Fast Linearized Coronagraph Optimizer (FALCO):

An Overview

Outline

1) Main Goals and Key Features

2) Block Diagram of Code Structure

3) Diagrams of Optical Layouts for Different Coronagraph Types

FALCO: Main Goals and Key Features

Goals
1. Provide example code for WFSC with several types of coronagraphs
   a) Usable for simulations, testbed experiments, and/or optimization of DM shapes for design.
   b) Uses PROPER library. Acts as WFSC wrapper around PROPER.
2. Provide a platform for different groups to add their own algorithms

Key Features:
- Provide rapid DM response matrix (aka control Jacobian) calculations for different classes of coronagraphs.
    - Algorithms used are orders of magnitude faster than conventional, direct methods.
    - May enable on-orbit calculations of control Jacobians for future missions.
- Testbed-specific code is modular and portable to different high-contrast coronagraph testbeds.
- Languages:
    - **Matlab** currently
    - **Python**
        - Translation not yet started. PyFALCO will be object-oriented.

FALCO: Classes of Coronagraphs
(Based on Jacobian Propagation Method to/from FPM)

- Babinet's Principle:
  - Occulting spot (LC, DMLC, APLC, HLC, APHLC)

- Single MFT
  - Opaque occulting spot + opaque outer diaphragm (FLC, SPLC)

- Double MFT
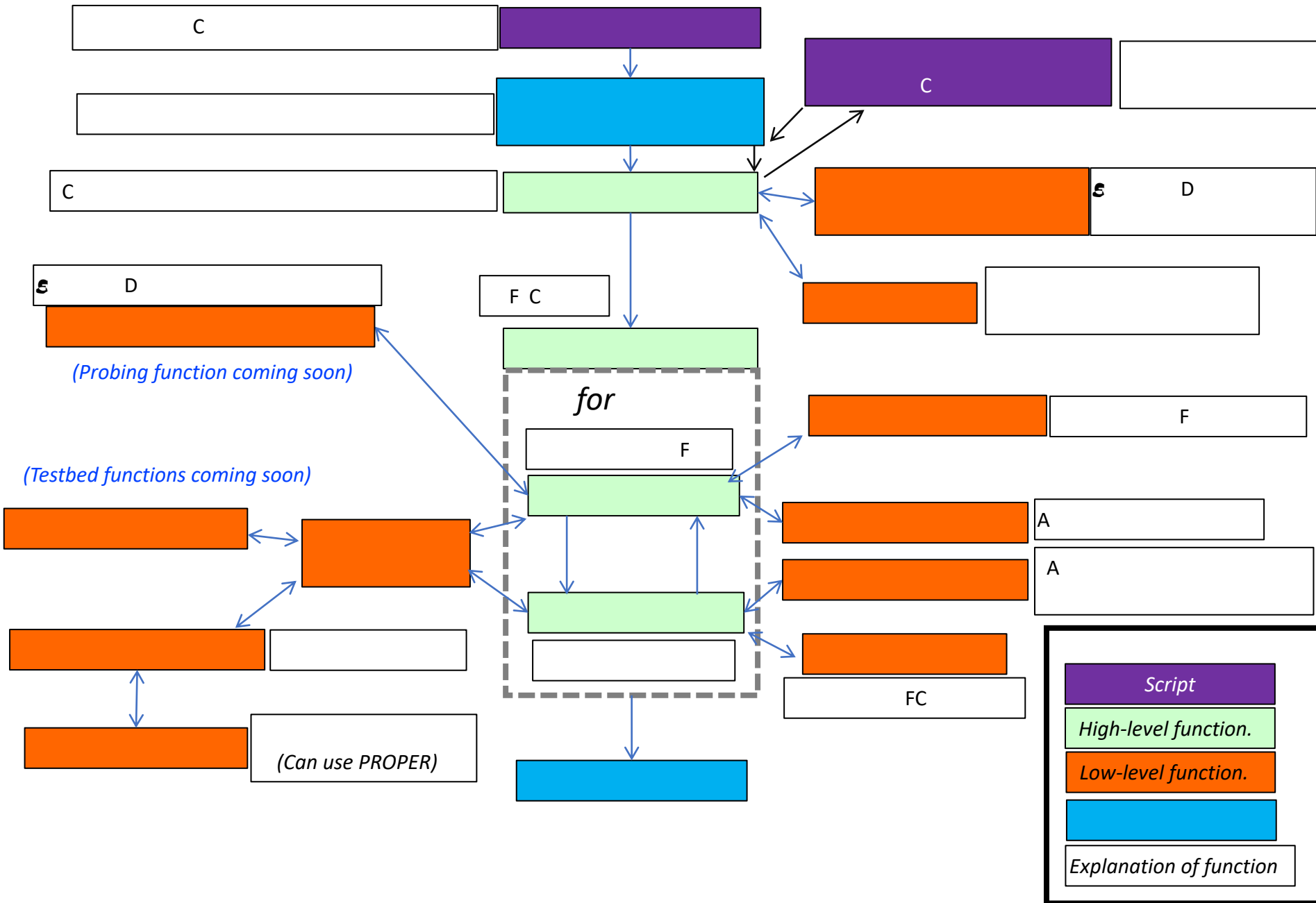 - High-res occulting spot + opaque outer diaphragm

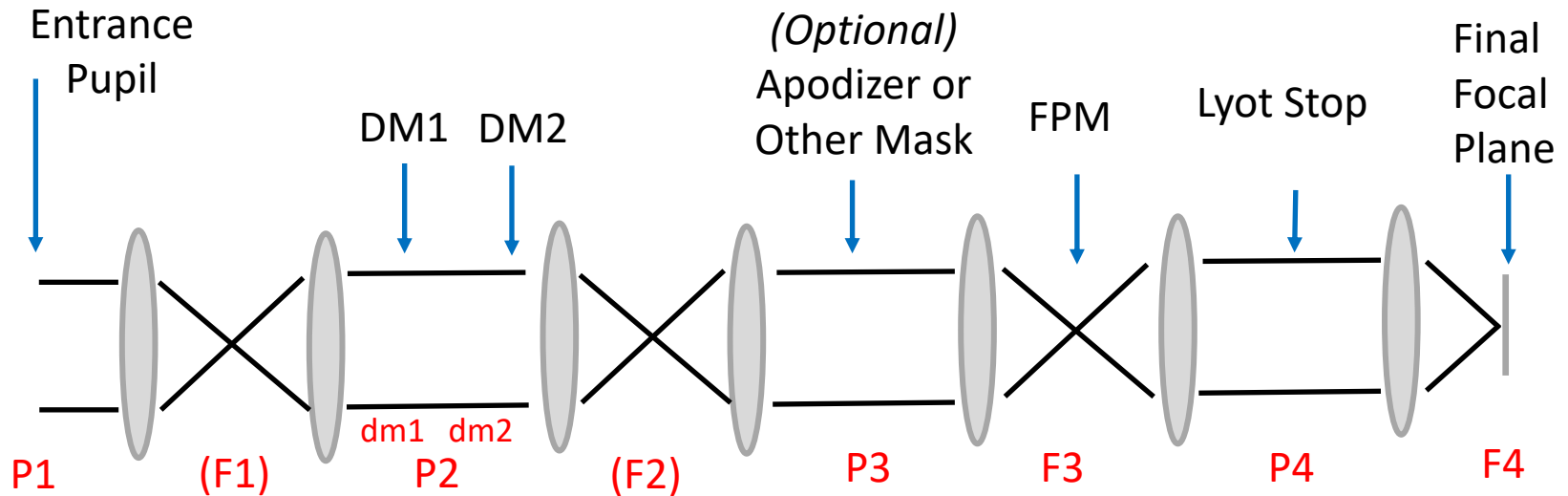- FFT
  - Infinite/pseudo-infinite FPM (vortex)

Classical PIAA not included because it cannot be used with Fresnel propagation

FALCO Code Structure

A

C

C

C

F C

ε   D

(Probing function coming soon)

(Testbed functions coming soon)

(Can use PROPER)

for

F

FC

ε   D

F

A

A

FC

Script
High-level function.
Low-level function.
Explanation of function

Mutual Layout for All Coronagraph Types

Entrance Pupil

DM1   DM2

(Optional) Apodizer or Other Mask

FPM

Lyot Stop

Final Focal Plane

dm1   dm2

P1   (F1)   P2   (F2)   P3   F3   P4   F4

Shorthand names of planes are in red

- Assume that the input pupil, apodizer, and Lyot stop are all at conjugate pupil planes
- DM1 and DM2 can be anywhere in the collimated beam near pupil plane P2.
- Focal planes F1 and F2 are empty. The final focal plane F4 can have a field stop superimposed on the detector.
- The rapid propagation method to/from the FPM varies with coronagraph type based on:
  - Outer FPM cutoff radius (finite or pseudo-infinite)
  - Finite inner mask (e.g., a spot) or pseudo-infinite (e.g., a vortex)