

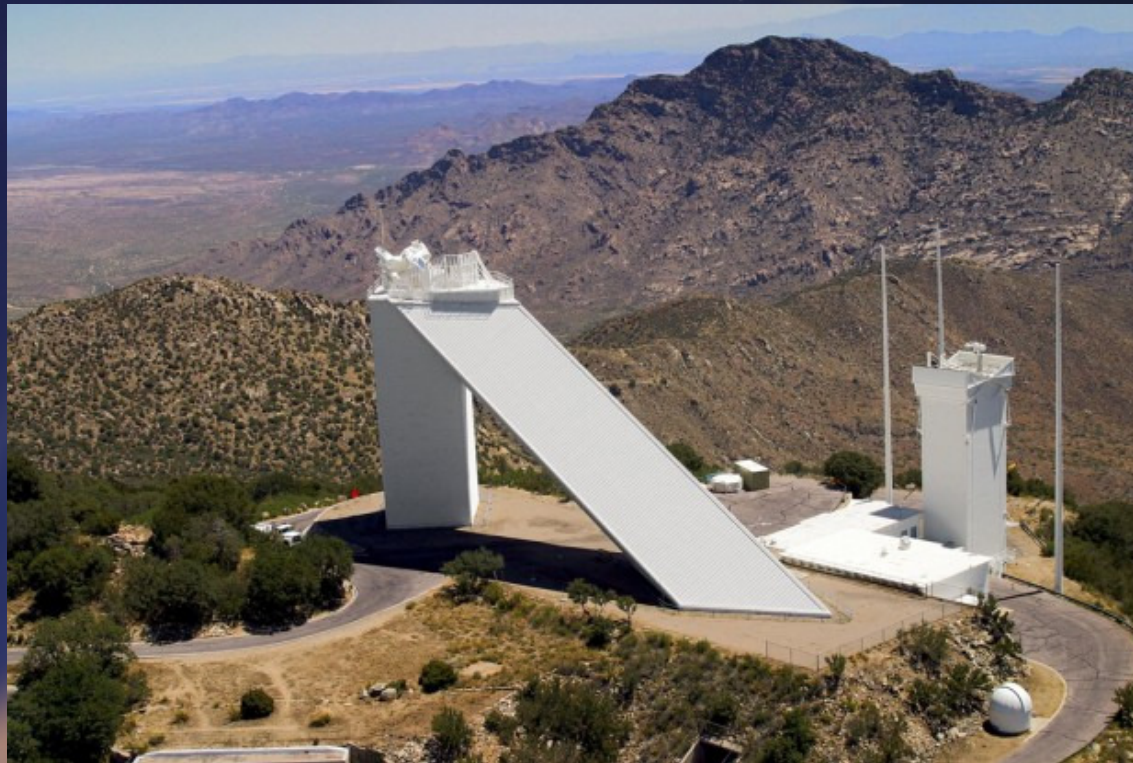
Speckle and Automation Using Amateur Class Telescopes, Inexpensive CMOS Cameras and Off the Shelf Components

Jimmy Ray



How it all began...

- KPNO II : The McMath – Pierce Solar Telescope (Professional Grade)



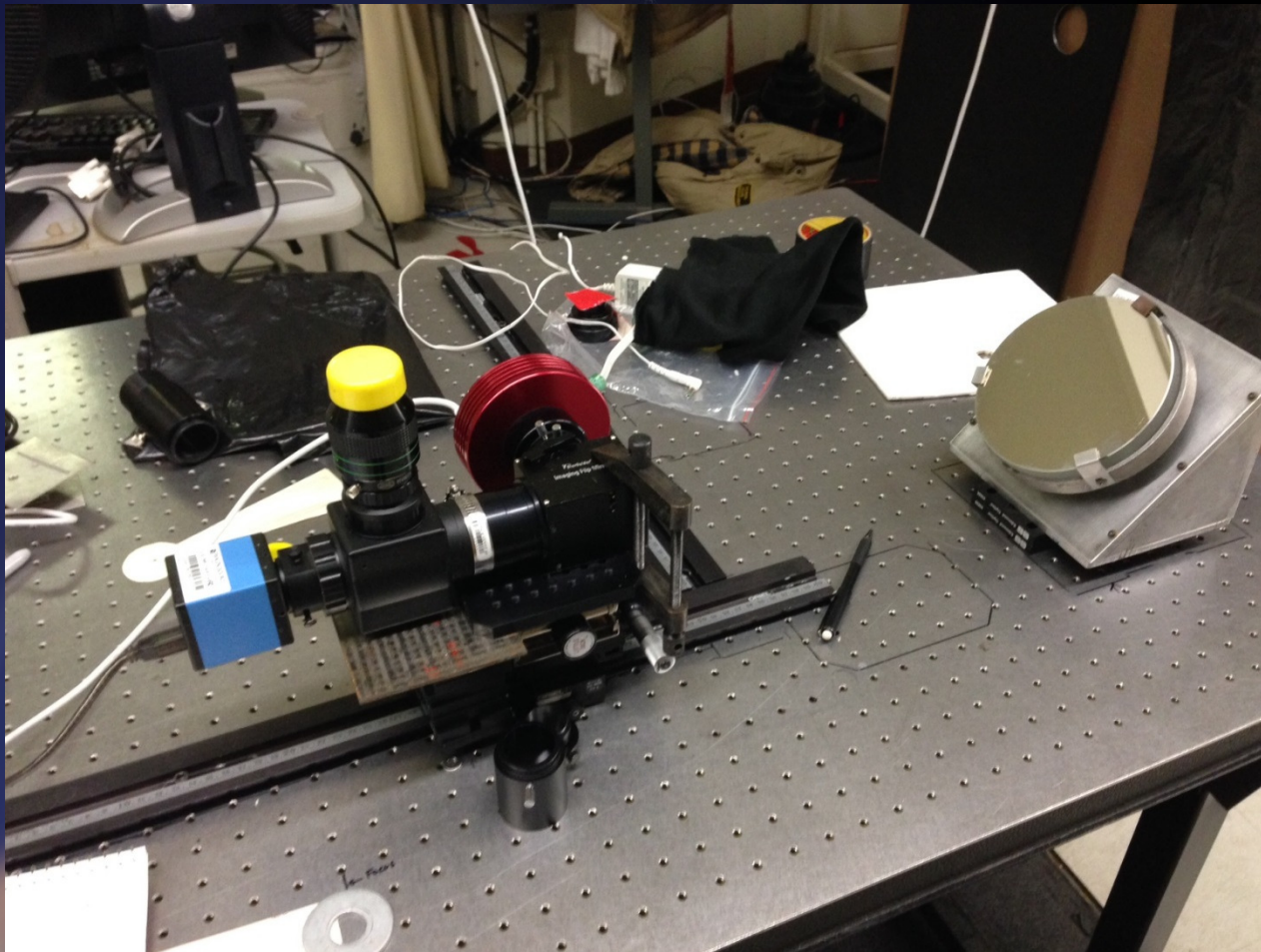
By the numbers...

Optical Parameters of the McMath-Pierce Telescope Facility			
	Main Beam	East Auxiliary	West Auxiliary
Normal Distances: (m)			
Helio to second	136	91	88
Second to Tertiary	75	30	27
Tertiary to Obs Rm	9	9	9
Diameters: (m)			
Heliostats	2.03	0.91	0.91
No. 2 Mirror	1.6	1.07	0.91
No. 3 Mirror	1.52	0.61	0.91
Clear aperture (m / in)	1.6 / 63"	0.81 / 32"	0.81 / 32"
Focal Length: (m)	87	40.37	35.6
f-ratio:	54	50	39
Image Diameter: (m / in)	0.82 / 32"	0.37 / 14.5"	0.33 / 13"
Image Scale(arcsec/mm):	2.37	5.11	5.82

Passing Muster!



Target Acquisition (Ray)



The Andor Luca R Science Camera



The Vision...

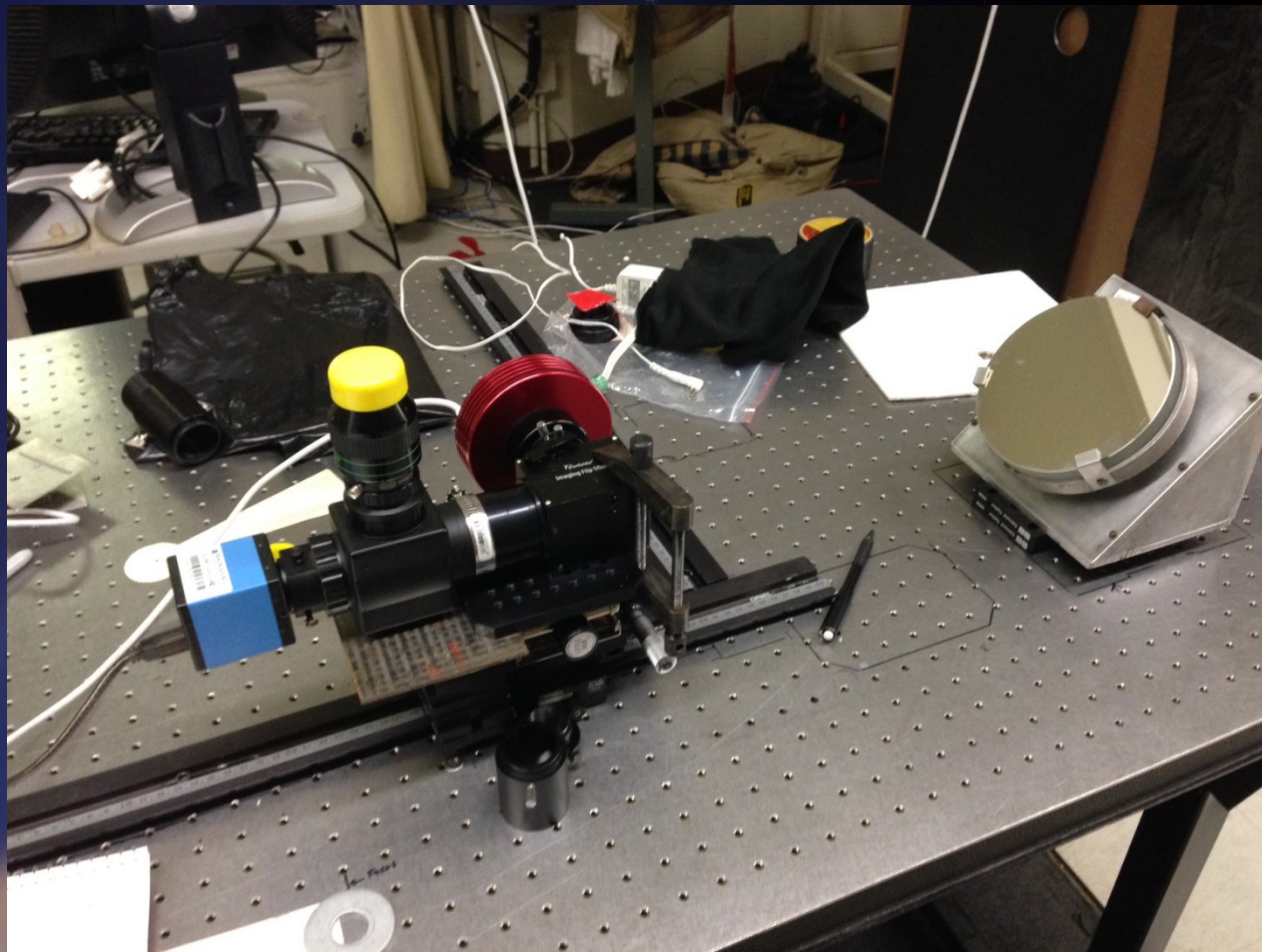
- Expand on the current efforts using speckle with professional class instruments
- Explore the use of Amateur class instruments for Speckle using low cost cameras and off the shelf components.
- Automate it!
- Enter ASDOG...







Setting Up for Speckle - Replicating KPNO Without the Price tag



Setting Up For Speckle -The Hardware

- The Scope





Setting Up For Speckle -The Hardware

- The Scope
- Science Camera



Science Camera - \$299.00

USB3.0 ASI120S

ASI120MM-S/MC-S

Sensor: 1/3" AR0130CS /MT9M034

Max resolution: 1.2MP 1280x960 35fps

Exposure Time: 64μs-1000s

Dimension: φ62mm X 28mm

Weight: 100g



1280X960

@72FPS

640X480

@133FPS

960X960

@74FPS

512X440

@145FPS

1024X768

@90FPS

512X400

@158FPS

800X640

@106FPS

480X320

@196FPS

800X400

@160FPS

320X240

@254FPS

Setting Up For Speckle -The Hardware

- The Scope
- Science Camera
- Acquisition Camera

Acquisition Camera – Astro “Modified”

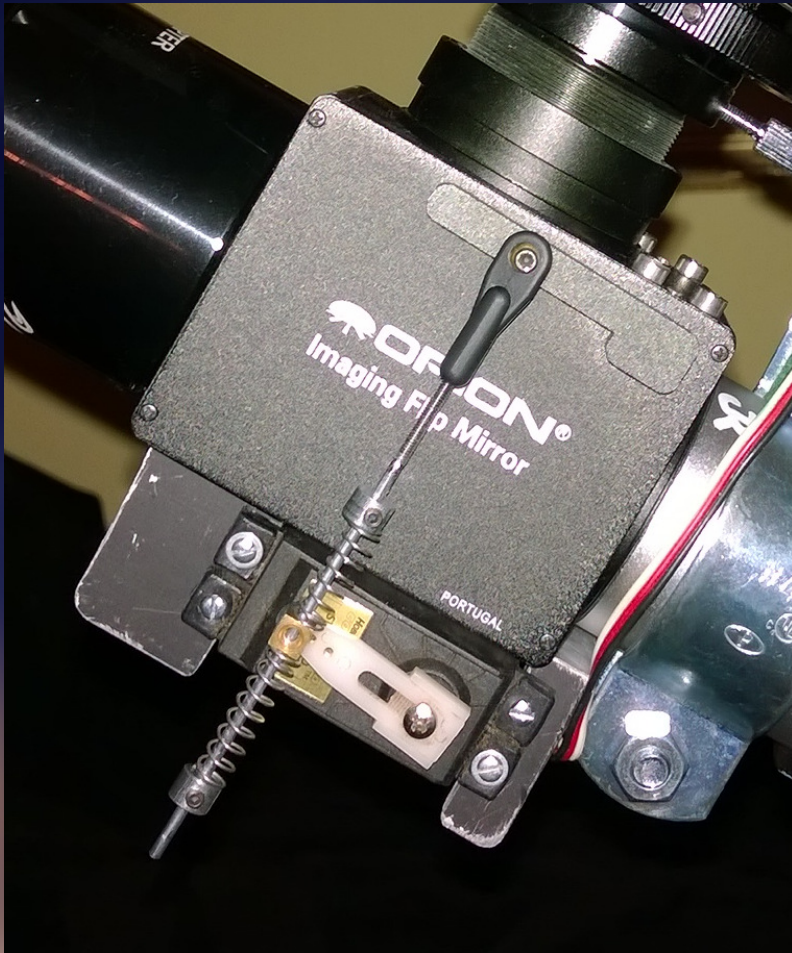


- 35mm Format (large Field)
- 10 Megapixel
- 2.5" LCD Monitor
- Live View Function
- High Sensitivity (ISO 1600)
- Ebay - ~\$80.00

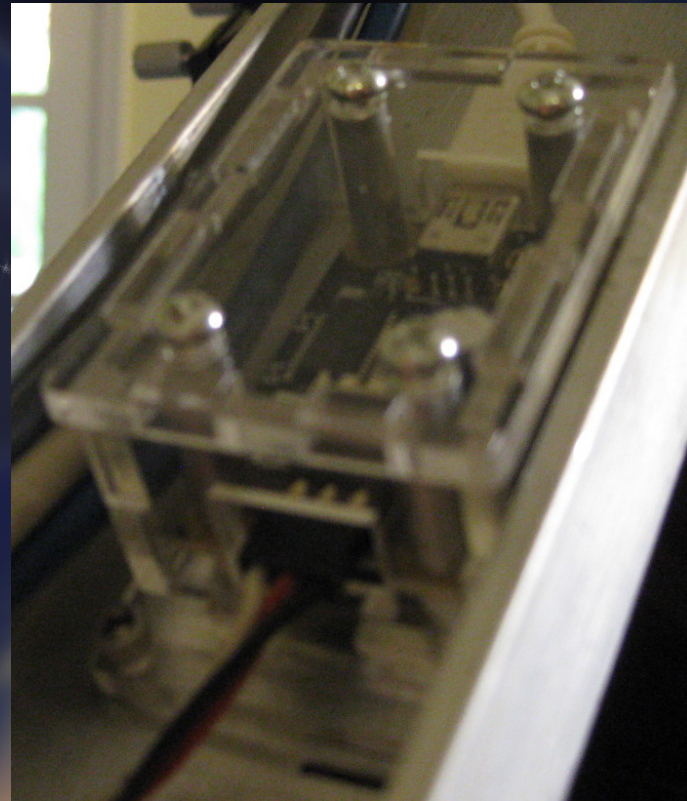
Setting Up For Speckle -The Hardware

- The Scope
- Science Camera
- Acquisition Camera
- Flip Mirror

Flip Mirror / Automation



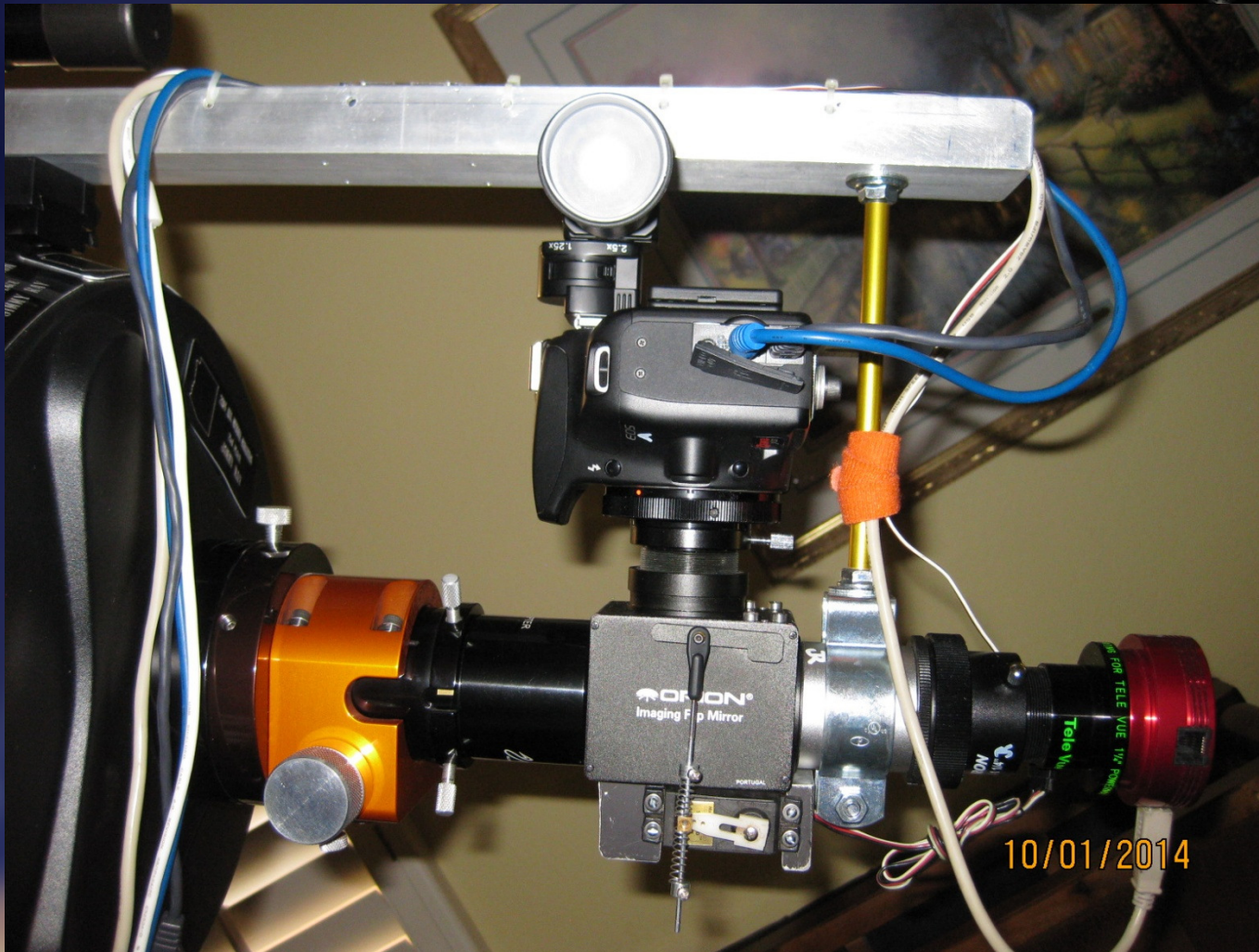
- Phidgets 1066 Servo Driver



Setting Up For Speckle -The Hardware

- The Scope
- Science Camera
- Acquisition Camera
- Flip Mirror
- Putting it all together

Putting It All Together



Putting It All Together (In Mrs. Ray's Living Room)



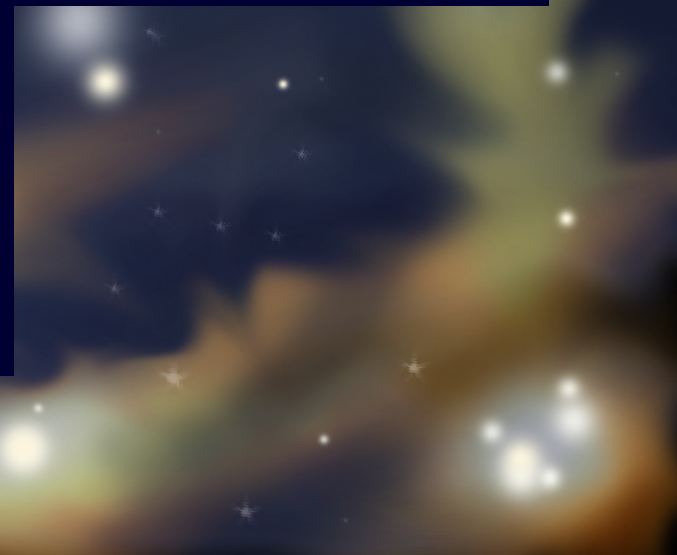
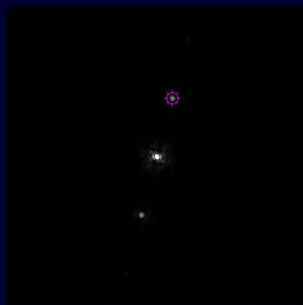
Setting Up For Speckle - The Software

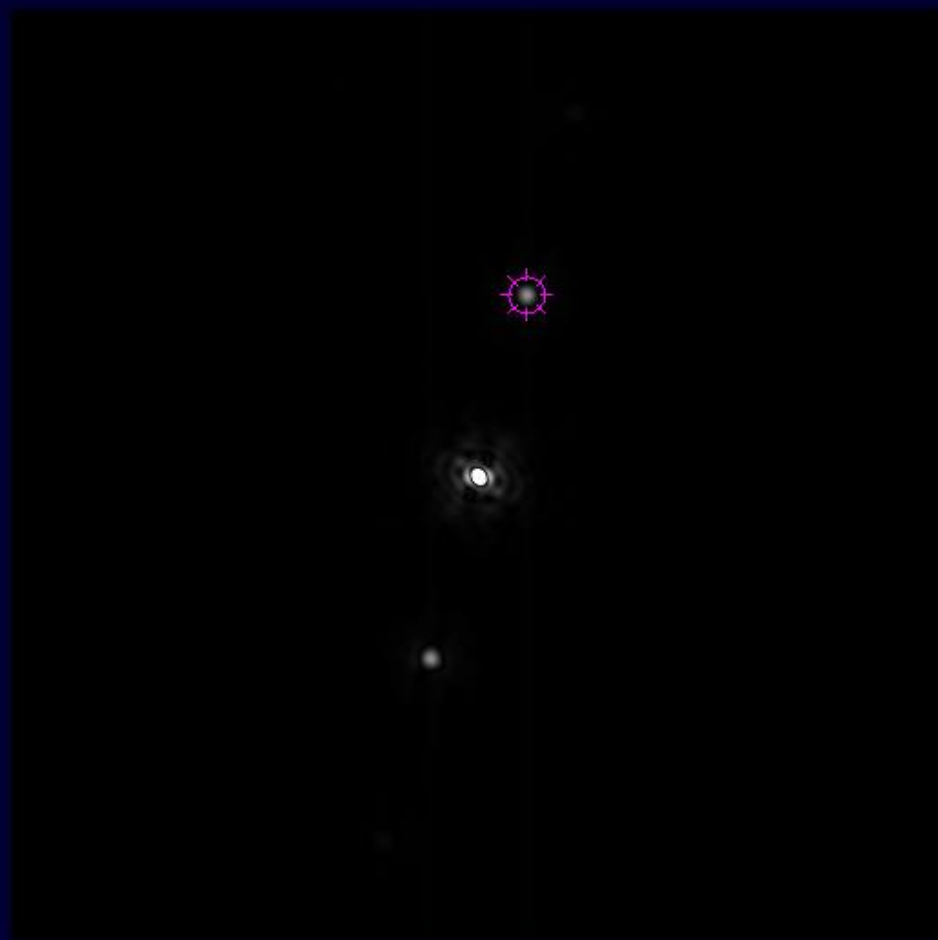
- Scope Control – SkyTools 3
- Science Camera Control – FireCapture
- Acquisition Camera Control – Images Plus (Mike Unsold)
- Flip Mirror Control – Phidgets driver / software package (EOM)
- MS XP and Win7 Based PC's and Laptops
- Full Remote Control via the Students of California Polytechnic

The Engineering Run / First Light

Nu m	Targ et	Theta O	Thet aC	Theta O-C	Rho O	Rho C	Rho -C	O Theta F	Ap RhoF	Reln D	DM t	Comm	DSFN	RSFN
	266.1 8				9.06 96			165.1 8	103.0 64	0.15 12	18	Calibration, Run 2	STF2727 RUN 2 CUBE_PSD.fit	HIP 102281 DECON2 CUBE_PSD.fit
	266.1 8				9.06 96			165.1 8	103.0 64	0.15 12	18	STF2727 RUN 2	STF2727 RUN 2 CUBE_PSD.fit	HIP 102281 DECON2 CUBE_PSD.fit
	118.4 55				3.39 36			17.45 5	38.56 4	0.02 16	76	STF 2762AB	STF2762 AB RUN 2 CUBE_PSD.fit	STF2762AB DECON ZETA CYG CUBE_PSD.fit
	273.2 01				2.18 16			172.2 01	24.79 1	0.14 16	57	STF2801	STF2801 RUN 1 CUBE_PSD.fit	STF2801 DECON HIP 105727 CUBE_PSD.fit
	273.2 01				2.18 16			172.2 01	24.79 1	0.14 16	57	STF2801	STF2801 RUN 1 CUBE_PSD.fit	STF2801 DECON HIP 105727 CUBE_PSD.fit

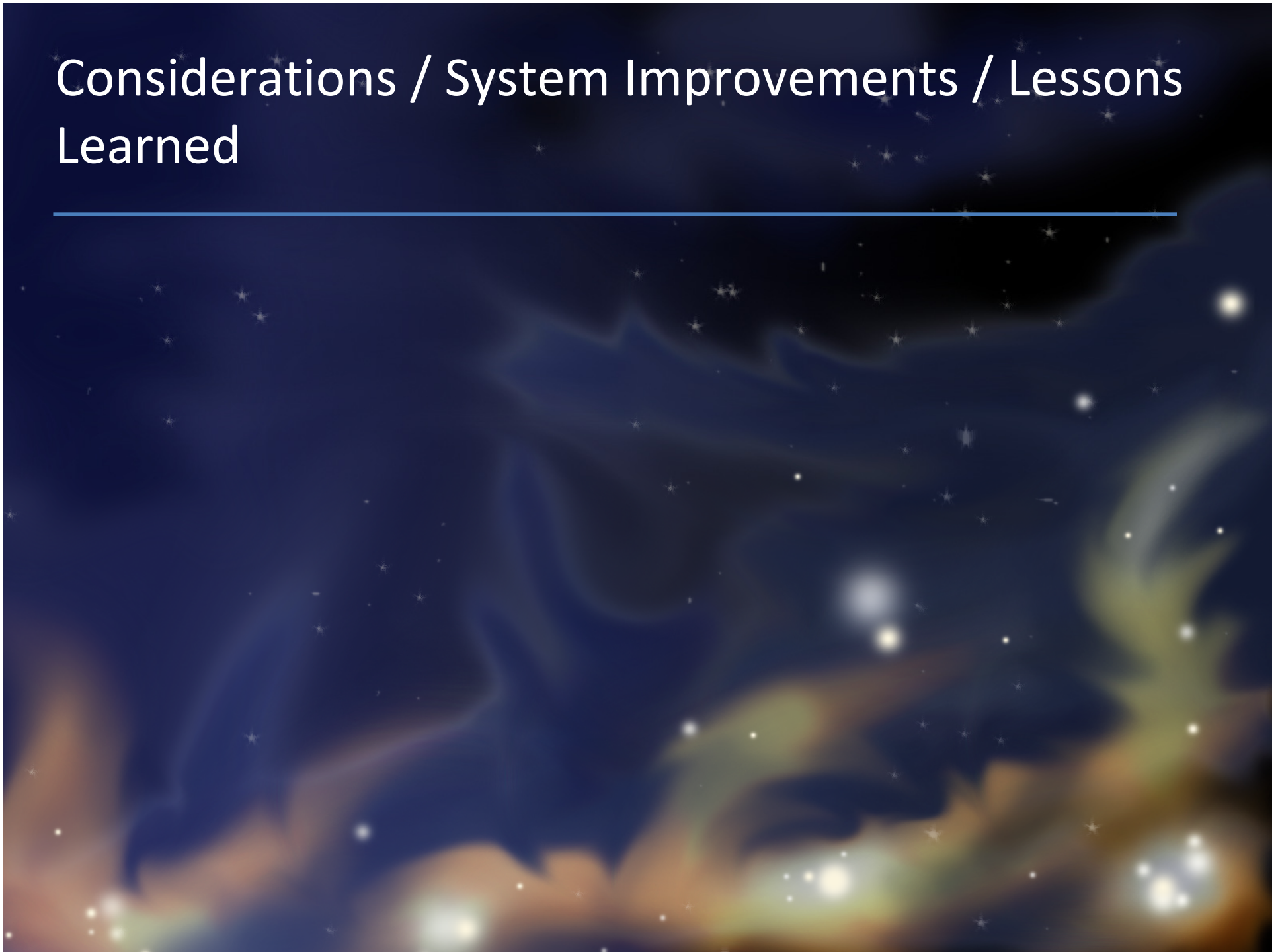
The Results...



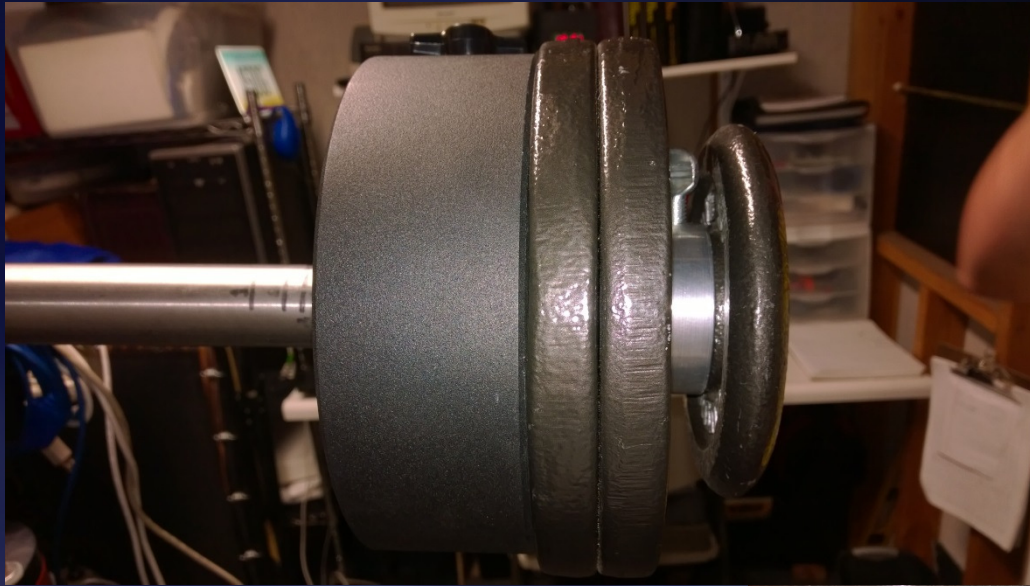




Considerations / System Improvements / Lessons Learned



Keep It Light !



Considerations / System Improvements / Lessons Learned

- Keep it light
- Scope alignment is critical to accurate target acquisition
- PEC is important at f25!
- DSLR “Live View” becomes a challenge beyond mag 7
- Low cost speckle can be done.
- More to come!