Recent Developments in the Lab

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Projects planned in 2019

- New delay line control > In progress
- New internal source IR and VIS by MIRCX and VEGA teams > STS in use
- JouFLU combiner upgrade > Design in progress
  Feed mirrors and bases on MIRCx table are aligned
- CHARA reference camera upgrade > DONE
- MIRCX/MYSTIC - > Presentations later
- Replacement of NIRO and the CLIMB combiners - - - - - - - - - - - - - - > Presentations later
- VEGA → SPICA > In progress
  - Development in Nice - > Presentations later
  - Preparations in the CHARA lab
    - Some VEGA/FRIEND parts shipped to Nice
    - LDC upgrade
    - Lab tiptilt move and upgrade

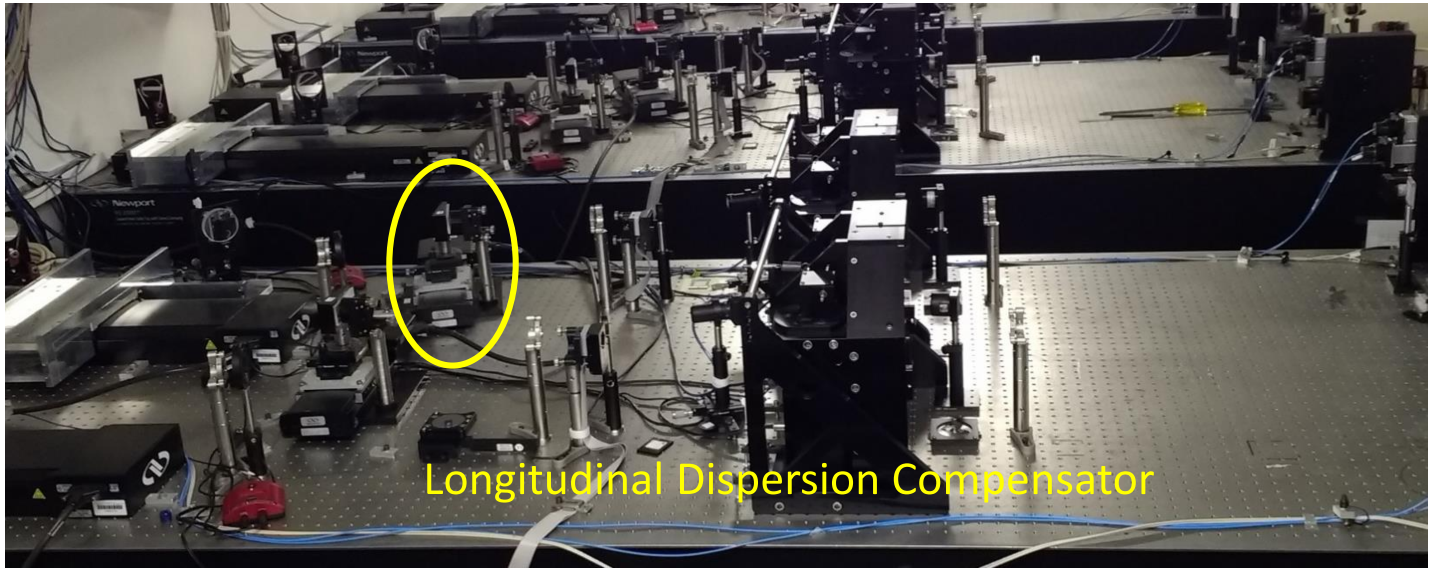
Topics in this Presentation

- VEGA → SPICA preparations in the CHARA lab
  - LDC upgrade
  - Lab tiptilt move and upgrade
- CHARA reference camera upgrade
- Coude alignment – M7 control

Longitudinal Dispersion Control Upgrade

The original LDCs were not intended to be used when IR combiners operate, so high IR transmission was not a requirement.
New observing modes with MIRCx, and the need for better dispersion control for the new SPICA visible beam combiner initiated the redesign of how we are going to handle longitudinal dispersion.

- **The original LDC units (→ common LDCs)**, we used in the beams on the beam sampling tables at the point before the VIS/IR split **got new prisms, which have high IR transmission**.
- These units still can be pushed in/out of the beam.



- **There will be new LDC units (→ VIS LDCs)** installed on the Metrology table **in the VIS beams only.**

Longitudinal Dispersion Control Upgrade

Details about the design are in a paper by **Cyril Pannetier *et al.*** :

Compensation of differential dispersion: application to multiband stellar interferometry

The article was submitted to MNRAS in March 2021

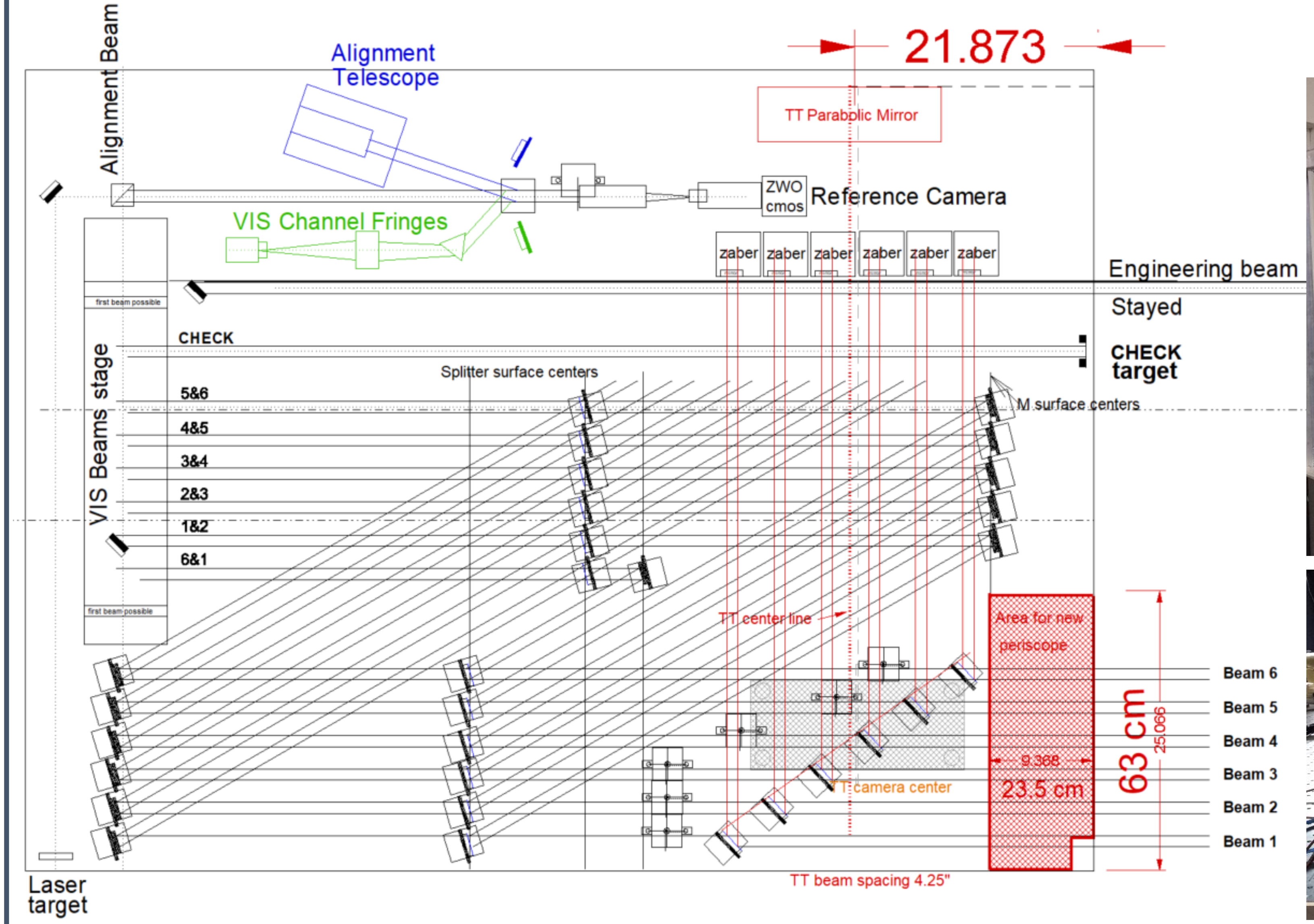
IR transmission measurements of the common LDCs

	Old LDC	New LDC
	SF10 T [%]	SF66 T [%]
J band	85	94
H band	80	95
K band	77	95

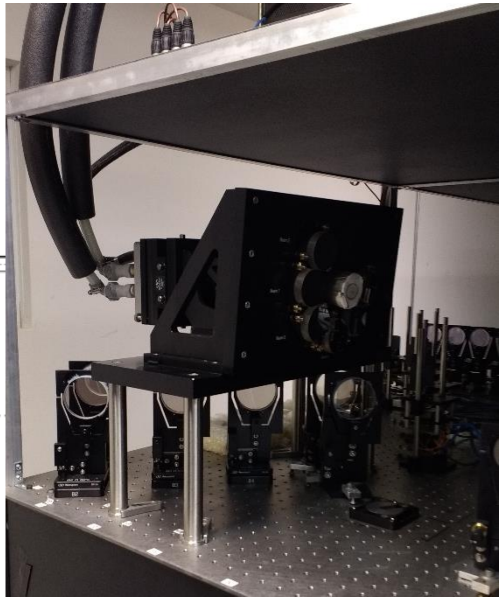
These are the results of lab tests using NIRO and the lab white light source. The LDC units were at their places on the beam sampling tables. E2 LDC still with the old glasses, S2 LDC with the new.

First on-sky test with PAVO on February 18, 2021. Theo: "*We performed tests on S1/S2 with PAVO using the new LDC glass and it worked without any difficulty. The glass_per_m number was the only thing to change and the number supplied by the Nice team was correct. Finer adjustments may be necessary …*"

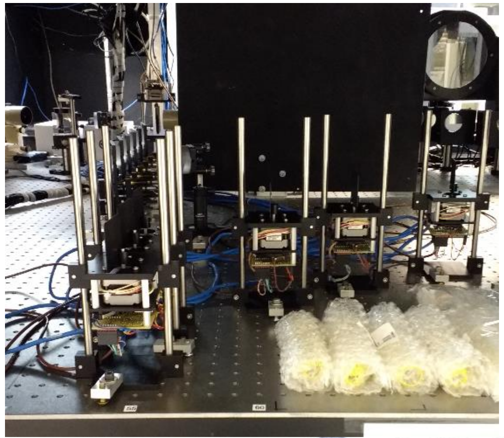
Lab Tip-Tilt Location and Camera Change



Current Images

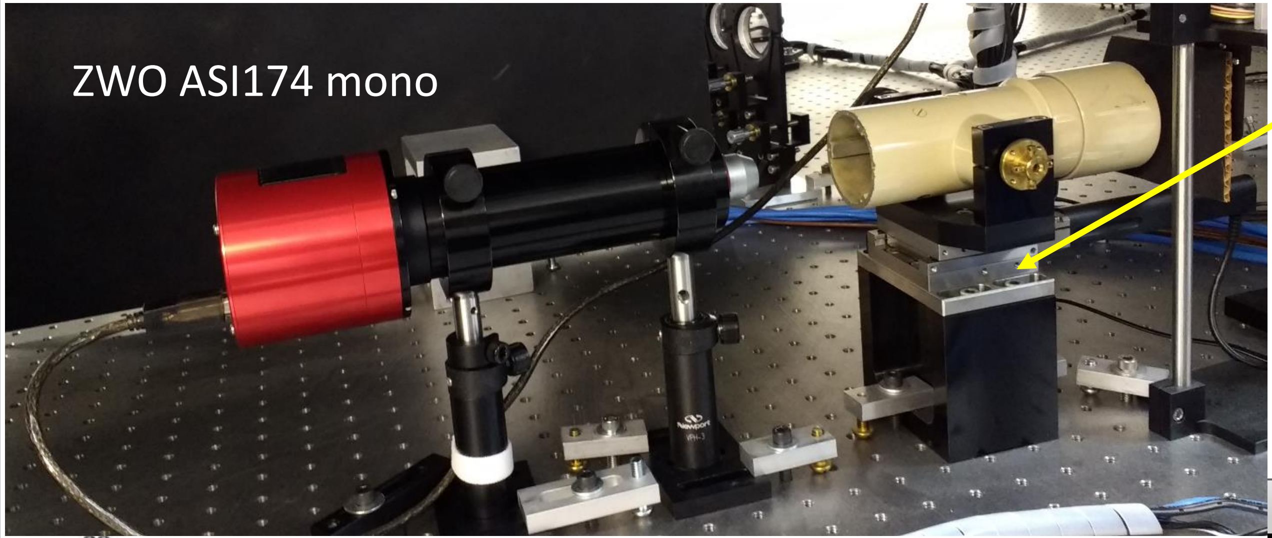


The water cooled CCD camera will be replaced with an Andor camera used in air cooled mode.
More details from Laszlo.

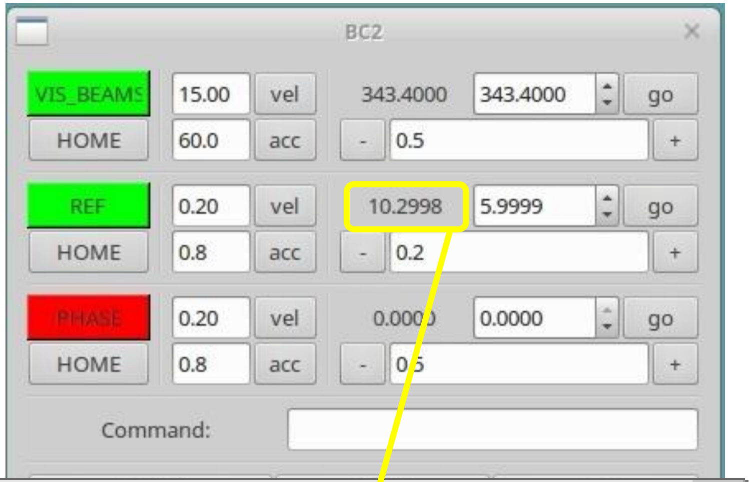


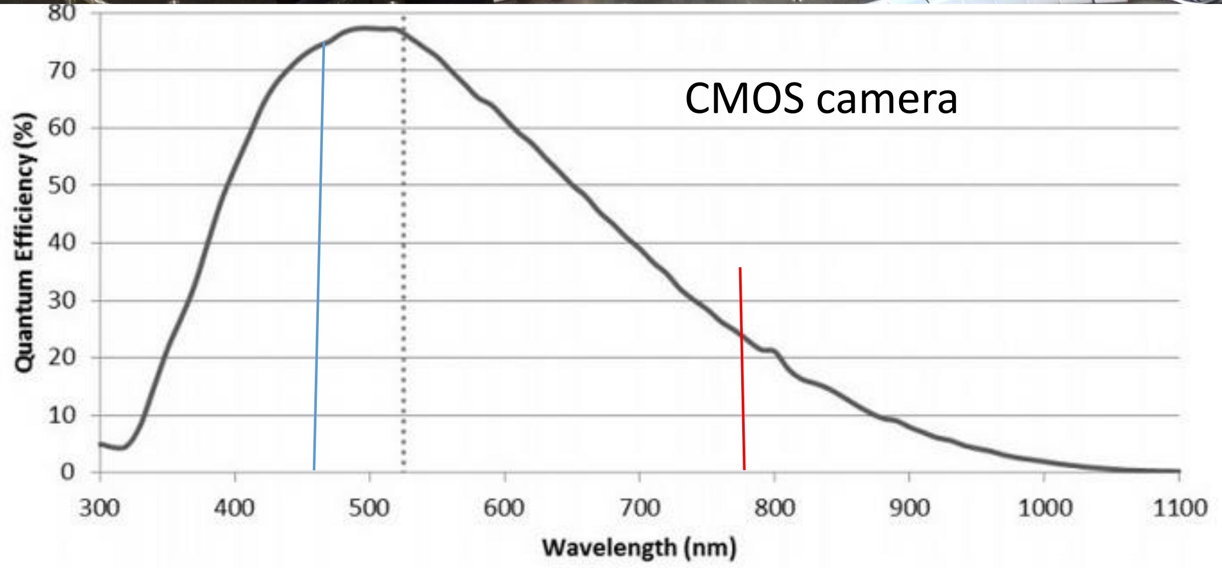
Shutters for alignment beams are already at new places, motors down to let the beam pass above VIS beams to SPICA.

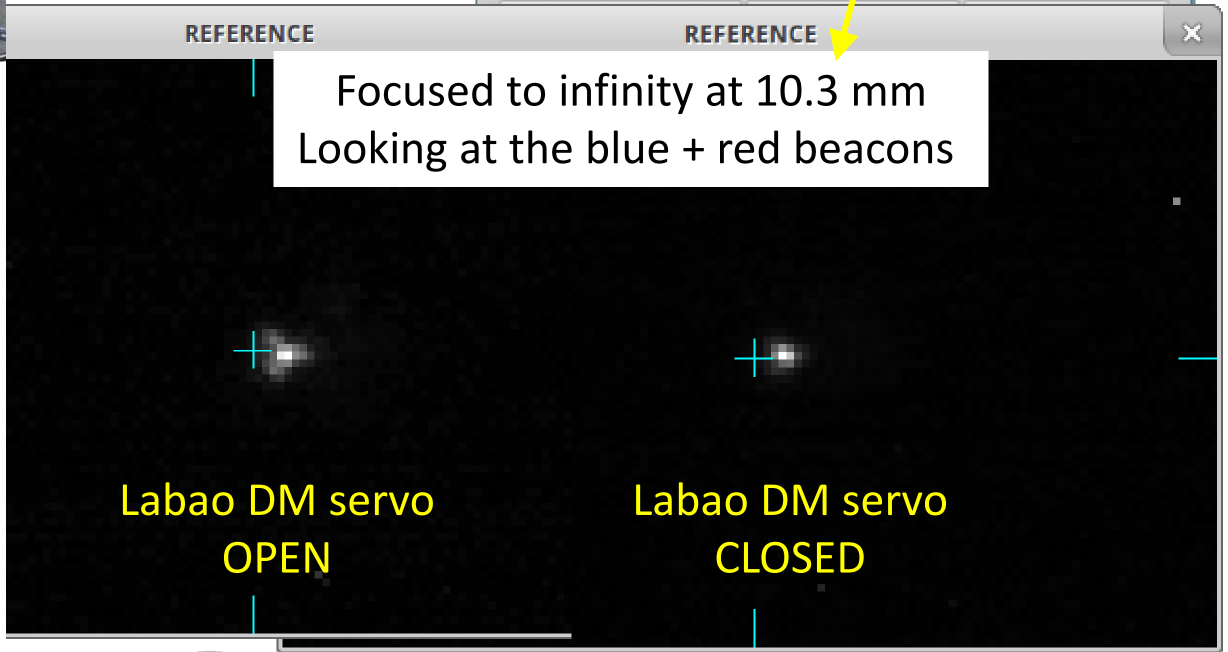
Reference Camera



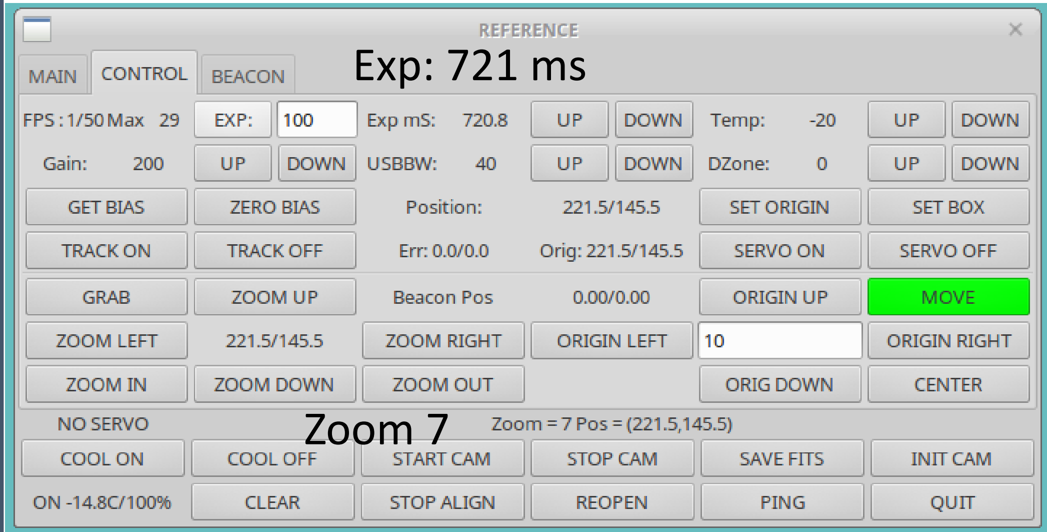
Same focusing stage and control.
On-axis accuracy is better than 3 pixels.





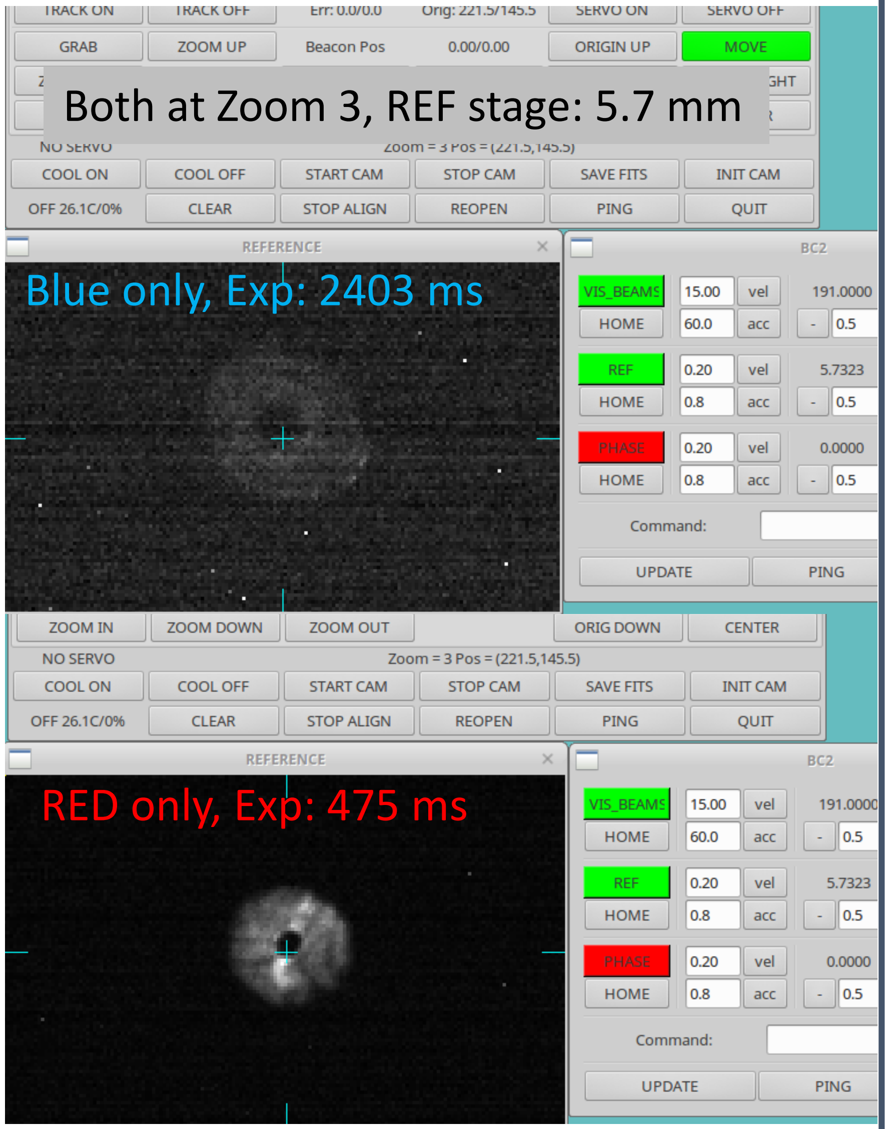


Beacon Pupil on Reference Camera

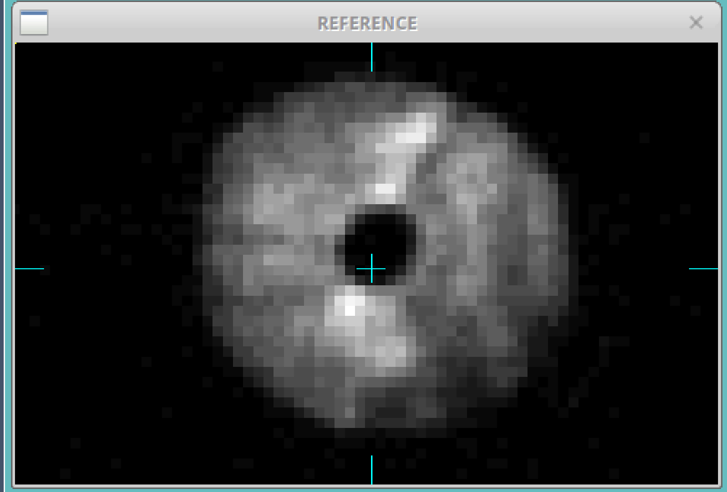


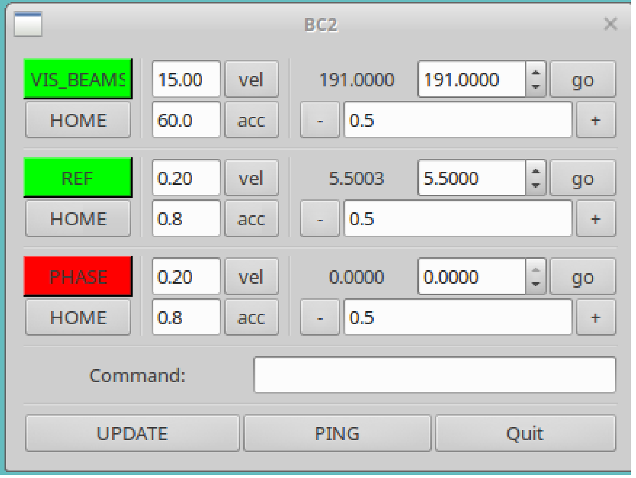
As expected

- There is less blue light, because the labao splitter reflects most blue to labwfs.
- Blue and red focus are different.



Red & Blue ON REF stage: 5.5 mm





Agreement on Optical Axis

REFERENCE and lab tip-tilt origins are defined by the alignment laser coming back from the corner cubes on the BS tables.

Same axis

- Tiptilt shows all beams at the same time.
- REFERENCE can be focused.

The beacon has to stay on this axis

An example when it is not

Here we can see an angular difference between the beacon and laser(=CHARA optical axis), as indicated by the fact that the beacon is off center both in tip-tilt and REF camera after the full beacon alignment has been done.

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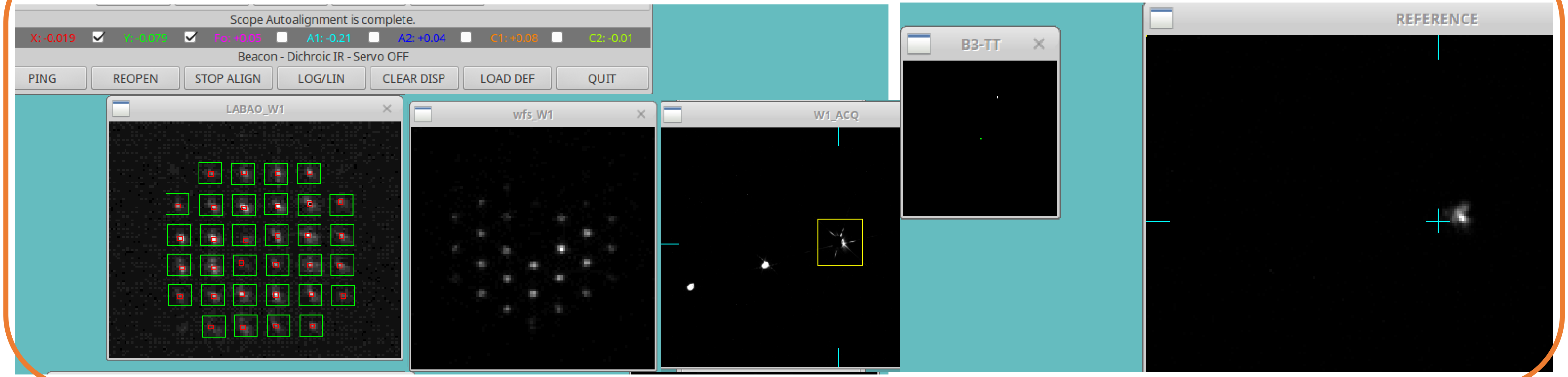

The twfs boxes were not at the right place.

Agreement on Optical Axis

REFERENCE and lab tip-tilt origins are defined by the alignment laser coming back from the corner cubes on the BS tables.

Same axis

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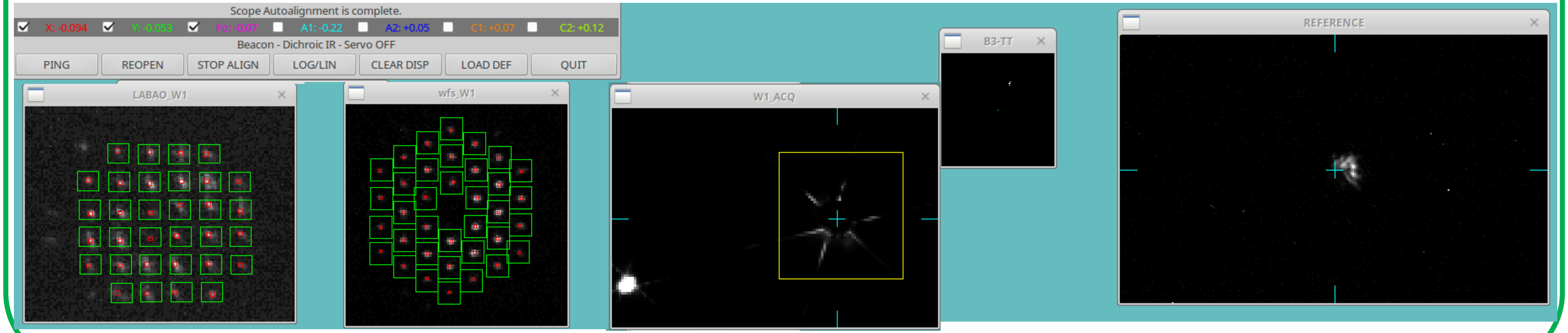
The beacon has to stay on this axis

A better example



With new twfs boxes. The red and blue beacon are both turned ON.

Agreement on Optical Axis

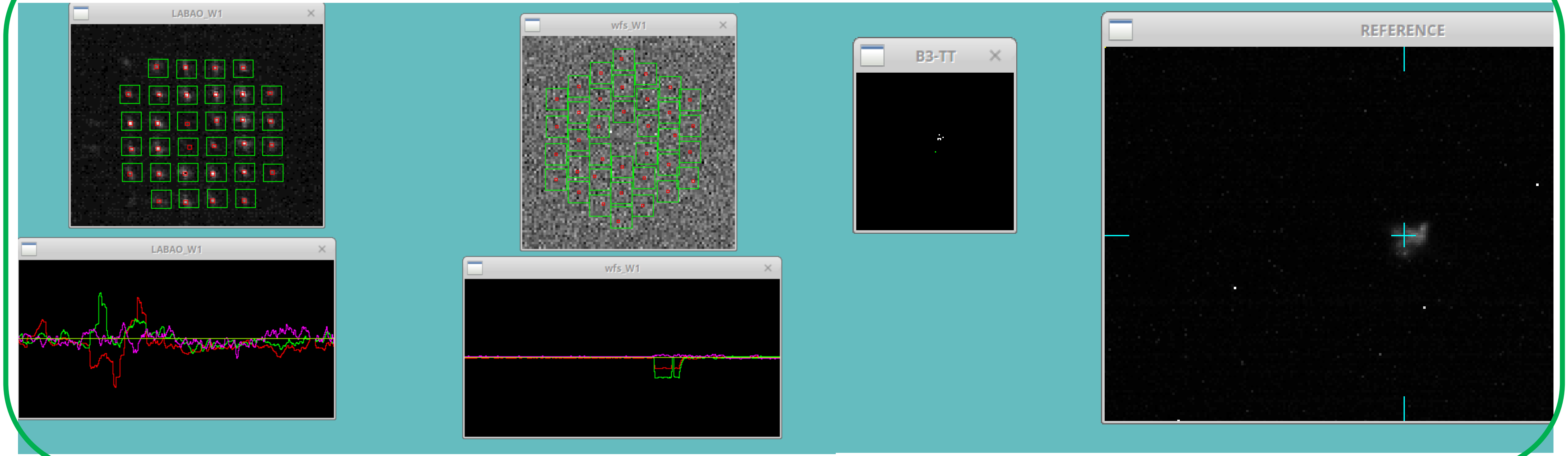
REFERENCE and lab tip-tilt origins are defined by the alignment laser coming back from the corner cubes on the BS tables.

Same axis

- Tiptilt shows all beams at the same time.
- REFERENCE can be focused.

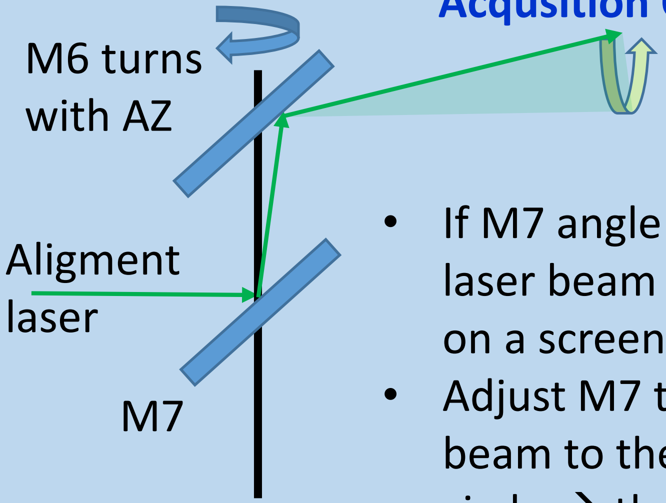
The beacon has to stay on this axis

The same alignment, as on the previous slide, is in good in good agreement with lab axis when looking at blue beacon only.



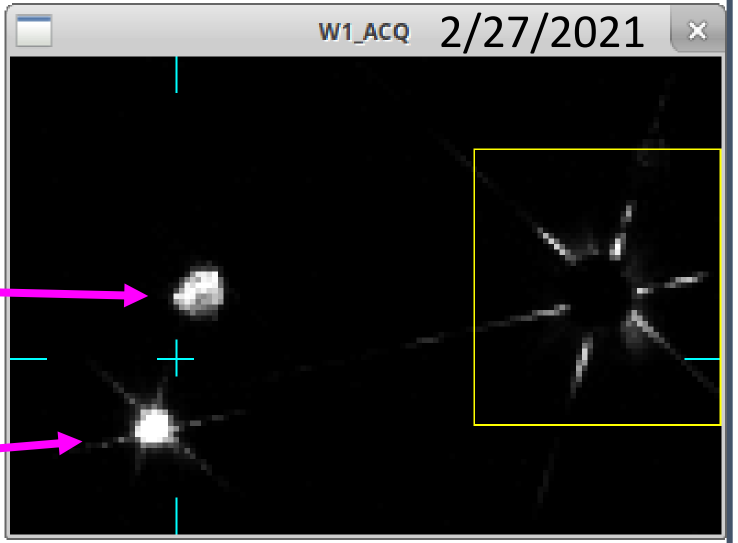
Azimuth Coude Alignment: Theory and Reality

Acqusition Coude alignment

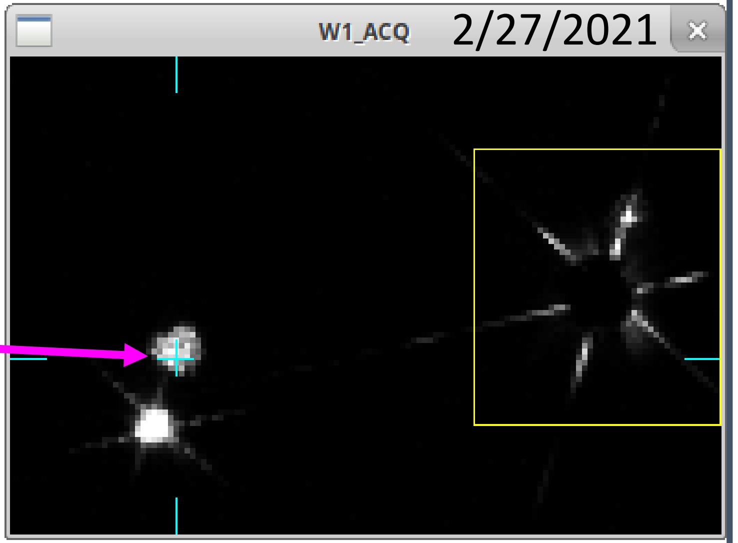


- If M7 angle is wrong, the laser beam makes a circle on a screen.
- Adjust M7 to send the beam to the center of the circle → the beam will move along the AZ axis.

2. At stow+180deg laser ended up here
1. At stow: beacon and laser were together here



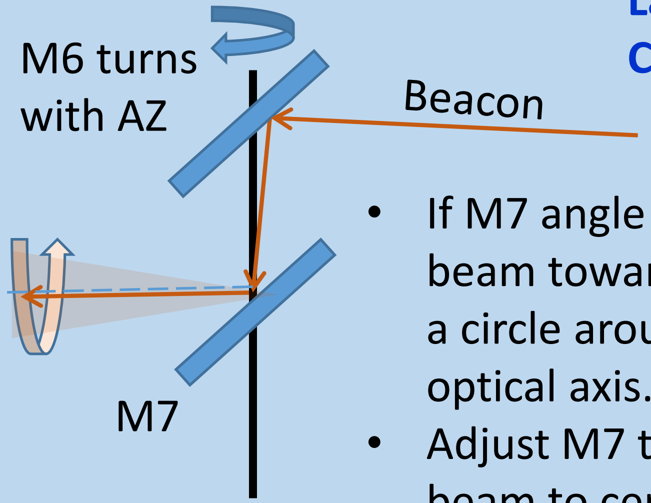
3. By moving M7 laser was sent to target position



- Works even when <u>the error is larger than the range of remote M7 alignment</u>.
- There is little information about how the laser or telescope moved during that 180 degree turn. (...unless video recording, but that's not precise enough, and needs a lot of processing.)

Azimuth Coude Alignment: Theory and Reality

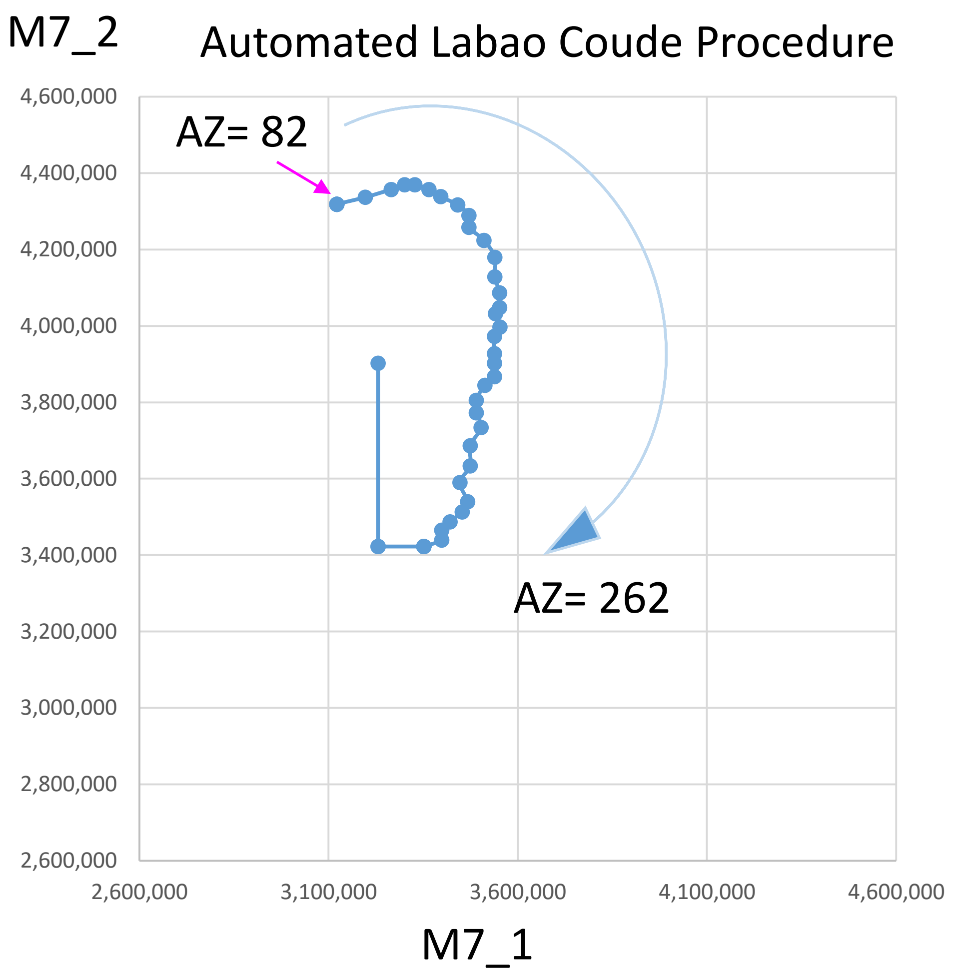
Labao Automated Coude Alignment



- If M7 angle is wrong, the beam toward the lab makes a circle around the correct optical axis.
- Adjust M7 to keep the beam to centered in labao

...

File: UT_2020_12_04 BEACONMON_S2



These data are from **Automated Labao Coude Procedure**:

- Beacon alignment done at STOW (to twfs and labwfs)
- Telescope continuously moved from STOW to STOW+180
  - M7 continuously automatically adjusted based on labwfs to keep spots centered in labao
  - Target M7 position = Average[M7(stow) , M7(stow+180)]

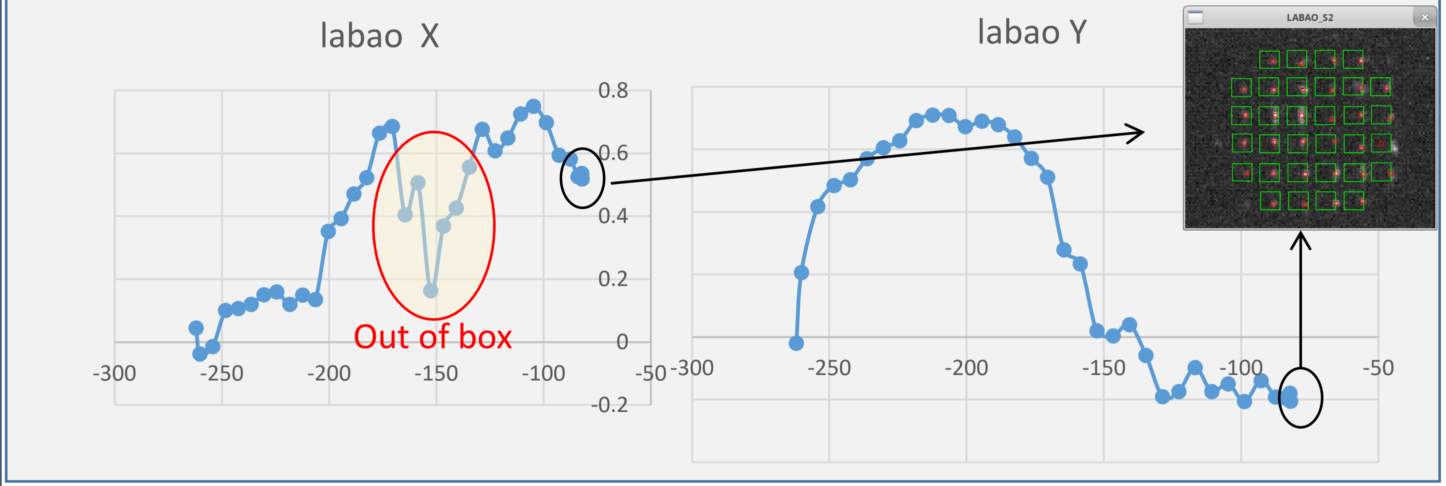
Azimuth Coude Alignment: Theory and Reality

These data are from **Automated Labao Coude Procedure**:

- Beacon alignment done at STOW (to twfs and labwfs)
- Telescope continuously moved from STOW to STOW+180
  - M7 continuously automatically adjusted based on labwfs to keep spots centered in labao
  - Target M7 position = Average of 2 points [M7(stow) , M7(stow+180)]

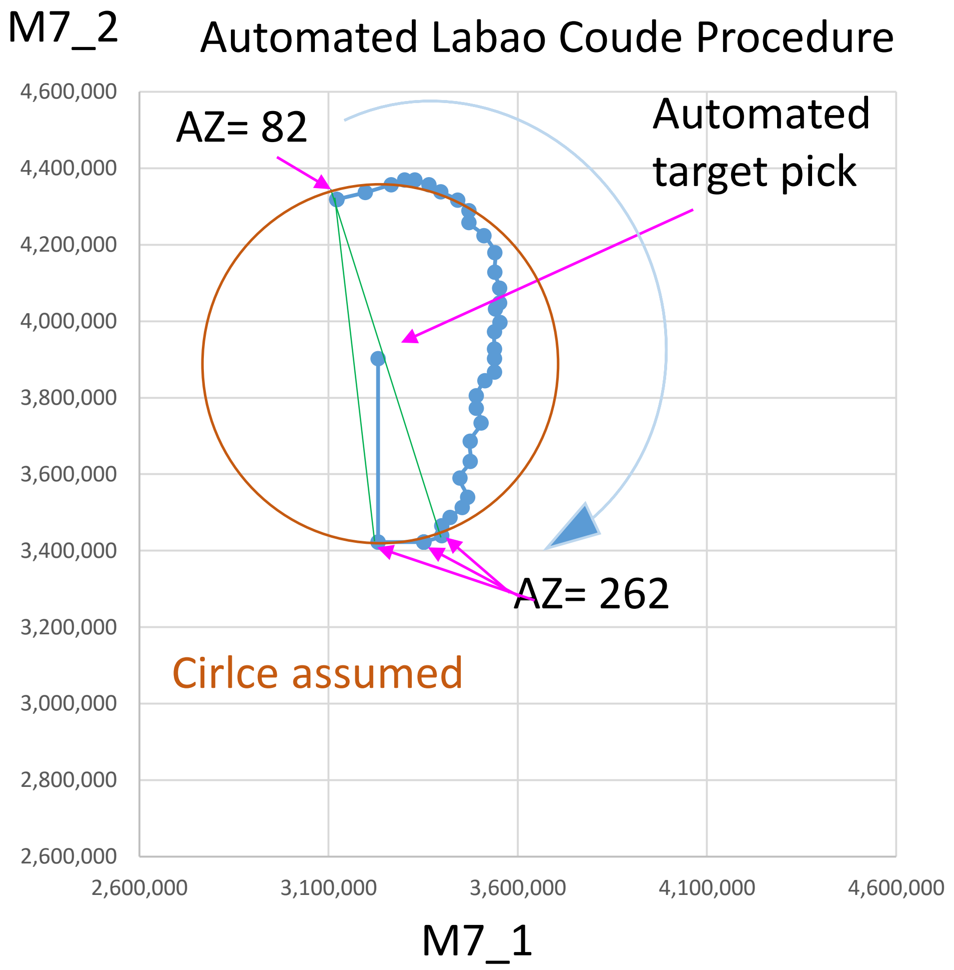
Slewing back to stow, no adjustments

UT_2020_12_04 BEACONMON_S2



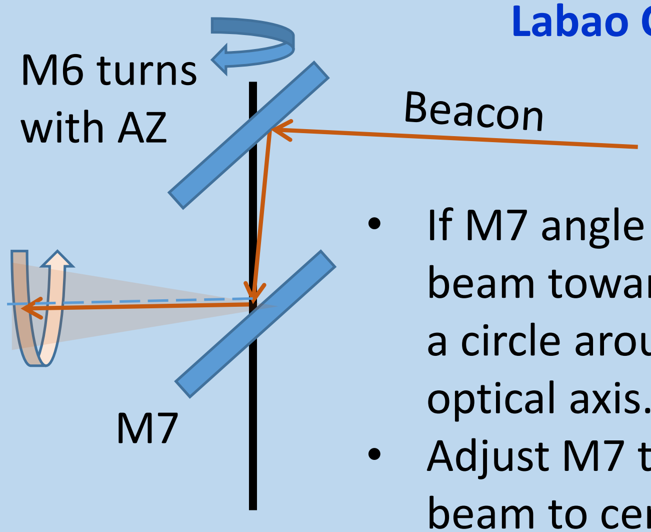
Not a good result, mainly because automatic M7 adjustment could not keep up with the telescope slew.

File: UT_2020_12_04 BEACONMON_S2

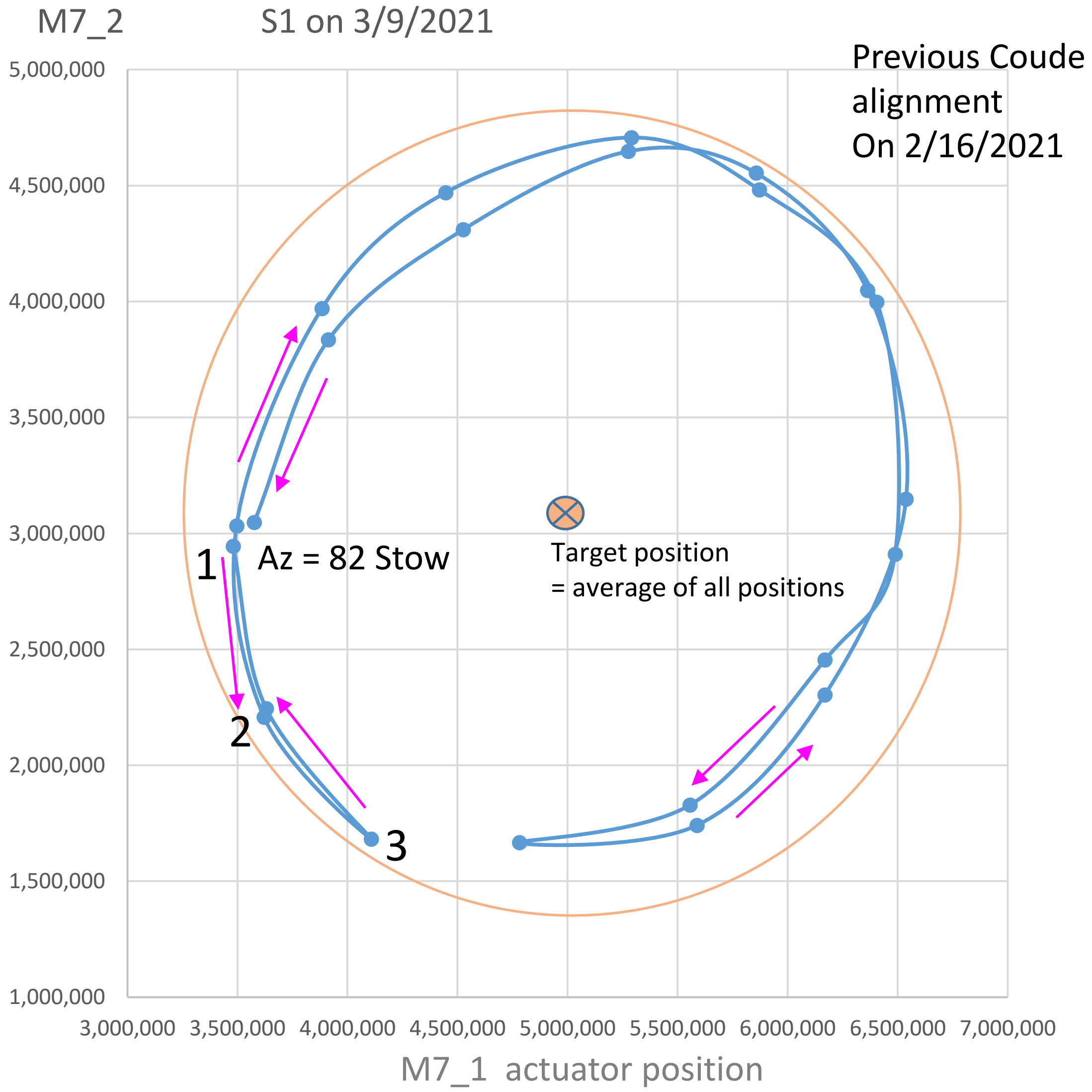


Azimuth Coude Alignment: Theory and Reality

Labao Coude Alignment



- If M7 angle is wrong, the beam toward the lab makes a circle around the correct optical axis.
- Adjust M7 to keep the beam to centered in labao and record M7 positions, then average them.



Labao Coude Alignment for Thorough Analysis

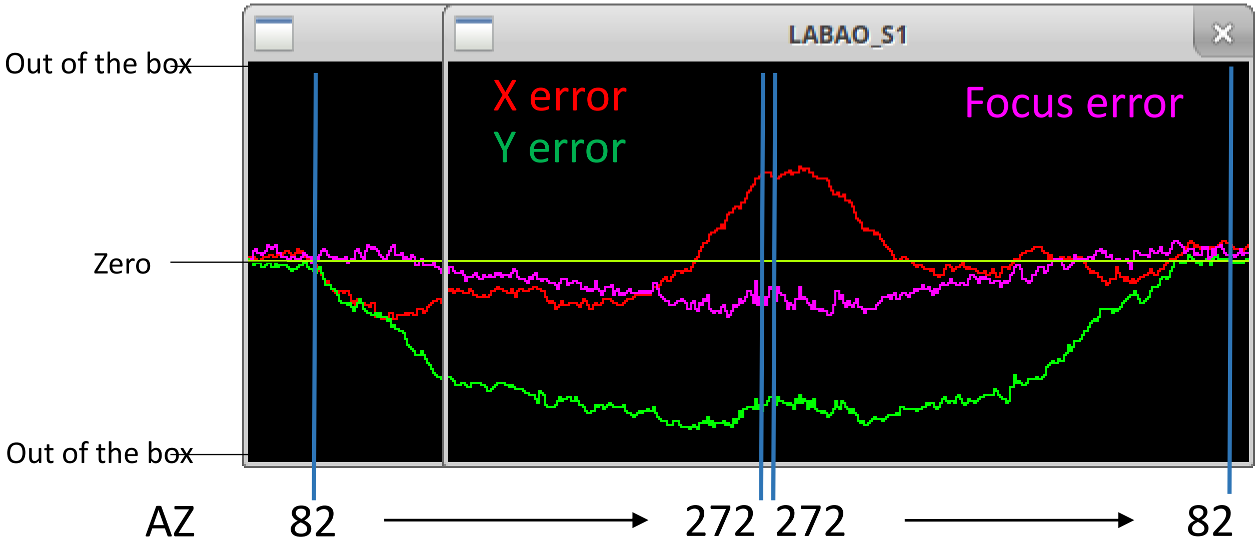
The procedure used to collect these data points:

- Beacon alignment done at STOW (to twfs and labwfs)
- Telescope moved in 30 deg increments in AZ and stopped
    - Spots on labao brought back by M7 adjustment
    - M7 position recorded at each stop

Residual Angular Error on Labao Wave-Front Sensor

- M7 set to the target position
- Beacon aligned to twfs and labwfs by tilting Bflat and AOB splitter
- Telescope moved in azimuth without any adjustment

Aberrations seen by lab wave front sensor



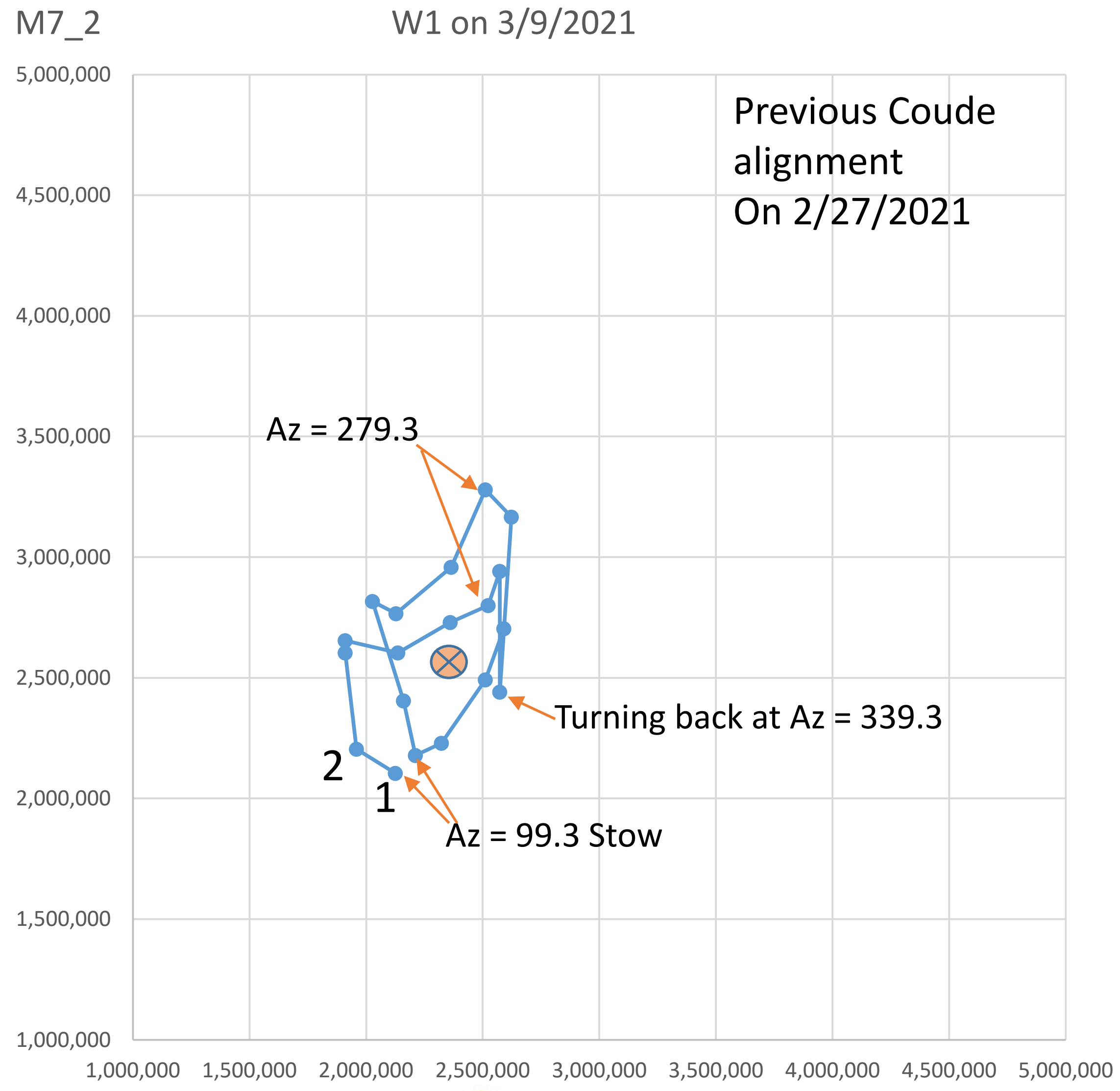
This plot shows that the beacon spots stayed in the boxes.

This is the best we can get, if M7 is not actively adjusted.

→ While observing, active M7 control is necessary.

There is a function in place to automatically adjust M7 based on labao wfs, and has been used successfully. Telescope tracking speed is much slower than slew.

The Case of W1 Azimuth Axis



Where is the circle, or ellipse now?

Average of all points (2.3 M, 2.6 M)

- If we used the end points of first “half circle”, the target position would be (2.3 M, 2.5 M)
- If we used the end points of second “half circle”, the target position would be (2.4 M, 2.7 M)

There is no single M7 position that could keep the W1 beacon spots in the labao wfs boxes.

→ Without active M7 control, W1 beam stability would be really bad.