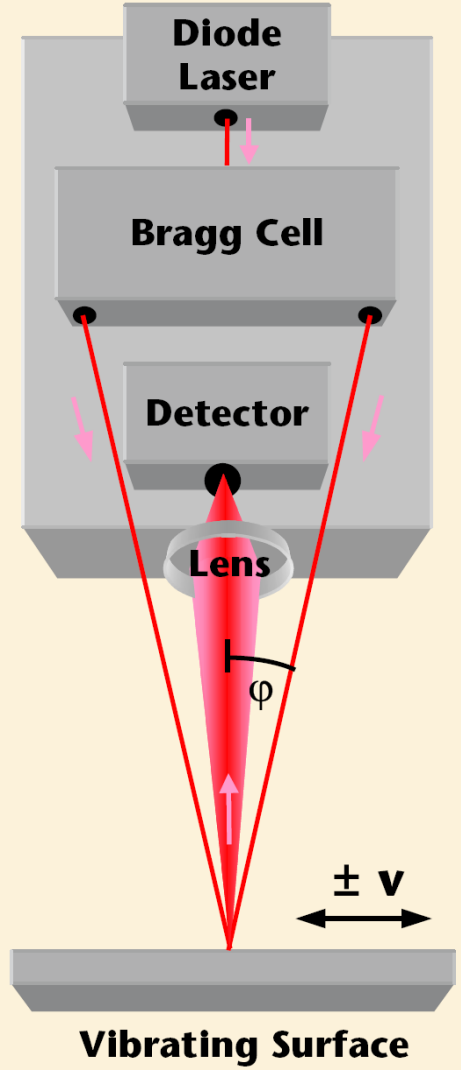
CNGS Magnetic Horn & Reflector Oscillation Measurements

using the

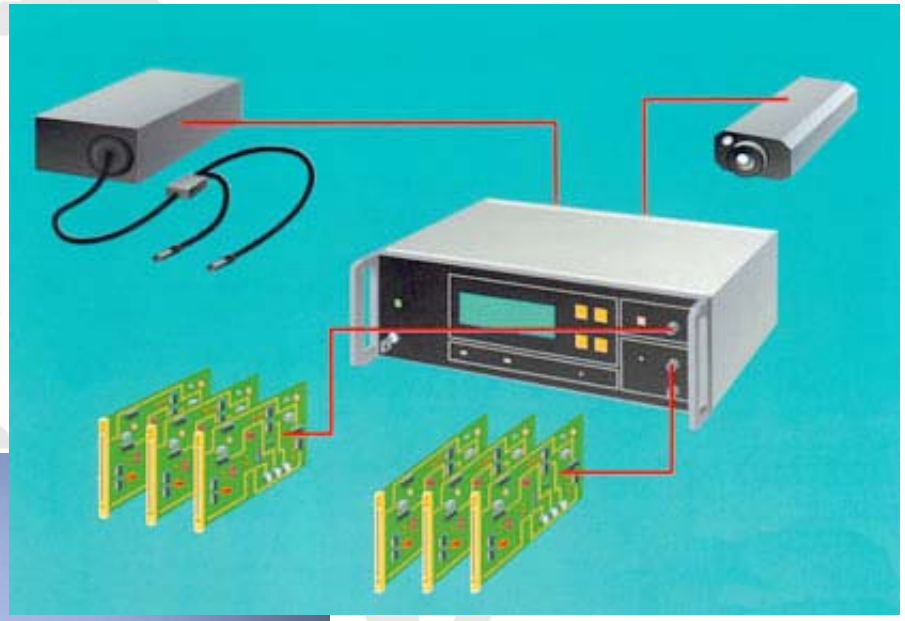
LDV in TCC4

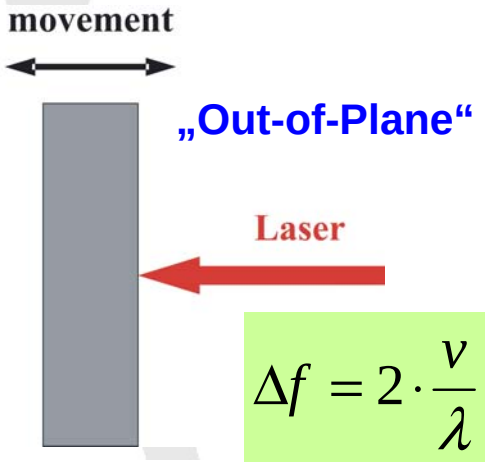
R. Wilfinger, S. Rangod, A. Pardons, K. Elsener, J. Lettry, R. Catherall, and the CNGS Project Team

Laser Doppler Vibrometer (LDV)



Single-Point Out-of-Plane Laser Doppler Vibrometer
from Polytec®, (Germany)





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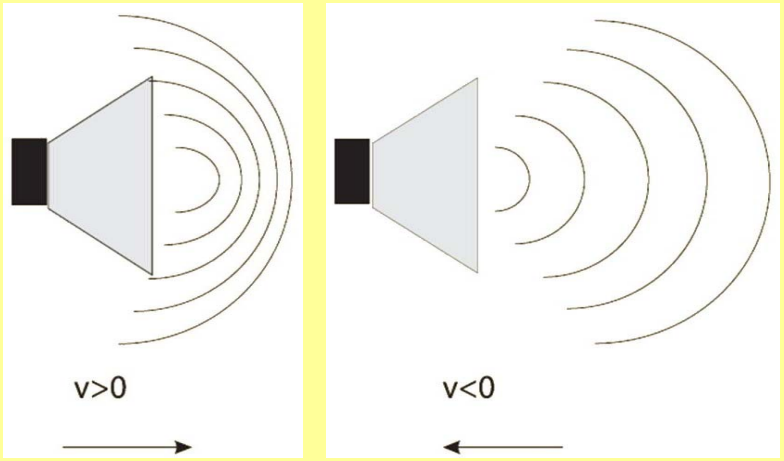
Laser Doppler Vibrometry

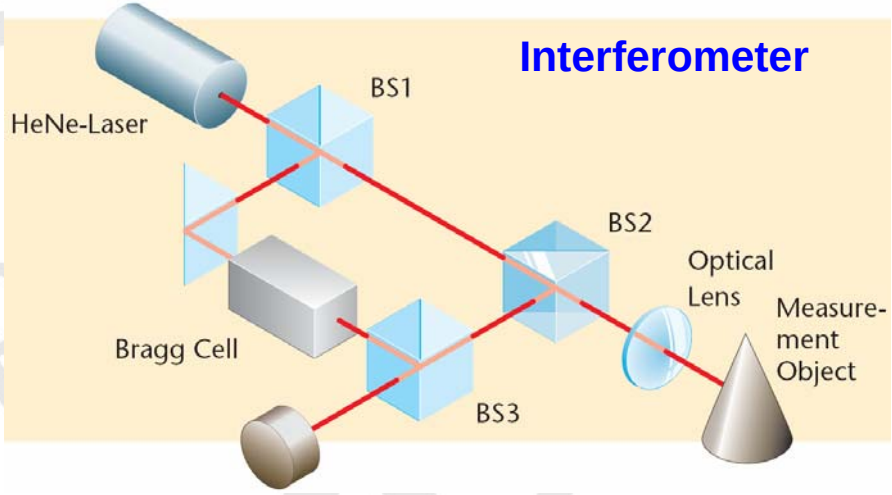
Doppler-Principle



$$f' = f \cdot (1 - \frac{v}{c}) \qquad f' = f \cdot (1 - \frac{(-v)}{c})$$

$$\Delta f = 2 \cdot f \cdot \frac{v}{c}$$

Interferometer



Properties:

- -) no mass load on the object of interest
- -) contact free (radiation, heat, high tension)
- -) measurement parameter: Doppler shifted frequency (high accuracy, linear!!)
- -) distance to target: 0.5 m up to 40 m (verified!)
- -) high dynamic range
- -) high reproducibility (for long term tests: fatigue, change of material parameters)
- -) displacements measurable even in nm-range!
- -) useable for frequencies up to 40 MHz
- -) sampling rate: 10 ns
- -) for cylindrically shaped surface: vertical effects can be analyzed

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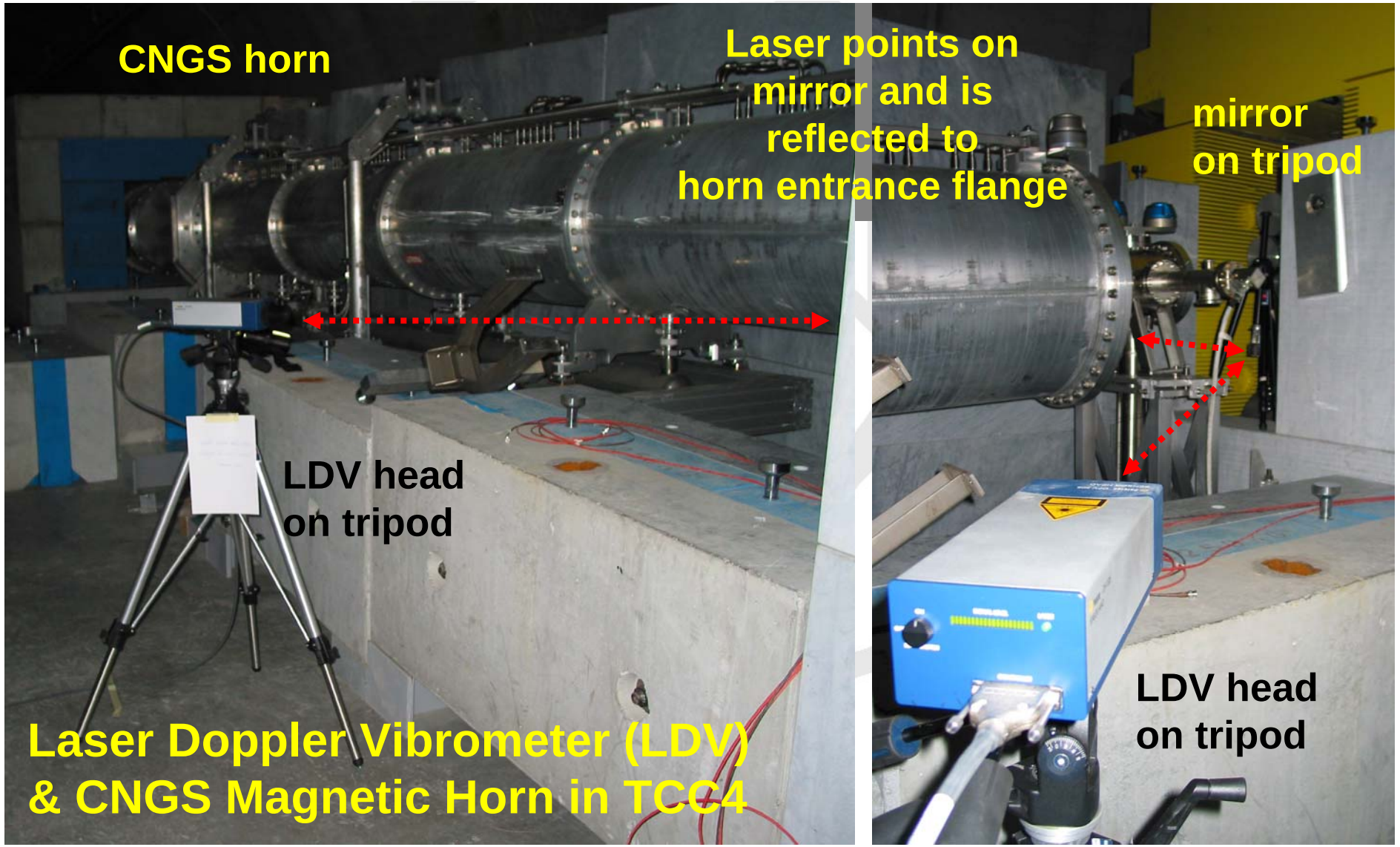
LDV–Setup in TCC4



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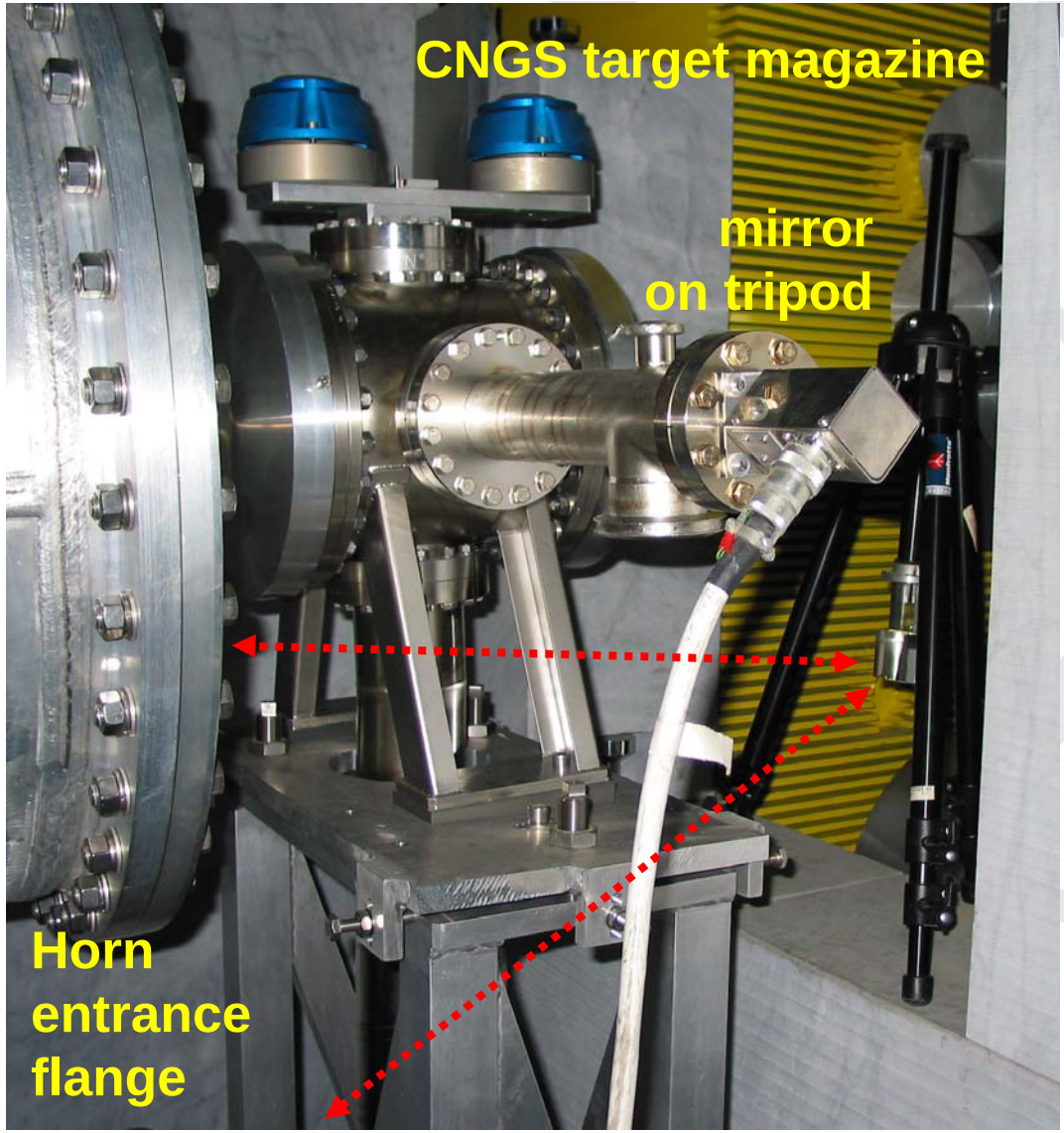

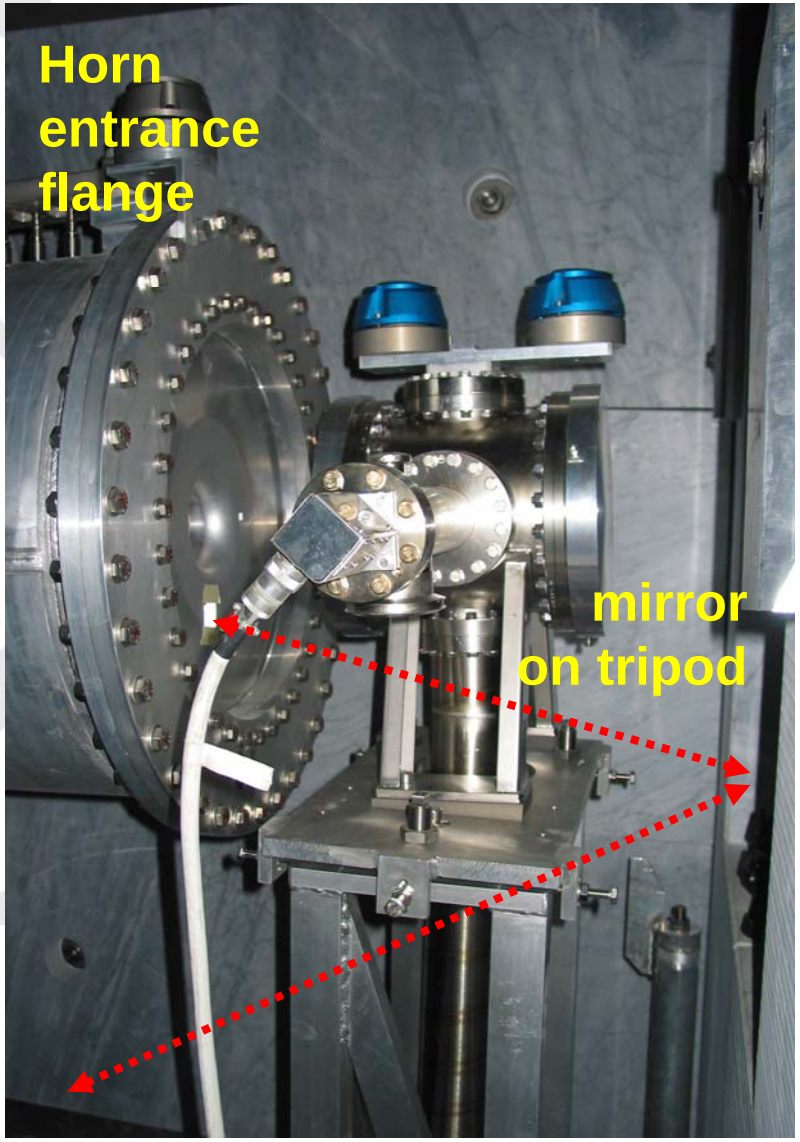

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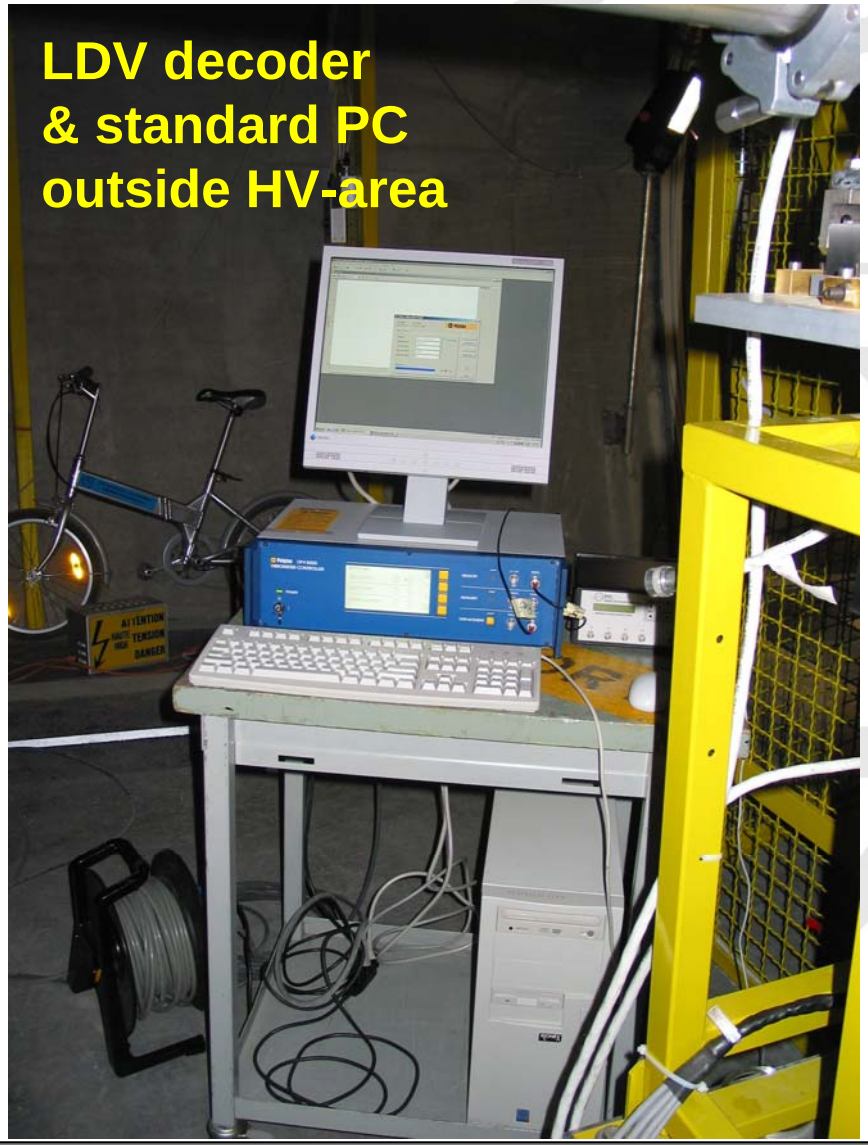

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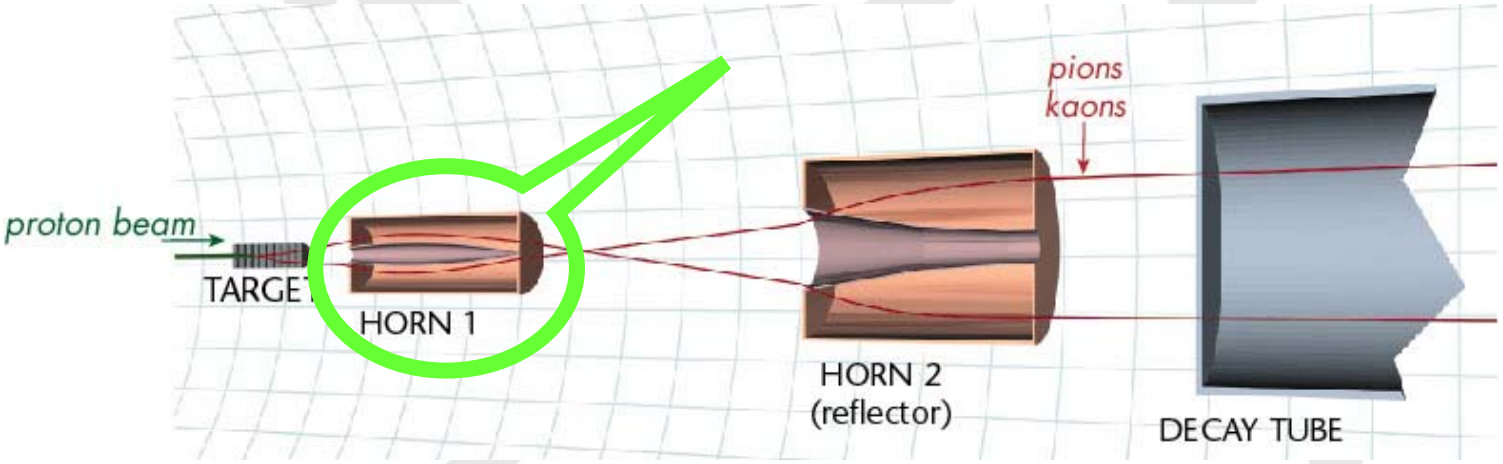
Horn



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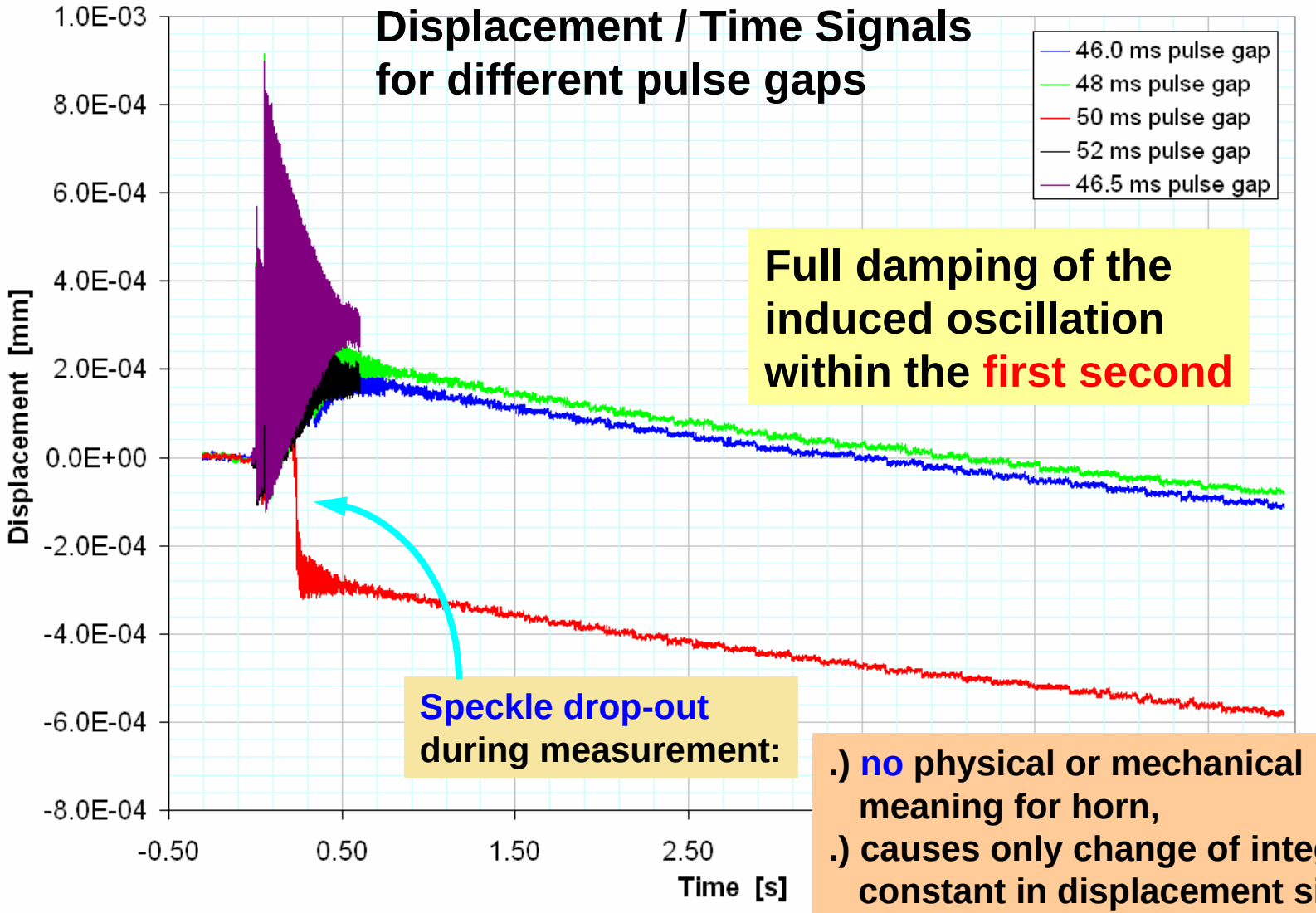
Response of Horn



.) no physical or mechanical meaning for horn,
.) causes only change of integration constant in displacement signal

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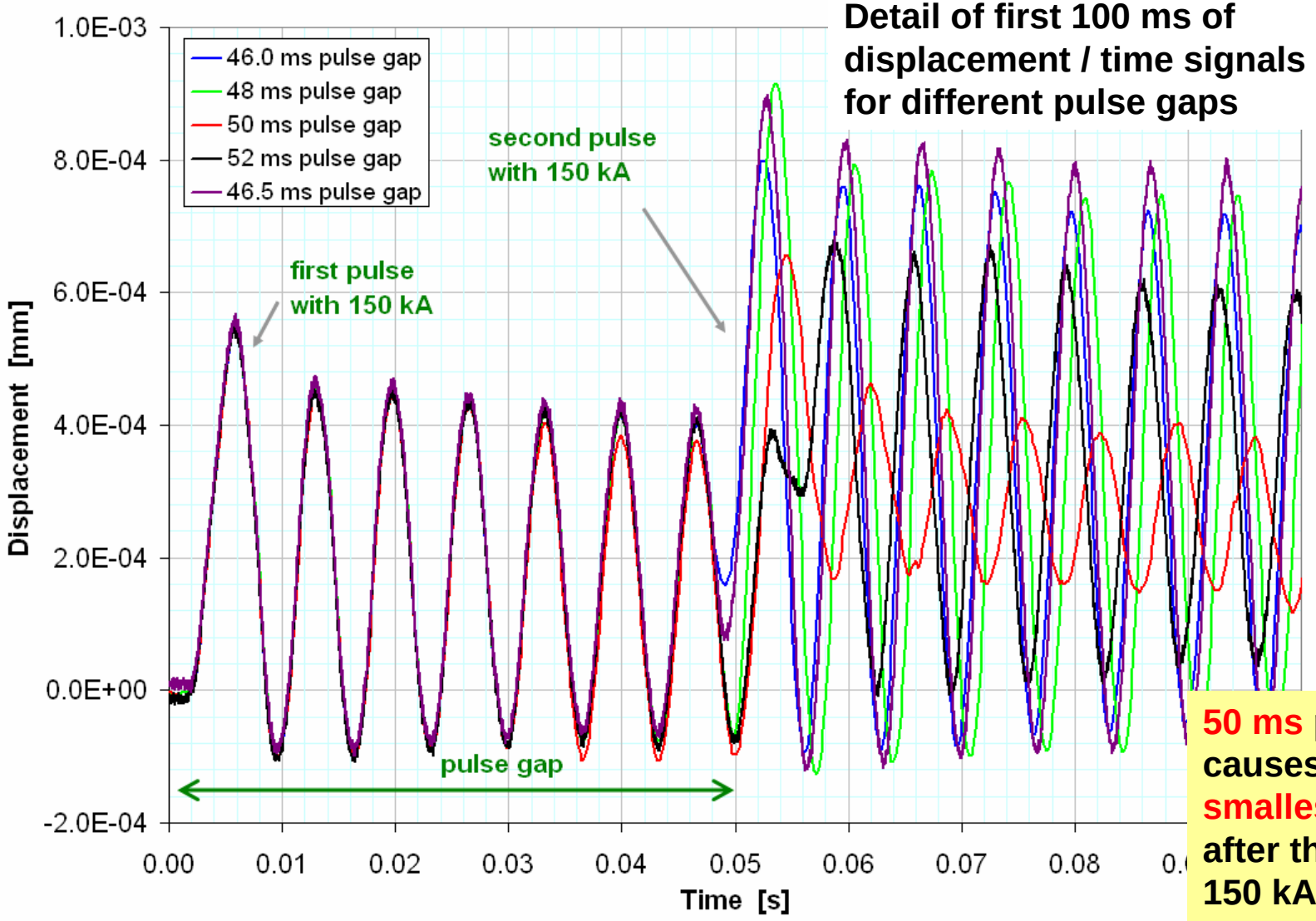
Response of Horn – Detail 1



50 ms pulse gap causes the smallest amplitude after the second 150 kA pulse

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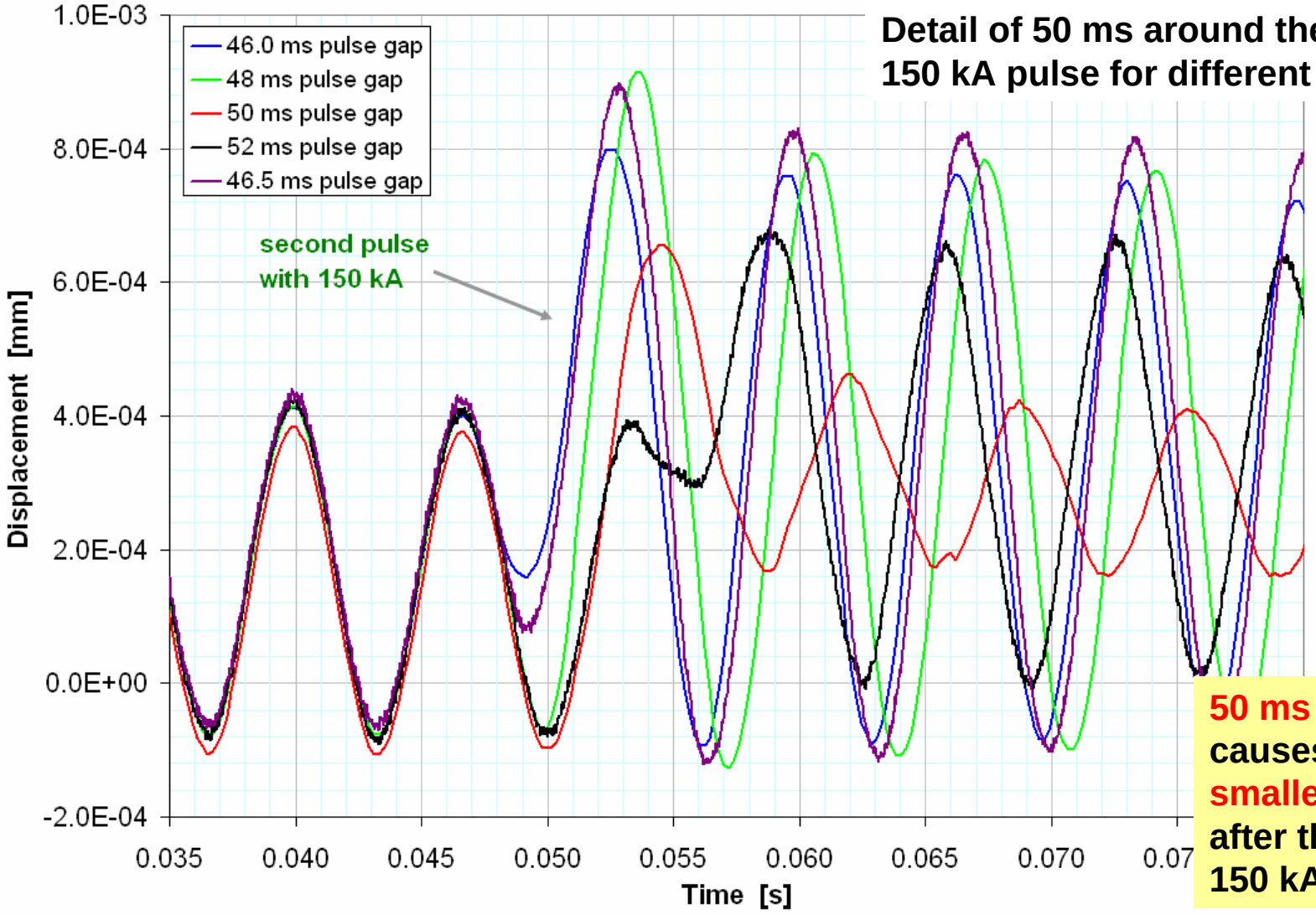
Response of Horn – Detail 2



Detail of 50 ms around the second 150 kA pulse for different pulse gaps

50 ms pulse gap causes the smallest amplitude after the second 150 kA pulse

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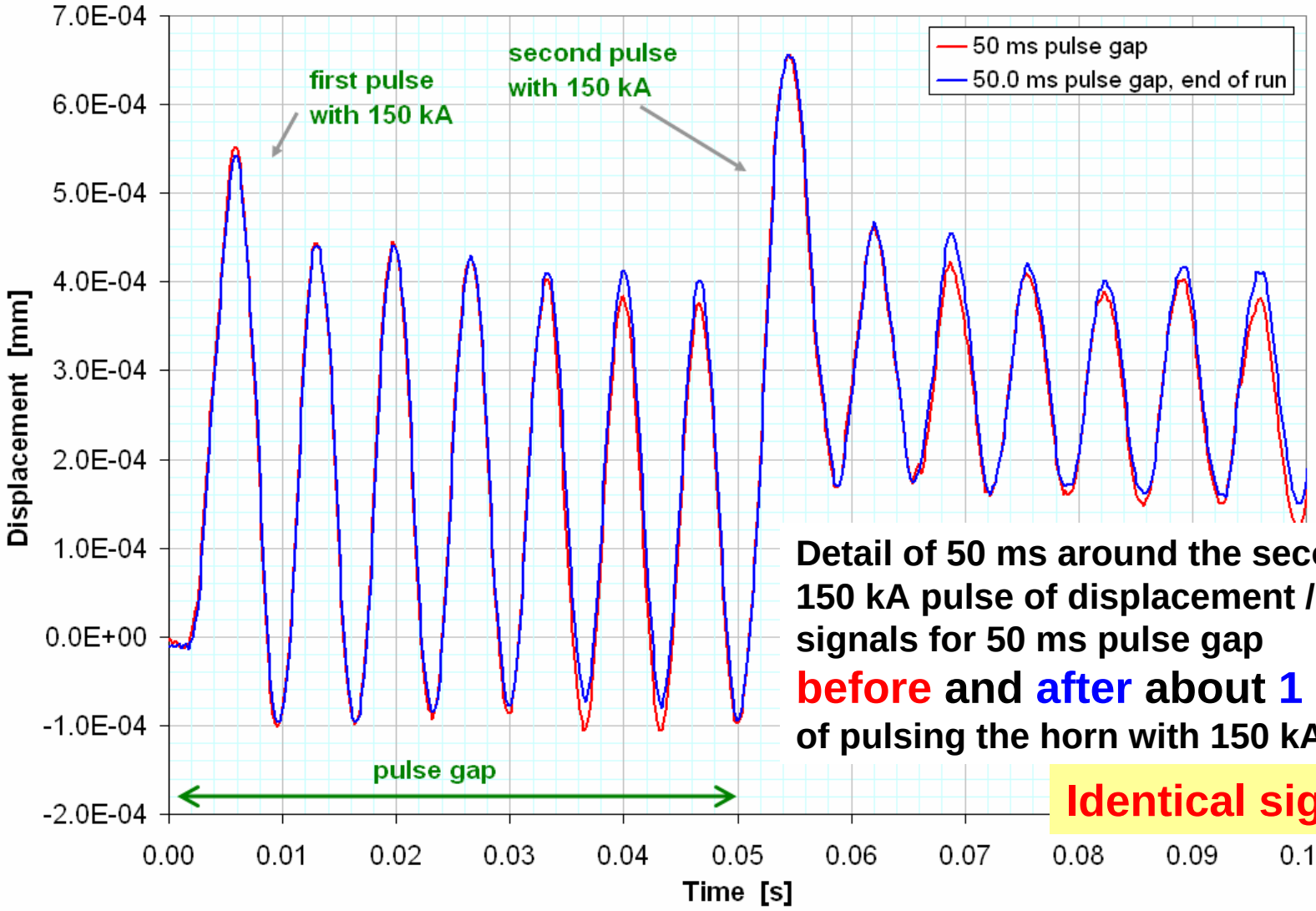
Horn Response – after 1 Day



Detail of 50 ms around the second 150 kA pulse of displacement / time signals for 50 ms pulse gap

before and after about 1 day of pulsing the horn with 150 kA

Identical signals!

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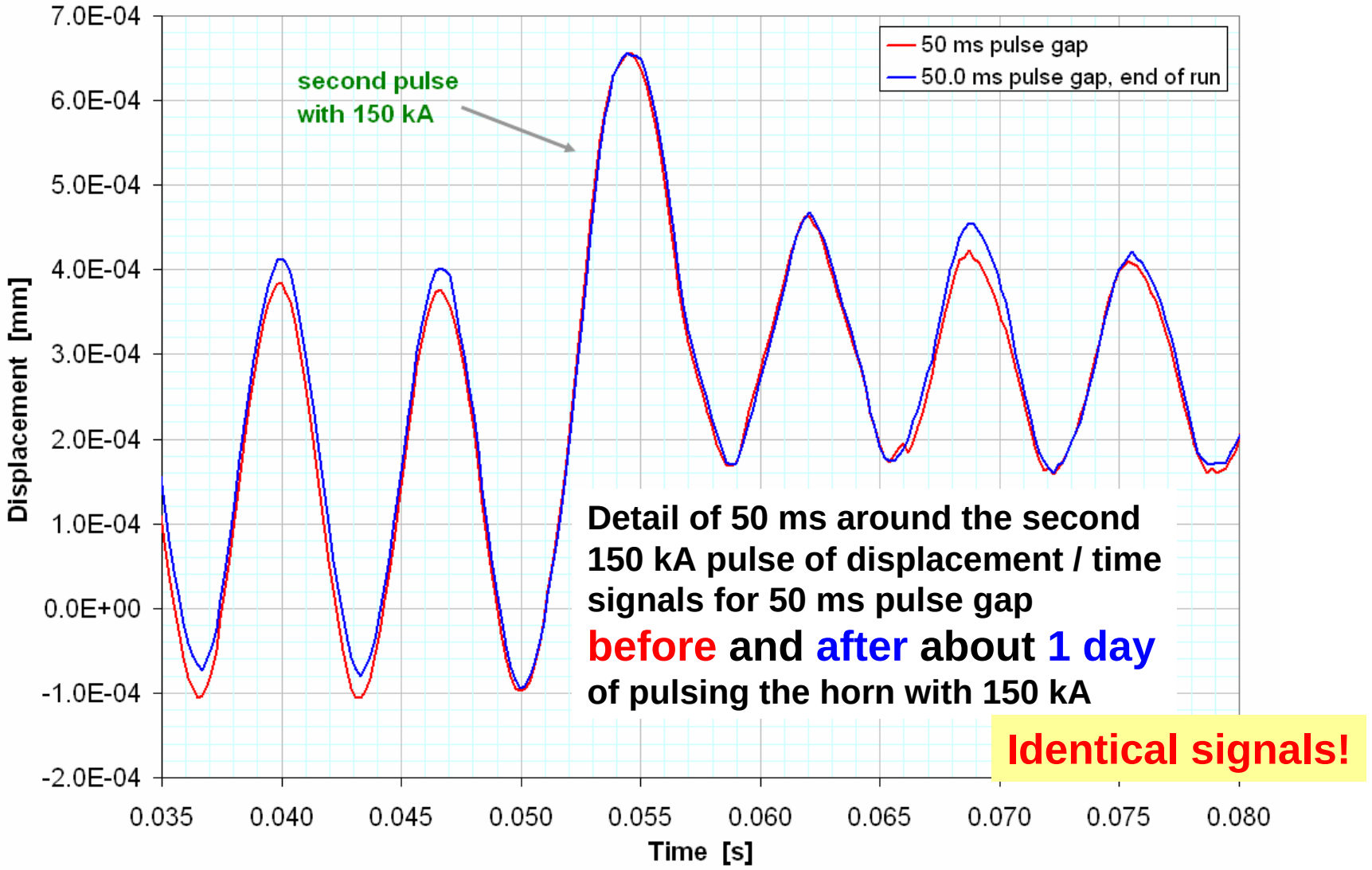
Horn after 1 Day – Detail



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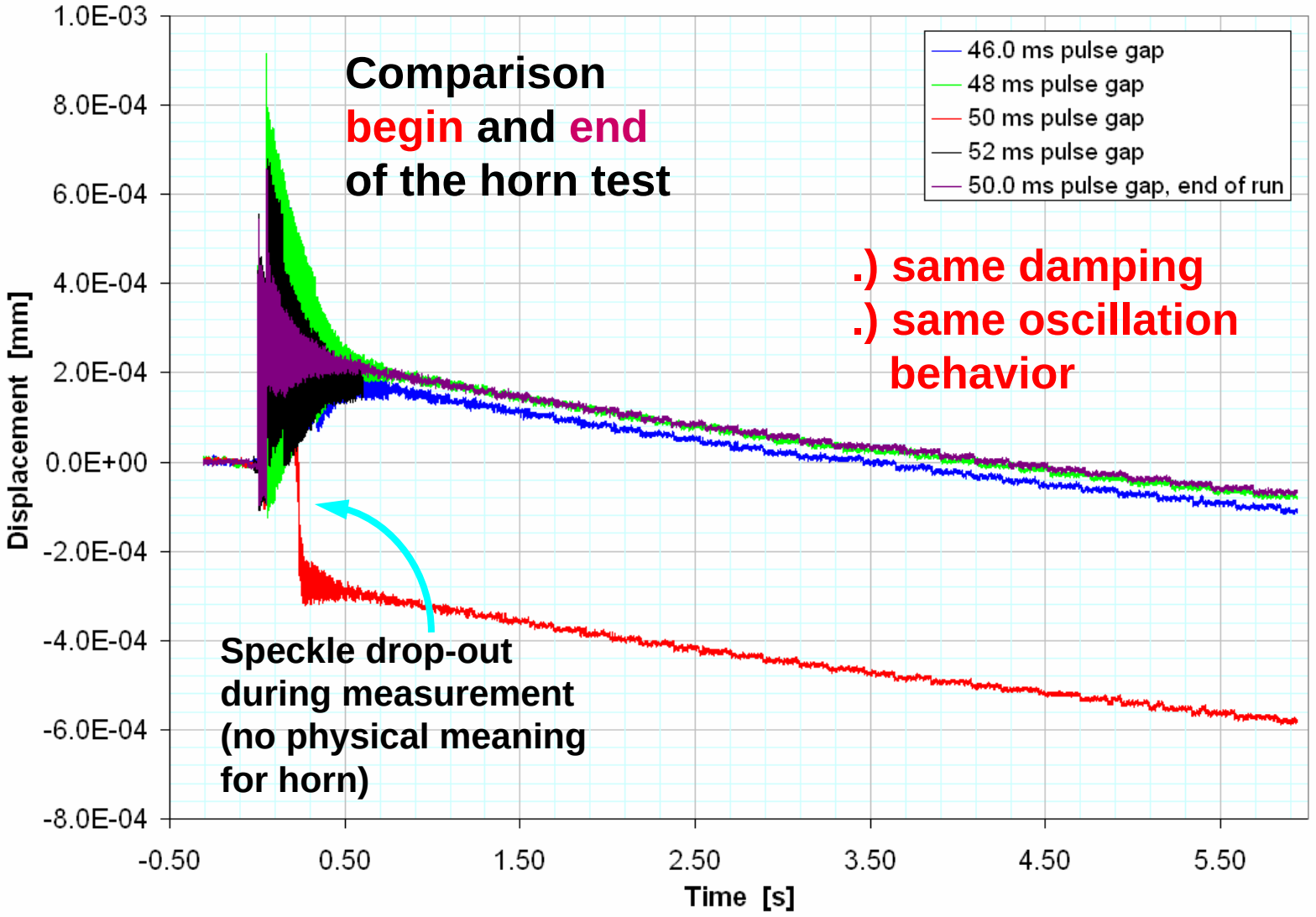
Response of Horn



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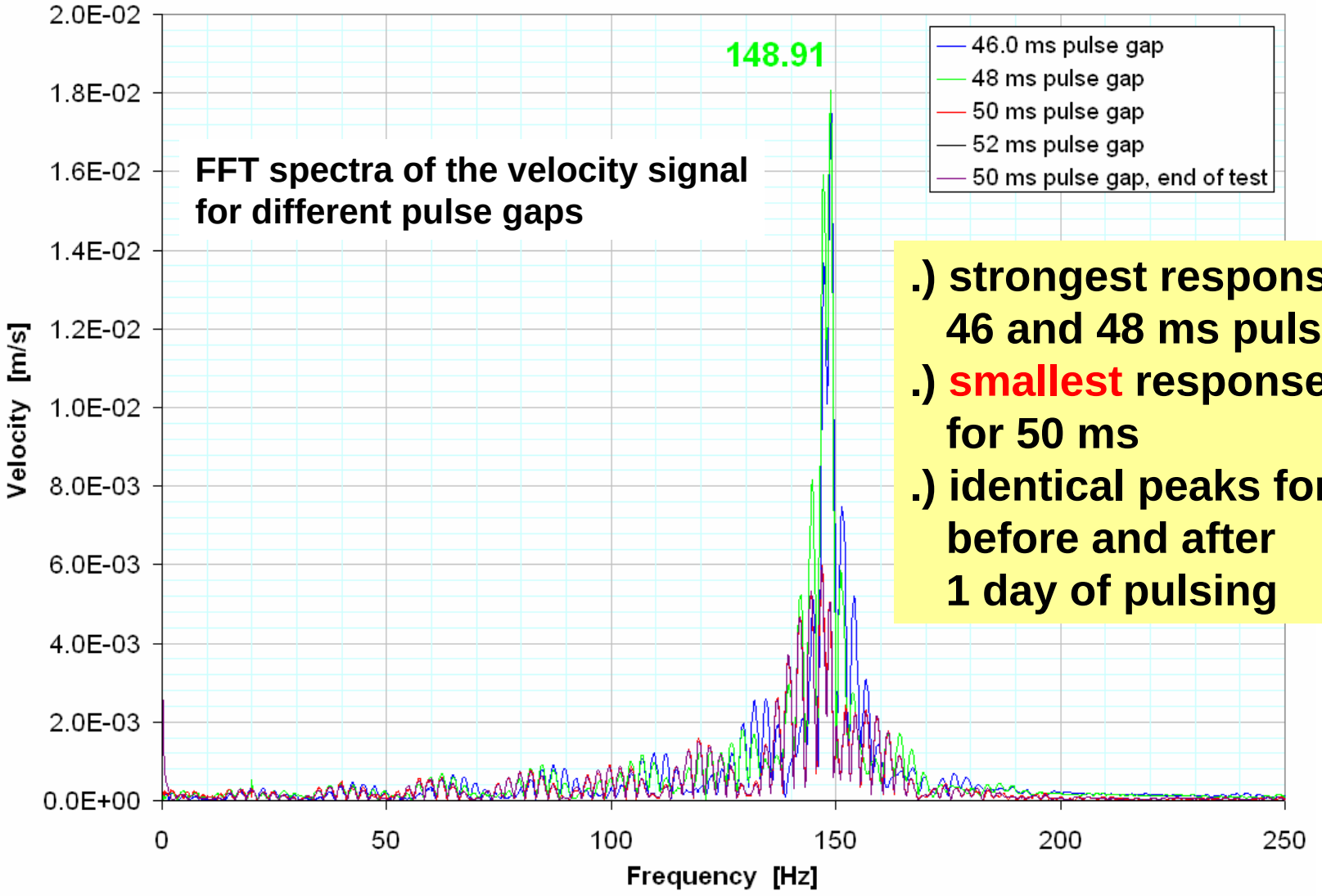
Response of Horn - FFT



.) strongest response for 46 and 48 ms pulse gap

.) smallest response for 50 ms

.) identical peaks for 50 ms before and after 1 day of pulsing

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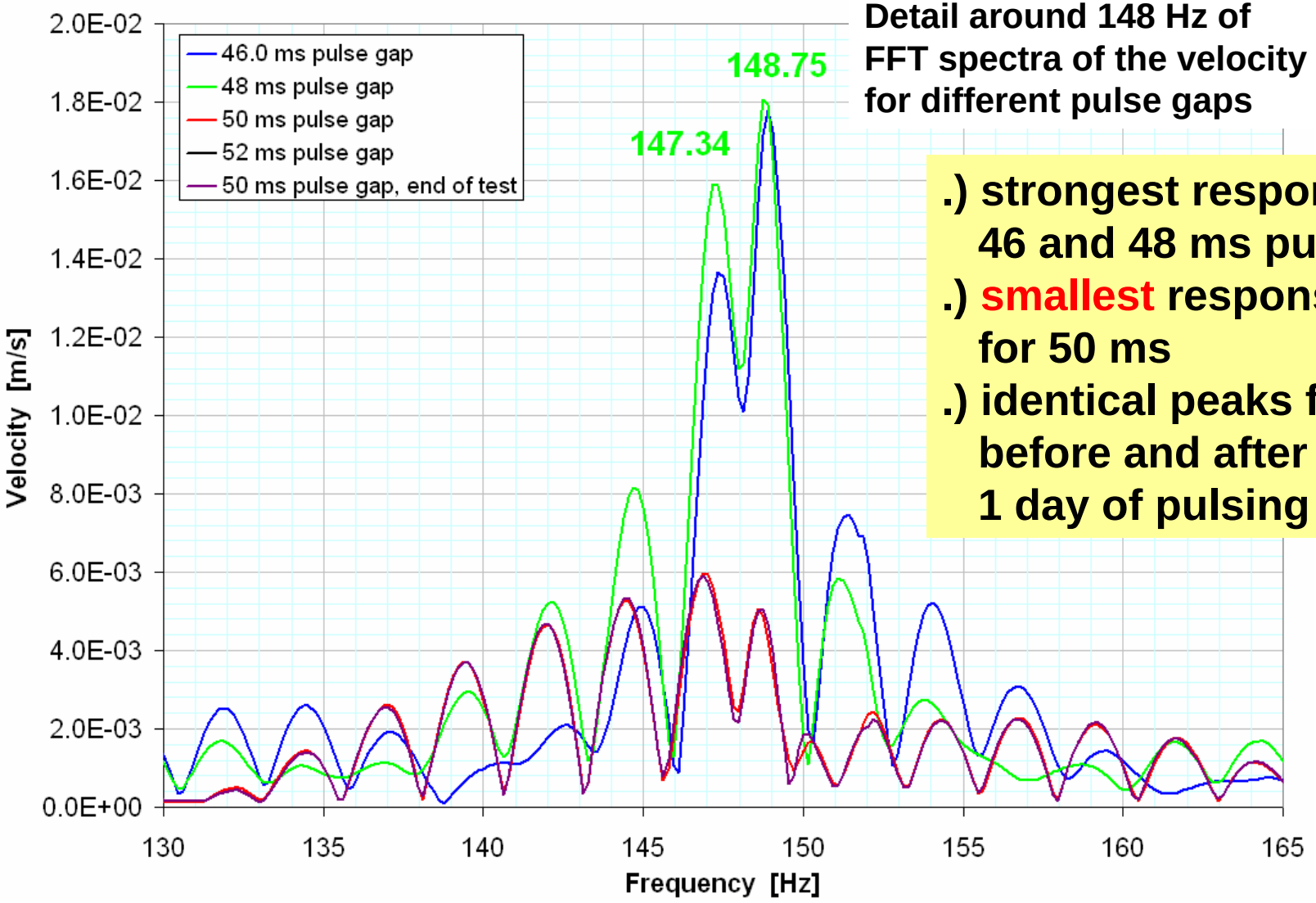
Horn Response – FFT – Detail



Detail around 148 Hz of FFT spectra of the velocity signal for different pulse gaps

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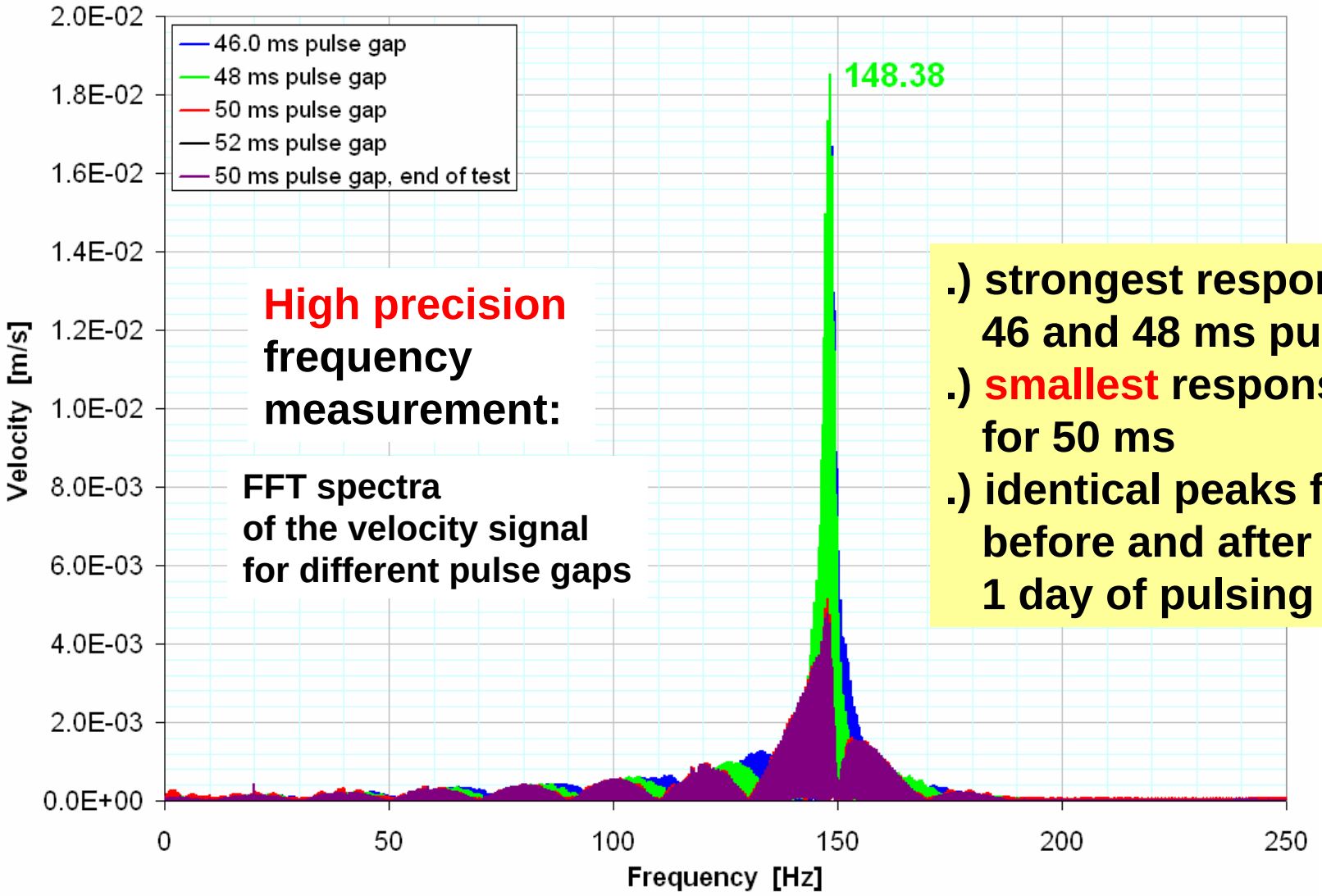
Response of Horn – FFT



High precision frequency measurement:

FFT spectra of the velocity signal for different pulse gaps

.) strongest response for 46 and 48 ms pulse gap
.) smallest response for 50 ms
.) identical peaks for 50 ms before and after 1 day of pulsing

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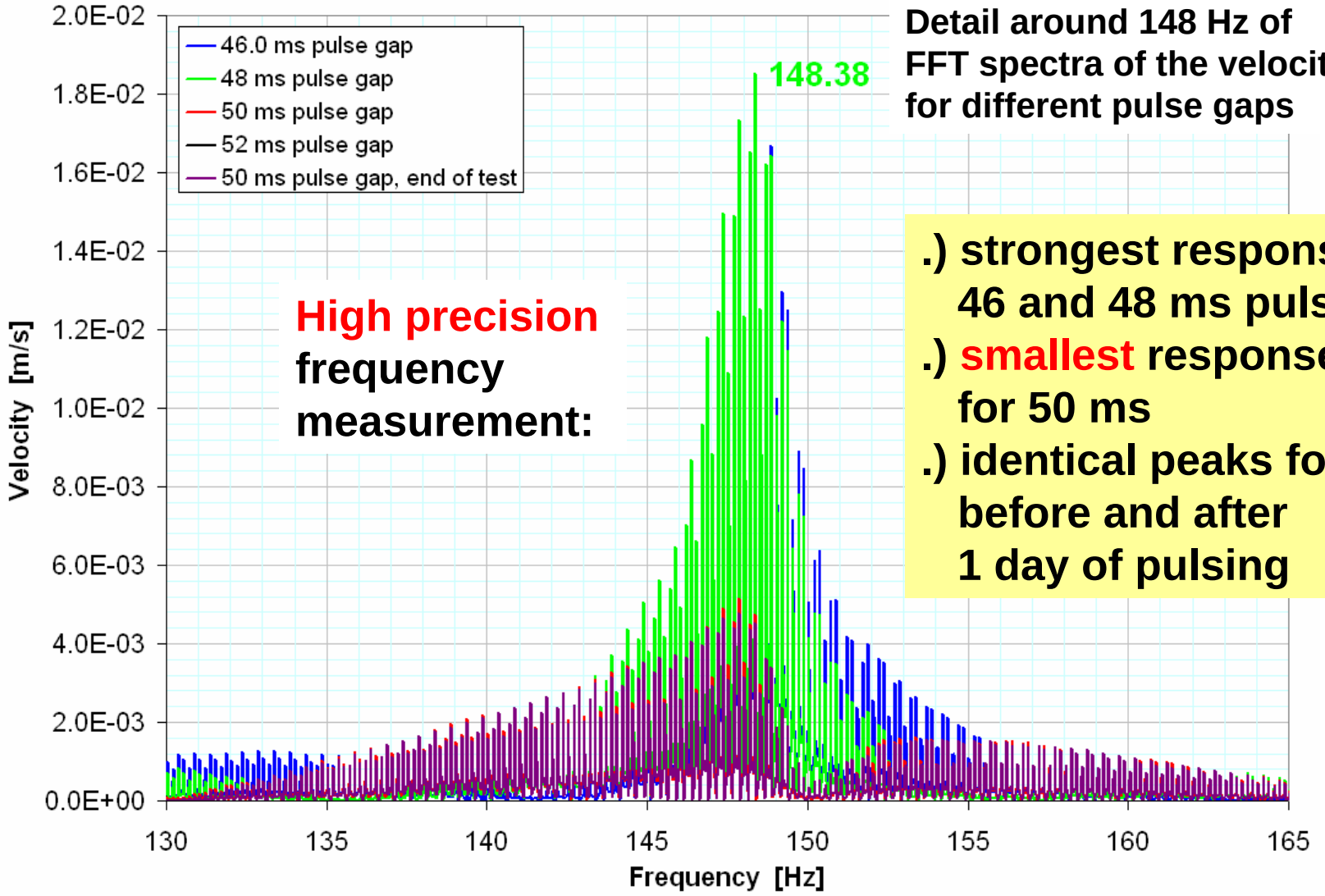

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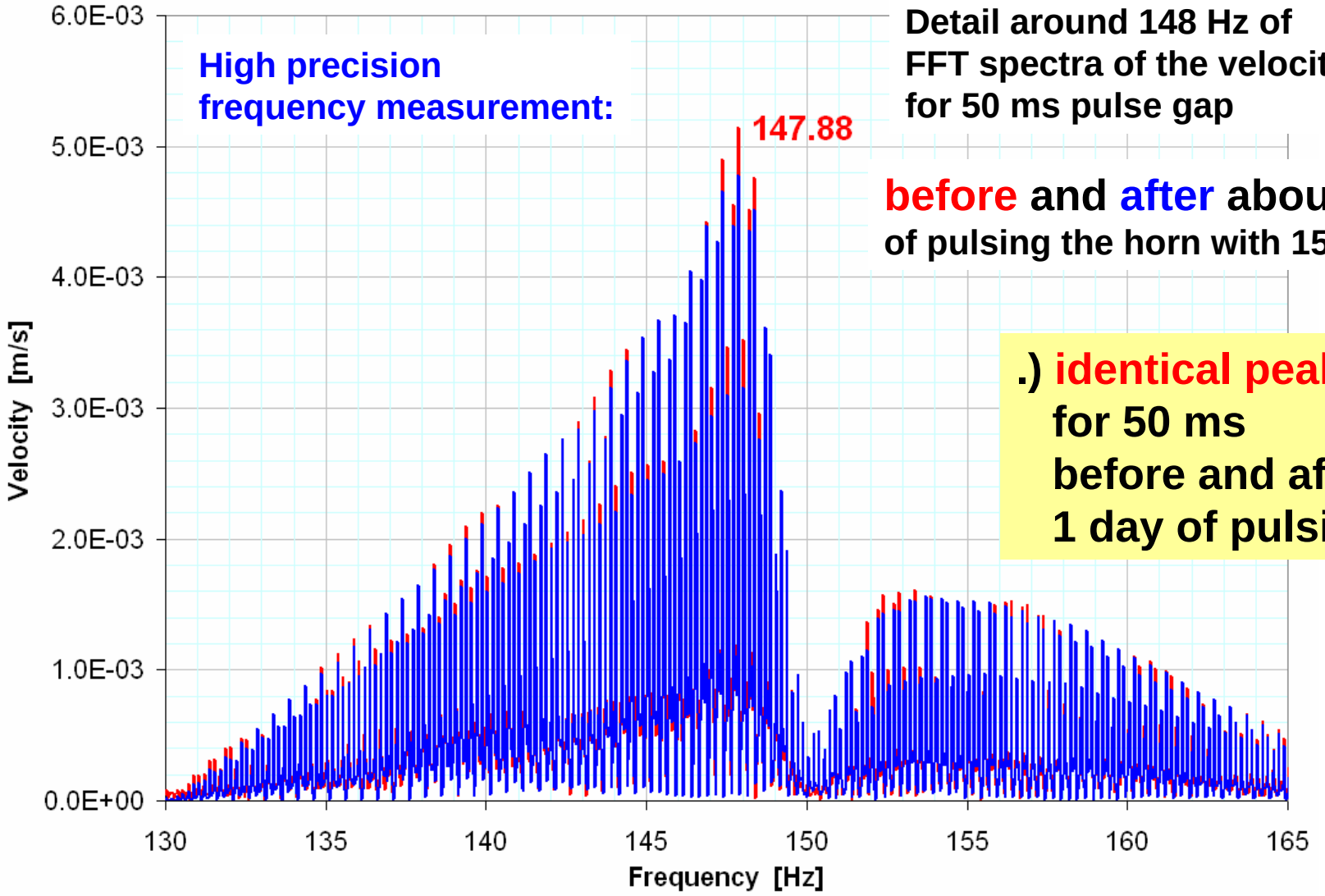
Response of Horn – FFT



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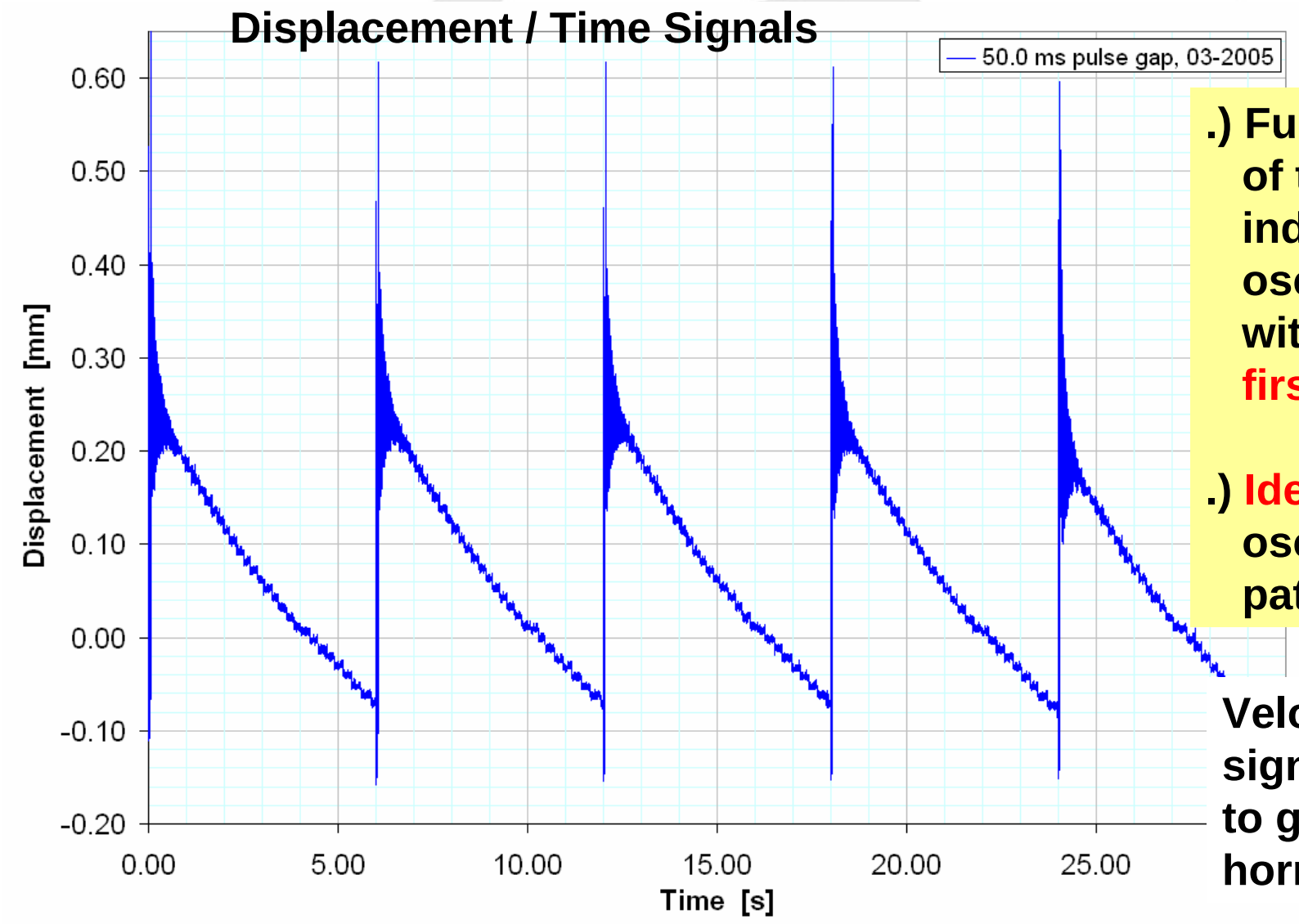
Response of Horn



.) Full damping of the induced oscillation within the first second

.) Identical oscillation pattern

Velocity / time signals used to generate horn “melody”

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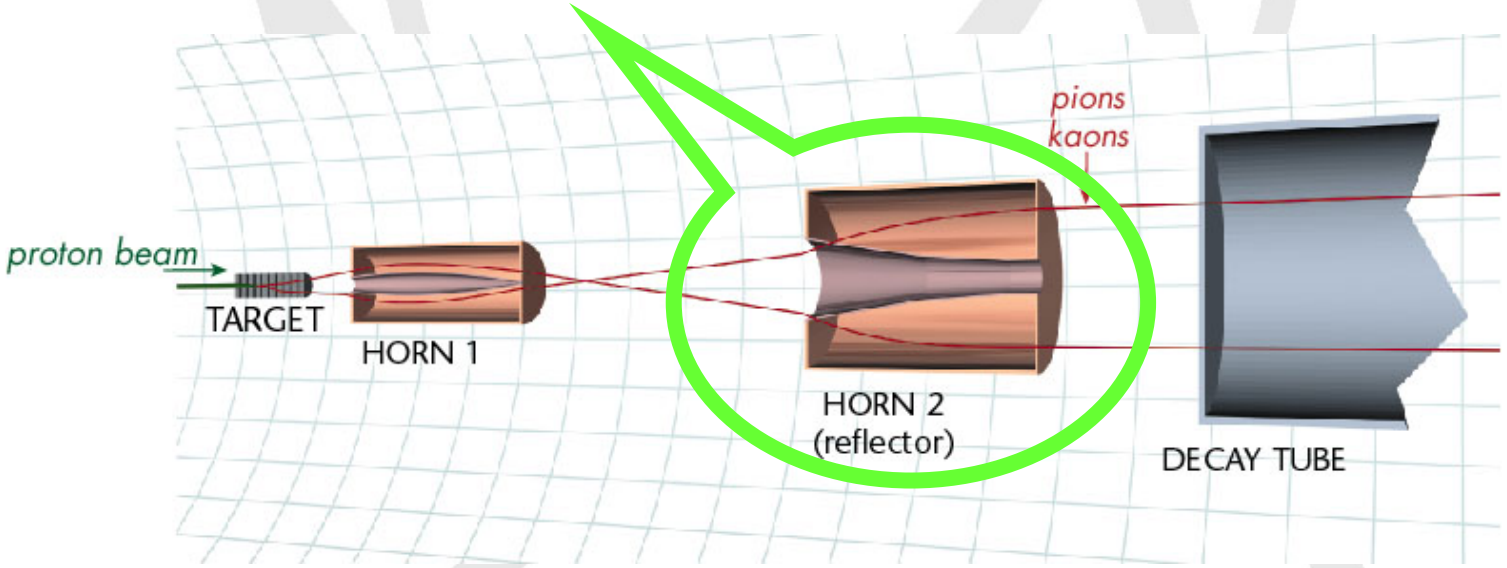
Reflector



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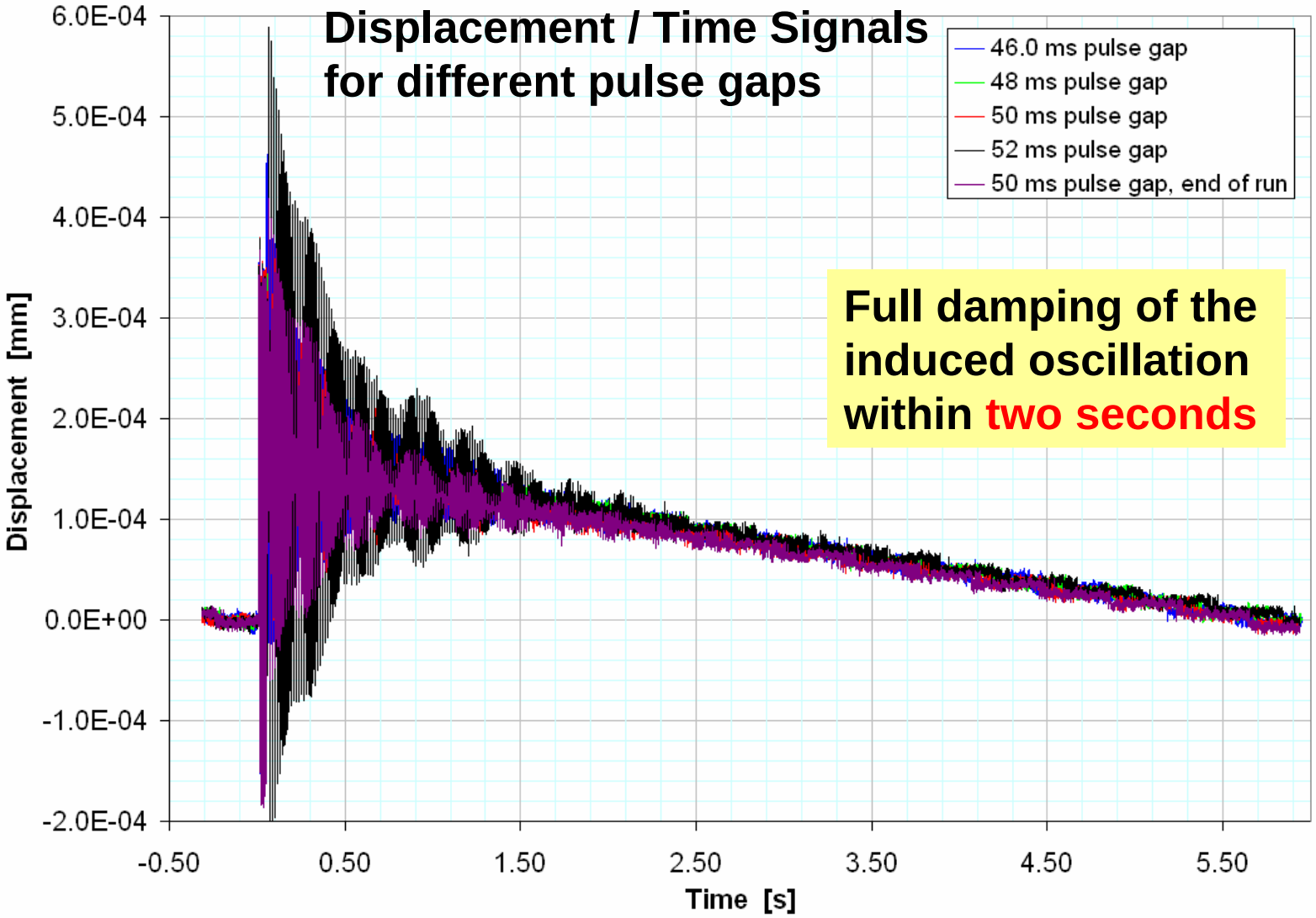
Response of Reflector



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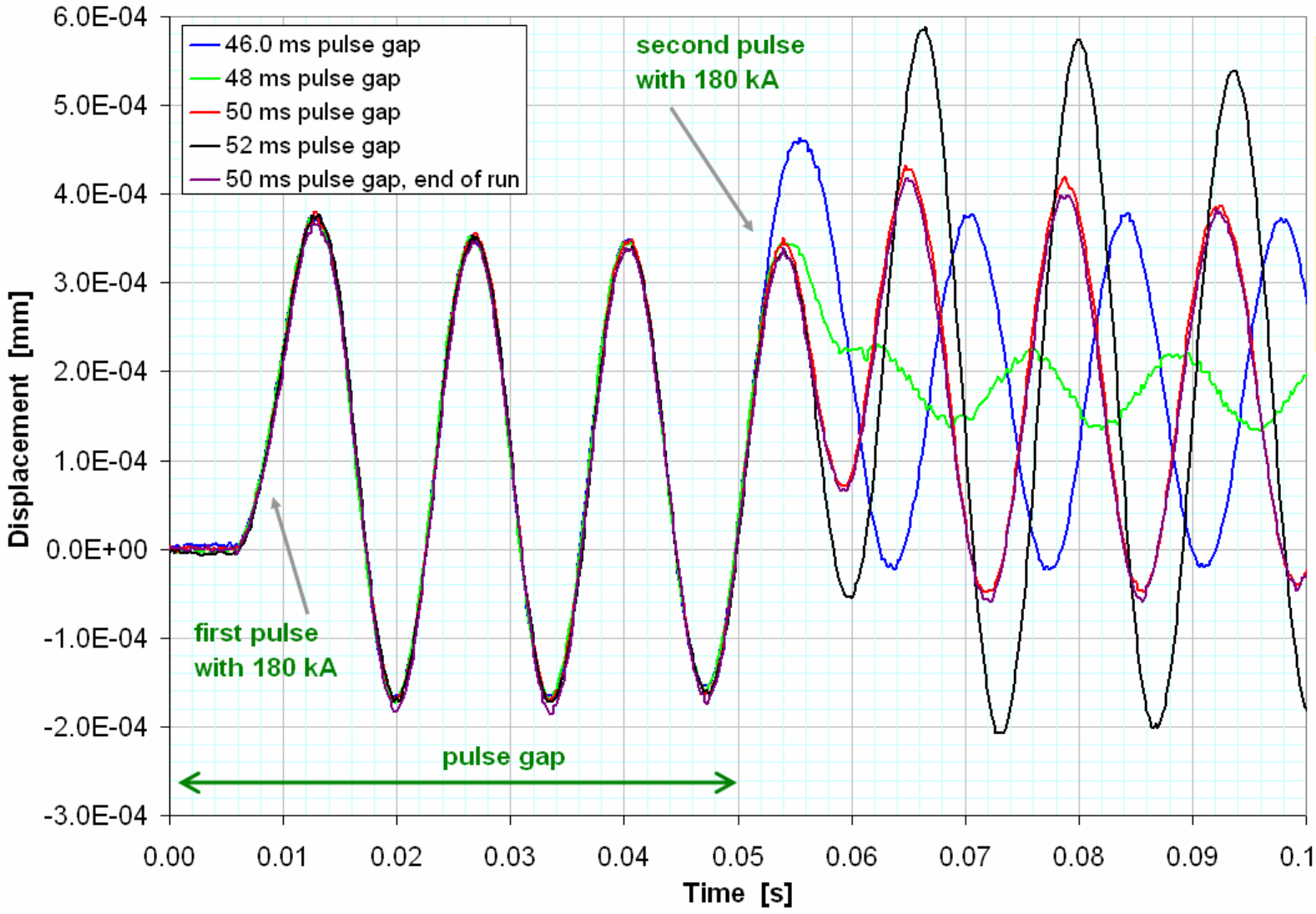

48 ms pulse gap causes the smallest amplitude after the second 180 kA pulse.

50 ms pulse gap causes a 20% increase for the first oscillation after the 2nd 180 kA pulse.

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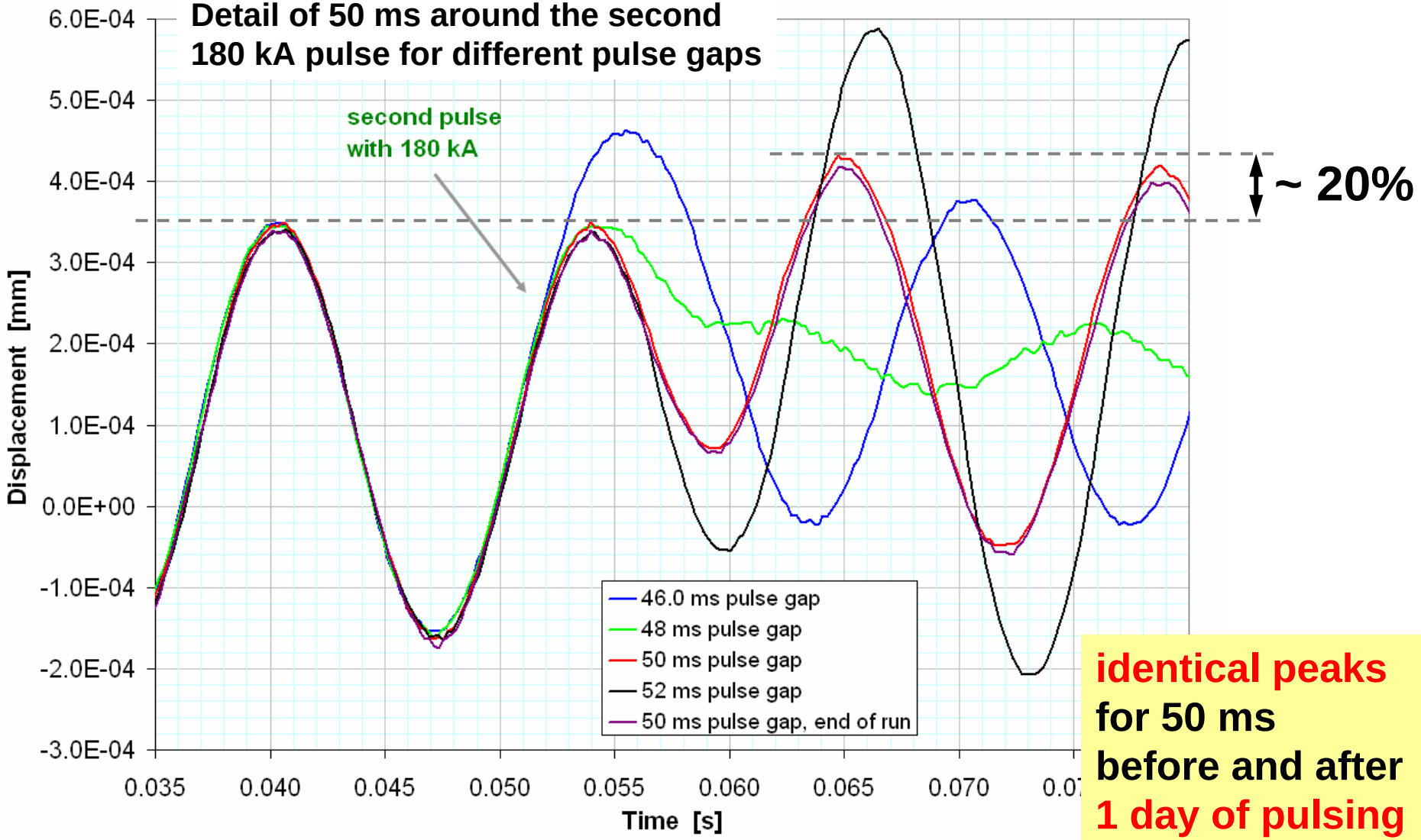
Response of Reflector



identical peaks for 50 ms before and after 1 day of pulsing

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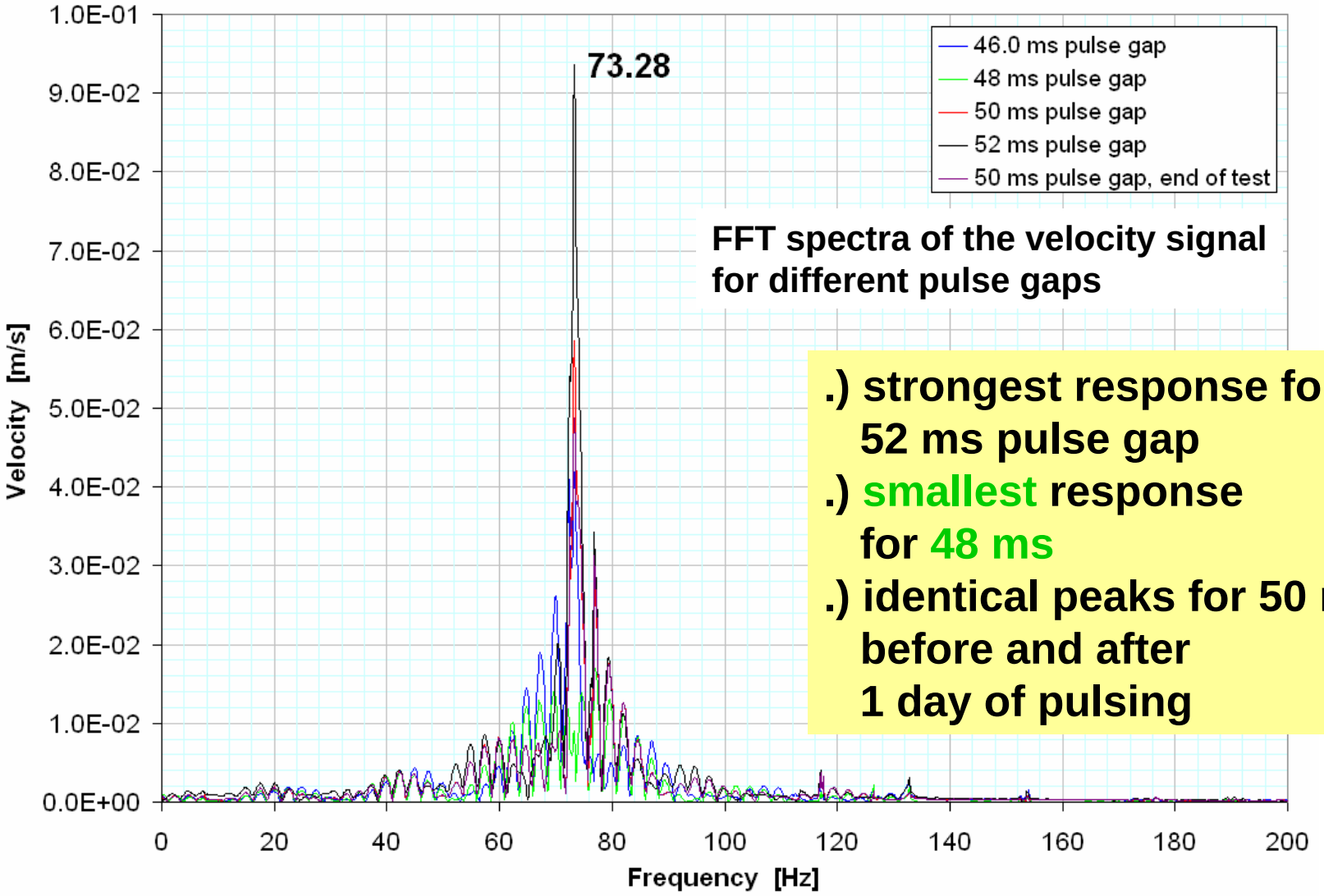
Response of Reflector



FFT spectra of the velocity signal for different pulse gaps

.) strongest response for 52 ms pulse gap

.) smallest response for 48 ms

.) identical peaks for 50 ms before and after 1 day of pulsing

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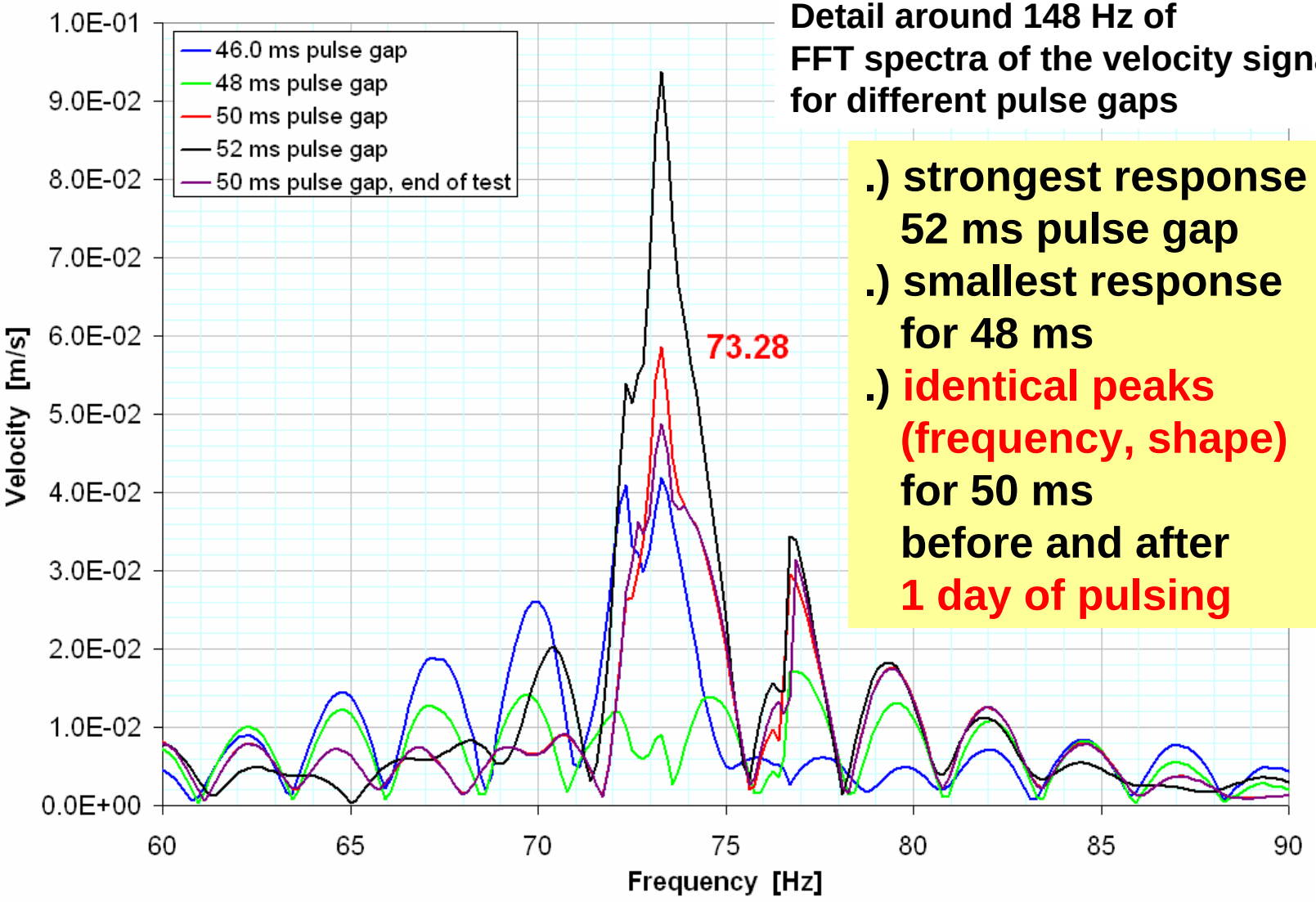
Response of Reflector



Detail around 148 Hz of FFT spectra of the velocity signal for different pulse gaps

.) strongest response for 52 ms pulse gap

.) smallest response for 48 ms

.) identical peaks (frequency, shape) for 50 ms before and after 1 day of pulsing

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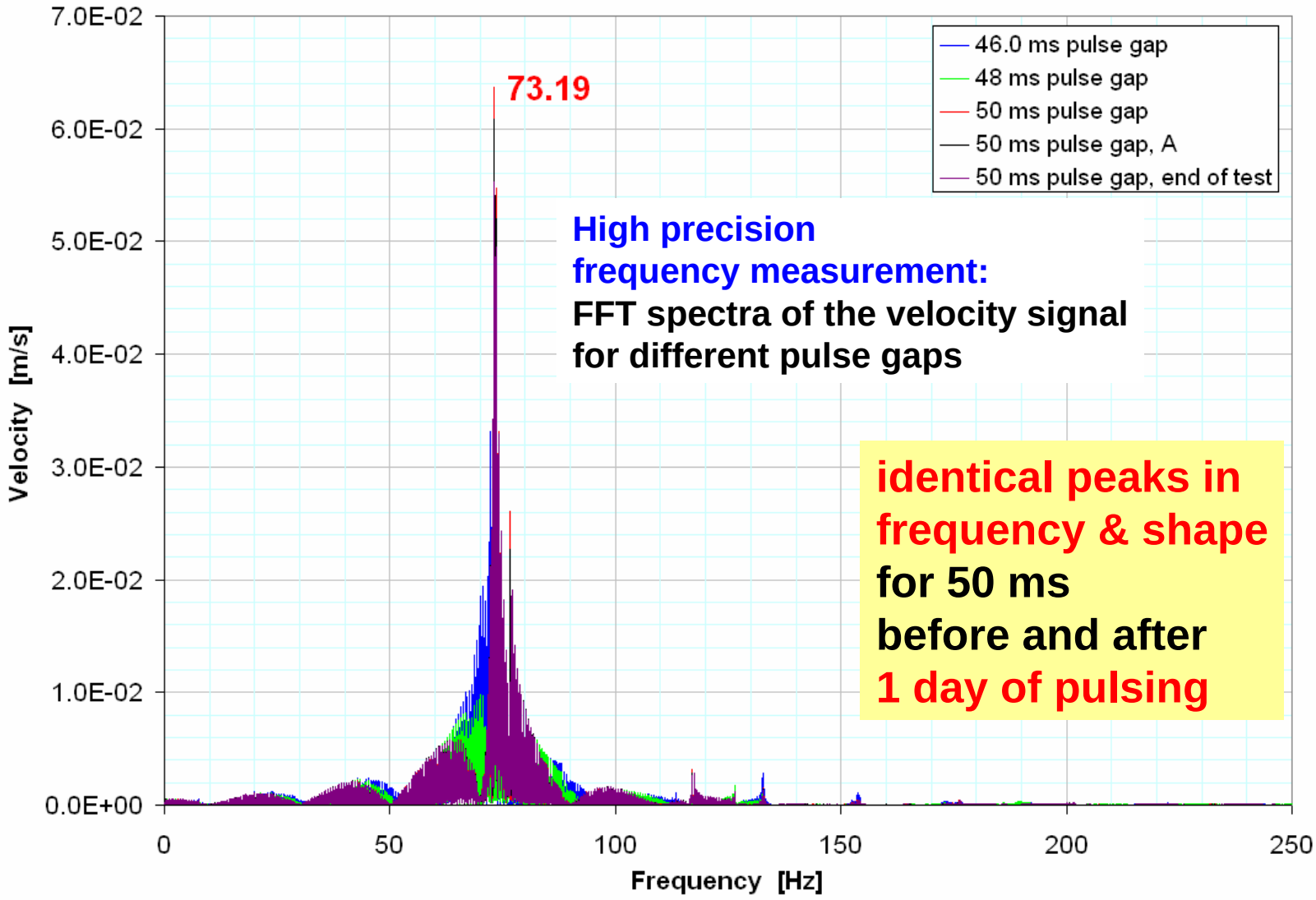
Response of Reflector



High precision frequency measurement:
FFT spectra of the velocity signal for different pulse gaps

identical peaks in frequency & shape for 50 ms before and after 1 day of pulsing

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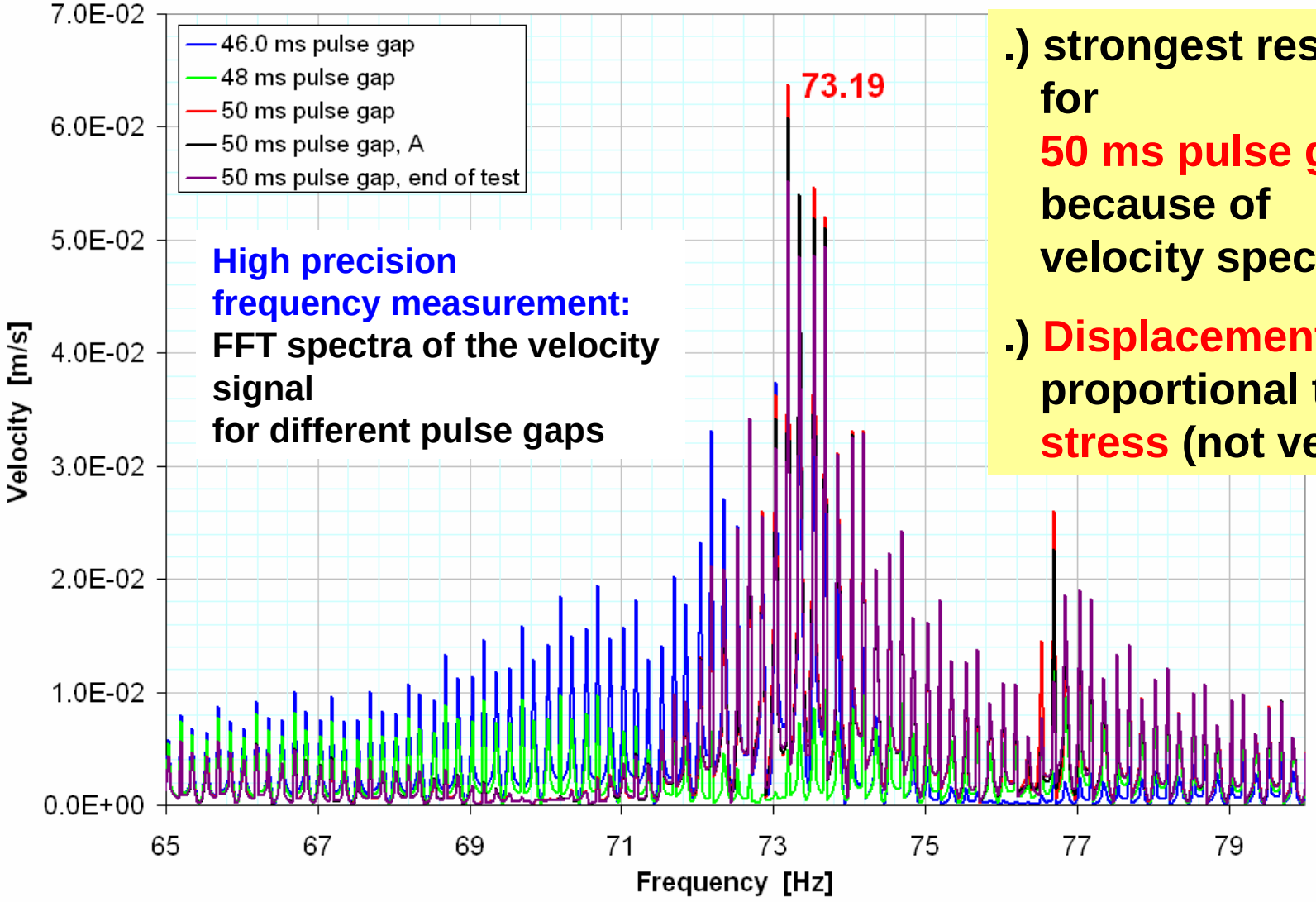
Response of Reflector



High precision frequency measurement:
FFT spectra of the velocity signal for different pulse gaps

.) strongest response for 50 ms pulse gap because of velocity spectrum

.) Displacement proportional to stress (not velocity)

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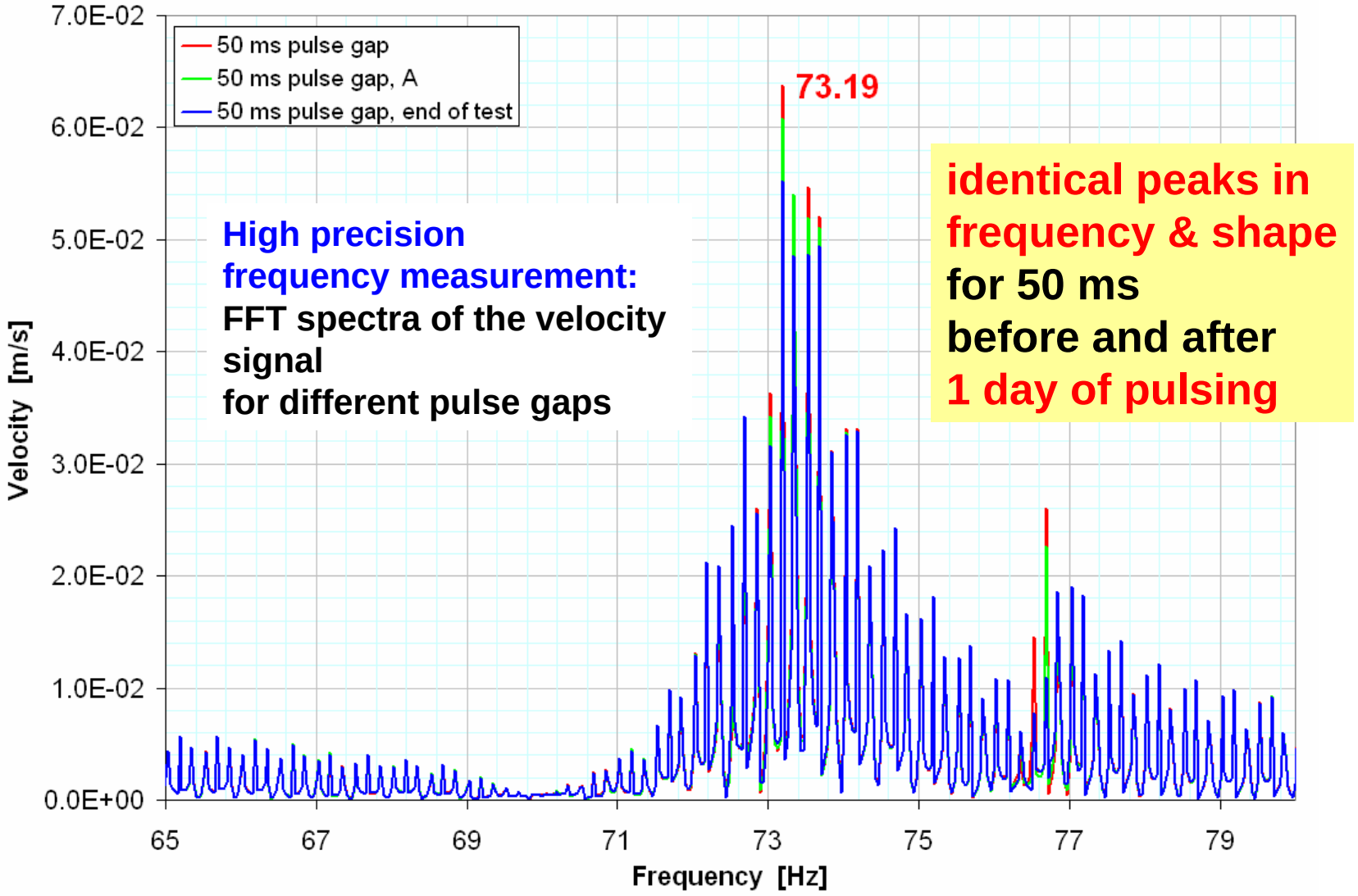
Response of Reflector



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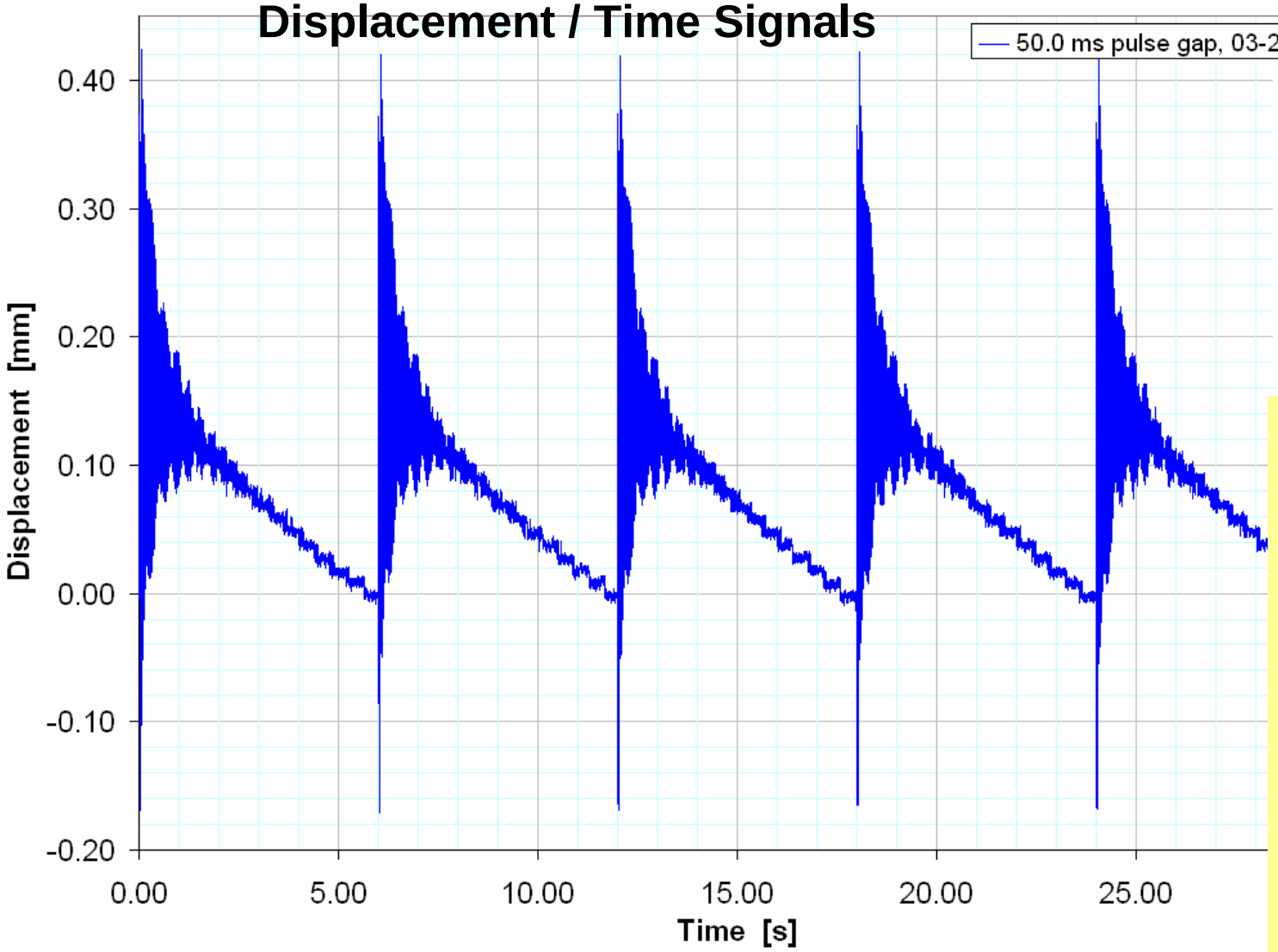

Velocity / time signals used to generate reflector "melody"

.) Full damping of the induced oscillation within the two seconds

.) Identical oscillation pattern

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Summary: Horn

Full damping of the induced oscillation within the first second.

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Summary: Horn

Full damping of the induced oscillation within the first second.

50 ms pulse gap causes the smallest displacement amplitude after the second 150 kA pulse.

Strongest response for 46 and 48 ms pulse gap.

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Identical displacement signals for 50 ms pulse gap before and after about 1 day of pulsing the horn with 150 kA.

Same damping and oscillation behavior before and after about 1 day of pulsing the horn with 150 kA.

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Identical FFT-peaks (frequency & shape) for 50 ms before and after 1 day of pulsing.

Identical oscillation pattern (amplitude & damping) for different pulses in a sequence.

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Summary: Reflector

Full damping of the induced oscillation within the two seconds.

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Summary: Reflector

Full damping of the induced oscillation within the two seconds.

50 ms pulse gap causes a 20% increase of the first oscillations after the 2nd 180 kA pulse.

Identical displacement signals for 50 ms pulse gap before and after about 1 day of pulsing the horn with 180 kA.

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Conclusion

Horn displacement response is minimized for a pulse gap of 50 ms.

50 ms pulse gap for the reflector causes a 20% increase of the first oscillations after the 2nd 180 kA pulse.

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Conclusion

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Horn is more sensitive to oscillation propterties,

.) since it is less rigid compared to the reflector

.) and closer to the target magazine

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- **.) and closer to the target magazine**

Horn and reflector can be pulsed with 50 ms.

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Thanks for your attention!!!

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