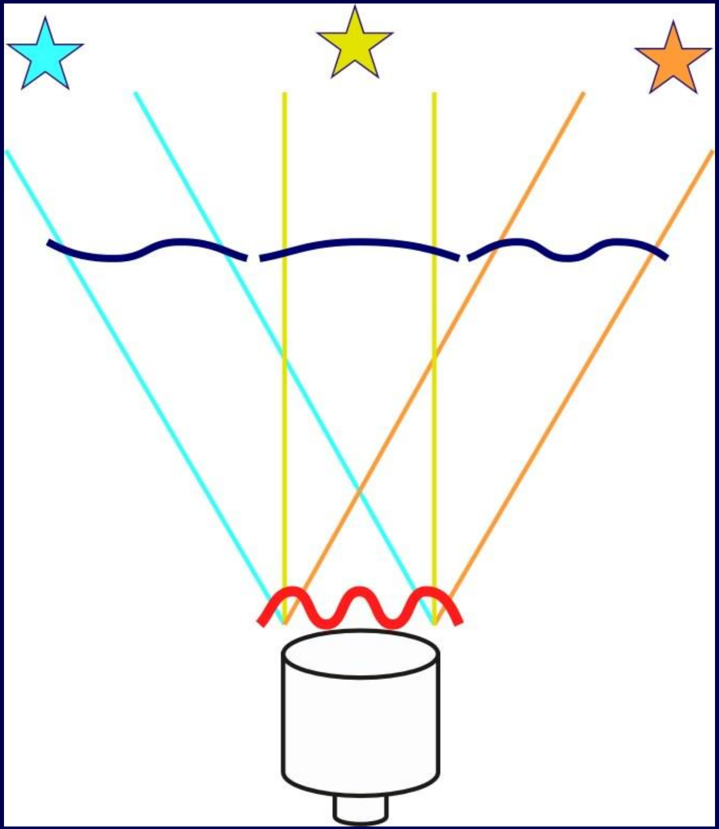
Future Plan of Subaru Adaptive Optics

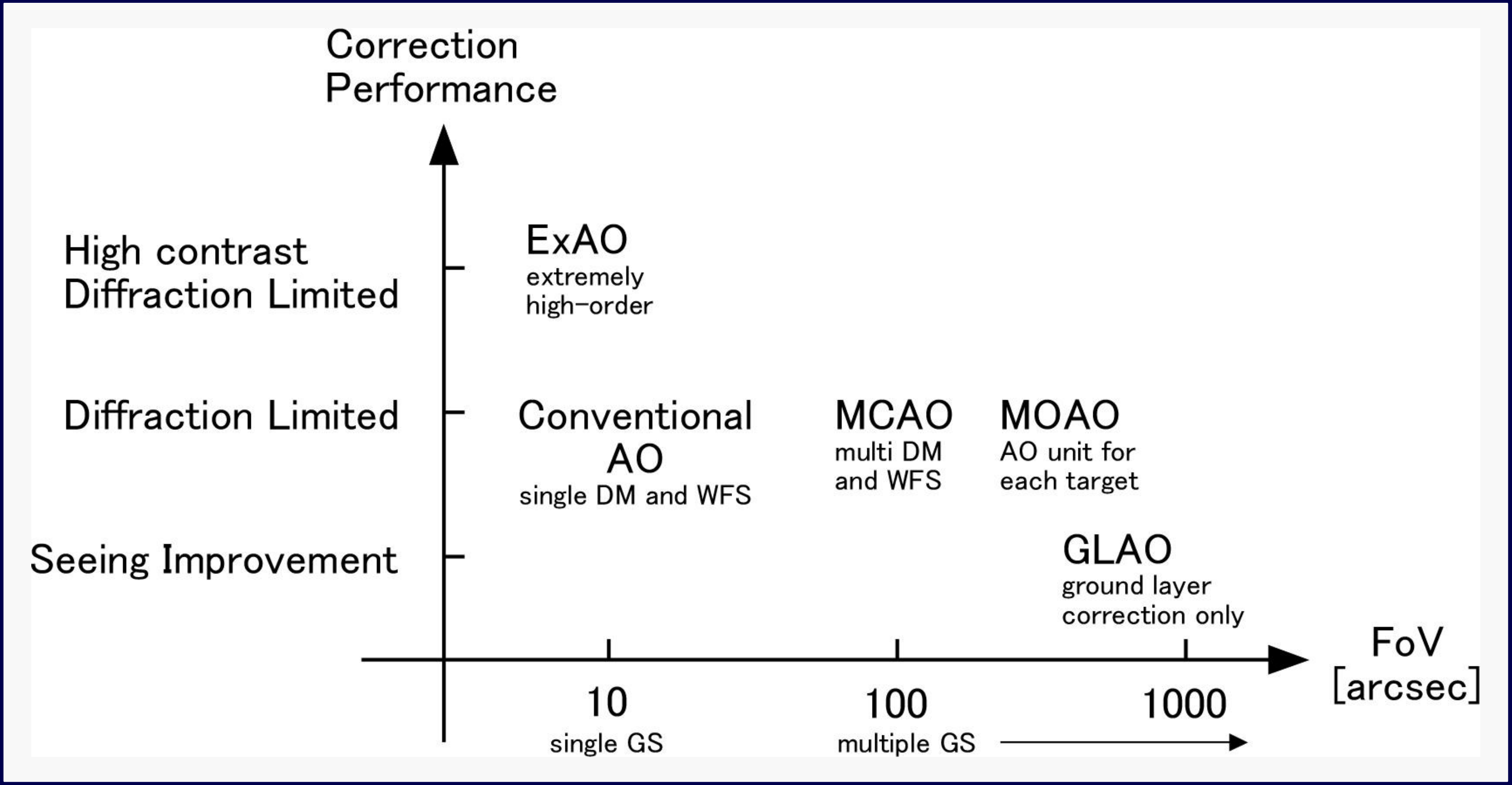
Wide Field AO



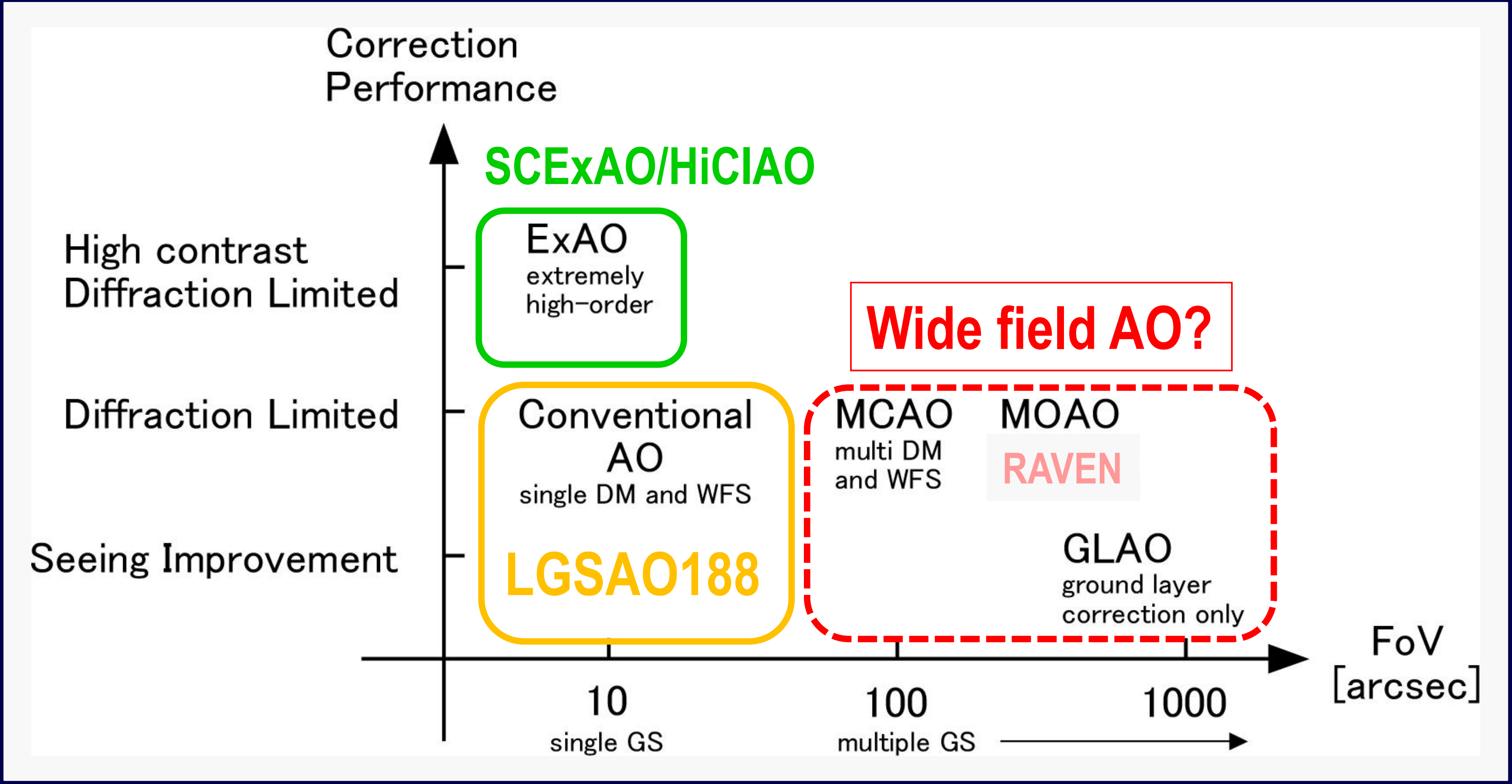
2010/8/19 @ Hilo, Hawaii

Shin Oya（Subaru Telescope/NAOJ)

Variety of AO type



Subaru AO line-up



Why Wide-Field AO?

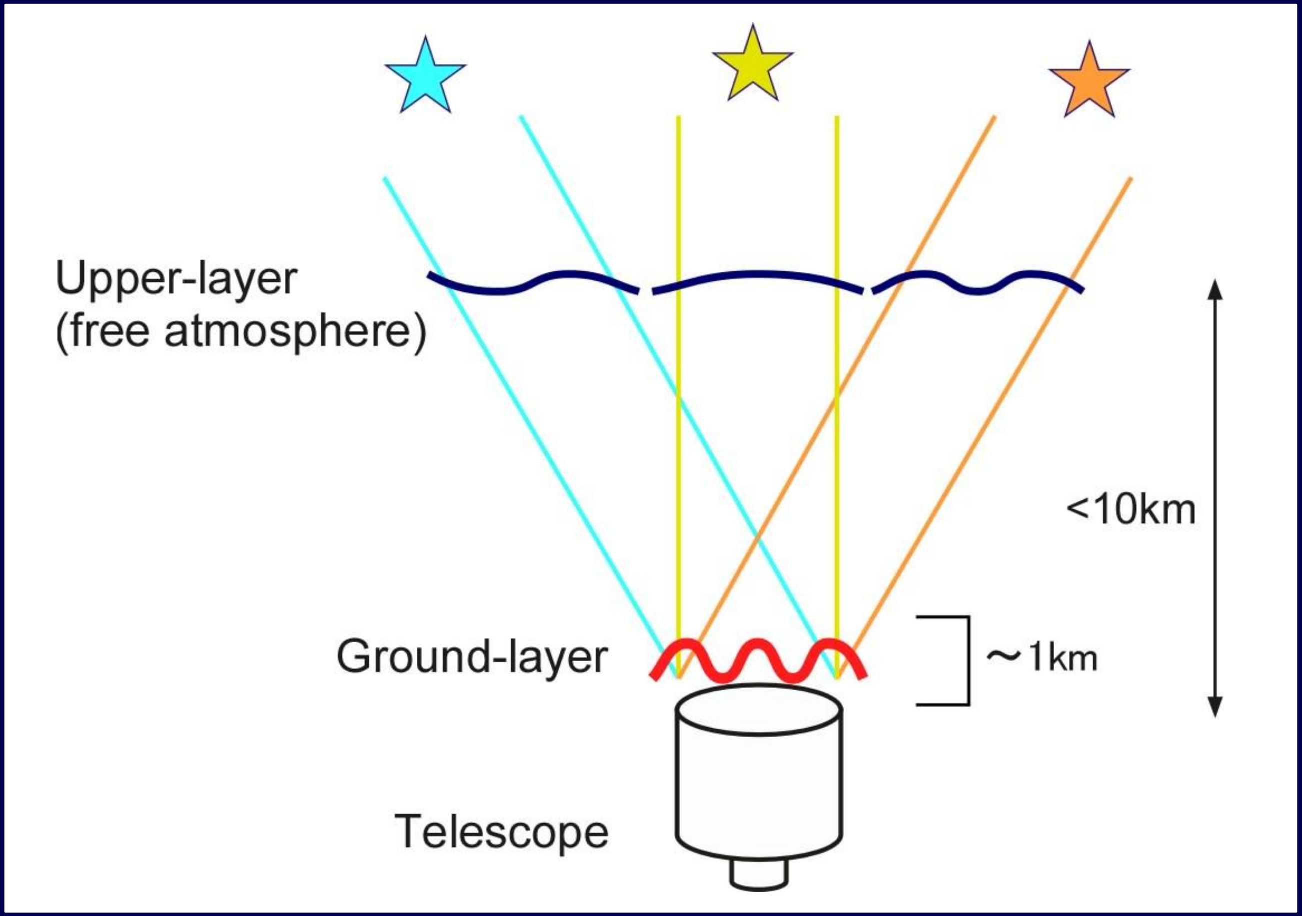
- Subaru has prime focus instruments
  - synergy: data / science
  - (hardware structure)

- Relation to other telescopes
  - 8m-class telescopes have a wide-field AO plan
  - complementarity with 30m-class telescopes

    (light-collecting power and angular resolution of 8m-class will be not attractive any more)

What is necessary for WF AO?

- Considering 3D structure of atmospheric turbulence
- Multiple guide stars



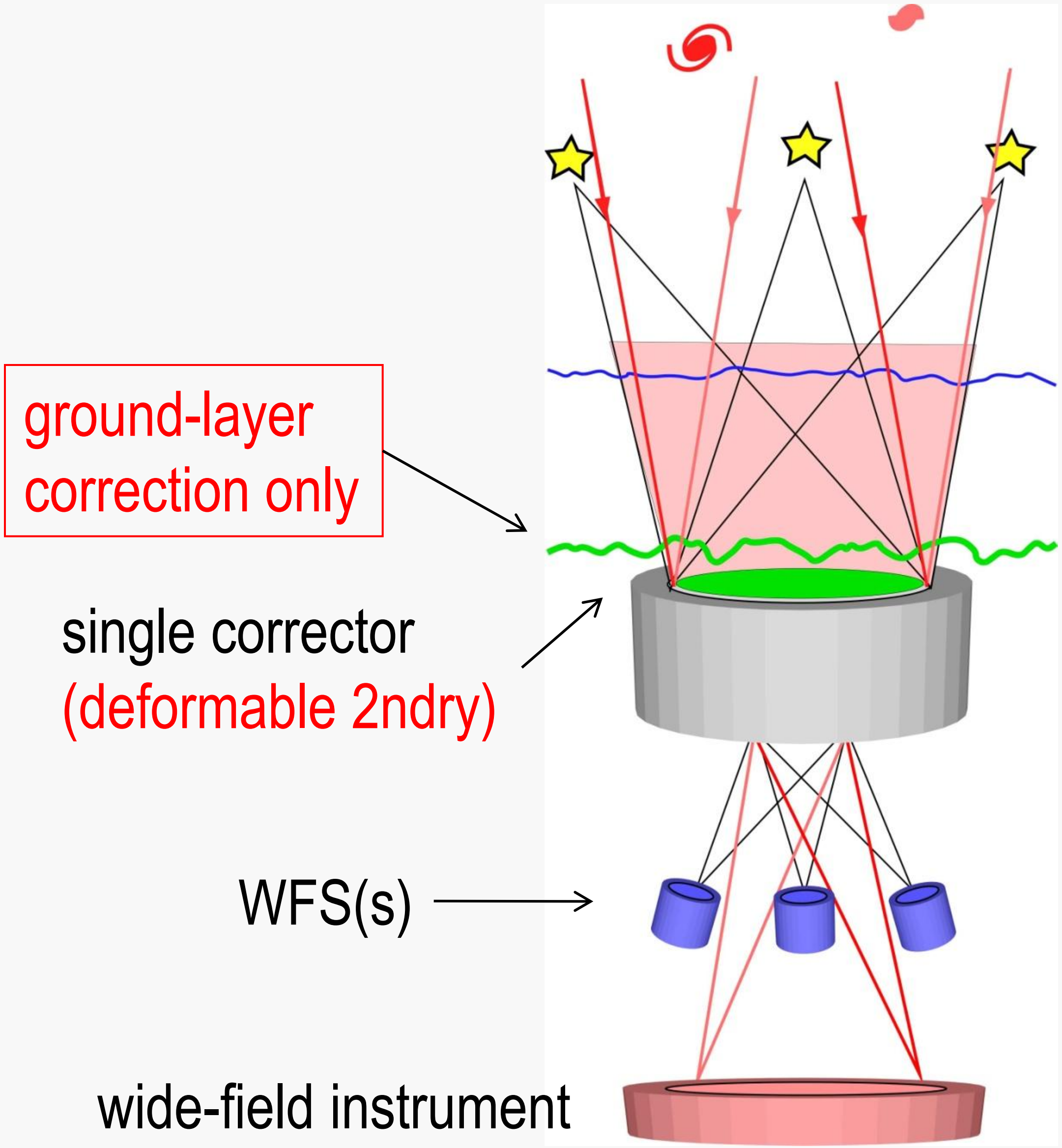
Which type of WF AO?

- GLAO: Ground-Layer AO
  - FoV: 10 arcmin, fwhm: < 0.4 [arcsec]
  - survey observation is possible
  - deformable secondary (low eimissivity)

- MOAO: Multi-Object AO
  - FoR: 3 arcmin, FoV :a few arcsec, diffraction-limited
  - targeted observation only
  - RAVEN (experimental w/ NGS) / CIRMOS

- MCAO: Multi-Conjugate AO
  - FoV: 2 arcmin, diffraction-limited
  - survey observation is possible

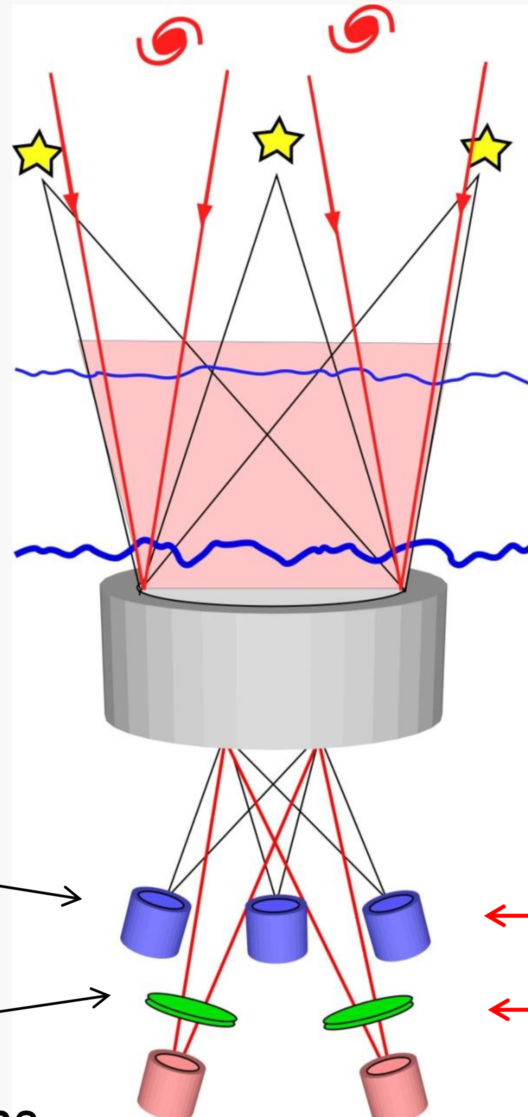
GLAO



FoV: 10 arcmin
fwhm: < 0.4 [arcsec]
survey possible

MOAO

FoR: 3 arcmin
FoV: a few arcsec
diffraction-limited
targeted only

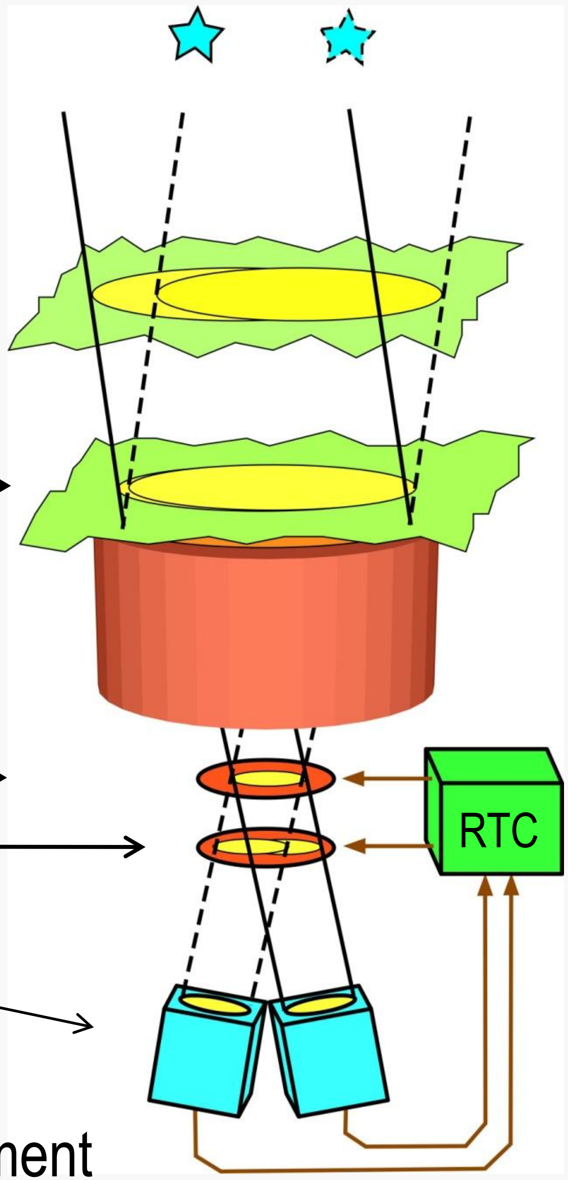


MCAO

FoV: 2 arcmin
diffraction-limited
survey possible

multiple layers
&
multiple correctors

conjugated



multiple WFSs

wide-field instrument

GLAO or MOAO ?

- GLAO & MOAO (Why not MCAO?)
  - These AO systems are proposed for Subaru (interested developers)
  - Possible contribution to TMT future plan

	GLAO	MOAO
FoV	10 arcmin	3 arcmin
correction	seeing improvement (< 0.4")	diffraction-limited
survey	Yes	No
port	Cs/Ns (w/WFS)	One port
budget	>$10M?	<$10M?

GLAO: seeing data

Important for accurate simulation

- Cerro Pachon (Gemini –S,1998,4 seasons)
- Balloon data (43 launches)
- resolution:6m, altitude:<5km

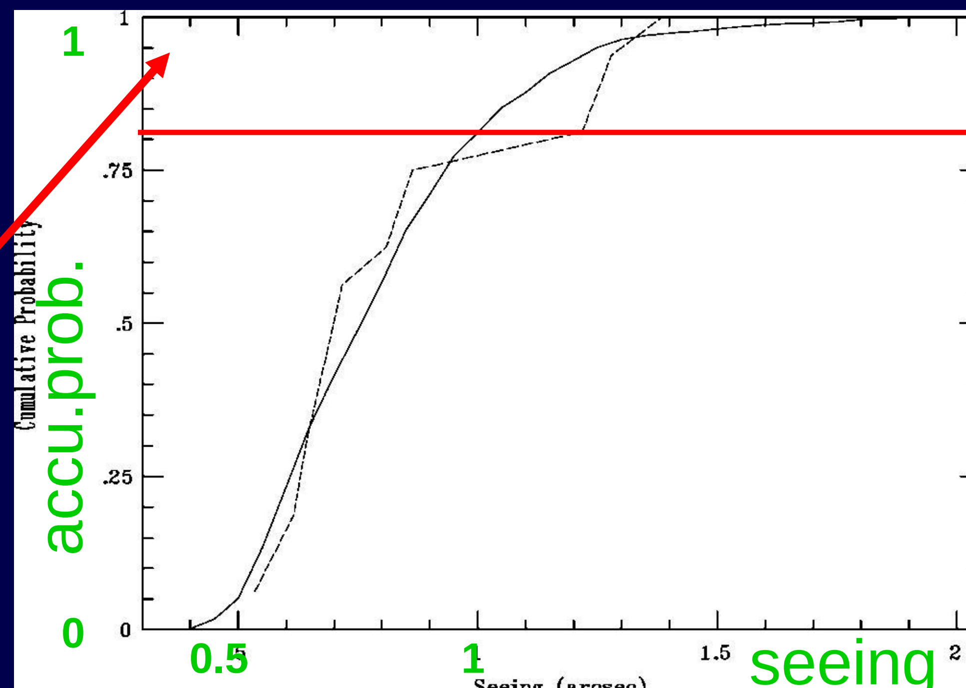
Andersen et al.(2006),PASP,118,1574

INTEGRATED TURBULENCE $J = \int C_n^2\,dh$ FOR "GOOD," "TYPICAL," AND "BAD" GROUND AND FREE ATMOSPHERES

Altitude (m) (1)	Good J (10^{-14} m$^{1/3}$) (2)	Typical J (10^{-14} m$^{1/3}$) (3)	Bad J (10^{-14} m$^{1/3}$) (4)
0	9.26	7.04	13.8
25	1.83	2.25	10.8
50	0.574	1.35	15.3
100	0.362	1.24	15.8
200	0.614	1.99	10.3
400	0.960	2.87	6.46
800	1.18	3.02	7.29
1600	0.913	1.75	6.77
3600	...	...	32.0
5500	...	17.0	...
8400	9.00	...	...

NOTE.—Altitudes >3 km are considered "free."

25% 50% 25%

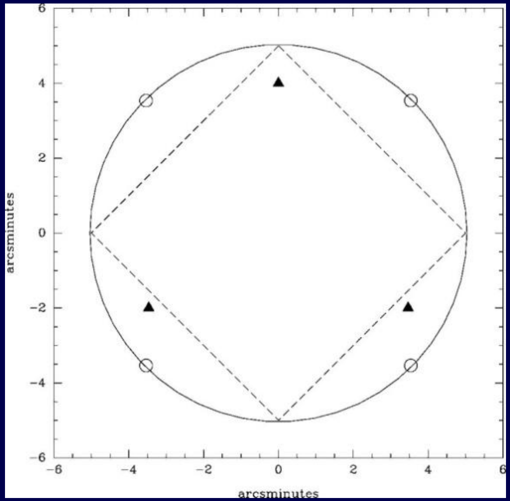


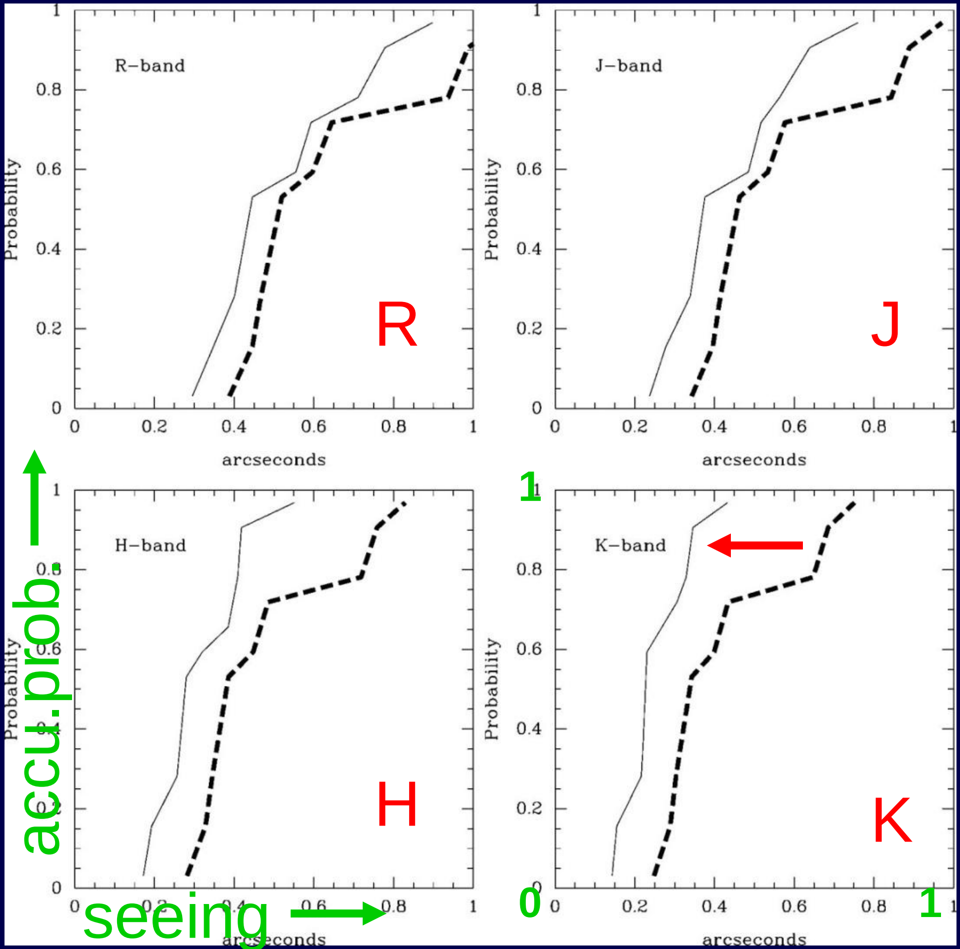
GLAO: expected performance

An example of 8m-class telescope

- 7’ X 7’ FOV, 4LGS(V～13)+3TT-NGS(V<15)
- WFS: 10x10 SH, SO
- DM: 77DOF

white ○: LGS
black ▲: NGS
circle: 10’ φ
squre: FOV

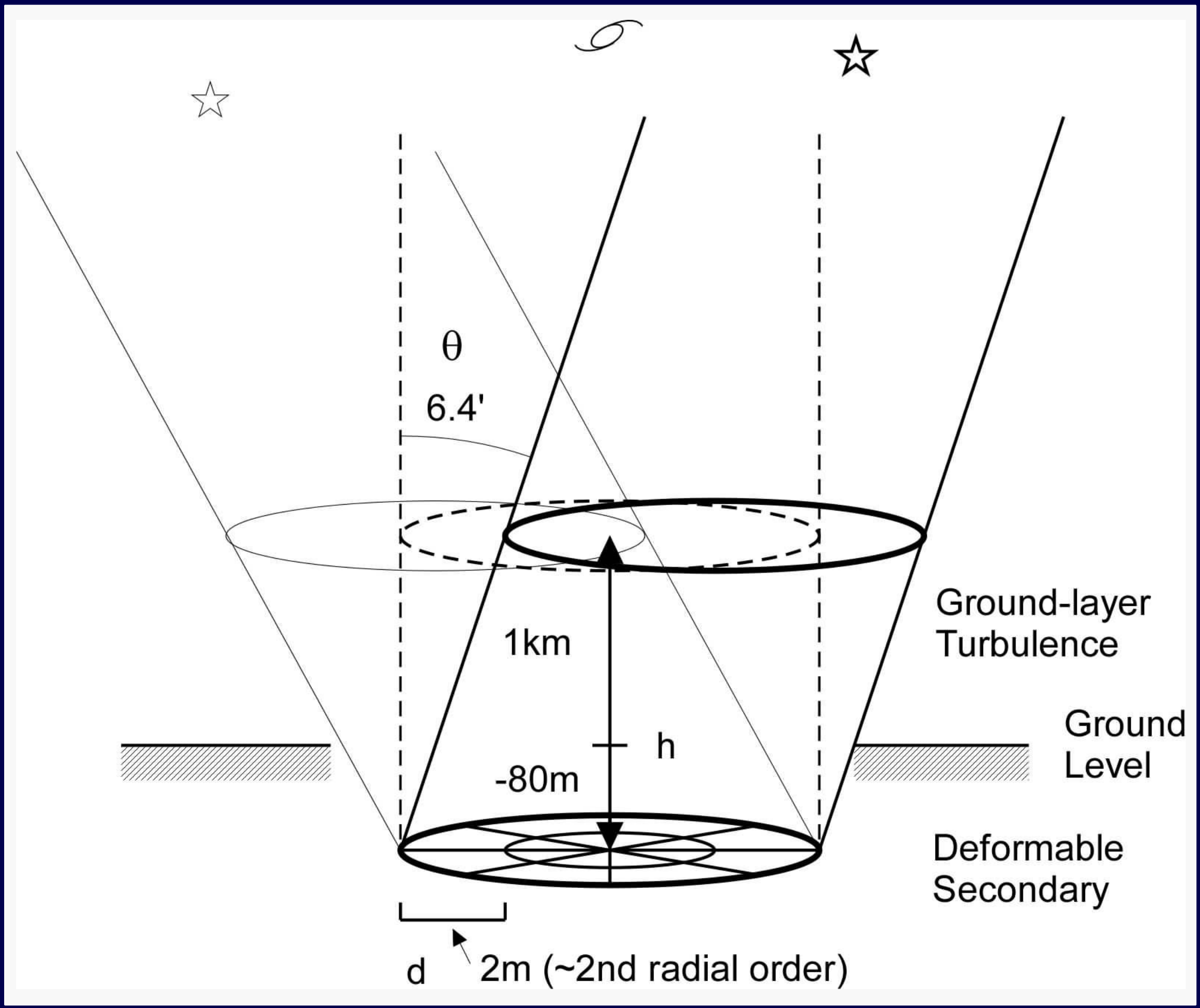


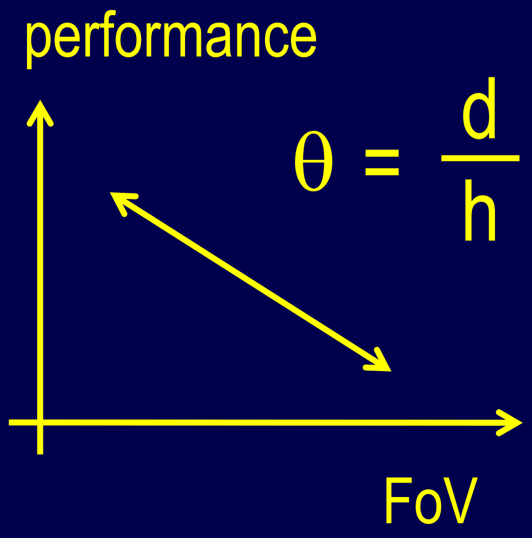


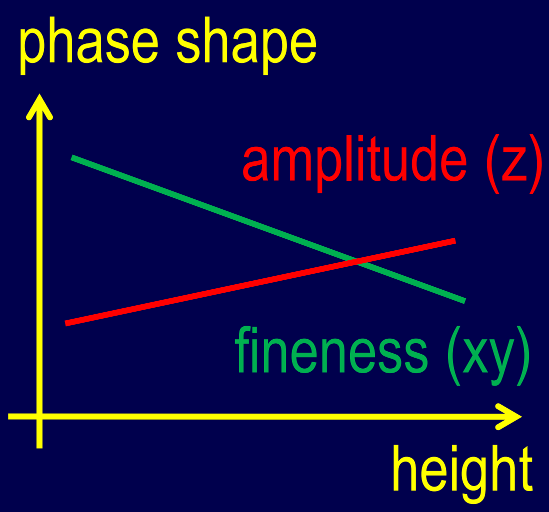
- Effective under bad seeing (depends on seeing statistics)
- Slight Improvement even at visible

Andersen et al.(2006),PASP,118,1574

GLAO: limitation of FoV



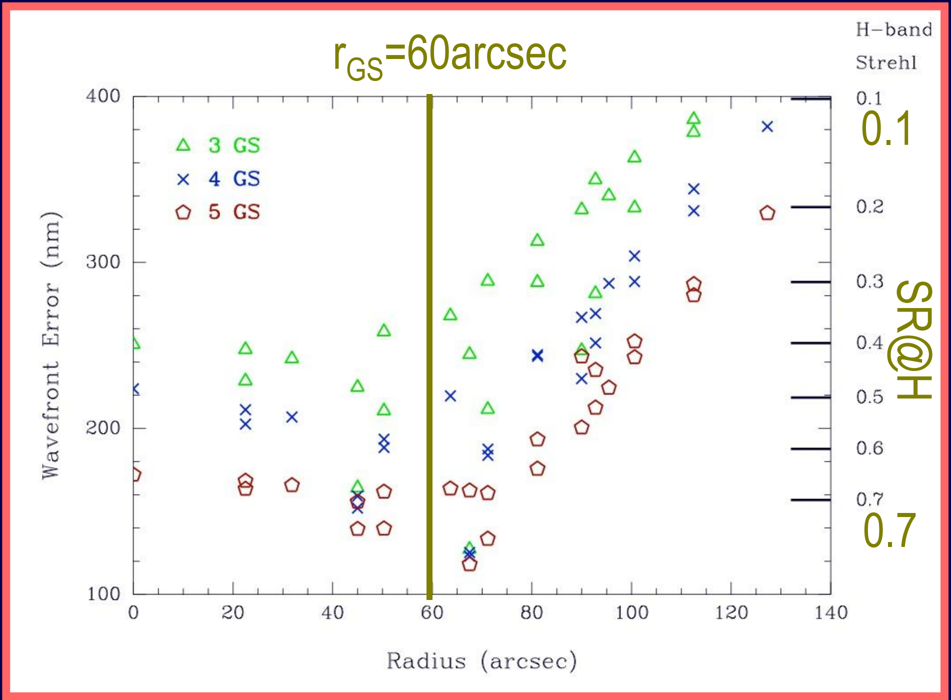


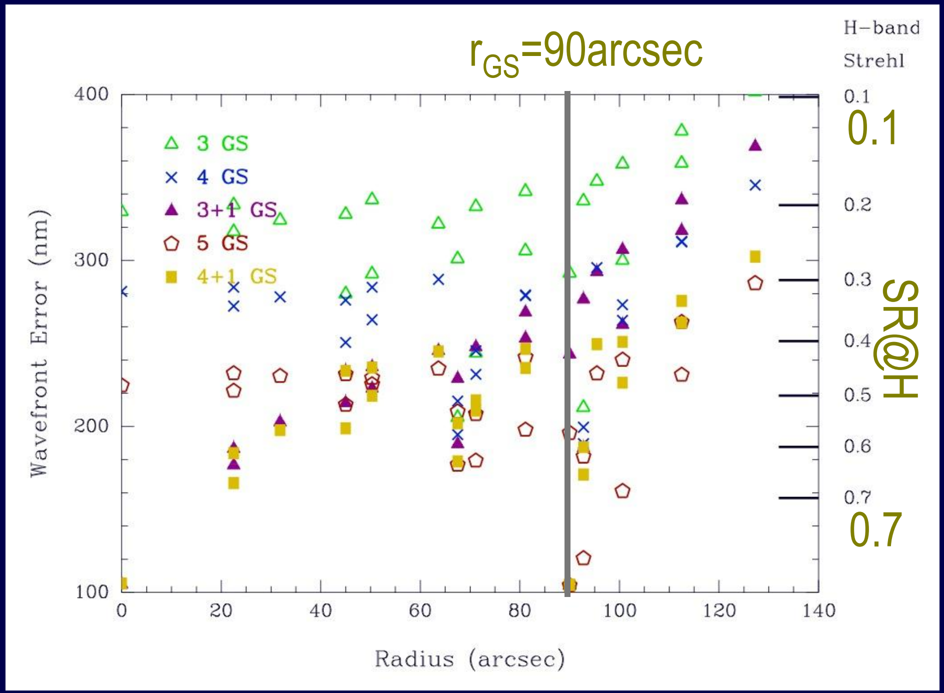


MOAO: expected performance

Raven case

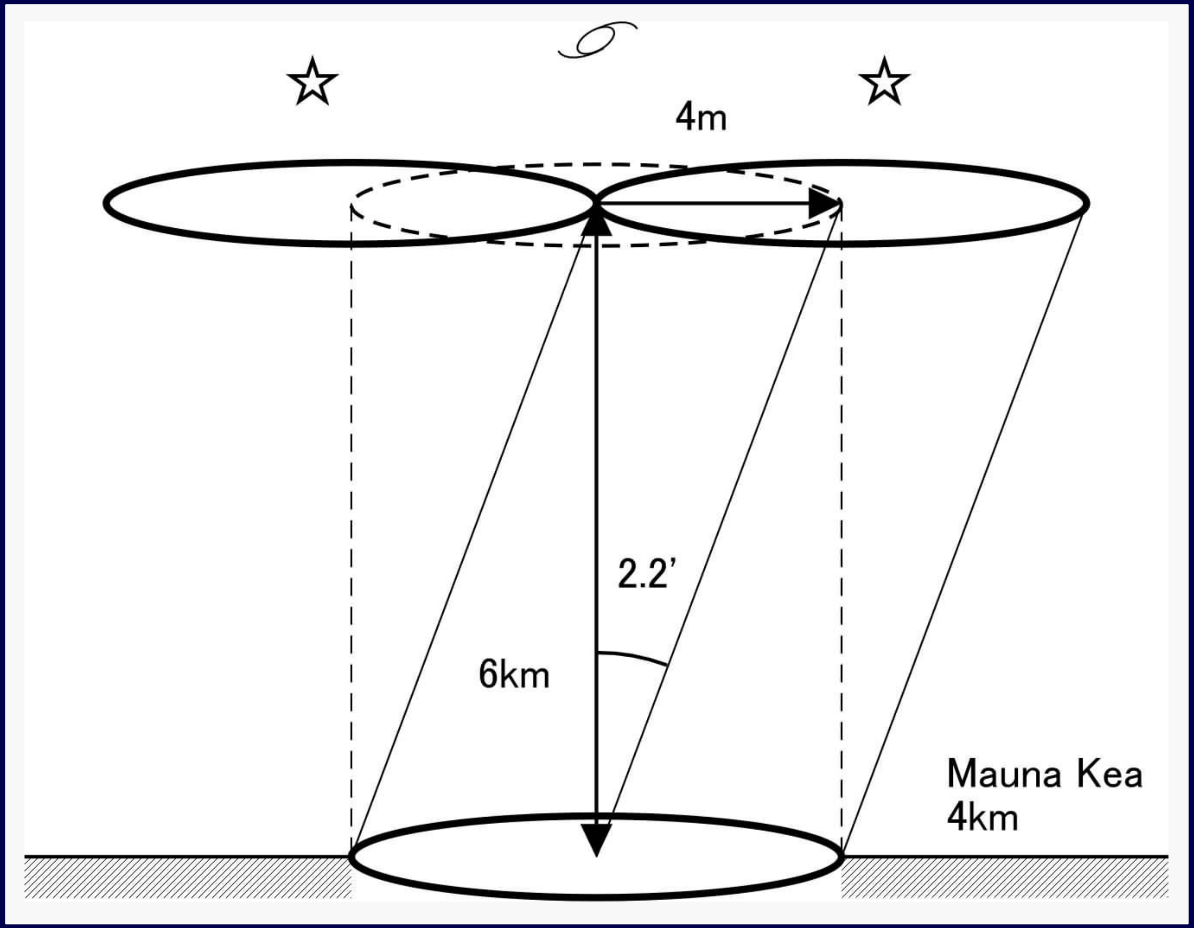
- 2'～3' FoR, 3～5 NGS (bright enough; V～10)
- WFS: 15x15 SH (?)
- DM: 16x16



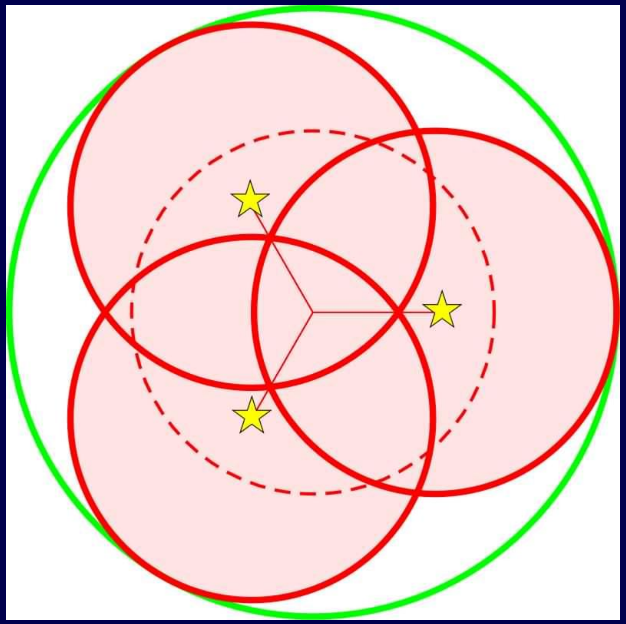


Simulation by Andersen (2010)

MOAO: limitation of FoR



beam overlap at 6km
(top view)



8m aperture
3arcmin FoR
3GS

MCAO: expected performance

MAD case

- 1’ or 2’ FoV; 3 NGS (V=9mag)
- WFS: 8x8 SH
- DM: 60 elem. bimorph x 2

Marchetti et al. (2006)

7.3. Multi-Conjugate AO

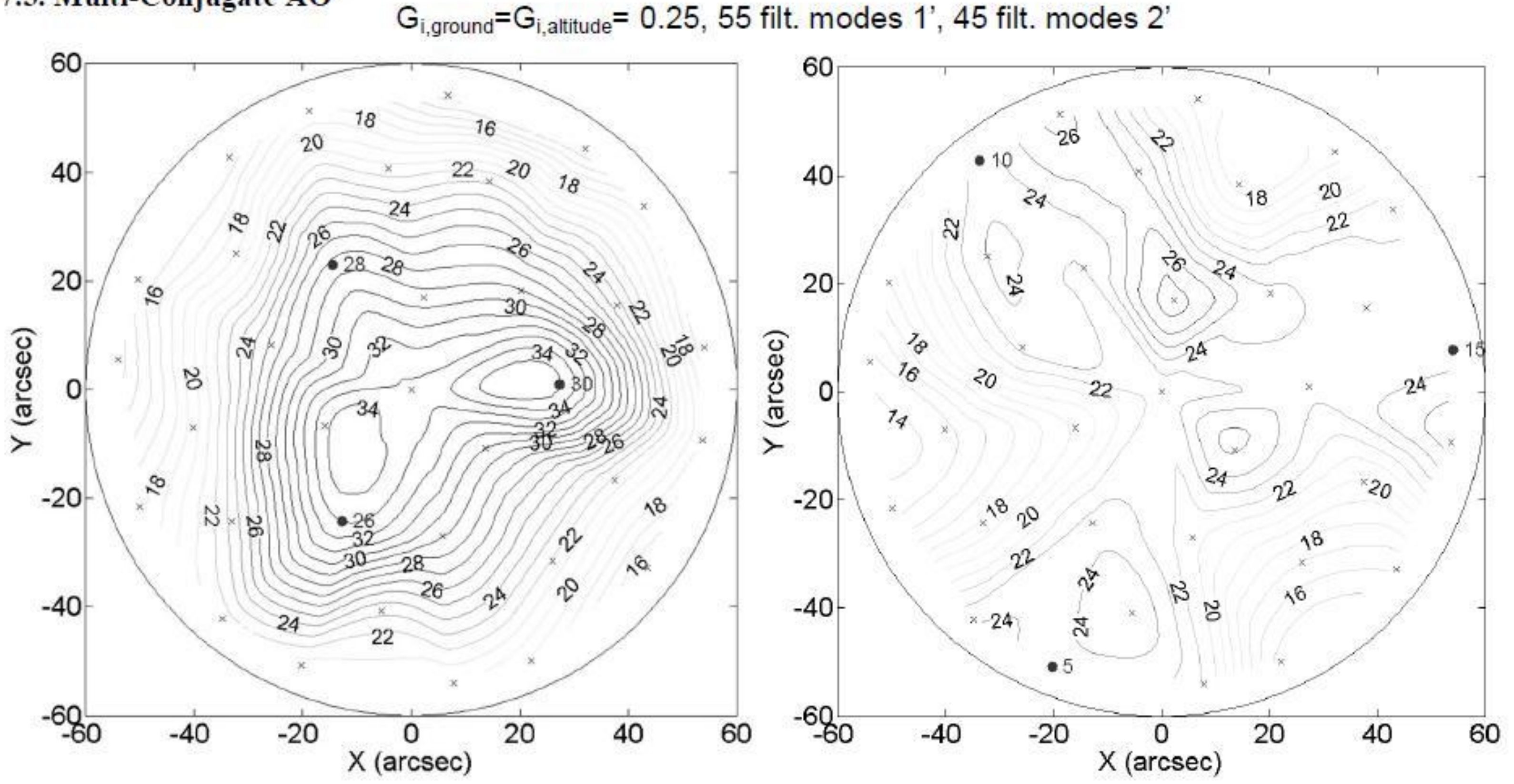
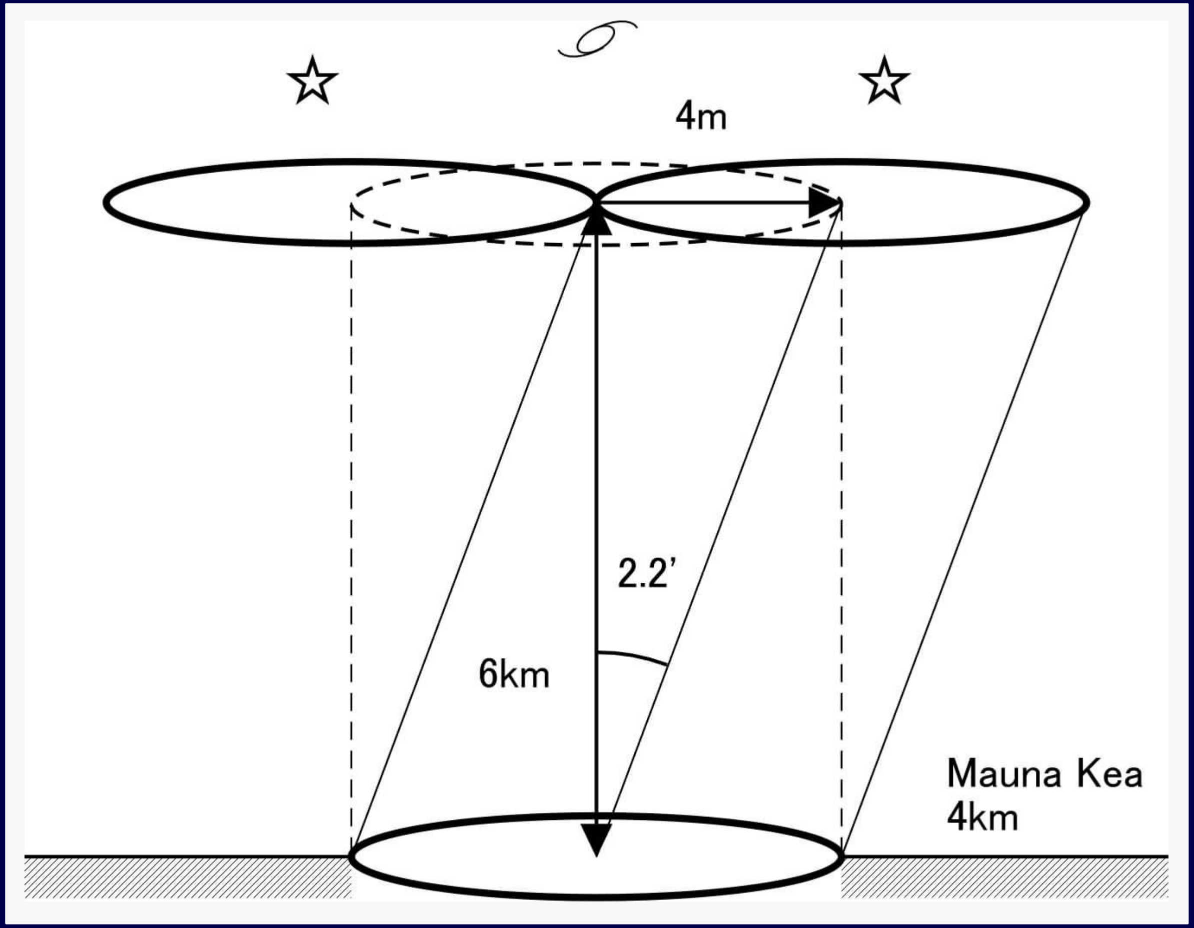


Figure 10 MCAO Strehl performance at 2.2 µm. Left: 1 arcmin FoV configuration. Right: 2 arcmin FoV

MOAO: limitation of FoR



beam overlap at 6km
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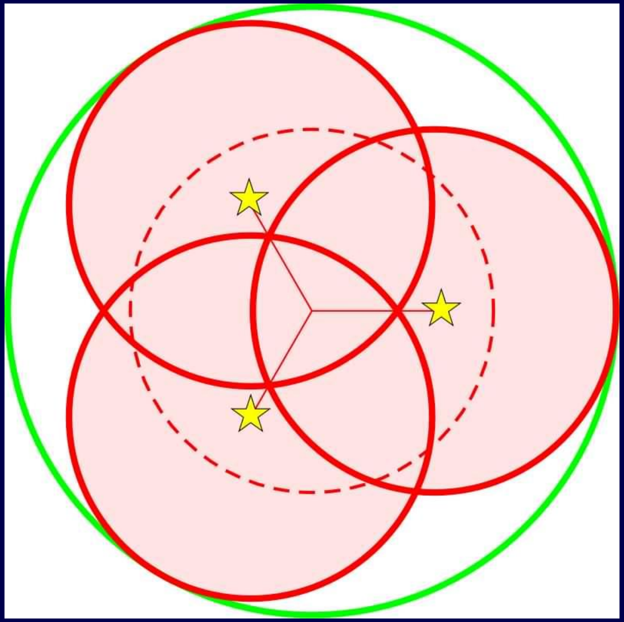

8m aperture
3arcmin FoR
3GS

Conclusion

- Wide field AO is suitable for future AO plane of Subaru telescope
  - synergy with prime focus instrument
  - competitiveness among 8m-class telescope
  - complementarity with 30m-class telescope

- Deformable 2dary is the best choice
  - not only GLAO, but also ...
  - MOAO is better suited for 30m telescopes

  Experiment activity should be kept going for the development of TMT instrument (e.g., Raven).

Future of Subaru AO