

# Update on the CCOB Wide Beam projector

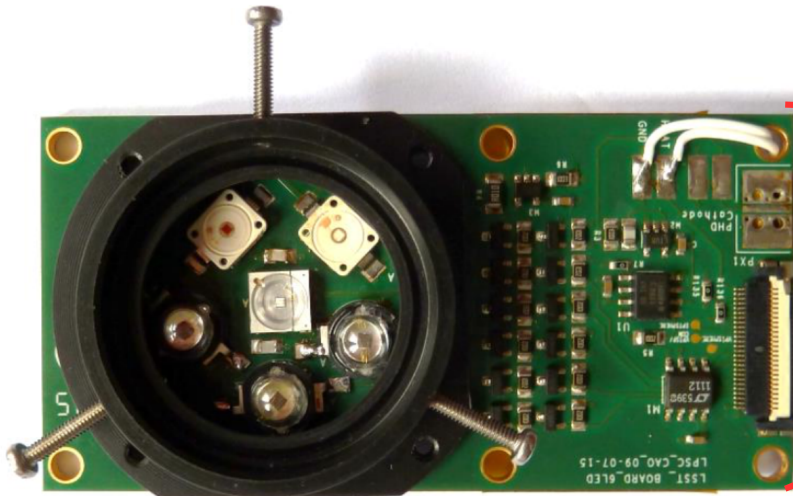
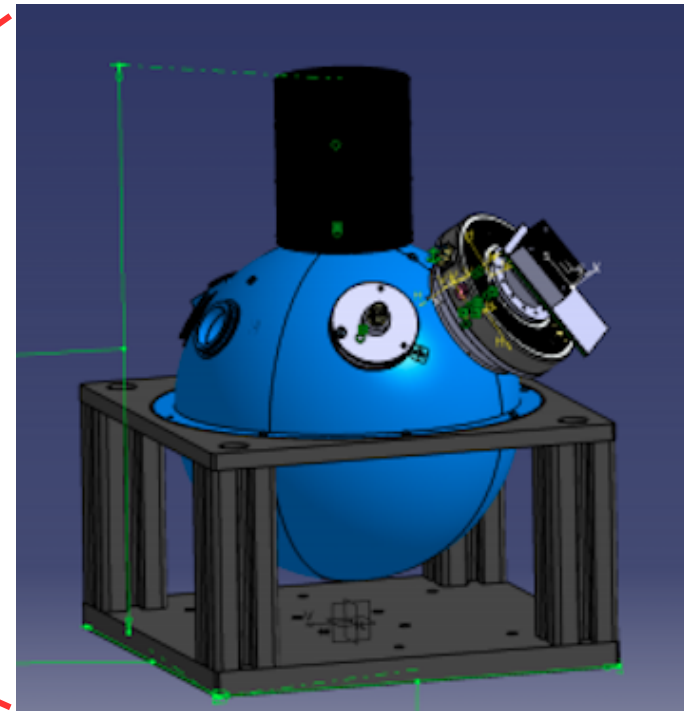
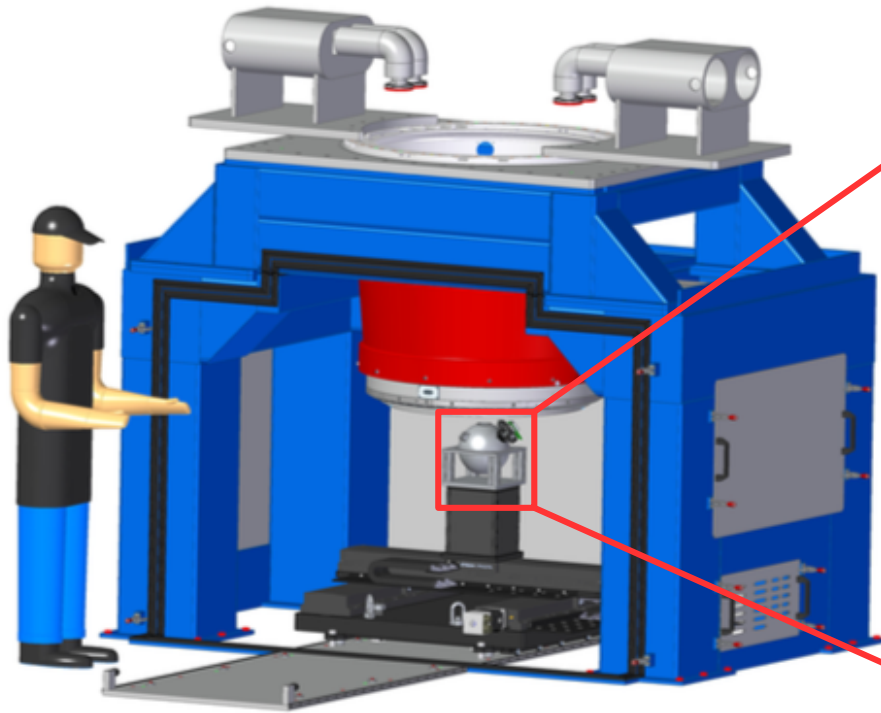
1. CCOB-WB design, requirements and data@SLAC (so far)

2. Stability

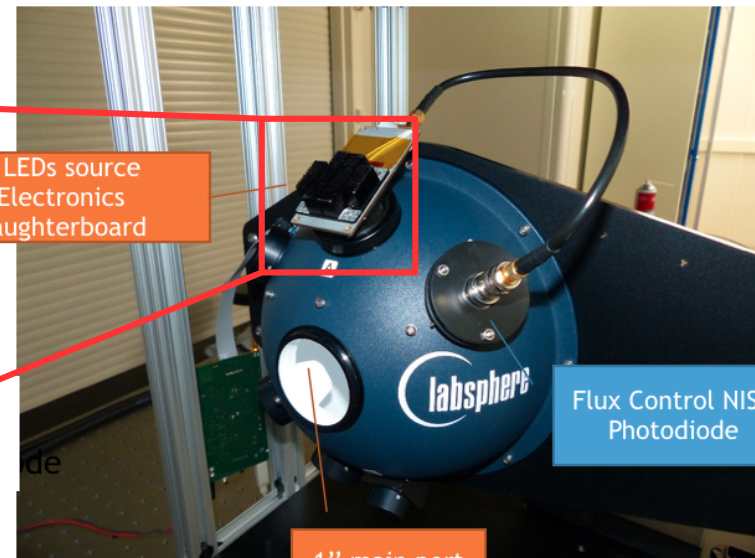
3. Analysis

- CCOB-WB beam reconstruction
- Relative QE measurement and comparison to SLAC results

# CCOB-WB design



6 LEDs source  
Electronics  
daughterboard



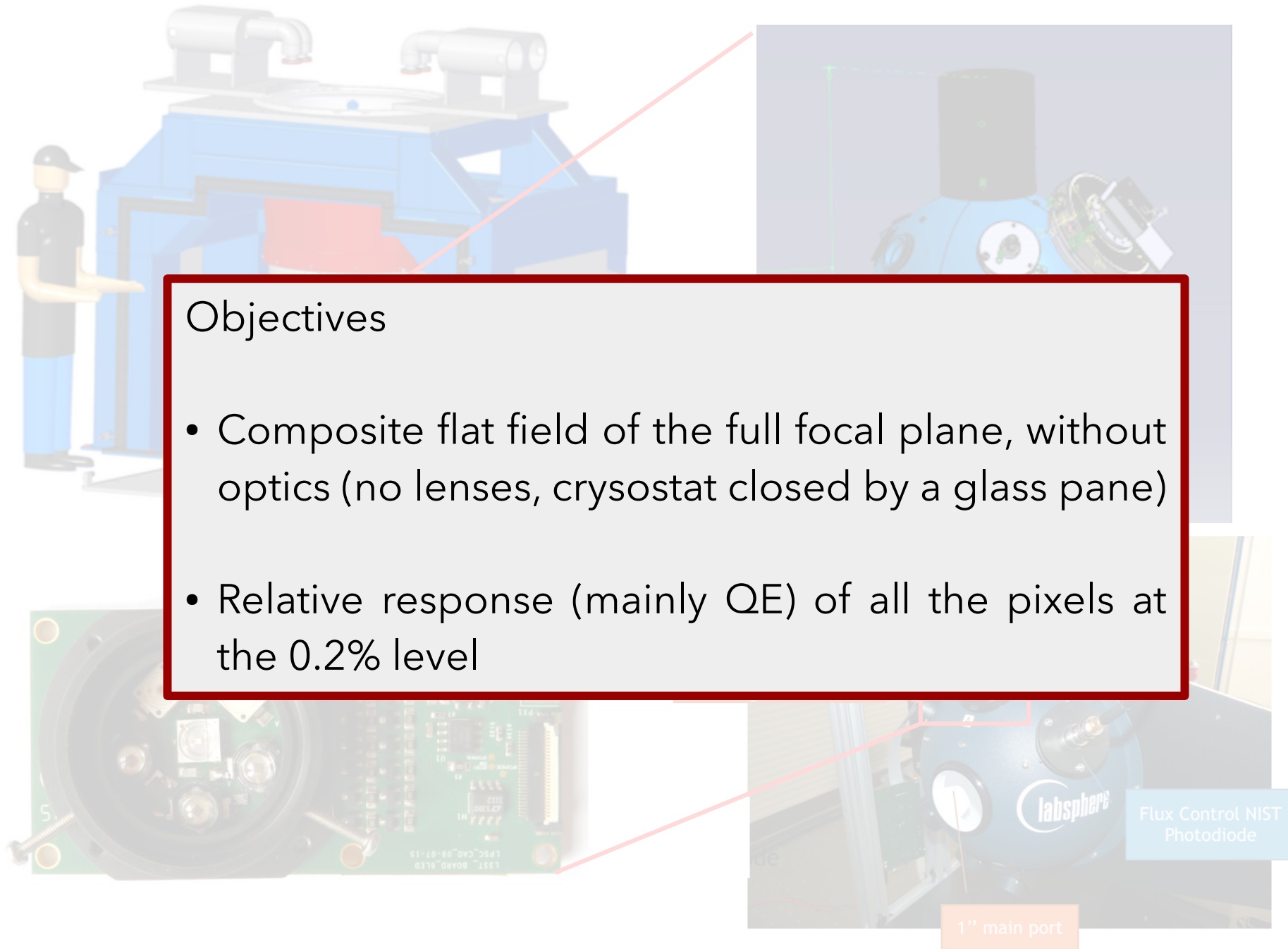
Flux Control NIST  
Photodiode

1" main port

# CCOB-WB design

## Objectives

- Composite flat field of the full focal plane, without optics (no lenses, cryostat closed by a glass pane)
- Relative response (mainly QE) of all the pixels at the 0.2% level

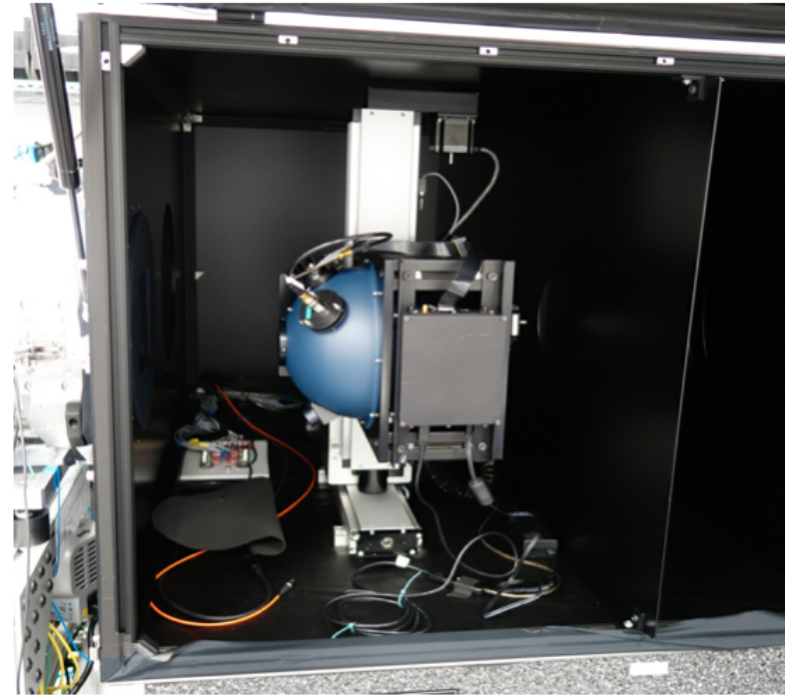
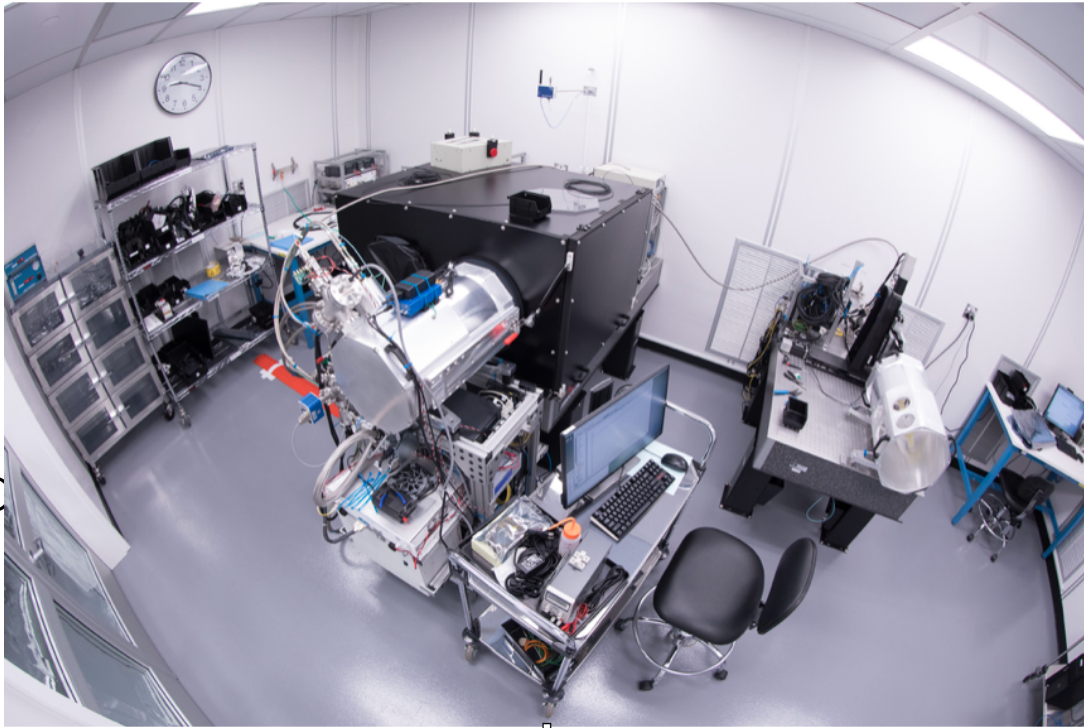


# CCOB-WB requirements

#	Requirement	Solution	Verification method	Compliance
1	CCOB Wide Beam ~ 40 mm diameter (~1ccd)	8" integrating sphere, 1"port, ~17cm from sensors. (Baffling available)	Test	C
2	CCOB shall produce light sampling each of the LSST filter bands	One LED in each band	Design	PC ("y led" overlaps in z band)
3	All illumination sources must be capable of being turned off	Electronic switch (Shutter option also available)	Design/Test	C
4	Internal accuracy and repeatability of the beam flux is required to be 0.2% for the g,r,i and z filter bands	- Mean beam flux controlled by NIST photodiode - Beam profile stability checked for expected ambient temperature variations	Test	C
5	Cleanliness	Components shall be cleanable for class 1000 clean room operations	Analysis	C

# Dataset from last April (RTM-006, e2v)

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1. CCOB-WB design, requirements and data@SLAC (so far)

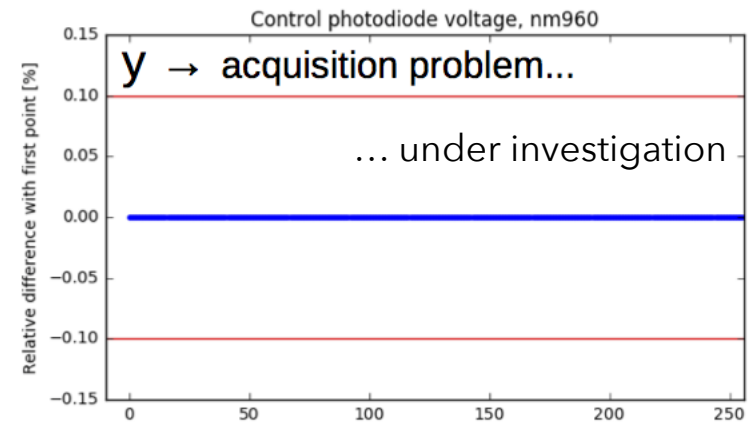
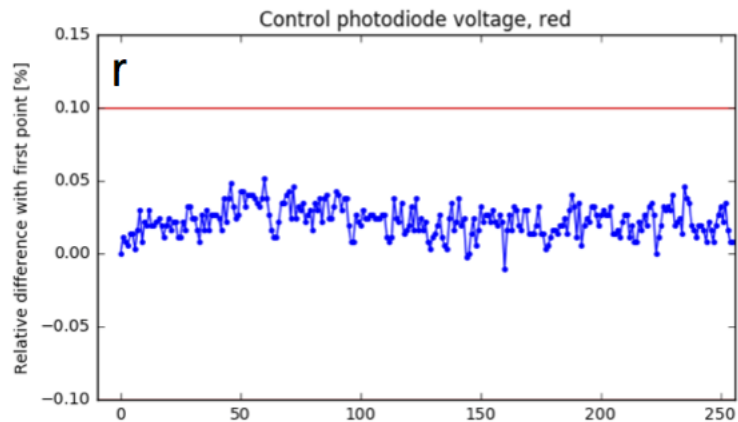
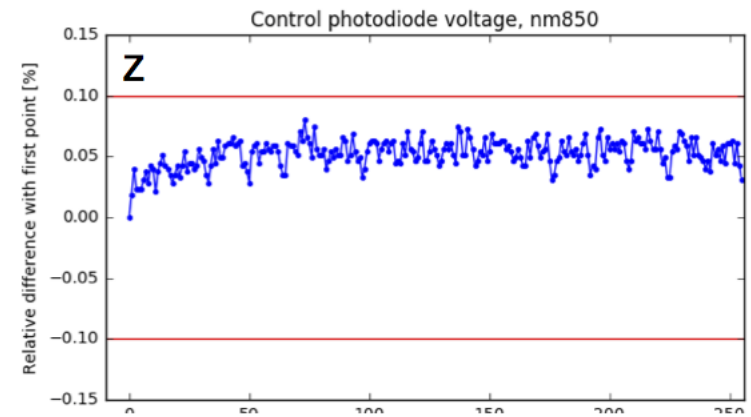
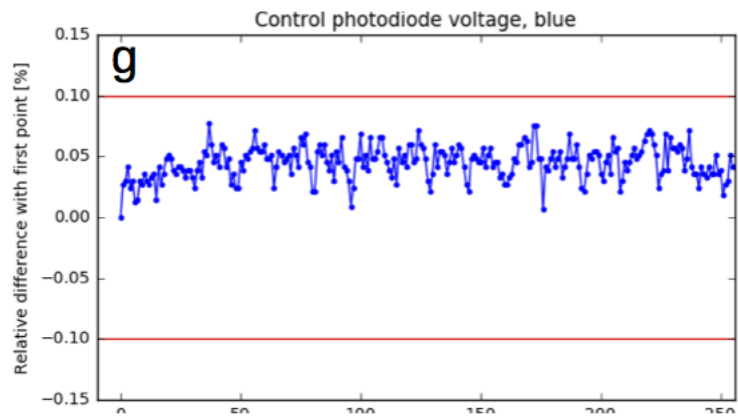
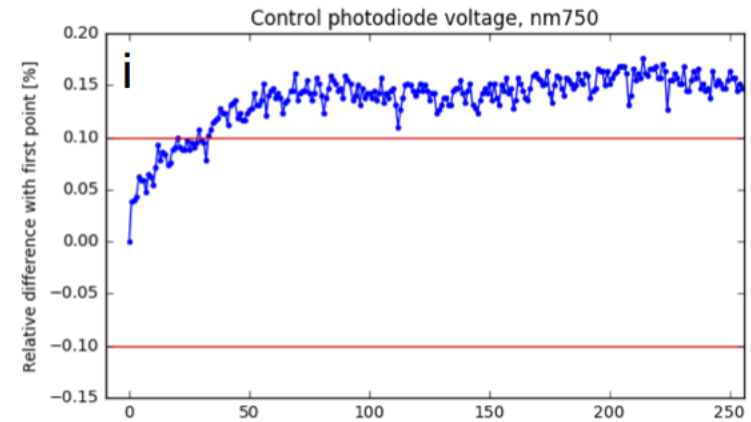
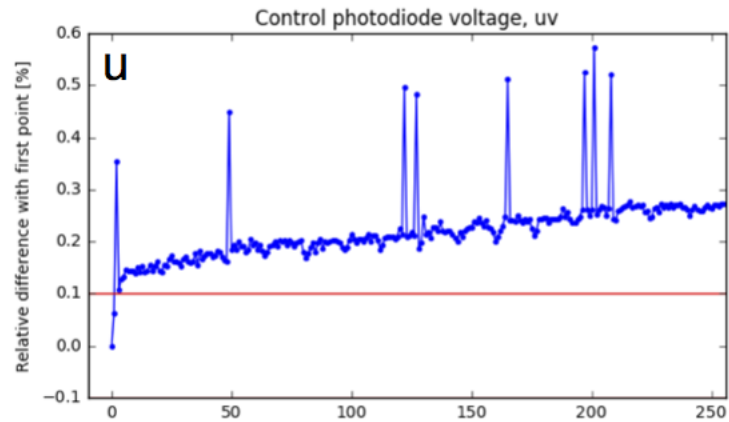
2. Stability

3. Analysis

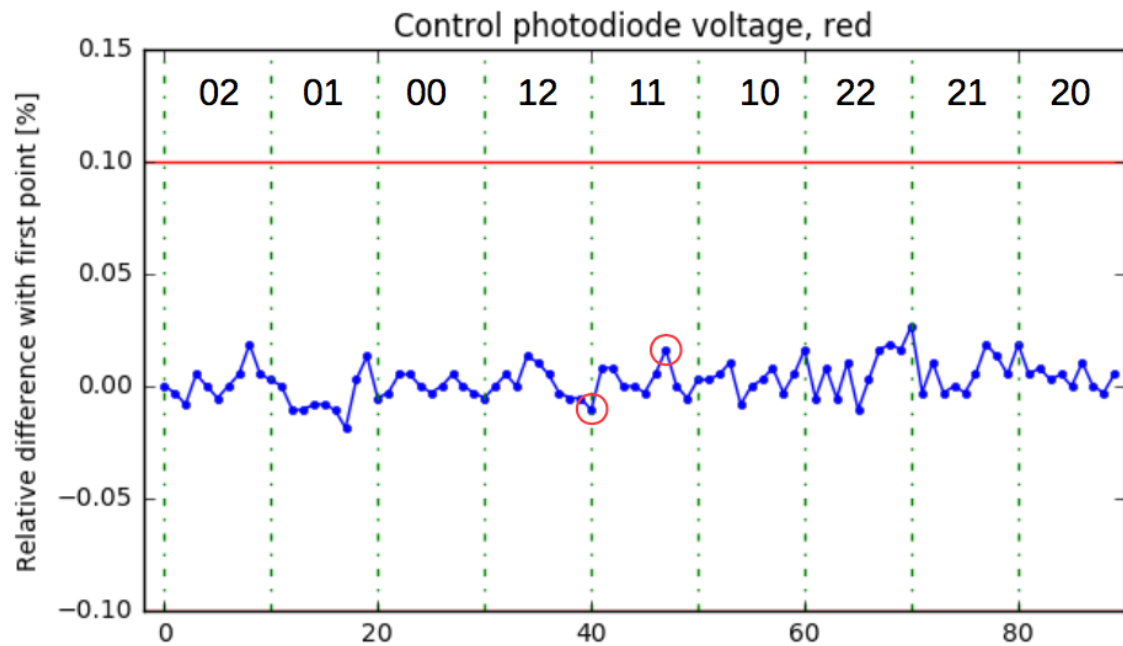
- CCOB-WB beam reconstruction
- Relative QE measurement and comparison to SLAC results



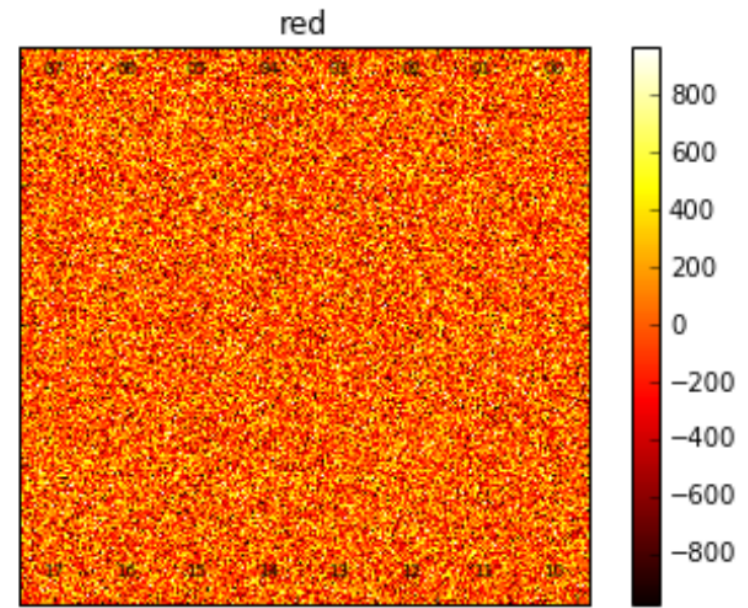
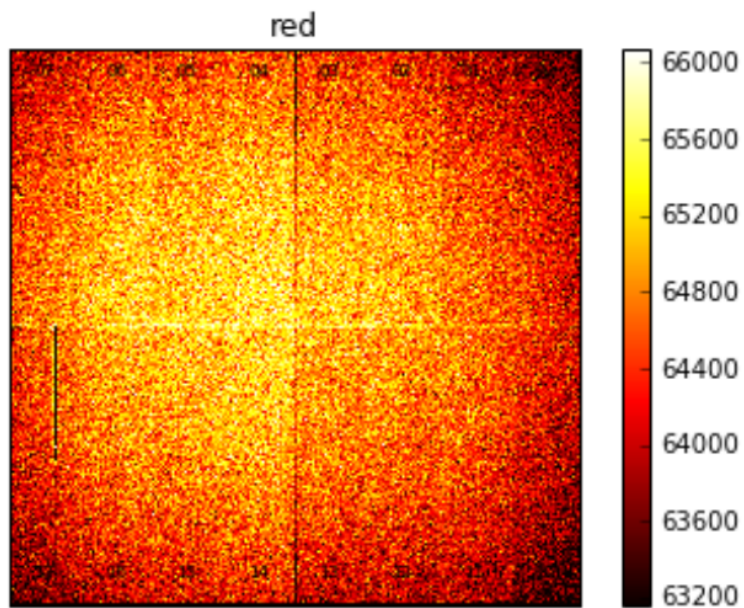
# Stability: control photodiode, 256 exposures ~1 hour



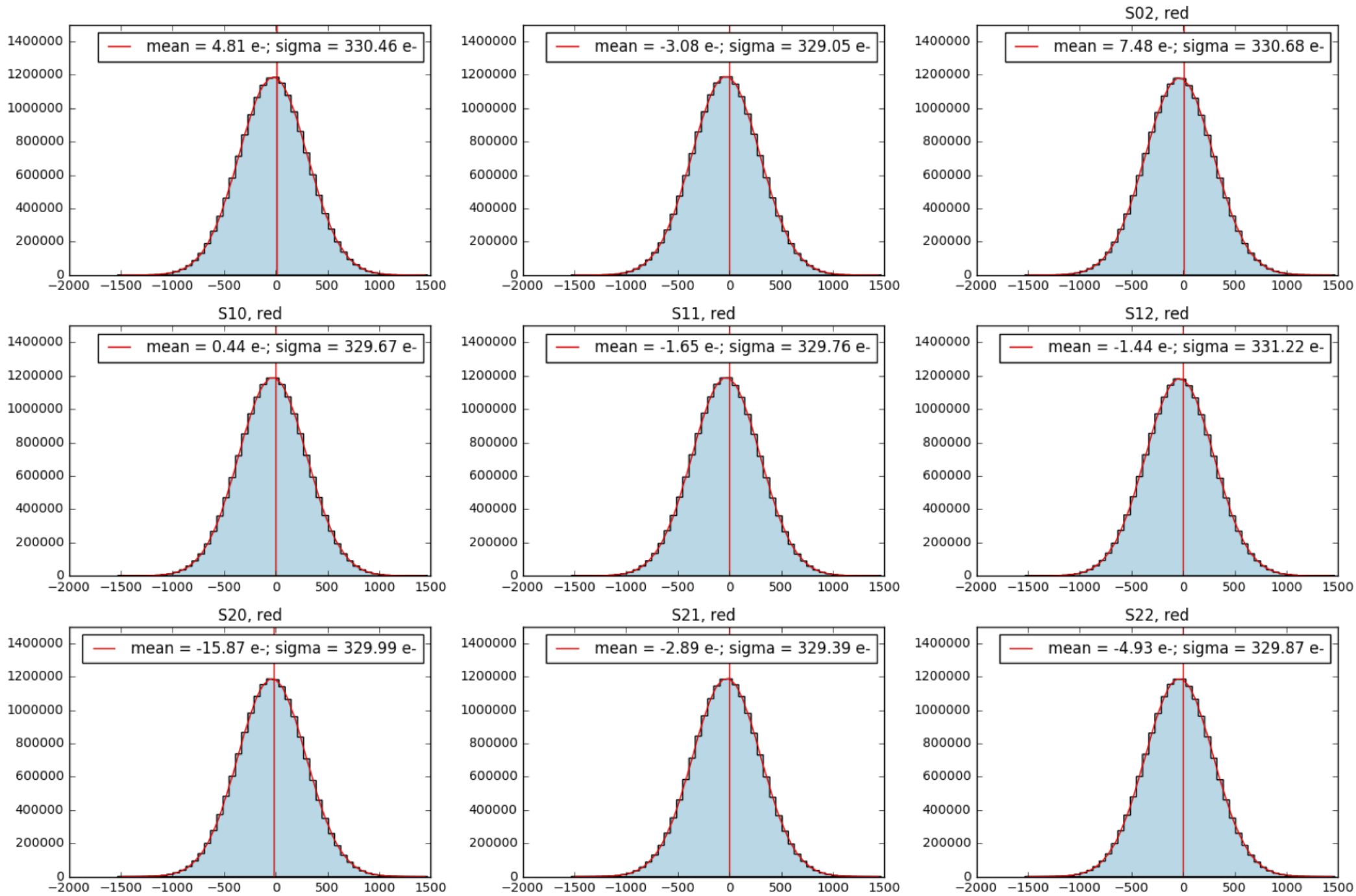
# Stability: image difference (red)



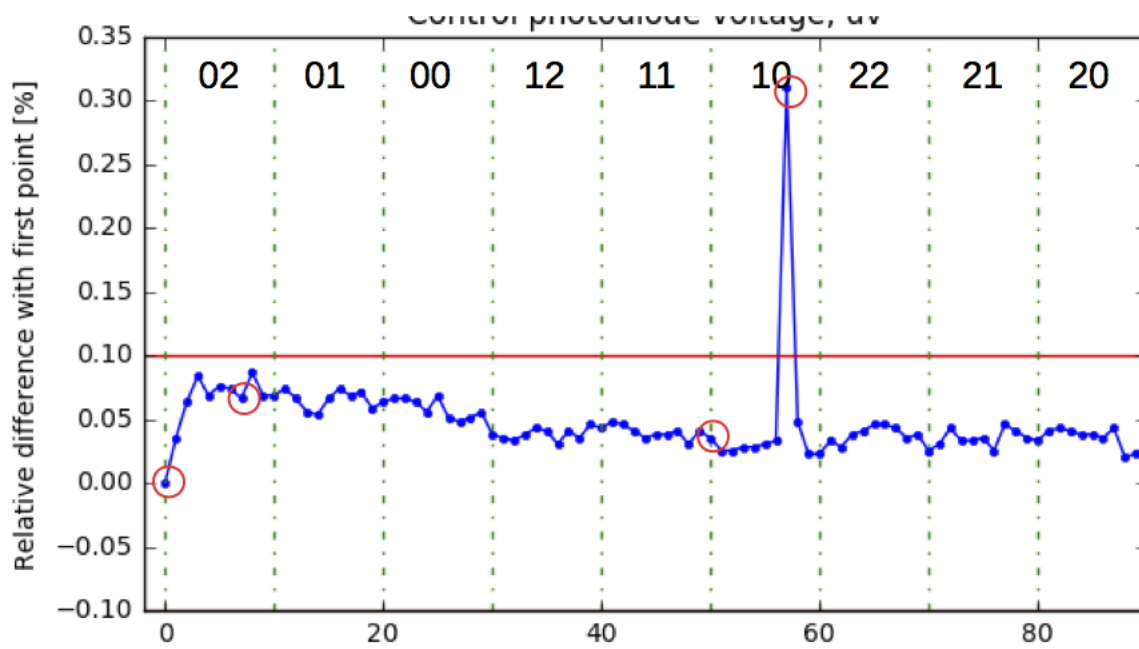
10 measurements/sensor



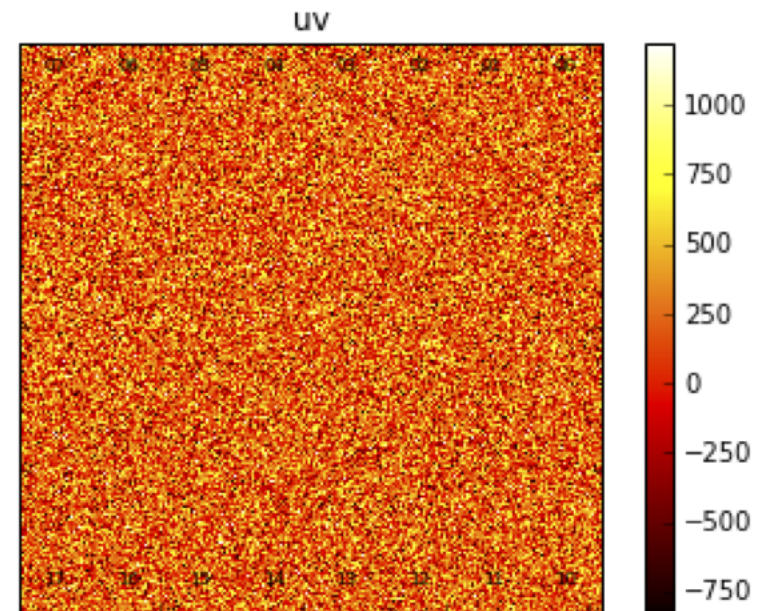
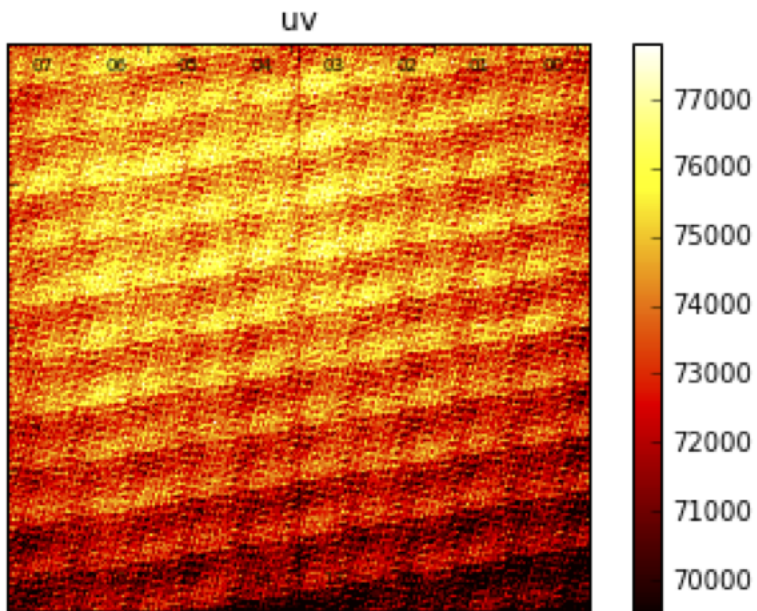
# Stability: image difference (red)



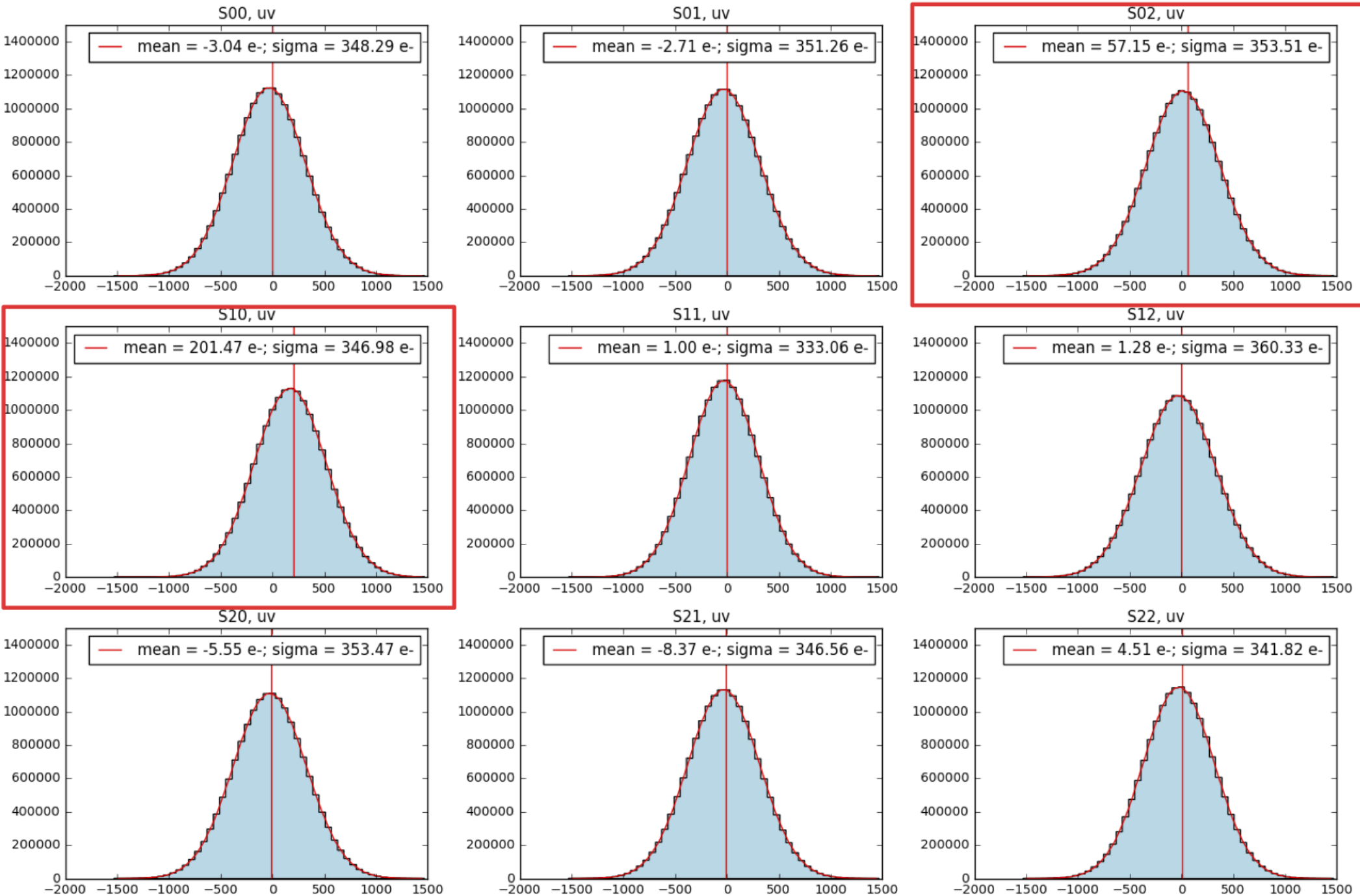
# Stability: image difference (uv)



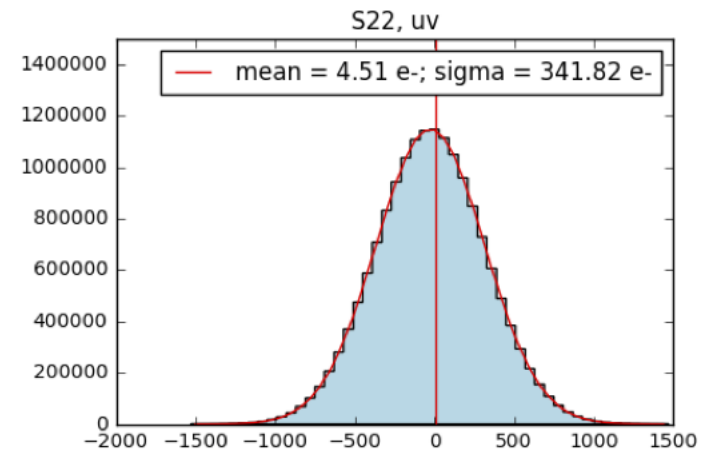
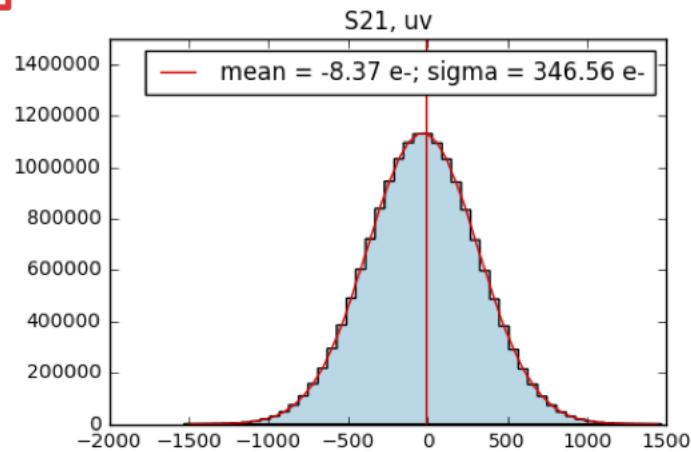
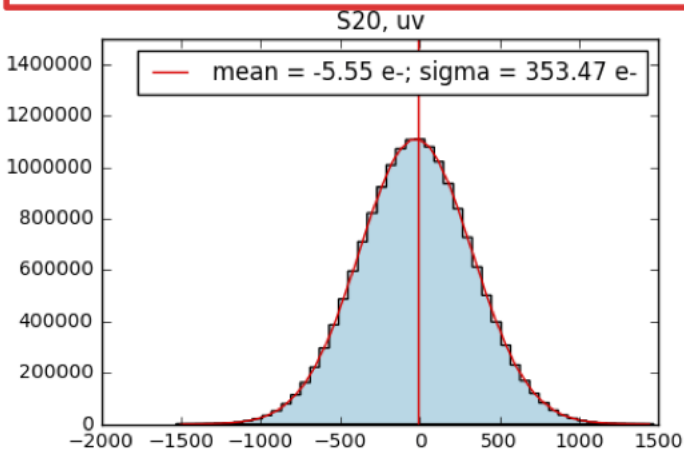
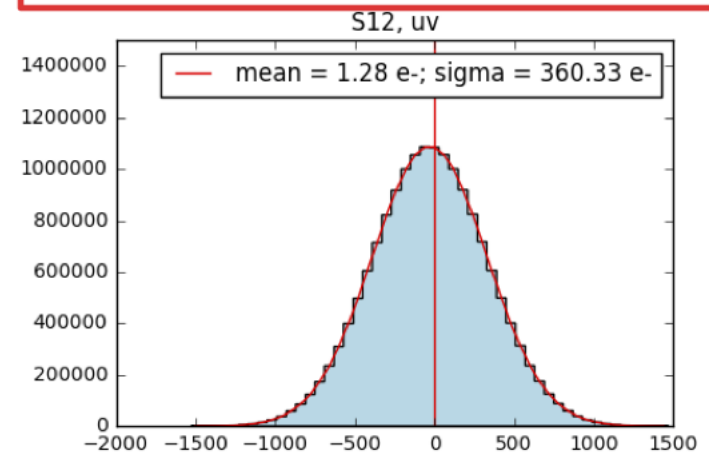
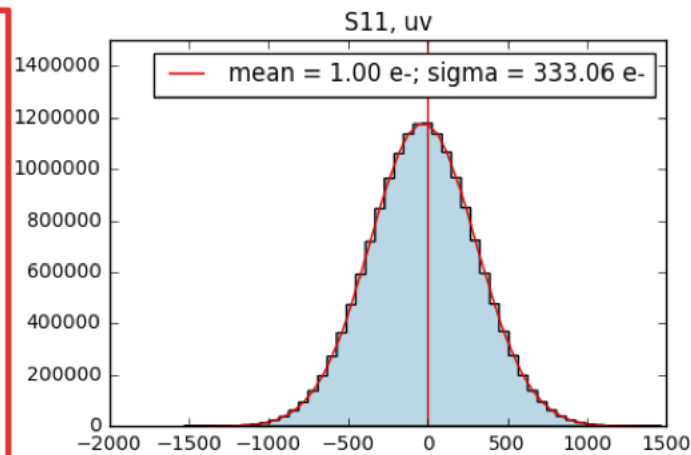
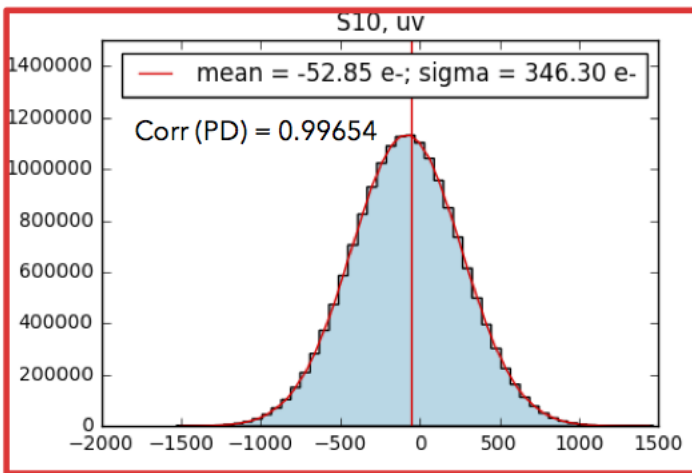
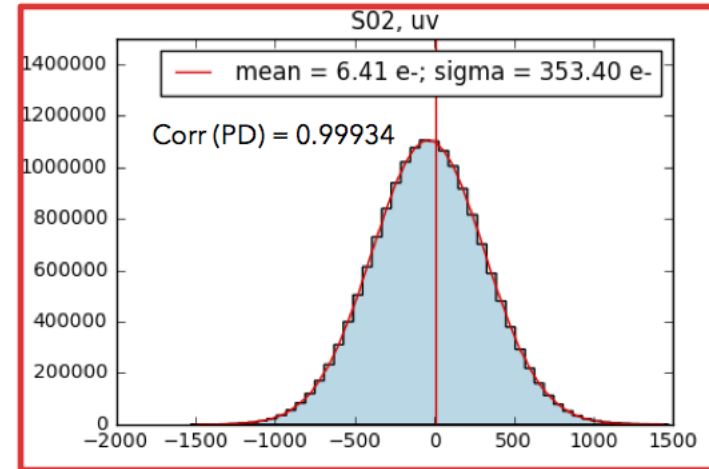
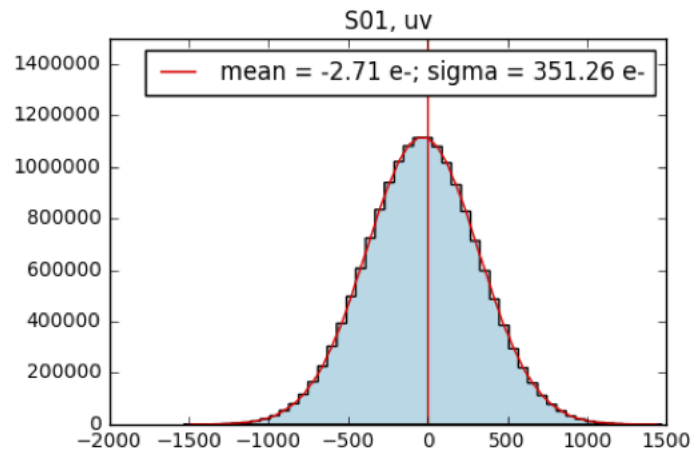
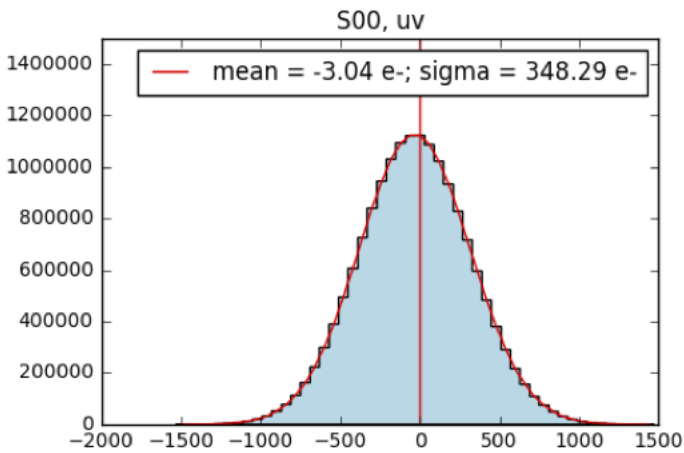
10 measurements/sensor



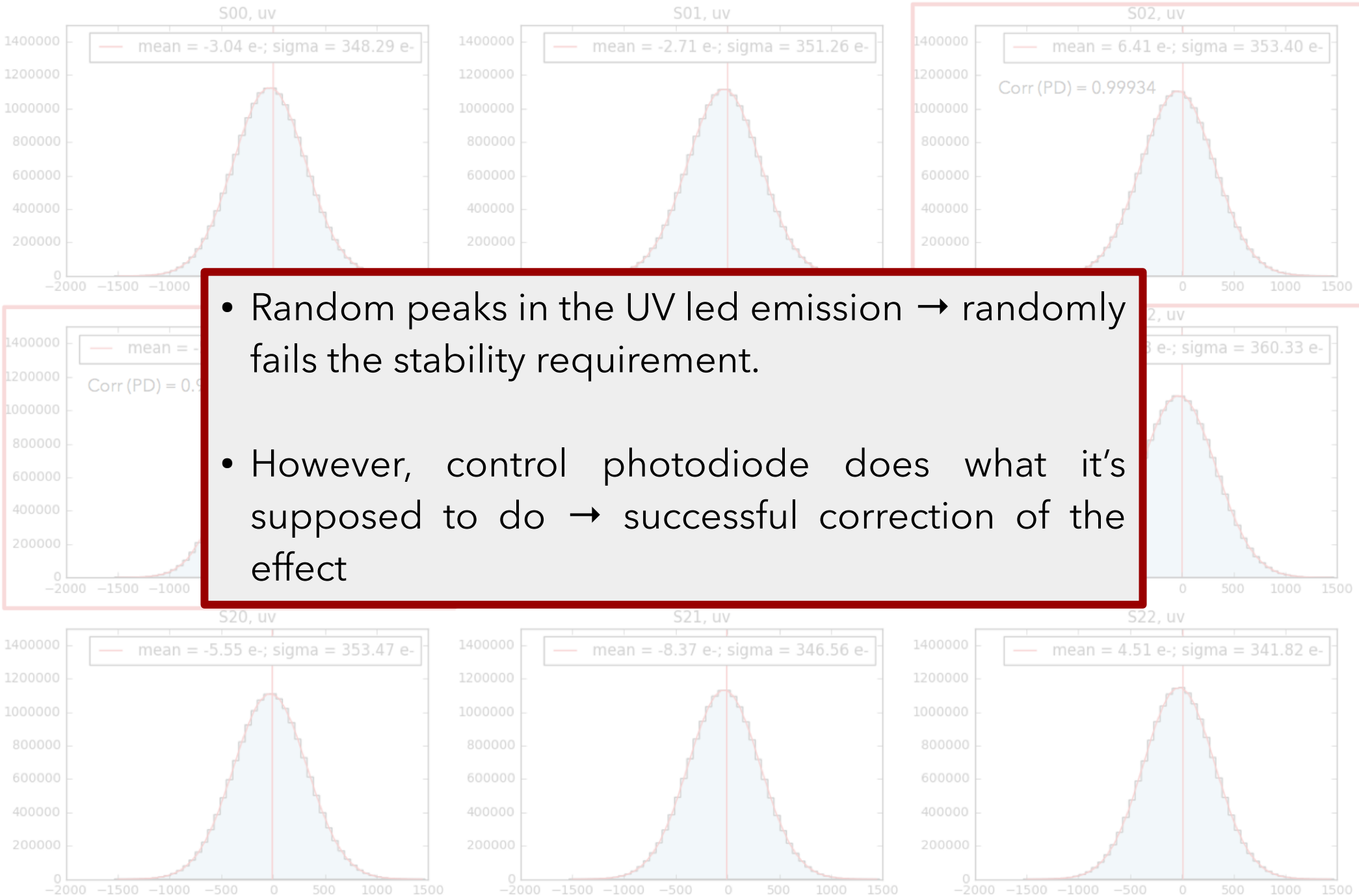
# Stability: image difference (uv)



# Stability: image difference (uv)



# Stability: image difference (uv)



- Random peaks in the UV led emission → randomly fails the stability requirement.
- However, control photodiode does what it's supposed to do → successful correction of the effect

1. CCOB-WB design, requirements and data@SLAC (so far)

2. Stability

3. Analysis

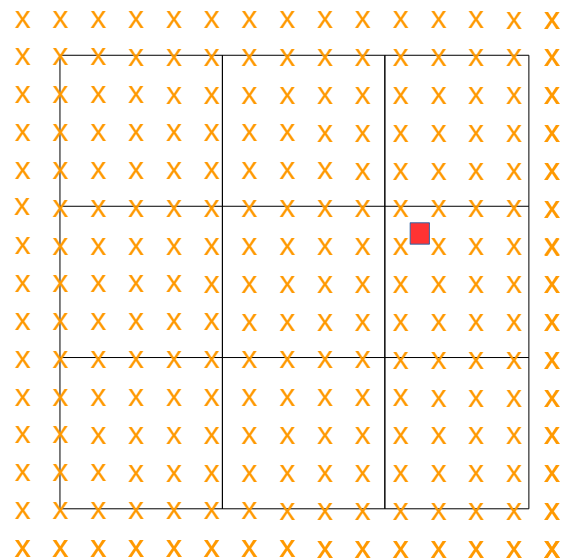
- CCOB-WB beam reconstruction
- Relative QE measurement and comparison to SLAC results



# Beam reconstruction

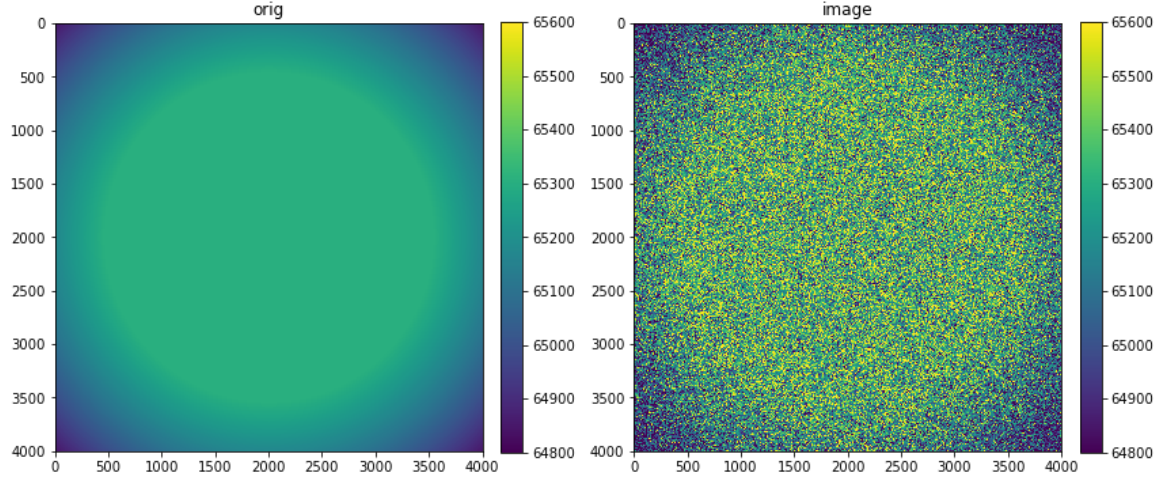
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- Original approach/idea: average the 189 images of the beam.
  - won't work if residual gain variations between amplifiers  $> 1\%$
  - won't work in the blue/uv because of annealing patterns
- Instead, use a single pixel (or bunch of pixels to reconstruct the beam)



# Beam reconstruction: simulations

CCOB-like simulated beam + Poisson noise

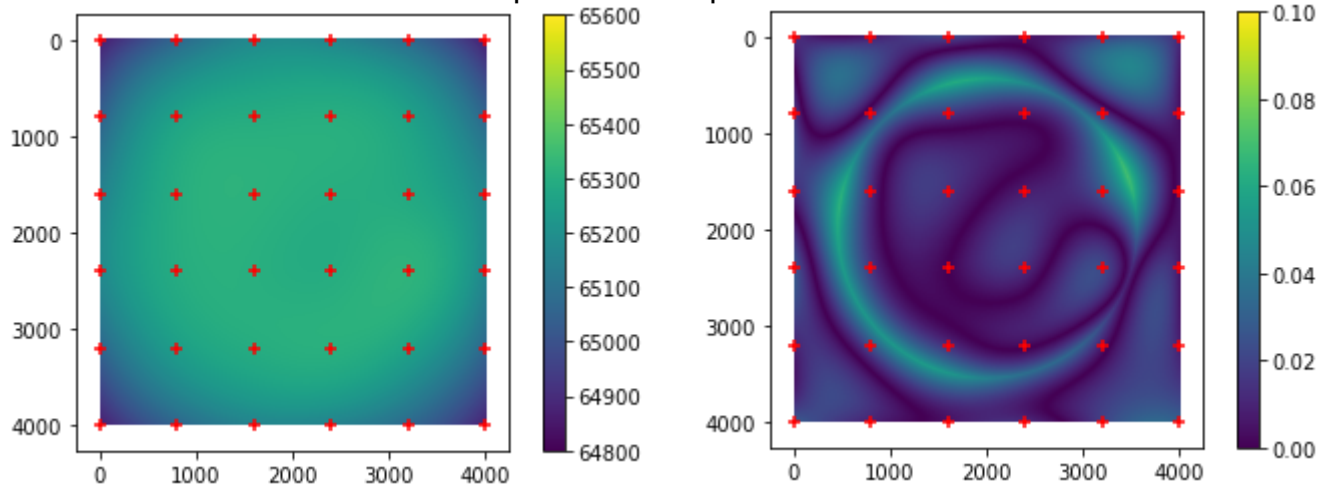


Average over 30 x 30 pixels to reduce the noise

Sample the beam at a few locations

Reconstruct using spline interpolations

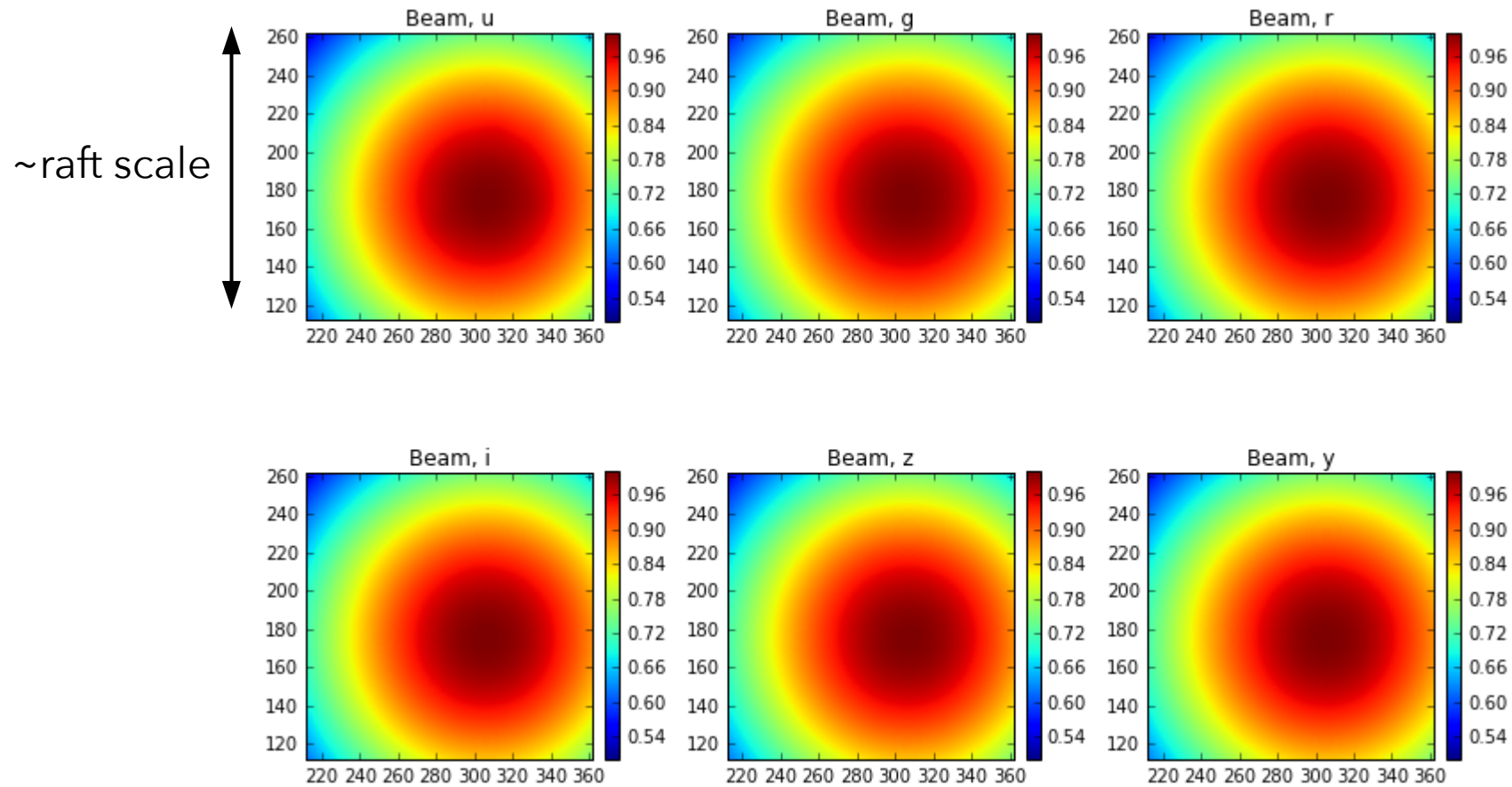
Reconstructed beam (spline interpolation) and residuals



Need a 6 x 6 sampling to reconstruct the beam at the per mil level at the CCD scale

More than the existing data set

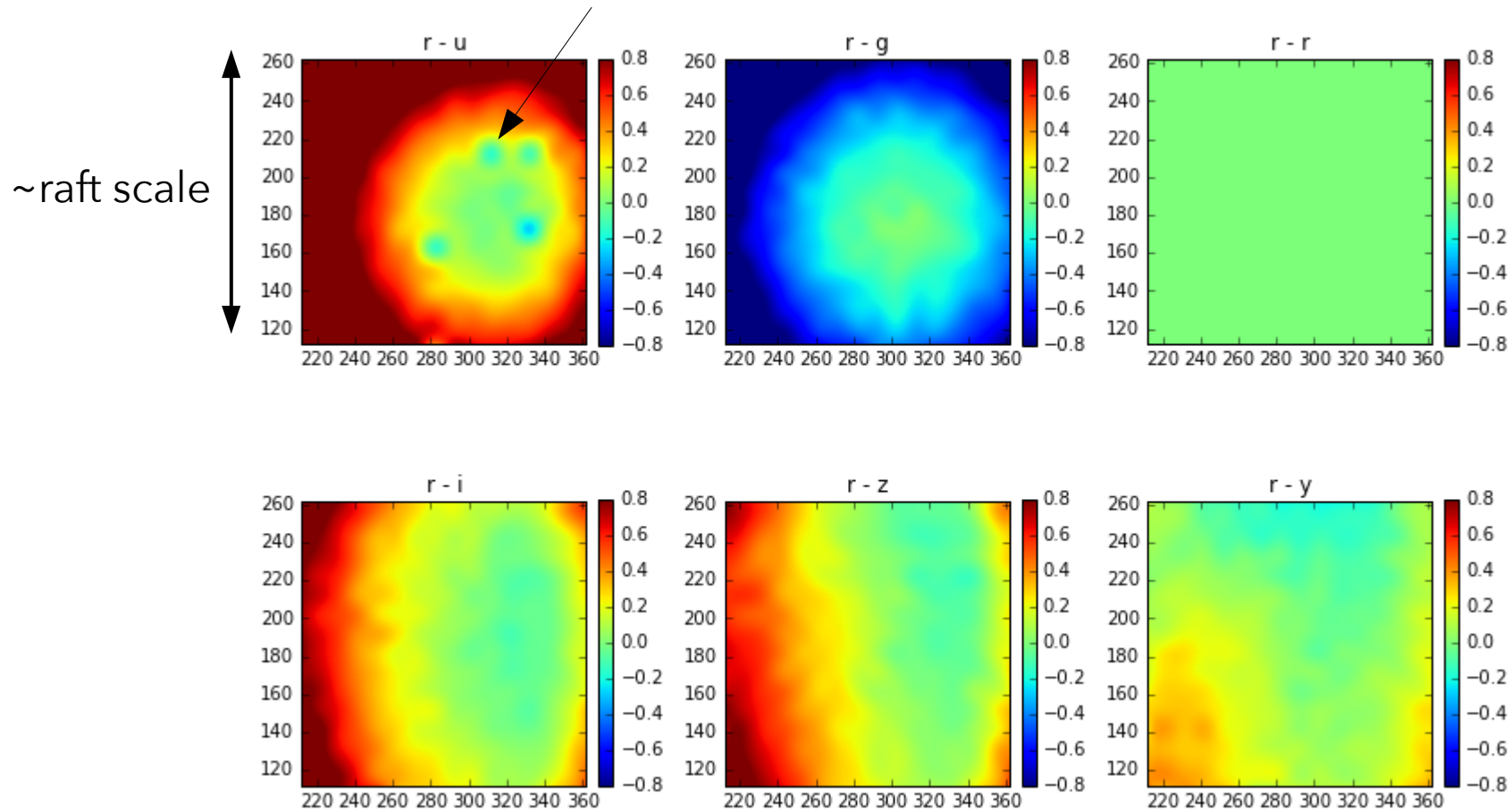
# Beam reconstruction: data (ref pixel in S11, amp #5 )



# Beam reconstruction: data (ref pixel in S11, amp #5 )

Beam difference w.r.t to red beam

UV data not corrected for emission peaks



Known effect from tests at LPSC:  $\neq$  LED  $\rightarrow$   $\neq$  beam shapes

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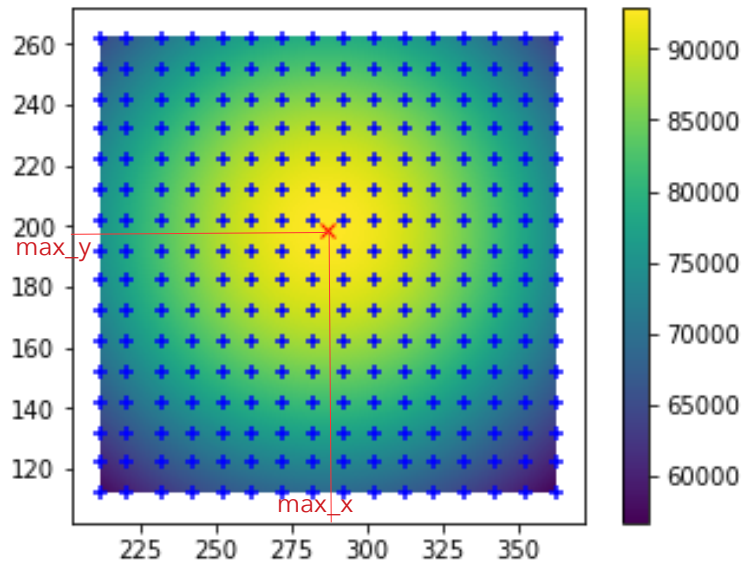
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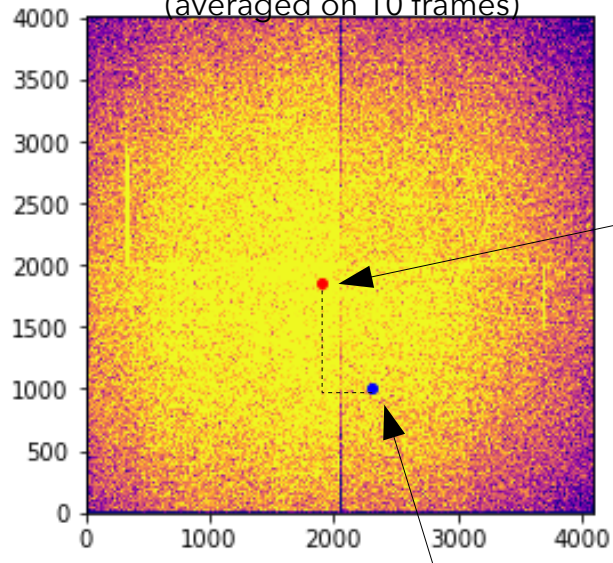
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# CCOB analysis

Beam model: reconstructed from a 30 x 30 pixel bunch



S11 illuminated by the CCOB  
(averaged on 10 frames)

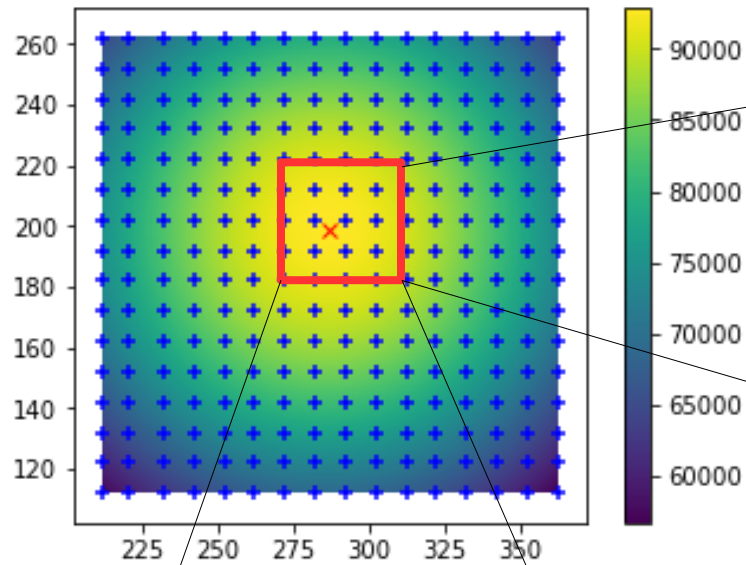


Position of the beam maximum given the position of the CCOB for that frame and the beam model max position.

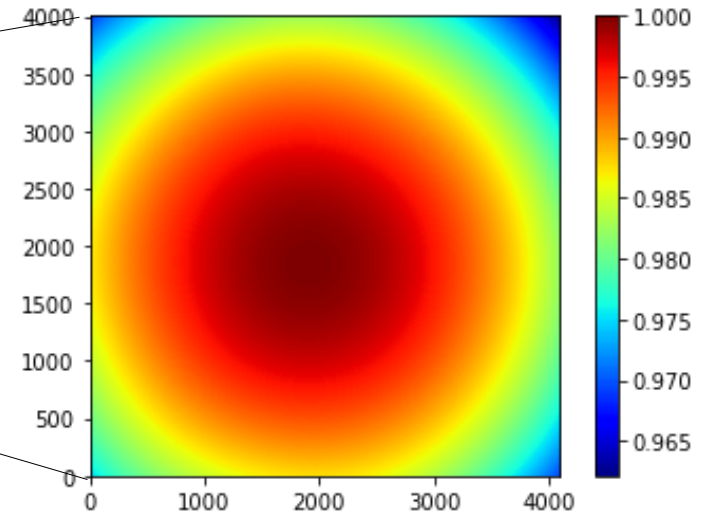
Pixel bunch used for the beam model

# CCOB analysis

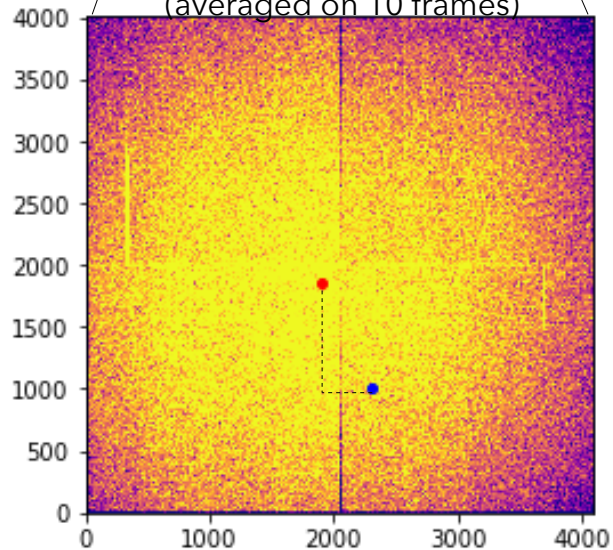
Beam model: reconstructed from a 30 x 30 pixel bunch



Beam model cropped and positioned to match data

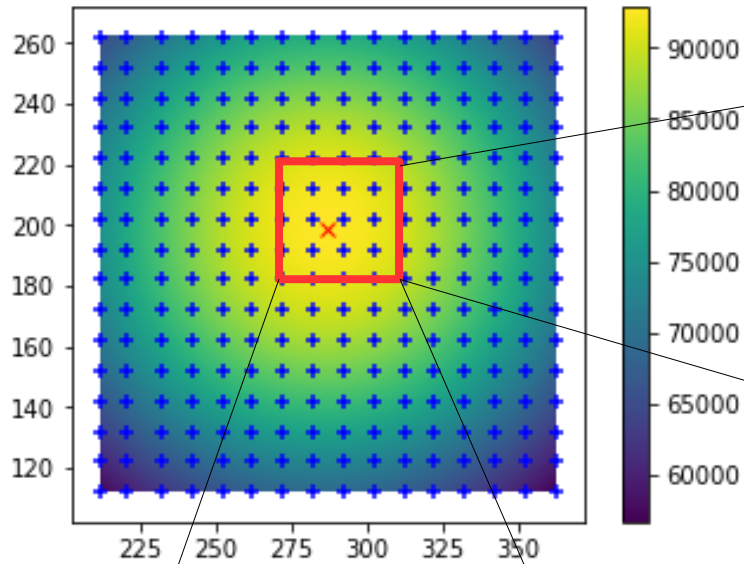


S11 illuminated by the CCOB  
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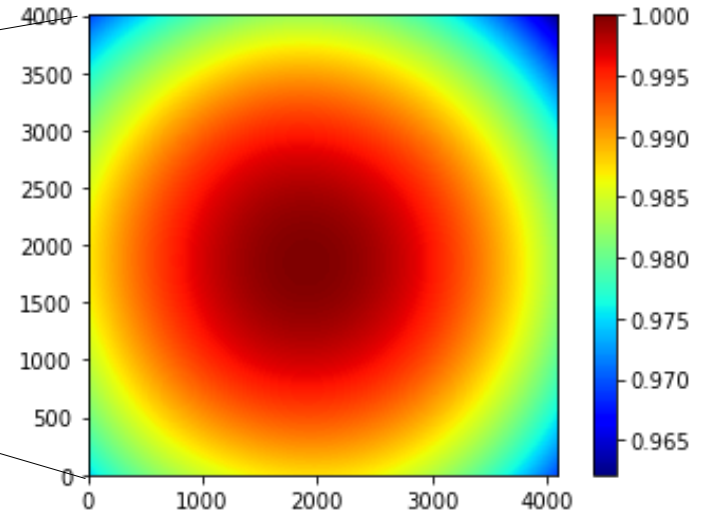


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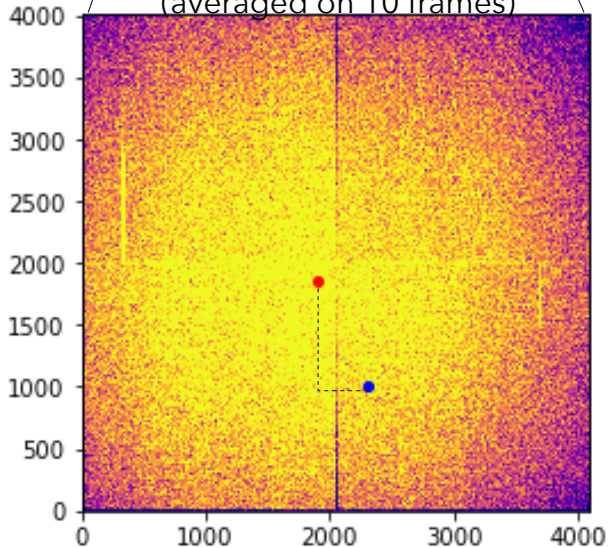
Beam model: reconstructed from a 30 x 30 pixel bunch



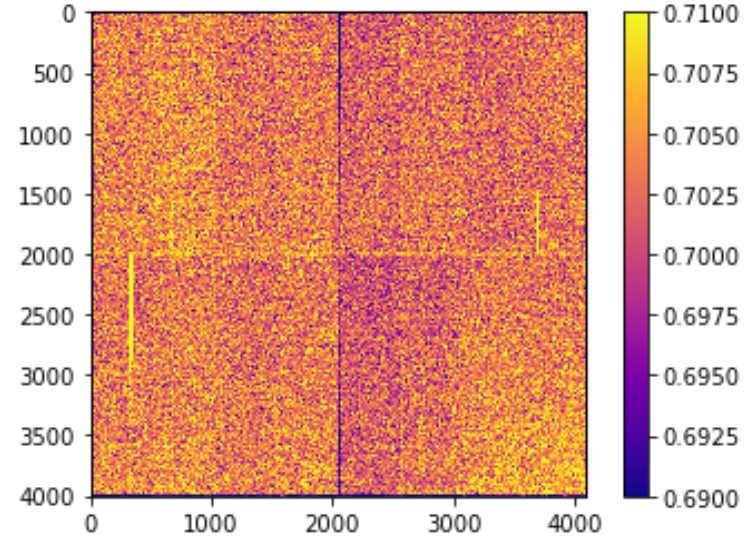
Beam model cropped and positioned to match data



S11 illuminated by the CCOB  
(averaged on 10 frames)



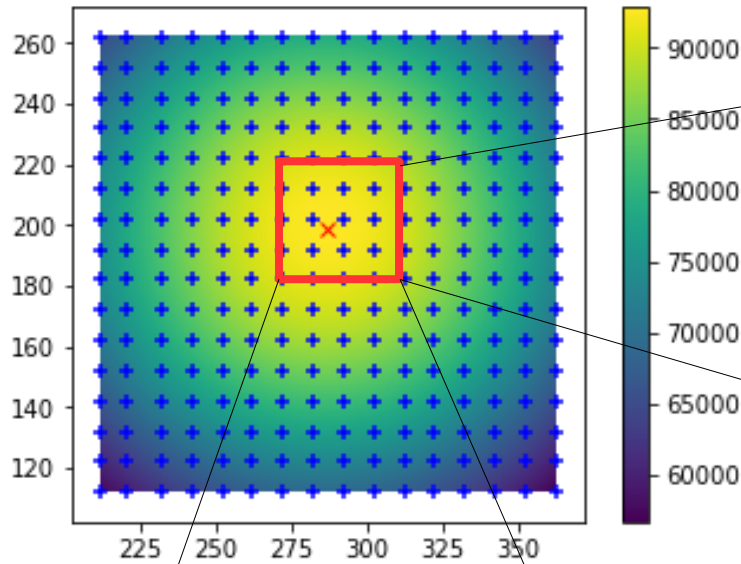
Flat field = data / beam model



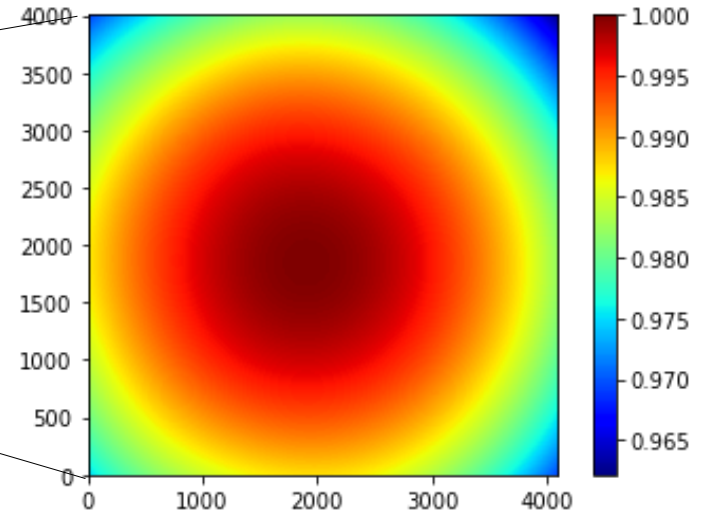


# CCOB analysis

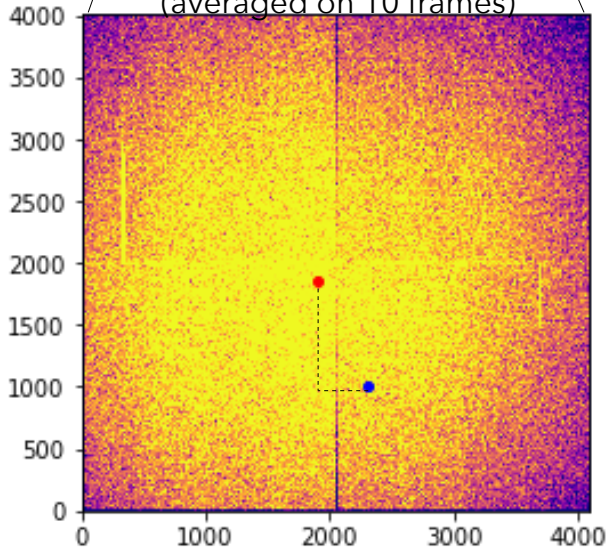
Beam model: reconstructed from a 30 x 30 pixel bunch



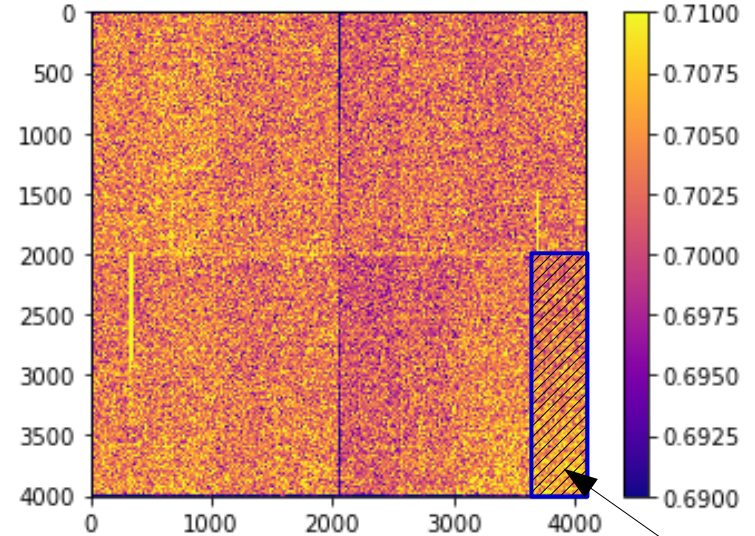
Beam model cropped and positioned to match data



S11 illuminated by the CCOB  
(averaged on 10 frames)



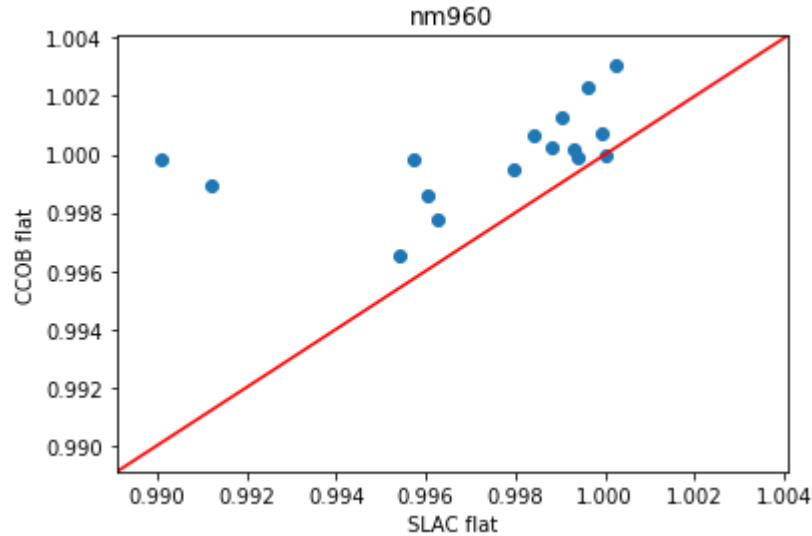
Flat field = data / beam model



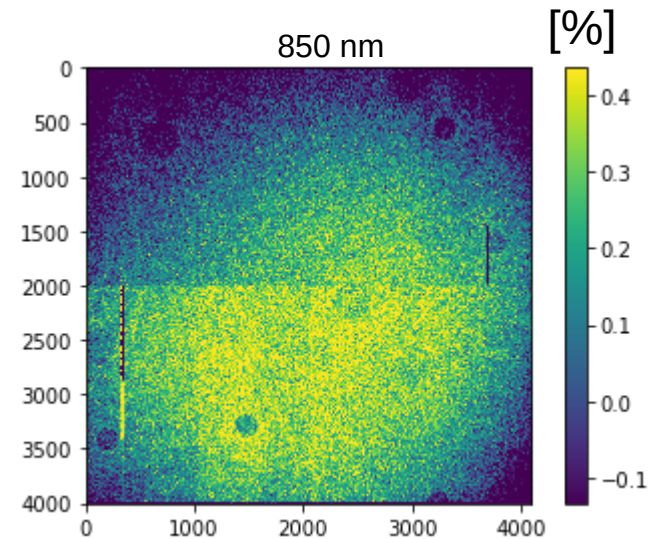
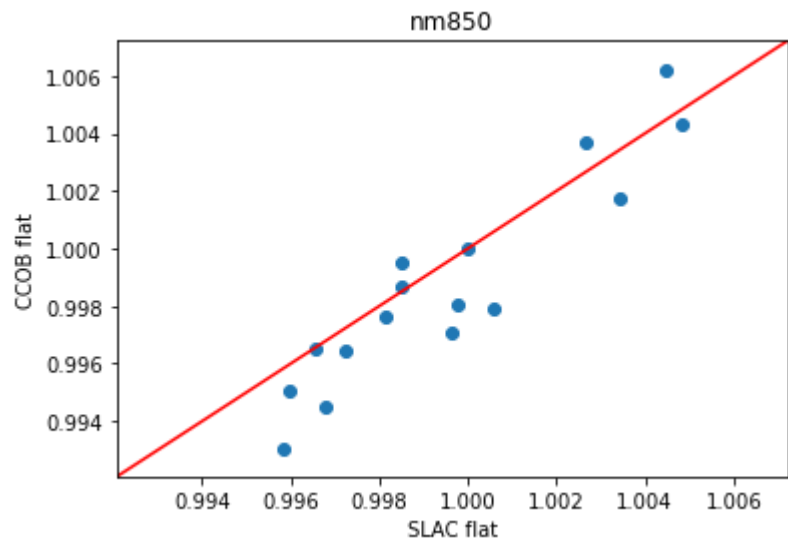
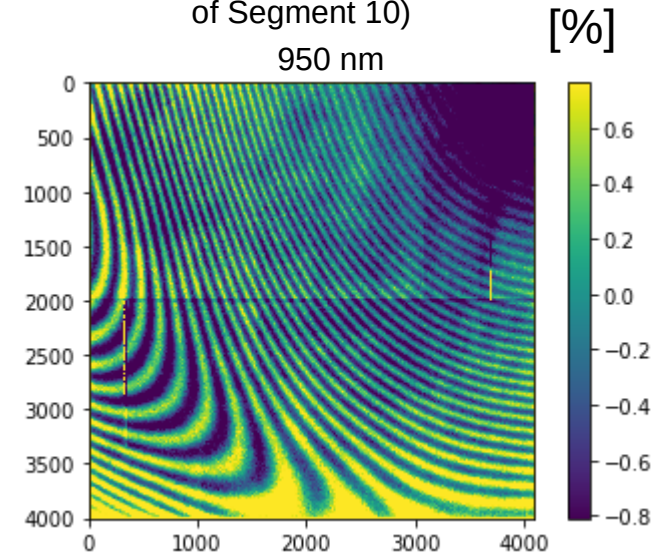
Use mean of Segment10  
as normalisation

# Comparison to TS8 flats

Scatter of all segment means (normalised to the mean of Segment 10)  
CCOB flat vs SLAC QE flat

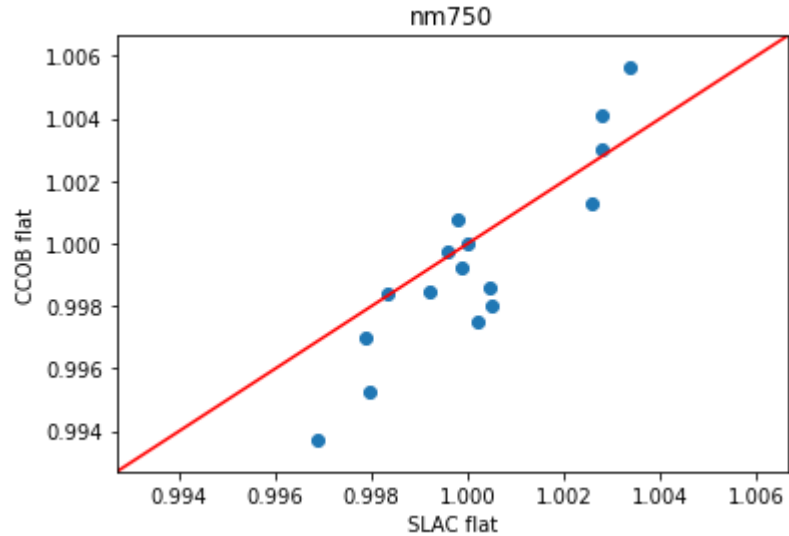


Relative difference between SLAC QE flat and CCOB flat (once normalised to the mean of Segment 10)

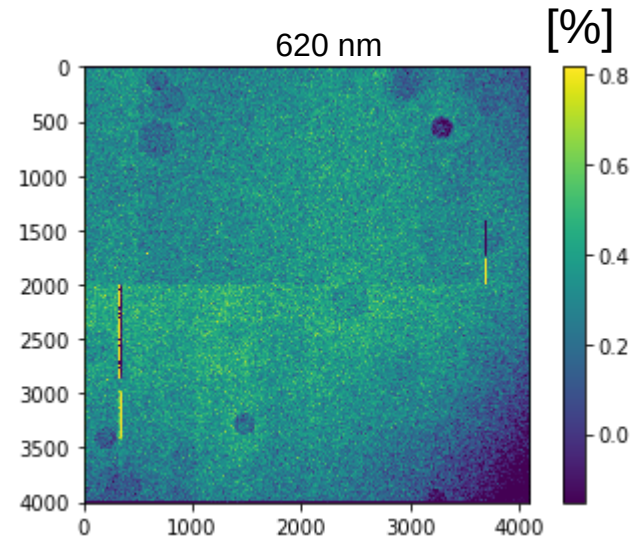
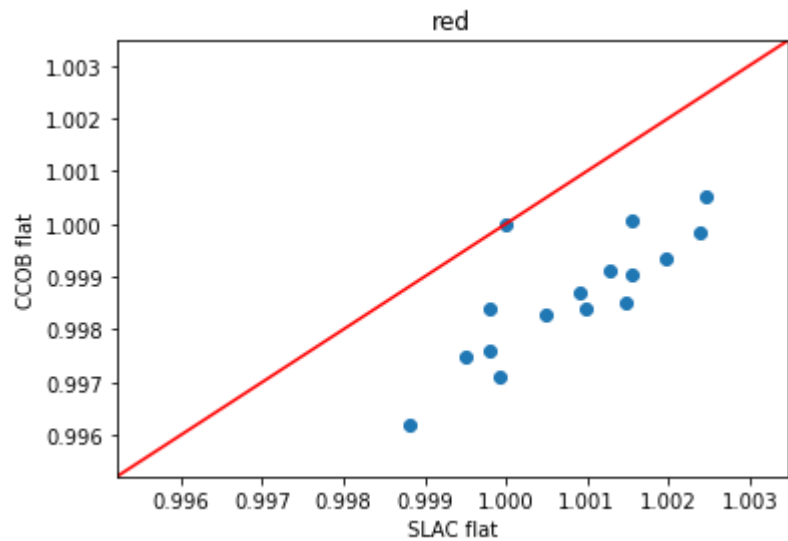
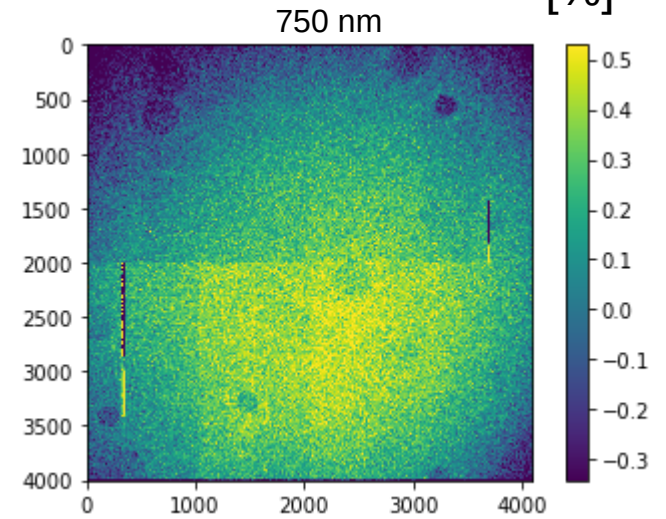


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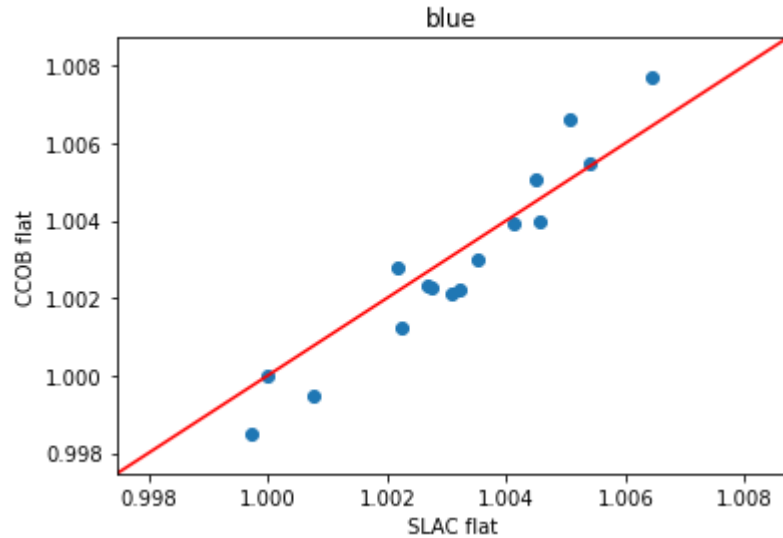


Relative difference between SLAC QE flat and CCOB flat (once normalised to the mean of Segment 10)

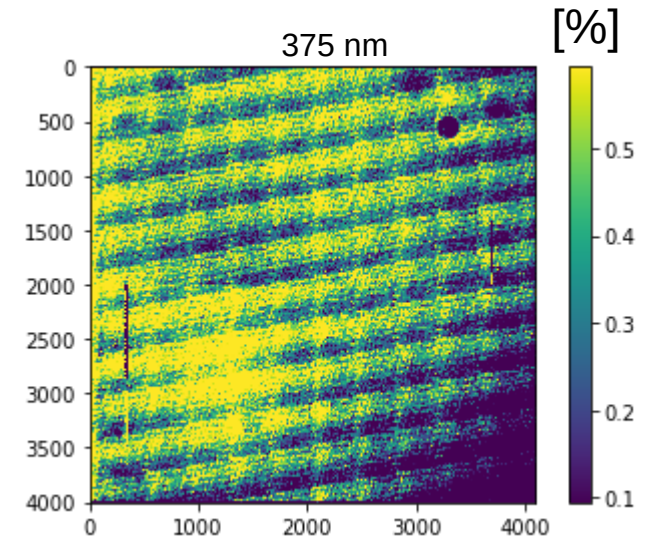
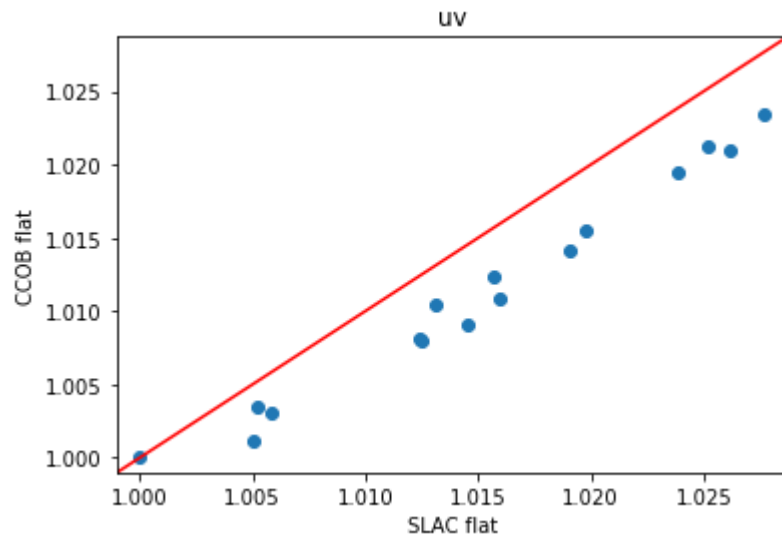
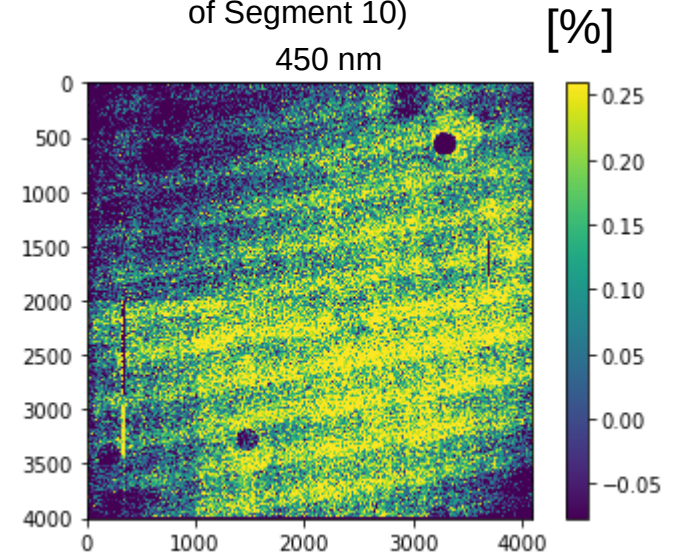


# Comparison to TS8 flats

Scatter of all segment means (normalised to the mean of Segment 10)  
CCOB flat vs SLAC QE flat



Relative difference between SLAC QE flat and CCOB flat (once normalised to the mean of Segment 10)



# Conclusions

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- Stability of the beam (after photodiode correction) looks good
- Comparison to TS8 flats look promising but, beam shape still visible in the relative difference maps → Beam probably not sufficiently sampled in the current data to allow reconstruction at the per mil level at the full CCD scale (sims suggest at least 6 x 6 points required over the span of a CCD).
- Presented only results for S11 of RTM-006. With the current data (symmetry around S11), beam reconstruction is degraded when using reference pixels in the other sensors.
- Limitation: at the moment, the bunch of pixels for the reconstruction needs to be in the same sensor. Will need to have full focal plane geometry to apply this “geometrical” approach across rafts and the full focal plane