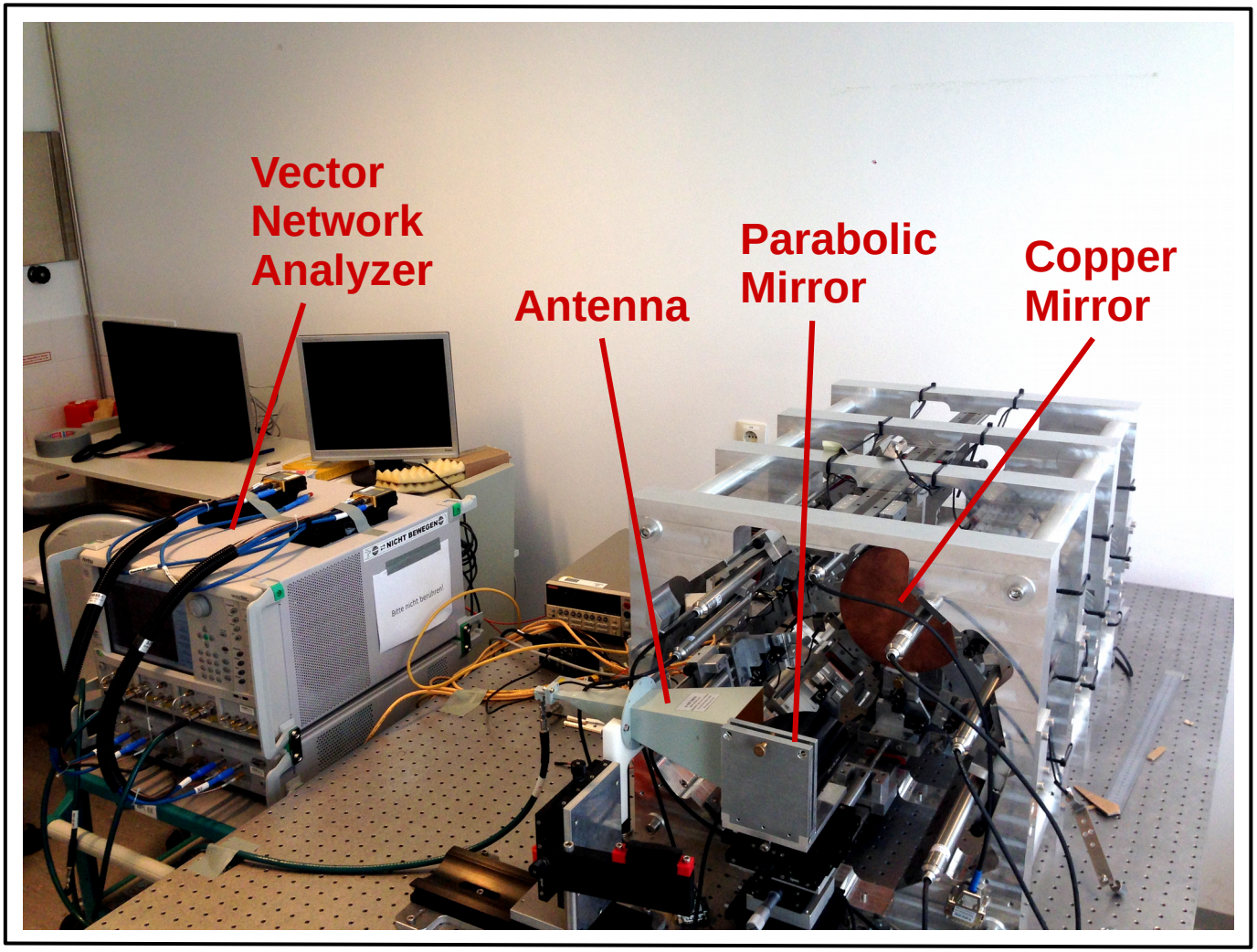
Proof of Principle Booster: Status

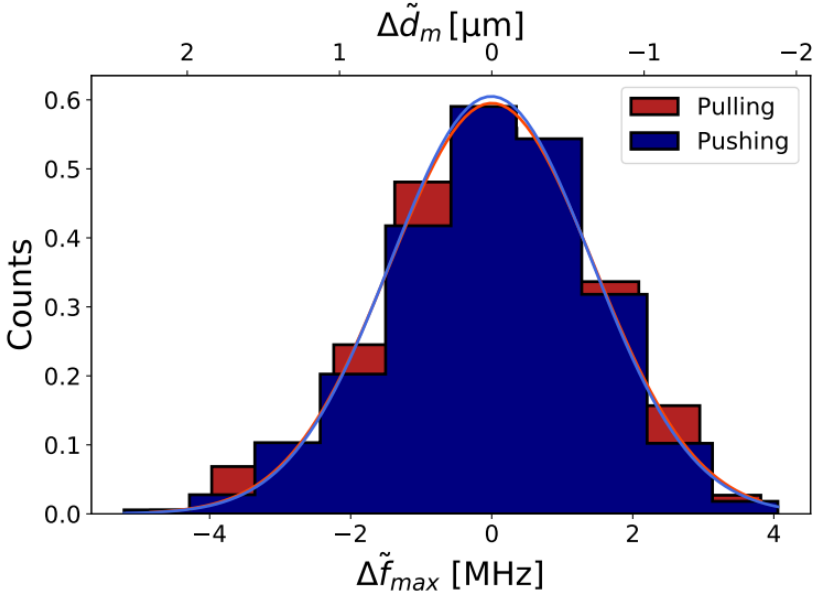
Jacob Egge

Setup


Vector
Network
Analyzer
Antenna
Parabolic
Mirror
Copper
Mirror

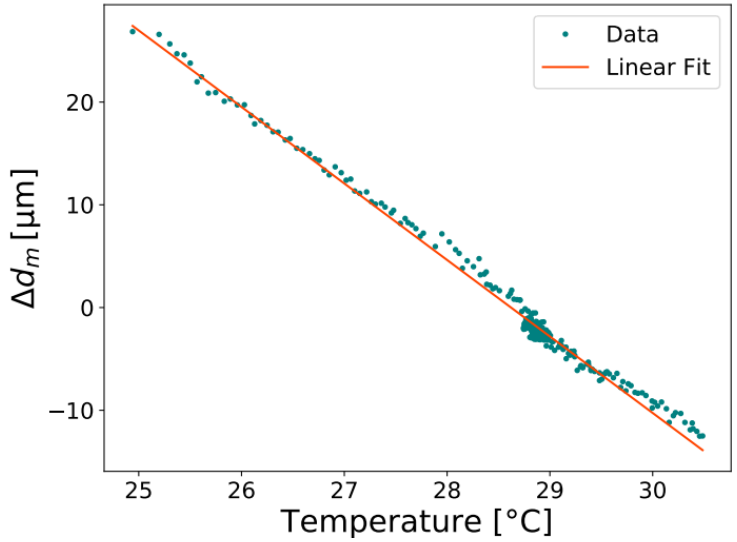
Systematic Effects - Mechanical

Mechanical Precision



$$\sigma_{mech} \approx 0.65\,\mu\mathrm{m}$$

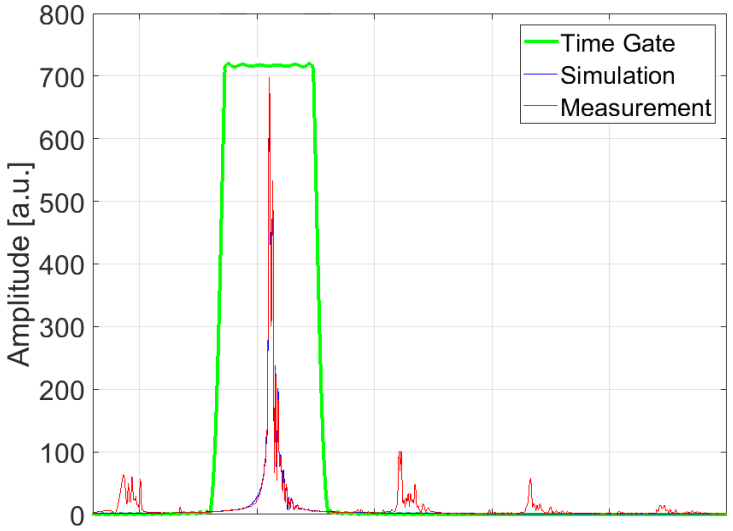
Temperature Response

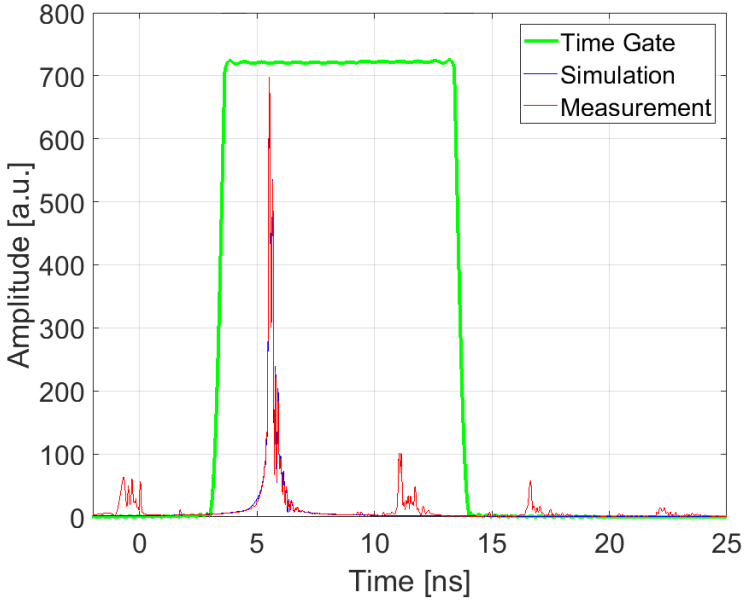


$$\Delta d_T \approx (7 \pm 2)\,\mu\mathrm{m\,K^{-1}}$$

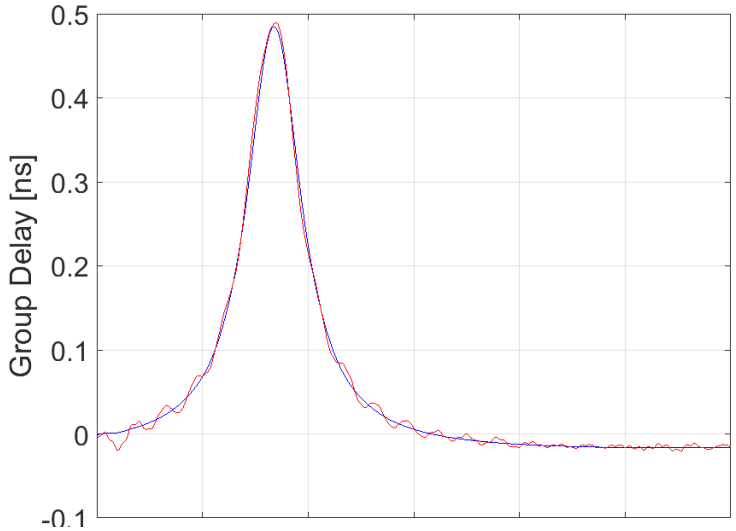
Systematic Effects - Reflections

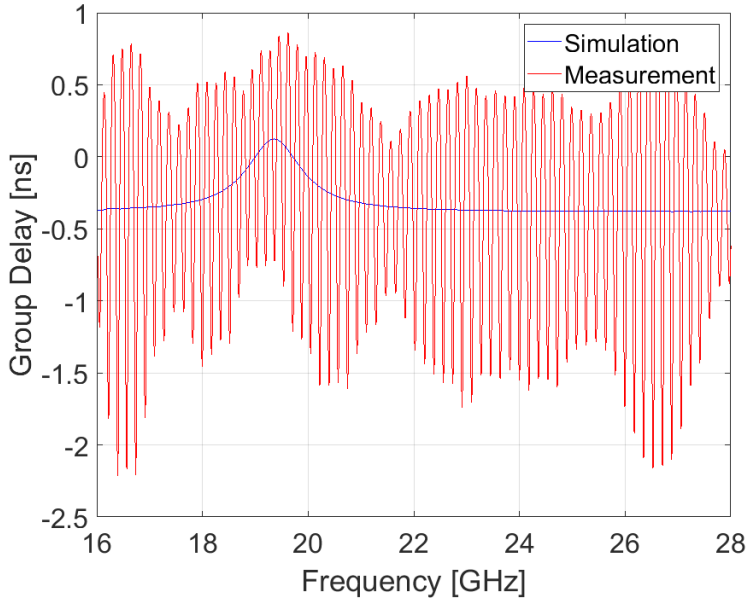
Time Domain





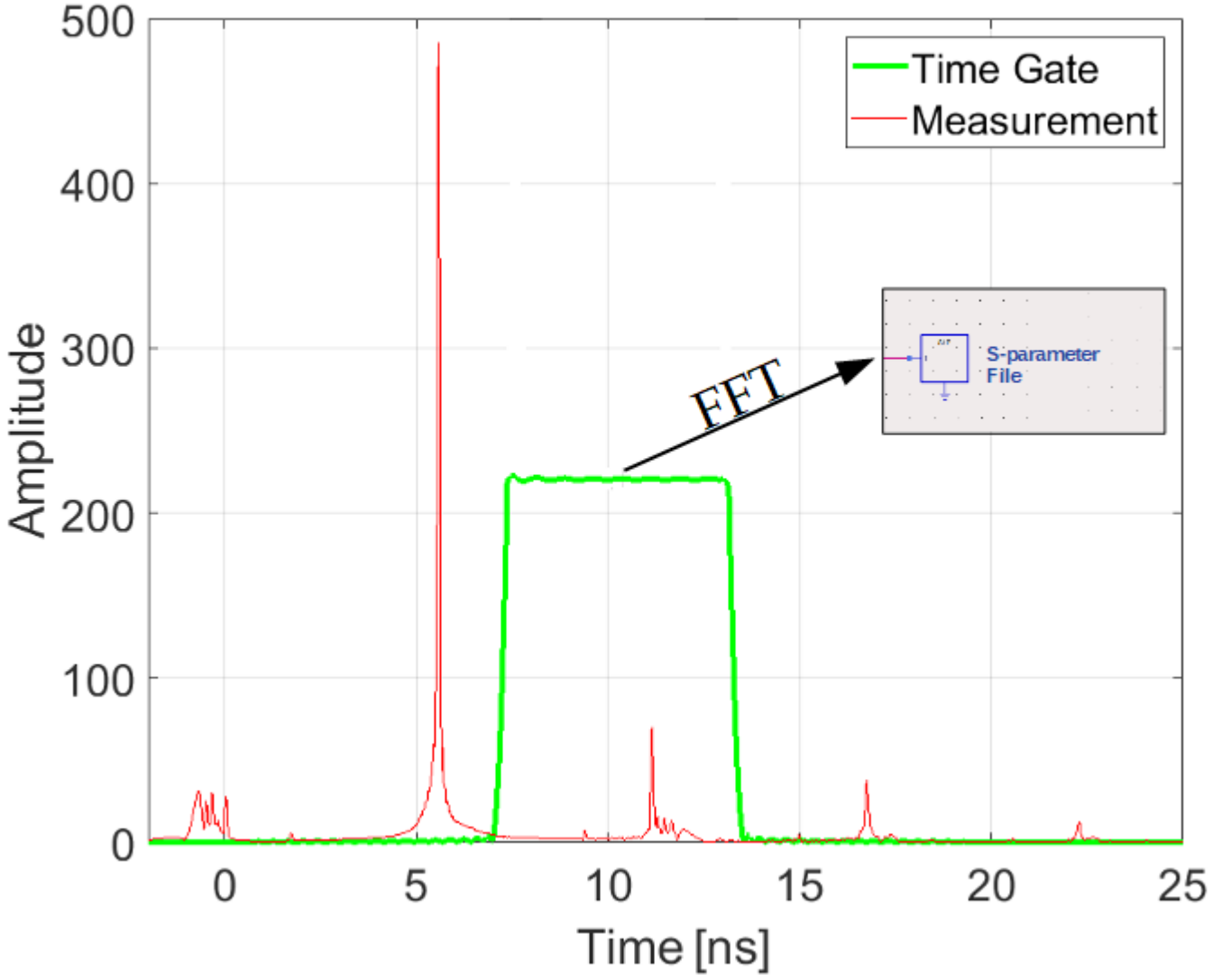
Group Delay





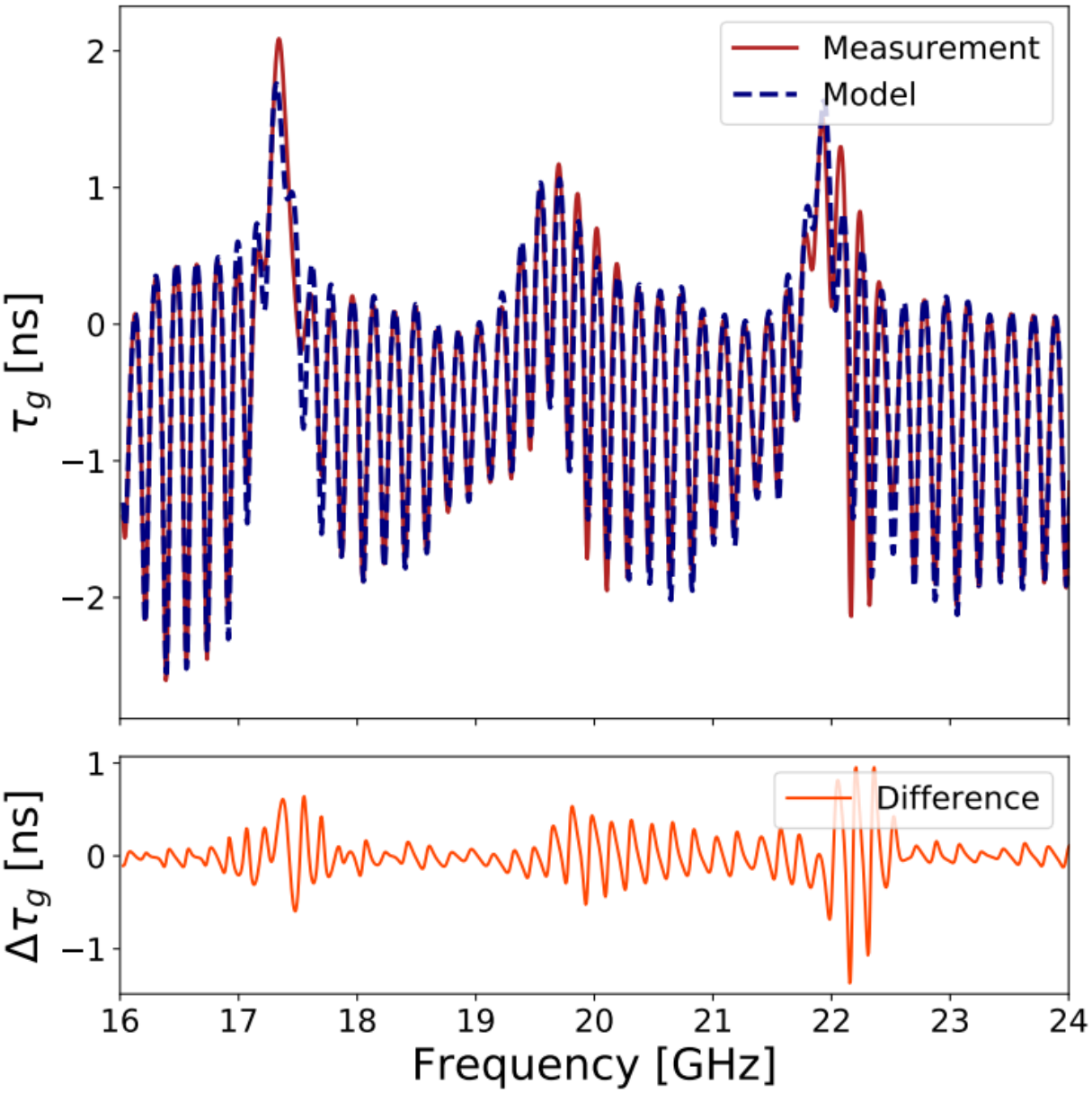
- Unwanted reflections cause ripples in group delay
- Change best fit disk distances

Systematic Effects - Reflections

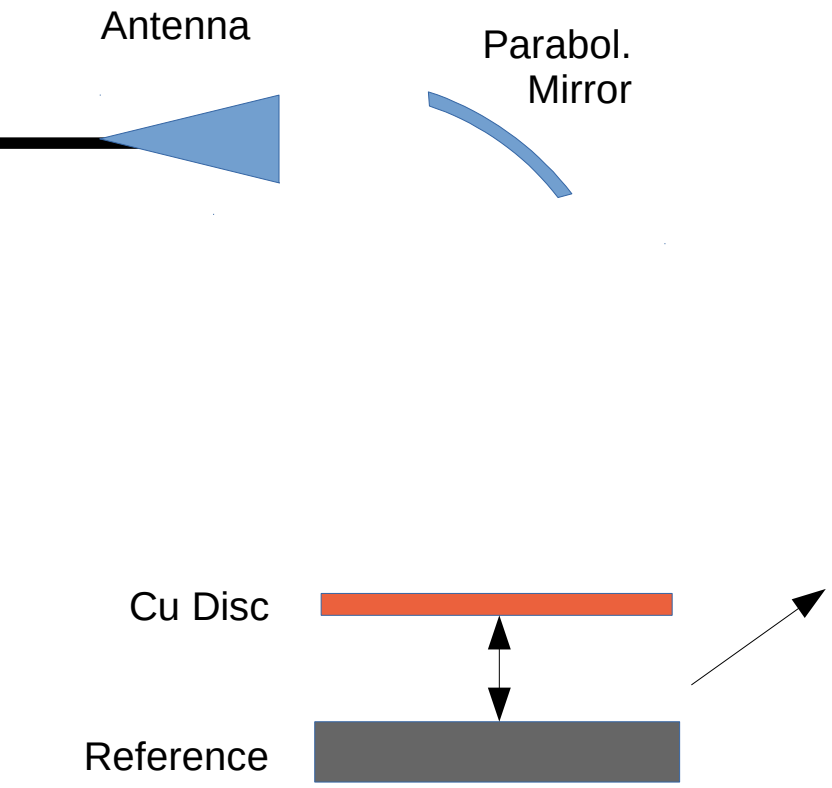


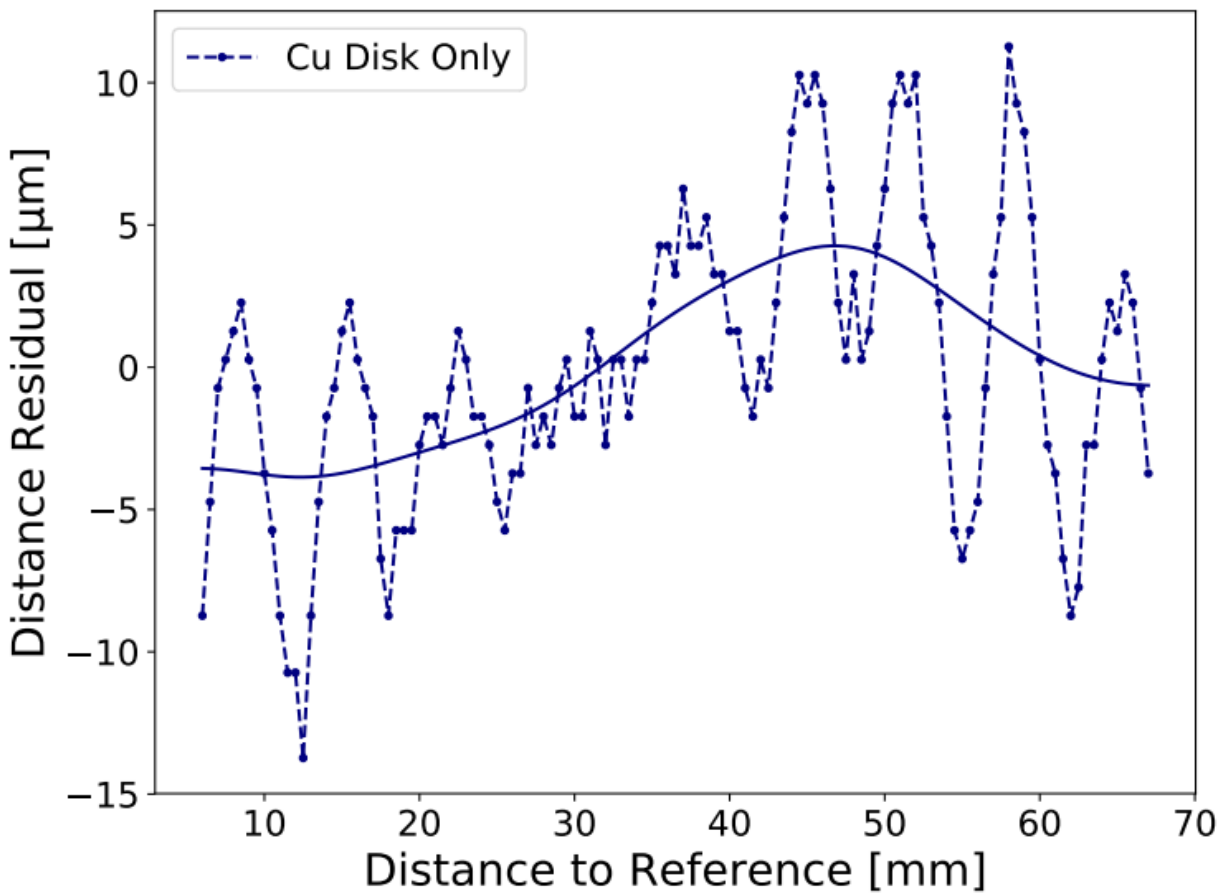
- Measure reflections S-parameters and give them to the model

Systematic Effects - Reflections

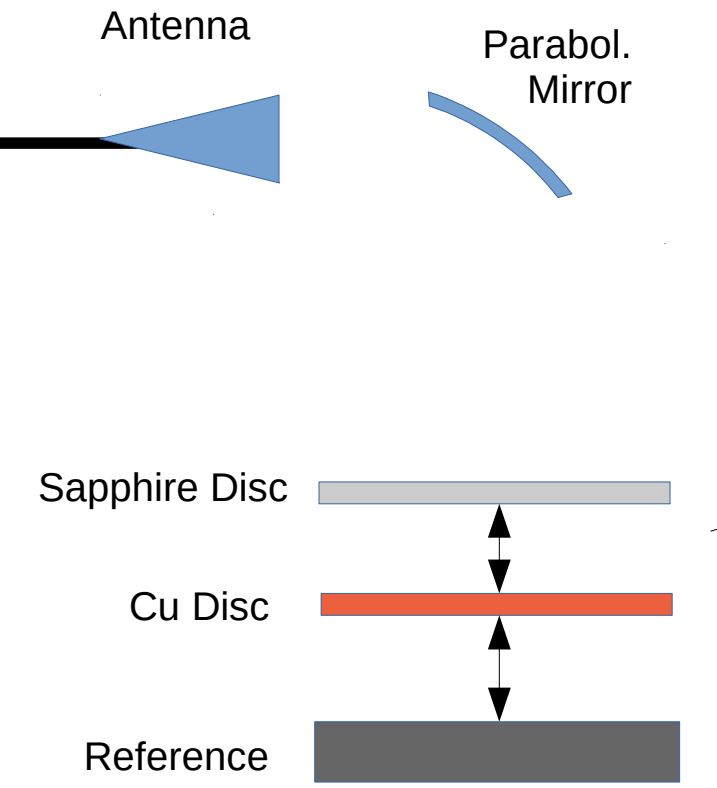


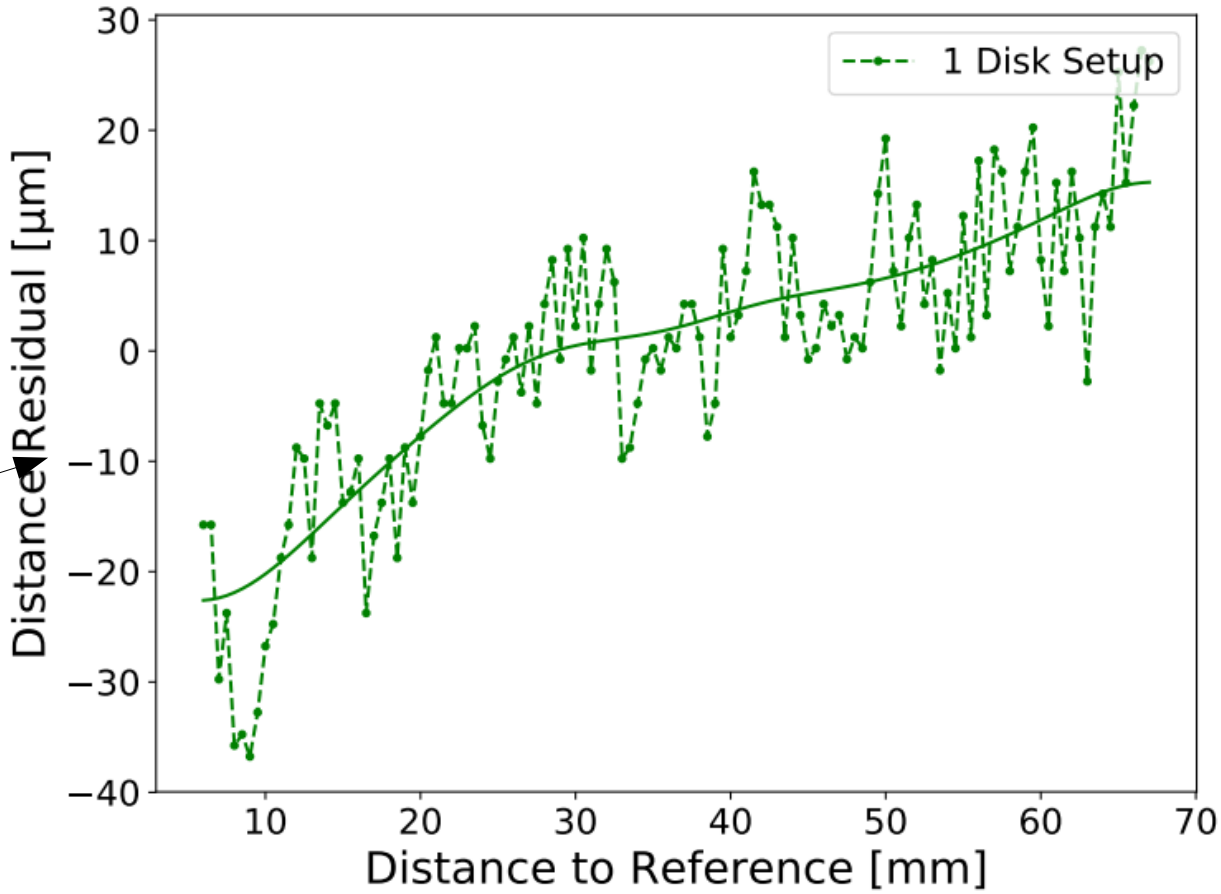
Systematic Effects - Reflections





Systematic Effects - Reflections





Systematic Effects - Reflections

Long range trend:

- Rail curvature

- Beam shape and thus unwanted reflections change over distance
- For up to 4 sapphire disks: < 3 µm/mm

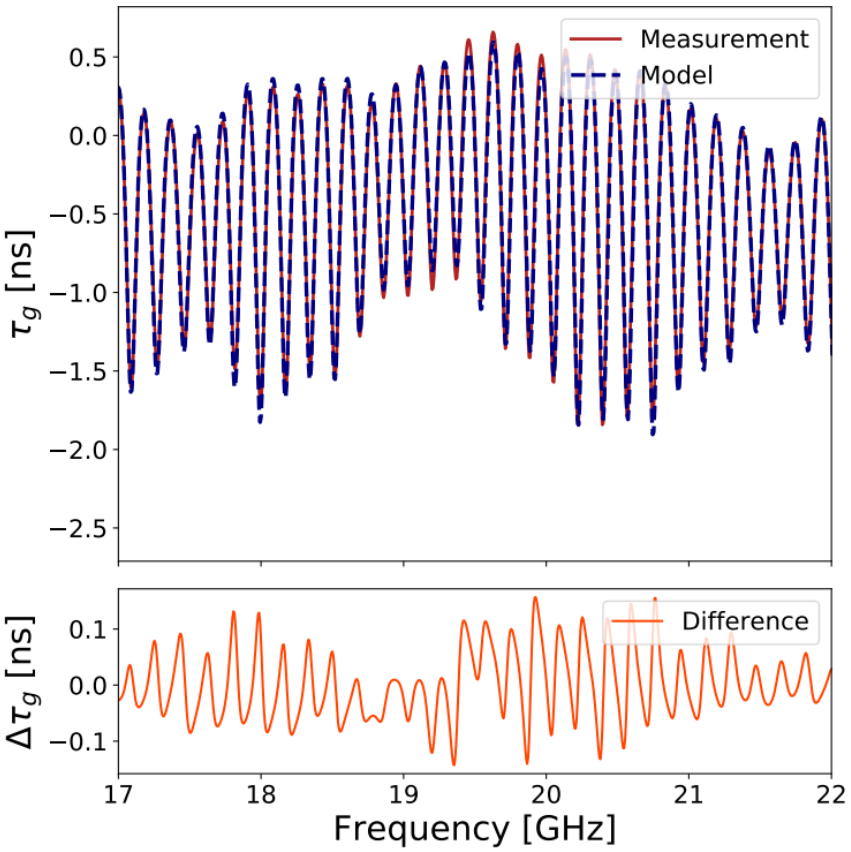
Fluctuations:

- Unmodelled reflections cause systematic oscillations

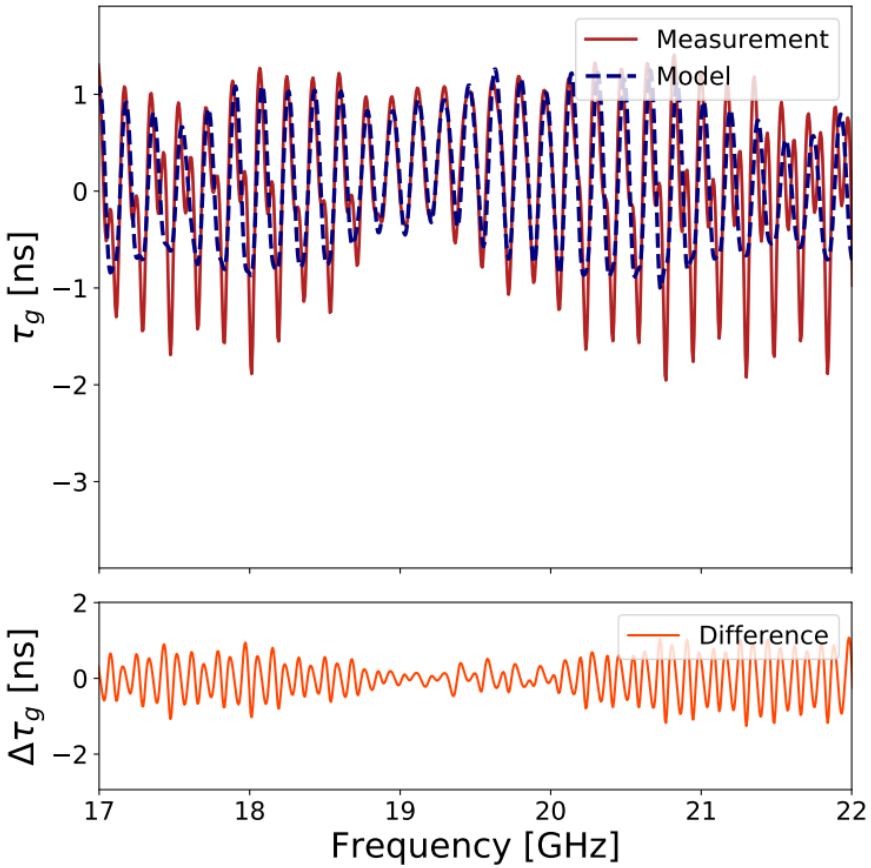
- Disk positioning precision and correlations cause statistical deviation
- For up to 4 sapphire disks: σ<17 µm

Systematic Effects – Reflections

Including first order unwanted reflections

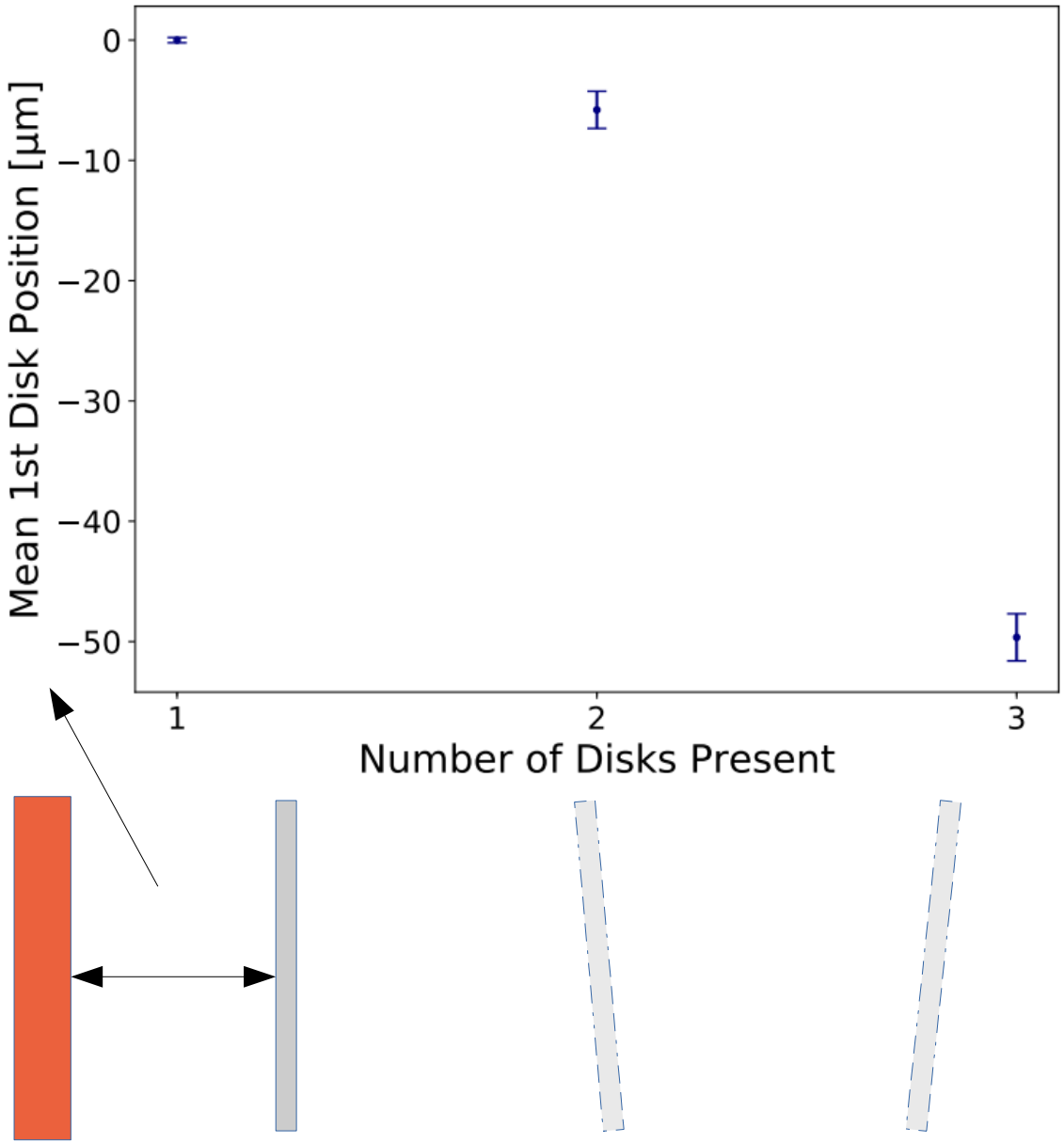


Including second order unwanted reflections



Likely cause: Beam shape changes with each order

Systematic Effects – Diffraction & Tilts



- Fitted disk position shifts with the presence of additional disks
- Additional disks increase diffraction
- Additional tilted disks change beam propagation

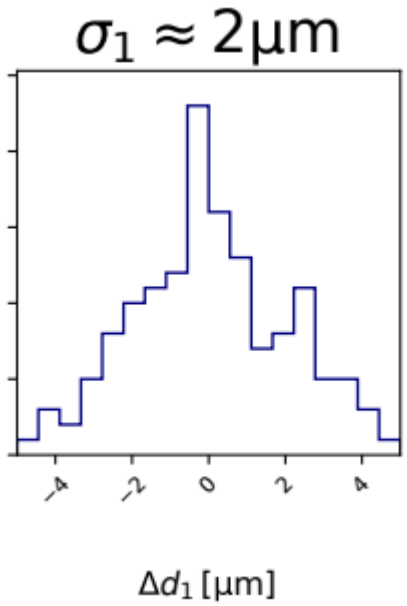
Reproducing EM Response

How well can one reproduce a desired group delay?

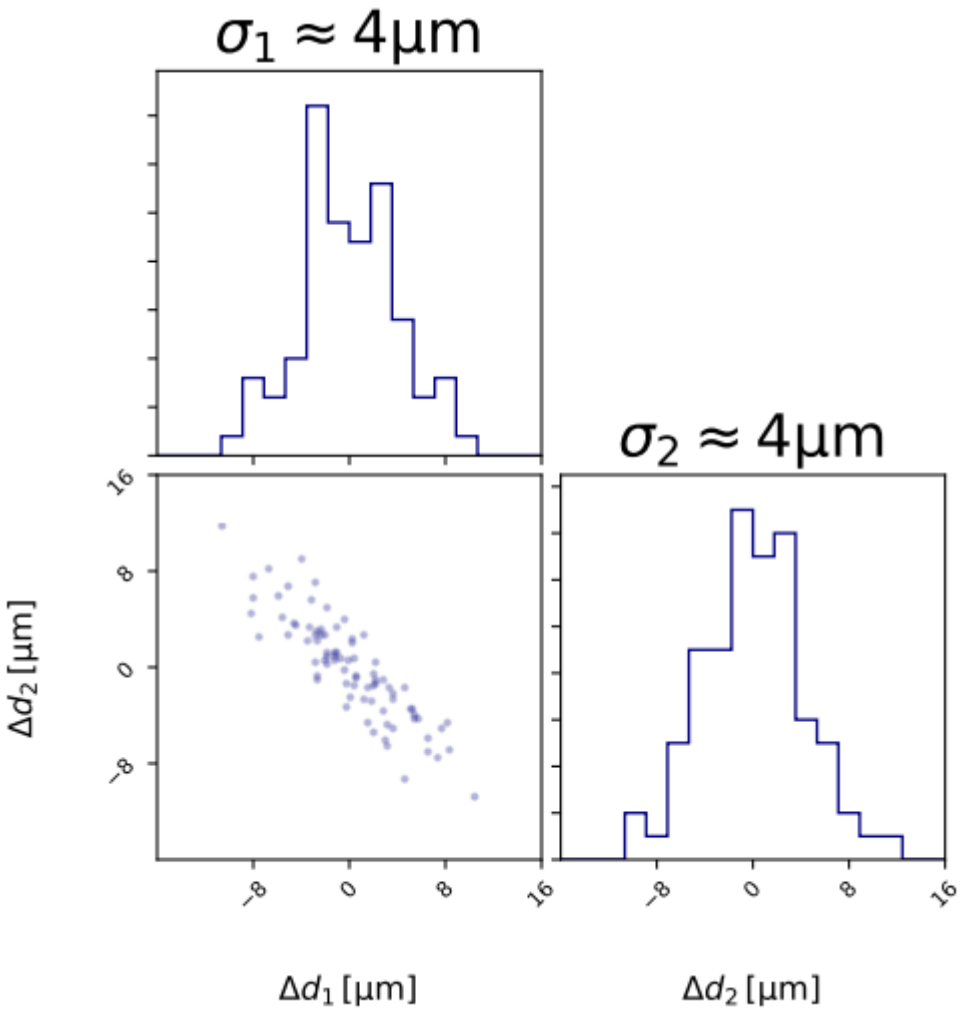
- Repeatedly adjust setup to model
- Equidistant spacings of 8mm
- Include first order unwanted reflection

Reproducing EM Response

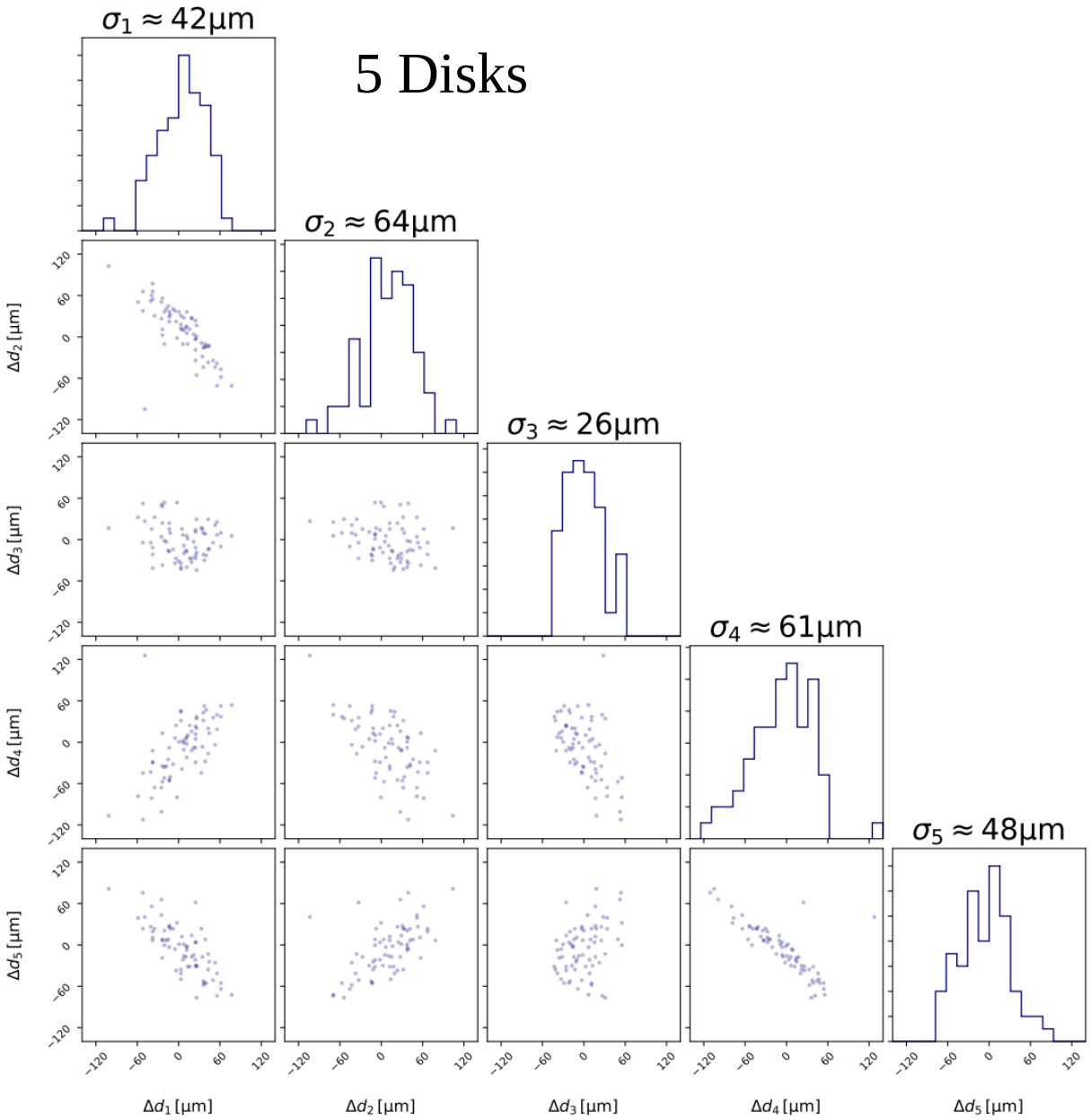
1 Disk



2 Disks

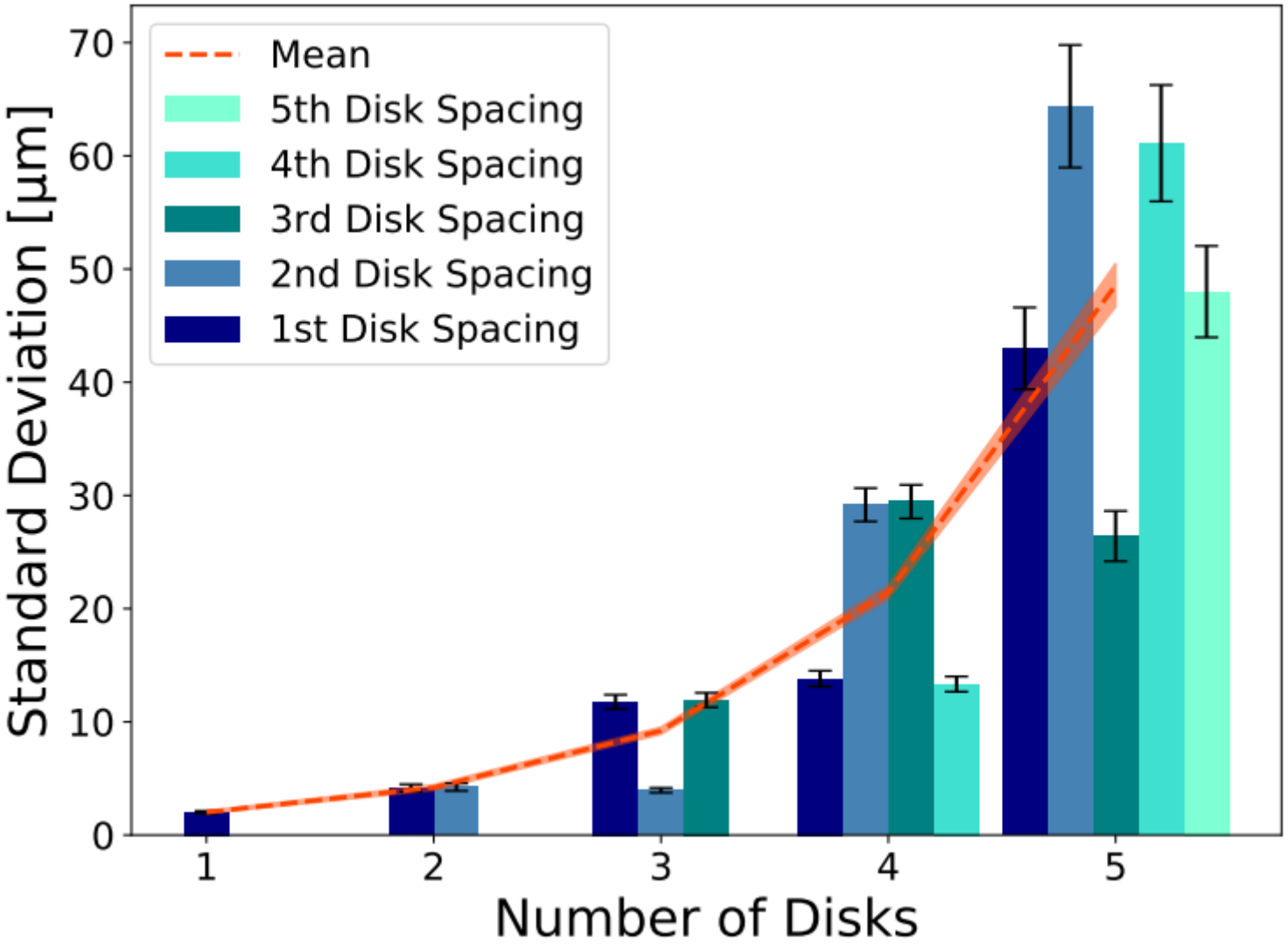


Reproducing EM Response



- Correlations between disks main contributor to deviation

Reproducing EM Response

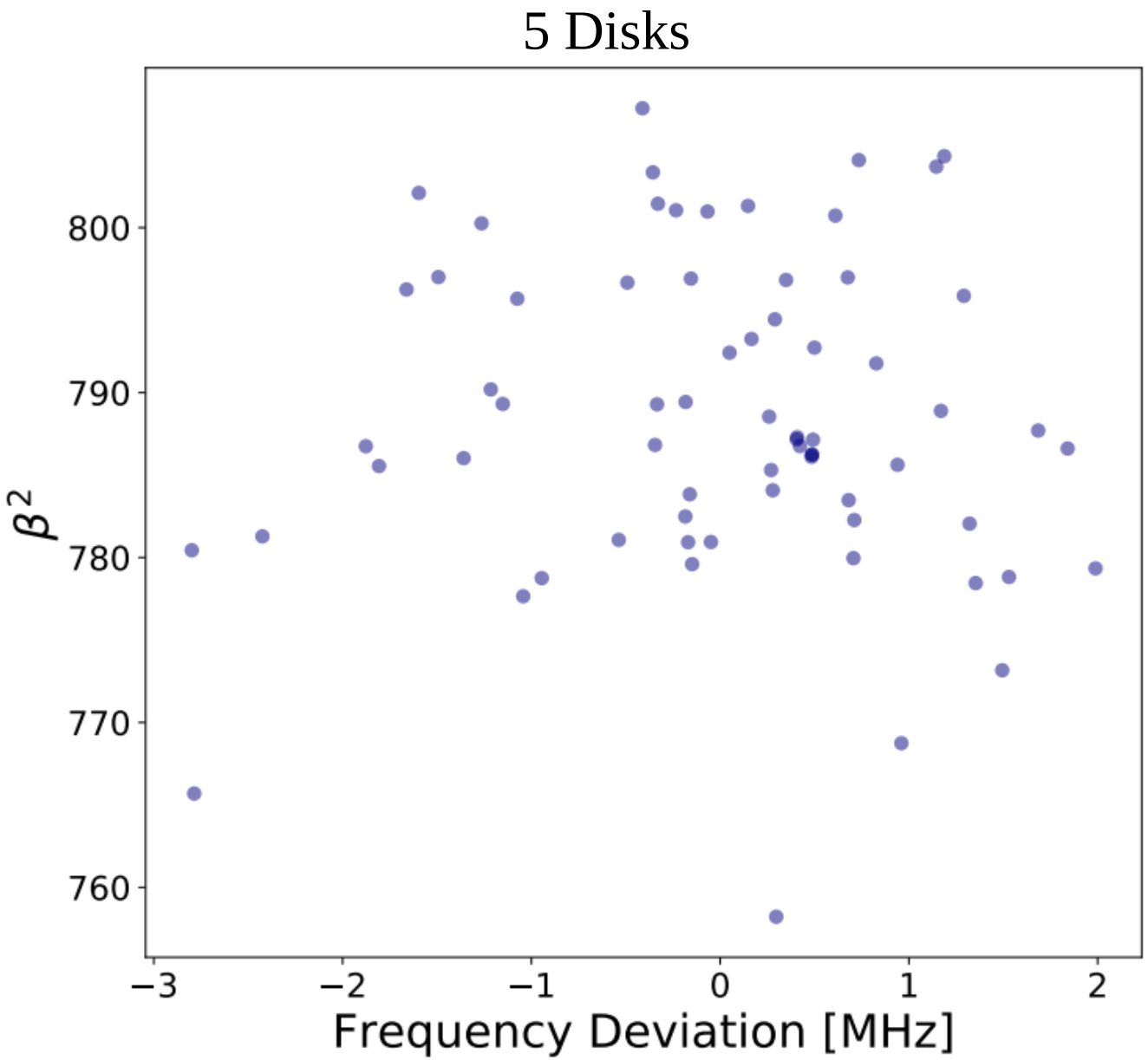


→ Exponential growth

Reproducing EM Response

- Correlations between disks
- Different spacings produce similar EM response
- Effect on boost factor?
  → Fit model to each previously adjusted setup

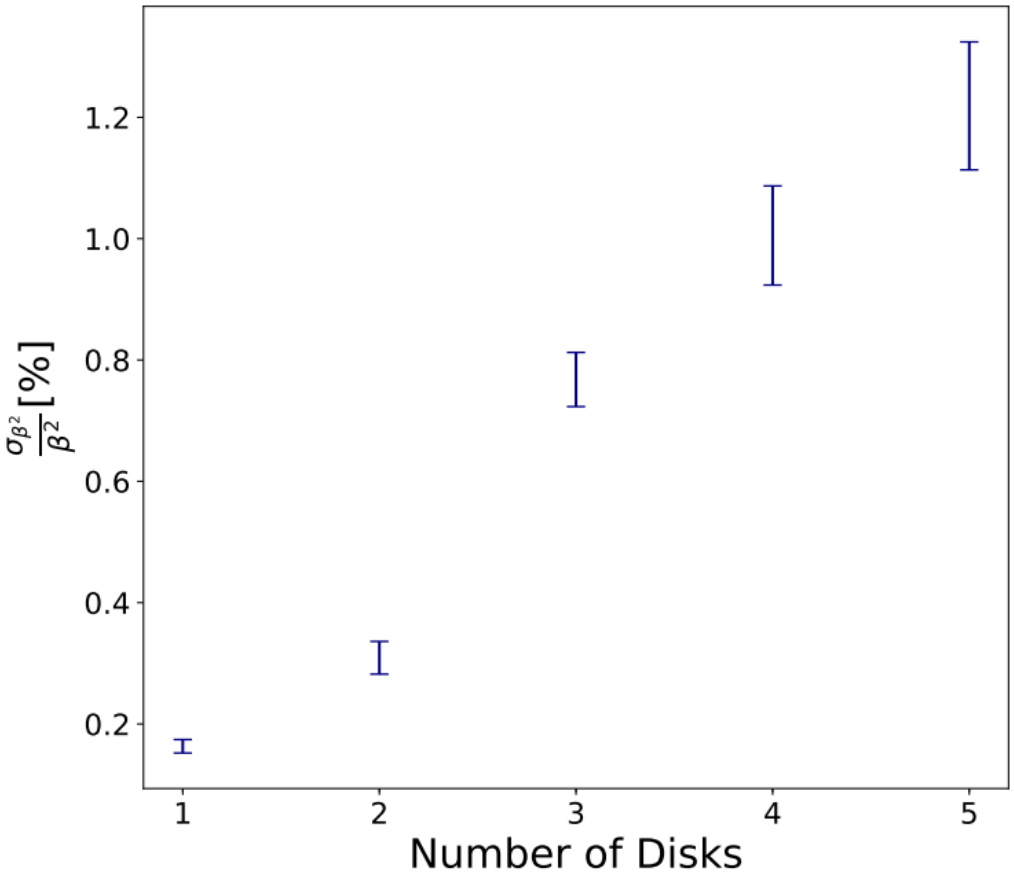
Reproducing EM Response



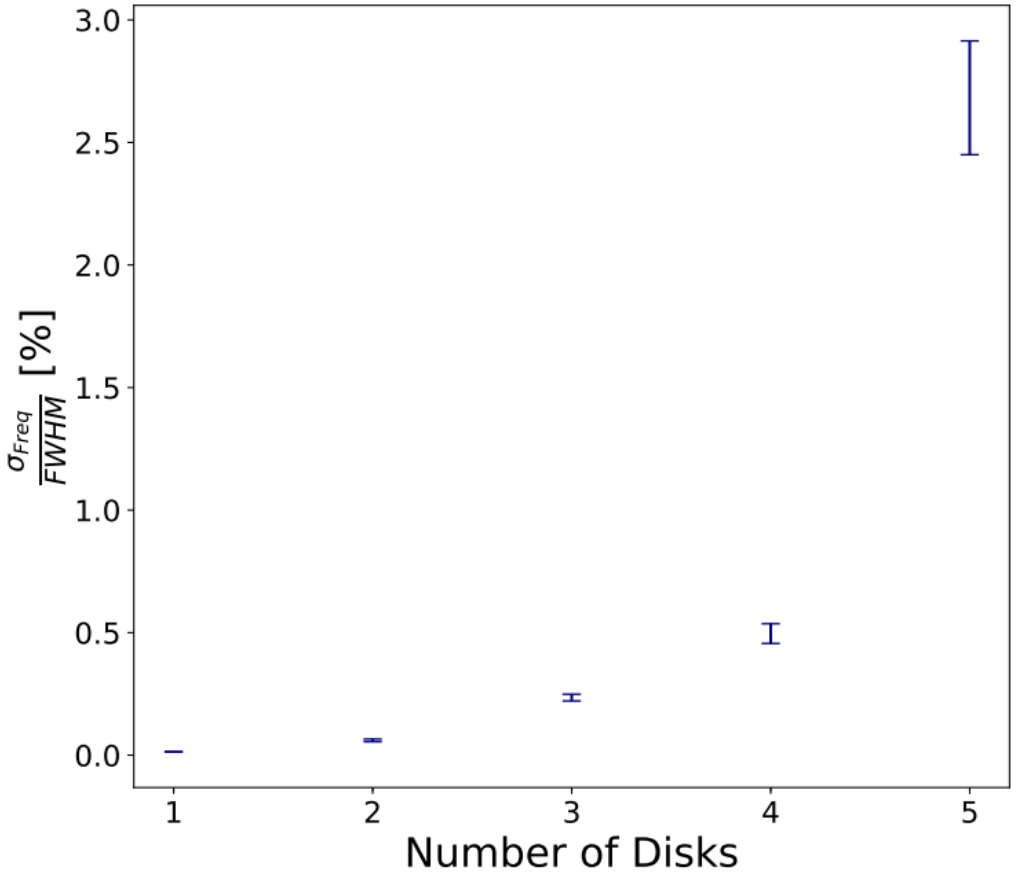
- Deviation in frequency and amplitude

Reproducing EM Response

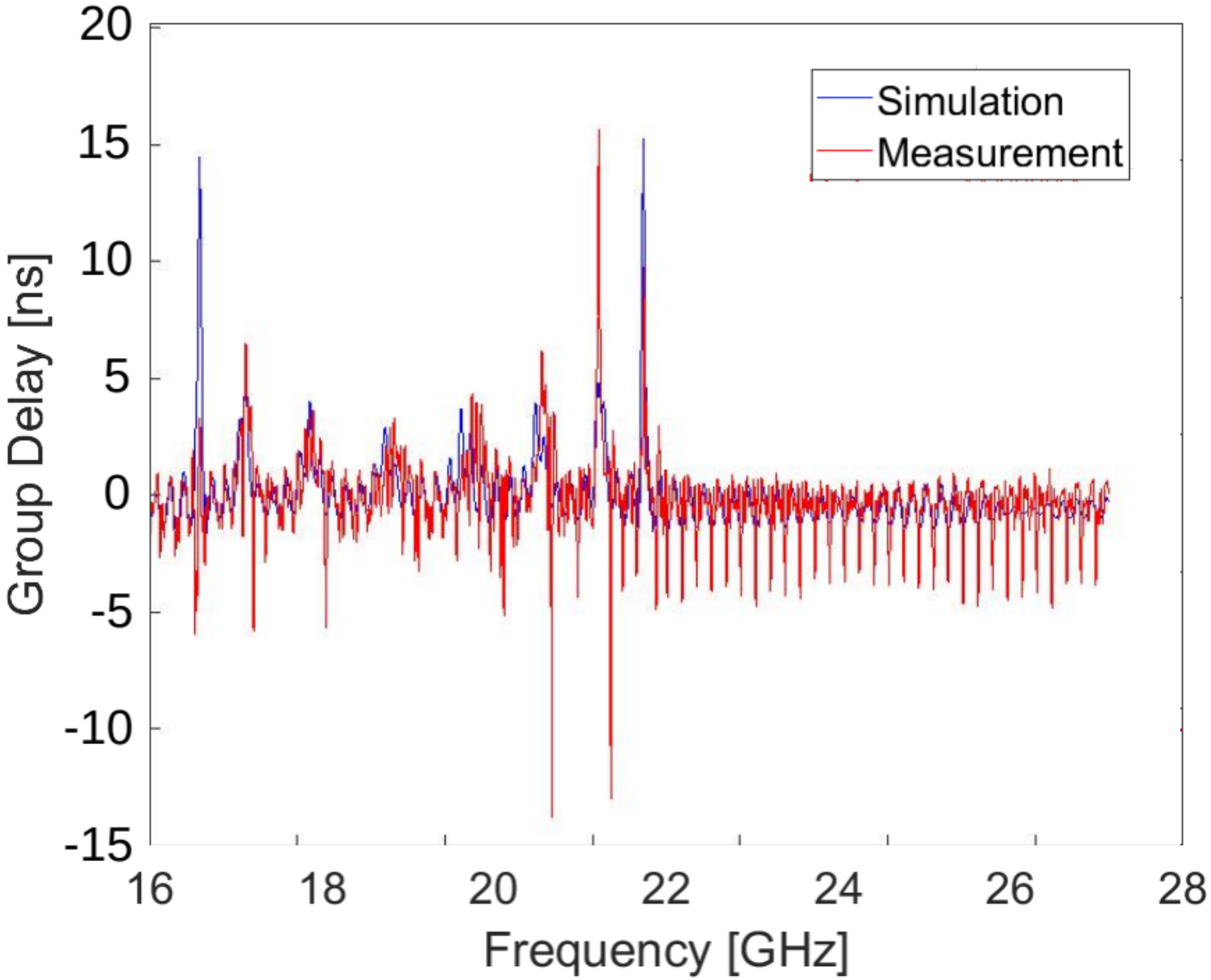
Relative Amplitude Deviation



Relative Frequency Deviation



Reproducing EM Response



- Tilts introduce losses
- Higher order reflections poorly modelled

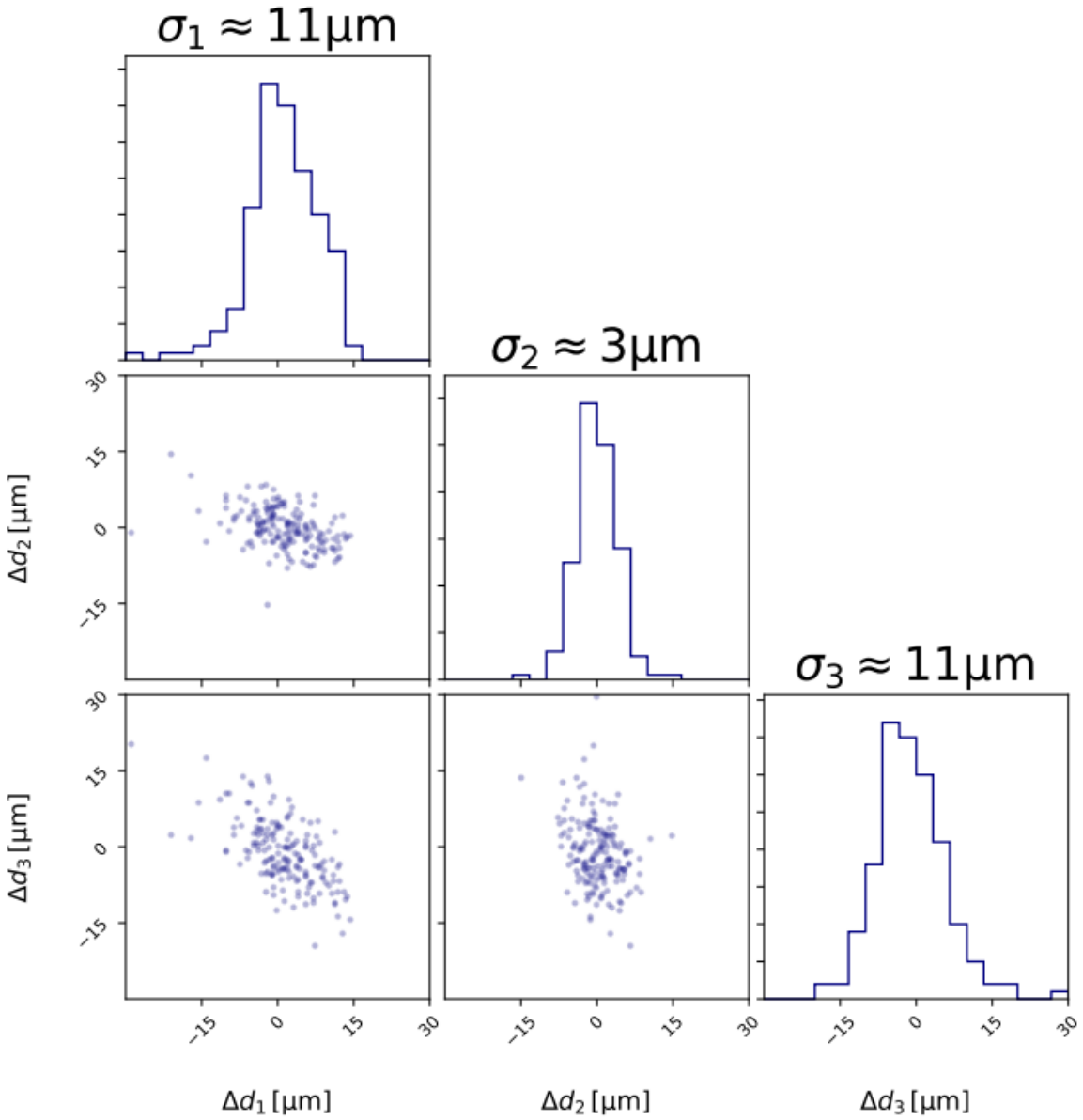
Conclusion

- µm disk positioning
- First order reflections can be modelled
  → still: long range trend and oscillations
- Diffraction and disk tilts likely cause shifts

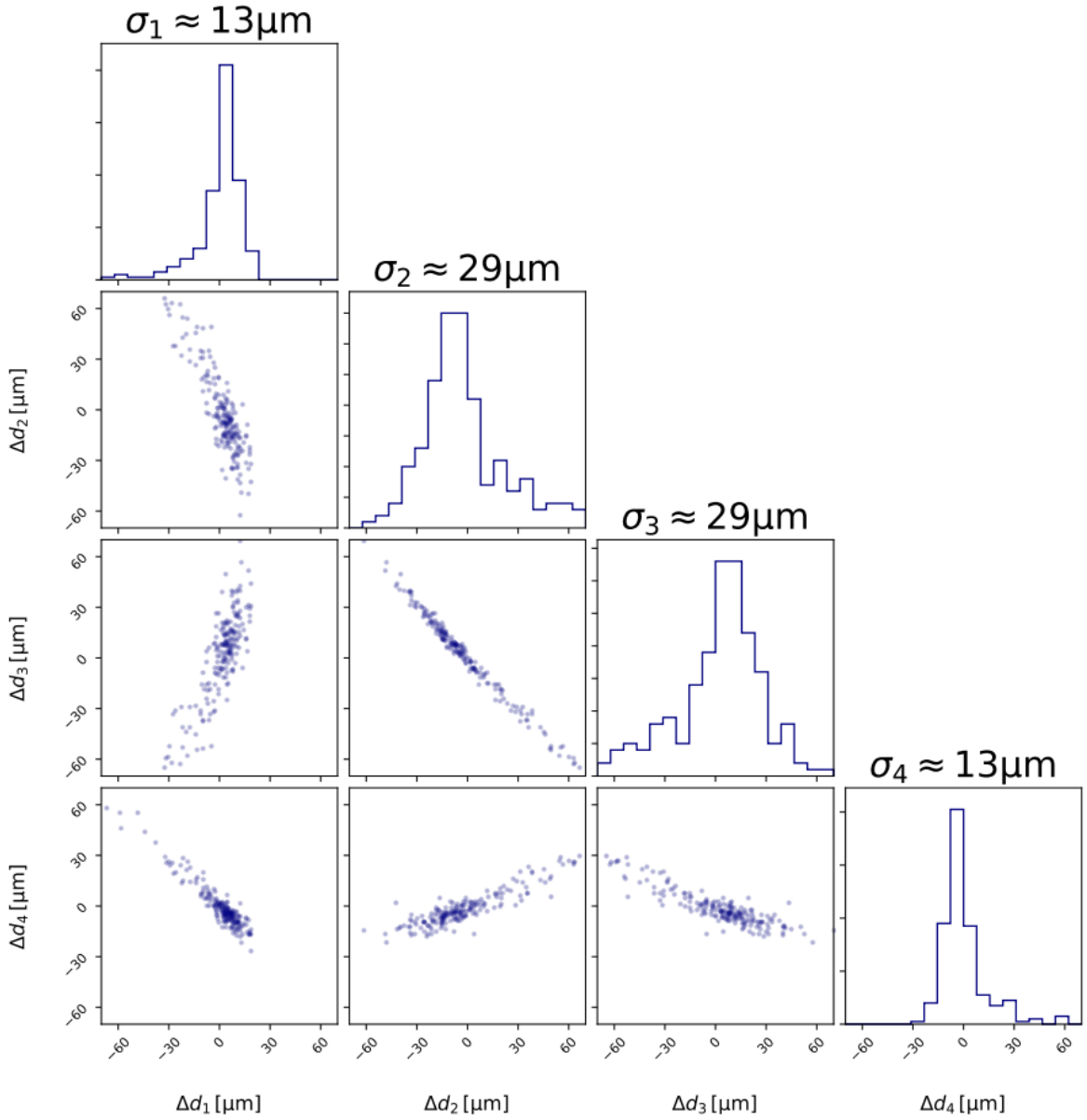
- Disk spacing deviation increases with more disks mainly due to correlations
- Boostfactor deviation still manageable for 5 disks
  → go to higher disks
  → Limited by tilts and higher order reflections
  → motorized tilts, interferometer, better antenna

Muchas gracias por su atención!

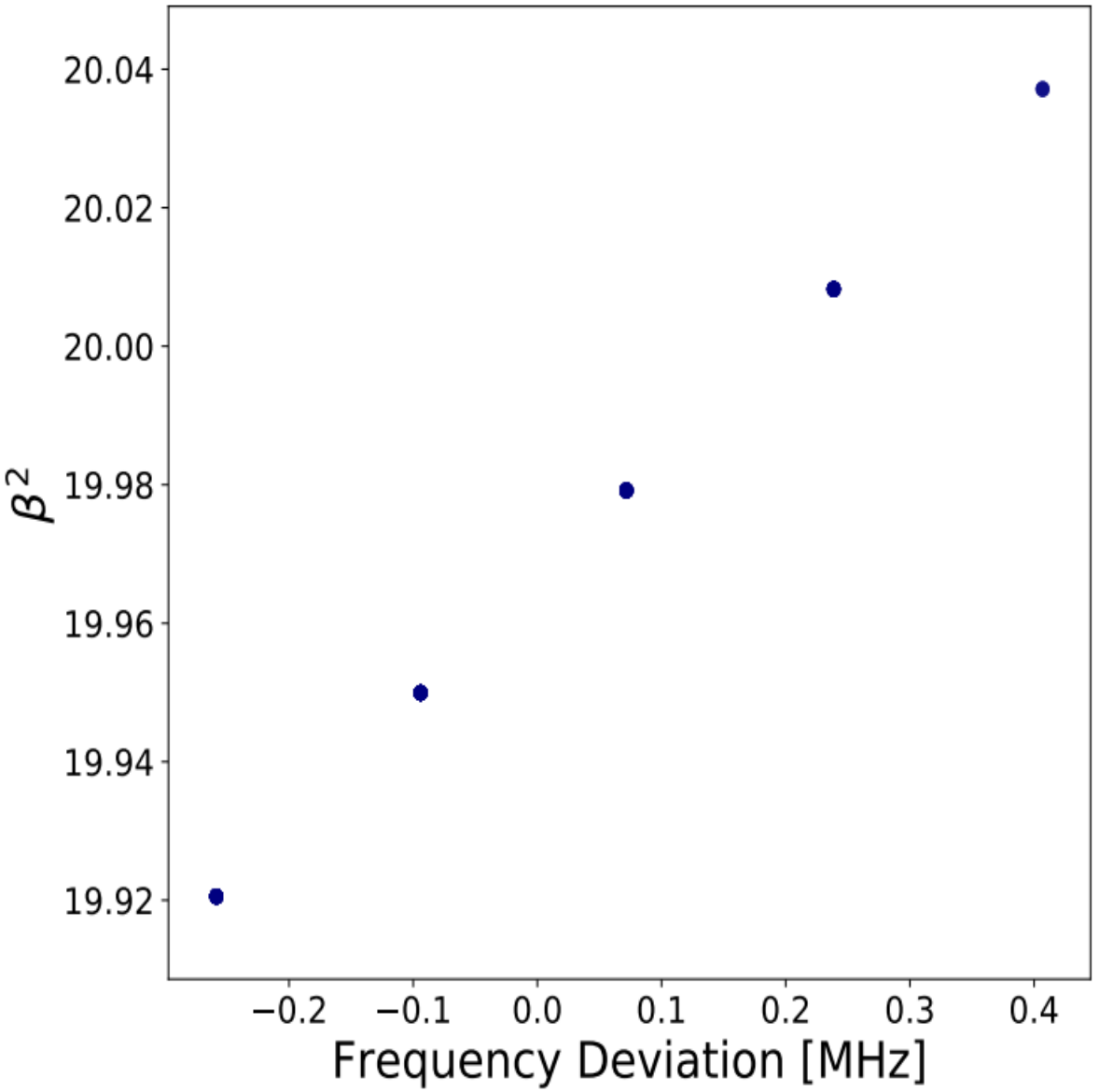
Backup Slides



Backup Slides



Backup Slides



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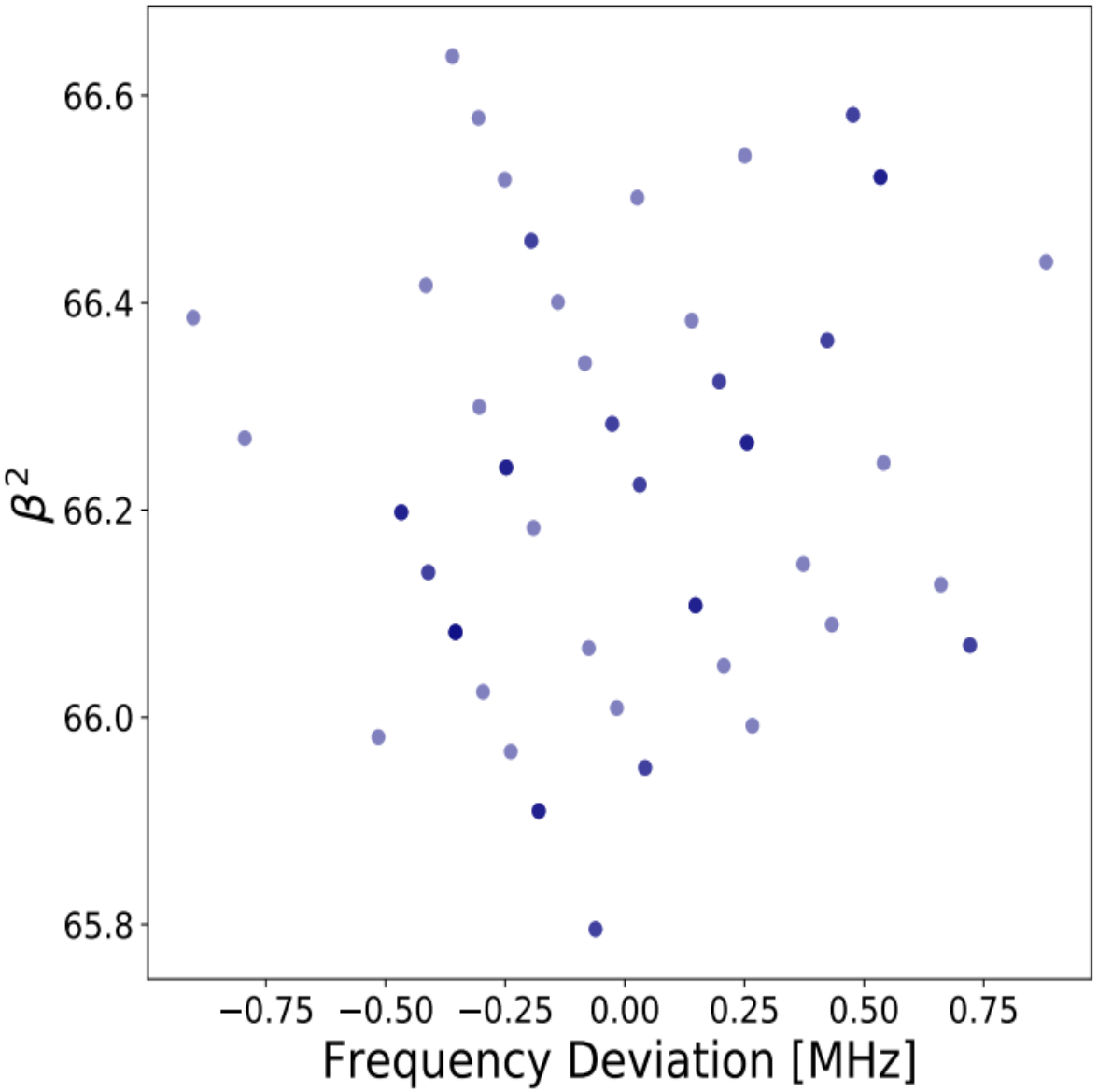

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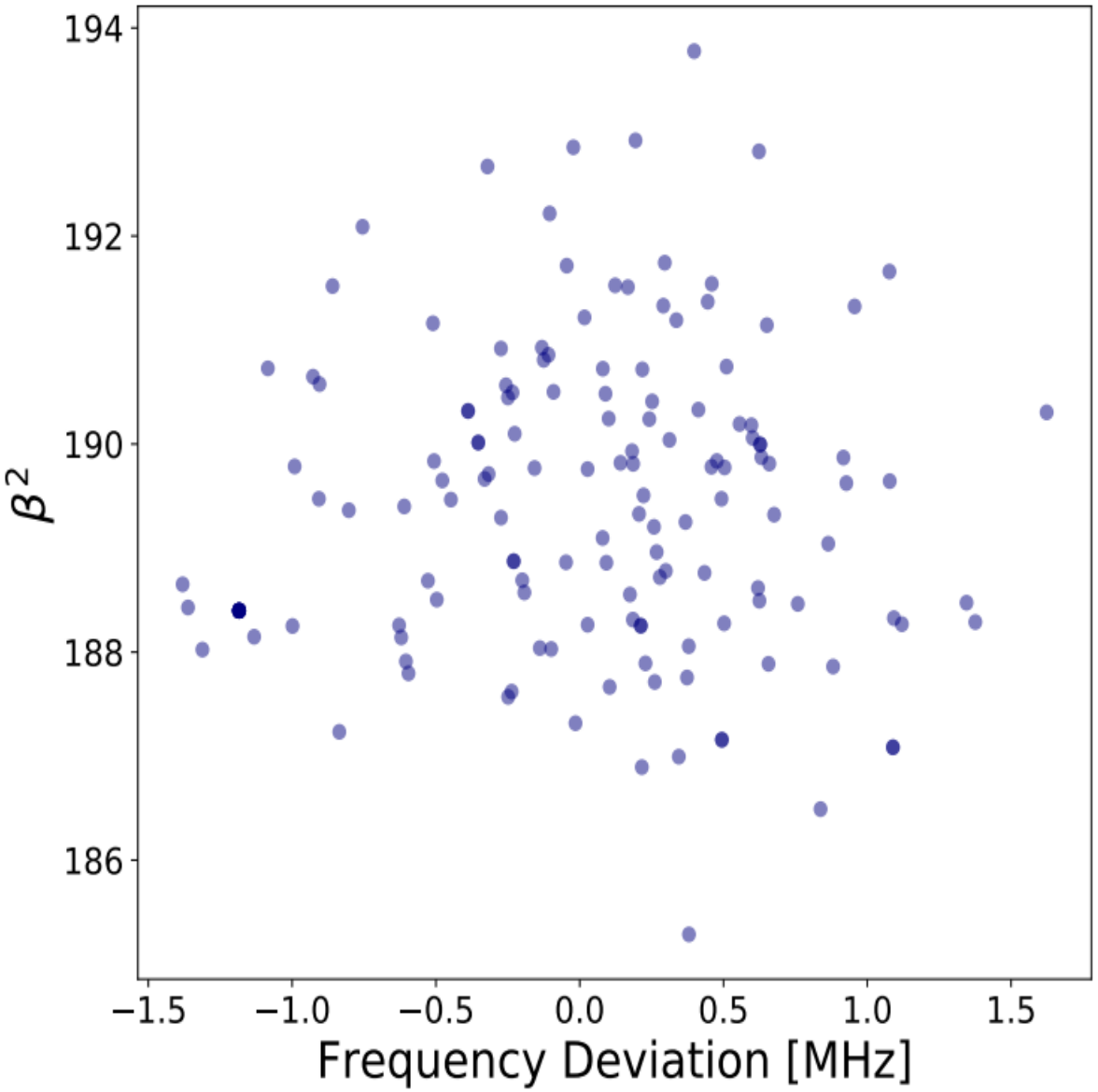

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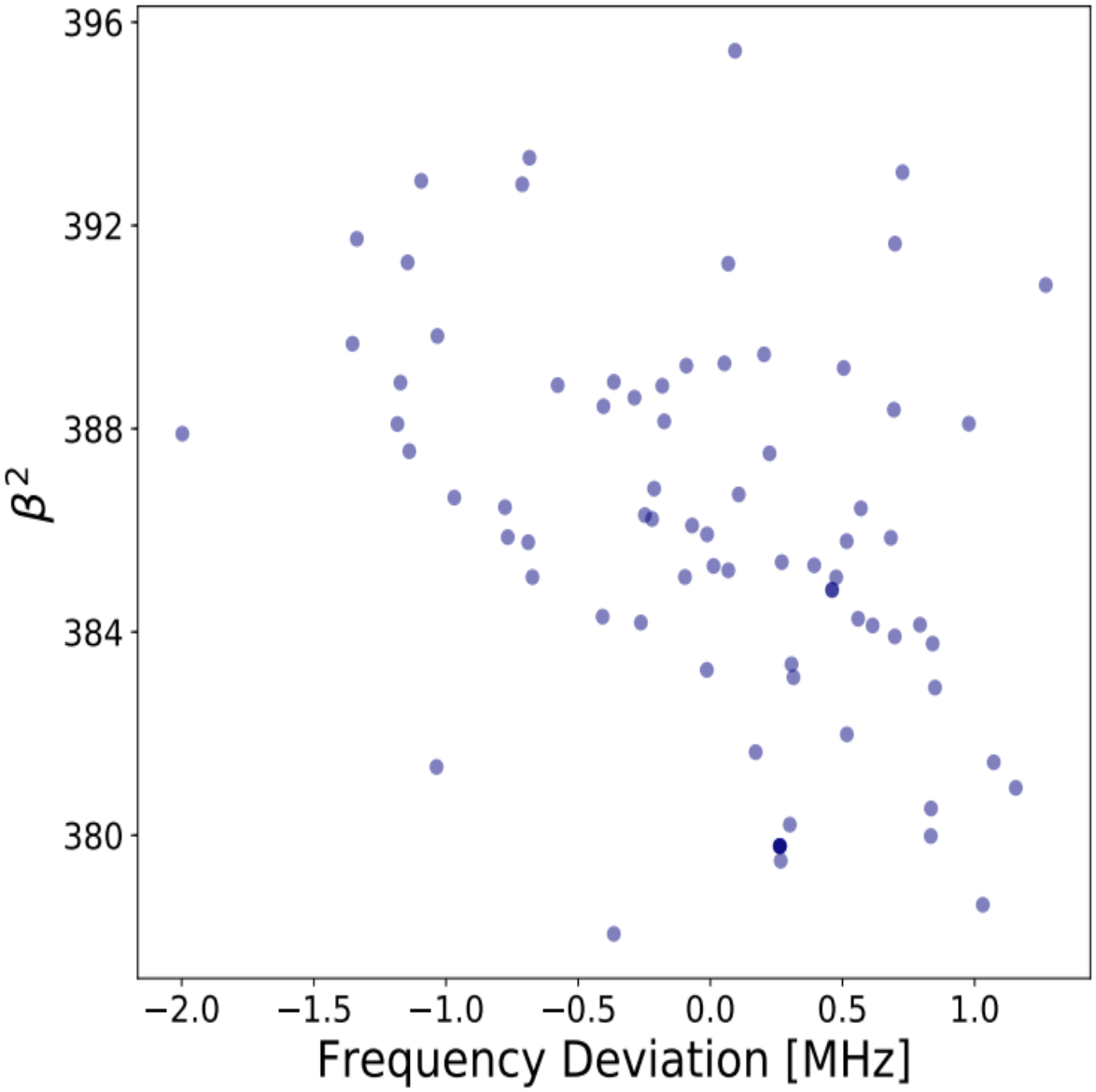

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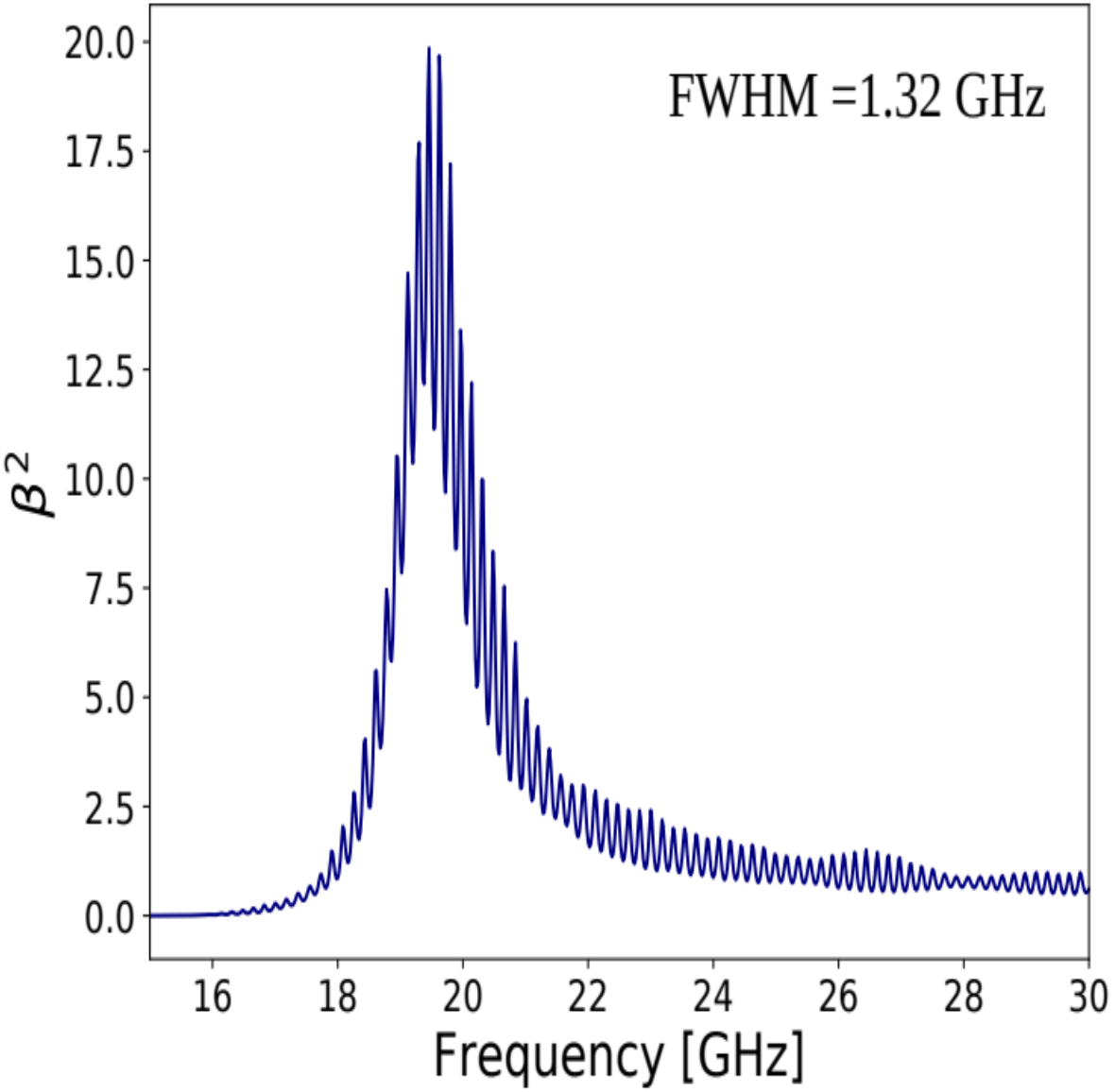

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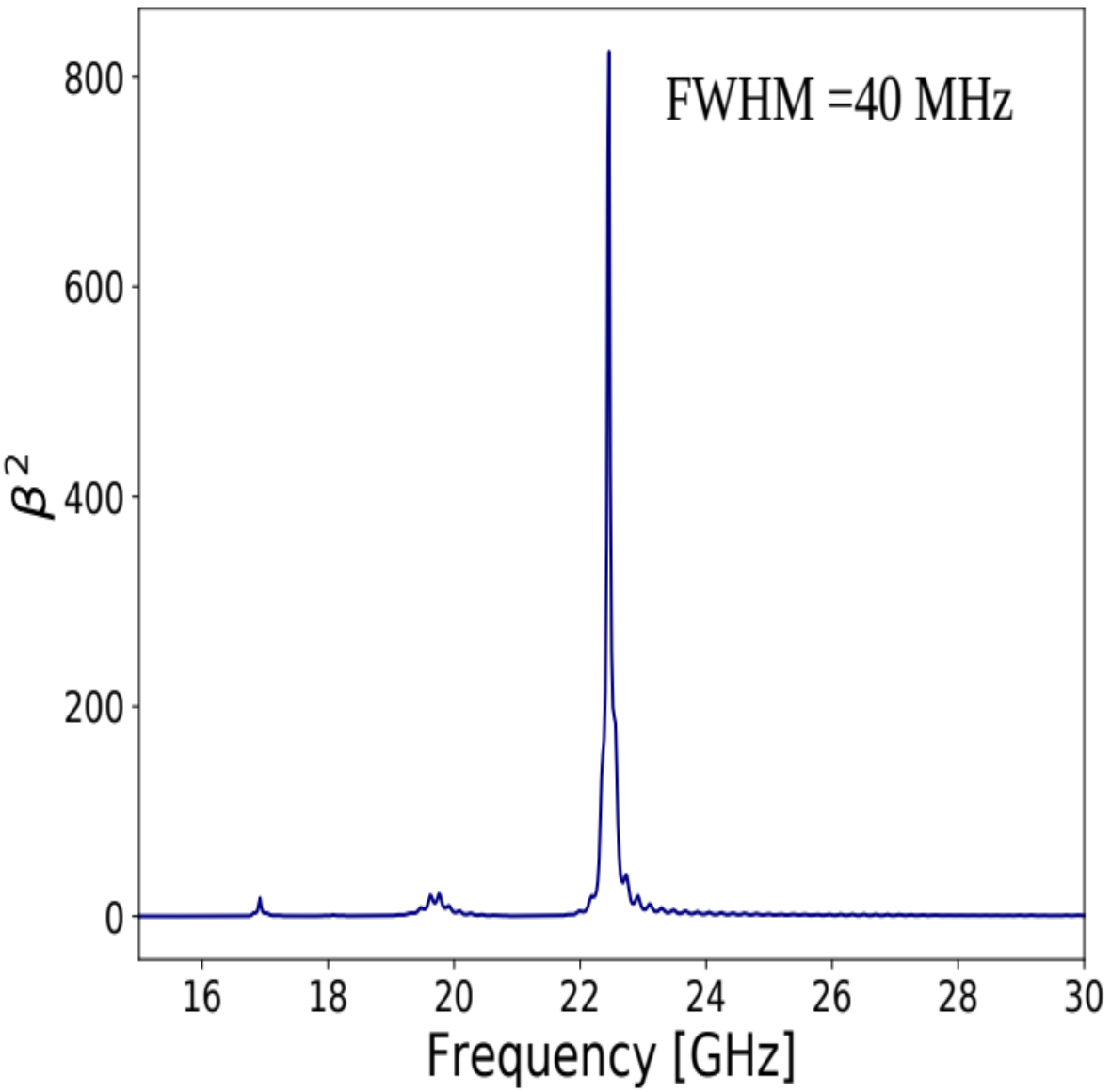

Backup Slides