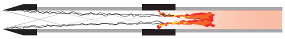
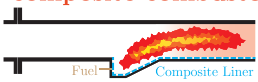
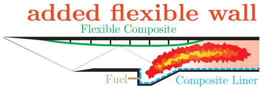
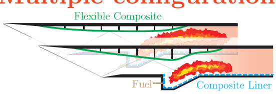
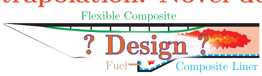
	Target	Goals & Critical Path	Notes & Supporting Research
Y1	**Combustion, isolator & unstart**  • Existing data from recent ACT-II-based dissertation[?] • Post-diction: unstart and underlying mechanisms	• Key physics: unstart, critical failure mechanism • Establish testing, verification, and code coverage for Y2–Y5 • Baseline performance modeling • Testing at scale: resolution needs, scaling roadblocks (including I/O) • Workflow: use and evaluate *Parsl*	• Provide training data for ML-anticipation of unstart • Assess 1D/2D models for training and UQ • Develop and evaluate composites for Y2 • Initial simulation models of physics-targeted experiments • Implement and evaluate initial traction-separation model • Initial surface/volume tomography and FIB-based analysis of composites • Implement surface kinetics, GSI/DSMC code design and coupling procedure
Y2	**Direct-connect composite combustor**  • Composite-lined combustor • Predict: material T and recession, flame characteristics, combustion completeness	• Packaged DG kernels in control layer + kernels • Transform to *Loo.py* IR, execute • Evaluate performance model for prediction; identify opportunities • Evaluate workflow and suitability of workflow metrics; identify opportunities • Identify pacing uncertainties; plan/refine models & targeted experiments	• Carbon fiber preform prediction • Runs with coupled *WARP3D* solver • Train ML for local material model selection • Evaluate ML for operator-trained surrogate • MD for T and O coupled traction separation curves • Evaluate performance models in new run scenarios, with local detailed materials models • First predictions and measurements of radiation contributions • Evaluate and refine IR strategy for facilitating transforms and generation • Courses: ML for Science; updated exascale; updated UQ; experiments for predictive science
Y3	**Flight conditions, with added flexible wall**  • Composite combustor; flexible composite in intake/isolator • Predict: material T and degradation, deformations, unstart, combustion completeness	• Simulation analysis of flexible materials • Coupled material degradation model codes • Use full-scale + low-D models with ML to propose designs • Full CS MIRGE infrastructure, evaluation of transform options • Quantify/analyze Δ performance: baseline code vs. CS optimized vs. predictions	• Identify and reduce pacing uncertainties • Physics-targeted experiments on coated materials and weaves • Beta-release *MIRGE-Com* under MIT licence • Complete fusion of kernels using select CS tools • Head-to-head comparison of available transform tools *ROSE*, *PIPs*, *Polly*, *etc.* • Bridge time scales: predict long-time temperature and degradation, bringing in furnace tests • Coupled solver to long-time thermal conduction, implicit time advancement, and (if needed) radiation models • Evaluate WENO–DG coupling
Y4	**Multiple configurations**  • Predict: improved design, geometry and materials • Morphed geometries: including unstart-prone and stable	• Assess prediction fidelity for design extrapolation • Evaluate workflow and suitability of metrics for improvement • Evaluate Δ performance, compare with models for strong and weak scaling • Evaluate hardware portability of *MIRGE* framework	• Adapt physics-targeted experiment to pacing uncertainties and needed model refinements • Refine performance model, accounting for multi-physics (MD, DSMC, DG) experience from actual predictions • Head-to-head workflow evaluation of CS tool options • Critical evaluation of ML: switching models, anticipating unstart, providing UQ/design surrogates • Assess and quantify fidelity of reduced models for full system to inform use (with uncertainty) in design strategies
Y5	**Extrapolation: Novel design**  • Predict: Simulation-based composite scramjet design • Test proposed design in ACT-II • Test variants (geometry, operation) to assess design optimality	• Multi-platform demonstration and analysis of achievable performance; identify pacing/limiting items • Testing at scale: resolution needs, scaling roadblocks (including I/O) • Document conception-to-decision workflow improvements with metrics	• Report scientific outcomes in open literature, especially successes in demonstrating scramjet design • Document workflow strengths and weaknesses, including strength and weaknesses of workflow monitoring metrics • Release/document: workflow, final code, end-to-end strategies • Pursue translation, CS & Phys.: NNSA, *Charm++*, Charmworks, NASA, AFRL, *etc.* • Refined ML course, covering strengths and limitations for scientific impact • Refined exascale course, based on evolving hardware