Scaling to Other Gradients

- Longitudinal wakefields require that the bunch charge scales with the gradient if the bunch length is kept constant

$$N \propto G$$

- Emittance growth due to wakefields after beam-based alignment is given by

$$\Delta\epsilon_y \propto \left(W_\perp N \sigma_z \Delta y\right)^2 L$$

$\Rightarrow \Delta\epsilon \propto G$

$\Rightarrow$ would allow to increase bunch length a bit

- But we use emittance tuning bumps

  $\Rightarrow$ can in principle correct all wakefield effects

  $\Rightarrow$ remanent component is given by difference in phase advance for beam head and tail between wakefield kick and correction

- Need to keep number of bumps the same

$$\Delta\epsilon_y \propto \left(W_\perp N \sigma_z \Delta y \Delta E L_{bump}\right)^2 L$$

  $\Rightarrow$ for constant RF phases: $\Delta\epsilon \propto G^{-1}$

$\Rightarrow$ Simulations demonstrate this point

- But smaller instantaneous wakefield effect allows to use less energy spread in beam (from BNS damping condition)

$$\Delta E \propto W_\perp N \sigma_z$$

  $\Rightarrow \Delta\epsilon \propto G$

- Slightly smaller wakefield effects could be used to increase N (and σ_z)

  $\Rightarrow$ but

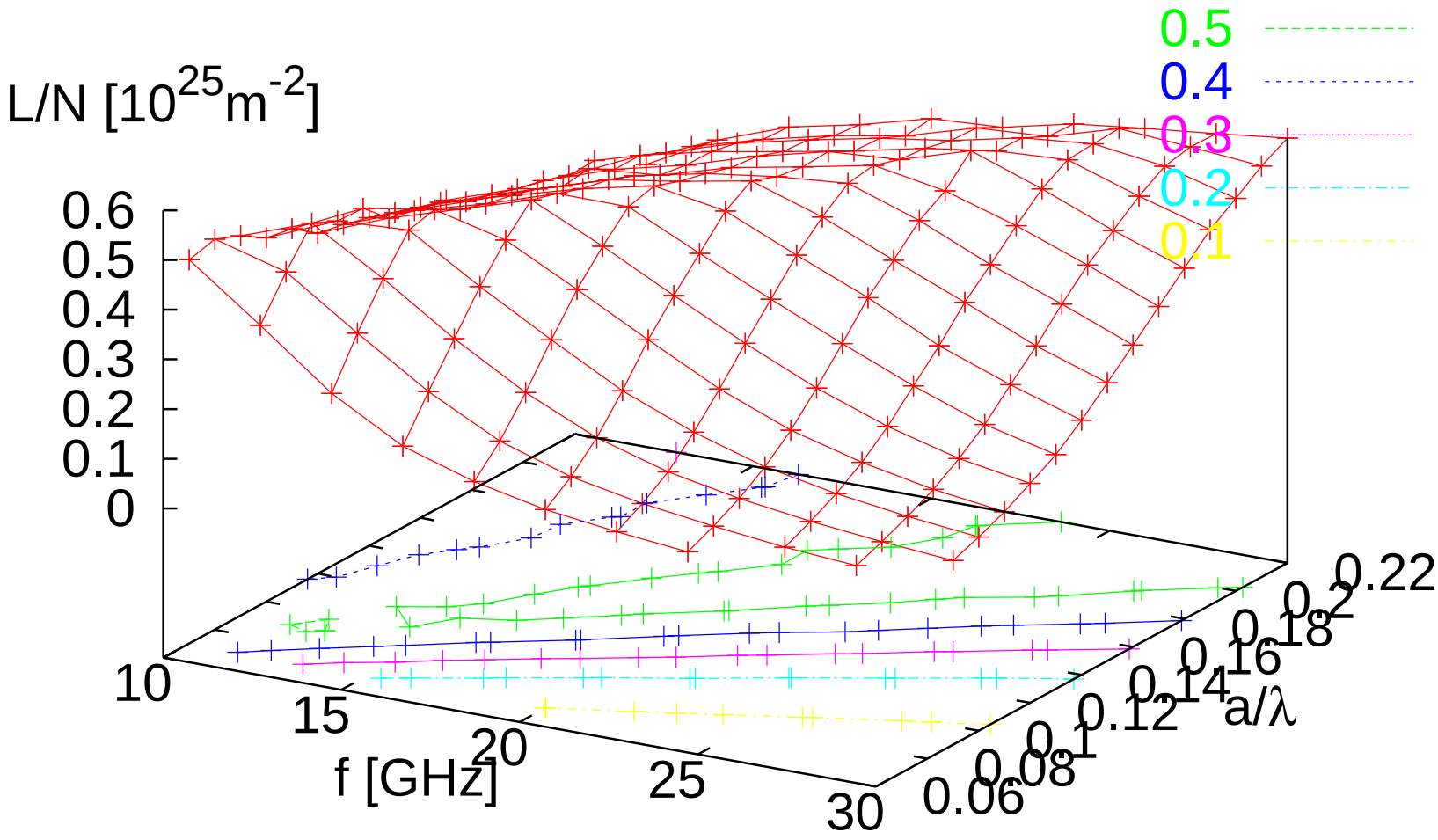
$$\Delta\epsilon \propto N_1^4 \sigma_z^4 G$$

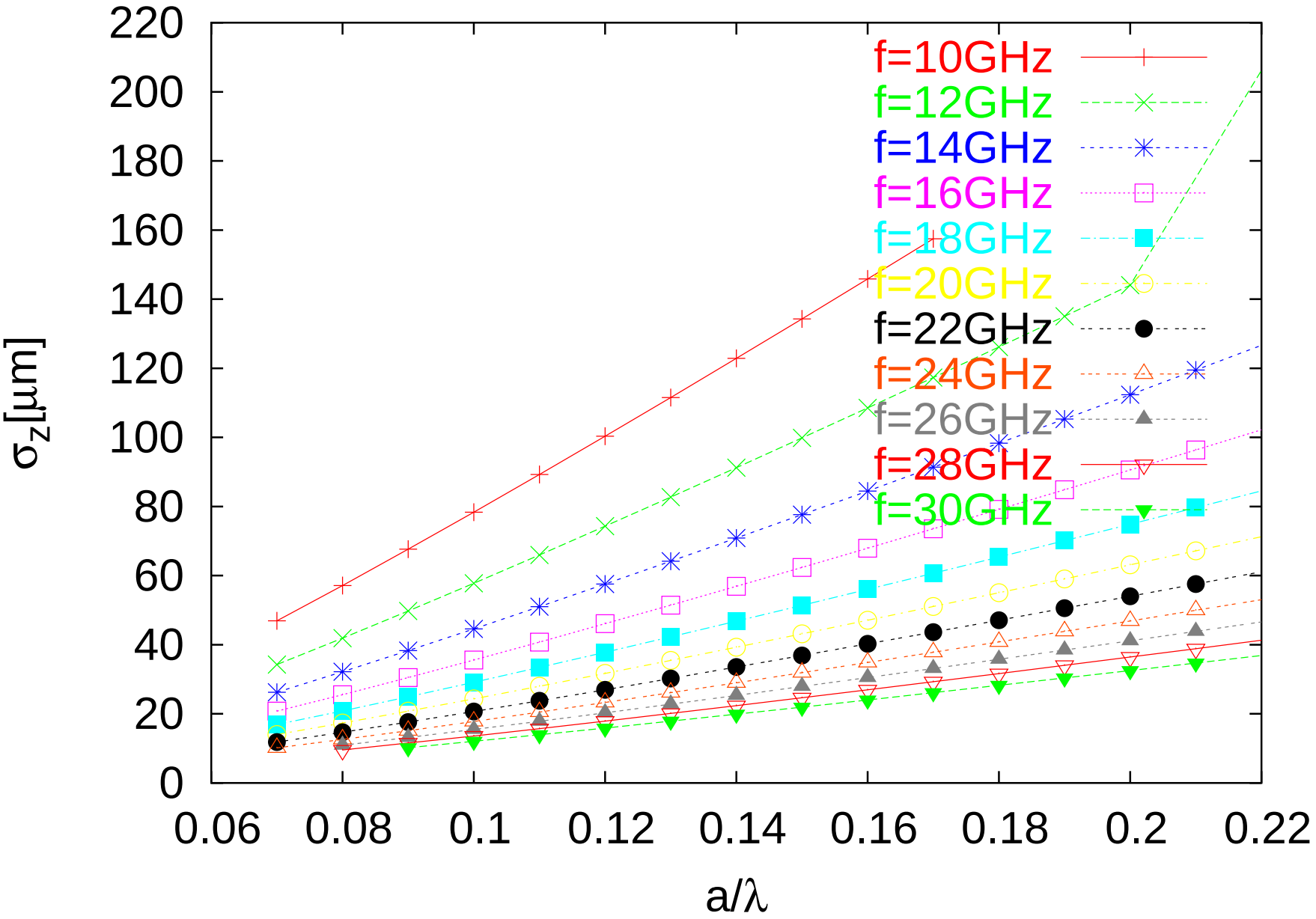
  $\Rightarrow$ can increase N_1 approximately following $G^{-1/8}$

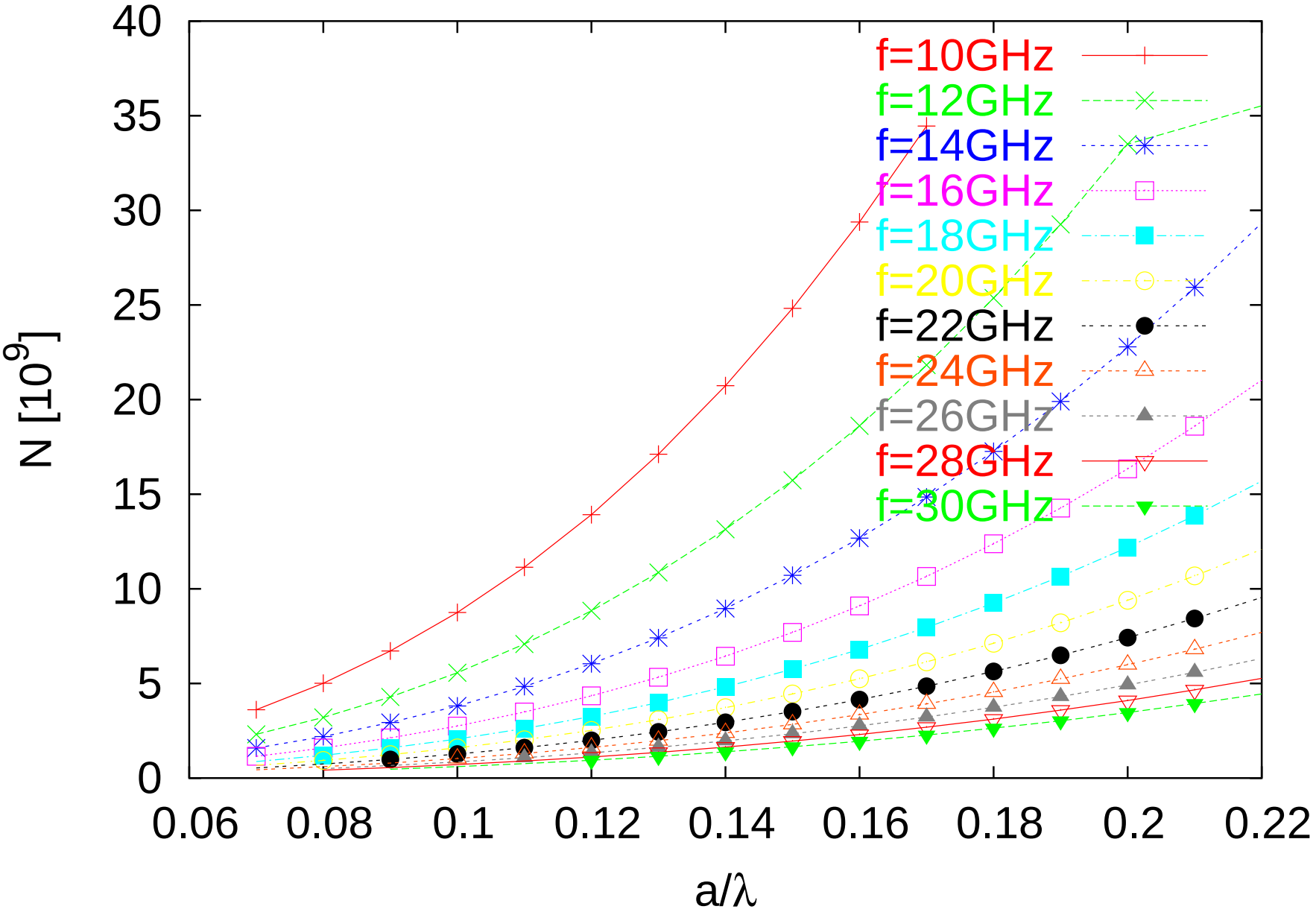
  $\Rightarrow$ not worth it, too uncertain anyway

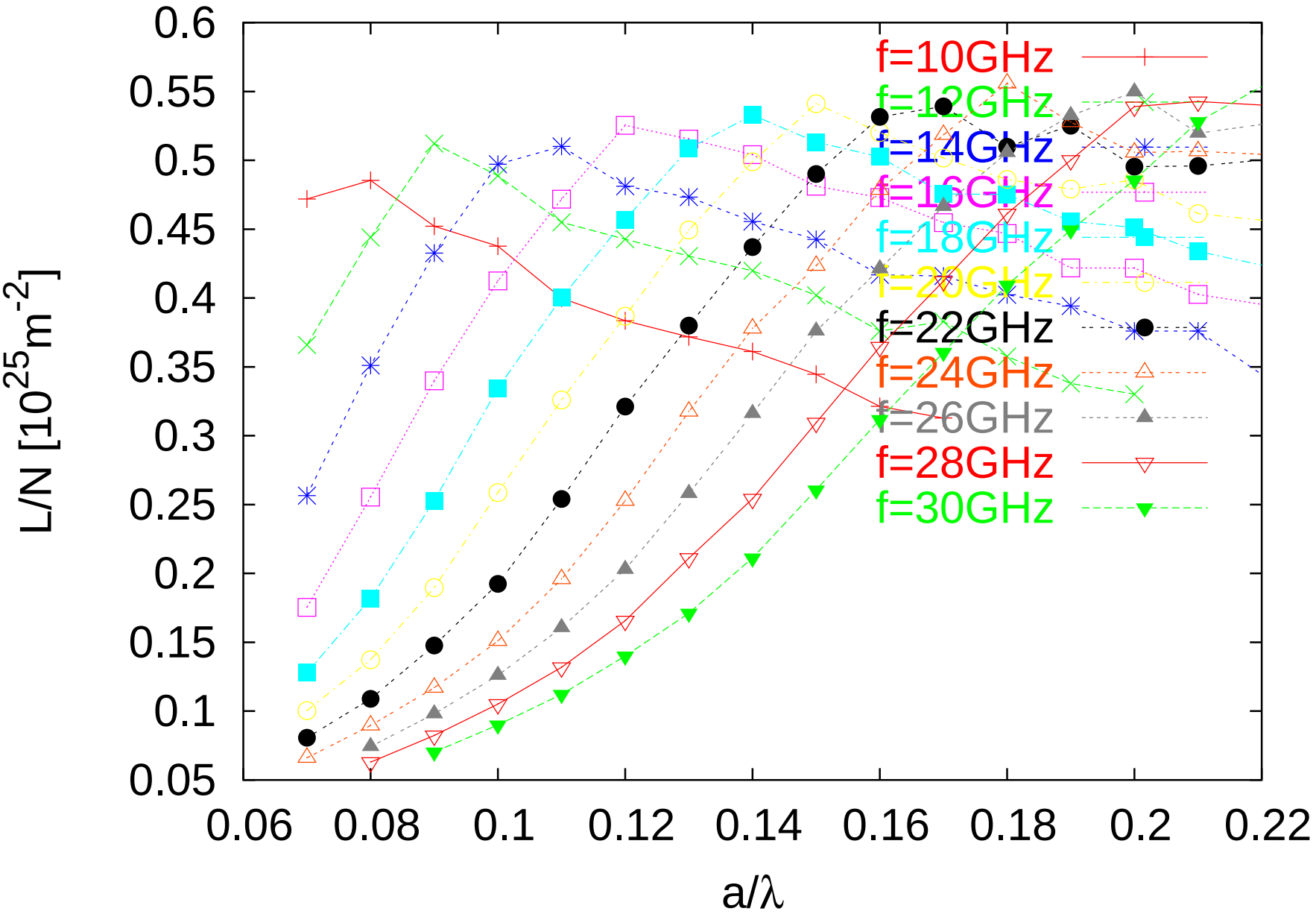
- Need to re-evaluate luminosities at different gradients

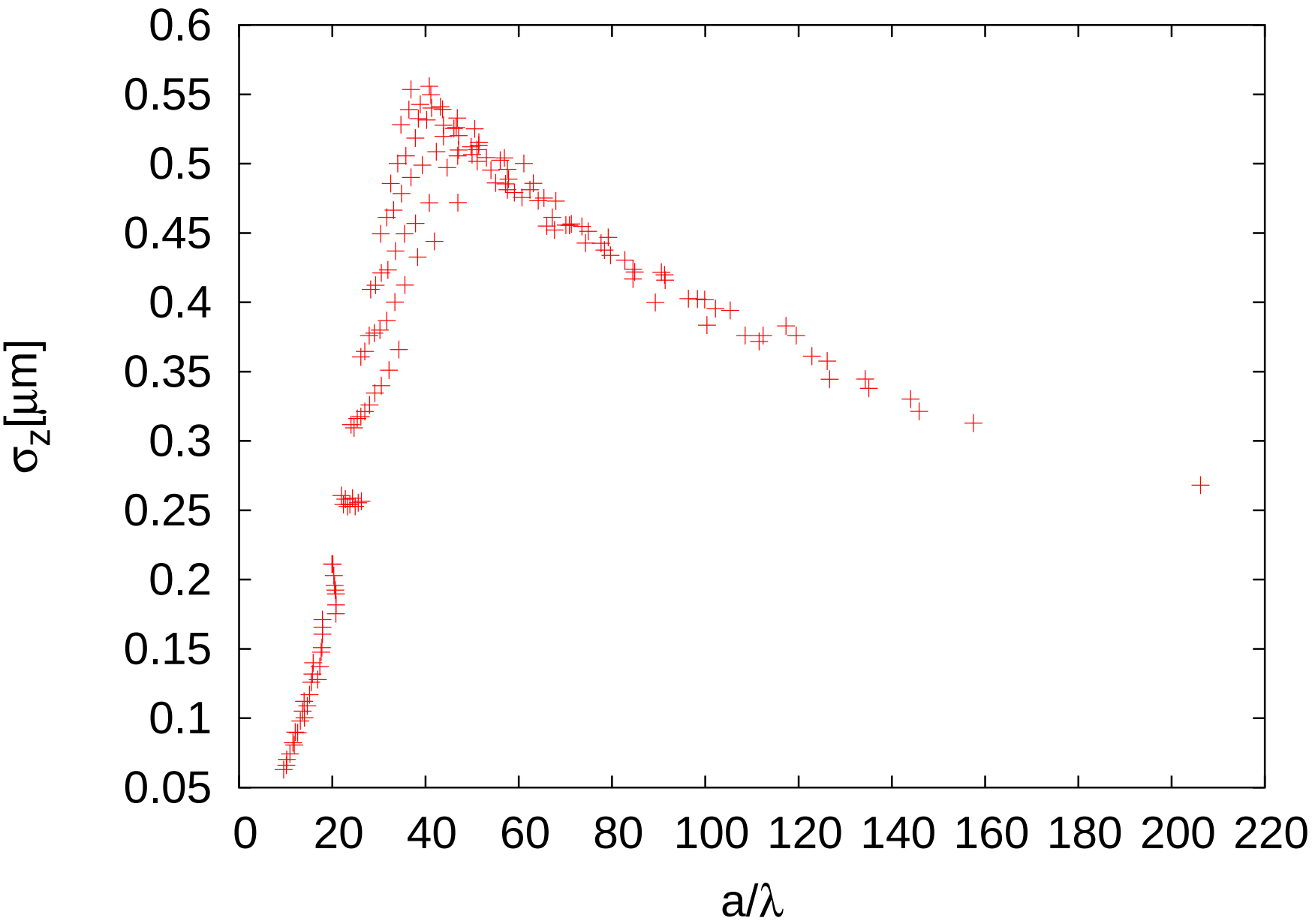
  $\Rightarrow$ done


L/N [10^25 m^-2]
0.6
0.5
0.4
0.3
0.2
0.1
0
10
15
20
25
30
f [GHz]
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
a/λ
0.5
0.4
0.3
0.2
0.1


220
200
180
160
140
120
100
80
60
40
20
0
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
σz[μm]
a/λ
f=10GHz
f=12GHz
f=14GHz
f=16GHz
f=18GHz
f=20GHz
f=22GHz
f=24GHz
f=26GHz
f=28GHz
f=30GHz


40
35
30
25
20
15
10
5
0
N [10^9]
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
a/λ
f=10GHz
f=12GHz
f=14GHz
f=16GHz
f=18GHz
f=20GHz
f=22GHz
f=24GHz
f=26GHz
f=28GHz
f=30GHz


0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
L/N [10^25 m^-2]
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
a/λ
f=10GHz
f=12GHz
f=14GHz
f=16GHz
f=18GHz
f=20GHz
f=22GHz
f=24GHz
f=26GHz
f=28GHz
f=30GHz


0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
σz[μm]
0
20
40
60
80
100
120
140
160
180
200
220
a/λ