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Squeezer Update Review

August 25, 2009

H1 Squeezer Experiment

ANU, AEI, MIT, CIT and LHO collaboration

G0900746-v1

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Highlights

- Grad. students Sheila D. (MIT), Sheon C. (ANU) and Michael S. (ANU)
- OPO development at ANU
  - 6 dB of squeezing observed
  - Traveling wave bowtie design works
- AEI loaner SHG at MIT
  - In the process of building our own (copy AEI design)
- Laser, optical table and clean room installed at MIT
- Noise model and simulation done
- Electronics design done for RF distribution
  - Shared with advanced LIGO

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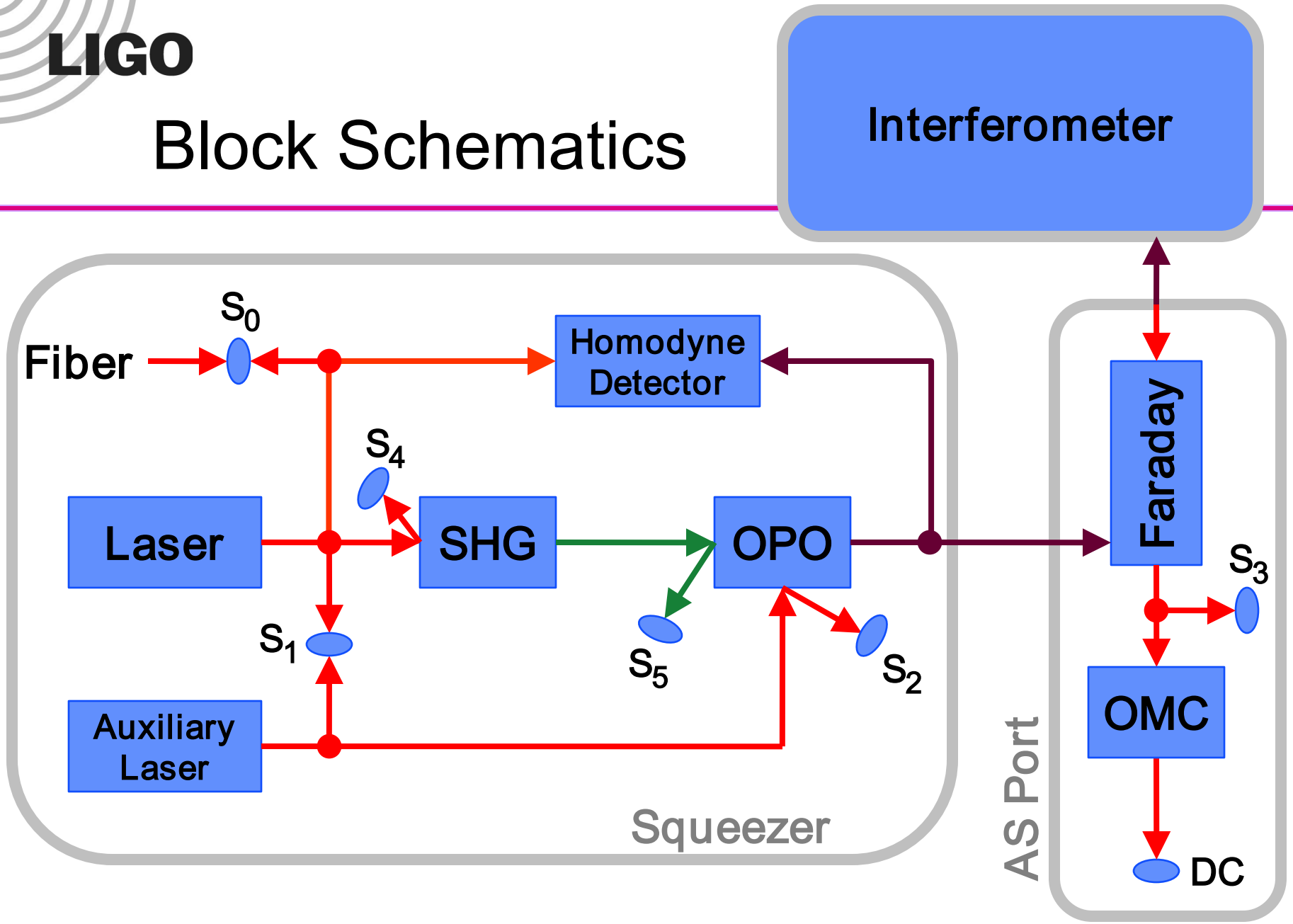
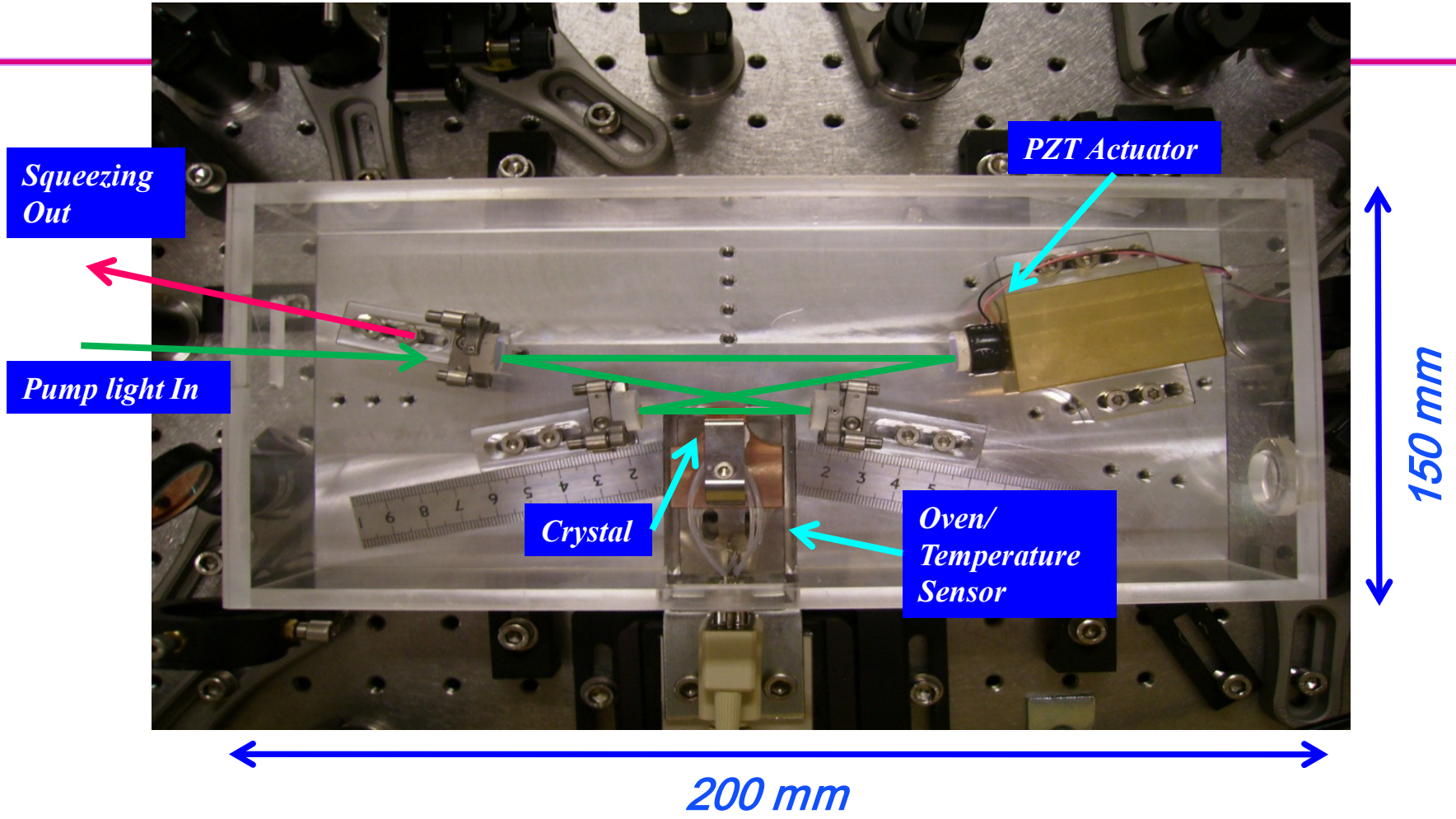
Block Schematics



ANU Traveling Wave OPO



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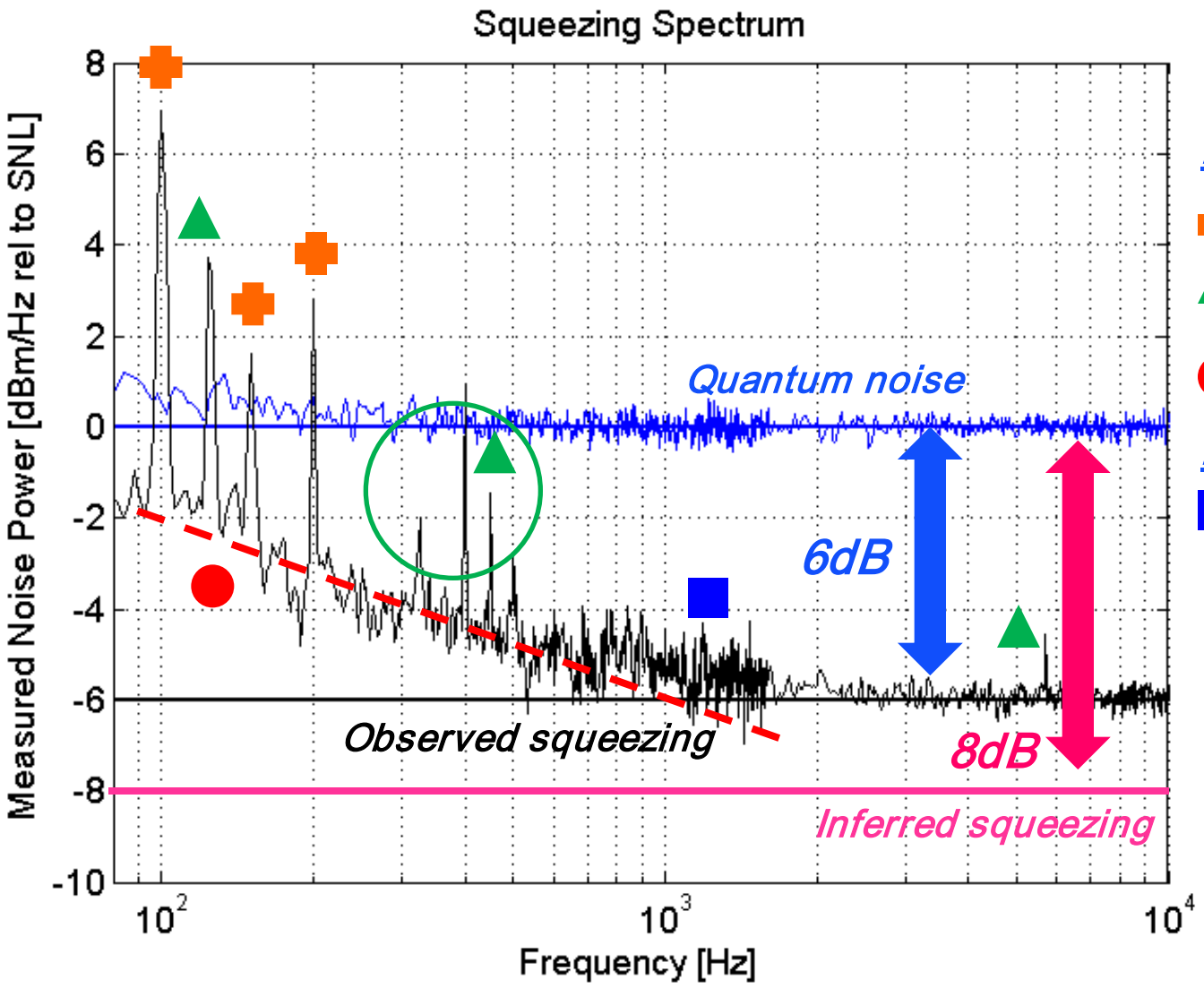
Squeezing Performance

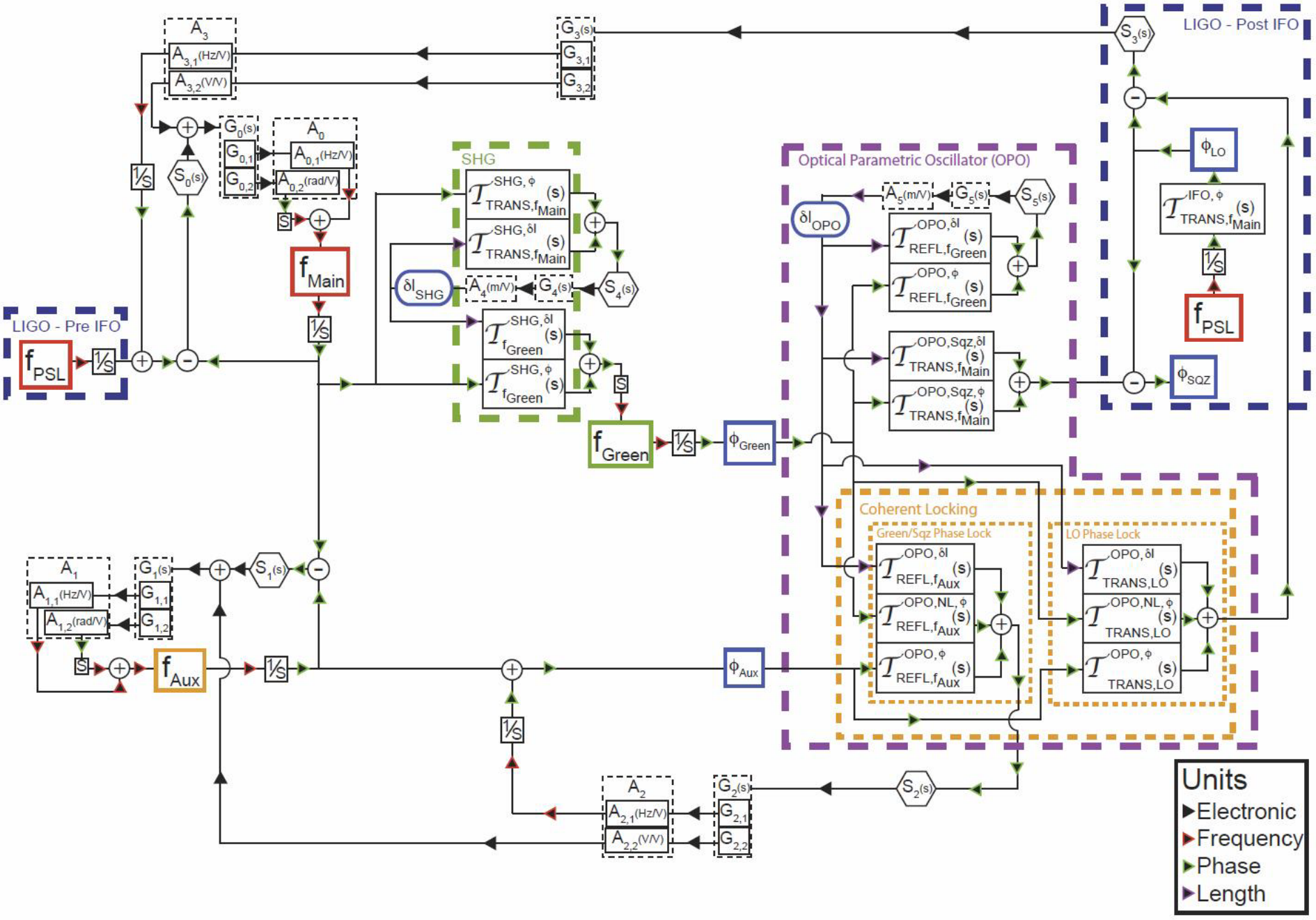


Electronics

- *Mains harmonics*
- *Cross coupling from Coherent Lock*
- *Electronic Noise?*

Lab environment

- *Acoustic Noise*


LIGO - Post IFO
LIGO - Pre IFO
SHG
Optical Parametric Oscillator (OPO)
Coherent Locking
Green/Sqz Phase Lock
LO Phase Lock
Units
Electronic
Frequency
Phase
Length

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Servo Model

- Laser 0: Frequency locked to PSL using FSS
- Laser 1 (aux): Frequency locked to laser 0 using FSS
- Coherent Lock 2: Phase lock laser 1 to green light using feedback to PZT & laser 1 additive offset
- LO Lock 3: Phase lock squeeze angle to AS port light using feedback to PZT & laser 0 additive offset
- SHG Lock 4: PDH to cavity PZT
- OPO Lock 5: PDH to cavity PZT

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Servo Model (2)

Servo	Description	Bandwidth	Crossover
0	Laser 0	500kHz	10kHz
1	Laser 1	500kHz	10kHz
2	Coherent field	100kHz	~2kHz
3	Local oscillator	100kHz	~2kHz
4	SHG length	~1kHz	—
5	OPO length	~1kHz	—

Fiber Stabilization no longer needed:
Laser 0 is frequency locked to PSL and phase locked to AS port light

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Noise Model

- **No bad surprises**
- Acoustic couplings
  - Direct back scattering under control
  - Require second in-vacuum Faraday
  - OPO ring topology is very helpful
- Phase noise requirement: <50 mrad rms
  - Remaining modulation sidebands after OMC are important
- Noise couplings
  - Laser frequency noise not important due to large bandwidth
  - Path length variations not important due to large bandwidth
  - Shot noise: 1 mW per detector seems enough
  - OPO length fluctuations are not getting suppressed by LO servo!

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Schedule

- ANU/OPO well on track
- Noise model completed
- AEI homodyne detector will be shipped to ANU ahead of schedule
- Assembly at MIT
  - Optical layout on track
  - Parts late by ~2 months (initial funds exhausted)
- Electronics production at LHO
  - Design on track
  - Procurement late by ~2 months (person power & money & H2 unavailable)

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Plan

- Need get some additional resources for
  - Electronics production at LHO
  - Setup at MIT
  - Procurement
- ANU will continue on development of OPO
  - On track for 2010 delivery
- Setup at MIT will continue with SHG & laser locking
- Electronics production can go forward
  - RF, PDs, TTFFS and length servos (common mode board)
- Additional funding is required now

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Budget Request

Task	Amount
Optics	90k
Electronics	80k
Travel	40k
Total	**210k**

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Summary

- Impressive progress on the OPO
- Setup at MIT is coming along
- No major roadblocks so far
- More funding is required now
- Some additional person-power is required at MIT and LHO for the second half of this year