



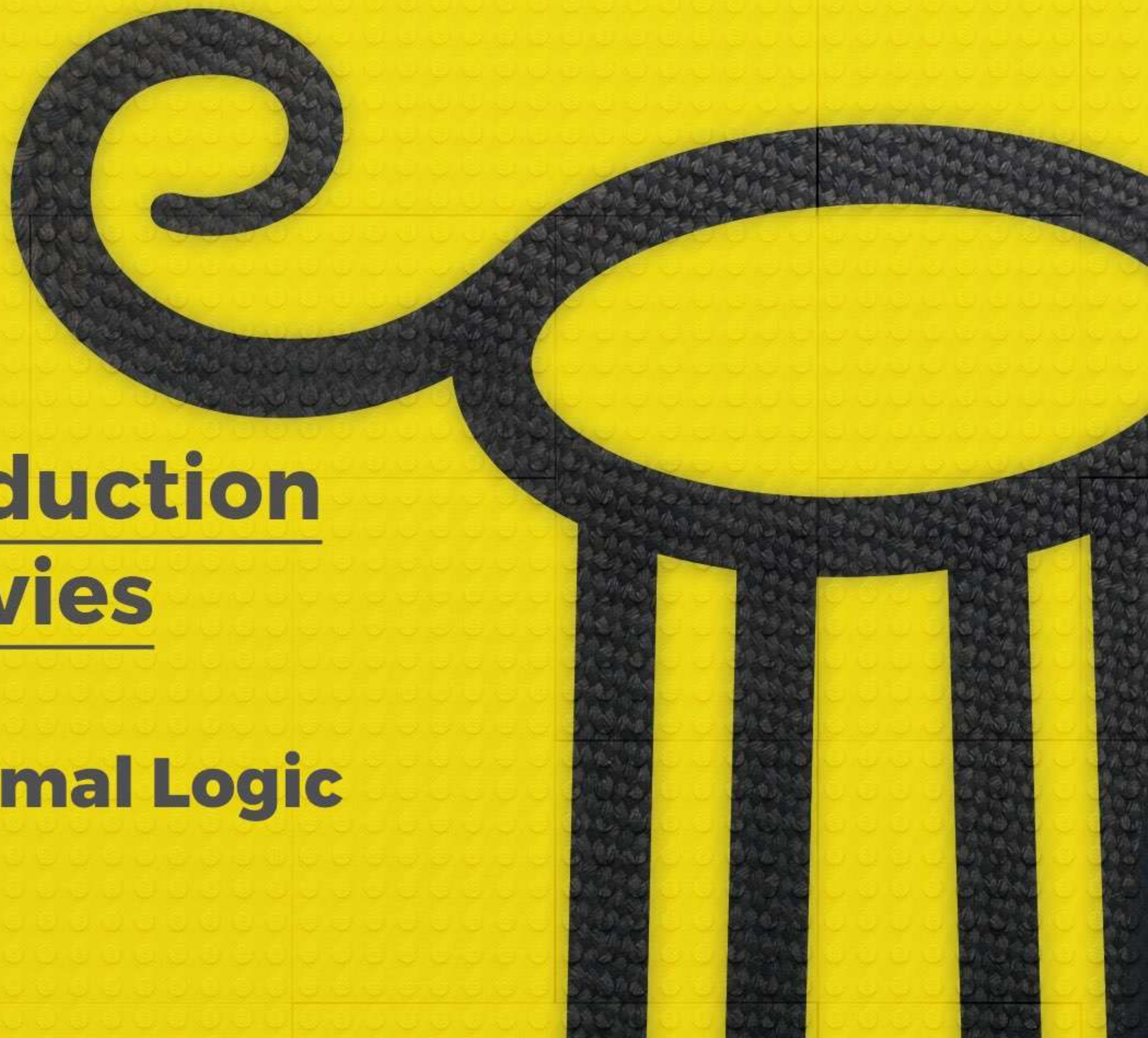
ANIMAL LOGIC

Path tracing in production

PART 2: Making Movies

A Change of Path at Animal Logic

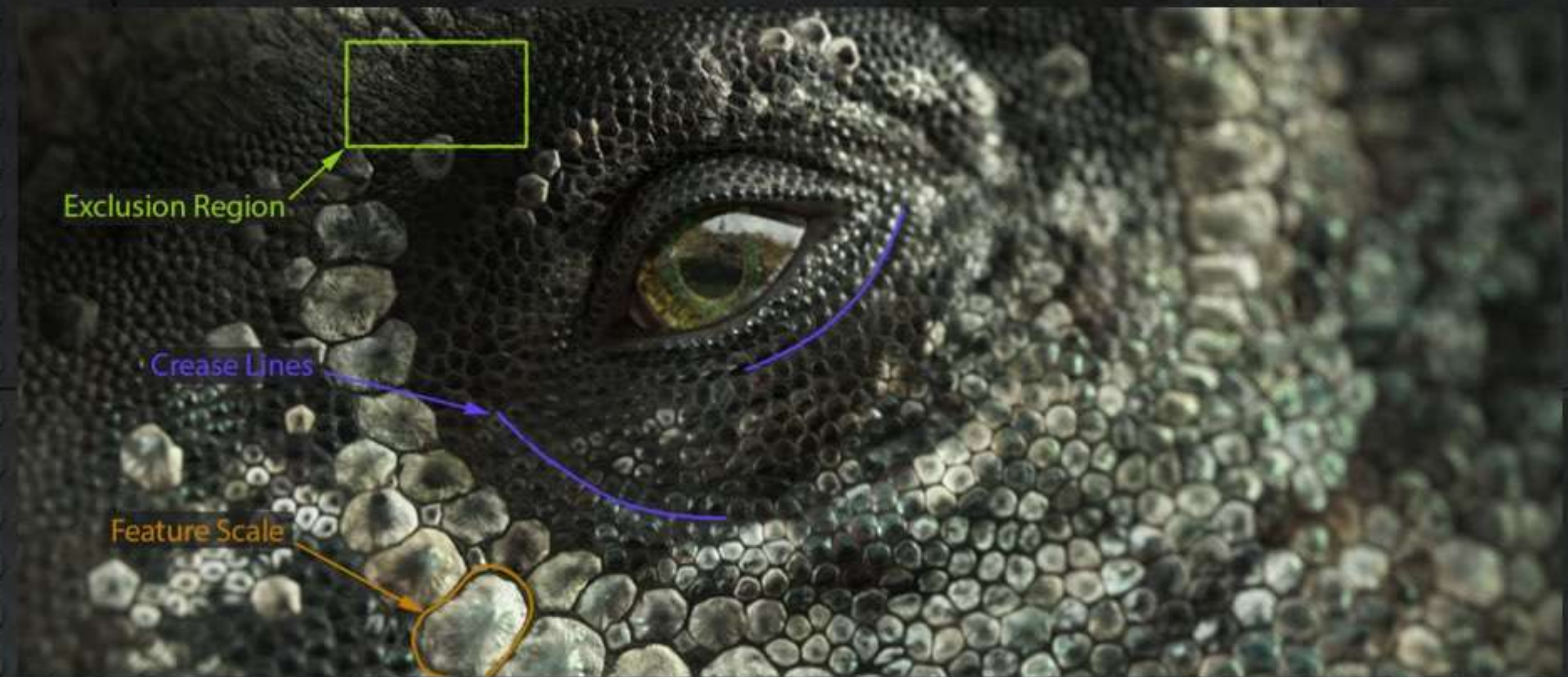
by Daniel Heckenberg



2012

- Maya, PRMan, MayaMan
- 3rd generation shading library, "PHX"
- The Great Gatsby
- Walking with Dinosaurs 3D

Walking with Dinosaurs 3D



[RepTile: How to Skin A Dinosaur (2014)]

Images (C) 20th Century Fox and BBC Worldwide

The LEGO Movie



Image (C) Warner Bros Inc., and The LEGO Corporation

Models and Aggregates

- Bricks or shells?
- Instancing!
- but... workflow
- but... pipeline
- but... no instancing



Image of physical LEGO models showing fine inter-brick edges.

Models and Aggregates

- Bricks or shells?
- Instancing?
- PRMan 17



Asset turntable render

A Brick Too Far?

- What method?
 - caches? passes?
- Memory
- Time
- Subsurface



Image (C) Warner Bros Inc., and The LEGO Corporation

Meanwhile...

- Glimpse (Max Liani)
 - fast, interactive lighting preview
- FrankenGlimpse (Luke Emrose)
 - PRMan ray-server
 - scene via RIFilter
 - tracing via RSL ShadeOps

Shadows and Light

FEATURE	VALUE
shadow tracing	speed (avoid shadow maps)
subdivision surfaces	improved shadow fidelity
plastic shader	indirect illumination
textures	improved indirect
subsurface scatter	quality, speed (avoid bakes)



... with Benefits

- Early pipeline integration
- Stand-alone renderer
- Maya translator
- Geometry procedurals
- Review renders

Putting the Pieces Together

- REYES primary visibility and shading
- Glimpse ray tracing for all other shading and light transport

How?

- PRMan extensibility
- Path tracing resources
 - PBRT, Embree, OIIO
 - collaborative research culture
- Building block
 - plastic subdivision mesh

Consequences

- Aggregation vs specialization
 - library of small, simple bricks and matching textures
 - complexity and richness through combination
 - simple physical material
 - emergent complexity through light transport

More Broadly...

- Workflows and tools
 - libraries
 - additional asset interdependencies
- Production schedules and bidding
- More assets!

Lost in the Weeds?

- The LEGO Ninjago Movie
- LEGO bricks and...
 - natural environments
 - natural effects
- 1 year development window



Image (C) Warner Bros Inc., and The LEGO Corporation

Render Everywhere

- Rendering is core
- Path-tracing is simple and flexible
- Direct problem solving
 - application of research
 - integration of other systems
 - OpenShadingLanguage, OpenVDB

The LEGO Batman Movie



Image (C) Warner Bros Inc., and The LEGO Corporation

Example clip from The LEGO Batman Movie.

Glimpse

“Render everywhere”



ANIMAL LOGIC

Comparison of automated animation review render and final render.

Example of ray-traced Glimpse viewport in Maya

Example of ray-traced instance placement on final geo.

Glimpse

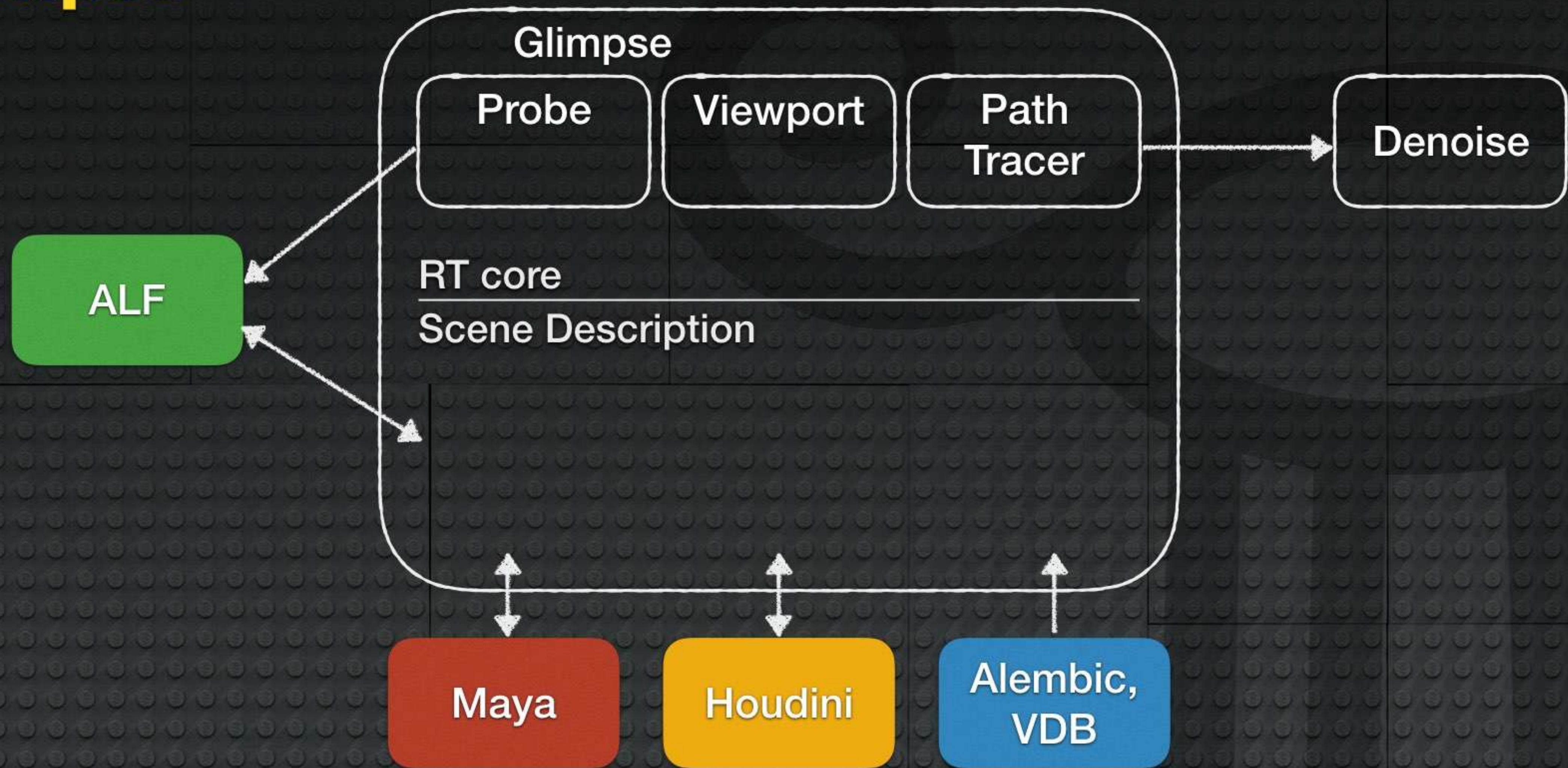
“Render everywhere”

- Fast
- Scalable and expressive
- Minimal

Glimpse Features

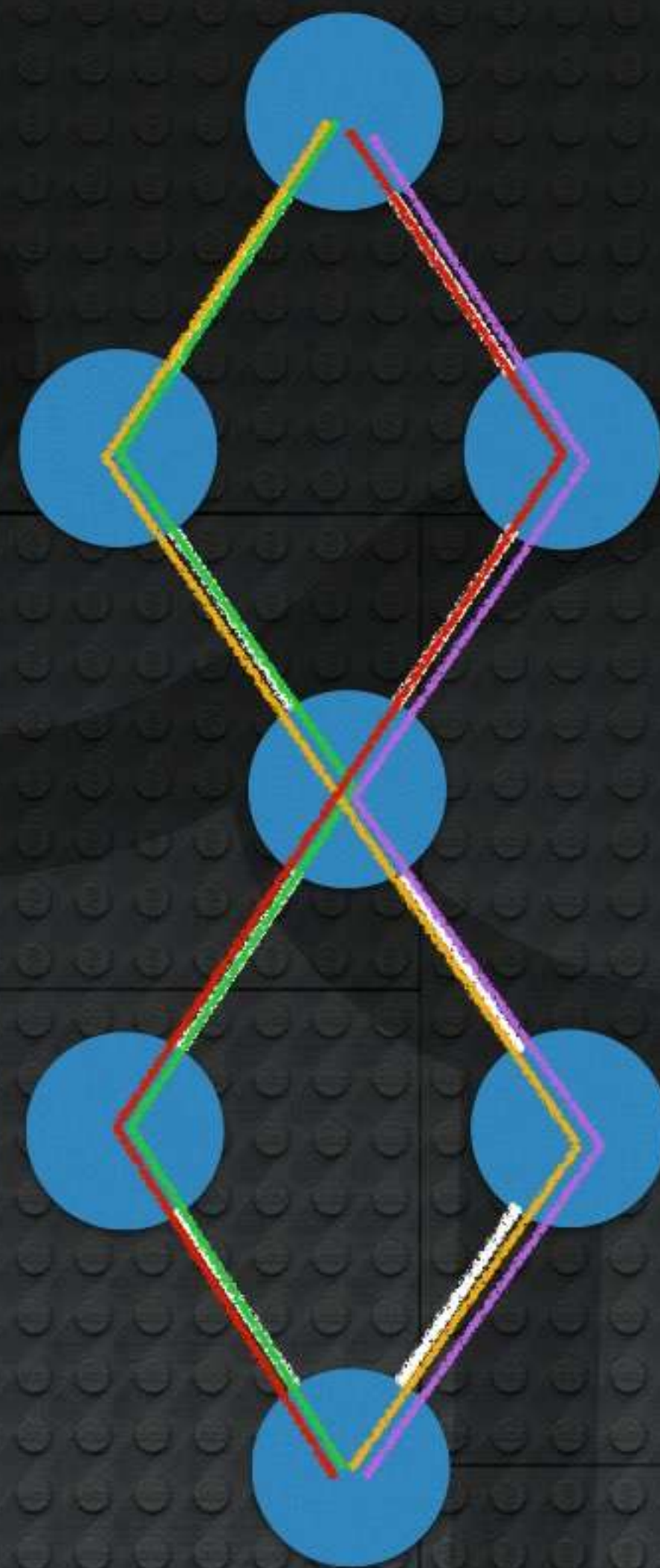
- Unidirectional CPU path tracer
- MIS, Russian roulette
- Adaptive subdivision surfaces
- Implicit curve primitives
- Volumes with emissive sampling
- OSL-based shading
- Scene description
- Adaptive sampling
- Denoise
- ERDoF integrator
- Light culling

Glimpse



Scene Description

- Expressive
- Hierarchical
- Editable
 - directly
 - overrides (tweaks), (instances)
- Compact



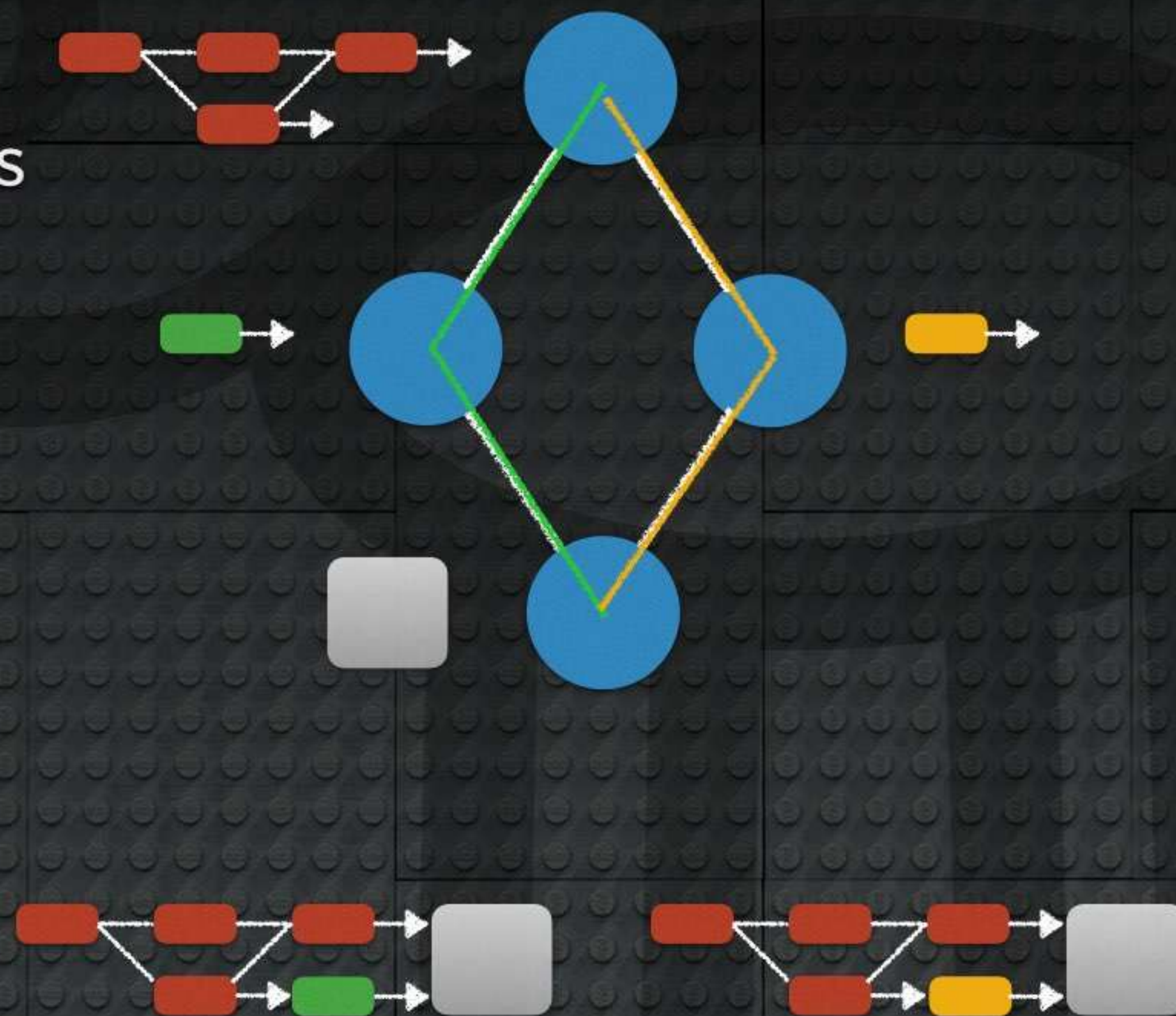
Materials (Ash)

- Substances with OSL-based pattern graphs
 - work with “integrated” parameters
- Hierarchical composition
 - multiple assignment with masking
 - interface values and interconnections

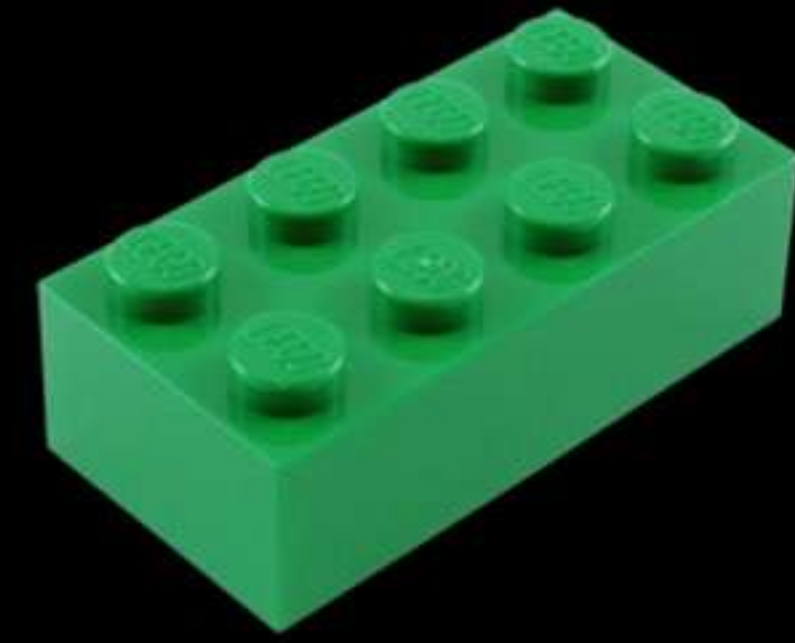
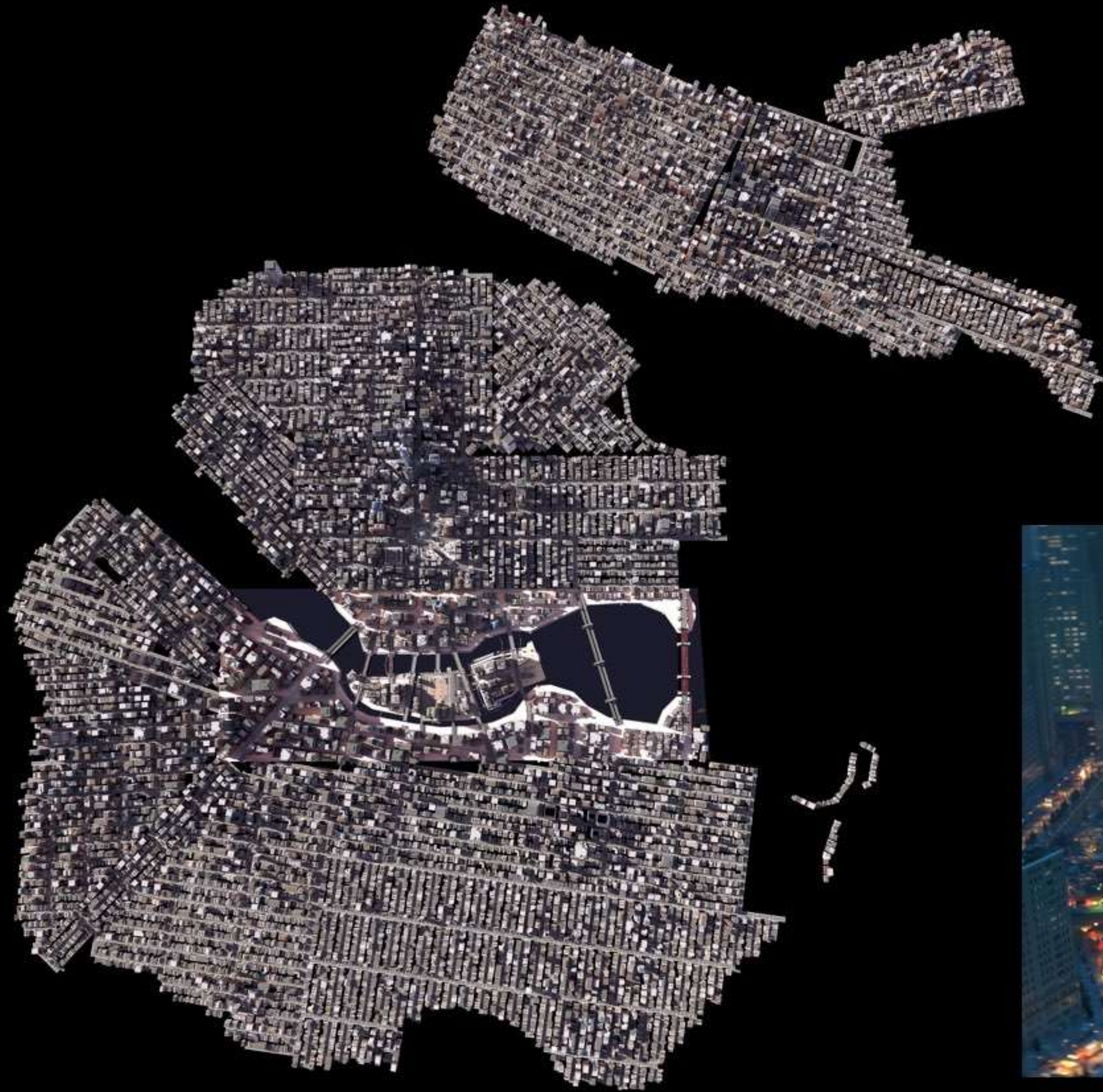
Example of
Ash Designer
Hierarchical
Assignment UI

Materials (Ash)

- Substances with OSL-based pattern graphs
- Hierarchical composition
 - multiple assignment with masking
- interface values and interconnections



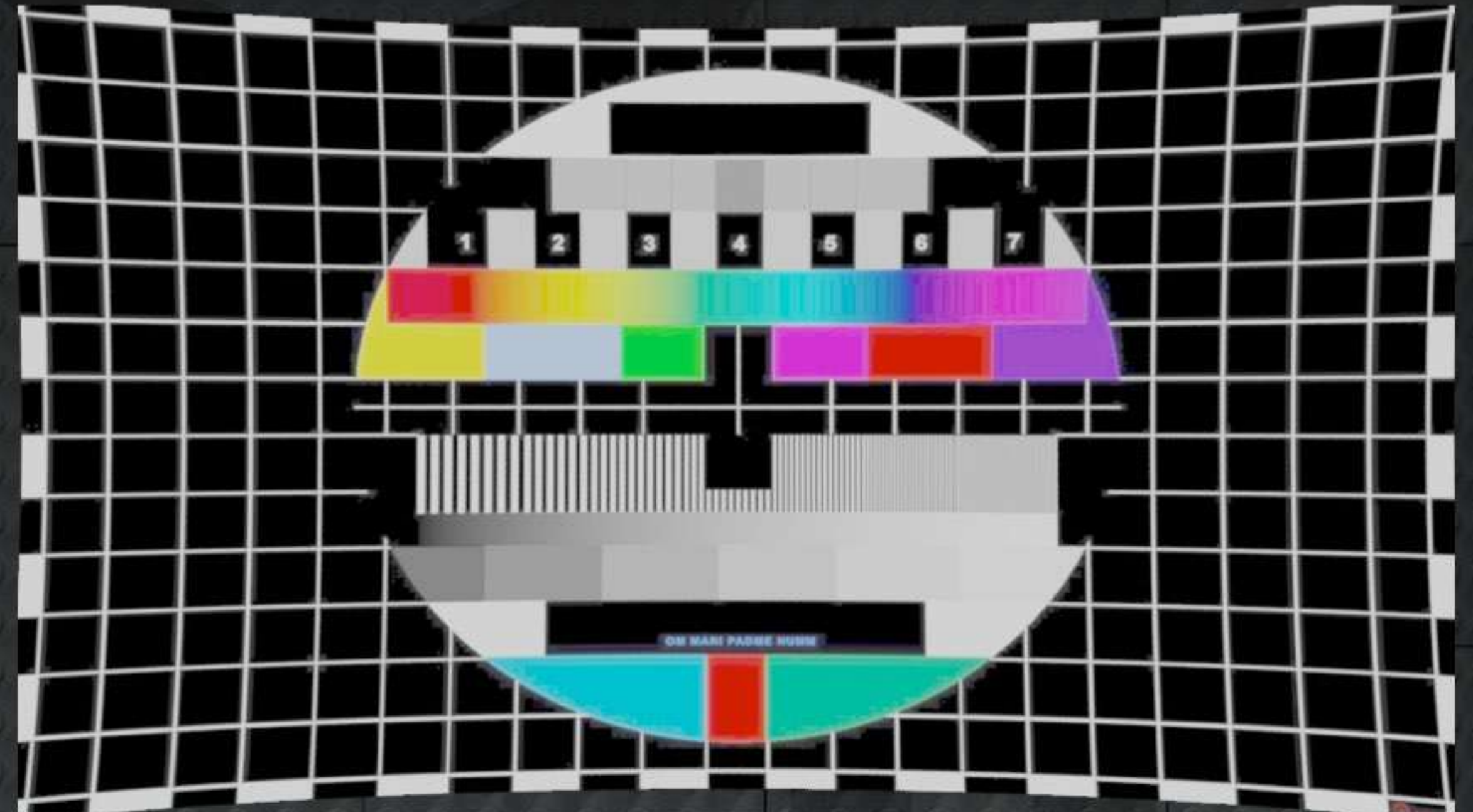
Example of interactive material editing and layering.



Images (C) Warner Bros Inc., and The LEGO Corporation

Camera

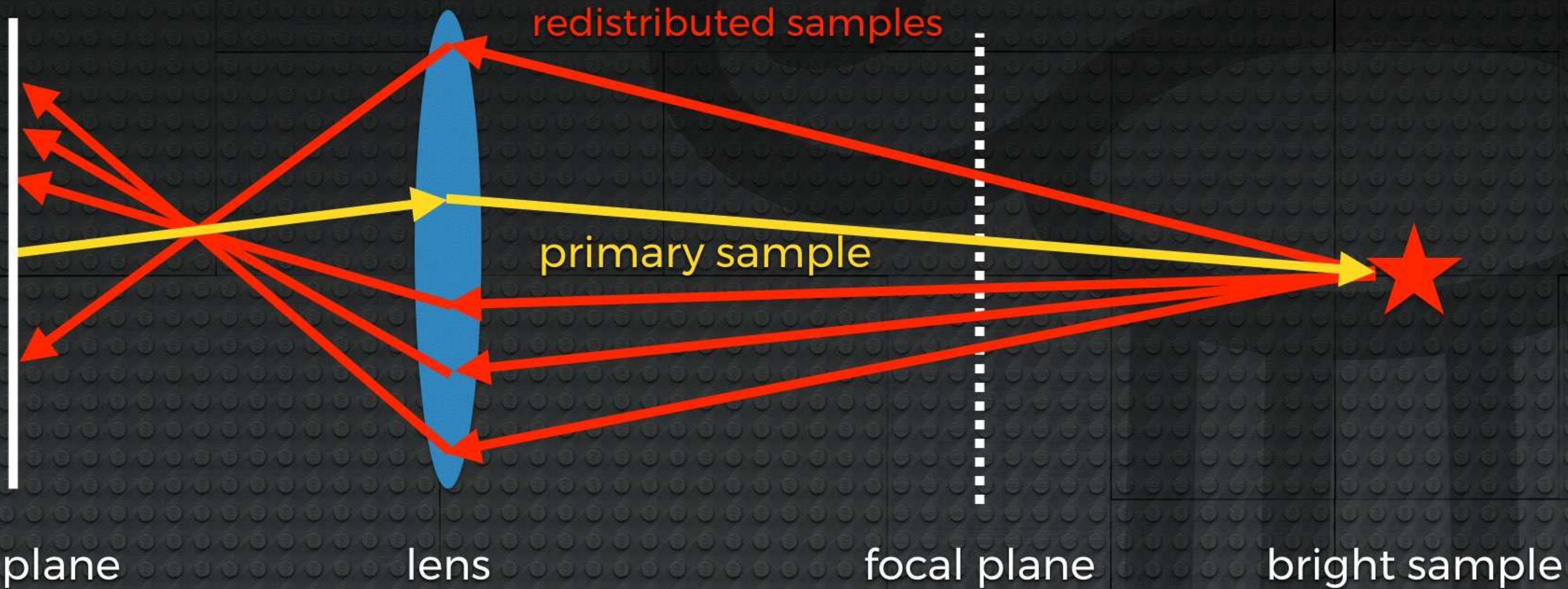
- Incorporate realistic camera early
- Lens distortion
- Depth-of-field



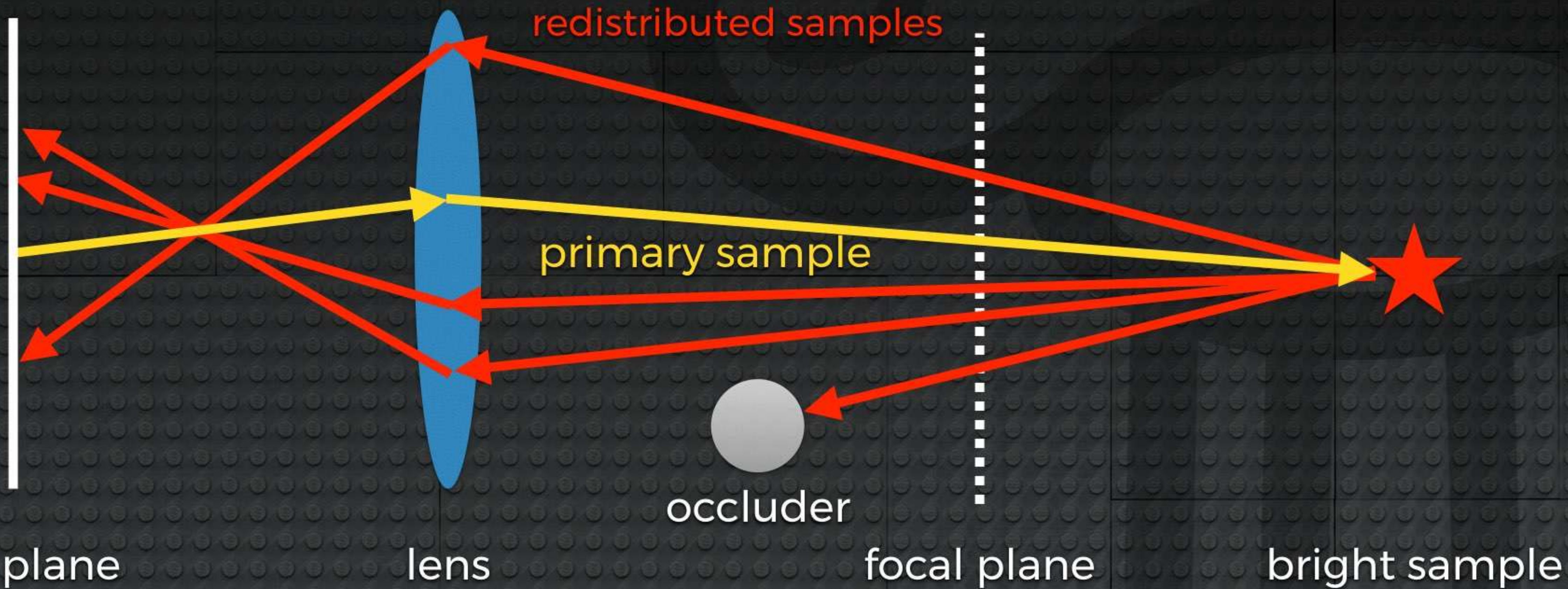
Energy Redistribution DOF

Example of interactive rendering with ER DoF.

ERDoF



ERDoF





Example of final frame rendering without ER DoF.

Without ERDoF (out of focus highlights remain poorly resolved)

Example of final frame rendering with ER DoF.

With ERDoF (out of focus highlights are nicely resolved)

Reflections

- More rendering
 - interactivity, speed and simplicity
- More robust lighting and configurations
 - automation
 - reusable light rigs and shot configurations

Set Building (2017)

Scenery

Example of library / instance based set building tools.

Example of set turntable showing multilevel instancing.

Challenges

- Light transport
 - extended Next Event Estimation methods
- Material models
 - hair, fur, skin
 - coatings
- Sampling / filtering / reconstruction
 - denoise

Challenges

- Representation / scale
 - model
 - subdivision
 - displacement
 - bump
 - roughness
- Frame rendering at scale:
 - redundancy!
 - internally
 - externally



Thanks

Glimpse Developers

Max Liani

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Lighting TDs

Steve Agland, Simon Bunker, Manuel Macha, Naren
Vadapalli

Craig Welsh and Lighting Crew