MADMAX Booster Seed Setup

Status and Plans

Stefan Knirck

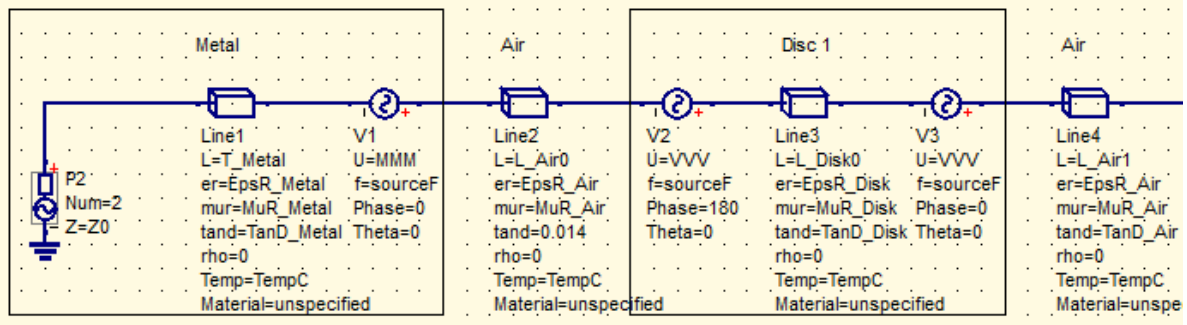
for the MADMAX working group

Excellence Cluster Universe

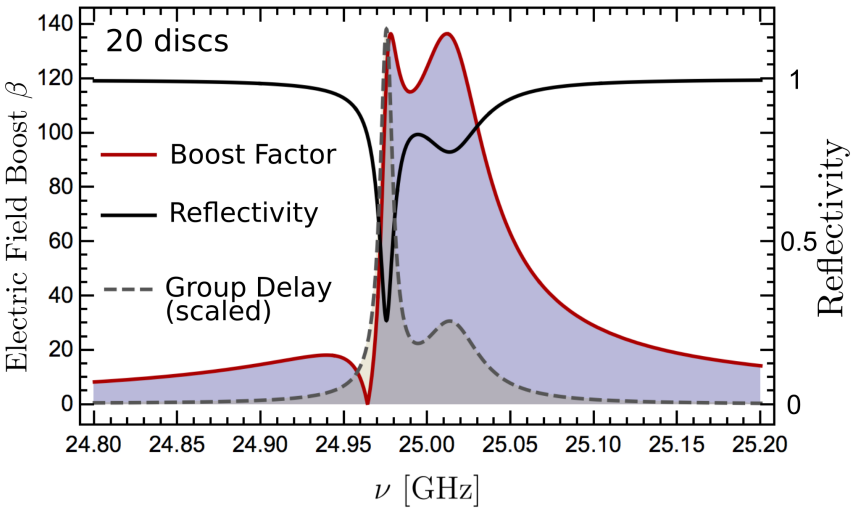
Controlling the Boost Factor

Simulate it!

1D, ideal



Measure Correlated Quantities!



Reflectivity

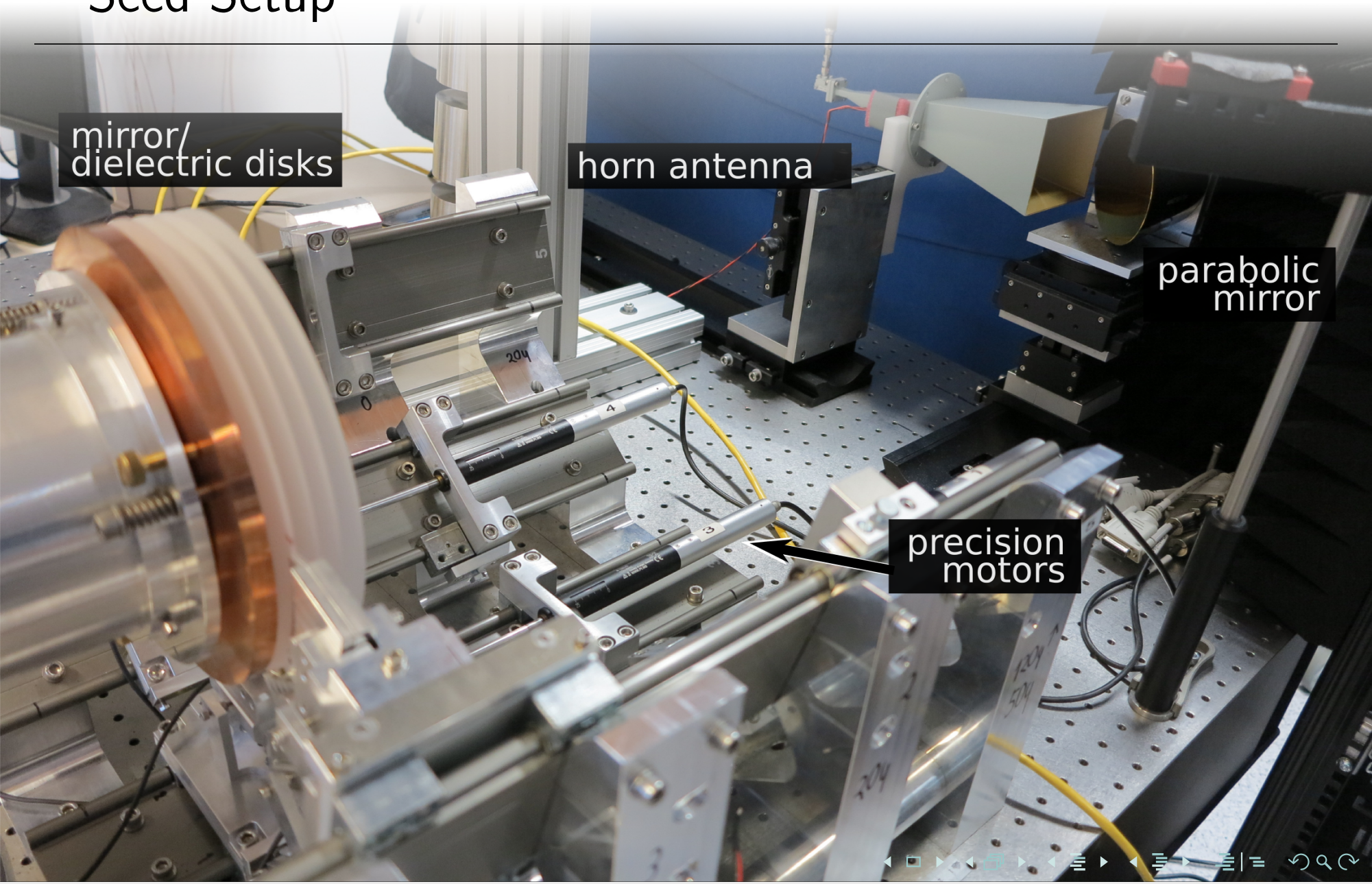
(Group Delay)

$$\tau_g = -\frac{d\Phi}{d\omega}$$

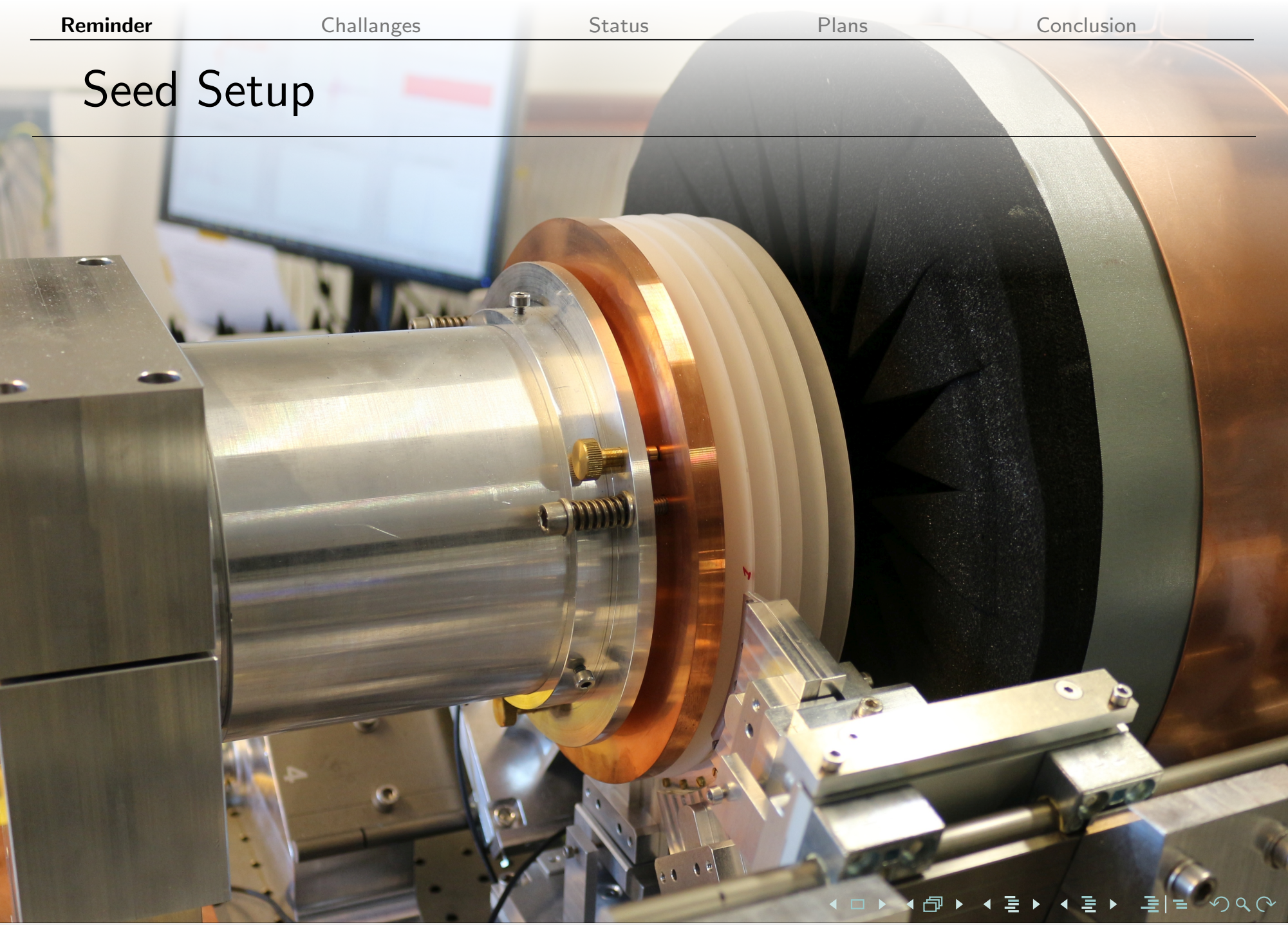
Transmission

Fit Disk Spacings

Seed Setup

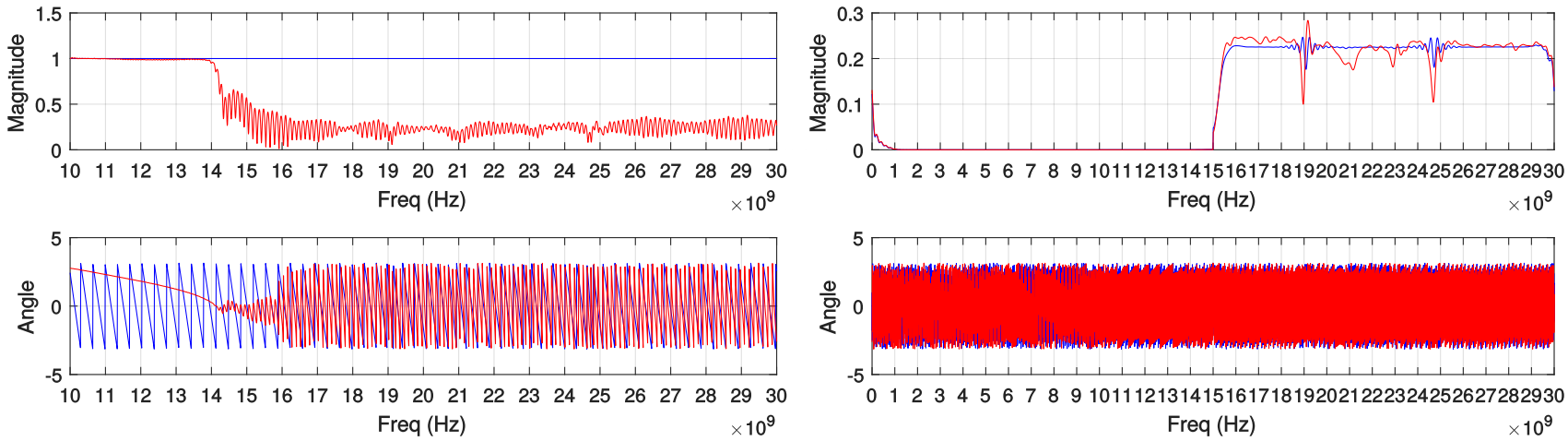

mirror/
dielectric disks
horn antenna
parabolic
mirror
precision
motors

Seed Setup

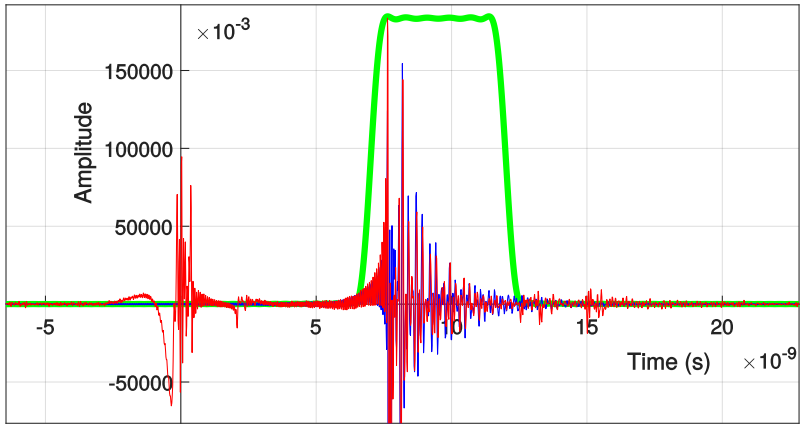


Signal Processing (Basics)

simulation
measurement

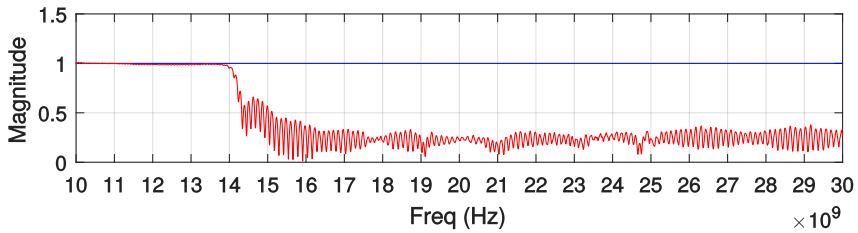


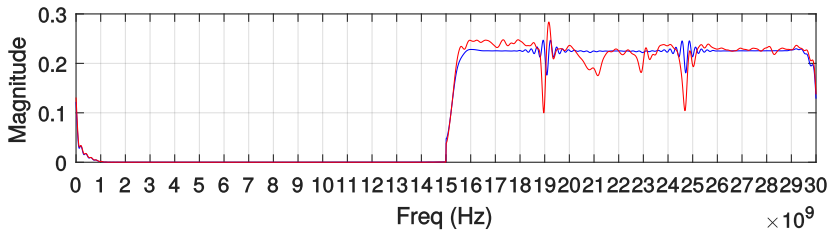
FFT^{-1}

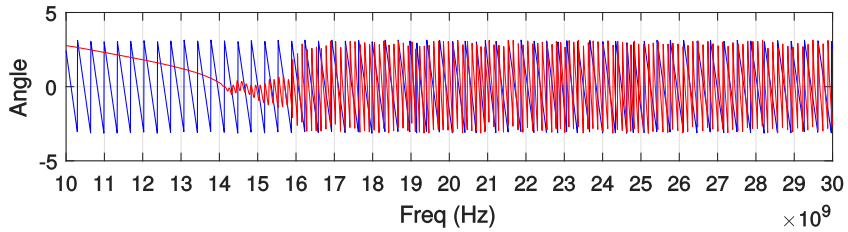


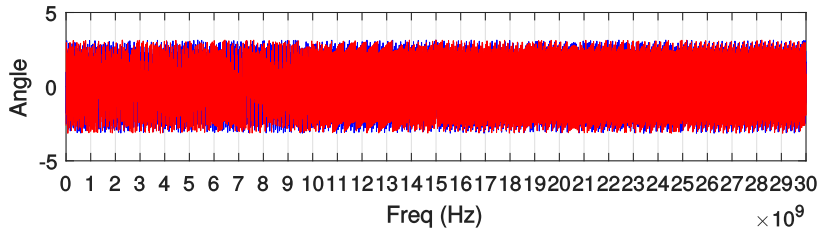
FFT

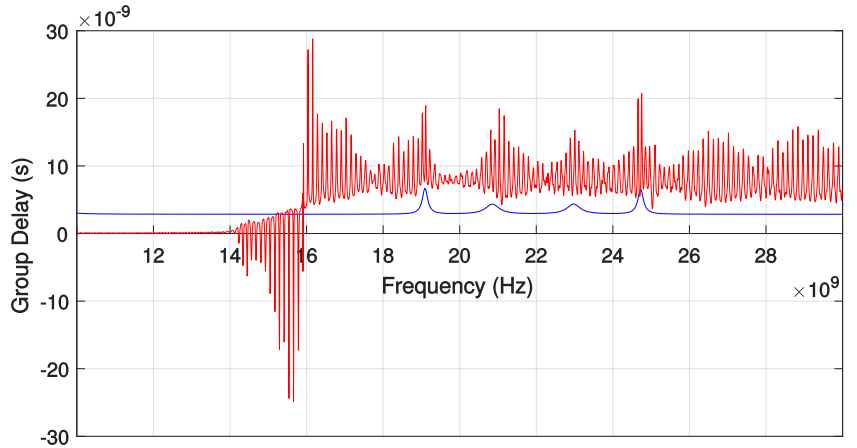
Signal Processing (Basics)

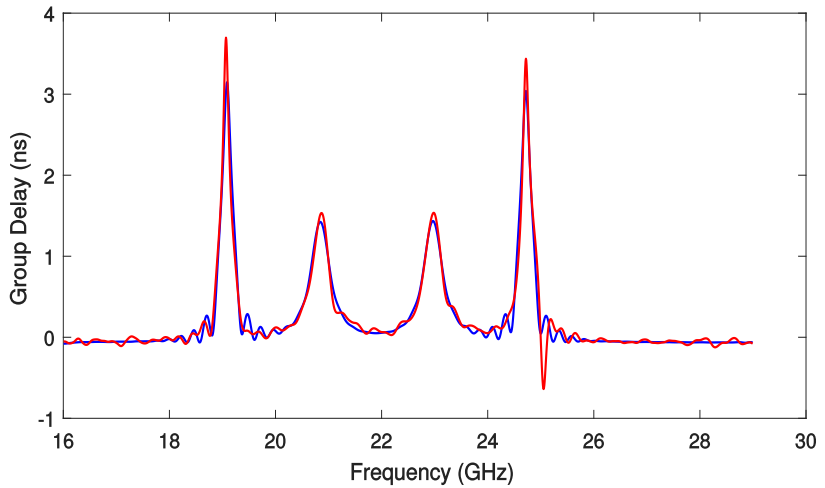




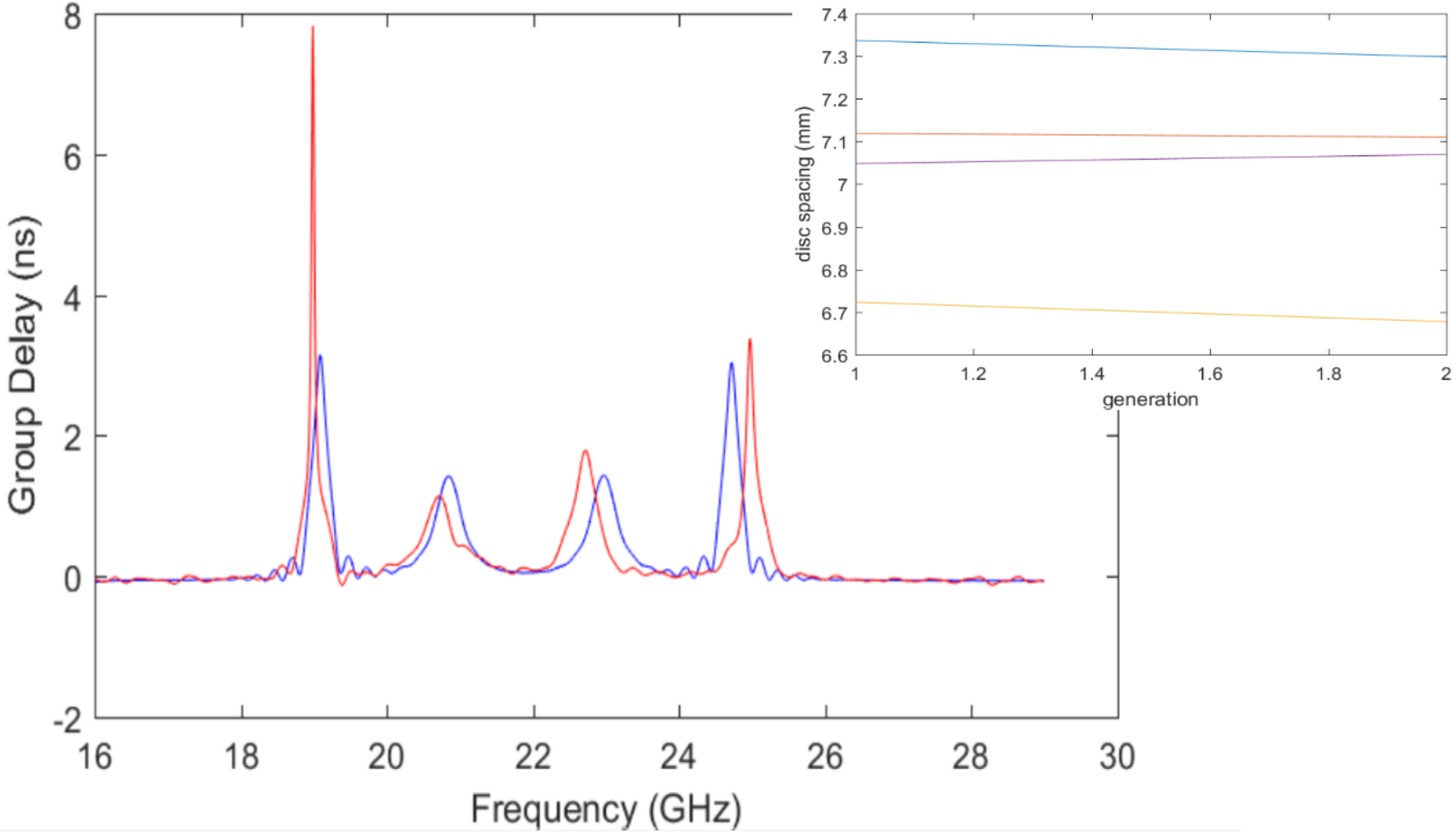




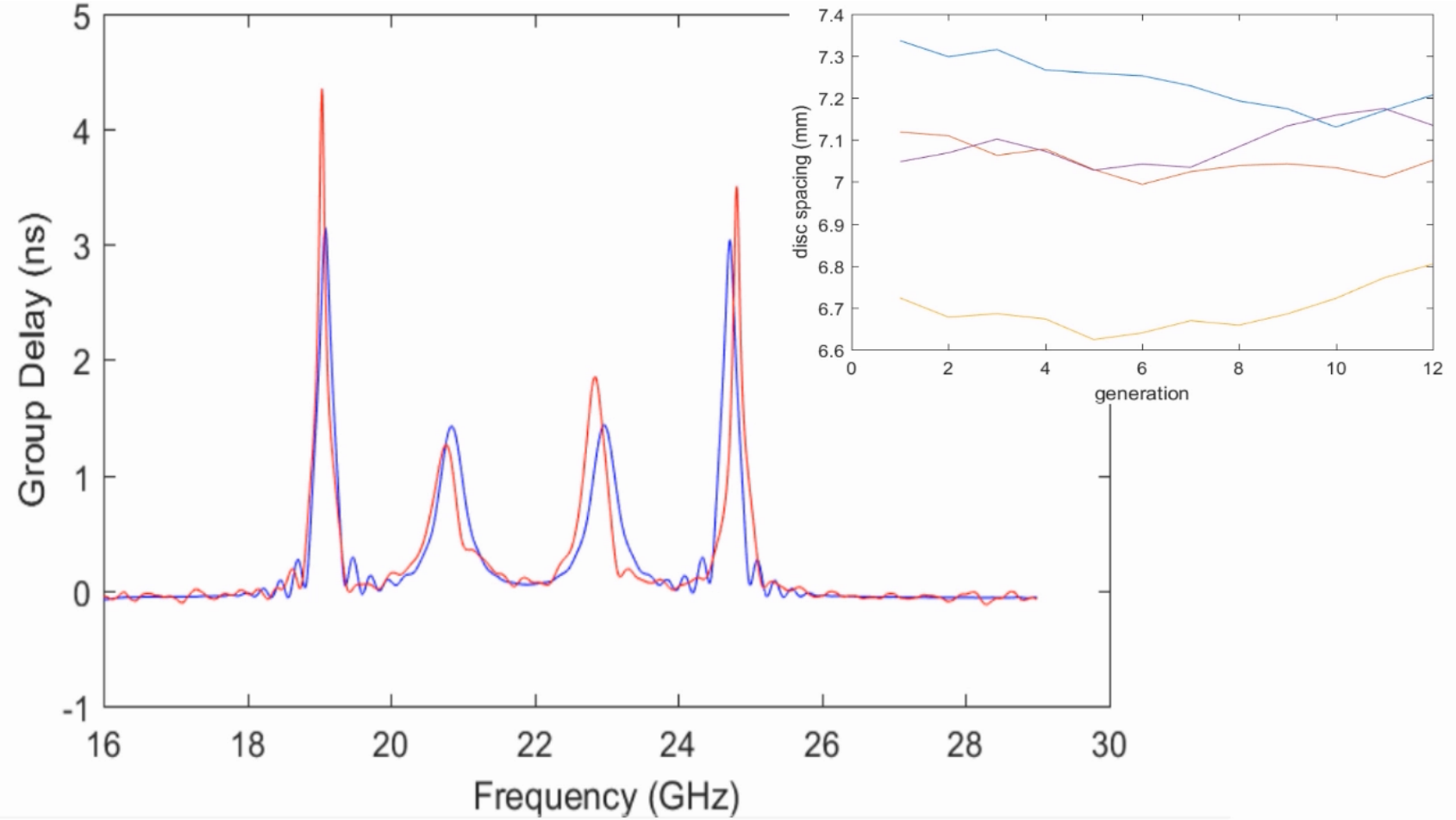




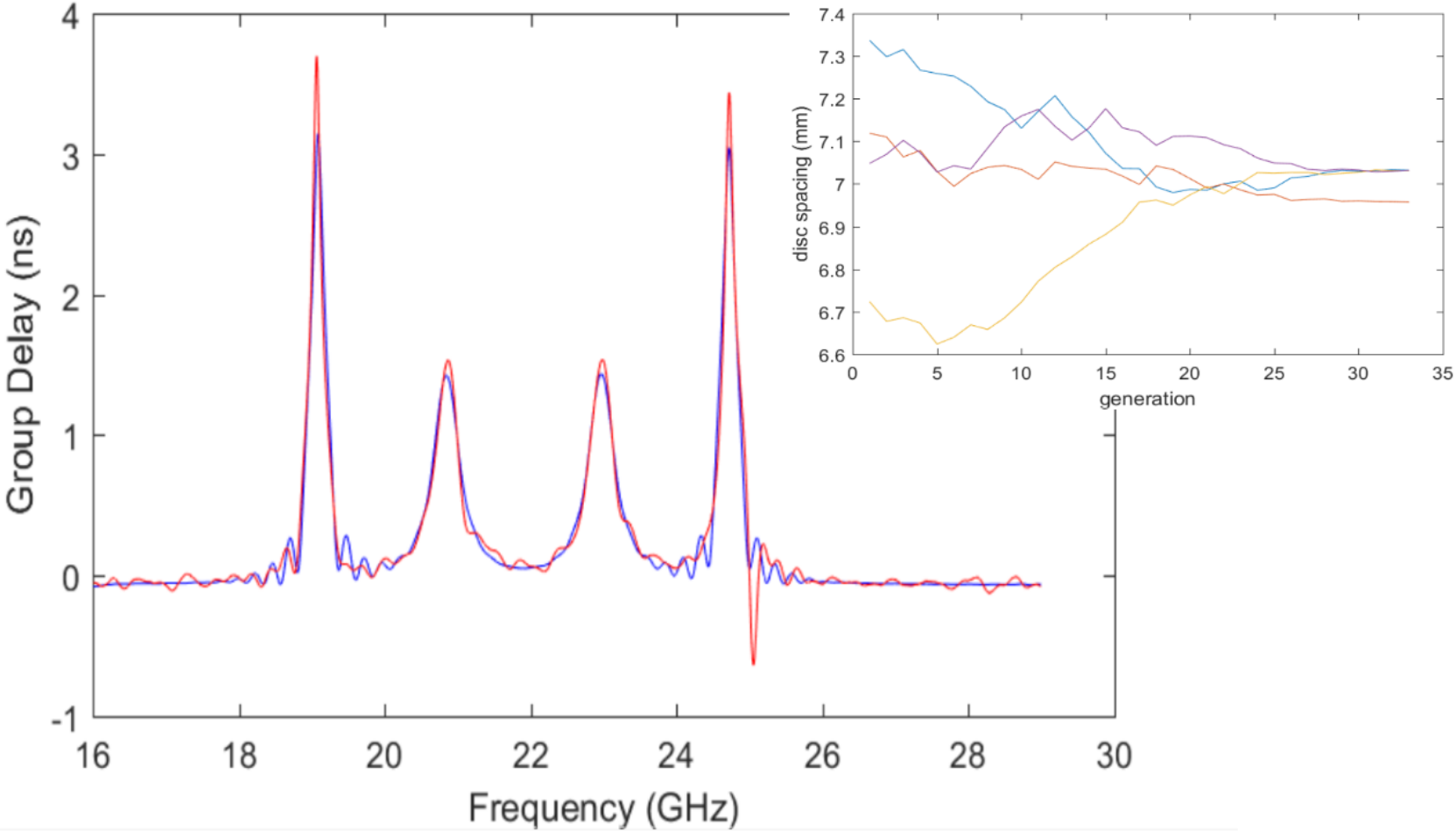
Fitting Algorithm



Fitting Algorithm

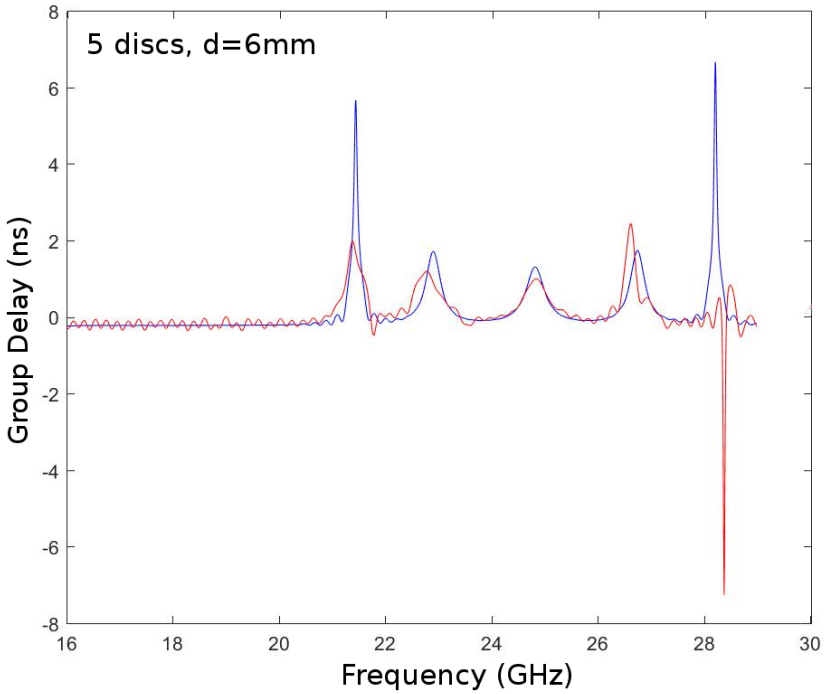


Fitting Algorithm

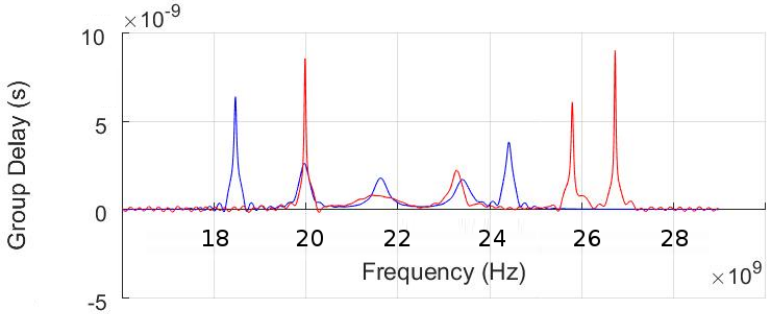


What can go wrong?

Negative Group Delay

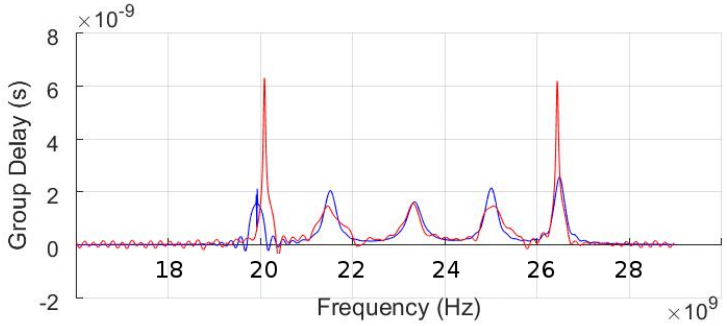


Fitting to Local Minimum



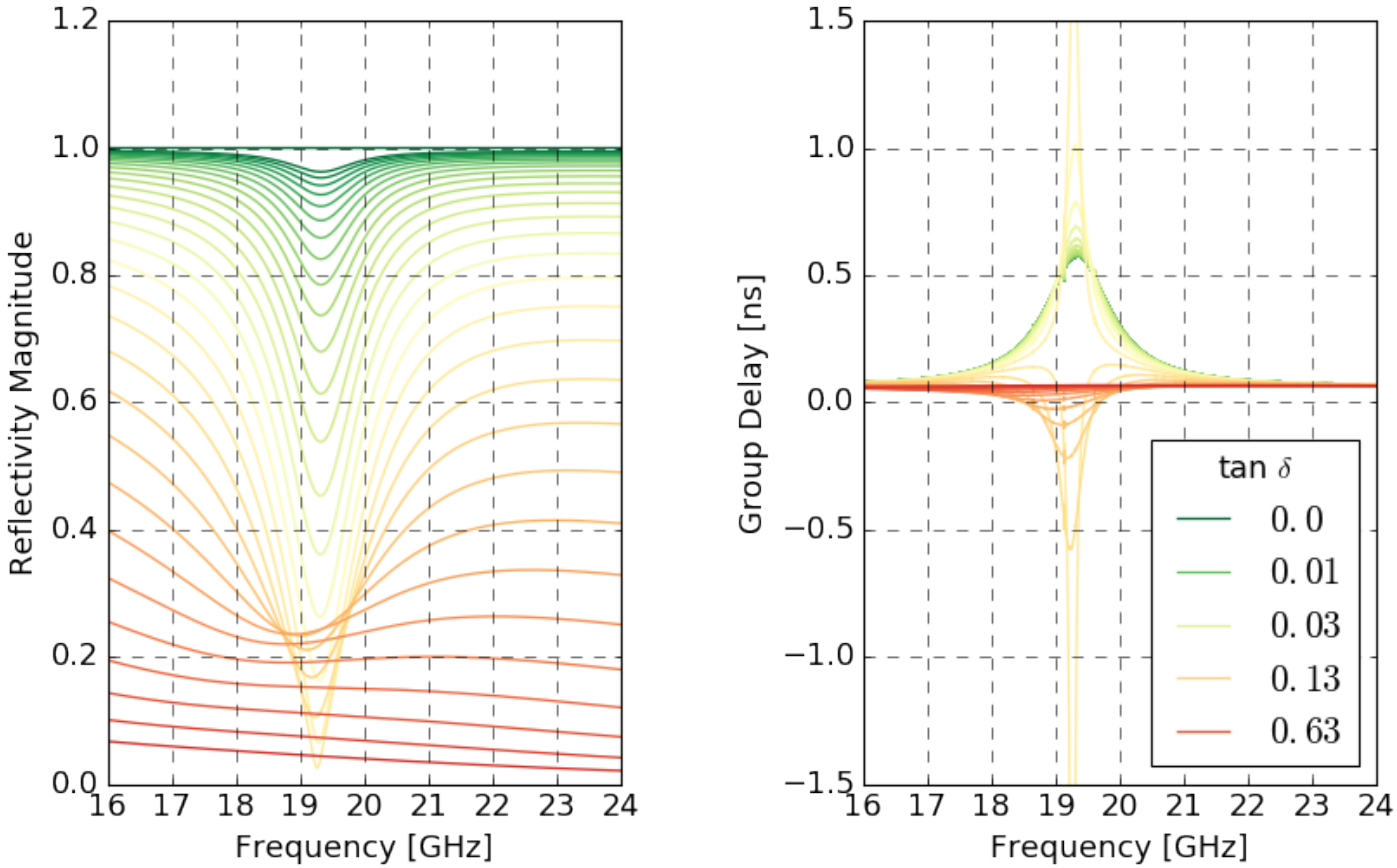
Misleaded Fit

(due to Negative Group Delay)



Loss Effects

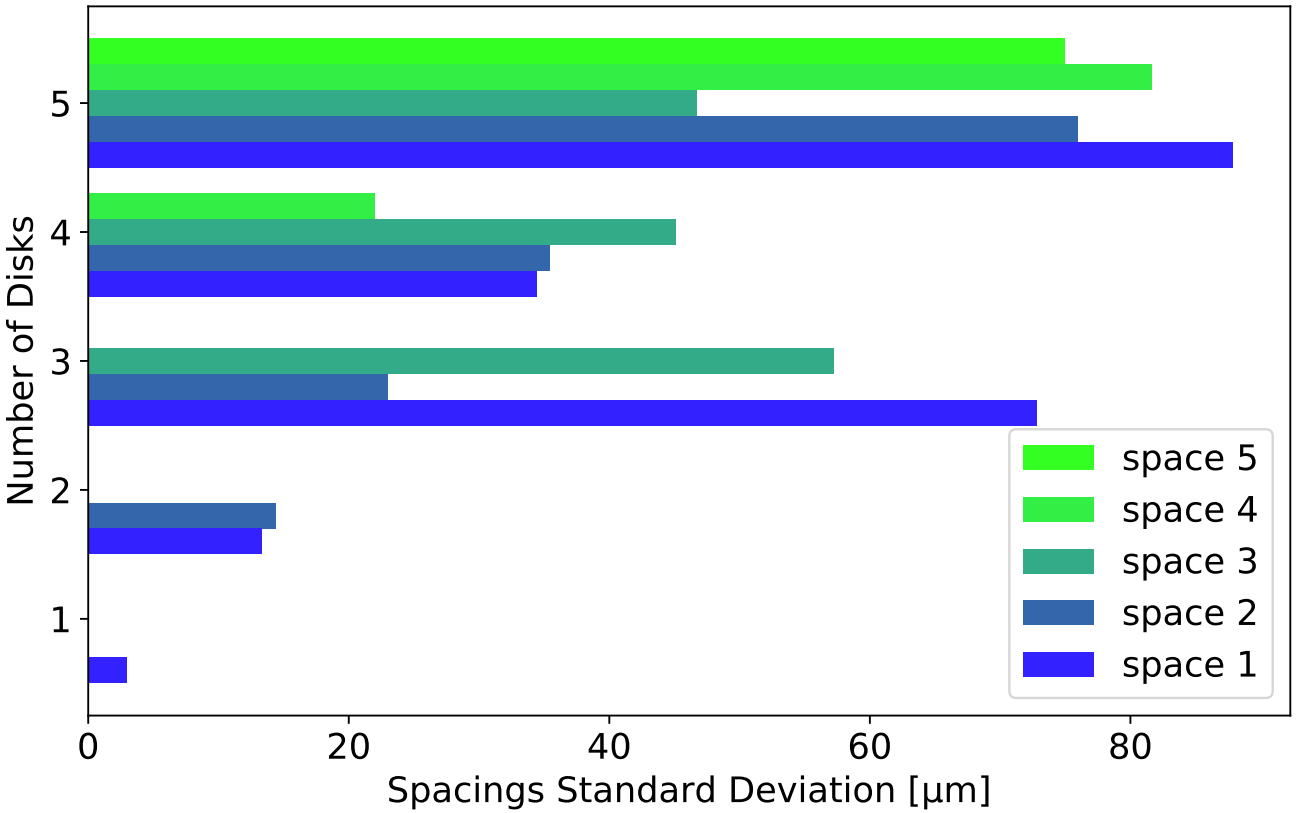
single disk and mirror, $d = 8\,\mathrm{mm}$



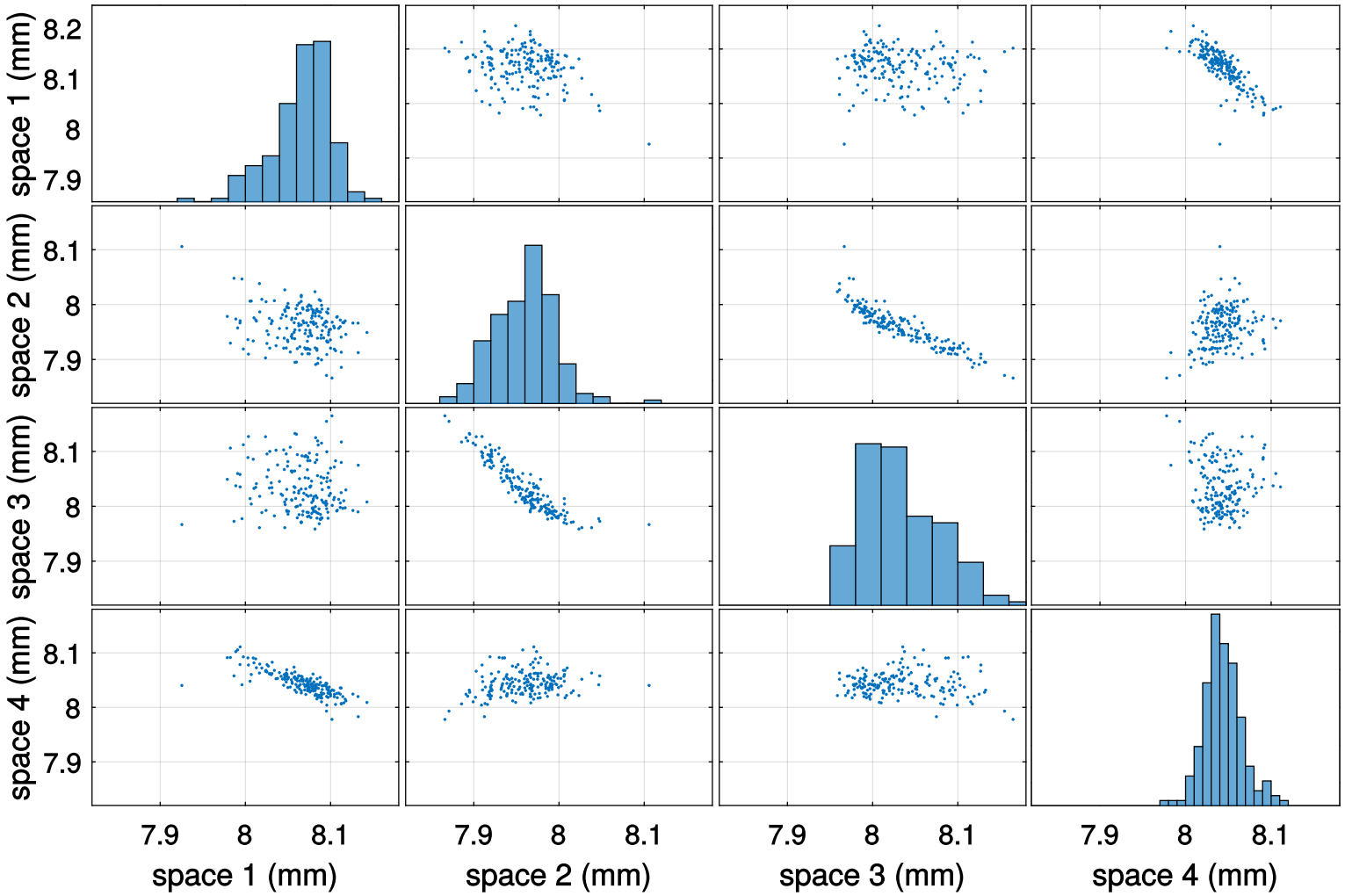
Chance: Understand Loss.

Disk Spacing Repeatability

initial misplacement: $\pm 200\,\mu m$ *(uniform distribution)*
all distances $d_i = 8\,mm$

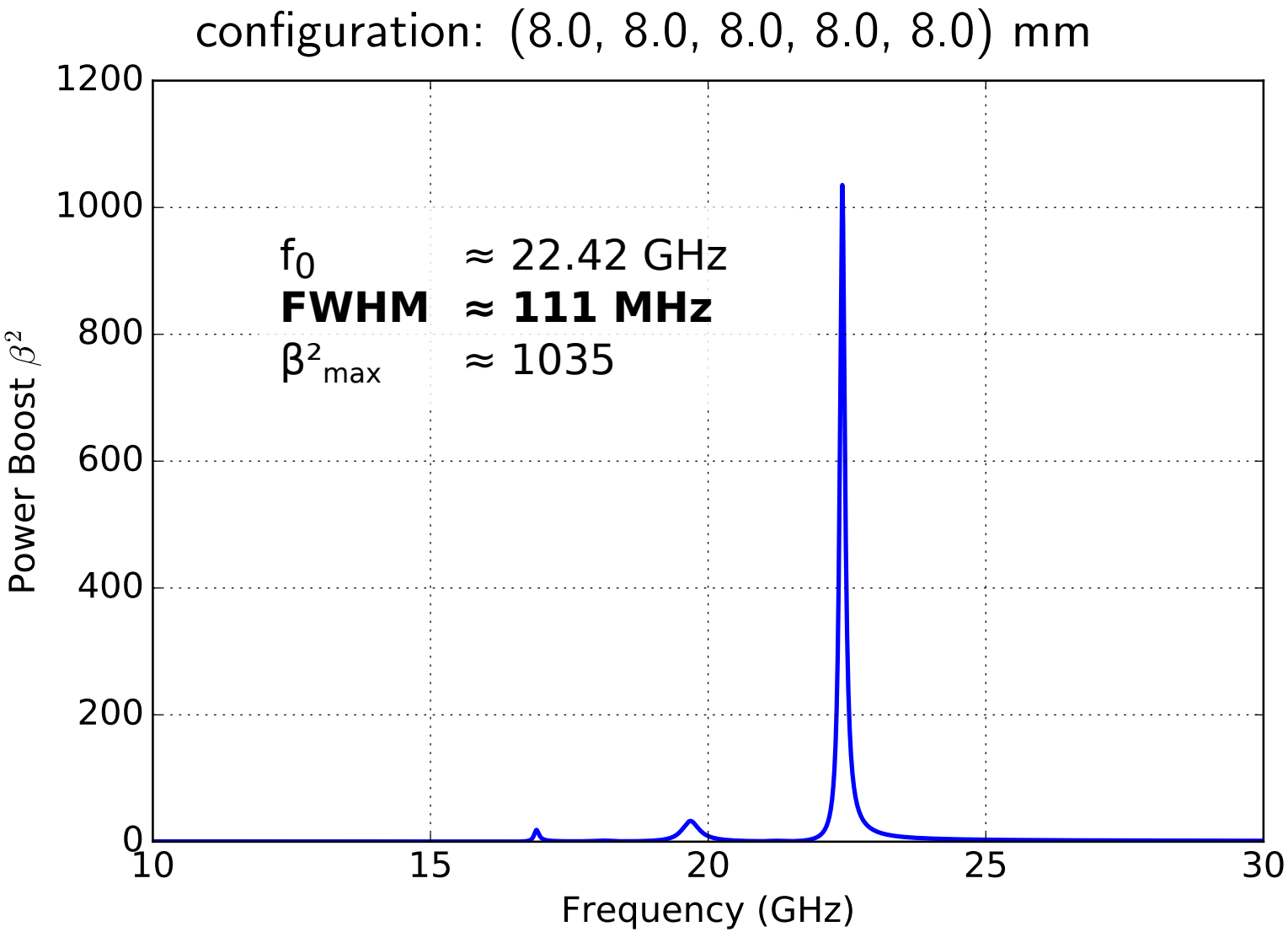


Disk Spacing Repeatability



Spacings Correlated

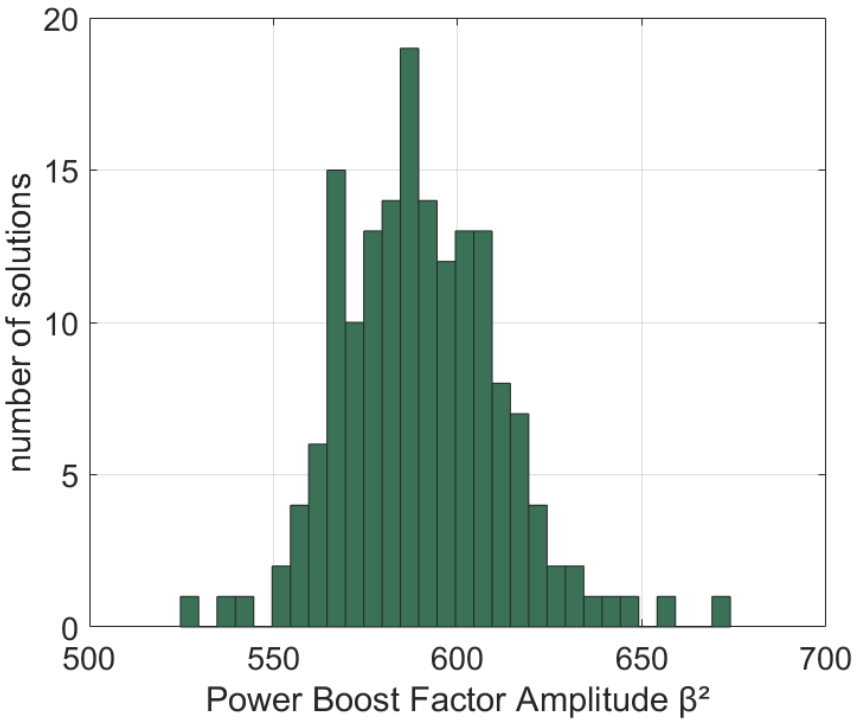
Boost Factor



Boost Factor Repeatability - 4 disks

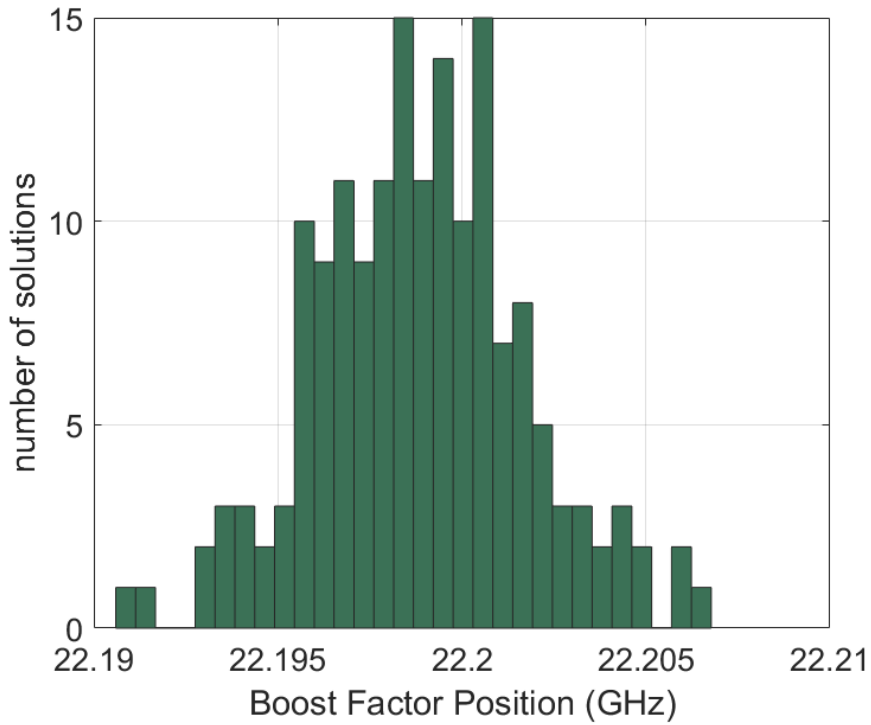
fitting Simulation to Measurement

Amplitude



± 40

Frequency



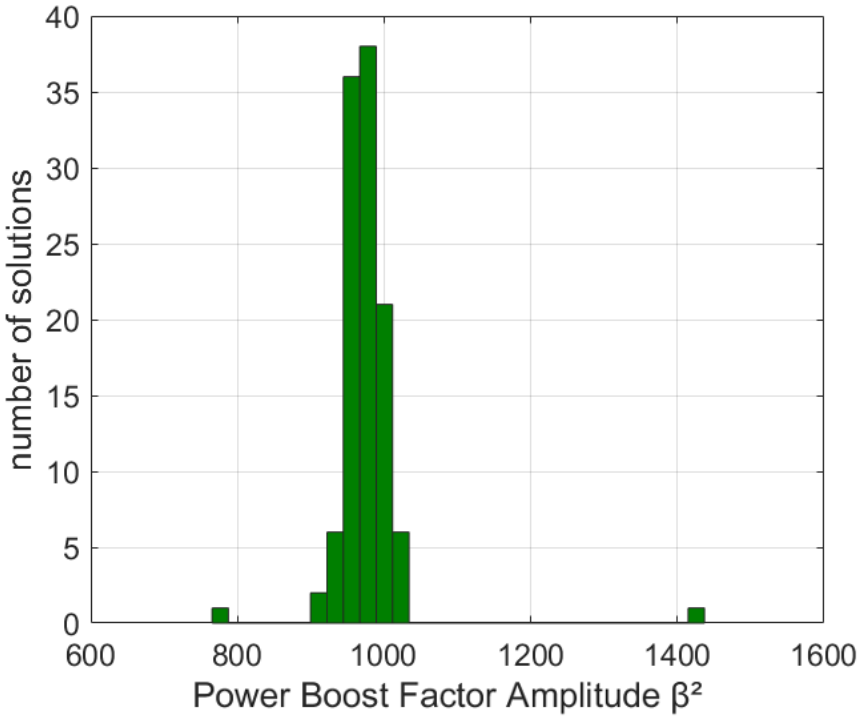
± 4 MHz

reasonably under control

Boost Factor Repeatability - 5 disks

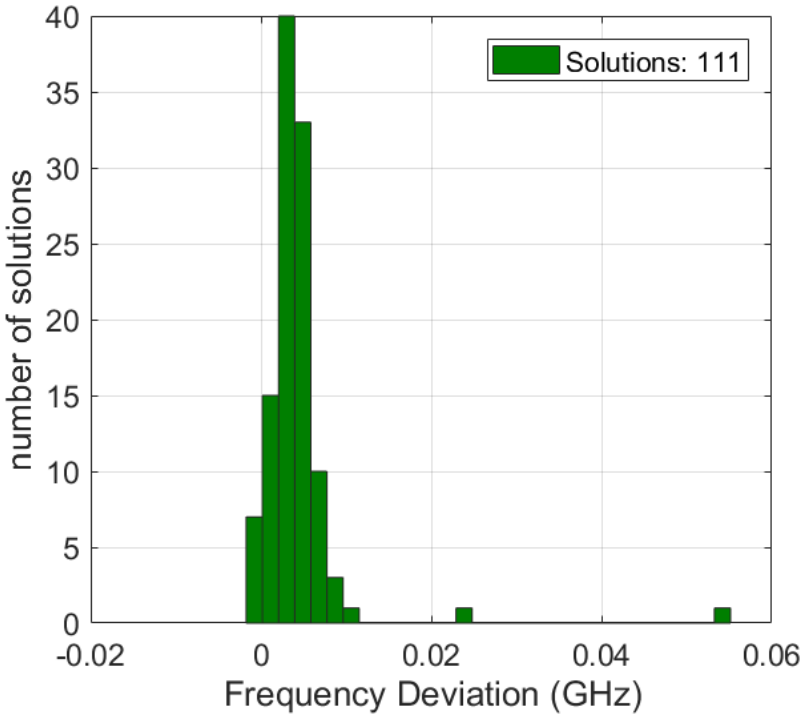
fitting Model Simulation to Measurement

Amplitude



± 50

Frequency

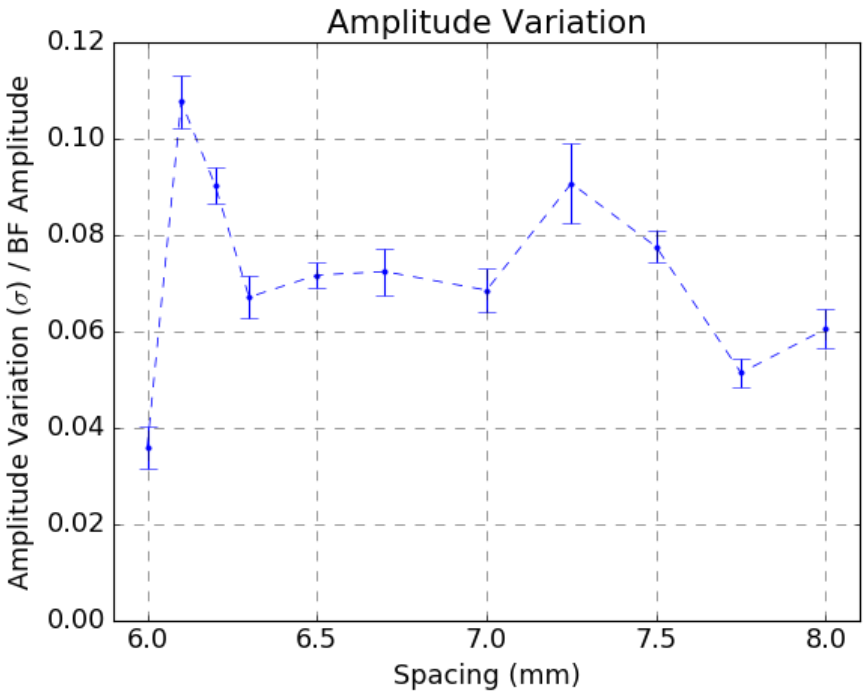


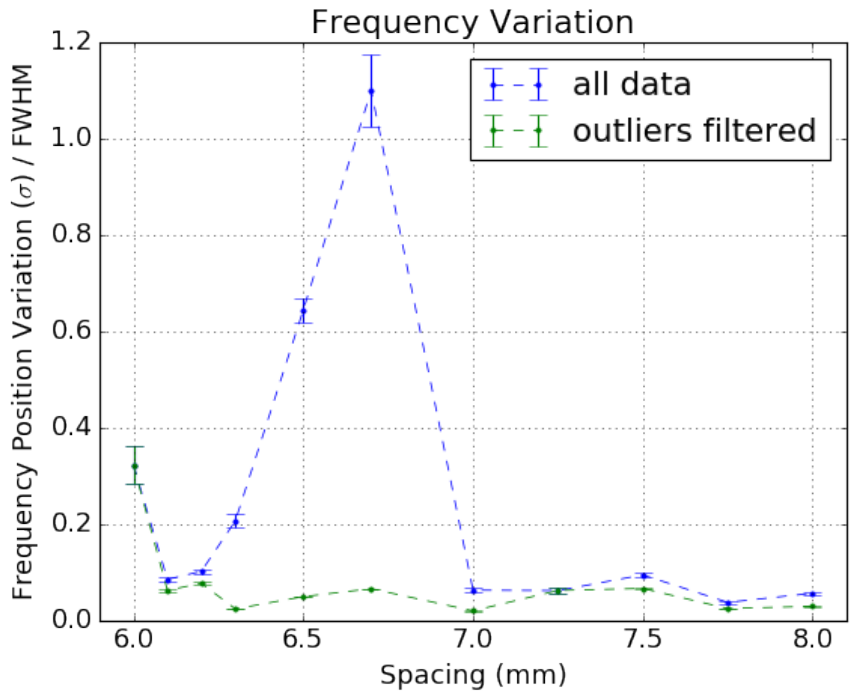
± 5 MHz

more disks → more loss → fit more difficult

Boost Factor Repeatability

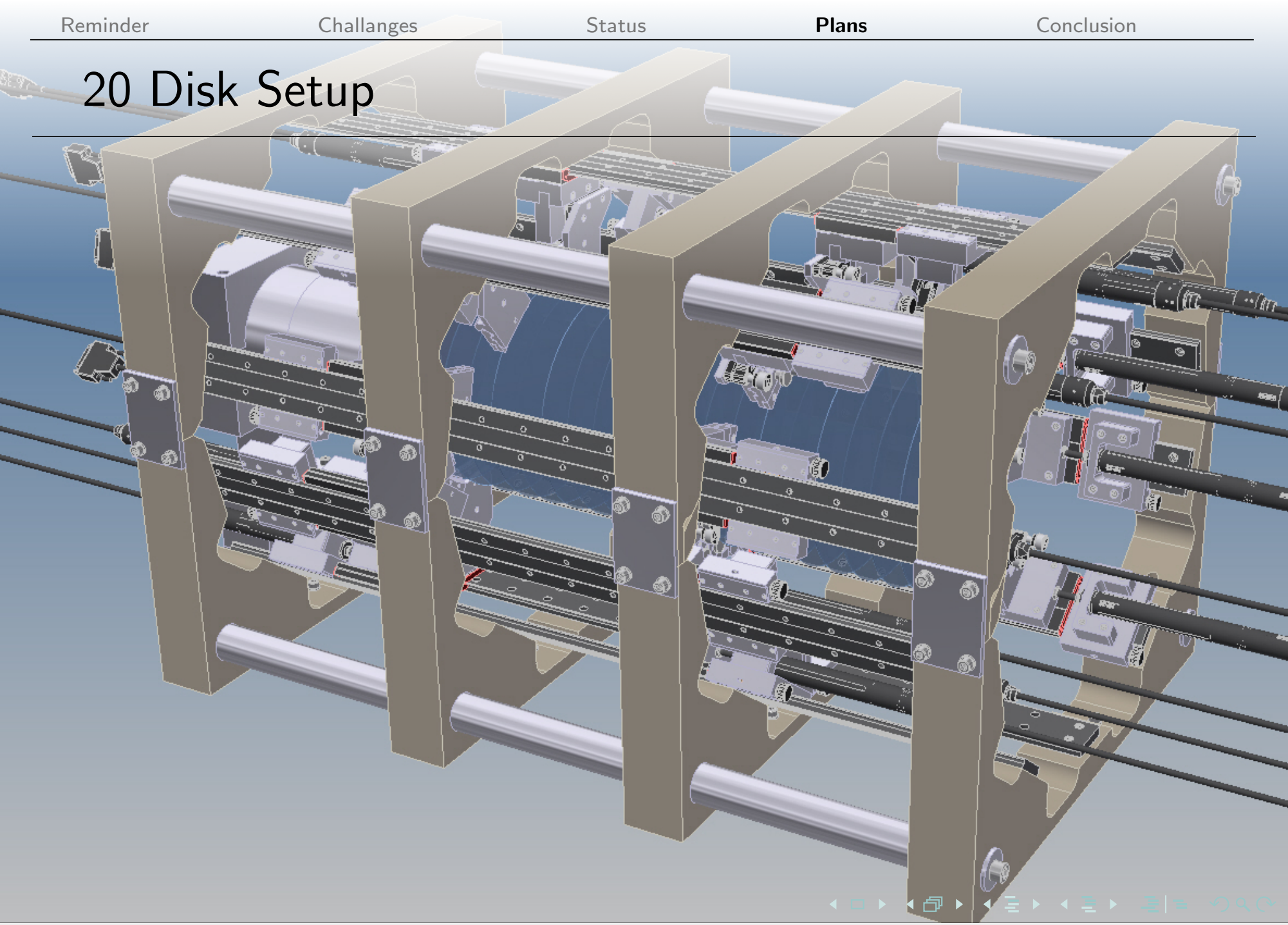
for different disk spacings



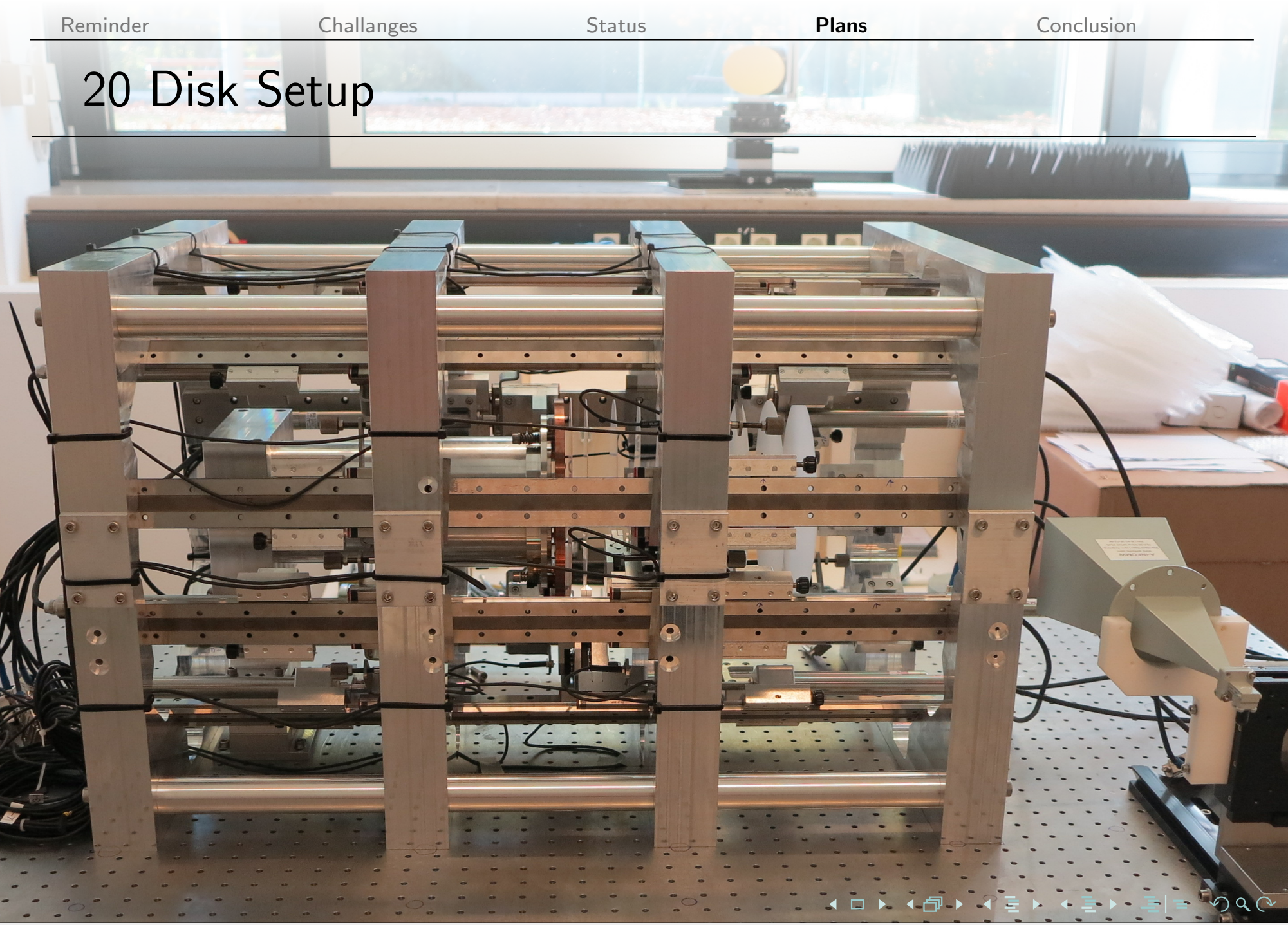


still reasonably good for different spacings

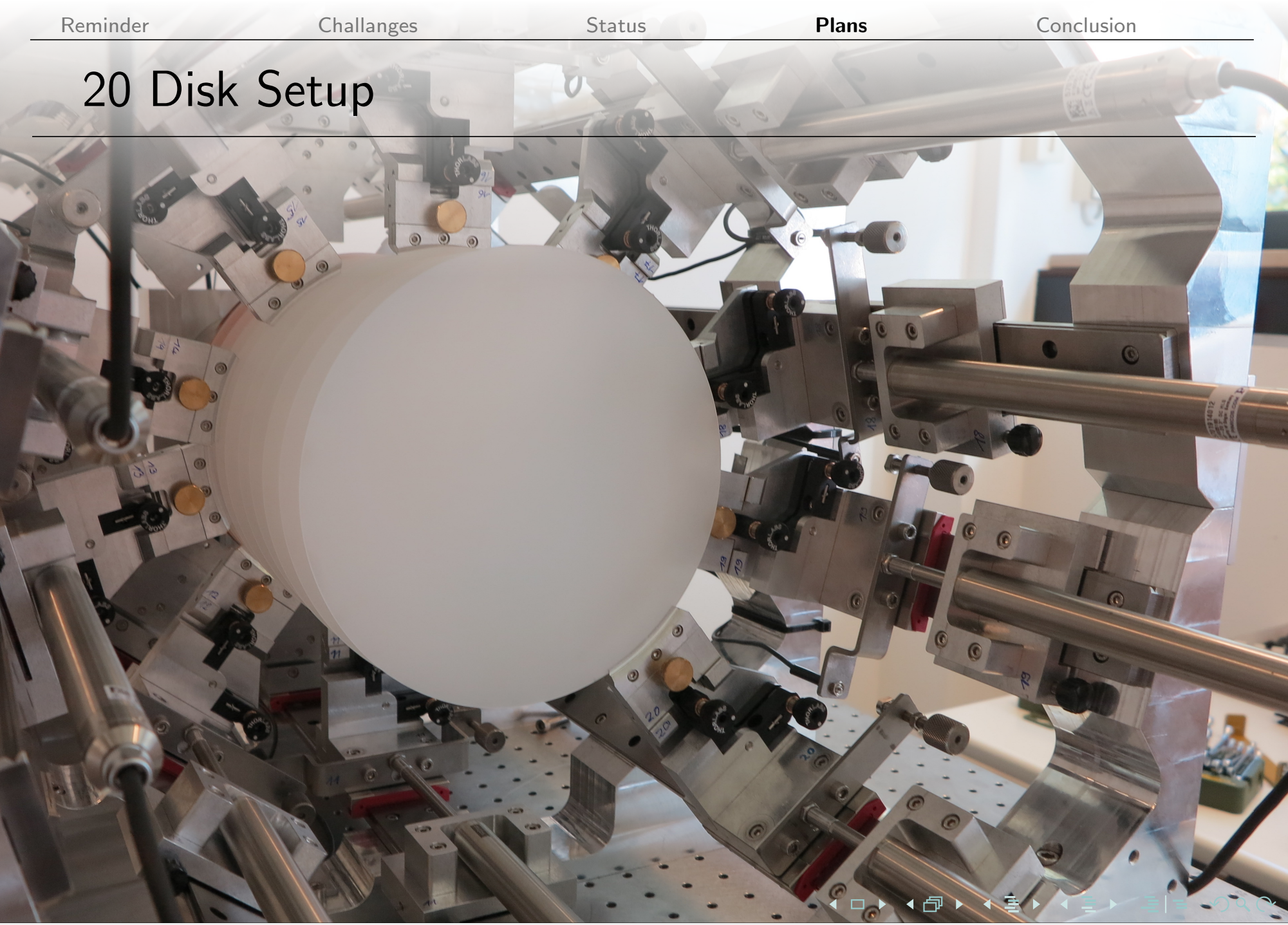
20 Disk Setup



20 Disk Setup

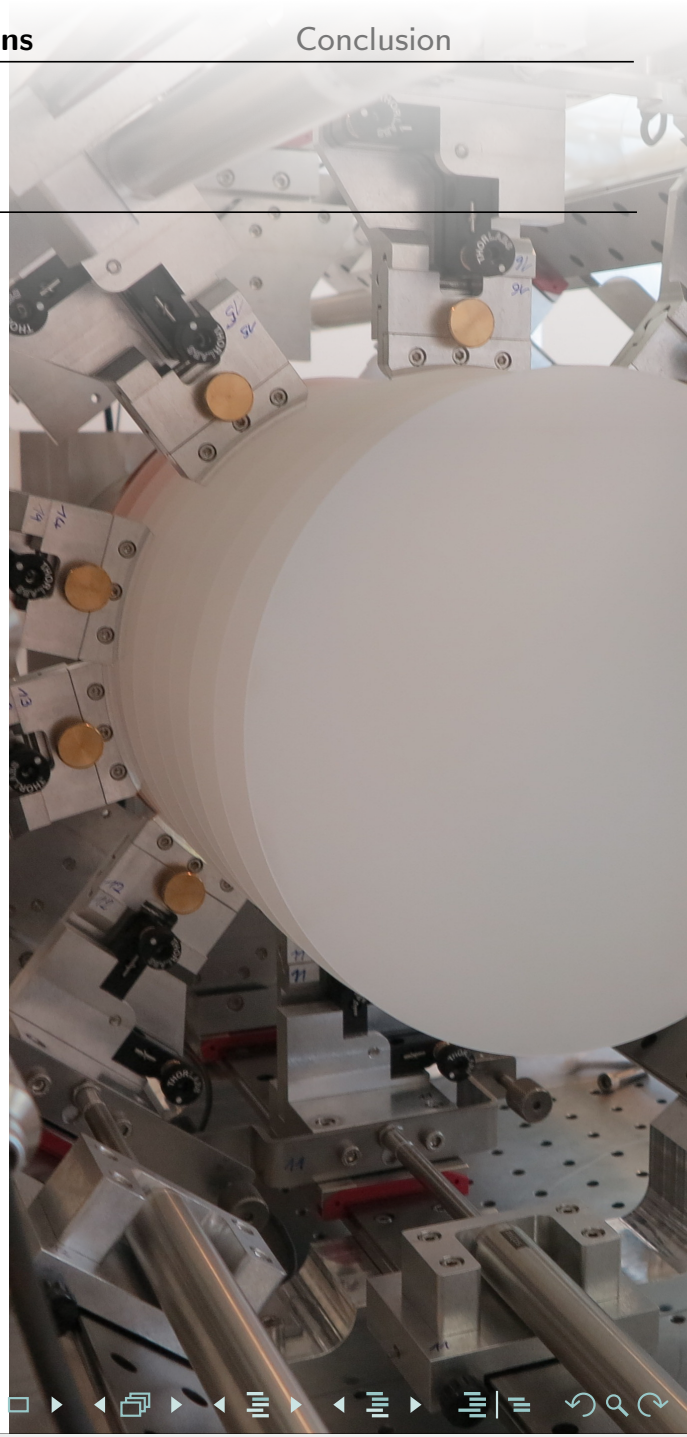


20 Disk Setup

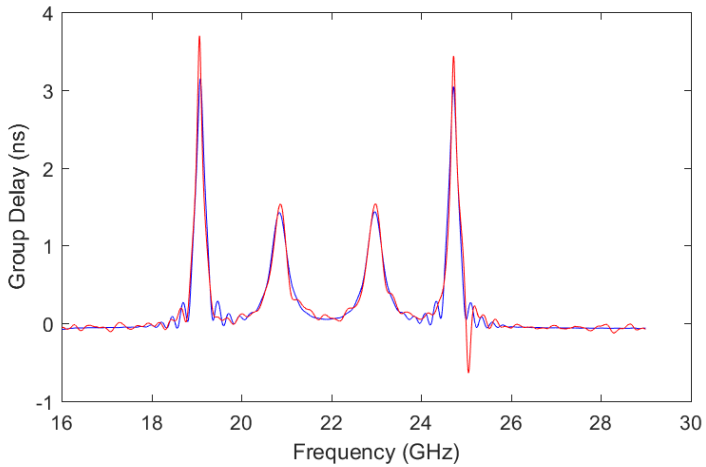


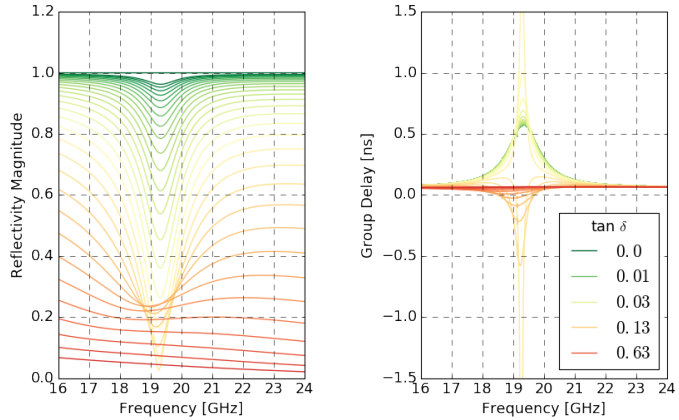
Next Steps - 20 Disk Setup

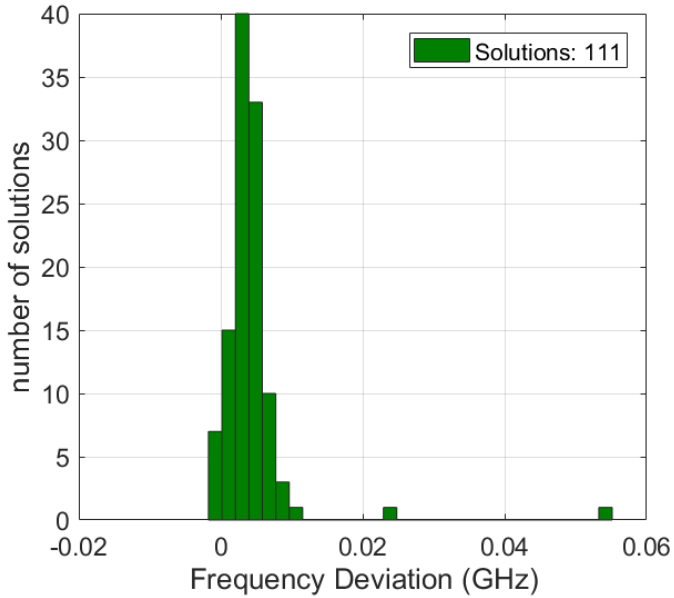
- commissioning ◀ **now**
- Reproduce current results
  confirmation, documentation
- **Extend to 20 Disks**
  better loss understanding
  broadband boost factors
  algorithm improvements

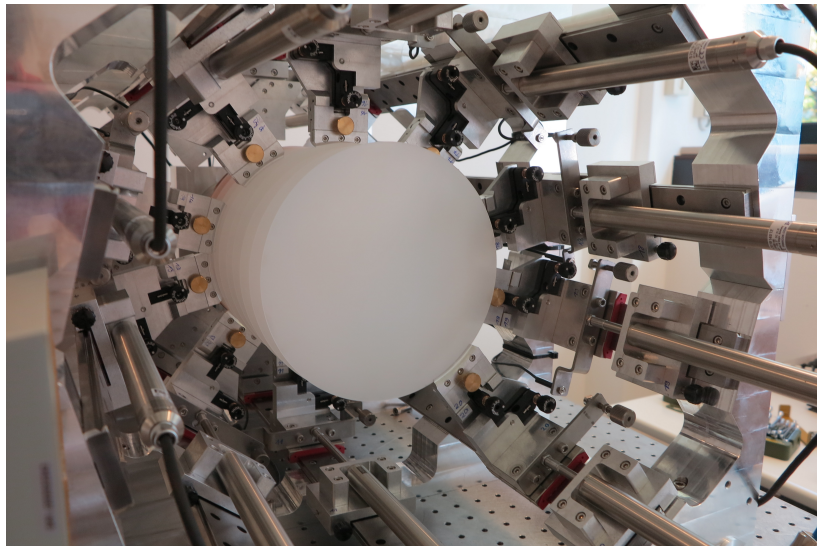


Conclusions

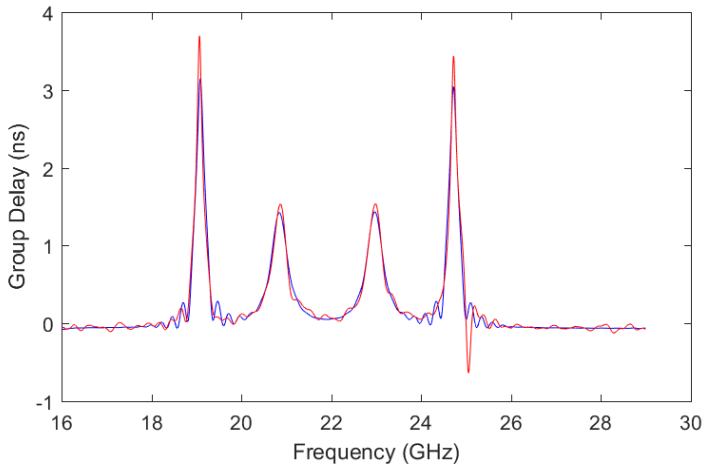


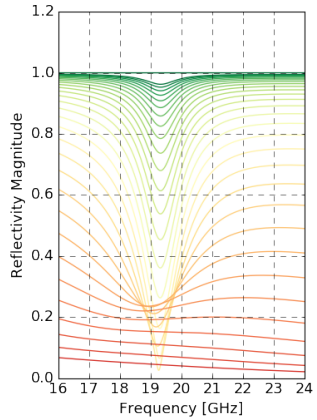


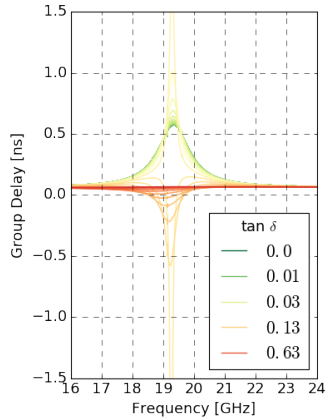


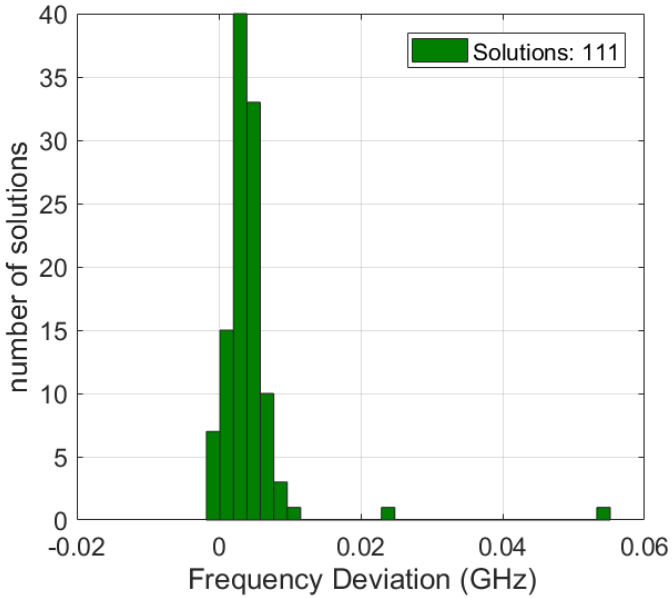


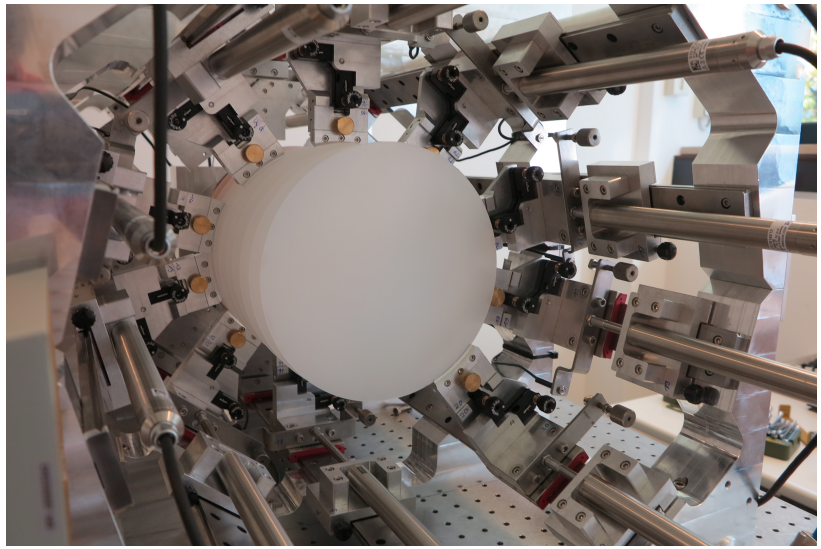
Thank You very much



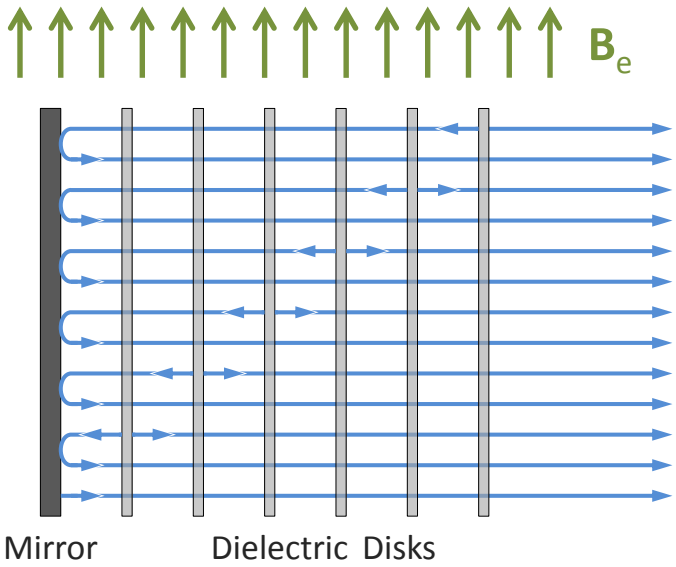


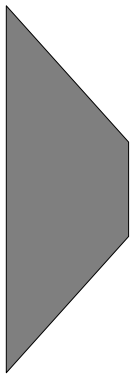


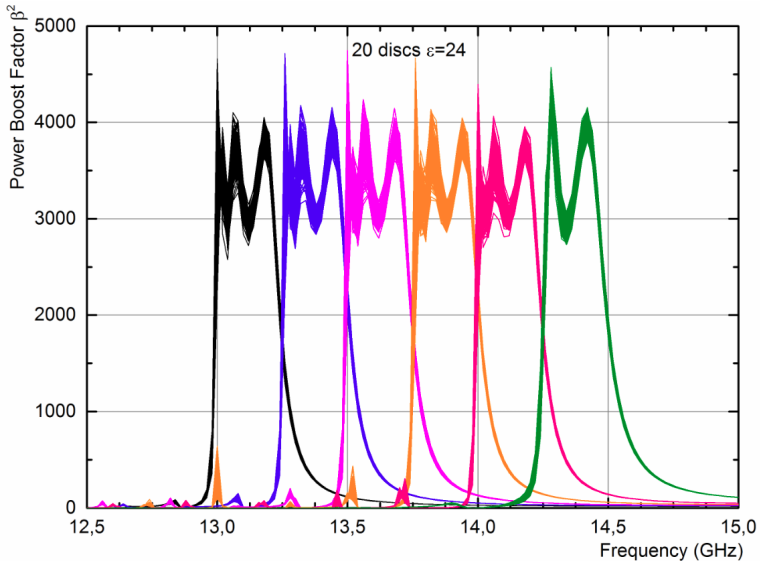




The MADMAX Idea







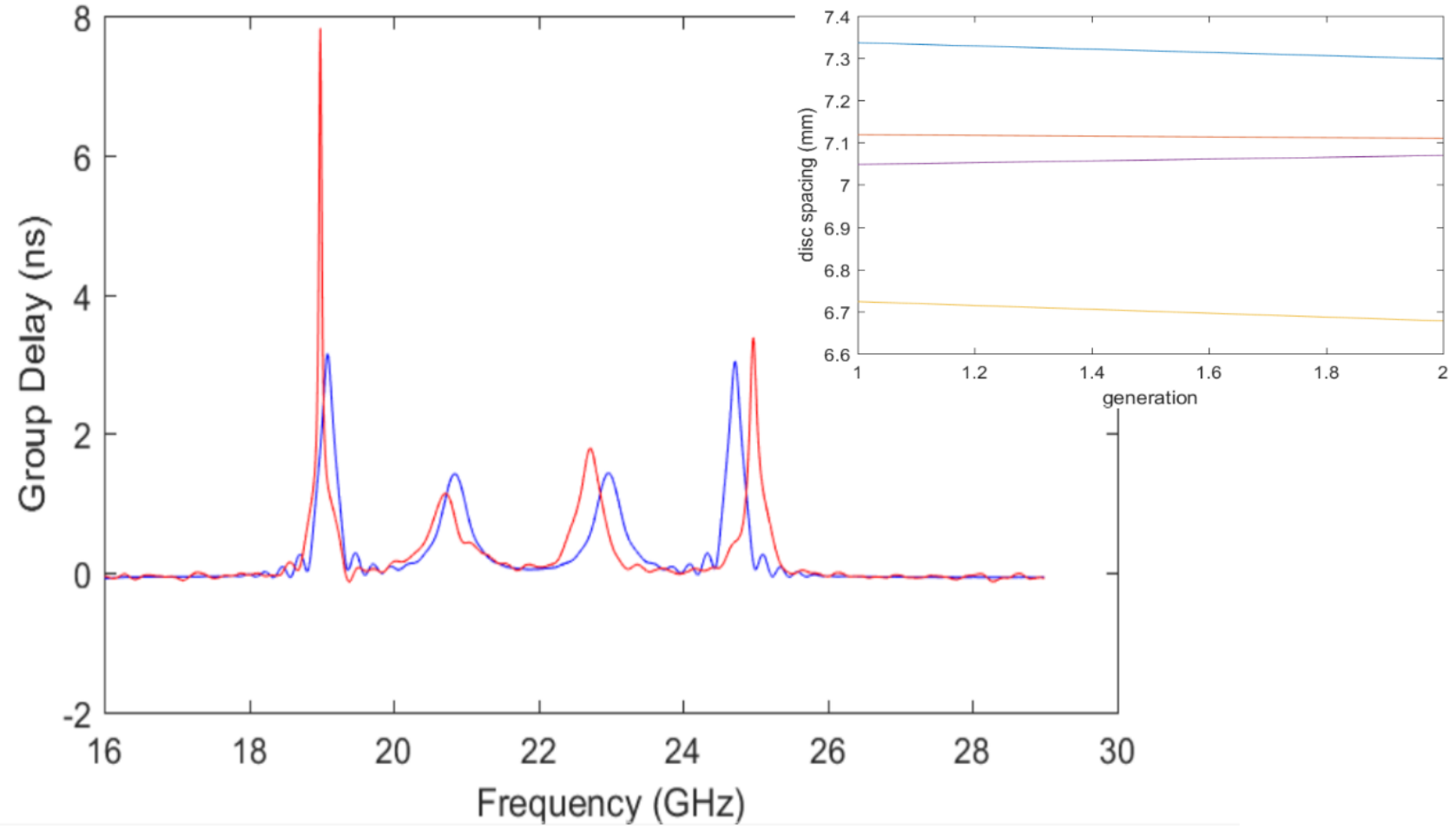
$$P/A = 2.2 \times 10^{-27}\,\mathrm{W\,m^{-2}} \left(\frac{B_e}{10\,\mathrm{T}}\right) {C_{a\gamma}}^2 \cdot \beta^2$$

β^2: power emitted by booster / power emitted by single mirror ($\epsilon = \infty$)

How to control Boostfactor?

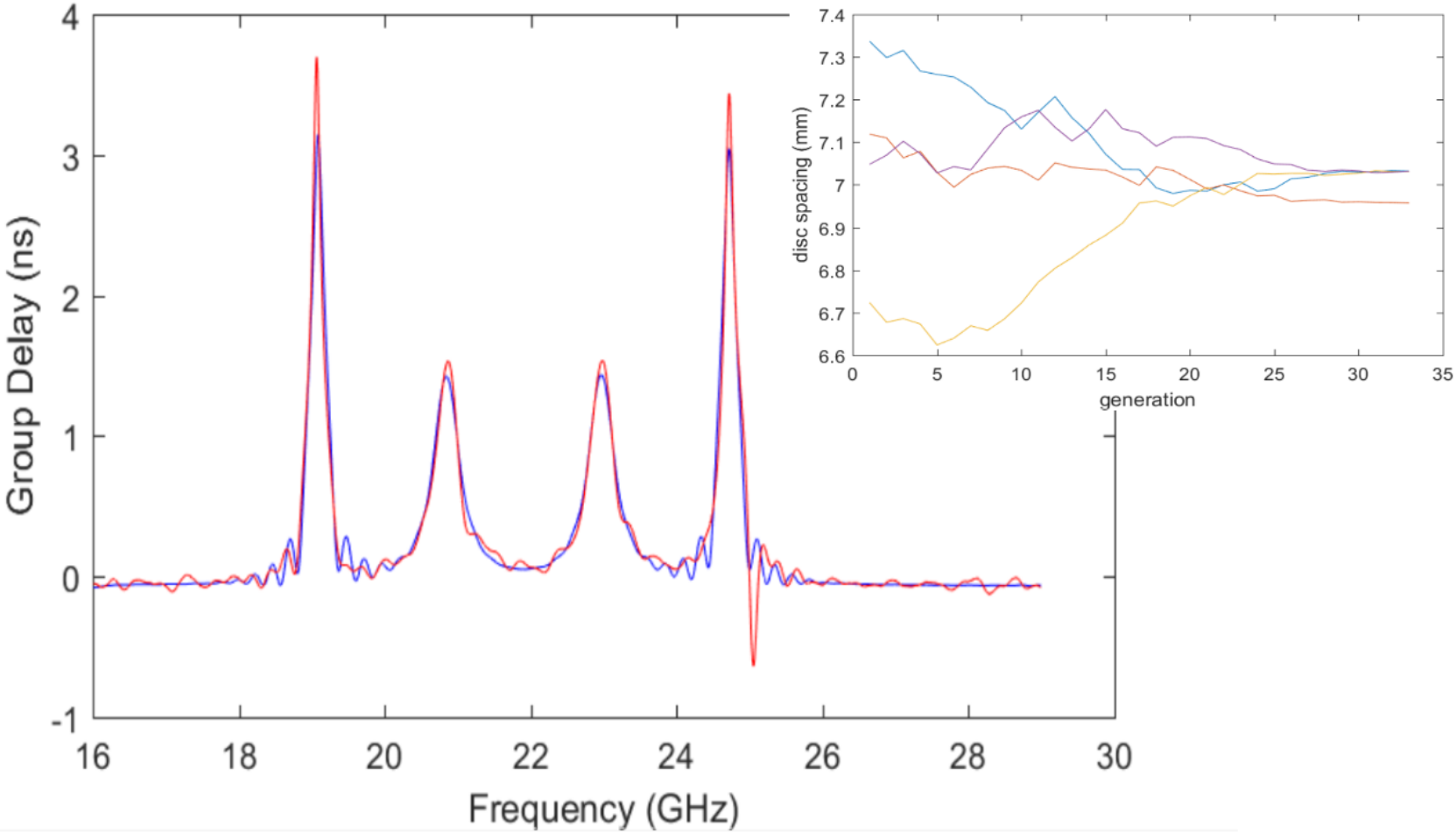
Fitting Algorithm

simulation
measurement

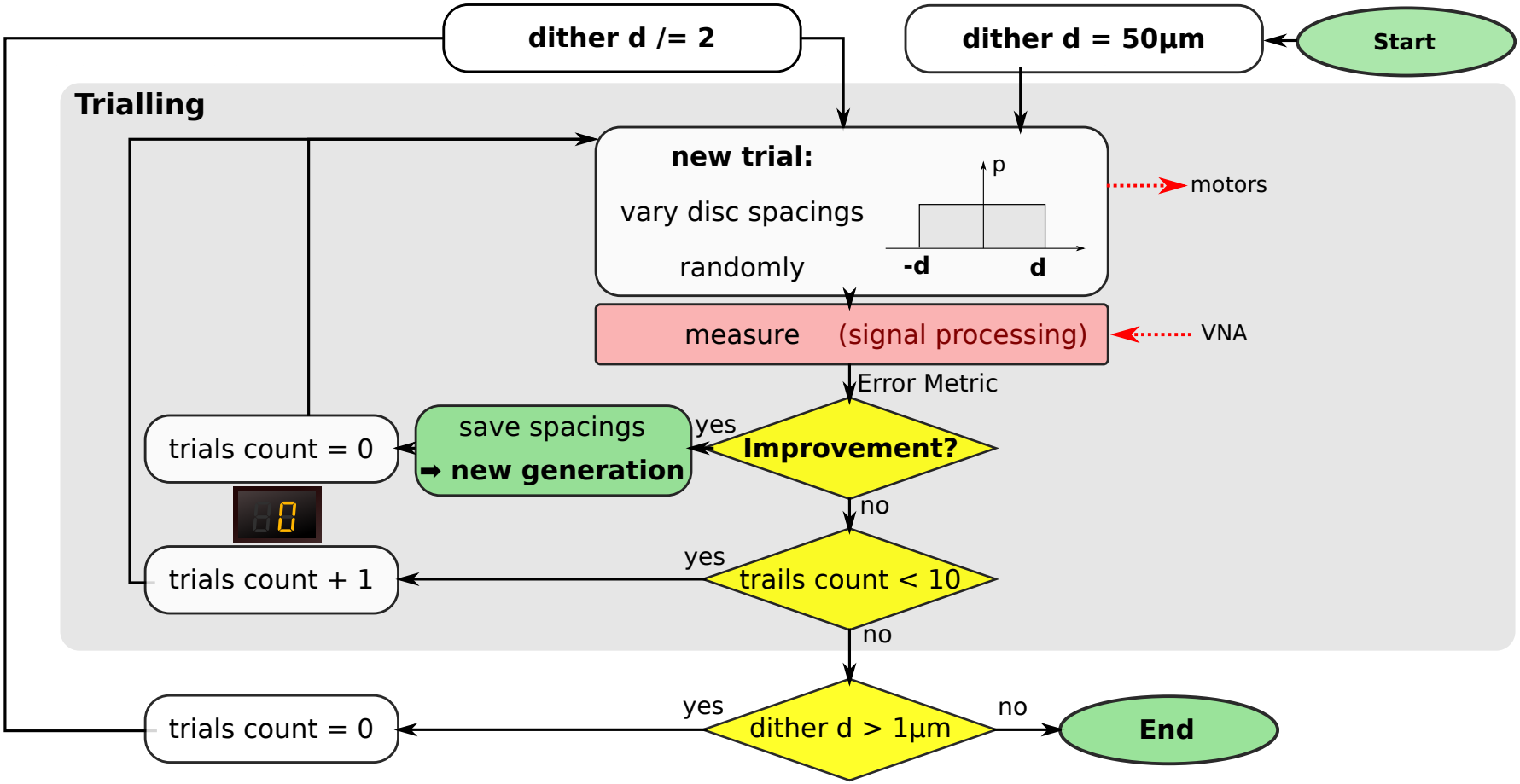


Fitting Algorithm

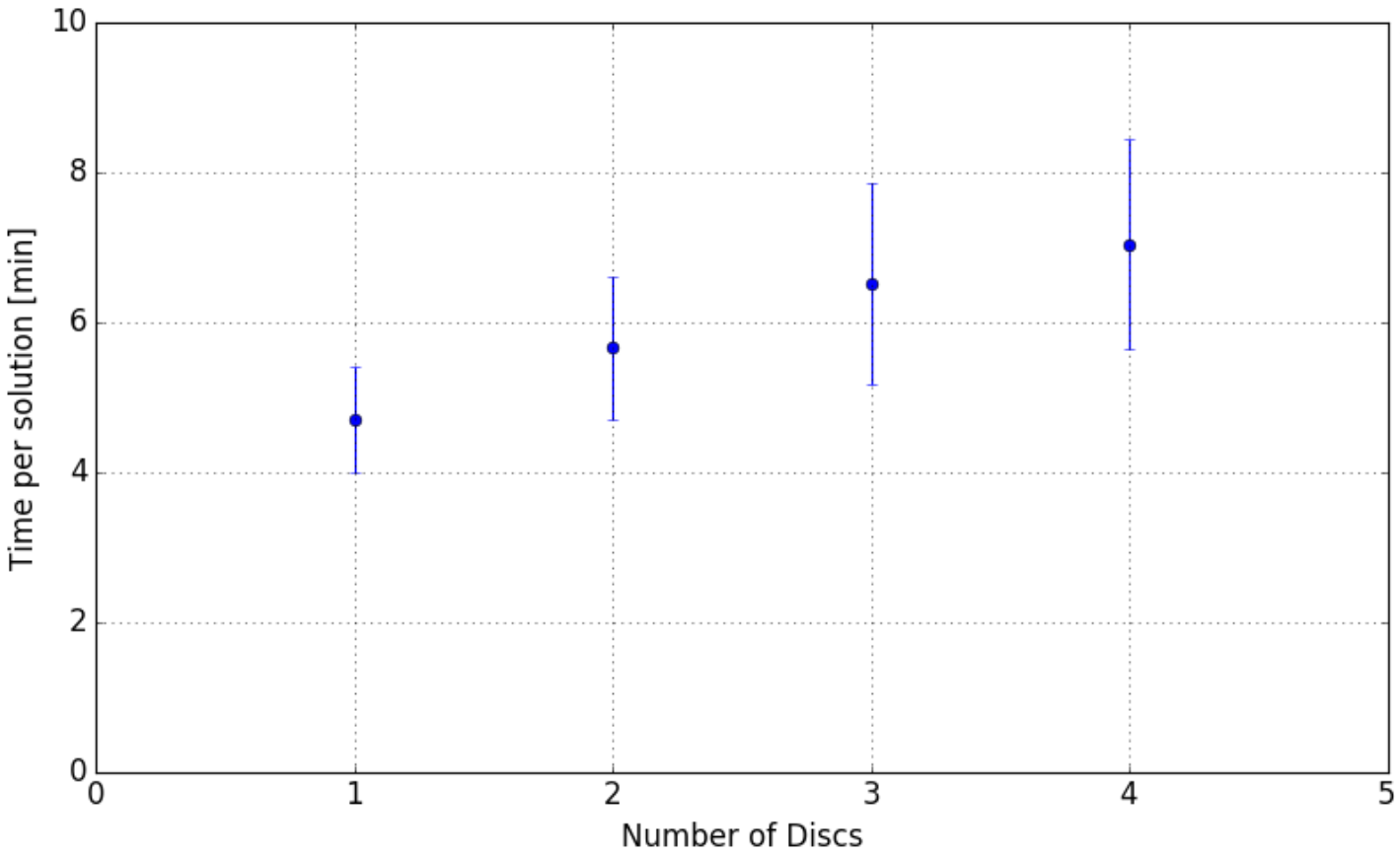
simulation
measurement



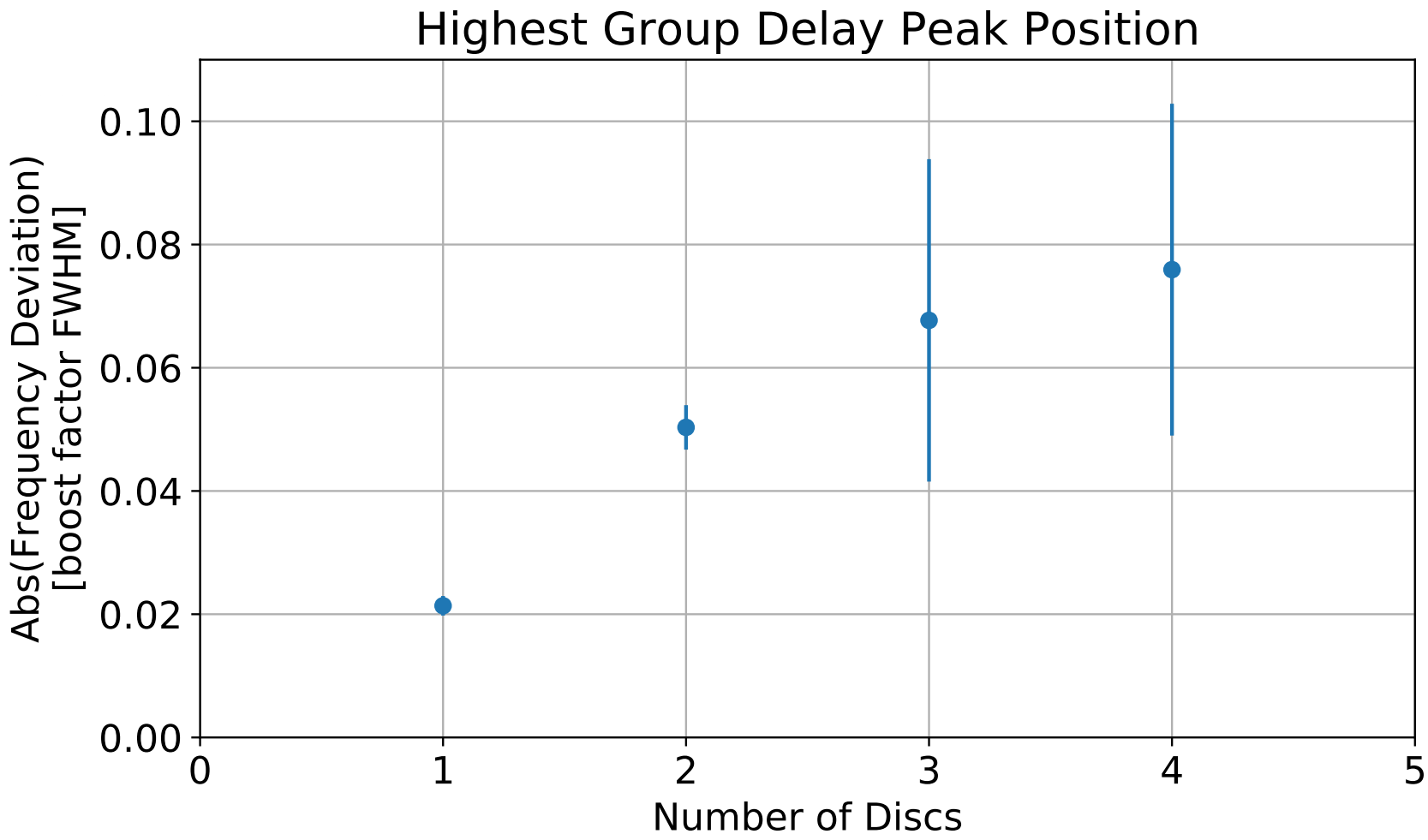
Fitting Algorithm (Basics)



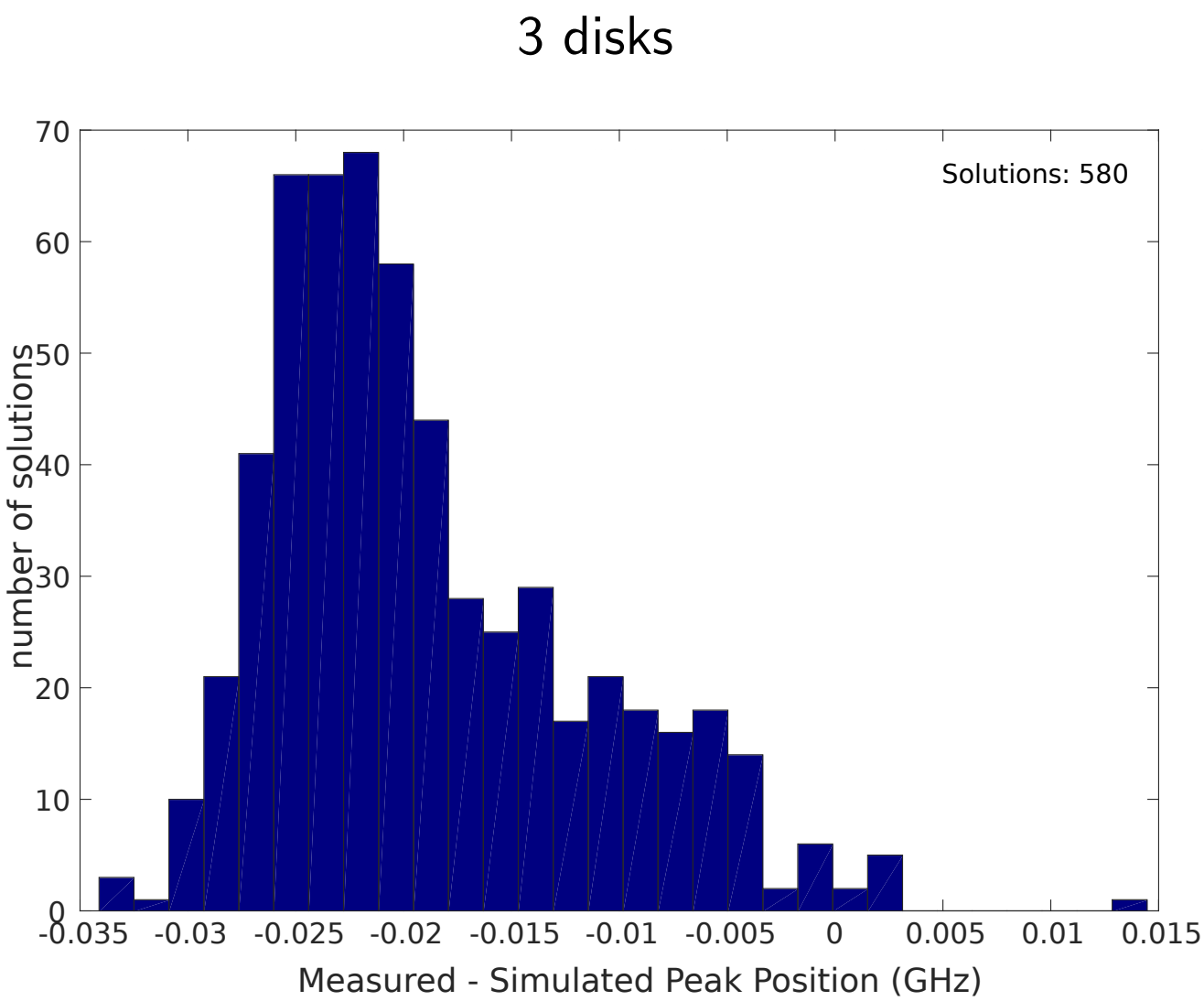
Time Scaling of Algorithm



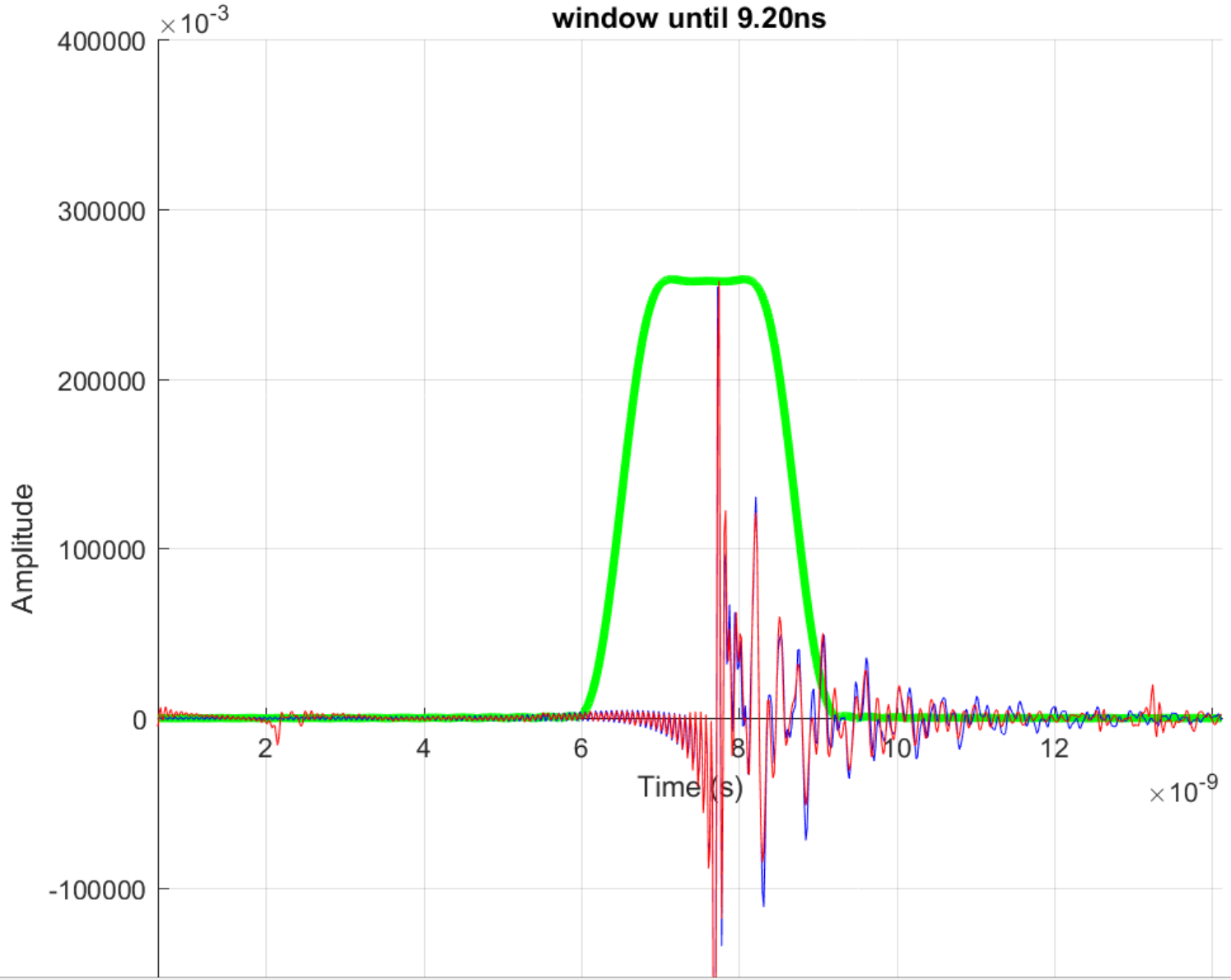
Frequency Accuracy



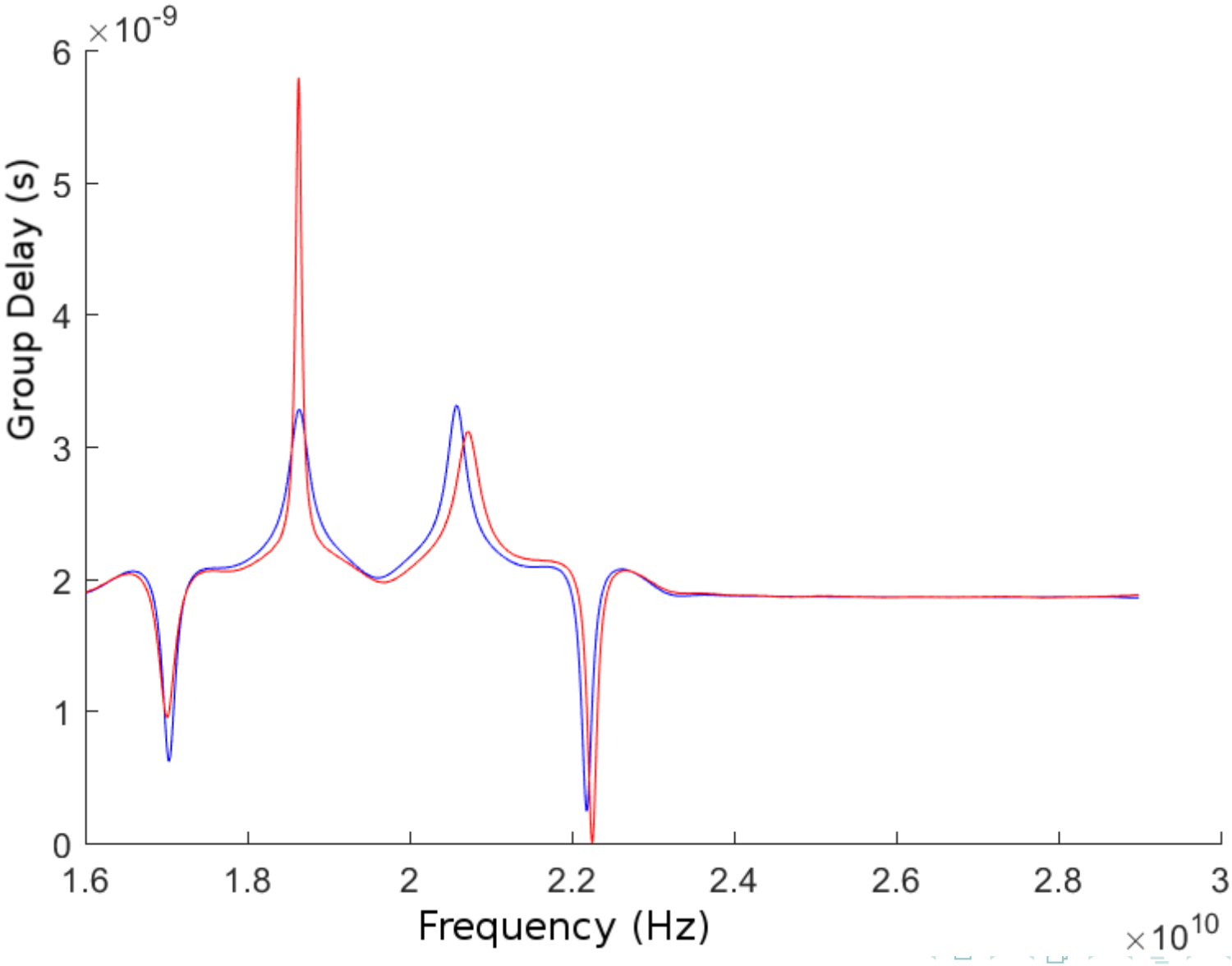
Frequency Accuracy



Time Window for Negative Group Delay

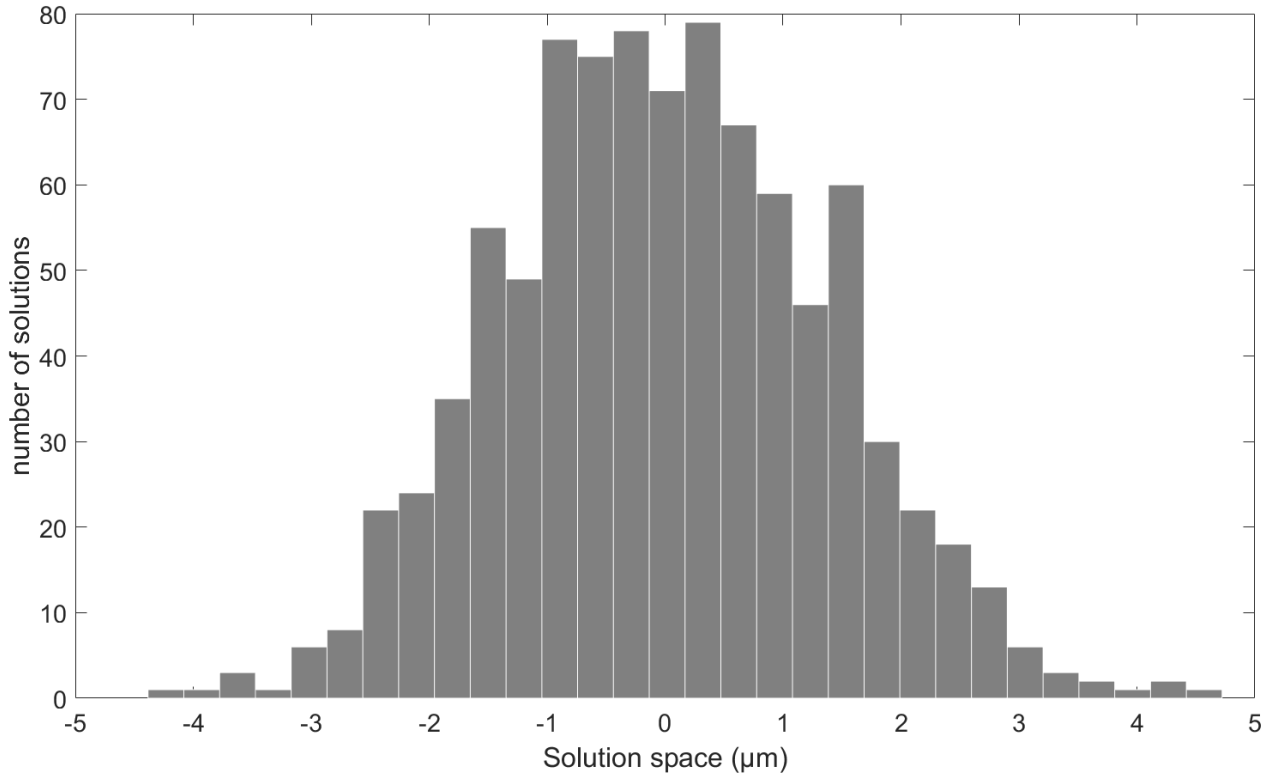


Negative Group Delay



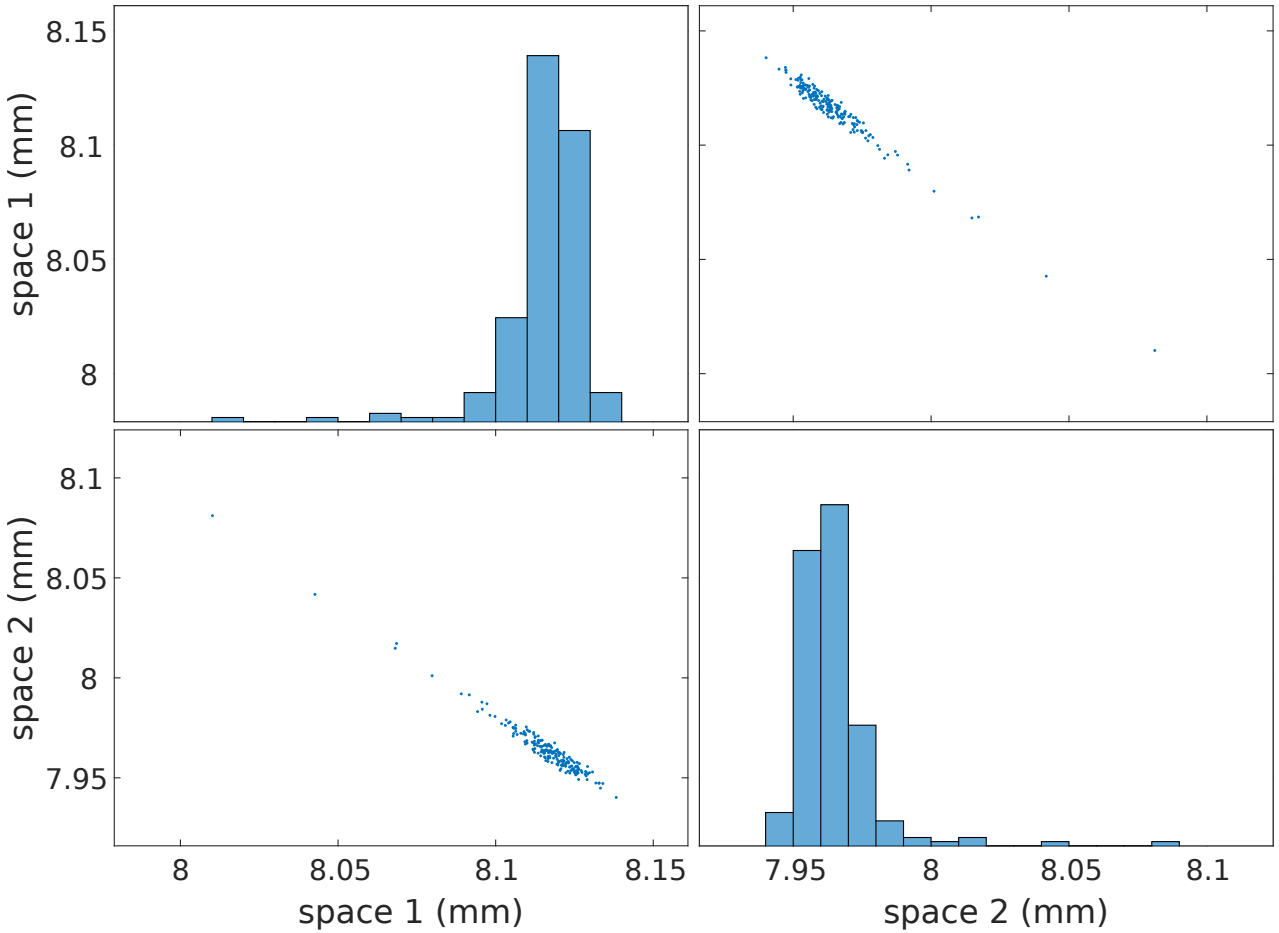
Disk Spacing Repeatability - One Disk

initial misplacement: $\pm 200\,\mu m$ *(uniform distribution)*
distance from mirror $d_1 = 8\,mm$



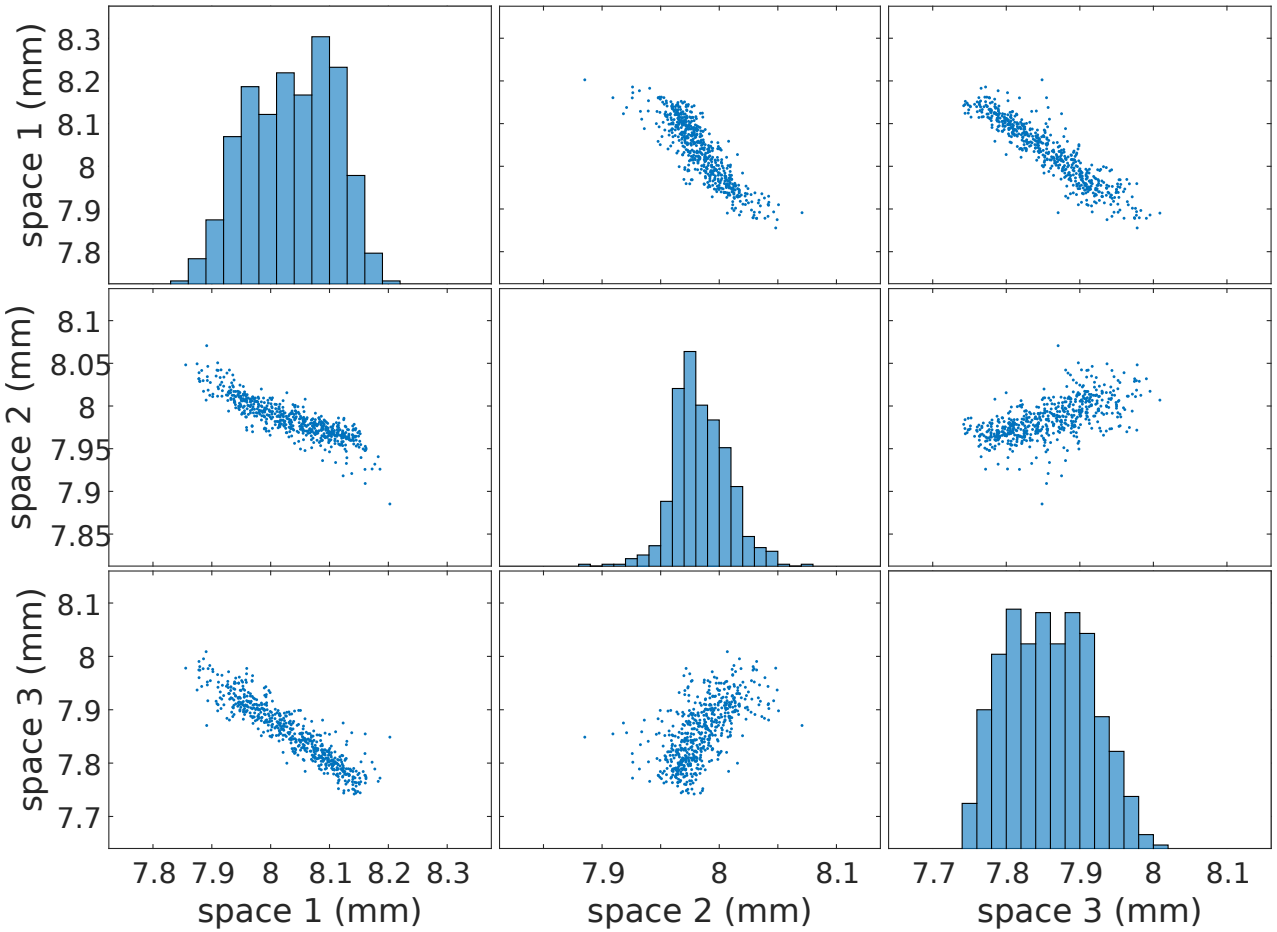
$\pm 2\,\mu m$ **reproducible**

Disk Spacing Repeatability - 2 Disks



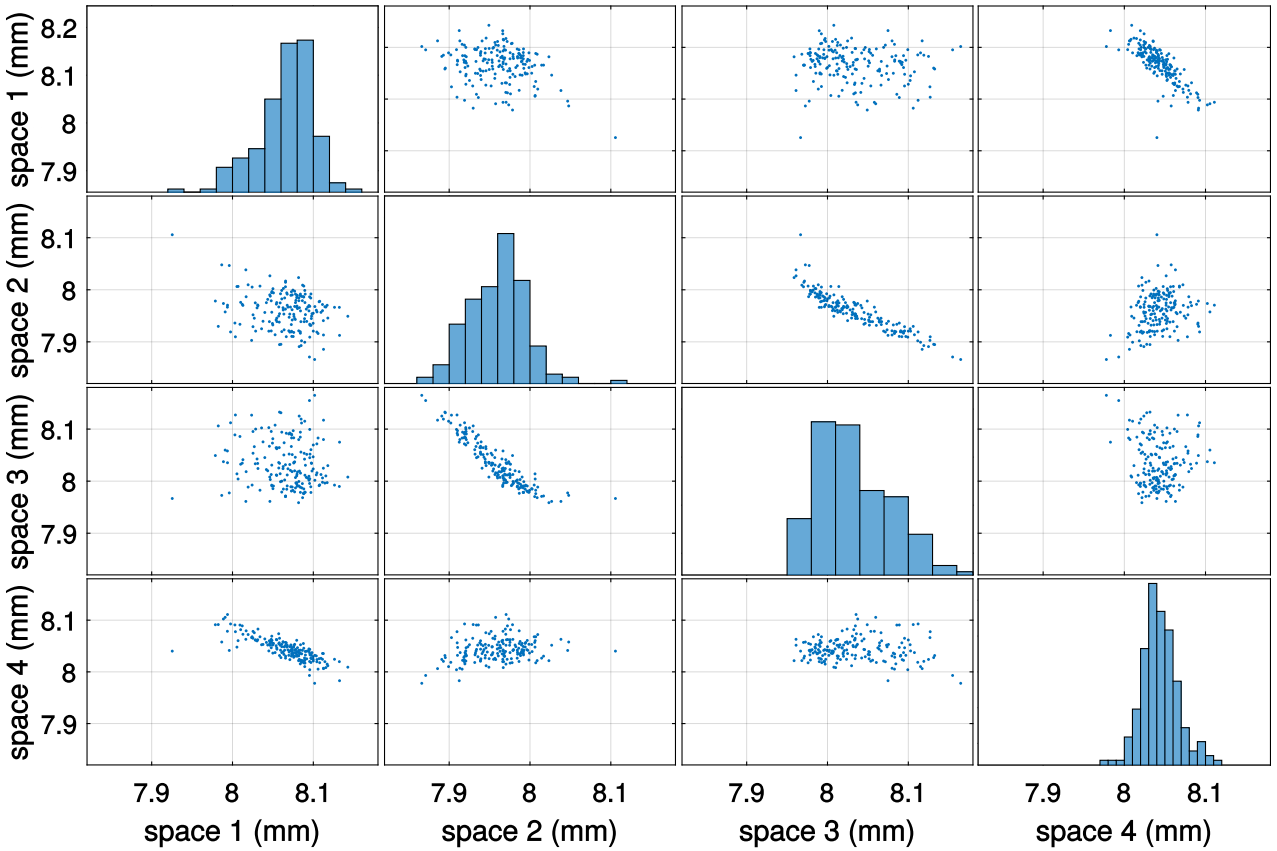
Spacings Correlated

Disk Spacing Repeatability - 3 Disks



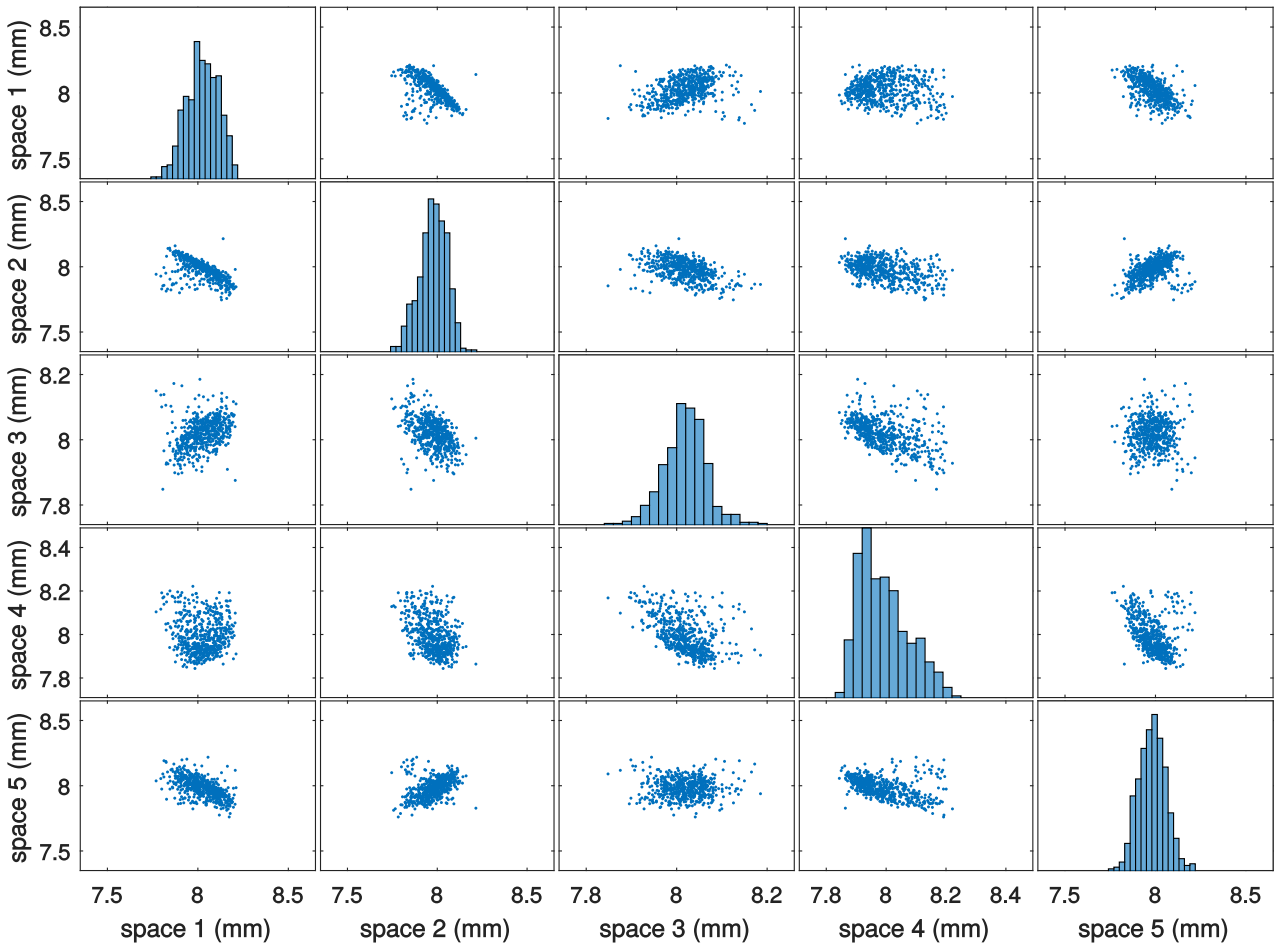
Spacings Correlated

Disk Spacing Repeatability - 4 Disks



Spacings Correlated

Disk Spacing Repeatability - 5 Disks



Spacings Correlated

Boost Factor Repeatability

for different disk number