MAX-PLANCK-GESELLSCHAFT

Frequency distribution of unmodulated bunch

Jan Pucek

Motivation

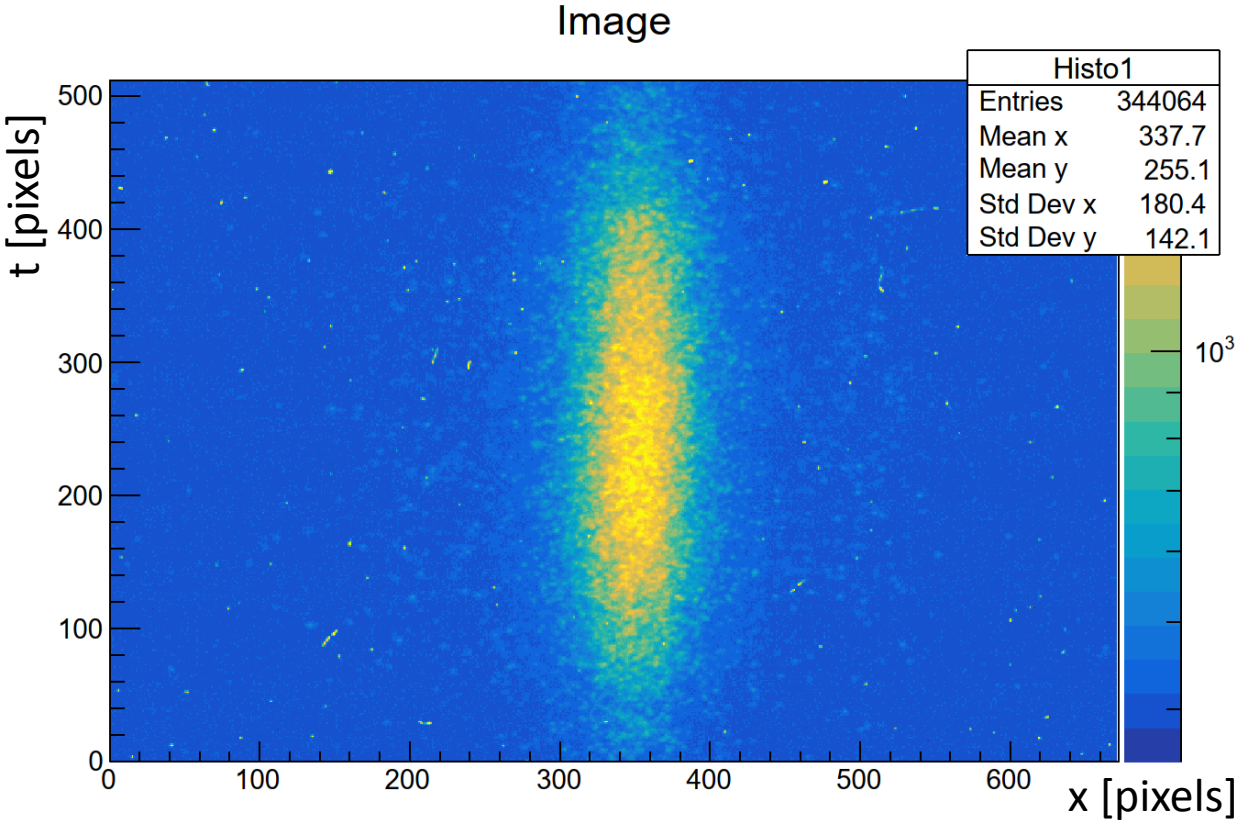
- Hosing has been observed under special conditions
- Simple question: Could this be introduced by modulation of the incoming bunch? (is the hosing frequency equal to any frequency already present in the bunch)

Used data

- Dataset one: 52 images, 10/09/2018, 00:16-00:38
- Dataset two: 52 images, 16/09/2017, 23:22-23:40
- Dataset three: 233 images, 02/11/2018, 09:33-14:19
- Data can be shown upon request

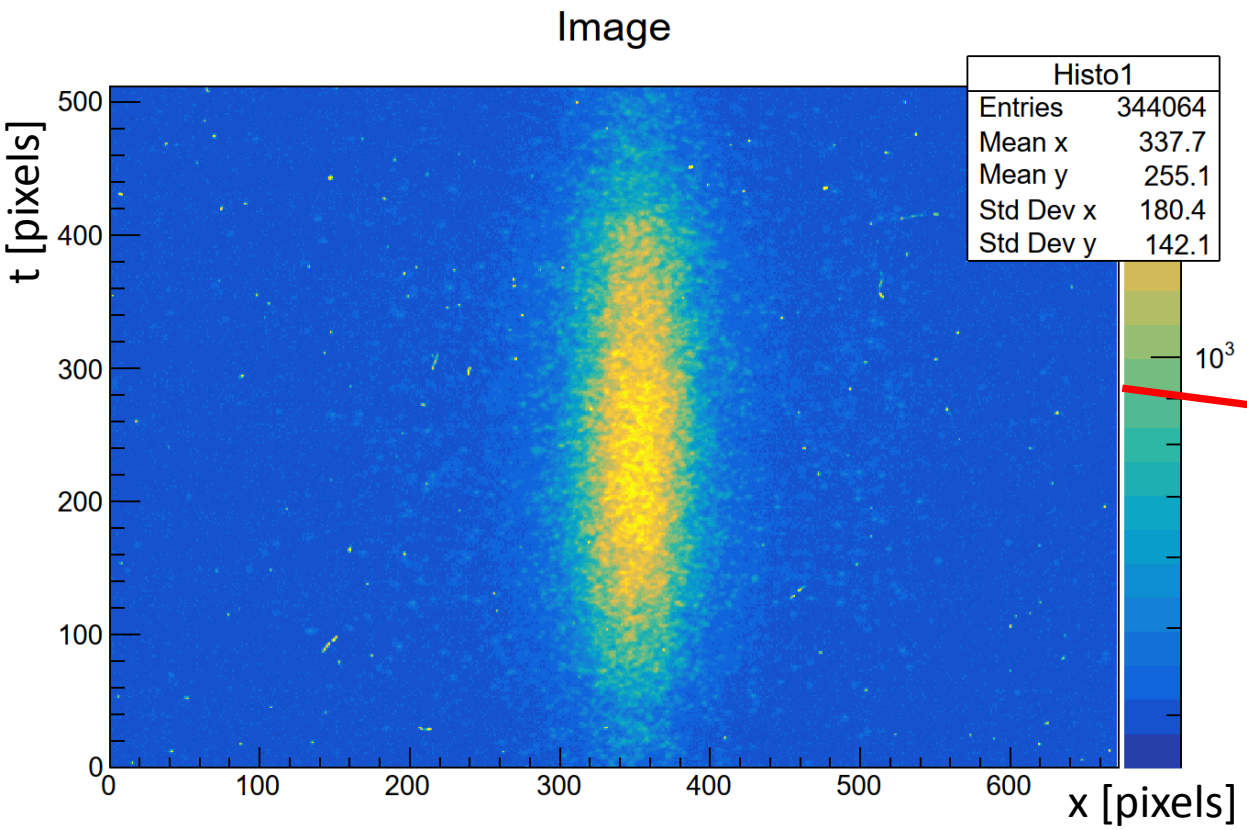
Analysis

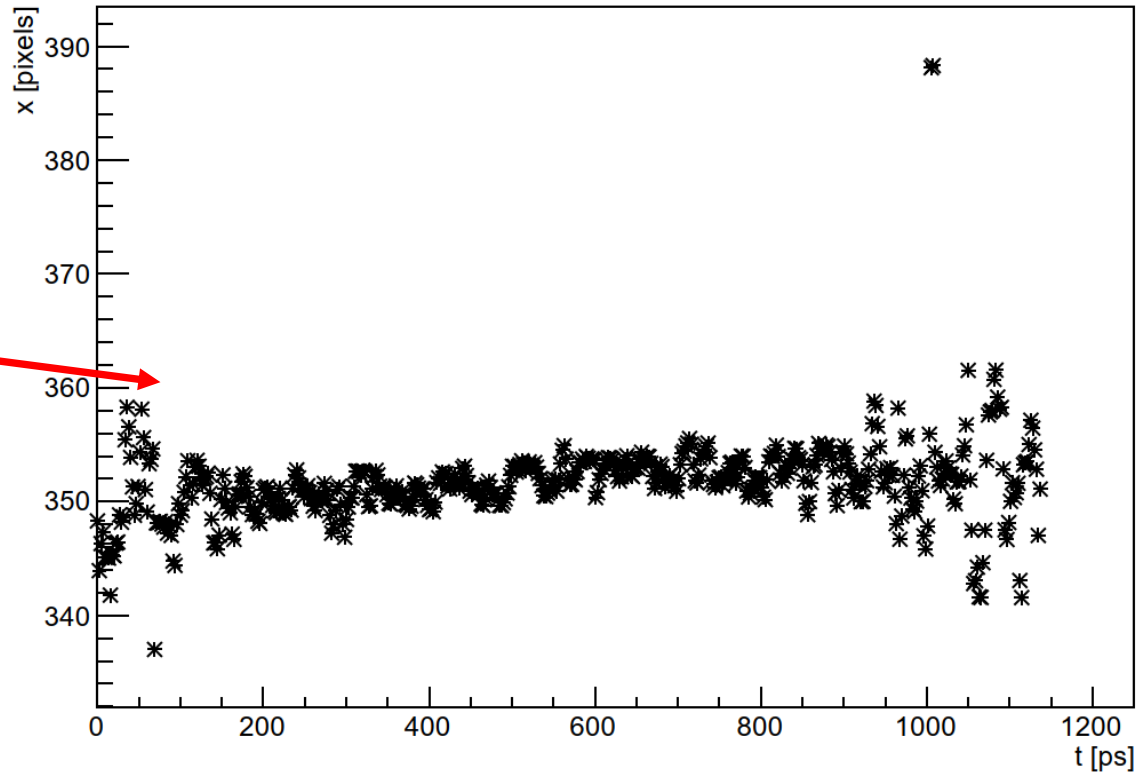
- From the streak camera “1 ns” images were obtained when the laser was OFF
- At each time t, the pixel row was fitted by a Gaussian to obtain mean value and beam width



Analysis

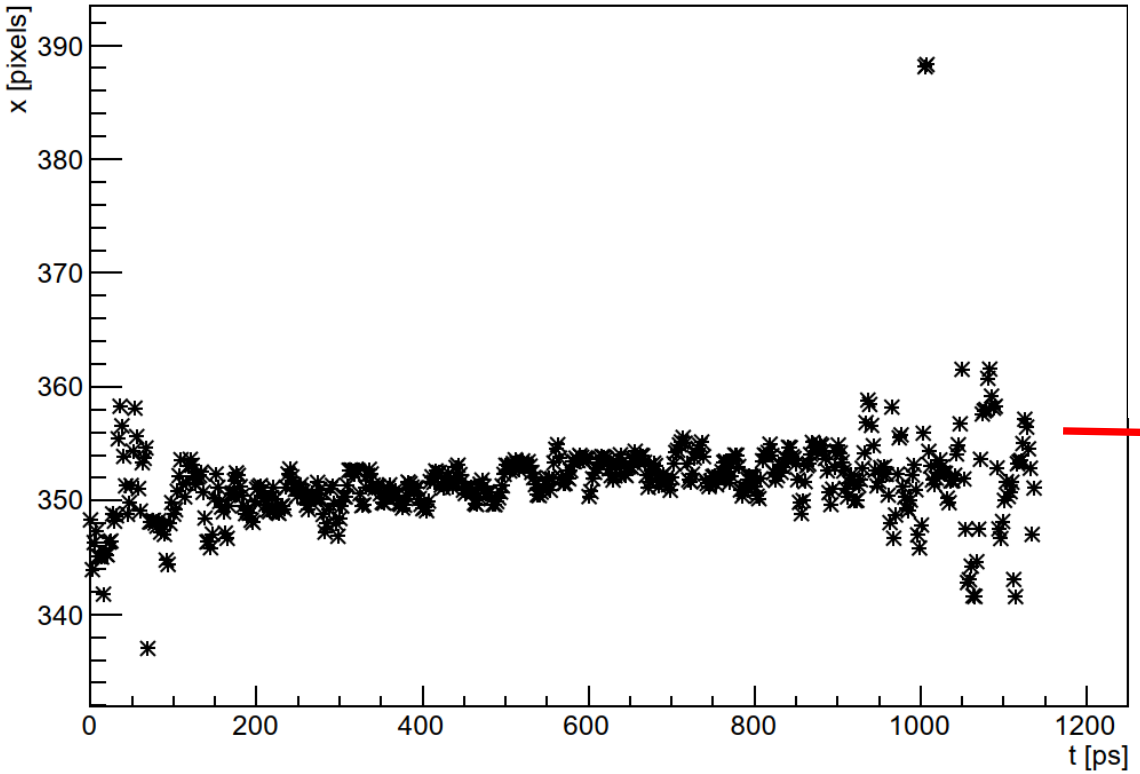
- All the fitted values were plotted showing mean value dependence in time or radial size dependence.

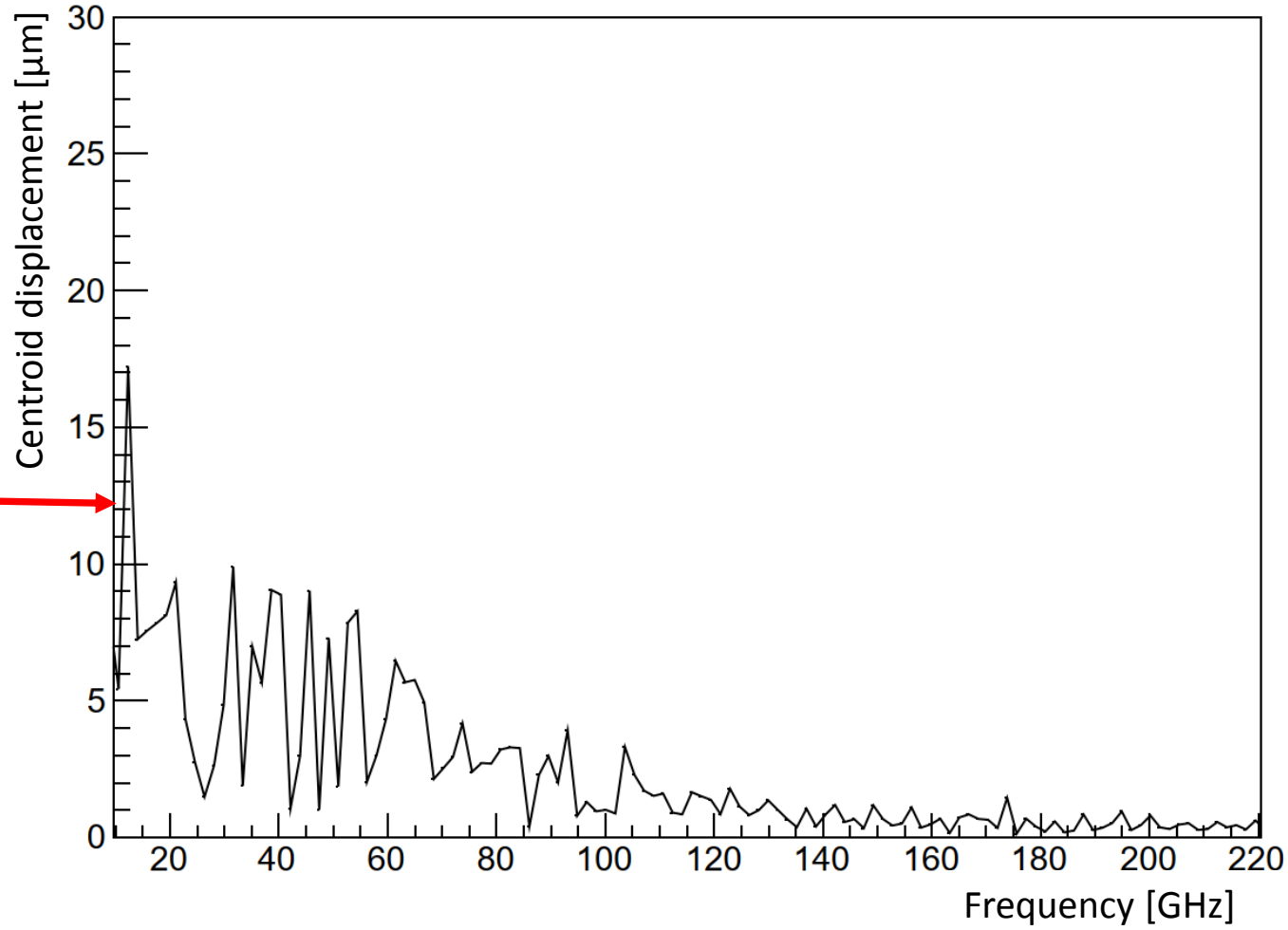




Analysis

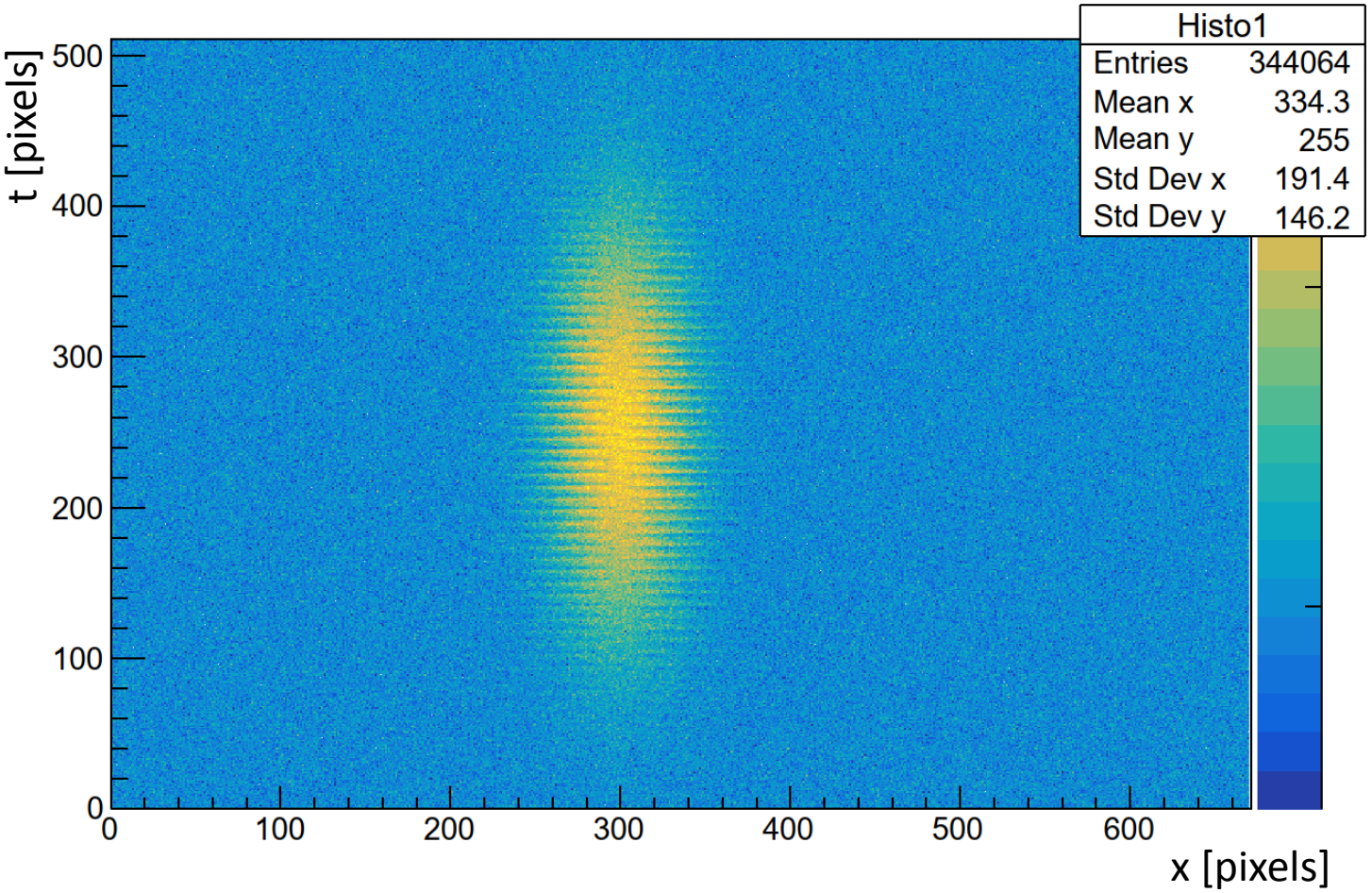
- The points were transformed by FFT into frequency space showing the amplitudes for each frequency.

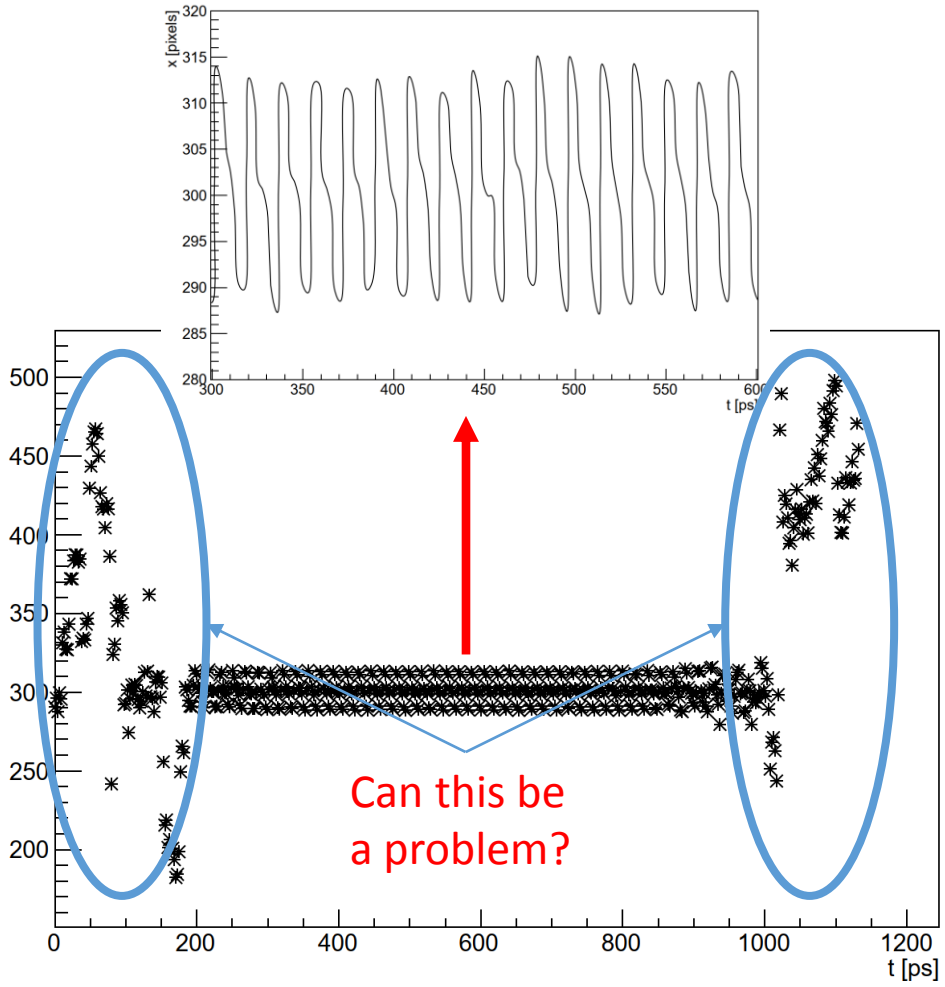




Randomly generated (artificial) data– large amplitude oscillations

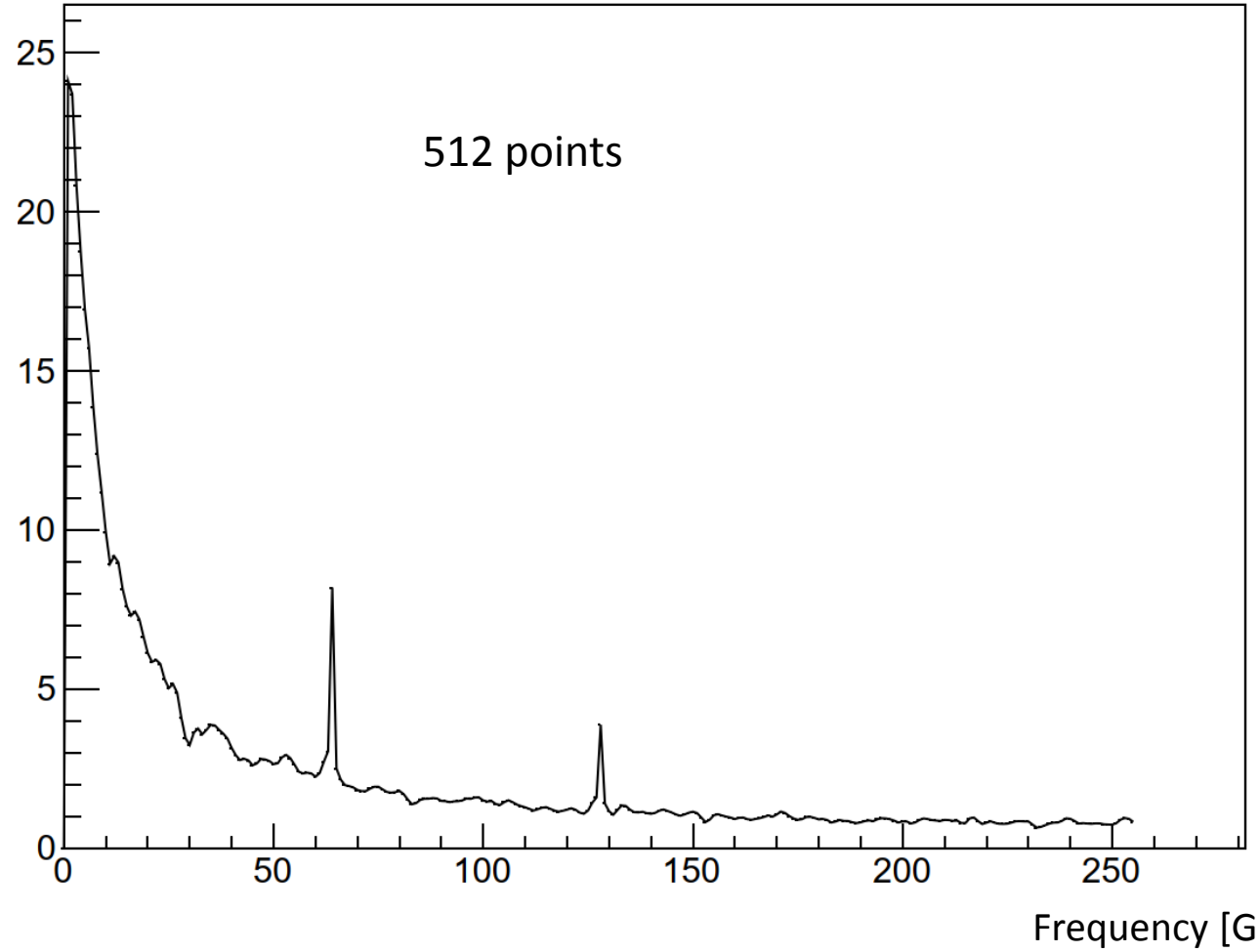
Center = $300 + 10 \sin \frac{2\pi t}{8} + 5 \sin \frac{2\pi t}{4}$

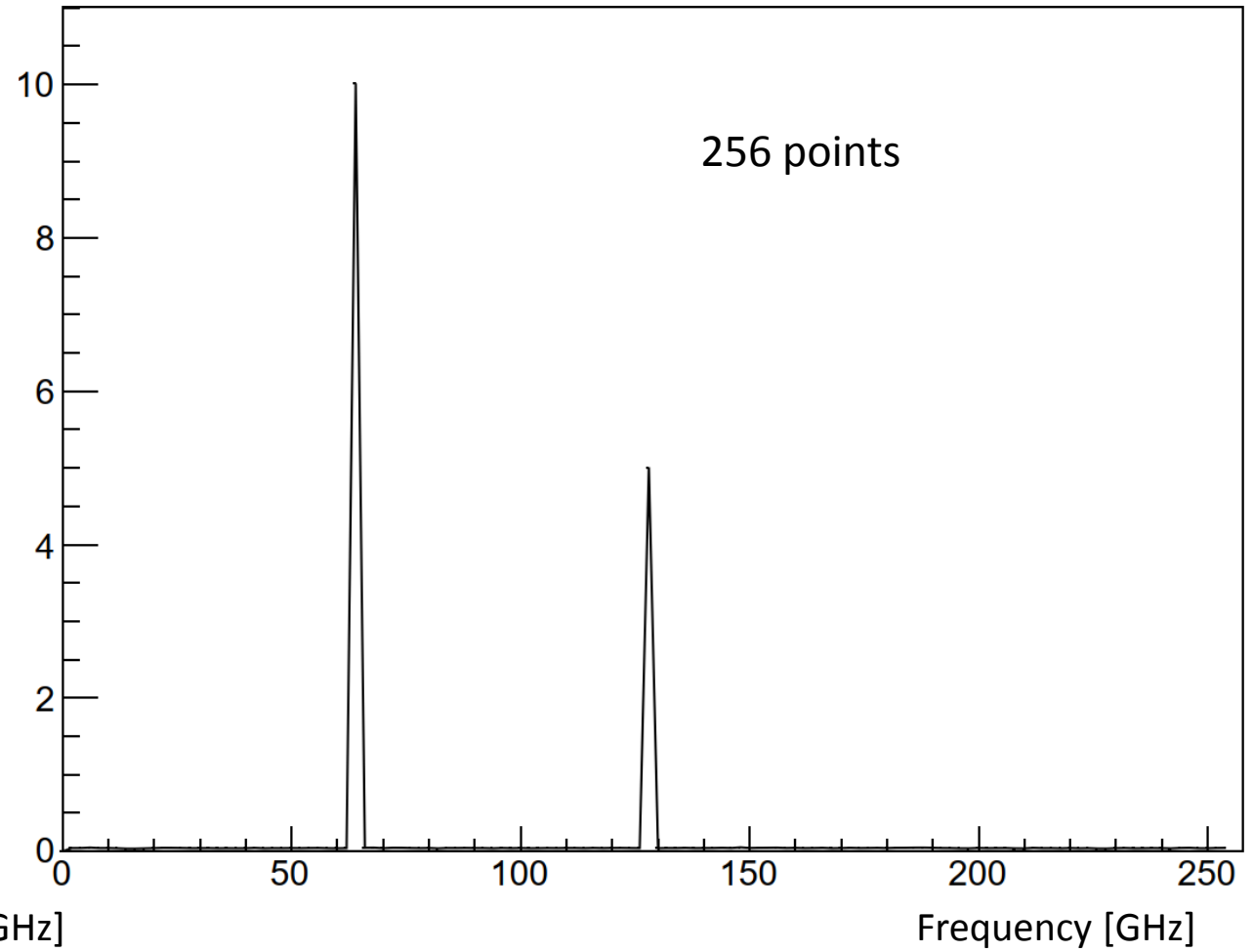




Randomly generated (artificial) data

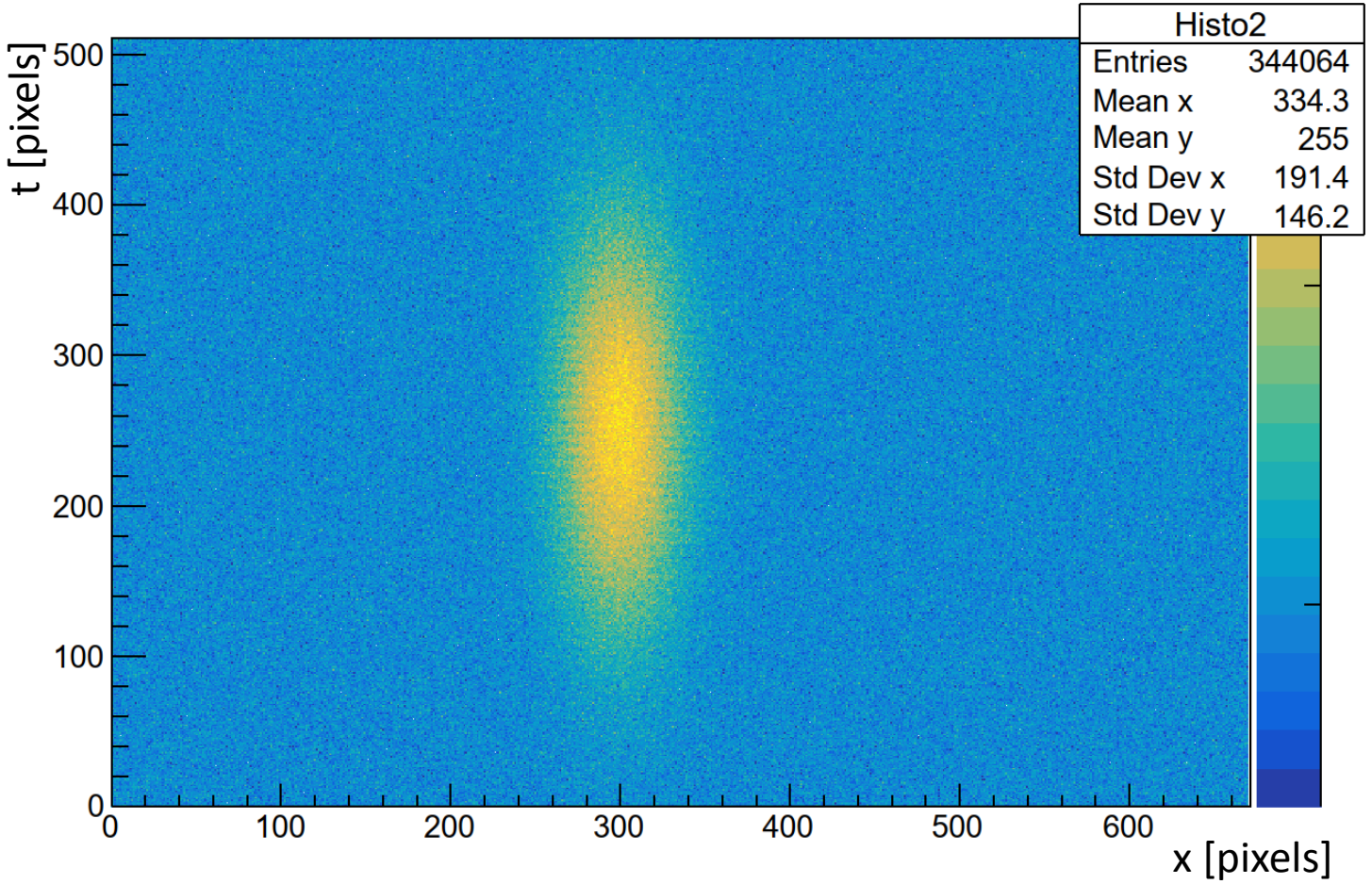
Even in background the oscillations are visible. Clear signal is obtained by using central 256 points.





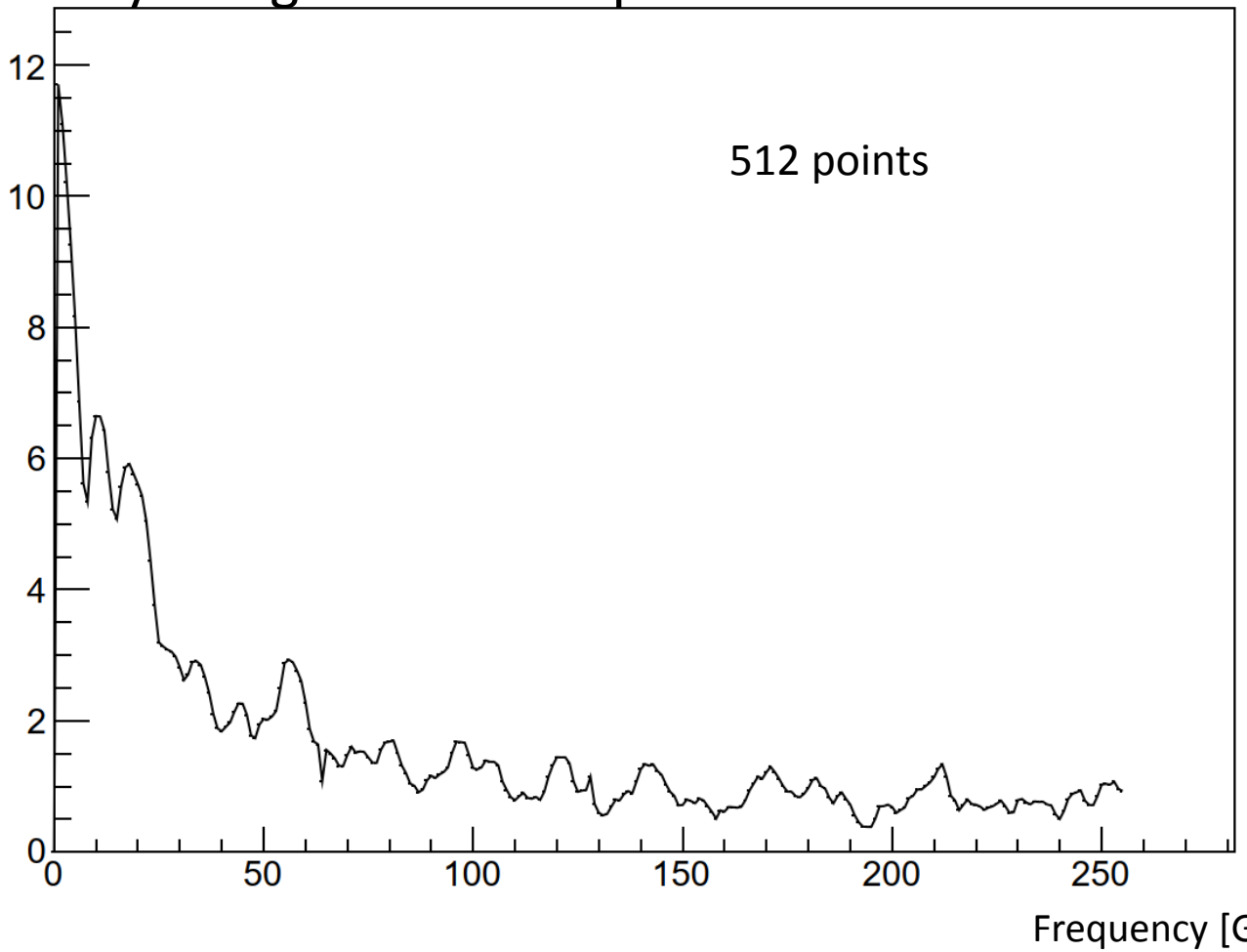
Randomly generated (artificial) data– small amplitude oscillations

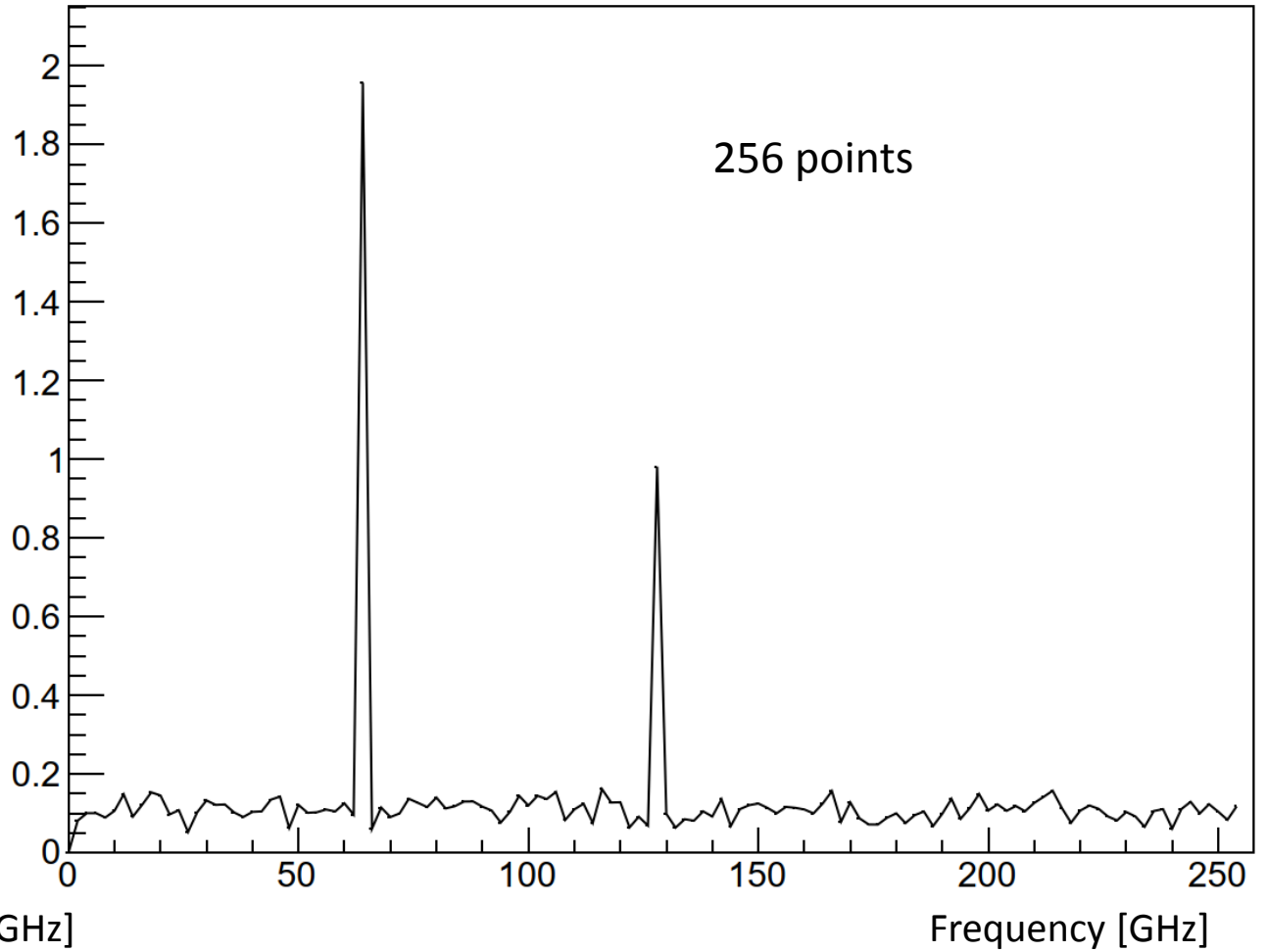
Center = $300 + 2\sin\frac{2\pi t}{8} + \sin\frac{2\pi t}{4}$



Randomly generated (artificial) data

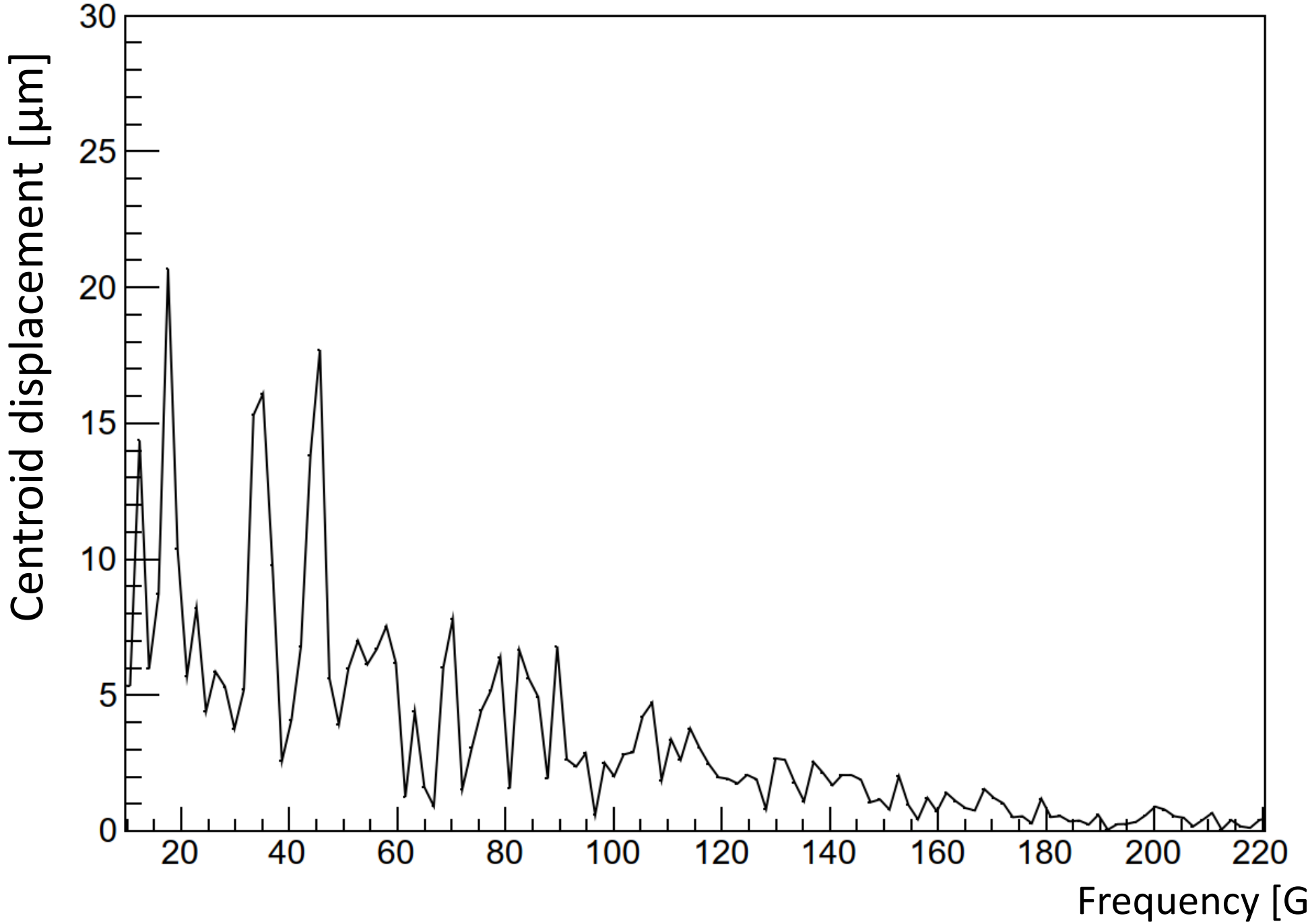
With the background present the signal is not visible. Signal can be made visible by using central 256 points

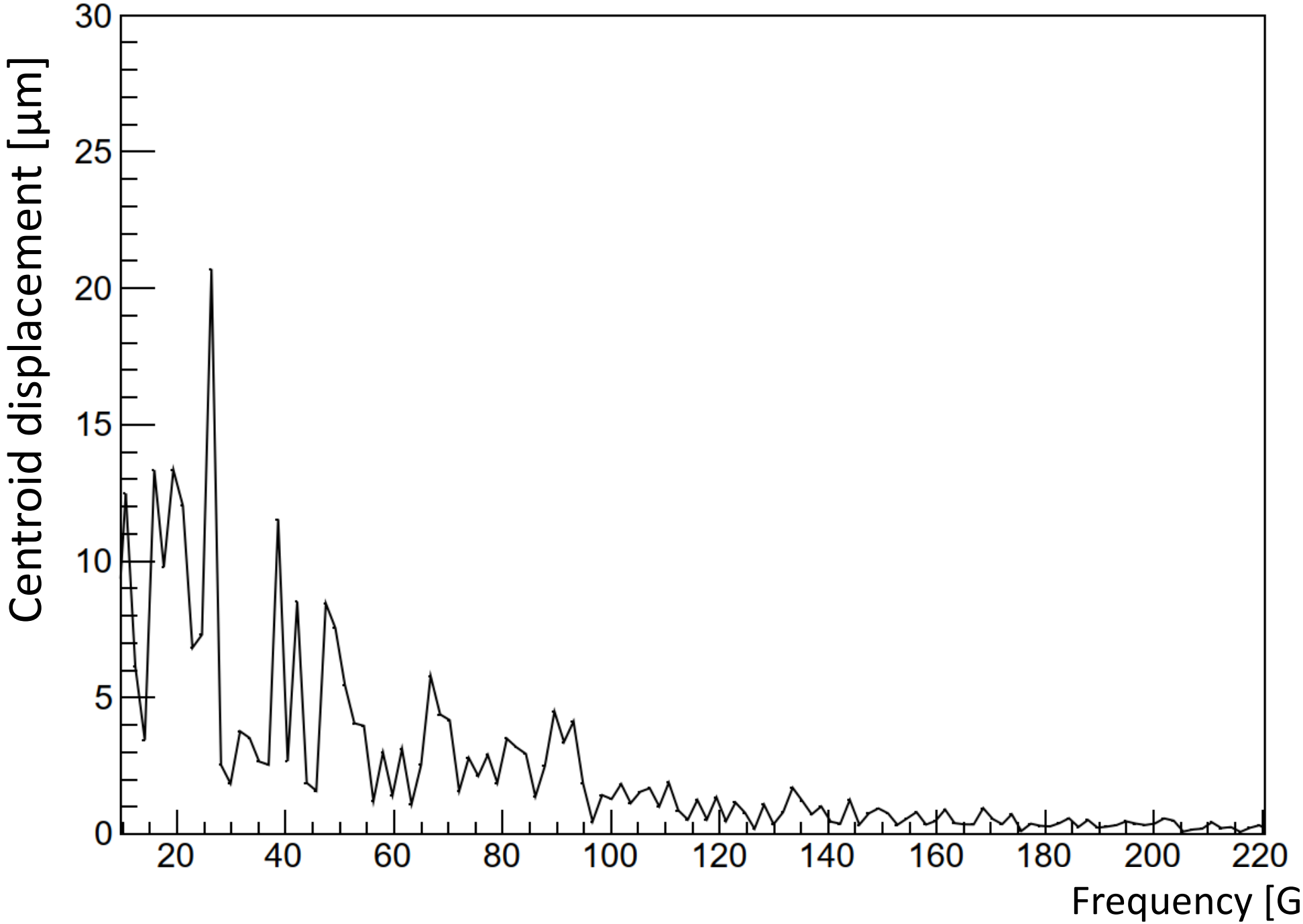




Individual FFT

- From the generated data better results are obtained by using the central 256 points.
- To obtain the frequency amplitudes, the absolute value of real and imaginary Fourier output was used.

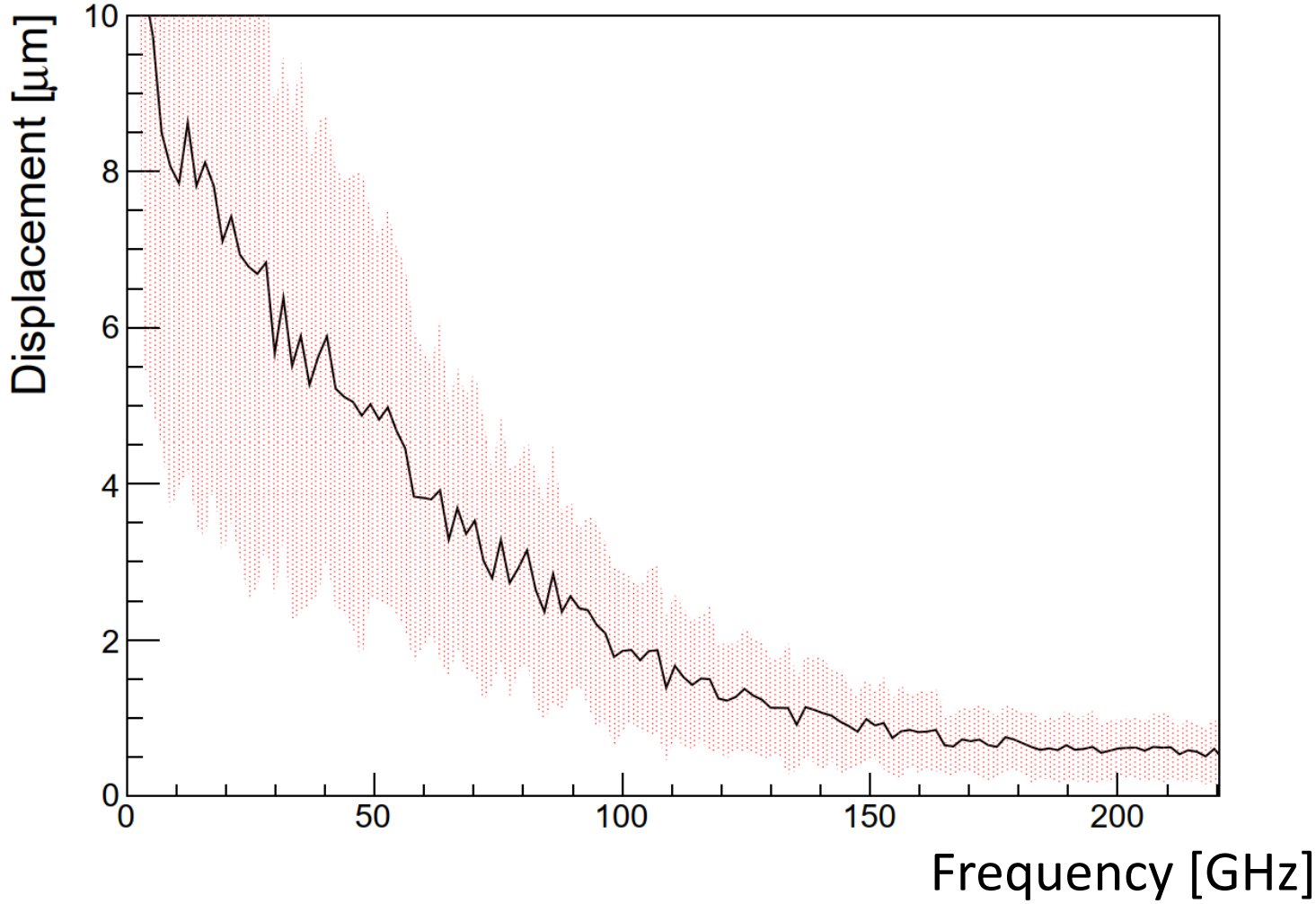

Centroid displacement [μm]
30
25
20
15
10
5
0
20
40
60
80
100
120
140
160
180
200
220
Frequency [GHz]


Centroid displacement [μm]
30
25
20
15
10
5
0
20
40
60
80
100
120
140
160
180
200
220
Frequency [GHz]

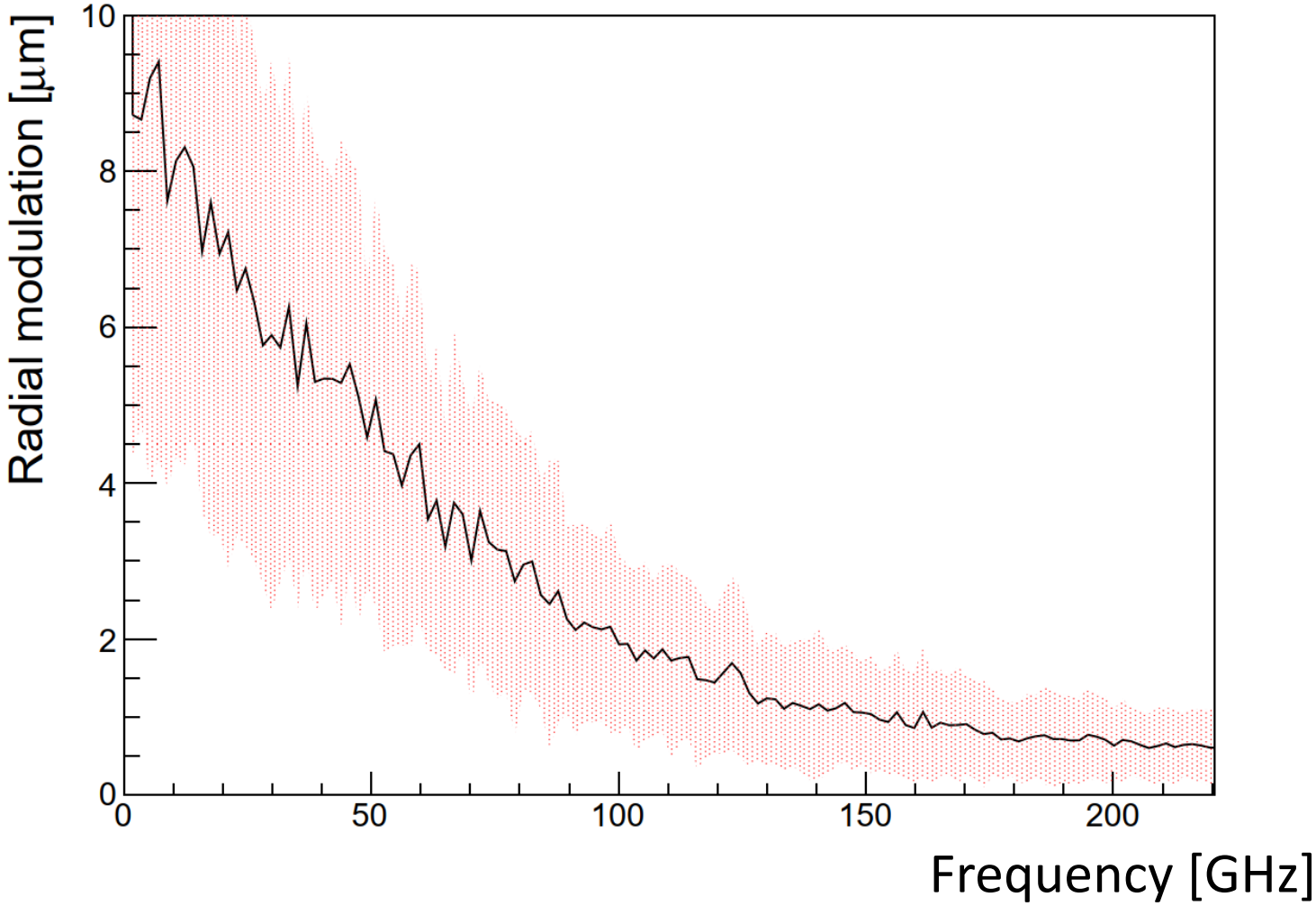
Individual FFT

- From the generated data better results are obtained by using the central 256 points.
- To obtain the frequency amplitudes, the absolute value Fourier transform was used.
- Individual FFTs vary a lot -> mean values for whole datasets were computed

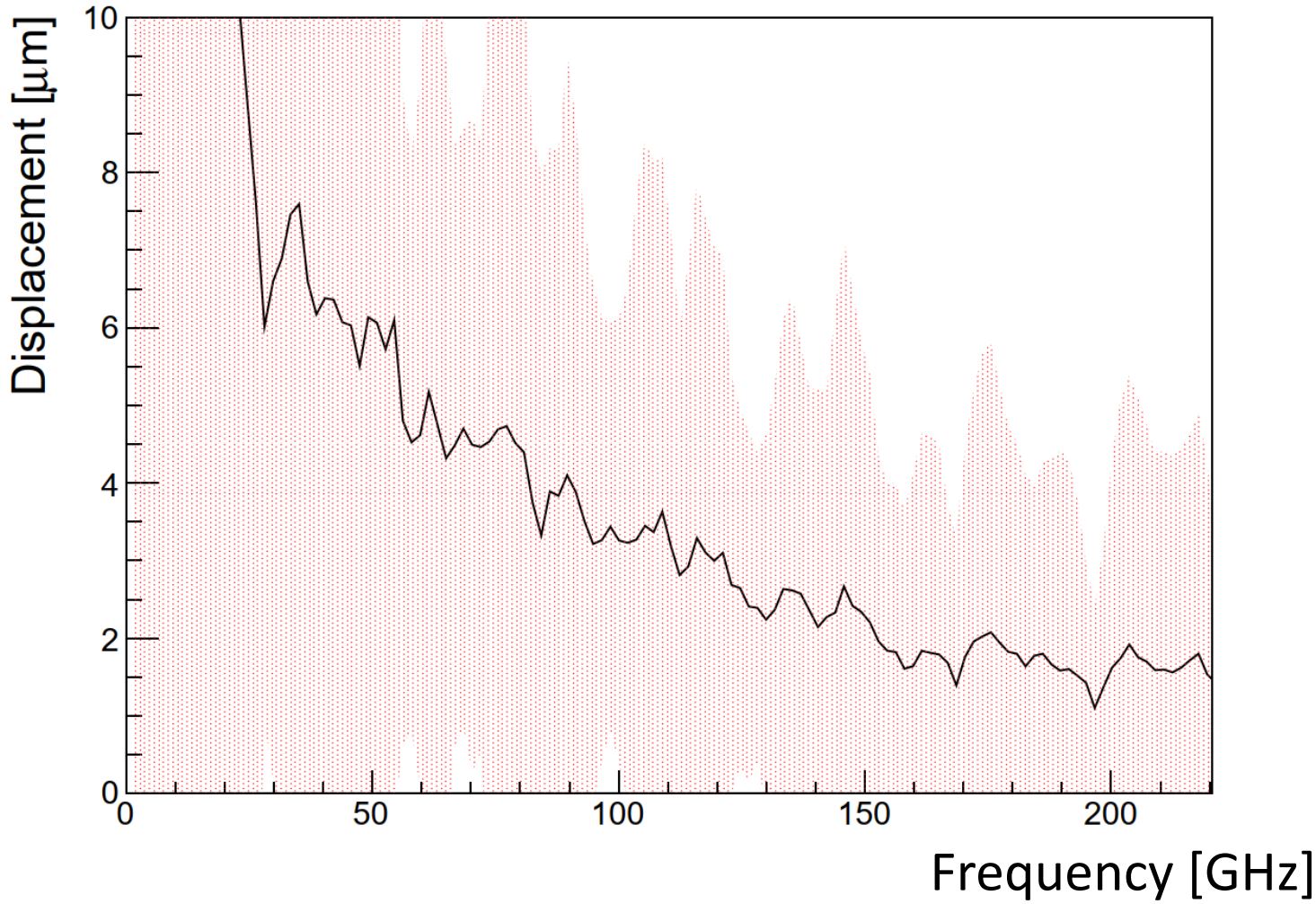
Results – Dataset 1



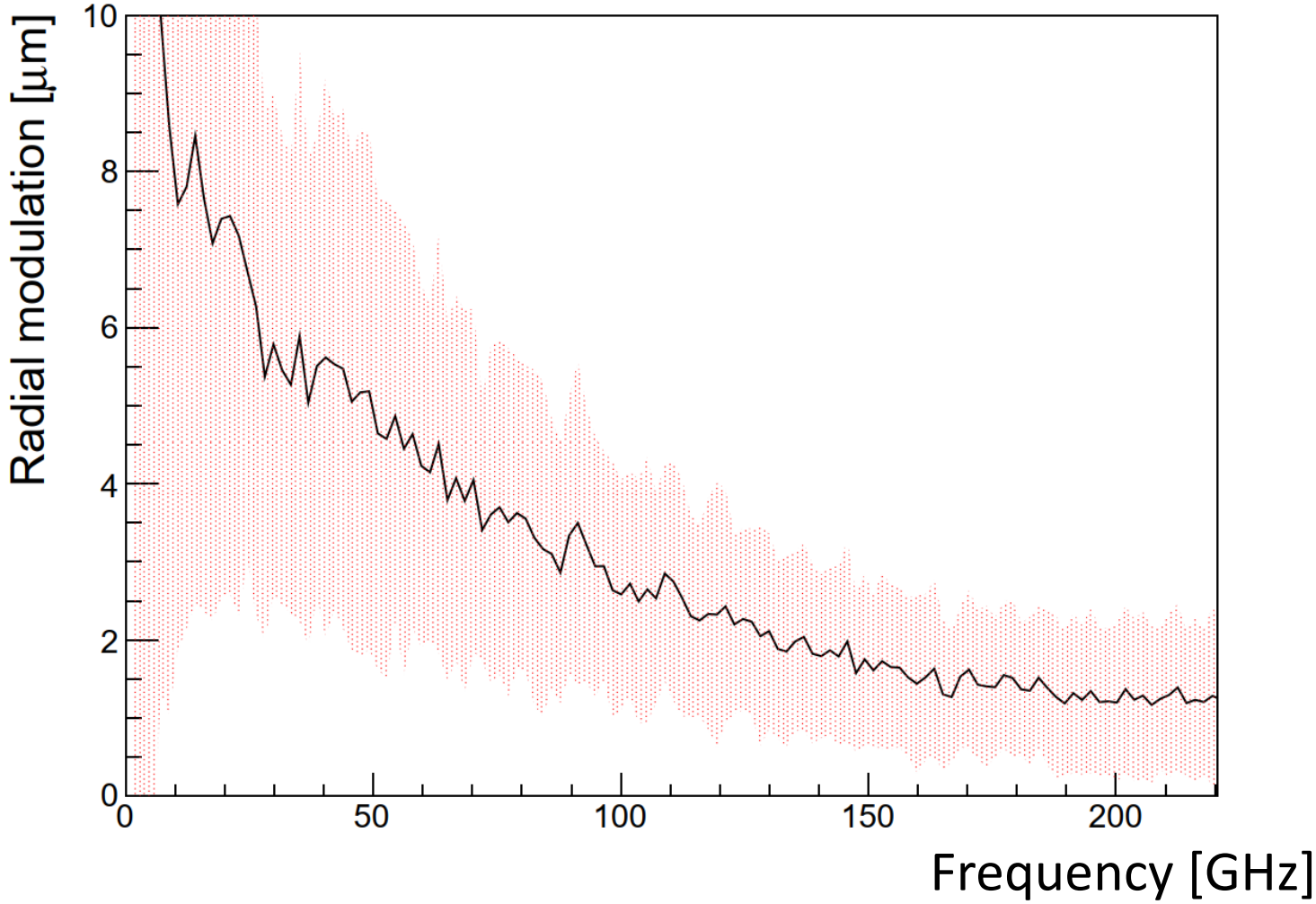
Results – Dataset 1



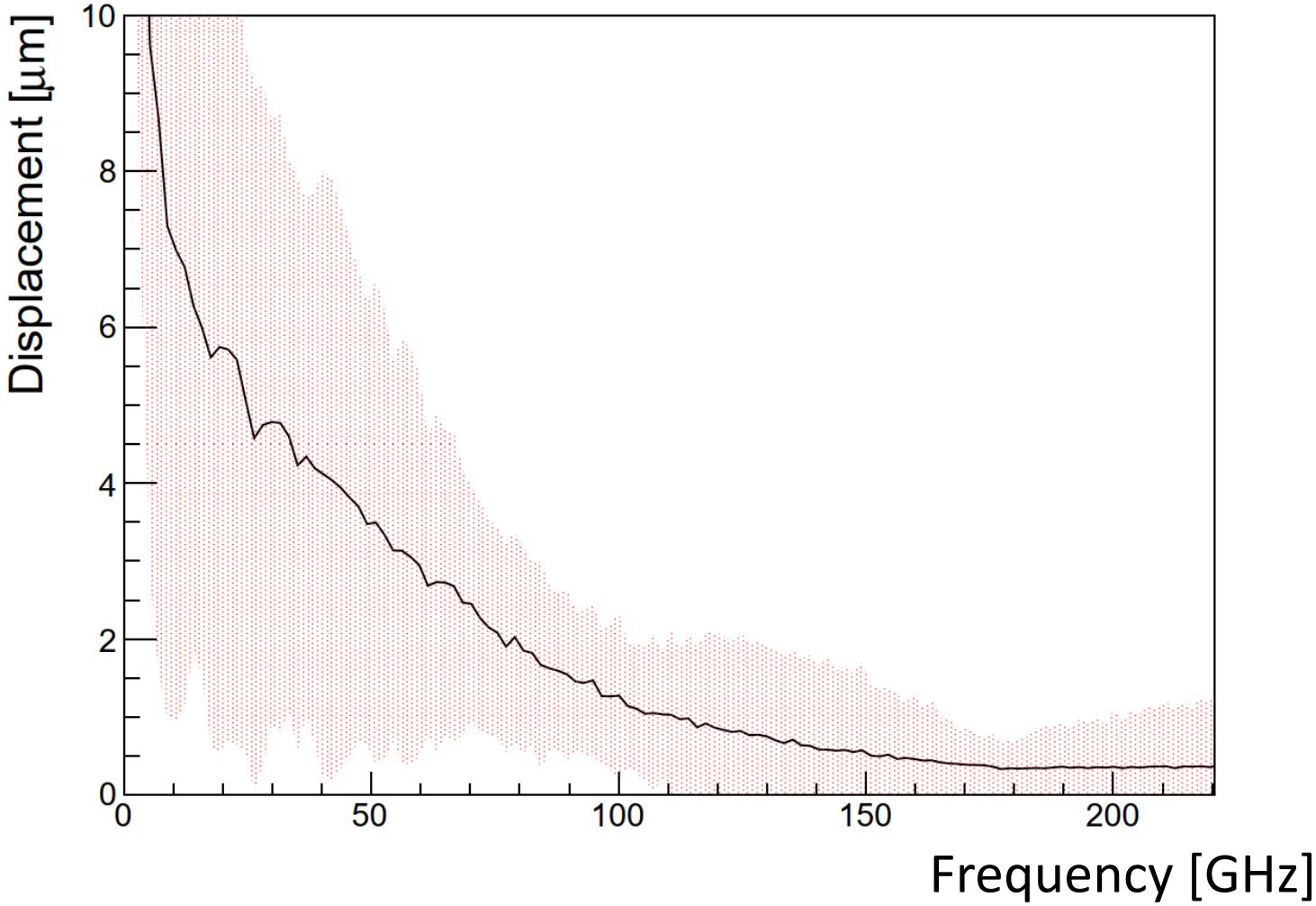
Results – Dataset 2



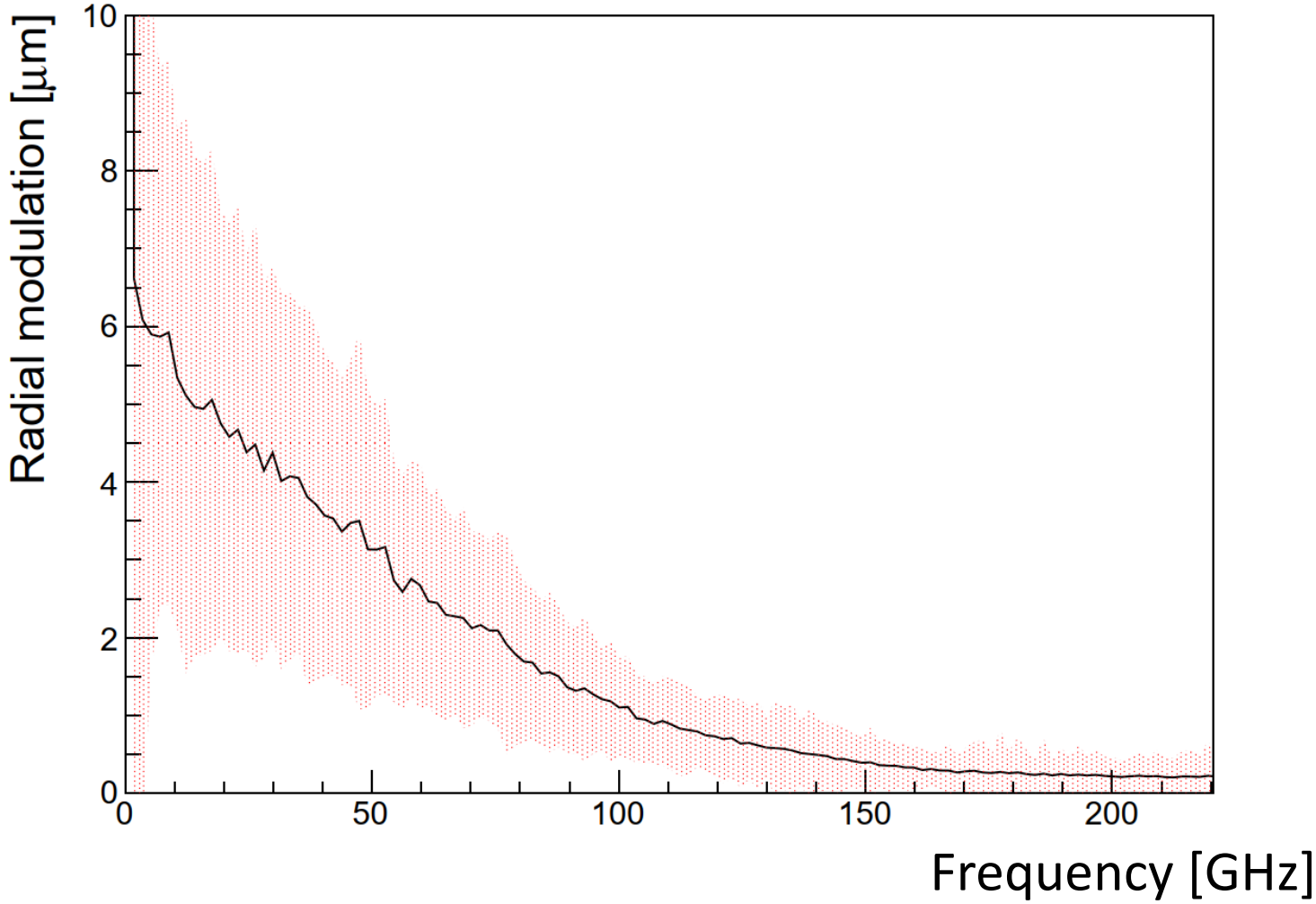
Results – Dataset 2



Results – Dataset 3



Results – Dataset 3

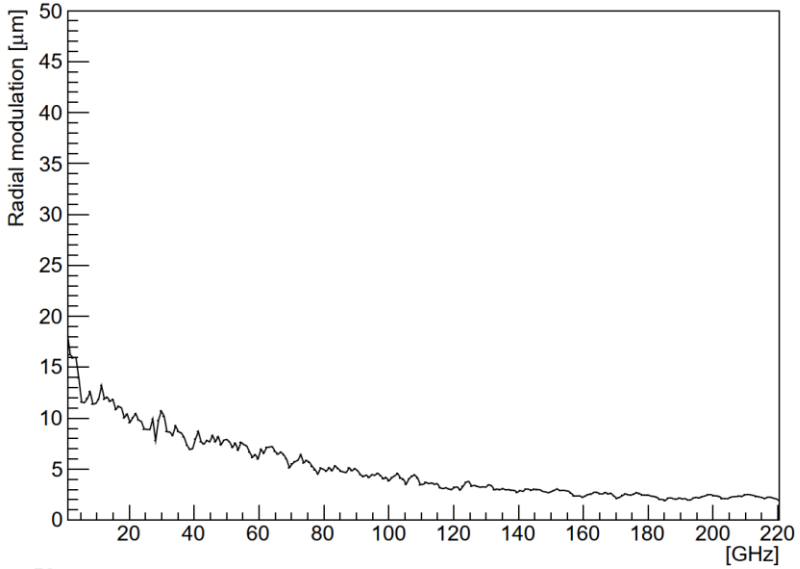


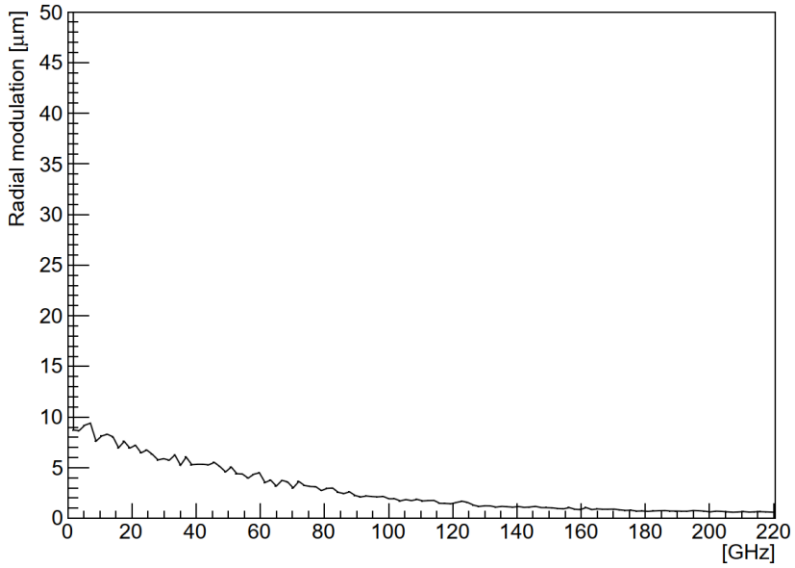
Conclusions

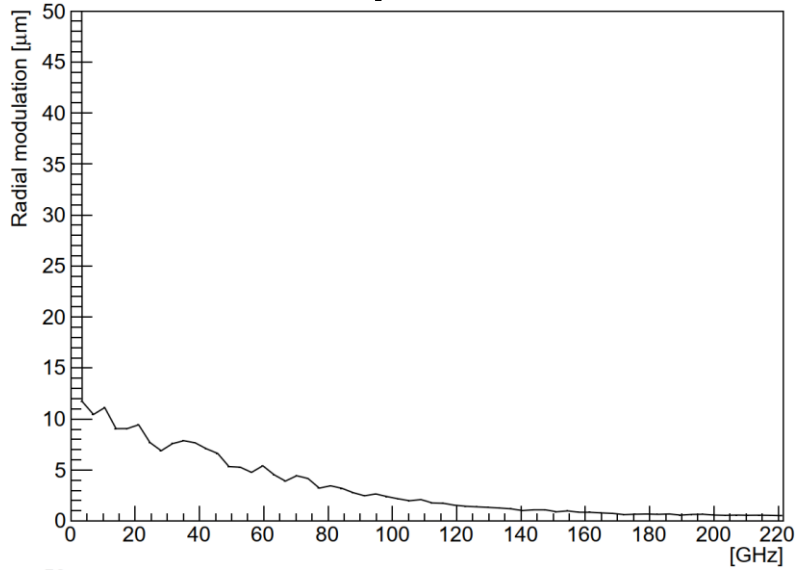
- Fourier transforms do not show any dominant frequencies.
  [to discuss – what does this mean?]
- The mean absolute amplitude of frequencies higher than 50 GHz is under 4 microns -> 1/5 of the pixel resolution of the streak camera.
- There is strong shot-to-shot variation (the standard deviation approaches the amplitude)

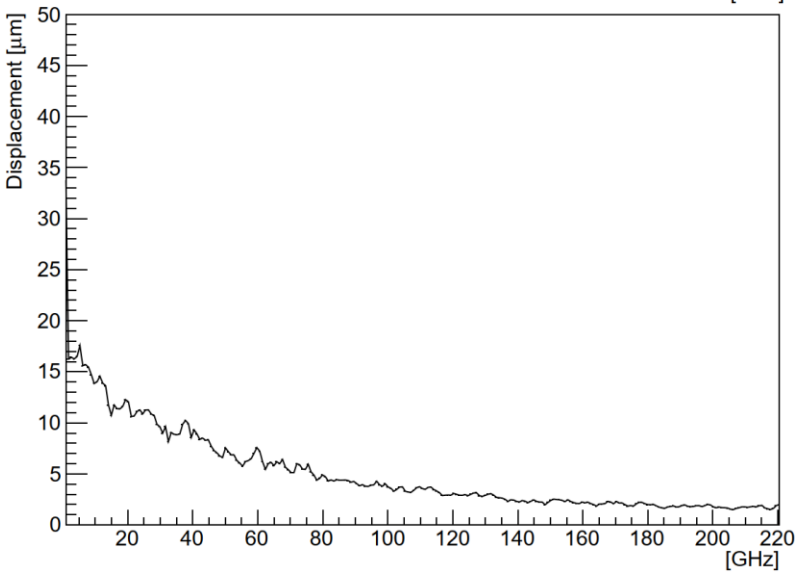
Thank you for your attention

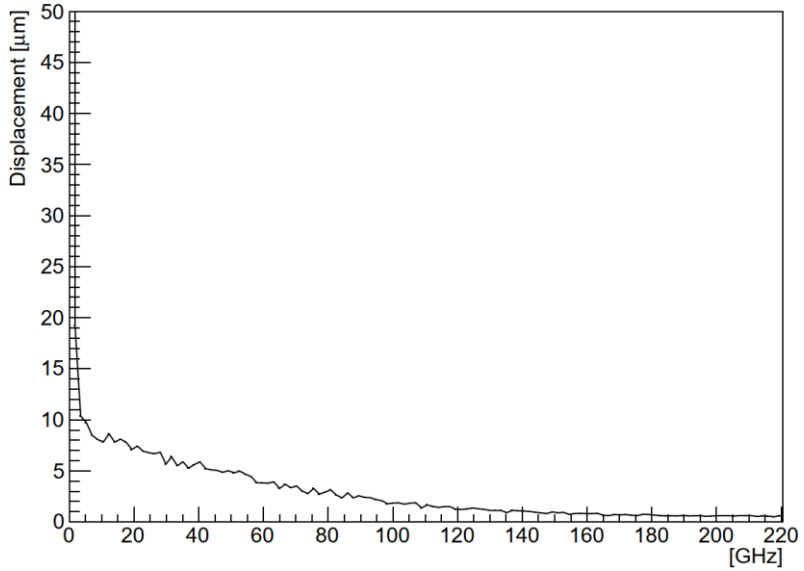
BACKUP – 512 vs 256 vs 128 (dataset 1)

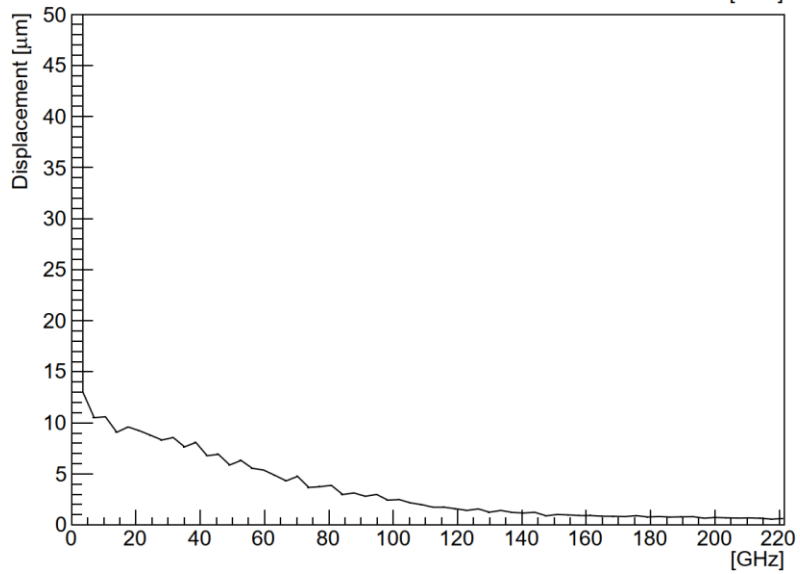




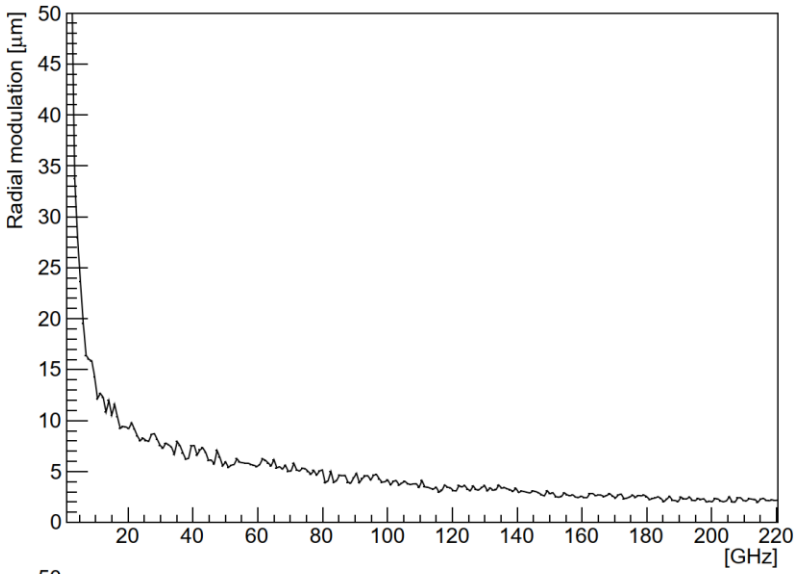


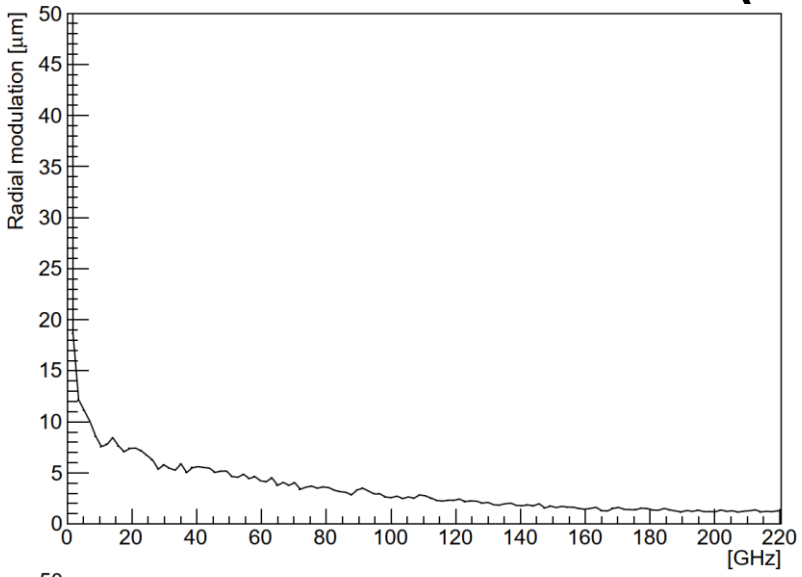


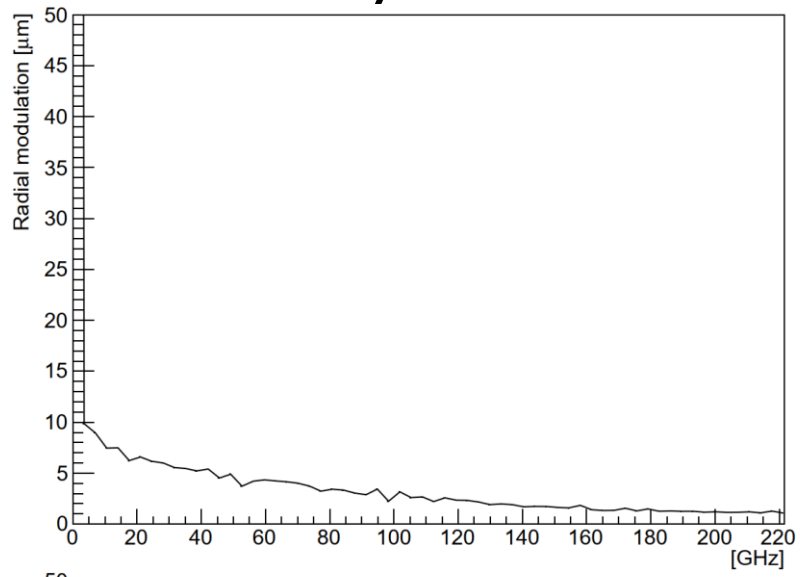


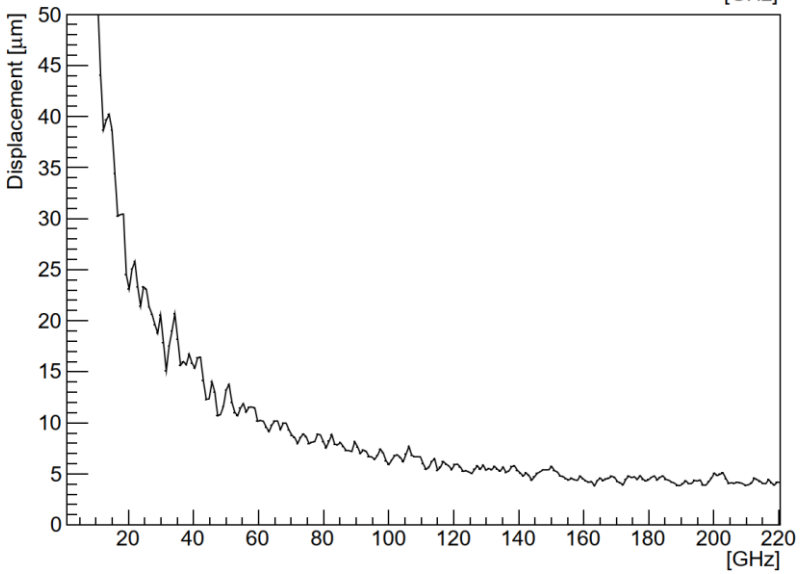


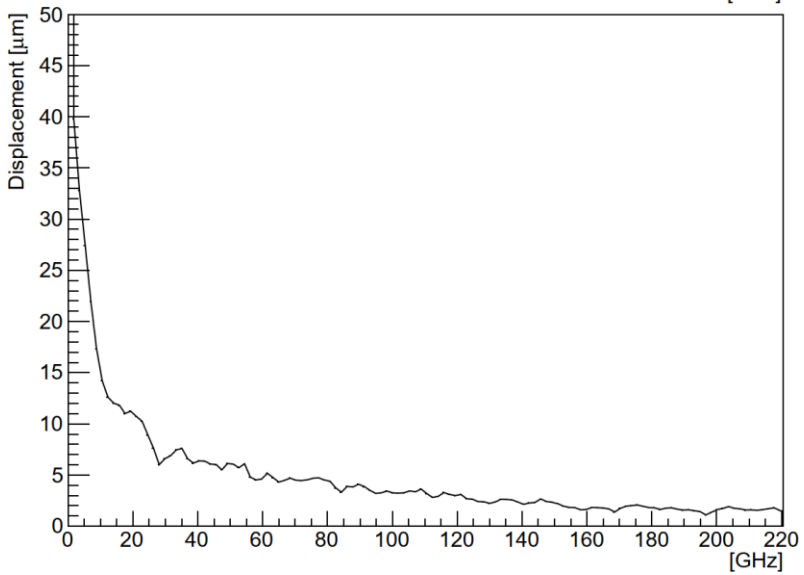
BACKUP – 512 vs 256 vs 128 (dataset 2)

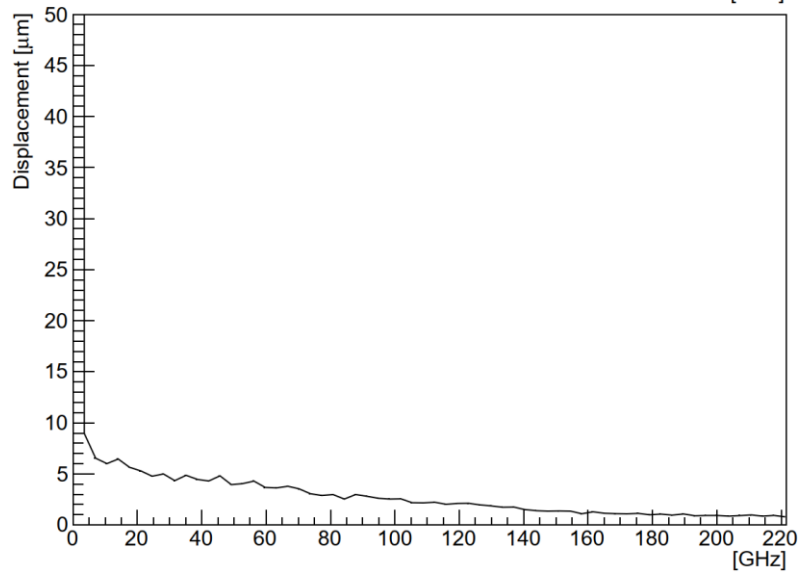












BACKUP – 512 vs 256 (dataset 3)