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Summary of Warm Tube Photodesorption Experiments

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INTRODUCTION

Experimental measurements of photodesorption coefficients of H_2, CH_4, CO, and CO_2 have been done to obtain data necessary to predict the vacuum performance of the 20-TeV Collider at the Superconducting Super Collider (SSC). Experiments have been done for warm tubes (*i.e.*, room temperature), cold tubes (*i.e.*, 4.2 K), and liner configurations.

Two synchrotron radiation beamlines, SSC1 and SSC2, were constructed on the VEPP-2M storage ring at Budker Institute of Nuclear Physics (BINP) in Russia. The photon-critical energy is 284 eV, as in the SSC Collider, and the angle of incidence is 10 mrad. Twenty-seven warm beam tube samples were tested, each 1 m long and 33 mm inside diameter (ID). The following materials for tubes were tested: electrodeposited Cu (Silvex and Fluhmann), electrodeposited Cu with Au coating (Silvex), bulk Cu (Hitachi 10100), Nitronic 40 SS (ASTM2169), and A7N01/4N Al (Japan). These tube samples were cleaned following ultrahigh vacuum cleaning procedures used at Brookhaven National Laboratory (BNL) and at CERN. Two tubes (007v, 008v) were thermally treated at Virginia Polytechnic Institute. Photodesorption measurements were also made for different experimental conditions, such as *in situ* bake of the tested sample and in the presence of 500–1000 G transverse dipole magnetic field. Experiments were also done on the VUV ring at BNL. The purpose of these experiments was to check a subset of the BINP data and to achieve the integrated photon flux of more than 10^{23} photons/m, or 100 days of SSC operation.

The goal of this summary is simply to provide a catalog of the warm tube photodesorption coefficients for each of the tested materials. The data for each experiment occupies two pages. The first page has a tube number, which was engraved on the tube, and includes three tables. Some details of the particular experiment are given in the first table. The second table contains photodesorption coefficients for H_2, CH_4, CO, and CO_2 at certain integrated photon fluxes. The last table contains the amounts of gas desorbed at different integrated photon fluxes. The second page has two plots. The first, basic plot shows the photodesorption coefficients versus integrated photon flux for each gas. The second plot shows the photodesorption coefficients as a function of desorbed gas.

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Parameters of VEPP-2M storage ring

Energy (MeV)	150 - 670
Bending radius (m)	1.22
Average radius of ring (m)	2.84
Perimeter of equilibrium orbit (m)	17.88
Beam current (mA)	up to 400
Maximum quantity of magnetic field H (kG)	18.25
Critical energy of photon radiation for E = 534 MeV (eV)	284
Radiation losses of energy per 1 turn for energy E = 534 MeV (keV)	6
Total photon flux for E = 534 MeV and I_e = 300 mA (photon/sec)	$1.3 \cdot 10^{20}$
Lifetime (E = 534 MeV I_e = 300 mA) (sec)	1000
Speed of electron injection (electron/sec)	$3 \cdot 10^{8}$

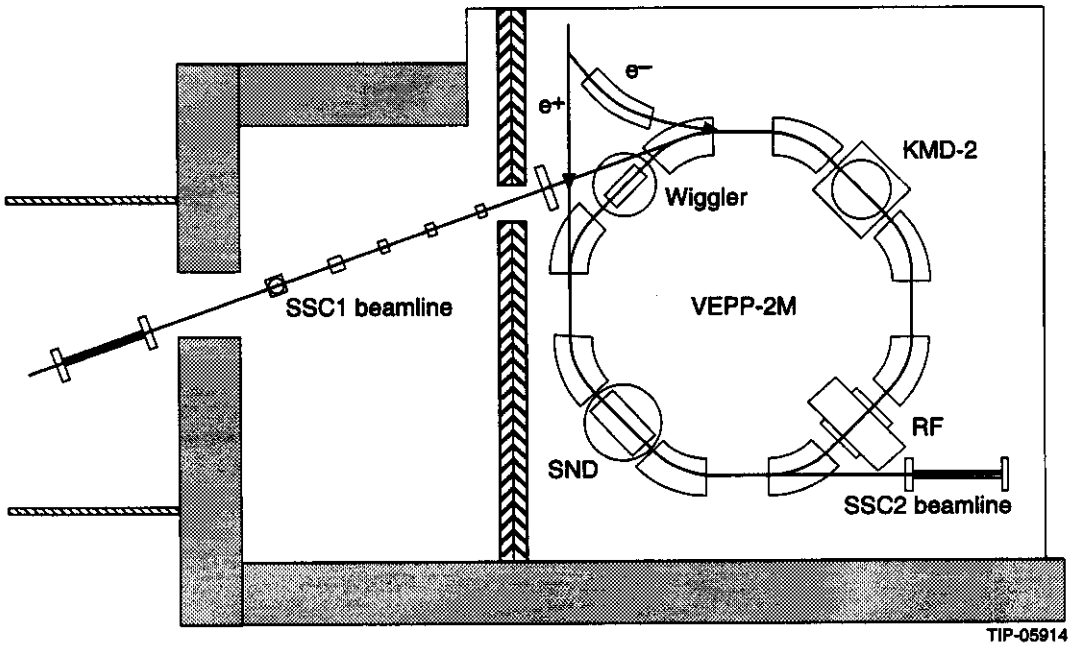


Figure 1. Layout of SSC1 and SSC2 Beamlines on VEPP-2M Storage Ring.

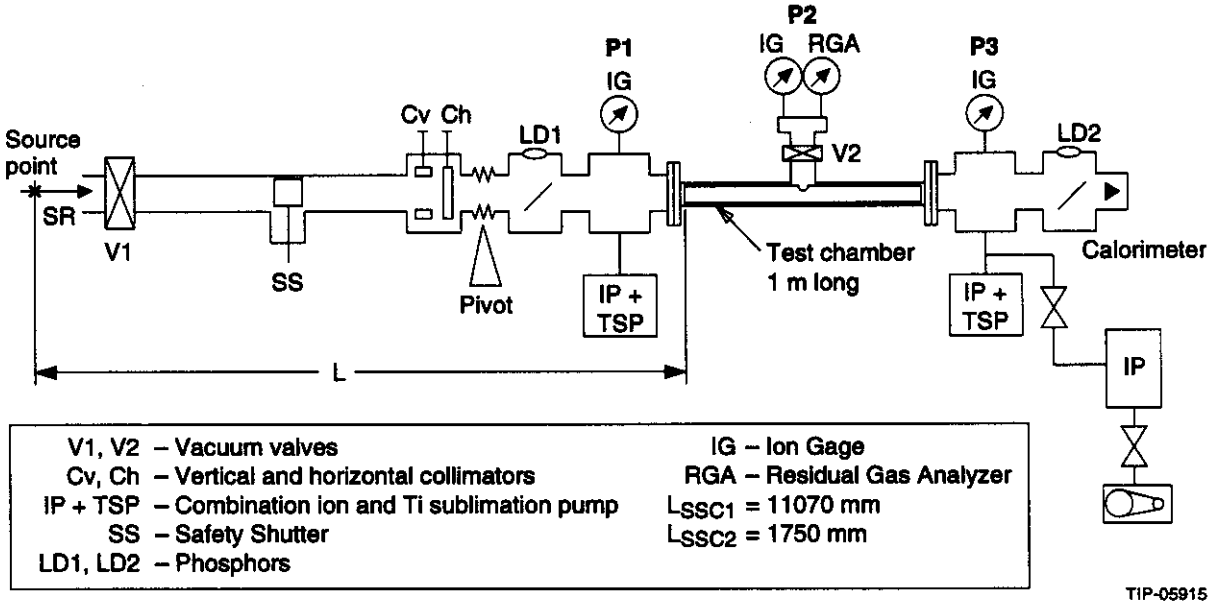


Figure 2. Experimental Setup of BINP SSC1 and SSC2 Beamlines.

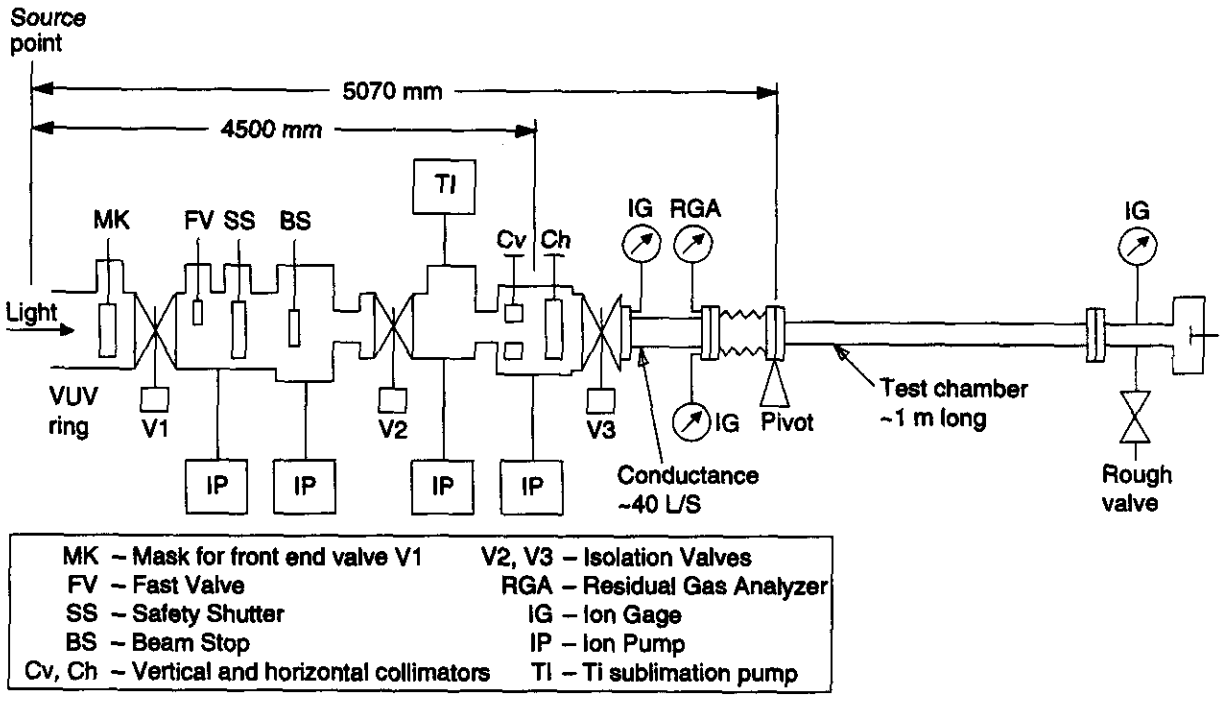


Figure 3. BNL Experimental Setup.

Synchrotron Radiation Beamline Parameters.

Beamline	E, MeV	I, mA	γ	E_{cr} , eV	$d\Gamma/dt$, ph/m/s	ϕ, mrad	$w_{1/2}$, mm	D, m
SSC1	534	300	1045	284	$1.1 \cdot 10^{16}$	10	52	11.65
SSC2	534	300	1045	284	$8.4 \cdot 10^{16}$	10	8	1.75
U10B	740	600	1448	490	$1.2 \cdot 10^{17}$	12	16	5.07
SSC	$2 \cdot 10^{7}$	70	21322	284	$1.0 \cdot 10^{16}$	2	4	20

E – particle energy;
I – beam current;
γ – relativistic factor;
E_{cr} – critical energy of photons;
$d\Gamma/dt$ – photon flux;
ϕ – angle of incidence;
$w_{1/2}$ – FWHM strip height of photons with the median energy $E_{1/2} = 0.08\ E_{crit}$;
D – distance from source point.

Tube #002

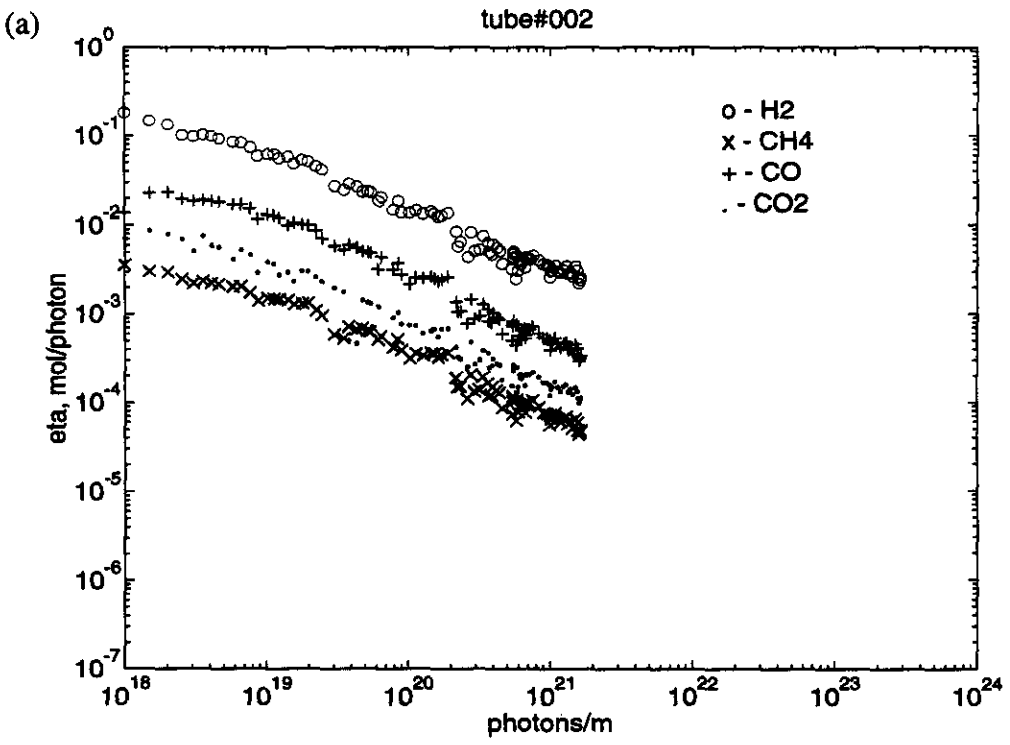
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	1a
Beamline:	SSC1
Date of test:	Jul 27 1992
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

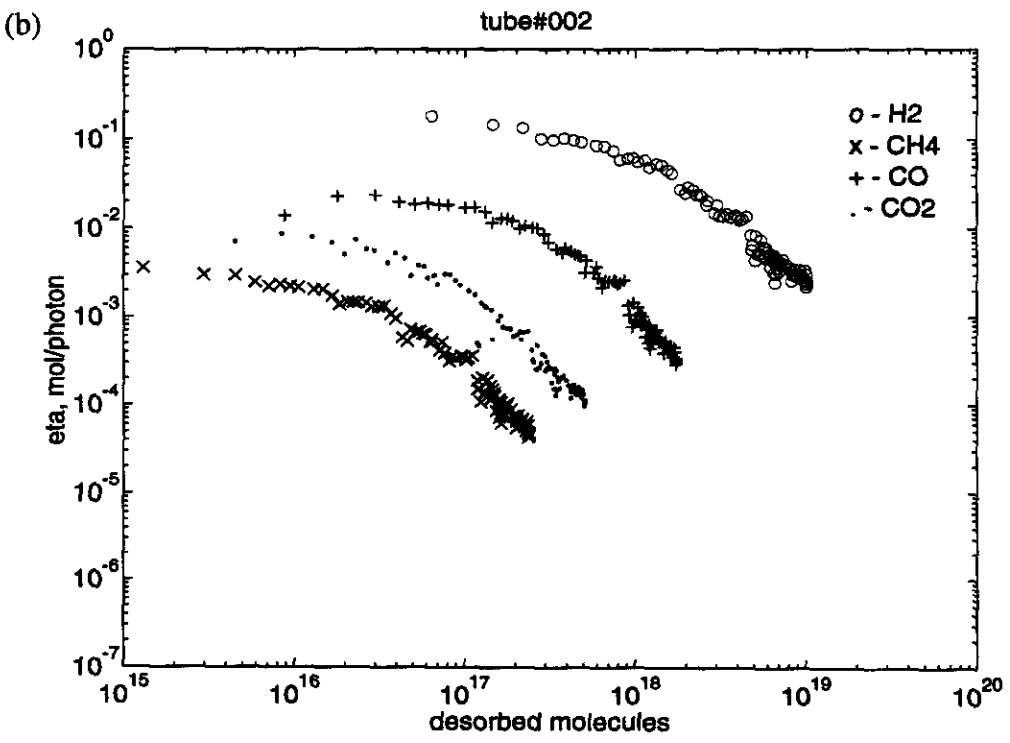
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$6.48 \cdot 10^{-2}$	$1.50 \cdot 10^{-2}$	$2.40 \cdot 10^{-3}$	N/A	N/A
CH_4	$1.57 \cdot 10^{-3}$	$3.87 \cdot 10^{-4}$	$6.08 \cdot 10^{-5}$	N/A	N/A
CO	$1.31 \cdot 10^{-2}$	$2.87 \cdot 10^{-3}$	$4.01 \cdot 10^{-4}$	N/A	N/A
CO_2	$3.67 \cdot 10^{-3}$	$7.49 \cdot 10^{-4}$	$1.16 \cdot 10^{-4}$	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$2.45 \cdot 10^{18}$	$6.93 \cdot 10^{18}$	N/A	N/A
CH_4	$6.17 \cdot 10^{16}$	$1.77 \cdot 10^{17}$	N/A	N/A
CO	$4.83 \cdot 10^{17}$	$1.29 \cdot 10^{18}$	N/A	N/A
CO_2	$1.28 \cdot 10^{17}$	$3.47 \cdot 10^{17}$	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #003

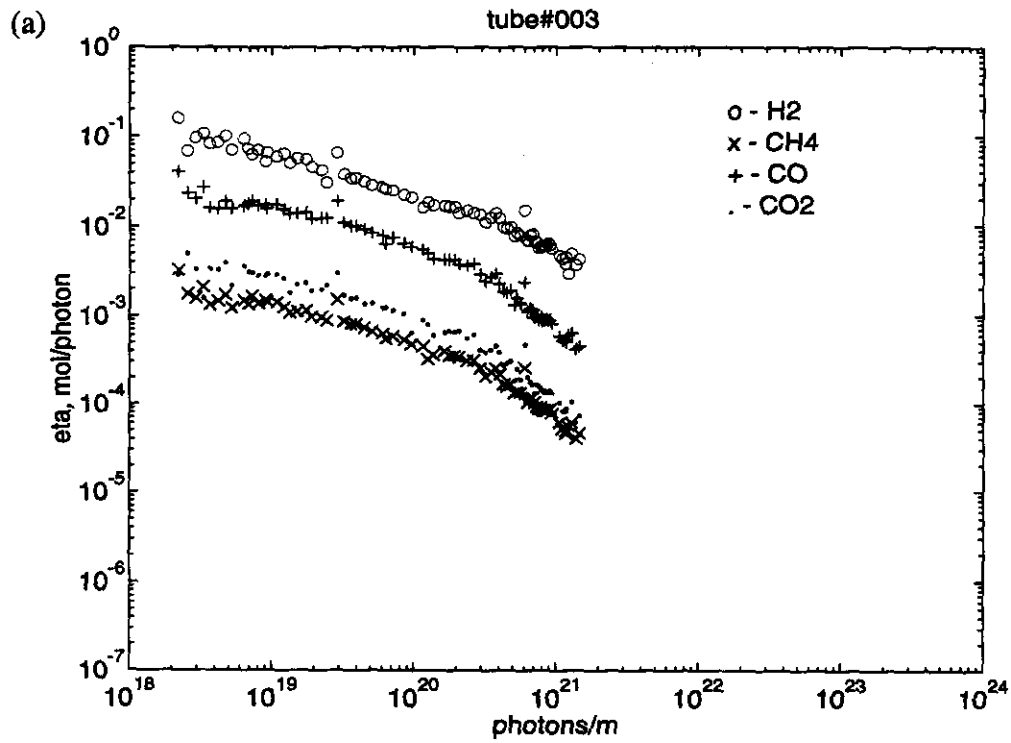
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BINP
Type of test:	warm, in situ bake 150C for 24 hrs, no magnetic field
Experiment #:	2a
Beamline:	SSC1
Date of test:	Jul 22 1992
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

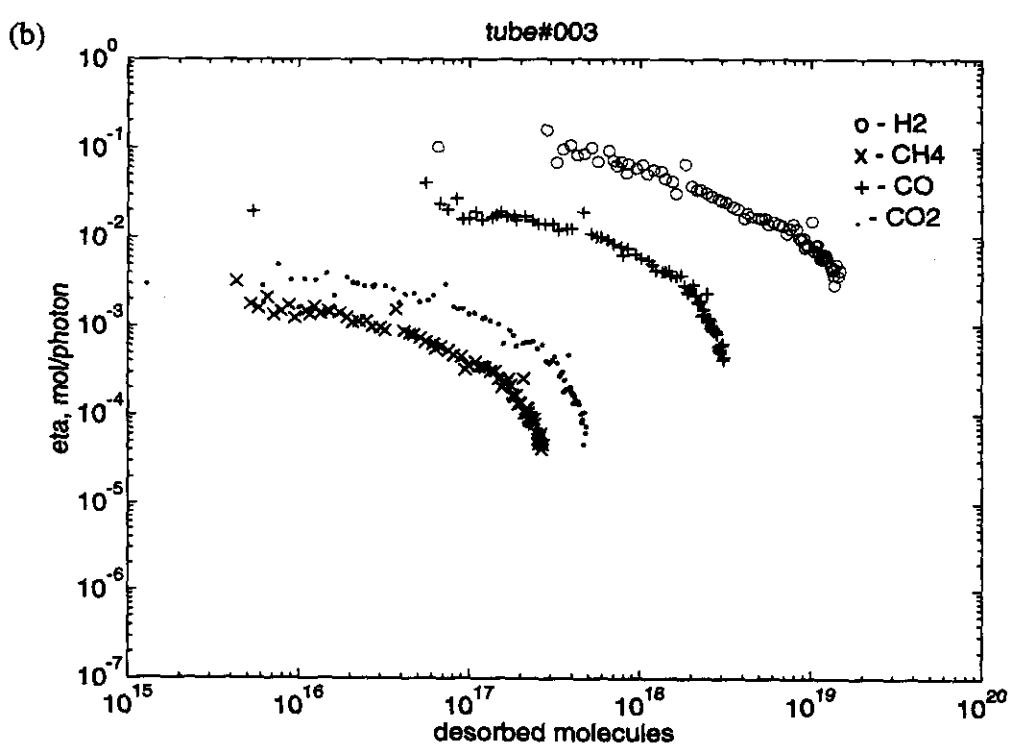
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$6.34 \cdot 10^{-2}$	$2.18 \cdot 10^{-2}$	$4.73 \cdot 10^{-3}$	N/A	N/A
CH_4	$1.31 \cdot 10^{-3}$	$5.01 \cdot 10^{-4}$	$9.69 \cdot 10^{-5}$	N/A	N/A
CO	$1.66 \cdot 10^{-2}$	$5.75 \cdot 10^{-3}$	$9.33 \cdot 10^{-4}$	N/A	N/A
CO_2	$2.72 \cdot 10^{-3}$	$9.34 \cdot 10^{-4}$	$1.33 \cdot 10^{-4}$	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$3.04 \cdot 10^{18}$	$1.08 \cdot 10^{19}$	N/A	N/A
CH_4	$6.94 \cdot 10^{16}$	$2.38 \cdot 10^{17}$	N/A	N/A
CO	$8.44 \cdot 10^{17}$	$2.60 \cdot 10^{18}$	N/A	N/A
CO_2	$1.33 \cdot 10^{17}$	$4.14 \cdot 10^{17}$	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #019

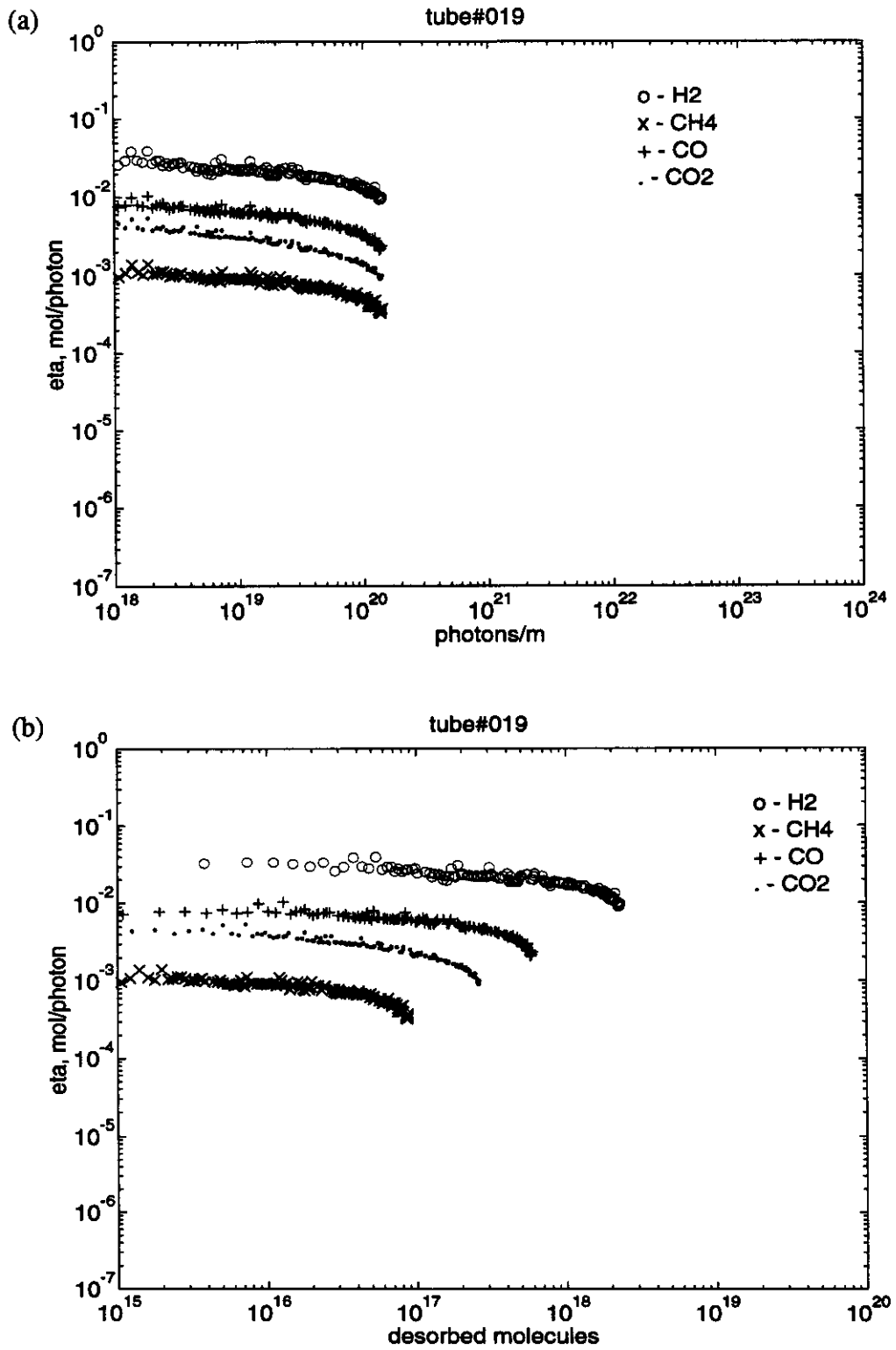
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	CERN procedure (Appendix: 3.2)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	8d
Beamline:	SSC1
Date of test:	Oct 28 1992
Pumping time before experiment:	308 hrs
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$2.27 \cdot 10^{-2}$	$1.29 \cdot 10^{-2}$	N/A	N/A	N/A
CH_4	$9.20 \cdot 10^{-4}$	$4.77 \cdot 10^{-4}$	N/A	N/A	N/A
CO	$6.43 \cdot 10^{-3}$	$3.17 \cdot 10^{-3}$	N/A	N/A	N/A
CO_2	$3.09 \cdot 10^{-3}$	$1.34 \cdot 10^{-3}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.55 \cdot 10^{18}$	N/A	N/A	N/A
CH_4	$5.98 \cdot 10^{16}$	N/A	N/A	N/A
CO	$4.05 \cdot 10^{17}$	N/A	N/A	N/A
CO_2	$1.79 \cdot 10^{17}$	N/A	N/A	N/A



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #009

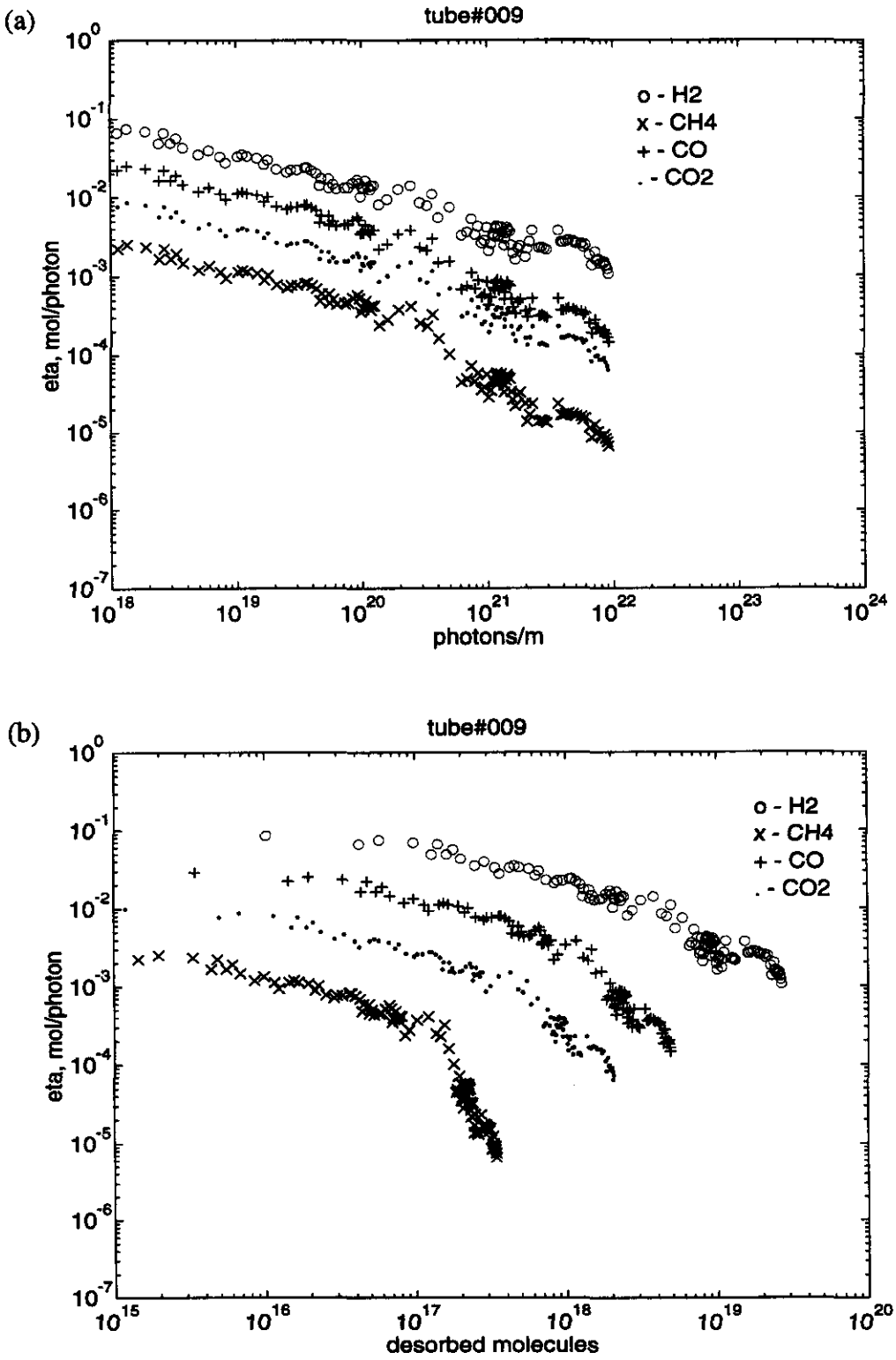
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	1a
Beamline:	SSC2
Date of test:	Sep 5 1992
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

Photodesorption coefficients, molecules/photon

	$1\cdot10^{19}$	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$3.33\cdot10^{-2}$	$1.27\cdot10^{-2}$	$4.52\cdot10^{-3}$	$1.56\cdot10^{-3}$	N/A
CH_4	$1.08\cdot10^{-3}$	$4.20\cdot10^{-4}$	$6.68\cdot10^{-5}$	$2.43\cdot10^{-6}$	N/A
CO	$1.08\cdot10^{-2}$	$4.07\cdot10^{-3}$	$8.28\cdot10^{-4}$	$1.61\cdot10^{-4}$	N/A
CO_2	$3.71\cdot10^{-3}$	$1.48\cdot10^{-3}$	$3.64\cdot10^{-4}$	$8.12\cdot10^{-5}$	N/A

Desorbed gas, molecules/m

	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$1.62\cdot10^{18}$	$7.53\cdot10^{18}$	$2.81\cdot10^{19}$	N/A
CH_4	$5.69\cdot10^{16}$	$1.89\cdot10^{17}$	$3.13\cdot10^{17}$	N/A
CO	$5.56\cdot10^{17}$	$1.96\cdot10^{18}$	$4.63\cdot10^{18}$	N/A
CO_2	$1.96\cdot10^{17}$	$7.60\cdot10^{17}$	$2.05\cdot10^{18}$	N/A



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #026

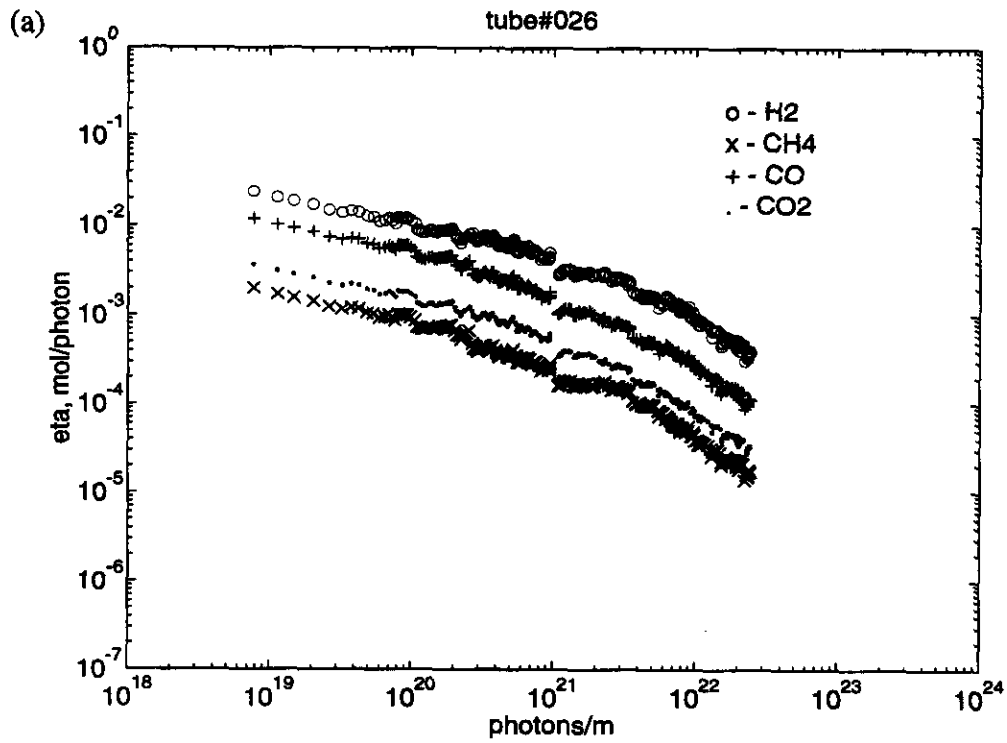
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	1a
Beamline:	SSC2
Date of test:	Jan 20 1993
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

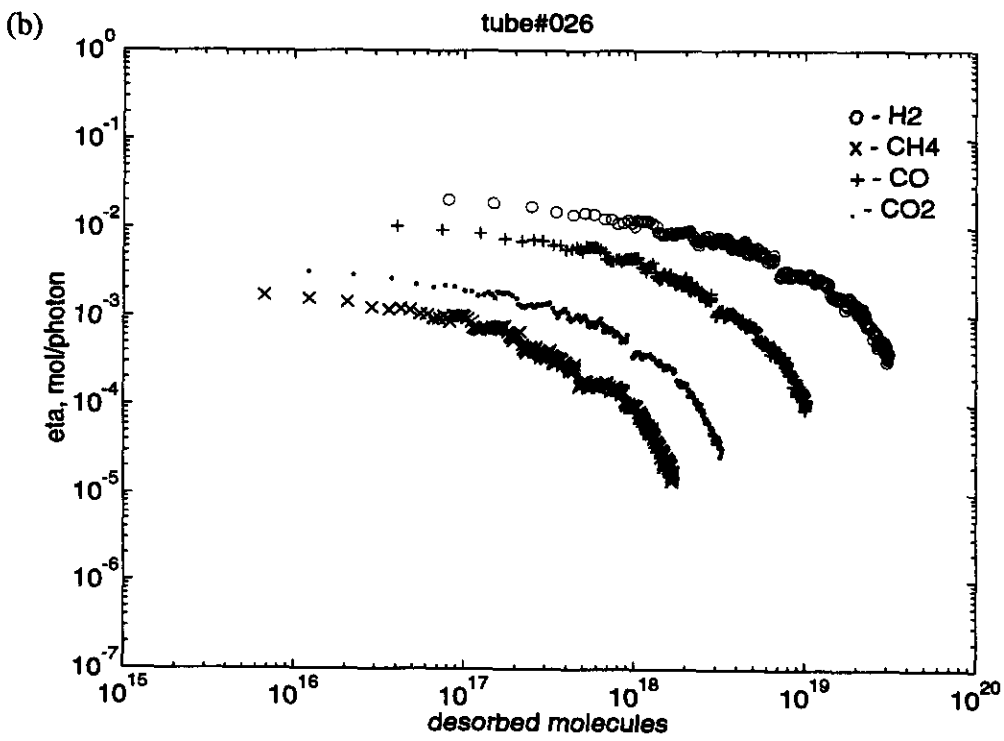
Photodesorption coefficients, molecules/photon

	$1\cdot10^{19}$	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$2.15\cdot10^{-2}$	$1.06\cdot10^{-2}$	$4.20\cdot10^{-3}$	$9.29\cdot10^{-4}$	N/A
CH_4	$1.78\cdot10^{-3}$	$8.27\cdot10^{-4}$	$2.47\cdot10^{-4}$	$4.15\cdot10^{-5}$	N/A
CO	$1.05\cdot10^{-2}$	$5.21\cdot10^{-3}$	$1.51\cdot10^{-3}$	$2.56\cdot10^{-4}$	N/A
CO_2	$3.22\cdot10^{-3}$	$1.59\cdot10^{-3}$	$5.18\cdot10^{-4}$	$8.04\cdot10^{-5}$	N/A

Desorbed gas, molecules/m

	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$1.20\cdot10^{18}$	$6.64\cdot10^{18}$	$2.25\cdot10^{19}$	N/A
CH_4	$1.02\cdot10^{17}$	$4.59\cdot10^{17}$	$1.27\cdot10^{18}$	N/A
CO	$6.07\cdot10^{17}$	$2.85\cdot10^{18}$	$7.64\cdot10^{18}$	N/A
CO_2	$1.83\cdot10^{17}$	$9.18\cdot10^{17}$	$2.56\cdot10^{18}$	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #028

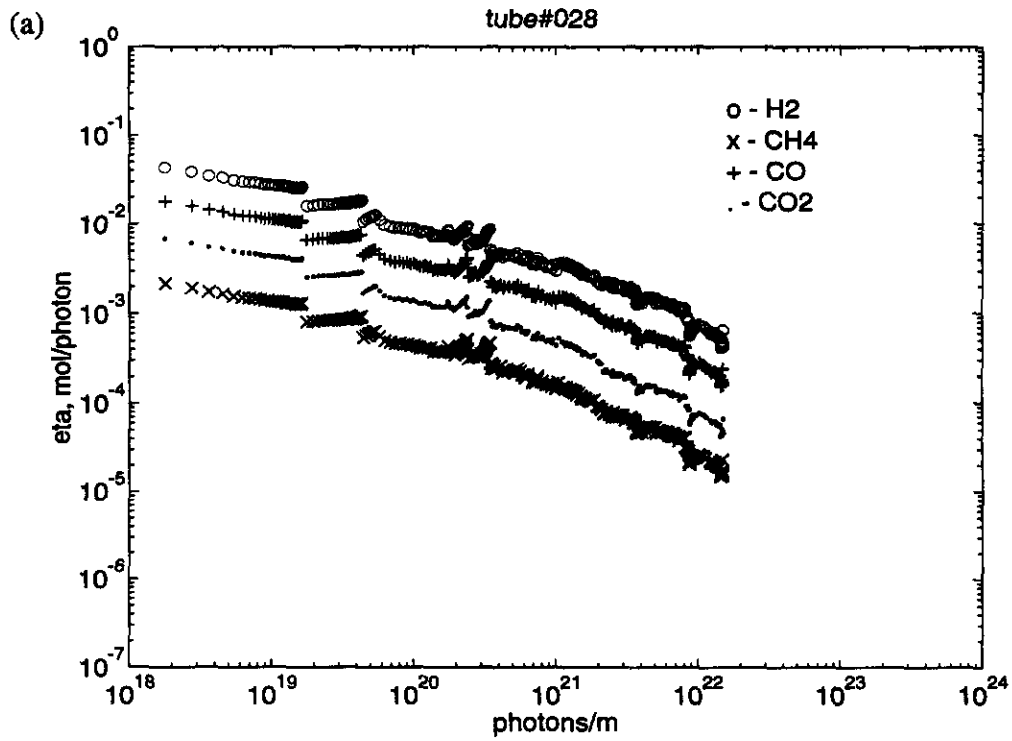
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BINP
Type of test:	warm, no bake, with magnetic field
Experiment #:	3a
Beamline:	SSC2
Date of test:	Jan 11 1993
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

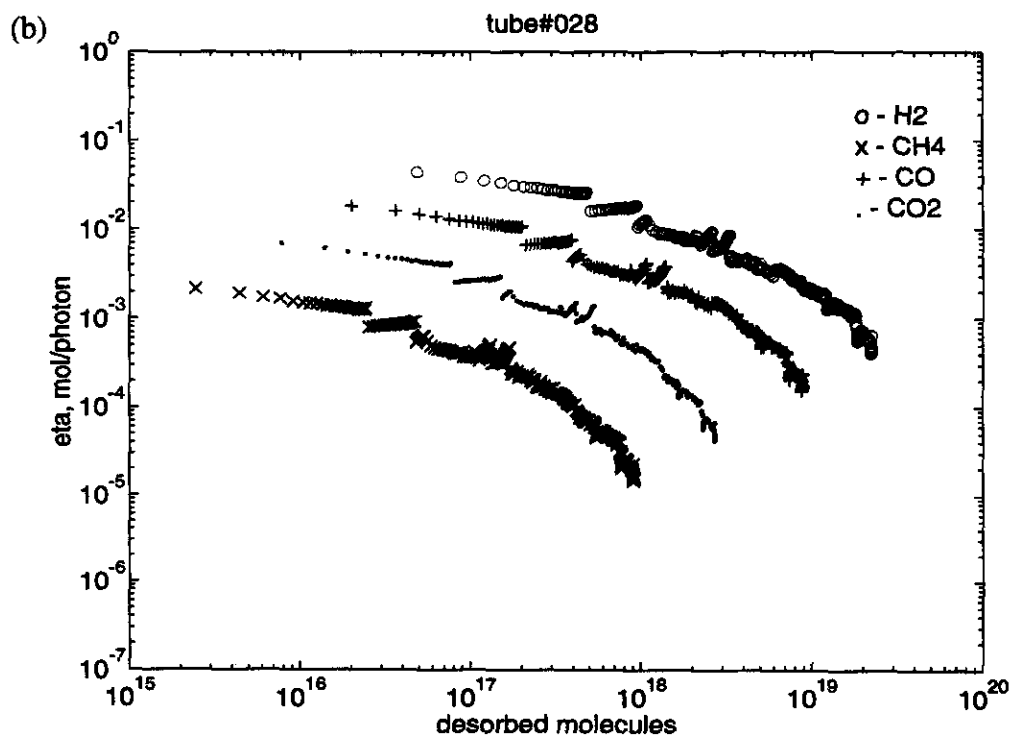
Photodesorption coefficients, molecules/photon

	$1\cdot10^{19}$	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$2.68\cdot10^{-2}$	$1.03\cdot10^{-2}$	$3.39\cdot10^{-3}$	$8.20\cdot10^{-4}$	N/A
CH_4	$1.34\cdot10^{-3}$	$5.28\cdot10^{-4}$	$1.63\cdot10^{-4}$	$2.30\cdot10^{-5}$	N/A
CO	$1.11\cdot10^{-2}$	$4.39\cdot10^{-3}$	$1.43\cdot10^{-3}$	$2.96\cdot10^{-4}$	N/A
CO_2	$4.28\cdot10^{-3}$	$1.65\cdot10^{-3}$	$4.88\cdot10^{-4}$	$6.61\cdot10^{-5}$	N/A

Desorbed gas, molecules/m

	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$1.33\cdot10^{18}$	$5.95\cdot10^{18}$	$1.91\cdot10^{19}$	N/A
CH_4	$6.75\cdot10^{16}$	$2.98\cdot10^{17}$	$8.21\cdot10^{17}$	N/A
CO	$5.58\cdot10^{17}$	$2.53\cdot10^{18}$	$7.76\cdot10^{18}$	N/A
CO_2	$2.13\cdot10^{17}$	$9.15\cdot10^{17}$	$2.44\cdot10^{18}$	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #018

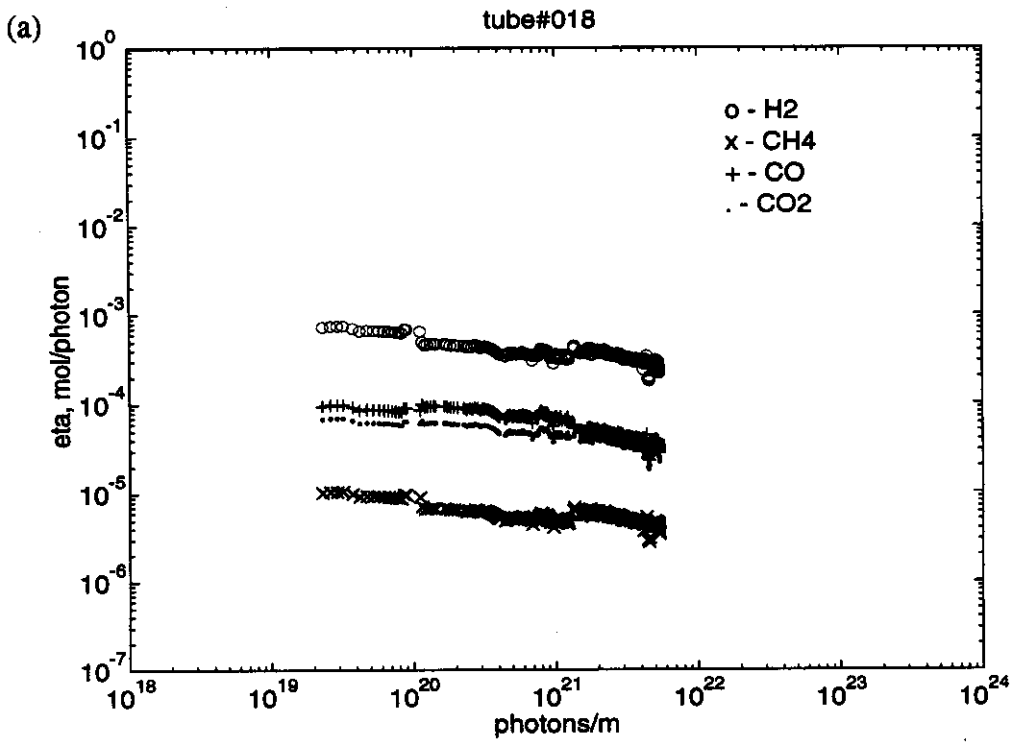
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	CERN procedure (Appendix: 3.2)
Test Laboratory:	BINP
Type of test:	warm, 350°C bake for 24 hrs, no magnetic field
Experiment #:	N/A
Beamline:	SSC2
Date of test:	April 1993
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

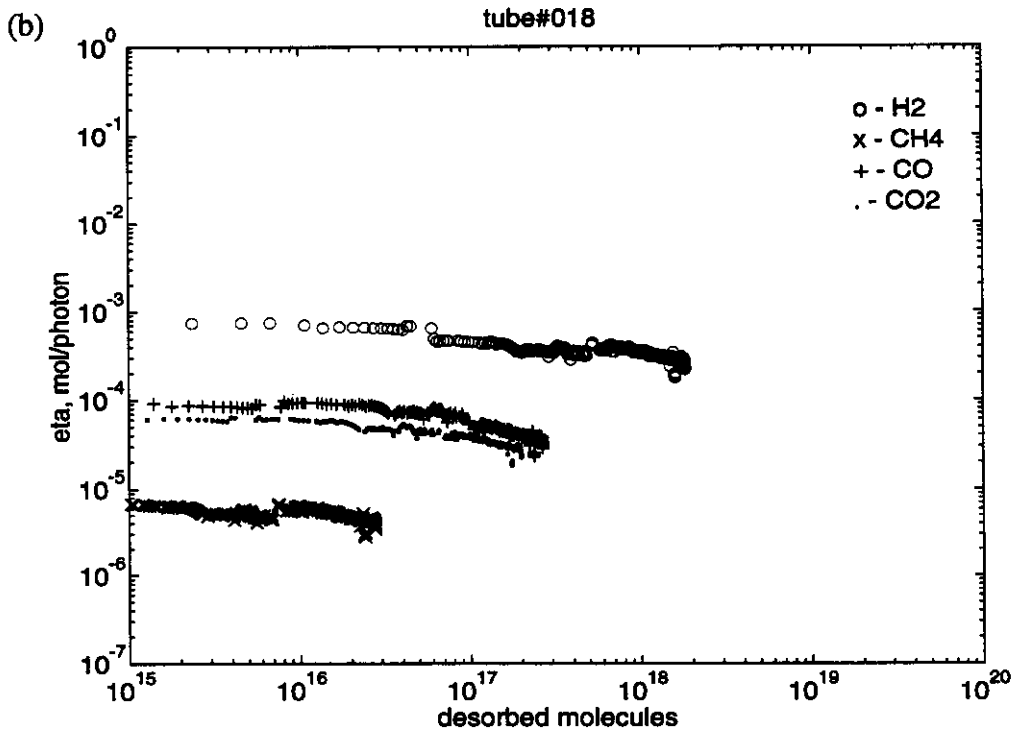
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	N/A	$5.60 \cdot 10^{-4}$	$3.30 \cdot 10^{-4}$	N/A	N/A
CH_4	N/A	$7.70 \cdot 10^{-6}$	$4.90 \cdot 10^{-6}$	N/A	N/A
CO	N/A	$8.80 \cdot 10^{-5}$	$6.80 \cdot 10^{-5}$	N/A	N/A
CO_2	N/A	$5.90 \cdot 10^{-5}$	$4.20 \cdot 10^{-5}$	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$5.30 \cdot 10^{16}$	$4.00 \cdot 10^{17}$	N/A	N/A
CH_4	$7.30 \cdot 10^{14}$	$5.60 \cdot 10^{15}$	N/A	N/A
CO	$6.70 \cdot 10^{15}$	$7.50 \cdot 10^{16}$	N/A	N/A
CO_2	$4.70 \cdot 10^{15}$	$5.00 \cdot 10^{16}$	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #024

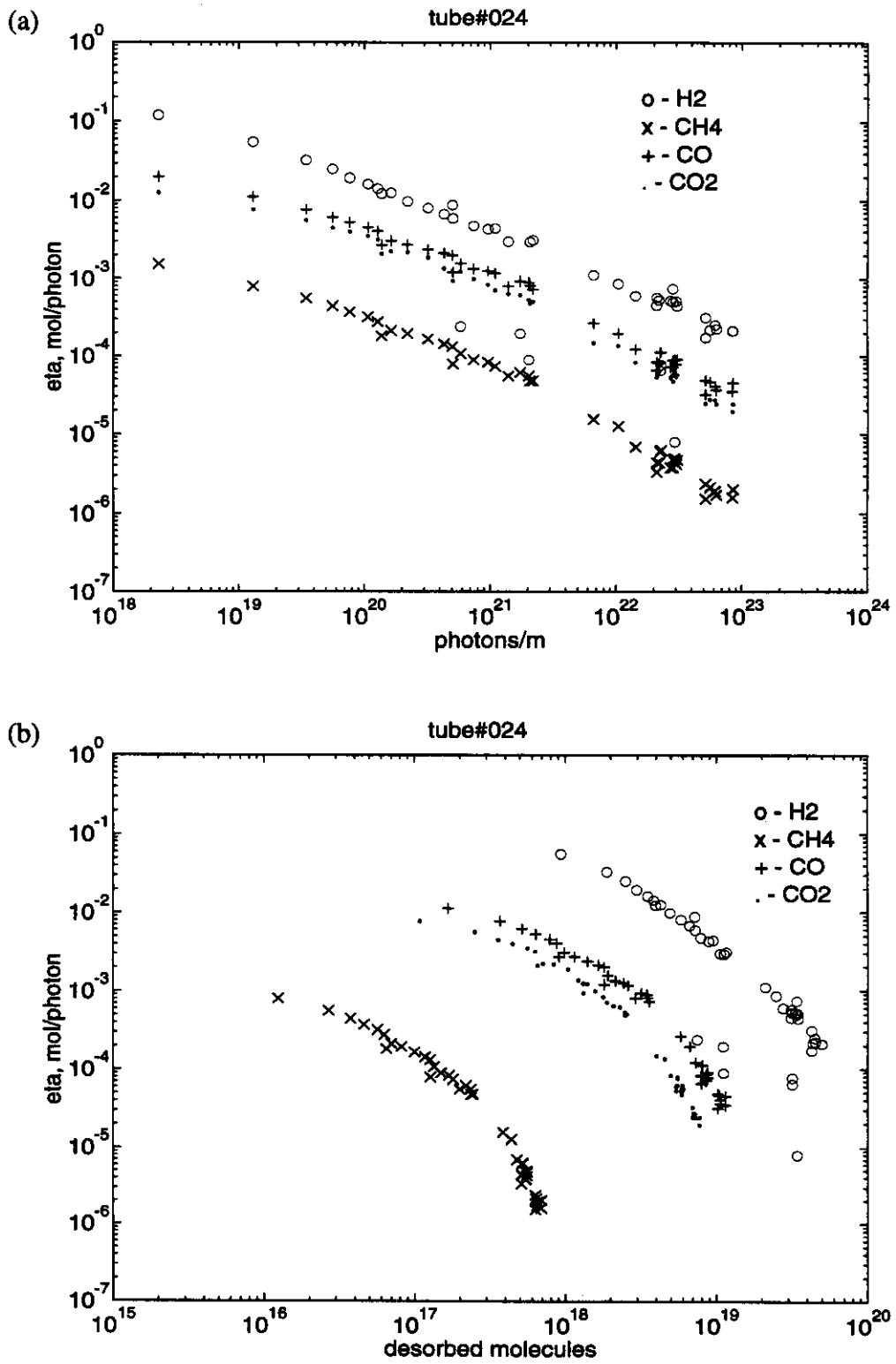
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	1
Beamline:	U10B
Dates of test:	10/29/92-11/12/92
Pumping time before experiment:	72 hrs
Base pressure before experiment:	$1.9 \cdot 10^{-8}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$6.34 \cdot 10^{-2}$	$1.72 \cdot 10^{-2}$	$3.95 \cdot 10^{-3}$	$8.40 \cdot 10^{-4}$	$1.70 \cdot 10^{-4}$
CH_4	$8.58 \cdot 10^{-4}$	$3.13 \cdot 10^{-4}$	$6.78 \cdot 10^{-5}$	$1.22 \cdot 10^{-5}$	$2.06 \cdot 10^{-6}$
CO	$1.22 \cdot 10^{-2}$	$4.42 \cdot 10^{-3}$	$1.06 \cdot 10^{-3}$	$2.21 \cdot 10^{-4}$	$4.35 \cdot 10^{-5}$
CO_2	$8.03 \cdot 10^{-3}$	$3.31 \cdot 10^{-3}$	$7.58 \cdot 10^{-4}$	$1.44 \cdot 10^{-4}$	$2.56 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$2.55 \cdot 10^{18}$	$8.78 \cdot 10^{18}$	$2.24 \cdot 10^{19}$	$5.06 \cdot 10^{19}$
CH_4	$4.31 \cdot 10^{16}$	$1.54 \cdot 10^{17}$	$3.69 \cdot 10^{17}$	$7.40 \cdot 10^{17}$
CO	$6.01 \cdot 10^{17}$	$2.26 \cdot 10^{18}$	$5.90 \cdot 10^{18}$	$1.32 \cdot 10^{19}$
CO_2	$4.41 \cdot 10^{17}$	$1.66 \cdot 10^{18}$	$4.13 \cdot 10^{18}$	$8.64 \cdot 10^{18}$



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #029

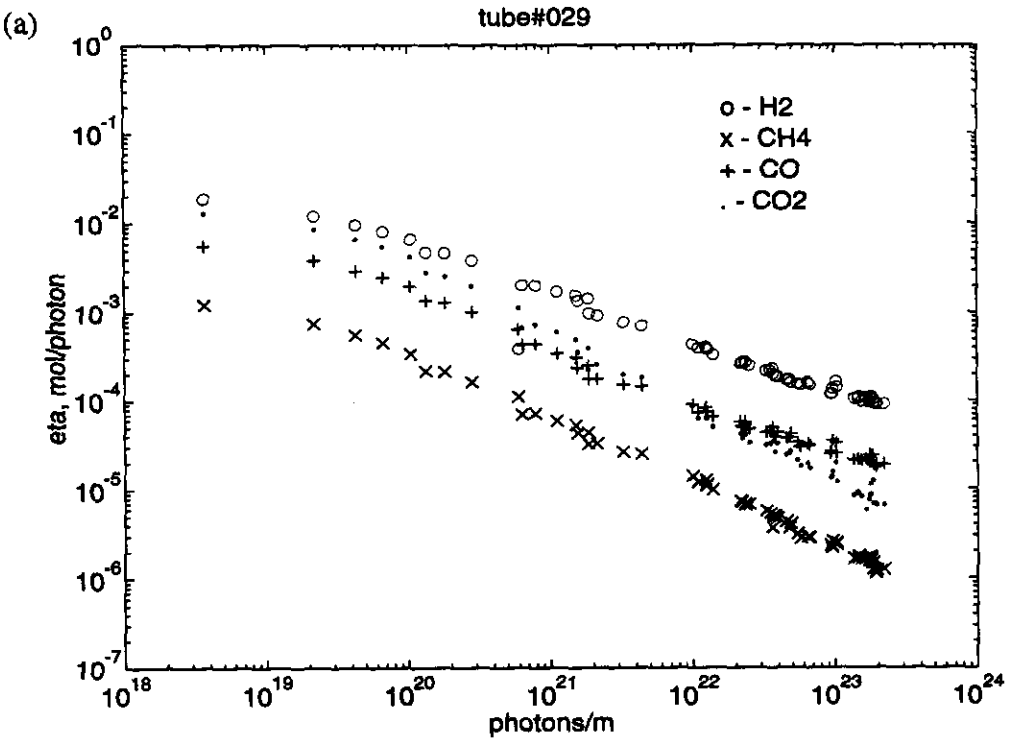
Material:	SS plated by 70 μm of Cu, made by Fluhman in 1992
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	4
Beamline:	U10B
Date of test:	2/2/93-3/24/93
Pumping time before experiment:	96 hrs
Base pressure before experiment:	$1.6 \cdot 10^{-8}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

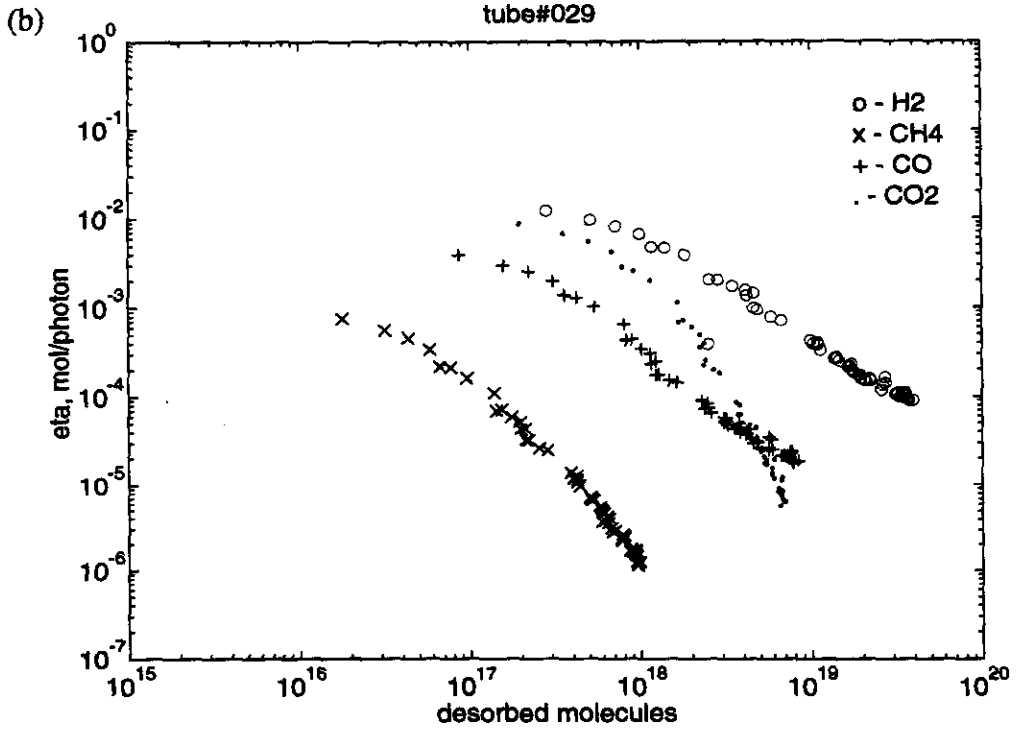
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.19 \cdot 10^{-2}$	$6.36 \cdot 10^{-3}$	$1.52 \cdot 10^{-3}$	$4.42 \cdot 10^{-4}$	$1.31 \cdot 10^{-4}$
CH_4	$6.84 \cdot 10^{-4}$	$3.27 \cdot 10^{-4}$	$6.21 \cdot 10^{-5}$	$1.32 \cdot 10^{-5}$	$2.01 \cdot 10^{-6}$
CO	$4.51 \cdot 10^{-3}$	$1.92 \cdot 10^{-3}$	$3.64 \cdot 10^{-4}$	$8.02 \cdot 10^{-5}$	$2.76 \cdot 10^{-5}$
CO_2	$8.56 \cdot 10^{-3}$	$4.08 \cdot 10^{-3}$	$5.93 \cdot 10^{-4}$	$8.11 \cdot 10^{-5}$	$1.28 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$8.24 \cdot 10^{17}$	$3.16 \cdot 10^{18}$	$9.32 \cdot 10^{18}$	$2.79 \cdot 10^{19}$
CH_4	$4.72 \cdot 10^{16}$	$1.51 \cdot 10^{17}$	$3.67 \cdot 10^{17}$	$7.62 \cdot 10^{17}$
CO	$2.58 \cdot 10^{17}$	$8.96 \cdot 10^{17}$	$2.11 \cdot 10^{18}$	$5.75 \cdot 10^{18}$
CO_2	$5.64 \cdot 10^{17}$	$1.75 \cdot 10^{18}$	$3.32 \cdot 10^{18}$	$5.72 \cdot 10^{18}$





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #030

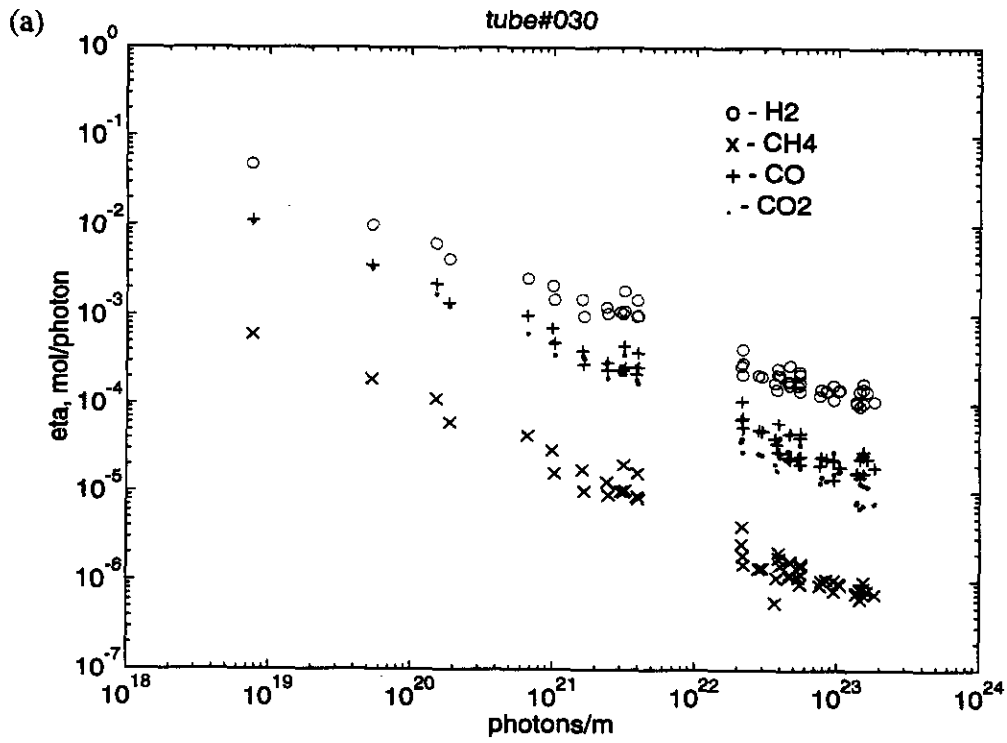
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BNL
Type of test:	warm, no bake, with magnetic field
Experiment #:	3
Beamline:	U10B
Date of test:	12/14/92-1/25/93
Pumping time before experiment:	120 hrs
Base pressure before experiment:	$1.2 \cdot 10^{-8}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

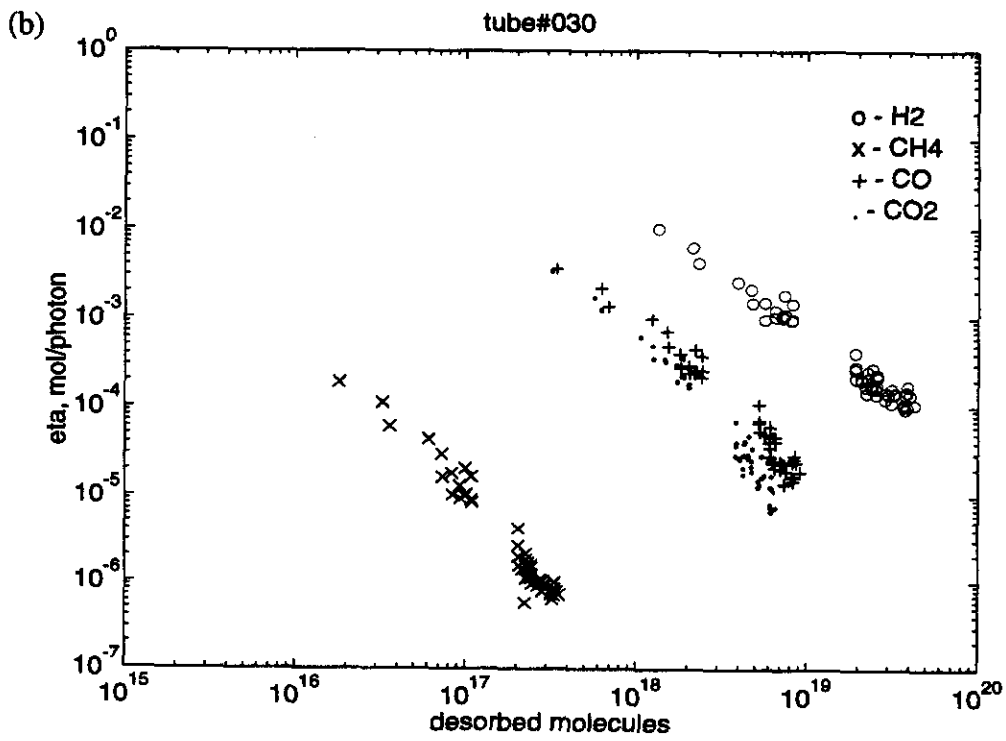
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$3.77 \cdot 10^{-2}$	$6.90 \cdot 10^{-3}$	$1.97 \cdot 10^{-3}$	$5.50 \cdot 10^{-4}$	$1.39 \cdot 10^{-4}$
CH_4	$5.22 \cdot 10^{-4}$	$1.24 \cdot 10^{-4}$	$2.48 \cdot 10^{-5}$	$4.54 \cdot 10^{-6}$	$7.95 \cdot 10^{-7}$
CO	$9.76 \cdot 10^{-3}$	$2.45 \cdot 10^{-3}$	$5.82 \cdot 10^{-4}$	$1.33 \cdot 10^{-4}$	$2.97 \cdot 10^{-5}$
CO_2	$9.27 \cdot 10^{-3}$	$2.17 \cdot 10^{-3}$	$4.48 \cdot 10^{-4}$	$9.06 \cdot 10^{-5}$	$1.82 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.12 \cdot 10^{18}$	$3.90 \cdot 10^{18}$	$1.19 \cdot 10^{19}$	$3.29 \cdot 10^{19}$
CH_4	$1.96 \cdot 10^{16}$	$6.12 \cdot 10^{16}$	$1.40 \cdot 10^{17}$	$2.81 \cdot 10^{17}$
CO	$3.71 \cdot 10^{17}$	$1.27 \cdot 10^{18}$	$3.36 \cdot 10^{18}$	$8.08 \cdot 10^{18}$
CO_2	$3.43 \cdot 10^{17}$	$1.08 \cdot 10^{18}$	$2.58 \cdot 10^{18}$	$5.60 \cdot 10^{18}$





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #032

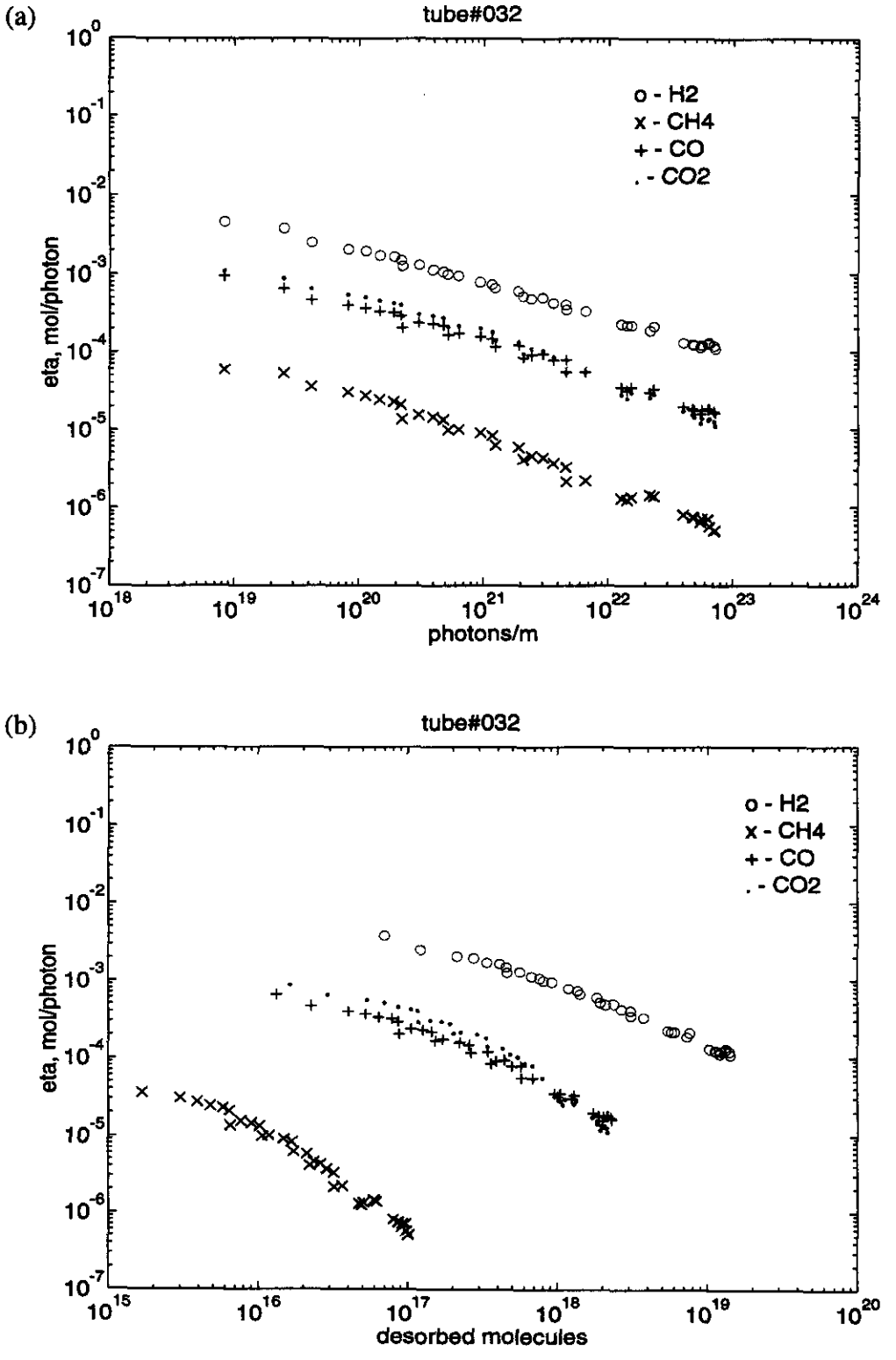
Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BNL
Type of test:	warm, no magnetic field, 350C bake at SSC for 24 hrs, shiped to BNL under vacuum
Experiment #:	5
Beamline:	U10B
Date of test:	3/31/93-4/16/93
Pumping time before experiment:	144 hrs
Base pressure before experiment:	$1.2 \cdot 10^{-9}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$4.41 \cdot 10^{-3}$	$2.01 \cdot 10^{-3}$	$7.41 \cdot 10^{-4}$	$2.63 \cdot 10^{-4}$	$9.26 \cdot 10^{-5}$
CH_4	$5.96 \cdot 10^{-5}$	$2.77 \cdot 10^{-5}$	$7.98 \cdot 10^{-6}$	$2.03 \cdot 10^{-6}$	$4.85 \cdot 10^{-7}$
CO	$8.72 \cdot 10^{-4}$	$3.70 \cdot 10^{-4}$	$1.40 \cdot 10^{-4}$	$4.63 \cdot 10^{-5}$	$1.38 \cdot 10^{-5}$
CO_2	$1.05 \cdot 10^{-3}$	$5.11 \cdot 10^{-4}$	$1.70 \cdot 10^{-4}$	$4.56 \cdot 10^{-5}$	$1.08 \cdot 10^{-5}$

Desorbed gas, molecules/m

	thermally desorbed gas for 24 hrs bake	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$2.3 \cdot 10^{20}$	$2.47 \cdot 10^{17}$	$1.21 \cdot 10^{18}$	$4.64 \cdot 10^{18}$	$1.68 \cdot 10^{19}$
CH_4	$4.5 \cdot 10^{17}$	$3.52 \cdot 10^{15}$	$1.50 \cdot 10^{16}$	$4.56 \cdot 10^{16}$	$1.20 \cdot 10^{17}$
CO	$4.5 \cdot 10^{18}$	$4.51 \cdot 10^{16}$	$2.26 \cdot 10^{17}$	$8.55 \cdot 10^{17}$	$2.80 \cdot 10^{18}$
CO_2	$2.0 \cdot 10^{18}$	$6.13 \cdot 10^{16}$	$2.94 \cdot 10^{17}$	$9.69 \cdot 10^{17}$	$2.65 \cdot 10^{18}$



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #032r

Material:	rotated tube 032, SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	see tube #032
Test Laboratory:	BNL
Type of test:	tube 032 was rotated by 140 degrees under vacuum
Experiment #:	6
Beamline:	U10B
Date of test:	5/17/93-6/15/93
Pumping time before experiment:	240 hrs
Base pressure before experiment:	$4.5 \cdot 10^{-10}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

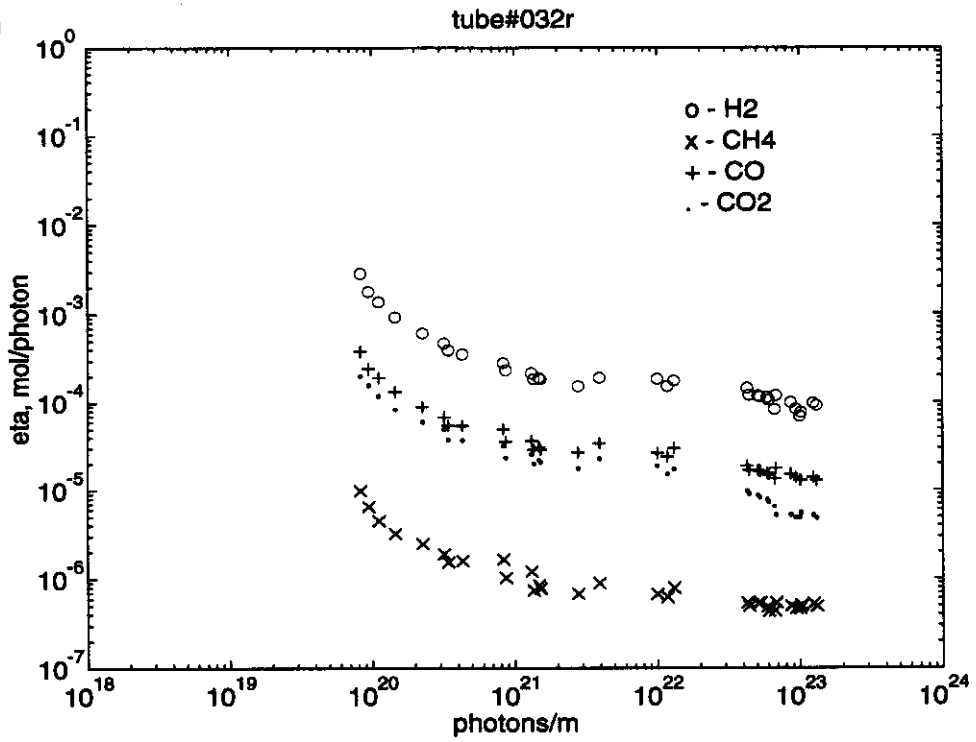
Photodesorption coefficients, molecules/photon

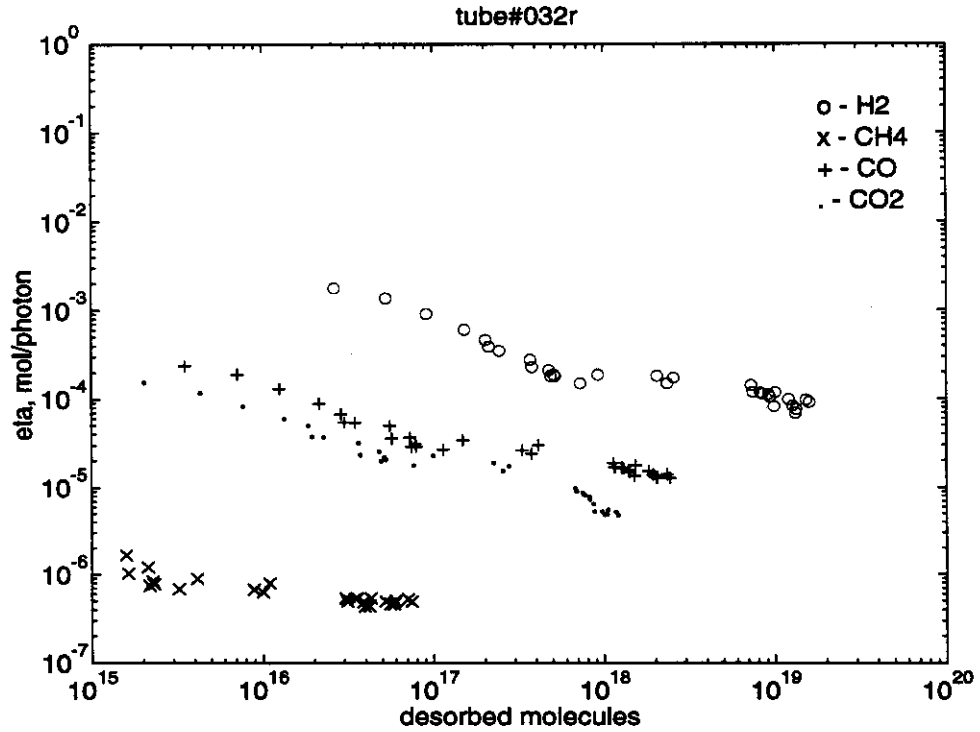
	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	N/A	$1.60 \cdot 10^{-3}$	$2.10 \cdot 10^{-4}$	$1.60 \cdot 10^{-4}$	$8.90 \cdot 10^{-5}$
CH_4	N/A	$5.60 \cdot 10^{-6}$	$1.20 \cdot 10^{-6}$	$6.70 \cdot 10^{-7}$	$4.80 \cdot 10^{-7}$
CO	N/A	$2.10 \cdot 10^{-4}$	$3.60 \cdot 10^{-5}$	$2.60 \cdot 10^{-5}$	$1.30 \cdot 10^{-5}$
CO_2	N/A	$1.40 \cdot 10^{-4}$	$2.60 \cdot 10^{-5}$	$1.60 \cdot 10^{-5}$	$5.00 \cdot 10^{-6}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$3.80 \cdot 10^{16}$	$4.30 \cdot 10^{17}$	$2.05 \cdot 10^{18}$	$1.30 \cdot 10^{19}$
CH_4	$1.30 \cdot 10^{14}$	$1.90 \cdot 10^{15}$	$9.20 \cdot 10^{15}$	$6.00 \cdot 10^{16}$
CO	$5.30 \cdot 10^{15}$	$6.20 \cdot 10^{16}$	$3.20 \cdot 10^{17}$	$2.05 \cdot 10^{18}$
CO_2	$3.10 \cdot 10^{15}$	$4.10 \cdot 10^{16}$	$2.30 \cdot 10^{17}$	$1.04 \cdot 10^{18}$

(a)





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #033

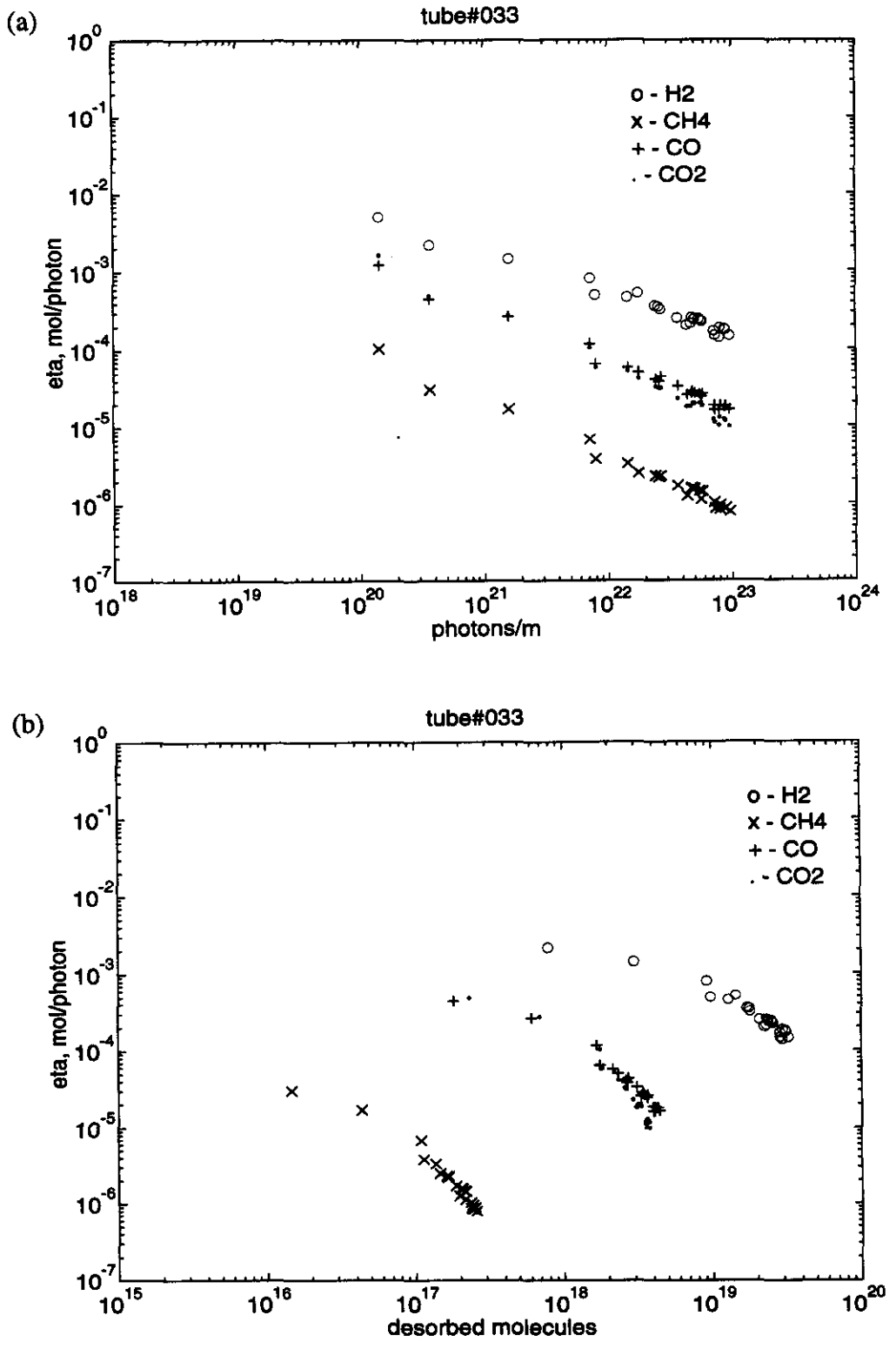
Material:	SS plated by 70 μm of Cu and 2 μm of Au, made by Silvex in 1993
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	7
Beamline:	U10B
Date of test:	7/12/93-7/29/93
Pumping time before experiment:	432 hrs
Base pressure before experiment:	$6.6 \cdot 10^{-9}$Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	N/A	$5.60 \cdot 10^{-3}$	$1.70 \cdot 10^{-3}$	$6.20 \cdot 10^{-4}$	$1.50 \cdot 10^{-4}$
CH_4	N/A	$1.20 \cdot 10^{-4}$	$2.20 \cdot 10^{-5}$	$4.20 \cdot 10^{-6}$	$7.60 \cdot 10^{-7}$
CO	N/A	$1.50 \cdot 10^{-3}$	$3.40 \cdot 10^{-4}$	$7.60 \cdot 10^{-5}$	$1.60 \cdot 10^{-5}$
CO_2	N/A	$2.00 \cdot 10^{-3}$	$3.50 \cdot 10^{-4}$	$7.60 \cdot 10^{-5}$	$1.00 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$2.50 \cdot 10^{17}$	$2.00 \cdot 10^{18}$	$1.10 \cdot 10^{19}$	$3.30 \cdot 10^{19}$
CH_4	N/A	$3.10 \cdot 10^{16}$	$1.30 \cdot 10^{17}$	$2.60 \cdot 10^{17}$
CO	$6.00 \cdot 10^{16}$	$4.20 \cdot 10^{17}$	$1.90 \cdot 10^{18}$	$4.40 \cdot 10^{18}$
CO_2	$8.50 \cdot 10^{16}$	$4.80 \cdot 10^{17}$	$2.00 \cdot 10^{18}$	$3.70 \cdot 10^{18}$



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #034

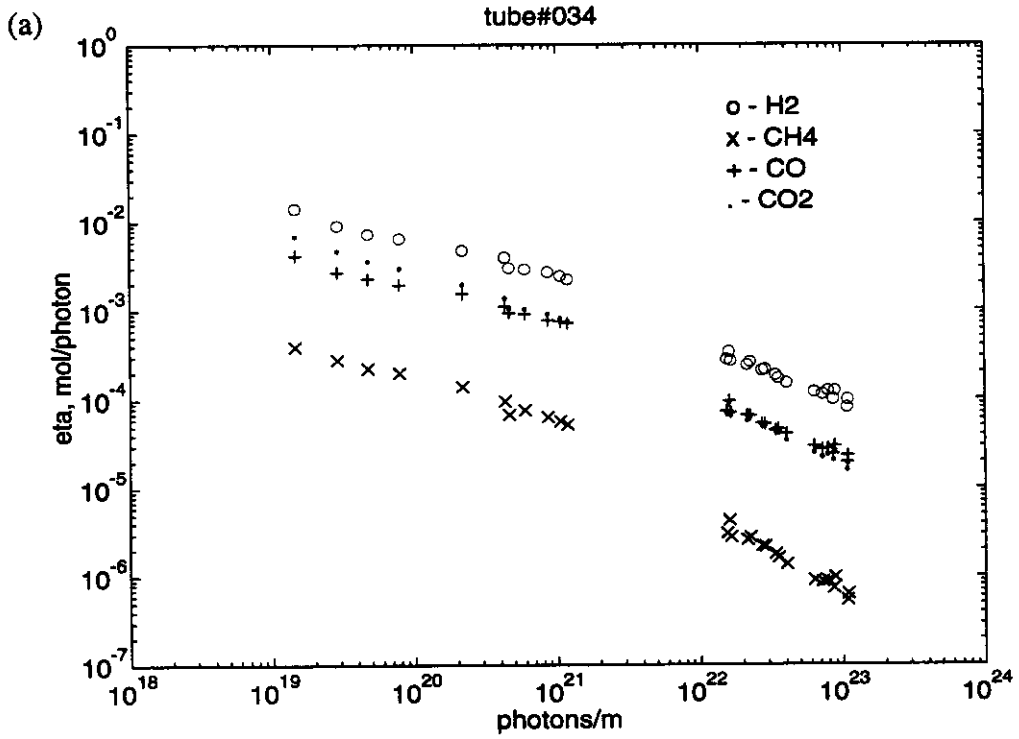
Material:	SS plated by 70 μm of Cu, made by Silvex in 1993
Treatment:	BNL procedure (Appendix: 3.1)
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	8
Beamline:	U10B
Date of test:	8/6/93-8/23/93
Pumping time before experiment:	172 hrs
Base pressure before experiment:	$8.1 \cdot 10^{-9}$Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

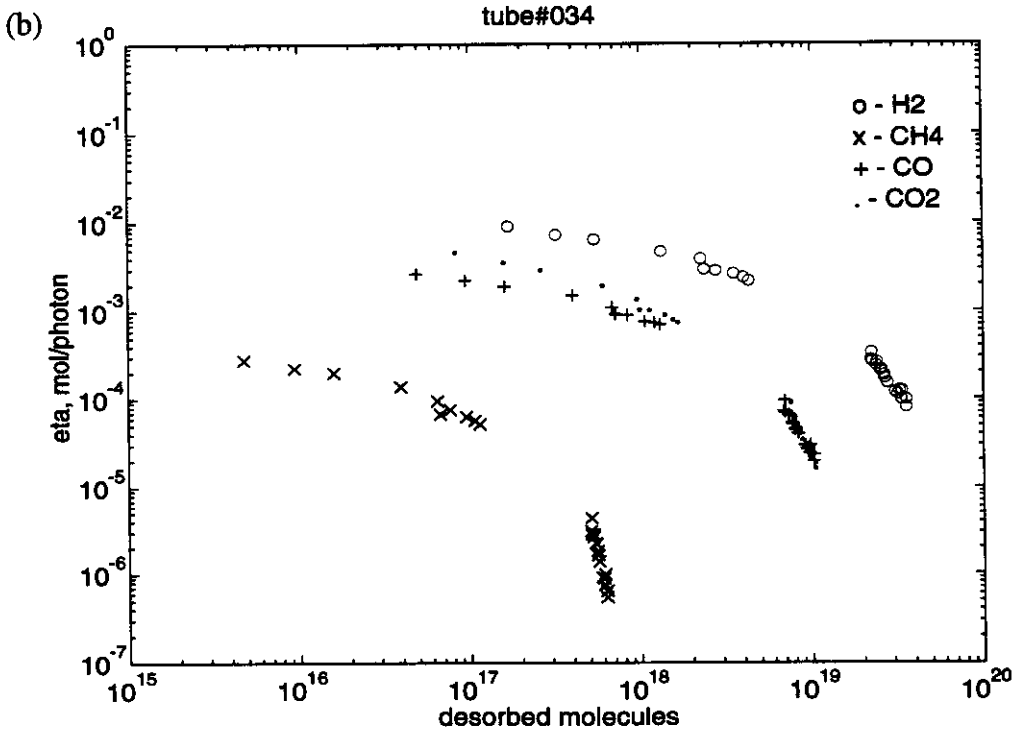
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.70 \cdot 10^{-2}$	$5.90 \cdot 10^{-3}$	$2.40 \cdot 10^{-3}$	$4.10 \cdot 10^{-4}$	$8.90 \cdot 10^{-5}$
CH_4	$4.30 \cdot 10^{-4}$	$1.80 \cdot 10^{-4}$	$5.50 \cdot 10^{-5}$	$6.40 \cdot 10^{-6}$	$6.00 \cdot 10^{-7}$
CO	$4.60 \cdot 10^{-3}$	$1.90 \cdot 10^{-3}$	$7.40 \cdot 10^{-4}$	$1.10 \cdot 10^{-4}$	$2.10 \cdot 10^{-5}$
CO_2	$7.70 \cdot 10^{-3}$	$2.70 \cdot 10^{-3}$	$7.90 \cdot 10^{-4}$	$1.10 \cdot 10^{-4}$	$1.60 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$7.50 \cdot 10^{17}$	$4.00 \cdot 10^{18}$	$1.80 \cdot 10^{19}$	$3.50 \cdot 10^{19}$
CH_4	$2.00 \cdot 10^{16}$	$1.00 \cdot 10^{17}$	$4.10 \cdot 10^{17}$	$6.10 \cdot 10^{17}$
CO	$2.00 \cdot 10^{17}$	$1.20 \cdot 10^{18}$	$5.90 \cdot 10^{18}$	$1.00 \cdot 10^{19}$
CO_2	$3.10 \cdot 10^{17}$	$1.50 \cdot 10^{18}$	$5.40 \cdot 10^{18}$	$1.01 \cdot 10^{19}$





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #008v

Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	VPI treated, 700C-2hrs,scanning annealing in 10%H_2+90%He atmosphere, Au flashed 200-300 Å*
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	9
Beamline:	U10B
Date of test:	8/30/93-9/16/93
Pumping time before experiment:	144 hrs
Base pressure before experiment:	$1.1 \cdot 10^{-8}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

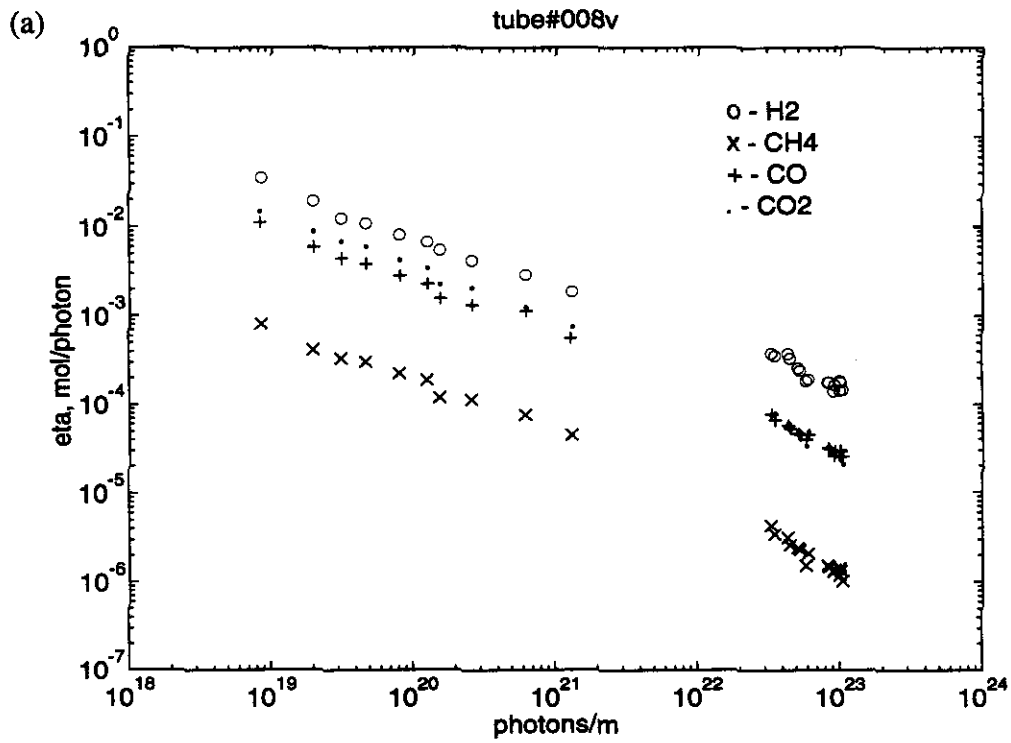
*. B. He et. al. Preprint SSCL-N-849 (1994)

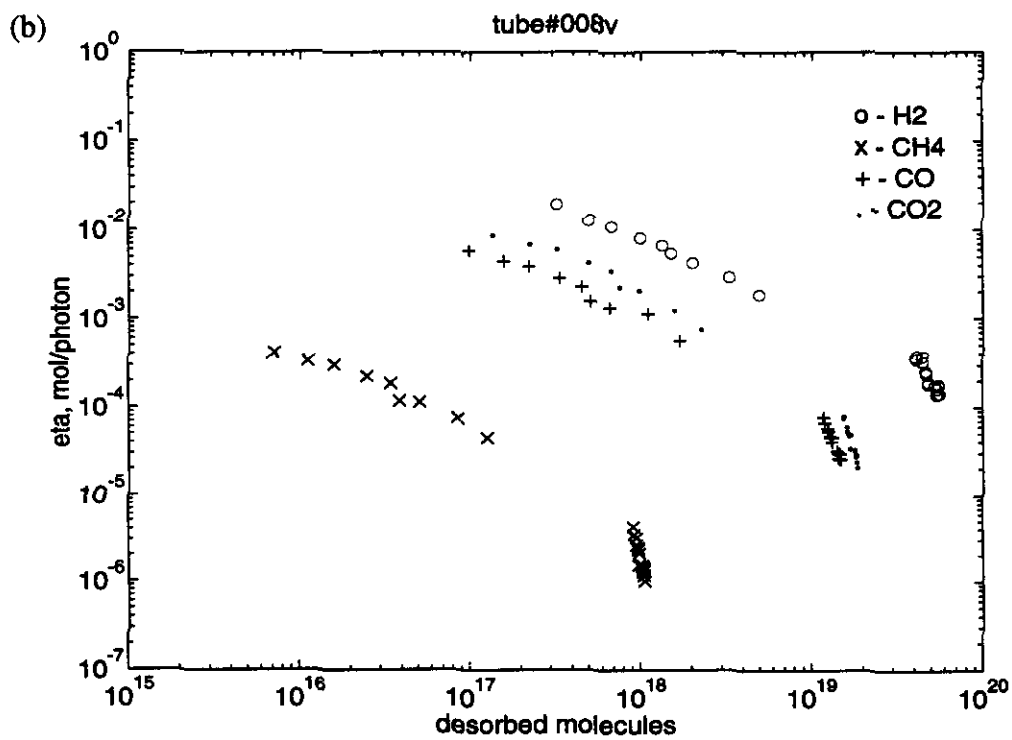
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$3.10 \cdot 10^{-2}$	$7.40 \cdot 10^{-3}$	$2.10 \cdot 10^{-3}$	$6.90 \cdot 10^{-4}$	$1.50 \cdot 10^{-4}$
CH_4	$7.10 \cdot 10^{-4}$	$1.90 \cdot 10^{-4}$	$5.20 \cdot 10^{-5}$	$9.60 \cdot 10^{-6}$	$1.10 \cdot 10^{-6}$
CO	$1.00 \cdot 10^{-2}$	$2.30 \cdot 10^{-3}$	$6.30 \cdot 10^{-4}$	$1.80 \cdot 10^{-4}$	$2.70 \cdot 10^{-5}$
CO_2	$1.30 \cdot 10^{-2}$	$3.20 \cdot 10^{-3}$	$7.90 \cdot 10^{-4}$	$1.70 \cdot 10^{-4}$	$2.20 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.20 \cdot 10^{18}$	$4.50 \cdot 10^{18}$	$1.90 \cdot 10^{19}$	$5.60 \cdot 10^{19}$
CH_4	$2.90 \cdot 10^{16}$	$1.10 \cdot 10^{17}$	$4.00 \cdot 10^{17}$	$1.00 \cdot 10^{18}$
CO	$3.90 \cdot 10^{17}$	$1.50 \cdot 10^{18}$	$5.00 \cdot 10^{18}$	$1.40 \cdot 10^{19}$
CO_2	$5.90 \cdot 10^{17}$	$2.00 \cdot 10^{18}$	$6.00 \cdot 10^{18}$	$1.80 \cdot 10^{19}$





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #007v

Material:	SS plated by 70 μm of Cu, made by Silvex in 1988-90
Treatment:	VPI treated, 700C-5hrs, annealing in 10%H_2+90%He atmosphere *
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	10
Beamline:	U10B
Date of test:	10/15/93-11/3/93
Pumping time before experiment:	96 hrs
Base pressure before experiment:	$6.7 \cdot 10^{-9}$ Torr
Critical energy:	490 eV
Angle of incidence:	12 mrad

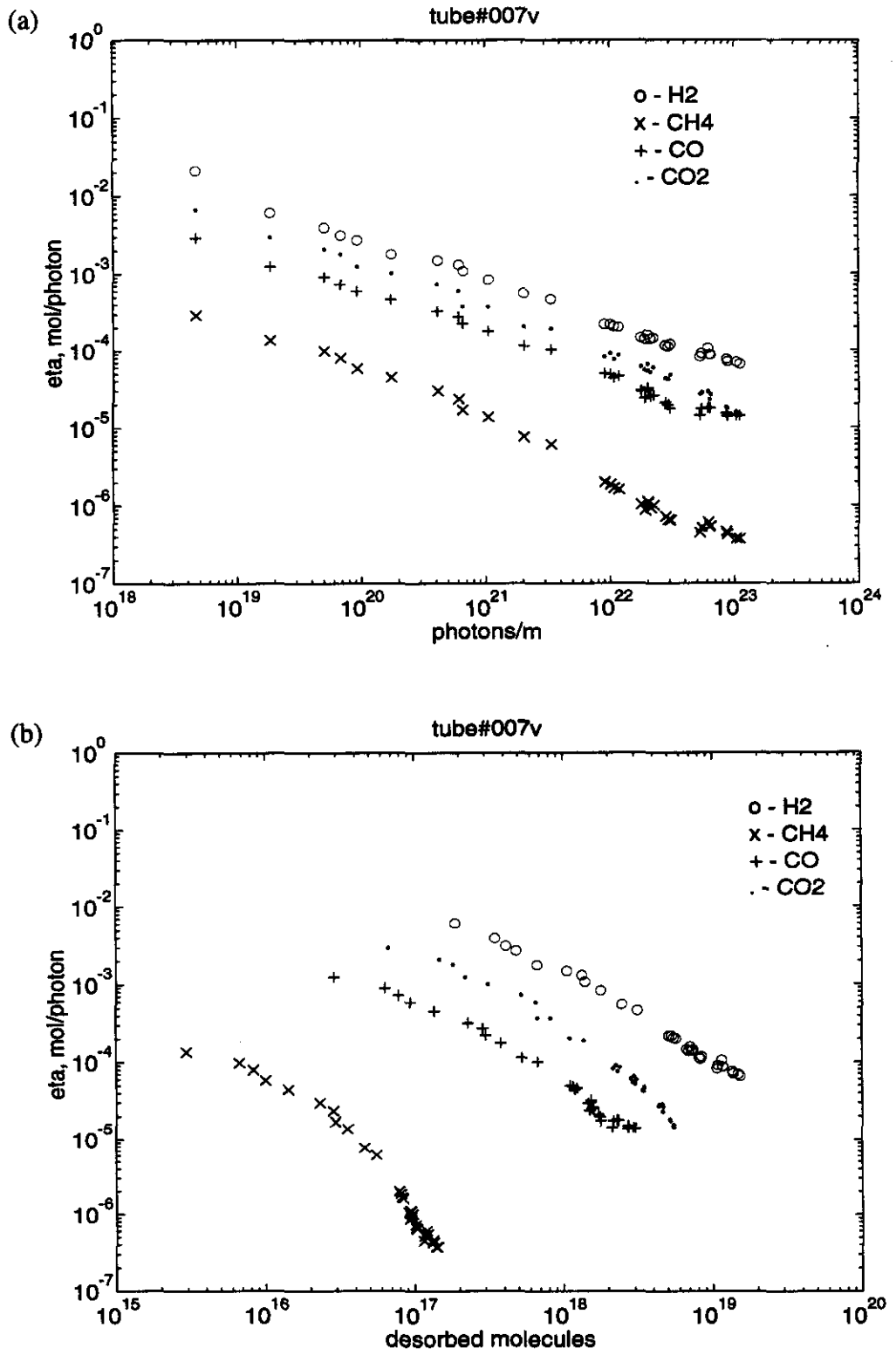
*. B. He et. al. Preprint SSCL-N-849 (1994)

Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.00 \cdot 10^{-2}$	$2.60 \cdot 10^{-3}$	$8.50 \cdot 10^{-4}$	$2.10 \cdot 10^{-4}$	$6.80 \cdot 10^{-5}$
CH_4	$2.00 \cdot 10^{-4}$	$5.70 \cdot 10^{-5}$	$1.40 \cdot 10^{-5}$	$1.80 \cdot 10^{-6}$	$3.80 \cdot 10^{-7}$
CO	$2.00 \cdot 10^{-3}$	$5.60 \cdot 10^{-4}$	$1.80 \cdot 10^{-4}$	$4.50 \cdot 10^{-5}$	$1.40 \cdot 10^{-5}$
CO_2	$4.20 \cdot 10^{-3}$	$1.30 \cdot 10^{-3}$	$3.80 \cdot 10^{-4}$	$8.60 \cdot 10^{-5}$	$1.60 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$5.20 \cdot 10^{17}$	$1.80 \cdot 10^{18}$	$5.40 \cdot 10^{18}$	$1.47 \cdot 10^{19}$
CH_4	$1.00 \cdot 10^{16}$	$3.50 \cdot 10^{16}$	$8.30 \cdot 10^{16}$	$1.40 \cdot 10^{17}$
CO	$1.00 \cdot 10^{17}$	$3.80 \cdot 10^{17}$	$1.10 \cdot 10^{18}$	$2.90 \cdot 10^{18}$
CO_2	$2.30 \cdot 10^{17}$	$8.30 \cdot 10^{17}$	$2.20 \cdot 10^{18}$	$5.40 \cdot 10^{18}$



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #010

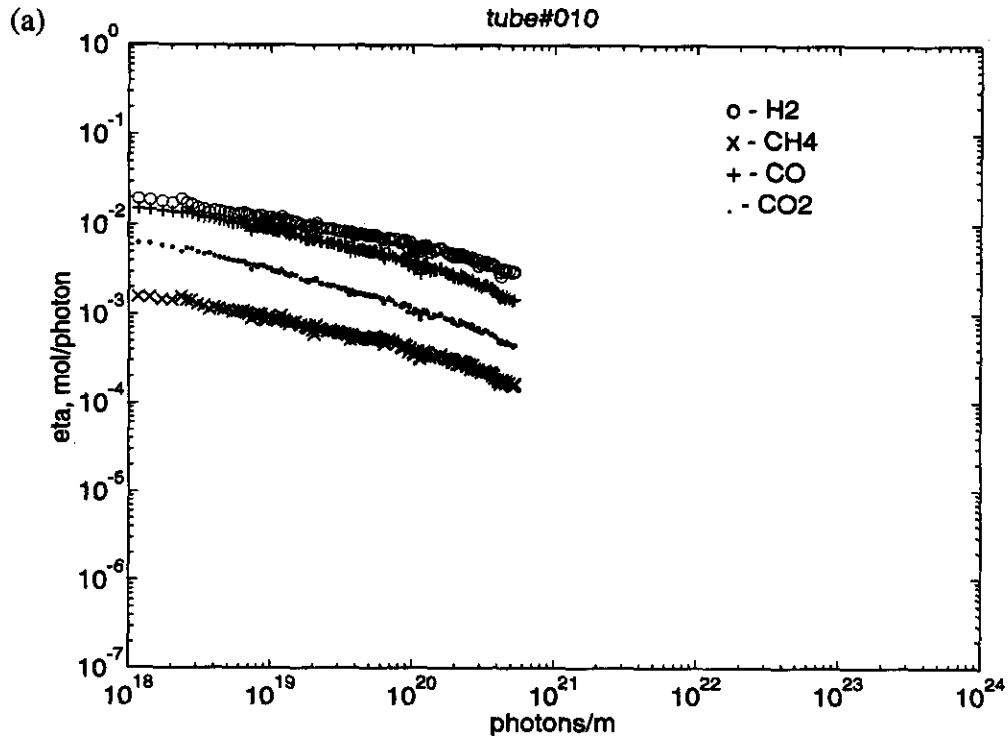
Material:	OFHC Cu Hitachi (10100)
Treatment:	BNL procedure (Appendix: 2.1)
Test Laboratory:	BINP
Type of test:	warm, in situ bake 150C for 24 hrs, no magnetic field
Experiment #:	8e
Beamline:	SSC1
Date of test:	Oct 8 1992
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

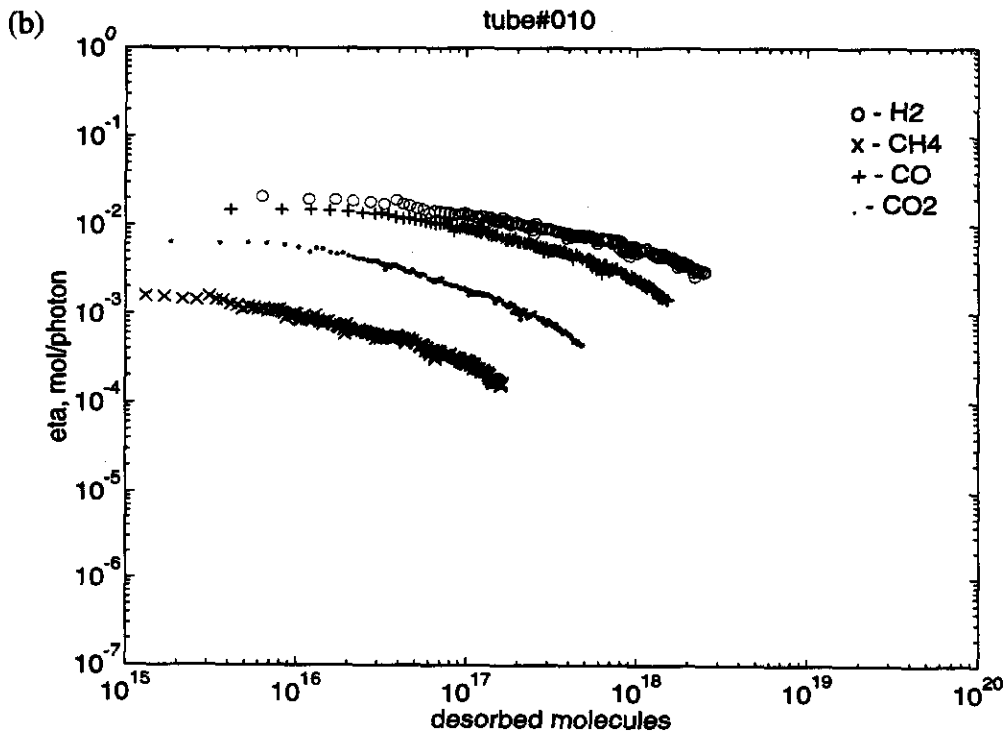
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.17 \cdot 10^{-2}$	$5.78 \cdot 10^{-3}$	N/A	N/A	N/A
CH_4	$8.90 \cdot 10^{-4}$	$3.92 \cdot 10^{-4}$	N/A	N/A	N/A
CO	$8.79 \cdot 10^{-3}$	$3.68 \cdot 10^{-3}$	N/A	N/A	N/A
CO_2	$3.16 \cdot 10^{-3}$	$1.14 \cdot 10^{-3}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$6.69 \cdot 10^{17}$	N/A	N/A	N/A
CH_4	$4.81 \cdot 10^{16}$	N/A	N/A	N/A
CO	$4.61 \cdot 10^{17}$	N/A	N/A	N/A
CO_2	$1.51 \cdot 10^{17}$	N/A	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #011

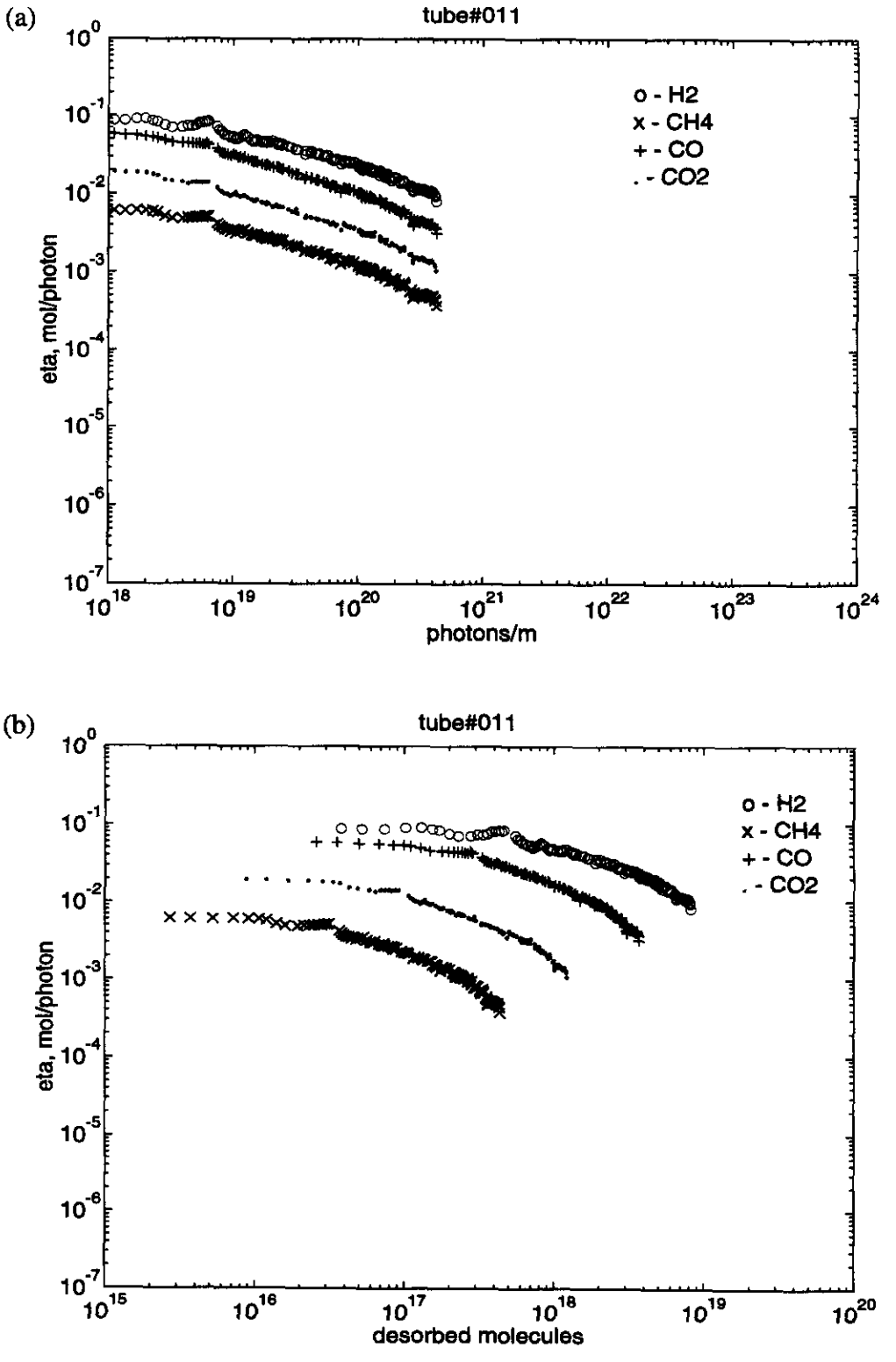
Material:	OFHC Cu Hitachi (10100)
Treatment:	BNL procedure (Appendix: 2.1)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	8f
Beamline:	SSC1
Date of test:	Oct 1 1992
Pumping time before experiment:	104 hrs
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

Photodesorption coefficients, molecules/photon

	$1\cdot10^{19}$	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$5.91\cdot10^{-2}$	$2.24\cdot10^{-2}$	N/A	N/A	N/A
CH_4	$3.64\cdot10^{-3}$	$1.23\cdot10^{-3}$	N/A	N/A	N/A
CO	$3.20\cdot10^{-2}$	$9.79\cdot10^{-3}$	N/A	N/A	N/A
CO_2	$1.02\cdot10^{-2}$	$3.22\cdot10^{-3}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$2.92\cdot10^{18}$	N/A	N/A	N/A
CH_4	$1.71\cdot10^{17}$	N/A	N/A	N/A
CO	$1.39\cdot10^{18}$	N/A	N/A	N/A
CO_2	$4.52\cdot10^{17}$	N/A	N/A	N/A



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #012

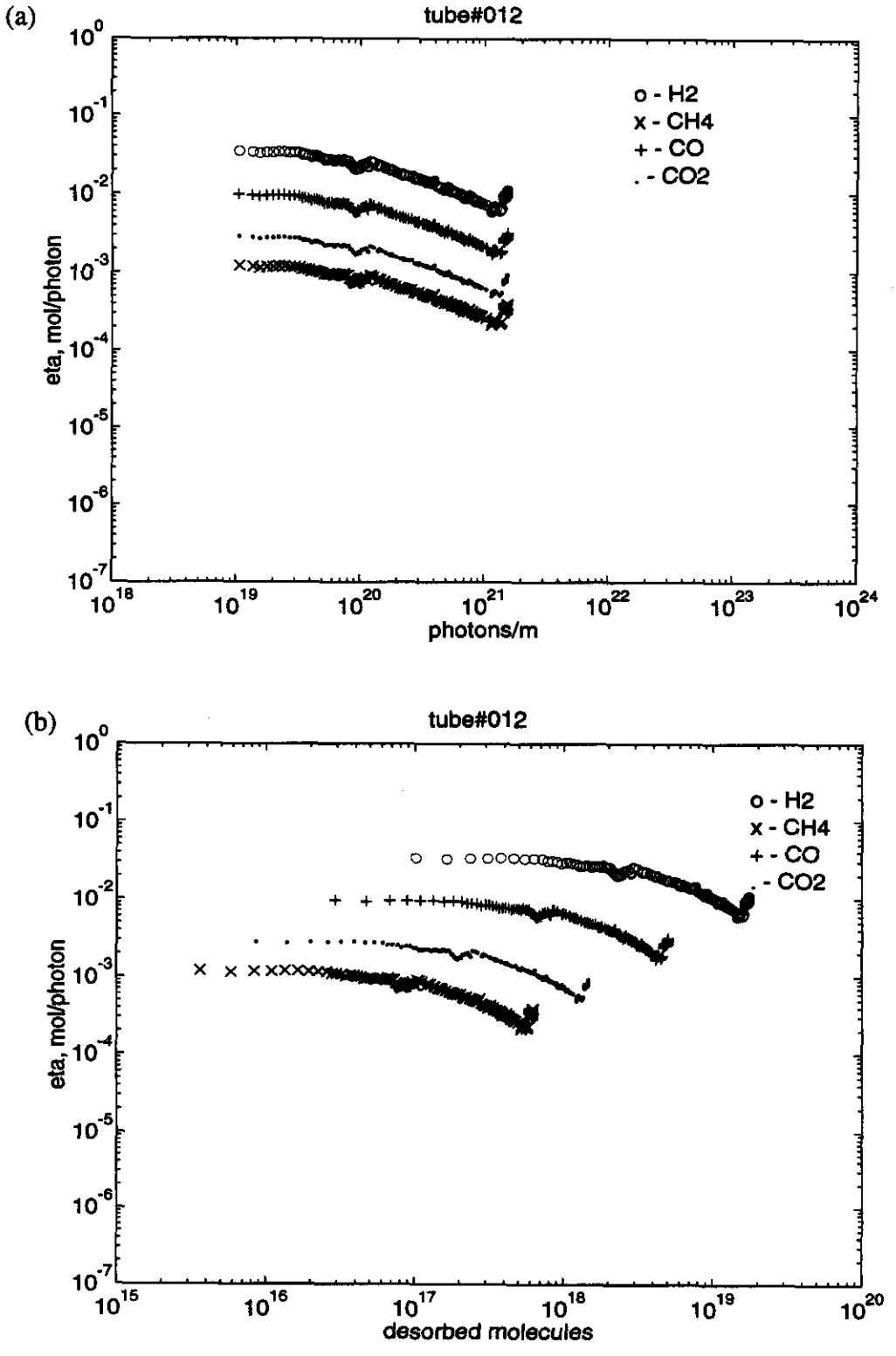
Material:	OFHC Cu Hitachi (10100)
Treatment:	BNL procedure (Appendix: 2.1)
Test Laboratory:	BINP
Type of test:	warm, no bake, with magnetic field
Experiment #:	8g
Beamline:	SSC2
Date of test:	Dec 3 1992
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

Photodesorption coefficients, molecules/photon

	$1\cdot10^{19}$	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$3.45\cdot10^{-2}$	$2.34\cdot10^{-2}$	$7.15\cdot10^{-3}$	N/A	N/A
CH_4	$1.22\cdot10^{-3}$	$8.31\cdot10^{-4}$	$2.54\cdot10^{-4}$	N/A	N/A
CO	$9.85\cdot10^{-3}$	$6.69\cdot10^{-3}$	$2.04\cdot10^{-3}$	N/A	N/A
CO_2	$2.88\cdot10^{-3}$	$1.96\cdot10^{-3}$	$5.99\cdot10^{-4}$	N/A	N/A

Desorbed gas, molecules/m

	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$2.54\cdot10^{18}$	$1.35\cdot10^{19}$	N/A	N/A
CH_4	$9.01\cdot10^{16}$	$4.80\cdot10^{17}$	N/A	N/A
CO	$7.25\cdot10^{17}$	$3.87\cdot10^{18}$	N/A	N/A
CO_2	$2.12\cdot10^{17}$	$1.13\cdot10^{18}$	N/A	N/A



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #022

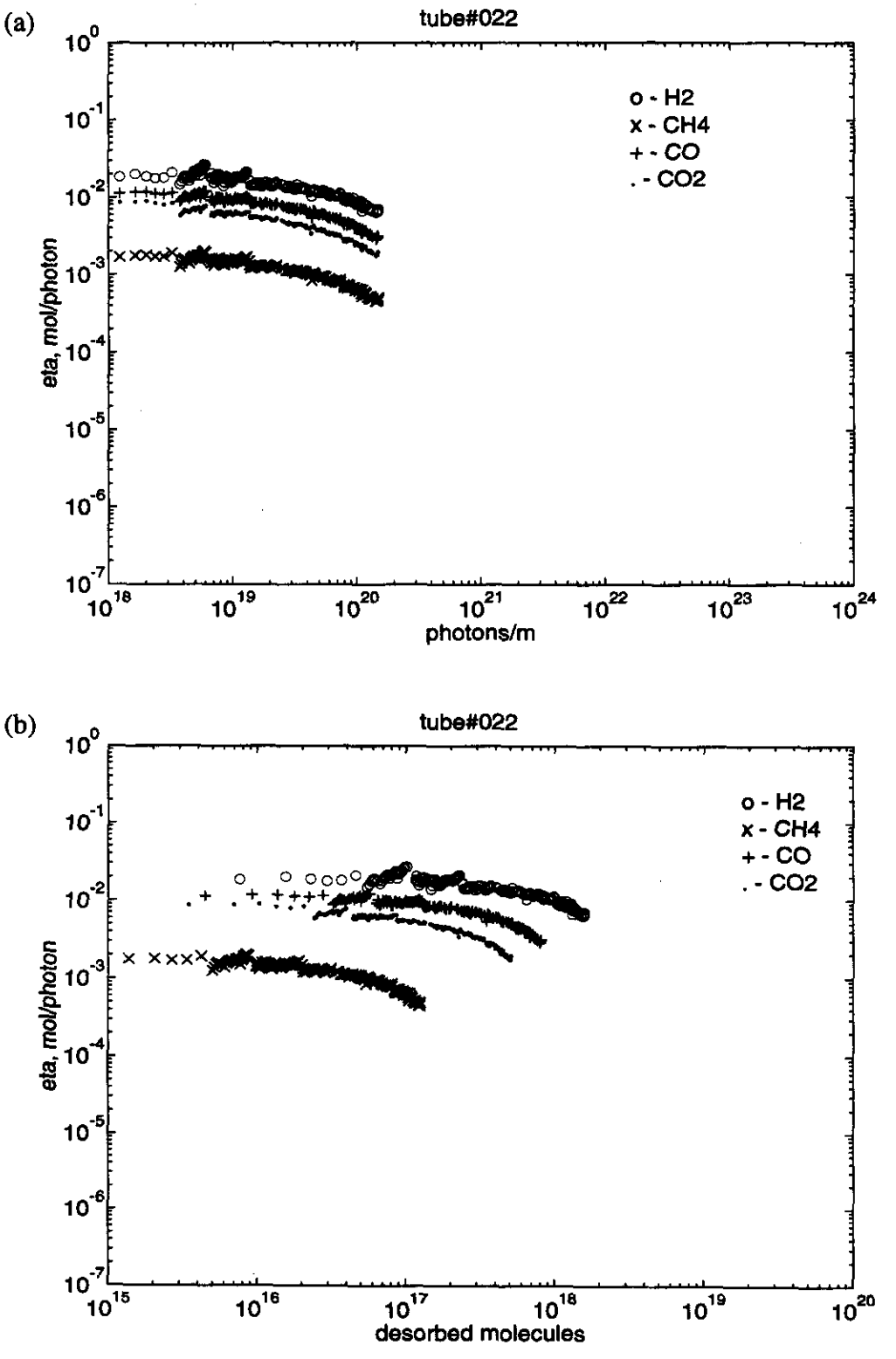
Material:	OFHC Cu Hitachi (10100)
Treatment:	CERN procedure (Appendix: 2.2)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	8c
Beamline:	SSC1
Date of test:	Oct 19 1992
Pumping time before experiment:	63 hrs
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.82 \cdot 10^{-2}$	$8.50 \cdot 10^{-3}$	N/A	N/A	N/A
CH_4	$1.49 \cdot 10^{-3}$	$6.30 \cdot 10^{-4}$	N/A	N/A	N/A
CO	$9.47 \cdot 10^{-3}$	$4.08 \cdot 10^{-3}$	N/A	N/A	N/A
CO_2	$6.13 \cdot 10^{-3}$	$2.49 \cdot 10^{-3}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.04 \cdot 10^{18}$	N/A	N/A	N/A
CH_4	$8.43 \cdot 10^{16}$	N/A	N/A	N/A
CO	$5.43 \cdot 10^{17}$	N/A	N/A	N/A
CO_2	$3.41 \cdot 10^{17}$	N/A	N/A	N/A



(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #025

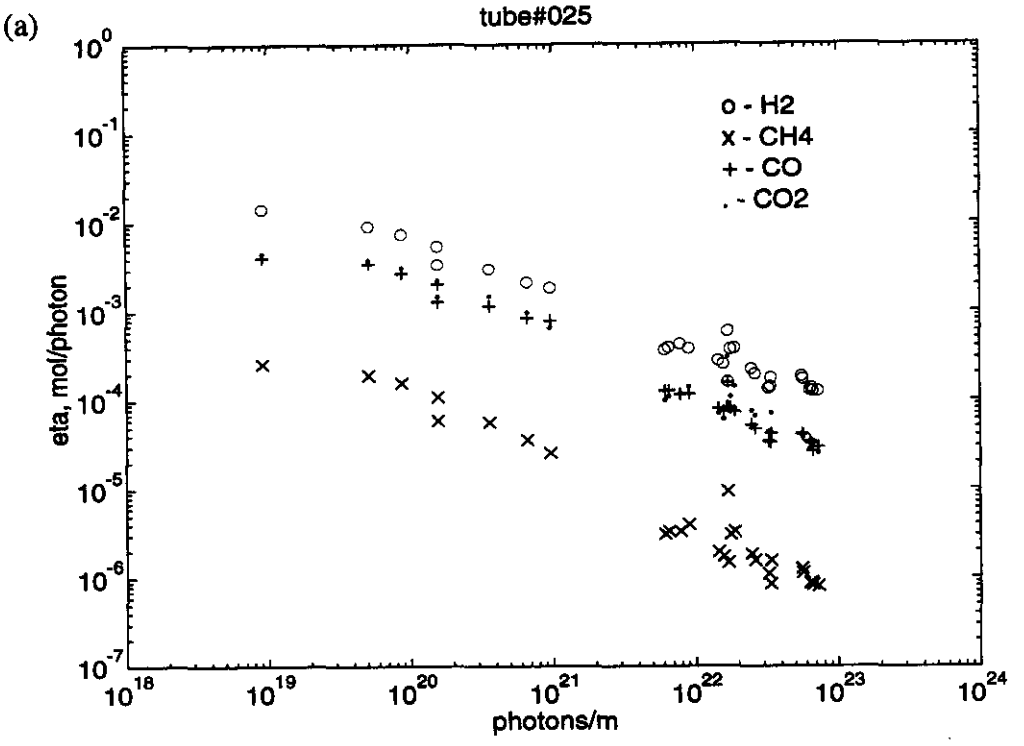
Material:	OFHC Cu Hitachi (10100)
Treatment:	BNL procedure (Appendix: 2.1)
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	2
Beamline:	U10B
Date of test:	11/23/92-12/9/92
Pumping time before experiment:	240 hrs
Base pressure before experiment:	$2.8 \cdot 10^{-8}$ Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

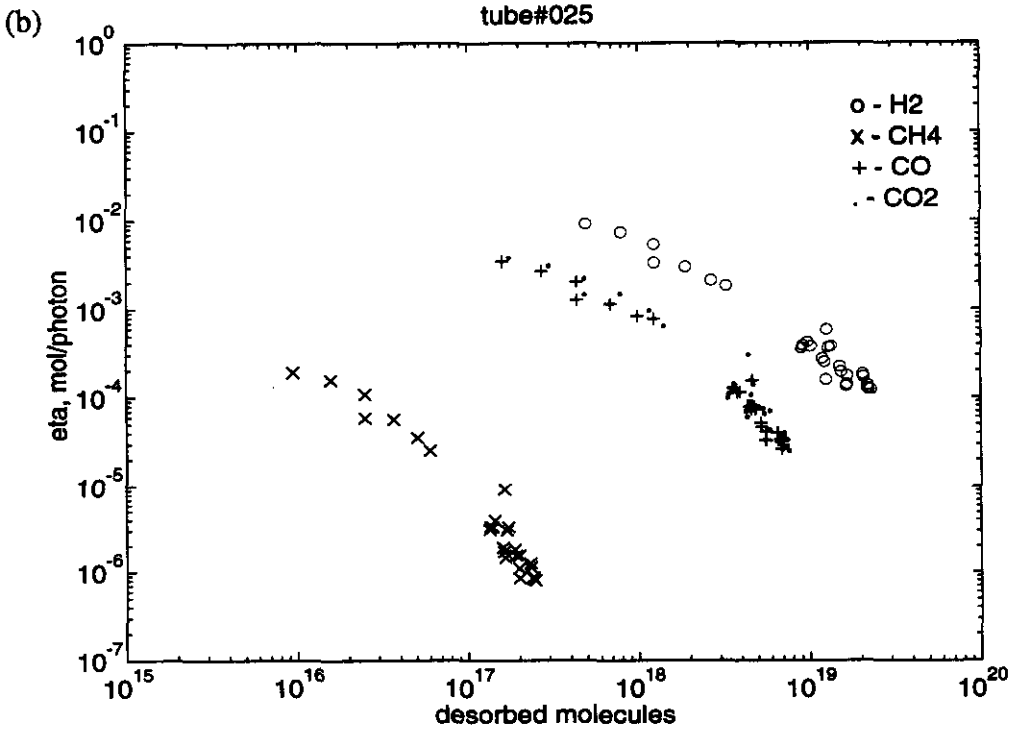
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$1.53 \cdot 10^{-2}$	$6.25 \cdot 10^{-3}$	$1.59 \cdot 10^{-3}$	$4.07 \cdot 10^{-4}$	$9.21 \cdot 10^{-5}$
CH_4	$2.80 \cdot 10^{-4}$	$1.28 \cdot 10^{-4}$	$2.32 \cdot 10^{-5}$	$4.02 \cdot 10^{-6}$	$7.14 \cdot 10^{-7}$
CO	$5.24 \cdot 10^{-3}$	$2.30 \cdot 10^{-3}$	$6.29 \cdot 10^{-4}$	$1.32 \cdot 10^{-4}$	$2.04 \cdot 10^{-5}$
CO_2	$5.31 \cdot 10^{-3}$	$2.63 \cdot 10^{-3}$	$6.85 \cdot 10^{-4}$	$1.41 \cdot 10^{-4}$	$2.26 \cdot 10^{-5}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$8.92 \cdot 10^{17}$	$3.25 \cdot 10^{18}$	$9.38 \cdot 10^{18}$	$2.40 \cdot 10^{19}$
CH_4	$1.84 \cdot 10^{16}$	$5.93 \cdot 10^{16}$	$1.30 \cdot 10^{17}$	$2.55 \cdot 10^{17}$
CO	$3.49 \cdot 10^{17}$	$1.27 \cdot 10^{18}$	$3.48 \cdot 10^{18}$	$7.36 \cdot 10^{18}$
CO_2	$3.68 \cdot 10^{17}$	$1.39 \cdot 10^{18}$	$3.76 \cdot 10^{18}$	$7.98 \cdot 10^{18}$





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #014

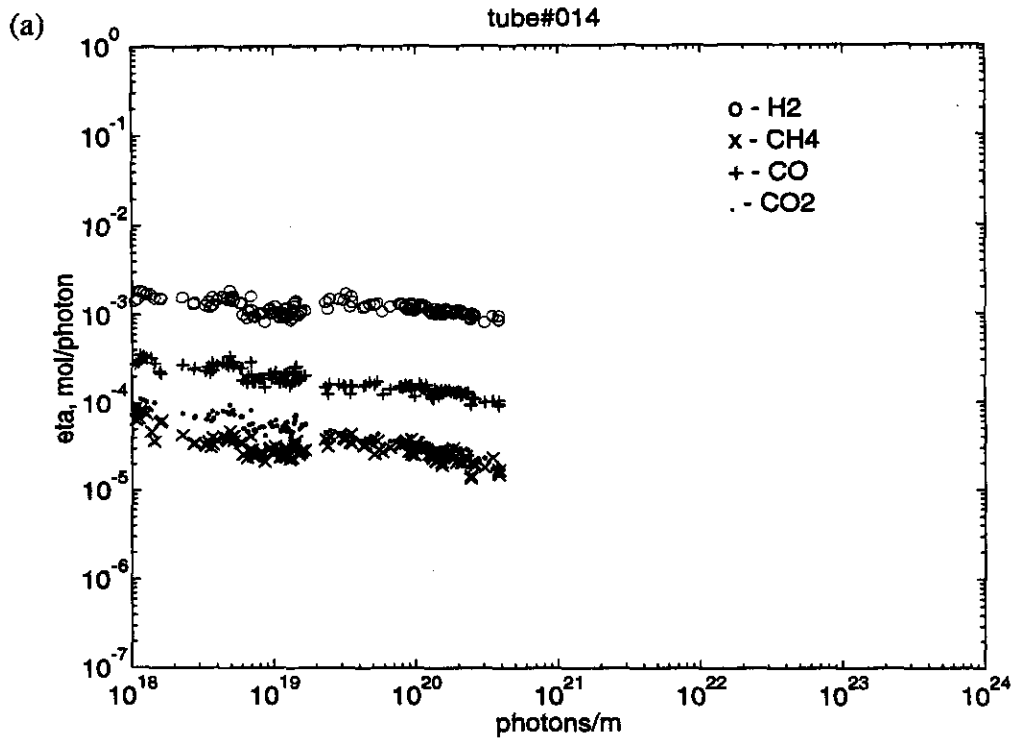
Material:	SS Nitronic 40
Treatment:	BNL procedure (Appendix: 1.1)
Test Laboratory:	BINP
Type of test:	warm, in situ bake 300C for 24 hrs, no magnetic field
Experiment #:	1d
Beamline:	SSC1
Date of test:	Sep 11 1992
Pumping time before experiment:	unknown
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

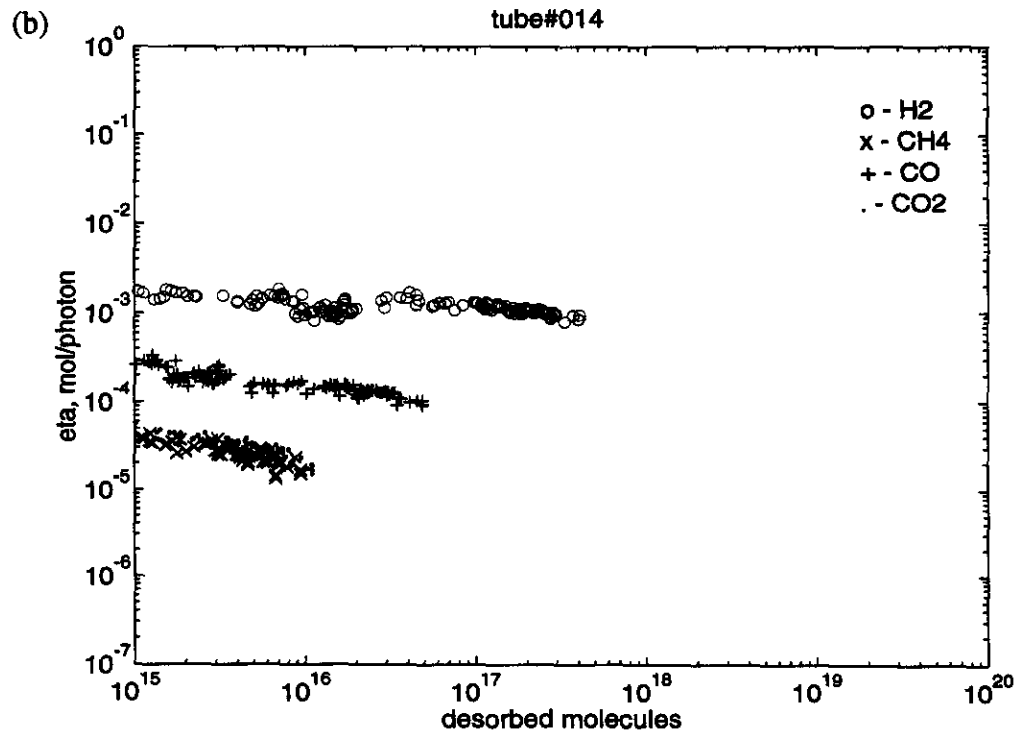
Photodesorption coefficients, molecules/photon

	$1\cdot10^{19}$	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$1.17\cdot10^{-3}$	$1.16\cdot10^{-3}$	N/A	N/A	N/A
CH_4	$3.06\cdot10^{-5}$	$2.78\cdot10^{-5}$	N/A	N/A	N/A
CO	$2.07\cdot10^{-4}$	$1.35\cdot10^{-4}$	N/A	N/A	N/A
CO_2	$5.81\cdot10^{-5}$	$3.14\cdot10^{-5}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1\cdot10^{20}$	$1\cdot10^{21}$	$1\cdot10^{22}$	$1\cdot10^{23}$
H_2	$1.08\cdot10^{17}$	N/A	N/A	N/A
CH_4	$2.74\cdot10^{15}$	N/A	N/A	N/A
CO	$1.40\cdot10^{16}$	N/A	N/A	N/A
CO_2	$3.56\cdot10^{15}$	N/A	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #020

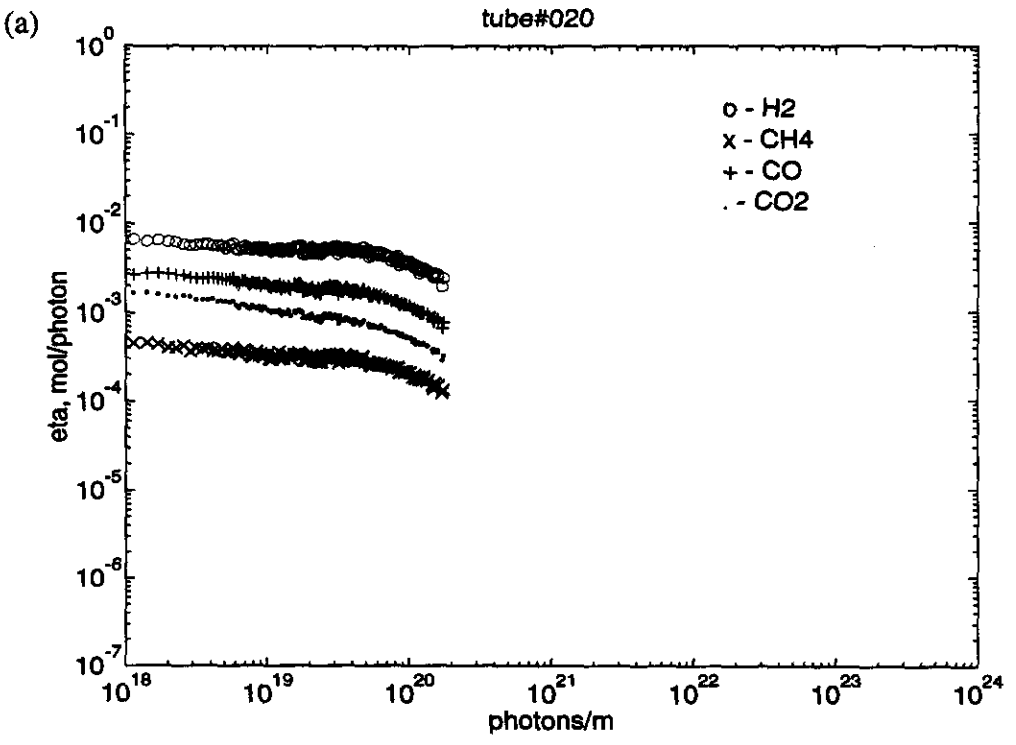
Material:	SS Nitronic 40
Treatment:	CERN procedure (Appendix: 1.2), 950C fire
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	8a
Beamline:	SSC1
Date of test:	Nov 26 1992
Pumping time before experiment:	73 hrs
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

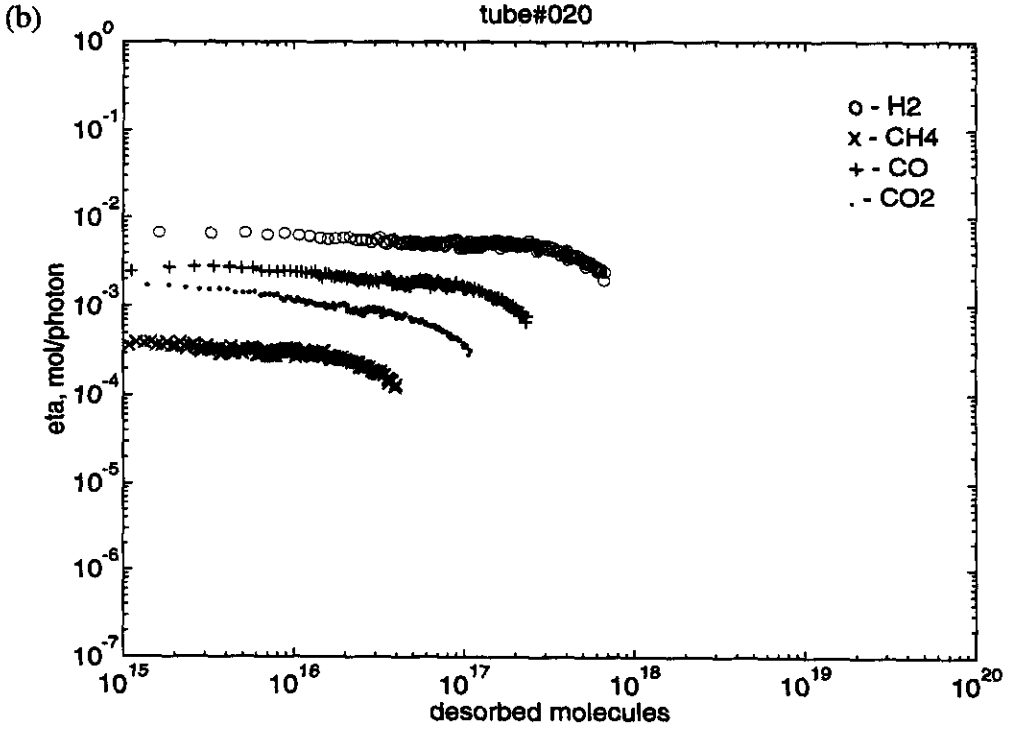
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$5.05 \cdot 10^{-3}$	$3.56 \cdot 10^{-3}$	N/A	N/A	N/A
CH_4	$3.23 \cdot 10^{-4}$	$2.05 \cdot 10^{-4}$	N/A	N/A	N/A
CO	$2.08 \cdot 10^{-3}$	$1.18 \cdot 10^{-3}$	N/A	N/A	N/A
CO_2	$1.09 \cdot 10^{-3}$	$5.25 \cdot 10^{-4}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$4.06 \cdot 10^{17}$	N/A	N/A	N/A
CH_4	$2.40 \cdot 10^{16}$	N/A	N/A	N/A
CO	$1.41 \cdot 10^{17}$	N/A	N/A	N/A
CO_2	$6.55 \cdot 10^{16}$	N/A	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #021

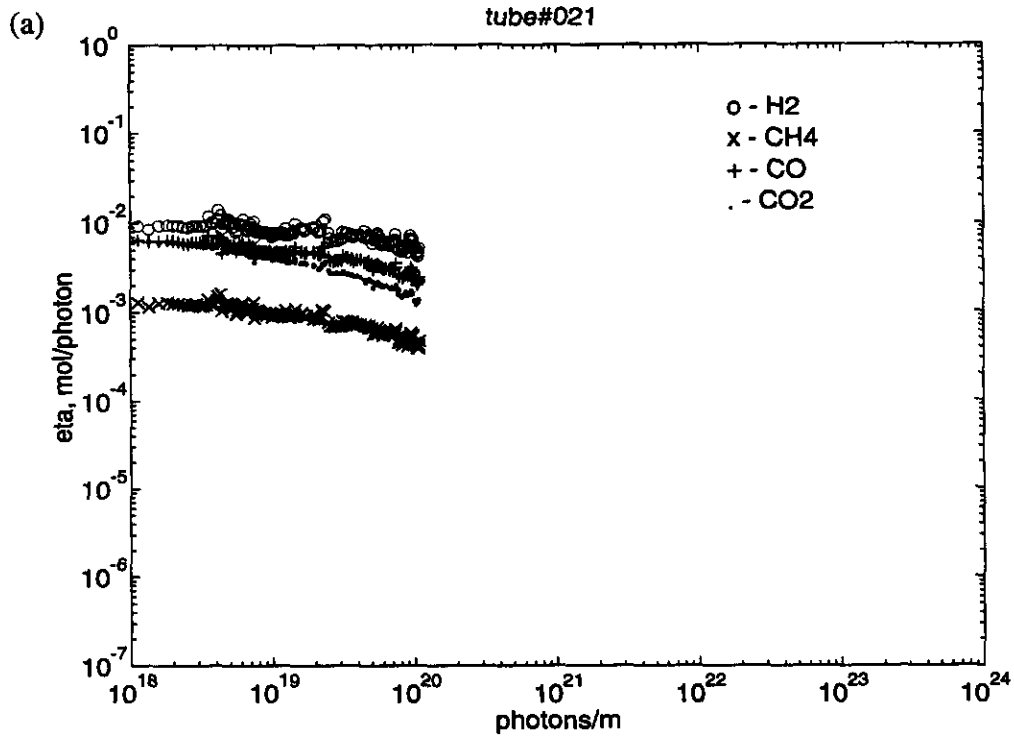
Material:	SS Nitronic 40
Treatment:	CERN procedure (Appendix: 1.2)
Test Laboratory:	BINP
Type of test:	warm, no bake, no magnetic field
Experiment #:	8b
Beamline:	SSC1
Date of test:	Oct 14 1992
Pumping time before experiment:	99 hrs
Base pressure before experiment:	unknown
Critical energy:	284 eV
Angle of incidence:	10.0 mrad

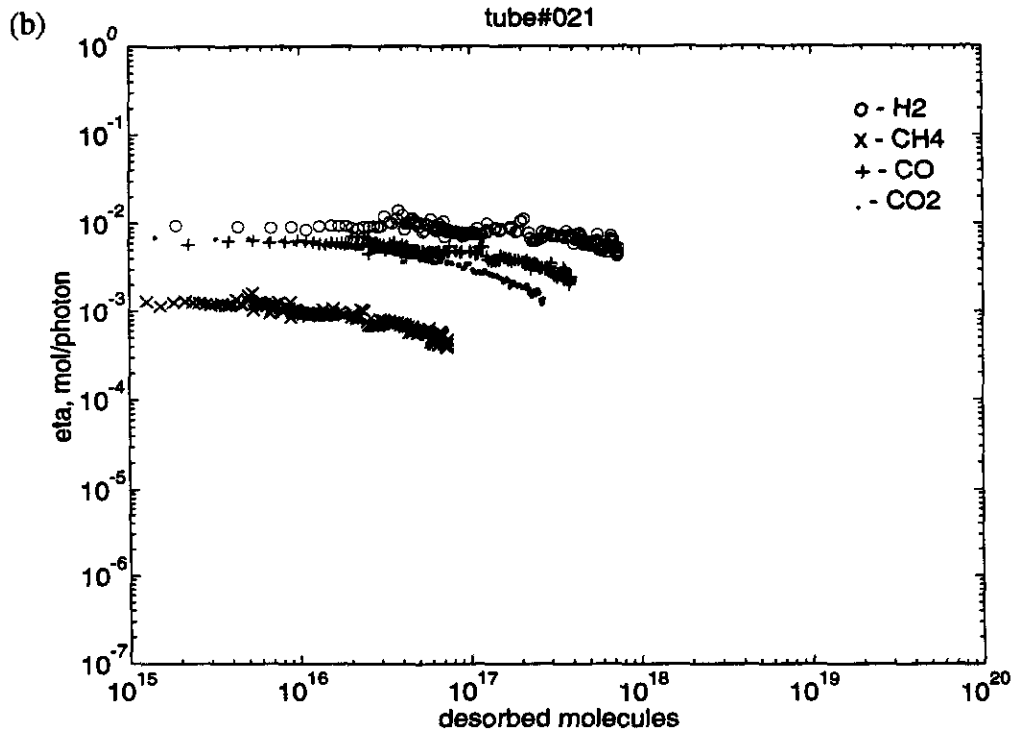
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$8.75 \cdot 10^{-3}$	$5.56 \cdot 10^{-3}$	N/A	N/A	N/A
CH_4	$1.02 \cdot 10^{-3}$	$4.70 \cdot 10^{-4}$	N/A	N/A	N/A
CO	$5.06 \cdot 10^{-3}$	$2.67 \cdot 10^{-3}$	N/A	N/A	N/A
CO_2	$4.12 \cdot 10^{-3}$	$1.45 \cdot 10^{-3}$	N/A	N/A	N/A

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$6.00 \cdot 10^{17}$	N/A	N/A	N/A
CH_4	$5.81 \cdot 10^{16}$	N/A	N/A	N/A
CO	$3.09 \cdot 10^{17}$	N/A	N/A	N/A
CO_2	$2.04 \cdot 10^{17}$	N/A	N/A	N/A





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

Tube #036j

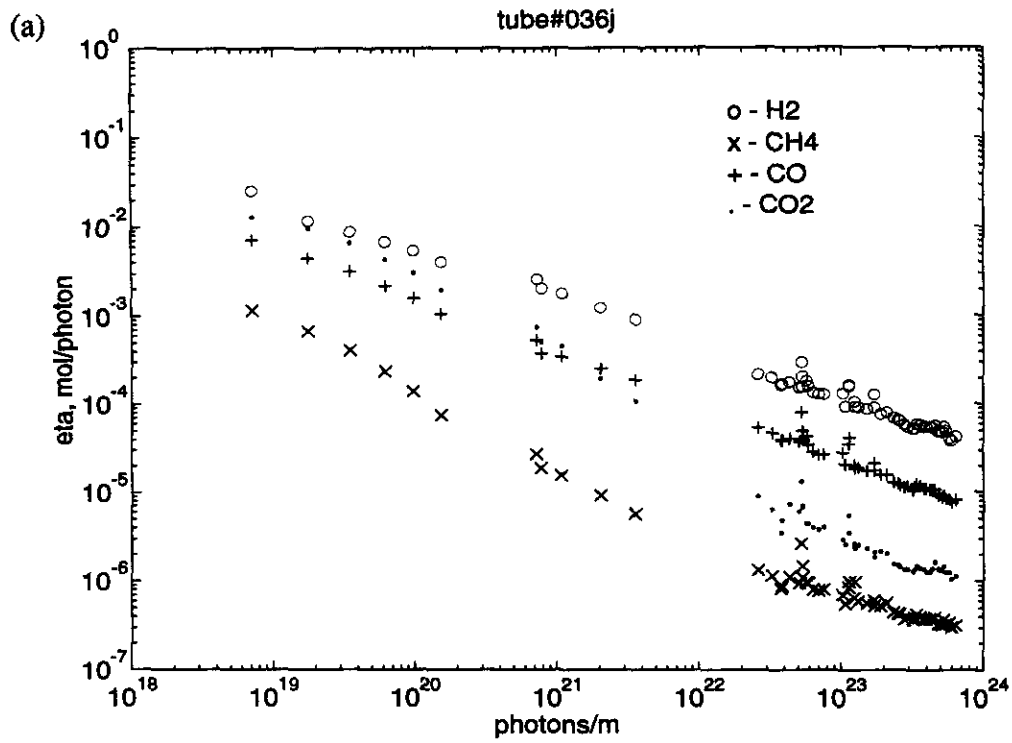
Material:	A7N01/4N Aluminum, Japan (diam. 50.5mm)
Treatment:	BNL procedure (Appendix: 4.4)
Test Laboratory:	BNL
Type of test:	warm, no bake, no magnetic field
Experiment #:	11
Beamline:	U10B
Date of test:	11/8/93-05/01/94
Pumping time before experiment:	72 hrs
Base pressure before experiment:	$8.1 \cdot 10^{-9}$Torr
Critical energy:	490 eV
Angle of incidence:	12.0 mrad

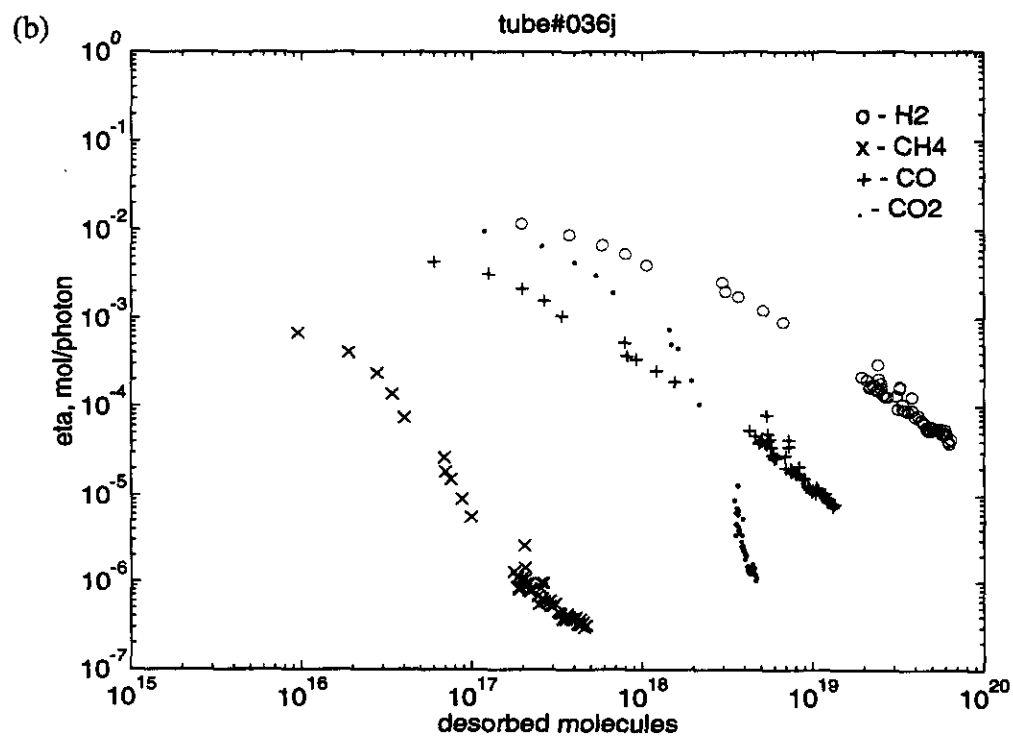
Photodesorption coefficients, molecules/photon

	$1 \cdot 10^{19}$	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$2.00 \cdot 10^{-2}$	$5.00 \cdot 10^{-3}$	$1.80 \cdot 10^{-3}$	$4.00 \cdot 10^{-4}$	$1.00 \cdot 10^{-4}$
CH_4	$9.50 \cdot 10^{-4}$	$1.20 \cdot 10^{-4}$	$1.60 \cdot 10^{-5}$	$2.30 \cdot 10^{-6}$	$6.40 \cdot 10^{-7}$
CO	$5.90 \cdot 10^{-3}$	$1.50 \cdot 10^{-3}$	$3.40 \cdot 10^{-4}$	$1.00 \cdot 10^{-4}$	$2.10 \cdot 10^{-5}$
CO_2	$1.10 \cdot 10^{-2}$	$3.00 \cdot 10^{-3}$	$4.70 \cdot 10^{-4}$	$2.30 \cdot 10^{-5}$	$3.10 \cdot 10^{-6}$

Desorbed gas, molecules/m

	$1 \cdot 10^{20}$	$1 \cdot 10^{21}$	$1 \cdot 10^{22}$	$1 \cdot 10^{23}$
H_2	$8.20 \cdot 10^{17}$	$3.60 \cdot 10^{18}$	$1.20 \cdot 10^{19}$	$3.10 \cdot 10^{19}$
CH_4	$3.50 \cdot 10^{16}$	$7.60 \cdot 10^{16}$	$1.30 \cdot 10^{17}$	$2.40 \cdot 10^{17}$
CO	$2.70 \cdot 10^{17}$	$9.20 \cdot 10^{17}$	$2.70 \cdot 10^{18}$	$6.70 \cdot 10^{18}$
CO_2	$5.50 \cdot 10^{17}$	$1.60 \cdot 10^{18}$	$3.00 \cdot 10^{18}$	$3.76 \cdot 10^{18}$





(a) photodesorption coefficient (eta) versus photon flux and (b) versus desorbed gas.

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Appendix: Cleaning Procedures

1. Cleaning Procedures for Stainless Steel

1.1 BNL[1]

1. ultrasonic cleaning in degrease soap[2] for 5 min
2. non etch cleaner (detergent) for 5 min
3. tap water rinse for 5 min
4. hydrofluoric acid for 5 min
5. tap water rinse for 5 min
6. alutone for 5 min
7. tap water rinse for 5 min
8. deionized water for 5 min
9. wipe all parts dry and place in oven for 30–45 min
10. remove from oven, allow to cool, wipe all parts with methyl alcohol.

1.2 CERN

1. vapor degrease in perchloroethylene (121° C)
2. ultrasonic cleaning in alkaline detergent (ph = 9.7) at 65° C). The detergent is ALMECO-18 (=P3-VR-580-17), manufactured by the Henkel Corporation. It is made up to a concentration of 20 g/l with ordinary water.
3. immediate rinsing inside and out with cold demineralized water jet
4. rinsing by immersion in a bath of cold flowing demineralized water
5. drying in a vacuum oven at 80° C.

2. Cleaning Procedures for Bulk Copper

2.1 BNL

1. ultrasonic cleaning in degrease soap for 5 min
2. AC 500[3] cleaner for 10 min
3. tap water rinse
4. methyl alcohol bath
5. wipe dry and let air dry.

---

1. BNL procedure described above is used for non-welded parts of the vacuum systems. After pretreatment the components are welded. No acid cleaning is carried out after welding; only acetone and alcohol are used. This note is also true for all BNL procedures described in this appendix.
2. LPS Precision Clean, Cleaner/Degreaser, LPS Laboratories, Inc., 46–47 Hugh Howell Rd., Tucker, GA 30085, (800) 241-8334.
3. Phosphoric acid metal cleaner, Rochester Midland Company, 333 Hollenbeck St., Rochester, NY 14621, (716) 336-2200.

2.2 CERN

1. vapor degrease in perchloroethylene (C_2Cl_4) at 121° C
2. ultrasonic cleaning for 5 min in alkaline detergent (ph = 9.7) solution at 50° C. The detergent is 1740S (special CERN) supplied by Cleaning Technology, Geneva, and is made up to a concentration of 10 g/l.
3. tap water rinse
4. pickling in HCl (33%) 50% by volume with H_20 50% at room temperature for 1–15 min
5. tap water rinse
6. acid etch in

H_2SO_4	(96%)	42% by vol.
HNO_3	(60%)	8% by vol.
HCl	(33%)	0.2% by vol.

H_2O to complete at room temperature for 30 s to 1 min;

7. tap water rinse
8. passivation in

CrO_3 (chromic acid)	80 g/l
H_2SO_4	3 cm3/l

at room temperature for 30 s to 1 min

9. hot demineralized water rinse
10. alcohol rinse
11. dry with N_2.

3. Cleaning Procedures for Copper-plated Tubes

3.1 BNL

1. ultrasonic cleaning in degrease soap for 5 min
2. tap water rinse
3. methyl alcohol bath
4. wipe dry and let air dry.

3.2 CERN

1. degrease in perchloroethylene at 121° C
2. ultrasonic cleaning for 5 min in alkaline detergent (ph = 9.7) solution at 50° C. The detergent is 1740S (special CERN) supplied by Cleaning Technology, Geneva, and is made up to a concentration of 10 g/l
3. tap water rinse
4. hot demineralized water rinse
5. alcohol rinse
6. dry with N_2.

4. Cleaning Procedures for Aluminum

4.1 BNL

1. vapor degrease in hot Vythane for 5 min
2. soak in non-etch alkaline cleaner for 5 min at 40°–65° C with air agitation
3. rinse in cold running tap water for 5 min
4. etch in 6% Oakite 360L solution for 2 minutes at 37°–43° C with air agitation
5. rinse in cold running tap water for 5 min
6. desmutt at room temperature in Alutone for 5 min with air agitation
7. rinse in cold running tap water for 5 min
8. rinse in hot, 70° C, deionized water for 5 minutes with air agitation
9. wipe all parts dry, bake in oven at 121° C.

4.2 CERN

1. perchloroethylene vapor treatment (121° C) followed by draining and drying
2. NaOH bath at 45° C for 1–1.5 min
3. rinse in cold demineralized water
4. immersion in HNO_3 + 1% HF bath
5. rinse in demineralized water
6. dry with N_2.