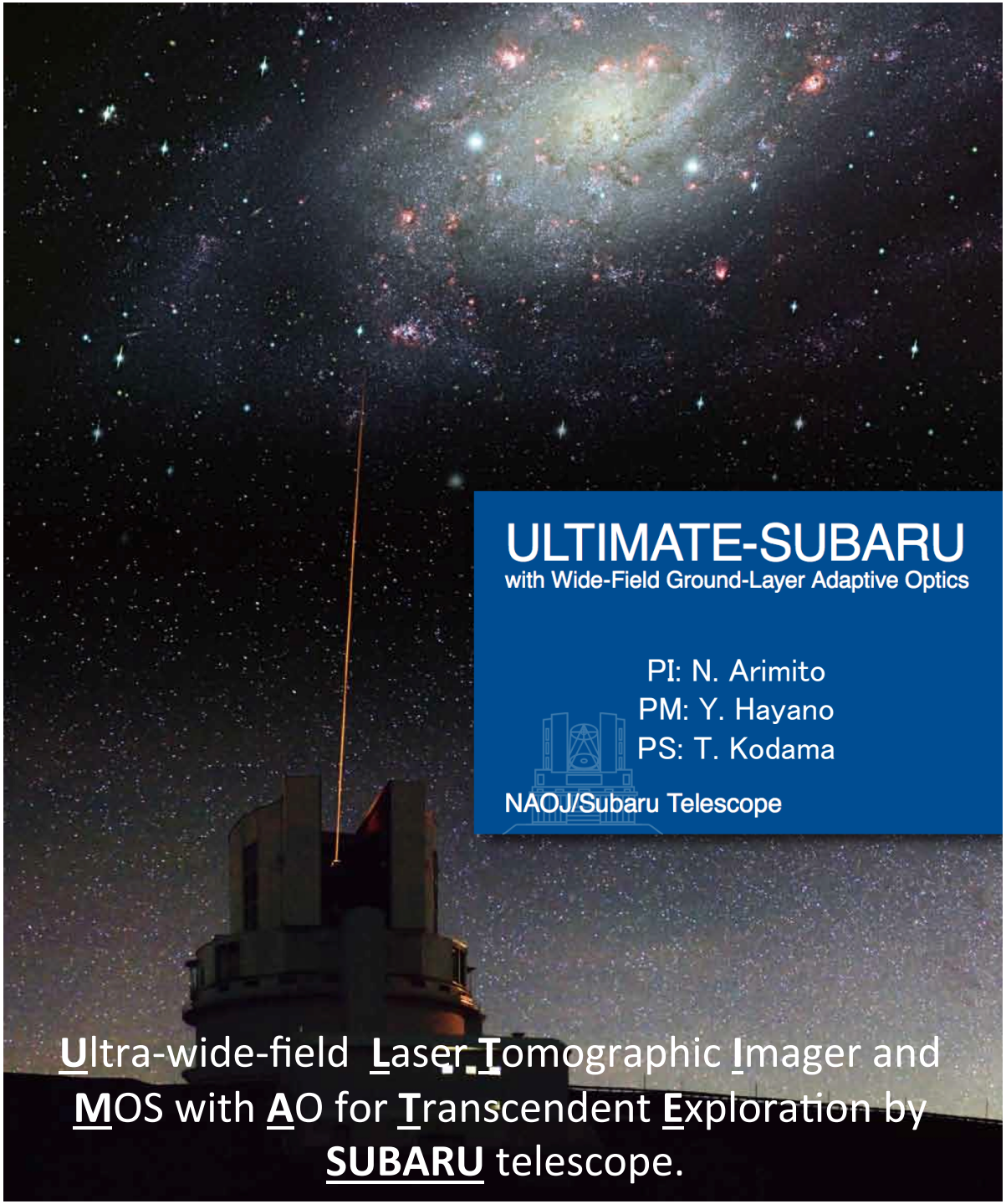
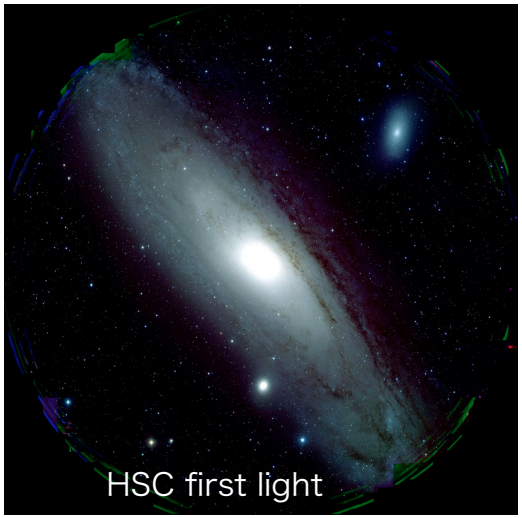
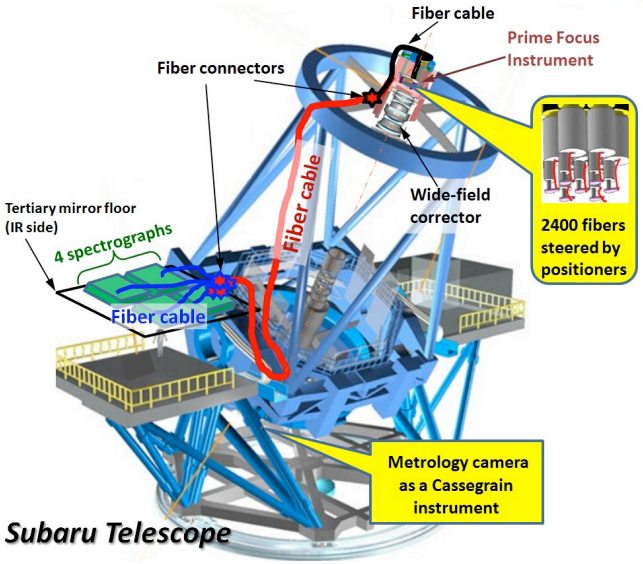

ULTIMATE-SUBARU
with Wide-Field Ground-Layer Adaptive Optics
PI: N. Arimito
PM: Y. Hayano
PS: T. Kodama
NAOJ/Subaru Telescope
Ultra-wide-field Laser Tomographic Imager and
MOS with AO for Transcendent Exploration by
SUBARU telescope.

Key instruments at Subaru Telescope

鼎(tripod pot)



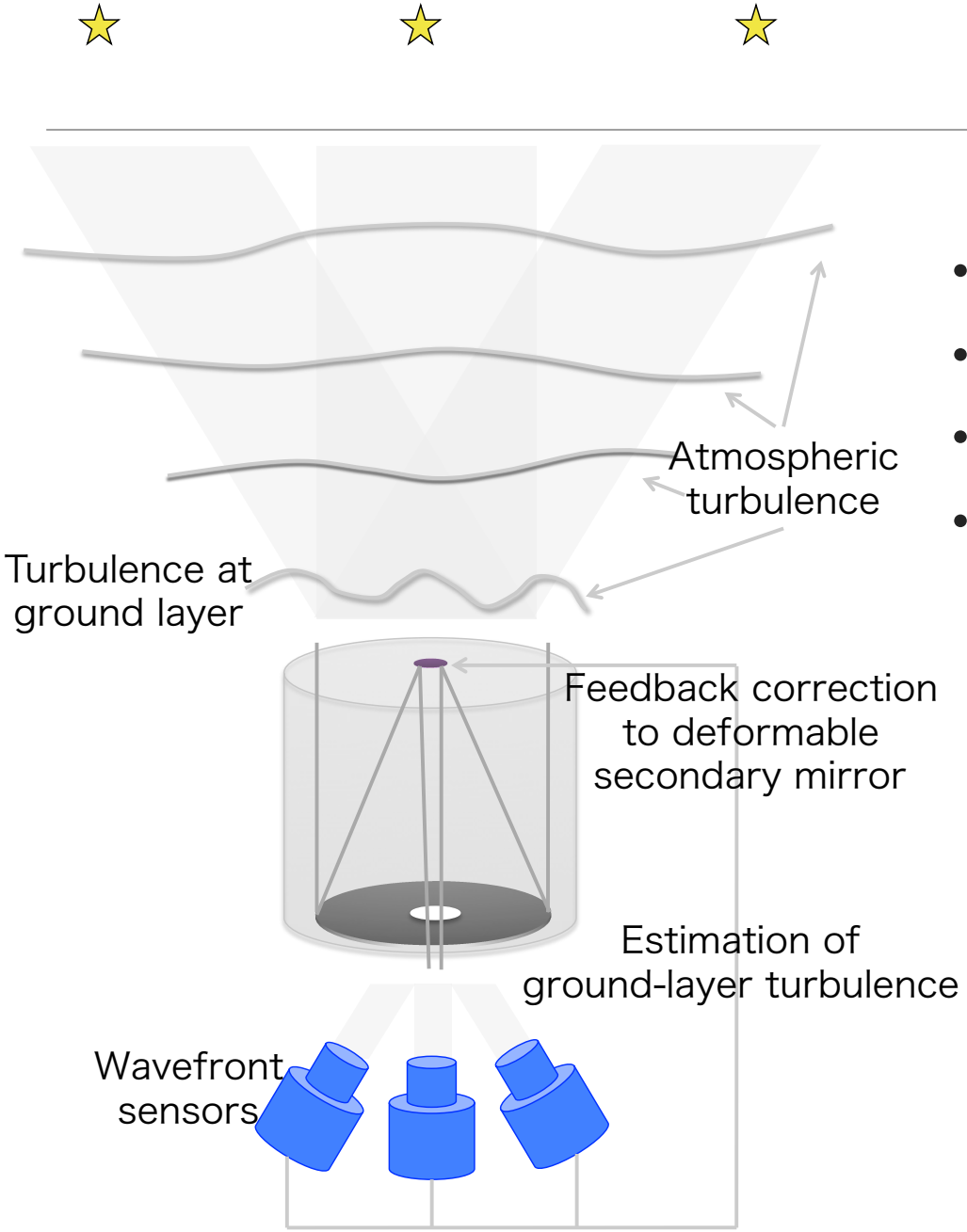


PFS (vis)

HSC (vis)

GLAO NIR instrument

Ground-layer adaptive optics (GLAO)



- **Deformable secondary mirror**
- **LGSs, NGSs**
- **WFSs**
- **3D atmospheric turbulence**

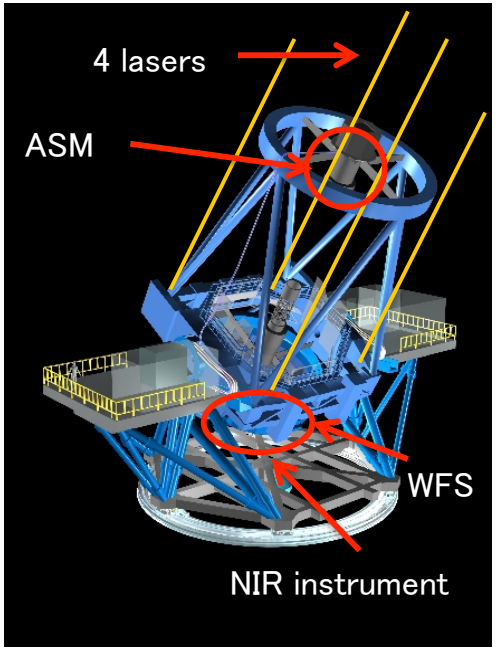
Overview

1. Ground Layer AO with Adaptive Secondary Mirror (4 LGSs)

2. Wide-field Near-IR Instrument (Imager + MOS or M-IFU)

→ Seeing Improvement (FWHM 0.4”→0.2”) over FOV ~15’

- **High Spatial Resolution Competitive to HST at NIR**
- **Higher Sensitivity Equivalent to 2x Telescope Aperture*1**
- **6 Times Wider Field of View*2**



- Targeted to Start Commissioning in 2020

*1 For point sources.
*2 Relative to MOIRCS (seeing limited NIR instrument)

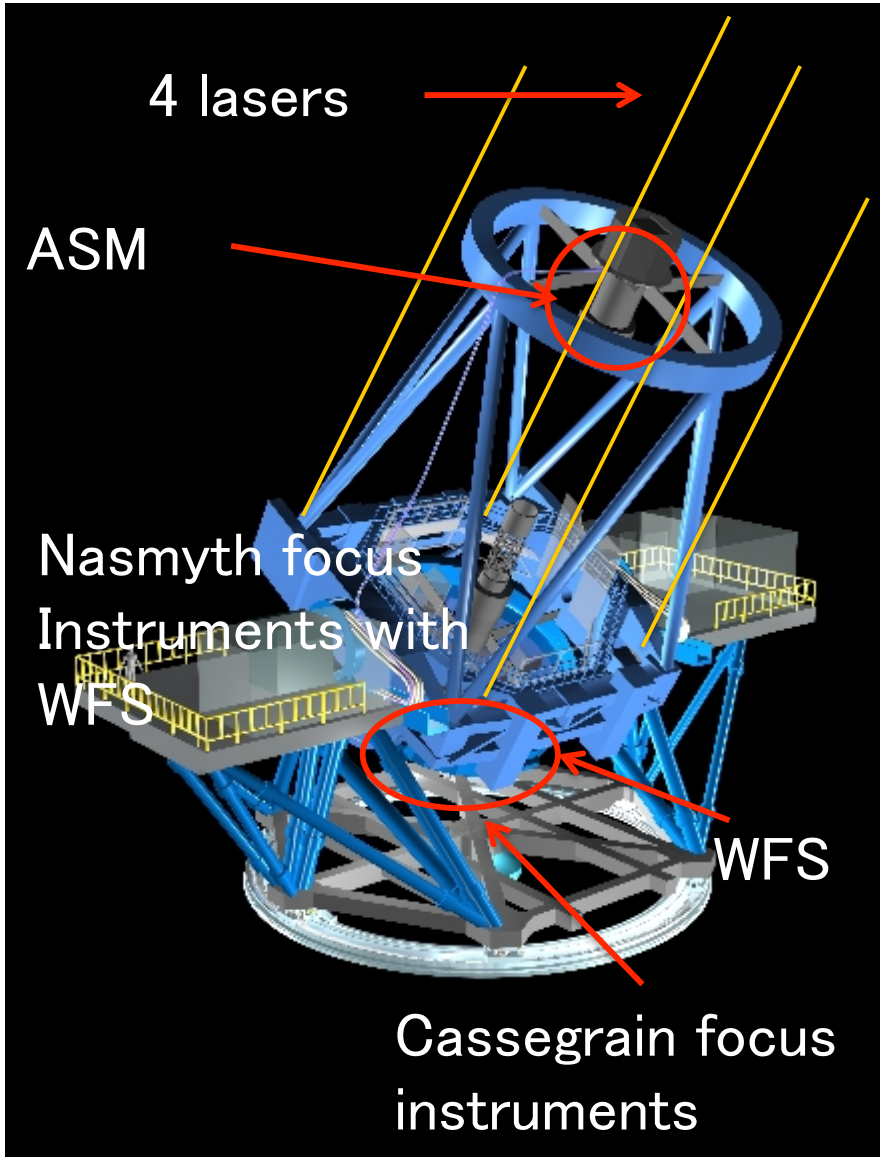
Science Target

- "Anatomy" of galaxies at z=1 – 3
  - *What are the key parameters to drive the galaxy evolution?*
  - *What determines morphologies of the galaxies?*
  - Large-Scale Near-IR Surveys (Imaging and spectroscopy) of about 5000 galaxies

- Discovery of the Most Distant Galaxies at z>7.5
  - Understand of the Cosmic Reionization
  - NBF imaging survey (∼180 arcmin^2), 100 galaxies.

  → Target sample for TMT.

Active/Adaptive Telescope



1. **Adaptive Secondary Mirror, WFS at each focus provides AO corrected images to instruments. (~1000 actuators)**

2. **Wavefront sensors are upgraded AG/SH (Auto Guider/Shack Hartmann) for telescope tracking and mirror analysis.**

GLAO - Specifications under Consideration

Guide stars	4 LGSs + 3 NGSs	
DM	Secondary mirror	~1000 actuators, modification of VLT ASM.
HO-WFS	> 8x8 SH	visible, EM-CCD(TBD)
TT(F)-WFS	2x2 SH or quad	visible
Laser	20 W CW	TOPTICA (589nm) (option: Rayleigh)
LGS constellation	15' in diameter	
Laser Launch	~25cm dia. (TBD)	side launch

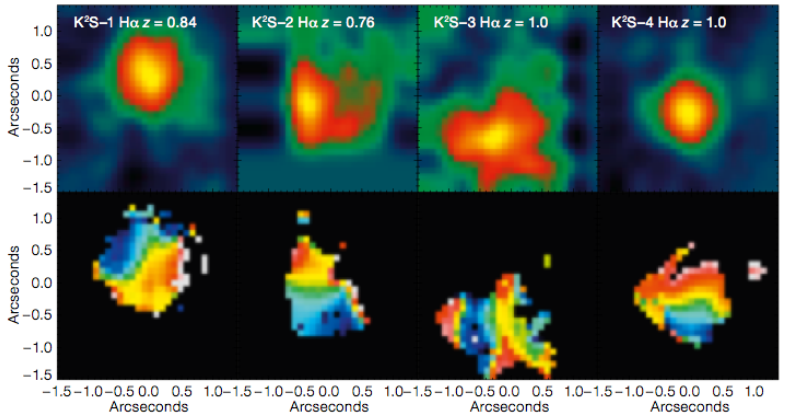
WFNIRIMOS - Specifications under Consideration

Wavelength	0.8-2.5μm	
Plate Scale	0.06-0.1”/pix	
FoV	approx.13‘x13’	Wider with Split FoVs?
Filters	Broad+Narrow	R?, I,z,J,H,K, NB
MOS	Multi Slit Mask	Alternatively Multi-IFU
λ Dispersion	2000(TBD)	Under Investigation

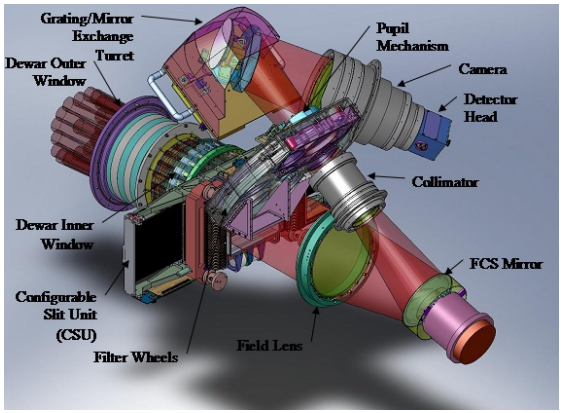
Prepared by I. Iwata

NIR instruments at other 8-10m class telescope

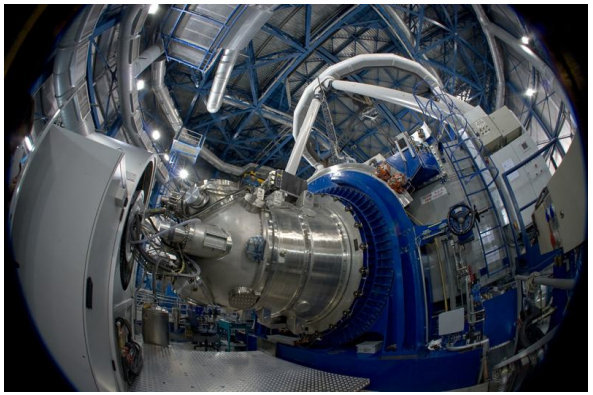
- Keck MOSFIRE, NGAO
- VLT HAWK-I + GRAAL
- VLT SINFONI, KMOS
- Gemini GeMS, GPI, FLAMINGOS2



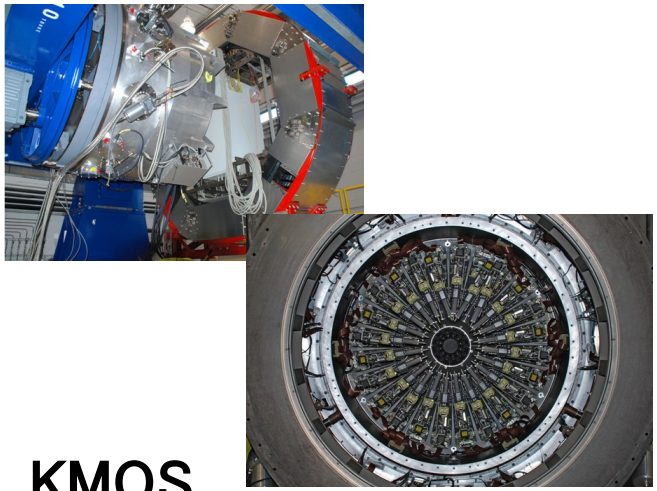
Under lined: with AO, Red: GLAO



MOSFIRE

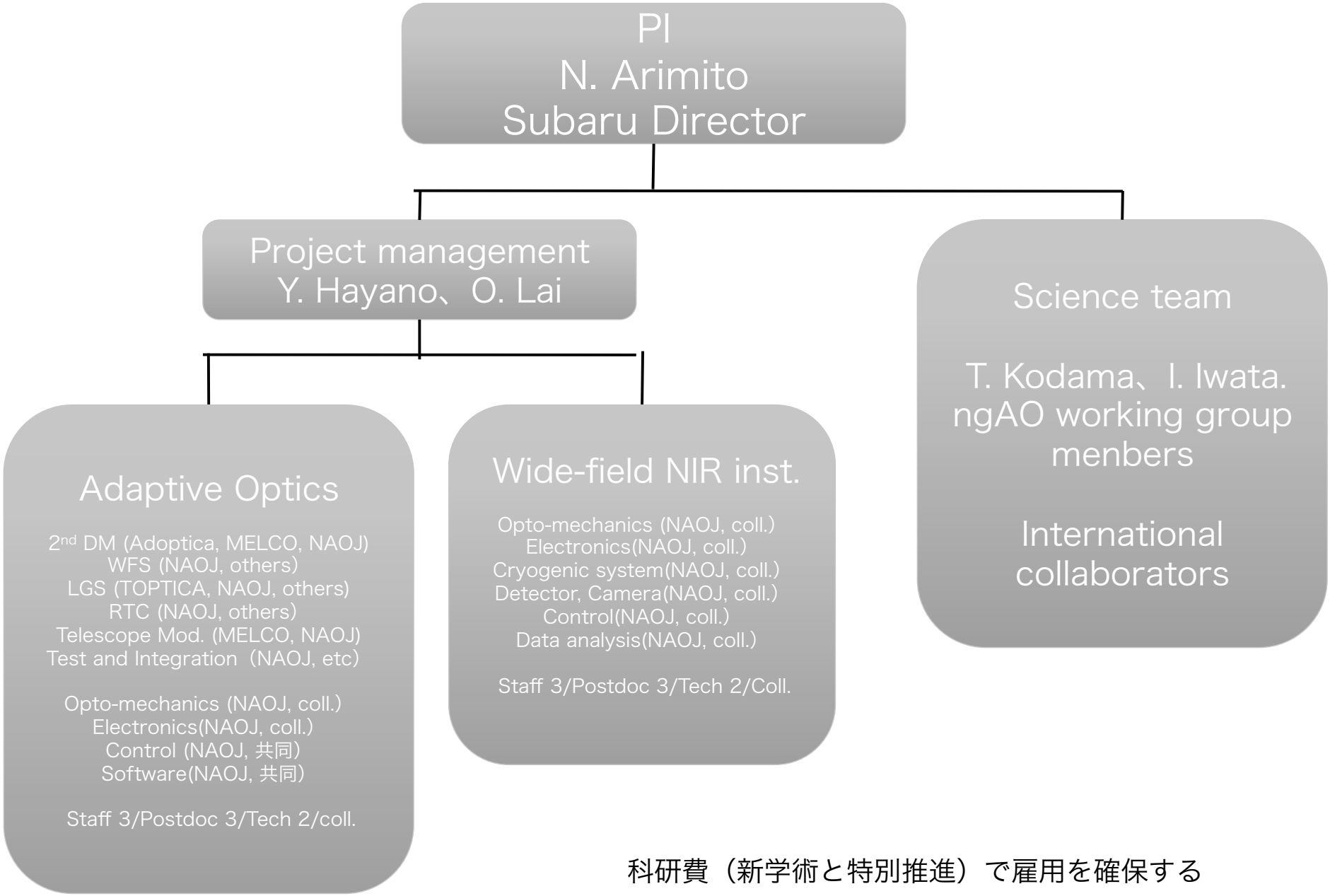


HAWK-I



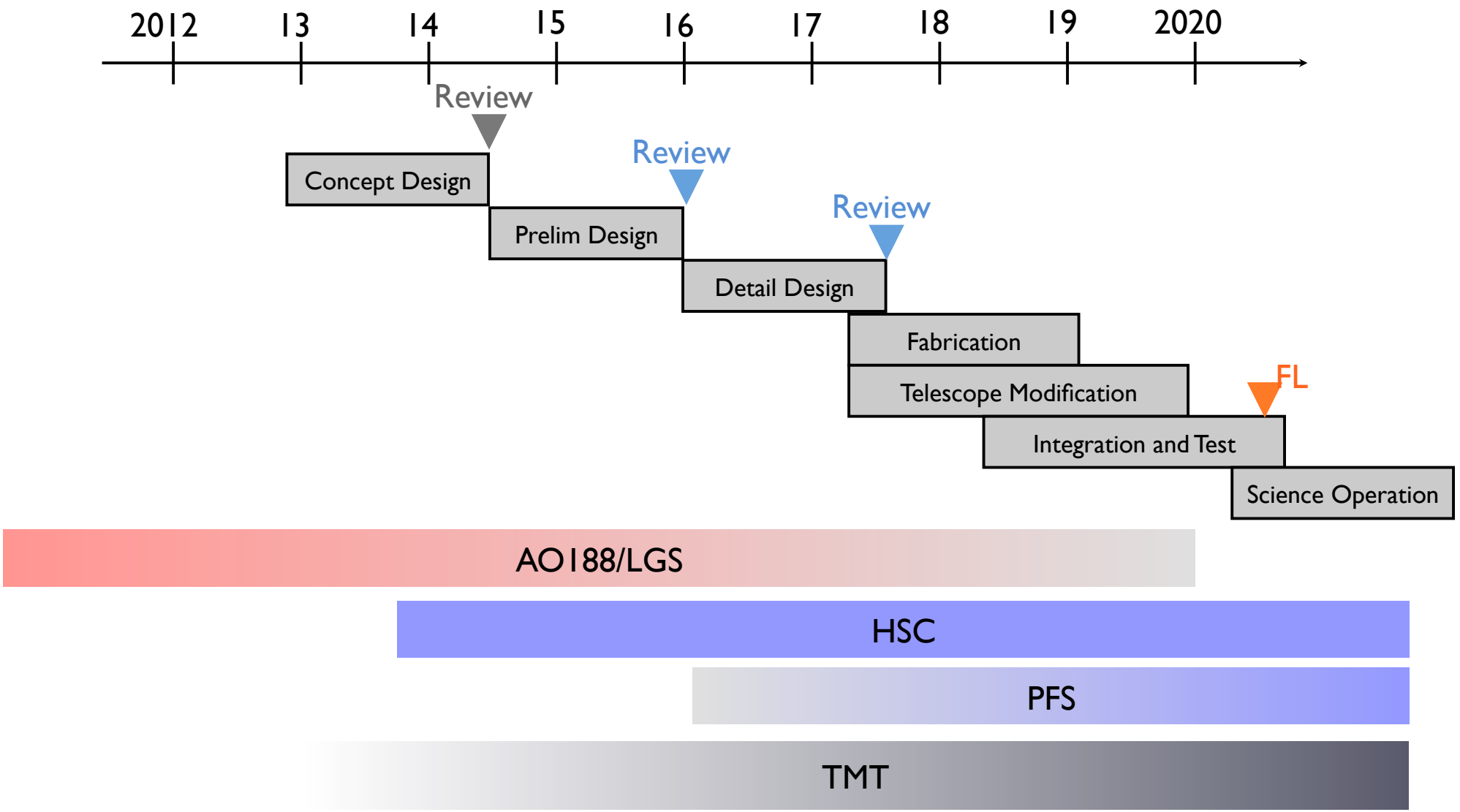
KMOS

ULTIMATE-SUBARU organization



科研費（新学術と特別推進）で雇用を確保する

Schedule


2012
13
14
15
16
17
18
19
2020
Review
Review
Review
Concept Design
Prelim Design
Detail Design
Fabrication
Telescope Modification
Integration and Test
Science Operation
FL
AO188/LGS
HSC
PFS
TMT

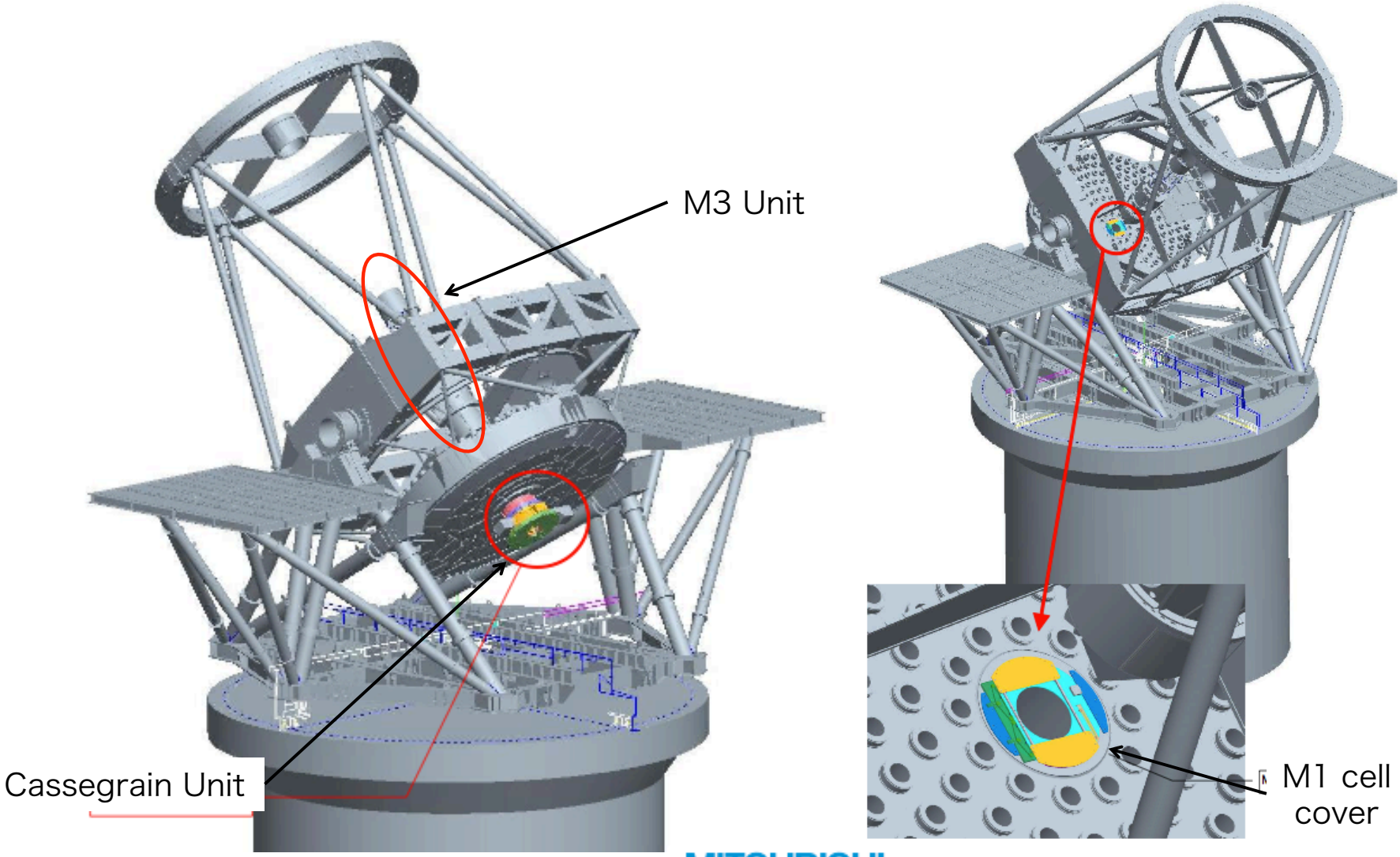
費用の見積（現在）

項目	予算額（億円）	予算獲得プラン
可変副鏡	~ 4	科研費(特別推進)、2015から5年間 Adoptica(Microgate, ADS intl.) 製作予定 （現赤外副鏡を流用）
レーザーシステム	0.4 – 4	科研費(新学術領域)、2015から5年間 TOPTICA/MPBC製作予定 （AO188レーザーアップグレードで準備中。レイリーレーザーなら約1/10のコスト）
波面センサーシステム	~ 1	上に同じリソース NAOJ主体製作、HIA協力の可能性あり （カセグレン改造費用を含めていて望遠鏡改造費とだぶっていた）
制御計算機	~ 0.2	可変副鏡と同じリソース TMT用のダウングレード版
望遠鏡改造・改修	5 – 8	運営費（IR副鏡流用、AG/SH機能の併合）
観測装置	0 – 10	初期はnuMOIRCSを利用 新装置は国際協力で製作（候補はHIA、ASIAA, AAO） （AAOのStar Bugと光ファイバー技術を用いるとnuMOIRCSでIFUを実現できる）
人件費	~ 2	In-kind貢献も含む（特別推進後の基盤Sに応募）
予備費	~ 5	
総額	17.6 – 34.2	

新学術領域は生物用補償光学系の研究グループと連携し、波面センサー、レーザーシステムを開発する

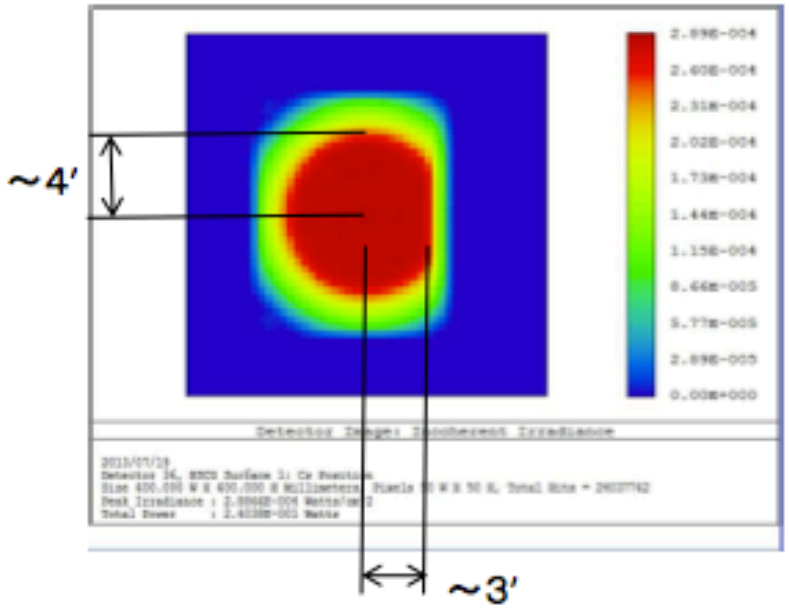
特別推進：可変副鏡製作、nuMOIRCS+GLAOを用いたサイエンスを柱とする

Vignetting by telescope structures

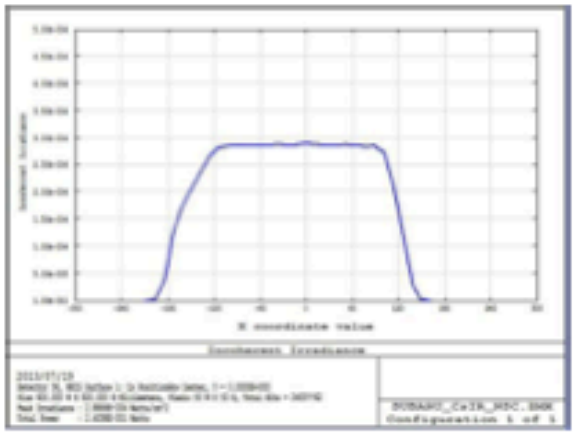


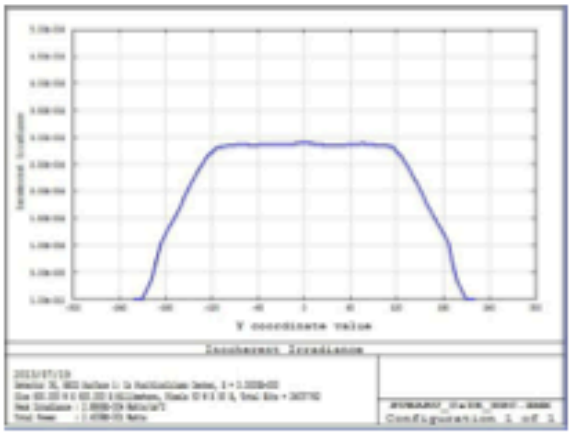
MITSUBISHI
Changes for the Better

現状のカセグレン焦点の視野

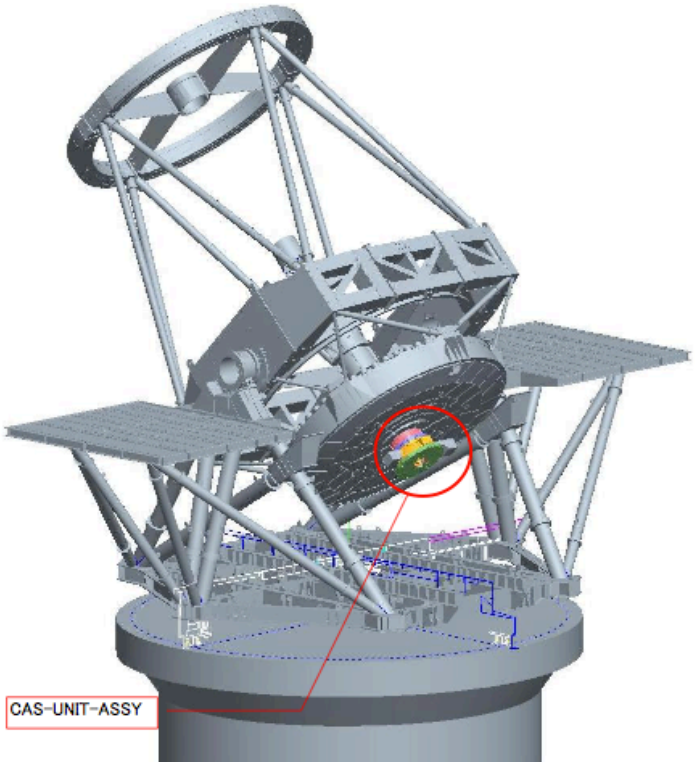


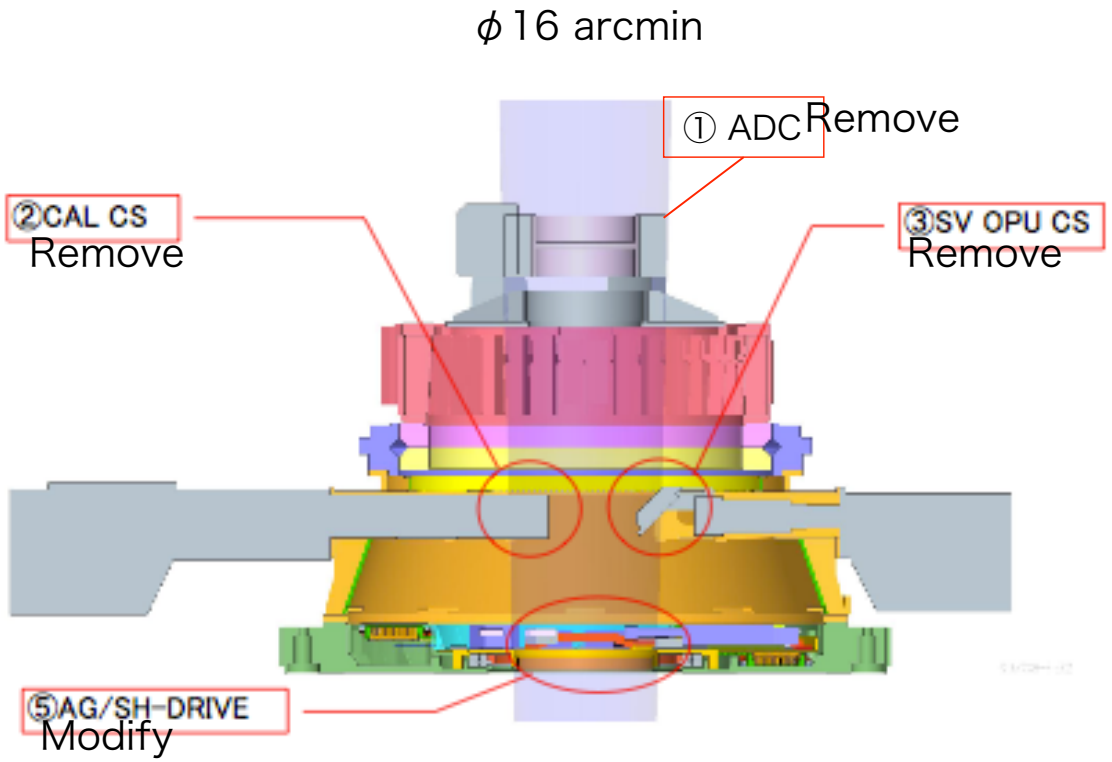
ケラレを生じる視野角度
X方向　100mm（約3′）
Y方向　110mm（約3′40″）





Cassegrain Unit





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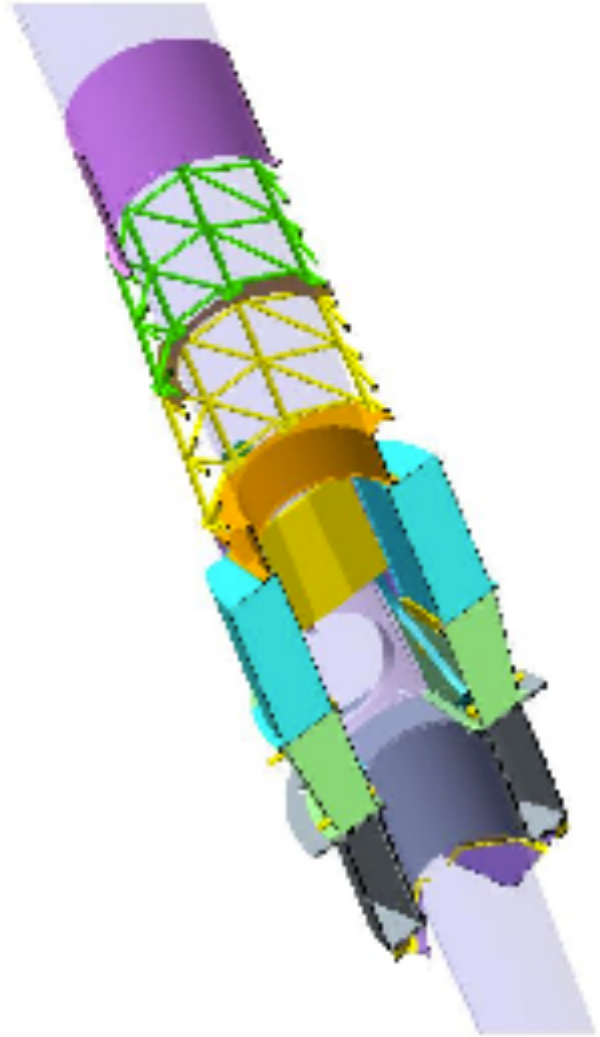
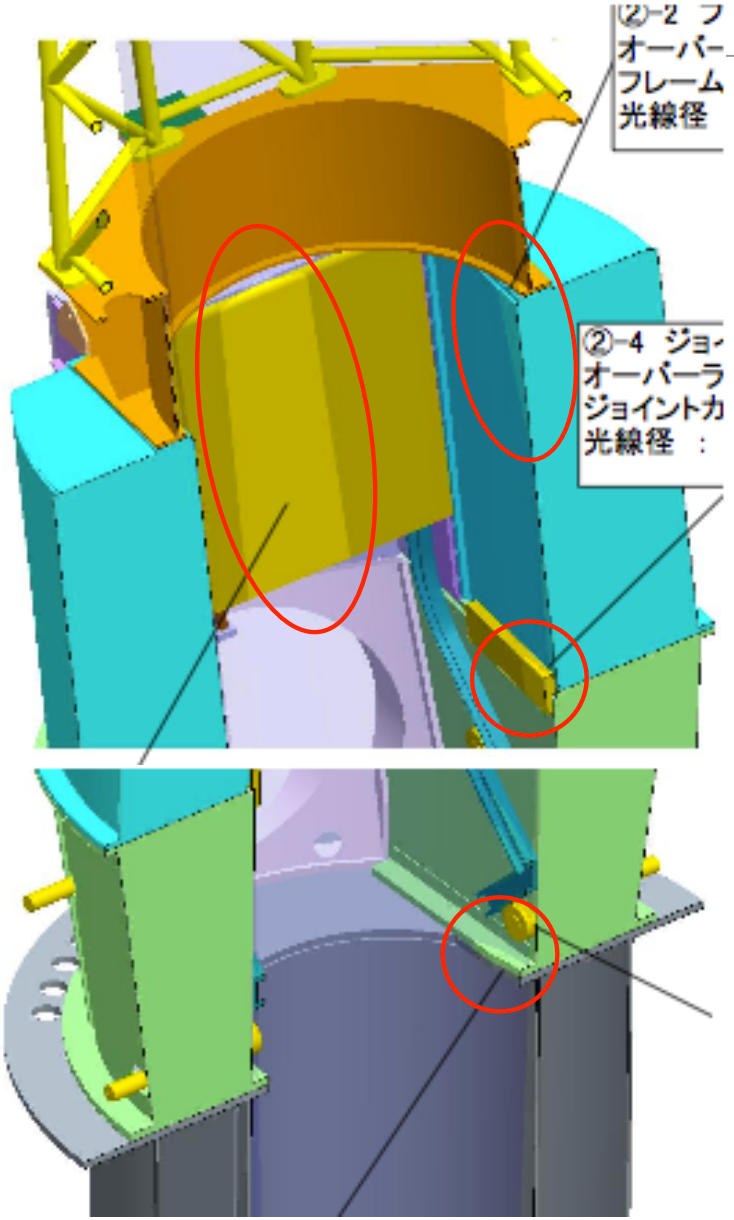
M3 unit

ϕ16 arcmin





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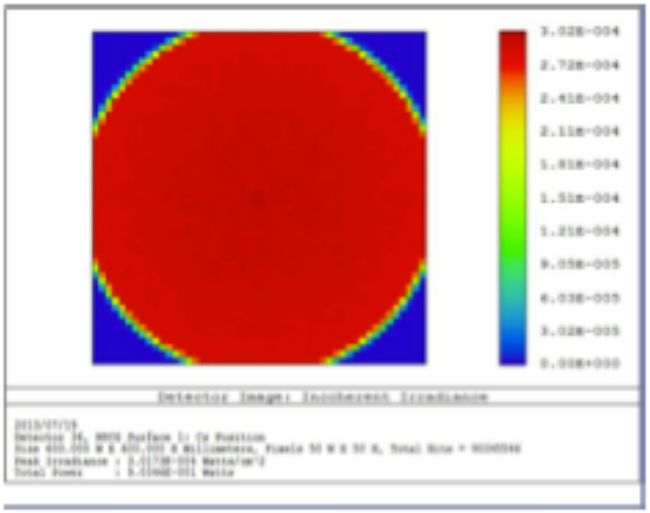
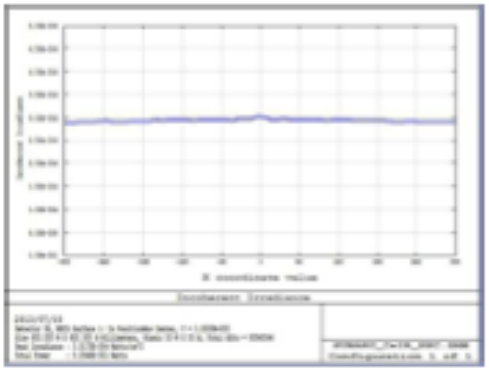
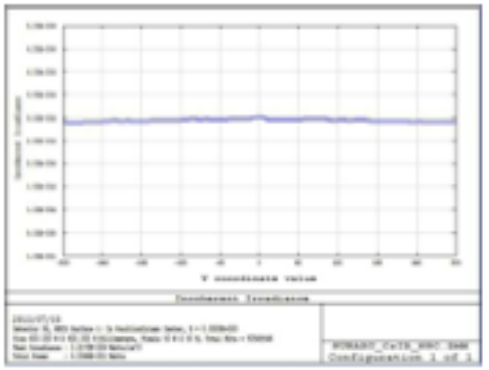
Changes for the Better

FoV at Cassegrain

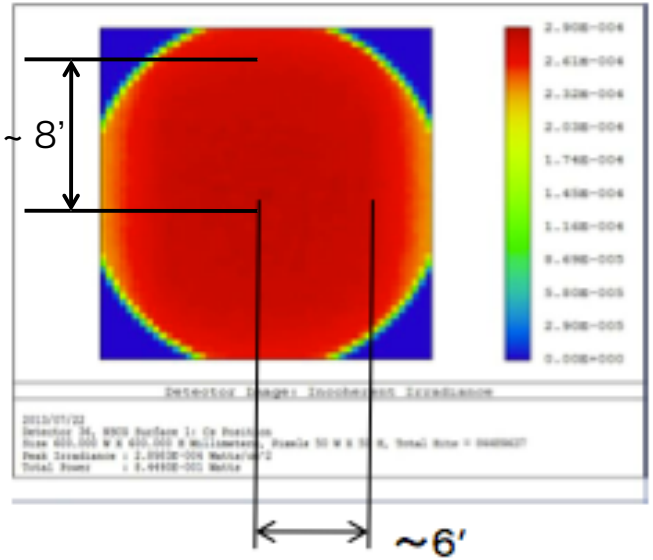
Only M1, M2

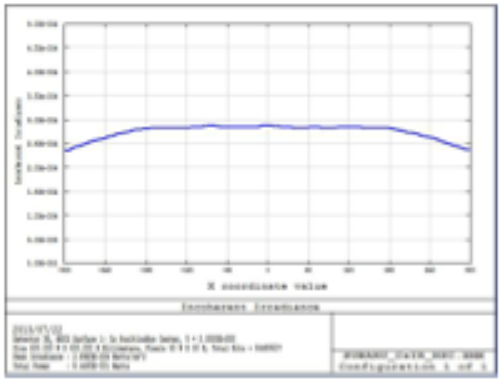


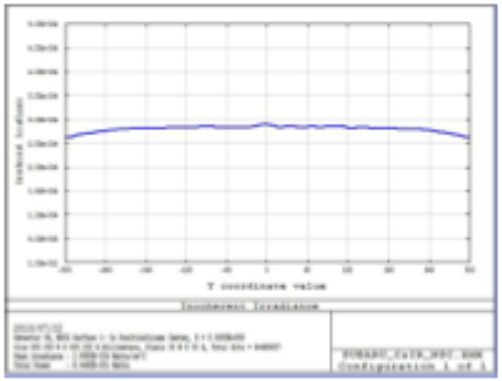




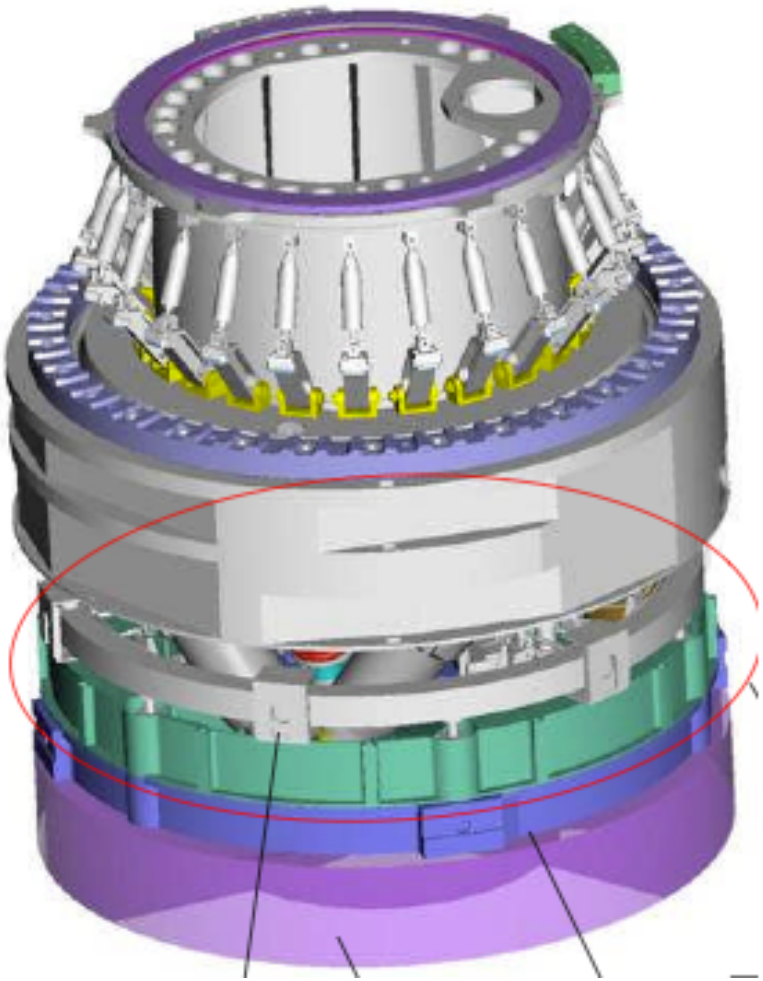
With M3 unit

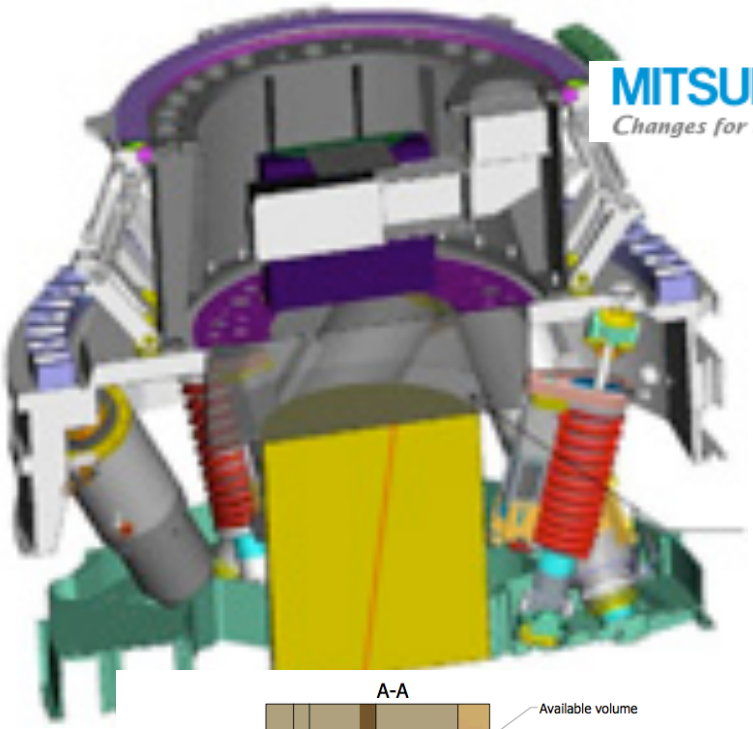


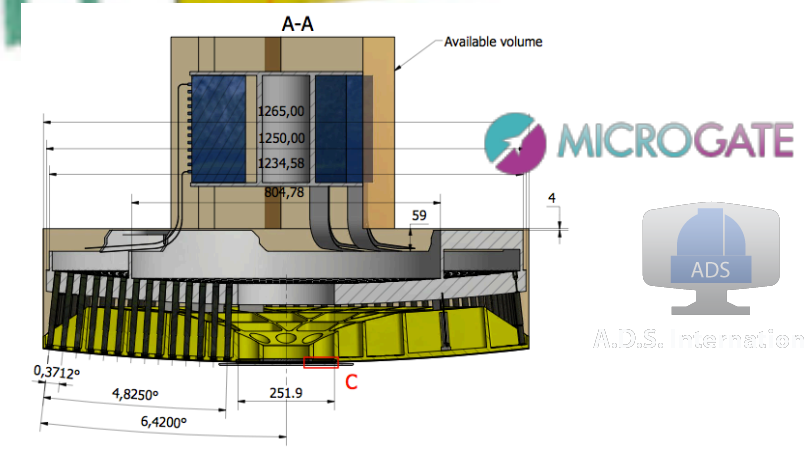




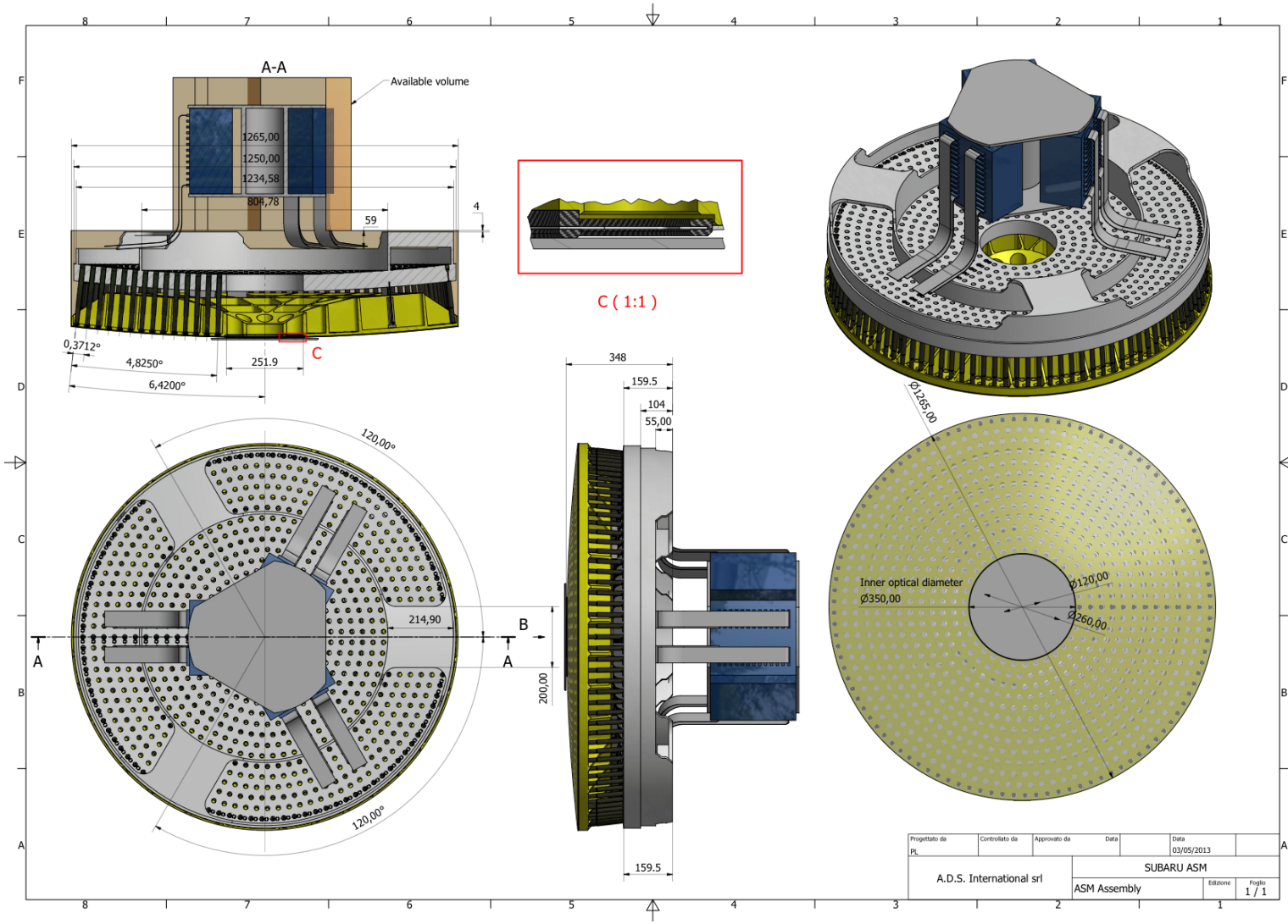
Interface to existing IR M2







Preliminary model for ASM



Mirror Dia: 1265mm

Actuators: 924
Spacing: ~ 35 mm

Center obscuration:

350mm

MICROGATE

ADS

A.D.S. International

Major Mile Stones

- Formed project working group — Jan. 2011
- First science workshop at Osaka — Sep. 2011
- Science case and feasibility Study report — Aug. 2012
- Second science workshop at Sapporo — Jun. 2013

- Conceptual design review — 2014
- Application to Grand-in-aid scientific research — Oct. 2014
- Preliminary design review — 2015
- Final design review — 2016
- Start fabrication — 2017
- Engineering first light — 2020年