LISE^{++}: extended and segmented configurations

Practical guidance for Distribution and Monte Carlo calculations

Purpose. This note summarizes when extended and segmented configurations should be used in LISE^{++}, and how to treat cuts, angular acceptances, apertures, and optical matrices consistently.

Executive summary

- Extended configurations are closer to the real separator description because they preserve individual optical elements, apertures, bounds, correlations, and high-order optics
- Segmented configurations are the practical default for fast analytical Distribution calculations, routine rate estimates, scans, and minimization
- The main argument for segmented configurations is speed, not higher physical realism
- Angular acceptance in a segmented configuration is an approximation to the full element-by-element acceptance
- Distribution mode cannot use physical apertures/bounds; it uses angular acceptance and slit cuts after blocks
- Using many artificial slits is not a good replacement for apertures in Distribution mode, especially in defocusing planes
- Extended configurations can calculate optical matrices up to second order; these matrices are used intensively for ARIS SpecTcl trajectory/reconstruction analysis based on ARIS save-sets

1. Configuration types

Segmented configuration. A segmented, classical, or condensed configuration groups a separator section into a compact optical block. It is optimized for speed and is the natural format for the analytical Distribution method used in production-rate calculations, scans, and fitting/minimization workflows.

Extended configuration. An extended or elemental configuration splits the separator into individual optical elements, similar to TRANSPORT-style descriptions. It can represent element-by-element optics, apertures/bounds, and correlations more directly. It is therefore the preferred format for Monte Carlo acceptance studies, optics diagnostics, aperture studies, and matrix generation.

Optical matrices. A very important practical advantage of extended configurations is the possibility to calculate optical matrices up to second order. These first- and second-order reconstruction matrices are used intensively in ARIS SpecTcl, based on ARIS save-sets.

2. When to use each configuration

Task	Recommended configuration	Recommended method	Reason
Fast production rates, planning, parameter scans, minimization	Segmented	Distribution	Fast and stable for repeated calculations; compact segment descriptions are efficient
Detailed acceptance, physical apertures/bounds, element-by-element losses	Extended	Monte Carlo	Apertures/bounds and correlations are physical MC concepts, not analytical Distribution concepts
Separator optics debugging or design diagnostics	Extended	MC + optics display	Individual elements and correlations remain visible
First- and second-order optical matrices for ARIS reconstruction	Extended	Optics / matrix calculation	Extended configurations preserve the element-by-element optics needed for reconstruction matrices
Derive effective angular acceptance for a segment	Extended first, then segmented	MC diagnostic, then Distribution production	Use MC to estimate the physical acceptance, then enter the effective angular acceptance into the segmented file
Benchmark transport with no cuts	Either, if matrices are equivalent	Distribution or MC, with cuts disabled	This checks transport consistency only; it does not test the cut prescription
Fast production calculation with real focal-plane slits	Usually segmented	Distribution, MC as cross-check	Focal-plane slits can be represented cleanly as slit blocks

3. Cuts, angular acceptance, and apertures

Quantity	Segmented / Distribution	Extended / MC	Practical rule
Angular acceptance	Used explicitly; entered for each segment	Usually not needed when apertures/bounds define the acceptance	Derive from extended MC when needed, then enter into the segmented Distribution file
Apertures / bounds	Not used by analytical Distribution	Used directly by MC	Use extended MC as the physical aperture/bound model
Slits after blocks	Used; best at real focal/cut planes	Can be used together with MC apertures/bounds	Use separate slit blocks only for real slit locations
Cuts in defocusing planes	Not reliable as a simple analytical approximation	Handled more naturally by element-by-element MC	Avoid many artificial slits in Distribution mode
Slits in material blocks	Not recommended	Not recommended	Put the slit in a separate optical block
Long optical blocks	Compact and fast, but aperture effects are condensed	Can be split where physical aperture effects matter	Split only where aperture/cut physics matters
Optical reconstruction matrices	Not the main use case	Can calculate matrices up to second order	Use extended configurations for ARIS SpecTcl reconstruction matrices

Key point. Distribution and MC do not use identical cut machinery. Distribution uses an analytical representation based on angular acceptance and slit cuts after blocks. MC can use the physical apertures/bounds in the extended element-by-element optics. Therefore, a single set of switches is not automatically optimal for both methods.

4. Why Distribution cuts should be close to a focus

For the analytical Distribution method, a cut is safest when it corresponds to a real physical slit/cut plane and is close to a focus. Away from a focus, the beam can have strong x-x' or y-y' correlations. A simple slit or angular-acceptance cut can then remove phase space in a way that does not reproduce a true element-by-element aperture. This is why adding many artificial slit blocks is usually not a good solution.

Practical consequence. If the physical limitation is a focal-plane slit, represent it as a separate slit block. If the limitation is an internal aperture, pipe, bound, or non-focus opening, use the extended MC configuration as the authoritative test and translate only the net effect into an effective angular acceptance for fast Distribution calculations.

5. Recommended working prescription

1. Keep two working files when possible: an extended MC/optics file and a segmented Distribution/production file
2. Use the extended file to model physical apertures, bounds, and element-by-element transmission
3. Avoid fixed angular acceptances in the extended MC file when bounds/apertures are already defining the acceptance, unless doing a controlled benchmark
4. Use explicit slit blocks only for real slit/cut locations and keep their number minimal
5. Place Distribution slit cuts at real focal/cut planes whenever possible
6. Do not approximate a distributed aperture system by many artificial slits in defocusing regions
7. Generate effective angular acceptances from the extended diagnostic configuration, then copy them into the segmented Distribution configuration
8. Validate in stages: no cuts first, then real slit cuts, then full acceptance/bounds
9. For final results, state which calculation is authoritative: segmented Distribution for fast production rates, extended MC for physical acceptance/aperture diagnostics

Suggested diagnostic for extracting angular acceptance. Use the extended configuration without target/wedges/materials, set the fragment to the primary beam, open momentum slits, set the beam emittance to zero except for a deliberately large angular spread, and place a gate/cup after the segment being tested. The accepted angular range can then be transferred to the corresponding segmented block.

6. Practical conclusion

Extended configurations should generally be regarded as more physically complete. They can describe the real optical line more directly, including apertures/bounds, element-by-element losses, correlations, and second-order matrices. Angular acceptance in a segmented configuration is an approximation to this more complete description.

However, Distribution mode has an important limitation: it cannot use apertures/bounds. Replacing apertures by many slit cuts is not a robust solution, because the analytical Distribution method is not reliable for arbitrary cuts in defocusing planes. Therefore, segmented configurations remain essential for speed, while extended configurations remain essential for physical acceptance and optics diagnostics.

Recommended summary sentence. Use extended configurations to understand the real separator and derive acceptances; use segmented configurations to calculate fast production rates with those effective acceptances.

References

- O. Tarasov, *Extended configurations at LISE^{++}*, presentation, 08-Jul-2014: PDF
- O. Tarasov, *S- & E-blocks, LISE^{++}* version 9.8.158 presentation, 12-Nov-2014: PDF