

A03k : Major upgrade of A0188

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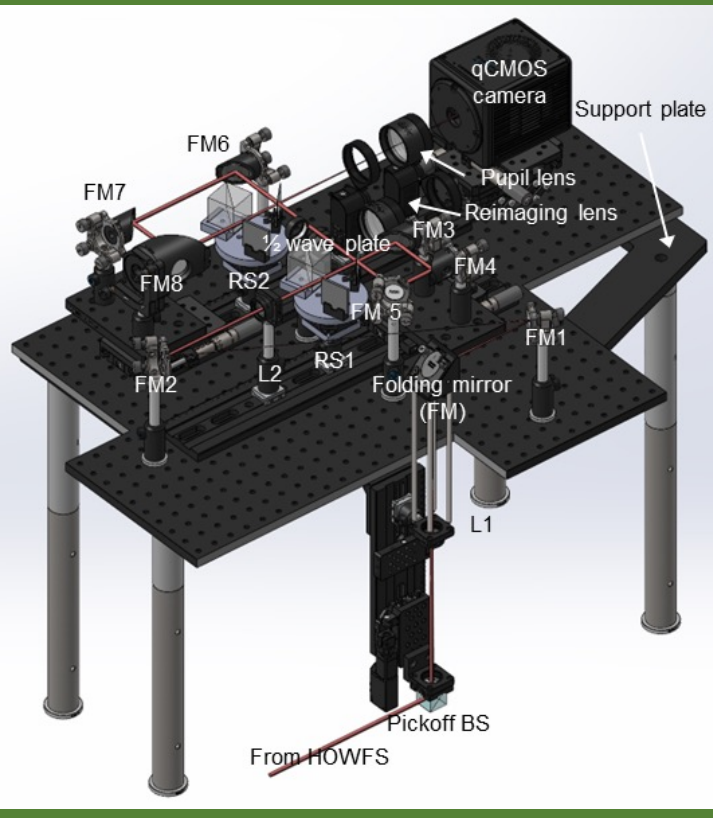
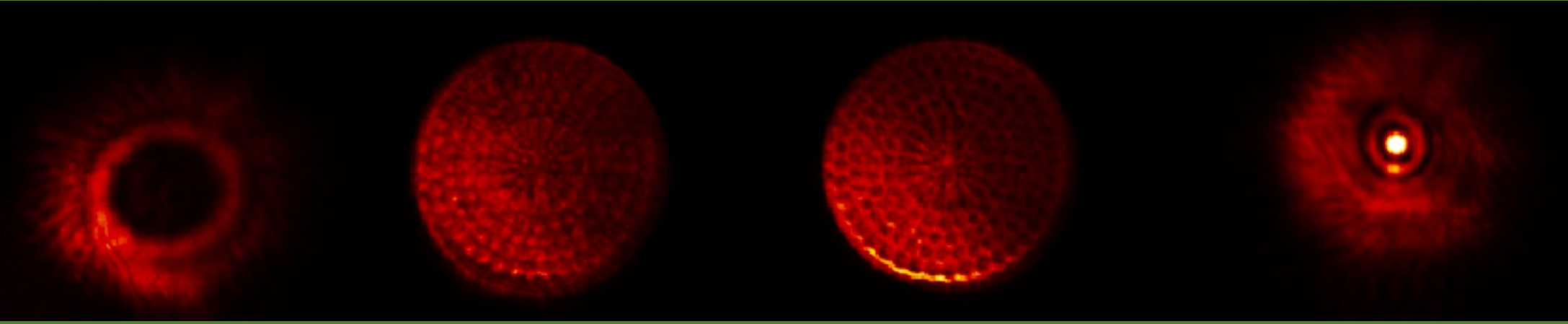
Upgrade from A0188 to A03k

A0188 is the 2nd-generation facility AO system operated at the Nasmyth IR (NsIR) platform, supporting two AO modes (NGS mode since 2008 and LGS mode since 2011) and achieving a **diffraction-limited performance in the NIR wavelength** with 188-elements WFS and DM.

A03K is an upgrade project of A0188 to improve the A0188 performance up to **the extremely good performance in NIR** and **the diffraction-limited performance in visible** by increasing the number of elements of DM and WFS from 188 to **~3000**. The upgrade includes four major developments: **(1) DM upgrade**, **(2) visible WFS upgrade**, **(3) new NIR WFS development**, and **(4) upgrade of the real-time control system**. A03k is a main pillar in the NsIR upgrade projects.

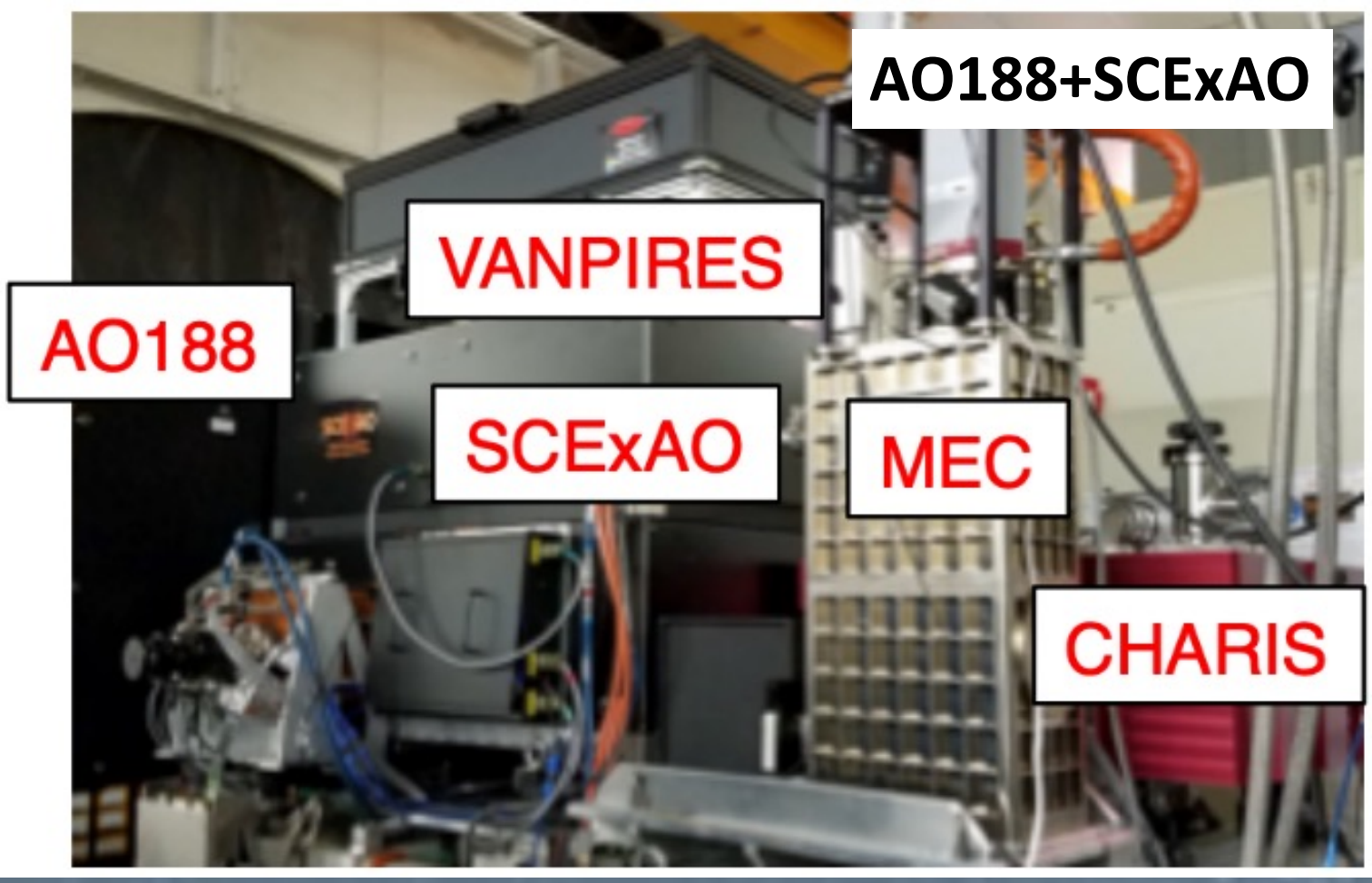
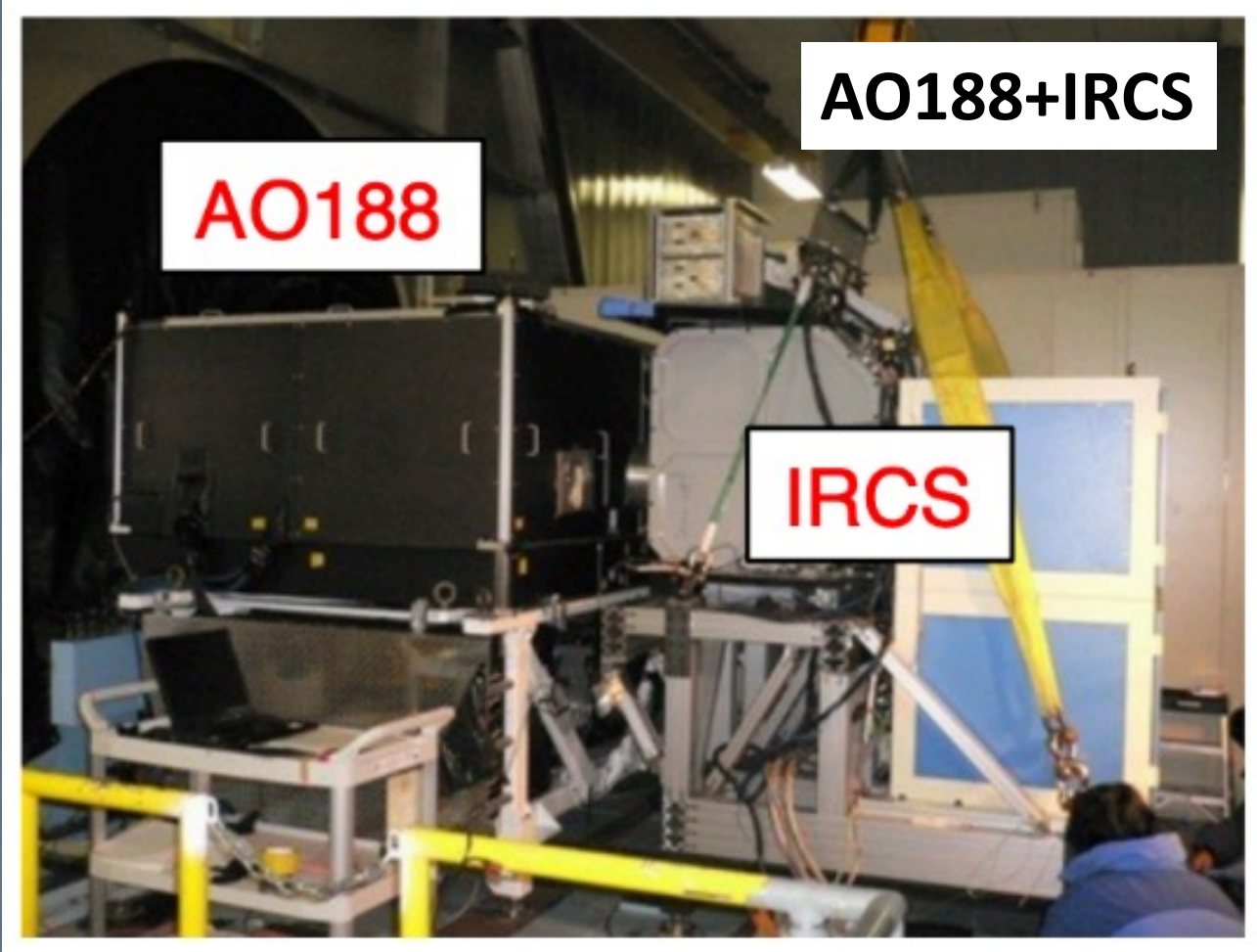
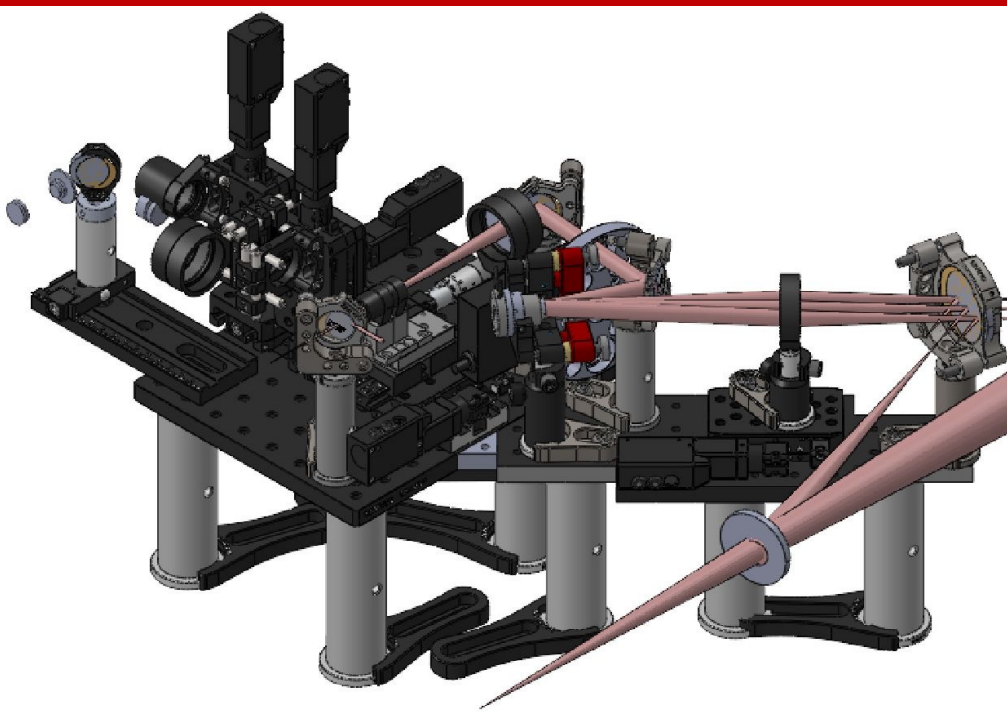
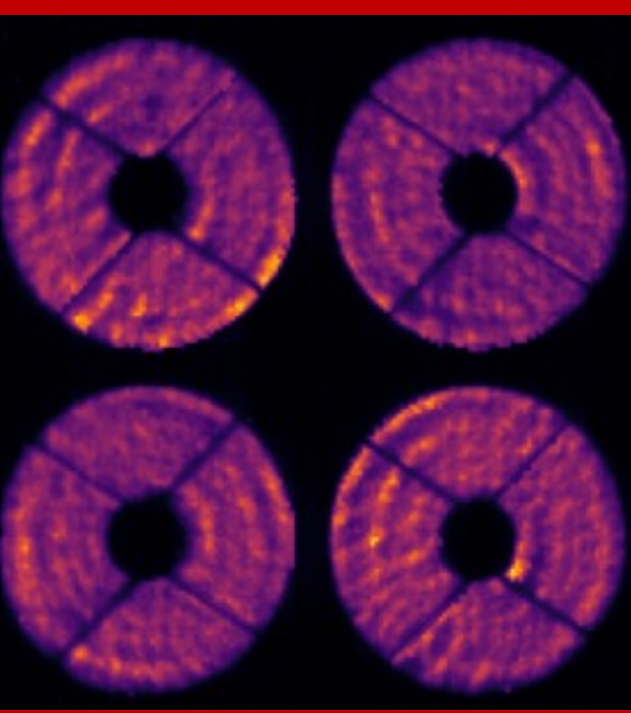
(2) non-Linear Curvature WFS (nLCWFS) [Kyohoon Ahn]

New visible curvature WFS compatible with the new 3k DM. A future replacement of current visible WFS. (See. P12 by Kyohoon Ahn)

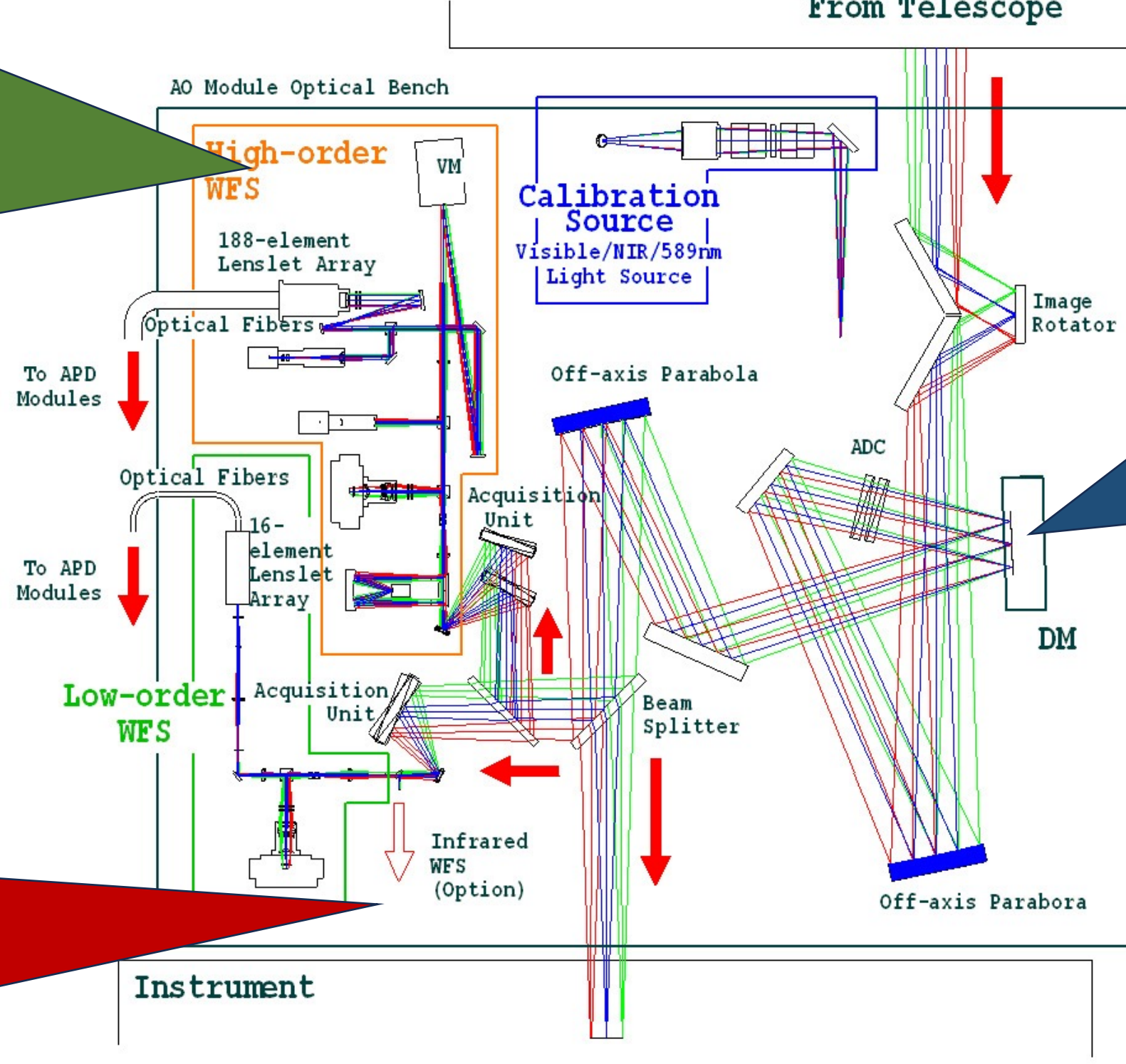


(3) Near-InfraRed (NIR) WFS [Shogo Nishiyama and Julien Lozi]

Pyramid WFS compatible with the new 3k DM, performing wavefront sensing in NIR wavelength. Already added to the A0188 optical bench. (See talk by Julien Lozi)



A0188/A03k Optical design



(1) 3k DM [Julien Lozi]

64x64 DM with 3228 effective actuators in the pupil developed by ALPAO, to replace with current the 188-element bimorph DM.



(4) New RTS system [Yoshito Ono, Vincent Deo, Olivier Guyon]

New real-time control system for A0188/A03k based on CACAO software, allowing integrated control among the AO systems at NsIR (A03k, SCExAO, ULTIMATE-START).

AO capability and performance

With A03k, three AO modes will be available. Additional Laser Tomography AO (LTAO) mode will be also implemented as the upgrade of the A0188 LGS mode (**ULTIMATE-START**, see P14 by M. Akiyama). A03k / LTAO are expected to provide

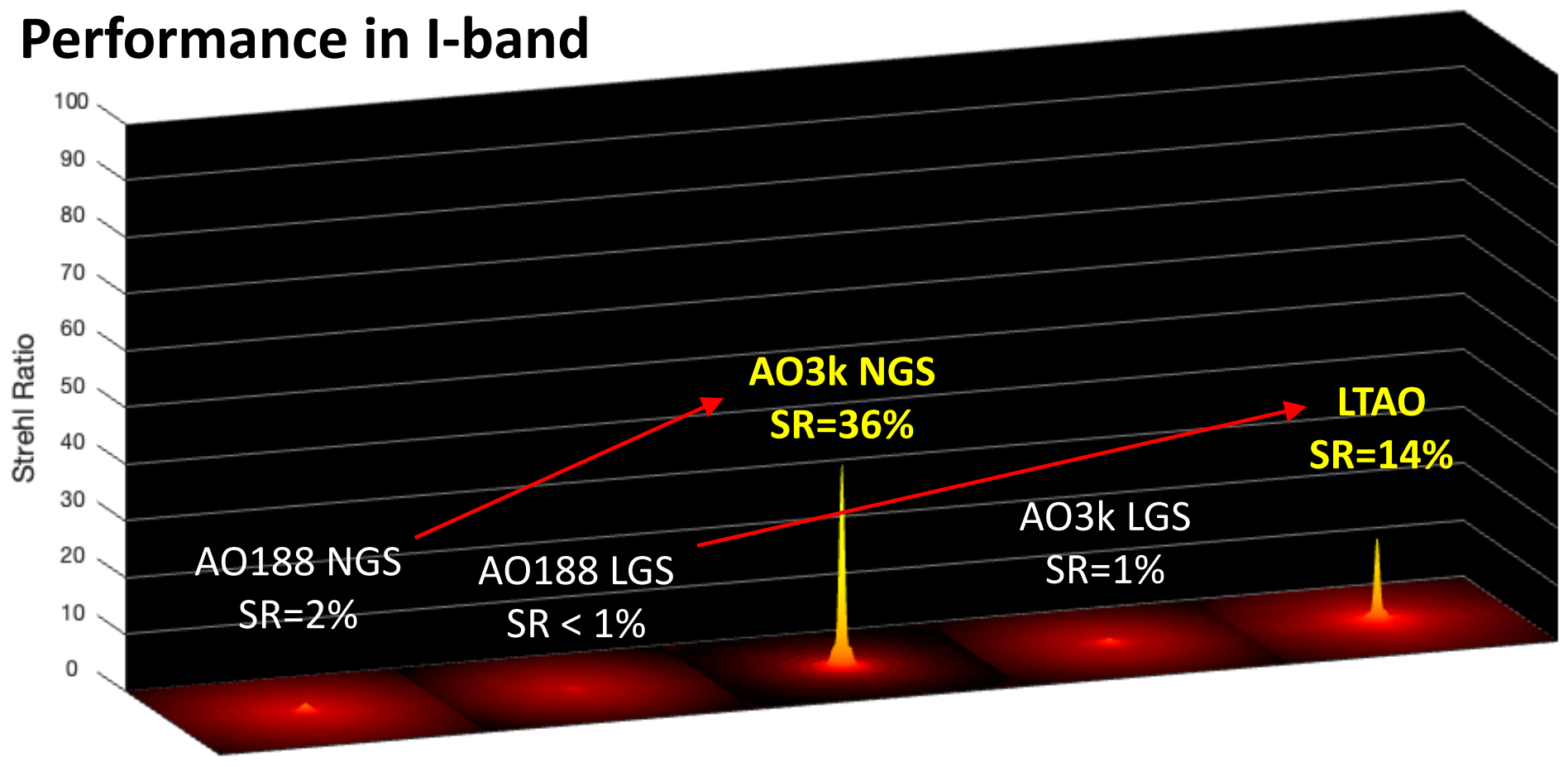
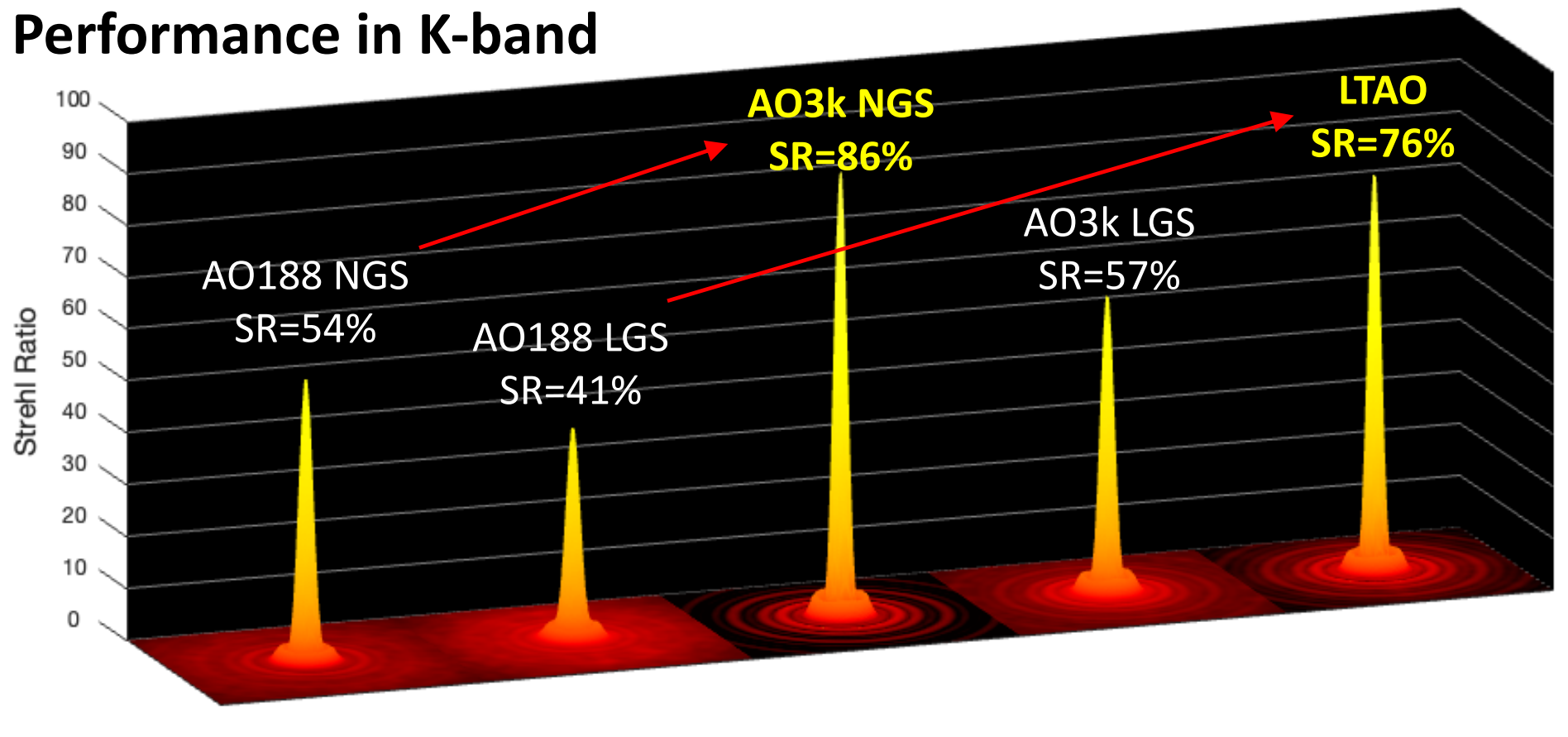
- **the extremely good performance in NIR, less speckle around PSF and good for high-contrast imaging**
- **the diffraction-limited performance in visible, significant improvement from A0188**

Also, NIR WFS will provide better sky-coverage especially in Galactic Center and dust-obscured regions by performing the wavefront measurement in NIR wavelength. Some of the AO modes is mechanically incompatible with IRD. The IRD/SCExAO observation with the LGS-based modes is under development/verification.

AO mode	Guide-star (s)		WFS	DM	Compatibility with the NsIR instruments			
	Type	(Tip/Tilt) NGS patrol field diameter			IRCS	IRD	SCExAO + modules	New instrument behind NBS
NGS-based modes								
AO3k Visible	NGS (Vis)	2 arcmin	nICWFS	ALPAO DM3228	○	○	○	○
AO3k NIR	NGS (NIR)	~20 arcsec	NIR WFS		○	×	○	○
LGS-based modes								
AO3k LGS	Single LGS Tip/Tilt NGS	2.7 arcmin	nICWFS LOWFS	ALPAO DM3228	○	TBD	TBD	○
LTAO	4 LGSs Tip/Tilt NGS	2.7 arcmin	LTAO WFS LOWFS		○	×	TBD	○

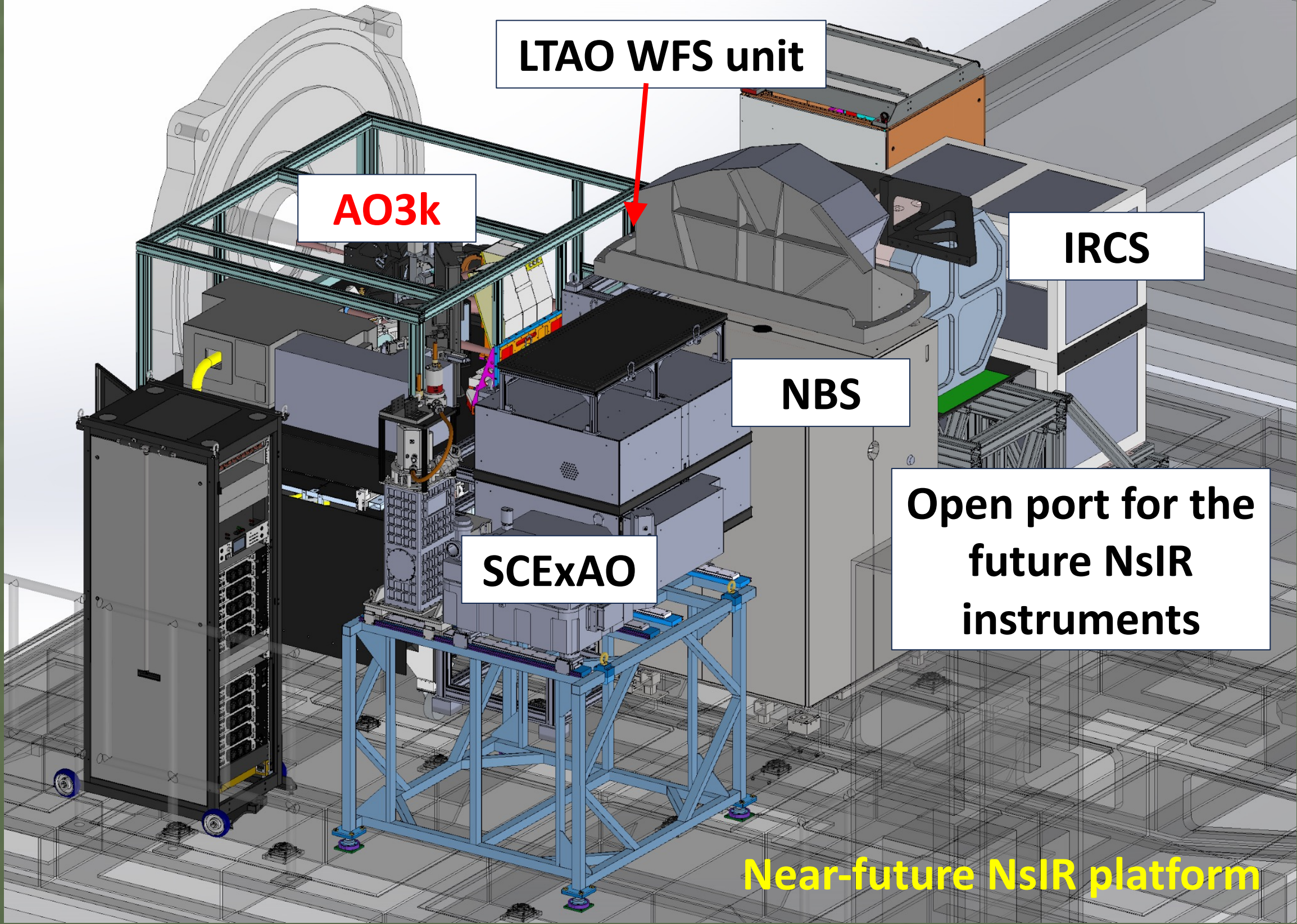
Simulated Performance

Assuming an optimal situation with on-axis bright guide star at the median seeing condition.



Schedule of NsIR upgrade

The several upgrade projects, including A03k, is planned in the next ~5 years for the NsIR platform to improve the AO performance and the operational capability/flexibility. The high-performance AO correction by A03k will be provided to all NsIR instruments through the Nasmyth Beam Switcher (NBS, see P03 by Takashi Hattori), which is the automatic beam switching system to be installed behind A0188. Also, there are several candidate of new PI-type instruments for NsIR platform.



(Tentative) timeline of the NsIR upgrade projects

This is possible schedule proposed by the development team. The current status of each project is

- **3k DM** : ALPAO DM will be delivered in this month. The test setup is ready in Hilo.
- **nLCWFS** : The testing/calibration at NsIR is undergone. Commissioning start will be in S24A.
- **NIR WFS** : Opened for the science observation from S24A with A0188. The relocation is required in the future.
- **ULTIMATE-START** : LTAO WFS is under assembling/testing in Hilo. Design of the 4-beam laser system is completed.
- **NBS** : Mechanical assembling in Hilo. The common platform is under design.

	S24A	S24B	S25A	S25B	S26A
A03k				Start open-use	
3k DM	Installation / Commissioning				
nLCWFS	Commissioning				
NIR WFS	Start open-use w/ A0188	Relocation / Commissioning			
ULTIMATE-START		Commissioning		Start open-use	
LTAO WFS		Installation to NsIR			
4-beam Laser System		LLT upgrade			
NBS	Installation / Commissioning (w/ a few month AO downtime)				