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# Tasks After S3

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Peter Fritschel, Daniel Sigg



# Major Goals and Tasks

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## □ Sensitivity

- Operate at high power
  - ❖ Laser
  - ❖ Thermal compensation system (TCS)
  - ❖ Output mode cleaner (OMC)
  - ❖ Design of sensing chain
- Manage auxiliary degrees-of-freedom (e.g., POB light level)
- Finish acoustic mitigation
- Clean up electronics: RFI & low noise redesign

## □ Reliability & Stability

- Seismic retrofit at LLO
- Auto-alignment system at full bandwidth

# “10 W” Laser

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- ❑ Current maximum power levels going into MC
  - L1: 4.3 Watts
  - H1: 3.0 Watts
  - H2: 3.65 Watts
  - Factor of 2-2.5 short
- ❑ IO transmission efficiency not great either; max power estimated at RM
  - H1: 1.8 W (60%)
  - H2: 2.6 W (72%)
  - L1: 2.6 W (60% -- ??)
  - Supposed to be 6 W
- ❑ Is a reliable 10 Watts feasible with present system?



# Thermal Compensation System

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- ❑ Add missing heat with a CO<sub>2</sub> laser
  - See G030167-01
- ❑ Build a prototype to fully equip a single ifo
- ❑ Testing on H1 is highest priority task at LHO
- ❑ Install phase cameras
- ❑ RF sideband measurement setup(?)
- ❑ Requires a quick vent to install ZnSe windows
- ❑ Aim to have hardware ready at end of S3
- ❑ Modeling of asymmetric heating

# Output Mode Cleaner

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- Study feasibility of OMC
  - Fixed spacer triangular Fabry-Perot cavity
  - In vacuum design?
  - Seismic isolation required?
  - Length sensing & control system: RF + thermal? PZT + dither?
- Model of sideband asymmetry
- OMC prototype & in-air test at LHO
  - Effect on contrast defect
  - Effect on ASI
  - Effect on  $2\Omega$  problem
  - Effect on fringe offset
  - Effect on noise



# H1 at 2.3 W into MC

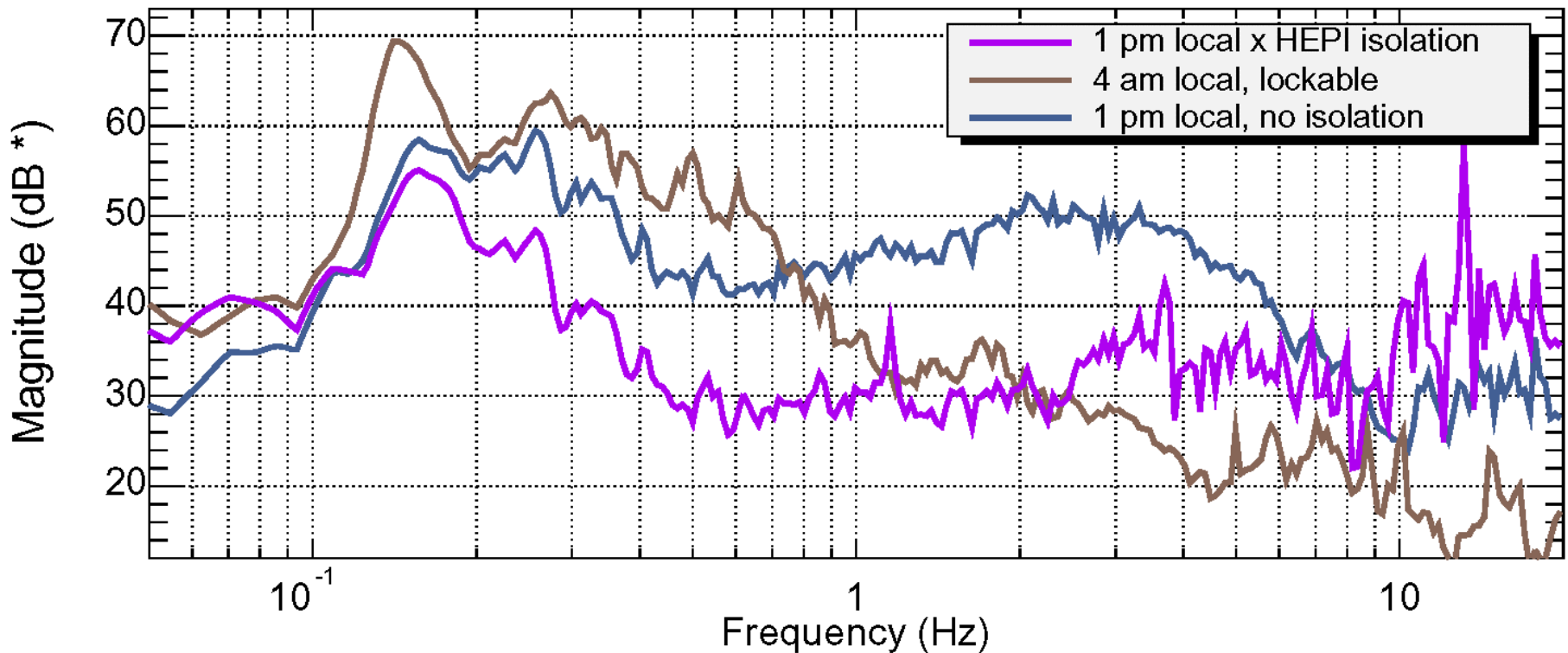
*All WFS engaged*

<i>Port</i>	<i>DC photocurrent per PD</i>	<i>Orthogonal phase signal</i>	<i>Notes</i>
AS	25 ma $\pm$ 2 ma	AS2I_CORR = 10,000 $\pm$ 4000 cnt (7ma $\pm$ 3 ma)	<ul style="list-style-type: none"><li>□ Designed for 100ma per PD</li><li>□ WFS introduces offset into AS_I?</li></ul>
POB	4 ma $\pm$ 0.15 ma		Designed for ~50ma
REFL	0.5 ma $\pm$ 0.1 ma	REFL_Q = $\pm$ 2500 cnts $\rightarrow$ $\pm$ 140 mV RF	Designed for ~50ma; will need REFL_Q servo

# Seismic Retrofit at LLO

*Example effect of HEPI isolation on daytime ground noise:*

**LLO Y End Ground Noise, various conditions**



\*T0=03/10/2003 18:20:50

G030527-00-D

Avg=10/Bin=7L

LIGO I

BW=0.0117187

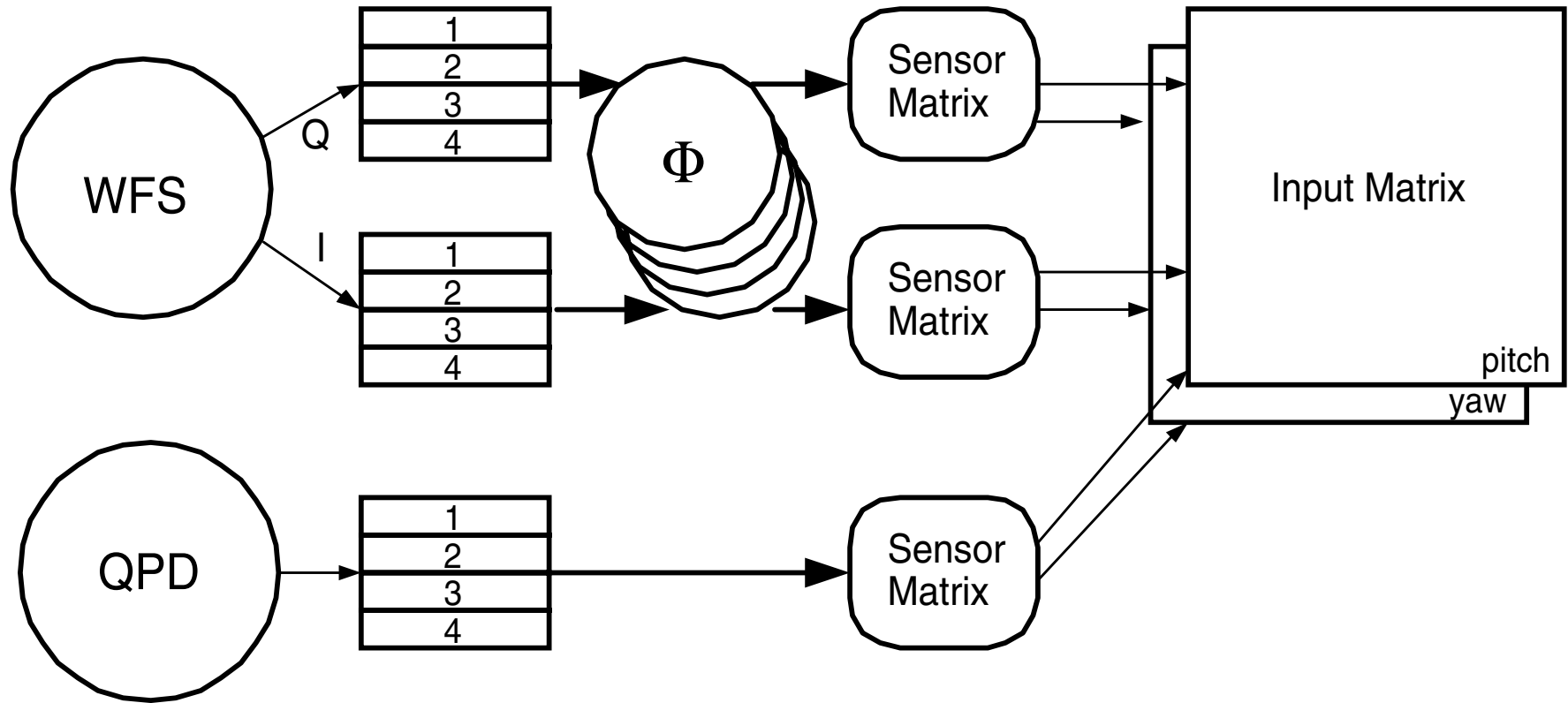
7

# Wavefront Sensing

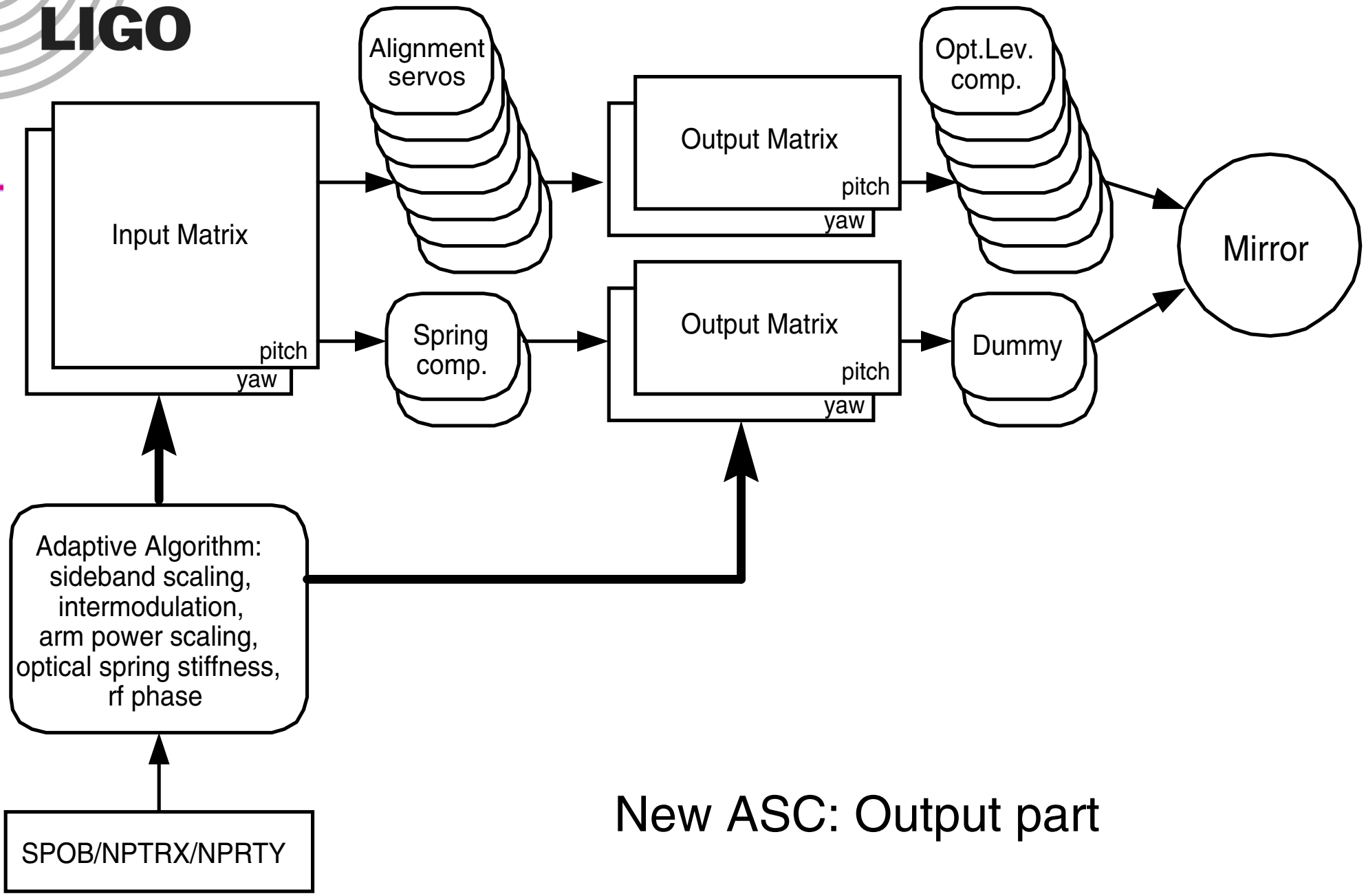
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- ❑ High bandwidth
- ❑ Noise investigations
- ❑ Study and minimize cross-couplings
- ❑ New software
  - Radiation pressure compensation
  - Input matrix
  - Adaptive control: power levels, SPOB & intermodulation
- ❑ Initial Alignment using WFS5





## New ASC: Input part



New ASC: Output part

# Acoustic Mitigation

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- ❑ ISCT1/ISCT7 acoustic mitigation
  - acoustic enclosure?
  - 2" mirrors & splitters
  - EO shutter replacement
  - REFL PD2, fast shutter & analog switching for CM
- ❑ IOT1/IOT7(?)
- ❑ Implement new periscope design
- ❑ Source isolation
- ❑ Move racks

# Miscellaneous (1)

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- ❑ More light power for POB
  - Install POB2 on POX or POY
  - New ITM with reduced AR coating efficiency???
- ❑ Bounce mode damping(?)
- ❑ Center beams on mirrors to within 1mm
  - 300mm zoom lenses for ITMs w/ remote controlled iris
  - Determine center of rotation with radiation pressure shifts?
  - Fast image processing for MMT1 servo?
- ❑ Automatic beam centering on ISCTs
  - Fast steering mirrors & quad detectors on every ISC/IOO table
  - Feedback using digital or analog controllers(?)
  - Automatic turn on and turn off

## Miscellaneous (2)

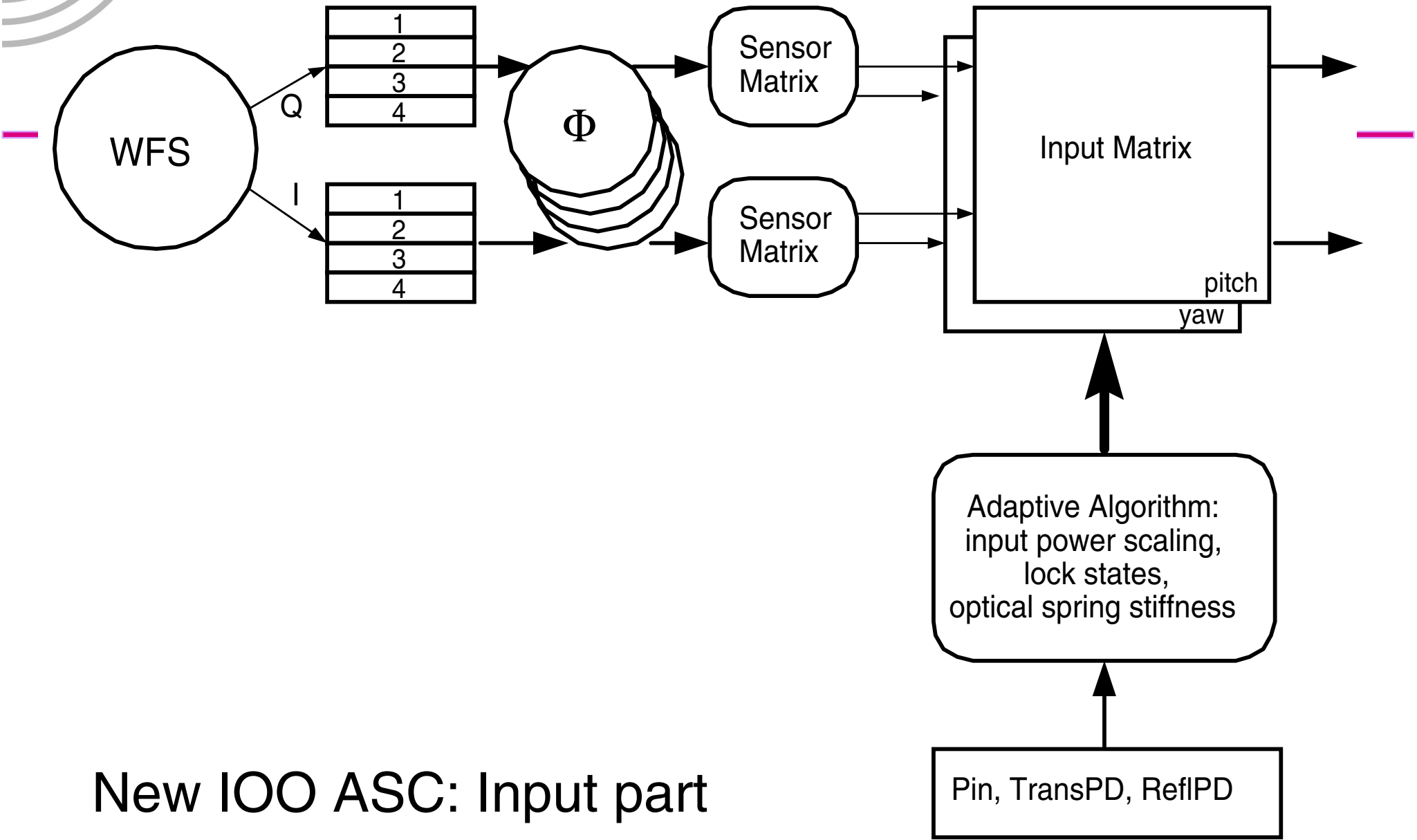
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- New timing diagnostics
  - Implement and test new timing distribution system
  - Implement and calibrate new atomic clocks
  - Implement photon calibrators
- IOO baffle retrofit at LHO
  - Target of opportunity or disaster?
- IOO Faraday
  - New larger aperture model(?)
  - Study thermal effects – UFI AdLIGO compensated design(?)
- PEM sensor re-allocation

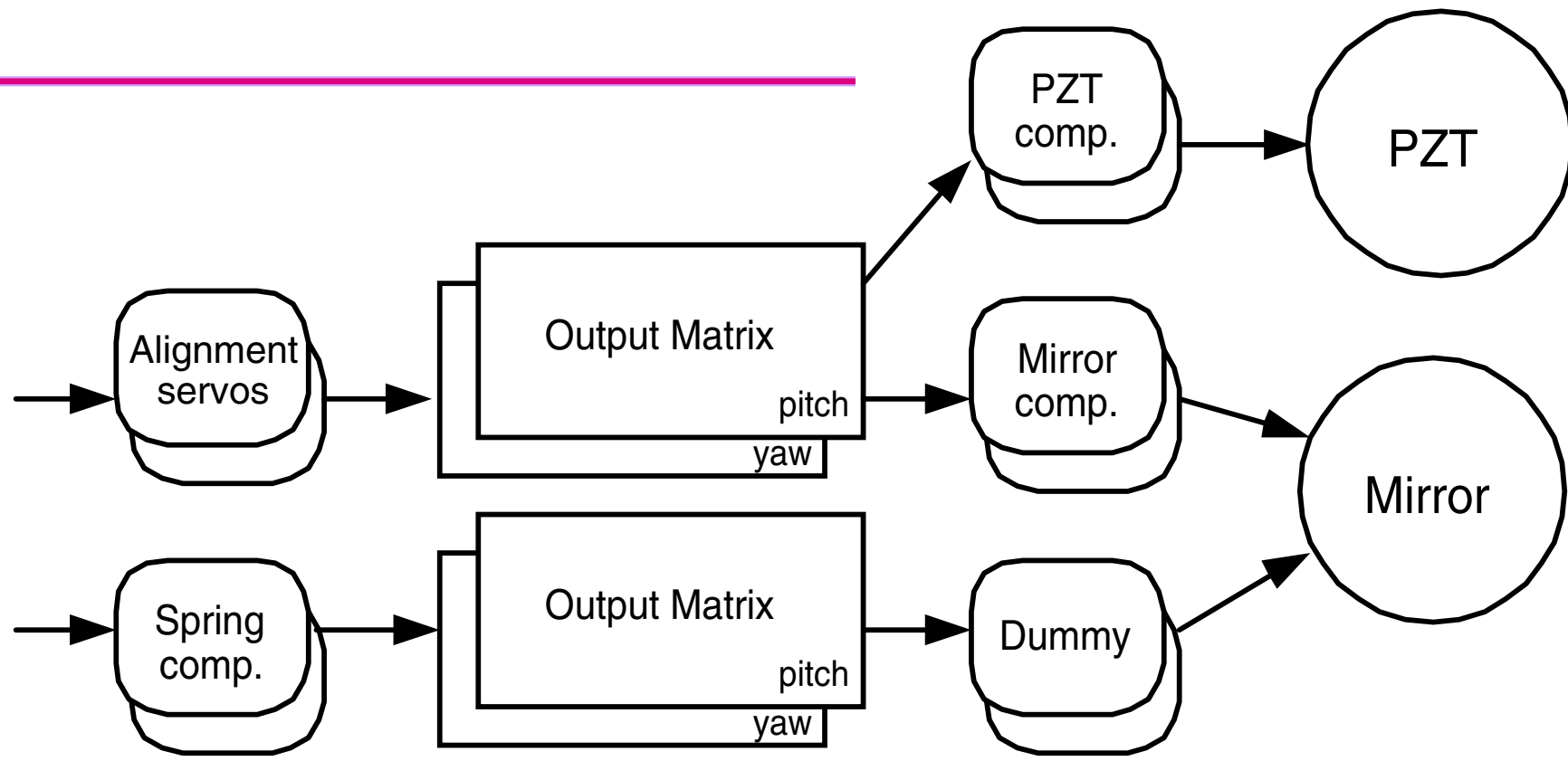
## Miscellaneous (3)

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- Common mode servo(s)
  - Complete noise model
  - New FSS board/box on PSL table
  - More light on MC/REFL PD & REFLQ servo
  - Eliminate EO shutters: replace by parallel design or remote controlled waveplate?
  - New MC board with lower noise & 37kHz resonant gain
  - New common mode board with analog switching to REFL PD2
- Digital IOO WFS
  - Feedback to MC mirrors
  - Better filtering
  - Radiation pressure compensation



New IOO ASC: Input part



## New IOO ASC: Output part



## Miscellaneous (4)

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- ❑ LSC photodetector redesign
  - ASI input
  - New 100Hz-10kHz output
- ❑ ISS (sure!)
- ❑ Finish ASI servo design and fabrication
  - Anit-image & dewhitening
  - Modulator:  $>1/4W$  output power(?), phase adjust
- ❑ New low-noise DACs from FDI (40 dB lower noise)
- ❑ Dewhitening/whitening switching
  - New boards with stages or parallel paths
  - Need an intermediate stage to avoid switching in one big step

## Miscellaneous (5)

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- Dual ETM transmission photodetectors
  - Single element, high-gain PD for acquisition
  - Current QPD for detection
  - Lower offsets & less drift
- Servo to track modulation frequency to MC length(?)
- RFI cleanup
  - Rack re-allocation
  - New EMI shielded racks
  - Redo cabling and connectors.
  - Redesign of critical electronics for low noise