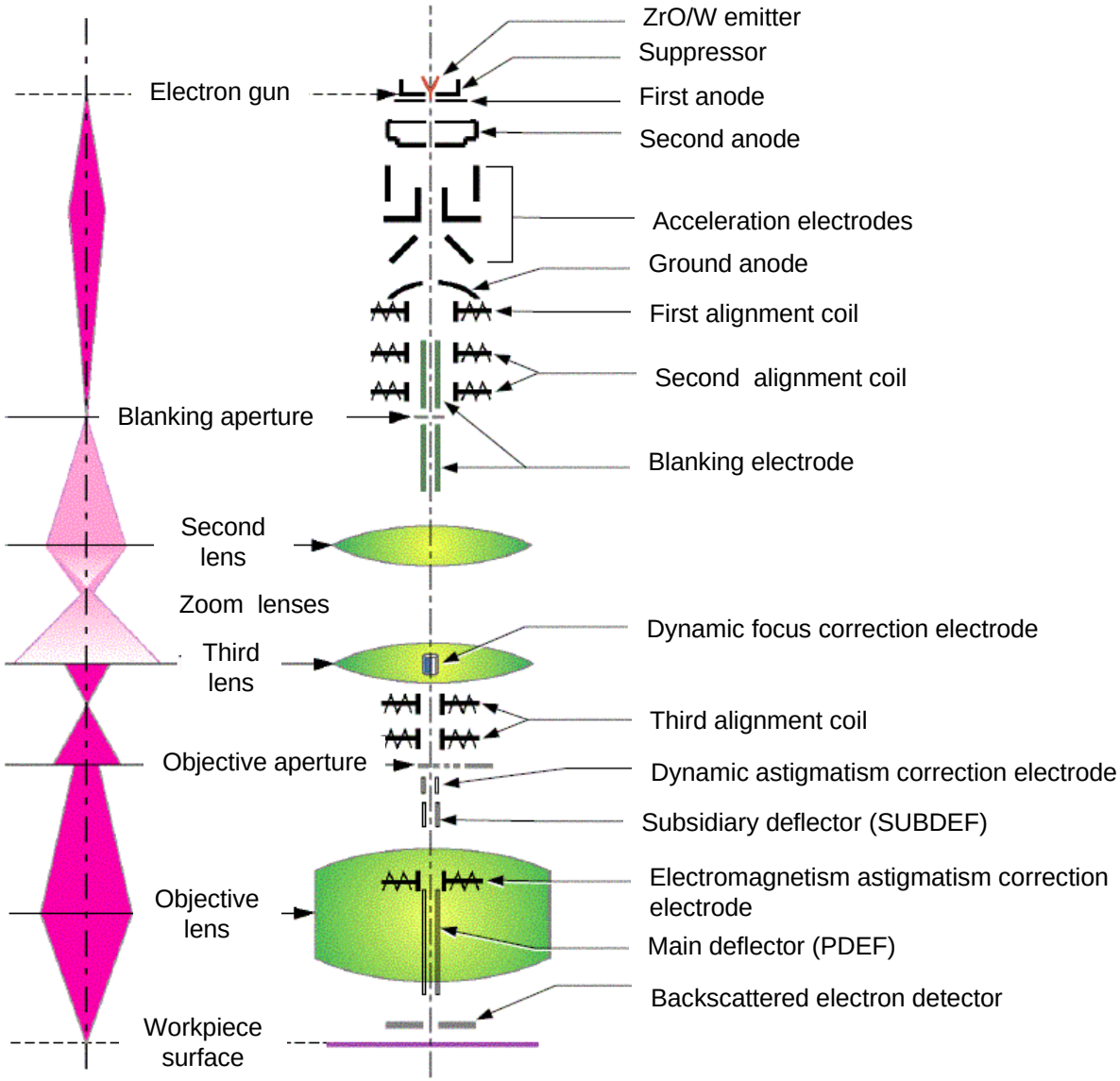
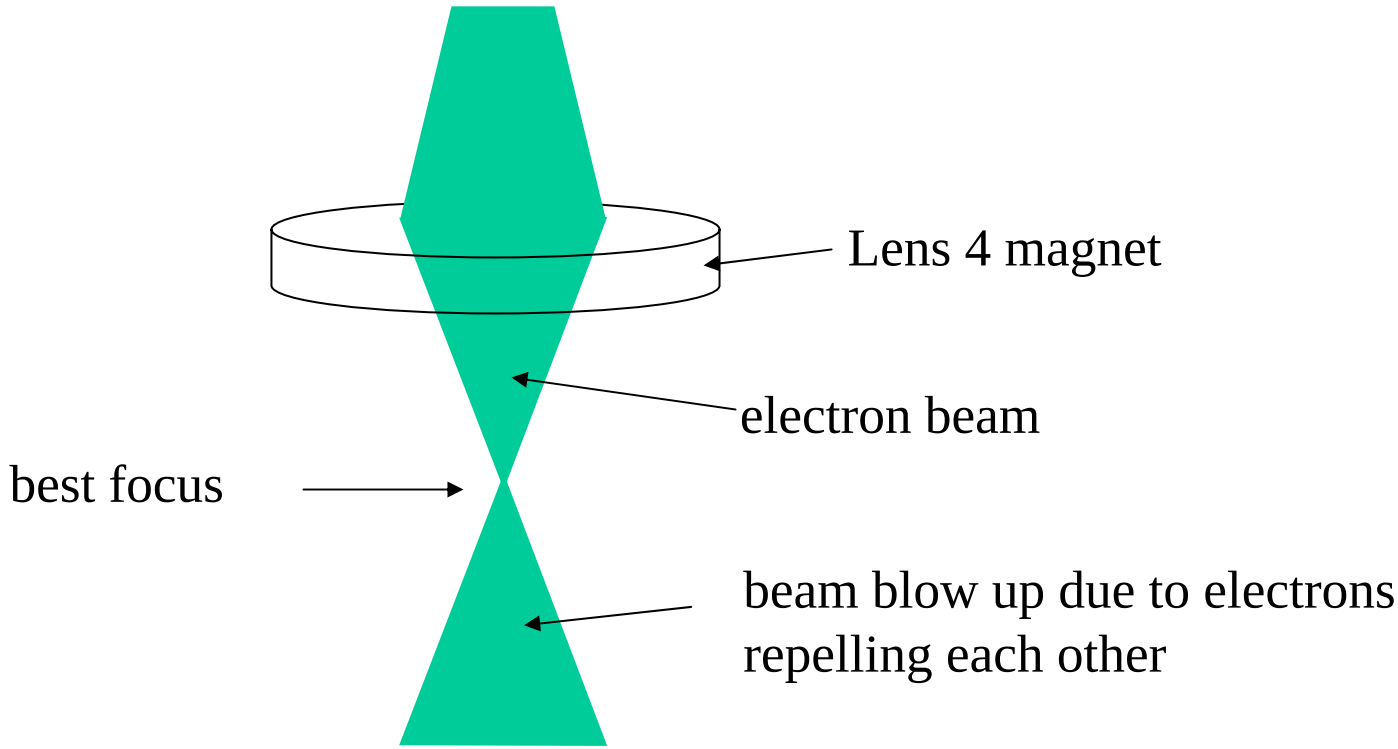
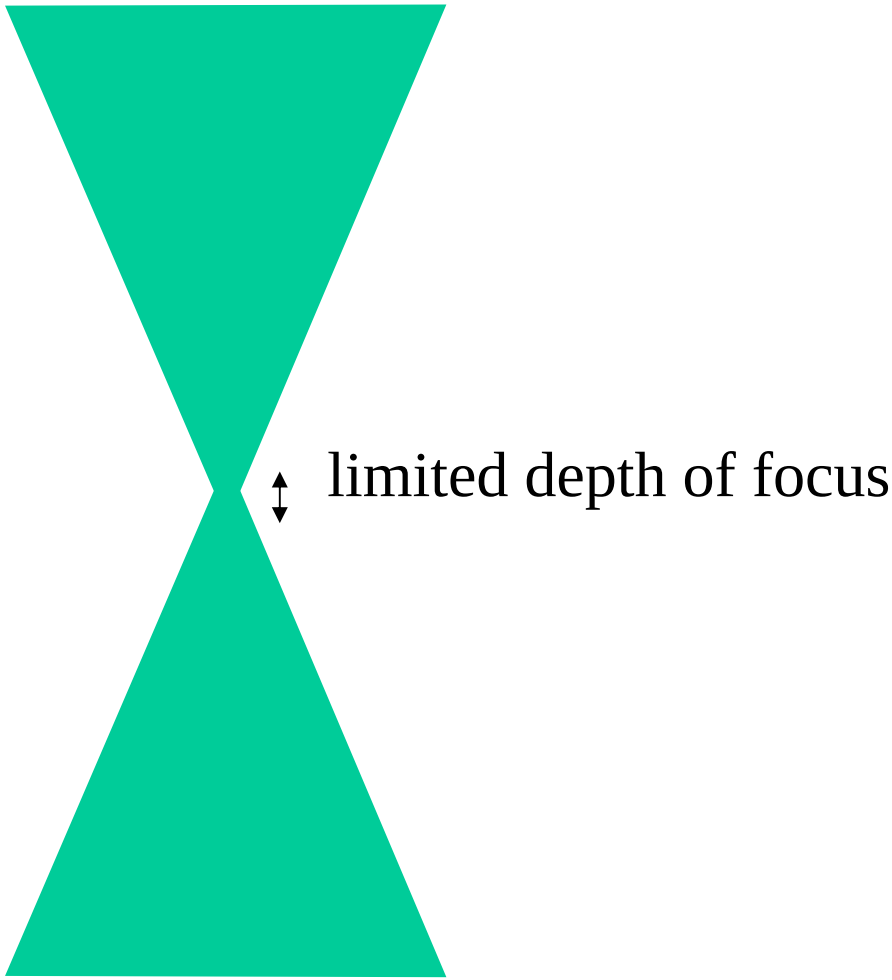
EBL: Focus & height

rev 0, 6/6/08

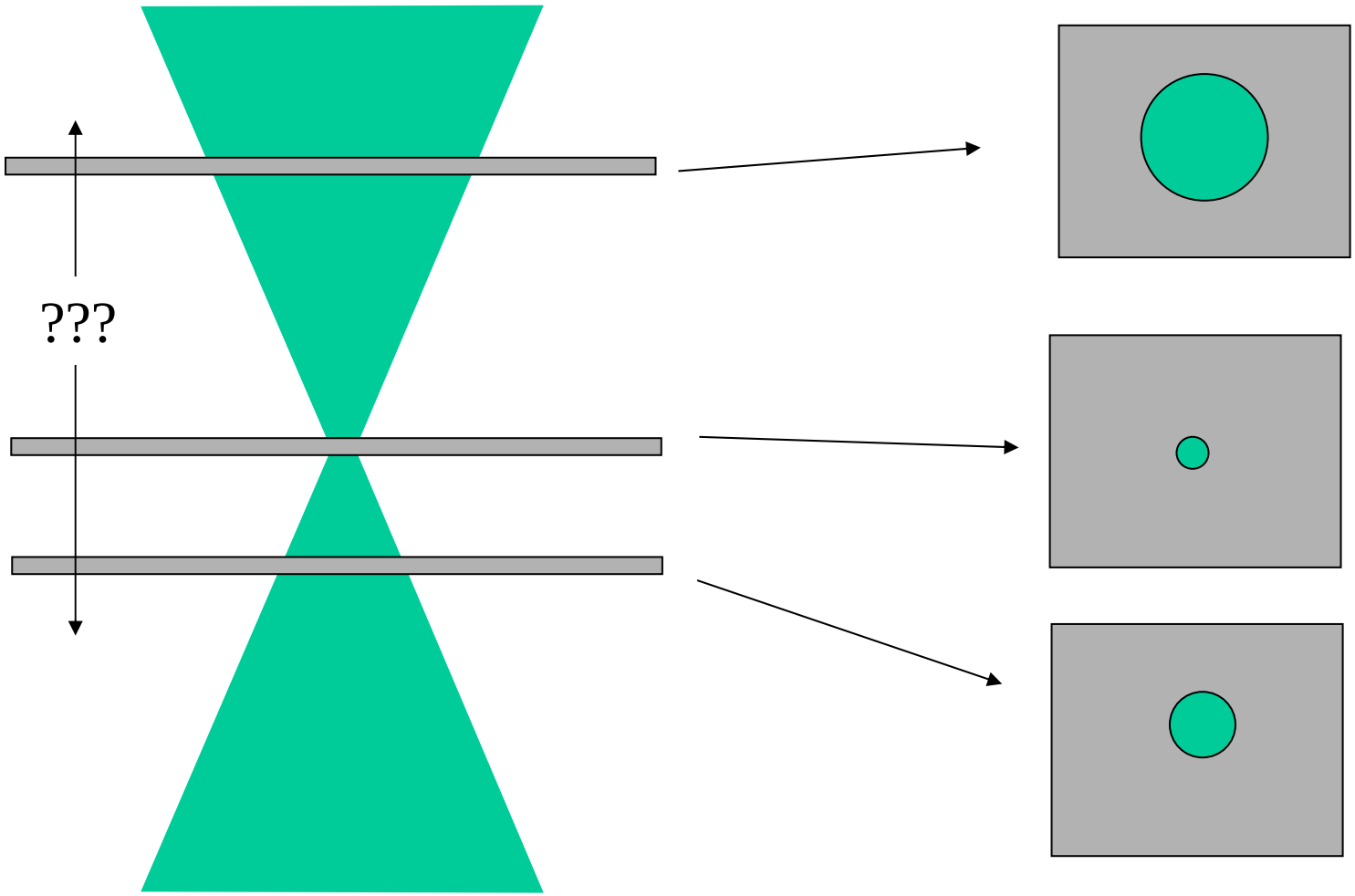

ZrO/W emitter
Suppressor
Electron gun
First anode
Second anode
Acceleration electrodes
Ground anode
First alignment coil
Second alignment coil
Blanking aperture
Blanking electrode
Second lens
Zoom lenses
Dynamic focus correction electrode
Third lens
Third alignment coil
Objective aperture
Dynamic astigmatism correction electrode
Subsidiary deflector (SUBDEF)
Electromagnetism astigmatism correction electrode
Objective lens
Main deflector (PDEF)
Backscattered electron detector
Workpiece surface



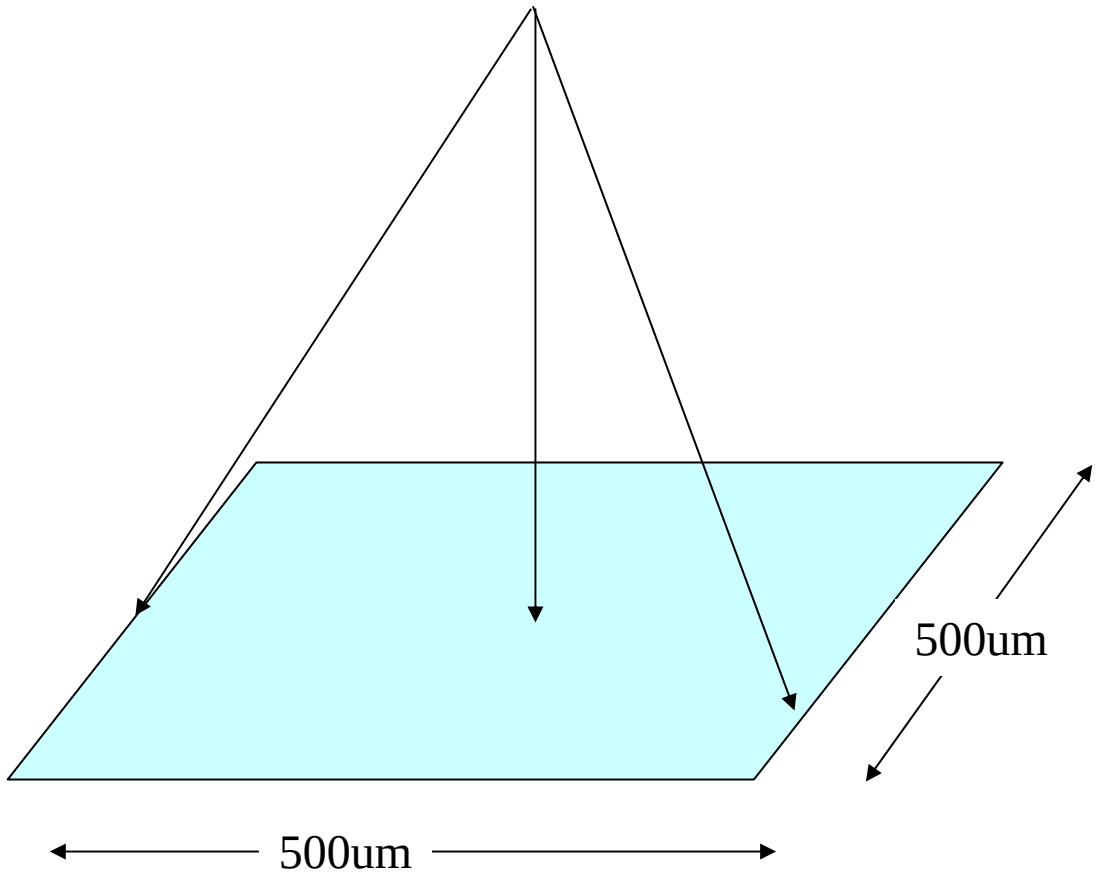
the Lens 4 magnet is the objective lens
it is used to focus the beam


limited depth of focus

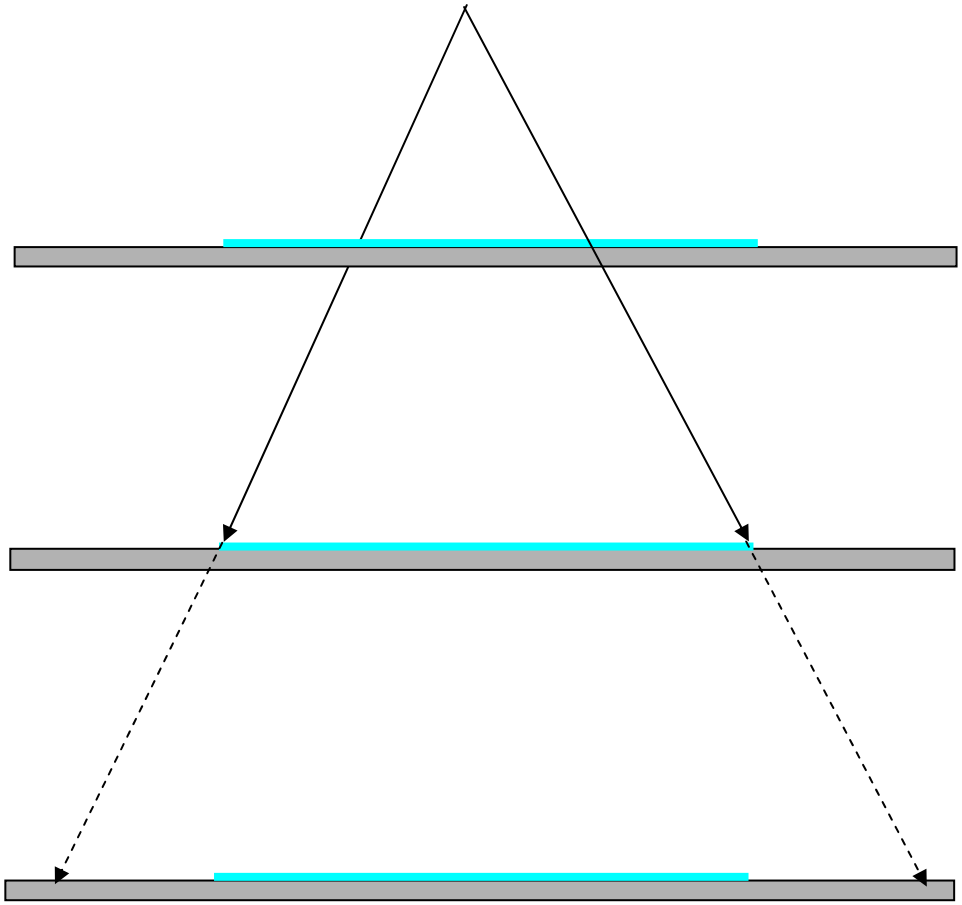
where is your sample?

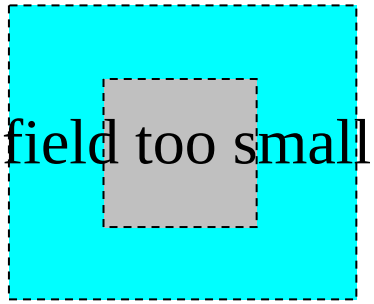


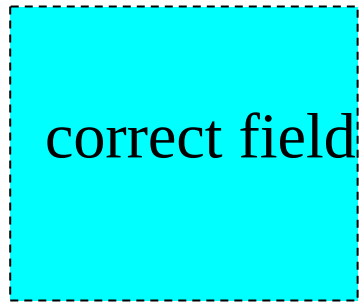
beam spot size will change on your sample
smaller spot = better pattern resolution



field vector scan




field too small


correct field


field too big

ways to focus

- SFOCUS
- manual
- HEIMAP
- virtual chip mark height detection

ways to focus

- SFOCUS
  - uses AE mark to measure beam width and sets focus to minimum beam diameter
  - can be considered in a sense as the "home" reference height
  - does not focus on your sample

ways to focus

- manual
  - use SEM mode and EOS to focus on your sample
  - can be used for optically transparent substrates
  - potentially more accurate than height detection system, but if your sample has height variation, it is only good at location where you focused
  - does not adjust field distortion correction values, you will get field stitching errors.
  - can use HEIGHT and SUBHEI commands to correct for field distortion, but must manually calculate

ways to focus

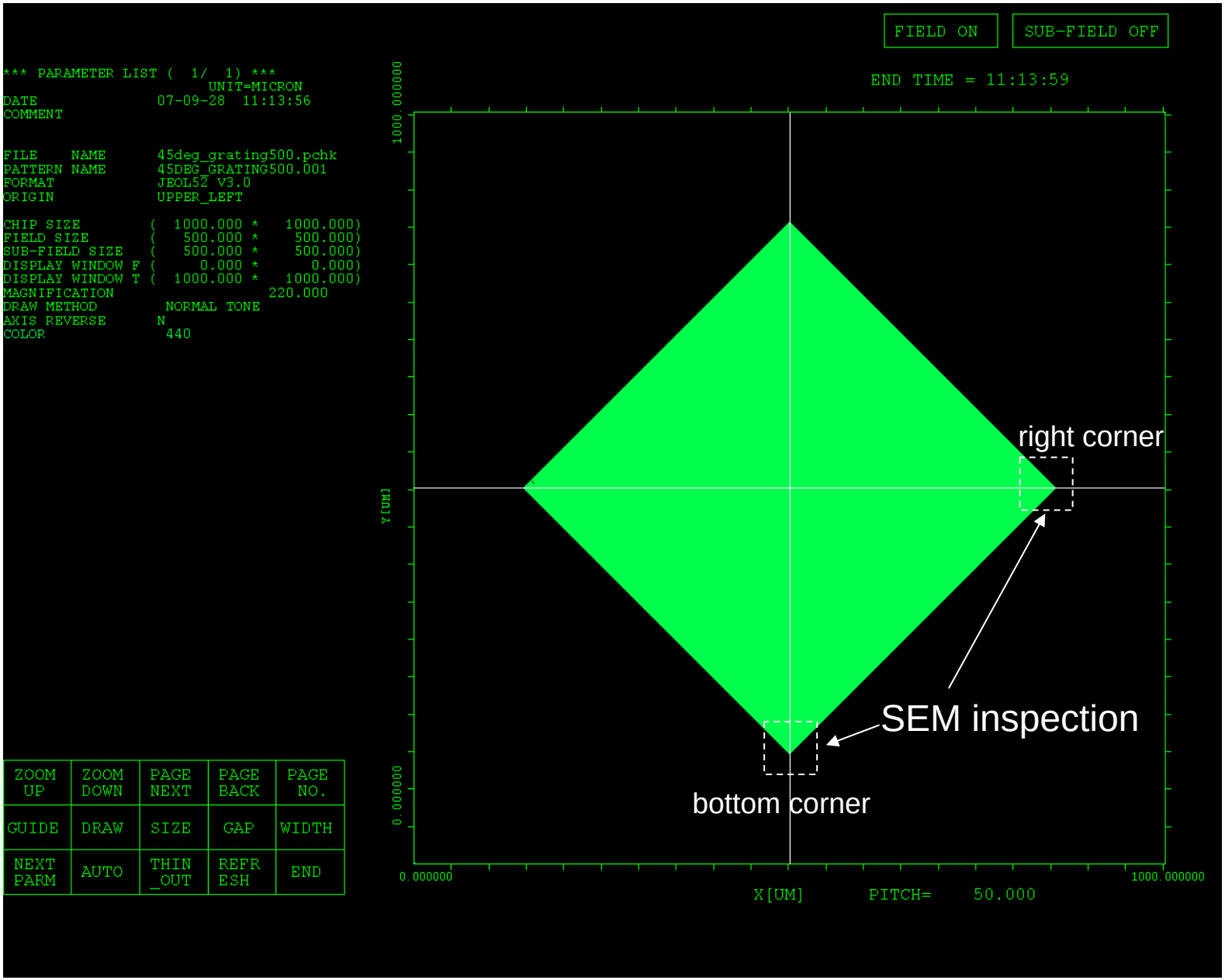
- HEIMAP
  - uses white light height detection system
  - sample must be optically opaque
  - define an array, takes average value, uses this to set focus for entire sample
  - must include in PATH to take effect for your job
  - spot size of light is ~3mm, cannot measure near edge of sample windows
  - average value may not be good enough if your sample has > 5um height variation

ways to focus

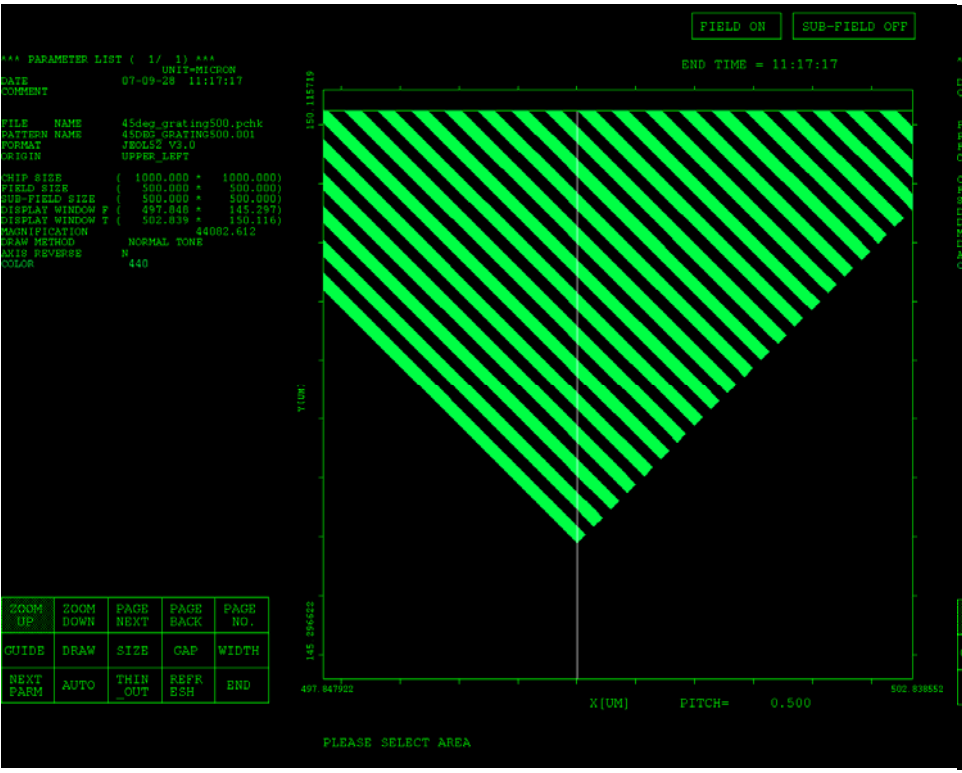
- virtual chip mark height detection
  - same white light height detection system as HEIMAP
  - sample must be optically opaque
  - measures height at location of chips and sets focus individually for each chip whereas HEIMAP uses single average value for all chips
  - cannot measure height near sample window edge (may be a problem on windows like 3A)

example of how
height/focus variation
affects field stitching on a
pattern

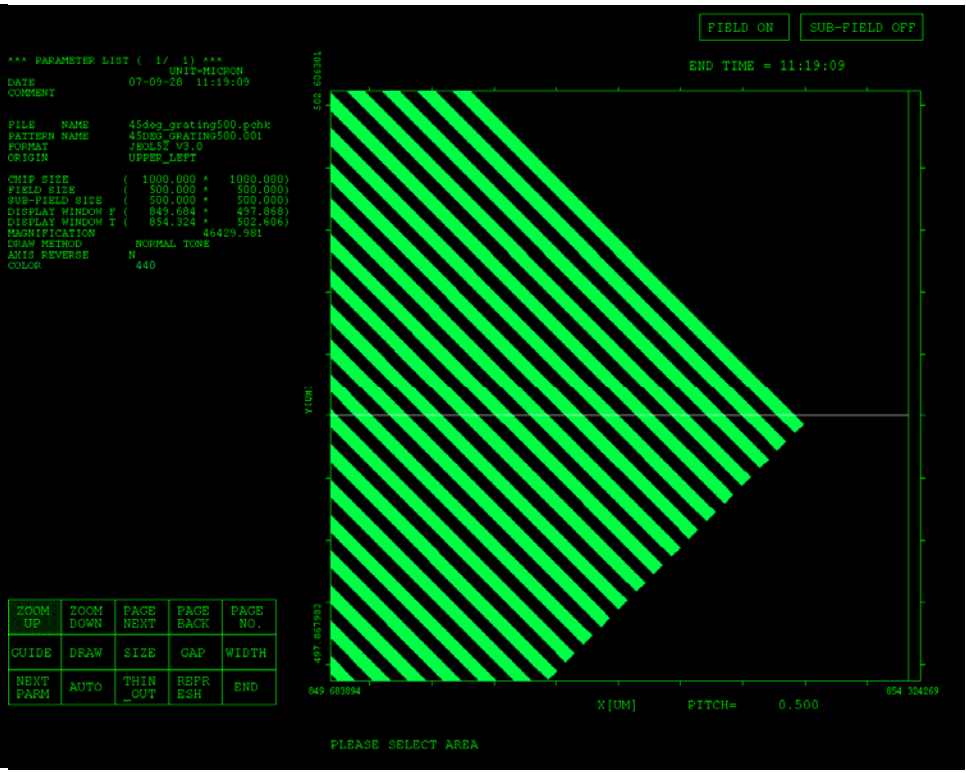
test pattern



bottom corner

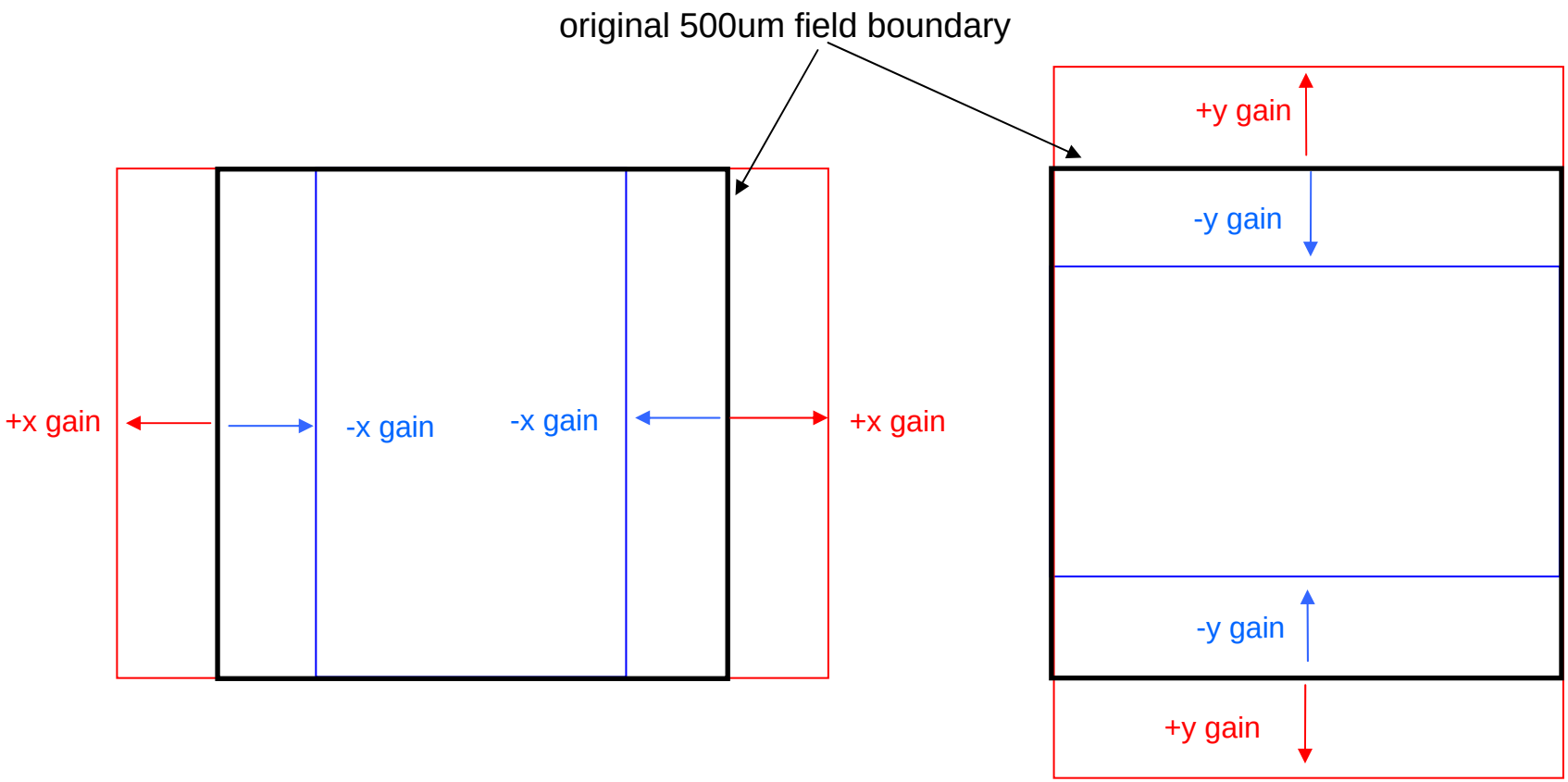


right corner

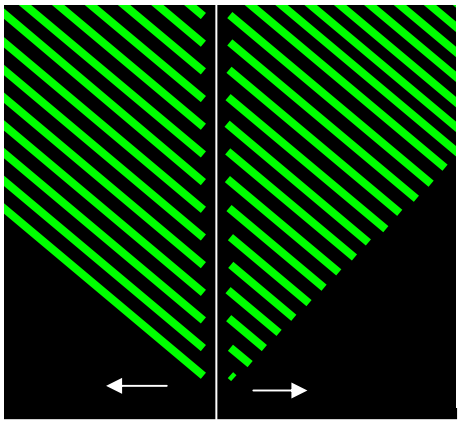


JEOL HEIGHT command

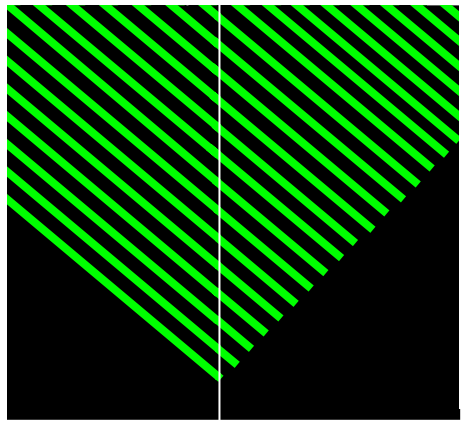
HEIGHT f,gx,gy,rx,ry,sx,sy
gx = x gain
gy = y gain



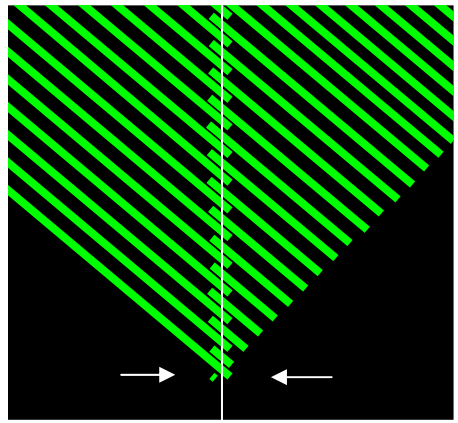
-x gain



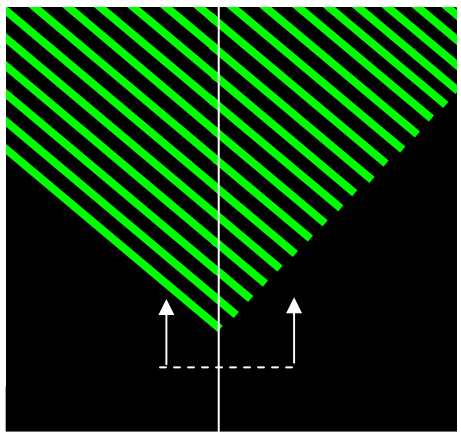
no gain



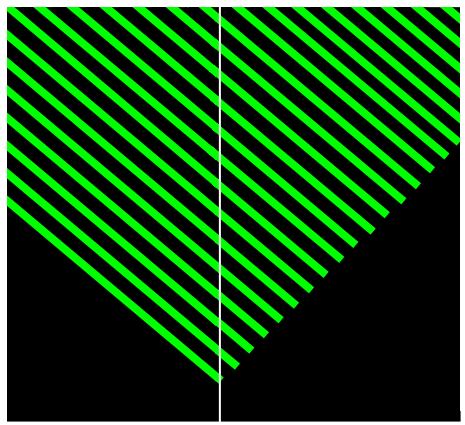
+x gain



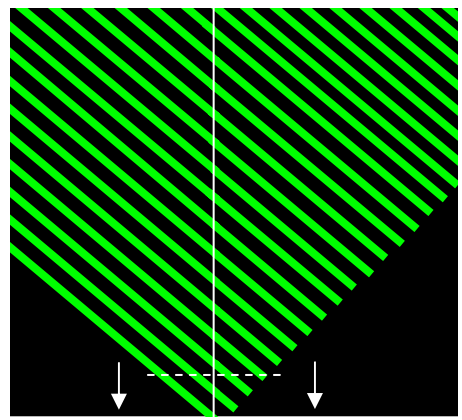
-y gain



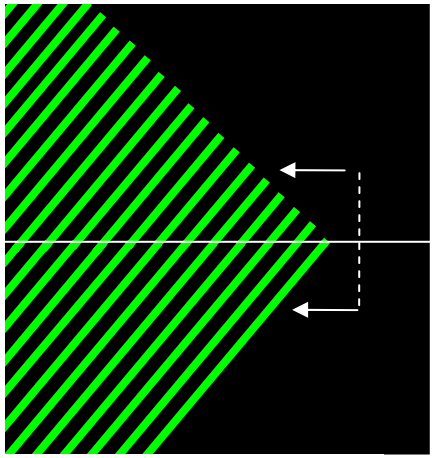
no gain



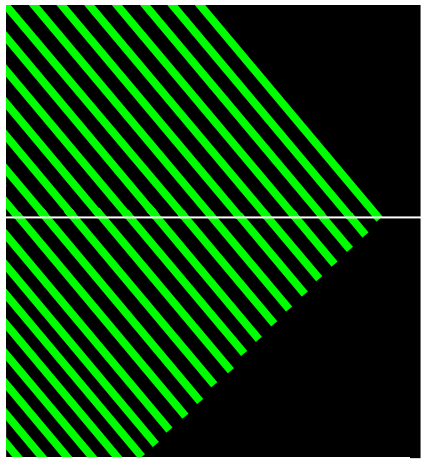
+y gain



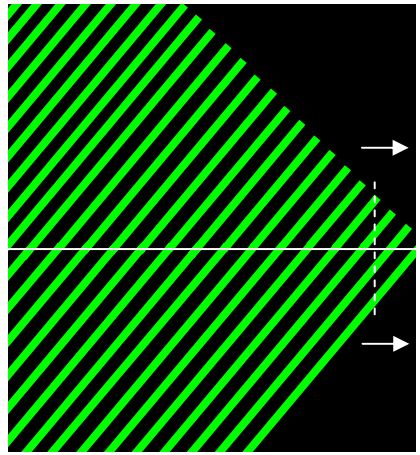
-x gain



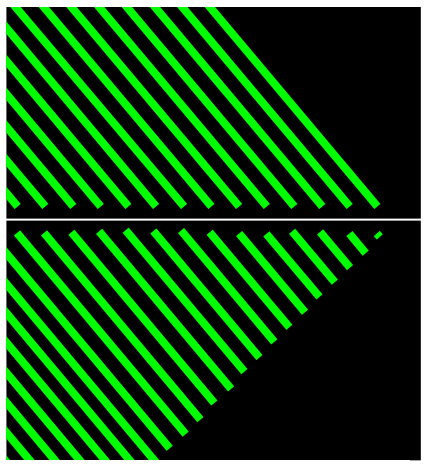
0 gain



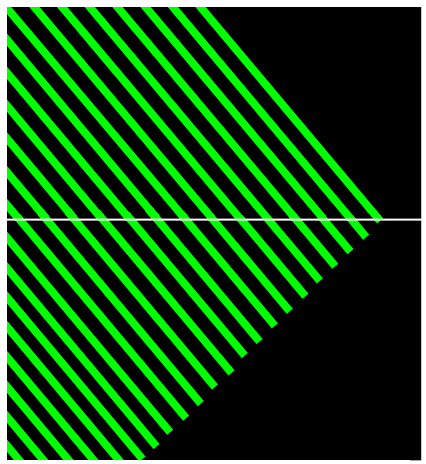
+x gain



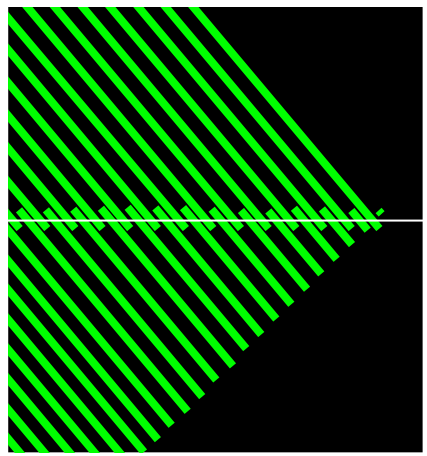
-y gain



0 gain

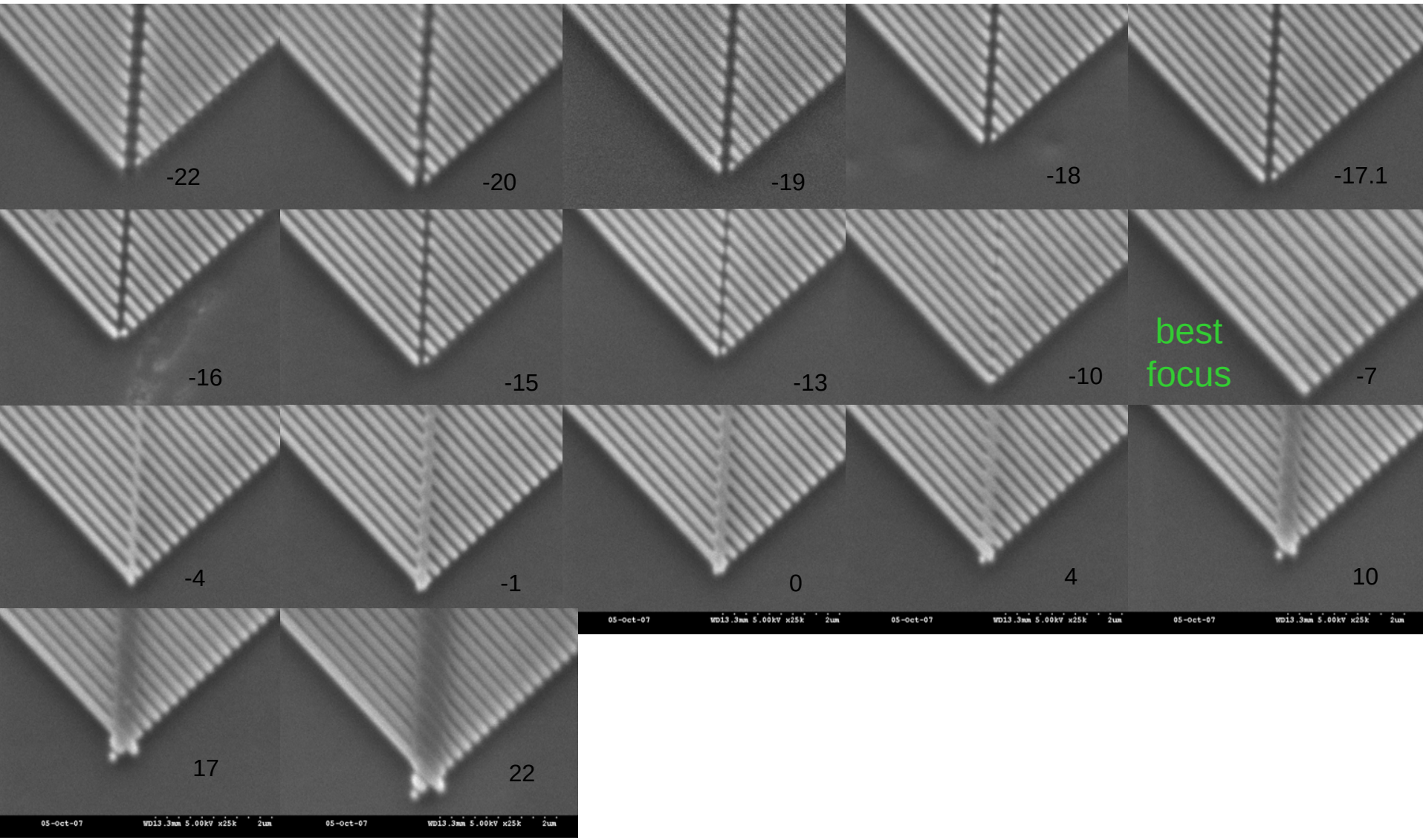


+y gain



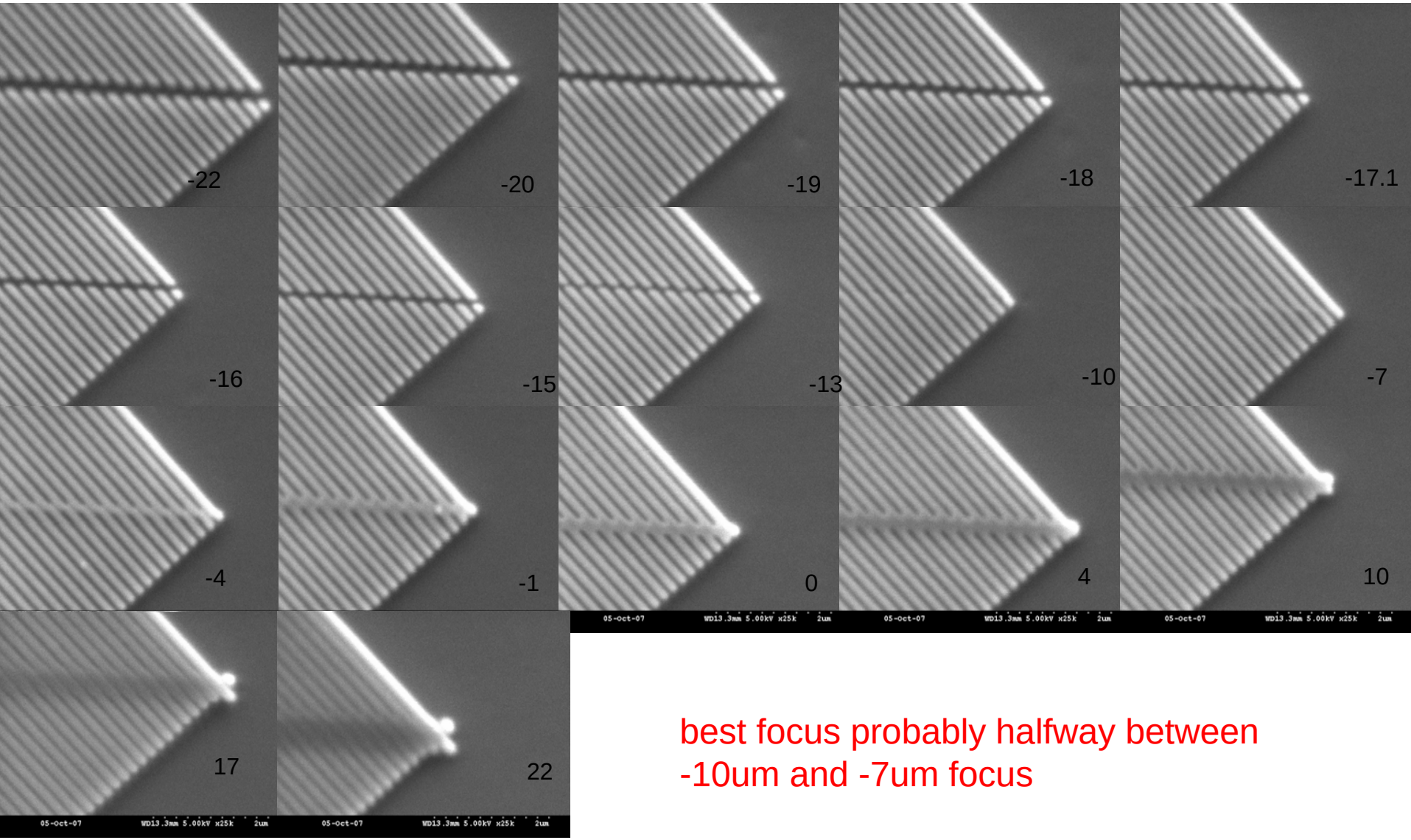
x direction stitching

(focus values shown in microns below reference)

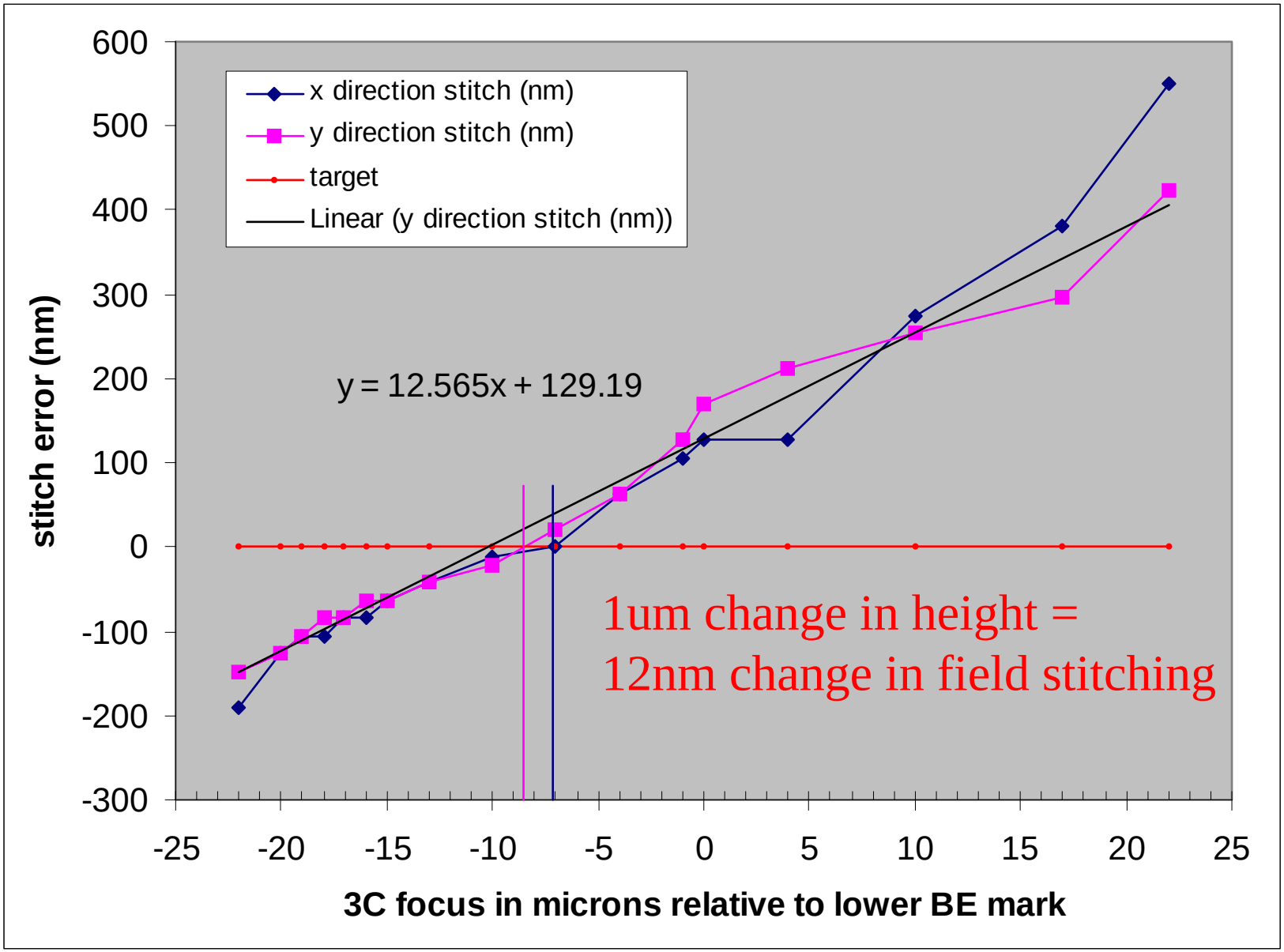


y direction stitching

(focus values shown in microns below reference)



best focus probably halfway between
-10um and -7um focus


x direction stitch (nm)
y direction stitch (nm)
target
Linear (y direction stitch (nm))
y = 12.565x + 129.19
1um change in height =
12nm change in field stitching
stitch error (nm)
600
500
400
300
200
100
0
-100
-200
-300
-25
-20
-15
-10
-5
0
5
10
15
20
25
3C focus in microns relative to lower BE mark