

Reflection Studies on the 20 Disc Setup

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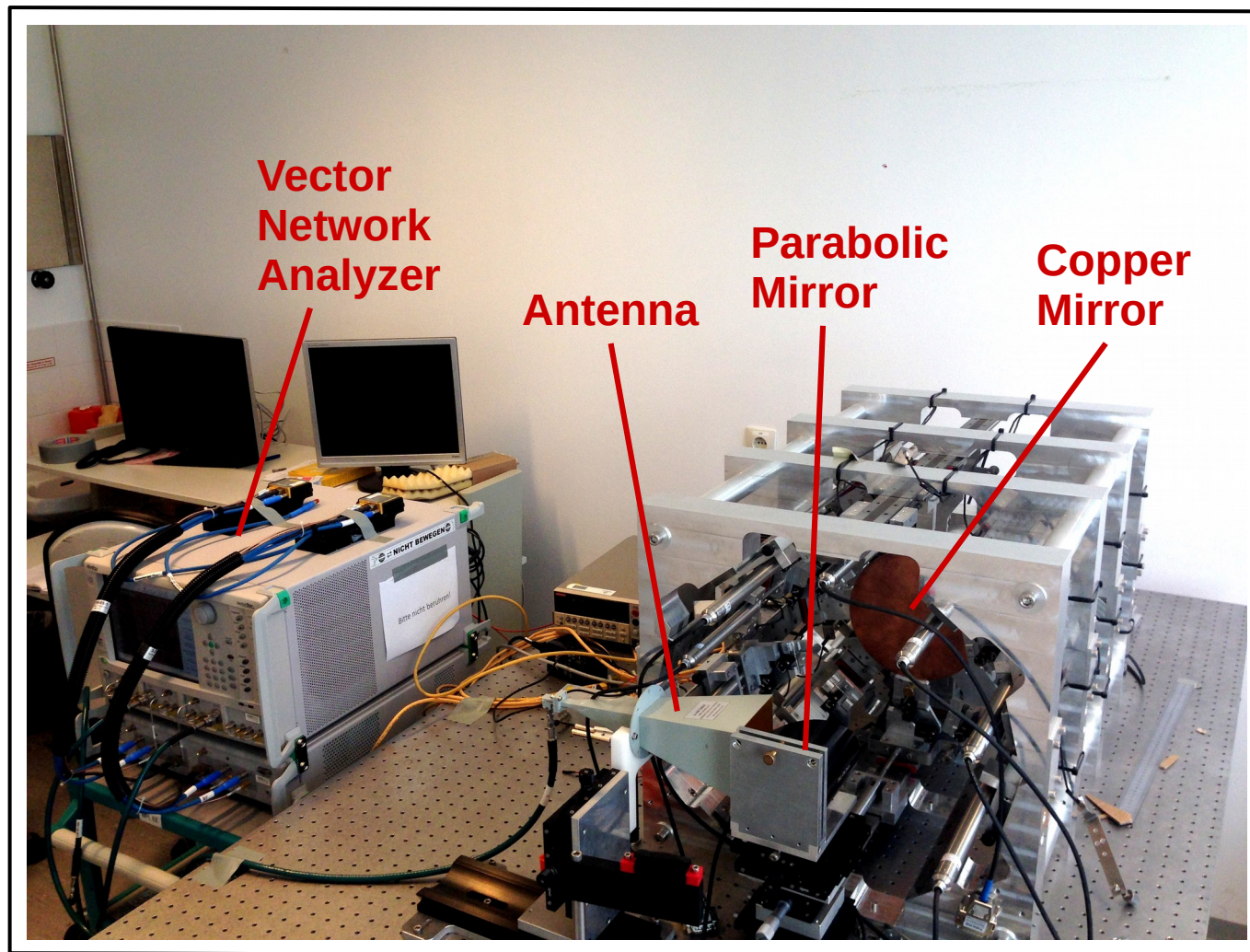


MAX-PLANCK-GESELLSCHAFT

Max-Planck-Institut
für Physik



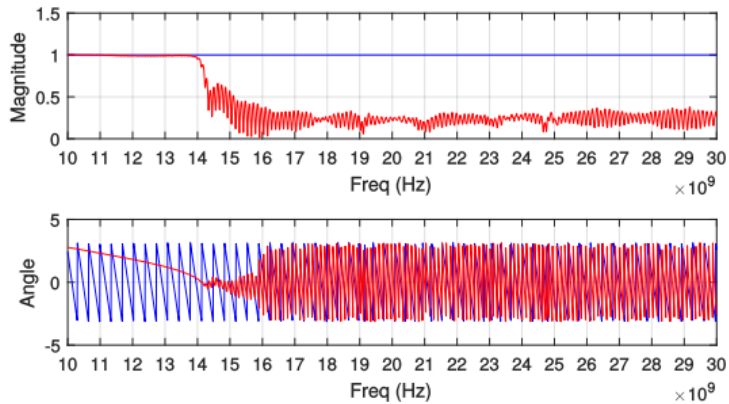
20 Disc Setup



- 20 disc seed setup
- No magnetic field
- Test electromagnetic response with a Vector Network Analyzer

Signal Processing

Raw Data



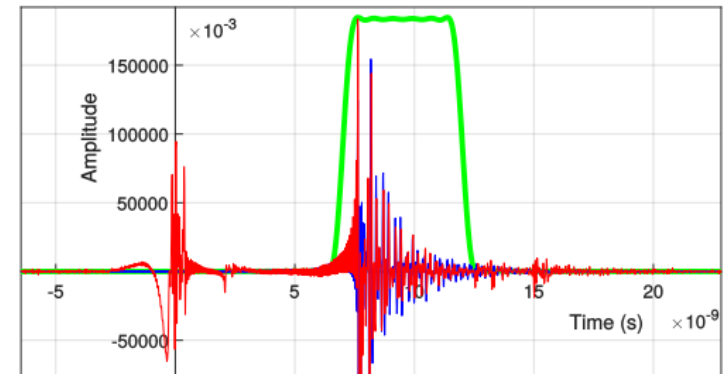
— simulation
— measurement

iFFT

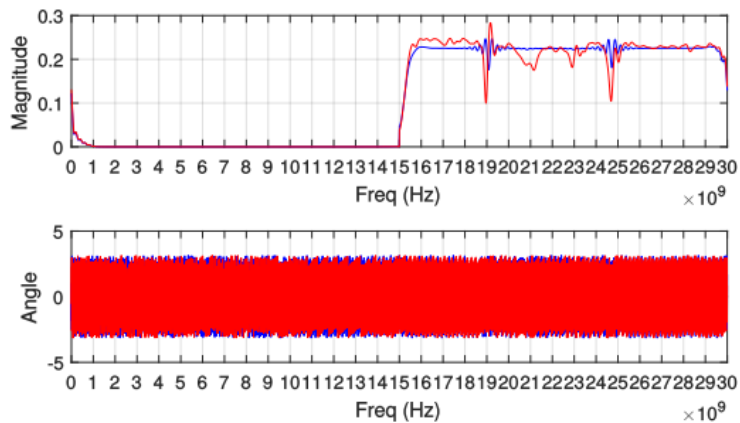
FFT

$$\tau_G = \frac{d\phi}{d\omega}$$

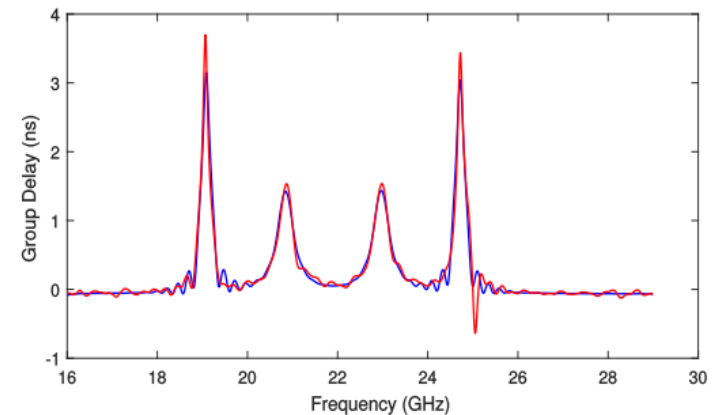
Apply Window



Processed Data

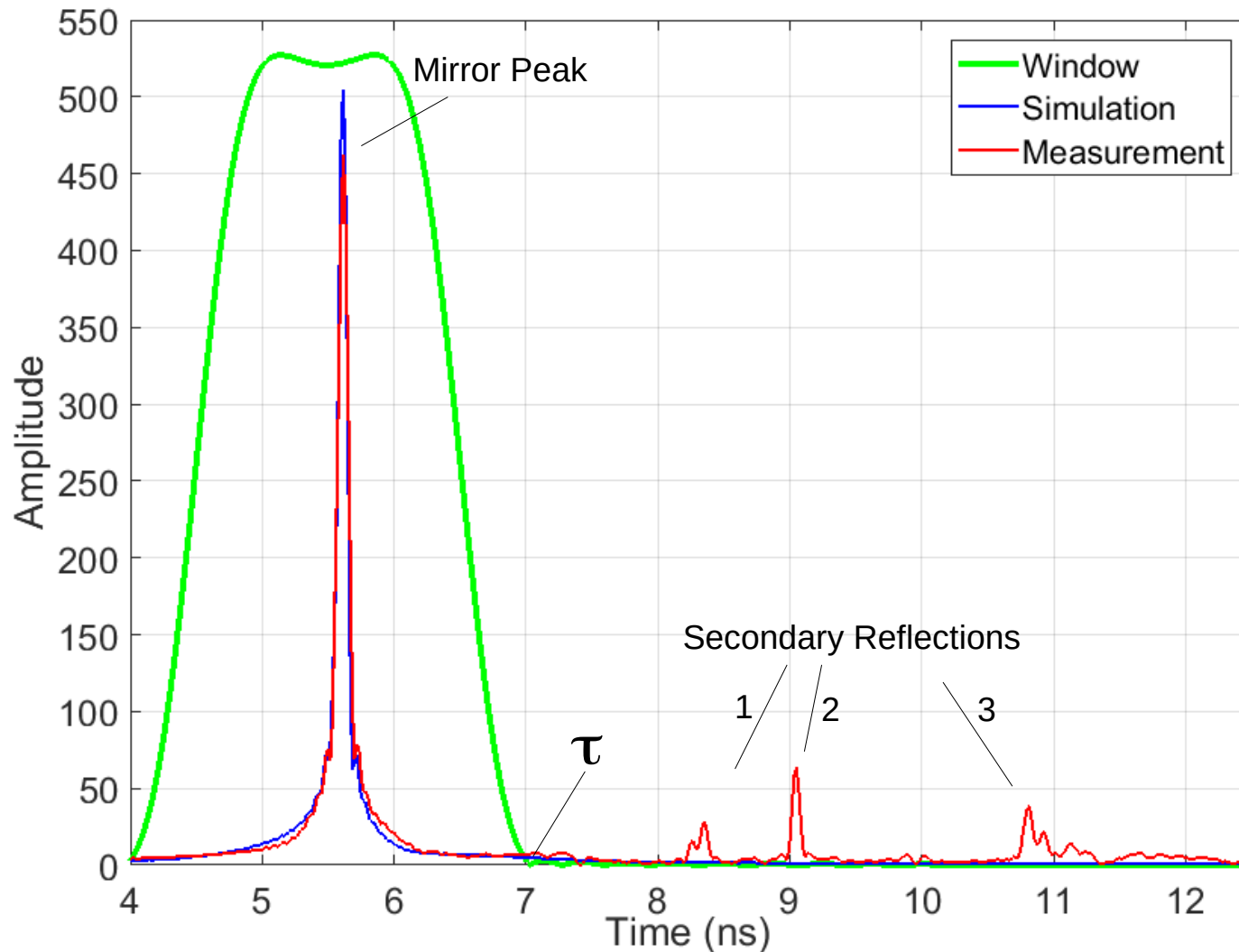


Group Delay



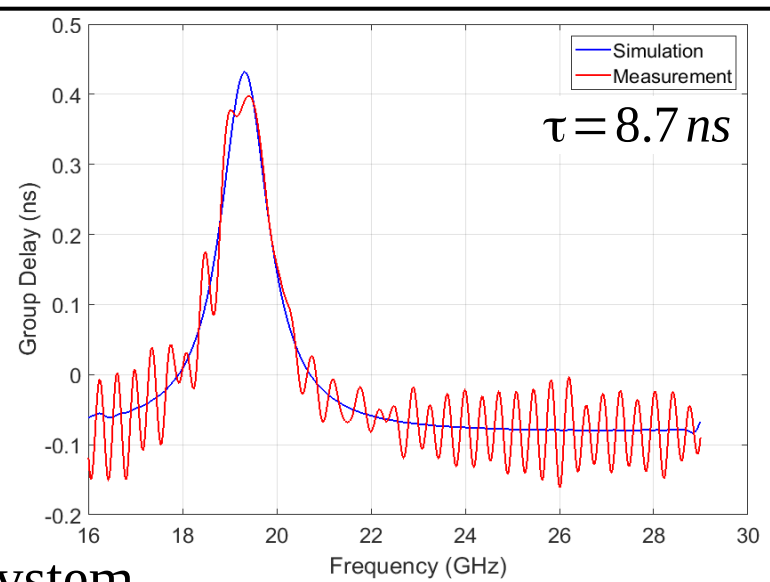
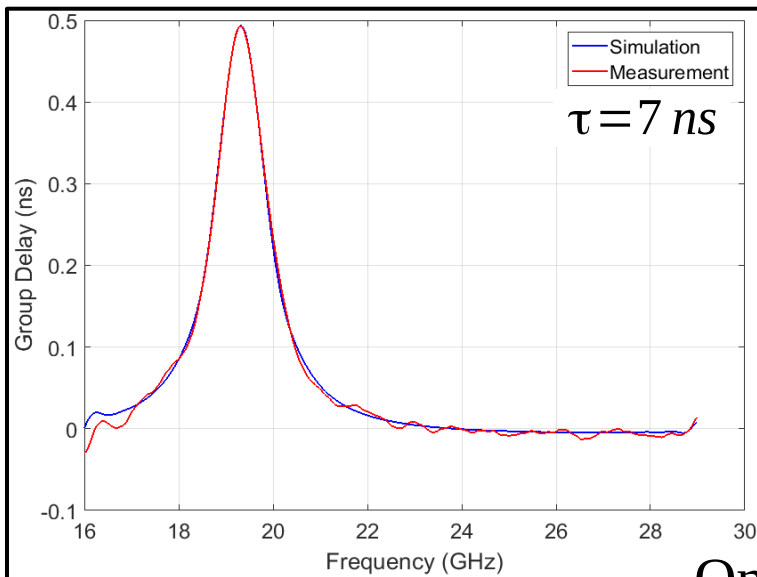
Reflections

Time Domain: FFT of complex reflectivity

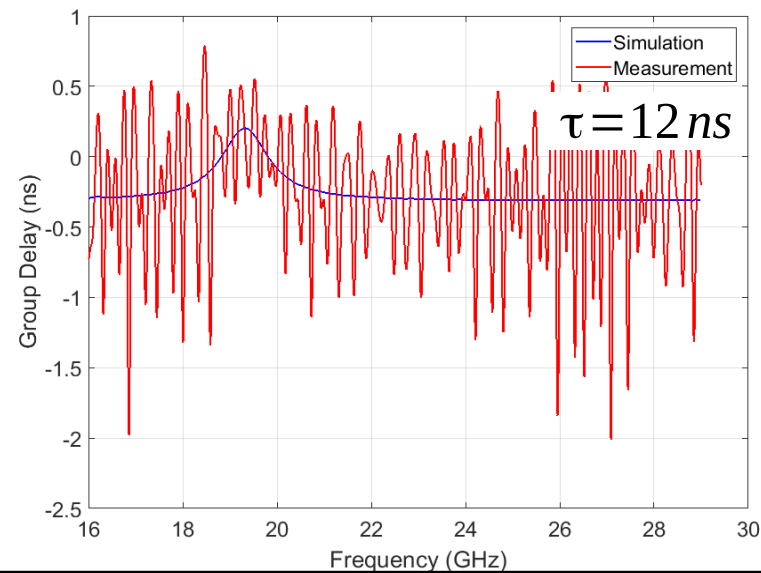
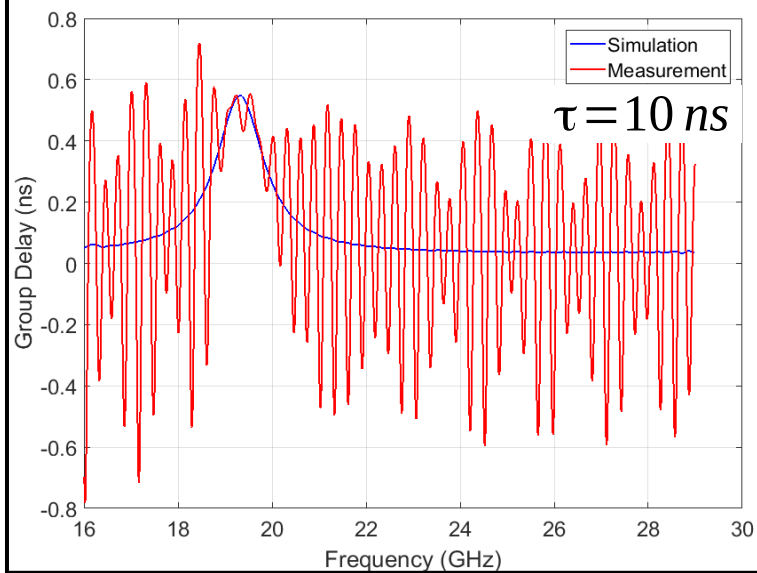


- Additional unwanted reflections in the system
- antenna mismatch, surroundings, ...
- Removal by time gate
- But: In a many discs system signal and unwanted reflections overlap

Reflections

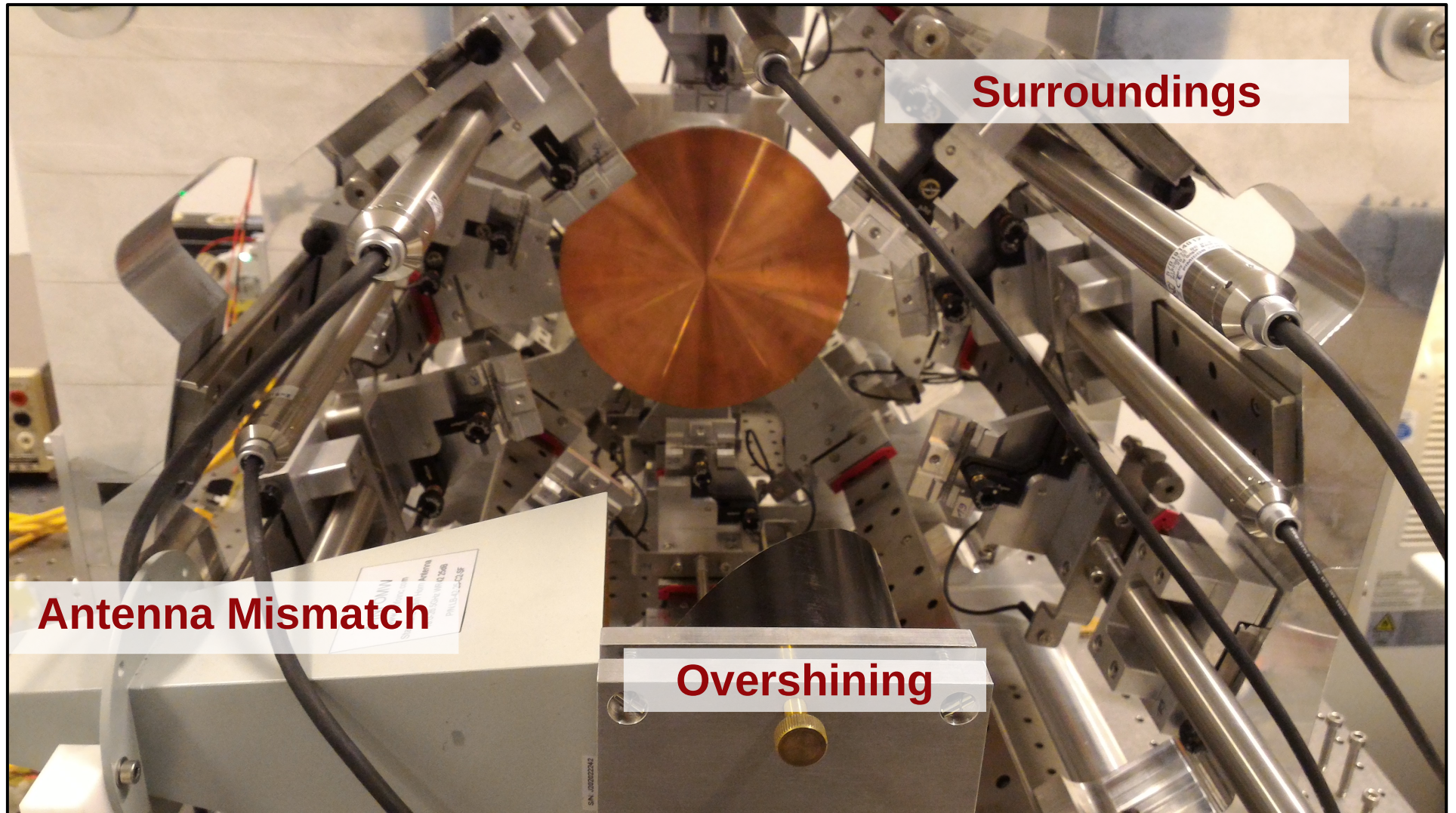


One disc system

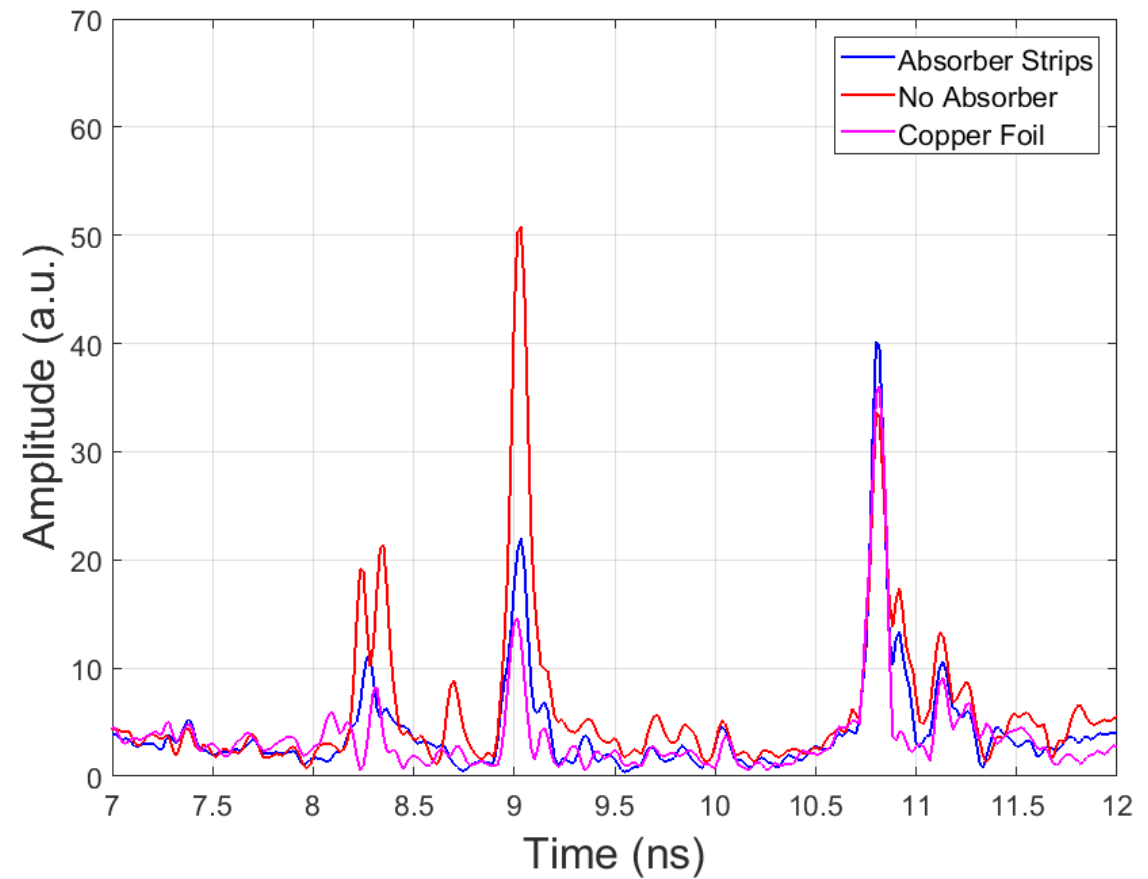
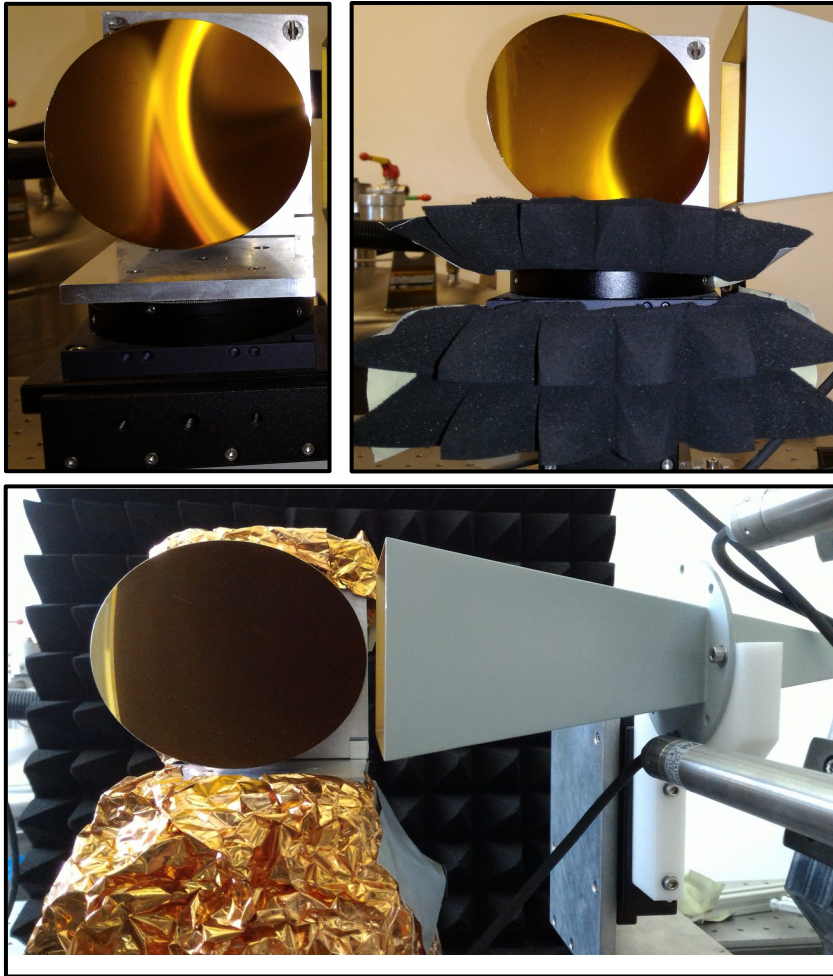


→ Necessary to model additional reflections

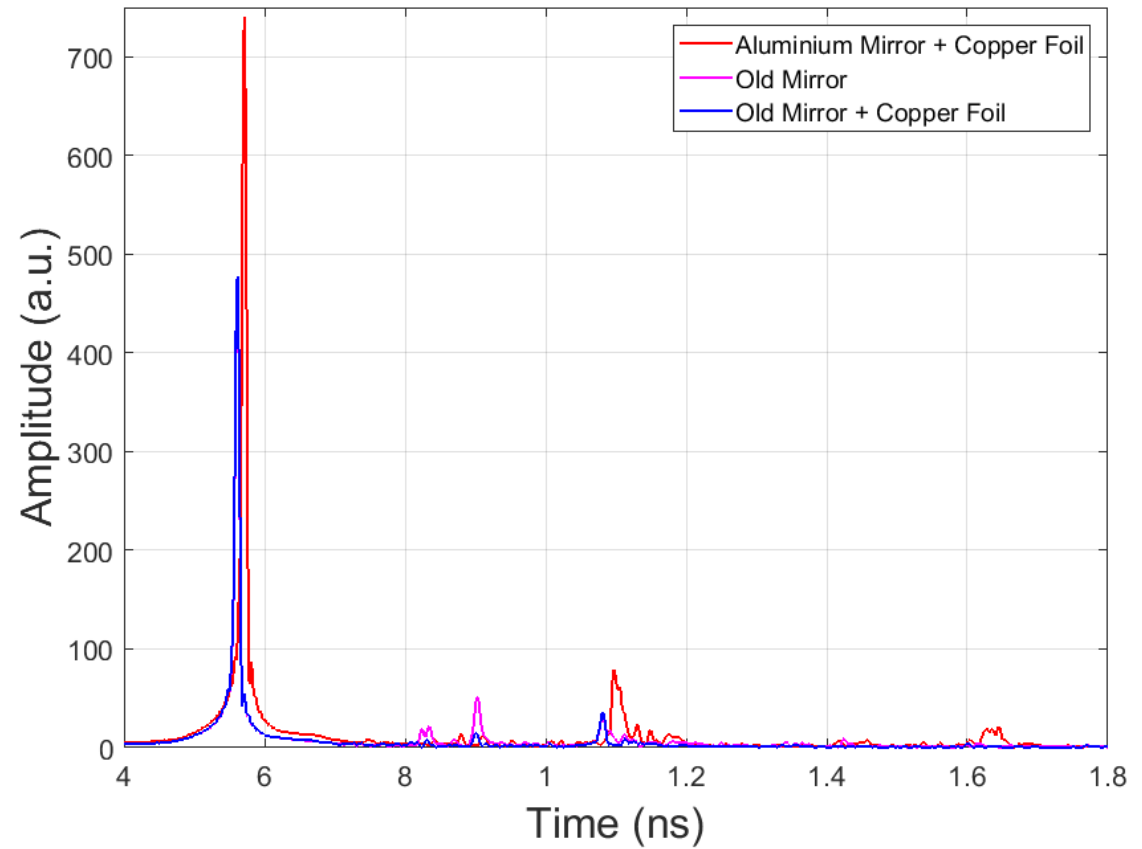
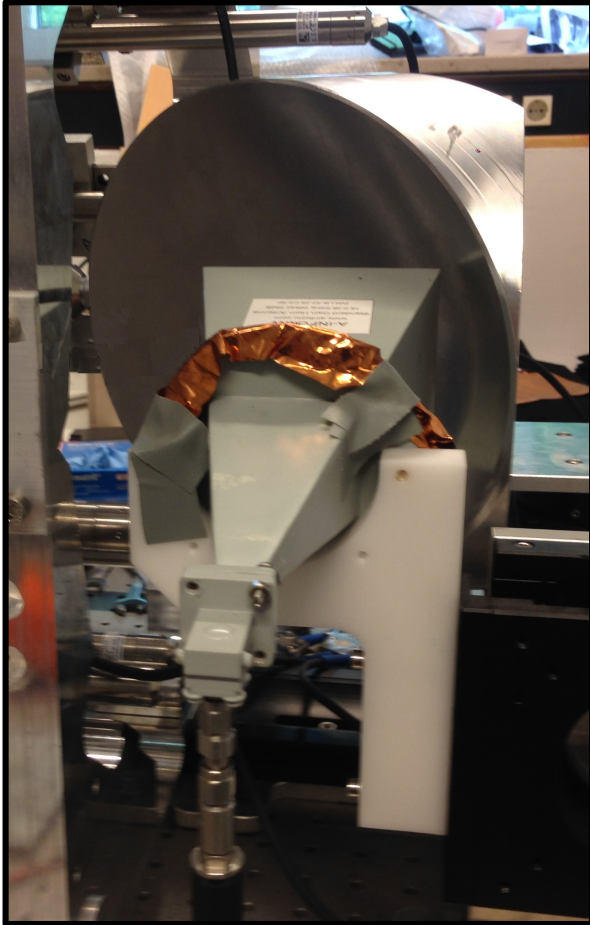
Identify Reflections



Suppress Reflections

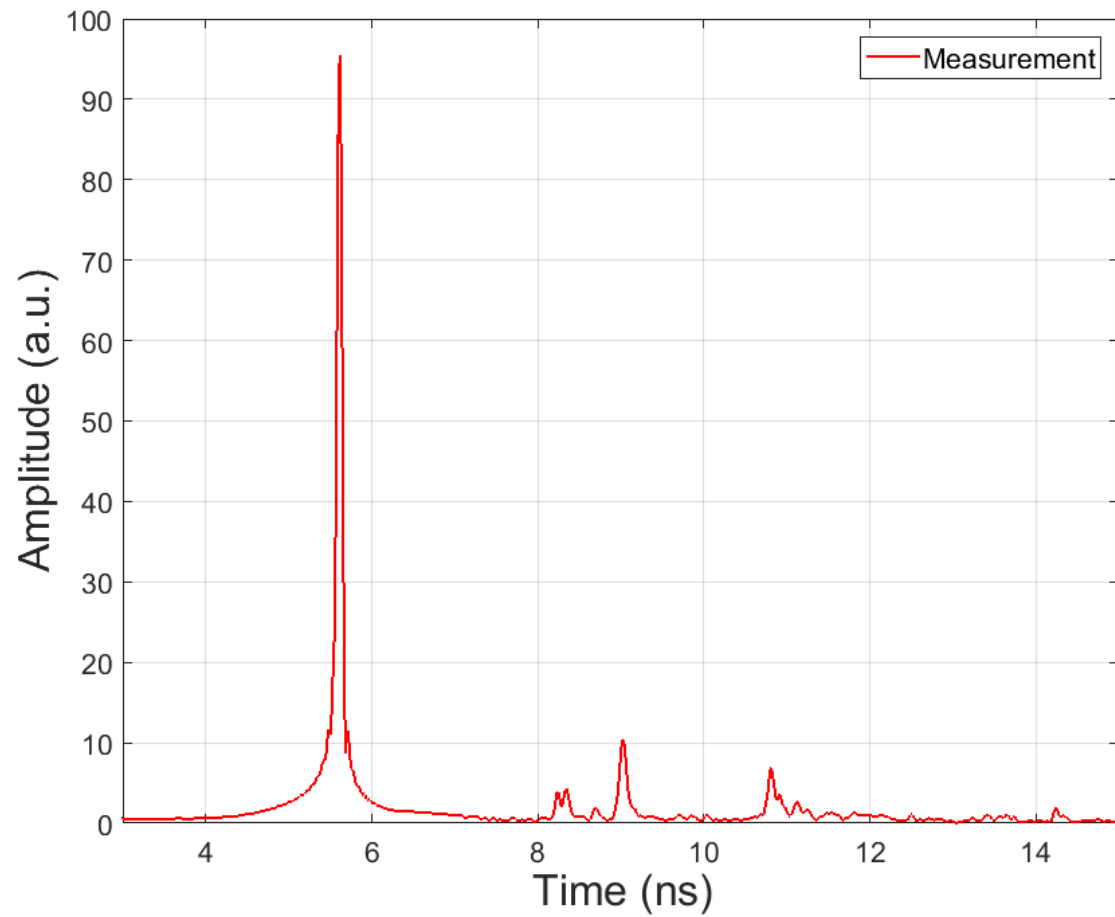
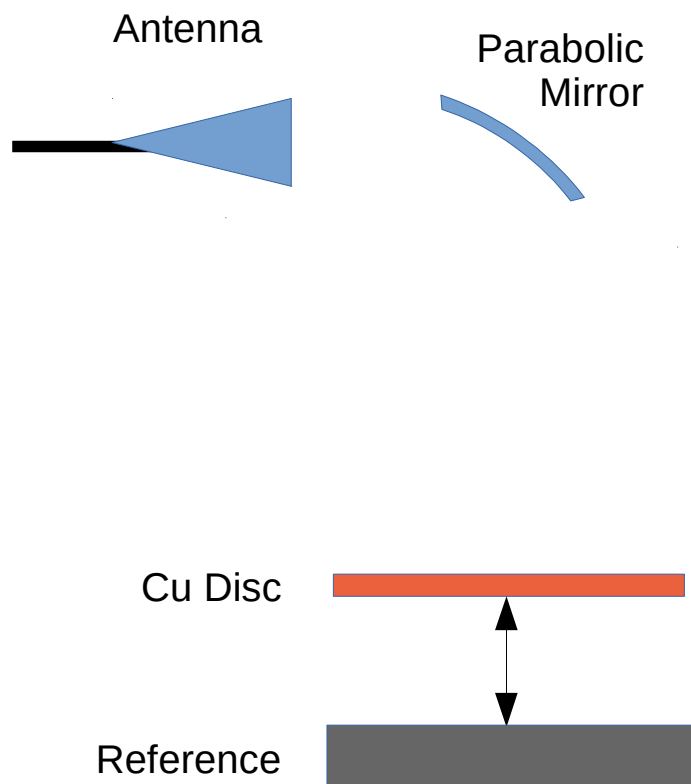


Suppress Reflections



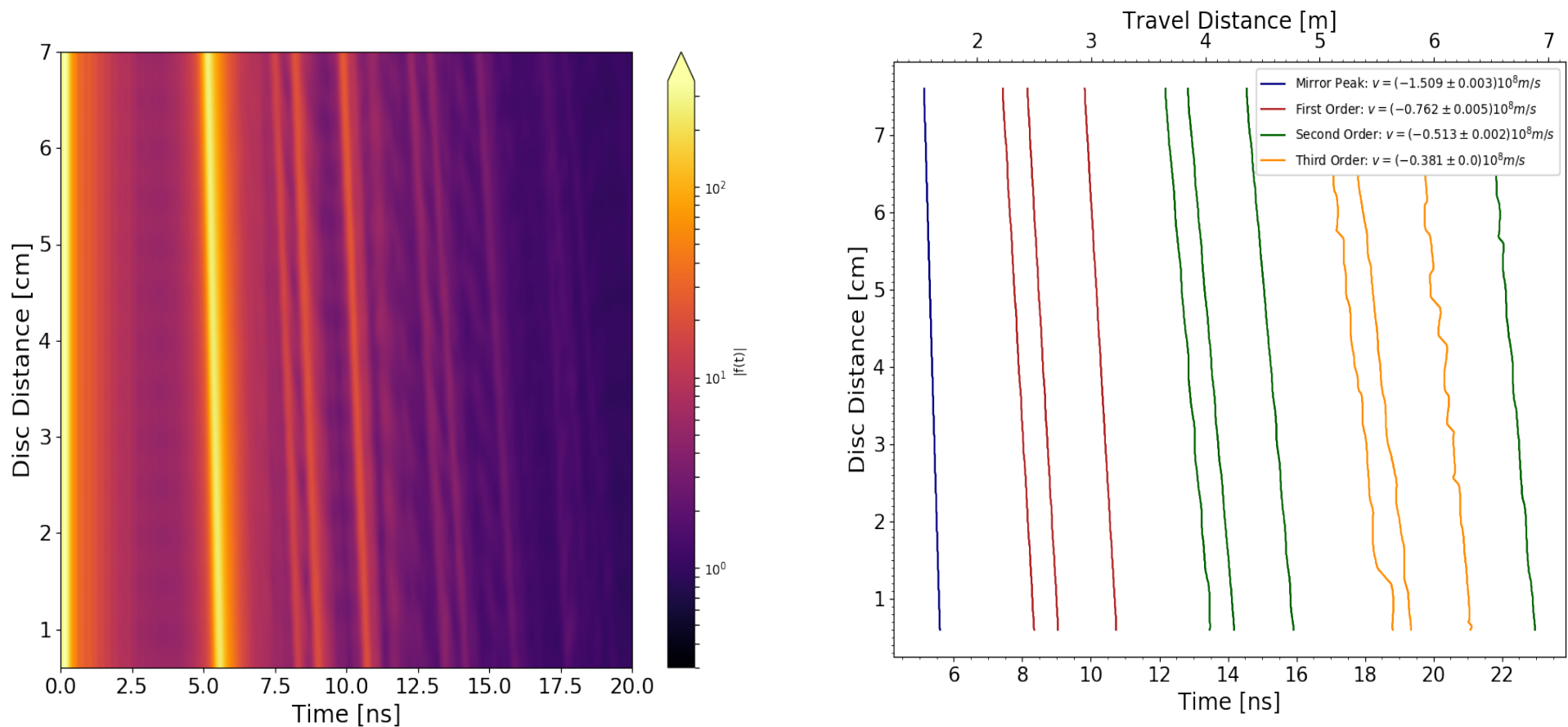
Reflection Behaviour

Distance Spectrum



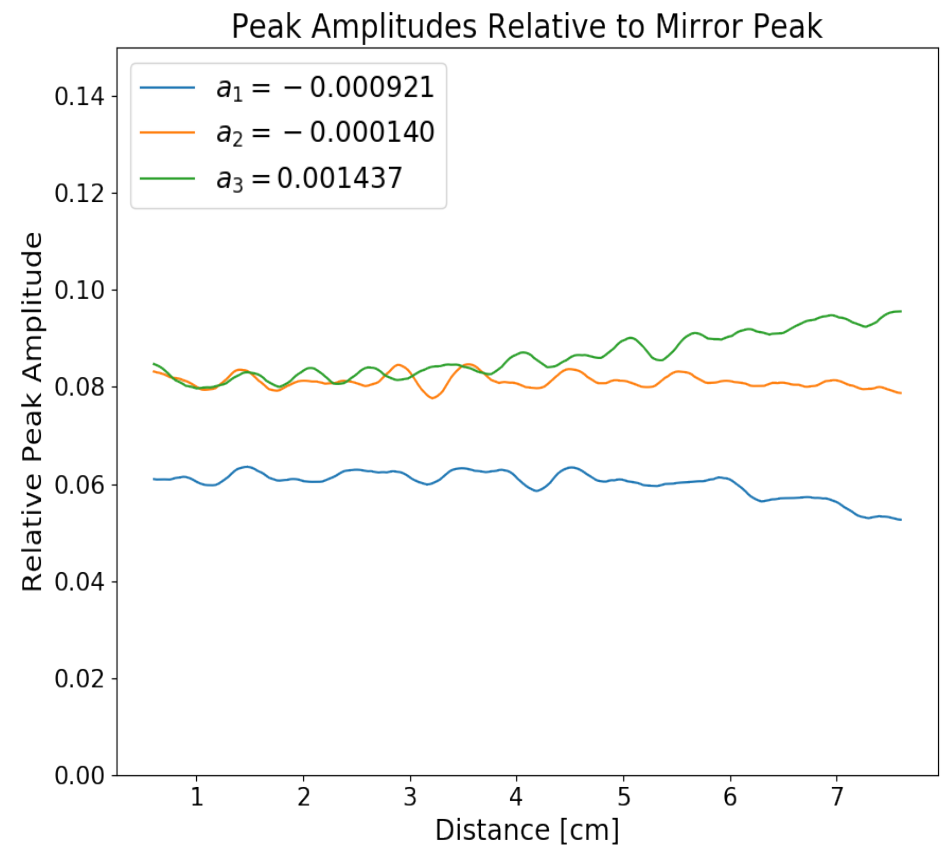
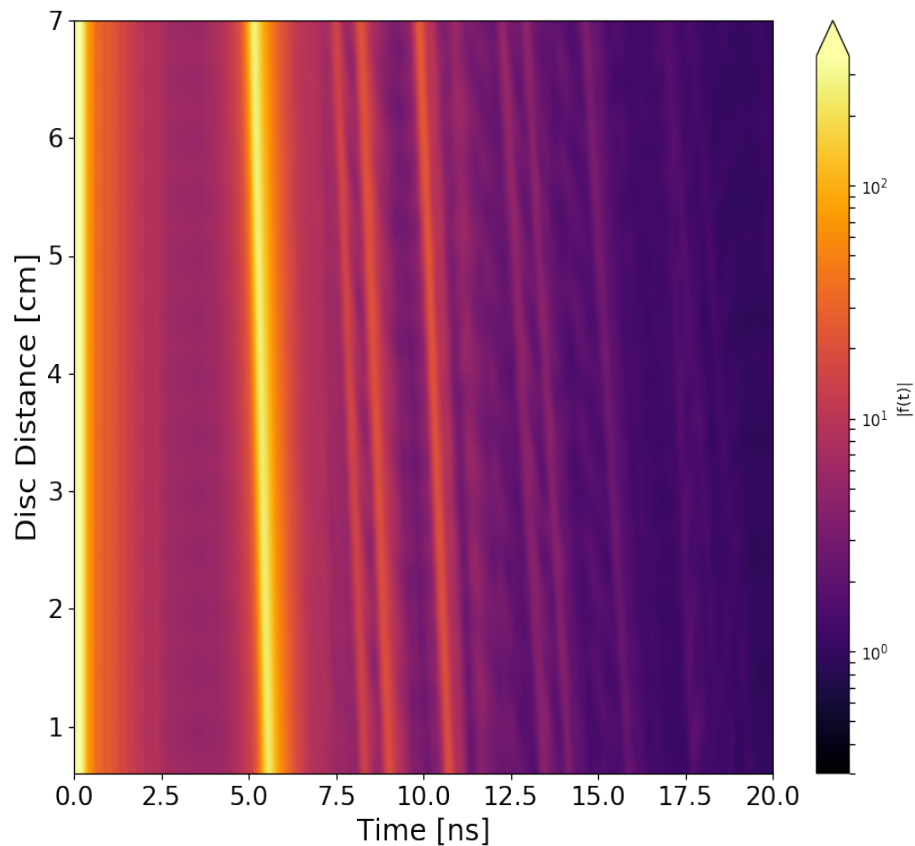
Reflection Behaviour

Distance Spectrum



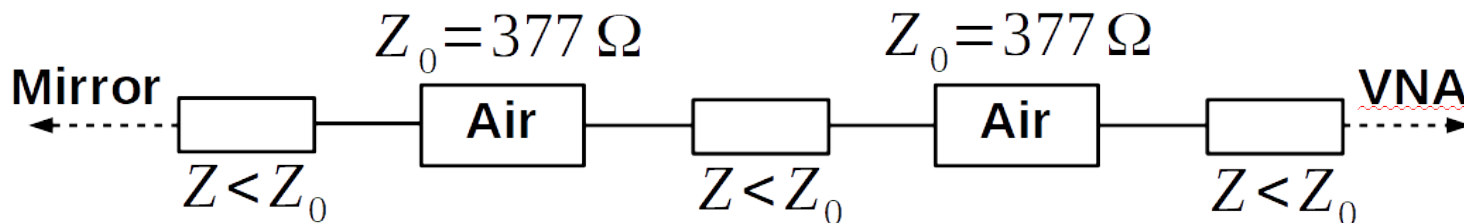
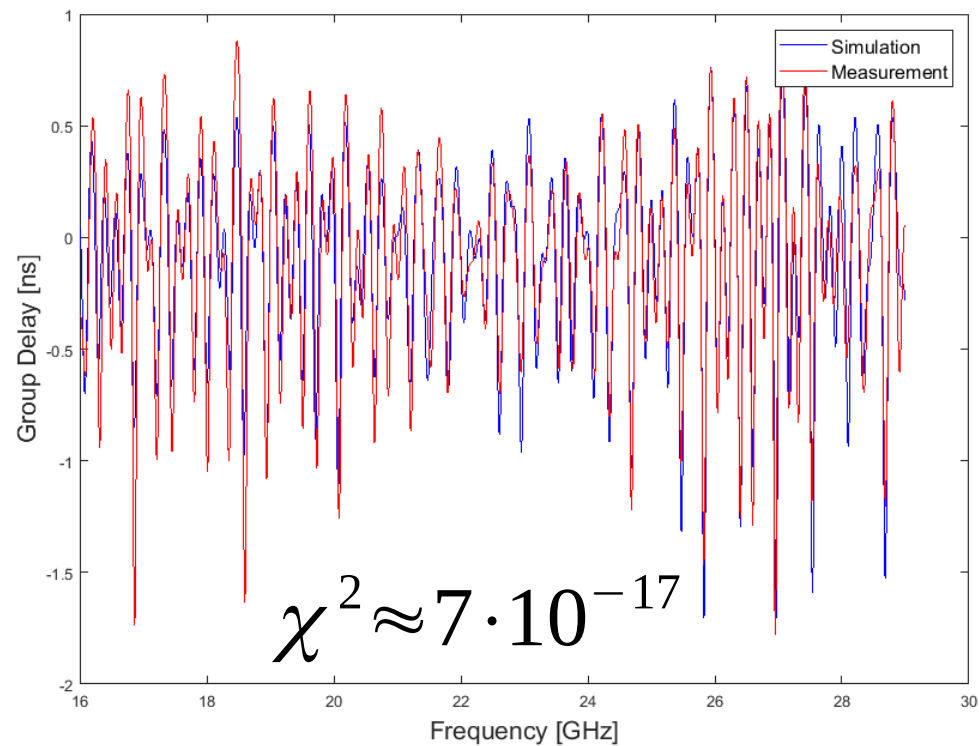
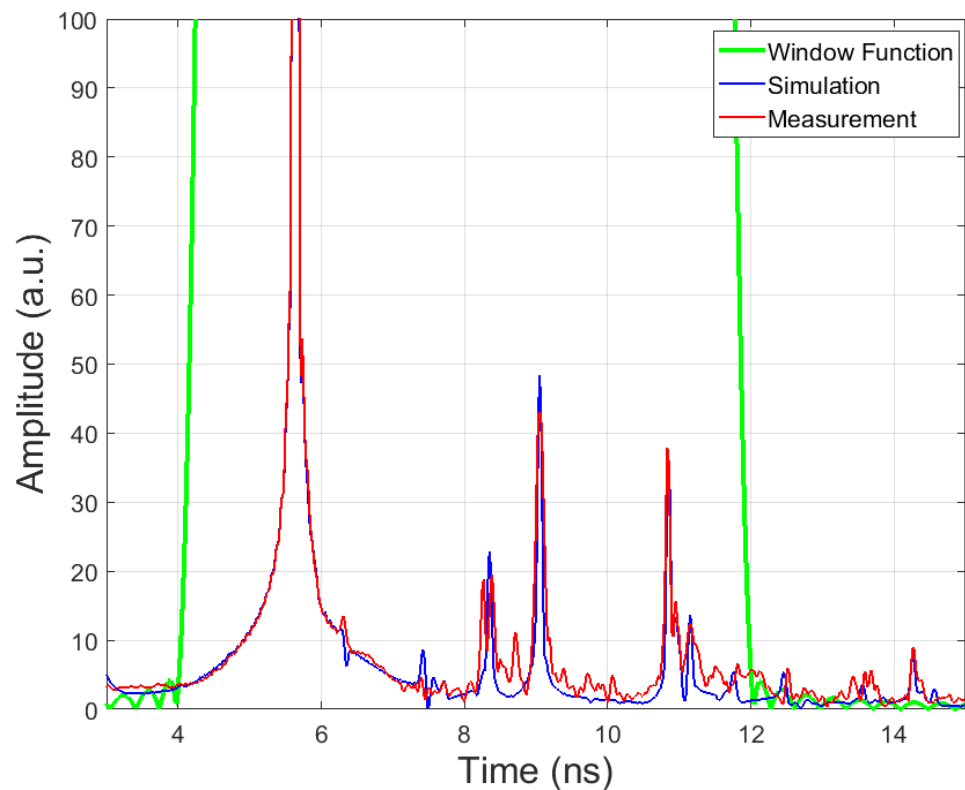
Reflection Behaviour

Distance Spectrum



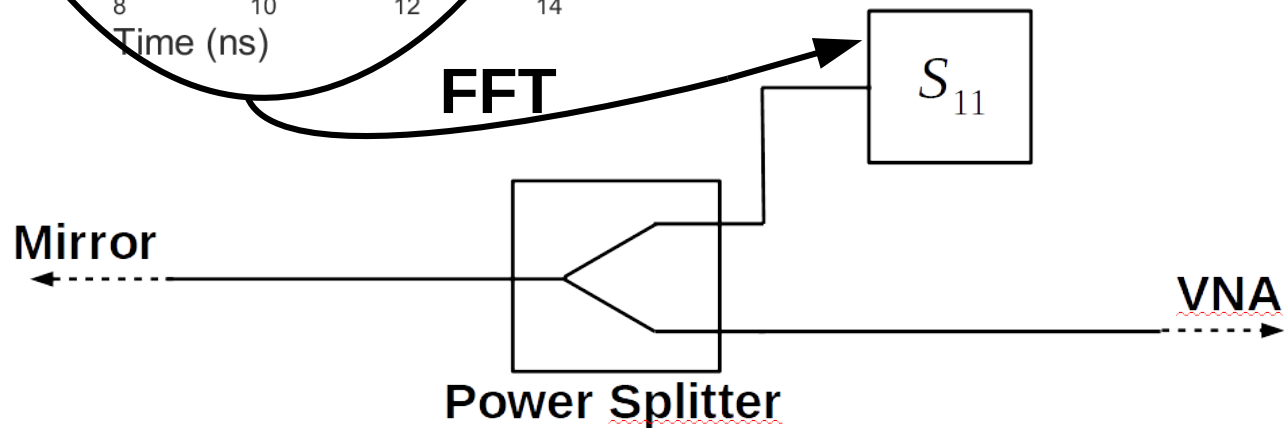
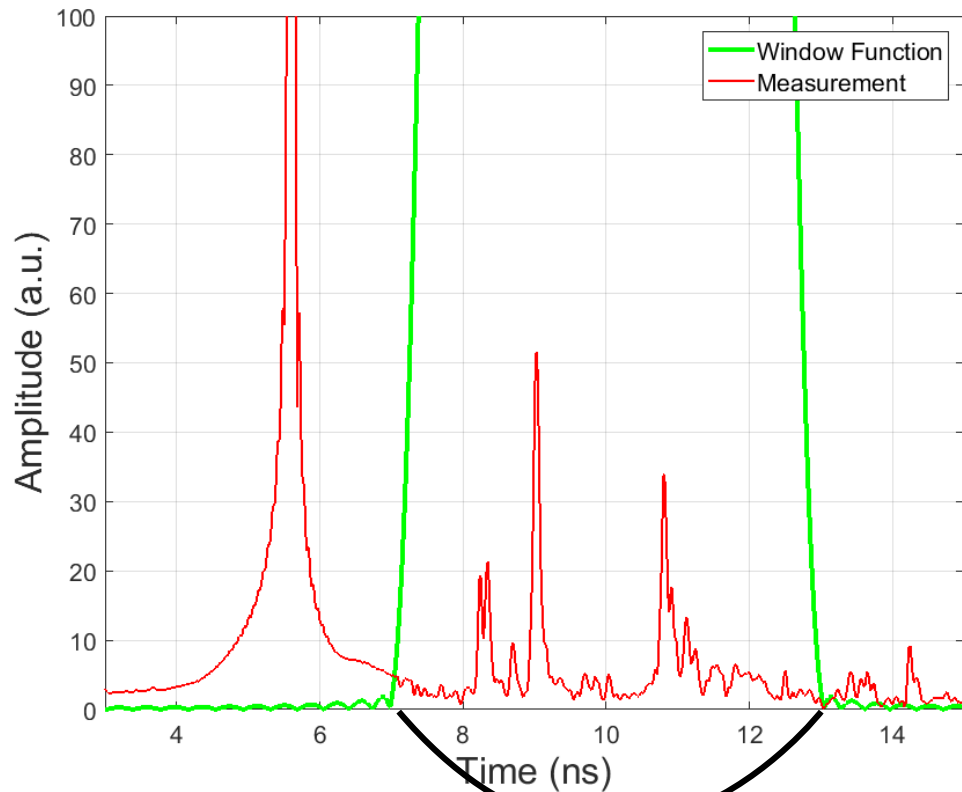
Model Reflections

Impedance Mismatch



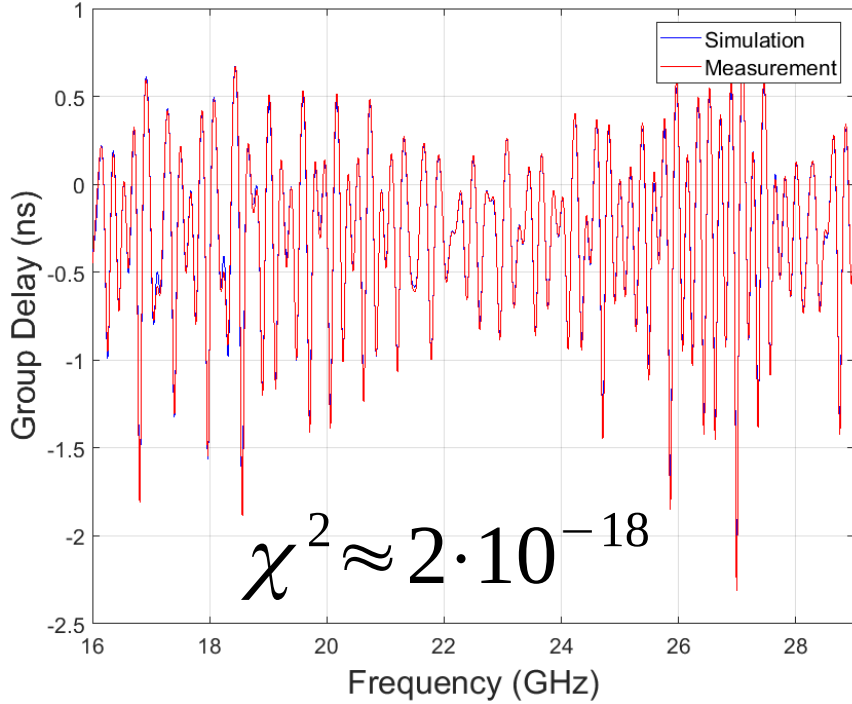
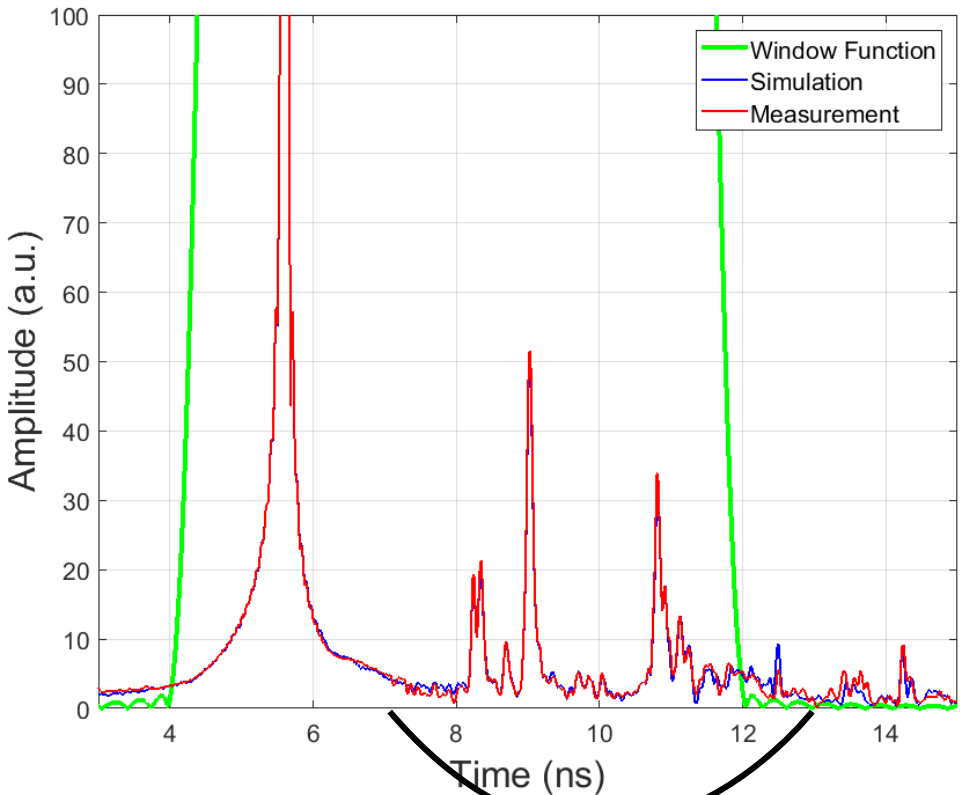
Model Reflections

Measure Reflections

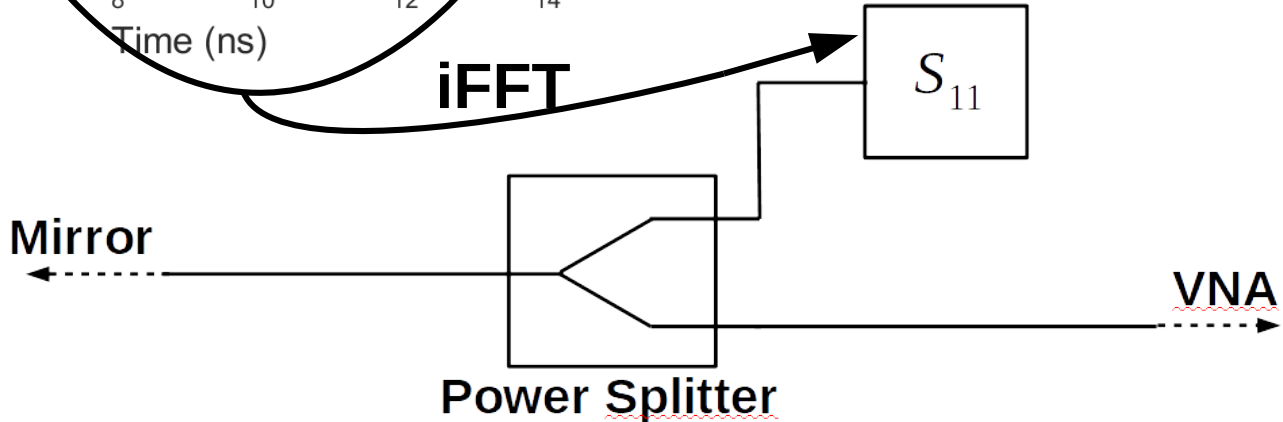


Model Reflections

Measure Reflections

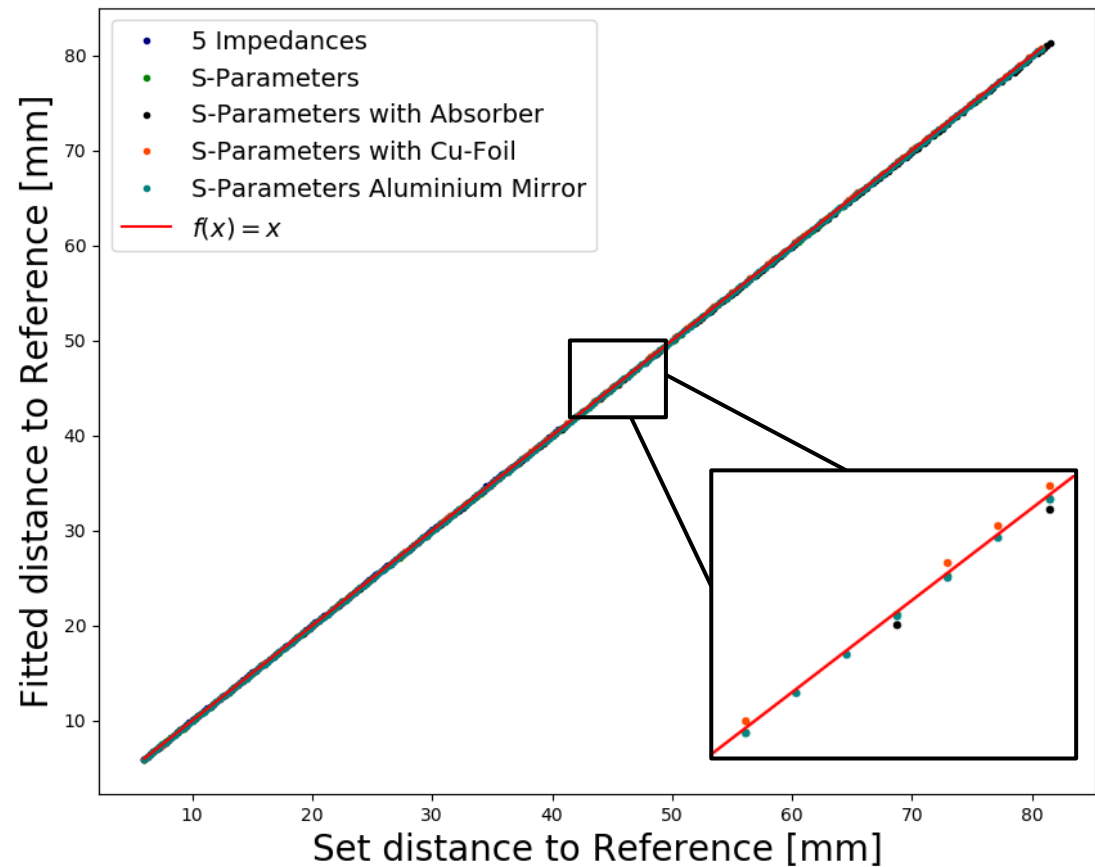
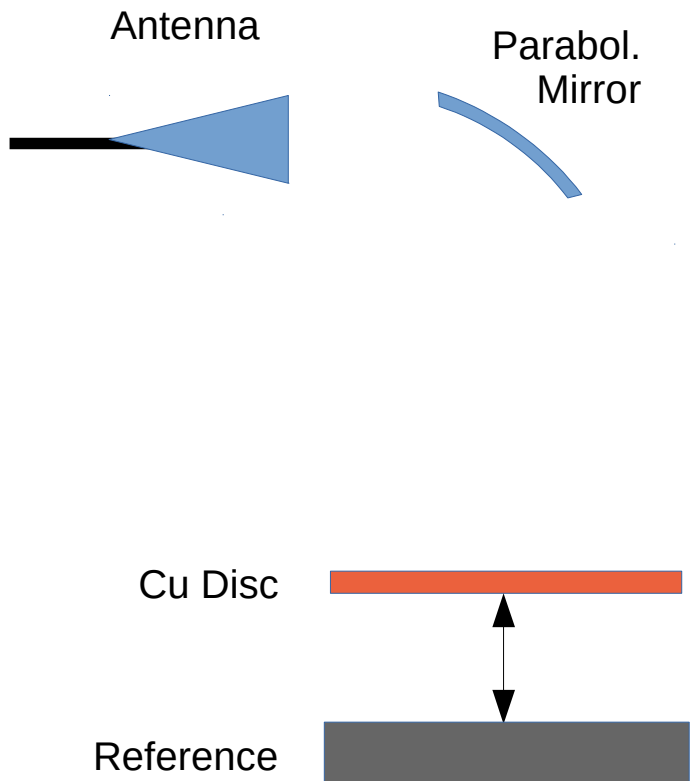


$$\chi^2 \approx 2 \cdot 10^{-18}$$



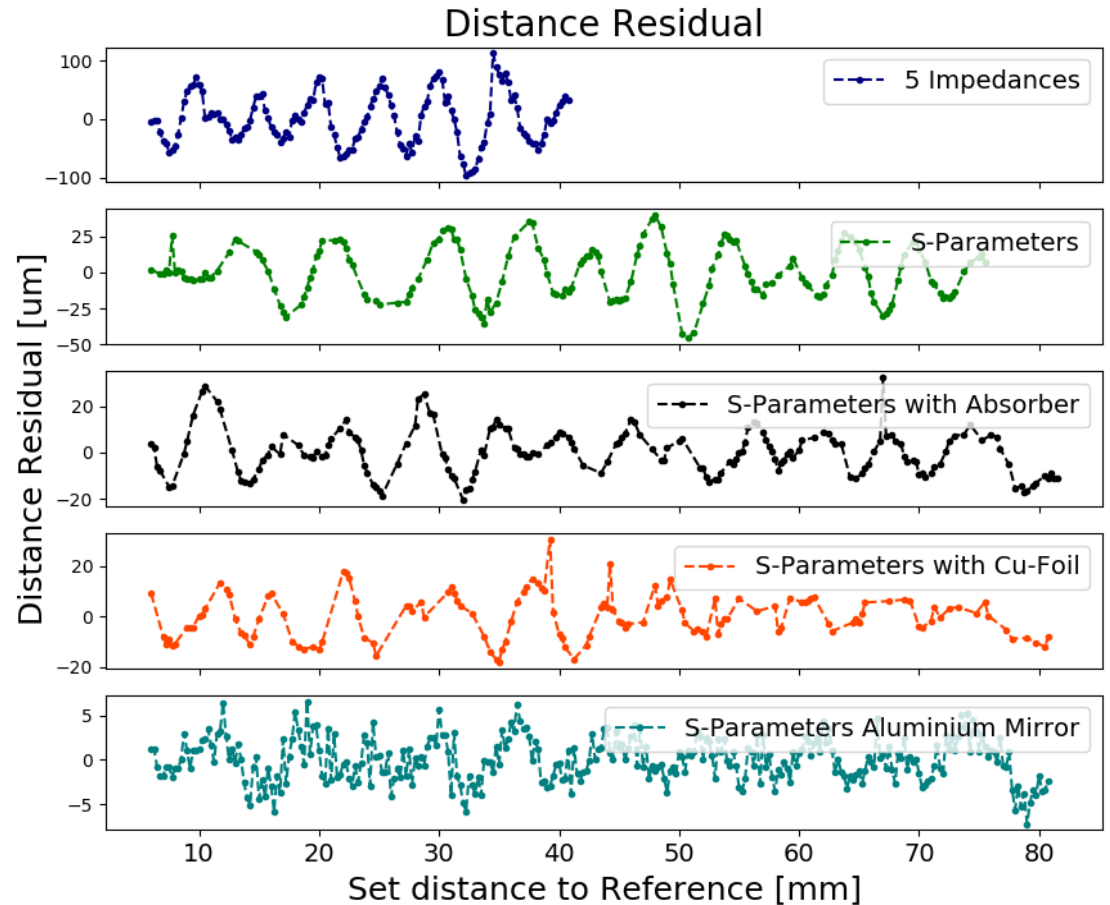
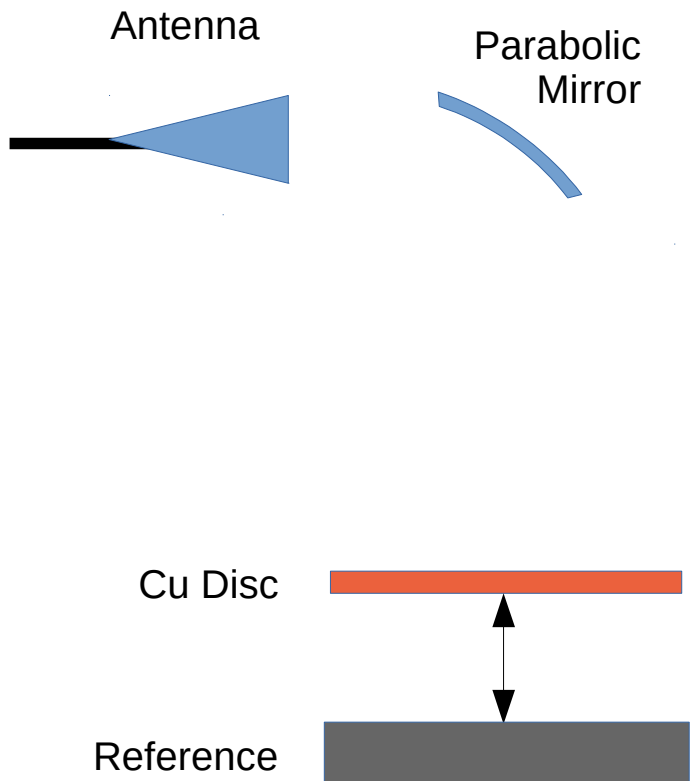
Test of model

Fit Distances – Mirror Only



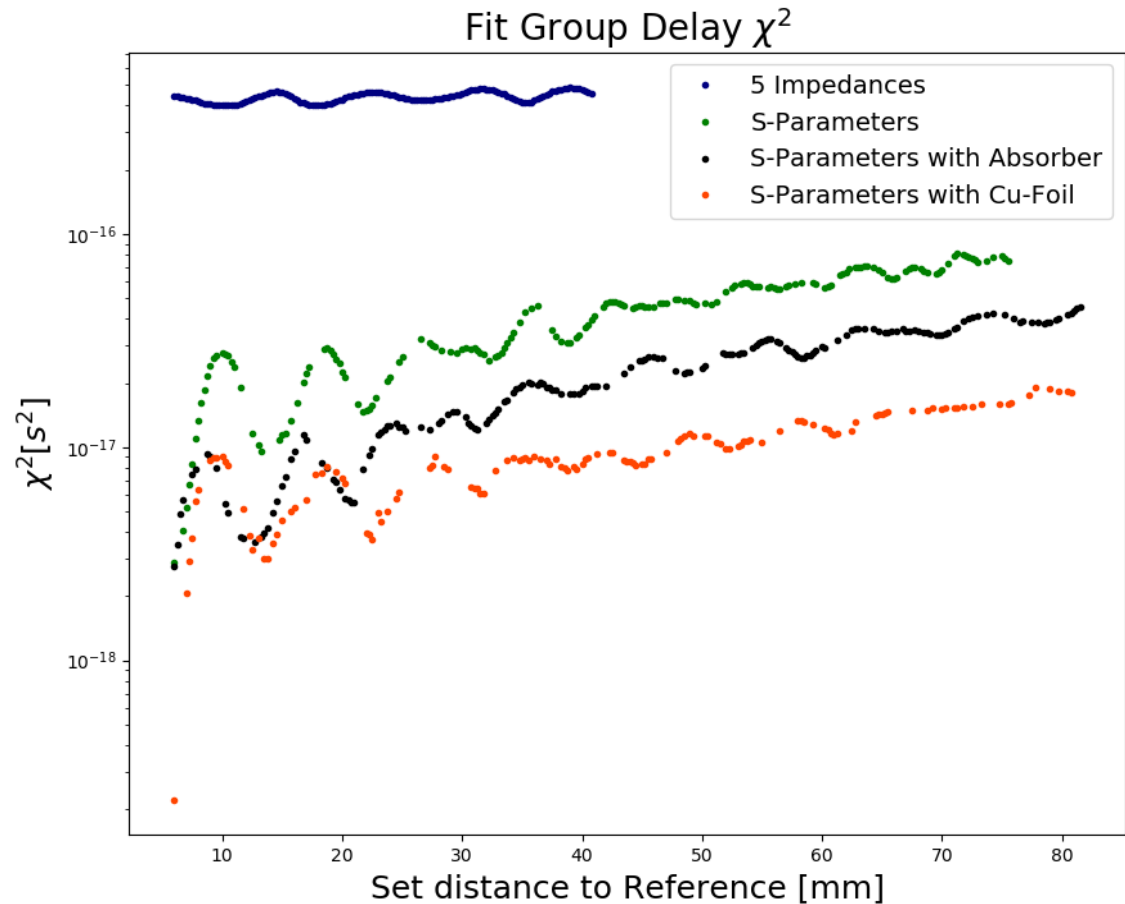
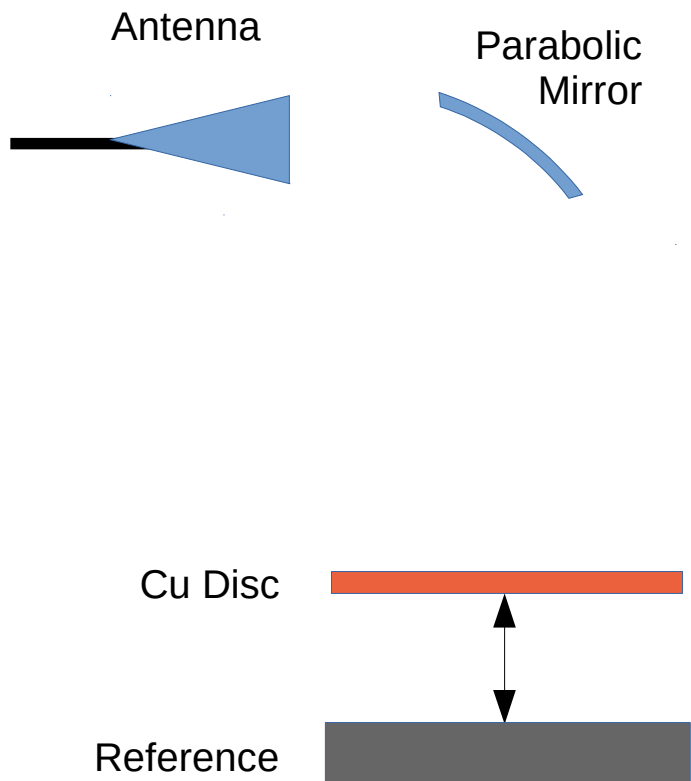
Test of model

Fit Distances – Mirror Only



Test of model

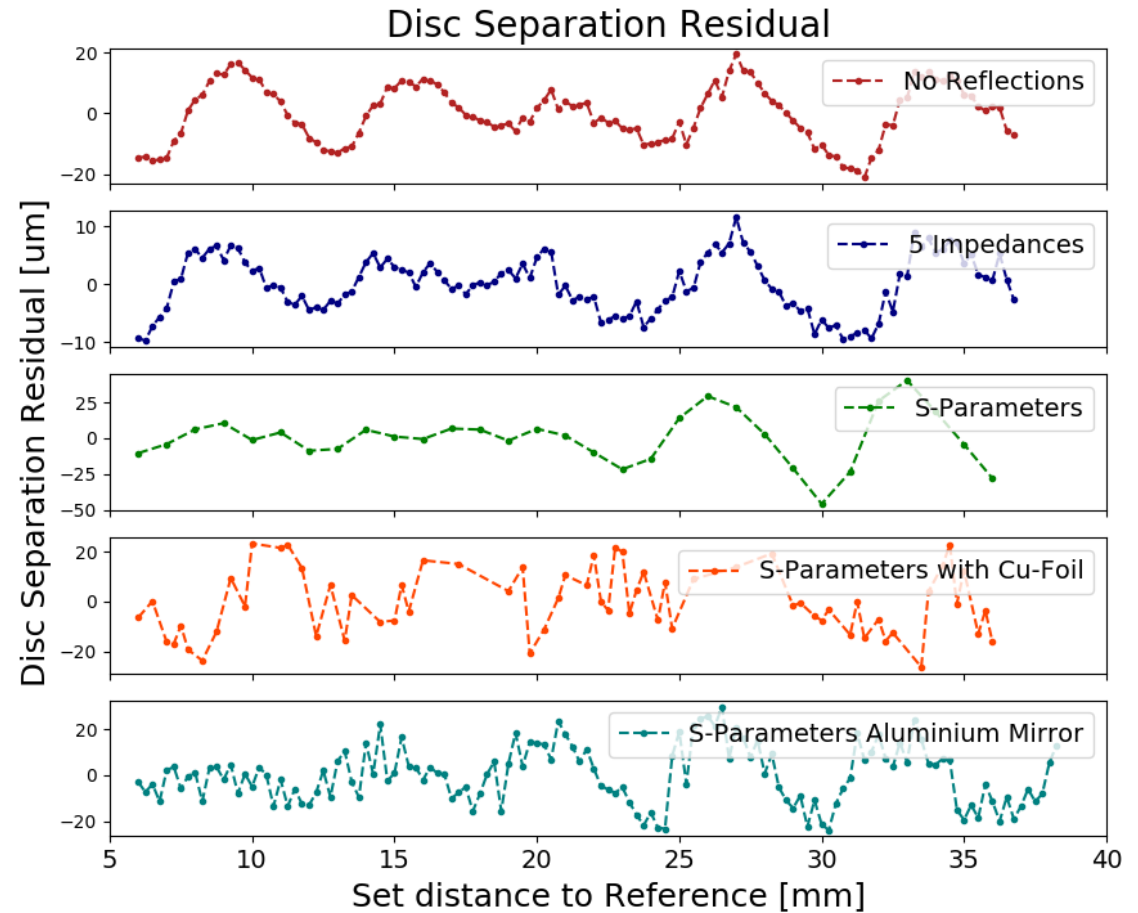
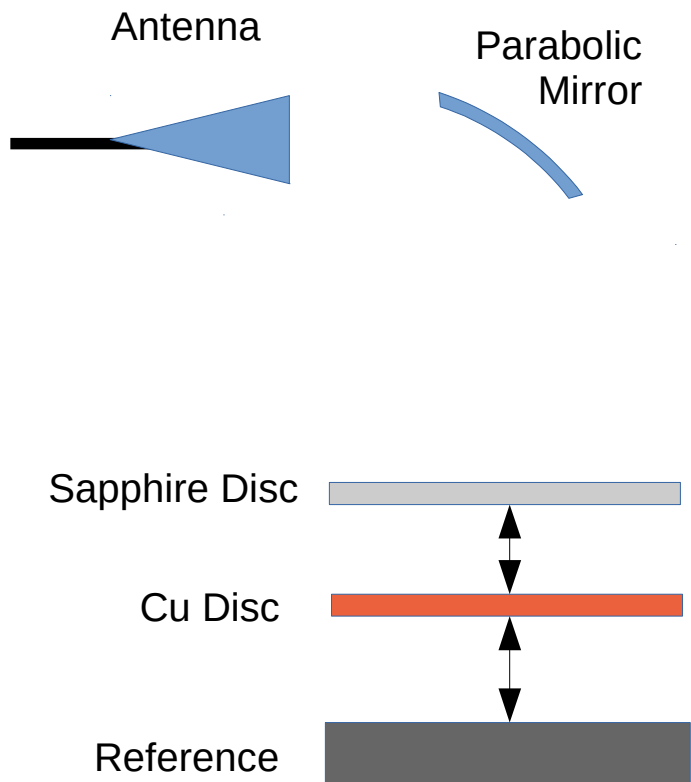
Fit Distances – Mirror Only



2 orders of magnitude improvement

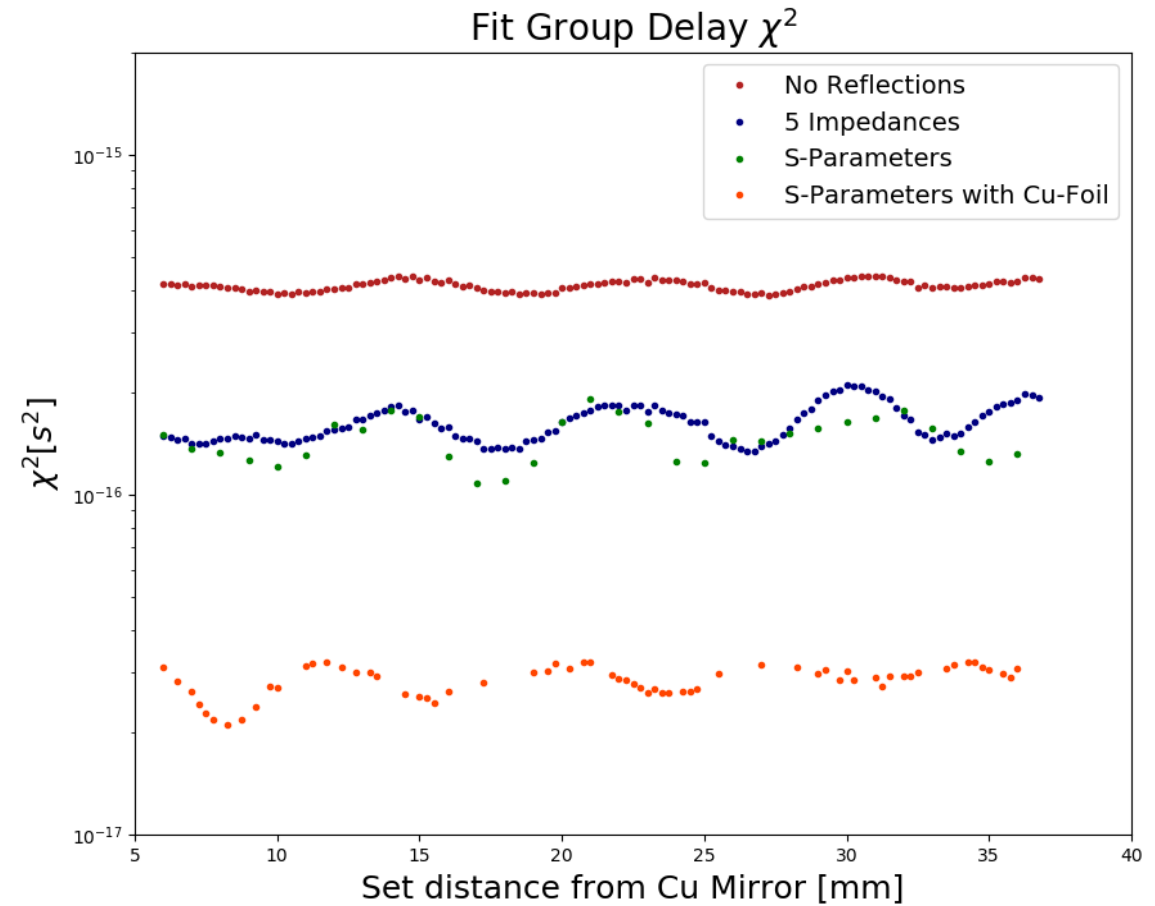
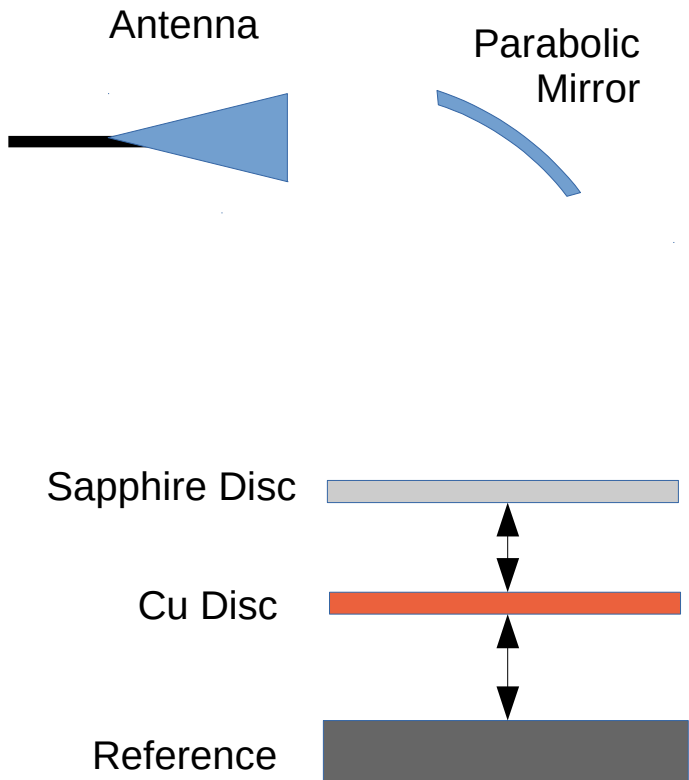
Test of model

Fit Distances – One disc

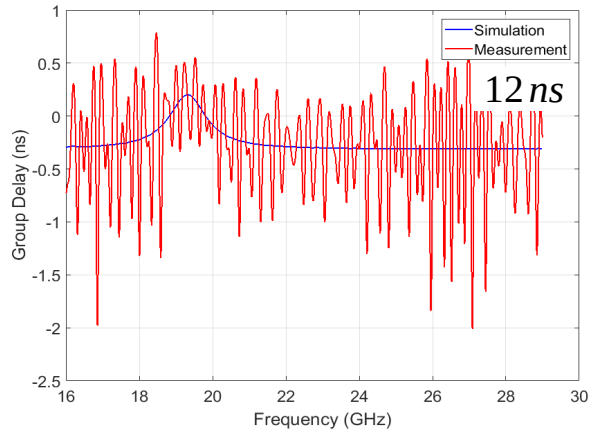


Test of model

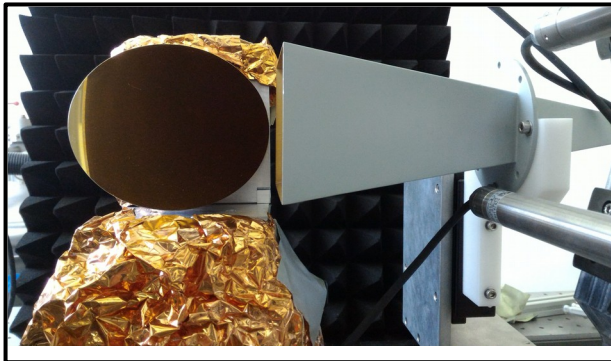
Fit Distances – One disc



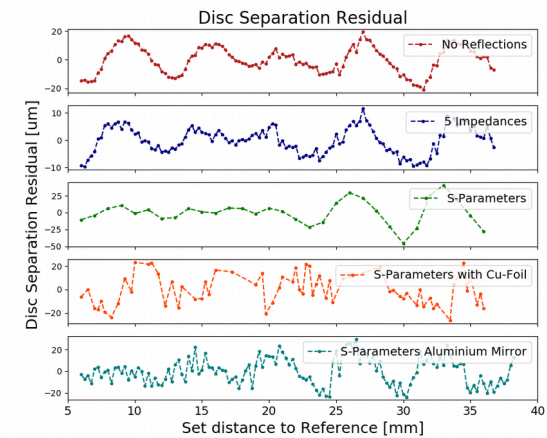
Summary



- Reflections cause problems

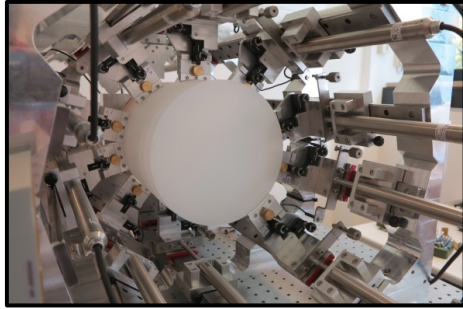


- Some can be suppressed

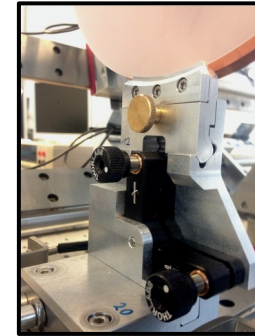


- Best Model accuracy $\approx 10 \mu\text{m}$

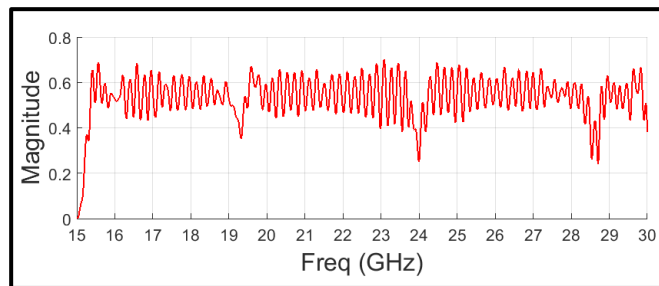
Outlook



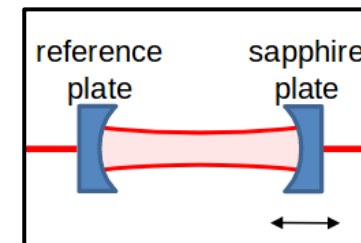
- Increase number of discs
→ Further test model



- Effect of disc tilts
→ Automatic tilting



- Study Losses
→ absorption, diffraction, disc tilts

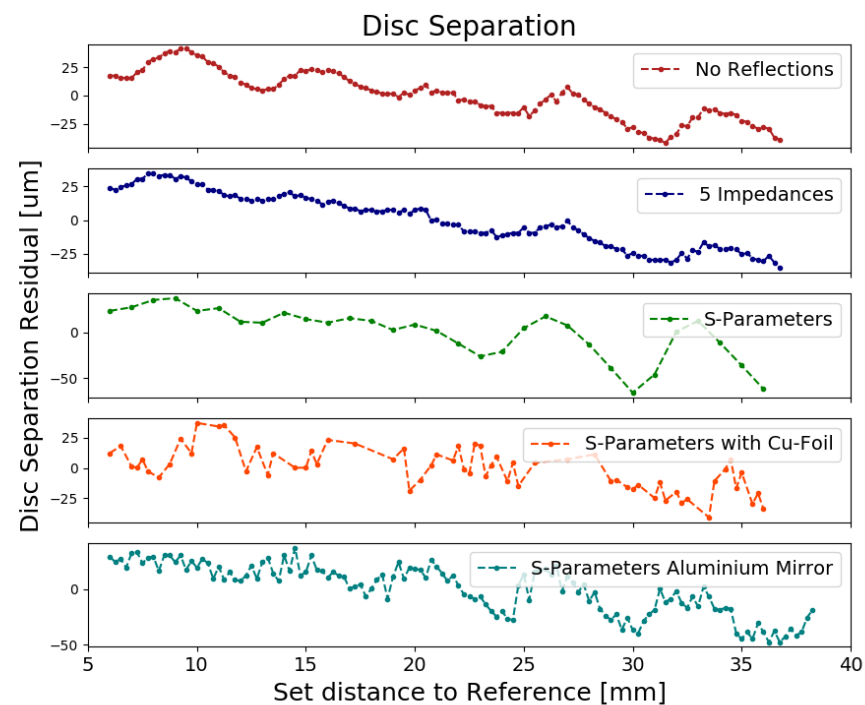
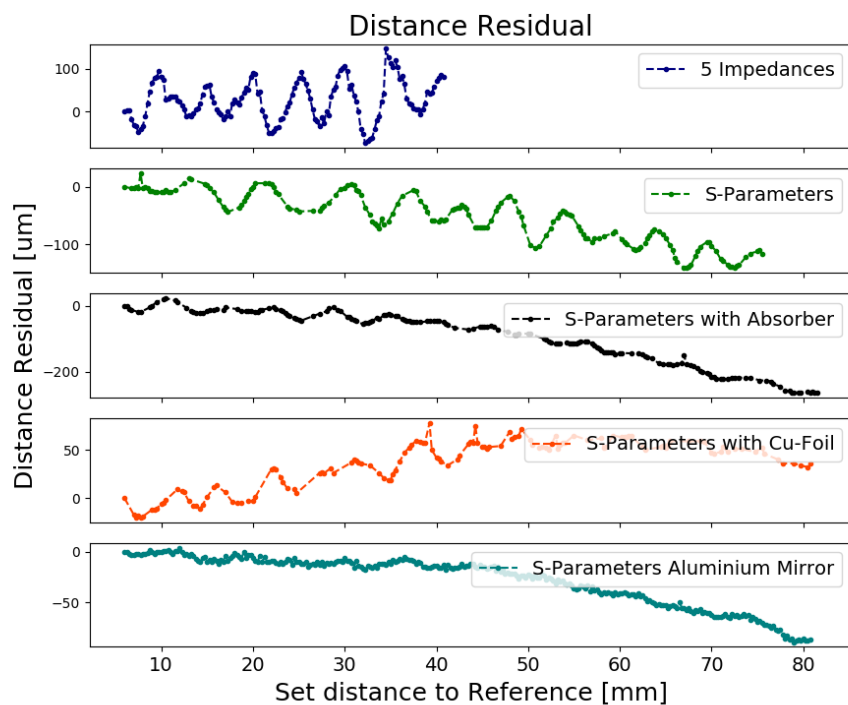


- Absolute positioning
→ Interferometer

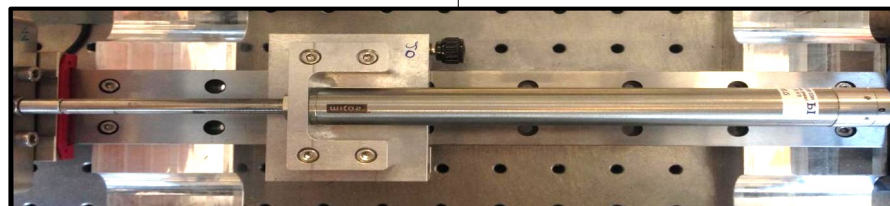
Appendix

Backup Slides

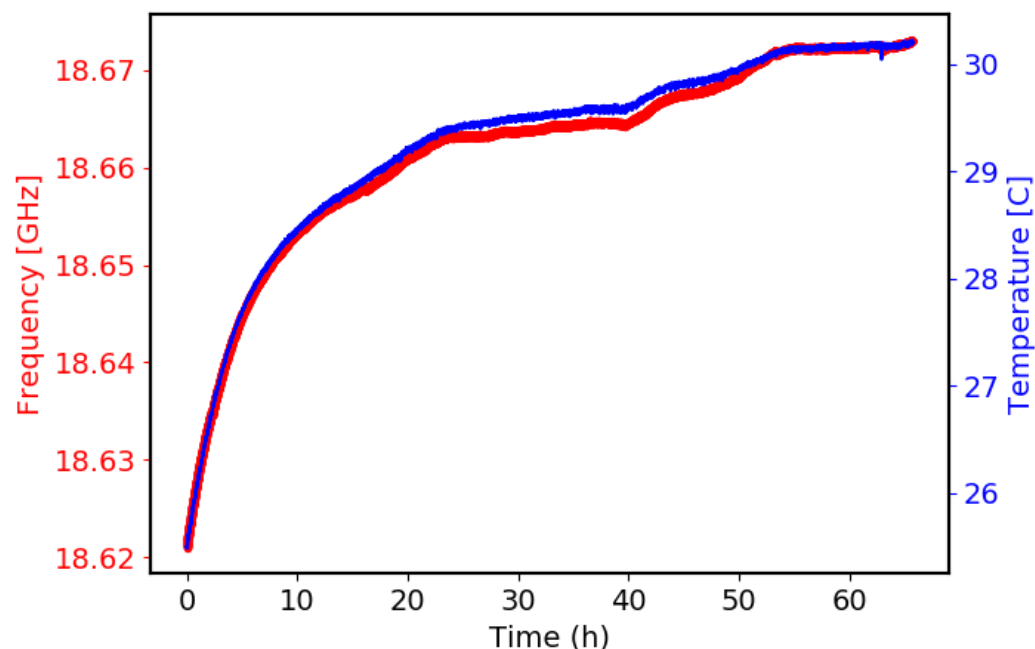
Uncorrected residuals with long distance trend



Backup Slides

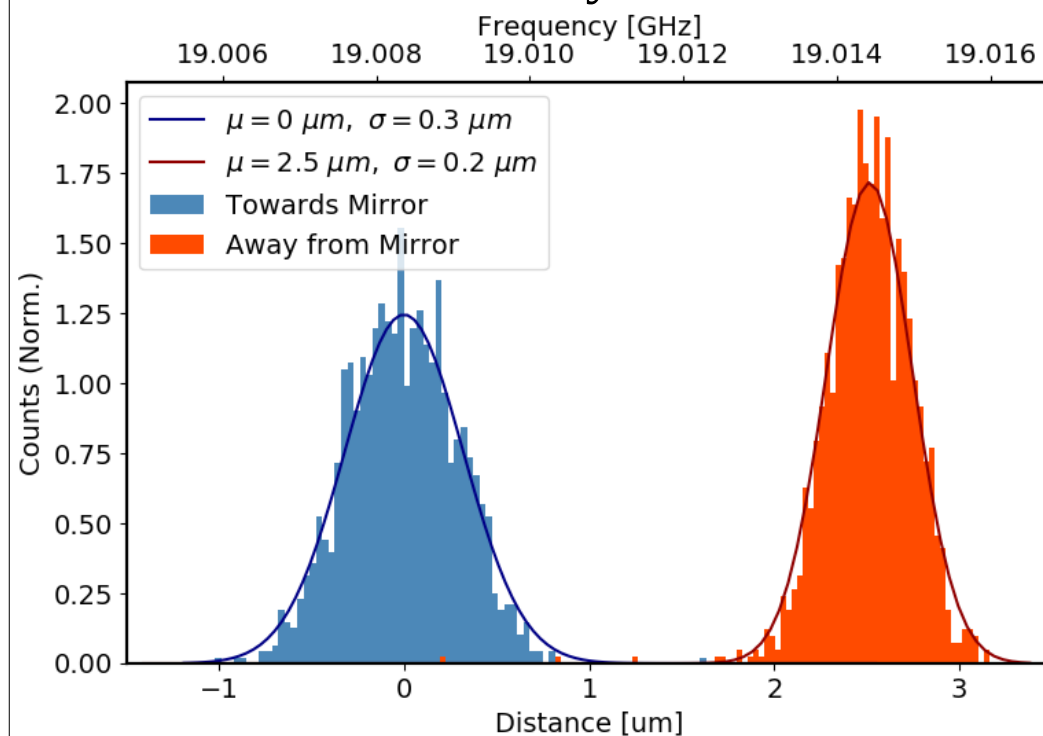


Temperature Response



- Thermal expansion changes disc distance

Motor Hysteresis



- Command motor to the same position coming from different directions