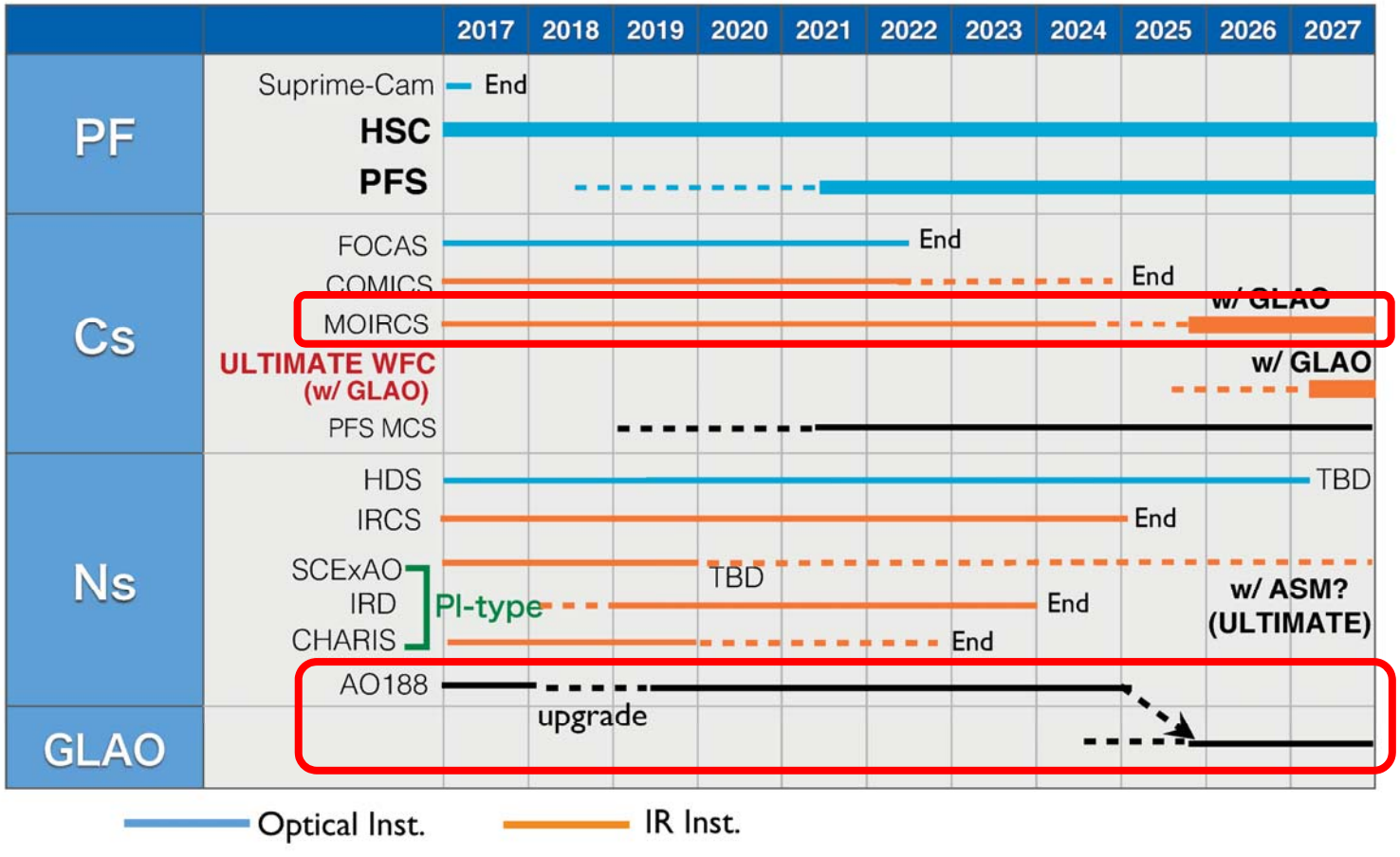
ULTIMATE Instrument Plan

Takashi Hattori (Instrument Division, Subaru Telescope)

2018/1/15 ULTIMATE-Subaru Collaboration Meeting

Instrument Plan

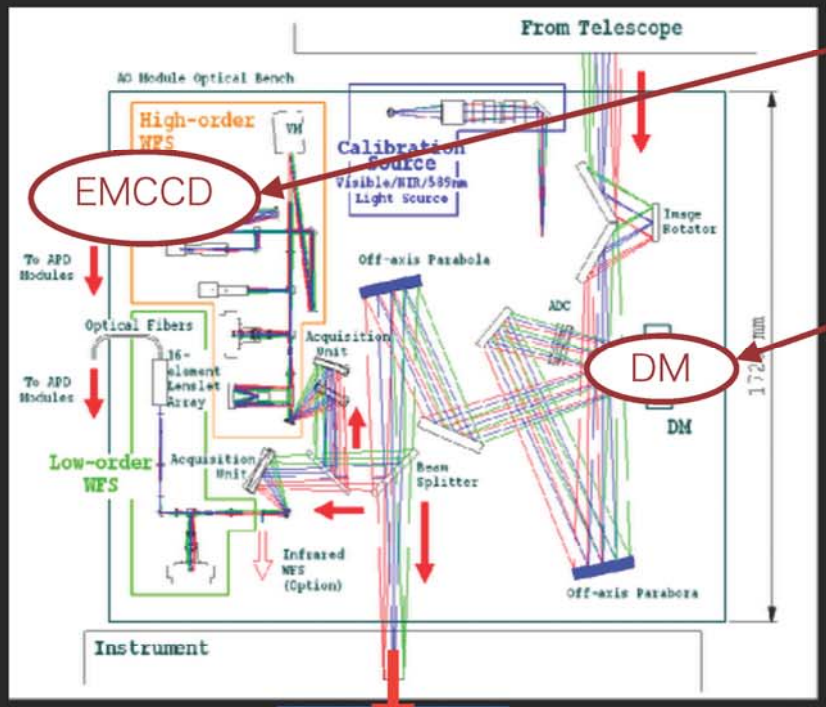
Subaru Telescope Instrument Timeline (version 2017/12/28)

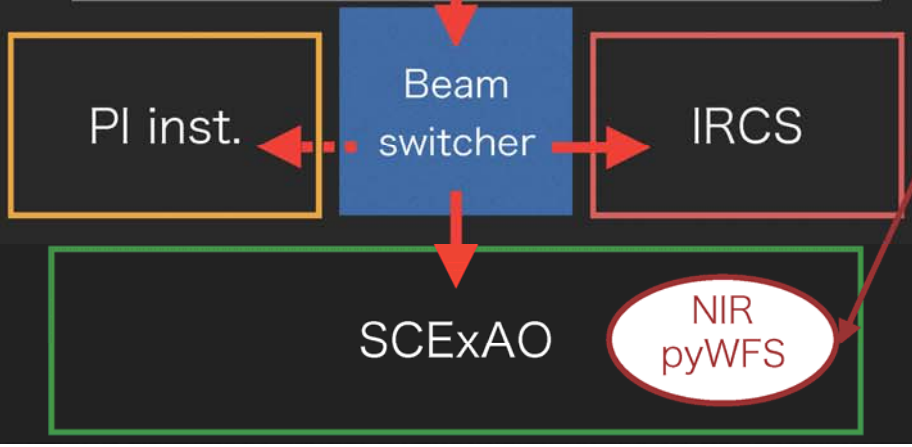


LGSAO188 upgrades

- ongoing projects
  - new real-time control system
  - TOPTICA fiber laser system
  - wavefront sensors for tomography

LGSAO188 : future upgrades





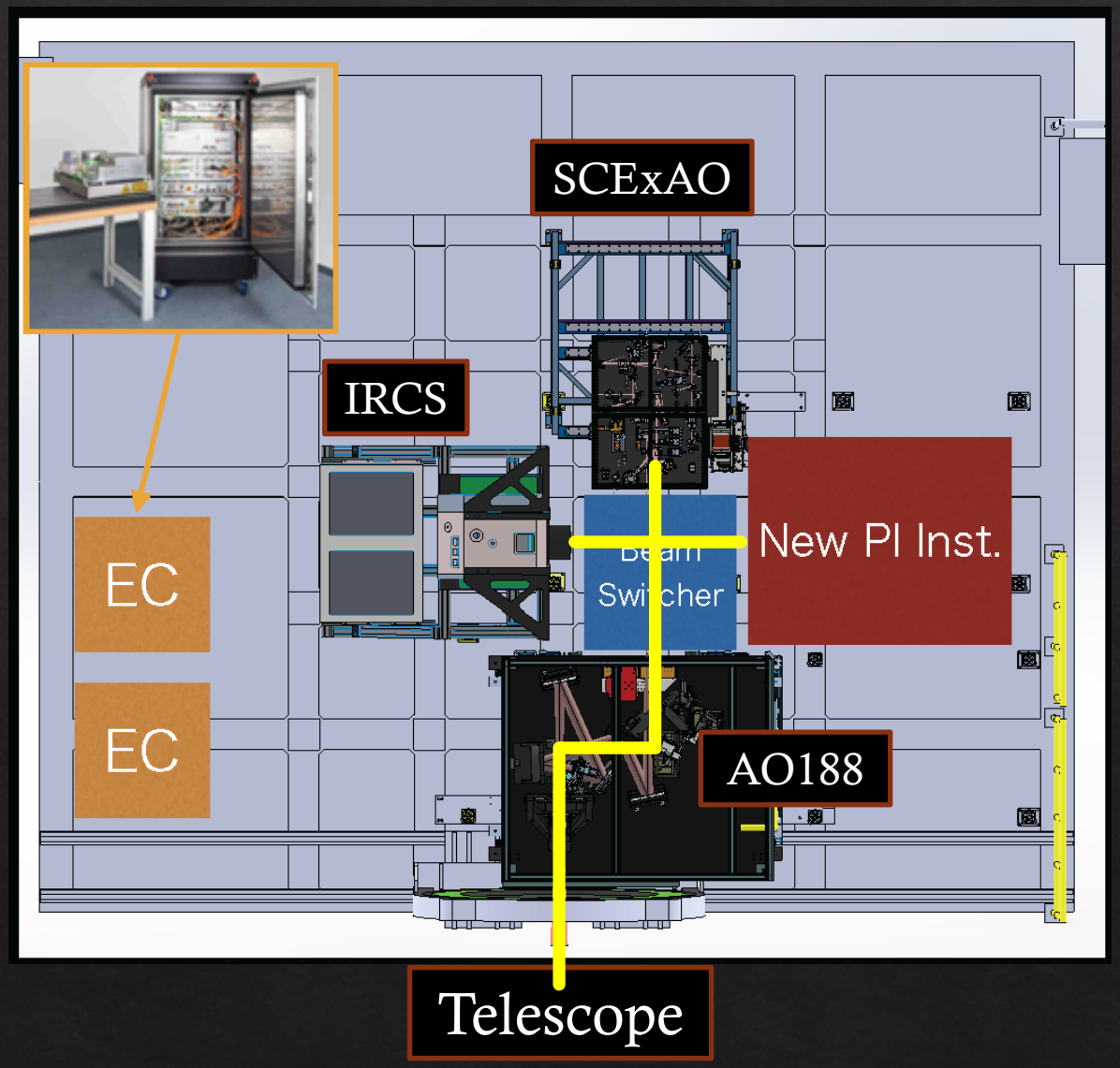
1. Replace APDs by EMCCD for HOWFS
   - high speed, low noise, and high dynamic range
   - APD will saturate with a new laser system (R~7mag)

2. Replace DM
   - ALPAO 64x64 DM is a candidate to meet the requirement for the pupil-size and stroke.
   - Faster response than the existing bimorph DM
   - Enable extreme AO only with AO188
   - Evaluate and demonstrate the equipment for 30m class telescope.

3. Implement NIR pyWFS to SCExAO
   - Pyramid WFS with a NIR eAPD array will provide better performance than visible curvature WFS
   - Enable extreme AO with 64x64 DM
   - NIR low-order WFS for LGS mode

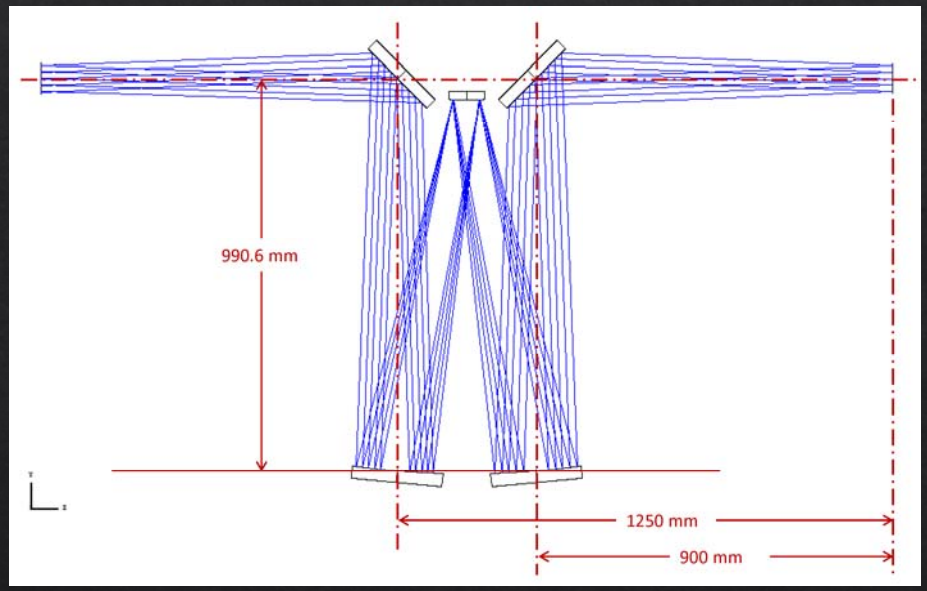
NsIR Beam-Switcher

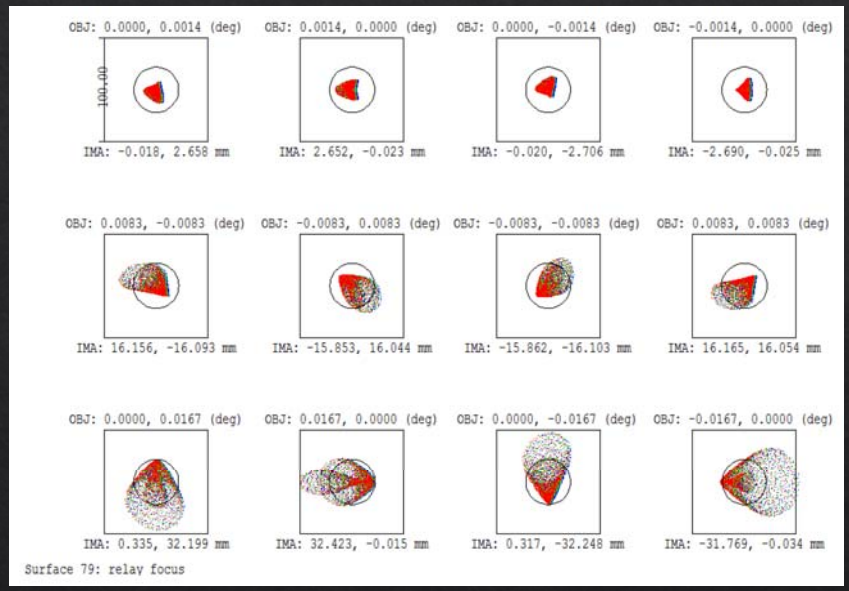
- after AO188
- Offner relay + switching-mirrors
- dynamically switch the instruments
- beam-splitter to use two instruments at the same time



NsIR Beam-Switcher

- working with AAO for the design



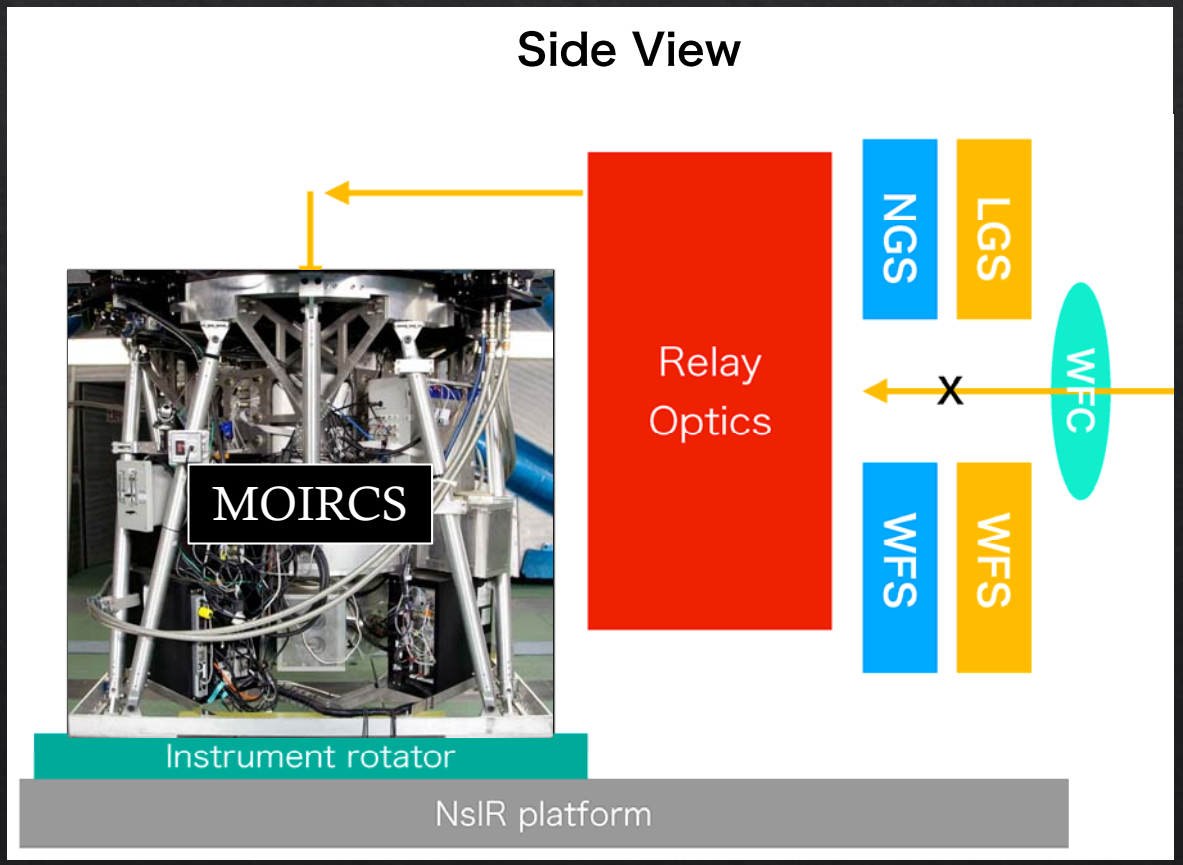


Peter Gillingham@AAO (2017/12/4)

MOIRCS@NsIR

- relay optics (for multiple instruments)
- instrument rotator
- better stability and performance

Example of possible layout

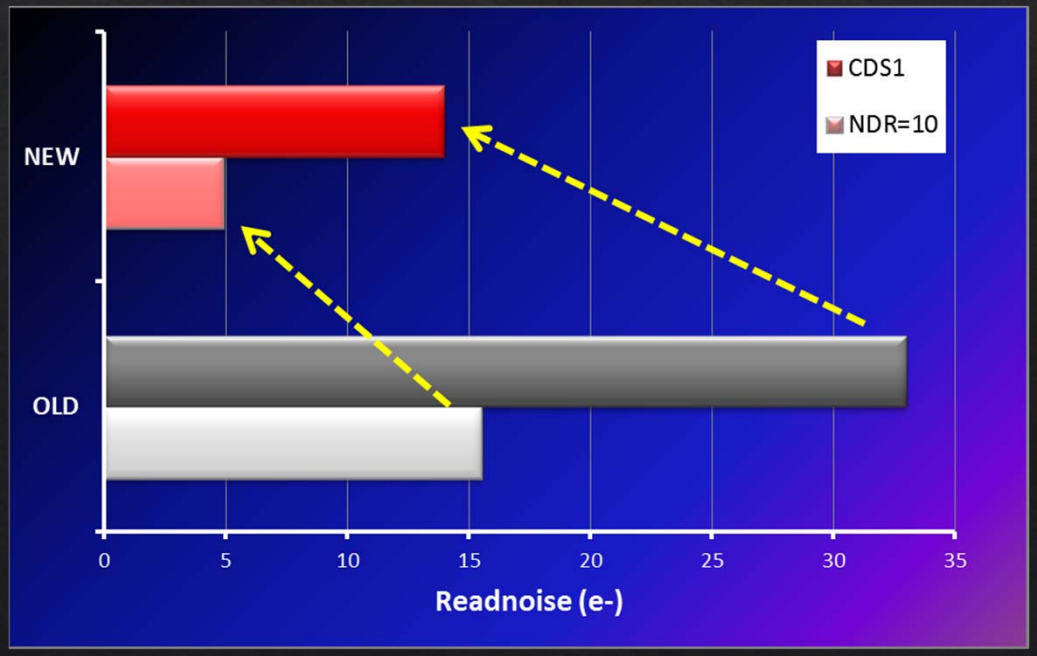


MOIRCS : upgrades and performance improvements

- detector upgrade (done)
  - Hashiba (Univ. of Tokyo), Yen-San Hu (ASIAA)
- grism upgrade (ongoing)
  - Ebizuka (RIKEN), Kodama (Tohoku Univ.)
- low-scatter MOS mask (testing)
- IFU, focal-plane modification (testing)
  - Ishigaki (Iwate Univ.)

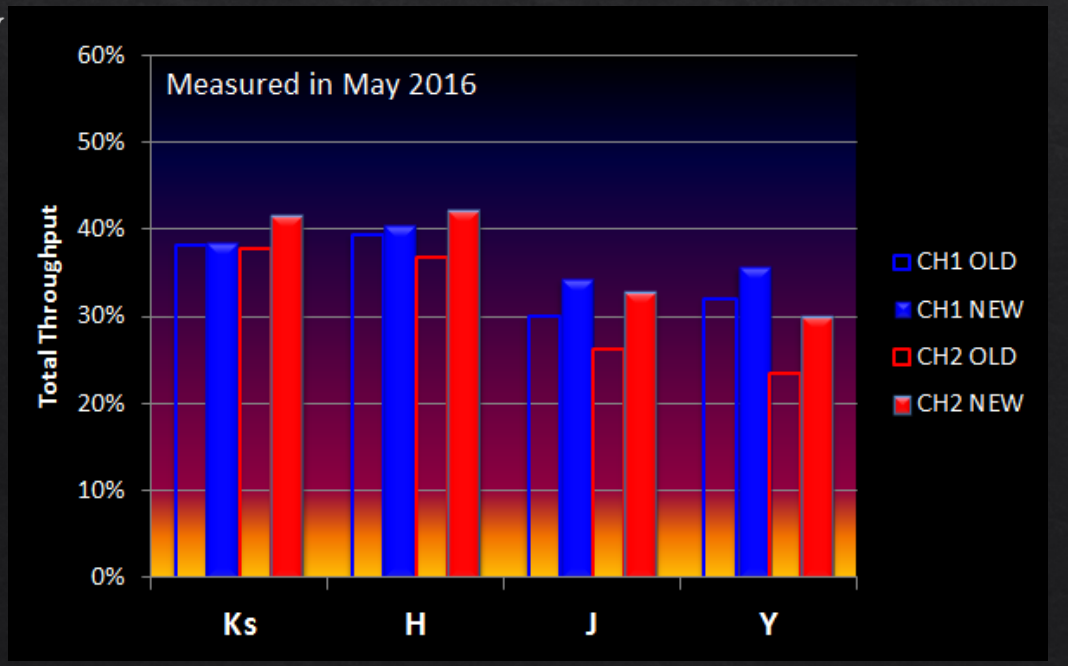
MOIRCS : Detector Upgrade (2016)

- Installation of Hawaii-2RG+ASIC+SAM
  - Better cosmetics and latent effects
  - Faster readout with 32ch
  - Lower readout noise
    - ~5e with 10 multi-sampling



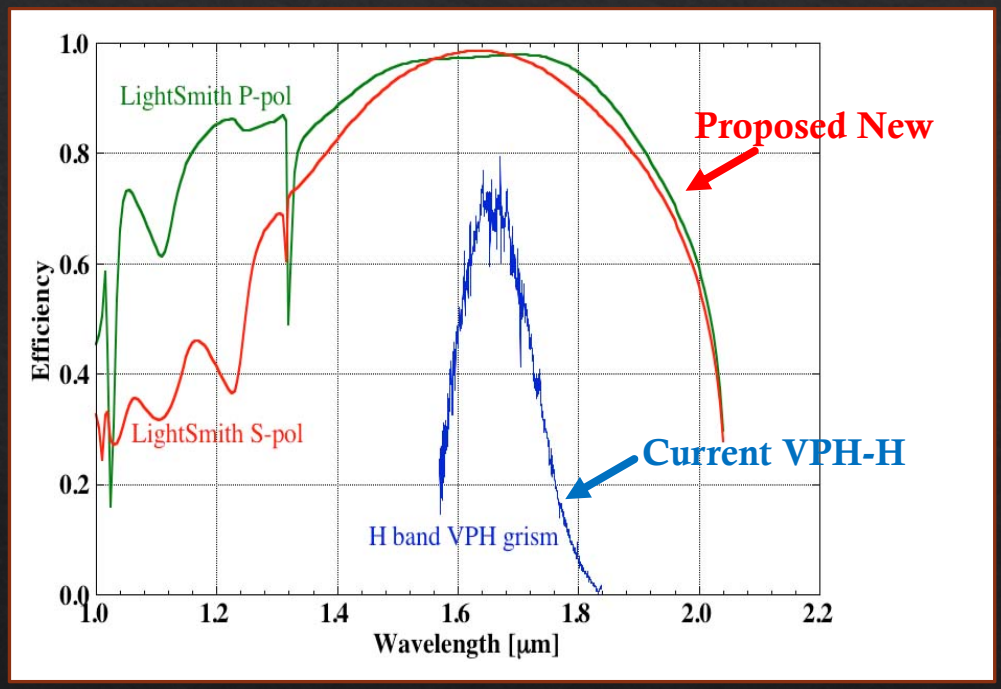
MOIRCS : Detector Upgrade (2016)

- Installation of Hawaii-2RG+ASIC+SAM
  - Better cosmetics and latent effects
  - Faster readout with 32ch
  - Lower readout noise
    - ~5e with 10 multi-sampling
  - Higher quantum efficiency



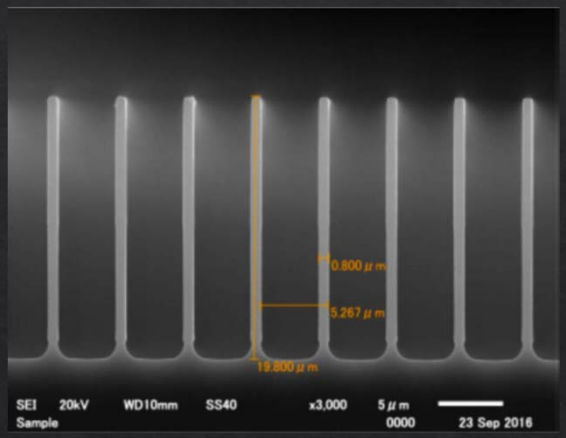
MOIRCS : Grism Upgrade

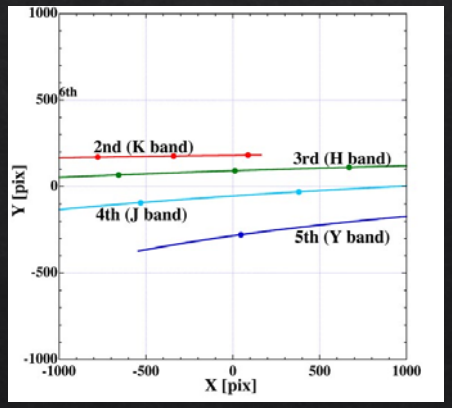
- Transmission Grating by LightSmyth
  - replace with the current VPH grisms
    - R~2700 with 0".5 slit
  - high diffraction efficiency
  - wide spectral coverage
  - low scattering

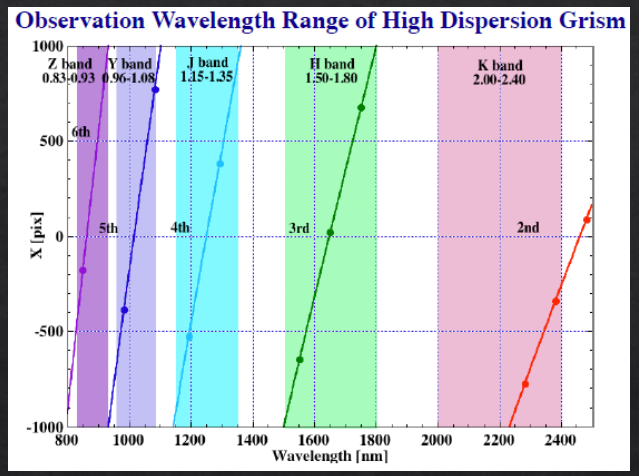


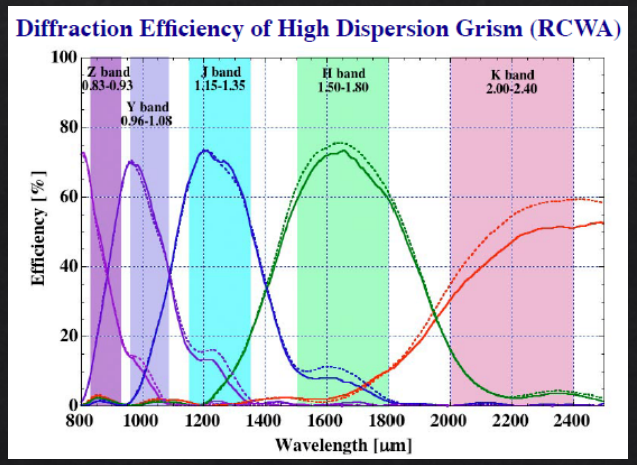
MOIRCS : Grism Upgrade

- Echelle Grism
  - High Dispersion Volume Binary Grating (Ebizuka@Riken)





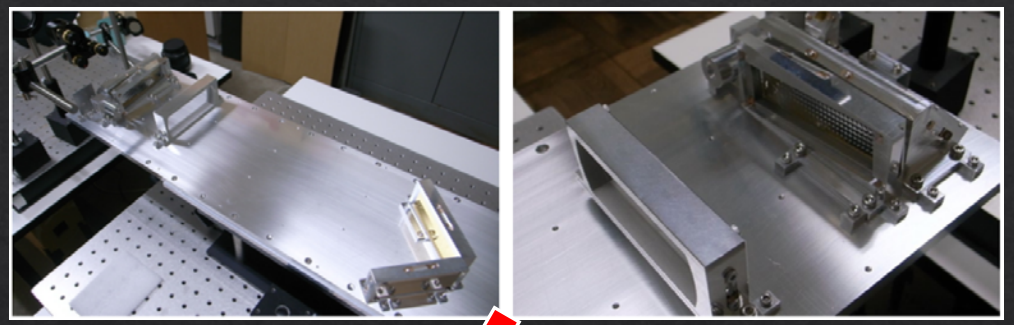


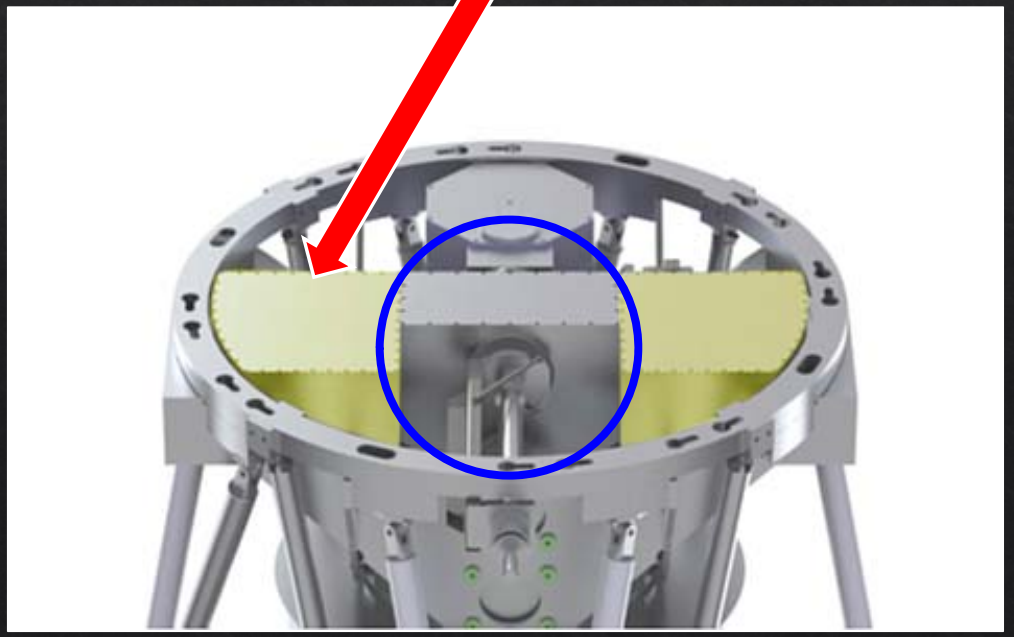


Cross Disperser: 12.1deg GaAs + 20 deg ZnSe Prisms.

MOIRCS : IFU

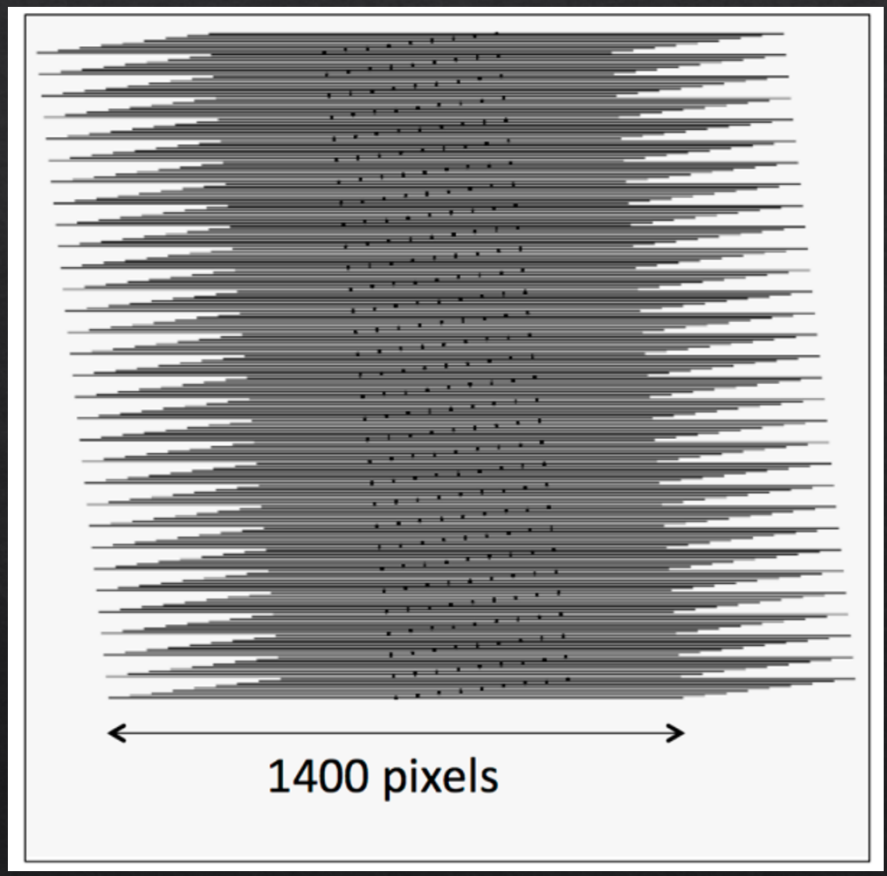
- will be installed at the side of the focal plane box
- the focal plane box and mask-exchanger need to be changed
- wing-box may be used for fiber-entrance in Starbug+ MOIRCS configuration



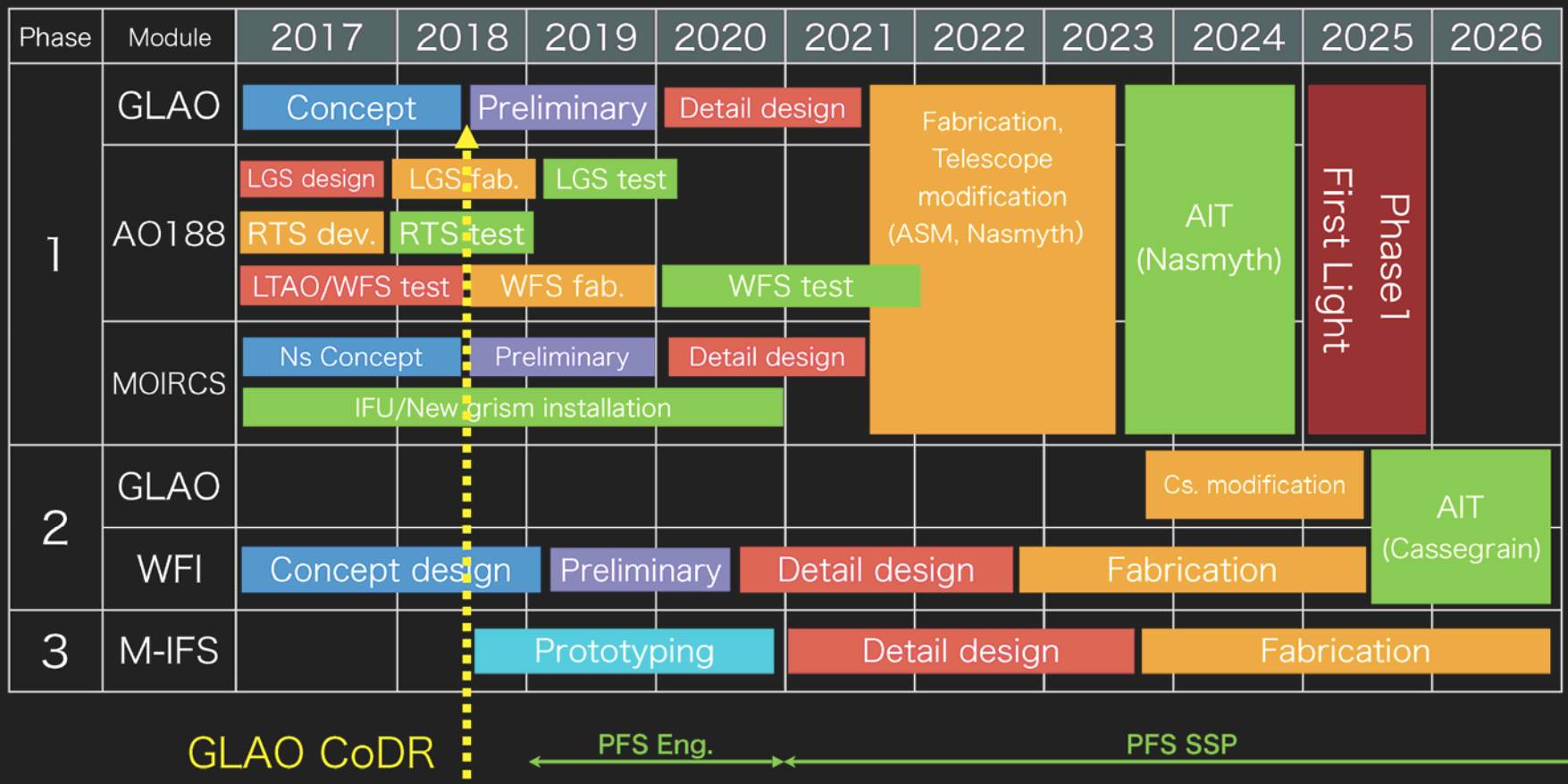


MOIRCS : IFU

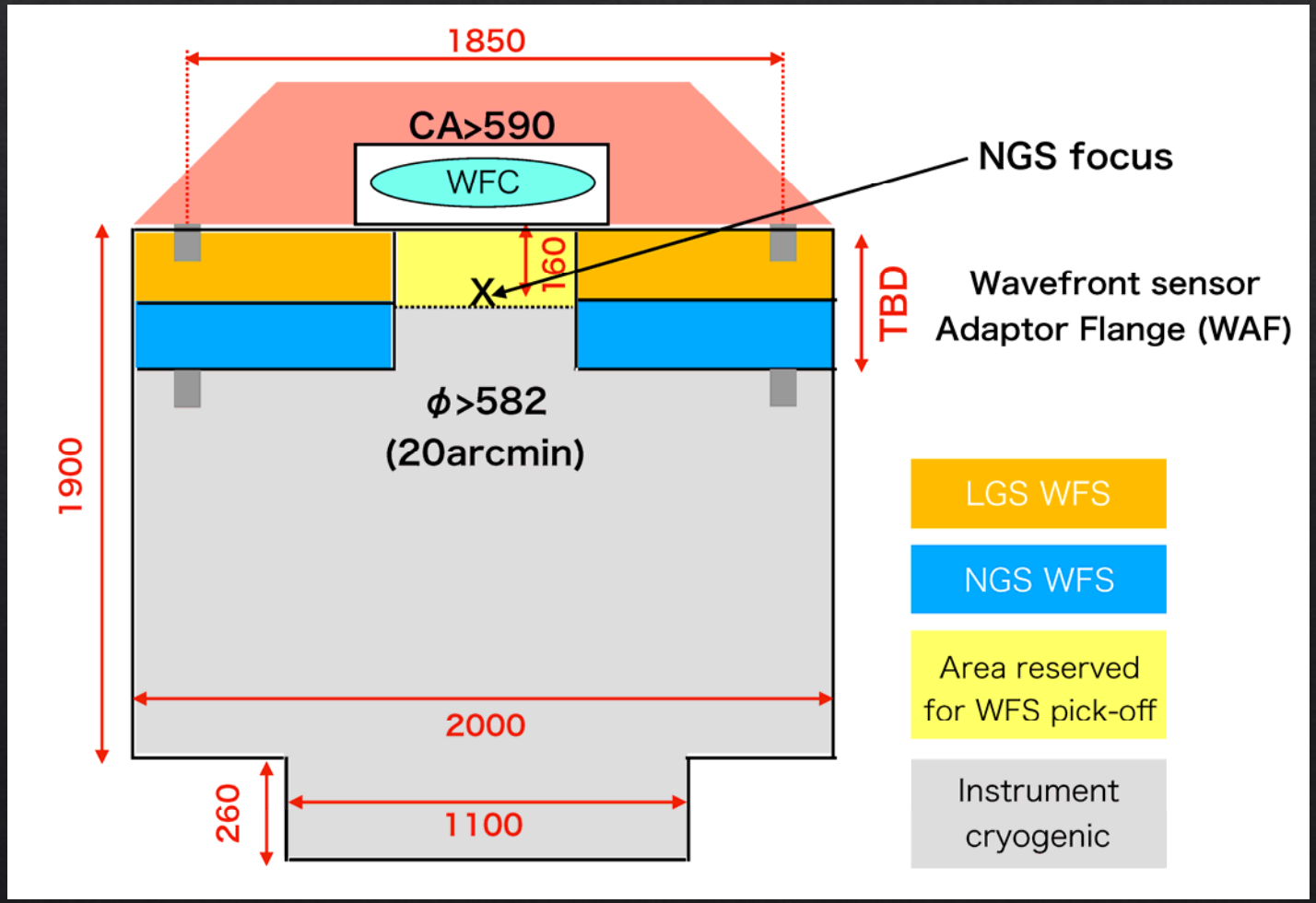
- IFU with Microlens Array
  - sampling : 0”.2
  - lens-array : 9×31 lenses
  - FoV : 1”.8×6”.2
  - spectral resolution : R~800 with zJ500, HK500 grisms



ULTIMATE-Subaru schedule

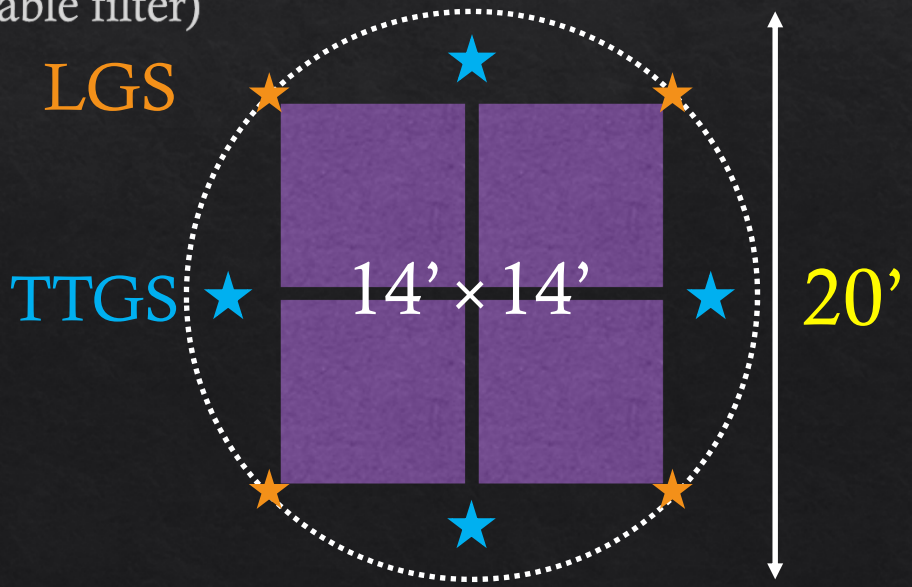


Cassegrain Instruments for ULTIMATE-Subaru



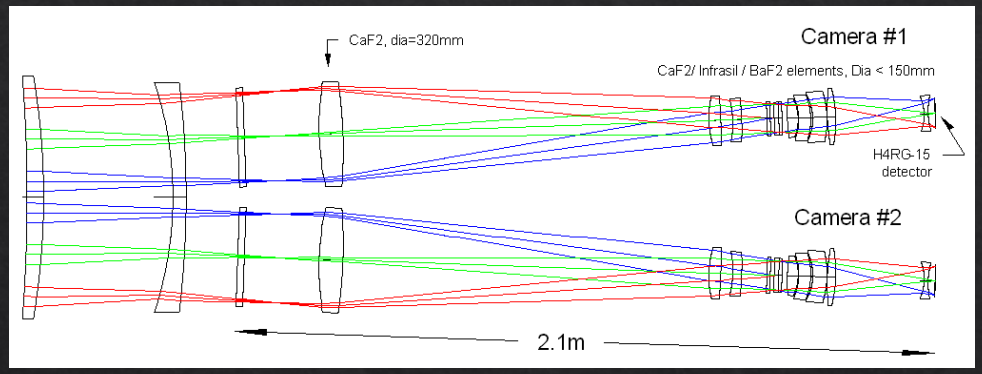
ULTIMATE Wide Field Imager (WFI)

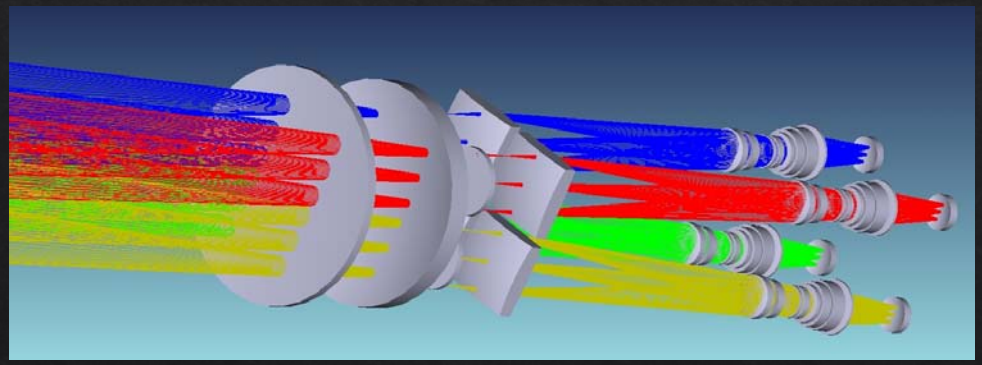
- Baseline Specification
  - Wavelength Coverage : 0.8-2.5μm
  - Pixel Scale : 0".1/pixel
  - FoV : 14' × 14'
  - Detectors : 4 × H4RG
  - Filter : YJHK/MB/NB (+tunable filter)
  - Total Efficiency : > 40%

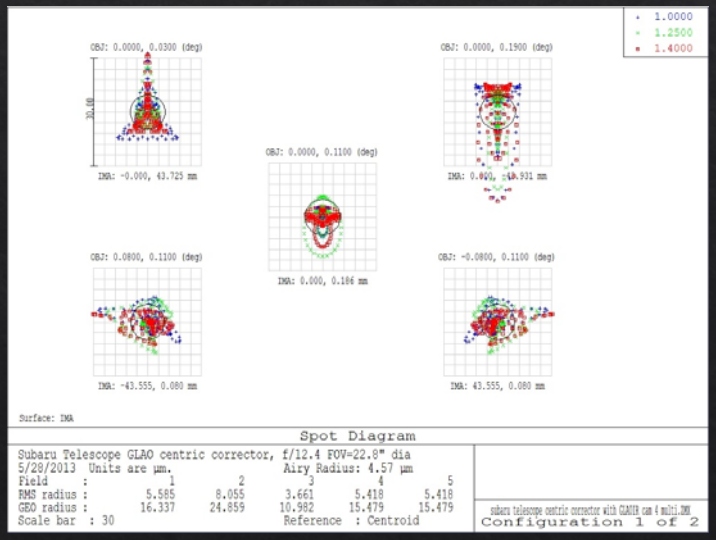


ULTIMATE Wide Field Imager (WFI)

- four barrel imager design (J. Pazder, HIA)

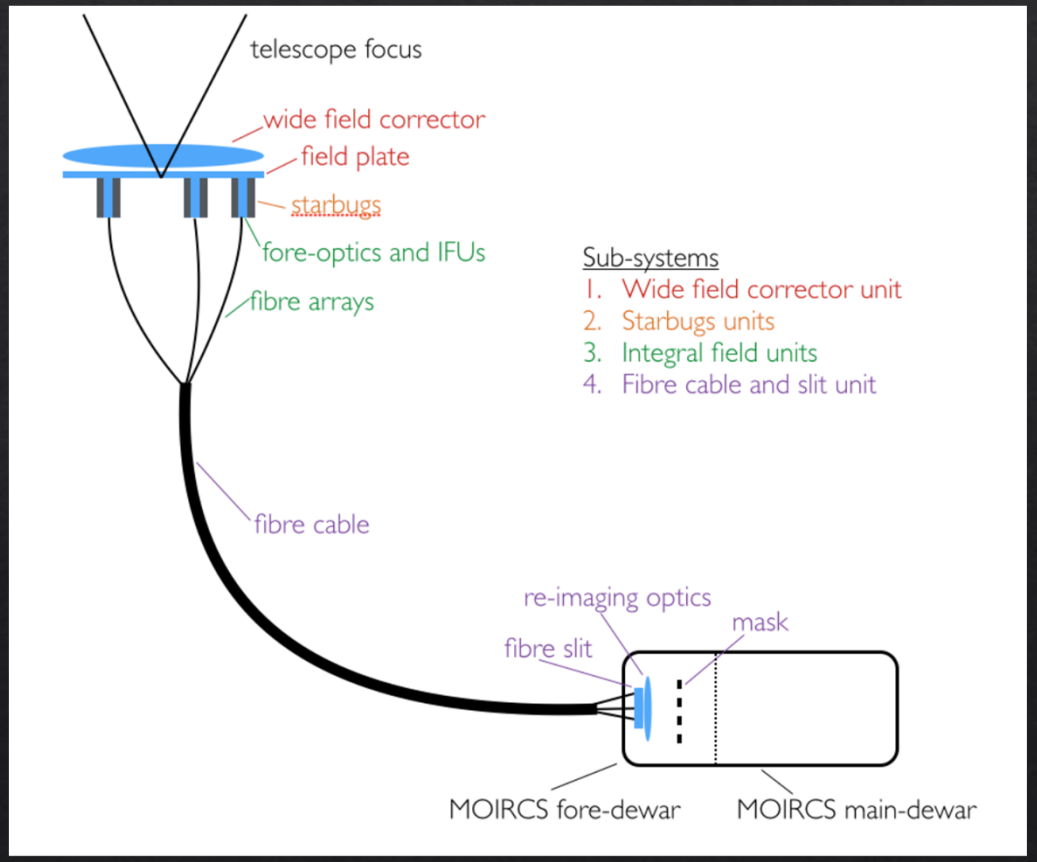






ULTIMATE multi IFU spectrograph (MIFS)

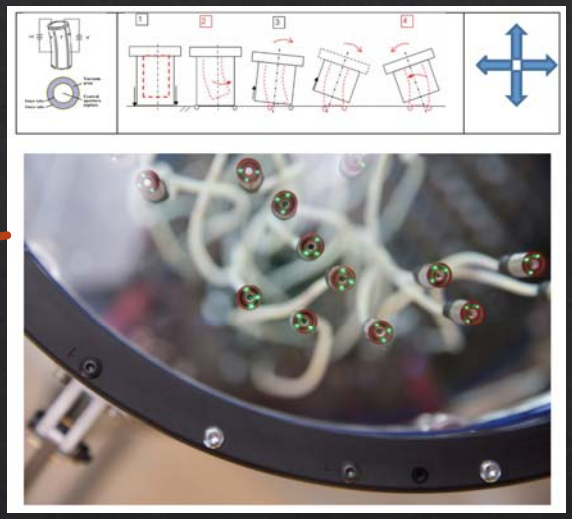
- Base line specification
  - IFU
    - elements per IFU : 61
    - special sampling : 0”.15
    - FoV per IFU : 1.18□”
  - spectrograph (MOIRCS)
    - number of IFUs : 8-13
    - wavelength : 0.9-1.8μm
  - spectrograph (PFS)
    - number of IFUs : ~40
    - wavelength : 0.38-1.26μm

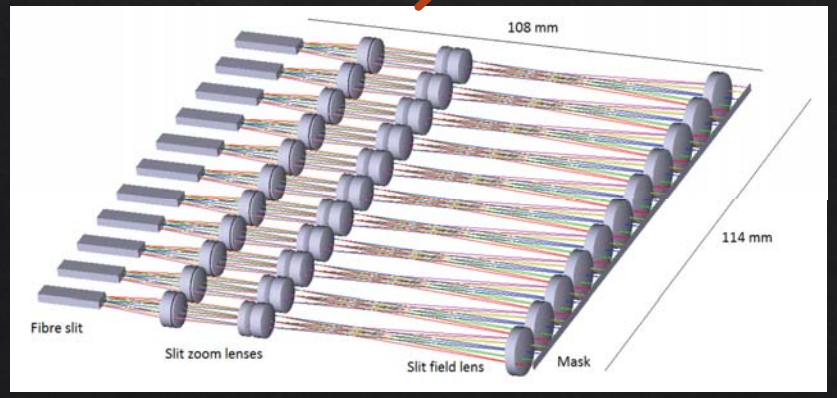


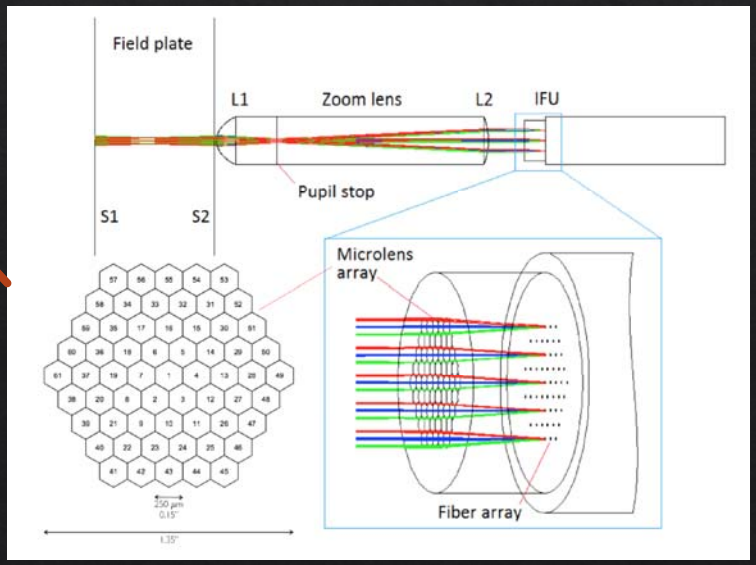
S. Ellis et al.@AAO (2016)

ULTIMATE multi IFU spectrograph (MIFS)

- Conceptual design by AAO
  - subsystems
    - wide-field corrector
    - Starbug unit
    - Integral field units
    - Fiber cable and slit unit







summary

- upgrades of existing facility instruments toward ULTIMATE are ongoing
  - LGSAO
  - MOIRCS
- conceptual designs for the new instruments
  - Wide Field Imager (WFI)
  - Multi-IFU Spectrograph (MIFS)

  (updates of the designs and feasibility studies are needed)