

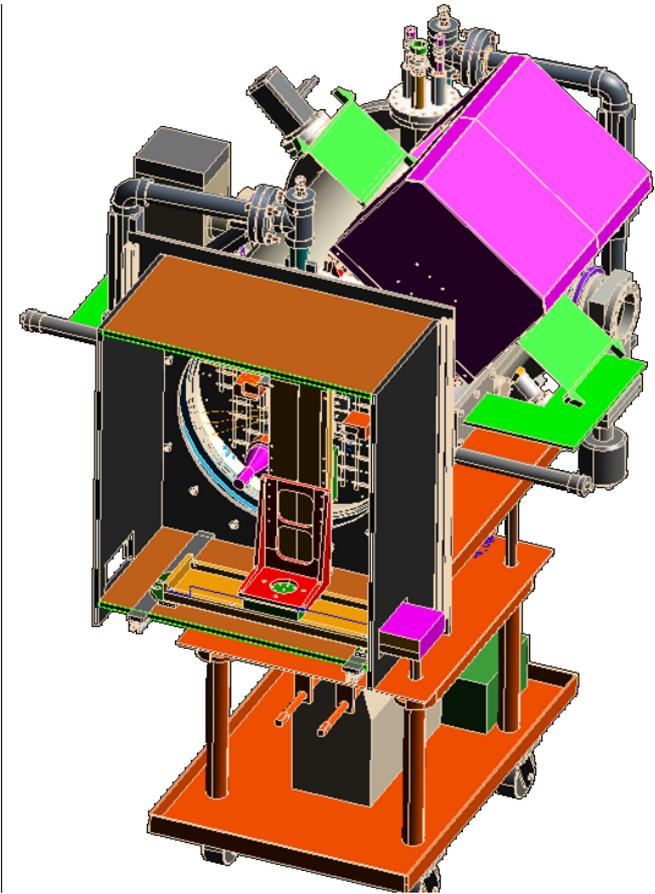


# Flatness of MCCDTV FPSP 2

DARK ENERGY  
SURVEY

- 44 CCDs on the MCCDTV
- Warm and Cold Scans
- Analysis of flatness
- Warm minus cold data

Tom Diehl  
11/19/2009





# CCD Map

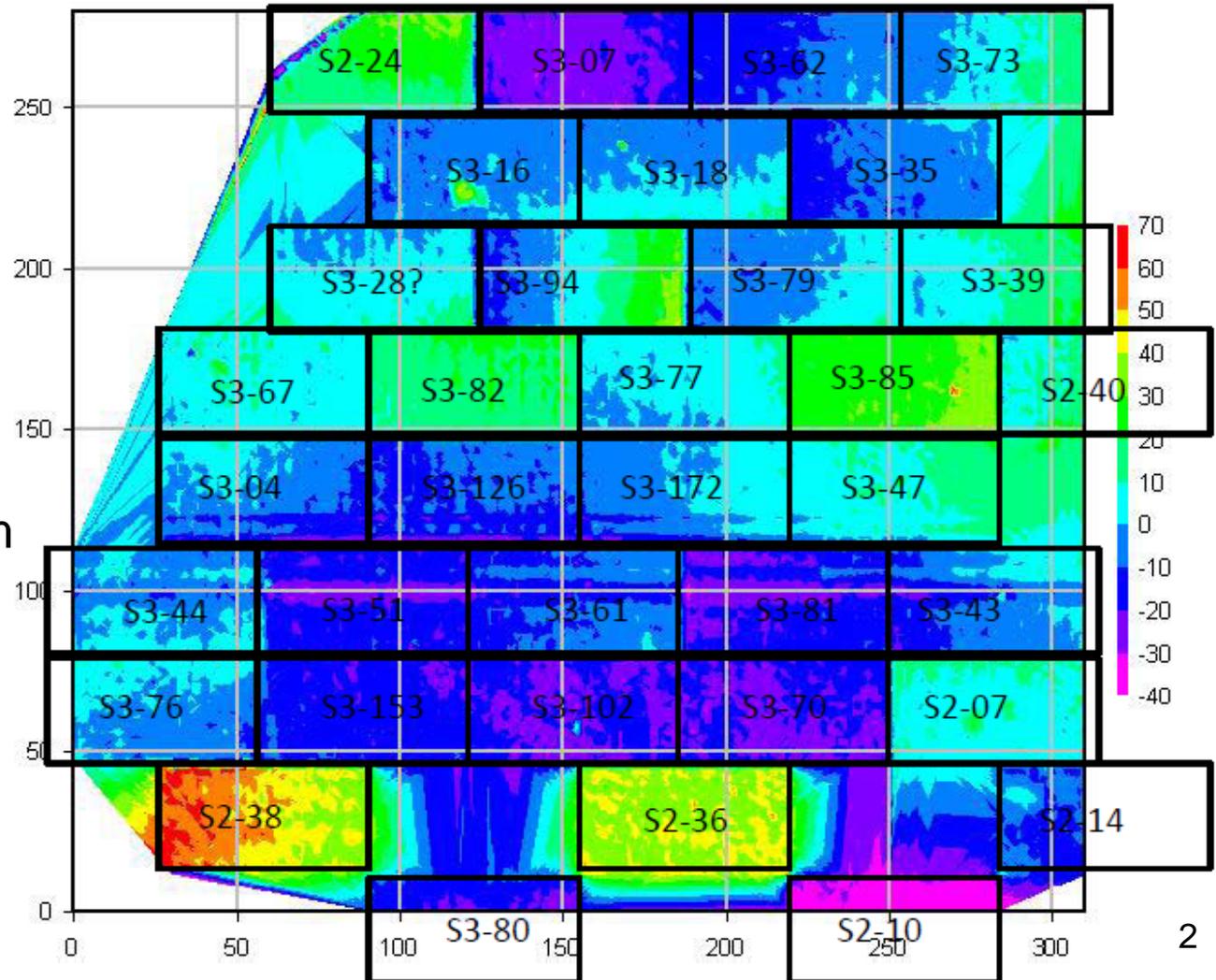
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SURVEY

I could measure  
more than 50% of  
the focal plane.

It's important to  
know which CCD  
is which.

Here I list them from  
the installation  
traveler.

Mixture of S2 & S3  
CCDs.

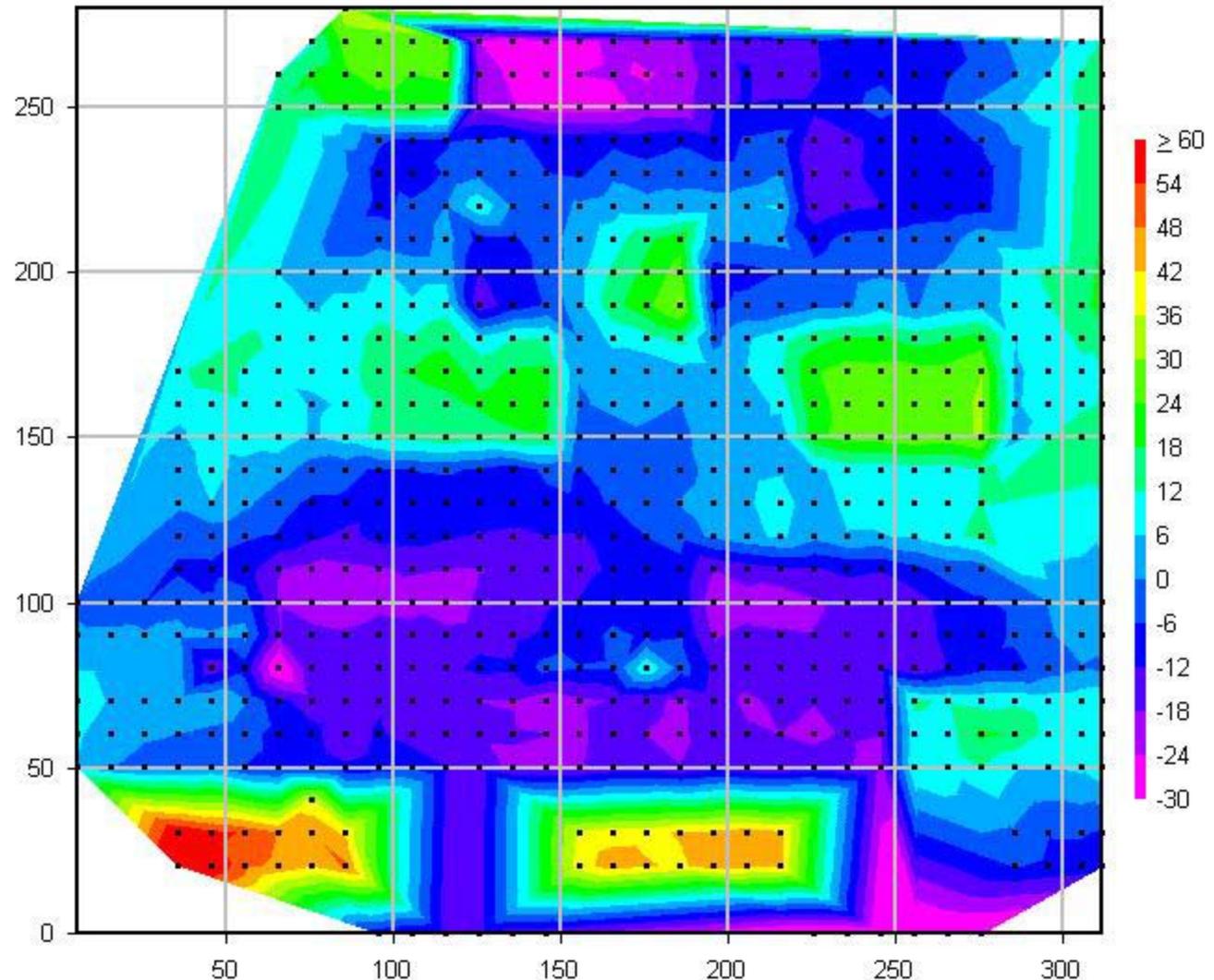




# Quick Warm Scan

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- $\frac{1}{2}$  cm x  $\frac{1}{2}$  cm scan was repeated 3 times. Use avg.
- We note that there are outliers
- B.F.P.:  
 $Z = Ax + By + C$   
 $A = -1.703 \mu\text{m}/\text{mm}$   
 $B = -2.584 \mu\text{m}/\text{mm}$   
 $C = 11654 \mu\text{m}$

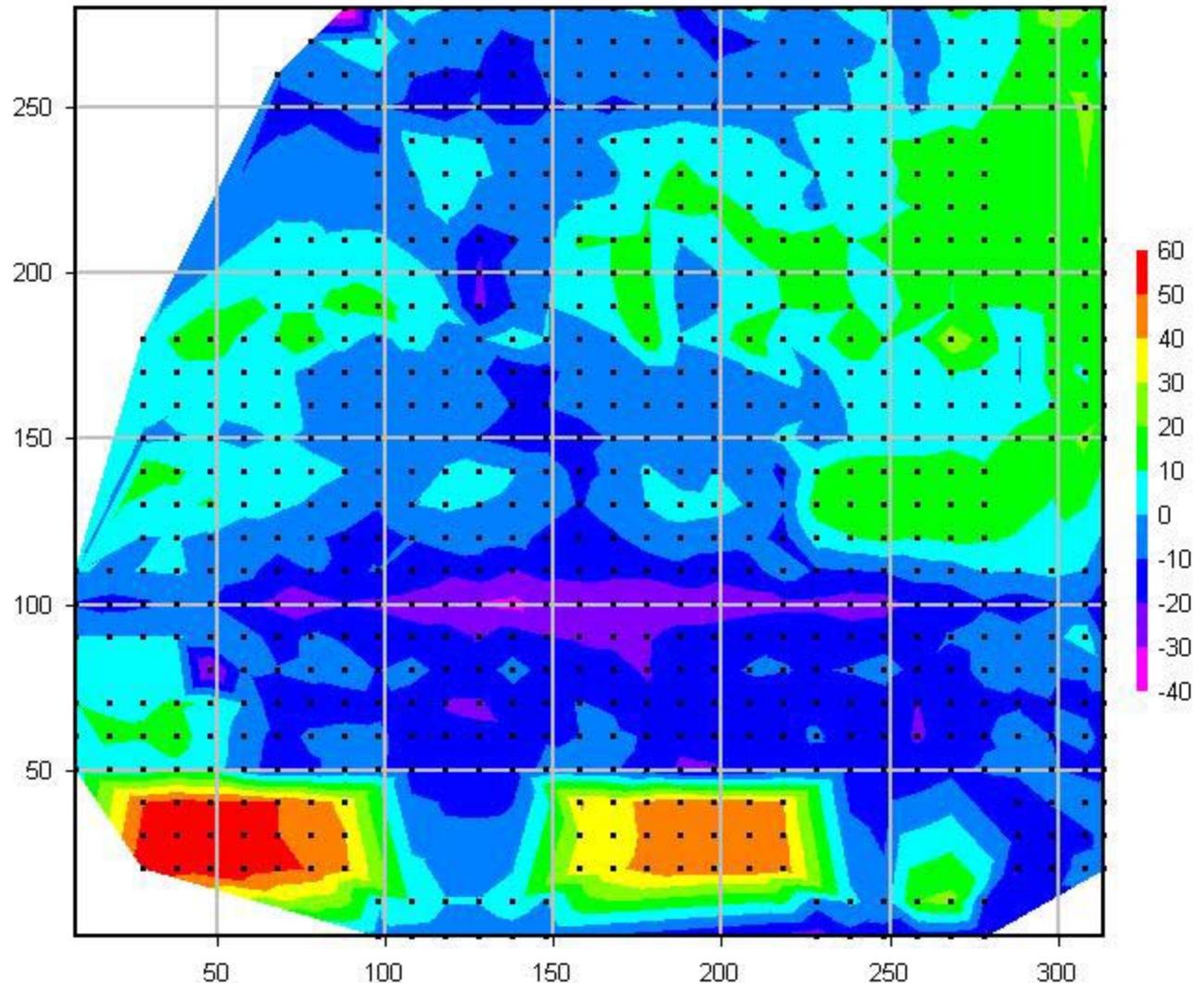




# Quick Cold Scan

DARK ENERGY  
SURVEY

- One  $\frac{1}{2}$  cm x  $\frac{1}{2}$  cm scan.
- B.F.P.:  
 $Z = Ax + By + C$   
 $A = -1.669 \mu\text{m}/\text{mm}$   
 $B = -2.446 \mu\text{m}/\text{mm}$   
 $C = 11813 \mu\text{m}$
- Warm vs.  
Cold:  $\Delta Z = 159 \mu\text{m}$ . Change in tilt angles is small.



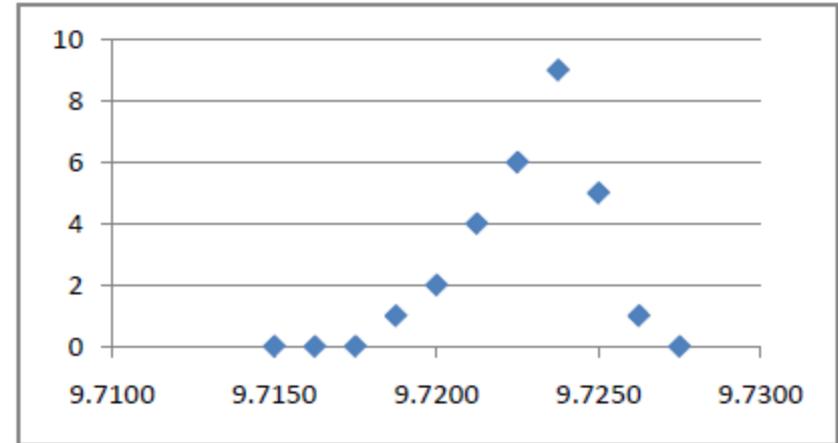


# CCD Thicknesses

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- I have good information about V3 packages from John Krider's measurements in docdb 2687 and the travelers. Mean is 9.722 mm with  $\sigma = 0.002$  mm (2  $\mu\text{m}$ ).
- Biggest outliers  $\sim 3$  microns from mean.
- I have almost no information from V2 packages except for packaging logbook notes.

S3 CCDs on MCCDTV

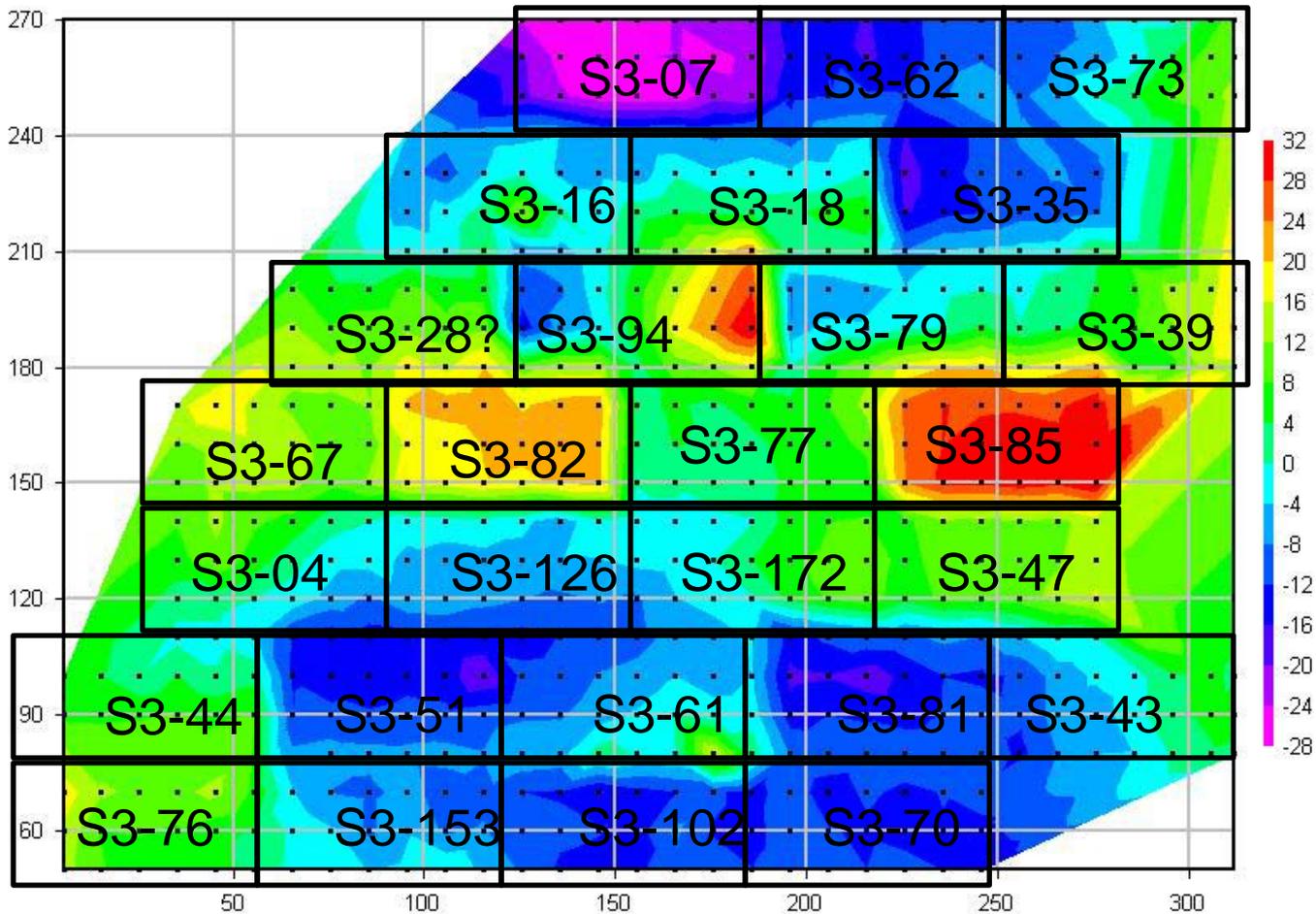


- There are V2 devices that were short because of glue release tests and others that were high because of extra shims.
- Eliminate them all.



# V3 CCDs Only (Warm)

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Data minus BFP

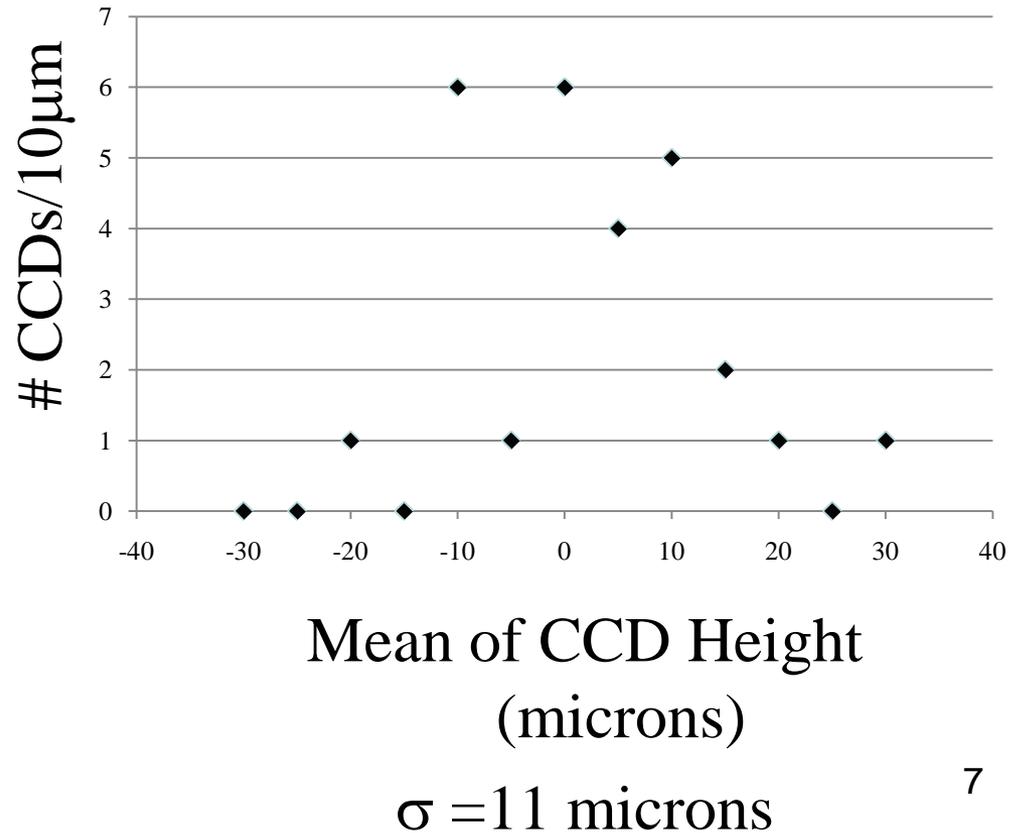


# CCD Data (Warm)

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Local Plane of CCD ( $Z=Ax+By+C$ ) w.r.t. overall best fit plane.

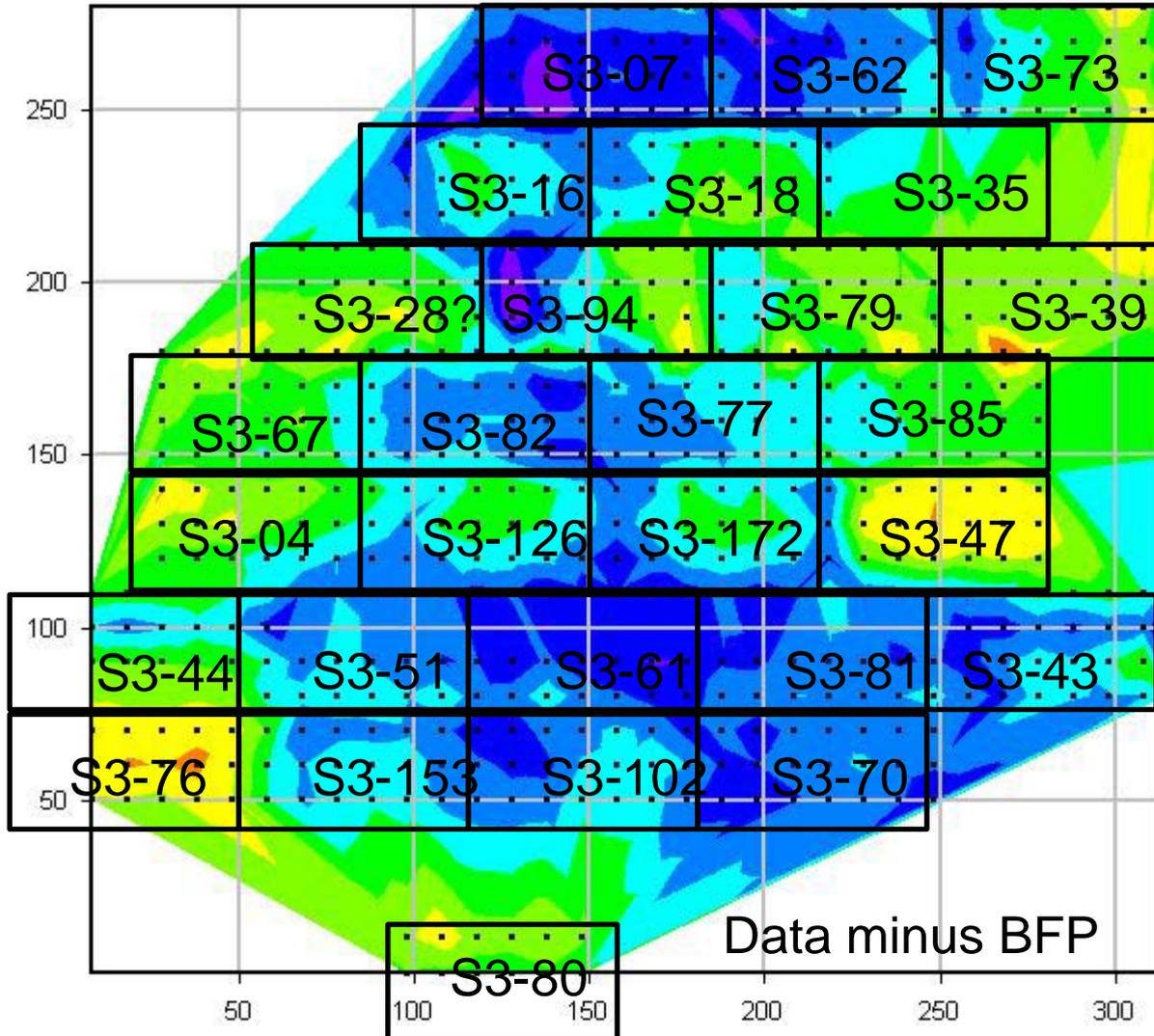
CCD	A	B	C	mean	A,B \microns per mm of a CCD C is in microns
S3-07	0.019	-0.037	-24.4	-24.2	
S3-102	-0.008	-0.086	-10.9	-12	
S3-126	-0.025	0.208	-6.3	-4.9	
S3-153	-0.07	-0.151	-1.7	-5.7	
S3-16	0.03	-0.308	1.7	-3.5	
S3-172	0.258	0.065	-5.9	2.4	
S3-18	0.021	-0.348	4.4	-0.6	
S3-28	-0.005	-0.397	14.1	7.8	
S3-35	0.173	0.055	-16.2	-11.3	
S3-39	0.381	0.043	-0.4	9.1	
S3-04	-0.23	0.422	4.1	2.5	
S3-43	0.277	0.172	-11.6	-2	
S3-44	-0.208	-0.333	10.9	1.2	
S3-47	0.142	0.029	6.7	10.6	
S3-51	-0.004	-0.141	-11.7	-13.2	
S3-61	0.161	-0.334	-4.6	-4.7	
S3-62	0.089	-0.202	-10.2	-11.5	
S3-67	-0.056	0.104	13	12.7	
S3-70	-0.038	0.078	-11.3	-11.1	
S3-73	0.423	-0.256	-5.6	2.1	
S3-76	-0.172	0.254	10.8	9.1	
S3-77	0.118	0.262	-1.2	5.5	
S3-79	0.128	-0.433	1.2	-1.6	
S3-81	0.096	0.124	-16.1	-12.5	
S3-82	0.027	-0.108	19.9	18.9	
S3-85	0.091	-0.313	28.5	25.7	
S3-94	0.666	-0.11	-11.8	7.1	





# V3 CCDs Only (Cold)

DARK ENERGY  
SUR



Put on same  
scale as “warm”

Limits are -20 to  
+25  $\sigma_m$

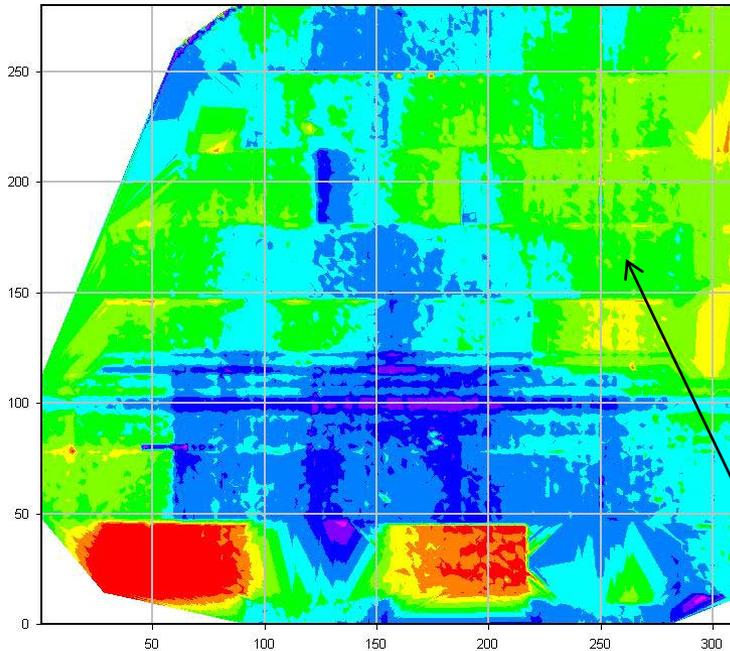
The  $\sigma = 9.2 \mu m$

Knocked out  
S3-35 by accident?  
Added S3-80!

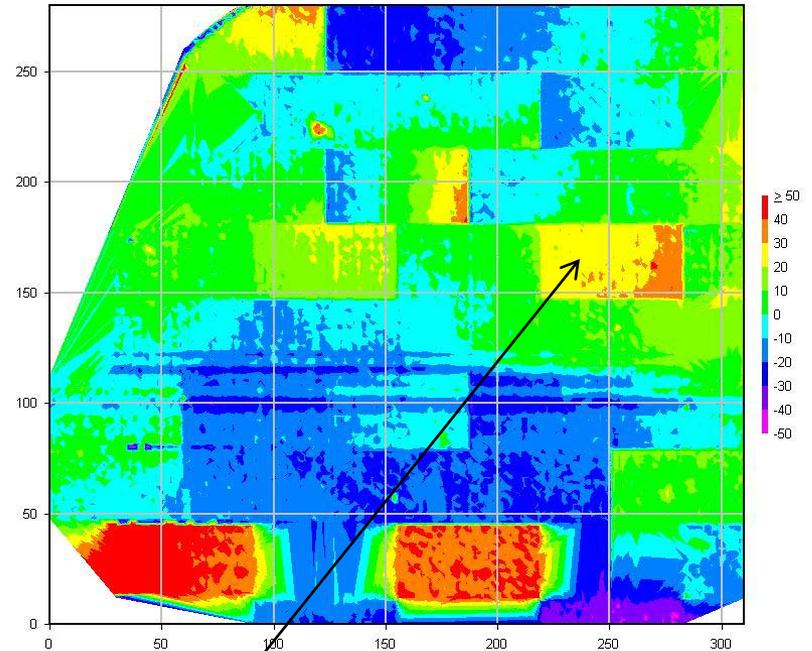


# Cold Scan Versus Warm Scan

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SURVEY



Cold ( $T=-150$  C on FPSP)



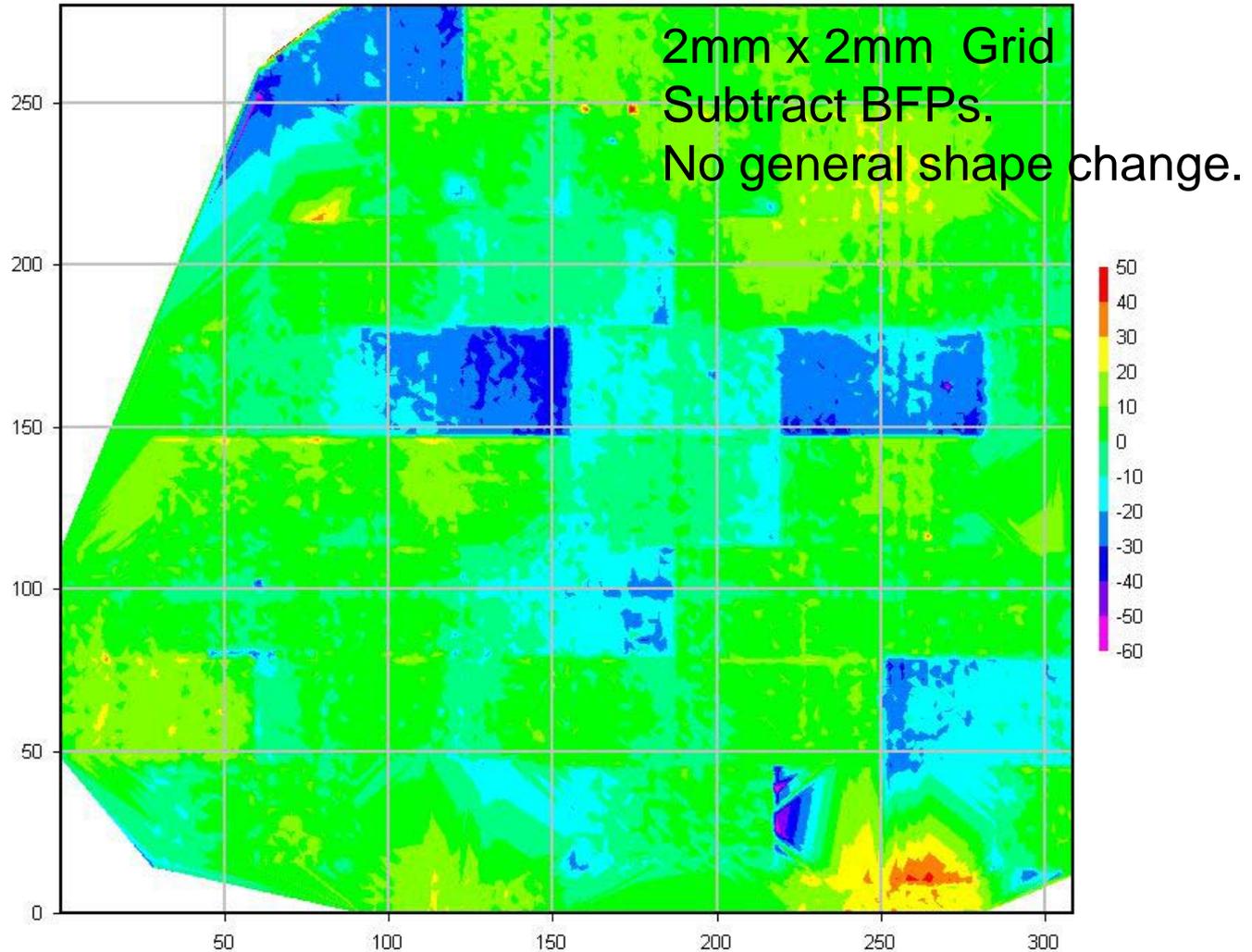
Warm ( $T=23$  C on FPSP)

In particular, note this one.  
It's in the plane nicely at  $T=-150$ .



# Cold Scan minus Warm Scan

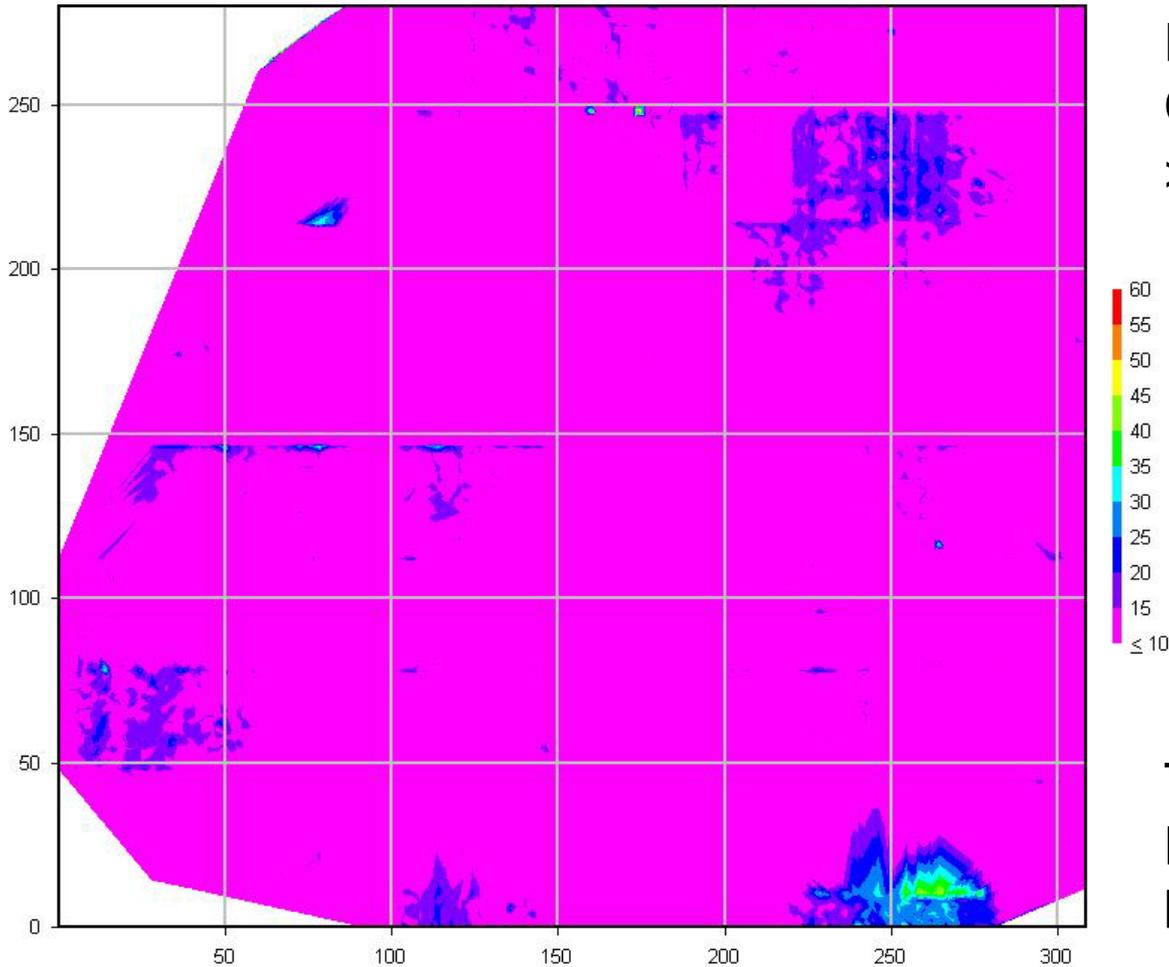
DARK ENERGY  
SURVEY





# Cold Scan minus Warm Scan

DARK ENERGY  
SURVEY



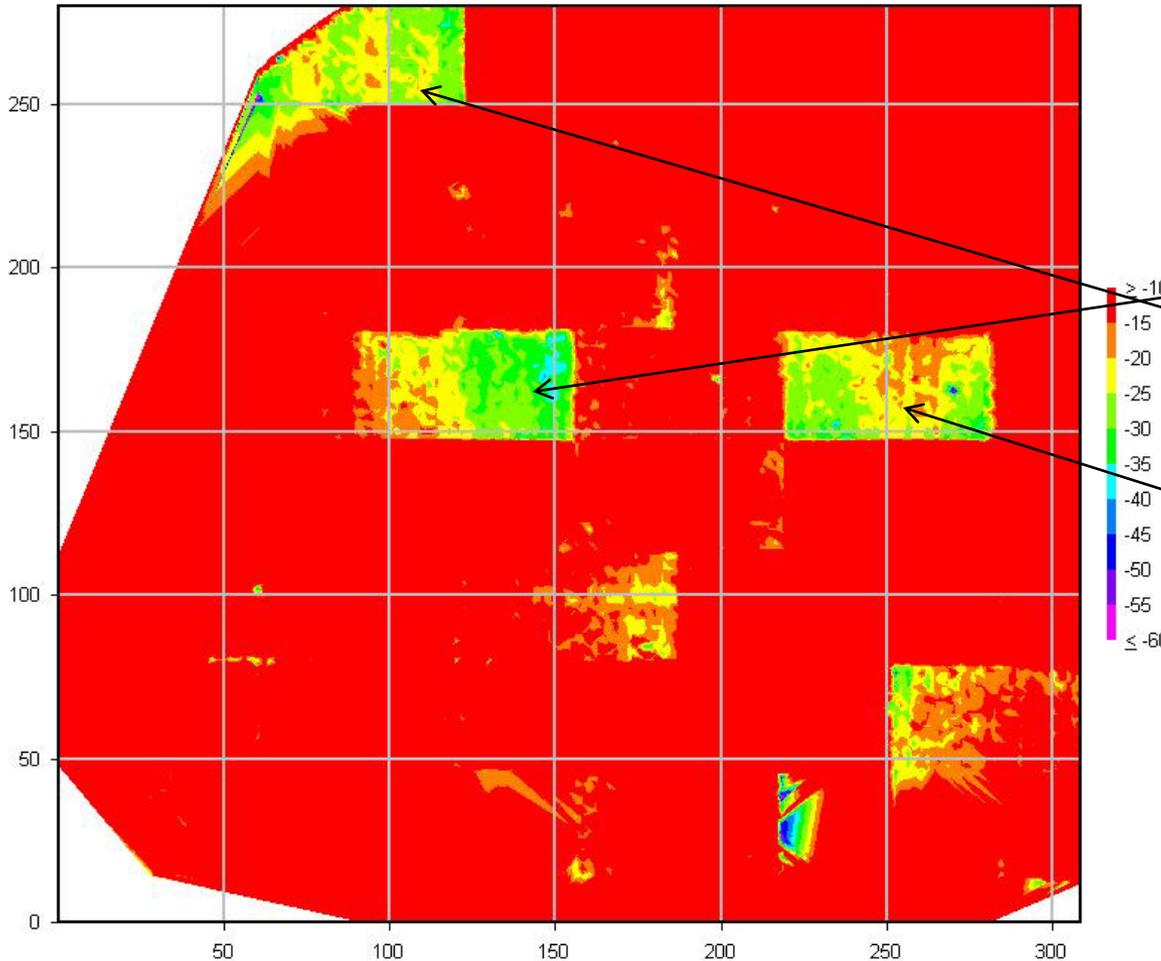
Highlight the data for which  
Cold minus Warm is  
>10 microns

There isn't much, really.  
Mostly data in cracks  
between devices.



# Cold Scan minus Warm Scan

DARK ENERGY  
SURVEY



Highlight the data for which  
Cold minus Warm is  
-10 to -60 microns

S3-82

S2-24

S3-85

Some CCDs stand out,  
As if they got popped in  
during cooling.



# Summary of Results

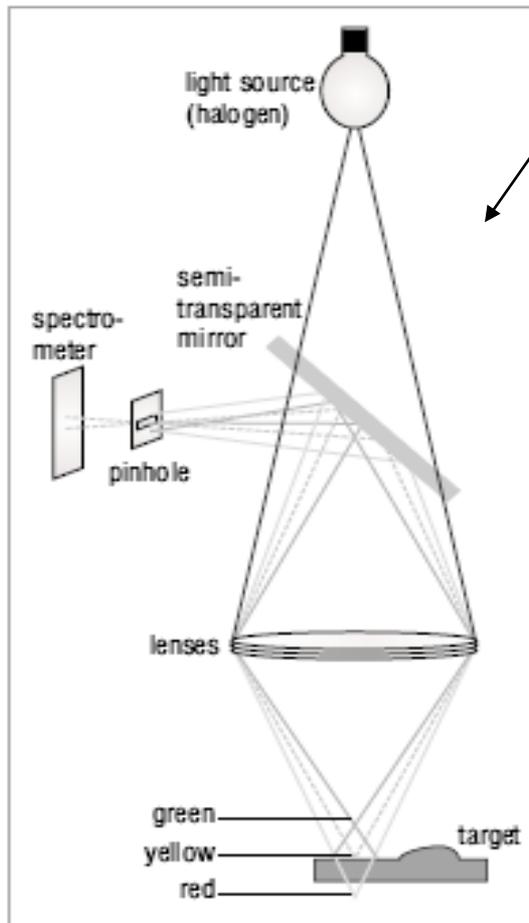
- For V3 CCDs  $\sigma(\text{thickness})=2$  microns
- The  $\sigma(\text{CCD height variation on the FPSP warm}) = 11$  microns.
- Some CCDs were not all the way into position when I measured them warm. Suggests procedure to ensure that?
- When we go cold from room temperature, the focal plane retracted 159 microns and the change in angles was small.
- The focal plane doesn't show any warping when we cool to operating temperature.
- The  $\sigma(\text{CCD height variation on the FPSP cold}) = 9$  microns.
- Some CCDs seemed to pop into place when we cooled.  
What's with that?



# Micro-Epsilon Opto-NCDT 2400

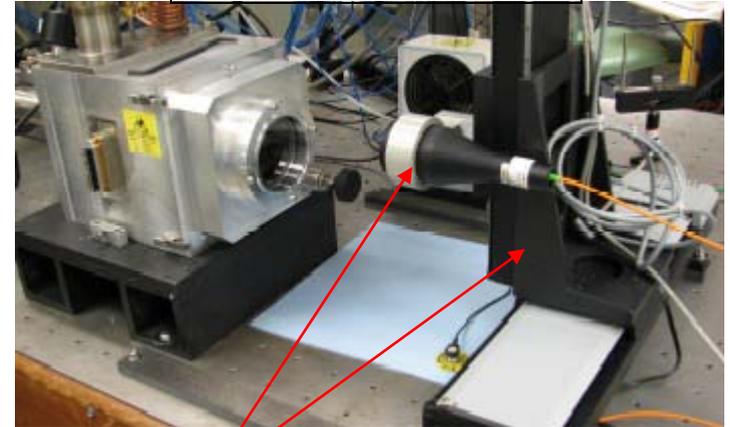
DARK ENERGY  
SURVEY

## How it works



- Confocal lens
- 100  $\mu\text{m}$  spot size
- Precision of 1  $\mu\text{m}$
- Labview Controls (written at FNAL)
- 2.4 cm range

## The Setup (old)



X and Y precision stages ( $\pm 1 \mu\text{m}$ )

Micro-epsilon imager

Sample

