Value of Responsive Launch Safety Toolsets

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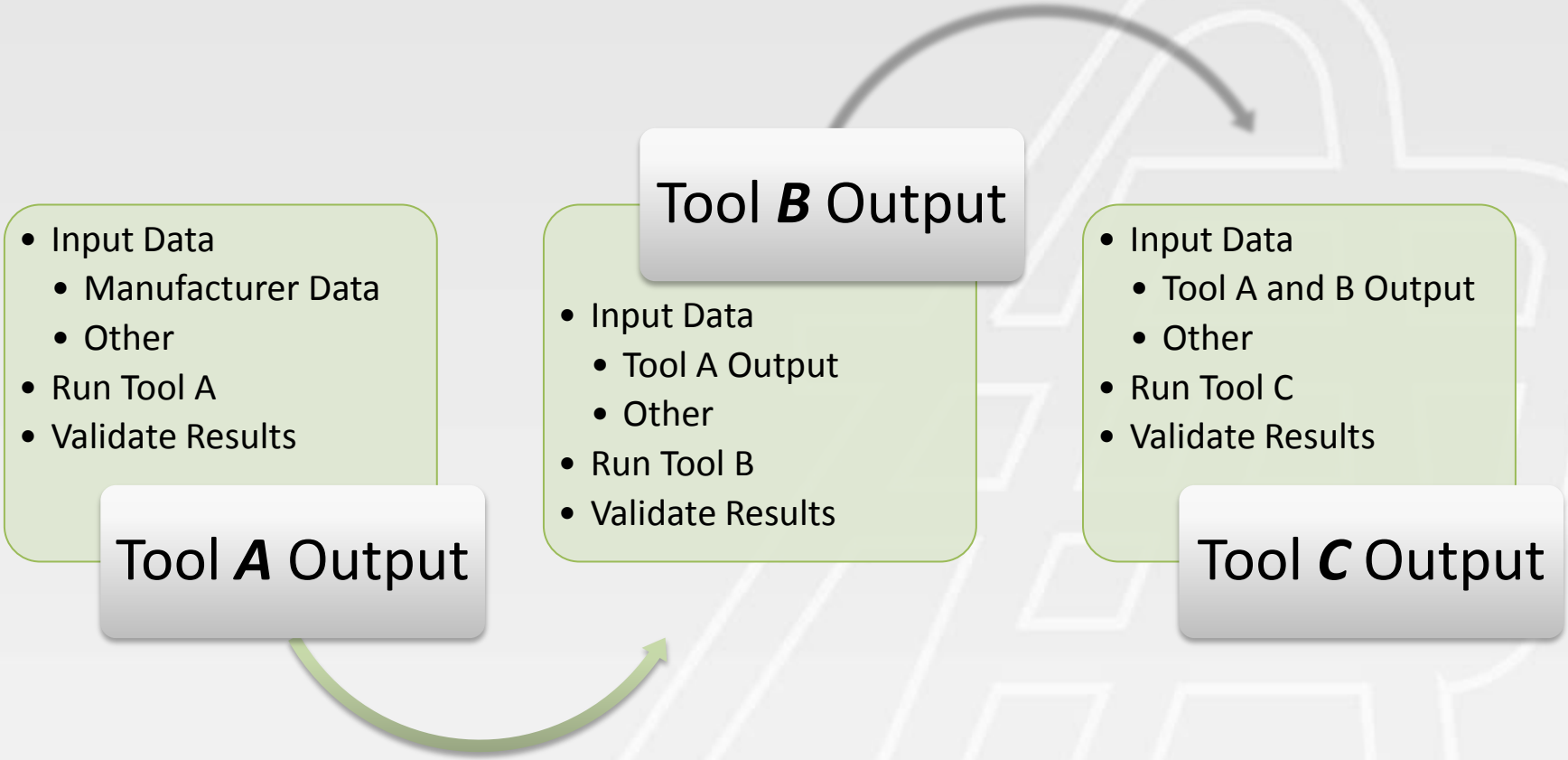
Discussion Topics

- Evolution of launch safety tools
  - Engineering tools
  - All-In-One toolsets
- Keys to a responsive toolset
- Advantages of a well planned toolset

Evolution of Launch Safety Tools
Engineering Tools

- Simple tools created by analysts/engineers to compute a single task
  - Convert trajectory data from one coordinate system to another
  - Estimate resulting state vector following a tumble turn simulation
  - Propagate a debris fragment to impact
- Tools were not designed for external use
  - Crude or non-existent graphical user interfaces (GUI)
  - Limited error checking
- Designed to run with limited computational resources
  - Efficient and precise algorithms
  - Easy to review, evaluate, and document algorithms
  - Easily modified and expanded
- Engineering tools were a staple for safety analysts even with their faults

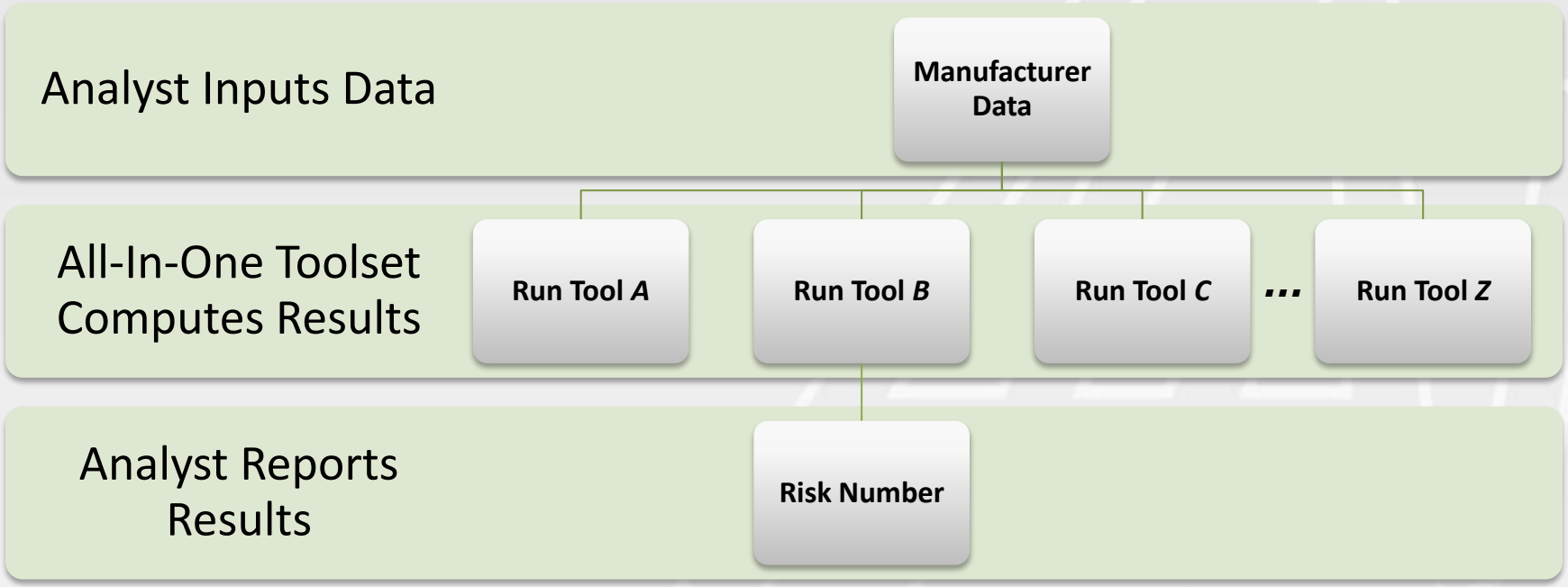
Evolution of Launch Safety Tools
Engineering Tools



Evolution of Launch Safety Tools
All-In-One Tools

- Analysts enlisted software developers to
  - Create user friendly GUIs
  - String tools together and reduce the need to shuffle output files around
  - Port algorithms in engineering tools to updated programming languages
  - Create common methods to streamline code
- New all-in-one toolsets can easily be marketed due to their
  - Simple user interfaces
  - Significant reduction in the time it takes to perform an analysis
  - Availability of report-ready results
- Legacy tools have been ported directly so there is little need for detailed testing of toolsets

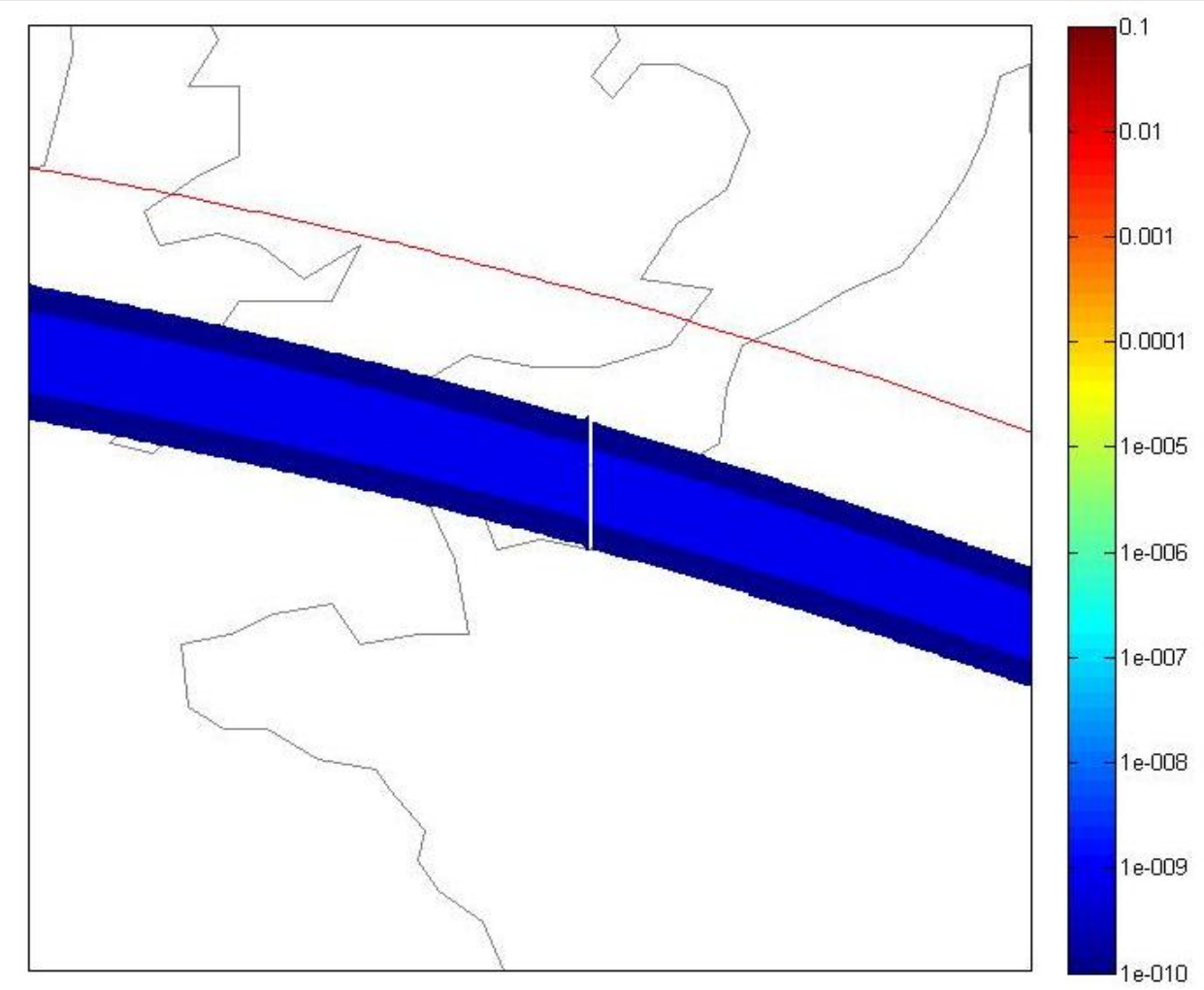
Evolution of Launch Safety Tools
All-In-One Tools



Evolution of Launch Safety Tools
All-In-One Tools

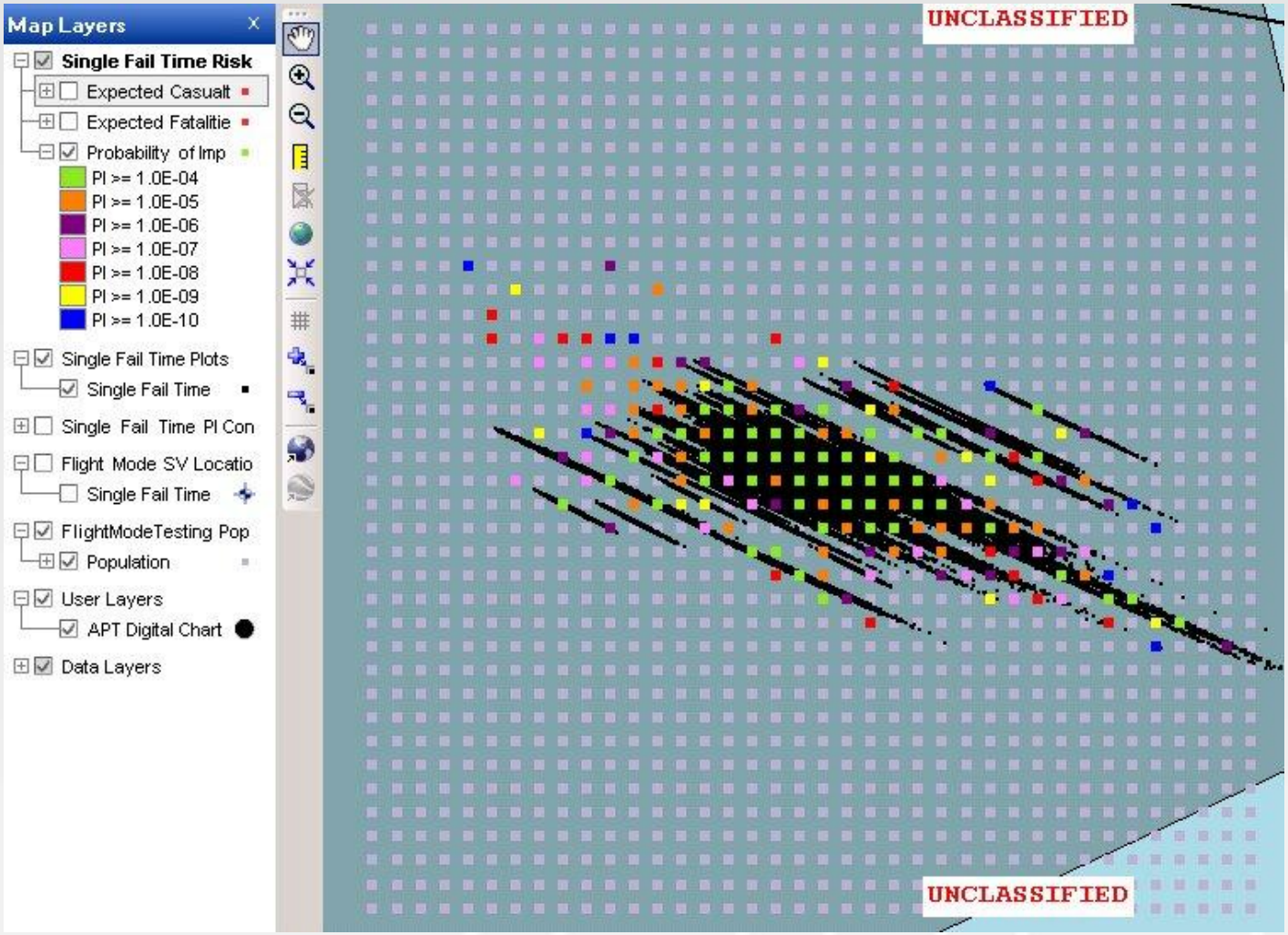
- Many all-in-one toolsets have not been thoroughly tested by analysts
- The complexity of the toolset often precludes rigorous testing
- Hard to trap errors and anomalous results
- Implementing improvements takes time
- The ease of use gives a false sense that the results will be accurate

Evolution of Launch Safety Tools
All-In-One Tools



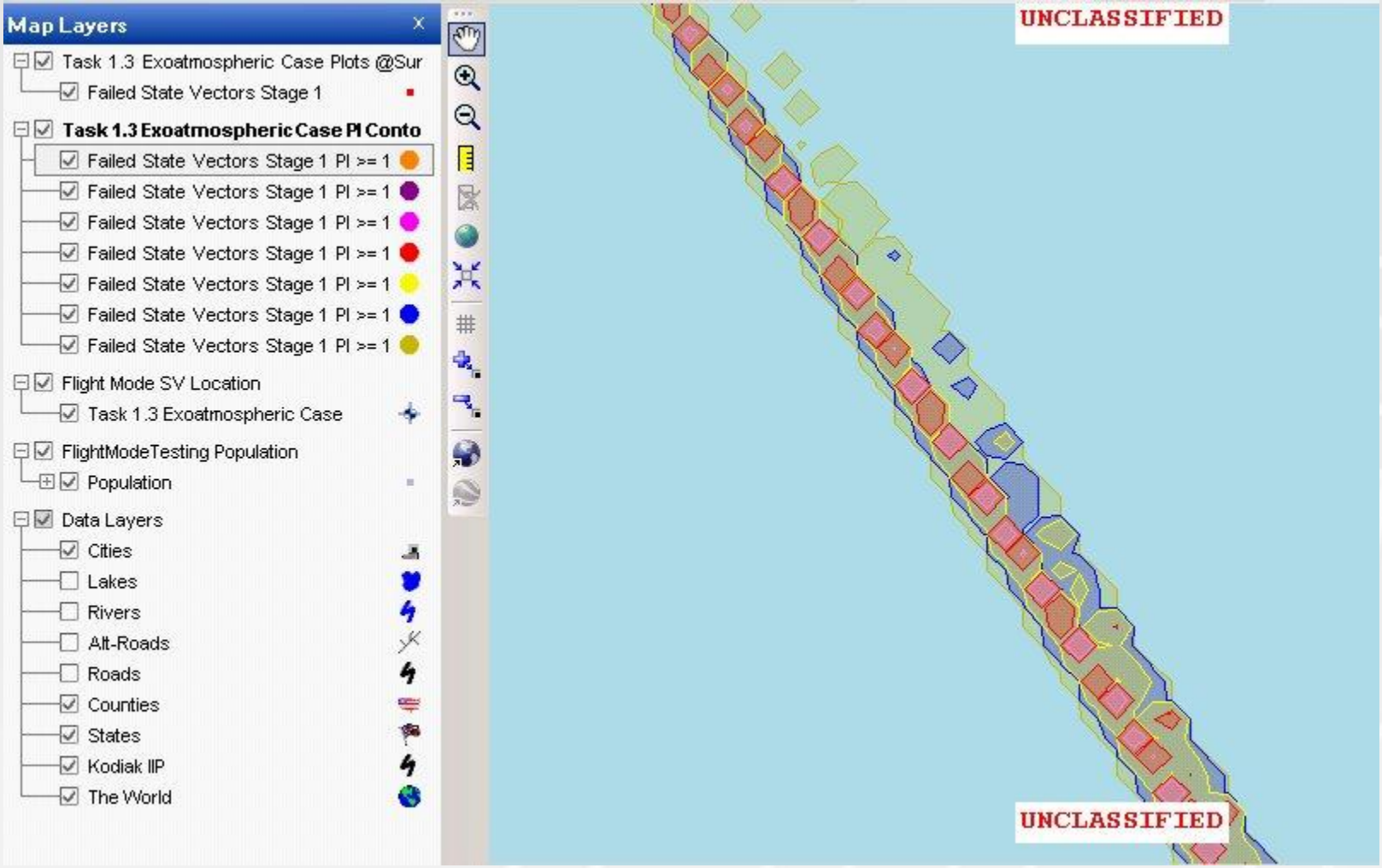
Prime meridian crossing error identified in a probability of impact surface as part of a downrange risk analysis

Evolution of Launch Safety Tools
All-In-One Tools



Probability of impact surface testing for a launch area risk analysis

Evolution of Launch Safety Tools
All-In-One Tools



Probability of impact contours from an all-in-one toolset

Keys to a Responsive Toolset

- The tool must be easy to install and operate with sufficient documentation to completely describe:
  - Input requirements
  - Output descriptions
  - Complete description of the algorithms used within the code
- The tool must be designed so that users can quickly make changes to existing algorithms or accept user created code
- All tools must return valid results that can be examined in detail by analysts

Advantages of a Well Planned Toolset

- Sufficient documentation for an analyst to
  - Quickly learn how to run the toolset
  - Understand how the input data is used to compute results
  - Be comfortable with the results
- Provides the means to easily ingest input data
- Allow an analyst the ability to quickly
  - Modify existing algorithms or I/O interfaces
  - Add a new tool without incurring development costs from the toolset distributor
- Provide ample output for an analyst to pinpoint errors in the computations

APT Research SafeLab Toolset

- A range safety “backbone” designed specifically for
  - Sharing data between separate analysis tasks and workflows
  - Adding new plug-in tools and modifying existing tools
- Analysts retain the ability to run tools within SafeLab much like legacy stand-alone engineering tools
- SafeLab can be customized to include only those tools that an analyst uses most often
- SafeLab is currently in beta testing

Conclusion

- Legacy range safety tools returned quality results but were difficult and time consuming to use
- All-in-one toolsets streamline analyses and provide a great user interface but sometimes give a false sense of security with results
- Ensure that the toolset you select has
  - Robust documentation
  - Flexibility in the code
  - Returns valid results
- Even the best toolset is no substitute for a conscientious analyst

Questions and Discussion