

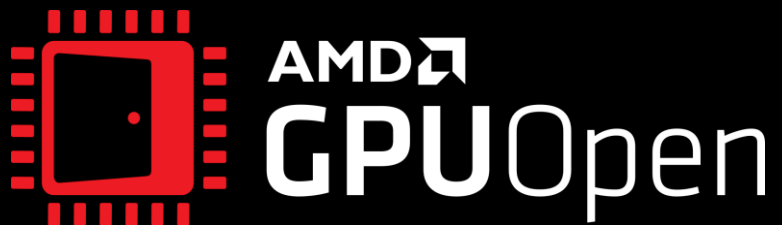


RAYTRACING PERFORMANCE REVEALED

HOW TO OPTIMIZE YOUR GAME WITH THE
RADEON™ DEVELOPER TOOL SUITE

CHRISTOPHER HESIK

CAN ALPER



GDC

RAYTRACING PERFORMANCE REVEALED

Part 1: Radeon™ GPU Profiler

- How does the use of ray tracing impact my frame?
- What is the performance of my ray tracing pipelines?
- What is the relative cost of my ray generation, traversal, any hit, closest hit, and miss shaders?

Part 2: Radeon™ Raytracing Analyzer

- How can I optimize an acceleration structure to reduce intersection cost?
- Did I apply the correct flags and transform onto my geometry?

RAYTRACING PERFORMANCE REVEALED

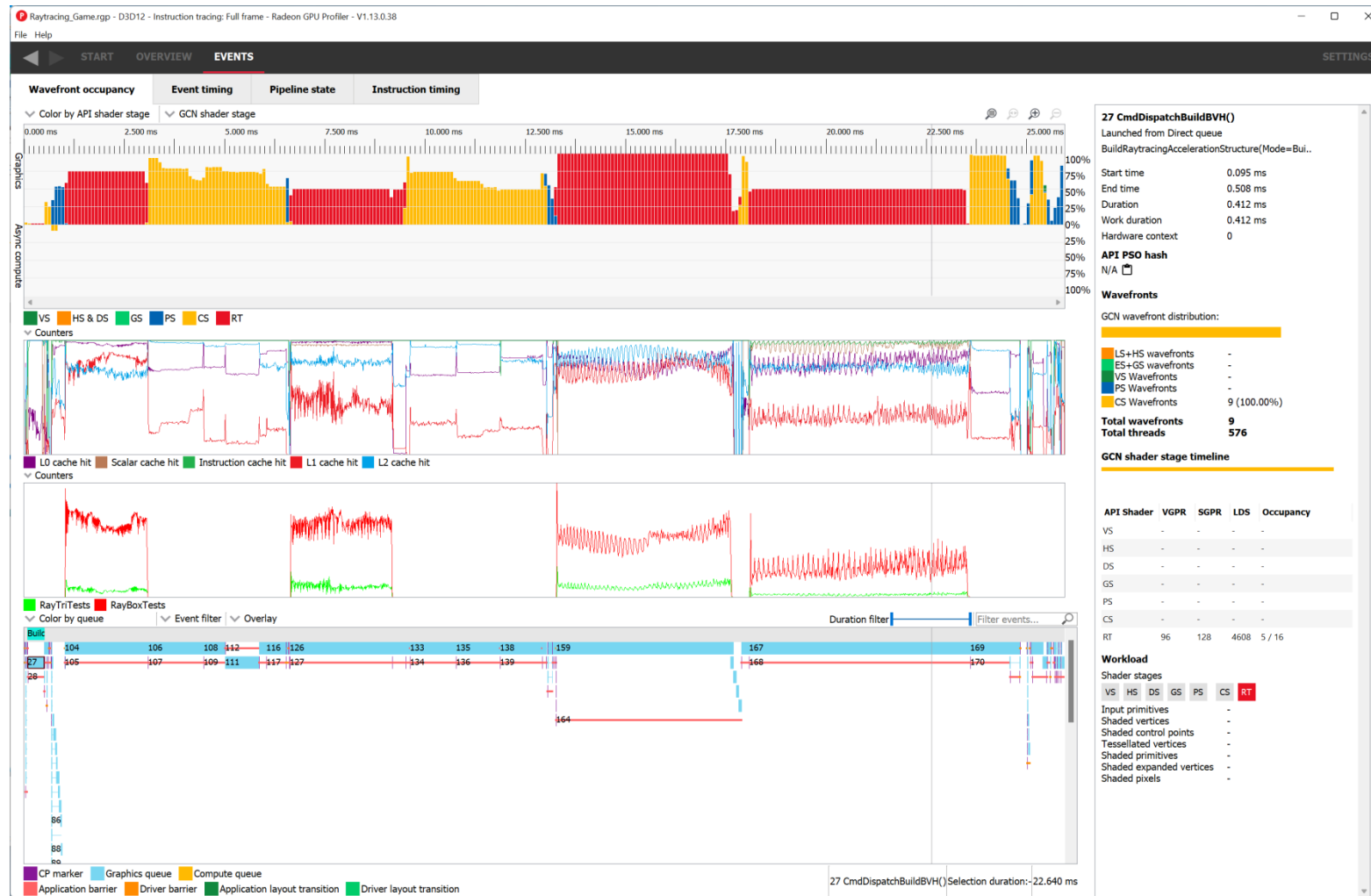
Part 1: Radeon™ GPU Profiler

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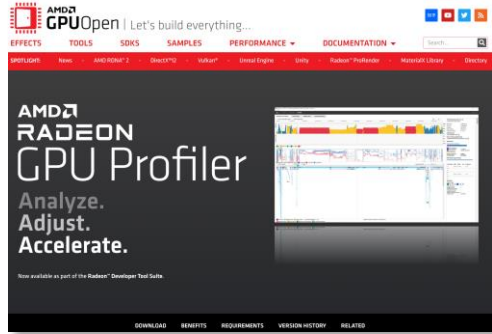
RADEON GPU PROFILER



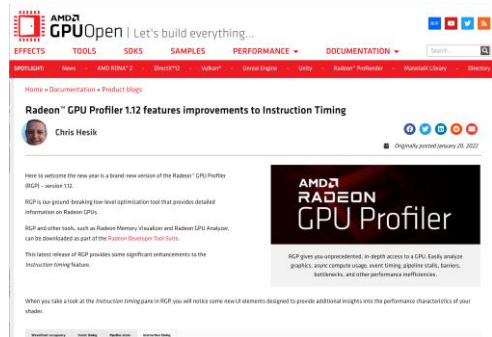
GPU Performance analysis tool

- Frame-based performance analysis
- Exposes hardware-level profiling data
- Identifies performance bottlenecks
- Visualizes GPU workloads intuitively

RGP CONTENT ON GPUOPEN.COM



<https://gpuopen.com/rgp/>

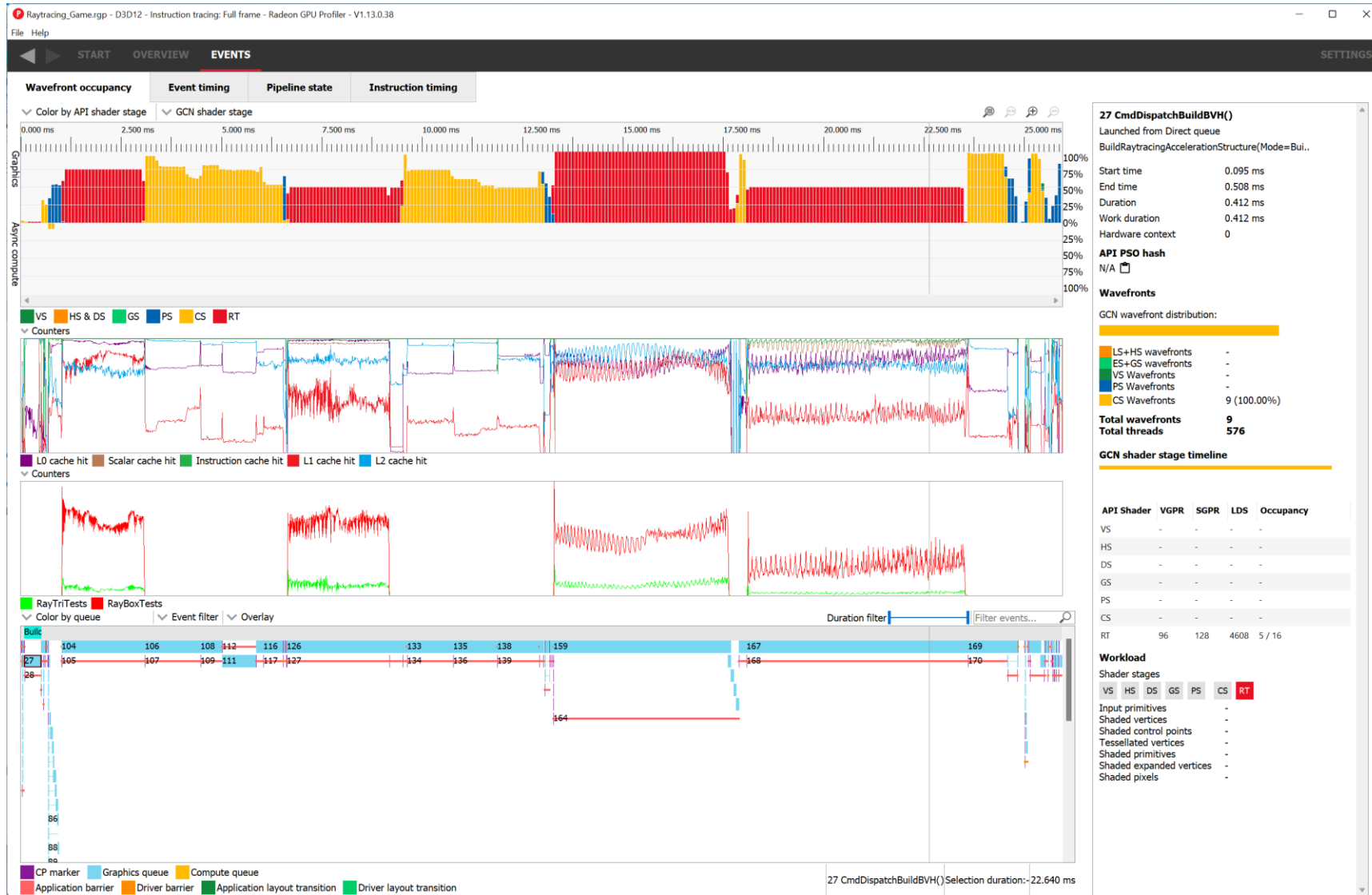


<https://gpuopen.com/learn/radeon-gpu-profiler-1-12-released/>



<https://gpuopen.com/videos/amd-rdna2-rgp-1-10/>

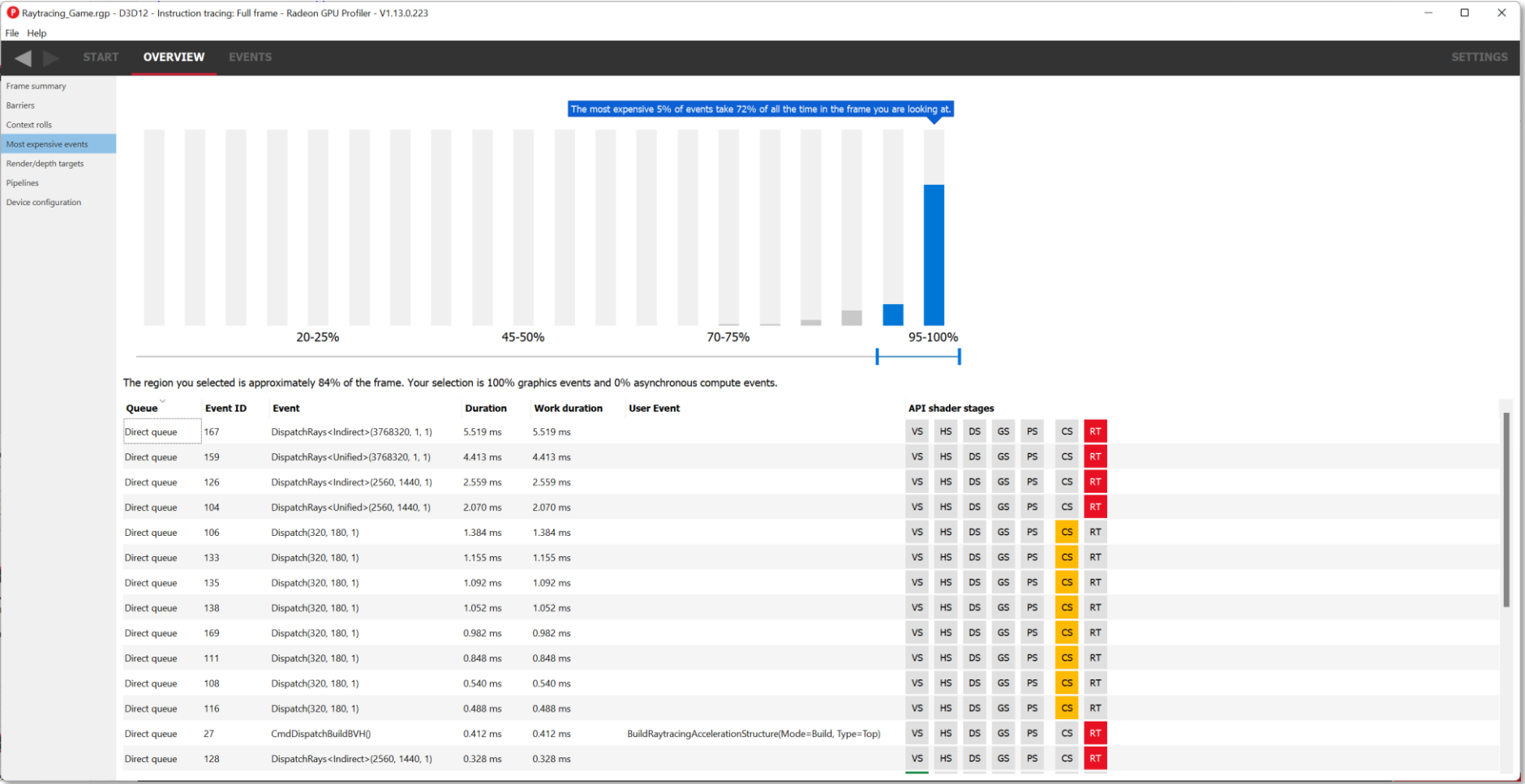
RADEON GPU PROFILER VIEWS



- Overview
 - Frame summary
 - Barriers
 - Context rolls
 - Most expensive events
 - Render/depth targets
 - Pipelines
 - Device configuration
- Events
 - Wavefront occupancy
 - Event timing
 - Pipeline state
 - Instruction timing

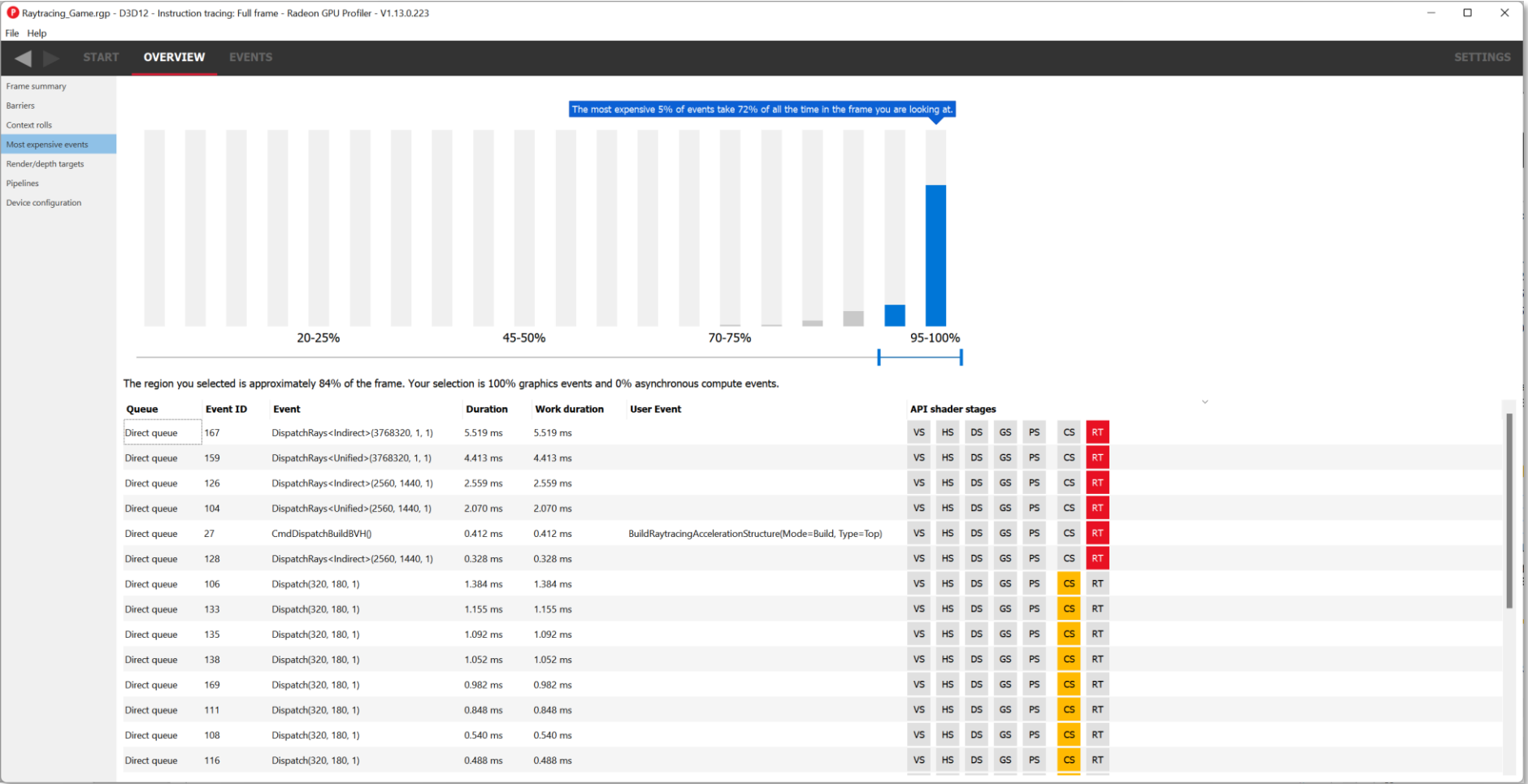
WHICH RAY TRACING EVENTS ARE THE MOST EXPENSIVE?

Overview -> Most expensive events



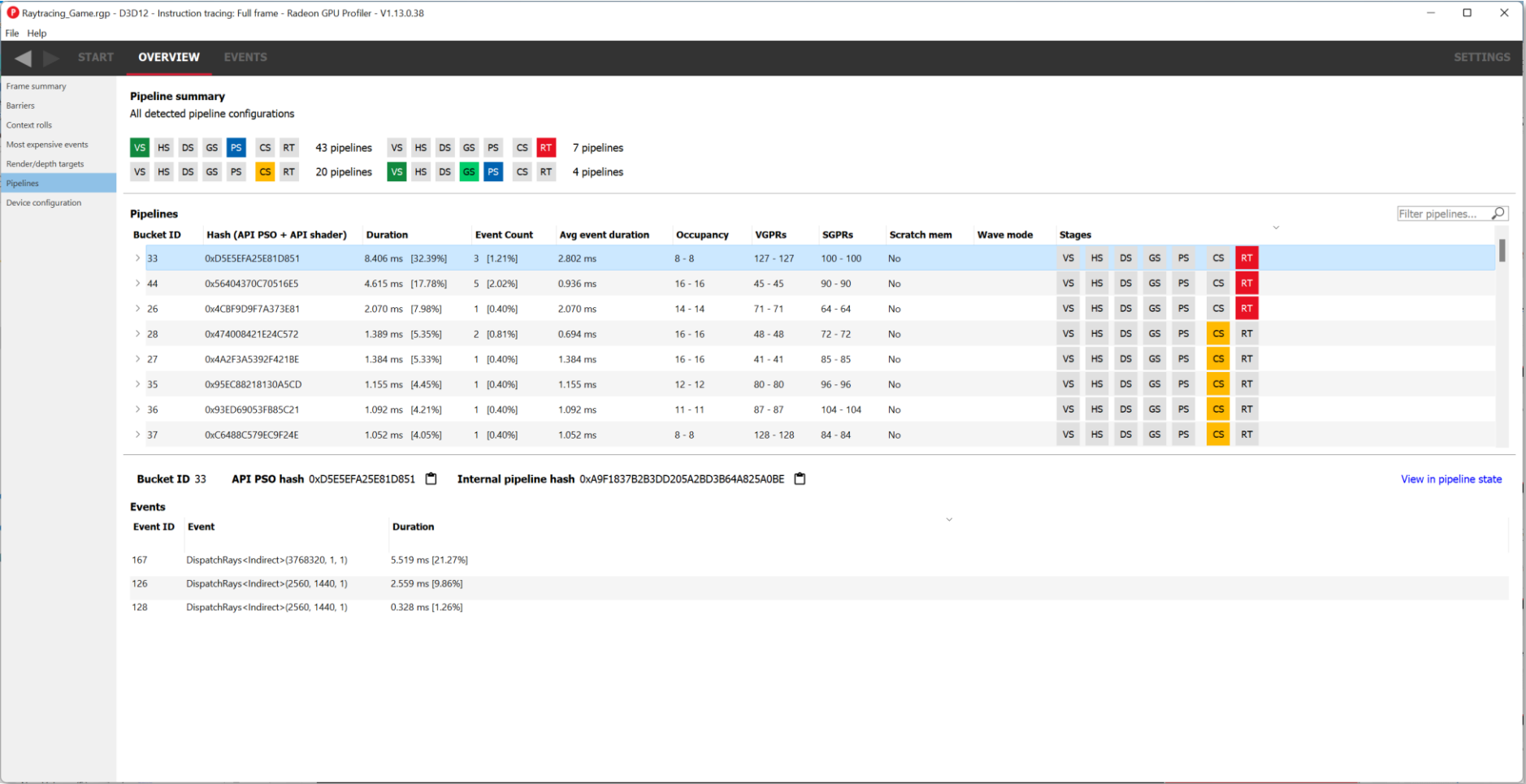
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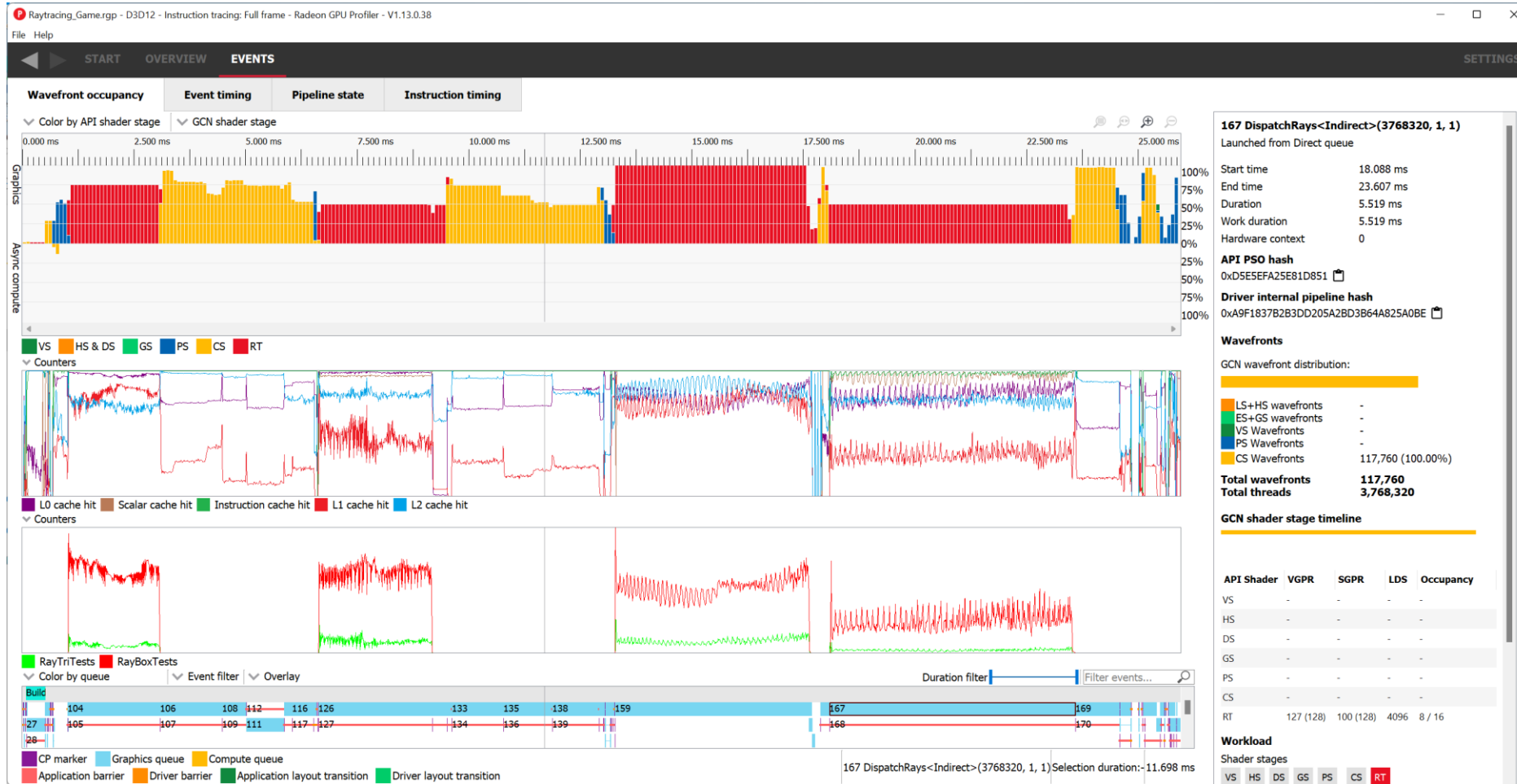
WHICH RAY TRACING PIPELINE IS THE MOST EXPENSIVE?

Overview -> Pipelines



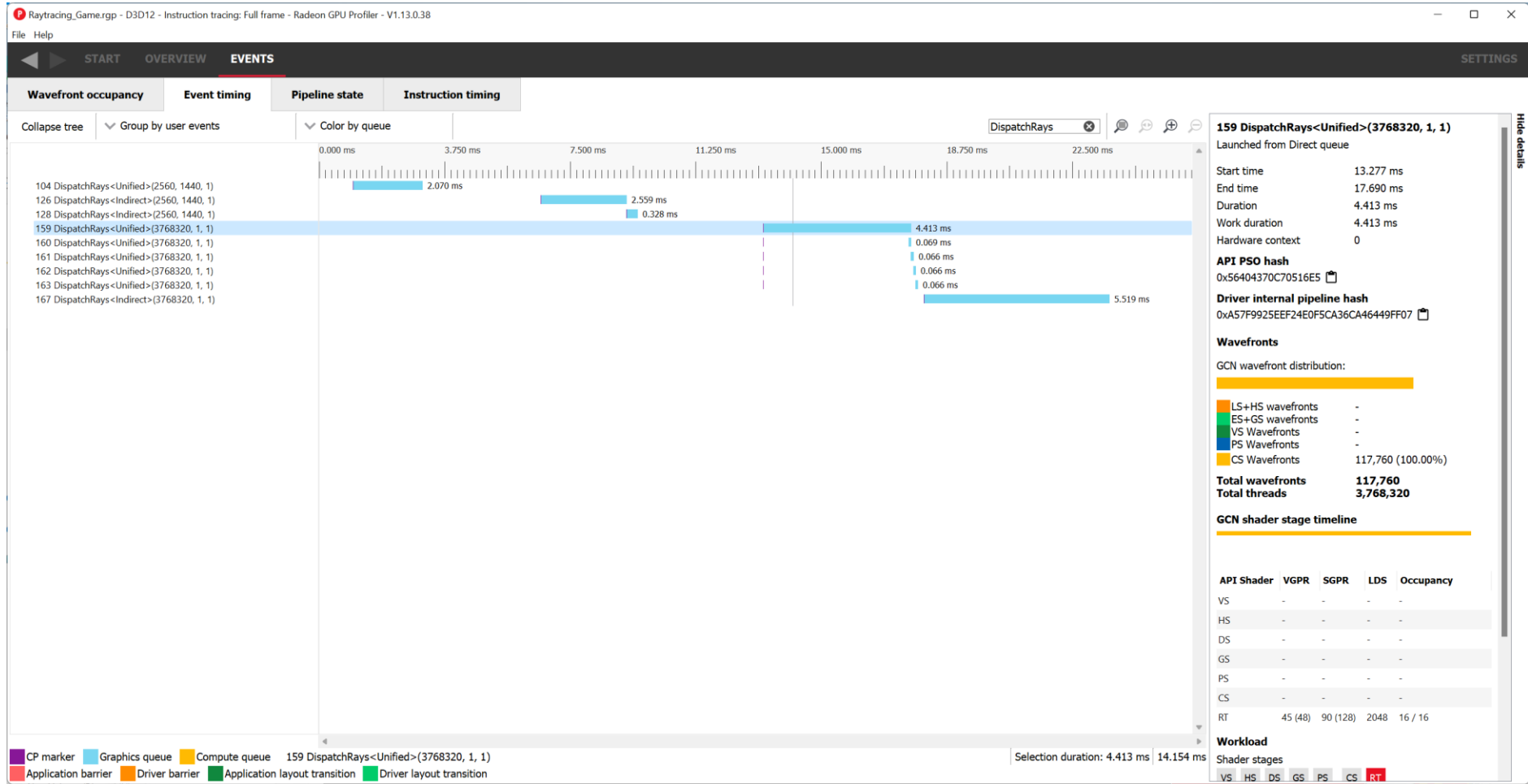
WHICH PARTS OF MY FRAME ARE USING RAYTRACING?

- Events -> Wavefront occupancy



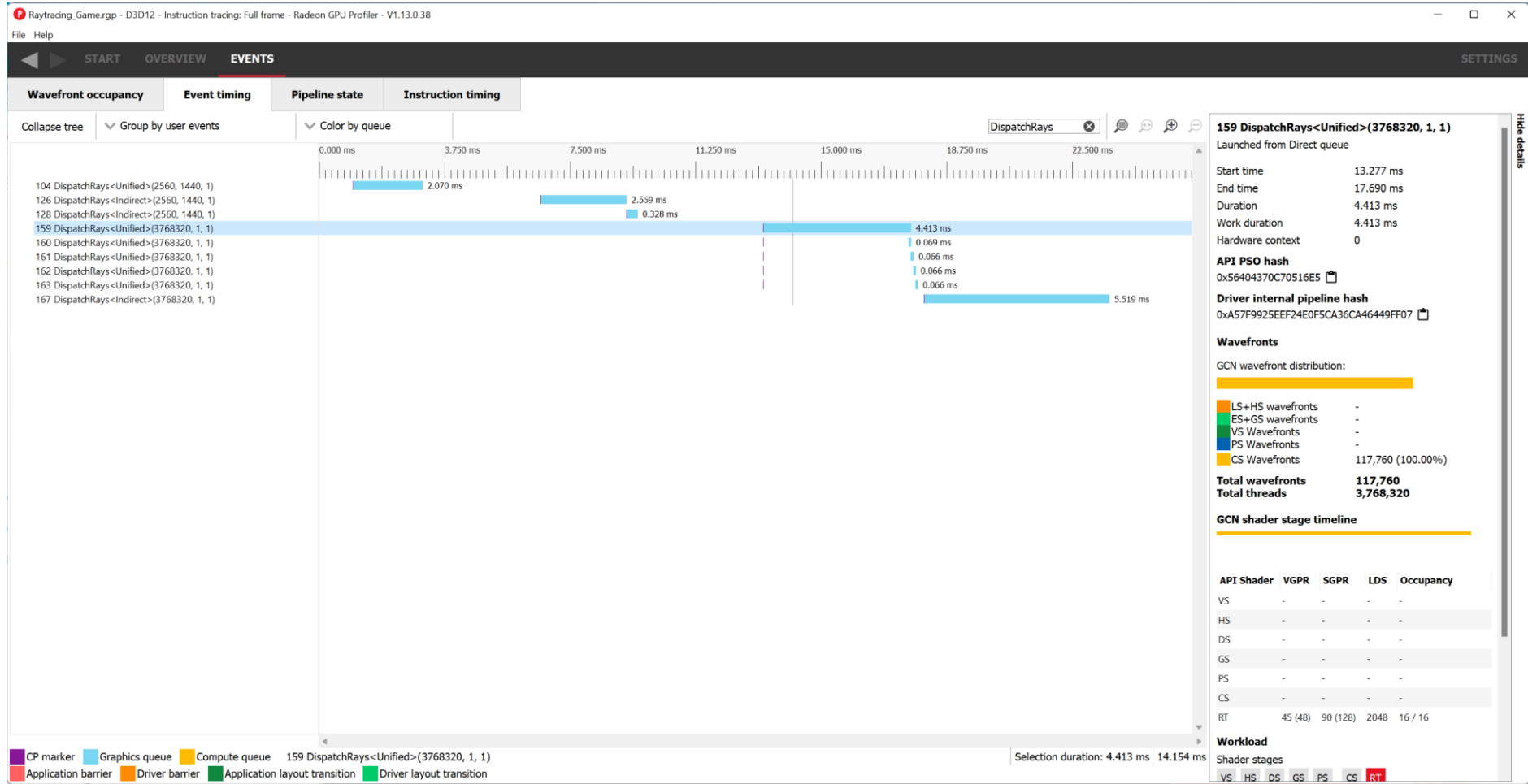
DOES MY USE OF RAYTRACING FIT MY BUDGET?

Events -> Event timing



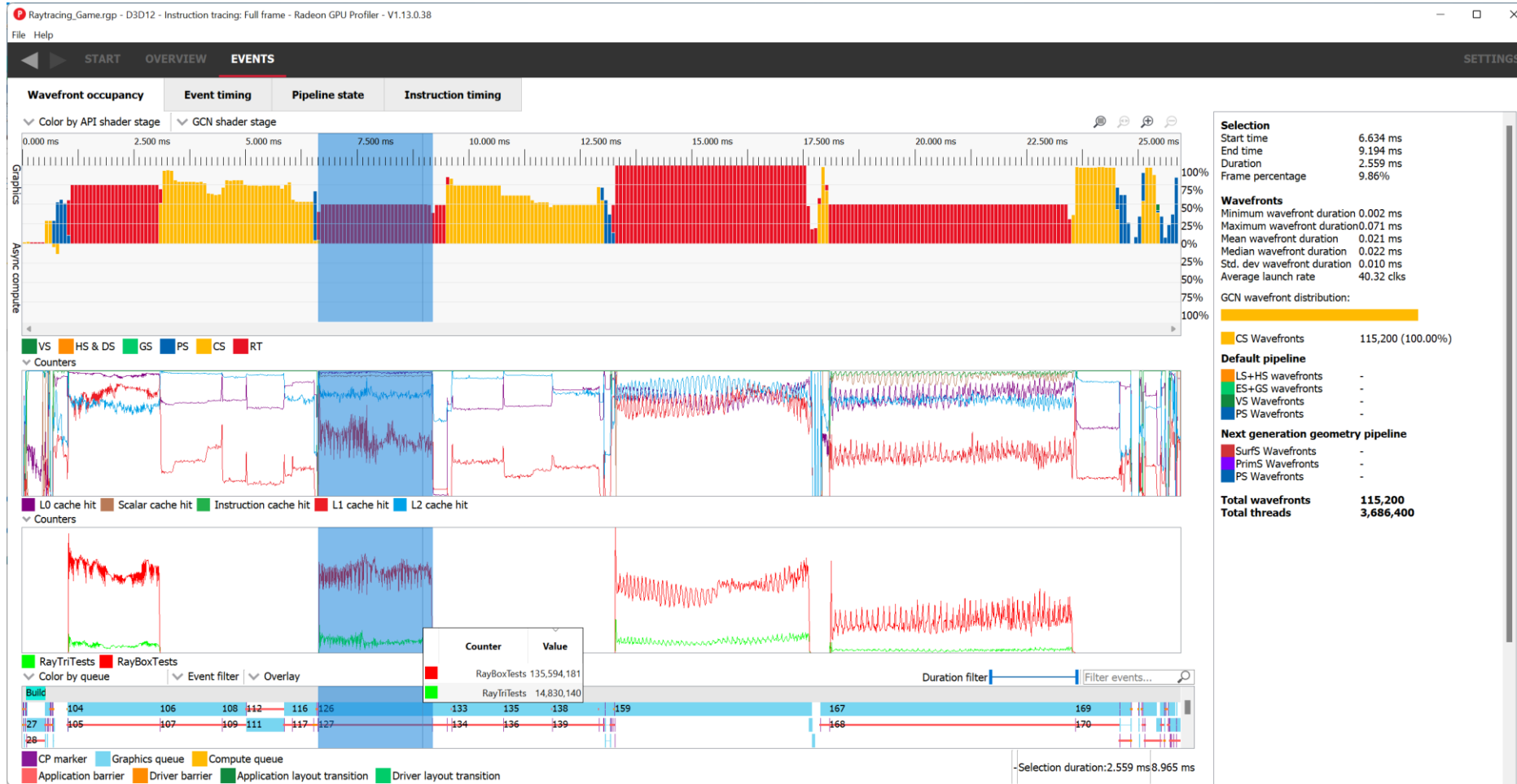
DOES MY USE OF RAYTRACING FIT MY BUDGET?

Events -> Event timing

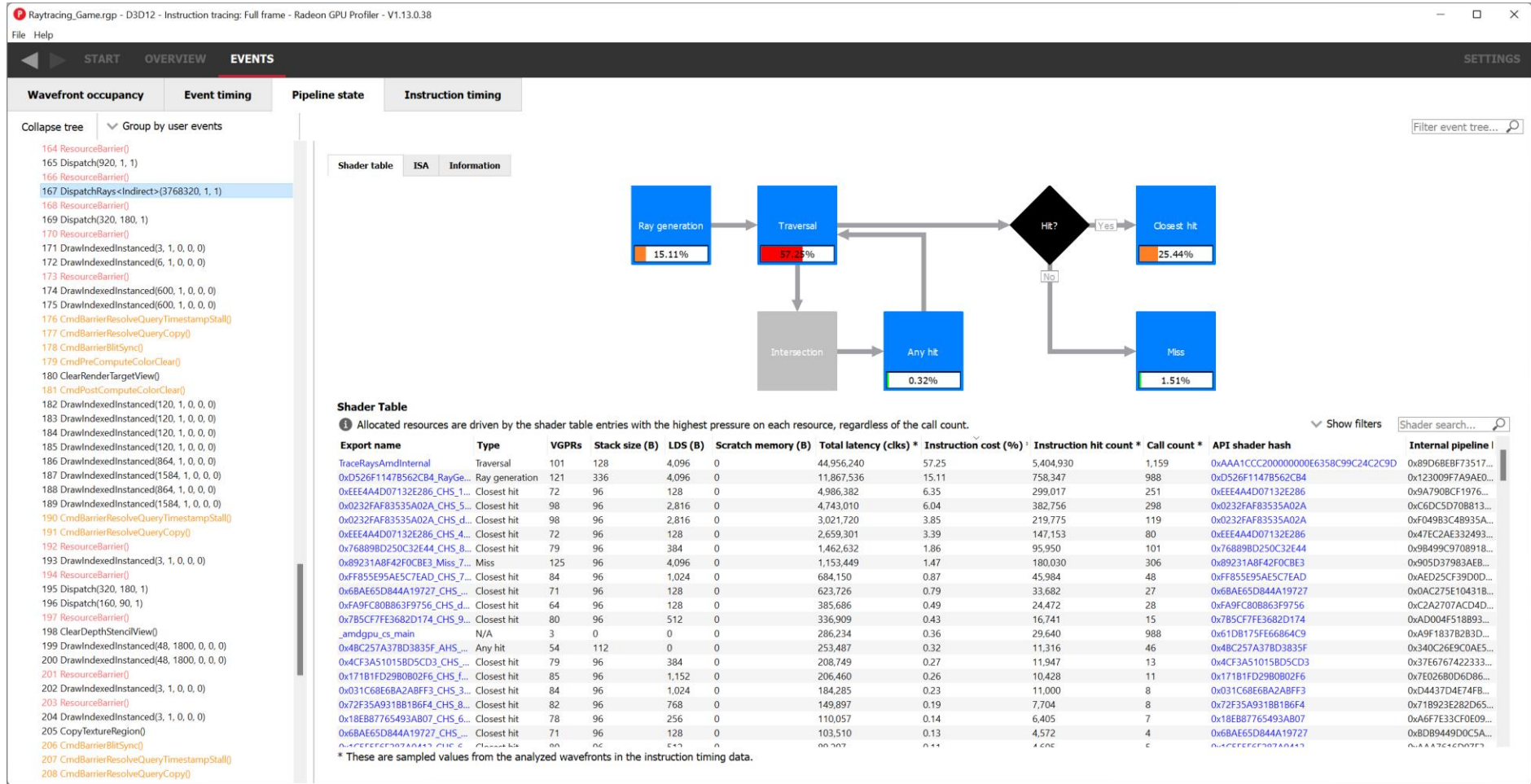


WHICH PARTS OF MY FRAME ARE PERFORMING THE MOST RAY TESTS?

Events -> Wavefront occupancy



EVENTS -> PIPELINE STATE



COMPILATION MODES FOR RAYTRACING EVENTS

DispatchRays<Unified> and DispatchRays<Indirect>

- Both correspond to the DispatchRays API call
- The specific type used depends on the compilation mode chosen by the driver and compiler

DispatchRays<Unified>

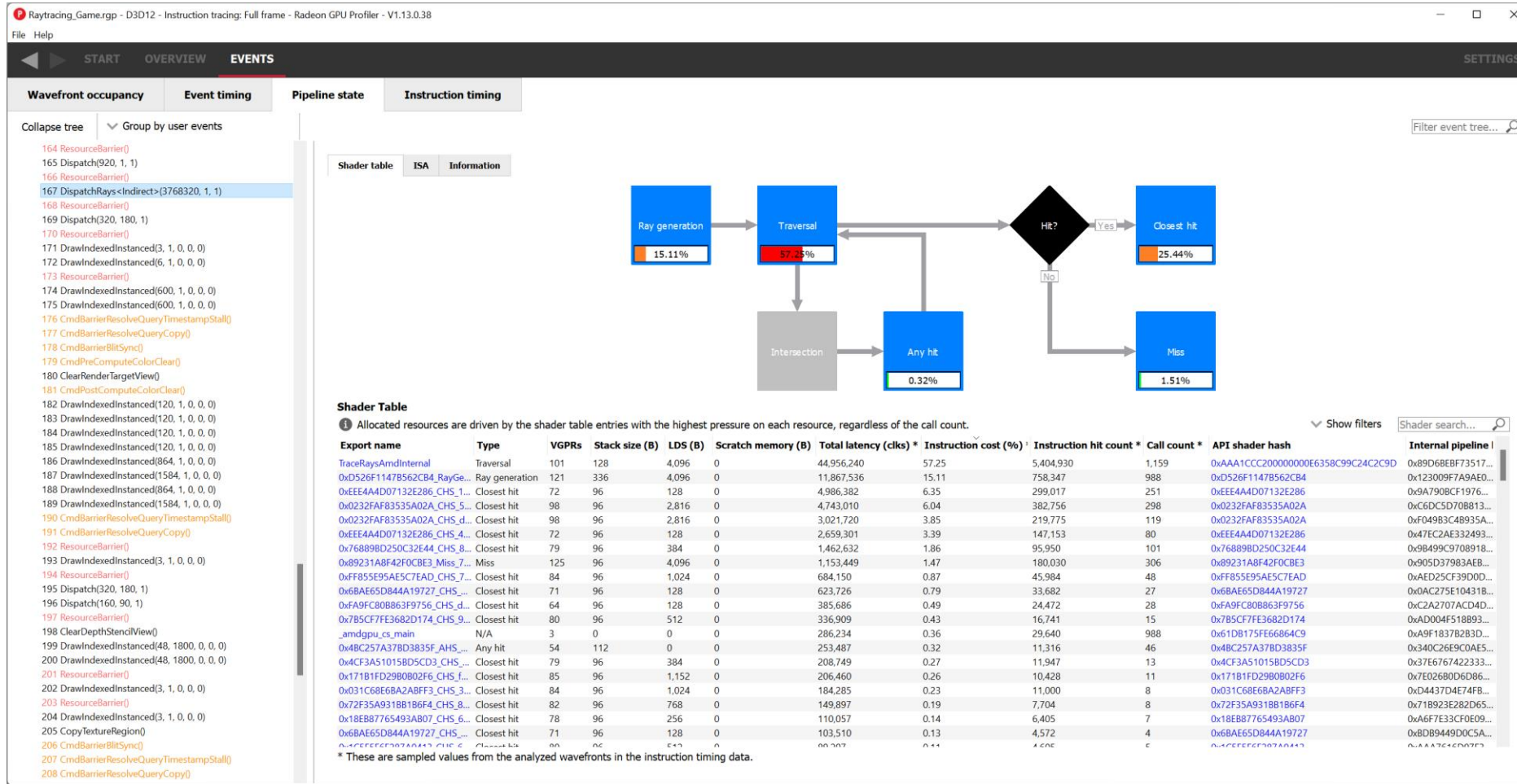
- The individual shaders are inlined into a single shader, resulting in a single stream of ISA instructions

DispatchRays<Indirect>

- The individual shaders are compiled separately, and the functions in each shader end up as their own stream of ISA instructions. In indirect mode, function call instructions are generated in the ISA to allow one function to call another.

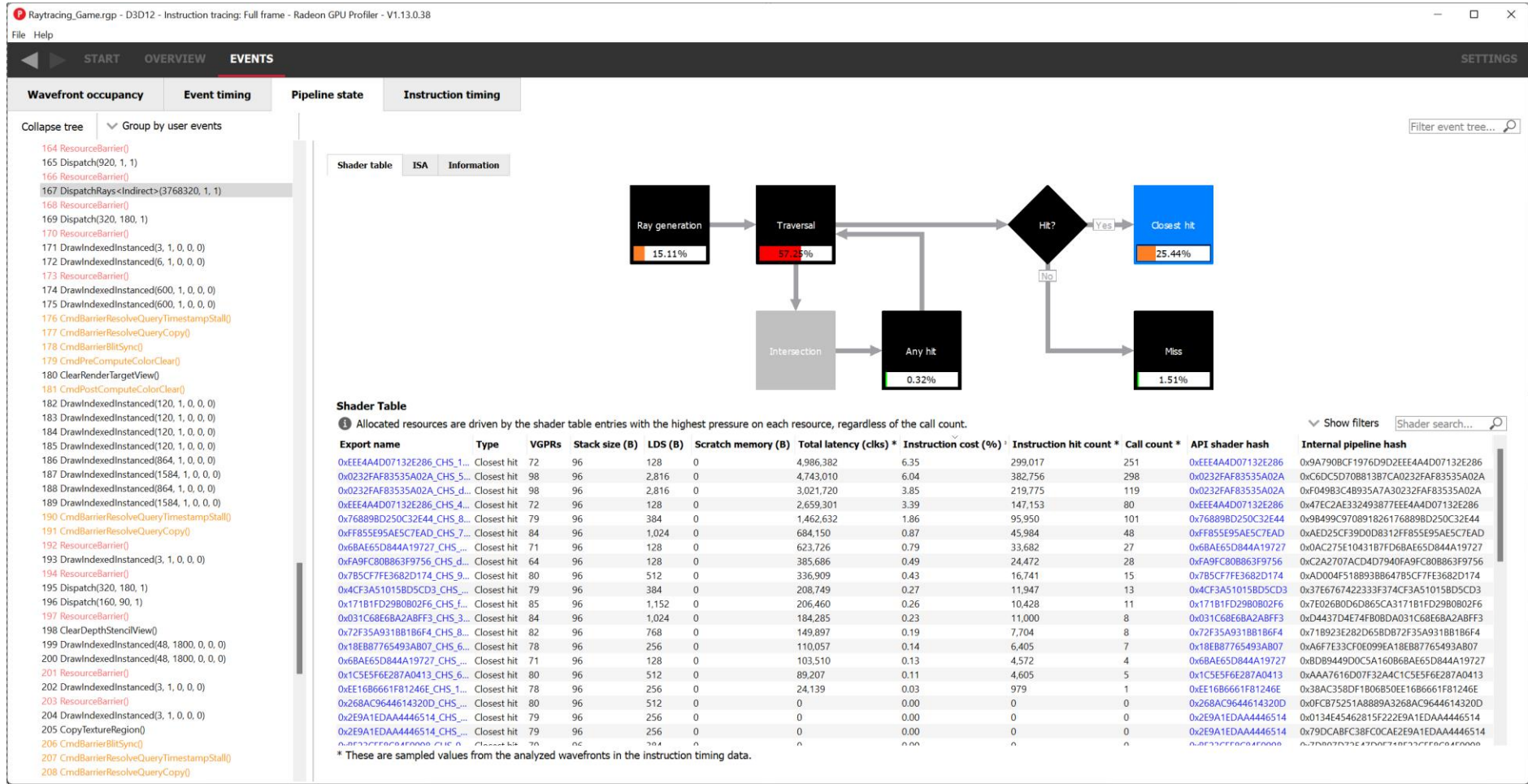
WHICH STAGE OF MY RAY TRACING PIPELINE IS THE MOST EXPENSIVE?

- Events -> Pipeline state



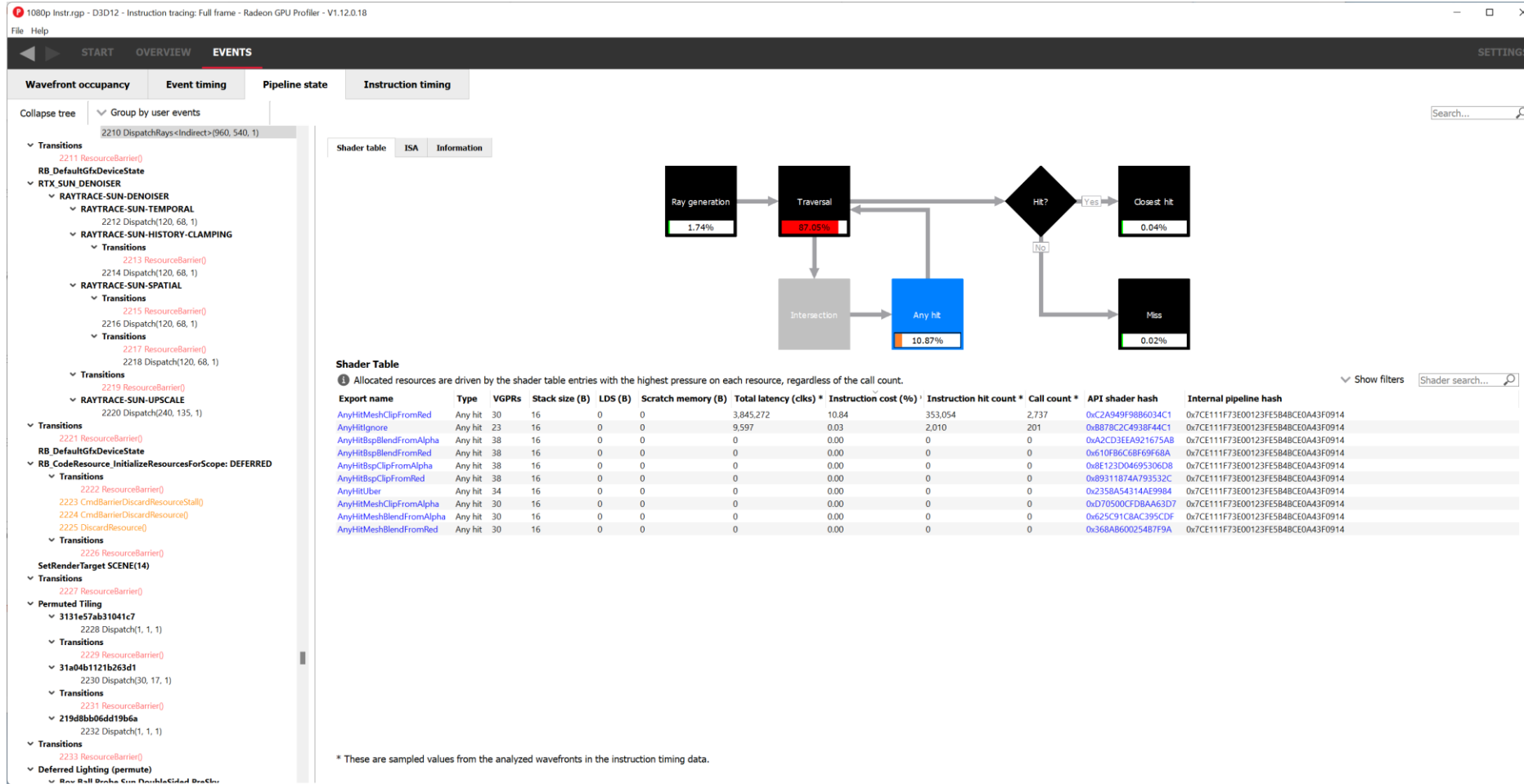
WHICH SHADERS IN MY PIPELINE ARE THE MOST EXPENSIVE?

- Events -> Pipeline state

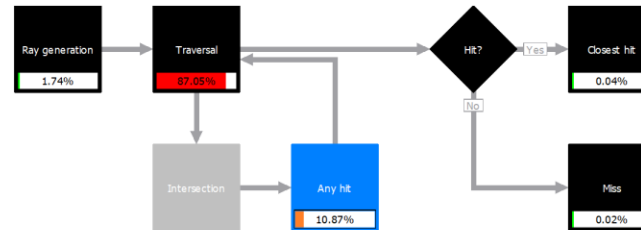


WHICH SHADERS IN MY PIPELINE ARE THE MOST EXPENSIVE?

Events -> Pipeline state



Shader table ISA Information



Shader Table

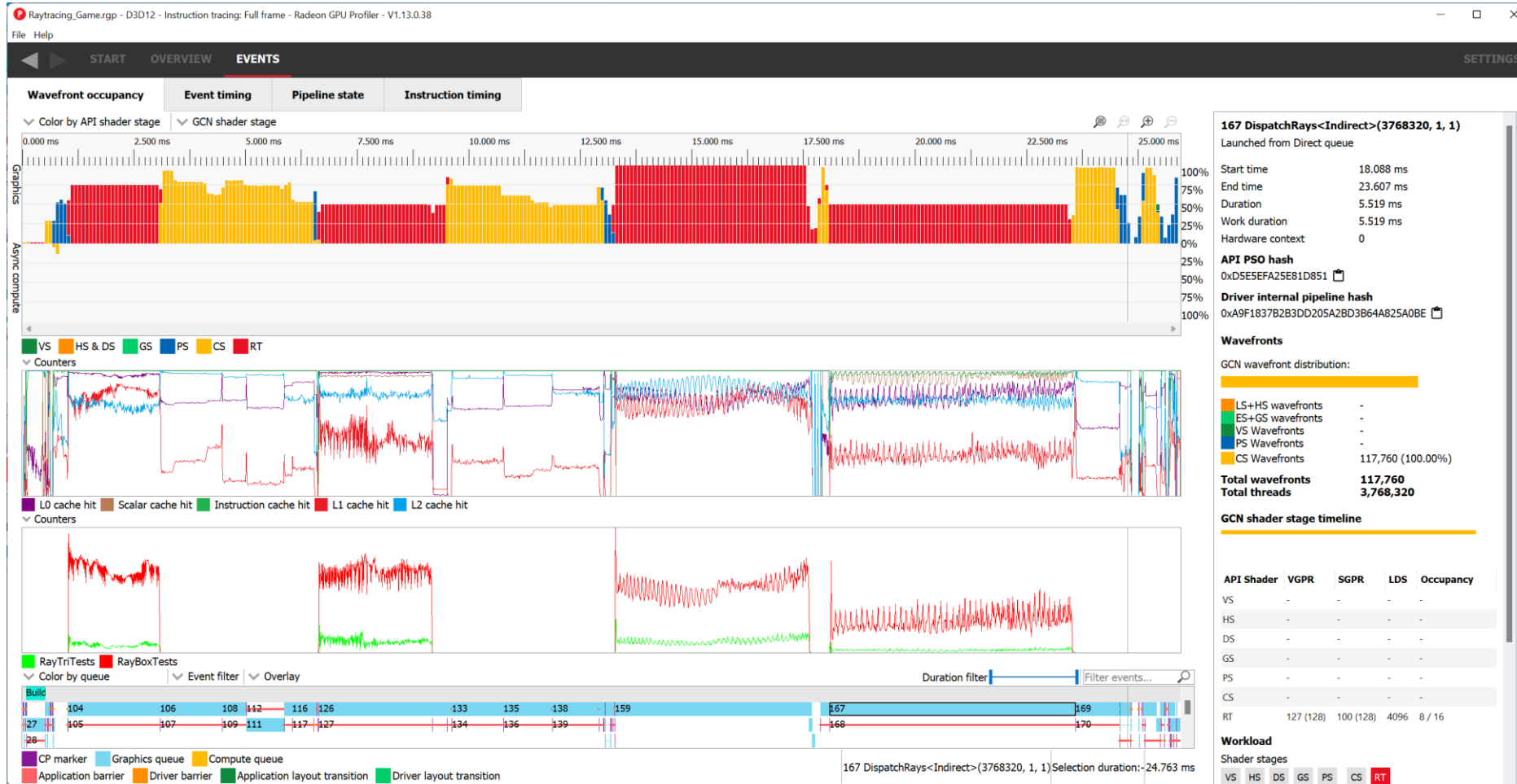
Allocated resources are driven by the shader table entries with the highest pressure on each resource, regardless of the call count.

Export name	Type	VGPRs	Stack size (B)	LDS (B)	Scratch memory (B)	Total latency (clks) *	Instruction cost (%) *	Instruction hit count *	Call count *	API shader hash	Internal pipeline hash
AnyHitMeshClipFromRed	Any hit	30	16	0	0	3,845,272	10.84	353,054	2,737	0xc2a949f9886034c1	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitIgnore	Any hit	23	16	0	0	9,597	0.03	2,010	201	0xb878c2c4938f44c1	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitBspBlendFromAlpha	Any hit	38	16	0	0	0	0.00	0	0	0xa2cd3ee921675a8	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitBspBlendFromRed	Any hit	38	16	0	0	0	0.00	0	0	0x610f86c68f69f68a	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitBspClipFromAlpha	Any hit	38	16	0	0	0	0.00	0	0	0x8e123d04695306d8	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitBspClipFromRed	Any hit	38	16	0	0	0	0.00	0	0	0x89311874a793532c	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitUber	Any hit	34	16	0	0	0	0.00	0	0	0x2358a54314ae9984	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitMeshClipFromAlpha	Any hit	30	16	0	0	0	0.00	0	0	0xd70500cfdbaa63d7	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitMeshBlendFromAlpha	Any hit	30	16	0	0	0	0.00	0	0	0x625c91c8ac395cdf	0x7ce11f73e00123fe5b4bce0a43f0914
AnyHitMeshBlendFromRed	Any hit	30	16	0	0	0	0.00	0	0	0x368a860025487f9a	0x7ce11f73e00123fe5b4bce0a43f0914

* These are sampled values from the analyzed wavefronts in the instruction timing data.

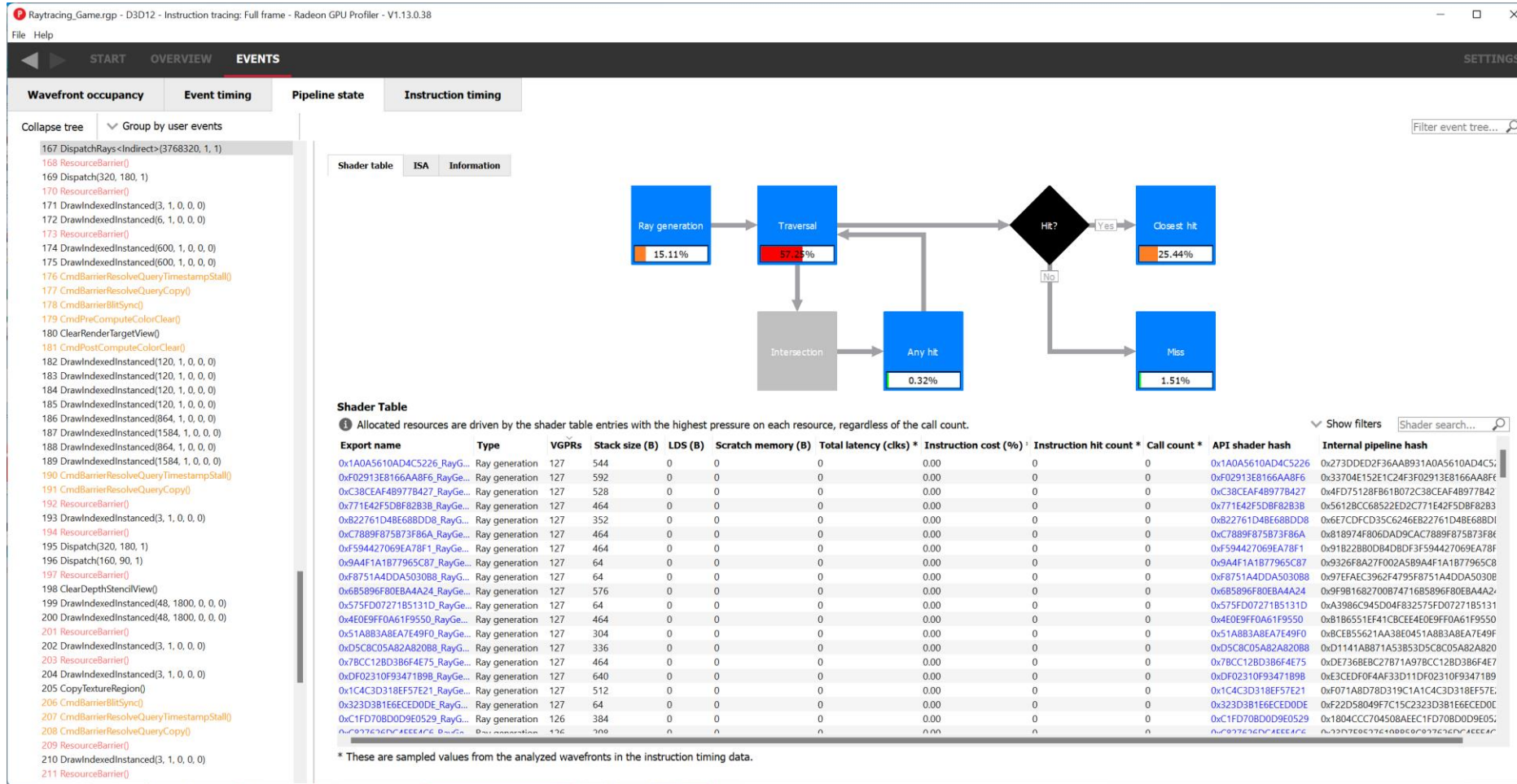
WHICH SHADERS IN MY PIPELINE ARE LIMITING MY OCCUPANCY?

- Events -> Pipeline state



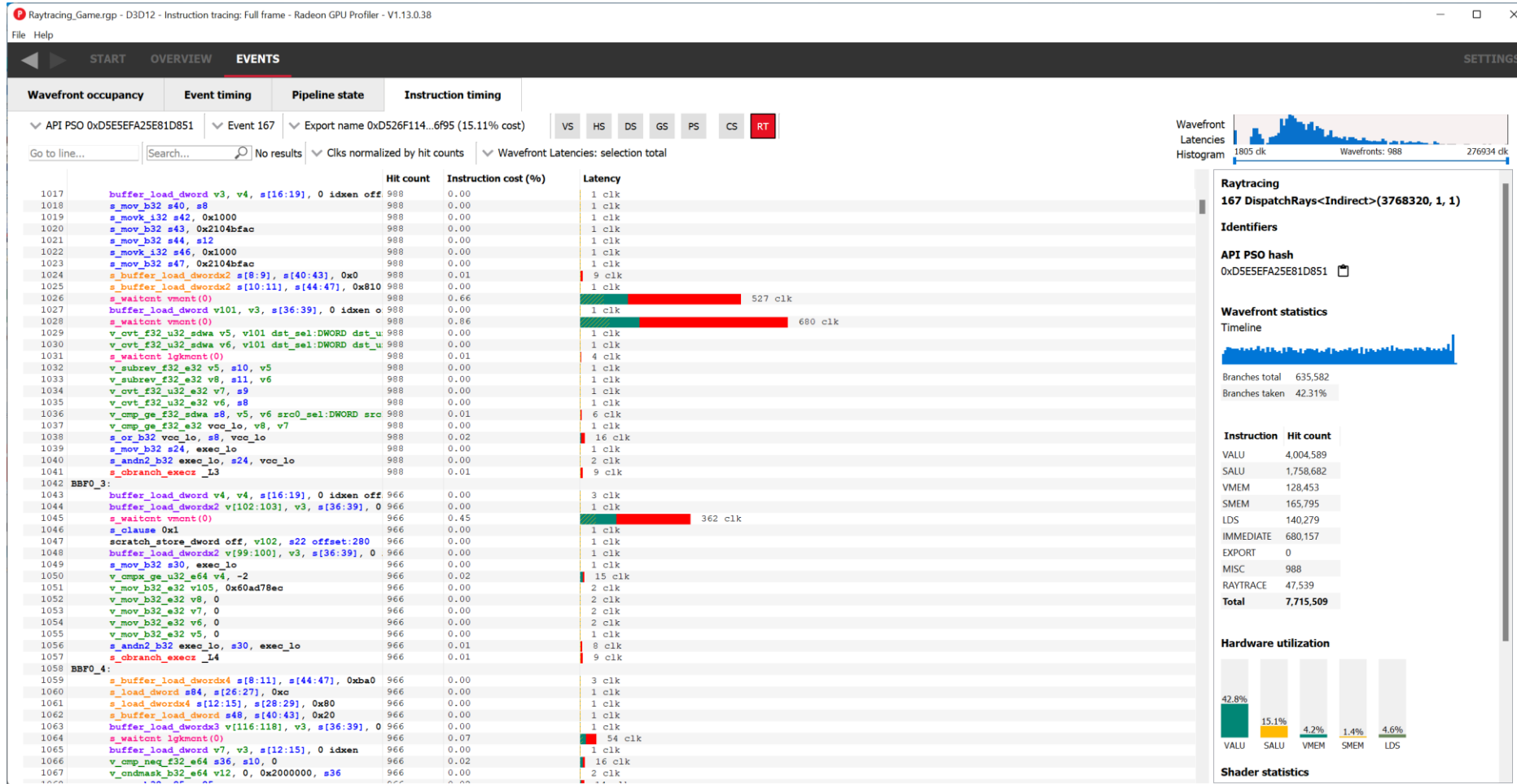
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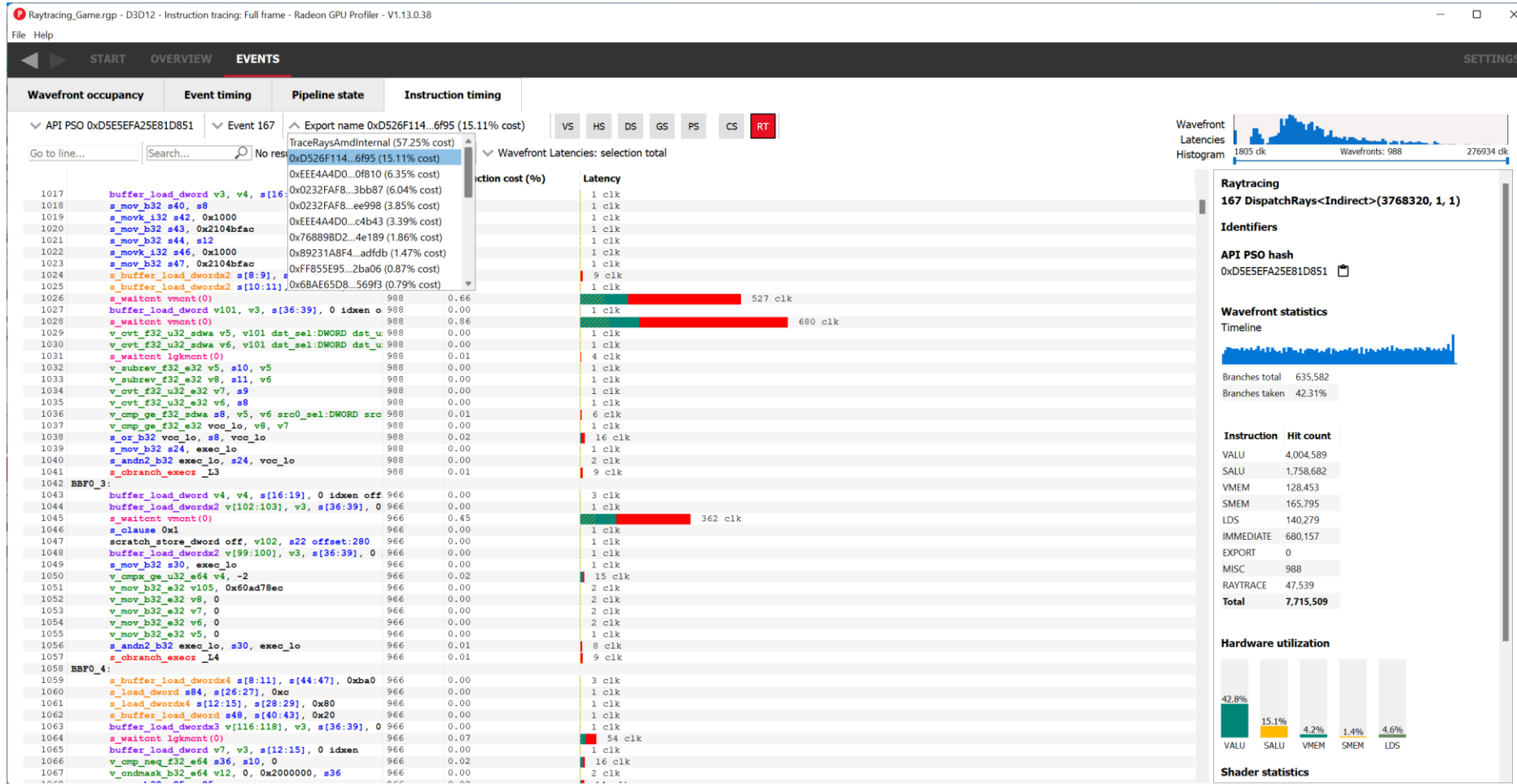
HOW CAN I FIND BOTTLENECKS WITHIN MY RAY TRACING PIPELINE?

- Events -> Instruction timing



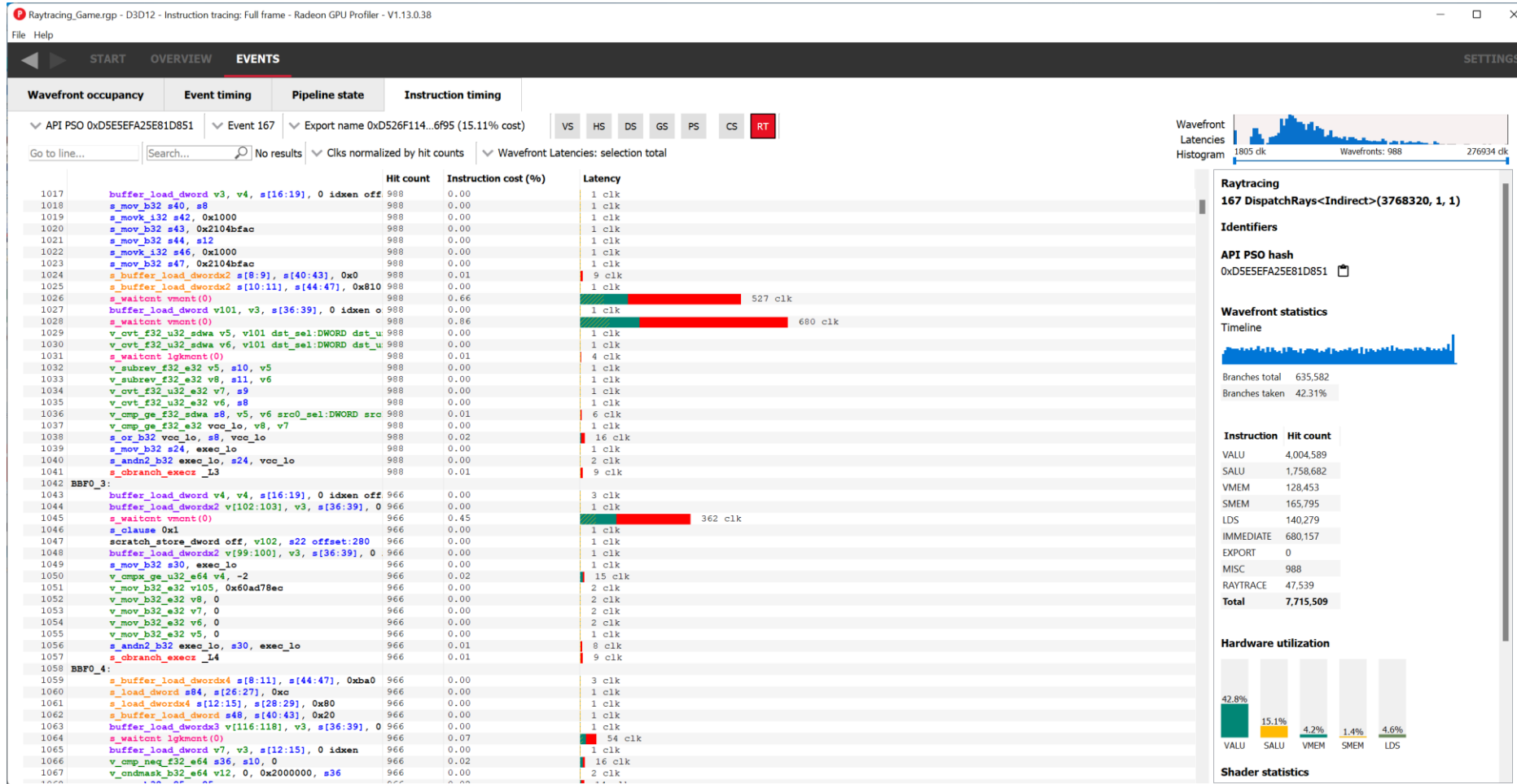
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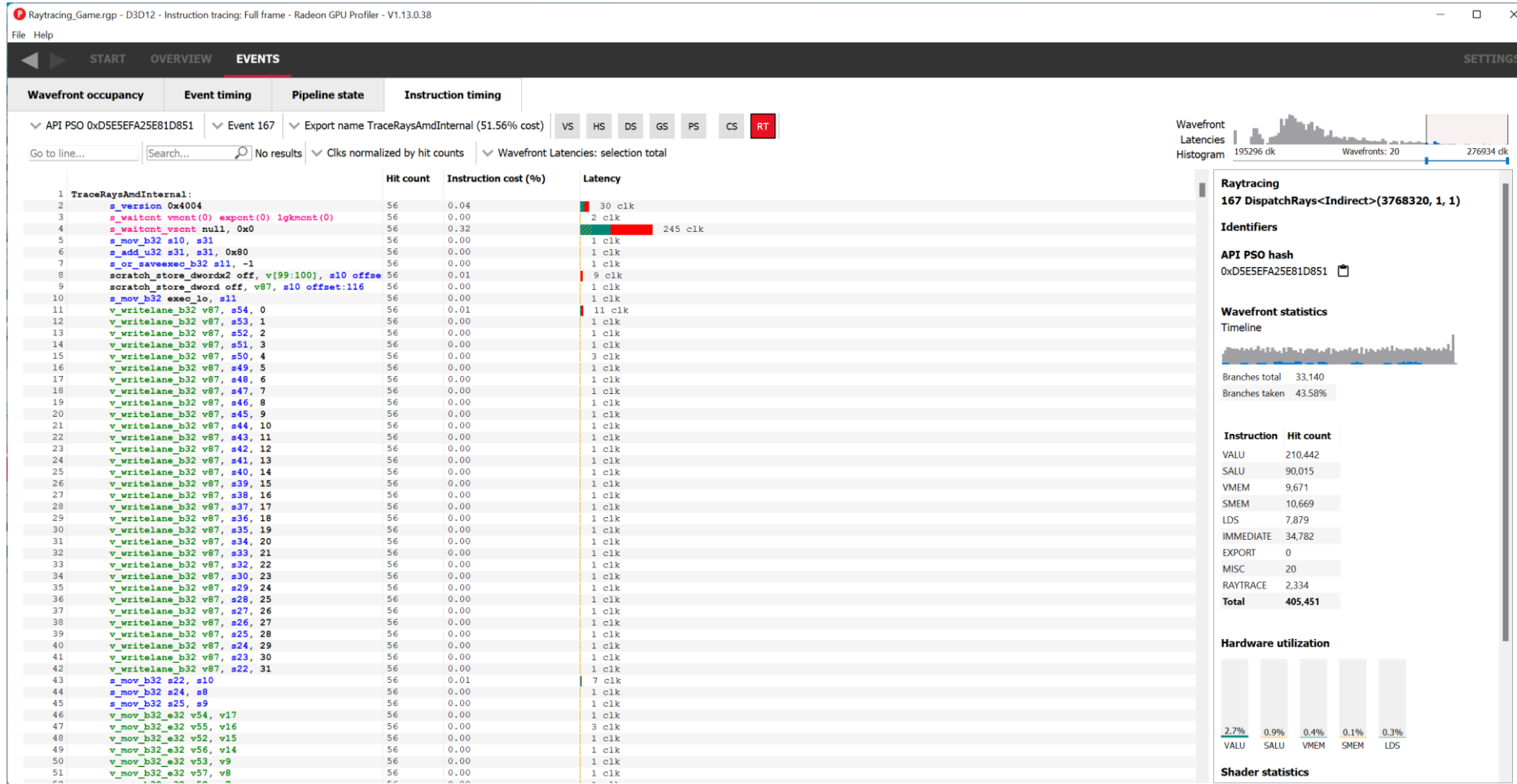
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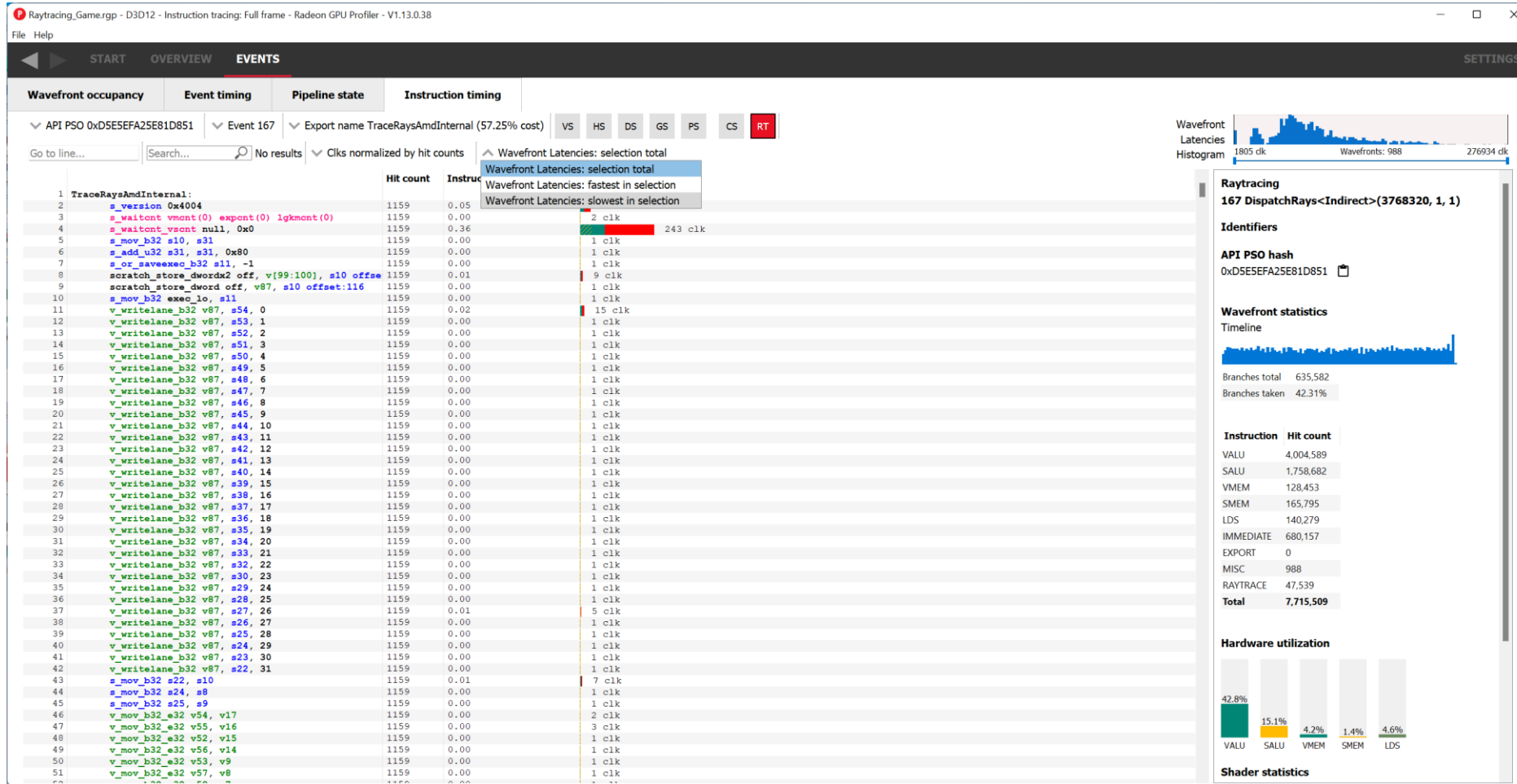
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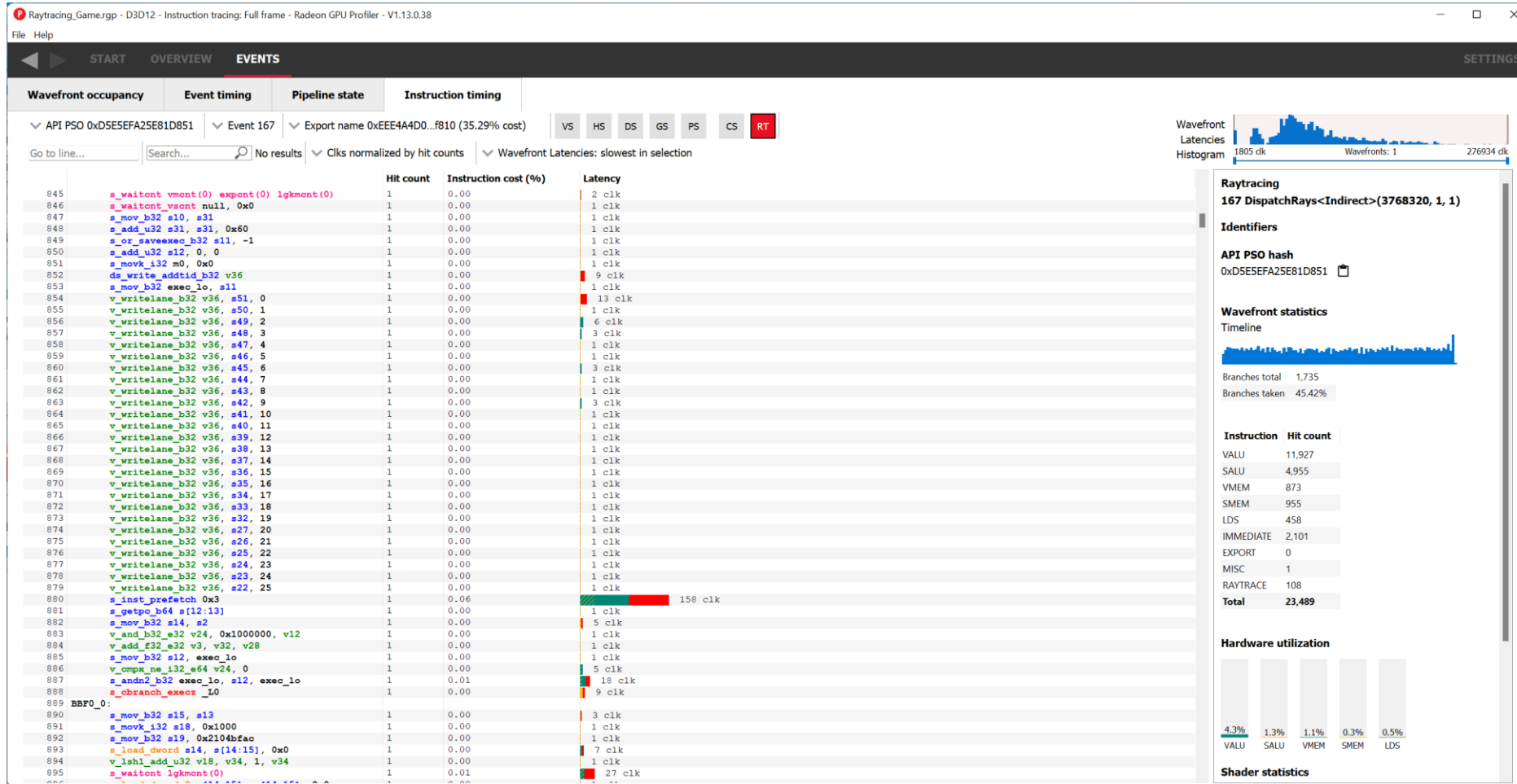
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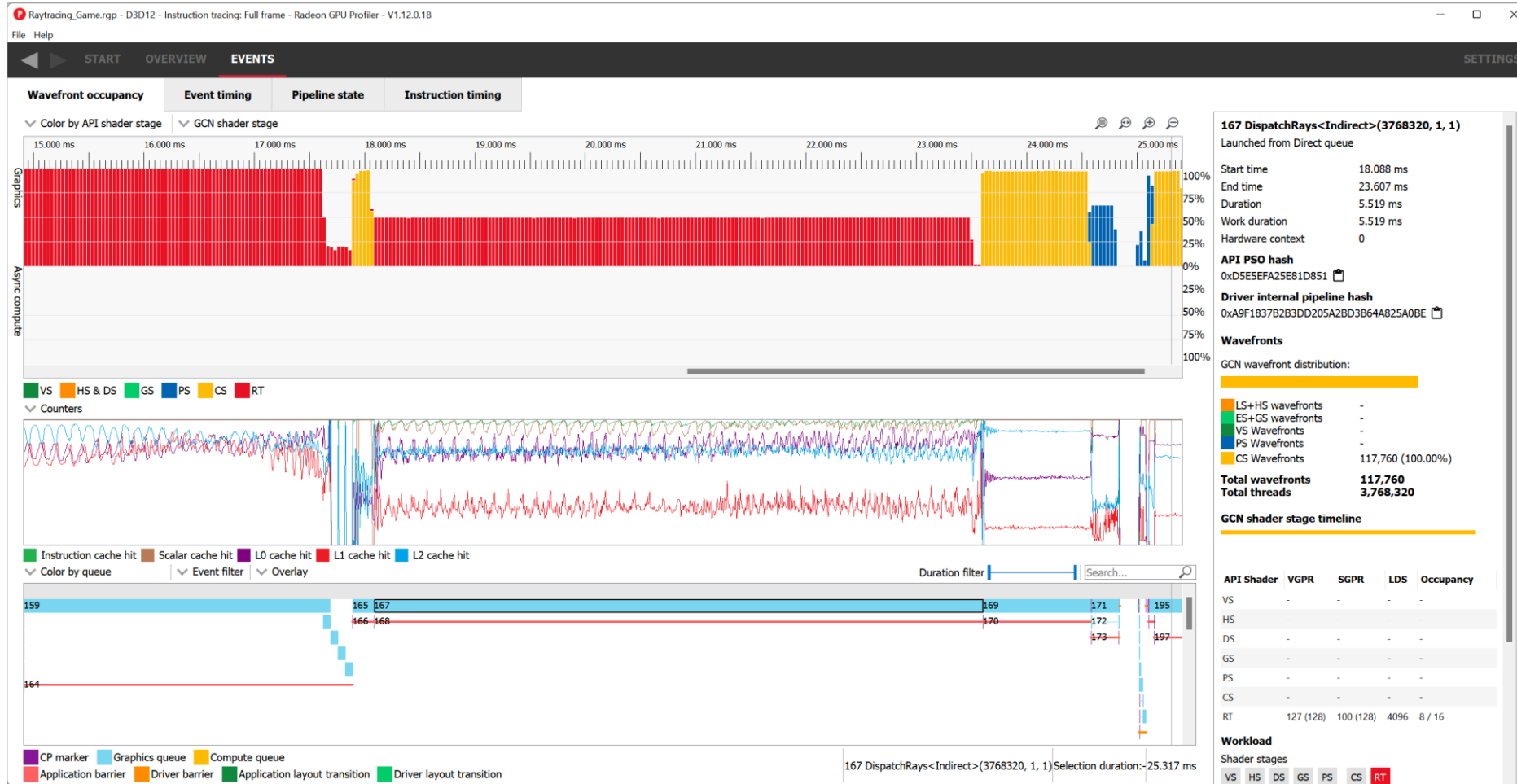


- Events -> Instruction timing



HOW CAN I ANALYZE MY ACCELERATION STRUCTURES?

- Stay tuned!



RAYTRACING PERFORMANCE REVEALED

Part 1: Radeon™ GPU Profiler

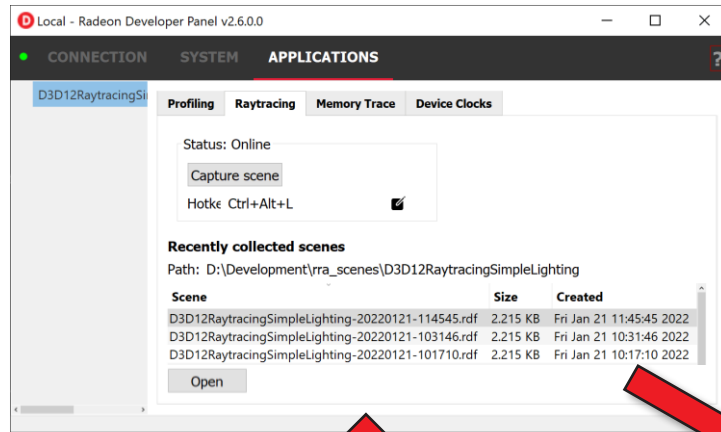
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CAPTURING AN RRA TRACE

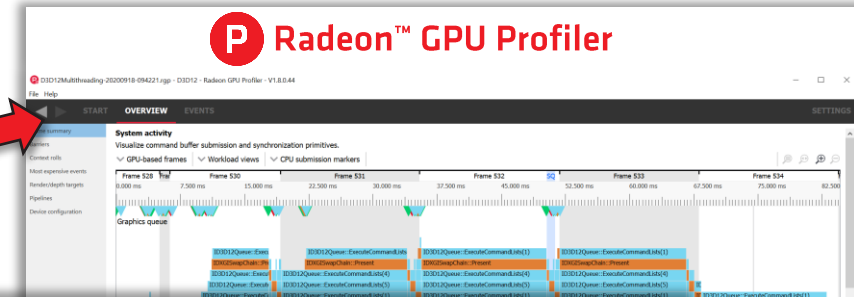
D Radeon™ Developer Panel



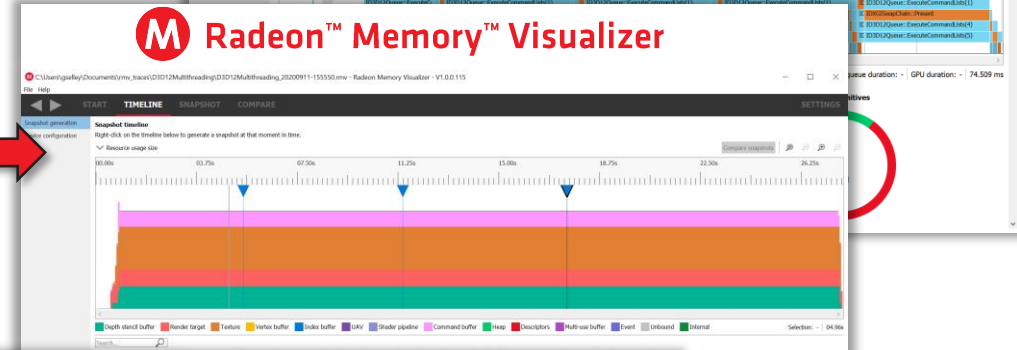
Game Application
Radeon™ Developer Driver with
AMD GPU



P Radeon™ GPU Profiler



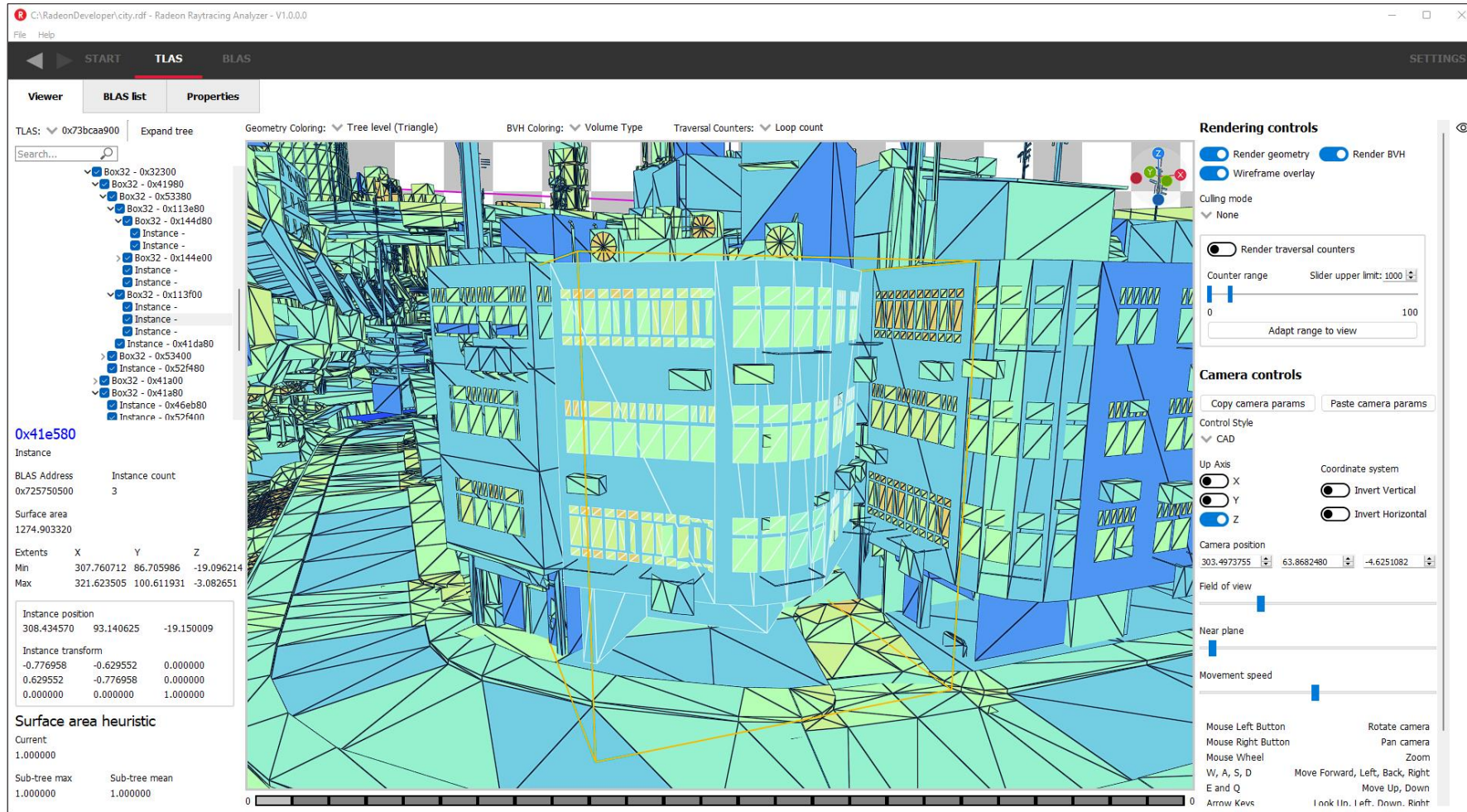
M Radeon™ Memory Visualizer



R Radeon™ Raytracing Analyzer



TLAS VIEWER



- Tree view
- Selected node information
- Coloring modes
- 3D Viewer
- Depth slider
- Rendering controls
- Camera controls
- BLAS List

TLAS VIEWER – BLAS LIST

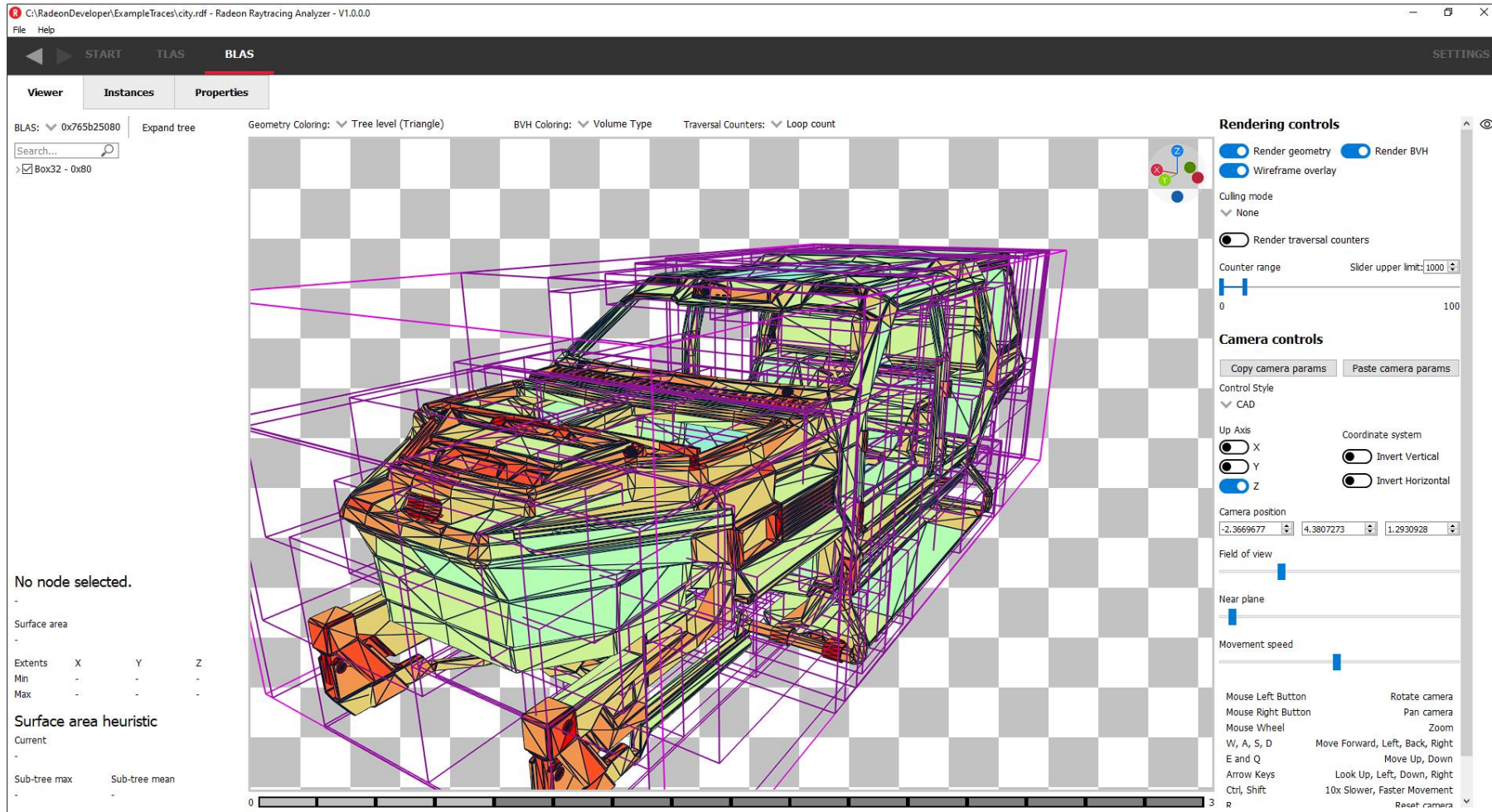
<div> <div>◀ ▶</div> <div>START</div> <div>TLAS</div> <div>BLAS</div> </div>													
Viewer	BLAS list	Properties											
Address		Instances	Nodes	Boxes	32-bit boxes	16-bit boxes	Triangles	Procedural	Root SAH	Max SAH	Mean SAH	Max. depth	Avg. depth
0x7a3bb0680		9	383	125	5	120	258	0	0.154801	0.488665	0.2086	9	6
0x7a3ba0980		1	373	121	121	0	252	0	0.339605	0.339605	0.212616	7	5
0x7a3b90080		6	8	3	1	2	5	0	0.500508	0.500508	0.234312	3	2
0x7a3b80b80		2	709	234	2	232	475	0	0.208825	0.571018	0.10635	9	6
0x7a3b71f80		1	1958	656	47	609	1302	0	0.305406	0.437703	nan	13	7
0x7a3b60280		11	132	44	1	43	88	0	0.334856	0.344761	0.178317	7	4
0x7a3b50e00		1	703	228	156	72	475	0	0.159387	0.352959	nan	11	7
0x7a3af0180		1	61	19	1	18	42	0	0.340952	0.340952	0.110343	5	4
0x7a3ae0a80		1	646	216	1	215	430	0	0.249574	0.502212	0.183095	10	7
0x7a3ad0080		60	17	5	1	4	12	0	0.281988	0.281988	0.176087	3	3
0x7a3ac0180		9	69	23	1	22	46	0	0.208575	0.351926	0.174931	5	4
0x7a3aa0080		20	4	1	1	0	3	0	0.0510343	0.25	0.200259	2	2
0x7a39d3500		1	2154	712	712	0	1442	0	0.269016	0.657119	0.112943	10	7
0x7a3980080		42	15	5	1	4	10	0	0.412484	0.412484	0.213369	3	3
0x7a3970500		1	273	90	7	83	183	0	0.0869047	0.290894	0.134451	8	5
0x7a3960900		2	564	187	1	186	377	0	0.554561	0.624031	0.132885	8	6
0x7a3950300		3	168	55	7	48	113	0	0.308089	0.439611	0.144288	7	5
0x7a3940080		33	16	5	1	4	11	0	0.438082	0.438082	0.211506	3	3

Statistical view of BLAS's

Example use:

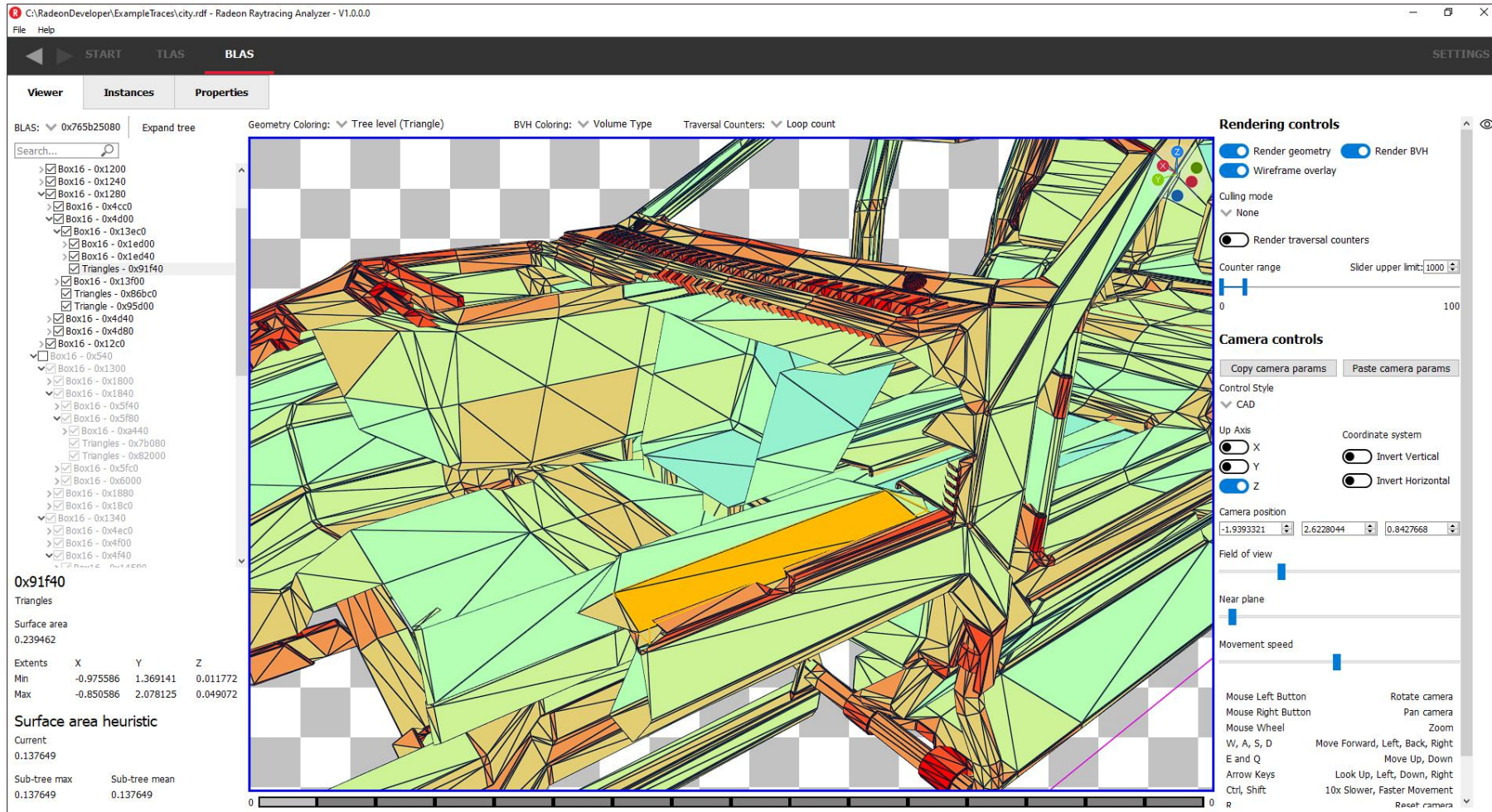
- Sort by max SAH
- Open the BLAS by double clicking

BLAS VIEWER



- **Camera & Navigation**
- The default control style is CAD. Control styles can be changed from the dropdown
- To find out more on how to use the camera scroll down
- **Bounding Volumes**
- Click and drag across range of levels to view bounding volumes.
- You can disable geometry rendering to get a better look

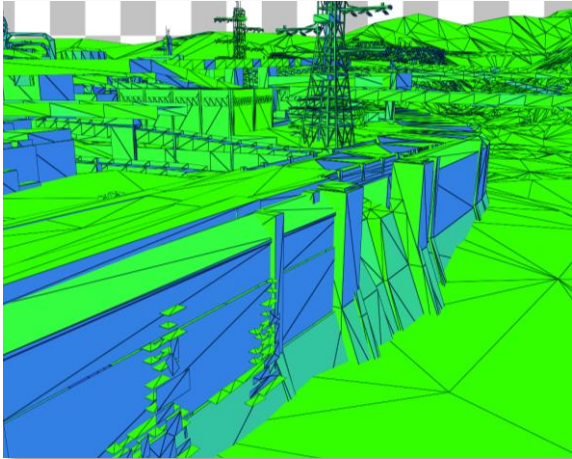
BLAS VIEWER



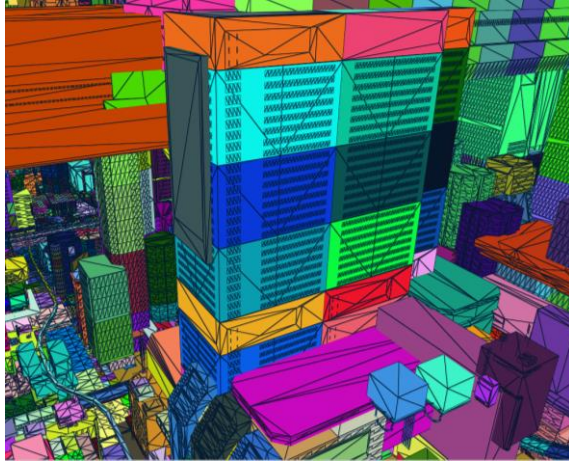
- Interaction
- Click on a triangle
- Press F to focus on selection
- Toggle volumes by using tree view
- Select parent volumes and focus
- Right click to open context menu
- Instances

GEOMETRY COLORING

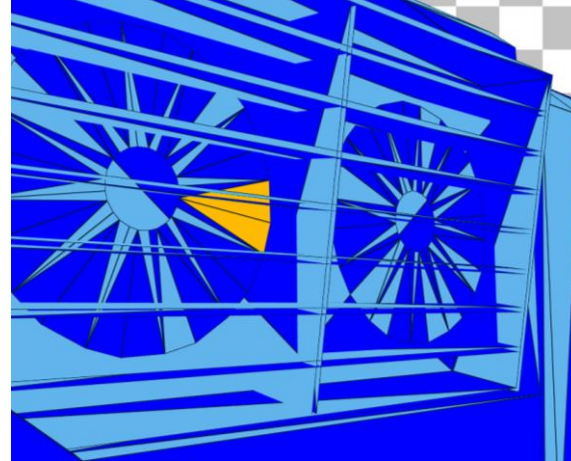
Technical



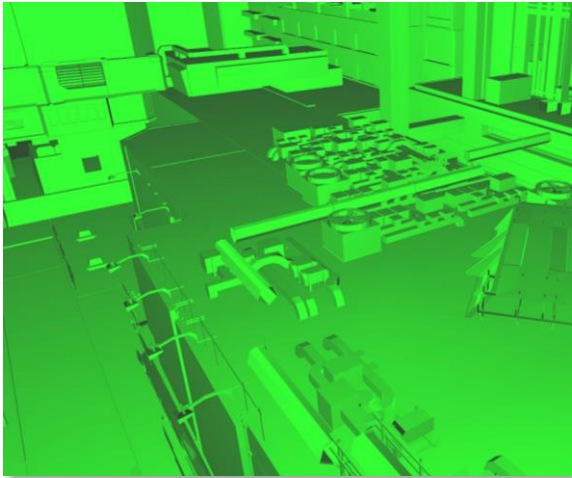
Instance index



Triangle indexes



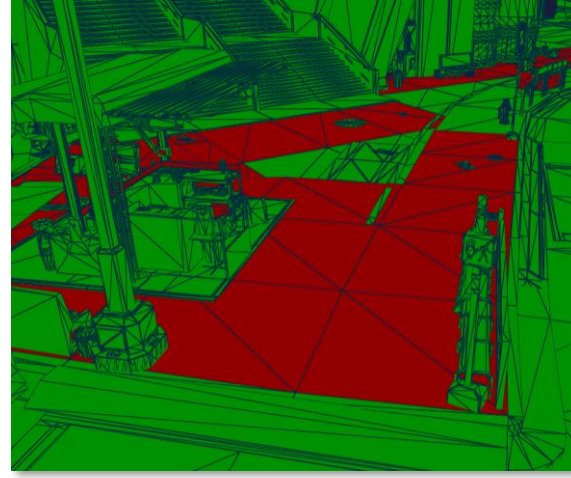
Lit



Unique BLAS's



Opaque?

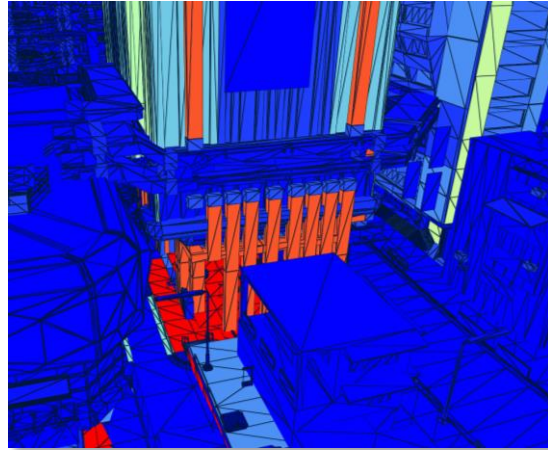


GEOMETRY COLORING

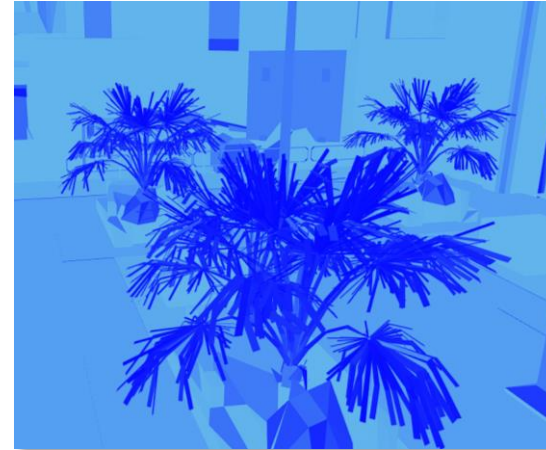
Triangle count



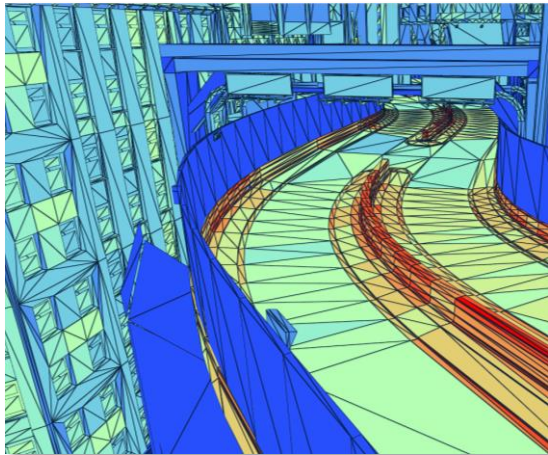
Instance count



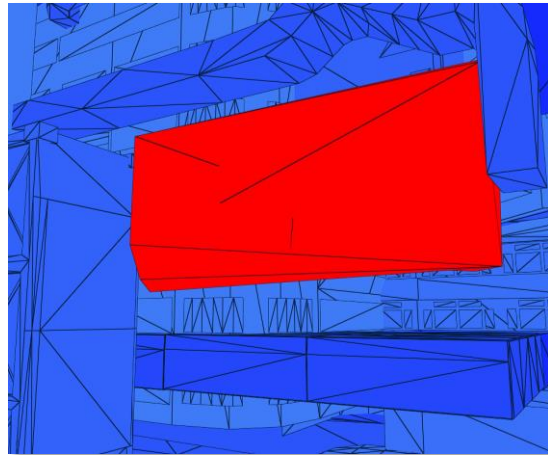
Max/Avg SAH



Tree depth (Triangle)



Max/Avg tree depth

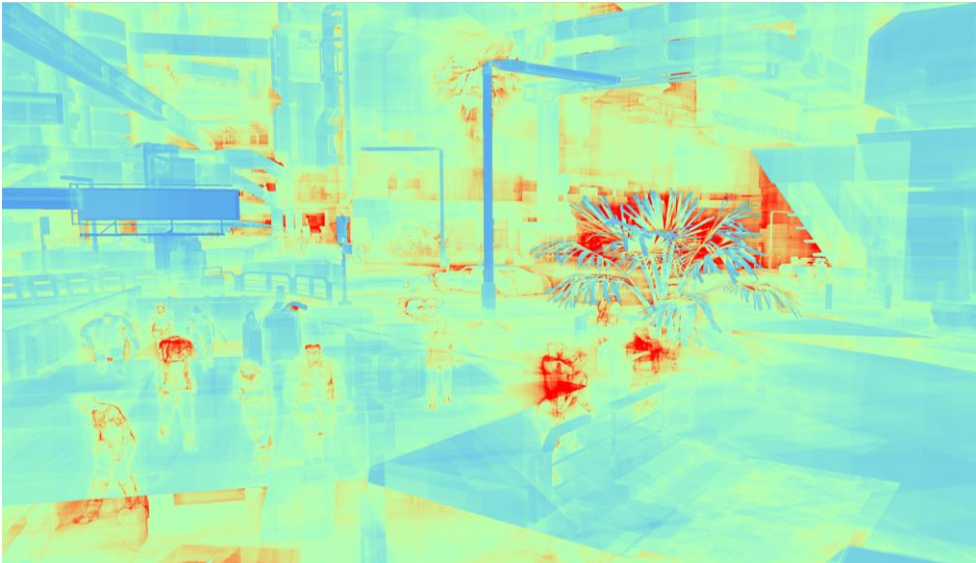


Geometry coloring gives specific information about individual pieces

TRAVERSAL COUNTERS

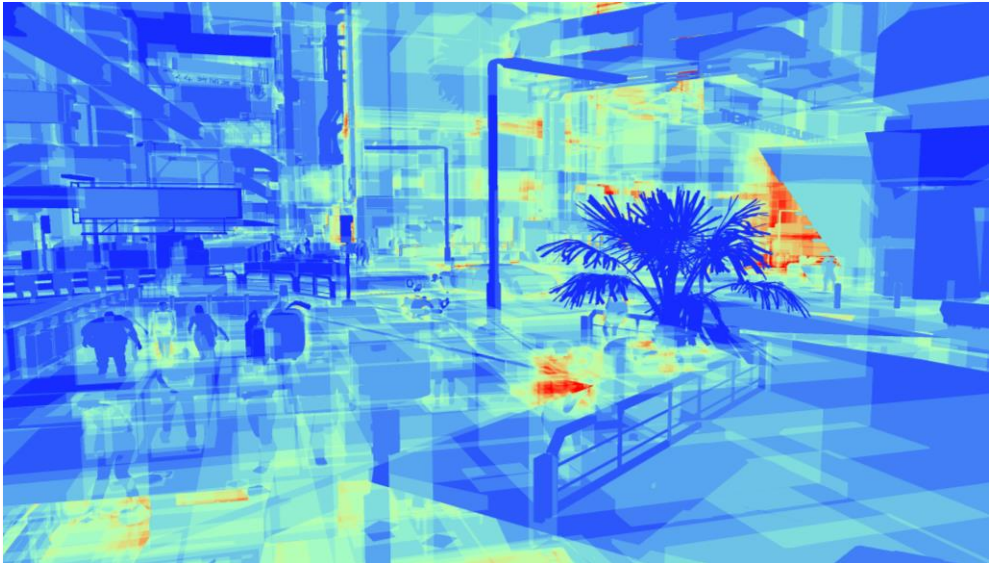
Loop count

0-299



Instance hit

0-18



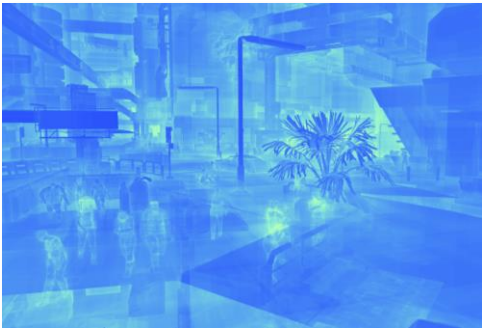
Box hit

0-299



Box test

0-299



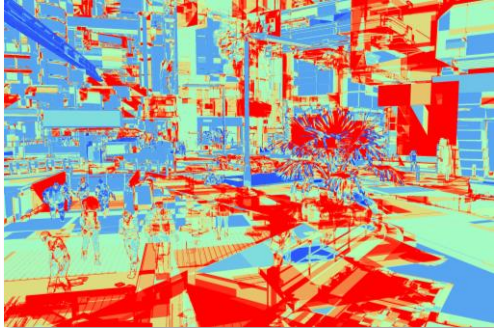
Triangle hit

0-18

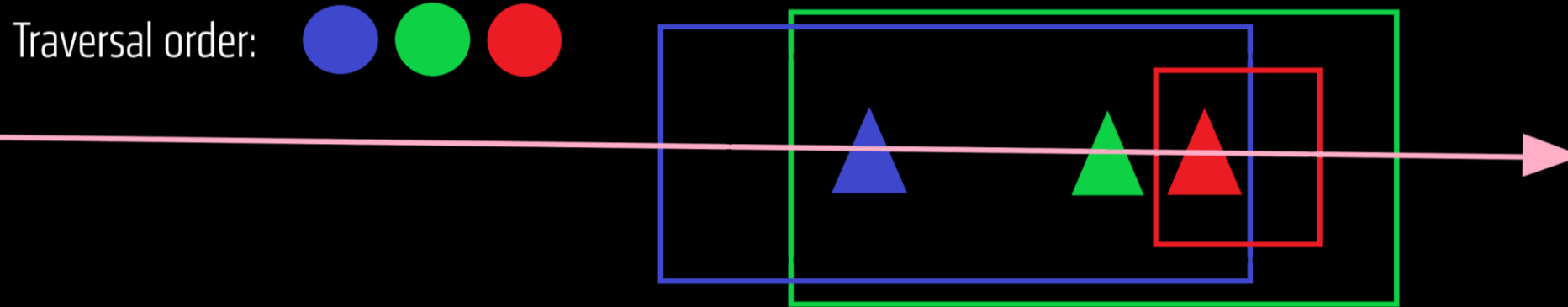


Triangle test

0-18



TRAVERSAL COUNTERS



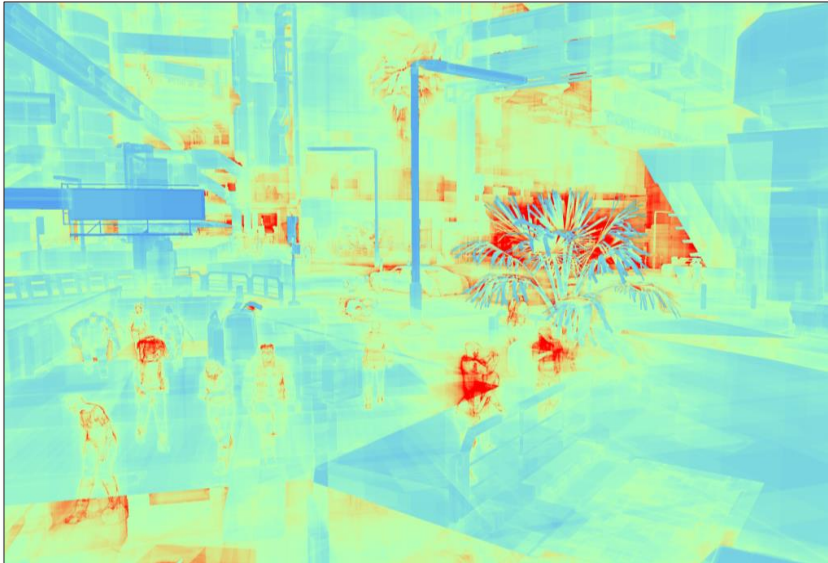
Red volume is completely discarded since the **Blue** triangle hit has been confirmed.
The closest potential hit **Red** volume could provide is further away from confirmed hit.

Green volume and triangle are checked, even though **Blue** triangle is closer.
The **Green** volume may still provide a closer hit than the **Blue** triangle.

TRAVERSAL COUNTERS

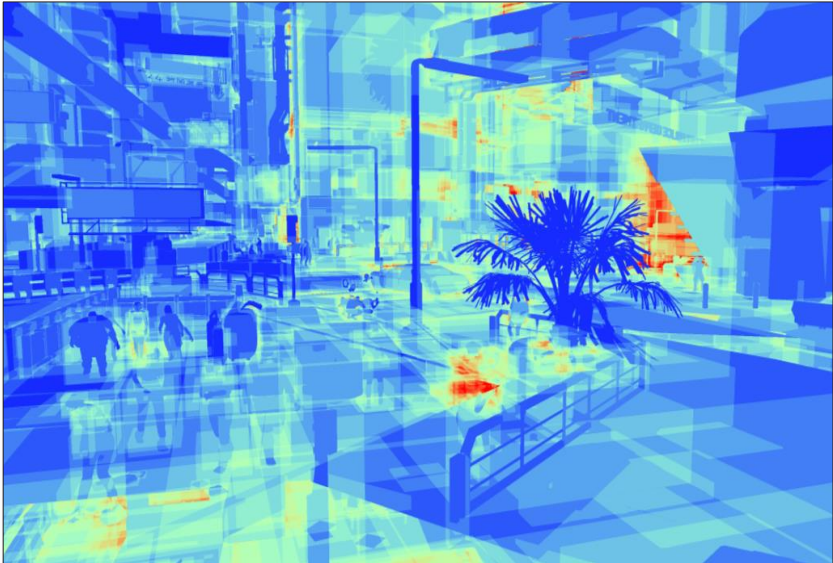
Loop count

0-299



Instance hit

0-18



Box hit

0-299



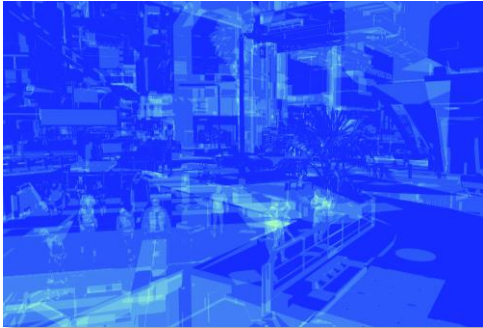
Box test

0-299



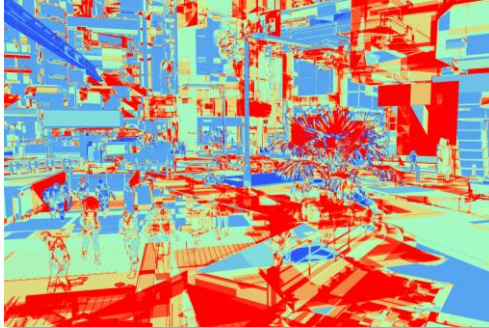
Triangle hit

0-18



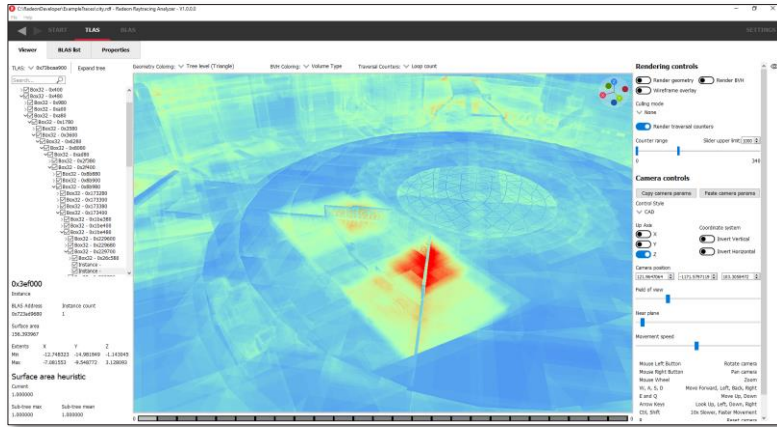
Triangle test

0-18

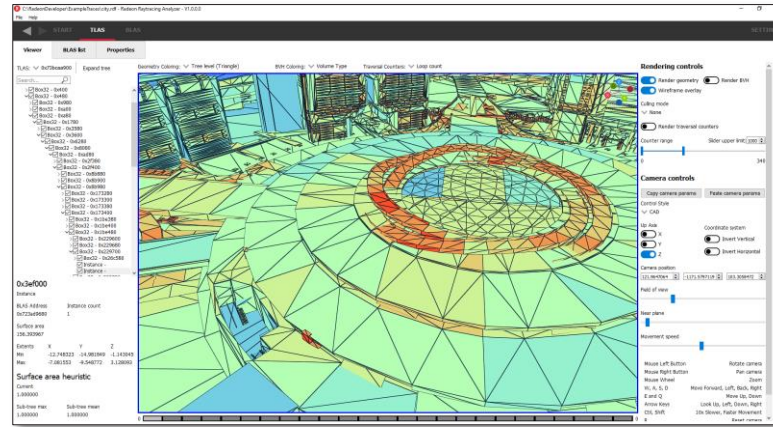


SUGGESTED WORKFLOW

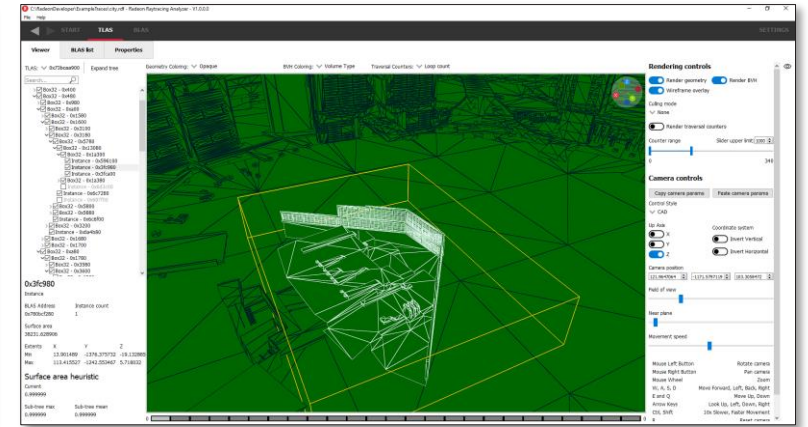
1: Explore



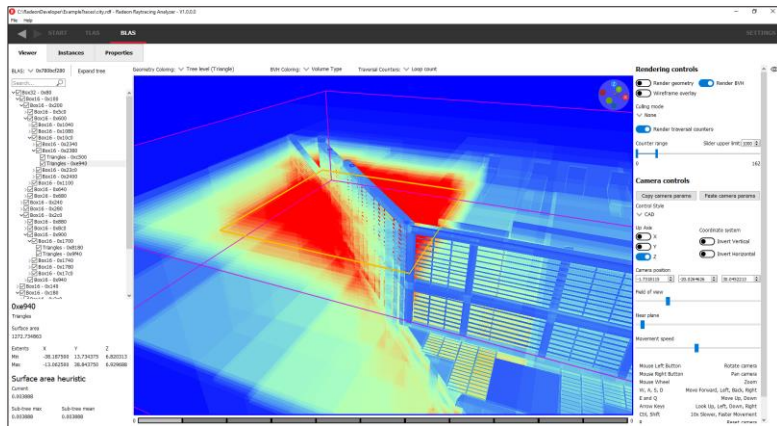
2: Check instance overlaps



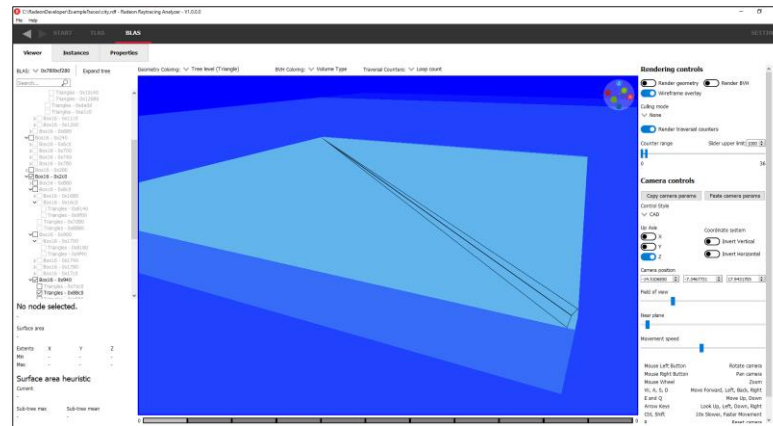
3: Isolate



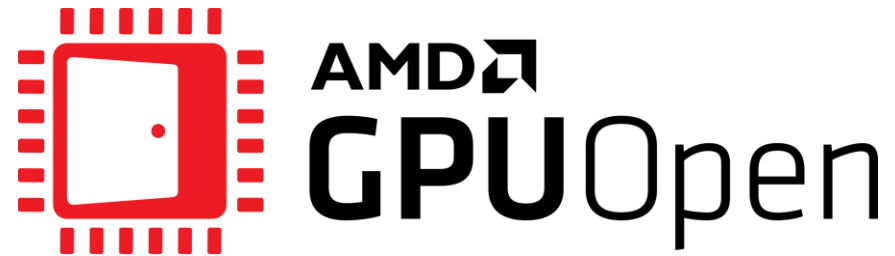
4: Deep dive



5: Plan & Resolve



AMD
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