

Reaction Dynamics Explorer

Subject 7 | LISE versions: 18.8.92-110 | 17 to 20 October 2026

This series develops a collision-dynamics diagnostic from a dimensioned trajectory solver into interactive friction maps, stability studies, thermal and abrasion-source comparisons, post-abrasion conservation studies and prescribed transfer-channel inspection. Saved inputs, clickable results and reproducible exports connect the numerical model to the interface. The calculations remain illustrative and conditional rather than calibrated predictions of fusion or absolute residue production. [1]

1 Collision solver and friction maps

Main revisions: 18.8.92-96 | Sources [1, 2]

Mechanical and thermal accounting

Version 18.8.92 replaces prescribed demonstration trajectories with a nonrelativistic RK4 solver for separation R , radial momentum, azimuth, orbital angular momentum, thermal heat and two fragment spins. The reference entrance system is $^{48}\text{Ca} + ^{208}\text{Pb}$ near 7 MeV/u. Adjustable Woods-Saxon, Coulomb and centrifugal terms define the potential.

Surface-localized radial damping removes radial mechanical energy. Tangential surface-slip friction transfers orbital angular momentum into rigid-sphere fragment spins and heat. Thermal and rotational excitation are accounted for separately, avoiding a second addition of spin energy. Pointwise diagnostics track total energy and orbital L plus both fragment spins.

Energy and impact parameter scans

The Explorer adds maps in beam energy and impact parameter, then expands comparison to four cases: zero friction, radial-only, tangential-only and combined friction. Independent radial and tangential rates preserve each case's meaning. Completed cells open their saved trajectories, excitation, spins and conservation diagnostics.

Background scans snapshot participants, masses and model settings. Progress, cooperative cancellation, partial-map retention and safe shutdown support long runs. Atomic CSV exports preserve completed cells and their inputs; selected trajectories have a separate export. Grid classifications remain distinct from independently refined boundary curves.

Contact duration and stopping states

Contact is cumulative time at or below the touching radius, with fractional crossing steps. Surface friction may act beyond that geometric threshold. Contact maps use shared logarithmic scales and explicitly mark censored overlap and time-limit cases. Integration limits extend to 1000 zs, with 100 zs retained as the default; one zs is 10^{-21} s.

Interpretation. Only separated events receive asymptotic outgoing TKE. Geometric overlap does not establish fusion or capture. A time-limit state, even when it appears settled, is not a measured final contact lifetime or outgoing-fragment yield.

2 Equilibrium stability and thermal diagnostics

Main revisions: 18.8.97-101 | Sources [1, 3]

Equilibrium and numerical refinement

Potential diagnostics show final radius, exterior minima, overlap cutoff, curvature, conservative radial force and surface slip. Radial-only references retain orbital L. Tangential and combined references minimize rotational energy at fixed total angular momentum and the torque-imposed spin ratio. A potential minimum is a diagnostic, not a separate outcome classifier.

The stability tab compares 0.5, 0.25 and 0.125 fm/c step caps through 1000 zs and applies radius perturbations of plus or minus 0.01 fm at fixed total angular momentum. Each perturbed run is compared against its own displaced initial energy. Fifteen reference checks examine late-time radius, speed, force, excitation and slip, with saved traces and CSV output.

Parameter sensitivity and adaptive boundaries

Six independent plus or minus 10 percent studies vary Woods-Saxon depth, radius and diffuseness, radial and tangential rates, and overlap allowance. The ranges express sensitivity to illustrative choices; they are not confidence intervals.

Adaptive refinement bisects detected coarse-grid transitions to at most 0.01 fm and extends 100 zs timeouts to 1000 zs. The archived study contains 251 brackets, each no wider than 0.0078125 fm, and nine slices with no sampled transition. All 387 extended timeouts remained settled in that study. Equal coarse endpoints can hide narrower islands; absent transitions are not measured boundaries. [3]

Friction heating and heat exchange

Separate projectile and target thermal reservoirs distinguish generated friction heat from redistribution of existing heat. Adjustable initial excitation, sharing and surface-localized exchange compare friction only, exchange only and both. Thermal reservoirs are passive: they do not alter the trajectory or potential. Fragment rotation remains a separate energy term.

In the archived nine-run thermal reference, friction-only ends with projectile/target thermal energies of 47.63064/33.06612 MeV; exchange-only gives 8.56387/31.43613 MeV; both give 15.13064/65.56612 MeV. The two frictional cases generate the same 40.69676 MeV of heat. Their endpoint times differ from the separated exchange-only case. These values belong to that specific reference, not a general collision law. [3]

Model limit. The common level-density convention converts thermal energy into temperature. Exchange transfers heat internally and must not be added as another energy source. At this stage the mechanics are fixed in composition; later conditional AA studies add separate assumptions.

3 Abrasion ensembles and conditional residue feeding

Main revisions: 18.8.102-104 | Sources [1, 3, 4]

Excitation distributions and ablation response

The prefragment ensemble tab imports one of five existing AA excitation models: surface, Gaimard, simplified, exponential or lognormal. A private Fireball context isolates participants and source preparation from the main calculation. Positive source intervals are represented by area and energy centroid, with normalized weights over retained support and no extrapolation of missing tails.

Four scenarios compare the abrasion baseline, friction only, exchange only and both. Weighted excitation histograms and low-excitation cumulative fractions expose the change in the represented distribution. A cumulative fraction below an energy threshold is not itself an evaporation-survival probability.

The ablation response weights existing LISE statistical-decay probabilities over the saved thermal-energy ensemble. Decay explicitly uses $J=0$; entrance orbital angular momentum and mechanical fragment spins are not assigned to the selected prefragment. Competing residues, fission, breakup and numerical omissions remain distinct. The result is conditional on the selected source, rather than an absolute production cross section. [3]

Eight parent feeding paths and UP comparison

The ^{48}Ca to ^{44}Ar study includes eight parents: $^{44,45,46}\text{Ar}$; $^{45,46,47}\text{K}$; and $^{46,47}\text{Ca}$. Clickable parent maps, excitation contributions and saved CSVs relate parent weights to conditional decay response. Universal Parameterization comparisons use the production UP shape and fixed kernels across thermal cases. In the recorded reference, UP mode 2 uses 14 MeV per removed nucleon rather than generated friction heat. [4]

Post abrasion initialization and conservation

A separate initialization diagnostic introduces an explicit co-moving free packet of removed nucleons, physical separation cost and a radial energy-payment prescription. The surviving parent and target propagate with common A times u kinetic masses and rigid-sphere inertias; atomic mass excesses provide the rest-energy cost. This is a Galilean conservation closure, not a microscopic abrasion event generator.

The ledger retains the removed packet, pair center-of-mass motion, relative motion, potentials, thermal energies and fragment rotations. Packet and pair-center orbital angular momenta are retained when the relative coordinate is recentered. Energy, angular momentum and linear momentum are checked independently. Members with unavailable radial energy remain explicitly inaccessible with their original source weights. Accessible weights are not renormalized in exports or outcome totals. [4]

Physical scope. The closure supplies no calibrated formation probability, target abrasion, intrinsic-spin sampling or ablation recoil. Empirical AA excitation may already contain dissipation; adding explicit heating remains a model hypothesis and can double-count it. Parent momenta are not final evaporated-residue UP spectra.

4 Initialization studies transfer channels and inspection

Main revisions: 18.8.105-110 | Sources [1, 4, 5]

Radius sampling and energy dependence

Initialization studies vary the surface gap from 1 to 3 fm and source-group caps of 24, 50 and 100, retaining the same radial payment rule. Grouping preserves total weight and mean excitation but can change threshold acceptance and outcome boundaries. Saved maps expose original source weights, inaccessible members and the full budgets.

The energy study compares 7, 15, 30, 40 and 60 MeV/u with privately prepared energy-specific AA sources. For ^{46}Ar at a 2 fm gap, represented accessible weight rises from 0.429153 at 7 MeV/u to 1 at the higher sampled energies. In the combined case recorded contact drops from 0.101927 to 0.0131928 zs between 7 and 60 MeV/u, while generated heat rises from 29.4519 to 349.091 MeV. Overlap endpoints censor contact. [4]

These trends apply to the archived settings and prescription. The nonrelativistic speed at 60 MeV/u exceeds the relativistic diagnostic by 4.76755 percent; the solver applies no relativistic correction. Gap envelopes are sampled model sensitivity, not confidence bands. [4]

Prescribed transfer channels

The selected-channel diagnostic chooses fragment A/Z and its complementary residual, previews the atomic-mass Q value, and matches an incoming trajectory at a chosen transfer radius. Common A times u inertias and radial energy payment accommodate Q, potential and inertia changes while retaining total energy and angular momentum. It compares a prescribed channel with no transfer; it does not predict transfer rates or probabilities. [5]

The archived $^{49}\text{Ca} + ^{207}\text{Pb}$ channel has $Q = -2.2214012146$ MeV for the $^{48}\text{Ca} + ^{208}\text{Pb}$ reference. It crosses the selected 12 fm radius at 2.2938137945 zs and enters overlap, as does the no-transfer reference. Version 18.8.110 enables Fragment and Residual shortcuts and complementary editing from either nucleus, conserving total $A=256$ and $Z=102$. Single-collision participant labels retain the fixed entrance composition. [5]

Playback presentation and source organization

Synchronized playback uses saved trajectories and exposes $R(t)$, phase portraits and complete energy/angular-momentum budgets. Collision animation adds saved azimuth, heat and spin readouts, play/pause, time and speed controls, and auto scale. Playback stops at the recorded event and performs no continuation beyond it.

Three-decimal displays improve readability while solver data and scientific CSVs retain full precision. Grouped tabs, tooltips and selection highlights clarify navigation. Version 18.8.108 groups the module in ReactionDynamics.pri with all 38 source/header/form entries preserved. [1, 4]

5 Validation and version references

Archived checks cover Coulomb and conservative motion, independent friction channels, spin transfer, analytic contact and exchange limits, energy/angular/linear-momentum budgets, step refinement, source quadrature, production mass/decay integration and snapshot isolation. Qt tests exercise map clicks, complementary selectors, cancellation, exports, playback and worker shutdown. Numerical maxima below describe separate archived studies, not one uniform benchmark. [1-5]

Study	Recorded numerical evidence
Four friction cases, 18.8.94	Half-step boundary shift below 0.000489 fm; maximum energy error 5.076e-6 MeV.
Thermal reference, 18.8.101	Nine runs: max dE 1.5514e-8 MeV; max dJ 3.4292e-12 hbar.
Energy scan, 18.8.106	Maximum energy residual 1.16994e-7 MeV; J residual 2.76544e-12 hbar; 7 MeV/u regression matched 18.8.105.
Transfer, 18.8.109	Five real mass-table channels passed; maximum energy residual 2.223e-8 MeV and J residual 2.274e-13 hbar.

MSVC builds and focused numerical/UI checks are recorded through the final releases. The 18.8.110 record also documents MinGW application compilation and focused transfer tests. This subject report summarizes existing evidence; no new solver run or application build was performed.

LISE versions	Merged development
18.8.92-96	Solver, energy/impact maps, four friction cases, contact duration and 1000 zs limits.
18.8.97-100	Equilibrium, refinement, perturbations, sensitivity and adaptive boundaries.
18.8.101-104	Thermal reservoirs, AA ensembles, conditional decay/feeding and post-abrasion closure.
18.8.105-108	Initialization sensitivity, energy scan, playback, animation and module organization.
18.8.109-110	Selected transfer matching and Fragment/Residual selection shortcuts.

Source records are relative to the repository root. Together the version groups cover all 19 releases in 18.8.92-110.

[1] L_Init/lise_version.h, entries 18.8.92-110.

[2] doc/reaction_dynamics/2026-10-17/: README.txt, ENERGY_SCAN.md, CHANNEL_COMPARISON.txt, CONTACT_MAP.txt and CONTACT_1000ZS.txt; associated diagnostics, figures and reproduction drivers.

[3] doc/reaction_dynamics/2026-10-18/: STABILITY.txt, SENSITIVITY.txt, ADAPTIVE.txt, THERMAL.txt, ENSEMBLE.txt and ABLATION.txt; associated release records and validation artifacts.

[4] doc/reaction_dynamics/2026-10-19/: FEEDING_STUDY.txt, INITIALIZATION.txt, RELEASE_18_8_105.txt, RELEASE_18_8_106.txt and RELEASE_18_8_107.txt; associated production CSVs, figures and tests.

[5] doc/reaction_dynamics/2026-10-19/RELEASE_18_8_109.txt and doc/reaction_dynamics/2026-10-20/RELEASE_18_8_110.txt. Detailed cumulative companion: doc/LISE_Reaction_Dynamics_Development_18.8.110_2026-10-20.docx.