EAPS
EXTENDED AREA PROTECTION & SURVIVABILITY

System Modeling for Projectile Design and Optimization

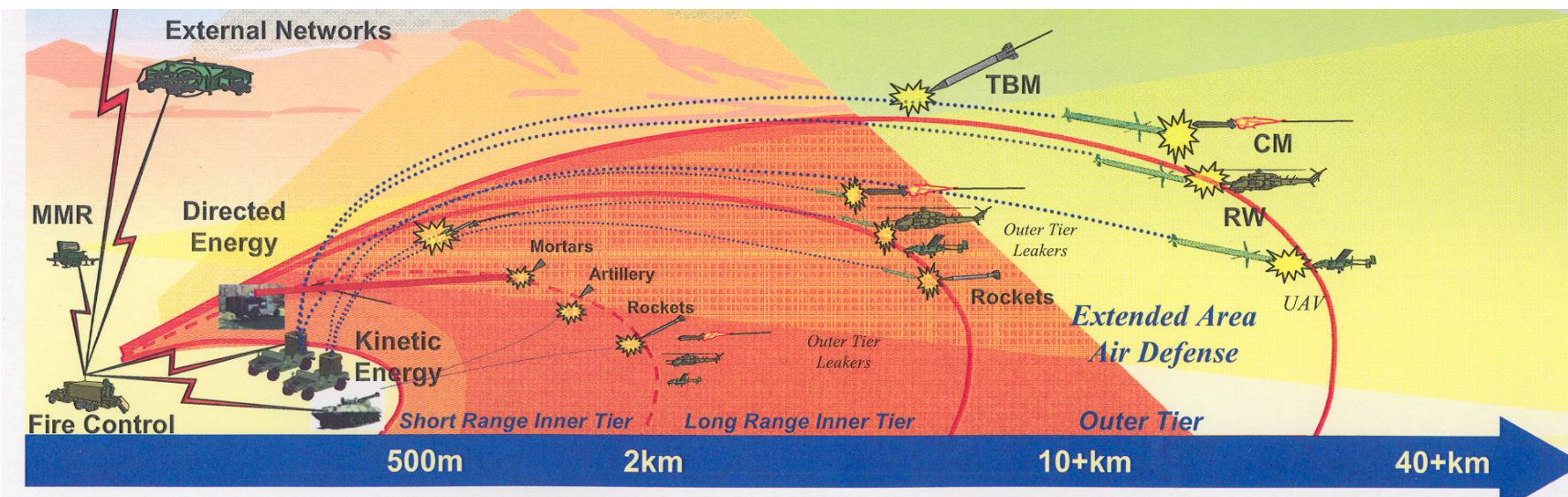
Presented By : Phil Brislin

AGENDA

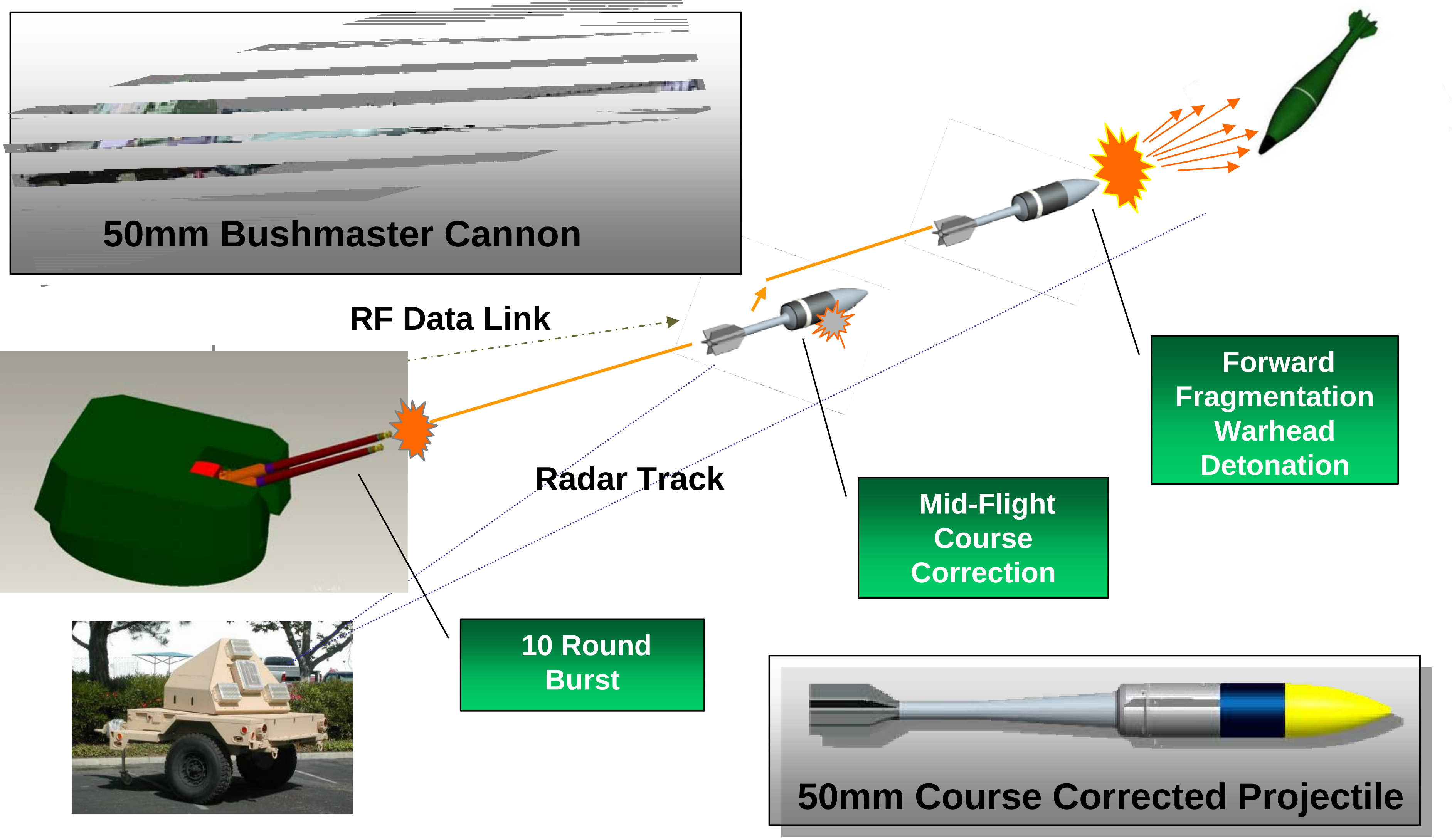
- What is EAPS?
- Development of a projectile design model.
- Algorithm description.
- Benefit to the EAPS program.

Extended Area Protection & Survivability (EAPS)

- Aerial defense system against Rockets, Artillery, and Mortars (RAM) threats.
- Two year ARDEC Advanced Technology Objective (ATO) ending in a demonstration of critical technologies including: course correction, lethality, and command warhead detonation.
- Provide future defeat capability for the Extended Area Air Defense System (EAADS) comprised of 360 degree mobile RAM defense.

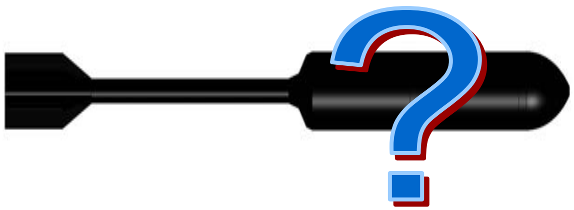


EAPS Baseline System Concept



Design Challenges and Goals

- The EAPs bullet has a number of difficult performance objectives that often have conflicting subsystem goals and limited available space.
- The system trade study provided a list of projectile requirements.
- What are the best projectile subsystem design compromises that will give maximum overall system performance?



- Develop one comprehensive model to evaluate projectile performance and find the best design space to begin detailed design.

Merging Requirements and Design Constraints

System Performance Requirements Flow Down

Examples

- 1000m Range
- Lethal Fragments
- Pattern Density
- Strike Velocity
- Thruster

50mm Trade Study Results

Matlab Configuration Study

Optimized Projectile Framework to Begin Detailed Design

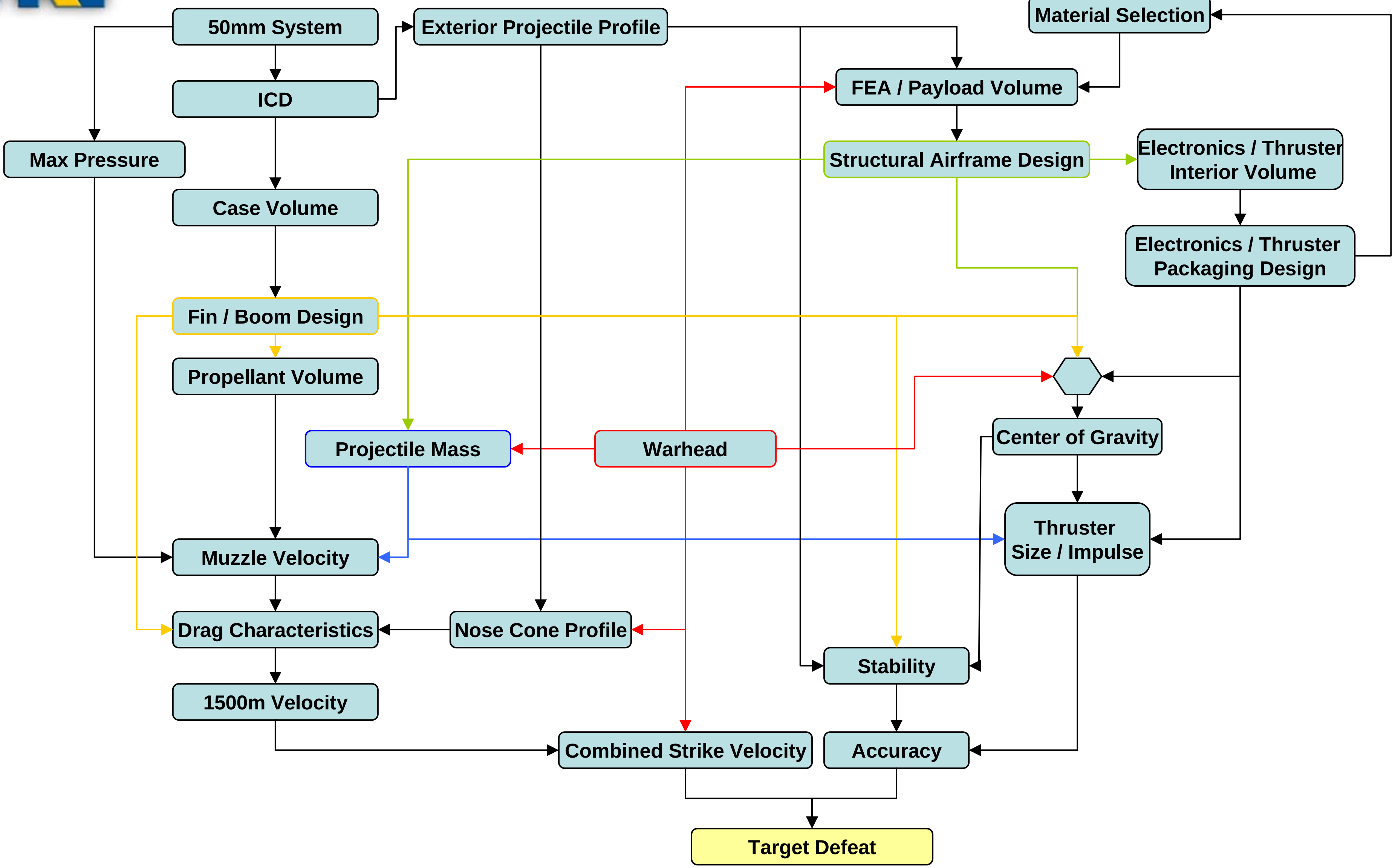
Design Constraints

Examples

- Aerodynamics
- Mass Properties / CG
- Survivability (Stress)
- Material Properties
- Propulsion Data
- Warhead Formation

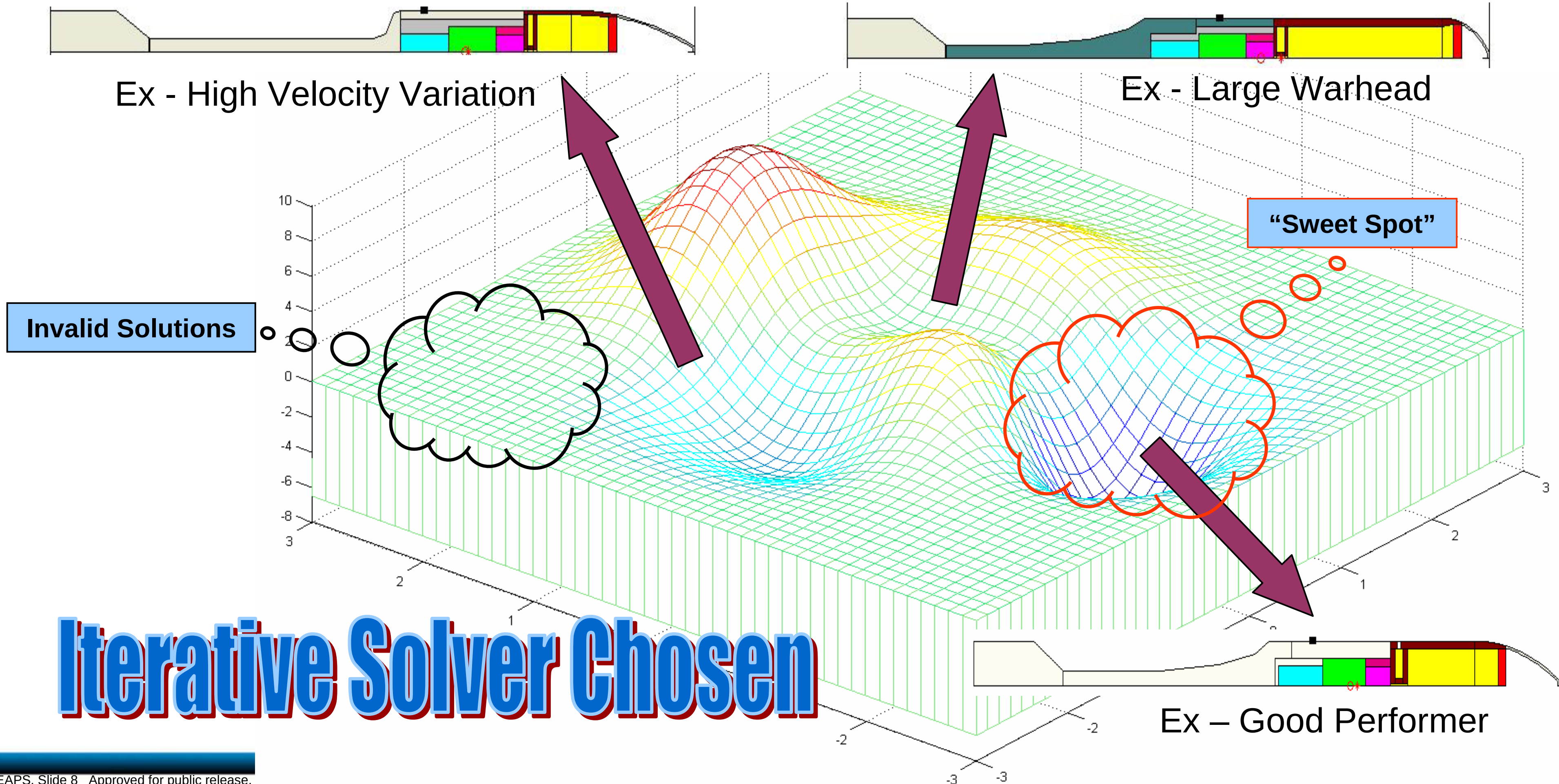
Collect Inputs from Design Groups

Understand the EAPS System



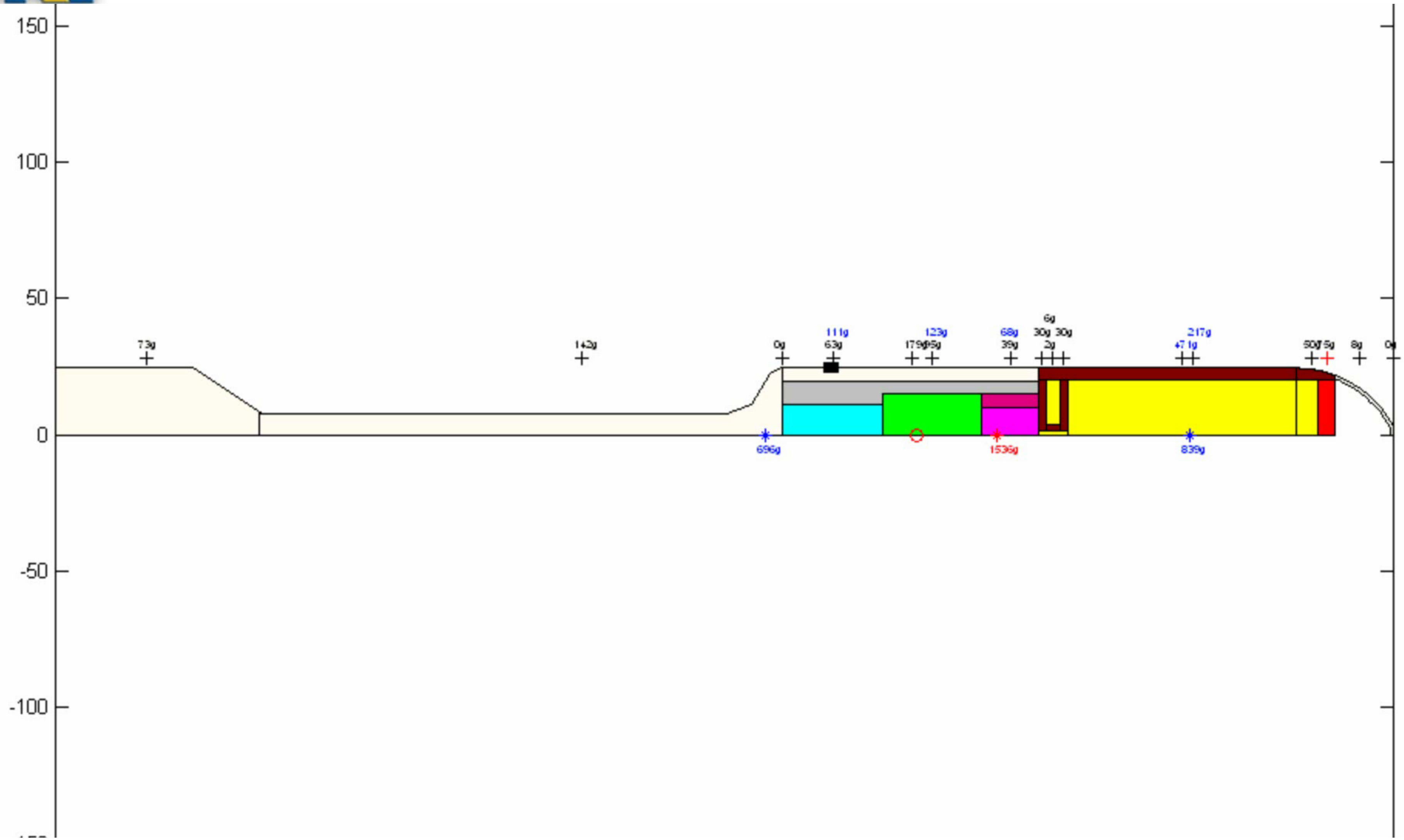
Implement a Solver Method

- Design Space Challenges
  - Numerous invalid variations exist causing convergence issues.
  - Analytic solution methods difficult to implement and adapt.



Iterative Solver Chosen

Matlab Configuration Study Video

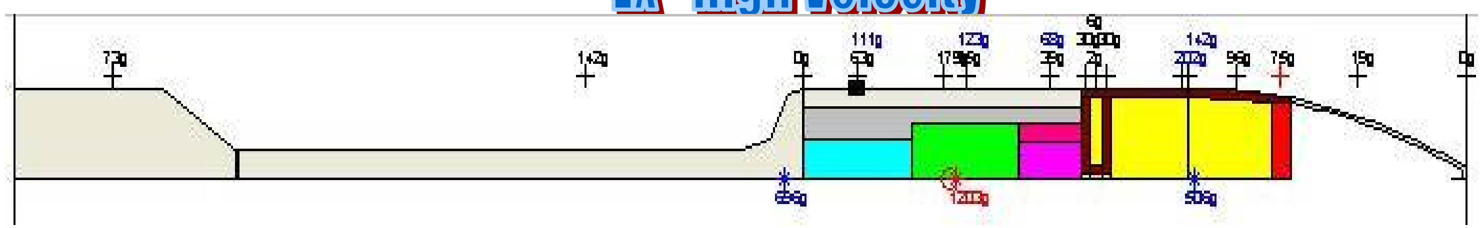


Algorithm Description

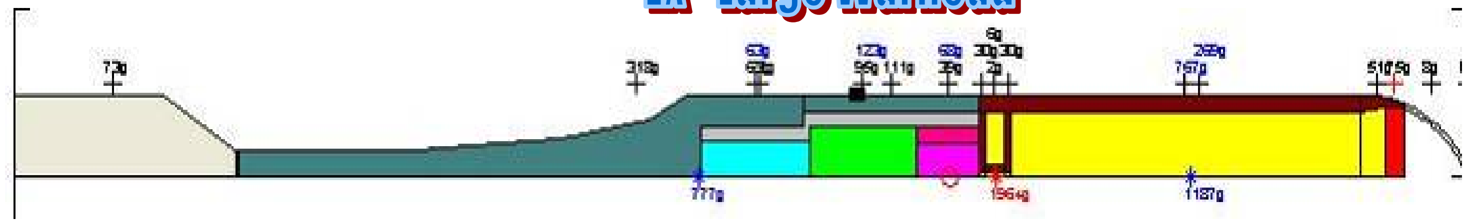
Requirements & Variable Inputs → Interior Ballistics & Survivability → Exterior Ballistics & Lethality → Requirements Check, Ranking & Summary

- Requirements - Strike velocity, center of gravity, max weight, etc.
- Generates geometry & assembles components
  - Calculates or integrates mass properties (Pro E verified).

Ex - High Velocity



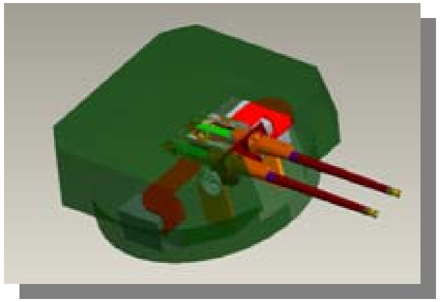
Ex - Large Warhead

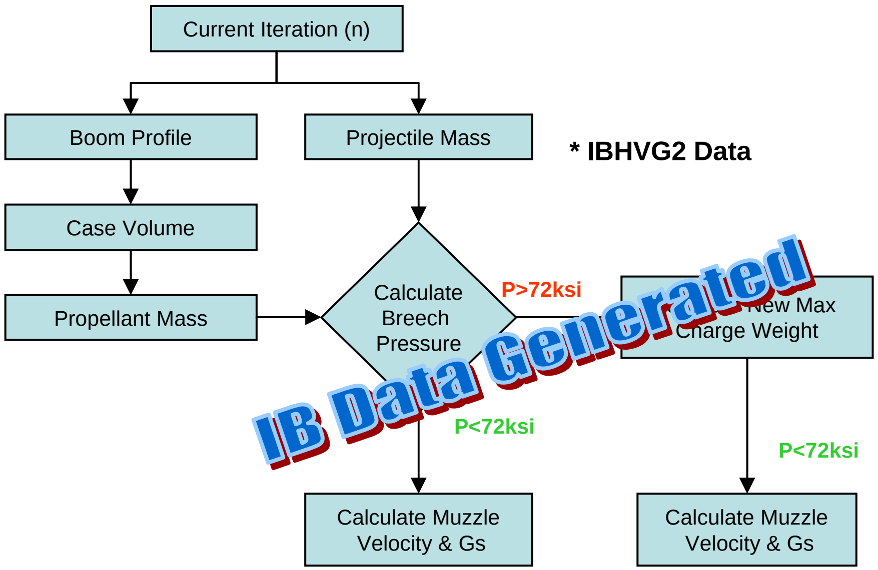


Algorithm Description

Requirements & Variable Inputs → **Interior Ballistics & Survivability** → Exterior Ballistics & Lethality → Requirements Check, Ranking & Summary

- Interior Ballistics and Survivability
  - Load max charge allowable
  - IBHVG2 data for max pressure and velocity
  - Stress checks throughout the projectile





* IBHVG2 Data

IB Data Generated

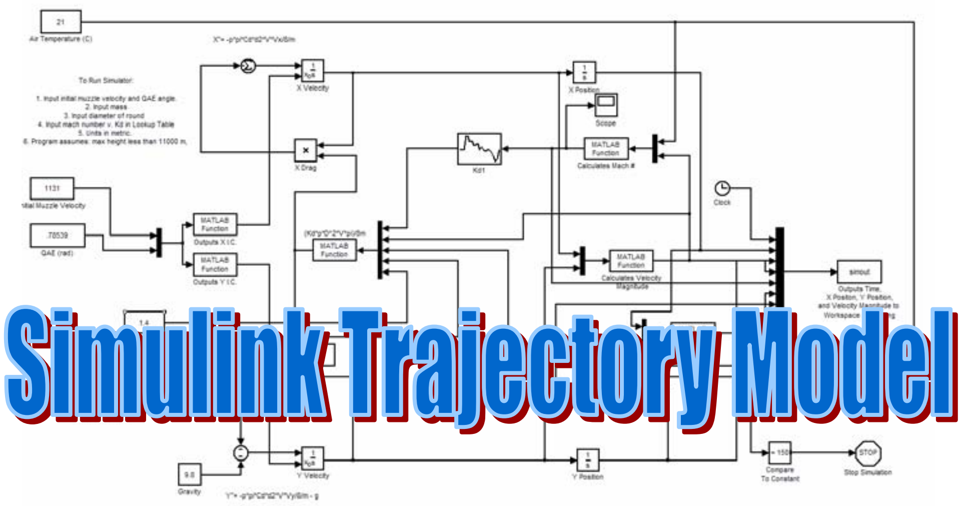
Localized Analytical Stress Checks
ANSYS Verified

Algorithm Description

Requirements & Variable Inputs → Interior Ballistics & Survivability → Exterior Ballistics & Lethality → Requirements Check, Ranking & Summary

- Flight Dynamics
  - Determines velocity falloff for every unique configuration.

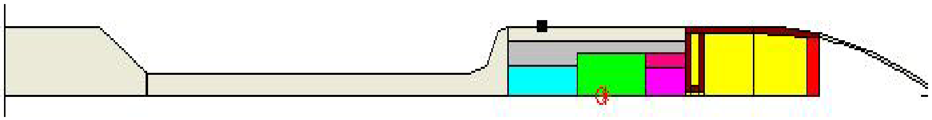
- Lethality
  - Determines warhead velocity (based on Dyna and CTH runs).
  - Calculates maximum effective range for target defeat.



Algorithm Description

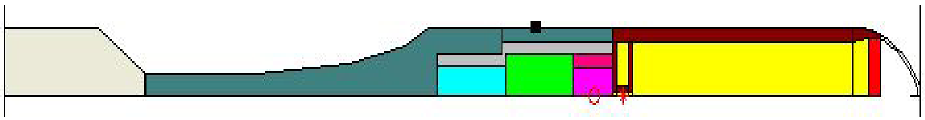
Requirements & Variable Inputs → Interior Ballistics & Survivability → Exterior Ballistics & Lethality → Requirements Check, Ranking & Summary

Ex - High Velocity



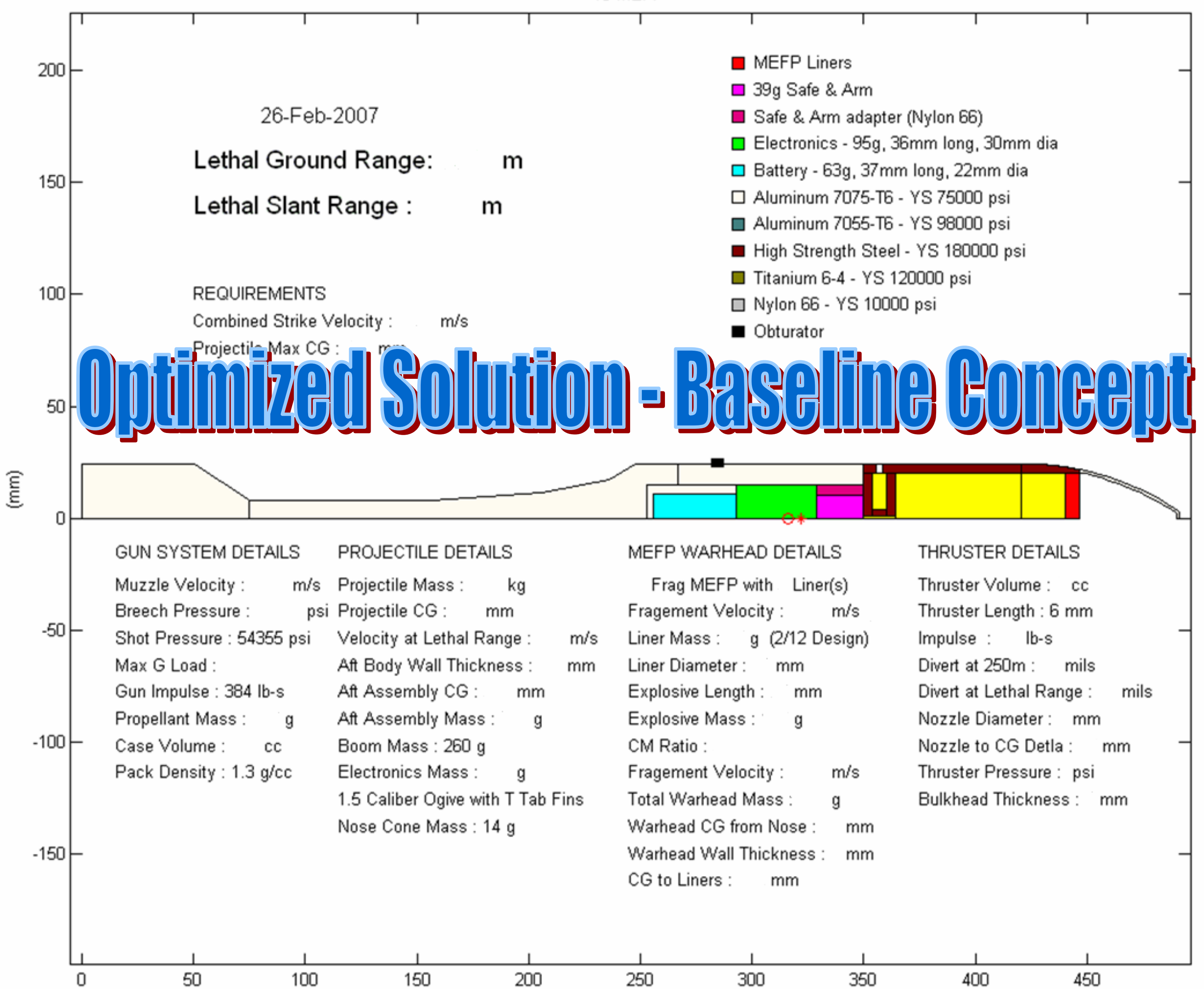
- High muzzle velocity
- Failed stress check
- Exceeds electronics G limit
- Warhead velocity insufficient
- Poor thruster location

Ex - Large Warhead

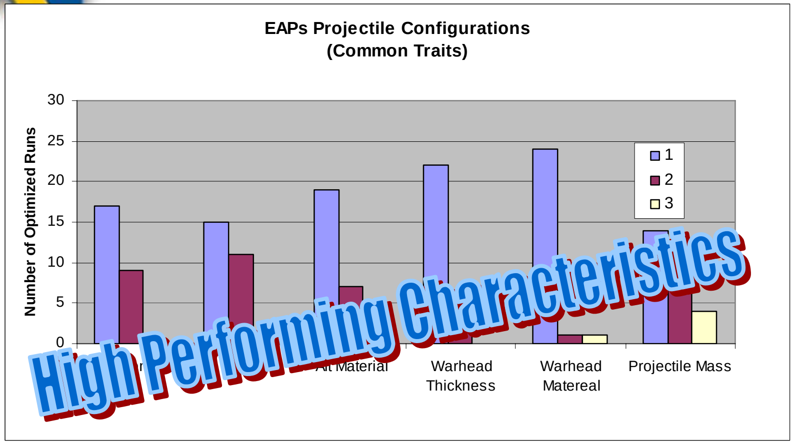


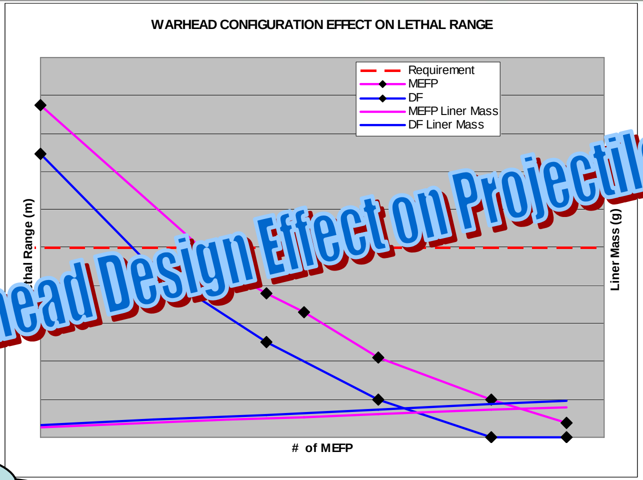
- Very low muzzle velocity
- Exceeds max weight
- High warhead velocity

Study Output Summary

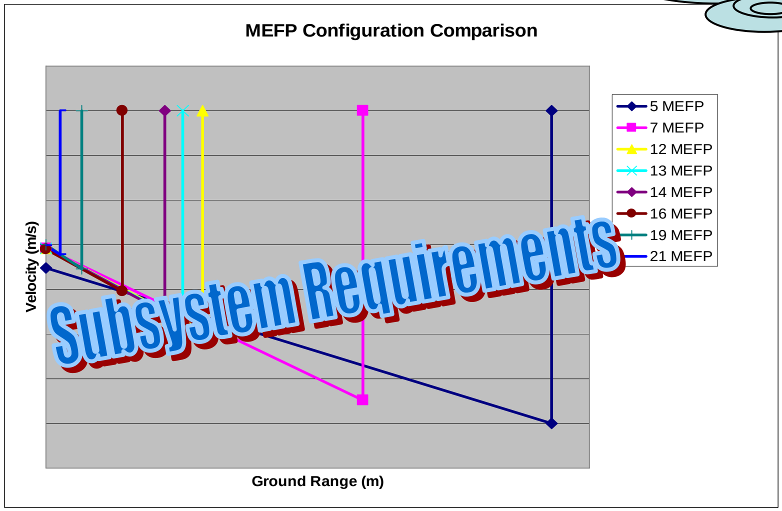


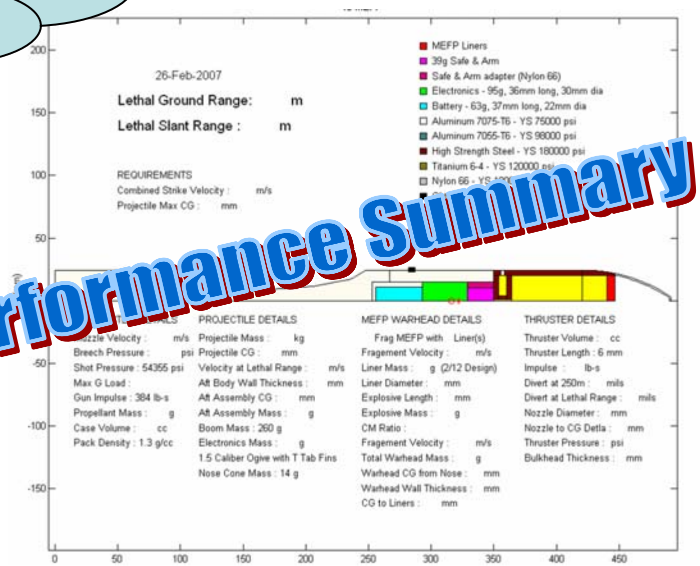
Additional Examples of Results





Solid System Understanding





Summary

- Level of fidelity and resolution of system modeling is time dependent.
- EAPS study provided an excellent first cut design for a 4 month time frame.
- EAPS subsystem design requirements established with modeling.
- Avoiding the sequential design method saved at least 4 months and ~$200k.

QUESTIONS ?