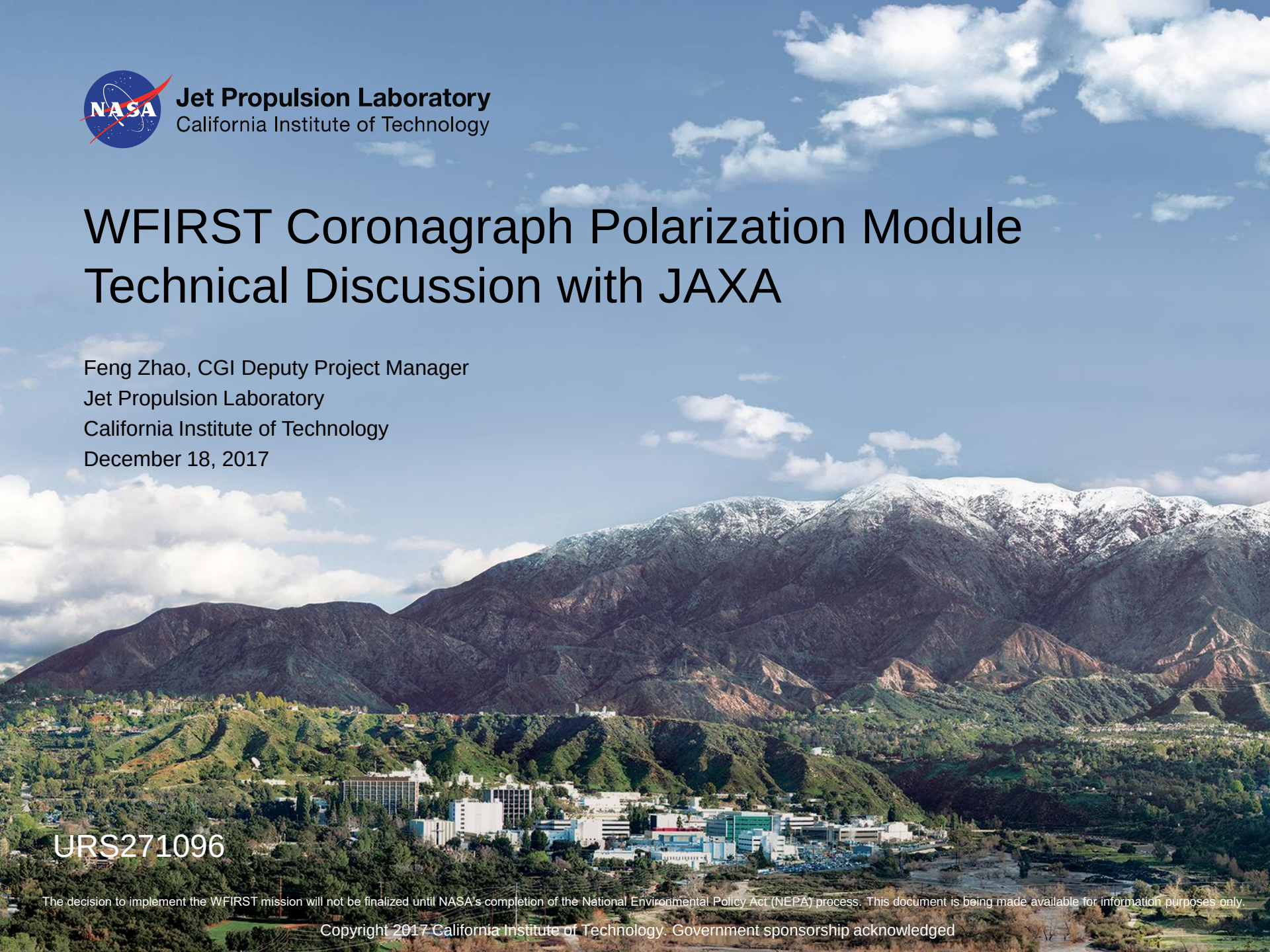


Jet Propulsion Laboratory
California Institute of Technology

WFIRST Coronagraph Polarization Module Technical Discussion with JAXA

Feng Zhao, CGI Deputy Project Manager
Jet Propulsion Laboratory
California Institute of Technology
December 18, 2017

URS271096

Outline

- **Post-WIETR requirements related to polarization**
- **CGI configuration snap-shot**
- **Potential contribution items:**
  - Polarization module:
    - Optics
    - Optics mounted on a wheel
    - Mechanisms assembly with optics
  - Polarization compensator
  - Coronagraph mask substrate
- **Discussions**

CGI-BTR3 I

- WFIRST shall be able to map the extended surface brightness from 0.25 arcsec to 0.95 arcsec around a host star with V magnitude as dim as 5 at a sensitivity at or below 17 mag/arcsec^2 (TBR) with an SNR of at least 10 and be able to map a linear polarization with a polarization fraction greater or equal to 0.3 with a systematic uncertainty of less than 0.03 (TBR).
- Parent links: PLRA-TECH-2.2.1, PLRA-TECH-2.2.2, PLRA-TECH-2.2.3,PLRA-TECH-2.2.5

December 12, 2017, versions: v4.2-0-g8b27ac5 .

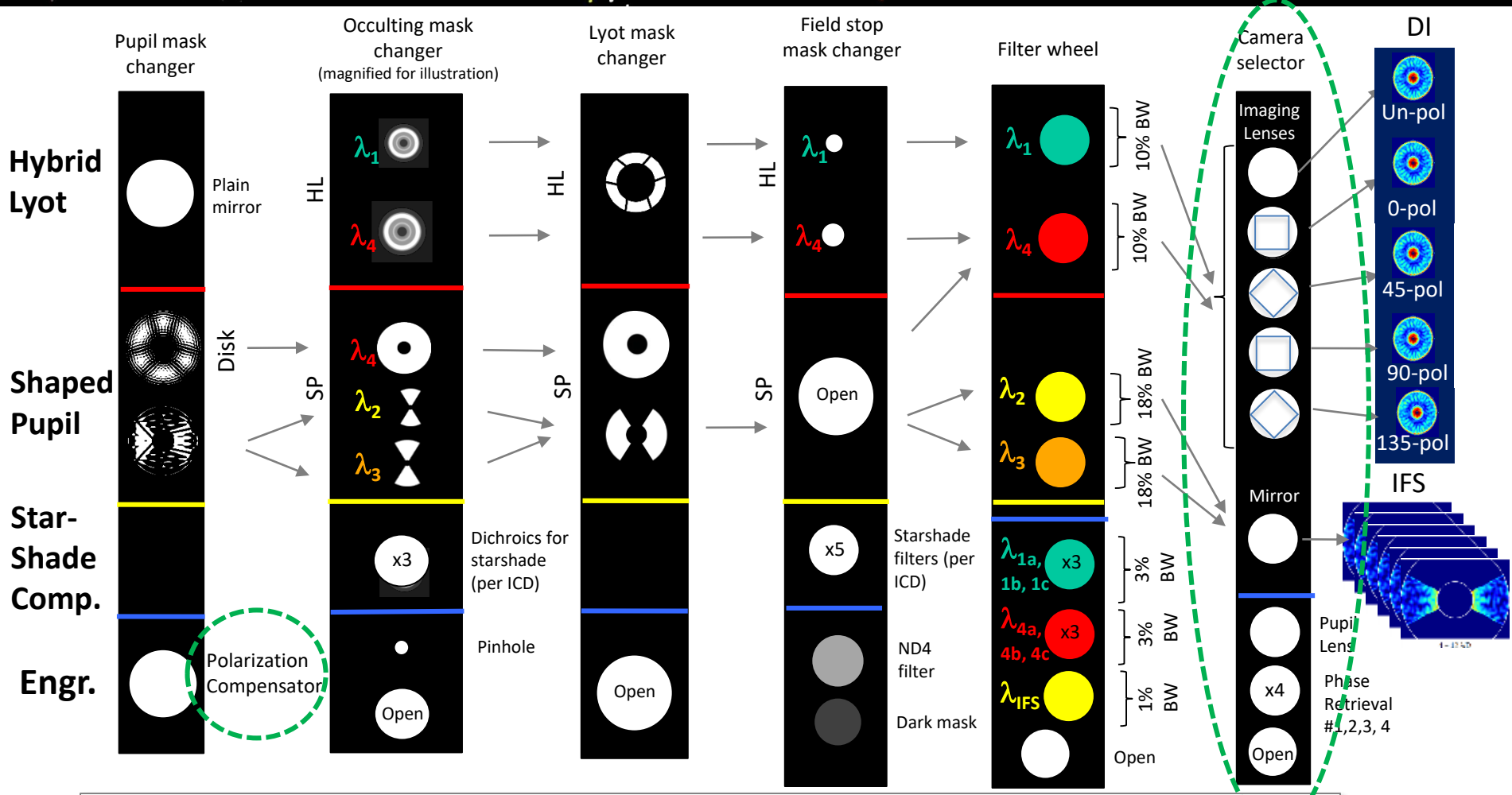
CGI-S-2 I

- The CGI shall be used to conduct operations and perform in-flight measurements of the CGI in the presence of flight error sources including WFE, WF stability, polarization, and jitter.
- Parent links: PLRA-TECH-2.2.2, PLRA-TECH-2.2.4

December 12, 2017, versions: v4.2-0-g8b27ac5 .

CGI Baseline (12/12/2017)

WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
DARK ENERGY • EXOPLANETS • ASTROPHYSICS



λ_1=575 nm, 10% (annular, 3-9 λ/D)
λ_2=660 nm, 18% (bow-tie / IFS, 3-9 λ/D)
λ_3=760 nm, 18% (bow-tie / IFS, 3-9 λ/D)
λ_4=825 nm, 10% (annular, 3-19 λ/D)

CGI Modes Table (12/12/2017)

CGI Filters	λ_{center} (nm)	BW	Channel	Masks	Working Angle	Can use w/ linear polarizers	Starlight Suppression Region	Tested before launch?
1	575	10%	Imager	HLC	3-9 λ/D	Y	360°	X
2	660	18%	IFS	SPC	3-9 λ/D		130°	
2	660	18%	Imager	SPC	3-9 λ/D	Y	130°	
3	760	18%	IFS	SPC	3-9 λ/D		130°	X
3	760	18%	Imager	SPC	3-9 λ/D	Y	130°	
4	825	10%	Imager	HLC	3-9 λ/D	Y	360°	
4	825	10%	IFS	HLC	3-9 λ/D		360°	
4	825	10%	Imager	SPC disk	6.5-20 λ/D	Y	360°	X

λ_1=575 nm, 10% (annular, 3-9 λ/D)
λ_2=660 nm, 18% (bow-tie / IFS, 3-9 λ/D)
λ_3=760 nm, 18% (bow-tie / IFS, 3-9 λ/D)
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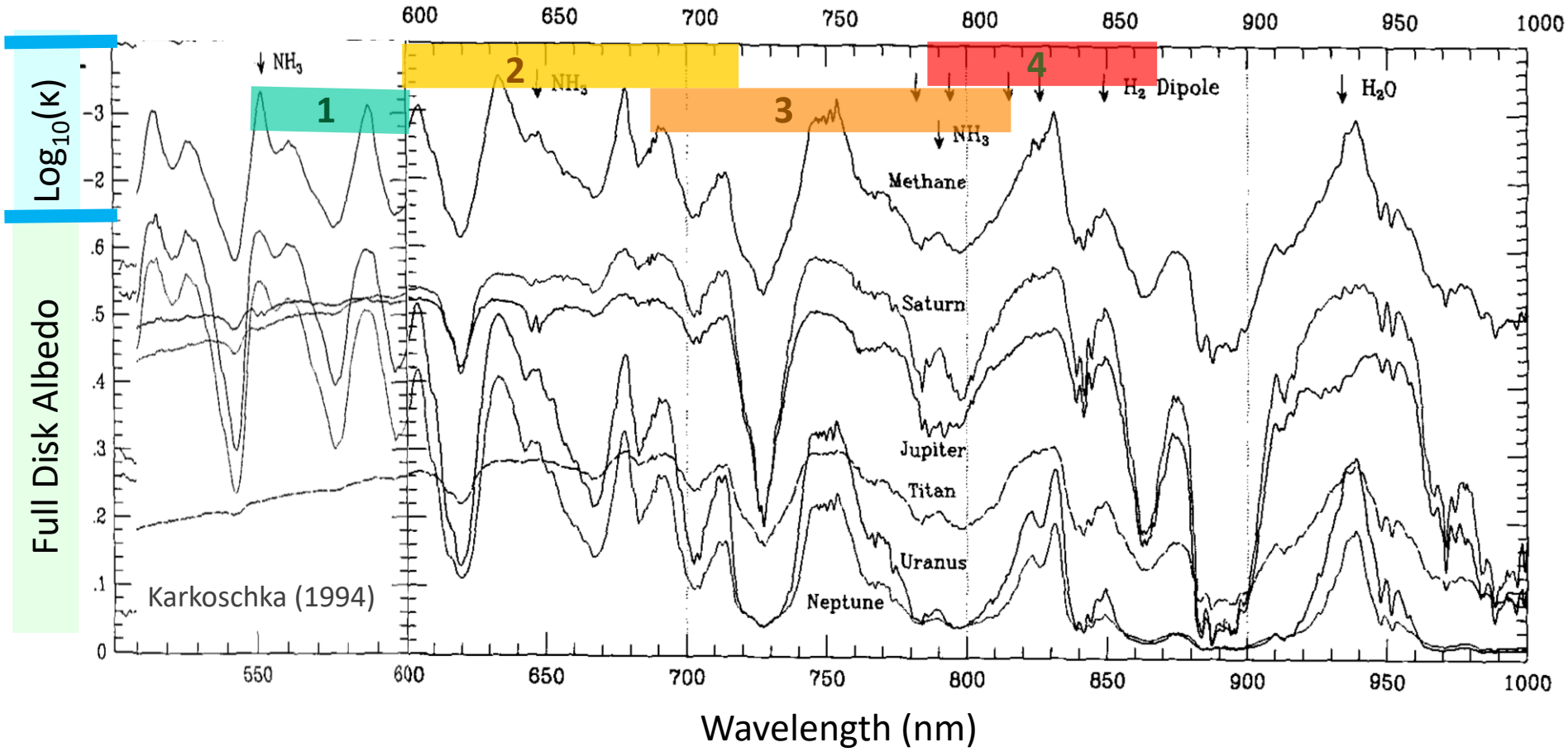
CGI Filters (12/12/2017)



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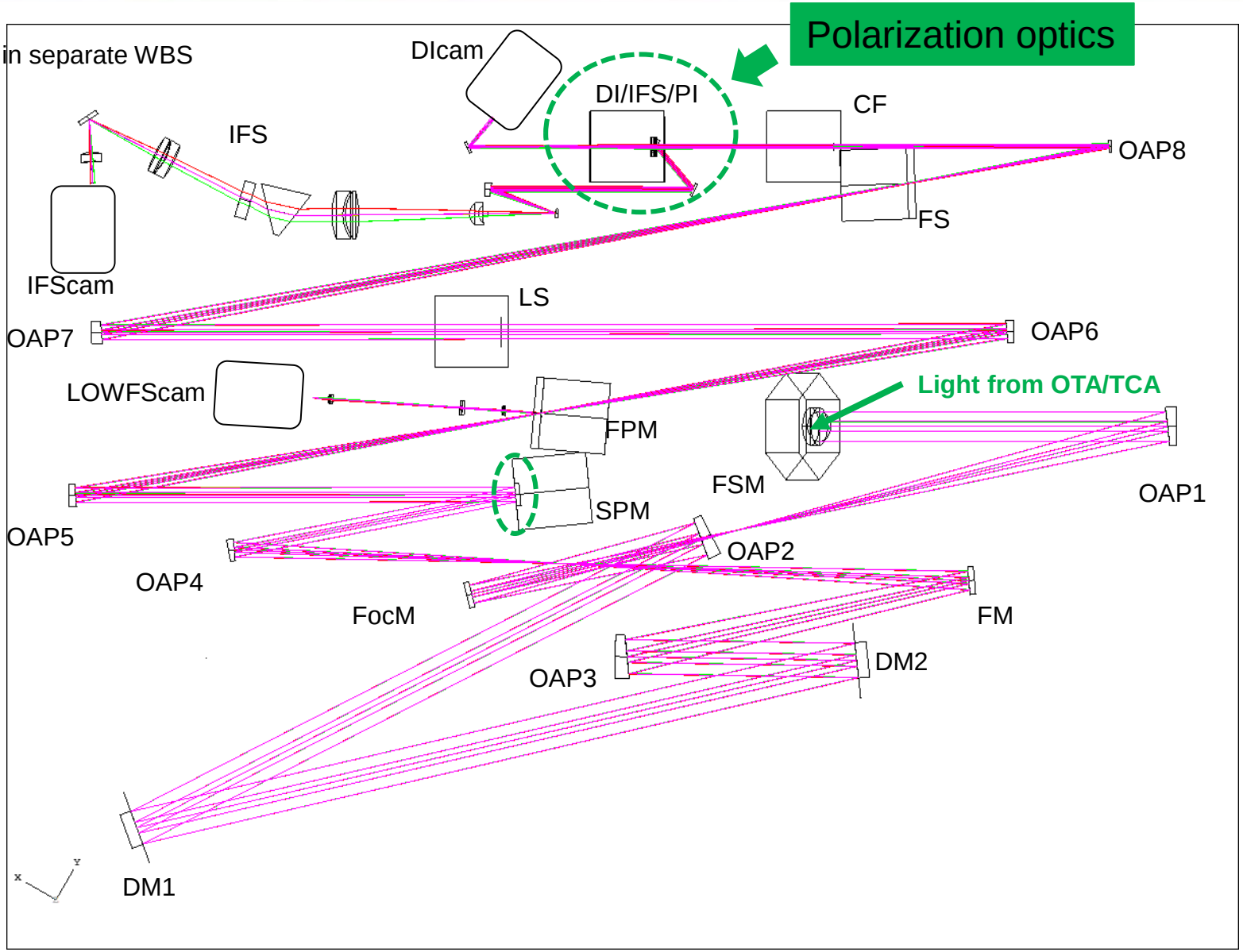
λ_4=825 nm, 10% (annular, 3-19 λ/D)

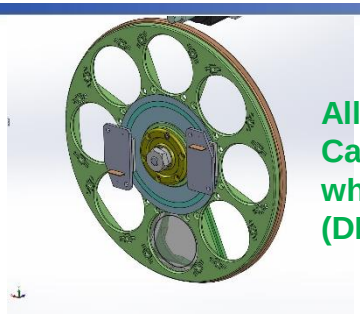
CGI Optical Layout - Top View



CL#17-1431

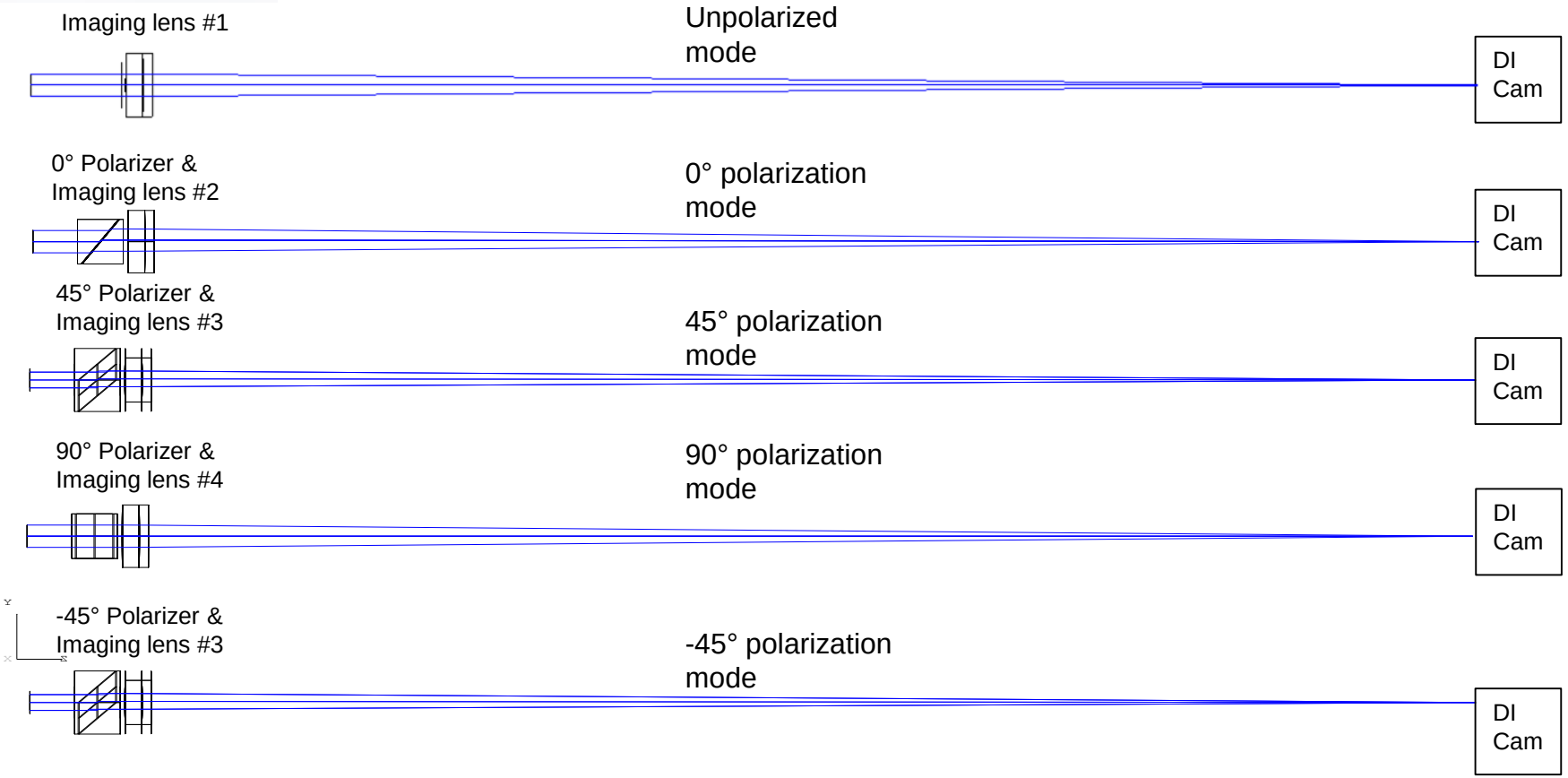
Courtesy of H. Tang

Polarization Optics



All lenses on Camera Select wheel (DI/IFS/PI)

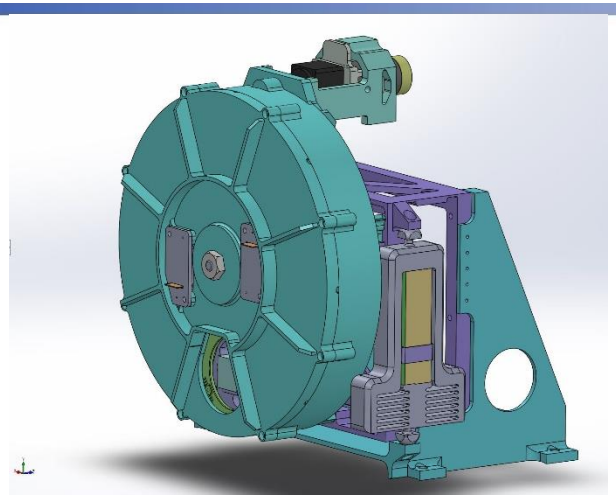
- **Provides a single unpolarized image (Mode #1) with higher throughput**
- **Meets requirements of polarization imaging (Modes #2, 3, 4 and 5)**

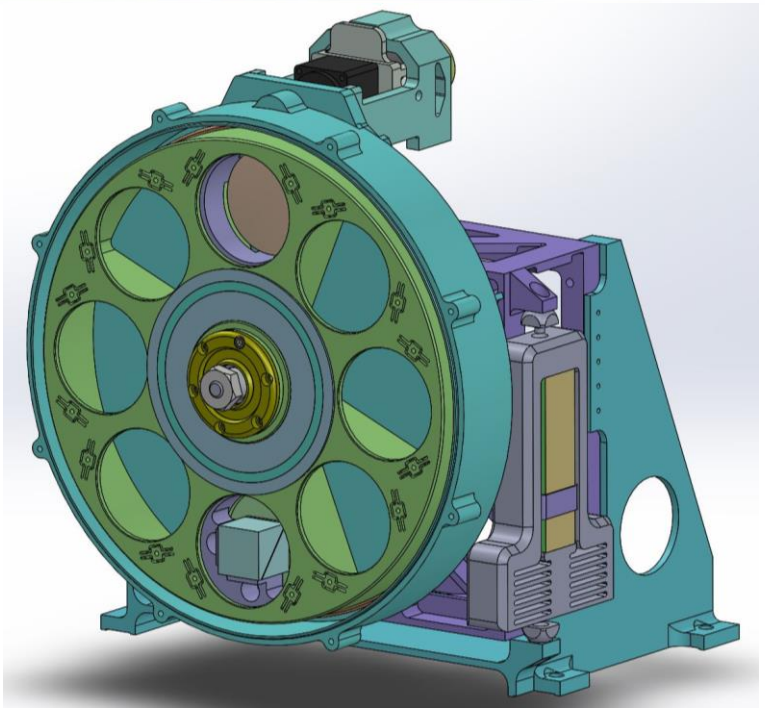


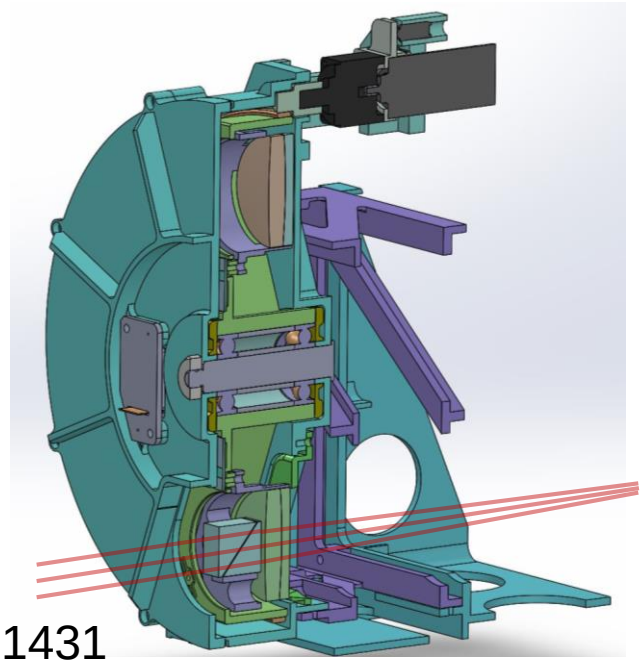
CL#17-1431

Courtesy of H. Tang

Polarizer and Lens in Wheel





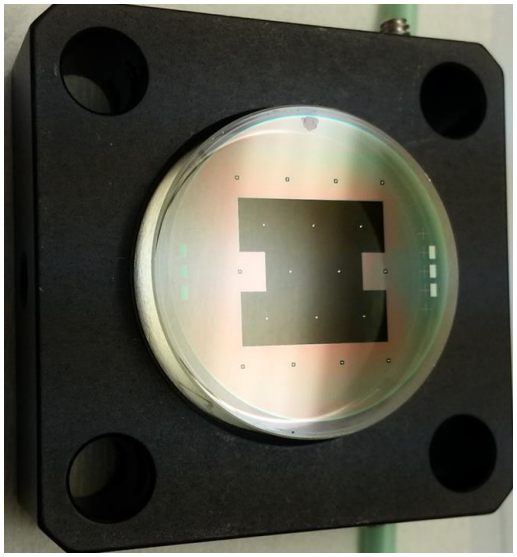


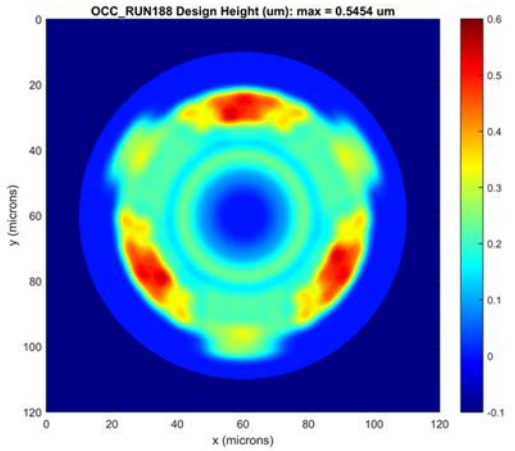
- 12 slots (enough for new baseline)
- Optic diameter 14 mm fits the slot size

Additional Candidates for JAXA Contribution

- **HLC substrates:**
  - Currently we employ a commercial product from CVI Laser Optics
  - e.g., part #: W2-PW1-1025-UV-415-700-0
  - AR coated on both sides for the wavelength band needed

Optical specifications	
Wavelength	400-700 nm; and 600 to 900 nm
Dimension	25.4 mm dia
Thickness	6.35 mm
AOI	8 deg
Coating Types	Antireflection Coating
Shape	Round
Surface Figure(p-v at 633nm before coating) λ/10	λ/10
Wedge	< 10 arc sec
Surface Quality	10/5
Material	Fused Silica
TWD	λ/10





Additional Candidates for JAXA Contribution

- **Shaped pupil mask Silicon substrate:**
  - Currently we employ 100mm dia 4mm thick silicon substrates to produce shaped pupil masks that are diced to 35mm x 35mm format for the testbeds. We would need qty 20 of these substrates now or in lots of 5 or 10.
  - For the flight instrument, we are planning to adopt 30mm dia 4mm thick substrates without going through the dicing process. So we look into the possibility to obtain qty 40 of these 30 mm dia 4mm thick substrates with the same optical specifications listed here.

Optical specifications	
Polished uncoated mirror grade silicon blanks	
Specifications	
Diameter	100mm +0.1/-0.0mm
Thickness	4mm +/-0.1mm
Flatness Side 1	1/20 wave peak to valley or better at 633nm
Flatness Side 2	1/10 wave RMS at 633nm or better
Power Side 1	1/20 wave at 633nm
Power Side 2	1/10 wave
Scratch/Dig Side 1	10/5 or better
Scratch/Dig Side 2	20/10
Edge Bevel	45 deg
Clear Aperture	90%
Wedge	<1 arc min
Material Resistivity	<0.01 ohm-cm or better; high conductivity is important
Dopant	Any
Orientation	<100> preferred or <111>

Picture of currently used mask

- **Discussions**