From weiss@tristan.mit.edu Sat Nov 26 11:06:27 1994
To: ljones@ligo.caltech.edu
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Subject: Summary for beamtube cleaning meeting

Larry,
I have put the figures on the engineering room fax machine.
file:cln112694.txt
to: L. Jones
from: R. Weiss November 26, 1994
concerning: Summary of information on cleaning of 8ft tube

Overall test summary

Test		uncl -> m,w,st	m,w,st -> m,w,st,sl	my weighting
Auger		improvement	improvement	3
Residue		improvement	worse	1
FTIR lines	C-H	improvement	improvement	2
	C-O	~improvement	no change	2
Water break		improvement	no change	3
Flourescence		improvement	improvement	1
weighted value		12	5	

Legend: weighting; 3 = most weight 1 = least weight; improvement= +1, no change = 0, worse = -1

Surface analysis using Auger spectroscopy

1) Figure 1 shows the carbon peak as a function of argon etching time for three samples:

u = uncleaned test sample average of two areas

ms = Mirachem 100% concentration liquid, deionized water rinse, deionized steam rinse average of two areas

mss = same as ms + propanol wash, propanol rinse average of two areas

There is a reduction in the carbon signal with each step in the cleaning process. The largest change is between the u and ms samples.

The Mirachem is effectively rinsed by the liquid rinse and steam. The characteristic sodium and sulfur peaks of Mirachem are not seen in the spectra. Figure 2a (u uncleaned), Figure 2b (cleaned ms) and

Figure 2c (cleaned ms,sl) show the Auger spectra before argon etching and indicate the positions where the sodium and sulfur peaks would occur.

The samples have slightly more carbon than the coupons tested by CBI when they were developing the cleaning comparison between Oakite, pure steam and steam with Mirachem. These were coupons from steel provided by the project and not from the current coils used in the QT. Almost every indication we have says that the current steel is initially dirtier than the steel provided by the project.

FTIR measurements

Figure 3 shows the change in the infrared absorption with the cleaning steps. The data is normalized to indicate the amount of contaminant per evaporated volume of sample

y axis = -ln(Transmission)/volume evaporated

The absorption lines used are

line	mechanism	symbol in fig 3
3420 cm-1	O-H stretch	OH3
2950	C-H stretch	CH3
2850	C-H stretch	CH2
1730	C-O stretch	CO1
1480	C-H stretch	CH1
1390	CH2 and CH3 bend	CHB
1280	C-O twist	COT
1090	C-O stretch	COS
810	inorganic (FexOy)	INO

The trend in the absorption signal at most of the lines is a reduction with each cleaning step.

There is a difficulty in the interpretation of the data which comes from:

1) The inconsistency in the contamination of the control sample of propanol. The residue measurements range from 27 ppm for the first control sample used to reference the uncleaned sample to 3.75 ppm for the reference sample used for the ms sample and 2.5 ppm for the reference sample for the mss sample. The data has been corrected for this but not in a straightforward way due to 2). CBI must have changed the propanol purity between the u run and the others or they way they clean their sample holding bottles.

2) The absolute transmission is not measured directly. This is a misunderstanding with Bob Fitzsimmons which must be rectified in future measurements. He bases his absolute values on the weight of the contaminant residue left after propanol evaporation from a Petri dish. This method does not distinquish hydrocarbon from inorganic contamination. The spectrum taken is qualitative and not quantitative as he resets the gain and offsets the zero with each of his spectra and does not retain the settings. I was able to restore the absolute values by using the continuum transmission and the invariant features of the spectrum, but this increases the uncertainty in the data analysis.

The residue data from Fitzsimmons is:

sample	reference solvent	contaminated solvent	diff
u	27.3 ppm	70.0 ppm	42.7 ppm
ms	3.7 ppm	18.7 ppm	15.0 ppm
mss	2.5 ppm	20.0 ppm	17.5 ppm

This disagrees with the spectral absorption data and indicates no improvement with the propanol wash and rinse.

Water break test

The expansion of the drops and the contact angle at the edge of the meniscus attachment show a significant change in both the tests reported by CBI as well as those performed in the lab on the coupons. The u samples show little water surface adhesion and the water does not spread on the surface. Water on the ms samples wets well (3/32 inch diameter drops spread to 3/8 inch diameter) and has a small contact angle (15 to 25 degrees) at the edge of the meniscus. The mss sample behave the same way as the ms sample.

Fluorescence test

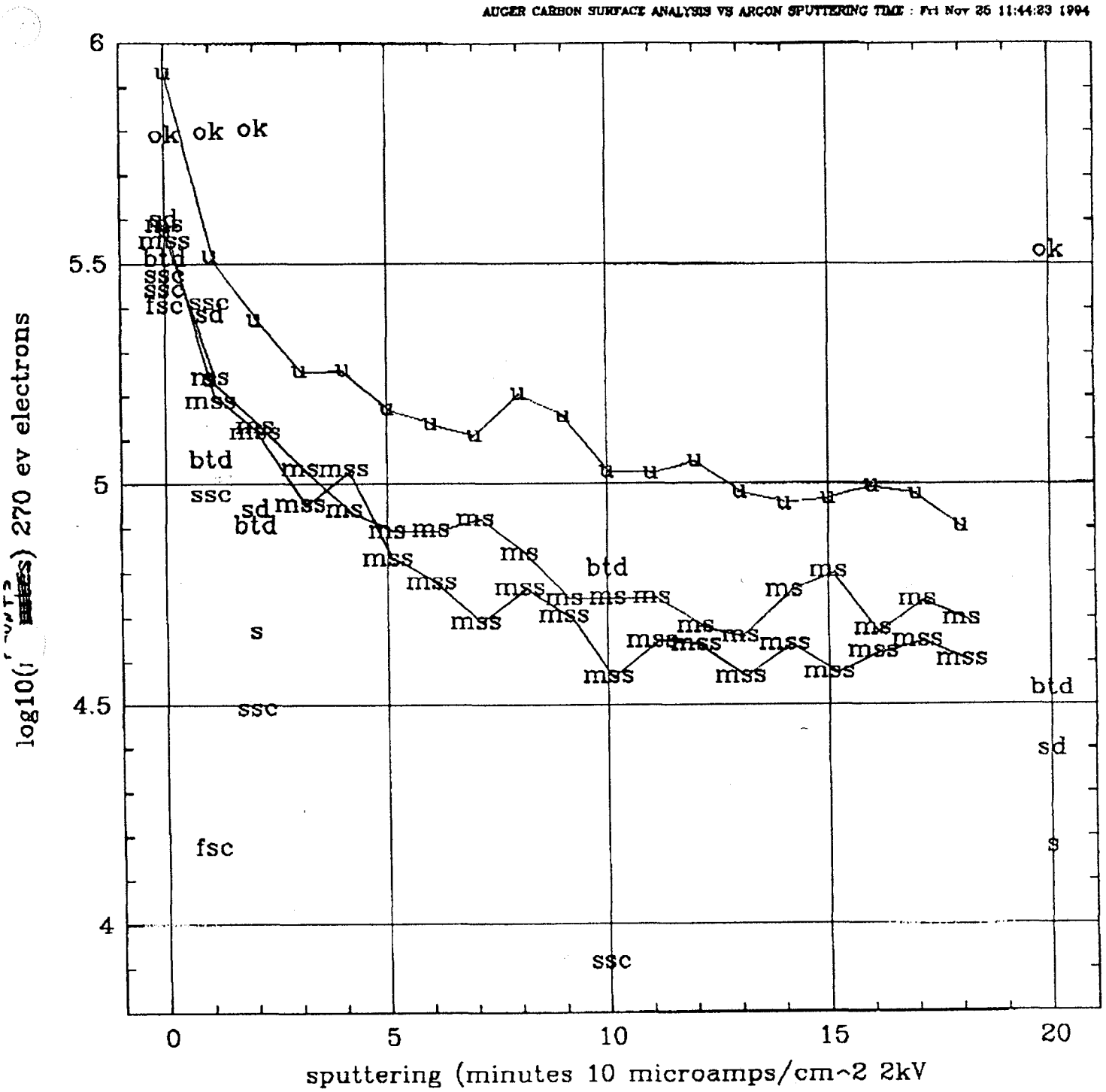
The u sample shows extensive fluorescence and is dirtier than the QT tubes since there was a lot of activity in the tube prior to cleaning tests.

The ms sample shows no fluorescence except at bleeder locations at a surface density of about 10/sq ft (fractional coverage of ~10^-5). CBI says the bleeders are weaker than in prior measurements

The mss sample shows no flourescence and no bleeders.

I have learned why the solvent makes the fluoresence appear. A good reference is "Principles of Fluorescence Spectroscopy" J.R. Lakowicz. The reason is that the solvent both increases the fluorescence and shifts it toward longer (and more easily seen) wavelengths. This is due to the change in the effective molecular dipole moment of the organic molecule in the solvent due to the large polarizability of the solvent (Lippert Equation).

FIGURE 1



OK OAKITE 33 CBI COUPON

S STEAM ONLY COUPON

SO STEAM + MIRACHEM COUPON

SSC OXIDE COATED SUPER CLEAN

FSC FLY CUT STEEL SUPER CLEAN

BTD BEAM TUBE DEMONSTRATION STEEL

U UNCLEANED 11/94

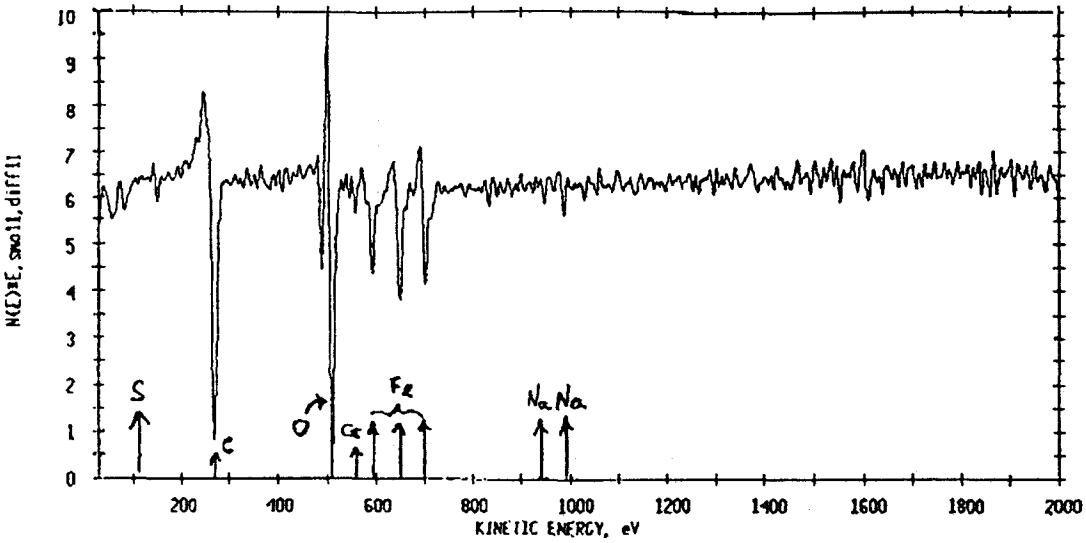
MS MIRACHEM, STEAM 11/94

MSS MIRACHEM, STEAM, SOLVENT 11/94

FIGURE 2a

FILE: ru1123a3 Uncleaned

SCALE FACTOR= 78.258 k c/s, OFFSET= 0.000 k c/s BV=5.00kV BI=0.0000uA

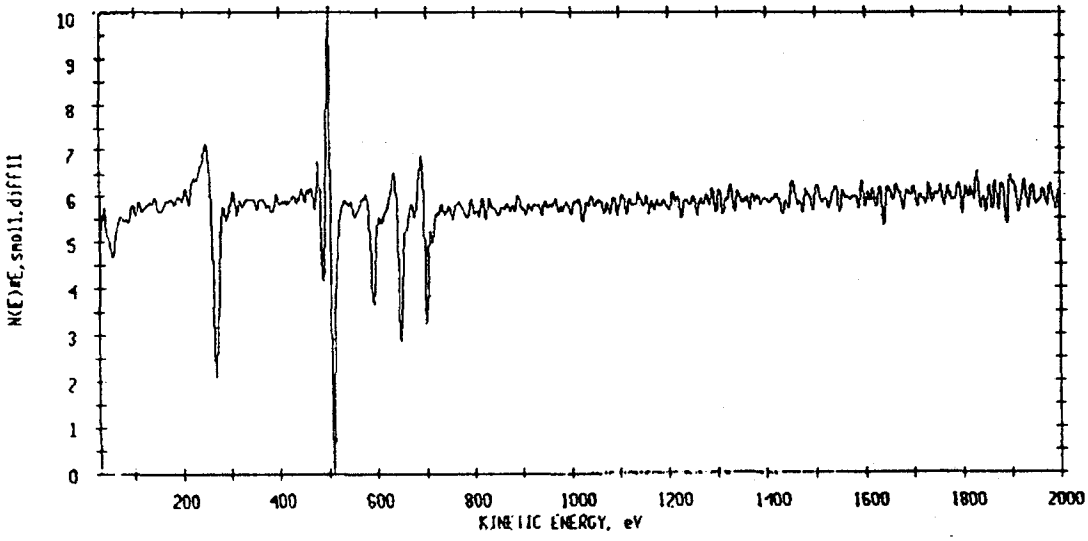


AES SURVEY V/F 11/23/94 AREA 2 ACQ TIME=1.64 MIN.

2b

FILE: ru1123b1 Mirachem and steam cleaning

SCALE FACTOR= 81.330 k c/s, OFFSET= 0.000 k c/s BV=5.00kV BI=0.0000uA

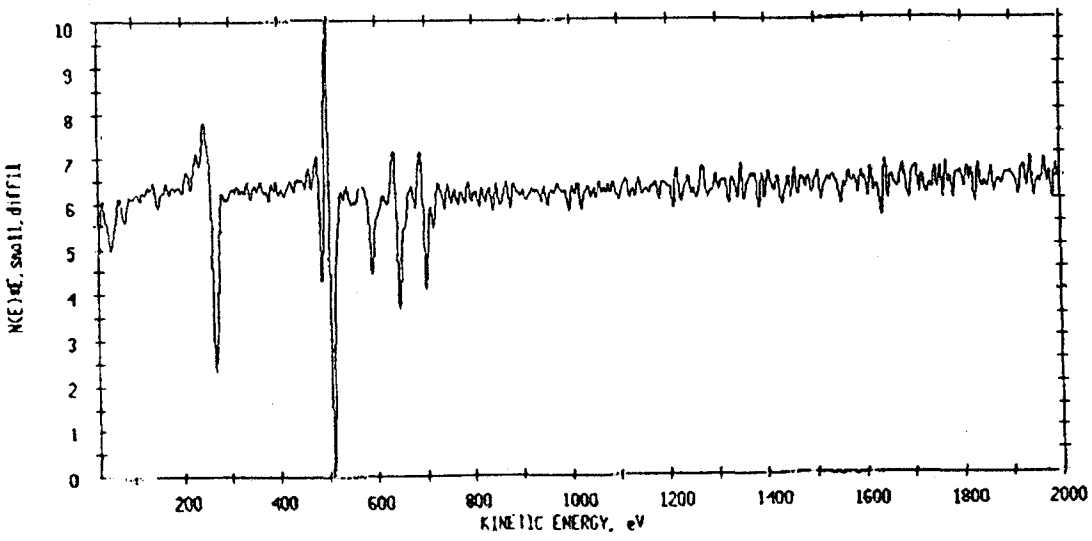


AES SURVEY V/F 11/23/94 AREA 2 ACQ TIME=1.64 MIN.

2c

FILE: ru1122c1 Mirachem, steam cleaning, propanol

SCALE FACTOR= 61.588 k c/s, OFFSET= 0.000 k c/s BV=5.00kV BI=0.0000uA



FTIR LINE ABSORPTION VS CLEANING STEPS : Sat Nov 26 12:26:47 1994