

**SLOW GROUND MOTION MEASUREMENTS IN  
MI-8 TUNNEL AND AURORA MINE FOR  
FERMILAB FUTURE COLLIDERS**

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Conco-Western mine, Galena-Plattville dolomite  
Aurora, IL since 1992



# Objectives for Aurora mine experiments:

\* 10/1999 - 10/2001: GM measurements in IL dolomite, depth ~300 ft  
 $\Delta L = 30 - 210 \text{ m}$ ,  $\Delta T_{\text{max}} \sim 2 \text{ days}$  (btw. blasts)

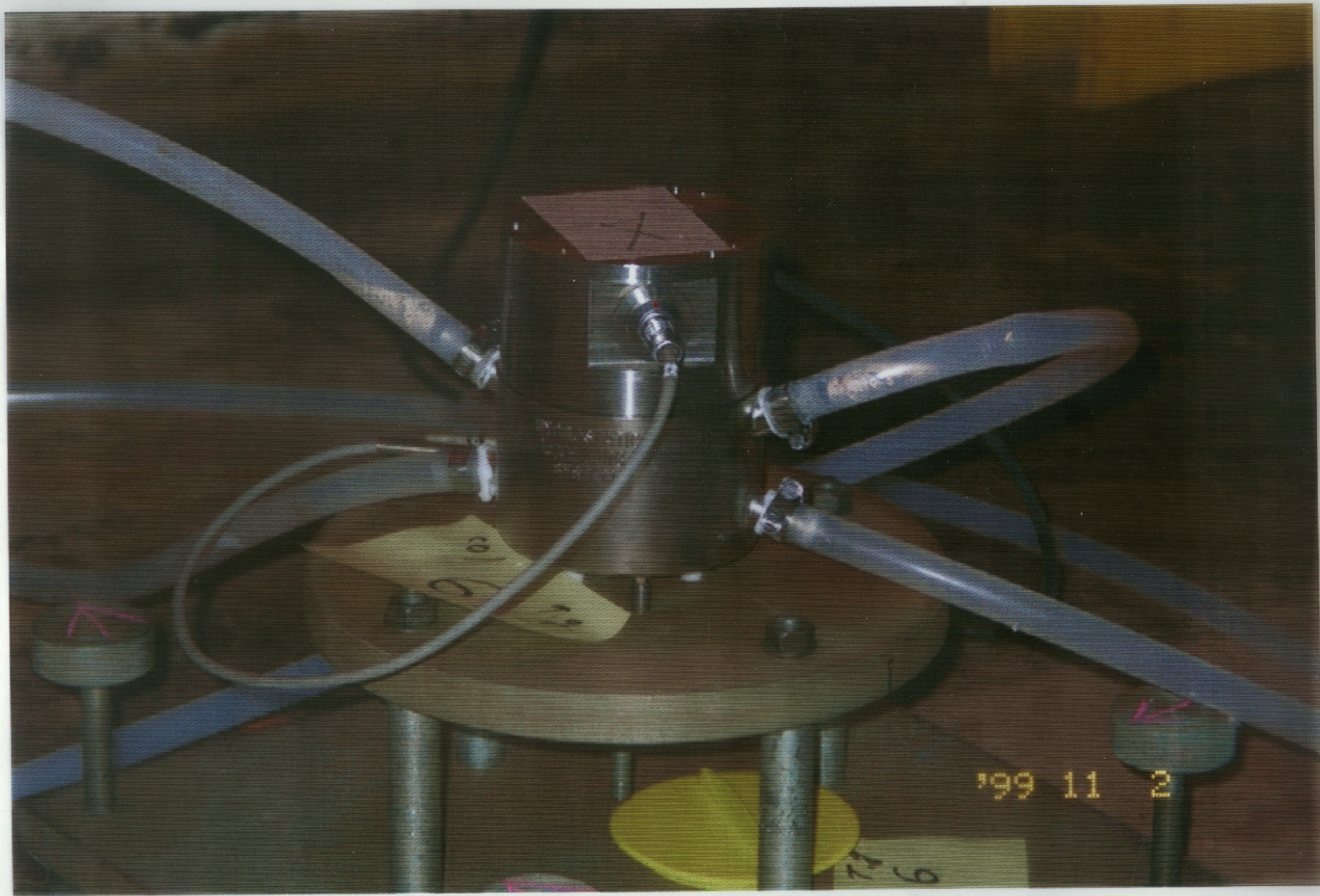
Summary (PAC'01): GM = Linear drifts (real?)  $1 - 3 \mu\text{m/day} @ 210 \text{ m}$   
 +  $T^\circ$  drifts (real?)  $\sim 15 \mu\text{m}/^\circ\text{C} @ 210 \text{ m}$   
 + ATL:  $A = (6 \pm 3) \cdot 10^{-7} \frac{\mu\text{m}^2}{\text{m} \cdot \text{s}}$ ;  $\Delta L \approx 30 - 90 \text{ m}$   
 $\Delta T \sim \text{min} \rightarrow 2 \text{ days}$

\* 10/2001 - present: Comparison of two types of HLS  
 GM measurements

	FOGALE	SAS
MANUFACTURER	NANOTECH, FRANCE	BINP, NOVOSIBIRSK
# pipes	2 (AIR, WATER)	1 (HALF FILLED)
$\phi$	$\frac{1}{2}''$	1''
electronics noise	$\approx 1 \mu\text{m}^2$ per day $\sim 0.03 \mu\text{m}^2$ per hr	$(\frac{1}{8} - \frac{1}{20}) \times \text{FOGALE}$
Temperature sensitivity in Aurora ( $L = 30 \text{ m}$ ; HLS + GROUND)	+ 14 $\mu\text{m}/^\circ\text{C}$	6 $\mu\text{m}/^\circ\text{C}$
MIN response time	< 2 min @ 30 m	same or a bit longer? (to be studied)
GM: tides	$\sim 2 \mu\text{m}$ P.P	$\sim 2 \mu\text{m}$ P.P
(linear + $T^\circ$ ) drifts	$\sim 1 \mu\text{m/day}$	small (?)
ATL: ( $L = 30 \text{ m}$ $T = \text{min} \rightarrow 2 \text{ wks}$ )	$8 \cdot 10^{-7} \frac{\mu\text{m}^2}{\text{m} \cdot \text{s}}$	$\sim 3 \cdot 10^{-7}$



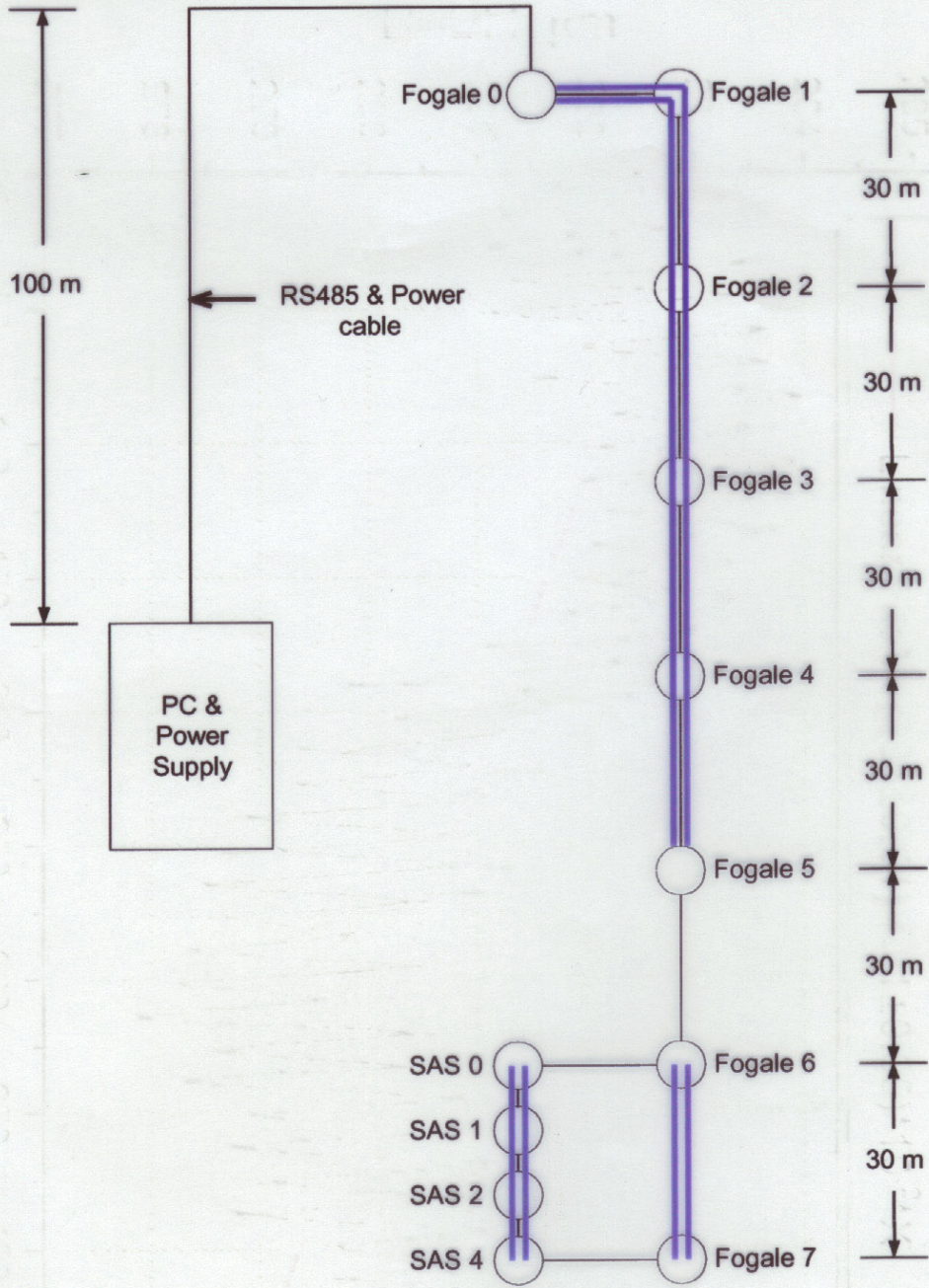
# Fogale Nanotech Hydrostatic Level System



HLS Noise  $\sim 0.45 \frac{\mu\text{m}}{\text{min}}$  under (closed) room T conditions

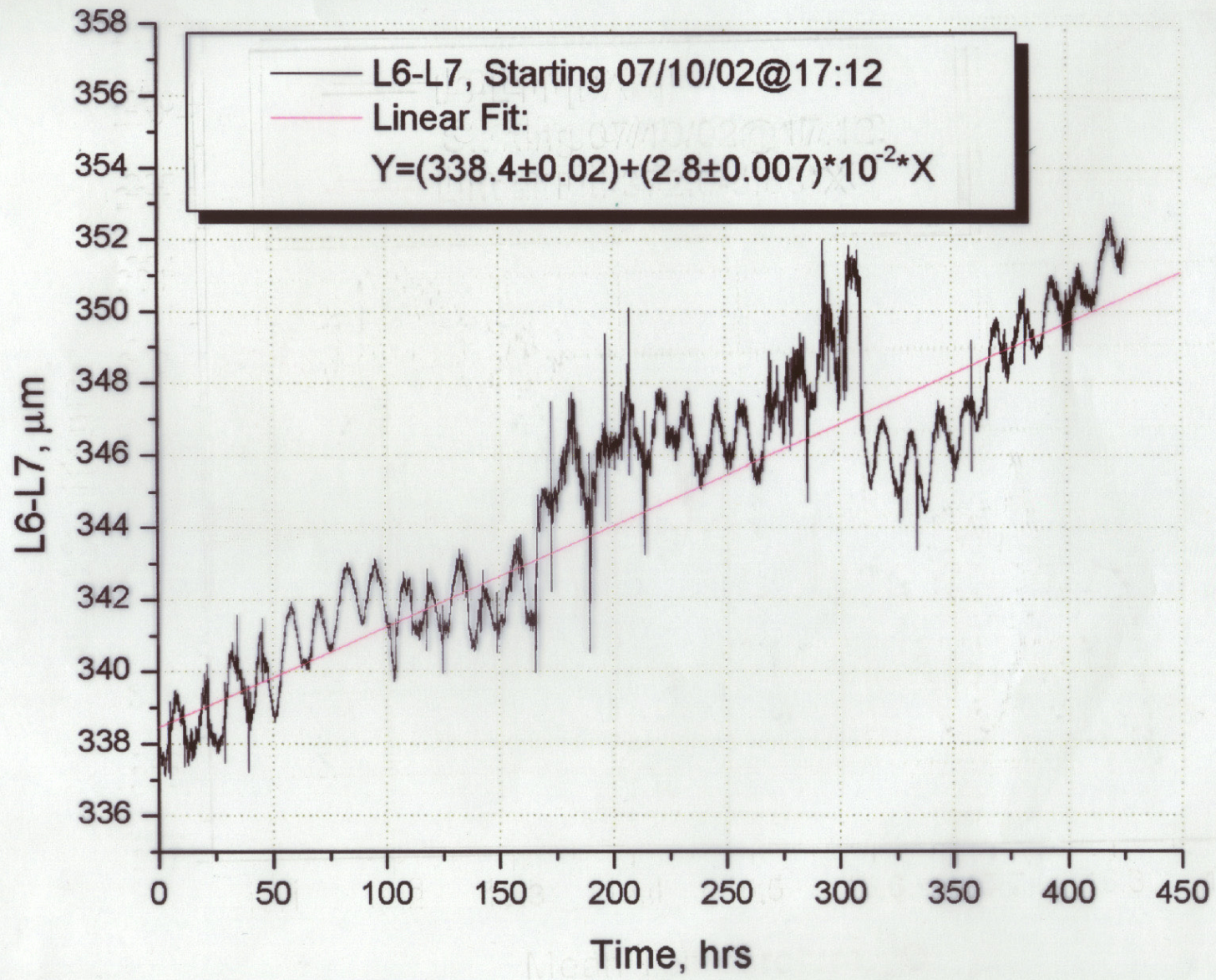


Aurora



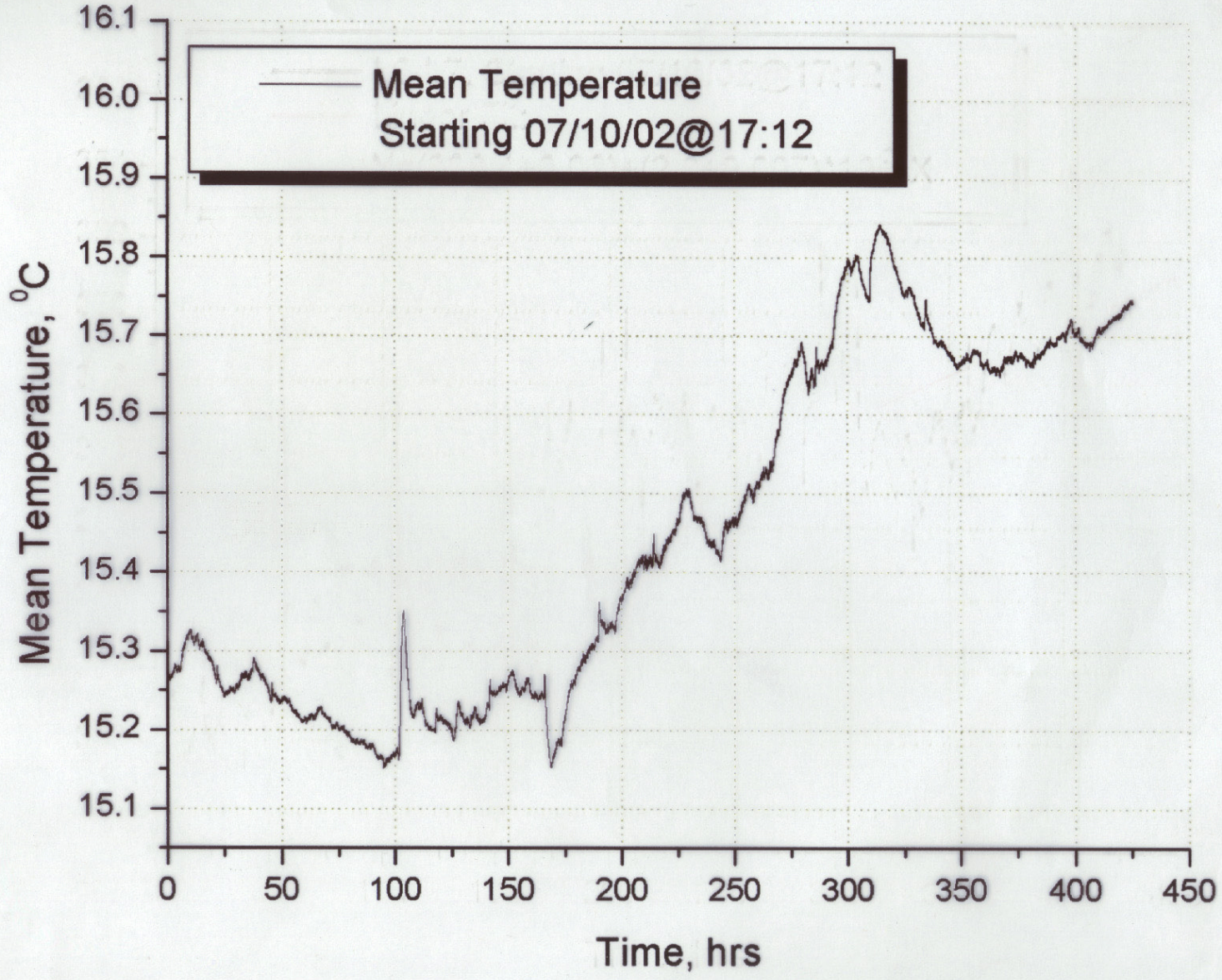


Aurora

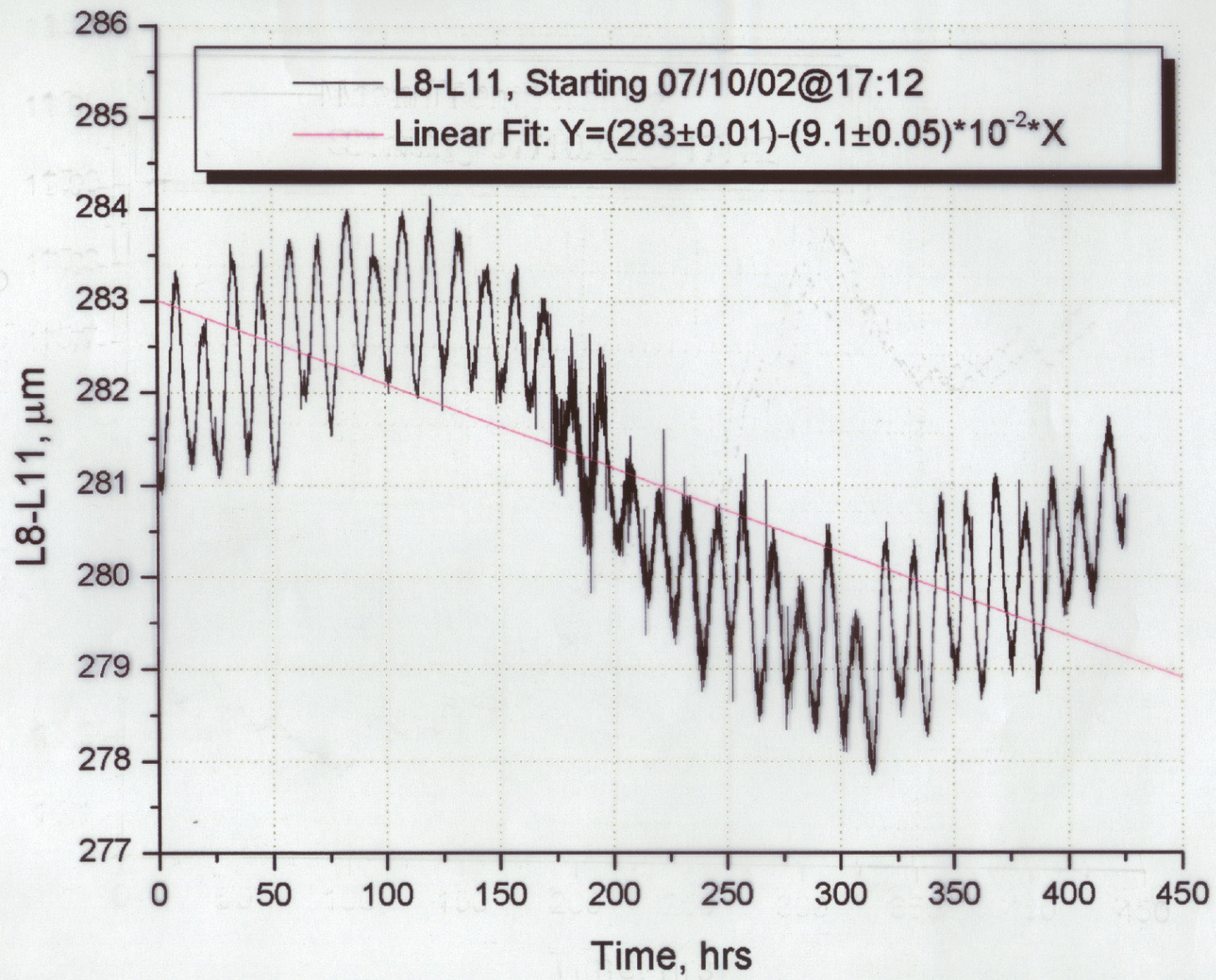




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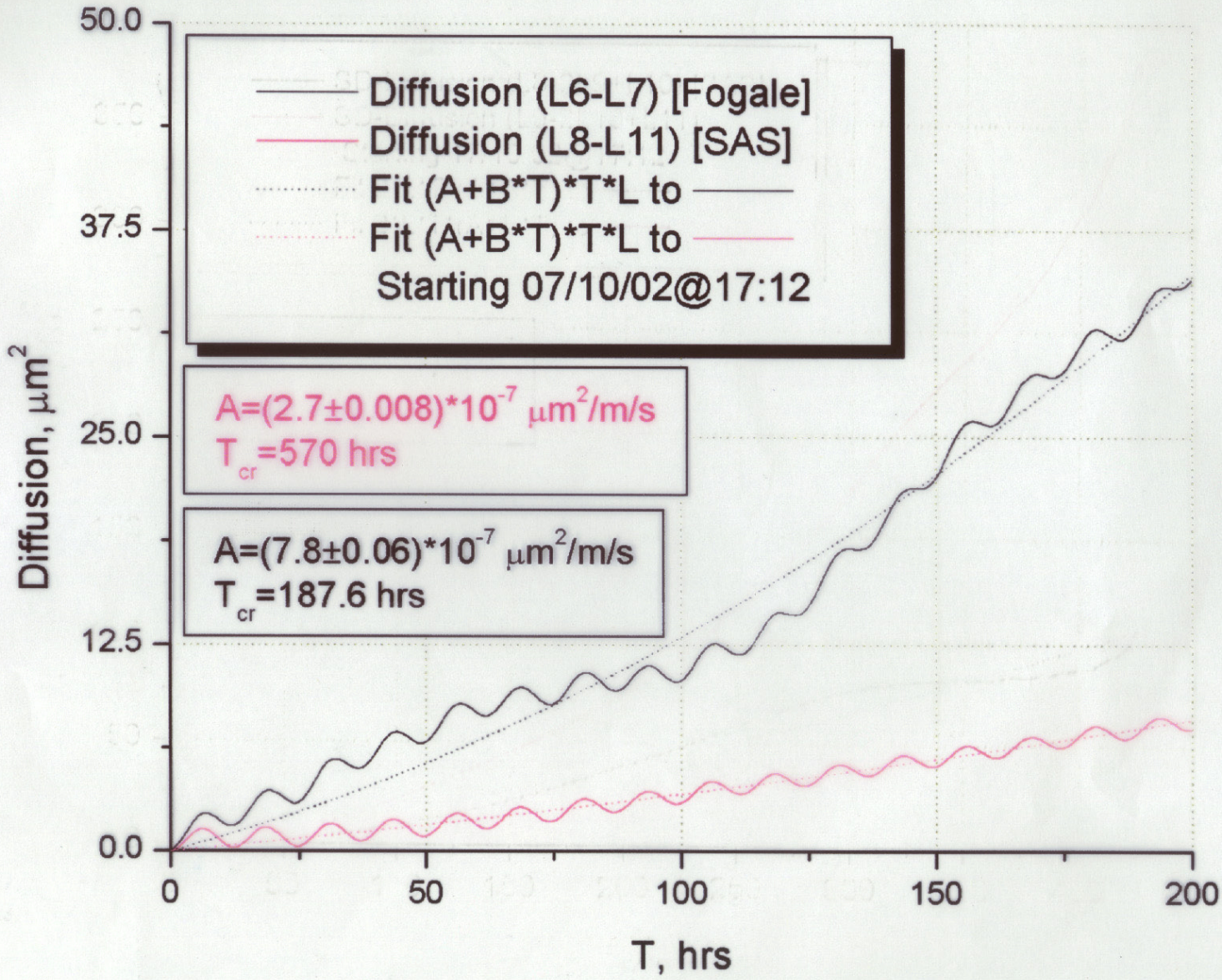




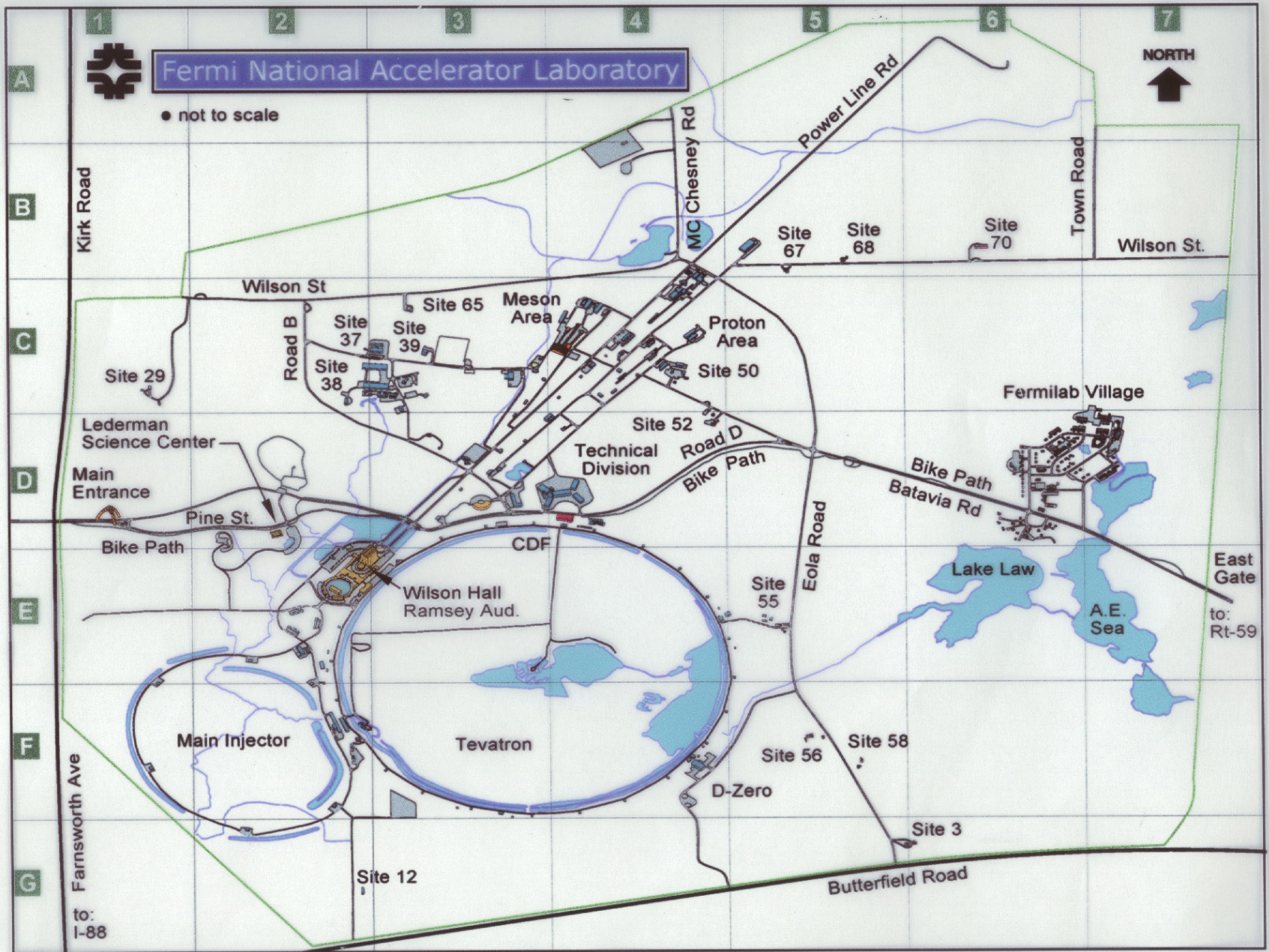




$$\Delta Y^2(T) = \langle (Y(t+T) - Y(t))^2 \rangle$$



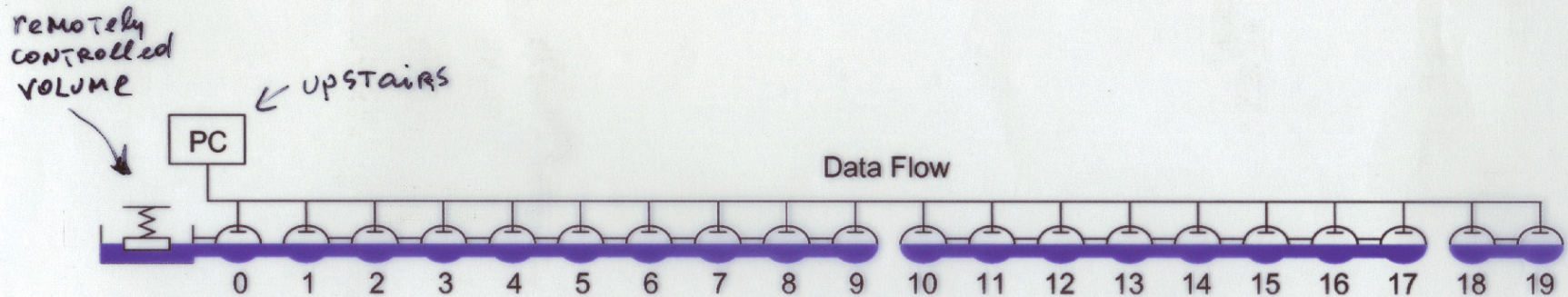






# Since 10/2001: Measurements in MI-8 line TUNNEL:

- Goals:
- \* G M measurements WITH LARGER STATISTICS in space ( $\Delta L = 15m \times 20$  PROBES)  $\leftarrow$  SAS type
  - \* in a "typical" cut-and-cover TUNNEL
  - \* OBSERVE SETTLEMENT of THE  $\sim 5$ yr OLD TUNNEL



Problems: \* till  $\sim$  March '02: sensors died due to RADIATION level in several locations ( $\sim 1$  probe / MONTH)  $\leftarrow$  fixed

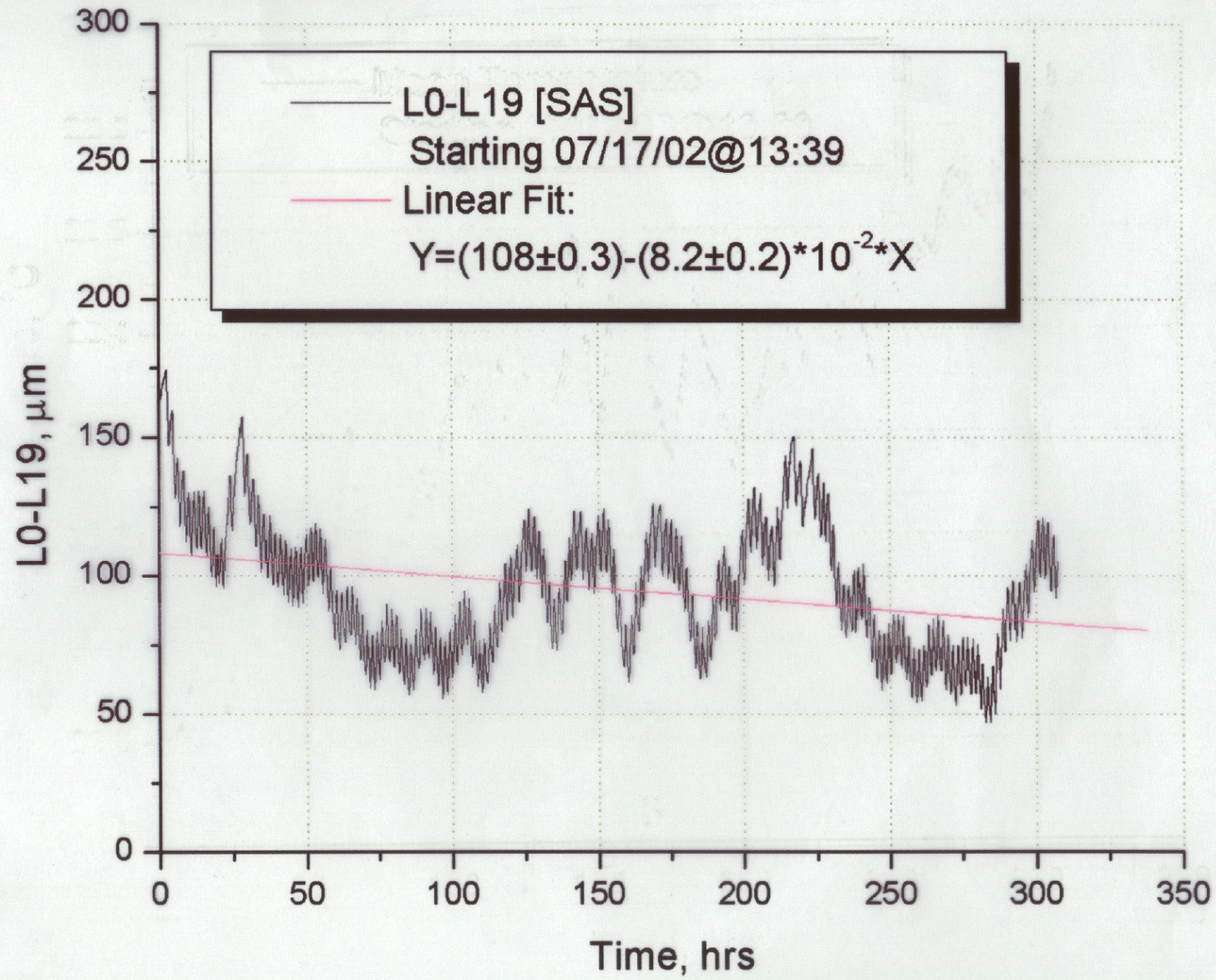
\* till Aug 29, 2002: large (10-20  $\mu m$ ) oscillations with period  $\sim 2$  hr  
 $\rightarrow$  July '02 system 'broken' (devised) in 3 parts  $\leftarrow$  did not help  
... 08/29/02 FOUND WATER PUMP IN ANOTHER TUNNEL affecting the HLS system  $\rightarrow$  INVESTIGATING why and how to remove it



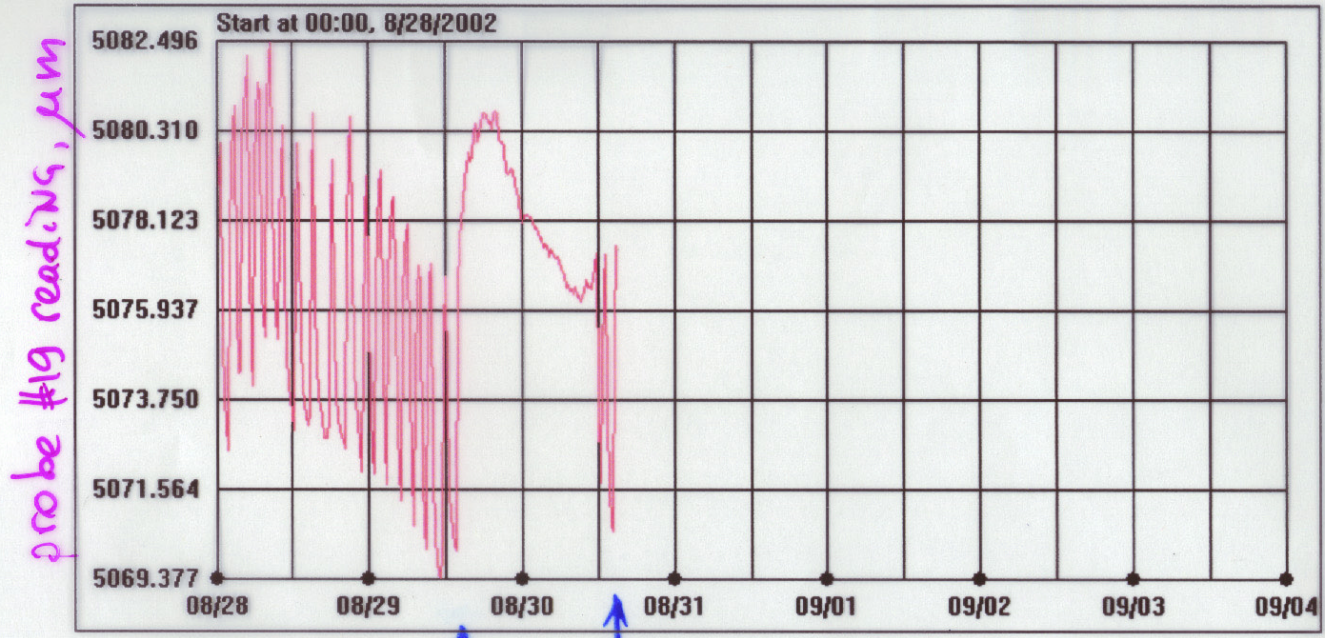




M18





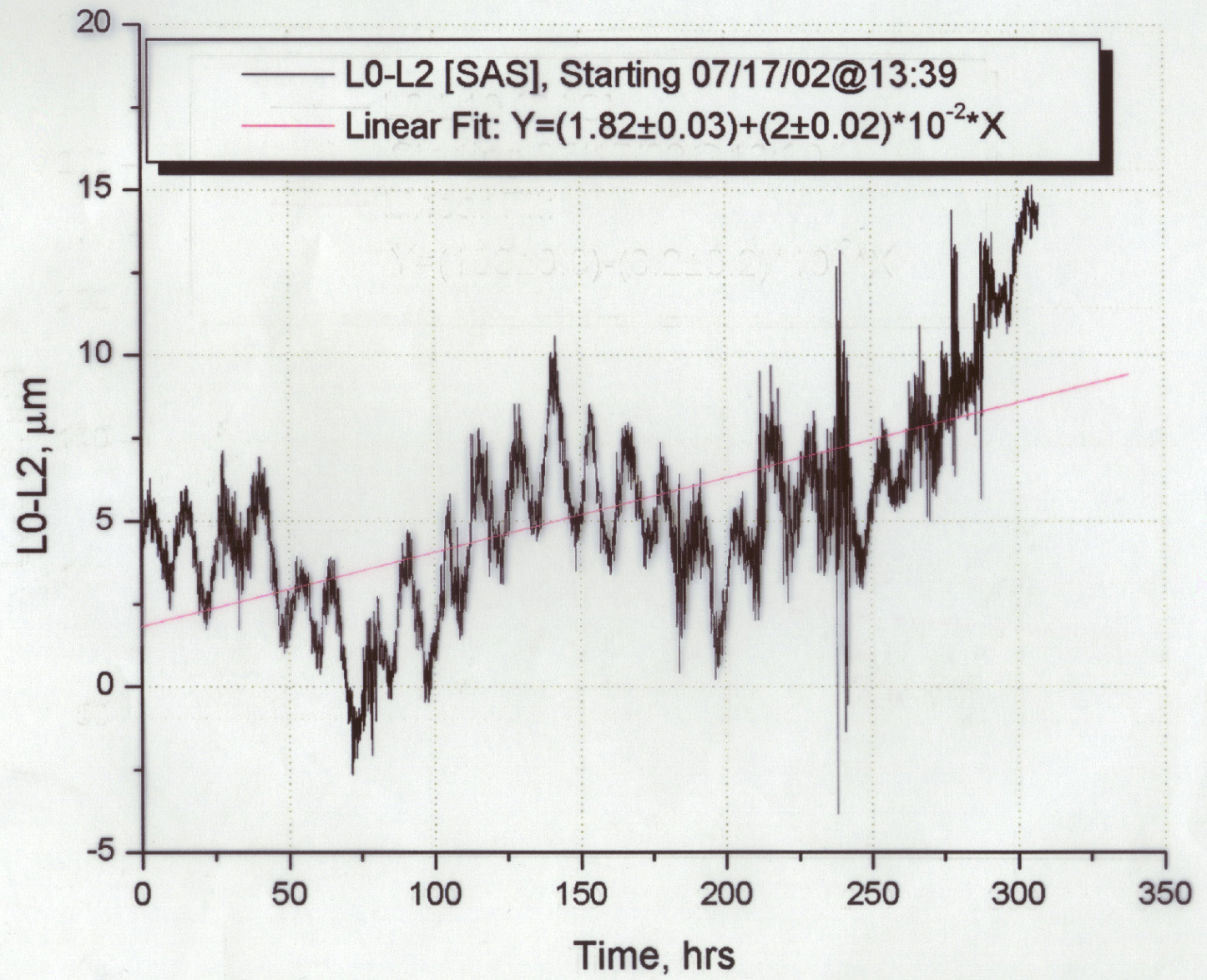


probe #19 readings, µm

↑  
OFF  
↑  
ON  
THE PUMP

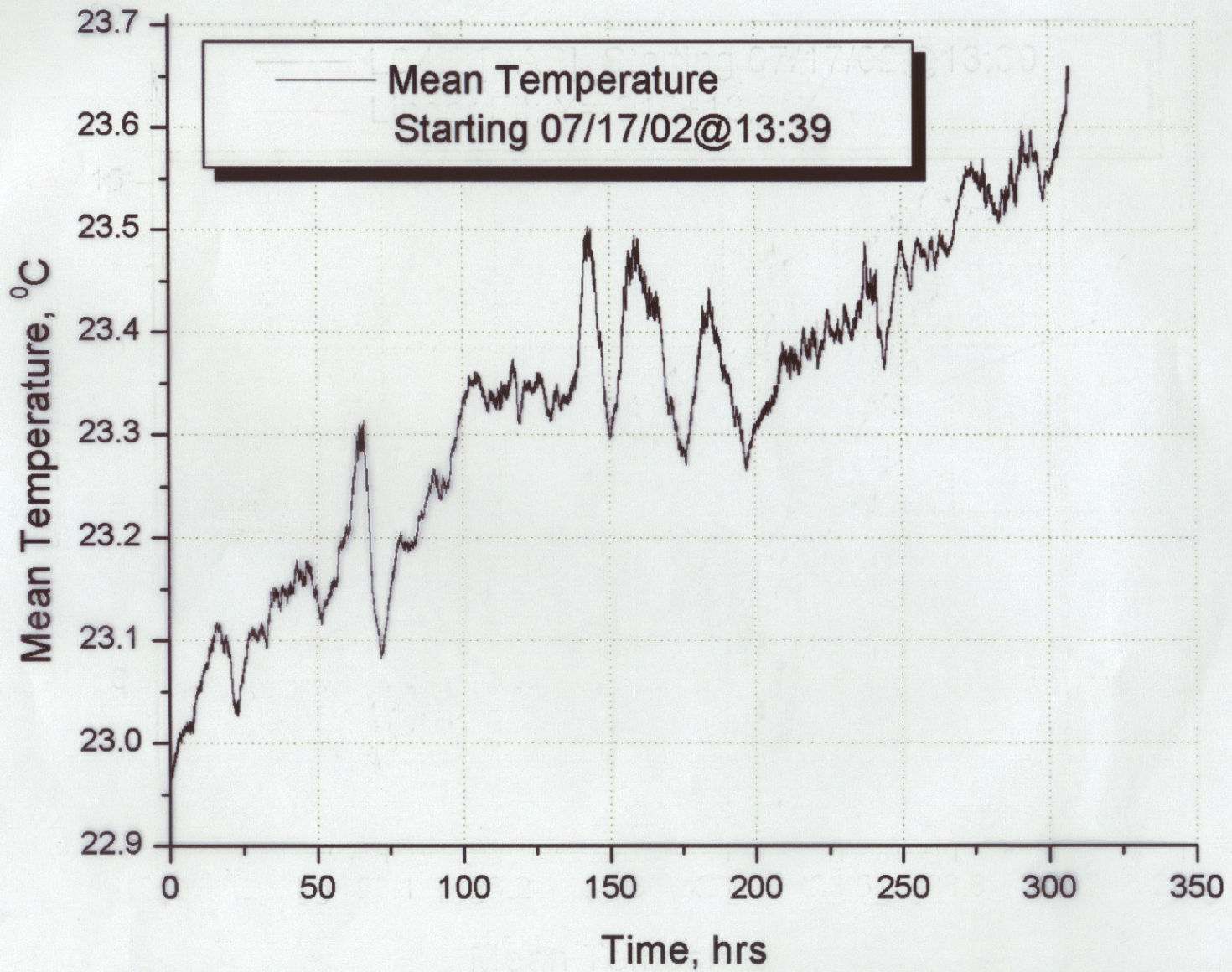


MI8





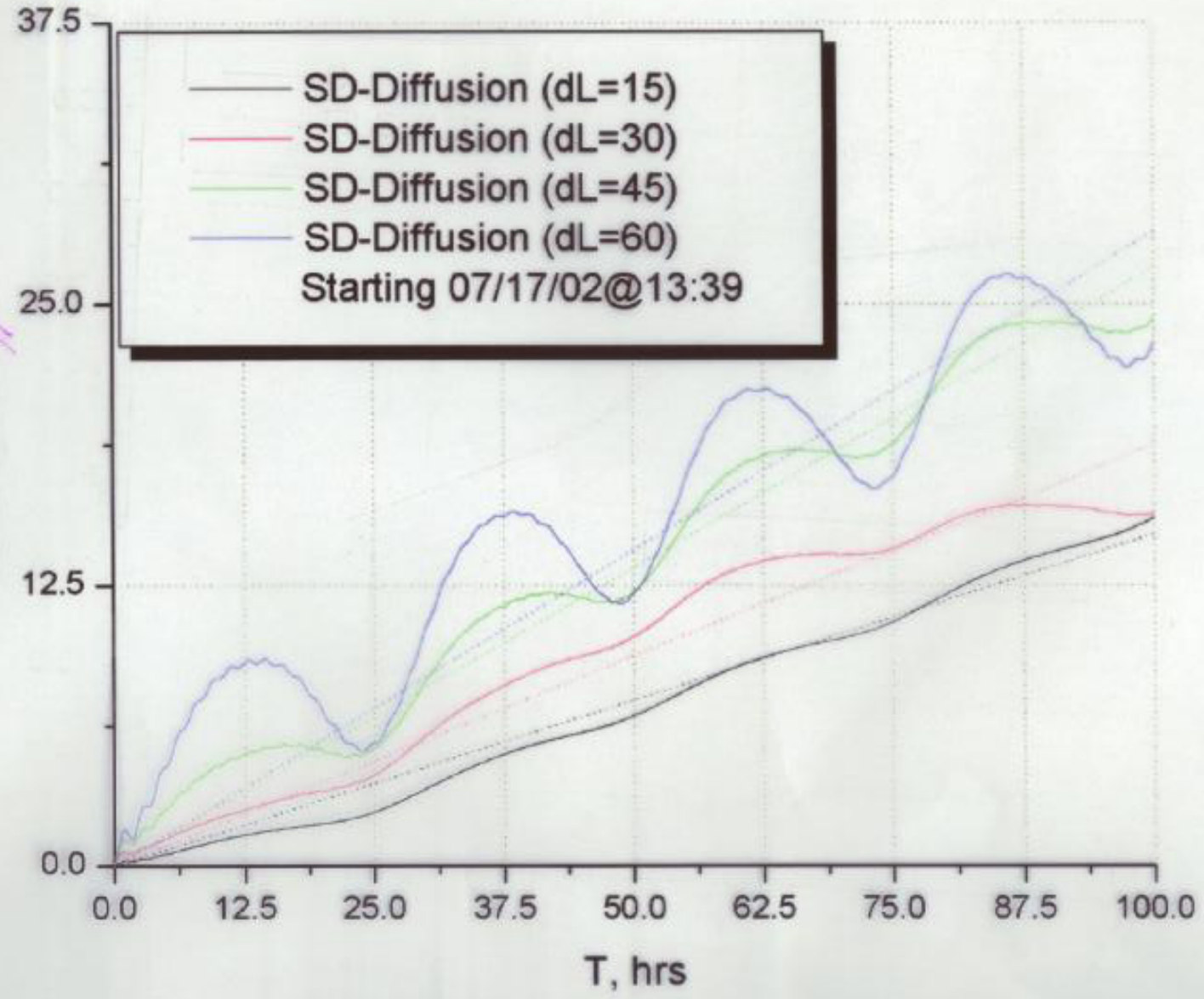
MLB



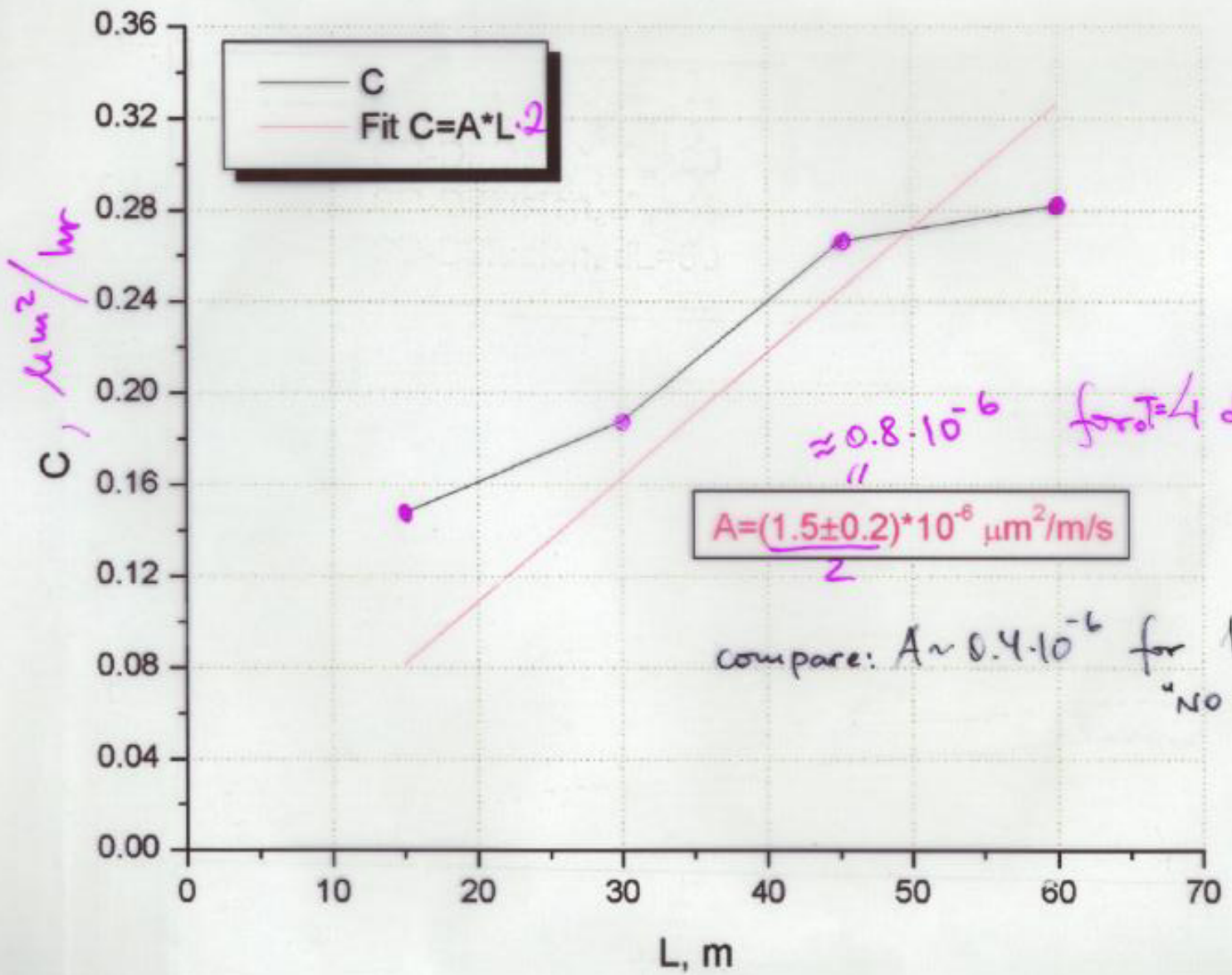


M18

$\Delta Y^2(\tau)$









M18

