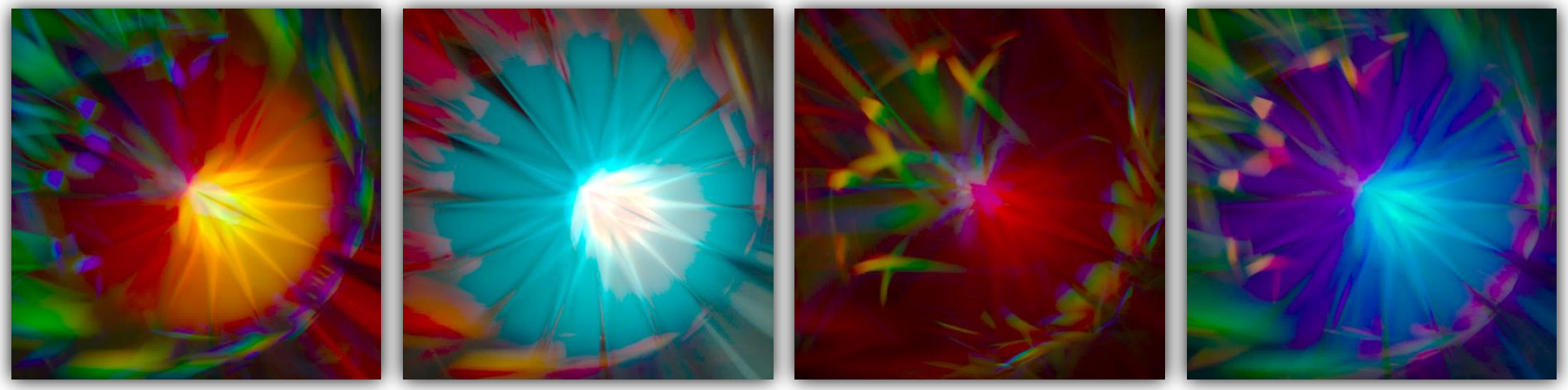

Oskar Elek [1,2,3] Pablo Bauszat [4,1] Tobias Ritschel [1,2,3]

Marcus Magnor [4] Hans-Peter Seidel [1,2,3]

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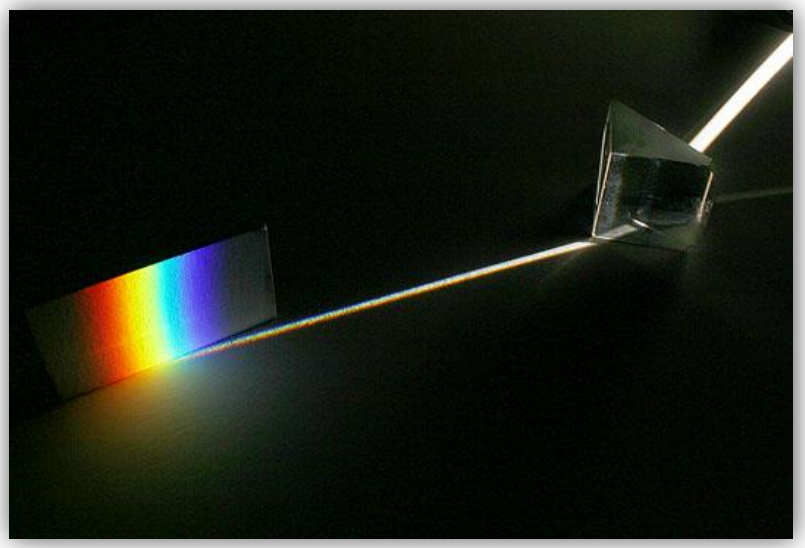
Technische Universität Braunschweig

PROGRESSIVE SPECTRAL RAY DIFFERENTIALS

VMV 2014, October 8-10, Darmstadt, Germany



Credit: Andrew Davidhazy

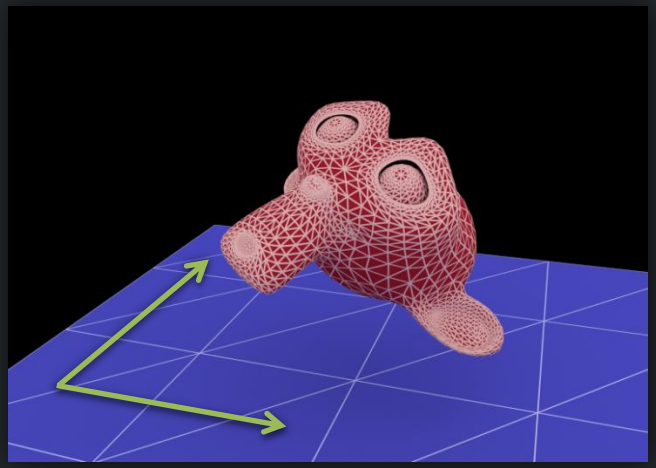
Credit: Peter Kutz

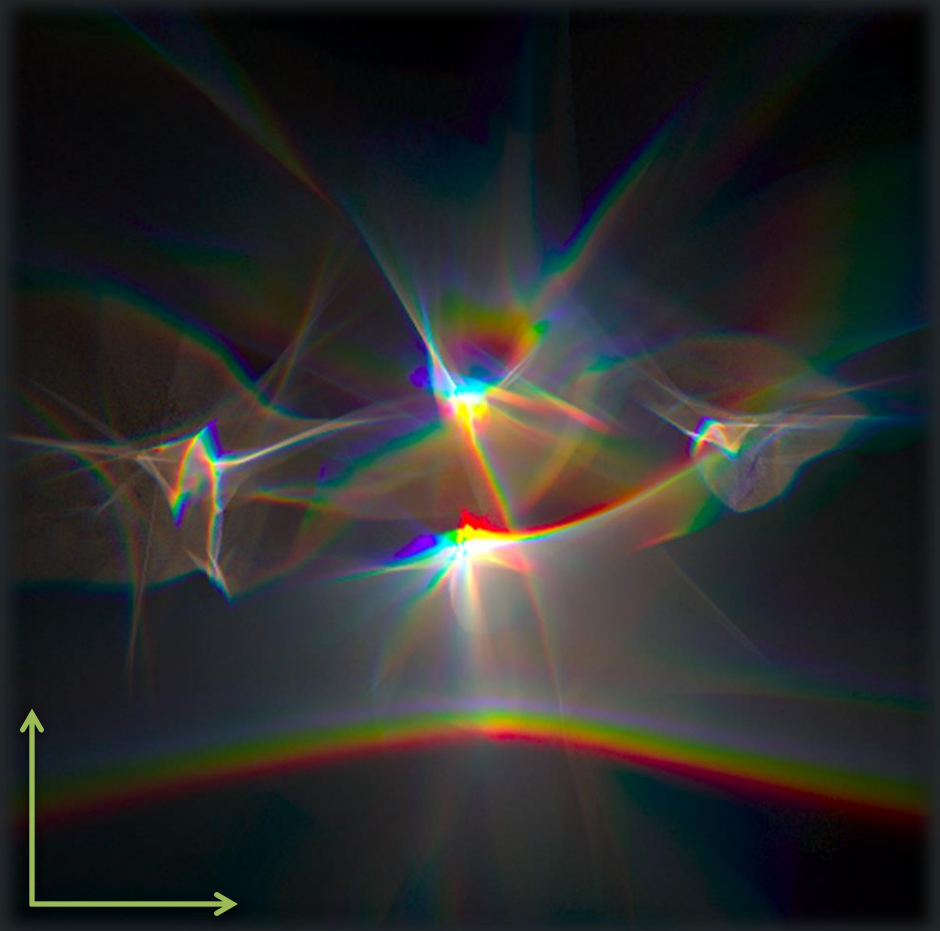
Dispersion

Oskar Elek: Progressive Spectral Ray Differentials

Credit: Bad Mobile Phone Camera ™

Dispersion

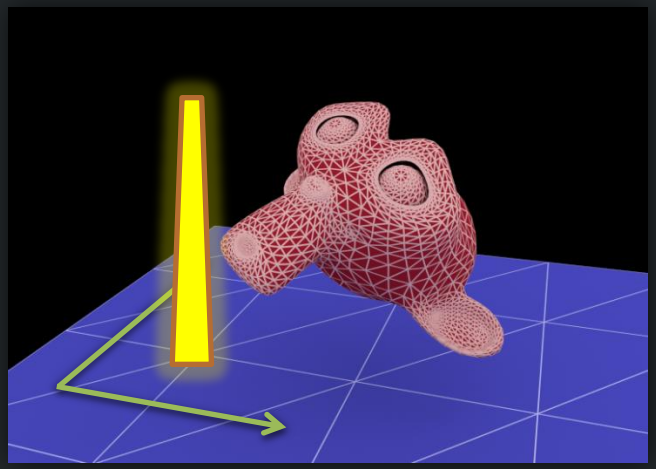


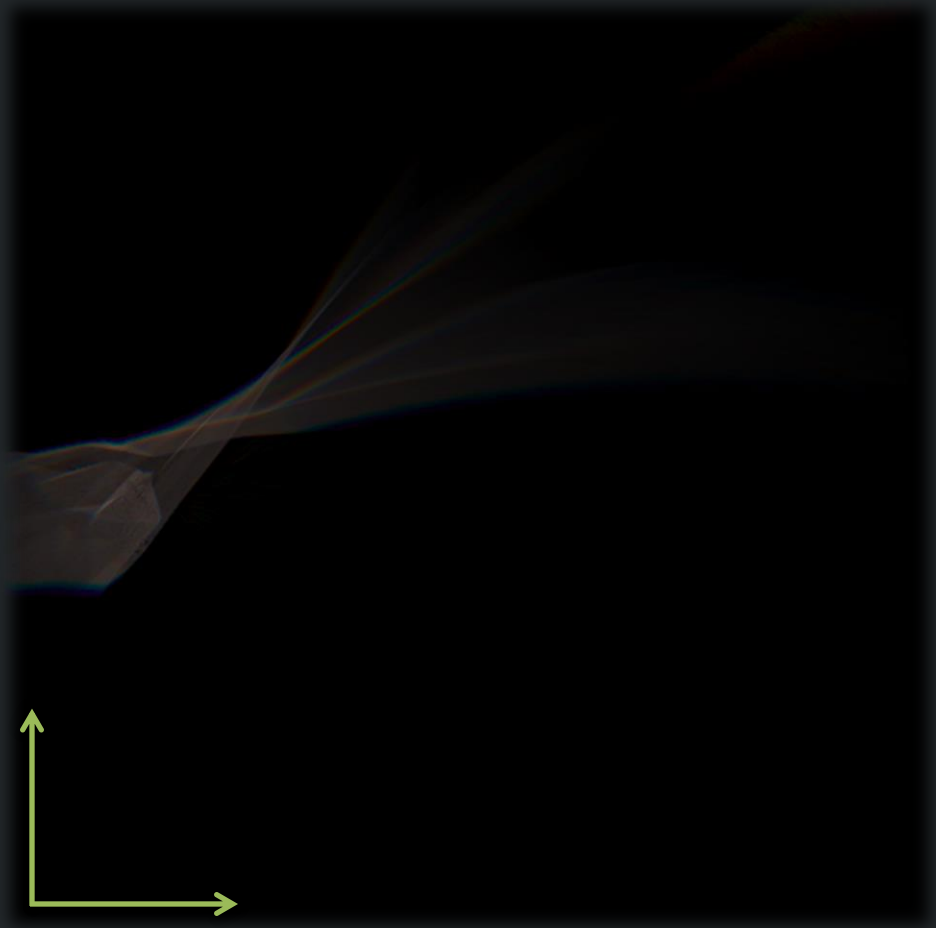


Rendering dispersion

Oskar Elek: Progressive Spectral Ray Differentials

Download “Caustic – Spectral Differentials” from
tinyurl.com/SpectralRayDifferentials if video is missing

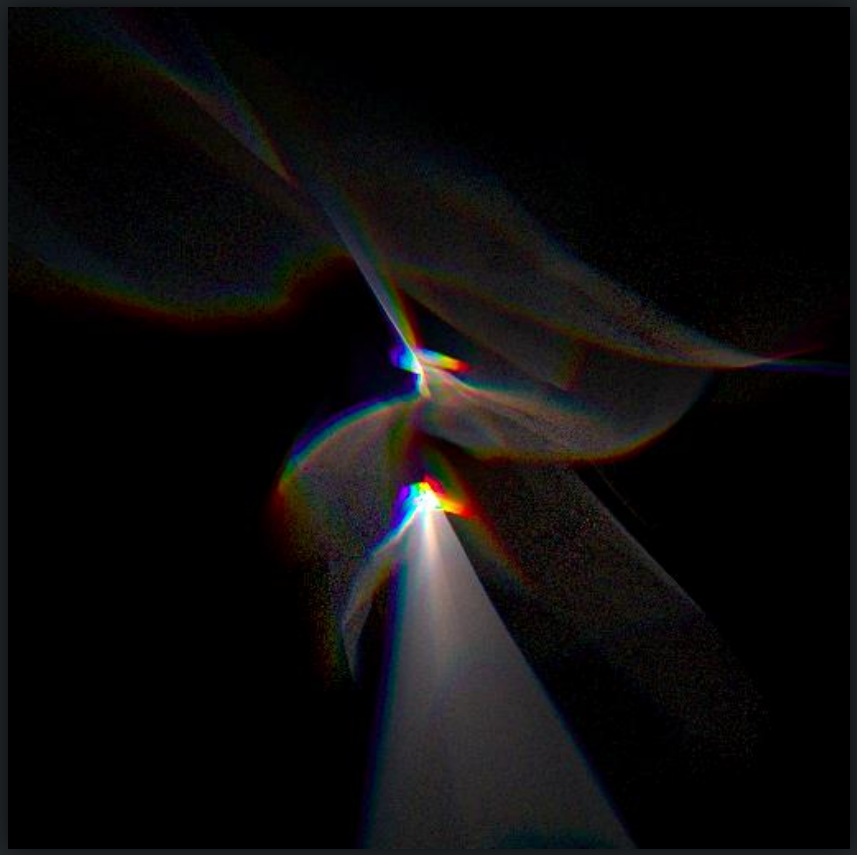




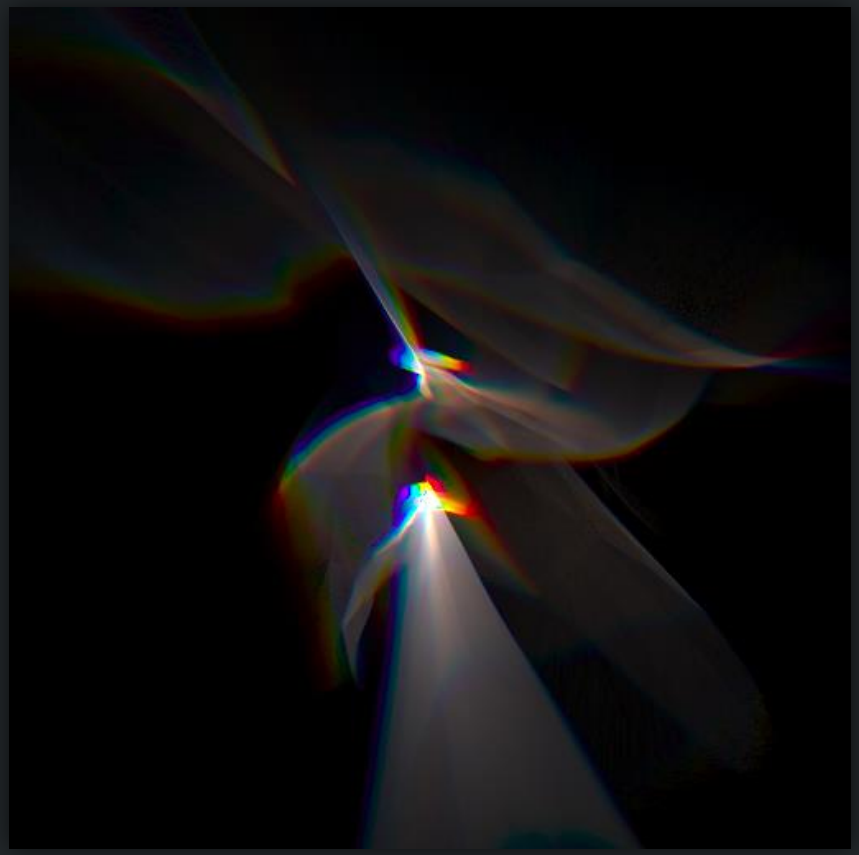
Rendering dispersion

Oskar Elek: Progressive Spectral Ray Differentials

Reference

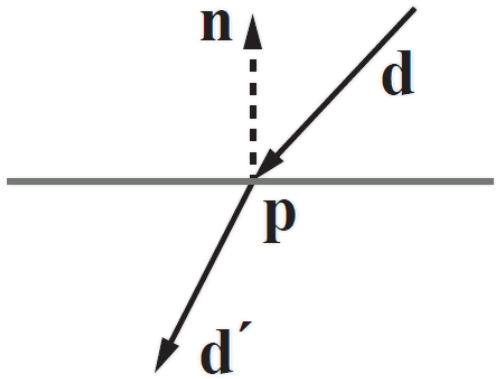


Progressive Spectral Ray Differentials



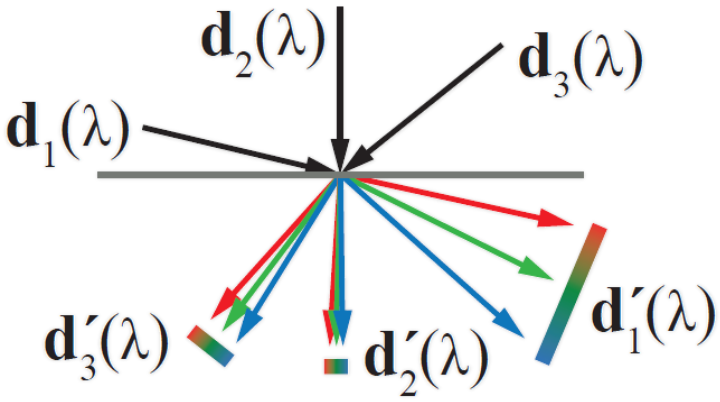
Rendering dispersion

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$



Snell's law

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$



Snell's law

Oskar Elek: Progressive Spectral Ray Differentials

- Introduced by [Elek et al. @ EGSR 2014]
- Extend classic ray differentials – [Igehy 1999], [Suykens & Willems 2001], [Schjoth et al. 2007]…

Spectral ray differentials

Spectral ray differentials

- Introduced by [Elek et al. @ EGSR 2014]
- Extend classic ray differentials – [Igehy 1999], [Suykens & Willems 2001], [Schjoth et al. 2007]…

$$\mathbf{R}(\lambda) = (\mathbf{p}, \mathbf{d})$$

SRD: $\left(\frac{\partial \mathbf{p}}{\partial \lambda}, \frac{\partial \mathbf{d}}{\partial \lambda} \right)$

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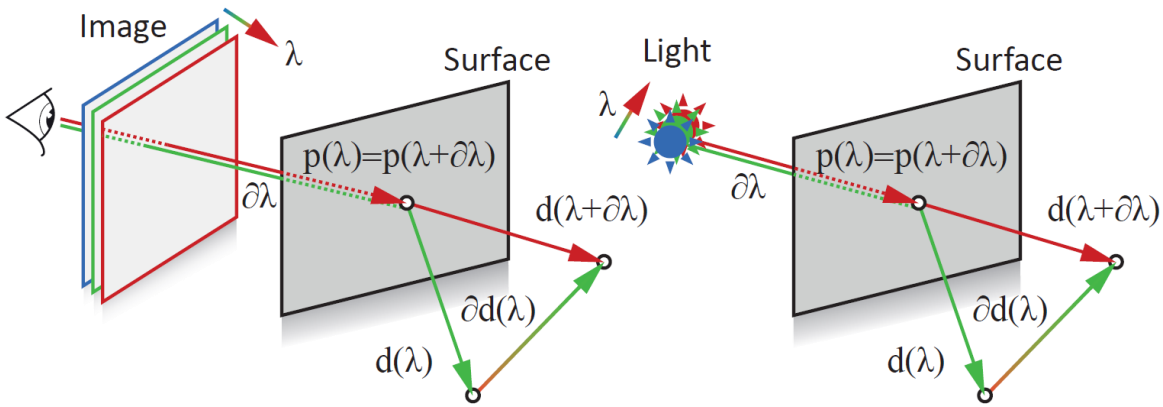

Spectral ray differentials

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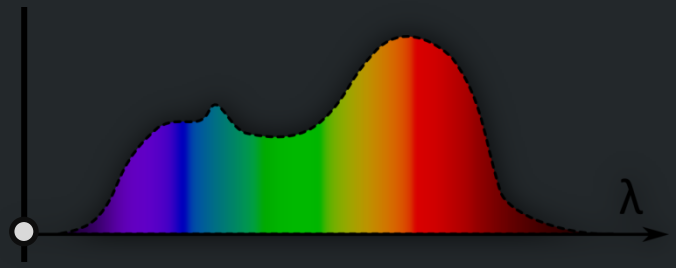
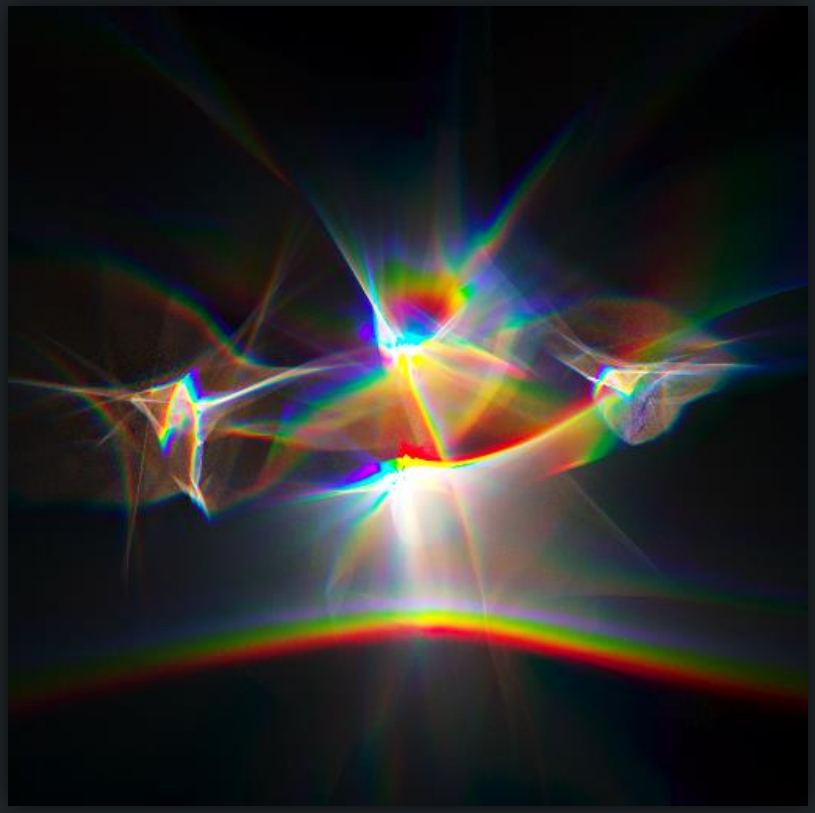
$$\mathbf{R}(\lambda) = (\mathbf{p}, \mathbf{d})$$

SRD: $\left(\frac{\partial \mathbf{p}}{\partial \lambda}, \frac{\partial \mathbf{d}}{\partial \lambda} \right)$

```
vec3 ∂n = normalDifferential(∂p);
float θ = dot(d, n);
float ω = sqrt(1 - sqr(η) + sqr(η)*sqr(θ));
float μ = η*θ + ω;
float ∂η = etaDifferential(η);
float ∂t = dot(∂d, n) + dot(d, ∂n);
float ∂O = (-η*∂η + η*∂η*sqr(θ) + sqr(η)*θ*∂t)/ω;
float ∂μ = ∂η*θ + η*∂t + ∂O;
return ∂η*d + η*∂d - ∂μ*n - μ*∂n;
```

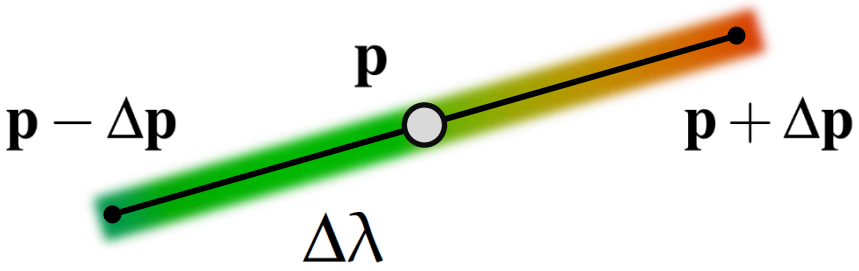




Spectral ray differentials

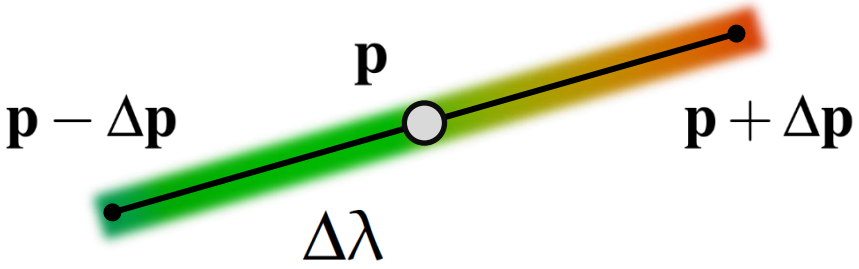
Oskar Elek: Progressive Spectral Ray Differentials

$$\mathbf{R}(\lambda + \Delta\lambda) - \mathbf{R}(\lambda) \approx \Delta\lambda \frac{\partial \mathbf{R}(\lambda)}{\partial \lambda}$$



Application of SRD

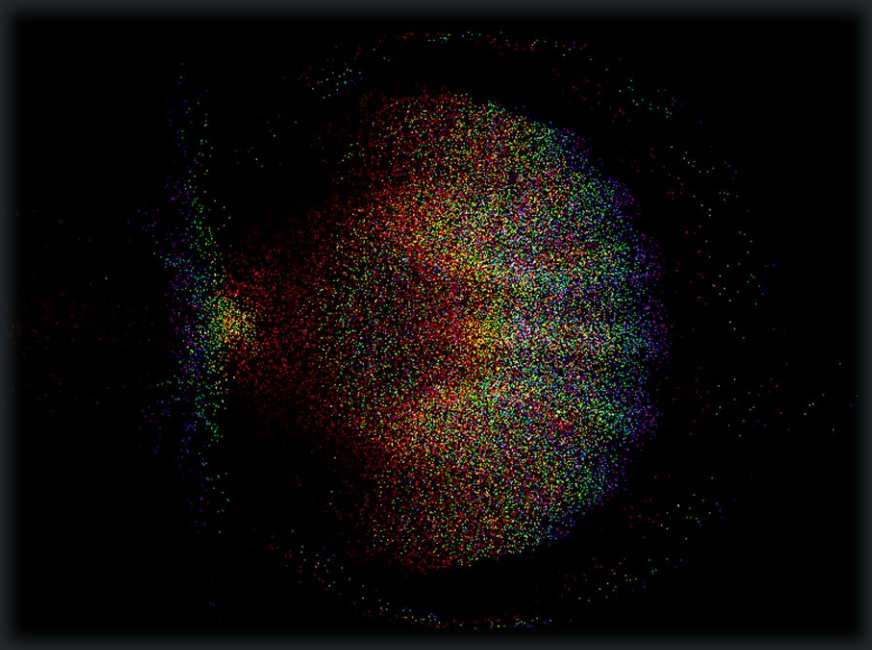
$$\mathbf{R}(\lambda+\Delta\lambda)-\mathbf{R}(\lambda)\approx\Delta\lambda\frac{\partial\mathbf{R}(\lambda)}{\partial\lambda}$$



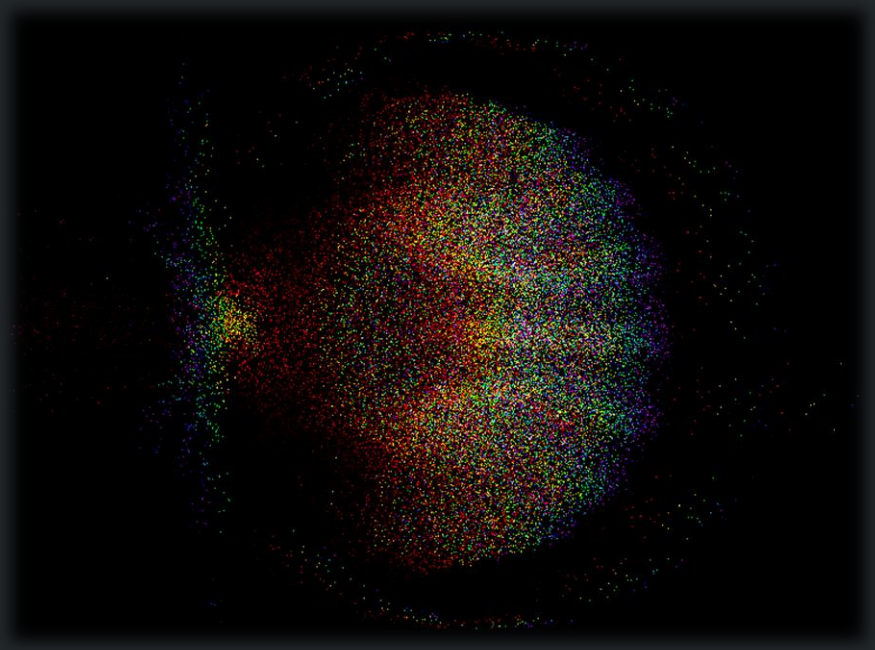
Application of SRD

Download “Basic MC convergence (pass)” and “(accumulated)” from tinyurl.com/SpectralRayDifferentials if videos are missing

i^{th} pass



Accumulated



0 → 500

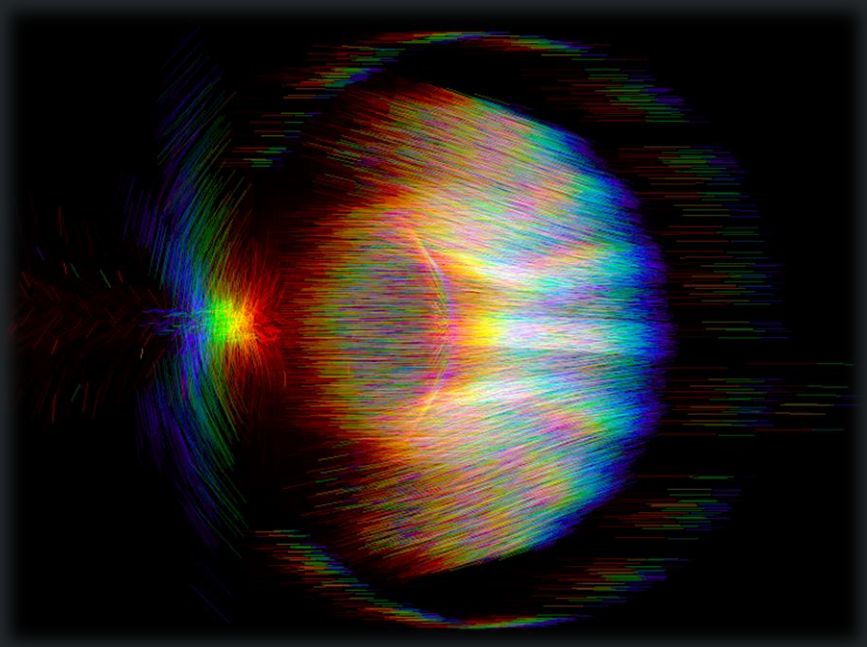
#passes

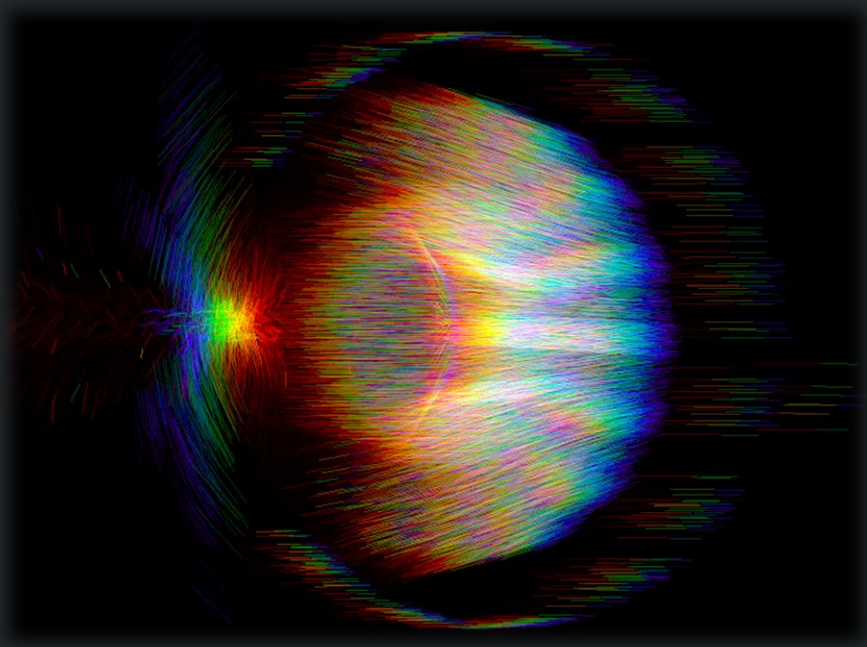
Progressiveness in MC

Download “SRD convergence (pass)” and “(accumulated)” from tinyurl.com/SpectralRayDifferentials if videos are missing

i^{th} pass

Accumulated



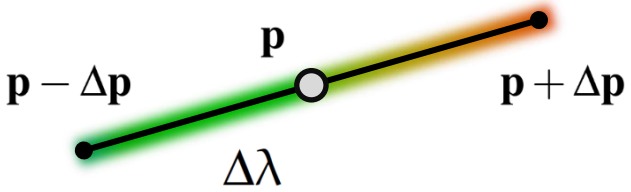


0 → 500

#passes

Basic SRD

$$\mathbf{R}(\lambda+\Delta\lambda)-\mathbf{R}(\lambda)\approx\Delta\lambda\frac{\partial\mathbf{R}(\lambda)}{\partial\lambda}$$



$$\alpha\in[0,1]$$

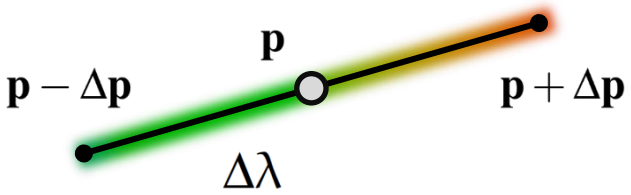
$$\frac{\Delta\lambda_{i+1}}{\Delta\lambda_i}=\frac{\mathrm{Var}[\epsilon_i]}{\mathrm{Var}[\epsilon_{i+1}]}=\frac{i+\alpha}{i+1}$$

- Probabilistic framework developed by [Knaus & Zwicker 2011] and [Jarosz et al. 2011]

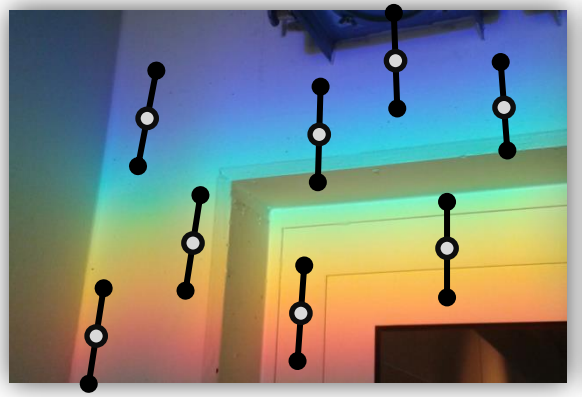
Progressive SRD

$$\mathbf{R}(\lambda+\Delta\lambda)-\mathbf{R}(\lambda)\approx\Delta\lambda\frac{\partial\mathbf{R}(\lambda)}{\partial\lambda}$$

$$\alpha\in[0,1]$$



$$\frac{\Delta\lambda_{i+1}}{\Delta\lambda_i}=\frac{\mathrm{Var}[\epsilon_i]}{\mathrm{Var}[\epsilon_{i+1}]}=\frac{i+\alpha}{i+1}$$



Pass i_1

Pass i_2

Pass i_3

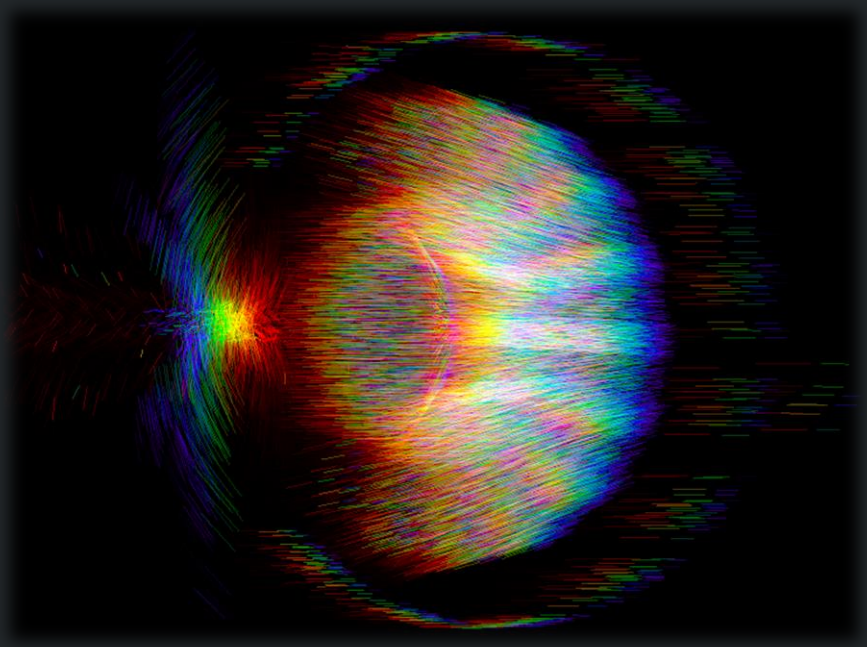
Progressive SRD

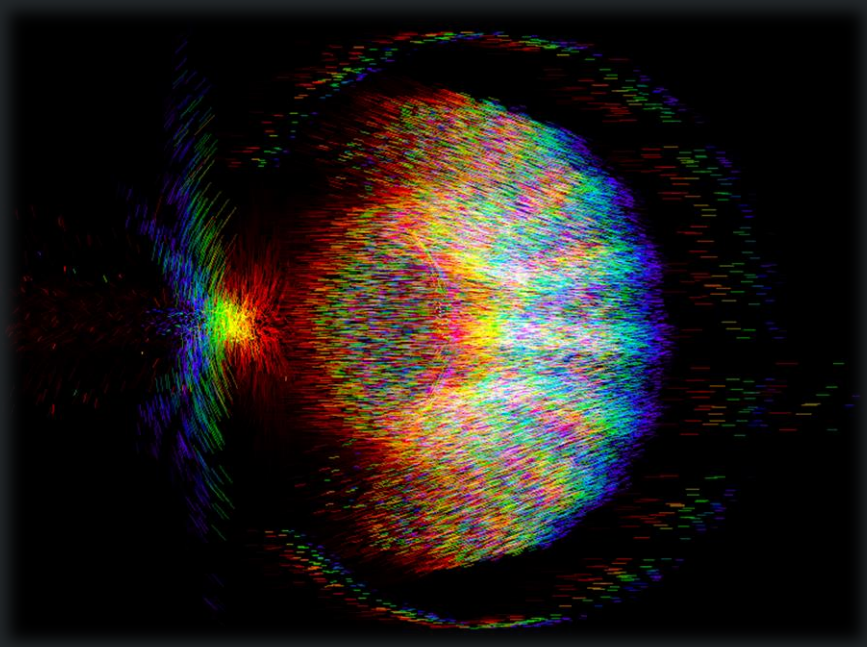
Oskar Elek: Progressive Spectral Ray Differentials

Download “PSRD convergence (pass)” and “(accumulated)” from tinyurl.com/SpectralRayDifferentials if videos are missing

ith pass

Accumulated





0 → 500

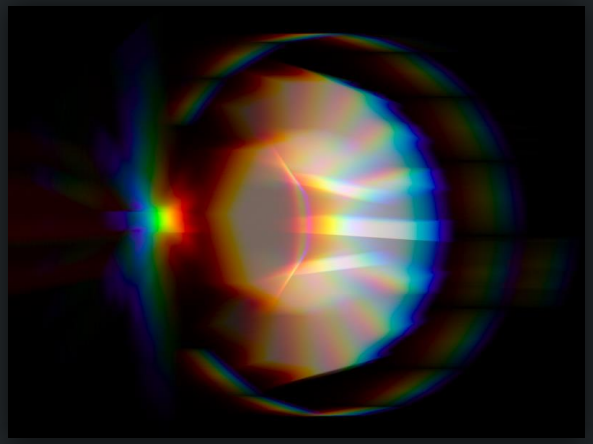
#passes

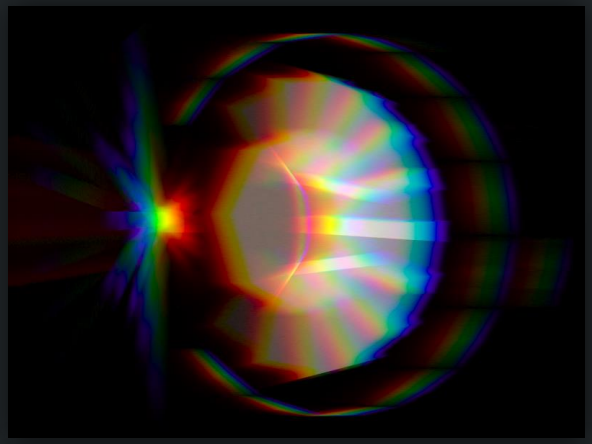
Progressive SRD

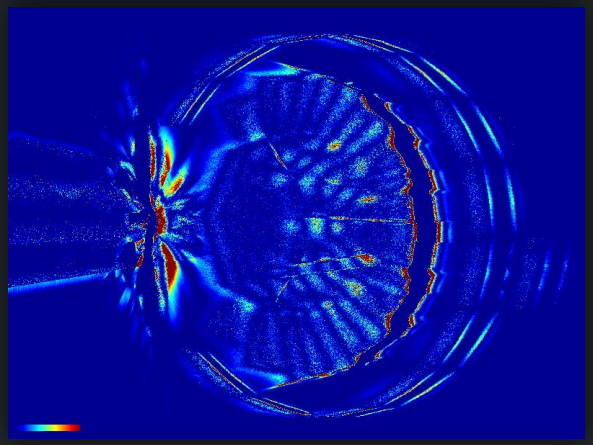
Oskar Elek: Progressive Spectral Ray Differentials

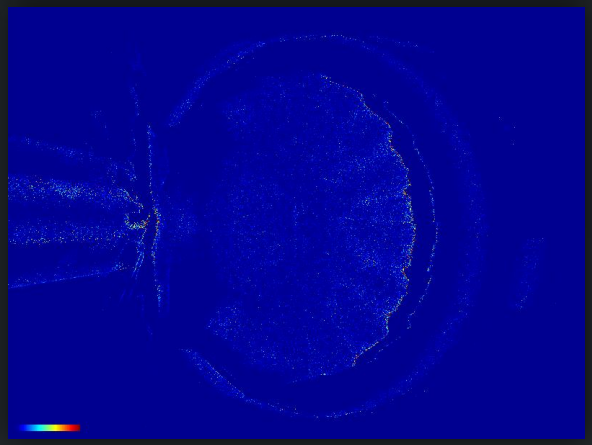
SRD (2k passes)

PSRD (2k passes)

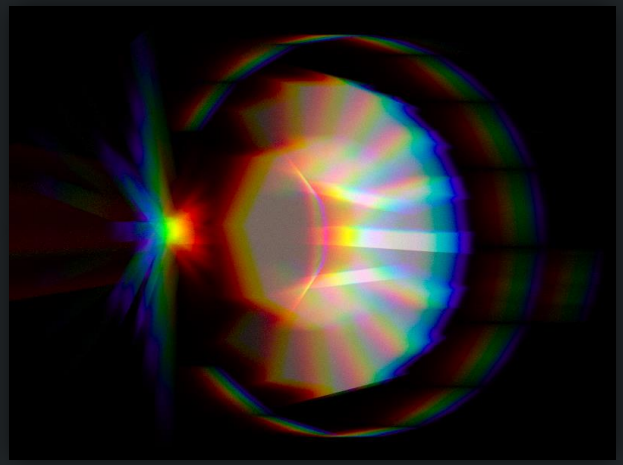






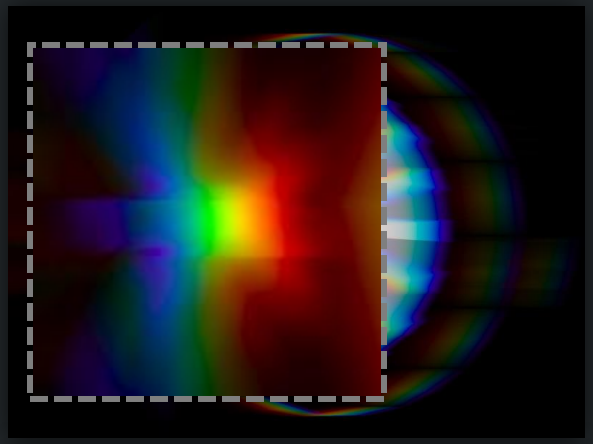


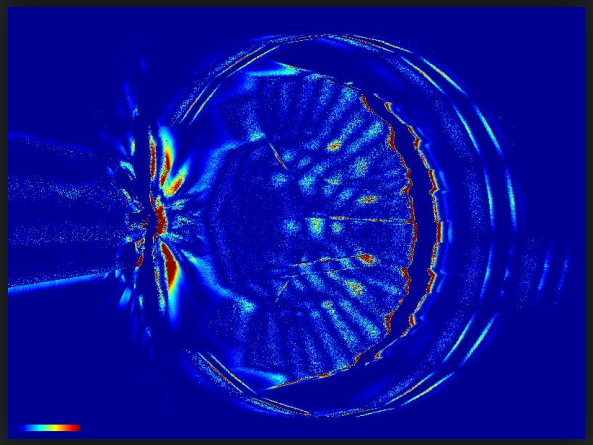
Reference (20k passes)



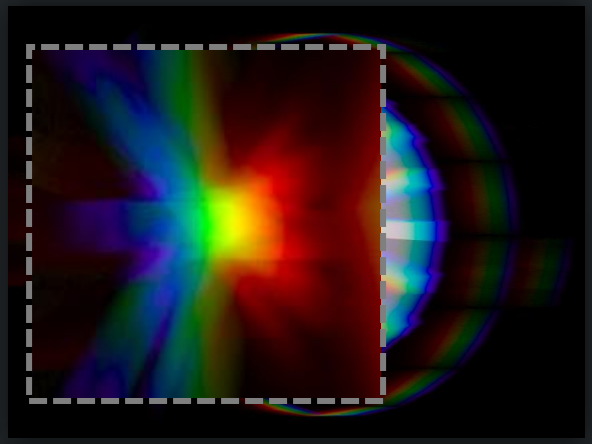
SRD versus PSRD

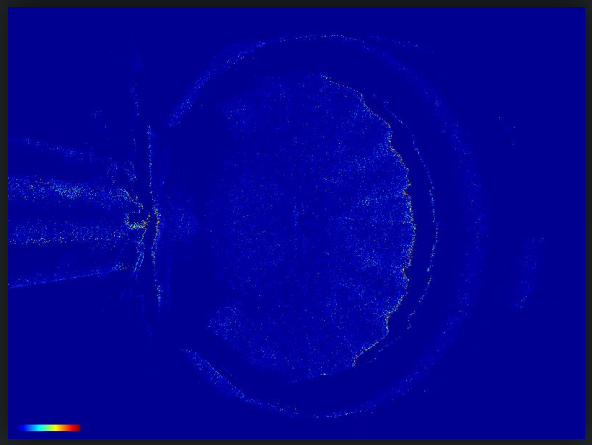
SRD (2k passes)



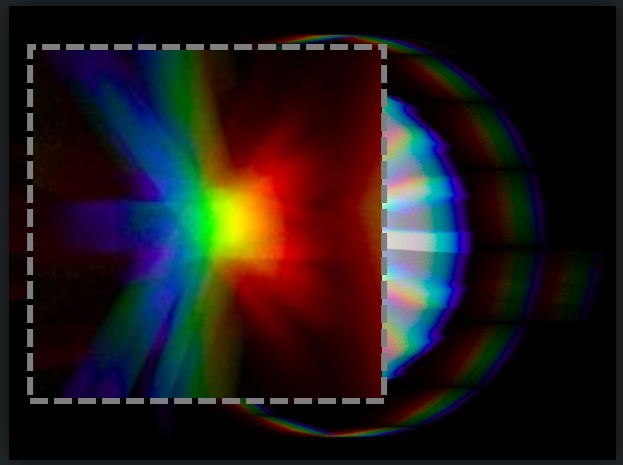


PSRD (2k passes)

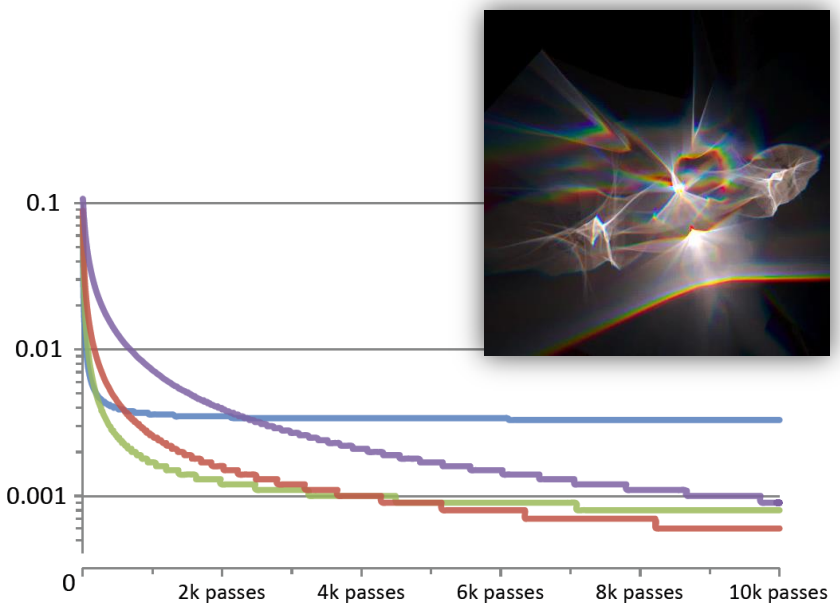


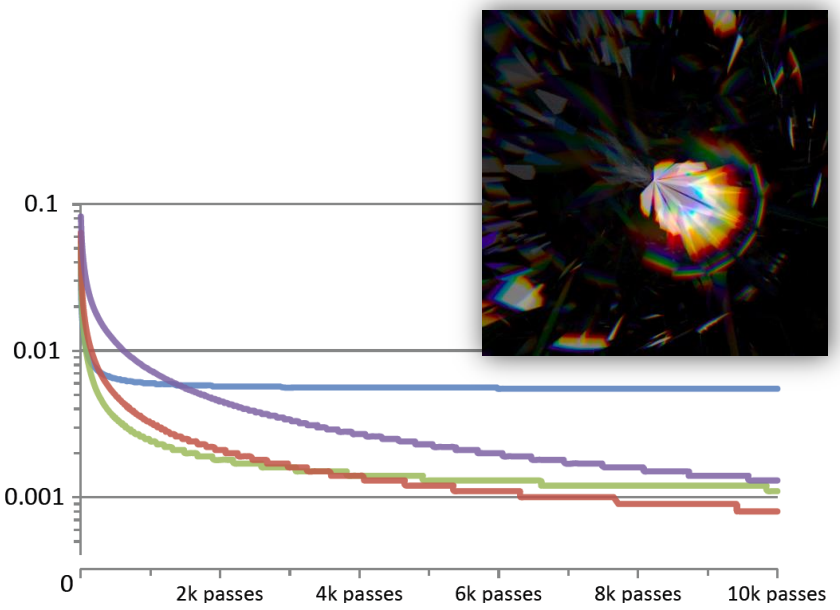


Reference (20k passes)



SRD versus PSRD





SRD PSRD (α = 0.8) PSRD (α = 0.9) PSRD (α = 0.95)

Convergence

Progressive Spectral Ray Differentials

Oskar Elek [1,2,3] Tobias Ritschel [1,2,3] Pablo Bauszat [4]

Marcus Magnor [4] Hans-Peter Seidel [1,3]

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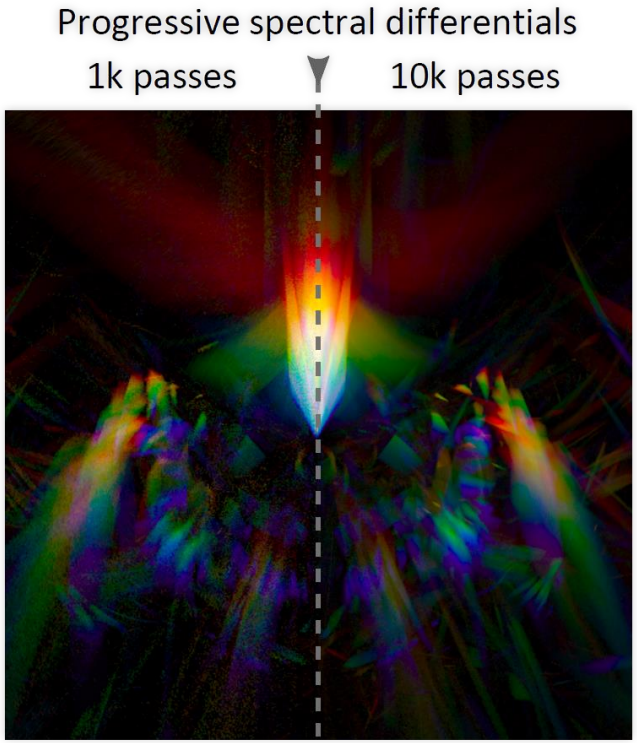

Thanks

- Antti Oulasvirta, Oliver Klehm, Alexander Wilkie, Karol Myszkowski
- Anonymous reviewers

More info

- tinyurl.com/**SpectralRayDifferentials**