

Introduction of RAVEN



University
of Victoria

Adaptive Optics Lab



Subaru Telescope



Herzberg Institute



TOHOKU
UNIVERSITY
Astronomical Institute

Subaru Future Instrument Workshop

2011/1/18 @ Mitaka

Shin Oya (Subaru Telescope)

Outline

- Overview of RAVEN project
- Multi-Object Adaptive Optics (MOAO)
- Details of RAVEN system

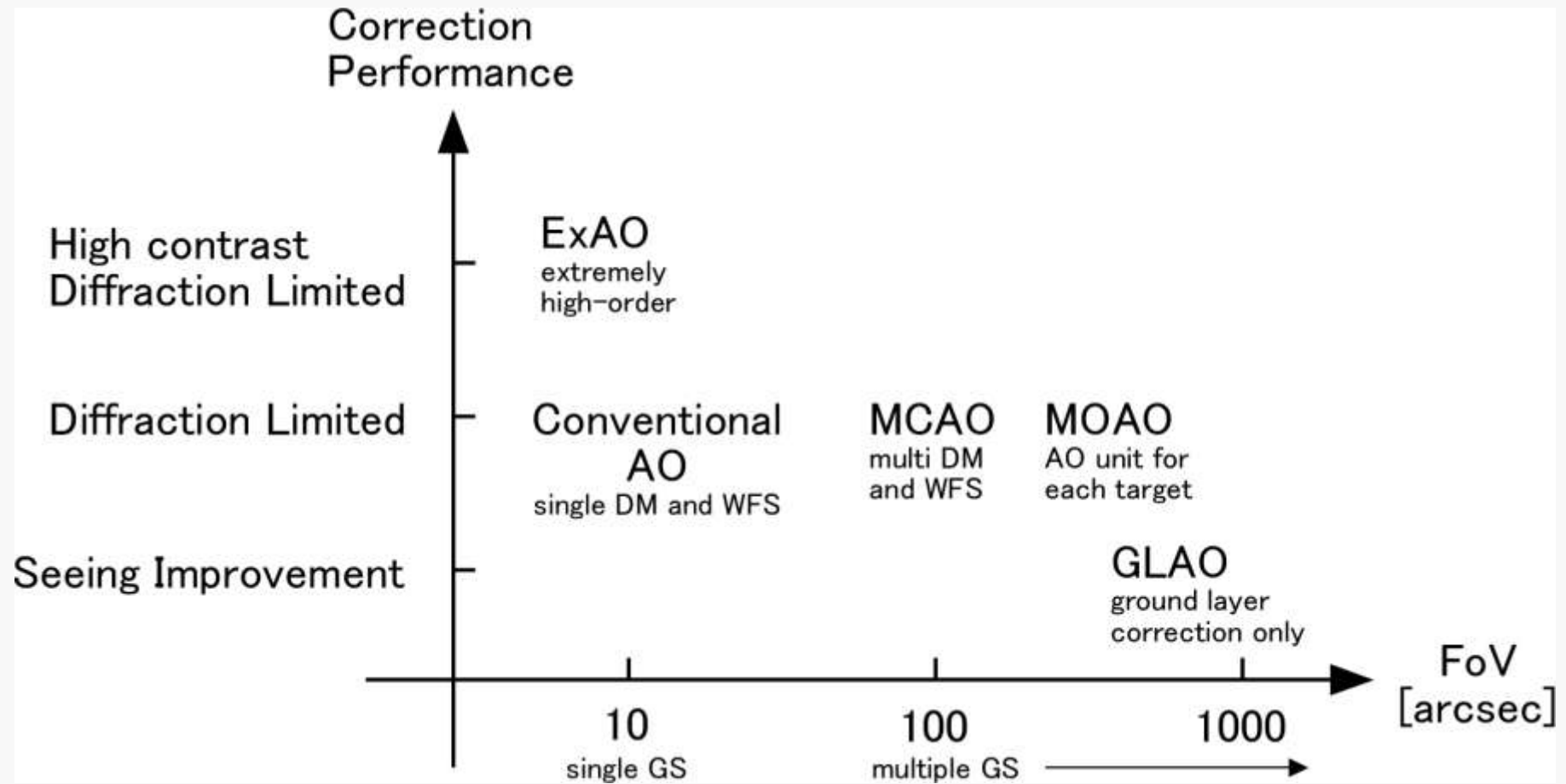
RAVEN Project

- MOAO demonstrator (targeting 1st on 8m class)
 - Validation in laboratory room
 - On-sky science verification
- Canadian group project
 - University of Victoria (UVic)
 - Herzberg Institute for Astronomy (HIA)
- Support by Japanese group
 - Subaru Tel. (infra/manpower, researcher exchange)
 - Tohoku Univ. (basic experiment in laboratory)
- Already funded
 - 6M CAD by BCKDF/CFI Leading Edge Fund
 - In kind contribution from HIA & Subaru (> 400K CAD)
- Schedule
 - 2013~(2015) Hilo/summit

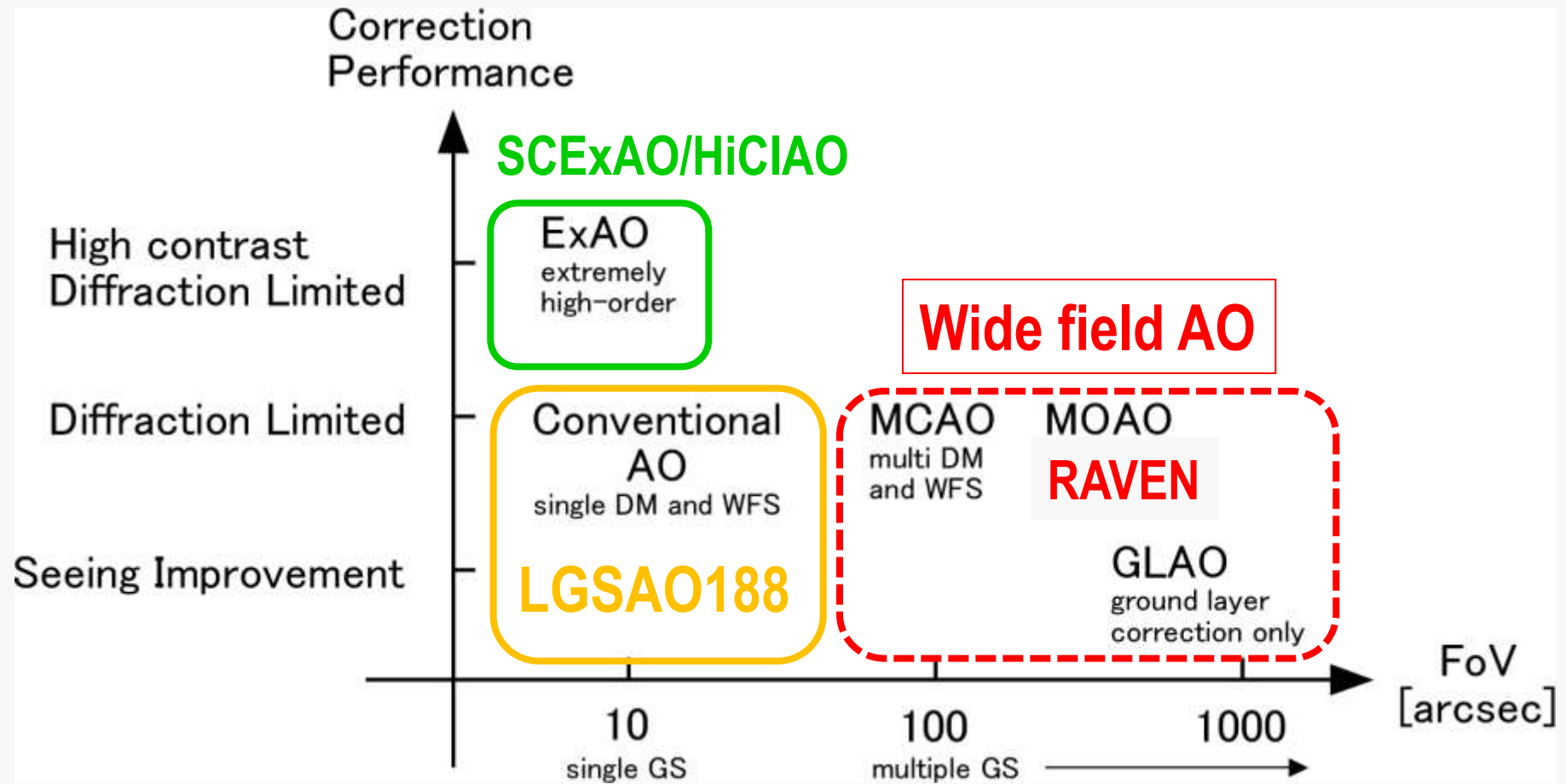
Meaning to Subaru

- Good chance to obtain wide-field AO tech.
 - no wide-field AO plan of Subaru is funded yet
(\Leftrightarrow seeing limited WF instr.: Suprim, FMOS, MOIRCS)
 - tomography is common technique for all types of wide-field AO
- Experience for TMT
 - MOAO is advantageous for larger telescope
 - experience of on-sky verification by 8m class is important for the future development

Variety of AO type



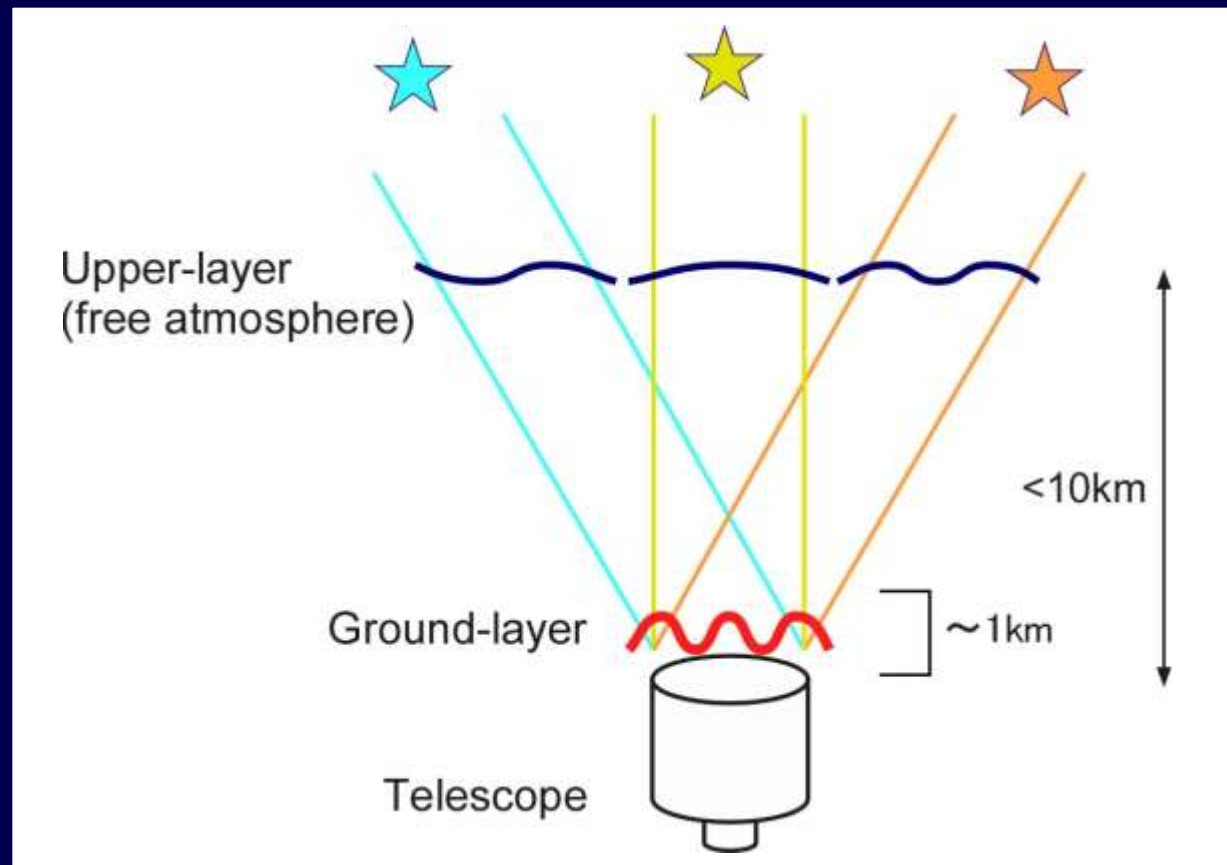
Subaru AO line-up



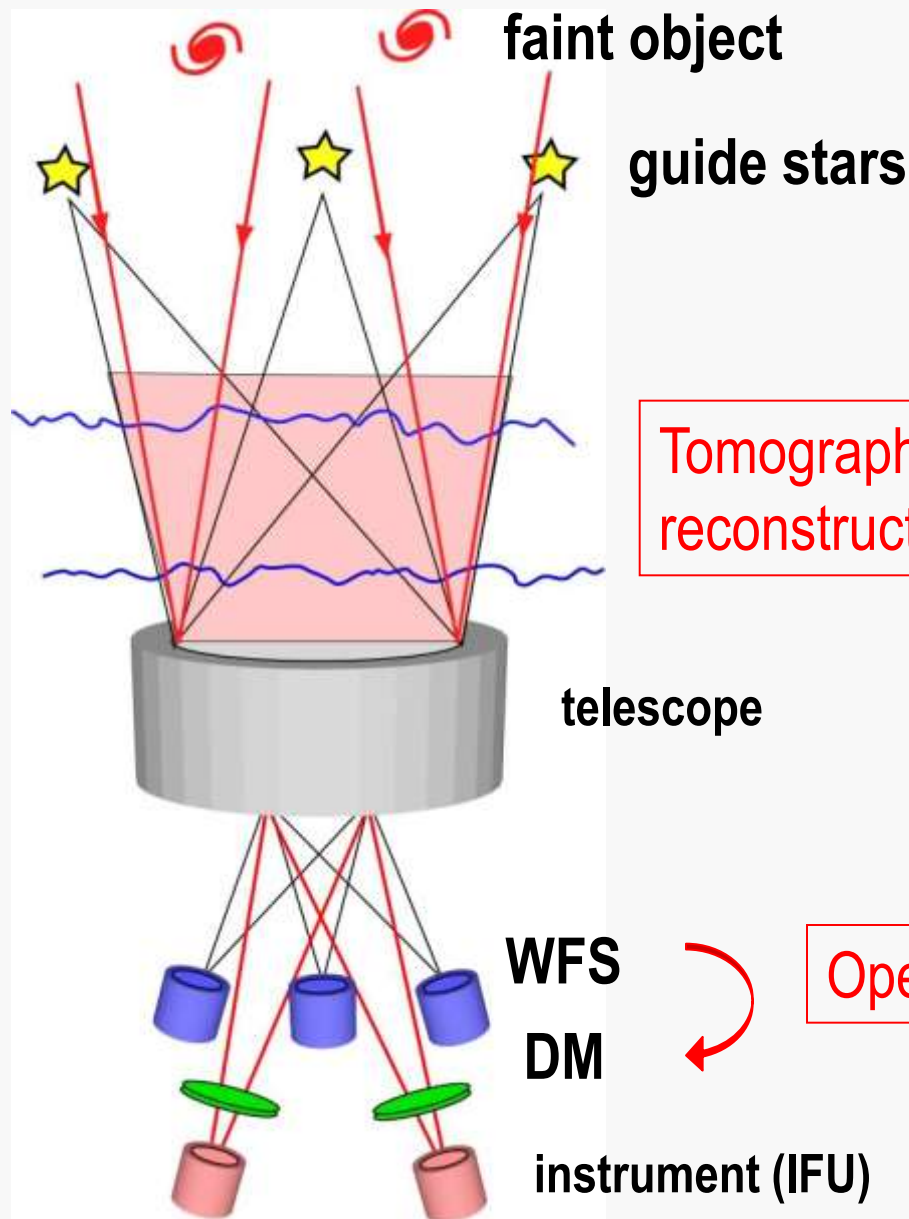
Tomography

Wide-field AO needs:

- Consideration 3D structure of the atmospheric turbulence
- Multiple guide stars



MOAO: Multi-Object AO



F0V:

- patrol: \sim arcmin
- unit: \sim arcsec
- diffraction-limit
- targeted obs.

Key Technology

Calibration !!

Advantage of MOAO

- High Strehl ratio on the target
⇒ the same type adopted for Keck NGAO
- Field-of-View expands w/ Tel. aperture
⇒ a candidate of TMT 2nd gen. instrument

Keck NGAO

Preliminary Design Review (June 2010)

LTAO
(Laser Tomography AO)

Narrow FOV , but high SR

- SR=0.8 @ K

- < 30" ϕ

- 7LGS + 3NGS

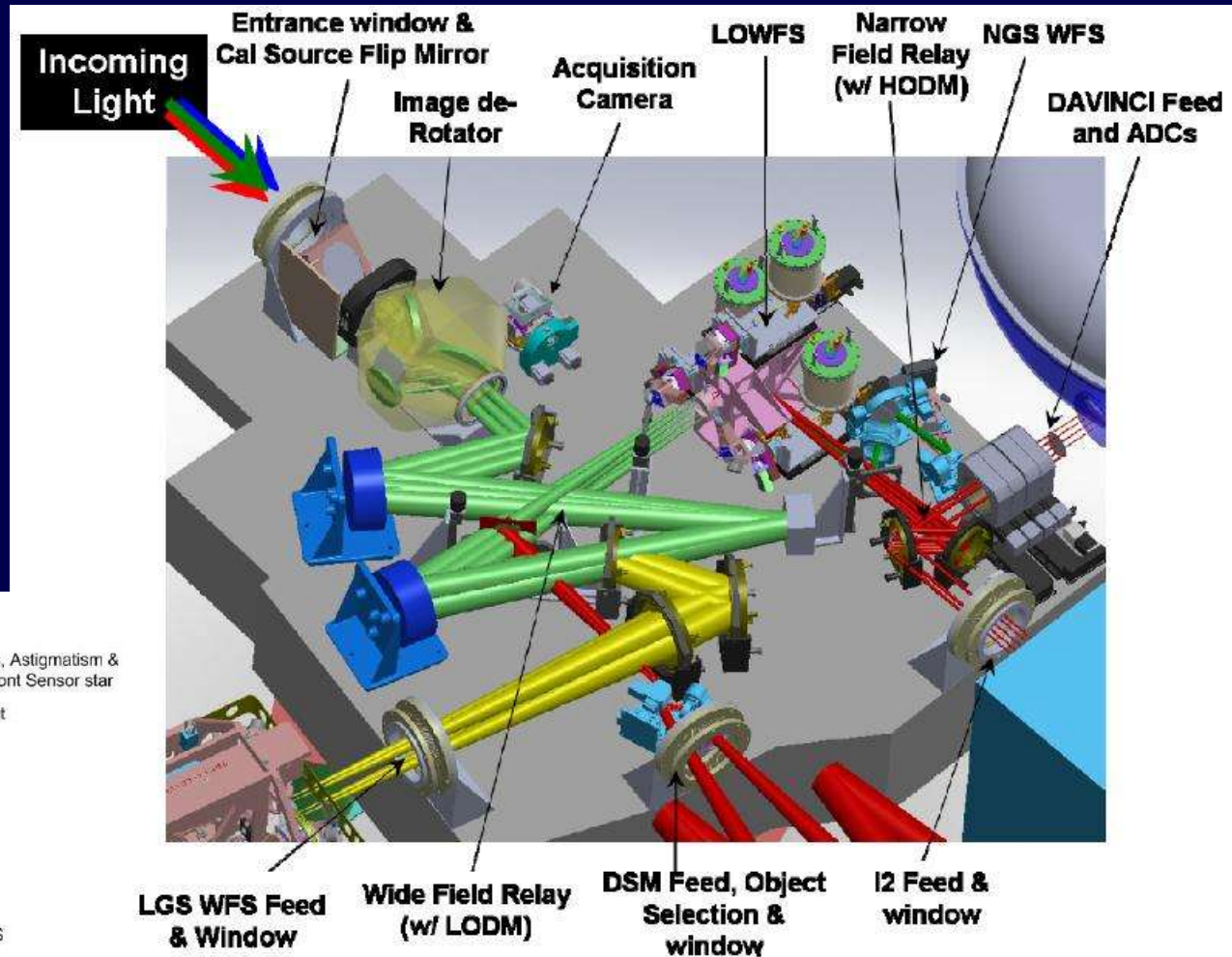
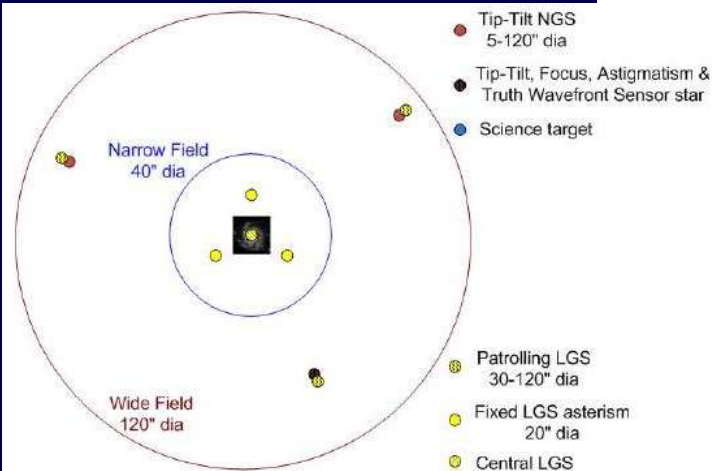
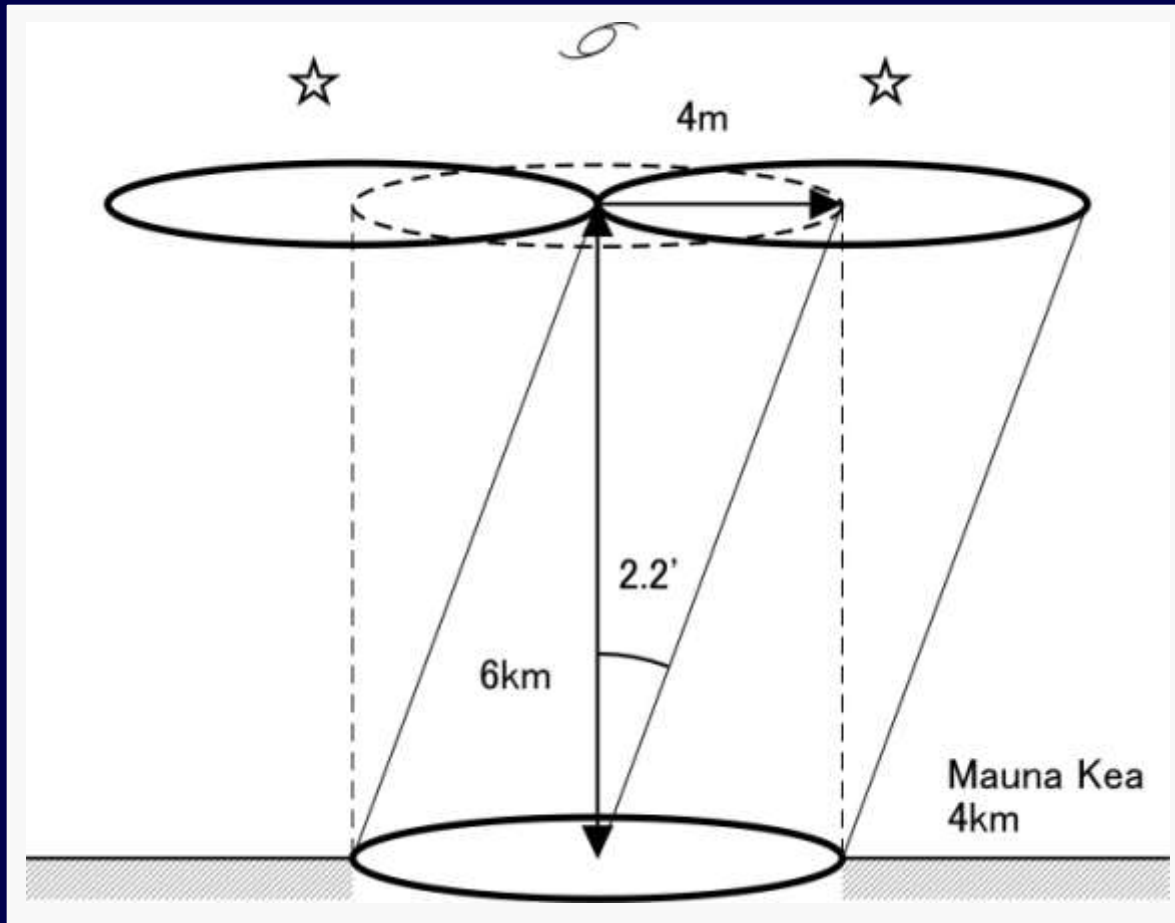
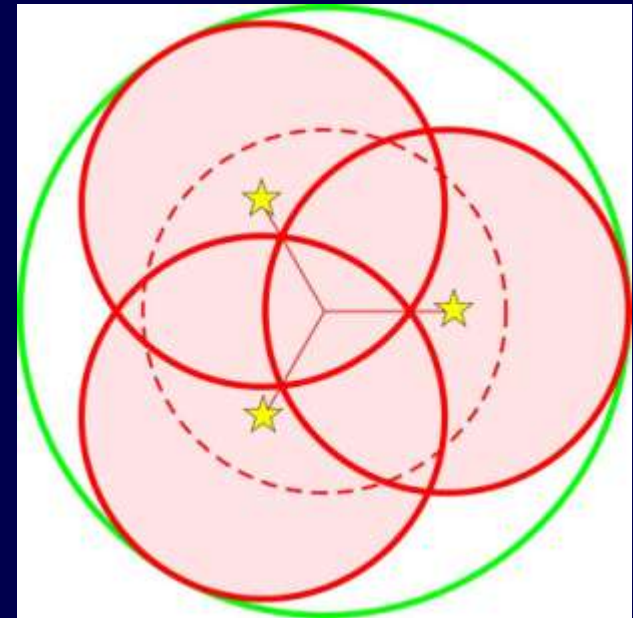


Figure 6: Perspective view of the AO bench with major components labeled.

Field-of-Regard of MOAO



beam overlap at 6km
(top view)

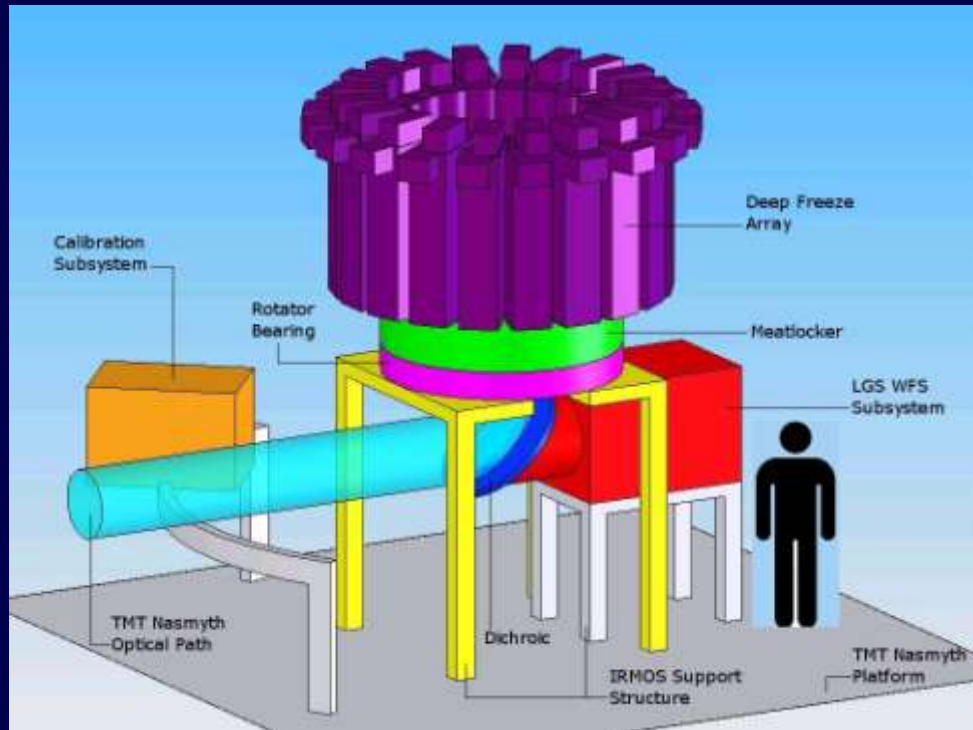


8m aperture
3arcmin FoR
3GS

MOAO for TMT

UF / HIA

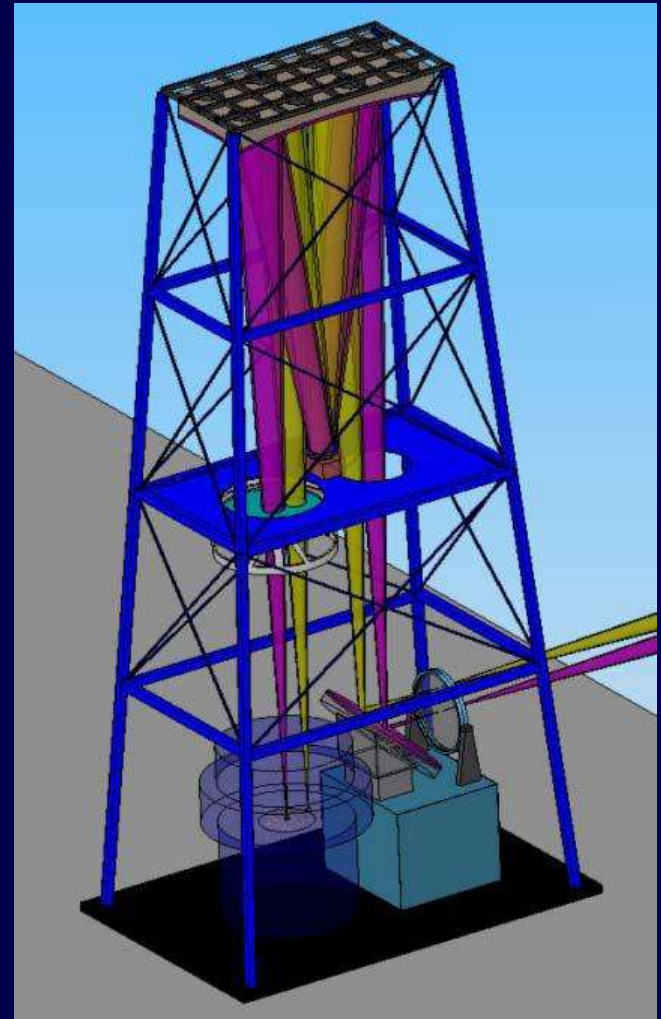
Caltech



Feasibility study in 2006

- opto-mechanical design
- performance evaluation
- system engineering

FoR: 5 arcmin, 20 units



RAVEN

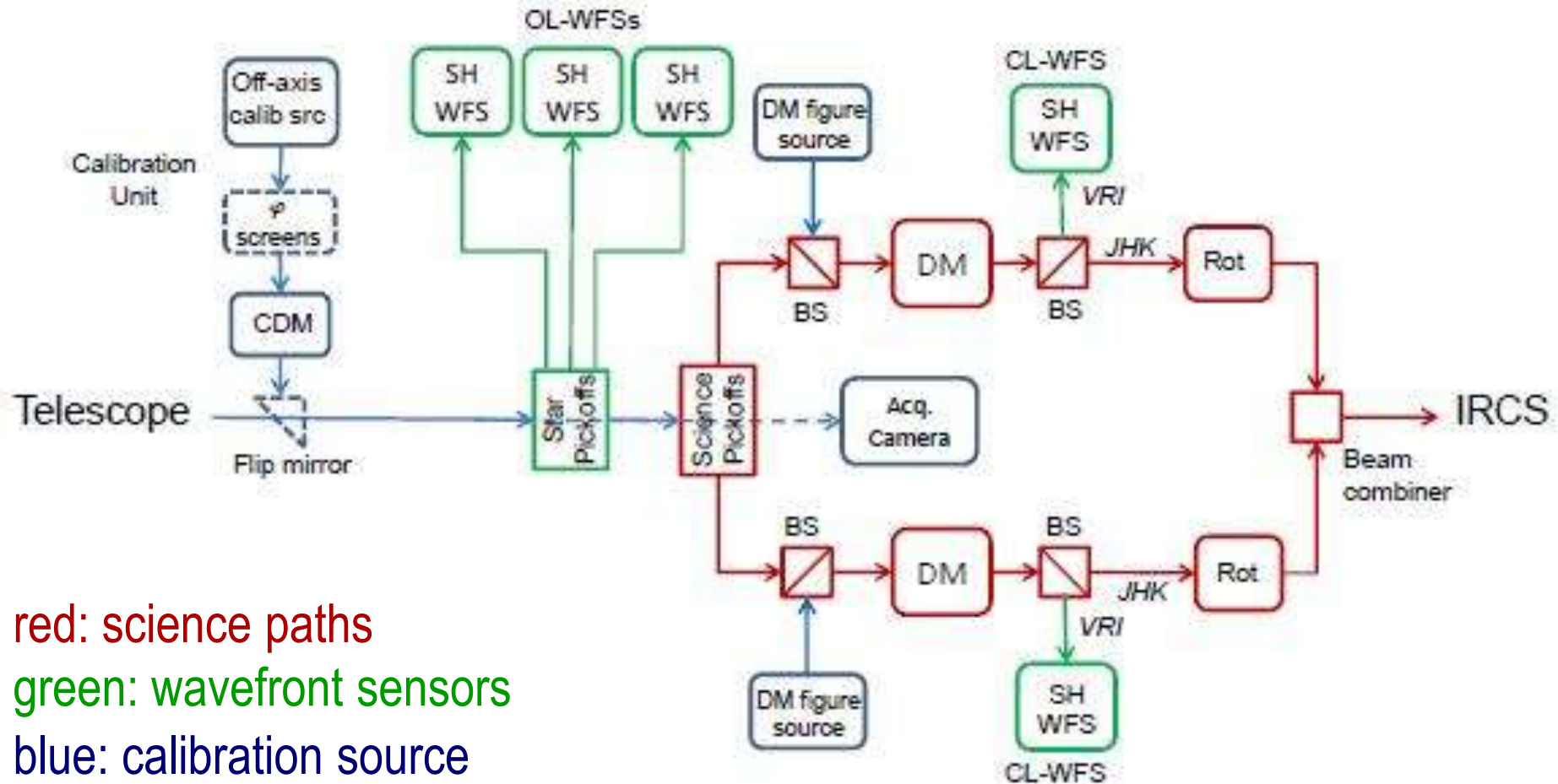
At Subaru Telescope

- Configuration
 - handled as a carry-in instrument
 - installed on NslR; science instrument is IRCS
 - feasibility study is going on to use LGS
- To be done
 - on-source open-loop experiment in Canada was successful. : $2.5'' \rightarrow 0.5''$
 - validation of on-sky tomography by multi-GS has not been done yet.
 - necessary to establish the calibration method
 - on-sky science verification

System Specifications

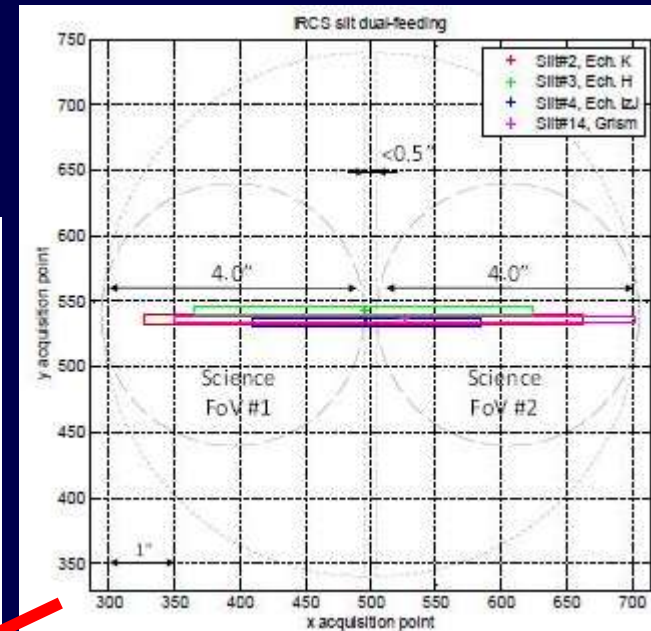
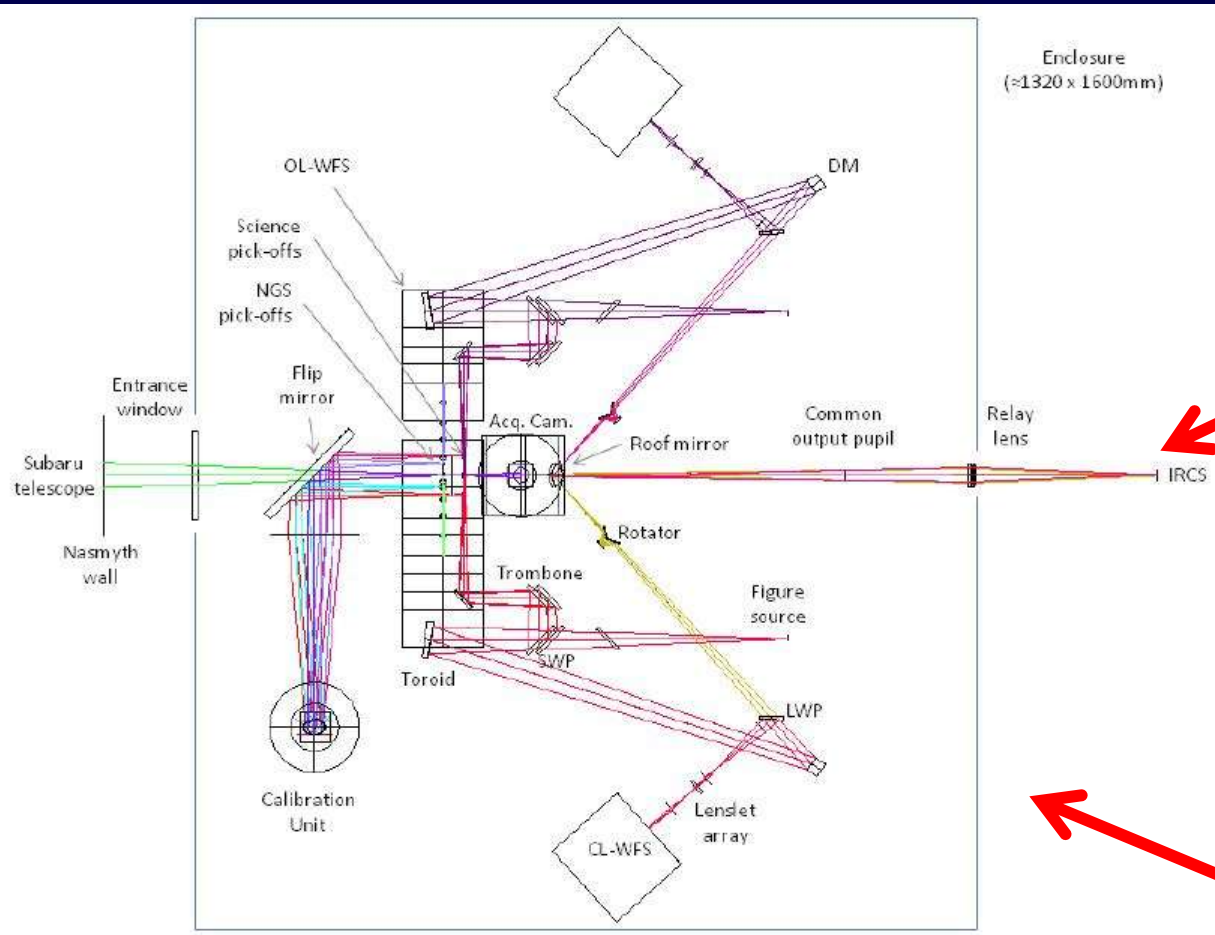
Number of Science CH	2 (= number of DM)
WFS	3 NGSs (+1 LGS) / 10x10 SH
Field size	FoR: 2' (3.5' goal); FoV: 4" each ch
Wavelength range	Sci: 0.9-2.5um ; WFS: 0.6-0.9um
Science instrument	IRCS (Imaging, Grism, Echelle)
Ensqured Energy	> 30% in 140mas slit (0.75" seeing)
System Throughput	> 32%

System Block Diagram



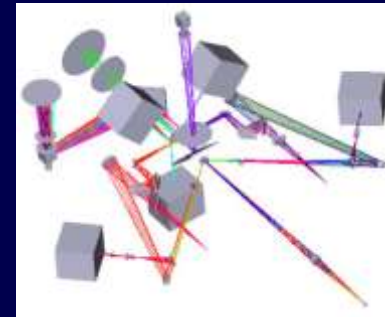
Optical Layout

top view (1320x1600)



on IRCS slit

3D



by O. Lardiere

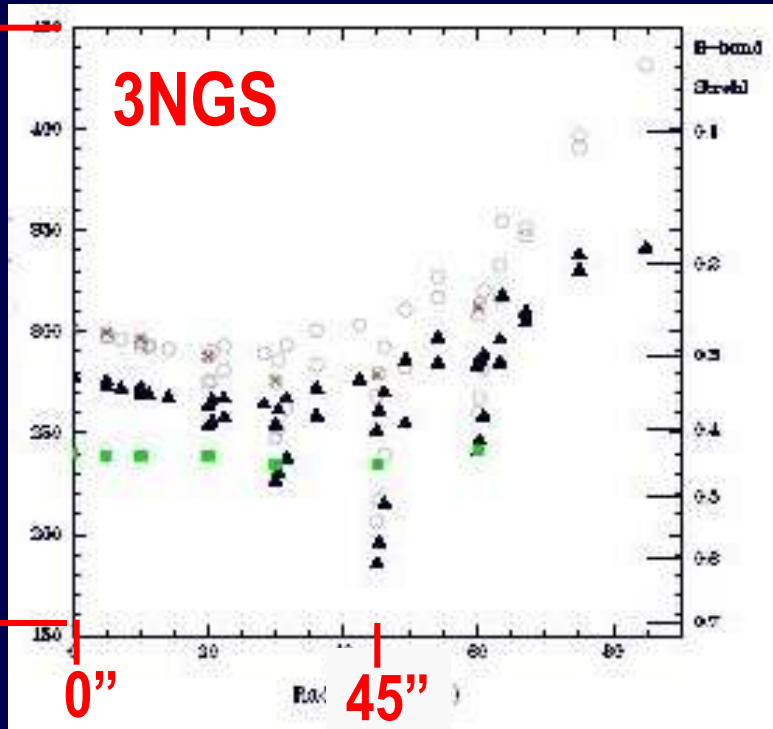
Expected Performance

Condition: 0.75" seeing; 3NGSs @ r=45"

WFE[nm]

450

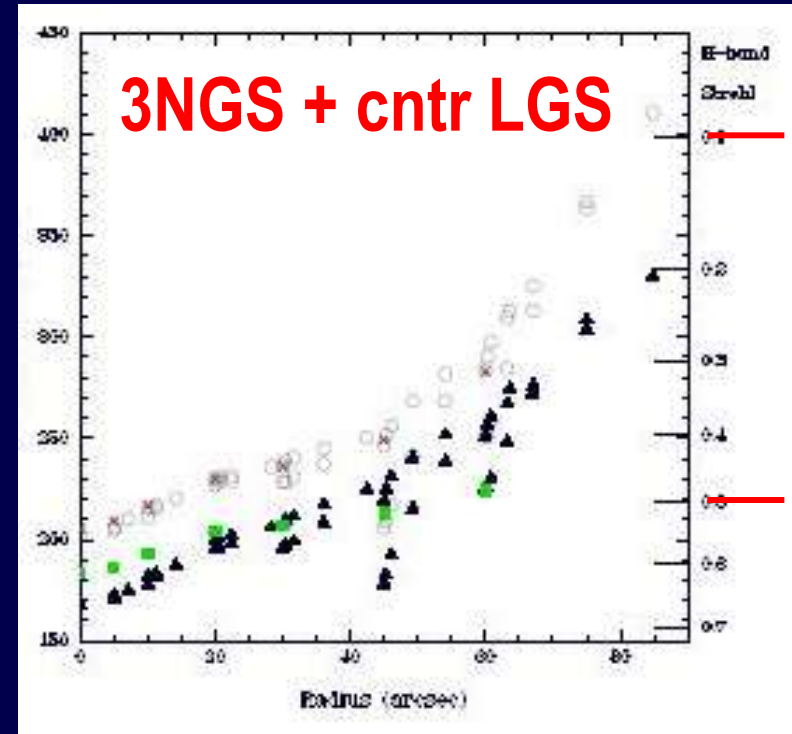
150



SR

0.1

0.5



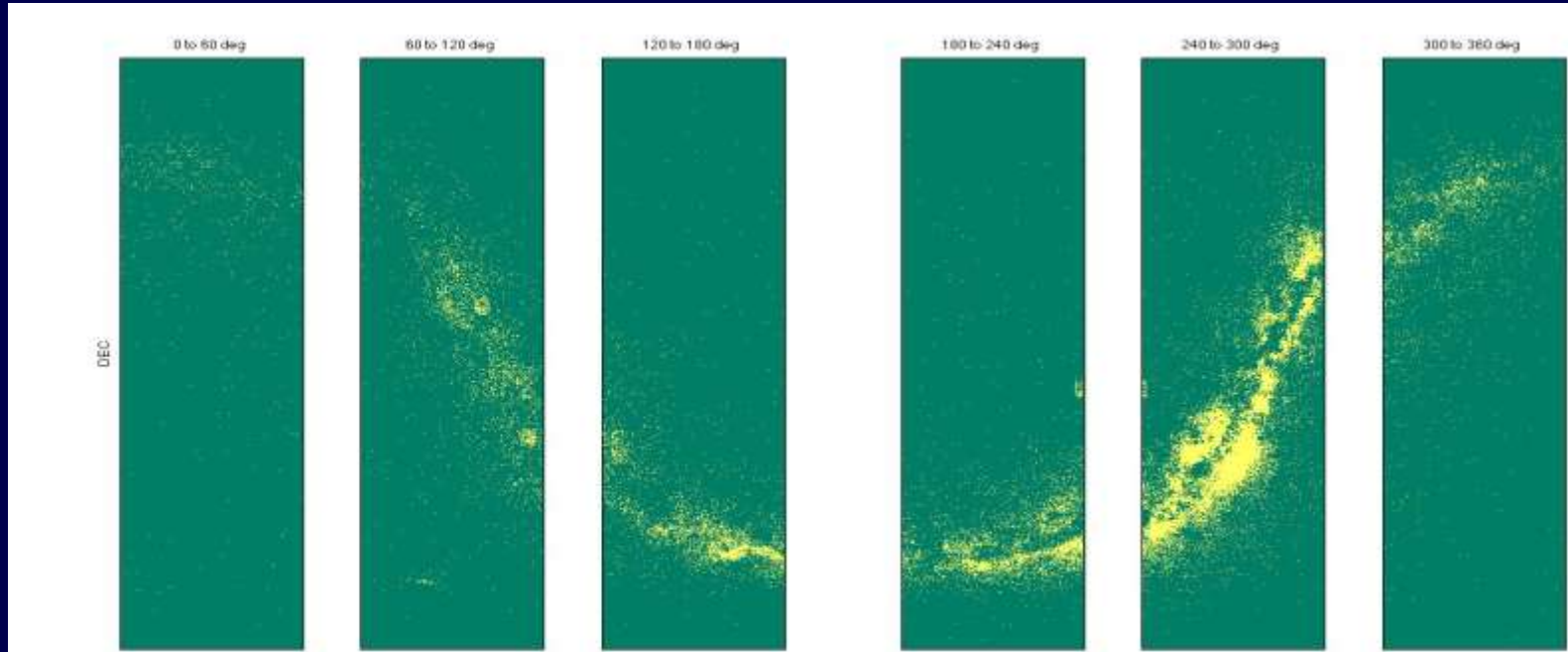
H-band

by D. Andarsen

X-axis: separation from the center of FOV in arcsec
Y-axis left: WFE in nm: ○ all modes; ▲ TT removed
right: SR × ; ■ EE

Sky Coverage

Obs. cond.: 3 NGSs ($R < 13\text{mag}$) within $2' \varphi$



RA [deg]	0 - 60	60 - 120	120 - 180	180 - 240	240 - 300	300 - 360
Sky Cov [%]	0.54	2.77	3.06	3.64	12.53	2.39

feasibility study is going on to ease the limit by:

by C. Blain

2NGS + 1LGS; $R < 14\text{mag}$; $2' + \alpha$ FoR

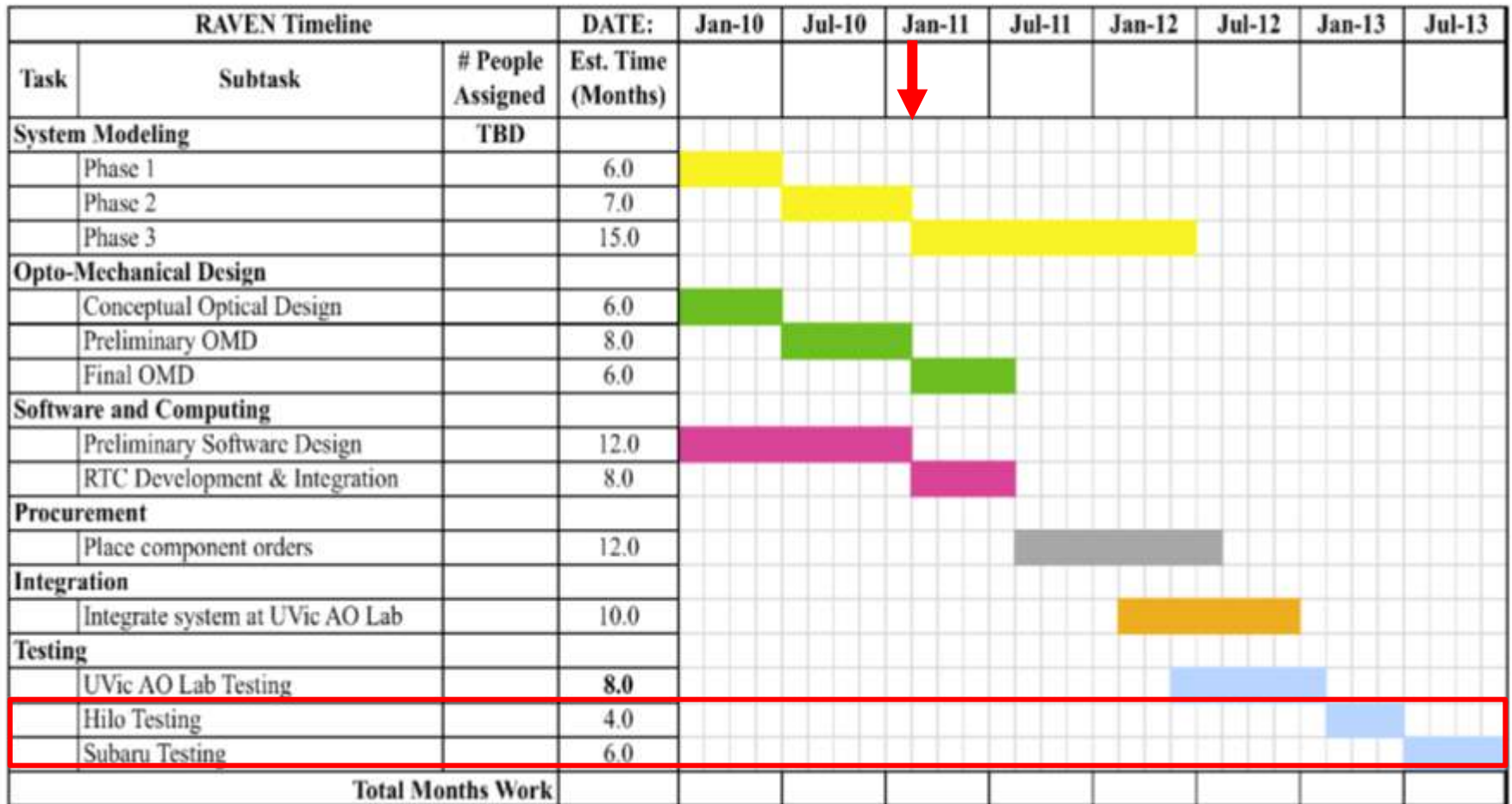
Science Case

- Metal poor stars
- Kinematic asymmetries in high- z disk galaxies
- Quasar pairs

If you are interested, please contact H. Terada, M. Akiyama, S. Oya. Especially, ideas on intra-galactic science are welcome because the sky coverage is almost limited to the Galactic plane.

2010/7/14

CoDR



Summary

- MOAO demonstrator
 - collaboration between Canada and Japan
 - project scale: 6M CAD / 3yr + α
 - targeting the 1st on 8m class telescope
- At Subaru Telescope
 - carry-in instrument ; uses IRCS @ NsIR (LGS?)
 - tomography, open-loop control & calibration
 - on-sky science verification
- Observation condition
 - 2 objects in 2' ϕ FOV with 3(2) NGS ($R < 13$)
 - max.SR@H=0.3 (3NGS); =0.5 (3NGS+1LGS)
 - help wanted for science case