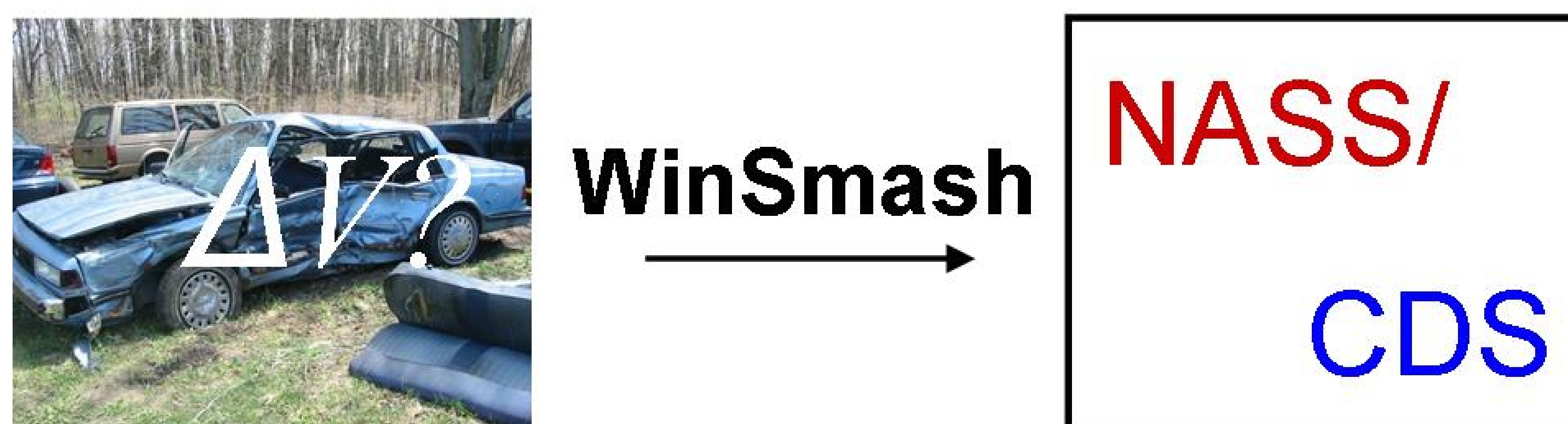


Enhanced Reconstruction Methods for Determining Side Impact Injury Risk

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Side Impact, WinSmash & ΔV

Side impact crashes are responsible for over 6000 deaths each year in the US. ΔV , the vector difference between pre- and post- crash vehicle velocity, is a commonly used metric of collision severity, and is frequently used when constructing relationships between accident severity and injury risk. Nearly all of the ΔV values recorded in large crash databases such as the NASS/CDS are estimated using a reconstruction program called WinSmash or one of its sister programs. **Thus, the statistical accuracy of WinSmash ΔV reconstructions is central to research and policy designed to mitigate the death toll from side crashes.**



To complicate matters, side crashes are particularly difficult to reconstruct accurately. Vehicles exhibit drastically different properties in different regions of the side structure [1], and of all the vehicle contact planes the side provides the largest area over which to engage structures independently of one another. **Ultimately, our research aims to characterize any inaccuracies in WinSmash ΔV reconstructions for side crashes and to correct them.**

Side Crash Tests, IIHS vs. NHTSA

- Prior work has found that WinSmash over-predicts net ΔV in IIHS side crash tests by 45.4% on average [2]
- IIHS side tests different from FMVSS 214 / Side NCAP tests used to characterize vehicle models for WinSmash
- Does WinSmash over-predict FMVSS 214 / Side NCAP ΔV ?**

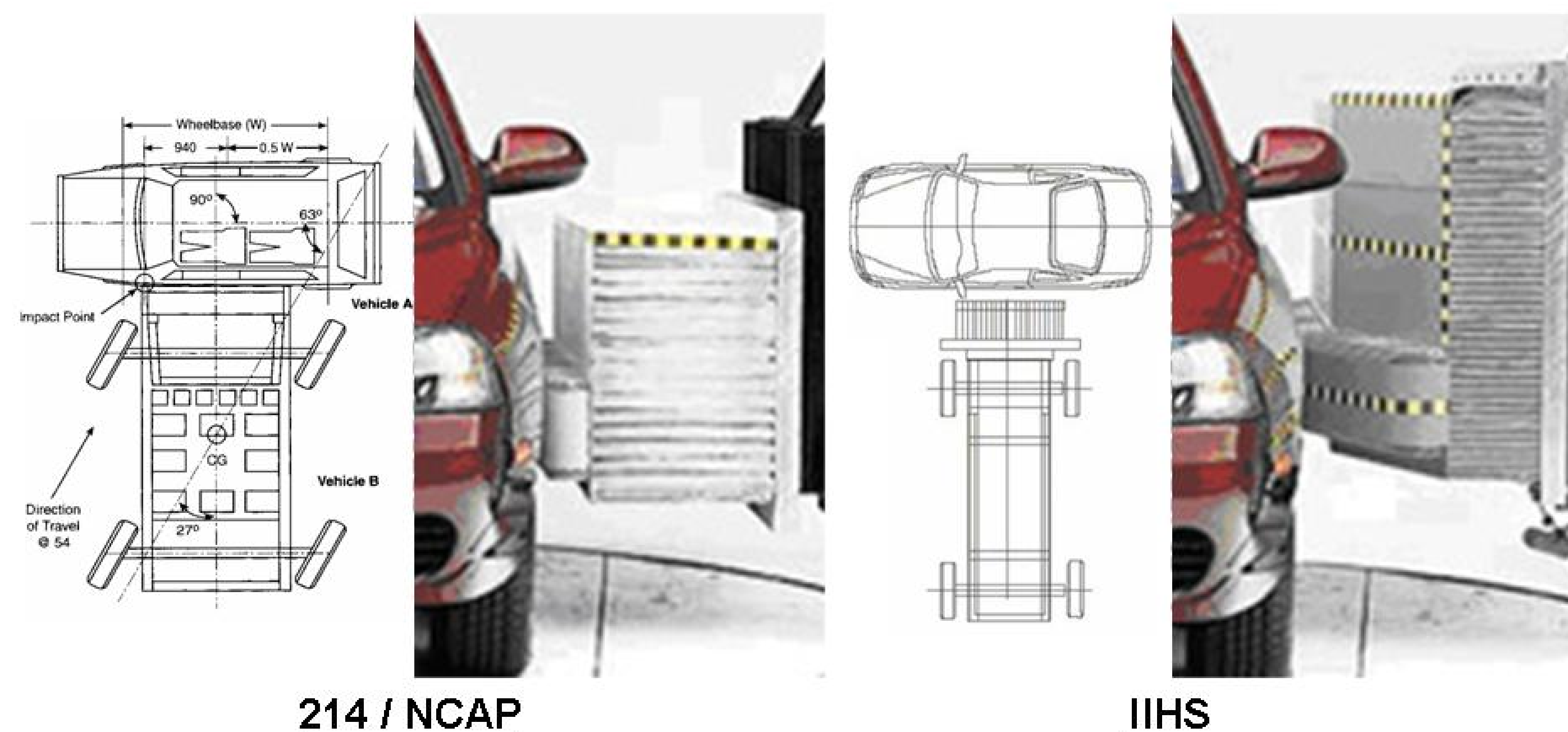


Figure 1: IIHS side test and FMVSS 214 / Side NCAP test configurations. In the 214 / NCAP tests, the Moving Deformable Barrier is crabbed and has a different geometry than in the IIHS test.

NHTSA Test ΔV Reconstruction

- 36 FMVSS 214 / Side NCAP tests examined**
 - 18 vehicles, one 214 test and one NCAP test each
 - Reconstructed in WinSmash
 - Vehicle stiffness: from WinSmash database
 - Moving Deformable Barrier stiffness: from Struble [3]
- Actual ΔV and absorbed energy determined from accelerometer data

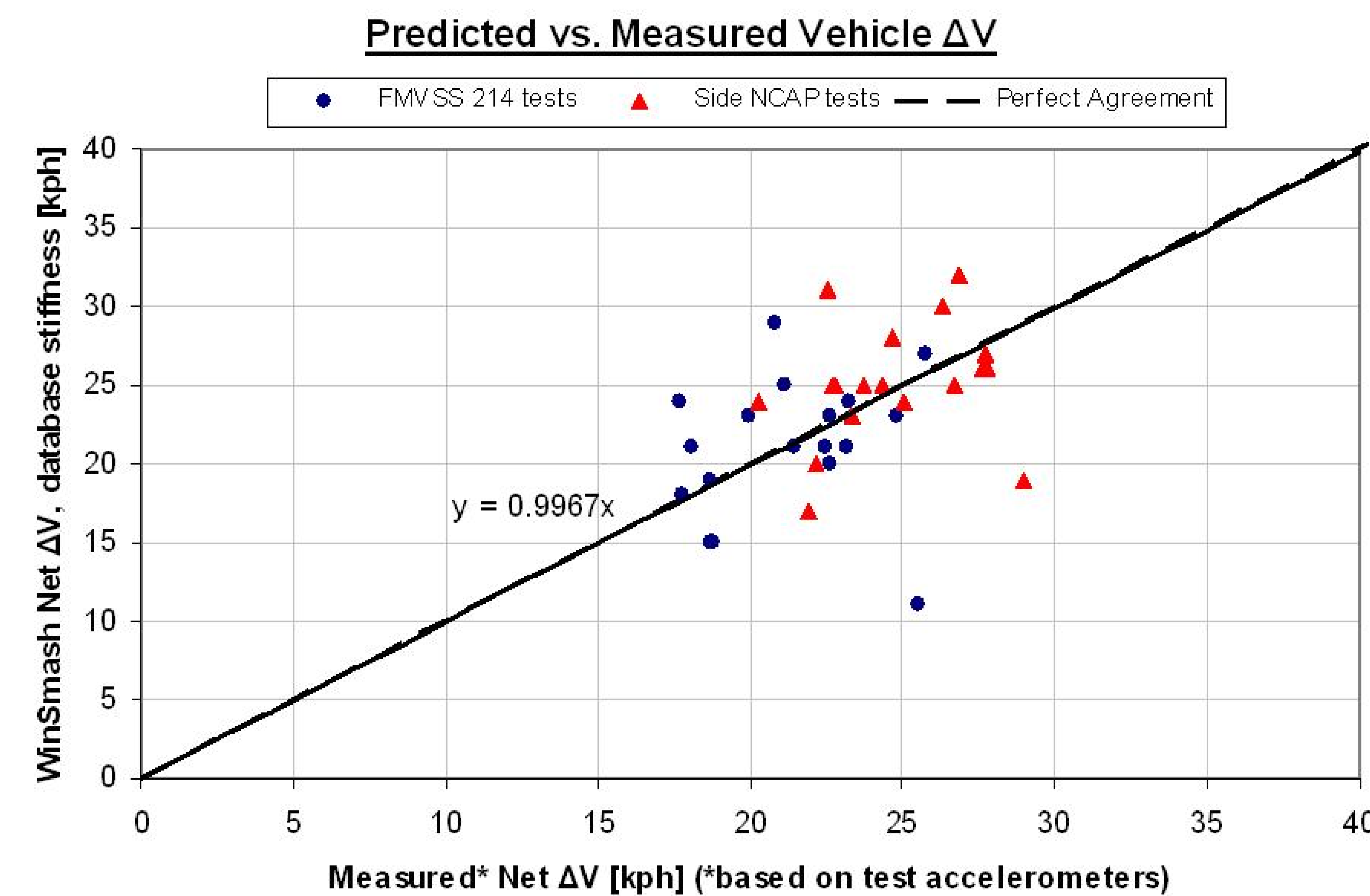


Figure 2: WinSmash predicted net ΔV vs. net ΔV measured from test instrumentation.

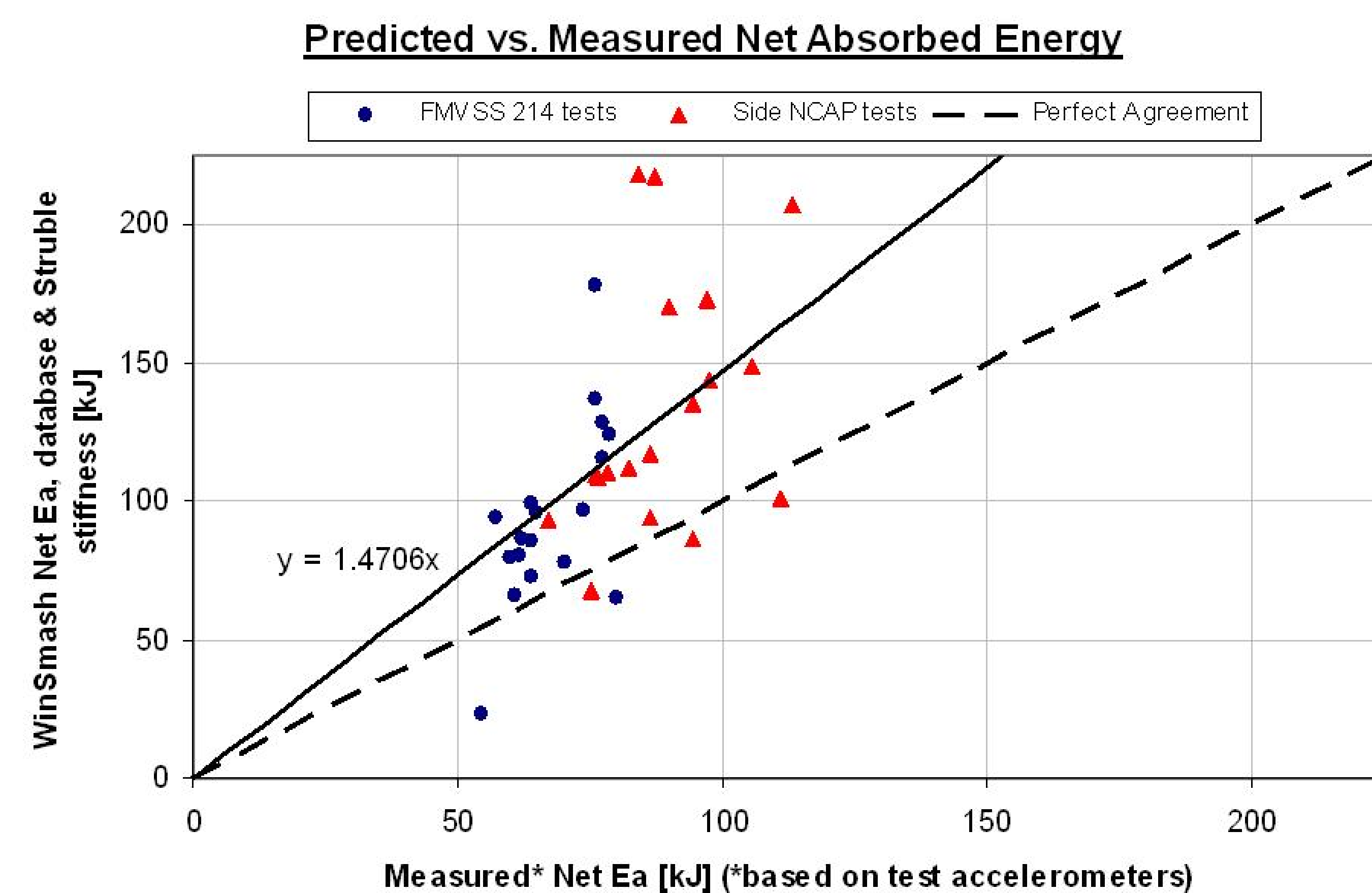


Figure 3: WinSmash predicted dissipated energy vs. dissipated measured from test instrumentation.

- WinSmash ΔV prediction error found to be negligible**
- However, WinSmash found to overestimate absorbed energy by roughly 47%**
 - Energy estimate used to calculate ΔV
 - Some other factor at work?

On the Origin of Stiffnesses

- WinSmash “stiffness” used to estimate energy absorbed at max crush from static crush after collision
 - Derived for individual vehicles from 214 / NCAP tests by the NHTSA
 - Static crush from test correlated to energy absorbed in test
- Energy absorbed in tests calculated using 1-D momentum conservation**
 - Theoretical upper bound on energy absorbed in a collision
 - Crabbed test configuration results in rotation and interface sliding
- MDB assumed to absorb only 5% of total dissipated energy**
 - Using MDB stiffness reported in [3], we see substantially more

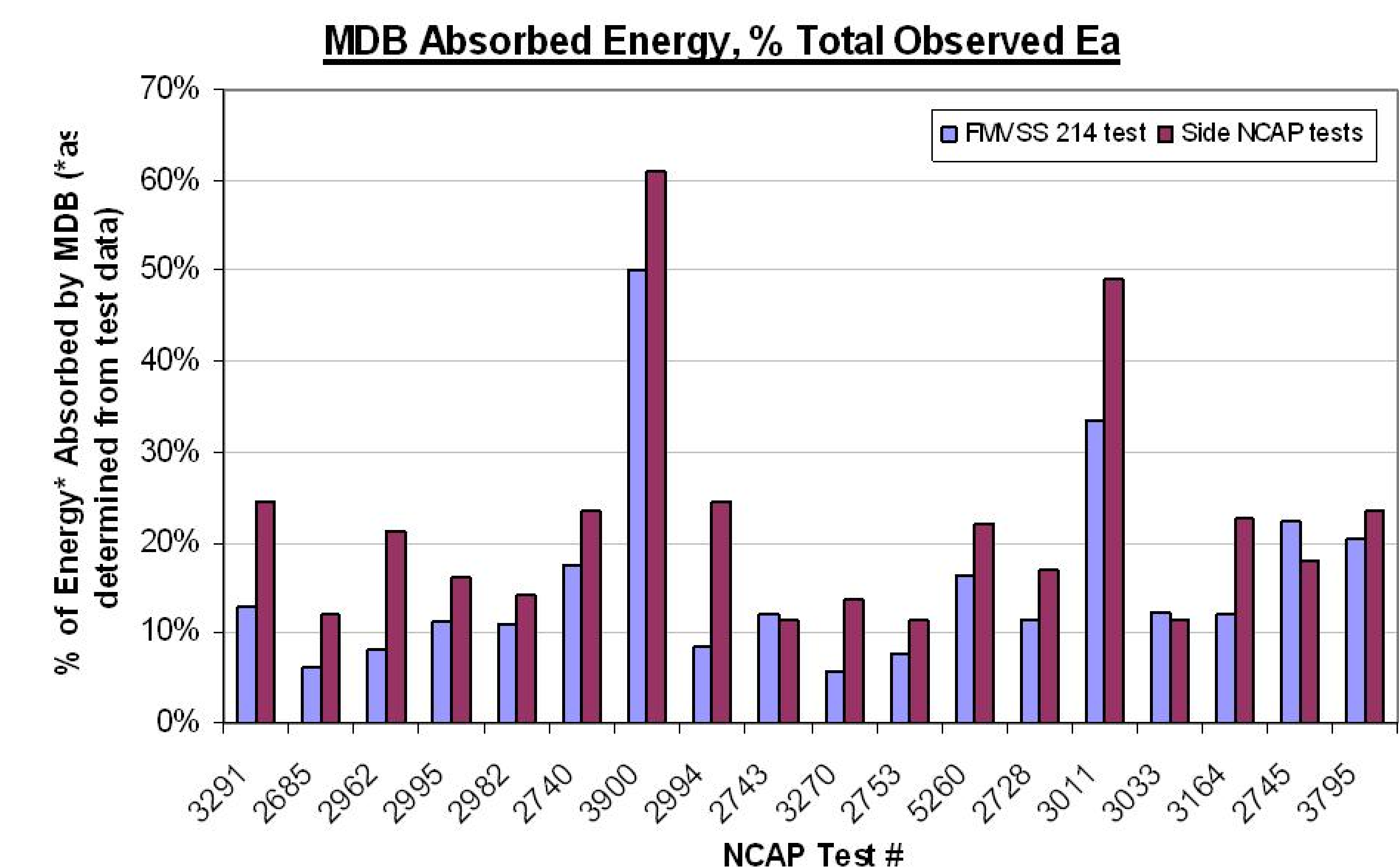


Figure 4: Fraction of energy absorbed by the Moving Deformable Barrier face in each of the tests. MDB energy was estimated using static crush and MDB face stiffness given in [3].

Future Work

- Stiffnesses appear to over-predict absorbed energy, but this yields accurate predictions for 214 / NCAP tests: why?
- Revisit study of IIHS test reconstruction to determine energy prediction accuracy for that mode as well

References

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