SPICA
Mid-Infrared Camera and Spectrometer

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“spica_mir” team

Instrument Overview

5 -- 38μm(--50μm) Camera and Spectrometer

- Wide Field Camera
  - 5 arcminutes square FOV x 2, λλ 5--25 and 20--38μm
- High Resolution Spectrograph
  - *R* ~ 30,000 λλ 4--8 μm and 12--18μm
- Mid Resolution Spectrograph
  - IFU by image slicer
  - *R*~1500--700 λλ (10--20)+(20--36)μm at once
- Low Resolution Spectrograph
  - *R* ~ 50--100 λλ 5-26μm and (20-38 or 25-48)μm

Membership

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Toru Yamada
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Scientific objectives

- Resolution of Birth and Evolution of Galaxies
- Thorough Understanding of Planetary System Formation
- The Transmigration of Dust in the Universe

--- Today's topics ---

We will show

- Specifications of the instrument
- Current design
- Status of developments

and also talk about

- Feasibility of the specifications
- Priority in the development process.

Please discuss

- What is important in the future?
- Modifications of the specifications.

Spec.: Wide-Field-Camera (WFC)

- FOV: 5’ x 5’ x 2 field WFC-S and WFC-L
- Diffraction limited image
- Zodiacal light limit noize
- WFC-S
  - 5 -- 25μm
  - Si:As 2048x2048 pixels 0.”146 fov/pix
- WFC-L
  - 20 -- 38μm
  - Si:Sb 1024x1024 pixels 0.”293 fov/pix

Spec.: High Resolution Spectrograph (HRS)

- Immersion Grating based High Resolution
- HRS-L
  - Si:As 2048 x 2048 detector
  - 12 -- 18 μm R~20,000 -- 30,000
  - 6”.0 x 1”.2 long slit
  - 0”.48 /pix
- HRS-S
  - Si:As 2048 x 2048 detector
  - 4 -- 8μm R~30,000
  - 3”.5 x 0”.72 long slit
  - 0”.288 /pix

Spec.: Mid Resolution Spectrograph (MRS)

- Integral Field Unit by Image slicer
- 2-octave wavelength coverage by dichroic filter
- MRS-L
  - Si:Sb 1024x1024 detector
  - 20 -- 36 μm R~700
  - 12”.0 x 2”.5 slitlet x 5 = 12” x 12” FOV
  - 0”.485 /pix
- MRS-S
  - Si:As 2048x2048 detector
  - 10 -- 20μm R~1500
  - 12” x 1”.2 slitlet x 5 = 12” x 6” FOV (part of MRS-L FOV)
  - 0”.403 /pix

Spec.: Low Resolution Spectrograph (LRS)

- Wide wavelength coverage
- High sensitivity
- LRS-S
  - 5 -- 26 μm covered by prism
  - 2'.5 x 1".40 long slit
  - *R* ~ 50 -- 100
- LRS-L
  - 20 -- 38 μm prism or grating
  - 2'.5 x 2".66 long slit
  - *R* ~ 50 -- 100

LRS issues

- High sensitivity is required. -- Feasible
- Choice of disperser and wavelength coverage
  - Prism : Wide coverage, Low Resolution, fab. Risk
  - Grating: Limited coverage, very feasible
  - Instantaneous wave length coverage for LRS-S
    - current plan : as wide as possible 5 -- 26μm
      option 5 --10μm (outside MRS, competitive JWST) or
      10 -- 20μm (inside MRS, outside JWST)
    - Slit width should be optimized at longest wavelength

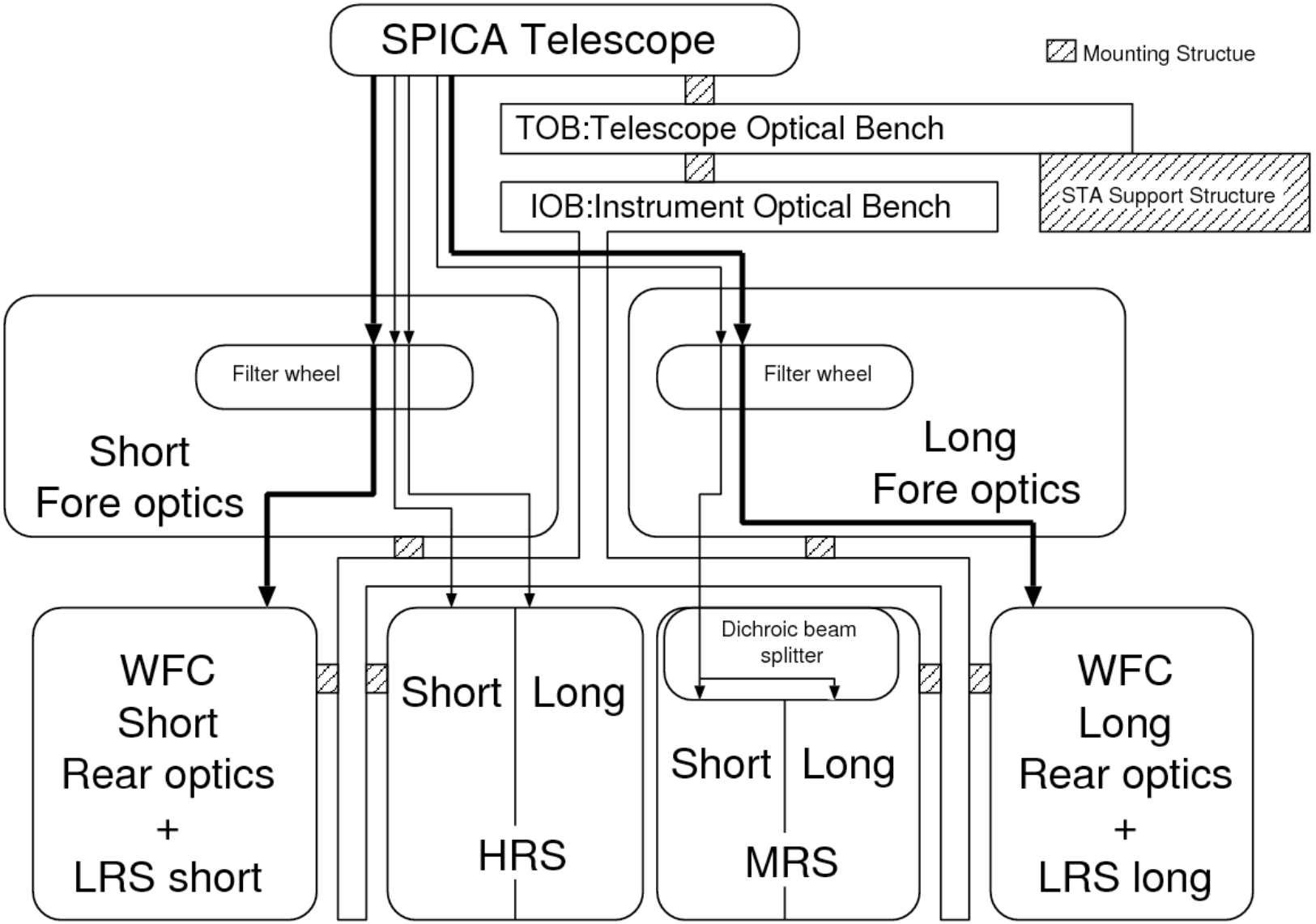
Extension to longer wavelength

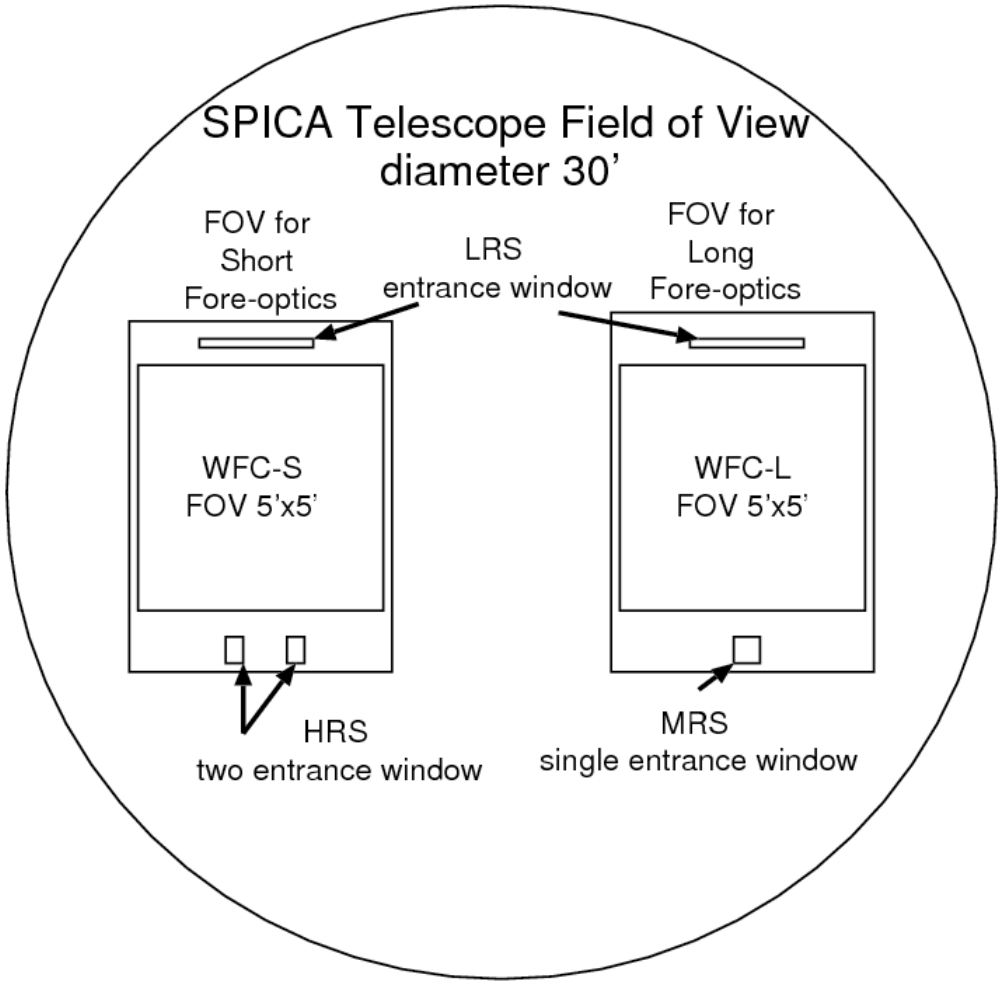
- Detector technology up to 50μm is under development
- Risk:
  - Detector prop. is unknown
  - Easy to cancel the extension and back to Si:Sb based 38μm limit
- Cost:

Expected performance

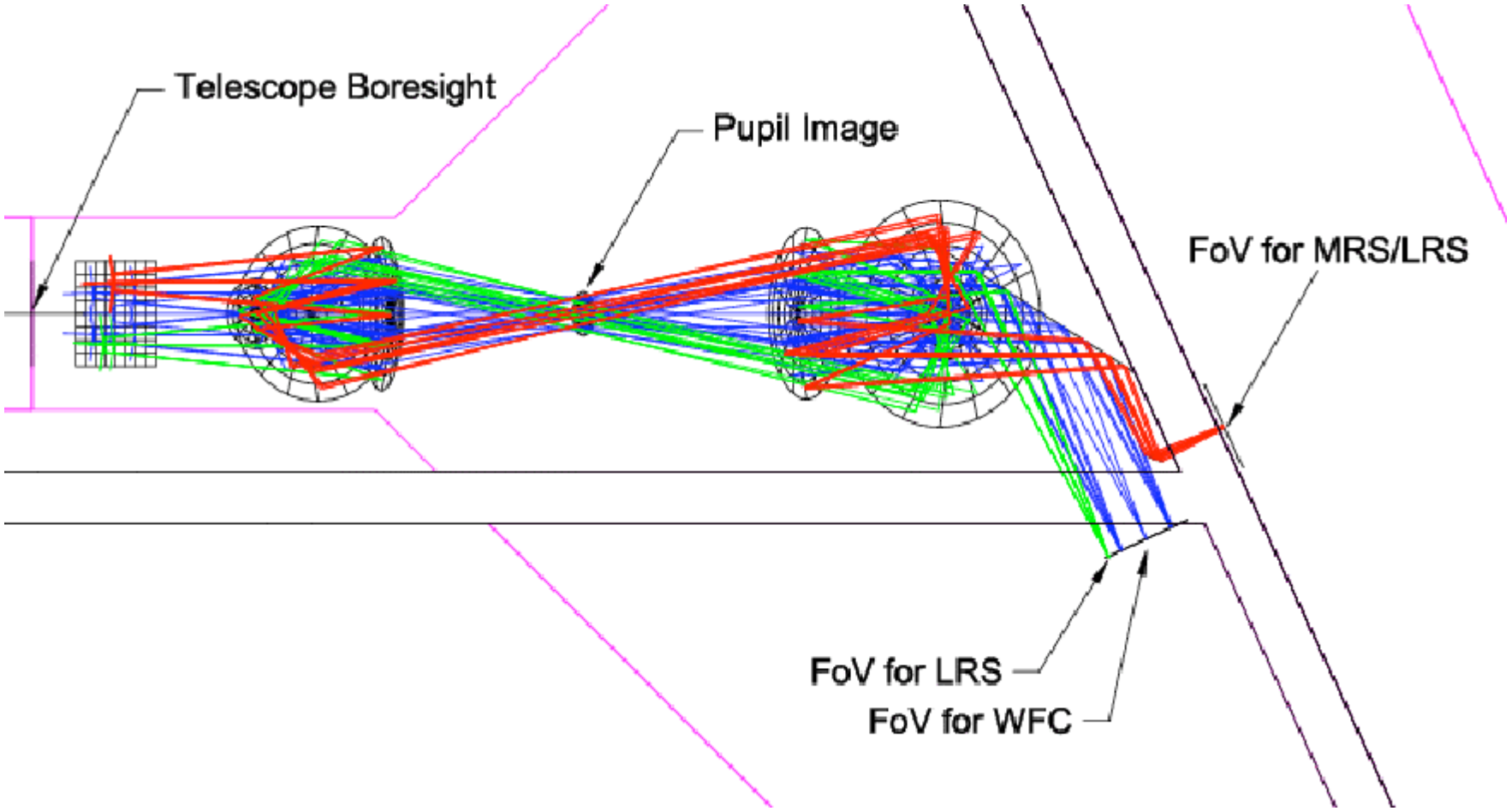
- WFC-S/L
  - Point source, 1hr, 5σ
  - 4.9 / 6.7 / 7.7 μJy for 20 / 30 / 38 μm
  - 0.13 / 1.2 / 3.5 μJy for 5 / 10 / 20 μm
- HRS-S/L
  - Point source, 1hr, 5σ 8mJy(L) 3mJy(S)
  - Diffuse , 1hr, 5σ 10 MJy/sr(L) 30 MJy/sr(S)
- MRS-S/L
  - Point source, 600sec, 5σ ~600 μJy(L) ~100 μJy(S)
- LRS-S/L
  - Point source, 600sec, 5σ
  - 64 / 84 / 108 / 136 μJy at 20 / 25 / 30 / 35 μm
  - 7.3/14/26/39 μJy at 7.5 / 10 / 15 / 20 μm

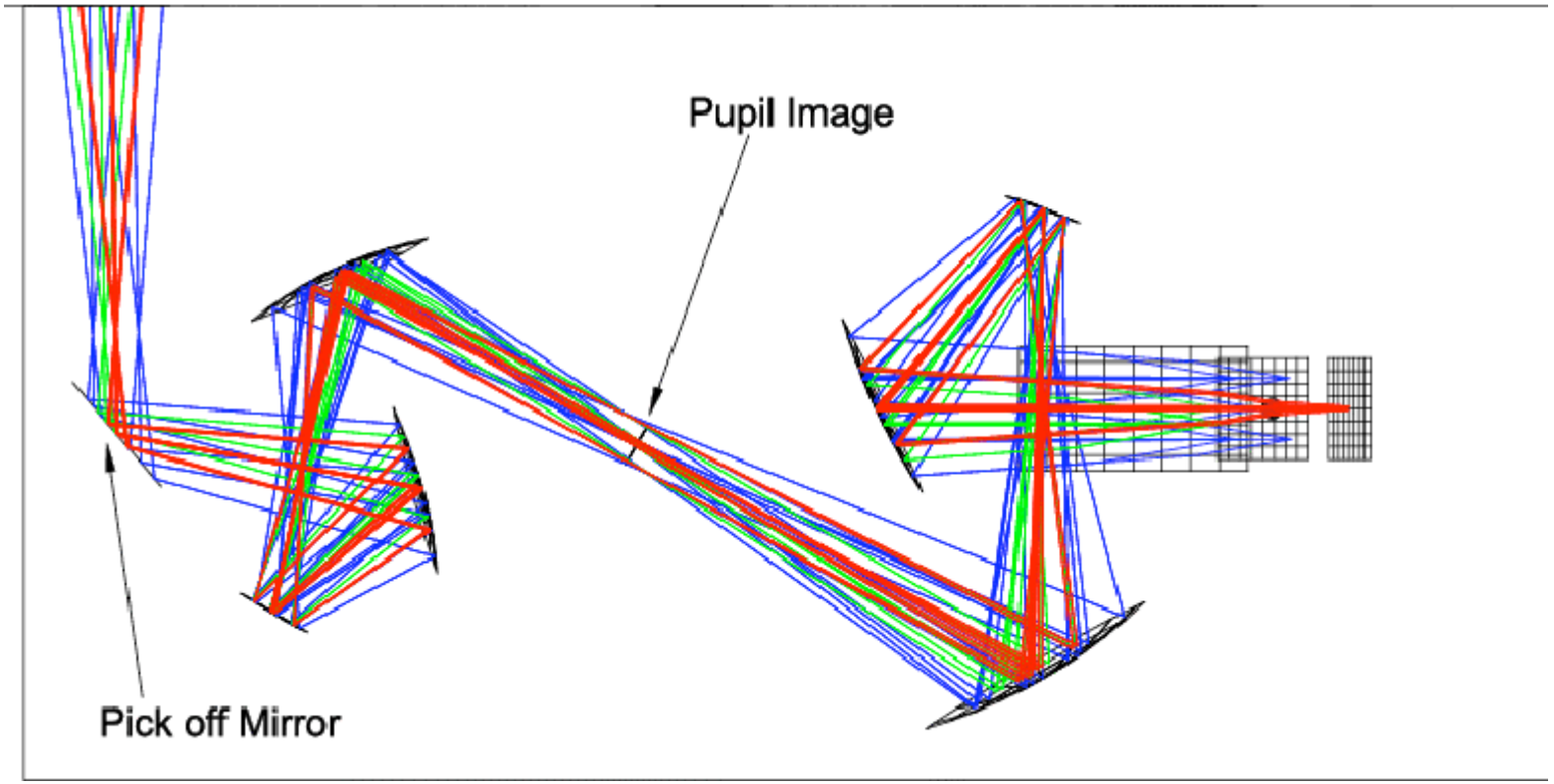
Design: Optical architecture




SPICA Telescope Field of View
diameter 30'
FOV for
Short
Fore-optics
LRS
entrance window
FOV for
Long
Fore-optics
WFC-S
FOV 5'x5'
WFC-L
FOV 5'x5'
HRS
two entrance window
MRS
single entrance window

Design: Fore-optics

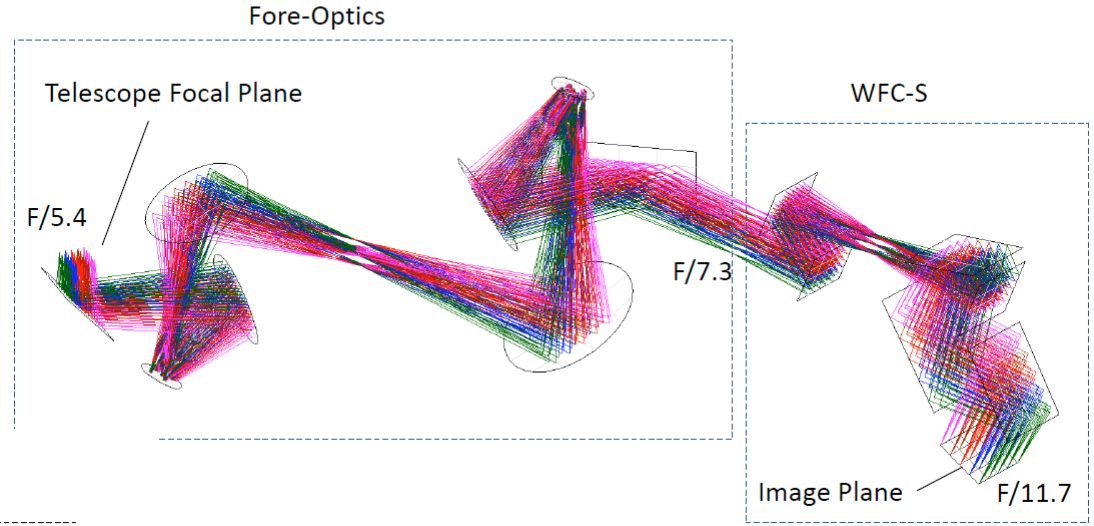



Pupil Image
Pick off Mirror

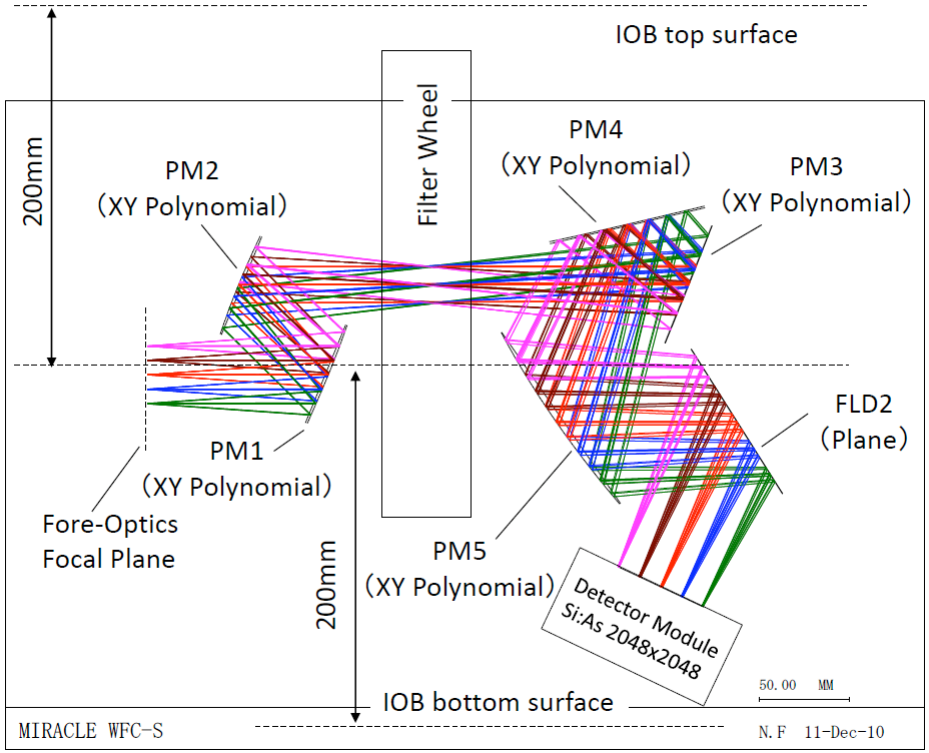
Design: WFC

- WFC-S

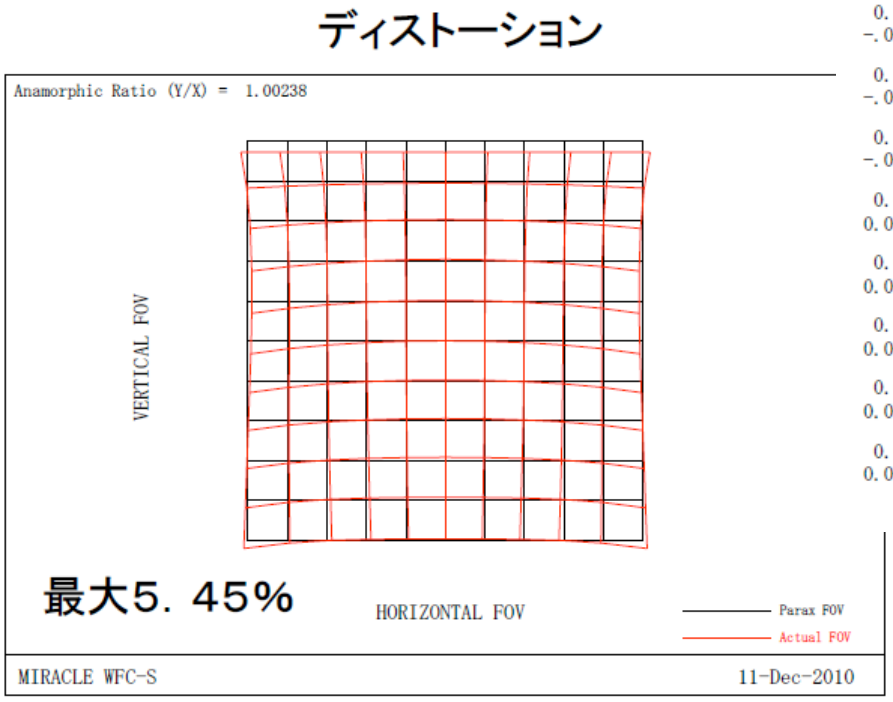
WFC-S 3D View

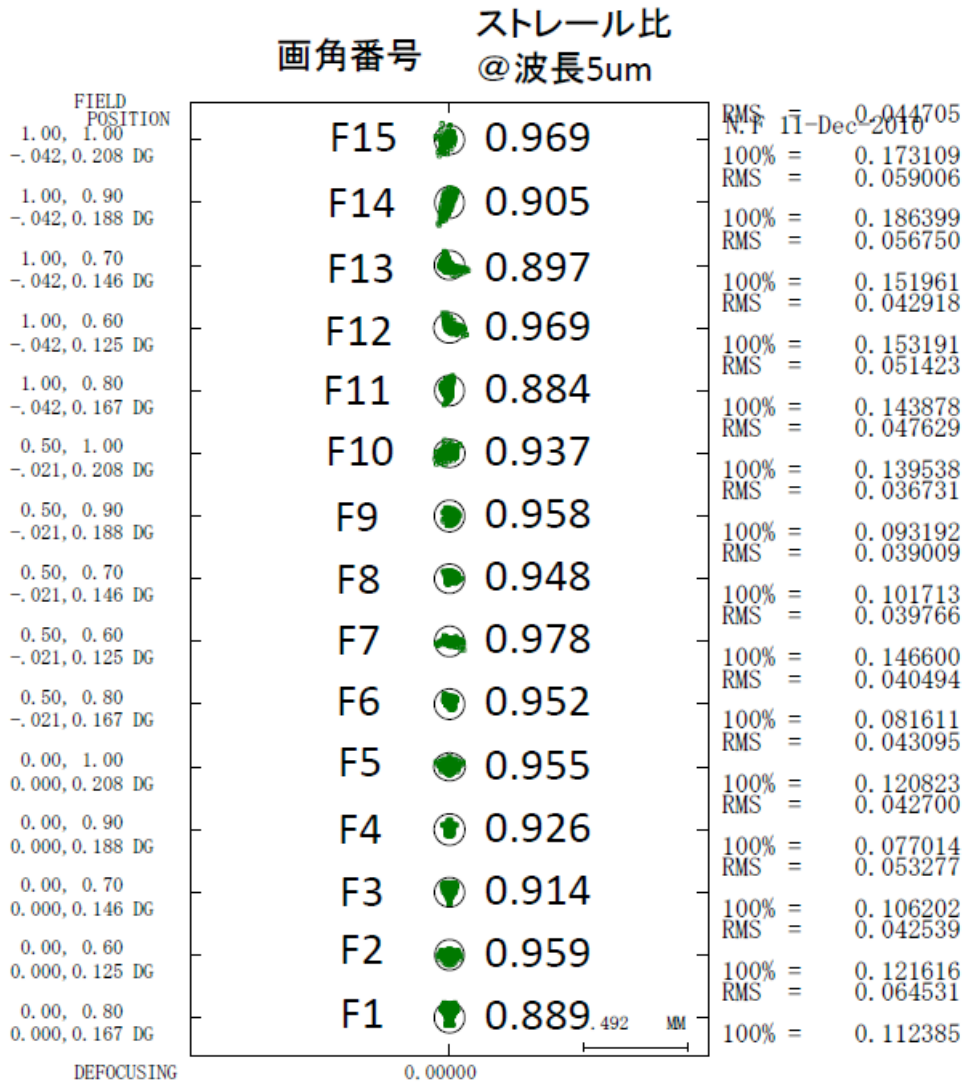


YZ Cross-Section



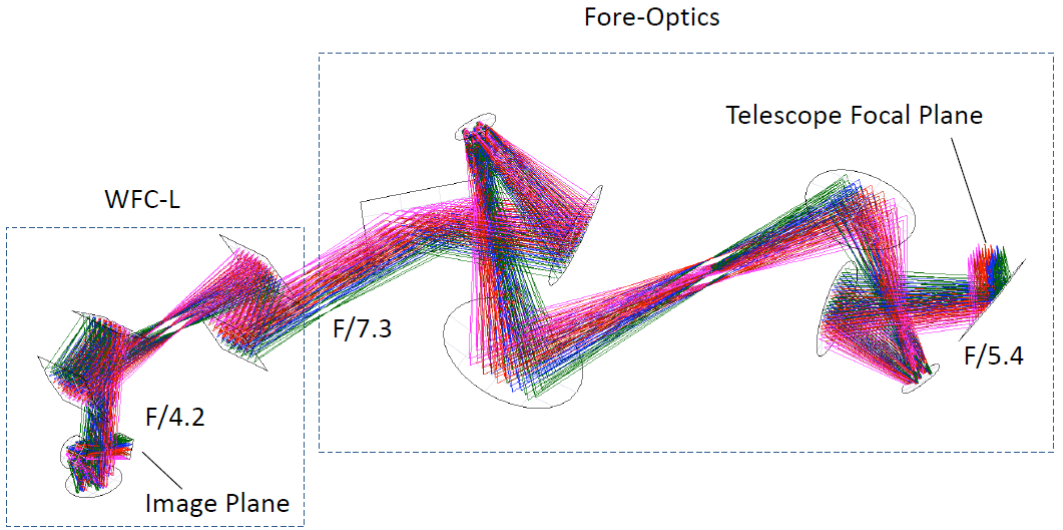
WFC-S


ディストーション
Anamorphic Ratio (Y/X) = 1.00238
VERTICAL FOV
HORIZONTAL FOV
最大5．45%
Parax FOV
Actual FOV
MIRACLE WFC-S
11-Dec-2010

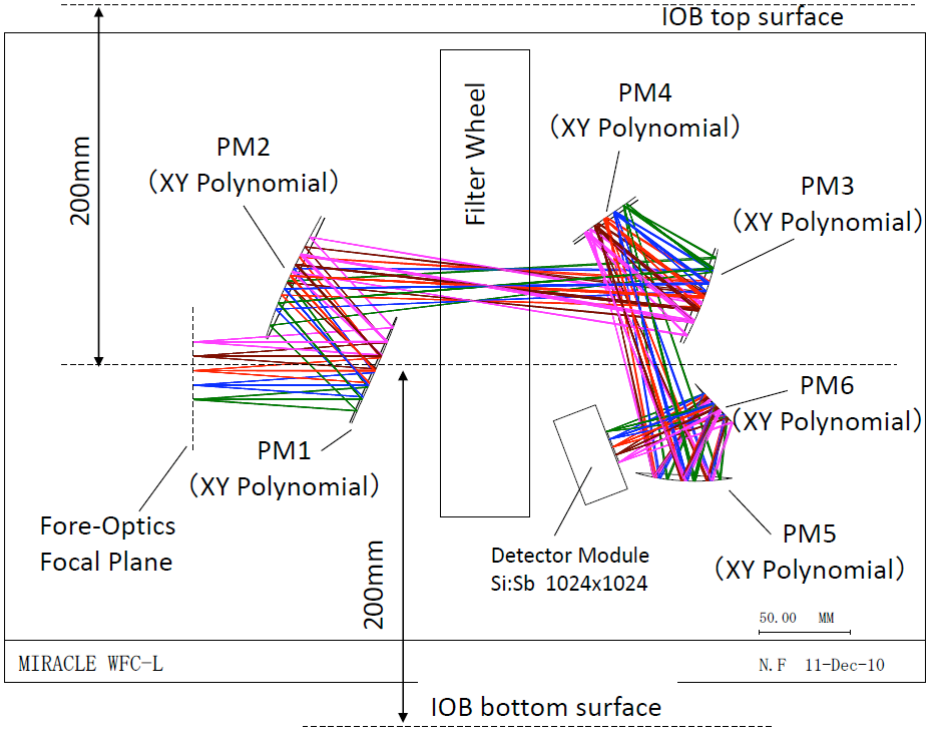

画角番号
ストレール比
@波長5um
FIELD POSITION
1.00, 1.00
-.042, 0.208 DG
1.00, 0.90
-.042, 0.188 DG
1.00, 0.70
-.042, 0.146 DG
1.00, 0.60
-.042, 0.125 DG
1.00, 0.80
-.042, 0.167 DG
0.50, 1.00
-.021, 0.208 DG
0.50, 0.90
-.021, 0.188 DG
0.50, 0.70
-.021, 0.146 DG
0.50, 0.60
-.021, 0.125 DG
0.50, 0.80
-.021, 0.167 DG
0.00, 1.00
0.000, 0.208 DG
0.00, 0.90
0.000, 0.188 DG
0.00, 0.70
0.000, 0.146 DG
0.00, 0.60
0.000, 0.125 DG
0.00, 0.80
0.000, 0.167 DG
F15 0.969
F14 0.905
F13 0.897
F12 0.969
F11 0.884
F10 0.937
F9 0.958
F8 0.948
F7 0.978
F6 0.952
F5 0.955
F4 0.926
F3 0.914
F2 0.959
F1 0.889
.492 MM
DEFOCUSING
0.00000
RMS = 0.044705
N.F 11-Dec-2010
100% = 0.173109
RMS = 0.059006
100% = 0.186399
RMS = 0.056750
100% = 0.151961
RMS = 0.042918
100% = 0.153191
RMS = 0.051423
100% = 0.143878
RMS = 0.047629
100% = 0.139538
RMS = 0.036731
100% = 0.093192
RMS = 0.039009
100% = 0.101713
RMS = 0.039766
100% = 0.146600
RMS = 0.040494
100% = 0.081611
RMS = 0.043095
100% = 0.120823
RMS = 0.042700
100% = 0.077014
RMS = 0.053277
100% = 0.106202
RMS = 0.042539
100% = 0.121616
RMS = 0.064531
100% = 0.112385

WFC-L 3D View

- WFC-L

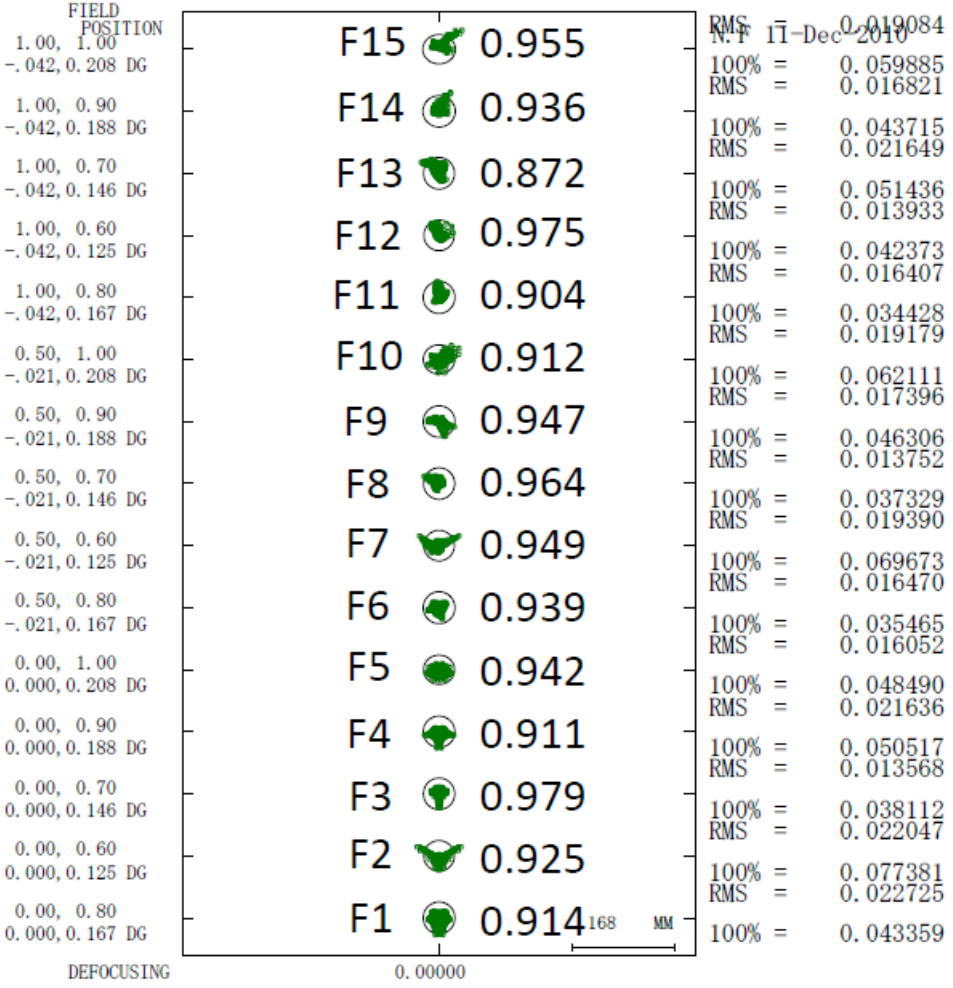


YZ Cross-Section

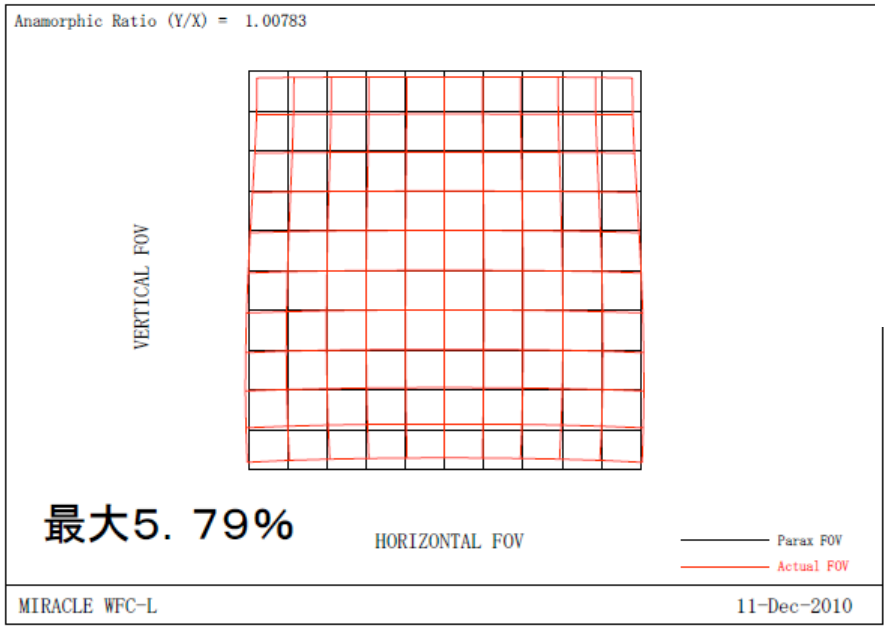


WFC-L

画角番号　　ストレール比
@波長5um



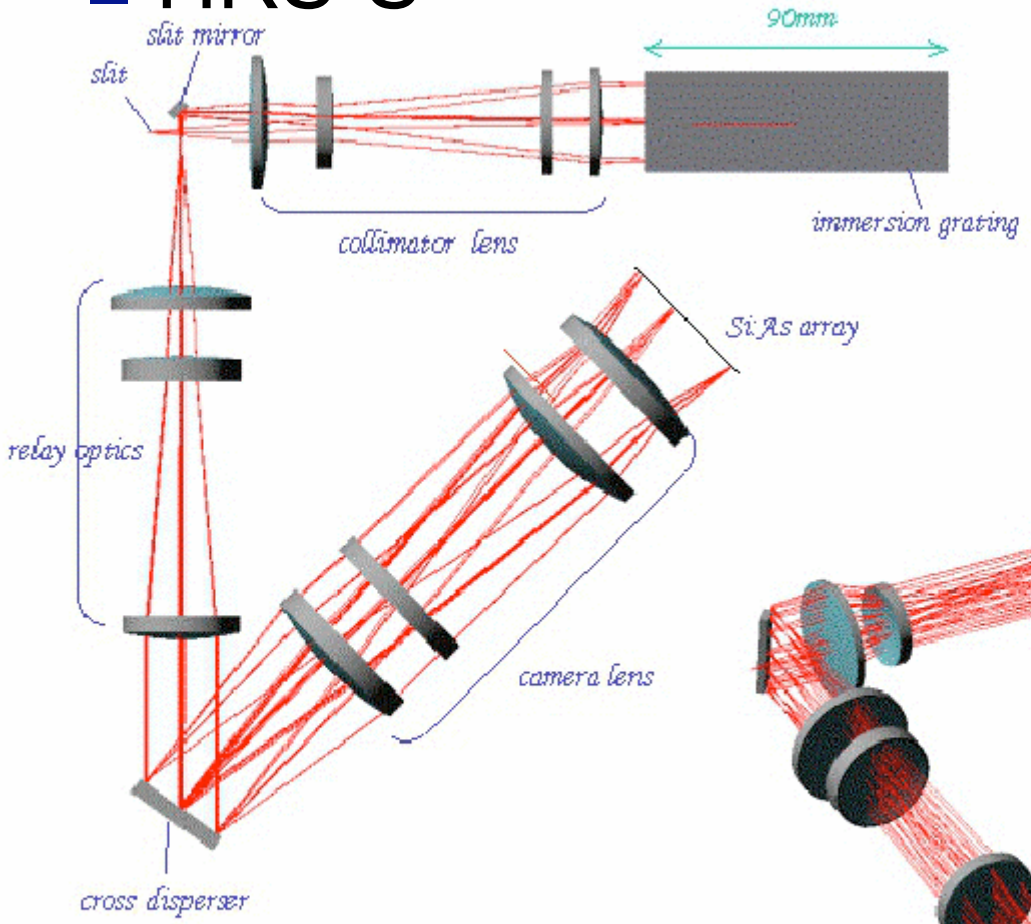
ディストーション

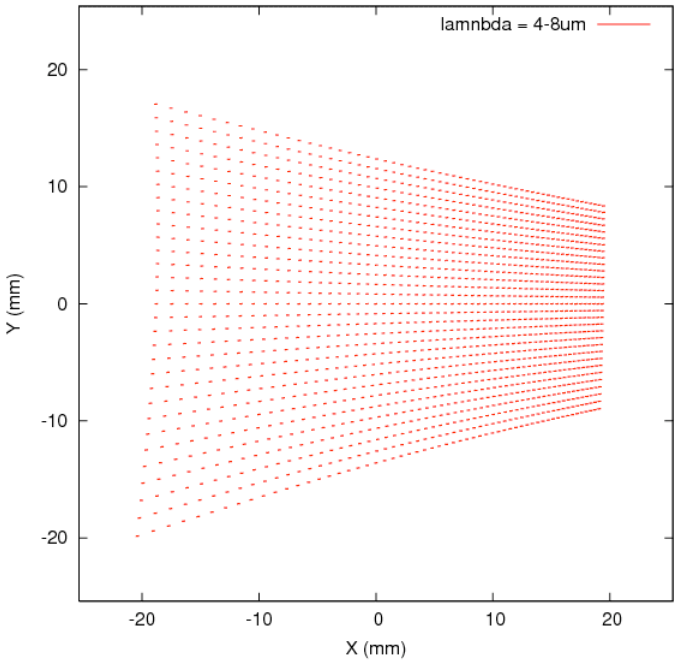


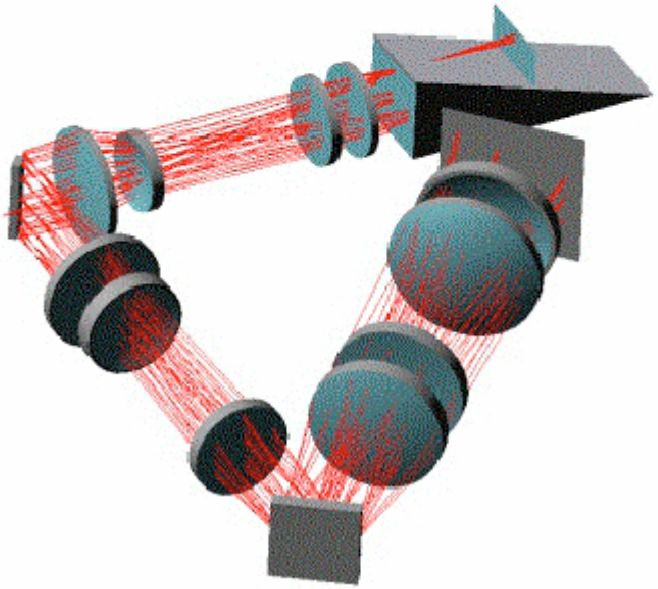
最大5.79%

Design: HRS

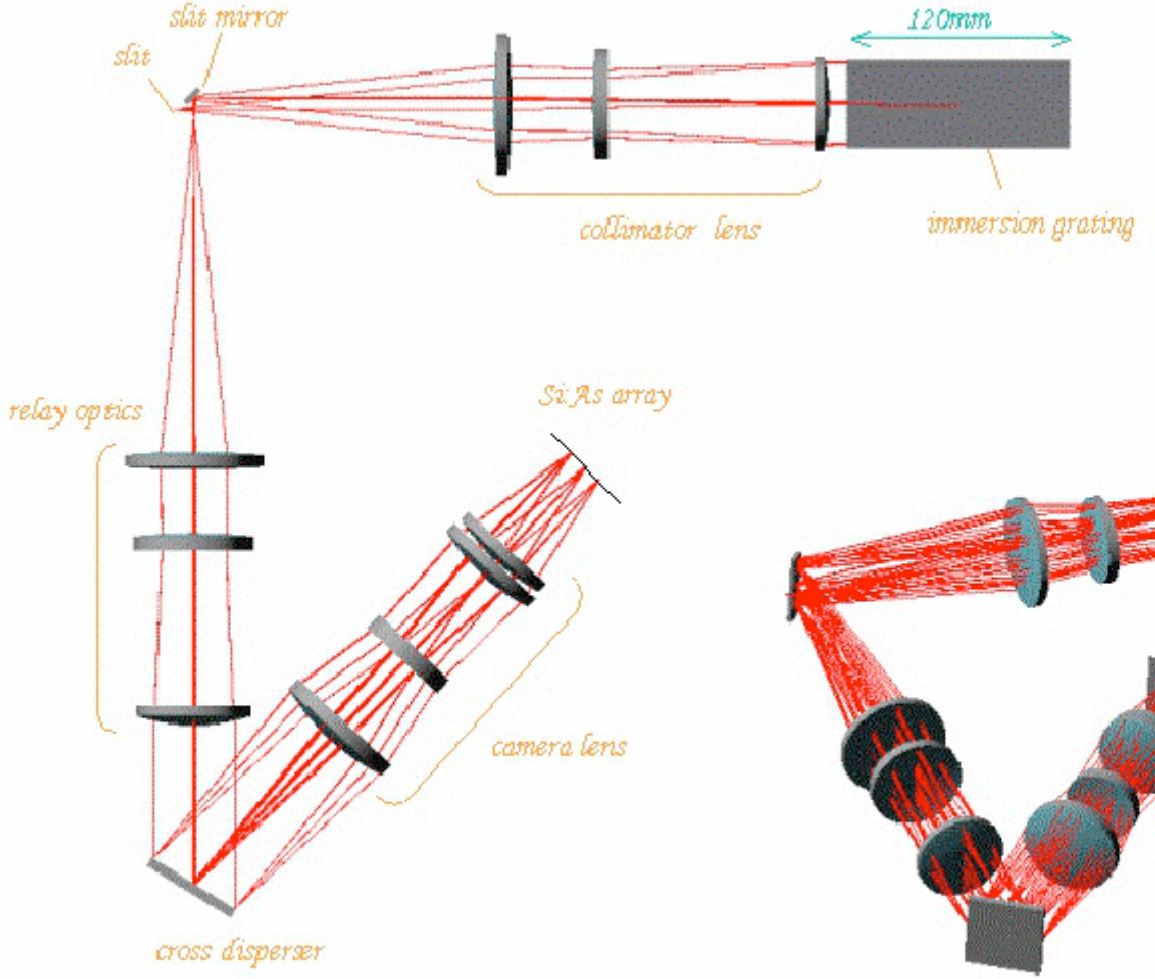
- HRS-S

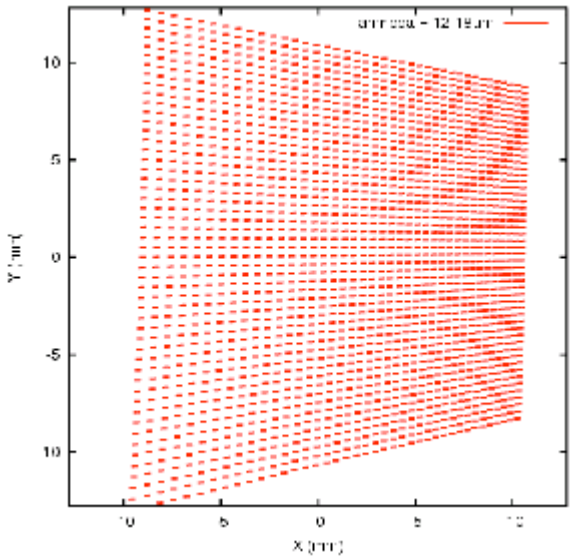






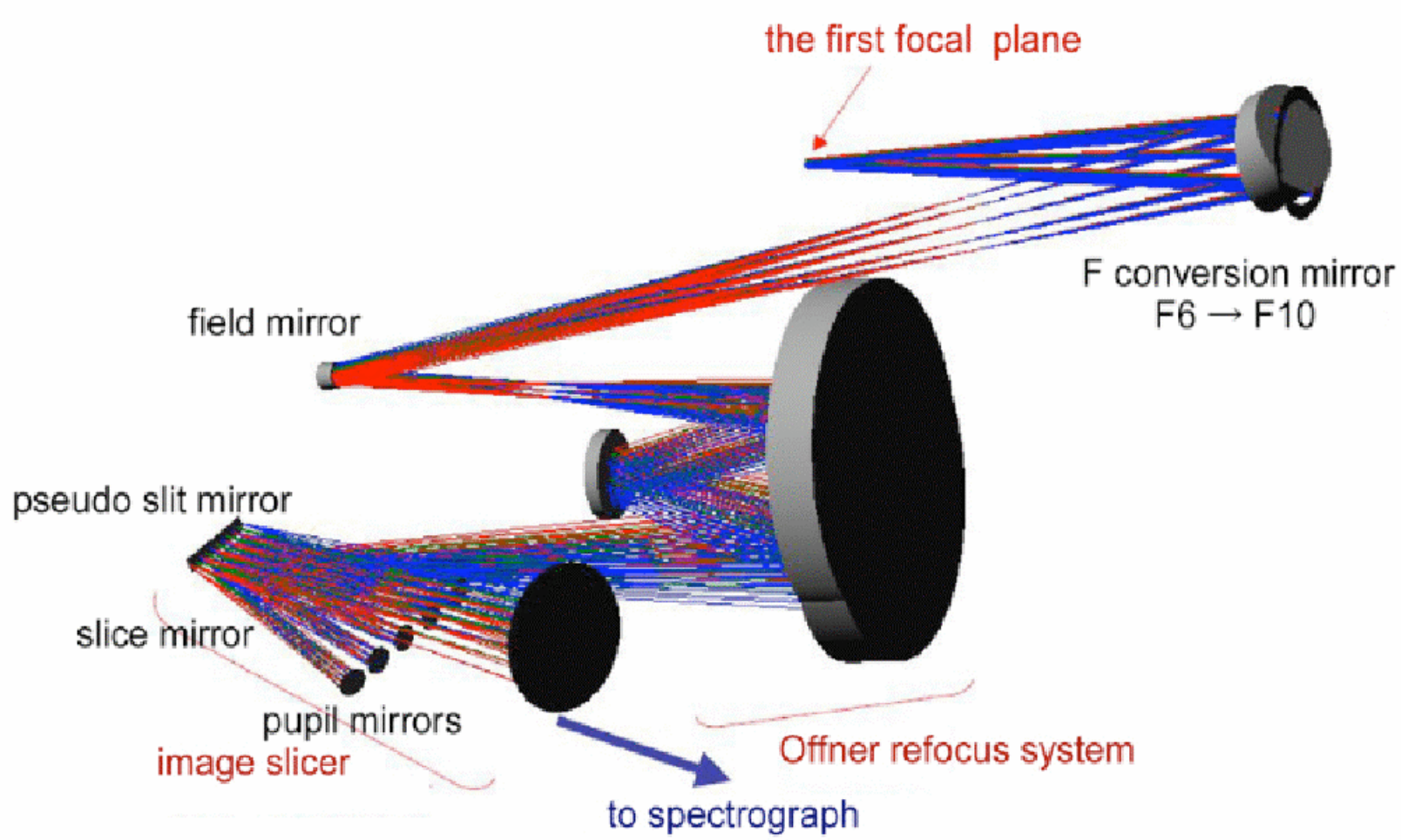
- HRS-H


slit mirror
slit
120mm
collimator lens
immersion grating
relay optics
Si:As array
camera lens
cross disperser

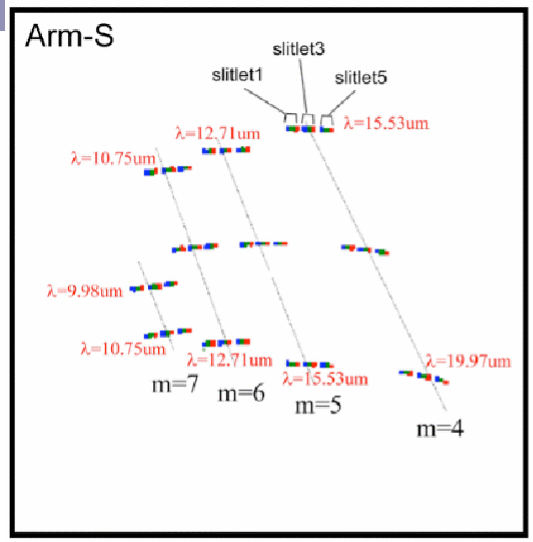

10
5
0
-5
10
Y [mm]
X [mm]

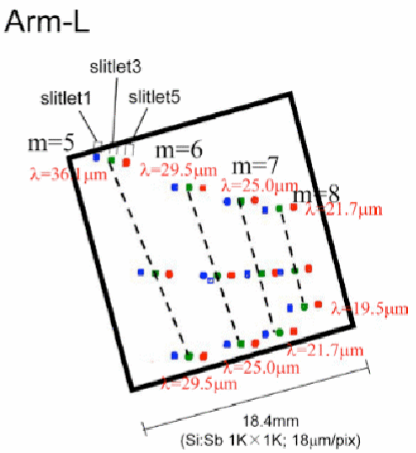
Design: MRS

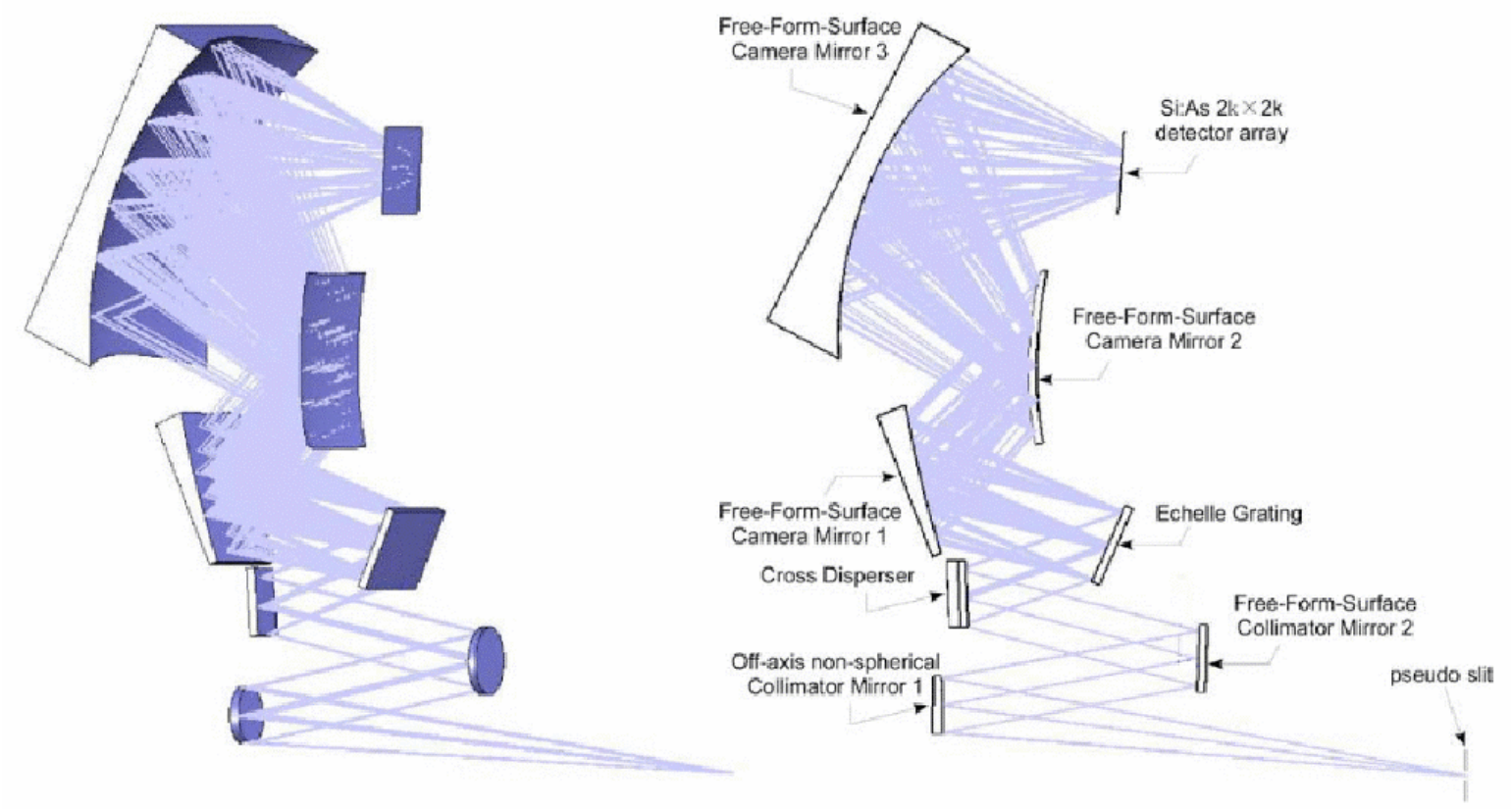
- Slicser



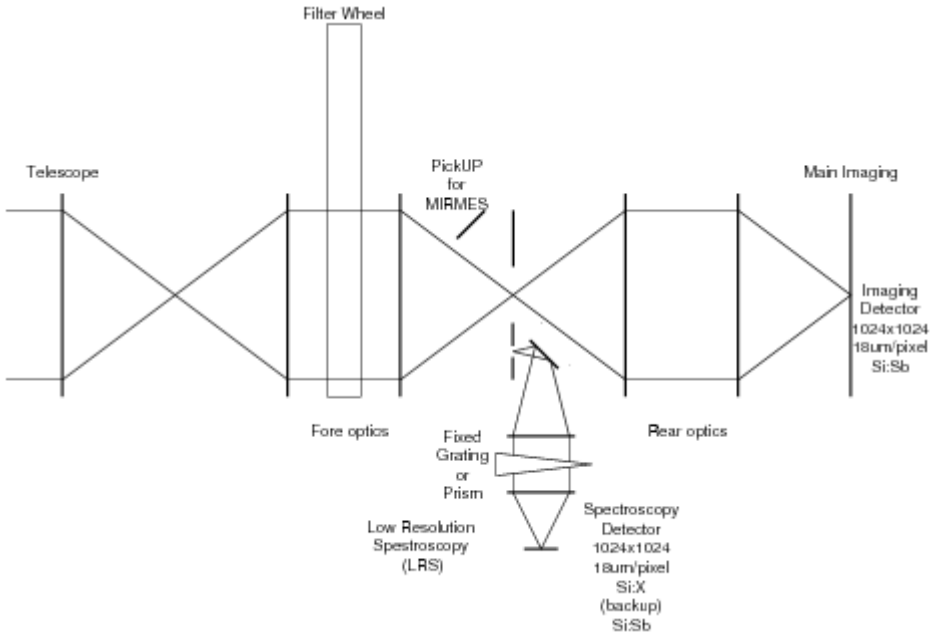
spectrograph







Design: LRS


Filter Wheel
Telescope
PickUP
for
MIRMES
Main Imaging
Imaging
Detector
1024x1024
18um/pixel
Si:Sb
Fore optics
Rear optics
Fixed
Grating
or
Prism
Low Resolution
Spestroscopy
(LRS)
Spectroscopy
Detector
1024x1024
18um/pixel
Si:X
(backup)
Si:Sb

Design: Heat and Mass

- Thermal design:
  - VERY Limited resource
  - Operation mode is limited, Clear the resource limit

- Mass budget:
  - Rough estimate, Within the budget

Table 20: Operation mode and heat load

Mode	20K (mW)	4.5K (mW)	1.7K (mW)	note
Standby Allocated	TBD	0.4	0.3	
Observing Allocated	TBD	4.0	2.1	
Standby	2.24	0.18	<0.01	
WFC-S/L + LRS-S/L	13.4	3.6	2.0	Frame rate 1Hz(WFC-L,LRS-L), 1/4Hz(WFC-S,LRS-S)
WFC-S/L + MRS-S/L	13.4	3.6	2.0	Frame rate 1Hz(WFC-L,MRS-L), 1/4Hz(WFC-S,MRS-S)
WFC-S/L + HRS-S/L	10.64	3.6	1.0	Frame rate 1Hz(WFC-L), 1/4Hz(WFC-S), 1/8Hz(HRS-S/L)

Devel.: Detector

- Si:Sb 1024 x 1024
  - On going development. Budget limited.
- Si:As 2048 x 2048
  - JWST Heritage, Start to develop.
  - Budget limited
- Si:As High dope 1024x1024
  - Development by another US project. (We can get information.)

Devel.: Optical elements

- Immersion Grating
  - HRS-S : ZnSe final development phase
  - HRS-L : CdTe Now, look hopeful
- Filter, Prism, Mirror, Lens, and etc
  - On going development.
  - Man power / technology / budget limit