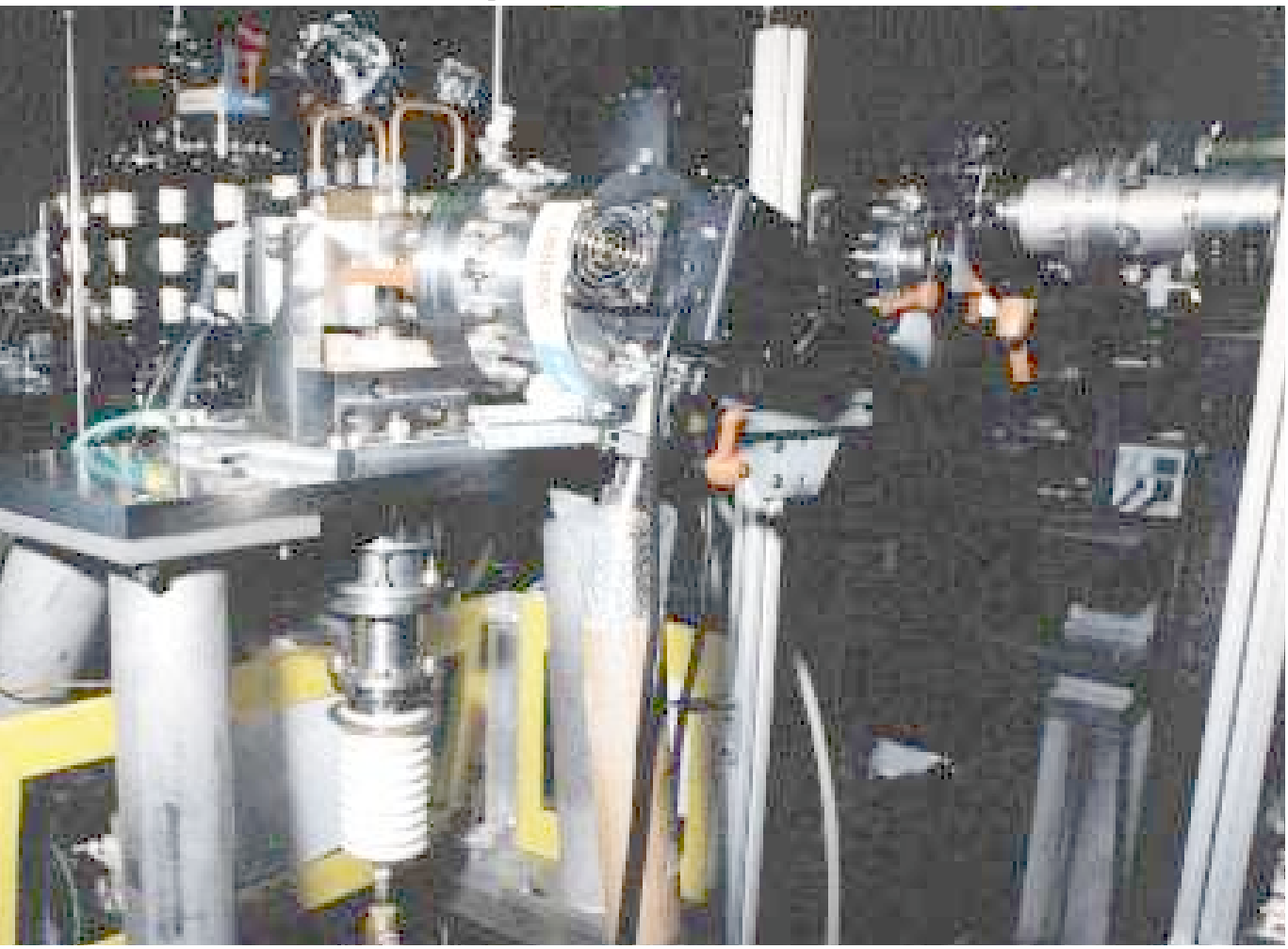
haracterization of the XSS

on-Impact Point Source (EIPS) and Filter Wheel Assembly (FWA)

Ron Elsner, Marshall Joy, Steve O'Dell,
ulkanen, Allyn Tennant, and Martin Weisskopf
arshall Space Flight Center, Space Sciences Laboratory

Robert Austin, Jeff Kolodziejczak,
Doug Swartz, and Galen Zirnstein
arshall Space Flight Center, Space Sciences Laboratory

EIPS photo



Purpose

res
ay flux in atomic fluorescence lines
size (0.5-mm-by-1-mm spot on anode surface)
eable targets (anode tips) of various materials
quivalent-width fluorescence lines (K and L lines)
(natural-width) lines above about 1 keV
r AXAF calibration
s at several energies
s very high x-ray flux to investigate wings of PSF
spread function (PSF) at several energies
s small spot, less than 0.5-mm (0.2-arcsec) diameter
rea at many energies
spread function
s narrow (natural-width) lines

Characterization activities

pecific count rates with FPC500.
ne dependence upon EIPS voltage and FWA filters.
to specific flux at HRMA entrance aperture.
operating range of EIPS anode current, for matrix of
e and bias settings.

nt
PC500 pulse-height distributions.
ne-to-continuum ratio for unfiltered x-ray flux.

nole images with HRI.
dependence of spot size and shape on EIPS settings.

ty
ith FPC500 mapper.

Description

-ray generator, by MSFC SAIL (ES71)

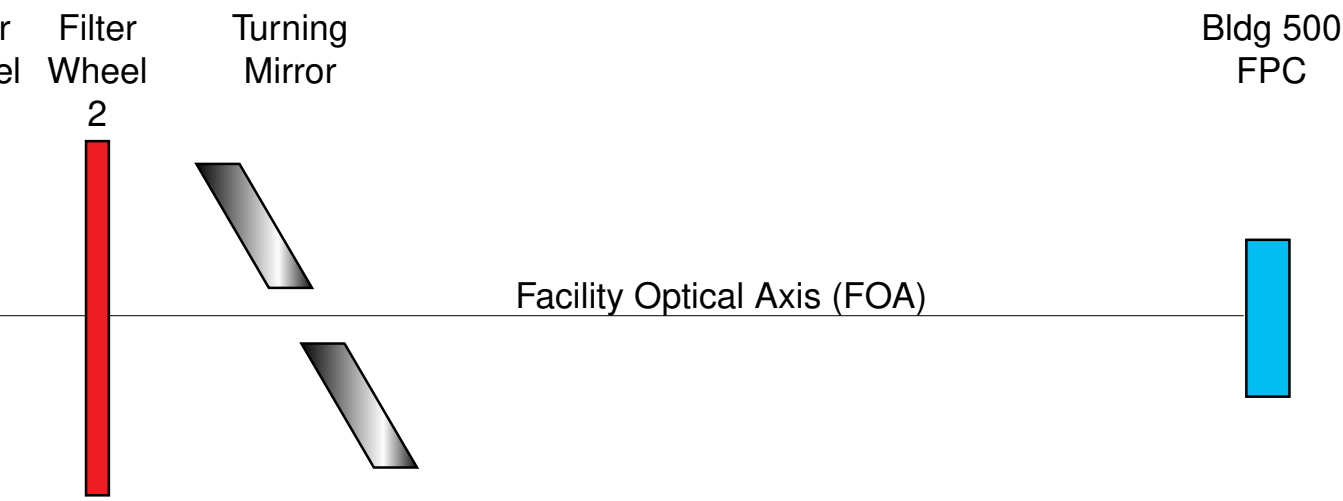
e assembly (LV under evaluation)
(from anode) for anode voltages from 1 kV to 40 kV
imensions 0.5 mm by 1 mm, adjusted with bias voltage

-diameter thoriated tungsten wire, up to 6-A filament

very close to 1.6-mm by 3.8-mm bias-plate slit

ed
erials
ngeable tips, of approximately 20 different types
and electronics, with no feed-back control of anode current

On-line configuration



ct Point Source targets use any of 20 different materials.

ssembly

el 1 contains 27 τ=2 filters, 2 pinholes, and 3 blanks.

el 2 contains 27 τ=4 filters, 2 occulting bars (TBR), and

is limiting aperture (in absence of pinholes).

EIPS lines

	Target line	Default filters	Energy (keV)	Target material	Default filter
	Be-K	Be-K	2.293	Mo-L	Nb-L
	B-K	B-K	2.982	Ag-L	Ag-L
	C-K	C-K	3.441	Sn-L	Sn-L
	Ti-L	*Ti-L*	4.509	Ti-K	Ti-K
	O-K (SiO2)	*Cr-L*	5.415	Cr-K	V-K
	Fe-L	Fe-L	6.399	Fe-K	*Mn-K* (Fe-K)
	Ni-L	Ni-L	6.925	Co-K	Fe-K
	Cu-L	Cu-L	7.478	Ni-K	Co-K
	Zn-L	Zn-L	8.048	Cu-K	Ni-K
	Mg-K	Mg-K	8.397	W-L	Cu-K
	Al-K	Al-K	8.631	Zn-K	Cu-K
	Zr-L	Zr-L	9.690	Au-L	Ta-L

re-examination. Cr-L and Mn-K filters, Au target are not yet available.

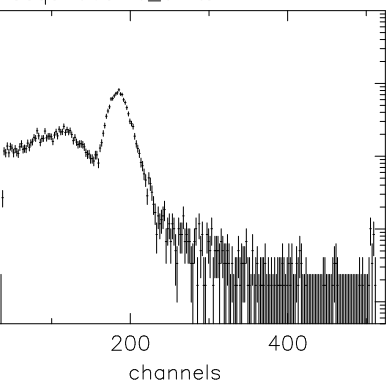
FPC500 measurements and analysis

ts accumulated approximately 10,000 counts, if feasible.
our different anode voltages
y at 2, 3, 4, and 5 times K-shell binding potential
y at 2, 3, and 4 times L-shell binding potential
ent filter combinations (using default filter)
=2 filter, τ=4 filter, and both filters combined

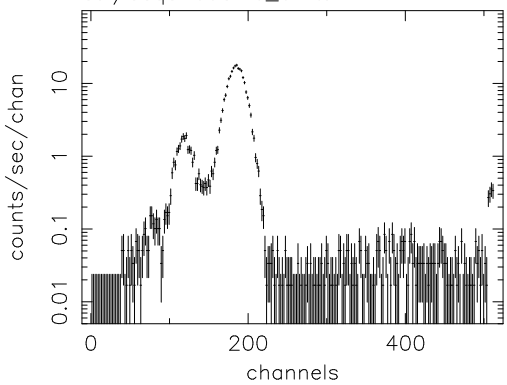
x and filter attenuation
OI count rate for τ2+τ4 to that for τ4 gives τ2 depth.
OI count rate for τ2+τ4 to that for τ2 gives τ4 depth.
eight distribution clearly distinguishes photons in and
e from other x rays.
ntinuum ratio and spectral purity
unfiltered spectrum to model, then use model.
s is not complete, but problems in fitting some data.

EIPS(Cu-K) at 4 x K potential

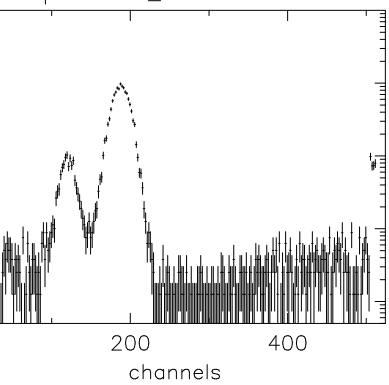
u, 35.92 kV, 1%, 0.4 mA) – FW(0, 0)
400 Torr, 1600 V, 5 CG, 0.5 FG, 1 mm)
/acq3406d1i0_0.fits



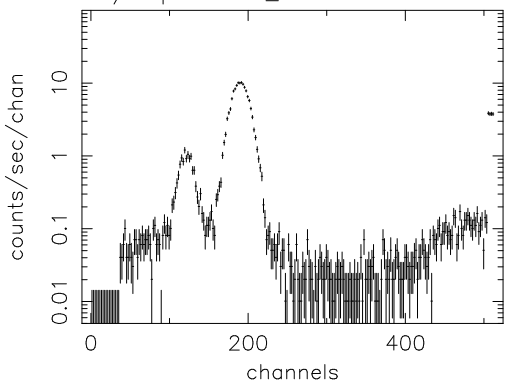
PS(Cu, 35.92 kV, 1%, 0.5 mA) – FW(NiK2, 0)
FPC(P10, 400 Torr, 1600 V, 5 CG, 0.5 FG, 4 mm)
cul/acq3409d1i0_0.fits



35.92 kV, 1%, 0.3 mA) – FW(0, NiK4)
400 Torr, 1600 V, 5 CG, 0.5 FG, 12 mm)
/acq3411d1i0_0.fits

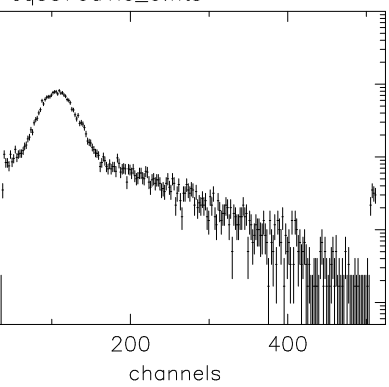


PS(Cu, 35.92 kV, 1%, 0.3 mA) – FW(NiK2, NiK4)
FPC(P10, 400 Torr, 1600 V, 5 CG, 0.5 FG, 36 mm)
cul/acq3413d1i0_0.fits

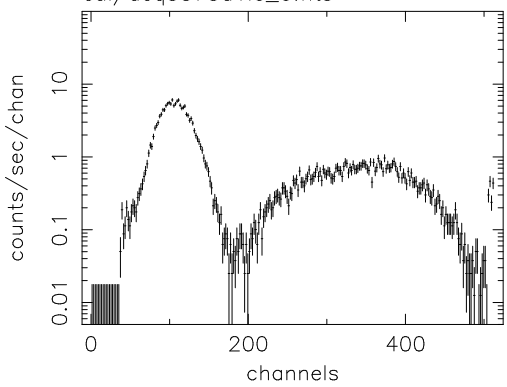


EIPS(Cu-L) at 4 x L potential

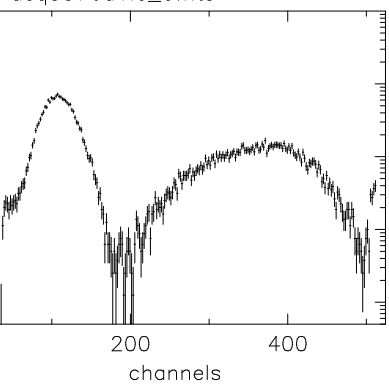
u, 3.73 kV, 1%, 0.2 mA) – FW(0, 0)
00 Torr, 1600 V, 20 CG, 0.675 FG, 4 mm)
/cq3370d1i0_0.fits



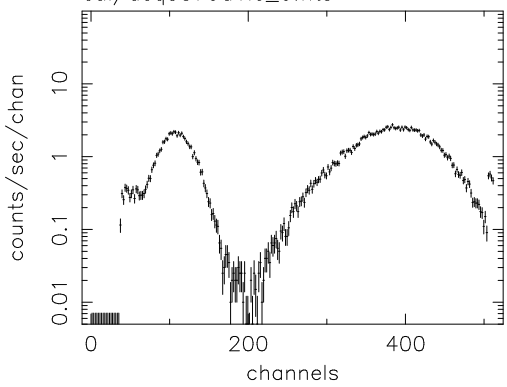
PS(Cu, 3.73 kV, 1%, 0.6 mA) – FW(CuL2, 0)
FPC(P10, 400 Torr, 1600 V, 20 CG, 0.675 FG, 12 mm)
cul/acq3373d1i0_0.fits



3.73 kV, 1%, 0.2 mA) – FW(0, CuL4)
00 Torr, 1600 V, 20 CG, 0.675 FG, 36 mm)
/acq3376d1i0_0.fits

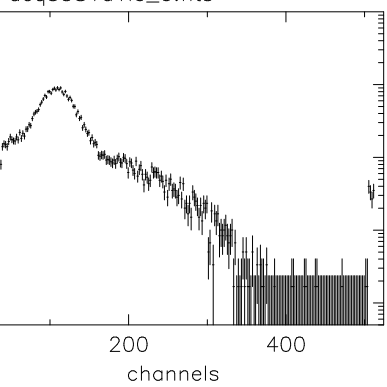


PS(Cu, 3.73 kV, 1%, 1.2 mA) – FW(CuL2, CuL4)
FPC(P10, 400 Torr, 1600 V, 20 CG, 0.675 FG, 36 mm)
cul/acq3379d1i0_0.fits

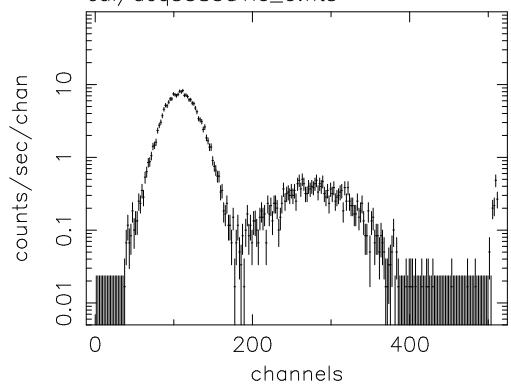


EIPS(Cu-L) at 3 x L potential

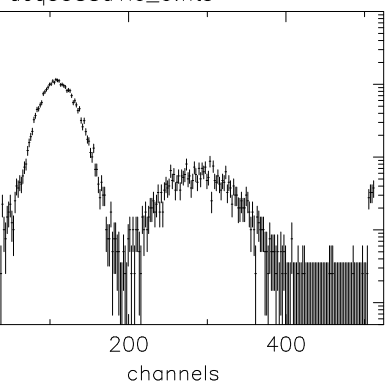
Cu, 2.8 kV, 1%, 0.4 mA) – FW(0, 0)
00 Torr, 1600 V, 20 CG, 0.675 FG, 4 mm)
/acq3381d1i0_0.fits



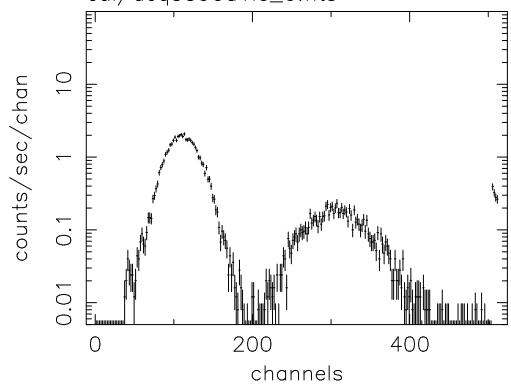
PS(Cu, 2.8 kV, 1%, 1.51 mA) – FW(CuL2, 0)
FPC(P10, 400 Torr, 1600 V, 20 CG, 0.675 FG, 12 mm)
cul/acq3383d1i0_0.fits



, 2.8 kV, 1%, 0.6 mA) – FW(0, CuL4)
00 Torr, 1600 V, 20 CG, 0.675 FG, 36 mm)
/acq3388d1i0_0.fits

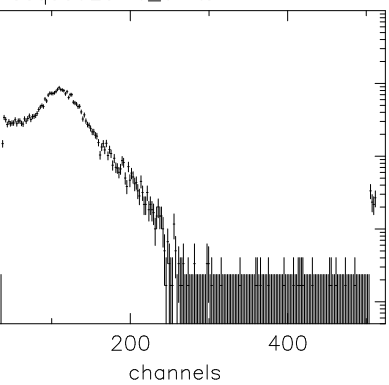


PS(Cu, 2.8 kV, 1%, 2.06 mA) – FW(CuL2, CuL4)
FPC(P10, 400 Torr, 1600 V, 20 CG, 0.675 FG, 36 mm)
cul/acq3390d1i0_0.fits

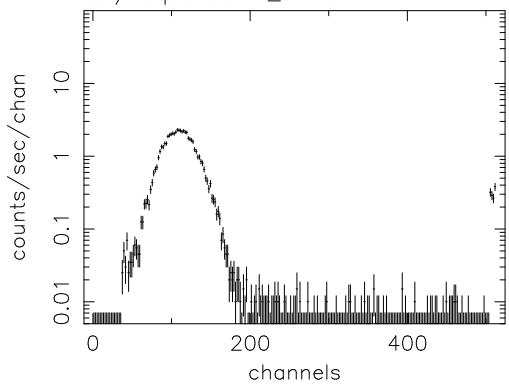


EIPS(Cu-L) at 2 x L potential

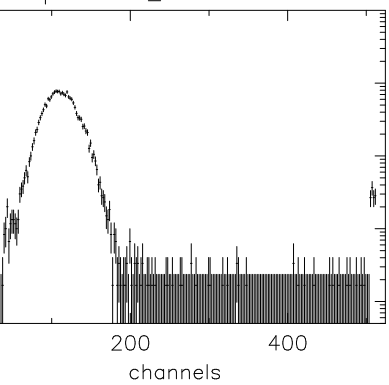
u, 1.87 kV, 1%, 1.02 mA) – FW(0, 0)
00 Torr, 1600 V, 20 CG, 0.675 FG, 4 mm)
/acq3392d1i0_0.fits



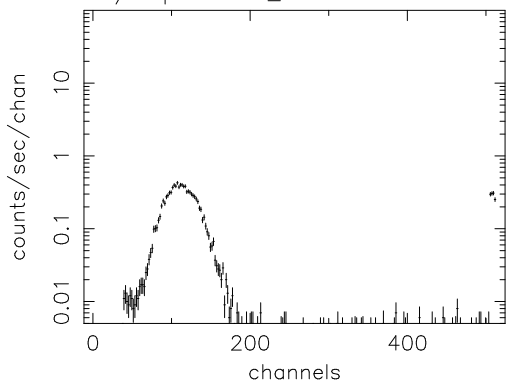
PS(Cu, 1.87 kV, 1%, 1.36 mA) – FW(CuL2, 0)
FPC(P10, 400 Torr, 1600 V, 20 CG, 0.675 FG, 12 mm)
cul/acq3395d1i0_0.fits



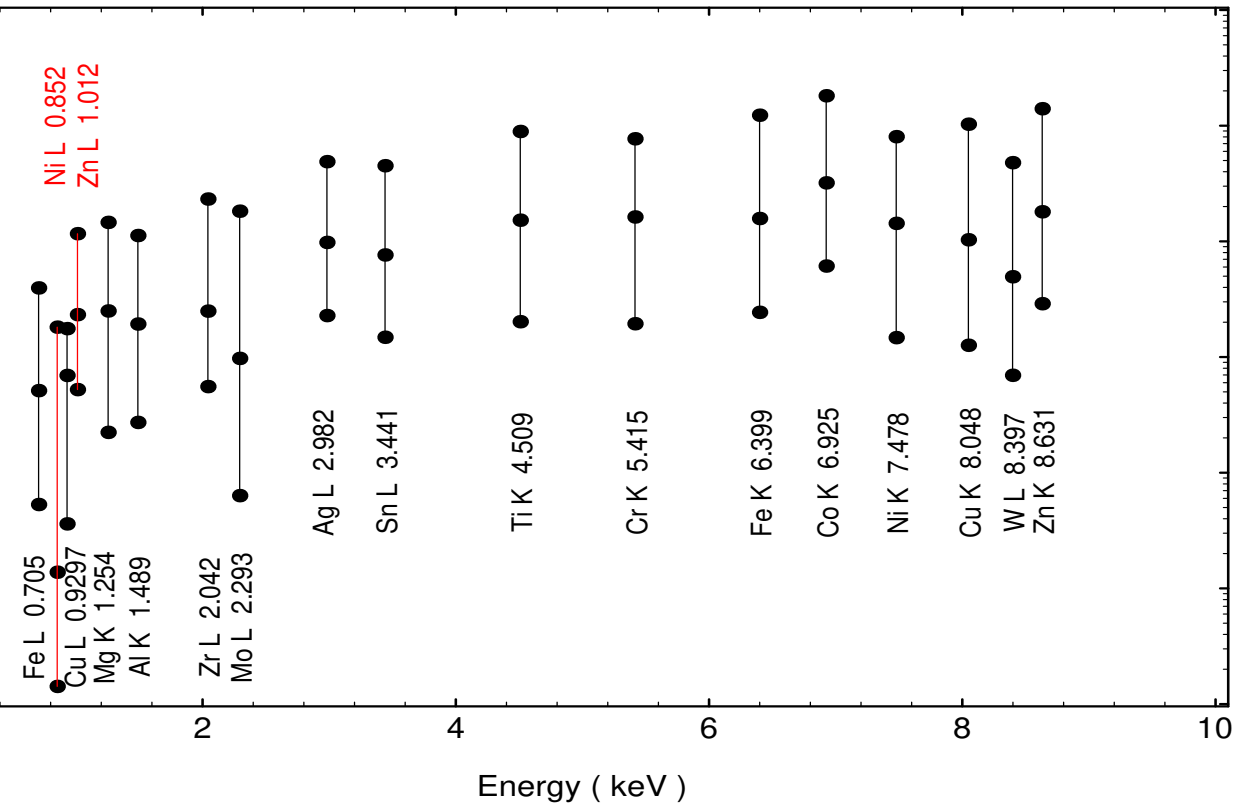
1.87 kV, 1%, 1.27 mA) – FW(0, CuL4)
00 Torr, 1600 V, 20 CG, 0.675 FG, 36 mm)
/acq3397d1i0_0.fits



PS(Cu, 1.87 kV, 1%, 1.27 mA) – FW(CuL2, CuL4)
FPC(P10, 400 Torr, 1600 V, 20 CG, 0.675 FG, 36 mm)
cul/acq3399d1i0_0.fits



Specific flux at HRMA aperture



data from the nominally τ=2, τ=4, and τ=6 filters. (Spectral purity of s not adequate for most applications.) Anode voltage is 4 times ell potential for K lines; 3 times respective L-shell potential for L lines.

Constraints on anode current

raints

ting of filament

ve heat will evaporate and damage filament.

$j_{e0}\pi(d/2)^2 \mathrm{Exp}[-\phi/(kT_{max})] \sim \gamma d^2 \mathrm{Exp}[-\phi/(kT_{max})]$,

he filament's diameter, T_{max} the filament's maximum
g temperature, and $\gamma(V,B)$ a geometric transmission.

ipation in anode limits anode current

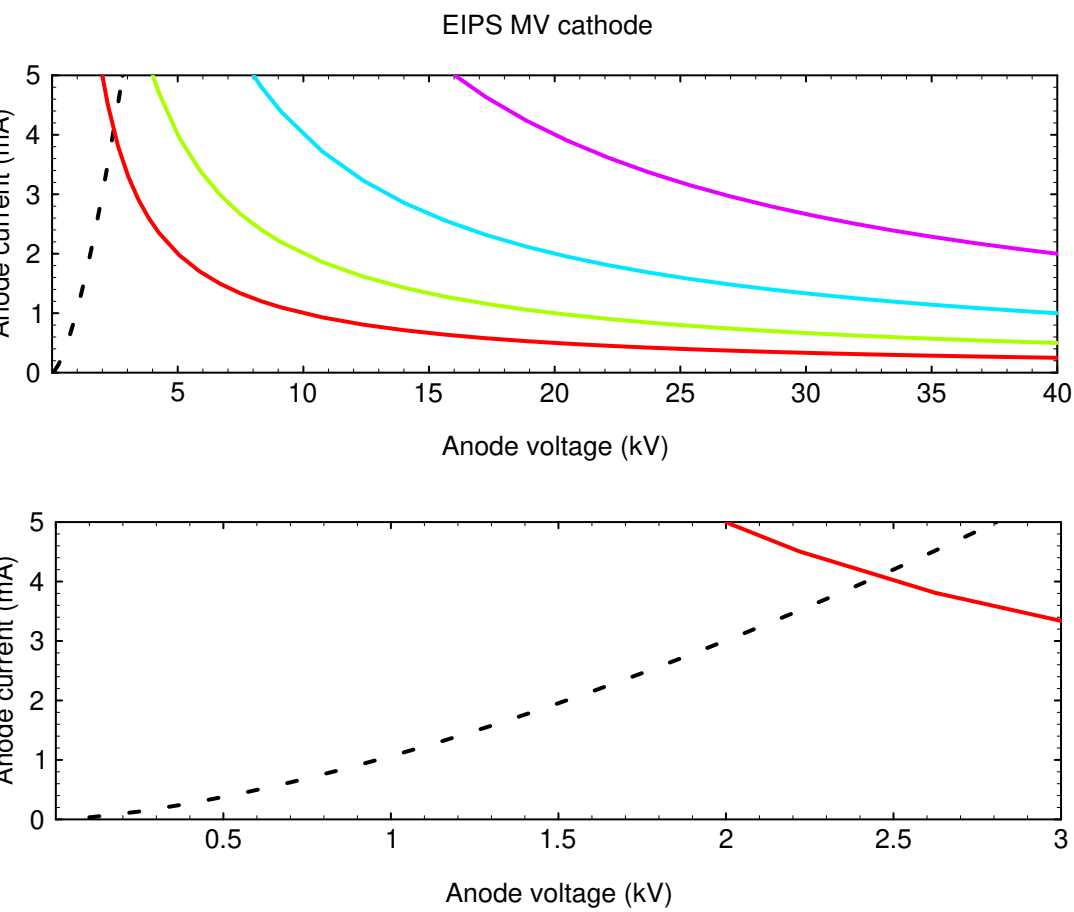
ve heat will evaporate and damage anode.

$_e/V$, with P_{anode} the allowed power and V the anode's

rge screening

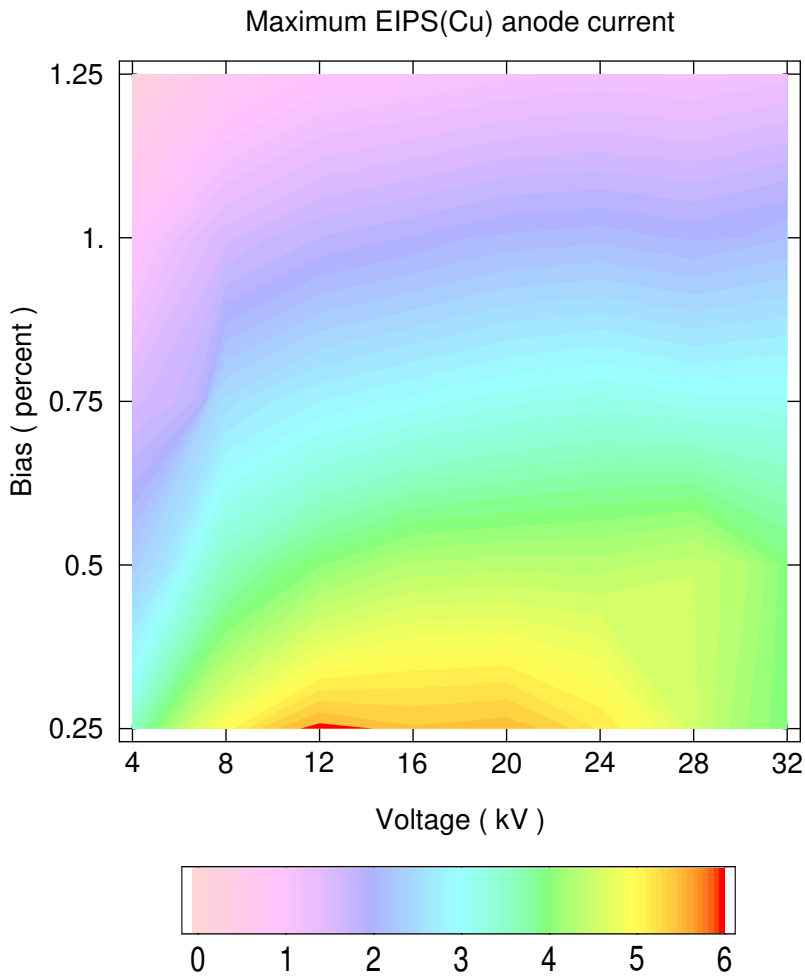
ve charge between anode and cathode will screen
field.

$/s)\ (A/s)\sqrt{(2eV)/m} \sim V^{3/2}\ (A/s^2)$, with V the anode's
A the electron-beam cross-section area, and s the
on between cathode and anode.



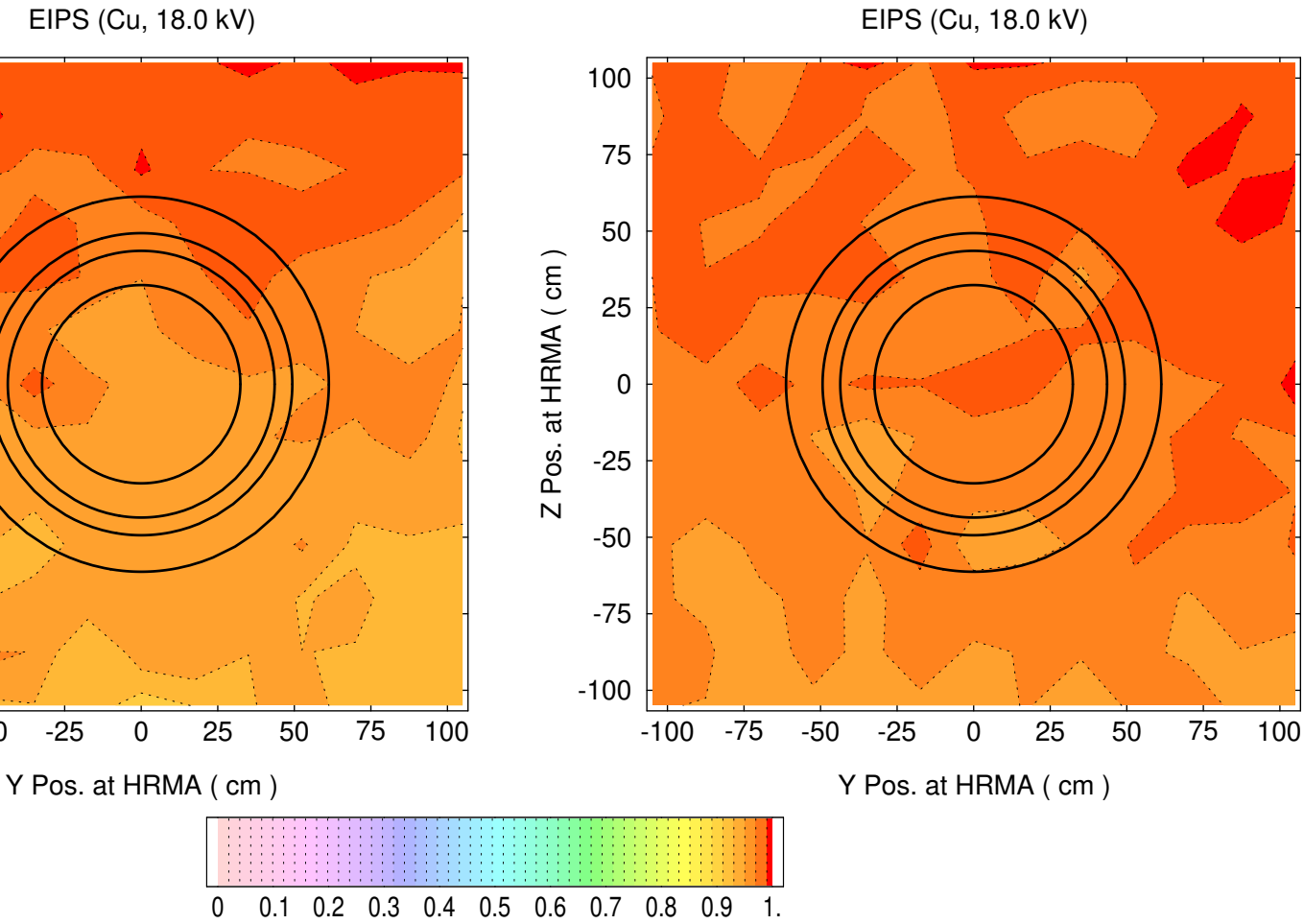
rrent limits. Power limits are 10 W, 20 W, 40 W, and 80 W. Space-
shed line) is for a 0.5-mm-by-0.5-mm spot and the MV cathode.

Maximum operating anode current



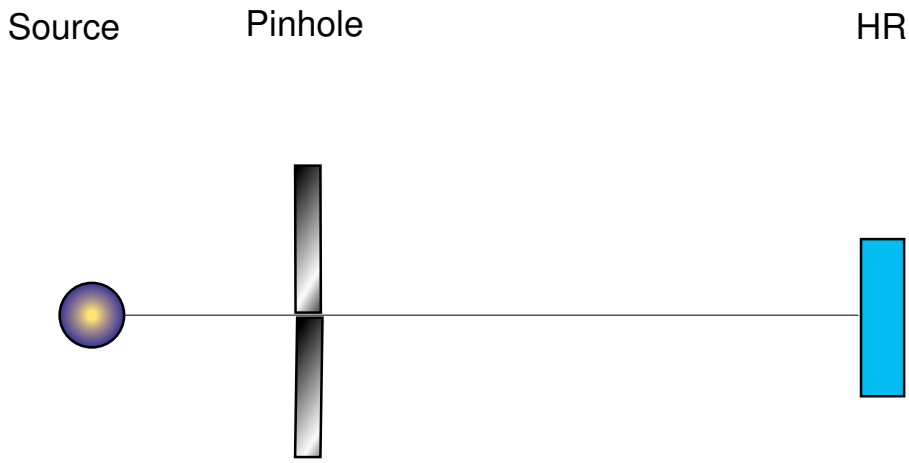
NB: These data are for a previous EIPS cathode assembly. The detailed dependence of maximum anode current and spot size, upon bias and anode voltages, is sensitive to filament placement, which is not precisely controlled

EIPS(Cu, 18 kV) beam maps



EIPS spot-size measurement

uration



liameter pinhole
hick gold
s
-pinhole 161 mm
–HRI 552 mm
cation 3.4

ole images are for the EIPS MV cathode (but not present
Cu anode target, with correction for magnification.

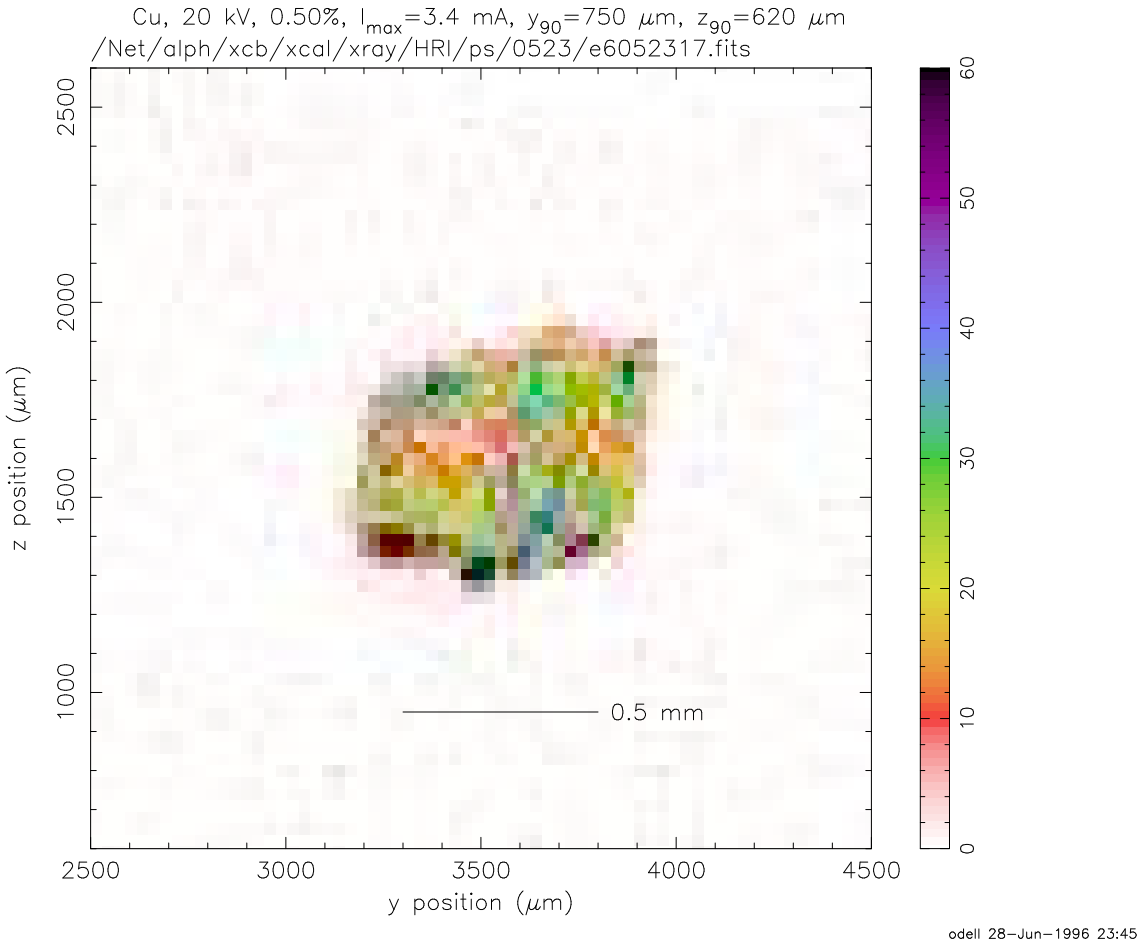
e between anode current and spot size

ives high anode current, but spot size exceeds 0.5 mm.

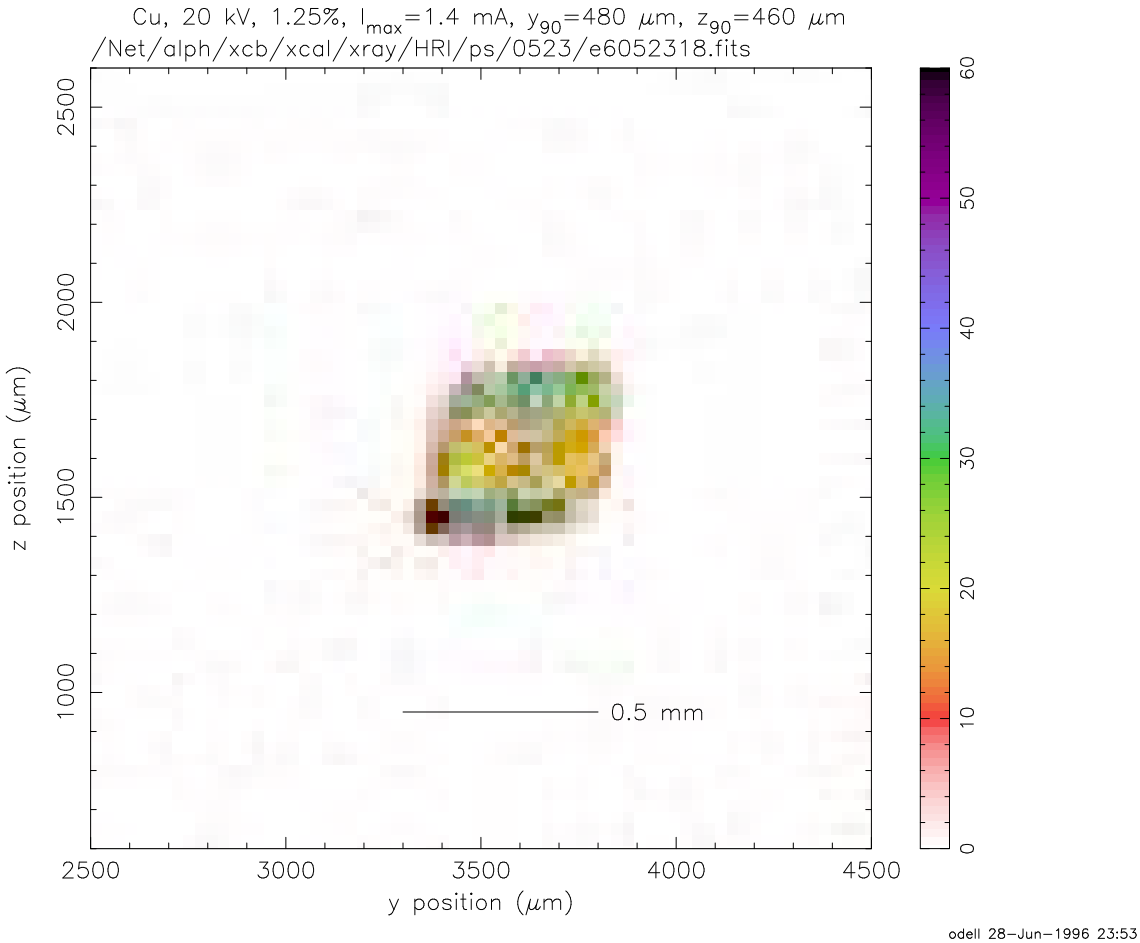
gives small spot, but lower maximum current.

is dominant factor in spot size (for a given configuration).

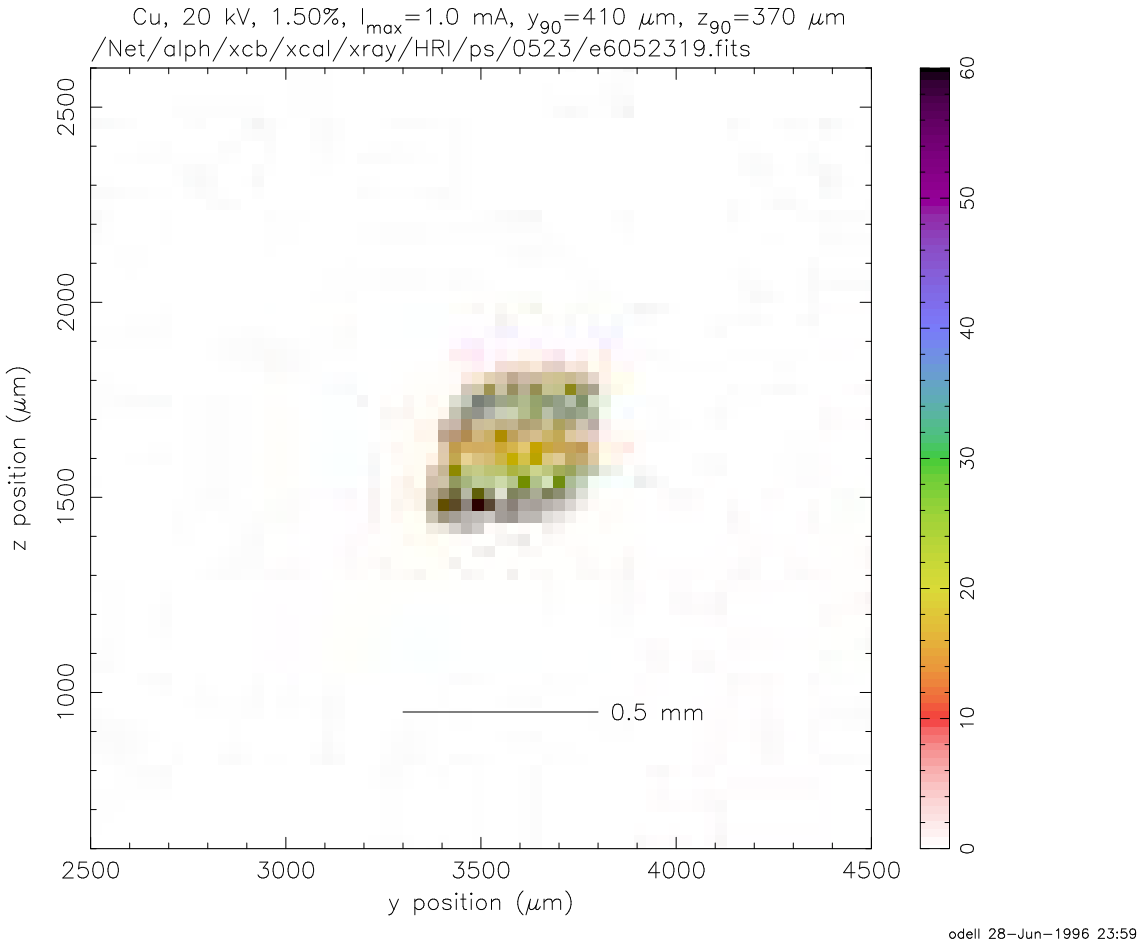
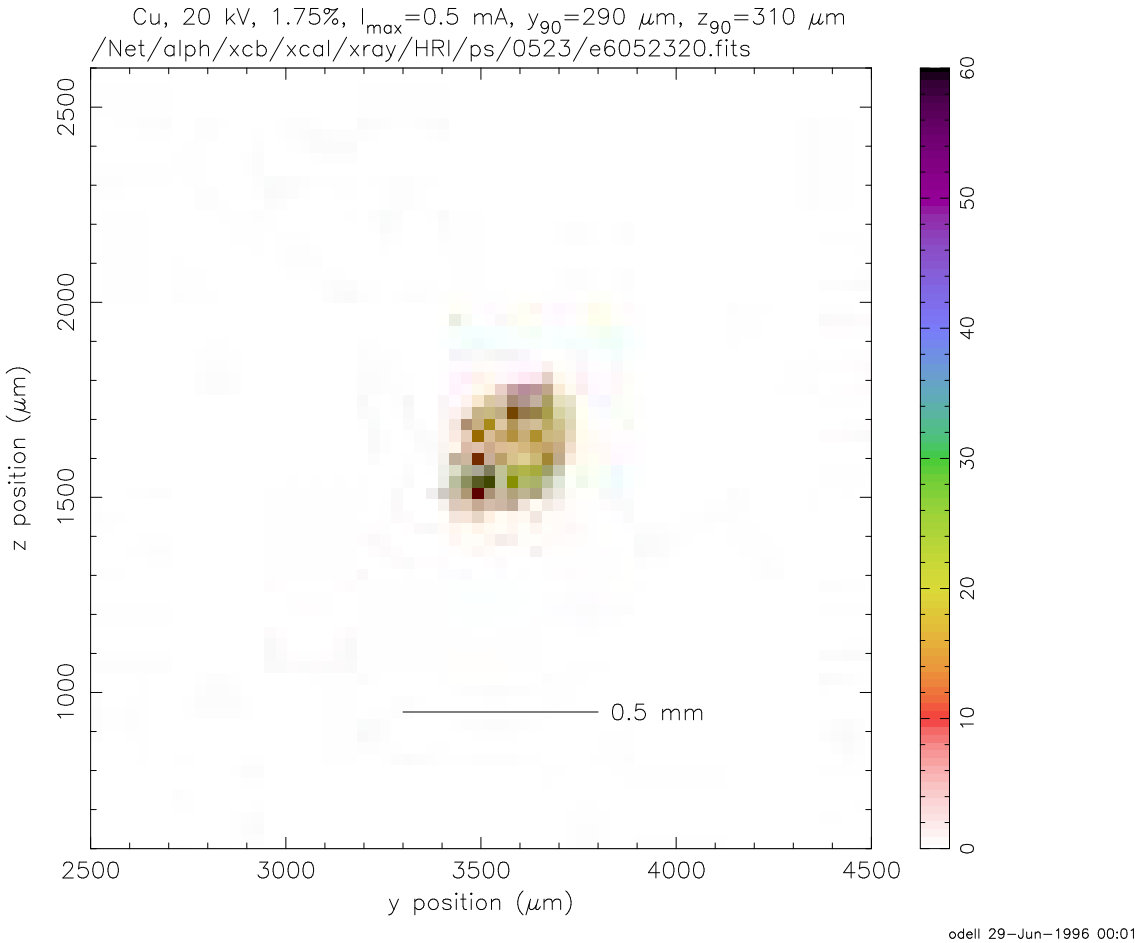
EIPS(Cu, 20 kV, 0.50%): I_{max} = 3.4 mA



EIPS(Cu, 20 kV, 1.25%): I_{max} = 1.4 mA



EIPS(Cu, 20 kV, 1.50%): I_{max} = 1.0 mA



EIPS(Cu, 20 kV, 1.75%): I_{max} = 0.5 mA