

A detailed illustration of the WFIRST coronagraph instrument is shown in the top left corner. It is a complex, cylindrical structure with various components and a large lens-like opening.

WFIRST Coronagraph Design Update and Phase B Plan

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WFIRST FSWG #7

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The decision to implement the WFIRST mission will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process. This document is being made available for information purposes only.

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1. Brief SPC Design Updates

a) SPC-IFS

b) SPC-WFOV (“Disk”)

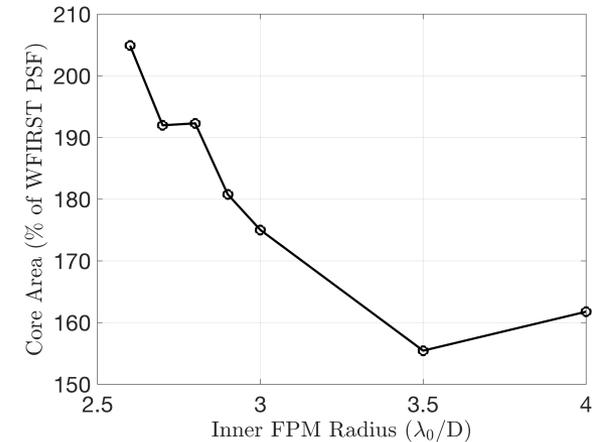
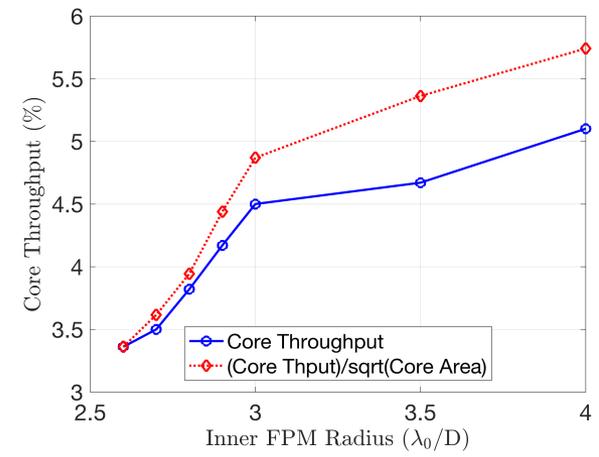
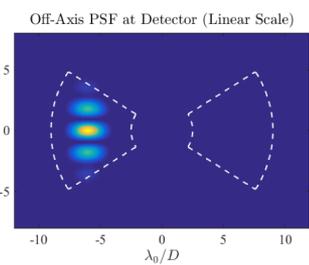
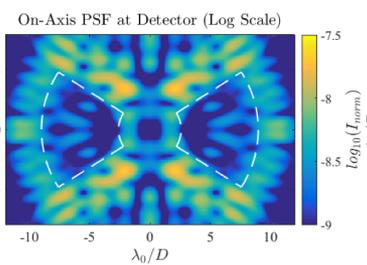
2. Key Activities in Phase B

- New SPC design survey with January pupil and varying IWA

SPC 20170714
(SRR design)



3.85% core throughput



2018-01-03 Pupil
(new COBS and struts)



Survey by Jessica Gersh-Range, Princeton Univ.

Thicker struts → lower throughput and larger PSF core area
➤ **Larger IWA is only way to mitigate those with SPC**

New SPC-WFOV ("Disk") Design Options

SRR Design:
 IWA = $6.8 \lambda/D$
 10% BW
 $1e-9$ design contrast

IWA = $5.3 \lambda/D$
 10% BW
 $1e-9$ design contrast

➤ *Much smaller IWA*

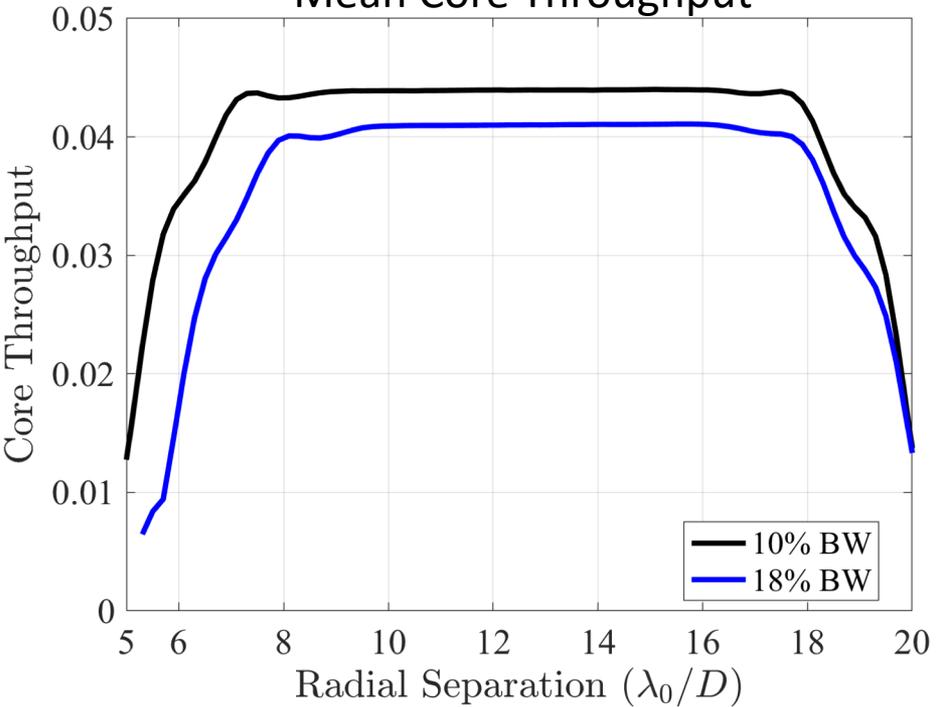
IWA = $6.1 \lambda/D$
18% BW
 $1e-9$ design contrast

➤ *Smaller IWA*
 ➤ *Larger bandwidth*

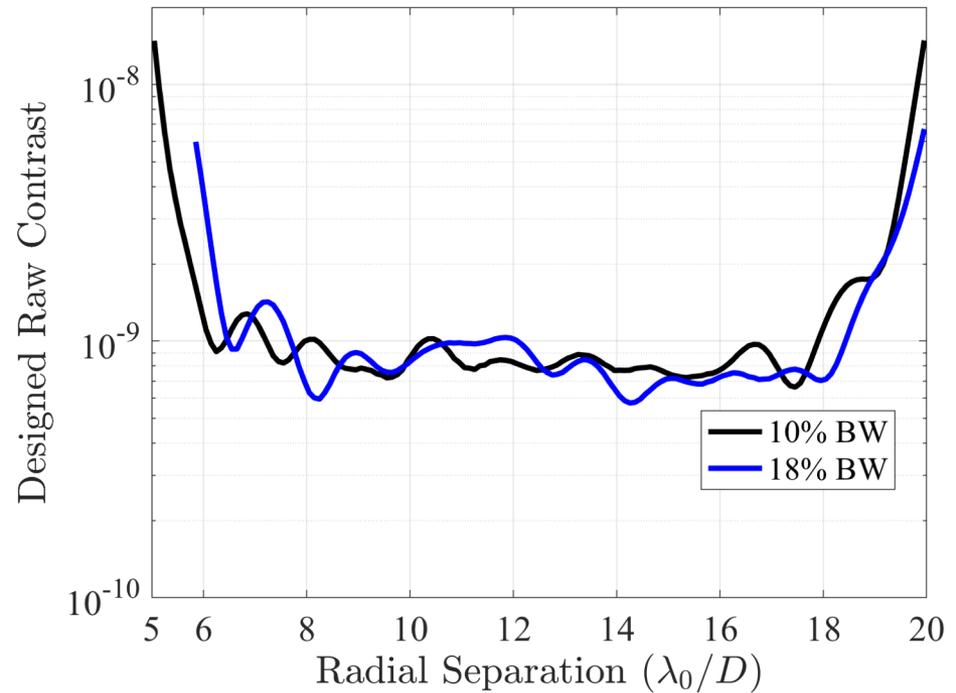


New Possible Designs:

Mean Core Throughput



Mean Designed Raw Contrast



1. Brief SPC Design Updates

a) SPC-IFS

b) SPC-WFOV (“Disk”)

2. Key Activities in Phase B

1) Anticipating telescope pupil uncertainties/changes:

- Establish clear strategy (to use through delivery of flight masks) on how to use provided pupil information for the design.
- Build robustness to telescope pupil and instrument uncertainties into designs

2) Develop Possible Alternatives to Bowtie SPC for IFS:

- 18-20% bandwidth HLC
- 18-20% bandwidth SP+HLC

3) Collaboration with SITs (e.g., CGI Filters WG)

- Trade studies:
 - Centers and bandwidths of filters
 - For all modes
 - Science and engineering filters
 - IFS:
 - What IWA gives best balance of other performance metrics?

4) HLC Occulter Fab Development

- Design, modeling, and testing HLC occulter with extended dielectric and/or multi-height nickel.
- Potentially *much better* throughput and robustness than baselined HLC occulter
 - Try to eliminate need for polarizer at redder bandpass

5) Documentation on code and methodology

- Need reproducible design process

Backup Slides

New Pupil in Phase B

Phase A (2014)



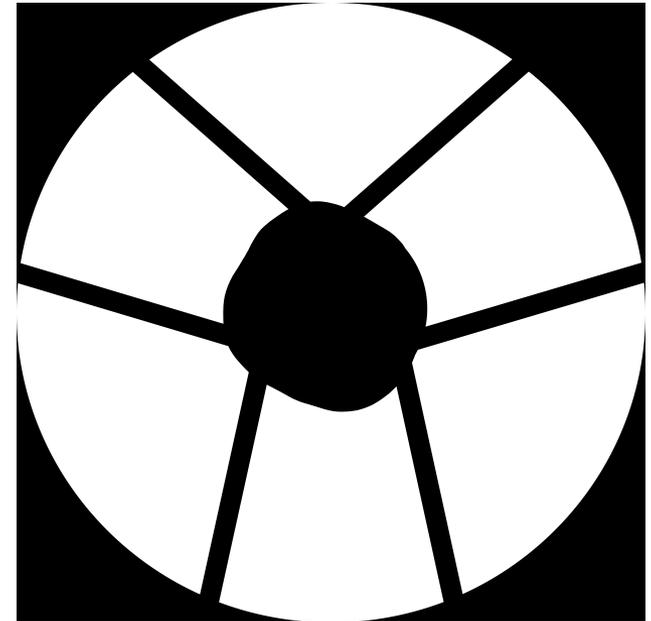
- 31% OD COBS
- 2.6% OD strut width



- *Larger, non-circular SM baffle*
- *Thicker struts*

(Preliminary Phase B Pupil)

Phase B (2018-01-03)



- **32-36% OD COBS**
- **3.22% OD strut width**

The WFIRST Coronagraphs

Shaped Pupil Lyot Coronagraph (SPC):

Zimmerman, Riggs et al. 2016

Shaped Pupil



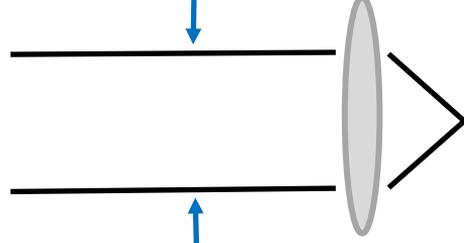
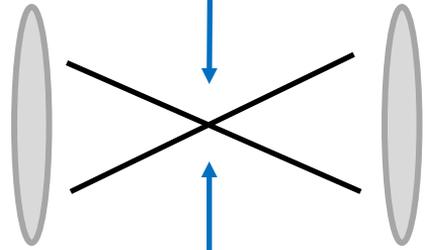
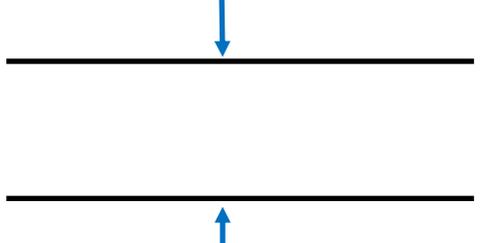
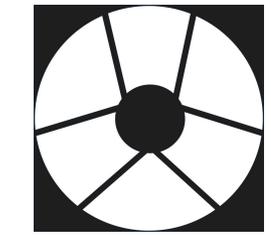
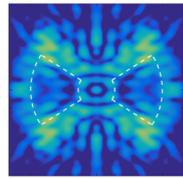
Hard-Edge FPM



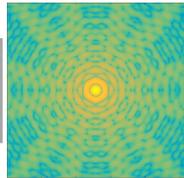
Lyot Stop



Stellar PSF



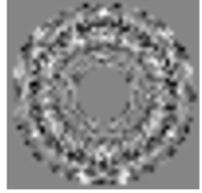
WFIRST PSF



Hybrid Lyot Coronagraph (HLC):

Trauger et al. 2016

DM1



DM2



Complex FPM

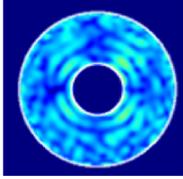


Phase Amplitude

Lyot Stop



Stellar PSF



Large DM stroke as part of nominal design.

Benefits of Each Coronagraph (complementary):

- **HLC**: Full **FOV**, fewer masks, easier **alignment**, less sensitive to pupil shape errors
- **SPC**: Broader **bandwidth**, better aber. **sensitivities** (esp. **PM pol.**), lower risk with DMs