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Exp #174

# Analysis of Tevatron Vacuum Resilience to Valved Turbo Pumps at B2

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Experiment performed : 20-Feb-1990 to 22-Mar-1990
Analysis : Joseph Longo

## I Procedure

In the Tevatron's cryostat vacuum system there are forty-eight 100 liter/sec turbomolecular pumps. These pumps are arranged two per numbered house. The purpose of this experiment was to turn off the pumps for one house and monitor the response of the vacuum. The pumps were not actually turned off but were valved out of the vacuum system by closing valves CV3U,CV3D and CV5U,CV5D (see fig. 1). The house selected was B2 due to its innocuous position and relative low quench occurrences. The vacuum was monitored via cold cathode gauges which operate in the range $10^{-3}$ to $10^{-8}$ torr. The typical operating cryostat vacuum of the Tevatron is on the order of $10^{-7}$ torr. Vacuum readings were recorded using the datalogger process running on the VAX. Using the datalogger it was possible to change the rate at which data was collected. In the plots that follow the change in resolution seen in the data for when the turbo pumps were valved out is a result of changing the reading rate of the datalogger from once every 4 minutes to once every half hour.

The cryostat vacuum valves were opened approximately 30 days into the experiment hence effectively turning back on the turbo pumps. Vacuum readings were then logged for when the pumps were working and the set of plots labeled 'B2xxx Turbo Pumps on' correspond to this data. Again the reading rate was once per half hour.

## II Analysis

The data analyzed was for B2CC1, B2CC4U, B2CC5U and B2CC8U. At house B2 there is a total of eleven cold cathode gauges. The above listed gauges are spaced well enough to give a good cross section of the vacuum for the house. The raw data consists of cold cathode gauge readings in torr v.s. time in hours. The main objective was to do a least square fit to a line and to observe the slope of this line as an indication of the vacuum's response. Before the data was submitted to the fitting program it was first submitted to a program that ensured that all the gauge readings were within a user defined range. The range selected for this experiment was $10^{-8}$ to $2\text{x}10^{-6}$ torr. The fitting program calculated the parameters of the best fit line, namely the slope and y-intercept. This slope is what is displayed on each plot. Also calculated was the correlation coefficient. Using the total number of data points and the correlation coefficient a 'probability of zero correlation' was computed using a program found in Bevington[1]. What this probability tells is if the data that gave rise to

the given correlation coefficient is completely uncorrelated. A very small value for this probability implies strongly correlated data. The probabilities calculated for the vacuum data were on the order of $10^{-4}$ this indicates an extremely high correlation for the data meaning high confidence for the fit.

One interesting result of the data reduction is that the slopes of the fitted lines for the data when the pumps were off are negative whereas those for pumps on are positive. This leads one to infer that the vacuum gets better when the pumps are valved out of the system.

## References

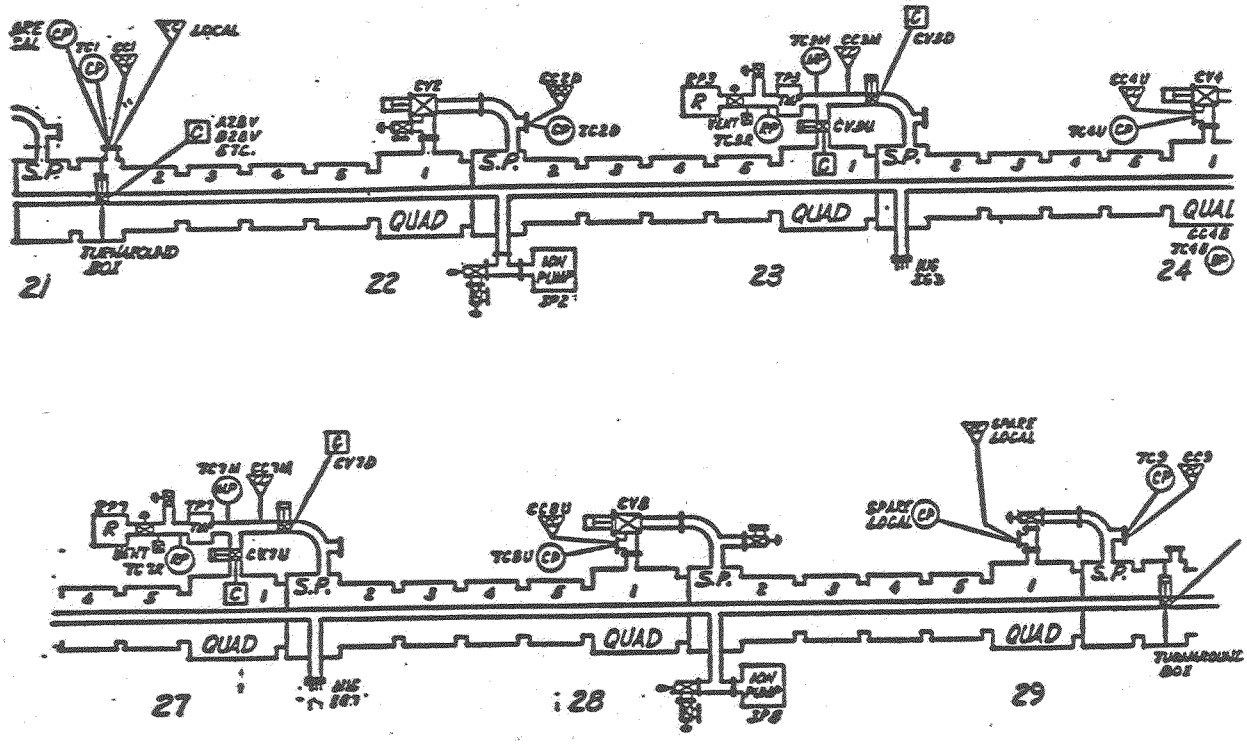

1 Bevington, Philip R. : Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill Book Company, New York, 1969.

Mandel, John : The Statistical Analysis of Experimental Data, Dover Publications, inc., New York, 1964.

Press, William H., Flannery, Brian P., Tevkolsky, Saul R., Vetterling, William T. : Numerical Recipes, Cambridge University Press, Cambridge, 1986.

Taylor, John R : An Introduction to Error Analysis, University Science Books, Mill Valley, California, 1982.

figure 1







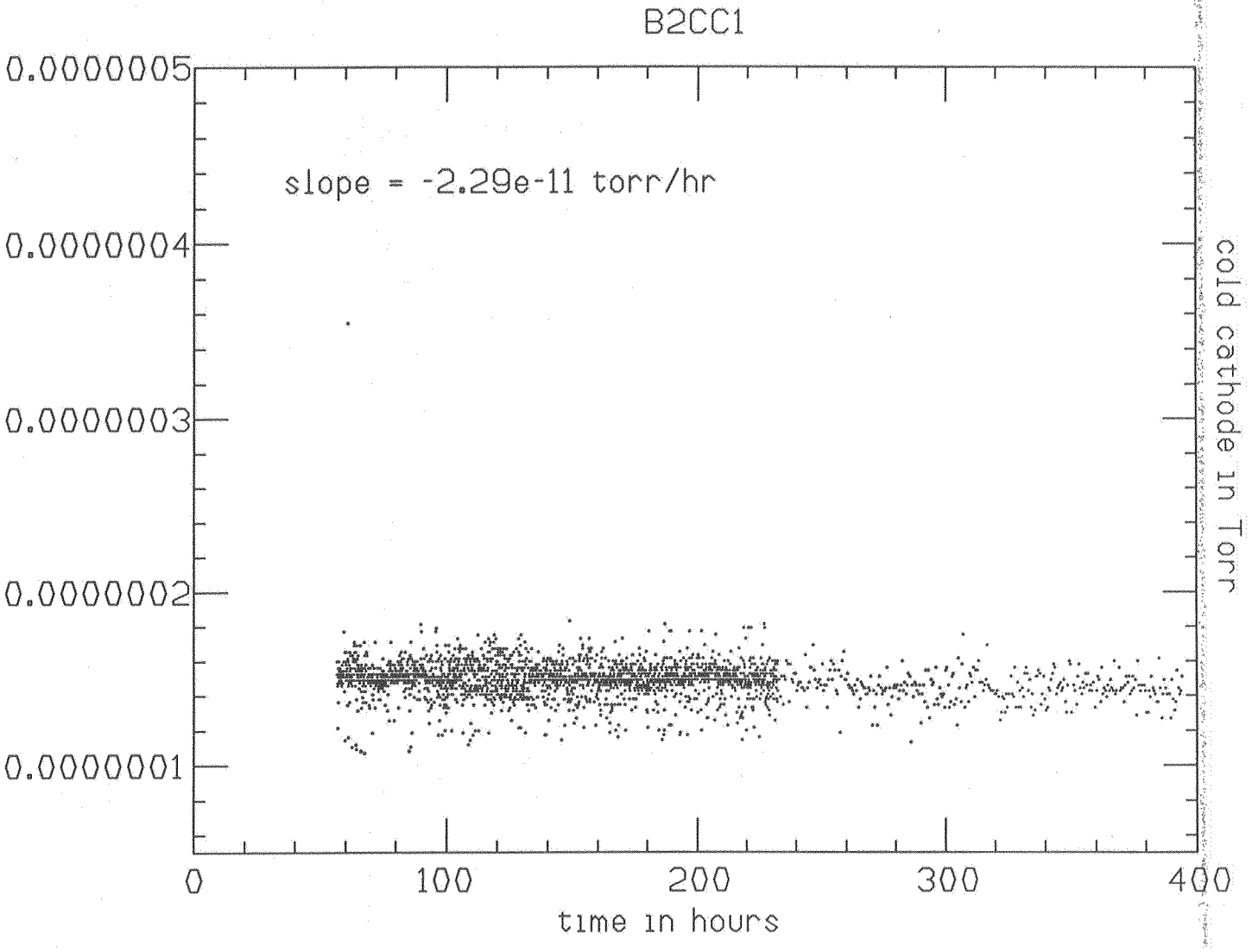
SP - SPOOL PIECE

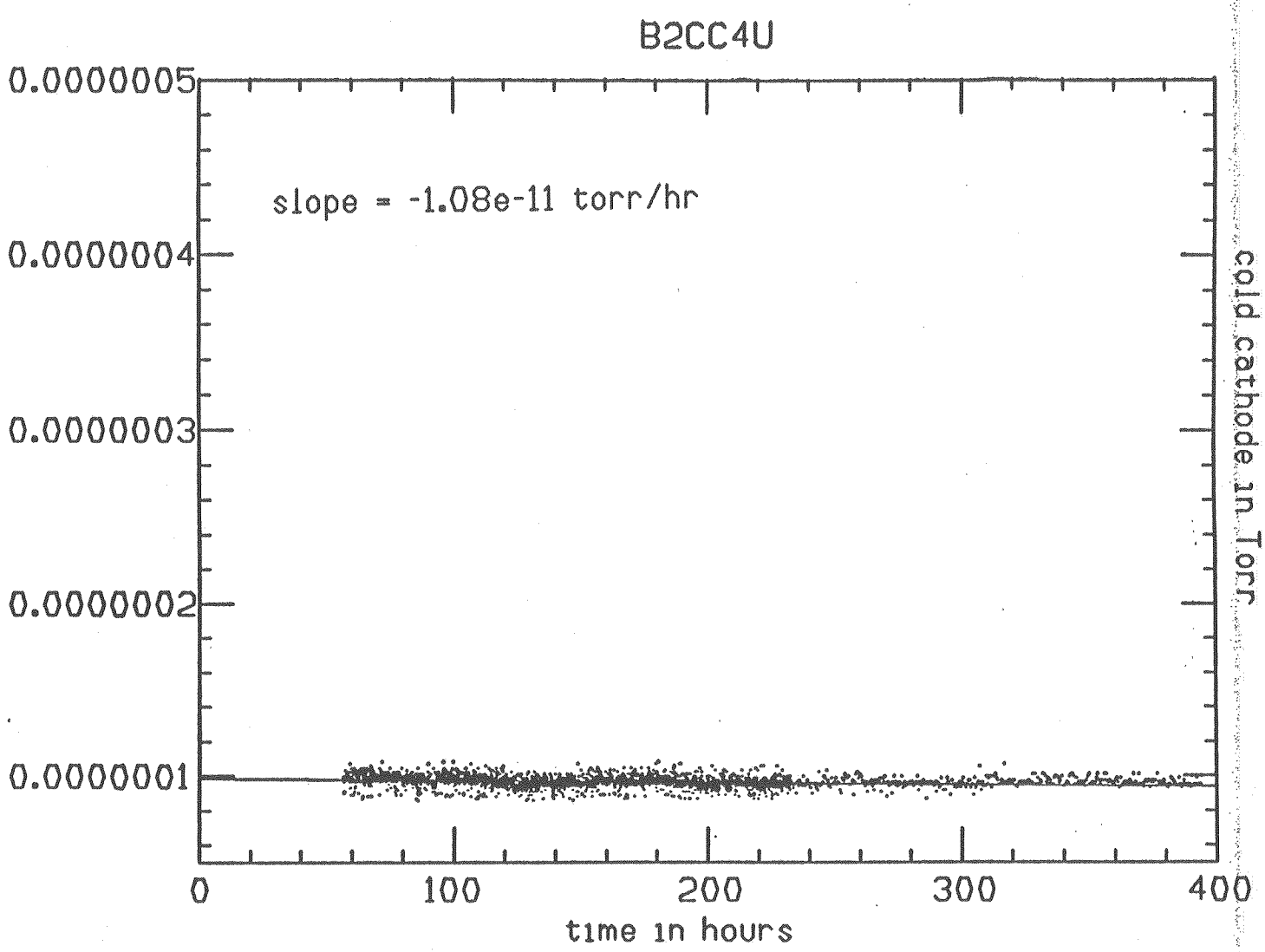
- COLD CATHODE

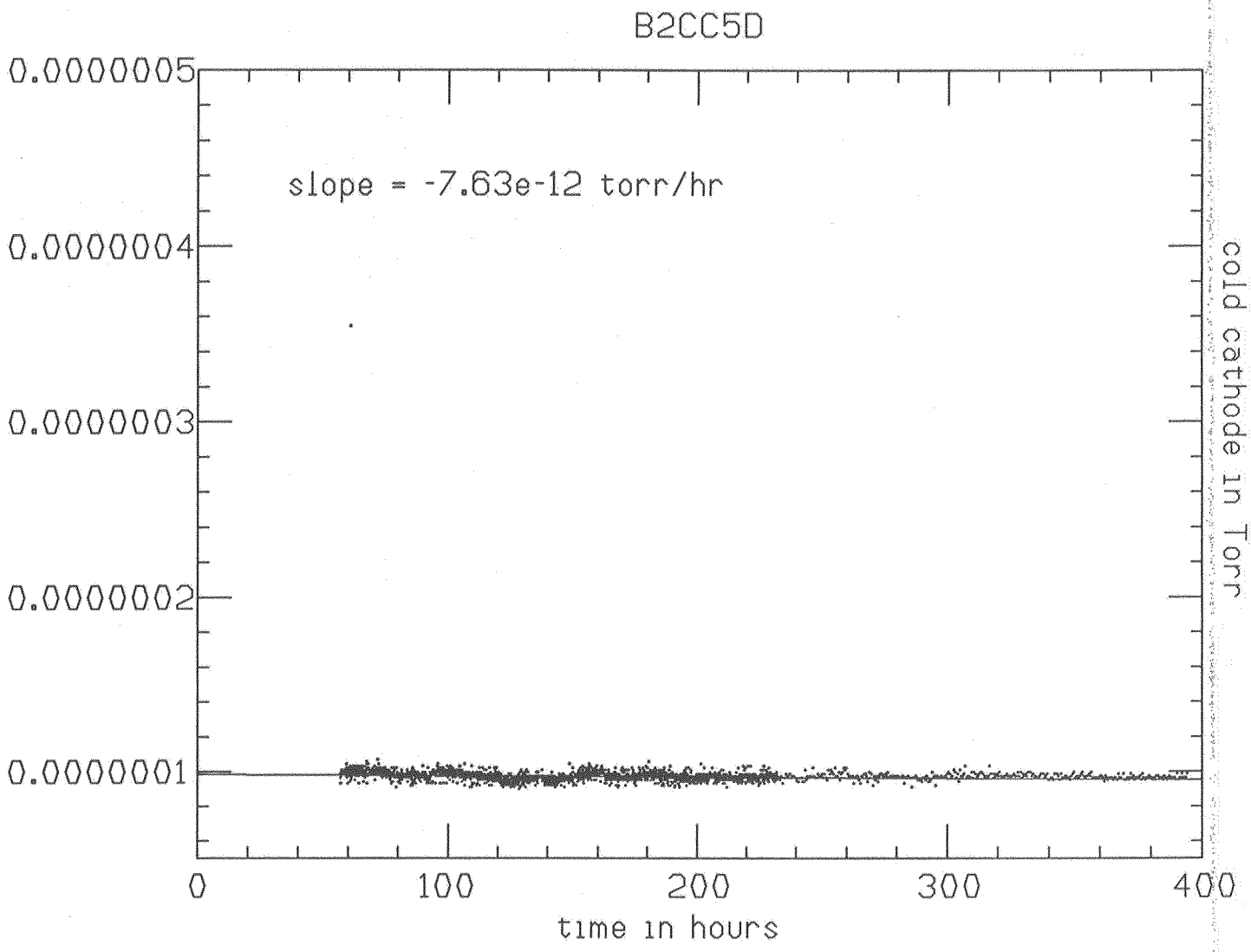
- PIRANI  CP - CRYOSTAT PRESSURE
  MP - MANIFOLD
  RP - ROUGHING
  BP - BORE

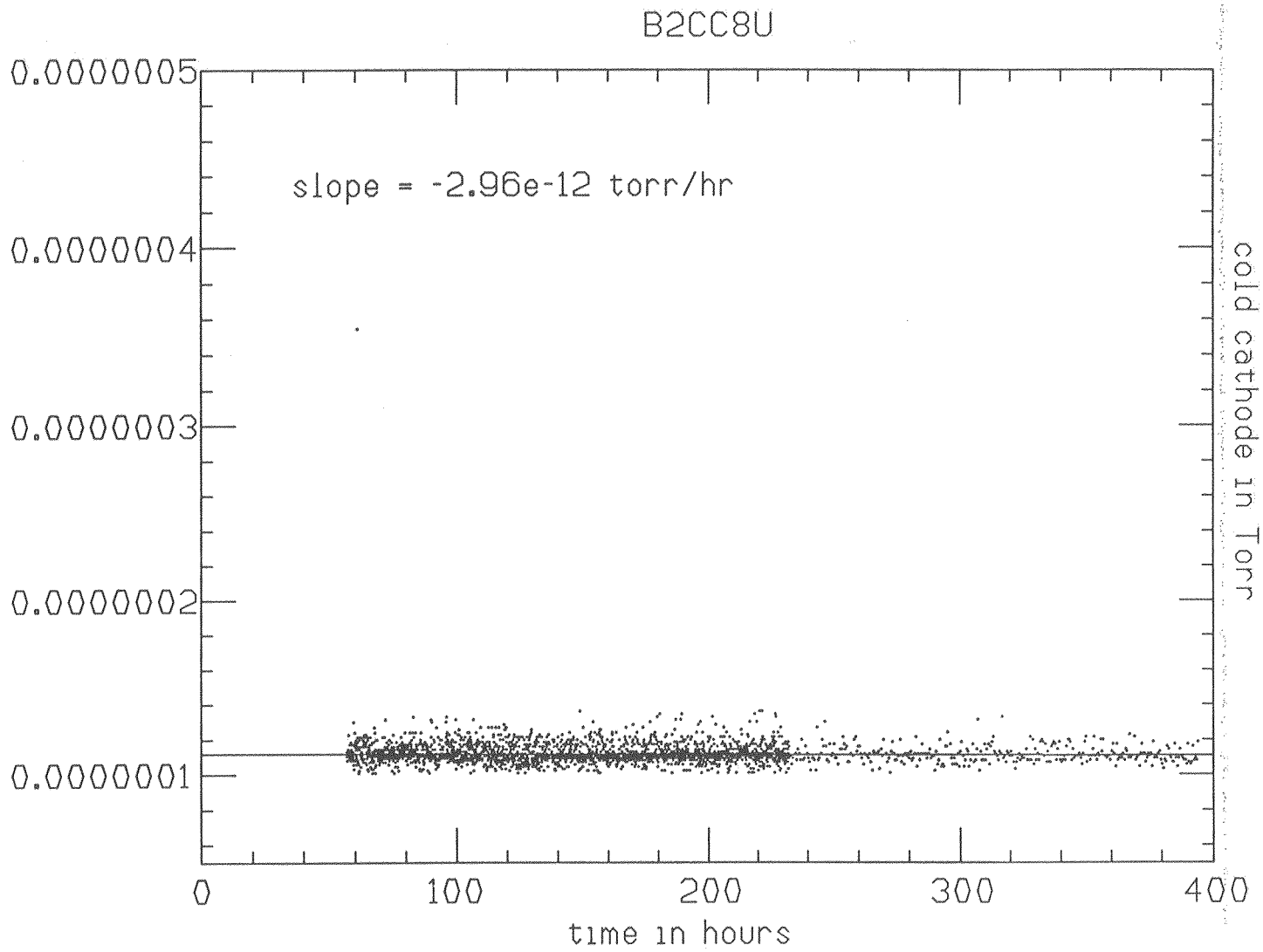
- ELECTROPNEUMATIC GATE VALVE
- MANUAL VALVE
- ALL METAL MANUAL VALVE
- ELEC. RT. ANGLE VALVE
- MANUAL RT. ANGLE VALVE
- CLAPPER SIDE

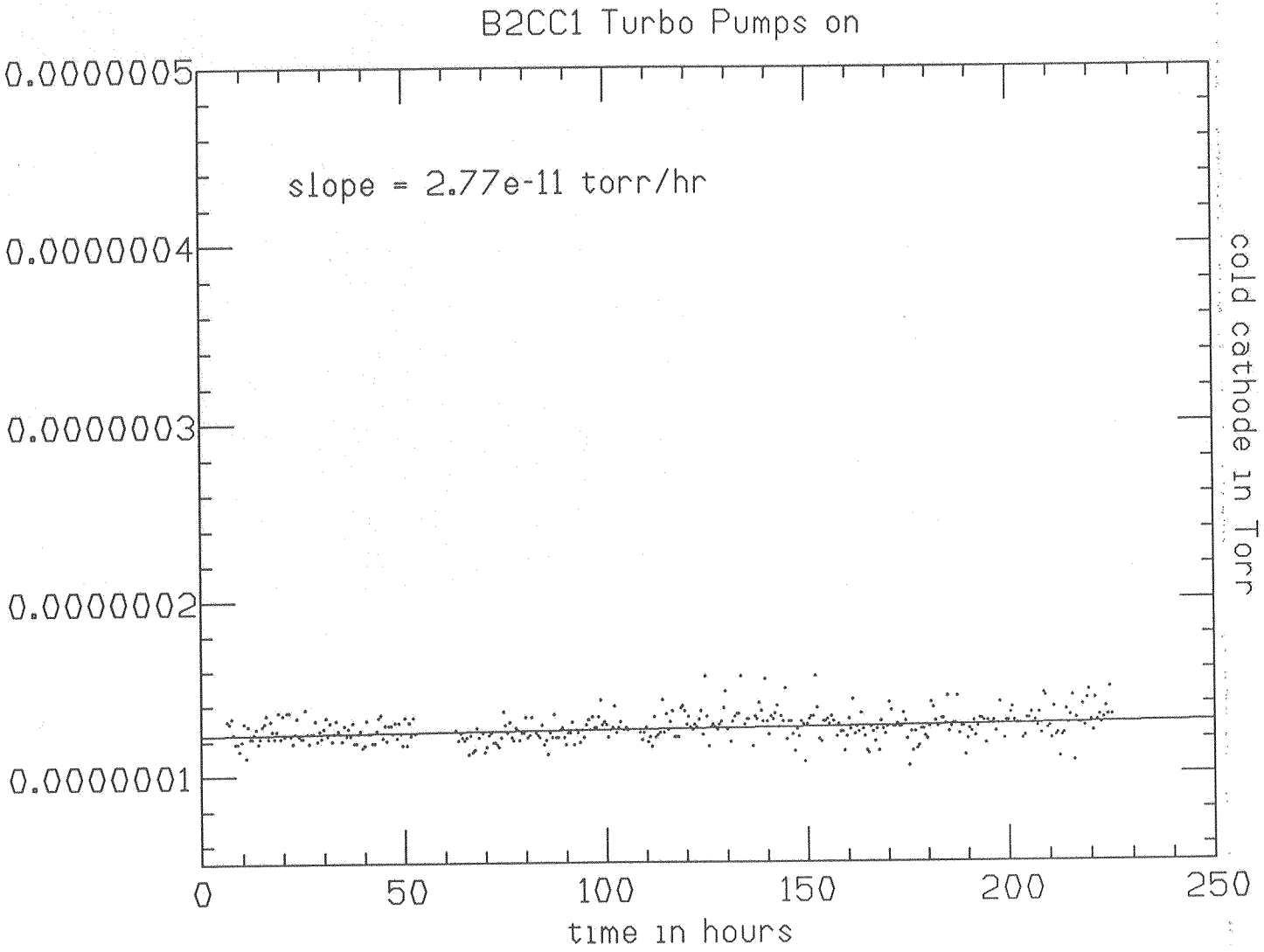
NUG - NUDE ION GAUGE

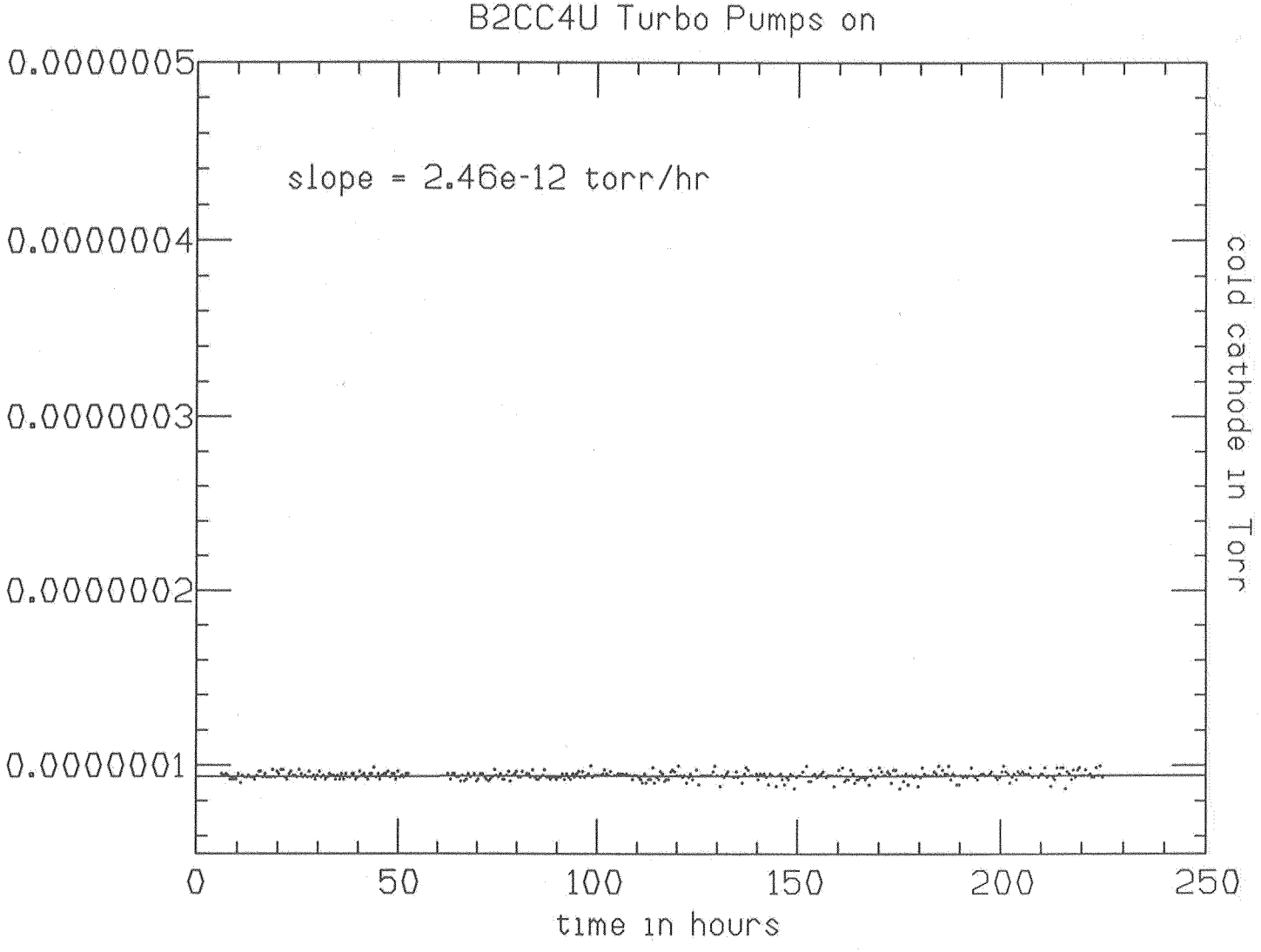

B2CC1
slope = -2.29e-11 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
100
200
300
400
time in hours
cold cathode in Torr

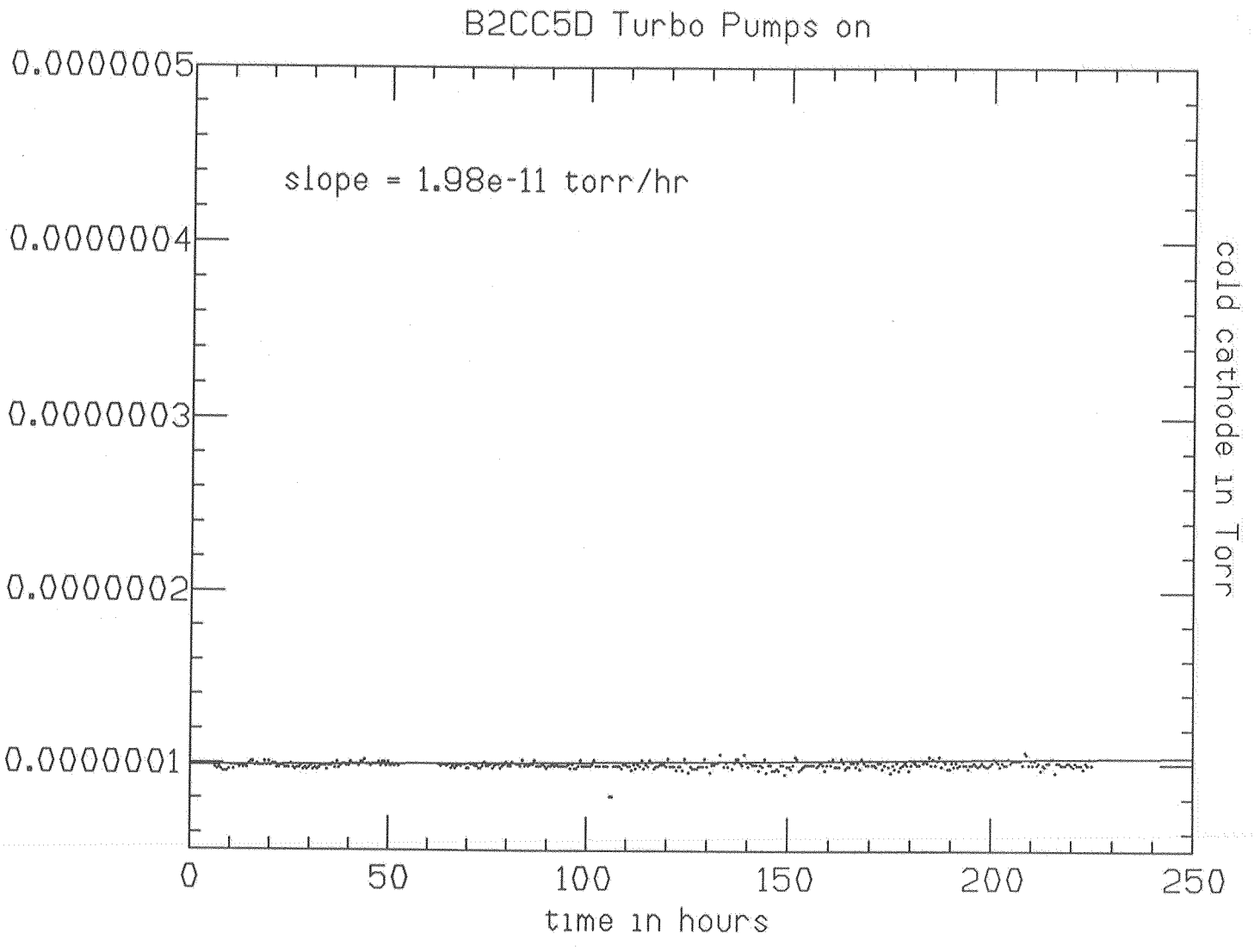

B2CC4U
slope = -1.08e-11 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
100
200
300
400
time in hours
cold cathode in Torr

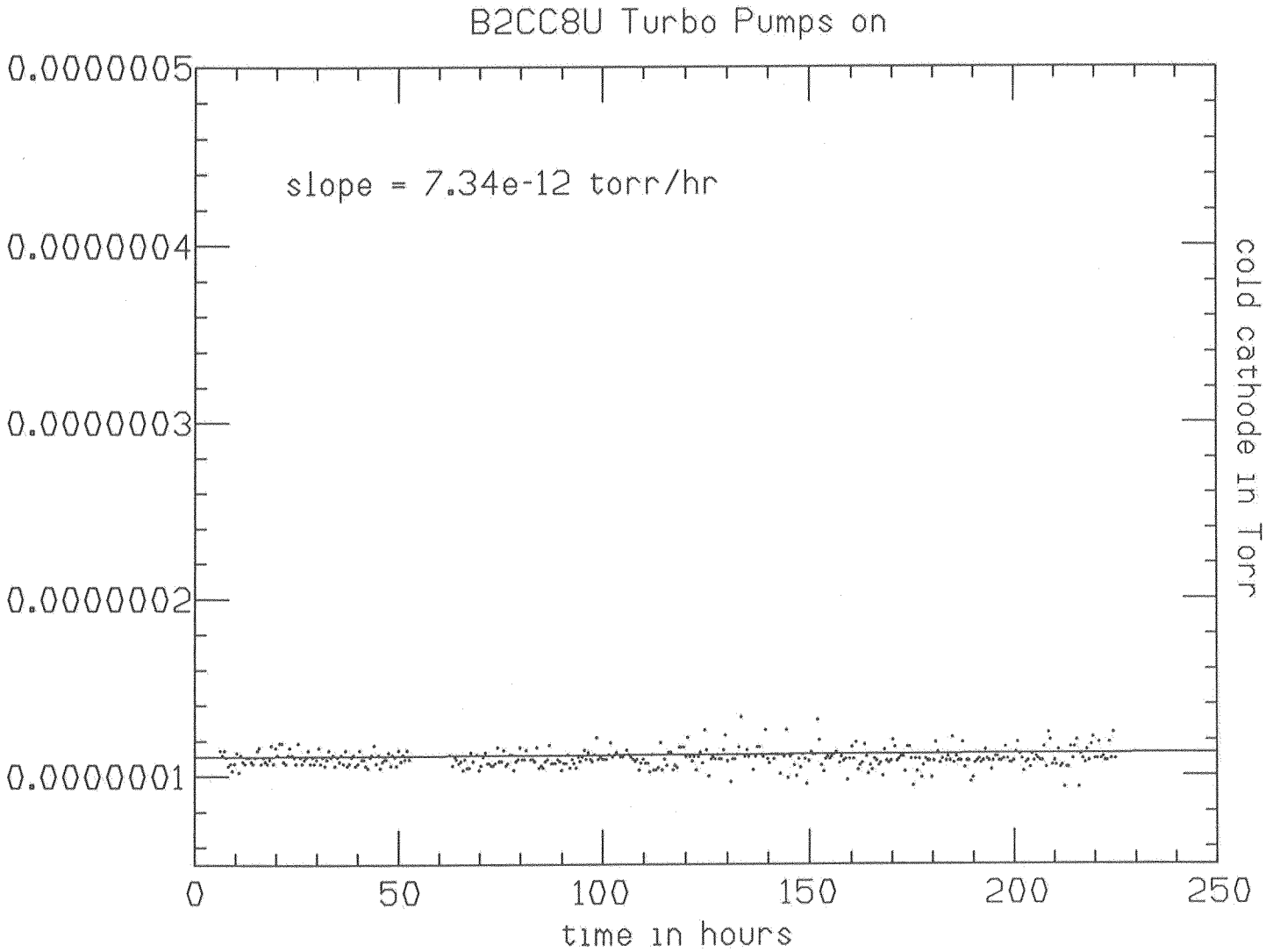

B2CC5D
slope = -7.63e-12 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
100
200
300
400
time in hours
cold cathode in Torr


B2CC8U
slope = -2.96e-12 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
100
200
300
400
time in hours
cold cathode in Torr


B2CC1 Turbo Pumps on
slope = 2.77e-11 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
cold cathode in Torr
0
50
100
150
200
250
time in hours


B2CC4U Turbo Pumps on
slope = 2.46e-12 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
50
100
150
200
250
time in hours
cold cathode in Torr


B2CC5D Turbo Pumps on
slope = 1.98e-11 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
50
100
150
200
250
time in hours
cold cathode in Torr


B2CC8U Turbo Pumps on
slope = 7.34e-12 torr/hr
0.0000005
0.0000004
0.0000003
0.0000002
0.0000001
0
50
100
150
200
250
time in hours
cold cathode in Torr