Surface counts for the five NGAO architectures.
Verison 0.7

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1 Introduction

The NGAO systems engineering team came up with five architectures during the course of meeting #8. This document describes the architectures using schematics that were made during the meeting and tabulates surface count to Science instrument, LGS WFSs and d-NIRI. Fig. 12 shows a schematic of d-NIRI for completeness.

2 NGAO Architectures

The architecture suggested were:

1. SplitRelay - Split 20" Narrow field instruments / 120" d-NIRI relay architecture (see figures 1, 2)
2. AM2 - Adaptive secondary mirror architecture (see figures 3, 4)
3. LargeRelay - Single 180" TFoV relay architecture (see figures 5, 6, 7)
4. KI Upgrades - Keck I upgrade path architecture (see figures 8, 9)
5. CascadedRelay - A variant of LargeRelay in which a 2nd stage is used for narrow-field instruments, reducing size (see figures 10, 11)

2.1 Assumptions

In order to make an *apples-to-apples* comparison of the five architectures the following assumptions are made:

1. d-NIRI has the TT sensors packaged into it. Which makes all the narrow field instruments look through it's dichroic pick off. Alternately one could envision a separate TT sensor package dedicated to the narrow field instruments (this is not considered in this document).
2. DMs are on TT stages where ever necessary, no extra surfaces are used for TT except In case of large DMs (Cascaded relay and Large relay). A second TT stage is assumed in case of large relays to equalize the TT bandwidth between the architectures. d-NIRI has its own TT stage (MEMS DMs can be mounted on this TT stage if we use MEMS DMs) to allow for dithering. It is assumed that buying more stoke on the DM to use its surface for TT correction is more expensive than using a stage. For $16M, it is assumed that the Adaptive Secondary has enough TT bandwidth.
3. All AO relays are reflective, the MEMS DM has a sapphire window on it and hence contributes to 5 surfaces when light bounces off of it.
4. A Risley prism pair based ADC design is assumed. For lack of space in the beam train, the ADC in K1 upgrade option is assumed to be inside the elevation journal bearing. For all other architectures the ADC is used only for the narrow field science

path. Brian has suggested the feasibility of using a trombone-type ADC, this is still to be confirmed.

5. There are two enclosure windows to prevent condensation on the cold AO system in all cases except the ASM. The ASM option has the least number of surfaces and hence may need to get cooled lesser and so may be able to achieve performance with just one window.
6. In case of cascaded relay, the K mirror is in front of the large relay for convenience. So both LGS WFSs and d-NIRI are stationary.
7. I have included the original meeting 8 schematics along with ones generated after the retreat. Color coding is used on the new schematics to represent different features. Optics/ subsystems shown in green rotate, MEMS DMs are magenta in color while piezo DMs are blue colored. d-NIRI/ TT pick off and path are shown in red and yellow coloration is used for the LGS WFS pick off, path and enclosure.

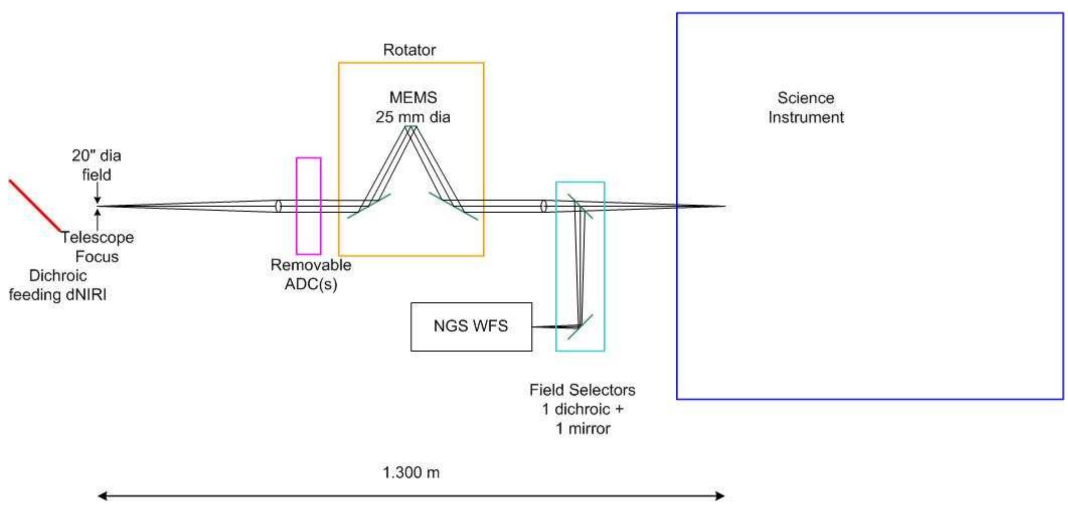

Figure 1: NGAO SplitRelay - Split 20” Narrow field instruments / 120” d-NIRI relay architecture - retreat version

References

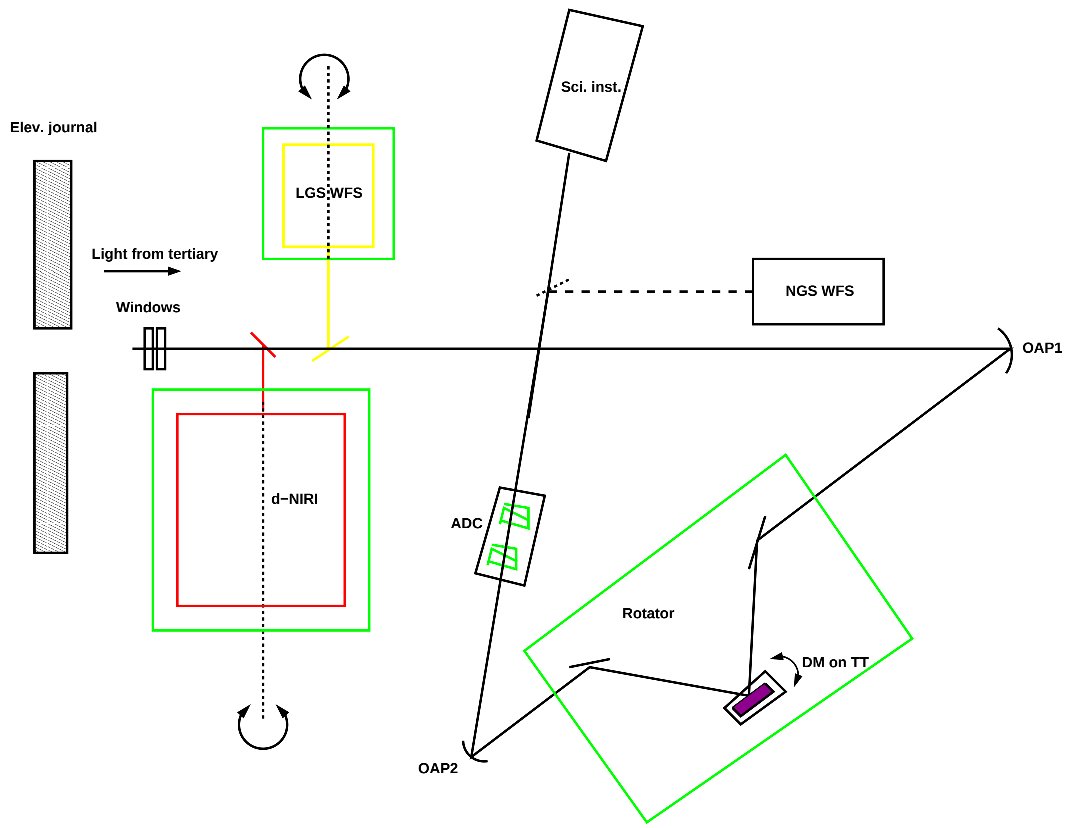

Figure 2: NGAO SplitRelay - Split 20" Narrow field instruments / 120" d-NIRI relay architecture - as envisioned now

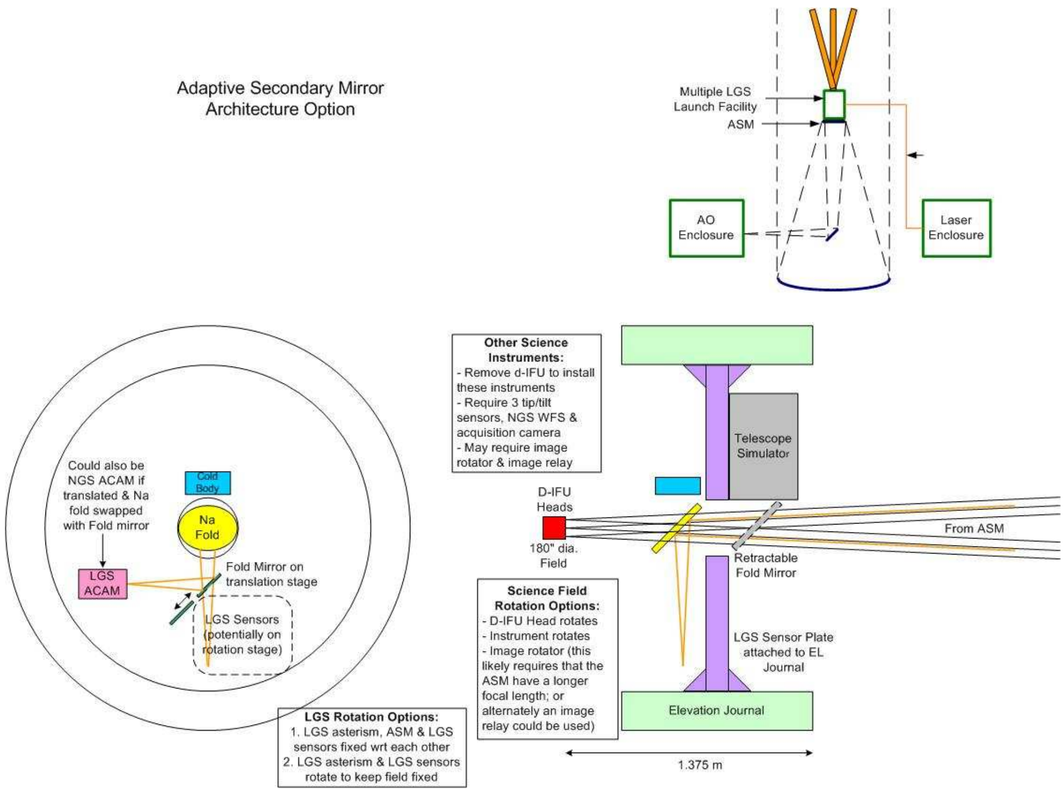

Figure 3: AM2 - Adaptive secondary mirror architecture - retreat version

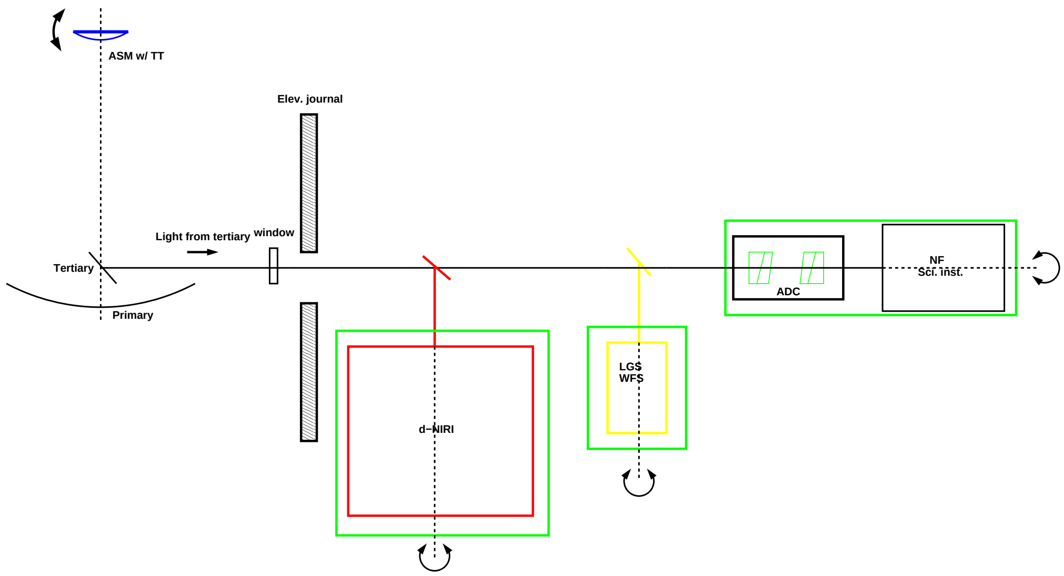

Figure 4: AM2 - Adaptive secondary mirror architecture - as envisioned now

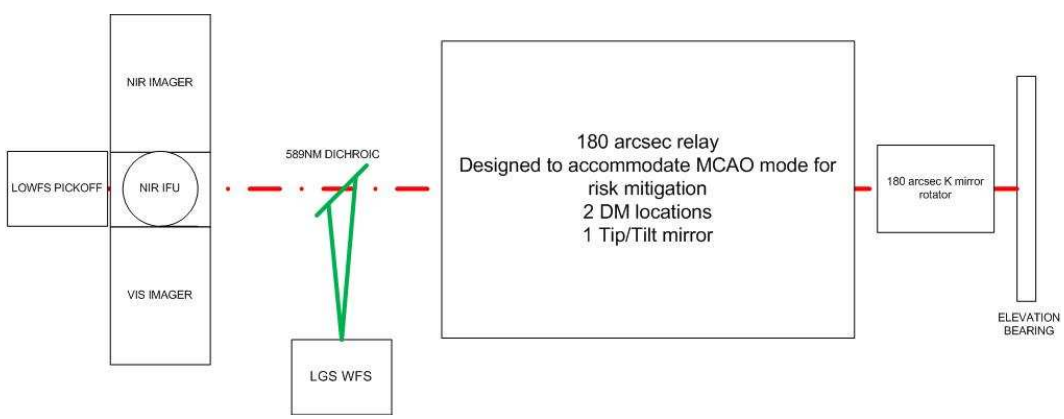

Figure 5: LargeRelay - Single 180" TFoV relay architecture - retreat version

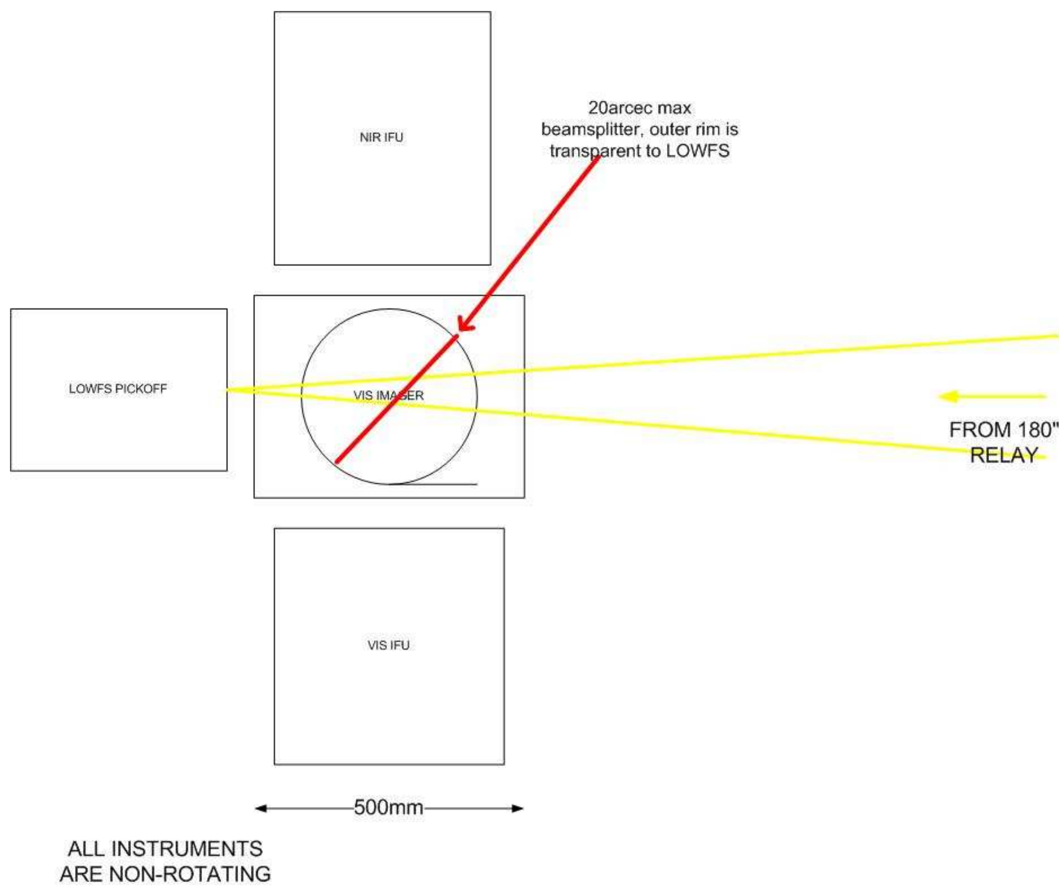

Figure 6: LargeRelay - Single 180" TFoV relay architecture instrument details- retreat version

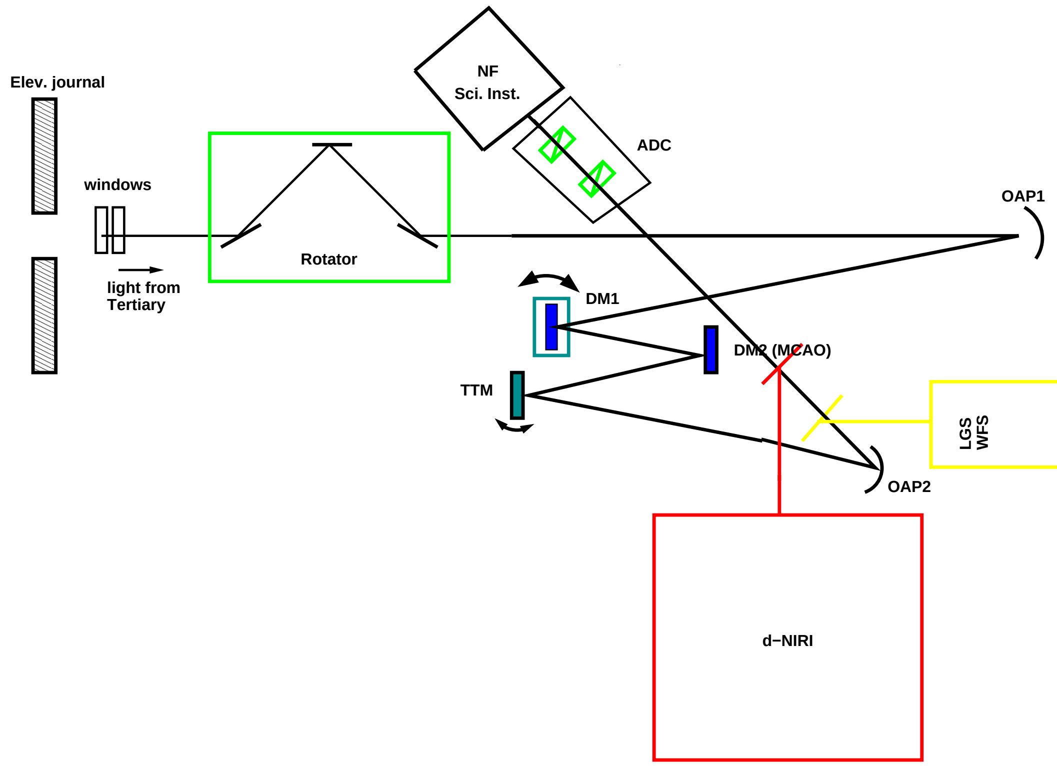

Figure 7: LargeRelay - Single 180" TFoV relay architecture - as envisioned now

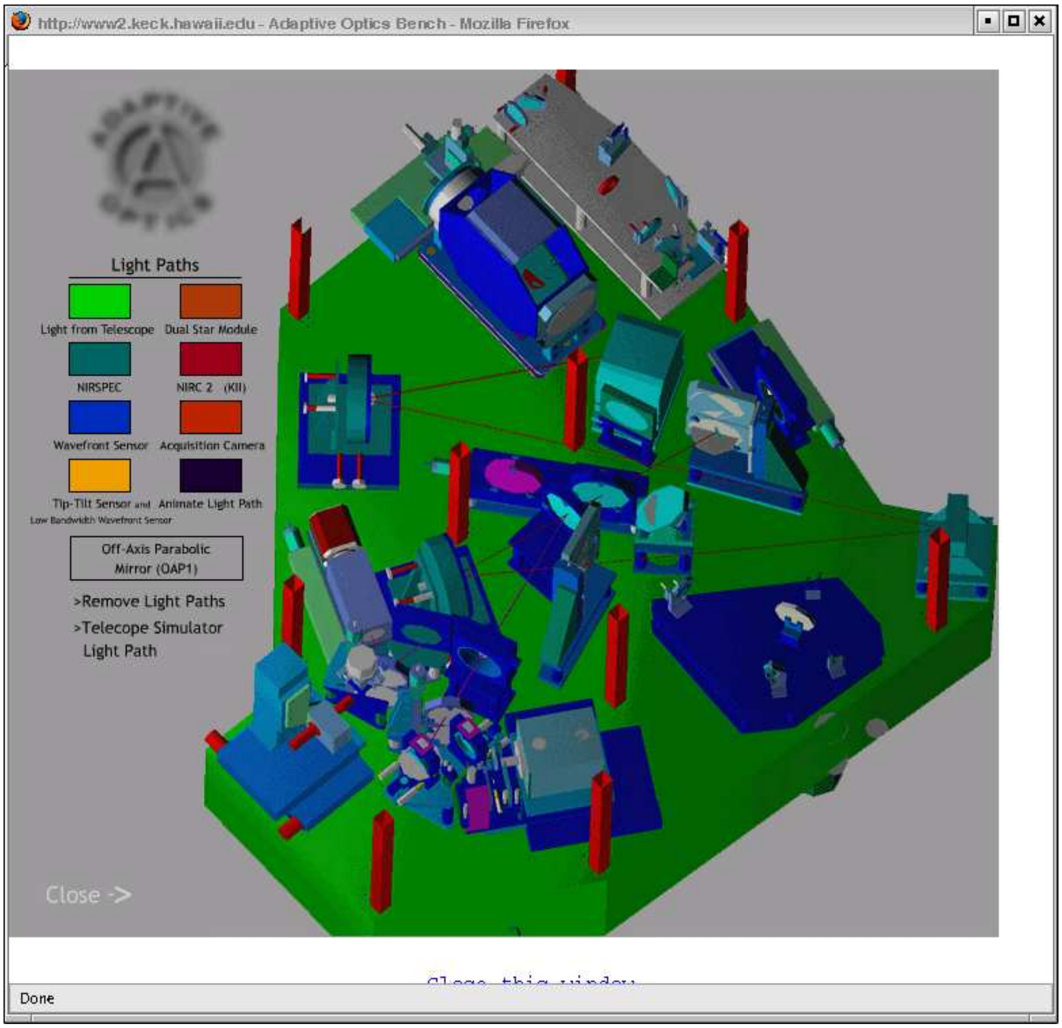

Figure 8: KI Upgrades - Keck I upgrade path architecture - from Keck website

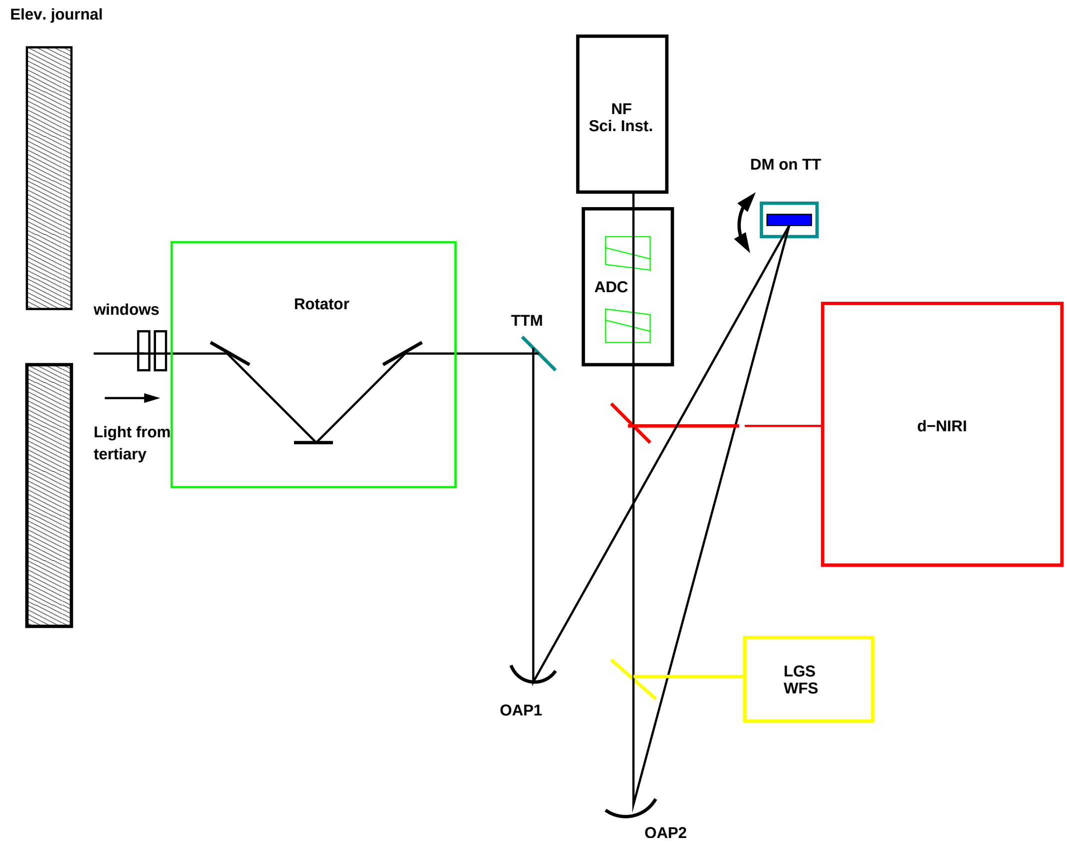

Figure 9: KI Upgrades - Keck I upgrade path architecture - as envisioned now

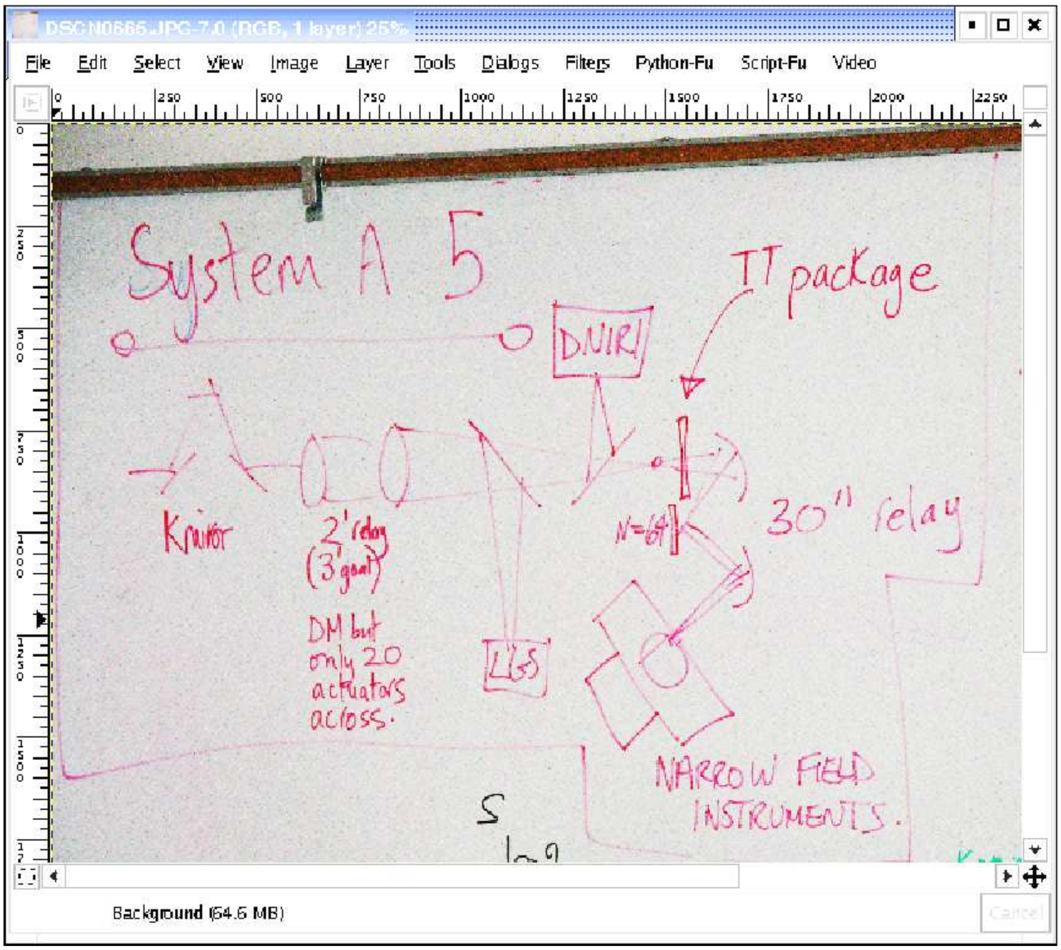

Figure 10: Cascaded relay architecture - retreat version

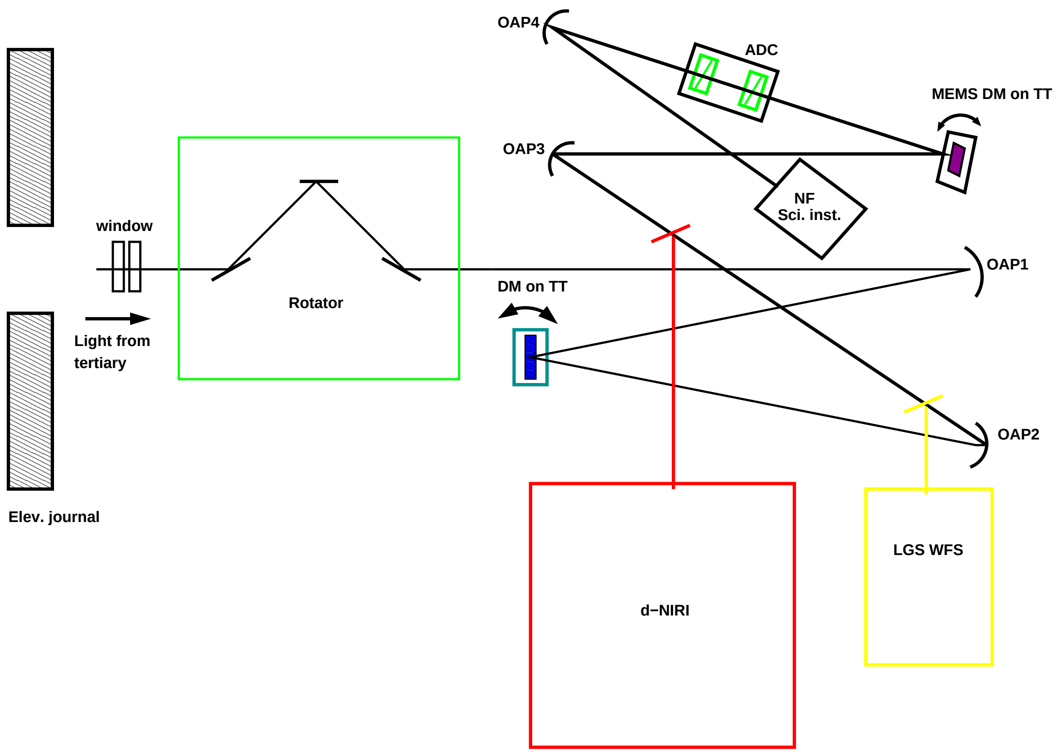

Figure 11: Cascaded relay architecture - as envisioned now

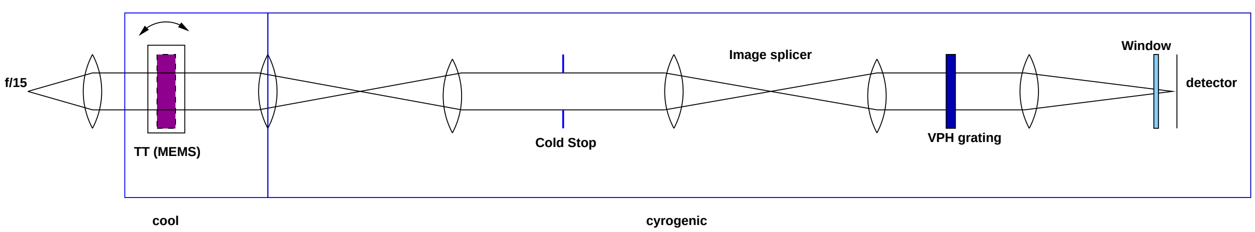

Figure 12: d-NIRI schematic, 18 surfaces overall from the focus in front of d-NIRI assuming no doublets in the design

Arch.	Tel.	N.F. AO	W.F. AO	K mirror	Na-dichroic	d-NIRI pickoff	ADC	2^{nd} TT	Entrance window(s)	Total
Split Relay	3	$3+4^{\oplus}$	-	2^{*}	2	2	6	-	4	26
ASM	3	-	-	$-^{\circ}$	2	2	6	-	2	15
Large Relay	3	-	$3+1^{\dagger}$	3	2	2	6	1	4	25
K1 upgrade	3		$4^{\ddagger}$	3	2	2	6	1	4	25
Cascaded relay	3	$3+4^{\oplus}$	3	3	2	2	6	-	4	30

Table 1: Table of surface count to the narrow field Science instrument for different NGAO architectures; *- DM is already counted as part of NF AO relay, † - MCAO option, ‡ - extra fold mirror due to packaging constraint, $\circ$ - Science instrument rotates, $\oplus$ - 4 more surfaces as the MEMS DM is hermitically sealed using a window.

Arch.	Tel.	N.F. AO	W.F. AO	K mirror	Na-dichroic	d-NIRI pickoff	ADC	2^{nd} TT	Entrance window(s)	Total
Split Relay	3	-	-	$-^{\circ}$	1	2	-	-	$2^{\dagger\dagger}$	8
ASM	3	-	-	$-^{\circ}$	1	2	-	-	2	8
Large Relay	3	-	$3+1^{\dagger}$	3	1	-	-	1	4	16
K1 upgrade	3	-	$4^{\ddagger}$	3	1	2	6	1	4	24
Cascaded relay	3	-	3	3	1	-	-	-	4	14

Table 2: Table of surface count to the LGS WFSs for different NGAO architectures; †† - one window before the LGS WFSs and another before it goes into the AO enclosure, $-^{\circ}$ - LGS WFSs rotate.

Arch.	Tel.	N.F. AO	W.F. AO	K mirror	Na-dichroic	d-NIRI pickoff	ADC	2^{nd} TT	Entrance window(s)	Total
Split Relay	3	-	-	$-^{\circ}$	-	1	-	-	4	8
ASM	3	-	-	$-^{\circ}$	-	1	-	-	2	6
Large Relay	3	-	$3+1^{\dagger}$	3	2	1	-	1	4	18
K1 upgrade	3	-	$4^{\ddagger}$	3	2	1	6	1	4	24
Cascaded relay	3	-	3	3	2	1	-	-	4	16

Table 3: Table of surface count to d-NIRI for different NGAO architectures, $-^{\circ}$ - d-NIRI rotates.