New Camera and Linear Stage

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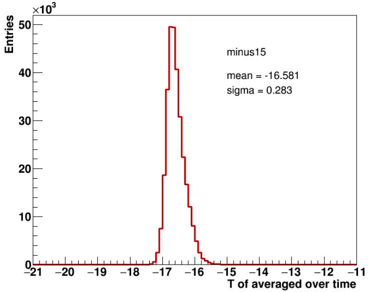
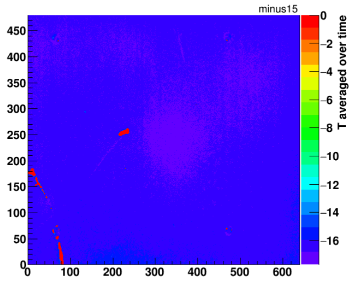
New Camera

- First look with data taking:
  - No thermal couple data. Rather take the readout from chiller (-20°C,-15°C,-10°C,...,50°C).
  - Set frequency at 25Hz, 200 frames (8 seconds) per temperature are taken.
  - Focus on the pedestal and common mode noise at $-15°C$ to be compared with previous data.
- Shown temperature averaged over the 200 frames, with emissivity=1.0.





Pedestal estimation

O	O	O
O	X	O
O	O	O

- For every 3x3 sensors, calculate the T of the center X and around O.

- The distribution of ΔR_X, hence $(P_X - < P >_O)$ with temperature at -15°C for previous camera (right) and current one (below).
  - Similar (slightly larger) width from the current data, very compatible. (Reminder of also plate difference.)
  - The pixels on the hot spots on the plate are not included in the study.
  - Slightly more number of pixels with $\Delta > 0.5$.
- Caveat: the method requires that the 3x3 sensors are facing the plate of **same** temperature and **same** emissivity.

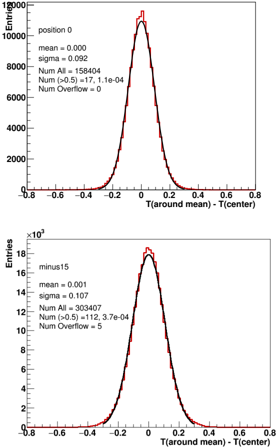


Figure: Pedestal per sensor from **previous** (top) and **current** camera (bottom).

Pedestal map, plate view

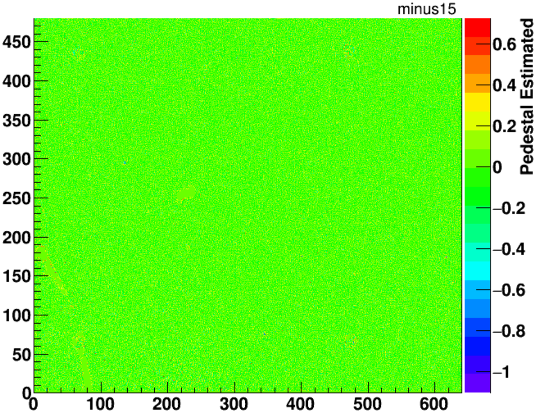
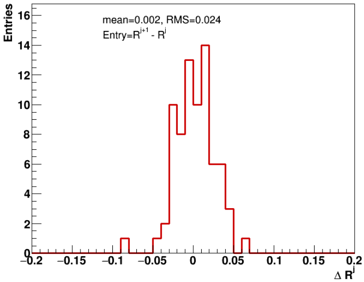


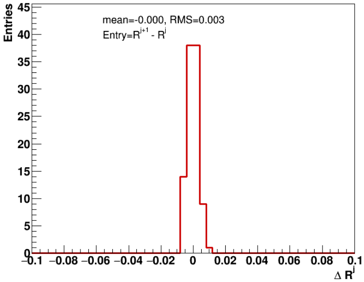
Figure: Pedestal per sensor from **current** camera.

Common mode noise: comparison

- Common mode noise (C^t): is a time-dependent sensor independent noise.
- If, for each sensor, we take two frames at close time periods, $t+1$ and t (2 seconds in previous data, $\frac{1}{25}$ in current data), and taking an average over all sensors. Then: $\Delta < R >^t = R^{t+1} - R^t = (C^{t+1} - C^t)$ where R^t is the temperature averaged over whole plate at time (frame) t.
- Caveat: the method requires the two frames to be taken at the same moment to avoid bias from plate temperature fluctuation. $\Rightarrow$ previous data is taken with 0.5Hz, which may have this problem.



previous data



current data

Common mode noise in time: comparison

- Now that we used lower frequency in previous data, the larger difference is found.
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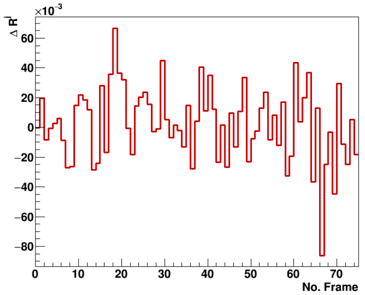
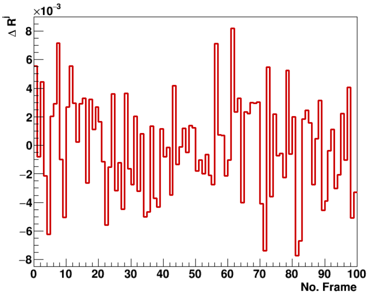


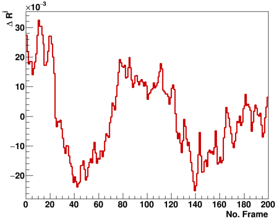
previous data



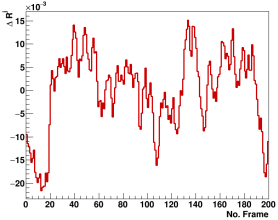
current data

Common mode: current data only

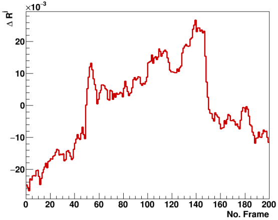
- Since we use very high frequency now, we assume that the plate temperature (on average) is stable during data taking.
- We can then compare plate averaged temperature $< R >^t$ to plate and time averaged $< R >$: $\Delta R^t =< R >^t - < R >$.
- We can compare the time dependent ΔR^t at different data taken temperature: -20°C, -15°C, 50°C.



-15°C

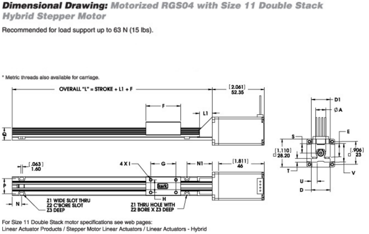


-20°C



50°C

- Linear stage, more choice than one: here.
  - Model RGS04 (4 - 8inches, price \$240.85 - \$384.99): here.
  - The stepper motor: here. For example, model 28H41-2.1-907 (price \$192, Step Angle 1.8°): here
  - Another web for stepper: here.



Recommended for load support up to 63 N (15 lbs).

	A	D	D1	E	F	G	H	I*	L1	N	N1	P	Q	S	T	U	V	Z1	Z2	Z3
(inch)	(0.4)	(0.75)	(0.75)	(0.53)	(1.4)	(1.0)	(0.5)	440	(0.5)	(0.375)	(1.0)	(0.6)	(0.5)	(0.37)	(0.15)	(0.23)	(0.73)	(0.11)	(0.2)	(0.09)
mm	10.2	19.0	19.0	13.5	35.6	25.4	12.7	UNC	12.7	9.52	25.4	15.2	12.7	9.4	3.8	5.8	18.5	2.8	5.1	2.3

* Metric threads also available for carriage

Backup

Define local regions for pedestal estimation

O	O	O
O	X	O
O	O	O

- Goal: to identify dead or bad (e.g. larger pedestal) pixels, and to get the pedestal / sensor.
  - From 400×400 pixels, each 3×3 small box forms a region, where the pixel (X) in the center can be tested by comparing the average around it (O).
  - The difference in time averaged T of the center and average around it is pedestal.
- For each sensor the time average is:

$$< R_x >^t = T + E_x + A_x + < L >^t + V_x + \mathbf{P_x} + < C >^t + < N_x >^t$$

  - where, $< \alpha >^t = \frac{1}{\int dt} \int \alpha^t dt$ is the time average, so that $< L >^t$, $< C >^t$, $< N_x >^t$ are constant values or 0.
  - therefore, for sensor under study X, $< R_{x=X} >^t = \mathrm{CONST} + E_X + A_X + V_X + \mathbf{P_X}$
  - and for the sensors around it O's, we take an average: $<< R >^t >_O = \mathrm{CONST} + < E >_O + < A >_O + < V >_O + < \mathbf{P} >_O$
  - We can fairly assume, $E_X = < E >_O$, $A_X = < A >_O$ and $V_X = < V >_O$ since the 3×3 sensors area is quite small $\sim 1 - 2mm^2$.
  - And, the 8 sensors around X forms $< P >_O = 0 \pm \sigma_P$ (plus 35% statistical fluctuation).
  - Now, we can do the subtraction of: $\boxed{\Delta R_X = < R_{x=X} >^t - << R >^t >_O = \mathbf{P_X} - < P >_O}$, which will be an estimate of the pedestal for sensor X (not a very good one due to stat fluctuation of $< P >_O$).
  - And the width of pedestals are: $P_X \sim \mathrm{Gaus}(0, \sigma_P)$ and $P_O \sim \mathrm{Gaus}(0, \sigma_P)$, so that $\boxed{(P_X - < P >_O) \sim \mathrm{Gaus}(0, \sqrt{2}\sigma_P)}$.