X8A Beam Divergence Measurements
(Vertical and Horizontal Direction)
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Motivation

Accurate measurement of beam divergence is beneficial to determine detector dimension and better management for PCD overfilling.

Experiment parameters

The data were acquired at Beamline X8A.
For accuracy, the regular 6-hole filter holder was used during measurement. At this time, #4 hole (out of 6) was picked randomly for this experiment. The 1/16" aperture is always used in our experiment. A fixed energy was determined by applying either crystals (Multilayer @ 1000 eV or Si @ 4000 eV) before the measurement. From the result of a profiling scan of the #4 position, the center of the hole position was verified, and the rough scan ranges for vertical divergence scan was determined at the same time. A 0.002" (0.05 mm) increment was applied for the divergence scans in order for a detailed and smooth divergence curve. And vertical scan was collected (repeat twice for better accuracy) by using automation (2 scans per point). The horizontal edge scans were performed manually.

Results

The left side diagrams below are divergence scans (by plotting Beam Location vs. Current); the graphs on the right side are plotted by using Average beam position vs. Divergence Ratio (or slope of the divergence scan diagram). By using diagrams on the right side, the distances of largest open at the base line (**FWFM divergence**) are measured.

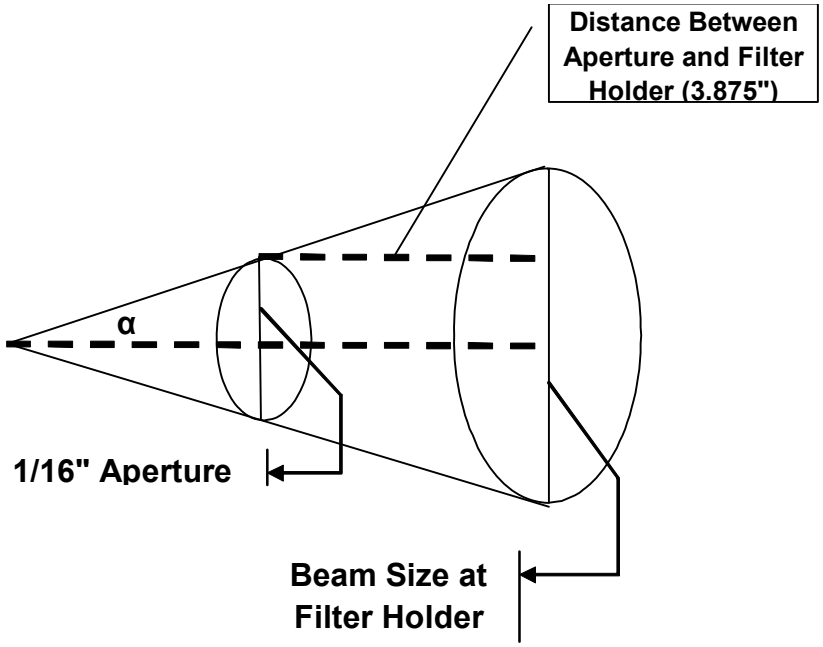
The divergence is given by

$$\tan(\alpha) = \frac{(FWFM - d)}{2} \Big/ L$$

Where

α is the half angle of beam divergence;
FWFM is the size of the beam at filter stalk;

d is the size of the aperture;
L is the distance between aperture and filter stalk.



So the results can be presented as **tan (α) ± Error V** (or **Error H**) **%**

Where

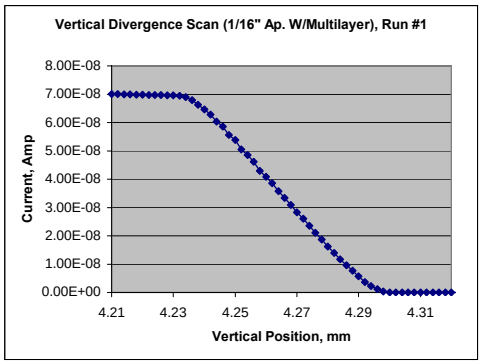
Error V is the Error of the divergence for Vertical edge scan and is STDEV of div

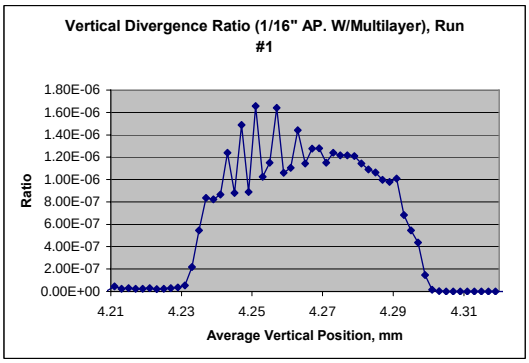
Error H is the Error of the divergence for Horizontal edge scan and is given by 2* positioning error / L

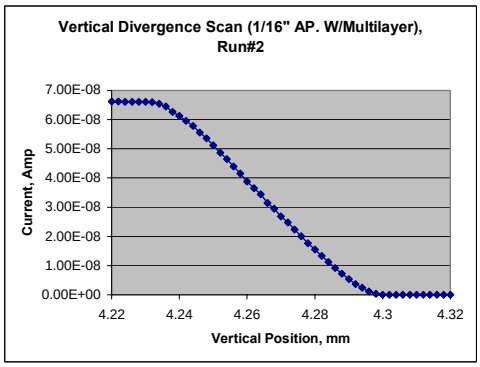
The complete results of beam divergence (both in vertical and horizontal direction) were presented in the table below:

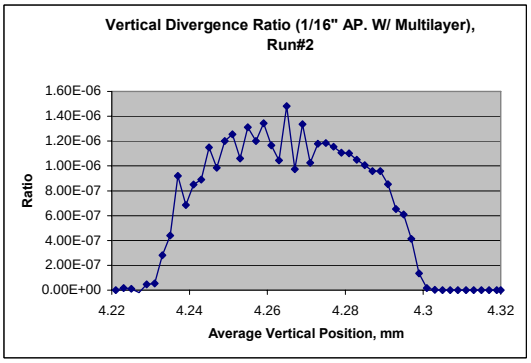
Summary Of Beam Divergence, X8A ---20060726

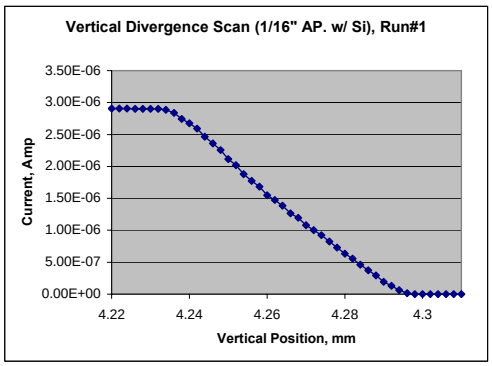
	Vertical Div.	Horizontal Div.
1kev (Multi)	0.19 ±0.021%	0.18±0.020%
4kev (Si)	0.0835± 0.019%	0.08 ±0.020%

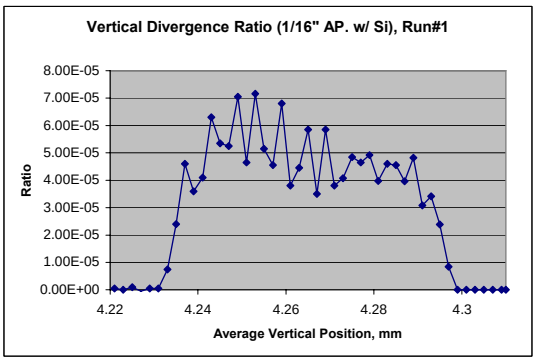

Vertical Divergence Scan (1/16" Ap. W/Multilayer), Run #1
Current, Amp
8.00E-08
7.00E-08
6.00E-08
5.00E-08
4.00E-08
3.00E-08
2.00E-08
1.00E-08
0.00E+00
4.21
4.23
4.25
4.27
4.29
4.31
Vertical Position, mm

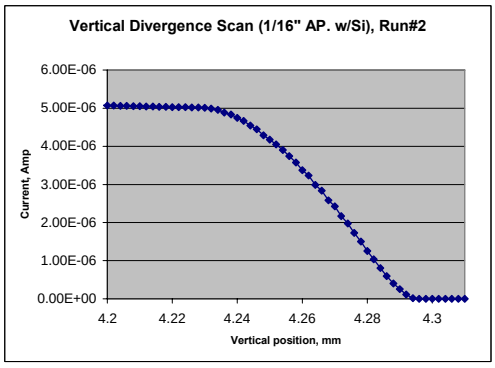

Vertical Divergence Ratio (1/16" AP. W/Multilayer), Run #1
Ratio
1.80E-06
1.60E-06
1.40E-06
1.20E-06
1.00E-06
8.00E-07
6.00E-07
4.00E-07
2.00E-07
0.00E+00
4.21
4.23
4.25
4.27
4.29
4.31
Average Vertical Position, mm

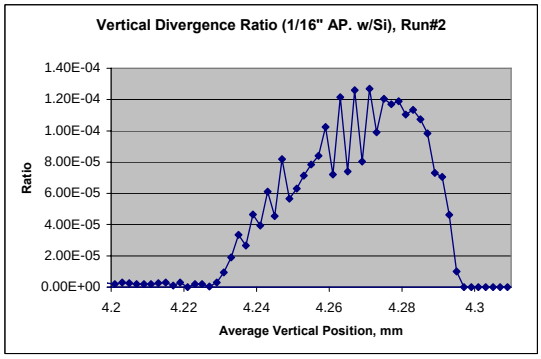

Vertical Divergence Scan (1/16" AP. W/Multilayer), Run#2
Current, Amp
7.00E-08
6.00E-08
5.00E-08
4.00E-08
3.00E-08
2.00E-08
1.00E-08
0.00E+00
4.22
4.24
4.26
4.28
4.3
4.32
Vertical Position, mm

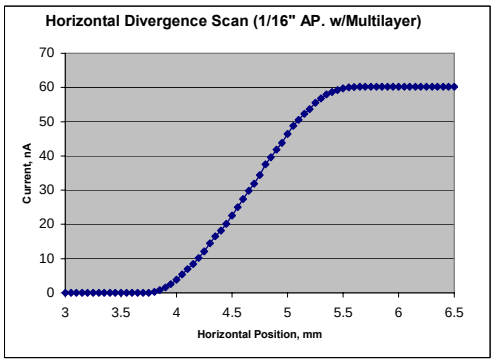

Vertical Divergence Ratio (1/16" AP. W/ Multilayer), Run#2
Ratio
1.60E-06
1.40E-06
1.20E-06
1.00E-06
8.00E-07
6.00E-07
4.00E-07
2.00E-07
0.00E+00
4.22
4.24
4.26
4.28
4.3
4.32
Average Vertical Position, mm

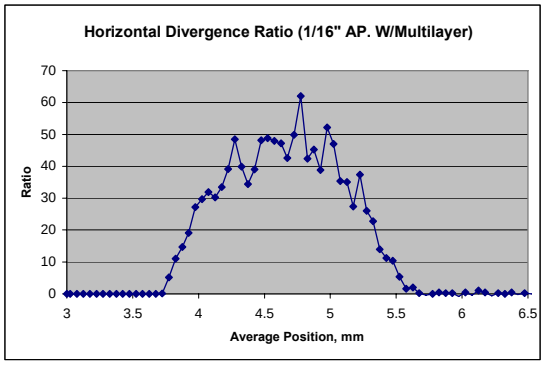

Vertical Divergence Scan (1/16" AP. w/ Si), Run#1
Current, Amp
3.50E-06
3.00E-06
2.50E-06
2.00E-06
1.50E-06
1.00E-06
5.00E-07
0.00E+00
4.22
4.24
4.26
4.28
4.3
Vertical Position, mm

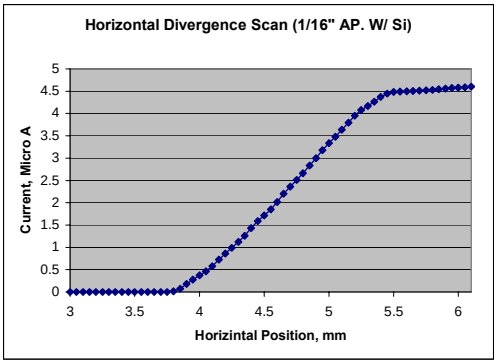

Vertical Divergence Ratio (1/16" AP. w/ Si), Run#1
Ratio
8.00E-05
7.00E-05
6.00E-05
5.00E-05
4.00E-05
3.00E-05
2.00E-05
1.00E-05
0.00E+00
4.22
4.24
4.26
4.28
4.3
Average Vertical Position, mm

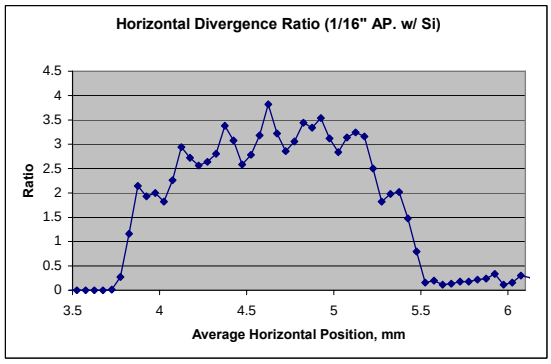

Vertical Divergence Scan (1/16" AP. w/Si), Run#2
Current, Amp
6.00E-06
5.00E-06
4.00E-06
3.00E-06
2.00E-06
1.00E-06
0.00E+00
4.2
4.22
4.24
4.26
4.28
4.3
Vertical position, mm


Vertical Divergence Ratio (1/16" AP. w/Si), Run#2
Ratio
1.40E-04
1.20E-04
1.00E-04
8.00E-05
6.00E-05
4.00E-05
2.00E-05
0.00E+00
4.2
4.22
4.24
4.26
4.28
4.3
Average Vertical Position, mm


Horizontal Divergence Scan (1/16" AP. w/Multilayer)
Current, nA
Horizontal Position, mm


Horizontal Divergence Ratio (1/16" AP. W/Multilayer)
Ratio
Average Position, mm


Horizontal Divergence Scan (1/16" AP. W/ Si)
Current, Micro A
Horizintal Position, mm


Horizontal Divergence Ratio (1/16" AP. w/ Si)
Ratio
Average Horizontal Position, mm