Co-Design for Satellite Development

- Co-Design for Computing
- Co-Design in Laboratory Experiment
- Example in Astrophysics
- Co-Design plan for Astrophysics

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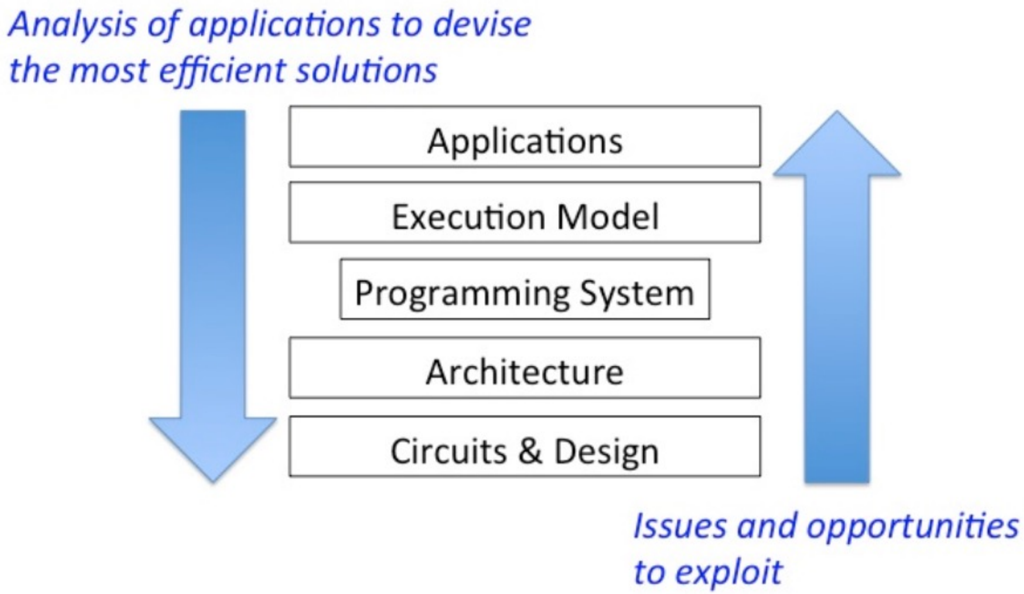
Co-Design in Computing

- At the national laboratories, scientists sought to develop high performance computing facilities that maximized their use in addressing computational problems.
- They developed a plan of co-design to help design hardware tuned to solve specific applications.



- Although the right sentiment, in part because this effort was led by managers of high-performance computing, this first pass of "co-design" focused on the hardware with less time focused on the applications. Even now, co-design efforts at the HPC-level have failed to understand application needs.

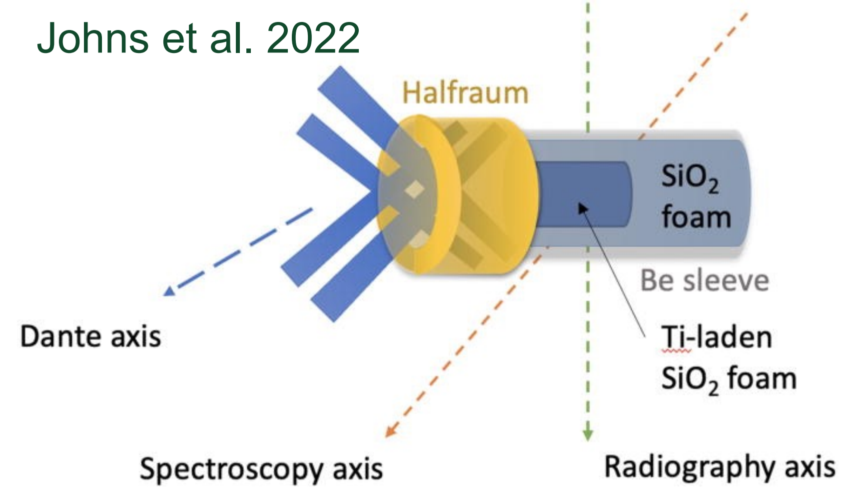
Gains of Co-Design in Laboratory Experiments

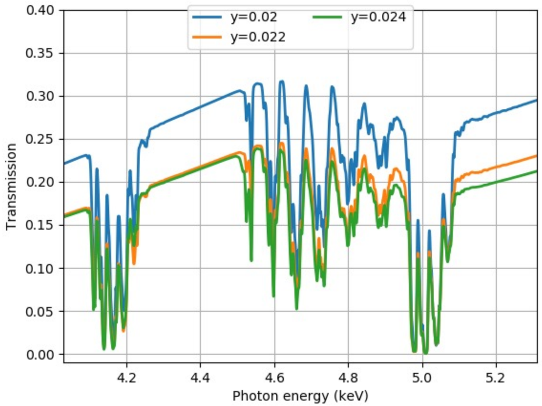
DOE laboratories design experiments to probe physics

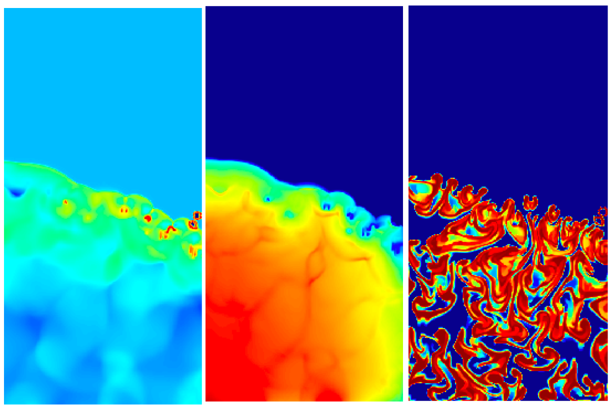
Radiation-Flow Experiments

- Initial experiments measured radiation flow, but the science goal was ill-defined (e.g. compare diffusion vs. higher-order transport methods).
- Working with computational scientists, the focus turned to tests of radiation-hydrodynamics coupling.
- Design of new experiments (e.g. COAX) and new diagnostics (X-ray spectroscopy).
- Iteration between theory, experiments, diagnostics leads to modifications in the experiment and the diagnostic.
- But laboratory physics has an advantage over satellites – it is cheap to change our diagnostics. We are slowly improving our efforts at co-design.

Johns et al. 2022

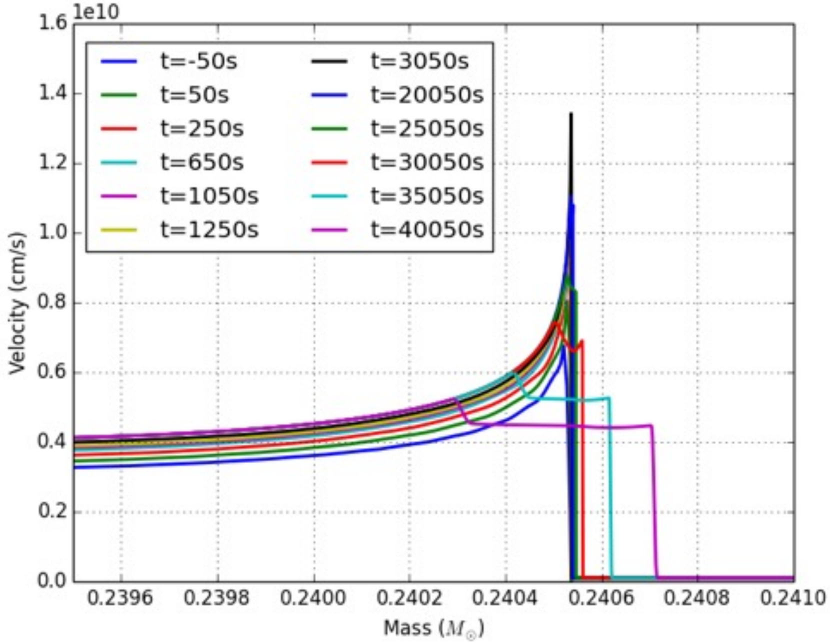






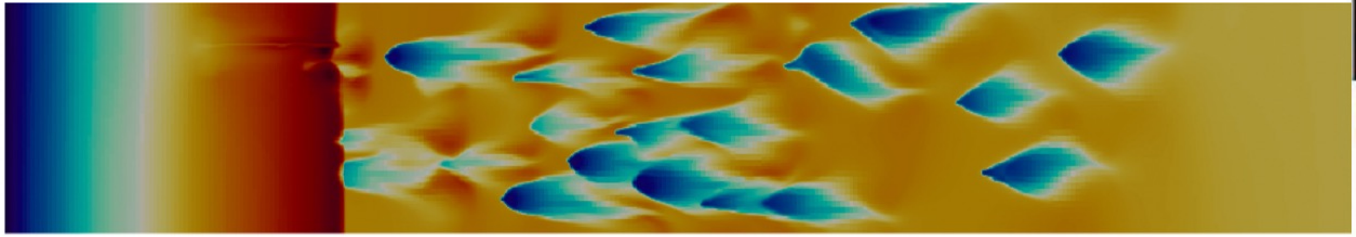
Shock Breakout

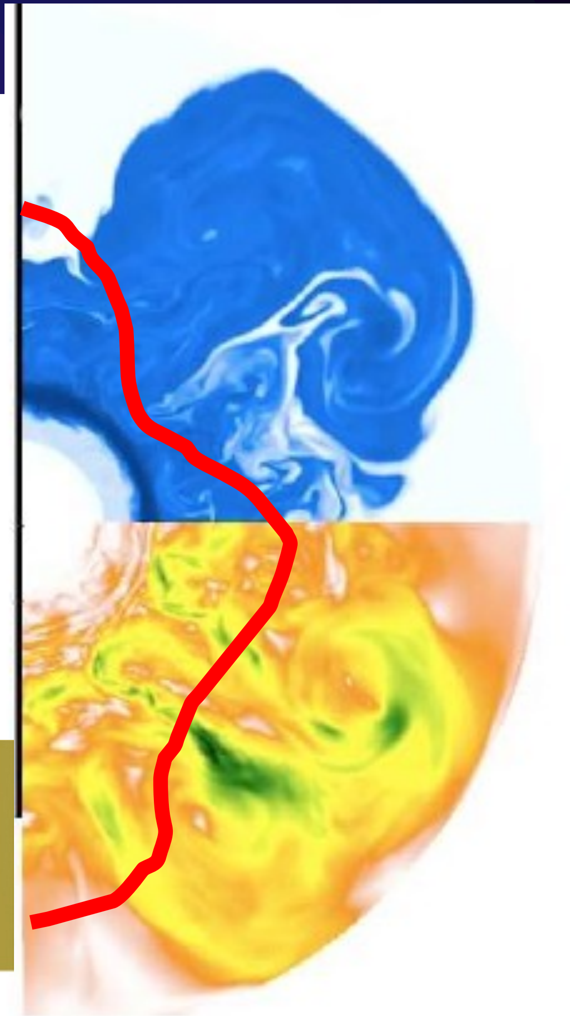
- Leading model relied on simple phenomenological solution (radiation escaping the shock front set by strong shock solution) which predicts direct tie between observations and stellar radius.
- Unfortunately, both physics-based models and observations (e.g. Alp & Larsson 2020) have shown that this simple model both underestimates the duration and the spectral energy (e.g. peak emission is in soft X-ray, not UV).



Co-Design of Shock Breakout

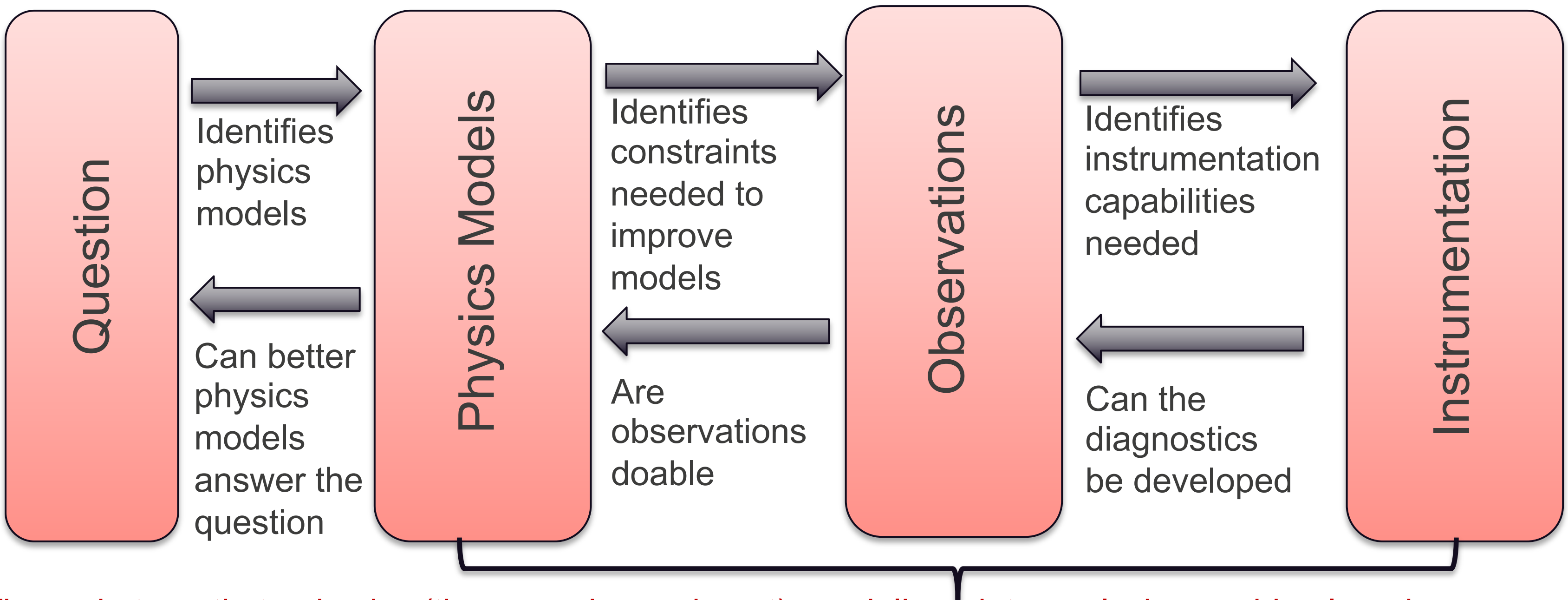
- Asymmetries in the shock caused by asymmetric explosions, stellar convection, and stellar winds will all alter the shock breakout signal. To actually learn properties of the explosion from shock breakout, we need detailed information!
- None of the current Phase A or accepted missions will be able to do this science!





We need more methodological approach -

- What question(s) are we trying to solve. The question should be more than – “we will make pretty pictures” or “if I believe this model (often phenomenological, I can probe this phenomenon”.



These, in turn, tie to physics (theory and experiment), modeling, data analysis, machine learning, engineering. A methodological approach highlights this, also making ties between NASA, DOE, and NSF