Updates on adaptive optics systems

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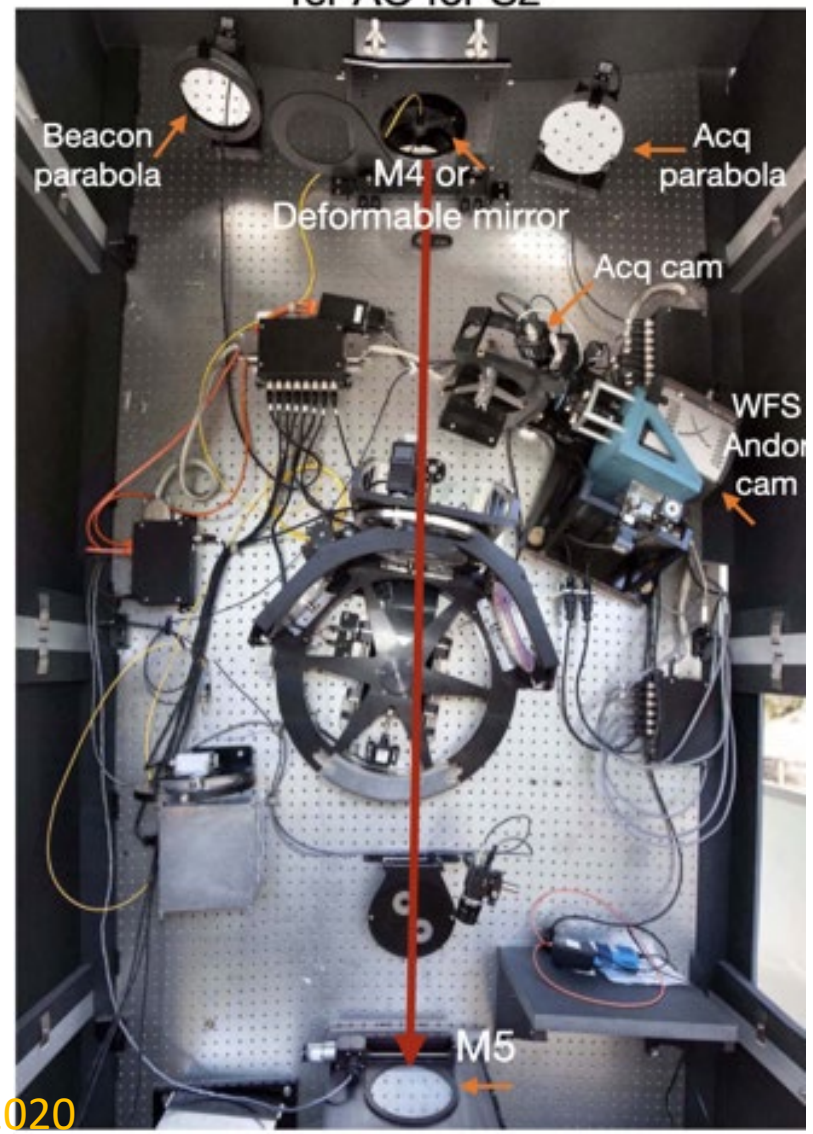
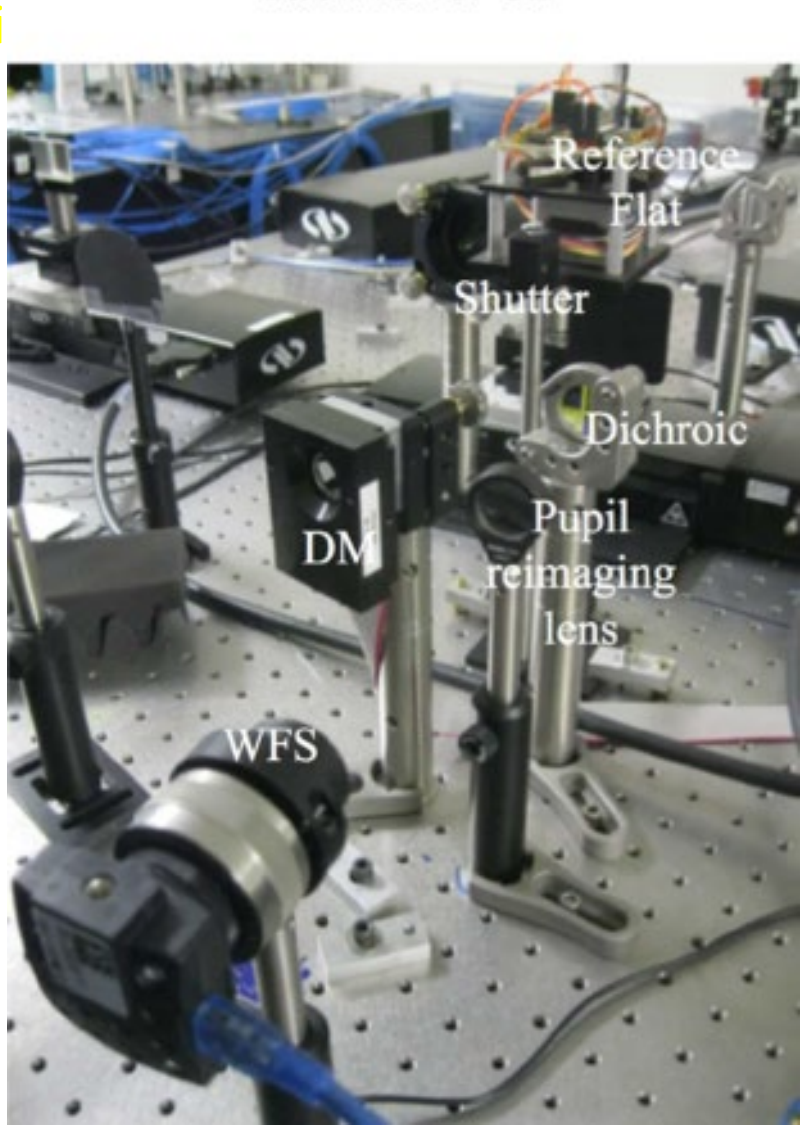
Overview

Overvi

- 1 system per scope
- fast WFS
- locks on star
- M2 as fast TT



Anugu et al. 2020



- 1 system per scope
- slow WFS
- locks on blue beacon
- responsible for guiding

Anugu et al. 2020

Overview

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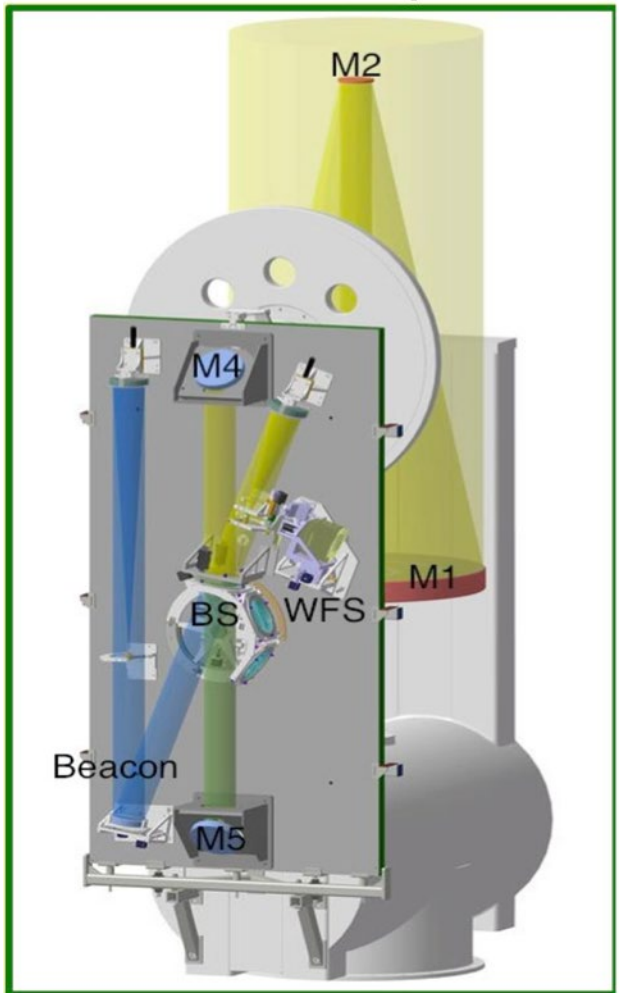
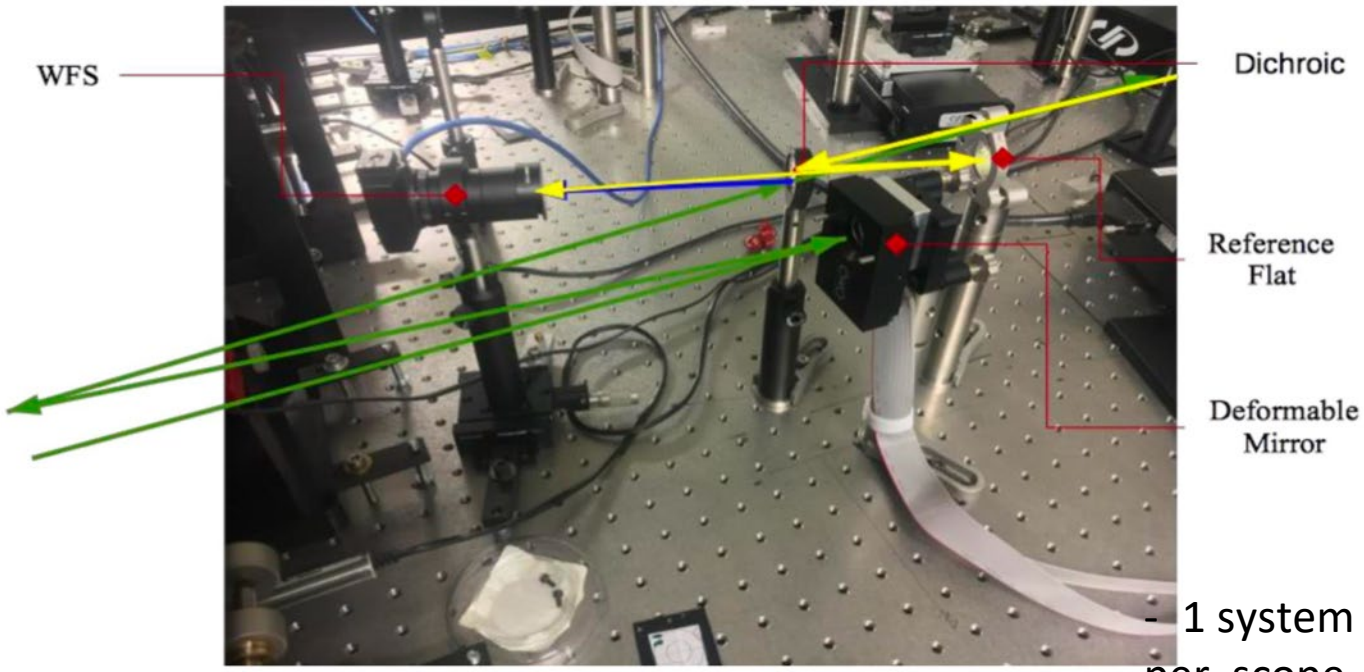
Telescope



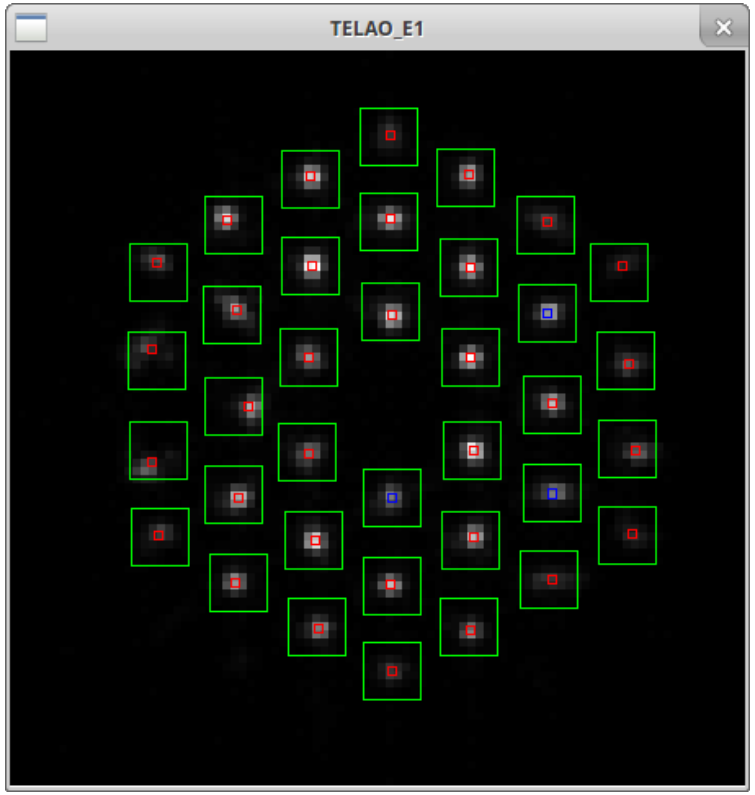
Optical Lab

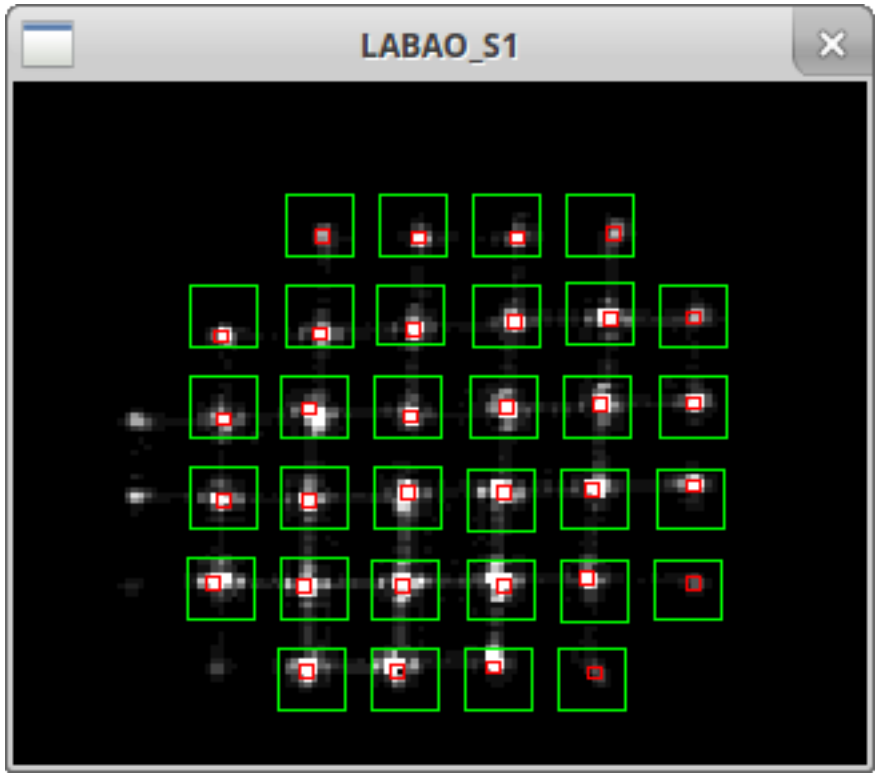


Slow WFS, locks on blue beacon

- 1 system per scope
- slow WFS
- locks on blue beacon
- responsible for guiding

- 1 system per scope
- fast WFS
- locks on star
- M2 as fast TT





- 1 system per scope
- slow WFS
- locks on blue beacon
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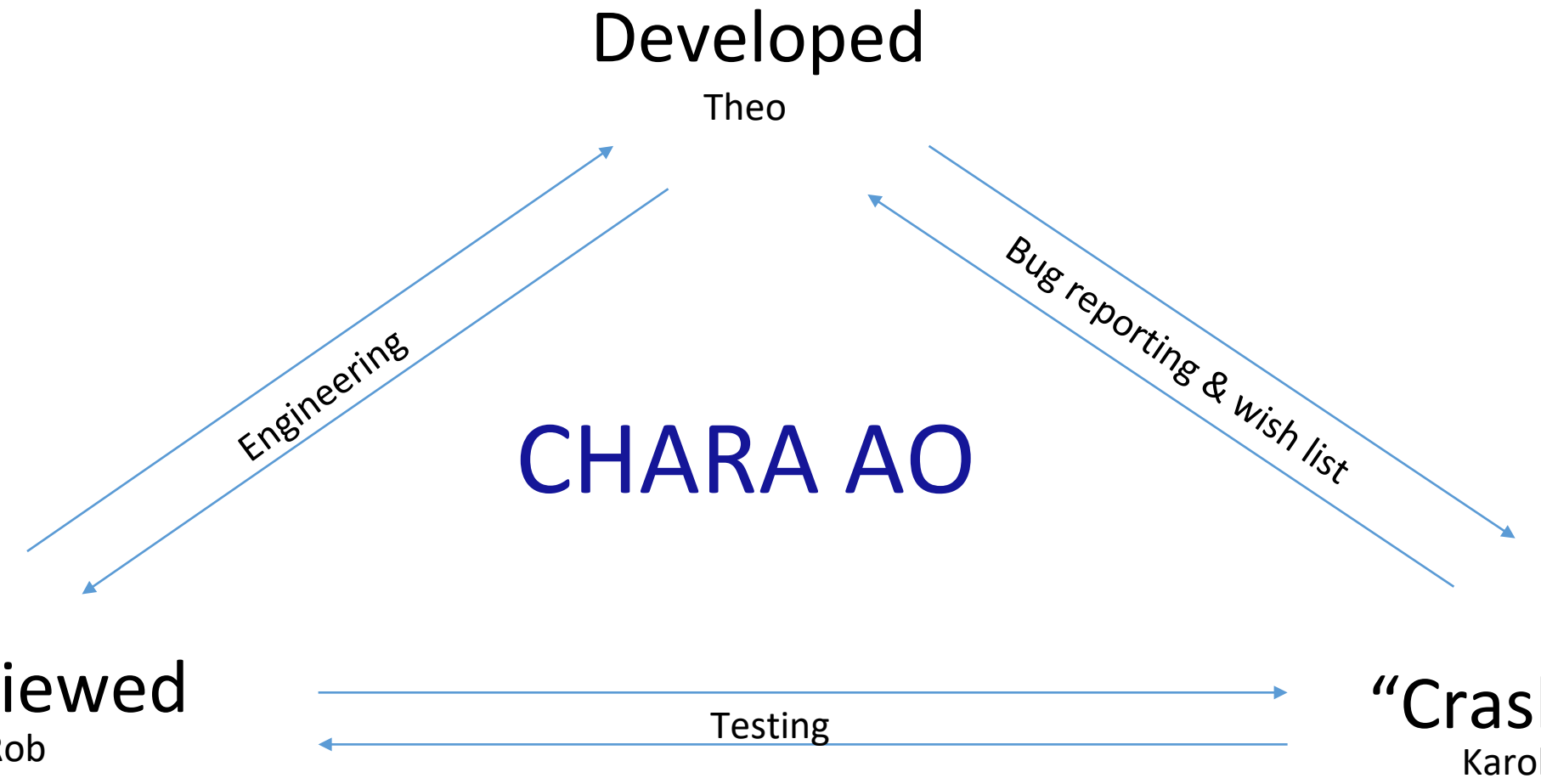
Parameter	Tel-AO	Lab-AO
DM actuators	ALPAO 60	OKO MMDM 37
Size	18 cm	15 mm
Dynamic range	16 µm	9 µm
Inter-actuator stroke	4 µm	0.5 µm
Frame Rate	500 Hz	100 Hz
Mirror best flat	< 30 nm	400 nm
WFS Camera	Andor 897 EMCCD	USB CCD
Lenslet	7x7	6x6

New SOFTWARE for TELAO and LABAO

September 2024

14 April 2025



CHARA AO improvements

1. Most of the improvements are from an operational point of view, eg:
   - the ability to isolate, remove, and follow each actuator. Allows us to make a functional if not best performing ao system for the night.

2. Due to the improved "spot location" algorithm we can go much fainter more reliably.

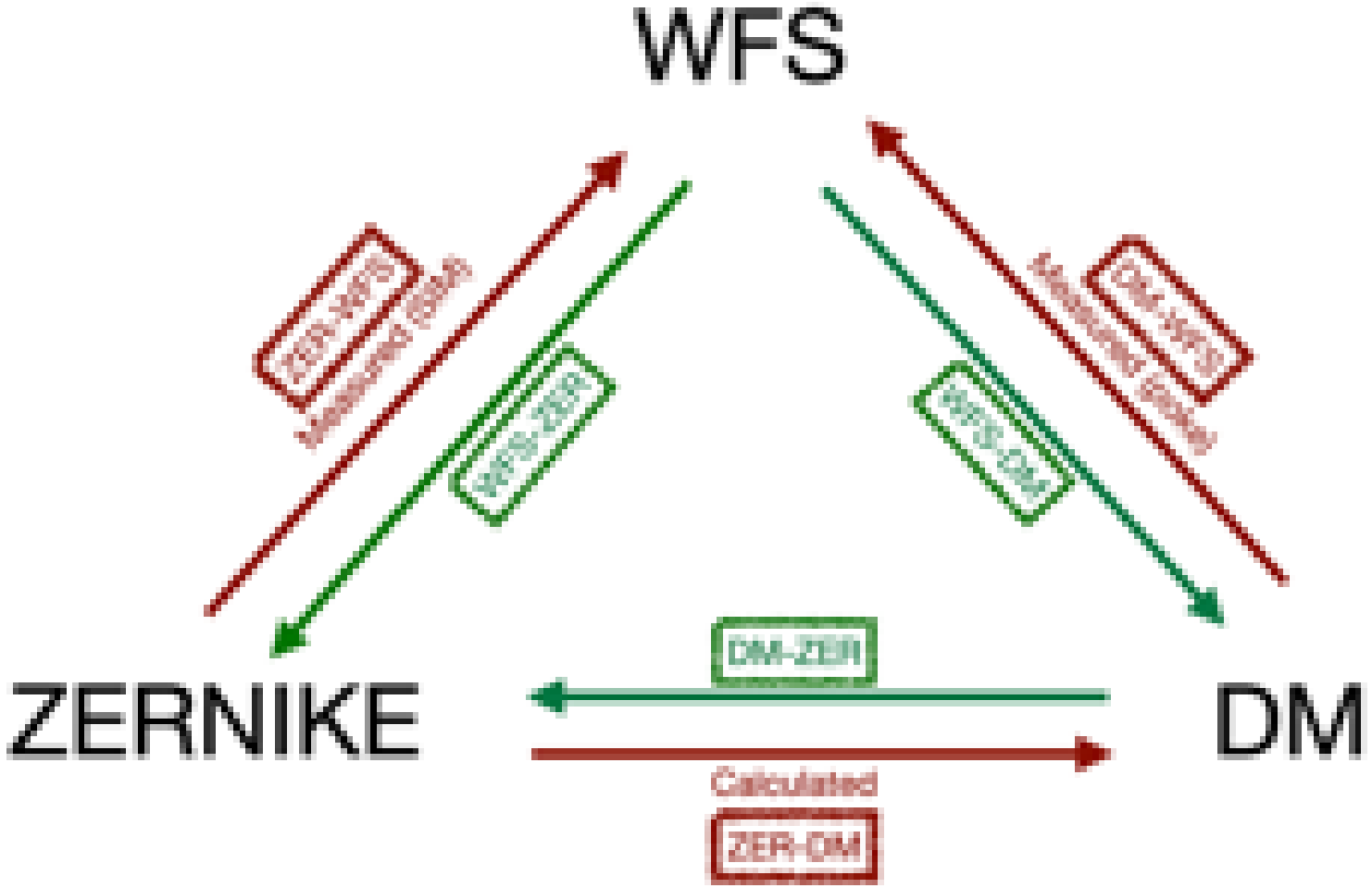
3. More parameters to experiment with to improve the faint limit further

4. Many online diagnostic tools in the new system to evaluate the performance of AO, to diagnose, analyze and adjust the AO systems

5. There is a true calibration of the Noll Zernike terms throughout allowing us to compare performance between systems.

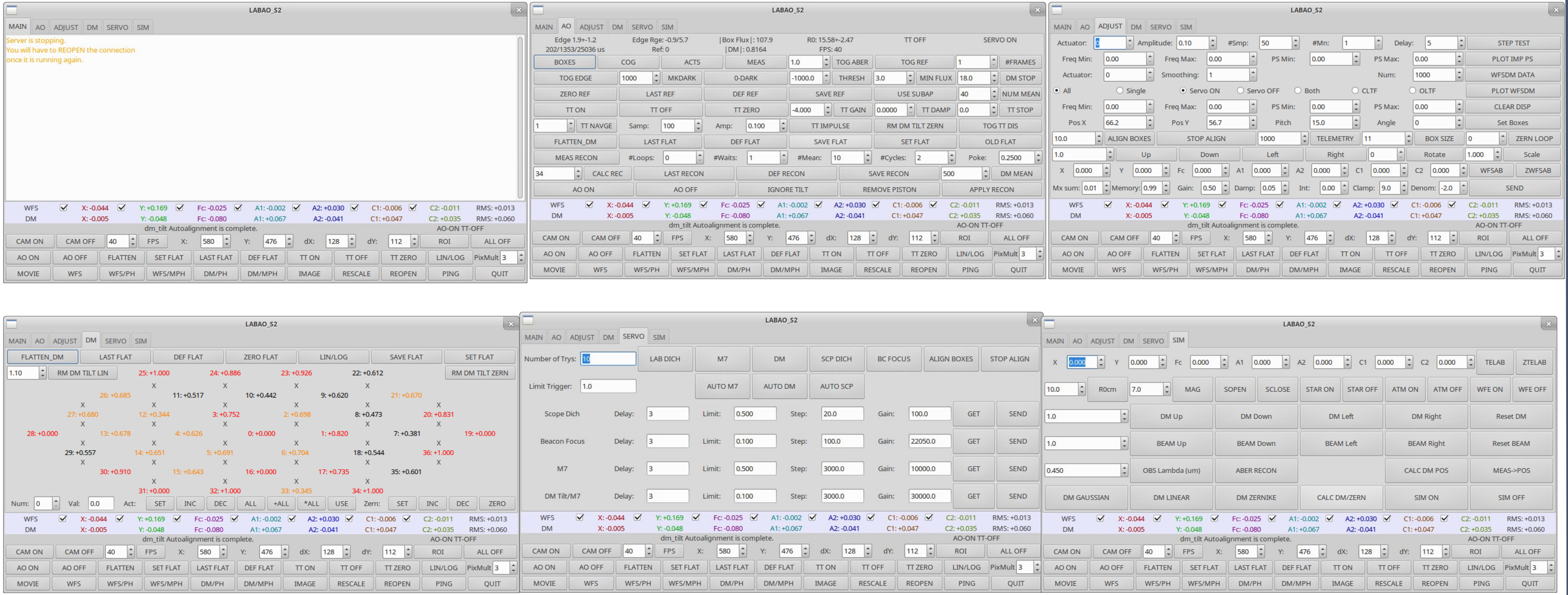
6 The code runs much faster than the old code so the bandwidth of the servo is better.

7. Simulations to help with qualitative comparison on the go.


WFS
ZERNIKE
DM
DM-ZER
Calculated
ZER-DM

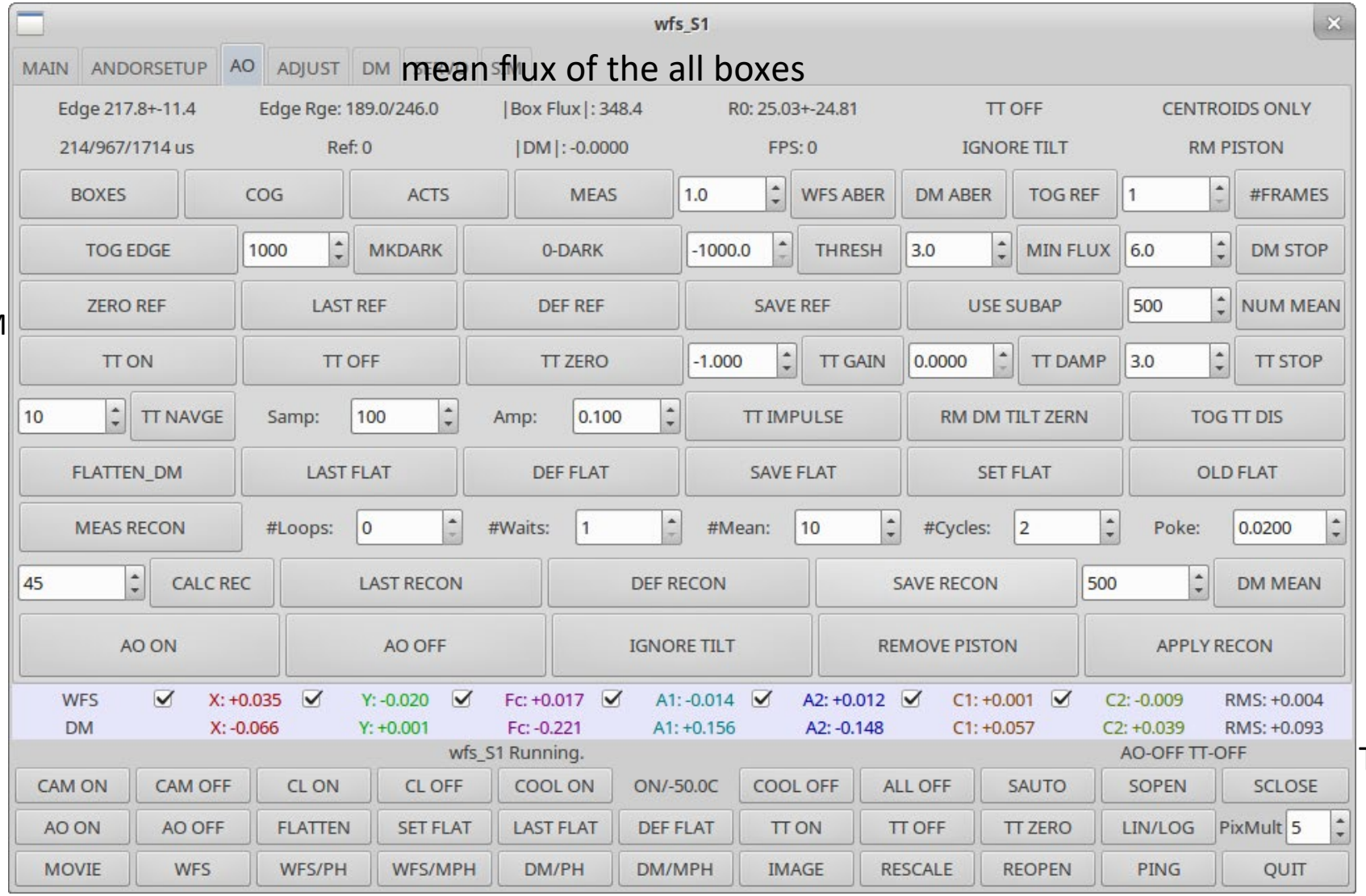
Engineering GUIs TELAO

Engineering GUIs LABAO



Some details

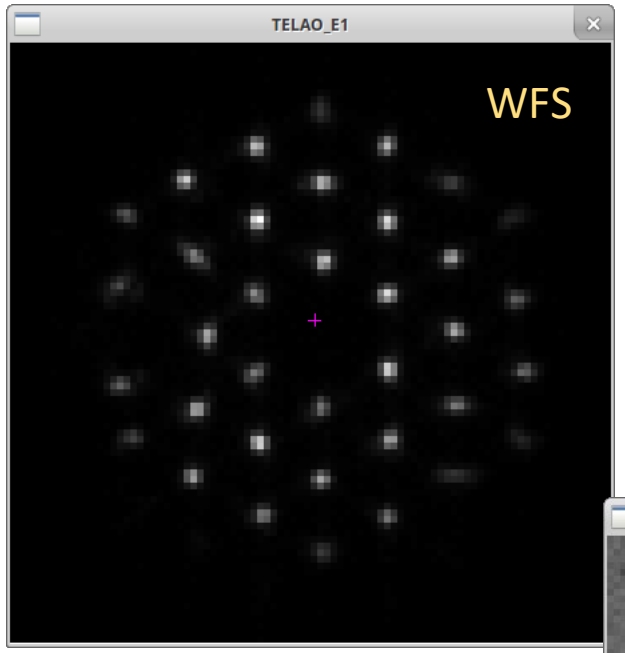
214 - time needed to close the AO loop;
967 - time needed to run all the calculations in FSM
1714 -time needed to run everything (close the AO loop, run the calculation, get data from a camera)

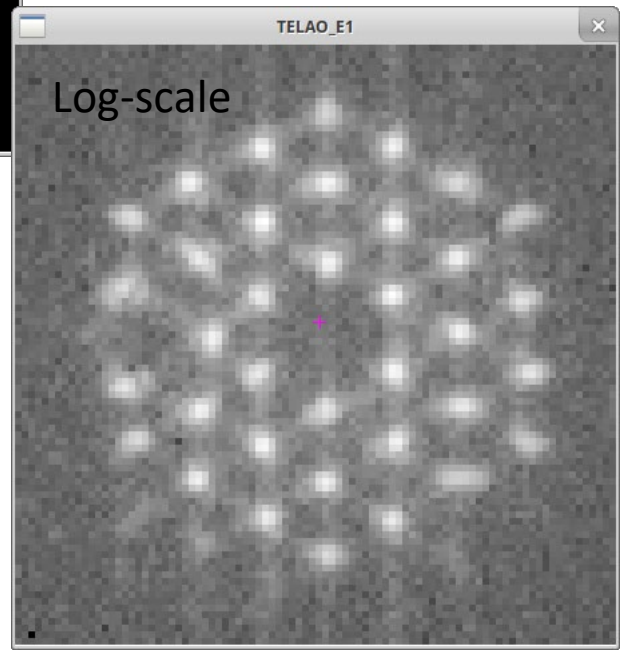


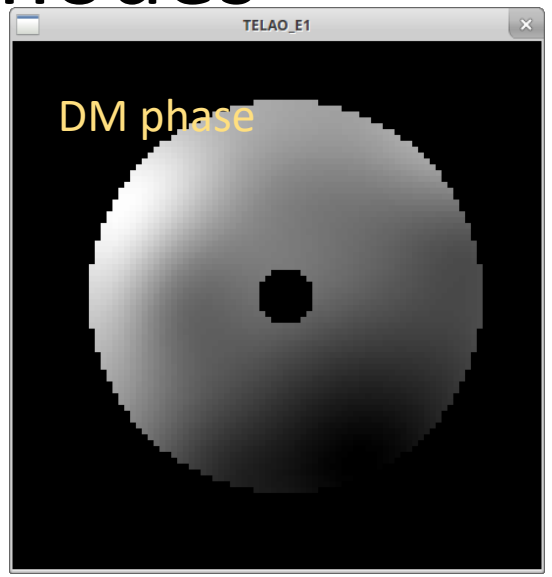
state of FSM

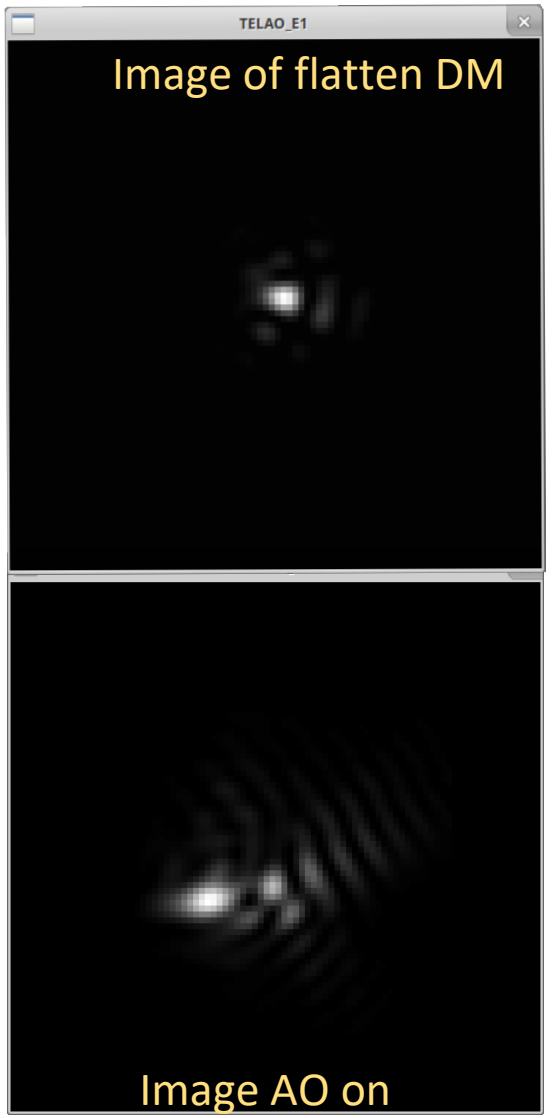
aberrations
TT & AO status

Display modes

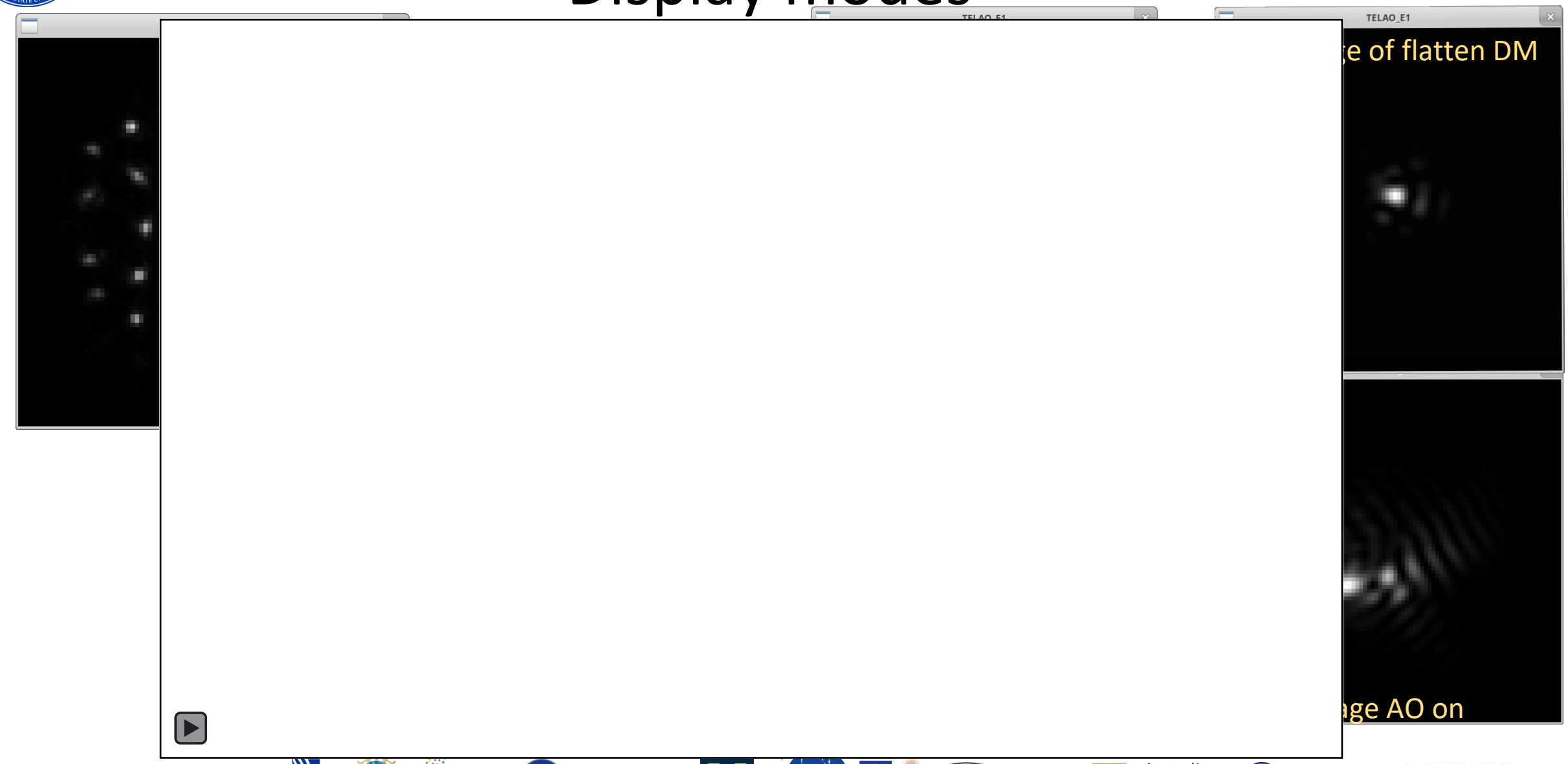




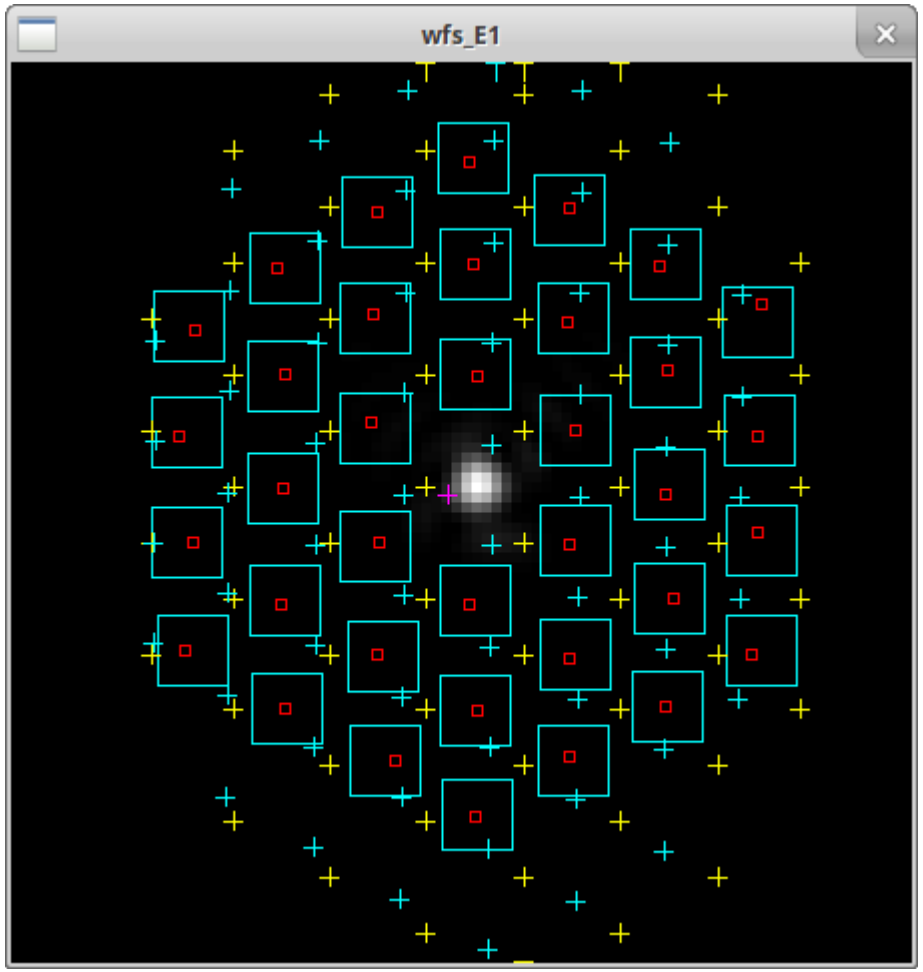




Display modes



Visualization tools

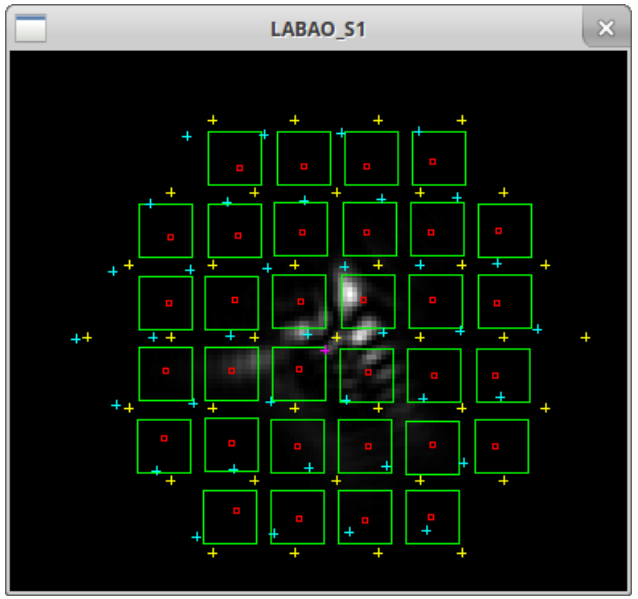


Theoretical actuators grid (yellow)

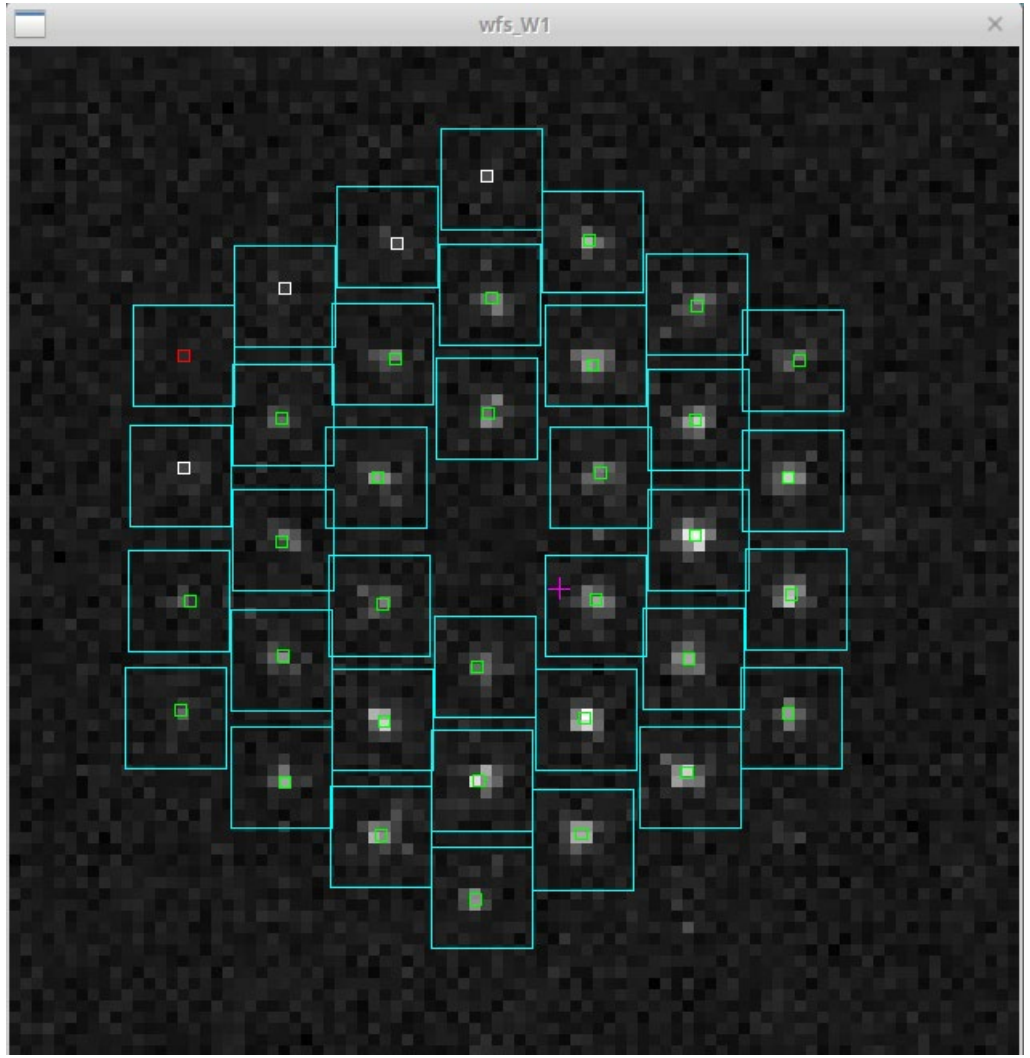
Measured actuators grid (turquoise)

Boxes - size, auto aligned, up to 10 grids

Center of gravity for light (purple) - auto alignment



Low flux - flexible centroid estimation

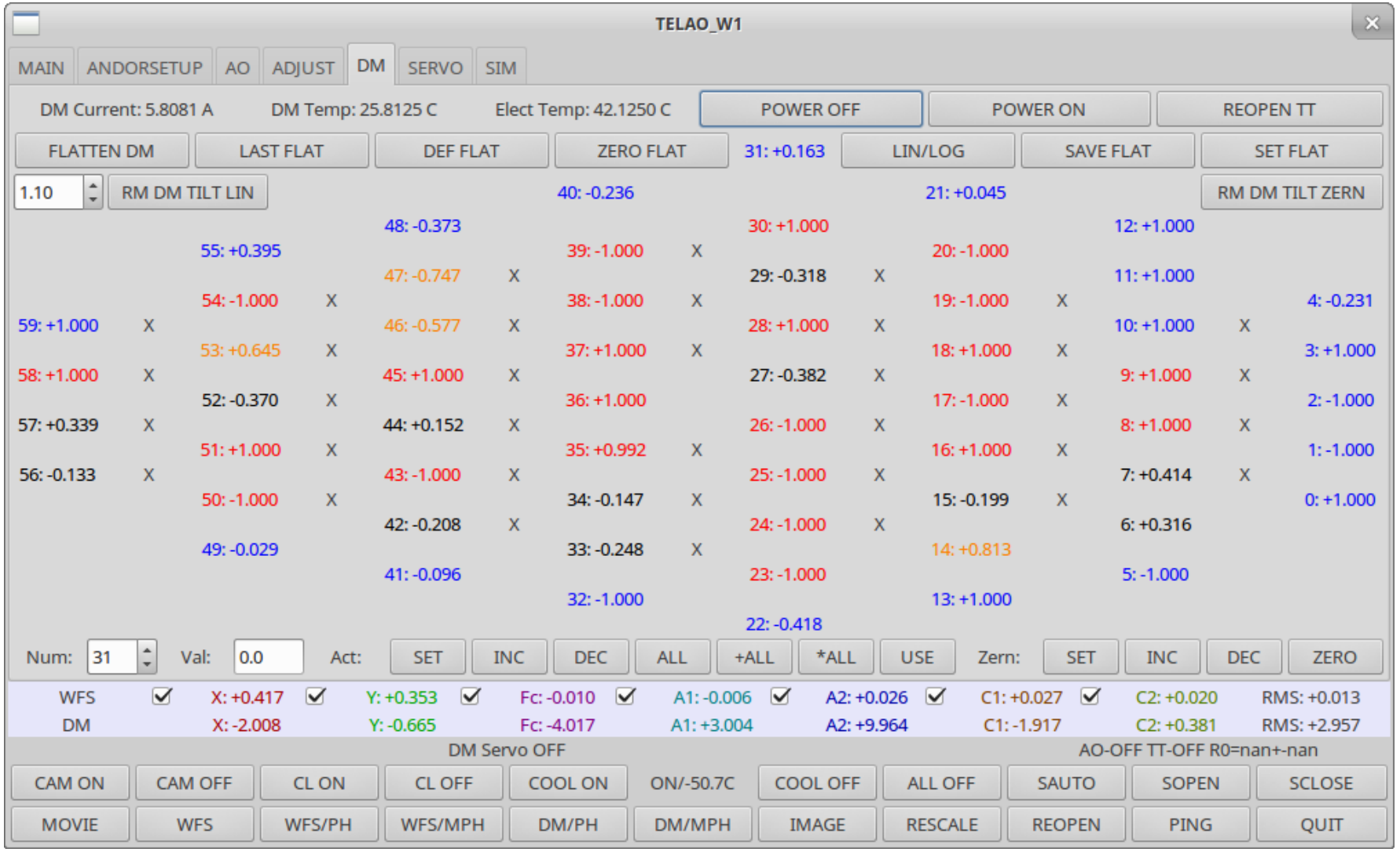


flux in the box > 9 std of flux - gaussian centroid

3 std < flux in box < 9 std - max pixel position

flux in box < 3 std - ignore the sub aperture

DM visualization and control



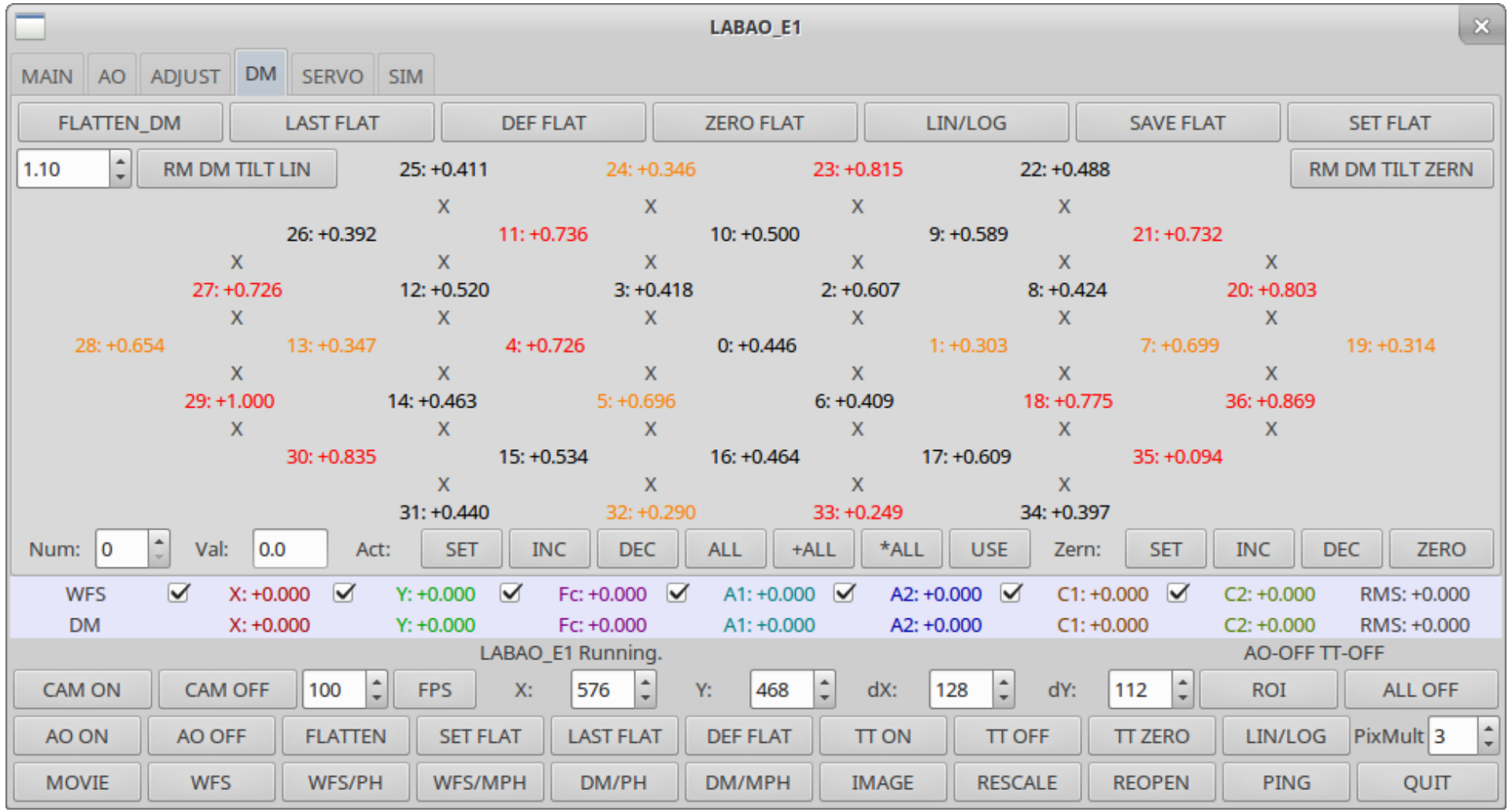
REGULAR range

50% - 90% range

>90% range

BLOCKED

DM visualization and control



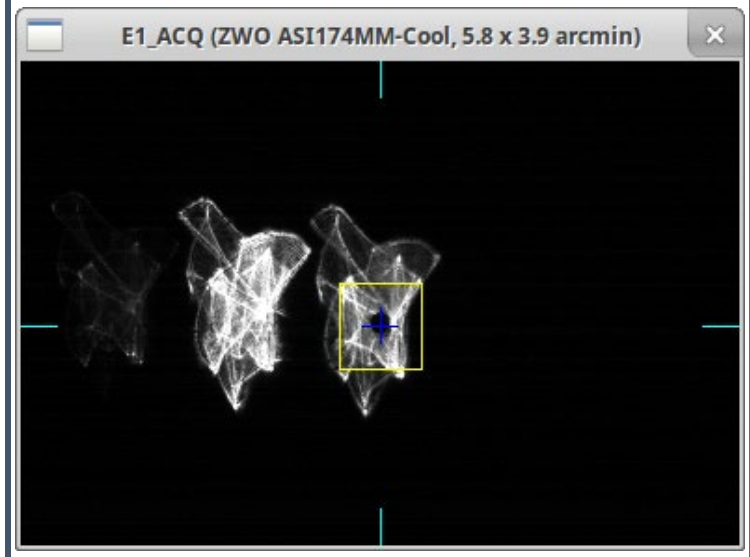
REGULAR range

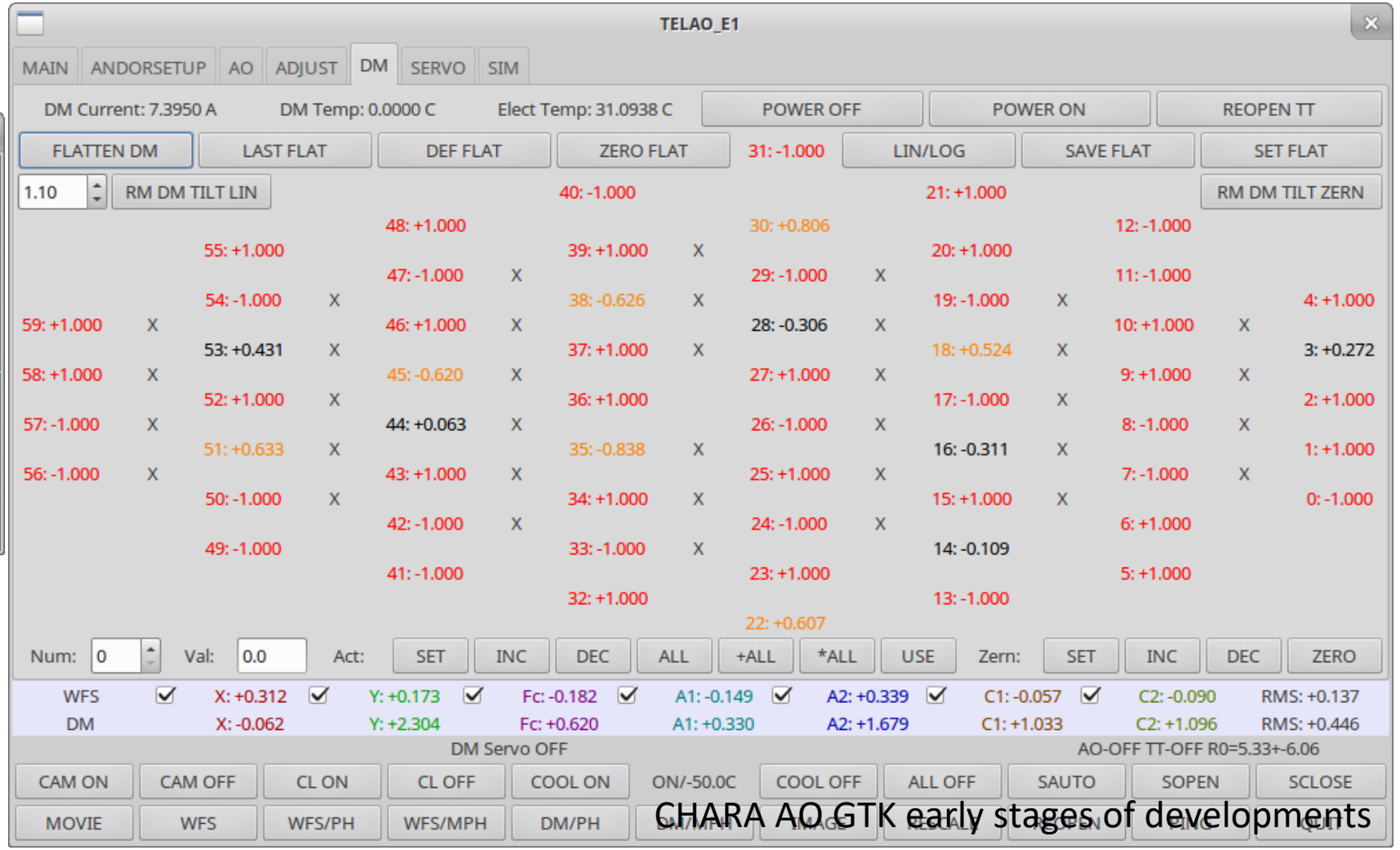
50% - 90% range

>90% range

BLOCKED

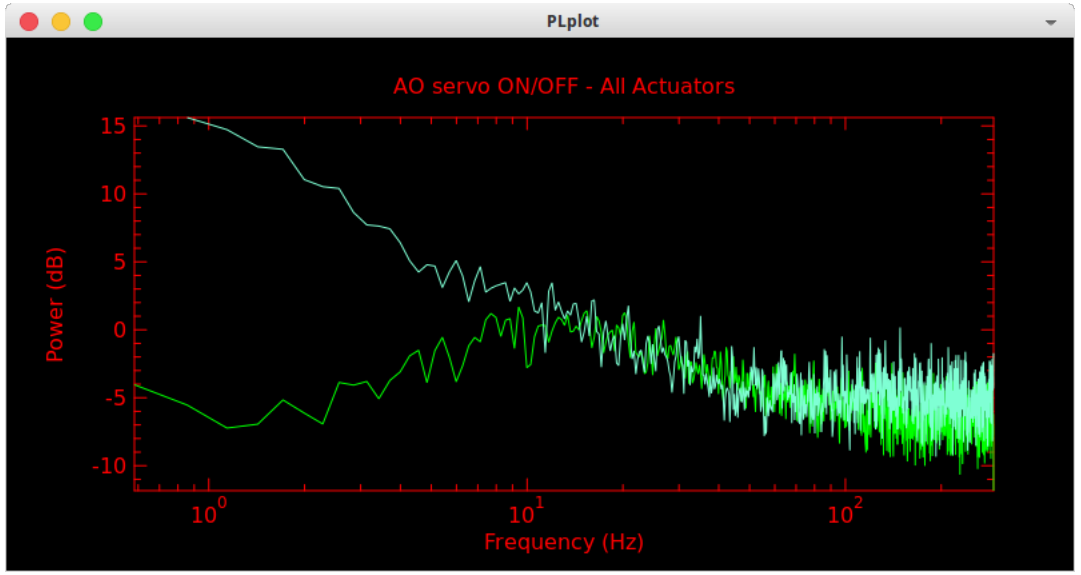
DM flaring





CHARA AO GTK early stages of developments

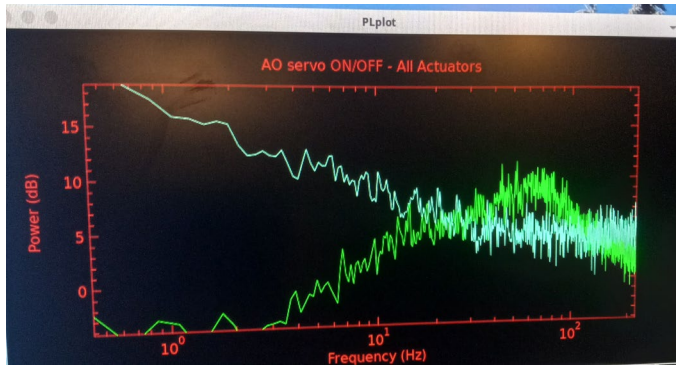
Optimizing TELAO performance - power spectrum

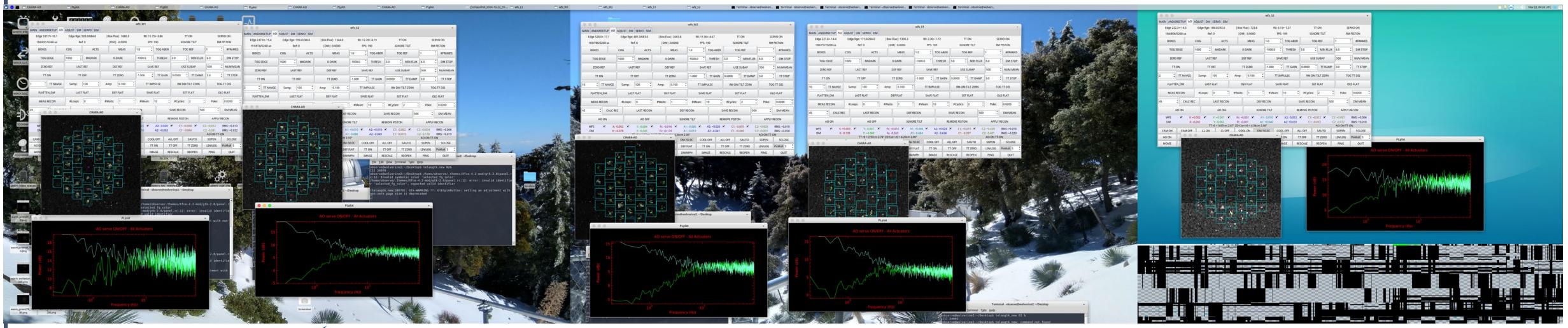


SERVO OFF - no DM loop, just TT

SERVO ON - both TT and DM

Gain and dumping





Tuning AO on-sky doing science time

wfs_S2

MAIN | ANDORSETUP | AO | ADJUST | DM | SERVO | SIM

DM Current: DM Temperature: Electronics Temp: POWER OFF | POWER ON | REOPEN TT

FLATTEN DM | LAST FLAT | DEF FLAT | ZERO FLAT | 31: -0.013 | LIN/LOG | SAVE FLAT | SET FLAT

1.10 | RM DM TILT LIN | RM DM TILT ZERN

			48: -0.215		40: +0.316		30: +0.000		21: -0.031		12: +0.148	
	55: +0.000		47: +0.000	X	39: +0.000	X	29: +0.000	X	20: +0.000		11: +0.000	
	54: +0.000	X	46: +0.000	X	38: +0.000	X	28: +0.000	X	19: +0.000	X	10: +0.000	X
59: +0.000	X	53: +0.000	X	45: +0.000	X	37: +0.000	X	27: +0.000	X	18: +0.000	X	9: +0.000	X
58: +0.000	X	52: +0.000	X	44: +0.000	X	36: +0.000		26: +0.000	X	17: +0.000	X	8: +0.000	X
57: +0.000	X	51: +0.000	X	43: +0.000	X	35: +0.000	X	25: +0.000	X	16: +0.000	X	7: +0.000	X
56: +0.000	X	50: +0.000	X	42: +0.000	X	34: +0.000	X	24: +0.000	X	15: +0.000	X	6: +0.000	
		49: +0.000		41: +0.054		33: +0.000	X	23: +0.000		14: +0.000		5: -0.032	
					32: +0.050			22: +0.053		13: -0.070			

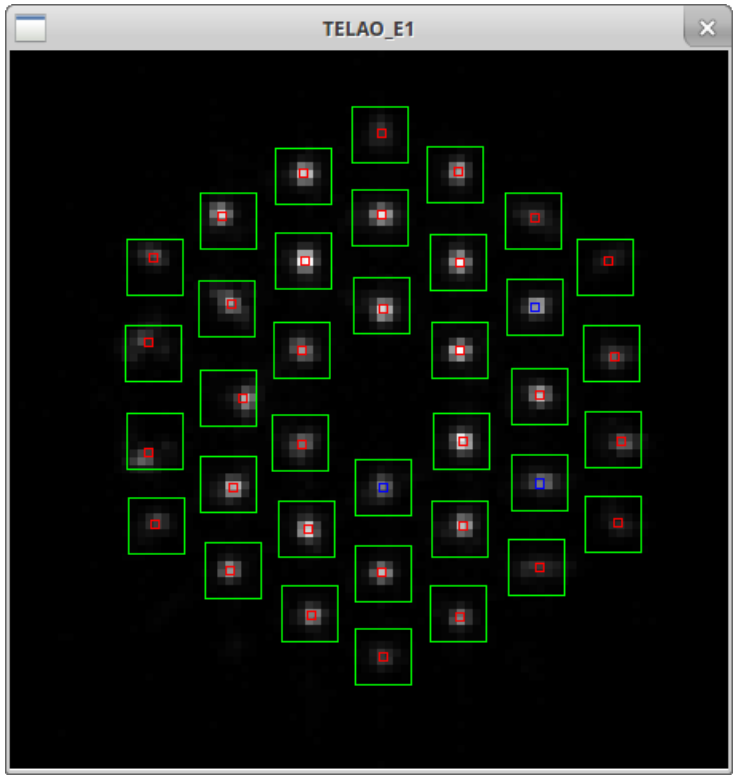
	4: +0.000									
	3: +0.000									
	2: +0.000									
	1: +0.000									
	0: +0.000									

Num: 0 Val: 0.0 Act: SET | INC | DEC | ALL | +ALL | *ALL | USE Zern: SET | INC | DEC | ZERO

WFS	X: +0.089	Y: -0.070	Fc: -0.039	A1: -0.016	A2: -0.069	C1: -0.015	C2: -0.002	RMS: +0.010	
DM	X: -0.125	Y: -0.453	Fc: -0.305	A1: +0.056	A2: -0.200	C1: -0.041	C2: -0.010	RMS: +0.098	

2 reference centroids have been loaded from /ctrscrut/chara/etc/wfs_S2_REF.cao AO-OFF TT-ON R0=8.44+-4.68

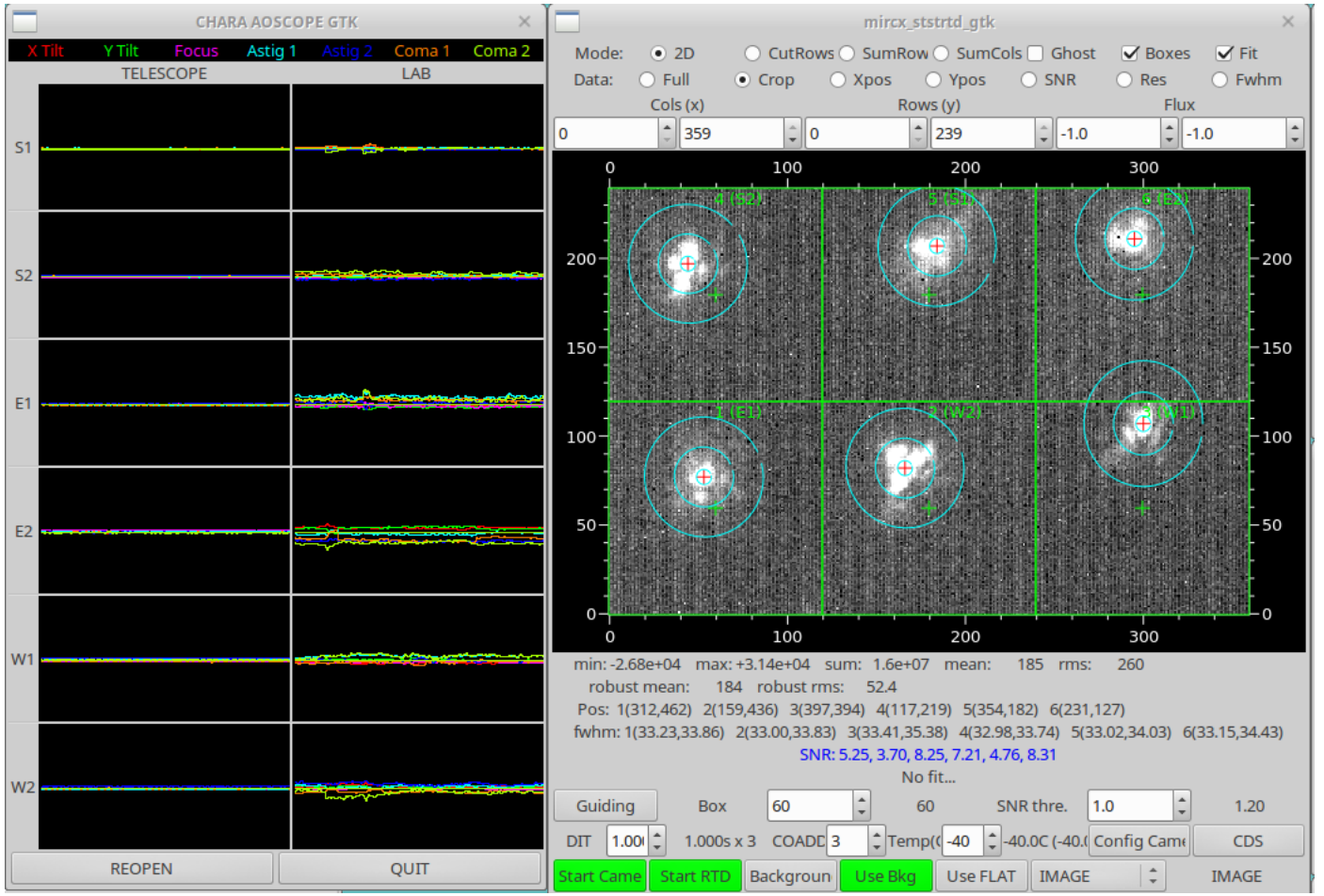
CAM ON	CAM OFF	CL ON	CL OFF	COOL ON	OFF/17.0C	COOL OFF	ALL OFF	SAUTO	SOPEN	SCLOSE
AO ON	AO OFF	FLATTEN	SET FLAT	LAST FLAT	DEF FLAT	TT ON	TT OFF	TT ZERO	LIN/LOG	PixMult 5
MOVIE	WFS	WFS/PH	WFS/MPH	DM/PH	DM/MPH	IMAGE	RESCALE	REOPEN	PING	QUIT



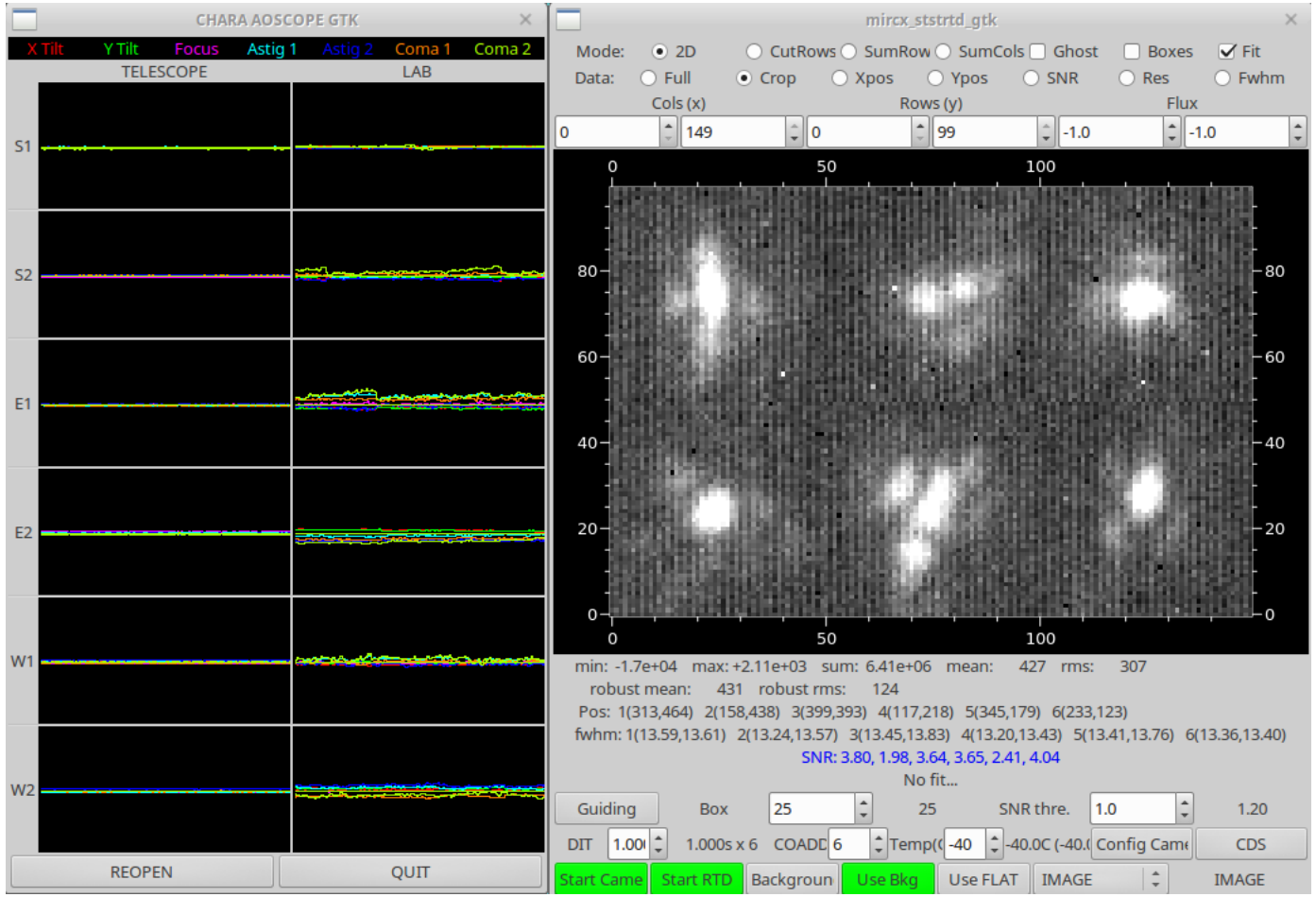
Some of next steps

- obsgtk - update, optimization, wish list
- labaogtk - wish list
- using DM as TT system
- on sky reconstructors
- AO performance diagnostics
- regular meeting with operators
- beaconmon logs, logs in general
- documentation
- aomon
- lurkgtk

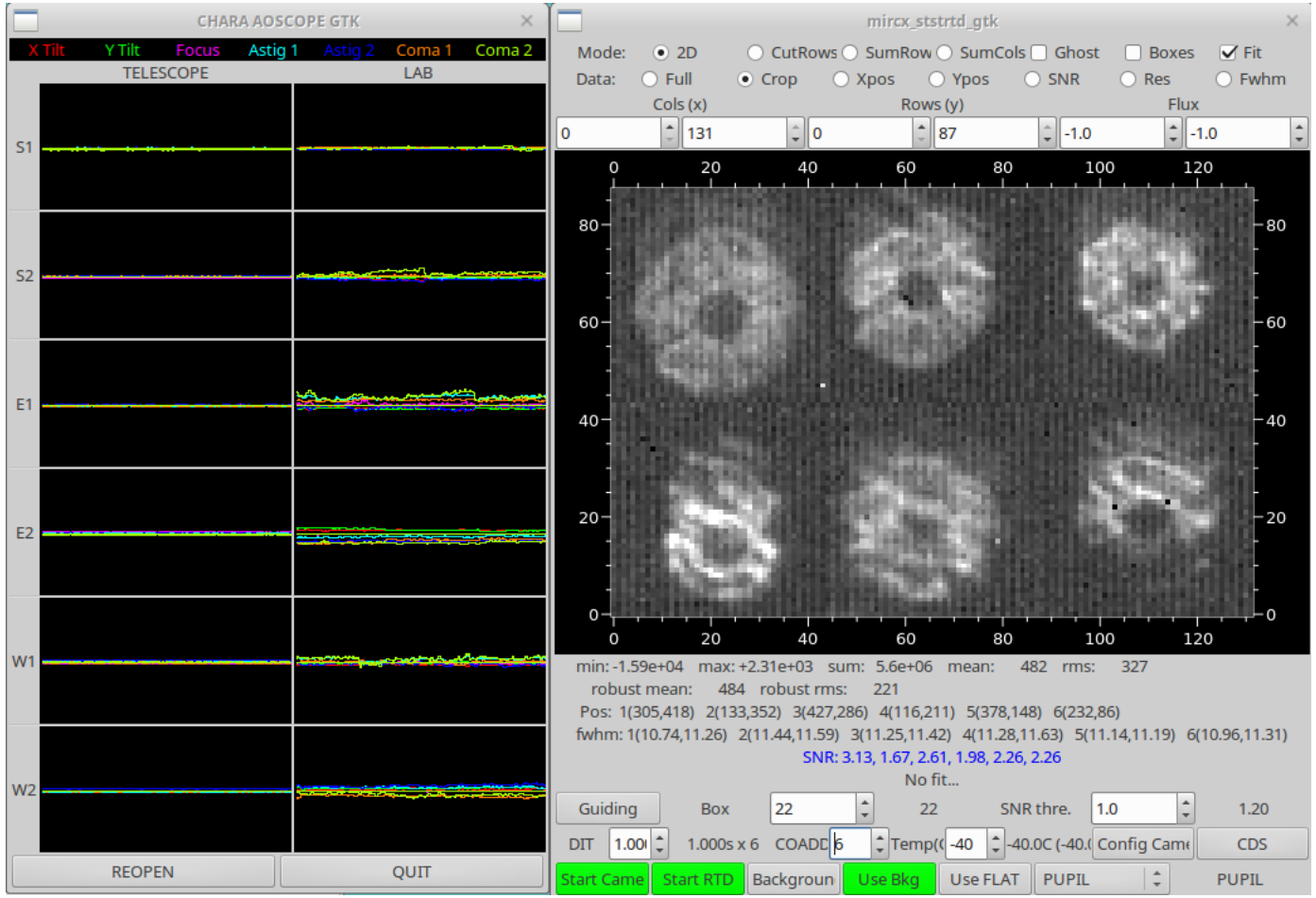
AO performance - STST & AOMON



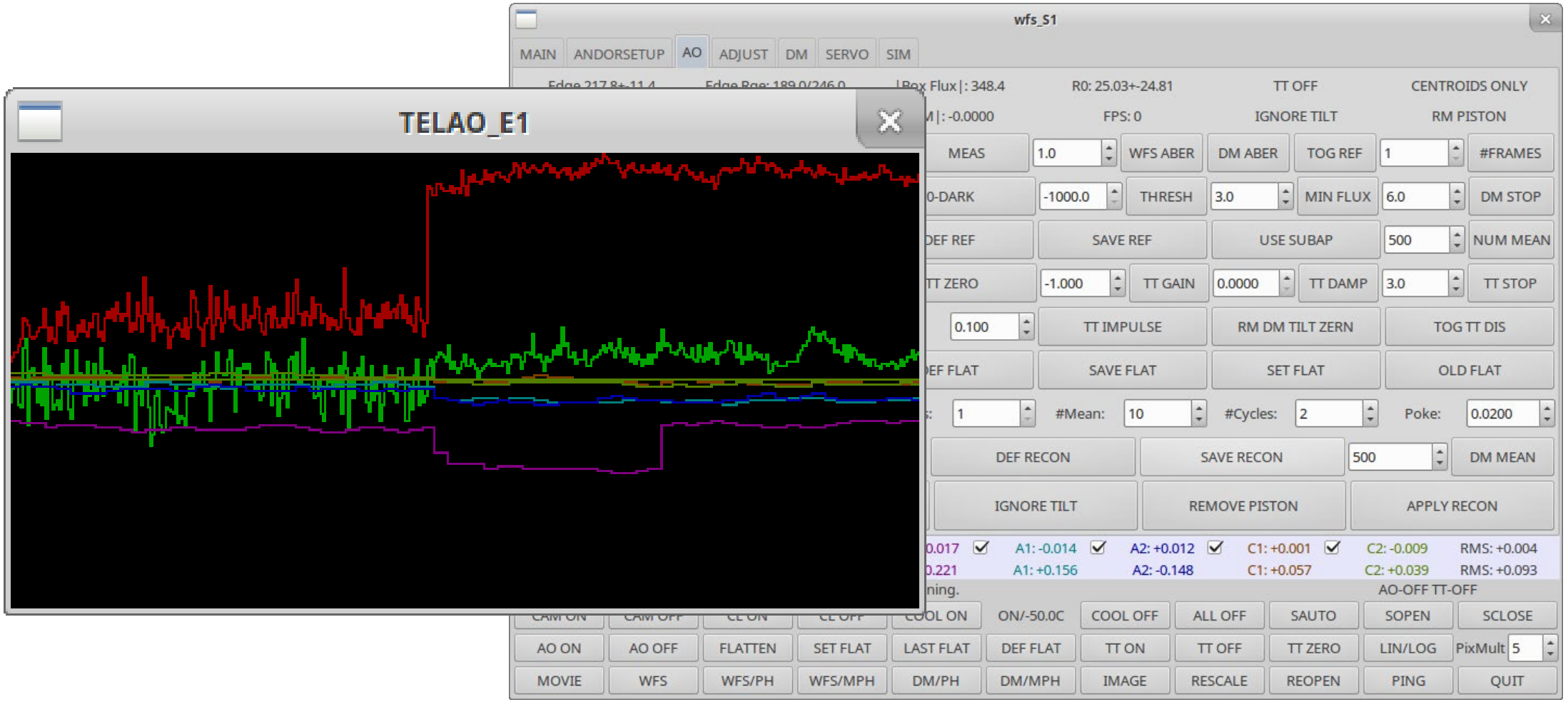
AO performance - STST



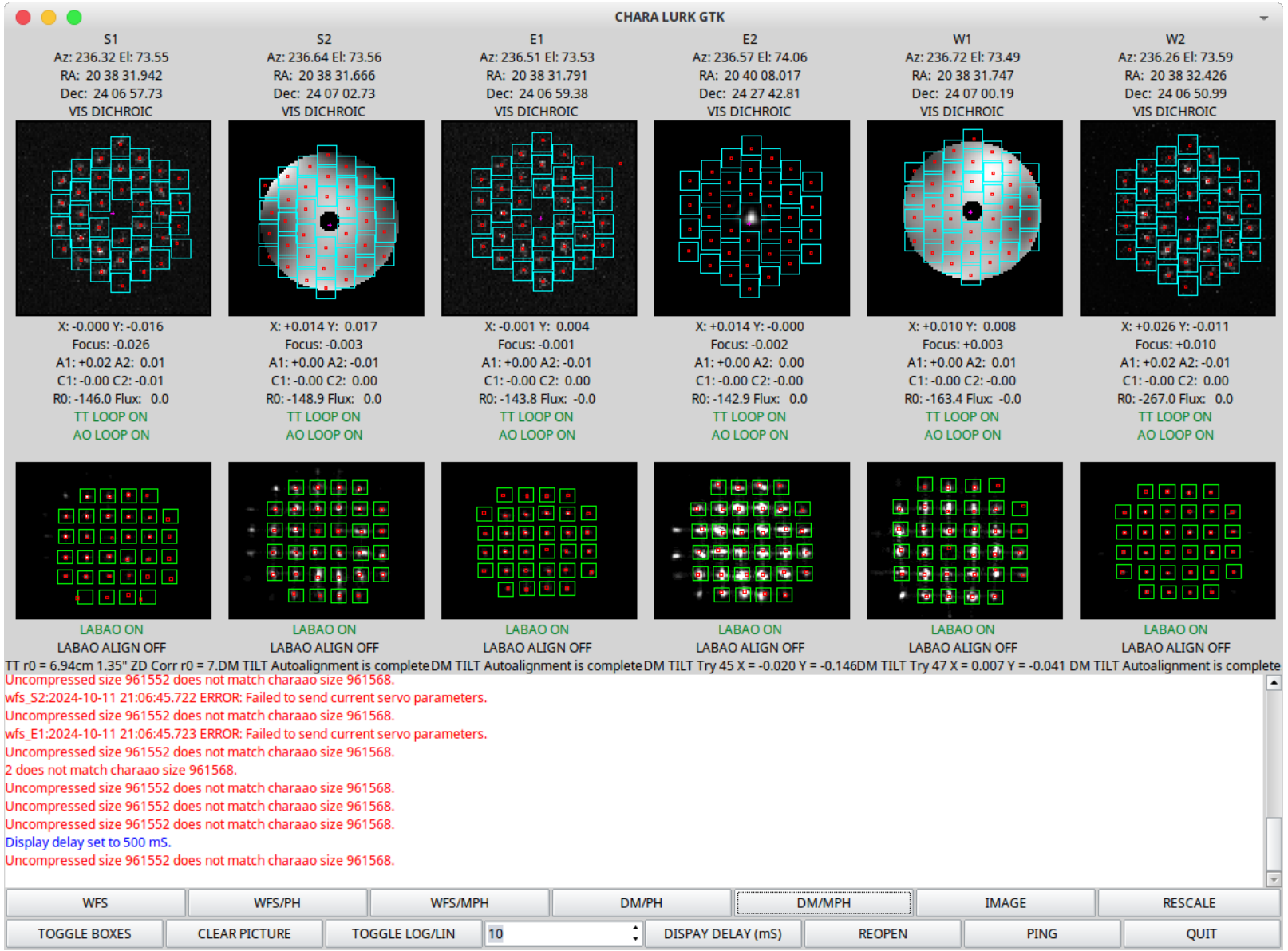
AO performance - STST



AO performance - aberration plot



lurkgtk


CHARA LURK GTK
S1
Az: 236.32 El: 73.55
RA: 20 38 31.942
Dec: 24 06 57.73
VIS DICHROIC
X: -0.000 Y: -0.016
Focus: -0.026
A1: +0.02 A2: 0.01
C1: -0.00 C2: -0.01
R0: -146.0 Flux: 0.0
TT LOOP ON
AO LOOP ON
S2
Az: 236.64 El: 73.56
RA: 20 38 31.666
Dec: 24 07 02.73
VIS DICHROIC
X: +0.014 Y: 0.017
Focus: -0.003
A1: +0.00 A2: -0.01
C1: -0.00 C2: 0.00
R0: -148.9 Flux: 0.0
TT LOOP ON
AO LOOP ON
E1
Az: 236.51 El: 73.53
RA: 20 38 31.791
Dec: 24 06 59.38
VIS DICHROIC
X: -0.001 Y: 0.004
Focus: -0.001
A1: +0.00 A2: -0.01
C1: -0.00 C2: 0.00
R0: -143.8 Flux: -0.0
TT LOOP ON
AO LOOP ON
E2
Az: 236.57 El: 74.06
RA: 20 40 08.017
Dec: 24 27 42.81
VIS DICHROIC
X: +0.014 Y: -0.000
Focus: -0.002
A1: +0.00 A2: 0.00
C1: -0.00 C2: -0.00
R0: -142.9 Flux: 0.0
TT LOOP ON
AO LOOP ON
W1
Az: 236.72 El: 73.49
RA: 20 38 31.747
Dec: 24 07 00.19
VIS DICHROIC
X: +0.010 Y: 0.008
Focus: +0.003
A1: +0.00 A2: 0.01
C1: -0.00 C2: -0.00
R0: -163.4 Flux: -0.0
TT LOOP ON
AO LOOP ON
W2
Az: 236.26 El: 73.59
RA: 20 38 32.426
Dec: 24 06 50.99
VIS DICHROIC
X: +0.026 Y: -0.011
Focus: +0.010
A1: +0.02 A2: -0.01
C1: -0.00 C2: 0.00
R0: -267.0 Flux: 0.0
TT LOOP ON
AO LOOP ON
LABAO ON
LABAO ALIGN OFF
TT r0 = 6.94cm 1.35" ZD Corr r0 = 7.DM TILT Autoalignment is complete
DM TILT Autoalignment is complete
DM TILT Try 45 X = -0.020 Y = -0.146
DM TILT Try 47 X = 0.007 Y = -0.041
DM TILT Autoalignment is complete
Uncompressed size 961552 does not match charaao size 961568.
wfs_S2:2024-10-11 21:06:45.722 ERROR: Failed to send current servo parameters.
Uncompressed size 961552 does not match charaao size 961568.
wfs_E1:2024-10-11 21:06:45.723 ERROR: Failed to send current servo parameters.
Uncompressed size 961552 does not match charaao size 961568.
2 does not match charaao size 961568.
Uncompressed size 961552 does not match charaao size 961568.
Uncompressed size 961552 does not match charaao size 961568.
Uncompressed size 961552 does not match charaao size 961568.
Display delay set to 500 mS.
Uncompressed size 961552 does not match charaao size 961568.
WFS
WFS/PH
WFS/MPH
DM/PH
DM/MPH
IMAGE
RESCALE
TOGGLE BOXES
CLEAR PICTURE
TOGGLE LOG/LIN
10
DISPAY DELAY (mS)
REOPEN
PING
QUIT