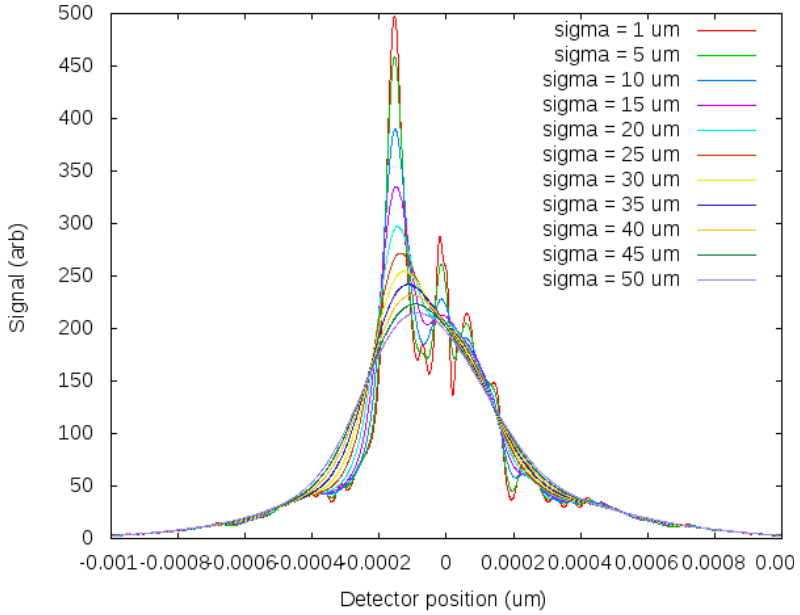
Resolution Estimation @ CesrTA

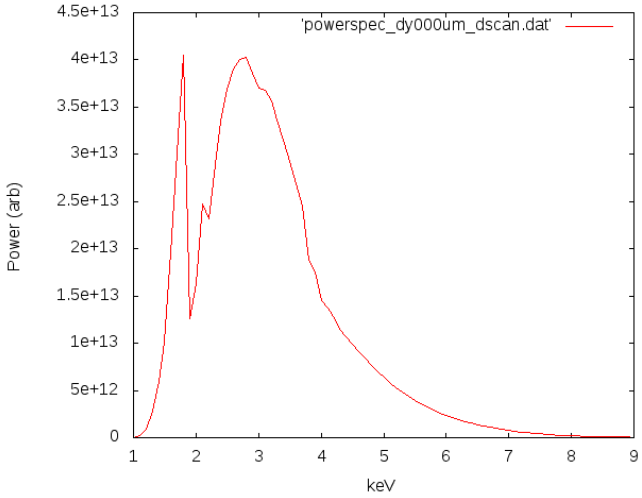
- Goal:
  - Define resolution limits in some way that is comparable against different configurations of beam energy spectrum and mask construction.
- Dimensions:
  - Beamline = D Line (e+) (e- C Line almost same)
  - 5 um 31-pixel masks and 10 um 31-pixel masks at 2.085 GeV and 4 GeV
    - 4 GeV masks: 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.

5 um mask, 2.085 GeV

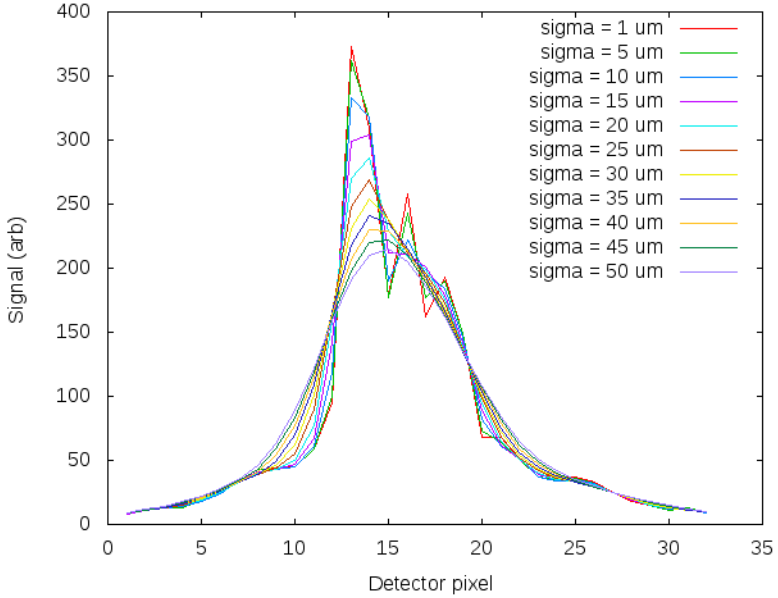
1 um pixels

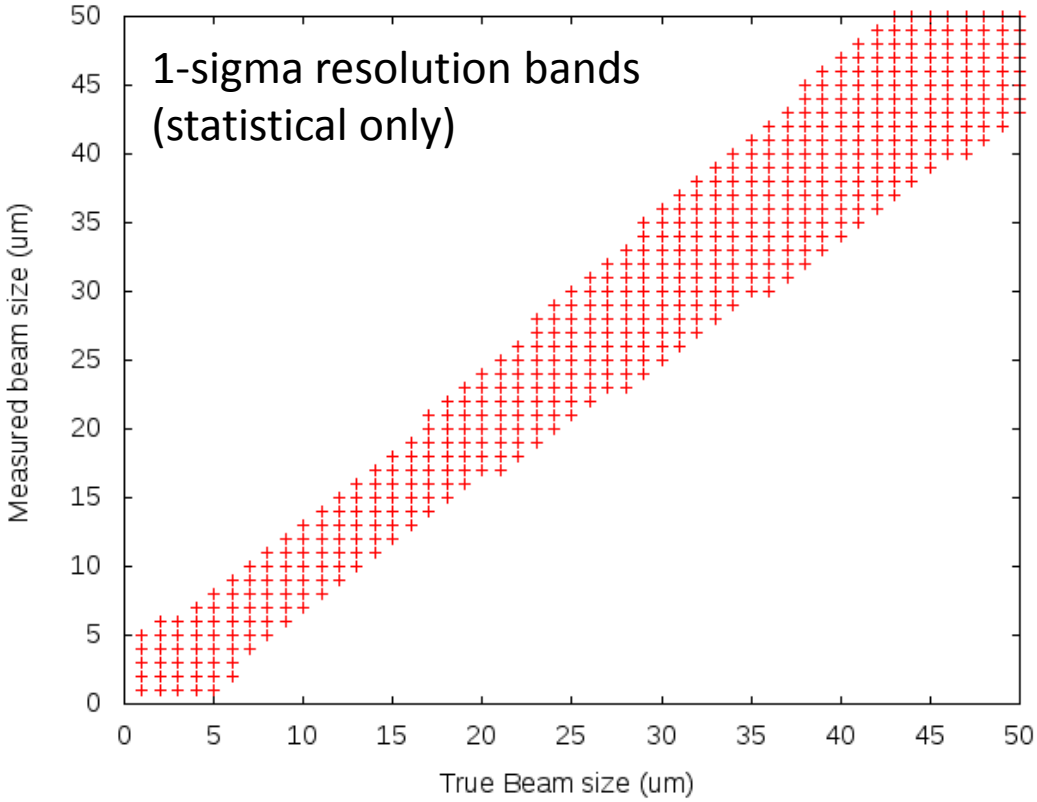


Detected power spectrum



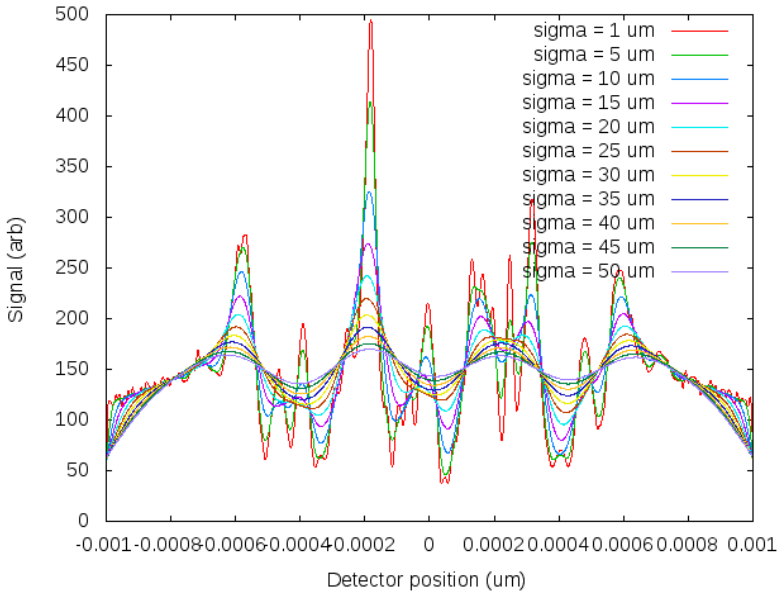
25 um pixels at 50 um pitch



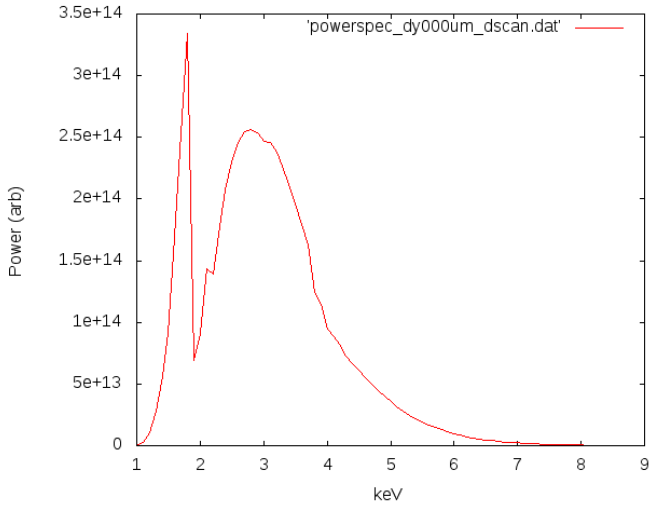


10 um mask, 2.085 GeV

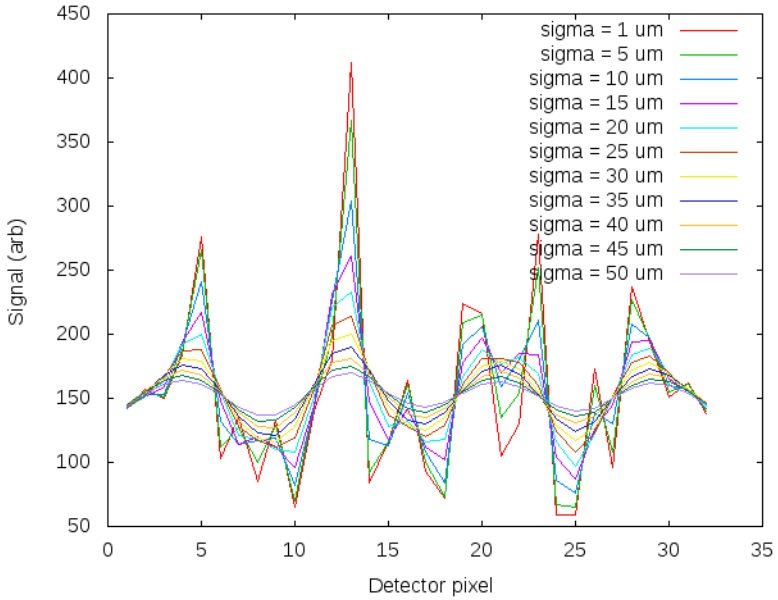
1 um pixels

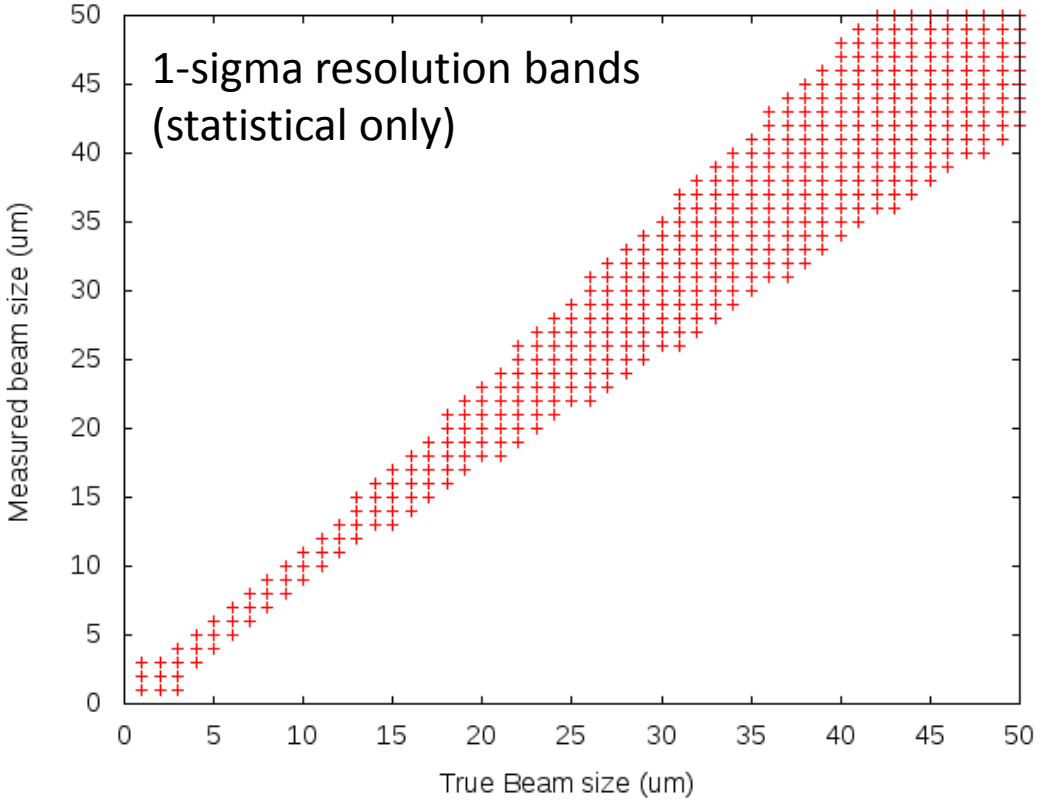


Detected power spectrum



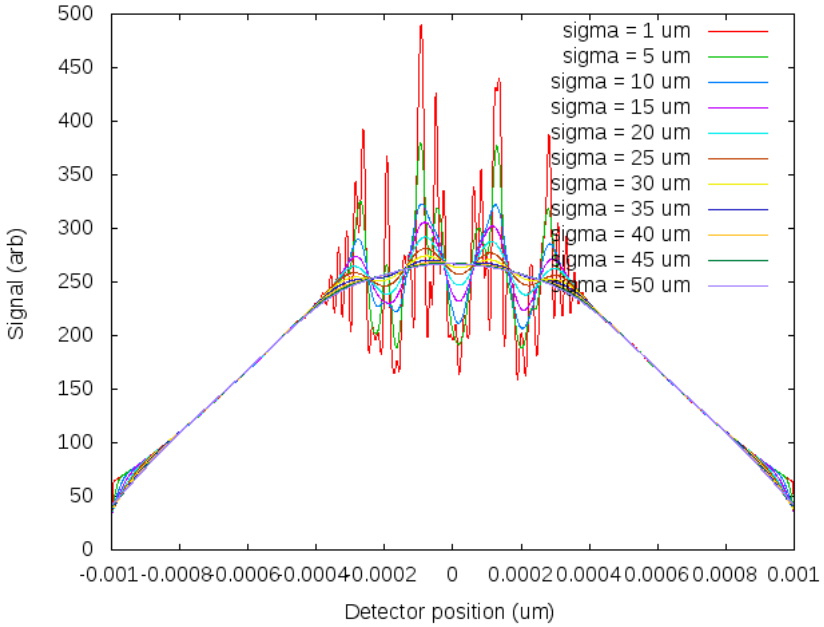
25 um pixels at 50 um pitch



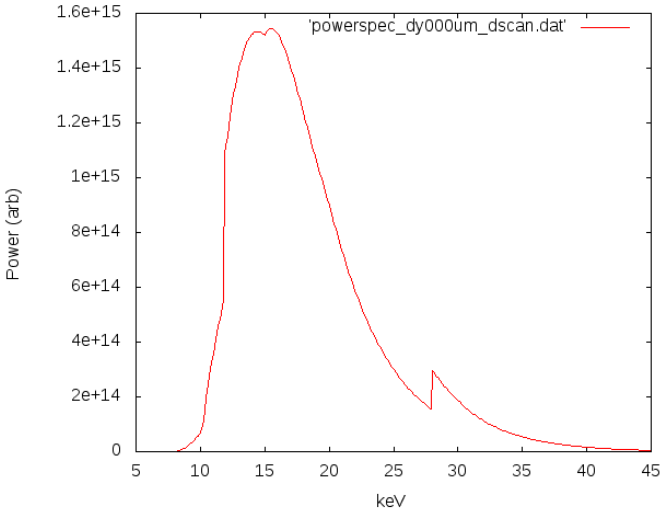


5 um mask, 4 GeV

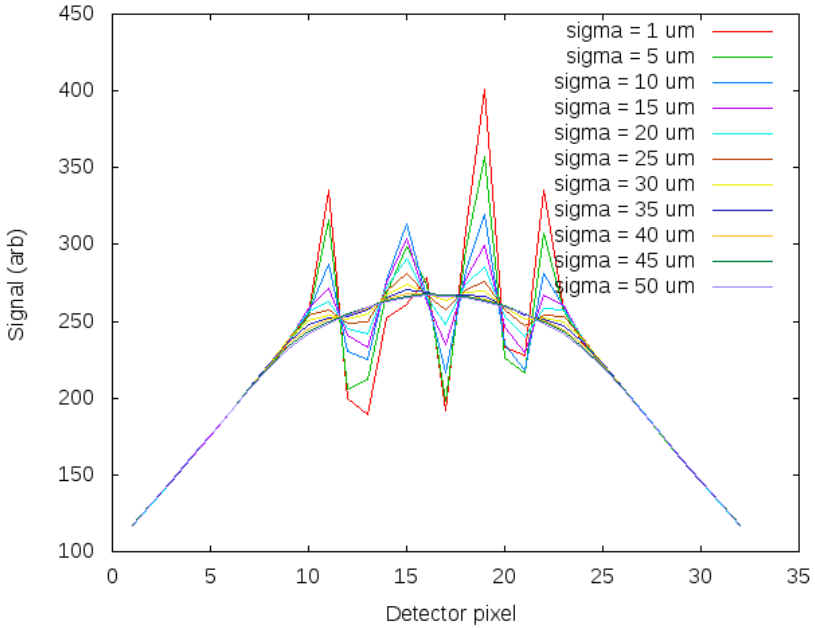
1 um pixels

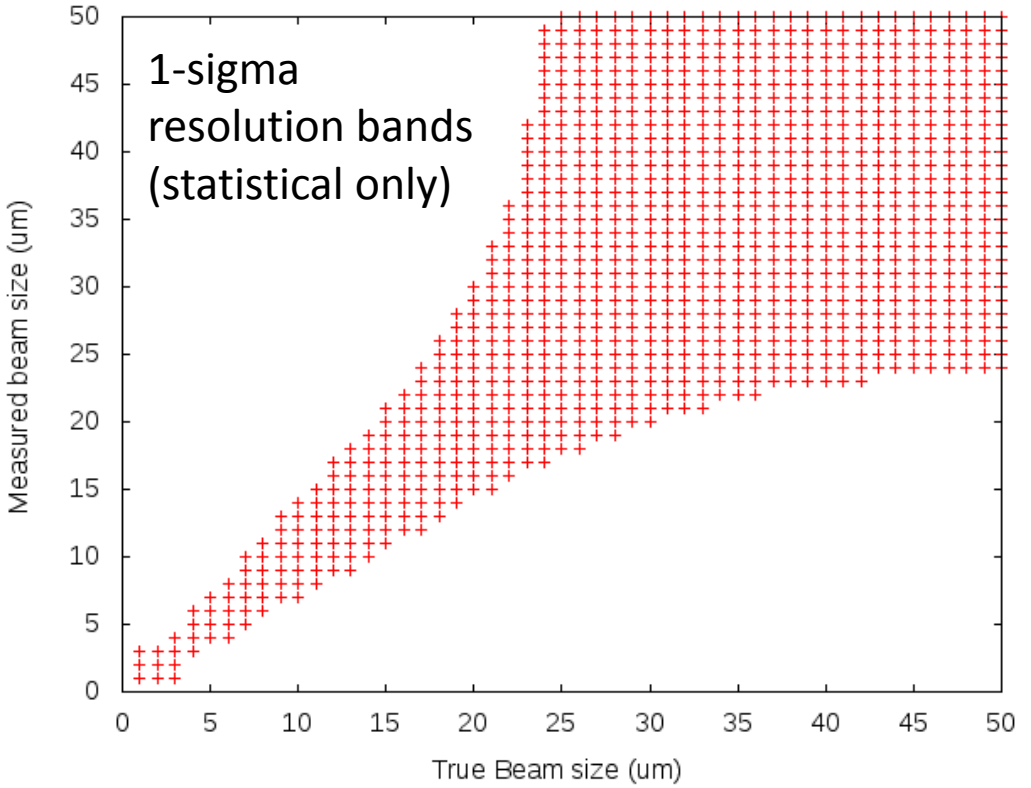


Detected power spectrum



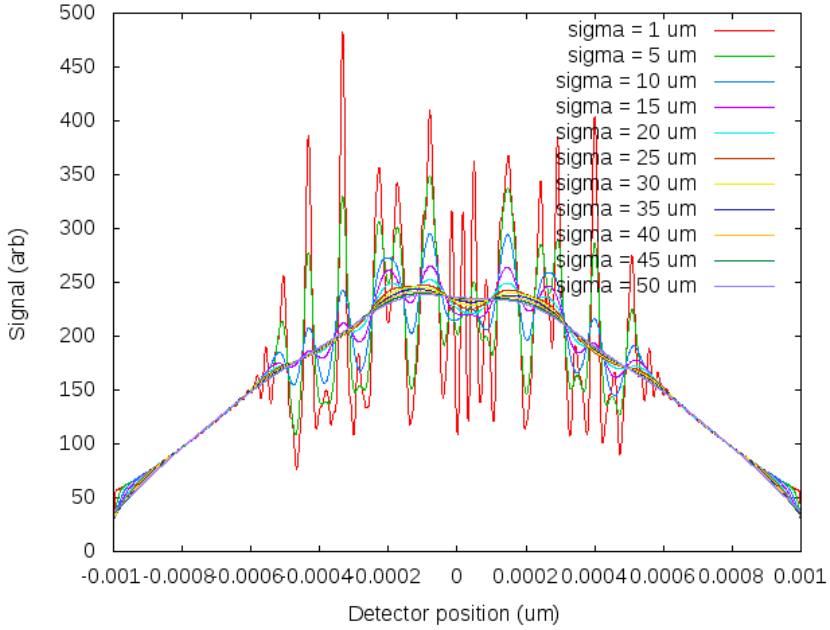
25 um pixels at 50 um pitch



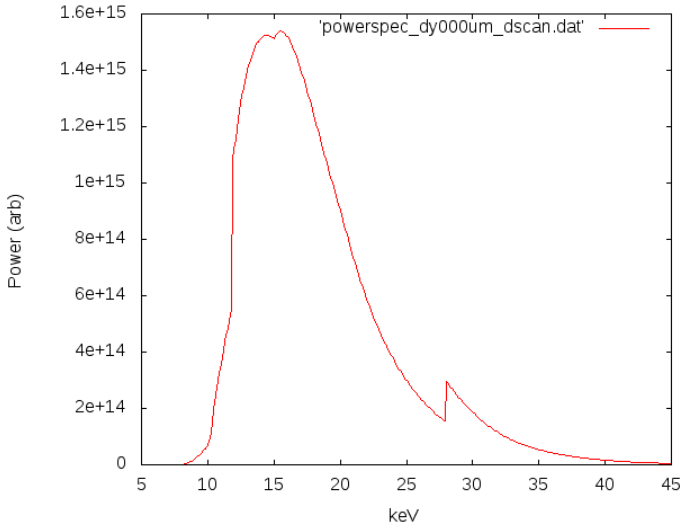


10 um mask, 4 GeV

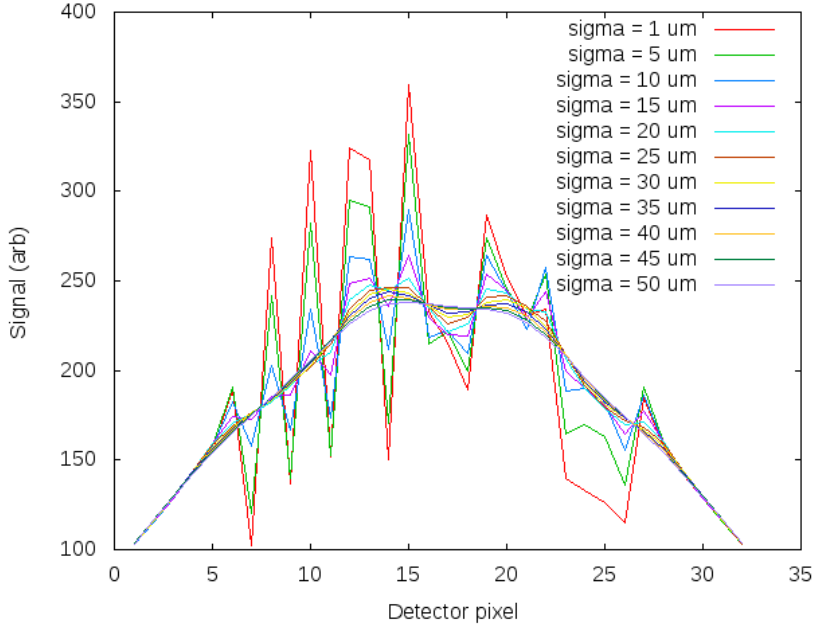
1 um pixels



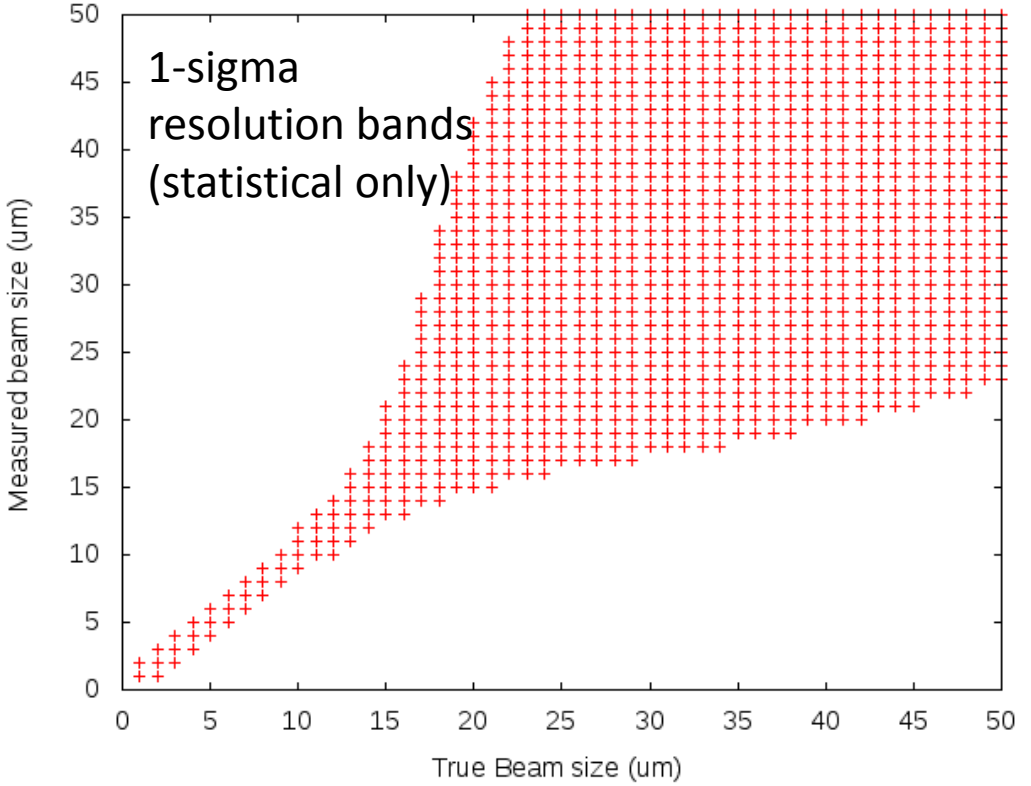
Detected power spectrum



25 um pixels at 50 um pitch



1-sigma resolution bands (statistical only)



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