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# **ENVIRONMENTAL DISTURBANCES (INCLUDING S1 - STOPPERS)**



**Robert Schofield (Oregon)**

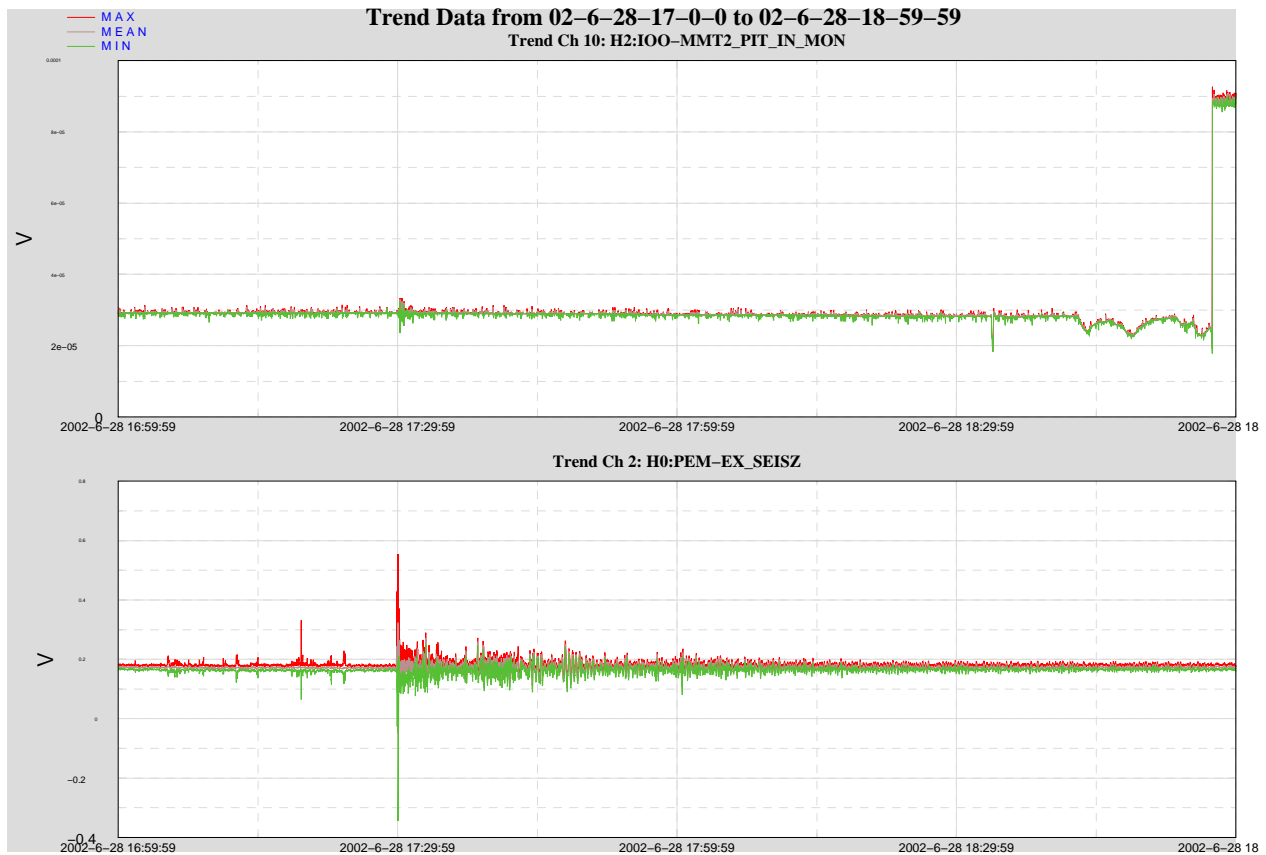
**E. D'Ambrosio (CIT), D. Cook (LHO), R. Drever (CIT),  
V. Sannibale (CIT), B. Bland (LHO)**

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# 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**

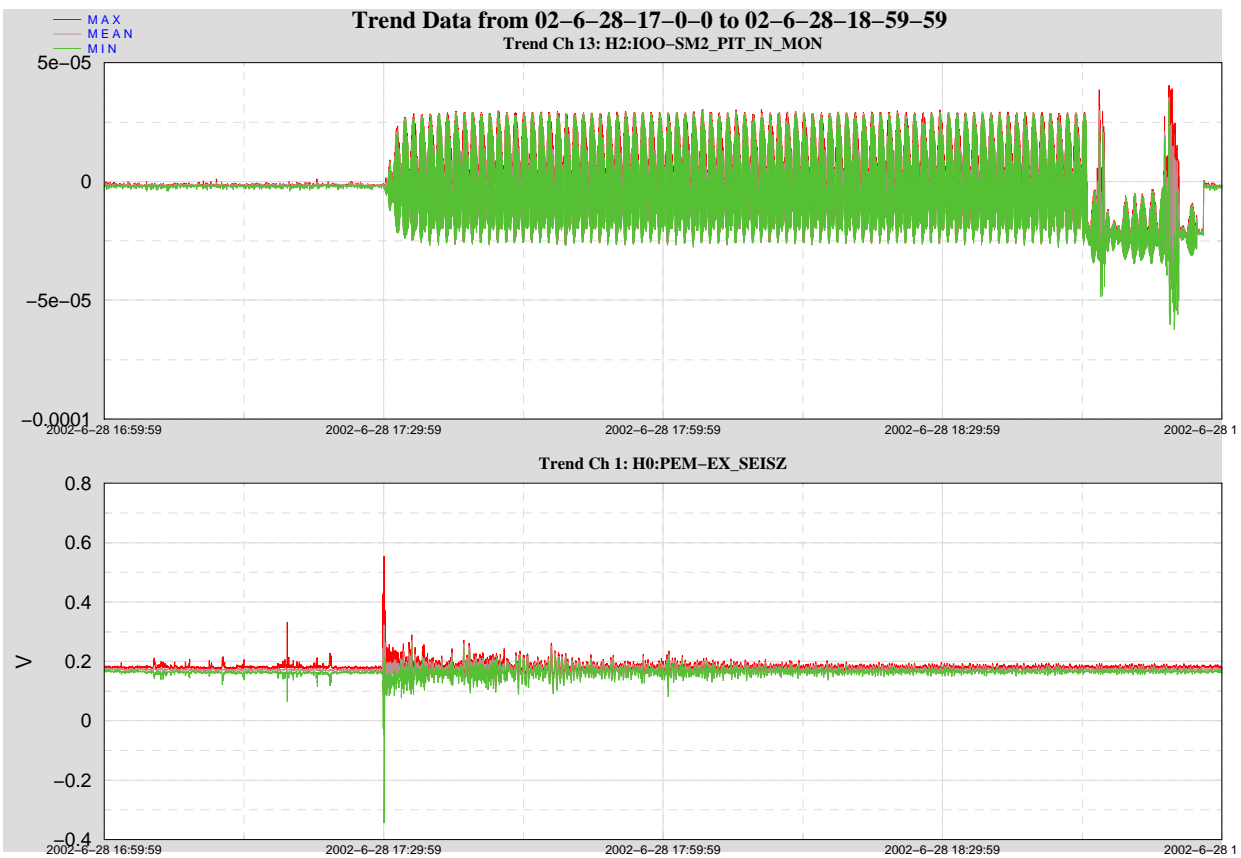
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# Quake Rings Up SM2

Same time period as shown previously for MMT2 pitch

Top: SM2 pitch; bottom: EX seismometer



Quake

Josh Quiets

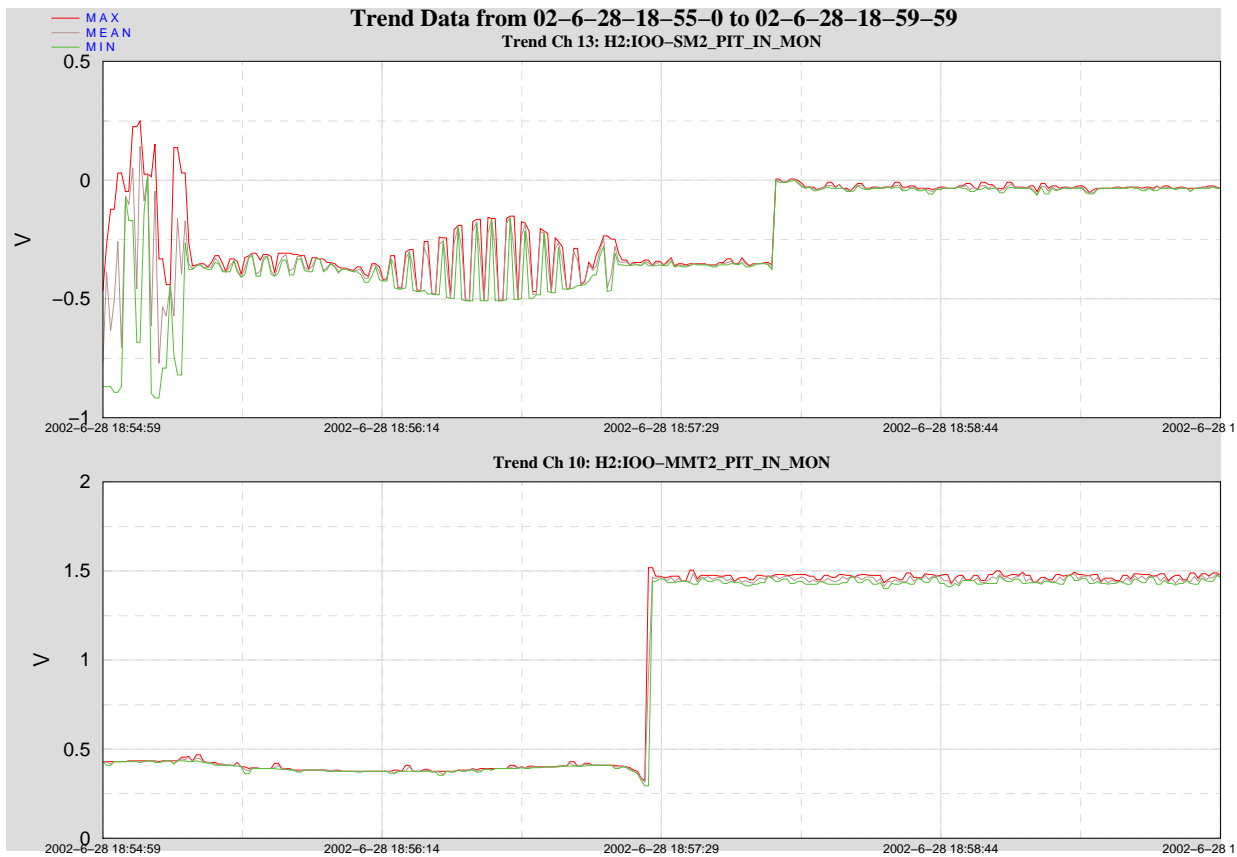
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# SM2 Pitch During Final Moments of MMT2

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.**

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## 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

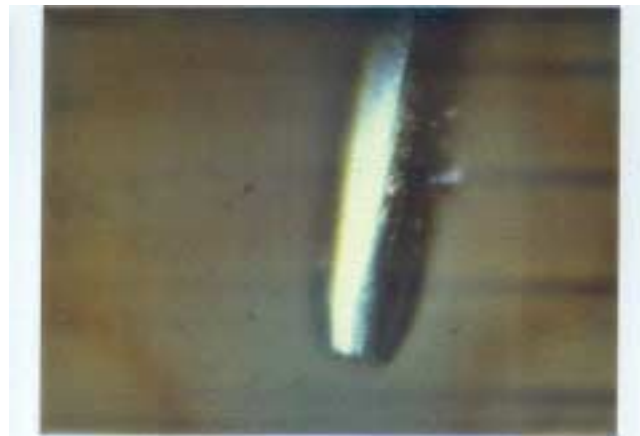
**Ends appear rounded; thin film colors near break.**

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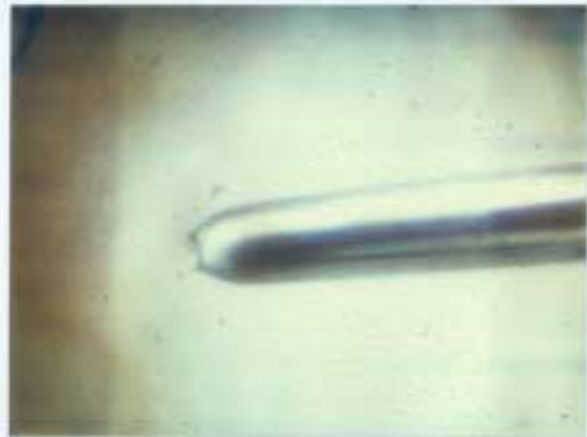
## Wires Broken Hot or Cold

**Broken at room temperature by increasing tension.**



COLD

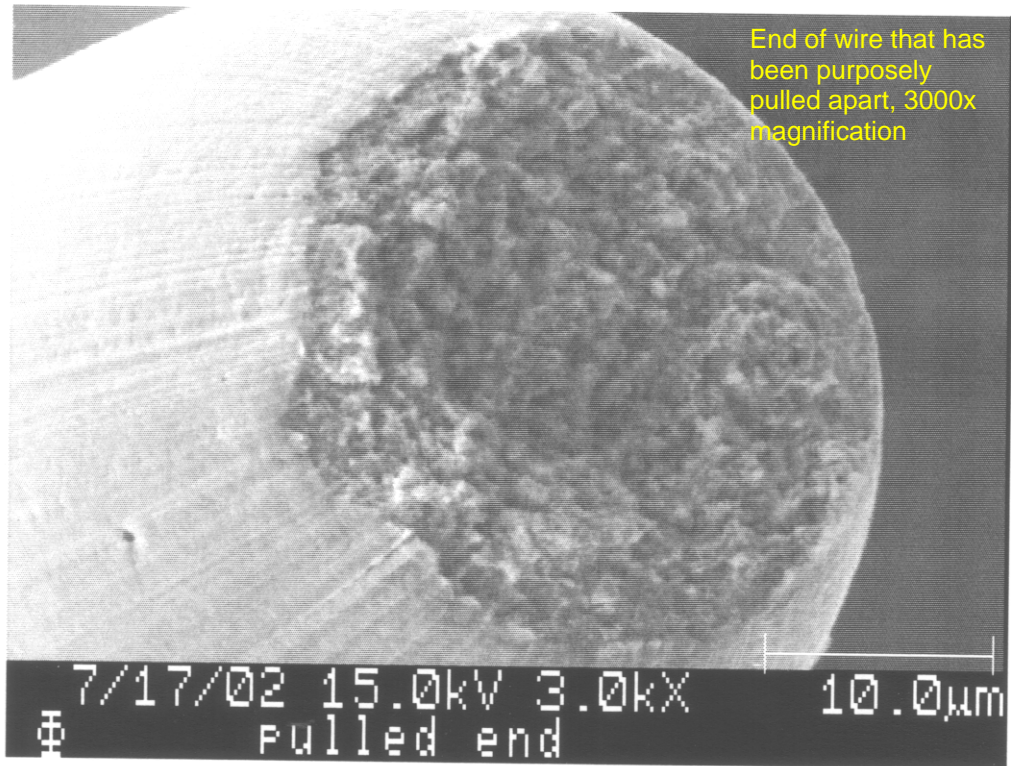
**Broken by touching with dull-red stove heating element (170 gms tension)**



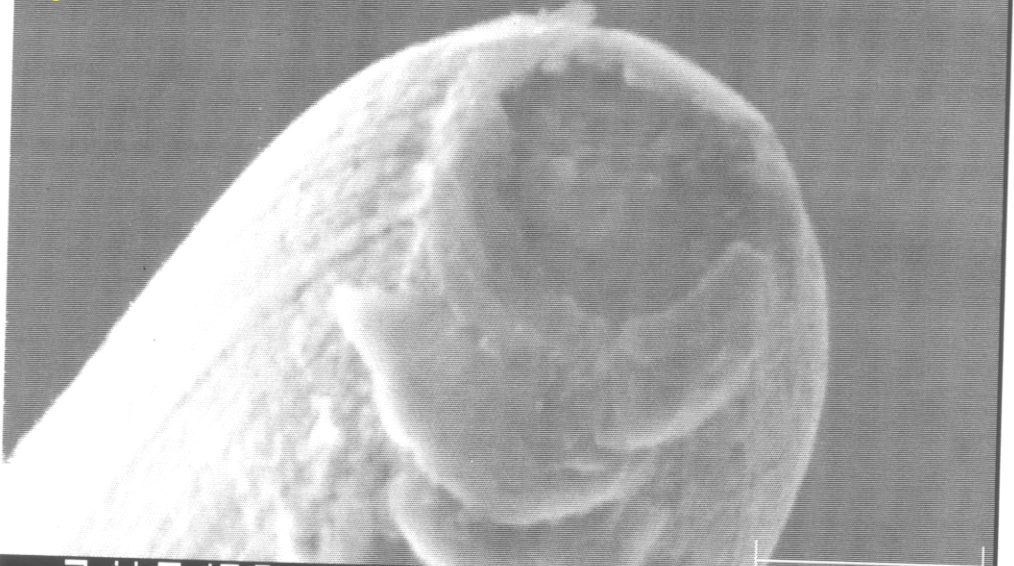
DULL RED HEATING ELEMENT

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



First end of wire that was  
broken, 3000x  
magnification



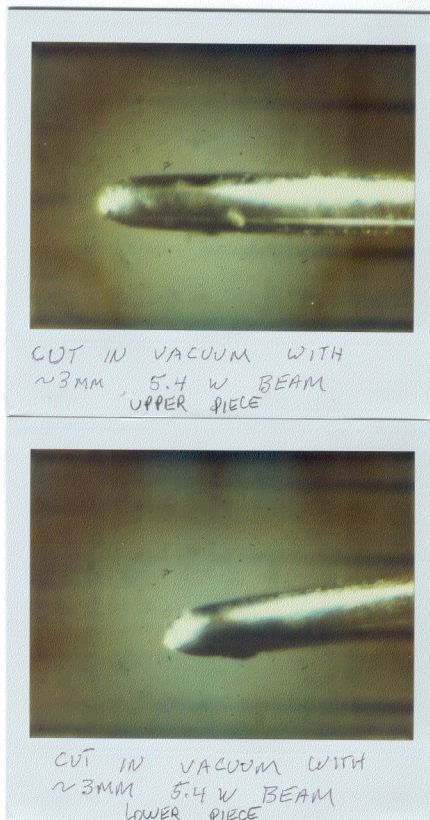
7/17/02 15.0kV 3.0kX 10.0µm  
Φ long end



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## Laser Cut in Vacuum

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



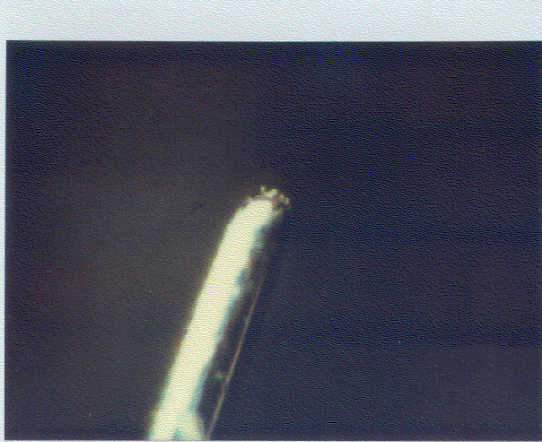
**5.4 W 3mm beam scanned  
across wire at about 1 cm/s**

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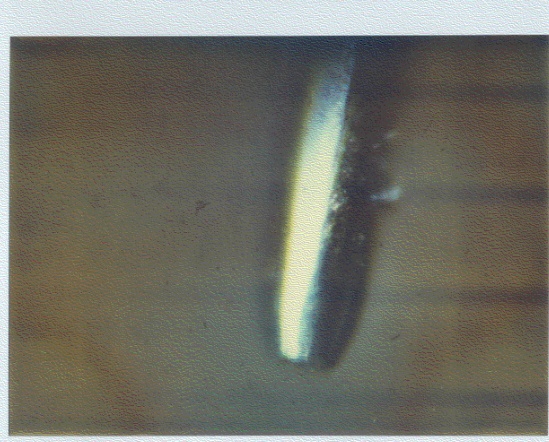
# Summary Comparison

MMT2

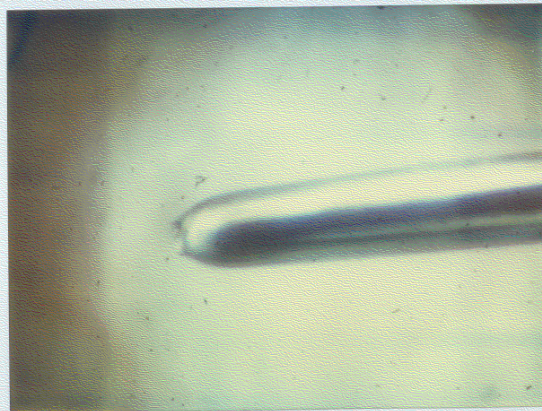
Cold



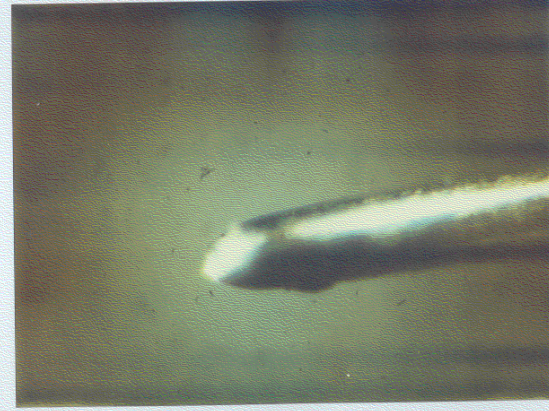
MMT2 LONG END



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.**

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## **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**

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# 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	ShutDown	Disable	Enable
					Normal	Disable	Enable
						Disable	Enable
						Disable	Enable
MMT1	0.3 mV	0.0 mV	0.0 mV	50	ShutDown	Disable	Enable
					Normal	Disable	Enable
						Disable	Enable
						Disable	Enable

50 Nominal operating limit

**4k Mode Cleaner**

MC LOCK

Length Path: ON/OFF | MC Lock: Disable | VCO Input: INTERNAL

Enable |  Enable |  WIDE BAND

**Resumption of Mode Cleaner Lock**

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

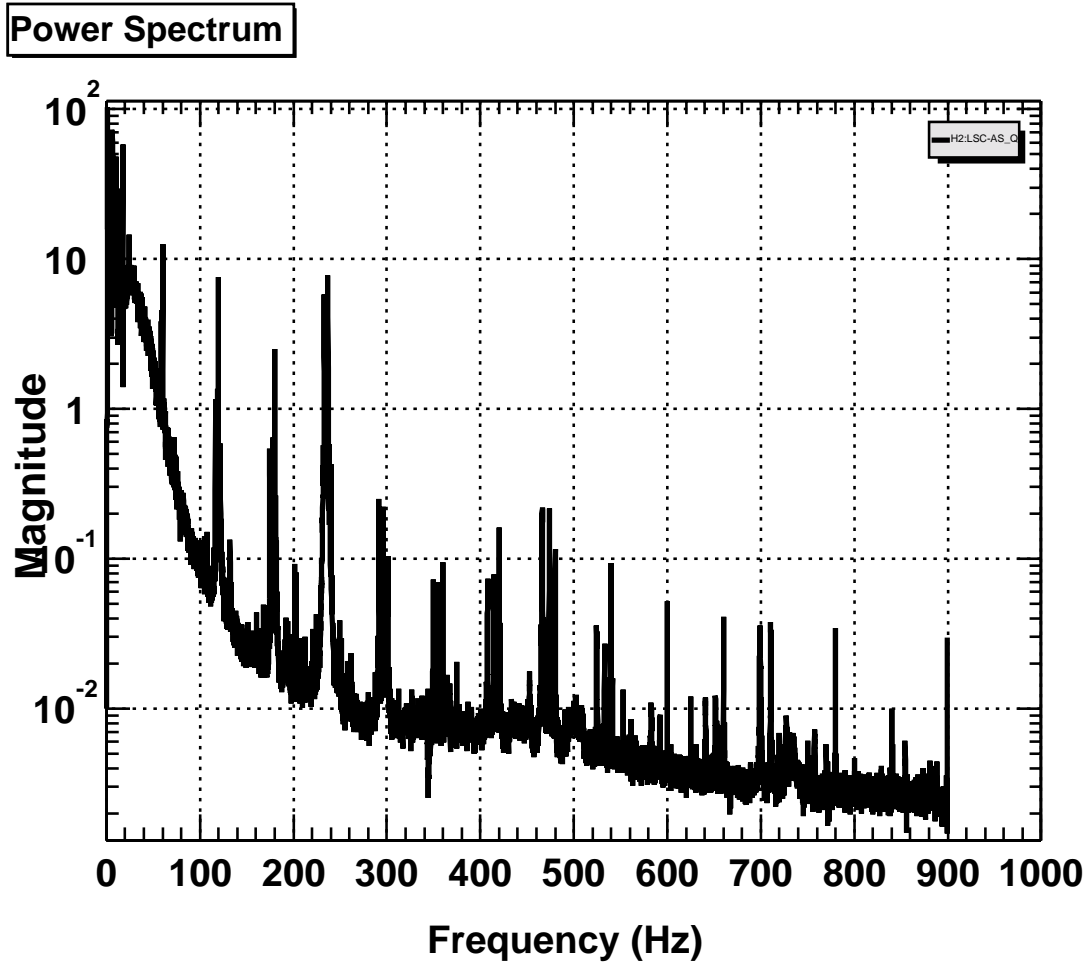
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# Fans That Show Up on the GW Channel



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# A Forest of Peaks in AS\_Q



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

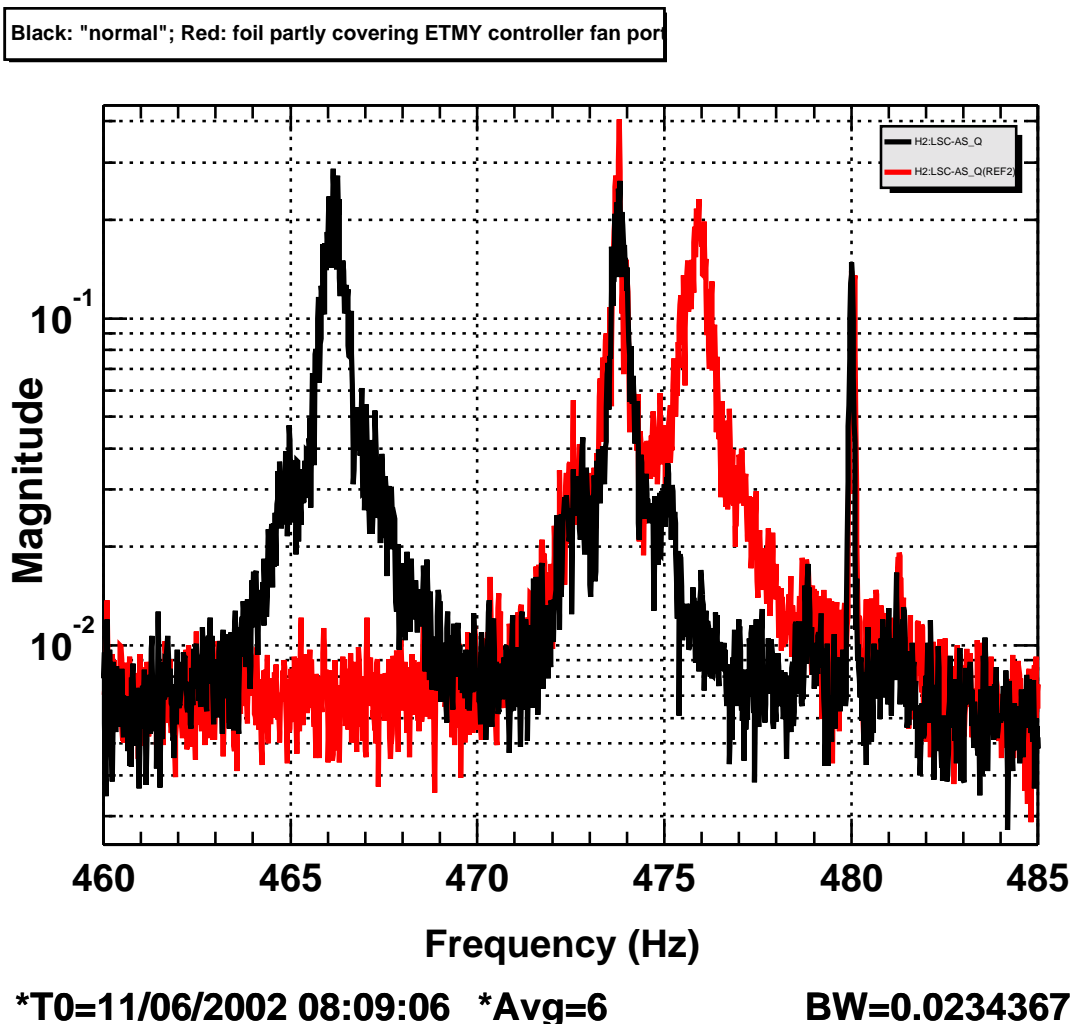
BW=0.0234367

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# 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

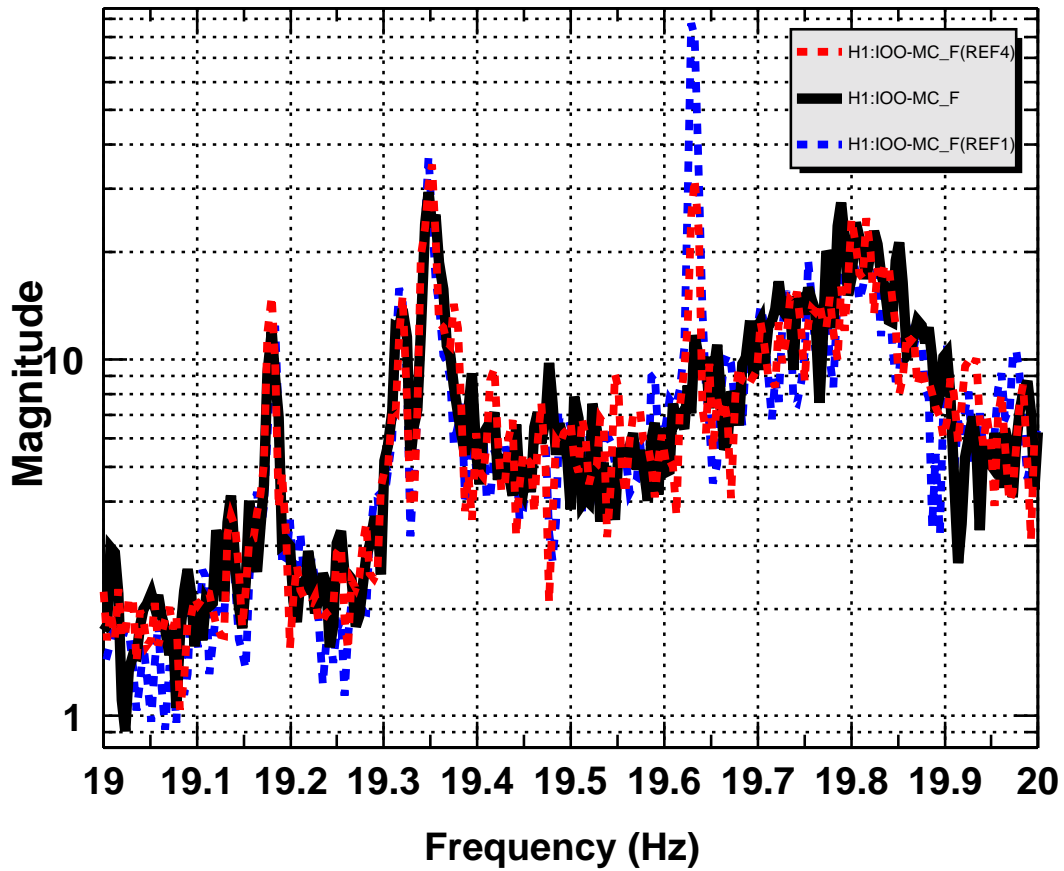
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# Hood Fans Responsible for 19.6 Hz Peak

“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

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# Hood Fans Responsible for 19.6 Hz Peak

**One of the two culprits:**

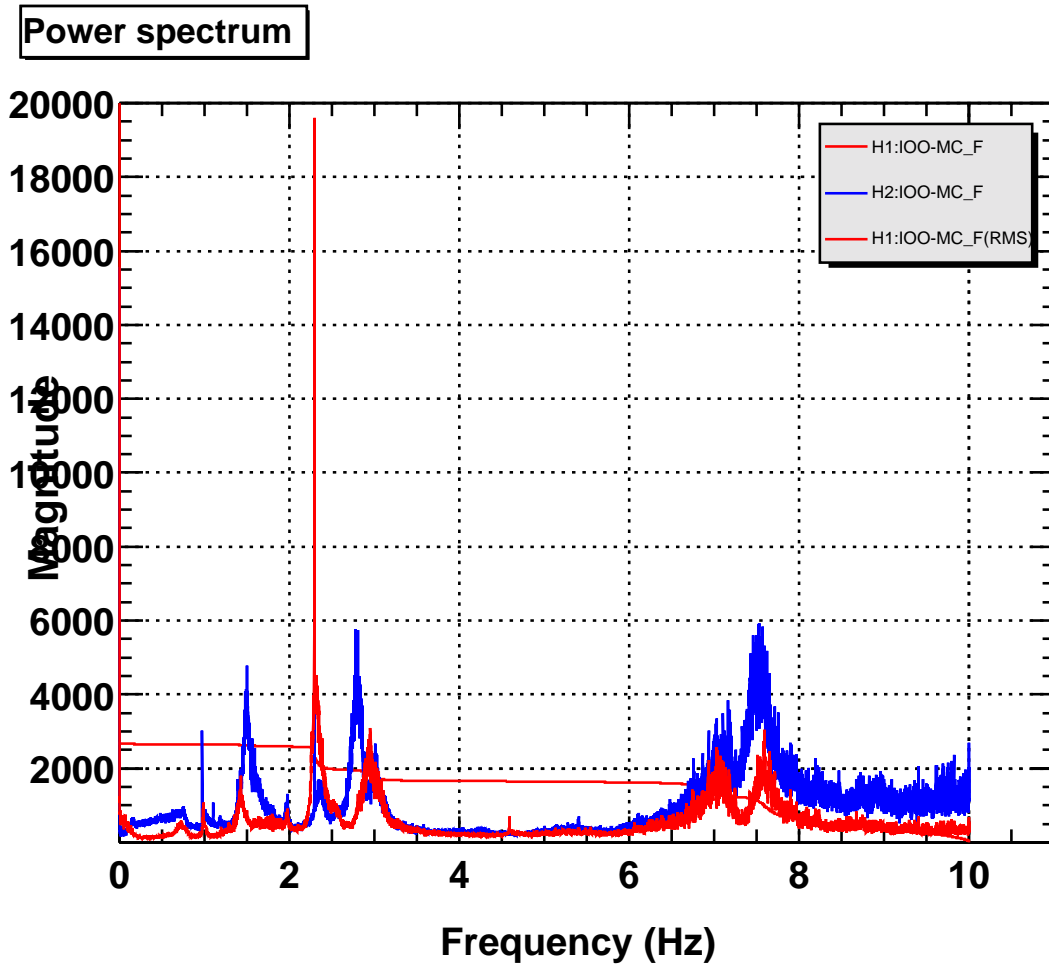


**The solution:**



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**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.**

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# 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.**

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**Inside the giant swamp-cooler;**



**motor shaft, gearbox and 30 ft. diameter blade.**

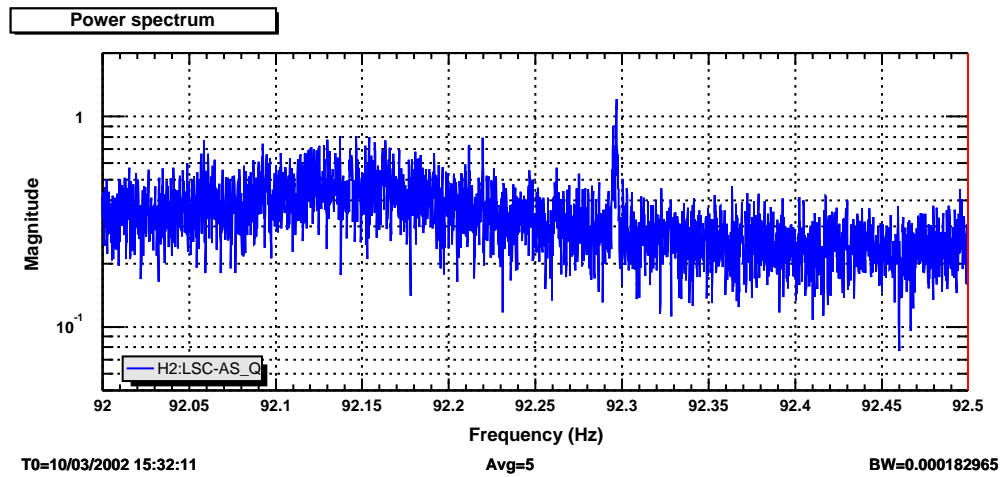


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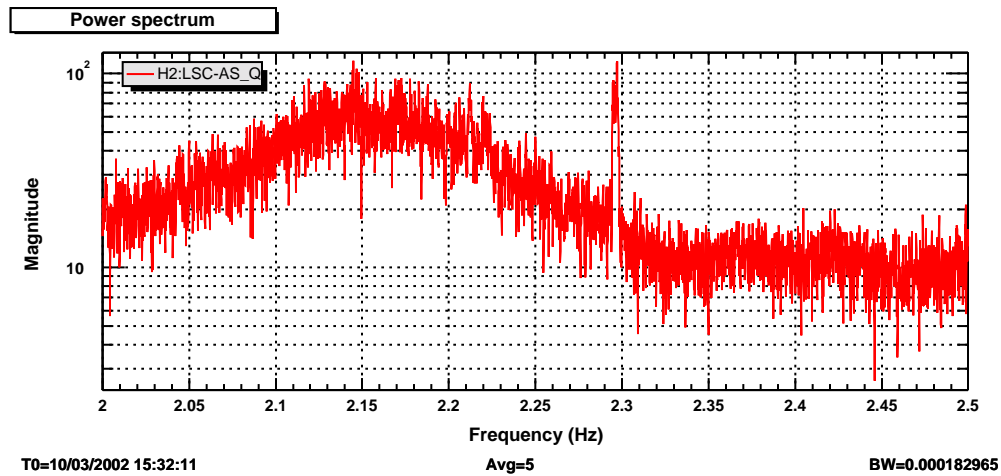
# Upconversion of Cooling Tower Fan Peak

sideband on 90 Hz injected peak

The peak at 92.295 Hz



The peak at 2.295 Hz

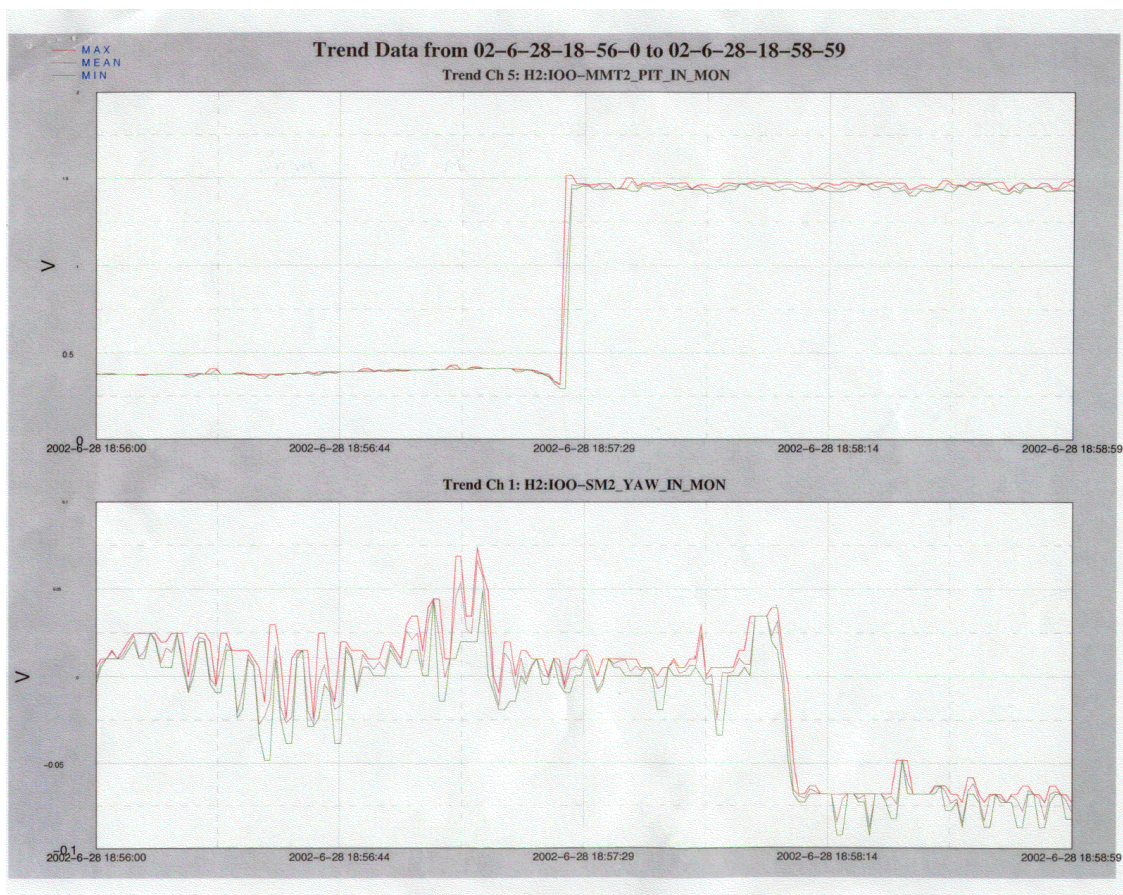


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# Bonus slide: SM2 Yaw During Final Moments of MMT2

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

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