

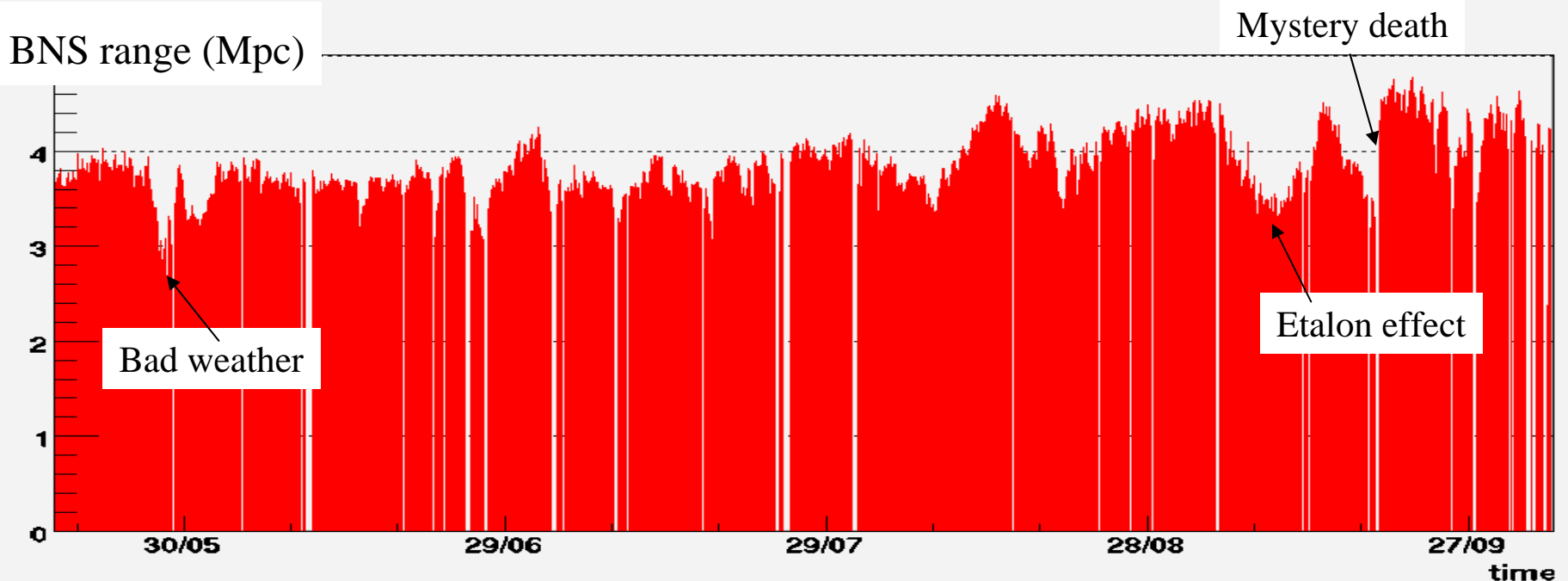
VSR1 summary
-
post VSR1 Commissioning plans

E. Tournefier (LAPP-CNRS)

LSC-Virgo meeting
Oct 23rd, 2007

VSR1

- Duty cycle: locked 84%, science 81%
- Long locks: 20 locks longer than 40 hours + longest lock 94hours
- Main unlock reasons:
 - Technical: injection fast unlocks / Global control software crash
 - Earthquakes
- Main causes of long unlocks:
 - Maintenance + Commissioning
 - Global control software crash
 - Earthquakes / bad weather
- Main causes of horizon variations:
 - bad weather
 - 'Etalon effect' combined with control noise



Duty cycle / stability improvements

- Fast unlocks of the injection system (22% of unlocks):
 - Several tuning of the fast loop of the laser lock
⇒ completely disappeared since then
- Earthquakes:
 - Several unlocks per week due to earthquakes at the beginning of the run
 - Suspensions get very excited ⇒ takes a couple of hours to recover

Improvement of the suspension control

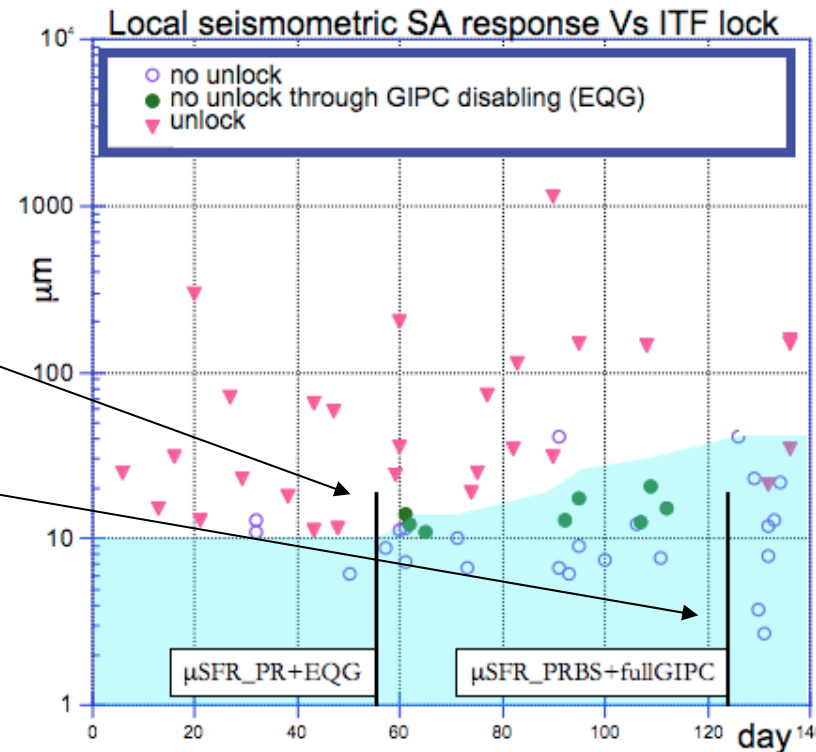
⇒ Earthquake unlocks ≤ 1 per week at the end

1/ Earthquake guardian:
automated switch to more robust control

2/ Suspension differential control
⇒ immune to common displacements

⇒ Survive to displacements 2-3 times larger

⇒ See E. Majorana's talk on thursday



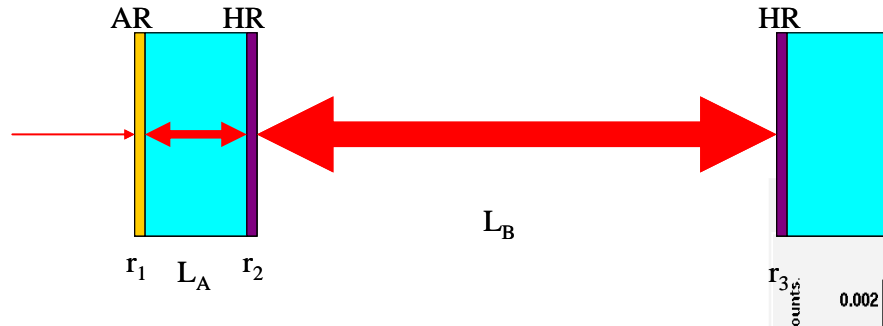
Slow variations: Etalon effect vs sensitivity

Etalon effect:

small FP cavity inside input mirrors (due to AR face)

⇒ effective reflectivity modulated with mirror thickness (i.e. temperature)

... and so the finesse of the cavities



$$\Rightarrow \Delta F/F = \pm 3.5\%$$

- Finesse asymmetry

- Coupling of noise to DF

⇒ Variation of the coupling of common mode noises to the dark fringe

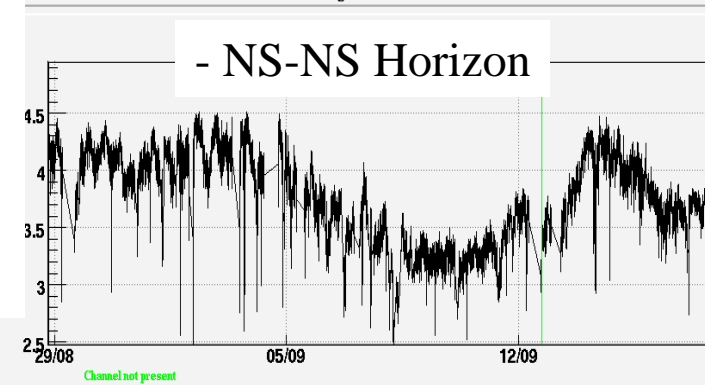
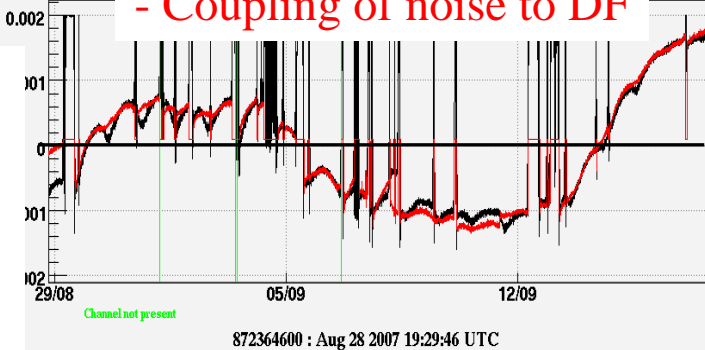
- Frequency noise

- Power recycling mirror position noise

Rough control of the temperature of the input towers

⇒ managed to keep the Etalon effect small enough during the last 2 weeks of the run

To be better characterized for Virgo+



Magnetic noise

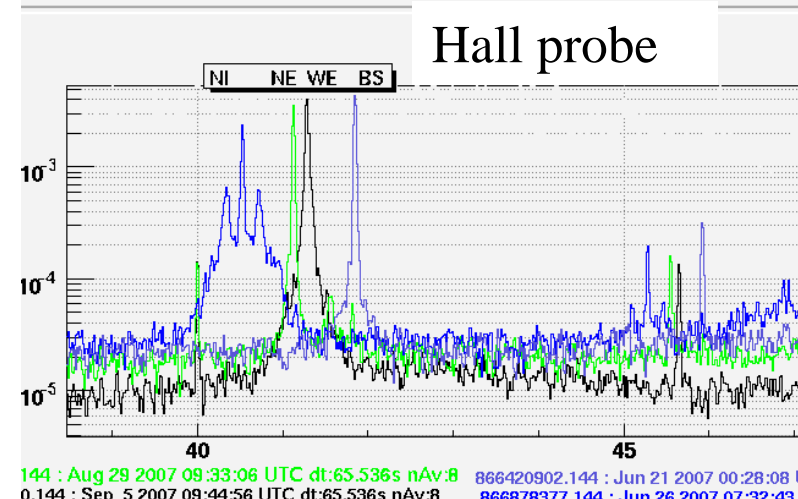
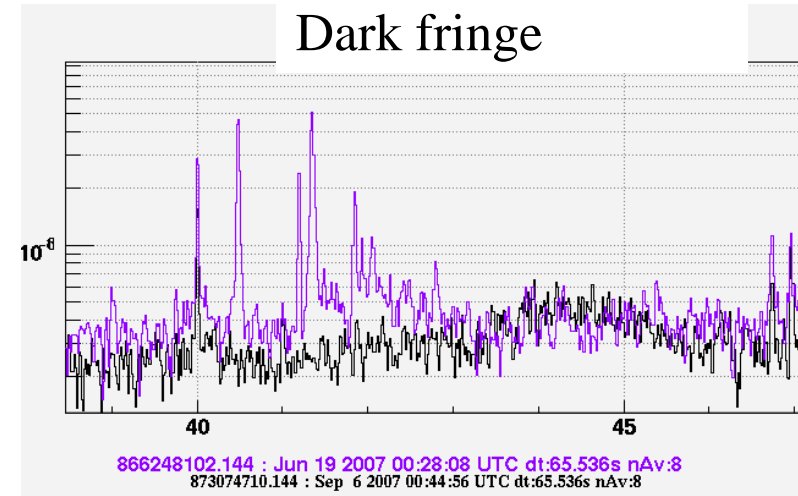
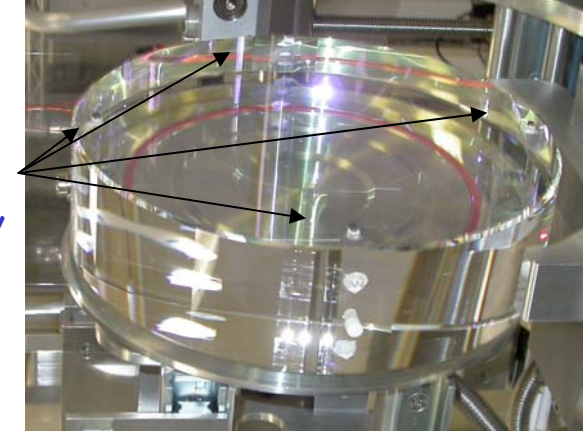
Magnets of the input mirrors are mounted with the same polarity

⇒ Direct coupling of the magnetic noise to mirror displacement

- Actions during the run:
 - Identify sources of large magnetic noise close to the mirrors
 - Switch OFF identified noisy devicesor
 - install them further away

⇒ Many lines removed from 40 to 100 Hz

⇒ To be continued for Virgo+



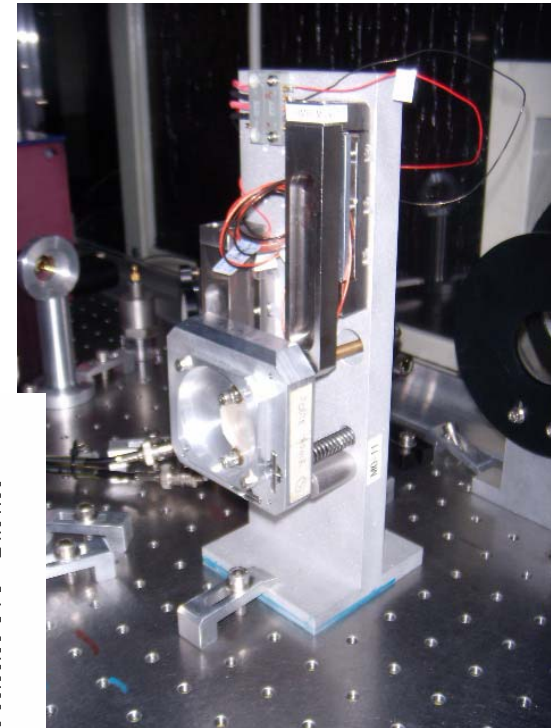
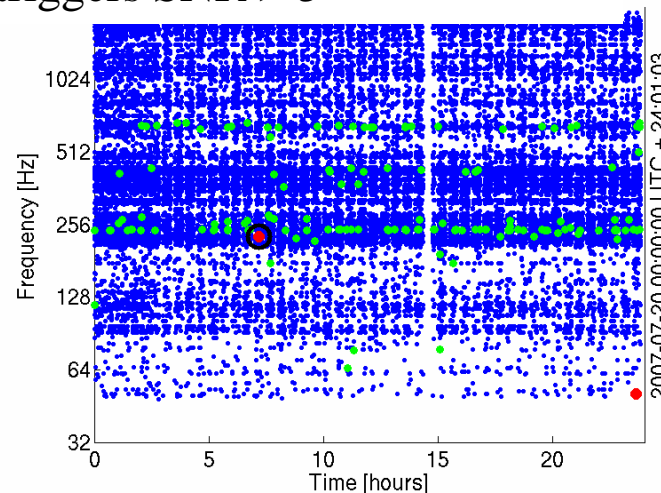
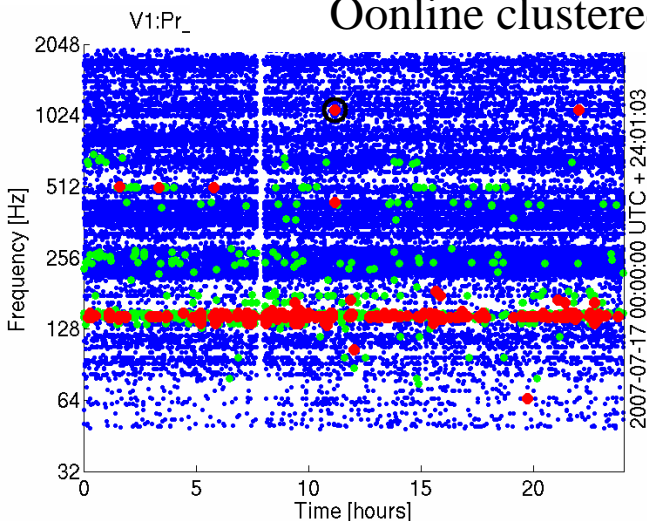
Beam jitter (I): piezo glitches

- Analysis of events found by online analysis
⇒ coincident with glitches on the input beam monitoring system
- Check electronics and mechanics of the piezo-actuators used for the input beam alignment (laser bench):
found and replaced 1 malfunctioning piezo
⇒ The rate of triggers in the online analysis is highly reduced

Before

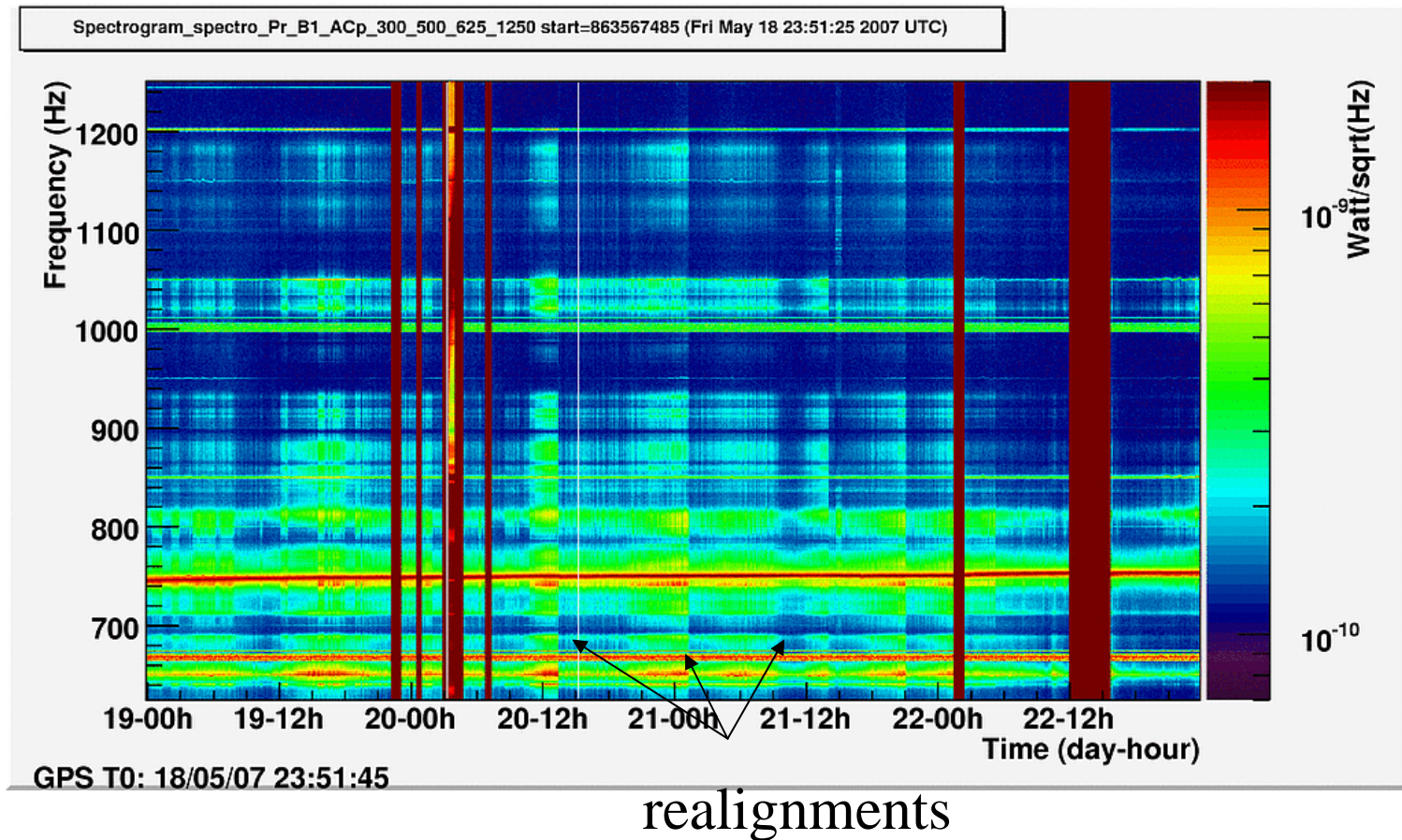
After

Online clustered triggers SNR > 5



Beam jitter (II): mystery noise

- Noise structures (200-300 Hz + 600-1000 Hz) highly non-stationary: depend on the quality of the ITF alignment



Beam jitter (II): mystery noise

Suspended bench

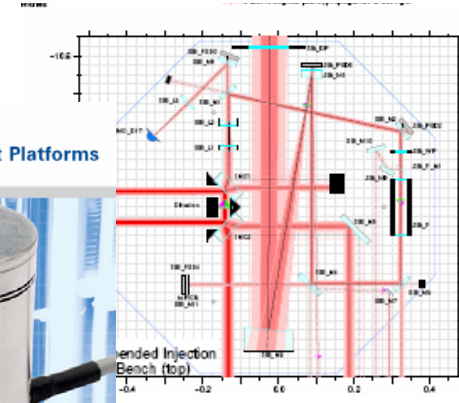
- Noise also seen in the suspended injection bench error signals
 - ⇒ investigations in laser lab, around injection tower (electronics, seismic noise, laser chiller, tapping test)
 - ⇒ investigations on the injection suspended bench

Guilty = piezo-actuators on the suspended bench

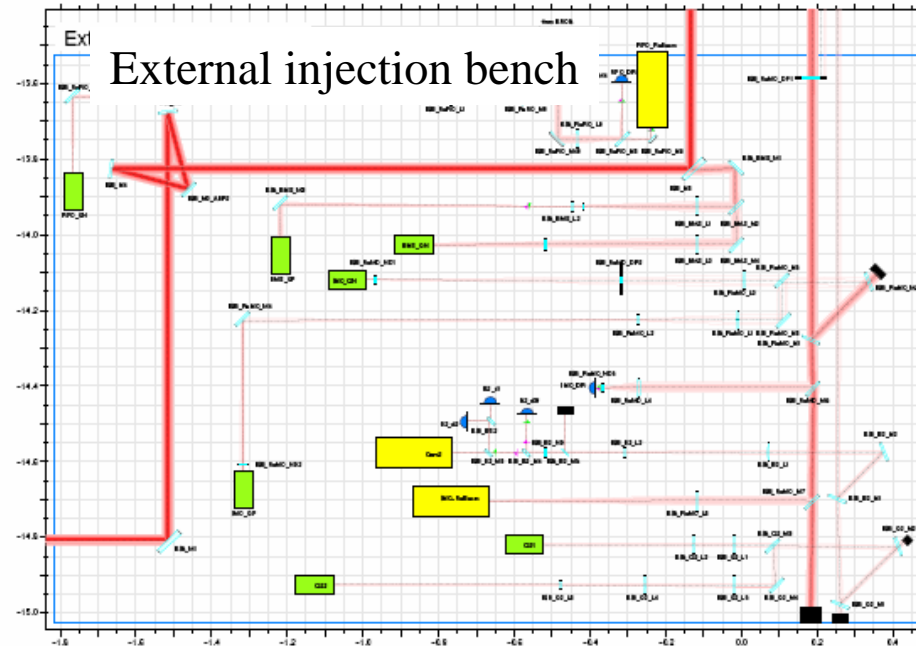
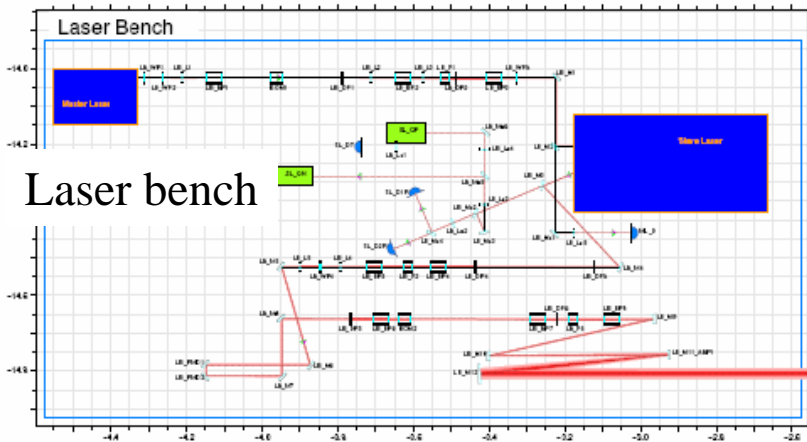
Mechanism:

- Piezo driver noise ⇒ actuator motion ⇒ IB shaken
- ⇒ IMC length noise + jitter noise

S-330 High-Speed Piezo Tip/Tilt Platforms



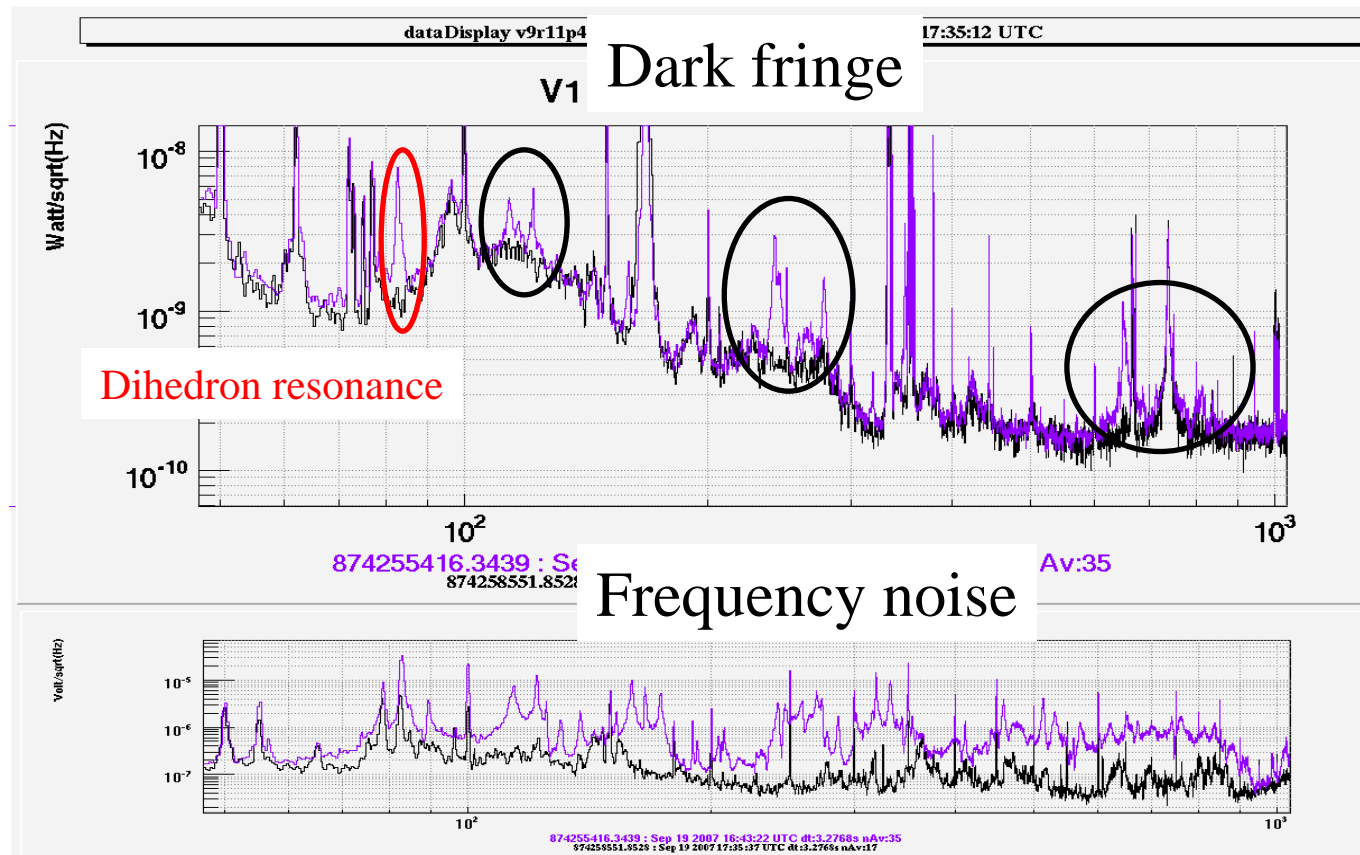
Tower window



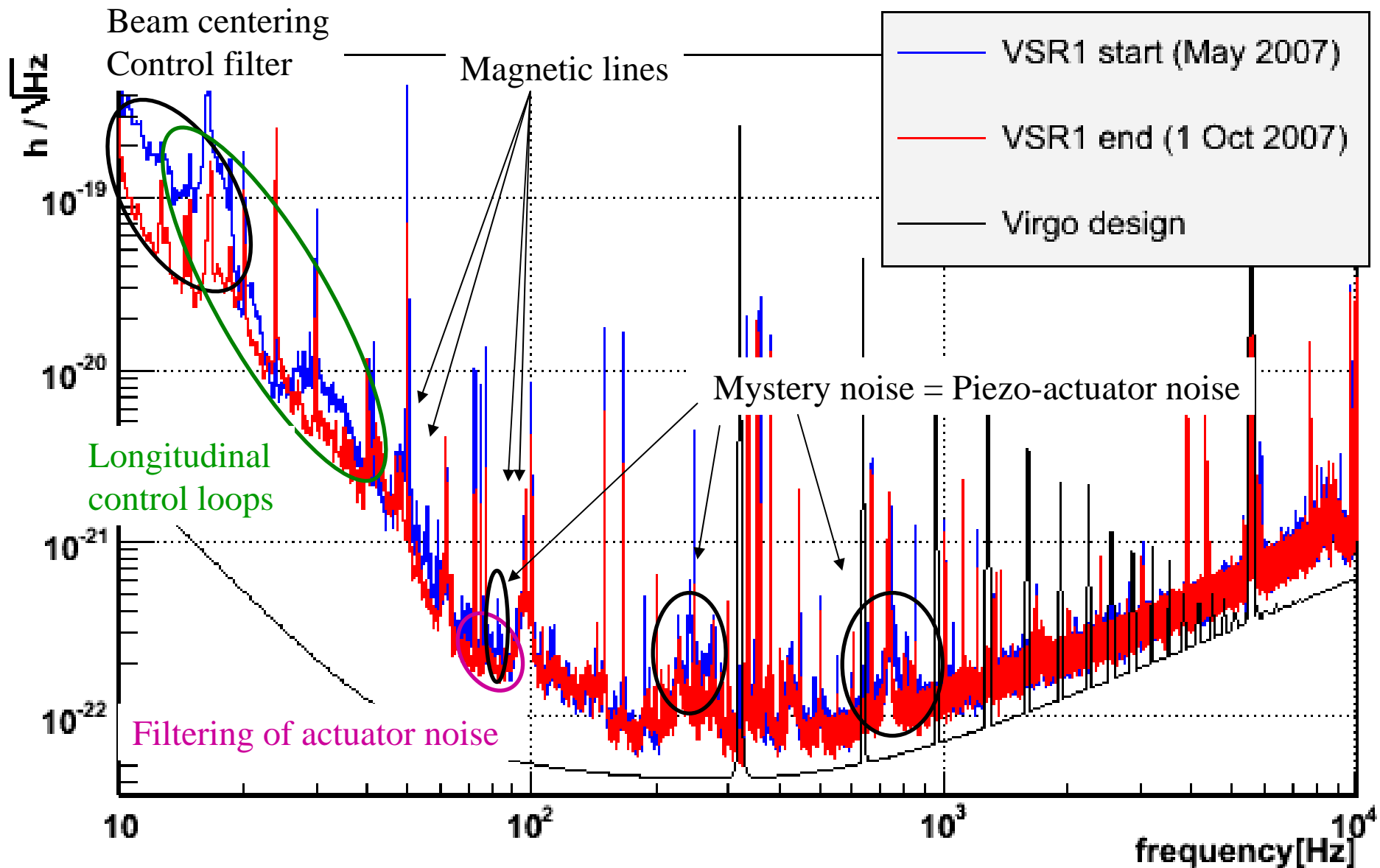
Beam jitter (II): mystery noise death

- Solution: low pass filter the signal of the piezo drivers
 - ⇒ impressive decrease of frequency noise and beam jitter noise
 - ⇒ (no more) mystery structures disappear from DF

Lesson: be careful with actuators on suspended benches

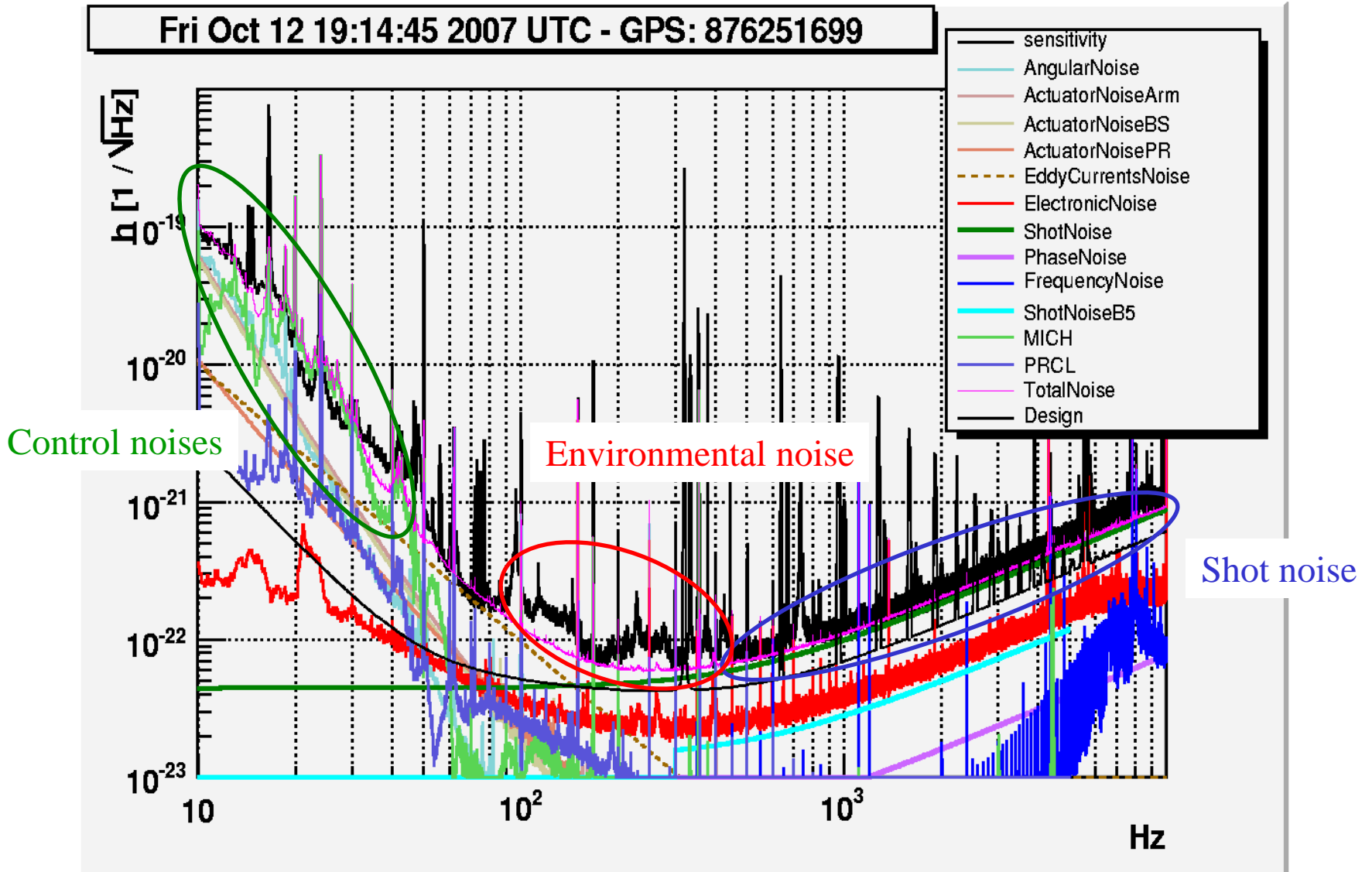


Sensitivity improvements summary



Noise budget now

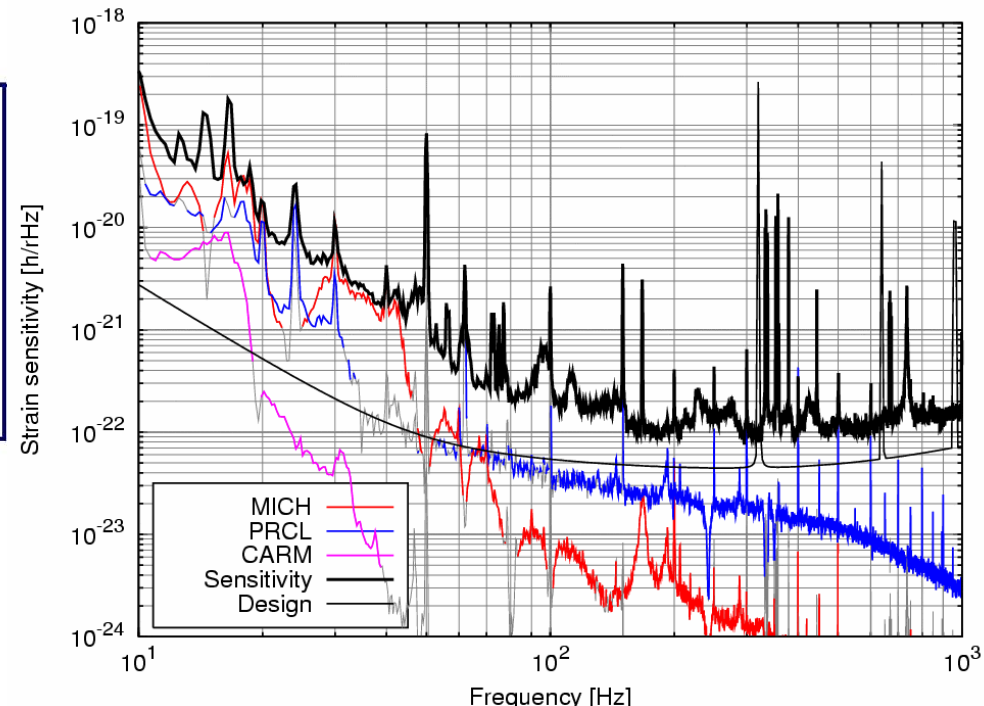
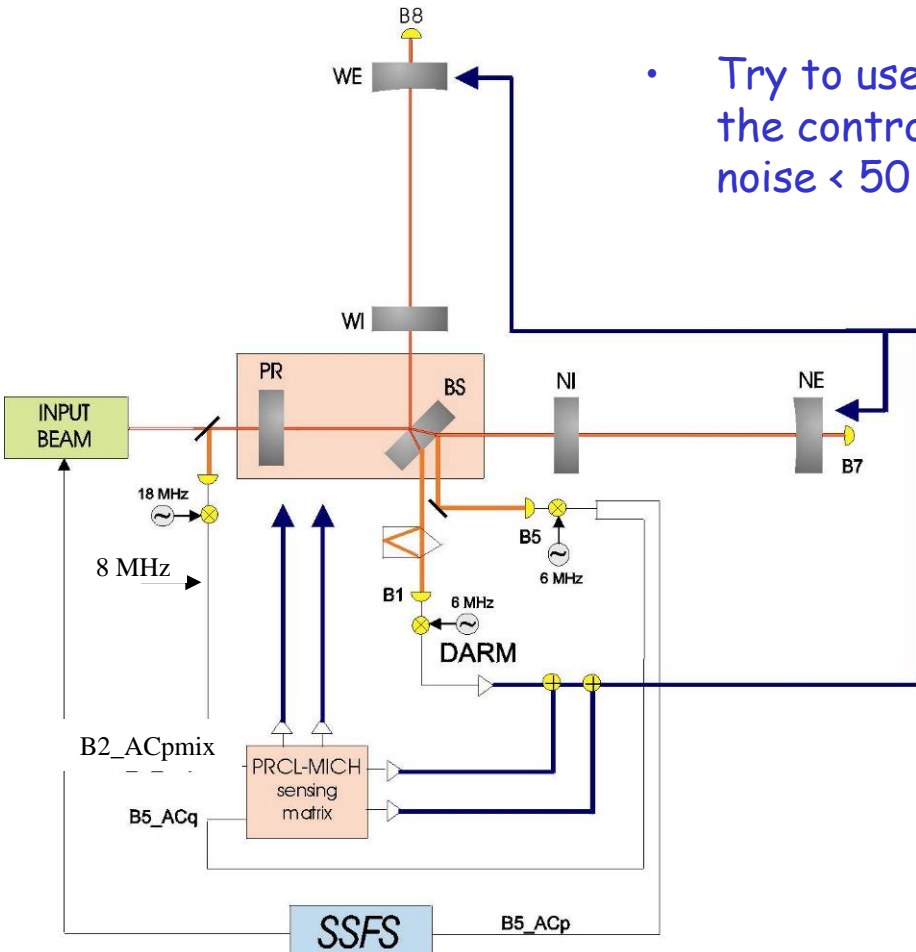
Fri Oct 12 19:14:45 2007 UTC - GPS: 876251699



Longitudinal control noises

- Just after VSR1: campaign of measurements of characterization of:
 - Actuators
 - Optical matrices
- ⇒ Start to improve the controls - should bring some noise reduction

- Try to use the second modulation frequency (8 MHz) for the control of the central cavity (main responsible for noise < 50 Hz): better signal?



Longitudinal control noises

- Thermal lensing side-effects:

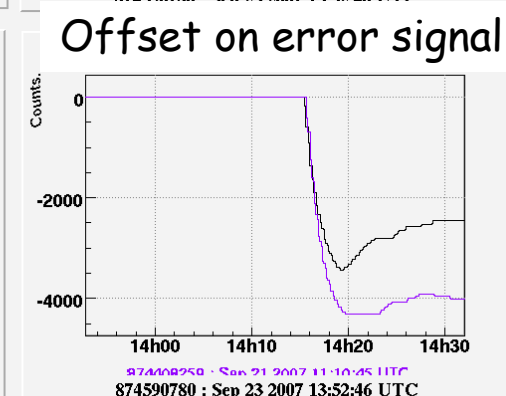
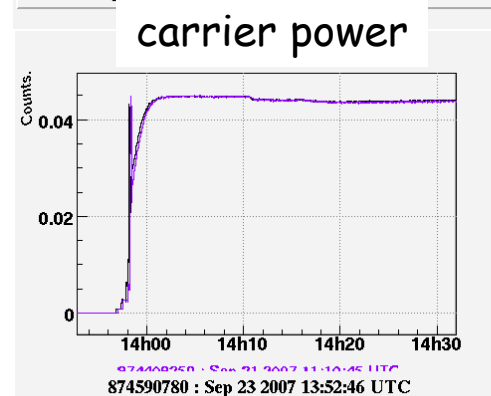
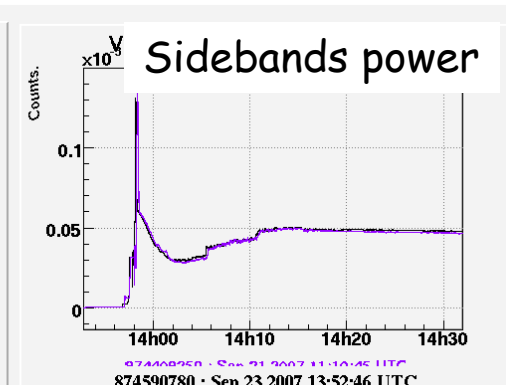
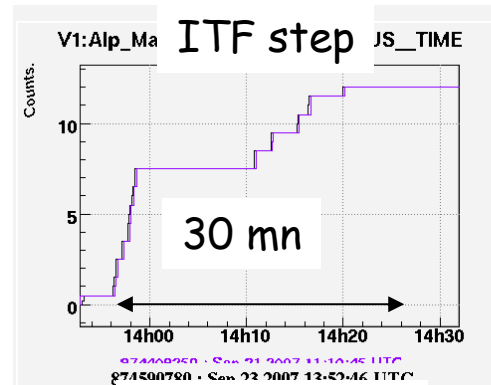
- Long lock acquisition (30mn)
- Lock acquisition sensitive to power variations + other effects
- Large offsets on error signals which need to be tuned
- The error signals might be cleaner without thermal effects ⇒ control noise

Duty cycle +
Commissioning
inefficiency

⇒ Cleaning of the input mirrors will be tried in November

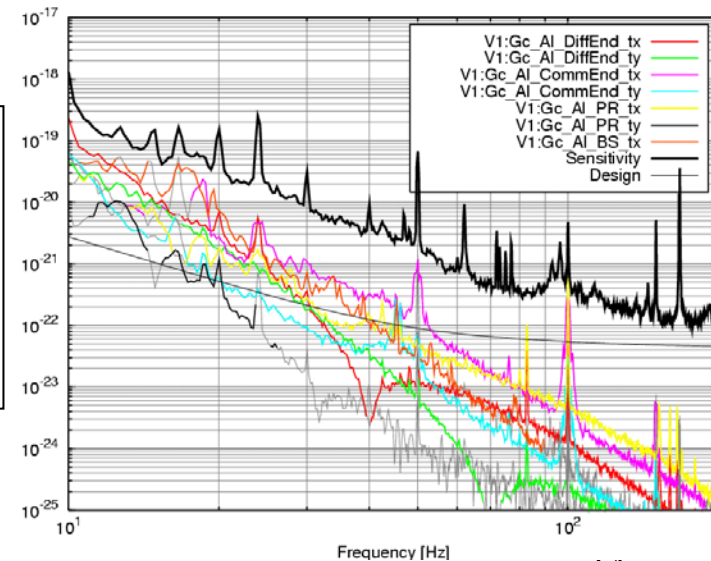
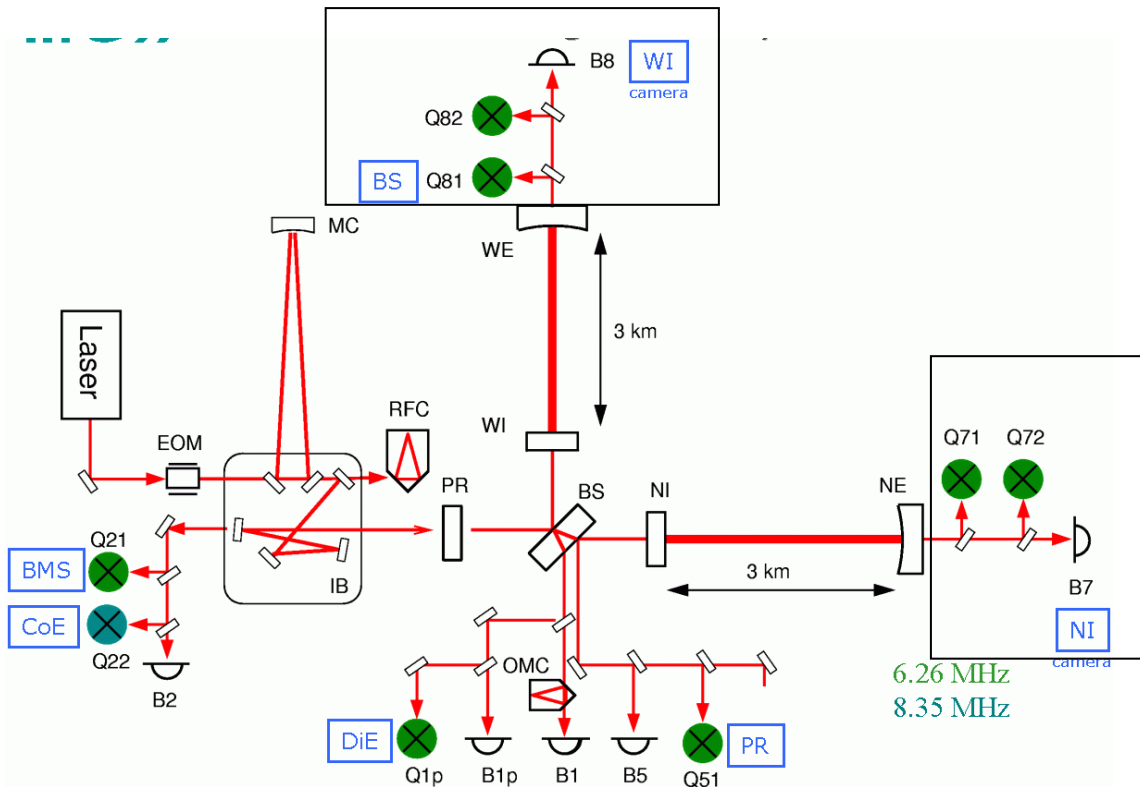
⇒ Thermal compensation in preparation
installation planned in Feb/March

⇒ see talk of A. Rocchi tomorrow



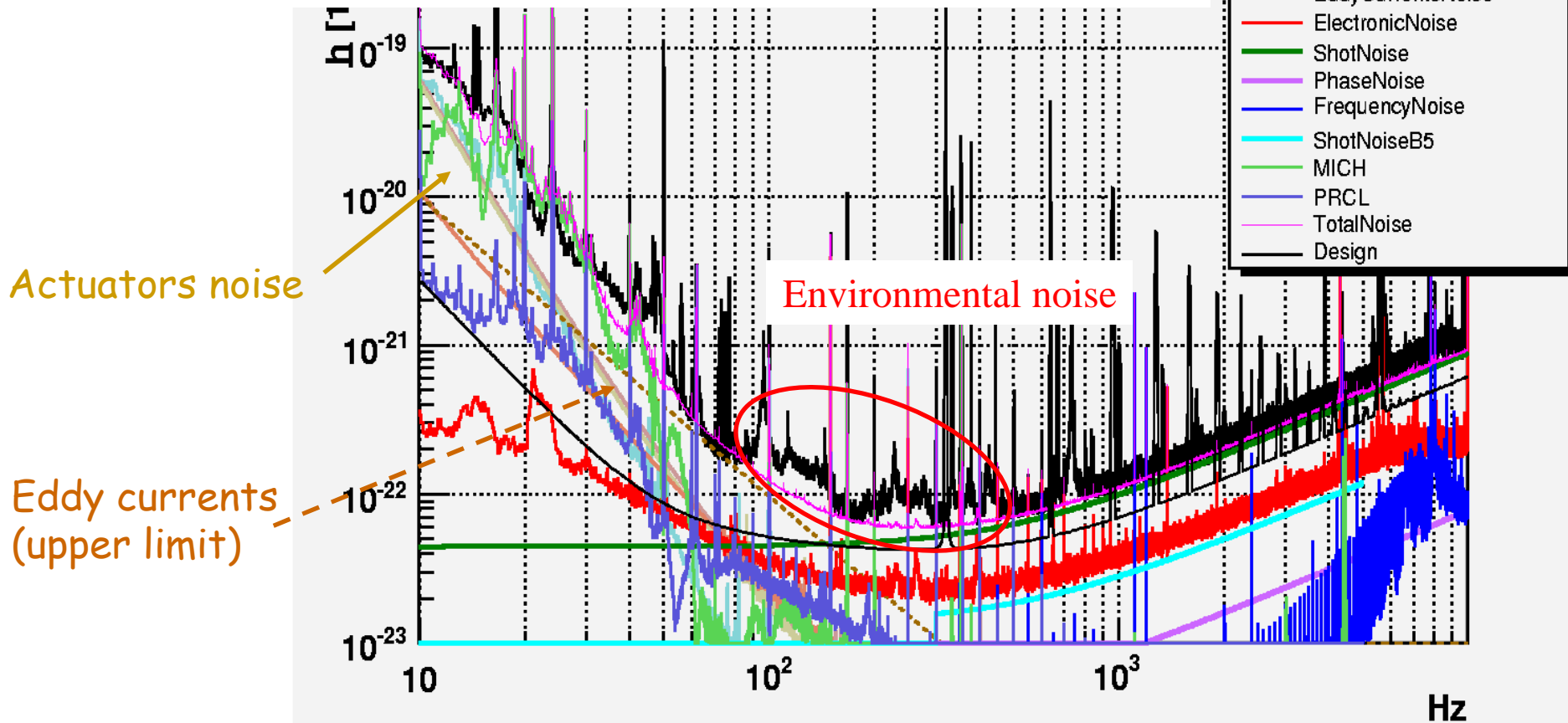
Angular controls

- Still some reduction of control noise needed
 - Install more quadrant photodiodes \Rightarrow look for better signals
 - Install less noisy electronics (Virgo+)
 - Improve the optical setup of the end benches (cleaner signals)
- \Rightarrow Need improved telescope (reduction factor ~ 50): under preparation for Jan/Feb



Noise budget now: what else?

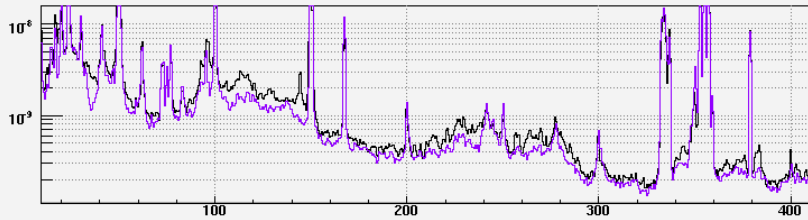
- Mirror actuator noise (<50 Hz)
 - ⇒ New coil drivers (more filtering capabilities) in preparation will be tested soon
- Eddy currents in reference mass
 - Not observed yet
 - ⇒ The magnets will be capped if necessary



Environmental noise

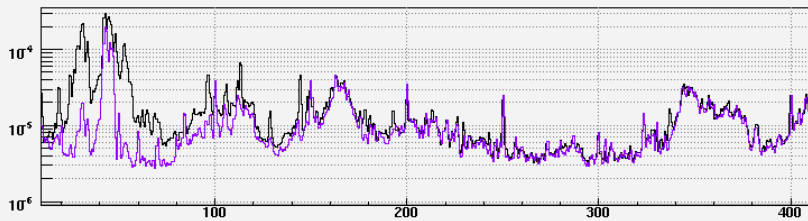
- Most of the structures between 50 to 500 Hz are coherent with the motion of the detection Brewster window
- Tapping tests \Rightarrow Brewster is the most sensitive of all vacuum pieces
- Structures were well reduced during an ENEL power cut which switched OFF some noisy devices (Air conditioning,...): BNS range 4.3 \rightarrow 4.8 MHz

V1:Pr_B1_ACp_FFT



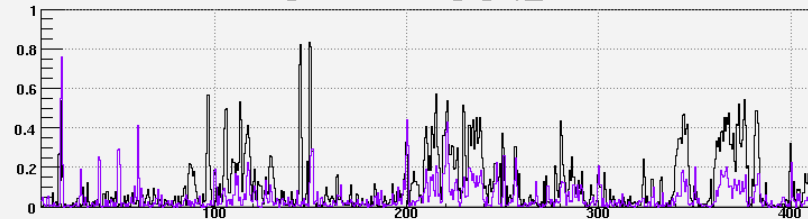
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V1:Em_SEDetBrew_FFT

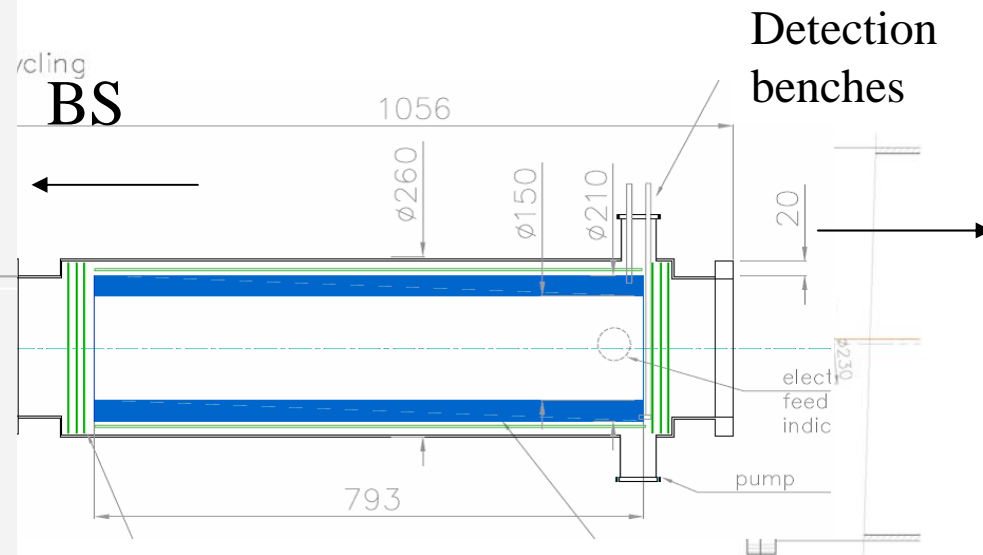


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V1:Em_SEDetBrew.vs.V1:Pr_B1_ACp_COHE



872844202.3328 : Sep 3 2007 08:43:08 UTC dt:1.6384s nAv:60



- \Rightarrow Remove the Brewster window
- \Rightarrow Will be replaced by a cryogenic trap to catch detection pollution (Jan/Feb)
- \Rightarrow And mitigate diffused light in Det tower

Summary of commissioning plans until Virgo+ shutdown

- ITF characterization (1-15 Oct): calibration, locking loops, suspension, noise
 - ⇒ Start to optimize locking strategy ⇒ control noise reduction
- Attempt to use the second modulation frequency ⇒ reduction of control noise?
- Go on with improvements of the suspensions and alignment loops ⇒ reduce noise coupling
- Install the new coil driver (start with 1 tower in November) ⇒ actuator noise reduction
- Clean the input mirrors (November)
 - ⇒ Re-commission the lock acquisition + re-tune the locking loops
 - ⇒ Faster/more stable lock acquisition + cleaner error signals?
- Replace the Brewster window with a cryogenic trap (Jan/Feb)
 - ⇒ environmental noise reduction
- Install new optics at end benches ⇒ better alignment performances (Jan/Feb)
- Install the Thermal compensation system and commission it (Feb/Mar)
 - ⇒ Re-commission the lock acquisition + re-tune the locking loops
 - ⇒ Faster/more stable lock acquisition + cleaner error signals?
- Cap the magnets when the Eddy currents noise is met