Interferometer Sensing & Control

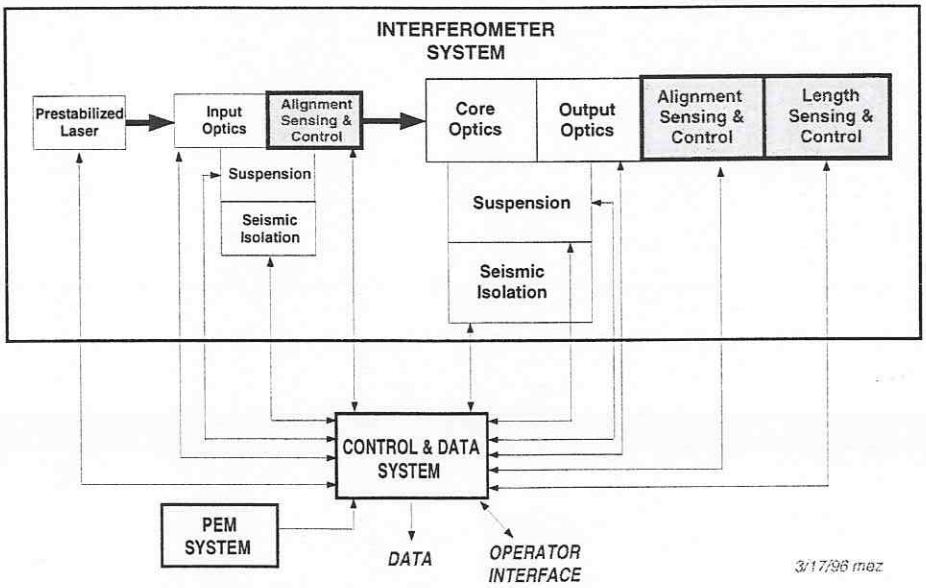
M. Zucker

3/20/96

- ISC Functions: Sense and Control Interferometer Lengths and Alignments
- Integrated task mission:
  - ››system design and implementation
  - ››supporting laboratory research
  - ››supporting analysis & modeling
- Task group members & facilities at MIT, Caltech, JPL

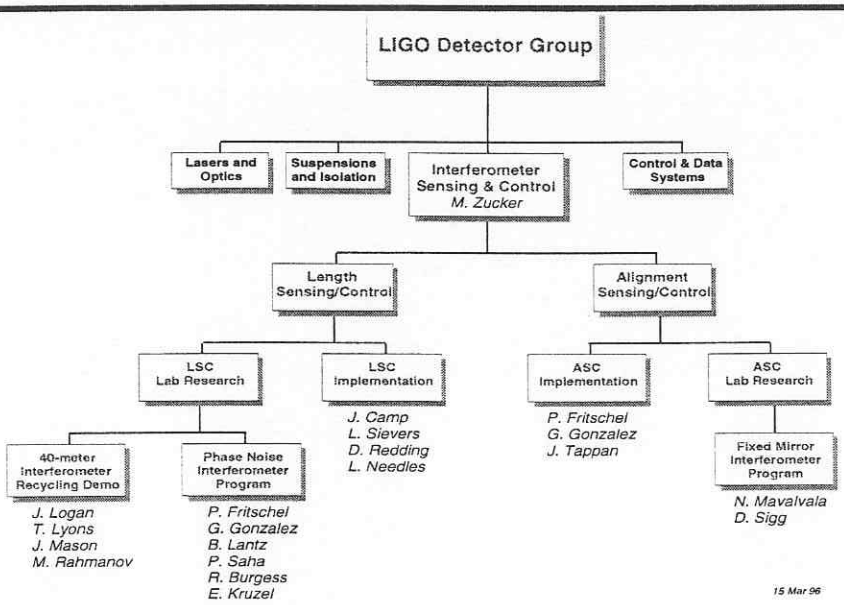
LIGO-G960039-00-M

ISC Functional Context



LIGO-G960039-00-M

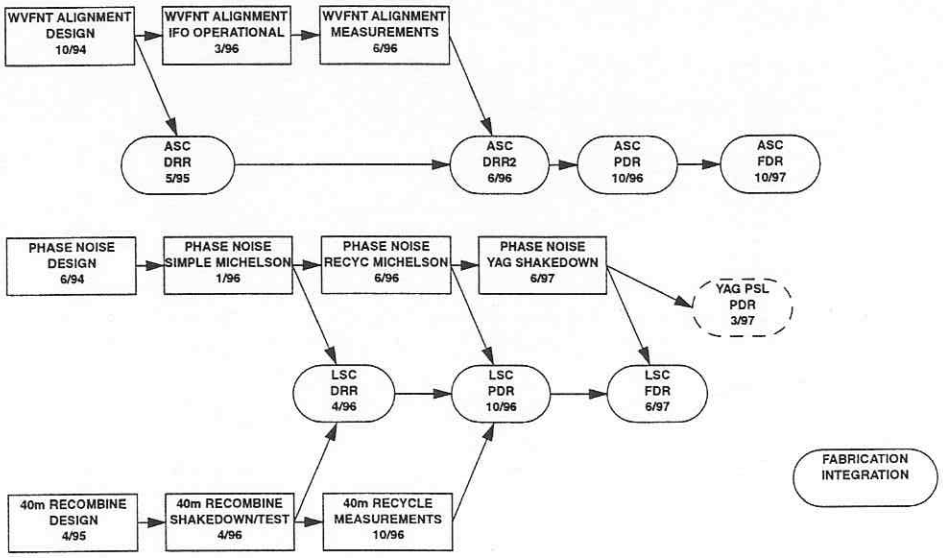
ISC Task Group Organization



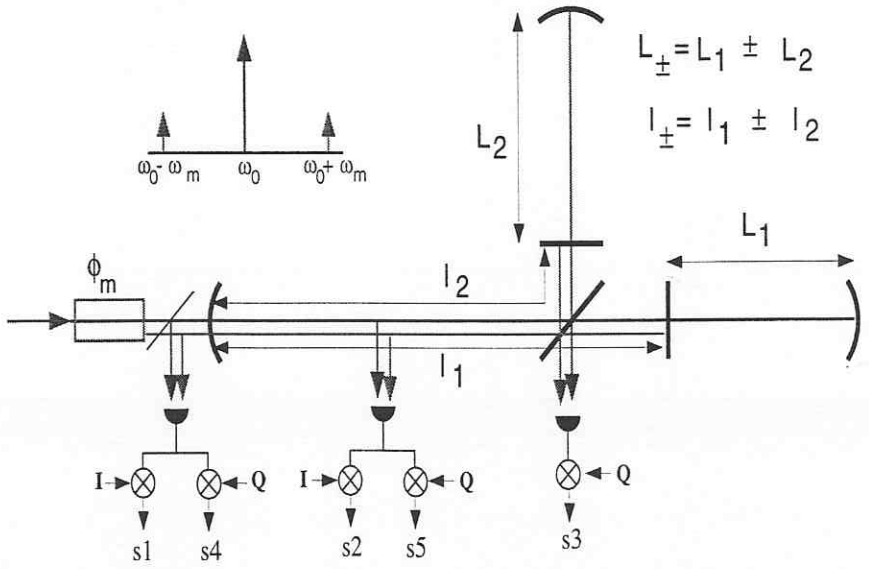
ISC Schedule Milestones

Milestone	Planned Date
LSC DRR	4/96
LSC PDR	10/96
LSC FDR	6/97
ASC DRR (II)	6/96
ASC PDR	10/96
ASC FDR	10/97
BEGIN INST. WA	7/98
BEGIN INST. LA	1/99

ISC Implementation; R&D Inputs



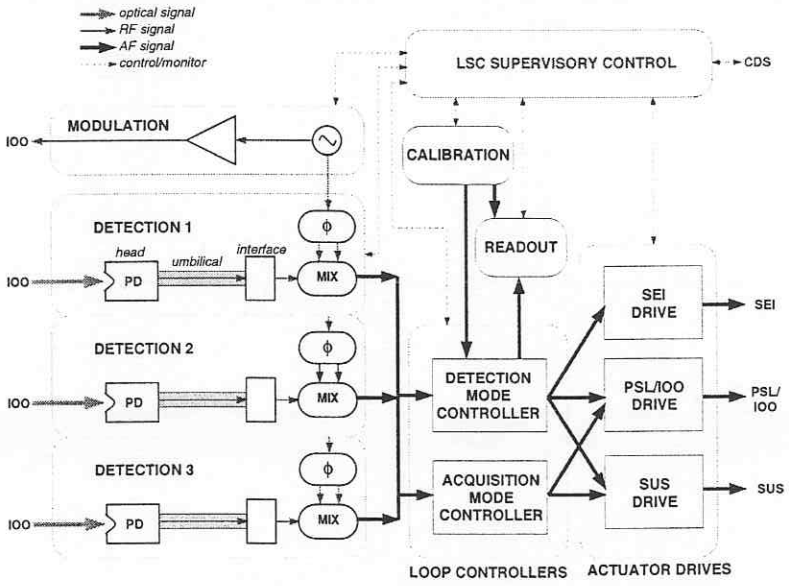
Length Sensing & Control (LSC)



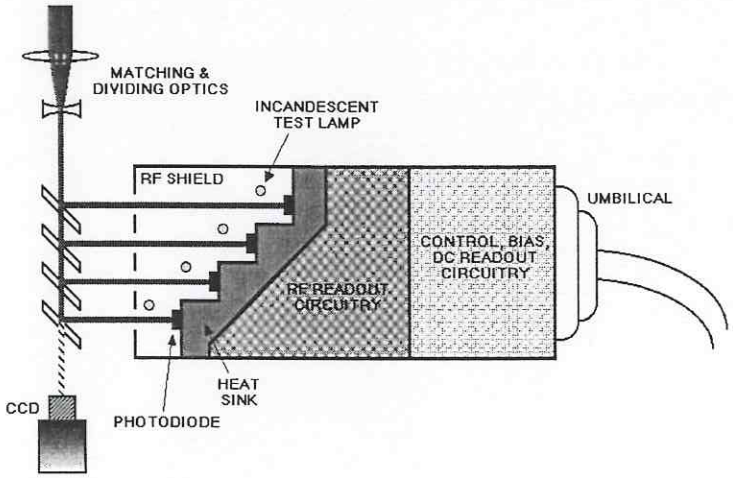
LSC Modes of Operation

- Acquisition mode
  - ››Optical response nonlinear
  - ››High dynamic reserve required
  - ››Noise, gains noncritical
  - ››Sequencing "intelligence" required
- Transition mode
- Detection mode
  - ››Optical response linear (cavities "resonant," circulating fields in equilibrium)
  - ››Low noise required
  - ››Gains critical (to suppress seismic length fluctuations, maintain linearity)

LSC Functional Block Diagram

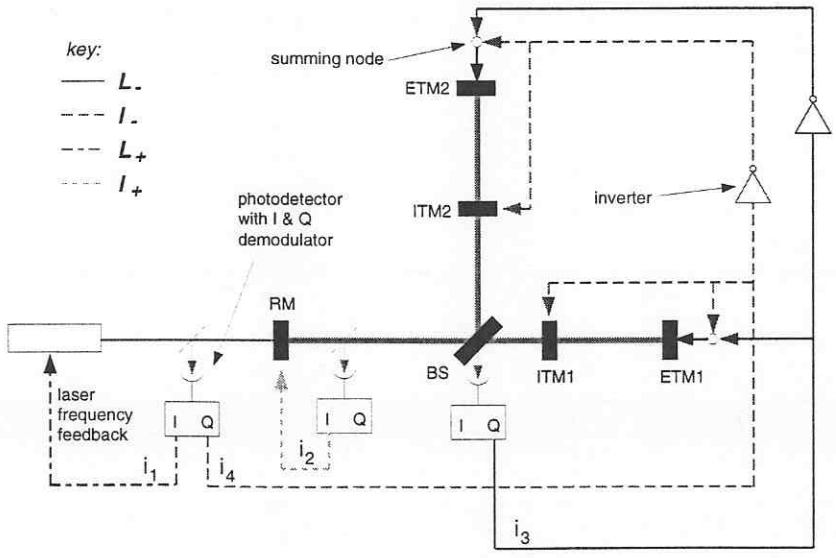


LSC Photodetector Concept



LSC Control Topology

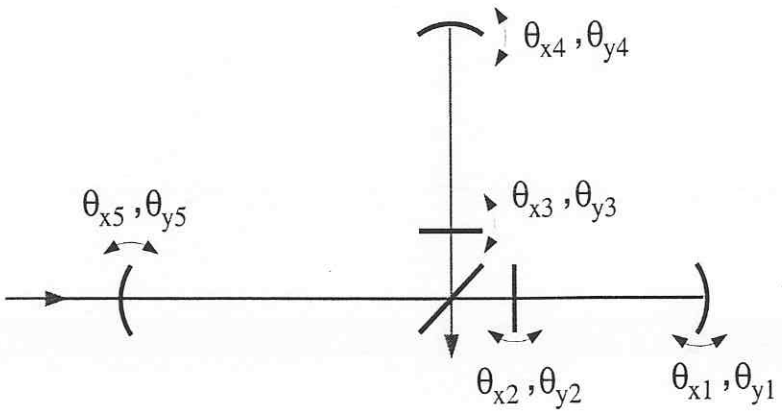
(simplified schematic, DetecLSC Implementation :



Current LSC Design Status

- In work:
  - ››Design Requirements Document preparation
  - ››Conceptual Design Description preparation
  - ››Detection mode optical response modeling
  - ››Detection mode controls modeling & optimization
  - ››Acquisition mode optical response modeling
- Next:
  - ››Detection, Acquisition mode controls prelim. design
  - ››Photodetection & modulation systems prelim. design
  - ››Supervisory control & sequence prelim. design

Alignment Sensing & Control (ASC)



ASC Functions

- Sense and control angular degrees of freedom for Core Optics and Input/Output Optics
- Maintain centering of beams (resonant modes) on mirror physical apertures
- Bootstrap from "coarse alignment" (optics installation) to high sensitivity during observations

ASC Modes of Operation

- Initial Alignment
  - ››Beams down tubes (~ 10^{-4} rad typ. error /optic /d.o.f.)
- Acquisition Alignment
  - ››TEM_{00} mode dominant, length control acq. enabled (~ 10^{-6} rad error ?)
- Detection Alignment
  - ››Nominal strain sensitivity (~ 10^{-8} rad error)

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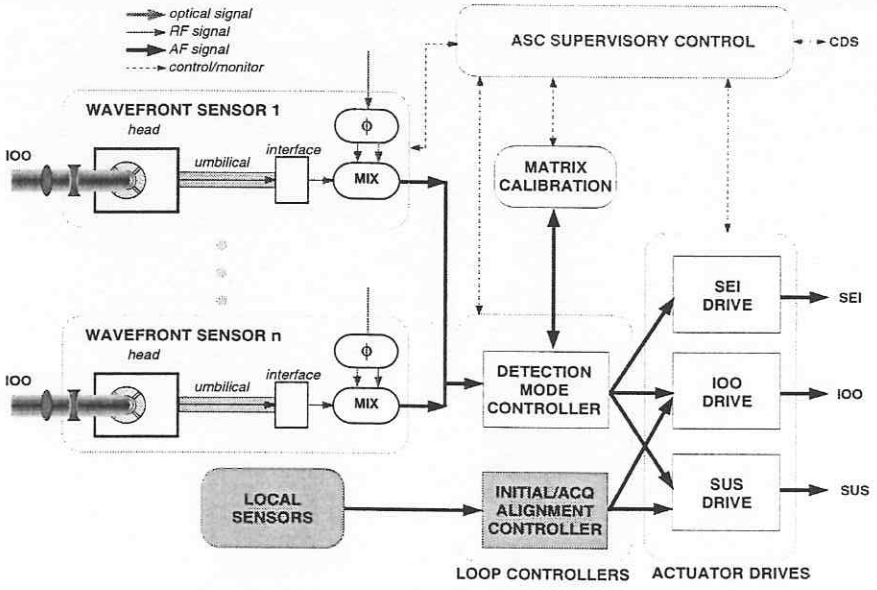
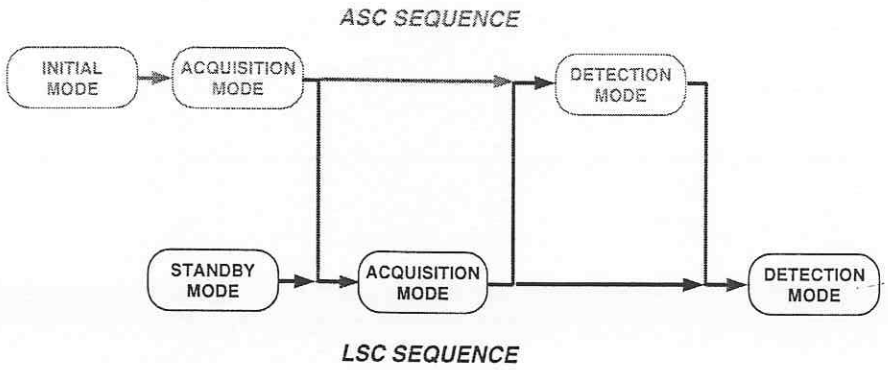


LSC/ASC Acquisition Sequencing



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  - ››Optical lever preliminary design, prototype testing
  - ››Wavefront sensing optical response modeling
  - ››Alignment drift modeling, tests & analysis
  - ››Wavefront sensing prototype design & test
  - ››Large-signal wavefront sensing model
- Next:
  - ››Design Requirements Document update
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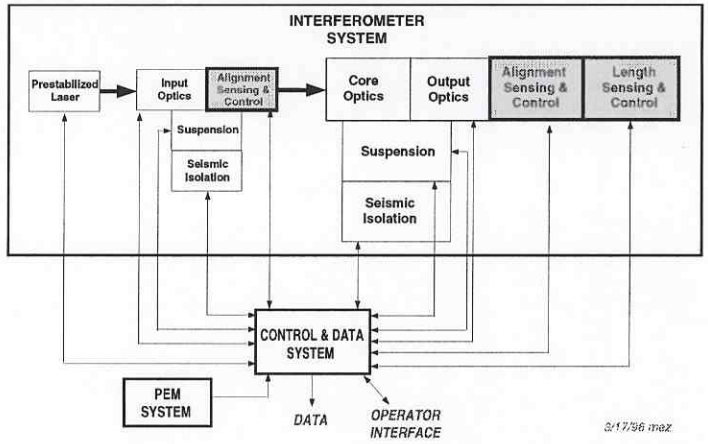

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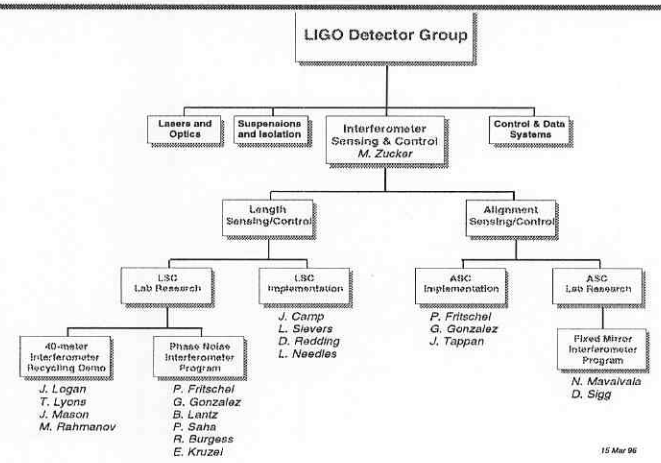

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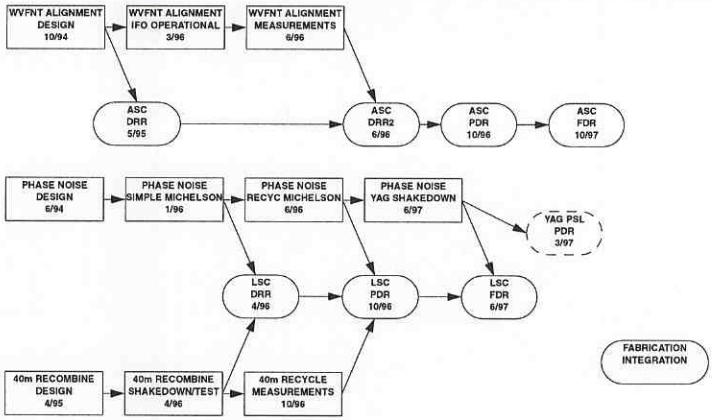

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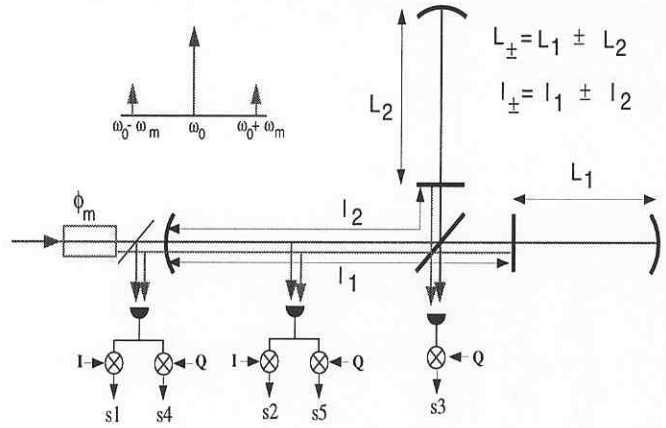

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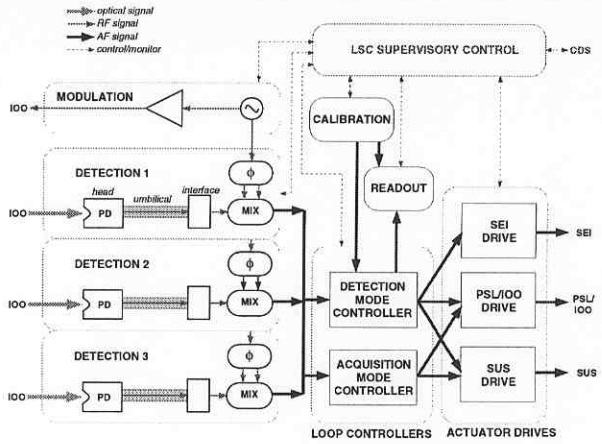

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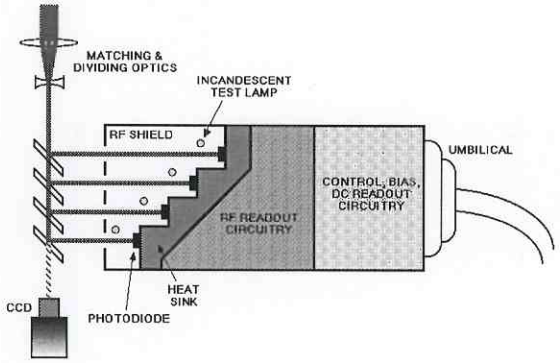

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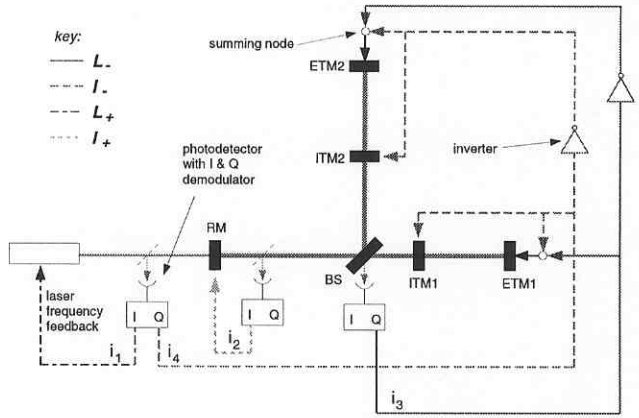

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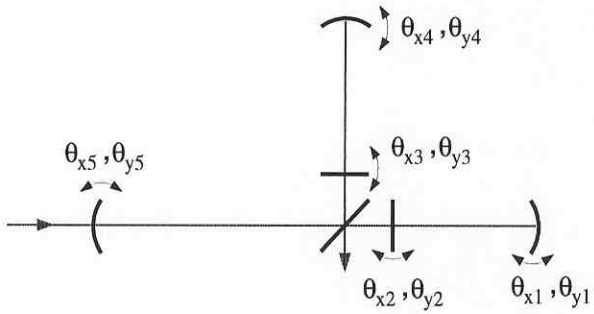

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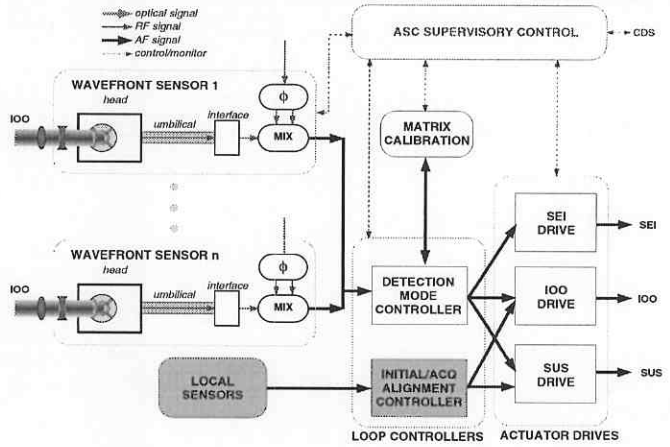

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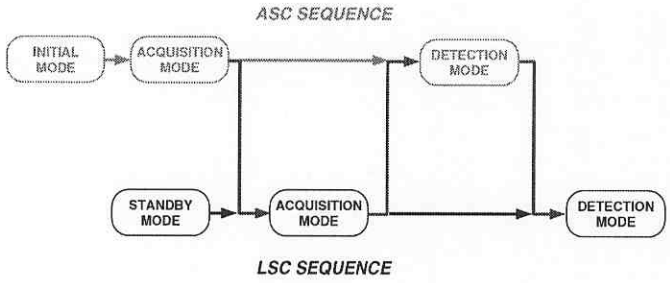

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