U.S. ARMY RDECOM

Shock Response and Failure of Magnesium

open campus

S&T Campaign: Sciences for Lethality and Protection

Kinetic Protection

Vehicle Protection

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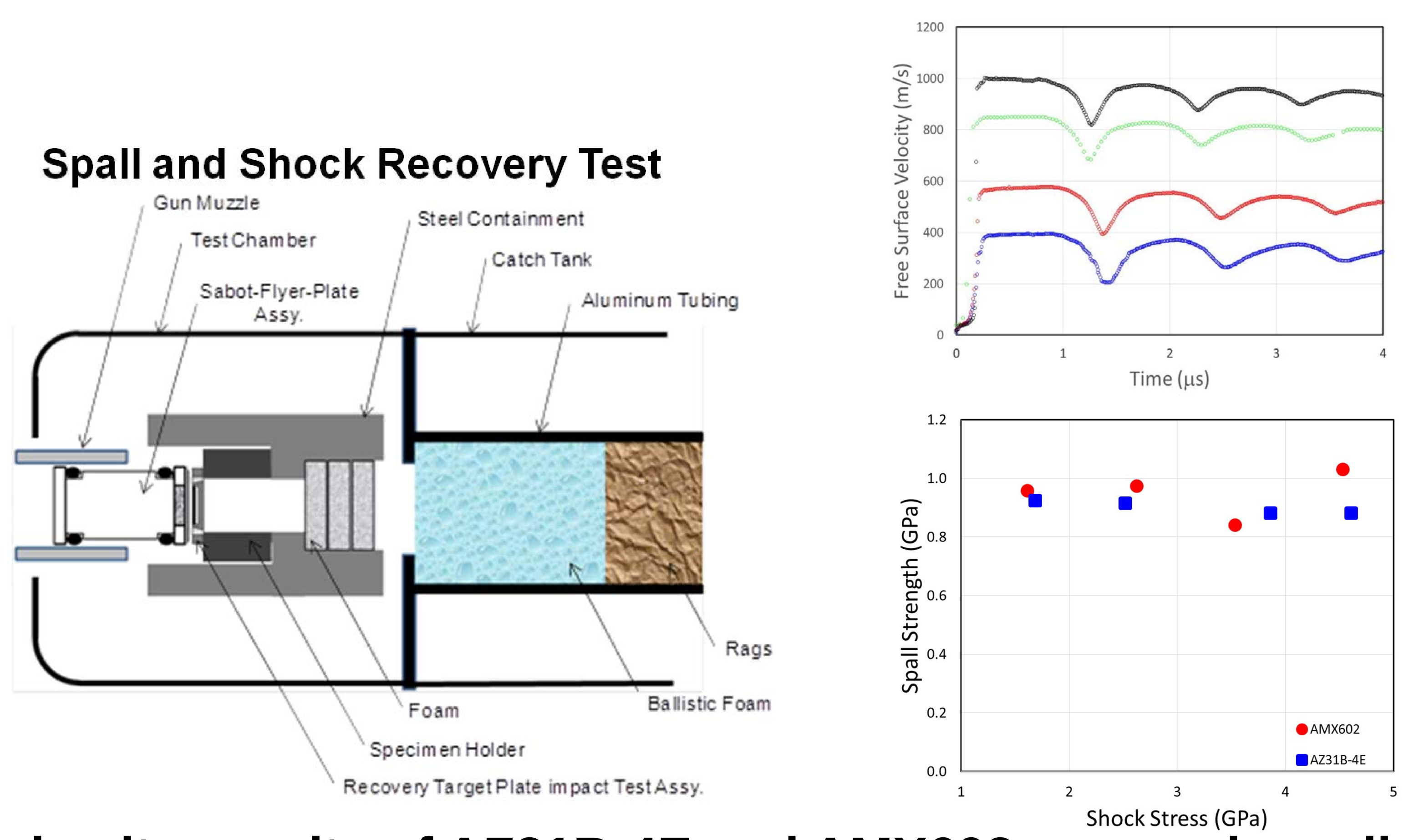
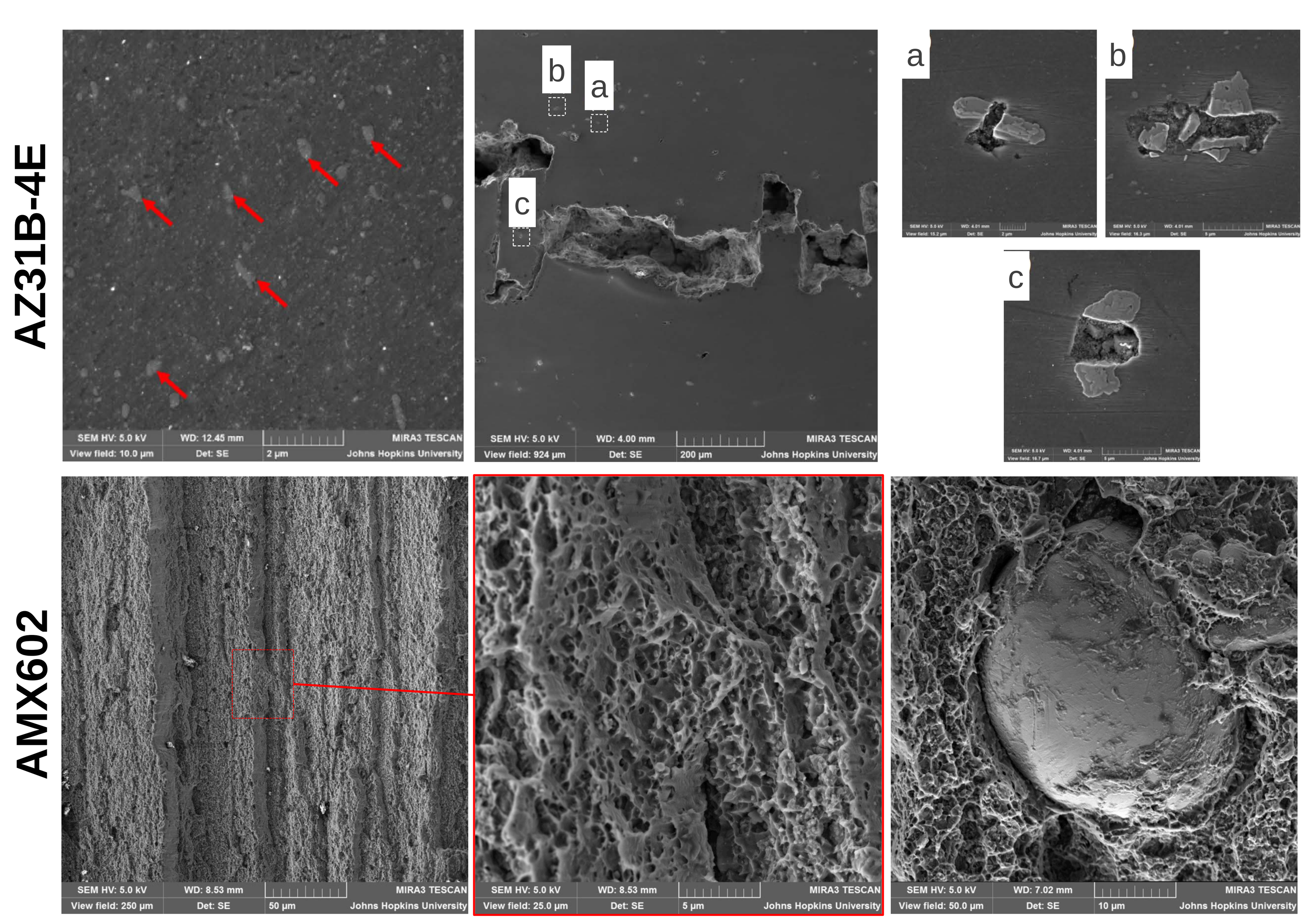
Research Objective

- Develop experimental approaches to study multi-length scale failure phenomena
- Understand damage evolution in metals during impact
- Alter dynamic failure response of metals



The in situ results of AZ31B-4E and AMX602 magnesium alloys [1]



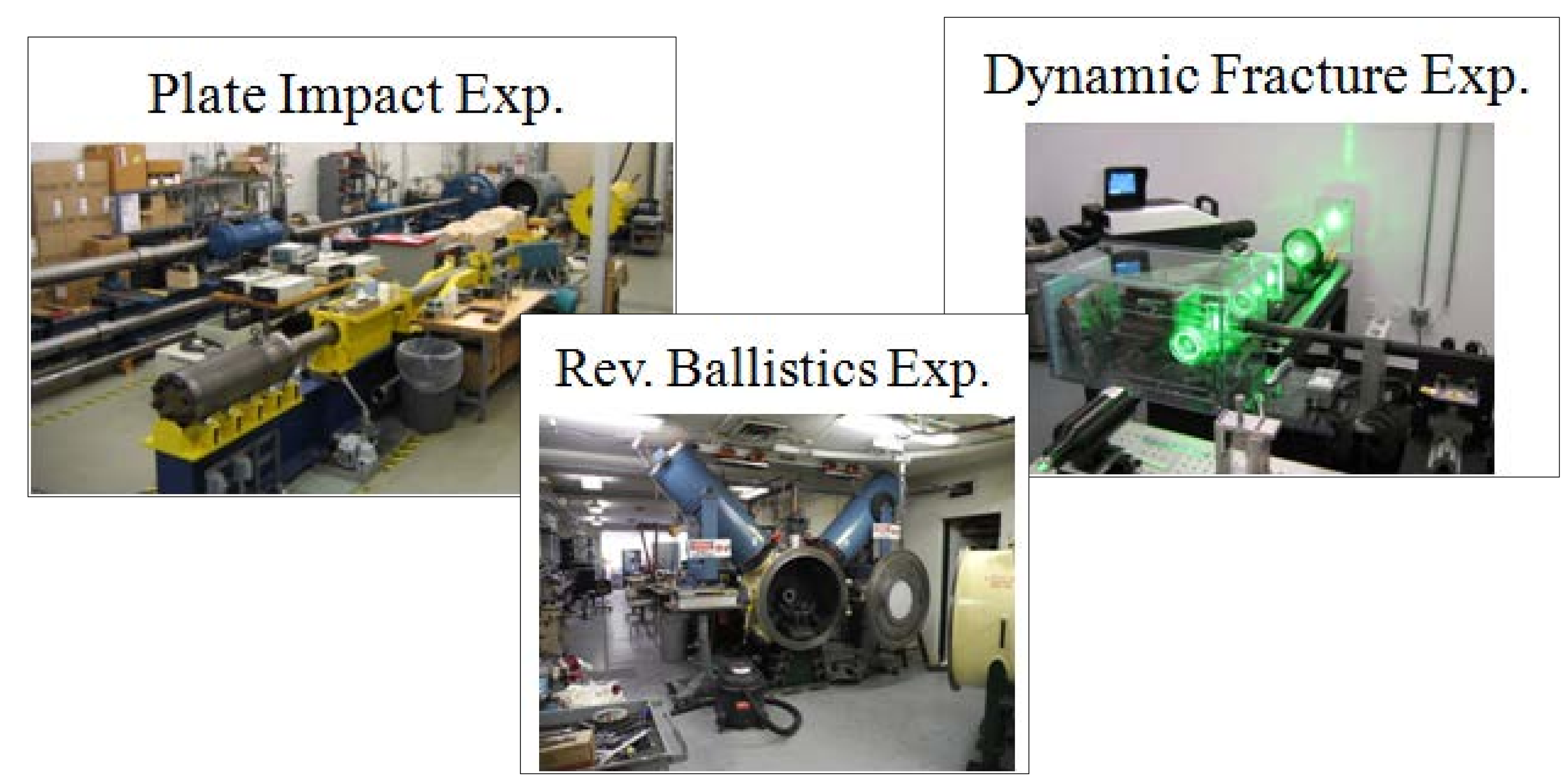
The end-state residual microstructures of AZ31B-4E and AMX602 magnesium alloys [1]

Challenges

- Extracting data from shock experiments that spans length scales while permitting specimen recovery
- Methods for altering the inherent dynamic failure of metals
- Computational mechanics of reduced length scale failure mechanisms

ARL Facilities and Capabilities Available to Support Collaborative Research

- Single and two-stage gas guns for ballistics and shock physics studies
- X-ray imaging, photon doppler velocimetry (PDV), velocity interferometer system for any reflector (VISAR)
- Extensive Kolsky bar laboratories
- Materials characterization: SEM, EBSD, XRD, Optical microscopy
- Significant results to date:
  - Develop credible scientific evidence to explain fracture initiation and consequent failure in magnesium alloys
  - A new technique to study dynamic damage evolution for biaxial expansion of materials using explosive driven cylinders



Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- In situ high energy XRD shock experiments up to 5 km/s
- In situ Phase Contrast Imaging (PCI) shock experiments up to 5 km/s
- In situ and post-mortem materials characterization of defects: vacancies, dislocations, twins, etc.
- Proton radiation: lattice strain measurements
- In situ ultra-high strain rate experiments using explosively driven cylinders

References

[1] C. L. Williams, L. Farbaniec, L. Kecskes, and J. Bradley, "Microstructural Effects on the Spall Properties of ECAE and SWAP Magnesium Alloys: AZ31B-4E and AMX602," APS-SCCM, 2015

[2] C. L. Williams, K. T. Ramesh, and D. P. Dandekar, "The Spall Response of 1100-O Aluminum," Journal of Applied Physics, 2012

[3] C. L. Williams, C. Q. Chen, K. T. Ramesh, and D. P. Dandekar, "On the Shock Stress, Substructure Evolution, and Spall Response of Commercially Pure 1100-O Aluminum," Materials Science & Engineering A, 2014

[4] C. L. Williams, C. Q. Chen, K. T. Ramesh, and D. P. Dandekar, "The Effects of Cold Rolling on the Microstructural and Spall Response of 1100 Aluminum," Journal of Applied Physics, 2013