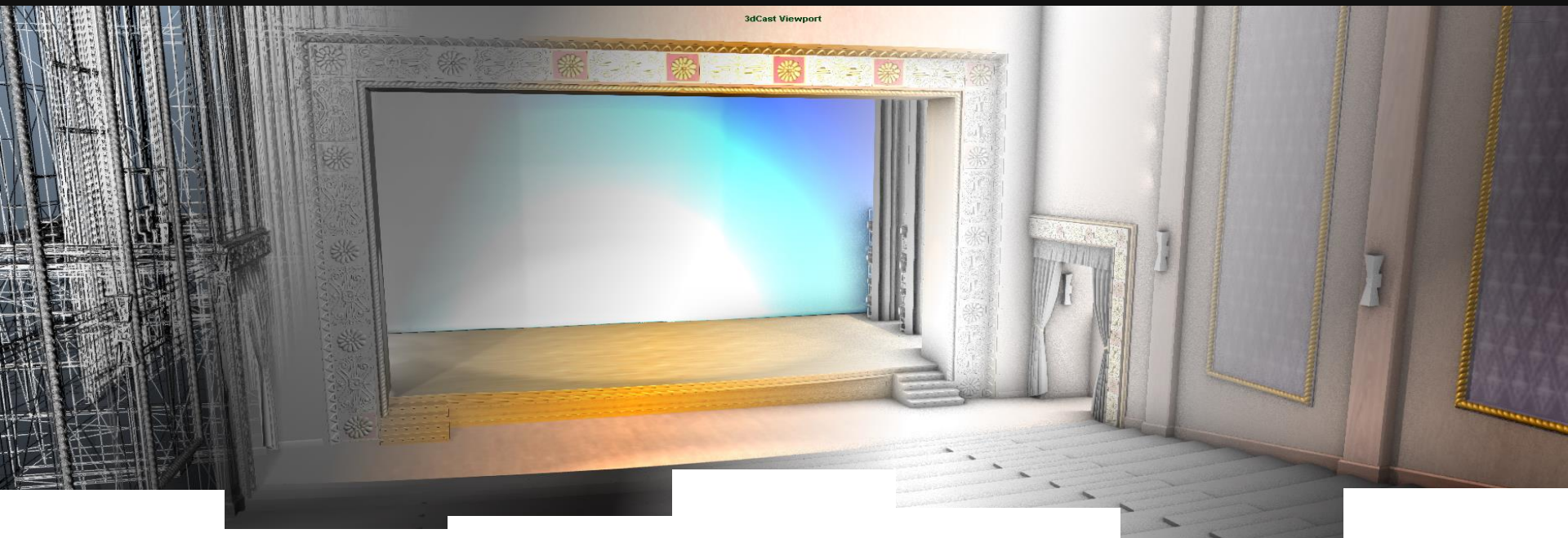


# Pre-viz technologies for standard animation workflows

Eurographics 2014 - Industrial presentations  
Jean-Eudes Marvie



THE 35TH ANNUAL CONFERENCE OF THE EUROPEAN ASSOCIATION FOR COMPUTER GRAPHICS  
**EUROGRAPHICS 2014**  
Strasbourg, France

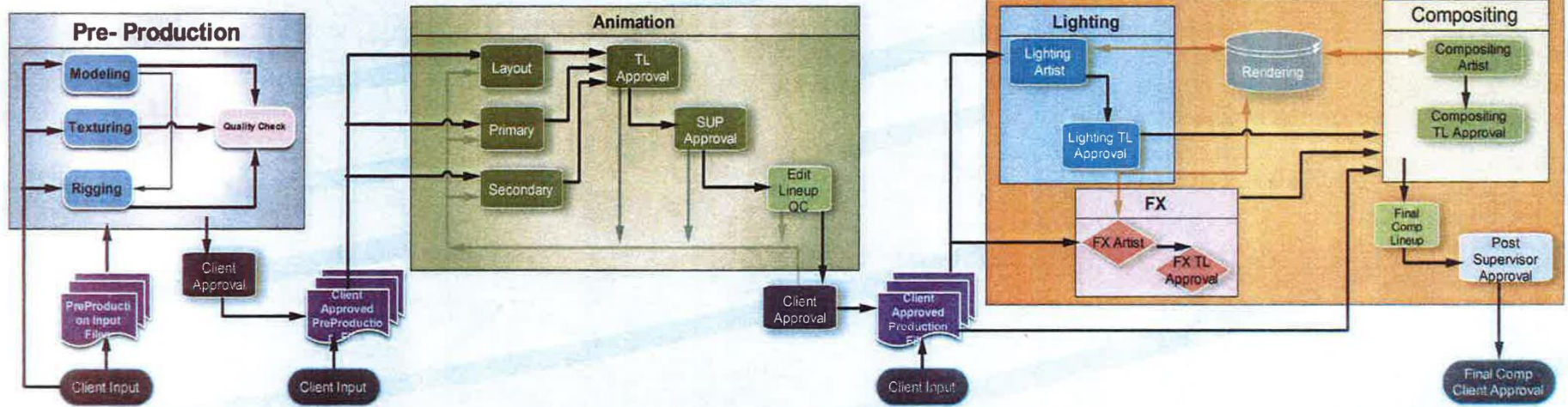
CONFERENCE 7-11 APRIL 2014 STRASBOURG PALAIS DES CONGRÈS



# Needs for pre-viz in animation workflows



## Production Work Flow



# Interactive viewport for Maya/Mental Ray

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# Outline

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- Animation
  - Animation caches
  - Selective evaluation
  - Contacts visualization
- Texturing, shading & lighting
  - Textures management
  - Standard shading & lighting
  - Area lights
- Post processing
  - Ssao
- Conclusion
  - Future directions

# Animation

- Introduction
- Animation
  - Animation caches
  - Selective evaluation
  - Contacts visualization
- Texturing, shading & lighting
- Post processing
- Conclusion

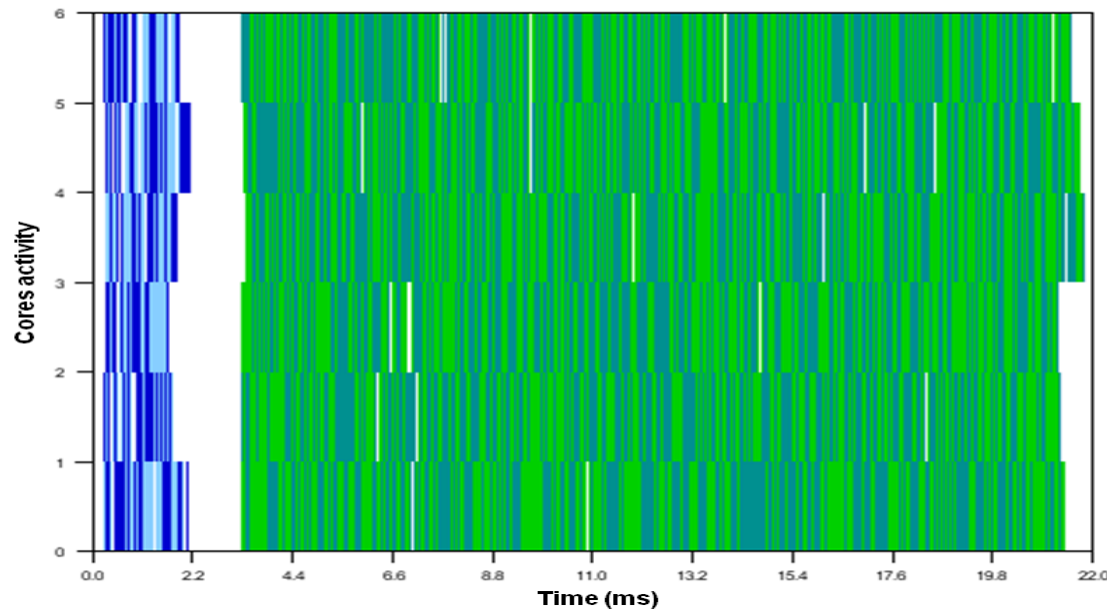
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# Animation

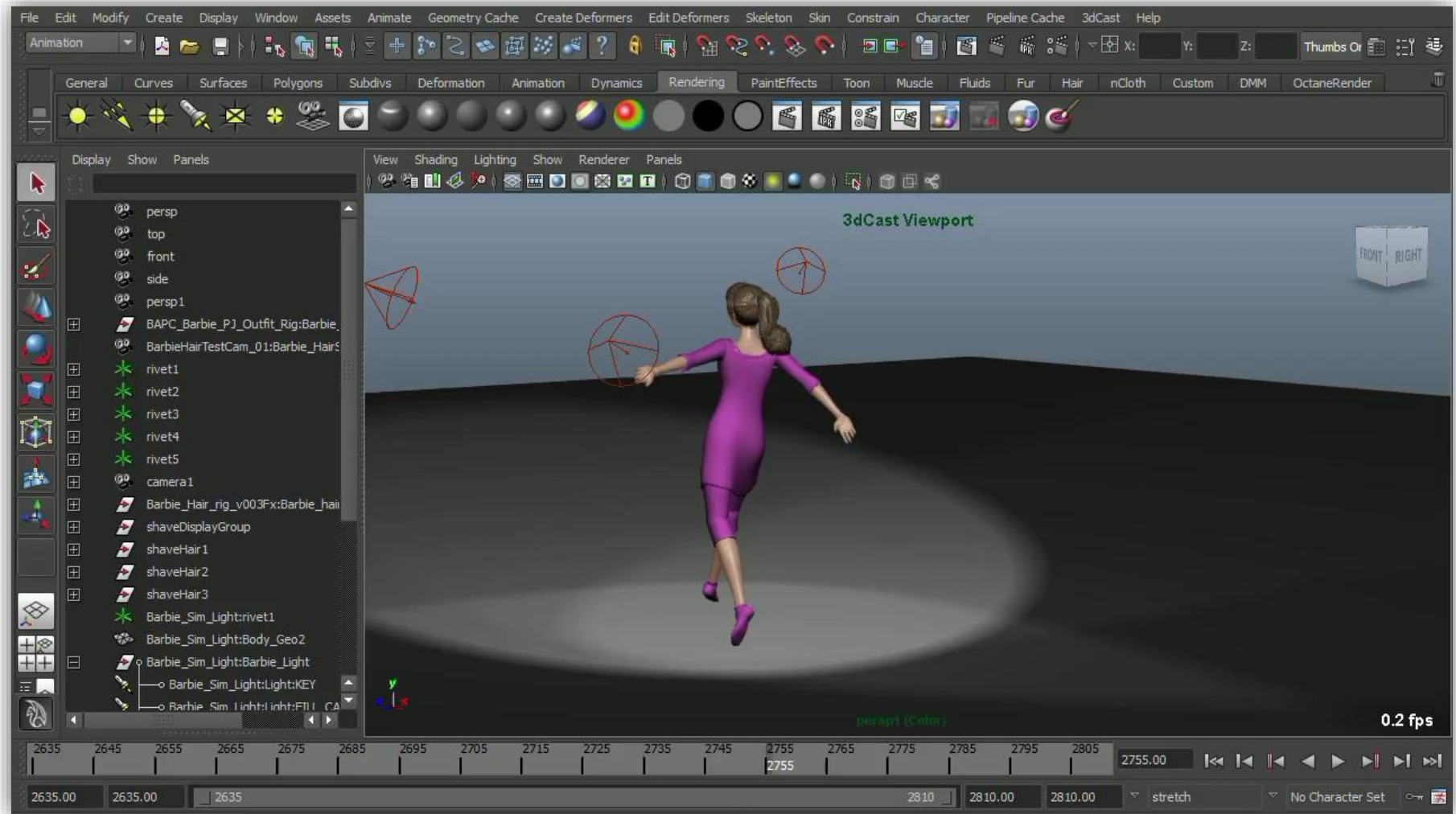
## Animation caches

- Maya's evaluation of animations can be expensive
  - IKs, physics, animated meshes, etc.
- We propose a RAM caching system to accelerate evaluations
  - Plays animation once, stores key-framed animation
  - Prevents Maya from updating nodes itself
  - Built on our multi-core event routing system [Marvie13]



# Animation

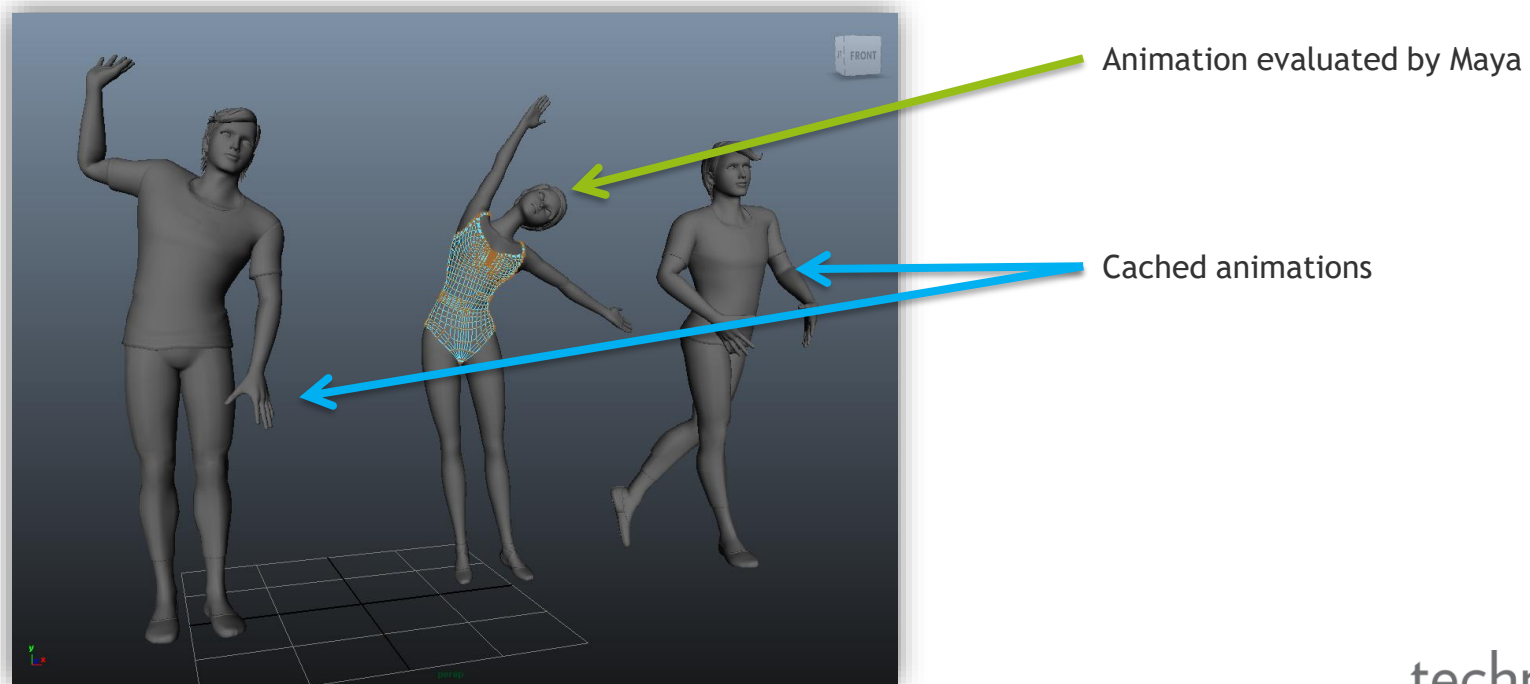
## Memory cached example



# Animation

## Animation selective evaluation

- Once caches are computed, Maya's built-in evaluation system can be re-activated on a per-object basis
  - Allows animators to keep performances while animating subsets of the scene
  - Performance gain more relevant with complex animated meshes
  - Especially useful when animating crowds

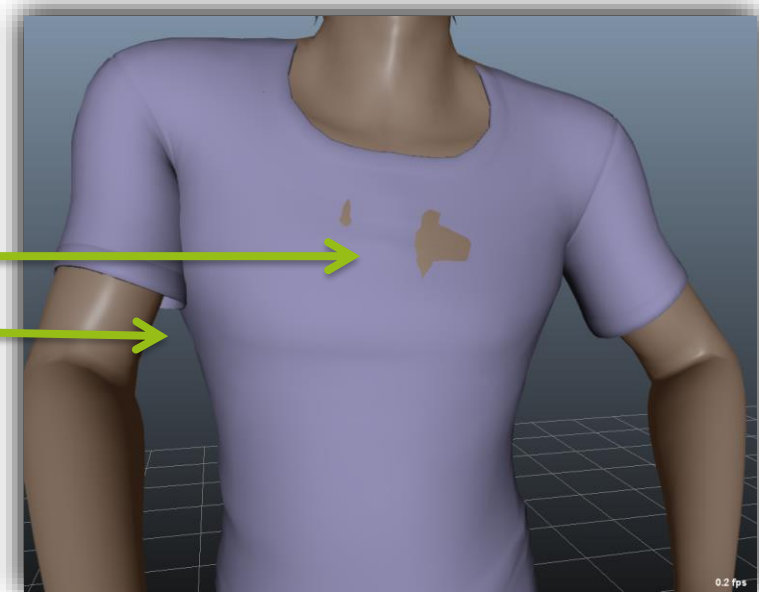
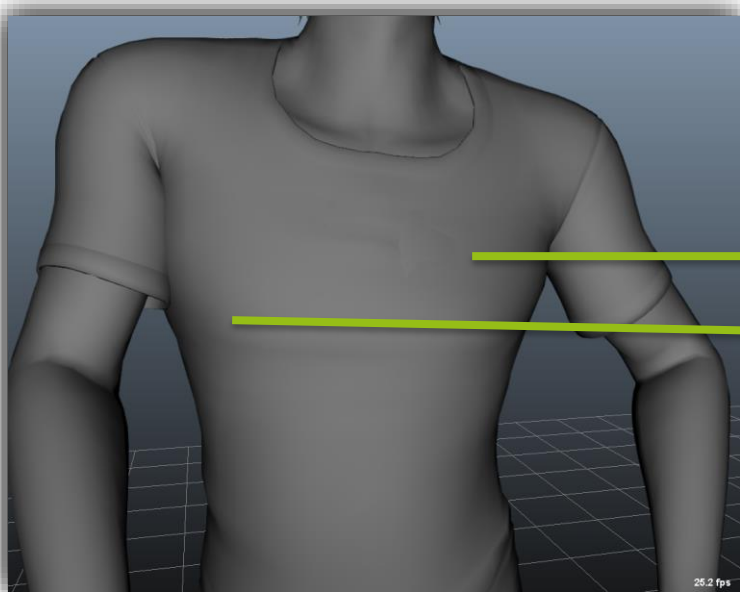


# Contacts visualization

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## Early quality check improvement

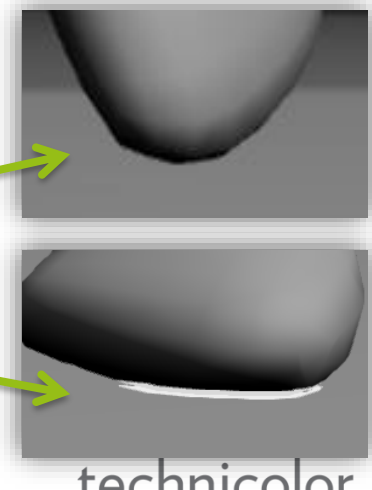
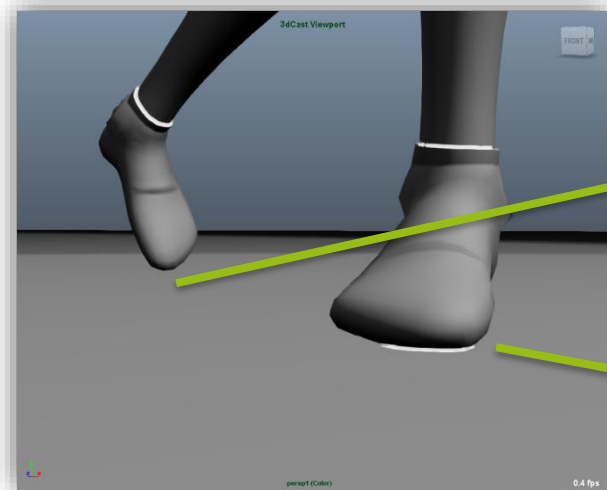
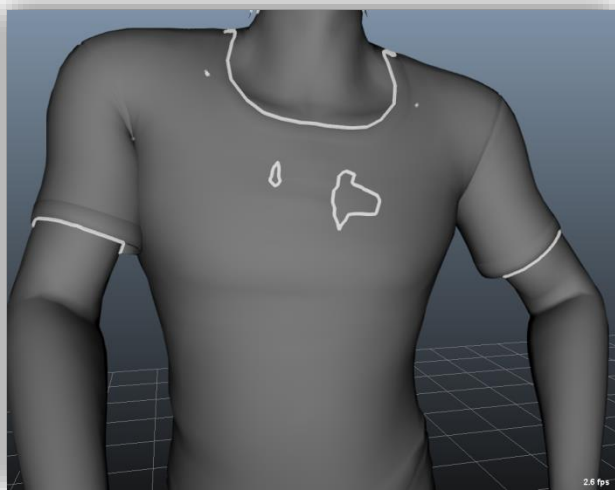
- In standard workflows, animation and cameras setup are usually done prior to texturing and/or lighting stages
- Objects relative positioning can turn out to be tedious, e.g.
  - Body/cloth interpenetrations when using a default shader
  - Lack of contacts (floating objects) with default headlight



# Contacts visualization

## Early quality check improvement

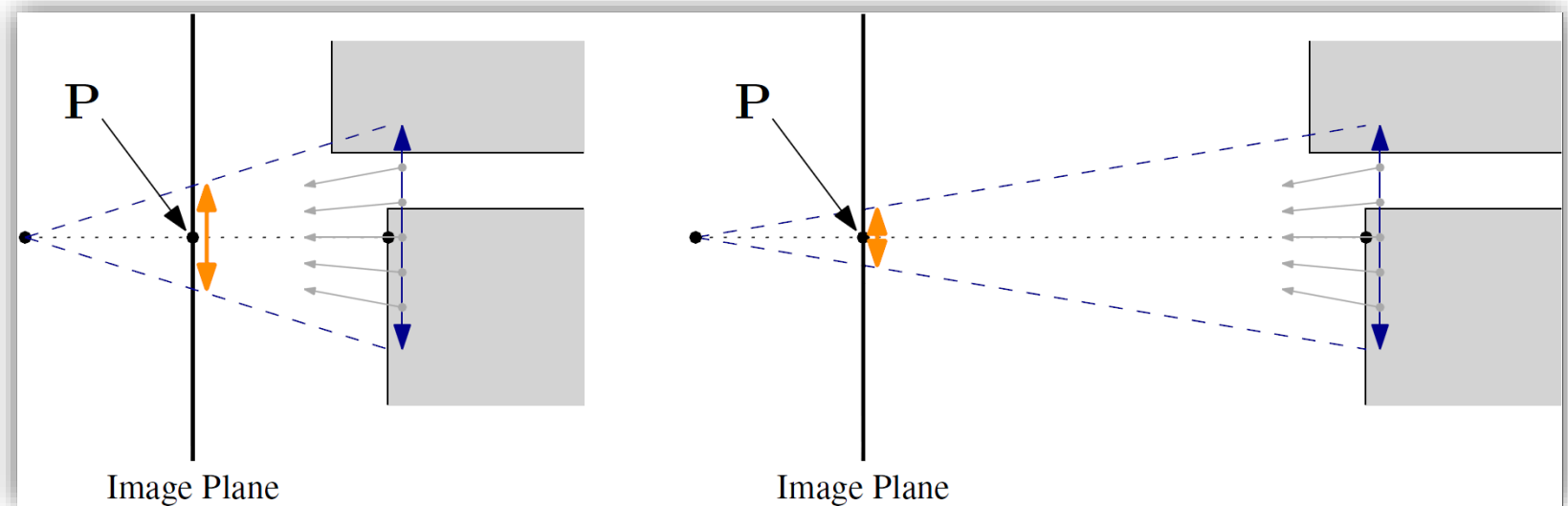
- Modeling / Animation mistakes usually caught later in the workflow
  - Implies rollback on the faulty assets
  - Potential re-validation process with the client
- Introduction of a cheap quality check tool
  - Visualization of contacts between 3D objects
  - Cheap: available to very low-end graphics hardware
  - Artists assess in real-time whether contacts or lack of is relevant to the scene



# Contacts visualization

## Principle

- Post-processing shader with a distance threshold parameter  $\sigma_d$
- Per-fragment inputs: object ID and eye-space pos.
- For each fragment:
  - Define filtering kernel in geometric space given input distance  $\sigma_d$
  - Project samples in image space
  - If there is at least one sample with a different object ID, display a contact



# Texturing, shading & lighting

- Introduction
- Animation
- Texturing, shading & lighting
  - Textures management
  - Standard shading & lighting
  - Area lights
- Post processing
- Conclusion

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# Textures management

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## Caching textures

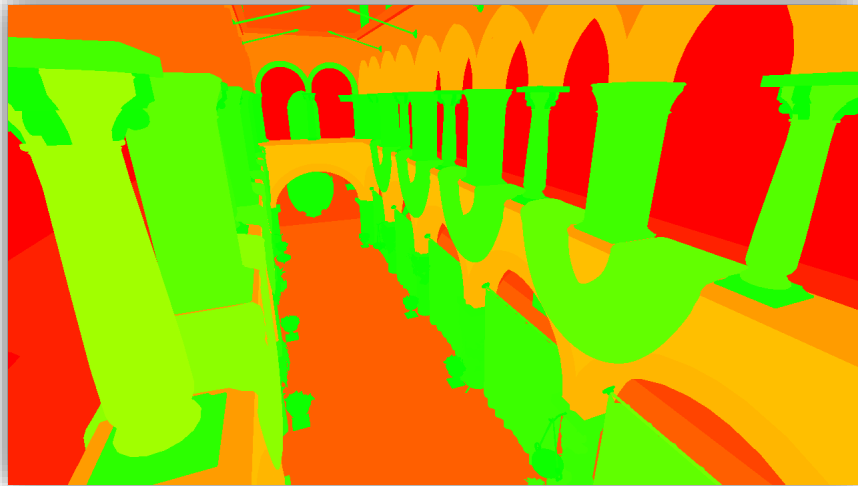
- In production scenes, plenty of (up to ~8k) textures do not fit in memory
  - And are down-sampled anyway when pre-sized
- Local caching system
  - Only one network fetch per HD texture map
    - Prevents waiting several minutes at each viewport activation
  - Automatic differential update on remote modification
    - E.g. if a painter updates a texture on server, each animator or lighter will have only this map updated locally when triggering a local refresh

# Textures management

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## HD textures

- Adaptive multi-resolution HD textures [Marvie03]
  - Due to limited graphics memory (~1GB) most pre-viz systems resize to lower resolutions
  - Our method preserves highest quality (up to 8K) and select best texture quality according to objects' visual importance
  - Streaming/deleting mipmap levels into/from GRAM on the flight

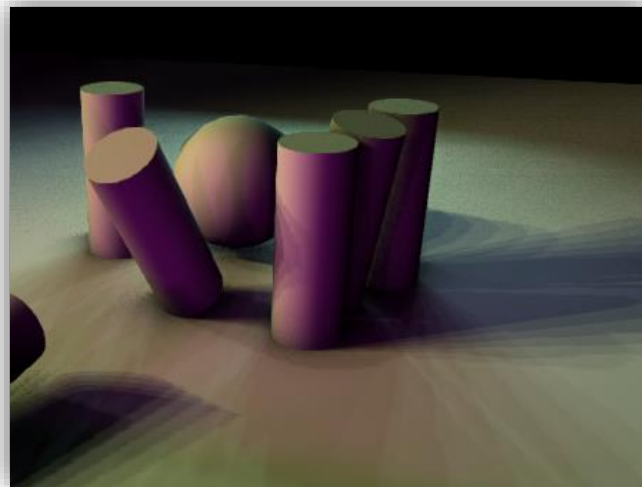
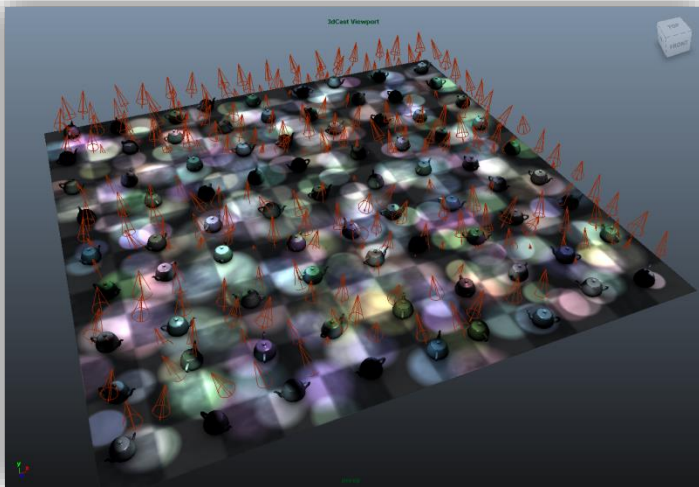


# Standard shading & lighting

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## Standard light sources

- Interactive pre-viz up to hundreds of point/spot/directional lights
  - Extensive use of Uniform Buffer Objects
  - Multiple passes for many shadow maps support
- Forward shading pipeline!
  - Slower than deferred shading, but...
  - Keep support for many material shader types
  - No need for a über-shader

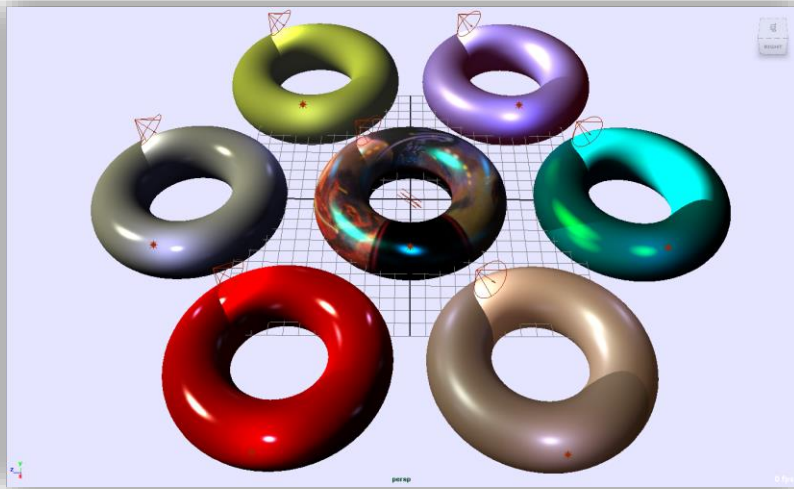


# Standard shading & lighting

## Surface shaders

- Simulate closely most common Maya / Mental Ray shaders
  - Maya lambert, phong, blinn, aniso, ...
  - Mental Ray architectural, fast skin, ...
  - Real-time approximation of BRDFs when unknown / not surfacic

Our solution



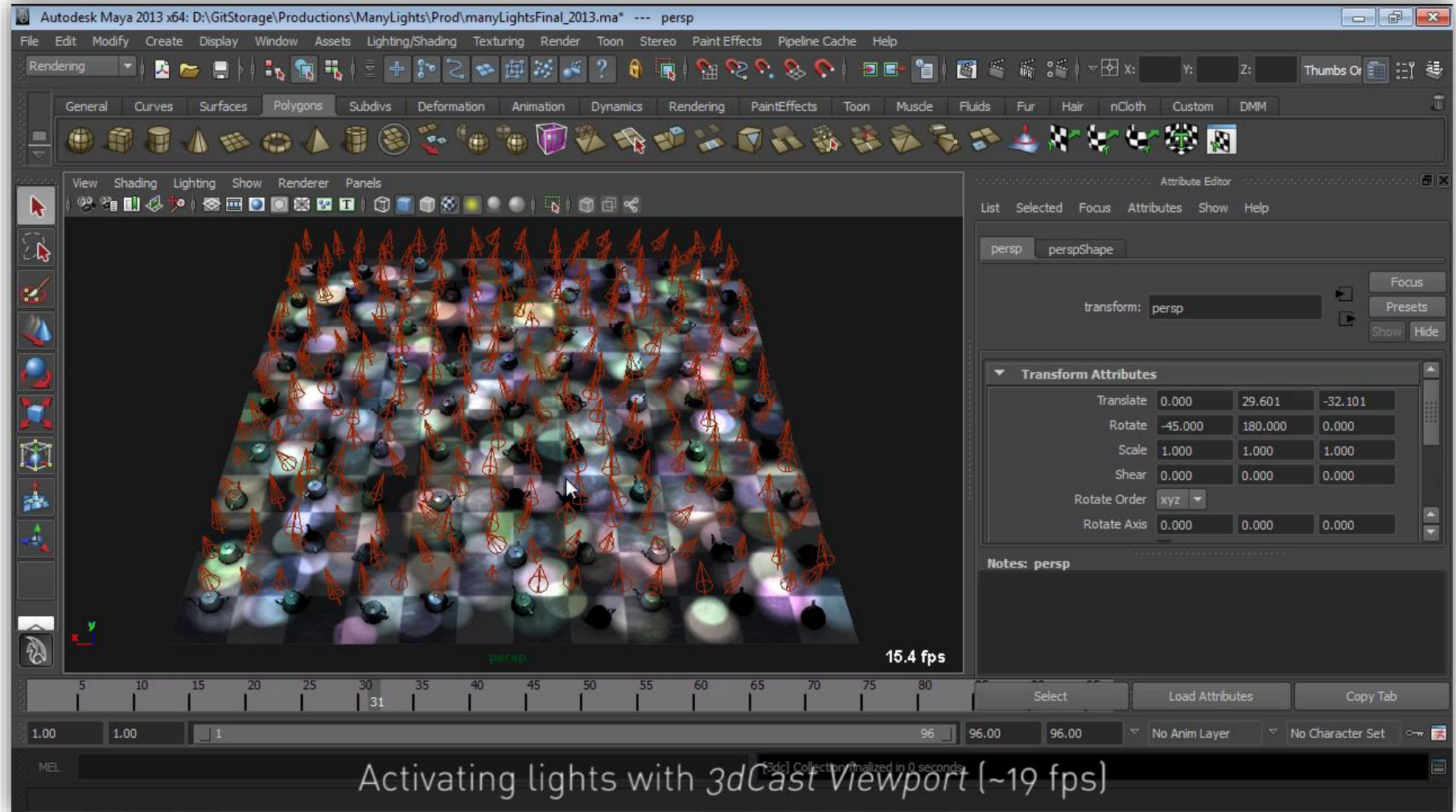
Mental-Ray



- Limitation: complex shader graphs

# Standard shading & lighting

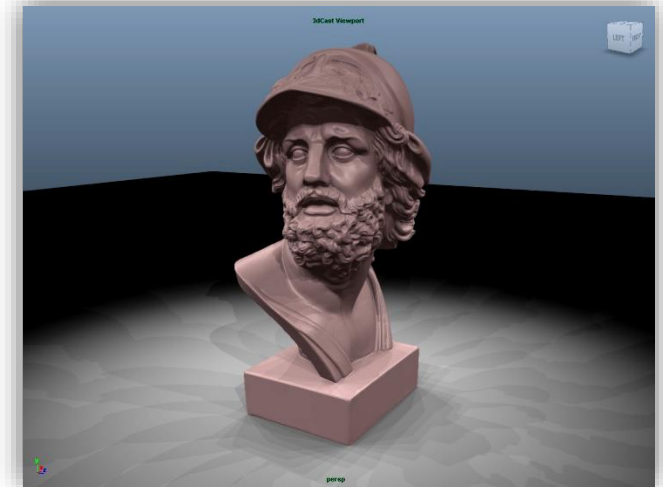
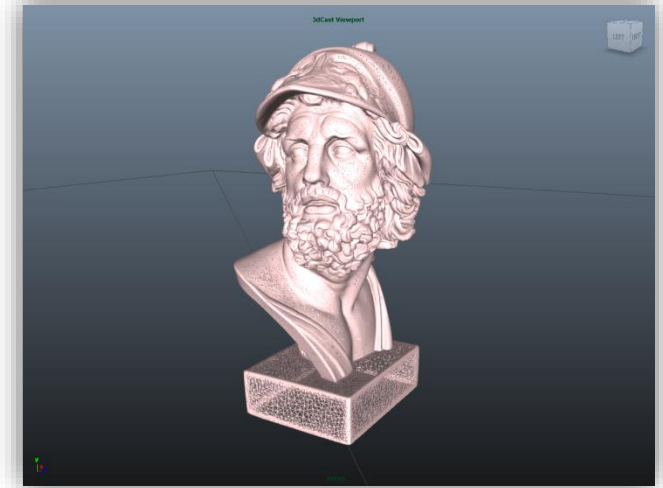
## Many lights video



# Shadowing

## Multi-pass shadow-maps

- Multi-pass rendering
  - Allows for many shadow maps support
  - Up to the number of supported lights
- Batch rendering of shadow passes
  - Better performances
  - Adapted to hardware support
- Specific shaders for depth maps generation
  - Minimal shaders, minimal map sets
  - But preserve alpha maps
- Future works
  - Shadow maps atlases (even less passes)

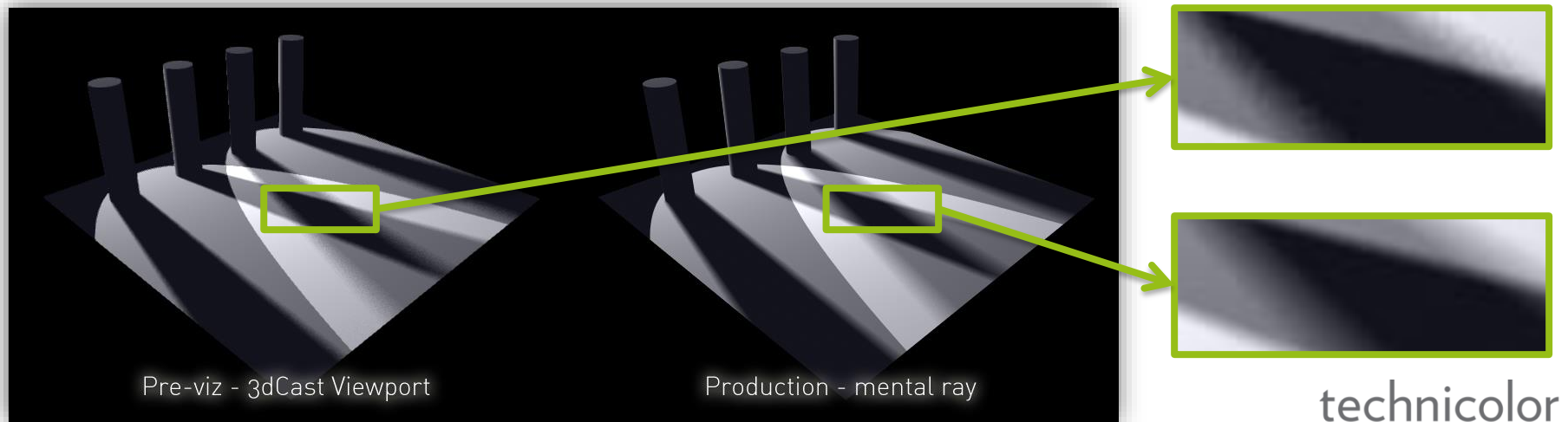


4.9M. Tris, 26x 2K shadowmaps, ~8-10 fps

# Shadowing

## Shadow softness

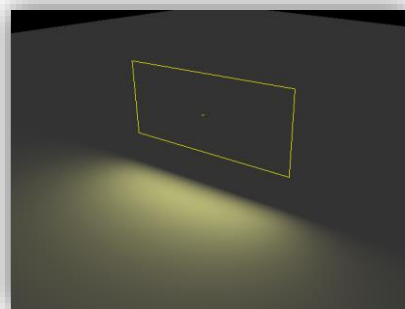
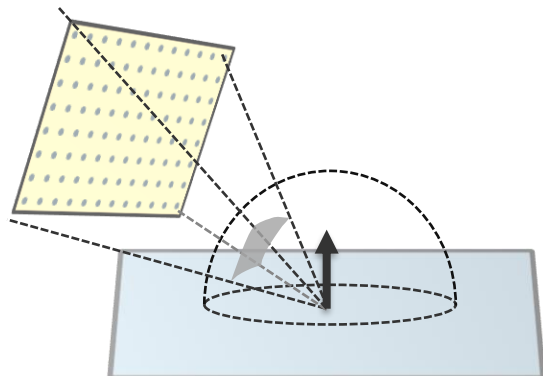
- Support for Mental Ray shadow softness
  - Shadow map sampling approach
- Uses a variable number of samples
  - Take advantage of hierarchical Poisson-disk distributions [McCool92]
- Rotation of the sampling kernel different for each fragment
  - Use of pseudo-random rotation seed given fragment's screen position
  - Avoid banding and repeating patterns



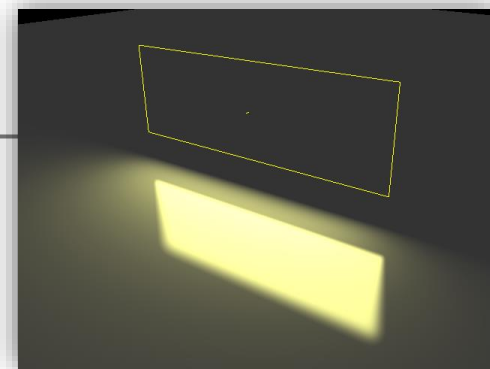
# Area lighting

## Sampling approach

- Use a collection of point light sources



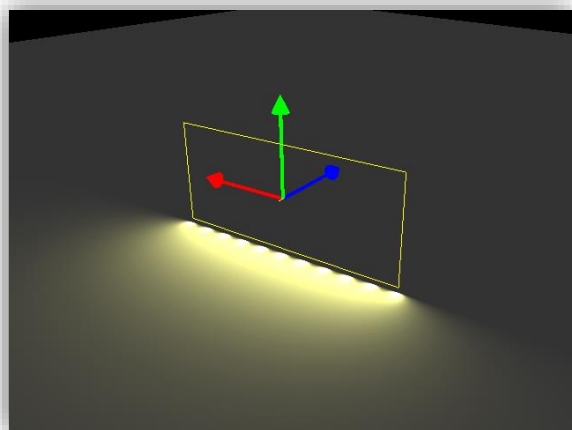
Sampling 11x11



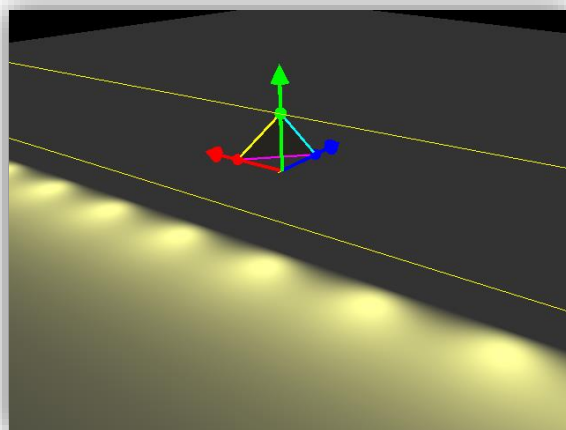
Reference with specular

← Works fine for area lights with reasonable size, not too close to surfaces and mostly diffuse materials

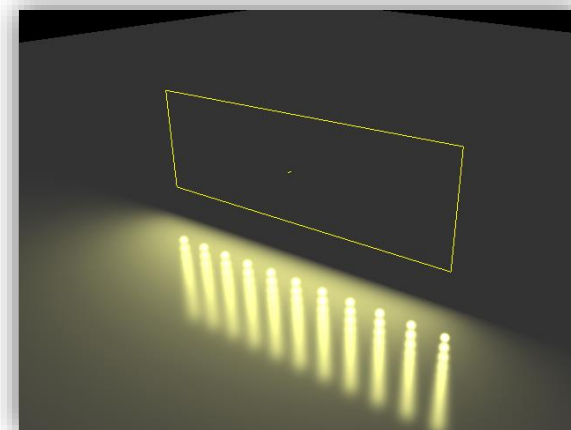
- Fails in most cases, requires more samples, not affordable !



Too close



Too large



Too specular

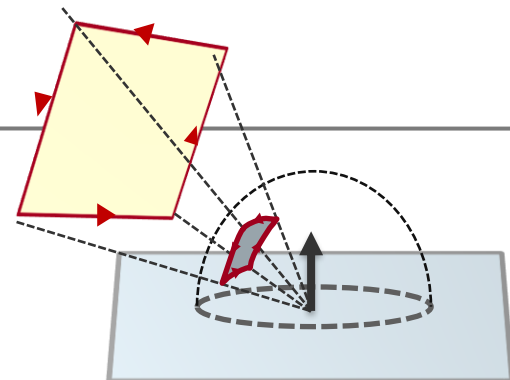
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# Area lighting

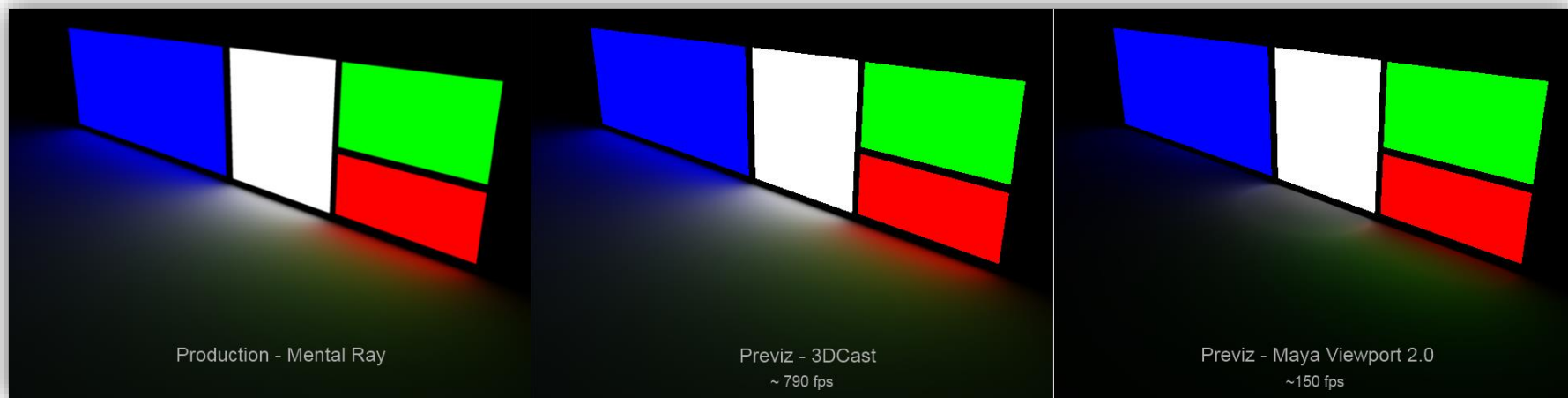
## Analytic approach: contour integral

- Stokes theorem
  - surface integral equivalent to contour integral
- Accurate: no more sampling!
- Constant time evaluation
- Real-time



$$\oint_{\partial S} \mathbf{F} \cdot d\mathbf{s} = \iint_S \nabla \times \mathbf{F} \cdot d\mathbf{s}$$

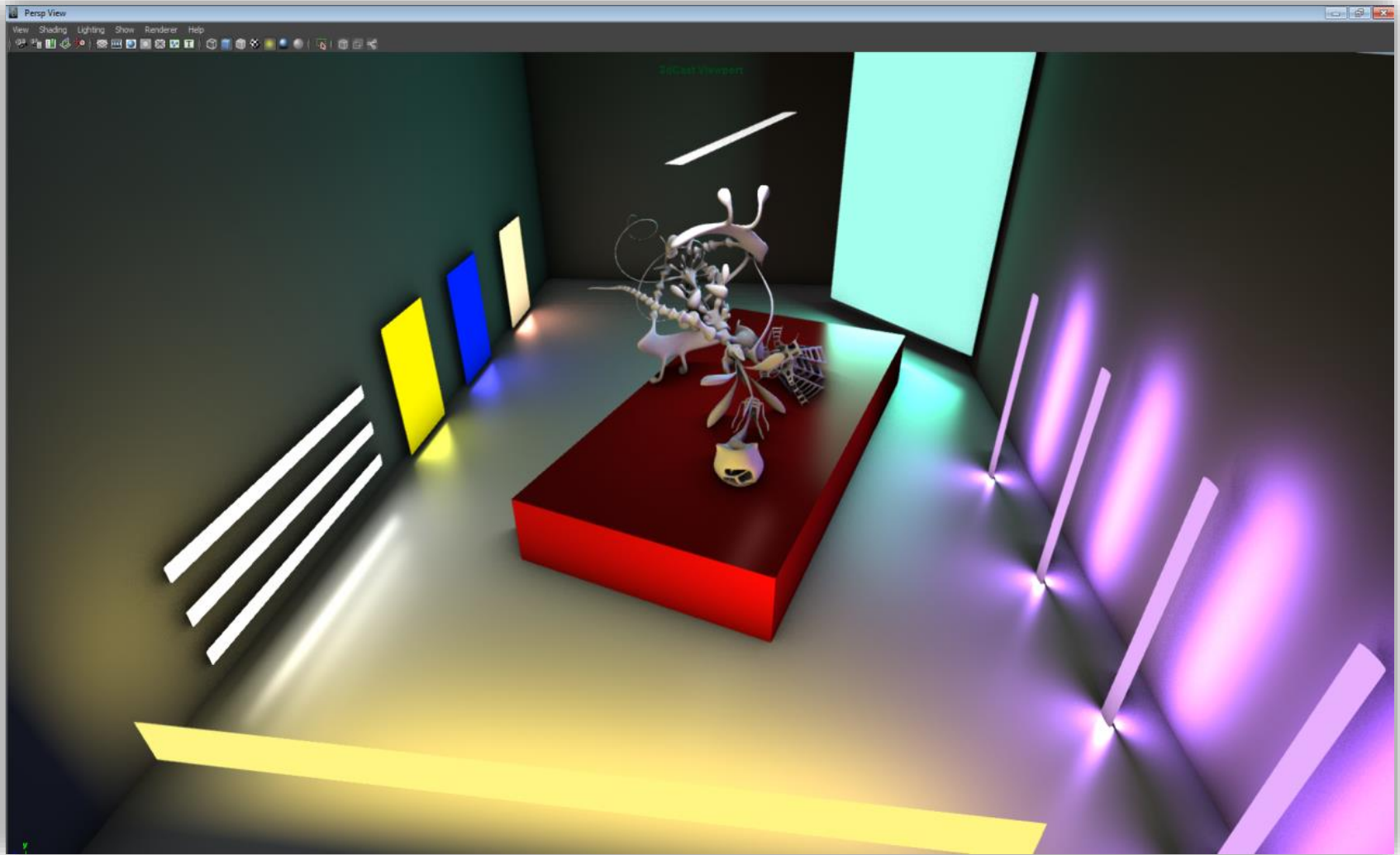
Derivations for diffuse and specular area lighting from [Arvo94][Arvo95]



[Arvo94] Arvo, James, "The Irradiance Jacobian for Partially Occluded Polyhedral Sources," Siggraph 94, pp. 343-350.

[Arvo95] Arvo, James, "Applications of Irradiance Tensors to the Simulation of Non-Lambertian Phenomena," Siggraph 95, pp. 335-342.

# Area lighting



12 area lights @720p - Diffuse  $\approx$  40 fps - Specular  $\approx$  20 fps

# Post-processing

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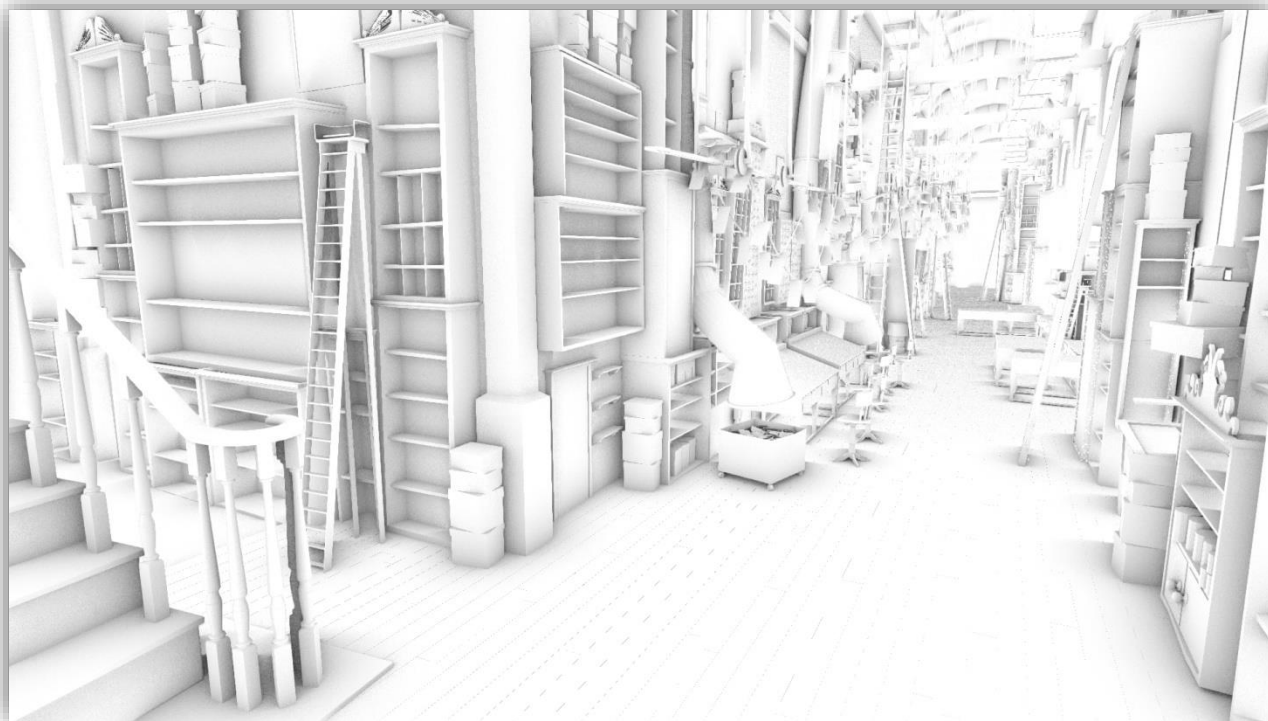


# Screen-space ambient occlusion (AO)

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Widely used in production shots

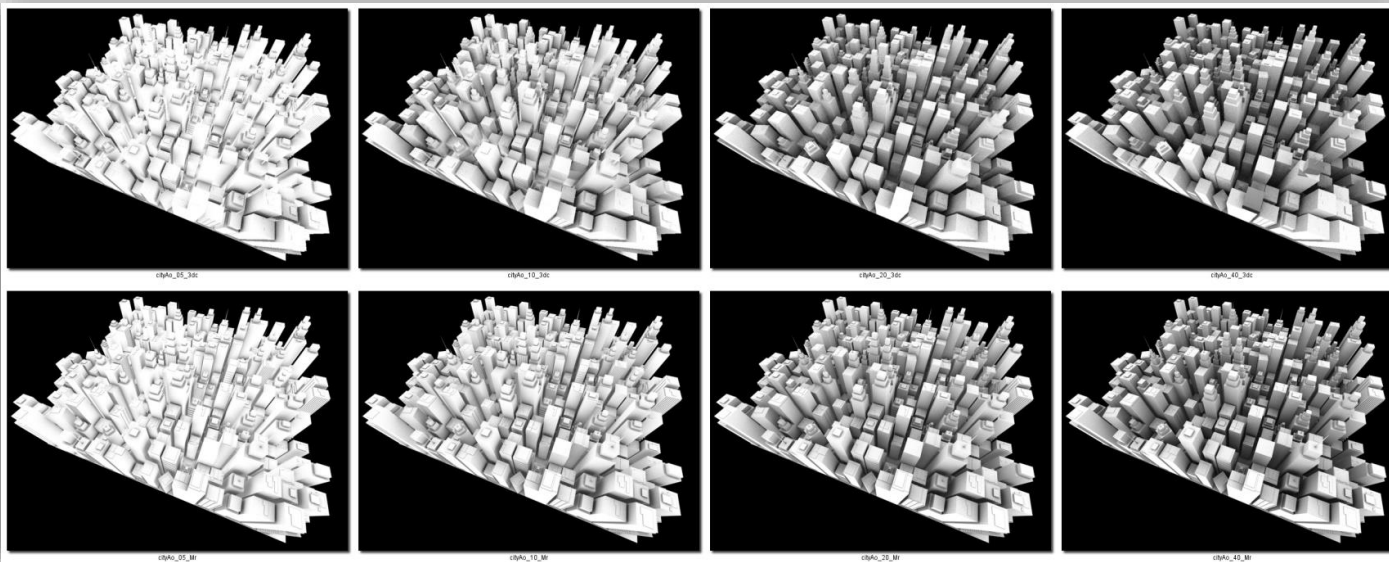
- Simulates shadows cast by omni-directional incoming light
  - e.g. overcast outdoor, indirect lighting
- Widely used in games in approximated or baked forms to add realism
- Need for interactive solution mapping ray-traced AO



# Screen-space ambient occlusion (AO)

## Interactive solution

- Using Ray-marched ambient occlusion [Sourimant11]
  - Screen-space approximation (computed in depth space, following normal)
  - Based on Poisson-disk sampling (see shadow softness slides)
  - Adaptive ray-marching (accounting for perspective projection)
- Parameterization close to ray-traced AO
  - Acts as previz tool for production AO passes



Ray-marched SSAO  
(interactive)

Ray-traced AO  
(offline)

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# Conclusion

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# Conclusion

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## Added value

- Integrated within standard tools, flexible and simple to use by artists
- Saves hours of rendering on the render farm
- Saves weeks of delay, number of re-takes drastically reduced

## Future works

- Hybrid renderer
  - Hybrid rasterizer / ray-tracer
  - Reflections, refractions, indirect lighting
- Other post-processing effects
  - Depth of field, motion blur, etc.
- Integration of more recent research works
  - Sub-pixel shadow mapping [Lecocq14], etc.

Thanks for your attention!

Time for questions

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# References

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- [McCool92] McCool M., Fiume E., “Hierarchical Poisson disk sampling distributions”, Graphics Interface, 1992.
- [Arvo95] Arvo J., “Applications of Irradiance Tensors to the Simulation of Non-Lambertian Phenomena,” Siggraph 95, pp. 335-342.
- [Arvo94] Arvo J., “The Irradiance Jacobian for Partially Occluded Polyhedral Sources,” Siggraph 94, pp. 343-350.
- [Marvie03] Marvie J-E., Bouatouch K., “Remote Rendering of Massively Textured 3D Scenes Through Progressive Texture Maps”, IASTED’s VIIP, 2003.
- [Sourimant11] Sourimant G., Gautron P., Marvie J-E., “Poisson Disk Ray-Marched Ambient Occlusion”, I3D Posters, 2011.
- [Marvie13] Marvie J-E., Hirtzlin P, Gautron P., “Many Core Event Evaluation”, ACM Siggraph Web3D, 2013.
- [Lecocq14] Lecocq P., Marvie J-E., Sourimant G., Gautron P., “Sub-Pixel Shadow Mapping”, I3D, 2014.