

## S&T Campaign: Computational Sciences Predictive Simulation Sciences

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### Research Objective

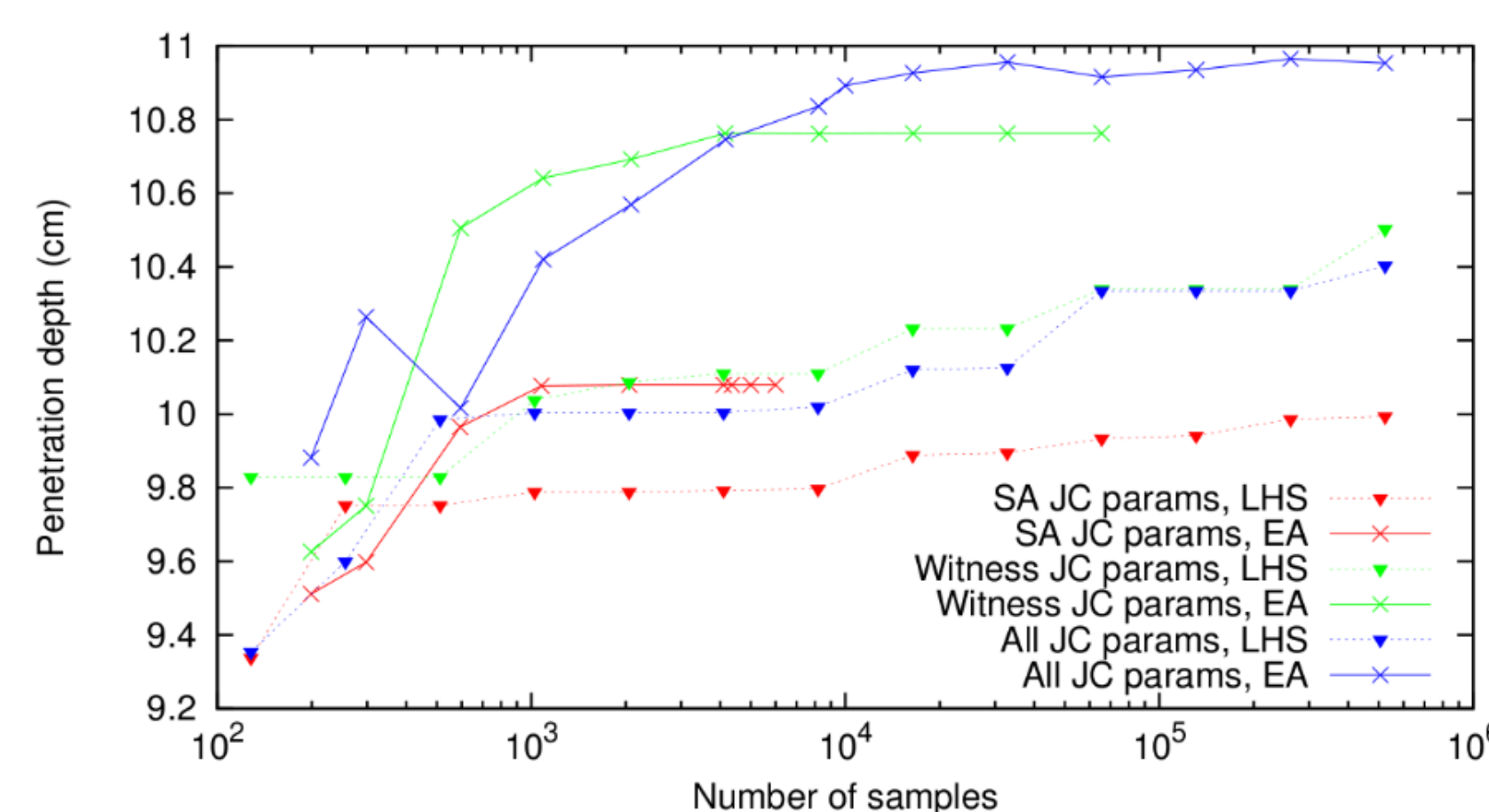
Identify & address capability gaps in the current state of the art of uncertainty quantification that impede its application to Army-relevant problems

### Challenges

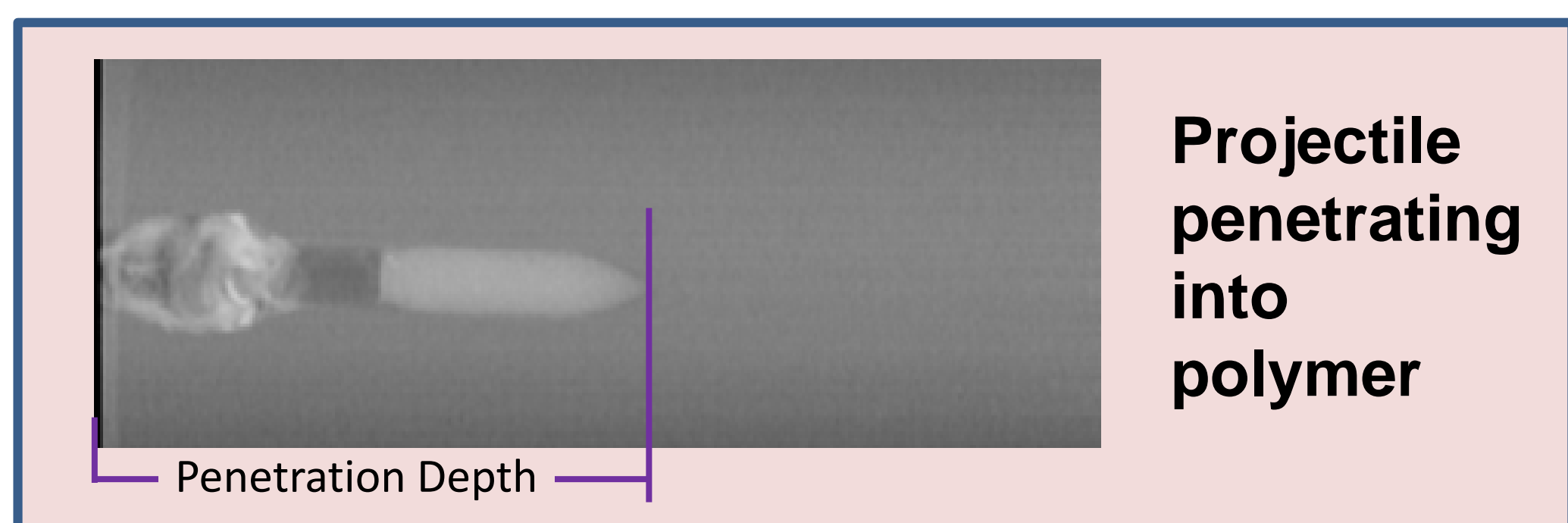
- **Organizational:**  
Application of uncertainty quantification for better risk-informed decisions not yet realized in predictive design and complex system optimization
- **Computational:**
  - **Curse of dimensionality:** Cost can explode as number of uncertain parameters increases.
  - **Cost of individual deterministic simulations,** used as input for uncertainty quantification, can be thousands of CPU hours each.

### ARL Facilities and Capabilities Available to Support Collaborative Research

- DoD Supercomputing Resource Center (DSRC)
- Expertise in the modeling needed to simulate Army-relevant problems, e.g. simulation of dynamic penetration of armor, multiscale modeling of transport in the optical semiconductors used in sensors and communication devices

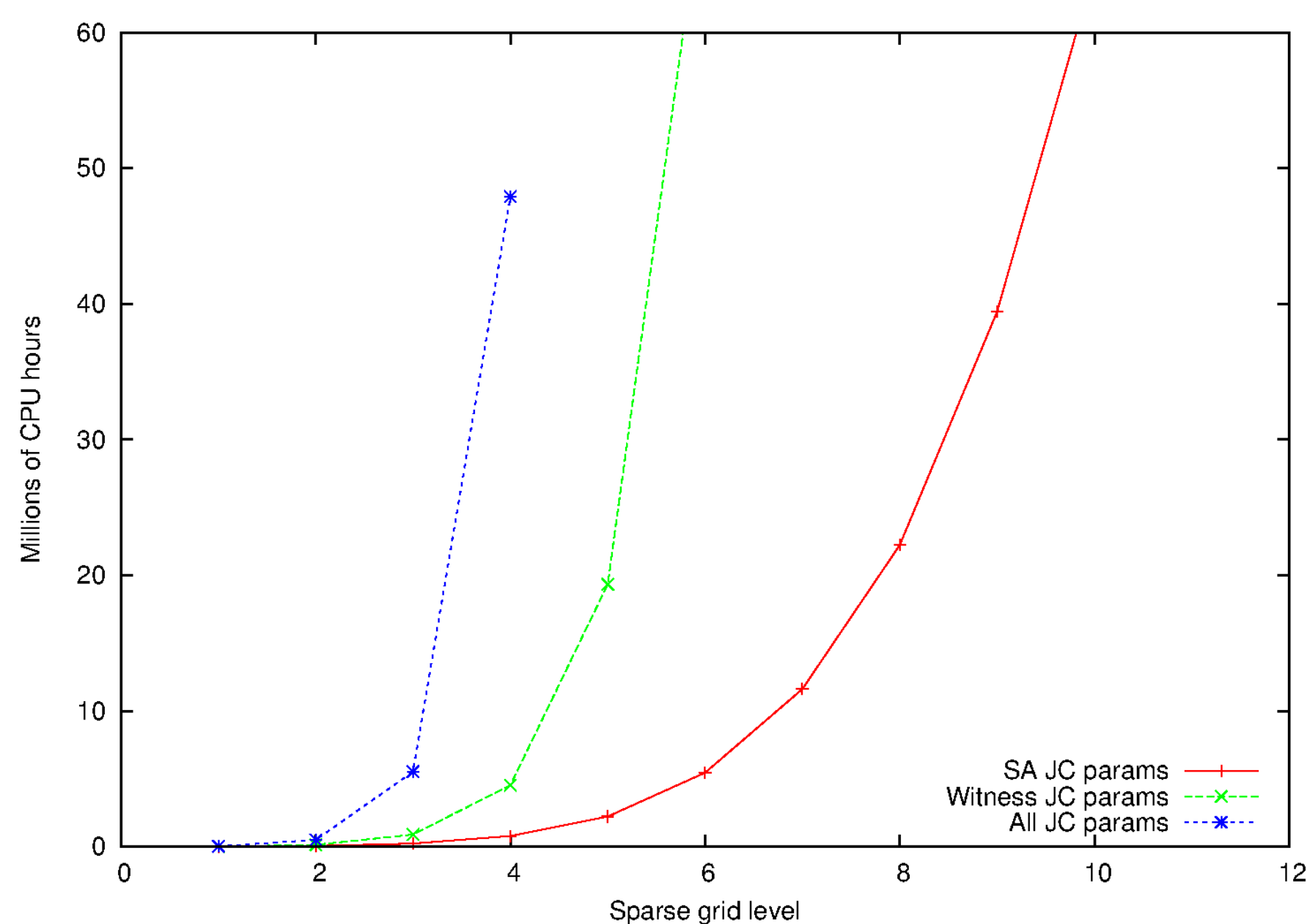


Estimated upper bounds of penetration depth in model armor penetration simulation



### Recent Publications

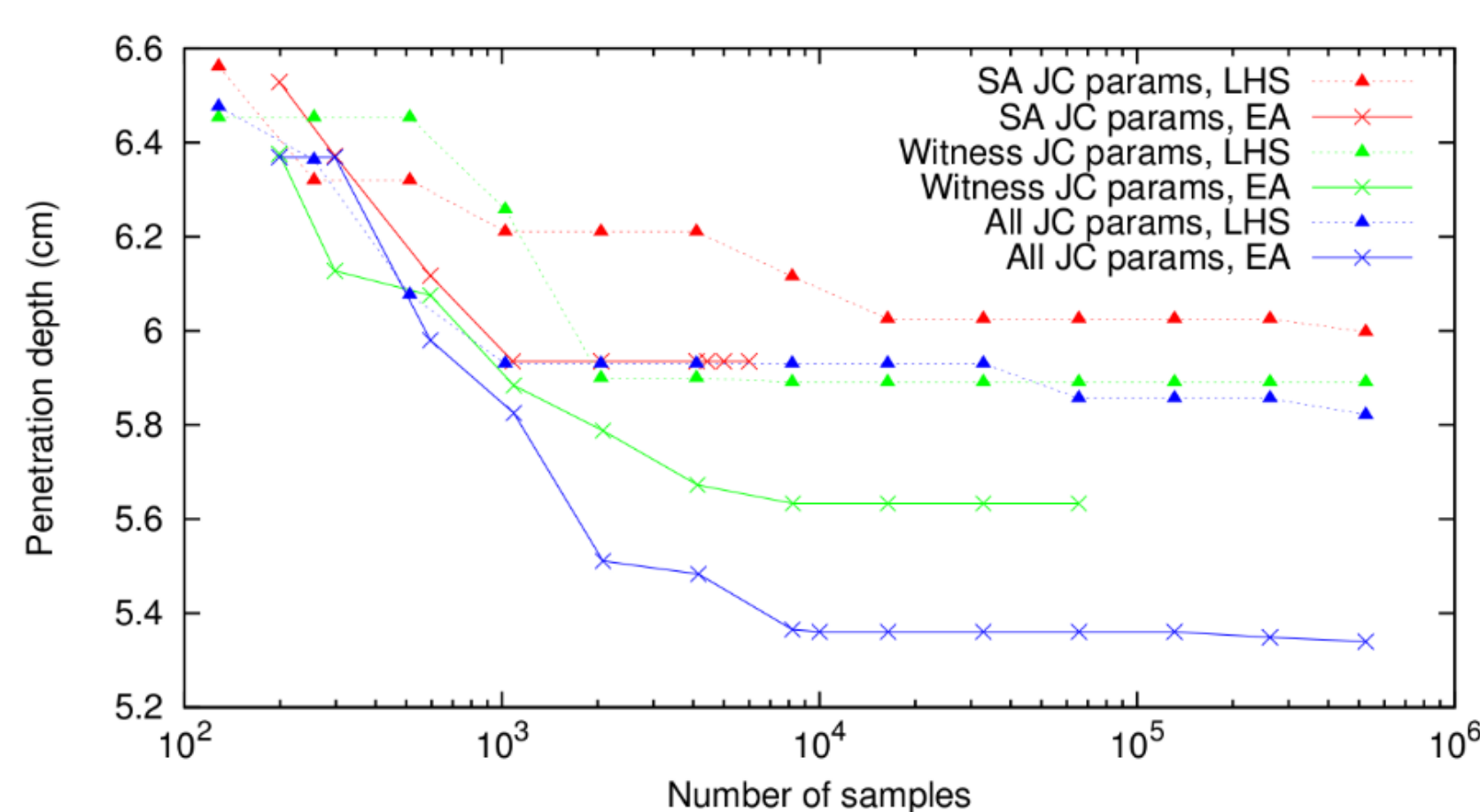
- Hornbaker DJ, "Quantifying Uncertainty from Computational Factors in Simulations of a Model Ballistic System," Report no. ARL-TR-8074 (2017)
- Kraczek B, Shishehchi S, Bellotti E., "Towards noise-aware surrogate models of carrier population dynamics in optically excited GaN," *Proceedings Volume 10206, Disruptive Technologies in Sensors and Sensor Systems*, 1020600 (2017)
- Ramsey JJ, "Survey of existing uncertainty quantification capabilities for Army-relevant problems " (in progress)



Computational cost of stochastic collocation with refined finite element model of armor penetration, as more points added to collocation grid

### Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- More accurate characterization of *input* uncertainties, e.g. of material strength parameters. This may entail refitting of data not owned by ARL, and possibly even redoing of experiments.
- Seeking expertise in inverse UQ, esp. Bayesian methods.
- Integration of UQ into modeling codes, rather than reliance on current deterministic ones. This may entail working with the owners of the codes currently used by ARL.



Estimated lower bounds of penetration depth in model armor penetration simulation