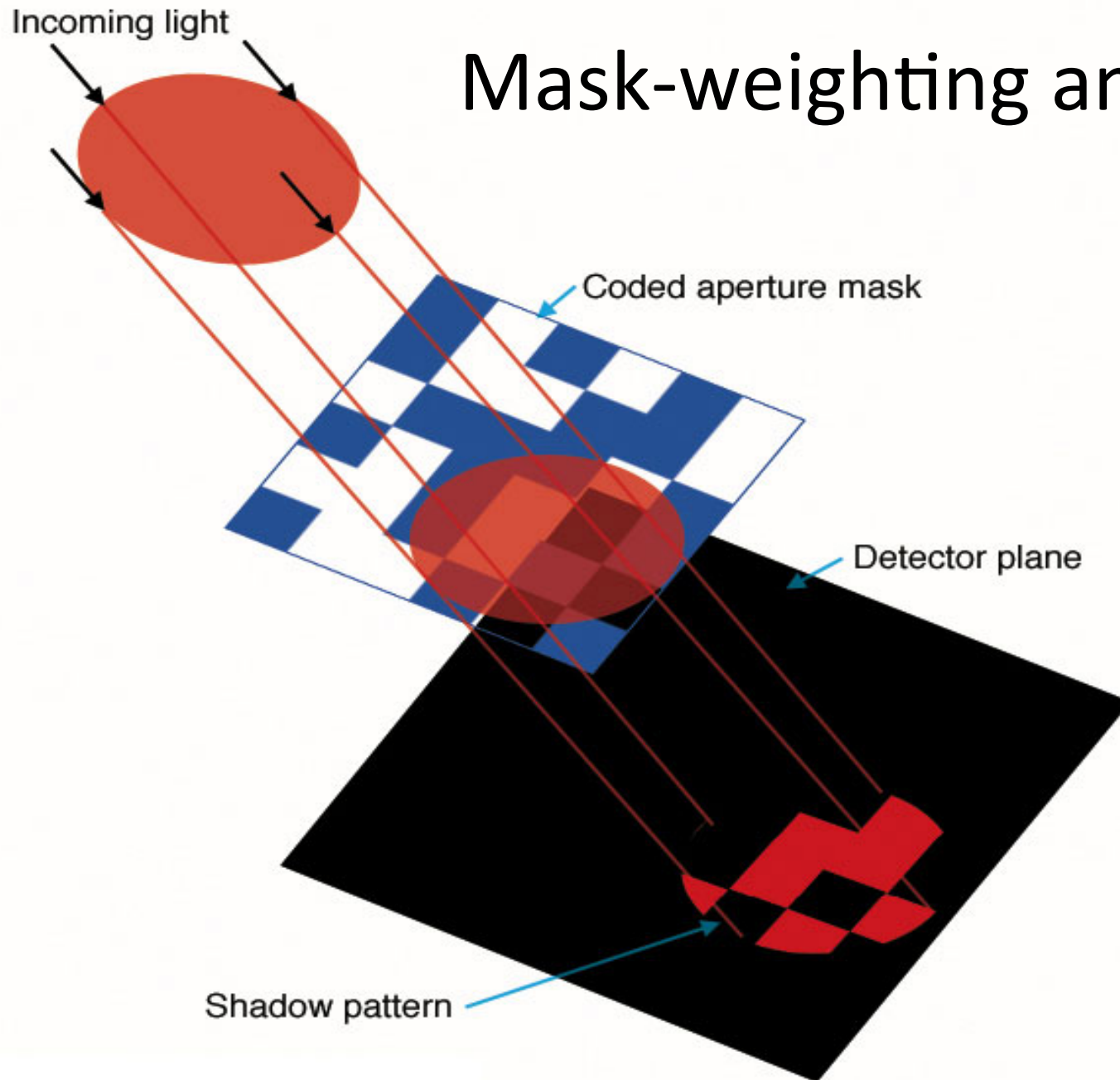
Last lab

- Integration package may have weird behavior.
- Integrate from 7 sigma to 100 gives you reasonable answer, while integrate from 7 sigma to $1.0e+6$ gives you zero....
- Also, different integration packages might give different results when using large limit (like $1.0e+6$).
- Important to understand the function behavior and do sanity check!

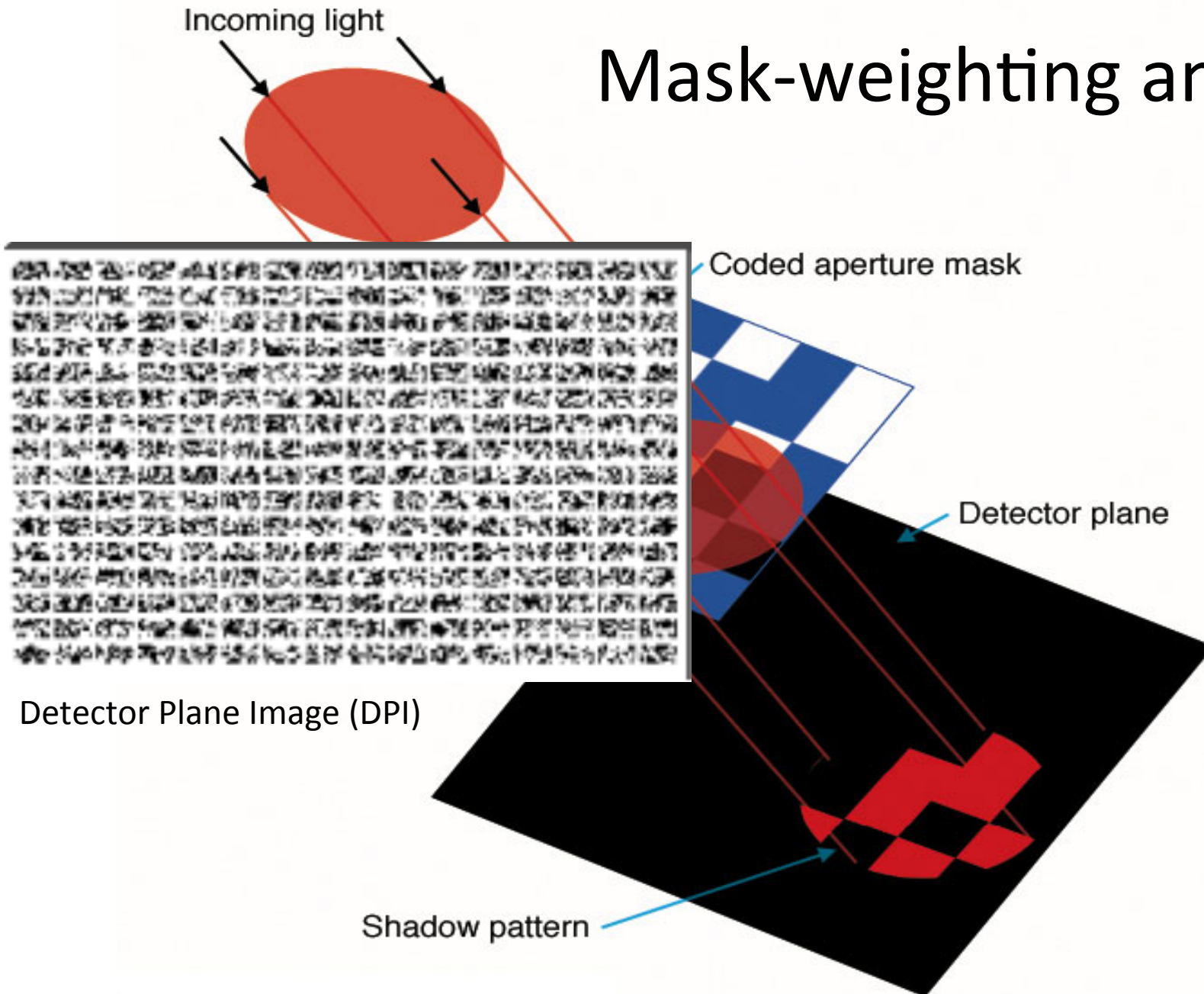
Mask-weighting analysis



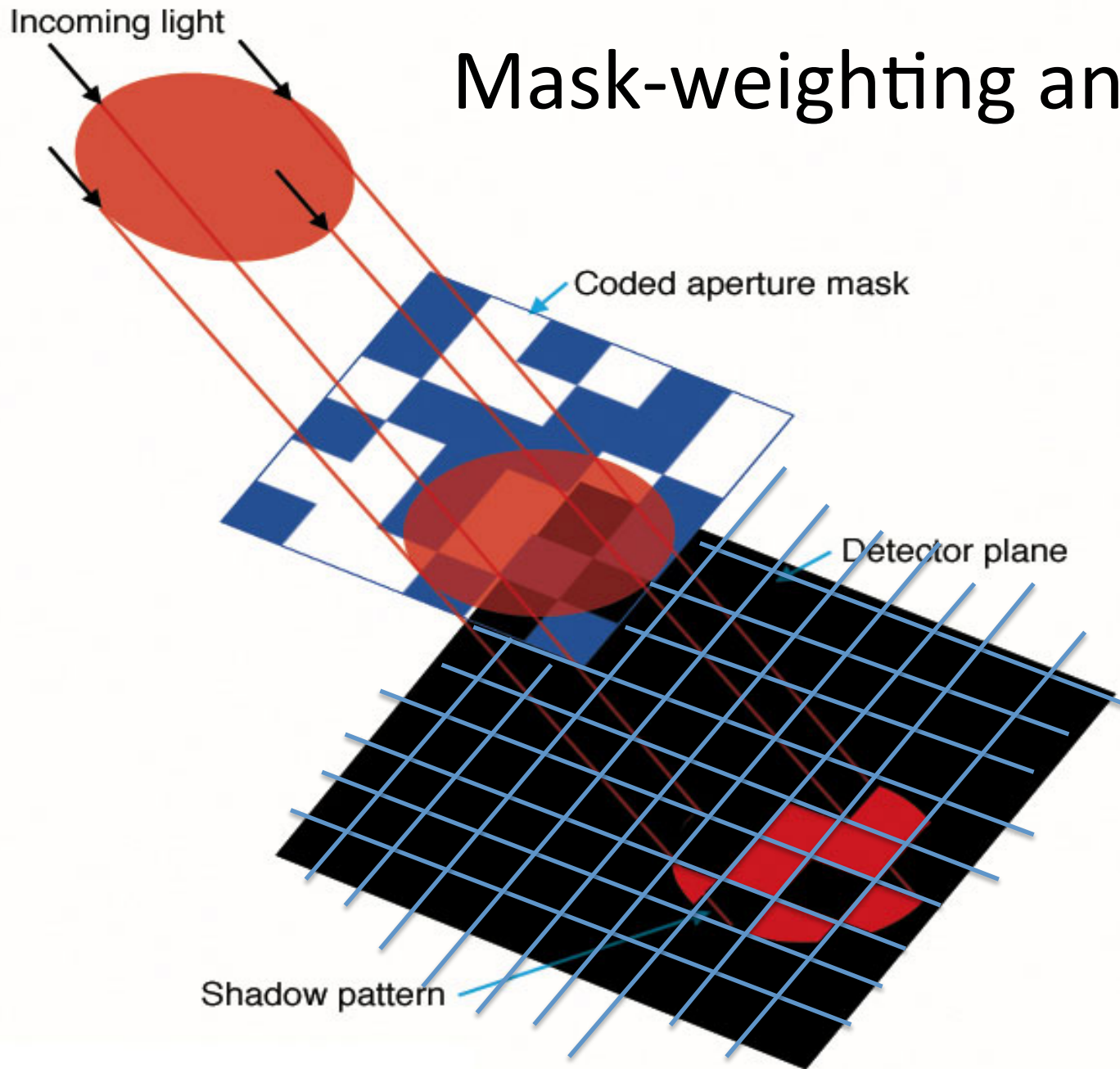
Mask-weighting analysis



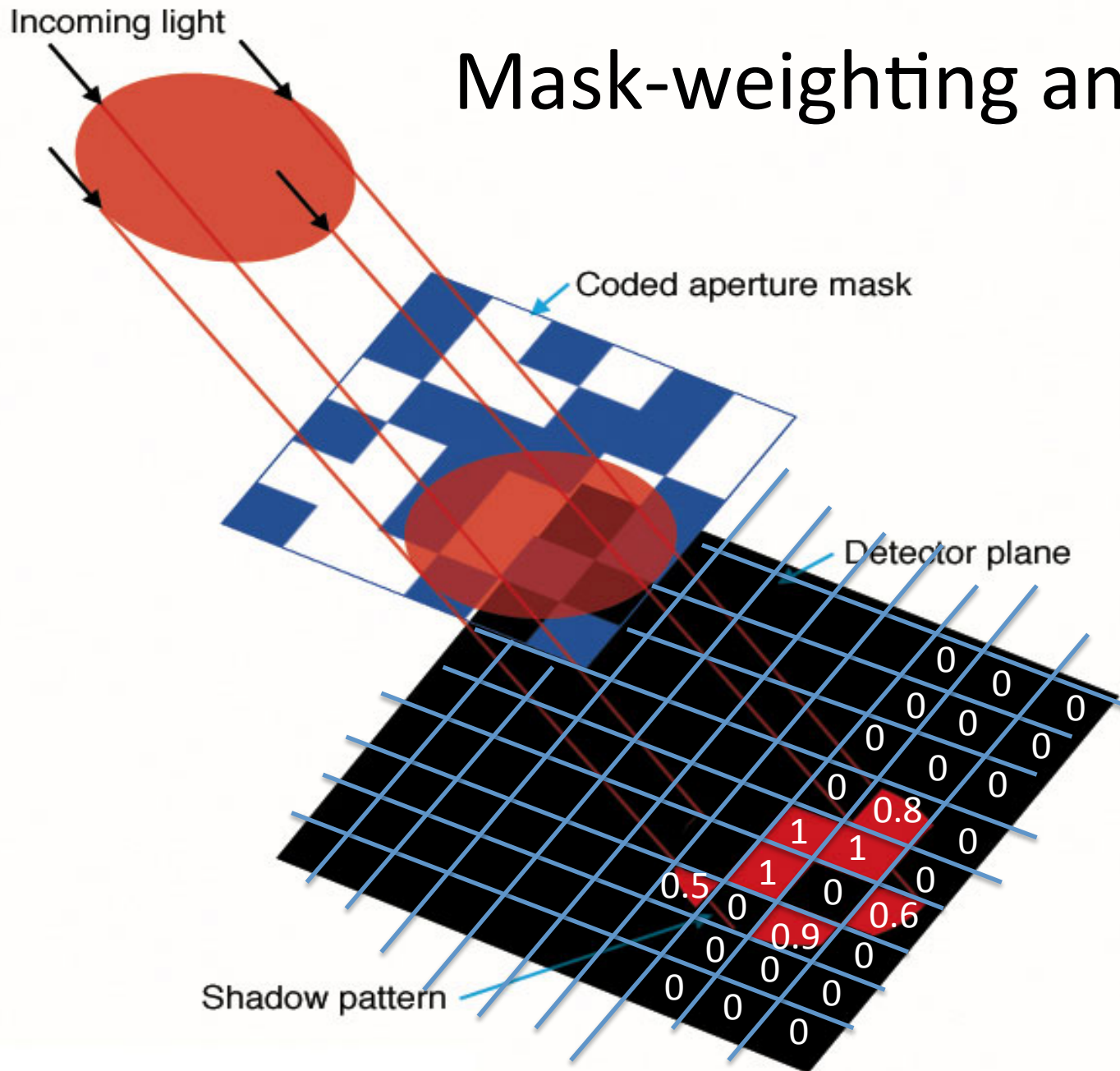
Mask-weighting analysis



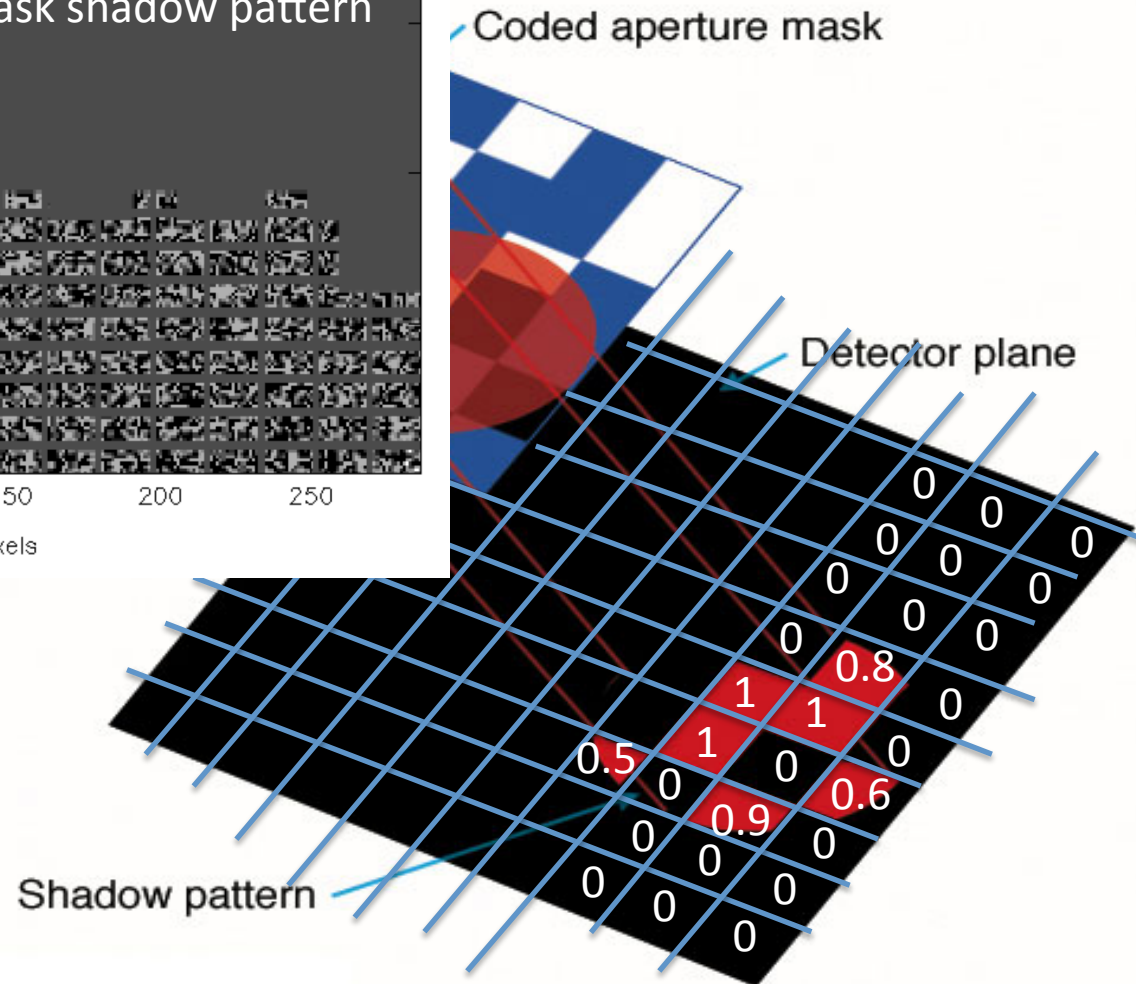
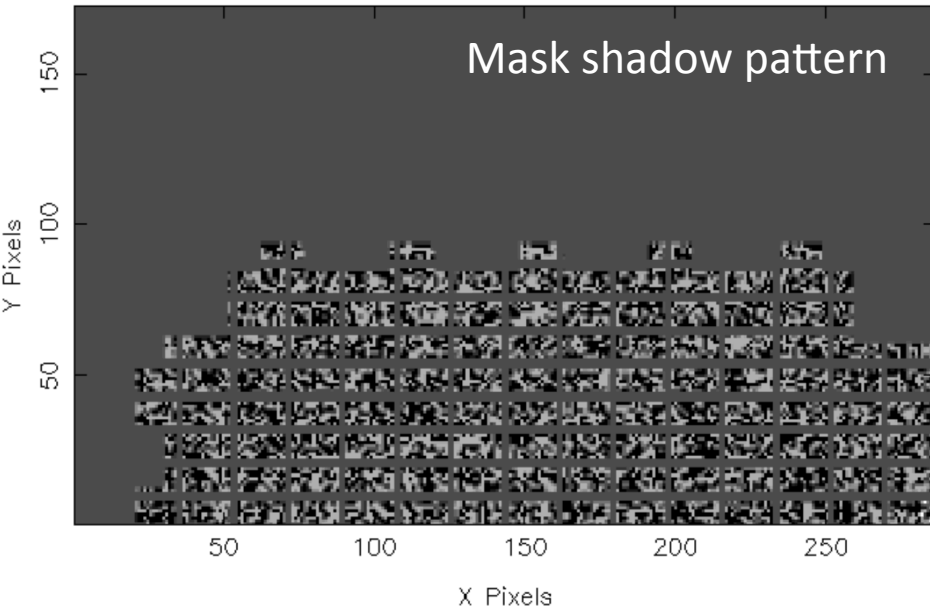
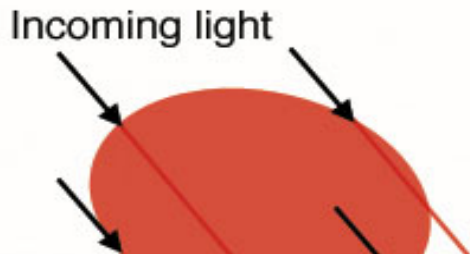
Mask-weighting analysis



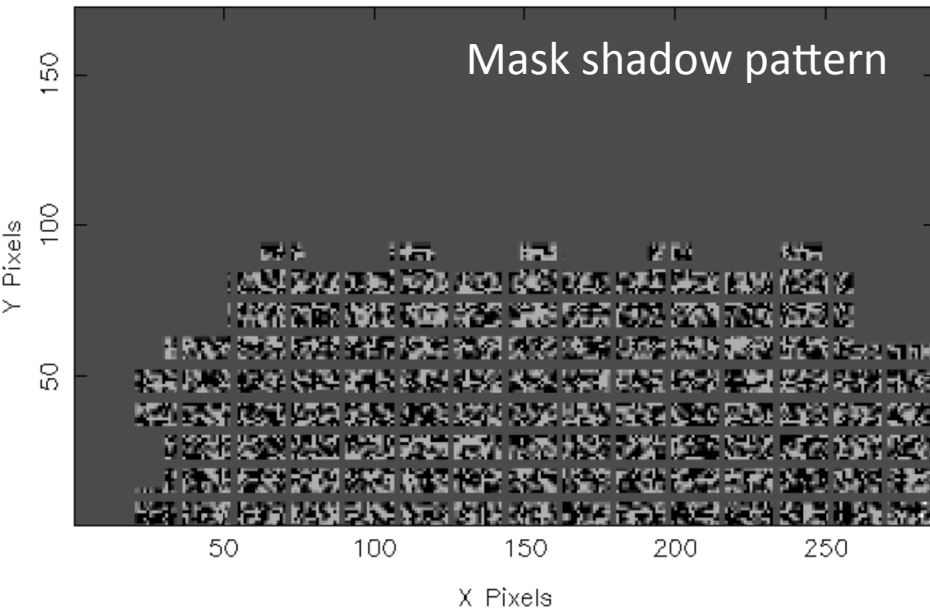
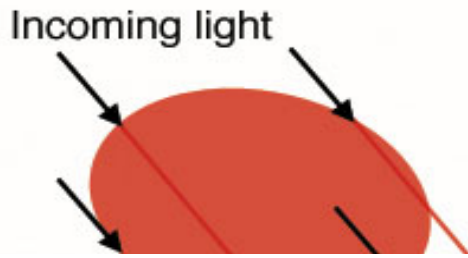
Mask-weighting analysis



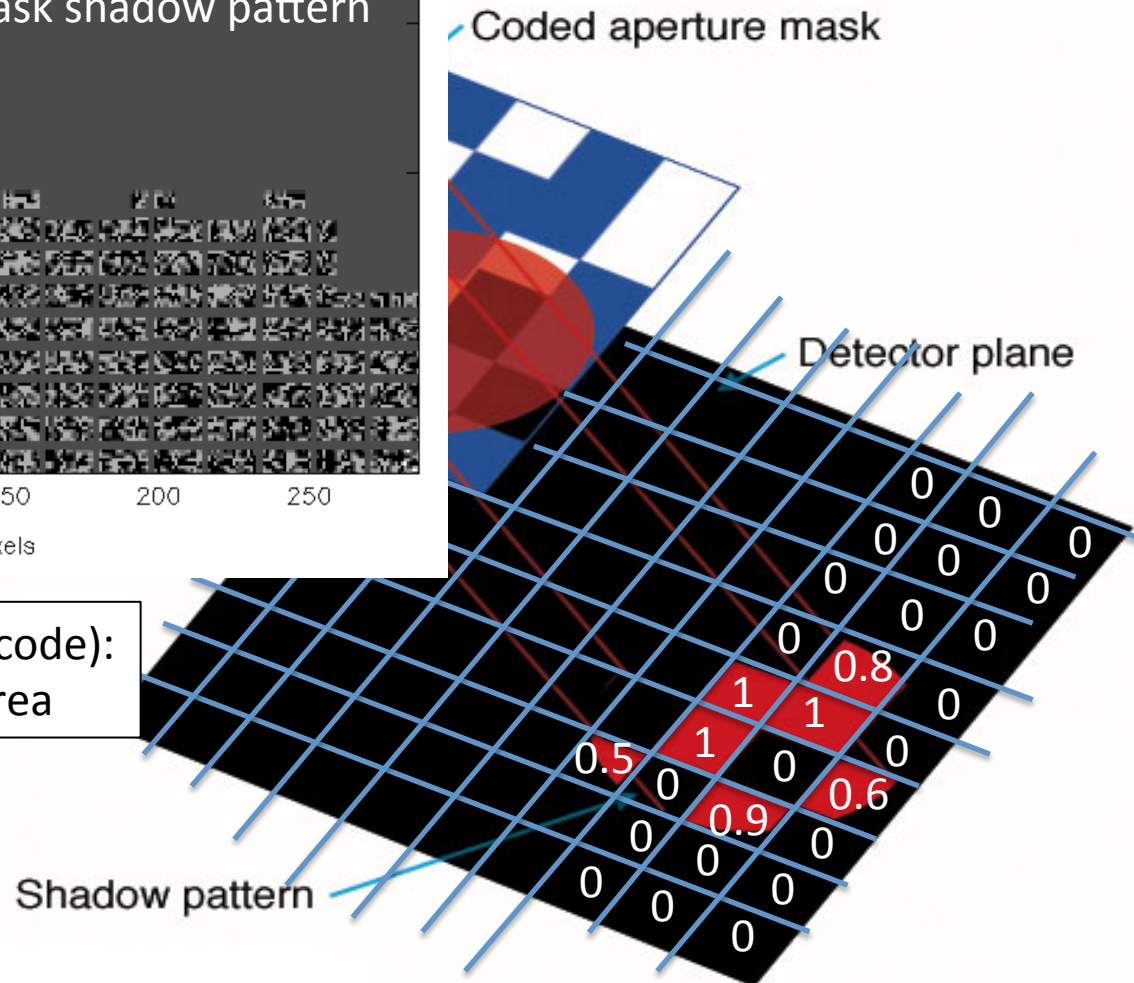
Mask-weighting analysis



Mask-weighting analysis

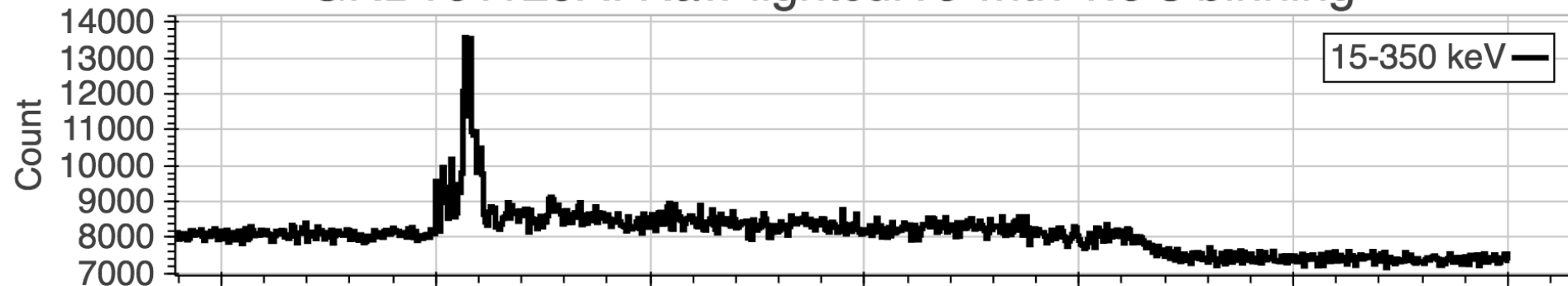


Partial coding fraction (pcode):
Fraction of illuminated area

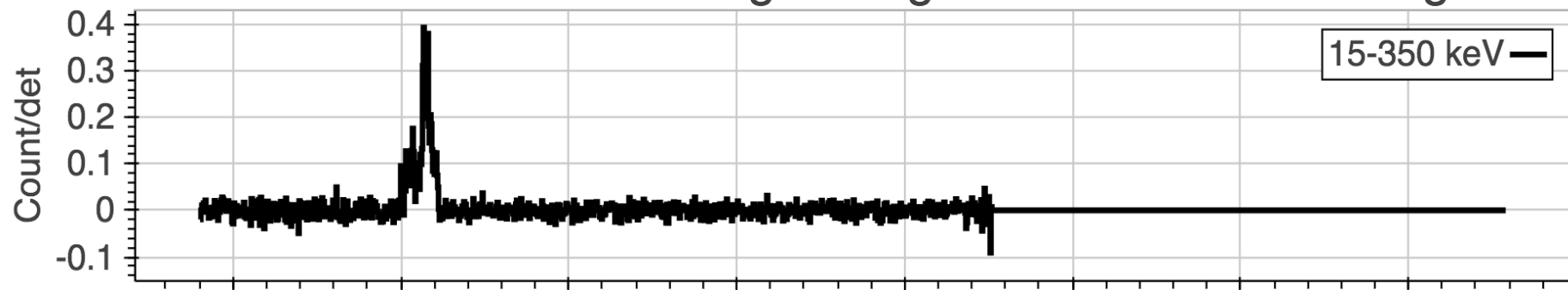


“Background subtraction”

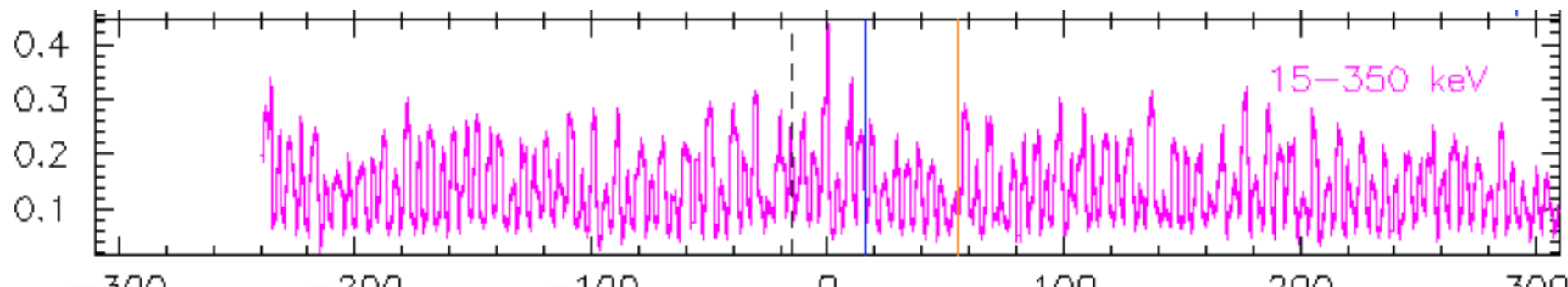
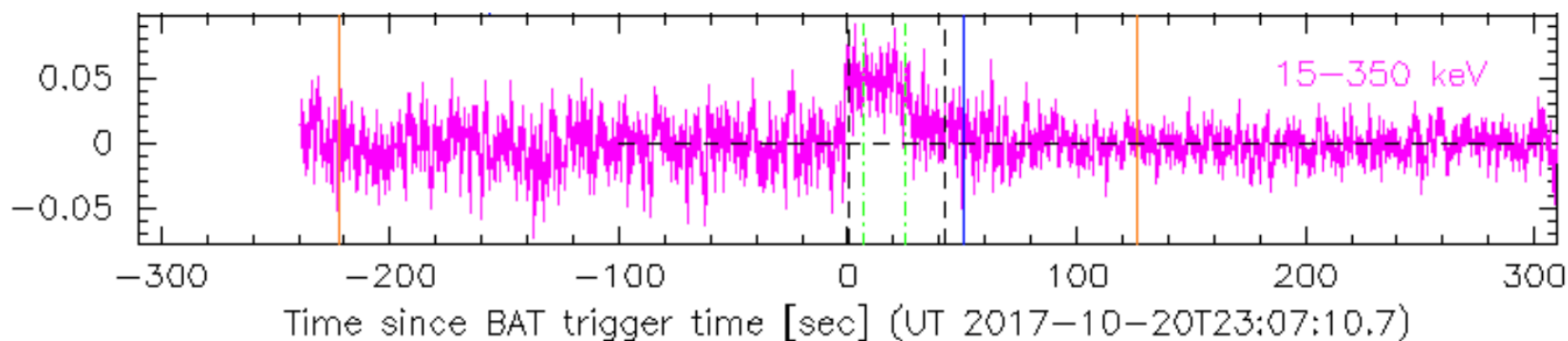
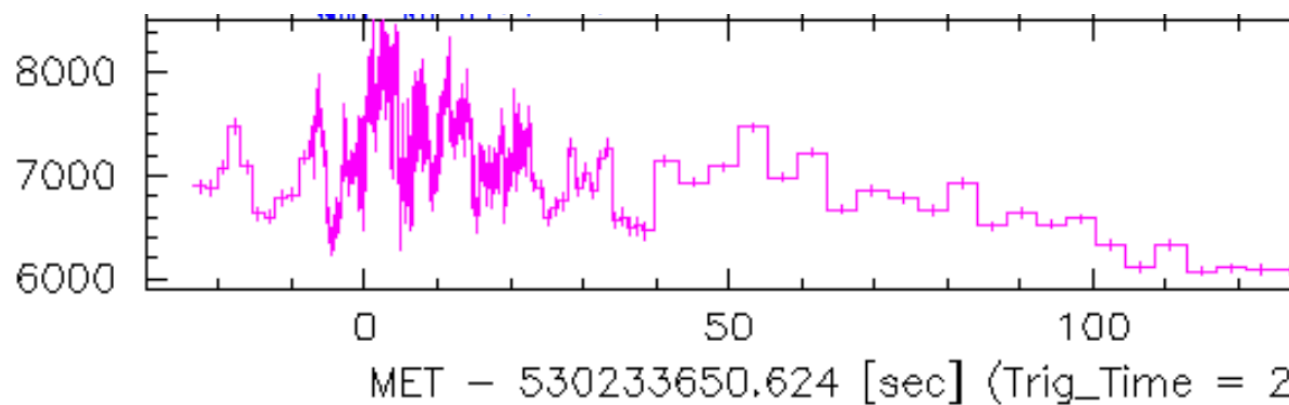
GRB161129A: Raw lightcurve with 1.6 s binning



GRB161129A: mask-weighted lightcurve with 1 s binning



“Background subtraction”



Mask-weighted count

- Definition:

Background subtracted counts
per fully illuminated detector
for an equivalent on-axis source

Mask-weighted count

- Definition:

Background subtracted counts

per fully illuminated detector

for an equivalent on-axis source

Illuminated detector $\sim$ enabled detector $\times$ pcode

Mask-weighted count

- Definition:

Background subtracted counts

per fully illuminated detector

for an equivalent on-axis source



$\cos(\theta)$ effect

Mask-weighting process

```
batbinevt infile='00680436000-results/events/sw00680436000b_all.evt'  
outfile=00680436000-results/lc/sw00680436000b_1chan_4ms.lc  
outtype=LC timedel=0.004 timebinalg=u energybins='15-350'  
detmask='00680436000-results/auxil/sw00680436000b_qmap.fits'  
weighted=YES outunits=RATE ecol=ENERGY gtfile='NONE' clobber=yes
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/batbinevt.html>

Mask-weighting process

Directory for observational ID 00680436000 (GRB GRB160325A)

```
batbinevt infile='00680436000-results/events/sw00680436000b_all.evt'  
outfile=00680436000-results/lc/sw00680436000b_1chan_4ms.lc  
outtype=LC timedel=0.004 timebinalg=u energybins='15-350'  
detmask='00680436000-results/auxil/sw00680436000b_qmap.fits'  
weighted=YES outunits=RATE ecol=ENERGY gtifile='NONE' clobber=yes
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/batbinevt.html>

Mask-weighting process

```
batbinevt infile='00680436000-results/events/sw00680436000b_all.evt'  
outfile=00680436000-results/lc/sw00680436000b_1chan_4ms.lc  
outtype=LC timedel=0.004 timebinalg=u energybins='15-350'  
detmask='00680436000-results/auxil/sw00680436000b_qmap.fits'  
weighted=YES outunits=RATE ecol=ENERGY gtifile='NONE' clobber=yes
```

```
weighted=NO  
for non-mask-weighted light curve
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/batbinevt.html>

Mask-weighting process

```
batbinevt infile='00680436000-results/events/sw00680436000b_all.evt'  
outfile=00680436000-results/lc/sw00680436000b_1chan_4ms.lc  
outtype=LC timedel=0.004 timebinalg=u energybins='15-350'  
detmask='00680436000-results/auxil/sw00680436000b_qmap.fits'  
weighted=YES outunits=RATE ecol=ENERGY gtifile='NONE' clobber=yes
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/batbinevt.html>

Mask-weighting process

```
batbinevt infile='00680436000-results/events/sw00680436000b_all.evt'  
outfile=00680436000-results/lc/sw00680436000b_1chan_4ms.lc  
outtype=LC timedel=0.004 timebinalg=u energybins='15-350'  
detmask='00680436000-results/auxil/sw00680436000b_qmap.fits'  
weighted=YES outunits=RATE ecol=ENERGY gtifile='NONE' clobber=yes
```

```
tstart = XXX tstop = XXX  
(XXX need to be in MET)
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/batbinevt.html>

Find burst duration

```
battblocks infile='00680436000-results/lc/sw00680436000b_bb_4ms.lc'  
outfile='00680436000-results/gti/sw00680436000b_bb_4ms.gti'  
durfile='00680436000-results/gti/sw00680436000b_bbdur_4ms.gti'  
tlookback=10 bkgsb='YES' timecol=TIME countscol=RATE errcol=ERROR  
hduclas3=RATE tpeak=1 clobber=yes
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/battblocks.html>

Find Burst Duration

- Bayesian Block Analysis

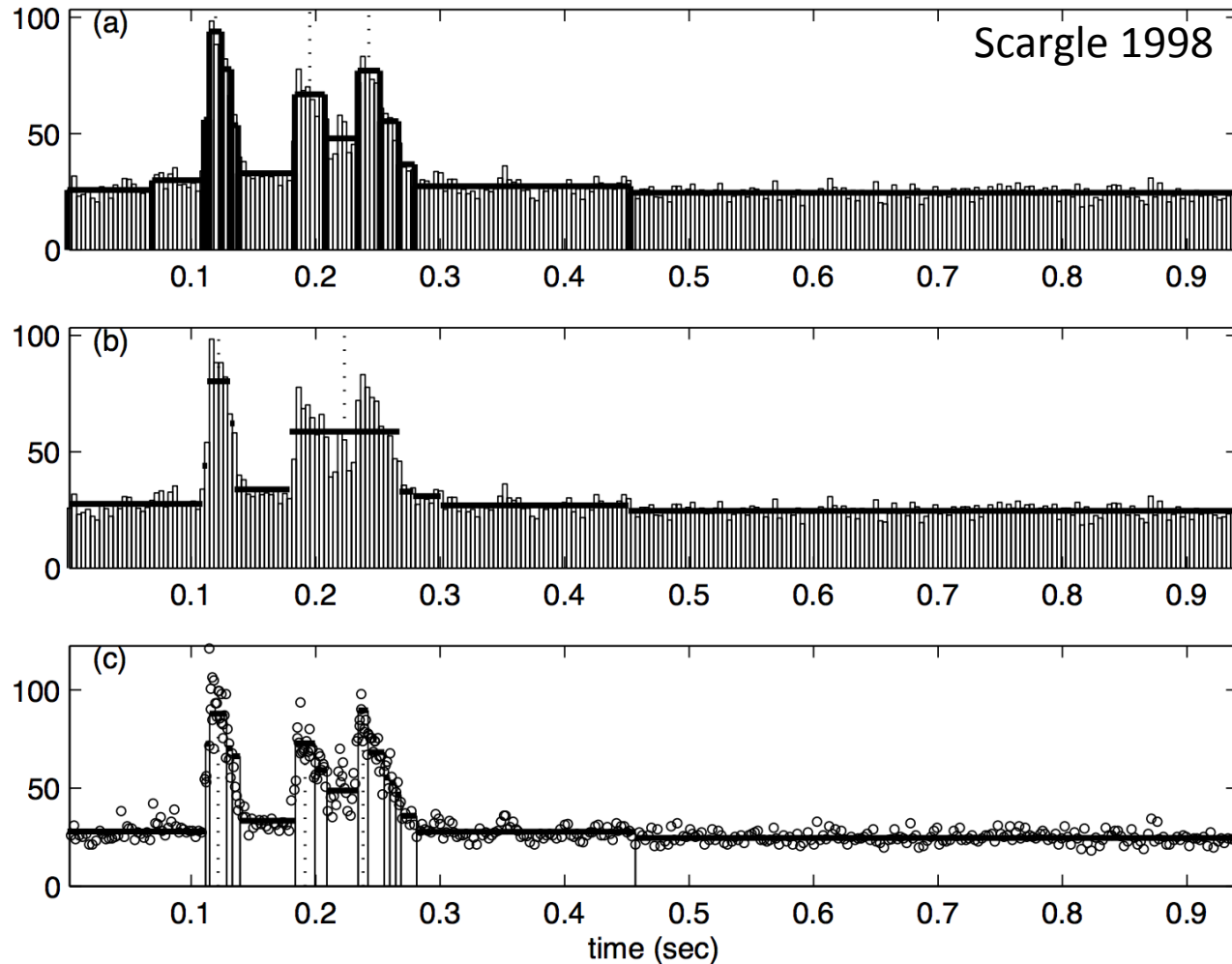


FIG. 2.—Bayesian blocks for the same data as Fig. 1, determined as explained in the text. (a) TTE data; (b) TTS data; (c) binned data.

Find burst duration

Input light curve

```
battblocks infile='00680436000-results/lc/sw00680436000b_bb_4ms.lc'  
outfile='00680436000-results/gti/sw00680436000b_bb_4ms.gti'  
durfile='00680436000-results/gti/sw00680436000b_bbdur_4ms.gti'  
tlookback=10 bkgsb='YES' timecol=TIME countscol=RATE errcol=ERROR  
hduclas3=RATE tpeak=1 clobber=yes
```

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/battblocks.html>

Find burst duration

```
battblocks infile='00680436000-results/lc/sw00680436000b_bb_4ms.lc'  
outfile='00680436000-results/gti/sw00680436000b_bb_4ms.gti'  
durfile='00680436000-results/gti/sw00680436000b_bbdur_4ms.gti'  
tlookback=10 bkgsb='YES' timecol=TIME countscol=RATE errcol=ERROR  
hduclas3=RATE tpeak=1 clobber=yes
```

Output files:

outfile – the bayesian blocks intervals

durfile – records T100, T90, T50, and peak time

Ref: <https://heasarc.gsfc.nasa.gov/ftools/caldb/help/battblocks.html>

Find burst duration

```
battblocks infile='00680436000-results/lc/sw00680436000b_bb_4ms.lc'  
outfile='00680436000-results/gti/sw00680436000b_bb_4ms.gti'  
durfile='00680436000-results/gti/sw00680436000b_bbdur_4ms.gti'  
tlookback=10 bkgsub='YES' timecol=TIME countscol=RATE errcol=ERROR  
hduclas3=RATE tpeak=1 clobber=yes
```

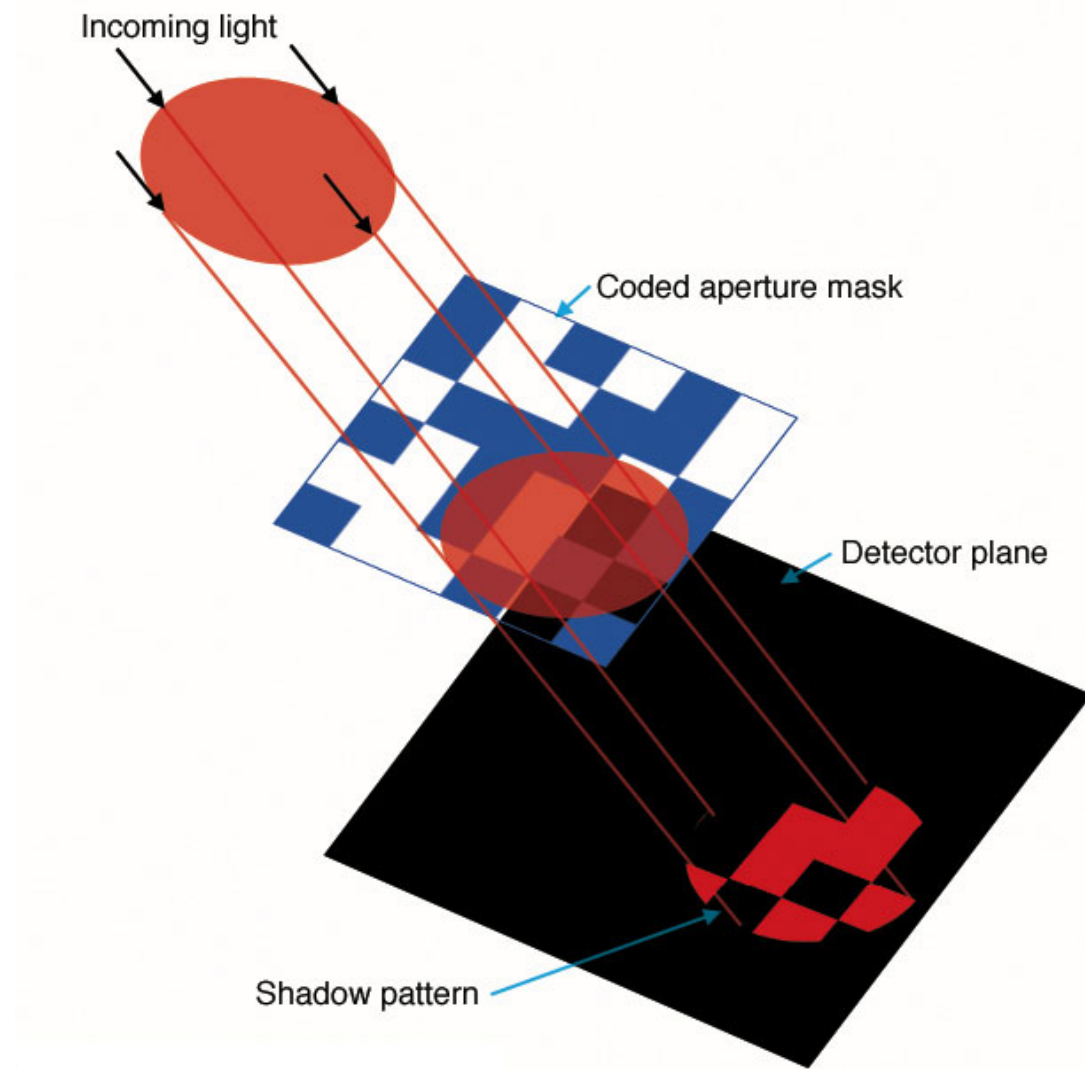
The peak time duration
(e.g. find 1-s peak time)

process.log

- Under the result directory, there is the log file for GRB process:
e.g., 00680436000-results/process.log
- process.log contains the original processes that have been applied to the burst to create light curves, images, burst durations...etc.
- Good way to figure out what should be the options for specific BAT process command (batbinevt, battblocks).

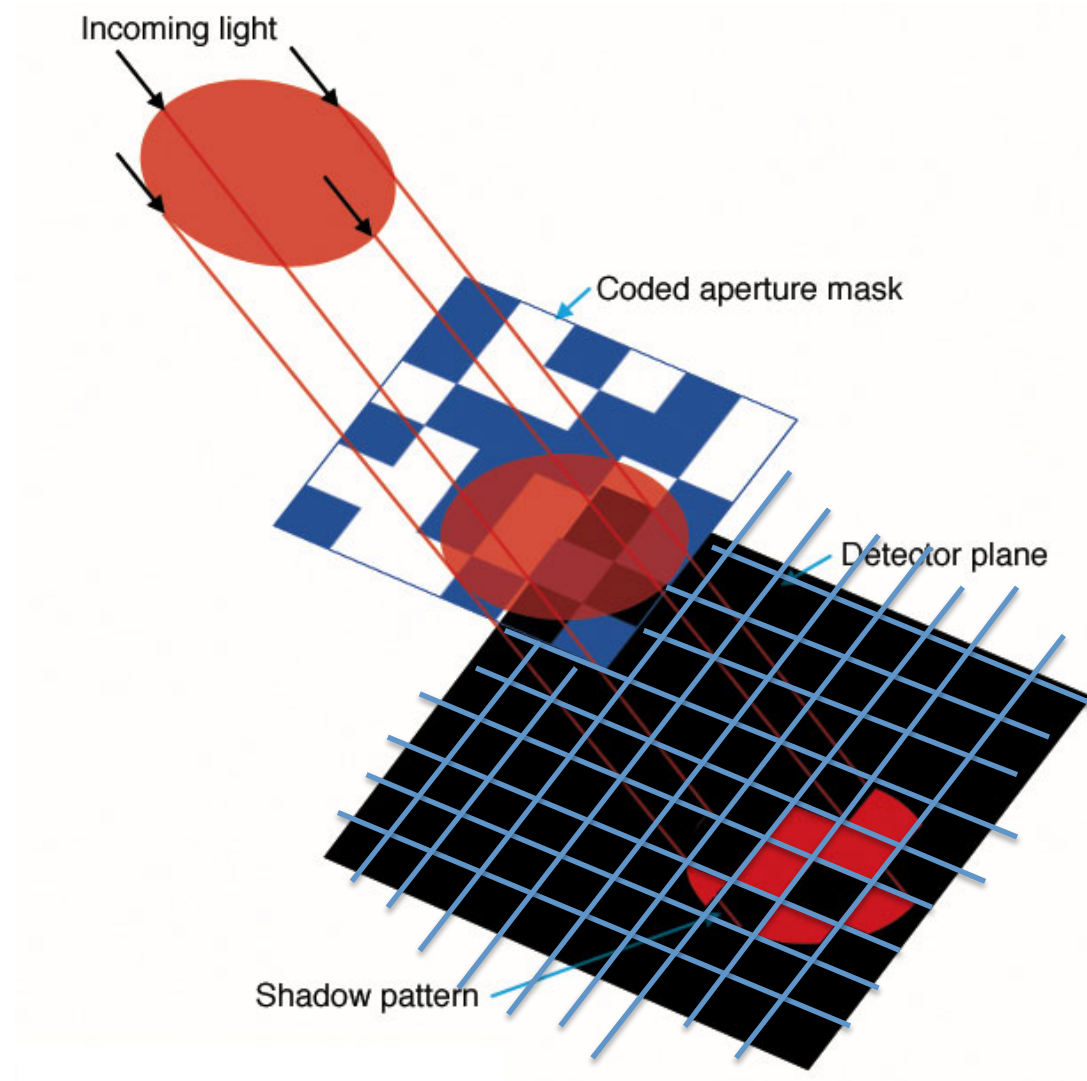
Backup

Mask-weighting analysis



Credit: NASA's Imagine the Universe and NASA/Swift

Mask-weighting analysis



Credit: NASA's Imagine the Universe and NASA/Swift

Find Burst Duration

- How to find burst duration?
 - Show some light curves here with different bin size, and thus with different structures.

Find Burst Duration

- Bayesian Block Analysis

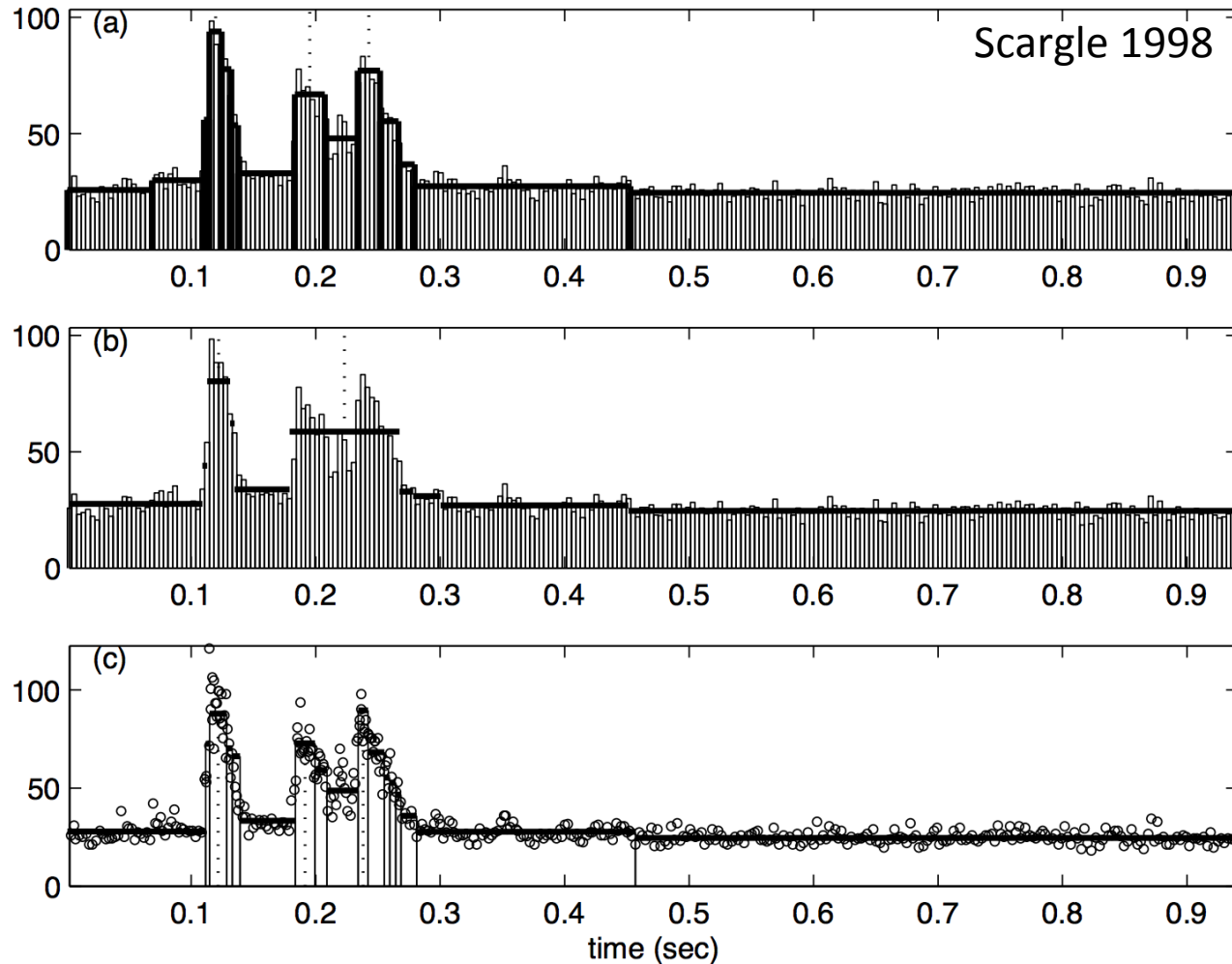


FIG. 2.—Bayesian blocks for the same data as Fig. 1, determined as explained in the text. (a) TTE data; (b) TTS data; (c) binned data.