

The XY Scanner

Long Term Performance Meeting 19 May 2020

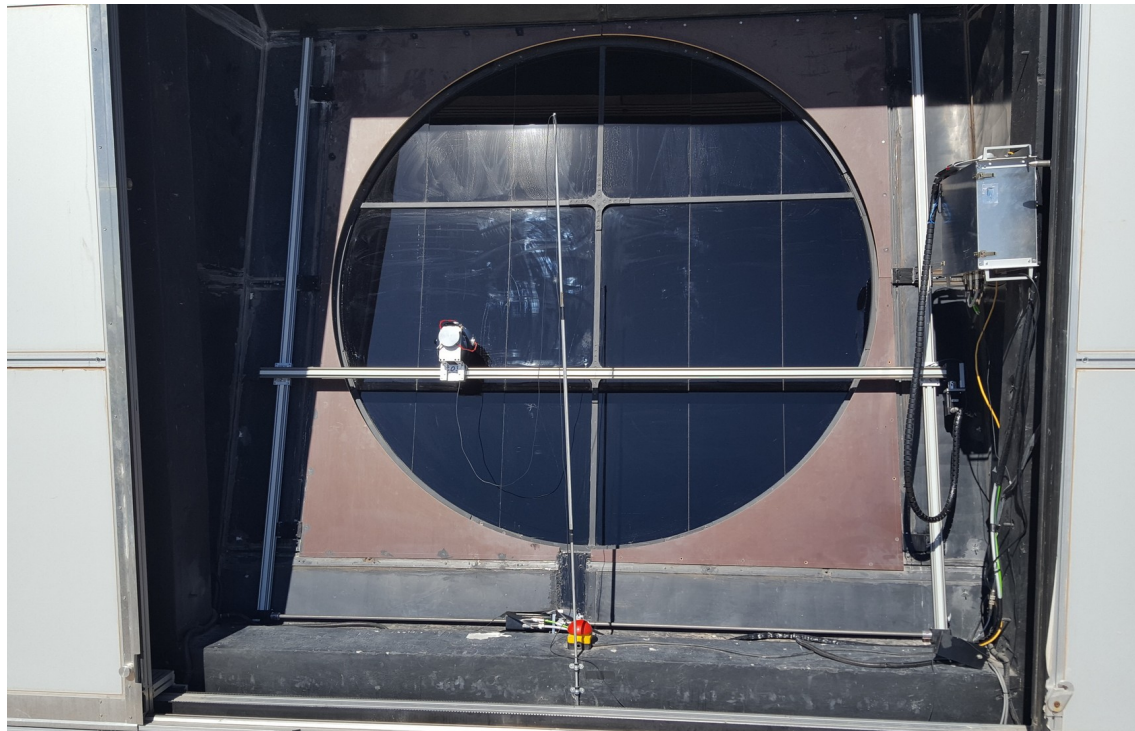
Christoph Schäfer for the XY scanner working group

K.-H. Becker, J. Berens, H. Bolz, L. Chytka, K. Daumiller, J. Debatin, R. Engel, T. Heibges, P. Horváth, M. Hrabovský, K.-H. Kampert, H. Klages, M. Kleifges, L. Kocián, D. Mandát, H.-J. Mathes, E. Mayotte, A. Menshikov, S. Michal, M. Palatka, M. Pech, J. Rautenberg, M. Roth, C. Schäfer, P. Schovánek, J. Šupík, M. Toron, R. Ulrich, M. Unger, M. Vacula, D. Veberič

Karlsruhe Institute of Technology, Palacký University Olomouc, Bergische Universität Wuppertal

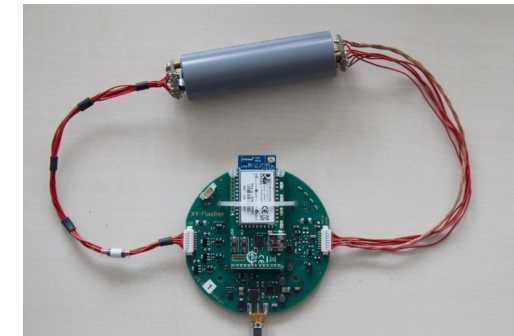
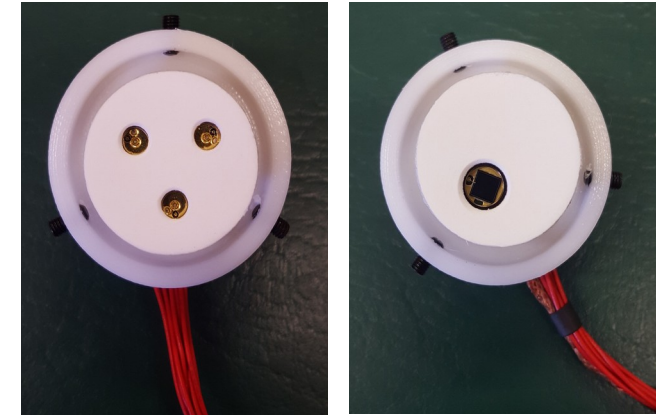
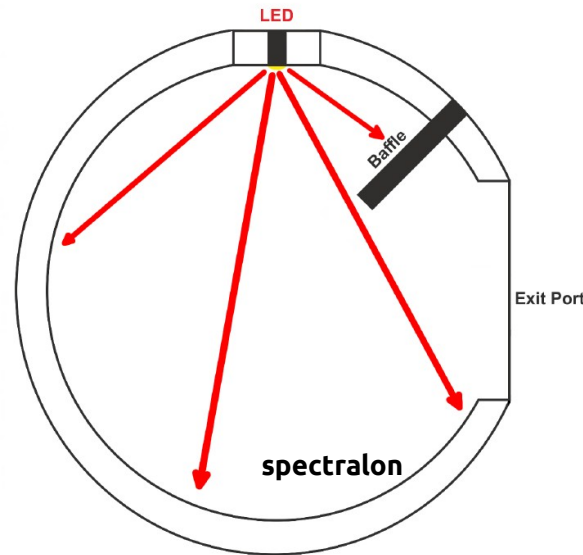
XY-Scanner Setup

- Replacement of drum by smaller light source
- Sum of many measurements at different positions should give similar results
- Light source portable
- Calibration on- and off-site possible

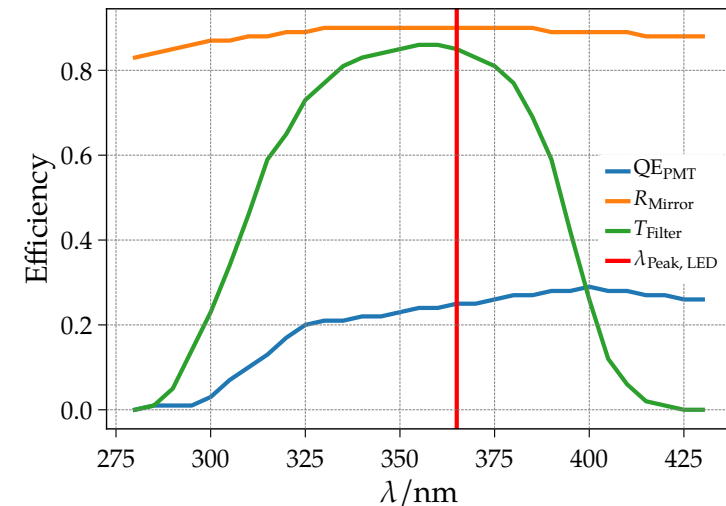


- Steerable light-source moved in front of the aperture
- Y-axes fixed at telescope
- X-axis with light source and electronics removable
- 2 X-axes per building

Calibration Light Source



- Ulbricht sphere by Labsphere (Ø 5.3 inch)
- Lambertian light source
 - 3 Roithner Lasertechnik UVLED365-110E
 - $\lambda_{\text{Peak}} \approx 365 \text{ nm}$, FWHM $\approx 15 \text{ nm}$
 - 5 μs long pulses
 - Temperature stabilized
- 1700 position of the scanner



March 2020 Campaign

- Interrupted and discontinued right after the start
 - 3 new systems installed at CO
- No calibration measurements performed in March 2020
- Issue(s) with WiFi communication not resolved



Status at the Observatory

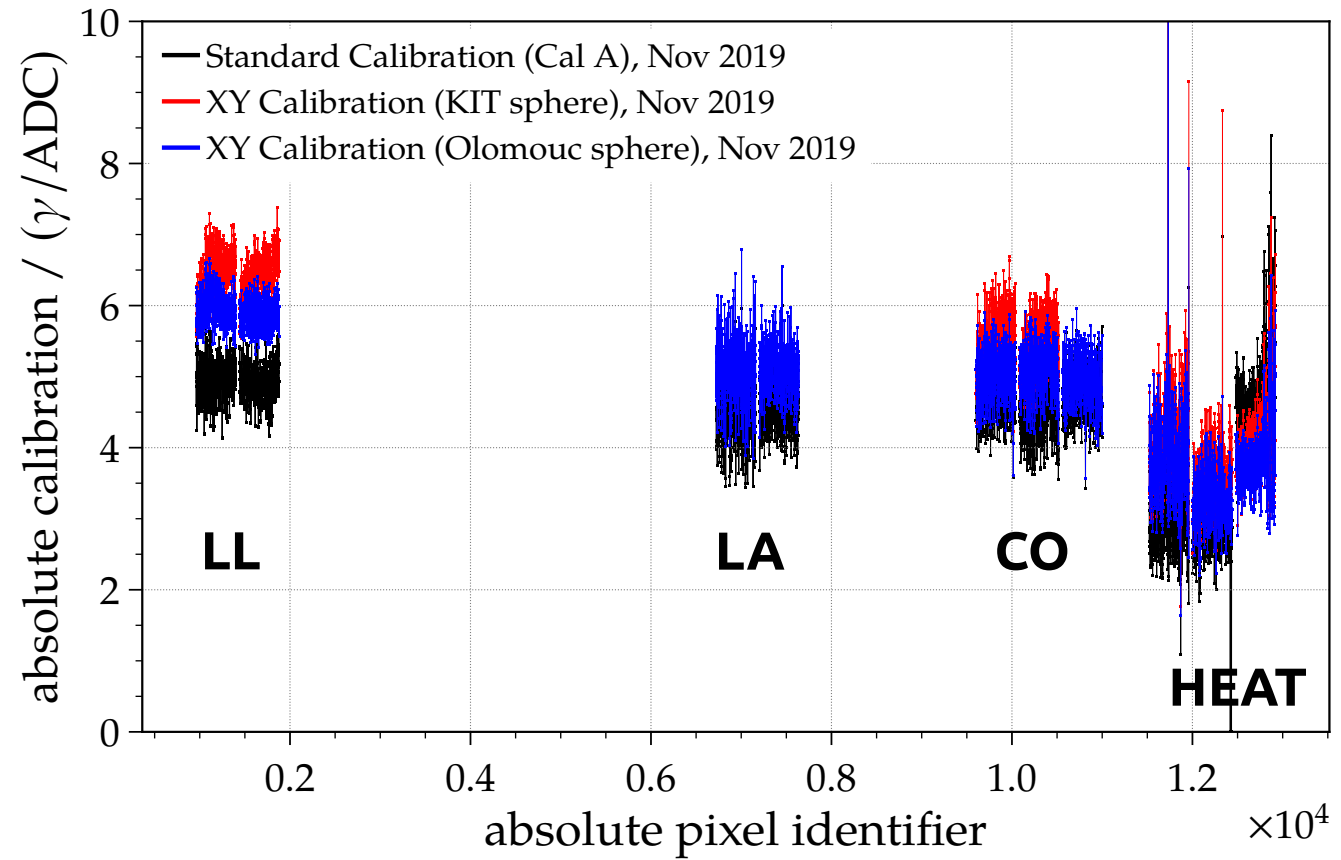
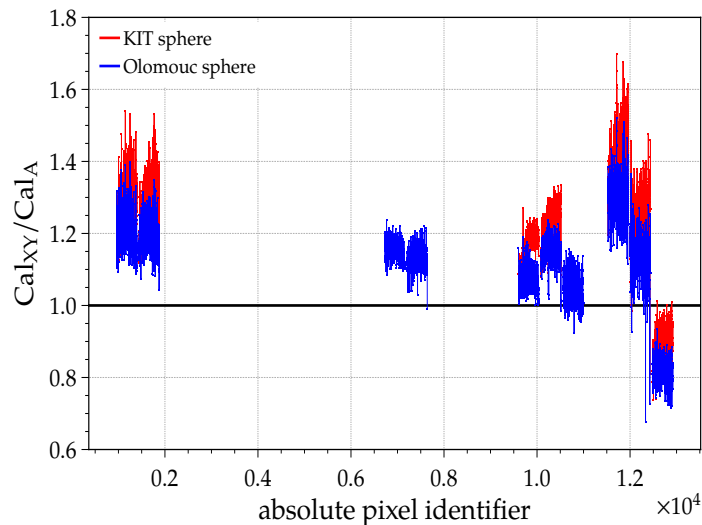
	Installed / Meas. ready	KIT sphere	Olomouc sphere	CB
LL3	Mar 19	X	X	(X)
LL4	Mar 19	X	X	(X)
LA3	Mar 19 / Nov 19		X	
LA4	Mar 19 / Nov 19		X	
CO1	Mar 20 / ??			
CO2	Mar 20 (almost) / ??			
CO3	Nov 18	X	X	
CO4	Mar 18	X	X	
CO5	Nov 19 / Nov 19		X	X
CO6	Mar 20 / ??			
HE1	Nov 18	X	X	
HE2	Mar 19	X	X	
HE3	Mar 19	X	X	

In total 13 systems

Absolute Calibration

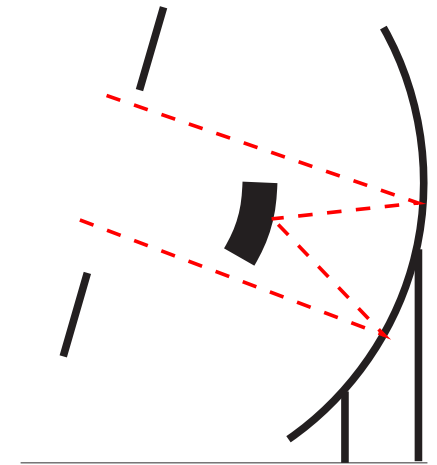
- Results are preliminary
- No errors taken into account
- Assumes ideal Lambertian light source which is not valid for the used integrating spheres
- Sphere calibrations performed in Wuppertal
- Photons per pulse:

$$N_{\gamma, \text{Olomouc}} \approx 2.353 \cdot 10^9$$
$$N_{\gamma, \text{KIT}} \approx 2.337 \cdot 10^9$$

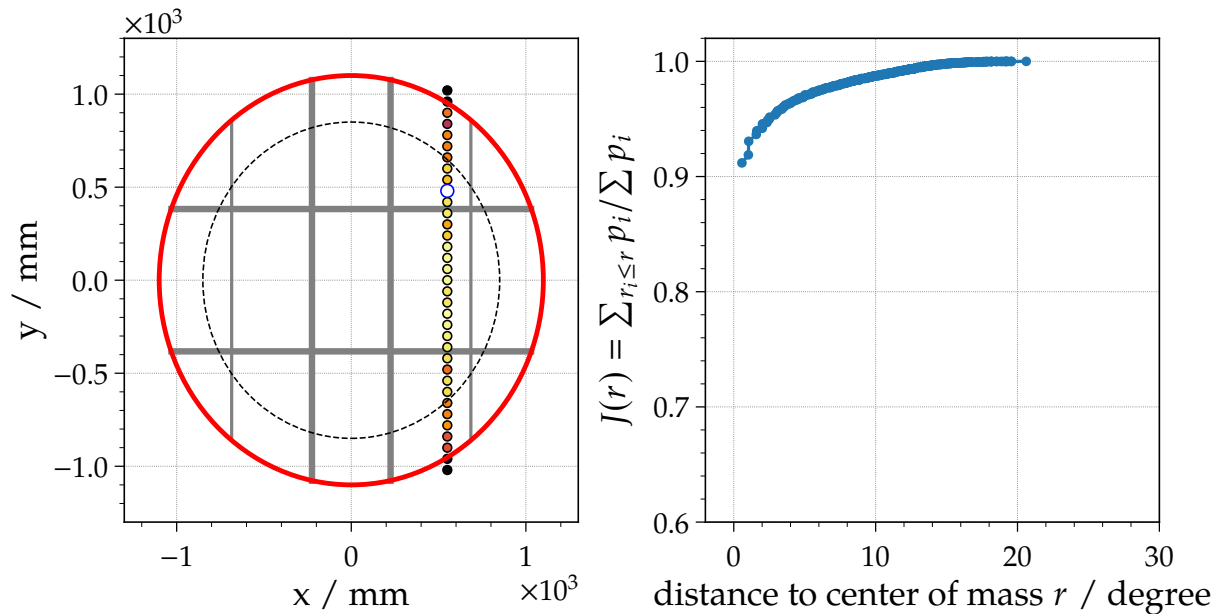
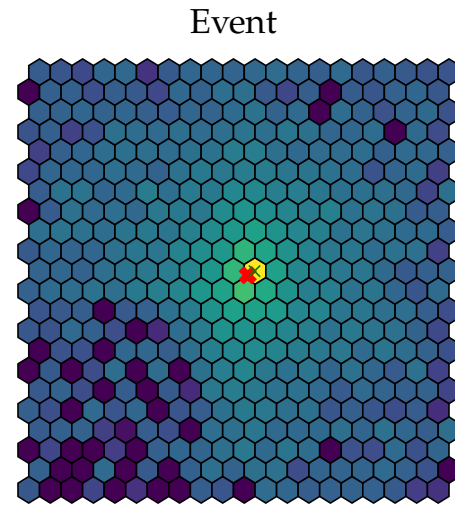
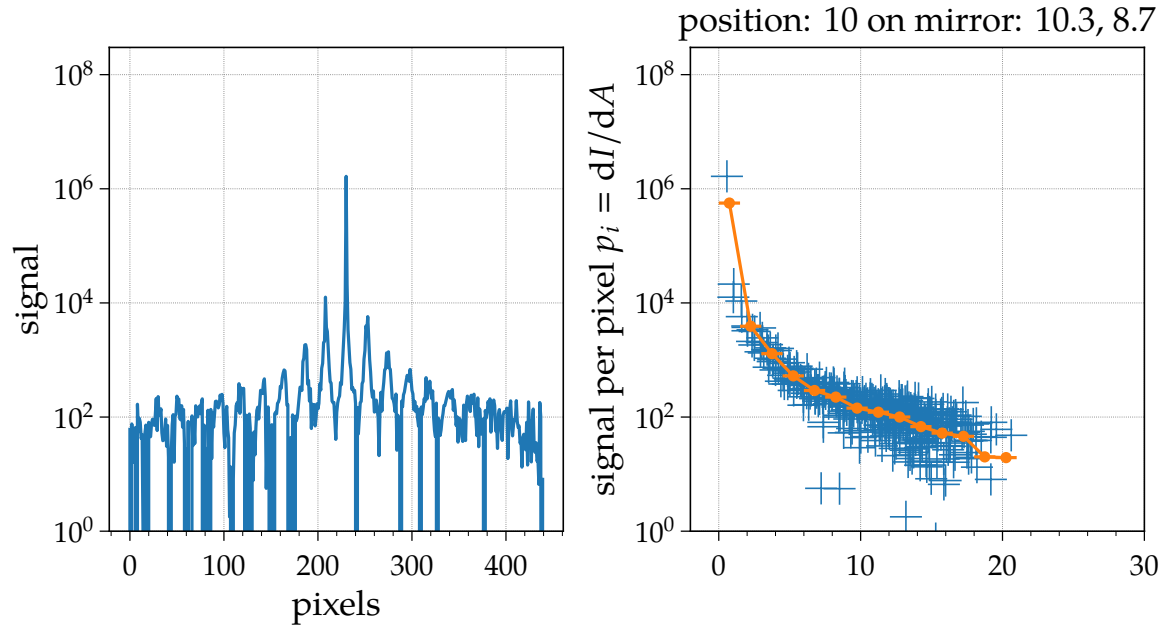


Collimated Beam (CB)

- Measure the PSF for telescopes
- Light scattering on dust layers on mirror
- Developed by the Olomouc group
- First test measurements performed in November 2019
- Measurements were planned for interrupted and discontinued March 2020 campaign

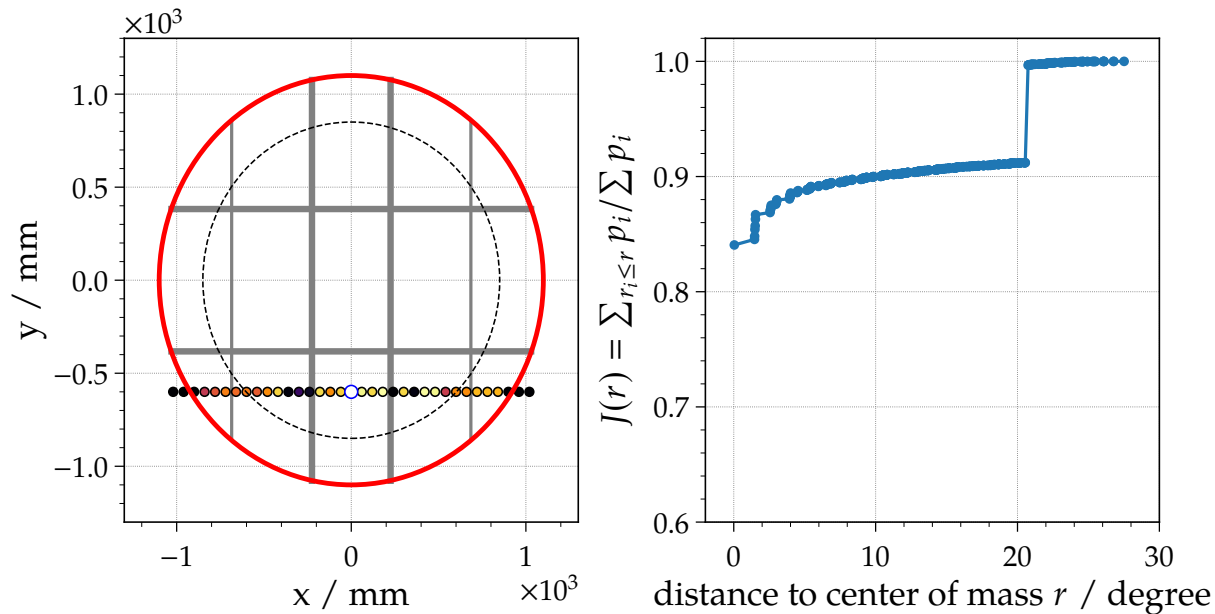
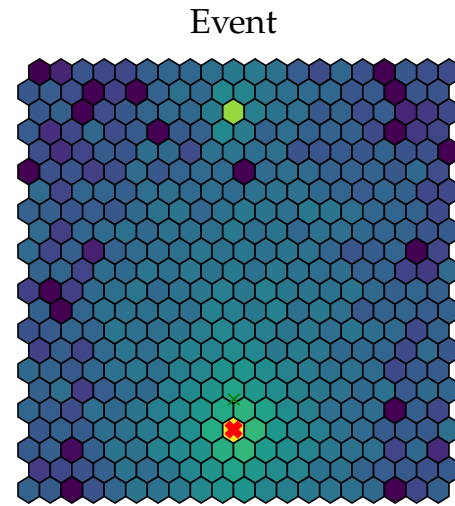
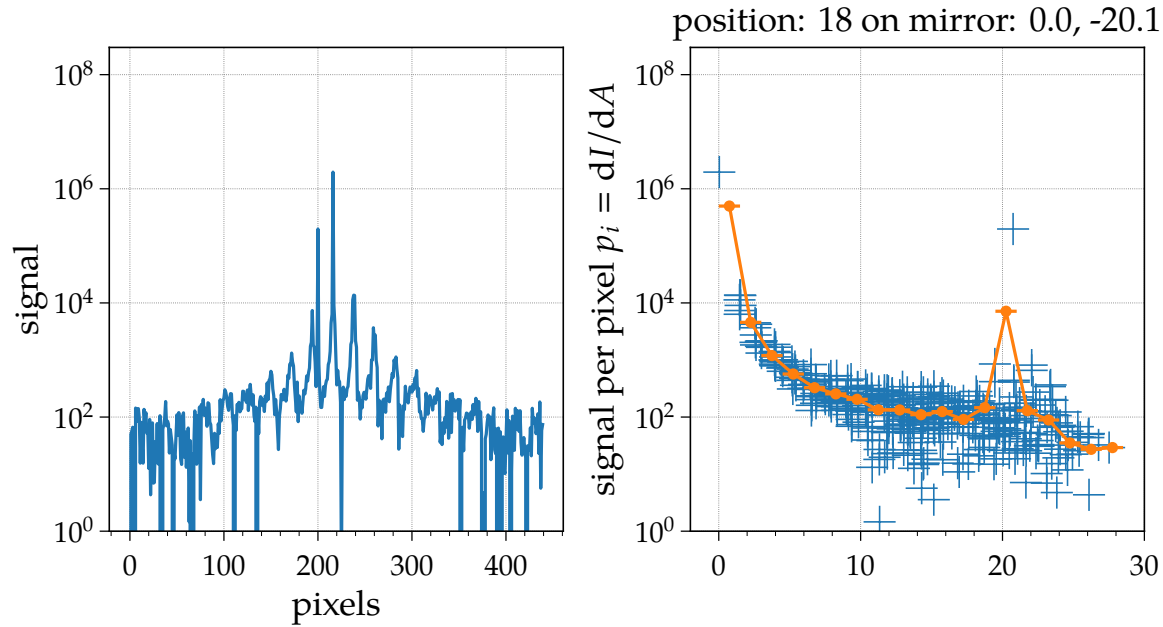


CB Test Measurements



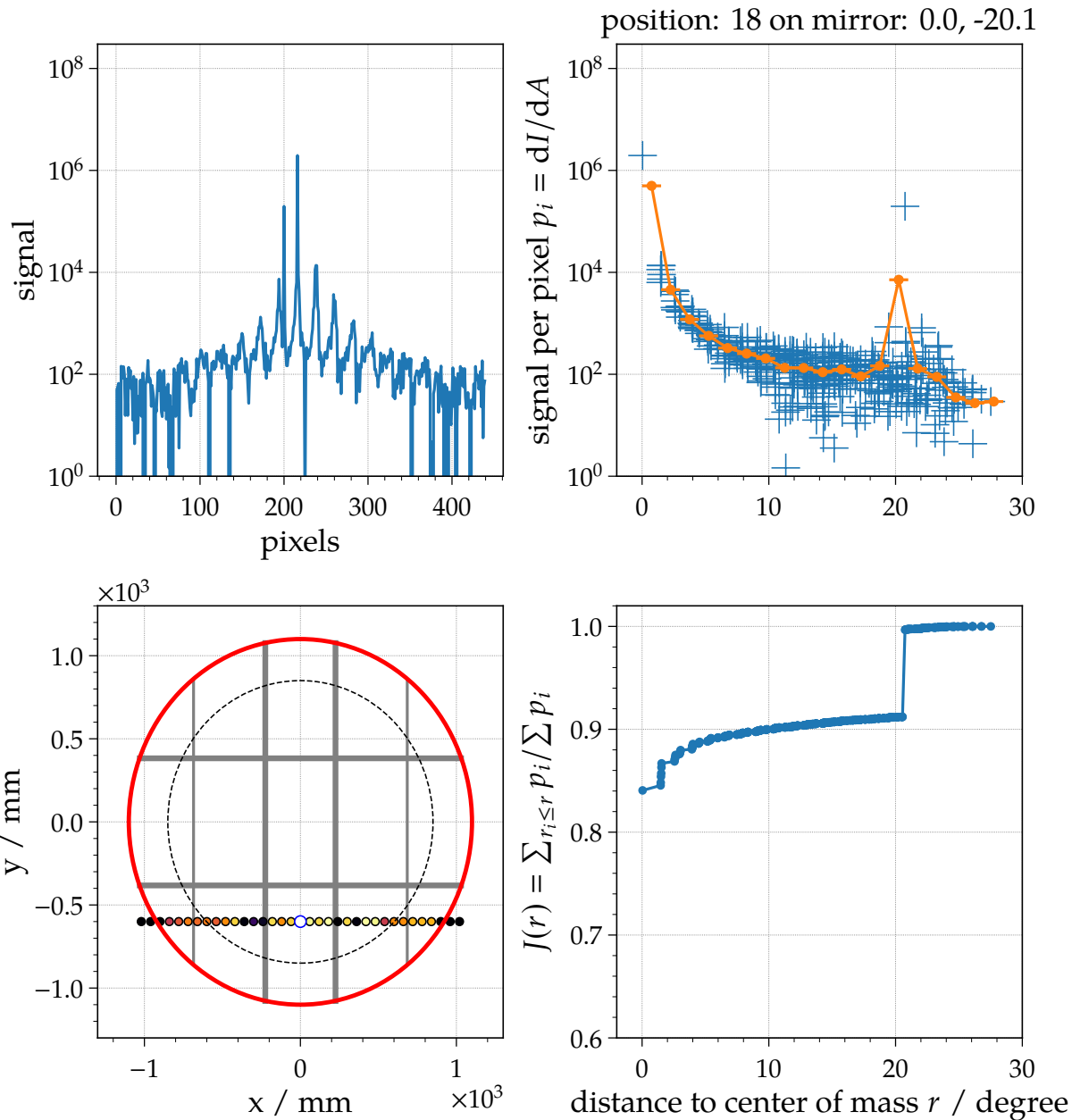
- Work in progress
- Typical event
- CO5

CB Test Measurements

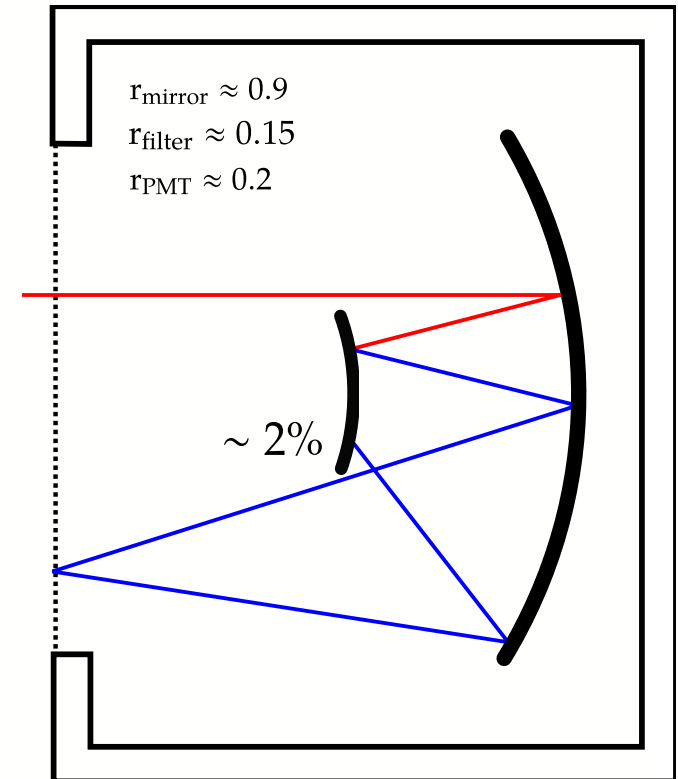


- Work in progress
- Event with a ghost
- CO5

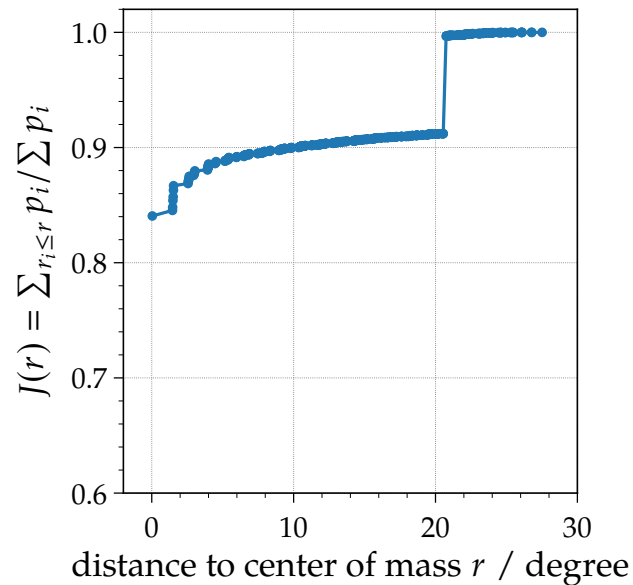
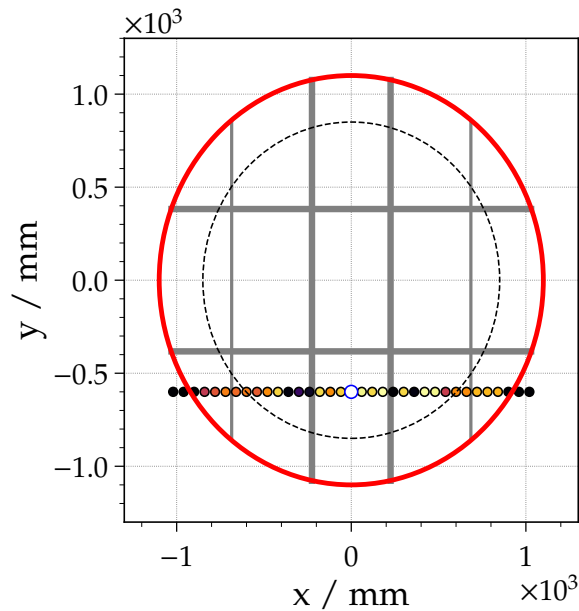
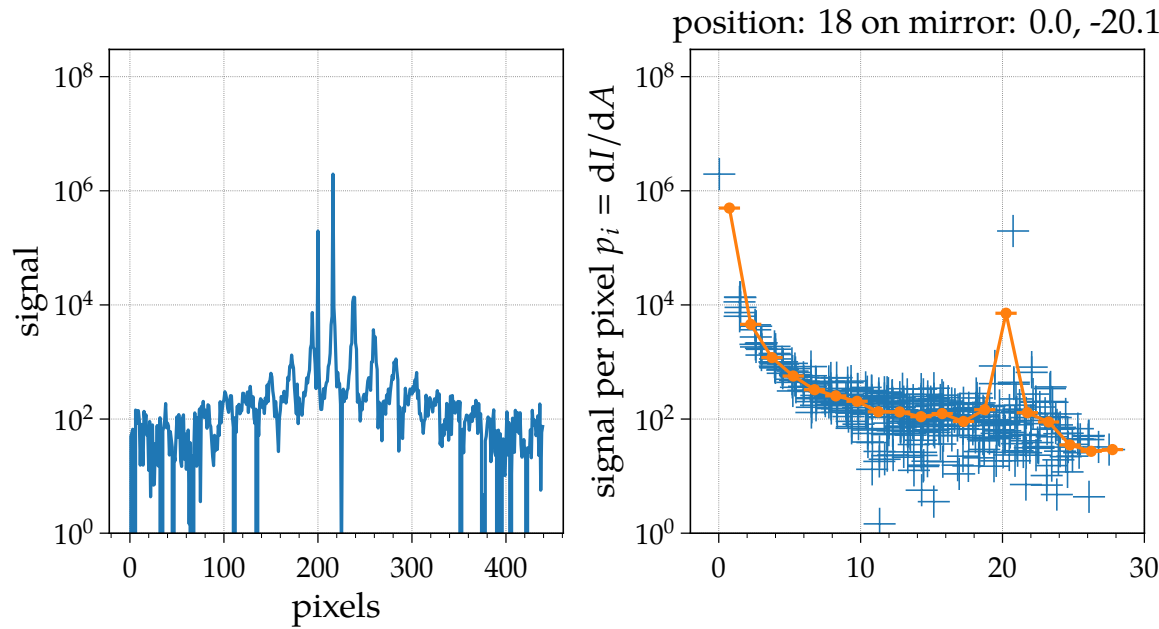
CB Test Measurements



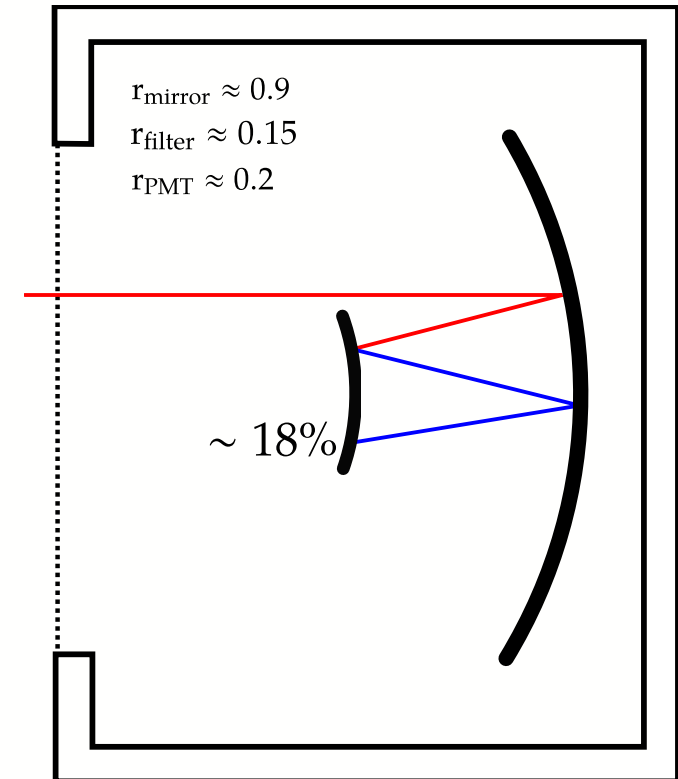
- **Ghost**
 - **Reflection on**
 - **PMT, Mirror, Filter, Mirror**



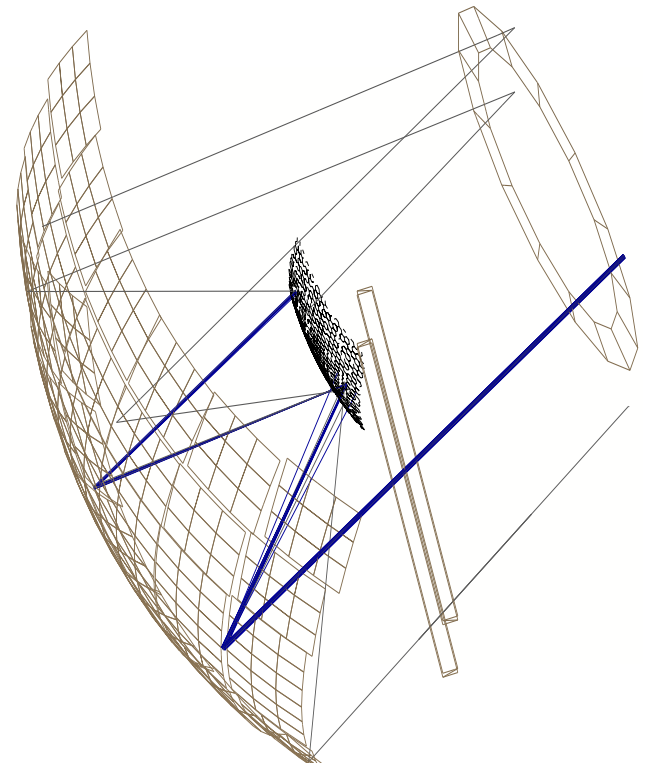
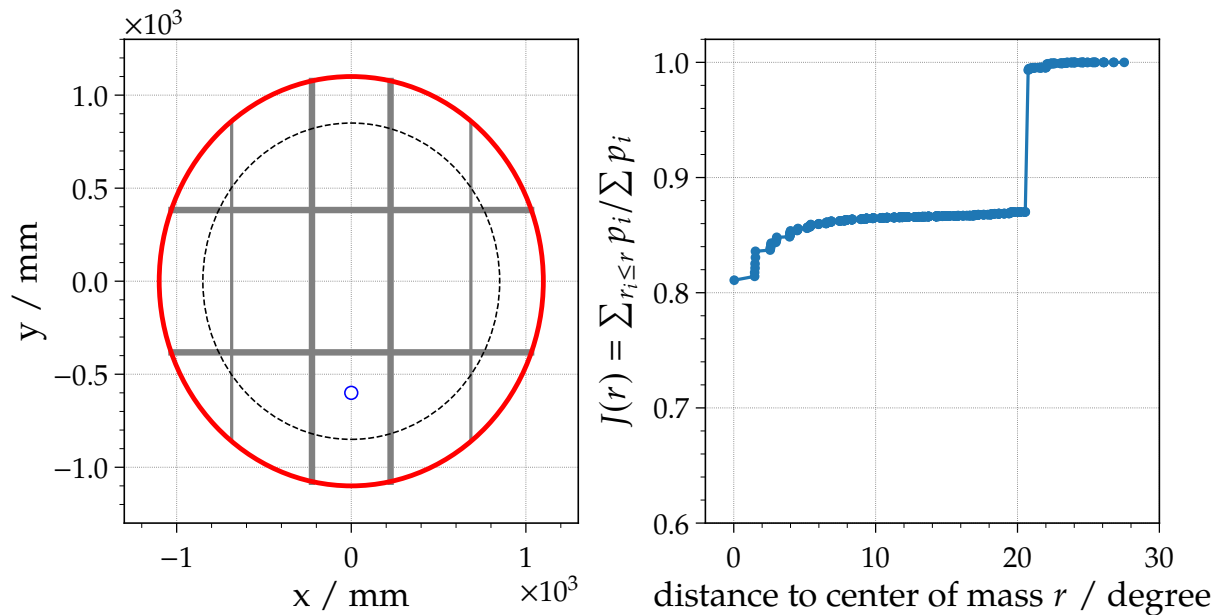
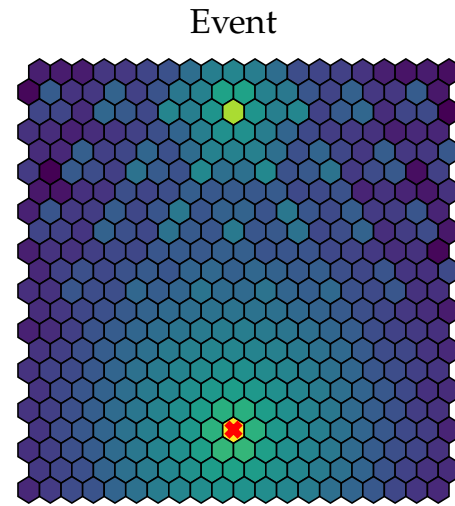
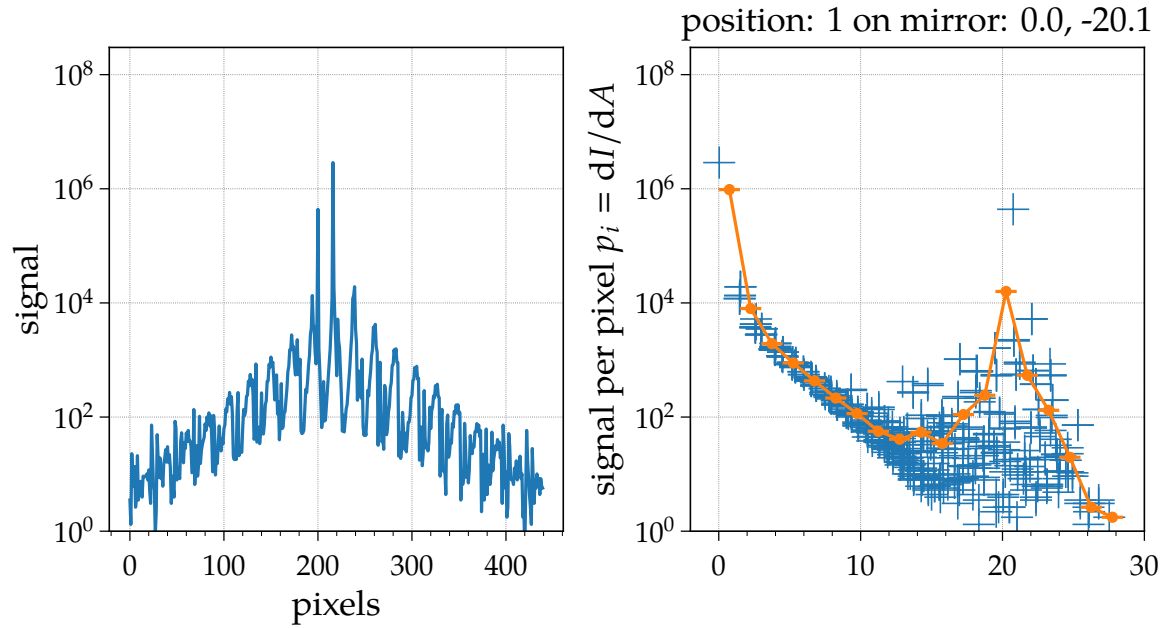
CB Test Measurements



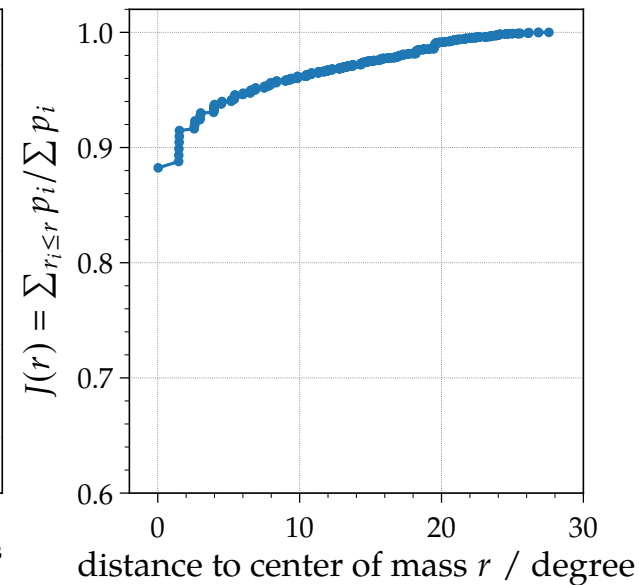
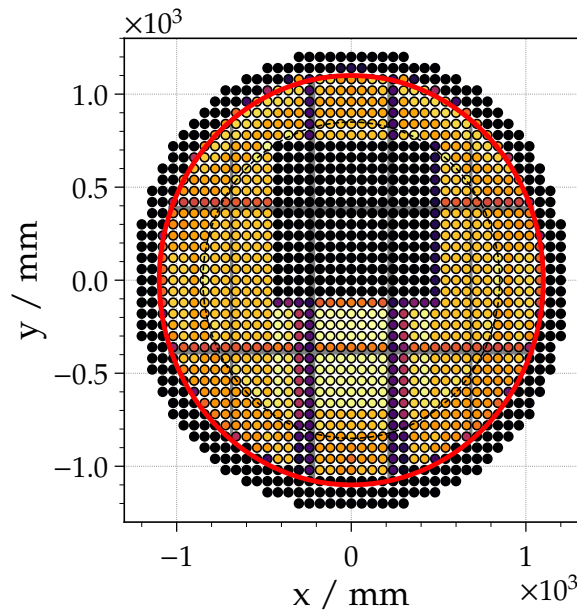
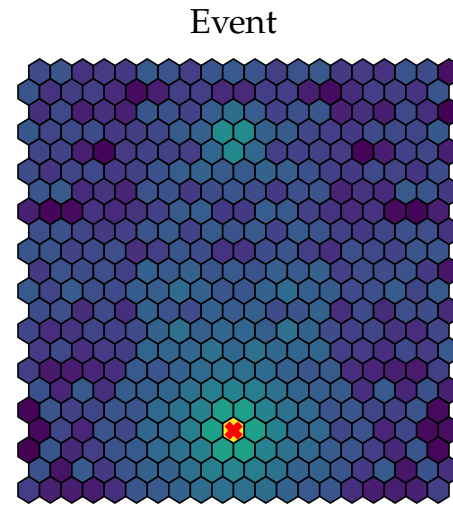
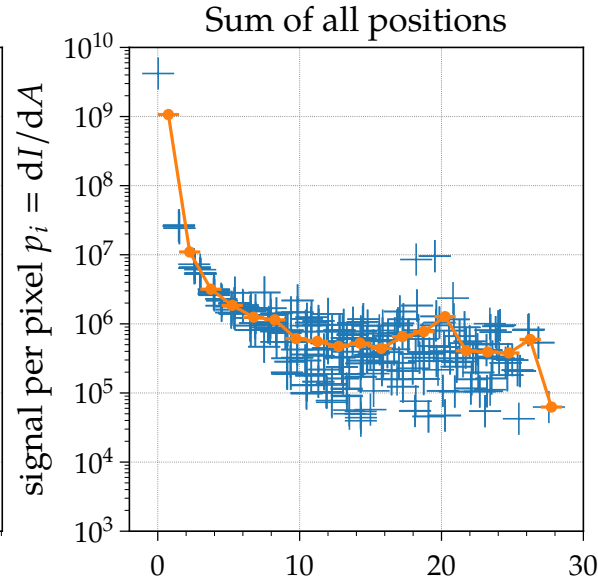
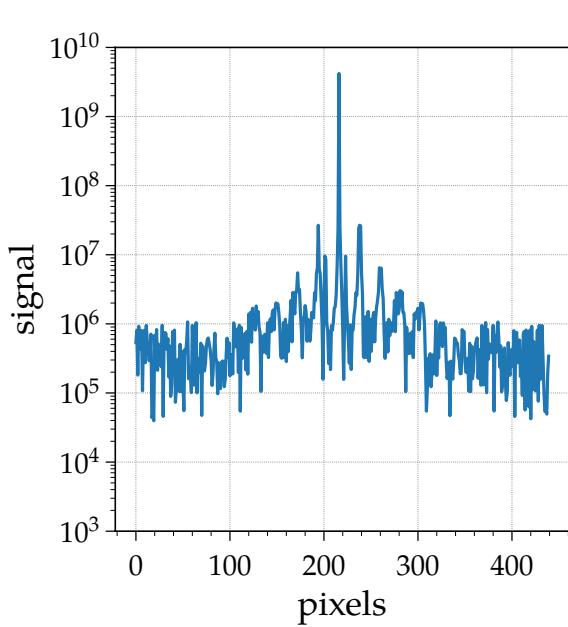
- **Ghost**
 - **Reflection on**
 - **PMT, Mirror**



CB Simulation



CB Simulation



- Work in progress
- Simulation
- Sum of 1361 positions
- Ghost $\sim 0.5\%$

Conclusion and Outlook

- **Further measurements ongoing**
- **Explanation for the ‘large-signal’ ghost**
- **HeCo CrossCalib**
- **Long term aim:**
 - **Install vertical axes on the remaining telescopes in 2020, 2021, ...**
 - **Determine calibration constants for all 27 FD telescopes**
 - **regular calibration campaigns**

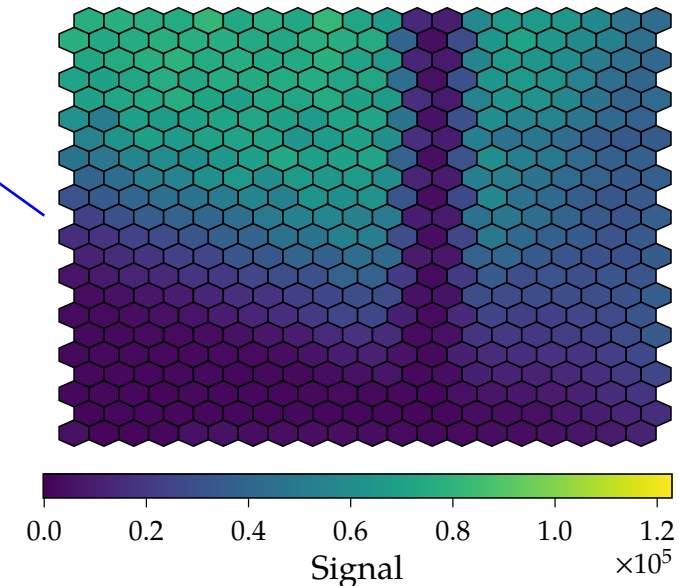
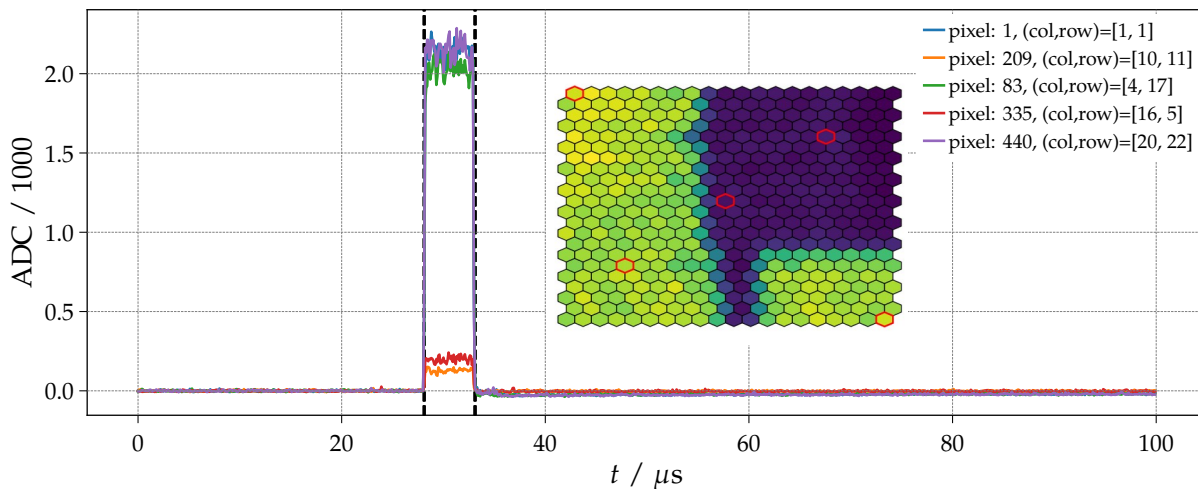
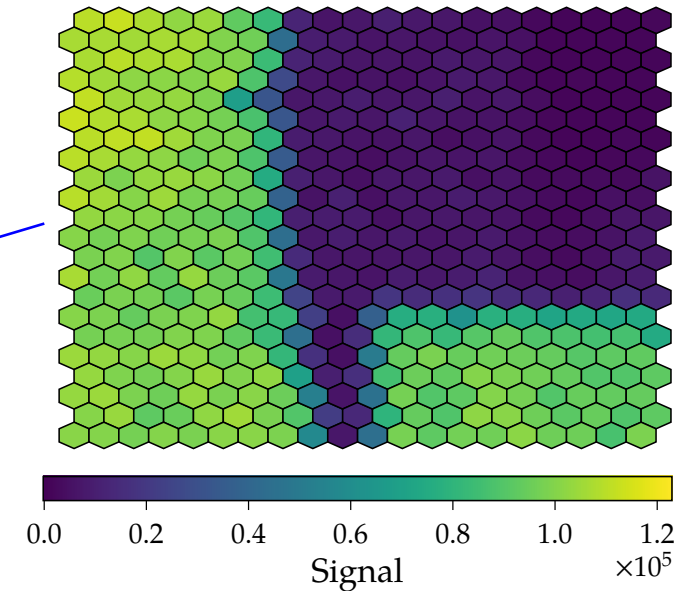
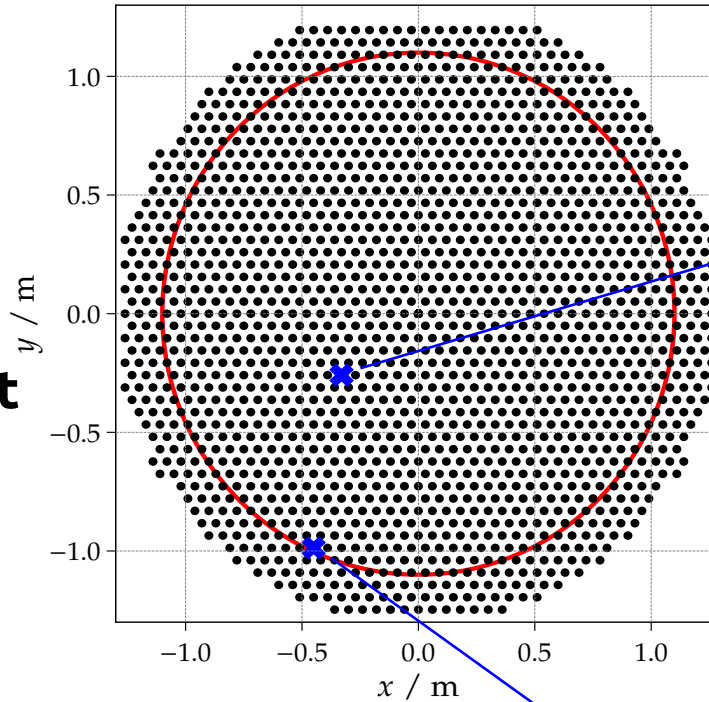
Backup

XY Scan Procedure

- Hexagonal grid
- 6 cm spacing
- ~1700 positions

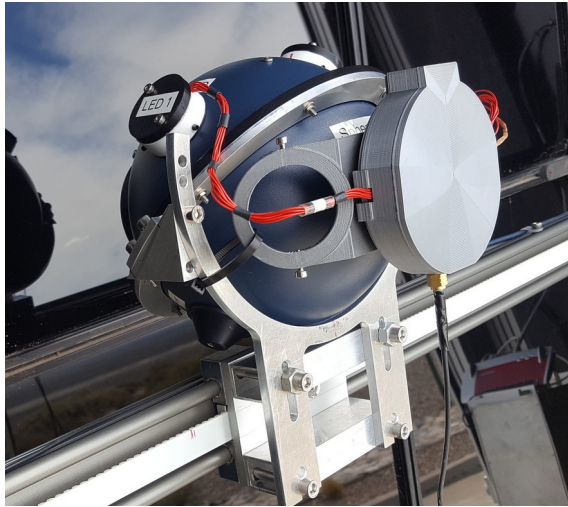
- 45 min per run
- 3 telescopes per night

- Pulse finder:
 - trigger: 0.5 of max
 - Duration until below 0.25 of max
 - For 4+ time bins

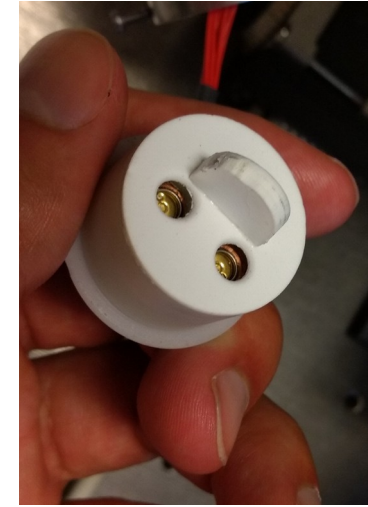
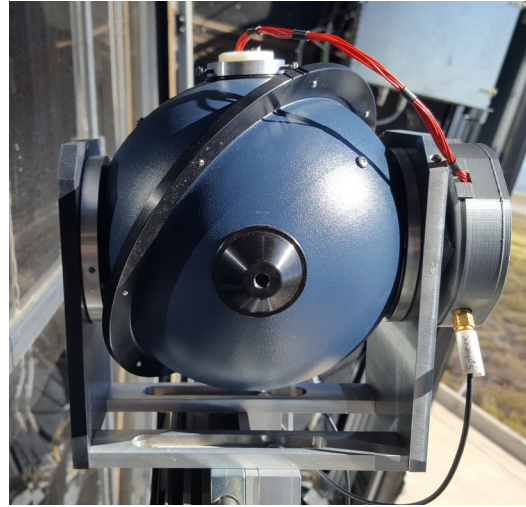


Improved Light Source

Standard sphere

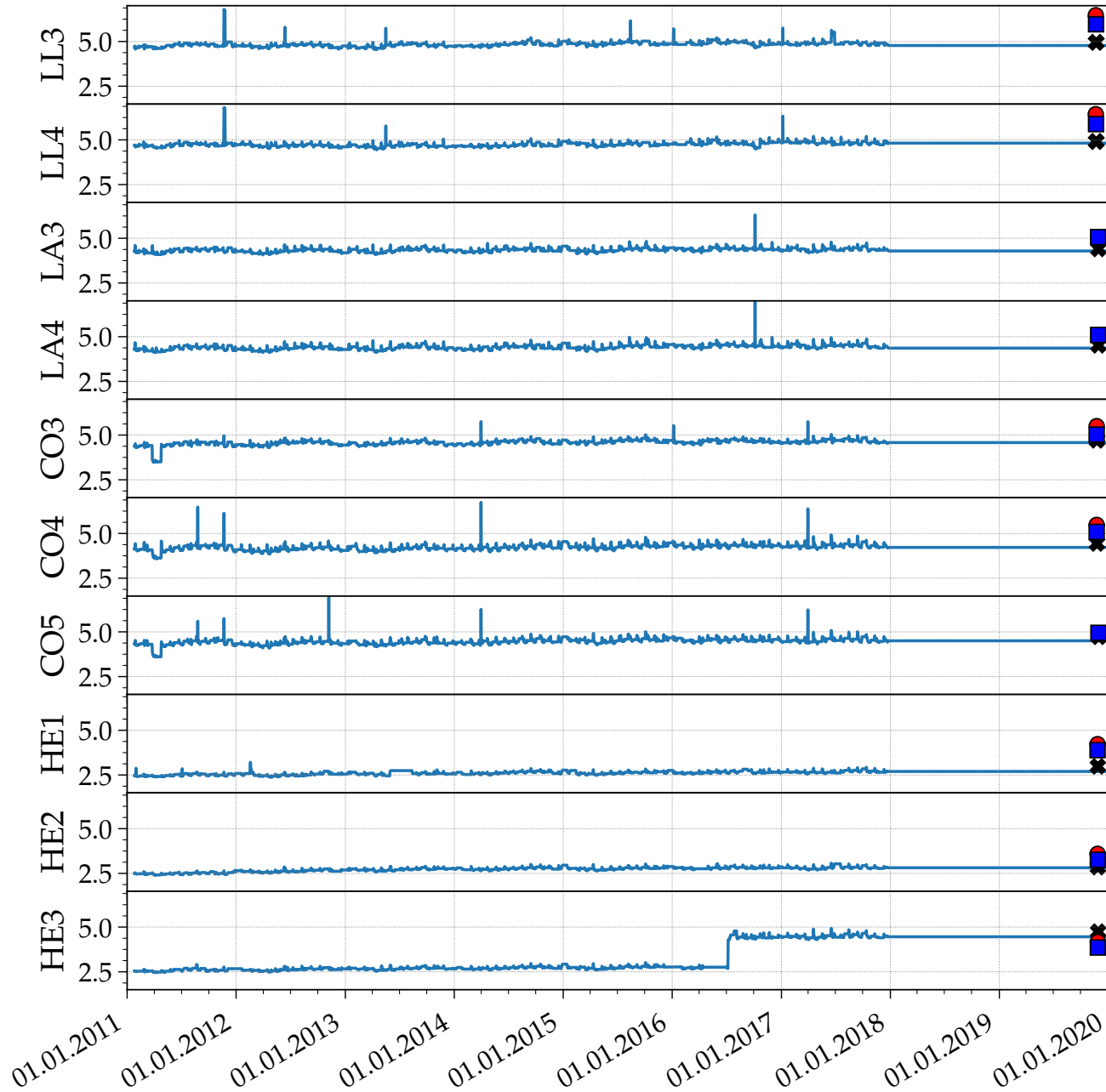


Improved sphere by the Olomouc group



See talk of M. Vacula from the Nov 2019 meeting

Absolute Calibration

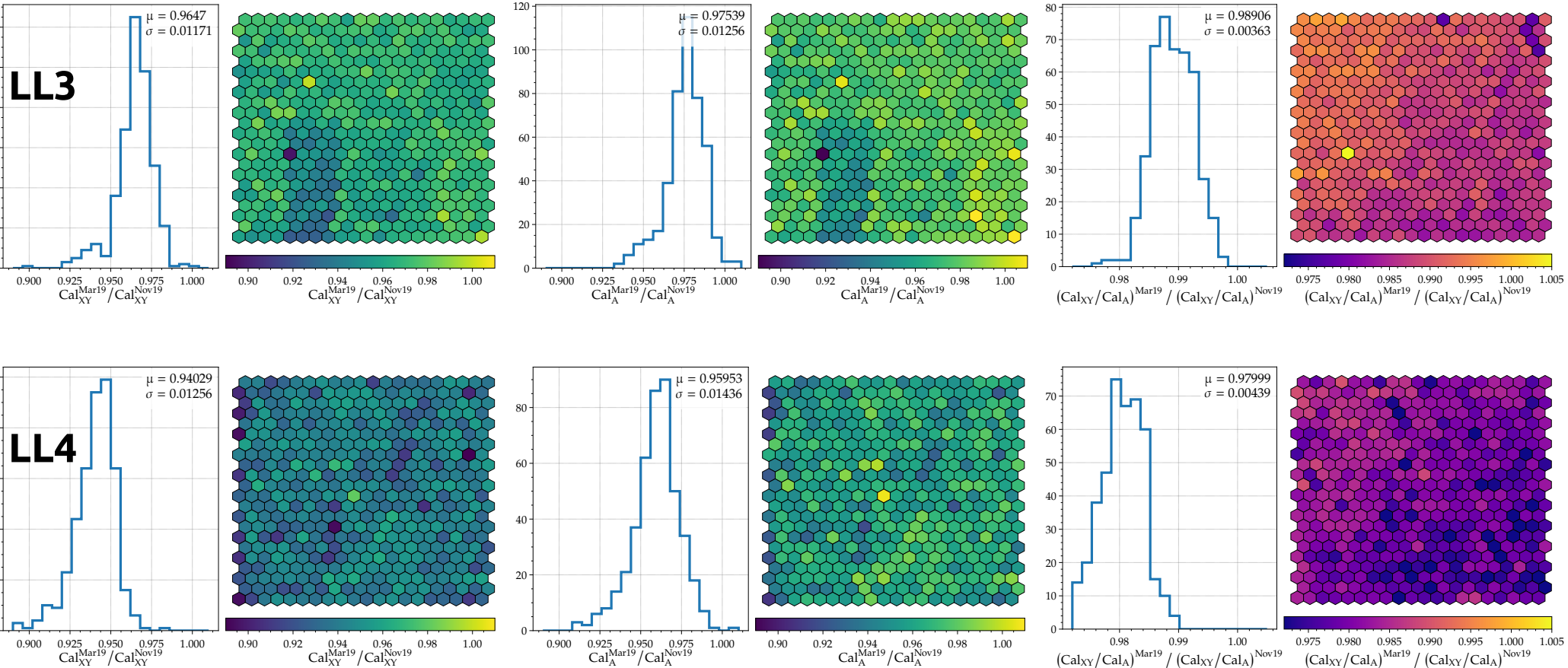


Long Term Stability at LL 3 & 4

XY calibration

Std. Calibration CalA

$\text{Cal}_{XY} / \text{Cal}_A$



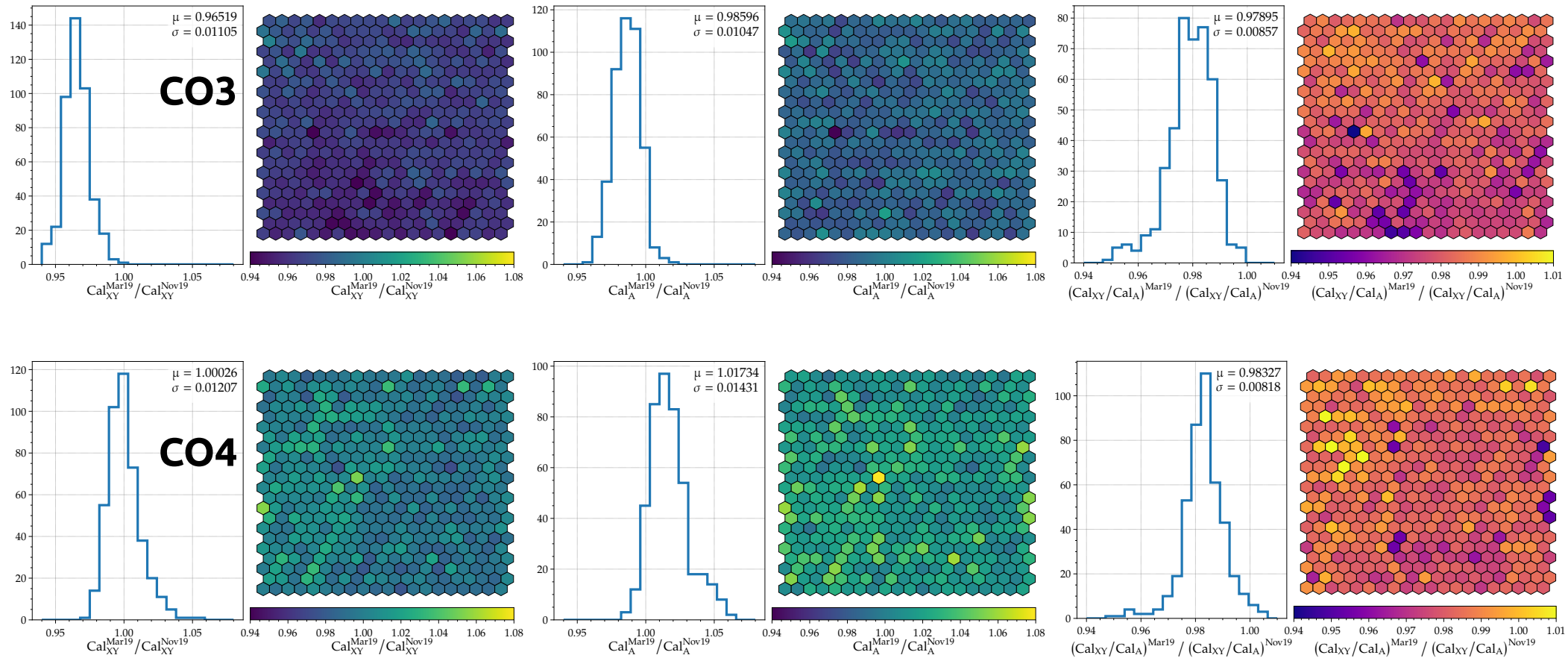
- March 2019 – November 2019
- Stable within 8 months
- Assuming constant light source

Long Term Stability at CO 3 & 4

XY calibration

Std. Calibration CalA

$\text{Cal}_{XY} / \text{Cal}_A$



- March 2019 – November 2019
- Stable within 8 months
- Assuming constant light source

Long Term Stability at HEAT

XY calibration

Std. Calibration CalA

Cal_{XY} / Cal_A

