Robust:
"Road Upgrade of Standards"
GRD1-2002-70021.

Acceleration transducers, data acquisition and validation.

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Introduction

- The comparison of severity indices and time histories between test and simulation requires that the tool used to extract these information works in a proper way.
- The definition and verification of numerical data acquisitions and numerical transducers is then one the steps needed to assess the validation of the model.

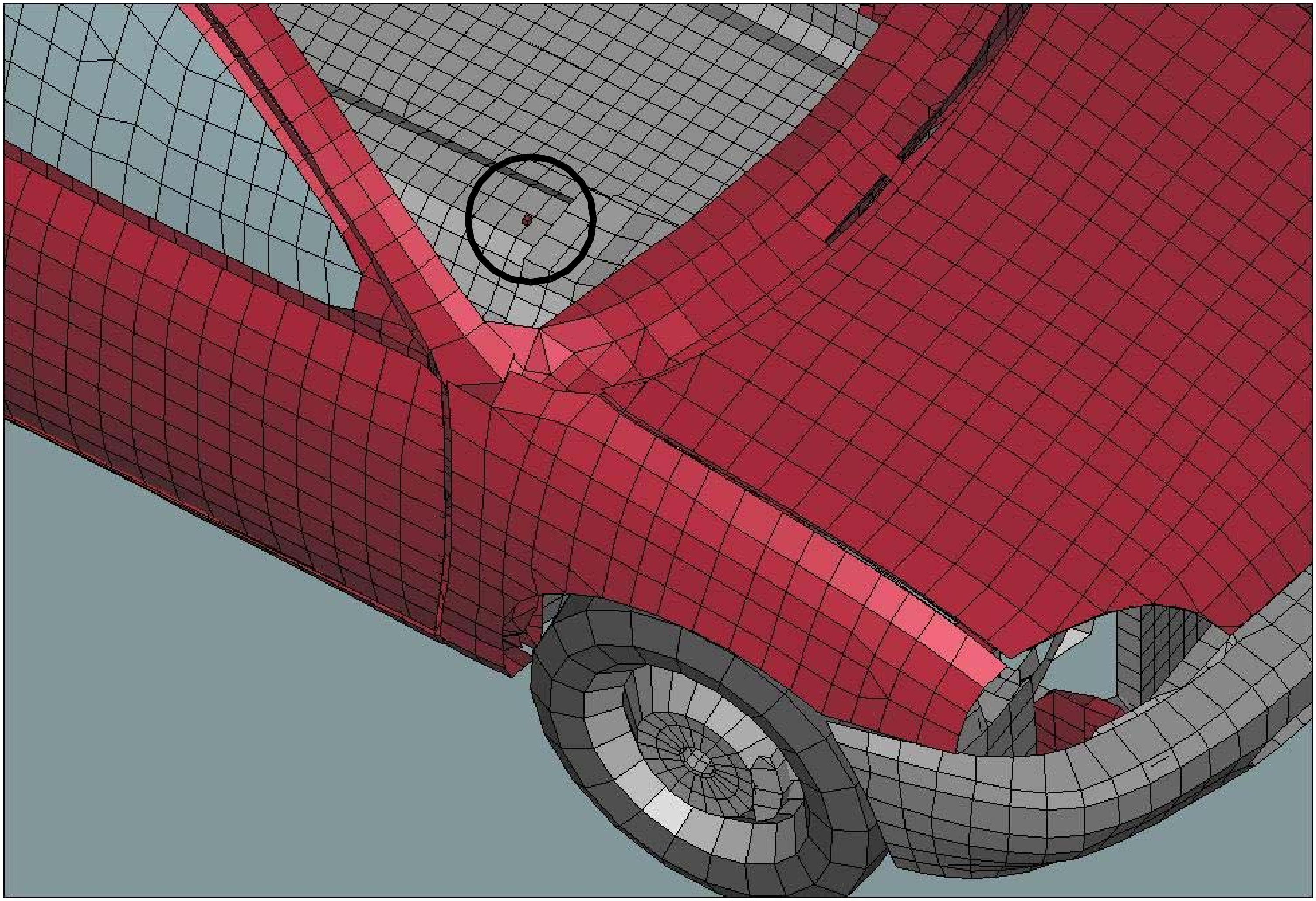
Measure of severity indices and time histories

- The numerical data acquisition must be able to acquire data that can reconstruct properly the physics of the phenomenon.
- The definition of the transducer must be comparable to the behavior of a typical transducer used during crash tests.

Numerical data acquisition.

- In order to collect the acceleration and the velocity-time histories of the vehicle an accelerometer sensor is included in the vehicle model.
- This element is represented by a rigid brick that must be properly connected to a massive part of the vehicle, usually by means of a rigid link, in order to attenuate high frequencies components.

Location of the accelerometer



Influence of sampling frequency

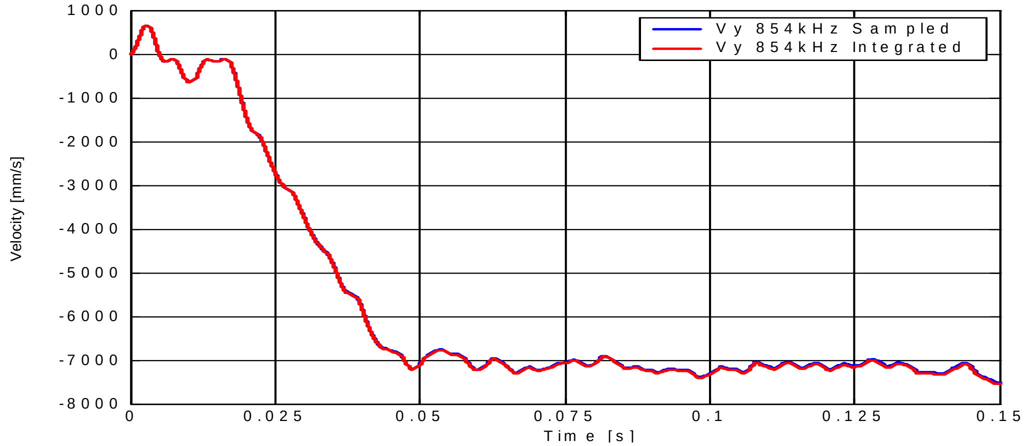
- Round Robin scenario. Small vehicle 100 km/h 20° rigid barrier.
- Ls-dyna 970 solver up to 5434a version.
- To verify the behavior of the numerical data acquisition system, accelerations have been sampled at different frequencies.
- Three output frequencies were considered:
    - 854 kHz (sampling time equal to the integration timestep),
    - 100 kHz
    - 10 kHz.
- The data output file were used to compute the occupant risk factors.
- The output data were initially filtered with a standard CFC180 filter and then processed by the software.

Comparison.

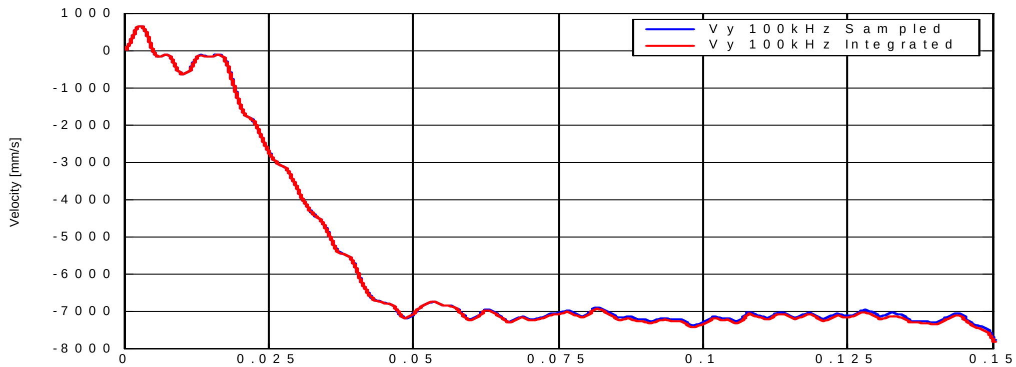
- The acceleration measures as the severity indices are different even if they are referred to the same impact.
- How can we define which is the proper acceleration and the wrong one and why an acceleration sampled during a numerical simulation can be wrong?

- Besides the acceleration time history also the velocity and displacement time histories can be obtained from these nodes.
- To understand which is the right acceleration and which is the wrong, we must verify that:
  - the velocity and the displacement obtained integrating the acceleration
    - And
  - the velocity and displacement directly sampled.
    - Must be equivalent

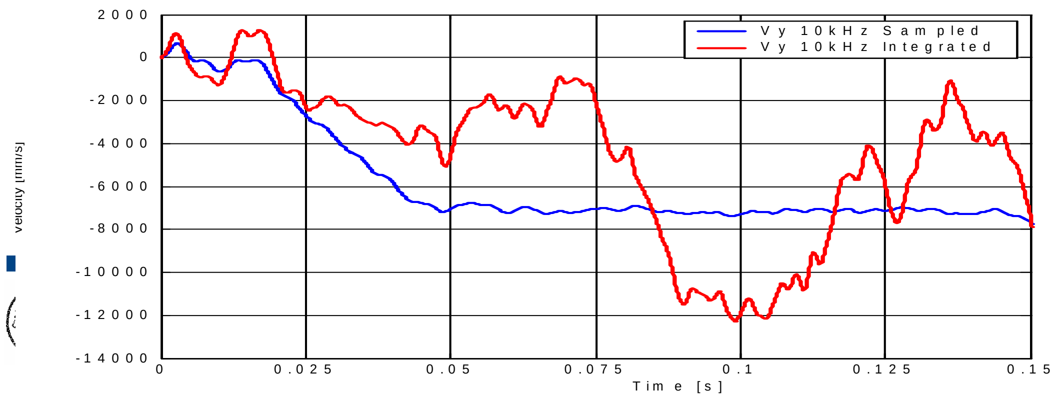
Lateral velocity comparison



- 854 kHz



- 100 Khz



- 10 Khz

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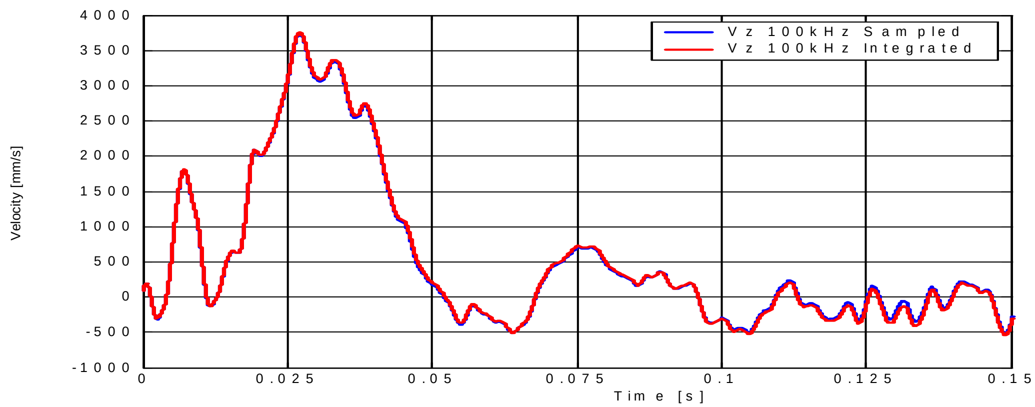
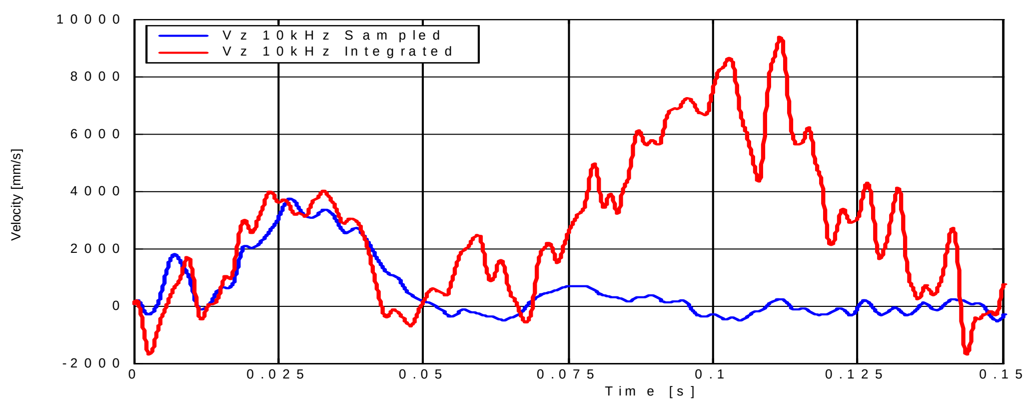
Vertical velocity comparison

- 854 kHz



- 100 Khz



- 10 Khz

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Comparison results.

- Acceleration sampled at 854 Khz and 100Khz are able to reconstruct correctly the velocity and the displacement of the vehicle.
- Acceleration sampled at 10 Khz (standard sampling rate used for experimental testing) is not able to reconstruct the motion of the vehicle.

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- Signals sampled at 10 Khz have aliasing problems.

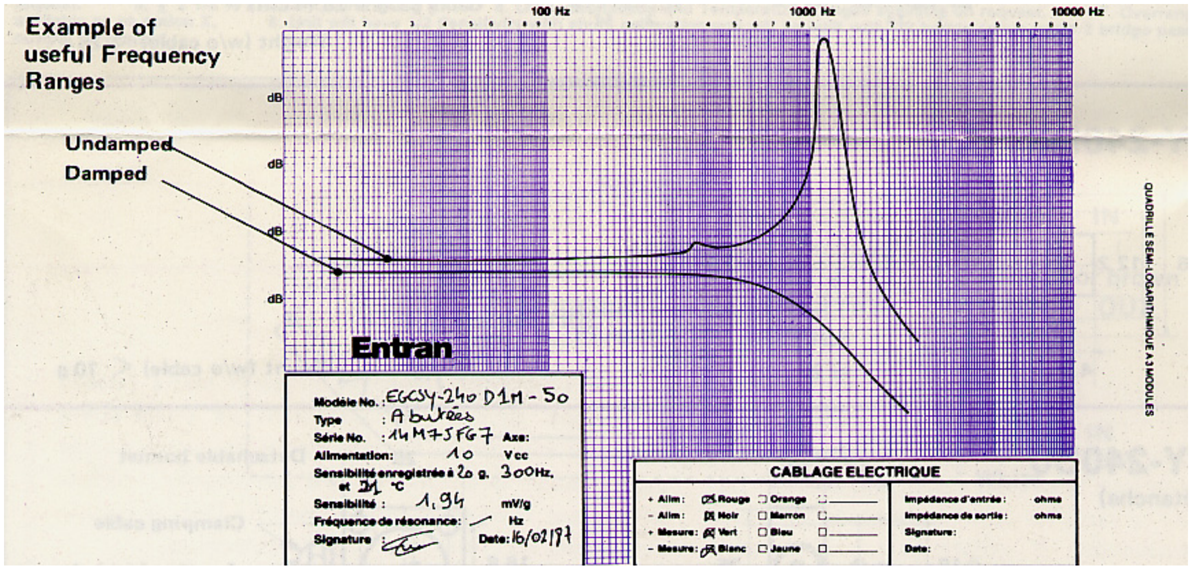
Data acquisition conclusion.

- This problem showed that numerical data acquisition has the same typical problems of the experimental data acquisition.
- Care must be taken for the definition of the sampling rate.
- This problem is mesh sensitive and code sensitive (Pam crash has pre-sampling filtering).
- The requirement is that, to prove the proper data acquisition, the reconstruction of the motion must be demonstrated starting from acceleration time histories.

Numerical accelerometer definition.

- Now that we have demonstrated the capability of our numerical data acquisition the problem is shifted to the transducer itself.
- This numerical transducer must be compared to a standard real transducer.
- If we want to compare these two output these transducers (numerical and experimental) must be equivalent.

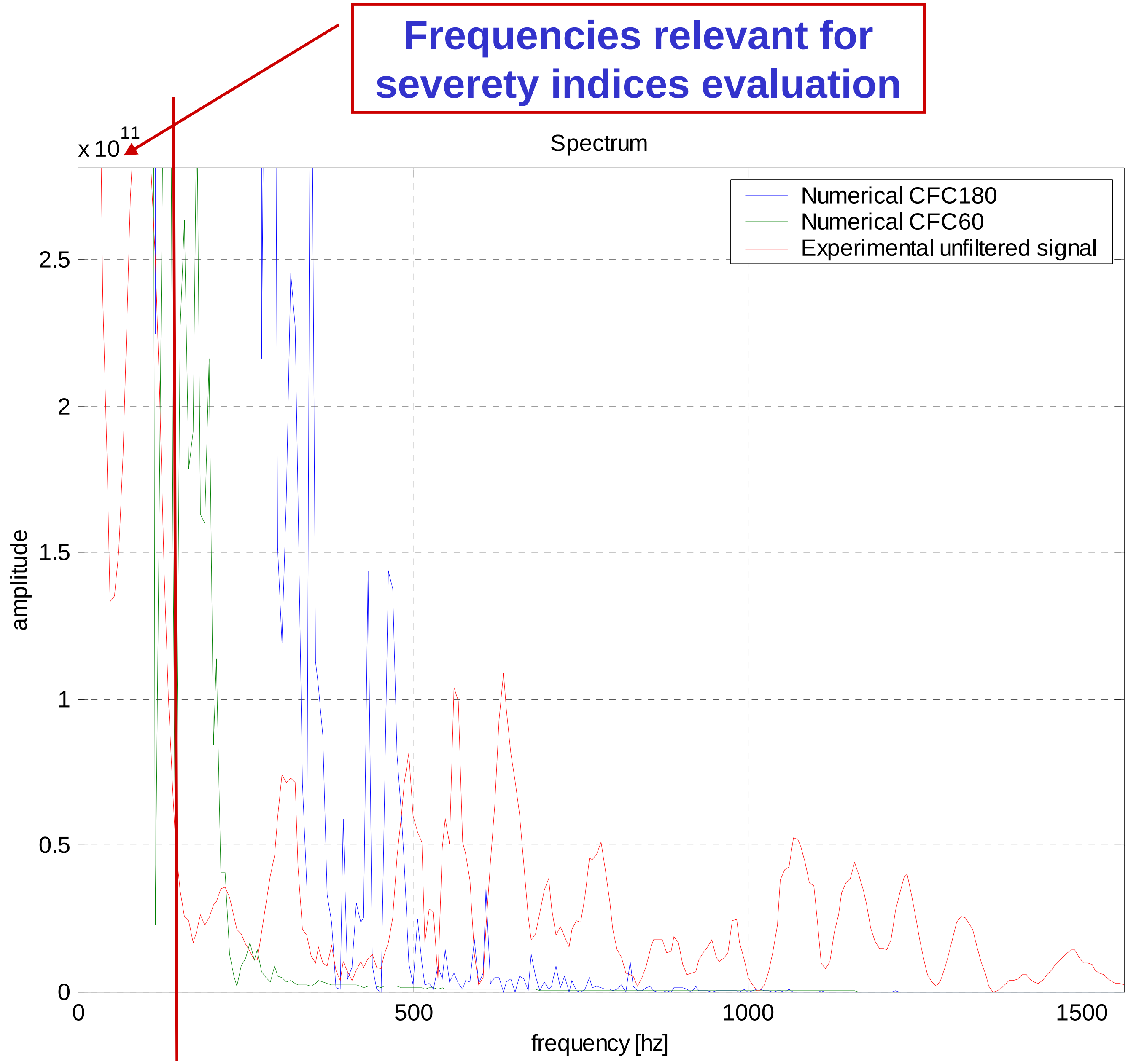
Numerical-experimental transducers.



- Typical real accelerometer frequency response.

- Numerical accelerometers are not damped. They can produce frequencies up to the natural frequency of the element where they are attached.
- We have seen how to acquire these signals but now we must make them equivalent to the experimental ones

Example applied to the Round Robin



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Numerical signals. Conclusion.

- To correctly sample acceleration time histories:
  - Demonstrate that you are able to properly reconstruct the motion (with Geo Metro R4 100 kKhz).
- To correctly compare the numerical accelerometer to the experimental one:
  - Pre-filter data to have a numerical frequency response similar to the experimental one (with Geo Metro R4 CFC60).