

Prompt Radiation Utility

User Manual for the integrated ARIS utility

Author: Oleg B. Tarasov

Scope. This utility is an internal ARIS tool for estimating prompt-radiation dose rates at FRIB neutron monitors from rare-isotope beams. Version 18.5 combines the normal fragment calculation (Phase 1) with the light-particle/slit-material calculation (Phase 2).

1. Before You Start

- Open the final production setting that represents the planned or delivered experiment.
- Confirm the primary beam, beam energy, target, wedges, magnetic rigidities, slit openings, and requested beam power.
- Calculate with the intended maximum beam power for planning estimates, or the appropriate operating power for an as-run estimate.
- Save the LISE⁺⁺ file before opening the Prompt Radiation utility. The utility temporarily modifies the in-memory configuration during its calculations.
- Use a configuration containing the expected block names, or update those names in Global Settings.

2. Opening the Utility

Open LISE⁺⁺ and select the internal **ARIS Radiation Analysis / Prompt Radiation** command from the main menu. A password dialog protects access to the internal utility.

The Prompt Radiation window provides commands to run the calculation, inspect settings, view the neutron-monitor map, prepare the temporary Phase 2 configuration, and restore the original configuration.

3. Global Settings

Parameter	Default	Purpose
Light-Z Yield Factor	10	Multiplier applied to H and He/light-Z yields in Phase 2.
Block Name to Calculate	BTS02	Block used as the calculation point for both Phase 1 and Phase 2.
Rate Cutoff [pps]	1e6	Minimum rate included in the automated isotope calculation.

Parameter	Default	Purpose
Momentum Slits	PS_Mom_slits	Name of the momentum-slit block used by Phase 2.
Preseparator Wedge	PS_wdg	Name of the preseparator-wedge block used by Phase 2.
Fragment Catcher Slits	Frag_Catchers	Name of the fragment-catcher slit block after the beam dump.
Show Details	User option	Prints the detailed isotope/contribution table.
Show X Plots	User option	Displays X-distribution graphs during the stopping-location calculation.
Phase Calc	Phase 1 / Phase 2	Controls which calculation phase is emitted and reported.

Settings are read from and written to the active INI file. Use Reset defaults only when you intentionally want to restore compiled default values.

4. Phase 1 - Normal Rare-Isotope Fragments

Phase 1 calculates prompt radiation from the fragments transported through the production setting and assigns each accepted isotope to a stopping zone from its DB0 X distribution.

1. Check the selected block name and rate cutoff in Global Settings.
2. Select Run LISE calculations (keyboard shortcut F5 where available).
3. The utility validates the requested configuration and inserts a temporary Faraday cup after the selected calculation block.
4. LISE⁺⁺ calculates the relevant isotope rows. Calculation work is stopped for a row when the rate falls below the configured threshold.
5. For each accepted isotope, the X distribution is split accurately across the configured stopping boundaries.
6. The isotope rate, energy, A, Z, reaction mechanism, and stopping zone are passed directly to the Prompt Radiation utility.
7. The utility applies the detailed PHITS-based scaling and monitor/location factors, then prints monitor totals.

5. Phase 2 - Light Particles from the Momentum Slits

Important. Phase 2 temporarily changes the LISE⁺⁺ beamline configuration. Do not save the temporary configuration as your experiment file. Restore the original configuration when the calculation is complete.

Phase 2 estimates light particles produced in the PS momentum-slit material and upstream light particles that penetrate the slit material.

8. The utility locates PS_Mom_slits, PS_wdg, and Frag_Catchers using the names stored in Global Settings.
9. The original states of all affected blocks are retained.

10. Frag_Catchers is temporarily changed from beam particles only to all particles.
11. PS_Mom_slits and PS_wdg are disabled for the dedicated material calculation.
12. A temporary Finger is inserted immediately before PS_Mom_slits and copies the slit position and horizontal size.
13. A temporary material block named Slit_material is inserted after the Finger.
14. The material is homogeneous Cu:Cr alloy, atomic ratio 9:1, density 8.85 g/cm³, and effective thickness 38.1 mm.
15. Reaction calculations in the material and charge-state calculations are enabled.
16. Phase 2 isotope rows are calculated separately and then merged with Phase 1 monitor totals and N0318 contributors.

Slit_material parameter	Required value
Material	Cu:Cr alloy
Atomic ratio	9:1
Density	8.85 g/cm ³
Effective thickness	38.1 mm
Profile	Homogeneous
Calculate reactions in material	Enabled
Use Q-state calculations	Enabled

6. Restoring the Original Configuration

After Phase 2, use Restore Original Configuration from the Prompt Radiation menu. Restoration removes the temporary Faraday cup, Finger, and Slit_material blocks and restores the original properties of Frag_Catchers, PS_Mom_slits, and PS_wdg.

- Restore after a successful run.
- Restore before closing the experiment file if the Phase 2 setup was prepared manually.
- Verify that the original block order, enabled states, and particle-selection options are back in place.
- Do not continue unrelated LISE⁺⁺ calculations while the temporary Phase 2 configuration remains active.

7. Reading the Results

The calculation report is time-stamped and identifies the calculation phase. Depending on the selected options, the output contains:

- accepted and skipped isotope rows;

- rate cutoff and block used for the calculation;
- per-isotope rate, energy, mechanism, X-position/zone, and monitor contribution;
- monitor dose-rate totals in mrem/h;
- merged Phase 1 + Phase 2 totals;
- outside-wall, fence, occupancy, and integrated-dose estimates when those outputs are requested.

8. Recommended Validation

- Check that the largest contributors are physically reasonable.
- Confirm that Phase 2 increases the total only through the intended light-particle contribution.
- Repeat with Show X Plots enabled when a stopping-zone assignment looks suspicious.
- Verify that no configuration block is missing and that no temporary block remains after restoration.
- Record the LISE⁺⁺ source file, beam power, rate cutoff, global settings, and calculation time with the result.

9. Troubleshooting

Symptom	Recommended action
Required block not found	Check the three configurable block names and verify that the opened LISE ⁺⁺ file contains those blocks.
No isotope rows	Check beam power, calculation status, selected block, Faraday cup placement, and rate cutoff.
X plots do not open	Enable Show X Plots. Rows are still calculated when this option is disabled.
Unexpectedly low total	Check the rate cutoff, beam power, shielding factor, location factors, and whether Phase 2 was included.
Unexpectedly high light-ion contribution	Confirm that Light-Z Yield Factor is applied once and that the normal slit geometry is not double-counted with Slit_material.
Configuration looks changed after calculation	Immediately use Restore Original Configuration and compare the block list with the saved production file.
Long calculation	Use the intended rate cutoff and keep Show X Plots disabled for routine production runs.

10. Calculation Record Checklist

- ☐ Correct production file and beam power

- ☐ Global Settings reviewed
- ☐ Phase 1 completed
- ☐ Phase 2 completed when required
- ☐ Merged monitor totals reviewed
- ☐ Original configuration restored
- ☐ Result and time stamp saved

Source basis: Prompt Radiation documentation prepared during development, ARIS Radiation Hazards procedures, and LISE⁺⁺ version history through 18.5.0.