LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
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ASC Channel Count

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ISC

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1 INTRODUCTION

This document is a first attempt to make a complete summary of ASC sensors, drivers and controllers; it includes a list of channels. In the present stage this list is an on-going effort and more work is needed to converge towards a final design.

2 OVERVIEW

The setup of the ASC sensors and drivers are drawn on page 3 and 4, respectively. The layout of the ASC controller and its subsystems are given on pages 5 to 7.

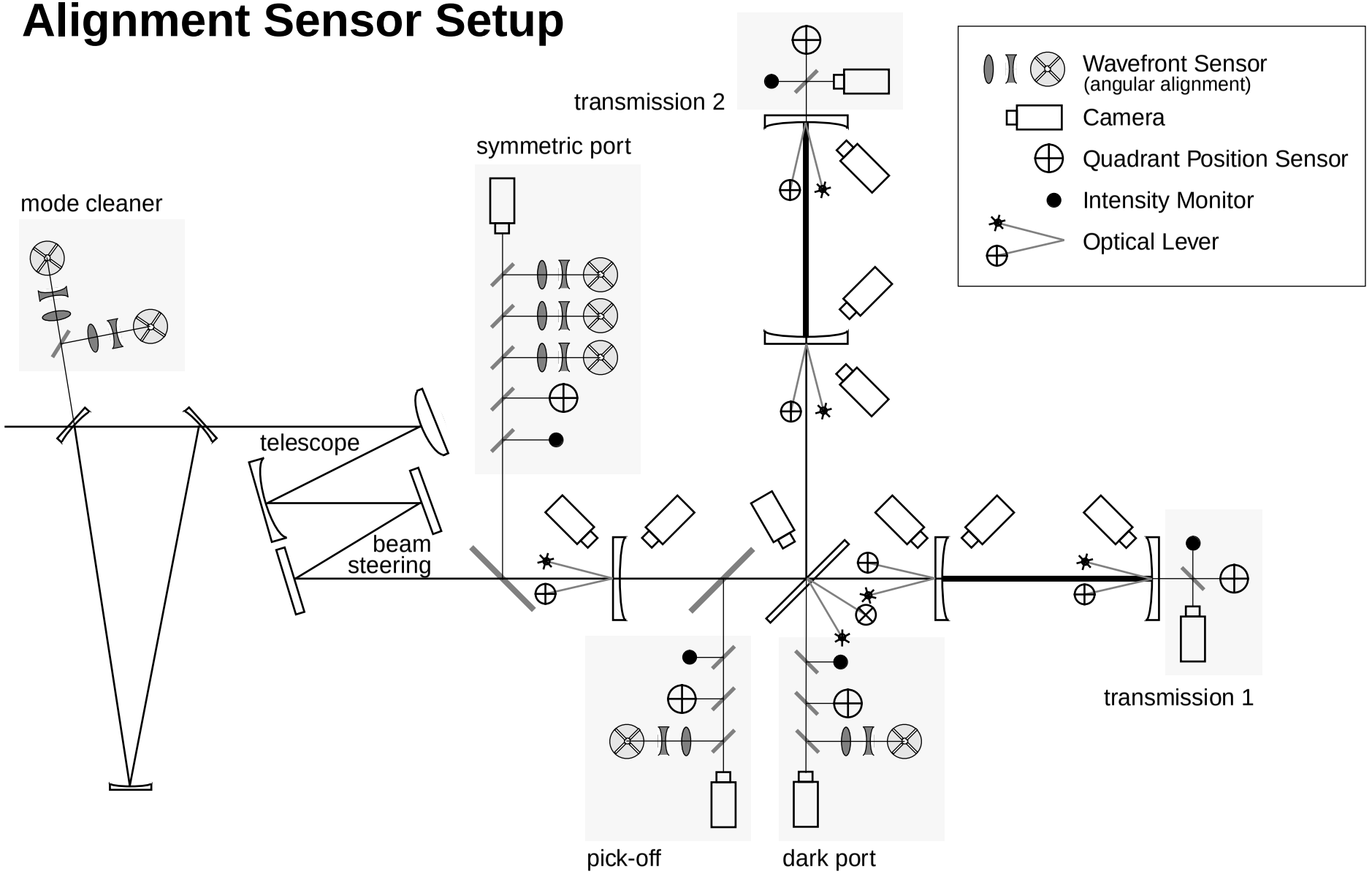
In detection mode the alignment data and the centering data is used by a digital servo to control the mirror angles of the interferometer and the beam steering optics. In this mode all other information which is gathered by the ASC subsystem is for monitoring only. On the other hand, during initial alignment, when no valid alignment data exists, the orientation data provided by the optical levers and the suspension controllers — together with the centering data — is used to align the interferometer to the point where the length degree-of-freedom of the interferometer can be locked. Centering adjustments which would require that the seismic isolation stacks are move transversely or mode matching adjustments are done as part of diagnostic/monitoring only, and not with a closed loop servo control.

The system provides the capability to digitally assist the interferometer length control, in case a combined ASC/LSC lock guiding algorithm will be necessary to decrease the amount of time required to reach the detection mode.

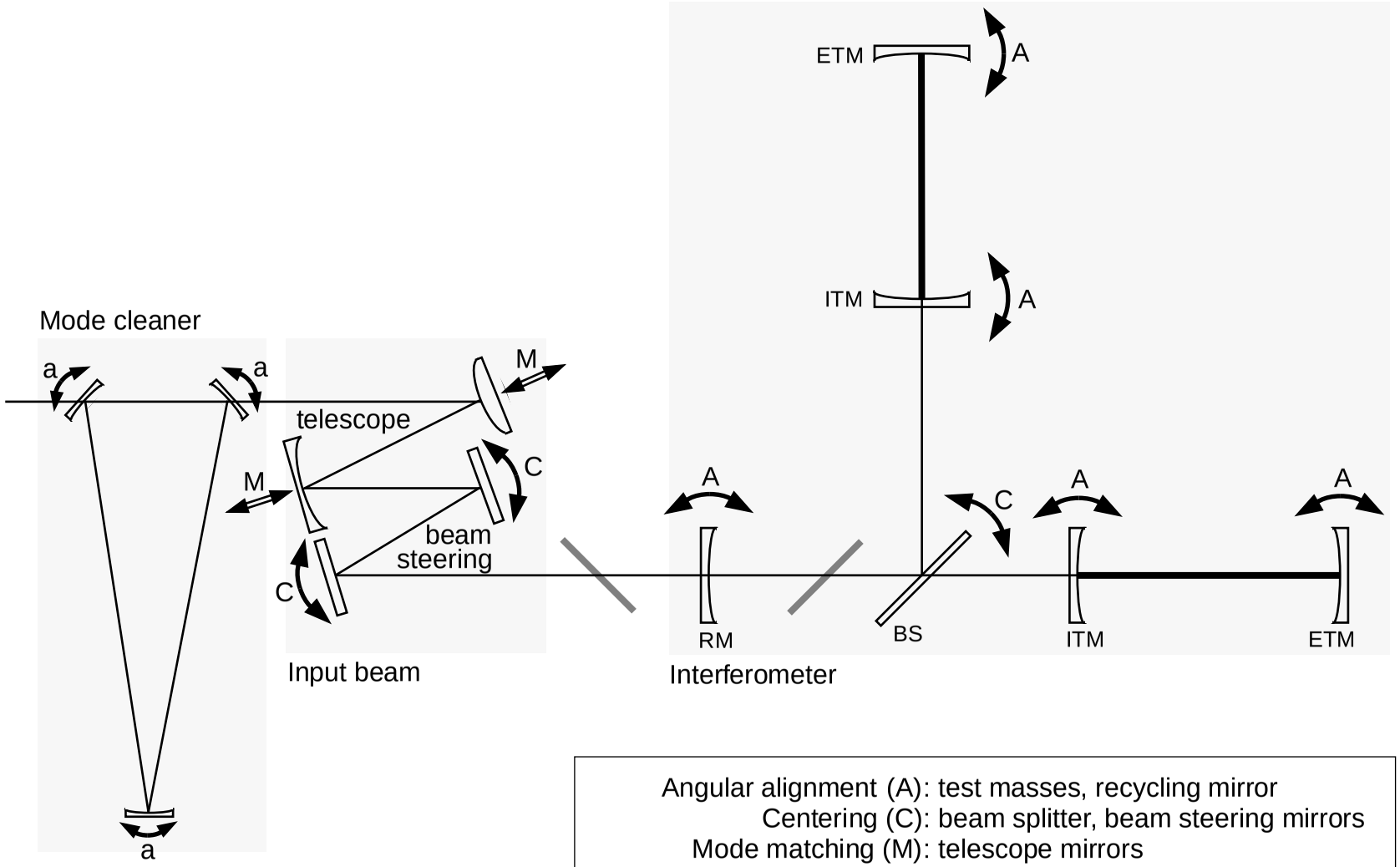
3 CHANNEL LISTING

A list of the ASC channels is presented in Table 1. They are sorted into ASC subsystems: wavefront sensing, image processing (cameras), beam positioning (quadrant photocells), mirror orientation (optical levers), drivers and computing. If a channel connects between ASC subsystems it is listed in each affected subsystem, either as an input or as an output. For digital and numerical channels an estimate of the maximum required sampling rate is given. Note that the channels from the mode cleaner alignment will form an independent subsystem.

Alignment Sensor Setup



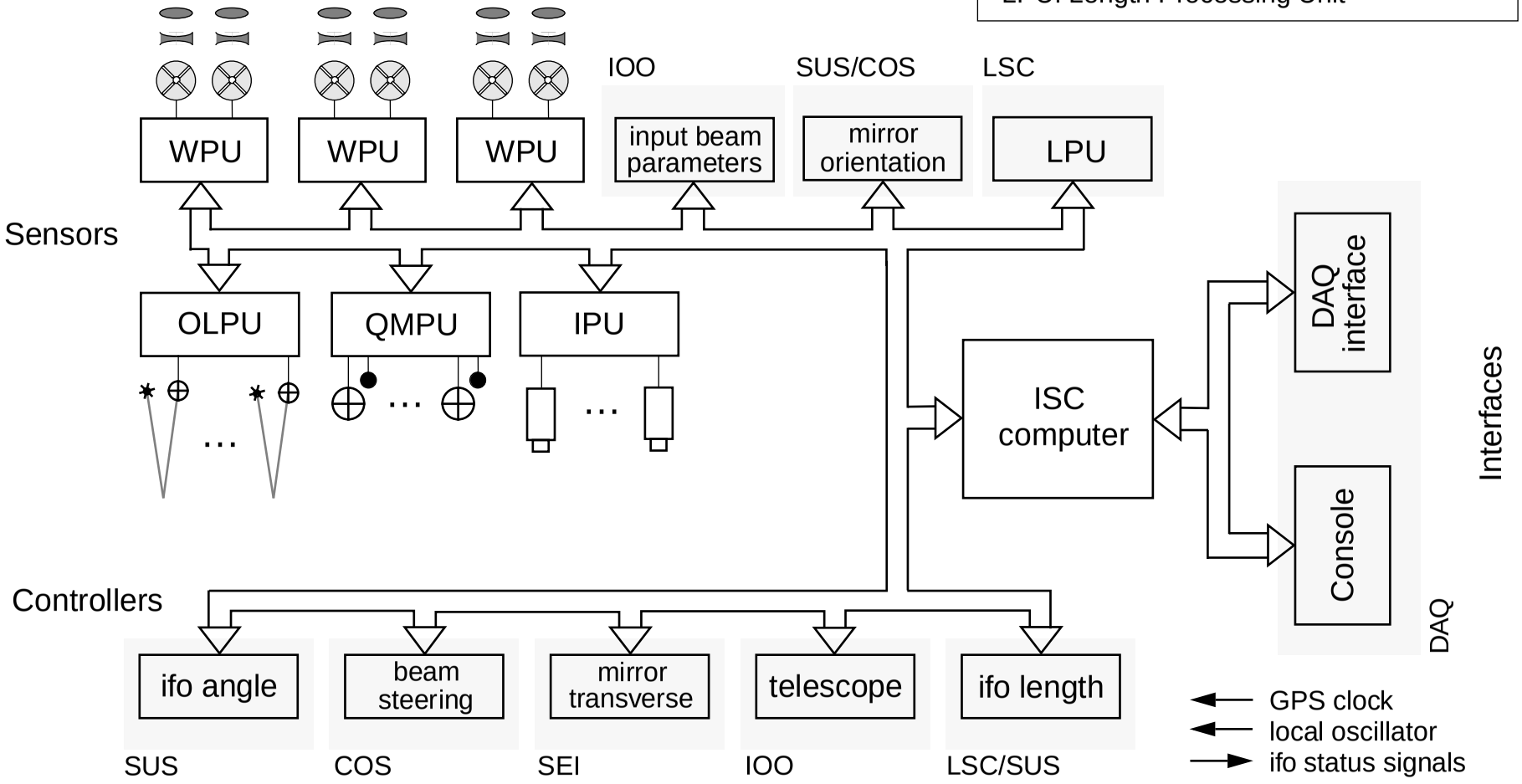
Alignment Driver Setup



Angular alignment (A):	test masses, recycling mirror
Centering (C):	beam splitter, beam steering mirrors
Mode matching (M):	telescope mirrors
Mode cleaner alignment (a):	mode cleaner mirrors

Alignment Controller

WPU: Wavefront Processing Unit
QMPU: Quadrant/Monitor Processing Unit
IPU: Image Processing Unit
OLPU: Optical Lever Processing Unit
LPU: Length Processing Unit



Wavefront Processing Unit

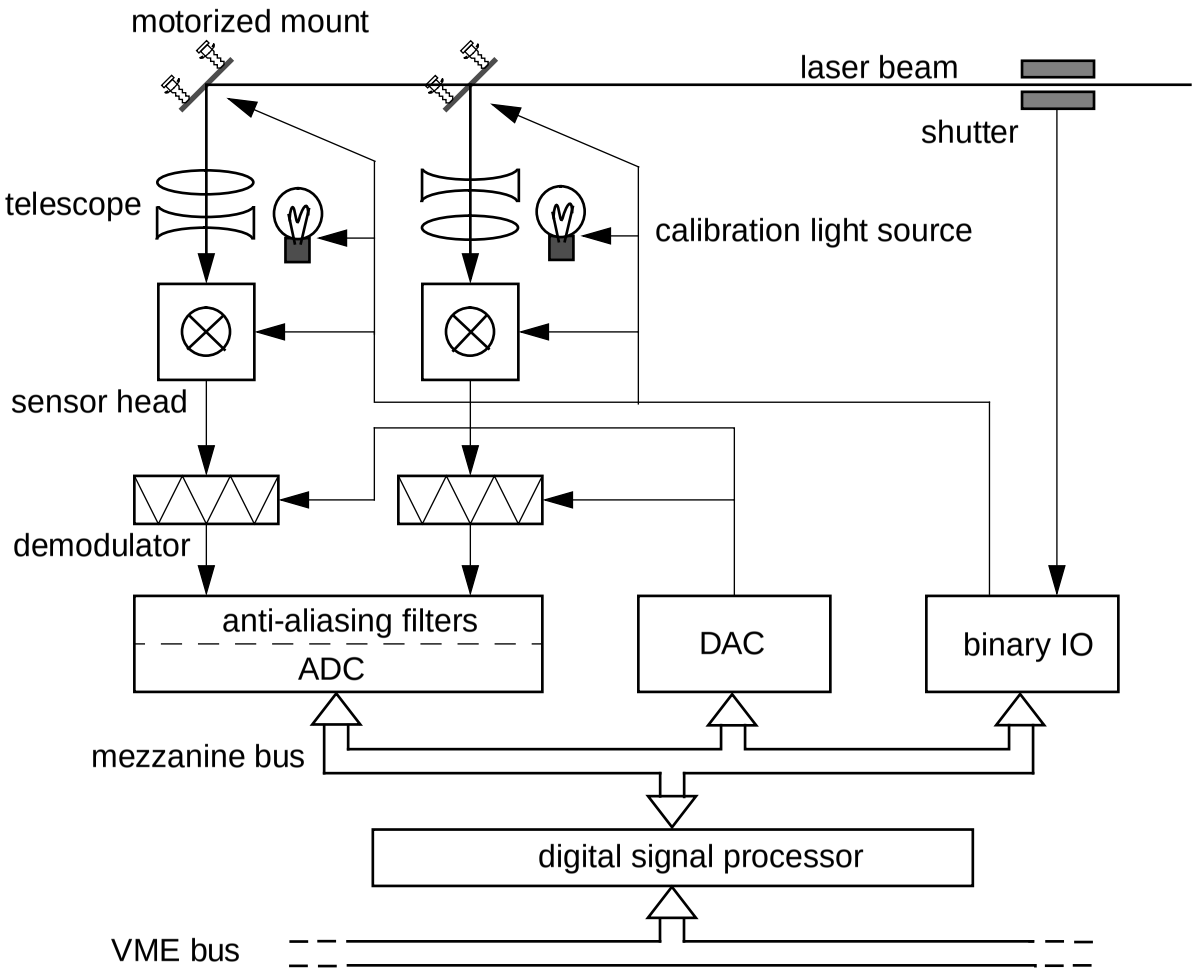
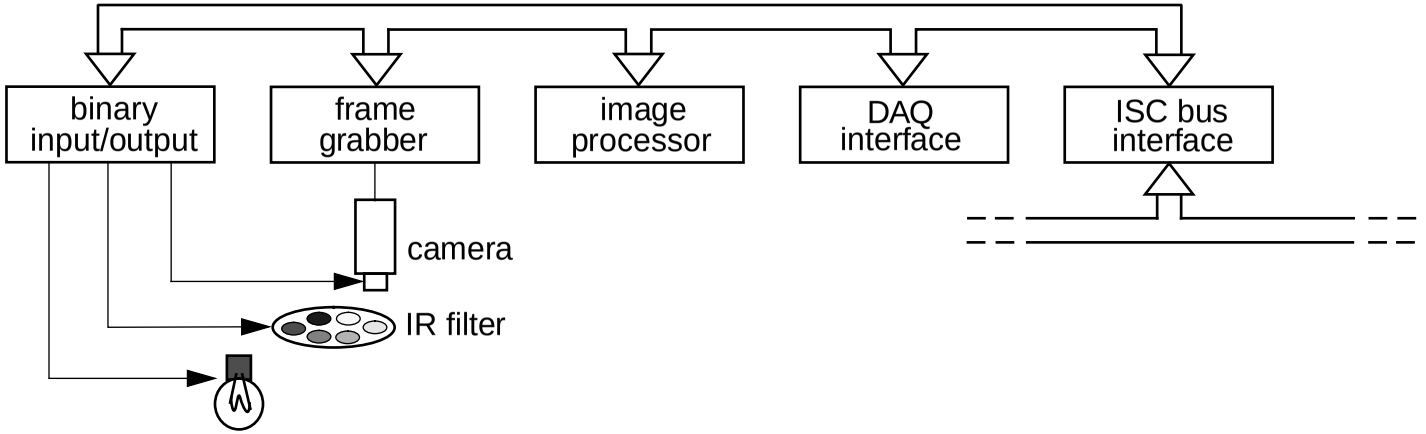


Image Processing Unit



Quadrant, Monitor and Optical Lever Processing Unit

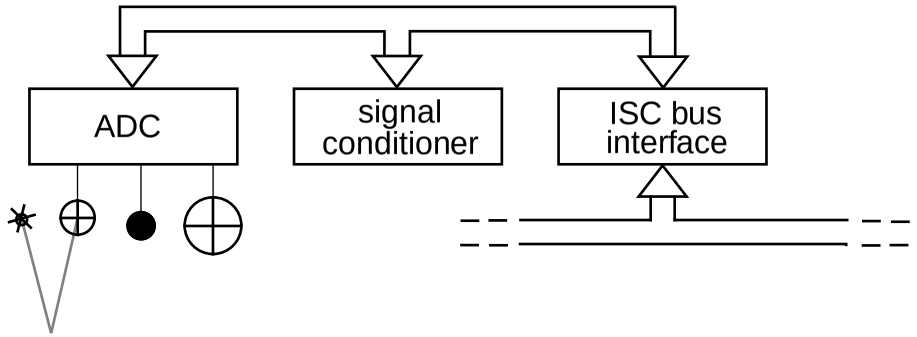


Table 1: ASC Channel Count

	Channel	No.	Type	Category	from:	to:	Rate (Hz)	Comment
WPU	**Wavefront sensing; angular misalignment (per sensor):**							
	PD DC	4	input	16 bit ADC	WFS	WPU	65536	PD: photodiode
	PD down-conv.	8	input	16 bit ADC	WFS	WPU	65536	
	sampling clock	1	input	clock	DAQ	WFS	65536	GPS
	world time	1	input	num.	ISCC	WFS		for time stamps
	angle	2	internal	32 bit num.	WPU	ISCC	2048	**Alignment Data**
	LO RF	1	input	RF	LSC	WFS		LO: local oscillator
	LO phase	1	input	16 bit ADC	WFS	WPU	65536	looped from DAC
	LO phase	1	output	16 bit DAC	WPU	WFS	65536	
	gain switch	1	output	binary	WPU	WFS		–20dB RF gain
	cal. light switch	1	output	binary	WPU	WFS		shot noise calibration
	shutter status	1	input	binary	WFS	WPU		
	beam steering	1	output	RS232/GPIB	WPU	WFS		motorized mount (e.g. New Focus)

Table 1: ASC Channel Count

	Channel	No.	Type	Category	from:	to:	Rate (Hz)	Comment
IPU	**Image processing (per camera):**							
	TV signal	1	input	TV	camera	IPU		
	zoom	1	output	binary	IPU	camera		
	IR filter	1	output	binary	IPU	camera		
	illumination	1	output	binary	IPU	camera		on-off switch for light
	TV image	1	output	digital/analog	IPU	DAQ	1MB	576x385 pixels, 30 Hz
	beam parameters	5	internal	16 bit num.	IPU	ISCC	256	**Centering Data** (CoG, Γ, I, etc.)
	world time	1	input	num.	ISCC	WFS		for time stamps
QMPU	**Beam position and intensity monitor (per quadrant cell/monitor):**							
	PD quadrant	4	input	16 bit ADC	sensor	QMPU	65536	
	intensity monitor	1	input	16 bit ADC	sensor	QMPU	65536	
	sampling clock	1	input	clock	DAQ	QMPU	65536	GPS
	world time	1	input	num.	ISCC	QMPU		for time stamps
	X/Y/I	3	internal	32 bit num.	QMPU	ISCC	2048	**Beam Direction Data**

Table 1: ASC Channel Count

	Channel	No.	Type	Category	from:	to:	Rate (Hz)	Comment
OLPU	**Optical levers (per unit):**							
	PD quadrant	4	input	16 bit ADC	sensor	OLPU	65536	
	intensity monitor	1	input	16 bit ADC	sensor	OLPU	65536	
	sampling clock	1	input	clock	DAQ	OLPU	65536	GPS
	world time	1	input	num.	ISCC	OLPU		for time stamps
	Θ/Φ/I	3	internal	32 bit num.	OLPU	ISCC	2048	**Optical Lever Data**
	laser diagnostic	2	input	8 bit ADC	laser diode	OLPU	256	voltage/current
	laser diagnostic	1	internal	16 bit num.	OLPU	ISCC	32	
Miscellaneous	**Miscellaneous Sensors:**							
	beam direction	2	input	num.	IOO	ISCC	256	
	beam offset	2	input	num.	IOO	ISCC	256	
	beam intensity	1	input	num.	IOO	ISCC	2048	
	laser ok	1	input	num.	PSL	ISCC	256	
	modulation depth	2	input	num.	IOO	ISCC	256	
	remaining AM	2	input	num.	IOO	ISCC	256	
	telescope	2	input	num.	IOO	ISCC	1	mode matching parameters
	shadow detector	16	input	num.	SUS/COS	ISCC	256	**Suspension Data**
LPU	**Length sensing (interferometer lock acquisition only):**							
	length signals[1]	6	input	32 bit num.	LPU	ISCC	16384	**Length Data** (I/Q phase)
	PD DC[1]	3	input	32 bit num.	LPU	ISCC	2048	
	status signals	TBD	in/out	num.	LPU	ISCC		TBD

Table 1: ASC Channel Count

	Channel	No.	Type	Category	from:	to:	Rate (Hz)	Comment
Drivers	**Alignment Drivers:**							
	ifo angles	12	output	16 bit DAC	ISCC	SUS	2048	
	beam steering	4	output	16 bit DAC	ISCC	COS	2048	
	mirror transverse	6	output	num.	ISCC	SEI	manual	centering of ITMs/BS
	telescope	2	output	num.	ISCC	IOO	manual	mode matching input beam
	ifo length[1]	6	output	16 bit DAC	ISCC	LSC/SUS	16384	lock acquisition only
	sampling clock	1	input	clock	DAQ	driver DACs	65536	GPS
ISCC	**ISC Computer:**							
	Alignment Data	10	output	32 bit num.	ISCC	DAQ	2048	yaw and pitch
	Beam Direction D.	8	output	32 bit num.	ISCC	DAQ	2048	x and y
	Centering Data	12	output	32 bit num.	ISCC	DAQ	1	x and y
	Optical Lever Data	12	output	32 bit num.	ISCC	DAQ	2048	yaw and pitch
	ifo angles	12	output	32 bit num.	ISCC	DAQ	2048	control signals
	beam steering	4	output	32 bit num.	ISCC	DAQ	2048	control signals
	sampling clock	1	input	clock	DAQ	ISCC	1	watch dog
	world time	1	input	num.	DAQ	ISCC		absolute time reference
	ifo lock	1	output	binary	ISCC	Cons./LSC		status signal / trigger
	ASC Status	TBD	output	data records	ISCC	Cons./DAQ		includes servo parameters
	ASC Control	TBD	input	data records	ISCC	Console		

Table 1: ASC Channel Count

	Channel	No.	Type	Category	from:	to:	Rate (Hz)	Comment
MCC	**Mode Cleaner Computer:**							
	alignment data	4	input	32 bit num.	WPU	MCC	2048	MC only
	mirror angles	6	output	16 bit DAC	MCC	IOO	2048	MC only
	shadow detectors	6	input	num.	IOO	MCC	256	MC only
	laser ok	1	input	num.	PSL	MCC	256	
	beam intensity	1	input	num.	IOO	MCC	2048	
	modulation depth	1	input	num.	IOO	MCC	256	

1. Only implemented, if a combined ASC/LSC lock guiding system is required.