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# Hanford 4km

## Recent improvements and currently limiting noise sources

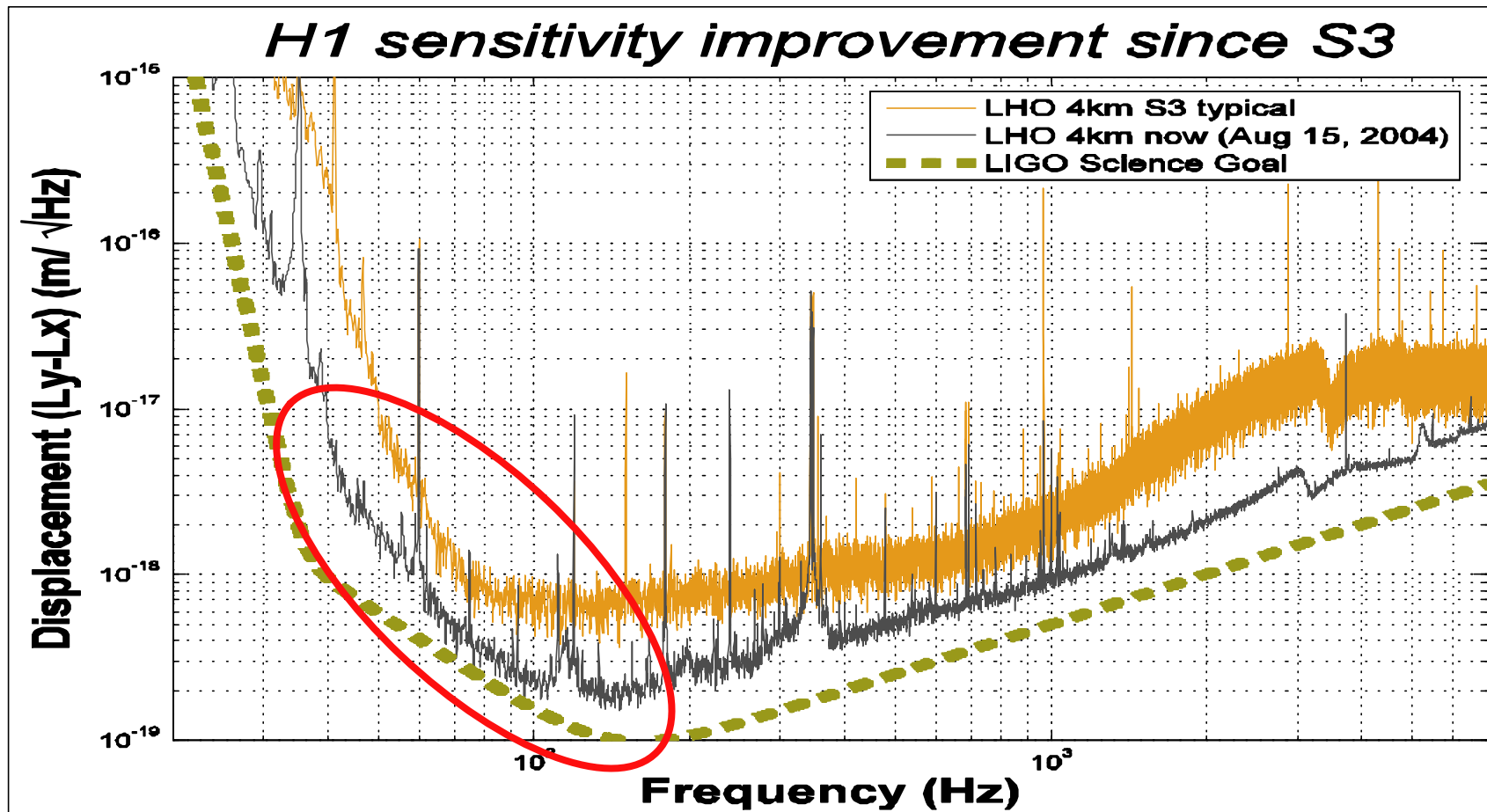
Stefan Ballmer

Massachusetts Institute of Technology

LIGO Hanford Observatory



# Improvements since S3





# Improvements below 100Hz

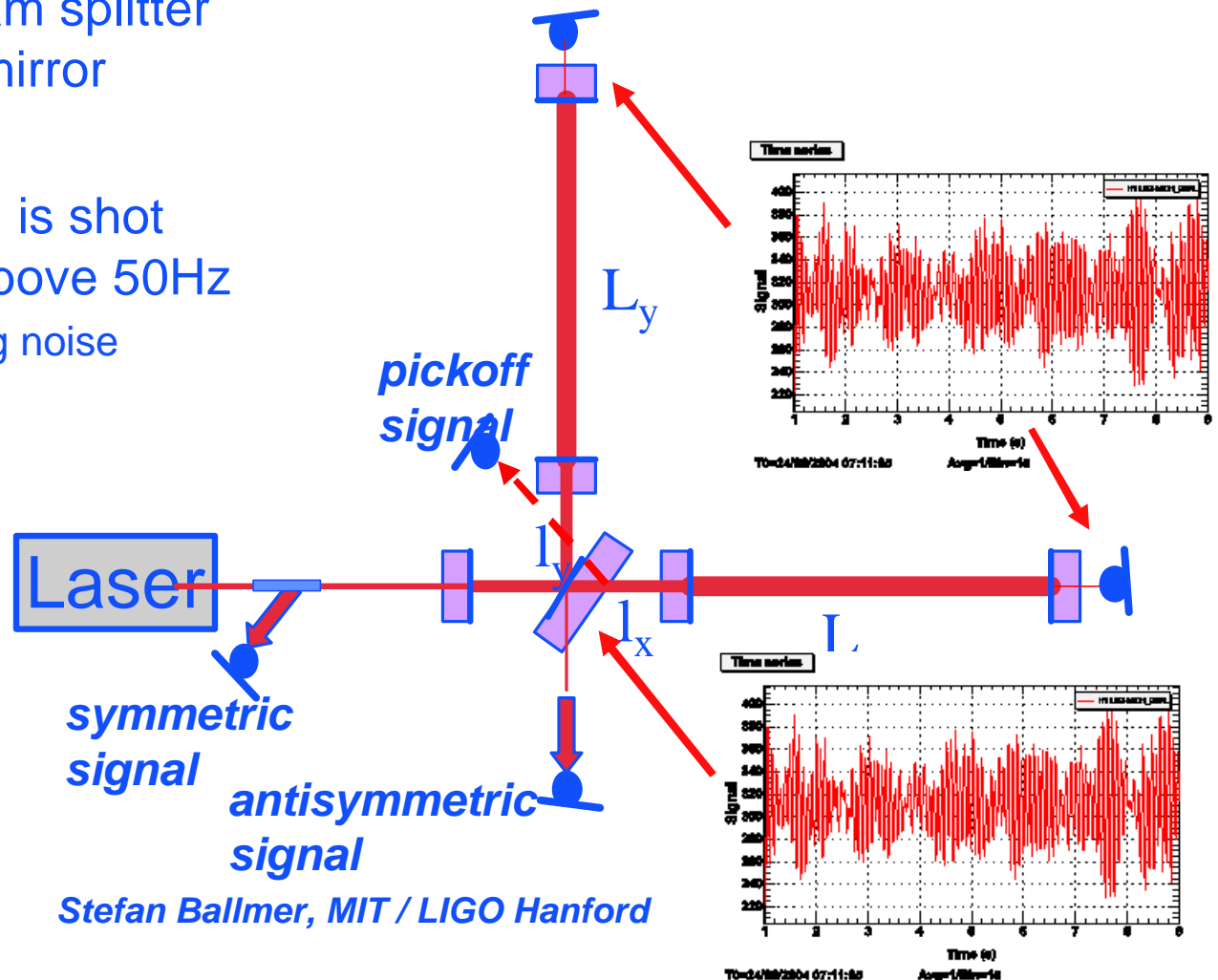
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## Eliminated noise sources:

- Auxiliary loops coupling
  - Coupling correction
  - High loop gain in auxiliary loops
- Non-linearity in mixer due to 2-omega
  - Additional notches in antisymmetric port photodiodes

# Auxiliary loops coupling correction

- Controlling beam splitter and recycling mirror
- But error signal is shot noise limited above 50Hz  
→ We are adding noise
- Trick:  
feed back to end mirrors too!
  - Coupling reduced by 40

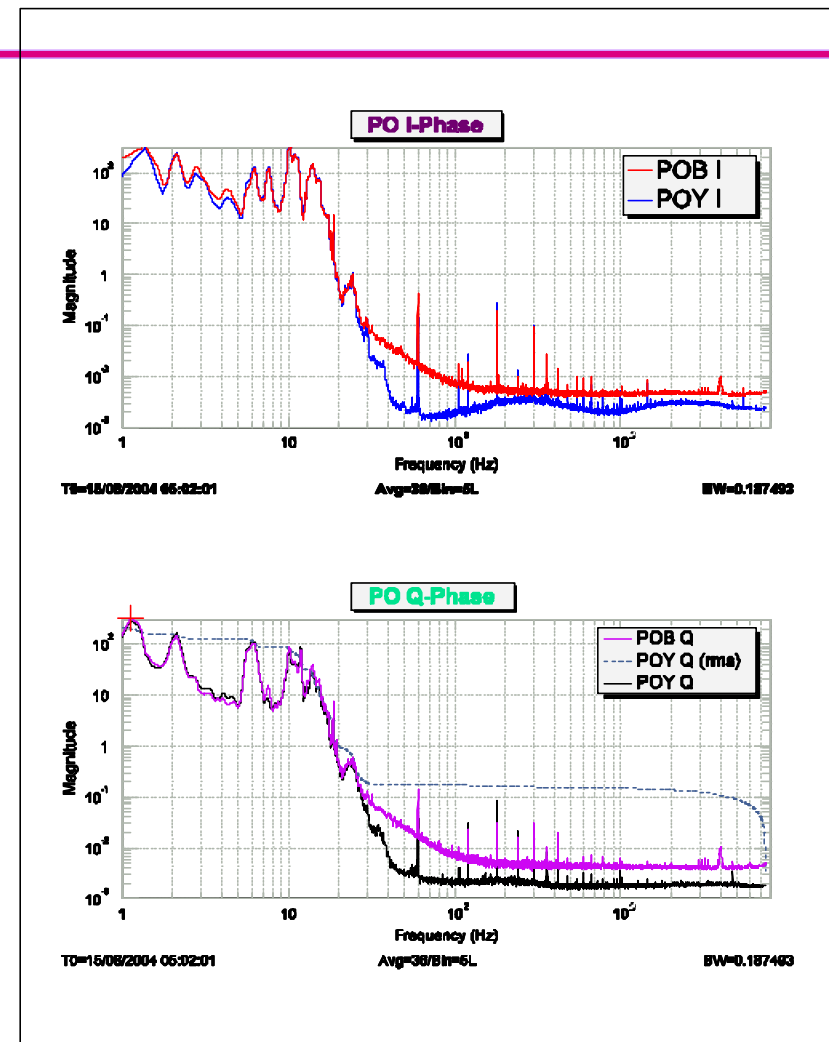


Stefan Ballmer, MIT / LIGO Hanford



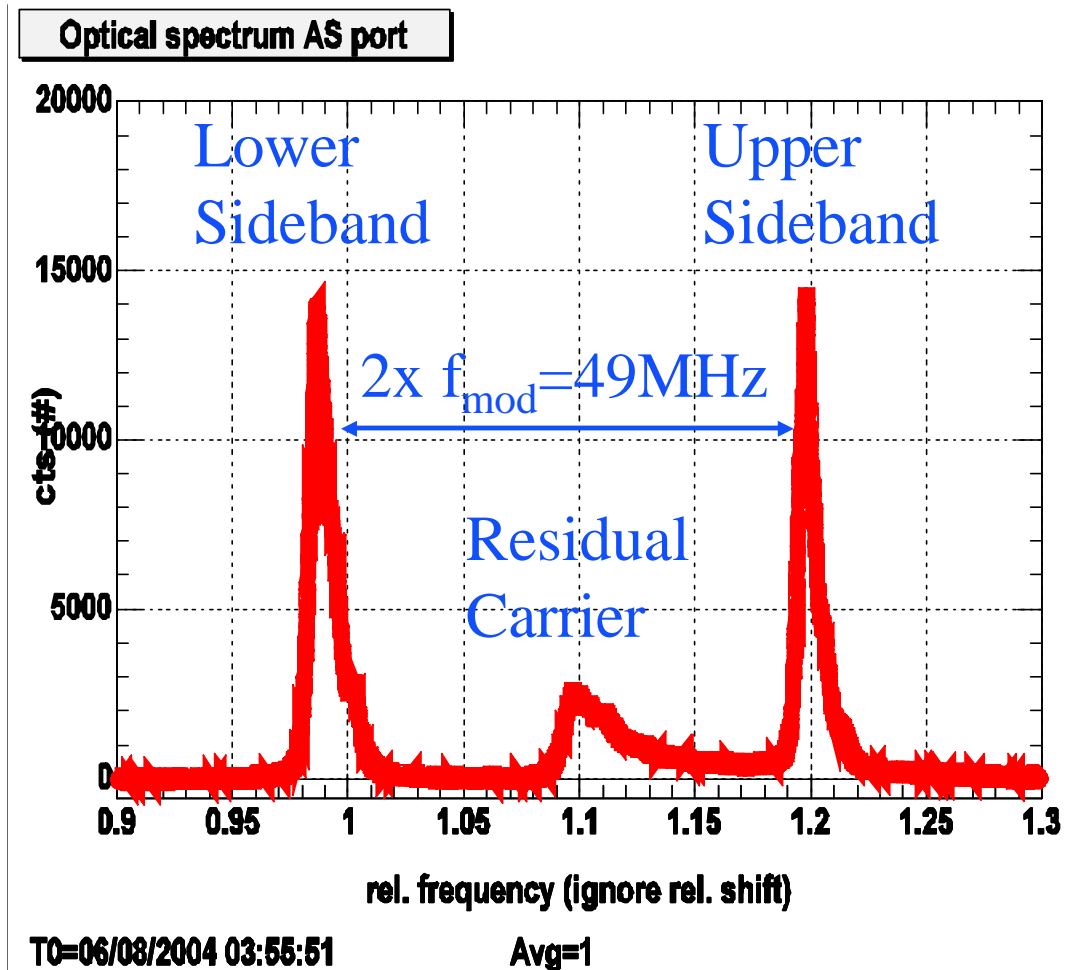
# Auxiliary loops high bandwidth

- This factor of 40 allowed us to
  - Back off cut-off filters
  - Increase bandwidth of those loops
- The higher gain reduced the loop's error signal and thus reduced the up conversion



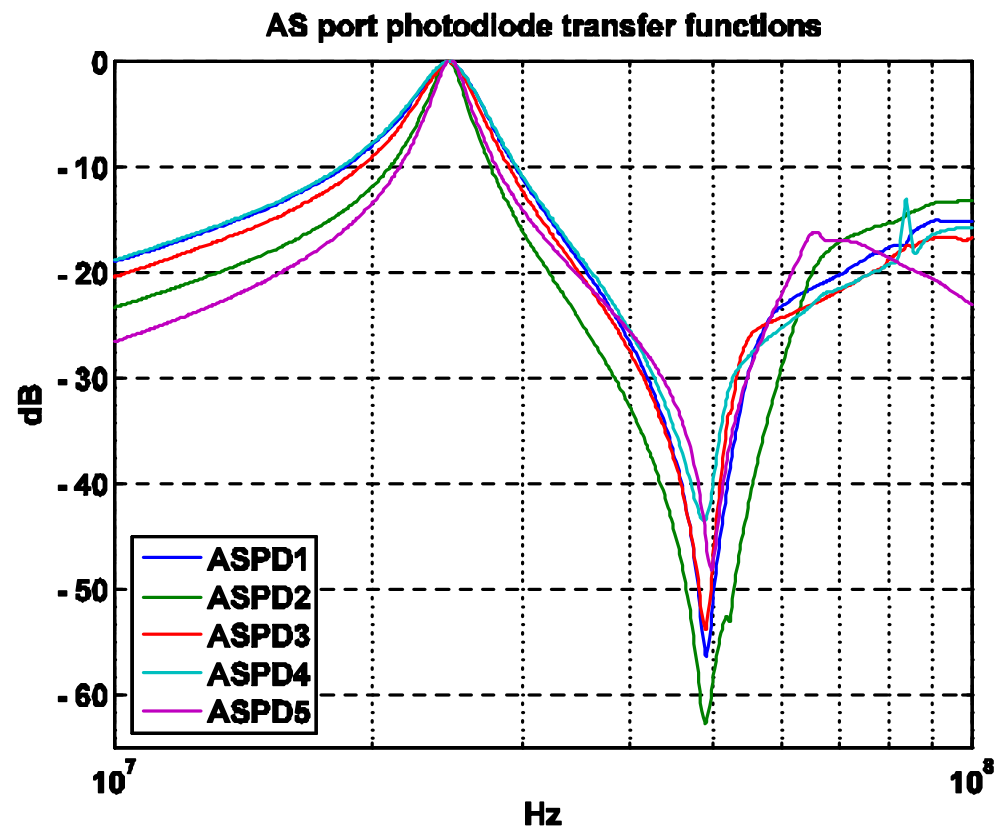
# 2-omega at antisymmetric port

- At AS port:
  - Light dominated by sidebands
    - Beat at 49MHz is dominant RF signal
    - Anticipated in RF photodiode design, but notch was not deep enough
  - ➔ Non-linear up-conversion in mixer



# Photodiode fix

- Added additional 20dB notch in RF amplifier stage
- huge effect on differential arm error signal (=GW signal)

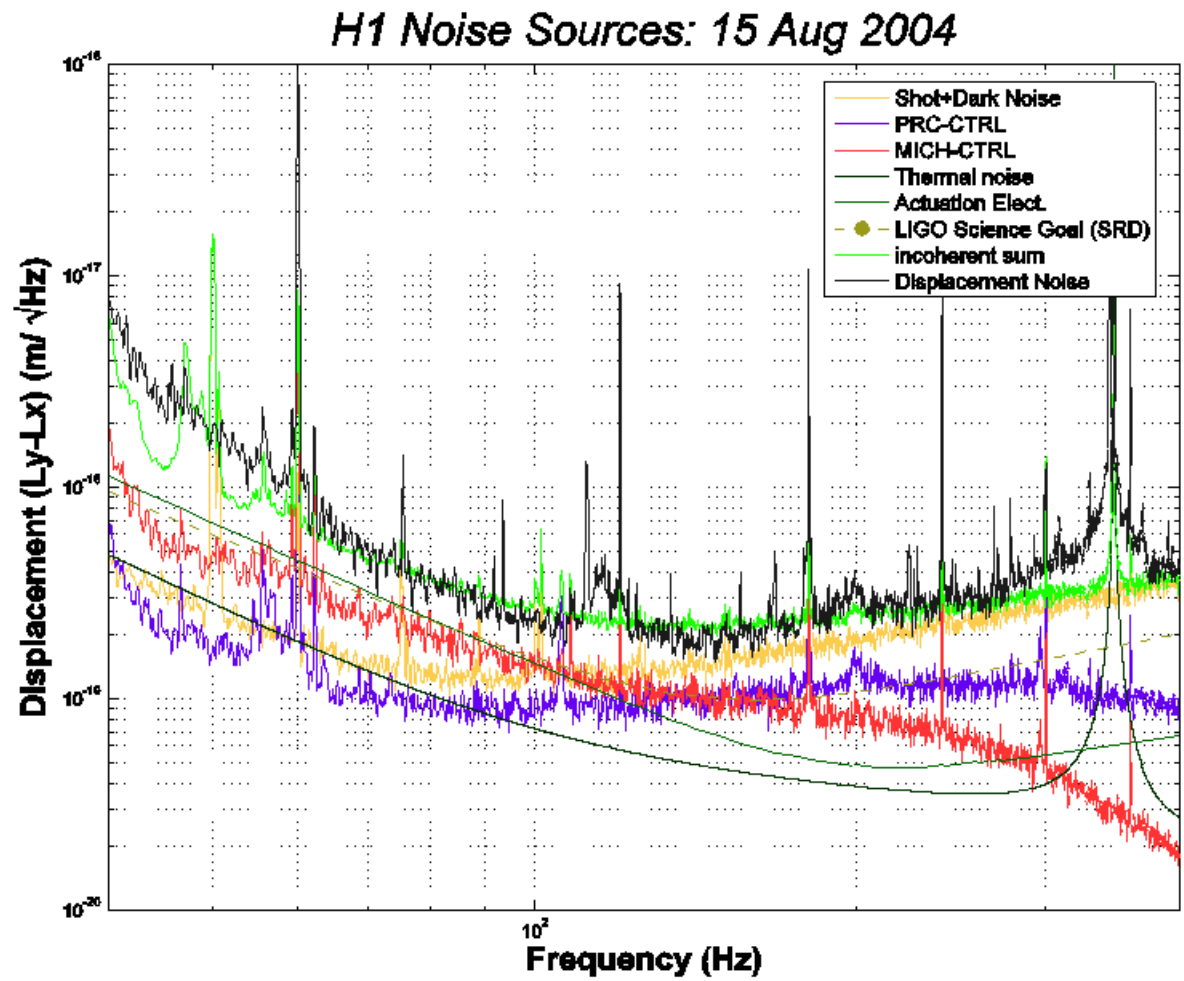




# Limiting noise below 100Hz Now

## And how to fix them

- Actuation electronics
  - Coil driver modification (passive filter at output) in preparation
- Auxiliary loops (MICH\_CTRL / PRC\_CTRL)
  - Sqrt(2) improvement easy with additional diode
  - Other approaches possible (use reflected signal)
- SRD thermal noise prediction was conservative







# Limiting noise, whole band Now

*H1 Noise Sources: 15 Aug 2004*

