LJK · EDP TEAM · AT THE LAB SINCE 2015

Jean-Baptiste Keck

Research engineer: I make numerical methods run fast, and GPUs run hot.

2015

PhD at LJK with C. Picard and G.-H. Cottet, fluid mechanics on GPU

High Perf. computing

performance portability code generation

2020

Postdoc / Research engineer at LJK, optics with B. Thibert

GPU computing

OpenCL
CUDA
SYCL

2024

Inria Startup Studio, project RayMapr

Distributed computing

MPI
multi-GPU

2026

Bourse French Tech Lab (BFT, Bpifrance)

Numerical simulation

remeshed particles
operator splitting
spectral · FD · FE

2027

RayMapr spin-off (hopefully)

Differentiable ray tracing

freeform optics
optimal transport
optimization

PHD 2015-2019 · JEAN-BAPTISTE KECK

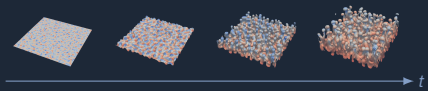
Sediment flows at high Schmidt number

Particles settling above salt water: double-diffusive fingering.

$$\partial_t \theta + (u \cdot \nabla)\theta = \frac{1}{Sc}\,\Delta\theta, \qquad Sc = \frac{\nu}{\kappa} \gg 1$$

Scalar grid: $Sc^{3/2}$ times more points.

remeshed particles · GPU · HySoP



with G.-H. Cottet, I. Mortazavi, C. Picard



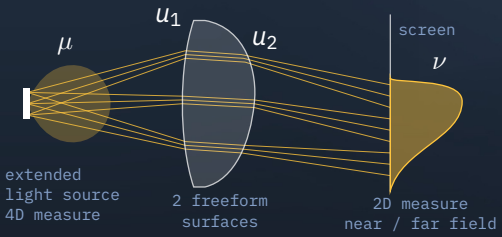
512^3

grid points, on GPU

SINCE 2020 · WITH B. THIBERT & Q. MÉRIGOT

Inverse optics by optimal transport

Find the lens (u_1, u_2) redirecting an extended light source μ onto a target ν.



Goal: find u_1, u_2 such that $(T_{u_1,u_2})_{\#}\,\mu \approx \nu$

$\mu \in \mathcal{M}(\mathbb{R}^2 \times \mathbb{S}^2)$, $\nu \in \mathcal{M}(\mathbb{R}^2)$ or $\mathcal{M}(\mathbb{S}^2)$ 4D → 2D: no diffeomorphism :(

(we also make nice Blender renders)



RayMapr
TAMING LIGHT ENERGY
raymapr.com

SIMPLER 2D → 2D CASES ¯_(ツ)_/¯

When the source is 2D (point or collimated), the ray map is invertible in single surface configurations: $T_{\#}\,\mu = \nu$ is a Jacobian equation on the surface u.

FAR FIELD

Optimal transport

$$\min_{T_{\#}\mu=\nu} \int c(x, T(x))\, d\mu(x)$$

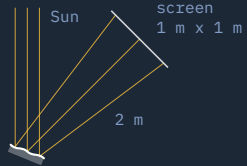
reflector: $c(x, y) = -\log(1 - \langle x, y\rangle)$
semi-discrete: Laguerre cells, damped Newton

NEAR FIELD

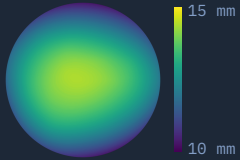
Generated Jacobian equation

$$\det DT(x, u, \nabla u) = \frac{\mu(x)}{\nu\big(T(x, u, \nabla u)\big)}$$

Monge-Ampère type
no cost function: it depends on u



freeform mirror
D 150 mm (drawn 3x)



mirror height map


its curvature


target


simulation, 10^9 rays