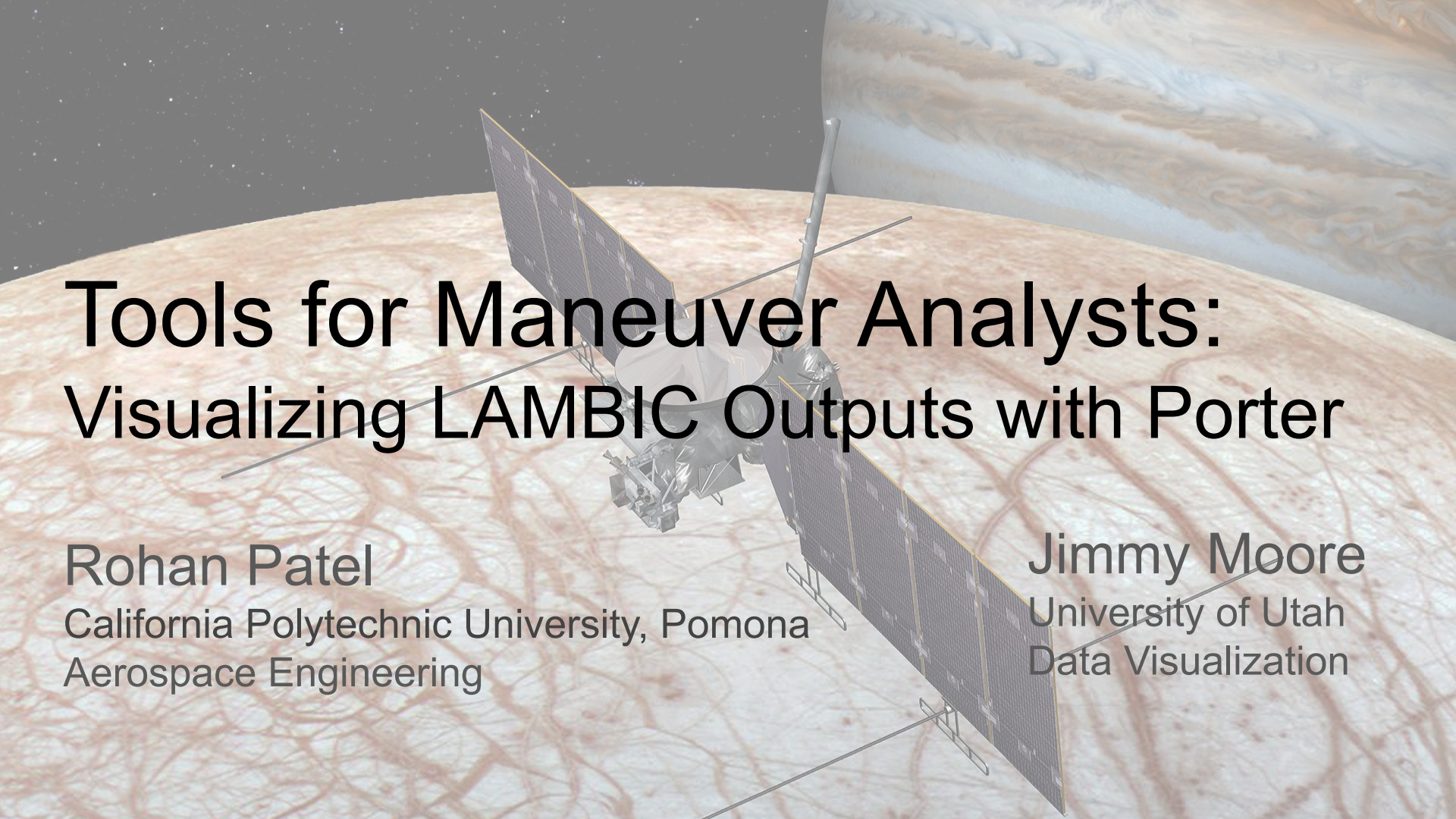


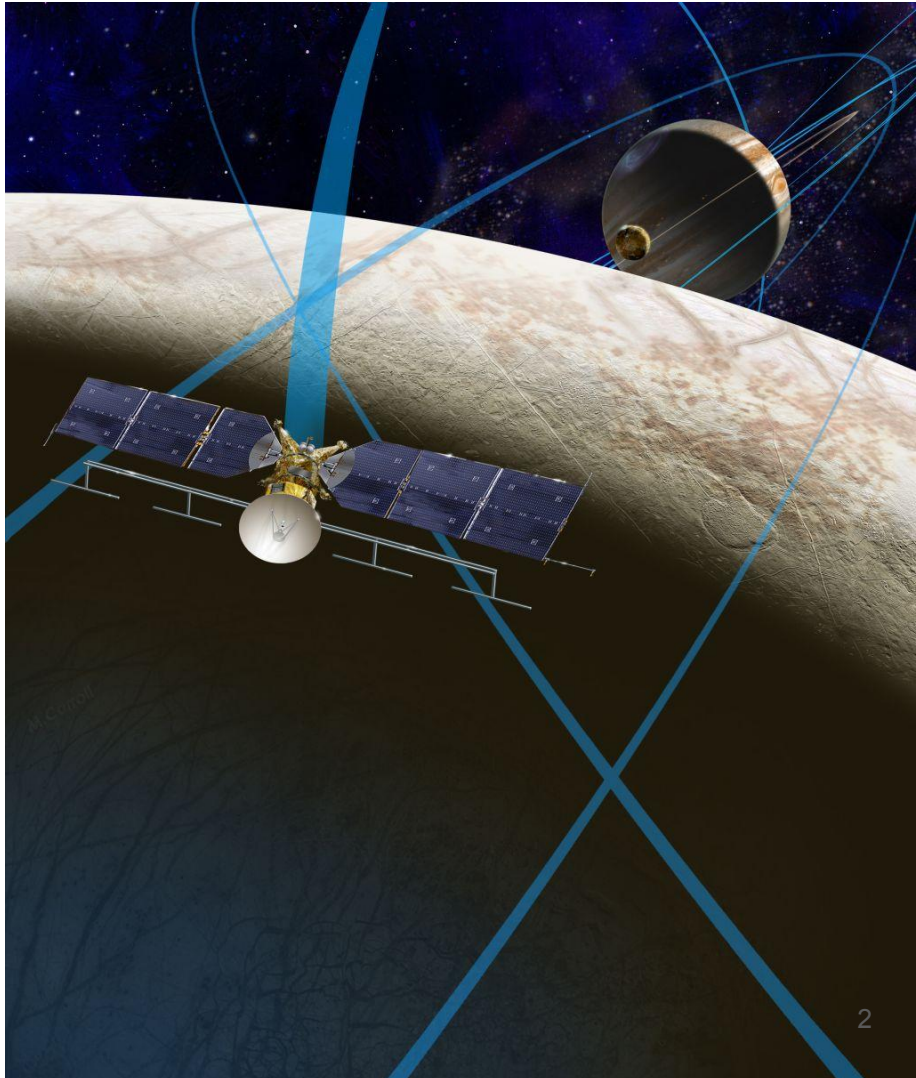
Tools for Maneuver Analysts:
Visualizing LAMBIC Outputs with Porter

Rohan Patel
California Polytechnic University, Pomona
Aerospace Engineering

Jimmy Moore
University of Utah
Data Visualization

Content

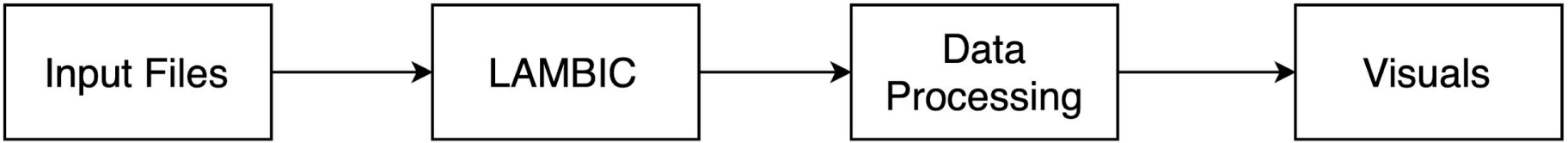
- Project Goal and Layout
- Data Sources and Processing
- Creativity Workshop
- Porter Prototype
- Future/Proposed Work



Project Goal

Process MONTE LAMBIC output data to more conveniently and effectively design maneuvers.

Project Layout



Data Sources and Processing

File	Information Extracted
results.pkl	LAMBIC summary statistics, all result blocks that user provides.
traj.boa	Spacecraft state for trajectory visual (and other body data)
optsamples.boa	Individual simulation sample data for post maneuver offsets

respkl2json.py

results.json

LAMBIC Results

- Most statistics blocks have functions to extract their data
- Designed to be used for multiple projects (with a config. file)
- Designed to handle different output data types (e.g.: Cartesian, Conic, etc.)


```
            "Sigmas": {
              "Conic.bDotFixedR": [
                15.030674189466446,
                "km"
              ],
              "Conic.bDotFixedT": [
                3.4669645654618866,
                "km"
              ],
              "Conic.linearizedTOF": [
                10.260464637685166,
                "sec"
              ],
              "Conic.sDotFixedR": [
                5.638766672550081e-05,
                ""
              ],
              "Conic.sDotFixedT": [
                0.00016639313284518952,
                ""
              ],
              "Conic.c3": [
                0.0011700160372130756,
                "km**2/sec**2"
              ]
            },
            "Skipped": null
          }
        },
        {
          "Commanded Delta-v Magnitude Cumulated Mean Delta-V": [
            1.0529769992299018,
            "km/s"
          ],
          "Commanded Delta-v Magnitude Cumulated Percentiles": {
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              1.0641979241758521,
              "km/sec"
            ],
            "95.0": [
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              "km/sec"
            ]
          },
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            "km/s"
          ],
          "Commanded Delta-v Magnitude Encounter Body Name": "E42",
          "Commanded Delta-v Magnitude Last Burn Of Encounter": false,
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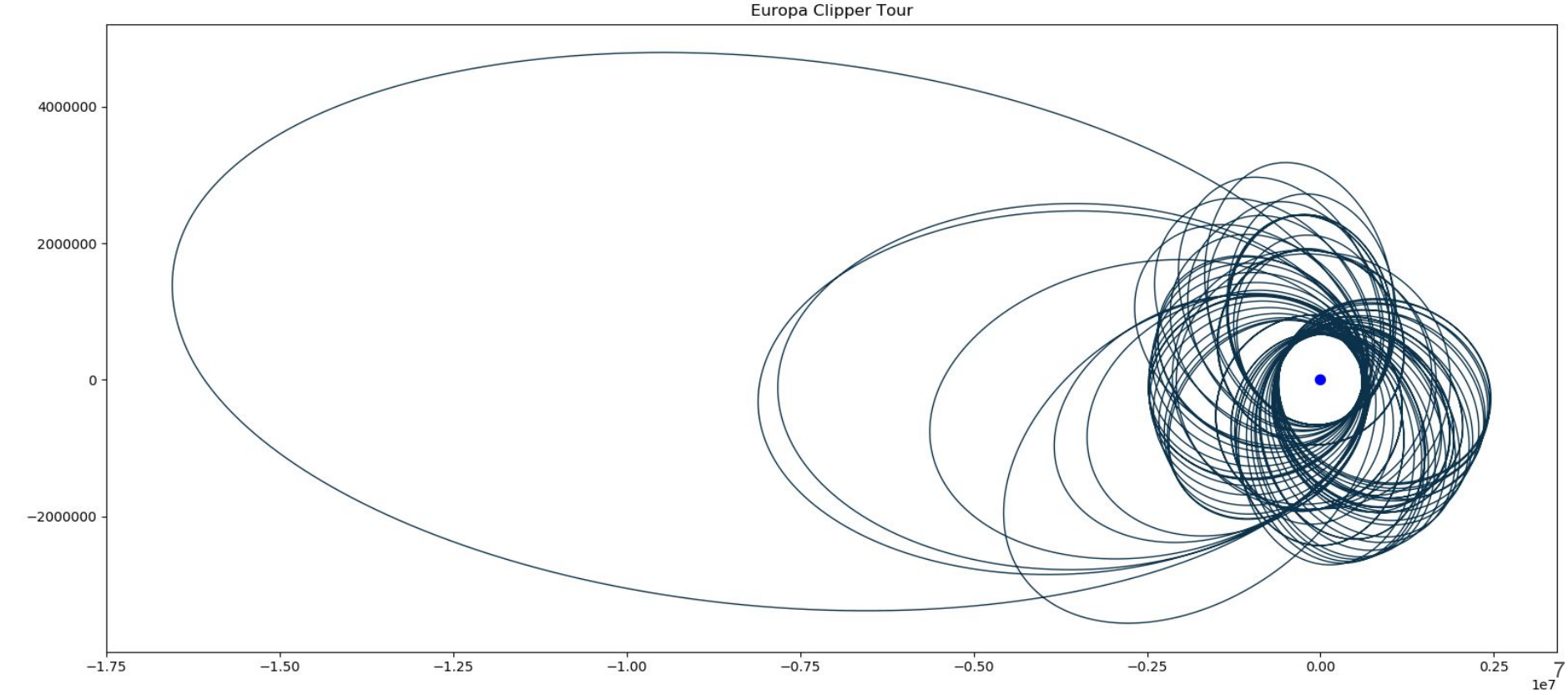
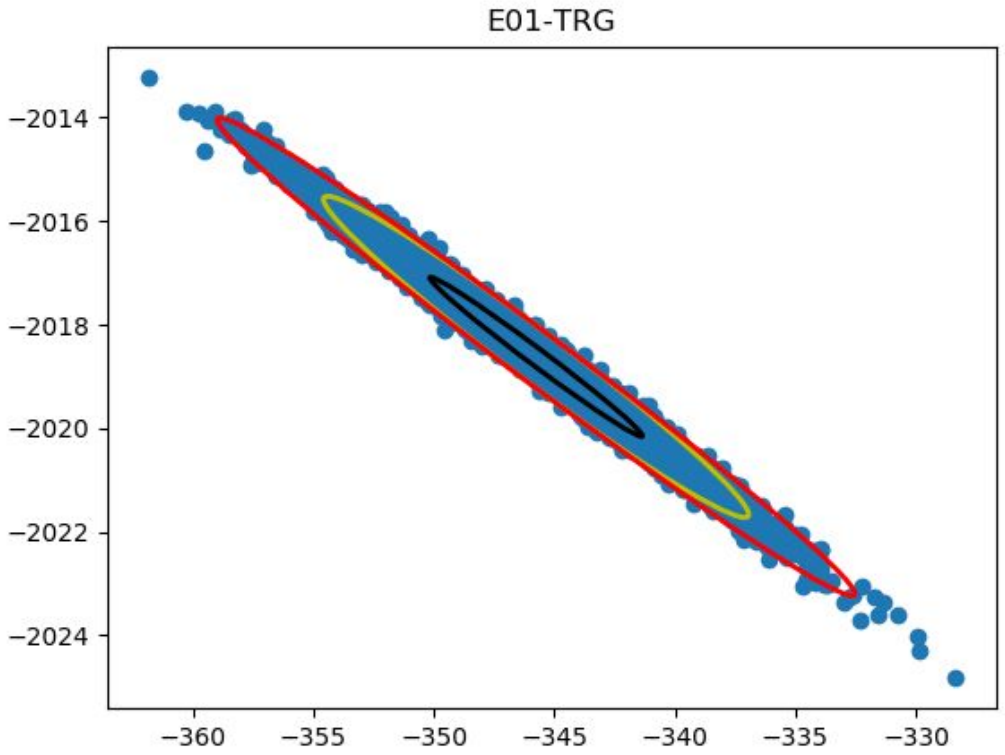
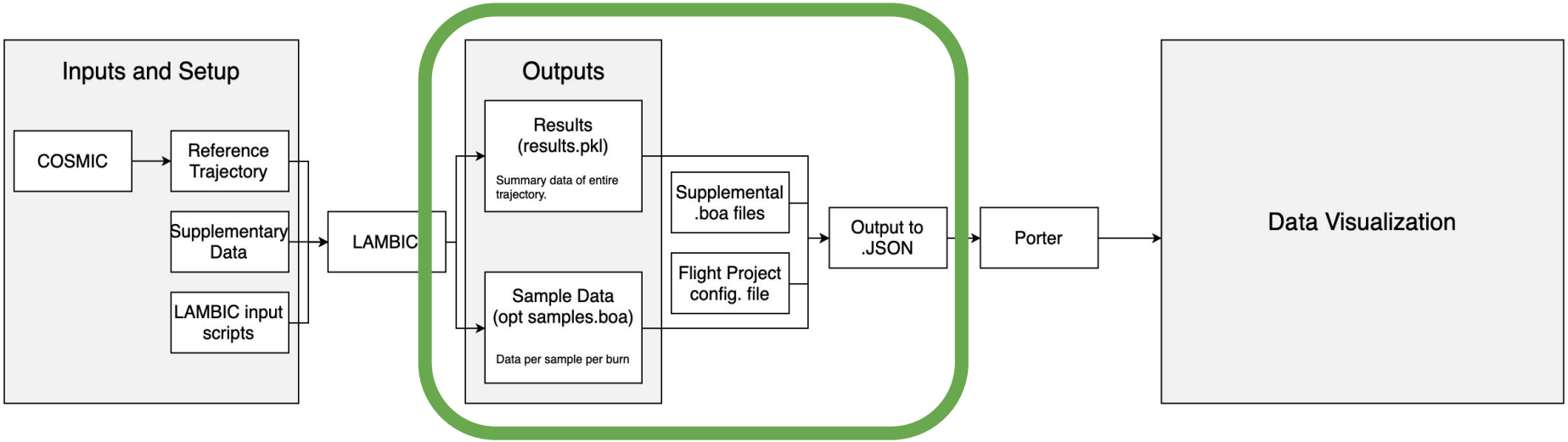
Spacecraft State Data

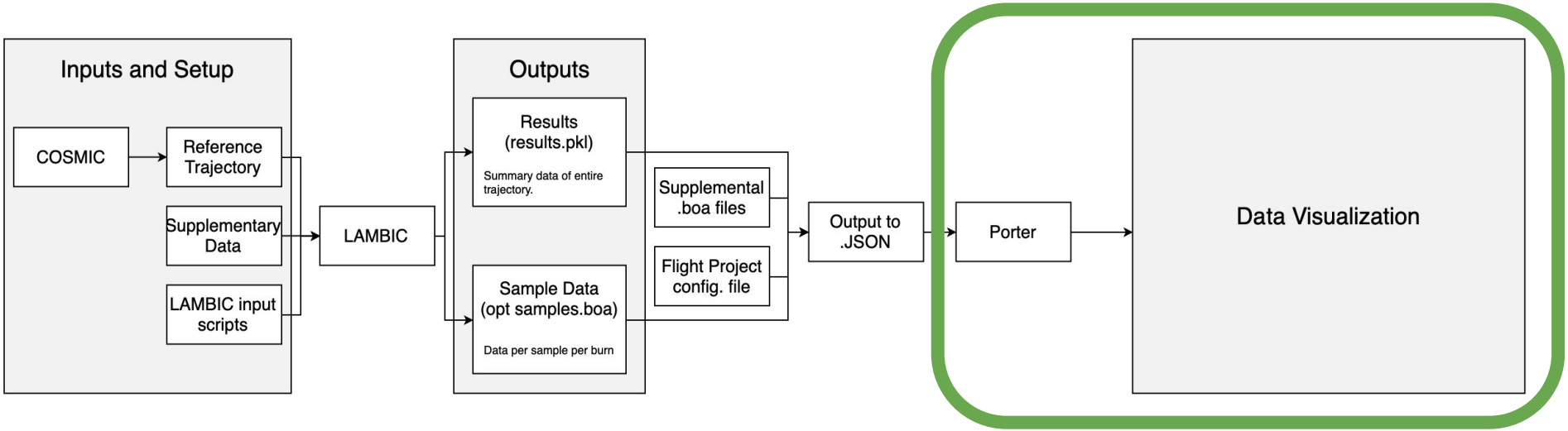


LAMBIC Sample Data

- Individual sample data extracted
- Will be implemented alongside summary data
- Useful to visualize actual distributions with aggregate statistics.




Inputs and Setup
COSMIC
Reference Trajectory
Supplementary Data
LAMBIC input scripts
LAMBIC
Outputs
Results (results.pkl)
Summary data of entire trajectory.
Sample Data (opt samples.boa)
Data per sample per burn
Supplemental .boa files
Flight Project config. file
Output to .JSON
Porter
Data Visualization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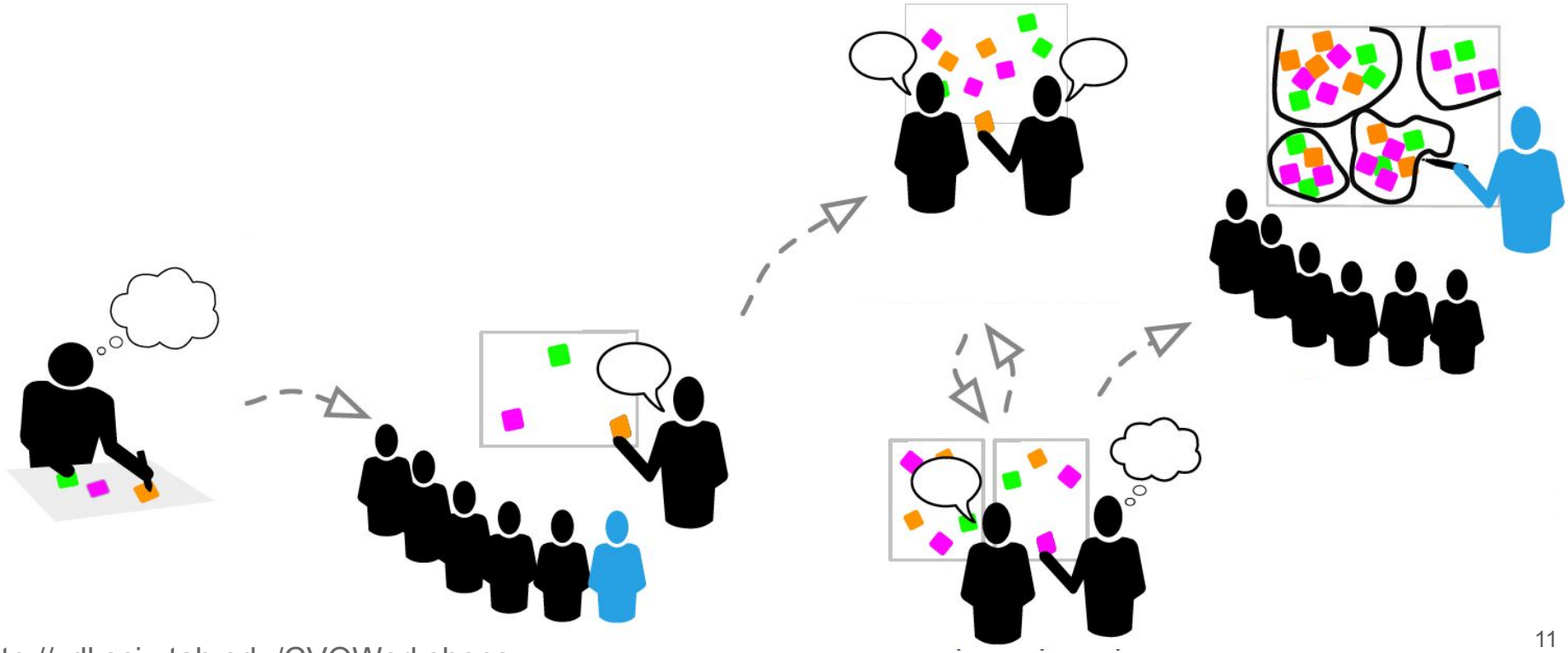
Creativity Workshops



http://vdl.sci.utah.edu/CVOWorkshops

12:00 to 12:10
Kickoff

12:10 to 12:25
Introductions

12:25 to 12:35
Describe use cases and pain points

12:35 to 12:50
Synthesize and cluster

12:50 to 13:00
Rank outcomes

13:00 to 13:15
Visualization techniques overview

13:15 to 13:30
Sketch solutions

13:30 to 13:50
Review results and refine

13:50 to 14:00
Summary and takeaways

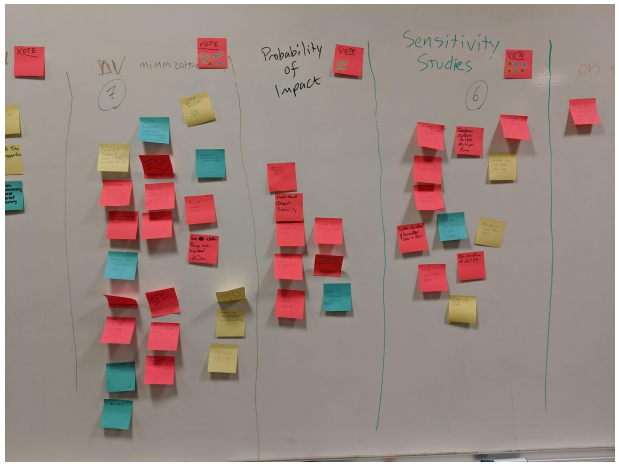
Describe use cases and pain points

Why do you perform maneuver analysis?

How do you approach the problem at the moment?

What are the inefficiencies and challenges involved?

Affinity Diagrams



High Level Workshop Themes

- Delta V: Understand where and how it’s spent & how to minimize it.
- Challenges around accessing and sharing data
- Simplify reviewing summary output, finding outliers
- Sensitivity studies, TCM placements
- Understanding and evaluating impact probabilities
- Tradeoffs between (non) linear solvers

High Level Workshop Themes

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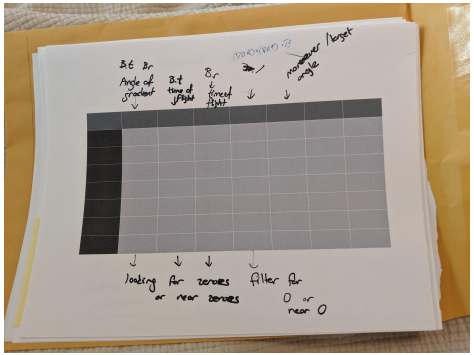
- Tradeoffs with (Non) Linear solver

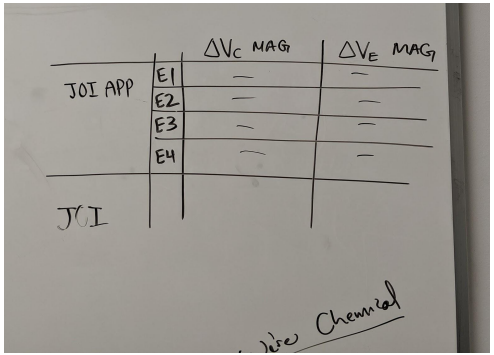
Sketch Solutions

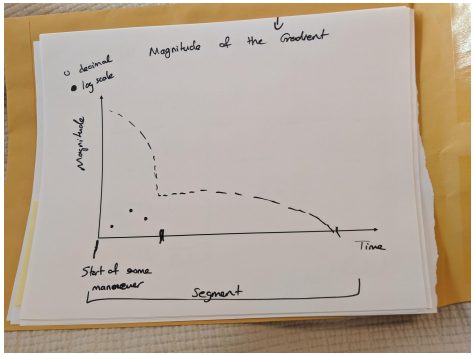
Imagine you have an ideal maneuver analysis tool:

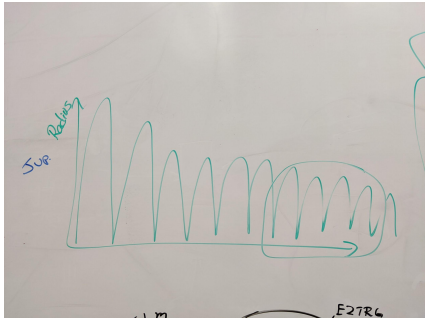
What would you like to do?
What would you like to know?
What would you like to see?

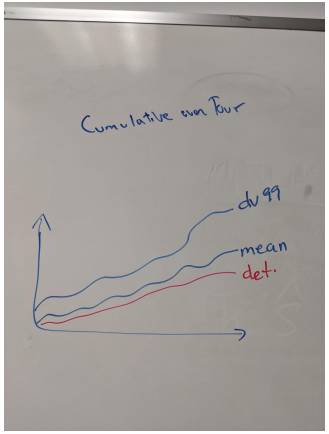
Sketches & Prototypes

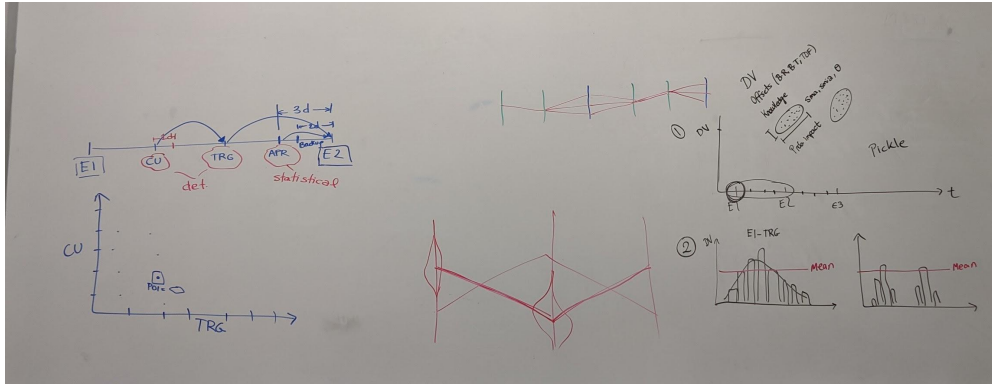


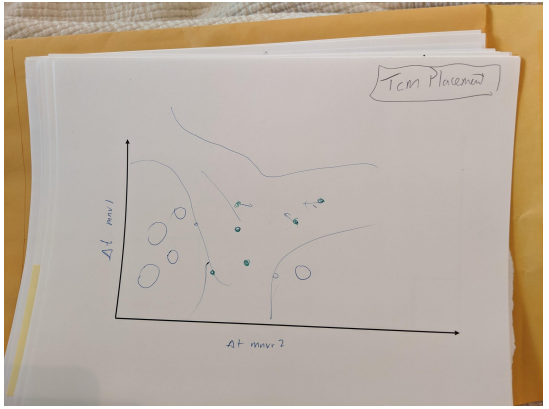




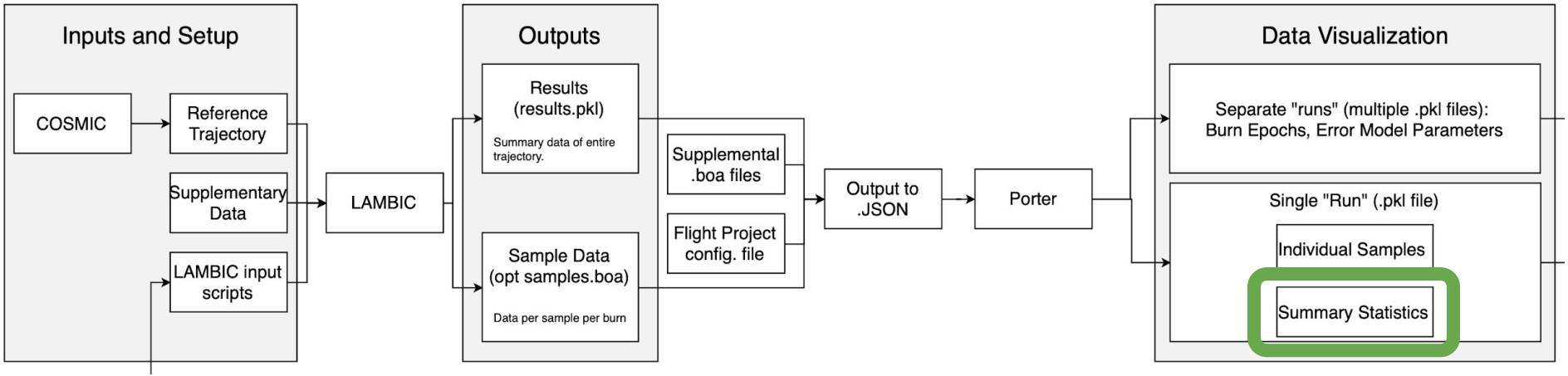




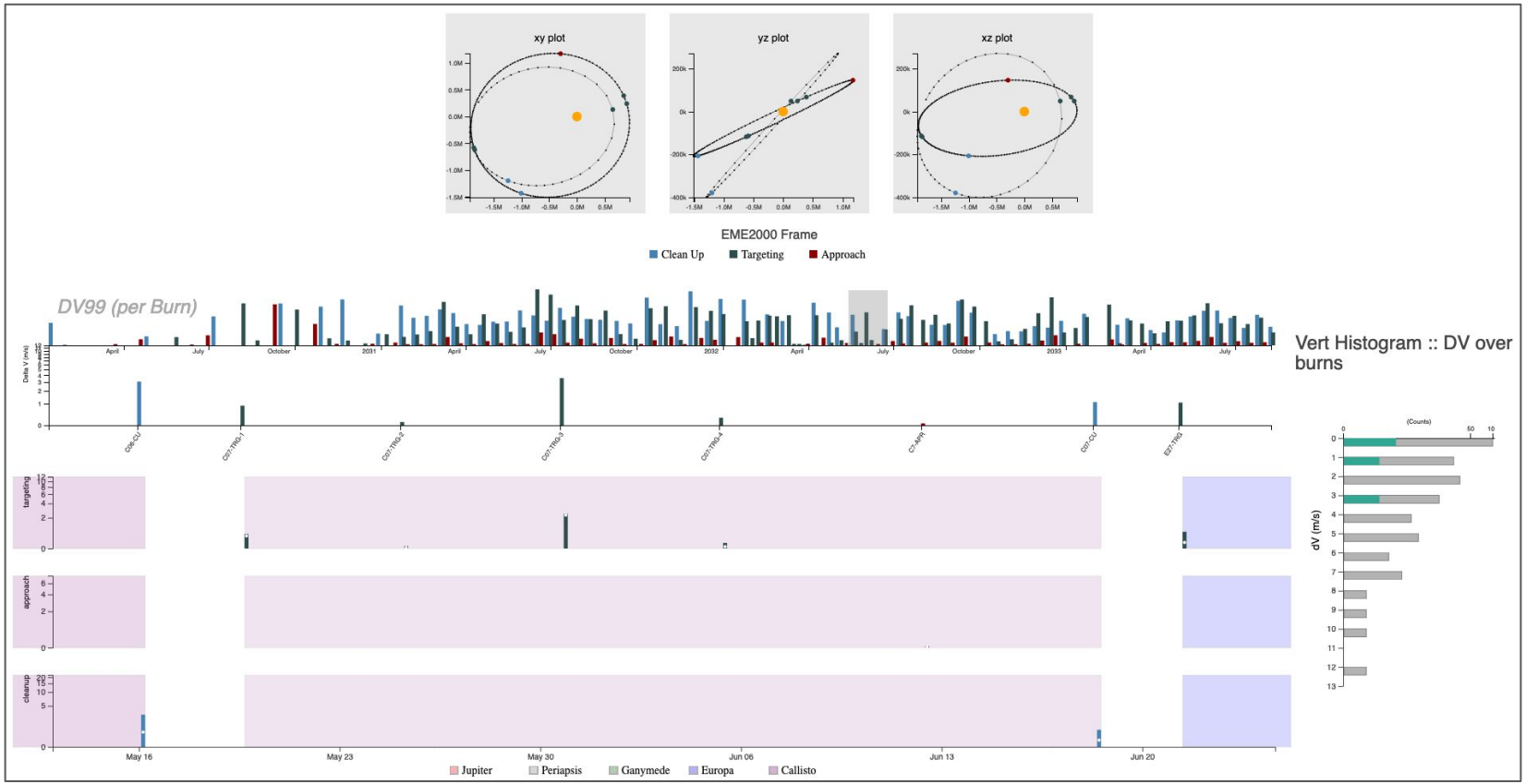




Divergent Goals



Visualization Tool Demo

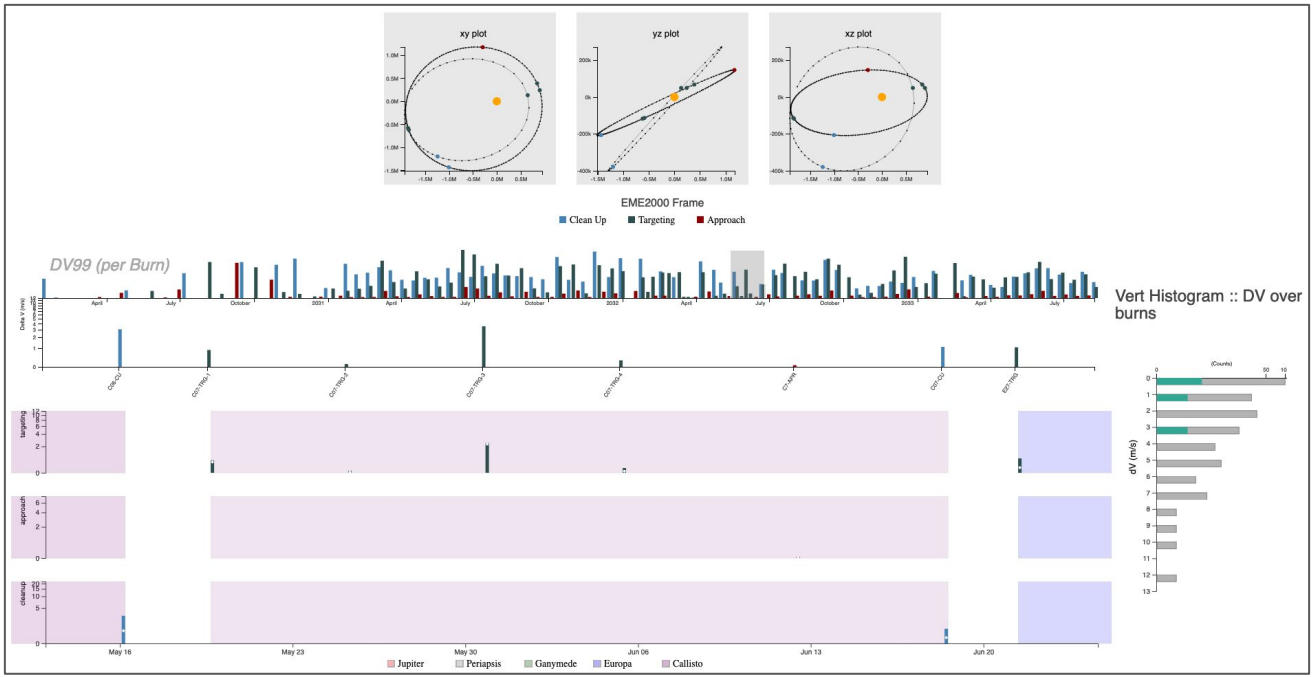


https://github.jpl.nasa.gov/pages/jamoore/porter/

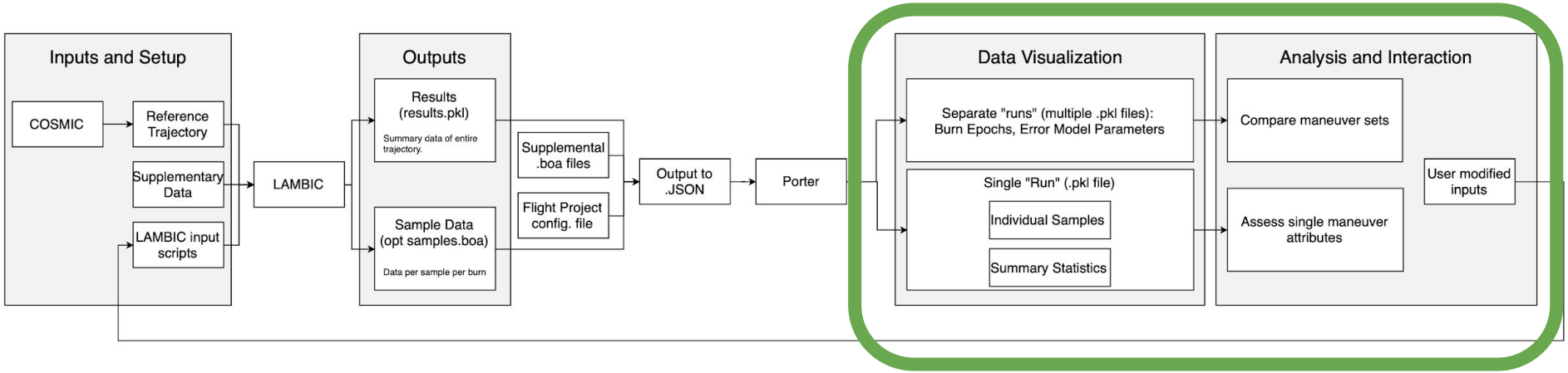
Future / Proposed Work

Evaluation and Feedback

Refine designs and interactions

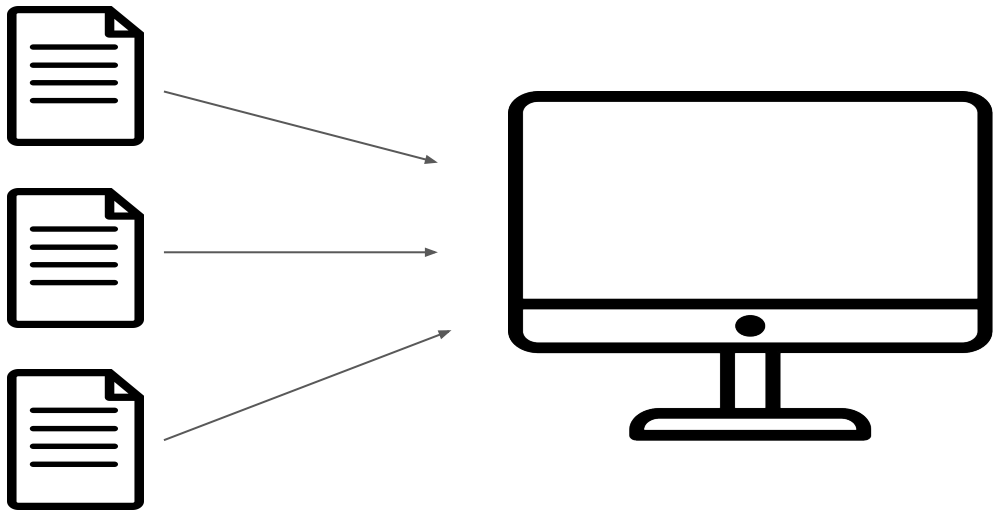


Planned Development

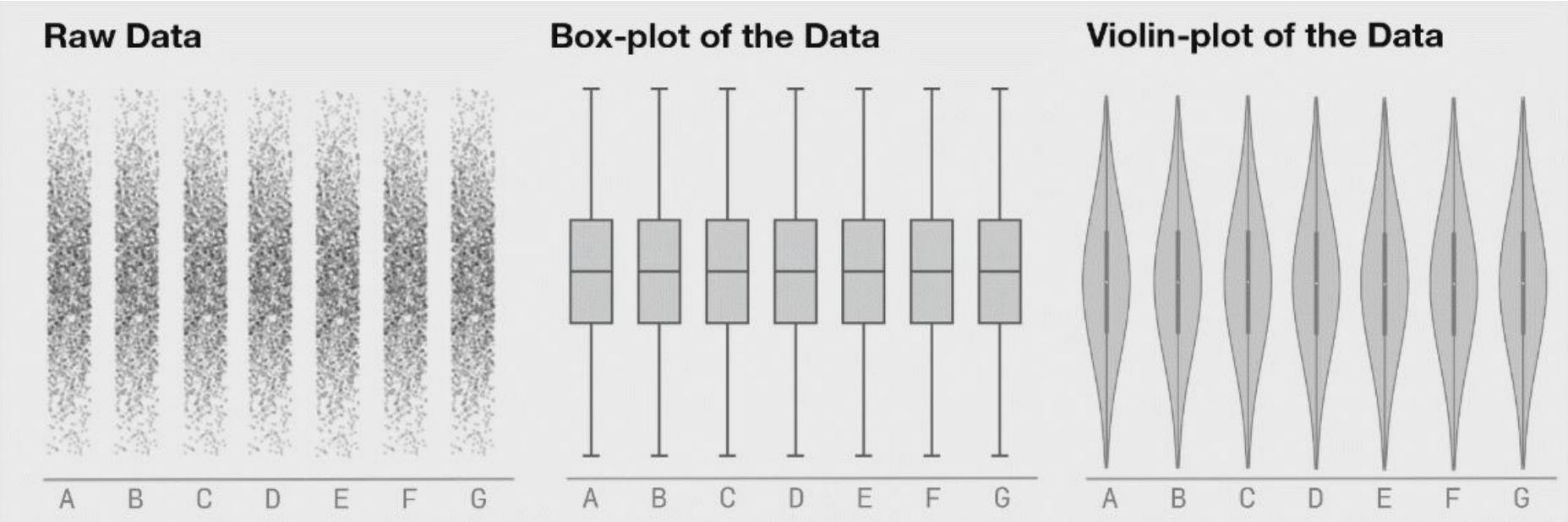


Compare and Contrast

Support visualizing multiple simulation outputs



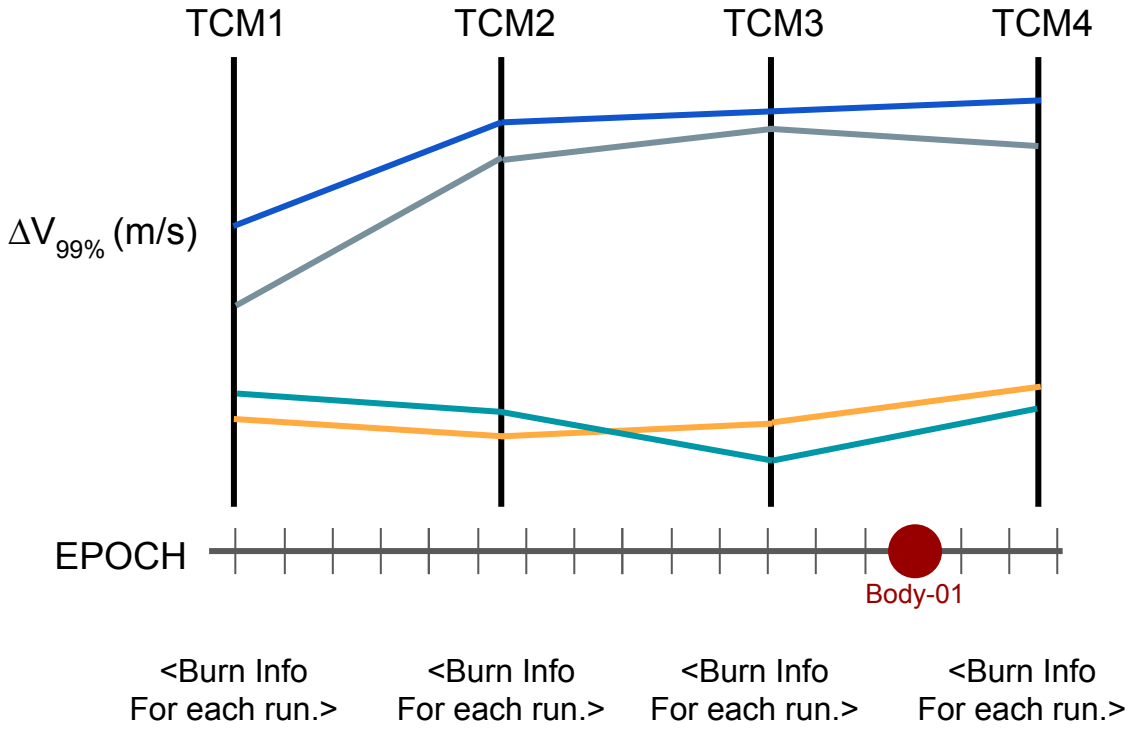
Understand How MC Runs Vary



Same Stats, Different Graphs: Generating Datasets with Varied Appearance and Identical Statistics through Simulated Annealing

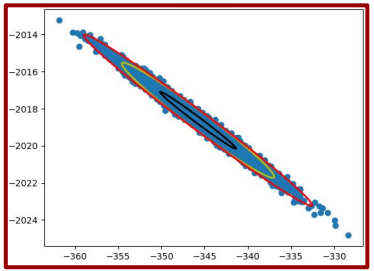
https://www.autodeskresearch.com/publications/samestats

Per-Run Visualization Tool



Run 1
Run 2
Run 3
Run 4

Body-01 Impact



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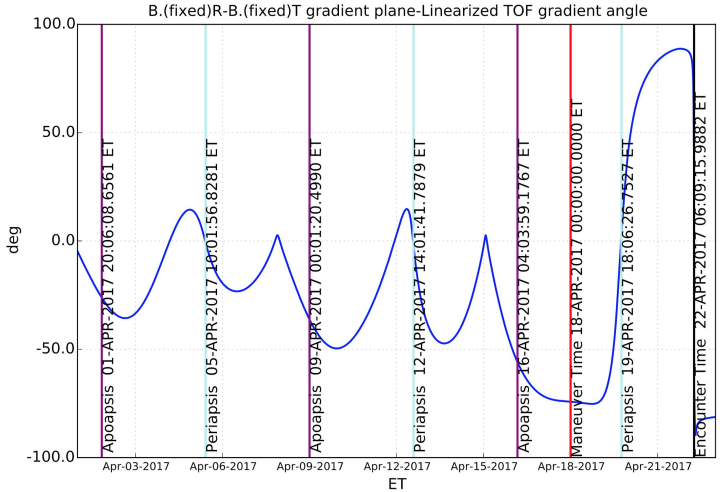
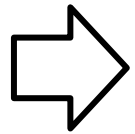
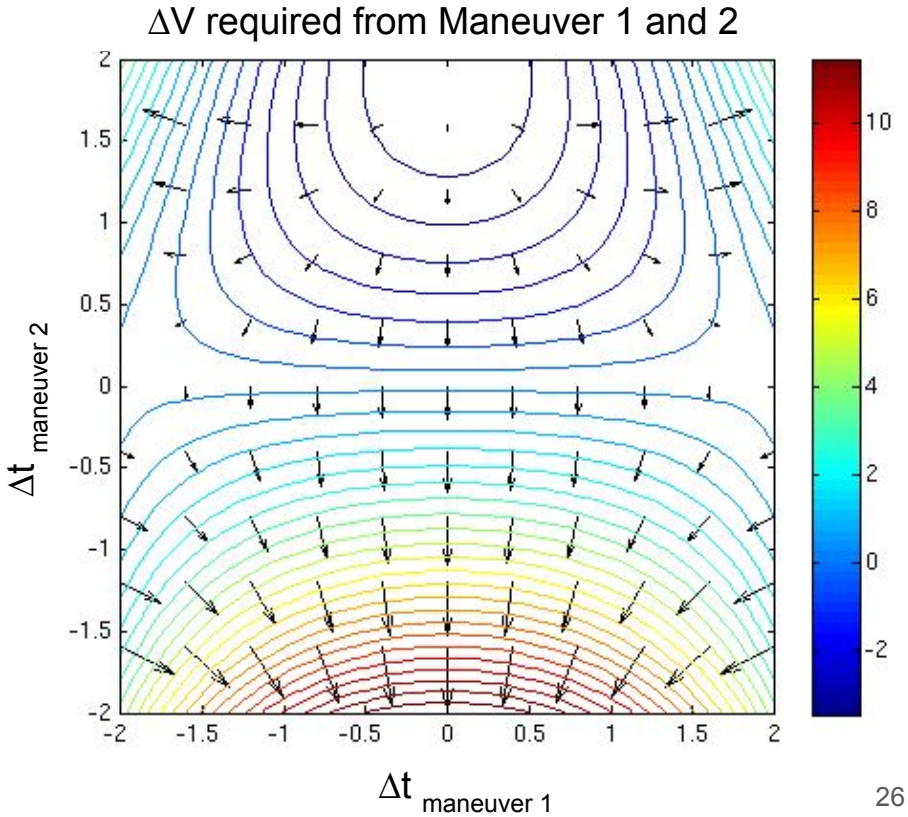


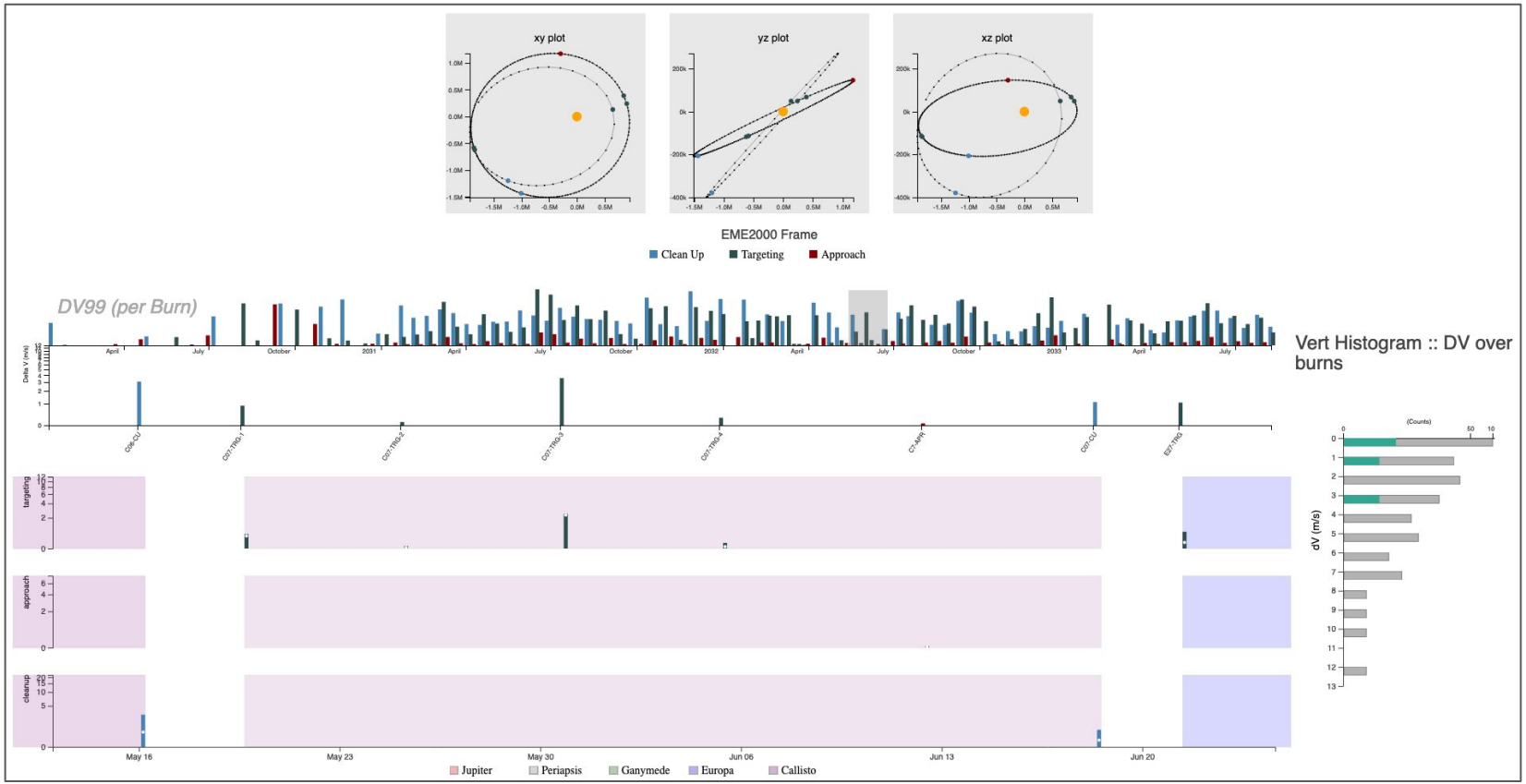




Extend Usability

Make tool robust and extensible to different flight projects

Thank you for coming!



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