Characterization of the XSS

Double-Crystal Monochromator (DCM)

AXAF Project Science

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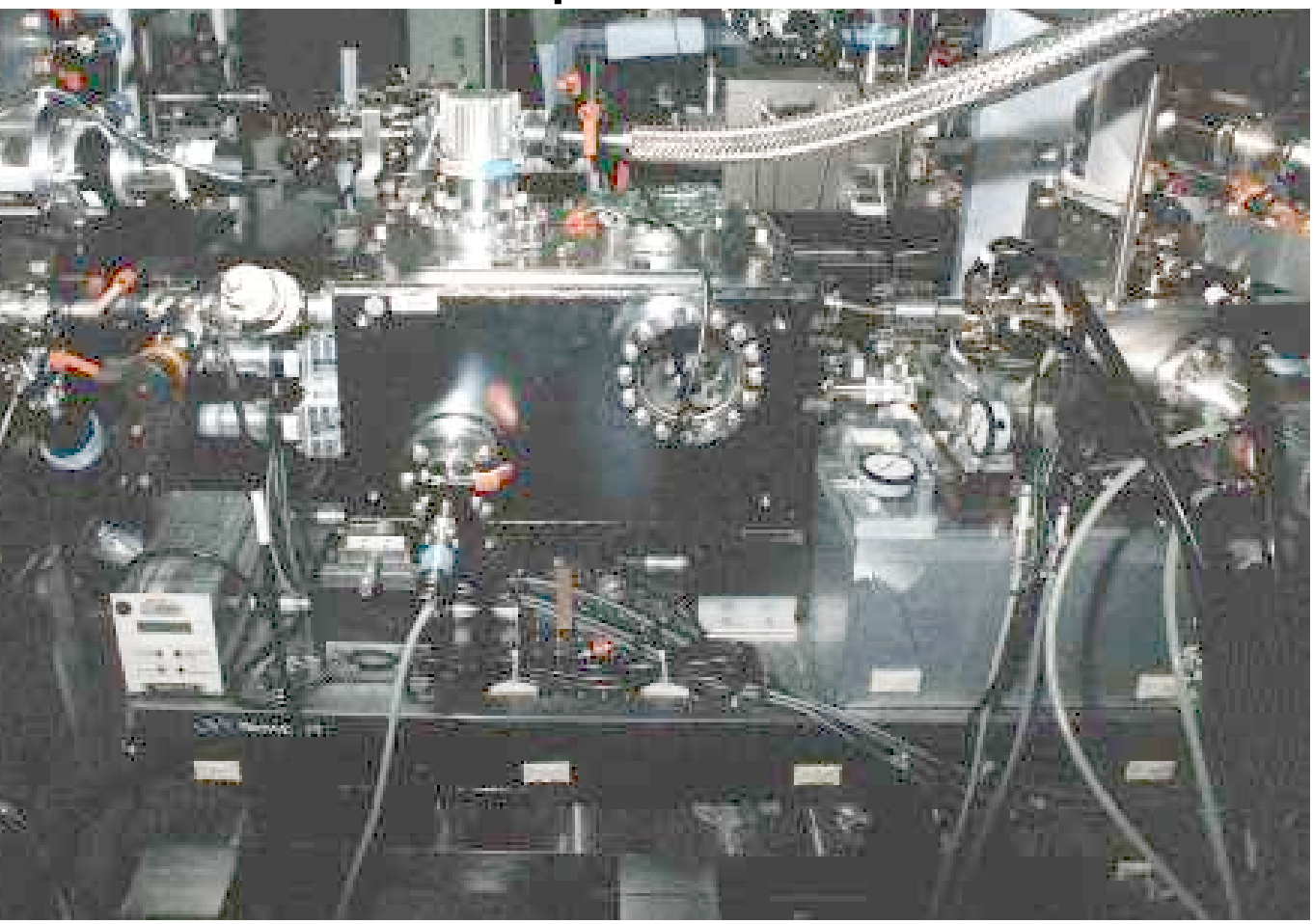
DCM photo



Purpose

eatures
continuously selectable energies above 1 keV
spectral purity
ge energy range, without change-out of hardware.
0.5-mm-by-0.5-mm, or smaller) spot size
ns for AXAF calibration
ve area
i-continuous scans across spectral features.
surements at selectable discrete x-ray energies
oint spread function (PSF) at many energies
uires small spot, less than 0.5-mm (0.2-arcsec) diameter

Characterization activities

re specific count rates with FPC500.
vert to specific flux at HRMA entrance aperture.

ontent

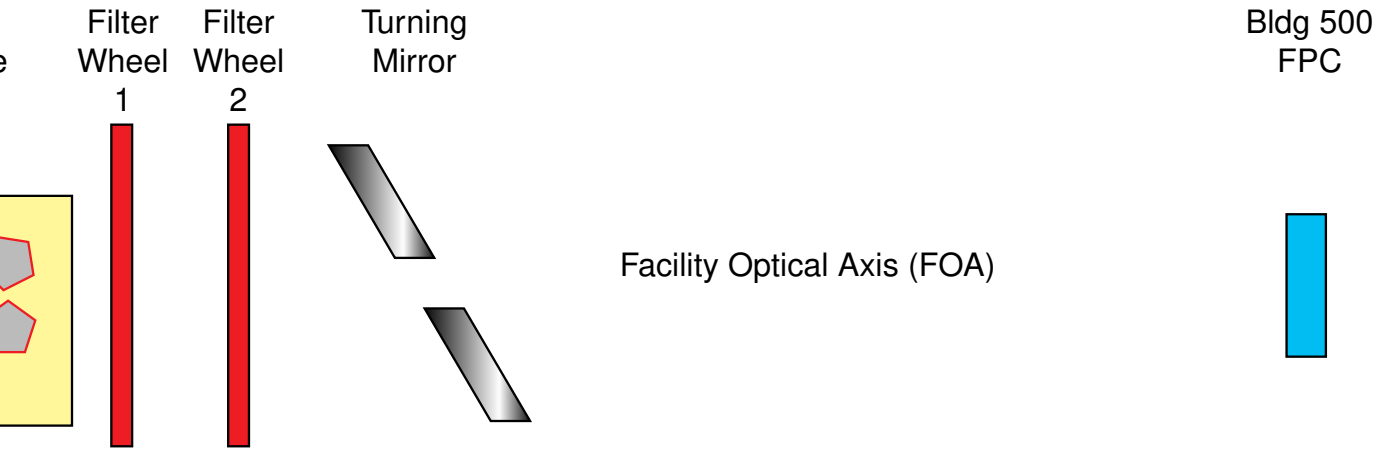
y line-free spectral regions for using monochromator.
e accuracy and repeatability of energy scale.
gate effects of higher spectral orders.
ermine contribution relative to first order.
ore detuning techniques for suppressing higher spectral
ers.

ormity

re with FPC500 mapper.
ine dependence upon DCM crystal and energy setting.

pinhole images of RAS7–DCM with HRI.
sure spot size.
ablish whether scattering is significant.
ine dependence of spot size and shape.
n RAS7 settings, primarily bias
n selected DCM crystal and energy setting

On-line configuration



Description

ting-anode x-ray generator from Rigaku
e x-ray emission, even in continuum
spot size

Characterization of the X-ray Source System (XSS)

Double-Crystal Monochromator *DCM-7*

National Institute of Standards and Technology (NIST)

entagonal-turret monochromator

(thallium acid phthalate) 001 reflection

(potassium dihydrogen phosphate) 011 reflection

(germanium) 111 reflection

(abraded silicon) 400 reflection

turret face not used

nternal degrees of freedom, with computer-controlled motors

ation of turret 1 (“X”) and turret 2 (“Y”)

gitudinal (“Z”) translation of turret 2 (“Y”)

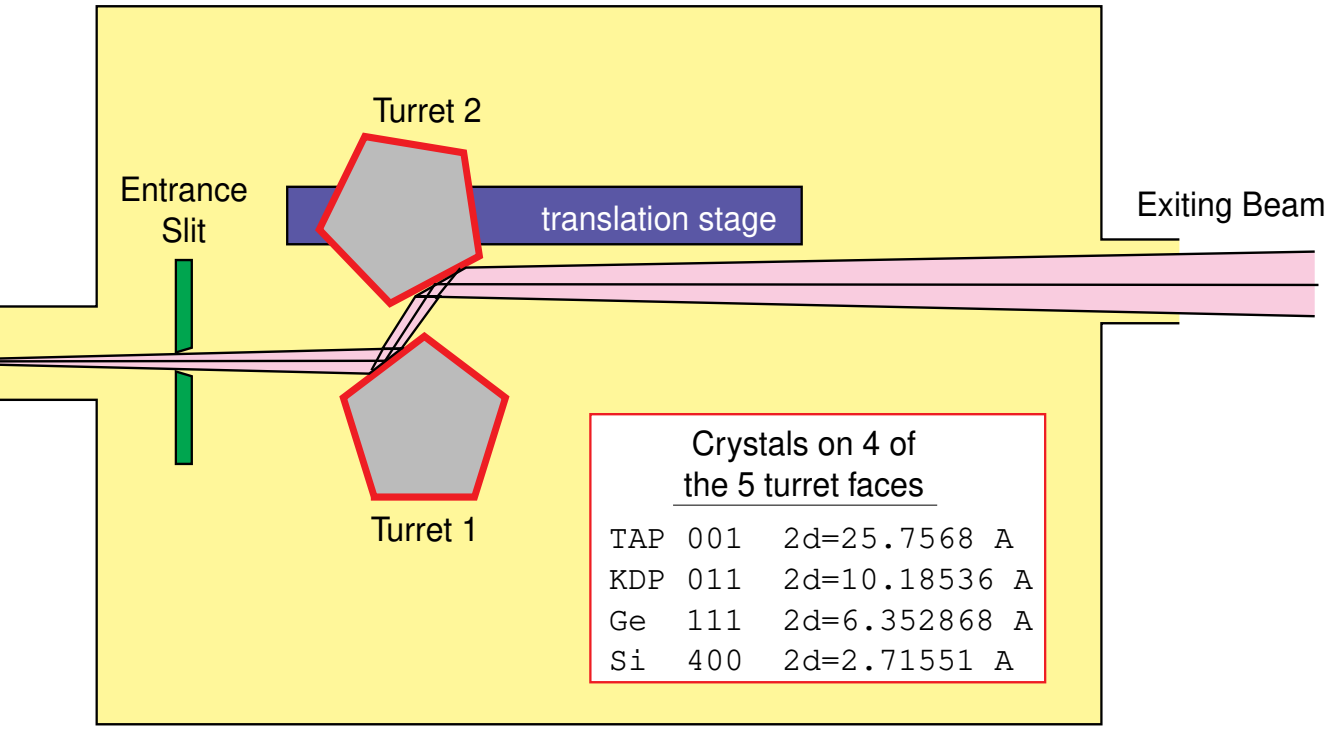
and data-acquisition software

plied by NIST, in LabView© environment

ified by MSFC to allow automatic energy scans, with

-scans to tune turrets relative to each other.

RAS7–DCM optical path



of optical elements and path. Turret-1 rotation selects Bragg angle; turret-2 eps selected crystal faces parallel. Turret 2 also translates parallel to the , to hold the beam displacement (hence, apparent source position) fixed.

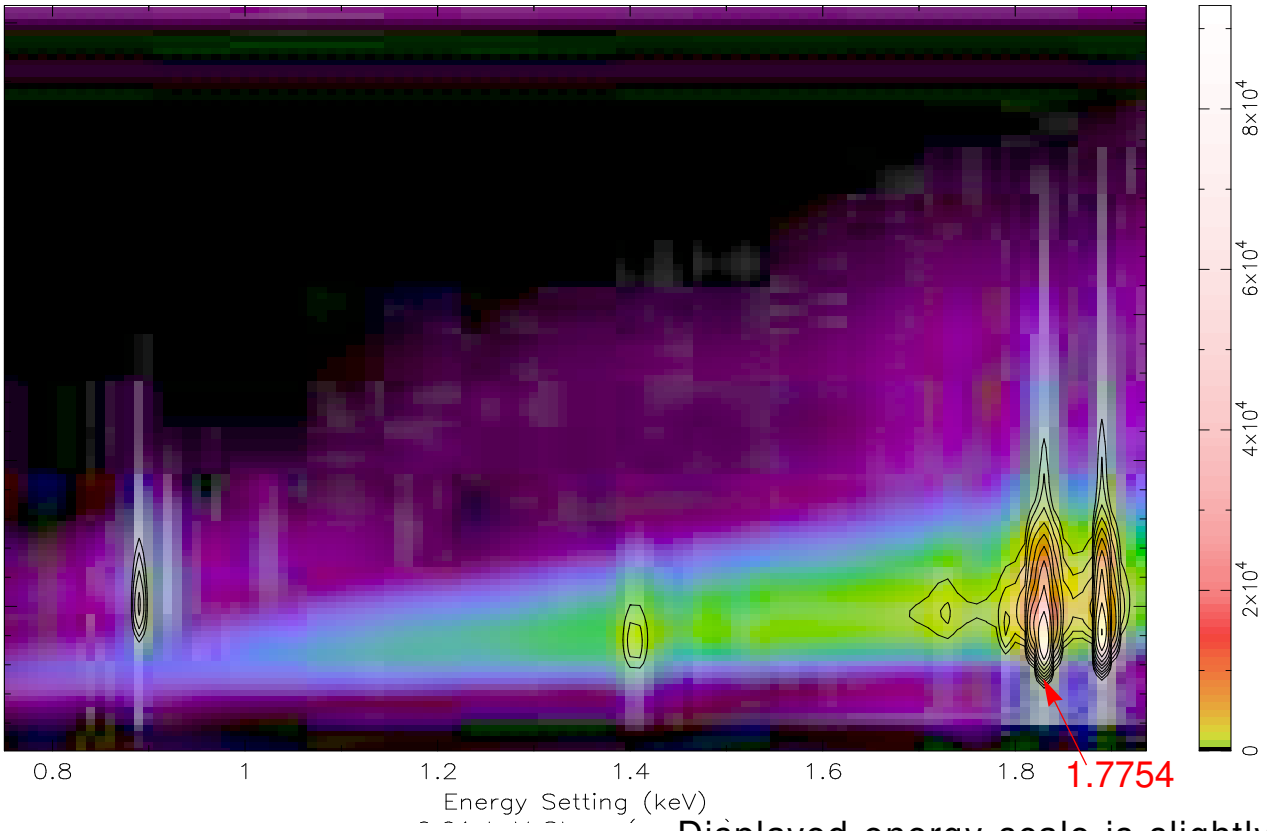
DCM energy scans

ter control of stepping motors
ate turret 1 to Bragg angle corresponding to next energy.
ate and translate turret 2 to predicted optimal location,
ed upon calibrated algorithm.
ate turret 2 in small steps while monitoring x-ray count
(mini-scan), to tune turret-2 to turret 1.
ll at tuned position for desired x-ray collection time.
o to advance to next energy in scan.

cquisition and reduction
e DCM performs energy scan, FPC500 iterates short
ects.
ost analysis, register FPC collects to DCM energy setting.
uence of pulse-height distributions is a bi-spectrogram.

DCM(TAP) coarse scan (low-range)

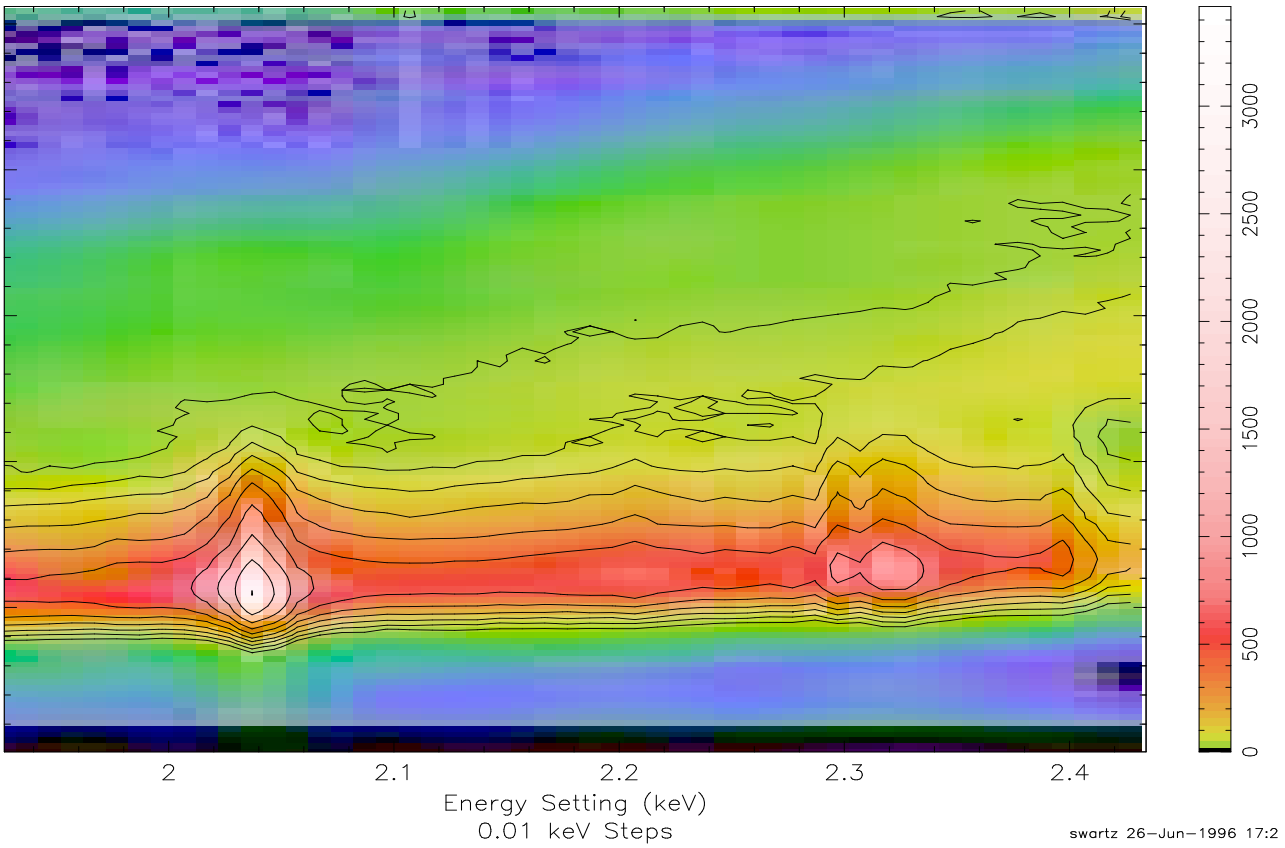
RAS7(W, 20 kV, 40%, 60 mA) – DCM(TAP)
ID 2974 FPC(P10, 400 Torr, 1650 V, 20 CG, 0.75 FG, 36 mm)



Displayed energy scale is slightly wrong.

DCM(TAP) coarse scan (high-range)

RAS7(W, 20 kV, 40%, 90 mA) — DCM(TAP)
ID 3034 FPC(P10, 400 Torr, 1650 V, 20 CG, 0.75 FG, 36 mm)



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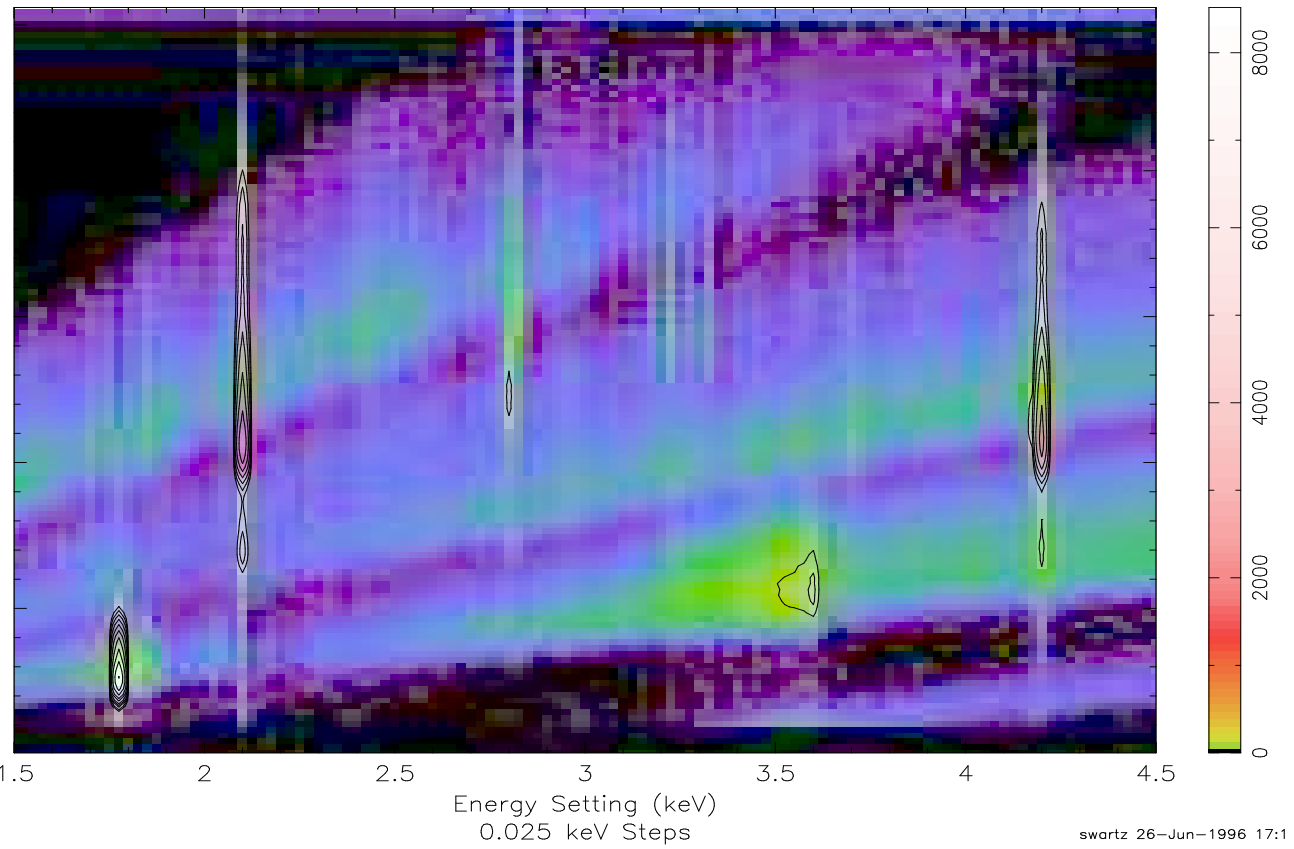
Characterization of the X-ray Source System (XSS)

Double-Crystal Monochromator *DCM-12*

DCM(KDP) coarse scan

RAS7(W, 20 kV, 40%, 90 mA) – DCM(KDP)
ID 2997 FPC(P10, 400 Torr, 1650 V, 10 CG, 0.8 FG, 36 mm)



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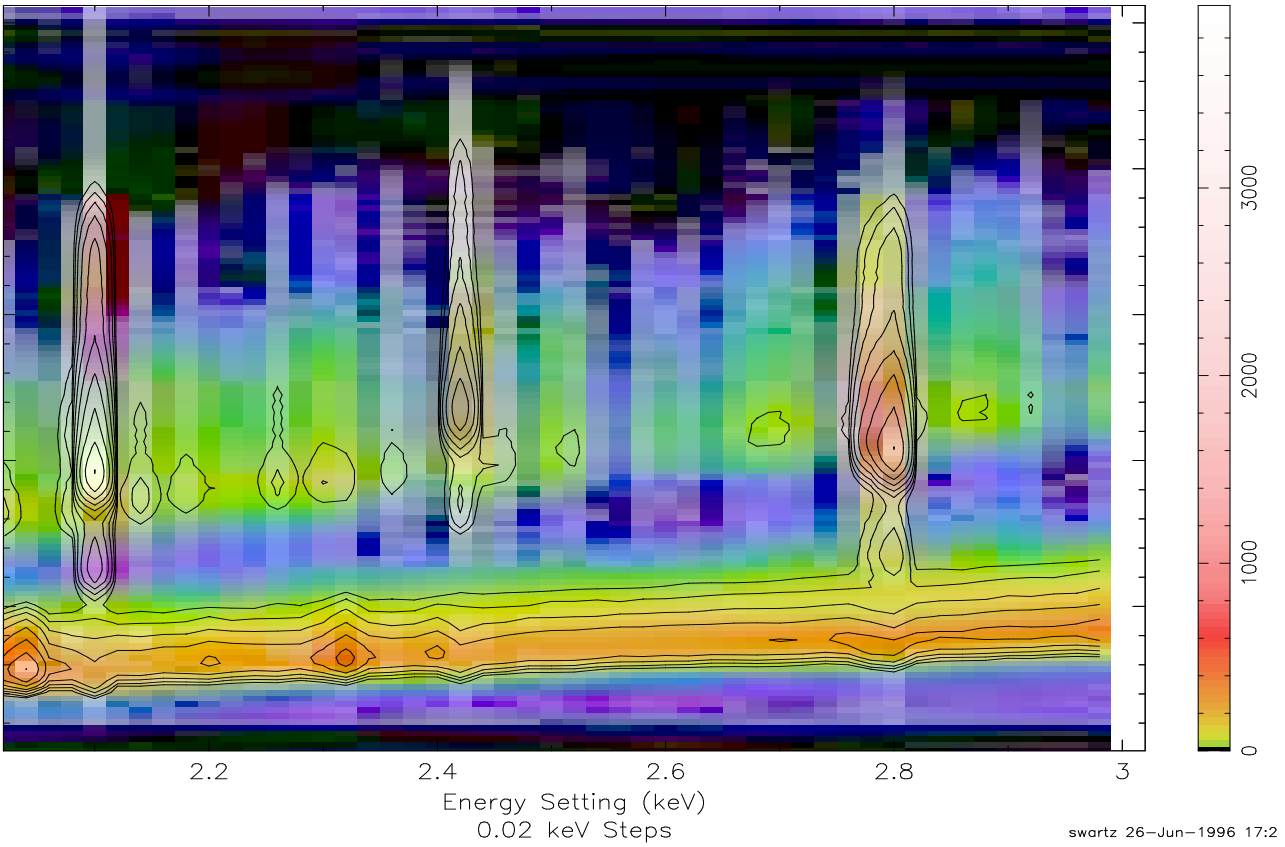
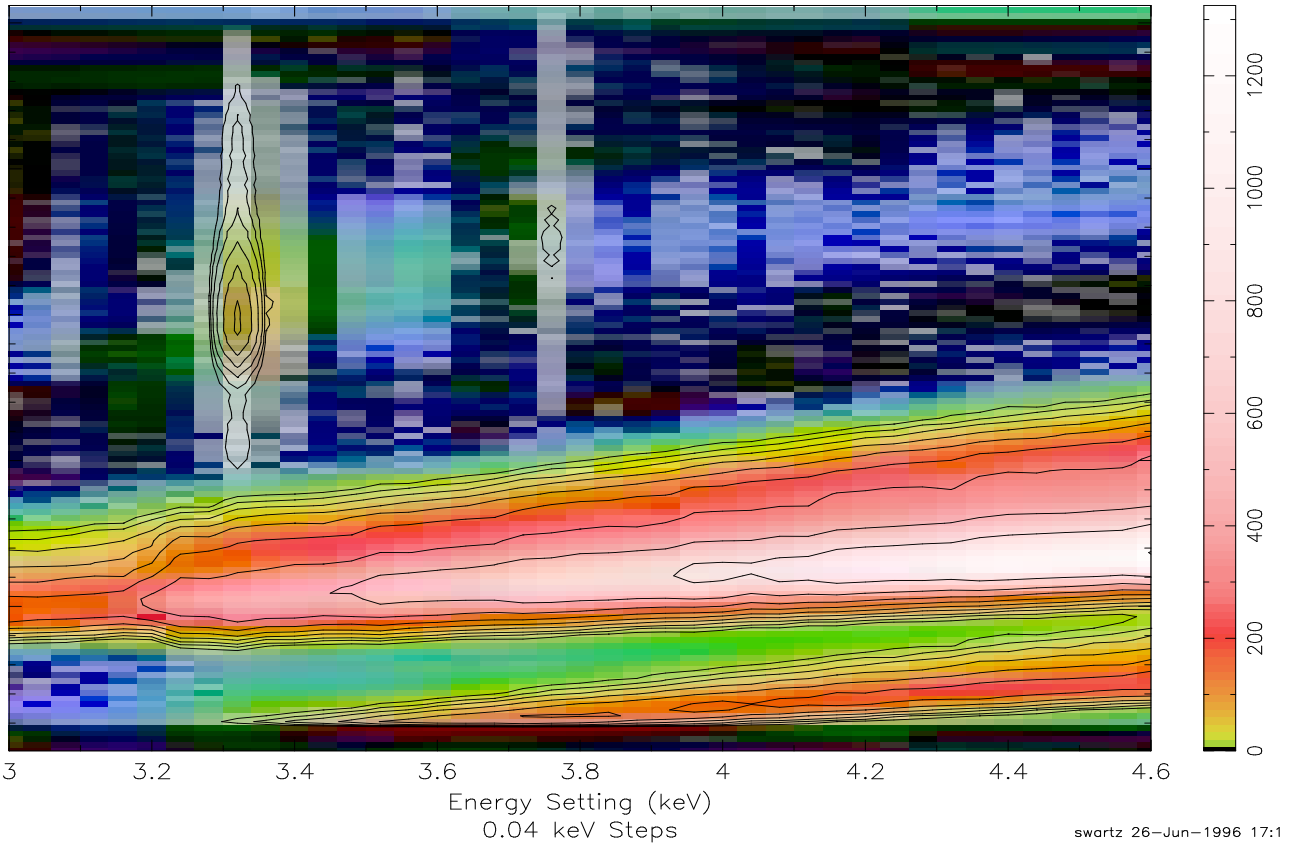
DCM(Ge) coarse scan (low-range)

RAS7(W, 20 kV, 40%, 90 mA) – DCM(Ge)
ID 3038 FPC(P10, 400 Torr, 1650 V, 10 CG, 0.8 FG, 36 mm)



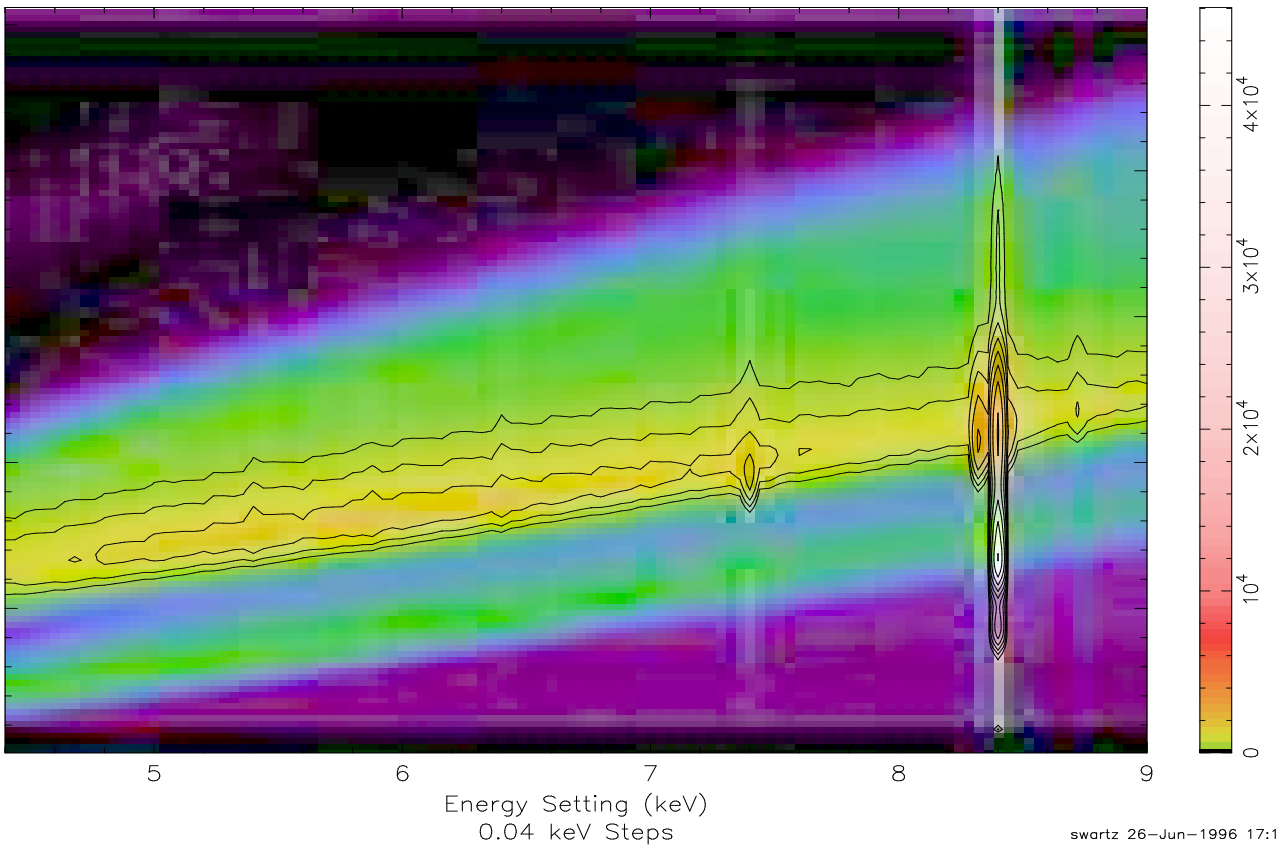
DCM(Ge) coarse scan (mid-range)

RAS7(W, 20 kV, 40%, 60 mA) — DCM(Ge)
ID 2991 FPC(P10, 400 Torr, 1650 V, 10 CG, 0.8 FG, 36 mm)



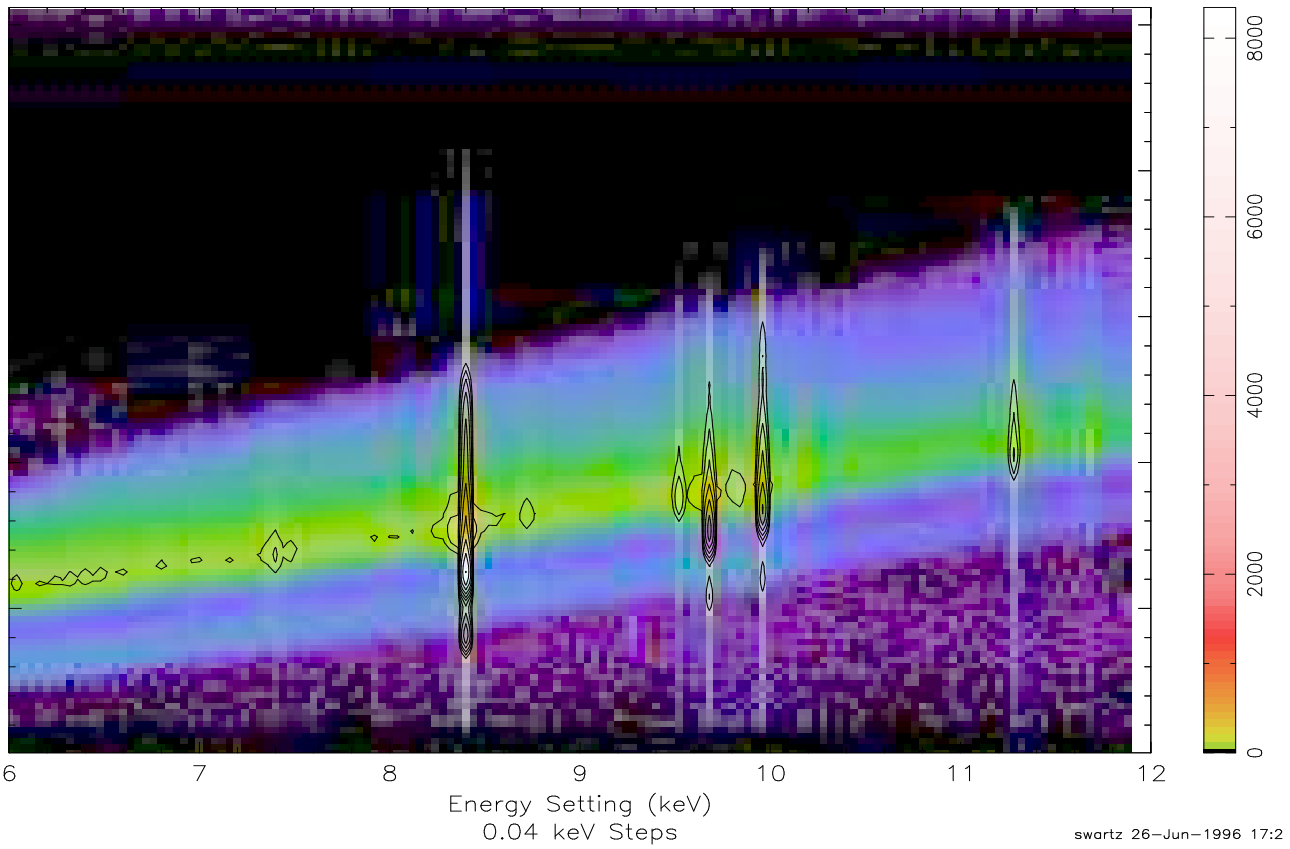
DCM(Ge) coarse scan (high-range)

RAS7(W, 20 kV, 40%, 60 mA) – DCM(Ge)
ID 2990 FPC(P10, 400 Torr, 1650 V, 10 CG, 0.8 FG, 36 mm)

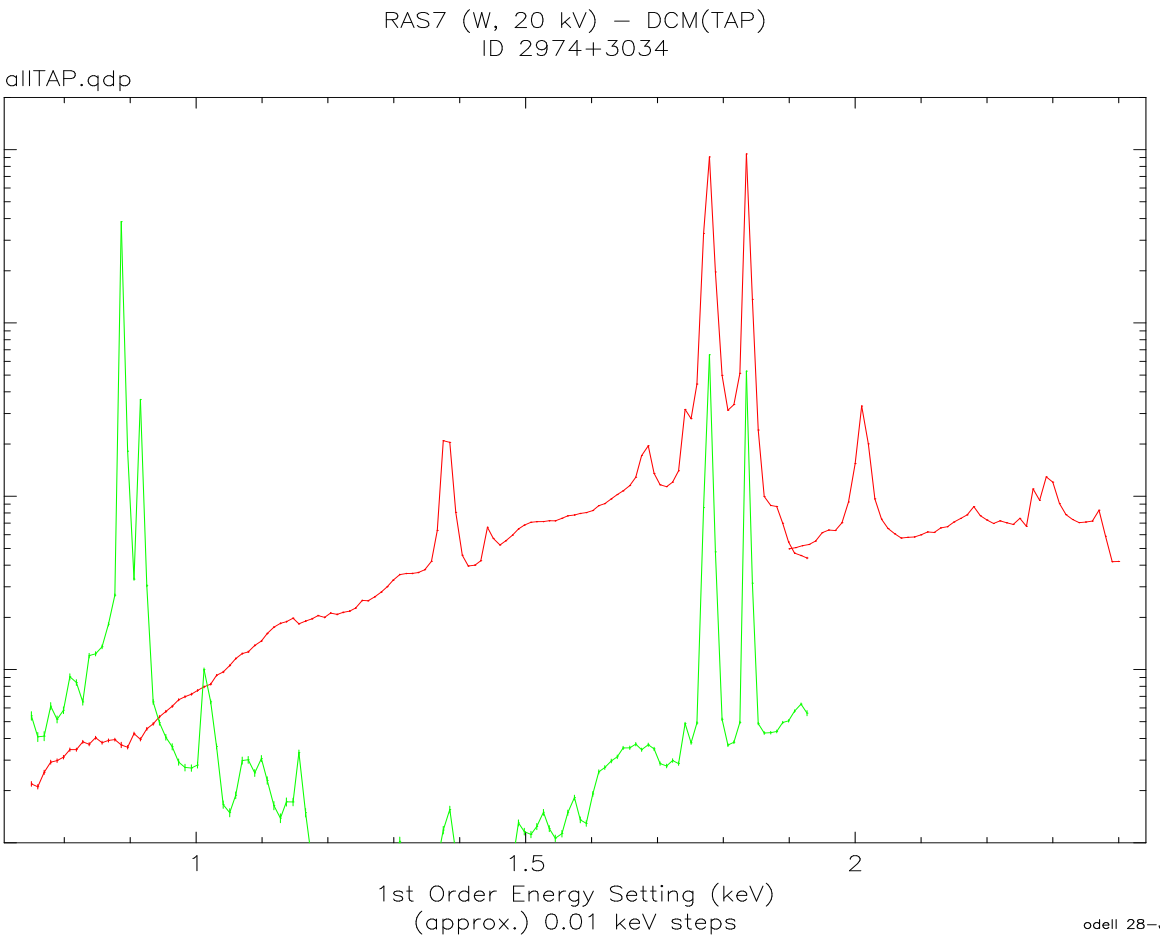


DCM(aSi) coarse scan

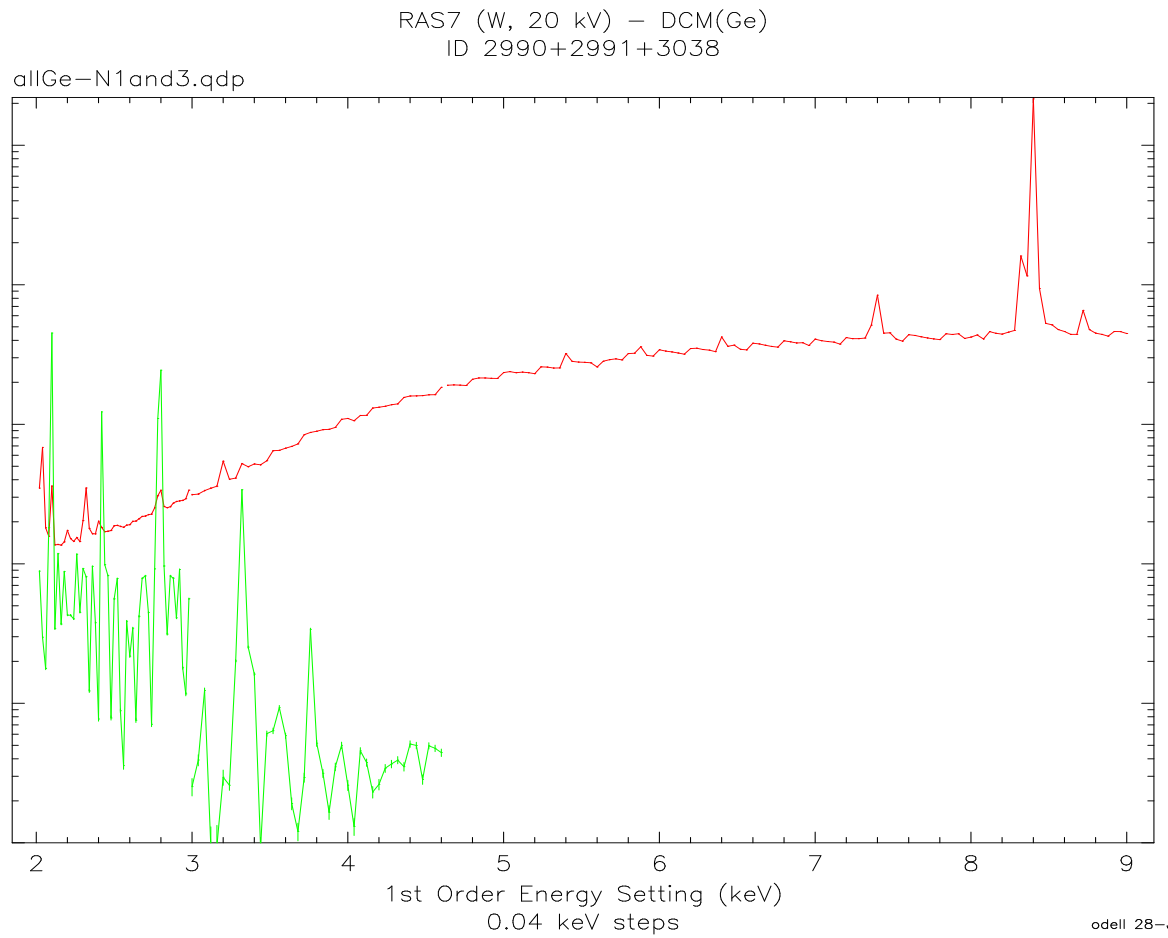
RAS7(W, 20 kV, 40%, 90 mA) – DCM(aSi)
ID 3013 FPC(P10, 400 Torr, 1650 V, 10 CG, 0.50 FG, 36 mm)



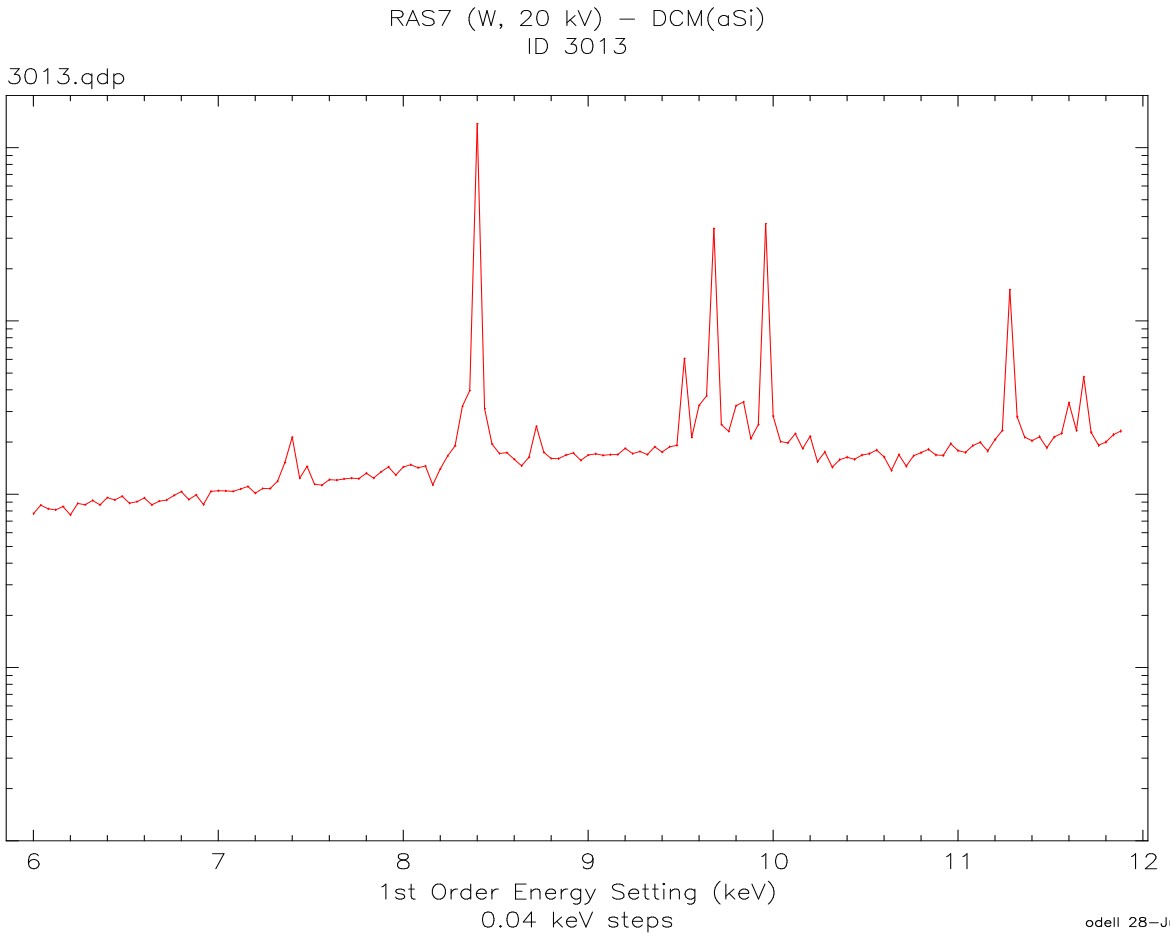
DCM(TAP) specific flux at HRMA aperture



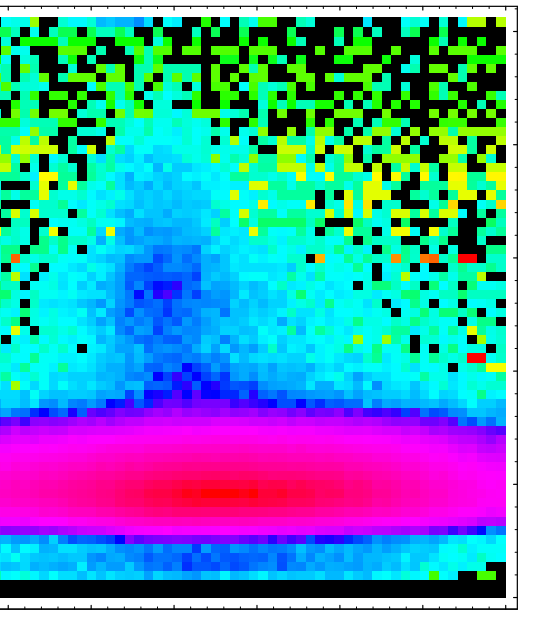
DCM(Ge) specific flux at HRMA aperture

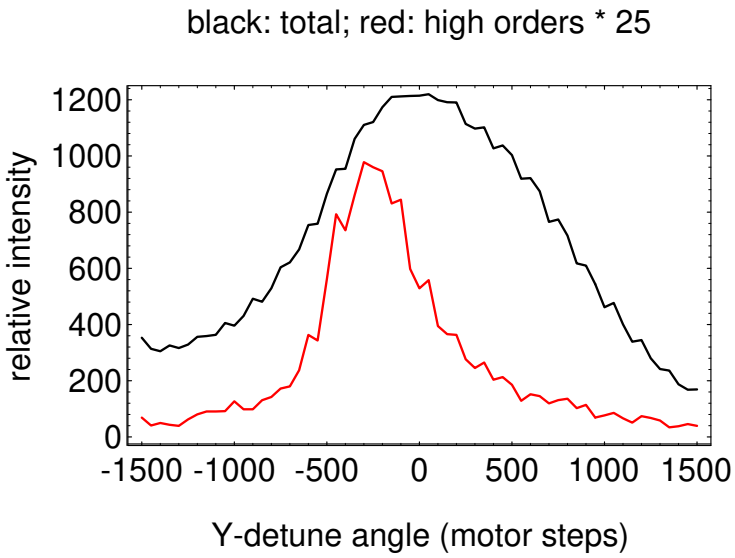


DCM(aSi) specific flux at HRMA aperture



DCM(TAP) detuning

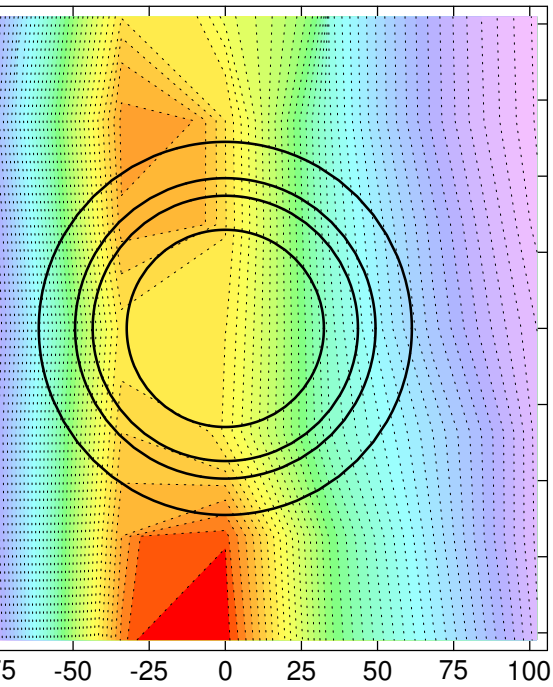




udy for TAP crystal suggests strategy for suppressing order-2 flux — namely, scan to slightly detune. Note also that order-2 flux is already relatively weak of order-1 flux), even without intentionally detuning.

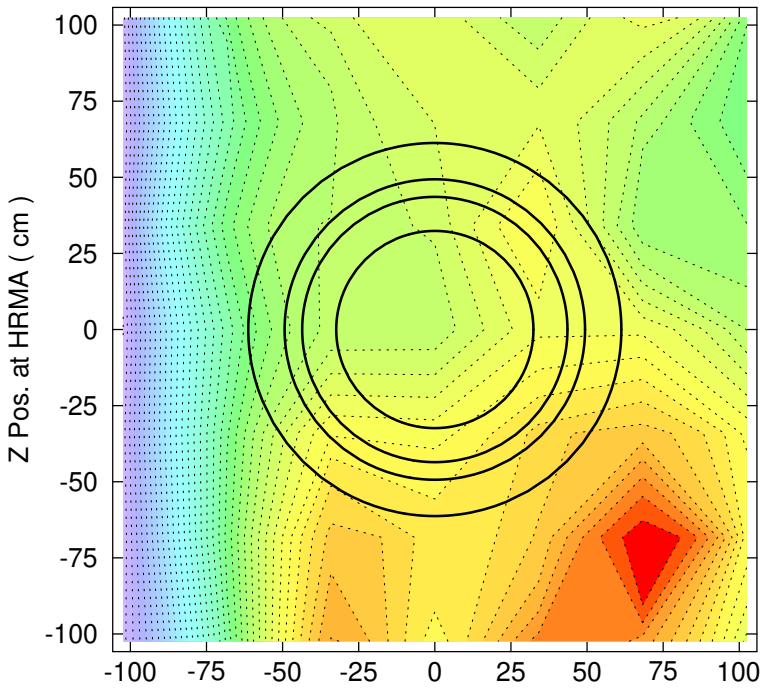
RAS7-DCM(TAP) beam maps

DCM (TAP) at 2.12 keV

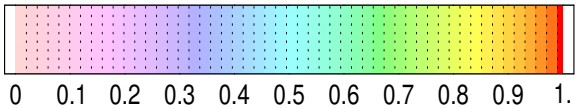


Y Pos. at HRMA (cm)

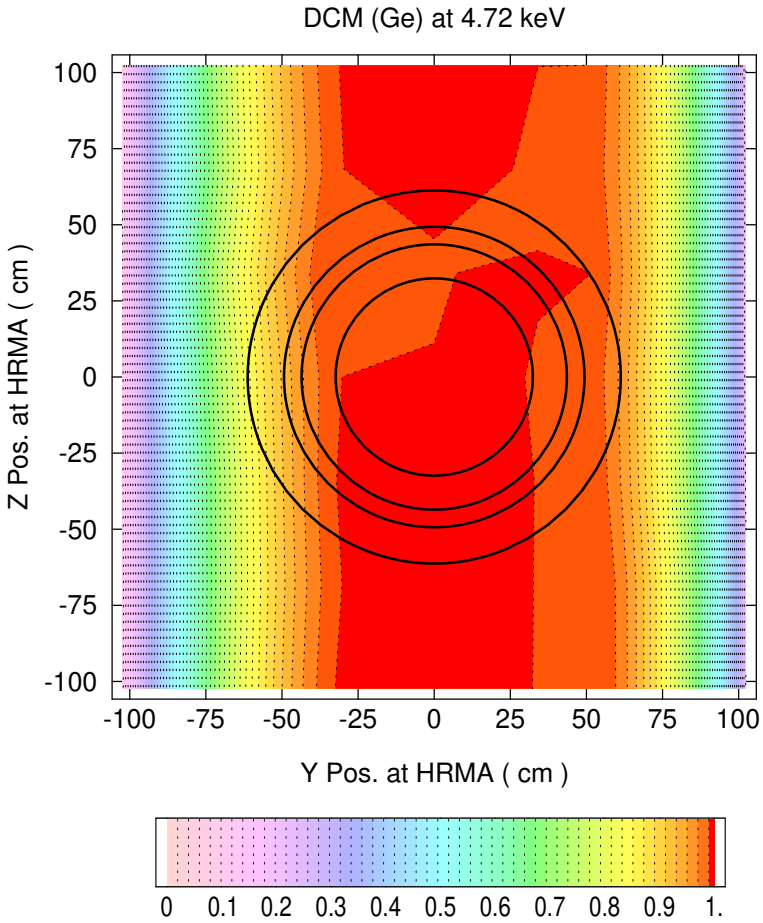
DCM (TAP) at 1.23 keV



Y Pos. at HRMA (cm)

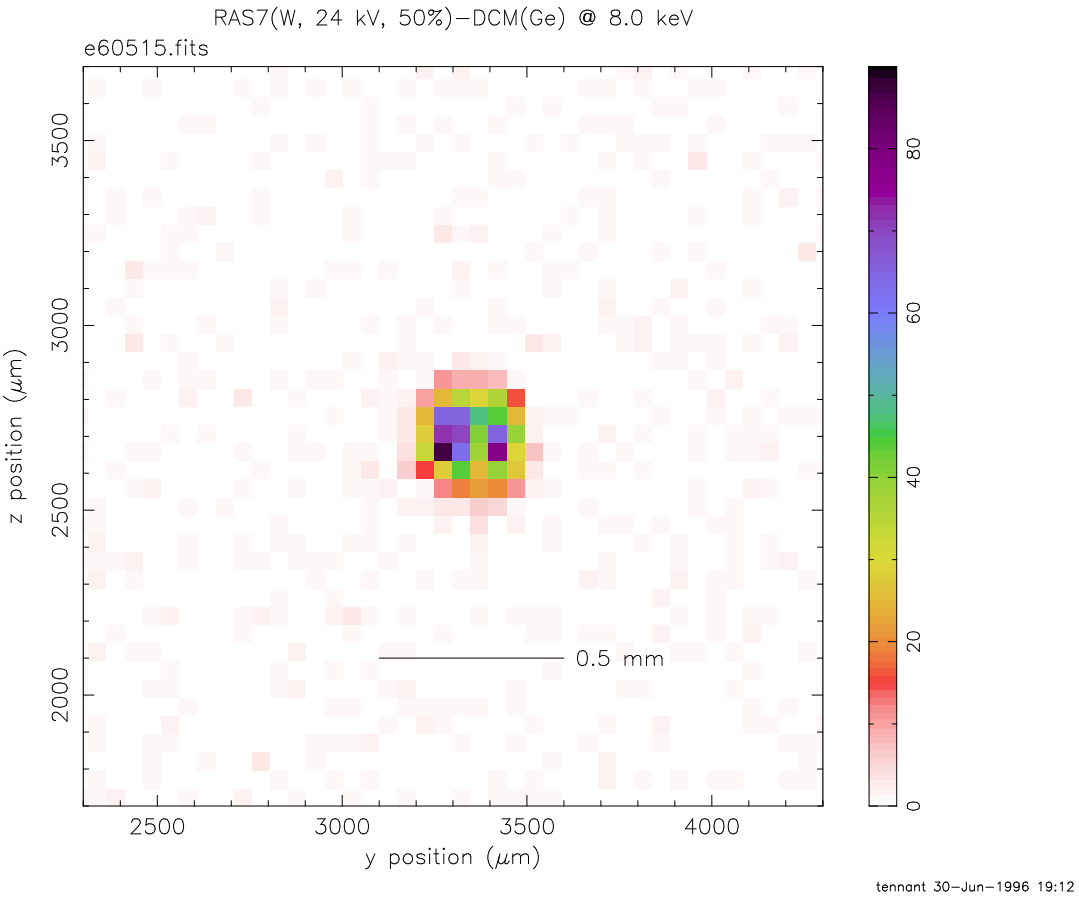


RAS7-DCM(Ge) beam map



Configuration for measuring RAS7–DCM spot

Pinhole HRI

e
um-diameter pinhole
um-thick gold
ations
rce–pinhole 1216 mm
hole–HRI 1235 mm
gnification 1.02

RAS7-DCM spot