CCOB wide beam and narrow beam: status and update

Céline Combet, LSST-France, 4 Feb 2020

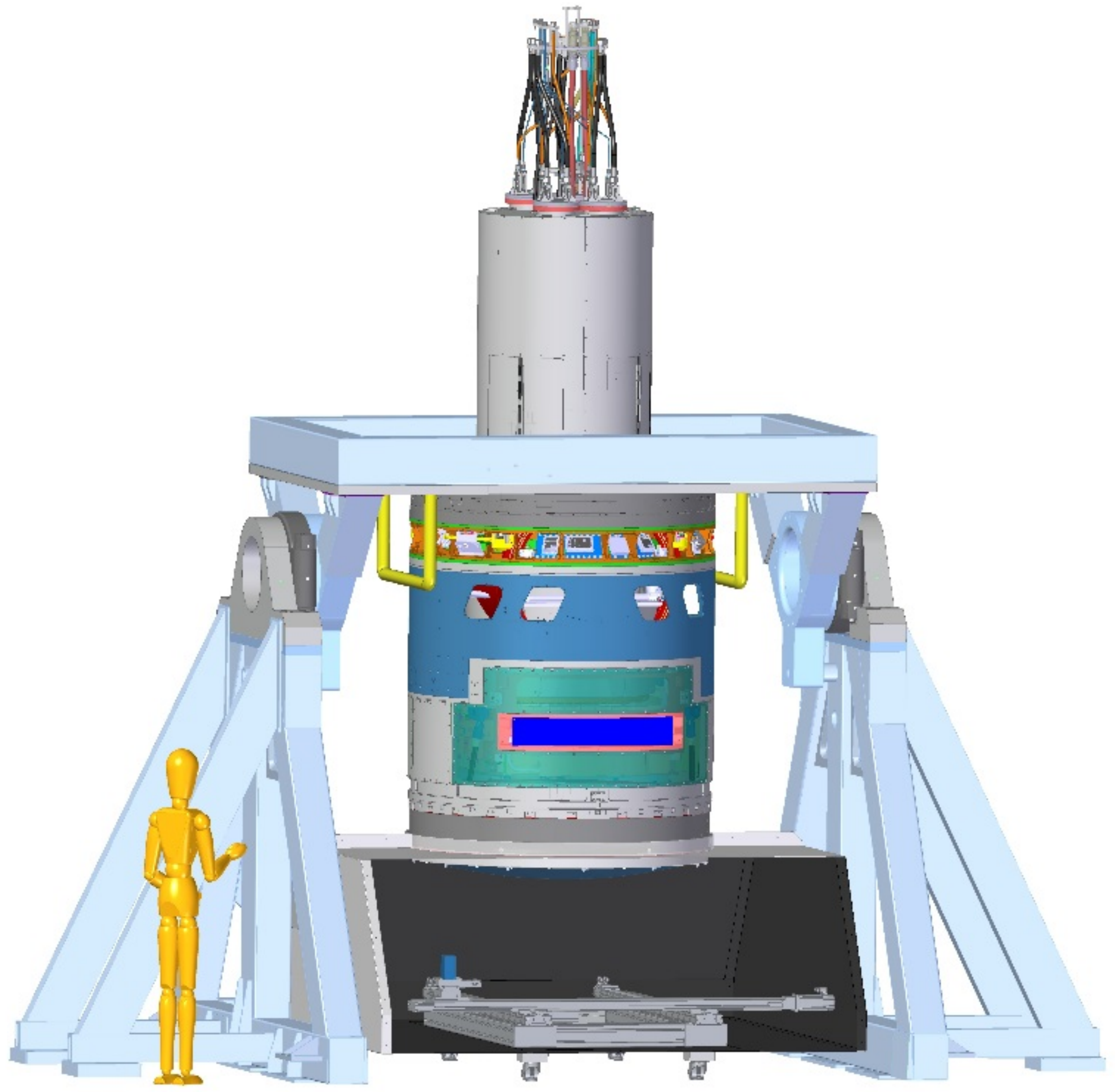
CCOB-NB

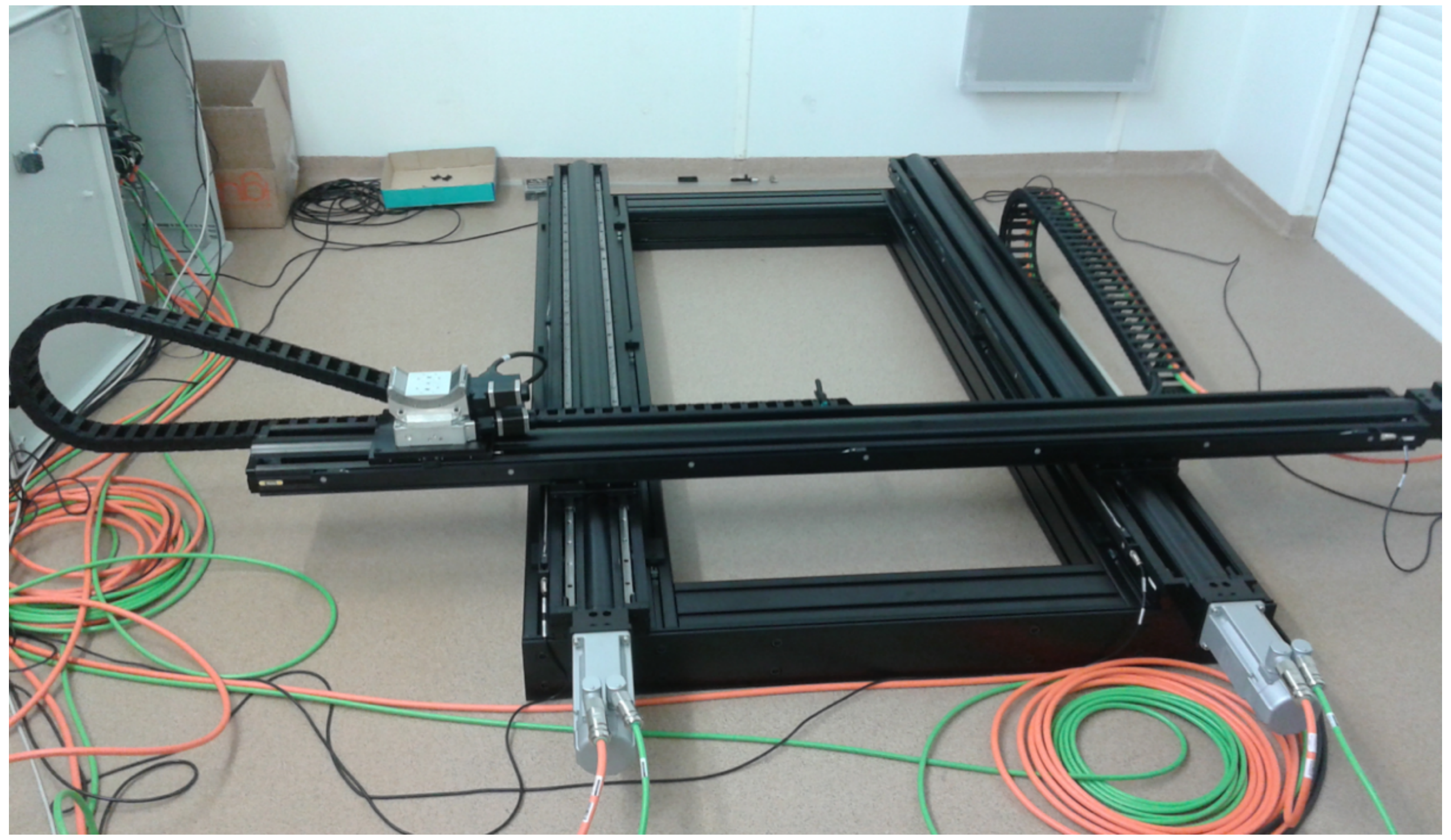
A. Barrau, J. Bregeon, M. Migliore, G. Dargaud

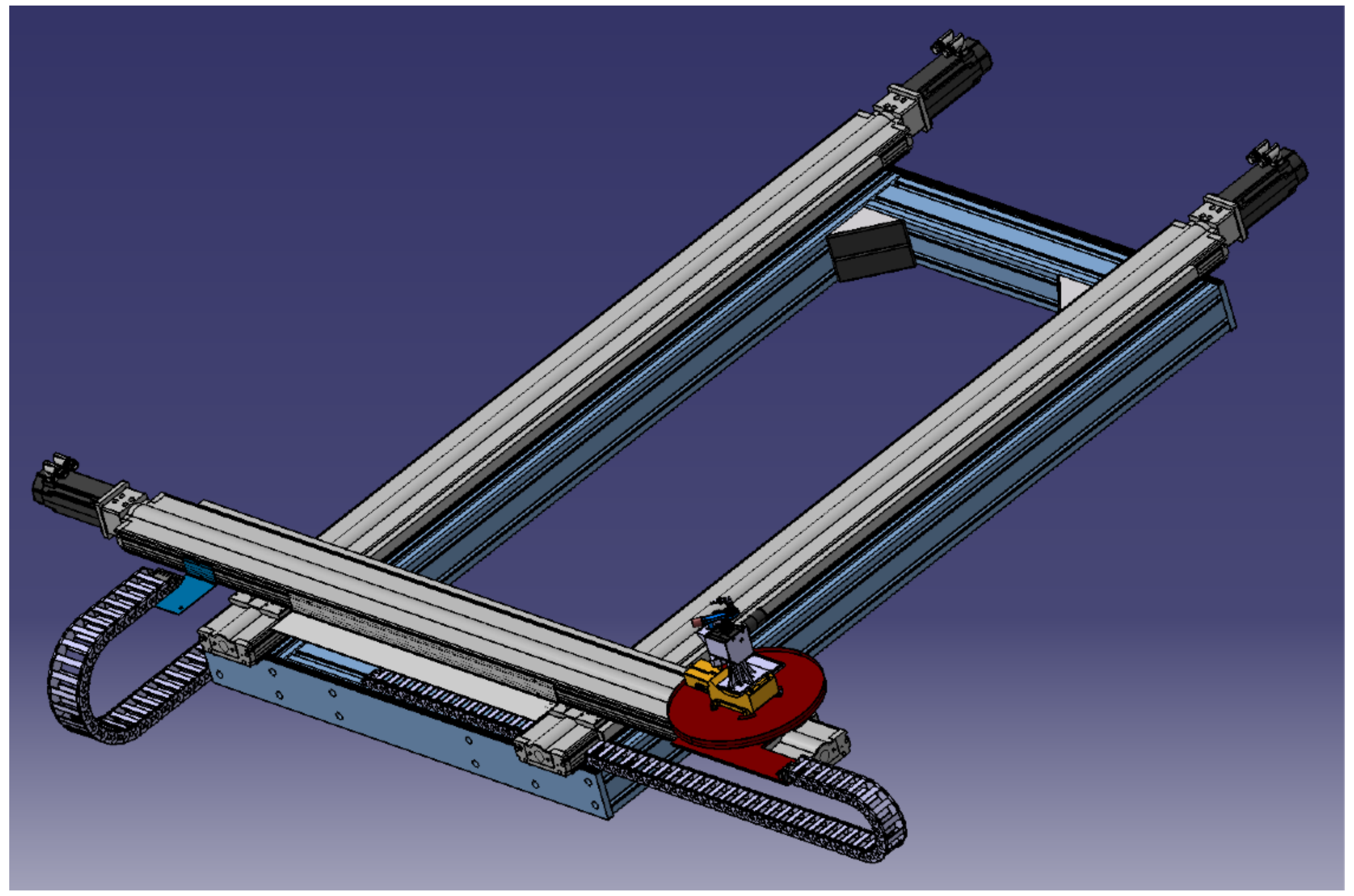
CCOB-NB: Commissioning of the integrated camera

- Illumination of the focal plane from a variety of incident angles in the 6 spectral band of LSST
  - → Check optics alignment/tilt from analysis of the ghost images
- 2mm-wide monochromatic beam ($\Delta\lambda < 1$ nm)
- Delivery to SLAC: Spring 2020

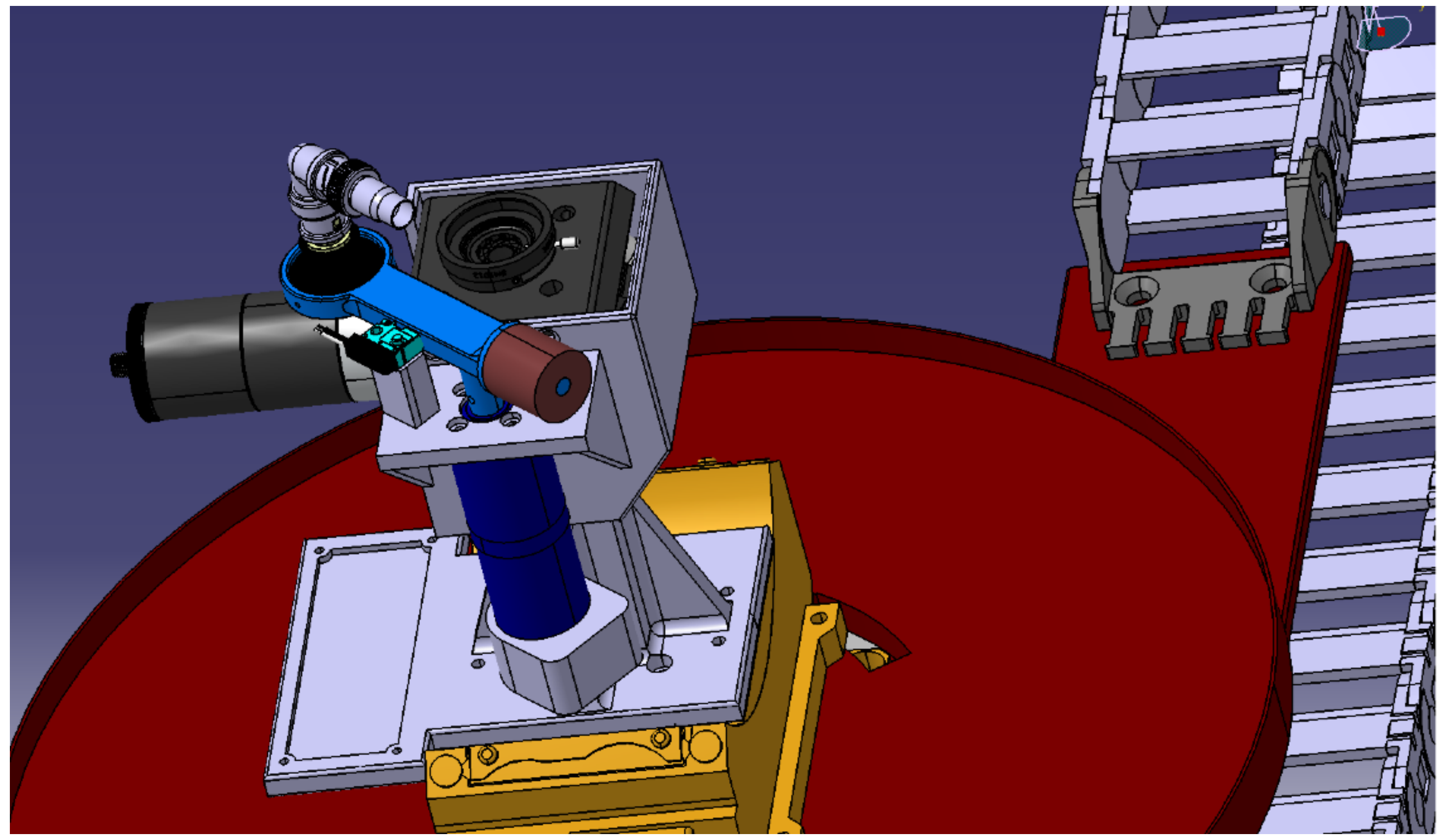
Design and status of the stand







- Black painted Elcom™ mechanical support done
- Igus® cable guides being installed and optimised
  - ⋆ plate support for rotative cable
  - ⋆ matt black coating of brackets
  - ⋆ footprint : 3000*3100 mm
- 5 tables installed (= goniometer, rotative + 3 linear tables)
  - ⋆ control command software ready



Design and status of the source

At the last meeting, conclusions about the Idil source were:

1. All elements of source have been delivered by the vendor (lamp, monochromator, fibers)
2. Fiber support has been printed
3. All elements to characterise the source have been delivered (spectrometer, beam profiler)
4. Characterisation of the beam →will determine final 'configuration' (fiber diameter + power)

Tests (N. Andres, M2) → Idil source solution does not fulfill the requirements

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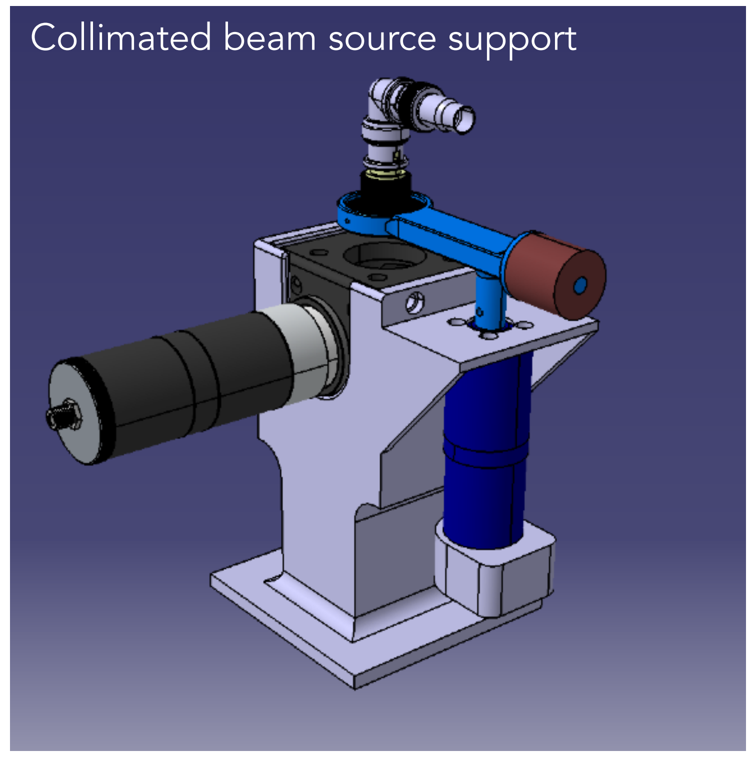
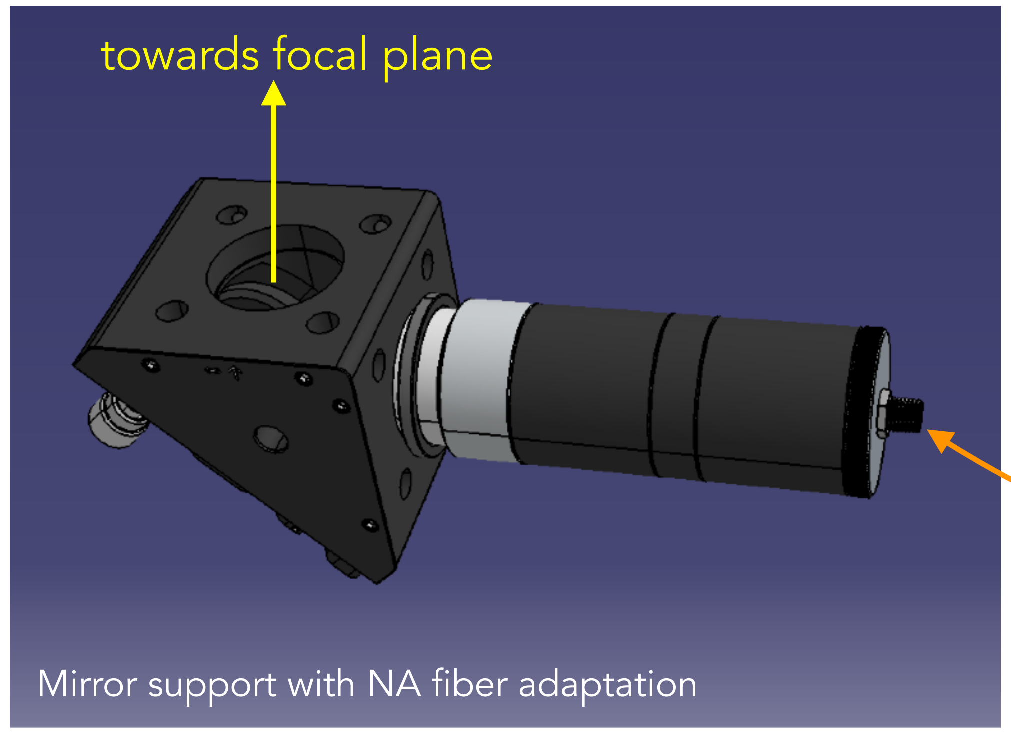
Tests (N. Andres, M2) → Idil source solution does not fulfill the requirements

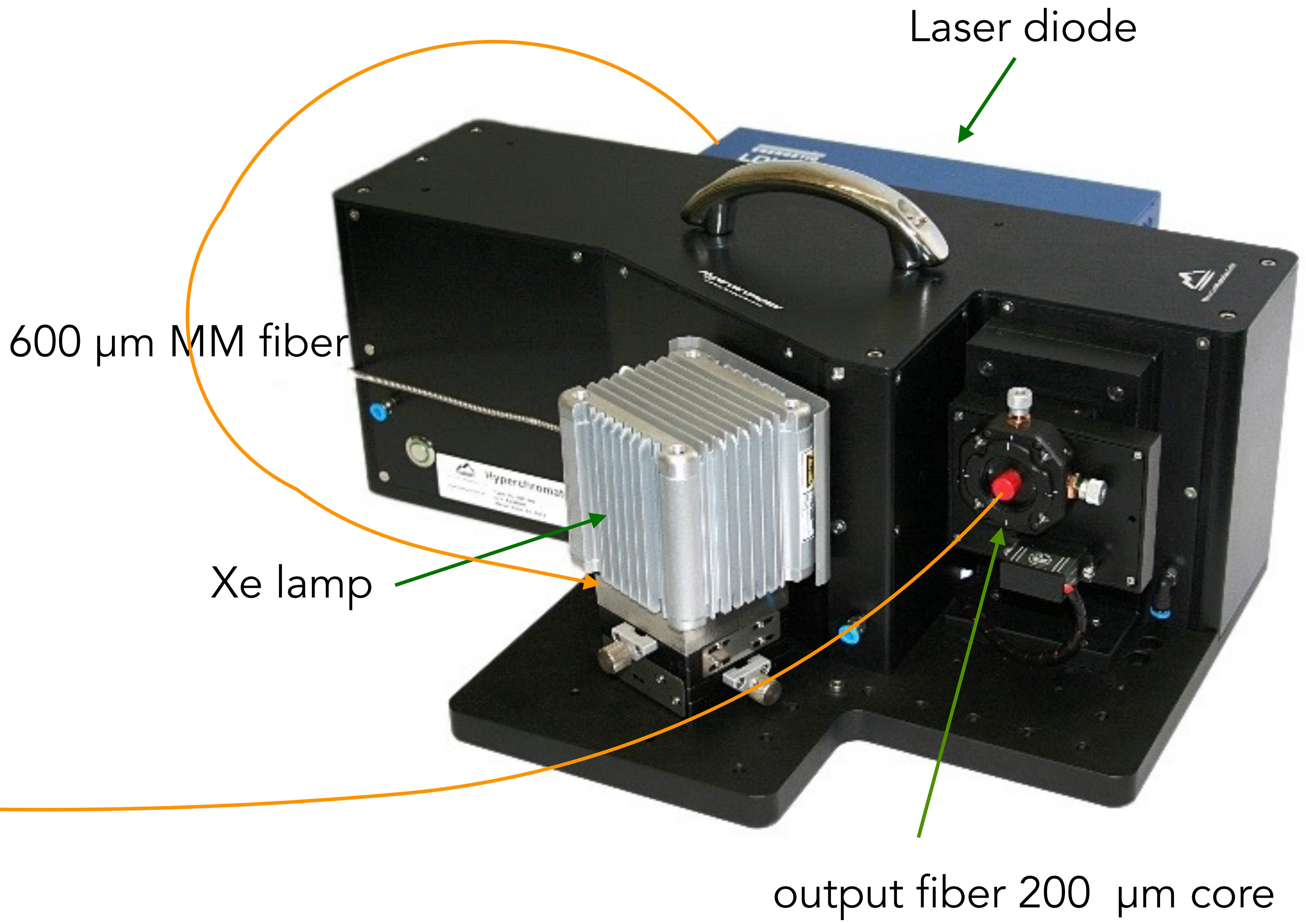
Since then, new compact solution from Mountain Photonics

1. Xe source pulsed by LASER diode coupled to monochromator
2. multimode 200μm output fiber
3. optical collimated solution with off-axis parabolic mirror
4. high reliable fast exposure shutter



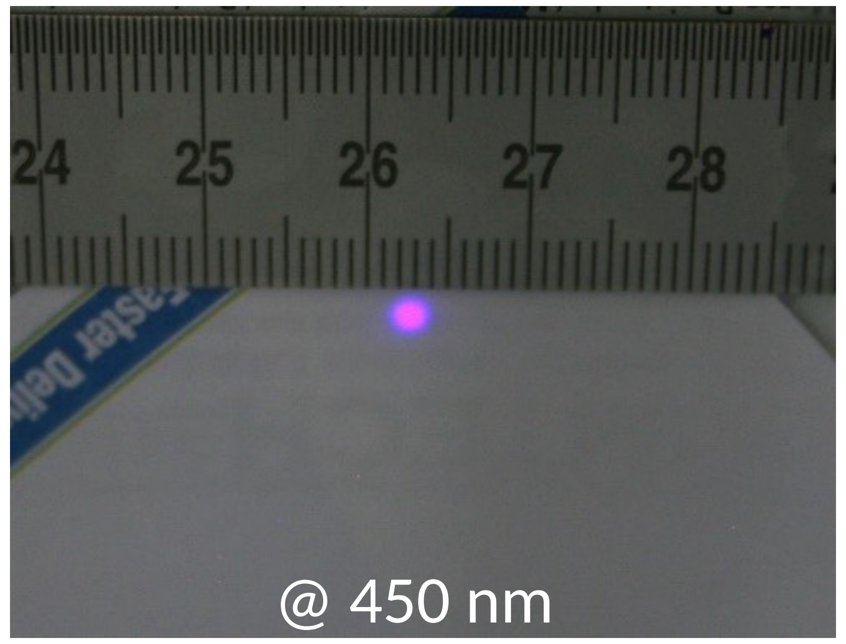
Support ready in ~3 weeks



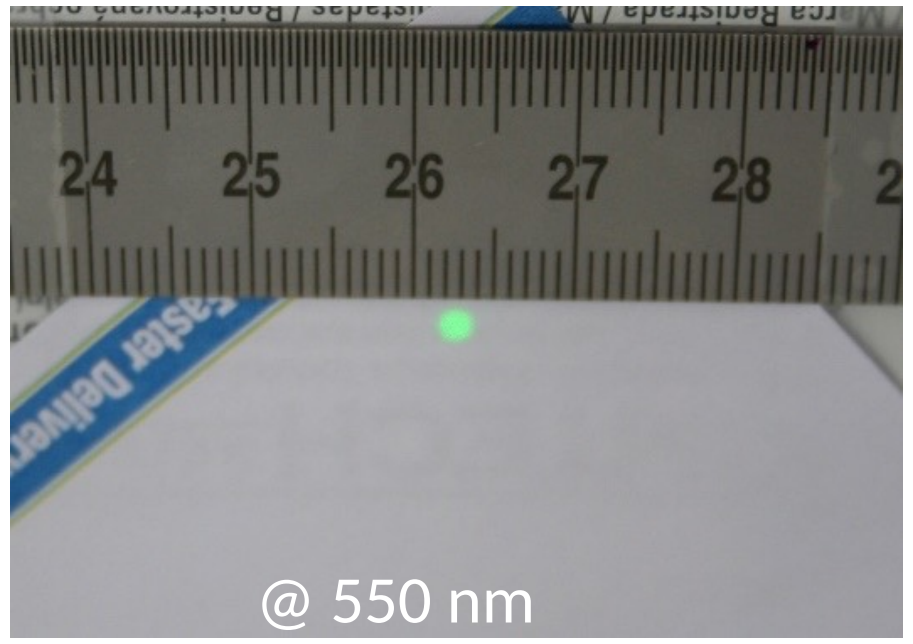


Good performances of the new source

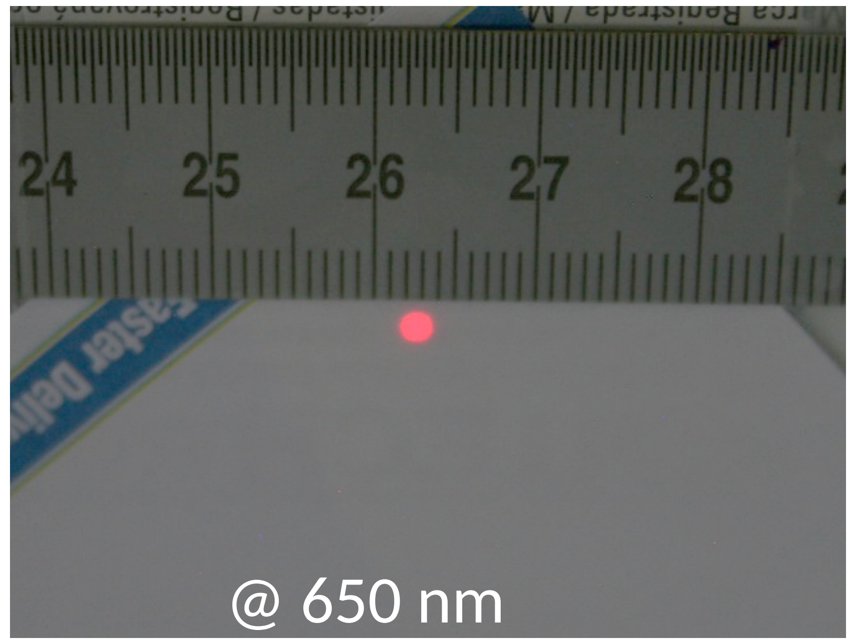
- Monochromatic source
- 2 mm wide circular beam at 1.2 m distance, on the full frequency range



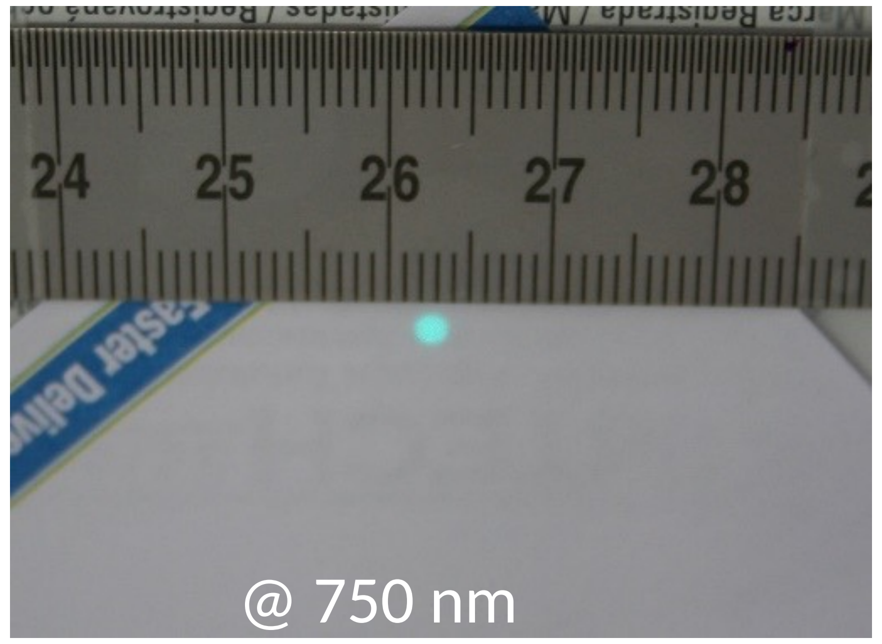
@ 450 nm



@ 550 nm



@ 650 nm



@ 750 nm

- High stability : 0,25% for 10s integration time during 1h
- Power @ 1nm fwhm

Wavelength (nm)	Power (nW)	Required power (nW)
415	34	23 @ 415 nm
600	20	4 @ 300 nm
900	10	8 @ 1000 nm

← OK, but not too much margin in the IR

Analysis, ghost simulation tool (J. Bregeon)

Goal: Simulate images on the FP for various displacements and rotations of the camera optics (lenses, filters), including multiple reflections (ghosts). Construct the corresponding ghost model (analytical, numerical, or machine learning approach - TBD)

Tool: Batoid ray tracing code

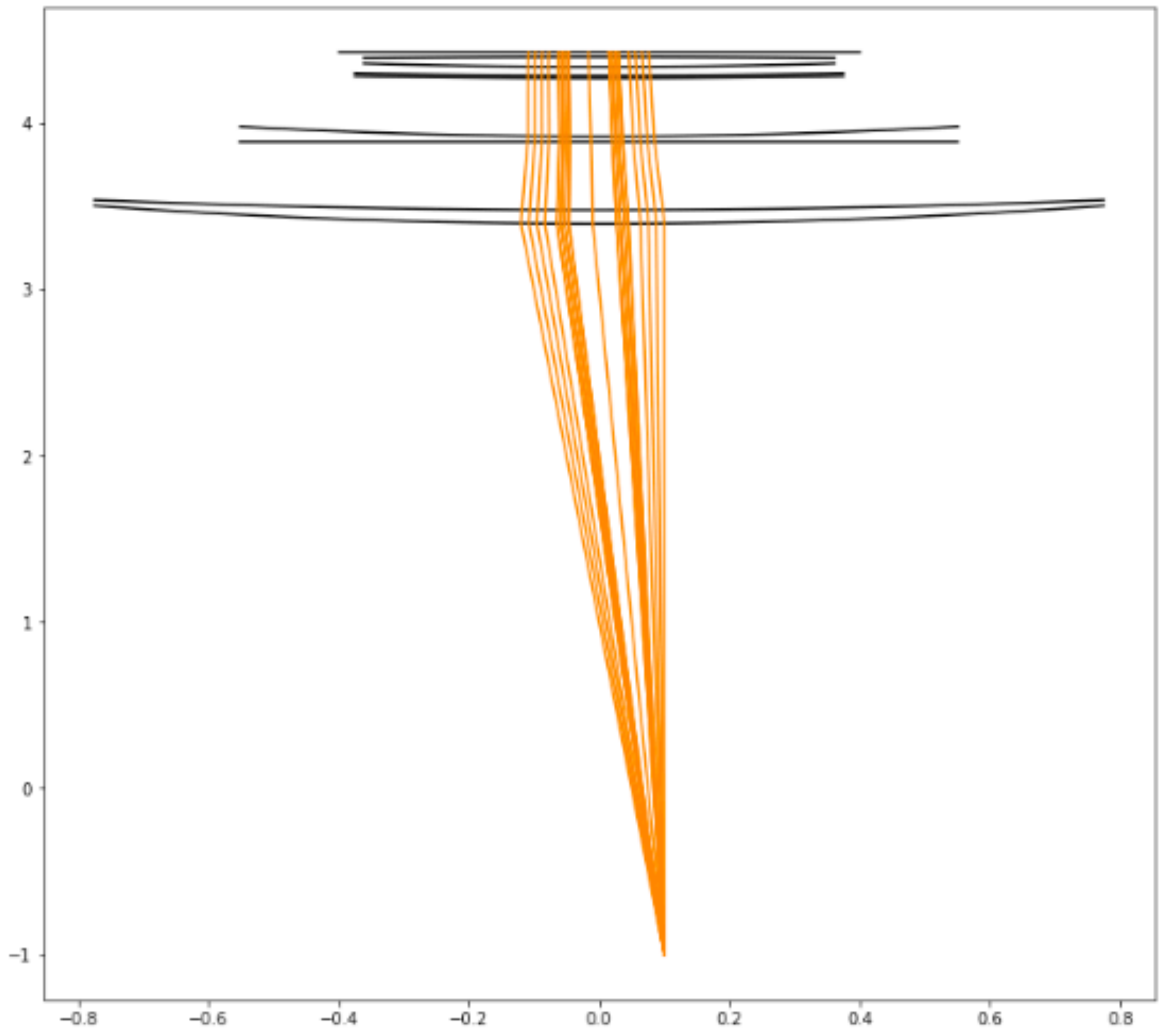
LSST trace lenses

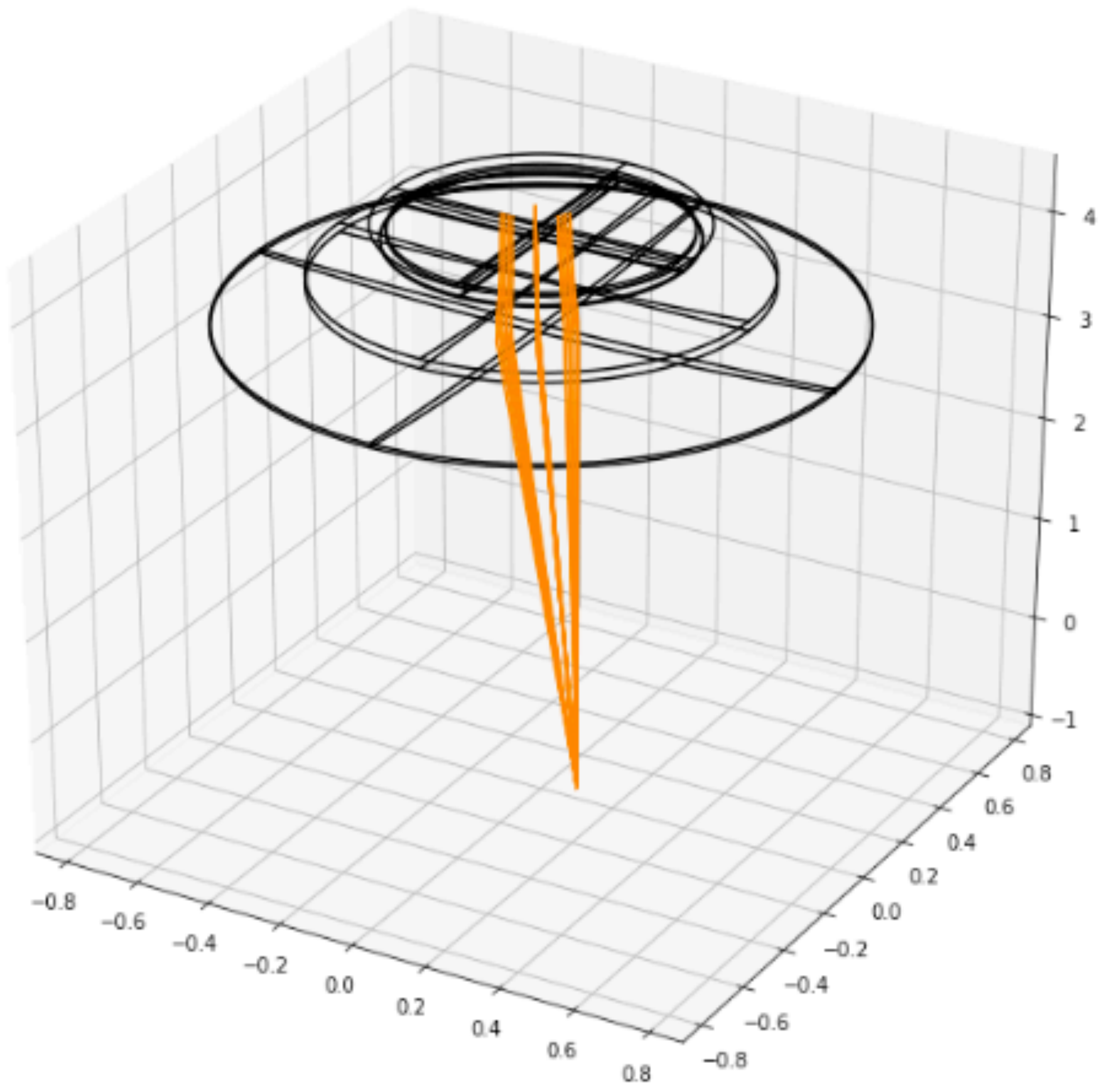
J. Bregeon

January 21, 2020

```
[1]: import batoid
     from copy import copy
     from batoid.utils import normalized
     import numpy as np
     from ipywidgets import interact
     import ipywidgets as widgets
     import matplotlib.pyplot as plt
     from mpl_toolkits.mplot3d import Axes3D
     %matplotlib inline
     batoid.datadir = '/home/bregeon/LSST/CCOB/batoid/batoid/data'
```

```
[2]: fiducial_telescope = batoid.Optic.fromYaml("LSST_CCOB_r.yaml")
```





Ongoing work…

CCOB-WB - analysis update

Céline Combet

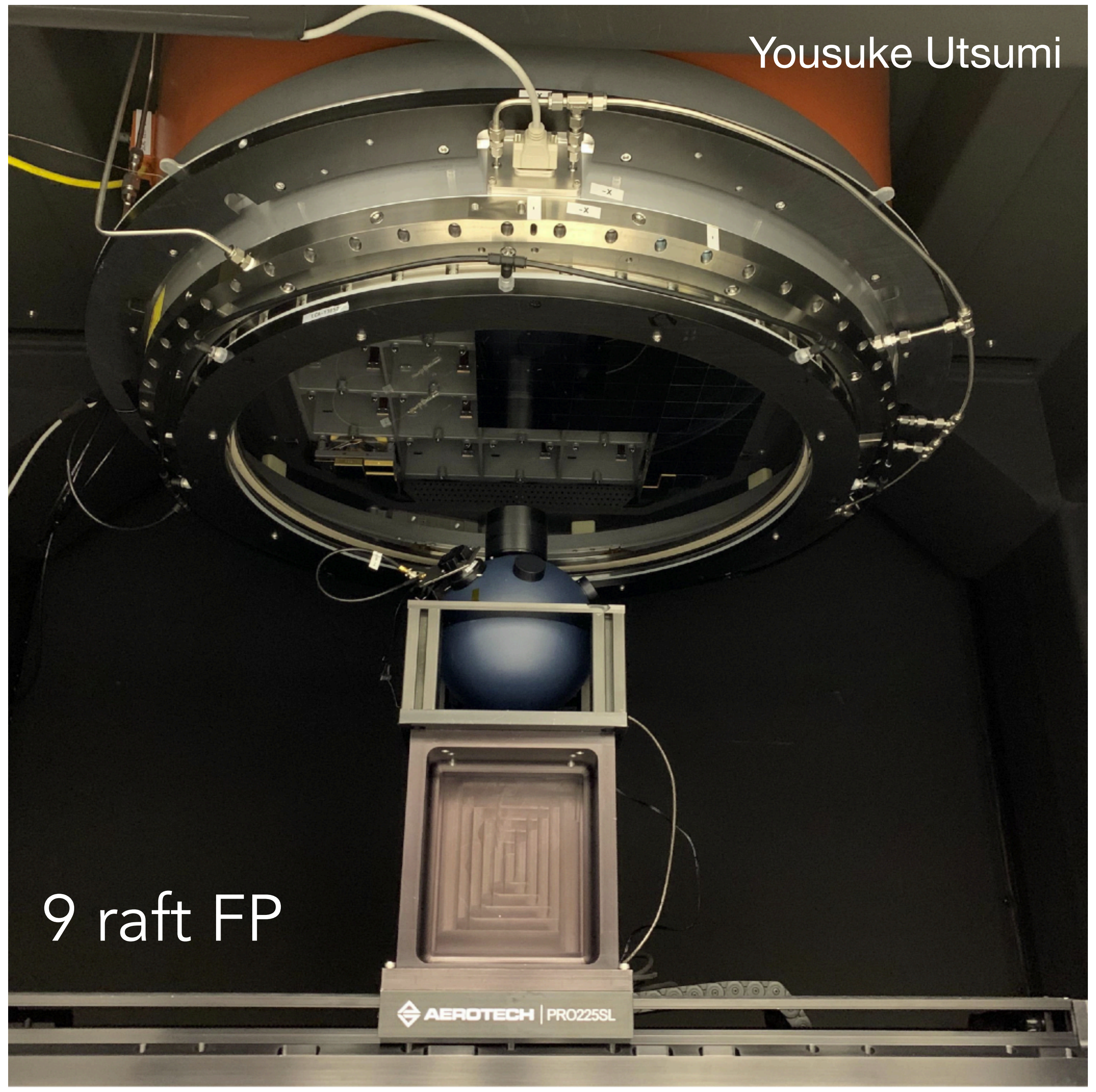
CCOB-WB: Commissioning of the raw focal plane

Goal: Composite flat field of focal plan; relative QE measurement at the 0.2% level in each band

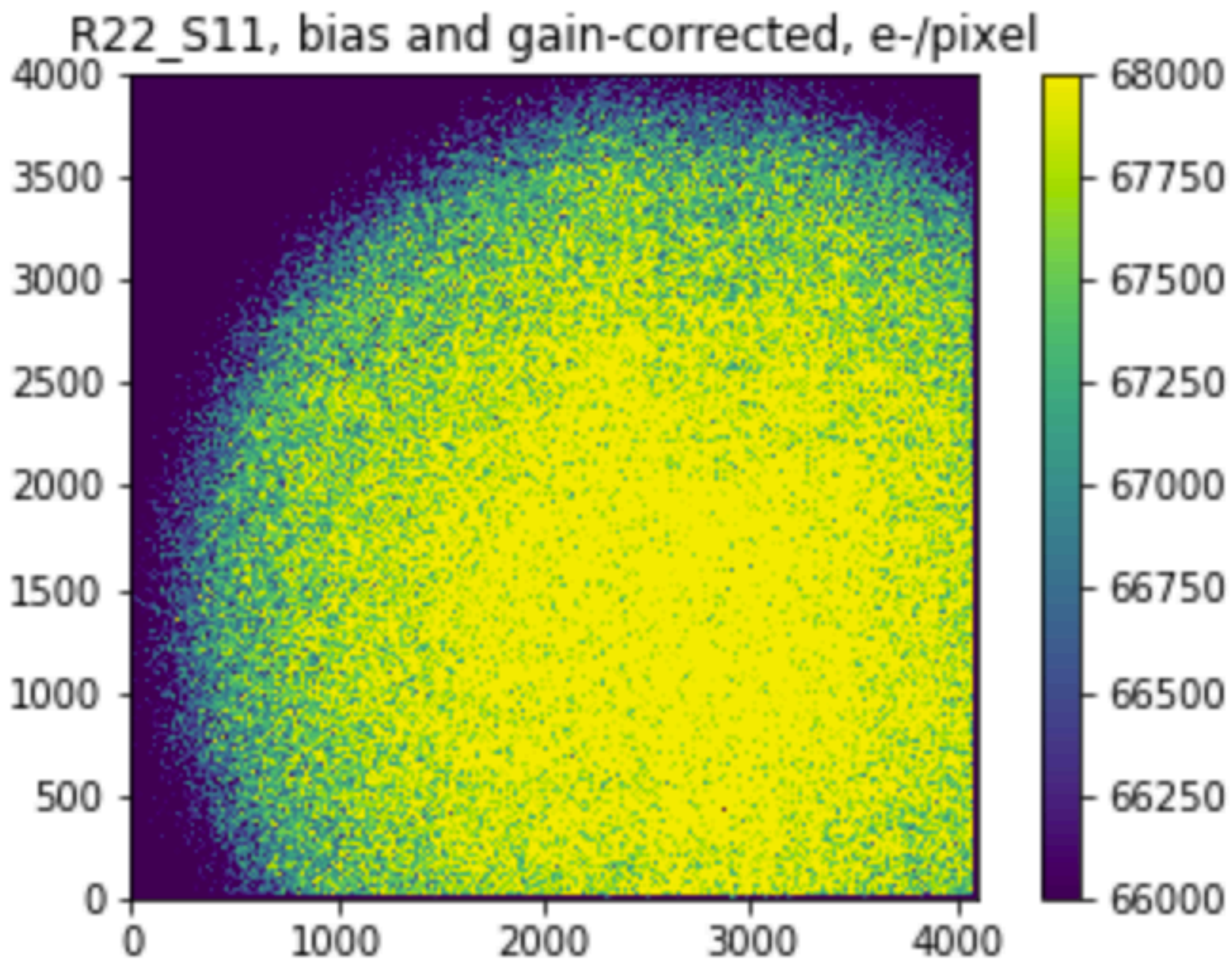
Procedure:

- Reconstruct the beam by scanning in front of a set of reference pixels → beam model
- Take images in each sensor (5 pointings/sensor)
- Exposure/model → Flat

Run 3 - October 2019



Data taken by the SLAC team
(S. Digel, Y. Utsumi, et al.)



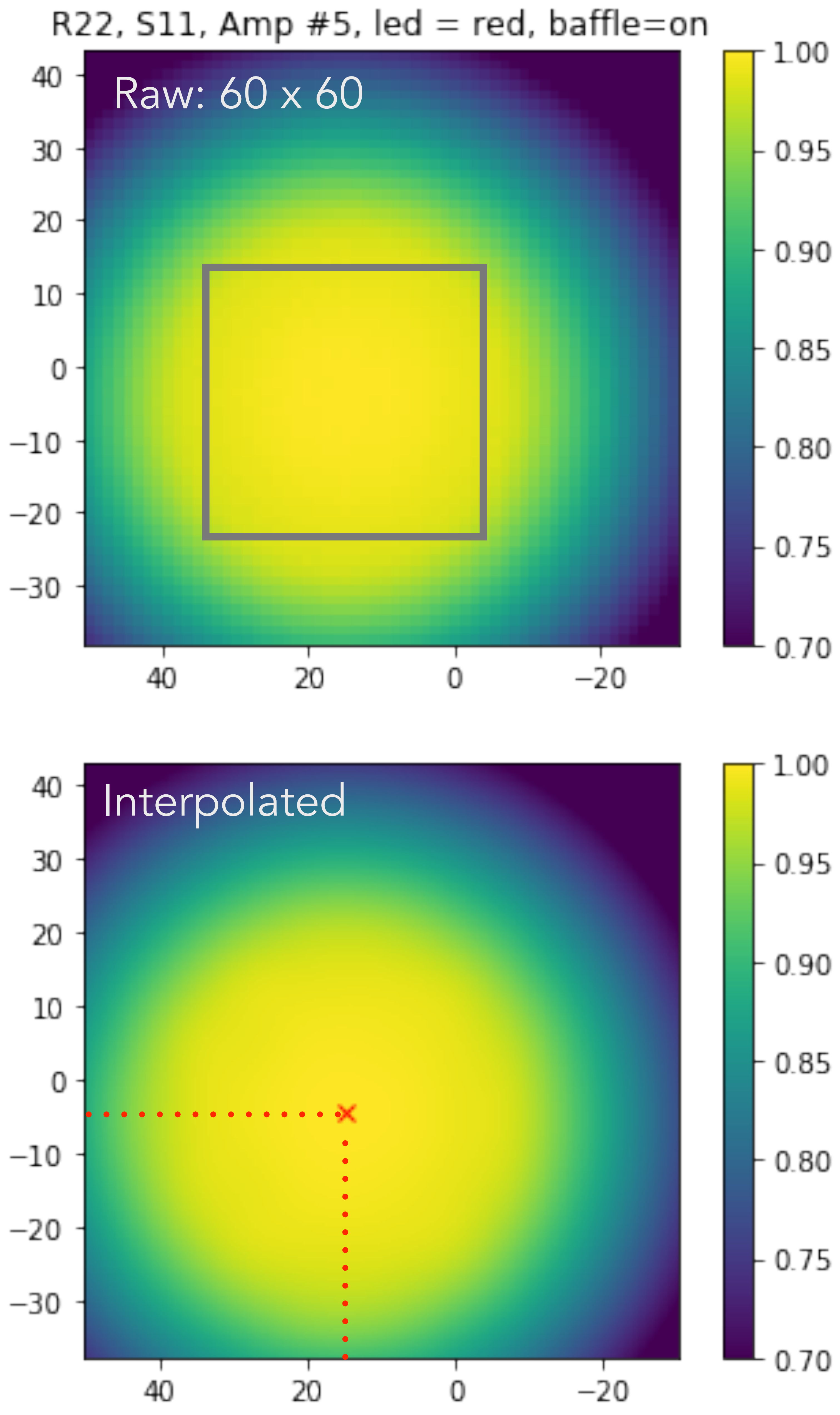
Since Run 1 & 2 (ETU testing)

1. Exposure time increase to account for the lowered position of the CCOB → Use ND filter in front of control PD to avoid saturation
2. Only save the REB in which the CCD under scrutiny is installed → reduce data volume by 27
3. No hardware solution found to mitigate the reflection on Fe55 ring

Final configuration defined from discussions with M.Migliore, A. Roodman

Beam reconstruction

- Ref pixels = 30 x 30 pixels in the center of Segment 14
- Scan size: 8cm x 8cm (low res or high res)
- 2D spline interpolation → beam model
- Find the coordinates of the beam maximum → compute the offset between CCOB location and beam maximum

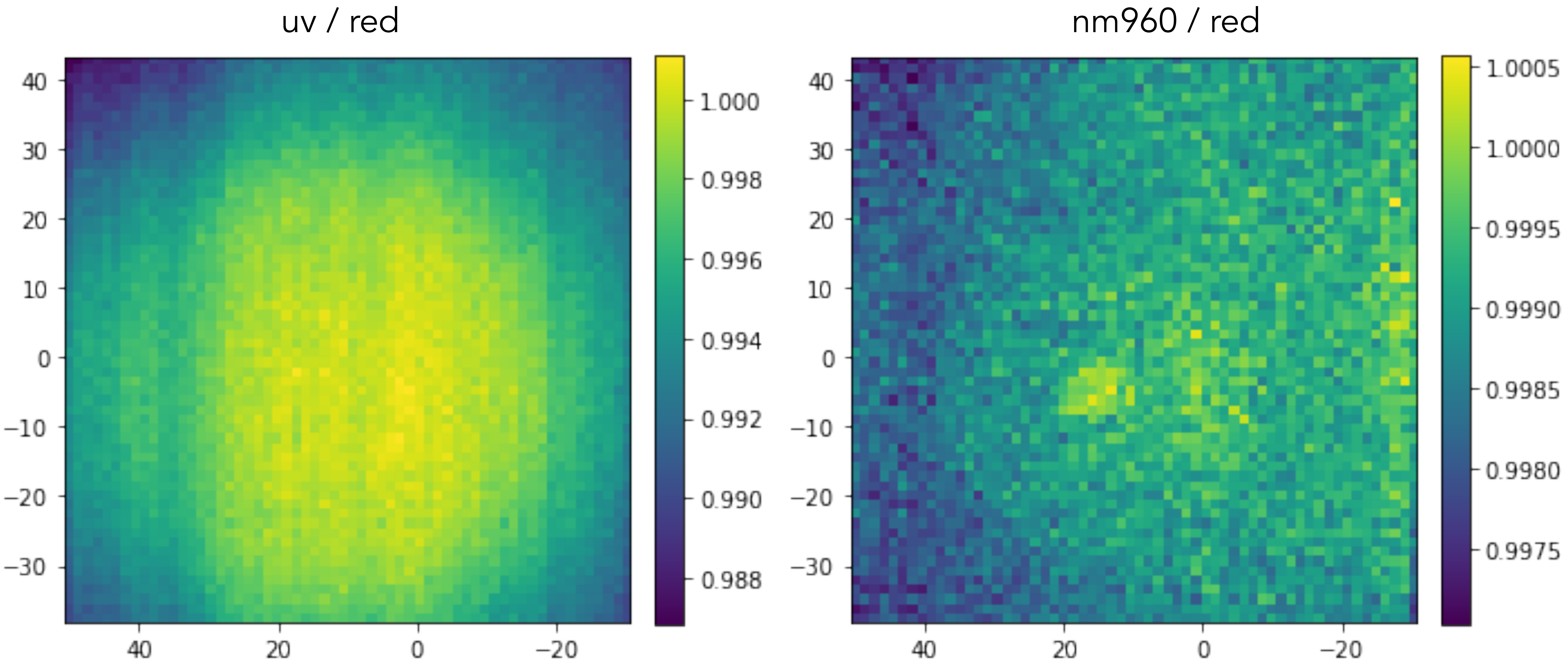


CCOB offsets:

delta_x = 7.1mm

delta_y = -4.9 mm

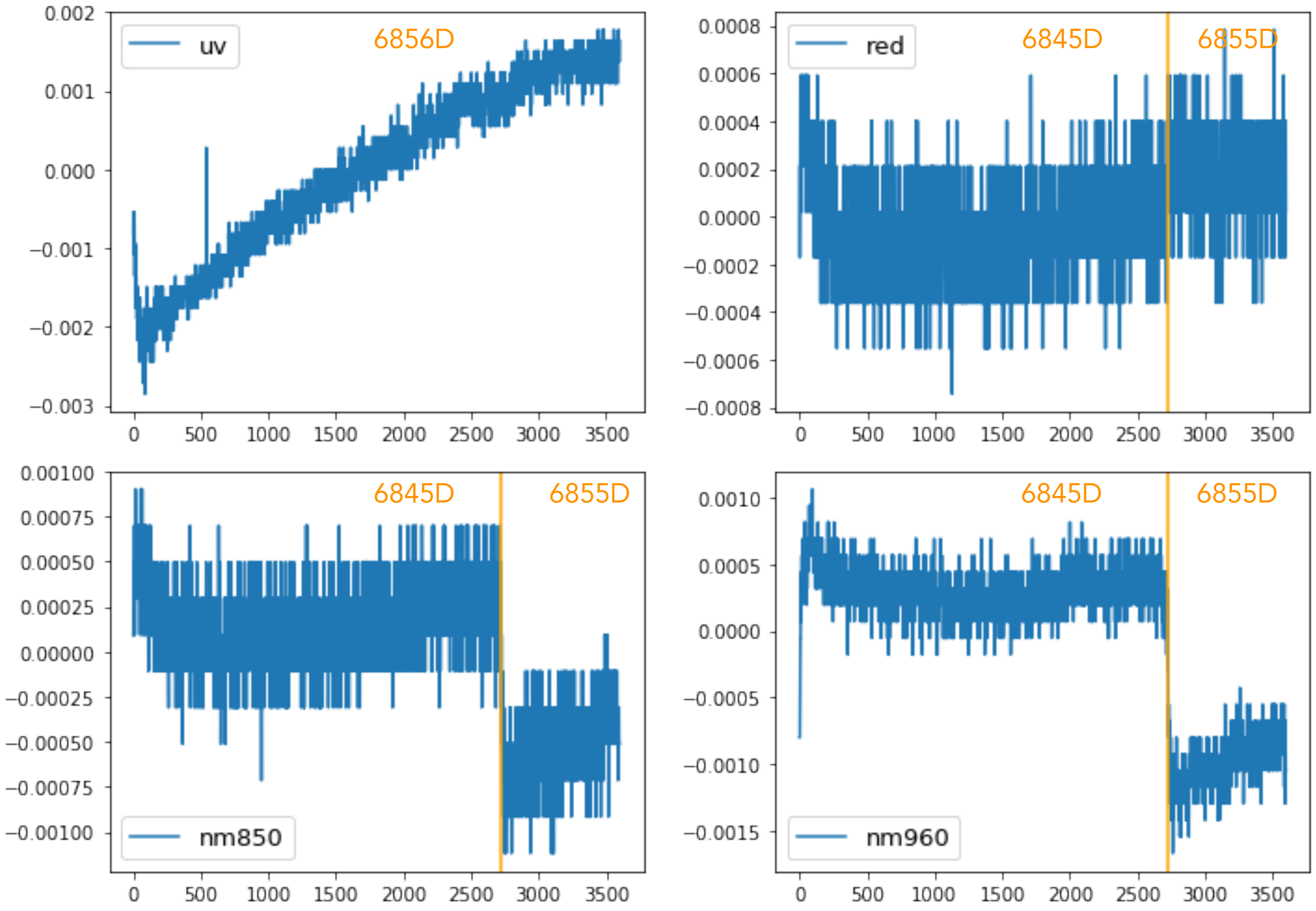
Beam shape with different LED - 60 x 60 scan



UV beam shape (in the wings) differ from the others LED at the 1% level - the UV LED is the central LED

Other LED beams much more similar, with variation ~0.1 - 0.3% level

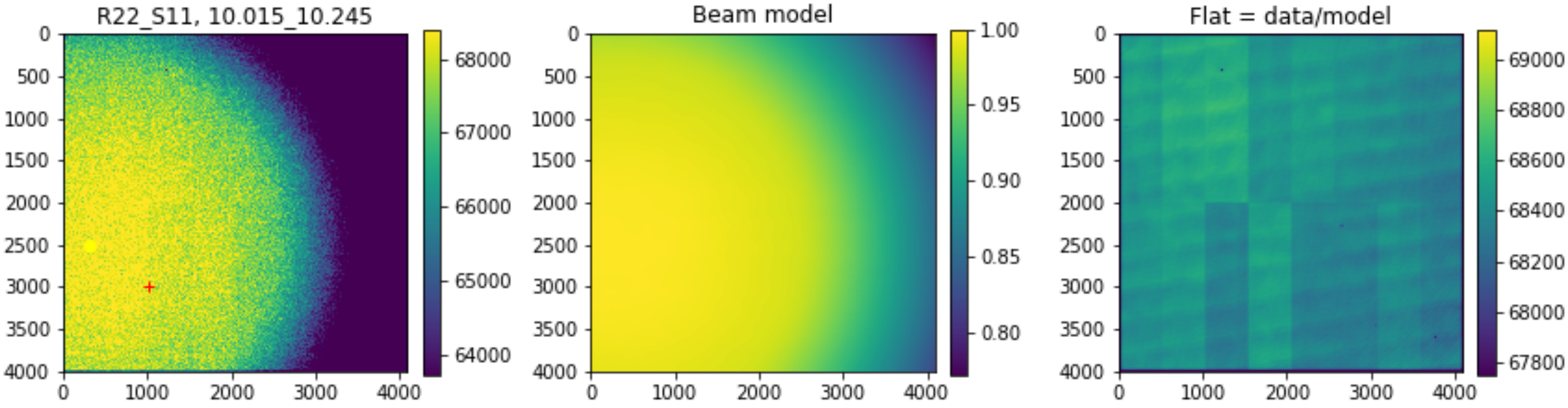
Photodiode reading



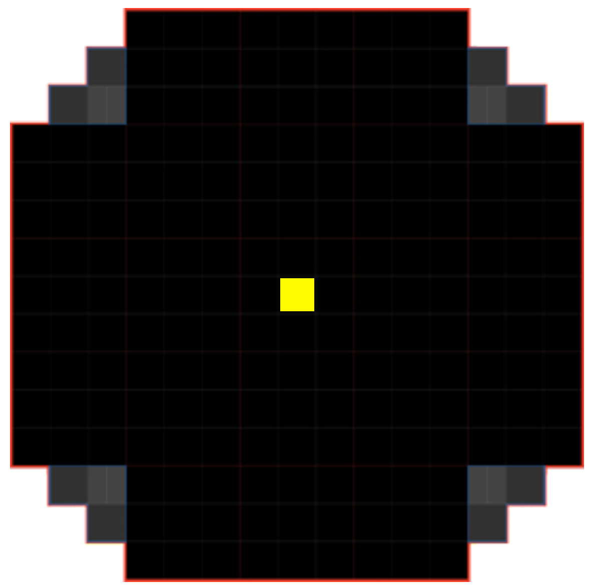
Relative difference to the mean over the 60 x 60 scan

- No saturation of the PD reading → good ND filter
- Variation < per mil level for red, 850nm and 960 nm LED
- Variation ~0.2% for the UV LED

Synthetic flat fields: R22_S11



- Red cross: pixel corresponding to the CCOB position
- Yellow circle: CCOB position + offsets computed from the beam model → beam maximum location
- Use the beam model to create a prediciton matching the data
- Flat = data / model



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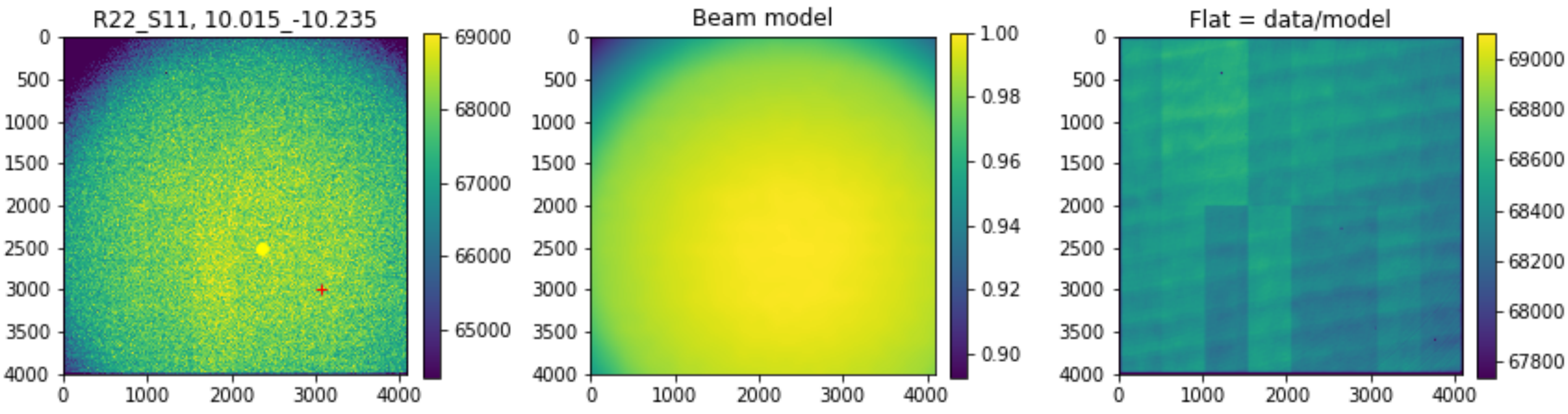

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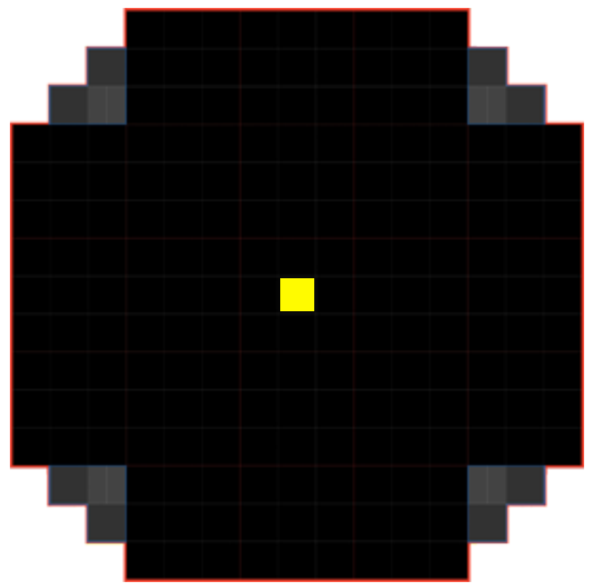

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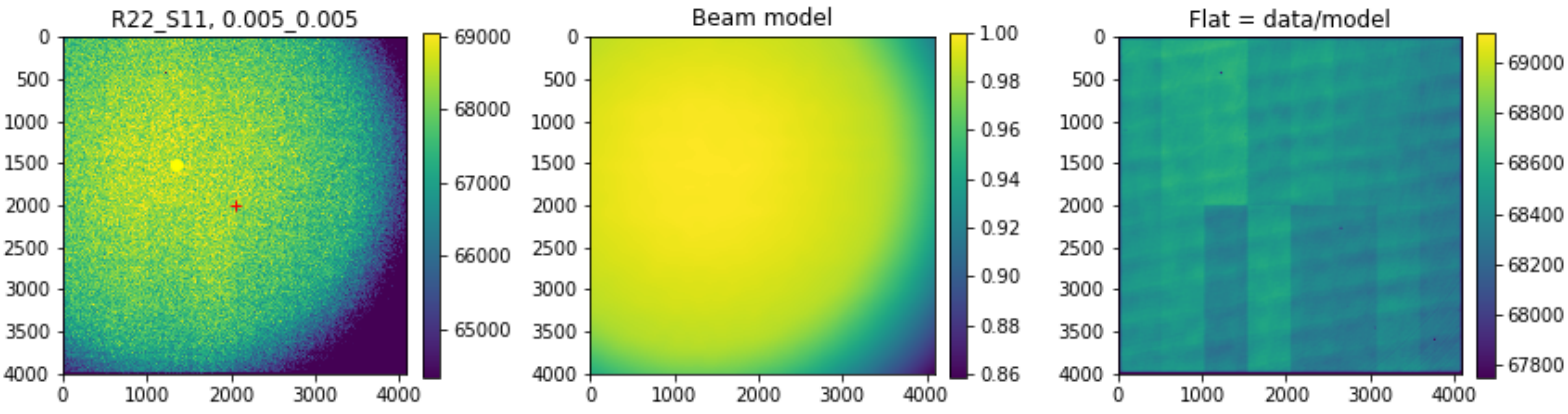

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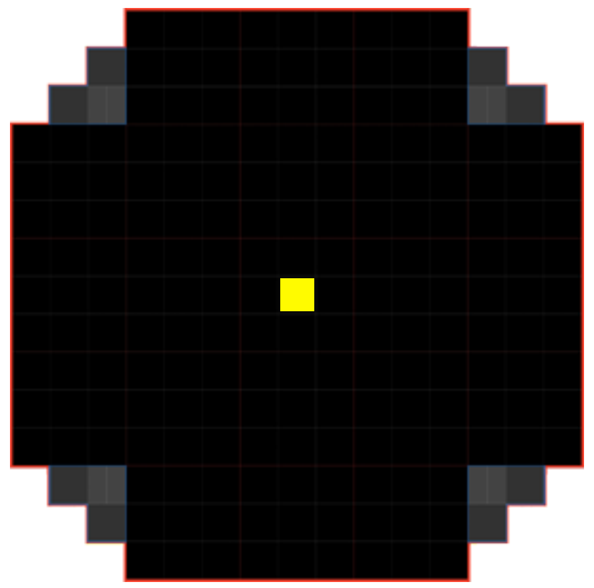

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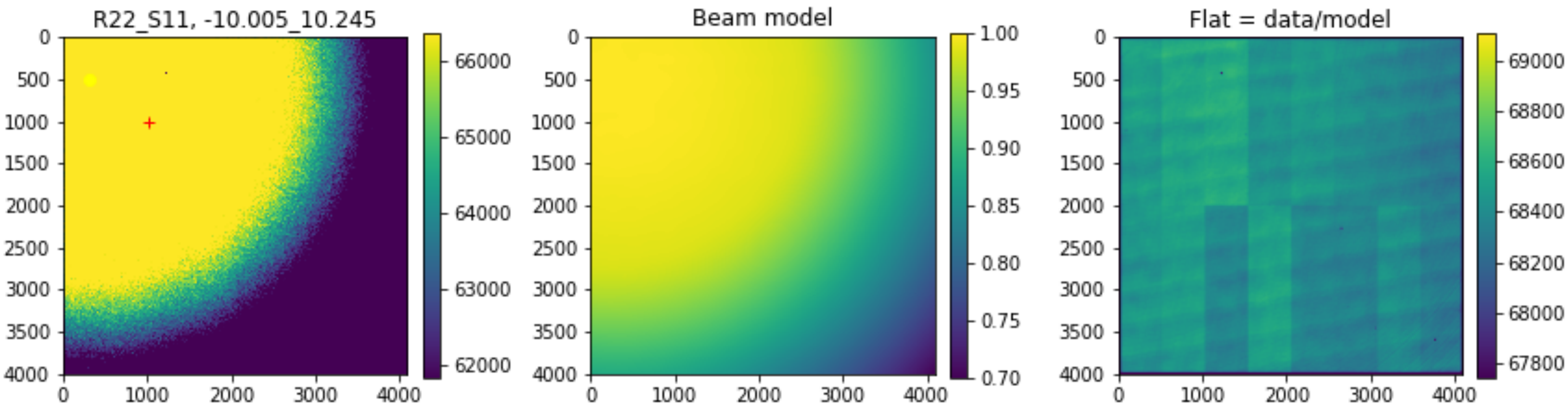

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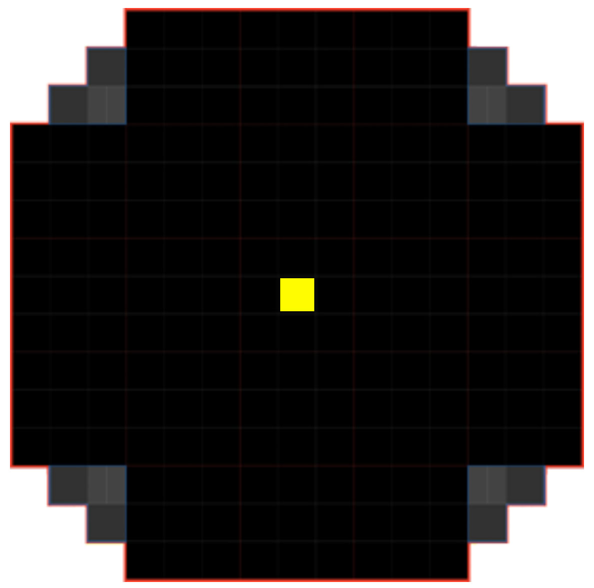

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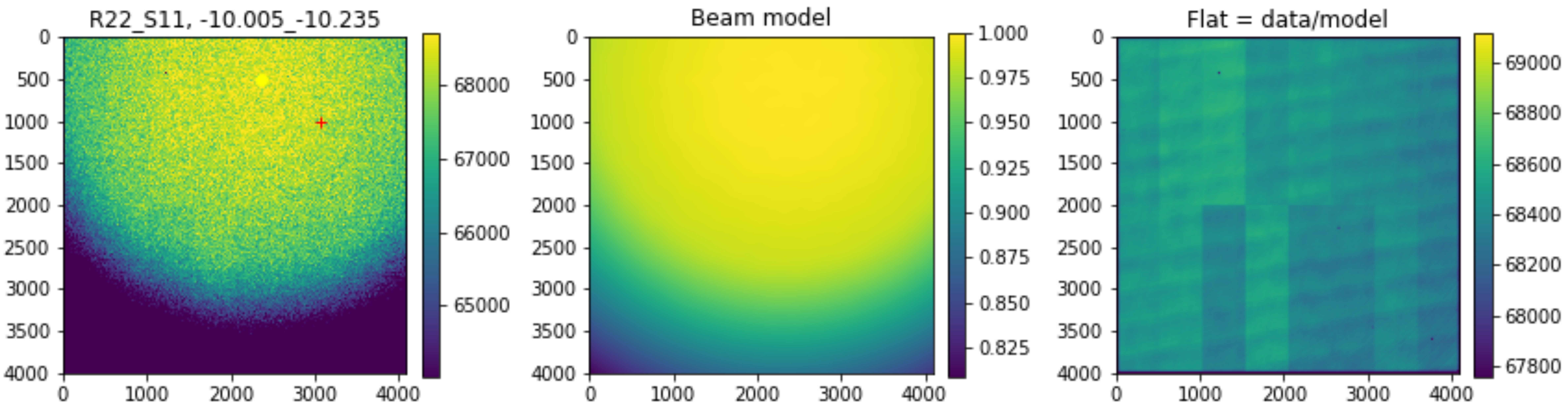

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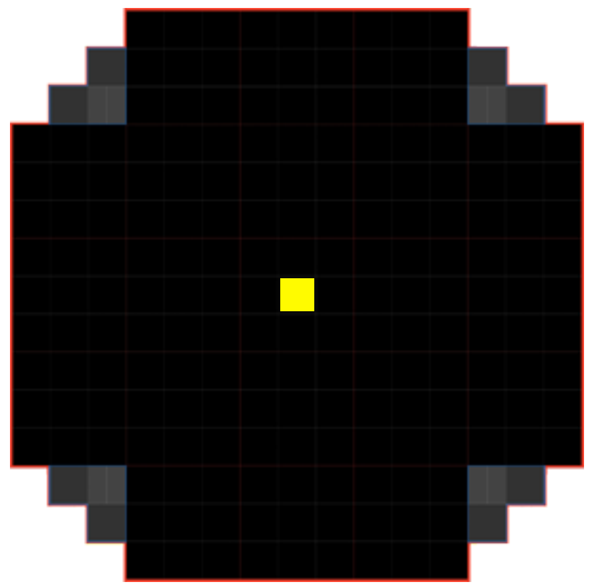
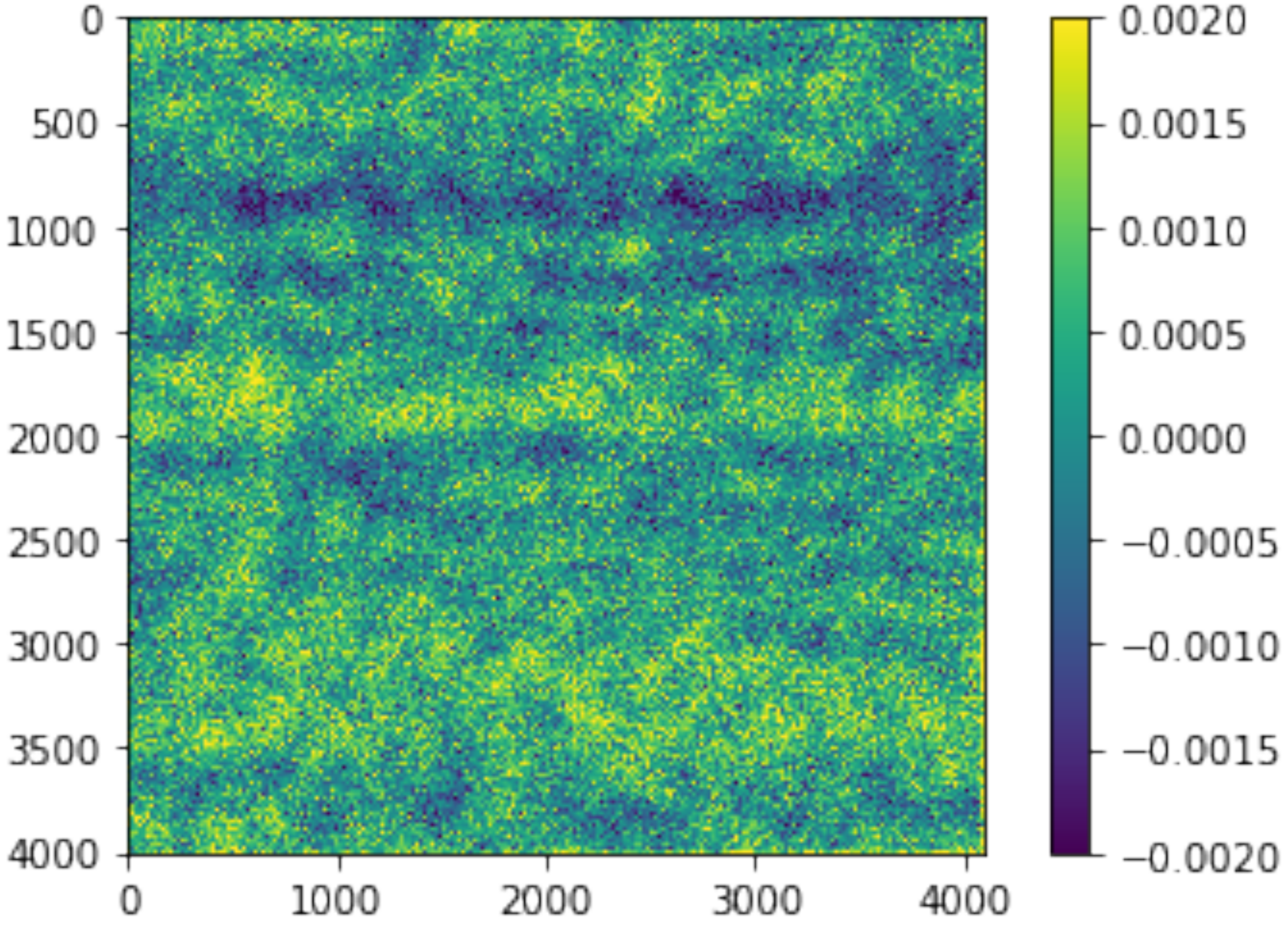


Synthetic flat fields: R22_S11

Relative difference between flats from 2 pointings

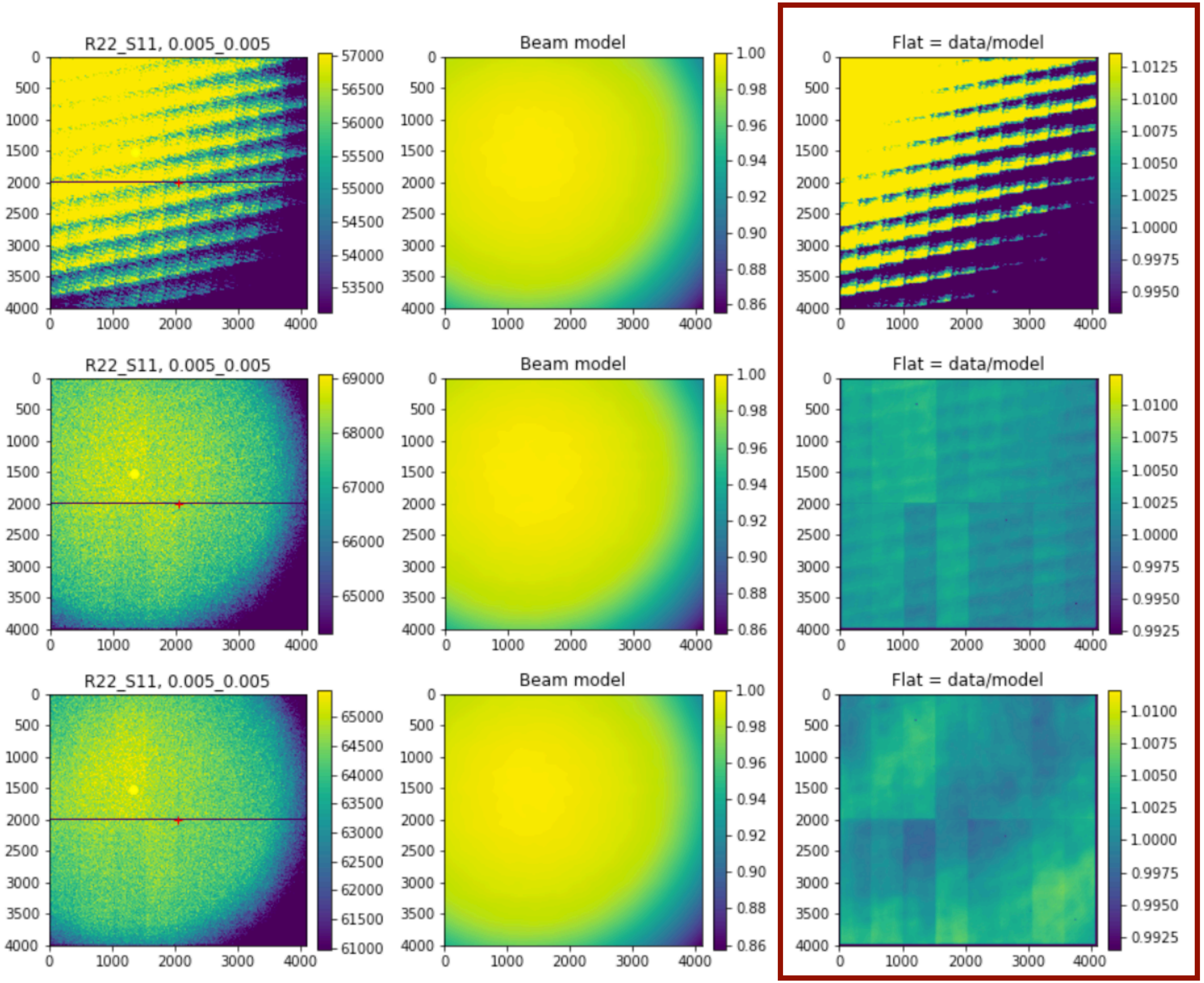


Synthetic flat fields: R22_S11 variation with wavelength

UV LED

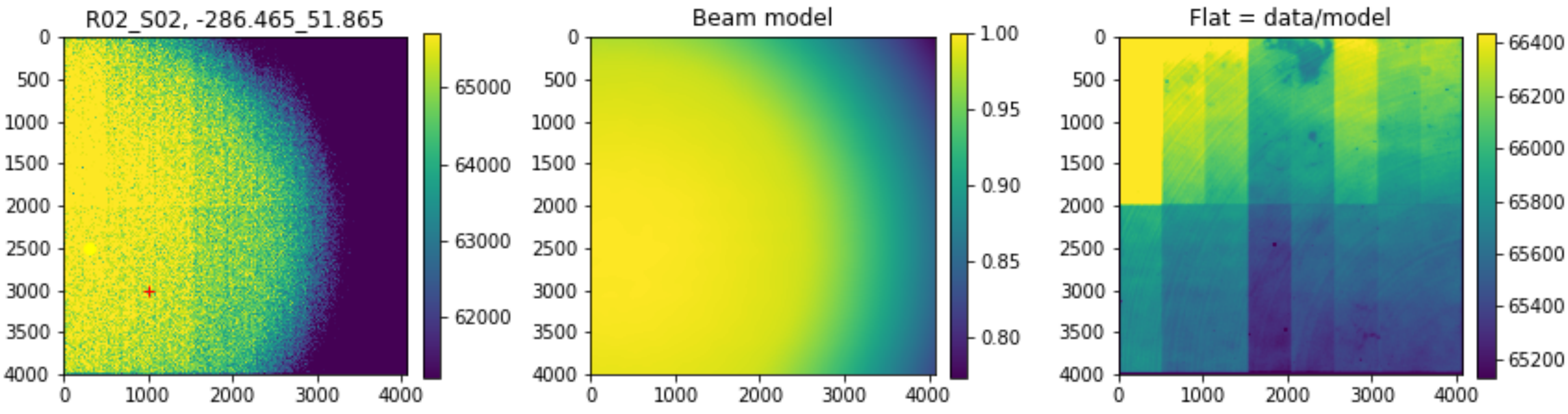
red LED

960nm LED



Run 3: missing data to perform analysis with the blue, 750nm and 850nm LEDs

Synthetic flat fields: R02_S02



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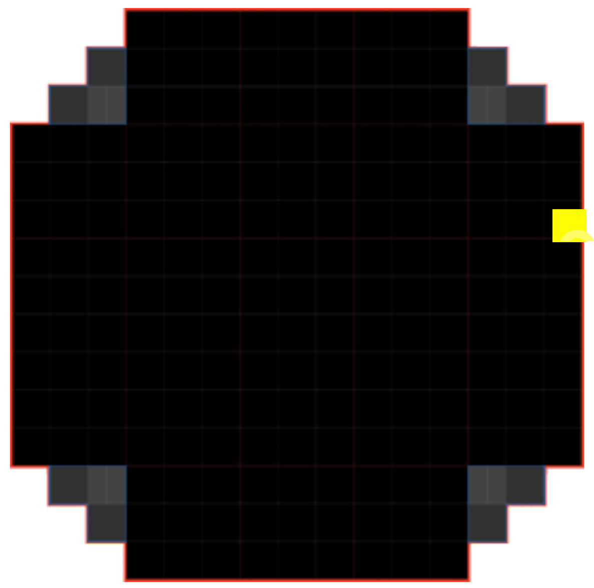

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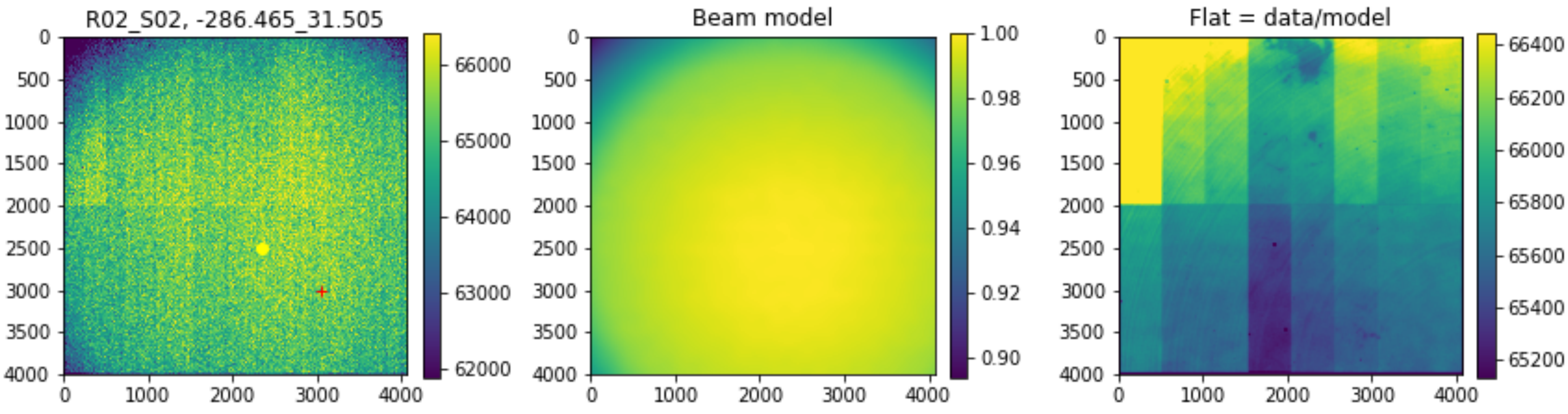
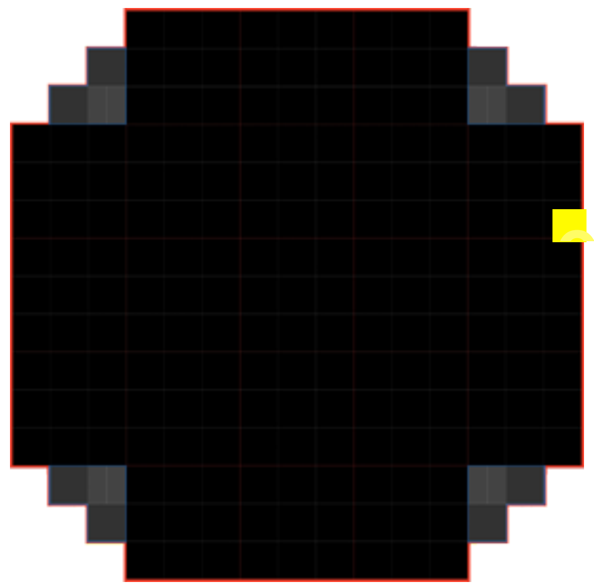


Origin of the variation (0.5% level)?

- ★ "Edge" effect (reflection)
- ★ Slightly off-positioning (inter-ccd spacing in DM coordinate code?)



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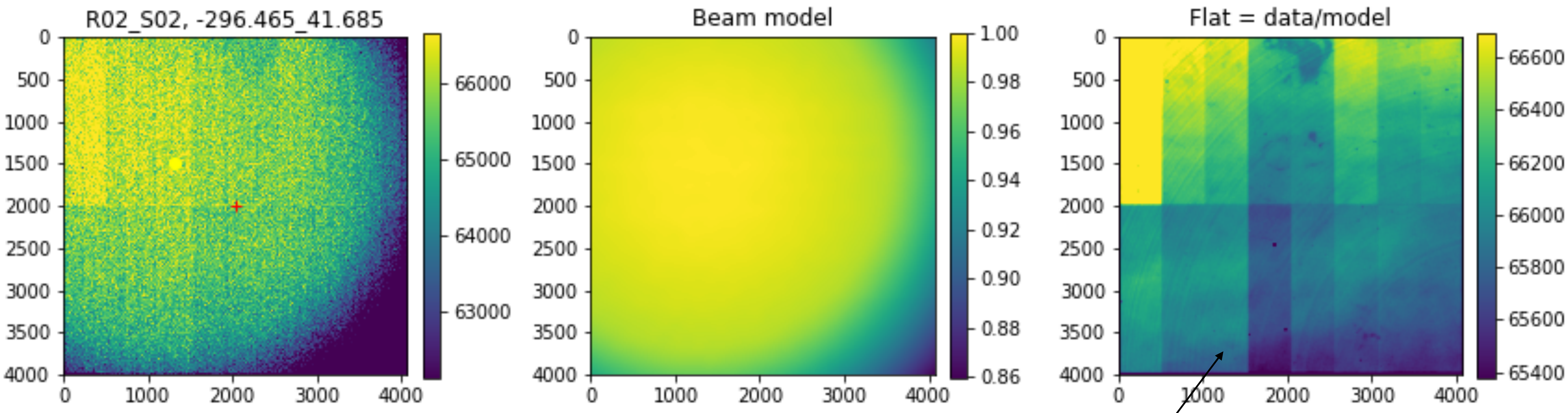
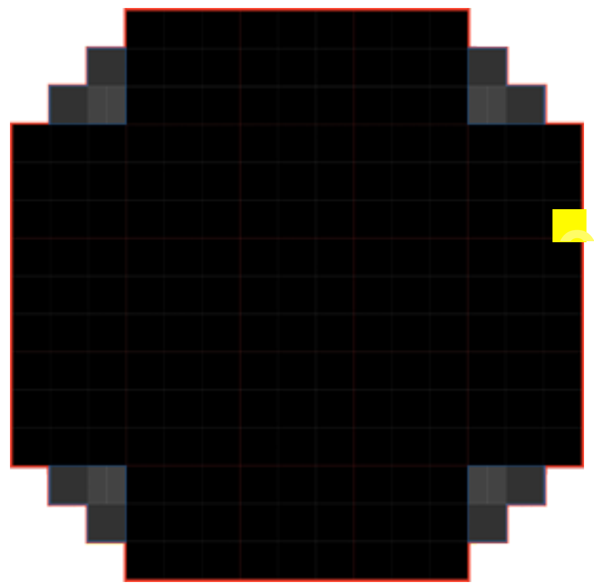


Small reflection arriving



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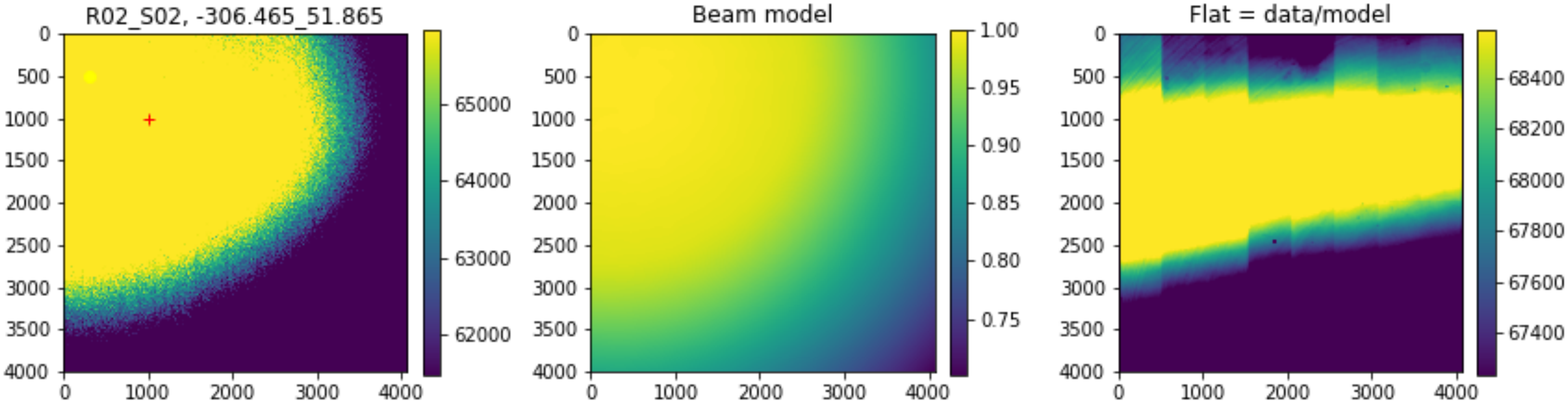
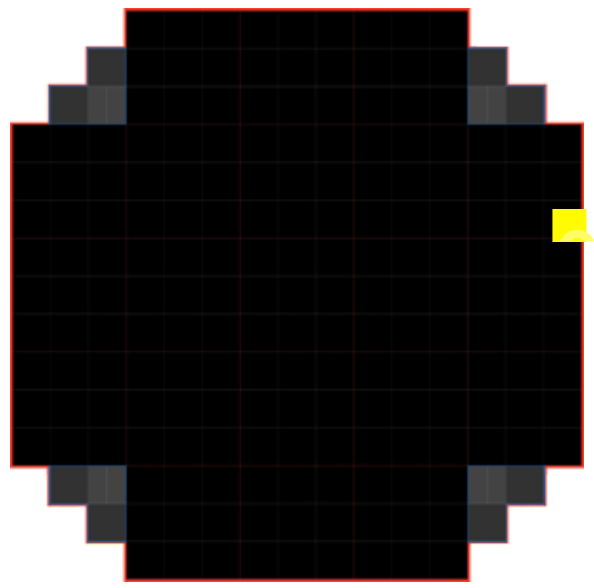


Pointings closest to the edge!



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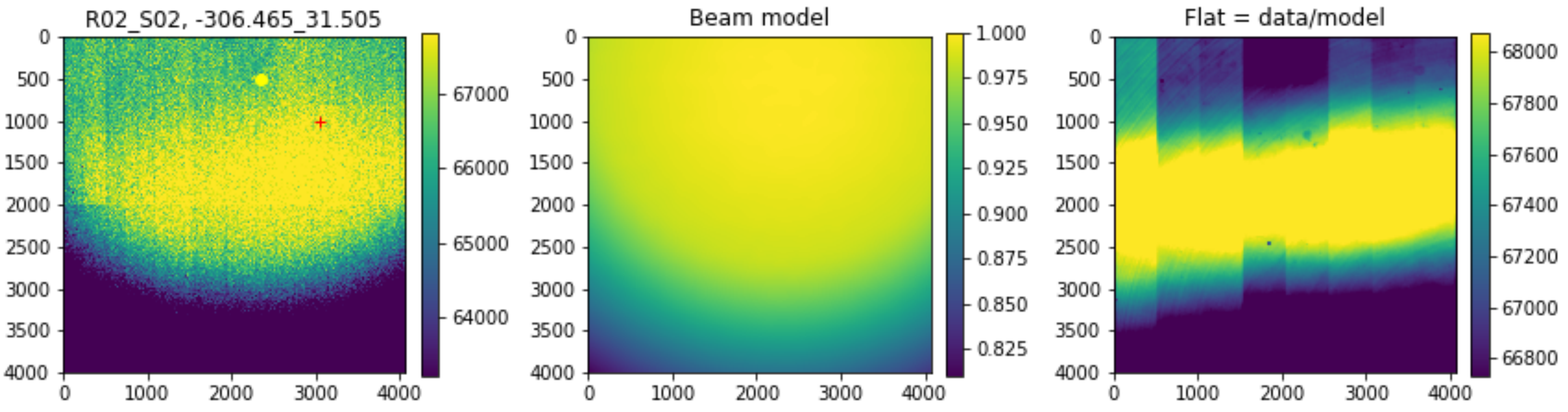

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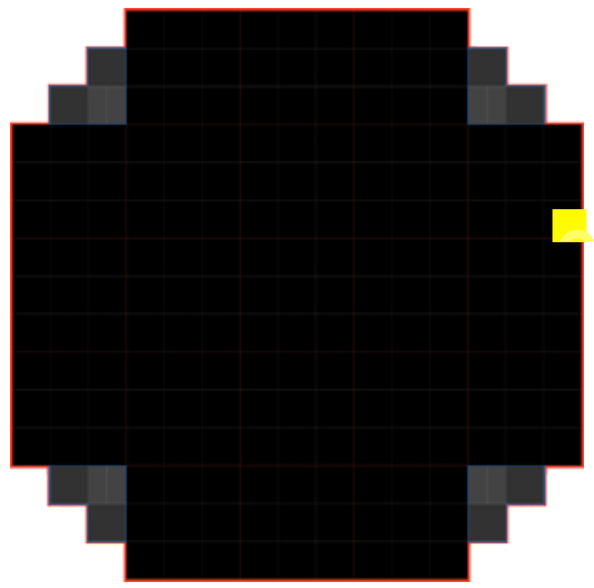
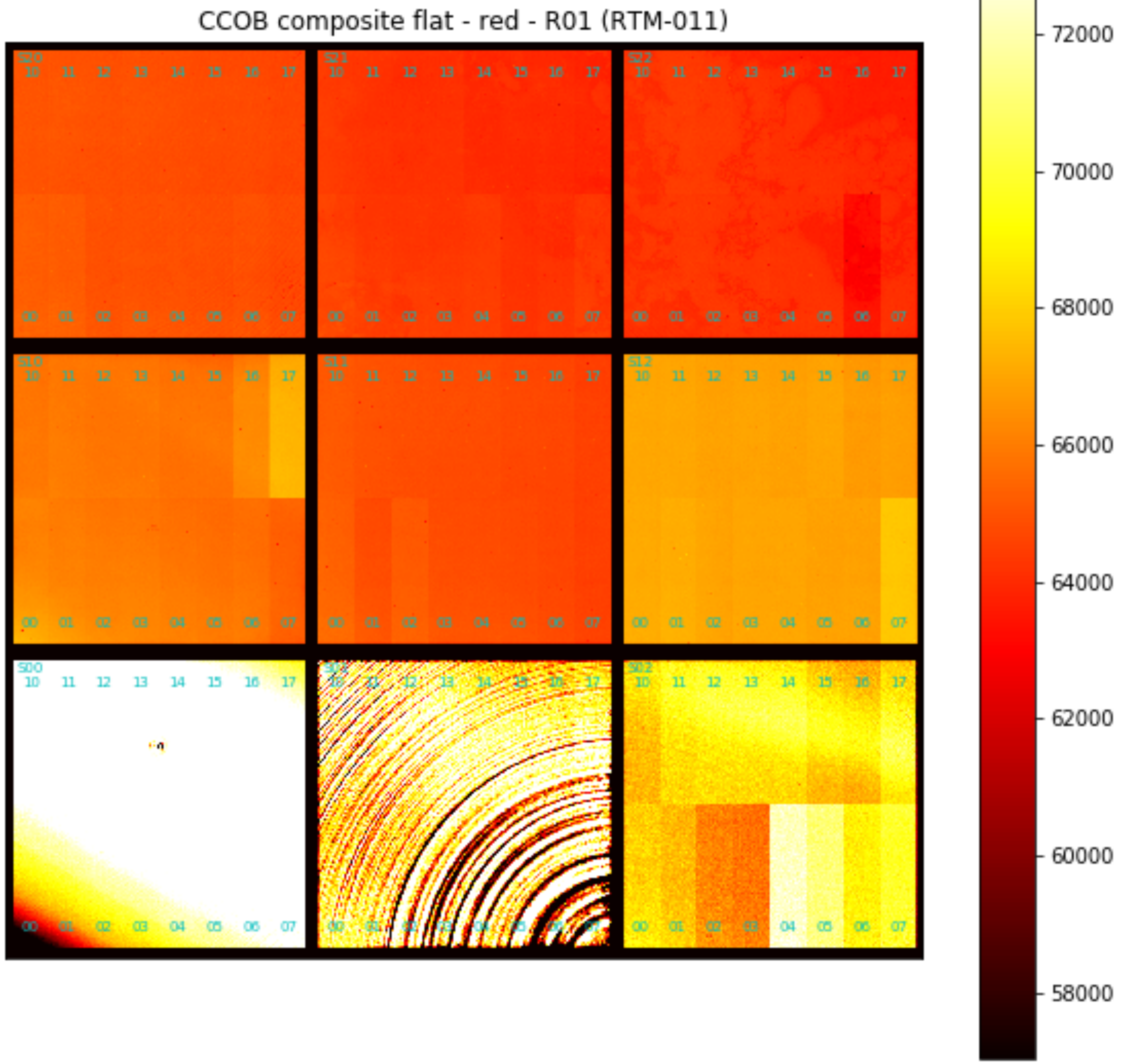
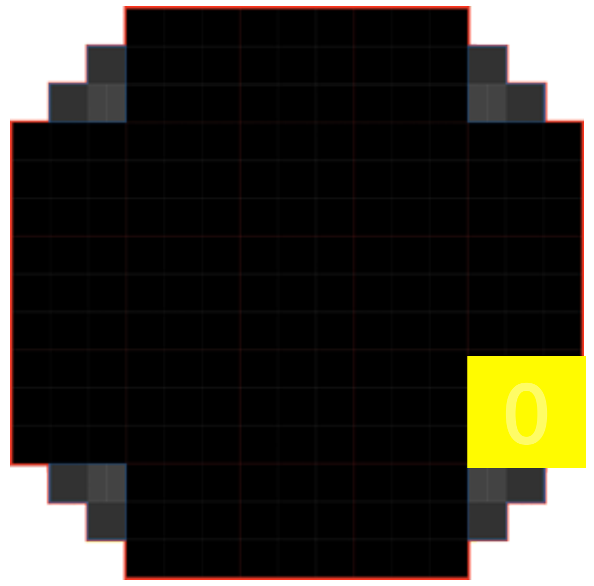


Synthetic flat fields (red): R01

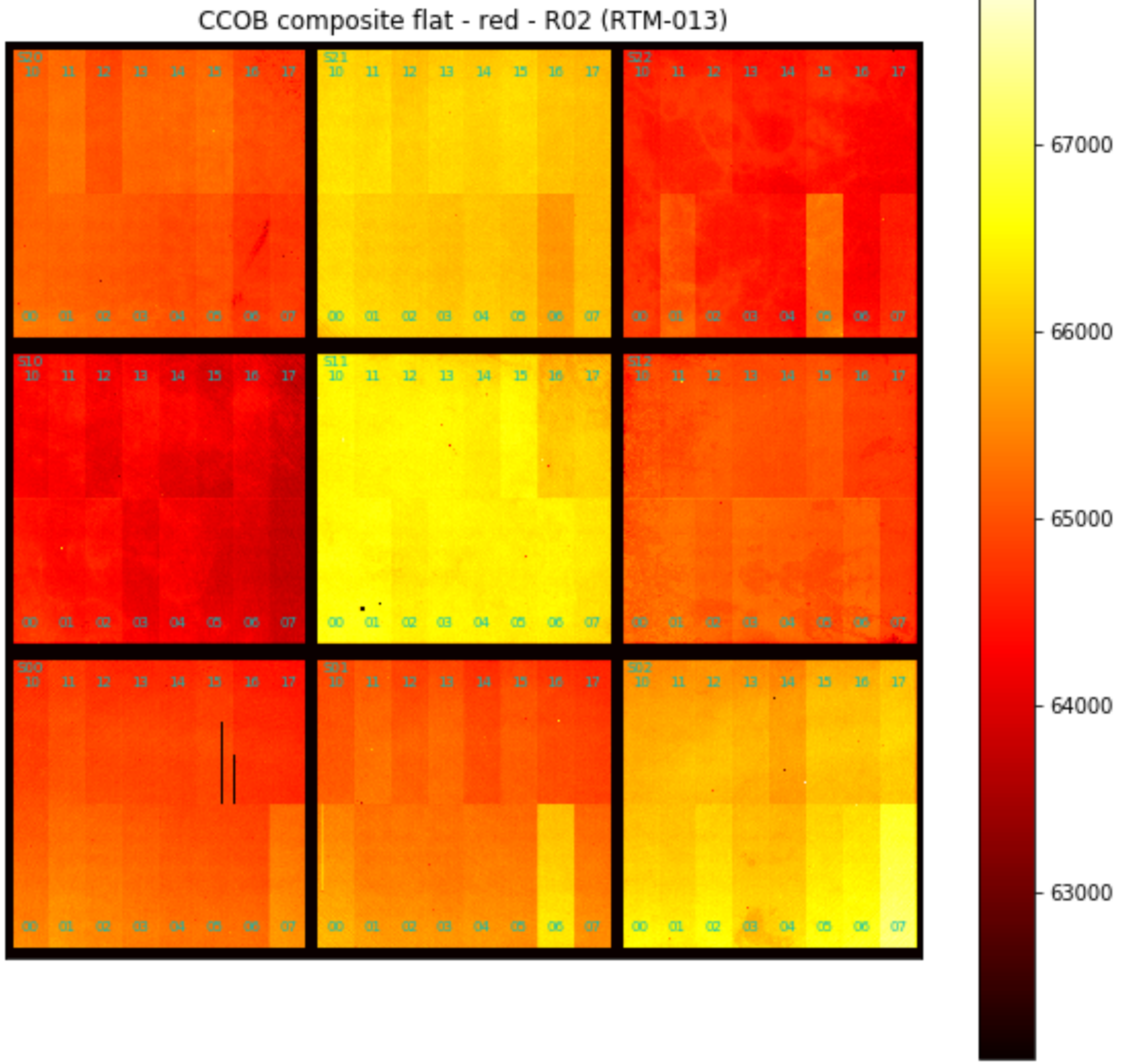
Using central pointing only

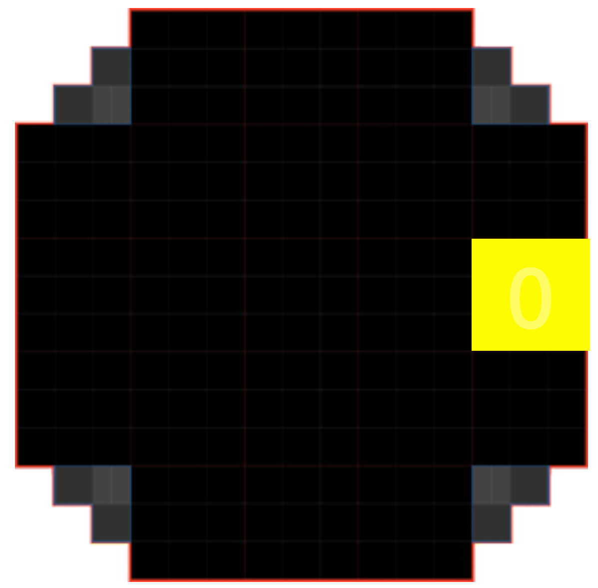




Synthetic flat fields (red): R02

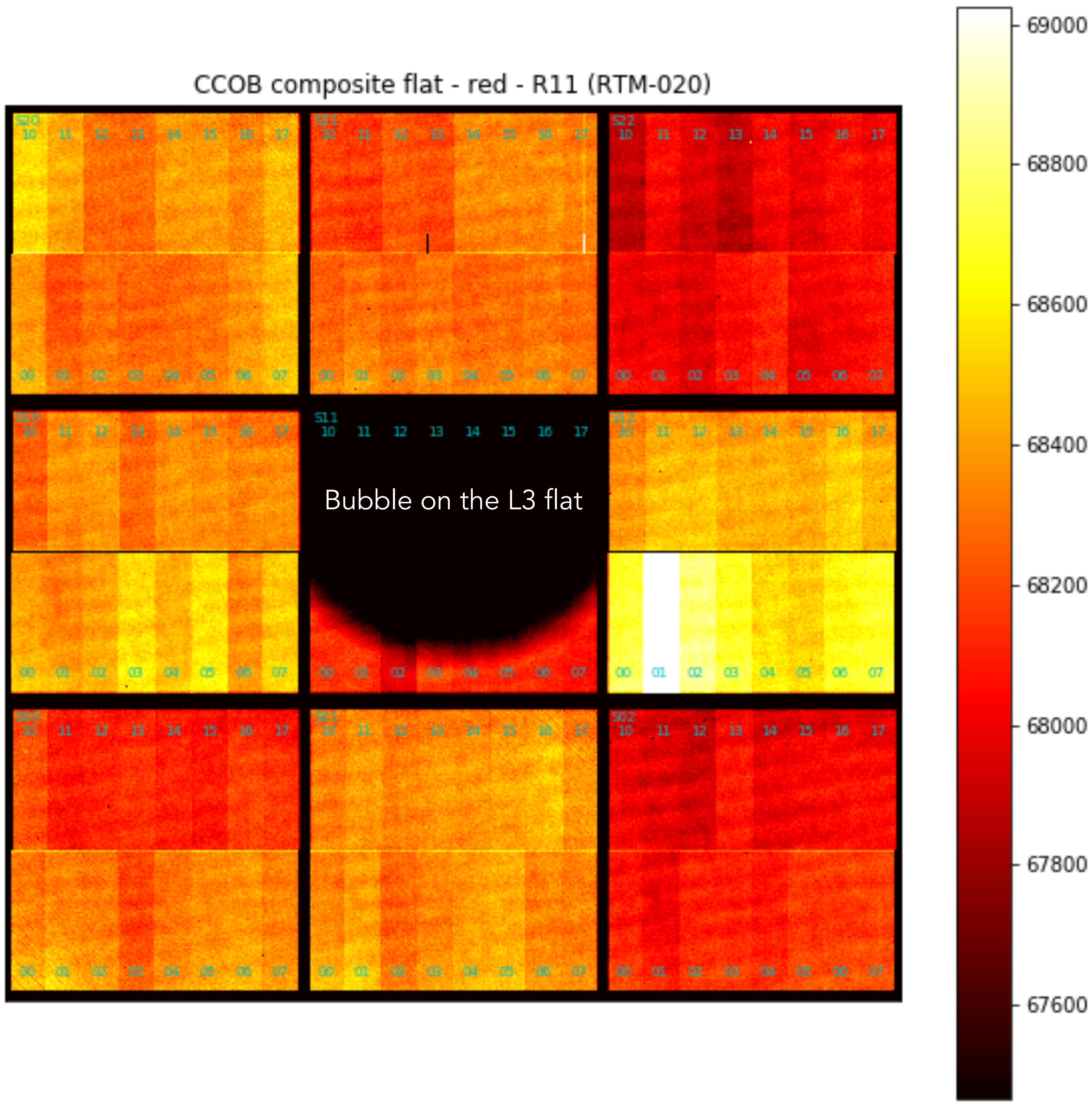
Using central pointing only

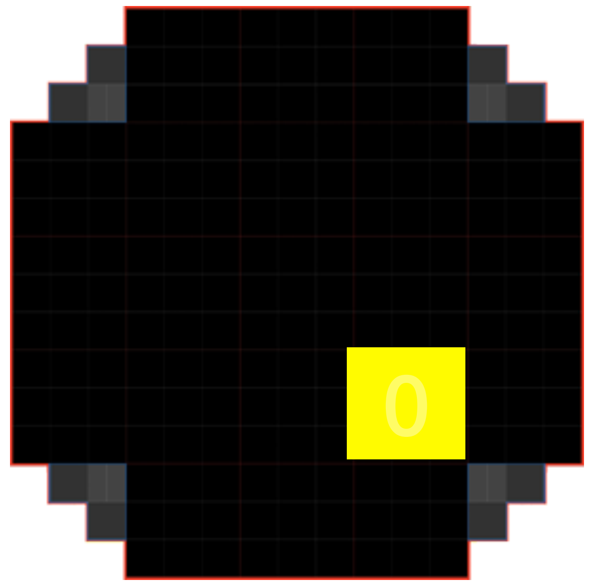




Synthetic flat fields (red): R11

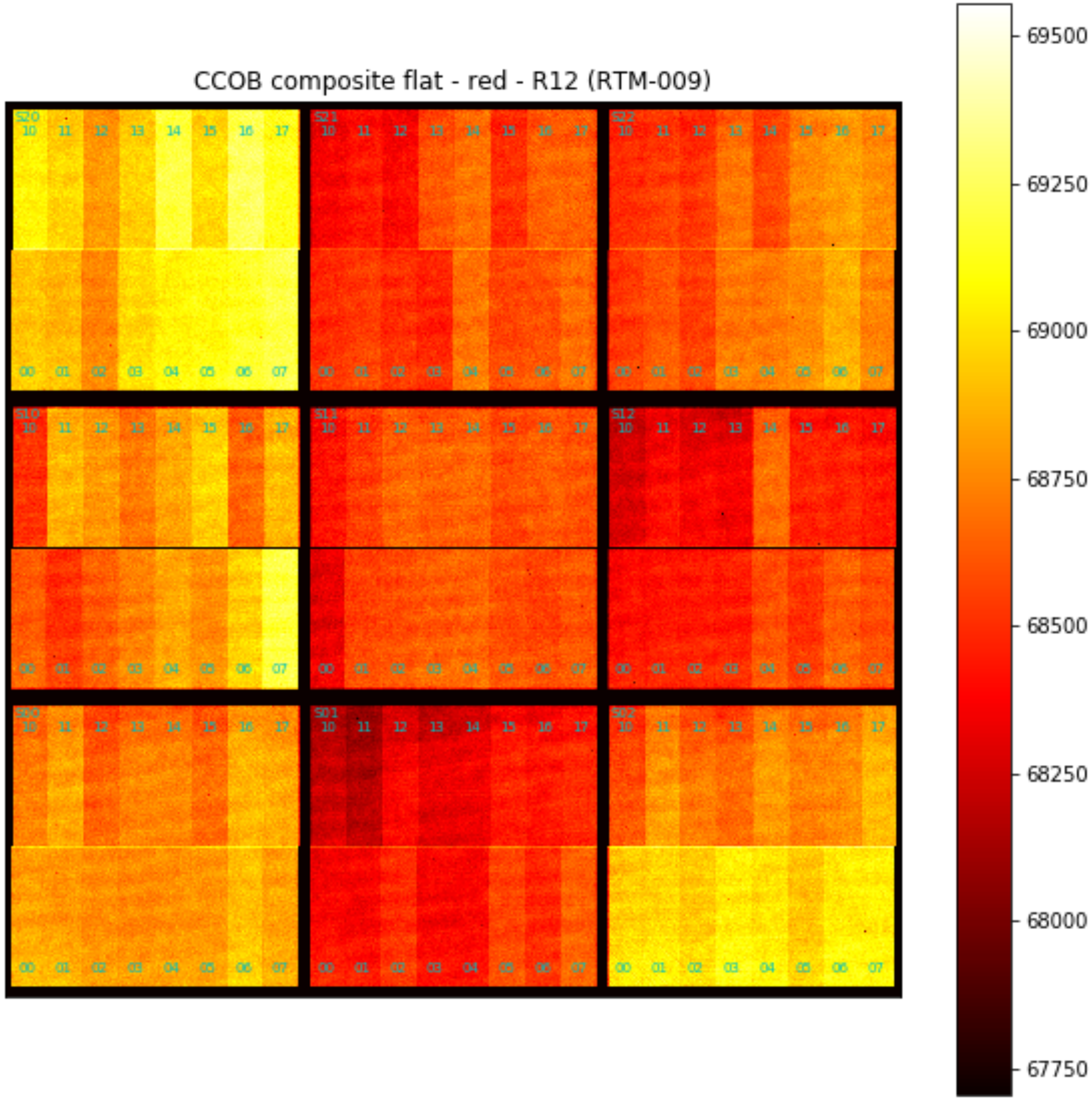
Using central pointing only

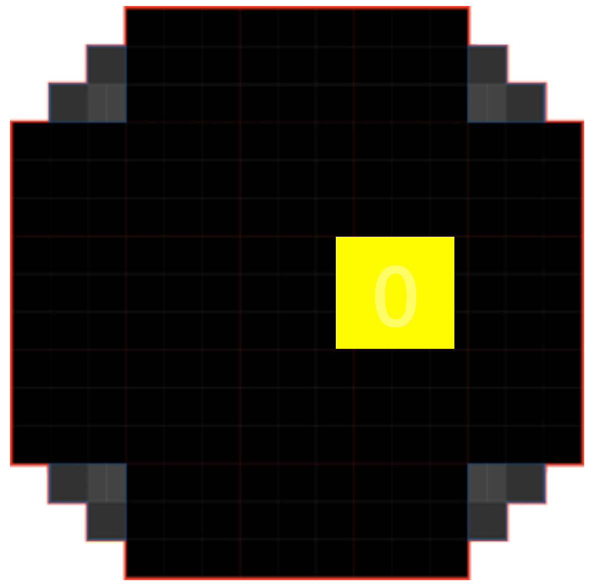




Synthetic flat fields (red): R12

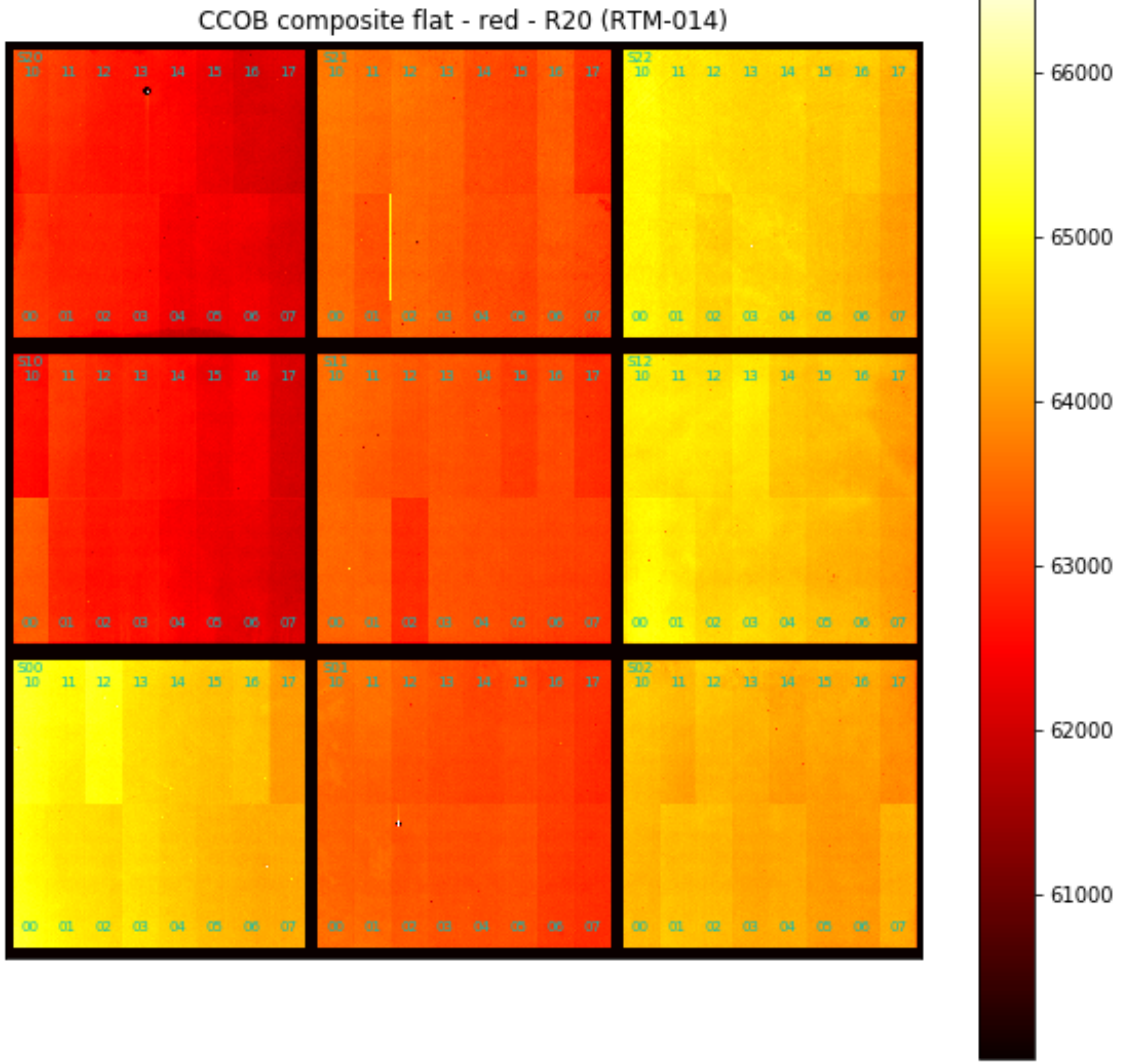
Using central pointing only

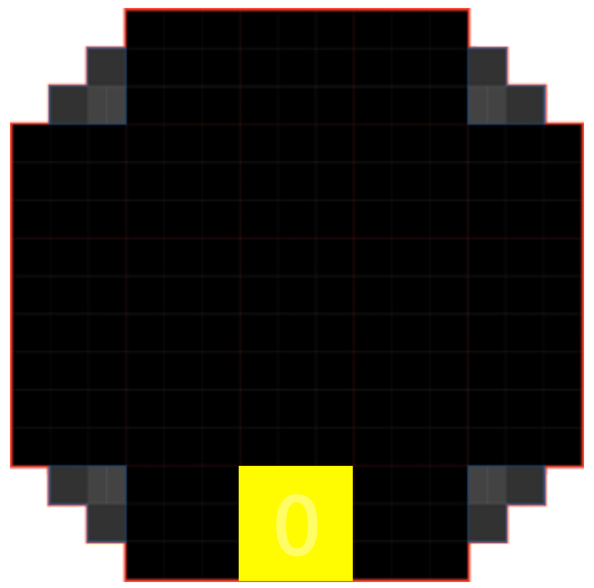




Synthetic flat fields (red): R20

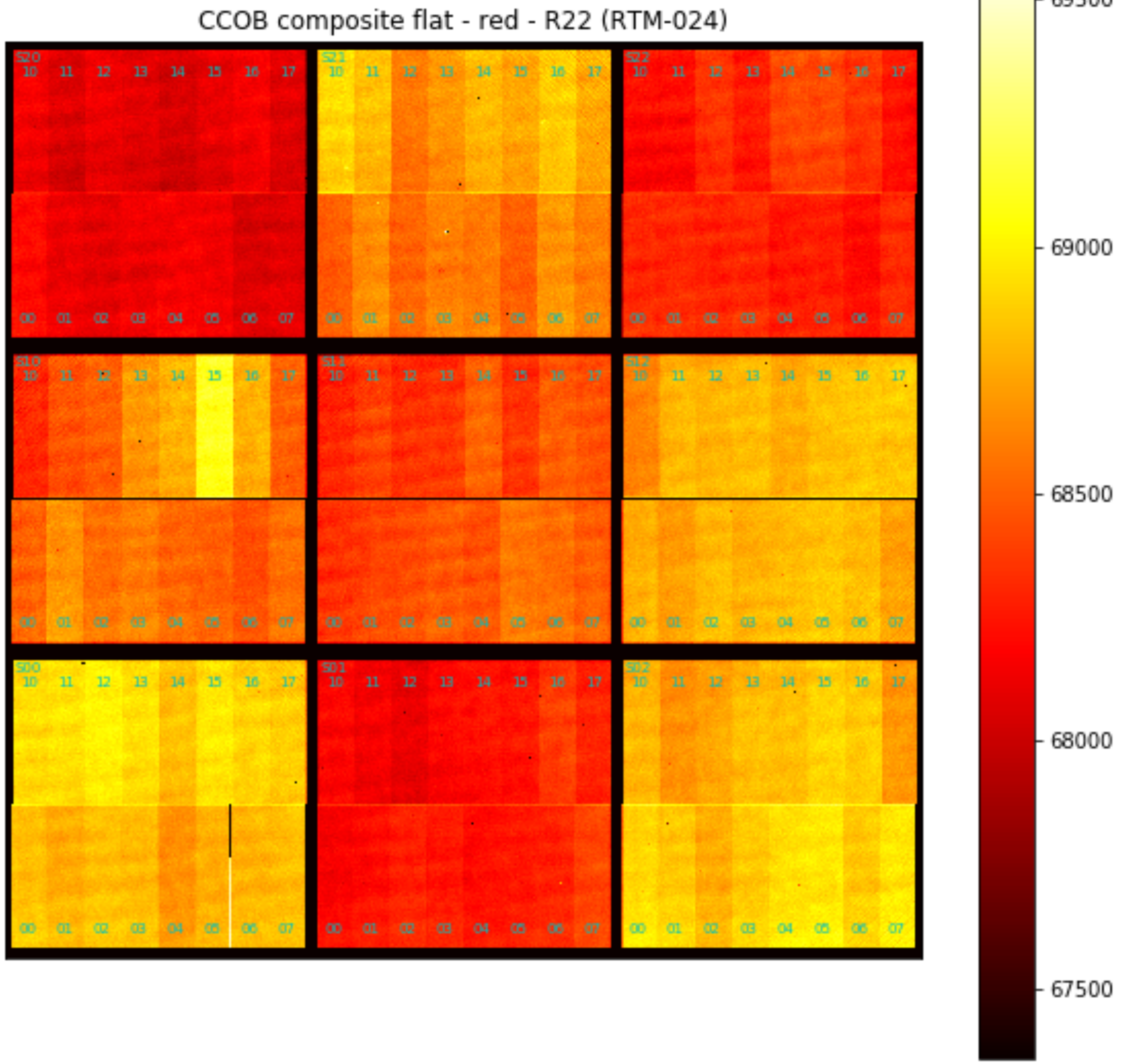
Using central pointing only

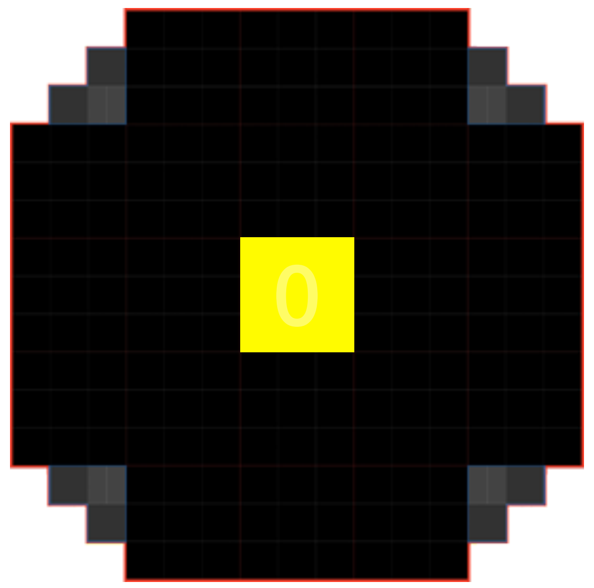




Synthetic flat fields (red): R22

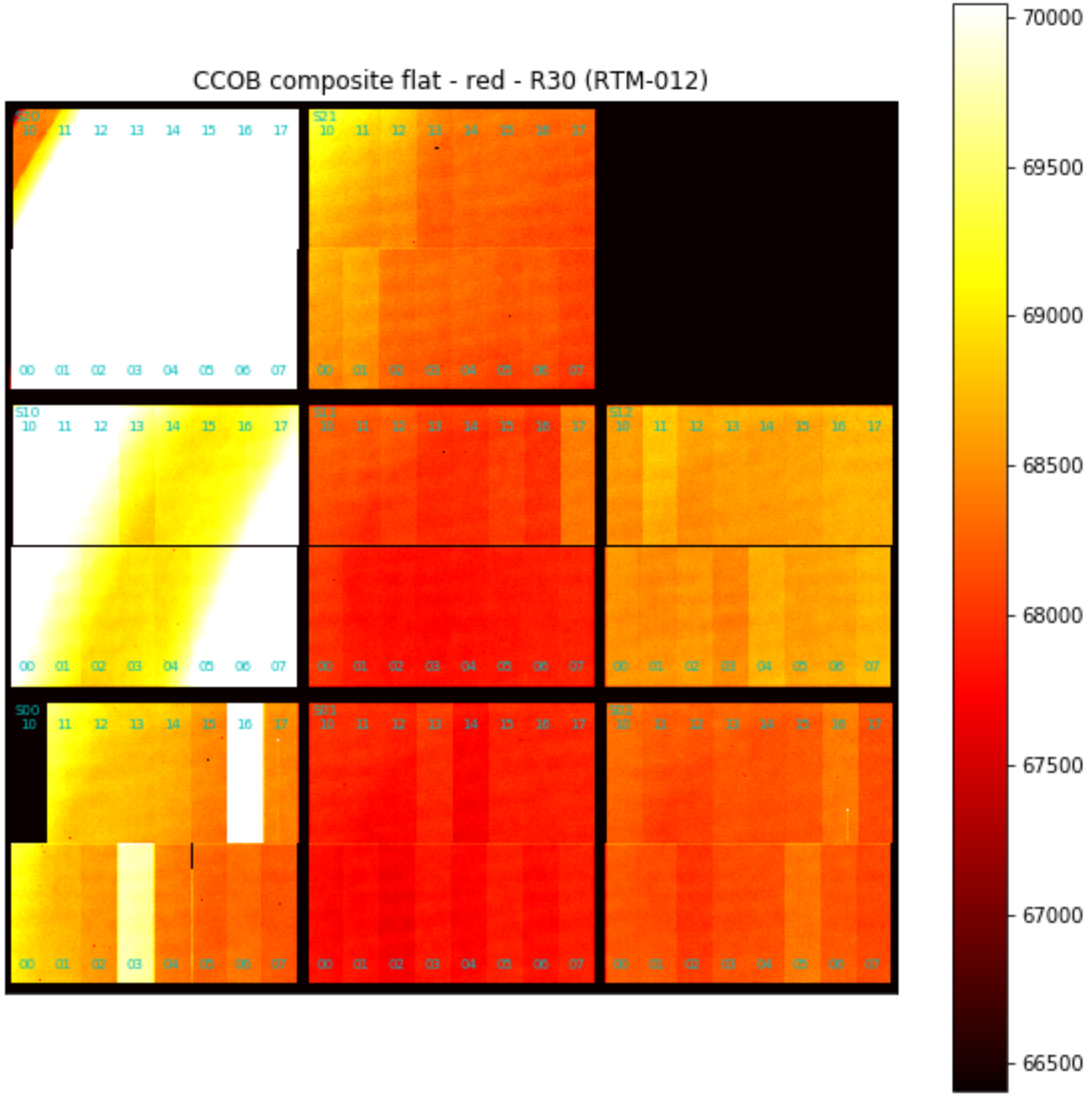
Using central pointing only

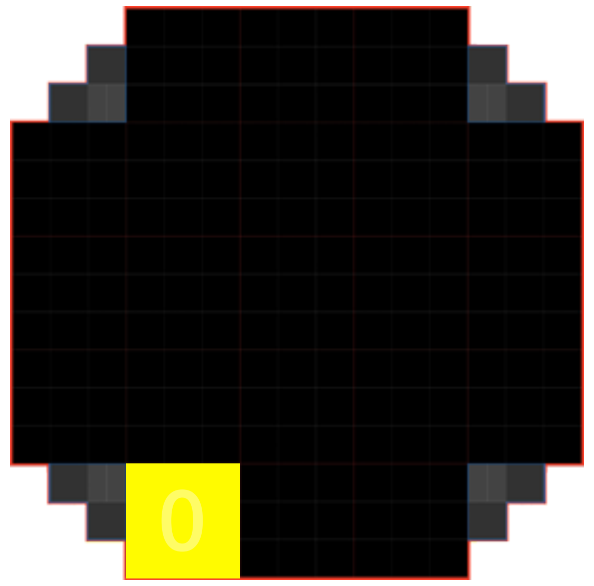




Synthetic flat fields (red): R30

Using central pointing only

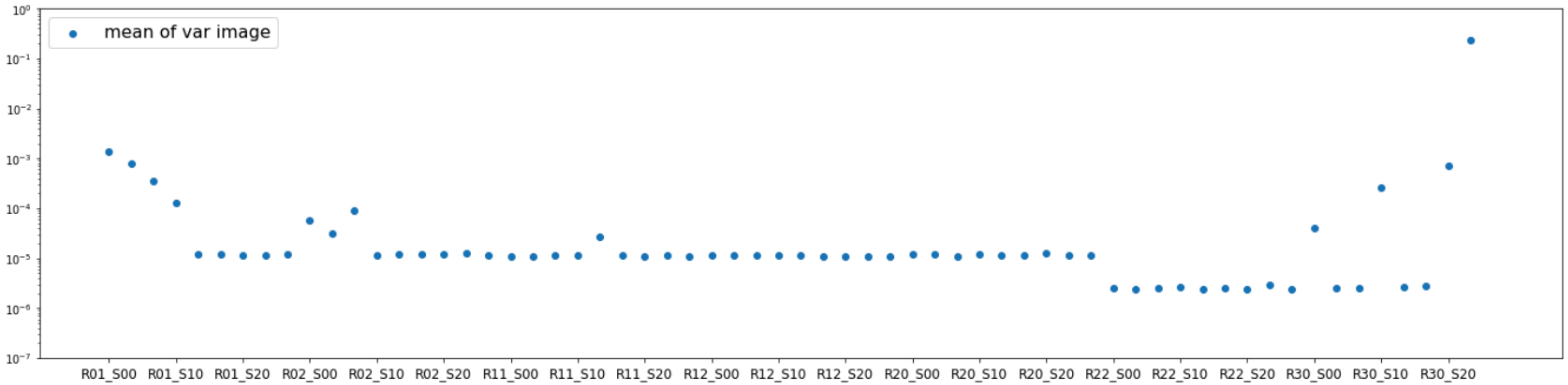




Identifying "bad" flats

Take advantage of the 5 pointings / CCD - the flat should be stable between pointing:

- Make variance map of the sensor from the 5 synthetic flats
- Compute the mean of the variance maps to identify (too) strong variations



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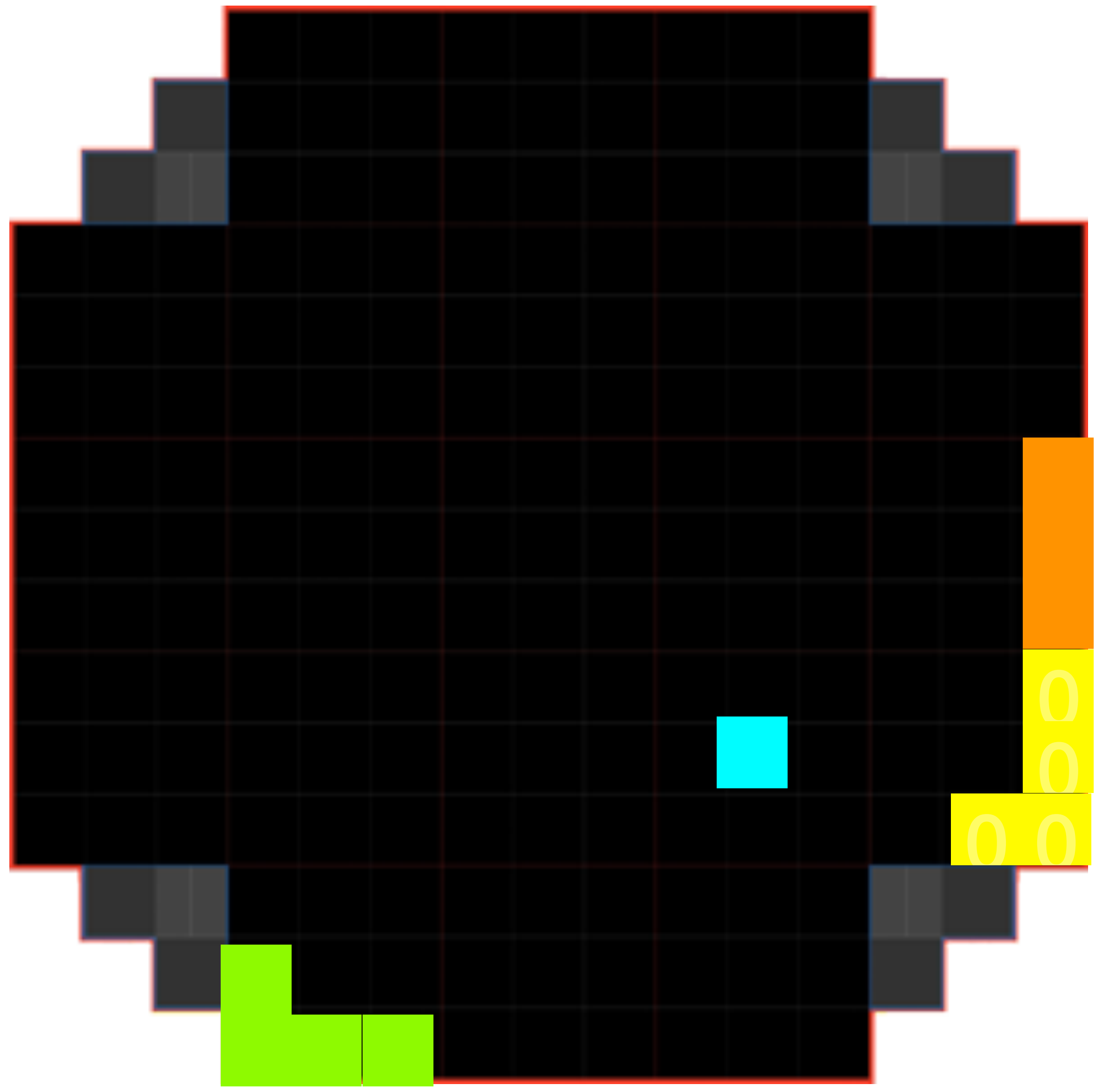

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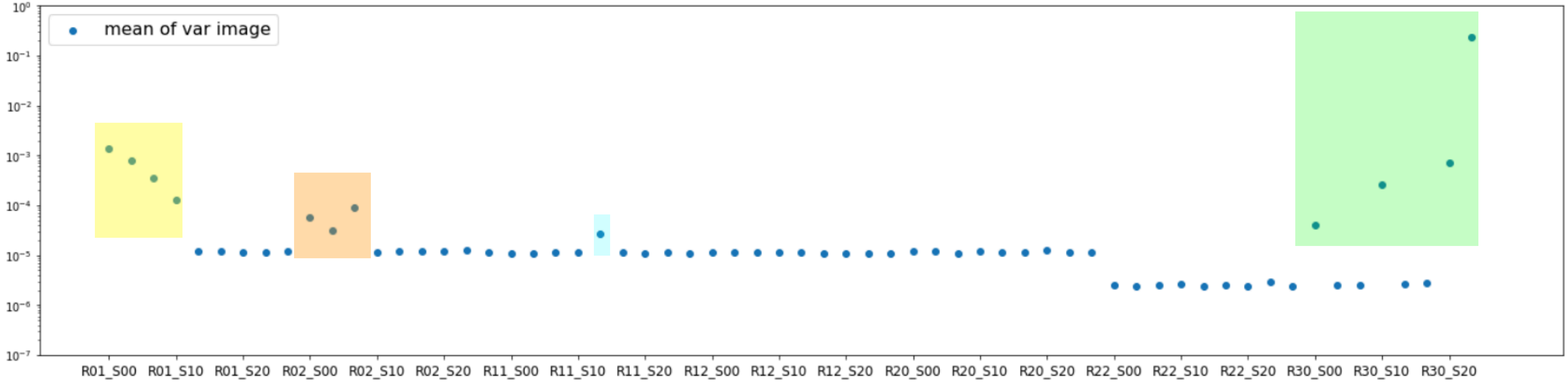
- Compute the mean of the variance maps to identify (too) strong variations

Projection for the full FP: ~45-50/189 ccd unusable for CCOB-WB analysis



Conclusions

- Run 3 = very complete CCOB-WB dataset!
- Good configuration and settings: CCOB distance, LED settings and ND filter
- Results:
  1. Analysis tested successfully in multi-raft configuration
  2. CCOB stability OK
  3. Beam shapes do vary with the LED (more striking for UV) → recommend 60 x 60 scan in all LED
  4. Synthetic flats (red LED) for all sensors (5 pointings/files per sensor) available in `/gpfs/slac/lsst/fs1/u/combet/DATA/CCOB_QE/`
  5. All edge sensors are affected by the Fe55 ring reflection
- Run 4 starting now! Full FP - check out progress on #cam-ir2-bot-data

Data acquired during run #3

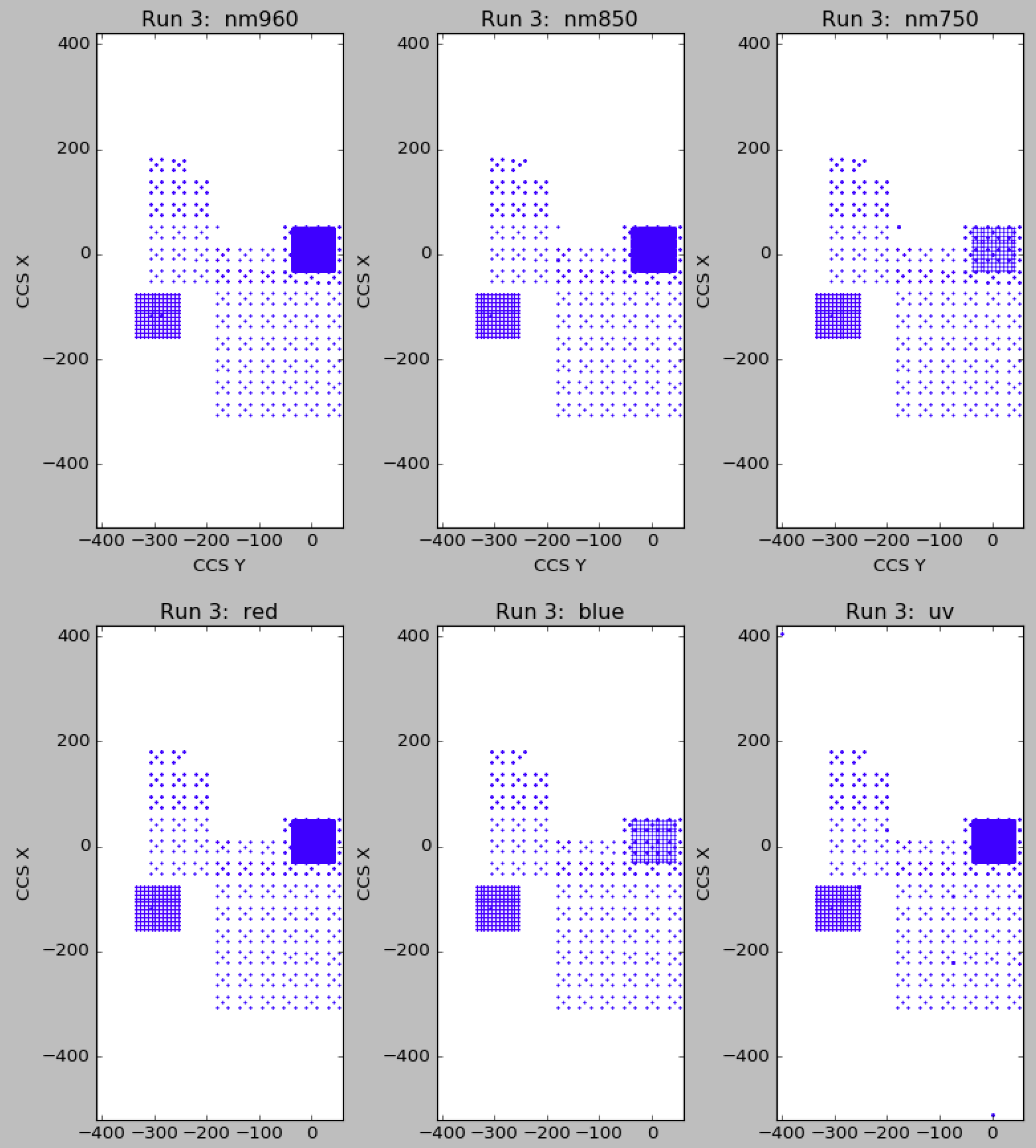
1. Beam reconstruction
   i. 12 x 12 scans in 6 LEDs
   ii. 60 x 60 scans for (uv, red, 850nm, 960 nm)
2. QE data: 5 pointings / CCD, 6 LED
   i. 1 exposure / pointing (R01, R02, R11, R12, R20)
   ii. 5 exposures / pointing (R22 and R30)

~50400 fits files (only 1/3 used for the analysis)

Runs:

- 60 x 60 scans: (6845D, 6855D), 6856D
- 12 x 12 scans: 6840D, 6841D
- QE 'long': 11974 (R22), 6843D (R30)
- QE 'short': 6848D (R01), 6849D (R02), 6851D (R11), 6852D (R12), 6853D (R20)

Acquisition trouble for R10, R21



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