Resolution Estimation @ CesrTA

- Goal:
 - Define resolution limits in some way that is comparable against different configurations of beam energy spectrum and mask construction.
- Dimensions:
 - Beamline = D Line (e+) (e- C Line almost same)
 - 5 um 31-pixel masks and 10 um 31-pixel masks at 2.085 GeV and 4 GeV
 - 4 GeV masks: 14-18 um Au on 625 um Si (NTT-AT)
 - 2 GeV masks:
 - 5 um mask: 4 um Ta on ~2 um Ru/SiN/SiC membrane (NTT-AT)
 - 10 um mask: 0.55 um Au on 2.5 um Si membrane (Applied NanoTools)
- Simulation:
 - Point-response functions generated for 1-um pitch detector with Fermionics-like layer structure.
 - PRFs smeared out for beams of sigma_y=1-50 um.
 - Smeared PRFs rebinned to look like 32 25-um wide pixels on 50-um pitch
 - Best guess as to what real fermionics detector behave like
 - Effective pixel width will (I hope) be measured in upcoming CesrTA run
 - Smeared PRFs then compared to each other and chi-squared calculated for cross-comparisons
 - Chisq/nu = (1/(N-n-1))*SUM[(y_i-y(x_i))^2 / sigma_i2^]
 - E.g., 5 um pattern is checked for fit against 1-, 2-, 3-, ... um patterns.
 - Bin weights are assumed to be statistical (sigma_i = sqrt(y(x_i))), assuming average bin height represents 100 photons
 - Detector noise is not included, only photon statistics.
 - Chi-sq 70% exclusion values are taken to represent the resolution contours
 - Should approximate something like 1-sigma contours.
- Note that these are *single-shot* resolutions.



1 um pixels

500 sigma = 1 um sigma = 5 um 450 sigma = 10 um sigma = 15 um 400 sigma = 20 um sigma = 25 um 350 sigma = 30 um sigma = 35 um 300 sama = 40 um Signal (arb) ama = 45 um 250 ama = 50 um 200 150 100 50 0 -0.001 - 0.0008 0.0006 0.0004 0.00020.00020.00040.00060.0008 0.001 0 Detector position (um) 25 um pixels at 50 um pitch Measured beam size (um) 450 sigma = 1 um sigma = 5 um 400 sigma = 10 um sigma = 15 um sigma = 20 um 350 sigma = 25 um sigma = 30 um sigma = 35 um 300 sigma = 40 um Signal (arb) s<mark>i</mark>ama = 45 um 250 ama = 50 um 200 150

100

50

0

5

10

15

Detector pixel

20

25

30

35

10 um mask, 2.085 GeV



1 um pixels

500

450

400

350

5 um mask, 4 GeV 1.6e+15 sigma = 1 um sigma = 5 um 1.4e+15 sigma = 10 um sigma = 15 um 1.2e+15 sigma = 20 um sigma = 25 um Detected 1e+15 sigma = 30 um Power (arb) siama = 35 um 8e+14 igma = 40 um power gma = 45 um 6e+14 ma = 50 um spectrum 4e+14 2e+14 0 5 10 50 0 0.00020.00040.00060.0008 0.001 1-sigma 45 Detector position (um) resolution bands 40 (statistical only) sigma = 1 um 35 sigma = 5 um sigma = 10 um sigma = 15 um 30



'powerspec_dy000um_dscan dat'





Summary

- Suprisingly little difference between 5 um and 10 um mask resolutions
 - Could be some effect due to higher average signal level at 10 um, due to fewer "shoulder" pixels
- Need more comparisons between different mask sizes

– Try 5 um 47-pixel mask at CesrTA

Procedure looks applicable to SuperKEKB design optimization