Daily Alignment Procedure with 2 AO Wave Front Sensors

First Version

Judit Sturmann

Talk Outline

- AO at CHARA design scheme
- Before sky alignment
- Keeping the alignment during the night

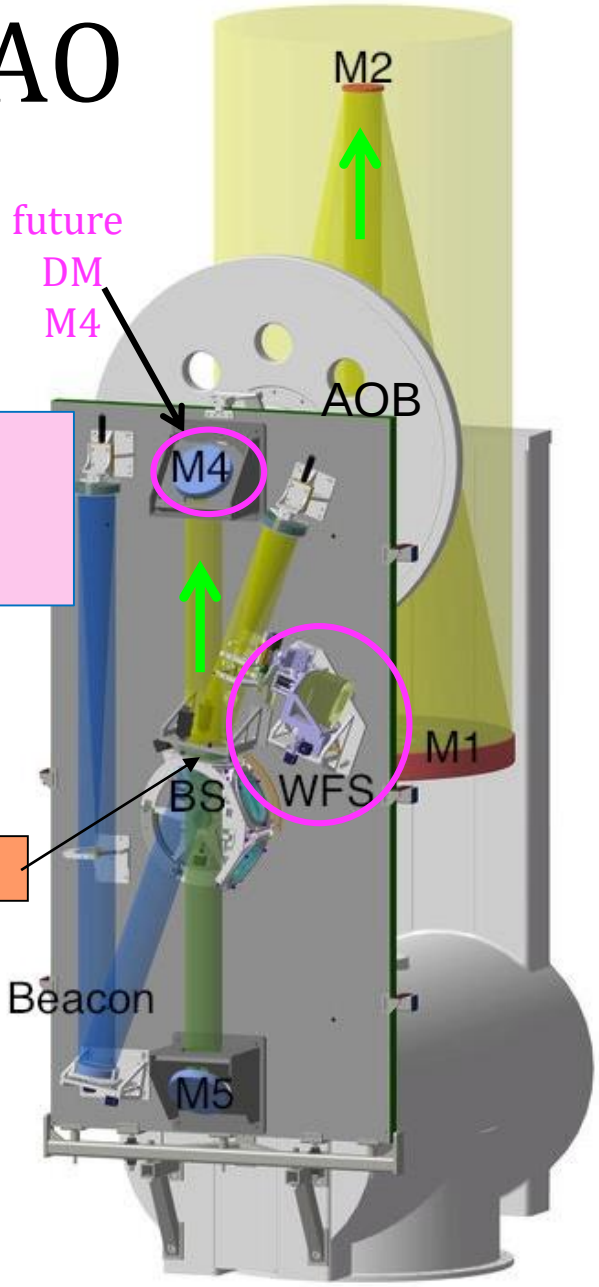
Lab and Telescope AO

Key components x 2

- Deformable Mirror (DM)
- Beam splitter → wave front sensor

Tel AO

- Fast to correct atmospheric effects with big DM
- Looks at stars



Lab and Telescope AO

Key components x 2

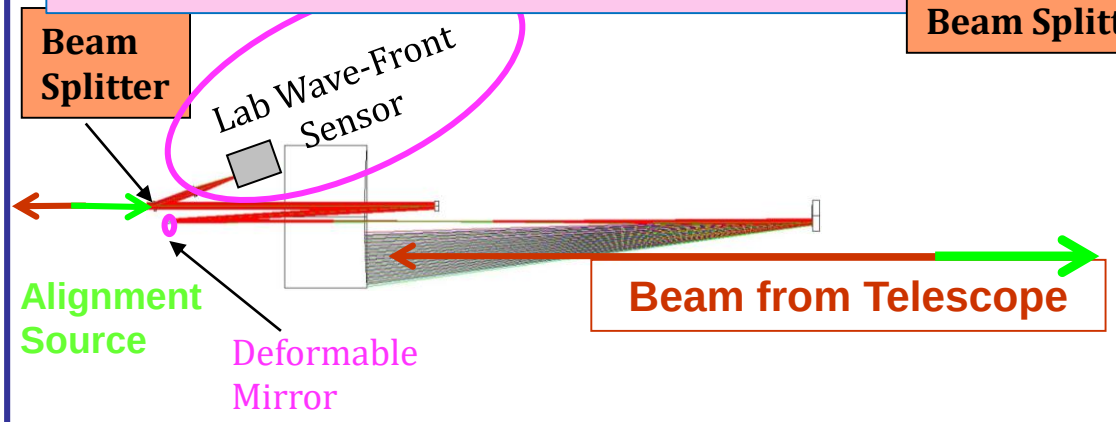
- Deformable Mirror (DM)
- Beam splitter → wave front sensor

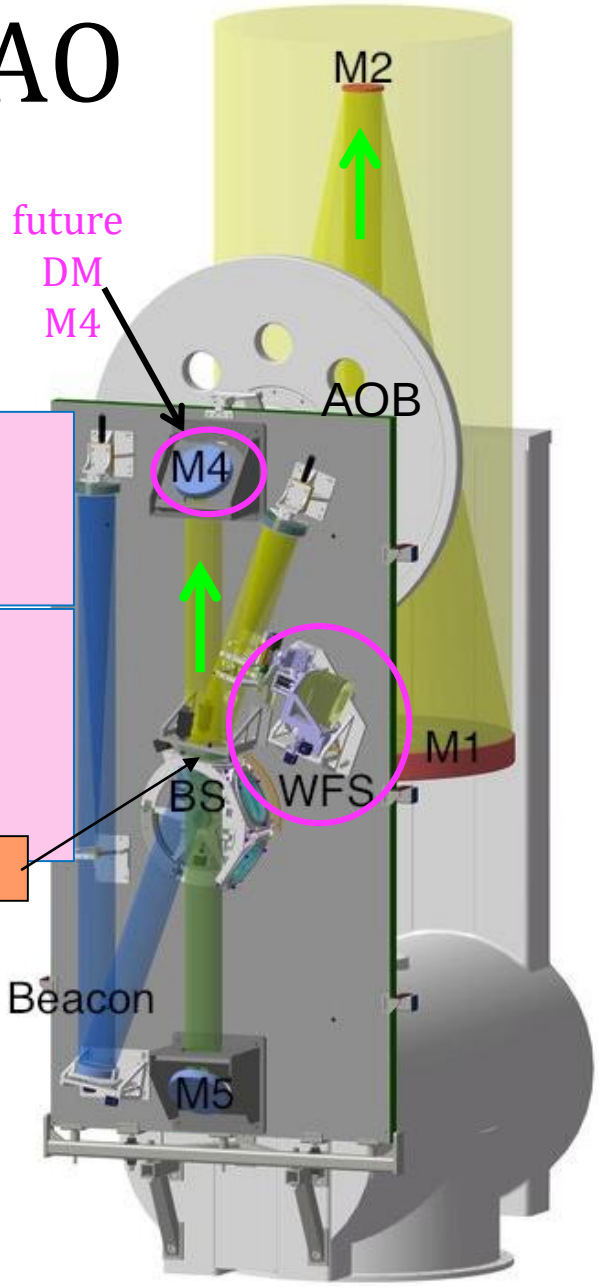
Tel AO

- Fast to correct atmospheric effects with big DM
- Looks at stars

Lab AO

- Slower to correct aberrations + seeing from AOB splitter to lab
- Looks at beacon (or bright stars)

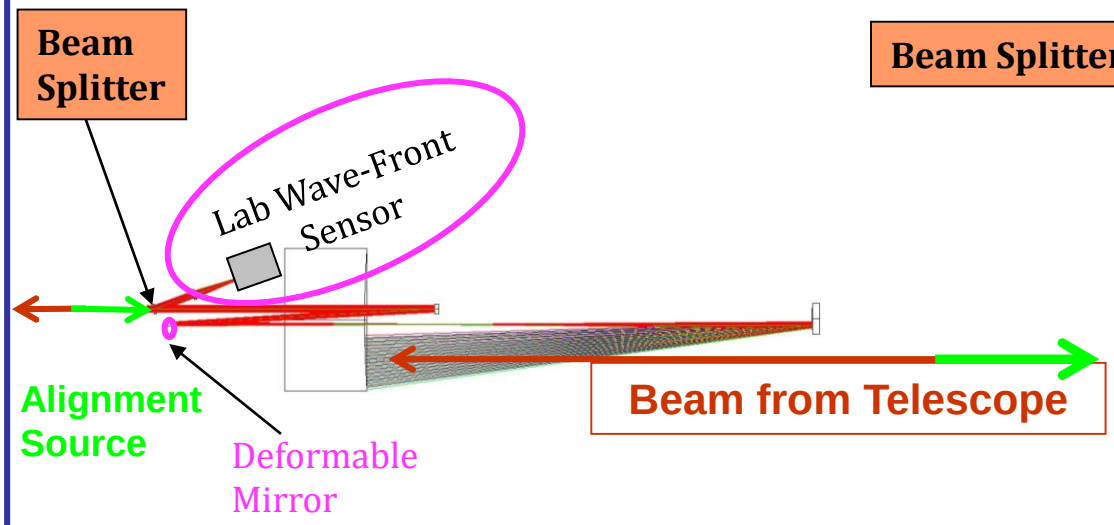


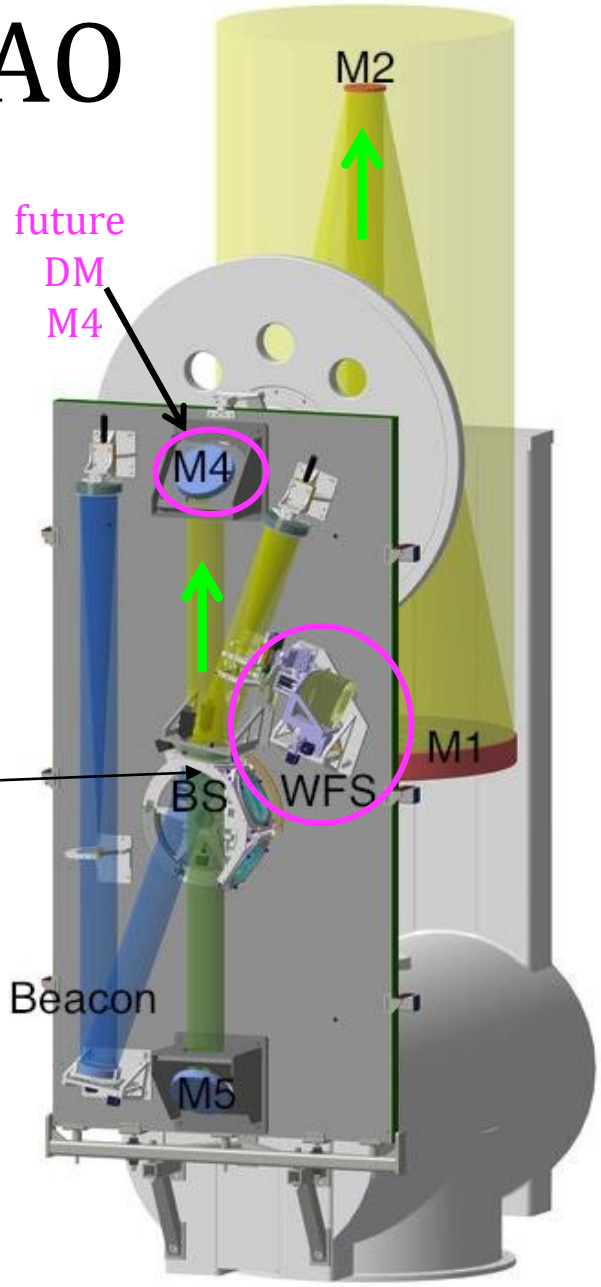


Lab and Telescope AO Progress

Key components
- Deformable Mirror (DM)
- Beam splitter → wave front sensor

To do
1. Installation, alignment the first time, calibration

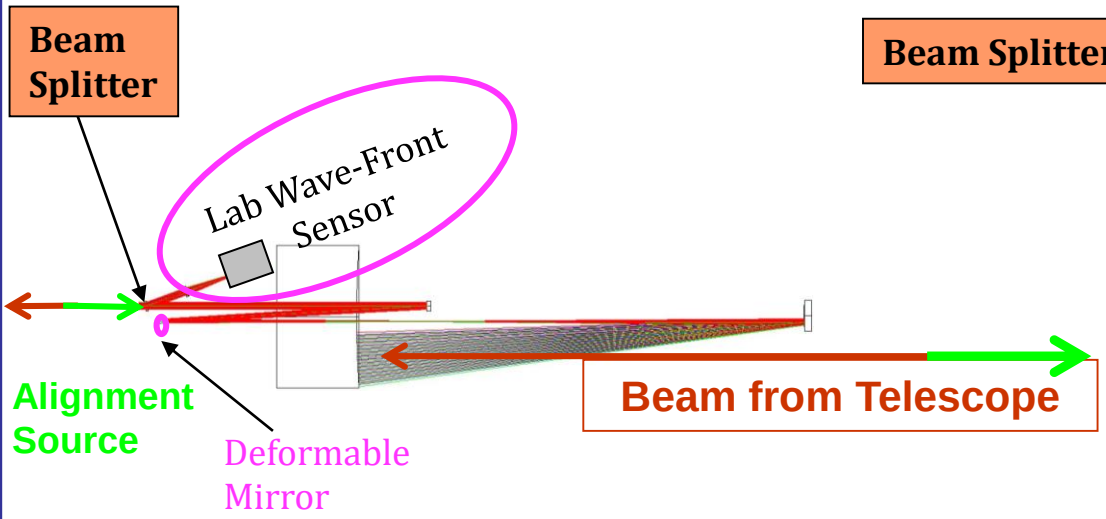


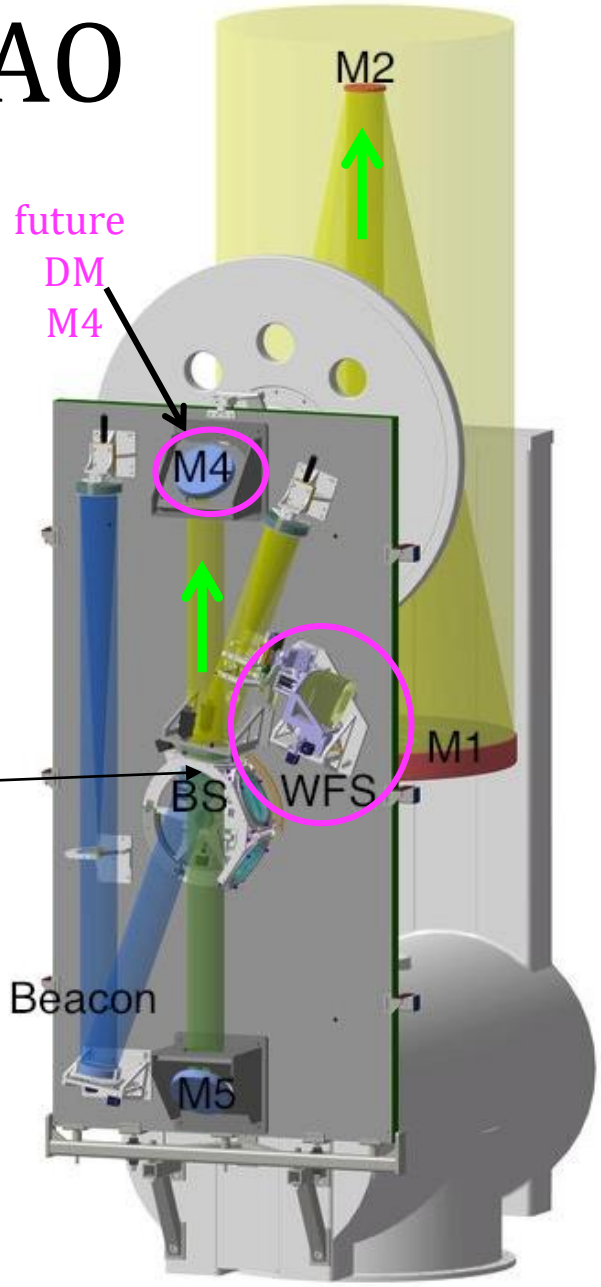


Lab and Telescope AO Operating

Key components
- Deformable Mirror (DM)
- Beam splitter → wave front sensor

To do
1. Installation, alignment the first time, calibration
2. Keep the alignment
   - Alignment checks for a night
   - Adjustments while tracking





Lab and Telescope AO Operating

Key components
- Deformable Mirror (DM)
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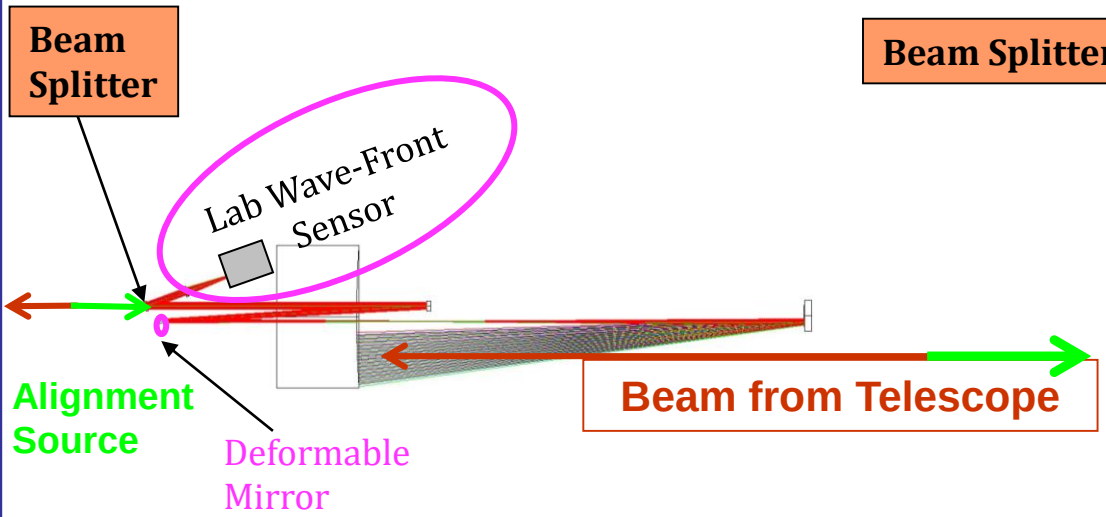
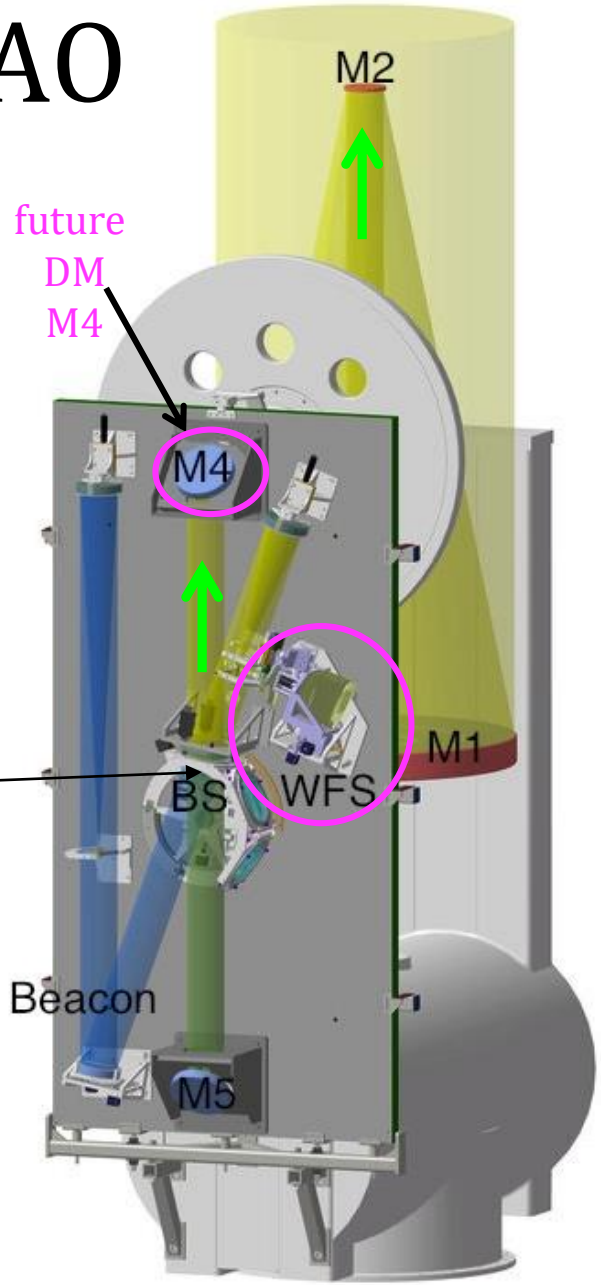
This talk





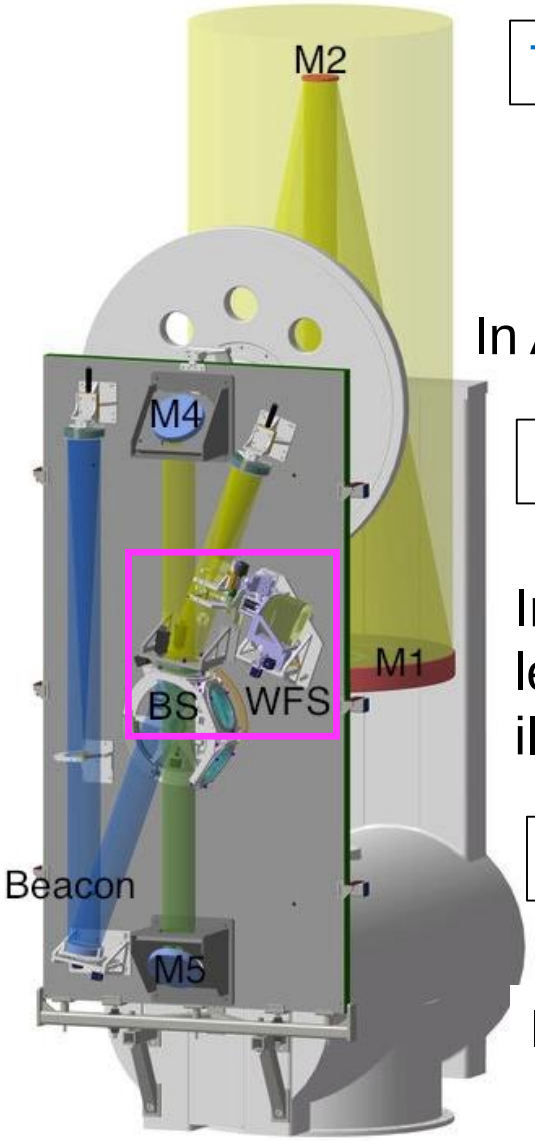
Alignment

- Goal: the star
  lands on the science detectors and
  stays there while tracking
- Tools: lab alignment sources, Finder, Acquisition, Tip/tilt
- Works if: alignment path = star path

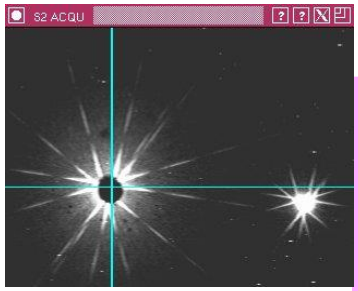
Alignment

- Goal: the star corrected by tel AO + lab AO lands on the science detectors and stays there while tracking
- Tools: lab alignment sources, Finder, Acquisition, Tip/tilt, AOB beacon, tel WFS, lab WFS
- Works if: alignment path = star path

Alignment Step 1: Beacon to telescope WFS



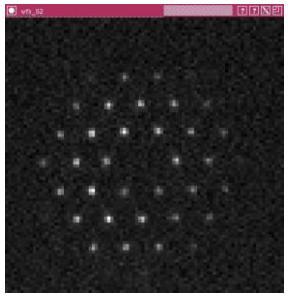
Tilt Bflat



In Acq overlap hole + beacon

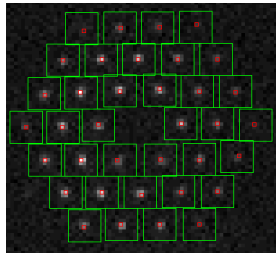
Tilt Bflat

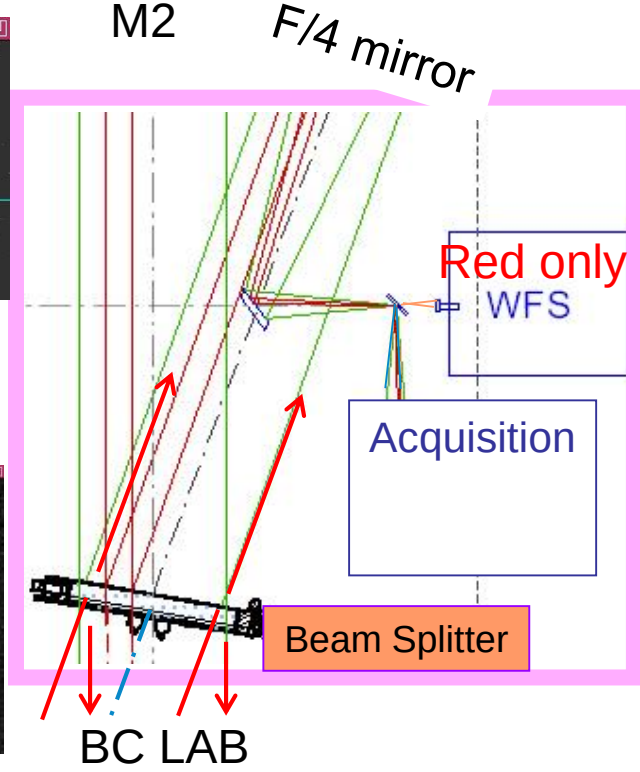
In WFS lenslets evenly illuminated



X-Y TWFS

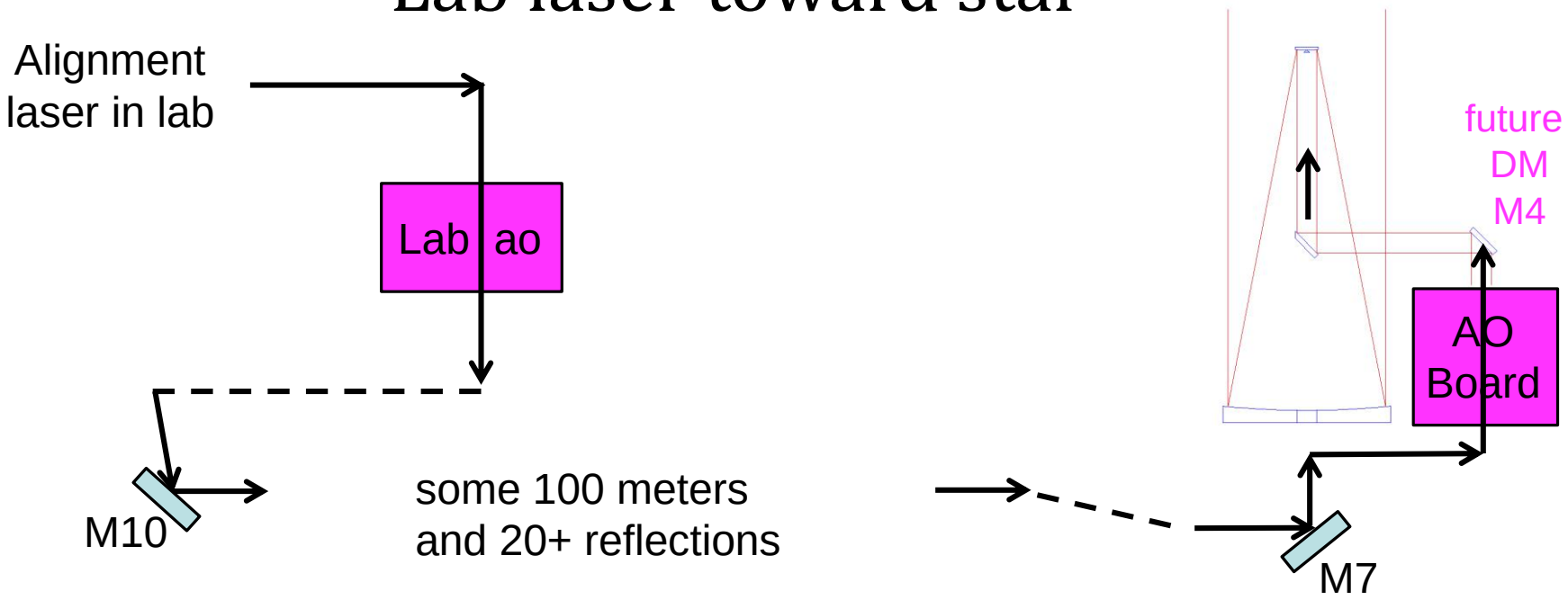
In TWFS boxes





Alignment Step 2:

Lab laser toward star



Alignment Step 2:

Lab laser toward star

Alignment laser in lab

Centered on several targets in the lab, including labao, delay line

Lab ao

M10

some 100 meters

future DM M4

AO Board

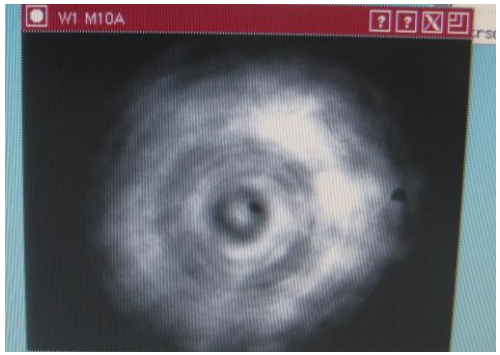
M7

Last adjustment in the lab is M10 to the center of M7→ laser beam crosses the azimuth axis at one point.

This screen is above M5.

M7 center is on AZ axis

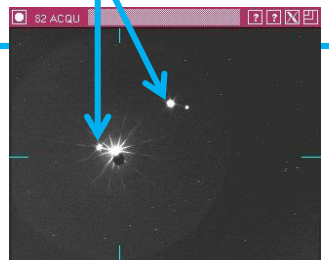
The centers of M7-M6-M5 overlap.

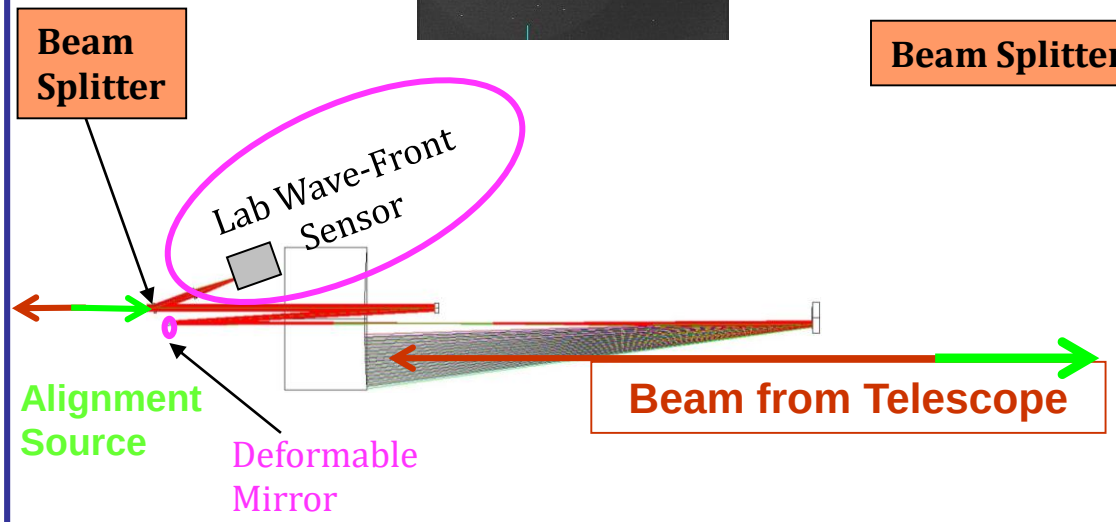


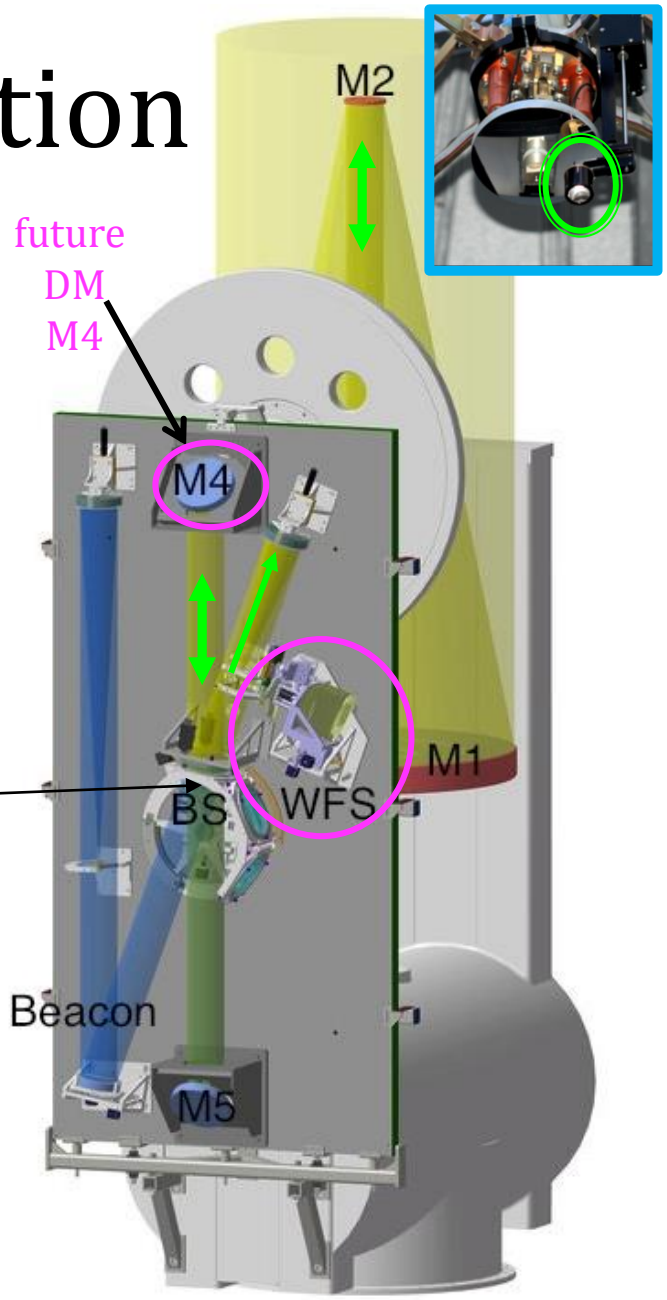
Lab Laser to Acqusition

Key components
- Deformable Mirror (DM)
- Beam splitter → wave front sensor

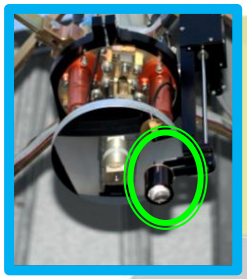
Retro returns the lab laser to be seen in acquisition



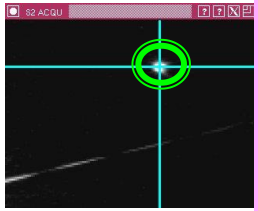


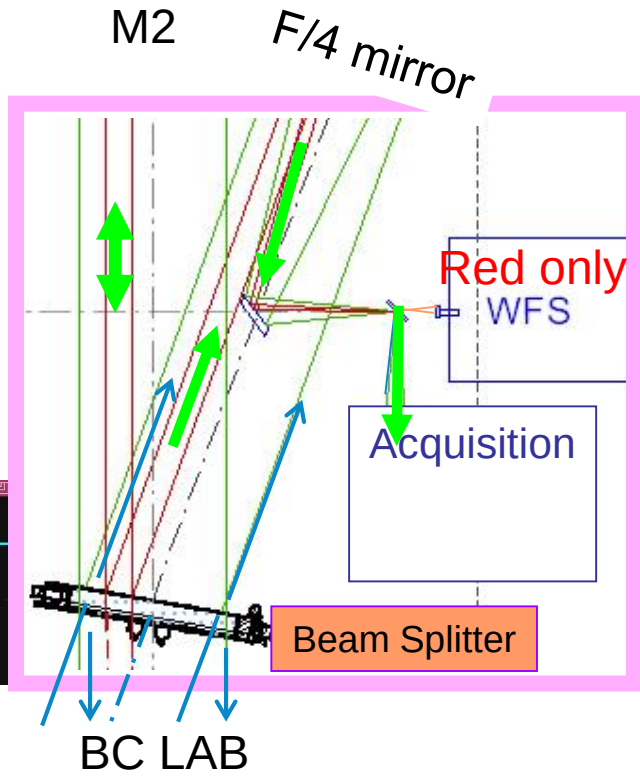


Alignment Step 3: Lab laser to AZ axis



Watch in Acq



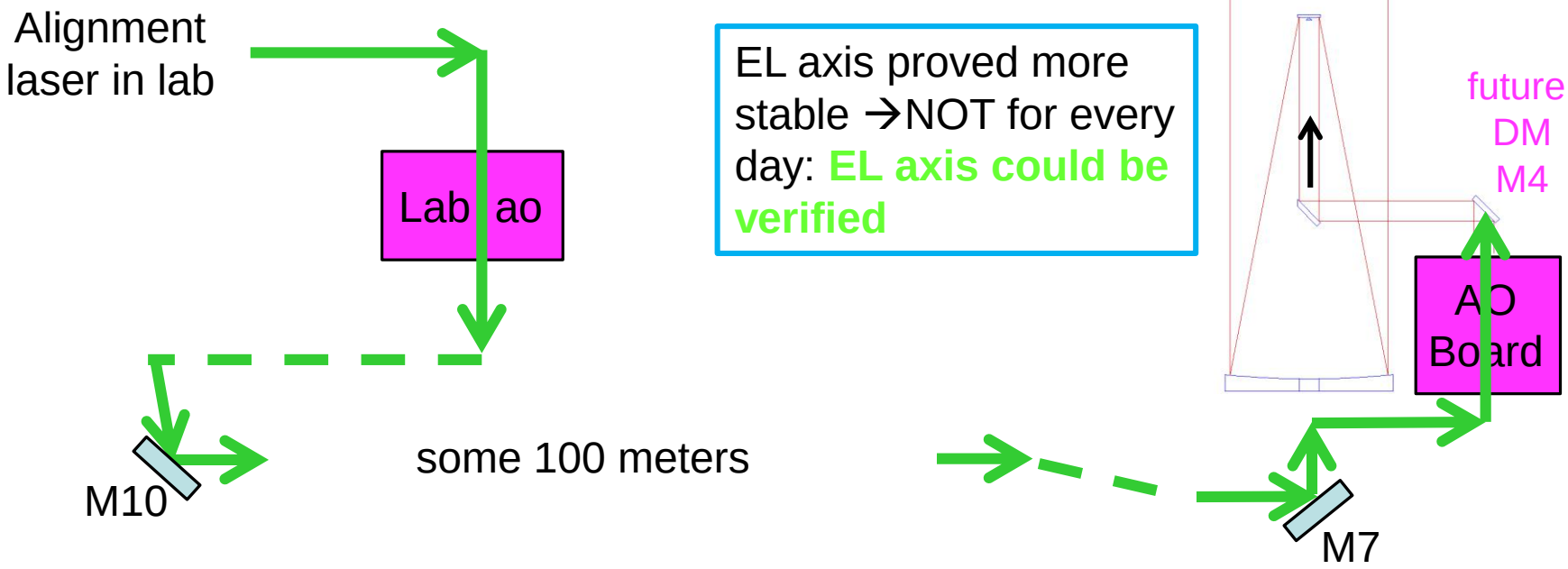


- Rotate telescope in AZ to find another point (P_{az2}) on the AZ axis
- Adjust M7 tilt [now remotely] to place laser to P_{az2} in the acq. field

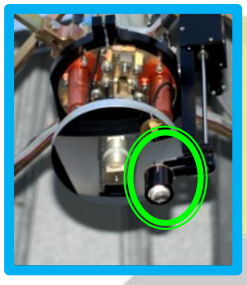
→laser on AZ axis

Alignment Step 3+:

Lab laser toward star

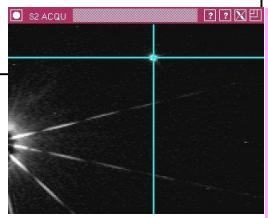


Alignment Step 4: Lab laser to beacon



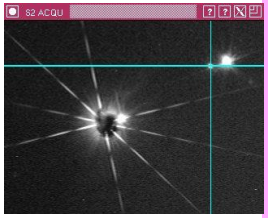
Set acq. ticks on secondary beacon spot

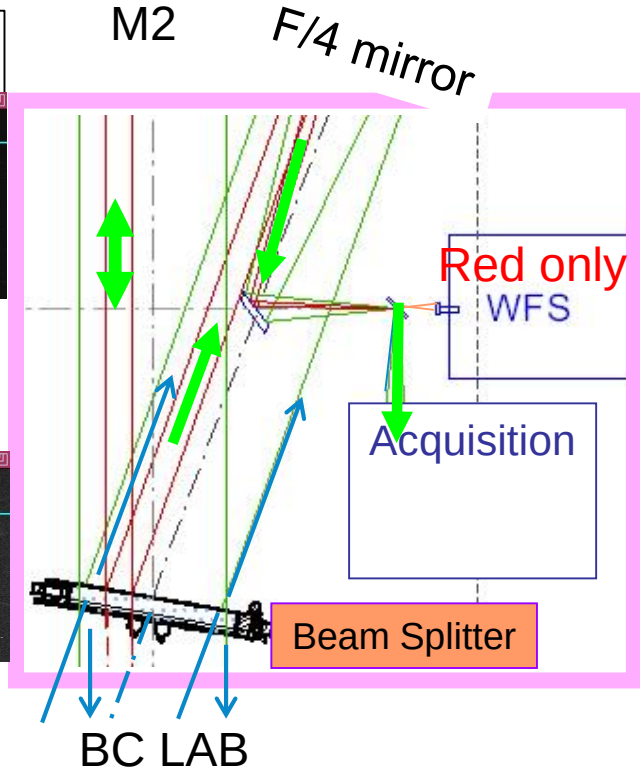
In Acq



Tilt AO beam spittter

In Acq place sec. laser on the mark
→laser ~|| beacon





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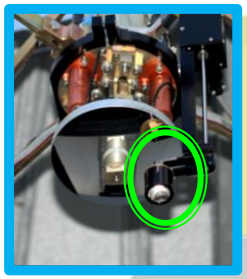

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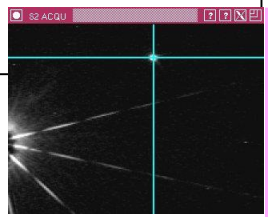

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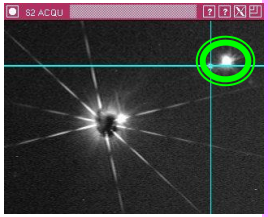

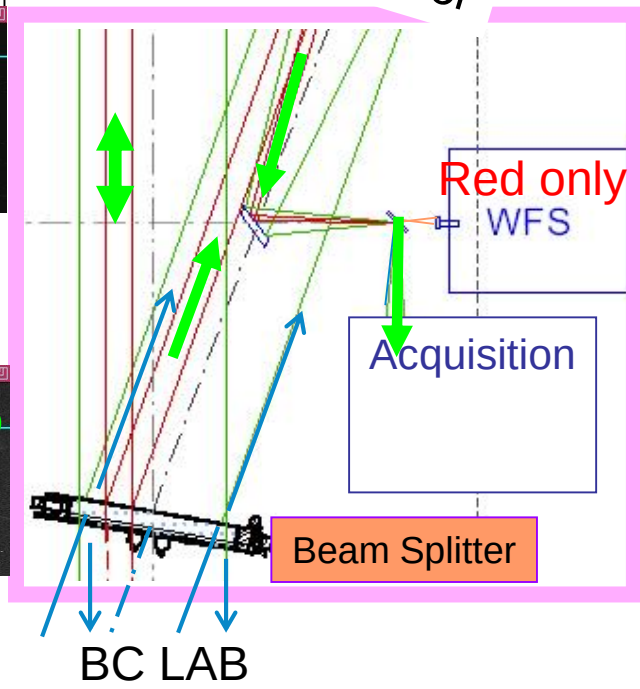

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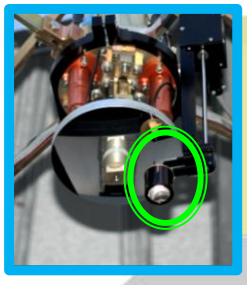
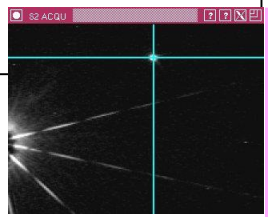


Set acq. ticks on secondary beacon spot

In Acq



Tilt AO beam spittter

In Acq place sec. laser on the mark
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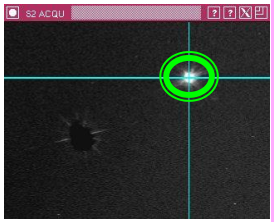
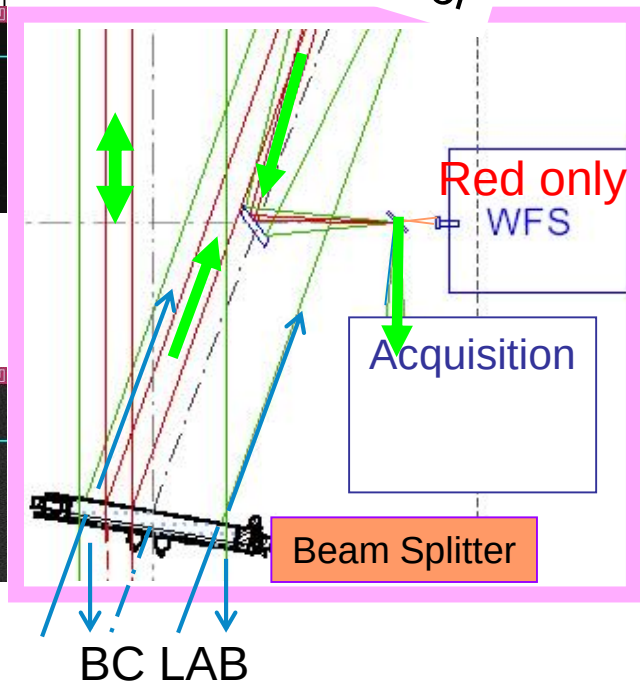
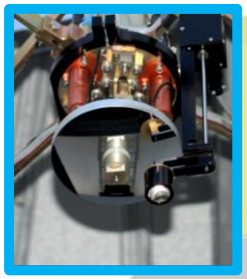


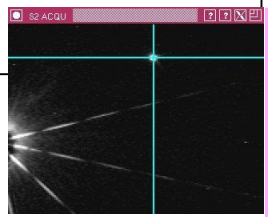


Enough precision to send beacon to labao

Alignment Step 5: Beacon to lab WFS



Set acq. ticks on secondary beacon spot



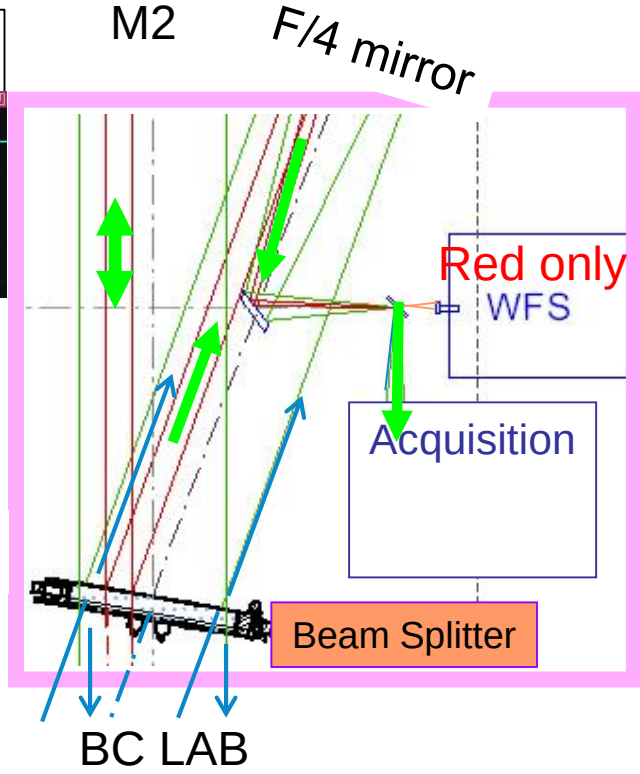
In Acq

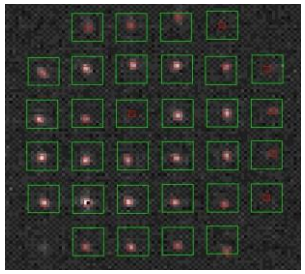
Tilt AOB beam spittter

→laser on AZ and ~|| beacon

Tilt AOB beam spittter

In labao match blue beacon spots with the boxes set with the internal blue source → laser on AZ and || beacon





Potential beam shear , can we avoid it ??

Alignment Step 6: Acquiring a star

The position of the laser spots with respect to the hole in the mirror is not critical as long as neither WFS is used.

When using telescope and/or lab WFS

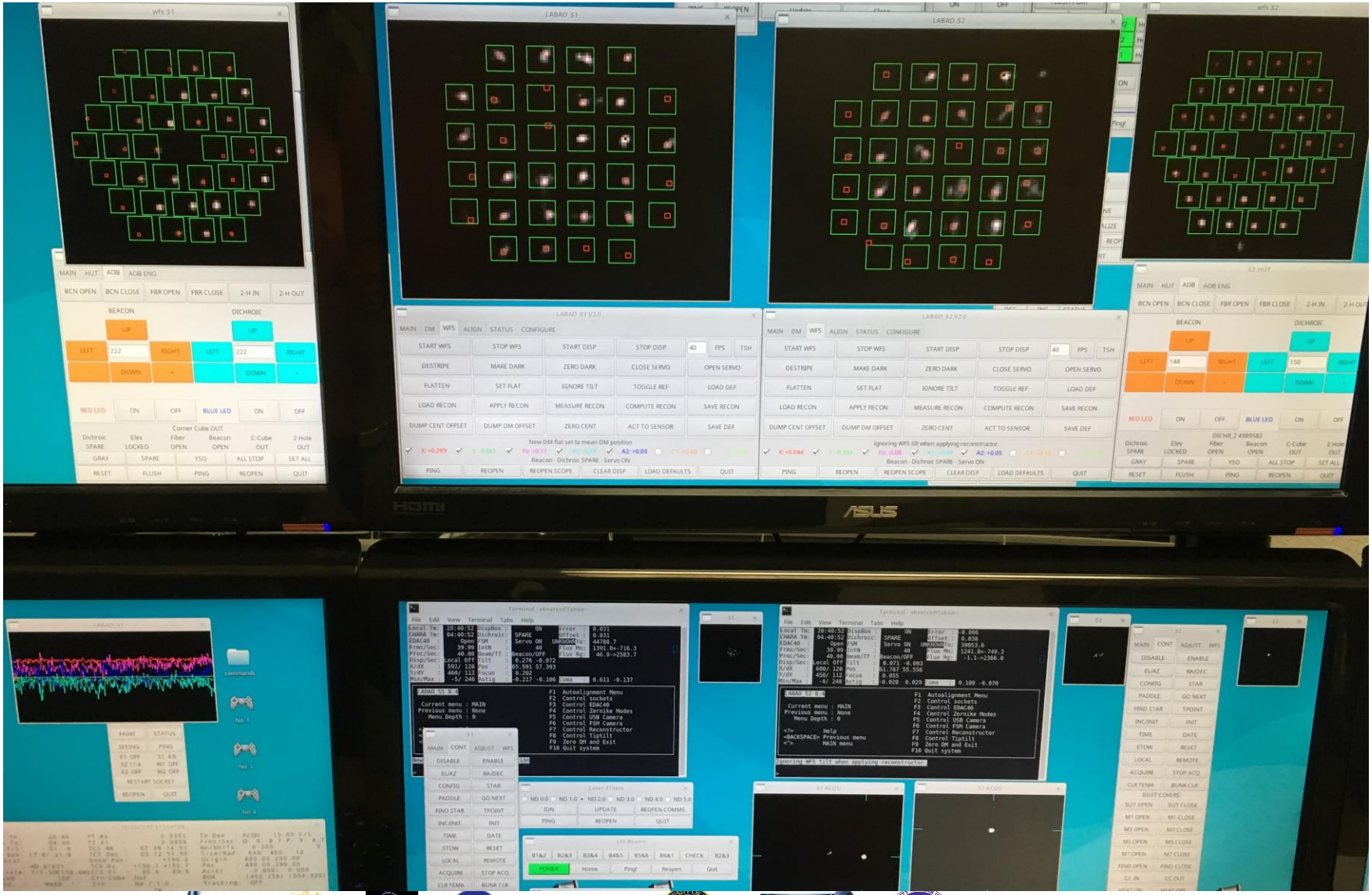
- Adjust tracking ticks to secondary alignment laser spot. (Other spot is in the hole.)
- Use “GET” or “GRAB” function and make sure the corresponding star image is selected.

  → routine will guide telescope pointing to place the star to the ticks

  →Tel WFS and/or tip/tilt detector in the lab sees the star and tip/tilt servo takes over to lock the star

First Test with 2 Telescopes:

Procyon in 2 Telescope and 2 Lab WF-Sensors (2017-03-09)

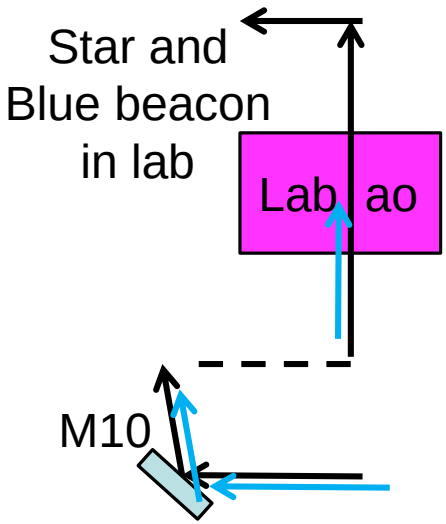


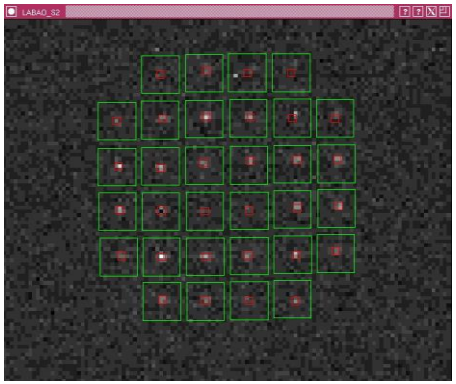
Tracking a Star

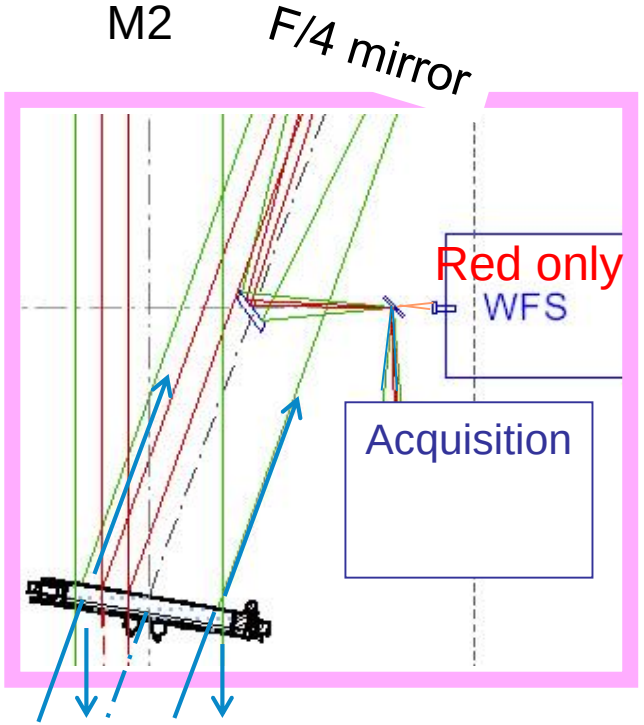
Current working version

Tilt beacon flat → Compensate AOB drift to keep beacon in tel-wfs, in turn lab-wfs

Tilt M7 → Compensate Coude wobble to keep beacon in labao wfs.







Light pipes

Tilt M10 ? +M7? → Compensate beam shear = center beacon in labao wfs.

M7

Steps for minimizing beam shear are to be determined

Outlook

- Need more on-sky experience
- Subsystems need to be characterized
- Most routines eventually will be automated