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Development of Omni-SLR System: (1) Optical subsystem

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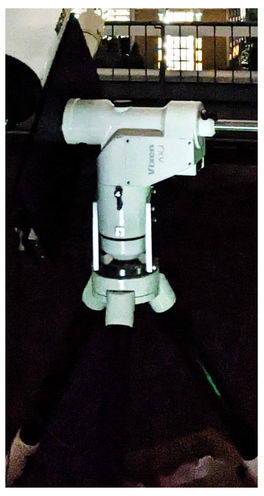
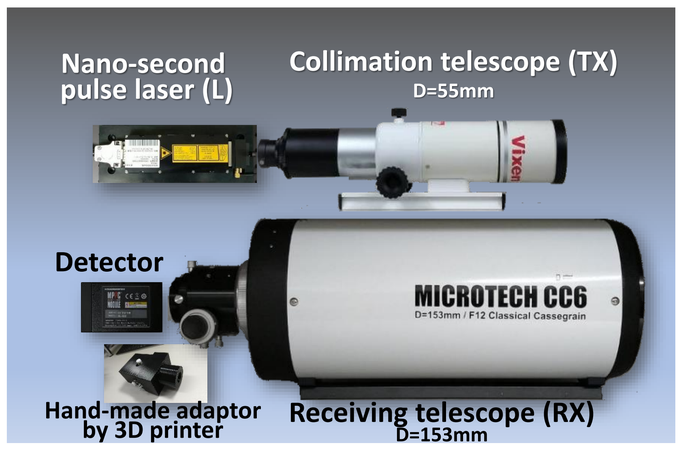
Optical subsystem on the modified AXJ mount

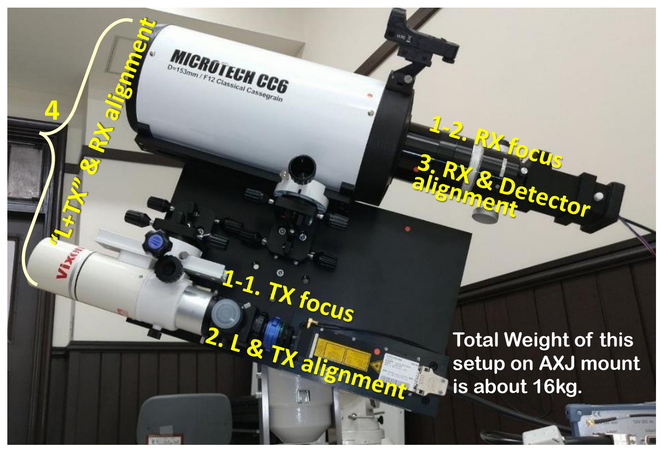


AXJ equatorial mount (VIXEN) modified to Alt-Az mount



Basic configuration of Omni-SLR optical subsystem：Nano-second pulse laser beam is collimated by small refractor (TX) to 10 arc.sec. divergence angle. Returned pulse is collected by receiving telescope (RX) and focused to the very small detector aperture (50 ~100 μm size).

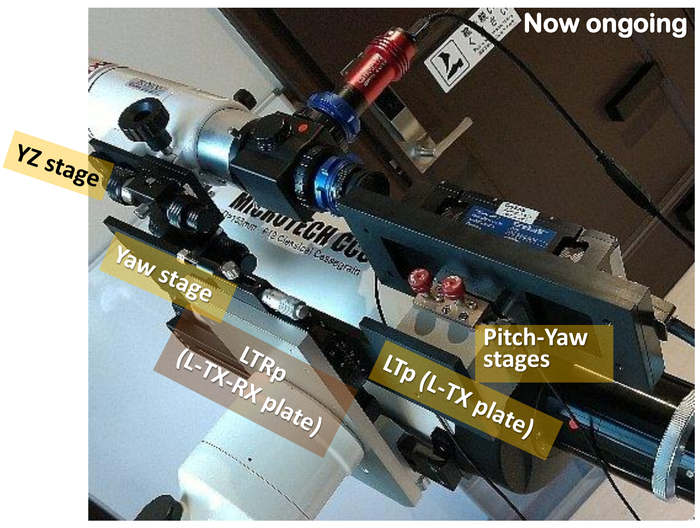
Breadboard setup (1)



1. TX and RX focus using star
2. Optical axis of L and TX is aligned within half beam div. (≲360").
3. Detector's window (50~100 μm size) is placed at RX focus.
4. "L+TX" and RX is aligned with the accuracy less than 10".

Breadboard setup (2)

5. Arrange and assemble several stages and plates. Total **weight must be less than 22kg** due to the limit of AXJ mount.



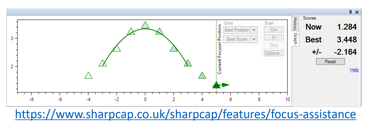
TX and RX focusing with star, Alignment between "L & TX" then 'L+TX' and RX

1. Auto Focusing of TX and RX [in preparation]


Bahtinov Mask

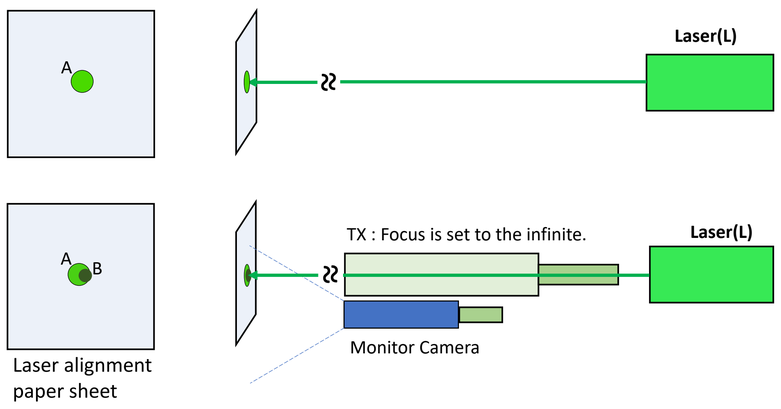

Electric auto focuser
https://astronomy-imaging-camera.com/product/eaf-5v

Star image through Bahtinov masked telescope


https://www.sharpcap.co.uk/sharpcap/features/focus-assistance

No touch focusing of TX and RX by SharpCap or other software with Bahtinov mask and auto-focuser.

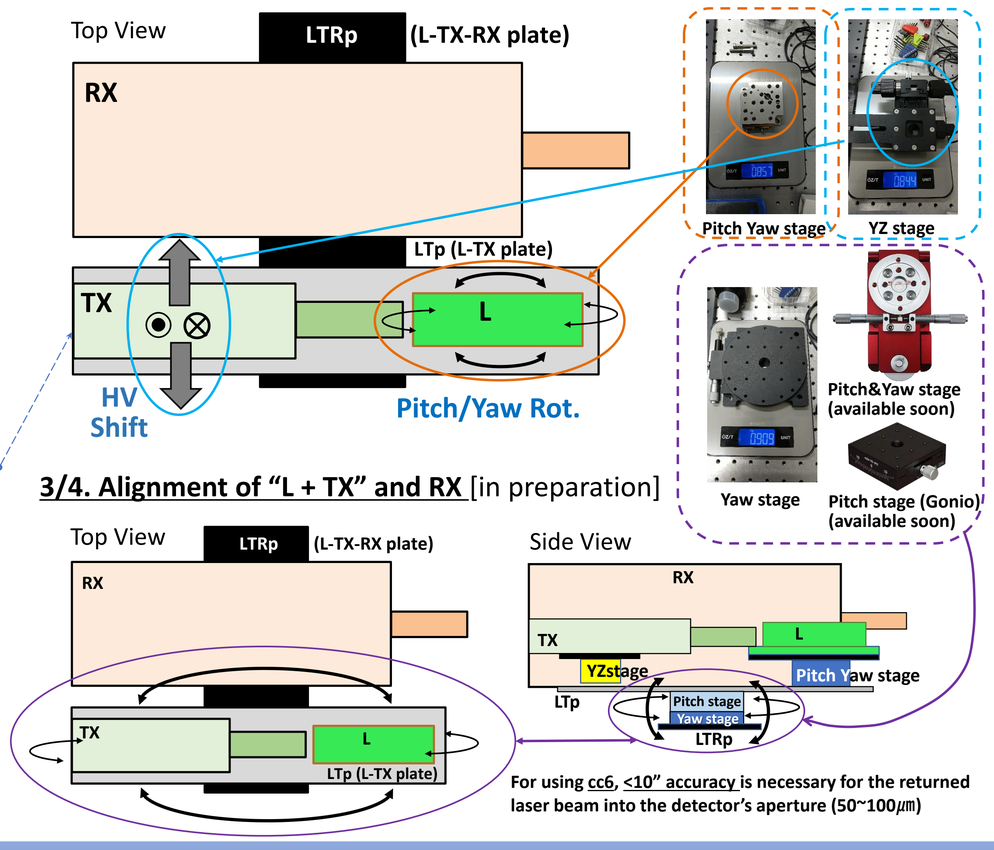
2. Alignment of Laser(L) and Collimation telescope(TX) [under investigation]



Laser alignment paper sheet

- Capture image A and B on the alignment sheet by Monitor camera mounted on the LTp (L-TX plate) or another place
- Align the center of A and B using PY stage and YZ stage carrying L and TX.

- Beam divergence Ω=3.5mrad ~720"(FDSS532-Q2; full cone)
- Alignment error angle b/w L and TX optical axis $\Delta\theta_{L\text{-}TX}$ must be < $\Delta\theta_{max}$= Ω/2 ~ 360"(6')
- TX magnification : M & target distance : d → laser footprint shifts : $\Delta s = d*\Delta\theta_{L\text{-}TX}/M$
- (Ex.) M=10 and d=5m → Δs must be < 0.875㎜ → L/TX alignment (upper right figure).
- (Ex.) Diameter of A =17.5㎜(←Ω*d), B=3.13㎜ $\left(\leftarrow \sqrt{\{d\cdot(\Omega/M)\}^2+(0.26\text{㎜}\cdot M)^2}\right)$

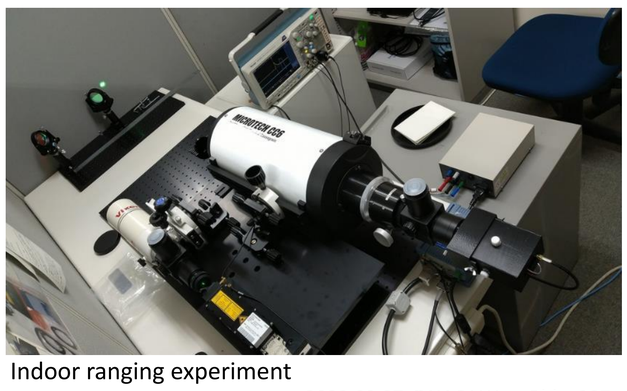


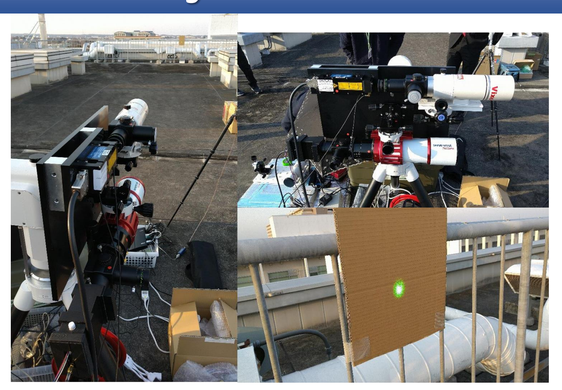
3/4. Alignment of "L + TX" and RX [in preparation]

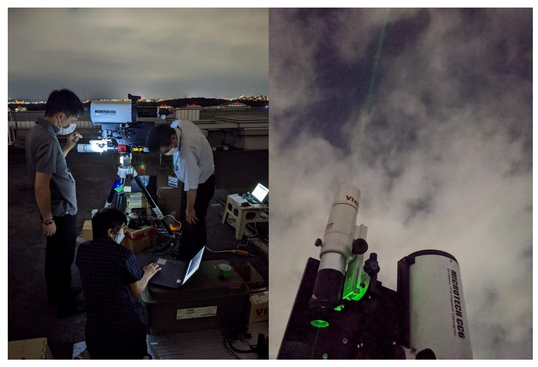
For using cc6, <10" accuracy is necessary for the returned laser beam into the detector's aperture (50~100μm)

Recent Development History in 2022


The first laser shot experiment to the sky through TX 2022.01.04 @NPRI rooftop

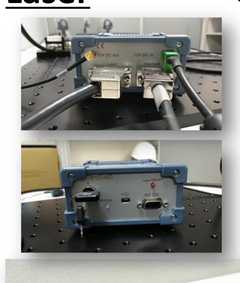

Indoor ranging experiment 2022.02.07 @NAOJ West Bldg. 207


Short ranging (10~20m) experiment - detection of scattered laser signal – [RX is 7.6cm aperture.]. 2022.03.10 @NPRI rooftop


Noise detection experiment w/o ranging [RX is 15.3cm aperture (cc6).]. 2022.09.08 @NPRI rooftop

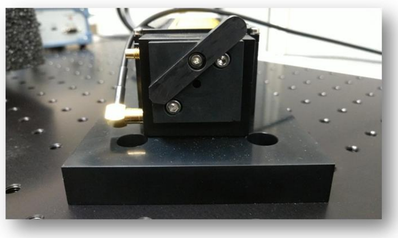
Components : Laser(L) / Collimation telescope (TX)/ Receiving telescope (RX) / Detectors (D)

Laser FDSS532-Q2 (CryLas)



Wavelength : 532nm
Pulse width : 1.3nsec. Pulse energy : 6μJ
Repetition rate : 10kHz
Beam diameter : 0.26±0.05㎜
Beam divergence : 3.5mrad (full cone)
Dimension (main body) : 147㎜×54㎜×39㎜
Weight : 1528g


Hand controller



Collimation telescope (TX) FL55SS (VIXEN)

Aperture 55㎜
Focal length 300㎜ Eyepiece FL= 3~6㎜
Magnification = 300/6~300/3 = 50~100
→Beam div. @TX aperture = 7.2～14.4 arc. Sec. (~10")
→Beam diam. @TX aperture = 13~26㎜ (＜55㎜)

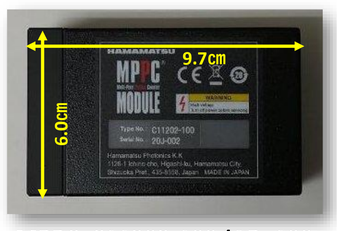
Receiving telescope (RX)[1] CC6 (Microtec)

Aperture : 153㎜
Type : Classical Cassegrain
FL : 1836㎜
Weight : 5.3kg

Receiving telescope (RX)[2] VMC260L(VIXEN)

Aperture : 260㎜
Type : Catadioptoric
FL : 3000㎜
Weight : 12kg

Detector(D)[1]



MPPC C11202-100 (AP=100μm)
Hamamatsu Photonics K. K.

Detector(D)[2]

μPMT H12406-01 (AP=1×3㎜)
Hamamatsu Photonics K. K.

Detector(D)[3]

id100-50-STD (AP=50μm)
ID Quantique

Detector(D)[4]

SPD-100-CTC (AP=100μm)
Micro Photon Devices

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