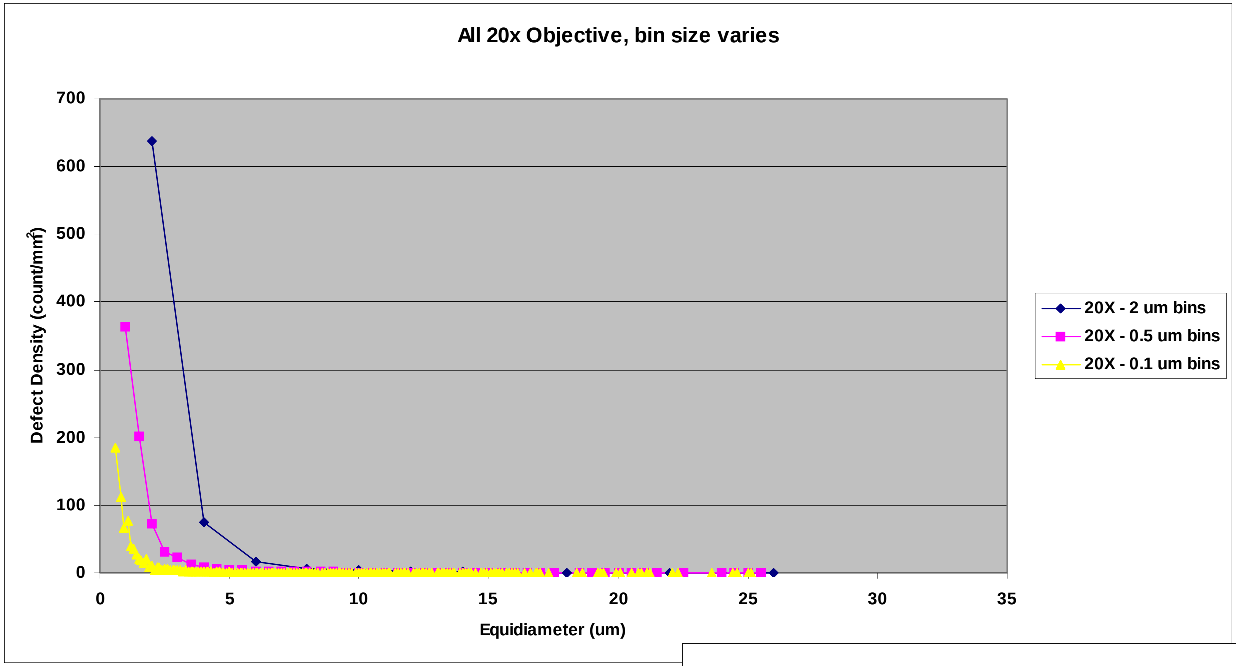
Some Defect Counting Microscope Results – Lessons Learned

Dark Field Particle Counting on
LMA Micromap Sample
&
Tinsley Scatter Master Sample

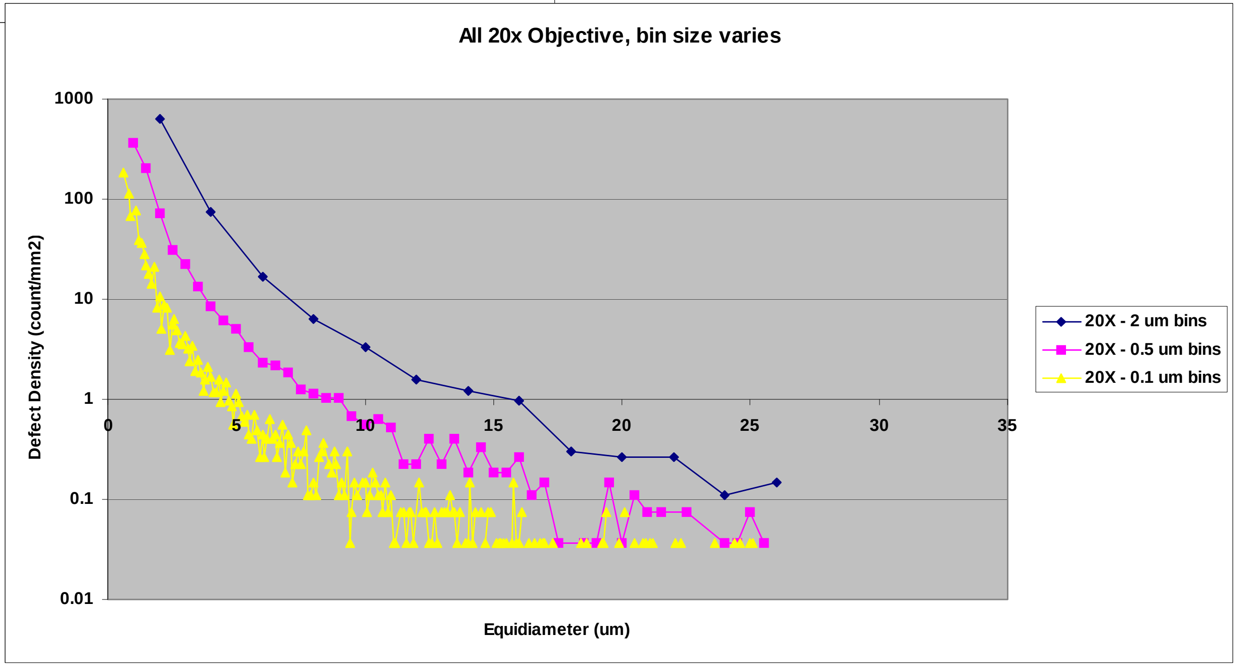
LMA Micromap Sample

- 3” diameter fused silica.
- 20X objective, 99 frames analyzed - 26.8 mm^2 total area.
- Histogram bin size varied: 2 um, 0.5 um, 0.1 um.
- ***Same Data manipulated from single map for fixed microscope, contrast & analysis settings.***
- Goal was to understand binning.

LMA Micromap Sample – Binning: the result can be made nearly independent of the bin size by dividing by the bin size. Below, the results are NOT normalized to a bin size.



$$Density(E,b) = \frac{counts(E,b)}{A_{total\_scanned}}$$



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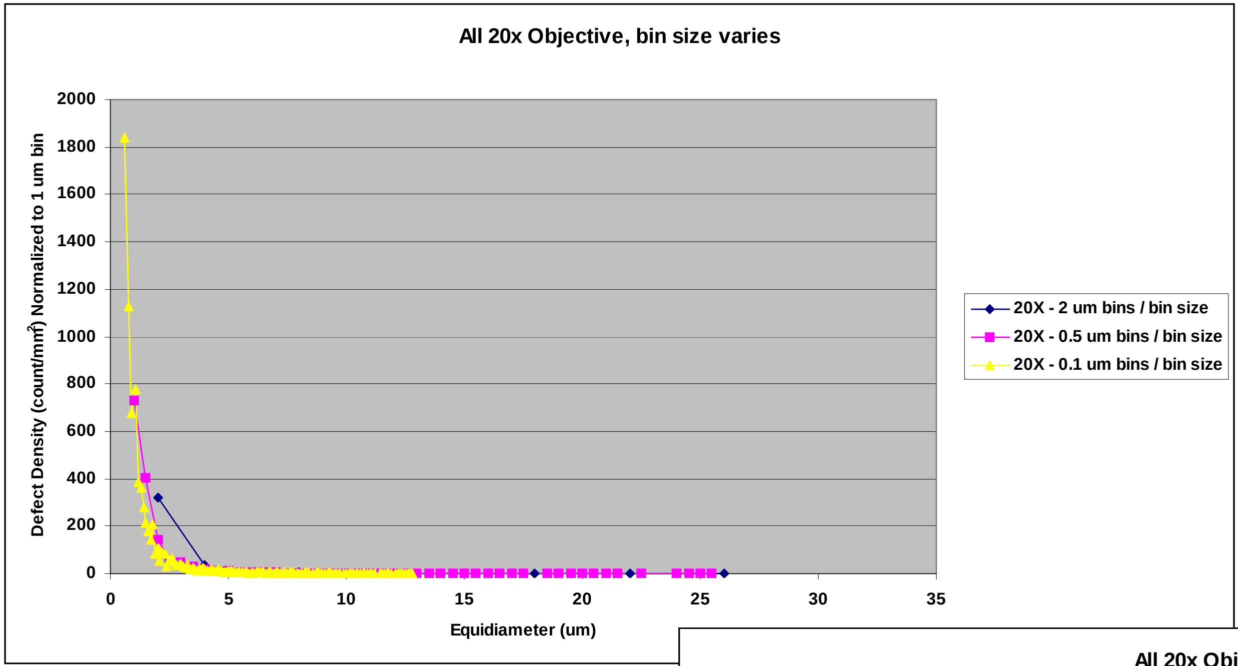
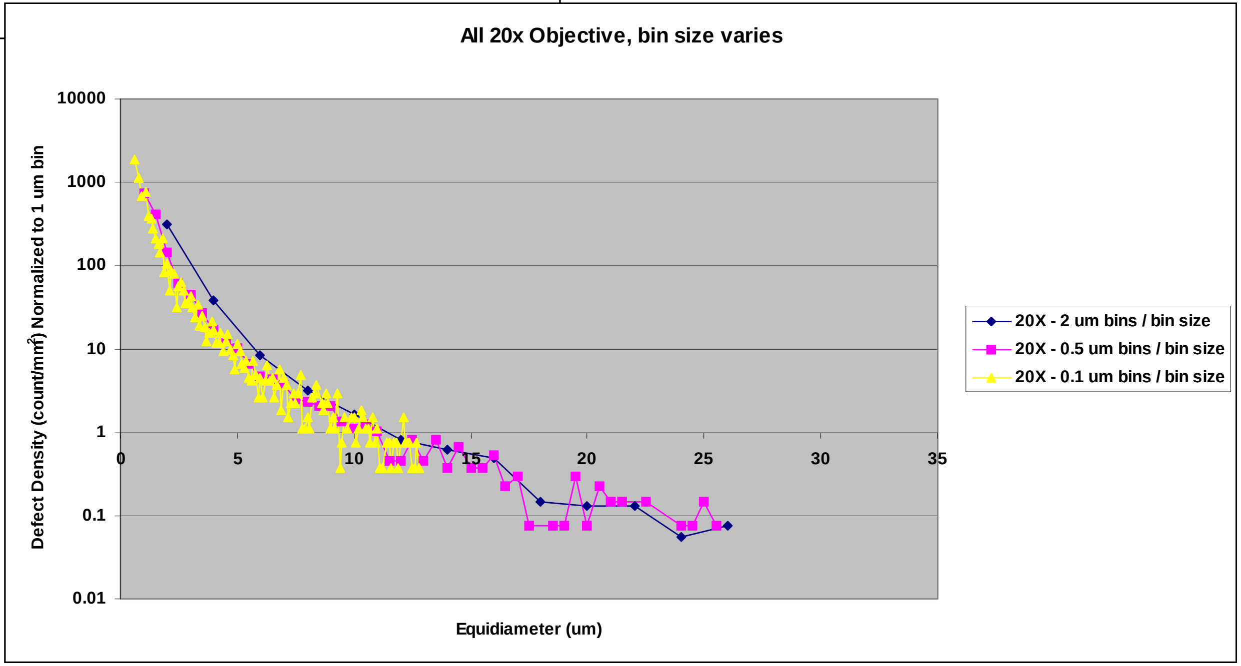
LMA Micromap Sample – Binning: By dividing by the bin size (in microns) the defect density is normalized to a bin size of 1 micron. Larger bin sizes then serve to integrate the data and reduce noise.



$$Density\_Norm(E,b) = \frac{counts(E,b)}{A_{total\_scanned}} \frac{1}{b}$$



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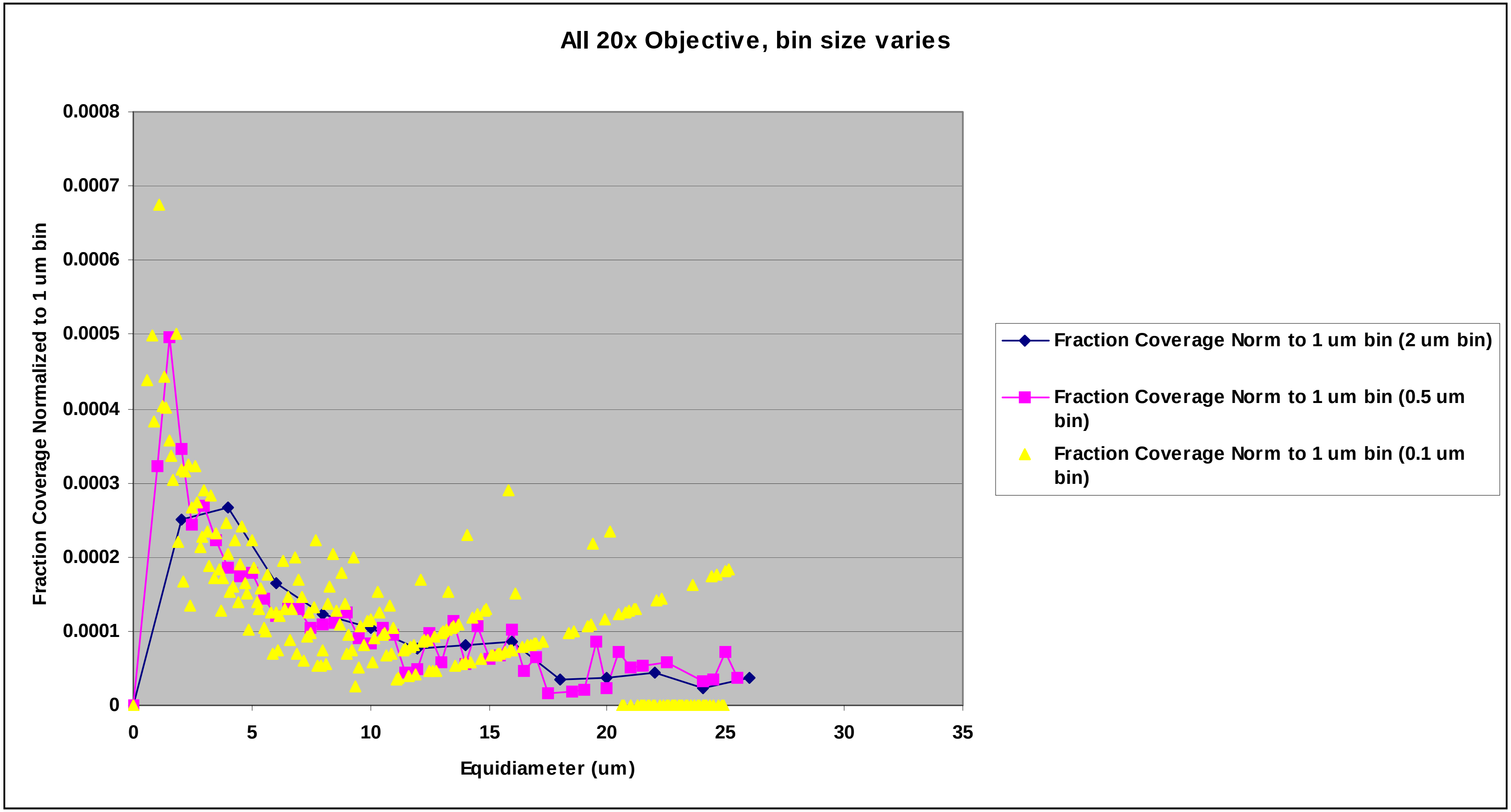
LMA Micromap Sample – Conversion of the bin-normalized defect density to a fraction of area covered is done by multiplying by the average defect size *S* in a bin range at each equidiameter *E*. The *b* is the bin size. This produces a peak at the most important equidiameter. Note the peak position is slightly dependent on the bin size. The micromap sample has mostly small defects 1.1 um < E < 1.5 um, discernable with the smaller bin sizes. Bin sizes that are too big give higher peak values (the 2 um bin has a peak near 3.5 um equidiameter).

$$S(E,b) = \pi\left(\frac{1}{2}\frac{E+(E-b)}{2}\right)^2$$

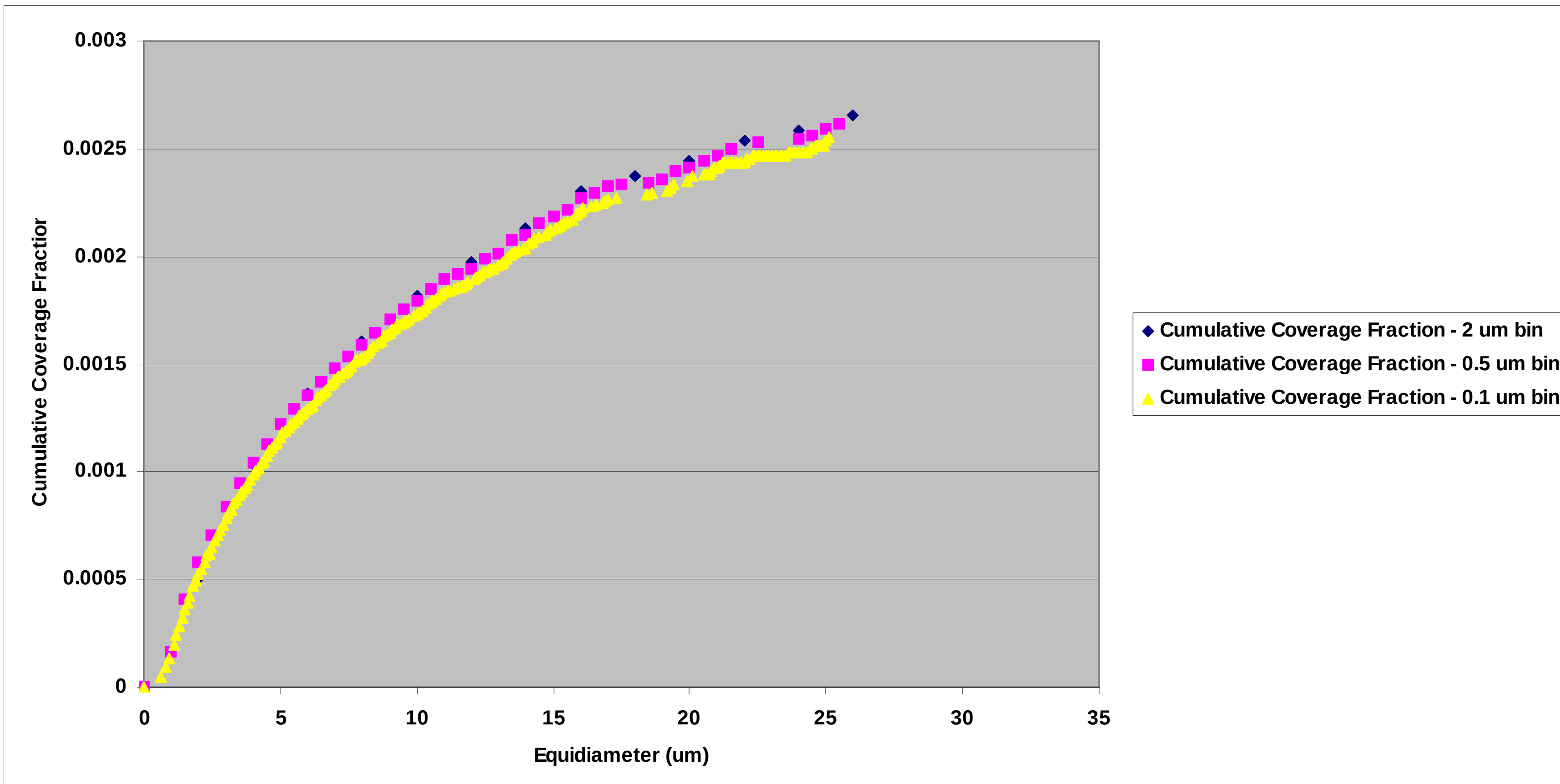
$$FC(E,b) = \frac{counts(E,b)}{A_{total\_scanned}}\frac{1}{b}S(E,b)$$



LMA Micromap Sample – Integrating over equidiameter then gives the cumulative coverage fraction.

Very weakly bin size dependent.

$$Cumulative\_FC(E,b) = b\sum_{\varepsilon=0}^{\varepsilon=E} FC(\varepsilon,b) = \sum_{\varepsilon=0}^{\varepsilon=E} Density(\varepsilon,b)S(\varepsilon,b)$$



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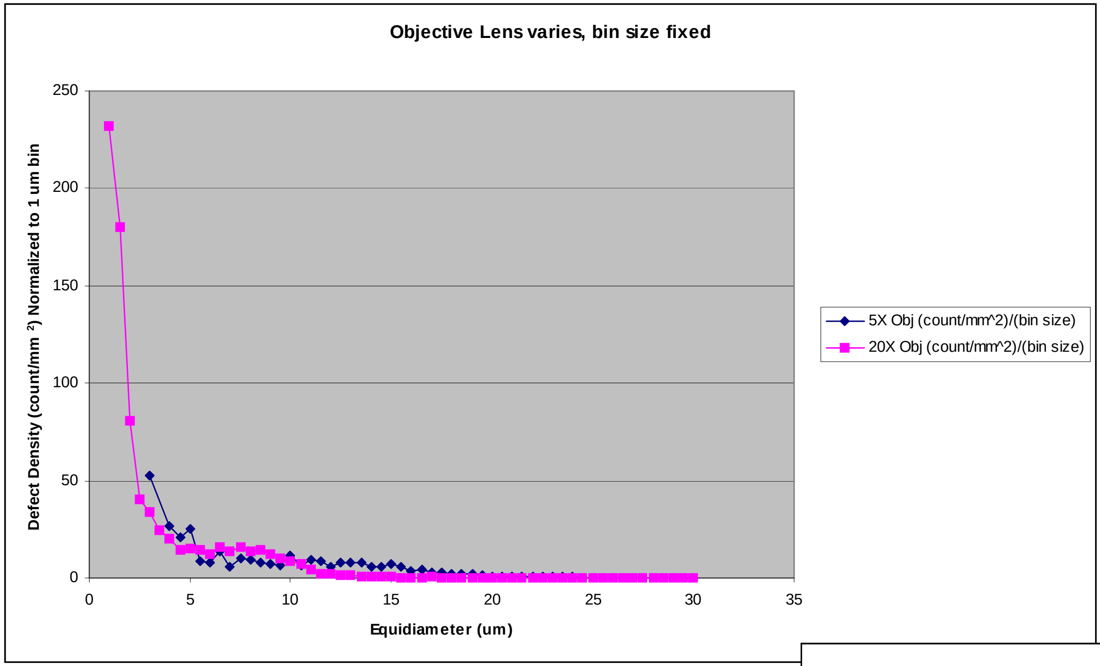
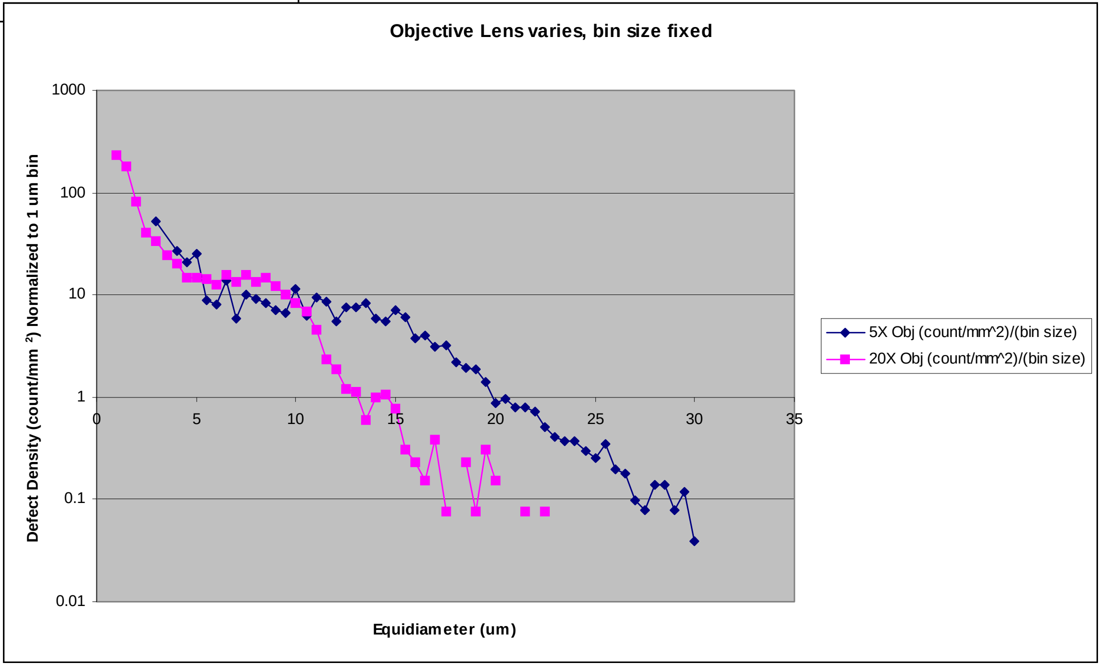
Tinsley Scatter Master Sample

- 1” x 3” microscope slide.
- 20X objective, 99 frames analyzed - 26.8 mm^2 total area.
- 5X objective, 24 frames analyzed – 102 mm^2 total area.
- Histogram bin size fixed at 0.5 um.
- ***Contrast (exposure time) must change on changing magnification,***
- ***Analysis settings (threshold + restrictions) must also change.***

Tinsley Scatter Sample – Defect density normalized to 1 micron bin.



Note that the 5X objective is more sensitive to larger defects, the 20X objective is more sensitive to smaller ones, while in the mid-range they are in closer agreement.



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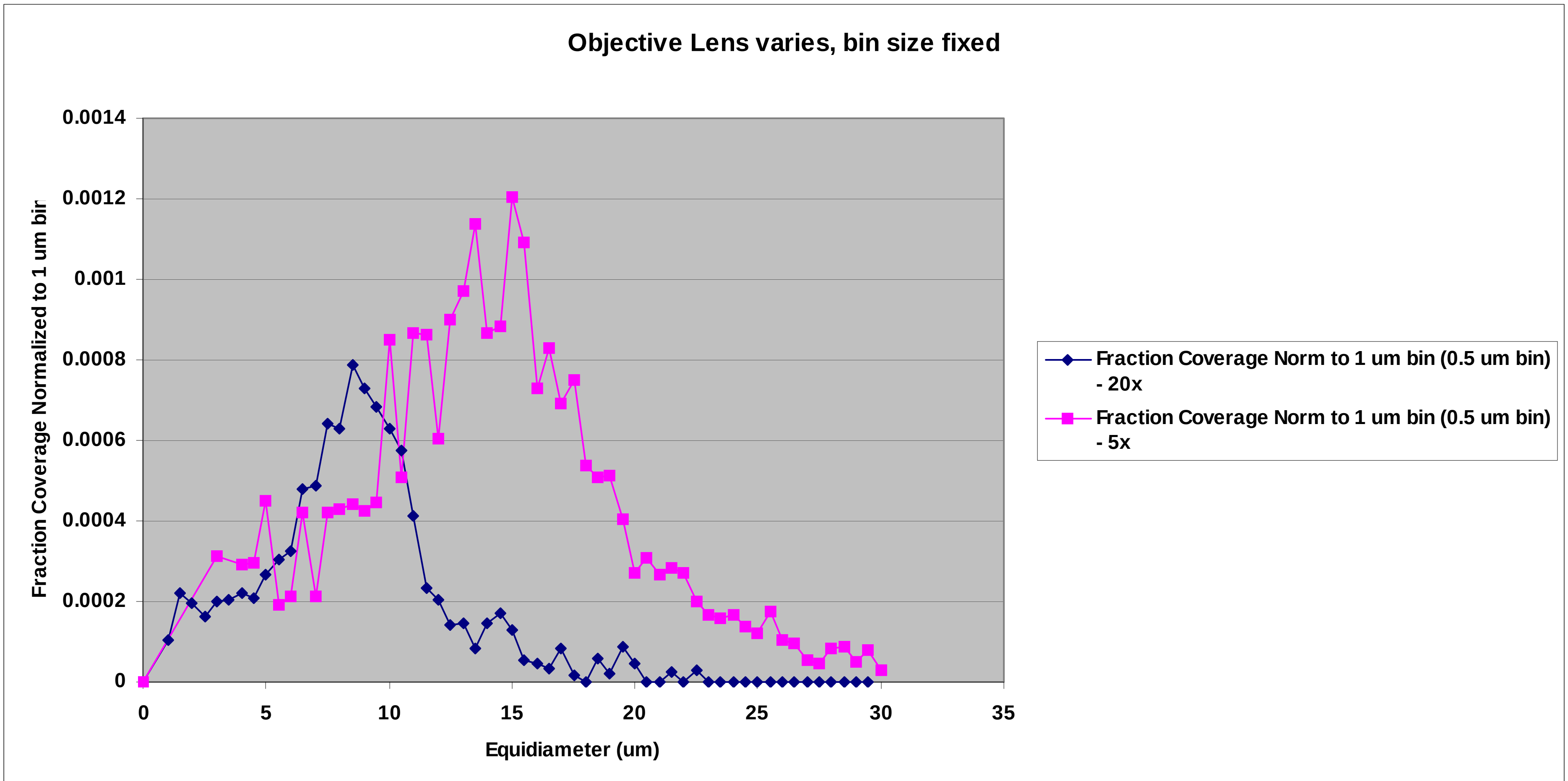
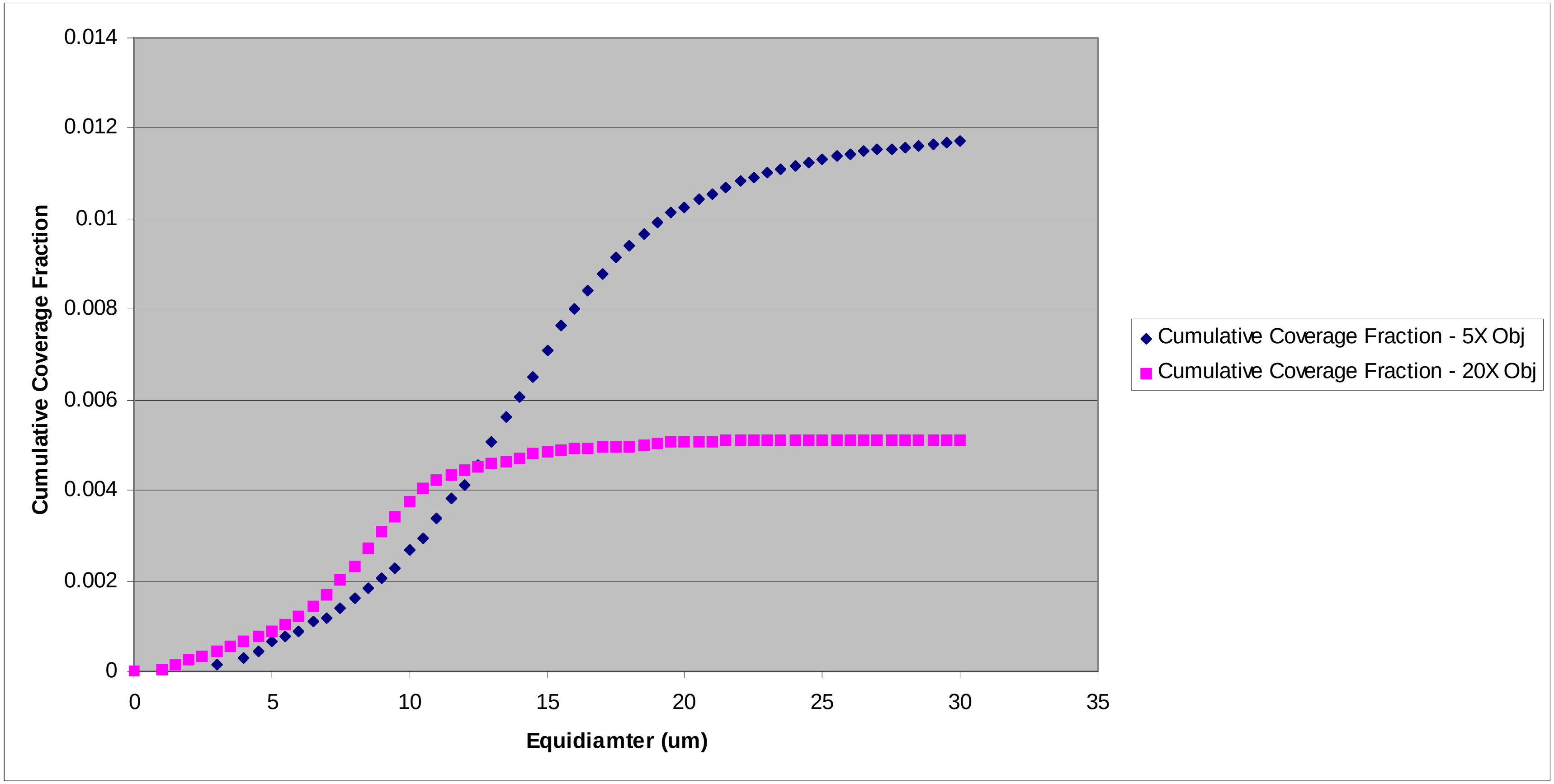
Tinsley Scatter Sample – Coverage Fraction normalized to 1 micron bin.

The peak range varies with the magnification. 5X is 13-16 um while at 20X the peak range is 7 – 11 um.



Tinsley Scatter Master Sample – Integrating over equidiameter then gives the cumulative coverage fraction.

Strongly magnification dependent.



Conclusions

- The results thus far seem to be more strongly magnification dependent, and less strongly bin size dependent.
- For a sample type, the bin size and magnification should be standardized before comparing with a scatter measurement.
- How to standardize will come with experience in analyzing real samples that are routinely generated.