MEDSI 2014
Australian Synchrotron

FMB Oxford

Vibration Measurement Standards of Optical Components

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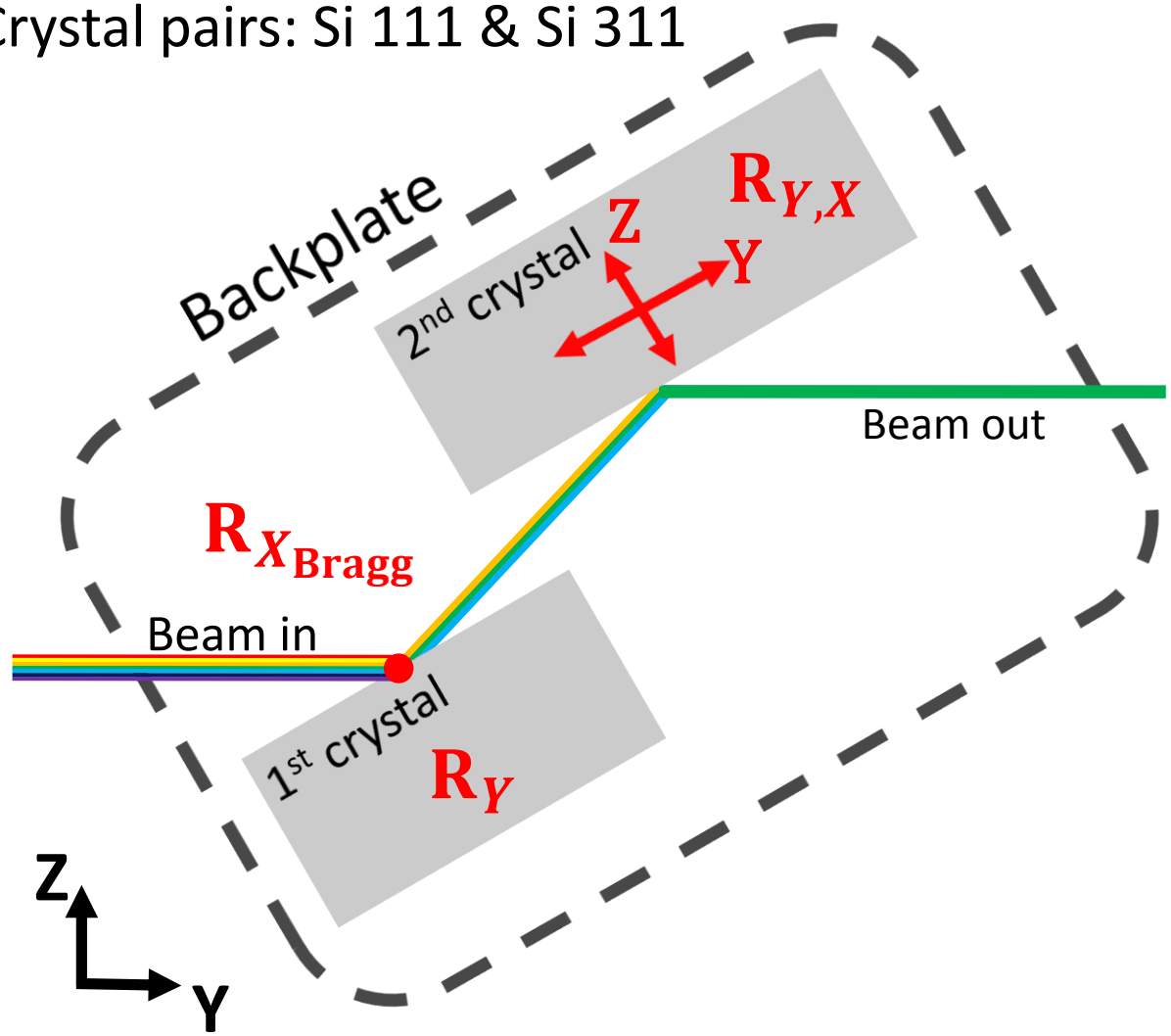
Tuesday 21st October 2014

A vibrational number is meaningless without a frequency range

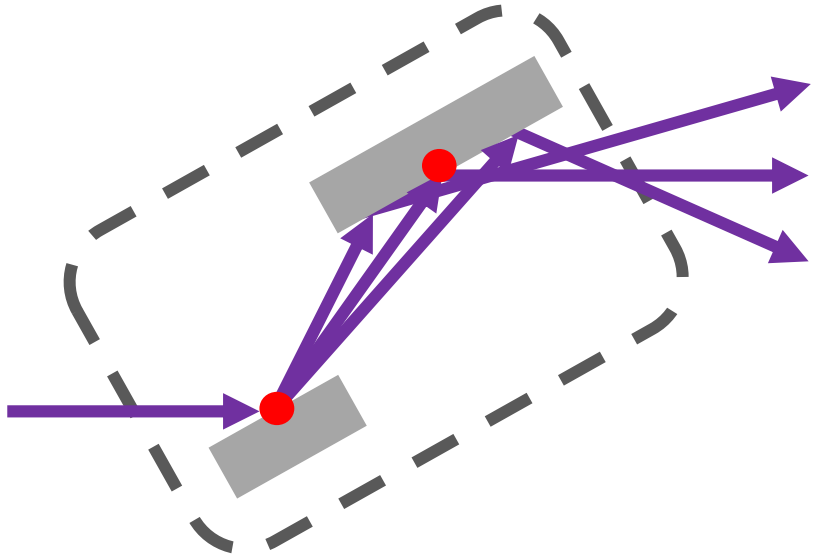
Motorized DCM motions

Energy range: 2.4 – 103 keV
Crystal pairs: Si 111 & Si 311

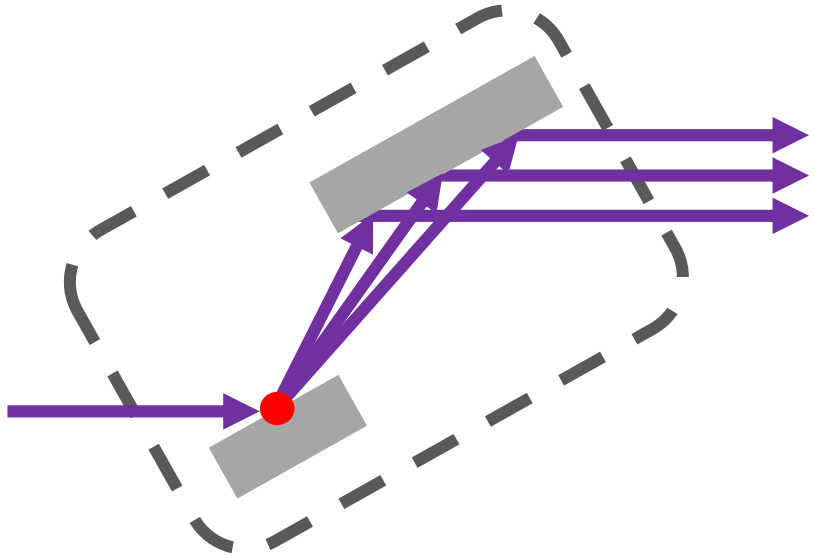


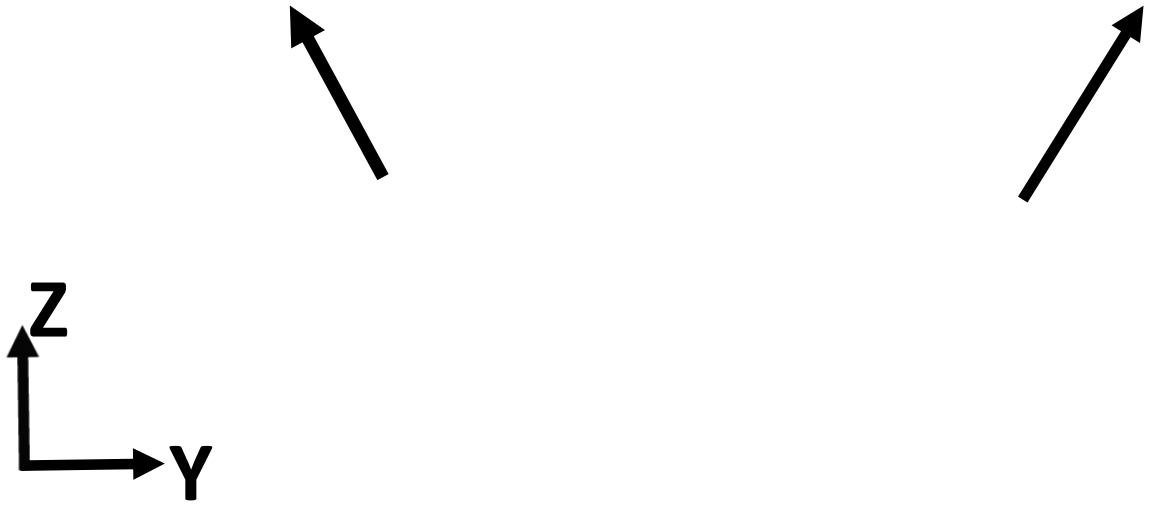
Motion	Range
Bragg rotation, $R_{X\,Bragg}$	63 °
1st crystal roll, R_Y	1.2 °
2nd crystal roll, R_Y	1.2 °
2nd crystal pitch, R_X	1.2 °
2nd crystal parallel, Y	29 cm
2nd crystal perpendicular, Z	2 cm
DCM lateral, X	8 cm

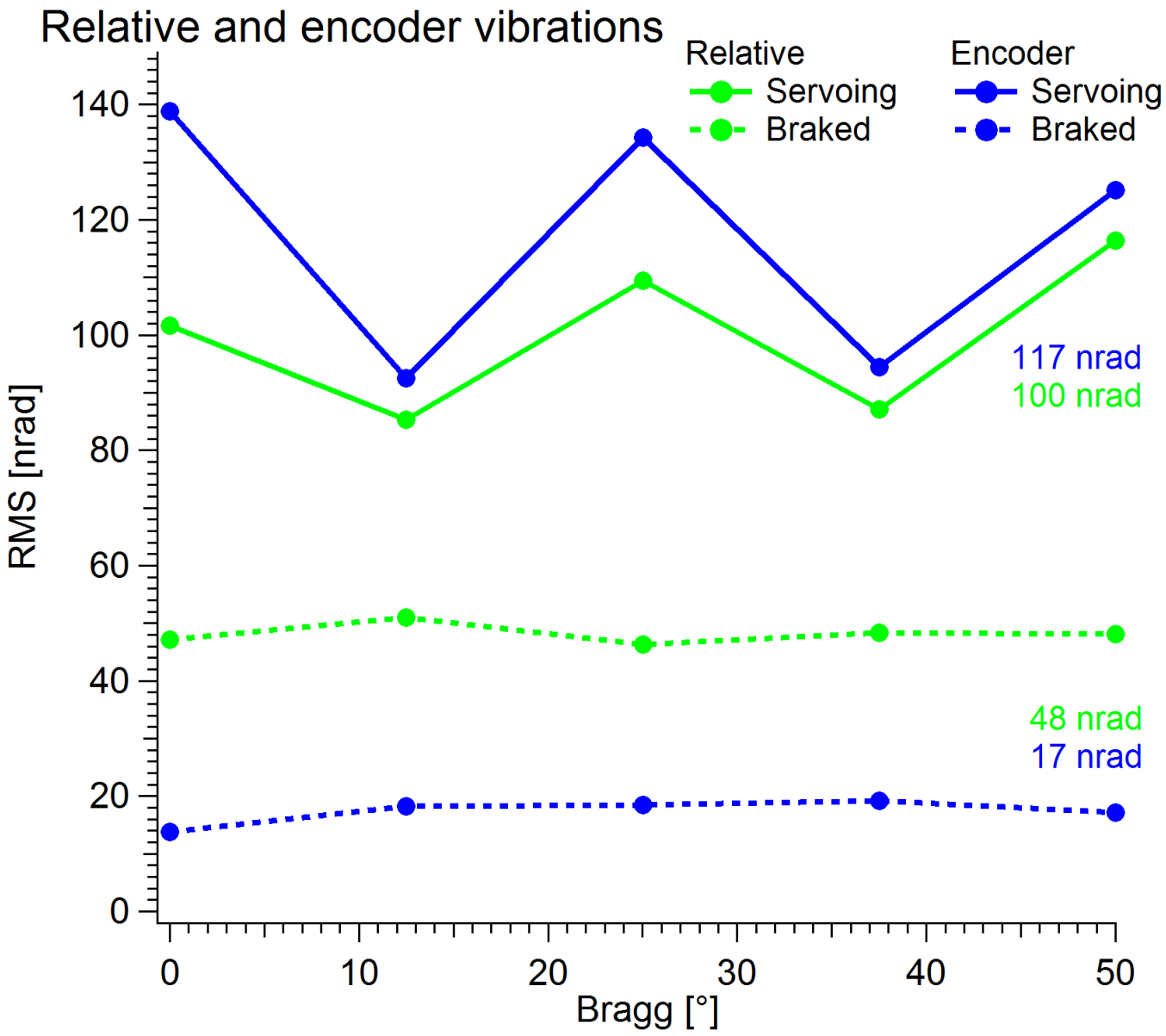
Relative pitch vibrations

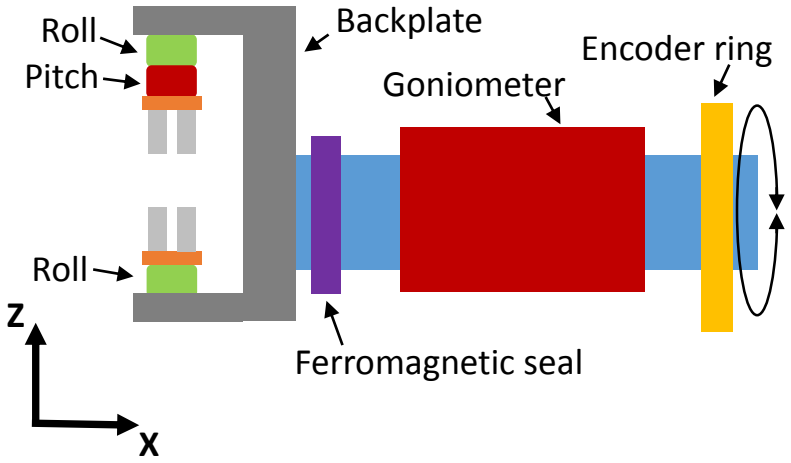


Absolute pitch vibrations

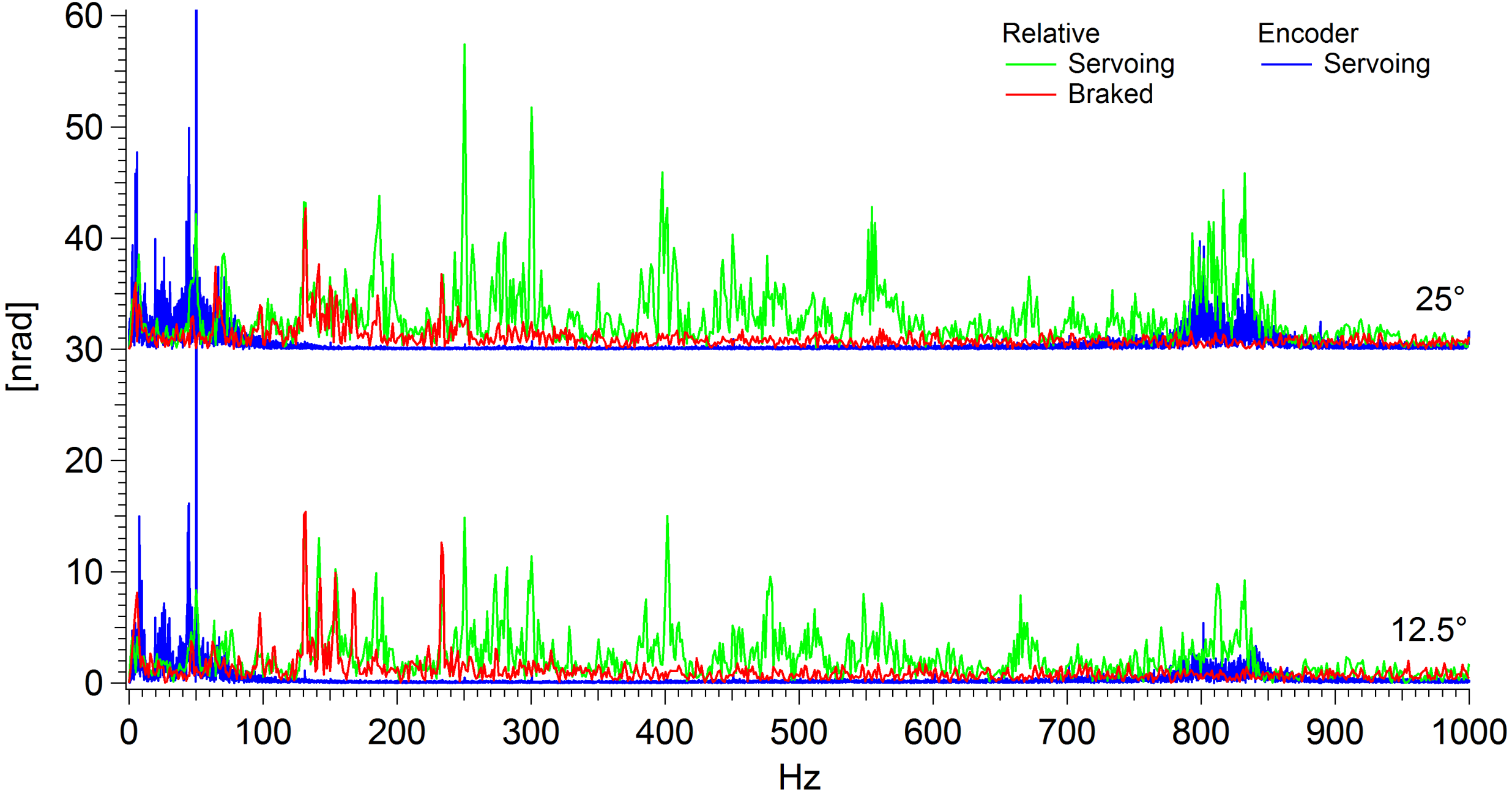


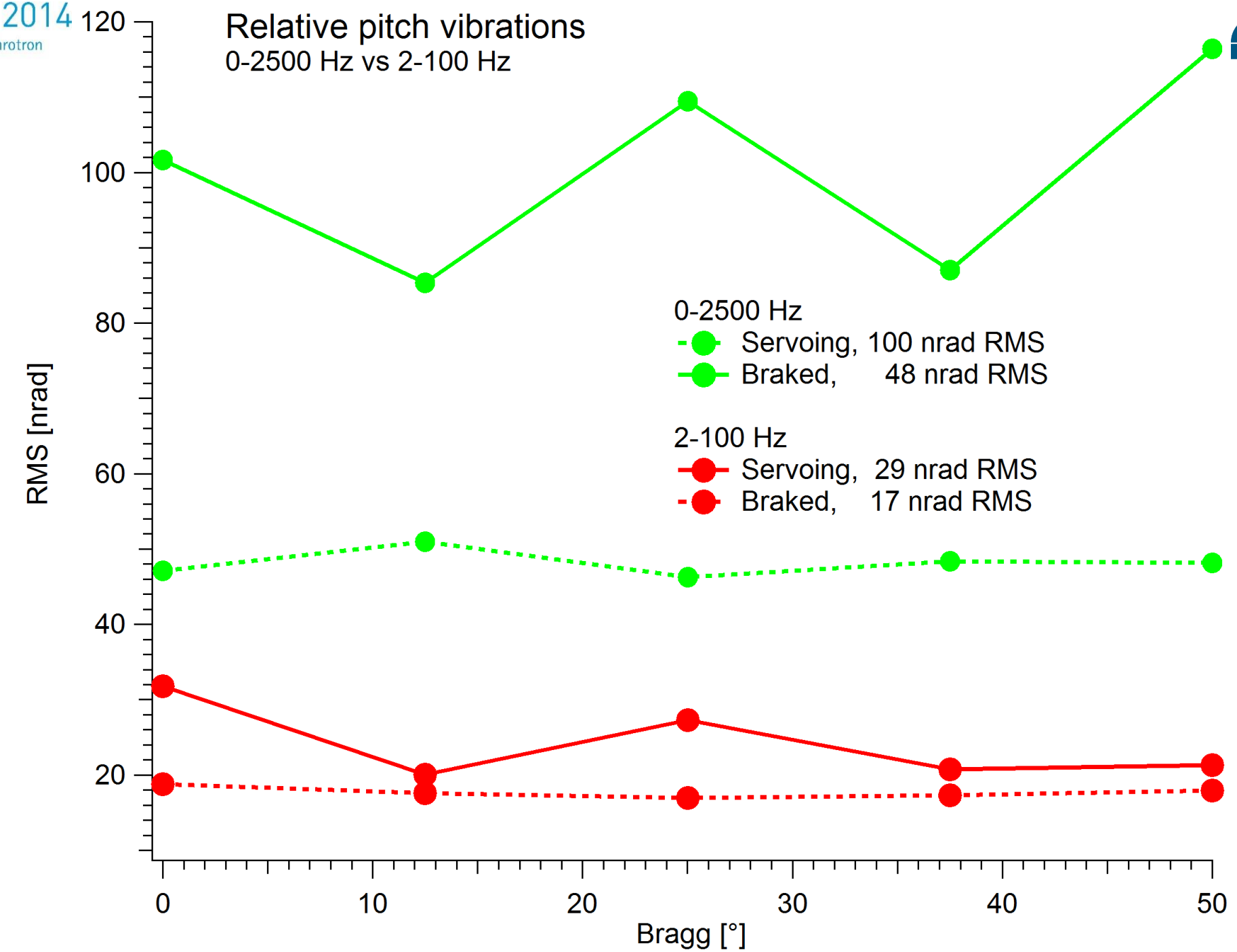

Z
Y



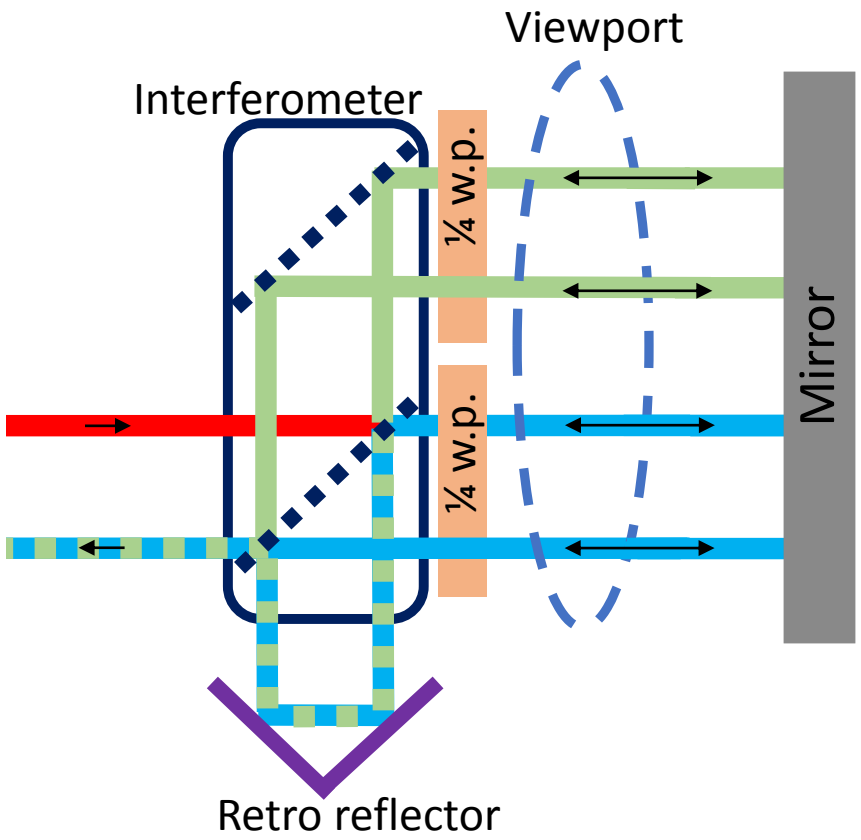


0-2.5kHz relative, 0-1.6kHz encoder


Relative
Servoing
Braked
Encoder
Servoing
25°
12.5°
[nrad]
Hz
0
10
20
30
40
50
60
0
100
200
300
400
500
600
700
800
900
1000


Relative pitch vibrations
0-2500 Hz vs 2-100 Hz
0-2500 Hz
Servoing, 100 nrad RMS
Braked, 48 nrad RMS
2-100 Hz
Servoing, 29 nrad RMS
Braked, 17 nrad RMS
RMS [nrad]
120
100
80
60
40
20
0
10
20
30
40
50
Bragg [°]

Absolute pitch vibration

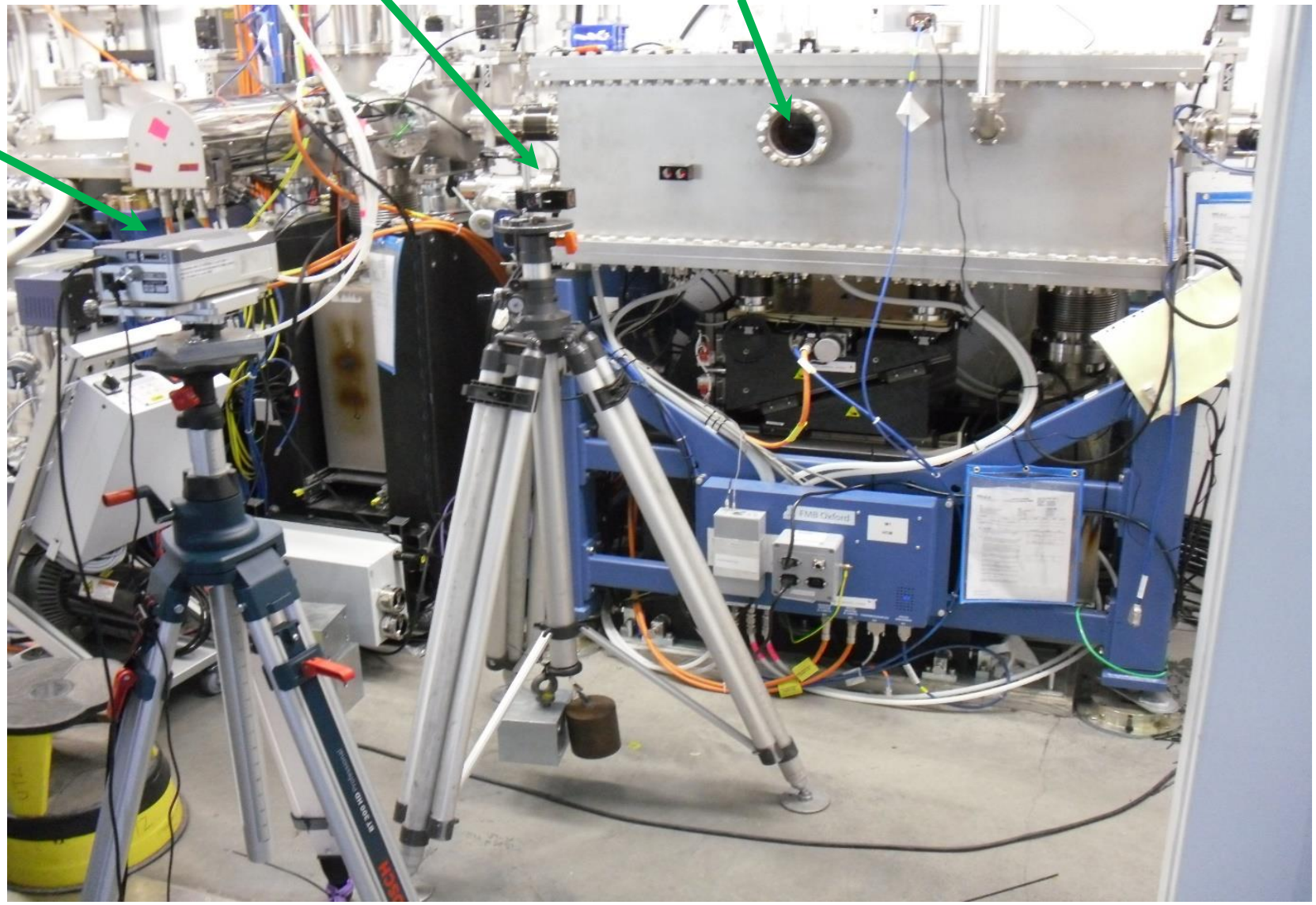


On a side note…

Interferometer

Viewport to HCM

Laser



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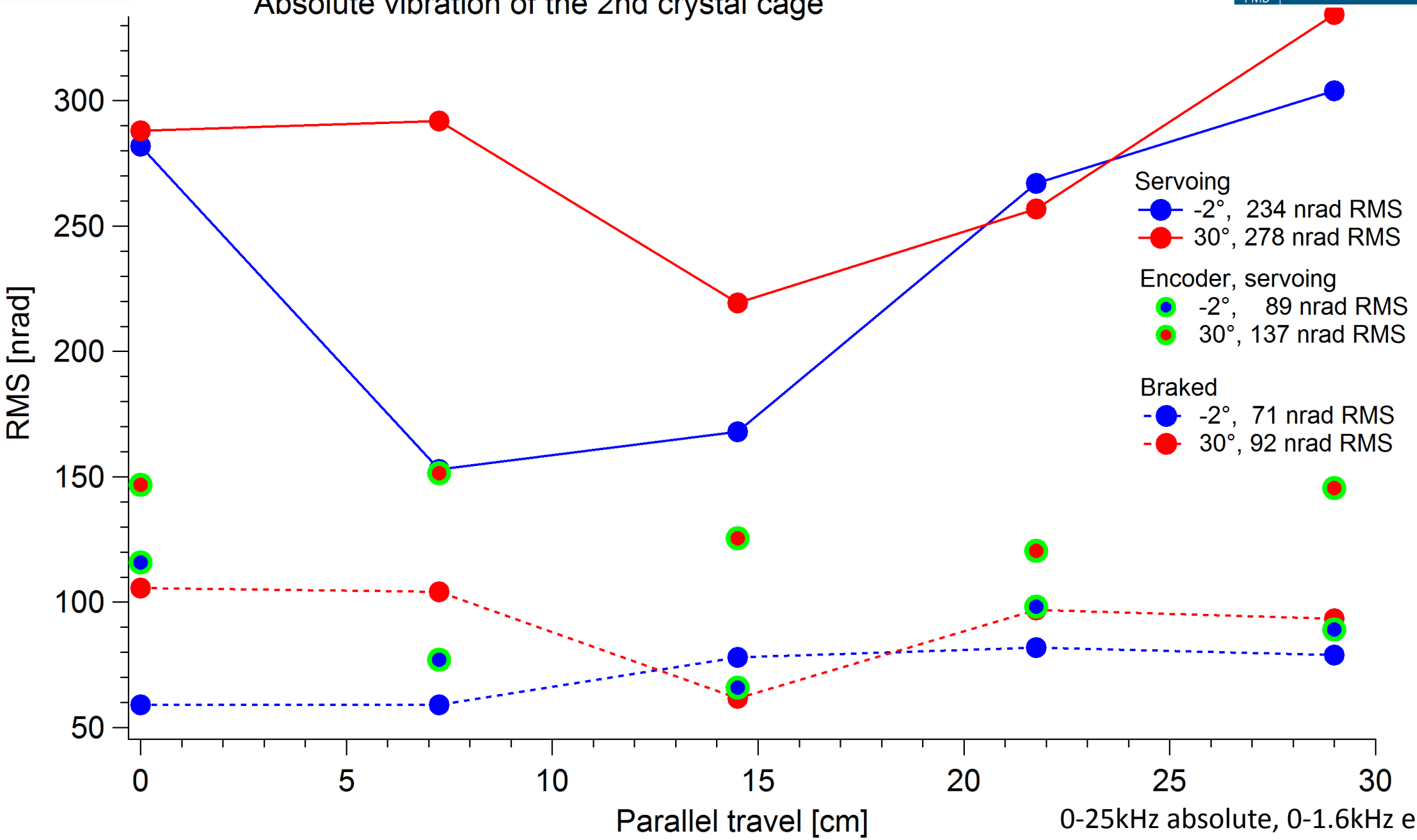
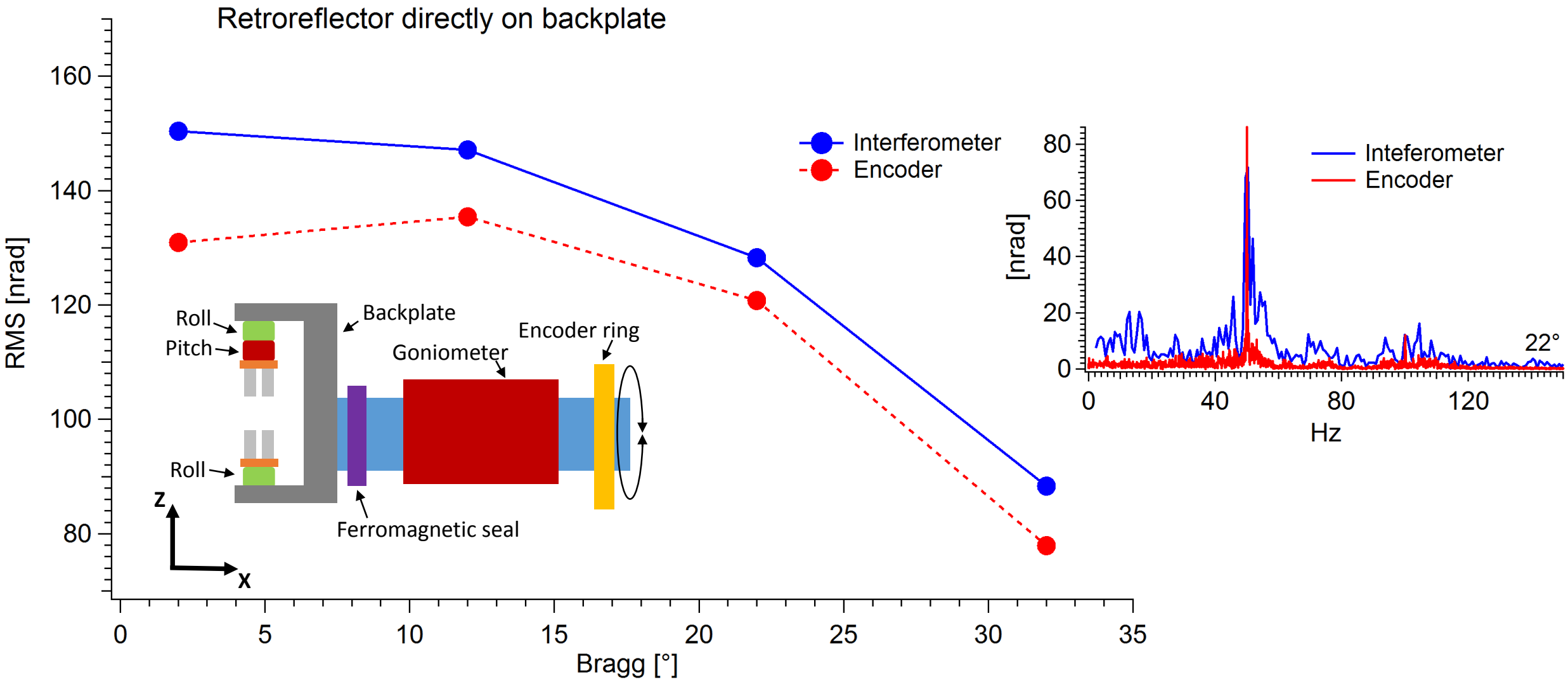
Absolute vibration of the 2nd crystal cage

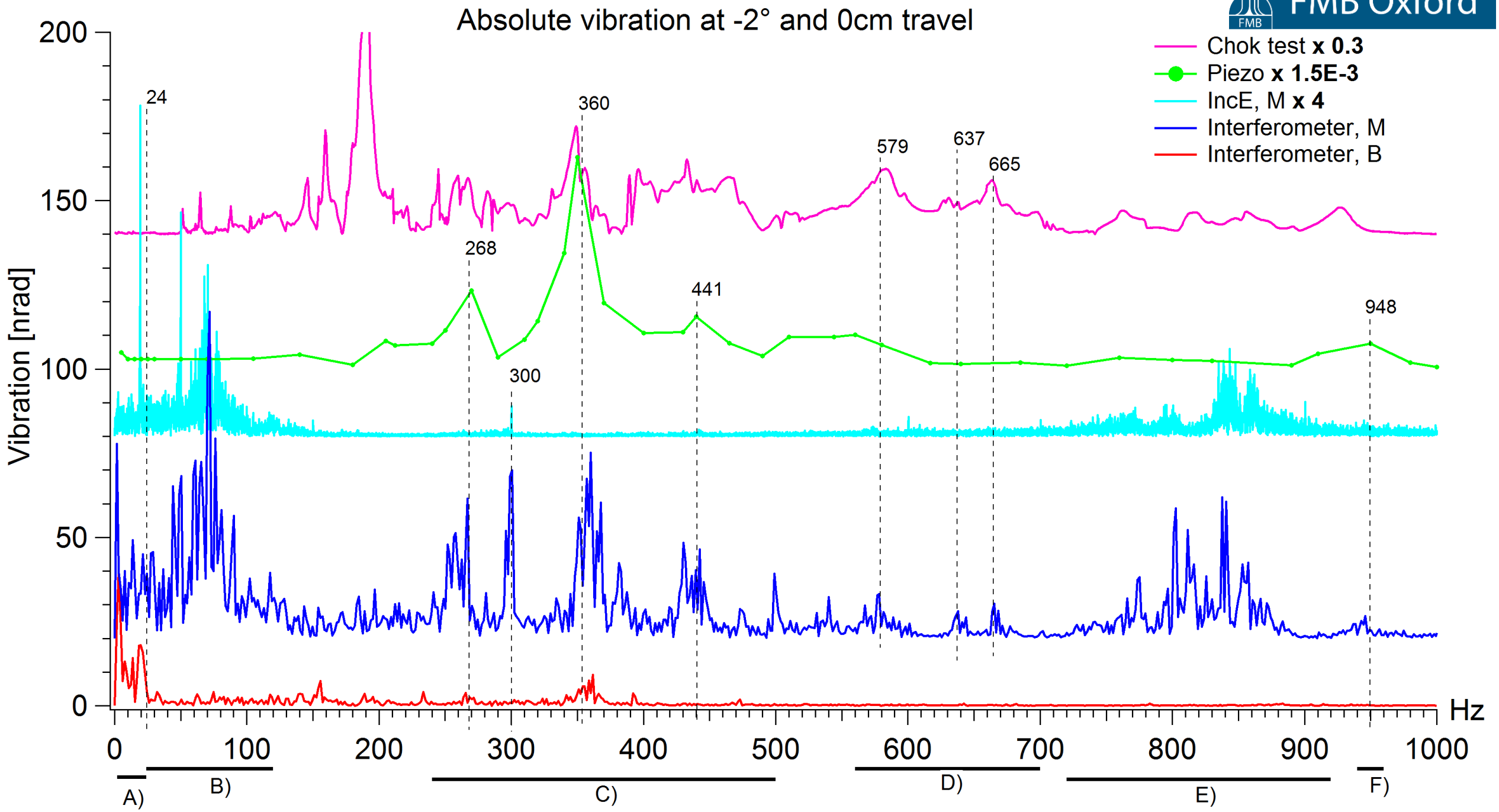


0-25kHz absolute, 0-1.6kHz encoder

Torsion spring effect

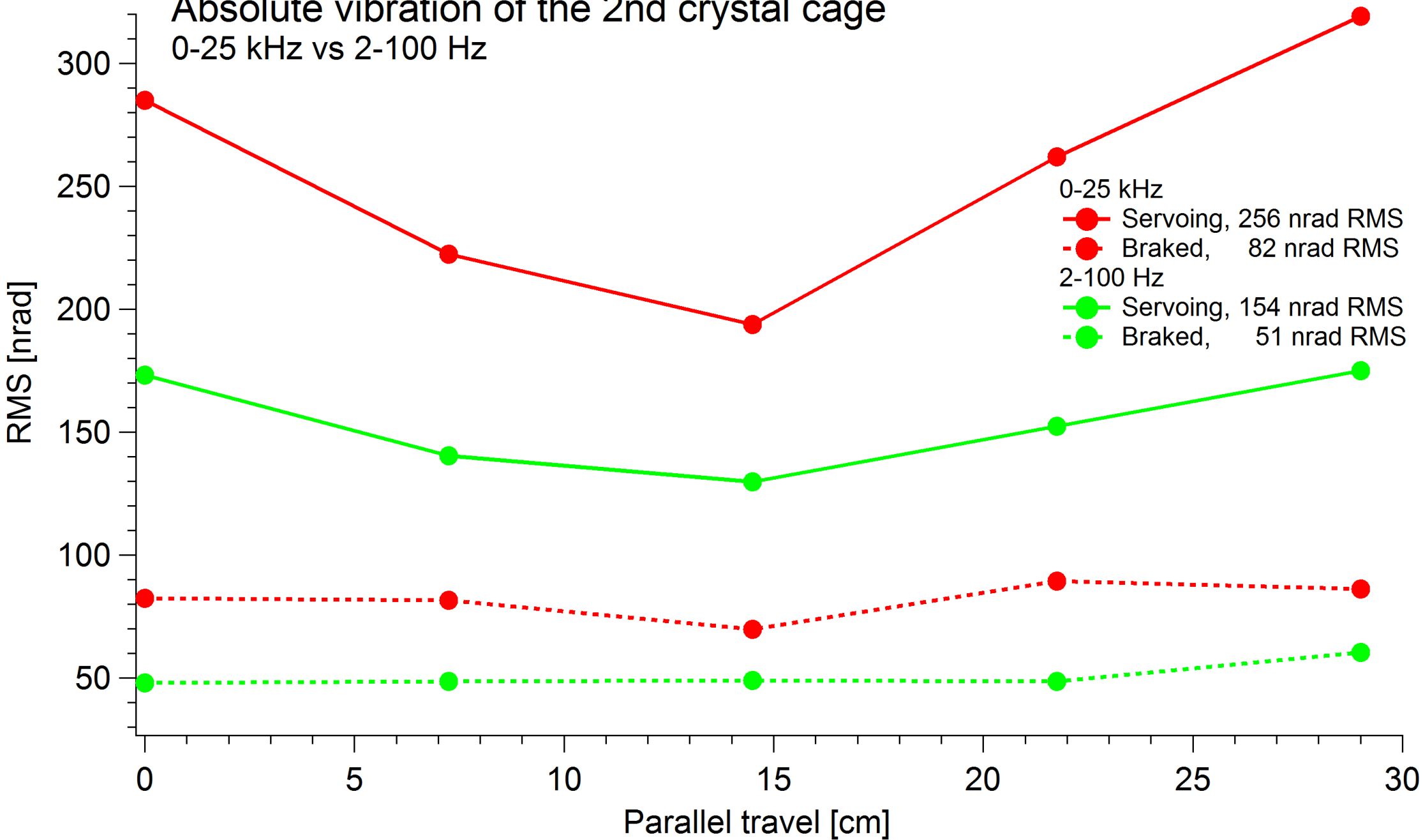


0-25kHz absolute, 0-1.6kHz encoder

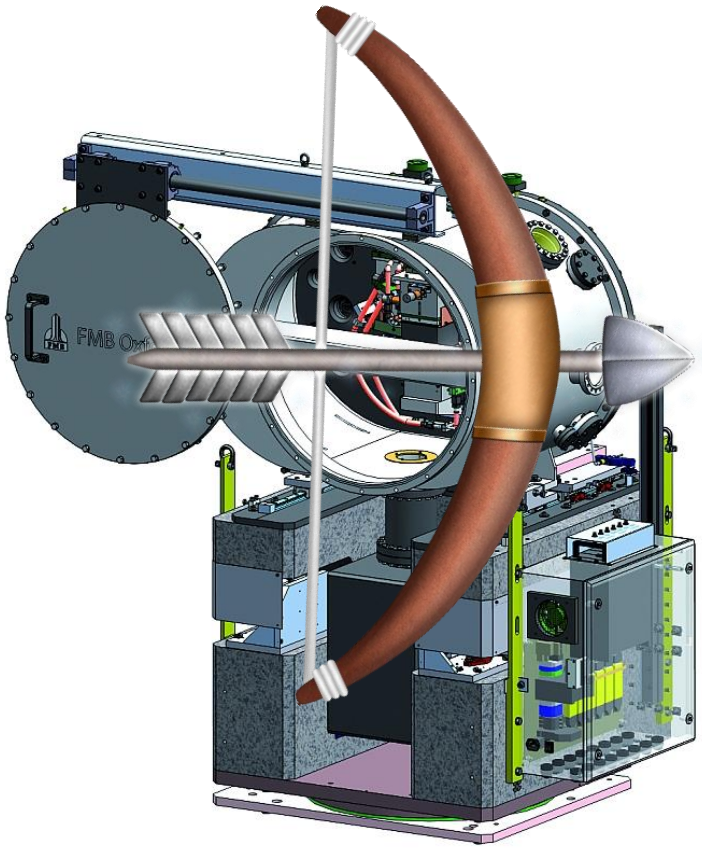

Absolute vibration at -2° and 0cm travel
Chok test x 0.3
Piezo x 1.5E-3
IncE, M x 4
Interferometer, M
Interferometer, B
Vibration [nrad]
Hz
24
268
300
360
441
579
637
665
948
0
50
100
150
200
0
100
200
300
400
500
600
700
800
900
1000
A)
B)
C)
D)
E)
F)

Absolute vibration of the 2nd crystal cage

0-25 kHz vs 2-100 Hz



Relevant frequency range…?



2-100 Hz: 29 nrad RMS ≈> 1300 km

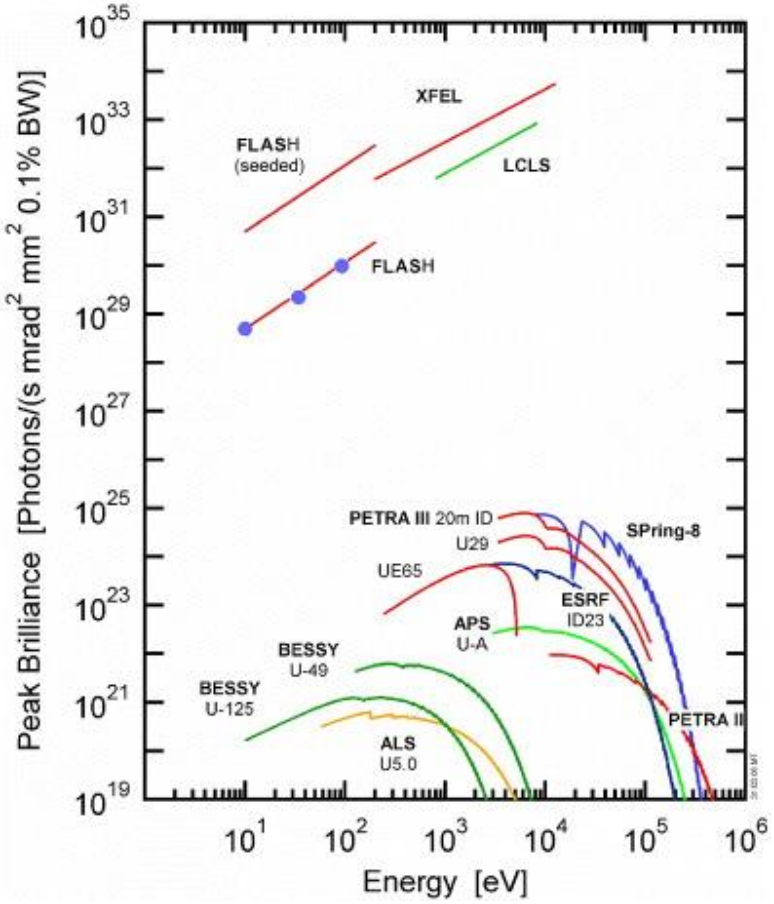
0-2.5 kHz: 100 nrad RMS ≈> 400 km

E.g. (differs between beamlines!)

XAFS:	1 Hz – 1 kHz
Crystallography:	0.1 – 200 Hz
RIXS:	4-200 Hz

New vibrational unit?

$$\text{brilliance} = \frac{\text{photons}}{\text{s} \times \text{mrad}^2 \times \text{mm}^2 \times 0.1\%\text{BW}}$$



$$'\text{vibton}' = \frac{f(\text{RMS})}{f(\text{s}) \times f(\text{Hz}_{\text{max}}) \times f(\text{Hz}_{\text{min}}) \times f(\text{cooling power})}$$

Thanks for your attention

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Questions..?

The shown results are being published…

Vibration Measurements of High Heatload Monochromators for DESY PETRA Extension

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[1] *FMB-Oxford Ltd, Unit 1 Ferry Mills, Oxford OX2 0ES, United Kingdom and*
[2] *DESY, Deutsches Elektronen-Synchrotron Hamburg, Notkestraße 85, 22607 Hamburg, Germany*

(Dated: October 9, 2014)

The requirement for vibrational stability of beamline optics continues to evolve rapidly to comply with the demands created by the improved brilliance of ultra-stable storage rings around the world. The challenge is to quantify the performance of the instrument before it is installed at the beamline. In this article we present measurement techniques that directly and accurately measure 1) the relative vibrations between the two crystals of a DCM and 2) the absolute vibrations of the 2nd

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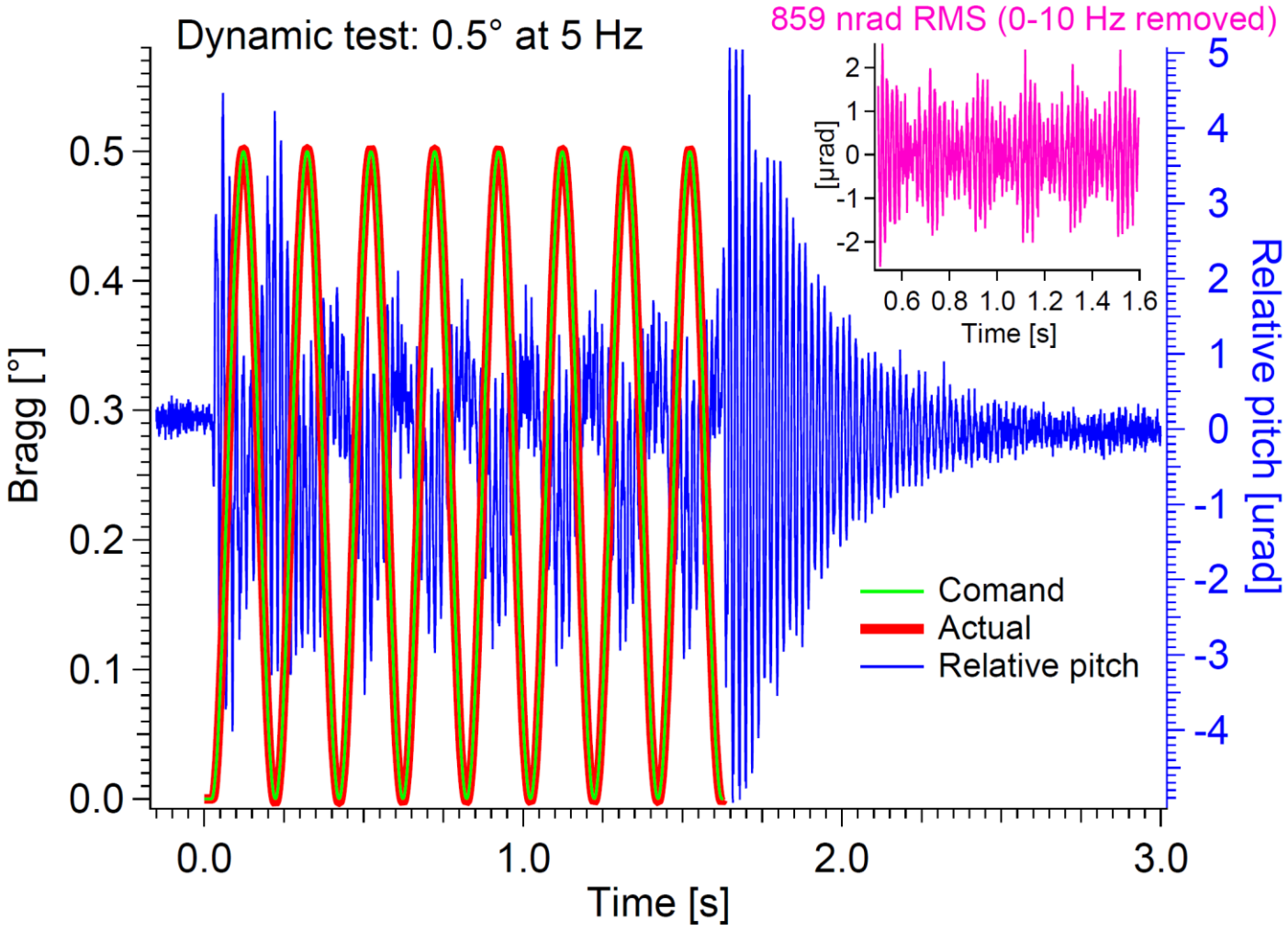
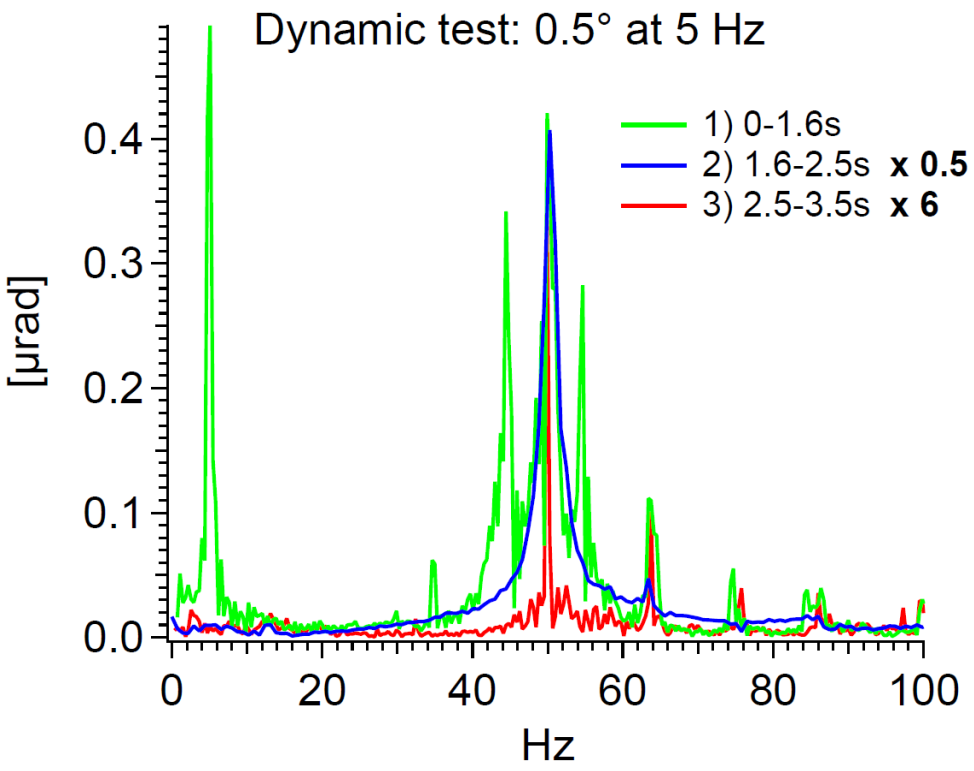
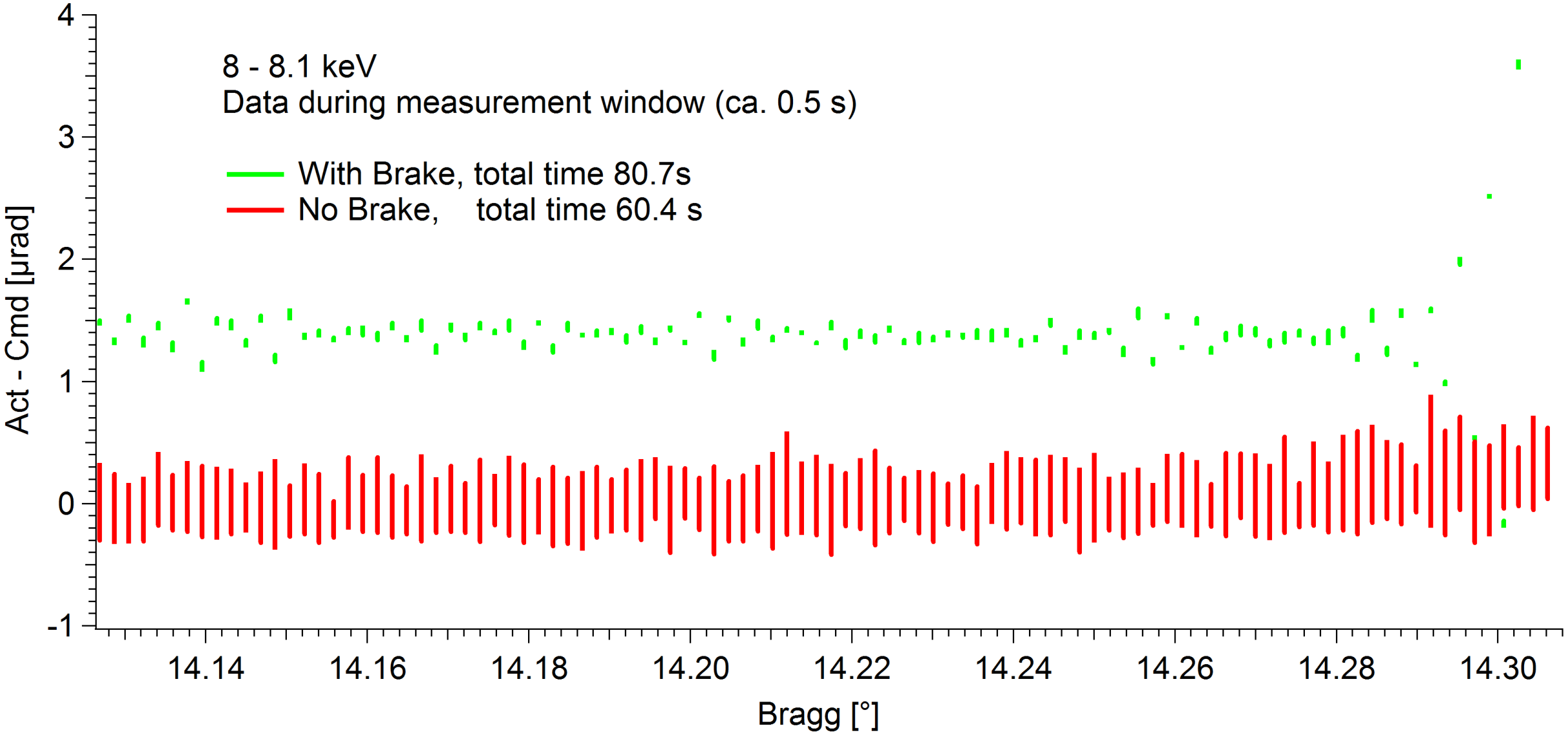

Dynamic test: 0.5° at 5 Hz
859 nrad RMS (0-10 Hz removed)
Bragg [°]
Relative pitch [urad]
Time [s]
Comand
Actual
Relative pitch
[µrad]
Time [s]


Dynamic test: 0.5° at 5 Hz
1) 0-1.6s
2) 1.6-2.5s x 0.5
3) 2.5-3.5s x 6
[µrad]
Hz

Braked energy scan