
ENVIRONMENTAL DISTURBANCES (INCLUDING S1 - STOPPERS)

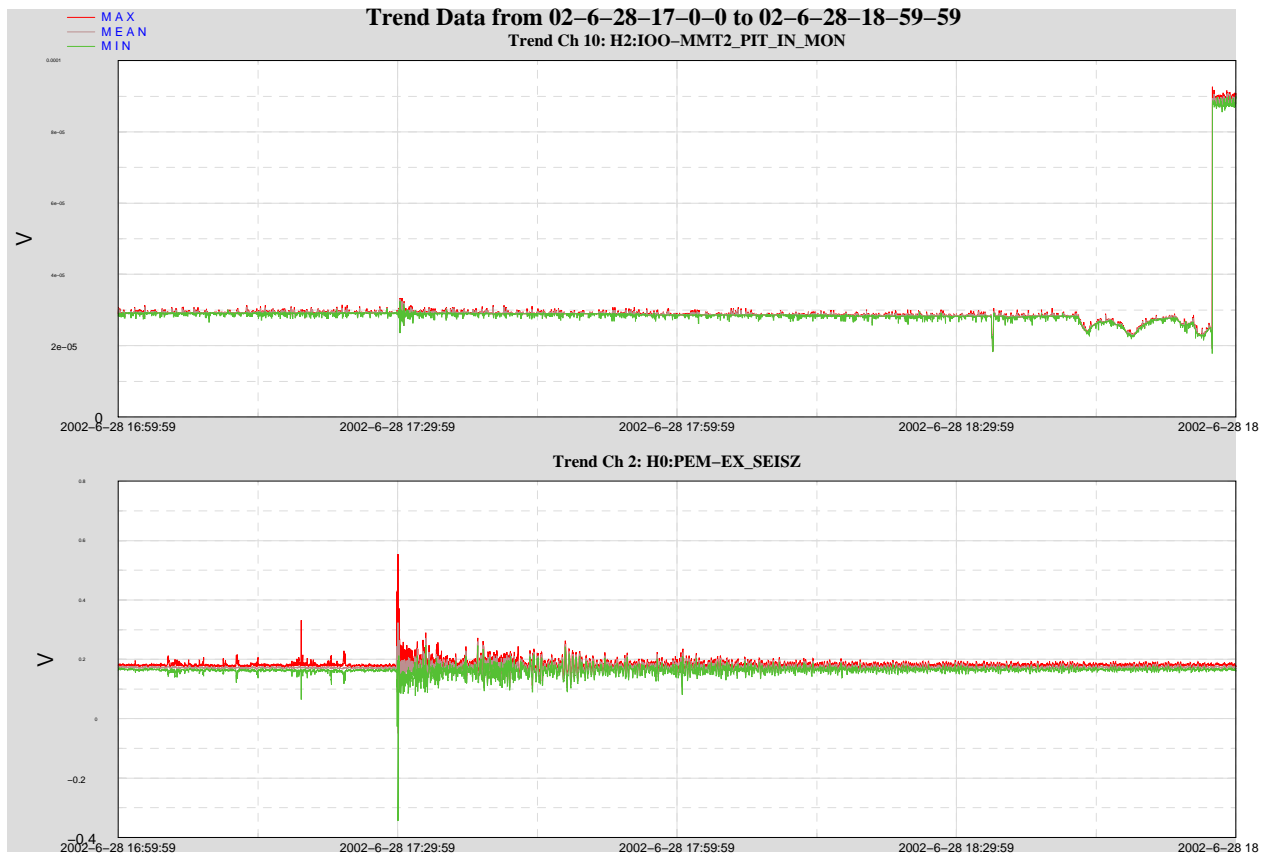


Robert Schofield (Oregon)

**E. D'Ambrosio (CIT), D. Cook (LHO), R. Drever (CIT),
V. Sannibale (CIT), B. Bland (LHO)**

Final Two Hours of MMT2 Suspension

Top: MMT2 Pitch; Bottom: EX seismometer



Quake

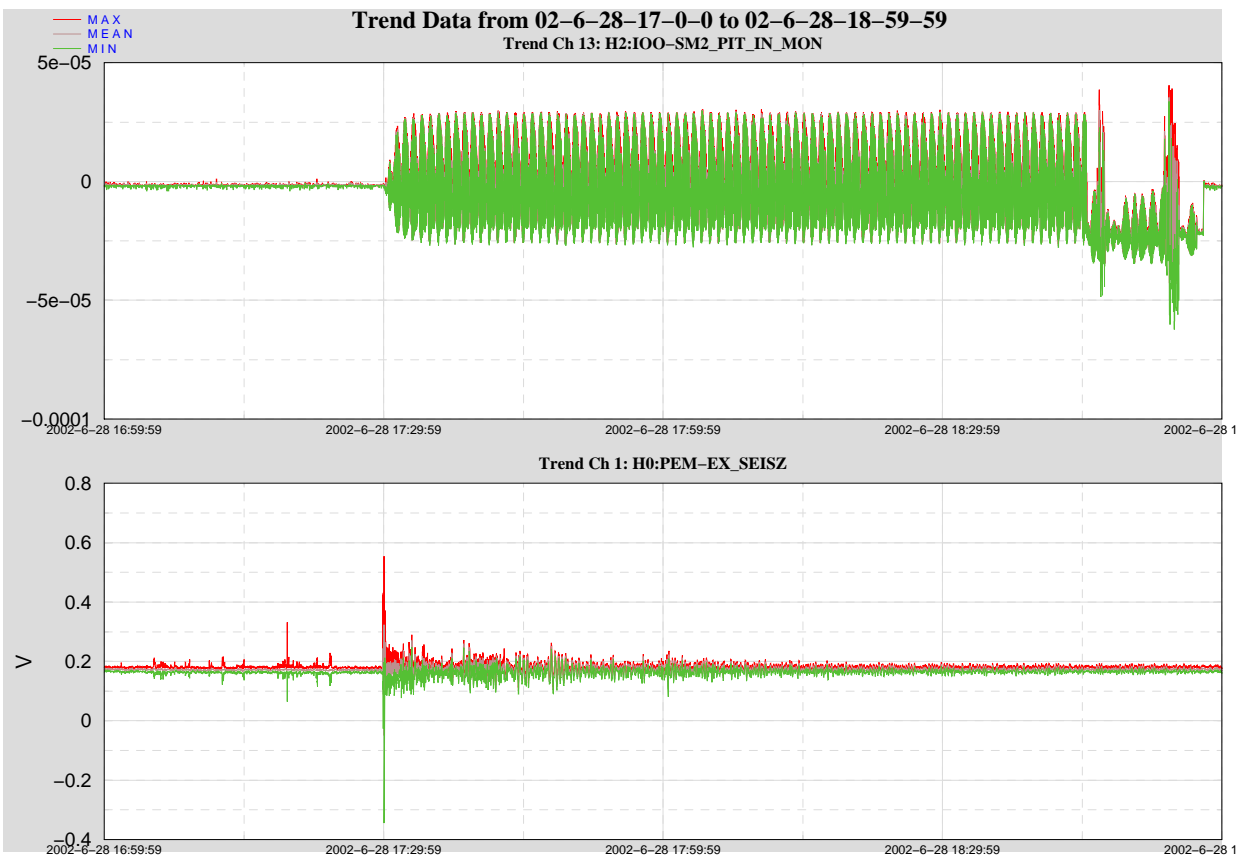
**Yaw Bias Drop
Drift**

**Optic recovered from Russian-Chinese quake.
Also, nearby optic MC2 was steady during final motions of MMT2:
any mechanical jolt would shake both**

Quake Rings Up SM2

Same time period as shown previously for MMT2 pitch

Top: SM2 pitch; bottom: EX seismometer



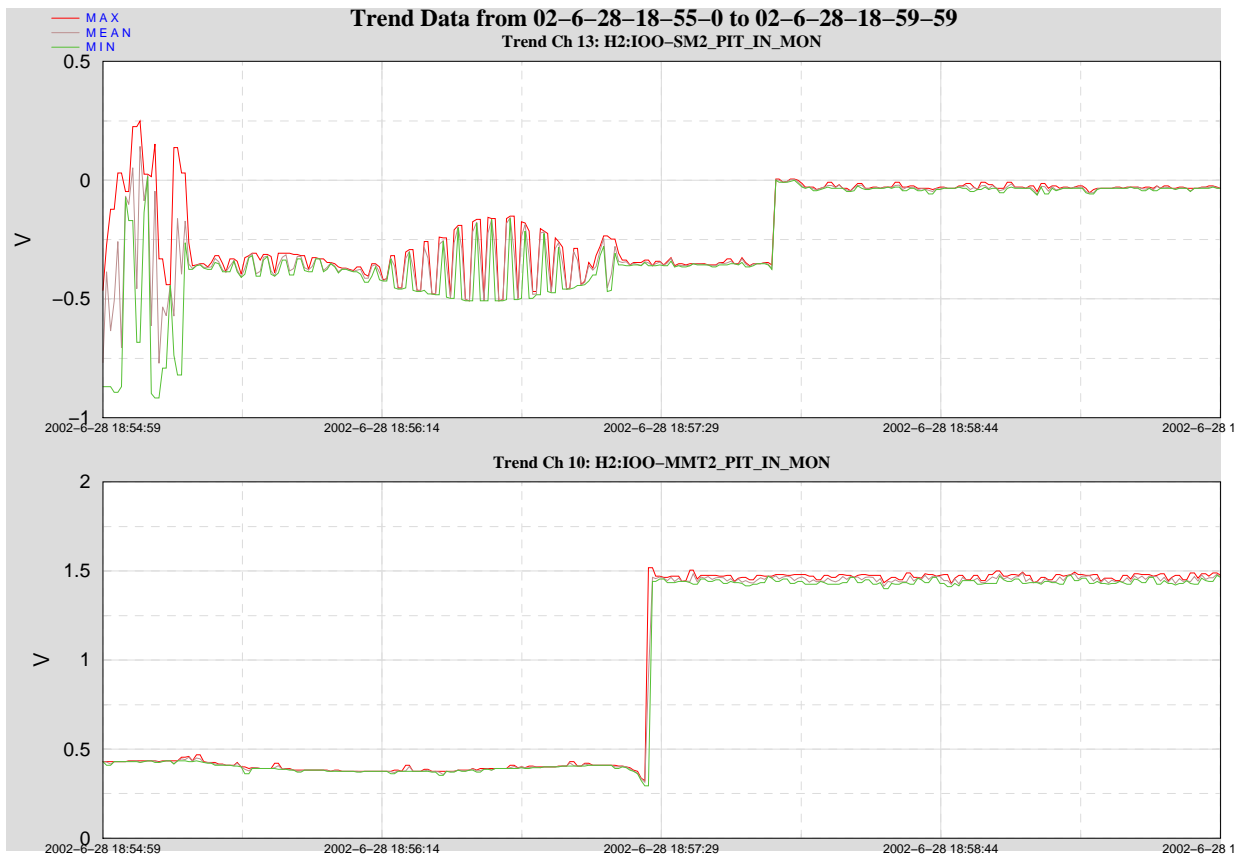
Quake

Josh Quiets

SM2 Pitch During Final Moments of MMT2

5 minute time span

Top: SM2 pitch; bottom: MMT2 pitch



Drop

- SM2 stabilized about 5 seconds before MMT2 drop
- MMT2 pitch-drift accelerates seconds before drop

Not suggestive of sub-second wire melt.

Ends of Broken MMT2 Wire

Top row: long piece; bottom row: short piece



END OF LONG PIECE
MMT2



END OF LONG PIECE
MMT2



END OF SHORT PIECE
MMT2



END OF SHORT PIECE
MMT2

Ends appear rounded; thin film colors near break.

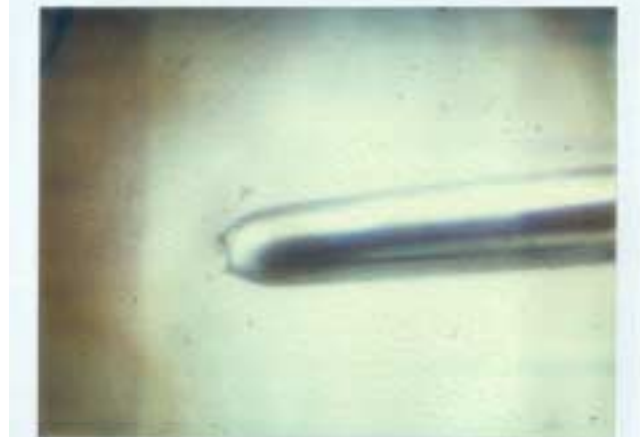
Wires Broken Hot or Cold

Broken at room temperature by increasing tension.



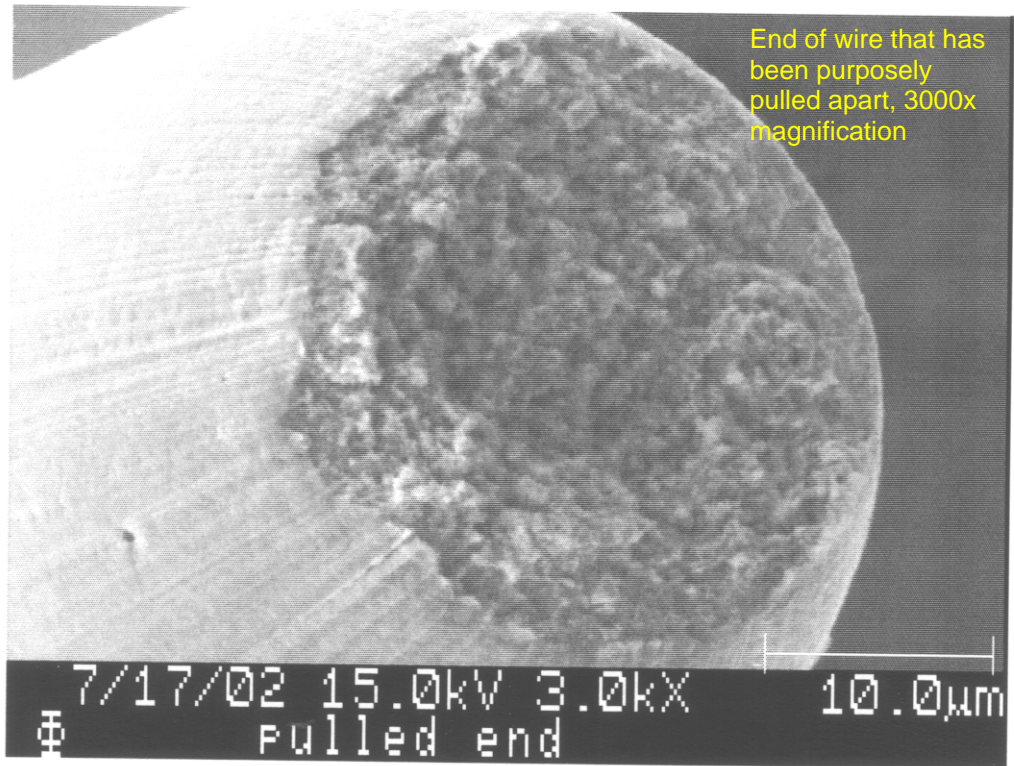
COLD

Broken by touching with dull-red stove heating element (170 gms tension)



DULL RED HEATING ELEMENT

End of wire that has
been purposely
pulled apart, 3000x
magnification



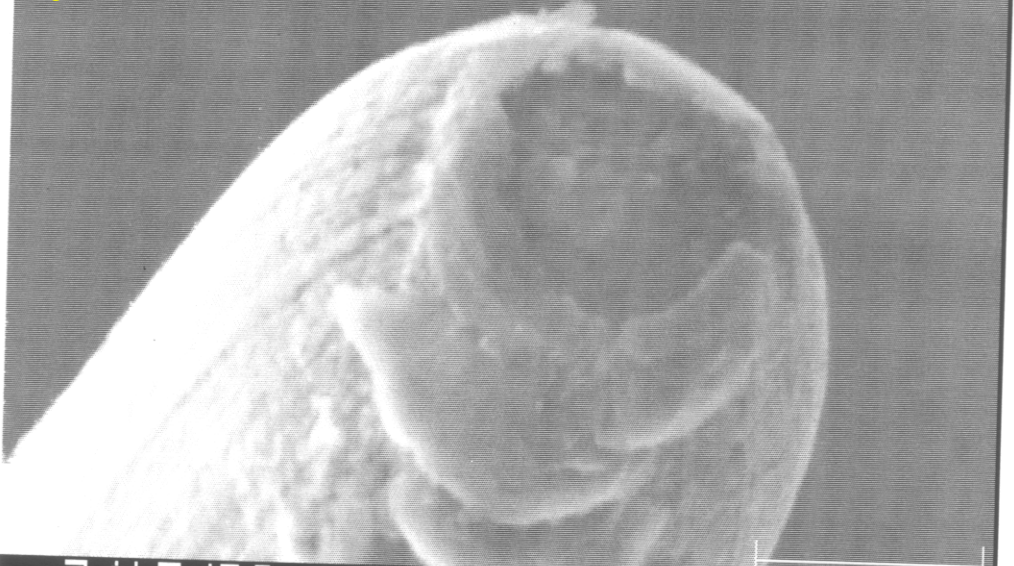
7/17/02 15.0kV 3.0kX

10.0µm

pulled end

⊕

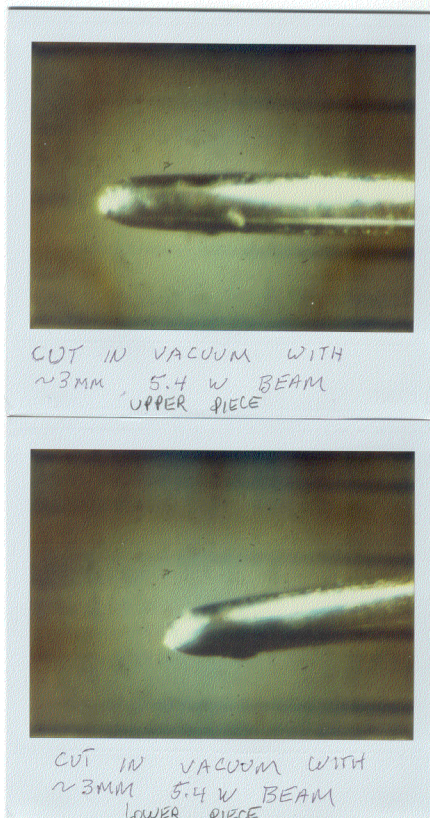
First end of wire that was
broken, 3000x
magnification



7/17/02 15.0kV 3.0kX 10.0µm
Φ long end

Laser Cut in Vacuum

**150 gm suspended from
SOS wire in vacuum cham-
ber with window**



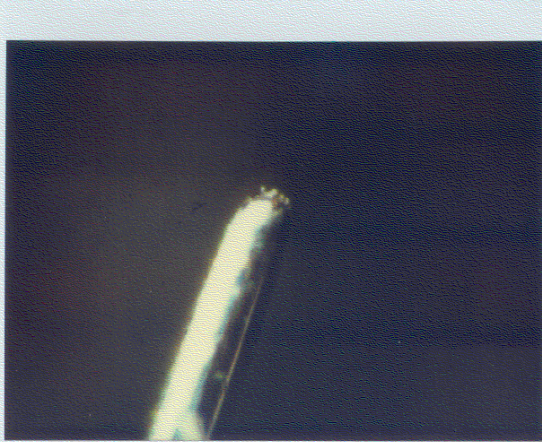
**5.4 W 3mm beam scanned
across wire at about 1 cm/s**



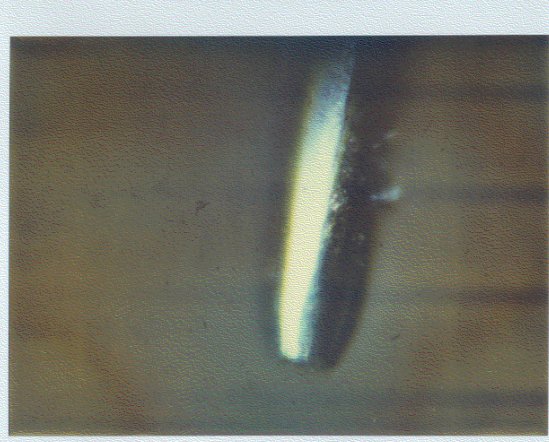
Summary Comparison

MMT2

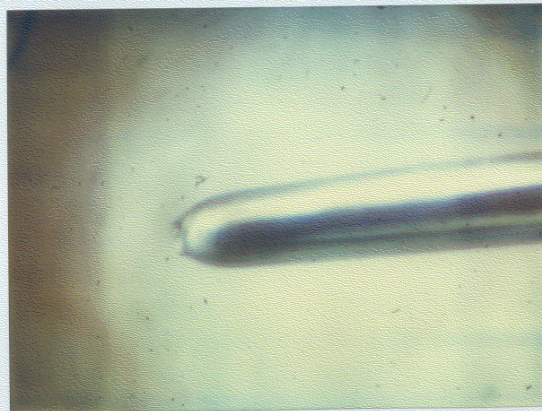
Cold



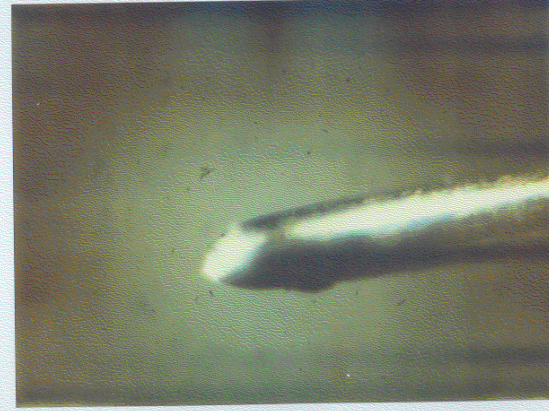
MMT2 LONG END



COLD BREAK



DULL RED HEATING ELEMENT



CUT IN VACUUM WITH
~3MM 5.4 W BEAM
LOWER PIECE

Heating Element (not melted)

Laser in Vacuum

MMT2 looks most like the warmed not melted wire, but not conclusive.

Some Lessons Learned

- 1) Sliders can move beams onto suspension wires: limit sliders.**
- 2) Breaking a wire may take a long time: “watchdogs” could be very useful even if there is a delay in blocking the beam.**
- 3) Warming, short of melting, can cause breakage and, short of breaking, may cause alignment drift.**

NEW PROTECTION:

H2: baffles on MC2 and MMT2‘

H1: SM and MMT1 Sliders limited and protected by watchdogs

Dave Barker's Wire Protector

H1WIREPROT.adl
LHO 4K H1WIREPROT SAT AUG 17 17:00:51 2002

4k MMT2 Wire Protection System Status: **Operational**

Sequencer Dialog Sequencer Operational (when blinking): █

- Ramping SM watchdog level down

Input Optics Slider Limits

		HOPR	LOPR	DRWH	DRVL			
SM	POFF	1.000	0.000	1.000	0.800	0.800	0.878	1.000
	YOFF	0.100	0.000	0.100	0.000	0.000	0.020	0.100
MMT1	POFF	0.000	-0.300	0.000	-0.300	-0.300	-0.158	0.000
	YOFF	0.000	-0.100	0.000	-0.100	-0.100	-0.076	0.000

Laser Power Controls

4k Digital Suspensions Watchdog

	UL	LL	SD	MAX!	Watchdog	Disable	Enable
SM	0.1 mV	0.3 mV	0.0 mV	50	Normal	Disable	Enable
	0.3 mV	0.0 mV	0.0 mV	50	ShutDown	Disable	Enable
	0.0 mV	0.0 mV	0.0 mV	50	ShutDown	Disable	Enable
MMT1	0.3 mV	0.0 mV	0.0 mV	50	Normal	Disable	Enable
	0.3 mV	0.0 mV	0.0 mV	50	ShutDown	Disable	Enable
	0.0 mV	0.0 mV	0.0 mV	50	ShutDown	Disable	Enable

50 Nominal operating limit

4k Mode Cleaner

MC LOCK

Length Path: ON/OFF Disable INTERNAL

Enable WIDE BAND

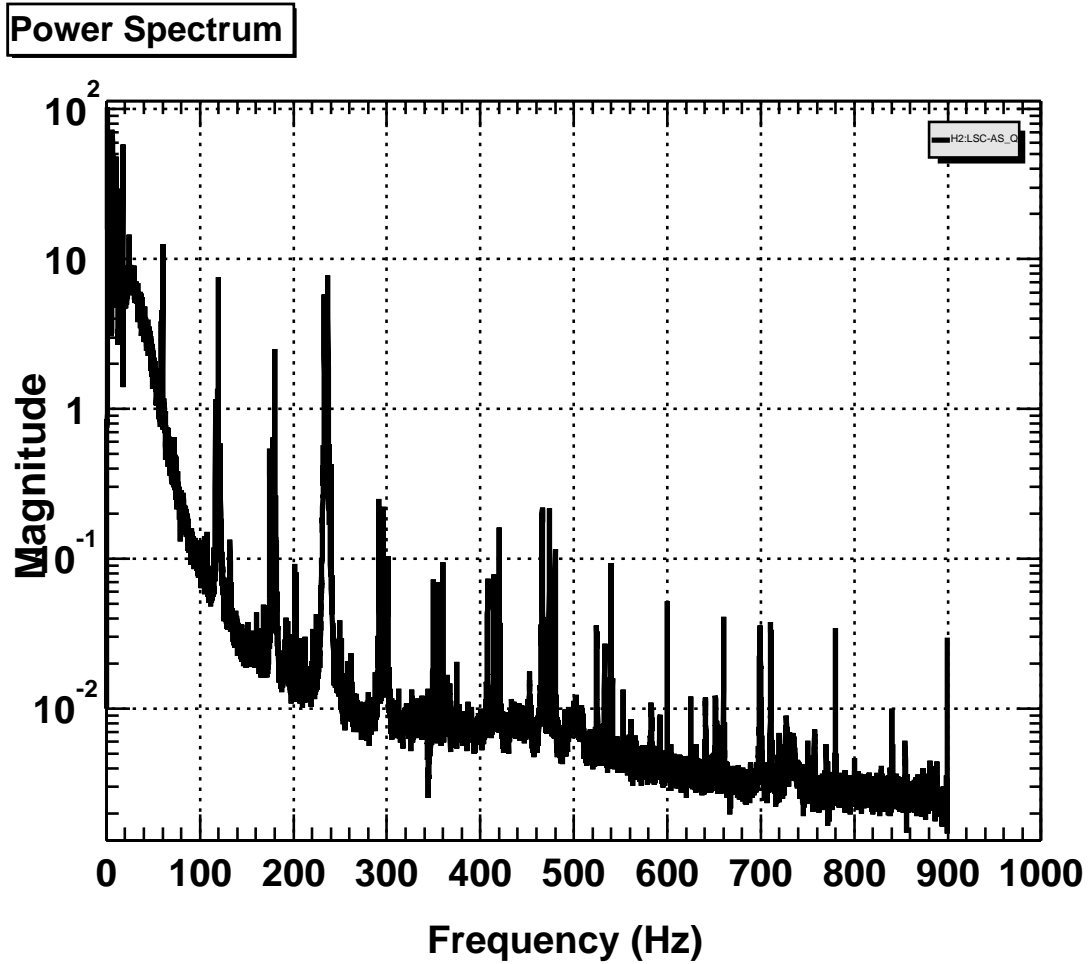
Resumption of Mode Cleaner Lock

Only permit MC locking to continue if danger of wire damage has passed

Fans That Show Up on the GW Channel



A Forest of Peaks in AS_Q

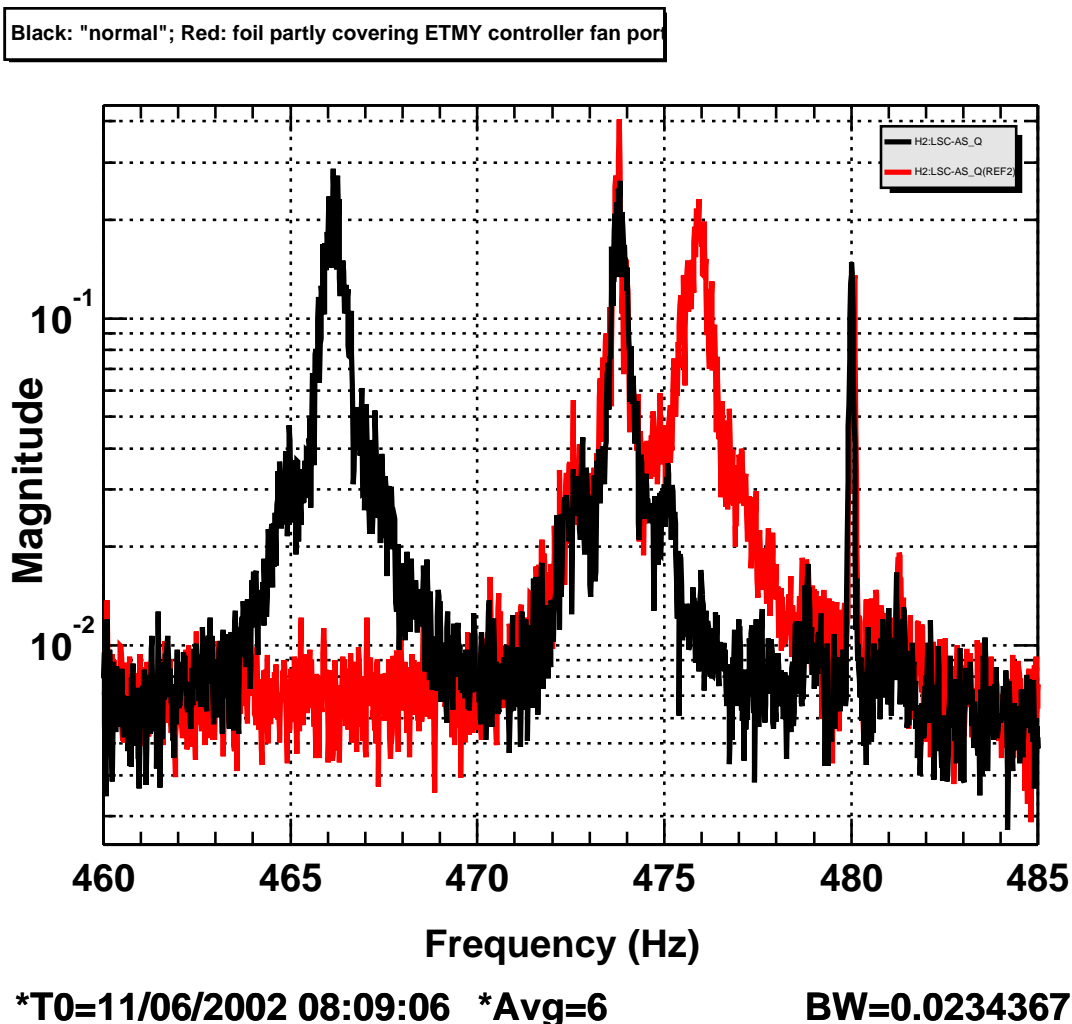


T0=11/06/2002 08:09:06 Avg=6

BW=0.0234367

Peaks Movable

by partially covering fan port of test mass controller with foil

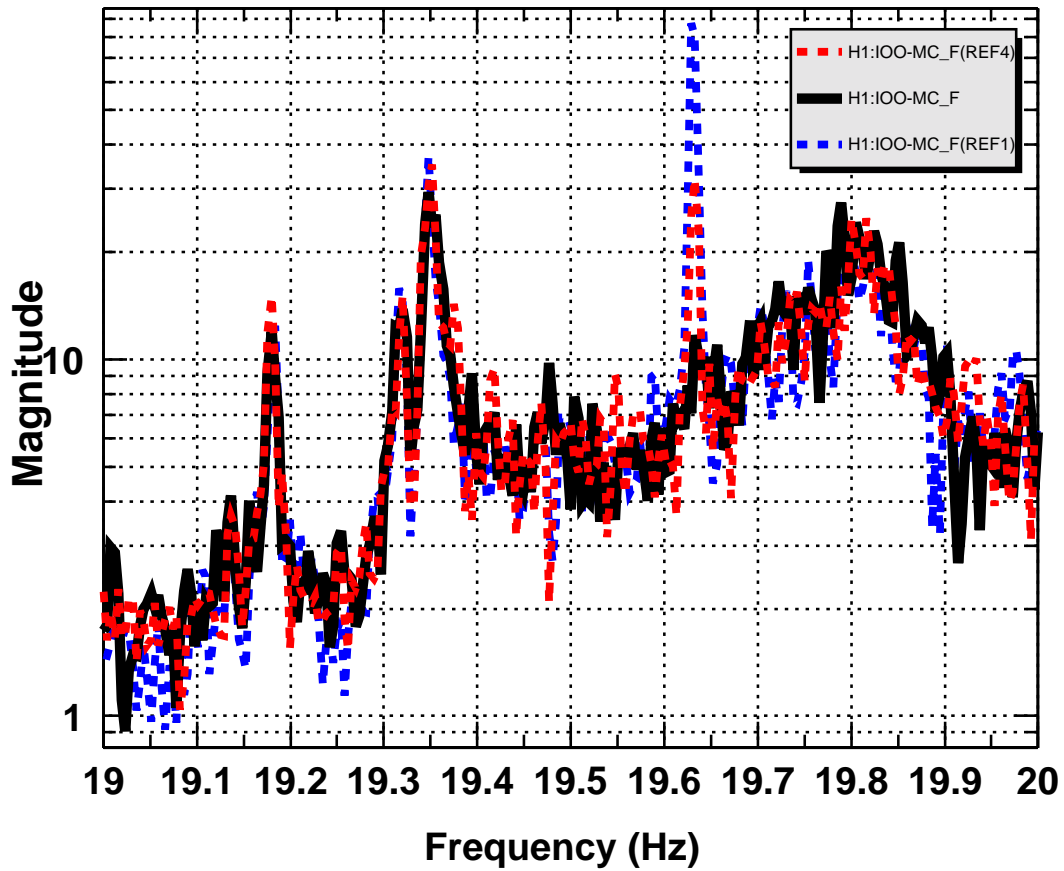


Separate fan power supply removed peaks - fans probably caused power supply ripple

Hood Fans Responsible for 19.6 Hz Peak

“mimicked” small optic bounce mode

Blue: both hoods on; Red: bake hood only; Black: both off



*T0=15/05/2002 06:33:26 *Avg=5

BW=0.00585928

Hood Fans Responsible for 19.6 Hz Peak

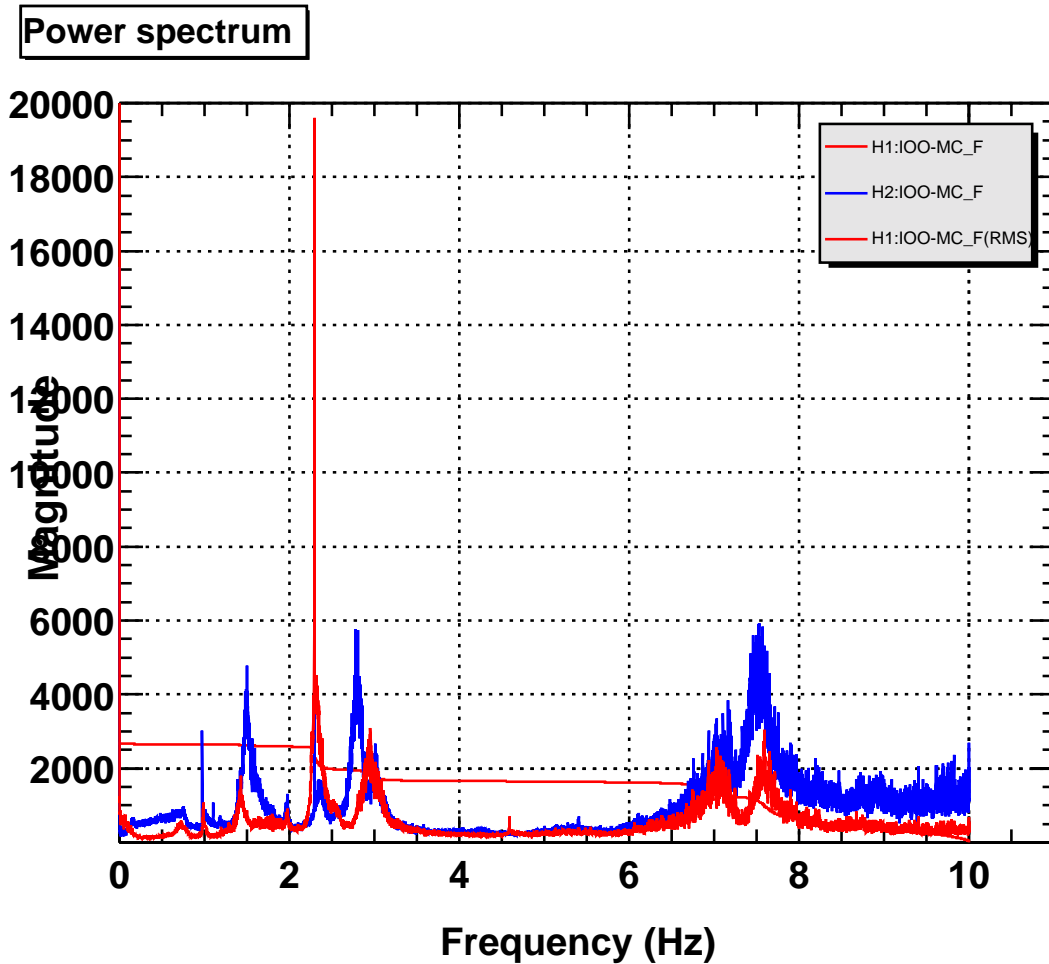
One of the two culprits:



The solution:



Peak at 2.295 Hz responsible for about 20% of RMS in 4k mode cleaner control



T0=11/01/2002 09:28:04 Avg=9

BW=0.00018309

Effect since reduced by resonant gain stage, but still responsible for several percent of RMS of HAM2 coils.

Cooling Tower Fans at ENW Nuclear Reactor

Mobile seismometer suggested cooling towers.



Motor monitors and gear-teeth ratios allowed calculation of frequency for each of 36 fans: nearly all fell within our peak.

Inside the giant swamp-cooler;



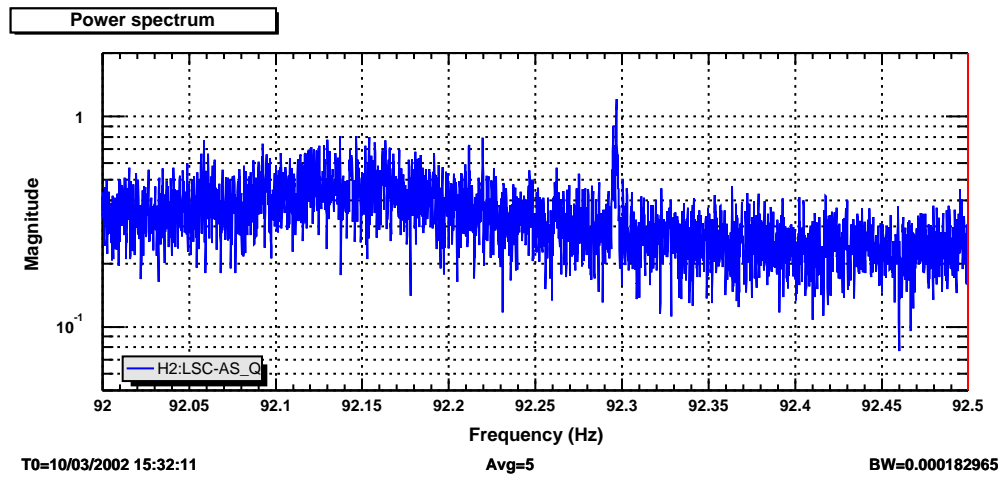
motor shaft, gearbox and 30 ft. diameter blade.



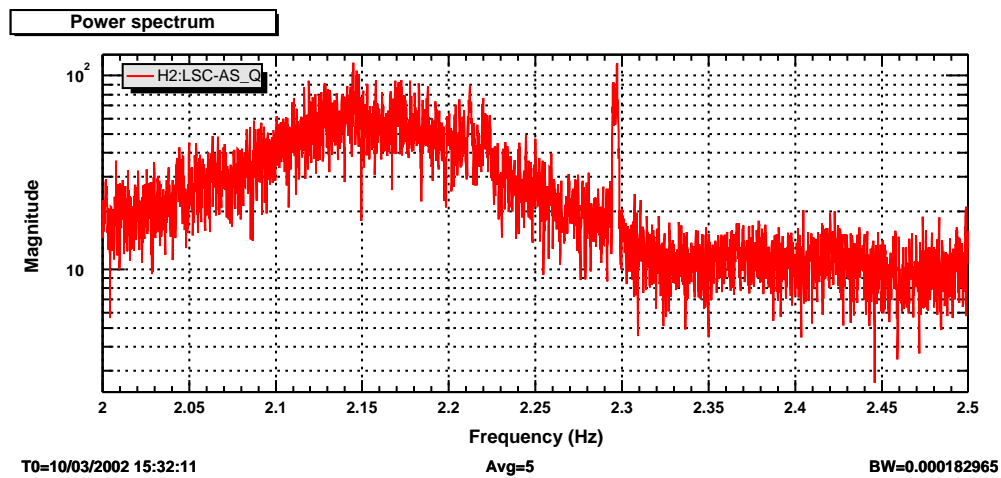
Upconversion of Cooling Tower Fan Peak

sideband on 90 Hz injected peak

The peak at 92.295 Hz



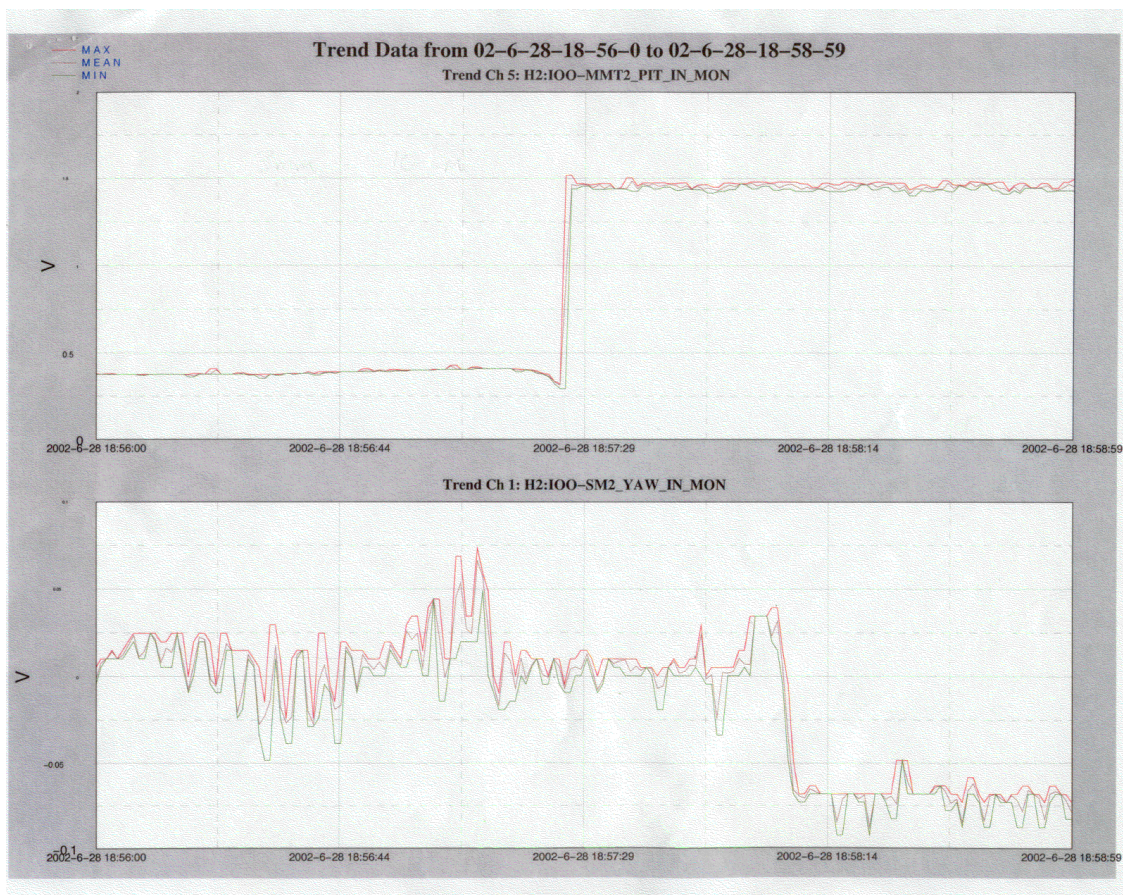
The peak at 2.295 Hz



Bonus slide: SM2 Yaw During Final Moments of MMT2

5 minute time span

Top: MMT2 pitch; bottom: SM2 yaw



Drop

Yaw appears to be offset far enough to put beam on or near wires. Motion just before drop may be a few beam diameters
