Crash Sleds: Technologies for Now and the Future
Higher Force Capacity
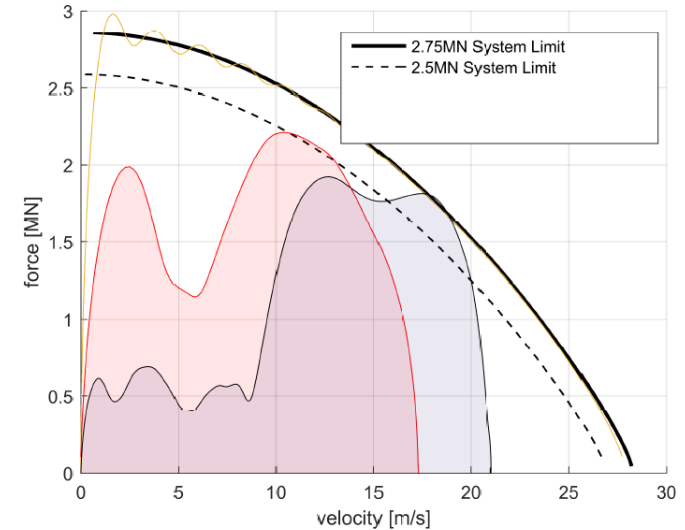## Live Load Compensation

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More is Better? An Ultra-High Performance Sled

- **Why?**
    - Higher Payload and Peak Acceleration Targets
    - More On-Sled Fixturing Flexibility
        - Intrusion
        - Static and Dynamic Yaw
    - 2nd Row Test Bucks

- **Why Not?**
    - High Mechanical Gain = Compromised Low Range Performance?
    - Cost (Complexity) and Risk

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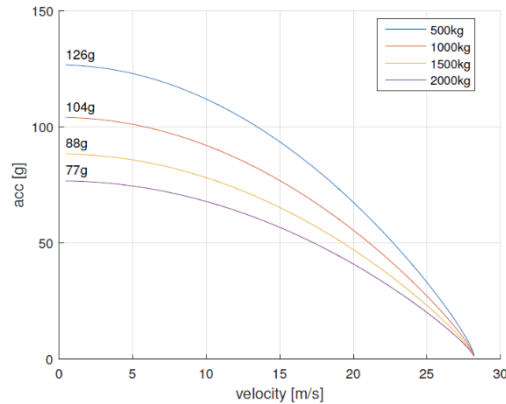# More is Better? An Ultra-High Performance Sled

- Technical Approach
  - Use Existing Analytical System Models to Understand Potential
  - Isolate and Improve Performance „Bottlenecks"
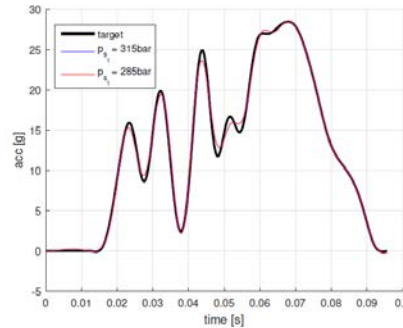 - Manage Risk

Modified Loading Unit

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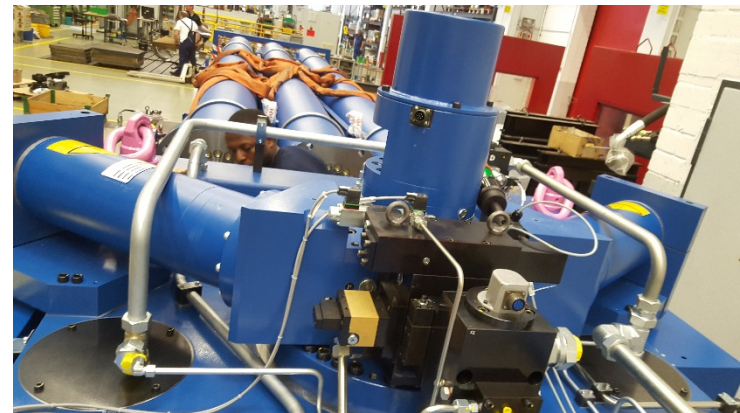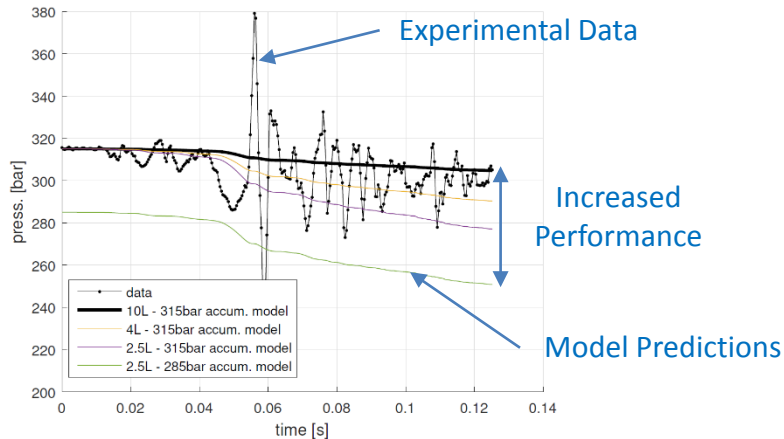
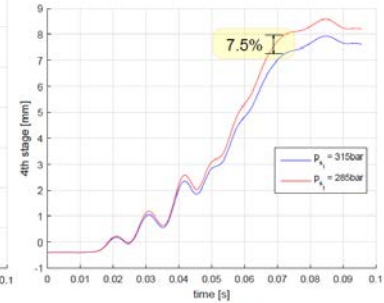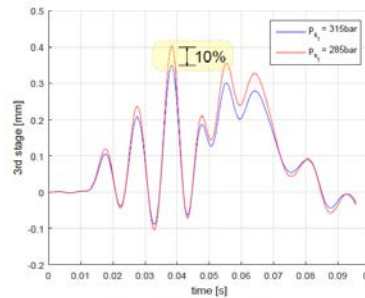# More is Better? An Ultra-High Performance Sled

- ## What we Got
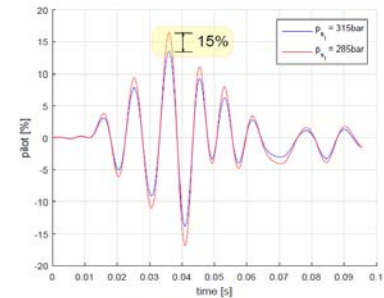

Higher force means higher peak acceleration…

(a) Acceleration

(b) 4th Stage (7.5% Reduction)

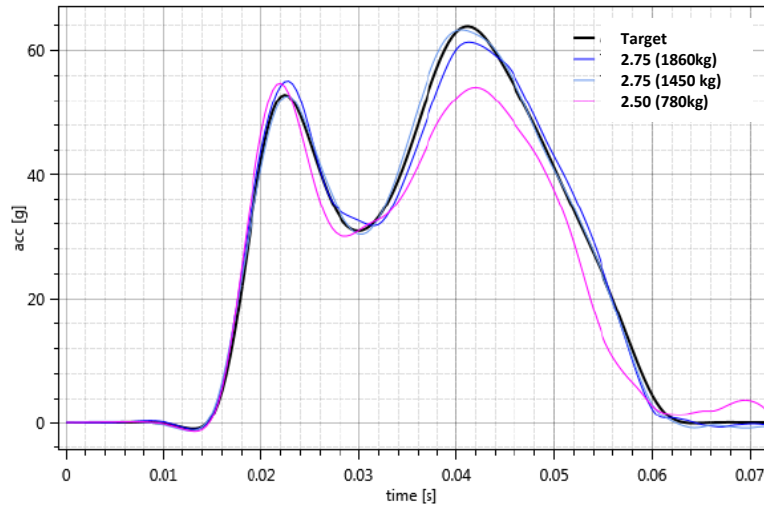(c) 3rd Stage (10% Reduction)

(d) Pilot (15% Reduction)
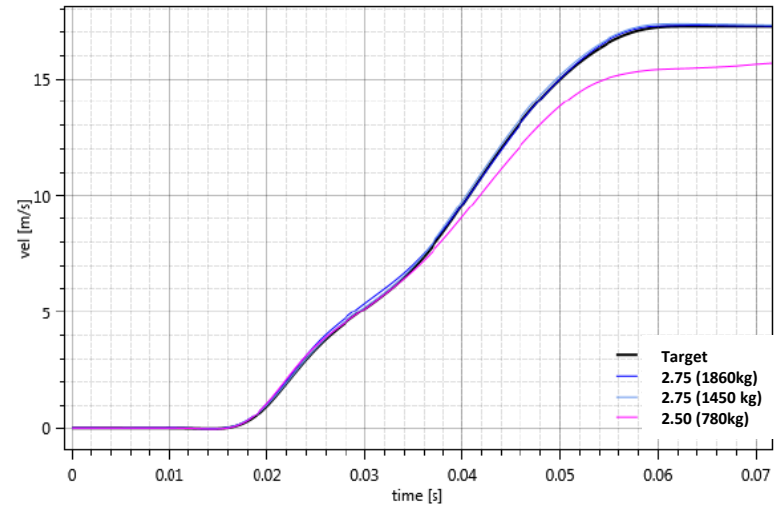
… but also higher dynamics due to higher mechanical gain

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- ## What we Got

(a) Acceleration

(b) Velocity

20% Increase in Peak Accel with 100% more payload
1G RMS from Target

< 0.5 kph difference from Target with 100% more payload

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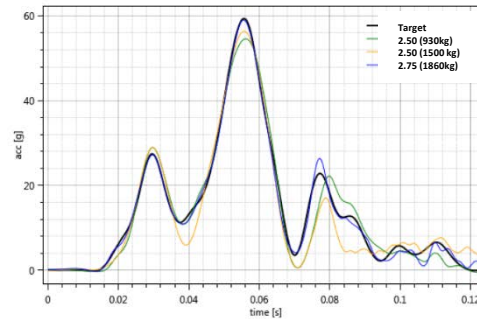
- ## What we Got

Improved Peak Replication with double the payload
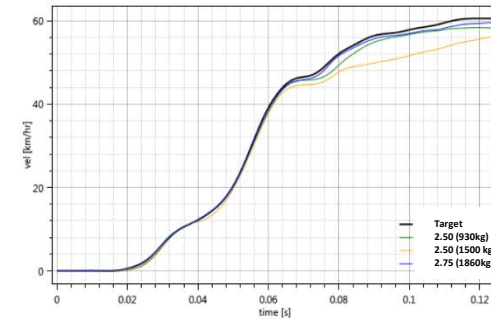
Better "late pulse" control

Improved Velocity matching
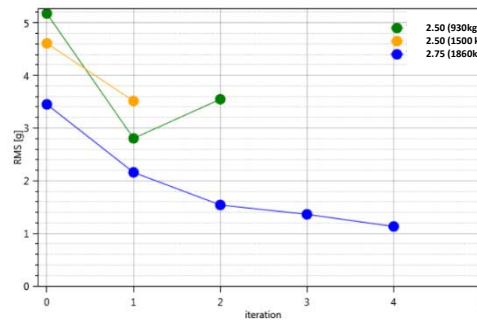
1G RMS Accuracy to Acceleration
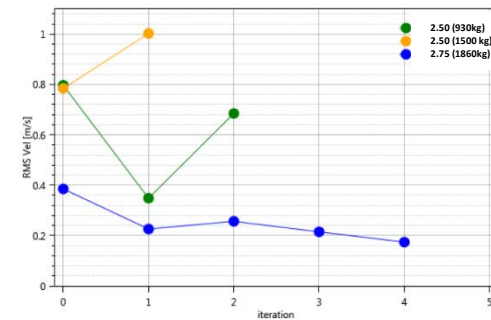
0.2 m/s RMS Accuracy to Acceleration
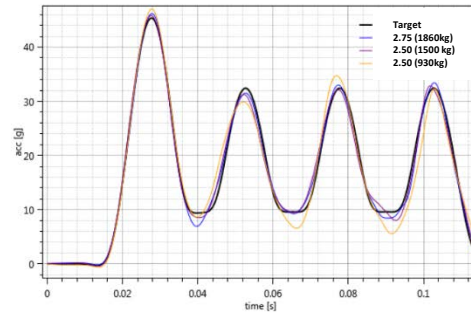

(a) Acceleration

(b) Velocity

(a) Acceleration
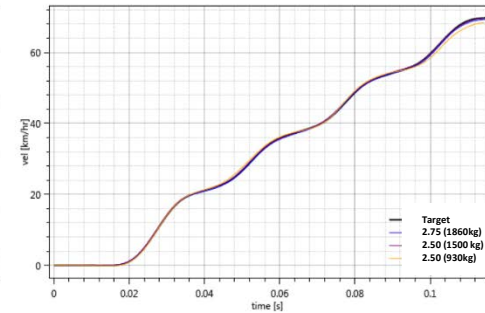
(b) Velocity

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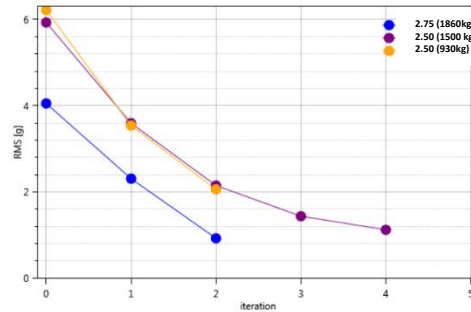■ What we Got

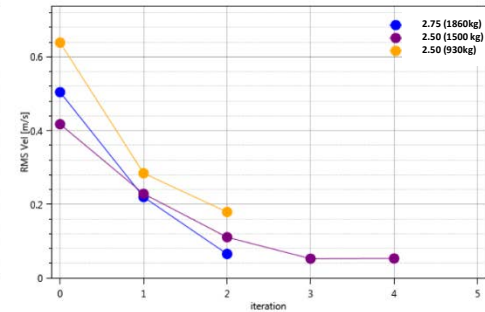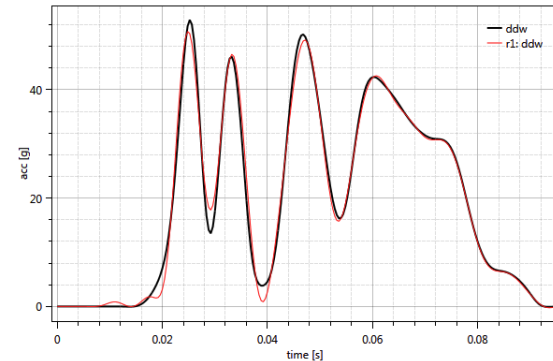Improved dynamics even with higher payload

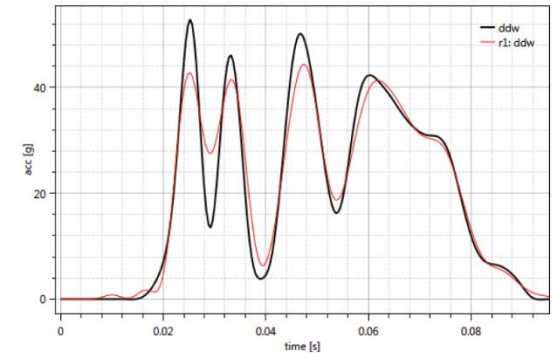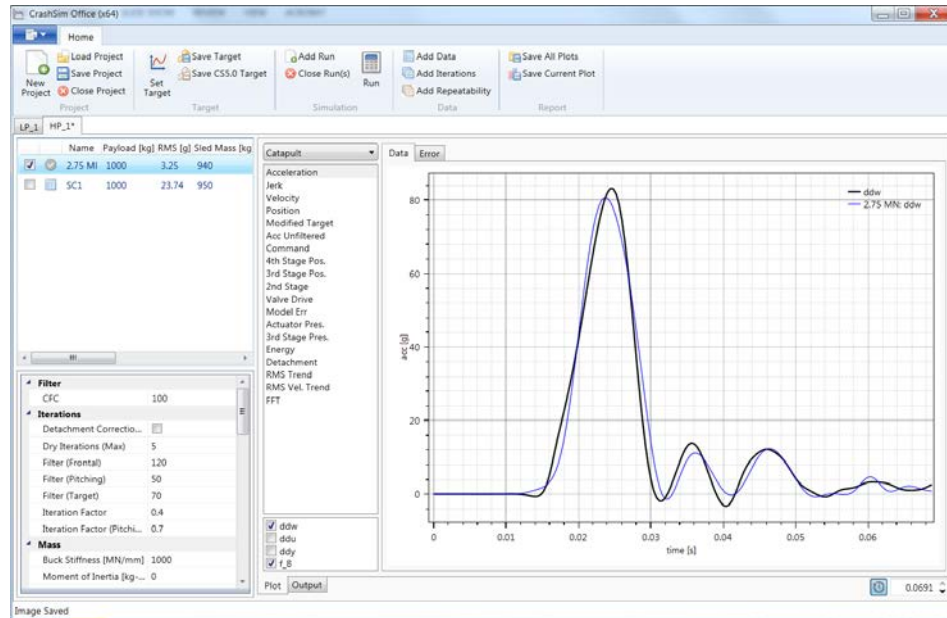(a) Acceleration

(b) Velocity

Better accuracy in fewer iterations
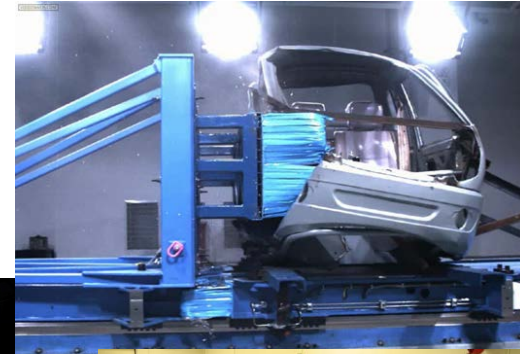

(a) Acceleration

(b) Velocity

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- ■ Fully Integrated Performance Predictions
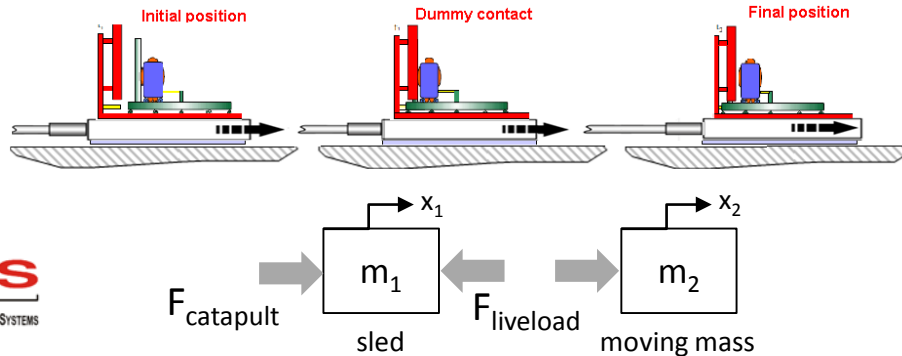
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- Sleds are Like Las Vegas
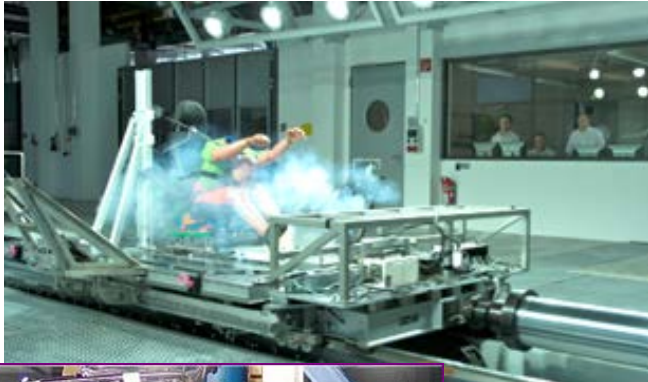
- **The Challenge**
  - What Happens on the Sled Affects Repeatibility
  - Intrusion, Side Impact Simulation, etc., Create „Live Loads"
    - ATDs are Uncoupled Mass (sometimes)
  - If we can Model the Live Loads, we can Compensate Them
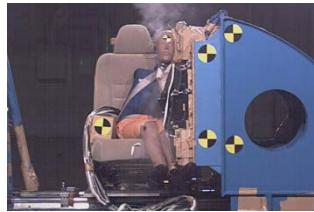 - Deliverables: Improved Repeatibility, Reduced Setup, → Better Data!

- ## Modeling Live Loads

  - ### Numeric Specimen Models

  - ### Experimental Derivation

  - ### Some Combination of the Two
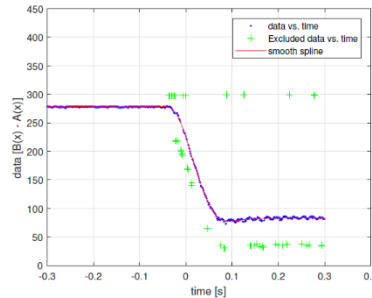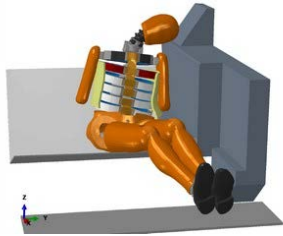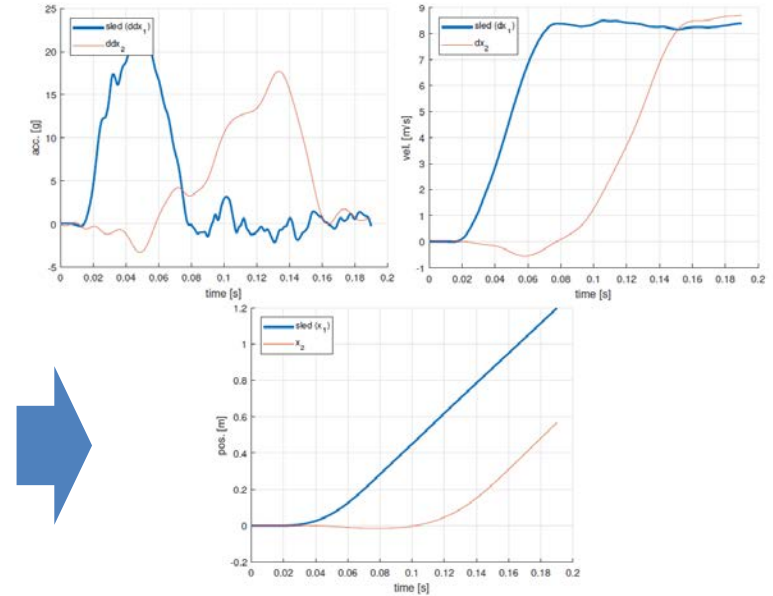

Measurement and/or Modeling
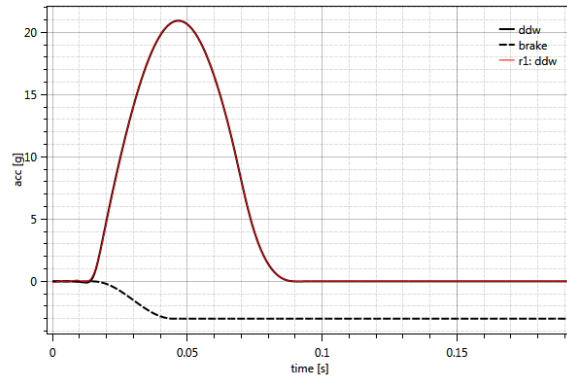

Figure 4: Raw data from high speed video analysis
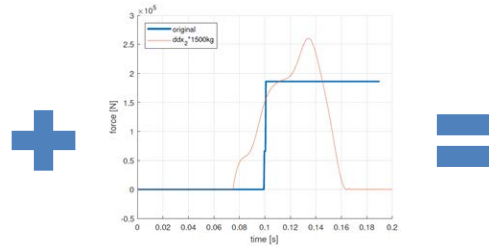
Live Load Dynamics

Combined Live Load with Sled Target
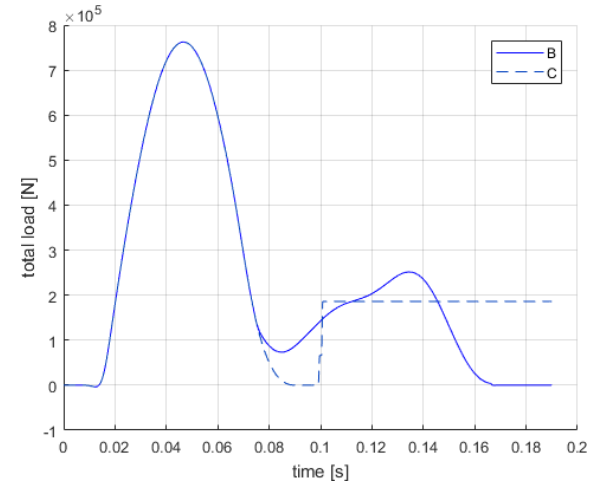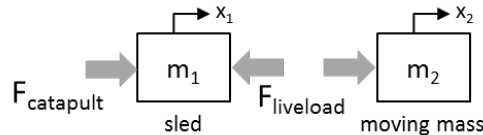
Live Load Compensation

- Disturbance Forces as Secondary Targets
  - Net Sled Acceleration is the Target
  - Live Load = Disturbance Force = Error
  - Combine Both in Pulse Development

Original "Target" Pulse (sled)

Live Load Disturbance Force
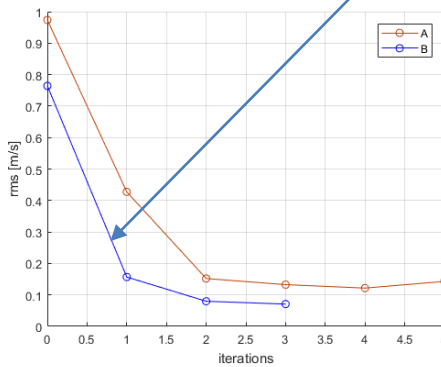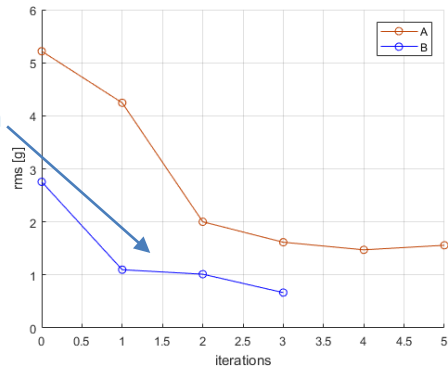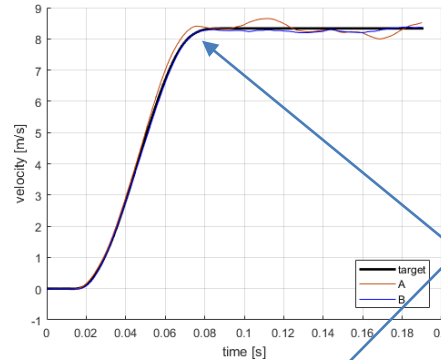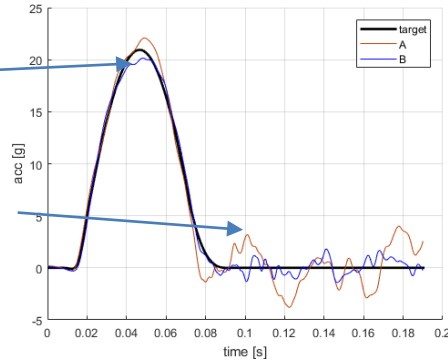

Net Accelerative Force (Modified Target)

$F_{catapult}$ → m$_1$ ← $F_{liveload}$ → m$_2$

x_1 x_2

sled   moving mass

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- ■ **Preliminary Results**

Improved Peak Matching

Reduced Oscillation

Improved Error with Fewer Iterations

Sled Mass: 1170kg
Coupled Payload: 1700kg
Dynamic (Live) Payload: 1500kg

Velocity Within 0.1 m/s

Benefits:
Reduce Setup Time for Complex Tests
Improved Results (Accel and Velocity)
Improved Side Impact Results
Improved Intrusion Results

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- **More Performance <u>and</u> Higher Accuracy**
  - Burden on Passive Safety Performance will not decrease
  - More complex crash scenarios means more complex tests
    - Alternative Materials
    - Lightweighting
    - Battery Power
  - Intrusion
  - Side Impact
  - Buck Dynamics
  - Belt Tensioners
  - ATD Payloads
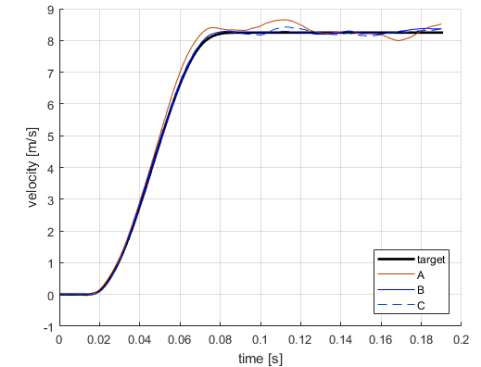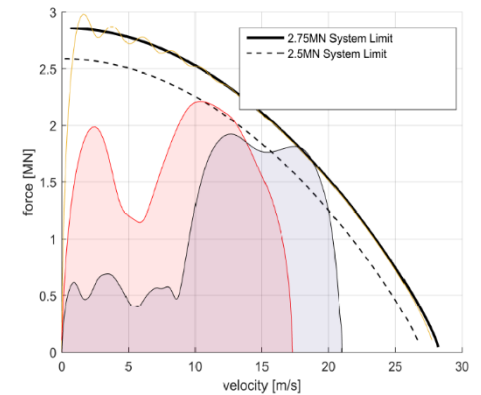
Thank You!

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