Euclid NISP photometry simulations

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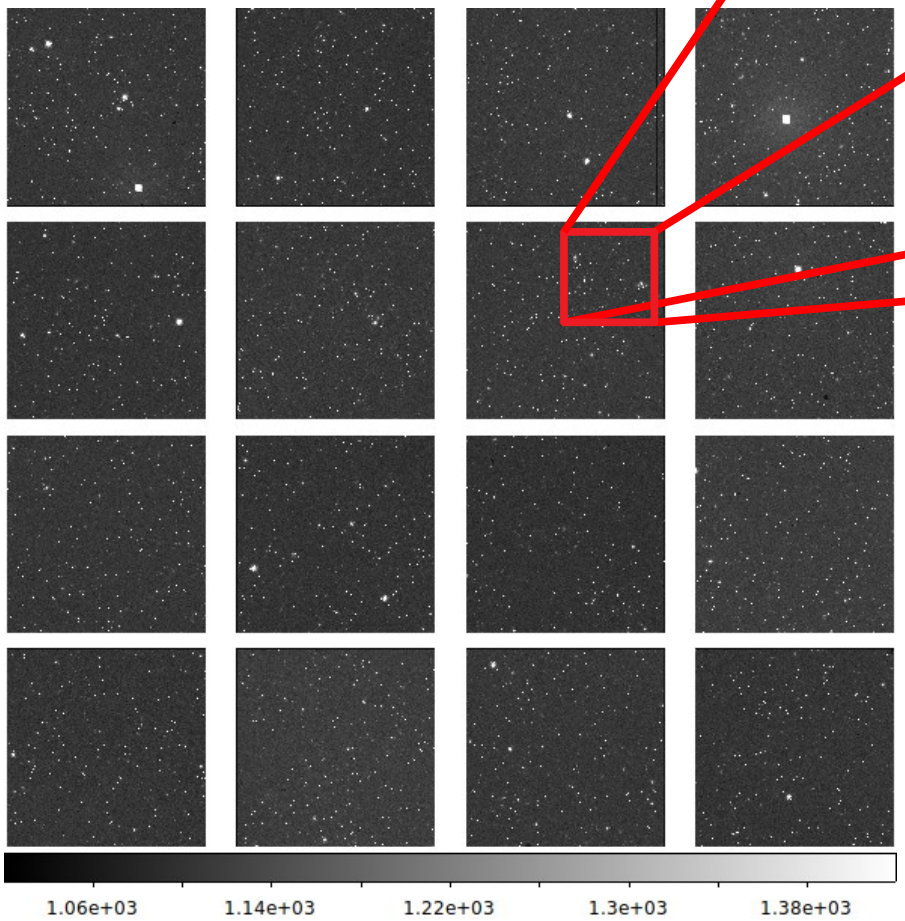
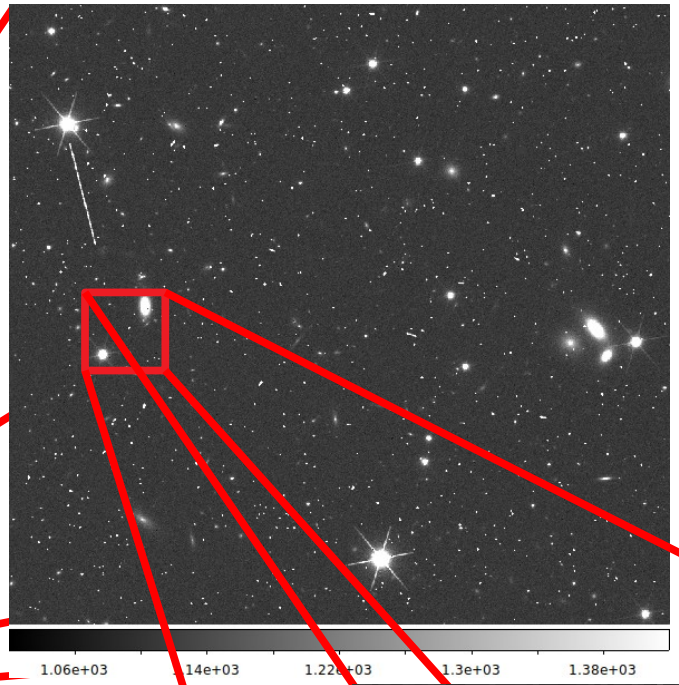
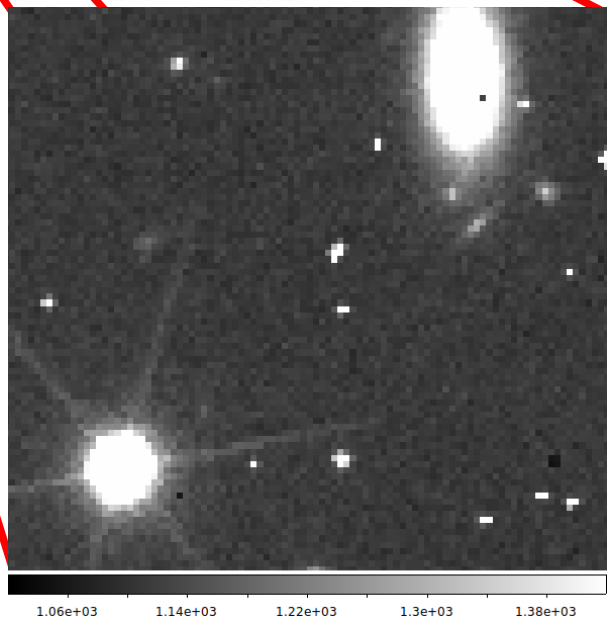
SIM_Imagem

- NISP-P Y-band focal plane
- 4 x 4 H2RG detectors
- 2040 x 2040 pixels per detector
- 0.3 x 0.3 arcsec^2 per pixel



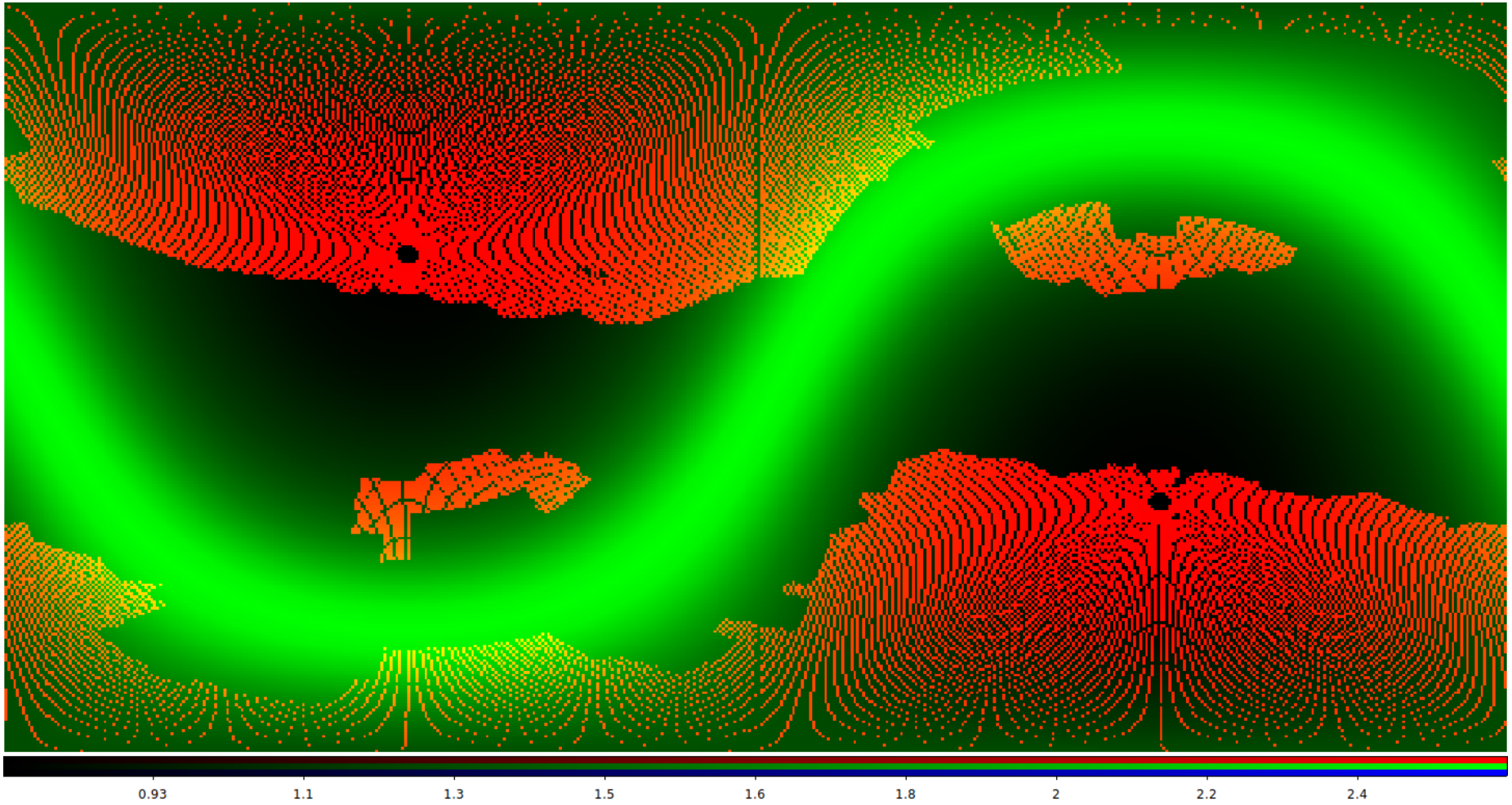




environment: zodiacal light

- red: survey green: zodiacal background

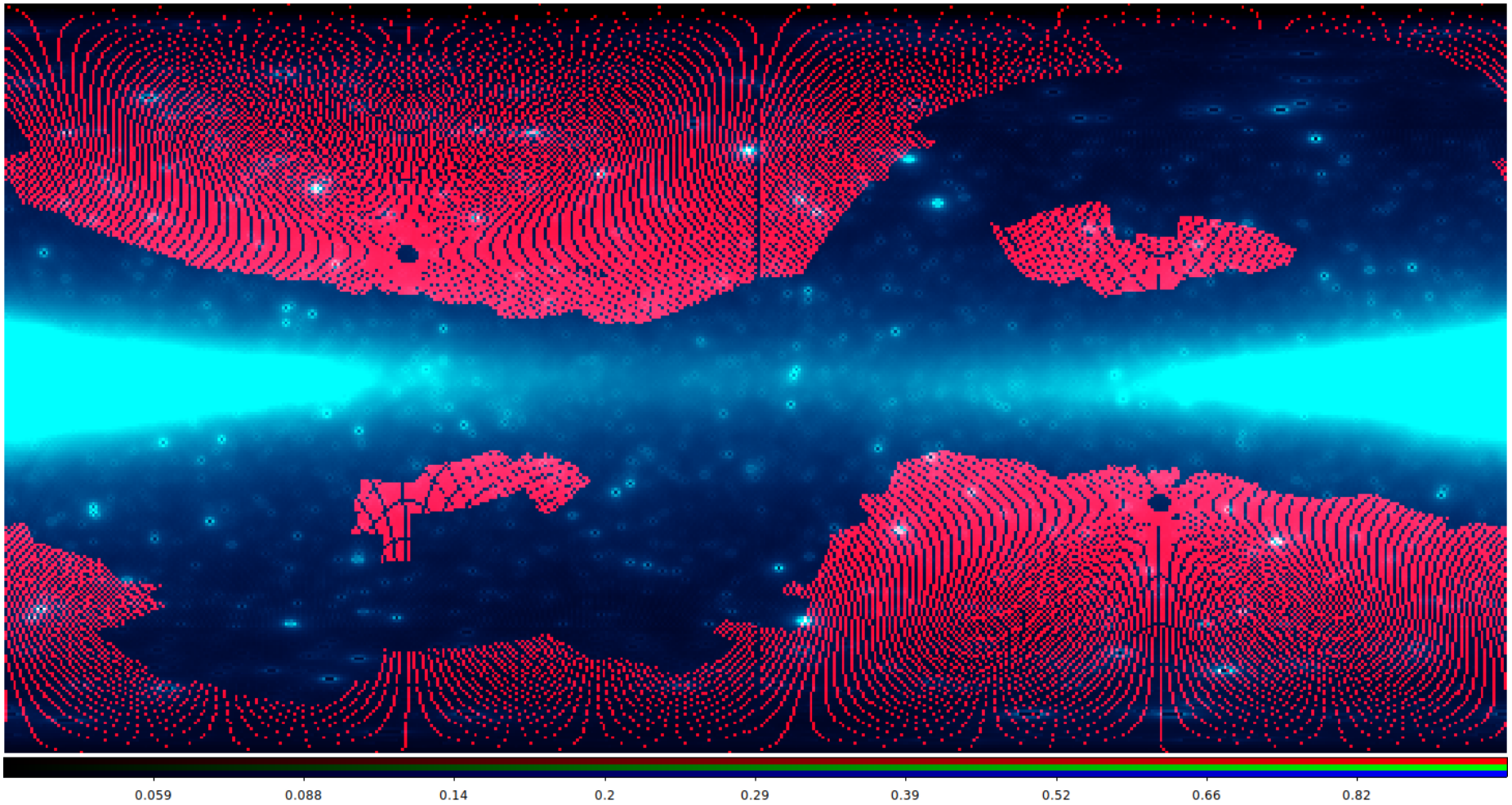
  ≈ 0.7 – 2.0 ph/(s pix) in the survey



environment: straylight

- red: survey green: straylight from stars outside of the field of view

  ≈ 0.05 – 0.3 ph/(s pix) in the survey



environment: straylight

- in-field straylight ≈ 0.01 – 0.1 ph/(s pix) in the survey

  each source in the field of view illuminates the whole detector

- Normalised Diffusion Irradiance NDI(θ_{DEG},λ_{nm})

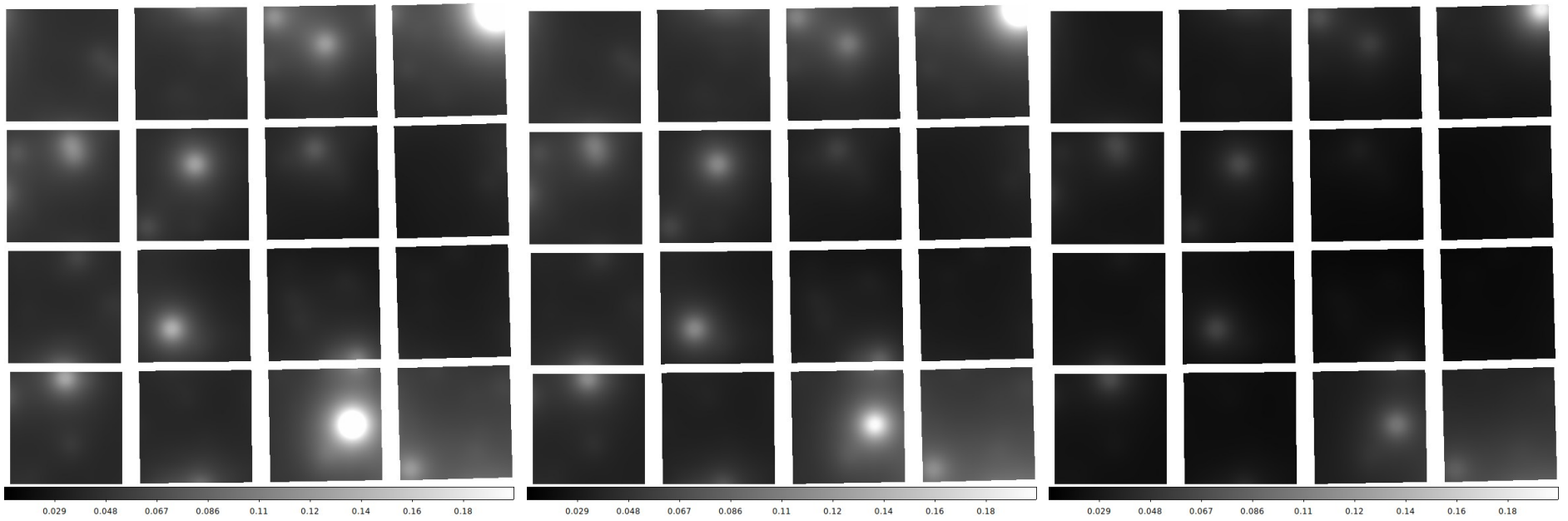
circular symmetry

shape depends on spectral energy distribution (SED)

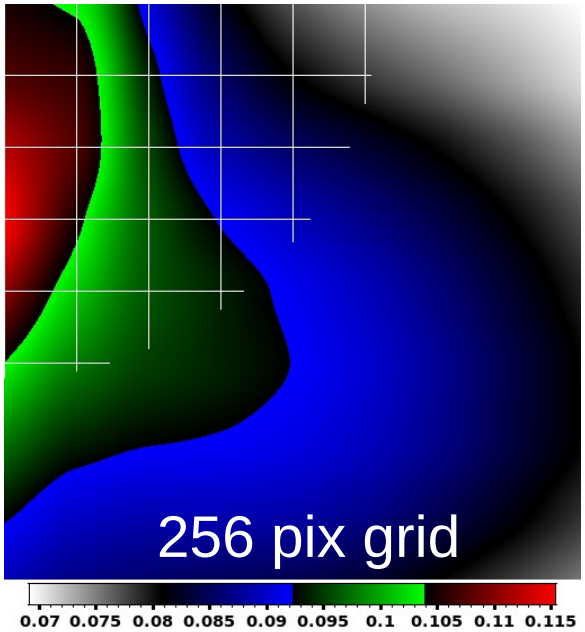
Y-band

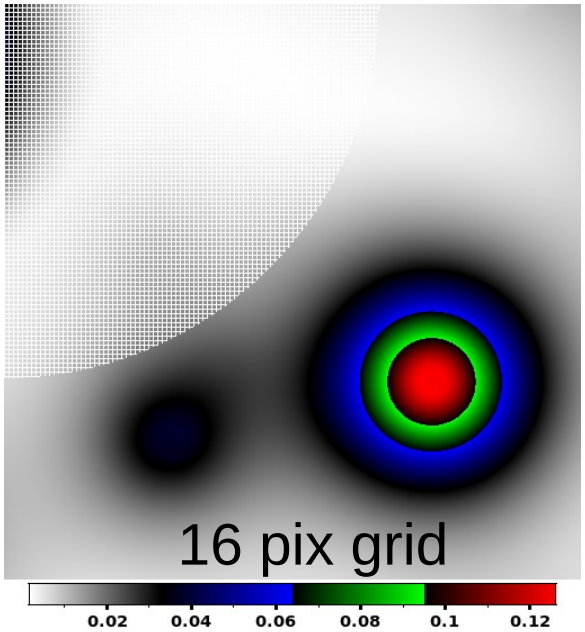
J-band

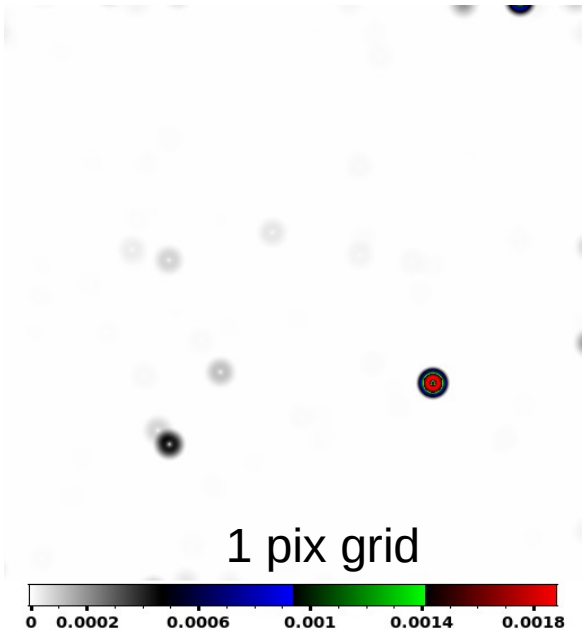
H-band



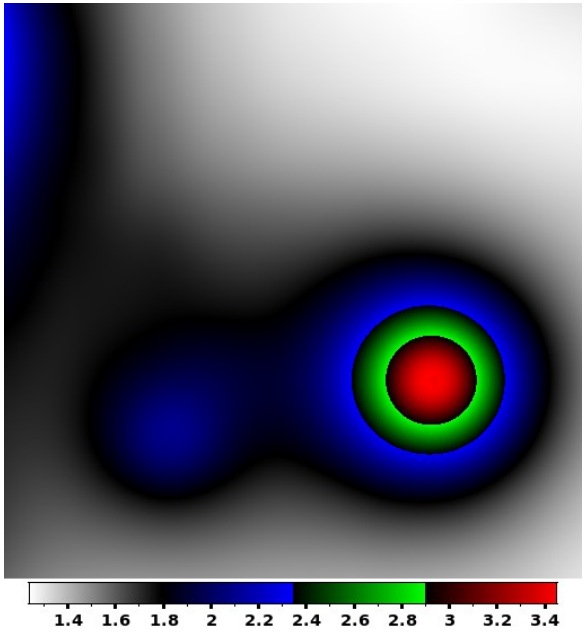
environment: straylight





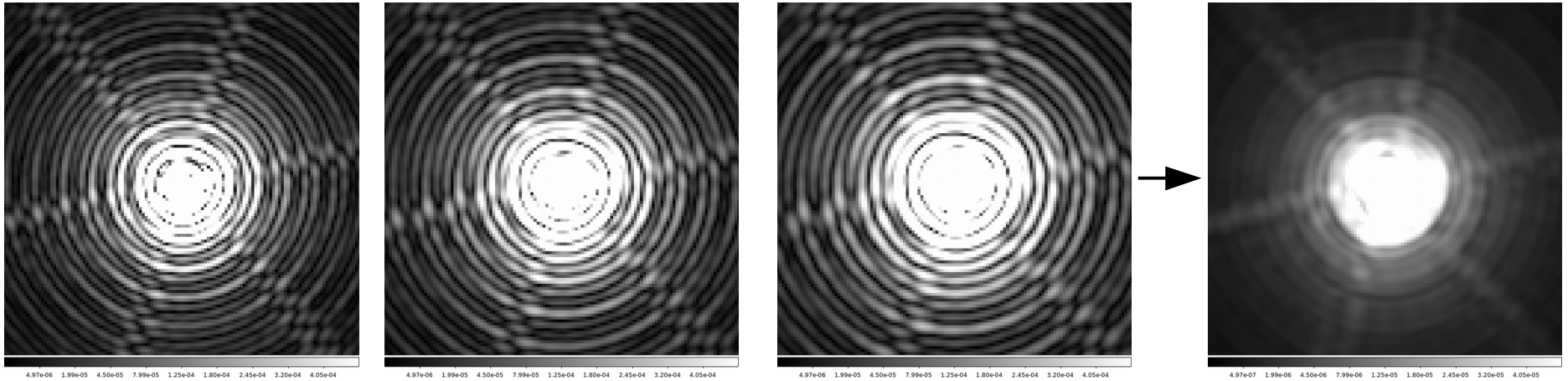


- compute NDI for each source SED
- separate NDI into components of different resolutions
- project NDI components into maps:
  256 pix grid radius: full detector
  16 pix grid radius: 1024 pix
  1 pix grid radius: 64 pix
- superpose final maps using splines



optics: PSF

DET44 Y-band, SED superposition, 3 of 9 model PSF shown:



PSF FWHM variation in the focal plane in um:

Y-band PSF FWHM

10.4602	10.7839	10.5815	10.4332
10.4236	10.6698	10.5482	10.4099
10.5184	10.6231	10.4327	10.6039
10.5057	10.5652	10.3689	10.3078

J-band PSF FWHM

14.3527	14.4623	14.4272	14.4725
14.3399	14.4123	14.3915	14.4597
14.3689	14.3857	14.3375	14.4097
14.3336	14.4274	14.3142	14.2676

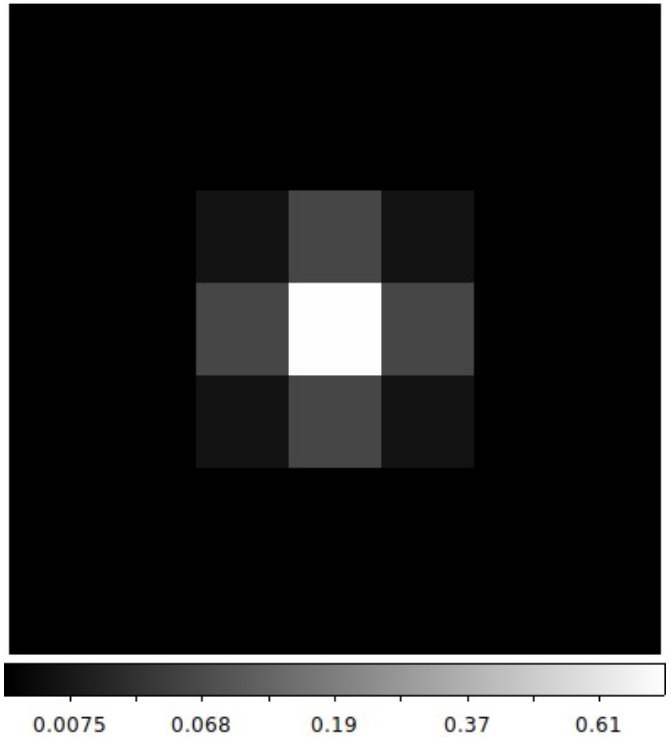
H-band PSF FWHM

17.0223	17.1699	17.1303	17.0593
16.9955	17.0468	17.0511	16.9655
16.9708	17.0027	16.9886	16.9511
16.9716	17.0688	17.0094	17.0081

optics: AOCS / jitter movement

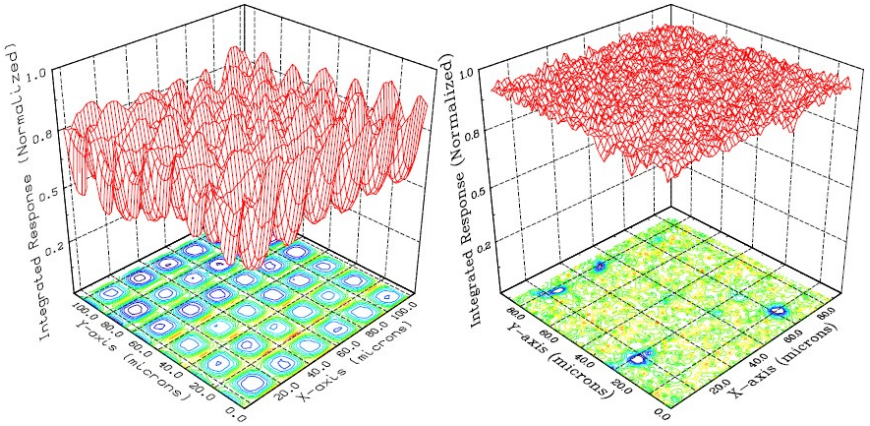
- AOCS: Attitude Orbit Control System
  small pointing variations during exposure
- additional (AOCS) PSF convolution
- approximately Gaussian
  FWHM less than 3.54492um

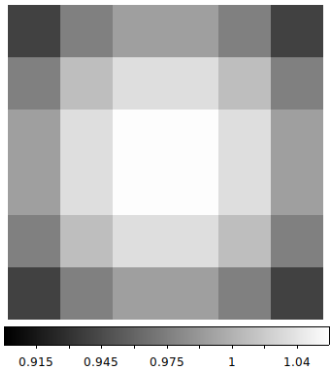
AOCS PSF 1/6 pix grid



intrapixel variations

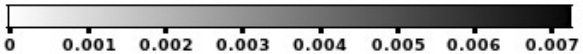
- quantum efficiency variation over each pixel surface
- parabolic model, 5% variation

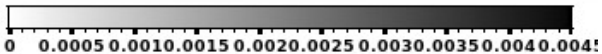


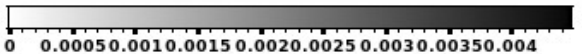


Intra-pixel response variations (N. Barron)

PSF → intrapixel variations →

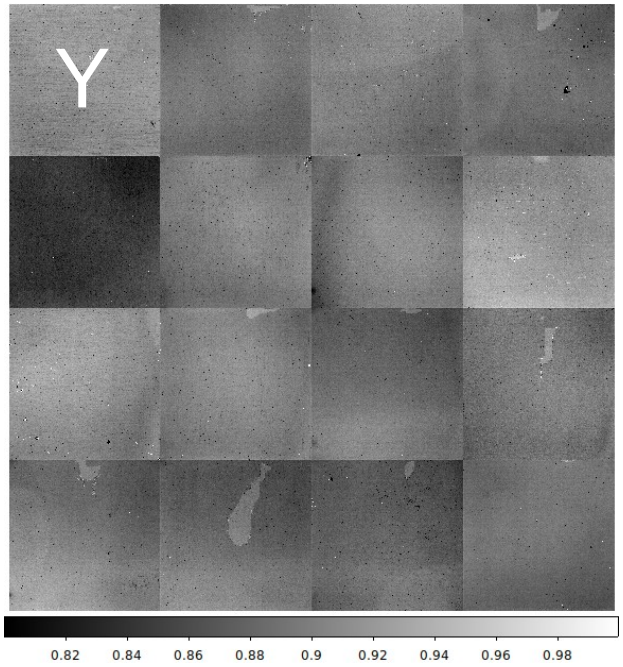


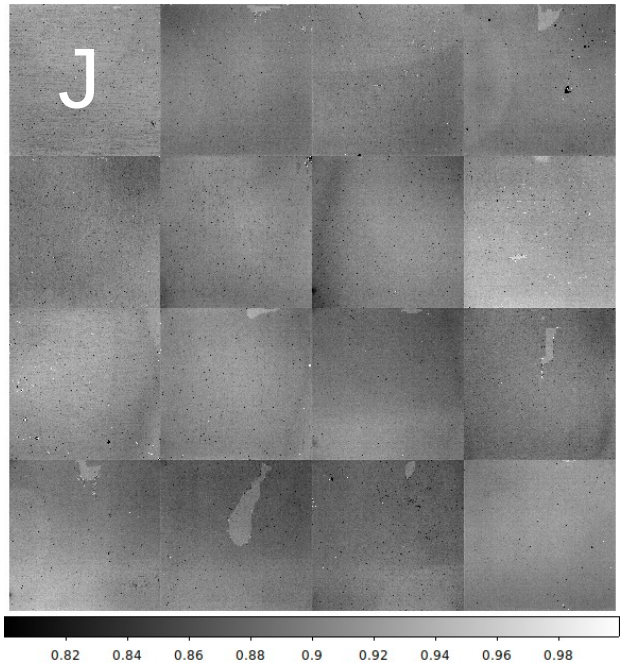


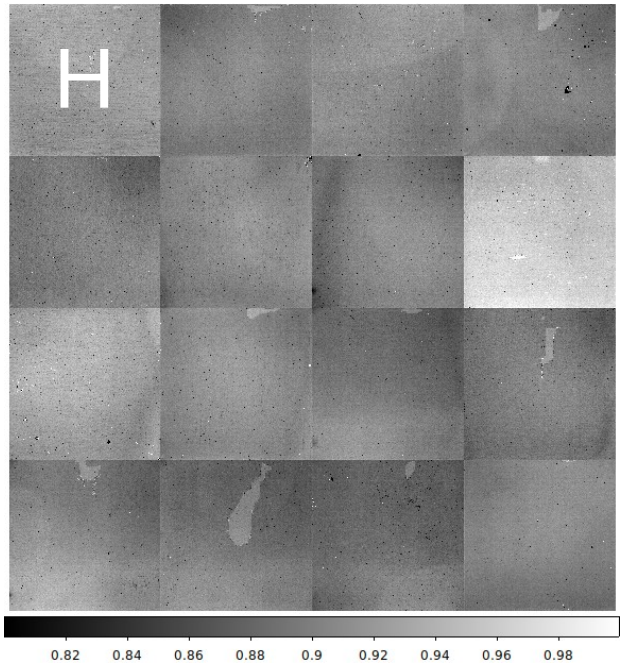


Quantum Efficiency

- 16 H2RG detectors
- Quantum Efficiency
  Y: blue J: green H: red
  in e/ph
- QE maps at 40 wavelengths

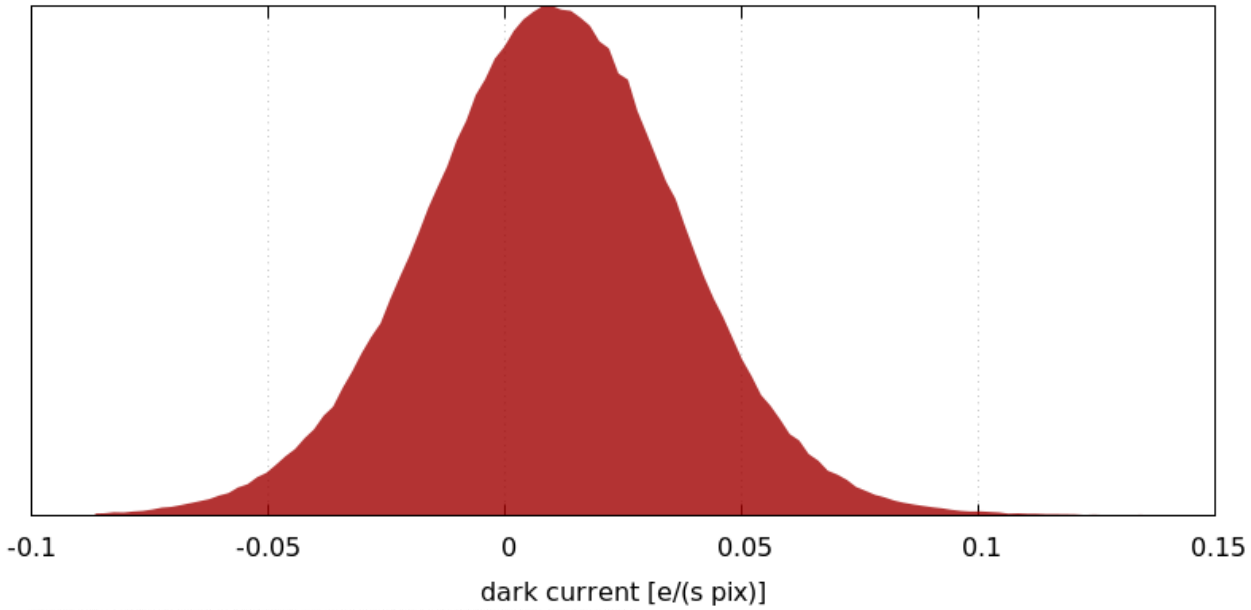


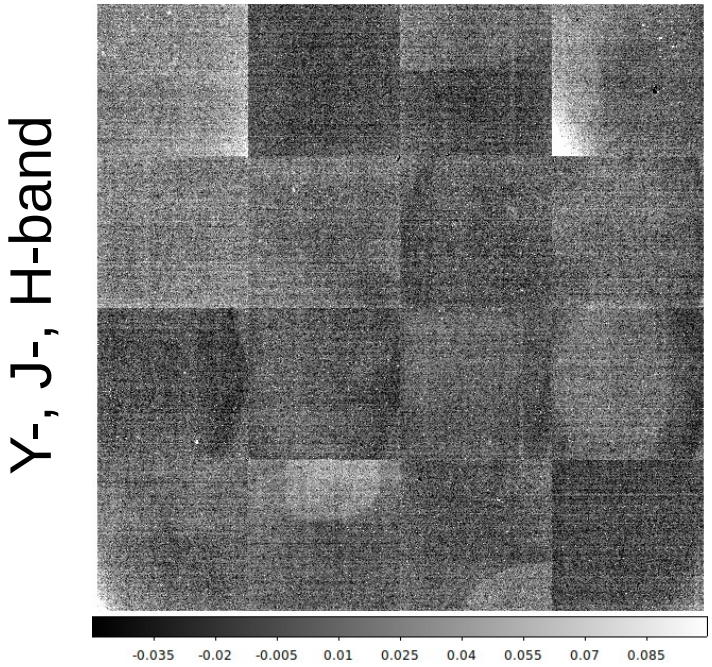




Dark Current

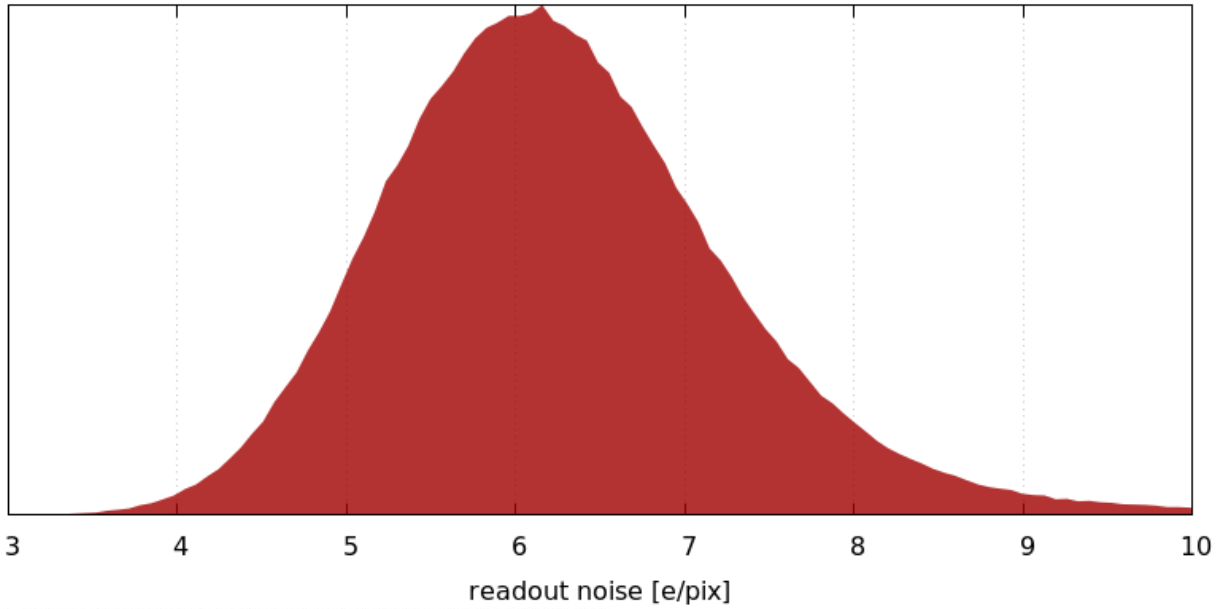
- Dark Current in e/(s pix)

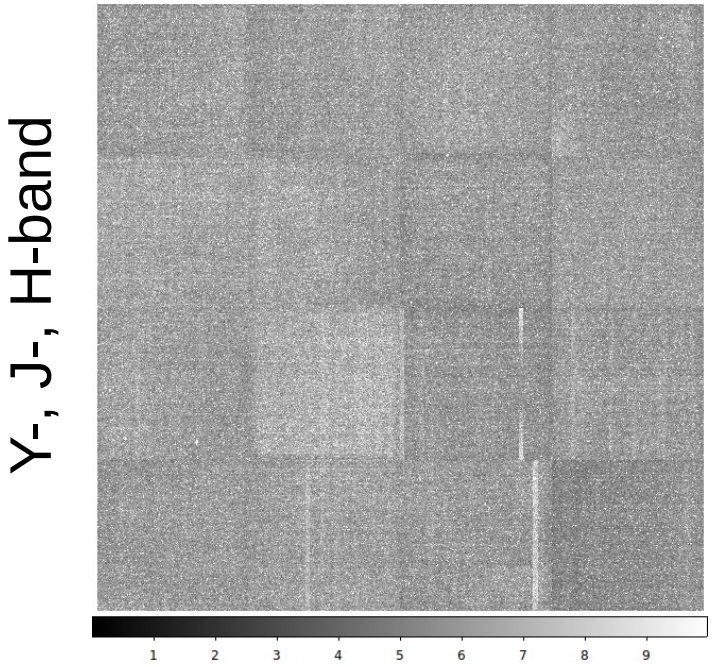




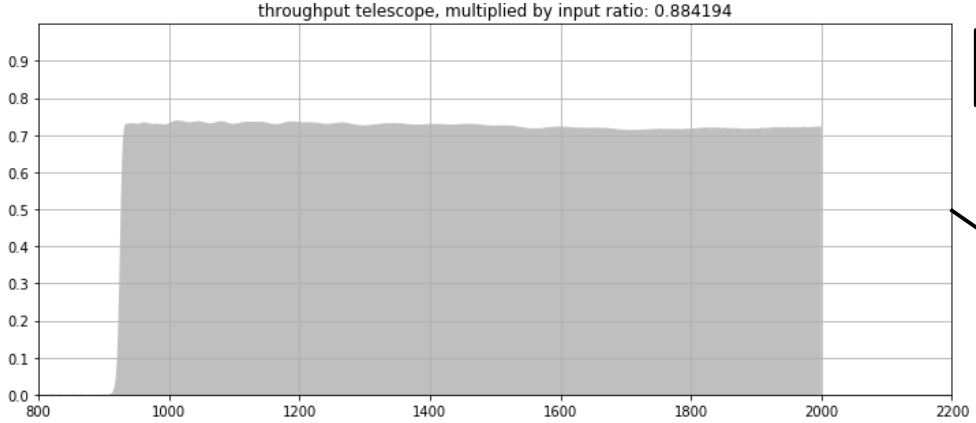
Readout Noise

- Readout Noise in e/pix

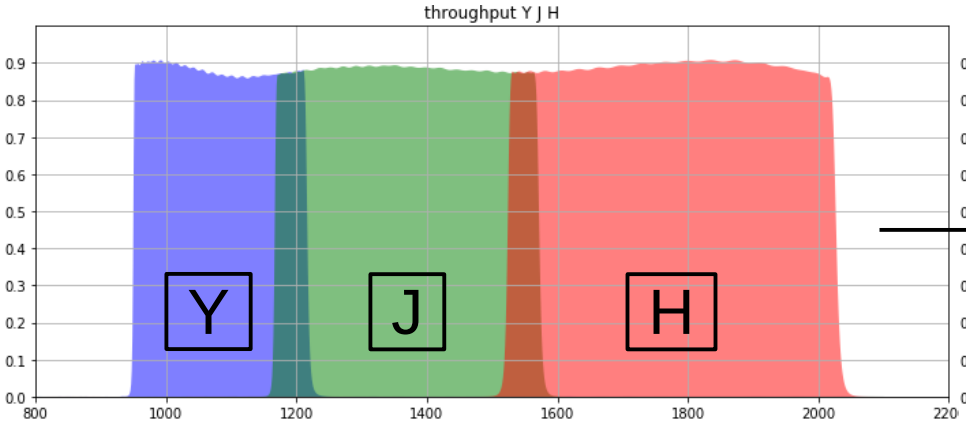


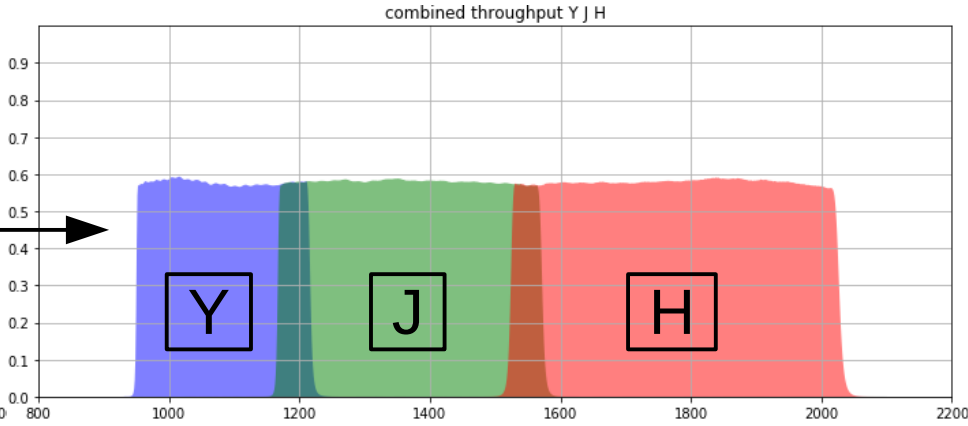


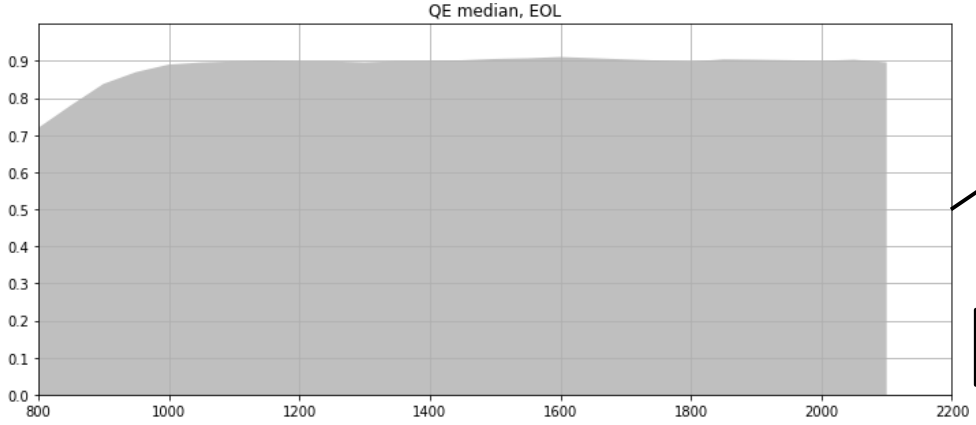
optics and detector throughput



Telescope







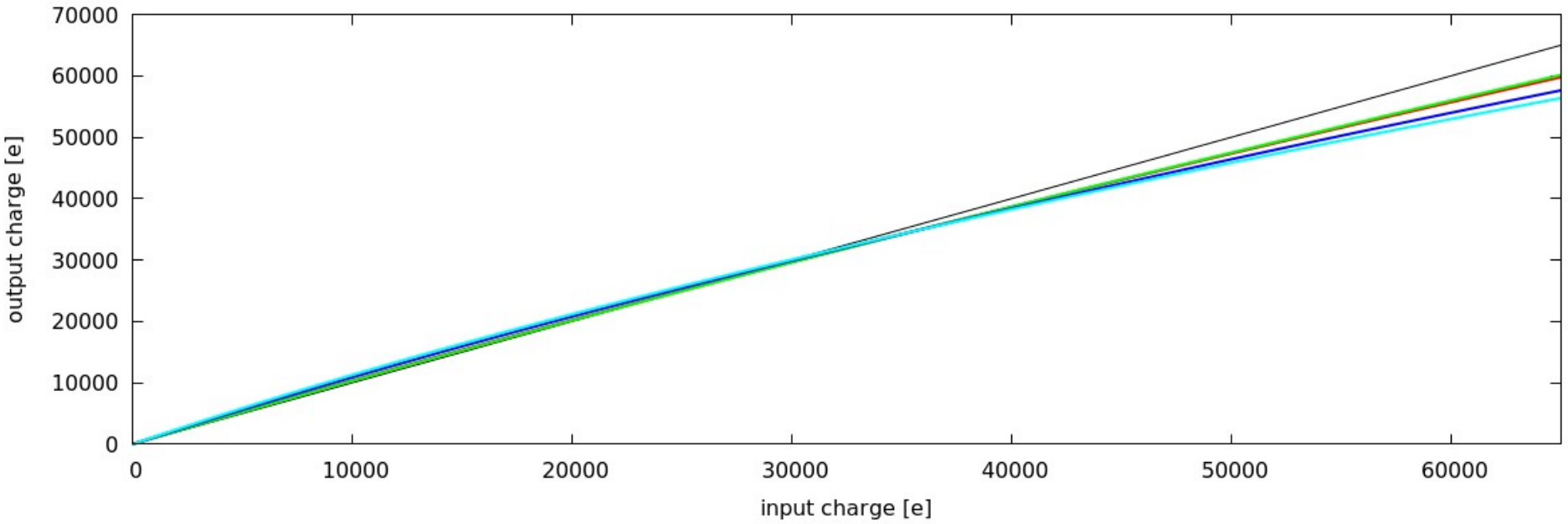
Detector QE

interpixel capacitance / non-linearity

- interpixel capacitance (IPC) PSF, convolved at pixel level

0.0	0.017	0.0
0.019	0.928	0.019
0.0	0.017	0.0

- non-linearity: inverse of 2-nd order polynomial



MACC readout

- prescription from Bogna Kubik et al., 2016

- MACC charge Q:
  in electrons, converted to ADU in later step

$$Q = \left(\frac{1+\alpha}{2} \left[\sqrt{1 + \frac{4 \sum_{i=2}^{groups} (G_i - G_{i-1} + \beta)^2}{(groups-1)(1+\alpha)^2}} - 1 \right] - \beta \right) (groups - 1)$$

$$\alpha = \frac{1 - reads^2}{3\, reads\, (reads + drops)} \qquad \beta = \frac{2\,\sigma_r^2}{reads\,(\alpha + 1)}$$

- MACC Quality Factor:
  used with threshold for on-board pixel flagging

$$QF = \frac{2}{(1+\alpha)(groups-2)} \left[(groups-1) K - (G_{groups} - G_1) \right]$$

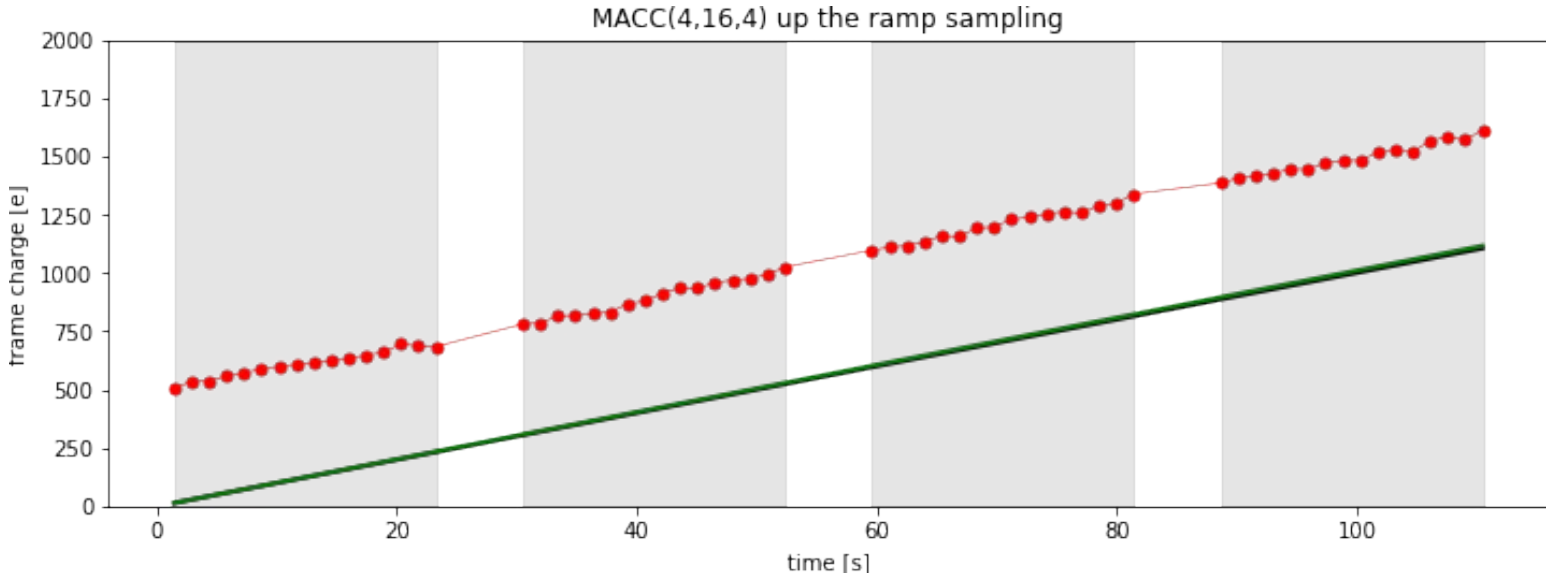
$$K = \sqrt{\frac{\sum_{i=2}^{groups} (G_i - G_{i-1} + \beta)^2}{groups - 1}} - \beta$$

$$G_i = \sum_{k=1}^{reads} F_{pix}(x, y, i, k)$$

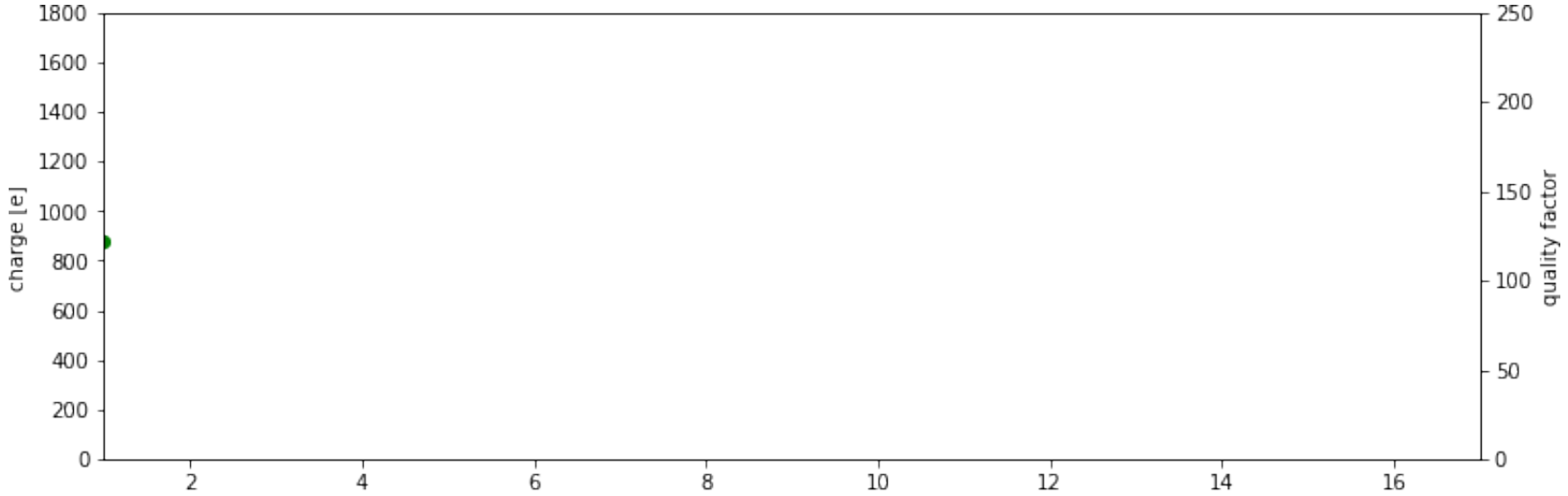
pixel group frame

MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops



- charge estimate (green) and quality factor (grey)



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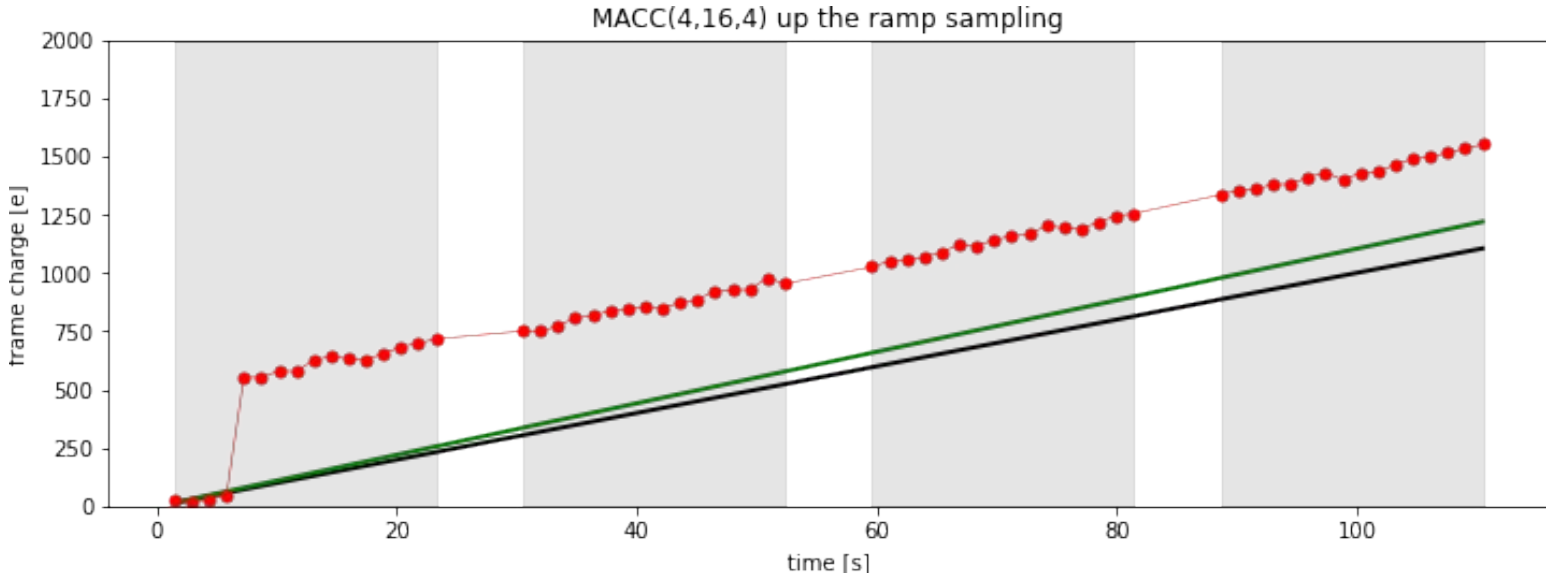

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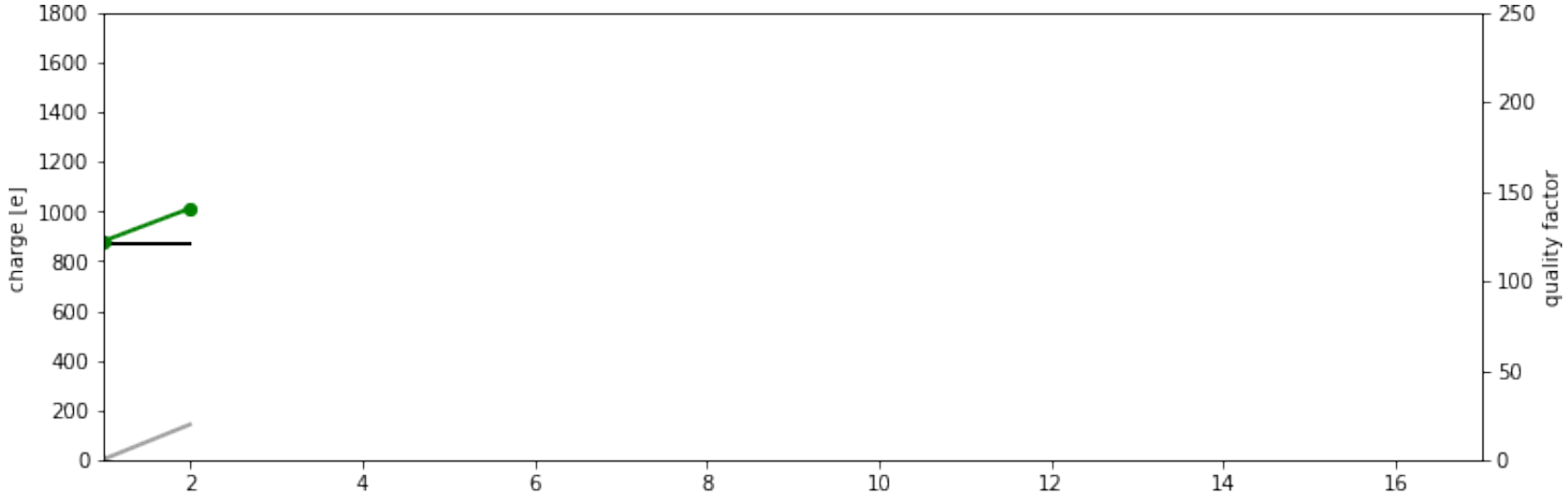

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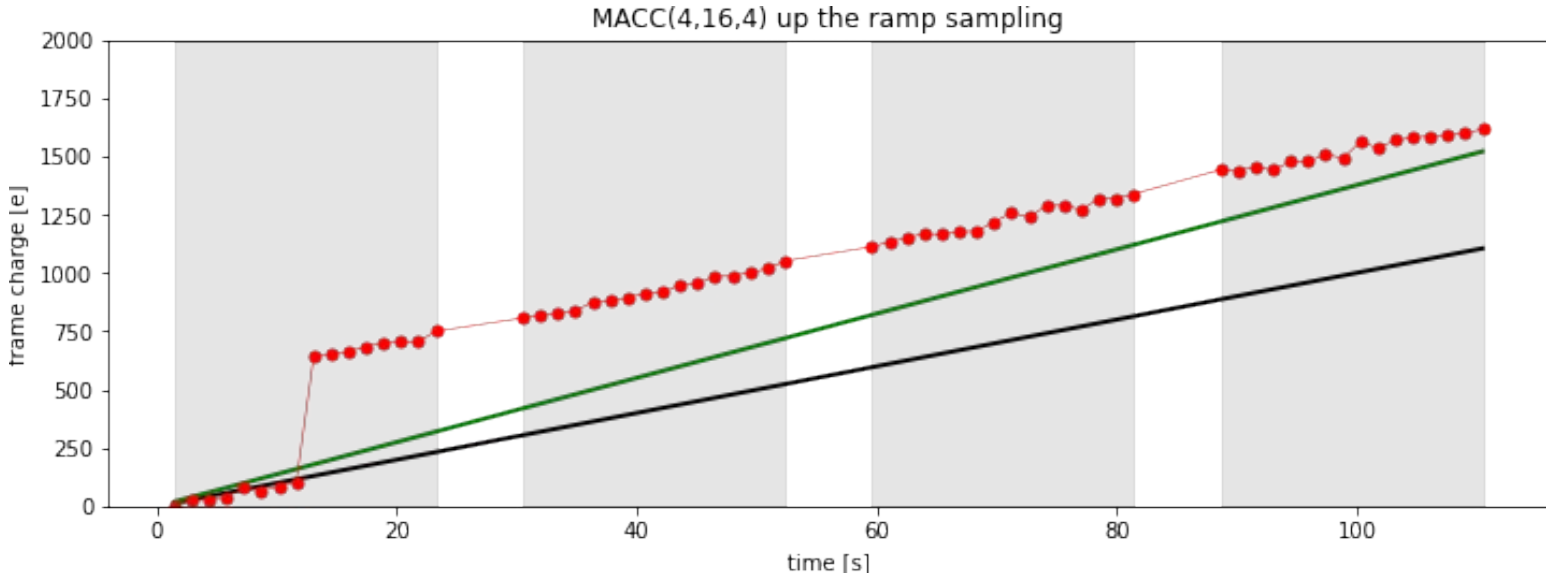

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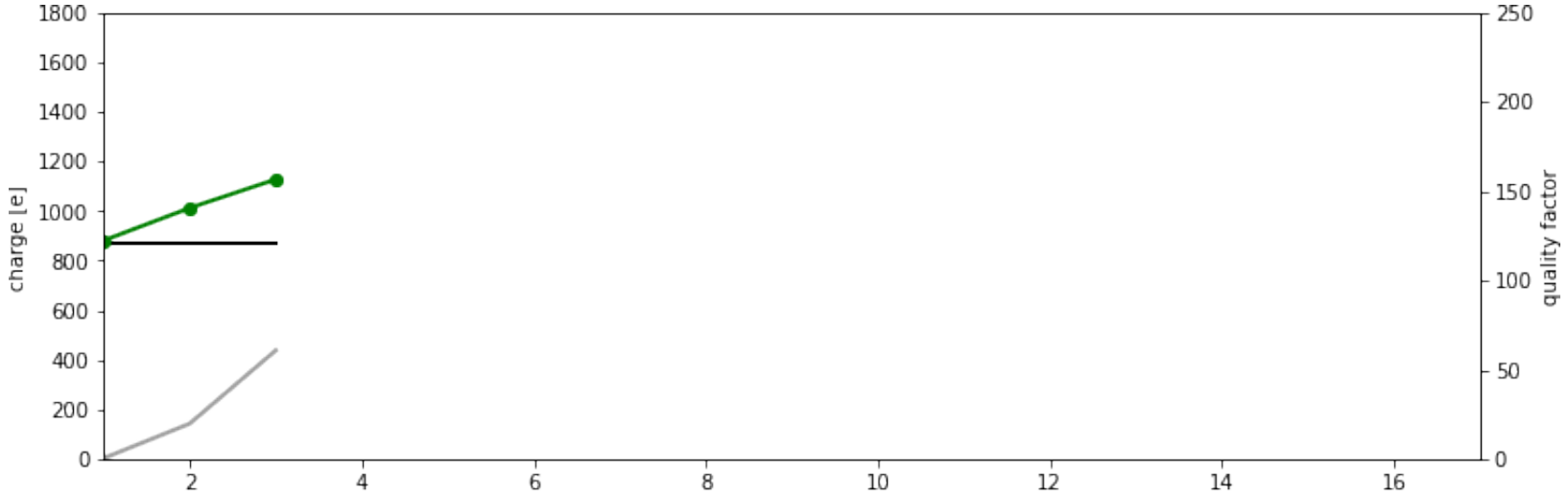

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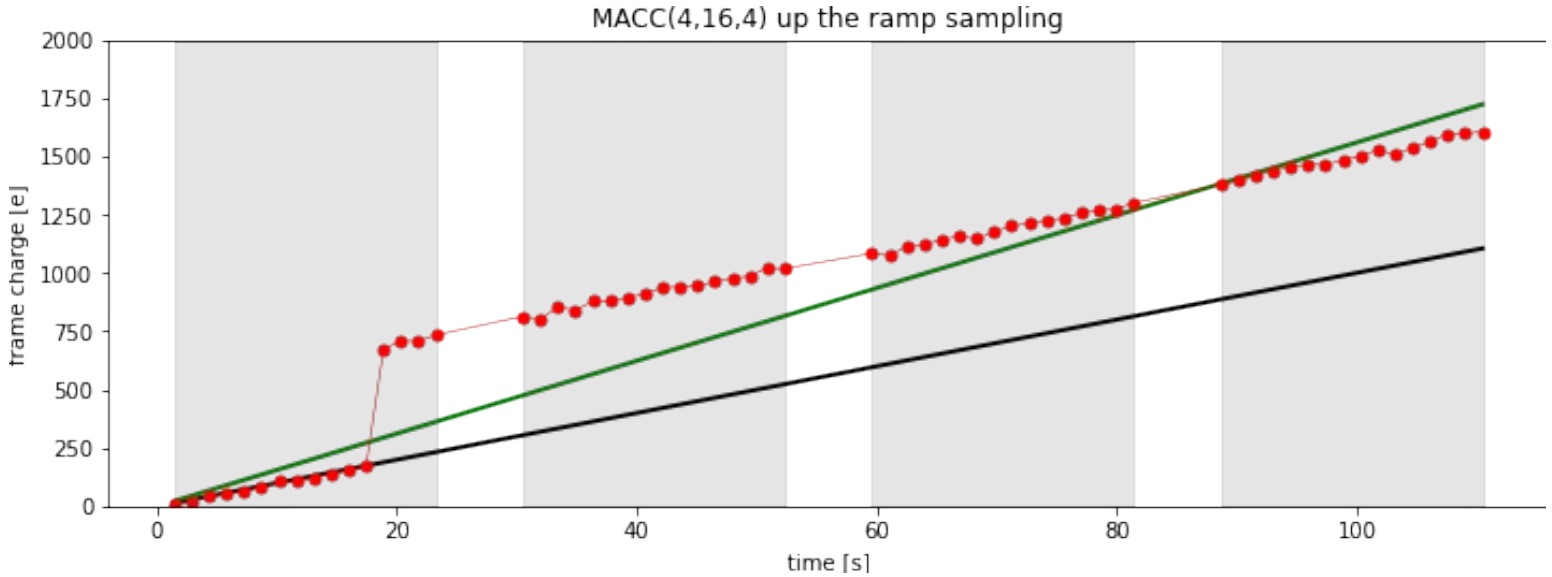

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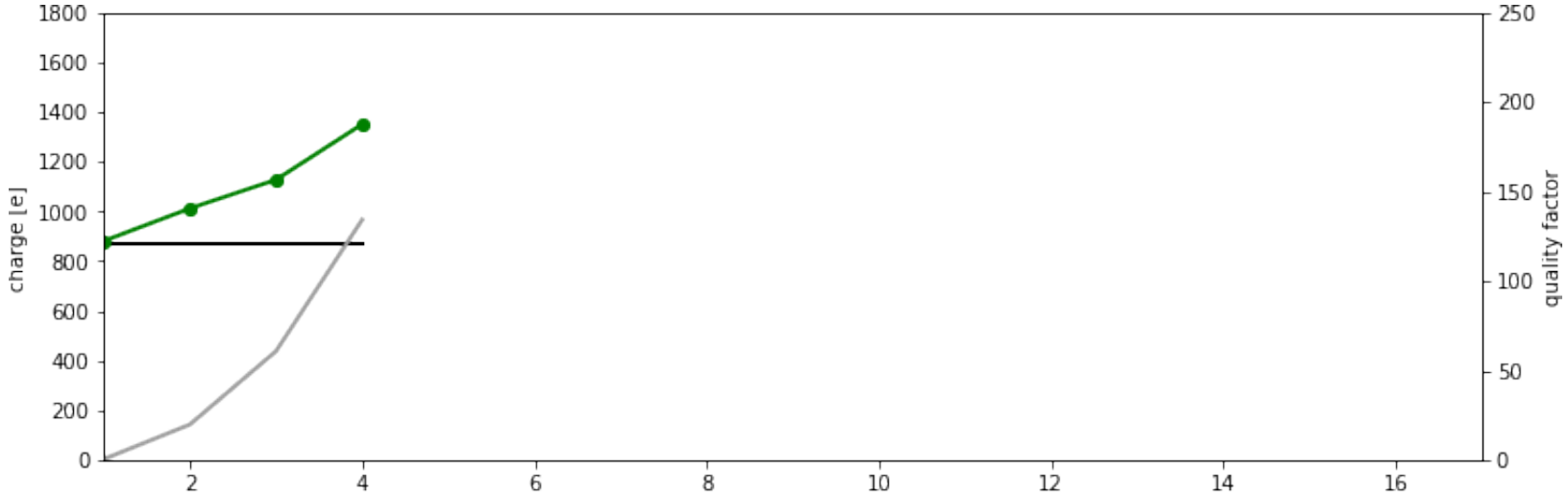

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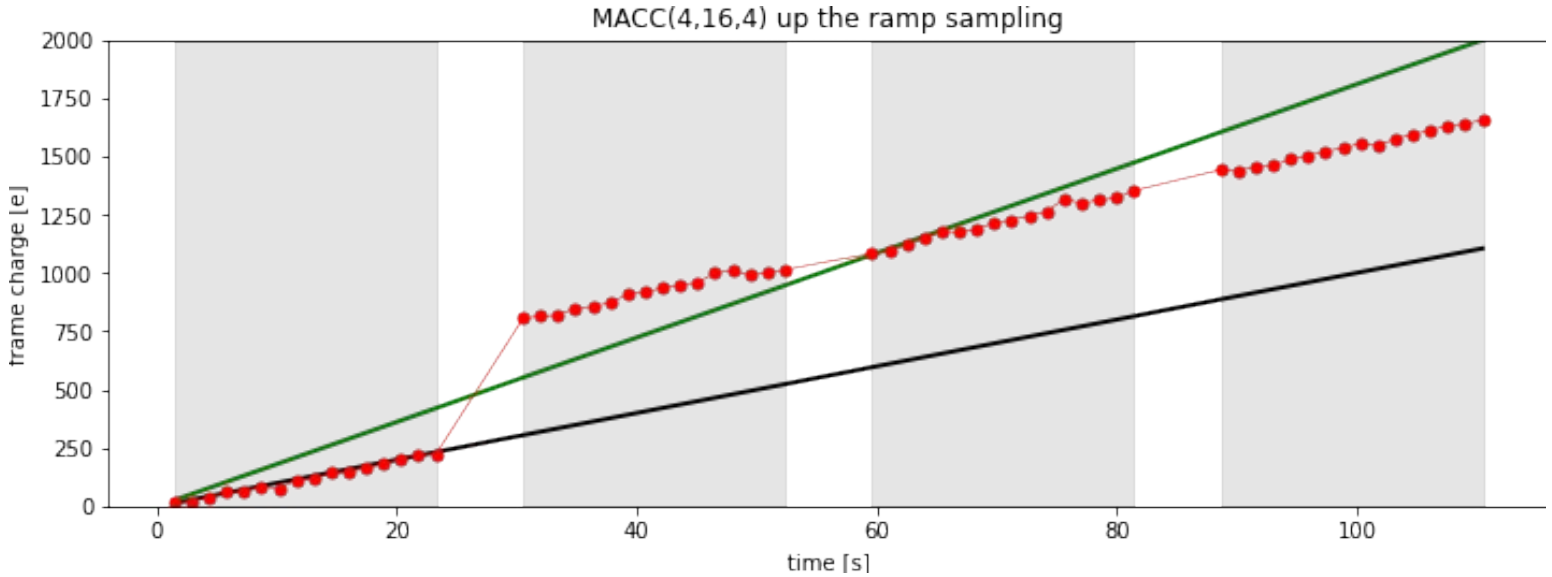

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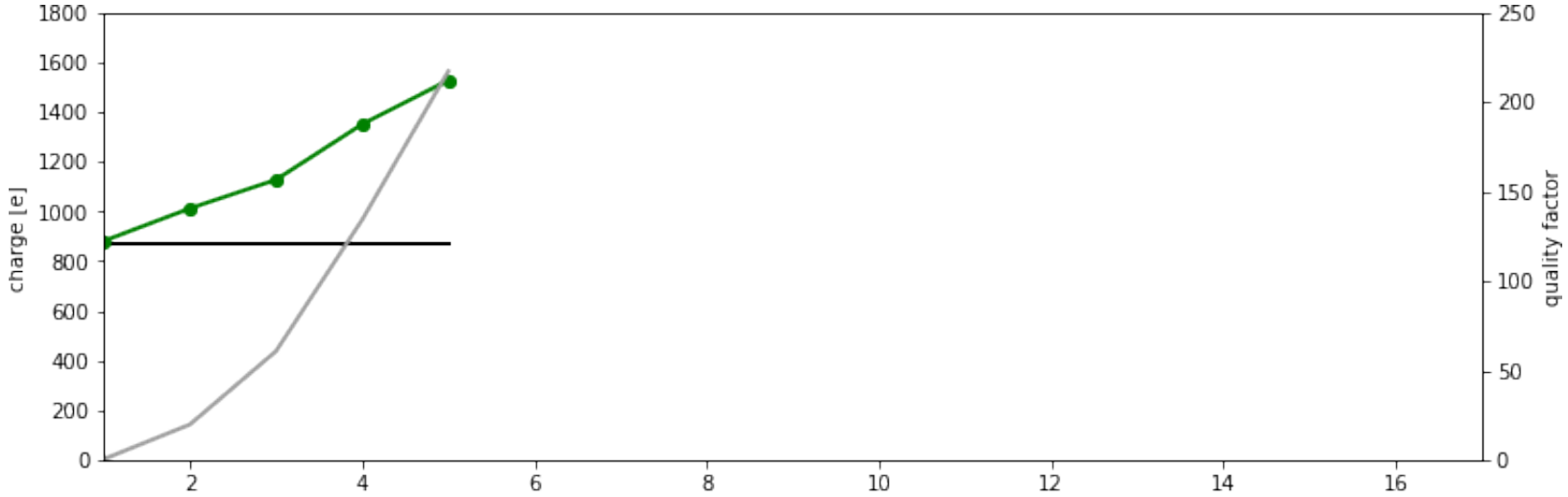

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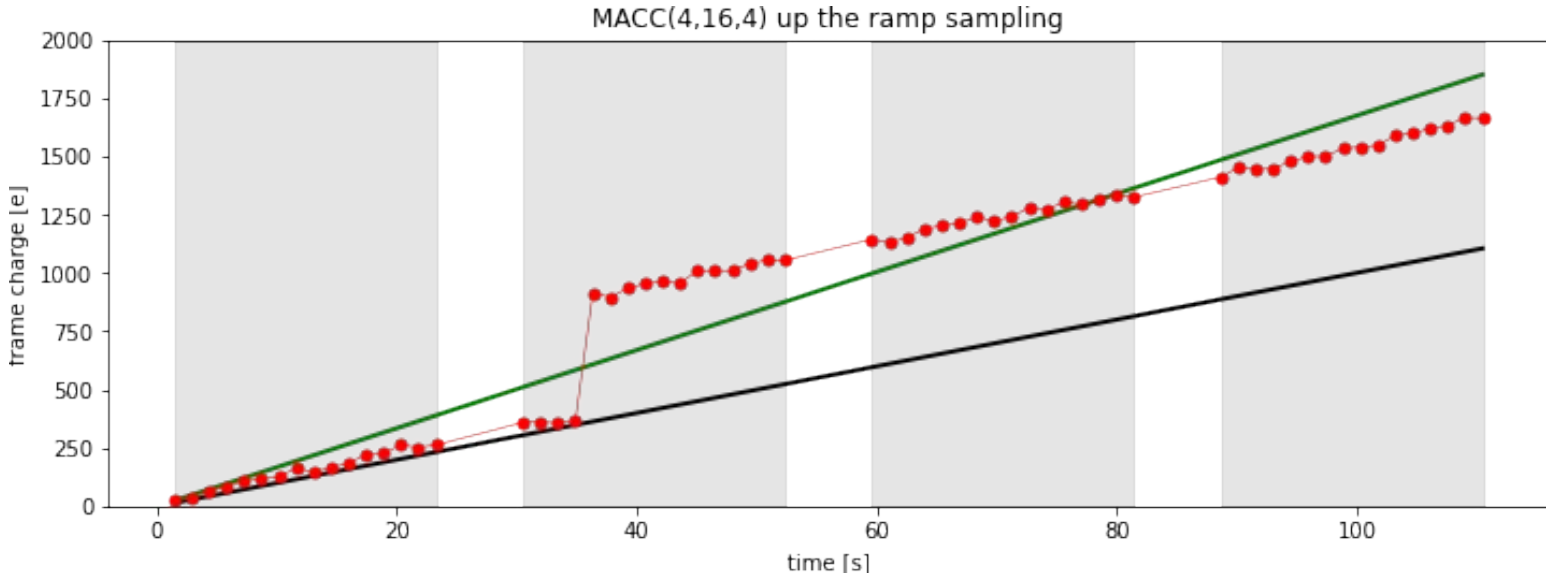

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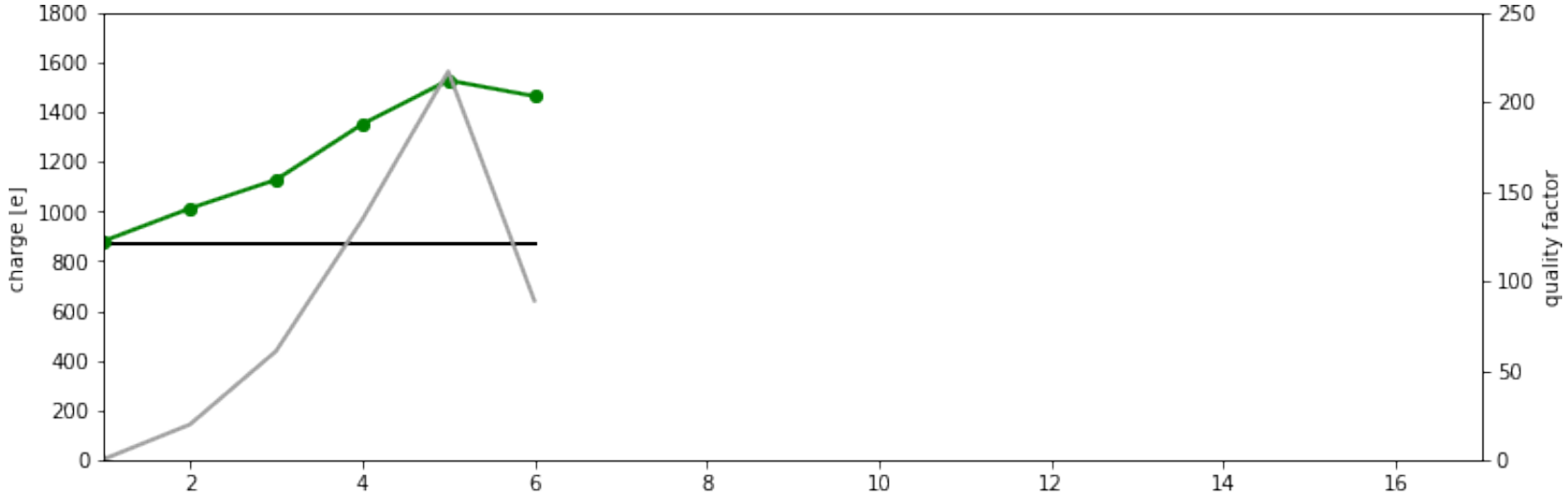

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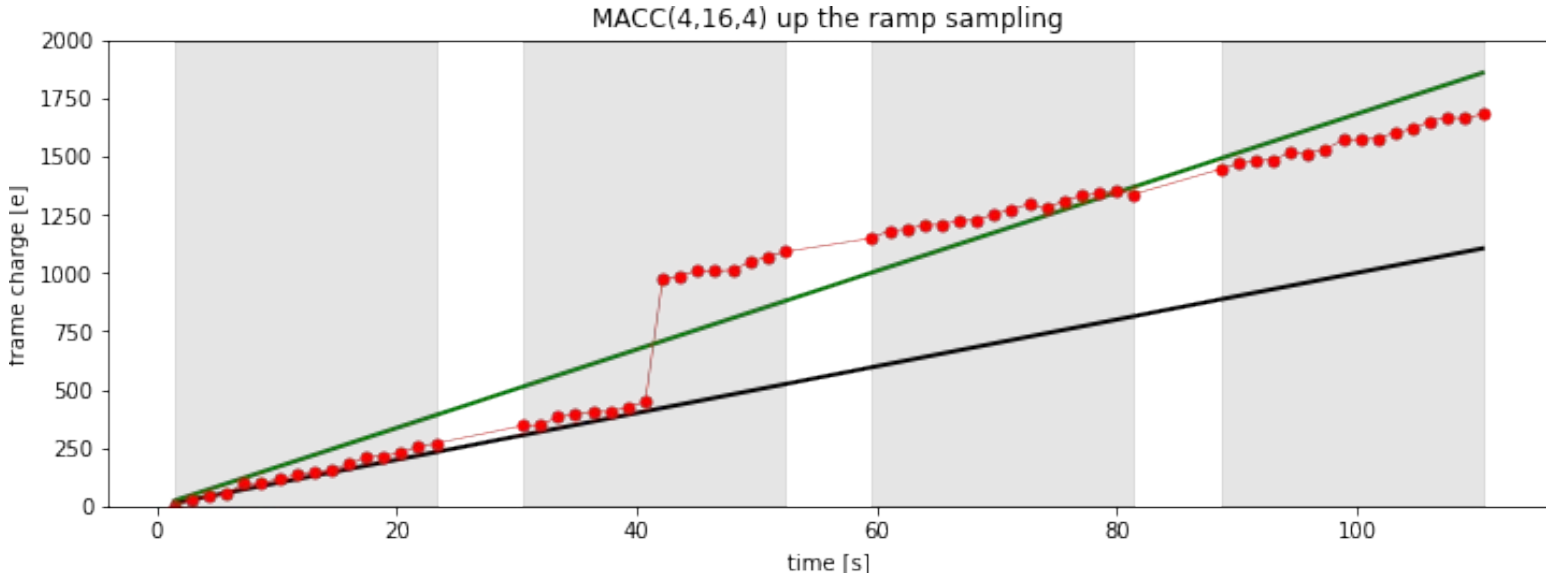

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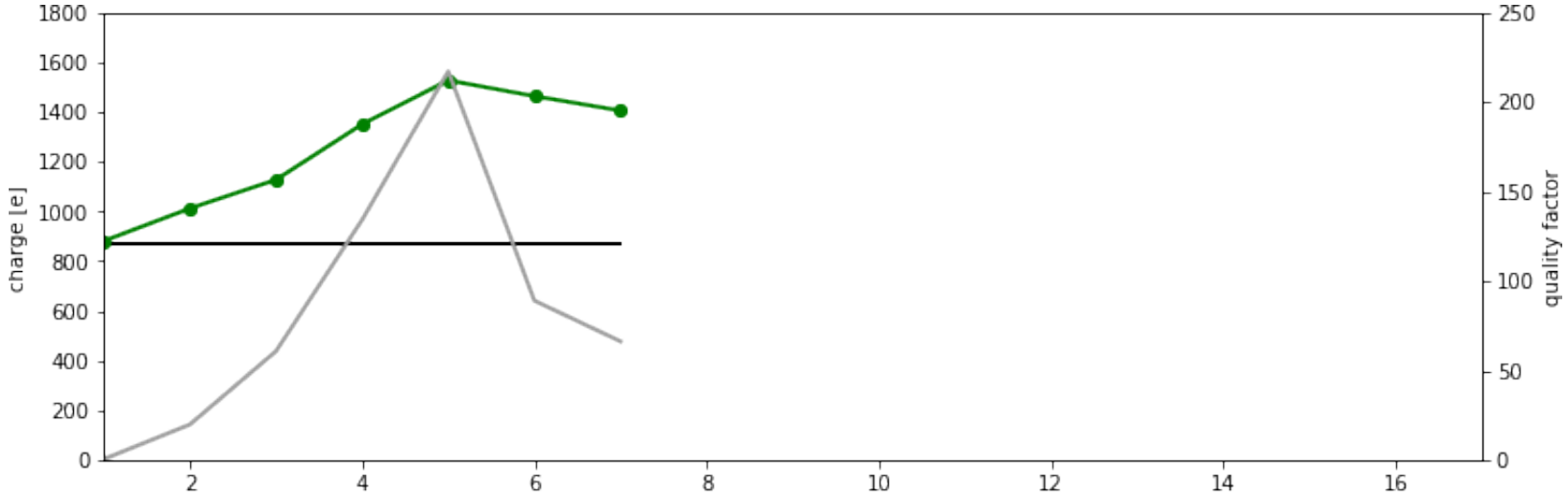

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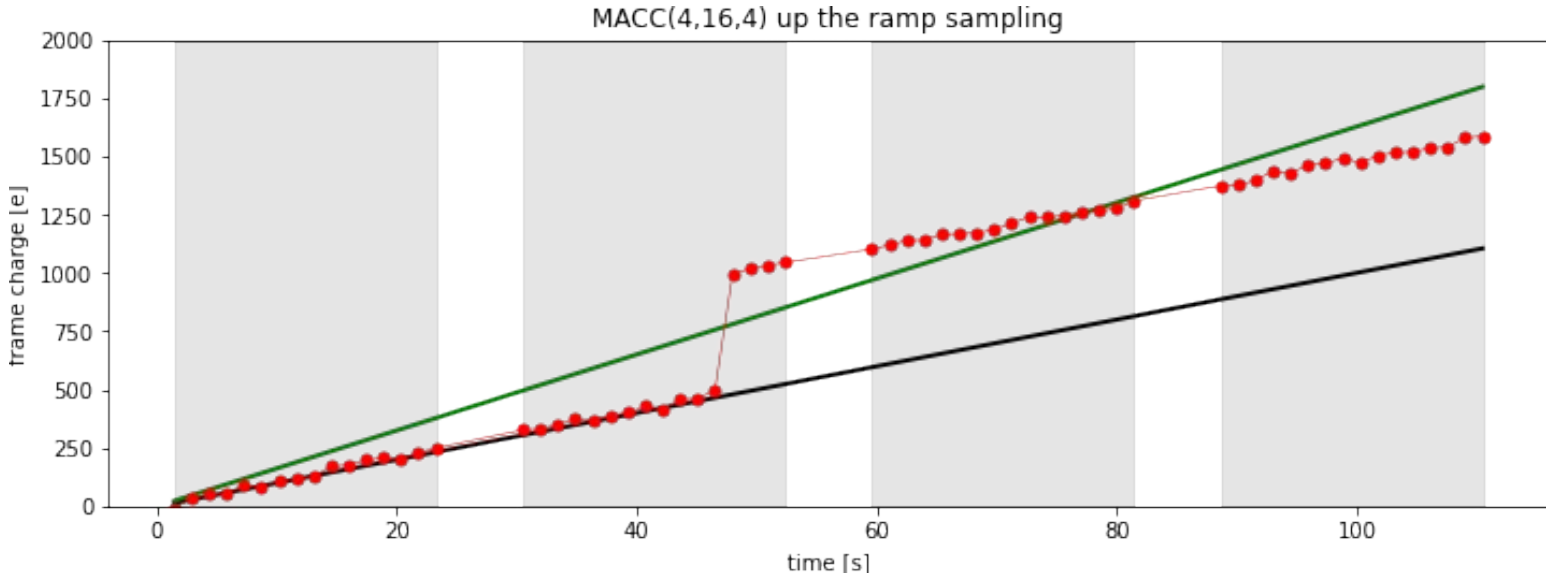

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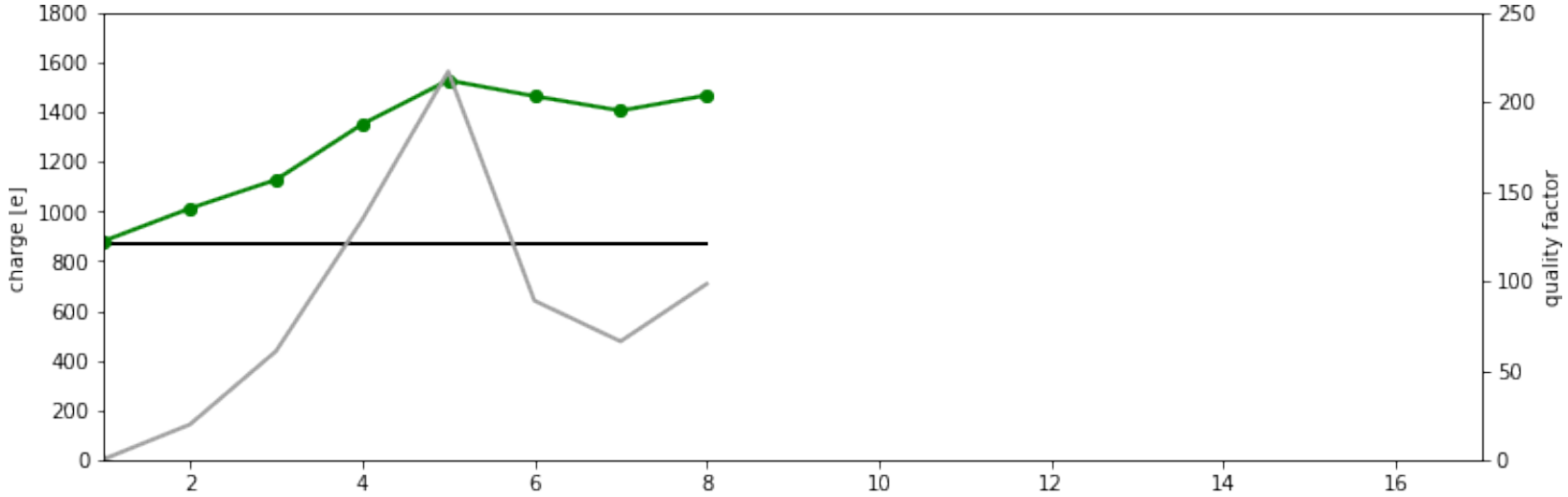

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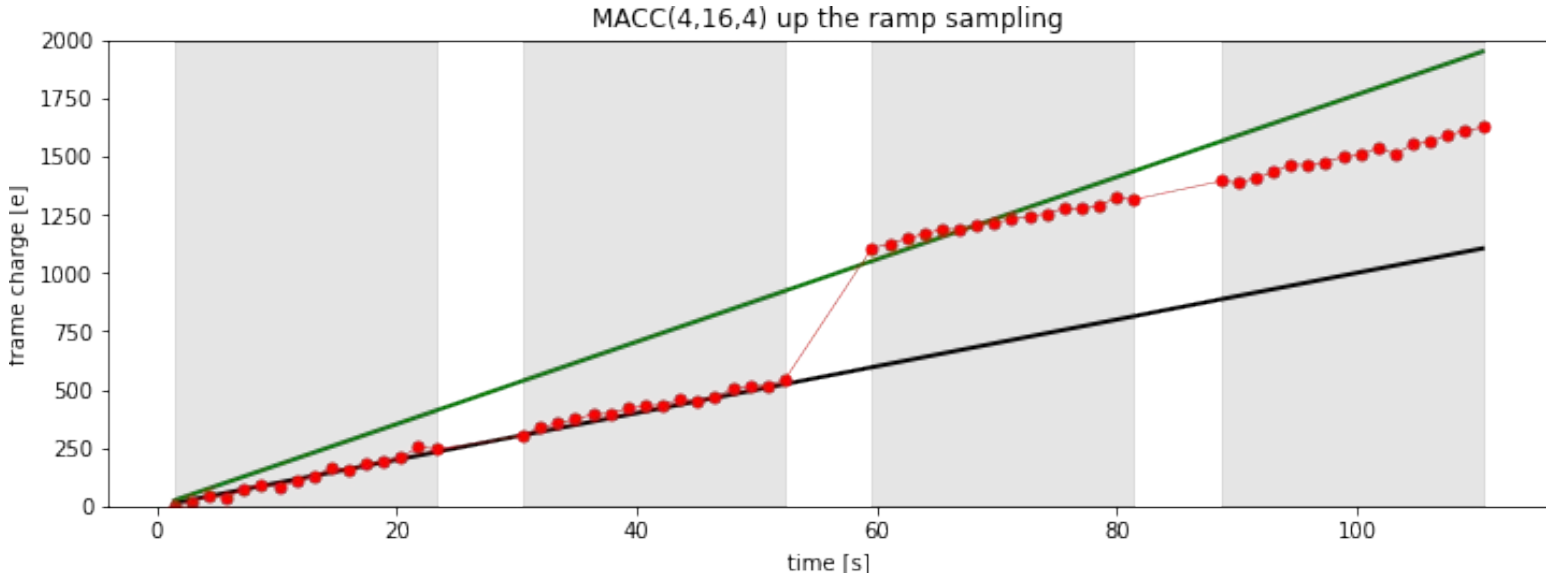

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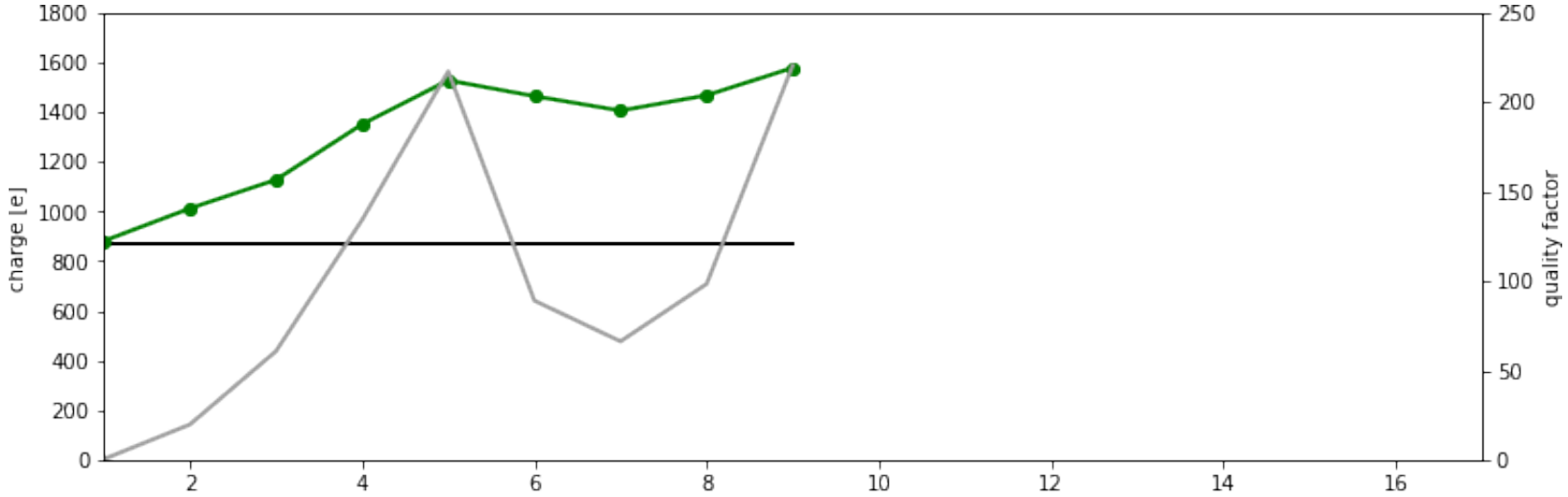

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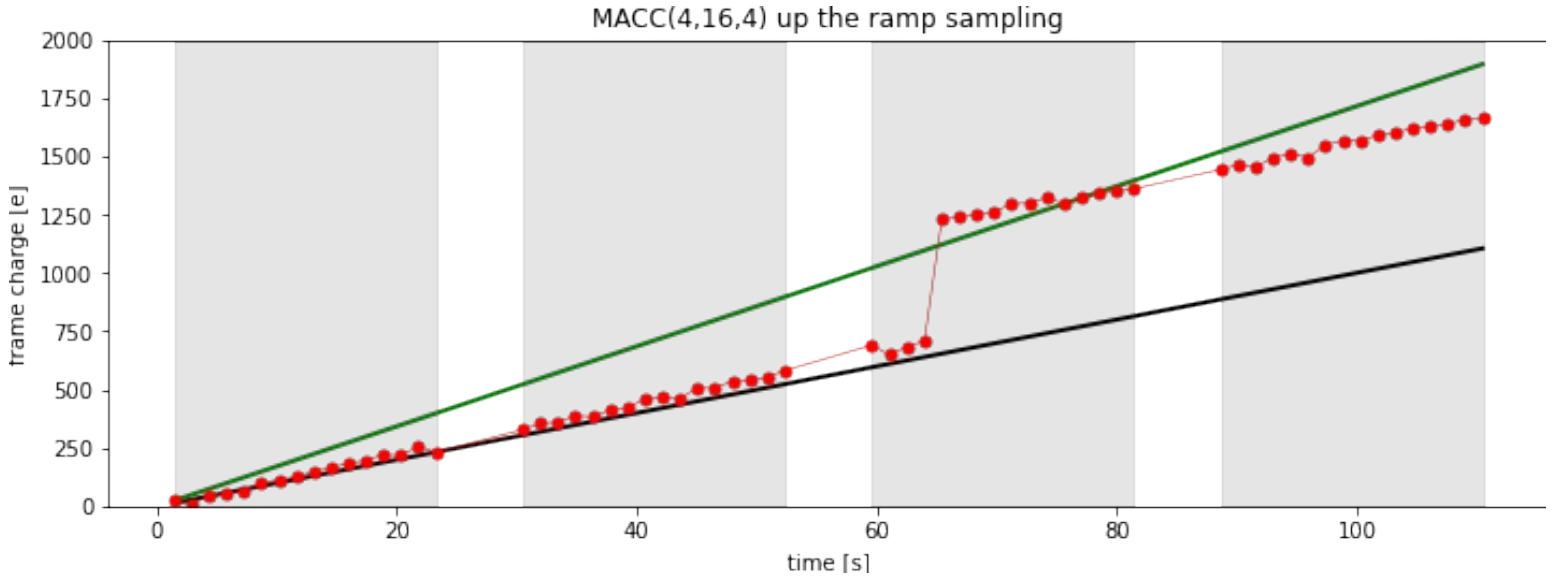

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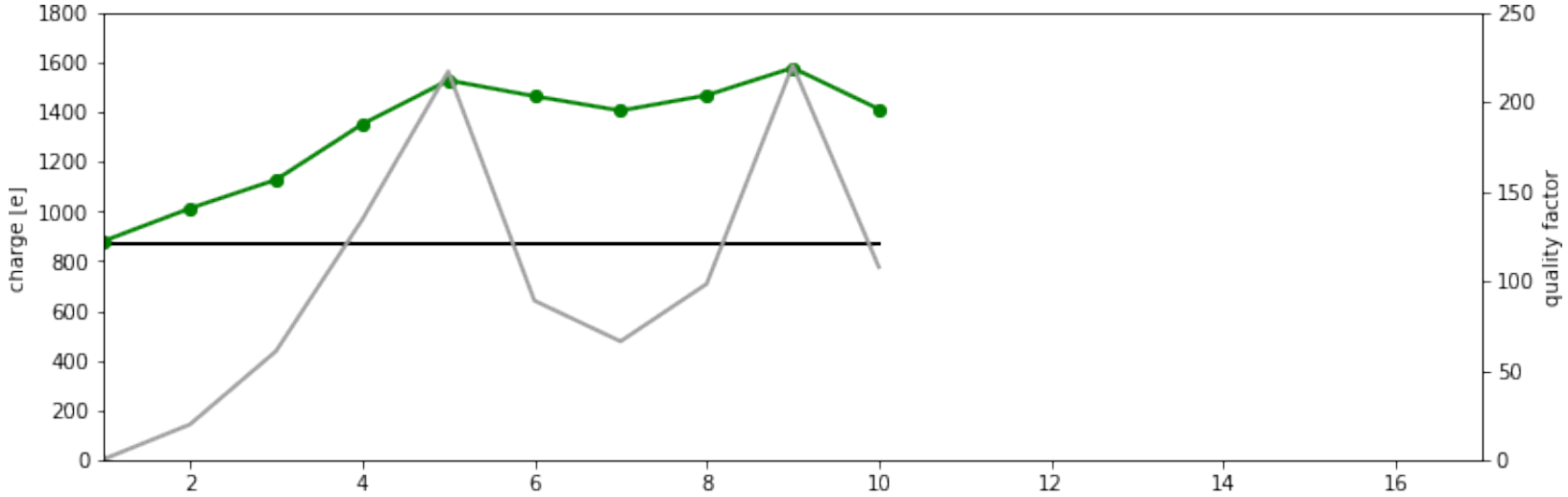

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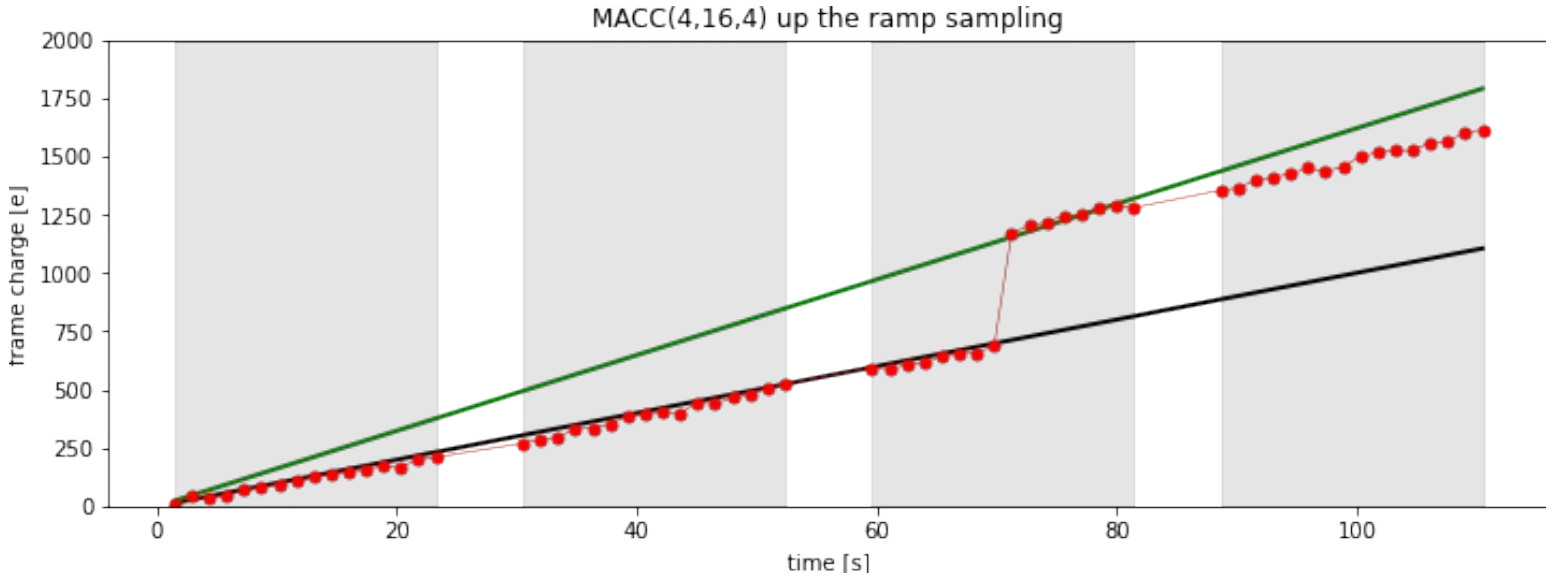
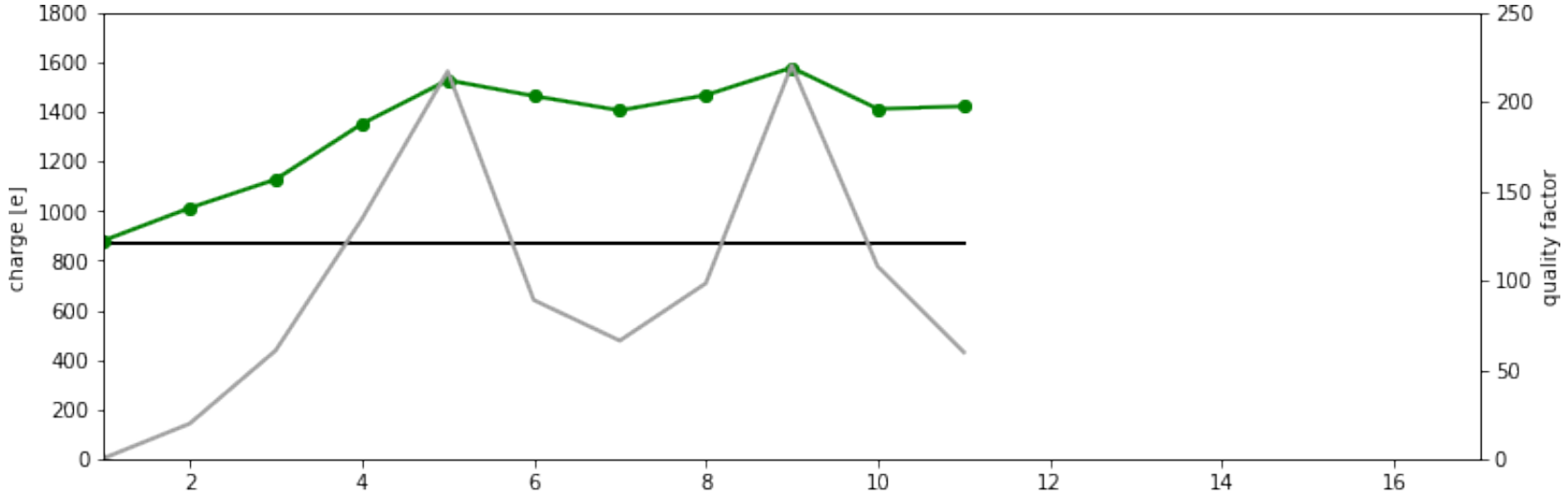
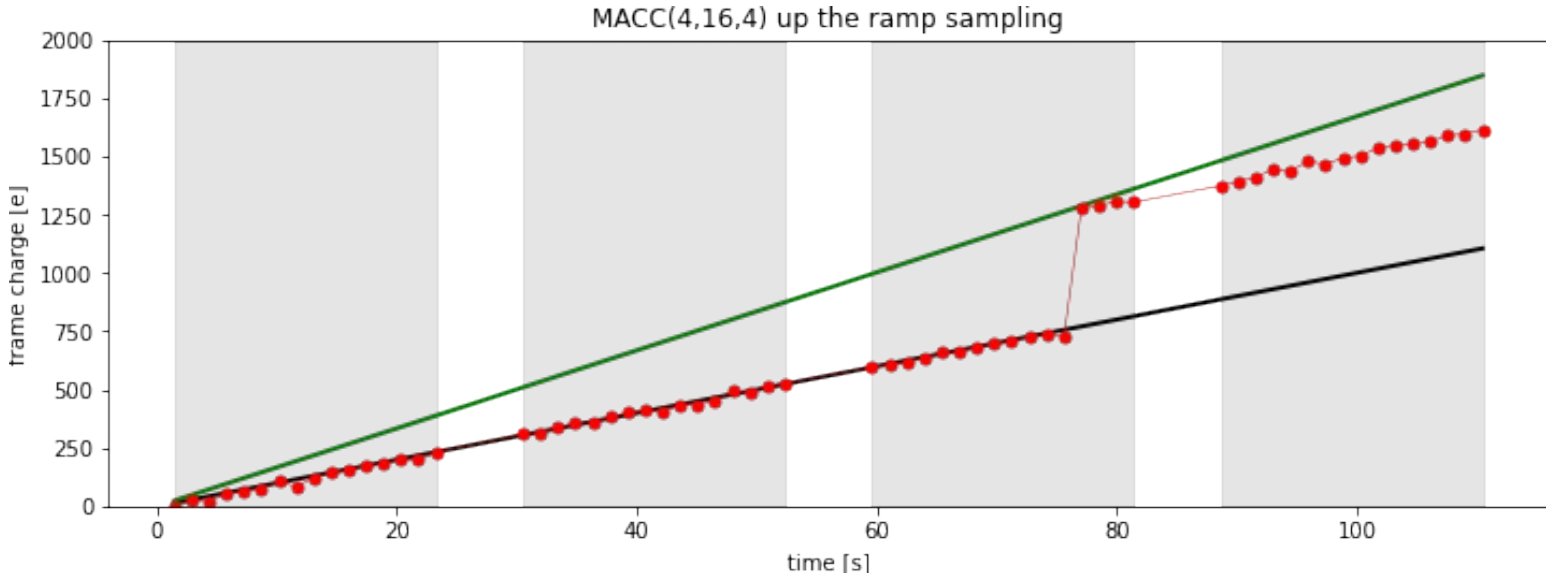


- charge estimate (green) and quality factor (grey)

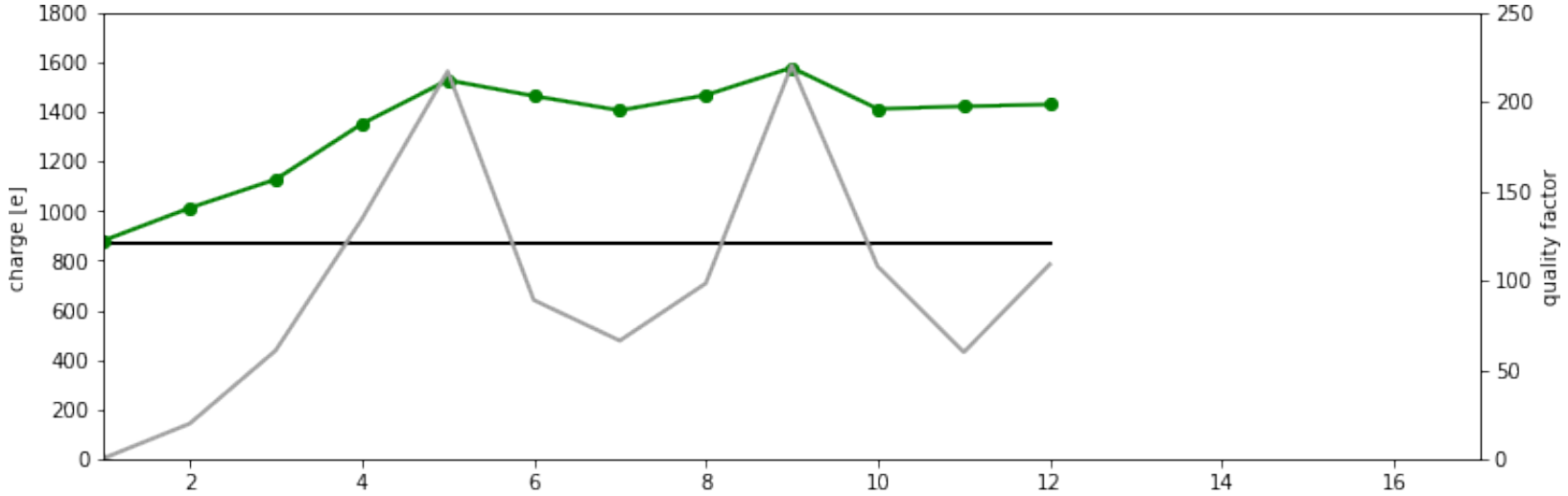


MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops

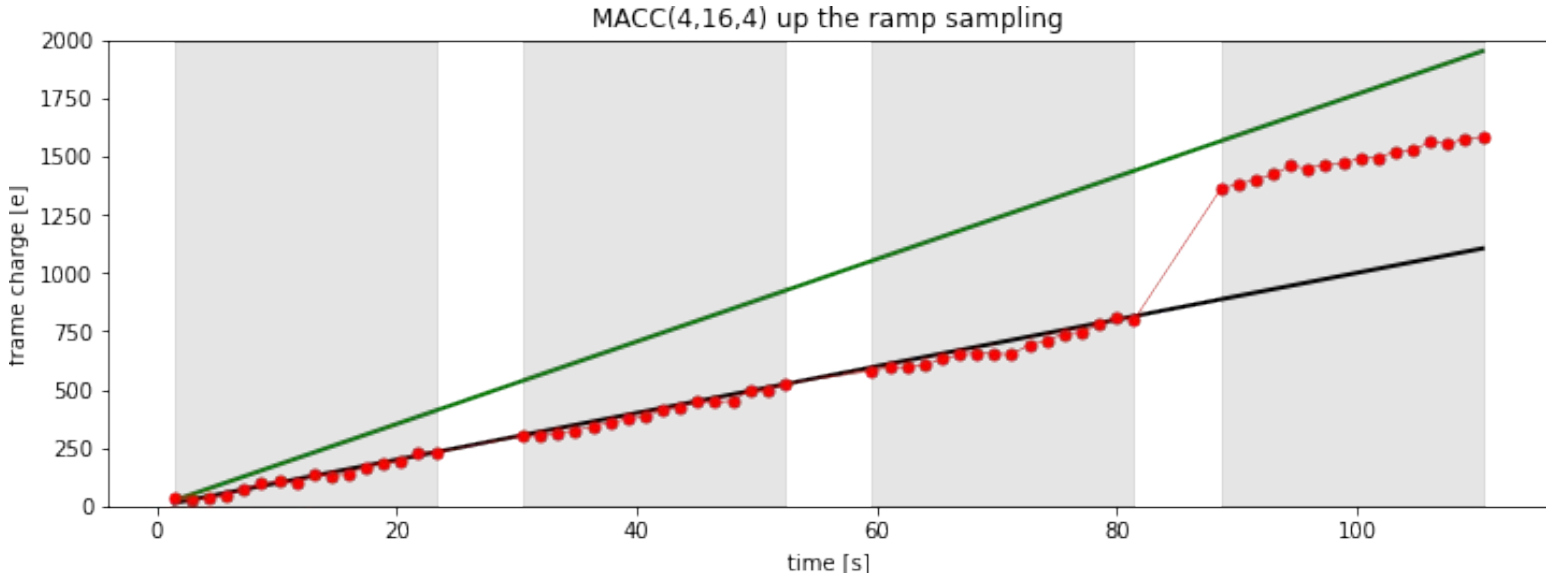


- charge estimate (green) and quality factor (grey)

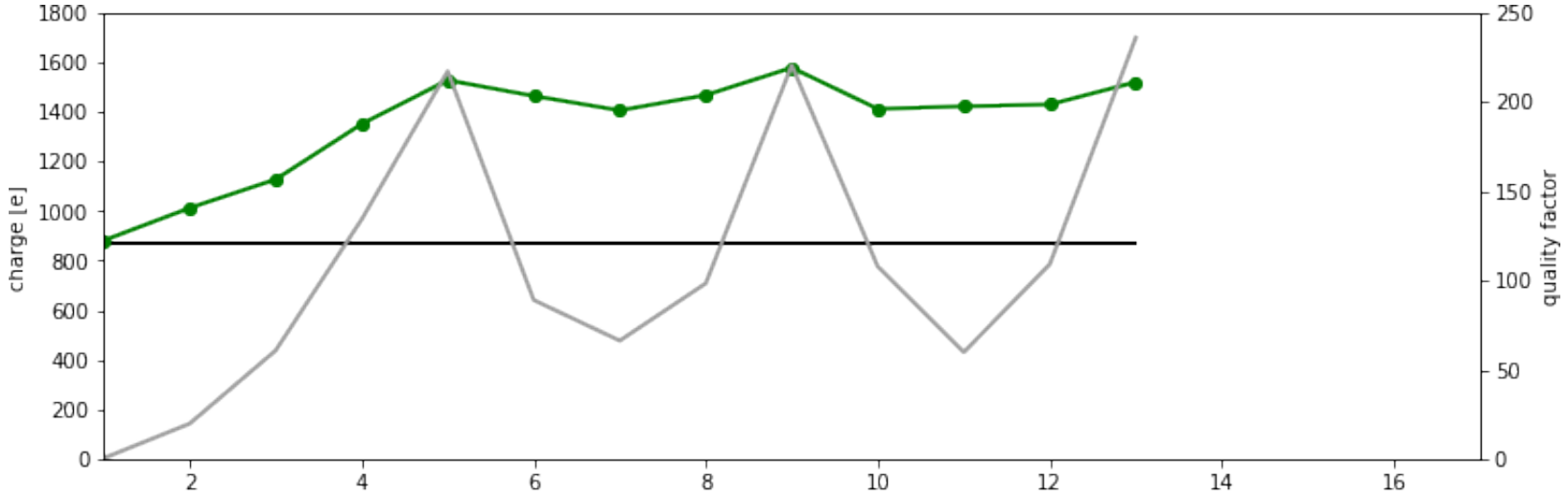


MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops

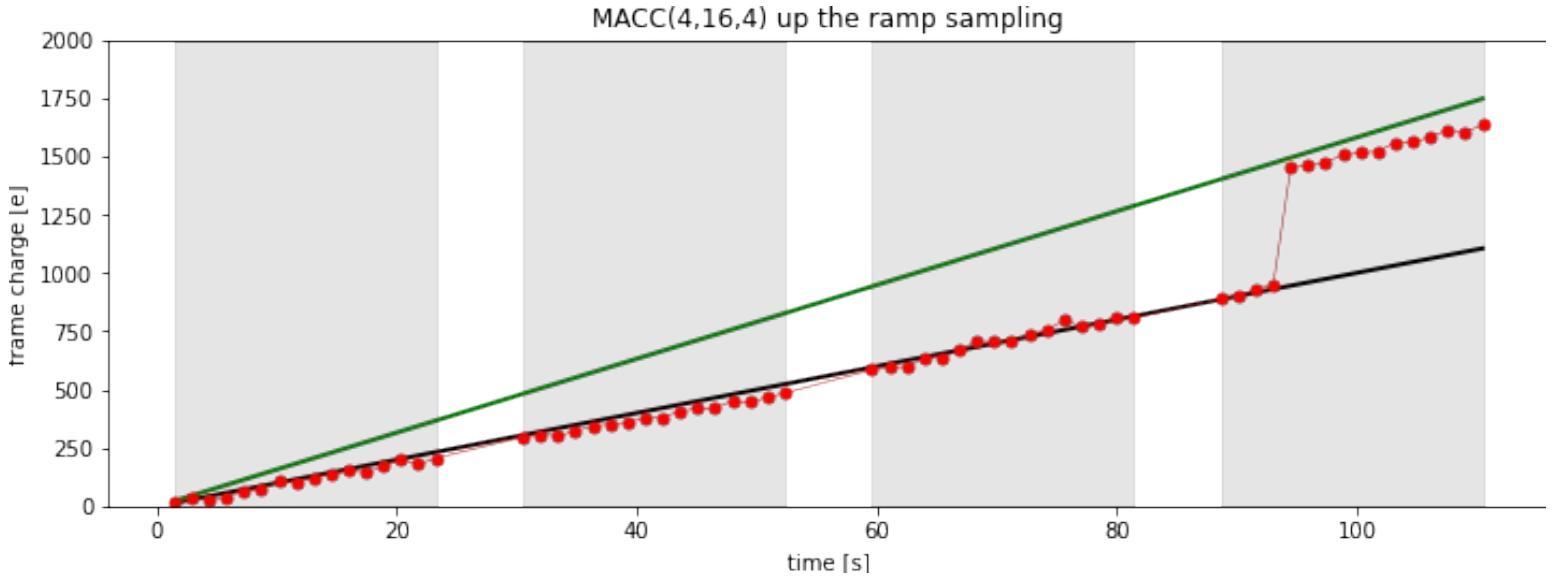


- charge estimate (green) and quality factor (grey)

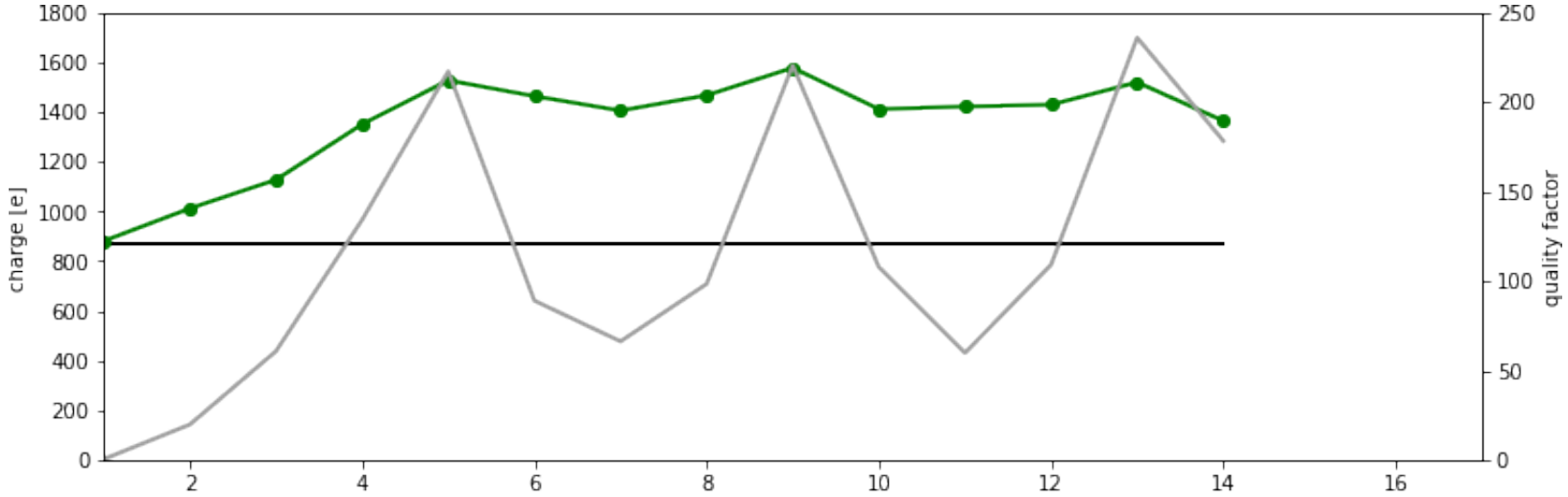


MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops

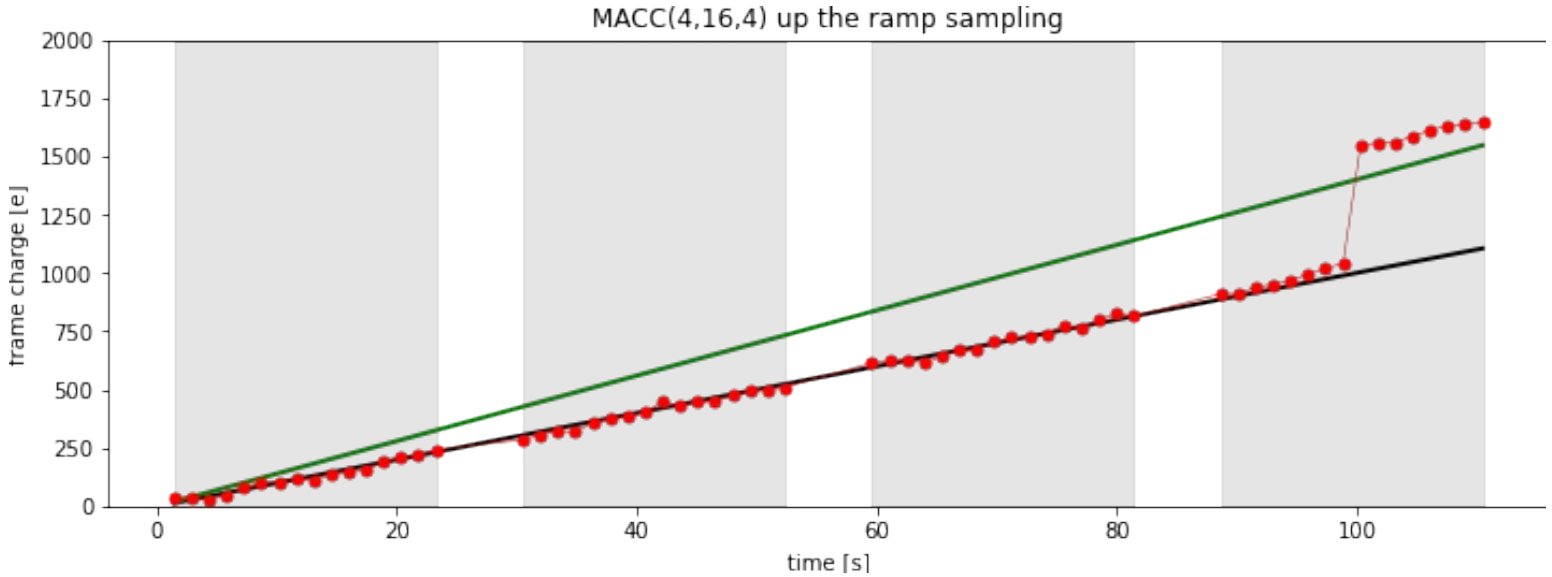


- charge estimate (green) and quality factor (grey)

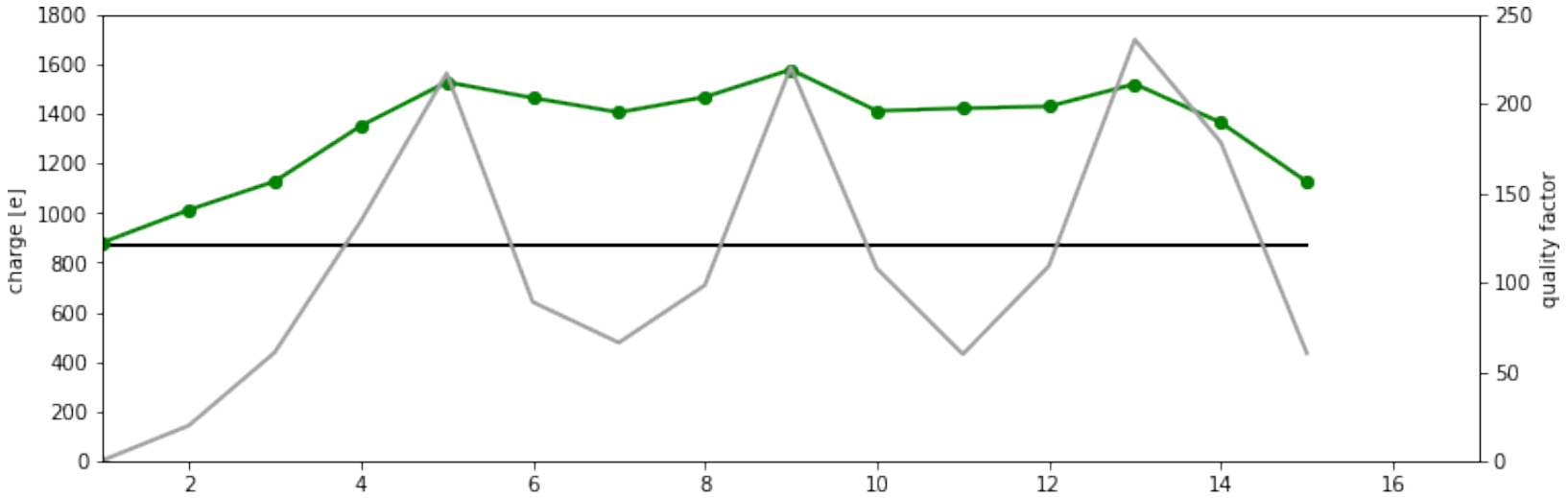


MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops

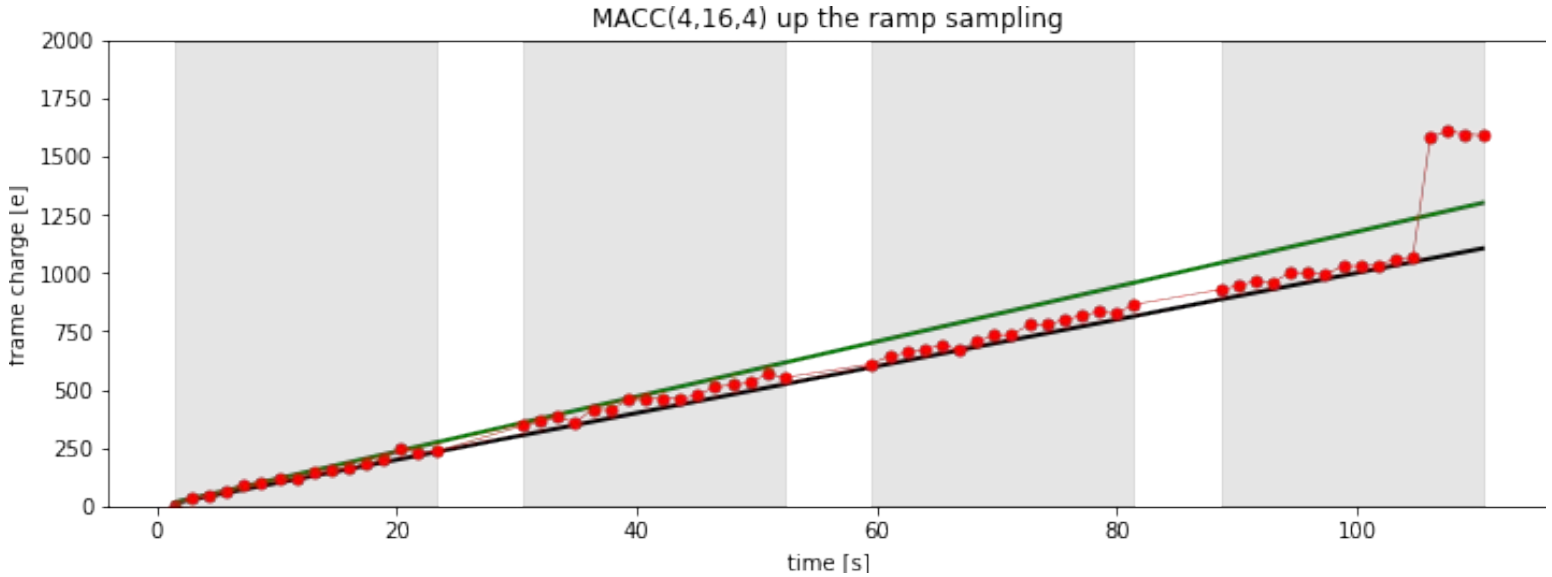


- charge estimate (green) and quality factor (grey)

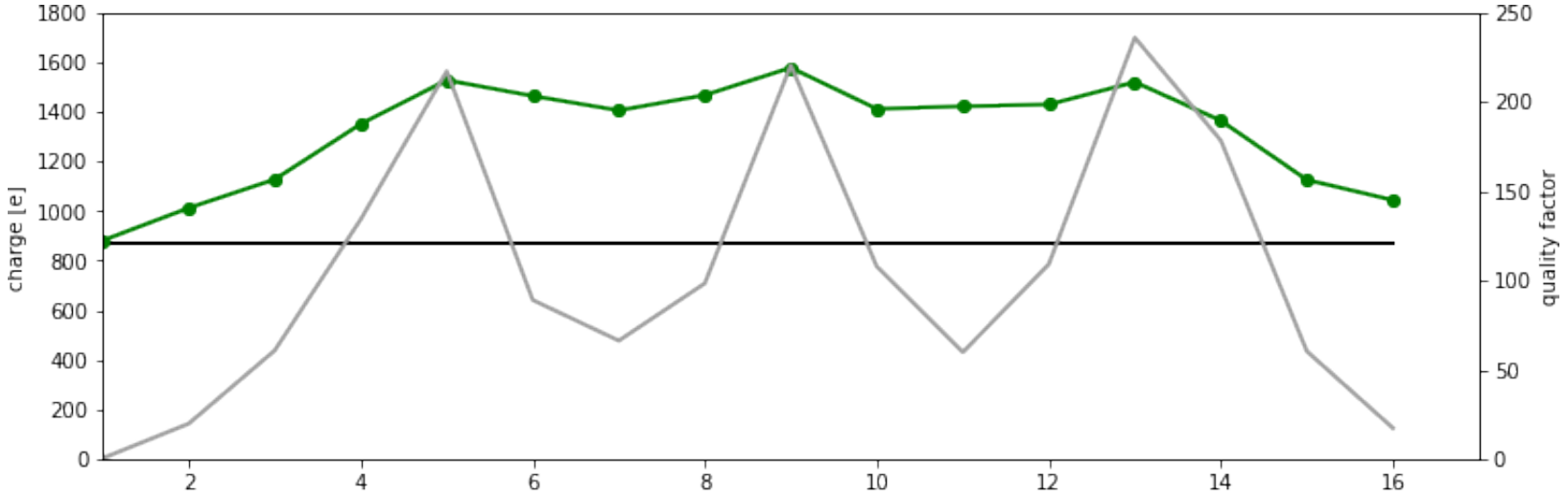


MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops

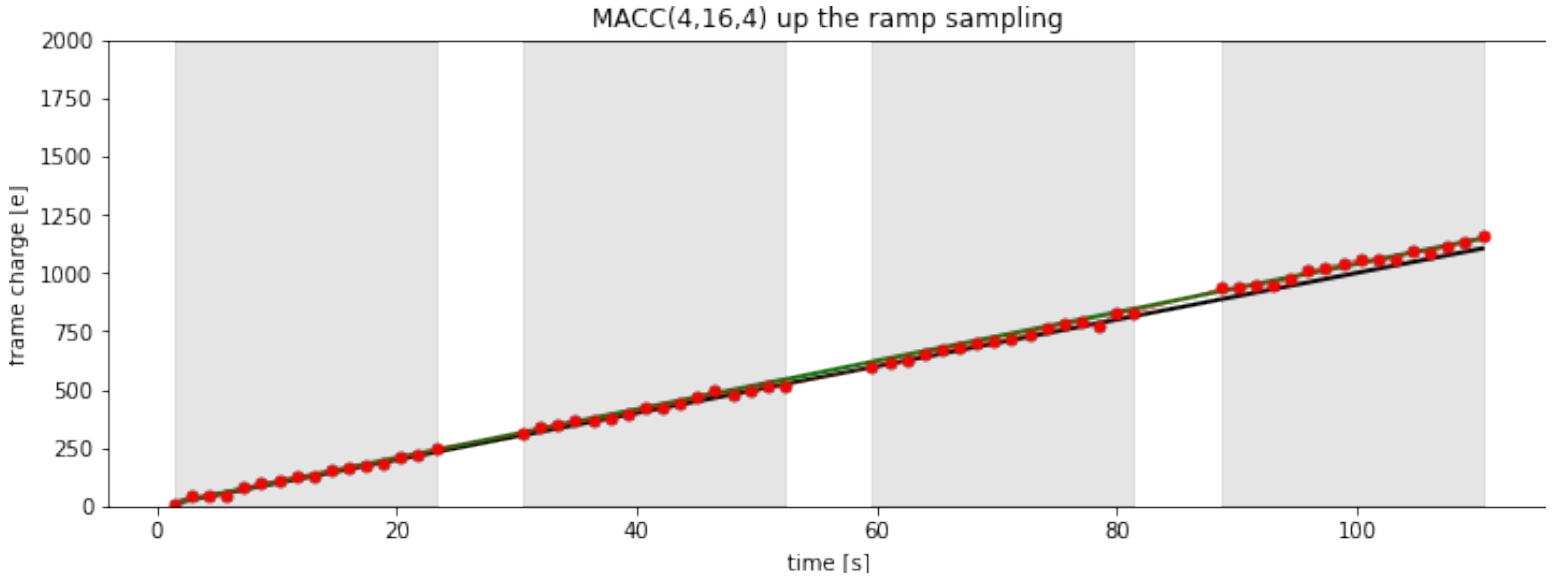


- charge estimate (green) and quality factor (grey)

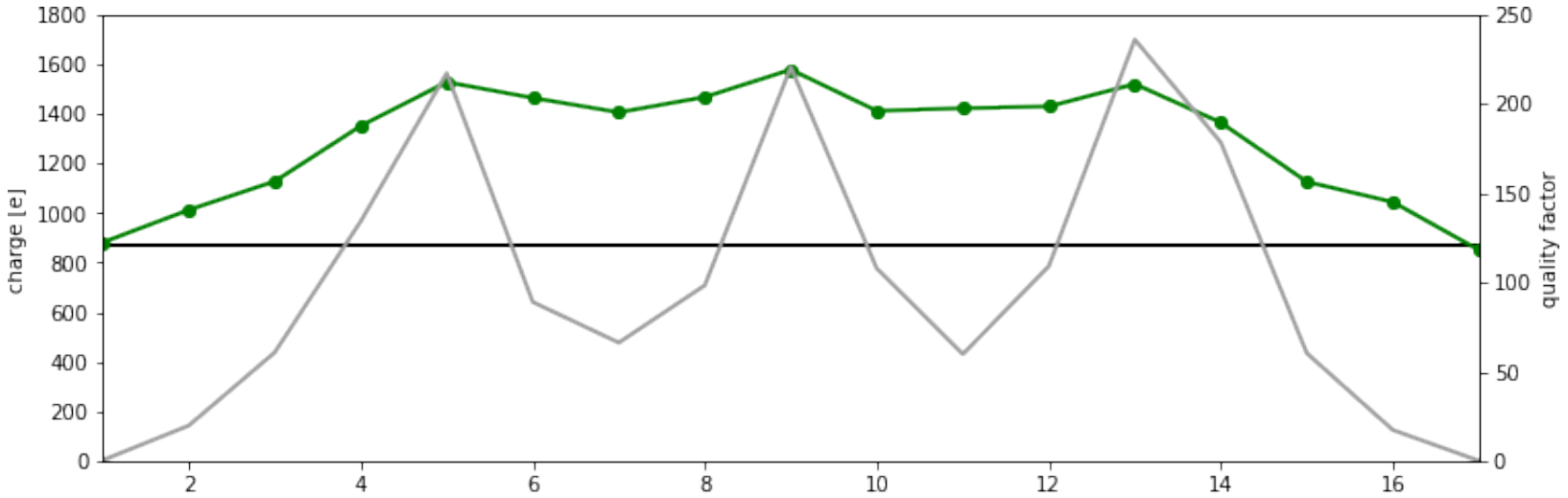


MACC up the ramp sampling

NISP-P MACC: 4 groups, 16 readouts, 4 drops

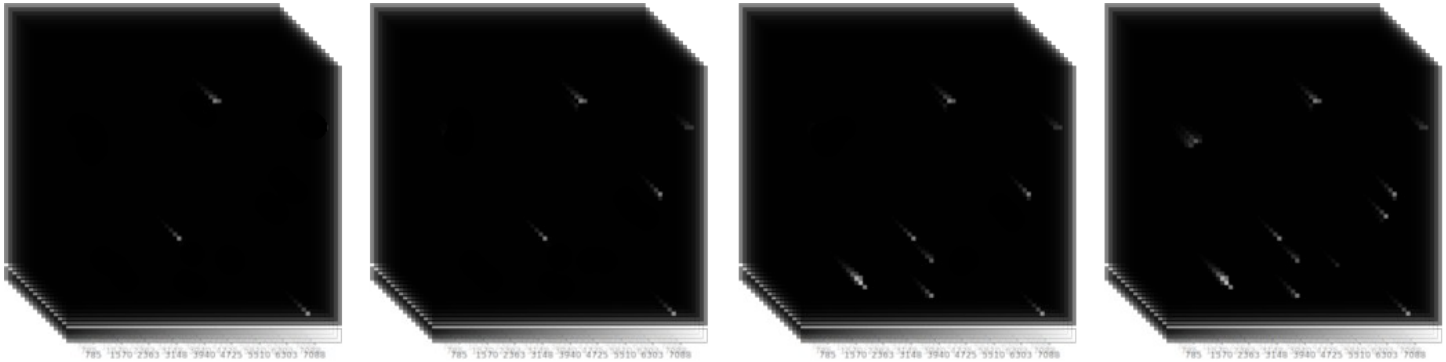


- charge estimate (green) and quality factor (grey)

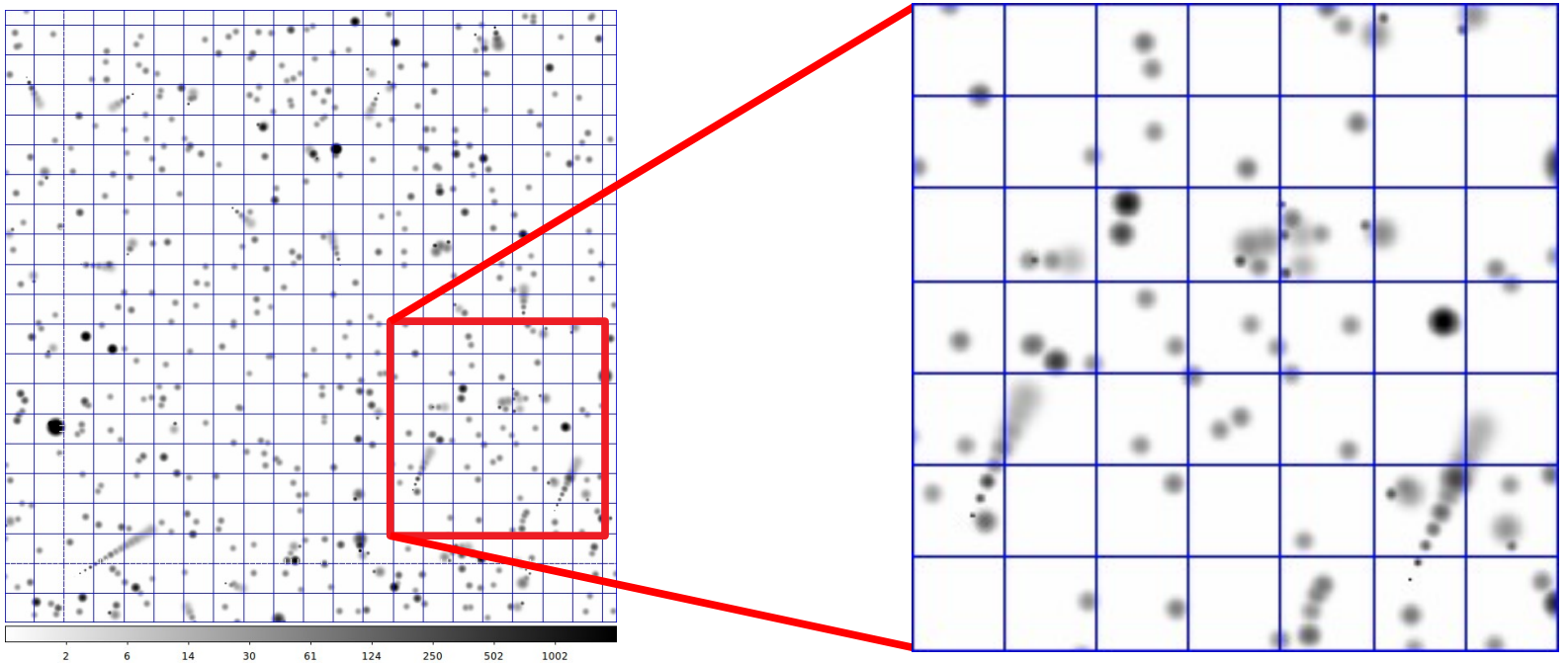


cosmics

- cosmic rays hit at different times in exposure and accumulate



- particle trajectories depend on physical detector properties

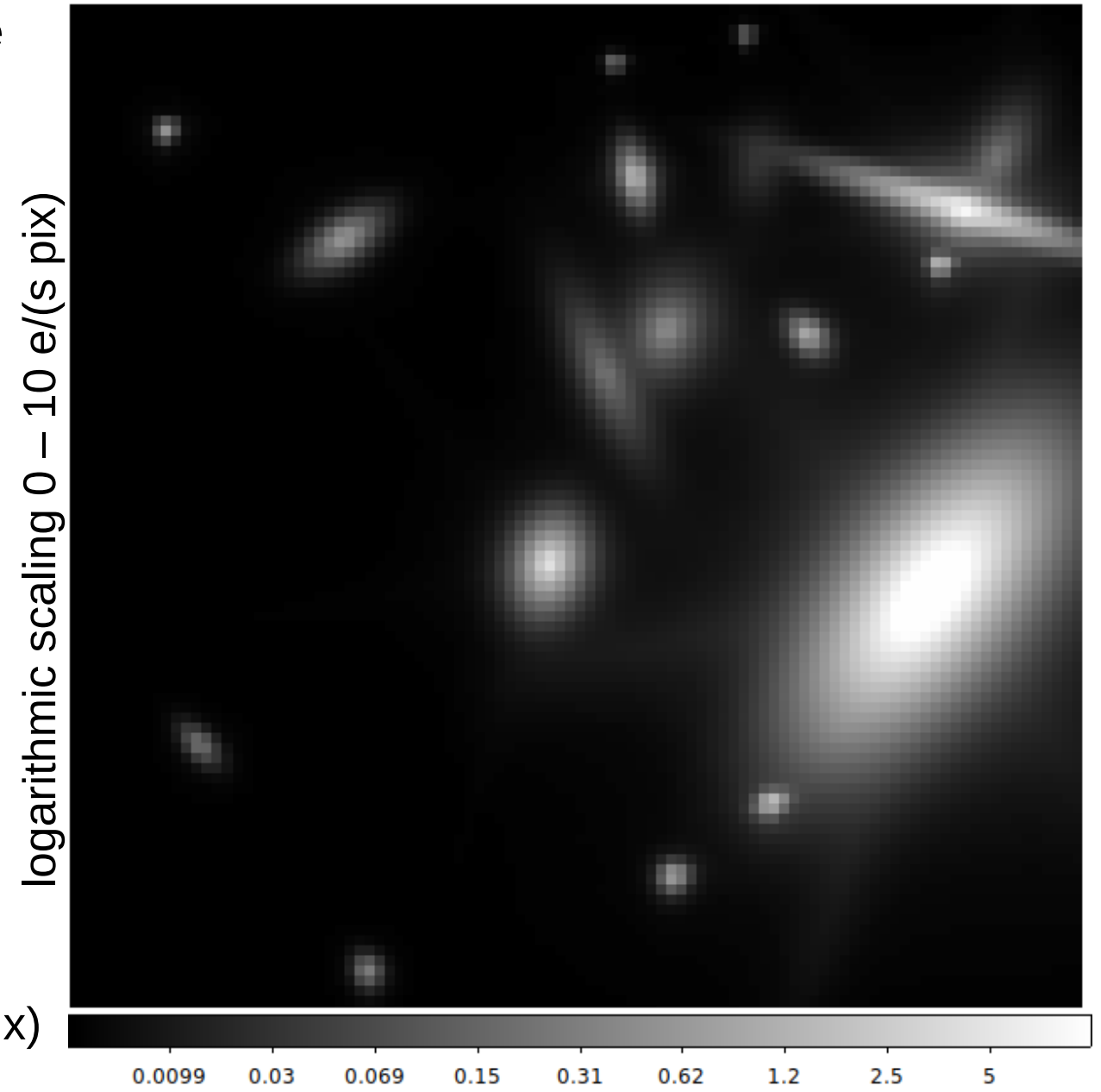


long exposure, unrealistically exaggerated step width and diffusion

instrument effects

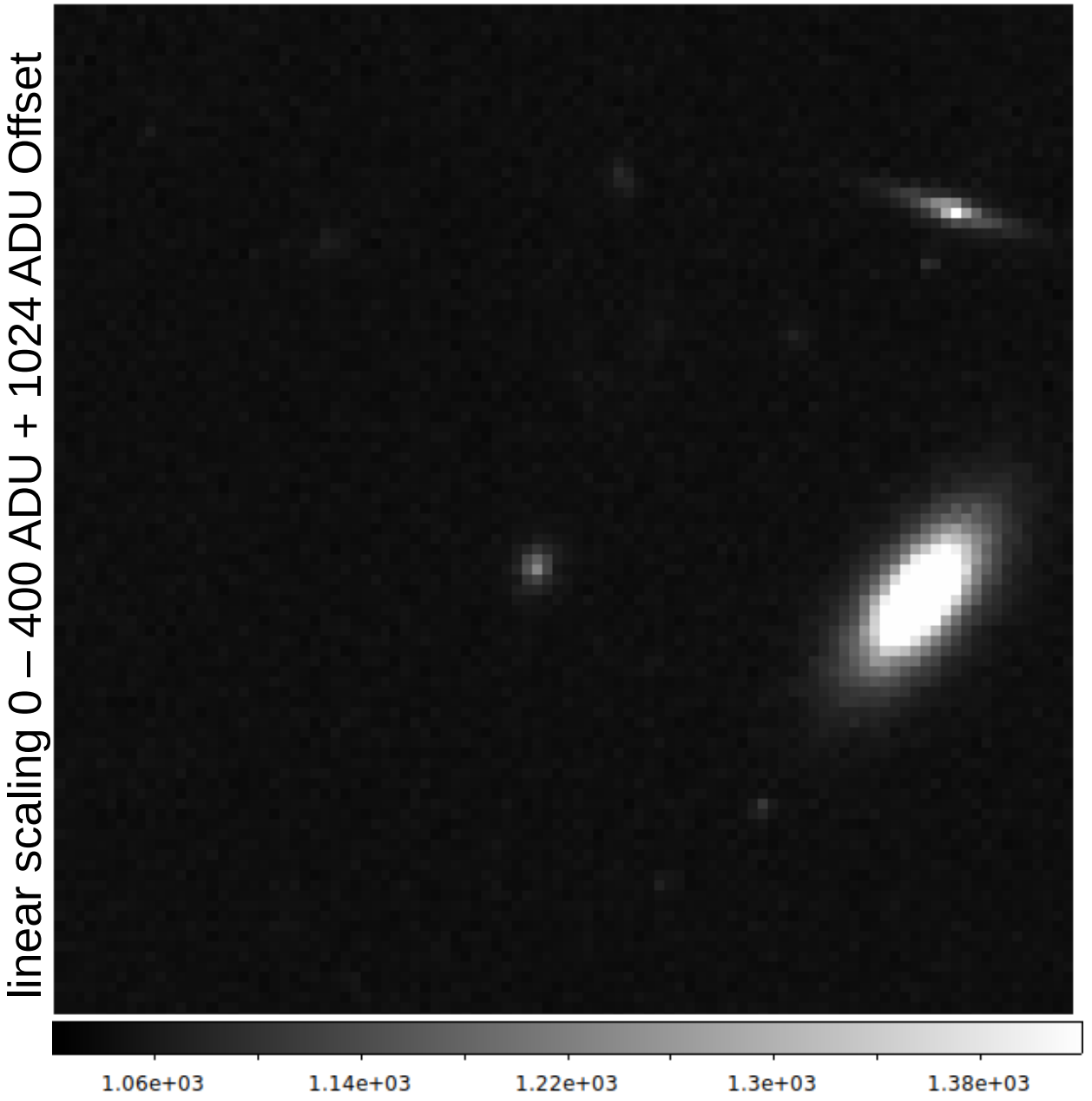
- noiseless pixel image
  100 x 100 pix^2

- brightest galaxy
  SDDS R mag: 18.48
  pix. max.: 27.3 e/(s pix)



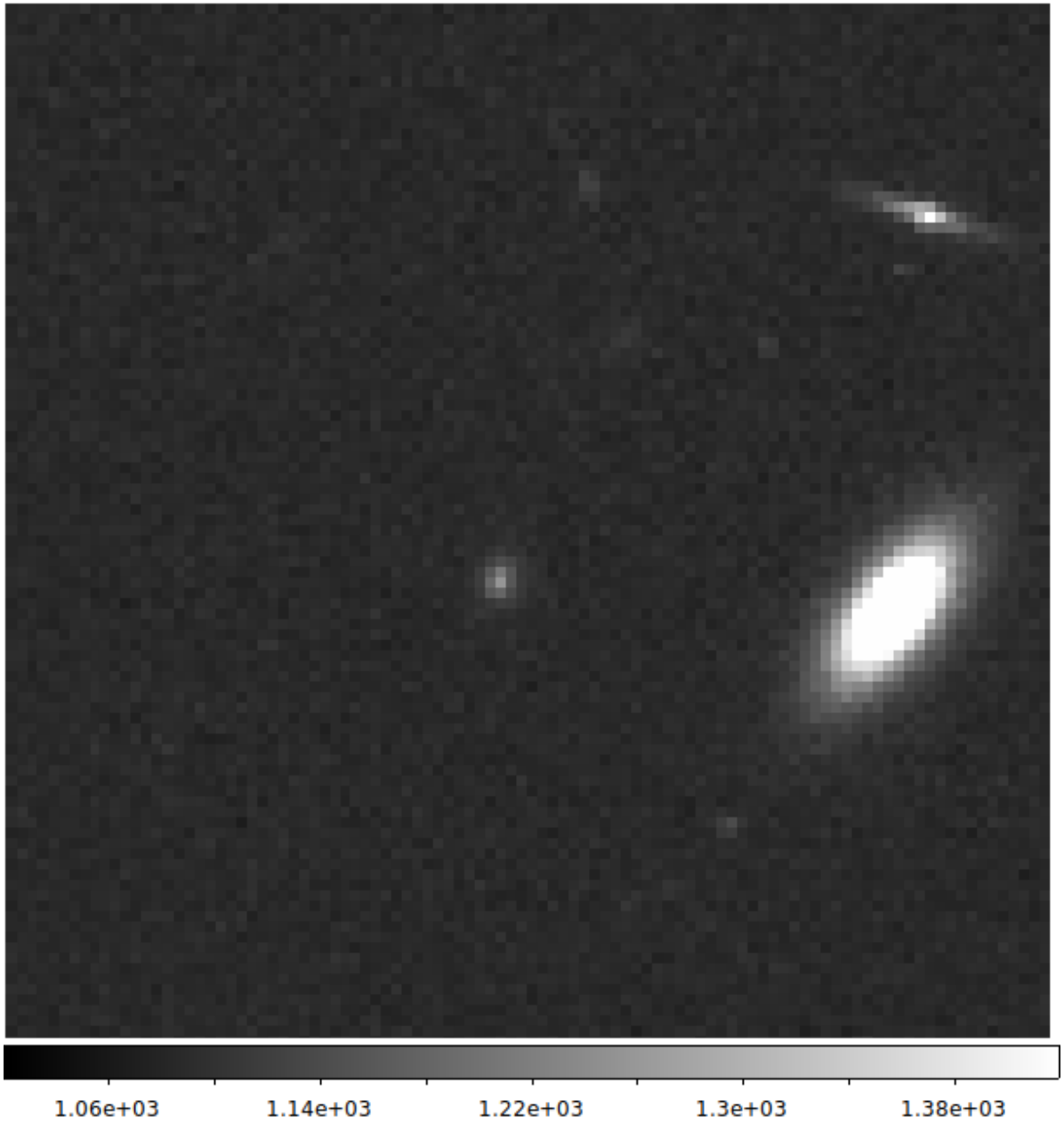
instrument effects

- noiseless pixel image
  100 x 100 pix^2
- Poisson / shot-noise



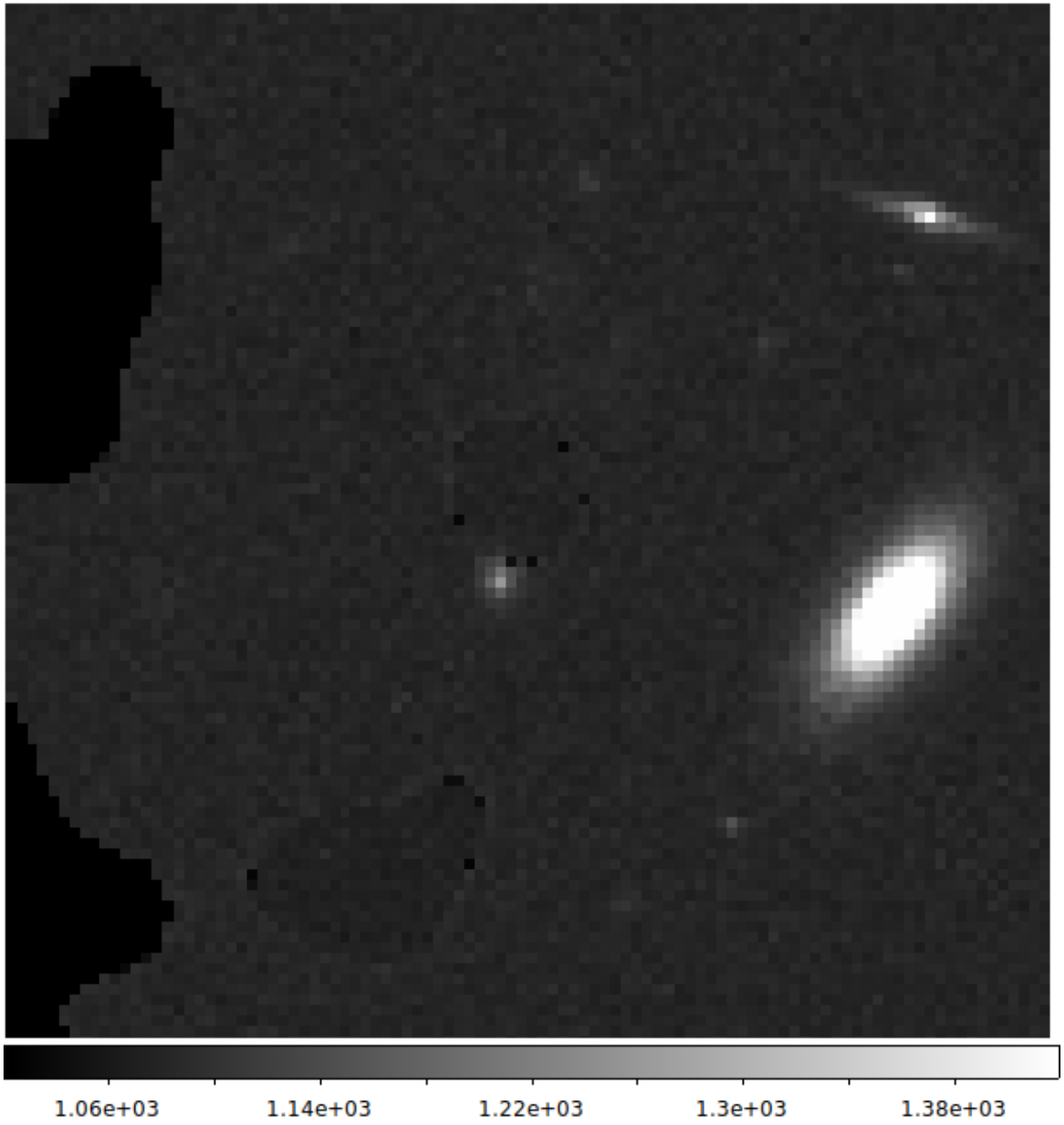
instrument effects

- noiseless pixel image
  100 x 100 pix^2
- Poisson / shot-noise
- background flux



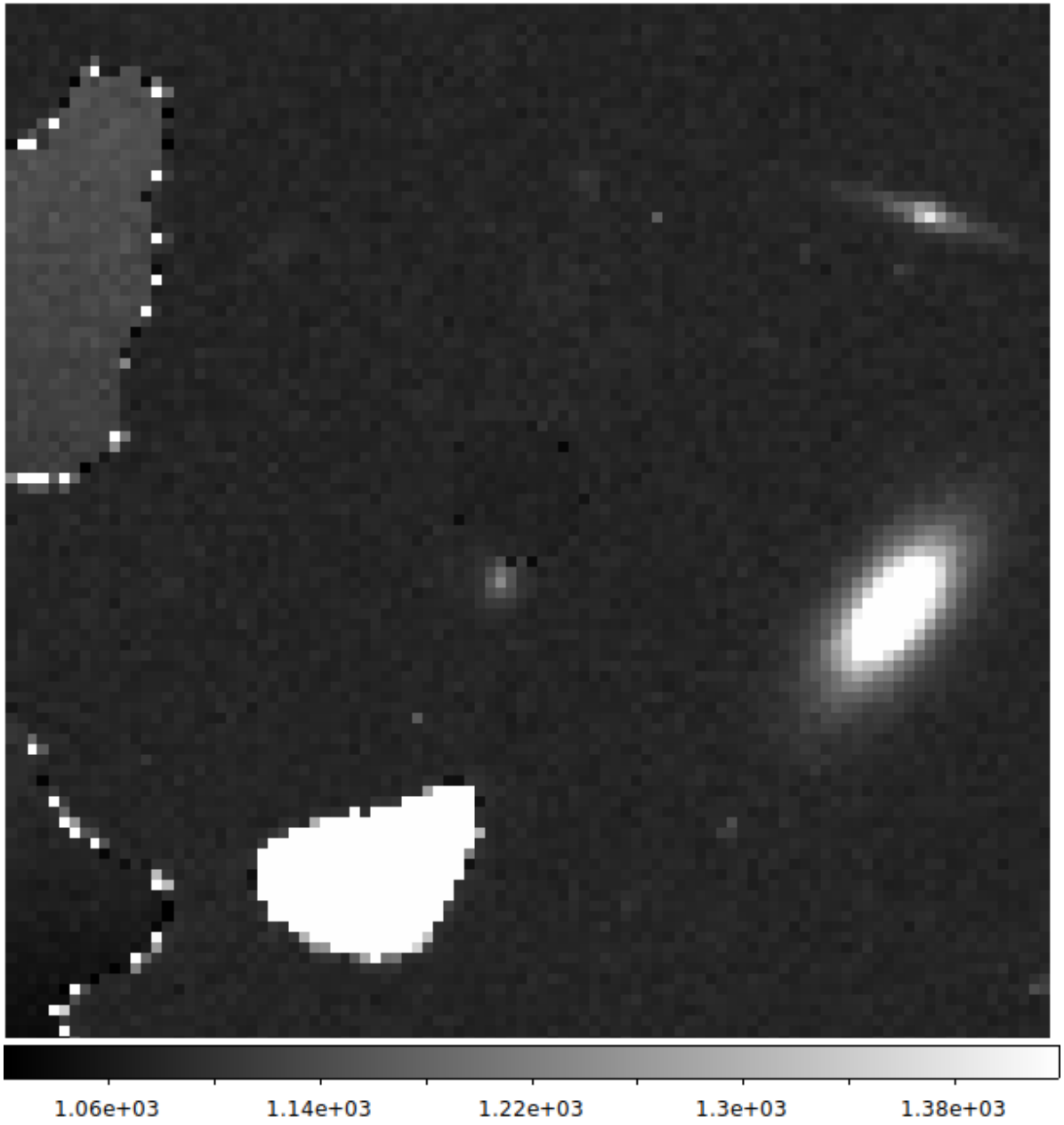
detector effects

- noiseless pixel image
  100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map



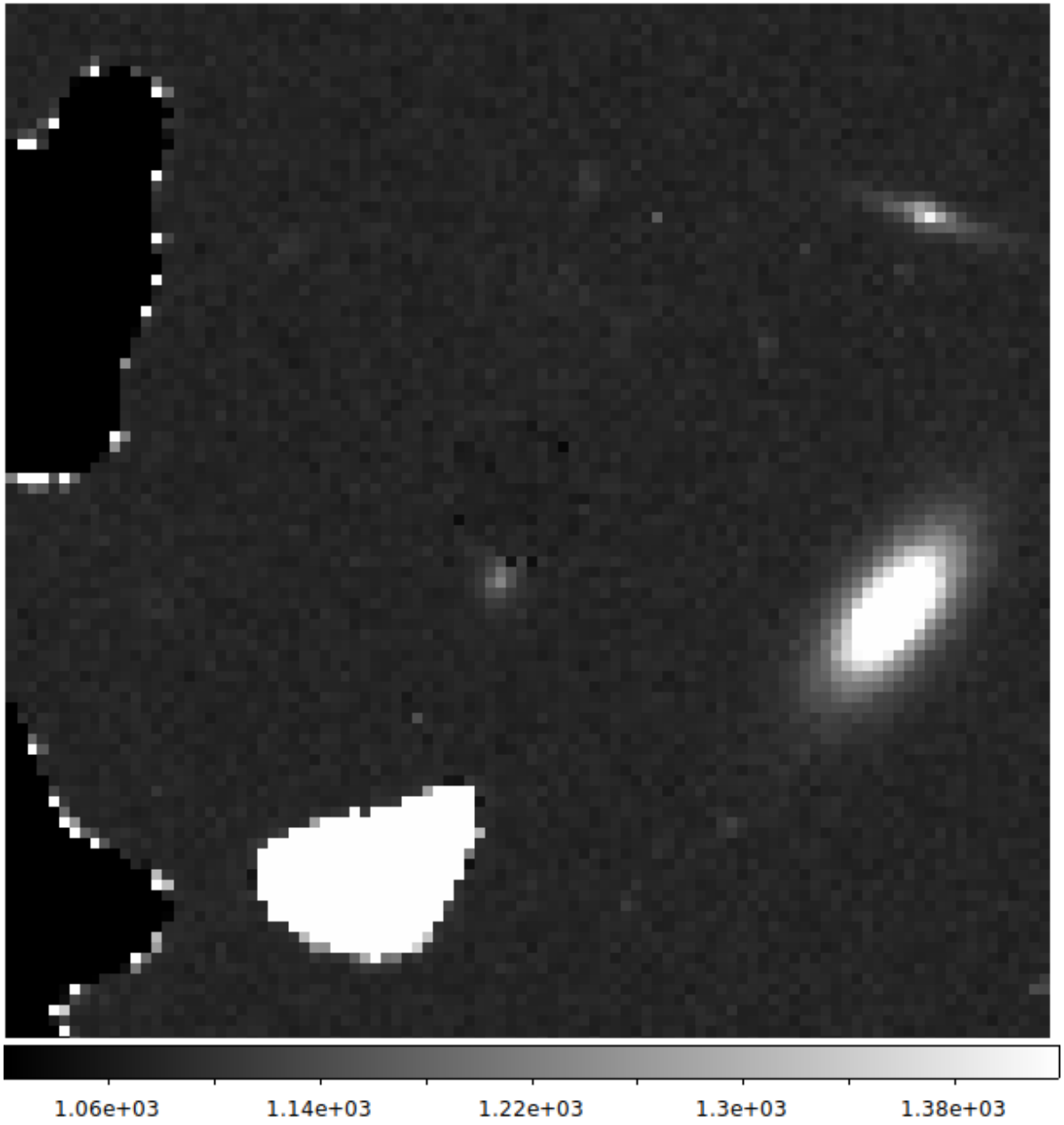
detector effects

- noiseless pixel image 100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map
- dark current map



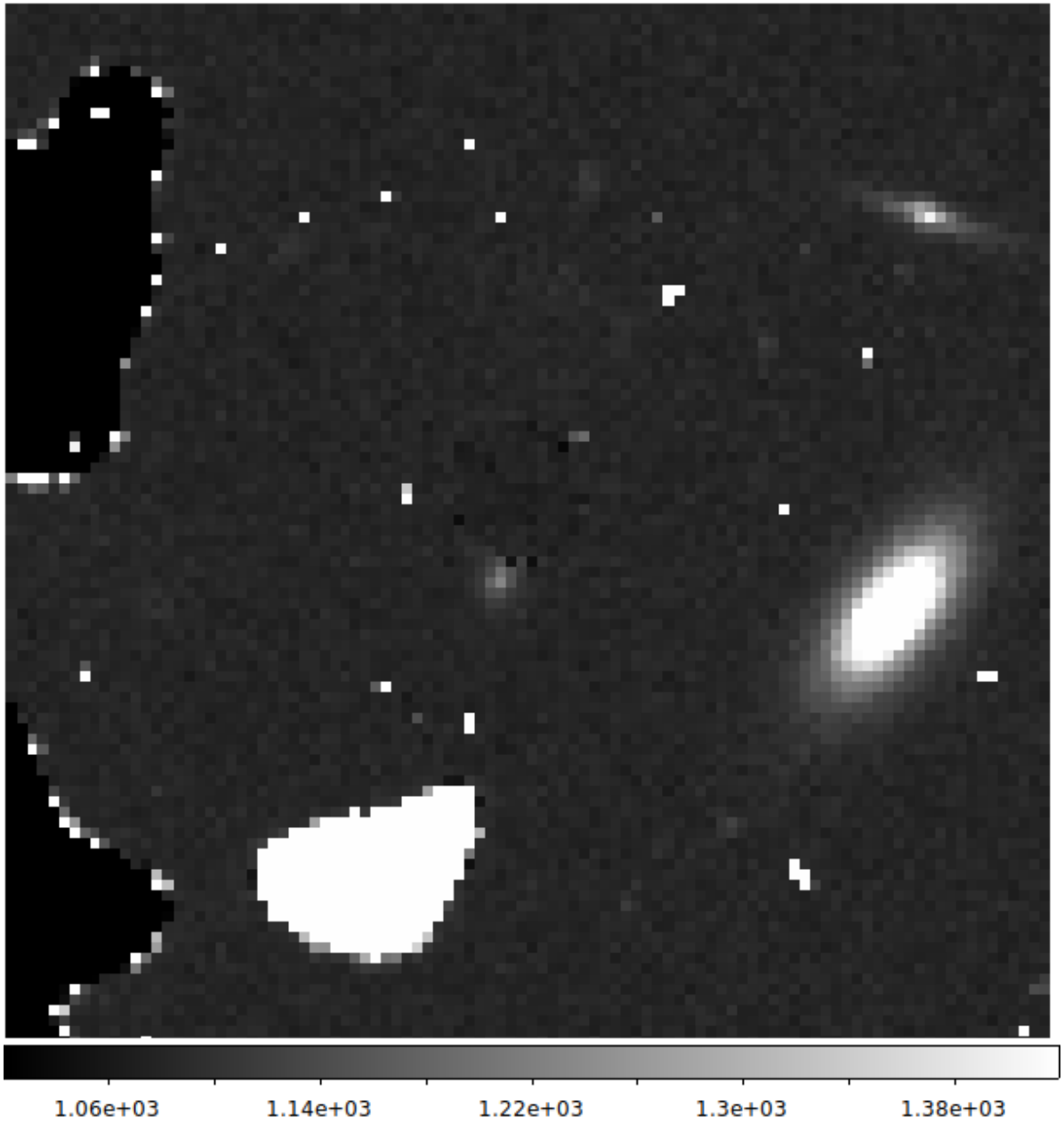
detector effects

- noiseless pixel image 100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map
- dark current map
- readout noise map



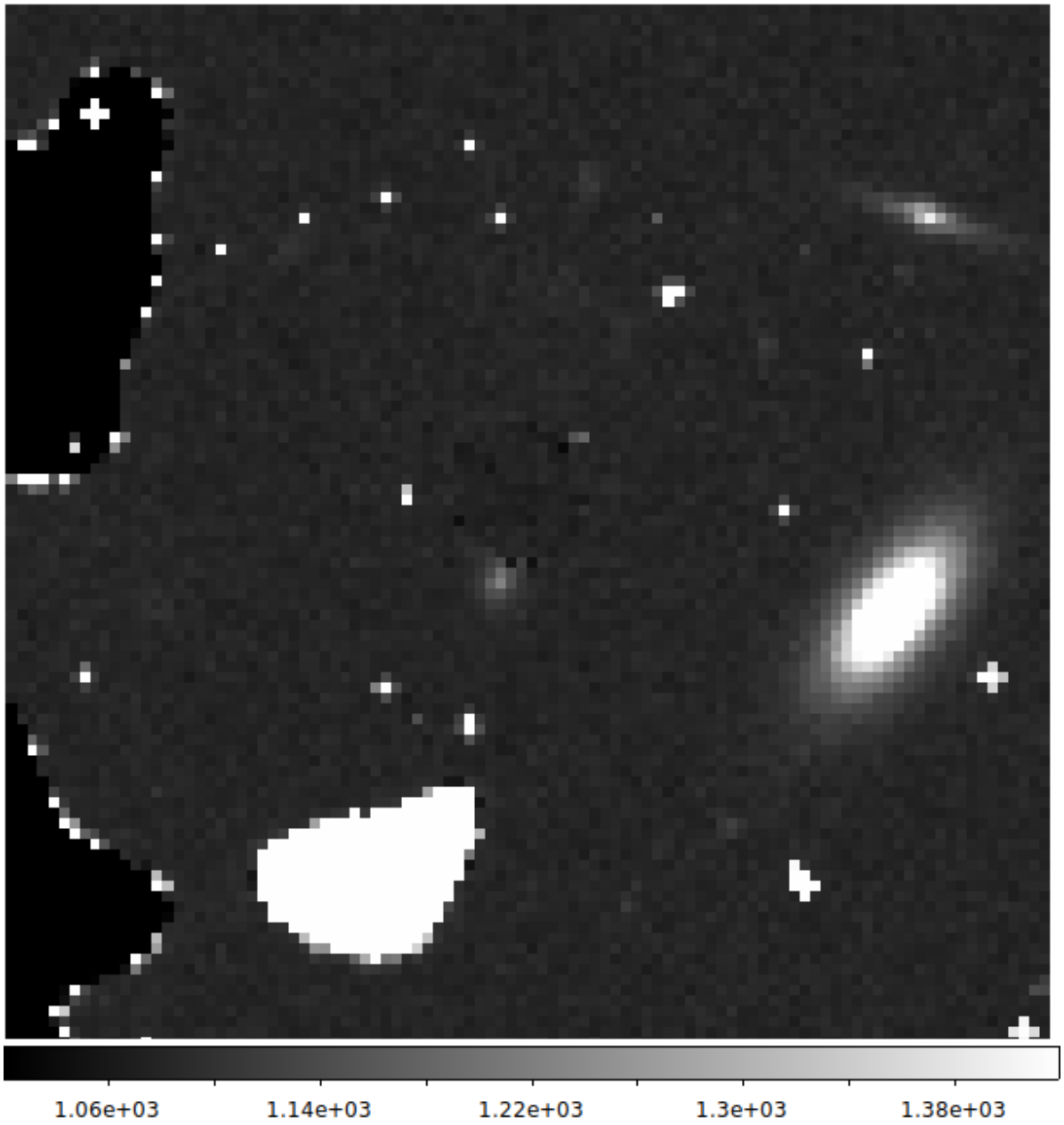
detector effects

- noiseless pixel image
  100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map
- dark current map
- readout noise map
- cosmic rays



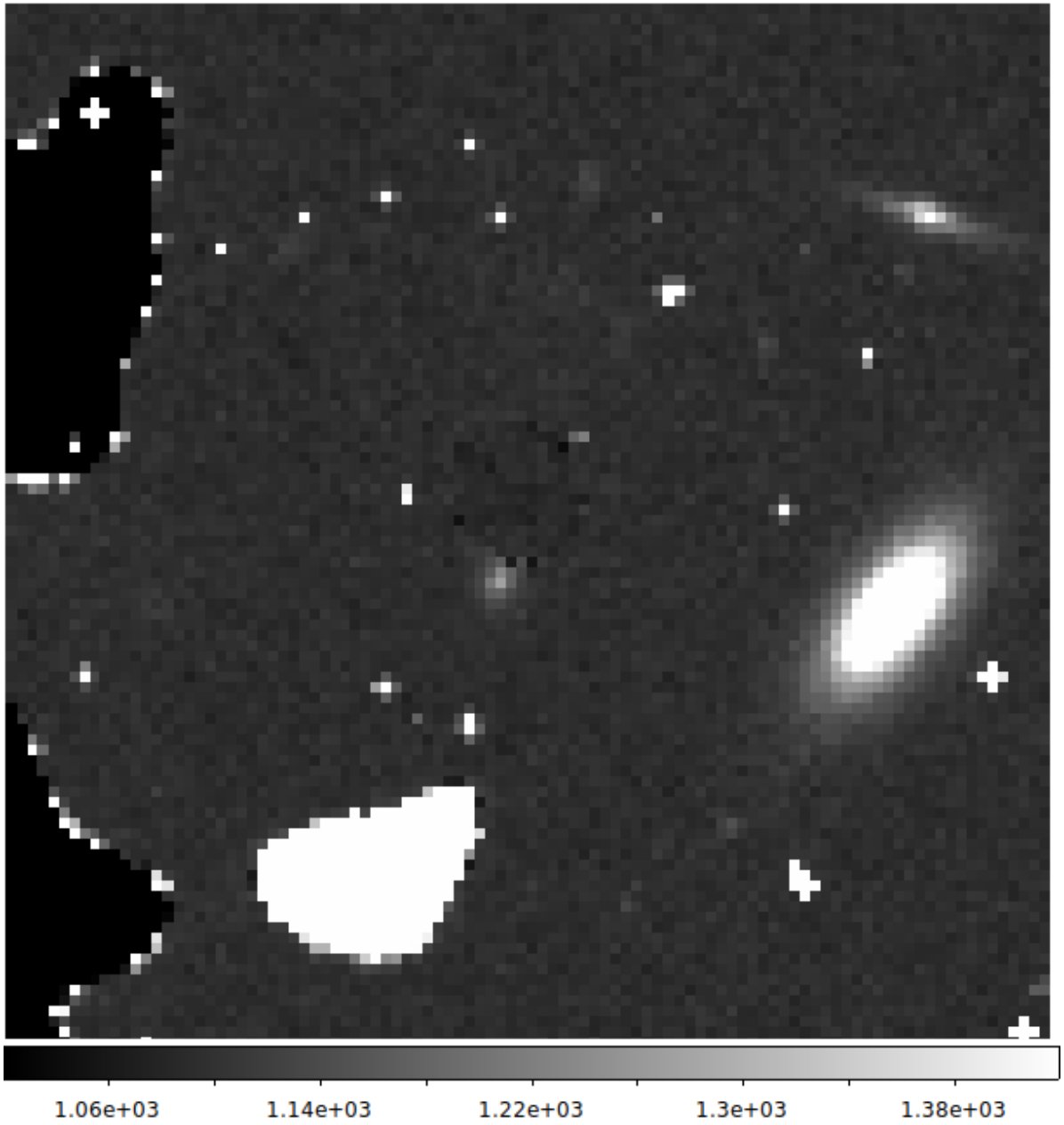
detector effects

- noiseless pixel image 100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map
- dark current map
- readout noise map
- cosmic rays
- interpixel capacitance



detector effects

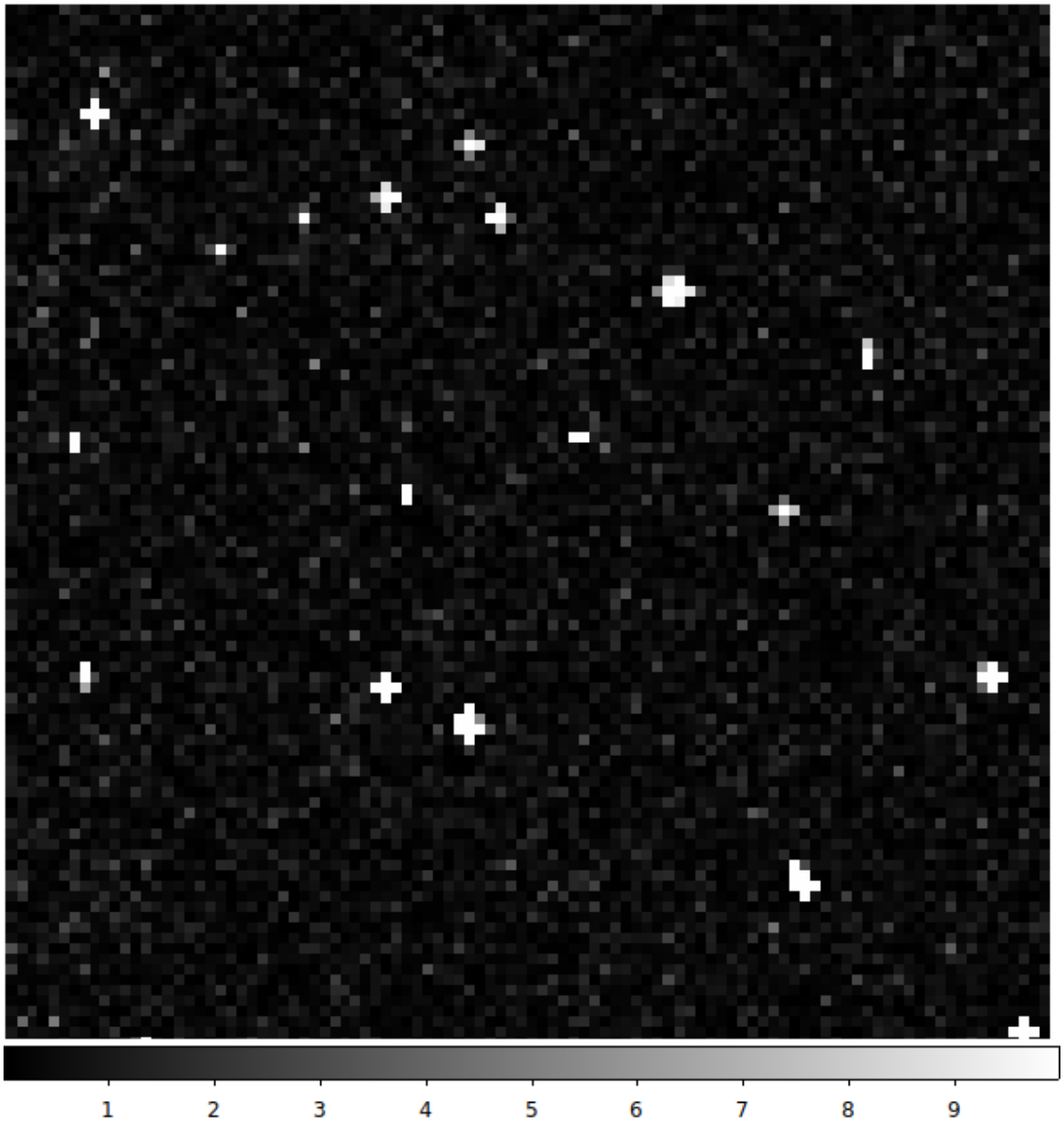
- noiseless pixel image 100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map
- dark current map
- readout noise map
- cosmic rays
- interpixel capacitance
- non-linearity



MACC readout: quality image

- noiseless pixel image
  100 x 100 pix^2
- Poisson / shot-noise
- background flux
- quantum efficiency map
- dark current map
- readout noise map
- cosmic rays
- interpixel capacitance
- non-linearity

- quality factor image



SC8 pipeline, excluding straylight