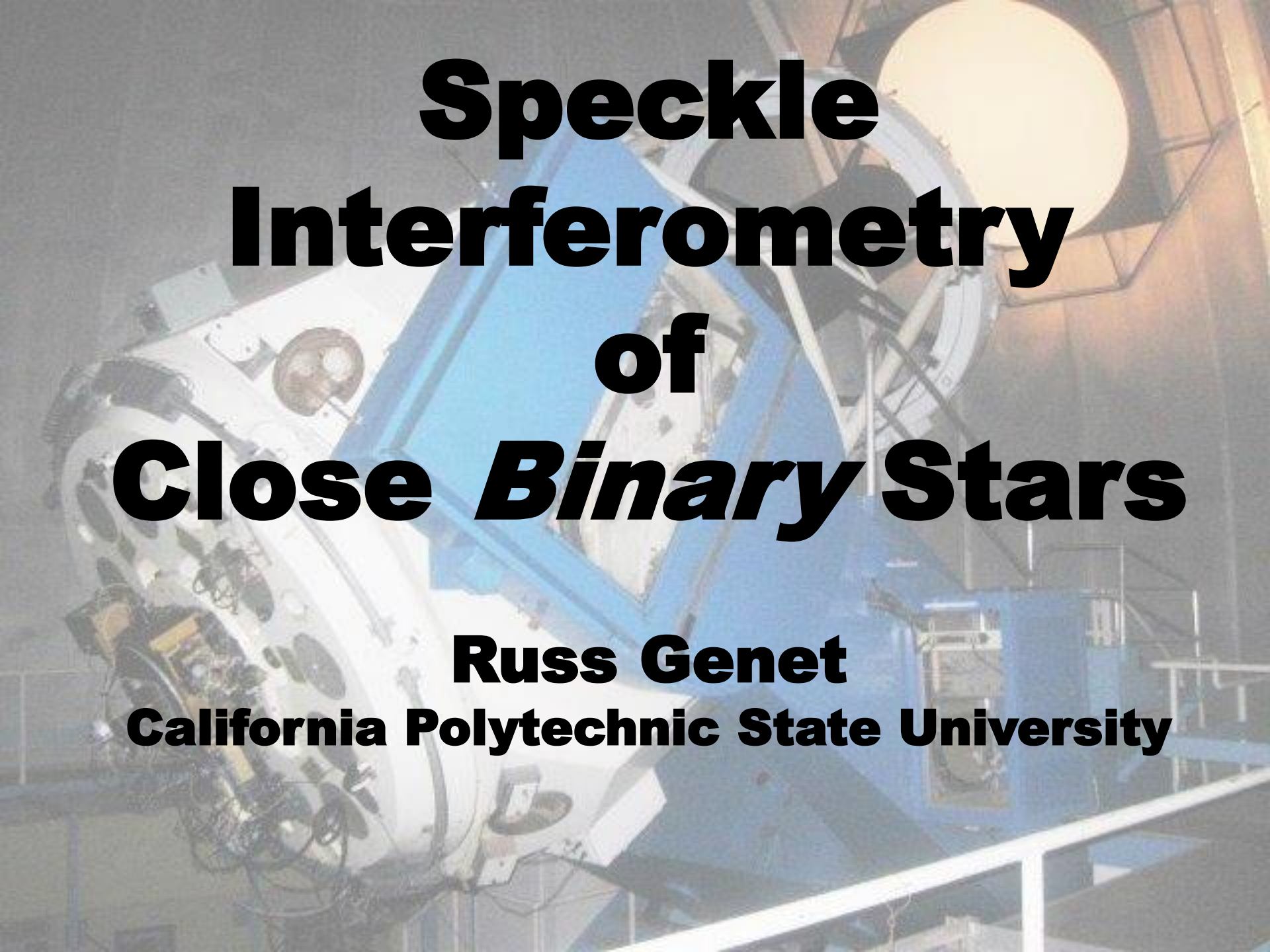
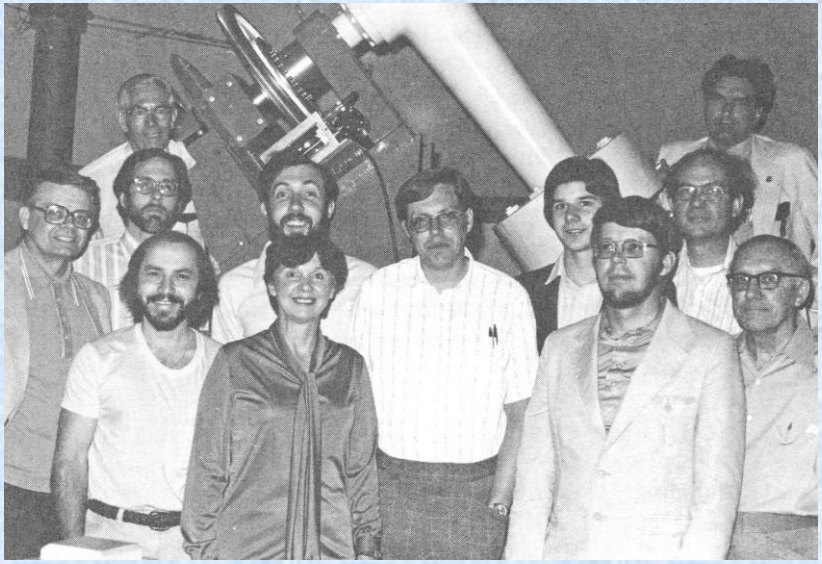
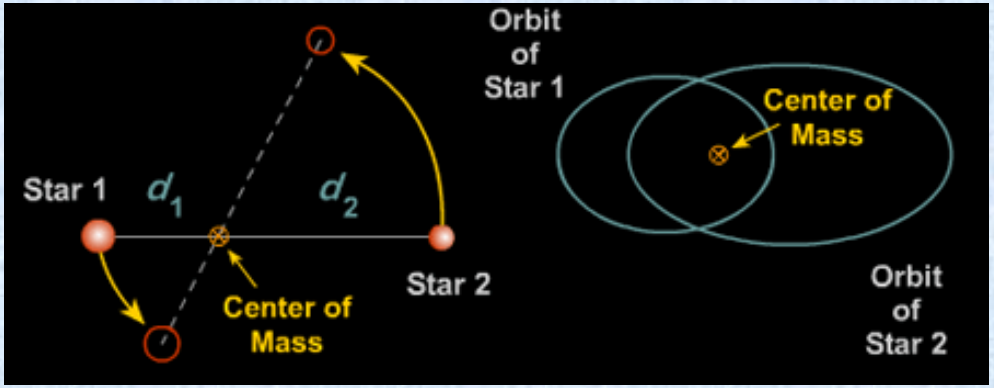
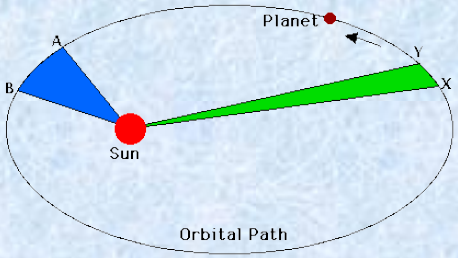


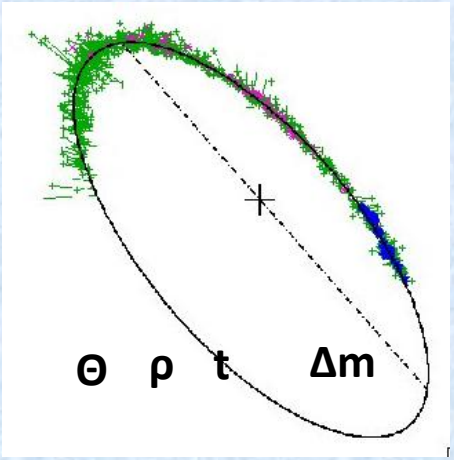
Speckle Interferometry of Close *Binary* Stars

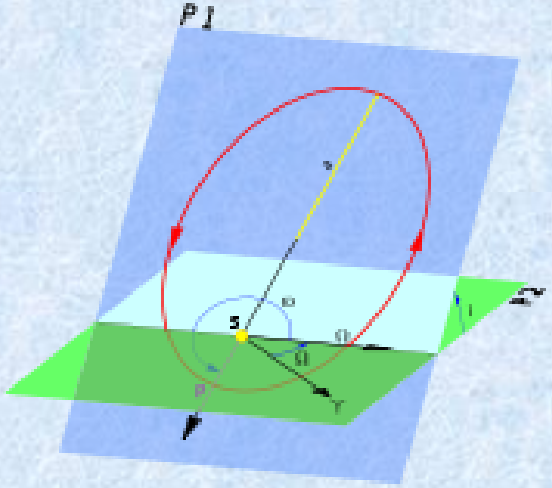
Russ Genet
California Polytechnic State University

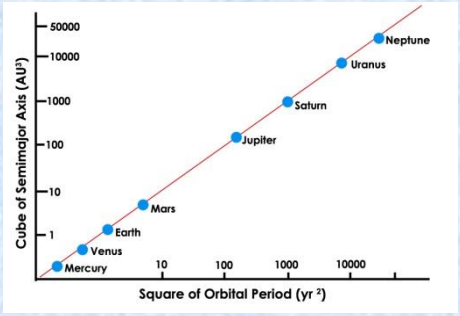




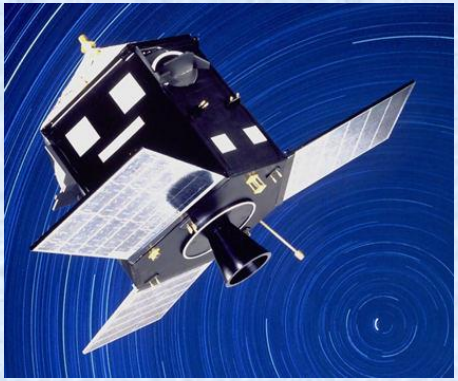


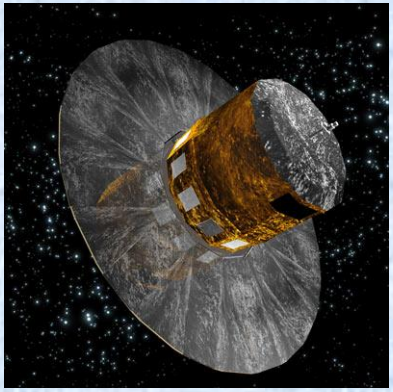






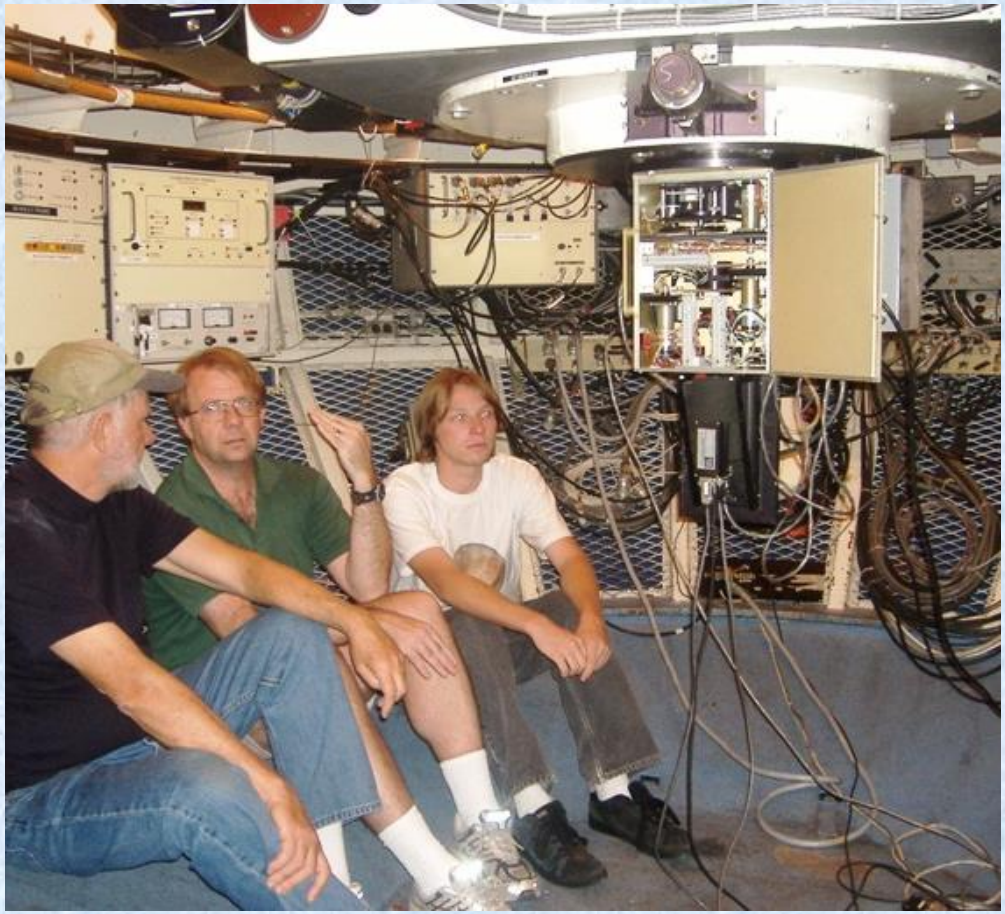
$$P^2 = \left[\frac{4\pi^2}{G(M+m)}\right] a^3$$

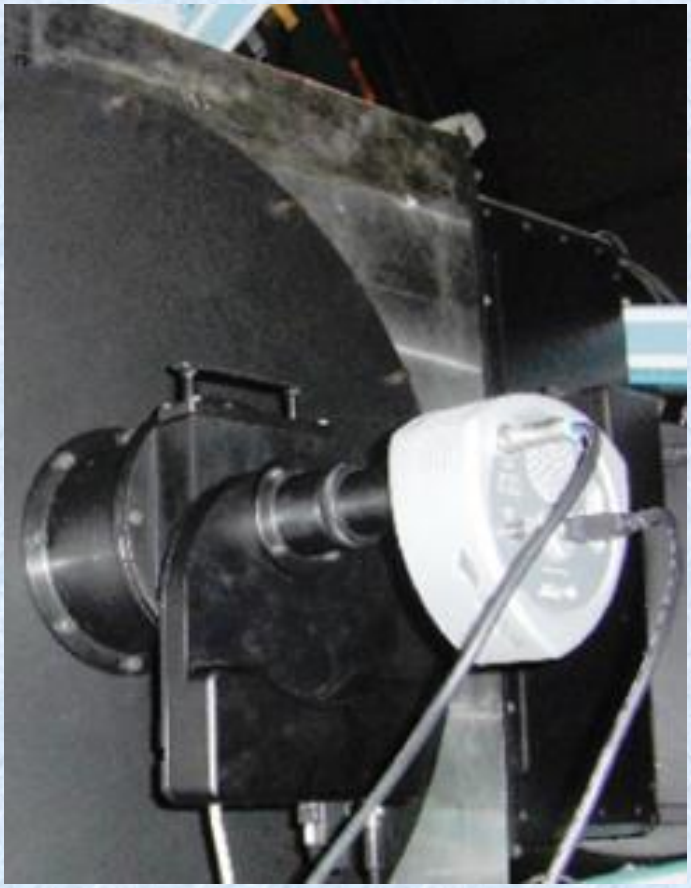





Crayons
Akash
RUSS


BROWN
UNIVERSITY



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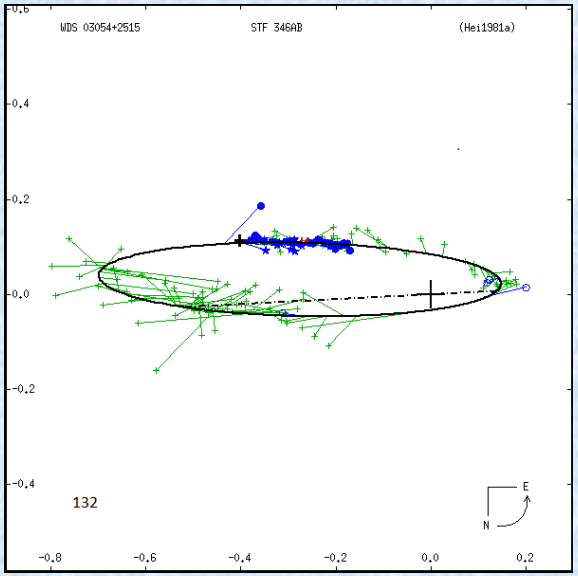
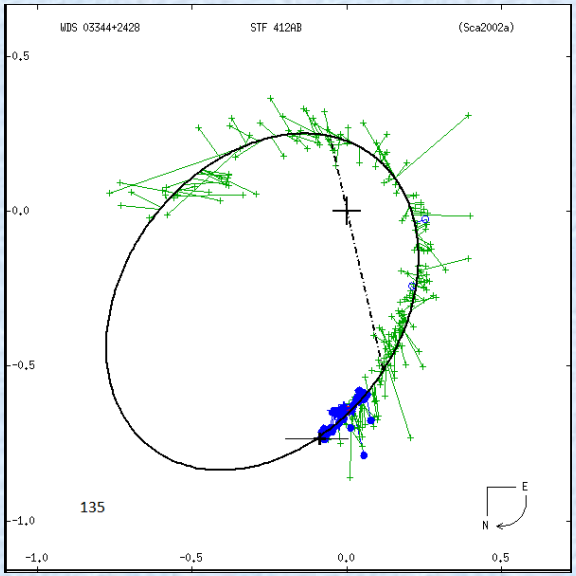
EMCCD Camera

	Precision	Accuracy
θ	1.1	16.0
ρ	3.4	24.8
RSS	3.6	29.5

WDS Designation α, β (2000)	Discoverer Designation	Primary Magnitude	Secondary Magnitude	Date Besselian	θ (°)	ρ (″)	O-C (θ)	O-C (ρ)	Orbit Grade	Orbit Reference	Note
00063+5826	STF 3062	6.42	7.32	2012.8876	352.8	1.521	0.6	-0.031	2	Kiyaeva et al. (2001)	
00546+1911	STT 20AB	6.12	7.19	2012.8876	179.5	0.584	0.2	0.016	3	Docobo & Ling (2007)	
00550+2338	STF 73AB	6.12	6.54	2012.8876	326.7	1.067	0.1	-0.024	2	Muterspaught et al. (2010)	
01095+4715	STT 515AB	4.59	5.61	2012.8877	118.2	0.495	0.1	-0.022	4	Muterspaught et al. (2010)	
01097+2348	BU 303	7.32	7.56	2012.8877	292.5	0.603					
01106+5101	BU 235AB	7.54	7.82	2012.8877	139.0	0.827	1.8	-0.028	4	Seymour et al. (2002)	
01283+4247	AC 14	8.29	8.88	2012.8878	91.9	0.765					
01401+3858	STF 141	8.28	8.61	2012.8878	303.4	1.666					
01493+4754	STF 162AB	6.47	7.22	2012.8877	198.8	1.946	0.5	-0.017	L+9	Genet et al. (this work)	b
01532+1526	BU 260	8.75	8.97	2012.8878	259.6	1.120	-0.7	0.027	5	Cvetkovic & Novakovic (2006)	
02062+2507	STF 212	8.35	8.71	2012.8878	161.8	1.904					
02140+4729	STF 228	6.56	7.21	2012.8877	295.6	0.749	0.0	-0.015	2	Soderhjelm (1999)	
02331+5828	STF 272	8.33	8.36	2012.8880	216.9	1.911					
02388+3325	STF 285	7.48	8.14	2012.8880	162.7	1.708					
02422+4242	STT 44AB	8.46	8.96	2012.8880	55.9	1.387					
02529+5300	STF 314AB,C	6.95	7.26	2012.8879	315.7	1.549					
02589+2137	BU 525	7.47	7.45	2012.8879	272.4	0.537	-2.1	0.043	4	Costa (1978)	
02592+2120	STF 333AB	5.17	5.57	2012.8879	209.9	1.381	0.4	0.025	4	Rica et al. (2012)	
03054+2515	STF 346AB	6.21	6,19	2012.8879	254.1	0.421	-3.2	-0.055	3	Heintz (1997)	
03058+4342	BU 1175	7.23	8.80	2012.8879	273.3	0.683					
03177+3838	STT 53	7.73	8.50	2012.8880	237.1	0.617	-1.0	0.016	3	Alzner (1988)	
03233+2058	STF 381	7.56	8.75	2012.8880	107.9	1.056					
03250+4013	HU 1058	8.22	8.83	2012.8880	113.8	0.840					
03285+5954	STF 384AB	8.13	8.85	2012.8880	272.4	1.953					
03302+5922	STF 389AB	6.42	7.89	2012.8879	71.5	2.523					
03312+1947	STF 403	8.71	8.92	2012.8880	172.3	2.290					
03344+2428	STF 412AB	6.60	6.86	2012.8879	353.1	0.742	0.8	0.001	3	Scardia et al. (2002)	
03401+3407	STF 425	7.52	7.60	2012.8879	60.8	1.898	0.7	-0.020	L+9	Genet et al. (this work)	b
03407+4601	STT 59	7.90	8.85	2012.8880	355.6	2.819					
03454+4952	HU 103AB	8.70	8.86	2012.8879	202.2	1.158					
04064+4325	A 1710	8.16	8.27	2012.8879	311.9	0.618	1.5	-0.001	3	Heintz (1982)	
04069+3327	STT 71AB	6.86	8.66	2012.8879	229.2	0.743					
04182+2248	STF 520	8.26	8.46	2012.8880	78.8	0.632	-2.5	0.039	3	Hartkopf & Mason (2001)	
04227+1503	STT 82AB	7.31	8.63	2012.8880	332.6	1.210	-1.2	-0.017	3	Mason et al. (2004)	
04233+1123	STF 535	6.95	8.29	2012.8878	270.5	1.054	0.8	0.002	5	Hartkopf & Mason (2000)	
04422+3731	STF 577	8.38	8.45	2012.8880	337.5	0.723				Mason et al. (2004)	
04478+5318	HU 612	7.06	8.54	2012.8880	0.3	0.699	-0.4	0.030	5	Novakovic (2007)	
05055+1948	STT 95	7.02	7.56	2012.8880	296.4	0.926	-0.6	-0.033	4	Jasinta (1996)	
05103+3718	STF 644AB	6.96	6.78	2012.8880	222.6	1.647					
05167+1826	STF 670AB	7.72	8.28	2012.8880	165.1	2.520					
05188+5250	STF 657	8.30	8.81	2012.8880	310.5	0.952					
05240+2458	STF 694AB	8.65	8.54	2012.8880	14.2	1.379					


WDS 03054+2515
STF 346AB
(Hei1981a)
132
E
N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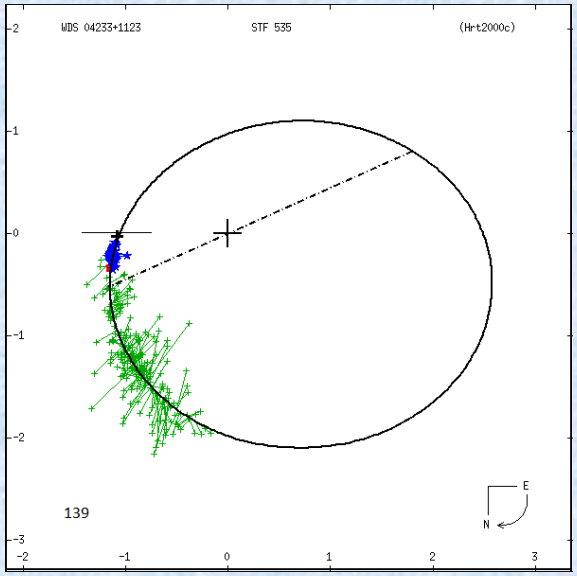
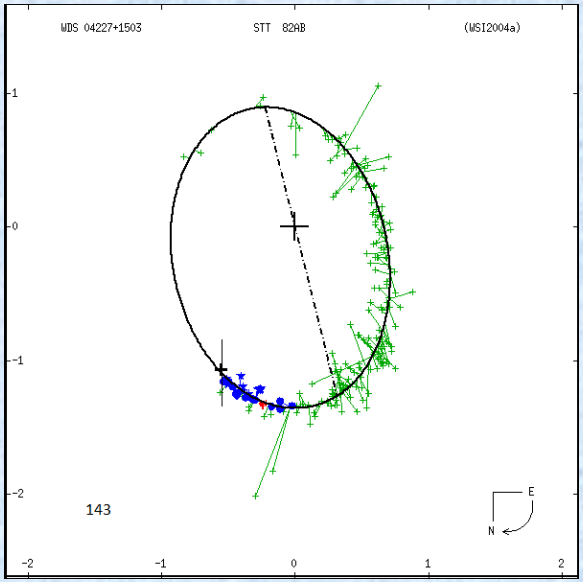
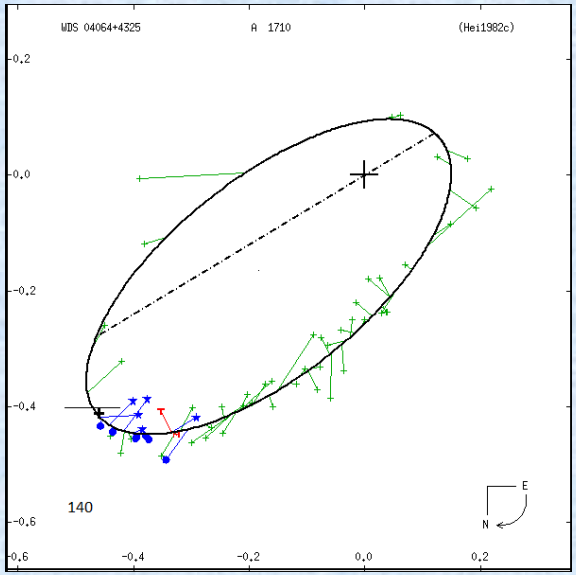
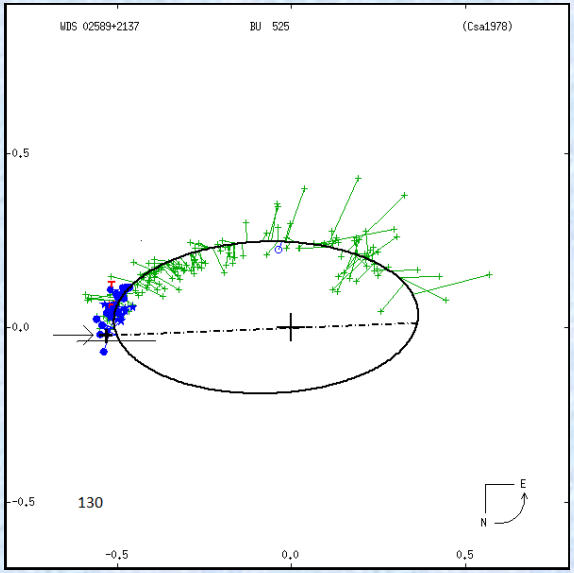
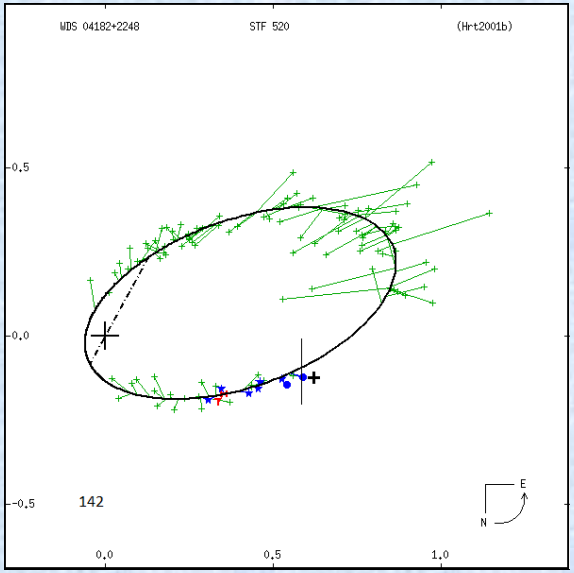
STF 412AB
(Sca2002a)
135
E
N


WDS 04233+1123
STF 535
(Hrt2000c)
139
E
N


WDS 04227+1503
STT 82AB
(WSI2004a)
143
E
N


WDS 04064+4325
A 1710
(Hei1982c)
140
E
N


WDS 02589+2137
BU 525
(Csa1978)
130
E
N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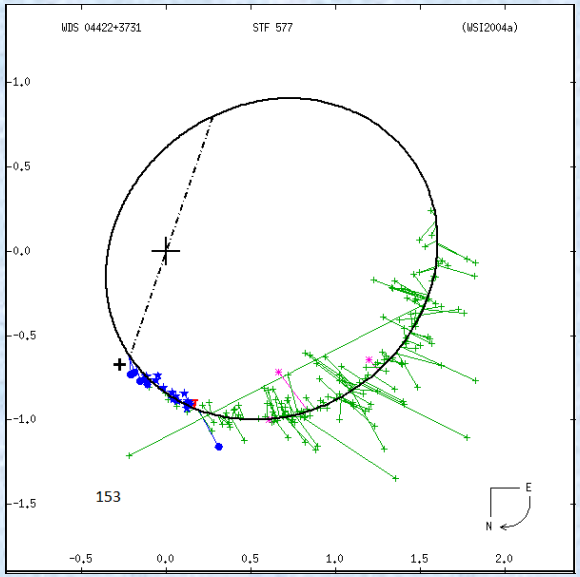
STF 520
(Hrt2001b)
142
E
N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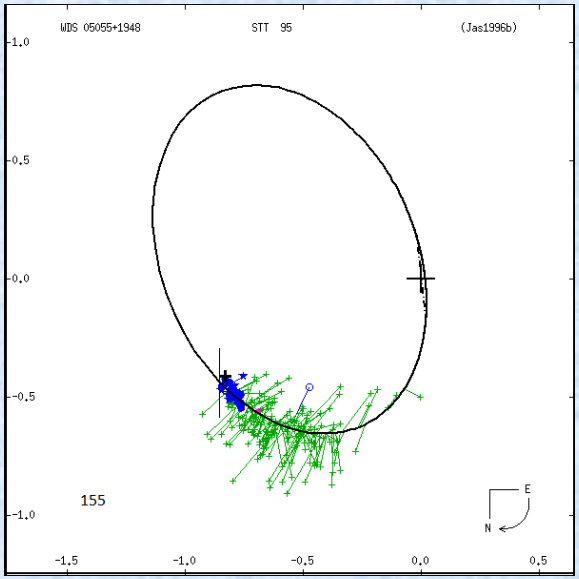
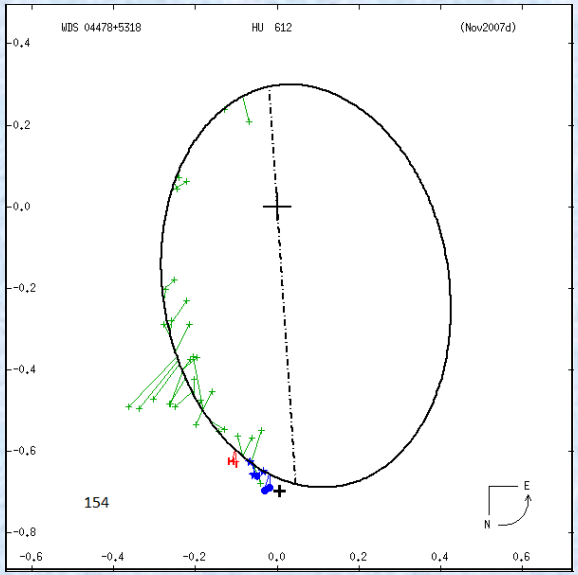
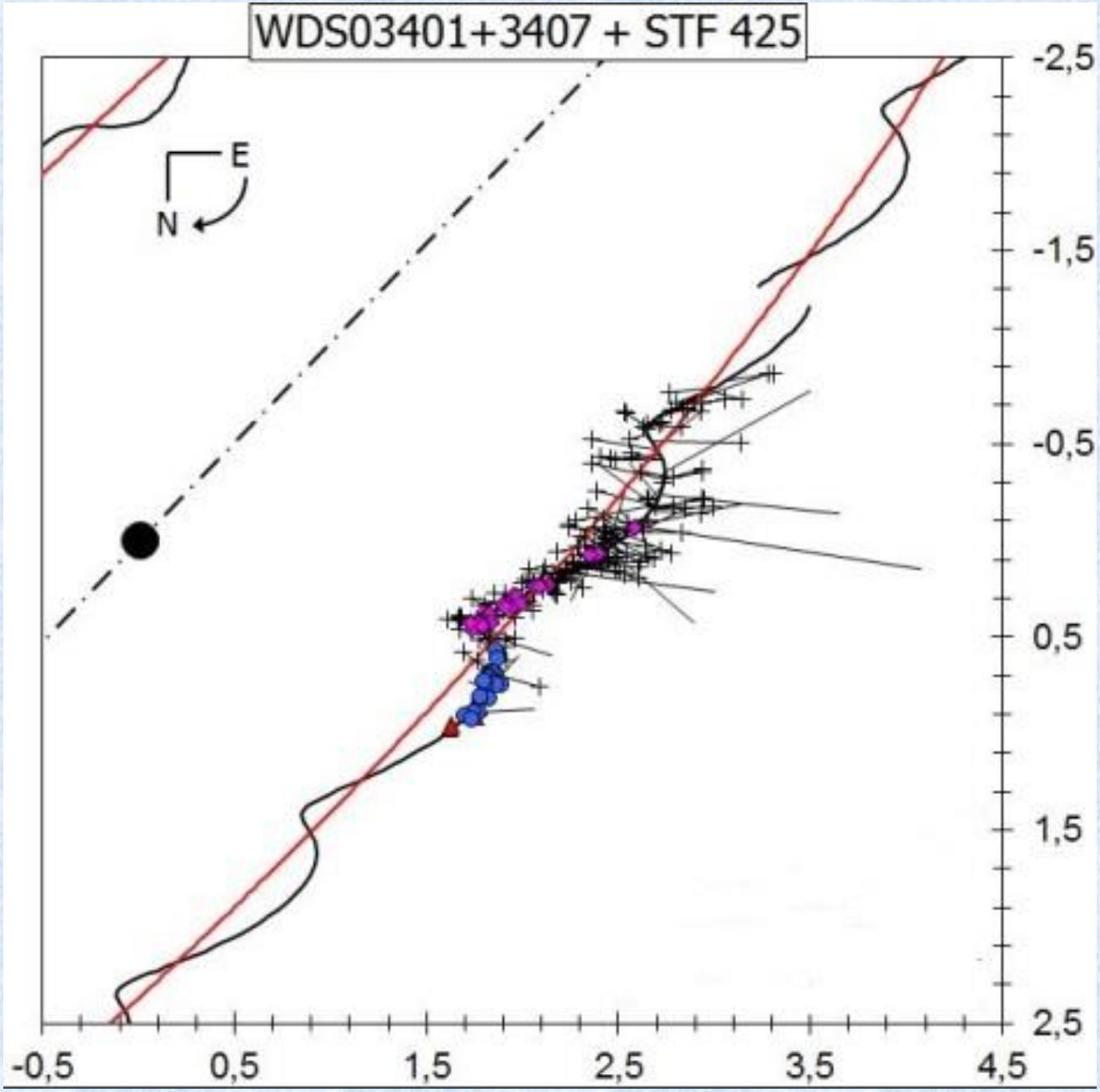
STF 577
(WSI2004a)
153
E
N


WDS 05055+1948
STT 95
(Jas1996b)
155
E
N


WDS 04478+5318
HU 612
(Nov2007d)
154
E
N


WDS03401+3407 + STF 425
E
N
-2,5
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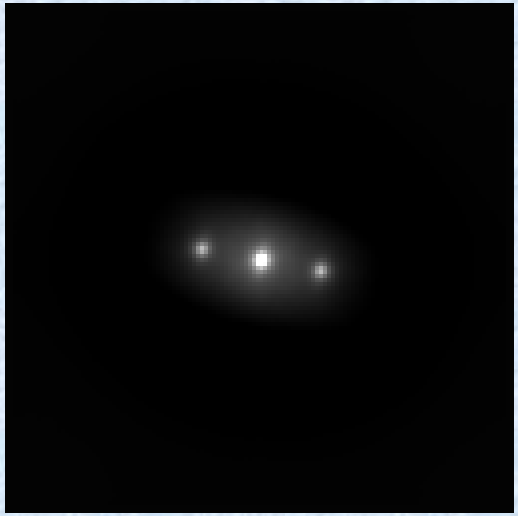

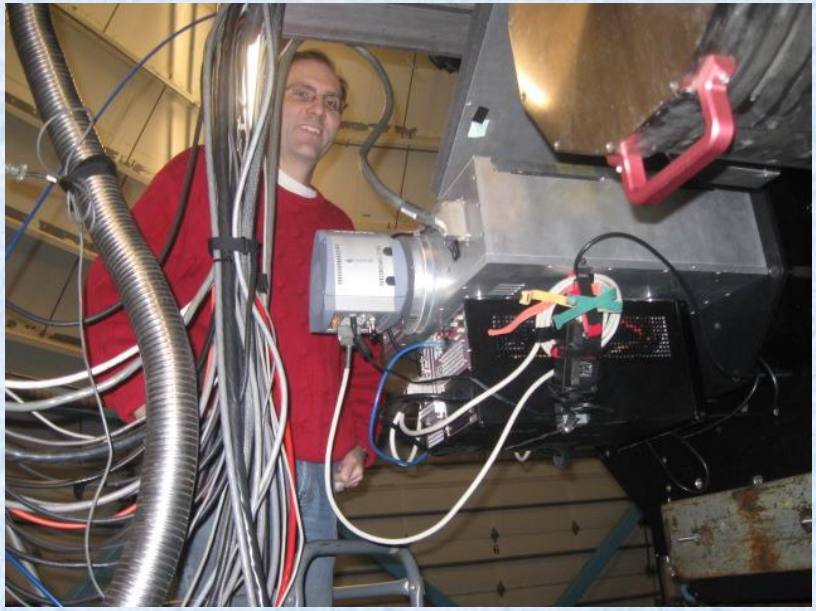

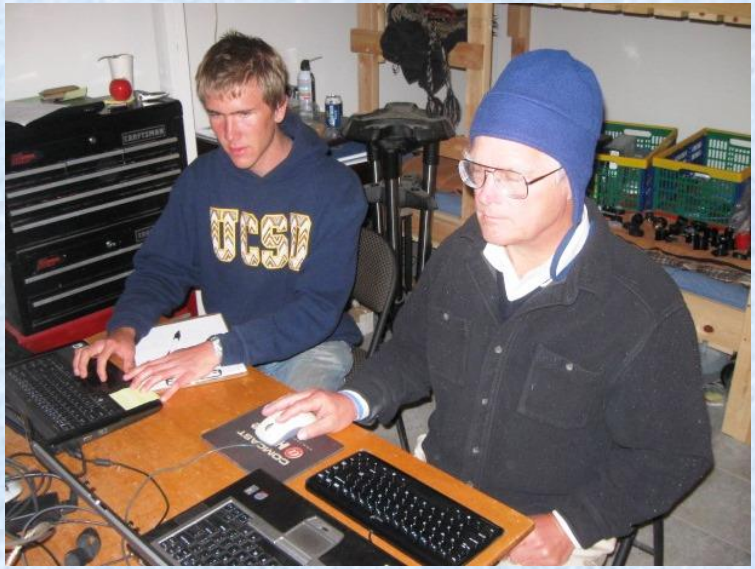
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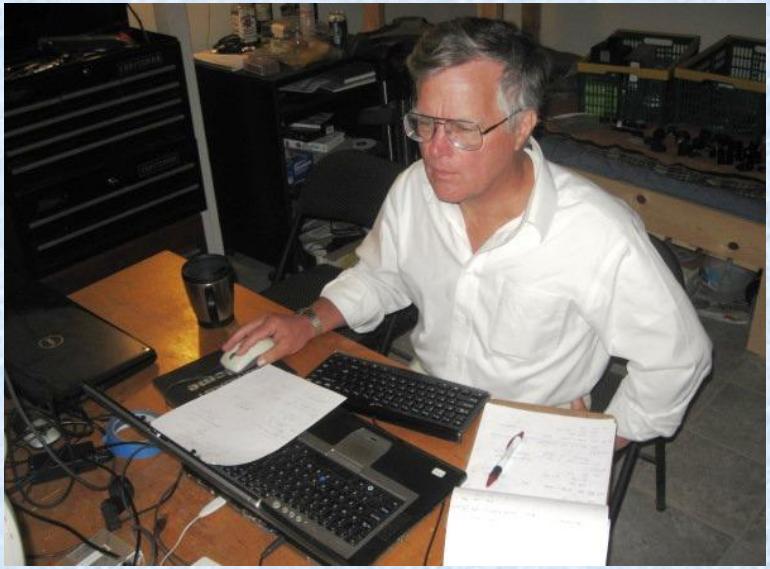


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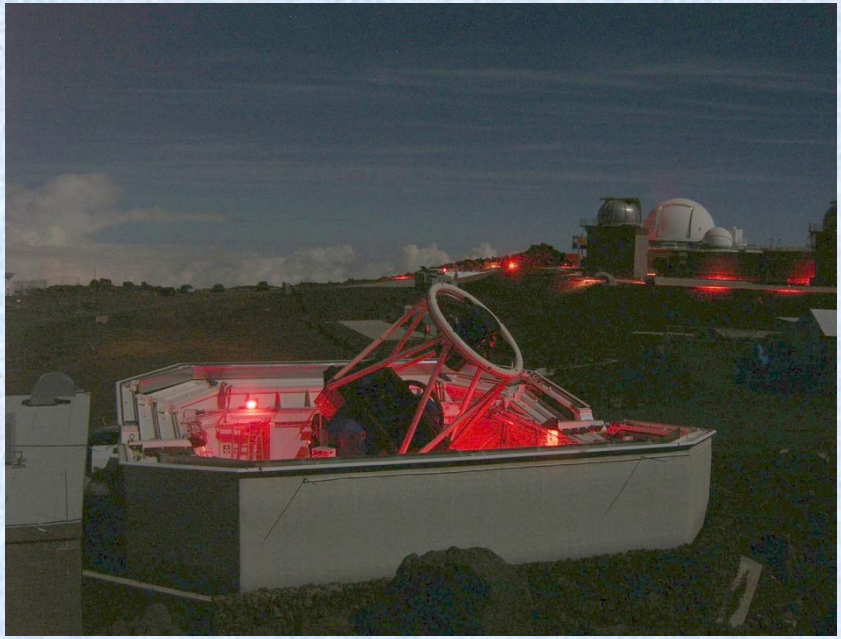
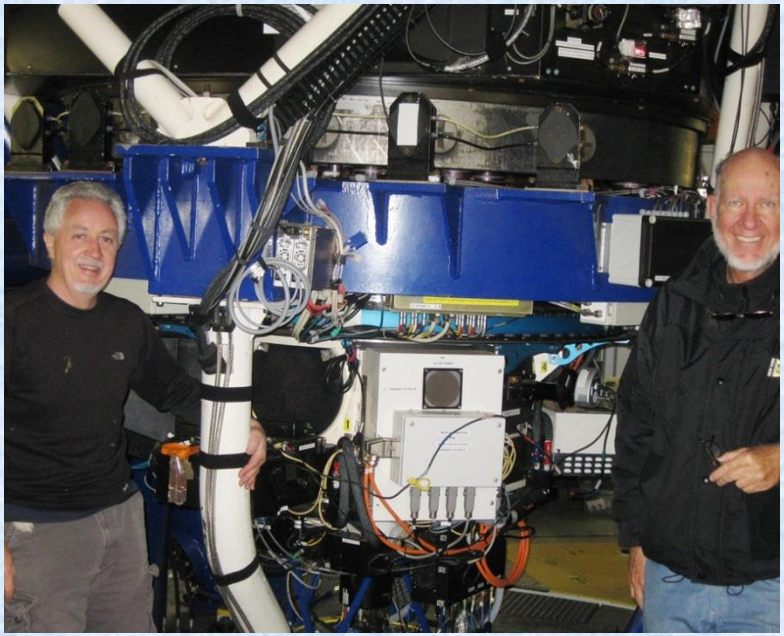
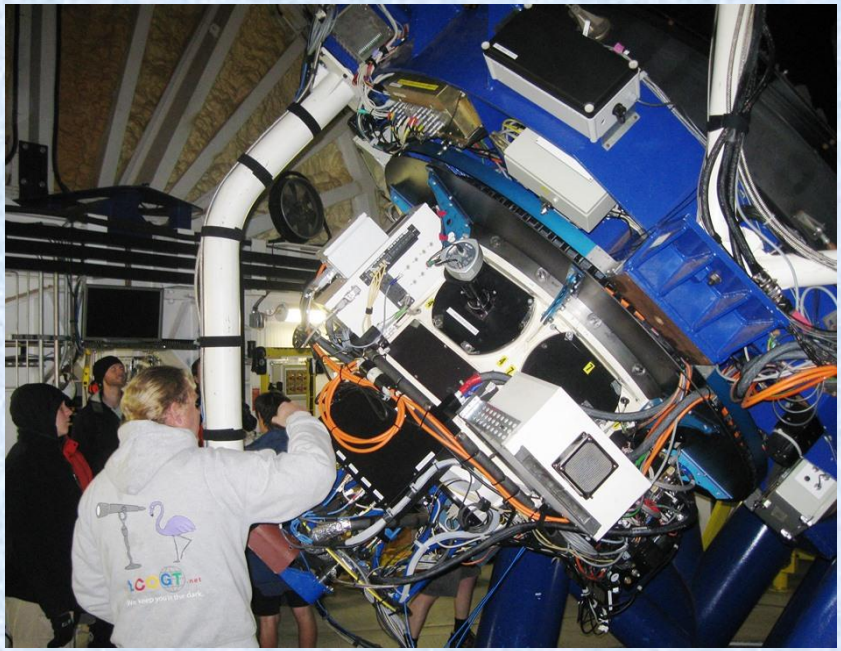
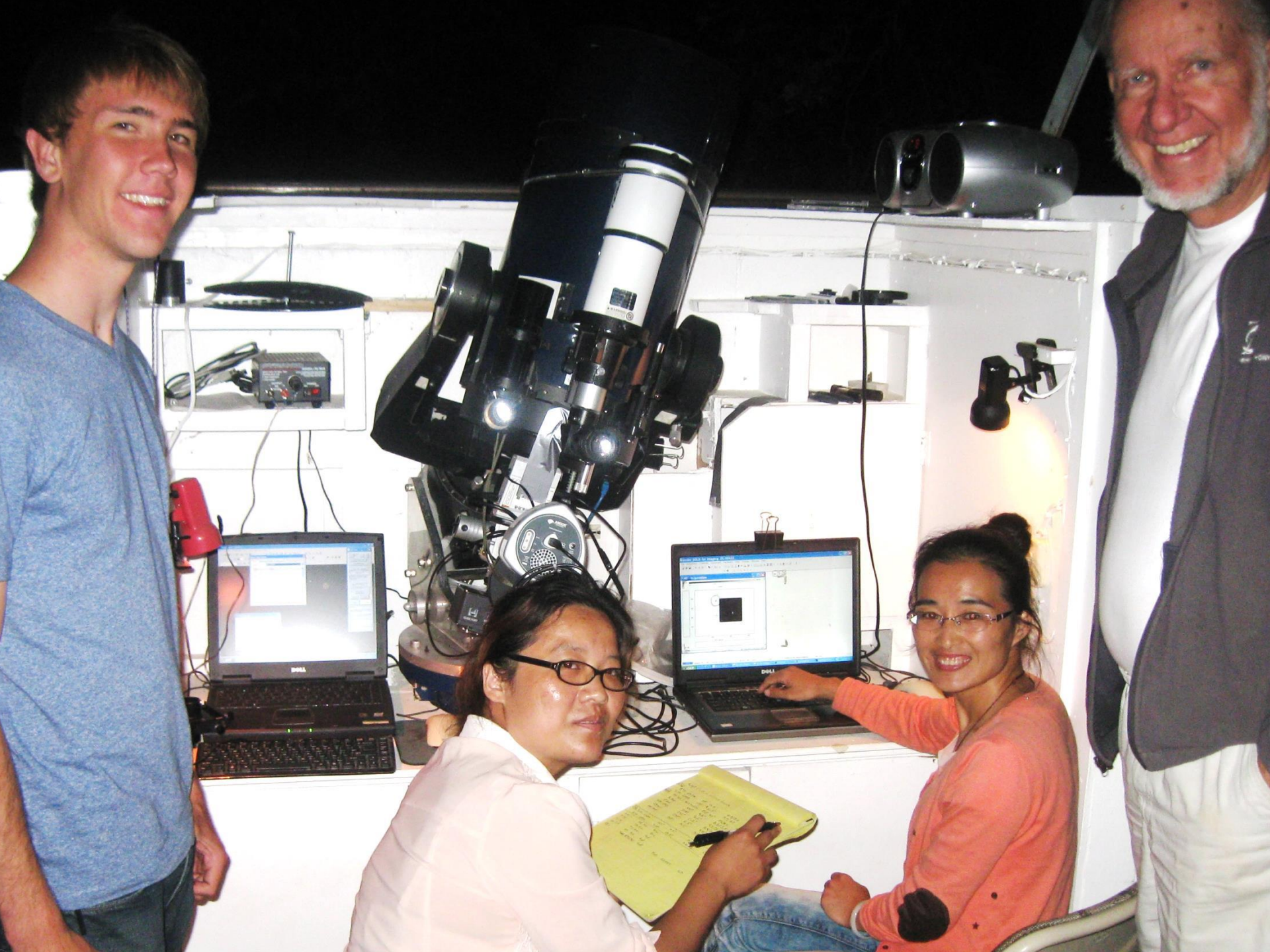


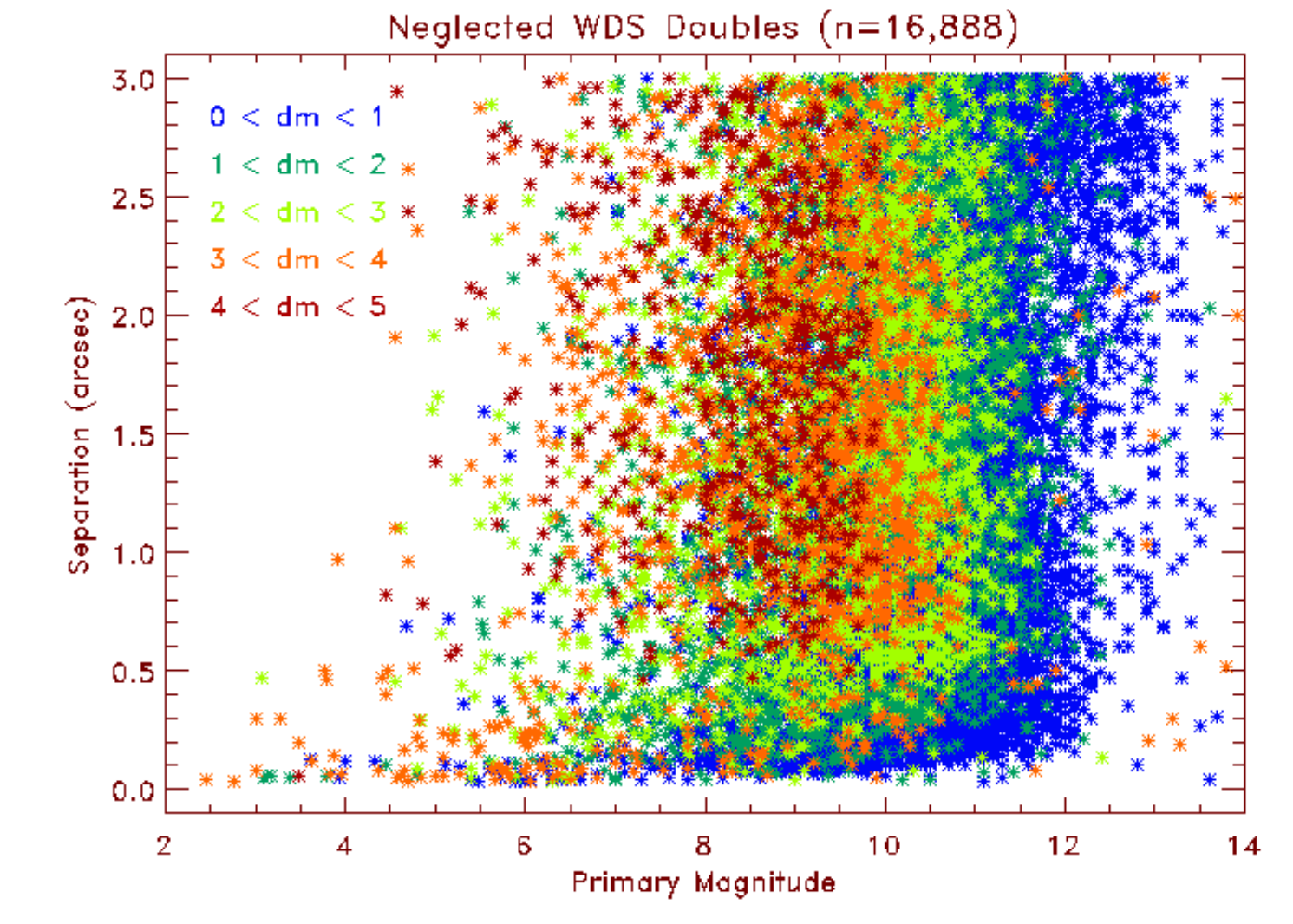




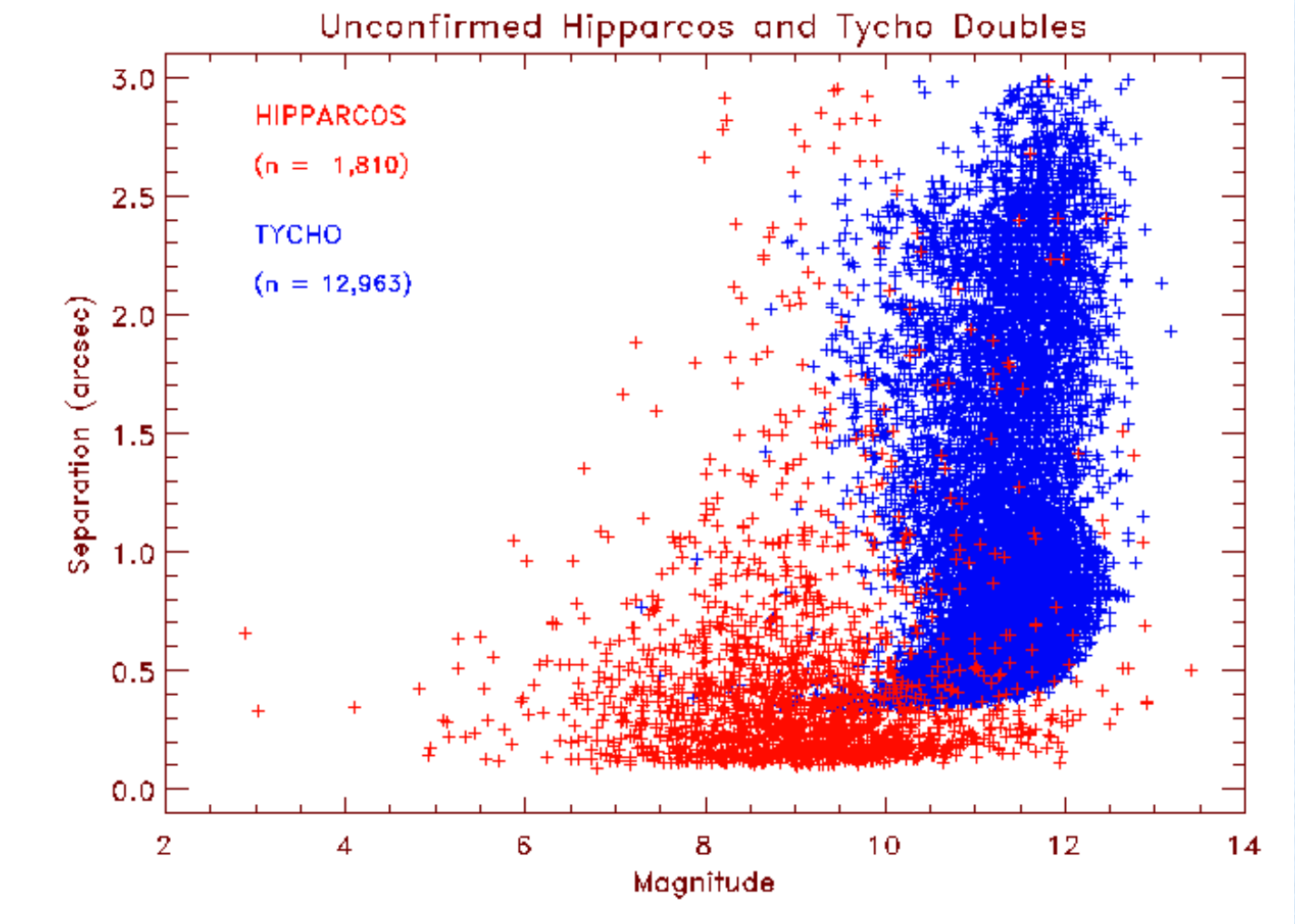


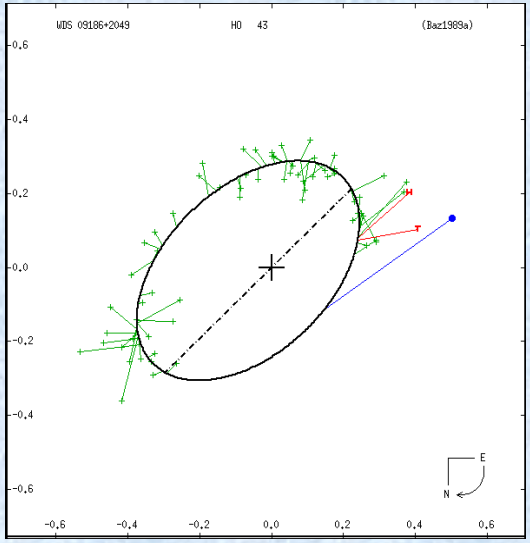

YOSEMITE

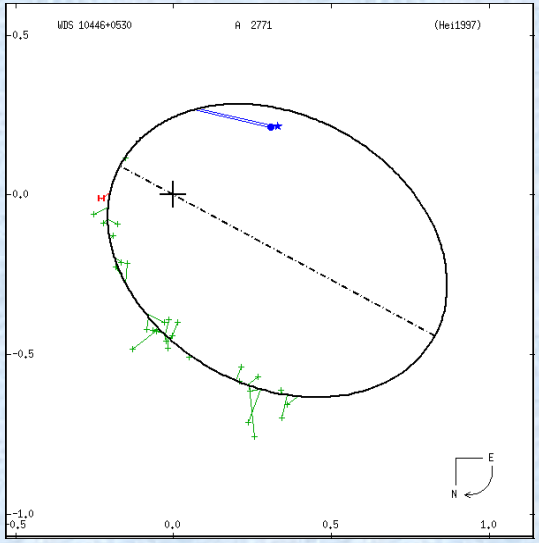
Neglected Double Stars

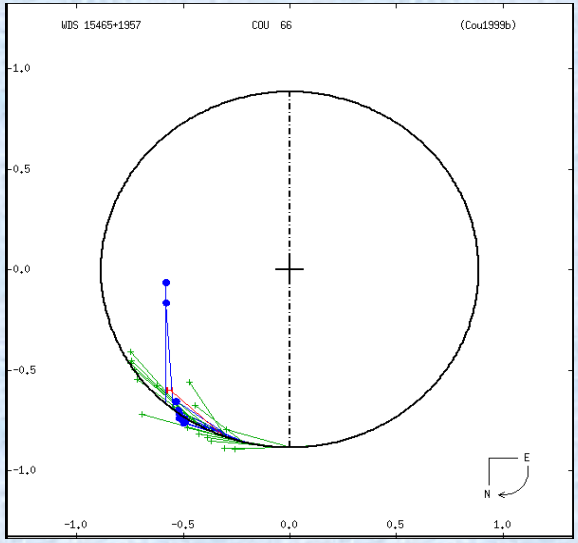


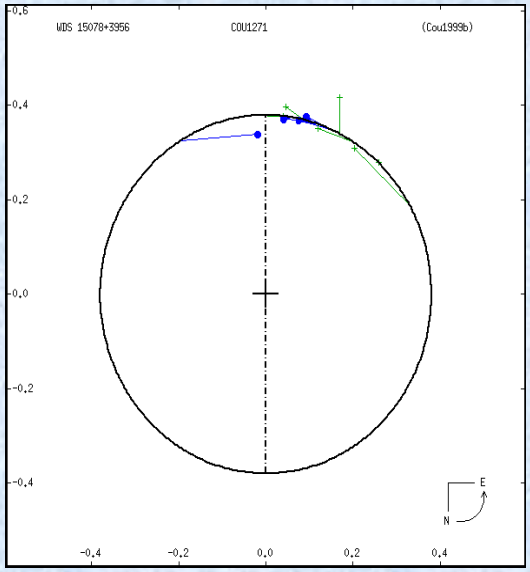
HDS and TDS Pairs

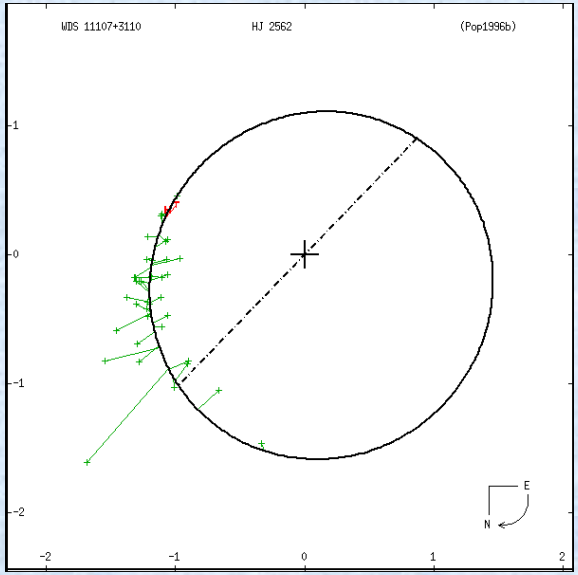


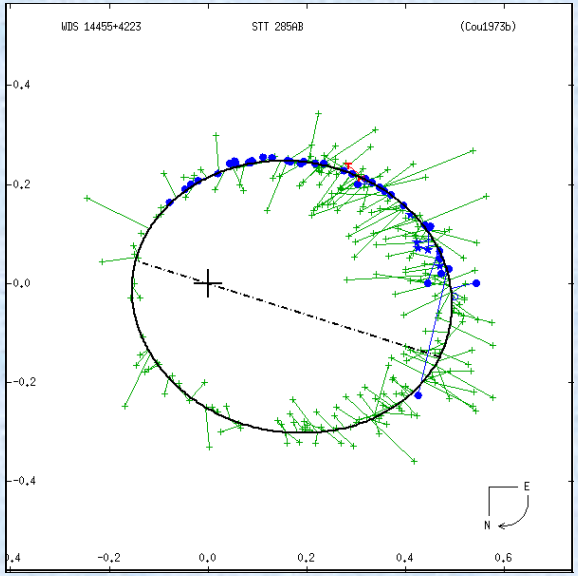

WDS 09186+2049
HO 43
(Baz1989a)
E
N

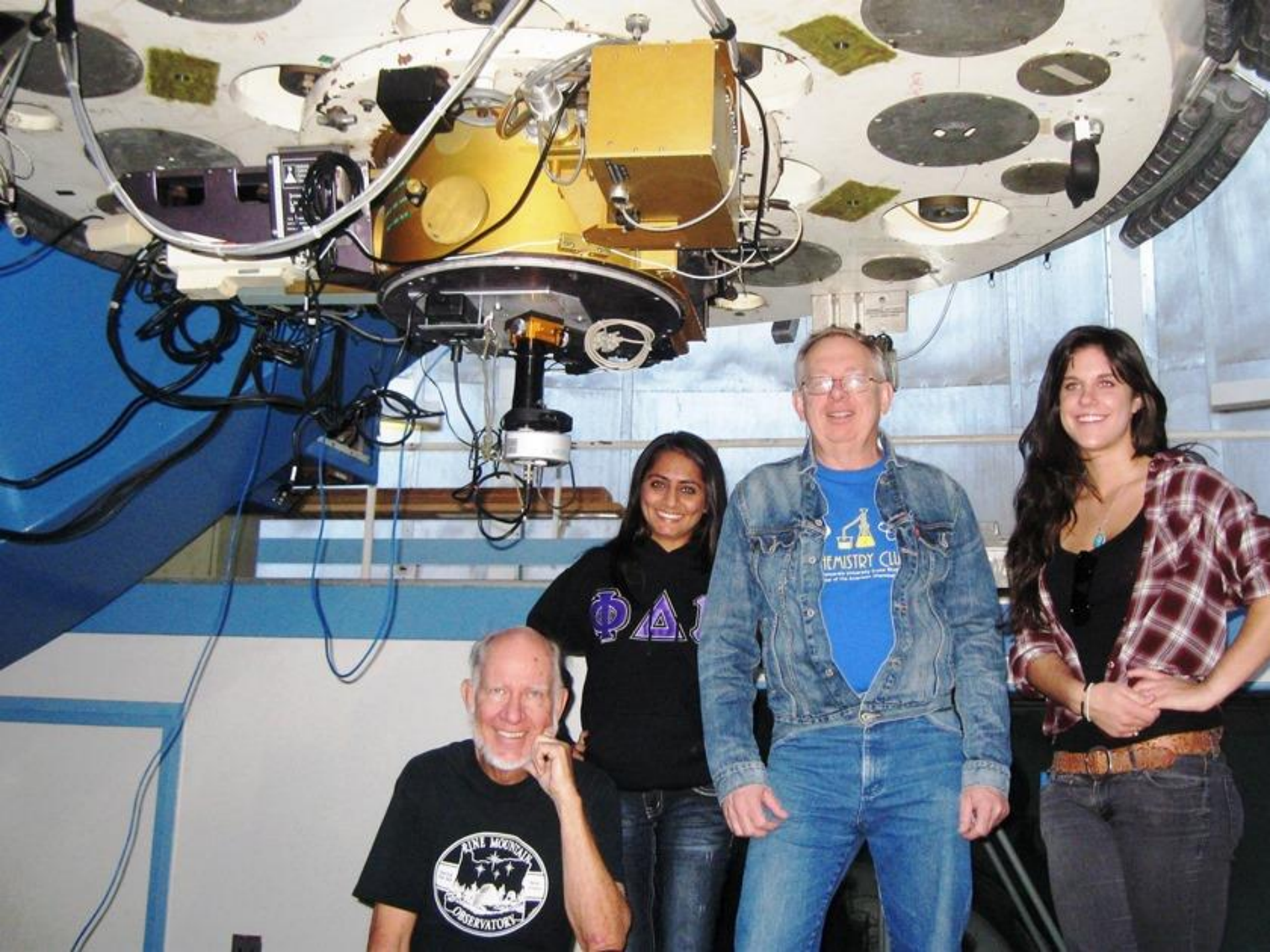

WDS 10446+0530
A 2771
(Hei1997)
E
N

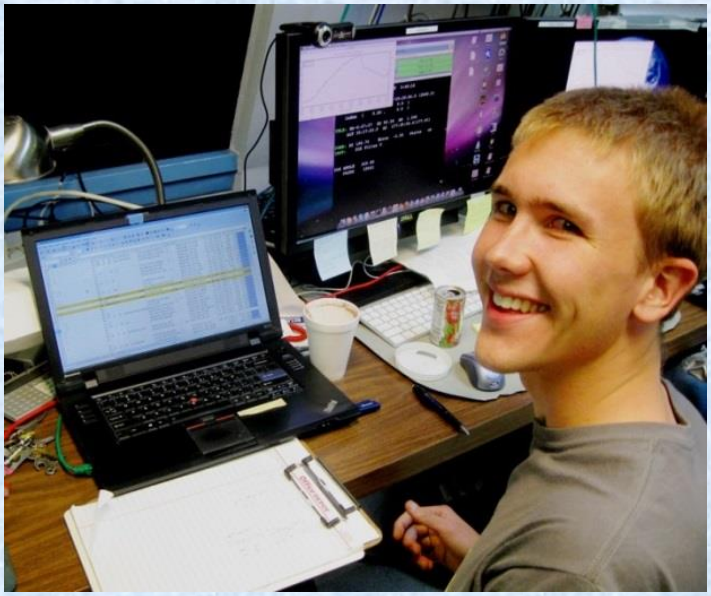

WDS 15465+1957
COU 66
(Cou1999b)
E
N

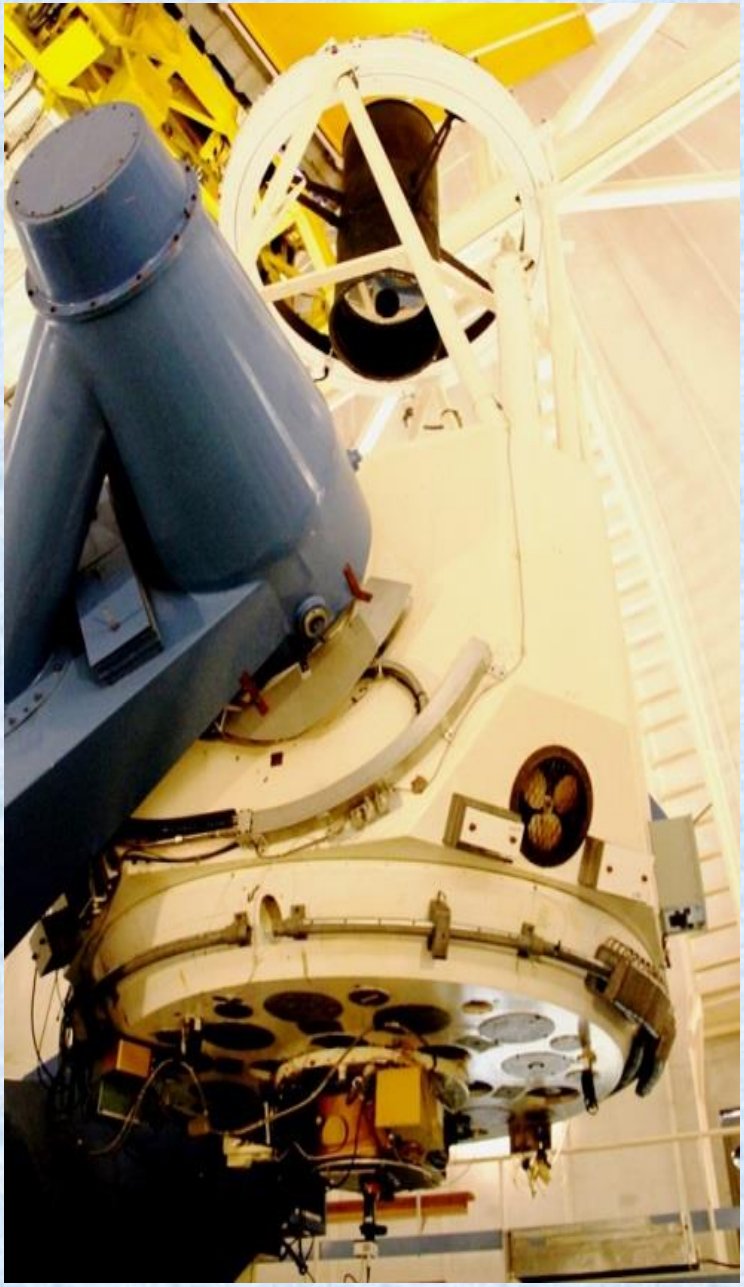

WDS 15078+3956
COU1271
(Cou1999b)
E
N


WDS 11107+3110
HJ 2562
(Pop1996b)
E
N

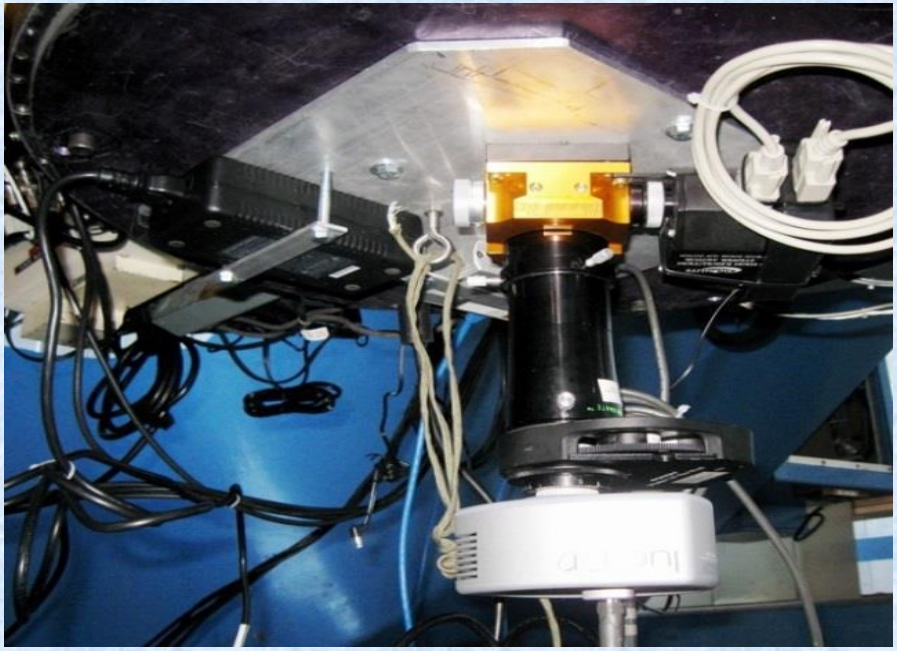

WDS 14455+4223
STT 285AB
(Cou1973b)
E
N

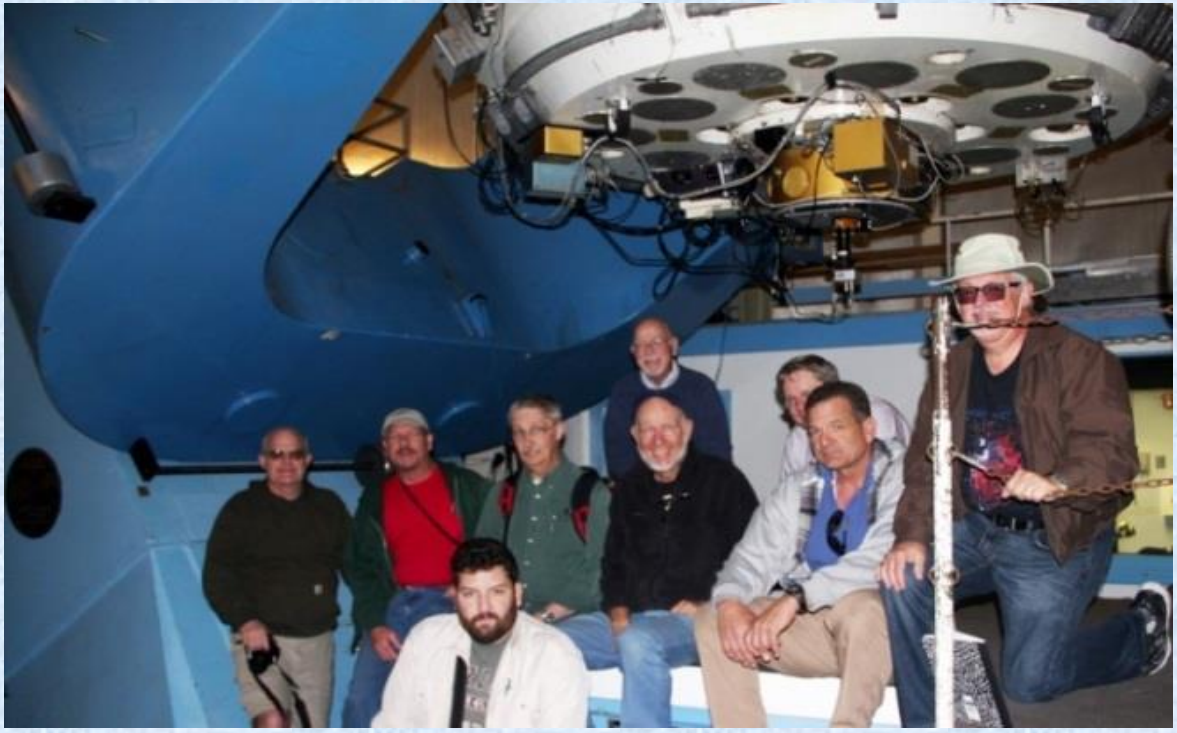

KITT PEAK NATIONAL OBSERVATORY





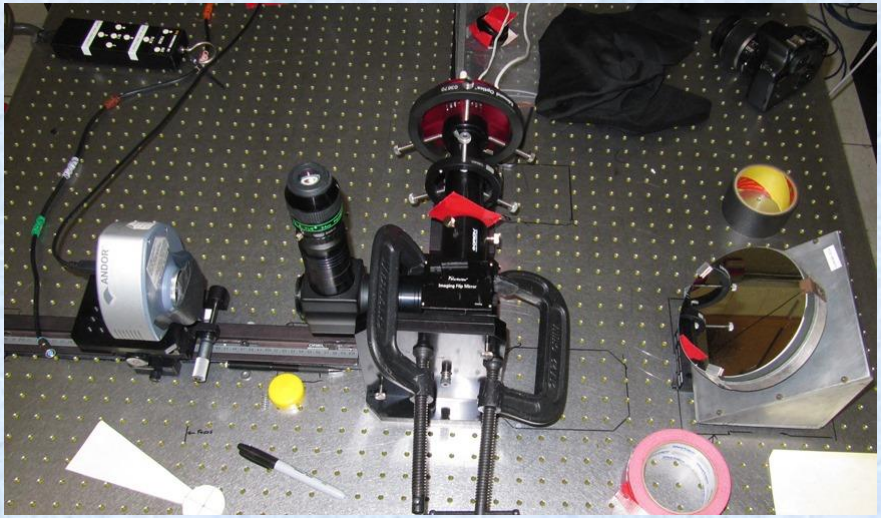

SCREAMING
EAGLES

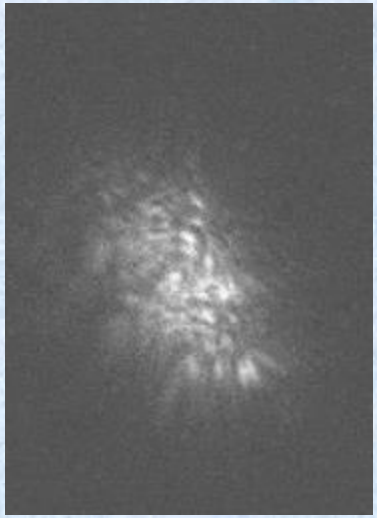


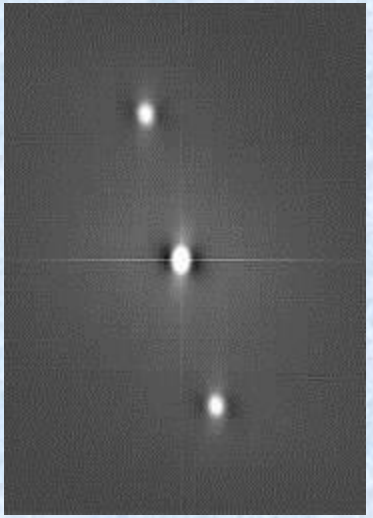


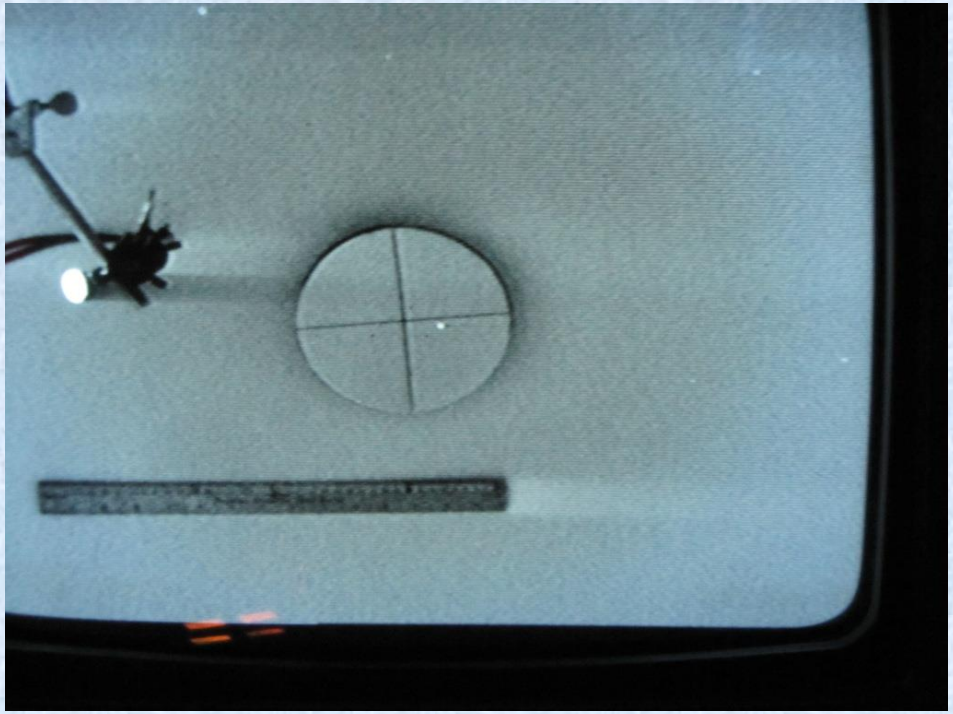

2.1 M-84 INCH
TELESCOPE
ENTRANCE
BEWARE
OF
SNAKES

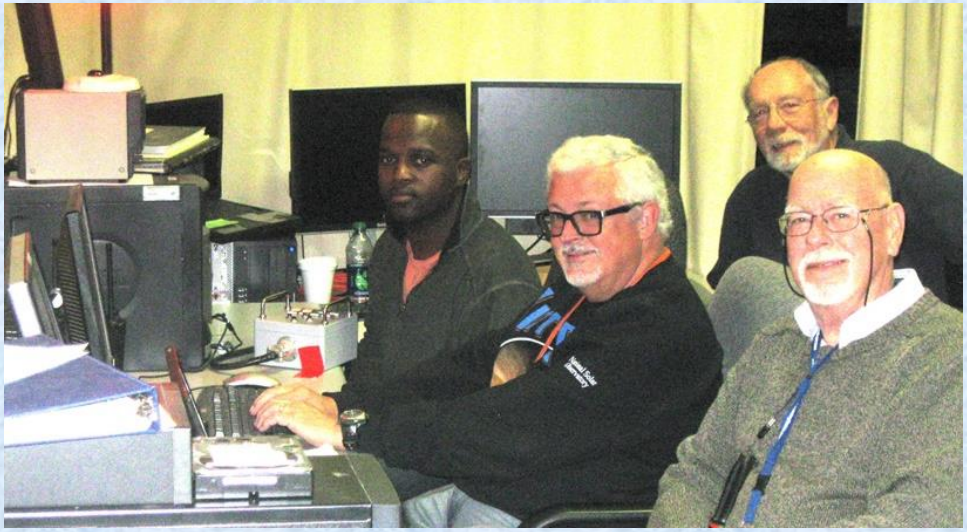

KITT PEAK



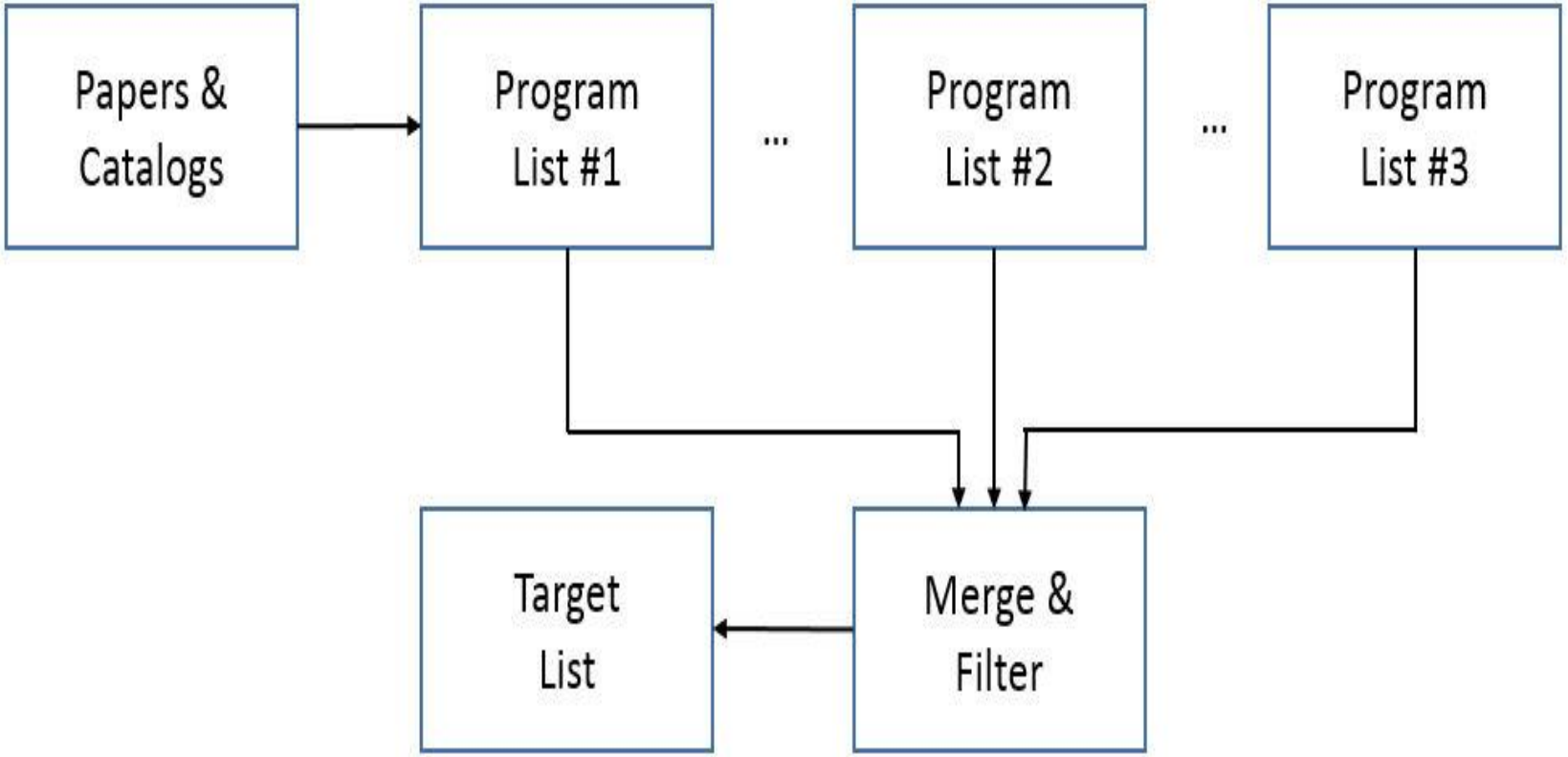


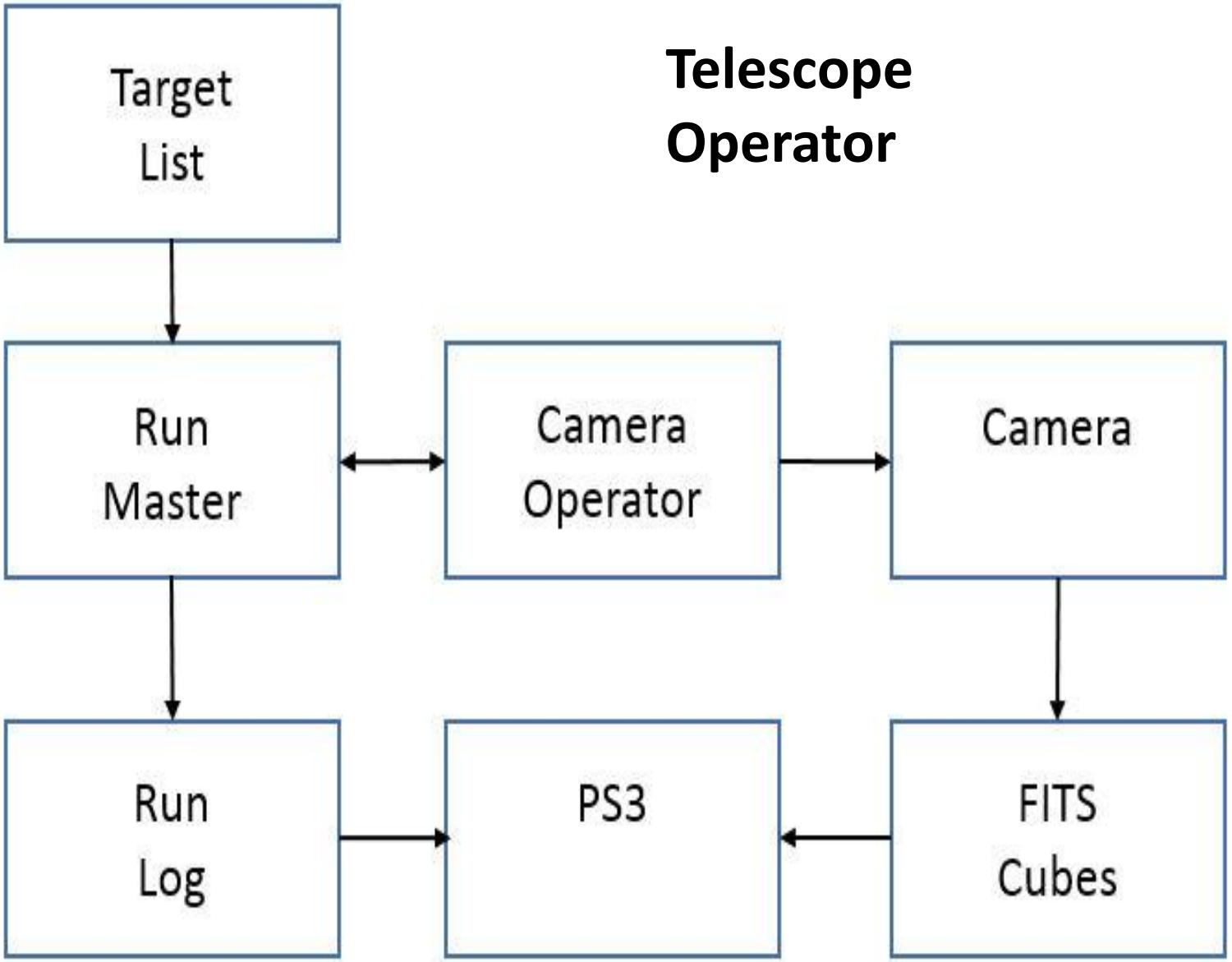


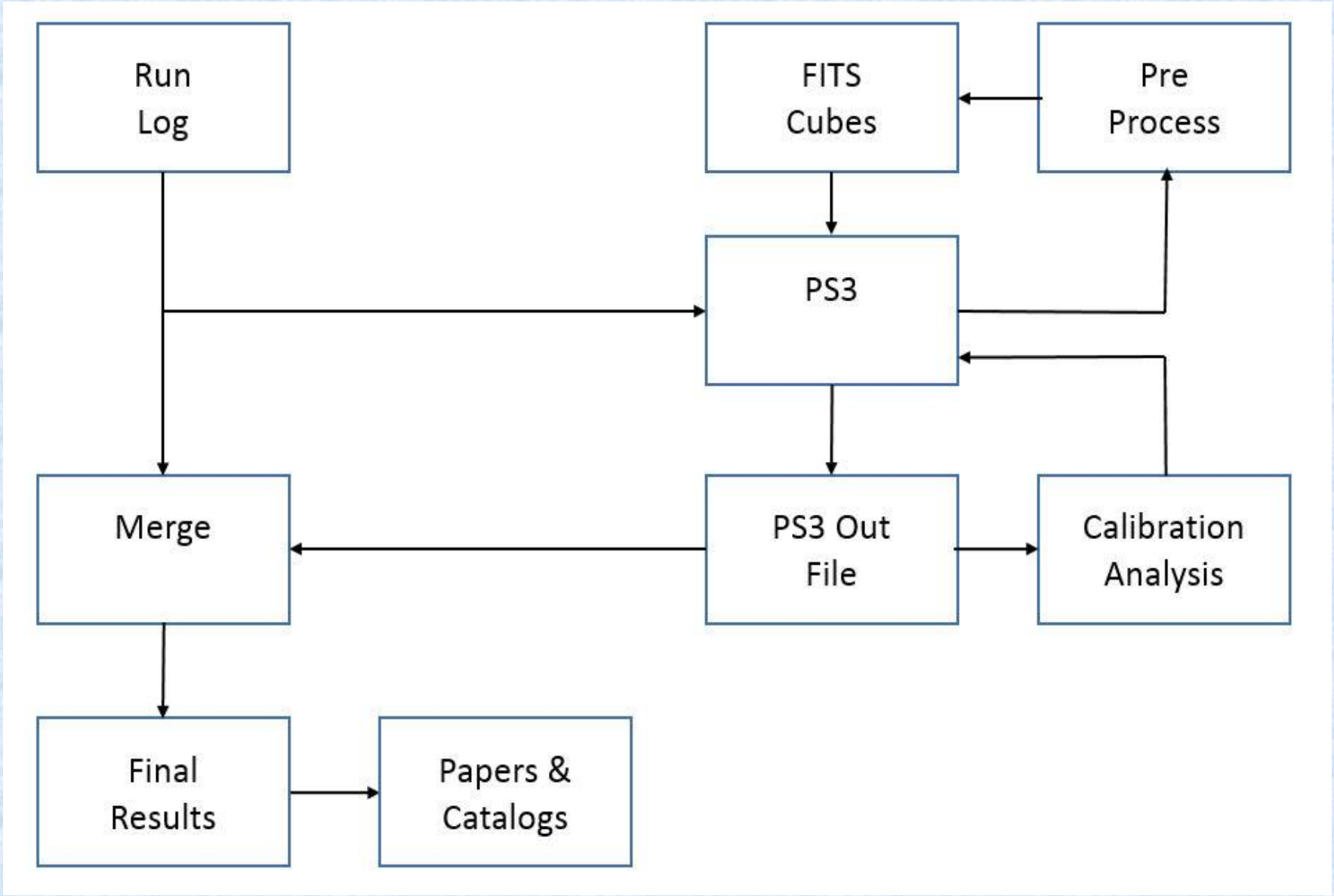


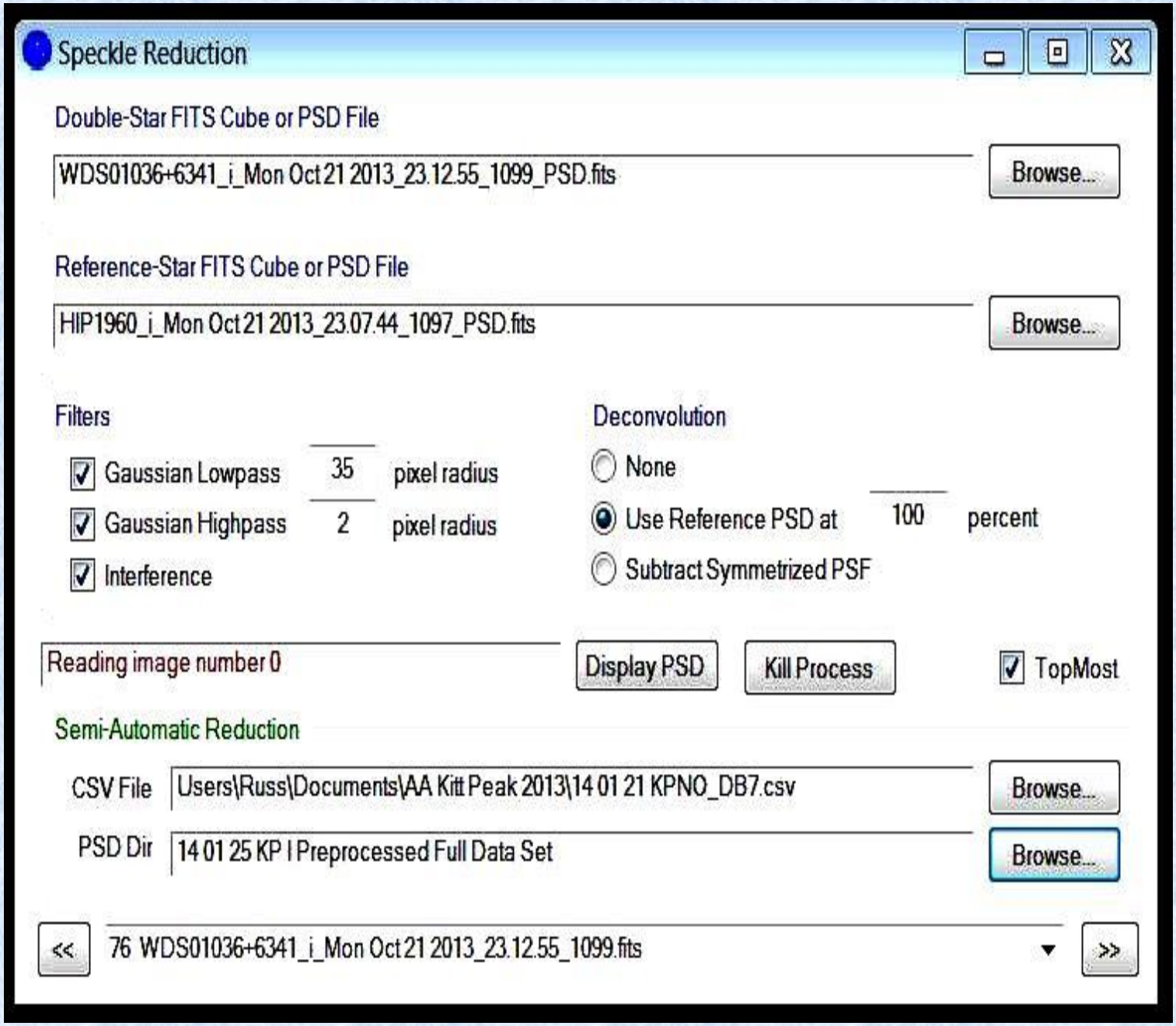


Speckle Interferometry Process

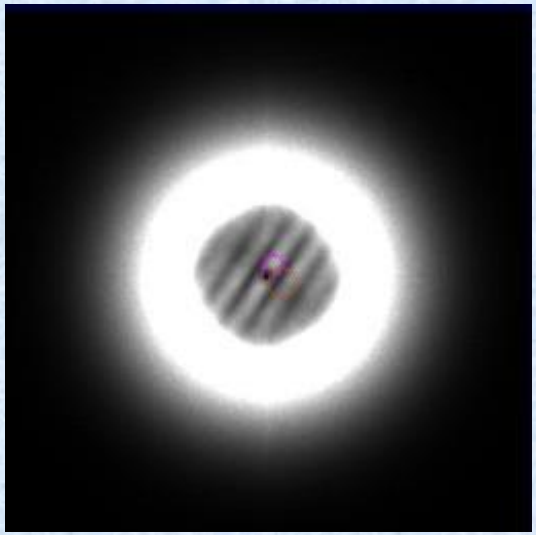


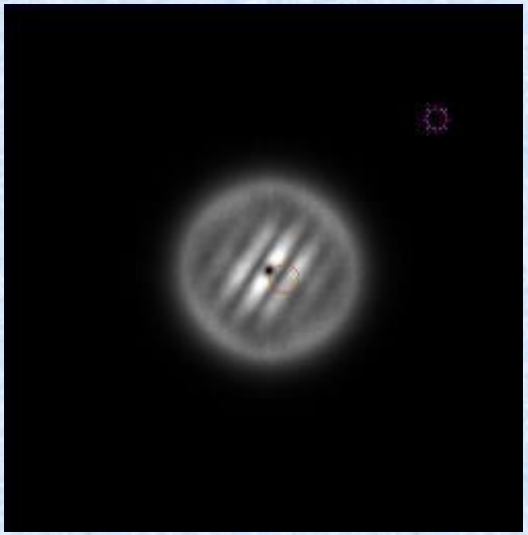

Target List
Telescope Operator
Run Master
Camera Operator
Camera
Run Log
PS3
FITS Cubes


Run Log
FITS Cubes
Pre Process
PS3
Merge
PS3 Out File
Calibration Analysis
Final Results
Papers & Catalogs


Speckle Reduction
Double-Star FITS Cube or PSD File
WDS01036+6341_i_Mon Oct 21 2013_23.12.55_1099_PSD.fits
Browse...
Reference-Star FITS Cube or PSD File
HIP1960_i_Mon Oct 21 2013_23.07.44_1097_PSD.fits
Browse...
Filters
Gaussian Lowpass
35
pixel radius
Gaussian Highpass
2
pixel radius
Interference
Deconvolution
None
Use Reference PSD at
100
percent
Subtract Symmetrized PSF
Reading image number 0
Display PSD
Kill Process
TopMost
Semi-Automatic Reduction
CSV File
Users\Russ\Documents\AA Kitt Peak 2013\14 01 21 KPNO_DB7.csv
Browse...
PSD Dir
14 01 25 KP I Preprocessed Full Data Set
Browse...
<<
76 WDS01036+6341_i_Mon Oct 21 2013_23.12.55_1099.fits
>>

Gaussian Lowpass Filter

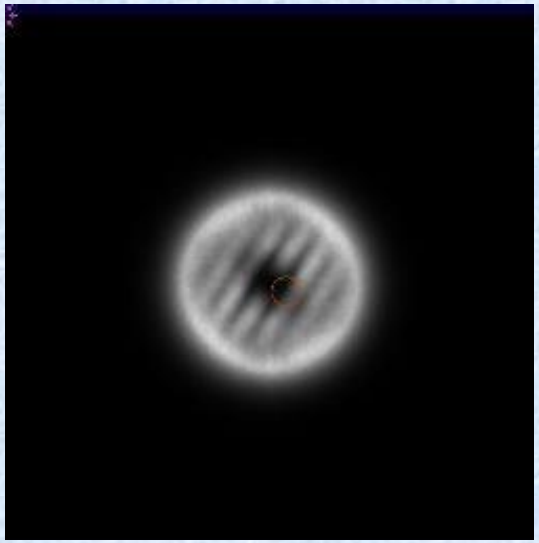


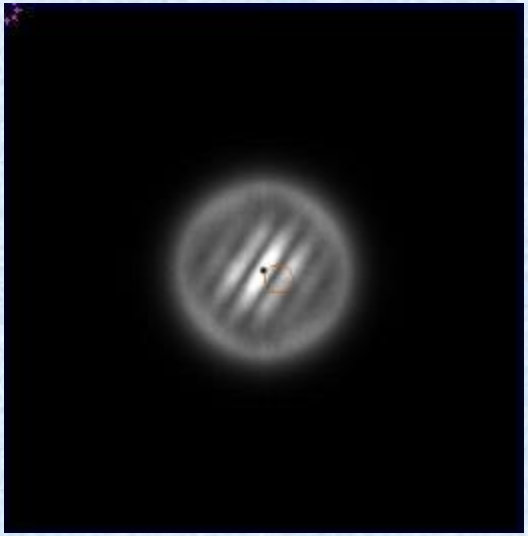


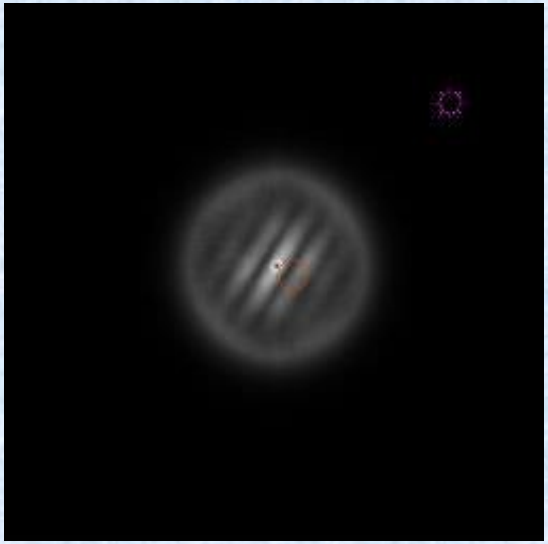
Too Wide

Too Narrow

Gaussian Highpass Filter

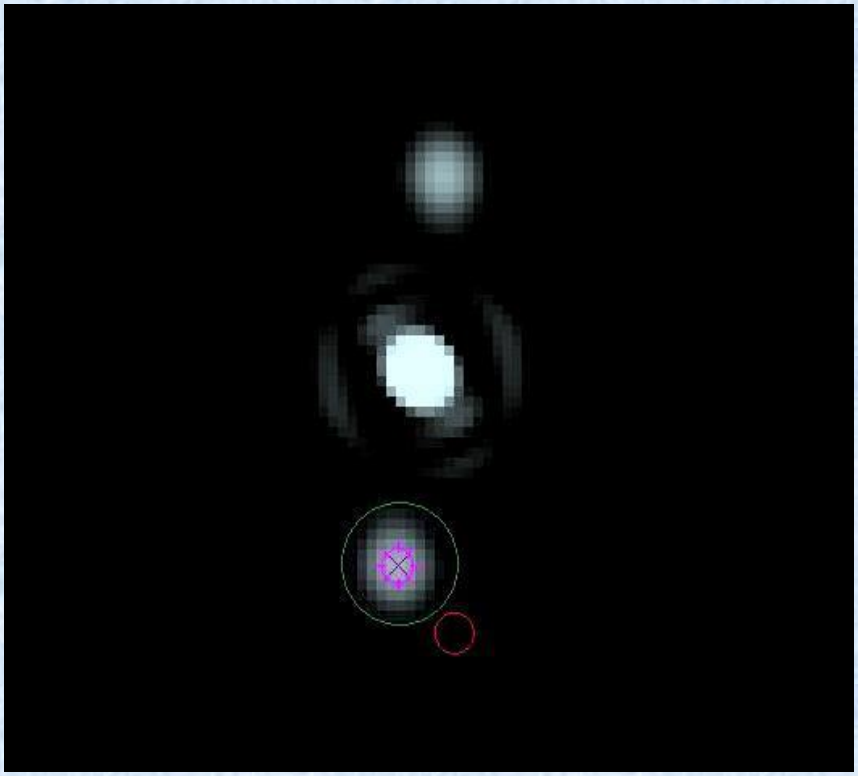






Too Wide

Too Narrow



Photometry/Astrometry

Aperture Diameters

Object	11
BG Inner	16
BG Outer	22

☐ Automatic

Centroid (J2000)

X	0
Y	0
RA	
Dec	

☐ Lock to Peak

Background

Mean	
SD	

Object

Max	
Signal	
SNR	
Mag	0

PSF Size and Shape

◉ RMS Diameter
○ FWHM (Gaussian)
○ FWHM (Moffat)

Pixels	0
Arcseconds	
Aspect Ratio	-100%
Angle	0°

☑ TopMost

Speckle Calibration

Delta -11.3 deg E 0.0116 AS / pix

Speckle Astrometry

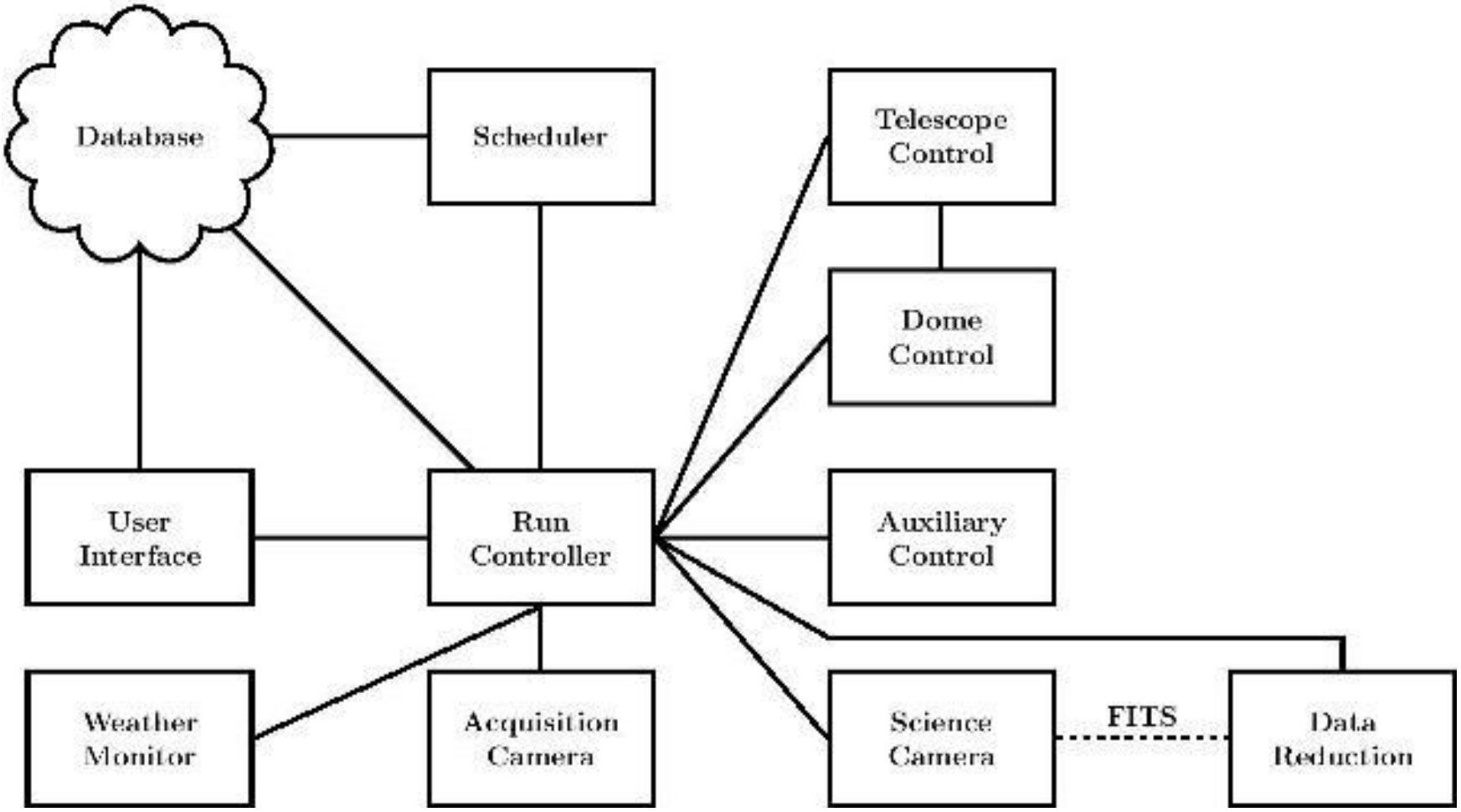
Frame	90	deg	0	pix
Observed	101.3	deg	0	AS

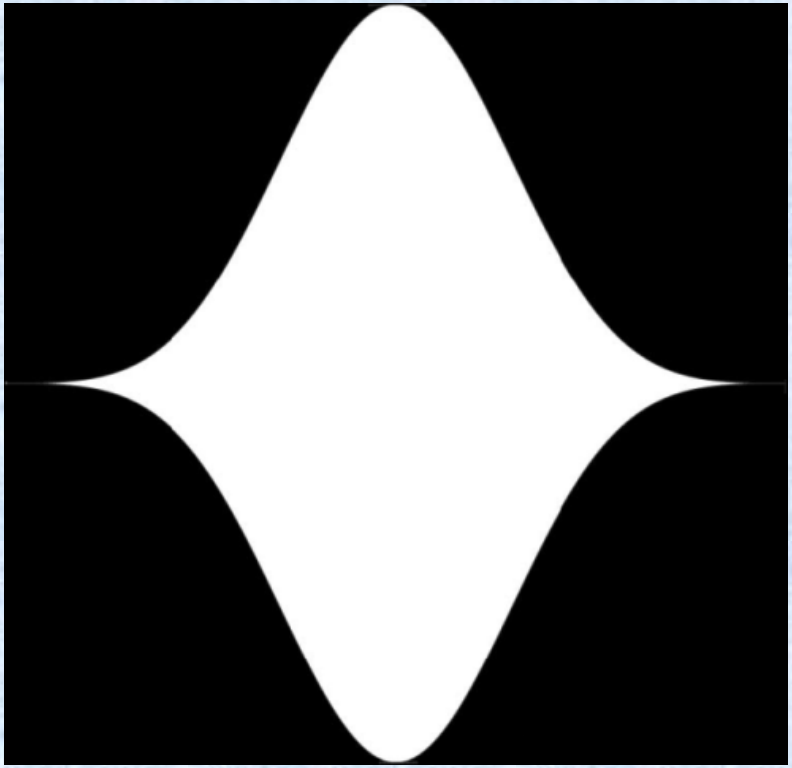
Comment ++

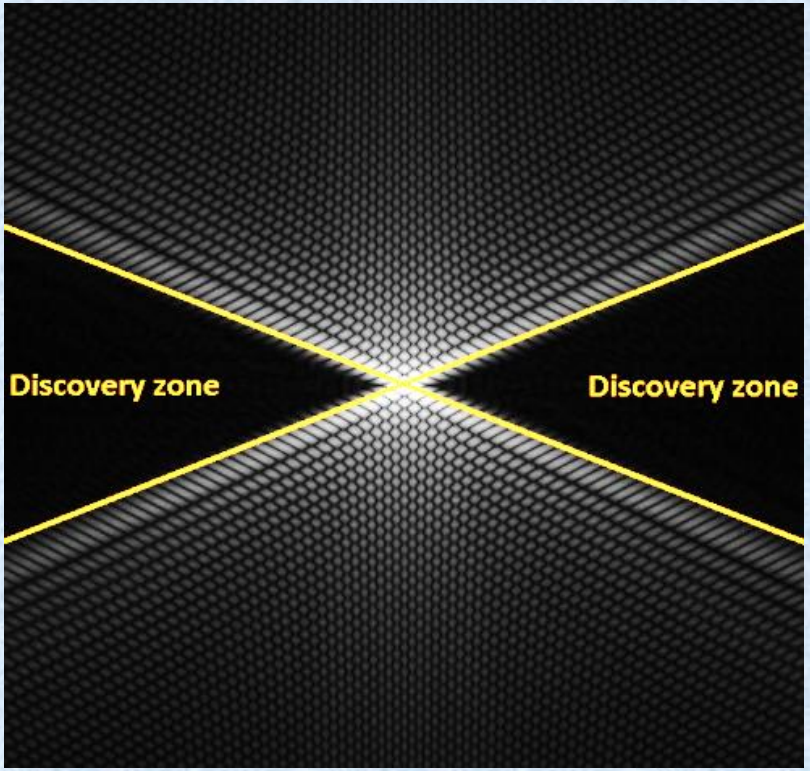
OutFile Brwse

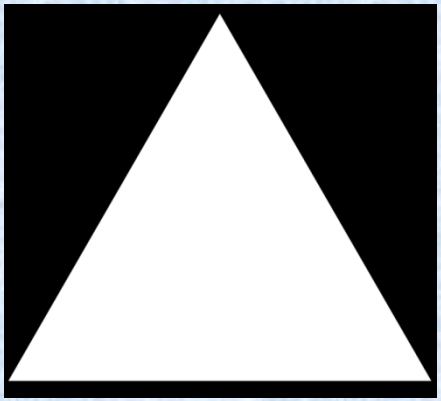
Auto Detect | Remove Target | Save Results

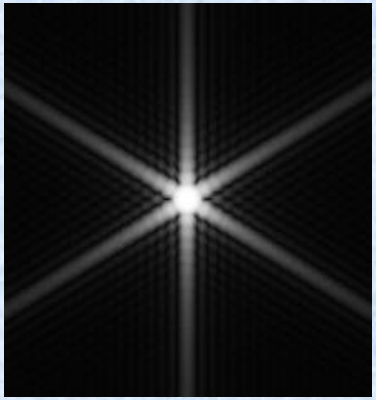
Num	Target	ThetaO	ThetaC	ThetaO-C	RhoO	RhoC	RhoO-C	ThetaF	RhoF	ApD	RelInt	DMag	Comm
24	00283+6344	111.831	91	20.831	0.3857	0.4	-0.0143	100.531	33.251	12	0.2216		
76	01036+6341	4.098	19	-14.902	0.2226	0.3	-0.0774	352.798	19.192	12	0.2312		
1	00022+2705	228.354	273	-44.646	0.166	0.8	-0.634	217.054	14.312	12	0.0571		Close one!
2	00024+1047	69.213	73	-3.787	0.2468	0.2	0.0468	57.913	21.273	12	0.0535		Prediction close.
3	00029+4715	294.729	295	-0.271	1.5947	1.6	-0.0053	283.429	137.47	12	0.155		Wide and easy. Prediction right on.
4	00046+4206	105.922	95	10.922	0.1304	0.1	0.0304	94.622	11.244	5	0.0486		Very close but good solution.
5	00055+3406	307.239	304	3.239	0.15	0.2	-0.05	295.939	12.933	5	0.0675		Also close. Prediction off a bit.
6	00073+0742	321.309	323	-1.691	0.3515	0.4	-0.0485	310.009	30.3	11	0.2919		Easy. 2nd & 3rd order images.
7	00085+3456	52.817	79	-26.183	0.1383	0.1	0.0383	41.517	11.922	5	0.1508		Close. Solution not stable.
13	00118+2825	67.367	69	-1.633	0.4474	0.5	-0.0526	56.067	38.571	11	0.1454		Easy. Prediction close.
14	00121+5337	317.605	313	4.605	0.3344	0.3	0.0344	306.305	28.827	11	0.1709		Very easy.
18	00174+0853	305.499	307	-1.501	0.1556	0.2	-0.0444	294.199	13.417	5	0.0411		Difficult. Not quite stable.
19	00174+0853	303.657	307	-3.343	0.1553	0.2	-0.0447	292.357	13.386	11	0.1254		Easy and stable.
20	00205+4531	96.724	102	-5.276	0.656	0.7	-0.044	85.424	56.553	11	0.0896		Verey easy. Clean!
21	00209+1059	118.746	117	1.746	0.7557	0.7	0.0557	107.446	65.145	11	0.1286		Very easy. Clean.
23	00251+4803	273.507	242	31.507	0.3186	0.3	0.0186	262.207	27.464	11	0.0335		Prediction off, but not too far.

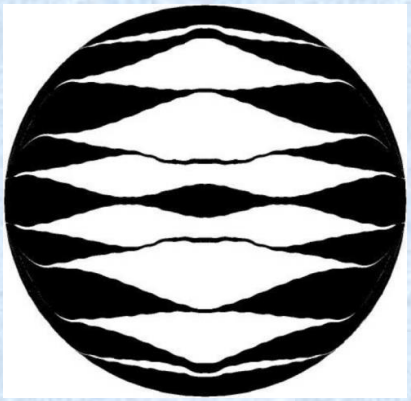

Database
Scheduler
Telescope Control
Dome Control
User Interface
Run Controller
Auxiliary Control
Weather Monitor
Acquisition Camera
Science Camera
FITS
Data Reduction

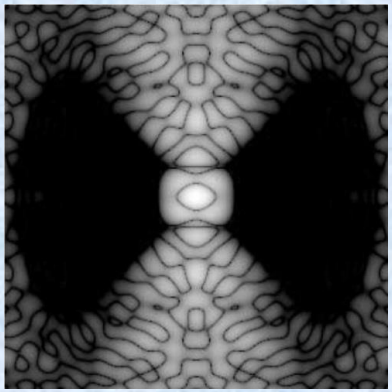


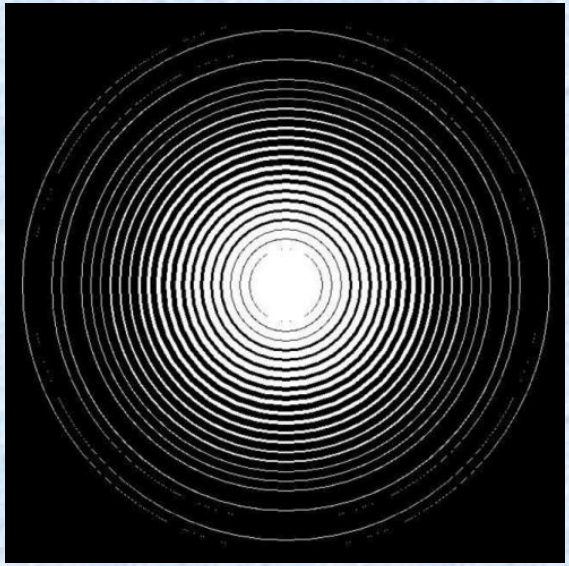

Discovery zone
Discovery zone

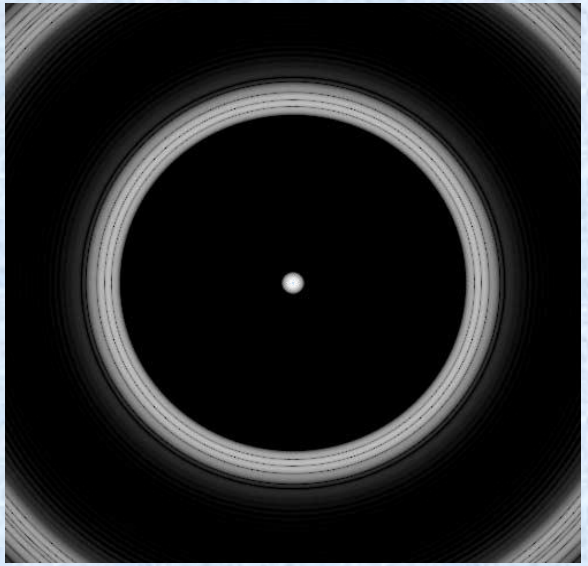


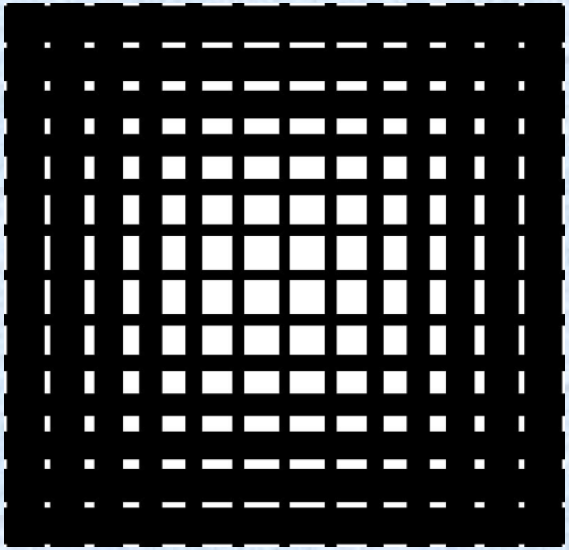


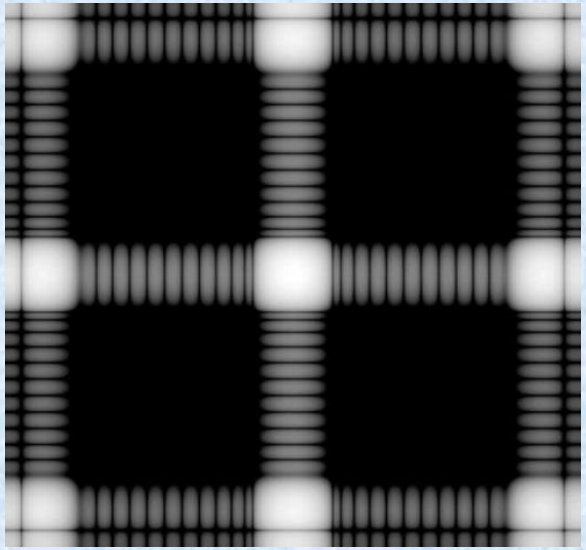


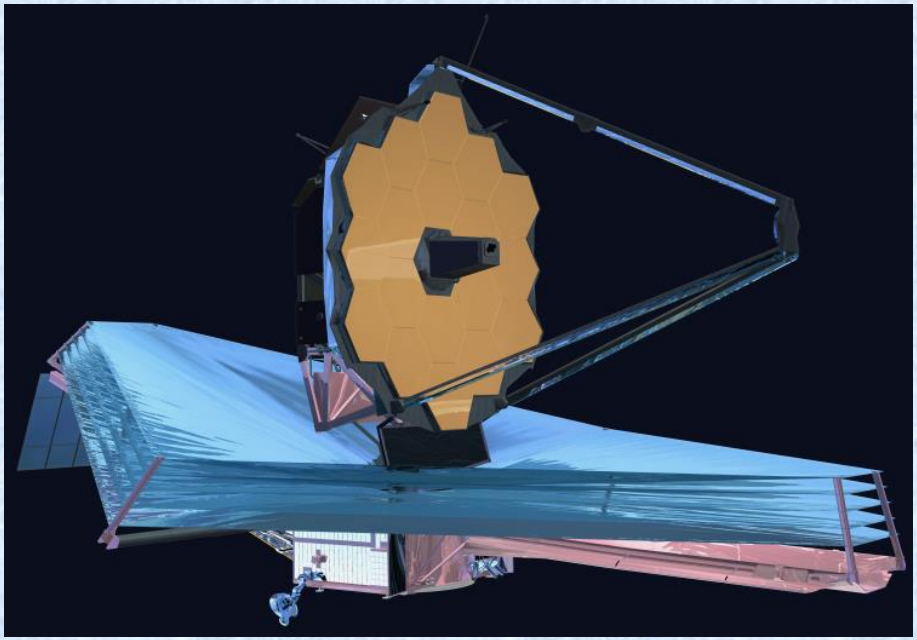


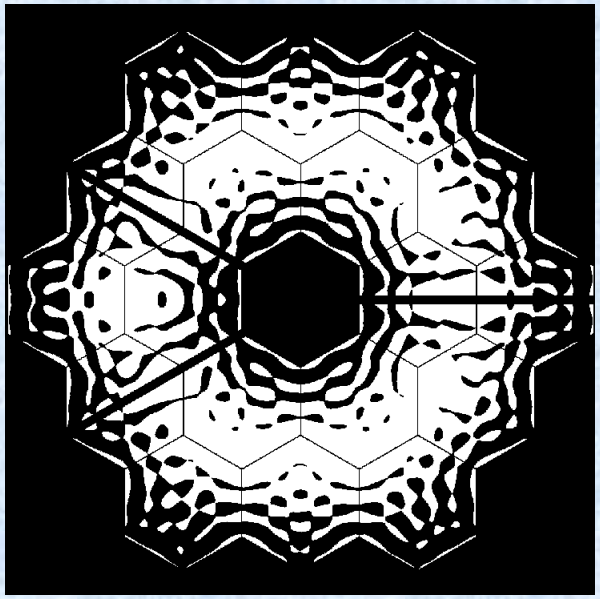


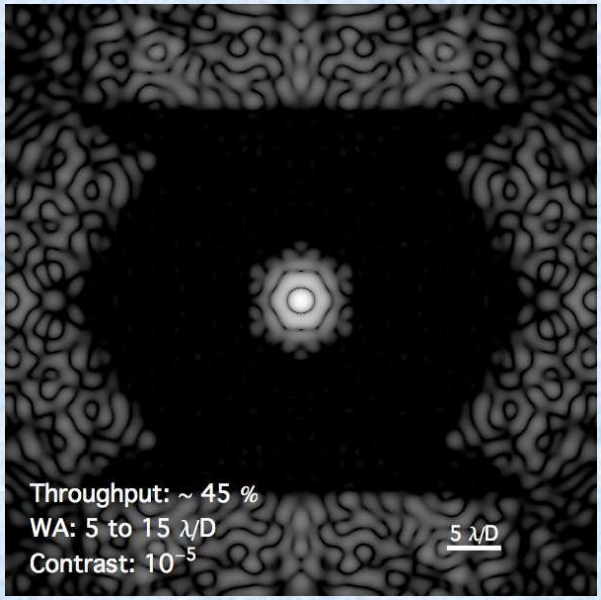


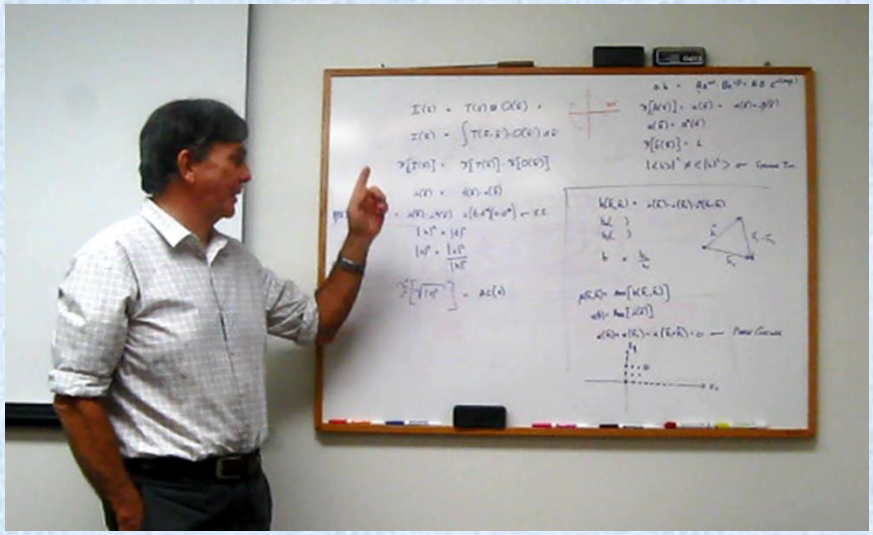


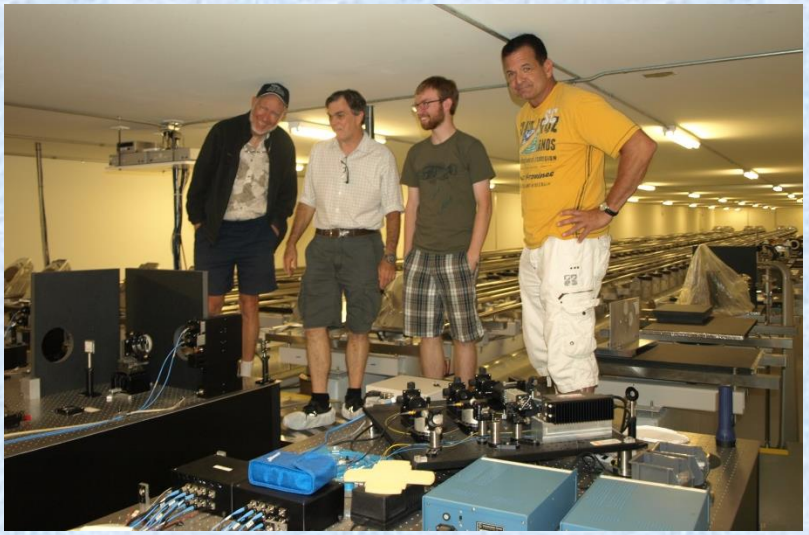


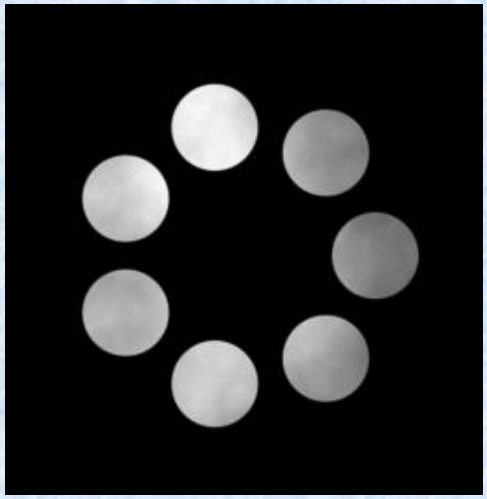


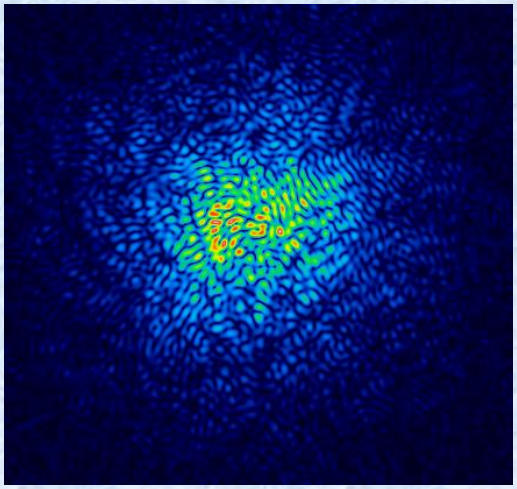


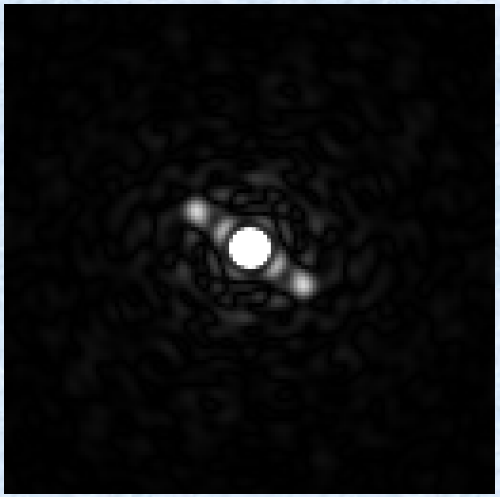

Throughput: ~ 45 %
WA: 5 to 15 λ/D
Contrast: 10^{-5}
5 λ/D











Maui Workshop

Wed-Fri, January 21-23, 2015
University of Hawaii, Institute for Astronomy, Maui

Binary & Multiple Star Systems

18-20 September, 2015

Vilanova I La Geltru, Spain

Advances in High Spatial Resolution Binary Star Research

Fri – Sun, July 3-5, 2016, Concordia University Irvine, CA